ACCIDENT

Aircraft Type and Registration:	Piper PA-38-112 Tomahawk, G-BGBN
No & Type of Engines:	1 Lycoming O-235-L2C piston engine
Year of Manufacture:	1978 (Serial no: 38-78A0511)
Date & Time (UTC):	5 June 2013 at 1239 hrs
Location:	Cranfield Aerodrome, Bedfordshire
Type of Flight:	Training
Persons on Board:	Crew - 2 Passengers - None
Injuries:	Crew - 2 (Serious) Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Commercial Pilot's Licence
Commander's Age:	21 years
Commander's Flying Experience:	390 hours (of which 145 hours were on type) Last 90 days - 77 hours Last 28 days - 15 hours
Information Source:	AAIB Field Investigation

Synopsis

During the climb following a touch-and-go landing, the engine began to run roughly. A turn was commenced during which the engine failed and control of the aircraft was lost. The aircraft crashed within the aerodrome boundary.

History of the flight

G-BGBN took off from Runway 03 at the aerodrome at 1232 hrs for a circuit training flight with the instructor sitting in the right seat and the student in the left. The weather reported by ATC at 1220 hrs was: wind from 040º at 8 kt, 20 km visibility, broken cloud at 1,400 ft aal, a temperature of 13ºC, a dew point of 10ºC and a QNH of 1022 hPa. The aircraft flew a right hand circuit and an approach to touch-and-go which seemed to observers to be uneventful.

G-BGBN was seen to touch down near the touchdown zone markers, power was applied and it lifted off near the intersection of the runway and taxiway C (see Figure 1). Approximately two seconds later, the instructor transmitted "GOLF BRAVO NOVEMBER ROUGH RUNNING ENGINE TURNING AROUND FOR RUNWAY 21". The aircraft was in a gentle right turn as it passed the intersection of the runway and taxiway B but it then reversed its turn abruptly to the left. As the aircraft passed the upwind end of the runway in the left turn, the nose began to drop. The aircraft descended and crashed within the aerodrome boundary 100 m north-west of the threshold of Runway 21.

