# Aviation Safety Investigation Report 199402661

## Piper Aircraft Corp
## Navajo

## 19 September 1994

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# Aviation Safety Investigation Report

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**Occurrence Number:** 199402661 **Occurrence Type:** Accident
**Location:** 1km E Moorabbin, Aerodrome
**State:** VIC **Inv Category:** 3
**Date:** Monday 19 September 1994
**Time:** 1226 hours **Time Zone** EST
**Highest Injury Level:** Serious
**Injuries:**

| | Fatal | Serious | Minor | None | Total |
|---|---|---|---|---|---|
| Crew | 0 | 1 | 0 | 0 | 1 |
| Ground | 0 | 0 | 0 | 0 | 0 |
| Passenger | 0 | 1 | 3 | 0 | 4 |
| **Total** | **0** | **2** | **3** | **0** | **5** |

**Aircraft Manufacturer:** Piper Aircraft Corp
**Aircraft Model:** PA-31
**Aircraft Registration:** VH-NNN **Serial Number:** 31-8112038
**Type of Operation:** Non-commercial Pleasure/Travel
**Damage to Aircraft:** Substantial
**Departure Point:** Cooma NSW
**Departure Time:** 1027 EST
**Destination:** Moorabbin VIC

**Crew Details:**

| Role | Class of Licence | Hours on Type | Hours Total |
|---|---|---|---|
| Pilot-In-Command | Commercial | 24.7 | 1096 |

**Approved for Release:** Thursday, August 8, 1996

FACTUAL INFORMATION

History of the flight

Before departing Moorabbin for Cooma on 17 September 1994, the aircraft's main fuel tanks were filled with aviation gasoline (AVGAS) and 50 litres were added to each auxiliary tank, providing at least 515 litres total fuel on board. The auxiliary fuel tank gauges had indicated near empty before the addition of the fuel. The pilot assessed from the gauge readings that the tanks had contained a small quantity prior to refuelling and that the total fuel load was 550 litres.

The flight time to Cooma was 70 minutes. Fuel was used from the main tanks for the departure, climb, descent and arrival phases of the flight, and the auxiliary tanks were selected for the cruise. The pilot calculated the quantity of fuel used on the flight at the rate of 130 litres/hour, flight time. He estimated that 385 litres remained for the return flight to Moorabbin, which was planned for the evening of 18 September. His planned time intervals to Moorabbin, totalling 89 minutes, were calculated using a forecast wind of 250 degrees T at 30 kt. The flight plan fuel calculations allowed 15 litres for taxi, 15 % variable reserve, 15 minutes for an alternate, although no alternate was nominated, and 45 minutes fixed reserve. Flight fuel was again calculated at 130 litres/hour. The plan indicated that the fuel required, including these allowances, was 385 litres. Late in the evening the pilot prepared the aircraft for departure, but experienced difficulty when attempting to start the left engine. Unable to correct the problem, he deferred the flight until the next day.

The following morning the pilot obtained the forecast en route winds up to 10,000 ft, and the Moorabbin terminal aerodrome forecast (TAF). The forecast wind at 10,000 ft was 230 degrees T at 50 kt. The Moorabbin TAF included intermittent periods with wind gusts to 48 kt, 4,000 m visibility, 5 octas of cloud at 1,200 ft and hail showers. No other information was requested or given. The forecast required that the pilot allow for 30 minutes holding and the much stronger head winds indicated that the en route time would be significantly extended. However, without making any changes, the pilot re-activated his flight plan from the previous night.

Having obtained advice from the aircraft operator the pilot was able to start both engines without further difficulty, and departed Cooma on climb to cruise at 10,000 ft. Other than during cruise when the right auxiliary fuel tank was selected to the right engine for about 10 minutes, the flight was conducted on the main tanks. The left auxiliary tank gauge was indicating almost empty.

The pilot extended his estimated time intervals when strong headwinds were encountered during cruise. At about Eildon Weir he requested the actual weather at Moorabbin and was advised that the sky was clear. He assessed that the remaining fuel was sufficient and elected to continue. The Moorabbin Automatic Terminal Information Service (ATIS) information Tango indicated that the wind was 170 degrees M at 20 kt to 30 kt, gusting to 45 kt, with a crosswind of up to 10 kt, and 4 octas of cloud at 1,500 ft, with lower patches and showers in the area.

At about 5 km from Moorabbin the left engine surged and failed. The pilot assessed that the problem was fuel related and selected the left auxiliary tank, which restored power to the engine. By this time he had extended the landing gear and lowered 15 degrees of flap. With runway 17L in sight, the pilot continued the approach and selected 25 degrees of flap. The tower controller advised that a squall was approaching the airfield and the pilot recognised that this may nesessitate a go-around. On final approach at about 1.5 km from the aerodrome at a height of about 300 ft to 500 ft, the left engine failed again. The pilot increased power on the right engine, but did not feather the left propeller. He assessed that the aircraft could not reach the runway and altered heading to the left, intending to land on a grassed area of the airport which he considered was within range. The pilot had not told the tower controller of either the engine failure or of his intention to land on the grass. Consequently, on seeing that the aircraft was low and well to the left of the runway, the controller instructed the pilot to go around.

