

Piper PA-31-350, G-PZAZ

AAIB Bulletin No: 3/98 Ref: EW/C97/10/4Category: 1.2

Aircraft Type and Registration:	Piper PA-31-350, G-PZAZ
No & Type of Engines:	2 Lycoming TIO-540-J2BD piston engines
Year of Manufacture:	1954
Date :	12 October 1997
Location:	During maintenance
Type of Flight:	N/A
Persons on Board:	Crew - None - Passengers - None
Injuries:	Crew - N/A - Passengers - N/A
Nature of Damage:	Pistons and piston pins destroyed
Commander's Licence:	N/A
Information Source:	AAIB Field Investigation

SYNOPSIS

In December 1994, two Lycoming TIO-540-J2BD piston engines from a PA-31-350 aircraft, G-PZAZ, were zero-hour overhauled during which all pistons and piston pins were replaced using Superior Air Parts components. In July 1997, 380 hours after that overhaul and during a scheduled maintenance check, the numbers 5 and 6 cylinders were removed from the right-hand engine to assist in the investigation of a persistent oil leak from that engine. During removal of the number 6 cylinder, it was found that the piston pin had fractured across its centre and was in two pieces. A Civil Aviation Authority (CAA) Occurrence Report was raised by the maintenance organisation on the 10th July 1997, reference 97/03668D. At that time no metallurgical examination was undertaken and the Occurrence Report was closed with no 'further action required.' The number 5 and 6 pistons and piston pins were replaced with Lycoming parts. In October 1997, 484 hours after overhaul and again during a scheduled maintenance check, the number 1,2,3 and 4 cylinders were removed from the right-hand engine to assist in the investigation of low compressions and engine oil leaks. During removal of the number 2 and 3 cylinders, both piston pins were found to have failed in a similar manner to the number 6 piston pin which had been found in July. Following this discovery, the maintenance organisation removed all the cylinders from the left-hand engine and found that the number 1 piston pin had failed in the same manner (see photograph 1). Another CAA Occurrence Report was raised on the 13th October 1997, reference 97/03668.

Engineering examination

All the pistons and piston pins which had been removed in October were obtained by the AAIB and subjected to detailed metallurgical examination. It was found that the piston pin failures were due to fatigue which had originated from intergranular cracking on the outer surfaces of the pins (photograph 2). Positive evidence was found to indicate that the intergranular surface cracking had originated from 'thermal shock' generated by grinding abuse of the outer surface of the pins prior to surface finishing (polishing) during the manufacturing process (photograph 3). There was evidence that the pins had been fractured for many engine cycles prior to their discovery. The three pistons associated with the failed pins had extensive fatigue cracking across the pin locating bores which had been induced by operation of the engines with the failed piston pins. The piston pin from the number 6 cylinder of the right-hand engine, which had been found in July, was recovered from the maintenance organisation's training centre and subsequent metallurgical examination revealed that it had failed in the same way and due to the same reasons as the piston pins that were discovered in October. In addition, examination of the piston pins that had not failed revealed fatigue cracks starting from intergranular cracking in the outer surface which had also been caused by grinding abuse during manufacture. There were no fatigue cracks present in the pistons from those cylinders where the piston pins had not failed. Inspection revealed identification markings on the piston pins, but they could only be made completely visible by removal of the piston pin end plug. The piston pin end plug is a solid aluminium alloy press fit part which could only be removed by a cutting process. The piston pins were part number SL13444-1.

Maintenance and manufacturing history

Examination of the records held by the maintenance organisation that fitted the piston pins during the engine overhauls in December 1994 showed that they were from three separate consignments, each of 12 pins, that were shipped from the manufacturer, Superior Air Parts, to an aircraft parts supplier in the UK during the month of October 1994.

The piston pin manufacturer ceased production and supply of these piston pins in 1996 because of a number of similar failures that had been brought to their attention. Their local Federal Aviation Administration (FAA) office in the USA had been made aware of the problem in 1995. The manufacturer was under the impression that the FAA had intended to issue an Airworthiness Directive (AD) regarding these piston pins, but at that time no related AD had been issued (see later).

In 1996 the piston pin manufacturer became aware that some piston pins, part number SA 629690, which they had supplied for fitting to a range of Teledyne Continental engines between 1994 and 1996 contained sub-surface manufacturing imperfections that, in some cases, had resulted in piston pin failure. A Mandatory Service Bulletin, number 96-001, was issued by Superior Air Parts in August 1996 requiring the removal of these piston pins from service prior to the next flight, ferry flights excepted. These piston pins were manufactured by the same sub-contractor as piston pin part number SL 13444-1, which is the subject of this investigation.

