Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

AVIATION INVESTIGATION REPORT
A05P0080

IN-FLIGHT FIRE

NAVAIR CHARTER, INC.
PIPER PA-31-350 C-GVCP
19 WING COMOX, BRITISH COLUMBIA
22 APRIL 2005

Canada

Aviation Investigation Report

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Summary

The Piper PA-31-350 (registration C-GVCP, serial number 317652080) was on a scheduled cargo flight from Nanaimo, British Columbia, to the civilian terminal on the south side of the military airbase at Comox, British Columbia. The crew members established communication with the Comox tower when they were at about 2000 feet over Hornby Island, 12 nautical miles southeast of Comox, and requested a practice back course/localizer approach to Runway 30, circling for landing on Runway 18. The request was approved and the aircraft continued inbound.

When the aircraft was about two miles from the threshold of Runway 30, the crew declared an emergency for an engine fire in the right engine. The tower alerted the airport response teams and requested standard data from the crew concerning the number of people and amount of fuel on board. Less than 30 seconds after the crew first reported the emergency, the aircraft was engulfed in flames. Shortly thereafter, at 0741 Pacific daylight time, the aircraft rolled inverted and struck the ground in a steep, nose-down, left-wing-low attitude. The aircraft broke apart and burned. Both crew members were fatally injured.

Ce rapport est également disponible en français.

Other Factual Information

The weather at the time of the occurrence was reported as follows: wind 310° True at 4 knots; visibility 20 statute miles; a few clouds at 25 000 feet. The incident occurred at 0741 Pacific daylight time.[1]

Solidified droplets of molten aluminum and several small structural components were found along the inbound course for Runway 30, as far back as 1000 feet before the initial impact point. The aircraft's first contact with the ground was approximately 300 feet short of the threshold for Runway 30 and slightly right of the runway's extended centre line. The aircraft broke apart after the initial impact; the cockpit section was destroyed and both engines detached from the wings. The main wreckage was further damaged by a post-crash fire. The right engine, along with its cowlings and firewall, came to rest in an upright position a few feet aft of its normal station on the wing. Because of this separation, the right engine remained outside the area most affected by the post-crash fire.

After a preliminary site survey, the wreckage was transported to the Transportation Safety Board (TSB) Regional Examination Facility for further examination.

The engine cowls and wing surfaces were examined to identify in-flight burn patterns. Under normal circumstances the engine firewall, coupled with an exhaust heat shield assembly, located aft of the engine and below the wing, are intended to defend critical systems from heat. In this instance, an examination of the fire patterns revealed the following information:

- The gill cowl, inboard of the right engine, displayed a burn pattern that was likely caused in-flight.
- The leading edge of the right wing, just inboard of the right engine nacelle, burned through in flight.
- The main fuel tank, located immediately aft of the leading edge, had been penetrated by fire.

Visual examination of the right-hand engine revealed that it had sustained moderate impact damage at the front. Most of the fire-damaged components and hoses were situated toward the rear of the engine. The fire originated near the centre of the accessory section, as evidenced by the heat or burn patterns in the area. A closer examination of the suspected area of fire origin revealed that the gasket material of the oil filter converter plate exhibited a bulging appearance and was partially extruded from beneath the converter plate.

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[1] All times are Pacific daylight time (Coordinated Universal Time minus seven hours).

The oil filter was removed to gain access to the converter plate. During removal, it was noted that the oil filter gasket, which was subjected to a similar heat stress, was basically undamaged. The converter plate hold-down bolt required less than usual torque to remove. Once the plate was removed, it was evident that the converter plate gasket was extremely deteriorated (see Photo 1). This deterioration would account for the reduced hold-down bolt torque.

Photo 1. Right-engine converter plate gasket

Because of the unrepresentative damage to the right-engine converter plate gasket, these components were removed from both the left and right engines and examined using Fourier Transform infrared spectroscopy. From that examination, the composition of the left-engine converter plate gasket was identified as an acrylonitrile-butadiene copolymer known as NBR or nitrile rubber. This gasket meets the standards of the appropriate Lycoming converter plate gasket (part number 06B23072). However, the deteriorated gasket taken from the right engine was found to be made of an ethylene-propylene-based elastomer known as EDPM or Dutral; this composition does not meet the standards of the current Lycoming component.

