ACCIDENT

Aircraft Type and Registration:	Piper PA-38-112 Tomahawk, G-BYLE
No & Type of Engines:	1 Lycoming O-235-L2C piston engine
Year of Manufacture:	1982
Date & Time (UTC):	22 October 2005 at 0839 hrs
Location:	Near Biggin Hill Airport, Kent
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - 2 (Fatal) Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Commercial Pilot's Licence with Flying Instructor Rating and CAA authorised Flight Examiner
Commander's Age:	60 years
Commander's Flying Experience:	4,451 hours (no record of any experience on type) Last 90 days - 39 hours Last 28 days - 18 hours
Information Source:	AAIB Field Investigation

Synopsis

Shortly after takeoff the aircraft experienced an engine problem which was probably the result of water contamination of the fuel. In the resultant situation, the recommended option was to land straight ahead into a field. However, possibly influenced by a partial engine recovery, the commander decided to attempt to turn back towards the departure runway. The aircraft had turned through approximately 180º to the left when it stalled and crashed.

Background to the flight

A few months prior to the accident flight, the commander had contacted the Chief Flying Instructor (CFI) of the Flying Club that operated G-BYLE and offered his services as a flying instructor. The CFI had known the commander for many years, knew that he was an experienced instructor and examiner, and had agreed that he would employ him when an additional instructor was required.

On Thursday 20 October 2005, the CFI contacted the commander and asked him if he would be available for instructional duties on Saturday, 22 October. The commander agreed and arranged to be at the flying club early on the Saturday morning. The CFI was aware that, sometime after the initial contact, the commander had visited the club and spoken to his other full-time instructor.

The student involved in the accident had been a member of the flying club since 22 January 2005. Since then, he had completed 26 flights totalling about 29 hours. He had not flown solo and had last flown an instructional flight on 1 October 2005, three weeks before the accident.

The previous flight of G-BYLE had been on 20 October 2005, two days before the accident, when two other pilots had flown the aircraft from Biggin Hill to North Weald and back. At the completion of the flight, the pilots' recollection was that the fuel gauges indicated between $^1/_3$ and $^1/_2$ full in each of the two wing tanks. They also commented on two aspects. Firstly, on initial application of electrical power, the fuel gauge had indicated that the left fuel tank was empty; a visual check of the tank contents indicated that it was about $^2/_3$ full. However, after engine start, the fuel gauge indicated correctly and did so for the rest of the flight. The pilots also noted that, during the pre-flight external checks it was necessary to drain three fuel-tester containers of water from the left fuel tank (a typical, tubular fuel drain test container holds approximately 35 cc of liquid). There was no indication of water in the right fuel tank or the gascolator.

History of the flight

On the day of the accident, the flying club operations assistant arrived at about 0720 hrs to open up the club. A few minutes after she did so, the student arrived and had a cup of coffee before taking the keys of G-BYLE and going to do the pre-flight external checks on the aircraft. Shortly after, the commander arrived and introduced himself to the operations assistant. She had been pre-warned by the CFI that the commander would be doing some instructing and arranged for him to complete the club membership form. She also showed him where the student records were kept and saw him take out a record and read it. He then commented that he would be doing a circuit detail, checked the Technical Log for the aircraft and booked out for the flight. He also commented that, as there would be no need for a long brief, he would go and join his student at the aircraft.

While the student was alone at the aircraft, the airport refuelling truck arrived and its operator began refuelling aircraft. G-BYLE was the second aircraft refuelled at about 0755 hrs and 65 litres were loaded into the aircraft to fill both fuel tanks.

Analysis of the radio recording from Biggin Hill 'Tower' on frequency 134.800 MHz, showed that G-BYLE checked in at 0818 hrs with a request to taxi for a circuit detail. Paperwork later found in the aircraft revealed that the commander had logged the brake release time as 0820 hrs. The paperwork also showed that the commander had noted the latest Biggin Hill weather report. The club CFI was also flying that morning and had heard G-BYLE call for taxi clearance. Shortly after, as the CFI taxied away from the aircraft power check area, he saw G-BYLE waiting to taxi in to the area. The next radio communication from the aircraft was at 0830 hrs when G-BYLE reported ready for departure. The controller instructed the aircraft to hold position and was then busy with other aircraft on the frequency. At 0834 hrs, G-BYLE transmitted again that the aircraft was ready for departure and the crew were advised that they would be called back as there was another aircraft departing on Runway 03. Then, at 0837 hrs G-BYLE was cleared to take off from Runway 21 for right hand circuits with a surface wind of 240º/ 05 kt. After acknowledging this clearance, the next transmission from G-BYLE was at 0838 hrs with the following message: "ER LIMA ECHO I'VE GOT A PROBLEM CAN I COME BACK AND LAND ON ZERO THREE". The controller immediately cleared the aircraft to do so and to make a left turn. G-BYLE confirmed that the aircraft would turn left. At 0839 hrs, the controller cleared the aircraft to land on Runway 03 but received no reply.

