ACCIDENT

Aircraft Type and Registration:	Piper PA-22-150 Caribbean, G-ARHN
No & Type of Engines:	1 Lycoming O-320-B2B piston engine
Year of Manufacture:	1960
Date & Time (UTC):	9 September 2010 at 1310 hrs
Location:	Woodlands, Hampshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Serious) Passengers - 1 (Serious)
Nature of Damage:	Aircraft extensively damaged, third party damage to buildings and garden
Commander's Licence:	Private Pilot's Licence
Commander's Age:	74 years
Commander's Flying Experience:	340 hours (of which 20 were on type) Last 90 days - 18 hours Last 28 days - 4 hours
Information Source:	AAIB Field Investigation

Synopsis

A forced landing was conducted following an engine failure. The pilot was unable to achieve his selected field and the aircraft struck the roof of a house before crashing into the garden. Both the aircraft occupants received serious injuries; however, there were no injuries to persons on the ground. No cause for the engine failure could be established.

History of the flight

The aircraft had departed from its base at Popham, Hampshire at 1050 hrs for a return trip to Bembridge Airfield on the Isle of Wight. Before departure from Popham, the pilot had conducted a pre-flight inspection, this included physically checking the contents of the fuel tanks, which he recalls as being just under full. The fuel level was as expected, as the aircraft tech-log showed 15 mins of flying since it had been refuelled to full four days previously.

The outward flight passed without incident and the pilot recorded a flight time of 33 minutes. After a stop of about an hour at Bembridge, the aircraft departed at 1250 hrs; the pilot had conducted a transit check, but had not physically rechecked the fuel quantities. For the outward flight, the pilot had selected the left fuel tank; for the return he therefore selected the right tank.

The accident flight initially routed west from Bembridge

to The Needles and, after orbiting once over Hurst Castle at the north side of the Solent, the aircraft flew north with the pilot intending to turn towards Popham once clear of the Solent Control Area (CTA).

The pilot recalls flying at an altitude of 1,800 ft amsl, this was in order to remain below the base of the Solent CTA at 2,000 ft. The flight was proceeding normally and it was about 15 minutes after departure when the pilot heard a bang followed by a spluttering noise. The pilot saw the engine rpm drop immediately to about 1,800 rpm. He selected carburettor heat to HOT and then changed the fuel selector to LEFT. Neither of these selections appeared to have any effect and the pilot recalls the engine rpm declining further.

At 1308 hrs the pilot transmitted a PAN call to Bournemouth Approach informing them that the engine was running very slowly and he was "LOOKING FOR SOMEWHERE TO PUT DOWN." Bournemouth Approach asked if the aircraft could reach the airfield; however, the pilot replied he was unable to maintain altitude. The pilot selected a field he believed he could conduct a forced landing into. The pilot recalled that in order to ensure he selected a field within the likely glide range of the aircraft, he had selected a field 45° below the horizon. He then flew a curving approach to the field; however, the aircraft had insufficient energy to reach the field, struck the roof of a house and then crashed into a garden, demolishing a greenhouse. The pilot does not recall making any flap selections during the approach.

At 1310 hrs another aircraft, which had seen the accident from several miles away, reported to Bournemouth Approach that G-ARHN was "NOW DOWN".

The passenger recalled that the flight seemed normal until the pilot started "moving various knobs" and said the engine had lost power. The passenger's last recollection of the flight was of the aircraft approaching the roof of the house, he then had no further memory until he came round following the accident.

Following the crash, a witness with flying experience was amongst several bystanders who went to help before the emergency services arrived. The witness asked the pilot to confirm the fuel and electrics were off. The pilot turned off the electrical master switch, located under his seat, and believed he had turned the fuel selector to OFF. At some stage the magnetos were switched to OFF and the keys removed from the ignition; however, it is unclear when this occurred.

Pilot experience

The pilot had gained his PPL in 1997. The pilot last conducted practice forced landings during his biennial flight with an instructor in November 2009. The pilot stated that he would normally practise forced landings during his biennial flight, but was unlikely to have done so during other flights without an instructor.

Injuries to persons

The pilot received multiple injuries, including serious head injuries and fractures to the right arm, and received extensive medical treatment.

The passenger received serious head injuries.

Witnesses

Various witnesses on the ground had seen parts of the forced landing approach. Their reports were all consistent that there had been no engine noise during the accident.

One witness described the aircraft as passing over them in a curving flight path. (Figure 1)

Figure 1

G-ARHN circled, witness ground track arrowed, note wires crossing field in foreground, pylon boxed.

