Grumman AA-5B, G-BEFC

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Aircraft Type and Registration:	Grumman AA-5B, G-BEFC
No & Type of Engines:	1 Lycoming O-360-A4K piston engine
Year of Manufacture:	1976
Date & Time (UTC):	27 November 1997 at 1950 hrs
Location:	1.8 miles north-west of Shobdon Airport, Herefordshire
Type of Flight:	Private
Persons on Board:	Crew - 1 - Passengers - None
Injuries:	Crew - Fatal - Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	49 years
Commander's Flying Experience:	240 hours Last 90 days - 7 hours Last 28 days - 35 minutes
Information Source:	AAIB Field Investigation

The pilot, who was a member of an eight man syndicate which owned the aircraft, took off from Shobdon Airport with the intention of updating his night flying currency. The weather conditions, observed by the Chief Flying Instructor (CFI) who had been flying at the airfield approximately 30 minutes prior to this flight, were reasonable. There was a thin layer of scattered cloud between 900 and 1,000 feet above the airfield, visibility was estimated generally to be in excess of 10 km below cloud but reduced in places by 'misty patches' at 600 feet, and the surface wind was light and variable. An aftercast by the Meteorological Office supported the observations and gave the dry bulb temperature and dew point as 7_C. The automatic recording meteorological station at Shobdon showed the dry bulb temperature to be 7.2_C and the dew point to be 6.7_C at 2000 hrs. The conditions were conducive to carburettor icing at any power (refer to CAA Safety Sense Leaflet 3A for further information about carburettor icing).

Radio transmissions by the pilot to the Air/Ground station operated from the Herefordshire Aero Club (HAC) at the airfield were normal and included 'radio check and taxi' and 'take off' calls. He also responded to a radio call from a fellow syndicate member who had arrived just as he called for taxi clearance and who intended to fly the aircraft after the pilot had finished his flight. The exact take-off time was not noted or logged but was close to 1945 hrs. The take off was observed by the syndicate member and the Air/Ground operator and appeared normal.

No further radio transmissions were received from the pilot and, at about 2000 hrs, the syndicate member decided to call him to check the weather and ask for his intended time of return. When he did not receive a reply to two calls the syndicate member became concerned as no 'circuit' transmissions had been heard and he knew that the pilot would normally have called before changing frequency. He therefore discussed the matter with the CFI of the HAC, who is also the airport manager, and who had been flying earlier that evening. Further transmissions were made from the Air/Ground stations in the club house and control tower and the fire crew were despatched to search the western end of the runway and the overshoot; nothing was heard or found.

Just after 2030 hrs, the CFI notified the Distress and Diversion Cell (D&D) at the London Area and Terminal Control Centre (LATCC) who contacted all local airfields that were still open, initiated radio calls from commercial aircraft on the emergency frequency of 121.5 Mhz and alerted the Plymouth Rescue Co-ordination Centre. The local police were informed and attended the airport.

At about 0100 hrs the next morning, after it was certain that the aircraft's fuel supply would have been exhausted and following consultation between all authorities, Shobdon Airport was closed. The search was recommenced at first light but the aircraft was not found until 0930 hrs when it was seen by a local farmer in a field approximately 1.8 miles north-west of Shobdon Airport (Figure 1).

A local resident heard an aircraft flying very low over her house at Downwood, which is approximately half a mile to the south-east of the accident site, around 2000 hrs. The aircraft was travelling in a south-east to north-west direction and the resident, who works in the family owned aircraft maintenance business at Shobdon Airport and is familiar with the locally based aircraft types, thought that it was a Grumman AA5-B and that its engine sounded normal.

The pilot held a valid Private Pilot's Licence (PPL) for the aircraft being flown with Night and Instrument Meteorological Conditions (IMC) ratings. His Certificate of Experience was current and he held a Class 3 medical category, with no conditions, which was valid to March 1998. His logbook indicated that he had flown a total of 240 hours, of which 178 hours were as pilot-in-command (PIC), on seven different aircraft types. He had recorded 29 hours of instrument flying, the last entry for which was 14 April 1997 when his IMC rating was re-validated. The previous entry was for 15 October 1995. The total night flying recorded was 7 hours 5 minutes, of which 1 hour 20 minutes was as PIC. The last entry was for 20 March 1997 when 35 minutes were

recorded. A total of 5 hours, of which 45 minutes were as PIC, was logged on 11 and 12 March 1997; 5 take offs and landings were noted during that period.

