

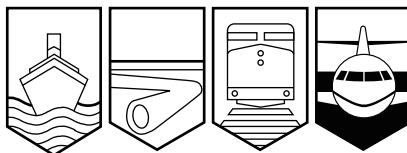
Transportation Safety Board
of Canada



Bureau de la sécurité des transports
du Canada

AVIATION OCCURRENCE REPORT

A98F0033



LOSS OF A PROPELLER IN FLIGHT

AÉRO 3000

PIPER PA-31P C-GAFG

WATERTOWN, NEW YORK, U.S.A.

22 JULY 1998

Canada

The Transportation Safety Board of Canada (TSB) investigated this occurrence for the purpose of advancing transportation safety. It is not the function of the Board to assign fault or determine civil or criminal liability.

Aviation Occurrence Report

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20 nm north of the VOR

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Summary

The Piper Navajo, registration C-GAFG, serial number 31P-76, with five persons on board, was on a commercial flight under instrument flight rules (IFR) from the Ottawa airport, Ontario, to Syracuse, New York, U.S.A. When the aircraft was cruising at 10 000 feet above sea level, the crew heard an unusual, very loud and very brief noise. The co-pilot saw the right propeller break away from the engine and move up and to the right, without touching the aircraft. A large quantity of oil spread over the right wing. The crew immediately carried out the emergency procedure, and informed the control centre in Boston, Massachusetts, U.S.A. The descent was made visually with only one engine. The aircraft landed without difficulty at Watertown airport, with emergency equipment standing by.

Ce rapport est également disponible en français.

Other Factual Information

The records indicate that the pilot-in-command was certified and qualified for the flight in accordance with existing regulations. He was a company employee and had accumulated approximately 690 flying hours at the time of the occurrence, including about 68 hours on type. He held a commercial pilot licence—aeroplane category since 1996.

The aircraft had accumulated 3 468 flying hours since its manufacture in 1972. It had been purchased in British Columbia in February 1998, and as soon as it was received by the operator, it was given a 1 000-hour major inspection in conformity with the approved inspection program. Since that inspection the aircraft had accumulated 69 flying hours.

The engine was installed on this aircraft in August 1986, with 947 hours since an overhaul in March 1979. At the time of the 1 000-hour major inspection in 1998, the engine had accumulated 1 178 hours. The technical records show that the engine had been used for only 231 hours in the past 12 years. At the time of the occurrence, the engine had accumulated 1 247 hours, and the time elapsed since the overhaul in March 1979 was 19 years 3 months. Textron Lycoming Service Instruction 1009AJ recommends a time between overhauls of 1 200 hours or 12 years. In publishing that service instruction, the manufacturer wanted to make clarifications and establish clear procedures for the operation and maintenance requirements for its engines. The service instruction also states that operators may increase the number of hours between overhauls if the engine is in continuous service, that is, not out of service for longer than 30 days. The manufacturer also warns about the possibility of deterioration of materials and parts during out-of-service periods. It states that the 12-year time between overhauls should never be exceeded.

The propeller had been installed on the right engine on 31 July 1997 following a complete overhaul. At the time of the 1 000-hour major inspection, the propeller had been in service for 15 hours since the last overhaul. At the time of the occurrence, the propeller had accumulated 84 hours since the last overhaul.

In Canada, operators must maintain their aircraft according to a maintenance schedule approved by Transport Canada (TC). These maintenance schedules are submitted for approval following an analysis by the operator, and depend on such factors as the type of operation, the type of flights performed by the aircraft, and annual use forecasts calculated in hours and in cycles. It is up to the operators to identify any amendments necessary to reflect changes in conditions, and to obtain TC approval to incorporate those changes. The operator had received its new operating certificate on 17 March 1998. The original maintenance schedule, bearing the number Q-2360, had been approved on 10 November 1997. The first amendment to the maintenance schedule was approved on 22 May 1998. The main purpose of this amendment was to include in the maintenance schedule Airworthiness Notice B041, concerning the engine on-condition program.

The Approved Maintenance Organization's maintenance policy manual was submitted to TC on 15 August 1996 and approved on 28 July 1997. It meets the requirements of an Approved Maintenance Organization (AMO) under *Canadian Aviation Regulations* (CAR) 573.10. The approval certificate, number 31-97, was issued on 28 July 1997. The AMO maintenance policy manual indicates that, except for the position of maintenance manager, all other duties related to the AMO's operations are delegated to the AMO president. Those duties include those of hangar foreman, quality assurance manager, assistant to the maintenance manager, apprentice, storesman, and records clerk.

According to the AMO maintenance policy manual, the maintenance manager performs the following duties: (a) is in charge of all maintenance activities carried out by the AMO, and must meet the standards of qualifications stated in *Airworthiness Manual* Chapter 573; (b) is in charge of distributing work to the maintenance personnel; (c) is in charge of initial training, recurrent training, and additional training given to the maintenance personnel; and (d) is in charge of carrying out the quality assurance program and ensuring that the maintenance and the management of maintenance activities comply with the standards stated in *Airworthiness Manual* Chapter 573.

According to the AMO maintenance policy manual, duties (b) and (c) are delegated to the assistant to the maintenance manager, and duty (d) is delegated to the quality assurance manager. The duties of assistant to the maintenance manager and quality assurance are performed by the AMO president. The maintenance manager is not a full-time employee.

Airworthiness Notice B041 contains the requirements for the engine on-condition maintenance program. Operators may incorporate such programs in their aircraft maintenance schedules as an alternative to the manufacturer's recommended "hard time" programs. Continued compliance with the *Pilot Operating Handbook*, *Aircraft Flight Manual*, *Engine Operating Manual*, and the maintenance practices recommended by the manufacturer may help to extend the time between overhauls. The program consists of repetitive periodic inspections to determine a unit's (component's) condition so that it will be removed from service prior to failure during normal operations.

