Robin HR200/120B, G-VECA, 26 July 2001

AAIB Bulletin No: 4/2002	**Ref: EW/G2001/07/30**	**Category: 1.3**
Aircraft Type and Registration:	Robin HR200/120B, G-VECA	
No & Type of Engines:	1 Lycoming O-235-L2A piston engine	
Year of Manufacture:	2000	
Date & Time (UTC):	26 July 2001 at 1500 hrs	
Location:	RAF Cosford	
Type of Flight:	Private (Training)	
Persons on Board:	Crew - 1	Passengers - None
Injuries:	Crew - None	Passengers - N/A
Nature of Damage:	Engine cylinder detached, cowlings distorted	
Commander's Licence:	Student Pilot	
Commander's Age:	52 years	
Commander's Flying Experience:	80 hours (of which 24 were on type)	
	Last 90 days - 22 hours	
	Last 28 days - 12 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	
	and further enquiries by AAIB	

The student pilot was on a solo cross-country navigation training detail from Wellesbourne Mountford. Whilst cruising at 2,400 feet, on a leg from Wolverhampton to Tatenhill, he experienced an unusual engine vibration and made a PAN call to Wolverhampton indicating that he intended to return and land at Wolverhampton.

He then heard several bangs and the vibration became severe. He continued to report the condition to Wolverhampton ATC. Further bangs, loud clattering, a drop in engine RPM and oil pressure led the pilot to search for a suitable field in which to carry out a forced landing, as he was unable to maintain height. He was given radar vectors towards RAF Cosford, which he quickly acquired visually. He saw that the runway in use was Runway 24 but assessed that the approach would take him close to a village. He was not sure, given that the engine rpm was now down to about 1000

with zero oil pressure, that he would be able to clear the buildings on the approach. He therefore elected to land on Runway 06, because there appeared to be suitable fields on the approach should he require them.

The aircraft landed safely at Cosford, but the pilot had difficulty exiting the aircraft because the canopy, which slides forward, became jammed by the engine cowling which had bulged outwards due to the engine failure. He praised the assistance he had received from the various ATC controllers he had spoken to during the emergency.

Upon opening the cowling it became evident that the No 4 cylinder had become detached from the engine, close to the attachment flange and the connecting rod and piston had both broken. The engine bay and the underside of the fuselage were covered in oil. The engine was not immediately removed but the failed cylinder was despatched to AAIB. Metallurgical examination suggested considerable fatigue cracking was associated with the fracture.

Metallurgical examination

From examination of both halves of the fractured cylinder it was concluded that a primary crack had developed on the front side of the barrel leading to full 360° separation. Fatigue was found over the first approximately 5.9 inches of the crack, the remainder being fast fracture. The origin, which was between the attachment flange and the first cooling fin adjacent to the front hold-down bolt (Figure 1) *(jpg 52kb)* was examined in detail and found to contain a deep corrosion pit from which fatigue had propagated. It was noted that severe corrosion was present in other areas of the barrel and also on all three of the other barrels from the same engine.

The material specifications and component dimensions were checked and found to be within drawing limits. It was also noted that, in areas not corroded, the black oxide coating was attached and appeared to have good adhesion.

Other cases of cylinder failure due to fatigue

On January 26 2001, Textron Lycoming issued Service Instruction (SI) No.1504, applicable to O-235 engines operating under the French Direction Generale de l'Aviation Civile (DGAC). The reason for the SI was given as follows:

"The French DGAC has reported a significant number of O-235 cylinder barrels in France. These failures have initiated from corrosion pits at the base of the cylinder. For O-235 engines operated under its authority, the French DGAC has issued AD(Airworthiness directive) 1998-225(a) which requires periodic inspection of the cylinder barrels for cracks

Since it is not possible to determine the depth of pitting or the point at which corrosion will initiate a crack, Textron Lycoming recommends replacement of cylinders affected by AD 1998-225(a) with new cylinder assemblies which offer improved corrosion resistance. O-235 engines and cylinder kits shipped from the factory after September 1 2000, incorporate these new cylinder assemblies."

The engine fitted to G-VECA was shipped from Textron Lycoming's factory on December 16, 1999 and installed at the Robin Aviation factory on 10 March 2000. The aircraft was delivered shortly afterwards. At the time of the accident, it had accrued some 299 hours from new.

The 'improved corrosion resistance' is understood to comprise zinc chromate treatment and shot-peening although the latter, of course, assists fatigue resistance only.

Reference to AD 1998-225(a) suggests that the 'significant number' (22 in France up to June 29, 2000), of cylinder failures included engines with a wide variety of calendar age and flying hours but all generally in a similar area to the failure suffered by G-VECA. The AD also infers that absence of significant corrosion is not a guarantee that cracks are not present and thus requires that all new or overhauled engines should be subjected to a technique of applying white developer spray to the cylinder barrels with the cooling baffles removed and then running the engine in this condition. The purpose is to highlight any oil leakage through a cracked cylinder. Various further steps are detailed should such leakage be detected or suspected and the procedure is to be repeated every 50 flying hours. On overhauled engines, an additional visual inspection for oil leaks, with baffles installed, is required to be performed at 20-hour intervals.

Textron Lycoming advised that problems in the subject area are unknown in the United States, or at least are extremely infrequent to their knowledge.

The same appears true in the United Kingdom, where a search of the CAA's Mandatory Occurrence Report database revealed only one apparently similar case of cylinder cracking since 1976. Although some 22 additional cases of cylinder cracking-related engine failures were found, the cracks occurred remotely from the attachment flange area and would not be covered by the DGAC AD Inspection (apart from possibly the unaided visual inspection for leaks). The CAA also point-out that, of the 22 cases mentioned, only 2 occurred in the last 5 years.

Conclusion

The reason why such corrosion-induced fatigue failures seem endemic only in France is puzzling. Textron Lycoming had advanced a theory on climatic differences between France and the United States as one reason for the disparity in experience, but one would expect that any such adverse conditions would apply even more so to the UK. The case of failure of G-VECA's engine seems to be isolated but is of concern because of the very low hours and calendar time from new at which it occurred. However, it appears that UK experience does not justify adoption of an AD similar to that of the DGAC. AAIB and the CAA will continue to monitor the situation should any future trend become apparent.