Yak-52, G-BWOD

AAIB Bulletin No: 4/2004	Ref: EW/G2003/10/16	Category: 1.3
Aircraft Type and Registration:	Yak-52, G-BWOD	
No & Type of Engines:	1 Ivchenko Vedeneyev M-14P piston engine	
Year of Manufacture:	1983	
Date & Time (UTC):	30 October 2003 at 1450 hrs	
Location:	Field next to Conington Airfield, Cambridge	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 1
Injuries:	Crew - None	Passengers - None
Nature of Damage:	Damage to both wings and propeller. Fuel leak reported	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	42 years	
Commander's Flying Experience:	258 hours (of which 70 were on type)	
	Last 90 days - 16 hours	
	Last 28 days - 4 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot and AAIB follow-up inquiries to the repair agency	

Synopsis

Following a partial loss of power, an increase in indicated cylinder head temperature and the onset of a vibration, whilst circuit flying, the aircraft sustained damage after the pilot landed in a field and collided with a row of fence posts. Examination of the aircraft revealed that the insulator core of one of the spark plugs in the No 4 cylinder was missing and that the plug casing had been burnt through. It was reported that this is not a unique occurrence with Yak-50/52 aircraft and that although there is an attendant risk of fire within the engine compartment, the engine will continue to produce reduced power for a significant period of time.

History of the flight

Following an uneventful engine start and power checks, the pilot flew a series of touch-and-go landings but, during climbout from the third of these, at approximately 300 to 400 feet agl, the engine started to run roughly and lost power. As the cylinder head temperature indication was increasing rapidly at this point, the pilot initiated an immediate turn back towards the airfield, throttled back and made a radio call announcing his intentions. However, upon completion of the turn he concluded that

he was both too high and too close to execute a successful landing on the reciprocal runway and he therefore continued downwind, with the intention of landing back on the take-off runway. When he opened the throttle to try and gain height, the engine started running roughly again and so rather than continue with his circuit he decided to land ahead in a field. At the last moment, having by that stage committed himself to landing, with the landing gear down, the pilot saw that the 'threshold' end of the field was bounded by a row of fence posts. The aircraft struck three of these posts, which caused extensive damage to both wings and separation of the outer end of one propeller blade. The aircraft remained intact and came to rest in the field on its landing gear.

The pilot later commented that the low-altitude of the aircraft at the time of the occurrence gave him insufficient time to fully assess the symptoms before having to commit himself to the landing.

Aircraft examination

The aircraft was recovered by a major UK importer of Yak aircraft. His investigation established that the power reduction and vibration were caused by the break-up and subsequent blow-out of the insulator core of a spark plug in the No 4 cylinder. It was considered that the resulting loss of compression had caused rough running and that venting of combustion gases through the centre of the spark plug body, in close proximity to a cylinder head temperature sensor, would have produced the rising cylinder head temperature indications seen by the pilot. The damage sustained by the aircraft was significant: sufficient to render questionable the economic viability of repair.

Markings on the failed plug included the letters C-49 CM, which it is understood identify it as the standard type of Russian manufactured spark plug used in the Vedeneyev M-14P engine. The AAIB examination of this plug, Figure 1, showed that a large sector on the side of the casing had melted and been burnt away, and that the ceramic inner core and central electrode were missing. Because the origin of the failure was no longer present, the underlying cause could not be established with any degree of certainty. However, the periphery of the melted region was locally thickened and pitted in a manner consistent with melting by an electrical arc, and surface features inside the body of the plug in the immediate vicinity of the burnt region were also consistent with electrical arc damage. It could not be established whether this arcing was a primary cause of the failure *per se,* caused by a breakdown of the ceramic insulator core, or whether it was a secondary feature symptomatic of some other, non-identifiable, mechanical failure within the plug.

Figure 1: View to damaged spark plug showing burn through and empty core

View of damaged spark plug
showing burn through and empty core

Additional information

The UK importer reports that plug breakdowns, involving loss of the ceramic core and casing burn-through, have been known to occur previously on both UK and US based aircraft. He also advises that, during the incipient stages of this type of failure, after combustion gases have started to leak from around the damaged insulator but before the insulator core has separated, progressive burn-through of the high tension (HT) lead insulation usually occurs, together with an accompanying smell of burning rubber in the cockpit. During this interim period, which reportedly lasts for around two minutes before the ceramic core of the plug finally blows out, the cylinder head temperature indications rise progressively due to the impingement of combustion gases on the cylinder head temperature sensor. It was also reported by the UK importer that there was no visible heat damage beyond the spark plug and harness.

Anecdotal evidence exists of spark plugs being found loose in the cylinder heads of Yak-50 and 52 aircraft. Failures involving fracture of the body adjacent to the topmost thread, and consequent ejection of the upper part of the plug complete with the ceramic core and electrode, are also reported to occur. One such failure in the United States in July 2002, reported as having occurred during climb-out after takeoff, resulted in a loss of control and impact with the ground, causing serious injuries to the two occupants. Following this accident, tests were carried out in the USA by members of the Yak aircraft owning community, to assess the likely loss of thrust under such conditions. These tests reportedly showed a reduction in static thrust of about 160 lbf (approximately 13% reduction) with a single spark plug removed. Further anecdotal evidence suggests that the engine itself is likely to continue to produce significant power for an extended period under this condition.

In summary, there appears to be a significant body of anecdotal evidence of spark plug failures on Yak-50 and 52 aircraft involving ejection of the plug core, in one form or another, the outcome of which is loss of compression on the affected cylinder accompanied by rough running and a reduction of power. Such failures also produce an accompanying jet of combustion flame from the missing or damaged plug body, and are possibly accompanied by indications of a rapidly rising cylinder head temperature. The nature of these failures inevitably give rise to an unquantifiable, and potentially very serious, risk of fire in the engine compartment. This fire risk dictates that any aircraft suffering a plug failure of this kind should be landed at the first available opportunity. However, the anecdotal evidence also suggests that an engine which has suffered a failure of this kind might reasonably be expected to continue to produce sufficient power with a plug failed in this manner, to enable a safe powered landing to be executed at an airfield at the earliest practicable opportunity.