Transportation Safety Board of Canada
Bureau de la sécurité des transports du Canada

Air Transportation Safety Investigation Report A18W0054

ENGINE POWER LOSS AND FORCED LANDING

Super T Aviation
Piper PA-31-350 Navajo Chieftain, C-FCWW
Calgary, Alberta
25 April 2018

About the investigation

The Transportation Safety Board of Canada (TSB) conducted a limited-scope, fact-gathering investigation into this occurrence to advance transportation safety through greater awareness of potential safety issues. It is not the function of the Board to assign fault or determine civil or criminal liability.

History of the flight

At 0444[1] on 25 April 2018, the Super T Aviation Piper PA-31-350 Navajo Chieftain (registration C-FCWW, serial number 31-8152192) departed Medicine Hat Airport (CYXH), Alberta, on an instrument flight rules (IFR) flight plan, with 2 flight crew members and 4 passengers on board for a scheduled charter flight to Calgary International Airport (CYYC), Alberta. The aircraft had been fuelled with 50.1 U.S. gallons of 100LL aviation gasoline (AVGAS) and the operational flight plan showed a final fuel load of 144 U.S. gallons (864 pounds).[2] This resulted in full inboard fuel cells (56 U.S. gallons in each) and approximately ⅓ full outboard cells (16 U.S. gallons in each).

After departure, the aircraft climbed to a cruising altitude of 8000 feet above sea level. The crew completed the cruise checklist, which included switching the fuel selectors from inboard to outboard fuel cells.

A descent was initiated at 0535, when the aircraft was approximately 20 nautical miles southeast of the threshold for Runway 35R at CYYC. Prior to the descent, the crew completed the normal descent checklist. At 0536, the arrival controller offered the aircraft a landing option for Runway 35L, which the crew accepted. At 0538, when the aircraft was approximately 12 nautical miles south of Runway 35R,

[1] All times are Mountain Daylight Time (Coordinated Universal Time minus 6 hours).

[2] 1 U.S. gallon of 100LL aviation gasoline (AVGAS) at 15 °C weighs 6.01 pounds.

the right engine began to surge. The captain then requested that the first officer run the engine failure in-flight checklist.[3] The items on the checklist were performed, with the exception of the cause check and feathering the propeller. The cause check directs the crew to check fuel flow, fuel quantity, fuel selector position, oil pressure and temperature, and magneto switches.[4]

Shortly thereafter, the flight crew contacted the arrival controller and requested to land on Runway 35R, because it was a more direct flight path. The arrival controller cleared the aircraft for the visual approach to Runway 35R. At 0539, the crew contacted the arrival controller and stated that they had lost the right fuel pump. The arrival controller asked if they wanted to place aircraft rescue and firefighting on standby; the flight crew declined. At approximately 0540, the left engine began to surge.

At 0542, the aircraft was transferred to the tower controller. Moments later, the flight crew transmitted a Mayday call. The tower controller cleared the aircraft for landing on Runway 35R and informed the flight crew that aircraft rescue and firefighting would be on standby. Recognizing that the aircraft was not going to make it to the airfield, the flight crew selected a suitable road (36 Street N.E.) to attempt an emergency landing.

At 0543, the flight crew made a second Mayday call, informing the tower controller that they would be landing on a road because they would not be able to make it to the airfield.

The aircraft touched down in the northbound lanes of 36 Street N.E., just north of the intersection with Marlborough Drive N.E. Shortly after the aircraft touched down, its right wing contacted a light standard on the right side of the road, shearing off the outer 4 feet of the wing. The aircraft continued north, through the intersection with Marbank Drive N.E., and came to a stop just south of the on-ramp for eastbound 16 Avenue N.E., which is part of the Trans-Canada Highway (Figure 1).

Figure 1. The occurrence aircraft after coming to a stop on 36 Street N.E., Calgary, Alberta

After the aircraft had come to a stop, the passengers opened the main door, and they and the first officer evacuated the aircraft before making their way to the east side of the road, away from the aircraft. Moments later, the captain also evacuated the aircraft. The passengers and flight crew waited on the side of the road for emergency services to arrive. There were no injuries to the passengers, the flight crew, or any persons on the ground. The emergency locator transmitter did not activate.

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[3] Super T Aviation, *PA31 Quick Reference Handbook*, Amendment 5 (November 2015), "Engine Failure during Flight (Above 76 KIAS)", p. 5.

[4] Ibid.

Checklist

Super T Aviation created a standard operating procedures (SOPs) document containing a normal procedures checklist for the PA-31-350. This checklist was compared to the one in the *Pilots Operating Handbook* (POH),[5] which is published by the aircraft manufacturer. The investigation found differences between the 2 documents. Of note, in the POH descent checklist, there is a step to check that the fuel selectors are set to inboard. However, the air operator's normal procedures descent checklist did not include this item. Instead, the step to check that the fuel selectors are set to inboard was included in the before landing checklist.

