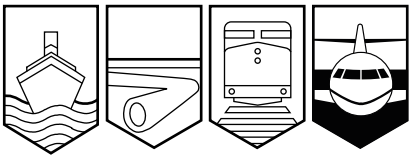
Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

AVIATION OCCURRENCE REPORT

A98P0100



ENGINE FIRE IN FLIGHT

SHADOW FOREST SERVICES LTD.
PIPER PA-31 NAVAJO C-GBFZ
PORT HARDY, BRITISH COLUMBIA, 50 NM NE
17 APRIL 1998

Canada

Aviation Occurrence Report

Engine Fire in Flight

Shadow Forest Services Ltd.
Piper PA-31 Navajo C-GBFZ
Port Hardy, British Columbia, 50 nm NE
17 April 1998

Report Number A98P0100

Summary

The Piper PA-31 Navajo, serial number 31-7752151, departed Machmell, British Columbia, at about 1600 Pacific daylight time with the pilot and one passenger on board. The aircraft was climbing through 10 000 feet above sea level en route to Nanaimo when the pilot noted low and fluctuating fuel pressure readings on the number-two engine. This problem had been noted before, and company maintenance had attempted to correct it by changing the fuel flow transducer on the number-two engine. The pilot contacted his company by radio to discuss the problem and, while talking with maintenance personnel, he heard an explosion. At the same time, the passenger reported that he could see flames through the vents in the lower cowl of the number-two engine. The pilot shut the engine down according to the aircraft's emergency checklist procedure, but it took three to four minutes for the fire to stop. The pilot then diverted to Port Hardy and landed without further complications, with the airport emergency response services standing by. There were no injuries; the aircraft sustained major fire damage.

Ce rapport est également disponible en français.

Other Factual Information

The PA-31 Navajo is equipped with two Lycoming TI0-540-J2BD engines. The occurrence aircraft had 10 250 airframe hours, and the number-two engine had 1 145 hours since the overhaul. Fuel is supplied to the engine by an engine-driven fuel pump (EDFP) in the accessory section of the engine. The EDFP is located about 8.5 inches forward and below the turbocharger and other hot exhaust system components.

A technical inspection of the aircraft following this accident revealed extensive fire damage to the accessory section of the engine, including the engine mount and lower cowling, as well as fire damage to the right main gear door, wing lower skin, flap, and engine cargo pod. The gear door had a section of aluminum of about six inches by six inches burned away at its leading edge. The flap had a similar-size hole burnt away at its leading edge. The flame track extended from the cowl door, below the engine accessory section, to the aft-end of the nacelle cargo pod and was about 14 inches wide for its entire length. For the length of the burn track, the paint and primer had been burnt away, the skin was wrinkled, some rivet heads were missing, and two holes were burnt through the skin.

The inspection also determined that the engine-driven fuel pump, part number RG 9080 J4A, had been leaking fuel at the gasket between the pump body and the relief valve cap. TSB Engineering Branch analysis showed that the leak was caused by insufficient torque on the four relief cap attaching screws. The torque on the screws was found to have ranged from 0 to 3 inch-pounds, whereas the specified screw torque is 23 to 25 inch-pounds.

The manufacturer of the fuel pump, Crane–Lear Romec, had been aware of fuel pump leakage due to screw torque loss and determined that the loss of torque on these screws is a result of the gasket between the pump body and the relief valve cap taking on a "set," that is, compressing but not springing back. This set problem is aggravated by thermal expansion of the pump. As the temperature of the air in the vicinity of the pump rises, the pump body and valve cap expand, further compressing the gasket. After the pump cools, the pump body and relief valve cap return to their original dimensions, whereas the gasket tends to remain in its compressed form. The torque on the four mounting screws, which secure the relief valve cap to the pump body, is applied against the gasket surface; any reduction in gasket size, under compression, will reduce the torque on the screws and the security of the valve cap.

Air temperatures in the enclosed engine compartments of the PA-31 Navajo reportedly rise as high as 200° Fahrenheit (93° Celsius), especially after engine shut-down, when the cooling airflow around and through the engine is eliminated. Over time, this high-temperature operating environment precipitated the gasket set, the loss of torque on the mounting screws, and the fuel leak that contributed to the in-flight engine fire.

When Lycoming became aware of this problem, they issued Service Bulletin (SB) number 406 on 19 November 1976. This SB states that the screws should be checked for torque and retorqued if necessary. Several revisions of this SB have been issued, and a new SB, number 529, was issued on 01 November 1997. SB 529 is similar to SB 406 in that it states that the screws should be checked for torque and retorqued if necessary, but SB 529 adds that compliance with the SB must be accomplished after 5 hours, but before 10 hours, of engine operation. This practice is to

expose the EDFP to the heat and stress of normal operation and so cause the gasket to set. The gasket set is accompanied by a loss of screw torque. The SB requires both that the screws be then re-torqued, and that the gasket be checked for leaks every 50 hours or 6 months thereafter and replaced if leaks are found.

At EDFP overhaul, the pump is not installed on an engine and, therefore, the SB cannot be complied with at that time. Following engine overhaul, the engine, with the EDFP installed, is usually operated on a test stand for 1 hour or less before the engine is returned to the operator. Since the SB requires at least 5 hours of engine operation, the SB cannot be performed at either overhaul.