At a very low height of possibly 10 ft to 20 ft, the pilot applied full power to the right engine, and selected the landing gear and flaps up. The airspeed was about 94 kt, the single engine best rate of climb speed. However, with the left propeller windmilling, little altitude was gained and the airspeed decayed below 94 kt. While drifting to the left, the aircraft tracked across the airport in a south-easterly direction towards an industrial estate. The aircraft passed very low over some buildings and with the stall warning sounding, it grazed a roof and collided with two trees before impacting the ground in a steep nose-down attitude.

The pilot and the front-seat passenger were trapped in their seats by the deformation of the forward fuselage and instrument panel. The three other passengers were able to evacuate the aircraft by the main cabin door.

Wreckage examination

The aircraft had tracked about 080 degrees M from the first contact with a factory roof to where it came to rest about 80 m further on. The impact caused substantial disruption of the fuselage nose section and the left wing. Both engines were torn from their mountings.

Less than 1 litre of fuel was obtained from the left main tank. No fuel was found in the left auxiliary tank. Thirty litres were obtained from the right main tank and 8 litres from the right auxiliary tank. The reason for the engine starting difficulty was identified and found to not affect the operation of the engines or the fuel flow at engine power settings above idle. No defects were found that might have contributed to the development of the occurrence.

Performance calculations indicated that at the time of the approach, the aircraft was capable of climbing on one engine. However, this was dependent upon the correct procedures being followed, including feathering the propeller of the inoperative engine. The aircraft loading complied with the requirements of the Flight Manual.

Pilot qualifications and experience

The pilot held a Commercial Pilot Licence with a Multi-engine Command Instrument rating. He also held a Grade 2 Instructor rating with a recently granted approval to conduct multi-engine aircraft training. He had logged a total of about 1,100 hours, including about 150 hours on multi-engine aircraft. The flight to Cooma was intended to further his experience.

The pilot's PA 31 endorsement training was conducted about 6 months before the accident. The training included engine failures after takeoff and single engine approaches during which he had been instructed that the minimum safe altitude from which to conduct a single-engine go-around was 300 ft.

Engine fuel flow management

During the endorsement training, the endorsing pilot cited an example of a PA 31-310 which he knew to have an average or block fuel consumption of 140 litres/hour. Subsequently, the pilot hired VH-NNN from another operator who conducted a check flight with him. The instructor drew the pilot's attention to a placard which had been placed in the aircraft. The placard listed takeoff, climb and cruise power settings. It also gave an exhaust gas temperature (EGT) setting of 1,400 degrees for the cruise. The pilot understood that the owner wanted these settings to be strictly followed. On subsequent flights in VH-NNN the pilot complied with the placarded power settings, including setting the EGT to 1,400 degrees F. The aircraft's engine management instrumentation included electronic digital fuel flow indicators, in addition to the standard fuel flow gauge. However, the pilot was not instructed in the use of the digital indicators.

The PA 31-310 Pilot Operating Handbook provides information on fuel mixture leaning procedures. The handbook indicates that for best economy the mixture should be set at peak EGT, provided 1,650 degrees F is not exceeded. To obtain the best power fuel flow setting, the handbook recommends setting the fuel flow to achieve an EGT of 125 degrees less than peak EGT. The best power fuel flow is considerably greater than that which results from the use of the best economy setting. Consequently, many operators use fuel flow settings between best power and best economy, typically 50 degrees F less than peak EGT.

The setting of 1,400 degrees as placarded, did not necessarily provide the pilot with a reference for peak EGT, which may vary between engines. By not establishing the reference peak EGT, the pilot did not verify the relevance of the 1,400 degree setting to the required fuel flow. The aircraft owner advised that the placard had been fitted for his own reference only.

Following analysis of information from previous flights of VH-NNN, and testing of the left digital fuel flow indicator, the investigation found that the standard fuel flow gauges were not accurate. Fuel consumption was calculated using the digital flow indicators, together with the manufacturer's information on fuel consumption for takeoff, climb and descent. These indicated that the left engine required a total fuel consumption for the flight to Cooma and return to Moorabbin of almost all the fuel in the left main tank and the 50 litres added to the left auxiliary tank. However, the fuel flow achieved by setting the mixture control to 1,400 degrees EGT was higher than would have occurred using the best power setting.

By not establishing the fuel quantity on board prior to takeoff from Cooma, the pilot was unable to confirm the fuel consumption rate for the engine settings used, and the actual fuel available for the return flight. However, he was confident that the aircraft contained sufficient fuel for the flight. His decision to not add fuel at Cooma was also influenced by his concern for better aircraft performance in the event of an engine failure.

Final flight path

Airport tower personnel reported that the aircraft initially appeared to be established on final for runway 17L. However, it then became apparent that the aircraft had deviated to the left of the extended runway centreline. The deviation to the left continued after the pilot was instructed to go around. The flight path carried the aircraft past the threshold of runway 17L in a shallow arc, briefly paralleling runway 13L, before crossing the aerodrome eastern boundary.

The difference in distance to run between the grass area nominated by the pilot, and the threshold of runway 17L, was found to be minimal.