When the tower controller heard the initial call from G-BYLE, he noted that the aircraft was already in a turn to the left. Following his transmission to G-BYLE, he then instructed another aircraft to go-around from an approach to Runway 21. The approach controller was also in the visual control room and had watched the aircraft. She had seen it turn slightly to the right after takeoff and then start turning to the left. By then, the tower controller was concerned that the aircraft would not make it back to the airfield and activated the crash alarm. The aircraft disappeared behind trees to the south of the airfield in a nose-down attitude.

The crash alarm was recorded as being activated at 0839 hrs and the AFRS recorded their arrival on the crash scene at 0844 hrs. The local Fire Service arrived on the scene at about the same time. There was no fire and with no indication of life from the occupants of the aircraft, the fire fighters laid and maintained a foam blanket around the area of the aircraft.

Near the airport, there were witnesses who saw the aircraft during its last moments of flight. One witness had previously worked as an aircraft engineer at the airport. He was in the driveway of his house, located some 400 metres south of the airport, when he heard a "*popping*" noise from an aircraft and looked towards it. The aircraft, which he recognised as a Piper Tomahawk, was coming from the airport. It appeared to have turned to the right because the normal departure from the southerly runway was directly over his house. The aircraft was much lower than normal and appeared to be descending. He then heard the engine noise increase and sound "*smooth*" for a couple of seconds before going back to the "*popping*" noise. He described the "*popping*" noise as similar to that occurring during a magneto check when one magneto was particularly bad resulting in a large rpm drop. The aircraft continued towards the south and he lost sight of it behind a tree. He moved position and saw it again. It was very low and almost in plan view. He was then aware of the aircraft pointing almost directly towards him at about 50 feet agl. His impression was that it was flying very slowly and he thought that it had just started a turn towards the left when the left wing went down sharply. He saw the aircraft strike the ground almost vertically with the underside pointing towards him but at an angle. During the last manoeuvres, he could not hear any engine noise. He asked his wife to ring the emergency services and he ran towards the aircraft but it was apparent that the occupants had not survived. Near the aircraft he could see and smell a substantial amount of fuel. One other witness, who is also an aircraft engineer, also heard the aircraft. His impression was that the throttle had been retarded and he thought that the pilot was practising an engine failure after takeoff. After one or two "*pops*" from the engine, he was no longer aware of any engine noise. He saw the aircraft turn to the left with its bank angle increasing to about 85 to 90º. Then, the nose of the aircraft came down and the aircraft dived towards the ground but rolling left as it did so. There were other witnesses who saw the aircraft in its last moments of flight. Their descriptions of the aircraft's manoeuvres were generally consistent and none of the witnesses mentioned seeing smoke, flame or liquid coming from the aircraft. One witness stated that she had seen something drop from underneath the aircraft shortly before the crash; she described the object as round and black and thought that it was a wheel.

Weather

The METAR for Biggin Hill Airport at 0820 hrs on the day of the accident showed a surface wind of 240º/05 kt varying between 200º and 300º, visibility of 10 km or more, cloud scattered at 2,000 feet and broken at 2,500 feet, air temperature of 11ºC with a dew point of

9º C and a QNH of 998 mb. Using the CAA carburettor icing chart, these conditions would be conducive to serious icing at any power.

The Met Office provided information on the rainfall between the previous flight of G-BYLE and the accident flight. The nearest site where rainfall was recorded was at Kenley, some 5 nm from Biggin Hill. This indicated that a total of 12.6mm ($^1/_2$ inch) of rain had fallen between 0700 hrs and 1900 hrs on the day before the accident.

Medical

Post-mortem examinations revealed no evidence of pre-existing natural disease in either pilot which could have caused or contributed to death or to the accident. Both pilots had died from very severe multiple injuries of the type typically seen in high-energy crashes; death would have been virtually instantaneous. It was not possible to deduce which of the pilots was handling the aircraft at the time of the crash. The relative weights of the pilots were as follows: commander 82.1 kg (181 lb), student 95 kg (209 lb).

