AAIB Bulletin No: 5/2005 **Ref: EW/G2004/12/10** **Category: 1.3**

Aircraft Type and Registration:	Yak-52, G-YAMS	
No & Type of Engines:	1 Ivchenko Vedeneyev M-14P piston engine	
Year of Manufacture:	1984	
Date & Time (UTC):	27 December 2004 at 1510 hrs	
Location:	Hill Crest Farm, Canewdon, Essex	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - 1	Passengers - N/A
Nature of Damage:	Damage to wings, fuselage, landing gear and propeller	
Commander's Licence:	UK Private Pilot's Licence	
Commander's Age:	51 years	
Commander's Flying Experience:	316 hours (of which 26 were on type) Last 90 days - 8 hours Last 28 days - 1 hour	
Information Source:	Aircraft Accident Report Form submitted by the pilot and examination of the aircraft by the AAIB	

Synopsis

Whilst in the cruise, the engine began to run roughly. As a result, the pilot was unable to maintain altitude and decided to carry out a forced landing in a field. The selected field, however, was un-suitable due to power lines along the field edge being seen late on the approach, so the pilot elected to land in an area of paddocks. The landing attitude was flat and the left wing struck a fence post, which rotated the aircraft to the left, before it came to a halt against the fence. There was no fire. The pilot sustained serious injuries and was assisted from the aircraft by the land owner. Later examination of the engine revealed that the core of the No 5 cylinder rear spark plug had 'blown out', causing a loss of compression on that cylinder.

History of flight

The aircraft had been flown earlier on the day of the accident, on a return flight from North Weald to Southend, which included some aerobatics, all of which were without incident. On its return, it was fully fuelled and the engine oil topped up.

The pilot had intended to carry out basic aerobatics but he found the oil level was in excess of that recommended for aerobatics, and so he decided to fly locally instead. The engine start up and power checks were carried out without any problems and, as the aircraft had recently been flown, the oil and cylinder head temperatures quickly reached their normal operating values. The takeoff and climb were also problem free and, at 2,500 feet, the aircraft was established in the cruise. Routine checks of the engine instruments did not reveal any abnormal running and the carburettor air heat gauge indicated normally. As the cylinder temperature gauge was reading a little low, the pilot reduced the cooling air around the engine by closing the gills at the front of the cowling.

Whilst flying in the area of Osea Island, the pilot noticed an oily smell, a slight change in the noise from the engine and increased vibration. He checked the engine instruments and they were all showing normal indications. After deciding to head to the south, he noticed a puff of smoke in his peripheral vision, coupled with the engine reducing in RPM and then picking up again. The RPM continued to cyclically change. In an attempt to maintain RPM, the pilot used the primer to inject fuel directly into the engine cylinders, but he was not sure if this improved the situation.

The pilot suspected that the engine had suffered a mechanical failure, but he still carried out the 'normal' emergency checklist items including setting the carburettor air control to hot and checking each magneto in turn. This had no effect on the engine performance. Southend Approach was notified by the pilot, who indicated that the aircraft was suffering from a rough running engine and that he intended on returning to the airfield, although he was not sure whether he would be able to make it. The engine continued to run roughly and was later described by the pilot as if only five of the nine cylinders were firing correctly. The opening of the throttle only seemed to increase the vibration levels and so the pilot left the throttle at its cruise setting. He was unable to maintain height and, on reaching about 700 feet to the South of the River Crouch, the pilot decided to carry out a forced landing. The forward visibility in the Yak-52 is poor so the pilot concentrated on finding suitable fields to the sides of the aircraft. He selected a field to the east and turned towards it, losing speed and sinking in the process. At this point he noticed power lines along the edge of the field and he realised that the aircraft did not have sufficient height to clear them.

The pilot then saw some small paddocks ahead and decided to land in one instead. He closed the throttle and flared, before contacting the ground in a flat attitude.[1] The left wing struck a fence post causing the aircraft to spin round to the left before coming to rest against the fence. The left wing fuel tank was punctured but there was no fire.

The pilot was badly shaken and seriously injured but was able to secure the aircraft systems. He was assisted from the aircraft by the land owner and taken to hospital by the emergency services who attended the scene.

Survivability

Due to the deceleration forces during the landing, with the aircraft stopping in a very short distance, the pilot sustained serious injuries despite wearing a five point harness and a helmet. His head had struck the top of the instrument panel with sufficient force to put a split in the helmet and he sustained serious chest injuries from the harness. However, had he not been wearing the helmet or the harness, it was considered that this accident would most likely have resulted in fatal injuries.

Aircraft examination

The aircraft was retrieved from the field by a specialist Yak-52 maintenance organisation and taken to their facility where the AAIB carried out an examination.

It was initially suspected that the rough running had been due to water collecting in the fuel filters and then subsequently freezing. However, on inspection, the fuel filters were found to be clean and to contain some fuel, but with no signs of water.

