ACCIDENT

Aircraft Type and Registration:	Piper PA-23-250 Aztec, G-BBEY
No & T ype of Engines:	2 Lycoming IO-540-C4B5 piston engines
Year of Manufacture:	1973
Date & Time (UTC):	29 June 2006 at 1237 hrs
Location:	Near Thirkleby Hall, Thirkleby, North Yorkshire
Type of Flight:	Private
Persons on Board:	Crew -1 Passengers - None
Injuries:	Crew - 1 (Fatal) Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	64 years
Commander's Flying Experience:	466 hours (of which 251 were on type) Last 90 days - 32 hours Last 28 days - 9 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft was making its first flight following a period of maintenance that had included work on the aircraft's left engine fuel system. On takeoff, it became apparent to witnesses that there was a problem with one, or possibly both, engines. The pilot flew a close-in circuit and returned to the airfield but, on landing, the aircraft bounced several times and a go-around was initiated. The aircraft was seen to climb slowly and at low speed before it banked steeply to the left, and directional control was lost. The aircraft stalled and dropped the left wing at a height too low for the pilot to effect a recovery.

The investigation determined that a reduction of power affecting the left engine occurred, probably due to blockage of a fuel injector nozzle.

History of the flight

The pilot, who was also the owner of the aircraft, arrived at Bagby Airfield on the morning of the accident. The aircraft had recently completed a period of maintenance and he intended to fly it to Gamston Airfield, where it was normally based.

During the morning, the pilot had taxied the aircraft to the fuel pumps and refuelled the left outer fuel tank. The pumps were located next to the maintenance hangar where the work on the aircraft had been carried out. The owner of the maintenance company reported that the pilot had requested his help as he was unable to get the right wing navigation light or left wingtip strobe light to work. No fault was found with the navigation light and the strobe light was made

serviceable by changing a connection on the strobe light power pack.

Shortly after midday, the pilot boarded the aircraft and started both engines. A witness reported that the engines appeared to start and run without problem and that the aircraft was then taxied out of view towards the threshold of Runway 24. He recalls hearing what he believed were power checks being carried out on the aircraft, but did not recall hearing the propellers being exercised as would be usual during a feathering operation check.

At about this time, the owner of the maintenance organisation received a call on his mobile telephone from the pilot. He reported that the pilot appeared to be in the aircraft with the engines running and had asked for one of the engineers to go to the unmanned tower to give him a radio check. The pilot gave no indications that there were any problems with the aircraft.

An engineer duly went to the tower to give the pilot the radio check as requested; again the pilot did not report any problems. Three engineers from the maintenance organisation saw the aircraft take off from Runway 24. They were immediately concerned as one, or both, engines sounded to be running rough and smoke was seen coming from the engine exhausts. One of the engineers described seeing black smoke coming from the left engine exhaust, with a lesser amount of grey smoke coming from the right engine exhaust. The others reported smoke coming from both engines, one describing it as having a similar appearance to a smoking diesel engine. Additionally, the takeoff ground roll was excessive.

The aircraft became airborne about three-quarters of the way along the runway and the landing gear was then seen to retract. One of the engineers ran to the tower and called the pilot over the radio to warn him that they believed the aircraft had a problem and to advise him to return. The pilot did not reply immediately but then made a transmission reporting that the aircraft was not climbing properly. It was then seen to fly a left circuit to Runway 24 with the aircraft appearing to be lower and closer to the airfield than normal. When on final approach for Runway 24, the pilot asked for visual confirmation that the landing gear was down. The engineer in the tower could see that it was and reported this back to the pilot.

The aircraft continued the approach and appeared to land heavily on its main wheels, following which it bounced back into the air. It was then seen to pitch down, land on its nosewheel, and run along on this wheel[1] before the main wheels touched down again. The aircraft bounced into the air again, subsequently bouncing two or three times in the same manner as it passed down the runway. When it was about two thirds of the way down the runway, the aircraft became airborne again and one witness then saw the landing gear being raised. Witnesses also recall seeing smoke still coming from the engines, one describing it as dense black smoke from the left engine and less dense smoke from the right engine.

The aircraft was seen to climb slowly at low speed, bank steeply to the left and turn onto a reciprocal heading to the runway. It then turned to the left again, at a height of about 100 ft, before the left wing suddenly dropped. The aircraft pitched down, hit the ground and burst into flames.

Airfield description

Bagby is an unlicenced grass airfield with two runways. The main runway, Runway 06/24, is 710 metres long and is crossed near the threshold of Runway 06 by the second runway, Runway 15/33, which is 450 metres long. At the time of the accident the grass was dry.