Medical enquiries indicated that the commander had been undergoing some treatment but had not informed the CAA. The pathologist did not consider that the unreported medical condition had any bearing on the accident.

Operational aspects

The Pilot's Operating Handbook (POH) for the aircraft was held in the flying club. Relevant extracts from the POH were as follows:

1. The basic empty weight of the aircraft was 1,236 lb (which included 12 lb of unusable fuel).
2. The maximum allowable weight of the aircraft was 1,670 lb. The CG limits at maximum weight were between 73.5 and 78.5 inches aft of datum.
3. The total fuel capacity was 32 US gallons (26.6 Imperial gallons).
4. The best angle of climb speed was 61 KIAS and the best rate of climb speed was 70 KIAS.
5. The stalling speed 'clean' in level flight at 1,670 lb weight was 48 KIAS.
6. The procedures for an engine power loss during takeoff (if airborne) included the following advice: '*At low altitudes with a failed engine, turns should not be attempted, except for slight and gentle deviations to avoid obstacles. A controlled crash landing straight ahead is preferable to risking a stall which could result in an uncontrolled roll and crash out of a turn.*'

The estimated weight of the aircraft based on a full fuel load less taxi fuel (approximately 175 lb) and the respective weights of the commander (191 lb) and student (209 lb) was 1,811 lb. This was 141 lb above the maximum allowable weight. The CG was estimated as 76.7 in aft of datum, which was within the limits specified at the maximum allowable weight.

The flying club had registered with the CAA as a facility for PPL training.

The club had a flying order book which included the following instructions:

1. '*It is required that all Pilots, Students and flying Staff read this Order Book every six months and sign the signature book accordingly.*' Note: There was no evidence of any signature book.

2. *'Flying instruction may only be conducted in Company operated aircraft, by instructors so approved by the Chief Flying instructor.'*
3. *'All licenced Pilots intending to use Company aircraft, must undertake an initial Dual Check Flight with a Company Instructor before being allowed to Fly solo in a Company aircraft. This rule applies regardless of the Pilot's previous experience.'*

Examination of the commander's logbook indicated that he normally operated from Redhill Aerodrome but had also flown from Biggin Hill Airport. Most of his recent flying had been in Cessna 152 and Grumman AA-5A aircraft. There was no available record that he had completed any flights in a Piper PA-38 between 20 September 1996 and the date of the accident.

The commander was last re-validated as a Flying Instructor on 13 September 2003, valid until 12 September 2006. He had also renewed his CAA Flight Examiner qualification in September 2005.

The student's regular instructor considered that the student was enthusiastic and conscientious in his approach to flying and assessed him as being close to solo standard. He was also confident that the student would be comprehensive in his pre-flight external checks. The instructor also confirmed that the normal procedure for fuel selection was to change the tank selection prior to the engine power check. He had also discussed with the student, the actions in the event of an engine failure after takeoff, and had briefed him never to attempt a 'turnback' in that situation. Finally, the instructor also stated that he and his students would normally select carburettor heat to 'HOT' approximately every 5 minutes on the ground if the aircraft was held on the ground prior to takeoff; for takeoff, the heat selector would be at 'COLD'.

The airport procedures for takeoff from Runway 21 were for the aircraft to remain at or below 500 ft QFE until passing the upwind end of the runway; the circuit height was 1,000 feet QFE. Beyond the airport boundary to the south, the ground falls away towards a valley.

Wreckage examination at the scene

The aircraft crashed onto a residential road forming part of a housing estate in the valley just to the south of the airfield, at a position approximately 400 metres from the end of Runway 21 and some 160 ft below runway level.

The pattern of structural damage together with ground marks and other evidence at the scene indicated that the aircraft had been in a steep descent, pitched approximately 70º nose down and sideslipping to the left with some rotational momentum to the left. These parameters were consistent with an incipient spin to the left. The impact into the tarmac roadway was severe and the forward fuselage and wing leading edges were crushed back almost as far as the main landing gears. During the final part of its descent, the aircraft's left wing severed an overhead domestic electrical supply cable; its nose and right wing struck the bonnet and side panels respectively of a light van parked in the roadway. Despite severing the electrical supply cables and the breakup of both integral fuel tanks, which released all the fuel on board the aircraft, there was no fire; nevertheless, the wreckage and surrounding roadway were comprehensively covered with foam by fire fighters attending the scene.