The engine was then examined in detail. This revealed the high tension (HT) lead for the No 5 cylinder rear spark plug had been 'blown out' of the elbow fitting to the plug. Subsequent removal and inspection of the plug showed that the ceramic insulating core of the plug had been damaged and the inner electrode was missing. There were also signs of significant local heating of the elbow fitting, Figure 1. The remaining spark plugs fitted to the engine were all in a satisfactory condition. The damaged spark plug was identified with the markings SD-49SMM and was a product of the original plug manufacturer, in Russia, for this engine type. It had been fitted to G-YAMS for approximately 60 flying hours; the spark plugs were last inspected during a routine 50 hr inspection, 11 flying hours prior to the accident.

[1] When performing a forced landing away from an airfield, it is recommended that the landing gear is left in the retracted position. The landing gear on the Yak-52 retracts to lie below the wing and forward fuselage and, as such, provides a measure of protection to the aircraft. Also, the aircraft is more stable and less prone to flipping over on soft ground.

Previous occurrence

The AAIB investigated a previous similar occurrence to spark plug on a Yak-52, G-BWOD (EW/G2003/10/16, Bulletin 4/2004). This failure also resulted in a rough running engine, vibration and a forced landing in a field. The spark plug had the same markings as that found on G-YAMS and was fitted to the No 4 cylinder.

Discussion

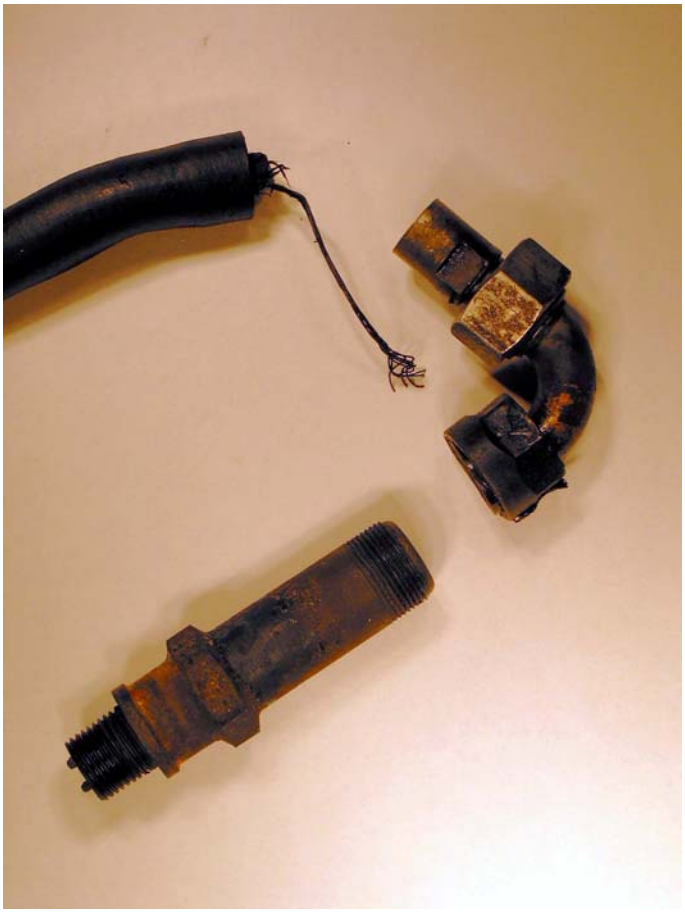
The rough running of this engine could be directly attributed to the failure of the No 5 cylinder rear spark plug. The inner insulating core had 'blown out', resulting in the hot gases from the cylinder escaping through the plug and blowing out the HT lead connection. The hot gases had then caused localised heating of the spark plug elbow fitting. As a result of the failure, the compression on cylinder No 5 was compromised, resulting in the engine running roughly, but with the remaining eight cylinders operating normally.

The spark plugs fitted to the M14P engine are usually those from the original equipment manufacturer in Russia. There is anecdotal evidence to suggest that these plugs are not as robust as those manufactured in Europe or the USA. It was stated by the aircraft maintenance organisation that 'blown' spark plug cores affect about two of their maintained aircraft per year and are normally limited to the lower three cylinders (Nos 4, 5 and 6). The cause, although not proven, is thought to be a mini hydraulic lock where oil, which may collect in the lower cylinders, is compressed during engine start, causing high localised stresses on the spark plug cores. Prevention of hydraulic lock is normally achieved by draining any oil from each of these cylinders, usually by removing a spark plug, and to turn the engine over by hand several times prior to starting.

Some Yak owners have converted their engines to take spark plugs manufactured in the USA, but these are approximately double the cost of the original Russian plugs and require an adapter to be fitted to the engine cylinder. The life of the USA manufactured plugs is no different to those of the Russian manufacture at 200 hours, but they have not been known to suffer from blow out of their cores.

As mentioned in the report on G-BWOD, tests conducted in the USA revealed that it may be theoretically possible for an engine with a spark plug removed to continue to produce enough power to enable continued flight, hence giving an improved chance of a safe landing at an airfield. However, the emergency procedure for a rough running engine is to land as soon as possible, which is especially relevant in this case, given the risk of an engine fire due to the hot gases escaping through the damaged spark plug.

Figure 1



Details of the failed rear spark plug from cylinder No 5