In Canada, *Canadian Aviation Regulations* (CARs) do not specify that compliance with an SB is mandatory. However, when an SB is complied with, CARs require that the performing maintenance organization enters an appropriate record in the applicable technical logbook to indicate compliance with the SB. Although CARs require a logbook record to be made to show compliance with an SB, the possibility exists of an SB being complied with, signed off, then a part being replaced with no record to indicate that the SB needs to be accomplished on the replacement part. On reviewing the records of the occurrence aircraft, investigators could find no evidence that the applicable SB had been carried out.

When the pilot had used the emergency checklist procedure entitled "Engine Fire in Flight" in his initial response to the explosion and fire, he was directed to move the firewall fuel shut-off valve of the affected engine to the OFF position, to close the throttle, feather the propeller, and place the mixture control at IDLE CUT-OFF. The pilot was then directed by the emergency checklist to follow the "Engine Securing Procedures" outlined in paragraph 3.7. That check, in part, required the pilot to "pull out the fuel boost pump circuit breaker." When the pilot attempted to complete this action, he found that he could not access or pull the circuit breaker for the high altitude boost pump because the location of his headset jacks interfered with the circuit breakers. He departed from the checklist procedure by first removing his headset jacks from their plugs to pull out the boost pump circuit breaker. As a result, the pilot's response to the emergency was slowed and his radio communication was degraded.

The position of the headset installation in relation to the high altitude boost pump circuit breaker is reported to be common and fleet-wide for Navajo models produced after 1976, and may also involve pre-1976 models in which optional high altitude boost pump systems have been installed.

Analysis

The pilot noted fuel pressure fluctuations on the cockpit engine instrument gauges. These fluctuations would have been caused by the fuel leak at the EDFP. This leak was the result of the gradual loss of torque on the four screws that hold the fuel pump relief valve cap to the body of the pump. The problem had been previously identified and SBs on the pump had been issued by the engine manufacturer as early as 17 November 1976. No record could be found of this SB being carried out to the EDFP on the occurrence aircraft.

Because of the requirement to operate the EDFP for 5 to 10 hours before retorquing the screws, this SB cannot be complied with at pump overhaul and is unlikely to be performed at engine overhaul. It is more likely that the aircraft maintenance facility would perform the SB after the specified time had been accumulated on the component. The fuel boost pump leak was a direct result of not performing the work set out in the SB.

The EDFP leaked fuel into the engine compartment, providing a source of fuel that could contribute to an in-flight fire when in contact with hot components such as the turbocharger or the exhaust system.

To respond to this in-flight fire emergency, the pilot had to remove his headset jacks to access the boost pump circuit breaker. This extra action impeded his check-list response and degraded his communication with his maintenance facility and air traffic control resources in a serious contingency situation.

The following Engineering Branch report was completed:

LP 054/98-Fuel Pump Examination

Findings

1. Company maintenance had previously noted fluctuating fuel pressure to the number-two engine and had attempted to correct the problem by changing its fuel flow transducer.

2. The manufacturers of the engine and of the EDFP had both been aware of circumstances causing the pump to leak and had issued SBs to correct the problem.

3. No record was found to show that the SB pertaining to the fuel pump leak had been performed on the accident aircraft.

4. SBs may be performed on components, signed off against the aircraft, then the component replaced with one that has not had the SB performed on it—with no record to indicate this to be the case.

5. Service Bulletins, even mandatory SBs, do not have to be complied with in Canada.

6. The EDFP is located near the turbo charger and other hot exhaust system components.

7. The EDFP leak was the result of loss of torque on the relief valve cap attaching screws.

8. The leaked fuel was likely ignited by the turbocharger/exhaust system.

9. The location of the headset jacks required the pilot to remove the jacks to access the fuel pump circuit breaker, thereby degrading the pilot's ability to communicate during a contingency situation and impeding the response to the in-flight emergency.

Causes and Contributing Factors

The leaking fuel pump in the vicinity of hot exhaust system components caused an in-flight engine fire. The fuel pump leak, which contributed to the fire, was a direct result of not performing the work set out in the SB.

Safety Action

The maintenance facility for the accident aircraft submitted a Service Difficulty Report to Transport Canada regarding the EDFP leak and subsequent fire.

The manufacturer of the pump, Crane–Lear Romec, had issued a service bulletin, SB 101SB020, as recently as July 1997 which advised re-torqueing four screws on the pump after five hours of service and inspecting the pump for leaks at every engine inspection thereafter. Transport Canada, in consultation with the United States Federal Aviation Administration, issued Airworthiness Directive AD 98-18-12, which mandates compliance with the Textron Lycoming Service Bulletin 529A dated August 2, 1999. SB 529A is a Textron Lycoming "mandatory" service bulletin that requires compliance with Crane–Lear Romec SB 101SB020, Rev. 2.

As a longer term solution, the pump manufacturer has redesigned the fuel pump to accept an O-ring—instead of a gasket—to prevent this problem. This O-ring would allow for thermal expansion and contraction of the fuel pump without loss of torque to the screws. As of October 1999, Crane–Lear Romec had drafted a service bulletin that detailed the modification instructions to engine driven fuel pump RG 9080 J4A providing an alternate means of compliance with SB 101SB020. This latest service bulletin is currently under review by both Textron Lycoming and the Federal Aviation Administration.

The TSB has sent an Occurrence Bulletin, number A98P0100, regarding the headset jack location, to the involved aircraft maintenance facility, the National Transportation Safety Board of the United States, the aircraft manufacturer, and Transport Canada.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board, consisting of Chairperson Benoît Bouchard, and members Charles Simpson and W.A. Tadros authorized the release of this report on 04 November 1999.