Zlin Z50LX, G-MATE

AAIB Bulletin No: 5/2004	Ref: EW/G2003/08/30	Category: 1.3
Aircraft Type and Registration:	Zlin Z50LX, G-MATE	
No & Type of Engines:	1 Lycoming AEIO-540-L1B5D piston engine	
Year of Manufacture:	1990	
Date & Time (UTC):	16 August 2003 at 1234 hrs	
Location:	6 miles south-east of Finningley, South Yorkshire	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - 1 (Minor)	Passengers - N/A
Nature of Damage:	Cockpit damaged, propeller blade broken off, fin and rudder damaged	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	37 years	
Commander's Flying Experience:	529 hours (of which 132 were on type)	
	Last 90 days - 31 hours	
	Last 28 days - 12 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot and engine examination by the AAIB	

History of the flight

The aircraft departed Gamston Airfield at 1205 hrs on an aerobatic practice sortie and headed for an area some 6 nm south-east of Finningley Airfield. During the climb and transit all engine indications were normal. Prior to commencement of his competition routine, the pilot performed his usual check of the aerobatic 'Husky' inverted oil system. This involved looping the aircraft to the inverted position and then performing a hesitation roll, whilst checking that the oil pressure recovers when inverting and returning to erect flight: the behaviour was reported as normal.

He repositioned the aircraft to his normal commencement altitude of 3,800 feet and initiated a dive from an indicated airspeed of 200 km/hr to start the routine. Engine power was set to 0.8 bar manifold pressure and 2,500 RPM, this being his normal setting for the entire sequence, except when spinning, for noise abatement reasons. The first nine elements of the sequence were flown with no abnormalities of power or of the temperature and pressure indications. However, during the tenth manoeuvre, which involved pulling up to the vertical from a height of approximately 1,000 feet agl

and a hesitation roll in the vertical plane, the engine emitted a loud screeching noise during the roll. Upon achieving level flight, the pilot throttled-back to idle and the noise reduced to a 'warbling whistle'; however, after a slow reapplication of half throttle there was a loud bang from the engine together with the appearance of oil and smoke from the forward right of the cowling, a severe lateral vibration and a loss of RPM.

The pilot turned the aircraft towards the north-west in an attempt to force land on the disused runway at Finningley. The engine continued to run but with no thrust or oil pressure, although the oil temperature appeared normal initially. Higher throttle settings resulted in more severe vibration and the aircraft was unable to maintain altitude; the pilot broadcast a 'MAYDAY' call to RAF Waddington. Realising that he could not reach Finningley, the pilot selected a nearby field for a forced landing. Although there were several to choose from many had obstructions; the one that he chose had been ploughed and rolled smooth. After touchdown, at minimum speed, the aircraft ran for about 50 yards before the landing gear struck a rut in soft ground and the aircraft flipped inverted. The canopy broke during the impact and the pilot was able to exit the aircraft through the frame by digging away the earth with his hands to obtain clearance, having first made the aircraft safe. He suffered minor abrasions and whiplash injuries but, following treatment at hospital, he was discharged. The pilot reported that prior to his decision to conduct a forced landing he had considered abandoning the aircraft using his parachute.

Having telephoned RAF Waddington to advise them of his wellbeing, the pilot cancelled an ambulance which had been despatched. A local policeman, who arrived at the scene after about 30 minutes, saw fuel dripping from the main and wing tank vents and asked him to drain the fuel onto the ground. The pilot correctly pointed-out that this would result in even more pollution and refused to do so.

Engine examination

It was immediately obvious that the No 4 cylinder had fractured completely, with the piston and a portion of the connecting rod and the small end bearing remaining jammed in the barrel. There were no obvious signs of the remainder of the connecting rod and it was apparent that there was severe distress to the No 4 big end journal. There had also been a rupture of the crankcase in that area.

The engine was shipped to an overhaul agency for strip examination under AAIB supervision. No anomalies were found outside the damaged No 4 cylinder and crank area. Much metallic debris, both coarse and fine, was found throughout the oil system, including the big-end bolts and nuts, which were recovered from the sump. These were still clamping pieces of the big end together, thus demonstrating that it was not a loss of torque which had caused the distress to the rod and crankshaft journal. With the crankshaft removed, it was possible to see the extent of the distress to the No 4 journal, although the other five journals and the main bearings appeared to be in good condition. The No 4 journal, however, was badly scored and overheated to a dark blue colour, and there were no obvious signs of the bearing shells (pieces and granulated debris were found in the oil system). Under daylight conditions, evidence of overheating could be discerned on most of the big end and main crankshaft journals to a greater or lesser extent, even though the bearing shells appeared to be in good condition. The crankshaft was submitted for laboratory examination.

