# AVIATION INVESTIGATION REPORT
# A99C0157

## LOSS OF CONTROL / COLLISION WITH TERRAIN

MOONEY M-20F C-GGIK

ST. ANDREWS, MANITOBA 2 NM SE

11 JULY 1999

# Aviation Investigation Report

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## *Summary*

The privately-registered Mooney M-20F, serial number 690031, C-GGIK, was engaged in a series of local familiarization flights for Girl Guides and Girl Guide leaders in the vicinity of St. Andrews, Manitoba. The pilot held a private licence and was one of several volunteers who participated in familiarization flights, which formed part of the activities of a Girl Guide Jamboree. Any costs associated with the flights were borne by the pilots and no remuneration was provided to them by the Girl Guides.

The morning of the occurrence, the pilot completed two flights with Girl Guides as passengers. Then, at 1121 central daylight saving time, he took off on a third flight with three Guide leaders. The aircraft was observed to depart from runway 18 at St. Andrews, enter a shallow climb, and turn left to an easterly heading, in a similar pattern to the first two flights. Recorded radar tapes of the aircraft indicated that the aircraft reached a maximum altitude of 340 feet above ground level. The aircraft was observed from both the air and the ground and was seen to level off after turning east. It was then seen to roll sharply to the left, enter a spiral dive, and crash into a residential area, about 75 feet from a house, at 1122 central daylight saving time. A short, routine radio transmission was made from the aircraft immediately prior to the upset. The pilot and two passengers were killed on impact and the third passenger died shortly after being evacuated by rescue crews. There was no post-impact fire.

*Ce rapport est également disponible en français.*

## *Other Factual Information*

The weather at the time of the accident was clear, with no cloud below 7 000 feet above ground level (agl). The wind was 250 degrees magnetic at nine knots, the temperature was 24 degrees Celsius, and the dew point 17 degrees Celsius.

The pilot held a private pilot's licence with a medical certificate valid until 01 November 2000, with the restriction that glasses must be worn. The pilot's empty glass case and glasses were found in the cockpit. The pilot's log book indicated that he began flying in 1977 and that he had approximately 225 hours of total flying time. He had flown 18.7 hours in the 90 days prior to the accident and 7.3 hours in the last 30 days—all on the occurrence aircraft, C-GGIK. Information provided indicated that he had received training in forced approaches in May 1999. In addition, the pilot had taken military flying training in 1983 and had received about 53 hours of instruction on the CT114 Tutor jet trainer.

The toxicology report was negative, with the exception that acetaminophen (a non-prescription drug found in pain remedies) was detected in the pilot's body. However, it was not found in the pilot's bloodstream and was not a factor in this occurrence.

The aircraft crashed into a roadside ditch one minute after take-off, bounced, and came to rest about 20 feet from the first impact point. The right wing was torn off, and the right wing fuel tank ruptured on impact. Impact damage to the aircraft and the short wreckage trail indicate that the aircraft struck the ground at a high rate of descent with a low forward speed. The condition of the propeller and the absence of propeller strike marks indicate that engine power was minimal at ground impact. The aircraft was transported to a hangar at St. Andrews airport for further examination. The control systems and control surfaces were examined and no pre-impact anomalies were found. The fuel selector was found selected to the right tank. There were indications of water contamination in all fuel system components downstream of the fuel selector. A fluid sample of 0.44 fluid ounces drained from the fuel line between the engine-drive fuel pump and the fuel control contained about 0.03 fluid ounces of water. Normally, visible water is not tolerated in fuel.

A review of the aircraft maintenance records revealed no entry for Airworthiness Directive (AD) 85-24-03 (discussed later in this report). No other discrepancies in the records were noted. The aircraft journey log indicates that the fuel tank cap seals had been changed about two months before the occurrence flight. The seals were examined and found to be in good condition.

The engine was removed from the aircraft and taken to the TSB regional wreckage examination facility in Winnipeg for detailed analysis. Impact damage to the engine precluded an engine test run. A thorough examination of the engine and its components revealed corrosion in the engine-driven fuel pump and on the engine camshaft. Particles of contamination were found in the fuel-control filter. No other anomalies were found during the engine tear-down. The camshaft and samples of the contamination found in the fuel filter were analysed at the TSB Engineering Laboratory in Ottawa. The corrosion on the camshaft was determined to have occurred after installation of the engine and likely during periods of engine inactivity. The particles of contamination were determined to have originated primarily in the engine fuel pump; however, some additional contaminants were paint and fibrous materials.

