Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

AVIATION INVESTIGATION REPORT
A09Q0181

FUEL STARVATION

PIPER PA-34-200T C-FANI
MIRABEL, QUEBEC
11 OCTOBER 2009

Canada

Aviation Investigation Report

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Summary

The privately operated Piper PA-34-200T (registration C-FANI, serial number 34-7570278) took off from Saint-Georges Airport, Quebec, and was headed for Gatineau, Quebec, on an instrument flight plan. The aircraft was in cruising flight at an altitude of 10,000 feet and was 7.4 nautical miles (nm) southwest of Mirabel Airport, Quebec, when both engines simultaneously lost power. The aircraft entered a 180° right turn. The pilot informed air traffic control that he was having engine problems but did not declare an emergency. Radar vectoring was provided to the pilot to direct him to Mirabel Airport. During the descent, the aircraft deviated southward before turning back toward the airport. The aircraft had insufficient altitude to glide to the airport and crashed in a maple bush 1.2 nm from the threshold of Runway 06 at Mirabel Airport at 1732 Eastern Daylight Time. The aircraft was located by a helicopter several minutes later. The pilot, who was the sole occupant of the aircraft, was seriously injured.

Ce rapport est également disponible en français.

Other Factual Information

Pilot

The pilot held a private pilot licence and was qualified for the flight in accordance with existing regulations. He had a total of over 4800 flying hours, including 3800 on the PA-34.

Weather Conditions

The weather conditions reported at Mirabel Airport at 1700 [1] were as follows: scattered stratocumulus at 6000 feet above ground level (agl), broken altocumulus at 9000 feet agl, wind 220° true at 10 knots, and occasional light rain showers. The crash delayed the broadcast of the routine 1800 weather report until 1817. At that time, the cloud layer consisted of scattered altocumulus at 8000 feet agl, and the wind was 280° true at 5 knots.

Aircraft

The twin-engine Piper Seneca PA34-200T was maintained in accordance with existing regulations and was equipped for instrument flight. The instrumentation had been modernized with a primary flight display and three-axis autopilot system connected to a global positioning system (GPS). A fuel flow meter for calculating the fuel used had also been added. At the time of the accident, the aircraft logbook contained no deferred maintenance items. The aircraft's weight and centre of gravity were within the prescribed limits.

History of the Flight

The day before the accident, the fuel tanks were filled with 258 litres of fuel, and the aircraft was stored in a hangar belonging to the pilot. The next day, the pilot realized that he had to return to Gatineau. He arrived at the hangar at the same time as a person hired to wash the aircraft.

The pilot initialized the fuel flow meter system by entering the value corresponding to a full tank (176 litres per tank). The aircraft took off around 1612 and reached a cruising altitude of 10 000 feet above sea level (asl) at 1627. The expected duration of the flight was 1 hour and 35 minutes. Fuel endurance with full tanks is just over 4 hours. During the flight, fuel management was limited to checking each engine fuel flow and the remaining quantity of fuel, which is indicated digitally by the system. Little attention was paid to the fuel gauges due to their inaccuracy.

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1 All times are Eastern Daylight Time (Coordinated Universal Time minus four hours).

Figure 1. Aircraft trajectory

At 1726, one hour and 14 minutes into the flight, the aircraft was 7.4 nm southwest of Mirabel Airport when both engines lost power. The autopilot disengaged, and the aircraft entered a right turn of approximately 180° (see Figure 1). After the turn, the aircraft was 1000 feet below its assigned altitude, and the pilot informed air traffic control (ATC) that he was having engine problems but did not declare an emergency. He said that the engines seemed frozen. He was assigned a heading of 080º magnetic to direct him toward Mirabel Airport. ATC asked whether he would need emergency equipment at Mirabel or whether he would like to declare an emergency. The pilot declined. Although he read back the heading of 080º, he continued to turn south on a heading of approximately 180º magnetic before being assigned a new heading toward Mirabel. Once the pilot stated that he had visual contact with the runway, ATC cleared him for a visual approach to Runway 24, because the surface wind was 6 knots and favouring this runway. At approximately 4500 feet asl, the pilot reported that the engines were still running, even though the engines were not developing any power. During the descent, the pilot activated the booster pumps, but to no avail. The propellers were not feathered and continued to windmill. At 1600 feet asl, 2.2 nm west of the threshold of Runway 06, the pilot advised Mirabel Radio that he could not make it to Runway 24. The aircraft disappeared from radar at approximately 400 feet asl (150 feet agl) and crashed at 1732, 1.2 nm from the threshold of Runway 06 at Mirabel Airport.

Impact

Figure 2. Occurrence aircraft

The aircraft crashed in a maple bush among mature trees measuring an average of 24 inches in diameter and over 100 feet tall. The aircraft entered the trees on a heading of 040º magnetic, with a right bank angle of approximately 30°.

