ACCIDENT

Aircraft Type and Registration:	Scheibe SF25B motorglider, G-BLZA
No & Type of Engines:	1 Sauer 1800 ESI piston engine
Year of Manufacture:	1970
Date & Time (UTC):	4 March 2006 at 1000 hrs
Location:	2.5 miles WNW of RAF Halton, Buckinghamshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - None Passengers - N/A
Nature of Damage:	Loss of propeller
Commander's Licence:	Private Pilot's Licence
Commander's Age:	70 years
Commander's Flying Experience:	1,927 hours (of which 219 were on type) Last 90 days - 6 hours Last 28 days - 4 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot and examination of propeller and engine by the AAIB

Synopsis

Whilst at 1,000 ft on the downwind leg of the circuit of Runway 02, the pilot experienced rapidly increasing airframe vibration; approximately five seconds later the engine stopped suddenly. The pilot noticed that the propeller was no longer attached to the engine and landed successfully on an alternate runway. Investigation revealed that the loss of the propeller was due to the fatigue failure of the bolts securing the propeller back-plate to the crankshaft.

History of the flight

On the day prior to the incident flight the aircraft had been flown without problems for 1 hour 10 minutes in air temperatures of -10°C but, as the aircraft was taxiing, a clattering noise was heard from the engine. An inspection after shutdown showed that the starboard exhaust baffle appeared to be loose.

The incident pilot, together with an engineer, inspected the engine the next day and, after finding no further faults, re tightened the exhaust baffle. Following a 10 minute ground run, the pilot decided to take off and fly a circuit to confirm that the source of the rattle had been rectified. Whilst at 1,000 ft on the downwind leg of the circuit for Runway 02, the airframe began to vibrate severely and, after approximately five seconds, the engine stopped. Realising that the propeller was no longer attached to the engine, the pilot carried out a successful emergency

landing on Runway 06. On inspection, the starter ring gear and generator pulley were found to have fallen into the lower engine cowling.

Propeller installation

The aircraft was fitted with a Sauer 1800 ESI piston engine, and is the only SF25 motorglider on the UK register fitted with this engine type. It had been installed by the engine manufacturer in December 2002 and had operated for 310 hours prior to the incident flight. The Sauer 1800 ESI is approved for operation with two propellers types, one manufactured by Mt Propellers (the type fitted to 'ZA), the other manufactured by Hoffman Propeller GmbH. The Hoffman propeller is directly attached, together with the starter ring gear and generator pulley, to a flange on the engine crankshaft by six bolts. The 'Mt' propeller requires the use of an adaptor, or back-plate, to accommodate the wider pitched bolt holes of the 'Mt' propeller, Figure 1. This is secured by six bolts to the crankshaft flange; the propeller is then secured to the back-plate with six additional bolts. The use of a back-plate in the 'Mt' installation also allows a spinner to be fitted.