Laboratory examination

Detailed examination confirmed the above visual findings except that the front No 1 main bearing did not show indications of overheating. All the other main bearings showed signs of discolouration and, of course, the No 4 was grossly discoloured indicating that it had reached temperatures in excess of 600°C (dull red heat) and then cooled rapidly. The report noted the lack of overheated oil tar deposits around the No 4 journal, indicating that there had been a rapid breakdown of lubrication.

History of the aircraft

The aircraft appears to have had several owners since new. However, there were two incidents in the recent past which may be of relevance. In July 2003, the aircraft was struck, whilst stationary with the engine stopped, by a runaway Pitts Special aircraft, registration G-BRJN (AAIB Bulletin 10/2003). A photograph provided by the owner indicates that the two aircraft met virtually head-on, causing damage to the composite propeller, spinner and cowling of G-MATE. After this incident, the owner was advised that there was no need to shock-load check the engine as it was not running at the time. Accordingly, the propeller was simply replaced and the other damage repaired before return to service.

Prior to this, in January 2003, the engine had been fitted with a replacement crankcase, due to the discovery of a crack in the original item. It is understood that the crankcase halves were the only parts replaced during this period of work. The engine total hours at that time were 271, and were 360 hours at the time of the accident.

Discussion

The possibility that the failure of the No 4 bearing could be related to damage caused by the collision with the Pitts Special appears unlikely beyond an hypothesis that incorrect replacement of the propeller introduced a leak path for oil. The owner would almost certainly have been aware of such a leak or an abnormal loss of oil quantity over a period of time. However, it appears that the collision should have warranted a shock load inspection of the engine, even though it was not turning at the time. Textron Lycoming Mandatory Service Bulletin No 533A, dated 9 August 1999, states that it is the company's position that an engine should be strip inspected for damage following:

> *"Any incident, whether or not the engine is operating, that requires repair to the propeller other than minor dressing of the blades."*

Since G-MATE's propeller was effectively destroyed by the other aircraft, it clearly fell within this category.

The metallurgical examination of the crankshaft suggested that a sudden interruption of oil supply to the entire assembly had caused distress to all the big end and main bearings apart from No 1. The rationale as to why damage to the No 4 big end bearing was so much more severe could be explained by the fact that such damage, from the start of the overheating to break-up of the bearing shells and failure of the connecting rod, tends to be effectively exponential; ie the others would have suffered similarly had conditions persisted slightly longer. However, various factors could lead to one or more bearings being susceptible and hence failing catastrophically more rapidly.

The pilot does not think that loss of oil pressure for any sustained period could have occurred, citing the fact that, prior to the engine failure, propeller governing was normal: loss of engine oil pressure would also lead to malfunction of the constant-speed propeller. Momentary loss of oil pressure will occur as the aircraft changes from erect to inverted flight and vice-versa, but oil in the propeller system appears to be able to cope with short transients such as this.

There remains the possibility that there was a blockage in the oil passageway feeding only No 4 bearing and that the evidence of overheating on the other journals was caused by the fact that the engine continued to run for several minutes after failure without oil pressure. A further detailed examination of the stripped engine parts revealed that it had been reassembled using RTV sealant to join the new crankcase halves together, and the sump and accessory gearbox cases to the crankcase. Textron Lycoming Service Instruction (SI) No 1125B allows the use of RTV102 sealant as an alternative to the traditional method using silk thread and a non-hardening sealant called 'POB' when joining the two crankcase halves together. It does not sanction use of RTV in any other location and neither is it specified in Lycoming manuals. In a reply to the owner, Textron Lycoming further stated that use in other areas was strongly discouraged, particularly the gearbox case/crankcase interface because of the possibility that excess sealant, squeezing out from the join, could block the passages to

the main oil galleries. It appears that use of RTV sealant in other areas is fairly widespread amongst overhaul agencies (but presumably not Textron Lycoming themselves). In the case of the subject engine, the application of RTV was not particularly excessive and there was no evidence of it having blocked any oil transfer ports.

The inverted oil system was not examined but the owner has taken the components for overhaul and undertook to advise the AAIB should anything abnormal be found during the course of this work. Should a cause for the engine failure become apparent in the future the AAIB will publish an addendum to this Bulletin.