The right fuel tank was punctured at impact, and the left fuel tank was torn open. The fuselage came to rest inverted against a tree about 8 inches in diameter that penetrated the cabin on the passenger side (see Figure 2). A strong smell of fuel was noted at the accident site, indicating that there was fuel on board at the time of impact. The pilot was seriously injured. He was able to exit the cockpit and was found in the rear cabin.

Rescue

Although the pilot did not declare an emergency, the flight service specialist on duty at Mirabel advised the airport's Aircraft Rescue and Fire Fighting (ARFF) personnel to stand by. Following the impact, the specialist advised ARFF that the occurrence site was approximately half a mile south of the threshold of Runway 29 but could not confirm whether the site was inside the airport perimeter. ARFF immediately notified the firefighters from the municipality of Mirabel and the Sûreté du Québec. Locating the aircraft was difficult. The specialist therefore asked a Bell 222 helicopter crew returning to Mirabel from Montreal to help locate the occurrence site. After locating it, the helicopter landed in a nearby field. The helicopter copilot walked through the bush toward the occurrence site with guidance from the helicopter which had taken off again and was hovering over the wreckage. The helicopter copilot arrived at the site at 1756 and indicated that the occurrence pilot was injured but conscious. Reaching the site was difficult, and it was not until 1815 that one of the firefighters was able to administer first aid to the occurrence pilot.

The helicopter was not configured to transport a patient lying down; as a result, the occurrence pilot was finally evacuated in a 4×4 truck around 1900 with the assistance of the maple bush owner who knew of a logging road adjacent to the site.

Fuel system

The fuel system for this aircraft consists of two cells, one in each wing, that are connected to form a single tank.
The tanks fit the wing profile, and because the tank surface area is so large compared to the tank depth, a difference of a few millimetres in the fuel level represents several litres of fuel. Each tank can contain 46.5 American gallons of fuel, 2.5 of which are unusable, leaving 44 gallons (166.5 litres) of usable fuel.

Figure 3. Fuel selector

The fuel system has two fuel selectors (see Figure 3), one for each engine, which are identified as LEFT ENGINE and RIGHT ENGINE. Each selector has three positions. The forward position (ON) allows each tank to feed its respective engine. The central position (OFF) cuts off the fuel supply. The rear position (XFEED) is for crossfeeding, feeding engine from the opposite tank. In other words, if the right fuel selector is on XFEED, the right engine will receive fuel from the left tank.

According to the pilot's checklist, the fuel selector operation is checked while the aircraft is taxiing. In this occurrence, the operation was checked before taxiing. The pilot sets one of the selectors to OFF. Once the corresponding engine starts to sputter, the selector is set to XFEED. The engine resumes operation after which the selector is set to ON. The selector for the other engine is checked in the same manner. The checklist then provides four other opportunities to ensure that both fuel selectors are set to ON: during the engine run up, during the pre-takeoff checks, when the aircraft is lining up on the runway, and once the aircraft is established at cruising altitude. When the aircraft was examined at the occurrence site, the left selector was found on ON, and the right selector was on XFEED.

A note in the aircraft flight manual indicates that each engine returns vapours and a percentage of fuel to its respective tank. Because of this, at least 30 minutes of fuel from that tank must be used before selecting crossfeed. If the fuel gauge indicates that the tank is nearly full, the fuel in that tank must be used for 30 additional minutes to lower the level of fuel in the tank; otherwise the fuel will be vented overboard.

An examination of the engine specifications for the Teledyne Continental TSIO-360-EB and LTSIO-360-EB engines installed in the occurrence aircraft revealed that each engine can return a maximum of 80 pounds of fuel per hour to its respective tank when operating at full throttle. No specifications are provided for lower revolutions like the throttle settings for cruising or descending. The rate of fuel return depends on engine speed. Since the rotation speed of the fuel pump in the fuel regulator is in ratio with the engine speed, the rate of fuel return decreases with a reduction in engine speed. For a given weight, the volume of fuel varies with the fuel temperature; at 15°C, 80 pounds of fuel equals 50.47 litres.

A fuel consumption calculation shows that, during the 15-minute climb with an average fuel consumption of 45 litres per hour per engine, each engine consumed 11.25 litres of fuel. After 59 minutes of cruising at 40 litres per hour per engine, each engine consumed 39.33 litres of fuel. A total of 50.58 litres was used by each engine, or 101.16 litres for both engines.

The aircraft used a Janitrol heater that consumes 3 litres of fuel per hour; therefore, it consumed 3.7 litres of fuel during the one hour and 14 minute flight.

Using fuel return quantities corresponding to the reduction in engine speed (50 litres while climbing and 45 litres while cruising), an estimated 56.75 litres of fuel would have been returned to the right tank and vented. This situation would not have occurred unless the right selector was set to XFEED for the whole flight (the position in which it was found at the occurrence site).