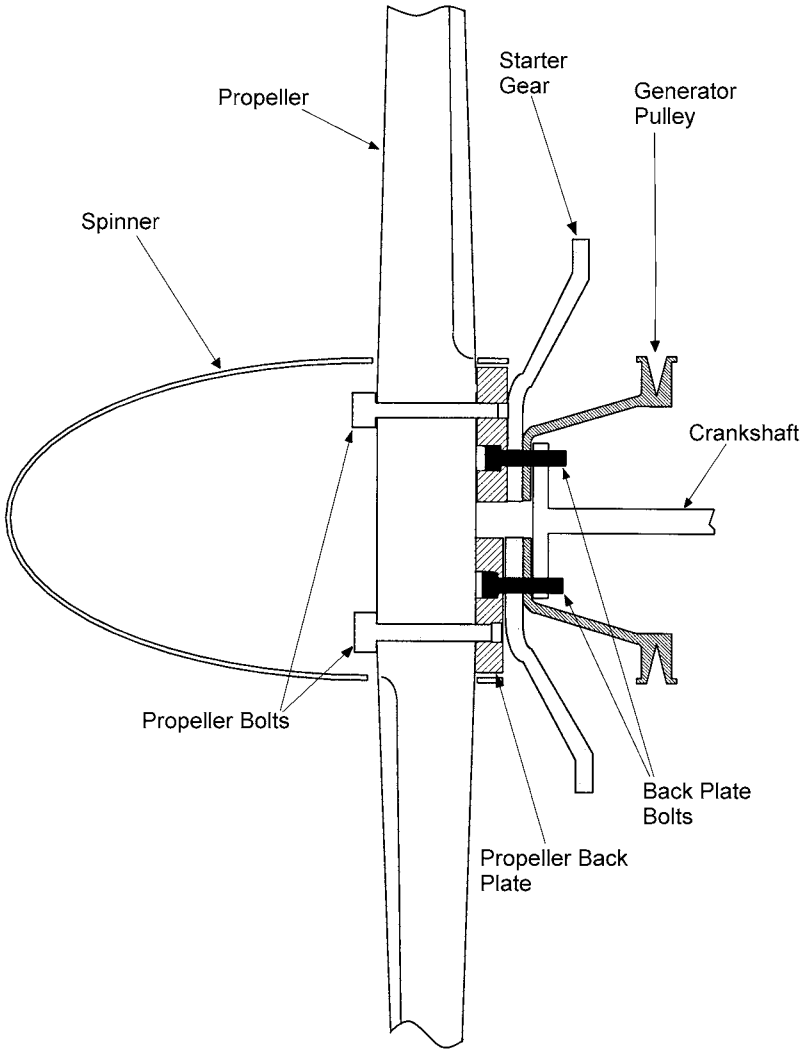

Figure 1

Diagram of 'Mt' propeller attachment to Sauer 1800 ESI engine, G-BLZA

Investigation

This event was the first propeller loss for this engine type. Initial inspection revealed that the bolts holding the back-plate, starter ring gear and generator pulley to the crankshaft had failed. The propeller, together with spinner and back-plate, was located several days after the event and these, and the remains of the bolts held in the crankshaft, were examined in detail. The propeller was found to be securely attached to the back-plate, with all bolts correctly torque tightened and wirelocked; the remains of the bolts which held the back-plate to the crankshaft were also found wirelocked.

The aircraft operators confirmed that the installation of the propeller had been carried out by the engine manufacturer and that, since installation, routine torque checks of the propeller attachment bolts, as specified in the CAA LAMS document, had been carried out. However, there was no specific requirement to check the back-plate bolts and these had not been checked since being installed. The back-plate bolts specified by the engine manufacturer are 'M 8.8' type, with an installation torque of 20 Nm; these bolts are manufactured from medium strength carbon steel with a minimum tensile strength of 120,000 psi.

All six of the failed bolts were 8 mm in diameter, with the corresponding holes in the back-plate being 8.1 mm in diameter. Four of the bolt heads were marked *'s 8.8'* and were unthreaded along the first 1.8 mm of the shank. The remaining two were marked *'e D 8.8'* and were unthreaded for the first 6.5 mm of the shank. Two adjacent bolts marked *'s 8.8',* had failed approximately 5 mm along the shank from the head, with the remaining four failing at approximately 17 mm. The fracture surfaces of each bolt showed clear signs of high cycle fatigue across approximately 95% of their surface areas.

The remains of the bolt shanks retained by the crankshaft flange were also examined and found to be between 17 mm and 18.5 mm long. Four of the shanks had failed in fatigue, and matched the four longer bolt heads from the propeller; measurement gave a complete bolt length of approximately 36 mm. The remaining two shanks showed signs of overload failures, which did not match the failure surface of the two shorter bolt heads. Further measurements indicated that approximately 13 mm was missing from each bolt shank. Given that these two bolts had initially failed by fatigue closer to the bolt head than the remaining four bolts, the portion of their shanks retained by the crankshaft would have projected approximately 13 mm further forward than the other four shanks. Distortion of two bolt holes on the starter ring gear indicated that after separation of the propeller, the ring gear had been held in place for a short while by these two longer shanks, until the rotational forces on the gear caused overload failures. The bores of the bolt holes in the back-plate, used to secure the plate to the crankshaft, showed evidence of damage caused by bolt threads.

On examination by the manufacturer, the engine was found to be fitted with spark plugs of a shorter reach than those specified. This can cause minor torque fluctuations in operation. The operators confirmed that they had originally ordered the long reach spark plugs specified by the manufacturer but, when the original plugs were removed, they were found to be the short reach type. The operators therefore installed new spark plugs of the same type as those they had removed, assuming them to be the correct plugs.

Analysis

Damage to the bores of the back-plate holes, caused by the bolt threads, showed that there had been relative movement between the propeller assembly and the

crankshaft. It was also apparent that the drive to the propeller was being transmitted across the threaded portion of the bolts where their cross sectional area is at its minimum. The damage also indicated that the torque loading of the bolts was insufficient to prevent movement of the back-plate. This may have been the result of either insufficient installation torque or a 'backing off' of the bolts in operation, possibly due to the differential contraction of the back plate, starter gear and generator pulley in the low temperatures experienced on the pervious days flight, or both. The possibility of minor torque fluctuations, as a result of operating with spark plugs of the incorrect reach, may also have been a contributory factor to the failure of the bolts.

Safety actions

As a result of this incident the engine manufacturer has incorporated the following changes to the 'Mt' propeller installation for this engine type.

- Replacement of the current bolts with items that are unthreaded for the first 10 mm, thus preventing contact between the back-plate hole bores and the bolt threads
- Changing the specification of the bolts from 'M 8.8' to 'M 10.9'; this gives a 25% increase in their minimum tensile strength to 150,000 psi
- Increasing the installation torque of the back-plate bolts to 25 Nm

As a result of these measures, it is not considered necessary to issue any formal safety recommendations at this time.