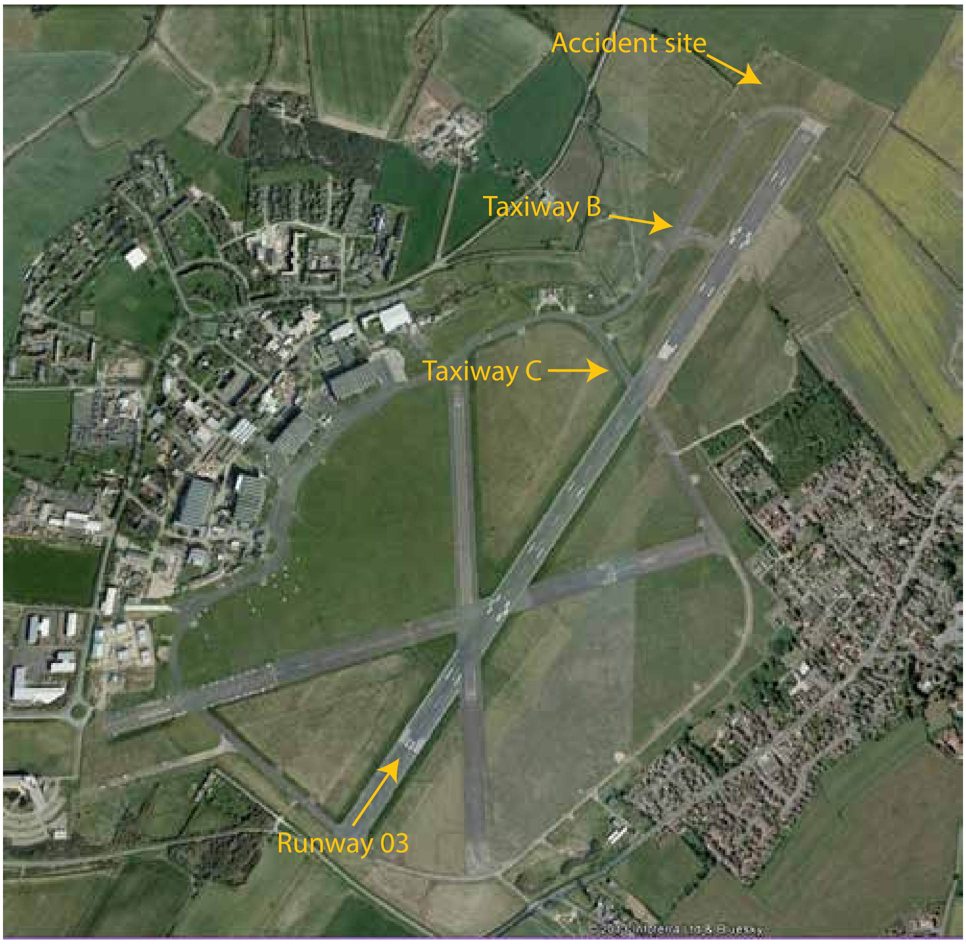

Figure 1
Cranfield Aerodrome

Witness information

Approximately one to two seconds after he heard the instructor mention rough running, the controller in the ATC tower sounded the crash alarm because it appeared to him that the aircraft might crash. He estimated that the aircraft climbed to a maximum of 50 to 75 ft agl which it had achieved by the time it was in its gentle right turn. It then made a “very sharp” reversal and began a turn to the left with an angle of bank high enough for him to “see the aircraft in plan form”. Almost as soon as the aircraft had established itself in the left turn, the nose began to drop. Another witness estimated that the aircraft climbed to a maximum of approximately 200 ft.

Information from the instructor

The instructor informed the AAIB that he did not recall flying a circuit and a touch-and-go landing before the accident; his recollection was that the accident occurred immediately after takeoff. He also stated that it was normal practice for him to select the carburettor heat control to HOT when reducing power on the base leg.

Approximately two hours before the accident flight, the instructor flew a circuit in G-BGBN because he had not flown in approximately 10 days and stated that, while on a short final to land, the engine began to run roughly. After landing, he carried out a magneto check before shutting down the engine. Moving the magneto selector from BOTH to a single magneto (he could not remember whether it was the left or right) led to a drop of approximately 500 rpm while selecting the other led to approximately 15 seconds of rough running before the engine stopped. The instructor stated that he obtained the same results when he restarted the engine and repeated the magneto check and so, after leaving the aircraft, he asked the owner of the flying school to investigate the fault.

The instructor stated that, just before walking with the student to G-BGBN for the circuit training flight, he was told by the owner of the school that the problem with the magnetos had been rectified and that the aircraft was "all fine". The instructor reported that the engine started normally and that the pre-takeoff power checks, including the magneto check, were normal.

The instructor recalled that after takeoff the aircraft drifted to the right because the student, who was handling the aircraft, over-compensated for the crosswind. The engine began to run roughly very soon after the aircraft left the ground and the instructor took control from the student. He stated that he "considered turning to land on Runway 21 and made a radio call to that effect because it was a "partial engine failure and the aircraft was still able to climb". He said that, had the aircraft been unable to climb, he would not have considered returning to the runway. Shortly thereafter, it became apparent that the aircraft was unable to climb and the nature of the rough running made him think that the engine might stop. A sports club was situated directly ahead of the aircraft on the near side of a road that ran left to right across his path. There were open fields to the left of the club on both the near and far sides of the road but the instructor did not consider the aircraft to be high enough to land beyond the road. He turned left away from the sports club and towards a clear area within the aerodrome boundary where he "considered that there would be sufficient space for the aircraft to land". He stated that, during the turn, the engine stopped completely and the stall warning operated immediately afterwards.

Aircraft information

The PA-38 Tomahawk is a single-engine, two-seat aircraft. The fuel is contained in two fuel tanks located in the leading edge of each wing and there is a combined useable capacity of 114 ltr. A strainer is fitted to the outlet of each fuel tank and the fuel pipes are routed down each side of the fuselage to the fuel selector valve located between the rudder pedals. The fuel selector valve has three positions: OFF, LEFT and RIGHT. Downstream from the selector valve, the fuel passes through an electrical fuel pump, gascolator and mechanical fuel pump before entering the carburettor. G-BGBN was equipped with a Lycoming 0-235-L2C piston engine with two magnetos and a 10-5199R Marvel-Schebler carburettor.

The wing was fitted with flow strips on the leading edges that were introduced under FAA Airworthiness Directive 83-14-08 in 1983 to improve the stall characteristics of the aircraft.