No evidence could be found at the scene to show that the engine was operating under power at the time of impact. The propeller had broken away from the crankshaft during the impact, but the fracture characteristics were consistent with a predominantly bending mode of failure with no evidence of a significant torsional component of failure. One blade, which was folded back beneath the remains of the engine, was heavily and irregularly scored on its forward face in the tip region, and more regularly at an approximately 45º angle to the chord over a region nearer the root. The other blade projected vertically, clear of the wreckage, and was undamaged except for a rearward bend at approximately 30% span. The condition of this blade matched damage to the bonnet of the van which the aircraft had struck including transfer of red paint from the propeller tip. Both the condition of the propeller itself and the pattern of damage and paint transfer on the van's bonnet were consistent with the propeller having been effectively stopped at the time of impact.

The engine was extensively damaged in the ground impact. In particular, the carburettor casing and float chamber had broken open; the mechanical fuel pump mounting had fractured, and its associated pipework partially torn away; and the fuel strainer and water drain assembly (gascolator) was broken apart. These components specifically, and the wreckage generally, were extensively contaminated with water and foam applied by the emergency services and no unimpaired samples of fuel could be recovered.

The cockpit controls would have been subject to significant disturbance during the impact sequence, and no reliable indications as to their pre-impact state could be determined at the scene.

Detailed examination of the wreckage

The wreckage was recovered to the AAIB's facility near Farnborough for detailed examination.

Engine

The engine was taken to an approved engine overhaul agency, where it was disassembled and inspected under AAIB supervision.

The engine suffered extreme damage in the impact but it was possible to confirm that there had been no mechanical failure of core components and nothing was found to suggest that there had been any pre-impact failure of relevant ancillary parts. All spark plugs were of normal appearance and it was possible to confirm by test that the left magneto was serviceable at the time of impact.

Fuel system

At the time of impact, the fuel selector valve was set to supply the engine from the left tank. However, the fuel system pipework was extensively disrupted by the impact and no fuel residues were recovered. Each of the fuel filler caps was in place and in the locked position, but the left cap was loose to the extent that it could be rocked on its seat. The right cap was somewhat looser than expected, but it did not rock on its seat.

The PA-38 filler cap is a deceptively complex mechanism. The seal assembly comprises a stack of three gaskets: a thin rubber gasket seal which abuts the face of the filler neck, backed by two very thin and stiff spring gaskets. The stack is clamped centrally within the concave underside of the fuel cap housing resulting in the stack adopting a slightly conical profile. When the cap is locked down into position by the action of a bayonet mechanism, the rubber sealing gasket is pressed down onto the face of the filler neck. The relatively soft material of this gasket accommodates any small surface imperfections whilst the thin (slightly conical) backing gaskets act as a circumferential spring which pushes the gasket down around the whole periphery to accommodate any larger-scale undulations which may exist at the seal interface.

The sections of fuel tank roof incorporating the fuel filler caps and their associated housings were excised from the remaining wing structure and the effectiveness of each of the cap seals as a barrier against water ingress was tested. When held under a water tap, it was found that the seal on the left cap admitted water at a rate of between 750 cc and 860 cc per minute; no water passed the seal on the right filler cap. Careful measurements to check for possible impact deformation of the mating surfaces eliminated impact damage as a possible cause of the poor seal. It was evident that the seal was defective prior to the accident, and that if conditions prior to the flight had been conducive to rainwater finding its way in substantial quantities into the area surrounding around the filler cap, then it could readily have entered the tank.

Examination of the filler cap bayonet mechanisms revealed that on each cap the projecting lugs (which abut the bayonet-cams) were grossly worn, to the extent that each lug was worn right through, beyond its full thickness, see Figures 1 and 2. The effect of this wear was to reduce significantly the extent to which the cap was pulled down onto its seat, with a commensurate reduction in the amount of compression of the seal assembly and an associated loss of seal effectiveness.

Age-related cracking was clearly visible around the periphery of the rubber sealing gasket from the left cap, but for the most part these cracks did not extend into the working (contact) area of the seal. This cracking was less significant in terms of the deterioration in seal performance than the reduced compression of the seal assembly caused by the wear in the bayonet mechanism.

Flying controls

No viable evidence remained as to the positions of the flying controls at the time of impact, but nothing was found to suggest any malfunction or abnormality affecting these systems.