Footnote

[1] Commonly referred to as 'wheelbarrowing'.

The airfield website publishes the following information:

> *'Runway 24 has a pronounced 2.6% downslope. This means (if you are landing downhill) that accurate speed control is vital to avoid that long float and desperate feel for the runway, or alternatively wheel barrowing at high speed down 24. In light and no wind conditions locals almost invariably land uphill and take off downhill.'*

Pilot's flying experience

Log book entries show that the pilot had been flying from Bagby since 1995 and had undertaken numerous flights from the airfield since that time. He was, therefore, familiar with its sloping runway and circuit patterns.

The pilot attained a multi-engine rating in 1989, since when he had conducted almost half of his flying on various multi-engine types. He had been flying the PA-23 Aztec since 1990. In the six months prior to the accident, he had flown for about 47 hours, of which only 3.5 hours were on multi-engine aircraft. On 14 February 2006, the pilot flew with a flying instructor from Gamston to Bagby, as the instructor wished to assess the aircraft with a view to leasing it from the owner. The instructor stated that, during this flight, the owner had practised flying with asymmetric power without, apparently, any problems. On the aircraft's penultimate flight, the pilot flew from Gamston to Bagby for maintenance. No problems were reported concerning this flight.

Weather

The following weather conditions were recorded shortly after the accident:

Wind 250º at 5-8 kt, visibility in excess of 10 km, broken cloud at 2,000 ft, temperature 22ºC, QNH 1019 hPa.

Accident site

The accident site was located 0.8 km to the south of Bagby airfield, at a position 0.25 km east of the A19 trunk road and 33 metres south of the entrance road to Thirkleby Park. The area around the accident site consisted of large open fields with small areas of woodland interspersed with the occasional building. A holiday caravan park and recreational area, together with some holiday apartments, were located less than 1 km to the east-north-east of the accident site.

Accident site examination

Examination of the accident site showed that the aircraft impacted the ground in a near vertical nose-down attitude, with a high rate of descent, initially with the forward fuselage and then the left propeller and left wing tip. The ground impact marks indicated that the aircraft was spinning to the left and had struck the ground on a west-south-westerly heading. Following the initial impact, the aircraft rotated in a cartwheeling motion, resulting in the right propeller and right wing tip impacting the ground. As a result, both wing spars failed in the areas between the engines and the fuselage, causing the wings to become detached. The fuselage and wings were thrown approximately seven metres to the north, with the fuselage coming to rest inverted and partially on top of the upright right wing. The left wing, which was also upright, came to rest to the north of the fuselage.

Initial wreckage examination

Fuel from the ruptured wing tanks had ignited and a substantial fire ensued which consumed the majority of the aircraft structure. Ground marks made by the propellers showed that they were both being driven by their respective engines, the right at high power and the left at medium power. Before the wreckage was disturbed,

an examination of the flying control systems showed that they had been intact, with no disconnections between the flying control surfaces and the cockpit controls. It was not possible to establish if any pre-impact jam or restriction had occurred, or the position of the flaps.

Engineering examination

After the wreckage had been recovered to the AAIB at Farnborough, both fuel-injected engines were taken to an approved engine overhaul facility for a detailed strip examination. This examination revealed that they had been in reasonable mechanical condition but there was evidence to indicate that they had experienced long periods of inactivity. The majority of the engines' ancillary equipment, such as the magnetos and fuel servo units, were excessively fire damaged and could not be tested. Limited visual examinations of these items did not identify any obvious pre-impact faults or failures.

The engine mounted fuel injector distribution valves, fuel pipes and injector nozzles were removed and tested. It was found that the fuel injector distribution valves and the fuel pipes fitted to both engines performed satisfactorily. However, one of the left engine injector nozzles was found to be blocked; the remaining five were found to function in a satisfactory manner. Analysis of the substance that had caused the blockage showed it to be an aluminium alloy corrosion product. When the fuel injector distribution valve from the left engine was dismantled it was found that heavy corrosion was present within the aluminium alloy body of this unit. This corrosion had occurred in the fuel chamber section of the valve, indicating that the chamber had been contaminated by water. Due to the severe post-impact fire, it was not possible to determine the serviceability or cleanliness of the fuel system in the airframe.

All six fuel injector nozzles from the right engine were found to function at flow rates ranging from 91% to 55% of the specified maximum flow rate. Detailed examination of the nozzles found that the flow restrictions had been caused by a general build-up of ferrous corrosion products and nickel.