The manufacturer's POH contains a caution note between the before takeoff and normal takeoff procedures that states, in part, "Outboard tanks are for coordinated level flight only and may never be used for takeoff."[6]

In the description of cruise flight, the POH contains the following statement: "If outboard cells are used during climbs, descents or prolonged uncoordinated level flight, power loss may result even if there is appreciable fuel remaining."[7] Neither statement was reproduced in the Super T Aviation normal procedures checklist document.

Quick reference handbook

Super T Aviation's SOPs for the Piper Navajo state the following:

> These SOPs are structured on SOPs commonly used on larger aircraft. As Super T Aviation is primarily an industry entry level organization, the complexity of the SOPs is meant as an introduction and learning tool to the type of SOPs Super T employees may find at organizations using larger aircraft.[8]

The quick reference handbook (QRH) forms part of the SOPs document (Chapter 10). The physical format and layout of the QRH were compared with those of QRHs commonly found in the industry. The following observations were made:

- The QRH pages lacked tabs to help the flight crew quickly identify the pertinent section to use.
- The table of contents at the front of the QRH indicates where corrective action for specific operating conditions can be found. However, the page numbers on the actual pages of the QRH are small and are located on the bottom left side of the page, which can make them difficult to find in an emergency.

Super T Aviation fuel management standard operating procedure

The air operator's SOPs do not include any guidance information on fuel monitoring or management, and the investigation found that the captain and first officer used different methods to manage and monitor fuel consumption throughout the flight. The captain referenced the global positioning system (GPS), which provides basic fuel-planning data based on a fuel load and fuel consumption rate input by the user. The GPS did not have any data input with respect to the actual fuel burn, nor did it

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5 Piper Aircraft Corporation, *Chieftain PA-31-350 Pilot's Operating Handbook and FAA Approved Airplane Flight Manual* (Revised 21 December 2011).

6 Ibid., Section 4: Normal Procedures, p. 4-9.

7 Ibid., p. 4-19.

8 Super T Aviation, *Standard Operating Procedures: Piper Navajo*, Amendment 7 (October 2015), p. 1-7.

have any data input with respect to how much fuel was actually on board the aircraft at a specific time, or in which fuel cell. In addition, the captain relied on memory to determine how much fuel was on board and in which fuel cell, and when to switch cells.

The first officer leaned the engines out[9] to 22 gallons per hour (per engine) based on the digital fuel flow meter and incorporated an observation of the fuel quantity gauges in his routine instrument scan.

The flight crew members did not discuss fuel management strategies during the pre-flight briefing.

Aircraft

The Navajo Chieftain fuel system consists of fuel cells, engine-driven and emergency fuel pumps, fuel boost pumps, control valves, fuel filters, fuel pressure and fuel flow gauges, fuel drains, and non-icing NACA[10] fuel cell vents.

Fuel is stored in flexible fuel cells (2 in each wing panel). The outboard cells hold 40 U.S. gallons each, and the inboard cells hold 56 U.S. gallons each, for a total of 192 U.S. gallons. Of this amount, 182 U.S. gallons is useable. The fuel management controls are located in the fuel control panel at the base of the pedestal and include the fuel cell selectors, fuel shutoffs, and fuel crossfeed controls. During normal operation, each engine is supplied by fuel from its respective fuel system. The fuel controls on the right side of the pedestal control the fuel from the right cells to the right engine, and the fuel controls on the left side of the pedestal control the fuel from the left fuel cells to the left engine.

Two electric fuel-quantity gauges are mounted in the overhead switch panel. The right fuel quantity gauge indicates the quantity of fuel in the selected right fuel system cell (inboard or outboard), and the left fuel quantity gauge indicates the quantity of fuel in the selected left fuel system cell (inboard or outboard). The fuel gauges are connected electrically to microswitches mounted in the fuel selector console. When a fuel cell is selected, its corresponding fuel level is shown.

The aircraft is equipped with 2 (left and right) red "FUEL BOOST INOP" lights in an annunciator panel mounted at the top of the centre instrument panel. These warning lights illuminate when the fuel boost pressure is sensed at less than 3 psi. There are also 2 (left and right) electrically powered emergency fuel pumps for use in case of an engine-driven fuel pump failure. These pumps are controlled by switches placed in the overhead switch panel, located in the ceiling above the right seat in the cockpit, and can be activated at any time.

Meteorological information

The aerodrome routine meteorological report (METAR) for CYYC at 0600 indicated the following:

- winds: 350° true (T) at 14 knots
- visibility: 15 statute miles
- broken clouds at 14 000 feet and at 22 000 feet

[9] To lean the engines out means to change the fuel mixture that is being fed to the engines. As an aircraft's altitude changes during flight, air density changes, and the volume of fuel being introduced to the engine needs to change accordingly to make a correct air-to-fuel ratio.