G-BGBN was equipped with four-point seat harnesses and one set of primary flying instruments positioned in front of the left seat position. The magneto switch was located beneath the left control yoke. Figure 2 shows the cockpit layout in a PA-38 similar to G-BGBN.

Figure 2

Location of primary flying instruments in a PA-38 similar to G-BGBN

Accident site

The accident occurred within the perimeter of Cranfield Aerodrome. G-BGBN impacted the ground approximately 100 m on a bearing of 320º from the threshold of Runway 21 in an area of firm, flat ground. The ground marks indicate that the left wing struck the ground first when the aircraft was on a heading of 180º. From the structural damage it is estimated that the aircraft was pitched 50º nose-down. The aircraft finally came to rest in a fairly level attitude on a heading of 090º, approximately 12 m from the initial impact point.

The left wing was destroyed and the nose section of the aircraft, including the cockpit and engine, were badly damaged. The right wing was mostly intact, with compression damage to the leading edge of the outer 2.6 m of the wing. The structure towards the rear of the fuselage had buckled and torn, leaving the tail section, which was upside down, attached by a small section of the skin. The seat harnesses and attachment points remained intact and connected to the airframe.

The fuel selector valve was found in the RIGHT tank position. The left fuel tank, which with the leading edge had detached from the wing, was empty. A small quantity of clean fuel was recovered from the right fuel tank which was intact. The fuel pipes from the left and right fuel tanks had been cut and crimped by the fire services where they were routed through the forward sidewalls of the cockpit. All the fuel pipes and fuel components forward of the firewall had been severely damaged. The aerodrome fire service reported that fuel continued to run out of a fuel pipe near the front left side of the aircraft for 20 minutes after the accident. The following marking was painted on the upper wing surface next to each fuel tank filler cap '*AVGAS Fuel 100LL Aviation Grade MIN 13.4 IMP GALLS*'.

The flying controls were examined prior to the aircraft being removed from the accident site and were assessed as being intact and serviceable prior to the accident with no evidence of a control restriction. The flaps were set at 15º down. The instrument panel and engine controls had been badly damaged and had been disturbed by the emergency services during the rescue operation. It was not therefore possible to determine with any confidence the position of the throttle, carburettor heater control or electrical fuel pump. The engine primer was found in the closed and locked position and the key in the magneto switch was found in the left magneto position. The key was undamaged and it is unlikely that it would have moved during the accident sequence. However, it was not possible to eliminate the possibility that the key had been moved after the accident in a belief that it would isolate the electrical power.

The carburettor, mechanical and electrical fuel pump had been ripped from the engine. All the spark plugs and their harness were correctly fitted. Scratches and damage to the propeller, and the ground marks made by the propeller blades during the impact, were consistent with the propeller producing very little or no power.

Detailed examination

Aircraft

A detailed examination of the aircraft and fuel system was carried out at the AAIB facility at Farnborough. The examination included a thorough examination of the fuel system using a video probe inserted into the fuel tanks and fuel lines. Both fuel tanks were clean and the filters at the tank outlets were clear of any debris. There was no blockage in any of the fuel lines and the fuel selector valve was fully open in a position consistent with the right tank having been selected. The electrical fuel pump operated when electrical power was applied and the internal parts were found to be in a serviceable condition. The flap for the carburettor heat was in the open (cold) position and the air intake filter was clean.

Engine

The engine was partially stripped and a number of components were tested by an independent engine overhaul facility under the supervision of the AAIB.

The engine turned freely, all the valves operated normally and there was no evidence of the engine having seized. Both magnetos were tested and found to be serviceable; the spark plugs were examined and tested in a pressurised test chamber and operated satisfactorily. The carburettor was dismantled and no blockages were found in either the idle or main fuel jets. The floats were intact and moved freely; the mixture control at the time of the accident was assessed as being in the fully-rich position. While it was not possible to test the carburettor, visually there was nothing to suggest that it would not have operated normally. The mechanical fuel pump and all the internal seals, valves and operating levers were also assessed as being serviceable. Due to the damage that occurred during the impact to the fuel priming line, the spark plug harness and the induction pipes, it was not possible to determine if a fault in any of these parts might have caused the rough running and loss of power.