Both propellers were taken to an approved propeller overhaul facility for a detailed strip examination. There was no evidence seen in either unit to indicate a pre-impact fault or failure that would have prevented normal operation. Evidence from witness marks seen within the propeller mechanisms indicated that all propeller blade pitch angles were consistent with the propellers being driven by the engines at the moment of impact.

A small number of items from the landing gear were identified and examination indicated that the gear was close to, but not in, the fully retracted position.

The post-impact fire precluded the possibility of establishing if there had been a bird strike, a pre-impact fire or, for example, if a panel or engine cowling had become loose or detached. However, no aircraft parts were found along the flight path between the takeoff point and the point of impact.

Maintenance history

During the five years prior to the accident, the aircraft had been stored for long periods of time in the open, with no maintenance activity or engine runs being carried out. The aircraft was stored in the open from July 2005 to February 2006 prior to being sold to the owner/pilot involved in the accident. In February 2006, in preparation for the sale, maintenance work was carried out at Bagby. This consisted of a 50 hour Inspection, in accordance with the Civil Aviation Authority Light Aircraft Maintenance Schedule (LAMS), replacement

of the engine spark plug high tension springs and ferrules, work on the fuel system, and the fitting of four new fuel tank filler caps. During this inspection, water contamination was found in the fuel system. As a result, the maintenance organisation drained all the fuel and water from the aircraft, removed a number of the fuel system filters and other components, flushed the fuel system, cleaned the filters and components and re-fitted them to the aircraft. Following this work, the aircraft was flown by the new owner from Bagby to Gamston, without any reported problems. Over the next two months the aircraft's airframe log book records that it flew for a total of 3 hours 10 minutes, which included its penultimate flight from Gamston to Bagby. It was not recorded if the pilot experienced any problems with the aircraft on this flight, and no problems were mentioned to the maintenance organisation.

Once at Bagby, the aircraft underwent further maintenance which consisted of an Annual Inspection in accordance with LAMS, the fitting of two overhauled propellers and general aircraft husbandry. Following this, a number of engine ground runs were carried out. During the first of these, it was noted that the left engine was running very unevenly and would not produce full power, and that the right engine had an excessive magneto 'rpm drop'. Examination of the left engine revealed that one of the fuel injector nozzles was blocked by material described as debris/particles, the appearance of which did not lead the maintenance engineer to think that it was corrosion debris. All the injector nozzles were then removed, cleaned, checked for correct spray pattern and refitted to the engine. Also, the engine fuel system was flushed, a process which did not reveal any signs of corrosion products. The spark plugs were removed from the right engine, cleaned and refitted. During a number of subsequent ground runs, both engines performed satisfactorily.

Analysis

Witness information indicated that a problem may have existed with both engines, once the aircraft had begun its takeoff run. This became evident to observers on the airfield as rough running with smoke coming from both engine exhausts. The examination of the engines revealed that two different types of corrosion debris had affected many of the fuel injector nozzles. The blocking of one of the six fuel injector nozzles, on the left engine was established by analysis to have been a result of by-products from the corrosion of aluminium alloy. This most probably originated within the fuel injector distribution valve body where evidence of corrosion was found.

Such a blockage would have resulted in the engine running unevenly and at reduced power, and excess fuel being delivered to the other five nozzles. This would have caused the engine to run in a fuel-rich condition, and to emit blackish coloured smoke from the engine exhaust. The presence of a nozzle blocked by corrosion debris on the left engine, which occurred so soon after the reported satisfactory post maintenance engine runs, would seem to indicate that, despite the cleaning and flushing of the engine's fuel system, not all of the corrosion debris had been removed from the system.

The partial restrictions found in all the fuel nozzles on the right engine were found on test to cause reductions in the maximum specified flow rates of between 91% to 55%, and were caused by the products of corrosion of ferrous and nickel materials. Their origin was not established and they were considered by both the maintenance and an approved engine overhaul organisation to be the effect of long term usage. Although any partial restriction has the potential to cause a reduction in power, particularly at high fuel flow rates, both engines reportedly ran satisfactorily during ground runs prior to

the accident flight. Also, the propeller ground witness marks indicated that the right engine was running at a high power level at impact. Therefore, it is likely that the restrictions identified had been present for a time and had not altered the power output of the engine on the accident flight, compared with previous flights.

The reason for grey/black coloured smoke, seen by witnesses to come from the right engine during the takeoff, was not established. The maintenance engineer offered the view that smoke may often emanate from these engines on takeoff, with the mixture set at full rich, but the possibility that it was also associated with the nozzle partial restrictions could not be completely dismissed.