On 18 April 1997, Textron Lycoming issued a Mandatory Service Bulletin No 527C which required the removal from service of piston pins part number LW-14077 within 50 hours of operation or one year from the date of the Service Bulletin. The reason for the Mandatory Service Bulletin was that the manufacturer had determined that a quantity of piston pins had been manufactured which did not meet Textron Lycoming specifications in that they might have had imperfections, with no visual method of detection. It was considered probable that these piston pins were manufactured by the same sub contractor as the Superior Air Parts piston pins which were the subject of this investigation. Textron Lycoming have not, thus far, responded to AAIB's request for

details of the associated defect and which company manufactured these piston pins. The FAA issued AD 97-15-11 on the 28 July 1997 which mandated the removal from service of these piston pins.

Previous occurrences

One previous occurrence of a piston pin failure was found on the CAA's database. The associated engine was of Teledyne Continental manufacture, but the piston pin part number was not specified. No detailed investigation was apparently carried out. The occurrence was closed as a random failure, with no proposed action.

Enquiries made with the Civil Aviation Safety Authority of Australia revealed three similar occurrences of Superior Air Parts piston pins SL 13444-1 having failed, one in 1996 and two in 1997. Two of these failures had caused severe engine damage but fortunately none resulted in an aircraft accident.

Enquiries made with the Transportation Safety Board of Canada revealed seven occurrences of failure of this type of piston pin on their data base, one in Canada and six in the USA. However, the failure in Canada was determined as a secondary failure following a connecting rod small end failure. Of the six reported failures of this type of piston pin in the USA, the National Transportation Safety Board had investigated the failure mode of one pin. Their metallurgical examination concluded that the failure had been due to fatigue cracking which initiated from a small region of intergranular cracking that had extended from the surface. They reported that it was likely that the intergranular cracking had resulted from 'corrosive attack', but that the reason for the corrosion could not be determined.

Piston pins part number SL 13444-1 are used on a wide range of Lycoming engines.

In addition, it is believed that the manufacturer of this piston pin may have used the same sub-contractor to produce a range of piston pins.

Safety Recommendations

In view of these serious findings, the following Safety Recommendations have been made to the FAA:

Recommendation 97-64:

In order to prevent in-service fatigue failure, from grinding abuse cracking, of Superior Air Parts piston pins part number SL 13444-1, the FAA should expedite action to mandate the removal of all such Superior Air Parts piston pins, and any pistons associated with cracked or fractured piston pins, from service.

Recommendation 97-65: The FAA should expedite action to establish whether other piston pin types supplied by Superior Air Parts could have suffered grinding abuse cracking at manufacture similar to that found in piston pins part number SL 13444-1 and, if confirmed, take action to remove all such other types of piston pin from service to prevent associated fatigue failure and serious secondary piston failure.

These Safety Recommendations were forwarded to the FAA on the 5th of November 1997. The FAA made the following response on the 22nd of December 1997:

"We have reviewed Safety Recommendation Numbers 97.320 (AAIB Safety Recommendation Number 97-64) and 97.321 (AAIB Safety Recommendation Number 97-65) regarding failure of piston pins manufactured by Superior Air Parts, and determined that the following FAA Airworthiness Directive (AD) projects satisfy the intent of these recommendations:

97-320: The FAA has determined that installation of Superior Air Parts piston pins, part number 13444-1, on Textron Lycoming engines represents an unsafe condition. Notice of Proposed Rulemaking (NPRM) 97-ANE-42 has been initiated and will be published later this month. This proposed AD defines any pin shipped from Superior Air Parts between August 23, 1993 and April 22, 1996, as defective, and would require removal from service of these defective pins within 20 hours time in service after the effective date of the AD.

97.321: The FAA has also determined that installation of Superior Air Parts piston pins, part number SA629690, on Teledyne Continental Motors engines, represents an unsafe condition. NPRM 97-ANE-37 has been initiated and will be published later this month. This proposed AD defines any pin shipped from Superior Air Parts between August 1, 1994 and June 20, 1996, as defective, and would require removal from service of these defective pins within 25 hours time in service after the effective date of the AD. In addition, the FAA issued AD97-01-03 on January 3, 1997, which mandated removal of defective piston pins P/N LW-14077, manufactured by Textron Lycoming for installation on Textron Lycoming engines. This AD was later superseded by AD 97-15-11, issued on July 28, 1997."