Cockpit settings

The throttle and mixture controls were each in the fully forward position 'as found', but it was not possible reliably to determine their pre-accident settings. The magneto key was broken off during the impact, with the surviving part of the key aligned with the left magneto position. Normally, the ignition switch would be set to both (ie to left and right magnetos), and would only be set

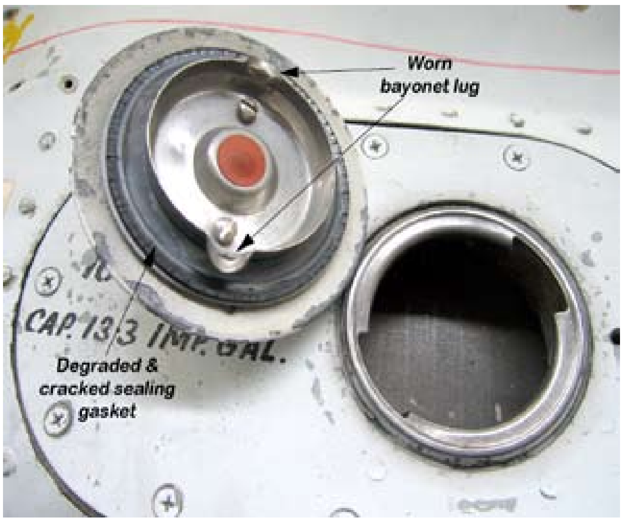

Figure 1

Fuel filler cap

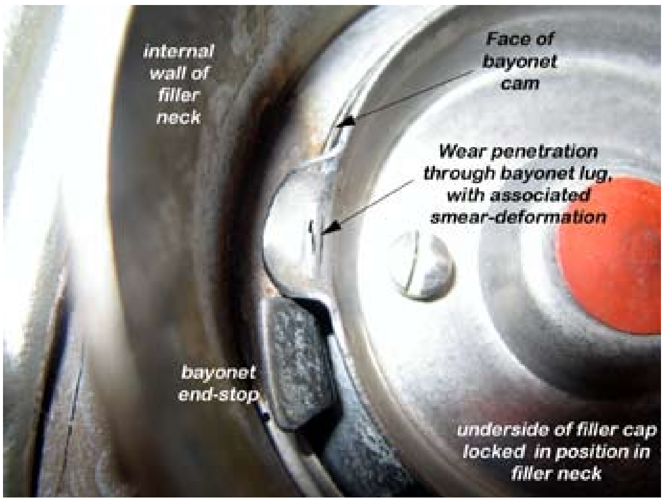

Figure 2

Underside of filler cap showing worn bayonet cams to a single magneto (whether left or right) in an attempt to isolate a faulty ignition system. It was not possible to establish whether the selection to left was caused by disturbance as the key broke off in the impact, or whether it was set to that position prior to impact. However, if it was the latter, then it was likely to have been put there in an attempt to restore engine power. Microscopic bruises were evident on the carburettor heat control consistent with it having been in the on (hot) position at the time of impact.

Stall warning system

The electrical coil of the stall warning horn in the cockpit was disrupted as a result of a connecting wire being torn away in the impact, and the stall-warning vane on the wing leading edge was ripped way from the leading edge during the impact. As a consequence, the pre-accident effectiveness of the stall warning system could not be established.

Maintenance records

The aircraft's documentation showed that it had undergone a 50 hour inspection on 12 October 2005 at 6,401 airframe hours, and that subsequently it had flown a further $1^1/_4$ hours by the time of the most recent log book entry on 20 October, two days before the accident. Prior to that, it had undergone a 150 hour inspection on 12 August 2005 at 6,353 airframe hours, some 50 flying hours prior to the accident.

The technical documentation covering the relevant period contained no entries of significance. The applicable Light Aircraft Maintenance Schedule (LAMS) calls for inspection, inter alia, of "…Tanks, filler caps, …" as part of 'task 74' of the 150 hr inspection. The work pack for the 150 hour inspection carried out on 12 August 2005 reported no findings against this item.

Tests & research

A series of engine test runs were carried out to explore the likely effect of water in the fuel supply to the engine of a PA-38, using a time-expired Lycoming O-235 engine of the same type as that installed in G-BYLE. The tests established that a single 'packet' of water of 25 cc or more entering the carburettor causes an immediate loss of power and stoppage of the engine. Packets of 20 cc volume or less did not cause stoppage provided that they reached the carburettor at intervals which gave the engine time to recover. However, they resulted in a significant rpm reduction followed by stagnation and/or pronounced hesitation or 'hunting' followed by recovery. On those occasions when the engine hesitated badly, there was an abrupt audible change, as though the ignition was being switched rapidly off and on again.

