AVIATION INVESTIGATION REPORT
A02Q0119

ENGINE FAILURE AND LOSS OF CONTROL

MOONEY M20E C-FWII
QUÉBEC/JEAN LESAGE INTERNATIONAL AIRPORT, QUEBEC
02 SEPTEMBER 2002

Aviation Investigation Report

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Summary

A Mooney M20E, registration C-FWII, serial number 670054, was to make a flight according to visual flight rules (VFR) from Québec to Rimouski, Quebec. The aircraft took off from Runway 30 at 1346 hours, eastern daylight time, with the pilot, a flight instructor and a passenger on board. As the aircraft was climbing through 600 feet above sea level, the control tower received a radio message from C-FWII, indicating that the engine had failed and an emergency landing would be made. The aircraft was observed in a steep right turn before nosing down and crashing near a baseball field, less than one nautical mile north of the end of Runway 30. The aircraft was destroyed on impact but did not catch fire. The three occupants were fatally injured.

Ce rapport est également disponible en français.

Other Factual Information

On 27 August 2002, the pilot took possession of a Mooney M20E, registration C-FWII, serial number 670054, which he had recently purchased. Since he was a new owner, the insurance company required that he complete 10 flying hours with a qualified flight instructor. From 27 to 29 August 2002, the pilot made five flights, totalling 5.7 hours, accompanied by a flight instructor. On these flights the pilot practised turns, slow flight, stalls, and emergency landings. No problems or deficiencies were noted or reported after these flights.

The aircraft was refuelled on 30 August 2002, and it was left parked outside in a safe place until 02 September 2002, the day of the accident. Nothing was found to suggest that the quantity of fuel on board had decreased in any way. Also, any anomaly with respect to the fuel load would have been noticed during the visual inspection conducted on the day of the occurrence.

About 15 minutes before departure, the pilot filed a visual flight rules (VFR) flight plan with the Québec Flight Service Station, indicating that he was the pilot-in-command. When the external visual inspection was completed, the three occupants boarded the aircraft. The pilot-owner took the left front seat, the flight instructor took the right front seat, and the passenger sat in the rear on the right side.

After completing the run-up, at 1346 hours eastern daylight time[1], the aircraft was cleared to take off on Runway 30 with instructions to stay on the extended runway centre-line up to 1500 feet above sea level (asl) before proceeding to Rimouski (Quebec). Less than two minutes after take-off, when the aircraft was about 600 feet asl, or less than 400 feet above ground level (agl), the controller advised the pilot that he could now proceed to Rimouski. Immediately after receiving this instruction, C-FWII reported by radio that his engine had stopped and he was going to make an emergency landing. Several fields, most running north-south, or 60 degrees off the runway centre-line, were available for landing. At about 400 feet agl, the aircraft banked steeply to the right, nosed down, and crashed in a field.

The front seats of the aircraft were fitted with seat belts, consisting of lap belts and upper torso restraints. The two front occupants were not wearing their upper torso restraints. They were not required to do so because the existing regulations did not require that they be installed on this aircraft, given that it was built prior to 18 July 1978. The rear passenger's seat belt showed signs of stretching, indicating that it had been worn. However, one of the attachments to the floor structure failed on impact.

The emergency locator transmitter (ELT), model Ameri-King AK-450, serial number 354036, did not activate on impact. It activated during the recovery of the wreckage, however, and the investigators had to switch it off to stop the signal. The ELT was installed and maintained in accordance with regulations, and the selector switch was on automatic. It could not be
determined why the ELT did not activate on impact. In spite of this, the aircraft was located quickly by the Québec airport fire service, which arrived at the crash site in less than ten minutes.

The weather conditions at the time of the occurrence were suitable for visual flight: a few scattered clouds at 6000 feet asl, visibility 30 miles, temperature 24°C, dew point 12°C, and winds from the southwest at 4 knots.

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[1] All times are eastern daylight time (Coordinated Universal Time [UTC] minus four hours).