## ANALYSIS

Appropriate pilot decision making and adherence to established procedures are vital to the effectiveness of the response to an emergency situation. The circumstances of this occurrence did not reflect a standard of operational practice and decision-making consistent with the qualifications held by the pilot. This is apparent both in his flight fuel management, and in his response to the resulting asymmetric condition.

### Fuel management

The pilot's fuel management relied on assumptions of fuel flow rates, placing an undue reliance on a block fuel consumption rate of 130 litres/hour, and on leaning the mixture to 1,400 degrees EGT. While these parameters may individually be appropriate in other circumstances, he did not verify that they were valid for this flight. By not confirming the aircraft's fuel state at Cooma, the pilot could not have known if sufficient fuel remained, and that his fuel management was appropriate.

Despite the forecast of winds considerably stronger than those for which he had planned, and the requirement to allow for possible holding at Moorabbin, the pilot did not reassess his fuel requirements or use a more appropriate engine management technique. He recognised that the initial failure of the left engine was due to fuel exhaustion and that the left auxiliary tank, which he then selected, contained little fuel. However, he did not appear to realise that a further failure of either or both engines due to fuel exhaustion could be imminent.

### Asymmetric operations

The pilot demonstrated a lack of understanding of the fundamentals of multi-engine aircraft performance. This is evidenced by his not feathering the left propeller, his inability to maintain the aircraft on the runway alignment during approach, and his non-adherence to a decision height.

Following the first failure of the left engine, the pilot did not appear to understand the need to minimise drag and conserve height until assured of a safe landing. Although unable to maintain directional control during the approach, and despite having assessed that the aircraft had insufficient performance to reach the runway threshold, the pilot attempted to go around. Had he recognised the importance of nominating and maintaining a decision height, he would not have attempted to comply with the instruction to go around.

It is likely that the pilot's decision to land on the grass was made as a result of inadequate asymmetric technique rather than inadequate aircraft performance.

## CONCLUSIONS

Findings

1. The pilot was appropriately licenced to conduct the flight.

2. The aircraft weight and balance were within the Flight Manual limitations.

3. The pilot did not allow for the provision of holding fuel and did not replan for the stronger headwinds and the resultant greater total fuel consumption.

4. The pilot did not establish the actual quantity of fuel on board the aircraft prior to departure from Cooma.

5. The aircraft fuel flow gauges provided erroneous readings.

6. The pilot was not familiar with the operation of the digital electronic fuel flow indicators and did not reference them during the flight.

7. The pilot did not establish whether the fuel flow management settings shown on a placard in the aircraft were appropriate to the flight.

8. The left engine failed at a late stage of the landing approach due to fuel exhaustion of the left main and auxiliary tanks.

9. The pilot did not advise the Moorabbin tower controller of the engine failure.

10. The prevailing wind conditions increased the pilot's workload.

11. The tower controller instructed the pilot to go around when, during final approach, the aircraft deviated from the runway alignment.

Significant factors

The following factors were considered relevant to the development of the accident:

1. The pilot did not ensure that the aircraft contained sufficient fuel for the flight.

2. The pilot did not establish that the engine control settings used were appropriate for his planned fuel consumption rate.

3. After the failure of the left engine the pilot did not maintain directional control of the aircraft.

4. The pilot made an inappropriate decision to attempt to go around from a very low height and did not feather the left engine propeller.

SAFETY ACTION

The investigation found that there are no specific CAR or CAO requirements with respect to essential training or testing prior to granting a multi-engine training approval. During the investigation of another occurrence (9402804) similar safety deficiencies were identified.

There is no approved or prescribed syllabus of training, or training approval test requirements for these aircraft categories. It is not a requirement to demonstrate to a CAA FOI or an approved ATO, knowledge and understanding of all systems and procedures essential to the safe operation of the aircraft, in all flight regimes, prior to the granting of a check and training approval.

Under CAR 217, a pilot is not required to hold an instructors rating in order to hold a check and training approval. Such approval is covered by the delegation under Part 5 of the CARs and includes the delegation to conduct training for endorsement and also to issue a certificate of endorsement. The delegation leaves the test requirements and parameters to the discretion of the testing FOI.

As a result of the investigation into occurrence 9402804 the Bureau issued interim recommendation IR950063 to the Civil Aviation Authority. It stated:

The Bureau of Air Safety Investigation recommends that the Civil Aviation Authority provide a syllabus of prescribed test requirements as a standard for the testing of an applicant for the granting of a check and training approval on a specific aircraft type. The test should ensure that the applicant has adequate knowledge and understanding of all systems essential to the safe operation of the aircraft, in all flight regimes, and that the applicant has the ability to pass on such detail to a student.

The CAA response stated:

Guidance on the conduct of check pilot approvals including flight test requirements are contained in MAOC Vol 1 Part A Ch 10 Appendix C3. The Authority agrees with this recommendation and has commenced a project to produce a standard flight test report form for candidates, both instructors and trainers, seeking multi-engine training approval. In support of this form the Authority will also produce a syllabus and a test-conduct guide.

The Bureau has classified this response as CLOSED/ACCEPTED.