Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

AVIATION INVESTIGATION REPORT

A99C0208

ENGINE POWER LOSS / FORCED LANDING

SOWIND AIR LTD.

PIPER PA-31-350 C-GHMK

PRINCESS HARBOUR, MANITOBA

29 AUGUST 1999

Canada

Aviation Investigation Report

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Piper PA-31-350 C-GHMK
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Report Number A99C0208

Summary

The Piper PA-31-350 Navajo, C-GHMK, departed from St. Andrews, Manitoba, on a visual flight rules charter flight to Berens River. One pilot and ten passengers, including one infant, were on board, and a dog was stowed in the baggage compartment behind the right, rear seat. At approximately 1530 central daylight saving time (CDT), while the aircraft was at an altitude of about 2 500 feet and about 30 nautical miles south of Berens River, the pilot heard a loud sound from the left engine. He saw deformation of the left engine cowling and smoke coming from the engine, and the aircraft yawed to the left. Part of the engine cowling departed in flight. The pilot could not pull the left propeller lever beyond half of its normal travel, nor could he move it into the feather position. He set maximum power on the right engine, but the aircraft did not maintain altitude. The pilot advised company dispatch over the radio that he would attempt a forced landing, then force landed in a mossy marsh area. Everyone on board, including the dog, deplaned. Five of the passengers sustained minor injuries during the evacuation. A fire ensued, completely destroying the aircraft except for the empennage aft of the horizontal stabilizers.

Ce rapport est également disponible en français.

Other Factual Information

Before departure, the pilot performed a run-up in accordance with the operator's standard operating procedures and did not notice any discrepancies. The aircraft weight at take-off was 6 676 pounds. Calculations indicate that the aircraft's weight and centre of gravity were within the specified limits.

The aircraft left a wreckage trail approximately 700 feet long and came to rest perpendicular to the flight path, with the landing gear retracted, in a mossy marsh. The landing area contained small trees, approximately two to three inches in diameter, which were severed by the aircraft on approach. The aircraft descended from 20 feet to ground level over a distance of 300 feet. The landing gear and flaps were in the up position.

All passengers were wearing their lap belts except for the infant, who was held by the mother on her lap. A passenger occupying the first officer's seat wore a lap belt and a shoulder harness. No fire or smoke entered the cabin area during the flight, and the cabin remained intact during the forced landing. The passengers and the dog deplaned through the cabin emergency exit on the right side of the aircraft. After evacuation of the aircraft, the pilot instructed all passengers to move away from the aircraft. The pilot exited through the cockpit crew door and, using a handheld fire extinguisher, attempted, unsuccessfully, to extinguish the fire in the area of the left engine. The fire was eventually extinguished by a water bomber that was in the area at the time.

An emergency locator transmitter (ELT) signal was detected after the accident. The ELT was mounted underneath a fairing, between the top of the aft section of the fuselage and the bottom of the vertical fin leading edge. The ELT was not visible from the outside of the aircraft and was accessible only by removing the fairing with a screwdriver. In addition to the switch on the ELT itself, there was a remote off/on/arm switch mounted on the instrument panel in the cockpit. The ELT had received extensive burn damage to the case, and both the remote switch and the switch on the ELT itself were destroyed.

The aircraft's passenger briefing card shows how to operate the ELT unit in the event of an emergency. However, because the ELT is only accessible with the use of tools, operation of the ELT in an emergency may be more difficult than the briefing card indicates. No tools to gain access to the ELT were found, nor are they required by regulation.