The total fuel consumed by the engines (101.16 litres), plus the heater's fuel consumption (3.7 litres), plus 56.75 litres of fuel returned to the right tank, yields a total of 161.61 litres. This is less than 5 litres below the 166.5 litres of usable fuel in each tank.

The addition of a digital system displaying the rate of fuel consumption allows the pilot to see the quantity of fuel used by each engine. However, the sensor is installed downstream from the fuel regulator and measures only the fuel fed to the injectors. The system includes a fuel meter which subtracts the quantity of fuel consumed by the engine from the quantity in the tank as indicated on departure, without taking into account the source of the fuel or the quantity left in the tanks. The system has proved reliable with use, indicating the exact quantity of fuel required when refuelling, thereby leading the pilot to pay more attention to the system than to the fuel gauges.

Engine failure

The pilot had carried out several engine failure drills. However, he had not carried out any drill for a simultaneous failure of both engines; there was no requirement to do so. The probability of a simultaneous mechanical failure of both engines is very low. Moreover, the aircraft manufacturer does not publish any procedures for a simultaneous failure of both engines. However, when an engine failure occurs, the first item on the pilot's checklist, after ensuring that there is no engine fire, is to set the fuel selector to ON or XFEED.

When the engine failure occurred, the aircraft was 6.5 nm from the threshold of Runway 06 at Mirabel and continued to within 4.5 nm of the runway threshold before deviating south. The deviation increased the distance required to reach the threshold. The aircraft glided 10.7 nm before crashing.

Emergency Locator Transmitter

The aircraft was equipped with an emergency locator transmitter (ELT) that transmits on 121.5 MHz and 406 MHz. The ELT was not damaged in the accident and was activated by the impact. However, the antenna mounted on the back of the cabin broke at impact, which hindered signal capture.

This ELT is programmed to transmit a coded message 50 seconds after impact that allows the Canadian Mission Control Centre (CMCC) to access the information provided when the ELT is registered, including the aircraft identification and the person or organization responsible for the aircraft. This message is normally received on 406 MHz by a GEO satellite. [2] However, unless the ELT is capable of transmitting a GPS position, which was not the case for the model installed on the C-FANI, the satellites can only identify the ELT sending the signal and cannot provide information on its position. The CMCC states that, because the satellites are positioned so high above the Earth, if the antenna is damaged or blanketed by wreckage after the accident, the coded message cannot be captured. However, the LEO satellite [3] can capture the coded message on 406 MHz and fix the position of the signal, even if the antenna is damaged or poorly oriented. LEO satellites can sometimes receive a signal and identify its location, as was the case in this situation.

As of 01 February 2009, the international search and rescue satellite network COSPAS-SARSAT [4] no longer receives signals transmitted on 121.5 MHz. However, these signals may be captured by aircraft monitoring this frequency. After the crash, no aircraft reported receiving a signal on 121.5 MHz.

The accident occurred at 1732. ATC transmitted the information to search and rescue (SAR) services at 1755. Since there are sometimes no LEO satellites in place to capture a signal, delays of up to two hours can occur.

In this occurrence, the first alert with the coded information sent to CMCC via satellite was received at 1802, thirty minutes after the crash. The signal transmitted two positions, one being a ghost position. On the second satellite pass, the actual position stayed the same and the ghost position changed. The second pass was reported at 1909 and provided a position less than 1000 feet from the occurrence site. The signal can be captured by more than one satellite at a time, and a total of 18 signal captures were recorded. The coordinates provided by each capture were different but were less than half a mile from the occurrence site. The last transmission was received at 0231 the next day.

The ELT was turned off around 0915. It was designed to transmit for at least 24 hours. No transmissions were received nine hours after the ELT activated.

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2 A satellite in geostationary orbit that is positioned approximately 35 800 km directly over the equator and orbits at the same rate as the Earth's rotation.

3 LEO stands for low Earth orbit satellite. It is called low orbit because it revolves around the Earth at a height of 1000 km. It takes approximately two hours to orbit the Earth. This means it is within range of equipment on Earth for only a few minutes. Because this type of satellite is relatively close, it can work with much smaller transmitting equipment, e.g., a very small antenna.

4 COSPAS is the space-based system that searches for vessels in distress, and SARSAT is the search and rescue satellite aided tracking system.

The TSB Laboratory examined the ELT and determined that it was capable of transmission on both frequencies and that the battery had enough power to generate a 5-watt signal, which met requirements. The broken antenna made it difficult to capture the signal.

Analysis

The most plausible hypothesis is that the right fuel selector was left on XFEED after being checked prior to the aircraft's departure from Saint-Georges.

