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

AVIATION INVESTIGATION REPORT
A07W0186

ENGINE FAILURE AND COLLISION WITH TERRAIN

PIPER MALIBU PA-46-310P, C-GTCS
INVERMERE, BRITISH COLUMBIA, 11 nm E
26 OCTOBER 2007

Canada

Aviation Investigation Report

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Summary

The privately operated Piper Malibu PA46-310P (registration C-GTCS, serial number 4608065) was en route from Salem, Oregon, to Springbank, Alberta, on an instrument flight rules flight plan. During the descent through 17 000 feet at approximately 55 nautical miles (nm) southwest of Calgary, the pilot declared an emergency with the Edmonton Area Control Centre, indicating that the engine had failed. The pilot attempted an emergency landing at the Fairmont Hot Springs airport in British Columbia, but crashed at night at about 1912 mountain daylight time 11 nm east of Invermere, British Columbia, in wooded terrain. The pilot and two passengers were fatally injured.

Ce rapport est également disponible en français.

Other Factual Information

The pilot was transporting friends to Salem, Oregon, from Calgary, Alberta, and planned to return the same day. The flight departed from the Calgary Springbank Airport at 0800 mountain daylight time [1] and arrived in Portland, Oregon, at 1030 to clear customs. The flight then departed Portland at 1100 and arrived in Salem, Oregon at 1120, where the occupants spent most of the afternoon. The aircraft was refueled and departed Salem for Springbank at 1620 on an instrument flight rules (IFR) flight plan. The aircraft had adequate fuel on board for the return flight in accordance with IFR regulations. The aircraft was equipped with avionics approved for en route IFR navigation. There was a handheld Garmin iQue 3600a PDA global positioning system in the cockpit. The IFR en route charts and approach plates found in the aircraft had expired 8 to 12 months prior.

At 1845, the pilot made initial radio contact with Edmonton Area Control Centre (ACC) at flight level (FL) 210 [2] and requested a descent to 14 000 feet above sea level (asl). The controller could not initially accommodate the descent request and issued a descent clearance to 16 000 feet at 1849. Further clearance to 14 000 feet was given at 1852. At 1856, passing through 16 500 feet asl, the pilot informed the controllers that they had an engine failure. The pilot was advised that Fairmont Hot Springs Airport - approximately 20 nautical miles (nm) from C-GTCS's position - was the nearest airport and was given a vector of 215° magnetic (M). The pilot acknowledged this and indicated that there would be a ridge to cross prior to reaching the airport. The flight was operating in visual meteorological conditions at the time of the engine failure.

At 1901, the area controller asked an overflying aircraft to orbit the area until C-GTCS had landed. At 1903, the overflying aircraft relayed that C-GTCS had the airport in sight and that they would clear the ridge. At 1905, the overflying aircraft relayed that C-GTCS was turning north towards Invermere because C-GTCS was not able to clear a ridge. No further communication was received until the overflying aircraft reported hearing an emergency locator transmitter (ELT) signal at 1912.

The impact site was located 11 nm east of Invermere, at approximately 3633 feet asl in wooded terrain in the Rocky Mountain ranges. There were a number of small narrow roads throughout the valley floor that were no longer being used. These roads are difficult to see from the air unless directly over them. The airframe was relatively intact with all major components generally in place. Clipped trees approximately 57 feet to the west of the fuselage indicate an aircraft descent angle of 45º and a bank angle of approximately 52° left wing down. The damage to the aircraft and impact angles were consistent with a non-survivable accident.

The pilot held a private pilot license valid for all single-pilot, non-high performance, single-engine land aeroplanes, day and night. He also possessed a valid and current group three instrument rating valid until 01 October 2008. He was certified and qualified to conduct the flight in accordance with existing regulations.

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1 All times are mountain daylight time (Coordinated universal time minus six hours).