The engine tachometer and the fuel pressure indicator were sent to the TSB Engineering Laboratory for microscopic examination. Impact marks found on the face of the fuel-pressure indicator placed the pointer

around 20 pounds per square inch at impact. Impact marks on the dial face of the engine tachometer placed the pointer in the range of 150 to 400 revolutions per minute (rpm).

The aircraft was equipped with a stall warning system designed to activate if the aircraft approached an aerodynamic stall. The stall warning horn was removed from the aircraft for further analysis in conjunction with the audio tape of the pilot's last radio transmission. The analysis found that a steady tone recorded on the St. Andrews tower tape during the last radio transmission was consistent with the steady tone produced by the stall warning horn during the test. No other useful information was obtained from the audio tape. Information provided indicated that the radio transmission occurred while the aircraft was observed flying eastward in level flight and immediately before the aircraft entered the abrupt manoeuvre.

The *Pilot Operating Handbook* (POH) indicates that the fuel capacity of the aircraft was 64 US gallons and the maximum allowable gross take-off weight was 2 740 pounds. For local flying, the aircraft was normally refuelled to the "bottom of the tab" for a standard load of 50 US gallons. No fuel was added on the occurrence date, and there was no entry in the journey log for the fuel load on the occurrence flight. A full fuel load, minus the fuel used in the first two flights of the day (estimated about 15 US gallons), and actual pilot and passenger weights were used to calculate the aircraft's weight and centre of gravity (C of G) for the occurrence flight. Using these criteria, the aircraft's take-off weight could have been, at most, about 80 pounds over the maximum allowable weight. However, it was not normal to fill the tanks for local flights. Assuming the fuel load was 50 US gallons, the take-off weight on the occurrence flight would have been about 2 740 pounds and the C of G would have been within limits.

Water can enter aircraft fuel tanks from leakage past the fuel-cap seals, contaminated fuel sources, and condensation within the tanks. Section 2-14 of *Mooney M20 Series Service and Maintenance Manual* states: "Keep fuel tanks at least half filled to minimize condensation and moisture accumulation in the tanks". To keep the tanks at least half filled requires a fuel load of at least 32 US gallons.

The last flight entered in the journey log was on 23 June 1999, and the aircraft was not refuelled immediately after this flight. There was no record of the refuelling date, but it was learned that approximately 29 US gallons of fuel were purchased by the pilot between June 25 and 30. The addition of 29 US gallons to achieve either a standard load or full load indicated that the total fuel remaining in the aircraft tanks after the flight on June 23 was between 21 and 35 US gallons.

The refuelling tanks for the last refuelling were checked for water contamination and none was found. The other refuelling sources for the 30 days prior to the occurrence were not checked for contamination because of the length of time between the refuelling and the occurrence. The refuelling sources all had appropriate filters and experienced high usage rates. No fuel contamination incidents had been reported by pilots after using these sources.

AD 85-24-03 refers to Mooney Service Bulletin (SB) M20-230, dated 10 April 1985, which requires that all rib drain holes within the fuel tanks be inspected for blockage by fuel tank sealant. It applies to all Mooney M-20F. The rib drain holes allow fuel and any accumulated water to move to the lowest area of the tank where the wing-tank drains are located. A wing-tank drain is located on each wing root forward of the wheel wells. Blockages of the rib drain holes allow water to be trapped between ribs in the tank. There is one oval drain hole in the rib at wing station 59.25 in each of the left and right fuel tanks; both of these holes were found sealed. The oval holes are the lowest of the rib drain holes. Other drain holes were found clear of sealant. Approximately 0.41 fluid ounces of water were found trapped outboard of the rib at wing station 59.25 in the

left fuel tank. Approximately 19 US gallons of fuel were drained from the left fuel tank, and no further water was found in the tank.

The Mooney M-20F POH requires that the fuel selector drain valve control, which is located on the cabin floor forward of the pilot's seat, be activated on each pre-flight check. Activation flushes the fuel selector-valve sump and the lines leading from the wing tanks to the selector valve. The valve is required to be activated for five seconds for each wing tank. The POH also requires the pilot to obtain fuel samples from the wing-tank sump drains. It explains the procedure and directs that fuel be sampled until all water is purged from the fuel tanks. There was no information to indicate whether the occurrence pilot carried out the required procedures to purge water from the fuel system. Information gathered during the investigation indicated that other users of this aircraft followed the POH procedures.