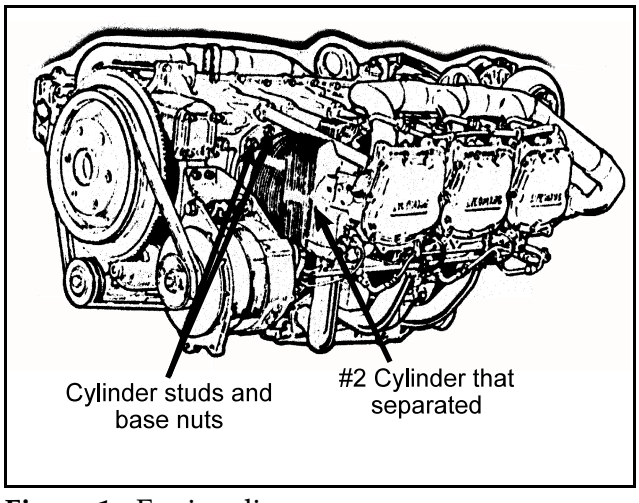

Figure 1 - Engine diagram

The left engine's number two cylinder had separated from the crankcase at the cylinder studs and was found adjacent to the engine, still connected to the oil sump by its oil return line. The connecting rod and piston were not found, and the fuel injector line was severed. The subject cylinder is mounted immediately aft of the propeller governor control and immediately forward of the number four cylinder. The lower left cowling remained in place but was destroyed by fire; however, it was able to contain the separated cylinder. Half of the

cylinder skirt was missing, and the remainder of the skirt was badly damaged. The left propeller was found in a mid-range pitch setting, while the right propeller was found fully feathered. The right propeller was feathered by the pilot just before the aircraft touched down. Recovered at the site, next to the left engine, were two ½-inch base nuts with fractured stud material in them, one ⅜-inch base nut with fractured stud material in it, and one ½-inch base nut with no fractured stud material in it.

The aircraft's journey log was destroyed by the fire. The left engine had a total time of approximately 972 hours. The aircraft's technical records revealed that the left engine sustained a failure of the number three cylinder 79.5 hours prior to the accident. In this instance, all the studs of the number three cylinder failed, and the cylinder was held in place by the two ½-inch through studs. During the repair all studs, through studs, and the cylinder were replaced. The aircraft maintenance engineer (AME) who replaced the cylinder indicated that all cylinder base nuts on the left engine were checked for proper torque values after he replaced the number three cylinder. The torque wrench used for the installation was checked for accuracy by the TSB and was well within the required specifications. The pilot and AME reported that the engine had not been over-boosted.

Examination of the left engine revealed that the lower, forward, ½-inch through stud on the number three cylinder had no cylinder base nut. The upper, forward through stud of the number three cylinder was backed up against the cylinder fins. Teardown of the subject engine was difficult because of the fire. The lower, rear, ½-inch through stud of the number one cylinder fractured during the attempt to remove the base nut.

Teardown of the subject engine revealed that the base nut was missing from the lower, forward, ½-inch through stud of the number three cylinder. It is likely that the one ½-inch base nut without the fractured stud material, found at the site next to the left engine, came from that through stud. Insufficient clamping force of this through stud leaves both the number two and number three cylinders without the required clamping force. The required clamping force is achieved by applying proper torque values to the cylinder hold-down nuts. After installing a cylinder, it is not sufficient to simply torque the cylinder base nuts of the cylinder being replaced; the opposing cylinder sharing the through studs must also be checked for proper torque. If these opposing cylinder nuts do not receive the required torque, then the through stud cannot apply the necessary clamping force to both cylinders.

The engine manufacturer advised that cylinders are occasionally replaced in the field under conditions in which paint or other foreign material can become trapped either between the cylinder and the mounting flange or under hold-down nuts. Operation of the engine results in vibration, which can cause the foreign material to migrate away from the mounting flange or the hold-down nuts and result in a loss of cylinder clamping force. Fire damage precluded a determination as to whether any such foreign matter was involved in this occurrence. However, the hold-down nuts were examined during a routine maintenance inspection about three flight hours after the cylinder change, and no foreign material was noted in the area.

The engine manufacturer indicated that insufficient clamping force by any cylinder base nut will transfer the hold-down force of the cylinder to the remaining seven studs, which will take on the full load of the cylinder and eventually cause fatigue failure. Lycoming Service Instruction No. 1029D (Part II) and the *Lycoming Operator's Manual* (part number 60297-23)

prescribe torque procedures when replacing cylinders. Both require that the base nuts of the opposing cylinder, which share the through studs of the cylinder that has been replaced, be re-torqued.

