ACCIDENT

Aircraft Type and Registration:	Europa, G-BWCV
No & Type of Engines:	1 NSI Propulsion Systems EA-81 piston engine
Year of Manufacture:	1997
Date & Time (UTC):	16 July 2006 at 1115 hrs
Location:	Near Portbury, North Somerset
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers -1
Injuries:	Crew - 1 (Minor) Passengers - 1 (Minor)
Nature of Damage:	Extensive damage to composite fuselage structure
Commander's Licence:	Private Pilot's Licence
Commander's Age:	46 years
Commander's Flying Experience:	977 hours (of which 31 were on type) Last 90 days - 30 hours Last 28 days - 14 hours
Information Source:	AAIB Field Investigation

Synopsis

Whilst cruising at 3,500 ft near the Severn Estuary, the aircraft suffered an alternator bearing seizure and smoke from the drive belts entered the cockpit. The engine stopped, but, due to its free-wheel mechanism, the propeller continued to rotate increasing the drag and causing a significantly higher rate of descent during the subsequent forced landing than for a propeller at idle or stopped.

The aircraft landed in a small field, struck a hedge and suffered major damage to the composite fuselage structure fore and aft of the cockpit. Both occupants suffered minor injuries.

History of the flight

The aircraft was cruising at 3,500 ft near the Severn Estuary with the engine at about 4,000 rpm, when, without warning, smoke entered the cockpit accompanied by a burning smell. The aircraft yawed and the nose dropped. The pilot then realised that the engine had stopped, although the propeller was still rotating.

The pilot, who also had approximately 1,000 hours gliding experience, reported that the aircraft attained an unusually high rate of descent as he manoeuvred it towards two adjacent fields which he had selected for the landing. He also reported a severe reduction in elevator effectiveness. He briefed the passenger and switched off the master switch, pulled the circuit breakers and turned off the fuel. He became aware of power lines

running across the larger of the two fields so he made his approach to the smaller field, which was later measured to be 290 m diagonally. His workload was high as he had to avoid several trees and pylons in the vicinity, and the electric trim was unavailable as the master electric switch had been turned off. The smoke in the cockpit however, had cleared. The gear and flaps were lowered and the aircraft touched down. Once on the ground the pilot, drawing upon his gliding experience, elected to retract the single wheeled landing gear in an attempt to decelerate more rapidly. Whilst this probably reduced the risk of tipping the aircraft over, it caused the propeller to break off and the flaps to retract. The loss of drag from the free-wheeling propeller, the lack of flaps and the fact that the wheel still rotated[1] all combined to reduce the deceleration rather than to increase it. The aircraft then struck a dense hedge at the far end of the field causing major damage to the composite fuselage structure fore and aft of the cockpit. Both occupants suffered minor injuries and exited through the doors. The police, fire and ambulance services attended the scene.

Aircraft and engine information

The Europa is a two-seat aircraft sold in kit form. G-BWCV was a mono-wheel version, and these have a single main wheel gear (called the mono-wheel) supplemented with a tail wheel and outriggers. The mono-wheel partially retracts into a bay situated between the two occupants. The deployment/retraction mechanism for the gear and the flaps is linked such that the mono-wheel and the flaps are deployed together.

This aircraft was manufactured in 1997 and the engine airframe combination had accumulated 76 hours. The aircraft was operating on a Popular Flying Association (PFA) Permit-to-Fly. There are over 200 Europas on the UK register, the majority of which are fitted with Rotax engines, as per the manufacturer's recommendations. G-BWCV was fitted with an NSI EA-81 engine, which is also approved, and there are believed to be around 11 similarly powered Europas on the UK Register.

The NSI EA-81 is a 98 hp refurbished and modified Subaru car engine. According to the literature supplied by the UK distributor of this engine, NSI obtained used low mileage Subaru engine cores from Japan. As part of the refurbishment they chemically washed, inspected and reassembled the engines using new seals and bearings. The provision of new or refurbished alternator components is not noted in this literature. The alternator is mounted on the top rear of the engine. The alternator and water pump are both fitted with two pulleys and are driven by two parallel toothed belts. The use of two belts is thought to provide redundancy should one belt fail.

The engine has electronic ignition and can run without the alternator using battery power. It also has a gear reduction drive with a 'Linear Cam Device' to reduce torsional vibration. If the engine stops in flight, this device acts as a free-wheel mechanism allowing the propeller to rotate, or 'windmill'. A free-wheeling propeller can generate significantly more drag than a static propeller and, since the glide ratio for an aircraft is the same as the ratio of lift to drag, a free-wheeling propeller can significantly increase the aircraft's glide angle and therefore its rate of descent in a glide.

