AVIATION INVESTIGATION REPORT
A01C0217

ENGINE POWER LOSS

BEARSKIN LAKE AIR SERVICE LTD.
PILATUS PC-12 45 C-FIJV
RED LAKE, ONTARIO
02 SEPTEMBER 2001

Aviation Investigation Report

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Bearskin Lake Air Service Ltd.
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Summary

Flight BLS363, a Pilatus PC-12/45, single-engine, turbine-powered aircraft was ready for take-off on Runway 26 at the Red Lake, Ontario, airport. Two pilots and three passengers were on board. When the condition lever was selected from ground idle to flight idle, the engine (Pratt & Whitney PT6A-67B) flamed out. An attempt to restart the engine was unsuccessful, and the aircraft was towed off the runway.

Ce rapport est également disponible en français.

Other Factual Information

Visual meteorological conditions existed at the time of the occurrence, with calm winds and a temperature of 33°C.

Both pilots held valid commercial pilot licences and were properly trained and endorsed for the intended flight.

The aircraft was fueled from a filtered fuel station at the Sioux Lookout, Ontario, airport on the night before the occurrence. Maintenance staff did a run-up on the aircraft at that time and found no anomalies. Fuel sumps were also checked, and no contamination was found. The next day, engine start was completed in accordance with the operator's standard operating procedures, using the aircraft battery but a run-up was not conducted by the crew. Immediately after ground idle (65% N_g[1]) was achieved, the air conditioning, avionics and vent blowers were turned on. While taxiing for position on Runway 26, no anomalies were noted by the flight crew.

Once the aircraft was positioned for take-off, and about 90 to 120 seconds after ground idle was achieved, the condition lever was advanced to flight idle (75% N_g). During the transition to flight idle, the battery ammeter indicated a draw of +300 A. Almost simultaneously the engine flamed out (lost all power). A restart was attempted but soon terminated because the battery voltage was down to 19 V, and only 8.5% N_g was achieved. The aircraft manufacturer indicated that after a typical battery start, the normal load required to recharge the battery will initially be about 190 A, and will gradually reduce as the battery charges. . The aircraft flight manual and the company standard operating procedures specify that the battery charging current prior to take-off shall not be more than 15 A, otherwise the take-off must be delayed. Following a battery start, 5 to 8 minutes may be required before the battery charge is sufficient for take-off. In addition to the battery charging, the following electrical equipment was operating at the time of the 300-A draw: air conditioning, navigation lights, and beacon and vent blowers. This equipment collectively draws 110 A and, when combined with the battery charging load, produces an aggregate generator load of +300 A.

After the aircraft was towed off the runway, company maintenance staff arrived to determine why the engine lost power. After a visual inspection revealed no obvious discrepancies with the aircraft, ground maintenance personnel ran the engine using a ground power unit. Efforts to duplicate the engine power loss and the high amperage draw were unsuccessful.

After the engine was shut down, the fuel filters and fuel sumps were inspected, but no contamination was found. Inspection of the engine revealed particles resembling carbon in the oil filter. Particles from the oil filter were sent to the TSB Engineering Laboratory in Ottawa. Initial inspection of the sample found it to have been cleaned with solvent, which removed all traces of oil. Analysis of the particles found them to be a varied collection of wood, synthetic and mineralogical fibres. A number of black particles were also found, which were determined to be either carbon or paint. The electrical system was inspected, but no anomalies were found. The No. 1 generator, the fuel control unit, and the engine-driven fuel pump were then replaced.

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[1] N_g is a percentage of the speed (rpm) of the gas generator (engine compressor).

It was learned that an oil sample, previously taken from the engine and analysed, indicated a magnesium count of 39.9 parts per million (ppm). The PT6A maintenance manual does not prescribe magnesium limits in the oil. An internal, non-published guideline of 35 ppm of magnesium was established by Pratt & Whitney (P&W) PT6 Customer Solution. When this guideline is reached, Pratt & Whitney will advise the operator that regular borescope inspections are required to assess wear of the splines. A borescope inspection of the second-stage in the reduction gear box (RGB) was conducted by the operator's maintenance staff; wear was found on the mating splines. Borescope inspections are required when oil samples indicate elevated levels of magnesium. The aircraft was then ferried back to Thunder Bay for engine removal.

The engine was sent to P&W Canada for teardown. P&W staff also conducted a borescope inspection before the RGB was disassembled. The inspection revealed fretting of the second-stage mating splines of the RGB. Disassembly of the RGB confirmed substantial fretting to the RGB's second-stage mating splines and the ring gear.

Required inspection criteria, such as the borescope inspections and oil analysis, are used to monitor the condition of a RGB case. Failure to complete these inspections could eventually result in a failure of the RGB. Compliance with P&W *Service Bulletin* No. 14267 R1 ("Reduction Gearbox Second Stage Ring Gear and Propeller Reduction Gearbox Front Housing— Replacement of") is recommended when wear limits are reached or when disassembly of a RGB case is necessary. About 200 PT6A-67B engines are currently in operation, for which approximately 20 have had P&W *Service Bulletin* No. 14267 R1 completed because of excessive wear of their RGB case. P&W has indicated that, to date, no catastrophic failures have occurred in the second-stage reduction gear.