Weather

At the time of the accident Bournemouth Airport reported the surface wind as from 270° at 6 kt, the temperature 19°C and dewpoint 13°C.

Accident site

The aircraft had initially struck the roof of a chalet bungalow, dislodging a number of ridge tiles, before impacting a flat roof extension on the far side. This second impact resulted in the nose wheel punching a hole in the roof, causing debris to fall into a bedroom below. From here the aircraft continued on a downwards trajectory before striking a greenhouse in the back garden some 15 m from the house, where it came to rest in a left wing low attitude and approximately level in pitch, with the left main and nose landing gear legs collapsed.

It was observed that the flaps were in their fully down position, which corresponded with the raised position of the operating lever located on the floor between the front seats. This area had sustained comparatively little disruption in the impact; accordingly it was concluded that the lever, which was of the automotive handbrake type, was likely to have been selected to the as-found position prior to the impact.

One of the two propeller blades bore scuff marks made by fragments of glass from the greenhouse. The fact that there were no similar marks on the other blade, together with minimal overall damage, suggested that the propeller had been stationary at the time of the accident.

The aircraft was equipped with an 18 US gallon (approximately 68 litres) fuel tank in each wing; the fuel system allowed the engine to be fed from either the left or right tank, but not both simultaneously. Inside the cockpit it was noted that the fuel selector, located on the left sidewall, was selected to RIGHT. However, given his injuries and medical treatment, the pilot did not have an entirely accurate recall; thus the as-found position of the fuel selector is not considered a reliable indication of the pre-impact selection. Nevertheless, it was clear that the pilot had managed to turn off the aircraft electrics via the master switch, which was located underneath the front left seat.

Elsewhere in the cockpit it was observed that the throttle, mixture and carburettor heat control knobs were all at their fully forward positions. The distortion on the area of the panel in which they were located, in conjunction with the injuries the pilot had sustained to his forearm, suggested that the pilot may have had his hand on the throttle during the impact.

Following an on-site examination, the aircraft was recovered to the AAIB's facility at Farnborough. The recovery entailed removing both wings in preparation for lifting the aircraft from its location in the garden. During this process, 45 litres of Avgas were recovered from the left fuel tank, with no evidence of water or any other form of contamination being observed. The right tank was empty, although after the fuselage was raised, it was apparent that the fuel strainer on the forward face of the engine firewall had been broken open as a result of the nose underside striking the ground. As a consequence, any fuel in the right tank would have drained away. It was additionally apparent that the quick release drain plug on the engine sump had been pushed up into its open position, thus allowing the engine oil to drain into the ground.

Detailed examination of the aircraft

General

The investigation focussed on the engine, together with the fuel and ignition systems. The fuel selector was removed and its right tank selection was confirmed.

All the remaining airframe fuel system pipe work was checked for evidence of blockages or debris; none was found.

Each fuel tank was equipped with a filler cap with the word 'vented' embossed on its upper surface. Whilst both components appeared superficially identical, it was noted that the internal fitting in the right cap did not contain the vent holes that were present in the left. The general appearance of the caps suggested that they were original to the aircraft, with the seals around the underside of each cap being in a worn condition such that they probably provided tank venting irrespective of the provision of vent holes. In the absence of any reported occurrence of fuel feed problems from the right tank over the years of service, the absence of vents in the filler cap was not considered to be a factor in the accident.

The airframe examination also included disassembling the ignition switch, which confirmed that there had been no internal failure that could have caused an inadvertent grounding of the magnetos.

Engine

The engine was last overhauled in April 2009 following a shock-load inspection and had since accumulated approximately 120 hours at the time of the accident.

Damage to the engine appeared to be limited to the oil drain plug, noted earlier, and the carburettor, which had sustained damage to the throttle body. This had resulted in the carburettor having been almost torn off its mounting on the engine underside, leaving it suspended by its two rear bolts. It was established that the throttle and mixture controls were correctly attached.

