ACCIDENT

Aircraft Type and Registration:	CZAW Sportcruiser, G-CGJS
No & Type of Engines:	1 Jabiru 3300A piston engine
Year of Manufacture:	2011 (Serial no: LAA 338-14962)
Date & Time (UTC):	18 August 2018 at 1314 hrs
Location:	Near Clacton-on-Sea, Essex
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - None Passengers - None
Nature of Damage:	Landing gear, engine cowling and minor damage to firewall
Commander's Licence:	Private Pilot's Licence
Commander's Age:	61 years
Commander's Flying Experience:	715 hours (of which 550 were on type) Last 90 days - 27 hours Last 28 days - 5 hours
Information Source:	Aircraft Accident Report Form submitted by the pilot

Synopsis

The aircraft suffered an engine failure while climbing through 1,400 ft after takeoff, and a forced landing was carried out into a ploughed field. The aircraft was damaged but the occupants were not injured. The flywheel had detached due to failure of its attachment bolts which were found to have broken; fatigue was evident on at least one bolt. There was a discrepancy in the time intervals for replacement of the bolts in the engine manufacturer's documentation.

History of the flight

The pilot/owner had built the aircraft and it was first registered in 2010. He was carrying out a training flight with a class rating instructor to revalidate his licence. The weather conditions in south-east England were fine with a westerly wind of around 15 kt.

The flight started from Maypole Airfield, north-east Kent, where a few circuits were flown. It then continued to Clacton Airfield, where Runway 18 was in use, so that a crosswind landing and takeoff could be practised. The aircraft landed uneventfully at Clacton and was parked on the grass for a short while.

The aircraft took off from Runway 18 at 1310 hrs. The pilot reported leaving the circuit to the west and changed frequency to Southend Radar. While he was making his initial call

to Southend Radar there was a “loud clank” from the engine and power was lost. The instructor took over the radio communications while the pilot continued to fly the aircraft.

A restart attempt was unsuccessful and the pilot, recognising that he could not return to Clacton, picked a series of three fields he thought would be suitable for landing. He decided to aim for the third field as it appeared to have the best surface and to be clear of a crop, but as he got nearer he realised the field contained a crop of potatoes and the surface was deeply furrowed.

While the pilot focussed on flying, the instructor communicated with Southend Radar and advised they would be landing in a field. Southend Radar confirmed they had radar contact. The instructor monitored the pilot, reminding him of the wind and pointing out a field. However, it became apparent the pilot had selected a different field. The instructor pointed out that the chosen field was rough and suggested another, but the pilot was fully engaged with carrying out the landing and so, as he judged the landing would be safely made, the instructor decided not to interfere further.

The landing was completed into wind with full flap, and the pilot estimated the touchdown was at around 30 kt (20 kt groundspeed). On touchdown the aircraft decelerated rapidly, and the nose wheel snapped off as the aircraft slid to a halt. Both occupants were wearing full four-point harnesses and neither was injured. The pilot secured the aircraft before both occupants exited in the normal way through the hinged canopy. They walked a safe distance away and telephoned Southend ATC to advise they had landed safely.

In the meantime Southend Radar had contacted a nearby aircraft and advised its pilot of the situation. He flew over to assist and reported that he could see the aircraft in a field, together with vehicles and people.

Engine examination

A post-accident examination of the engine found that the flywheel had detached due to fatigue failure of at least one of its mounting bolts (Figure 1). Jabiru 2200 engines, which have the same flywheel mounting arrangement, have experienced similar failures.

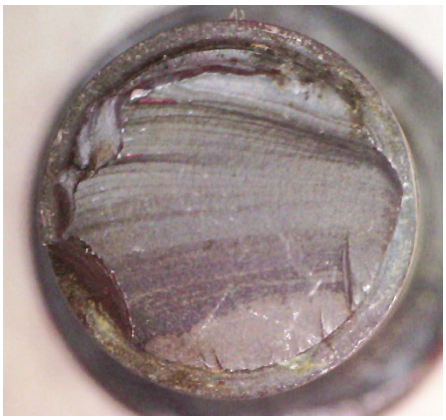

Figure 1

Fatigue striations on flywheel attachment bolt

Aircraft information

The aircraft was home-built from a kit by the owner and first flown in 2011. At the time of the accident it had flown 447 hours. The aircraft was fitted with a Jabiru 3300A engine and a Sensenich, ground adjustable, carbon fibre, two-bladed, 64-inch diameter propeller. The engine manufacturer advised that this propeller was not an 'approved propeller' for the engine, although this aircraft / engine / propeller combination was approved by the Light Aircraft Association (LAA). Therefore, special engine maintenance procedures were specified by the engine manufacturer, which required replacement of the flywheel bolts at 100 hourly intervals. These procedures were provided in '*The Maintenance Manual for Jabiru 2200 aircraft engine Jabiru 3300 aircraft engine Document no. JEM0002-7 Dated: 30th June 2016'.* The engine manufacturer advised this 100-hour requirement was introduced in October 2014.

'Service Bulletin JSB 014-2: Propeller Installation Maintenance', dated 9 June 2011 and available on the engine manufacturer's website at the time of the accident, provided in Section 6, '*Special Maintenance Schedule for Non-Approved Propellers*', a table of maintenance requirements which included the replacement of flywheel bolts every 500 hours.