Aviation fuel

Mogas

Mogas (Motor Gasoline) is not intended for aviation use and in comparison with Avgas (Aviation Gasoline) has different physical properties and quality requirements. CAA Safety Sense leaflet 4 '*Use of Motor Gasoline (MOGAS) in Aircraft*' provides advice on the use of Mogas. This includes the additional quality checks to be carried out on the fuel, additional maintenance requirements and entries that have to be made in the aircraft and engine log books.

Factors to consider when using Mogas

Characteristics of Mogas such as the stability of fuel in storage are not as good as for Avgas. Consequently, over time Mogas may suffer a loss of octane rating and form gum deposits that can cause intake and exhaust valves, and fuel metering valves to stick. The additives in the fuels are also chemically different and those in Mogas can cause corrosion and increase the amount of water in the fuel.

Lead additives are normally used to control the rate of combustion but in unleaded fuels these have been replaced with other components, such as aromatics. If the engine is not designed to operate on unleaded fuel then the different speed of combustion can result in hotter exhaust gasses that can damage the crown of the pistons, the exhaust valves and their seats. Aromatics can also damage seals in the aircraft and engine fuel systems.

A further significant difference is that in comparison to Avgas, Mogas has a relatively high vapour pressure[1] and is therefore much more susceptible to causing vapour lock in aircraft fuel systems, particularly at elevated temperatures and higher altitudes. So, although an engine may be able to operate on Mogas, other aircraft components have to be considered because of the potential for vapour lock within the fuel system, as well as potential adverse effects on seals and components. Therefore, approval to operate on Mogas is required for both the aircraft and engine.

Most Mogas contains alcohol (ethanol) which can adversely affect seals and elastomers; it also affects the fuel's vapour pressure leading to an increased probability of vapour lock. The ethanol also absorbs water which increases the likelihood of carburettor icing. Nevertheless, Civil Air Publication (CAP) 747, *Mandatory Requirements for Airworthiness,* permits the use of ethanol in Mogas used in microlight aircraft.

Fuels approved by the engine manufacturer

Lycoming Service Instruction number 1070S, dated 24 April 2013, which lists the fuels that can be used from that date in the Lycoming 0-235-L engine, authorises the use of Avgas 100LL and Avgas UL 91. The Service Instruction also authorises the engine to operate on unleaded Mogas provided it meets the specifications in ASTM D4814 and EN228. However, Lycoming do not permit fuel containing ethanol to be used in their engines.

Footnote

[1] Vapour pressure can be thought of as the ease by which a liquid turns into a gas.

Fuels approved by the CAA

CAP 747 specifies the fuel which can be used in aircraft and their engines. While the Generic Concessions in CAP 747 permit the use of unleaded Mogas obtained from garage forecourts to be used in the PA-38 and Lycoming 0-235-L engine under certain circumstances, the concession is not applicable to aircraft such as G-BGBN that are used for aerial work such as flight training. With the exception of microlight aircraft, the CAA generally prohibits the use of ethanol in fuel used by aircraft and requires that Mogas is tested for ethanol before it is used.

Testing of fuel

The following fuel samples were tested as part of the investigation:

- A sample taken from the right fuel tank of G-BGBN.
- A sample taken from the refuelling facility at Cranfield on 3 June 2013. The 3 June 2013 was the last time that the refuelling company's documentation recorded that G-BGBN was refuelled at Cranfield prior to the accident.
- Samples taken from two other PA-38 aircraft owned by the flying school and based at Hinton-in-the-Hedges.
- A sample taken from the fuel pump at Hinton-in-the-Hedges on 7 June 2013.
- A sample of unleaded Mogas obtained from a garage forecourt local to the laboratory where the testing was carried out.

The tests established that the fuel samples taken from the bulk supplies at Cranfield on 3 June 2013 and Hinton-in-the-Hedges on 7 June 2013 were blue in colour and consistent with the specification for Avgas 100LL. Ethanol could not be detected in either sample.

The sample taken from G-BGBN was very similar to the sample taken from the fuel installation at Cranfield on 3 June 2013 and was assessed to be Avgas 100LL. However a trace quantity of ethanol was detected in the fuel sample.

Of the two aircraft sampled at Hinton-in the-Hedges, one contained fuel which was virtually identical to the sample taken from the fuel pump at Hinton-in-the-Hedges and was assessed to be Avgas100LL. The sample taken from the second aircraft was green in colour, contained ethanol and had a lead content that was not considered to be consistent with the specification for Avgas 100LL. The laboratory concluded that this fuel sample had features that were consistent with it being a mixture of Avgas 100LL and unleaded forecourt Mogas. The investigation was unable to establish the source of this fuel.