Analysis

General

The accident resulted from an attempted turnback following an engine malfunction. During the turnback, the aircraft stalled and struck the ground in an almost vertical attitude. This analysis considers the possible reasons for the engine problem and the relevant operational aspects.

Engineering

Cause of the engine malfunction

The condition of the propeller leaves no doubt that the engine was stopped, or almost stopped, when the aircraft struck the ground. The witness evidence also points strongly to loss of engine power after takeoff, as does the position of the carburettor hot air control at the time of impact (ON) since hot air is not likely to have been used during takeoff except in an attempt to restore a loss of power. The 'as found' position of the magneto switch (left magneto selected) could also be indicative of attempts to rectify a power loss.

Detailed examination of the engine remains showed that it was mechanically sound at the time of impact. Whilst the possibility of a subtle ignition, carburation, or fuel system malfunction could not be ruled out totally, no evidence of such could be found and indeed it was possible to establish that at least one of the aircraft's dual magnetos was serviceable. The fuel valve was selected to the left tank, and the mechanical fuel pump was serviceable. On a balance of probability, therefore, the evidence does not suggest that the power loss was caused by a mechanical or electrical malfunction or fuel starvation. There is, however, strong circumstantial evidence suggesting that the engine stopped because of water in the fuel.

Extreme disruption of the engine and fuel system by the impact combined with extensive post-accident water contamination by the fire service precludes any positive conclusion being drawn as to whether or not water was actually present in the fuel supply to the engine. However, it was positively established that the left filler cap seal was ineffective against the ingress of water and it is significant that an unusually large amount of water was drained from this tank during pre-flight checks by a different pilot on the preceding flight two days before. Given that it had rained heavily for 12 hours on the day before the accident, it is possible that a significant quantity of water had entered the left fuel tank by the morning of the accident flight. It is not known whether water drain checks were carried out prior to the accident flight or, if they were, by whom and when in relation to refuelling of the aircraft that day. However, assuming that water checks were carried out, if the sample drawn from the left tank had comprised 100% water, then the lack of a visible fuel/water boundary could have been misinterpreted as 100% fuel. On the available evidence, it must be concluded that there would have been some water present in the left tank that morning, quite possibly an abnormally large amount. Even if water drain checks were carried out, there is a strong possibility that significant amounts remained in the system at the start of the flight. Depending upon which tank was selected for start-up and taxi, and the subsequent management of the fuel system, it is possible that this water may not have entered the engine supply in sufficient quantities to affect it adversely until the aircraft was in the climb out.

The tests conducted to explore the effect of water in the fuel were not designed to replicate conditions on the accident flight, not least because of the number of unknown parameters involved, but rather they were intended to establish some baseline parameters regarding the volume of water needed to cause stoppage of an engine of this type at full power, and to characterise the engine's response in qualitative terms. The movement and vibration of an aircraft in motion, both on the ground and in flight, would tend to disperse any water in the tank and it would be likely to enter the system pipework as a series of separate 'packets', rather than as a continuous flow of neat water. As any such water makes it way through the tank pipework, selector valve, gascolator and fuel pump, its progress towards the carburettor would be halted temporarily as water separated out and filled any cavities acting as traps, for example in the gascolator. Thereafter, it would continue to make its way towards the engine, still in the form of packets of water mixed with fuel, and it is probable that it would reach the carburettor in small packets. If the volume of one of these packets was greater than 25 cc, immediate engine rundown and stoppage would result. If 20 cc or less, the effect would be to cause the engine to run down, stagnate briefly with audible hesitations or hunting, and to recover before the next packet of water caused further hesitations, or stoppage depending on its size and the rate at which the water entered the carburettor. These symptoms are not dissimilar to those reported by witnesses.

Although it cannot be proven, the available evidence points very strongly to power being lost because the fuel supply to the engine was contaminated by water that entered the left wing tank via an ineffective filler cap seal.

Filler cap effectiveness

Whilst the rubber sealing gasket on the left cap had visibly degraded and cracked, for the most part these cracks did not extend into the interface region, and were not in themselves responsible for the absence of an effective seal. Rather, the loss of seal effectiveness was almost wholly caused by wear in the bayonet fittings, which reduced the distance through which the cap was pulled down onto its seat in the filler neck as it was locked down. It was not possible to measure precisely the extent of this wear, but the depth of wear in the lugs alone, illustrated in Figure 3, exceeded the rubber gasket's thickness by some 40% and approached the total thickness of the complete gasket stack. The reduced compression of the fitted cap meant that the seal was no longer in proper contact with the seat and the cap would be prone to leakage. Any appreciable wear in the bayonet cam faces would also have contributed to a poor seal.

