**INCIDENT**

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| **Aircraft Type and Registration:** | Piper PA-31-350 Navajo Chieftan, G-VIPW |
| **No & Type of Engines:** | 1 Lycoming LTIO-540-J2BD piston engine<br>and 1 Lycoming TIO-540-J2BD piston engine |
| **Year of Manufacture:** | 1979 |
| **Date & Time (UTC):** | 13 May 2009 at 1046 hrs |
| **Location:** | 10 miles south of Isle of Man Airport, Isle of Man |
| **Type of Flight:** | Private |
| **Persons on Board:** | Crew - 1 Passengers - None |
| **Injuries:** | Crew - None Passengers - N/A |
| **Nature of Damage:** | Damage to right engine and right engine cowling |
| **Commander's Licence:** | Commercial Pilot's Licence |
| **Commander's Age:** | 29 years |
| **Commander's Flying Experience:** | 1,321 hours (of which 483 were on type)<br>Last 90 days - 147 hours<br>Last 28 days - 46 hours |
| **Information Source:** | Aircraft Accident Report Form submitted by the pilot and further enquiries by the AAIB |

**Synopsis**

During the initial climb after takeoff the right engine lost power at FL60. The pilot shut down the right engine and carried out an uneventful landing. The right engine failure was caused by separation of the No 2 engine cylinder, but the cause of the cylinder separation could not be determined.

**History of the flight**

After a normal departure from Isle of Man Airport the aircraft was climbing through FL60 when the pilot heard an unusual noise and the right engine suddenly lost power. He identified that the right engine had failed from the right yaw of the aircraft. He decided not to try to set full power on both engines due to the noise coming from the right engine and the fact that the aircraft was at a safe speed of 130 KIAS. He then carried out his engine shutdown checks which included feathering the propeller, although photographs taken of the aircraft after landing showed the right propeller unfeathered. The pilot reported that he had no difficulty flying the aircraft on just the left engine and made an uneventful landing back at Isle of Man Airport.

The pilot reported that all engine indications had been normal during the takeoff and the climb. The power setting on both engines was 35 inches of manifold pressure, with rpm set to 2,400 and the mixture set to 30 USG/hour.

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**Aircraft examination**

The left forward section of the right engine cowling had split apart revealing that the No 2 cylinder had detached from the engine but was still retained within the cowling. The left side of the cowling was coated in oil see Figure 1.

**Figure 1**

Right engine cowling revealing the separated No 2 engine cylinder

**Maintenance history**

The failed engine was a Lycoming LTIO-540-J2BD six-cylinder piston engine. It had last been overhauled, by the engine manufacturer, in April 1998 and had accumulated 1,744 hours at the time of the failure. The engine's approved 'Time Between Overhauls' (TBO) was 1,800 hours. The No 2 cylinder had been replaced on 3 November 2006 at 1,280 engine hours, so this cylinder had accumulated 464 hours at the time of failure. The replacement was as a 'cylinder kit', due to the previous cylinder having a worn exhaust valve guide, and no further work to this cylinder was recorded until the time of the incident.

There were two 'WDC' numbers found imprinted on the spine of the engine crankcase which indicated that the crankcase had been repaired some time between 1995 and 1997 by a particular FAA-approved engine overhaul facility. This facility was contacted regarding the nature of the repairs, but they only held records for the past two years, in accordance with FAA regulations. The aircraft operator reported that they did not hold any logbooks for the engine for the period prior to 1998.

**Engine examination**

Six of the eight studs that had retained the No 2 cylinder had failed in overload and the remaining two studs had been stripped from the casing. The small end of the No 2 connecting rod had failed and its failed end had been crushed in subsequent impacts with the piston, while the engine continued to turn see Figure 2. The big end of the connecting rod was still securely attached to the crankshaft.

The No 2 piston was found seized inside the cylinder. To remove the piston the top half of the cylinder was cut away and a press was applied against the piston head. A force of 2,000 lb was required to free the piston. The piston appeared to have seized as a result of distortion to its lower sidewall where it had suffered multiple impacts from the failed connecting rod; a large piece of the piston sidewall had broken off as a result of these impacts. All three piston rings were found broken in half at their approximate mid-points and parts of the remains of these piston rings were later retrieved from inside the engine crankcase. There was no evidence on the piston sidewall of overheat distress and the cylinder bore was in good condition, with no evidence of overheat distress. The piston gudgeon pin was in good condition with no evidence of overheat, as was the inner surface of the connecting rod small end.