At 1500 CDT on the day of the accident, the Berens River automatic weather observation system recorded a temperature of 20 degrees Celsius, dew point six degrees Celsius, and altimeter setting 31.09 inches. The ceiling, visibility, and wind speed data were missing. The area forecast for the area of the accident site predicted scattered cloud at 5 000 feet to 6 000 feet, high thin scattered cloud, visibility greater than six miles, and surface winds southeasterly at 10 knots gusting to 20 knots. The weather at the time of the accident, visual meteorological conditions, played no role in the accident.

The pilot held a commercial pilot licence valid for single- and multi-engine land and sea aeroplane, with a Group 1 instrument rating. The pilot had successfully completed a pilot proficiency check for the subject aircraft type, valid until 1 May 2000. The pilot had a valid Category 1 medical certificate. There was no indication that incapacitation or physiological factors affected the pilot's performance.

The aircraft flight manual indicates that the aircraft should have been capable of maintaining a rate of climb of about 250 feet per minute with one engine operating, the propeller of the other engine feathered, and the landing gear and flaps in the up position.

Analysis

After the left engine lost power, the pilot tried to shut the engine down but was unable to feather the left propeller because he could not get full travel on the left propeller lever. The drag from the unfeathered left propeller and the deformed left engine cowling resulted in the aircraft being incapable of maintaining its altitude.

Although the number two cylinder separated from the crankcase, it was contained in the engine area by the propeller governor, the number four cylinder, and the lower engine cowling. Because there is very little clearance between the propeller governor control and the number two cylinder, the number two cylinder was in a position to interfere with the operation of the propeller governor control after it separated, preventing full travel of the propeller lever. With the separation of the number two cylinder, engine oil and raw fuel from the severed fuel injector line likely sprayed onto the hot exhaust stack, resulting in the smoke and fire that eventually destroyed the aircraft.

Damage to the trees on the approach path indicated that the pilot was able to maintain control of the aircraft during the approach and was able to execute a very gradual descent. The aircraft came to a rest in an upright position, which aided the evacuation process. The pilot was in touch with the company dispatch by very high frequency radio and assisted in coordinating the rescue operation.

Although it was the number three cylinder that was missing a base nut, the through stud is shared by the lower rear hold-down point of the number two cylinder. The missing base nut of the through stud indicates that the base nut did not have sufficient clamping force; however, it could not be determined if the base nut did not receive the required torque during installation or if the base nut lost its clamping force during engine operation. The insufficient torque led to insufficient clamping force by the lower rear base nut of the number two cylinder. Without the

required clamping force of the lower ½-inch hold-down point of the number two cylinder, the remaining studs took on the load of the cylinder and eventually failed in fatigue. Analysis of the fractured studs and through studs by the TSB Engineering Branch indicated signs of fatigue failure.

The following Engineering Branch report was completed:

LP 117/99—Cylinder hold-down stud and through bolt failure.

Findings as to Causes and Contributing Factors

1. The number three cylinder lower forward through stud was missing its base nut, which allowed the lower rear base nut of the number two cylinder to loosen.

2. The missing base nut of the through stud indicates that the base nut did not have sufficient clamping force; however, it could not be determined if the base nut did not receive the required torque during installation or if the base nut lost its clamping force during engine operation.

3. The ⅜-inch studs and the ½-inch through studs of the number two cylinder failed in fatigue, and the number two cylinder of the left engine separated from the crankcase.

4. The left propeller could not be feathered because of interference between the propeller governor control and the separated number two cylinder.

5. The drag from the unfeathered left propeller and the deformed left engine cowling resulted in the aircraft being incapable of maintaining its altitude.

Other Findings

1. The pilot was certified and qualified for the accident flight.

2. The aircraft's weight and balance were within the specified limits at the time of the accident.

3. The ELT was not readily accessible without tools.

Safety Action

The company has relocated the ELT on the remainder of its fleet for easier access.

Transport Canada shall write an article in the AME safety newsletter, *Maintainer,* stressing the importance of following the proper torque procedures, especially when changing a cylinder. Additionally, Transport Canada has a national training program, Human Performance in Aviation Maintenance, that addresses human factor errors found in aviation maintenance.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 3 August 2000.