'Service Bulletin JSB 012-4: Jabiru Engine Flywheel Attachment', dated 21 December 2017 and also available on the manufacturer's website at the time of the accident, introduced 10 possible causes that could lead to flywheel retaining screw failure. It states in section 3:

> *'…the following bulletin acts in concert with JSB 014 – failure to follow the recommendations of either bulletin will result in an incomplete approach which does not deliver the improvements to operating safety intended.'*

Section 4.1 states:

> *'Jabiru Service Bulletin JSB 014 provides information and recommendations for installing and maintaining all propeller types'*

and:

> *'Jabiru Aircraft consider compliance with JSB 014 mandatory for all aircraft being used for air work (such as training, hire and glider towing).'*

The owner stated he had been following the information contained in Service Bulletins and had checked the torque of the flywheel attachment bolts at every 100-hour inspection. He intended to replace the bolts at 500 hours as specified by Service Bulletin JSB 014-2, current at the time of the accident.

The engine Maintenance Manual notes:

> *'Due to the use of Loctite on the flywheel screws fitted with plain or Belleville washers this test is only intended to identify screws which are very near to or already have failed. The torque check will not identify screws which have begun to fail.'*

On 12 February 2019 the engine manufacturer issued Service Bulletin JSB 014-3 which aligned the maintenance requirement for '*non-approved propellers'* to that described in the Maintenance Manual.

Previous events

In 2014, when following up on a Jabiru 2200 engine failure, the Light Aircraft Association (LAA) identified high-cycle fatigue of the flywheel attachment bolts as the cause. Following this accident to G-CGJS, the LAA advised the AAIB they were aware of a number of events of flywheel attachment bolt failures on Jabiru 2200 series engines in the UK and elsewhere. However, this event was the first they were aware of affecting the larger, Jabiru 3300 engine.

The LAA published '*Safety Spot*' articles in June 2014, March 2015 and December 2018 related to failures of flywheel attachment bolts on Jabiru engines[1]. The LAA continued to work on the issue in consultation with the engine manufacturer, UK agents and other specialist organisations.

The engine manufacturer advised the AAIB of a case in 2014 where broken flywheel bolts were found on inspection on a 3300 series engine after a pilot had experienced some vibrations during flight. It was noted, and considered causative, that the aircraft had previously been flown with a damaged propeller and that the flywheel bolts had not been replaced afterwards.

The LAA commented that a failure of the flywheel attachment can cause an engine stoppage, even a partial failure such as an attaching cap screw head separating. The reason is that the flywheel on Jabiru engines forms an integral part of the aircraft's ignition and power supply systems.

Analysis

The engine failed suddenly when the aircraft was at 1,400 ft agl over an area of open fields. There were two qualified pilots on board, the pilot/owner who was flying the aircraft at the time, and the flying instructor who was the more experienced pilot. The instructor was able to assist the pilot by taking over the radio communications and monitoring the flying but did not feel he should intervene any further and risk making the situation worse. A safe landing was made.

The aircraft was fitted with a propeller type which was classified by the engine manufacturer as 'non-approved' although it was approved by the LAA. Due to its classification, the engine Maintenance Manual specified that flywheel bolts should be replaced every 100 hours. However, a current Service Bulletin on the engine manufacturer's website, which the owner had been following, specified replacement of the flywheel bolts every 500 hours, in contradiction to the engine Maintenance Manual.

Footnote

[1] Available at: http://www.lightaircraftassociation.co.uk/2014/Mag/June/safety%20spot%20June.pdf [Accessed 2 January 2019]
http://www.lightaircraftassociation.co.uk/2015/Magazine/Mar/safety_spot.pdf [Accessed 2 January 2019]
http://www.lightaircraftassociation.co.uk/2018/Magazine/Dec/SS.pdf [Accessed 2 January 2019]

The flywheel attachment bolts had been installed for 447 hours. Although there are a number of propeller installation risk factors described by the manufacturer in JSB 014, the failure is likely to have been as a result of the inadvertent exceedance of the intended life of these bolts.

Conclusion

The engine failed while the aircraft was climbing through 1,400 ft, and a successful forced landing was made. The engine flywheel had detached due to failure of its attachment bolts. The engine had completed 447 hours, which was within the service interval of 500 hours for replacement of the bolts, as published in a Service Bulletin on the engine manufacturer's website and as followed by the pilot/owner. The engine manufacturer's Maintenance Manual specified an interval of 100 hours for replacement of the bolts, but this was not reflected in the Service Bulletin. This discrepancy was resolved such that the documents only referred to the correct 100 hours replacement interval.

The LAA, in consultation with the engine manufacturer, identified proposed new safety actions which would be publicised to aircraft owners, in addition to those previously highlighted.

Safety action

The engine manufacturer made a series of improvements to the configuration of the flywheel attachment system on this engine type. The improvements included the introduction of Nordloc washers, which the manufacturer stated '*should be implemented on existing engines whenever flywheel bolts are replaced'.* The various configurations that have been used, and the installation process for Nordloc washers are detailed in Service Bulletin JSB 012.

The LAA was proactive in highlighting the failures of flywheel attachment bolts after first becoming aware of the problem.

On 12 February 2019, the engine manufacturer issued Service Bulletin JSB 014-3, which aligned the maintenance requirement for '*non-approved propellers'* to that described in the Maintenance Manual.