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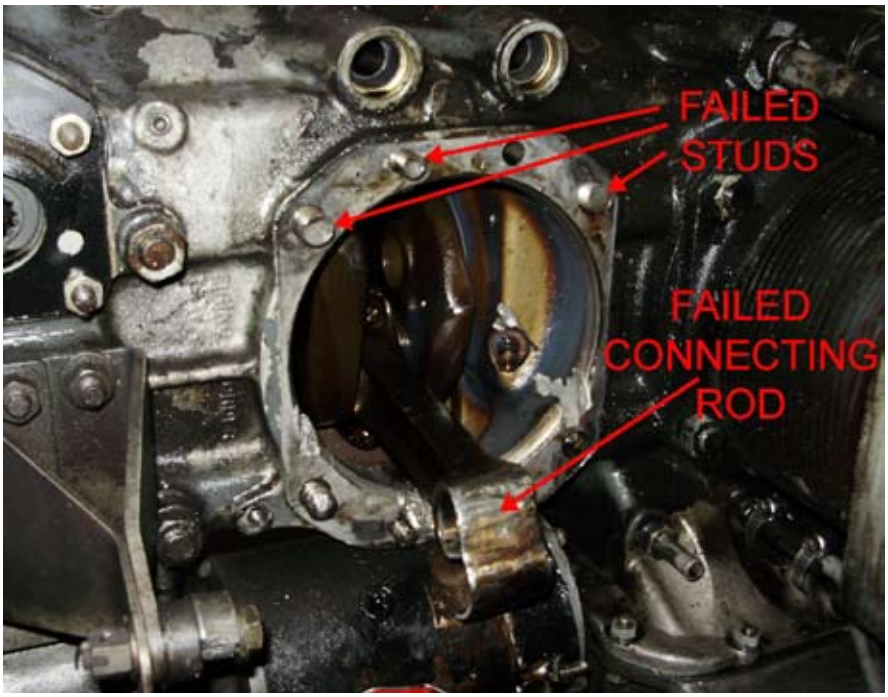


**Figure 2**

Location of detached No 2 cylinder revealing failed studs and failed connecting rod small end

**Analysis**

The engine manufacturer was consulted regarding the cause of the cylinder separation. They stated that they had seen similar cylinder separations and that piston ring failure was usually a consequence, rather than a cause, of a cylinder separation. They stated that, in many cases, cylinders had separated as a result of either insufficient or excessive torque on the hold-down nuts, or as a result of improper or illegal weld repairs of the crankcase in the area of the cylinder pad. If insufficient or excessive torque is applied to the hold-down nuts during cylinder installation, the nut can work itself loose, and the stresses that result from the ensuing cylinder movement can cause a cylinder to detach. The engine manufacturer stated that they had also seen six cases of cylinder detachment in the previous two years as a result of improper or illegal crankcase repairs. The engine manufacturer had not approved any crankcase repairs that included welding, but the FAA had approved several engine overhaul facilities to carry out weld repairs, including the facility that had carried out an unspecified repair on the failed engine in this incident. The engine manufacturer stated that a potential consequence of a crankcase weld repair near a cylinder is that the cylinder hold-down pad area starts to soften, and this softening leads to the cylinder flange pounding into the material, eventually causing the hold-down nuts to loosen.

The No 2 cylinder had accumulated 464 hours prior to failure. If the hold-down nuts had been installed incorrectly with either excessive or insufficient torque, it is likely that a failure would have occurred sooner. However, if the torque was only slightly outside the specification, a nut might become loose after 464 hours, but no data was found to substantiate this. The possibility of a weld repair leading to a loosening of hold-down nuts was also considered, although a visual examination of the crankcase in the vicinity of

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the No 2 cylinder did not reveal any obvious evidence of welding. The aircraft operator has tasked an engine overhaul organisation to carry out a further inspection of the crankcase but the results of this inspection had not been received at the time of publication. In conclusion, there was insufficient evidence available to determine the cause of the cylinder separation.

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