Maintenance of flying school aircraft

Maintenance of aircraft operated in a flying school environment can be performed either by contracted individual Part 66 licenced engineers, or by third party Approved Maintenance Organisations. Pilot/owner maintenance is not permissible on aircraft undertaking aerial work such as flying training.

Hinton Pilot Flying Training is not approved as a maintenance or Continuous Airworthiness Management Organisation (CAMO). Instead it contracted the annual airworthiness review in support of issuing an Airworthiness Review Certificate (ARC) to a Part M, Sub-part G, CAMO. In order to issue an ARC, a CAMO needs to understand what maintenance work has been carried out on an aircraft.

Aircraft documentation

Under EASA Part M, Sub-part C, a technical log is required only for Commercial Air Transport operations. However, to ensure the continuous airworthiness of its aircraft, the flying school required a system to manage the recording of aircraft and engine hours, cycles and defects. The system that the flying school had in place was based on the aircraft technical log, and the engine and airframe logbooks.

Twenty Aircraft Daily Technical Logs dating back to 19 April 2013 were reviewed during the investigation. The logs were sequentially numbered and the hours to the next maintenance check were consistent with the hours recorded against each flight: at the time of the accident the logs showed that 35:20 hours remained to the next check.

It was noted that on a number of occasions the 'A' check had not been signed as having been carried out and there was no record of the amount of oil in the engine. A modified form was used from 26 May 2013 that included an entry for the hours of the next check and a column for the fuel quantity with an annotation that it '*must be completed before flight*'. In the subsequent 22 flights since the introduction of the form the fuel quantity was only recorded once. The hours that the next check was due was either not completed or completed incorrectly.

On the day of the accident, the 'A' check was signed as having been carried out by the instructor and there was one flight recorded in the Technical Log which had a '*Take off*' time of 1150 hrs and a '*Land*' time of 1210 hrs. A check of the aerodrome movements log showed that these times were British Summer Time and should have read 1050 and 1110 hrs. The column against this flight titled '*Nil Defects Initials*' was annotated NIL. The section at the bottom of the Technical Log used to report defects had no entries. There was no record in the aircraft technical log of the accident flight which departed at 1232 hrs.

While establishing how ethanol might have been introduced into the fuel, the investigation tracked the movement of G-BGBN during the month prior to the accident. While the investigation was unable to find any documentation to show that Mogas had been used in the aircraft, from the movement logs at Sywell Aerodrome it was established that on 3 May 2013 the aircraft flew one flight and on the 25 May 2013 five flights at Sywell Aerodrome. The movements log at Cranfield Aerodrome also recorded one flight on 3 May 2013 and two flights on 25 May 2013. None of these flights were recorded in the Aircraft Technical Logs or the aircraft and engine logbooks presented to the AAIB.

Fuel used in flying school aircraft

The flying school advised the AAIB that Mogas had not been used in G-BGBN and provided recent fuel receipts showing that it had been refuelled with Avgas 100LL; there was no record in the aircraft documentation that Mogas had been used.

The movements log at Sywell Aerodrome shows that G-BGBN operated from this aerodrome on a number of occasions in the month preceding the accident flight. The aerodrome has the facilities to dispense three types of fuel: Jet A1, Avgas 100LL and unleaded Mogas. The unleaded Mogas is the same fuel that is supplied to garage forecourts and can contain ethanol. The fuel pumps are normally manned during the day when the flying school account would be debited. However, outside of the normal working day for the aerodrome refuelling personnel, fuel can still be obtained from the pump by inserting a debit or credit card into a card reader on the pump. CAP 747 allows microlight owners to use Mogas containing alcohol and a notice displayed on the Mogas dispensing pump at Sywell Aerodrome stated:

> *'Unleaded MOGAS BS EN228 1995, BS707*
> *For use by Rotax microlight engines only in accordance with Airworthiness Notice 98B'*

Sywell Aerodrome authorities advised the AAIB that on two occasions during April 2013, instructors from the flying school attempted to refuel a PA-38 with Mogas against the advice of the refuelling personnel that the fuel was not authorised for use in the aircraft. As a result of these concerns, the aerodrome managing director contacted the owner of the flying school who told him they would not use the fuel again. The PA-38 concerned was not the accident aircraft but was the aircraft from which a fuel sample – later found to contain ethanol – was taken at Hinton-in-the-Hedges on the 7 June 2013. The fuel records at Sywell Aerodrome show that G-BGBN was refuelled with Avgas 100LL on 3 May 2013 (52 ltr) and on 25 May 2013 (20 ltr).