It was the syndicate's normal practice to fuel the aircraft to 'one inch above the tabs' in each tank at the end of a flying day; this gave a total quantity of approximately 36 imperial gallons. The 'tabs' are metal indicator plates which project down from the top of each tank and can be viewed through the fuel tank filler orifice on the top of the wing. Fuel sales records at HAC confirm syndicate member's recollections that the aircraft was fuelled to 'one inch above the tabs' on its return from Gloucestershire airport on 21 November 1997. It was subsequently flown on local sorties by a third syndicate member on 21 and 27 November 1997 for a total of 35 minutes. The member visually checked the fuel level prior to each of his flights, the second of which was on the same day as the subject flight, and used fuel from the left tank on one flight and the right tank on the other. Allowing for the normal usage rate of 10 gallons per hour, the fuel quantity at the start of the subject flight was therefore approximately 30 gallons, distributed approximately equally between tanks.

Radar recordings.

The D&D Cell had reviewed recorded data from the Clee Hill radar, which is approximately 14 miles north-east of Shobdon, during the search but had not seen any returns which could be attributed to G-BEFC. Five primary returns in an area between 2 and 2.5 miles south-west of Shobdon between 1945:33 hrs and 1946:23 hrs were analysed later. There were gaps between returns, which indicates that consecutive sweeps of the radar head did not produce a return, and the data can not be considered reliable. With that proviso, analysis showed that the position of the returns was in the area of the crosswind leg for the normal circuit pattern at Shobdon but ground speed was between 11 and 54 kt.

A short trial was conducted with the HAC Grumman AA5-B to determine the likelihood of receipt of a primary return at Clee Hill from that aircraft in the Shobdon area. Whilst secondary radar information was received clearly at the normal circuit height of 1,000 feet, no primary returns were observed until a descending turn was initiated after a climb to 2,500 feet. The returns continued until straight flight was resumed as the aircraft descended through 2,300 feet.

The absence of primary returns from low-level aircraft at Clee Hill and other radar sites is well known and is attributable to the ground-clutter filter system which removes returns from stationary or slow moving targets. However, it is possible that the returns observed near Shobdon in the relevant time period can be attributed to G-BEFC, particularly if the aircraft changed its radar aspect by entering a turn.

Airfield and local area lighting

Runway 27 at Shobdon is licensed for night use and is equipped with omni-directional edge lights and Precision Approach Path Indicators (PAPIs). The edge lights were easily visible from the downwind position during a short night flight in the HAC Grumman AA5-B in good weather conditions. Local villages are well lit by street lights and domestic lighting and bright lighting at the rugby pitch at Kingsland, the car auction site near the end of the downwind leg, and an industrial unit immediately to the south-west of the airport would have been in use on the night of the accident. However, the villages of Kingsland, which is on the right at the end of base leg, and Shobdon, which is just to the north of the airport, have similar lighting shapes and orientation. Similarly, the small villages of Pembridge and Eardisland, which are on the left on the downwind leg, have been confused by student pilots. Additionally, whilst they are of different colours, the location of each of 3 bright light clusters could be mistaken. It would therefore be possible, in relatively bad weather, to mis-identify local lighting patterns at night if the runway became obscured.

Engineering investigation

The aircraft had crashed in a field 1.8 miles from the airfield on a bearing of 345_(M) which is on the 'dead' side of the circuit for Runway 27L. Circuits at Shobdon are normally flown to the south of the runway. The crash site was 340 feet above airfield elevation and the aircraft had crashed flying on a track of 302_(M), heading away from the airfield and towards higher ground.