During the takeoff roll, it should have been possible for the pilot to realise that there was a power problem by the aircraft's rate of acceleration, engine indications and a possible power asymmetry, which might have been evident through the aircraft attempting to yaw. It is not known at what point the pilot became aware of this loss of power, but his radio call to the effect that the aircraft was not climbing demonstrates that he did know there was a problem shortly after becoming airborne. Despite any power loss experienced at the time, he was then able to complete a tight low level circuit to land back on Runway 24.

The pilot's radio call when on final approach, asking for a check that the landing gear was down, could have indicated that he was either unable to confirm it was down, due to an unknown problem with the cockpit indications or, possibly, that he was under considerable pressure and did not have sufficient spare mental capacity to check for himself. It is also possible that, if he did feel under pressure, the desire to get the aircraft on the ground quickly could have lead to the subsequent touchdown being sufficiently hard to make the aircraft bounce. A natural tendency, following a bounce, and especially with a runway downslope, can be for a pilot to pitch the aircraft nose down. This appears to have occurred, resulting in the aircraft running along on its nosewheel, or 'wheelbarrowing', as warned of in the airfield brief. To minimise the risk of such problems, the runway normally chosen by pilots for landing at Bagby is Runway 06. Even with the strength of the tailwind that would have been experienced at the time of the accident, this would have been an option.

The pilot's decision to go-around was presumably made when he considered that he could not stop the aircraft safely in the remaining runway length. The aircraft would not have decelerated normally as it bounced along the runway and, when power was re-applied, it would appear that there was minimal distance in which to accelerate to a safe flying speed. The aircraft was seen to climb away slowly, suggesting that it could have been below its optimum single-engine climb speed as it became airborne. If so, this would have reduced the aircraft's capacity to either accelerate or climb. However, the very fact that the aircraft was seen to climb also suggests that sufficient power might have been available, at that time, for the aircraft to accelerate in level flight. Given that the pilot had chosen to land back at the airfield he was faced with making low level turns through a total of 360º or 180º for Runways 24 or 06 respectively. The possibly less risky alternatives would have been to fly straight ahead and carry out a forced landing or, if sufficient power was available, gain height before returning to land or find an alternative airfield.

In order to accelerate the aircraft, the pilot would have had to fly straight and level, or in a shallow descent if height permitted, and raise the landing gear and flaps. It is not known what flap setting was selected at the

time of the attempted go-around but the landing gear retraction sequence began shortly after the aircraft took off. It was not found in the fully retracted position, and it could not be determined whether it was either just about to complete the retraction cycle, had just started an extension cycle, or had unlocked from the up position due to the impact rupturing the hydraulic lines.

Witnesses described seeing the aircraft bank steeply to the left at a height of approximately 100 ft shortly after it become airborne, and turn on to the runway reciprocal heading. Control of the aircraft was then lost, the left wing dropped and the aircraft entered a spin to the left. The reason for the loss of control would seem to have resulted from insufficient power being available to sustain the aircraft's speed whilst the pilot tried to remain airborne. In this slow speed situation, with an attendant high angle of attack, any increase in the aircraft's pitch attitude was likely to have led to the wing stalling. The fact that the aircraft turned to the left and dropped the left wing may have resulted from the right engine producing more power than the left, resulting in a yaw to the left as the wing stalled. From such a low height, it would not have been possible for the pilot to recover the aircraft from the ensuing spin before striking the ground.

Although the pilot had been flying the PA-23 Aztec since 1990, and a variety of other multi-engine aircraft since that time, he had only flown for 3.5 hours in such types in the six months prior to the accident.

Conclusions

Following maintenance work on the aircraft's left engine fuel system during an annual check, the aircraft appeared to suffer a significant reduction in power from the left engine on takeoff. This was either not recognised by the pilot in time to stop the aircraft safely on the runway, or it occurred too late in the takeoff roll. The reduction in power probably resulted from the complete blockage of one fuel injector on the left engine, caused by corrosion products associated with the aircraft's left engine fuel system. Having flown a tight circuit, the pilot landed the aircraft back at the airfield, but appeared to mis-judge the subsequent landing, possibly, due to the nature of the sloping runway. This resulted in the aircraft bouncing repeatedly. A go-around was initiated and the aircraft became airborne, but it was seen to climb only slowly. The aircraft then banked steeply to the left on to a reciprocal heading but, subsequently, control was lost, the aircraft stalled and entered a spin from a height too low for the pilot to effect a recovery. The aircraft consequently crashed and caught fire.