[10] NACA stands for the U.S. National Advisory Committee for Aeronautics, the precursor to the National Aeronautics and Space Administration (NASA).

- temperature: 6 °C; dew point −4 °C
- altimeter setting: 30.09 inHg

Weather was not considered a factor in this occurrence.

Personnel information

Records indicate that the captain and first officer were certified and qualified for the flight in accordance with existing regulations. The captain held a valid airline transport pilot licence – aeroplane, Class 1 aeroplane instructor rating, a Group 1 instrument rating, a glider pilot licence, and a category 1 medical at the time of the occurrence. She had accumulated over 9500 hours total flight time, including 250 hours on type. In addition, she was type-rated on the Cessna 501 and the de Havilland DHC-8.

The captain had been employed by Super T Aviation since March 2016 and had last successfully completed the captain pilot proficiency check for the PA-31 on 27 March 2018. Based on a review of the captain's work–rest schedule, fatigue was not considered a factor in the accident.

The first officer held a valid commercial pilot licence – aeroplane, with multi-engine and Group 1 instrument ratings at the time of the occurrence. In addition, he held a valid Class 3 instructor rating and a valid category 1 medical. The first officer had accumulated 948 hours total flight time and 23 hours on type.

The first officer had been employed by Super T Aviation since May 2017 and had last successfully completed the first officer pilot proficiency check for the PA-31 on 23 March 2018. Based on a review of the first officer's work–rest schedule, fatigue was not considered a factor in the accident.

Aircraft examination

The aircraft was towed back to the airport property and placed in a hangar for post-accident examination.

Electrical power was applied to the aircraft using the battery, and the fuel quantity readings from the fuel gauges were noted. Both the left and right inboard fuel cells were indicating that they were approximately ¾ full. This corresponds to a useable fuel quantity of approximately 40 U.S. gallons in each inboard fuel cell.

With the fuel selector valves in the outboard position, the left outboard cell was indicating empty and the right outboard cell was showing a full gauge deflection—past the full mark. Mechanical damage to the outboard fuel quantity–sending unit of that cell was observed through the fuel filler opening. The outboard fuel cells were drained of fuel. The left outboard fuel cell contained 0.09 U.S. gallons, and the right cell contained 0.05 U.S. gallons. The POH specifies that the unusable fuel for the outboard fuel cells is 2 U.S. gallons per cell.

The wing-root fairings were removed to facilitate a visual inspection of the major fuel system components. Control continuity and operation of both firewall shutoff valves, fuel cell selector valves, and crossfeed valves were checked. All items operated as required. A visual and operational inspection of both fuel boost pumps and both emergency fuel boost pumps was completed. No anomalies were noted. A visual inspection and an operational check of both powerplant controls were completed for freedom of movement and travel. No anomalies were found.

A ground run of the aircraft engines was performed. Both engines were operated up to 25 inches manifold pressure and 2500 rpm. The aircraft's fuel system and engine performance were found to be nominal, i.e., there was nothing mechanically wrong with the engines that would have prevented them from being able to power the aircraft. Due to the absence of fuel in the outboard fuel cells, the ground run was carried out with the inboard fuel cells selected.

Safety messages

As shown in this occurrence, when fuel management SOPs are not in place, fuel starvation can occur even if there is sufficient fuel remaining on board the aircraft to complete the planned flight. In addition, if flight crews do not complete checklist procedures in their entirety, opportunities to rectify emergency situations can be lost. However, in this occurrence, when the flight crew decided that the aircraft could not make it to the airport, their prioritization of selecting a suitable alternate landing area and managing the energy state of the aircraft contributed to the success of the emergency landing.

Safety action taken

Following this occurrence, Super T Aviation made several changes to its Piper Navajo SOPs, QRH, and normal procedures checklist for the aircraft, and submitted them to Transport Canada. These changes included the following:

- A step has been added to set a timer when the outboard tanks are selected.
- The step to switch from the outboard tanks to the inboard tanks has been moved from the before landing checklist to the descent checklist on the company-generated normal procedures checklist.
- Guidance on procedures for accepting runway changes has been added to the company SOPs.
- More detail on aircraft evacuation procedures has been added to the SOPs.
- Enhanced procedures on preparing passengers for an emergency landing have been added to the SOPs.
- Tabs have been added to the QRH pages to facilitate quick procedure identification.
- More detail on procedures for rough-running engines has been added to the SOPs and a rough-running engine checklist has been added to the QRH.

Additionally, the training syllabus for new crew members and the company's emergency response plan have been amended, and an industry-supplied course on fatigue management and human factors has been scheduled.

This concludes the TSB's limited-scope investigation into this occurrence. The Board authorized the release of this investigation report on 25 July 2018. It was officially released on 09 August 2018.

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