A document from the flying club titled 'STAFF UPDATE NOTES MAY 2013' included the following statement:

> *'FUEL - The aircraft are certified for UL91 or AVGAS 100 or AVGAS 100LL. The PA38s ARE NOT CERTIFIED FOR THE USE OF MOGAS (which is different from UL91)…'*

Recent fuel usage

G-BGBN operated from Cranfield between 26 May 2013 and 5 June 2013 when the accident occurred. During this period it had flown 22 flights, uplifted 300 ltr of Avgas 100LL and the engine had operated for 15.6 hours.

Aircraft maintenance

The aircraft and engine log books recorded that a 50-hour inspection had been carried out on 13 May 2013 at 10,298 hours, by the authorised maintenance organisation, during which the ignition switch was checked and found to be satisfactory. The investigation did not identify any documented technical faults following completion of the 50-hour check.

On the day of the accident, and just prior to the accident flight, an individual was seen with the engine cowl open working on the engine. There were conflicting witness accounts as to the work that the individual carried out. The individual concerned told the AAIB that the instructor had informed him that there had been a magneto drop of around 200 rpm and that the engine had been running roughly. He removed the lower two rear plugs and found a build-up of lead. After cleaning and refitting the spark plugs, he stated that he carried out a power check and the magneto drop was found to be within limits. No documentation had been completed to support this maintenance activity. The CAA later advised the investigation that the individual who carried out the work is not currently a Part 66 licensed engineer.

Although the individual reported that he had previously held an engineer's licence issued by the CAA, the CAMO stated that he was not authorised to carry out maintenance on this aircraft.

Carburettor icing

Carburettor icing occurs as a result of vaporisation of fuel and a reduction in pressure as the fuel / air mixture passes through the venturi in the carburettor. These effects cause a drop in the temperature which, if it falls below the dew or freezing point of water, will result in ice forming on the sidewalls and the butterfly valve in the carburettor. As the ice builds up, it gradually blocks the venturi and alters the fuel / air balance which causes the engine to run roughly and lose power. Figure 3[2] shows combinations of atmospheric temperatures and dew points where there is a risk of carburettor icing. At the time of the accident, the temperature was 13ºC and the dew point was 10ºC. In these conditions, there was a risk of serious carburettor icing at any power setting.

CAA Safety Sense Leaflets

Safety Sense Leaflet 14 – '*Piston Engine Icing*' explains in detail the cause of carburettor icing and the precautions to take during different phases of flight.

The leaflet states that, during base leg and final approach:

> *'Unless otherwise stated in the Pilot's Operating Handbook or Flight Manual, the HOT position should be selected well before power is reduced and retained to touchdown. On some engine installations, to ensure better engine response and to permit a go-around to be initiated without delay, it may be recommended that the carb hot air be returned to COLD at about 200/300 ft on finals.'*

Safety Sense Leaflet 1e – *'Good airmanship'* states:

> *'In the event of engine failure after take-off, achieve and maintain the appropriate approach speed for your height. If the runway remaining is long enough, re-land; and if not, make a glide landing on the least unsuitable area ahead of you.'*