Before approving this program, the maintenance manager must review all recommendations issued by the aircraft, engine, propeller, and component manufacturers in the form of service publications and other documents, such as service bulletins, directives, letters, etc. The maintenance manager must study the recommendations to determine whether incorporation of a given element is appropriate to the new program. The program provides for repeat inspections at intervals of 25, 50, 100, and 200 hours. The entries for the checks performed and the actions taken must be made and certified in the relevant technical records in accordance with CAR 571.03.

The level of inspection provided for in the program is not comparable to an overhaul by an approved engine shop. The inspection consists in assessing the current condition of the engine, and ensuring that the operating parameters set by the manufacturer are within prescribed limits and that the engine's external and internal condition does not show any form of corrosion, damage, or wear. Oil analysis and removal of the cylinders are the only possible means of determining internal condition. Even when the cylinders are removed for inspection, several important parts are not visible; therefore, they cannot be assessed.

The engine teardown identified some fractured components that needed metallurgical analysis and evaluation. These included a broken valve spring (part number LW-11799), an intake valve (part number LW13087), and the propeller shaft-driven gear (part number 75562). Even though the valve spring breakage did not contribute to the loss of the propeller, there was a fatigue point caused by corrosion. The intake valve head was broken into four segments, but did not exhibit signs of progressive failure; rather, the fractures were consistent with a rapid overstress most likely caused by overspeed due to the loss of the propeller.

On the other hand, the propeller shaft-driven gear exhibited widespread fatigue cracking of the gear teeth, complete separation of the rim from the hub at the web, and ovalization of the rim itself. Although the roots of the gear teeth were covered with a carbonaceous oil residue, there was indication of corrosion pitting. After removal of the bulk of the oil residue by repeated application of an oven cleaner solution, the corrosion pitting became even more noticeable. Detailed examination of the fatigue crack initiation sites established a link between the corrosion pits and the cracks.

Analysis

The pilot was certified and qualified for the flight in accordance with existing regulations. The aircraft was airworthy, and there were no known deficiencies before the flight.

Before submitting an amendment to a maintenance schedule, the maintenance manager must review all recommendations issued by the engine manufacturer, such as service bulletins, directives, letters, etc. The maintenance manager must study the recommendations to determine whether incorporation of a given element to the new program is appropriate. The engine manufacturer had issued Service Instruction 1009AJ, clearly stating the possibility of engine deterioration. The maintenance manager, in his analysis, and TC, in granting its approval, did not take those recommendations into account.

The operator had its own AMO. Except for the position of maintenance manager, all other duties related to AMO operations were delegated to the AMO president. Three of the four duties ordinarily carried out by the maintenance manager had been delegated to the assistant to the maintenance manager, who is the AMO president. This seems to indicate that a single individual directed the operator's operations and maintenance, especially since the maintenance manager was not a full-time employee. This organizational structure had been approved by TC.

The engine manufacturer has established a limit for hours of operation for each engine type it manufactures. The limit varies depending on the type of operation and the quality of the maintenance done on its product. However, the engine manufacturer allows no flexibility as to the number of years of use, and clearly recommends never exceeding the 12-year limit, as specified in Service Instruction 1009AJ.

The TSB Engineering Branch determined that the presence of corrosion pitting in various areas resulted from a lack of proper corrosion prevention measures. Examination of the technical records revealed that no action had been taken to that effect. The presence of corrosion caused an accelerated wear, considering the relatively low number of hours of operation of the engine. The possible increased play and the fatigue from corrosion pitting both contributed to the failure of the propeller shaft-driven gear. This failure in turn led to the destruction of the propeller housing case, and the propeller separated in flight.

The following Engineering Branch report was completed:

LP 90/98—Engine components examination.

Findings

1. Review of the records indicates that the pilot was certified and qualified for the flight in accordance with existing regulations.
2. The aircraft was certified and maintained in accordance with existing regulations and approved procedures.
3. The first amendment to maintenance schedule Q-2360 was approved on 22 May 1998. The main purpose of this amendment was to include in the maintenance schedule Airworthiness Notice B041, which refers to the on-condition engine program.
4. Textron Lycoming Service Instruction 1009AJ recommends a time between overhauls of 1 200 hours or 12 years.
5. The engine had accumulated 1 247 hours, and 19 years and 3 months had elapsed since it was overhauled.
6. The AMO's organizational structure had been approved by TC.
7. The condition of certain internal engine components could not be assessed due to the level of inspection performed under the on-condition engine inspection program.
8. The propeller housing case was destroyed, and the propeller separated in flight.

Causes and Contributing Factors

The increased play and fatigue caused by corrosion pitting both caused the propeller shaft-driven gear to fail. This failure in turn led to the destruction of the propeller housing case, and the propeller separated in flight. Contributing to the occurrence was the fact that neither the maintenance manager nor TC took into account the manufacturer's Service Instruction 1009AJ concerning the time between engine overhauls.

Safety Action Taken

Changes to the maintenance schedule (Q-2360) were requested by TC and were made by the operator to discontinue the on-condition engine program.

In December 1998, TC issued a notice of suspension of the operator's operating certificate because the operator no longer had a maintenance agreement. The operator revised its organizational structure and subcontracted its maintenance to another AMO.

TC is assessing the regulations contained in CAR 573 that apply to the reporting structure within an AMO.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board, consisting of Chairperson Benoît Bouchard, and members Jonathan Seymour, Charles Simpson, W.A. Tadros and Henry Wright, authorized the release of this report on 13 January 2000.