2 Flight level 210 is approximately 21 000 feet above sea level.

A satellite image of the southeast portion of British Columbia at 2000, approximately 40 minutes after the occurrence, showed no cloud cover. The hourly weather report at 2000 for Cranbrook (located 60 nm south of the accident site) was wind calm, visibility 25 statute miles, skies clear, temperature 0°C, dew point -9°C, altimeter setting 30.45. Sunset for the latitude and longitude of the accident site for 26 October 2007 was 1830 with official night at 1903.

The glide time and distance chart from page 5-27 of the PA-46 *Pilot Operating Handbook* indicated that, at standard temperatures, the aircraft would glide from 16 500 feet asl to 3600 feet asl (the accident site elevation) in approximately 35 nm or 17 minutes. Sixteen minutes passed from the time the pilot declared the engine failure to when the ELT signal was detected.

Logbooks and technical records indicated that the aircraft was certified, equipped, and maintained in accordance with existing regulations and approved procedures. The aircraft logbooks showed no entry of any deficiencies before the accident flight. In the summer preceding the accident, the engine developed a knocking sound that was audible when power was reduced for landing. This had not been entered into logbooks nor reported to any maintenance facility. The aircraft weight at the time of the occurrence was estimated to be approximately 3735 pounds, which was under the maximum gross weight limit, and the centre of gravity was within limits at the time of the accident.

The TSIO 550C – 1B engine is of the Permold Series design, manufactured by Teledyne Continental Motors. The engine is lubricated internally by a wet sump, high-pressure oil system. Pressurized oil is delivered to the number two and three connecting rod journals and bearings from the number two main journal by way of passages inside the crankshaft. All flights on the day of the accident were carried out without the oil filler cap in place, as it was found at the hangar where the aircraft was kept. The absence of the oil filler cap could have resulted in the loss of engine oil, but its absence did not result in any loss of oil through that opening. The crankcase oil breather has a tube running from the dipstick opening to the breather canister. There was no evidence of oil accumulation here or at the bottom of the cowling.

Two alternators generate electrical power, one belt-driven and one gear-driven. The gear-driven alternator derives its rotational power from a gear bolted to the crankshaft between the number four and five main journals. This in turn drives the alternator coupler. This coupler consists of a sleeve with an attached cup, locked to the alternator shaft. The cup is driven by a formed rubber ring on the inner surface of the cup outer wall, which is then attached to the gear on the alternator shaft. The alternator drive hub is designed to slip when abnormal torque is required to rotate the alternator shaft. This prevents engine damage or loss of power in the event of an alternator seizure.

In the months before the occurrence, a number of maintenance actions were performed on the gear-driven alternator as a result of alternator failure indication. The alternator drive coupling was replaced approximately five flight hours prior to the accident flight. The coupling that was removed had a substantial amount of rubber material missing from both the front and back surfaces. This allowed the slip joint to spin and not lock to the cup as is normally the case. The coupling also made use of a handmade unapproved flat washer inside the cup that had a number of very rough edges and markings. This type of alternator is not designed to be used with such a washer, nor is it approved as a repair for continued airworthiness of the engine.

This washer was found to have forced the rubber ring further out of the cup and engage the gear teeth of the crankshaft alternator drive gear. This resulted in the destruction of the rubber portion of the coupling. Rubber particles of various sizes found their way into the engine sump (see Photo 1).

The rubber particles found in the engine sump matched those of the old coupling. In addition, several of the lifters contained rubber debris, indicating that the oil filter had been in a bypass state, allowing debris to flow into the system. The oil filter was also found to contain a large amount of rubber and metal debris. When the coupling was changed, the engine oil and filter were not changed, nor was the engine oil system flushed. The engine maintenance manual recommends checking the oil filter for metal debris during oil changes, but does not specify checking for other types of debris during other forms of maintenance. The engine manufacturer issued Service Bulletin M84-5 in 1984 that addressed gear-driven alternator malfunctions on all of its 520 series engines. It specifies that if any contamination is found upon removal of the alternator, the oil sump must be removed, the pick up cleaned or replaced, and, if anything further is found, a Teledyne Continental service representative should be contacted. This service bulletin does not apply to the 550 series engines even though they are equipped with gear-driven alternators. Standard industry practice is to check oil systems when contamination of any kind is found or known about, to flush the system, and to ascertain the source before releasing the aircraft for flight.