The first impact was between the outer section of the aircraft's right wing and outer branches of a tree about 11 feet above ground level. The wing was identified as the right hand one from a small amount of debris found below the tree. This showed that the aircraft had been upright at the time of impact and the condition of some of the debris showed that the wing had been slightly distorted by the impact. The right wing then collided with a hedge 130 feet further on with the aircraft slightly banked to the right. The final impact was in an open field 190 feet beyond the hedge. The aircraft had descended on to the ground inverted with the left wing hitting the ground first. A survey showed that the elevations of the tree, the hedge and the final impact point were virtually the same. The aircraft had, however, rolled to the right through more than 180_ between the hedge and its descent into the ground. In order for the right wing tip to clear the ground when it was banked vertically, it must have described a ballistic trajectory between the hedge and the final impact having previously followed a horizontal flight path between the tree and the hedge. This implies that the aircraft was pitched up, probably before it hit the hedge, and probably as a result of an instinctive pilot reaction following the collision with the tree. As the right wing had been damaged, it would produce less lift than the left wing and the aircraft would roll to the right. This evidence implies that the pilot was not totally incapacitated when the aircraft hit the tree and it indicates that the aircraft was, at least in some measure, still in controllable flight up to that time. The terrain up-track of the tree collision was searched but no sign of a previous collision or touchdown was found.

After impact, the aircraft lay upside down with the right wing detached. The engine had broken away from the nose, the instrument panel was crushed inwards and the canopy fragmented. There was light damage on the propeller which was consistent with some rotation at impact but there was very little indication of the sort of distortion that normally results from power being generated by the engine at impact.

The controls and equipment settings in the cockpit were examined. The throttle control knob was fully forward but it could have been pulled to this position in the crash as the cable had been pulled and broken when the engine detached from the fuselage. The magneto switch was at BOTH and a (later) check of the condition of the switch and its wiring found no fault. The fuel selector was selected to the right wing tank. The fuel primer knob was correctly locked in. The pressure datum of the altimeter was set at the current airfield QFE. The flaps were fully retracted. The carburettor HOT AIR knob was pulled out to the HOT position and the stalk had been bent, trapping it there. Thus HOT AIR had been selected before the crash.

The No 2 VHF communication radio was the only one that was switched on. Its frequency was set to 123.55 Mhz which is one digit different from the Shobdon airfield frequency (123.50 Mhz). A hand-held transceiver and a torch were found on the ground next to the left-hand side of the aircraft; the transceiver was selected OFF. A bag found in the area of the rear seats contained a Southern England and Wales 1:500,000 scale chart, flight-planning equipment and documentation and the pilot's licence and logbook. A holdall in the pilot's car, which had been left at Shobdon Airport, contained further flight planning documentation and Garmin GPS 55 and Skyforce 'Locator' navigational equipment.

Group members' flying time was recorded by reference to the digital time indication on the Tachometer. The 'Tacho' time is displayed to two decimal places and was recorded in a log book before and after each flight . The log book was found in the aircraft and contained the entry for the previous flight of that day. The difference in the Tacho time indicated after the accident from the entry for the end of the previous flight was 0.08 hours, or 4 minutes 48 seconds.

The mixture control was found fully forward in the FULLY RICH position. However, the cable was detached from the mixture lever on the engine and the screw fitting which attaches it to the lever was missing. The lever was undamaged and the wire end showed only the normal bending and polishing which results from it being clamped in the fitting and showed no sign of having been traumatically pulled out of the fitting. The wreckage was searched for the small parts that make up the fitting and a search with a metal detector was carried out on the accident site but they were not found. There appear to be two possibilities; that the fitting had become loose before the crash or that the screw within the fitting had broken, before or during the crash, releasing the cable without any damage to it. If the cable did detach before the crash then it is not clear that it would necessarily cause the engine to lose power in flight. There was a certain amount of friction in the movement of the lever so that it would not easily move under vibration or normal flight loads and, in any case, it is mounted so that gravity tends to move it towards the FULLY RICH position. It

therefore appears improbable that a disconnection of the mixture cable had caused a power loss in flight.

Seventeen months before the accident one member of the group had a problem starting the engine after he had flown to Bournemouth Airport. An engineer from an aircraft maintenance company offered assistance and diagnosed that the outer sleeve of the mixture cable was insecure. He re-clamped it and tied it with wire to improve the security. A wire was still in position after the crash. The sleeve was no longer held in the clamp but it was not possible to tell whether it had become insecure before the crash or simply pulled out when the engine was torn off. The rectification of the sleeve clamping was not recorded in the aircraft's log book as it should have been but the aircraft had undergone several inspections during routine maintenance by the time of the accident.

