SERIOUS INCIDENT

Aircraft Type and Registration: Piper PA-31-350 Navajo Chieftain, G-VIPP

No & Type of Engines: 2 Lycoming TIO-540-J2BD piston engines

Year of Manufacture: 1979

Date & Time (UTC): 30 May 2008 at 0915 hrs

Location: After departure from Boscombe Down, Wiltshire

Type of Flight: Commercial Air Transport (Passenger)

Persons on Board: Crew - 2 Passengers - 1

Injuries: Crew - None Passengers - None

Nature of Damage: Fire damage to a circuit breaker and to electrical wiring

near the overhead panel

Commander's Licence: Commercial Pilot's Licence

Commander's Age: 29 years

Commander's Flying Experience: 980 hours (of which 280 were on type)

Last 90 days - 270 hours Last 28 days - 60 hours

Information Source: Aircraft Accident Report Form and subsequent AAIB

investigation

Synopsis

During the climb after departure, the crew observed smoke in the cockpit and flames emanating from the overhead panel. All non-essential electrics were turned off and the aircraft returned to the departure airfield safely. There were no injuries. One of the air recirculation fans was found to have suffered a mechanical failure and there was evidence that its circuit breaker had failed to trip. The excessive current drawn by the fan had caused the wiring to overheat, producing the smoke and flames.

History of the flight

The aircraft departed from Boscombe Down and was passing through FL70 when a burning smell was noticed by the crew. Flames then appeared from the overhead panel and smoke emanated from the circuit breaker for the air recirculation fans. The commander attempted to pull the circuit breaker, but found that it was stuck in the closed position. He turned off all non-essential electrics, but kept the radio, transponder and navigation equipment on to avoid entering Danger Areas, and proceeded to return to Boscombe Down. He maintained frequent radio communication with Boscombe ATC and requested fire service attendance.

© Crown copyright 2009 28

The co-pilot tackled the fire with a BCF fire extinguisher, but the fire continued to smoulder throughout the descent. The aircraft landed with a fire crew in attendance. Although the three occupants reported no ill effects or injuries, they were taken to a local medical centre as a precaution.

Aircraft information

The aircraft is fitted with two air recirculation 'blower' fans, located in the lower fuselage, just forward of the wing main spar. The fans draw cabin air from floor level and distribute it to vents situated throughout the cabin. There is a HIGH/LOW switch in the overhead panel, and a single 10 Amp (A) circuit breaker in the switch and circuit breaker panel, located to the left of the left pilot's seat.

The fans are checked for 'condition and operation' every 200 hours. They are classified as 'on-condition' and therefore have no overhaul life. Circuit breakers must be checked for 'compliment and rating' every 200 hours, but they are not required to be functionally checked.

Service Bulletin (SB 704) 'Cabin Fan Fuse Installation', applicable to certain PA-31-350 models, was introduced in 1982 due to problems with the windings in fan motors shorting and circuit breakers failing to trip. SB 704 required the installation of in-line fuses in the fan motor power circuit, of a lower rating than the circuit breaker. However, SB 704 was not applicable to this aircraft.

Engineering investigation

The 10A circuit breaker was found to have significant heat damage and although it would operate mechanically, it remained in the open circuit electrical state. There was also significant heat damage to the wiring and connectors in the cockpit roof area, near the overhead panel.

Both fan units were removed, whereupon the right fan was found to have seized. Further inspection revealed that the impeller had detached from the central boss. This was apparently due to a material failure in the fan back plate. The insulation on two of the three wires in the power feed cable had suffered significant heat damage. It was concluded that the fan failure had caused the circuit to become overloaded and, since the circuit breaker had not opened, a small fire had ensued. The circuit breaker was found in the open circuit state; this was probably due to the effects of the heat.

Internal inspection of the circuit breaker revealed significant heat damage. There were some signs of slight corrosion but, given the heat damage, it was not possible to make any firm conclusions about the serviceability of the circuit breaker at the time of the incident.

The circuit breaker and heat damaged wires were taken to a specialist electrical laboratory. Tests were carried out on lengths of wire in an attempt to generate similar heat damage to the insulation material and thus infer the electrical loading in the circuit during the incident. The currents tested ranged from 20A to 50A. The most noteworthy test was on the undamaged third wire from the fan motor which was tested for 30 minutes at 40A. Whilst there was some discolouration of the insulation material, there was no significant deformation. The temperature of the wire reached 80°C after three minutes and remained constant thereafter. Although it was not possible to simulate accurately the physical environment of the various wires that were damaged (for example the proximity of other cables or the volume of air around the cable), the test results suggested that the fan motor circuit was probably subjected to a current of at least 40A, well in excess of the 10A circuit breaker rating. At 400% of the maximum rated load, a 10A circuit breaker should typically trip in under 5 seconds.

© Crown copyright 2009

Civil Aircraft Airworthiness Information and Procedures – CAP 562

CAP 562 gives general information on a variety of matters concerned with the manufacture, overhaul, repair, maintenance and operation of civil aircraft. Leaflet 11-22 Appendix 24-4 is entitled 'Thermal Circuit Breakers', and in Section 5 'Maintenance Considerations' it states:

'It has become apparent that the progressive development of the Maintenance Review Board determining scheduled maintenance has led to a significant erosion of maintenance checks on circuit breakers. Users are reminded that there is a continuing duty to monitor the performance of equipment and that items such as circuit breakers which are largely passive in nature should be assessed for dormant faults.

As a minimum and where Maintenance Schedules do not require a high level of checking, all CBs which are not regularly exercised by mechanical switching should be checked for correct mechanical operation by performing two manual switching cycles at periods of not more than two years. The necessary action should be taken to revise Maintenance Schedules as appropriate.'

Operator's safety actions

As a result of this incident the operator has:

- 1. Embodied SB 704: 'Cabin Fan Fuse Installation'
- Amended the maintenance programme to include a check for 'any abnormal noise' during the recirculating fan functional check
- 3. Amended the maintenance programme to include a circuit breaker functional check every 600 flying hours or 12 calendar months

Some time after the incident the operator discovered that a landing gear circuit breaker on the same panel on the incident aircraft was open circuit, despite appearing to work mechanically. When the circuit breaker was opened significant internal corrosion was found that showed some similarities to the heat damaged circuit breaker from this incident. The proximity of the circuit breaker panel to the DV window might be a contributory factor to the corrosion and the operator is considering a program of circuit breaker replacement.

Other circuit breaker failures

Interrogation of the CAA Mandatory Occurrence Report (MOR) database for circuit breaker failures resulting in smoke in the cockpit revealed only three occurrences since January 2002. One of these was attributed to a 'faulty circuit breaker', but no further information was available. There have been several incidents worldwide of arcing faults which failed to trip a circuit breaker due to the current remaining within the rated circuit breaker load; this has led to research into alternative circuit protection devices. However, there is good evidence that this incident was caused by a failure of the circuit breaker to trip when exposed for a significant period of time to levels of current well in excess of the rated value.

Discussion

The crew's actions of concentrating on flying the aircraft, isolating all non-essential electrics, fighting the fire and making a prompt decision to return to Boscombe Down ensured that a more serious, potentially catastrophic situation was avoided. The aircraft landed safely and there were no injuries to the crew or passenger.

The operator's decision to include a functional check of the recirculation fan circuit breaker and to check for abnormal fan noise should help to identify fan problems prior to failure and thus prevent similar incidents in the future.

© Crown copyright 2009