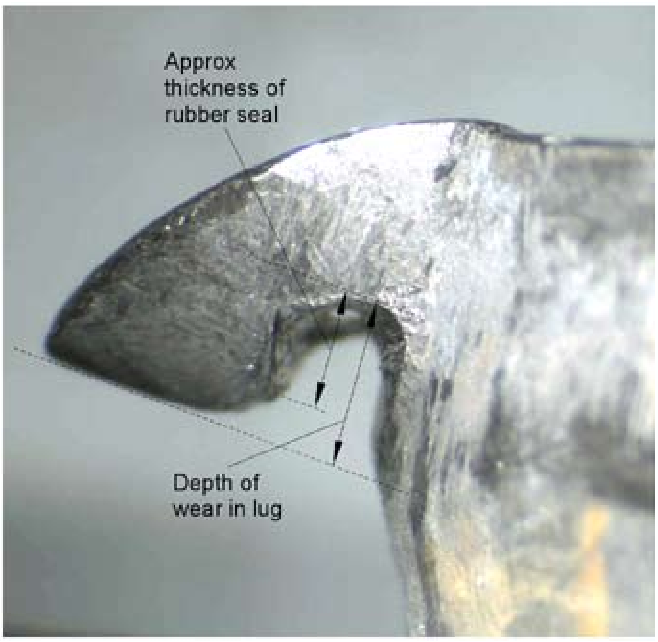

Figure 3

Illustration of wear in bayonet lug (viewed from the side)

The 150 hour check calls for inspection, inter alia, of the fuel tank filler caps, but in practice it is likely that inspections of apparently simple items like fuel filler caps would be somewhat cursory and, in the case of PA-38 filler caps, would be likely to focus mainly on the condition of the rubber seal. Wear in the cam element of the bayonet mechanism might not be identifiable visually. Moreover, even significant wear in the lugs would almost certainly be missed unless attention was directed specifically to them.

Given the typical age of PA-38 aircraft currently in service and the probability of significant bayonet wear in the filler caps of such aircraft, it is considered that the existing requirements for fuel cap inspections under the CAA LAMS system may be insufficiently explicit to assure continued effectiveness of the filler caps of these aircraft. However, it is recognised that the LAMS schedule is generic and intended to cover all light aircraft on the UK register, and that consequently it may not be appropriate to introduce type-specific detail into the LAMS schedule.

Therefore it was recommended that:

Safety Recommendation 2006-075

The UK CAA should alert light aircraft owners, operators and maintainers of the dangers inherent in using worn, degraded or loose-fitting fuel tank filler caps.

Safety actions taken

The UK CAA undertook to publicise in a forthcoming GASIL[1] the fuel cap wear issues identified during this investigation.

One manager of a sizeable fleet of light aircraft stated that the type of fuel filler cap fitted to many of the PA-28 range of aircraft is identical to that fitted to the PA-38. On learning of the fuel cap maintenance issues disclosed by this accident, his company had examined all the PA-28 and PA-38 aircraft within its managed fleet. Of the 50 aircraft, the company found it necessary to refurbish or replace about 30 fuel filler caps. This high incidence of defects suggests that wider action by the authorities responsible for maintenance oversight in Europe would be appropriate. Therefore, it was recommended that:

Safety Recommendation 2006-109

The European Aviation Safety Agency should instigate a one-off inspection of PA-28 and PA-38 aircraft fuel filler caps to identify any with unserviceable rubber gaskets or excessive wear in the metal locating lugs and require refurbishment or replacement of any defective caps.

Operational aspects

The commander had not previously flown with the student or with the flying club. Although he was an experienced instructor and examiner and had reviewed the student's training records, it was surprising that the commander had not had a more formal briefing with the student to ensure that both were properly prepared for the flight. Additionally, there was no evidence that the commander had previously flown in a Piper PA-38. Although he was licensed to fly the aircraft, it would have been prudent for him to have had a familiarisation flight with another club instructor prior to undertaking a flight with a student.

The student had gone alone to the aircraft to complete the external checks and while he was there, the aircraft was refuelled to full. It is likely that the student, who was considered conscientious, also completed a 'water check'. It is also likely that water was present because the aircraft had been parked outside, the left filler cap was loose, its seal was ineffective and there had been rain since the previous flight. It was not possible to determine whether this check was completed before or after the refuelling and whether the student detected any water in the fuel tester container. If he completed the check immediately after the refuelling, water in the tank could have been temporarily dispersed. Soon afterwards, after the fuel had been sampled from the tank drain point, water may have gathered at the lowest point in the tank. Alternatively, it is possible that the container may have been completely full of water on the student's check and that the inexperienced student assumed that this fluid was all fuel. It was also not possible to determine whether the commander had carried out a 'water check' or whether he had relied on the student. The possibility remains that the fuel system was contaminated with water regardless of whether the 'water check' had been done.