The pilot held a valid private pilot licence. He received his licence in 1997, and his logbook indicated he had accumulated 570 flying hours, including 5.7 on the Mooney M20E. He had acquired most of his flying experience on single-engine aircraft such as the Cessna 150 and Cessna 172. The flight instructor held a valid commercial pilot licence with a group 1 instrument rating and a class 1 instructor rating, which is the highest instructor qualification issued by Transport Canada. His logbook indicated that he had accumulated about 1357 flying hours, including about 960 hours as a flight instructor. With the exception of the 5.7 hours on C-FWII, he had never previously flown or given flight instruction on the Mooney M20E. Since the flight instructor's licence carried a general endorsement, the regulations allowed him to give flight instruction on the Mooney M20E even though he had no experience on that aircraft type. Based on the autopsy and toxicology testing, there is no indication that the pilot's or flight instructor's performance was degraded by physiological factors.

A review of the relevant airworthiness directives and service bulletins and the aircraft's maintenance logbooks indicates that the aircraft was certified, equipped, and maintained in accordance with existing regulations and approved procedures.

The aircraft was powered by a Lycoming model IO-360-A1A engine, bearing serial number L 3606-51A. It had accumulated 44.7 hours since its last overhaul in October 1999. The investigation revealed that, in March 2002, the former pilot-owner had to land the aircraft due to an engine malfunction. The propeller had struck the ground on landing, requiring that a special engine inspection be done before returning the aircraft to service. The inspection revealed a contaminant in one of the injectors. The injectors were cleaned and the fuel servo control was replaced. An annual inspection, which is the equivalent of a 100-hour inspection, was then carried out. During that inspection, aircraft maintenance engineers found corrosion at the fuel lines. The lines were replaced from the two tanks to the fuel selector under the cabin floor. All fuel filters were inspected and cleaned as required by the manufacturer and applicable regulations. The aircraft was returned to service and experienced no engine problems until the day of the accident.

Examination of the propeller blades confirmed that the propeller was not rotating on impact. As well, witnesses reported seeing blue smoke, turning to black, coming from the engine at the start of the climb. To determine what factors may have contributed to the engine failure and crash, the wreckage was transported to the TSB Engineering Branch Laboratory for further analysis. A complete teardown and examination of the engine, electrical components, and air intake system revealed no irregularities that could have caused the engine to lose power or stop. The investigators therefore concentrated on the fuel system. A complete inspection of the fuel system established that there were no contaminants in the fuel filters or system components. The tanks, filler caps and vents exhibited no deficiencies, and there was no indication of water in the fuel recovered from the injection system. A strong odour of fuel was noted at the crash site, which tends to confirm that the aircraft was carrying a significant quantity of fuel. All indications are that both tanks were full on departure from Québec, indicating an endurance of 4 hours 30 minutes. The fuel source used had suitable filters and was used often. No pilots who used the same supply source reported any impurities in the fuel.

At the time of impact, the fuel selector, which is installed on the floor just forward of the pilot, was selected to the right tank, indicating that the engine was supplied from that tank. The selector exhibited no deficiencies after the impact. It was established, however, that the fuel selector on Mooney M20 models A to G can be hard to reach without interfering with the flight controls. In fact, depending on the pilot's physiology, it can be difficult to change the position of the selector. The pilot would have to move his seat aft and bend forward to change the fuel selector position, which could adversely affect the pilot's ability to control the aircraft. It was

not determined whether the pilot changed or tried to change the position of the fuel selector after the engine stopped. Of models A to G, model C, in 1978, was the last to be built with the fuel selector on the floor in front of the pilot. Since model J commenced production in 1976, all models J to S are equipped with a fuel selector mounted between the two front seats, where it is easier to reach.

All flight control surfaces were found at the site and all damages to the aircraft were attributed to impact forces. The flaps were extended 15 degrees and the landing gear was up, which is the normal configuration after take-off. The debris pattern at the crash site and the deformation of the fuselage reveal that the aircraft stalled and had entered a spin prior to impact. The aircraft's flight manual indicates that the rate of rotation in the initial phase of a spin is very high and can cause disorientation of the occupants. The flight manual also warns that the loss of altitude incurred in a spin and its recovery may be as much as 2000 feet. The same warning also notes that a stall at low altitude would be extremely critical. The aircraft was equipped with a stall warning device designed to alert the pilot when an aerodynamic stall is imminent. There was no indication that the warning device was not in working order.