## *Analysis*

The engine rpm indicator found on the tachometer dial face and impact information indicate that the aircraft experienced a power loss before impact with the terrain. The observed level-off of the aircraft at about 340 feet agl indicates that the power loss likely occurred after the aircraft turned on crosswind. There was insufficient information to determine whether a complete or partial power loss occurred; however, the power remaining was inadequate to maintain altitude and flying speed. Because the aircraft remained in level flight, the airspeed would have reduced rapidly by aerodynamic drag. When the pilot did not stop the airspeed reduction and establish a safe glide speed, the aircraft reached aerodynamic stalling speed, stalled, and entered a spin. It could not be determined why the pilot did not stop the reduction in airspeed and whether the pilot attempted to recover from the spin; however, recovery from a spin entered at 340 feet agl is unlikely because of the rapid altitude loss. The tone heard on the radio indicated that the aircraft stall warning system functioned and should have alerted the pilot to the immediate need to maintain flying speed. However, on crosswind, the aircraft was at low level and subject to a tailwind. While the apparent ground speed of the aircraft would have increased due to the tail wind, the airspeed was reducing as a result of the engine power loss. The resultant effect may have created the illusion of adequate speed and masked the rapid reduction in airspeed.

While the engine-driven fuel pump was found to be contaminated and may have malfunctioned, the impact marks on the face of the fuel-pressure gauge indicate that the fluid in the fuel system was being delivered to the engine at an adequate pressure. The pressure may have been produced by a combination of the engine-driven pump and the electrical boost pump. The complete dispersal of water throughout the fuel-system components indicates that the fluid pumped to the engine was a mixture of water and fuel. The water in the fuel likely caused the power loss.

Because the fuel-cap seals had recently been replaced and were in good condition, it is unlikely that water entered the fuel tanks from leakage past the fuel-cap seals. This may have occurred before the fuel-cap seals were replaced or may have resulted from condensation during periods of inactivity. The last refuelling source was free of water contamination and the possibility of water contamination from fuel sources used in the previous 30 days is unlikely. Thus, water contamination present on the occurrence flight may have originated primarily from condensation in the fuel tanks when the aircraft tanks were less than half full for several days between June 23 and 30.

Because the oval drain holes in the rib at wing station 59.25 were blocked, the water found trapped in the left fuel tank could not have been removed by following the purging procedures specified in the POH.

Consequently, it is not possible to conclude, from the water found throughout the fuel system, whether the pilot correctly followed the POH purging procedures for the fuel system. The blocked drain holes also indicate that AD 85-24-03 was not followed. Water trapped outboard the rib at wing station 59.25 can move over the rib during manoeuvring in flight and contaminate other areas of the fuel system.

The corrosion found in the engine fuel pump may have occurred because of water contamination in the fuel or from condensation within the pump itself. The corrosion found on the camshaft was likely as a result of condensation within the engine crankcase and likely not related to the water contamination in the fuel.

The following TSB Engineering Laboratory reports were completed:

LP 79/99—*ATC Transmission Analysis*
LP 84/99—*Contamination Analysis*
LP 85/99—*Camshaft Examination*
LP 86/99—*Instrument Analysis*

## *Findings as to Causes and Contributing Factors*

1. The engine lost power, likely as a result of water contamination.

2. For reasons undetermined, the pilot did not maintain sufficient airspeed after the engine lost power, and the aircraft stalled and spun; the aircraft stall warning horn sounded before the stall.

3. The pilot may have been subject to an illusion because of a change in apparent ground speed, which resulted from the tail wind after the turn to crosswind.

## *Other Findings*

1. The pilot held a valid private pilot's licence and medical certificate and was qualified to fly the aircraft type while carrying passengers.

2. The pilot was likely wearing glasses, as required by his licence restriction.

3. AD 85-24-03 had not been followed, and water could be trapped behind the rib at wing station 59.25 in both the left and right fuel tanks.

4. Water contamination could not be eliminated from the fuel system by following the procedure in the POH because AD 85-24-03 had not been followed.

5. Water was trapped behind the rib at wing station 59.25 in the left fuel tank.

6. The water in the fuel tank and the fuel line may have entered the system by condensation occurring during the period the aircraft tanks were likely less than half full after the flight on June 23.

7. There was insufficient information to determine if the pilot purged the fuel system as required by the POH. However, even if the procedure was followed, water trapped behind the rib at wing station 59.25 would have remained in both tanks.

8. Recovery from a spin entered at 340 feet agl is unlikely due to the rapid altitude loss.

9. Corrosion was found in the engine fuel pump and on the engine camshaft.

*This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 19 July 2000.*