Gas generator disassembly revealed no anomalies. The No. 2 bearing had previously been modified in accordance with P&W *Service Bulletin* No. 14320 R2 ("Replacement of Compressor Turbine Air Seal and No. 2 Bearing Oil Nozzle and Housing Cover and Flange"). The bearing was relatively clean; however, a black, flaky deposit was found on the walls of the bearing oil housing. Analysis of the deposit revealed a combination of carbon and magnesium.

On disassembly of the power section, the thermal blanket was found to be covered with soot. The power turbine shaft housing and the No. 3 bearing cover were also covered with soot, which was revealed to be carbonaceous. An inspection of the power turbine rotor air seal revealed that the diameter of the air passage holes was reduced because of a black residue build-up, also revealed to be carbonaceous.

The engine fuel control unit (FCU), fuel pump, and flow divider were bench tested at the P&W facility. The only FCU anomaly discovered was that specified governing air pressures (P_y) produced insufficient fuel flow, which did not contribute to the occurrence in any way. All three units were then installed on another PT6A-67B engine that was ready for test run in a test cell. After ground idle was reached, acceleration, deceleration, N_g idle, flight idle speed settings, transient power settings, and engine shutdown showed no anomalies. The engine flame-out on the runway during transition from ground idle to flight could not be duplicated. Disassembly of the FCU, the fuel pump, and the flow divider revealed no anomalies. Intake of water or air can interrupt the fuel scheduling system enough to cause an engine to flame out and not leave any indication of the reason for a power loss in the fuel scheduling components.

The starter generator was sent to a local overhaul facility. The unit was bench tested, and no anomalies were found. Disassembly and overhaul of the unit did not reveal any discrepancies that would have contributed to the 300-A draw.

Canadian Aviation Regulations, section 703.22(2), require that single-engine, turbine-powered aircraft used to transport passengers in instrument-flight-rule or visual-flight-rule conditions be equipped with an engine type that has a proven mean time between failure (MTBF) of .01/1000 or less over 100 000 hours in service (that is, less than one engine failure every 100 000 hours of operation). Engine power losses resulting from fuel supply interruptions are not considered engine failures for the purpose of the MTBF standard.

Analysis

The magnesium count in the oil was the result of fretting wear between the second-stage ring gear and the magnesium mating splines of the RGB case. Fretting between the second-stage gear teeth and the mating splines of the RGB case will result in magnesium dust particles being released into the engine oil. The magnesium dust particles are heated as a result of the friction to a point where the oil immediately surrounding the particle will breakdown, depositing a thin carbonaceous layer around the particle. These particles were eventually captured by the oil filter. The pure carbon particles captured by the filter were produced in the system prior to the incorporation of P&W *Service Bulletin* No. 14320 R2 ("Replacement of Compressor Turbine Air Seal and No. 2 Bearing Oil Nozzle and Housing Cover and Flange").

A combination of oil sample analysis and borescope inspection is used to monitor the RGB case. Implementation of these inspections and compliance with the service bulletin have been successful: there have been no reported catastrophic failures due to excessive fretting of the RGB housing splines.

The sudden power loss of the PT6A-67B engine most likely resulted from an interruption in fuel supply; however, this could not be determined with certainty. Inspection of the fuel system did not reveal any sign of water, and testing and disassembly of the FCU, fuel pump, and flow divider did not reveal any anomalies that would have contributed to the power loss.

During the initial battery start of the engine, the condition lever was set at ground idle (65% N_g), and the equipment that was turned on demanded a large electrical load. With the engine remaining at ground idle for only 90 to 120 seconds, the generator might have been slow to meet the demands of charging the battery and running the equipment. Once flight idle (75% N_g) was selected, the generator was more able to meet these demands, which resulted in a 300-A draw on the amperage gauge. Because the engine was able to accelerate from ground idle to flight idle speed with the electrical equipment already selected, it is likely that the 300-A draw and the engine power loss were coincidental and that the draw did not contribute to engine power loss.

The engine power loss and fretting of the RGB case mating splines were not considered an engine failure and therefore did not affect the engine's reliability record.

The following TSB Engineering Laboratory Report was completed:

LP 107/2001—Oil Filter Debris Analysis

Findings as to Causes and Contributing Factors

1. The engine power loss most likely resulted from an interruption in fuel supply.

Other Findings

1. Fretting between the second-stage ring gear teeth and the magnesium reduction gearbox (RGB) case resulted in a magnesium count in the engine oil. The magnesium particles were coated with a thin carbonaceous layer and eventually became trapped by the oil filter.

2. Carbon particles in the oil filter originated from the #2 bearing area prior to the incorporation of P&W *Service Bulletin* No. 14320 R2 ("Replacement of Compressor Turbine Air Seal and No. 2 Bearing Oil Nozzle and Housing Cover and Flange").

3. The electrical power draw resulted from battery charging and the electrical equipment that was selected. The electrical power draw likely did not contribute to the engine power loss.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 19 September 2002.

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