The top of the engine at centreline had a large hole over the number two connecting rod. The crankshaft and the number two connecting rod had indications of extreme heat, which was localized to this area (see Photos 2 and 3). The number two main bearing on one side was broken due to low-cycle pounding stresses. The number two piston had been making contact over time with its cylinder head and valves.

Photo 1. Gear damage to rubber material

Photo 2. Heat and contact damage to connecting rod 2

Photo 3. Crankshaft showing heated area

Analysis

Examination of the airframe wreckage and its components found no indication of any mechanical malfunction that may have initiated or contributed to the accident.

Weather was also not considered to be a factor, though the darkness in the valley floor may have contributed to the pilot's inability to find a better location to conduct the forced landing. The wreckage trail and the evidence of impact forces indicate that the aircraft crashed in a stalled flight condition.

An unapproved, shop-made washer that had been installed in the alternator drive coupling contributed to a quantity of rubber debris entering the engine. The presence of the washer in the coupling also caused the rubber disc to contact the alternator spur gear on the crankshaft, causing more debris to enter the sump. This debris then restricted oil flow in the failed area of the engine. The industry standard check of oil systems when contamination is found or known to exist was not carried out. The company performing the maintenance did not benefit from guidance developed in Service Bulletin M84-5 as the bulletin did not include this series of engine even though it had a gear-driven alternator.

It is highly probable that the engine failure was initiated by a partial blockage of oil flow, caused by debris in the oil, to the number two connecting rod journal and bearing. This resulted in a progressive loosening of the clearances at that location, which allowed a gradual increase in piston stroke and increasing contact between the piston and the cylinder/valves. This looseness caused repeated reaction forces on the number two main bearing, pounding it until fatigue cracking broke up the left bearing shell. The connecting rod journal continued to overheat and elongate the bearing area until the lower connecting rod end cap nut came apart. Total engine failure and seizure then occurred.

The engine knocking that occurred during the summer prior to the accident was not noted in the journey log book nor mentioned to maintenance personnel. Early detection of the loosening and overheating parts might have prompted preventative maintenance.

The following TSB Engineering Laboratory reports were completed:

LP116/2007 – GPS Analysis

LP115/2007 – Engine Failure Analysis

These reports are available from the Transportation Safety Board of Canada upon request.

Findings as to Causes and Contributing Factors

1. An unapproved part was installed in the alternator coupling. This resulted in debris from the coupling causing a partial blockage of oil flow to the number two connecting rod bearing. This low oil flow caused overheating and failure of the bearings, connecting rod cap bolts and nuts, and the subsequent engine failure.

2. The engine failure occurred after sunset and the low-lighting conditions in the valley would have made selecting a suitable landing area difficult.

3. The engine knocking was not reported to maintenance personnel which prevented an opportunity to discover the deteriorating engine condition.

Finding as to Risk

1. All flights on the day of the accident were carried out without the oil filler cap in place. The absence of the oil filler cap could have resulted in the loss of engine oil.

Other Findings

1. There were no current instrument flight rules charts or approach plates on board the aircraft for the intended flight.

2. The Teledyne Continental Motors Service Bulletin M84-5 addressed only the 520 series engines and did not include other gear-driven alternator equipped engines.

Safety Action Taken

Teledyne Continental Motors states that it will update Service Bulletin M84-5 to include the 550 series engines. The Teledyne Continental Motors Instructions for Continued Airworthiness will also be updated to reflect the content of Service Bulletin M84-5 as periodic updates to that document are performed.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 11 September 2008.

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