Before removing the engine from the airframe it was observed that the 'P' leads, which connected the magnetos to the ignition switch (and which were grounded when the ignition key was selected to OFF) were in poor condition over the sections running between the magnetos and the firewall. Each lead had an outer braided sheath to provide Radio Frequency (RF) shielding. It was noted that the sheaths were severely frayed close to their attachments to the rear of the magnetos and, in the case of the left P lead, had completely separated at the point where it emerged from the firewall, thus exposing a short length of the inner lead. (Note: during discussions with members of the G-AHRN flying group, it emerged that there was a history of poor radio reception. It is possible that this was associated with the condition of the P leads.) It was noted that the holes in the firewall had jagged edges and this had caused the damage to the sheathing. In addition, in the case of the right lead, there was a severe kink close to a ferrule that formed part of the attachment to the magneto. A close examination revealed that the inner lead was also kinked, to the extent that the insulation had broken. However, no strands of wire from the internal conductor were visible, and there was no obvious evidence of arcing, either on the braided sheath or the ferrule. Thus, whilst this was clearly an undesirable feature, it was considered that, although the possibility of intermittent arcing could not be excluded, it was not likely to have caused the engine to fail, particularly as the left P lead insulation was found to be intact.

The engine was taken to an overhaul company, where, following an inspection, refilling with oil, and fitting a replacement carburettor, it was run in a test cell. The engine started and ran normally, although below specified maximum power output. This was attributed to the replacement carburettor, which was a different model from that normally fitted to this engine type (no example of the correct model being available).

After the test, the magnetos were removed and subjected to a bench test, where it was found that they performed satisfactorily. They were then disassembled, when, despite the external labels indicating that they had not been overhauled since 1995, it was found that the internal components were in good condition. Documentation subsequently came to light indicating that the magnetos were overhauled by a specialist company at the time of the engine overhaul.

Finally, since the carburettor could not be run with the engine, it was disassembled. It was noted that the accelerator pump was primed with fuel and that the float chamber was approximately one third full. This activity took place approximately one week after the accident. Although there would have been limited scope for evaporation via the broken fuel strainer, it is considered more probable that, if the carburettor was tilted significantly away from the vertical after the accident, fuel could have drained through the holes in the venturi that supplied the idle fuel flow. No debris was found within the carburettor and it was noted that the main jet and the fuel inlet screen were clear.

Despite the damage to the carburettor, it was possible to mount it on a rig in order to test the functionality of the float assembly and float valve. This confirmed that the latter opened and closed at the required fuel inlet pressures, thus indicating that there was little likelihood of fuel flooding or starvation.

New Zealand CAA forced landing advice

In January 2007 the New Zealand CAA published[1] in its *Vector* safety magazine a guide to conducting a forced landing. It included a section on field selection which states that, in order of importance a pilot should consider the field's Size, Shape, Slope, Surface, Surroundings Stock and Sun.

For Size the guide states:

> *'Size*
>
> *Look for the longest possible landing site that faces into wind…'*

And for Surroundings the guide suggests:

> *'Select a landing site that has a clear approach path. An approach should not be planned over tall trees, power lines and buildings that will prevent you from achieving an unimpeded profile. A clear approach path will also mean that undershooting your landing site is less likely to result in a collision with a solid obstacle. Some consideration should also be given to the possibility of an overrun….'*

Analysis

The pilot's choice of field was guided by his perception of the likely glide range of the aircraft. He had selected a field that was, in his recollection, 45° below his line of sight and should have been achievable. It is difficult to be certain which field the pilot was intending to land in; the field most in line with the aircraft's accident orientation was relatively short, with a 177 m distance from fence to fence. A slight change in flight-path, to the left, would have offered almost 300 m and it may have been this field that the pilot was aiming for. Both these fields required the aircraft to cross over a residential street before reaching the landing site. Ultimately the aircraft had insufficient energy available and struck the roof of a house before coming to a stop in the garden.

Footnote

[1] http://www.caa.govt.nz/Publications/Vector/Vector_2007_Issue-1_Jan-Feb.pdf

The pilot had, however, maintained flying speed and thus control of the aircraft, avoiding stalling and/or spinning which, with the resultant high vertical descent rates, often result in the most serious or fatal injuries.

The pilot only recalls practising forced landings at his biennial flight with an instructor. The flight path angle of an aircraft with a stopped engine is likely to be steeper than that achieved during practice forced landings and it seems that the pilot did not account for this in his field selection.

An exhaustive examination of the engine and fuel system revealed all components to be in good condition, with the exception of the damage to the magneto P leads. The insulation of the right lead was broken; however, it was considered unlikely to have resulted in an engine stoppage. At worst there may have been some misfiring of the right magneto, although no evidence, in the form of arcing damage, was found. The engine ran satisfactorily on test, indicating there had been no internal mechanical failure. There was thus no explanation for the reported engine failure. The temperature and dewpoint were respectively 19ºC and 13ºC, which, according to the CAA's carburettor icing probability chart, gives a 'moderate' risk of icing at cruise power. However, the apparent suddenness of the stoppage tends to militate against this as a potential cause.