Footnote

2 Figure 3 was taken from CAA Safety Sense Leaflet 14, '*Piston Engine Icing*'.

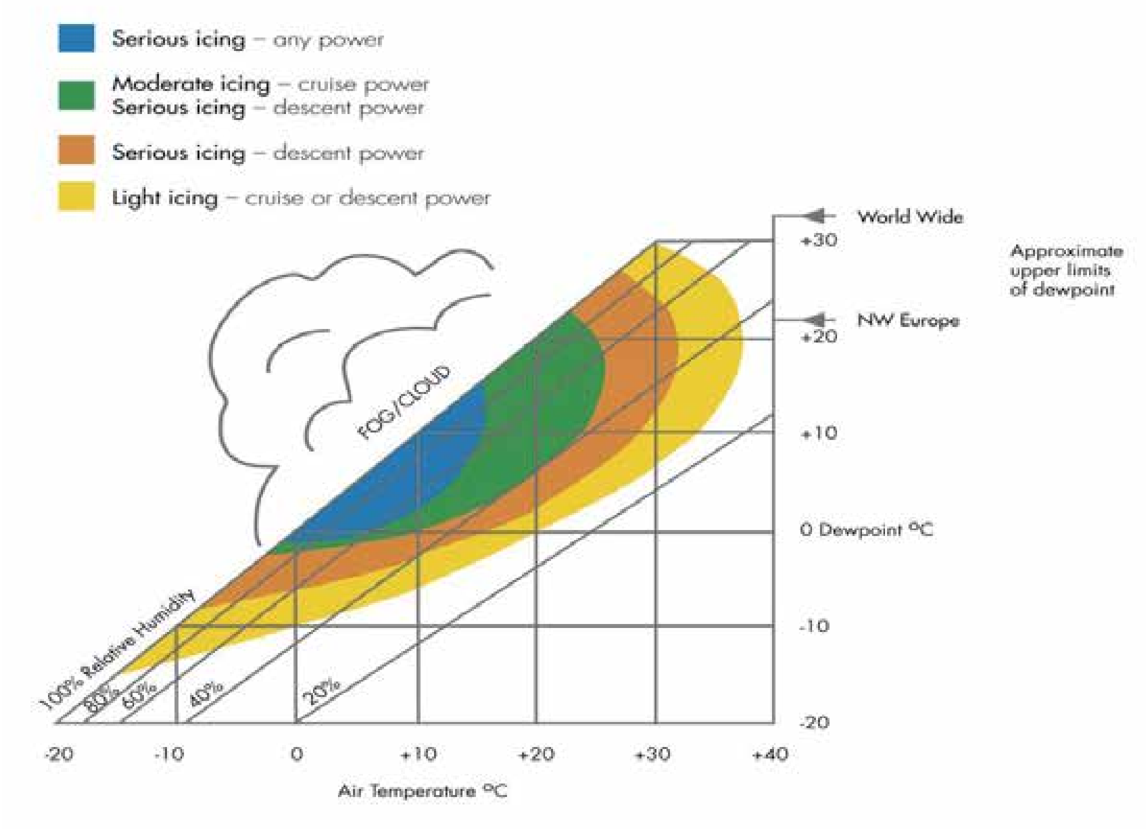

Figure 3

Carburettor icing chart for piston engines

and:

> *'Attempting to turn back without sufficient available energy has killed many pilots and passengers.'*

Piper PA-38 Pilots' Operating Handbook (POH)

The Piper PA-38 POH states that the magnetos should be checked at an engine speed of 1,800 rpm. A maximum reduction of 175 rpm is permitted when each magneto is selected and a maximum difference of 50 rpm is permitted between the resulting engine speeds.

Section 3.7 of the POH, '*Engine Inoperative Procedures'*, states:

> *'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.'*

Section 4.21 of the POH, *Before Takeoff,* states that the carburettor heat control should be set to COLD for takeoff. During flight, the POH states that carburettor heat should be selected to HOT if the engine begins to run roughly.

Section 4.29 of the POH, *Approach and Landing,* states that, during the approach and landing phase:

> *'Carburettor heat should not be applied unless there is an indication of carburettor icing, since the use of carburettor heat causes a reduction in power which may be critical in case of a go-around. Full throttle operation with carburettor heat on can cause detonation.'*

Analysis

The damage to the aircraft and the ground marks were consistent with the aircraft stalling and dropping the left wing at a relatively low height while close to the threshold of Runway 21. Evidence from examination of the wreckage indicated that the engine was producing little or no power at impact.

G-BGBN was one of a number of aircraft owned and operated by the flying school and flown on a Certificate of Airworthiness (C of A) issued by the CAA. Safe operation of aircraft, and the validity of a C of A, is dependent on an aircraft being maintained in an airworthy condition. This requires an aircraft to be operated on an approved fuel, maintained at the intervals specified in its maintenance programme, and for work to be correctly documented and carried out by qualified individuals. This investigation discovered that two of the flying school's aircraft operated on fuel that is not approved by the CAA. With regard to G-BGBN, it appeared that flying hours, defects and rectification had not been recorded in the log books and technical records, and an individual carried out maintenance on G-BGBN who did not hold the required approvals.