The Propulsion System Operator's Manual for the NSI EA-81 contains a section on handling instructions. There is no reference in this manual to the significantly higher rate of descent for a free-wheeling propeller.

Footnote

[1] In the retracted position approximately ¼ of the wheel is exposed beneath the fuselage. The pilot inspected the aircraft's ground marks and concluded that the wheel had continued to rotate when in its retracted position.

Wreckage examination

The AAIB did not attend the accident site. However the wreckage was subsequently recovered to the AAIB's headquarters in Farnborough for inspection.

Inspection of engine installation – drive belts

Black rubber deposits were found on the engine around the alternator. The two drive belts were removed and there was evidence of slippage and scorching on the belt surfaces. Whilst there was significant damage to the belts, they were not broken.

The engine cowling was vented on the lower surface, and directly aft of this was the well for the mono-wheel. Discussions with the pilot concluded that this was the likely route for smoke from the drive belts to have entered the cockpit.

Alternator

The alternator main bearing was found to have seized and was stripped for examination. The bearing was a sealed unit with caged balls. The cage was found to have failed; see Figure 1. A metallurgist with significant experience in investigating failed bearings concluded that the failure was due to lack of grease in the bearing. In addition to lubrication, grease dampens vibration between the balls and the cage pillars, and the lack of grease removed this damping, causing the cage to fail in overload. Typically such sealed bearings have a shelf-life since the grease can degrade with time. The pilot considered that the life of the grease might also have been adversely affected by elevated temperatures associated with the configuration of the installation.

Flight testing

The PFA were informed of the accident and initiated a flight test to quantify the rate of descent for a similar aircraft with a free-wheeling propeller; the rate of descent measured was 1700 ft/min, which is significantly higher than that encountered with the propeller turning and the engine at idle.

Belt strength

The twin belts used were Super HC belts manufactured by the Gates Corporation. This organisation has a policy of not recommending the use of its power transmission products on aircraft, including home-built and FAA certified types.

This type of belt is suitable for multiple drive systems. The engine is rated at 98 hp at 5,800 rpm and the failure occurred in cruise at around 4,000 rpm and approximately 60 hp. The opinion from an engineer from the Gates Corporation was that the belts would slip at these conditions if the alternator seized.

Figure 1

A simple estimate of the load in one belt at this cruise condition made by the AAIB was 150 lbf. The ultimate strength of the belt was not available from the manufacturer, but with such a load the strength of the belts may well have been sufficient to stop the engine without the belts failing.

Previous incident

An incident occurred several years ago to an NSI powered Europa. The aircraft was in the cruise when the alternator seized. The belts were damaged but did not fail; smoke filled the cockpit and the pilot switched the engine and fuel off. The cockpit cleared of smoke and the pilot made a satisfactory forced landing. The pilot minimised the drag penalty of the free-wheeling propeller by adjusting the propeller pitch (NB the propeller on G-BWCV was fixed-pitch). The pilot also trimmed for 80 kt to increase the control effectiveness. The reason for the alternator failure was not determined.

Analysis

The main bearing of the alternator had seized due to lack of grease. This engine was refurbished approximately 10 years ago as part of its conversion to an aircraft unit and it was not possible to determine the history of the alternator components.

The pilot's account was consistent with the alternator seizing, causing the belts to slip and generate the smoke, and causing the engine to stop. There is evidence from the belt manufacturer and AAIB engineering estimates that this could have occurred.

If only one belt had been fitted, the single belt might have failed after the alternator seizure, and hence the engine might have continued running. However more detailed analysis is required to determine if this would be a better option. Therefore the following safety recommendation is made:

Safety Recommendation 2007-033

It is recommended that the Popular Flying Association review the use of dual belts on NSI EA-81 engines to minimise the consequences of an alternator seizure.

The greater concern with this incident, however, is the unexpected and abnormally high rate of descent in the glide after the engine stopped. In order to advise owners and pilots of this situation, a further safety recommendation is made:

Safety Recommendation 2007-034

It is recommended that the Popular Flying Association (PFA) advise all owners and operators of PFA Permit-to-Fly aircraft which have a free-wheeling fixed pitch propeller, that such aircraft may have a high rate of descent if the propeller free-wheels following an engine failure.

As a result of these two Safety Recommendations, and shortly before publication of this report, the PFA has advised that it is in the process of issuing two PFA Airworthiness Information notices. The first informs all operators of the NSI EA-81 engine (as well as operators of any other engine with a free-wheeling propeller) of the high rate of descent which may result if the engine stops. The second requires all aircraft fitted with the NSI EA-81 to have the alternator bearings inspected every 50 hours or at least annually. In the meantime the PFA intend to review the option of removing one of the two belts. In view of these safety actions the AAIB is satisfied that the PFA have already responded appropriately to the two Safety Recommendations 2007-033 and 2007-034.