Lycoming converter plate gaskets were originally identified by part number (P/N) LW-13388. Under normal circumstances, these gaskets would be replaced at engine overhaul or on-condition. However, on or after 01 April 1999, a bad batch of gaskets got into the aviation supply system; these gaskets were found to break down over time, allowing loss of engine oil. The problem was identified and first addressed by Lycoming Mandatory Service Bulletin 543A, issued on 24 July 2000. Over the next three years, both Lycoming and the Federal Aviation Administration (FAA) continued to address the gasket issue using Airworthiness Directives (ADs), Supplements, Amendments and letters.

A new gasket (P/N 06B23072) was subsequently manufactured to replace the old P/N LW-13388 gasket. The new gasket met all Textron Lycoming blueprint and test requirements and was installed on engines shipped from the factory after 04 October 2000.

On 03 July 2002, the FAA issued AD 2002-12-07, which required, in part, that owners/operators of all affected engines replace the oil filter converter plate gasket with the newly manufactured part before 01 October 2003. An additional requirement of the AD was that the converter plate be vibro-peened with the number "543" to provide a visual confirmation of AD compliance.

The accident engine had been overhauled at the Lycoming factory in 1997, about two years prior to the bad gaskets entering the supply system. Its most recent annual inspection was done in the United States on 05 March 1999, after which it operated for about 19 hours before being removed from service and placed in storage on 28 June 1999. There is no record of any maintenance action being done to this engine after the annual inspection of 05 March 1999, until

Navair Charter purchased it and removed it from storage. As part of that activity, the maintenance personnel dismantled the engine and inspected, re-assembled and tested it prior to putting it back into operation on 14 December 2004 (log book entry date).

The post-accident examination of the aircraft found that, in addition to containing an inappropriate gasket, the vibro-peening required by AD 2002-12-07 was not present on the converter plate of the accident engine. Based on this data, it is evident that the requirements of the AD had not been applied to this engine. It follows from the engine maintenance history that the defective gasket could have been put into the engine prior to its removal for storage, while it was in storage, or at some point after it was removed from storage and put back into operation by Navair Charter.

Investigators conducted an informal telephone survey of supply and overhaul facilities, inspected eight affected engines and found the following:

- All surveyed aviation supply companies stocked only the new part-numbered gasket; the old part number has been cross-referenced to the new component.

- All stocked gaskets in supply at Nav Air Charter's facilities were the new components.

- Some overhaul companies reported that they are still finding and replacing the older style gaskets during engine repairs and overhauls.

- The instructions issued in AD 2002-12-07 were not always carried out, in that some of the gaskets inspected by the TSB had not been glued and many of the converter plates had not been vibro-peened.

- A follow-on inspection of two additional engines found that, although both of the gaskets were made of the correct material, one of them was not stamped with the appropriate part number of the new component. Although this cannot be confirmed, it is possible that the unmarked gasket may be one of the original gaskets (PN LW-13388) that was installed prior to the introduction of the bad batch in 1999. If that is the case, then AD 2002-12-07 was not complied with on the inspected engine.

The aircraft boost pumps are designed to remain ON during the operation of the aircraft. Additionally, emergency boost pumps are selected ON by the crew for both take-off and landing; this action ensures that pressurized fuel will reach the engine-driven fuel pump during the critical phases of flight.

A firewall shut-off valve for each engine is available and may be selected by the crew for use in an emergency situation involving an engine fire. Activating this valve shuts off fuel to the engine. With the firewall shut-off valve closed, the boost pumps continue to operate, but the fuel is not fed to the engine driven pumps.

The aircraft is not equipped with an engine fire-warning system, nor is such a system required by regulation. In the absence of a warning system, a pilot has to rely on other indications to determine whether a fire has ignited. These indications may include the following:

- visual identification of smoke or fire. In this instance there were no reports of trailing smoke prior to the aircraft being suddenly engulfed in flames;

- fluctuations of fuel or oil-pressure indications, or malfunctions of the propeller pitch controls; and/or

- degraded engine performance or yaw in the direction of the failing engine.

The aircraft is not equipped (nor required to be equipped) with an engine fire suppression system. Once the crew members identify the presence of a fire, they are trained to respond in accordance with a critical action checklist entitled "POWER PLANT FIRE IN FLIGHT." The first items in that check are to turn the firewall shut-off valve to OFF; close the throttle; feather the propeller; and place the mixture control to idle/cutoff. That sequence of actions is aimed at removing pressurized fuel and oil from the engine compartment, and shutting down and securing the affected engine.

TSB inspectors found that the firewall shut-off valves for each of the two engines were in the OPEN positions. The physical positions of the valves and the position of the mechanical linkages to the cockpit control levers indicate that the crew had not activated the firewall shut-off system in response to the in-flight fire.