Fuel

The fuel tests indicated that fuel containing ethanol had been used in two of the flying school's aircraft, one of which was G-BGBN. However, G-BGBN had operated from Cranfield in the 11 days prior to the accident during which it had uplifted 300 ltr of Avgas 100LL, which is approximately 2.5 times the aircraft's useable fuel capacity. Any ethanol in the fuel would have been significantly diluted and, therefore, it is unlikely that the trace amounts detected would have made the probability of vapour lock or carburettor icing more likely during the accident flight. Moreover, a detailed examination of the aircraft fuel system detected no evidence of any deterioration that might have occurred as a result of using an unapproved fuel; there was also no evidence of any restrictions in the fuel system.

The fuel selector valve was in the right tank position and the fuel that the emergency services reported leaking out of a pipe for twenty minutes after the accident could only have come from the right fuel tank that was still connected to the aircraft. Therefore, the aircraft did not run out of fuel.

Ignition

The ignition switch was found in the LEFT position instead of the required position which was BOTH. The switch might have turned during the impact sequence but this seemed unlikely because the key and switch were undamaged. Alternatively, the key might have been turned immediately after the accident by the emergency services although there were no reports of this having been done. Had only the left magneto been selected during the flight, the engine should still have been able to operate, albeit with a slight reduction in power. Both magnetos and their spark plugs were tested and found to be serviceable and the aircraft took off and flew a circuit before the accident with no reported problems. While there was no evidence that there was a fault in either ignition system, the possibility could not be completely excluded that there was a fault in the left ignition system that caused the rough running.

Maintenance

The possibility was considered that the undocumented and unauthorised maintenance, carried out on the aircraft immediately before the accident flight, might have contributed to the loss of power. While the engine had been badly damaged, the investigation determined that the spark plugs had been correctly fitted and could identify no mechanical reason why the failure should have occurred. Moreover, the instructor and student carried out a power check at the start of the accident flight, during which the engine behaved normally, and the aircraft subsequently flew a circuit and touch-and-go landing (rather than a full-stop landing), suggesting that the engine was operating normally.

Carburettor icing

The CAA advises that carburettor heat should be applied during approach and touchdown in anticipation of carburettor icing with the caveat that there might be contrary information within the POH. The POH for this aircraft type advocates leaving the carburettor heat off until symptoms of icing are encountered. The atmospheric conditions were such that there was a risk of serious carburettor icing at all power settings. While the carburettor heat control was found in the COLD position, as would be expected following a touch-and-go, it could not be determined whether it had been applied during the approach. The instructor habitually selected carburettor heat to HOT while descending on base leg and, presuming this was done prior to the touch-and-go, much of the ice that had formed (if any) would probably have cleared before touchdown. It was not possible to determine if carburettor icing was present at the end of the approach or during the subsequent takeoff but the decision to continue with the touch-and-go suggests that the engine was performing correctly at the point the decision was made to apply power.

In the absence of evidence of alternative causes, carburettor icing appears to be the most likely cause of the rough running.

Aircraft handling

The POH advises that only gentle deviations from heading should be attempted at low level with a failed engine and this is common knowledge and teaching in regard to single-engine aircraft. The instructor stated that the aircraft was still able to climb following the first symptoms of rough running and so there was not a clear-cut power failure. He believed initially that the aircraft could be turned back towards Runway 21 and initiated a turn to the left. Had that turn been flown through 180º, the aircraft would have been displaced to the right of the Runway 21 centreline and the pilot would have had to continue to manoeuvre the aircraft in order to line up with the runway. It is possible that there would have been sufficient runway available to enable this course of action to lead to a successful landing but only if the engine continued to provide sufficient thrust to maintain level flight during the turn.

After he commenced the turn and the symptoms of rough running worsened, the instructor believed that all power might be lost and amended his plan so that the aircraft would turn only far enough to enable a landing to be made within the aerodrome boundary. It was not determined where in this turn the symptoms worsened but, before the instructor could roll out on his chosen heading, the aircraft stalled and departed controlled flight at a height that was insufficient to allow recovery.

AAIB comment

This accident reinforces the advice that following engine failure it is essential to maintain flying speed and control of the aircraft. It is the experience of the AAIB that a controlled crash landing straight ahead is preferable to stalling at low level.