To determine whether the weight and balance of the aircraft might have affected its flight characteristics, the approved standard summer weights without carry-on baggage published in the *Aeronautical Information Publication* (A.I.P. Canada) were used. They show that the aircraft weight and centre of gravity were within the limits prescribed by the manufacturer. However, based on the actual weights of the three occupants, the weight of the aircraft exceeded the maximum allowable take-off weight by 80 pounds, but the centre of gravity was within the limits prescribed by the manufacturer. There was nothing to prevent the pilot from using the approved standard weights from the A.I.P. Canada, although the A.I.P. Canada indicates that the actual weight of passengers should be used wherever possible.

The aircraft was not equipped with a flight data recorder or cockpit voice recorder, nor was either required by the regulations. As a result, no information is available as to what was happening in the cockpit before the crash.

Analysis

Examination of the aircraft revealed no deficiencies that could have contributed to the engine failure. There was no indication of any failure with respect to the airframe or the flight controls. The weather conditions were suitable for visual flight and there was no indication that they were a contributing factor in the accident. Based on the approved standard summer weights, weight and centre of gravity were within the manufacturer's prescribed limits. Based on actual weights, the aircraft weight was 80 pounds over the maximum allowable and the centre of gravity was within the prescribed limits; this surplus weight could not have had a serious impact on the aircraft's flight characteristics. There was no indication that physiological factors affected the pilot's or flight instructor's abilities.

The pilot and flight instructor were qualified for the flight in accordance with existing regulations. Although the insurance company had not specified the flight instructor's qualification class, the pilot took the trouble to engage a class 1 flight instructor, which is the highest level of qualification issued by Transport Canada. However, one may question the adequacy of a regulation that allows a flight instructor to give flight instruction on an aircraft type on which he has no experience. Even though the pilot and the instructor practised stalls and emergency landings on previous flights with the Mooney, their level of experience on type meant they had little knowledge of its flight characteristics.

The reason for the ELT's failure to activate on impact could not be determined. This failure could have caused a delay in locating the aircraft and rescuing the occupants. Despite the prompt arrival of the airport fire service at the site, the occupants had no chance of survival due to high impact forces.

Since there was no cockpit voice recorder, the events in the cockpit prior to the crash could not be determined. However, it is highly probable that the pilot-owner was flying the aircraft on take-off, because the purpose of the flight was to allow him to become more familiar with the aircraft. On the other hand, given the circumstances, it is likely that the flight instructor took the controls when the engine failed. When the engine fails at low altitude, the pilot is in a very critical situation. He has very little time to select a suitable landing area, place the aircraft at the recommended gliding speed, and complete the emergency checklist.

The aircraft was seen in a steep right turn before it nosed down and crashed; the pilot may have been trying to turn back to the runway for a landing. It is acknowledged that many accidents occur when the pilot tries to turn about and land on the runway. Since altitude is often insufficient, the pilot tends to raise the nose of the aircraft in the turn. This causes the speed of the aircraft to drop below the stall speed, which increases with the angle of bank.

The aircraft stalled because the pilot flying did not maintain the minimum flying speed and the altitude was insufficient to allow the pilot to effect recovery. The steep turn caused the stall speed to rise.

The following laboratory reports were completed:

LP 082/2002 - *Engine examination*
LP 091/2002 - *Pump element examination*

Findings as to Causes and Contributing Factors

1. The pilot flying did not maintain the minimum flying speed after the engine stopped. The aircraft stalled at an altitude insufficient to allow the pilot to effect recovery.

2. The engine stopped when the aircraft was at low altitude, allowing little time for the pilot flying to select a suitable landing area, place the aircraft at the gliding flight speed, and complete the emergency checklist.

3. After the engine stopped, the pilot flying made a steep turn, thereby increasing the stall speed.

4. The reason for the engine's failure was not determined.

Findings as to Risk

1. The pilot instructor did not know the flight characteristics of the aircraft any better than the pilot he was training. However, regulations permitted him to give flight instruction on aircraft types with which he was not familiar.

2. The emergency locator transmitter did not activate on impact, which might have had negative consequences if the aircraft had crashed in an uninhabited area.

Other Findings

1. The fuel selector on Mooney M20 models A to G can be hard to reach without interfering with the flight controls, thereby adversely affecting the pilot's ability to control the aircraft.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 26 November 2003.

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