The right propeller was subsequently disassembled for inspection and was found to be in the FINE PITCH position rather than FEATHER.

Analysis

Based on the fire pattern in the accessory section of the right engine and on the inspection and testing of involved components, it was apparent that an oil filter converter plate gasket had failed, allowing pressurized engine oil to spray into the engine compartment. The engine oil ignited, likely on contact with hot turbo-charger/exhaust components.

The failed gasket was one of a bad batch that had entered the supply system in 1999. Corrective action to remove these gaskets should have been completed by 01 October 2003, under the requirements of AD 2002-12-07. However, despite the intent of the AD and the presence of other regulatory safeguards, the incorrect gasket remained in the accident aircraft's engine. The source of the gasket and its time of installation could not be determined.

There is no engine-fire warning system on the aircraft, thus the crew would have had to rely on other system indications to determine whether a fire had ignited. Relying on secondary indicators of fire would delay the crew both in identifying a fire and reacting to it. In this

occurrence, it can be assumed that the crew members were not aware of the fire when they requested the practice approach, and that they became aware just prior to their declaration of the emergency.

Because there are no fire-suppression systems in the engine compartments, it is important that the crew members accomplish the critical action checklist immediately, to restrict flammable fluids from entering the engine area and to land as soon as possible. Based on an examination of the wreckage, the crew members did not activate the firewall shut-off valve, nor did they feather the right-hand propeller. These actions may have been omitted because of the time and workload associated with configuring the aircraft for an immediate landing, while simultaneously attending to the engine fire while on a short final approach to landing.

The firewall shut-off valve remained in the OPEN position, and pressurized fuel continued to be delivered to the engine-driven fuel pump by the aircraft's boost pumps. Fire damage to the engine compartment indicates that the engine-driven fuel pump was subjected to considerable heat from the initial oil-fed fire and that, at some point, the pump casing melted. The resultant pressurized fuel-fed fire was extremely hot and melted aluminum components in the vicinity of the fire. The burn pattern on the aircraft wreckage indicates that the flames moved out of the engine compartment through the left side of the cowlings and burned through the leading edge of the right wing, inboard of the engine. The flames then breached the main fuel tank, inboard of the engine, causing the aircraft to become engulfed in flames.

Findings as to Causes and Contributing Factors

1. At some point after 01 April 1999, a bad gasket (P/N LW-13388) was installed in the accident engine.

2. The requirement of Airworthiness Directive 2002-12-07 (to ensure that old converter plate gaskets were removed and replaced by new parts) was not carried out on the accident engine.

3. The improper oil filter converter plate gasket in the right engine compartment failed, allowing pressurized oil to spray into the engine compartment and ignite on contact with hot turbo-charger and exhaust components.

4. The firewall fuel shut-off valve remained in the OPEN position, allowing pressurized fuel to be delivered to the engine-driven fuel pump by the aircraft's boost pumps.

5. The initial oil-fed fire generated considerable heat, which melted the casing of the engine-driven fuel pump, allowing pressurized fuel to intensify the fire.

6. The flames breached the main fuel tank, inboard of the engine, causing the aircraft to become engulfed in flames.

Findings as to Risk

1. Inappropriate converter plate gaskets, identified by part number LW-13388, are known to have remained in the aviation system after the date of the terminating action required by Airworthiness Directive (AD) 2002-12-07.

2. Compliance with the full requirements of AD 2002-12-07 is not always being accomplished with respect to vibro-peening and proper gluing procedures.

Safety Action

During the course of this investigation, Transport Canada confirmed, after consultation with the U.S. Federal Aviation Administration, that the intent of Airworthiness Directive (AD) 2002-12-07 was to include "ALL rebuild or overhauled engines." Effectively, the intent was to broaden the "Applicability" section of the AD to ensure that all affected (old-style) gaskets identified by P/N LW-13388 be removed from service, purged from the system, and replaced with new gaskets identified by P/N 06B23072, in accordance with Part II or Part III of Textron Lycoming Supplement 1 to Mandatory Service Bulletin (MSB) 543A.

Transport Canada has sent a Service Difficulty Alert (AL-2005-08), dated 17 October 2005, to all owners, operators and overhaul facilities to bring to their attention the hazards identified within this report. The objective of this alert is to ensure that owners/operators and overhaul facilities of engines affected by AD 2002-12-07 have carried out the following:

a. complied with all the requirements stated within the AD;

b. incorporated Lycoming MSB 543 latest issue; and

c. ensured that inventories of spare parts have been purged of any converter plate gaskets identified by P/N LW-13388.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 13 December 2005.

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