The atmospheric conditions were also conducive to carburettor icing and the aircraft had been held at the holding point for some 7 minutes. However, it was a standard club procedure for carburettor heat to be applied every 5 minutes if held on the ground before takeoff. For takeoff, the carburettor heat should be off and normal procedure would be to check the engine parameters with full power applied during the ground roll. Any adverse indication should have resulted in the pilot stopping the takeoff.

Footnote

1 General Aviation Safety Information Leaflet.

It was not possible to determine who was handling the controls during takeoff but, if the commander was not handling the aircraft, he would probably have been following through on the controls. Normal airmanship procedure prior to any takeoff would be for the commander to brief the actions to be taken in the event of a problem on takeoff. It was not possible to determine what, if any, contingency plans were briefed by the commander prior to takeoff. However, once there was any indication of a problem, the commander would likely have taken control. There was some slight variance in the witness accounts about the noise of the aircraft. There was no doubt that there was an engine problem but some difference in opinion as to whether there was any temporary recovery. For the commander, a total engine stoppage would have left him with no choice other than to land ahead and there were fields ahead, which would have been suitable for a forced landing.

The excess weight of G-BYLE would have increased its stalling speed in level flight from 48 to 50 KIAS. However, in a 60º angle of bank turn, the stalling speed would have further increased to 70 KIAS which was identical to the best rate of climb speed. Consequently, the aircraft would probably have been prone to stalling immediately a level, steep turn was attempted.

All flying training emphasises the importance of setting up for a landing straight ahead in the event of an engine failure in a single-engine aircraft. This advice is normally included in aircraft type flight manuals and was included in the POH for G-BYLE. However, there is always a natural temptation for a pilot to attempt to rectify the problem and to return to a runway; this is particularly true when the problem is not a total engine stoppage. This may have been more relevant on the takeoff from Runway 21 when the lower ground to the south would have given the pilot a visual impression that the aircraft was well above the ground.

There was also evidence that the carburettor heat had been applied and the magneto switch may have been set to LEFT instead of BOTH. It is improbable that an experienced instructor would permit his student to takeoff with these two controls incorrectly set, irrespective of his lack of experience on type, since these controls and their correct positions for takeoff are common to most light aircraft. The magneto switch position may have changed during ground impact but not the carburettor heat control. Consequently, the 'as found' settings may be indications that either the commander or the student was attempting to recover the engine to full power.

It was also apparent that the handling pilot, who by this stage was probably the commander, was attempting to turn the aircraft back towards the airport. In that situation, the control of airspeed and height would have been critical and any recurrence of the engine problem would have resulted in the crew having few options other than to continue the turn. In this accident, the excess weight of the aircraft would also have meant that control in the turn would have been even more critical in an aircraft with which the handling pilot was not totally familiar. When the engine problem first occurred, the safest option would have been to land straight ahead. Once the crew initiated and maintained the turn to the left, the final engine stoppage meant that an accident was unavoidable.

Conclusion

The accident occurred following an engine problem shortly after takeoff, when the handling pilot attempted to turn back towards the airport and lost control of the aircraft. Although it was not possible to eliminate carburettor icing as a potential causal factor, it was more probable that the engine problem resulted from water contamination of the fuel. Two safety recommendations have been made relating to fuel filler cap deterioration and inspection.

The commander was very experienced and would have been well aware of the dangers associated with any attempt to turn back after a problem on takeoff. Once the turnback had been initiated, he was not well placed to control the aircraft in a critical condition because of his lack of currency on type. The performance of the aircraft would also have been adversely affected by its excess weight.

Safety Recommendations

The following safety recommendations were made:

Safety Recommendation 2006-075

The UK CAA should alert light aircraft owners, operators and maintainers of the dangers inherent in using worn, degraded or loose-fitting fuel tank filler caps.

Safety Recommendation 2006-109

The European Aviation Safety Agency should instigate a one-off inspection of PA-28 and PA-38 aircraft fuel filler caps to identify any with unserviceable rubber gaskets or excessive wear in the metal locating lugs and require refurbishment or replacement of any defective caps.