The fuel consumption calculation shows that, in such a case, the aircraft would have had 166.5 litres of fuel available for 74 minutes of flight before the engines stopped, equivalent to an hourly consumption of 135 litres, which is much higher than the usual consumption of 80 litres per hour. The difference of 55 litres was therefore returned to the right tank. Since the right tank was full, this fuel was vented.

When the aircraft is being fuelled, the large surface area of the tanks is such that a difference in fuel level of a few millimetres represents several litres. Therefore the five-litre discrepancy between the fuel available and the fuel used is negligible. In addition, the exact rate of consumption and the precise departure time could not be validated. The simultaneous stopping of the engines, the position in which the right selector was found and the fuel consumption calculation confirm that the double engine failure resulted from both engines being fed from the same tank.

When departing from Saint-Georges, the pilot may have been distracted by the person who greeted him while he was doing his preflight check and may have forgotten to return the right fuel selector to ON. However, the checklist provided four opportunities to ensure that both fuel selectors were set to ON : during the engine run up, during the pre-take-off checks, when the aircraft was lining up on the runway, and once the aircraft was established at cruising altitude. The pilot did not correct the selector position, which suggests that the checklist was not used.

Since the pilot did not pay close attention to the fuel gauges in flight, he did not realize that the left tank was being depleted rapidly while the right tank remained full. Because the autopilot was on, the pilot could not feel the lateral imbalance caused by the difference in the quantities of fuel in each tank. This imbalance explains why the aircraft turned to the right once the autopilot disengaged. The pilot's workload suddenly increased and he did not realize that the aircraft was turning.

The primary duty of a pilot is to effectively manage flight-related risks. Checklists are the most readily available means of defence against threats, errors and undesirable conditions. The omission of checklist items during the engine run up, during the pre-takeoff checks, when the aircraft was lining up on the runway, once the aircraft was established at cruising altitude, and following the power loss, gradually increased the risk until the crash.

The digital fuel consumption system operated normally. Each tank contained 166.5 litres of usable fuel, but the system had been programmed to indicate the total per-tank capacity of 176 litres when it was re-initialized before the aircraft departed Saint-Georges. Since the system is not designed to detect the fuel remaining in the tanks, the system would have indicated approximately 125 litres per tank (176 litres minus 50.58 litres) at the time of the power loss, because the system only takes into account the fuel consumed by the engine. The system's customarily reliability led the pilot to not wonder how much fuel was left in the tanks after the engines lost power. In the absence of yawing, the pilot did not identify the power loss as an engine failure, and the emergency checklist for engine failure was not completed.

The propellers were not feathered, and were windmilling. This gave the impression that the engines were still running, albeit slowly. This could explain why the pilot told ATC that the engines were still running as he descended through 4500 feet. Setting the left selector to XFEED and the right selector to ON would have restored fuel supply to both engines.

When the engines stopped, the aircraft was at 10 000 feet asl and 6.5 nm from the threshold of Runway 06. Considering that the aircraft's deviation to the south increased the distance to be travelled by 4.2 nm and that the aircraft crashed 1.2 nm from the threshold, it is very likely that the aircraft could have glided to the threshold of Runway 06, even though the propellers had not been feathered.

Despite the obvious lack of engine power, the pilot chose not to declare an emergency. Declaring an emergency at the right time allows pilots to benefit from immediate, sustained attention from ATC and better assistance when they face an emergency or an abnormal situation. Any deviation from the instructions provided is immediately indicated to the pilot to provide him with the best possible assistance.

The ELT was capable of transmitting on 121.5 and 406 MHz, and the battery had enough power to generate a signal. However, the broken antenna made it difficult to capture signals.

While locating the aircraft was facilitated by a passing helicopter, reaching the site proved difficult. The delay of one hour and 30 minutes between the accident and the evacuation of the injured pilot is due to the fact that the aircraft crashed outside the airport perimeter in a private maple bush, access to which was not well known except by the owners.

Findings as to Causes and Contributing Factors

1. The right fuel selector was left in the XFEED position, probably because the pilot was distracted and/or failed to follow the checklist. As a result, both engines were being fuelled by the left tank until it was completely empty, causing both engines to stop simultaneously.

2. The pilot relied on a fuel quantity indicator system that was based on the engine's fuel consumption and not on the quantity of fuel remaining indicated by the gauges.

3. The pilot did not recognize the power loss as being a failure of both engines. The emergency checklist for engine failure was not completed.

Other Findings

1. The aircraft's emergency locator transmitter (ELT) broadcast signals on 121.5 MHz and 406 MHz. The ELT was not damaged on impact, but its antenna was broken, making it difficult to capture signals.

2. The pilot did not declare an emergency and did not clearly indicate the nature of the problem; therefore air traffic control (ATC) could not anticipate his needs.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 29 April 2010.