Very little trace of fuel was found in the aircraft. A little was recovered from the right tank and its pipework (the selected tank) and none from the left tank. A small amount was found in the carburettor bowl. In all three cases, because the tanks and the carburettor had lain upside-down, it was possible to identify means by which the fuel could have drained away. The fuel that was recovered was clean. There was a small amount of very fine dust in the carburettor bowl but this is not abnormal. The fuel pipe lines were clear and there was no sign that any had disconnected before the crash. The group which owned the aircraft had devised a pair of lockable caps for the fuel tanks to prevent theft of the fuel when the aircraft was parked outside at the airfield. These caps were not approved for use in flight and so the group's practice was to fit the lockable caps after flight and replace them with the normal caps before flight. The normal caps were found fitted. A group member had flown the aircraft earlier on the day of the accident and stated that had left the aircraft with the lockable caps fitted. The evidence of the fuel caps means that the pilot did open the tanks and would have been able to check the contents. This, together with the refuelling record described above, indicates that, though it was not possible to confirm the presence of adequate fuel on board from physical evidence, there probably was sufficient on board at the start of the flight. A sample of fuel from the airfield supply was tested in a fuels laboratory and it was found to conform to specification.

The engine was stripped and examined but nothing was found that could have caused the engine to lose power in flight. The magnetos and sparking plugs were tested. The sparking plugs all operated but were low on insulation and their sparking gaps were larger than normal. They were fitted into another engine to test them under normal operating conditions. After some initial roughness, probably due to one plug, the engine ran smoothly and the standard test of the operation of the plugs and magnetos showed no deficiency. The plugs showed no sign of carbon build-up or sooting which is sometimes associated with the rich running that results from carburettor icing.

The aircraft was examined for signs of electrical failure but none was found. All the fuses were intact. The alternator had been only recently fitted. Its fitting was secure apart from one connecting wire which had been broken in the crash. Bulb filaments can display characteristic distortion if they are hot, and therefore illuminated, when they are subjected to severe forces in a crash. The LOW VOLTAGE warning light filament revealed no sign of illumination. Three instrument panel lights did show such distortion and it was concluded that there had been electrical power available at impact.

The flying controls were examined and no disconnections or defects other than clear crash damage were found. The fact that the aircraft was upright and not in a steep descent at impact is consistent with it being in controlled flight up to that point.

Analysis

The time indication on the Tachometer after the accident showed a difference of 0.08 hours from the last reading noted at the end of the previous flight in the group's record book. The Tacho clock is simply geared from the RPM indicator and gives accurate elapsed time at 2,500 RPM and a proportionately slower indication of time at lower engine speeds. A reading of 0.08 hours equals 4 minutes 48 seconds but the actual elapsed time from start-up to the crash would have been longer as for much of the time the engine would have been operating at less than 2,500 RPM.

Figure 1 shows the location of the accident site relative to Shobdon Airfield and also illustrates the advice given by the flying club on how a circuit should be flown. The intention is to avoid overflying local communities, particularly Pembridge and Eardisland. Normal circuit height is 1,000 feet above airfield level. South of the airfield the terrain is generally at about airfield elevation (318 feet), rising to 500 feet at one locality. North of the airfield the terrain rises progressively to a ridge which reaches 1,000 feet amsl.

When flying a normal circuit in a similar aircraft, the club's Chief Flying Instructor noted Tacho times and found that, after an elapsed time of 0.08 hours from start-up, he was approaching abeam Pembridge. At the same elapsed time G-BEFC crashed 4 miles further north. It is apparent that if it was the pilot's intention to follow the normal circuit pattern then he diverged from it very early in the flight.

It is possible that the pilot intended to fly a 'bad weather' circuit, also illustrated on the map, in which he would turn left earlier in order to pass north of Pembridge and Eardisland, keeping closer to the airfield, and flying lower, say 700 feet, to stay clear of cloud. A calculation of flight time was made assuming a hypothetical flight-path for G-BEFC in which it turned after take off as if to fly the bad weather circuit but continued to turn until it was heading North and flew directly to the crash location. Assuming normal flight speeds, engine speeds, climb rate and a rate 1 turn the flight time would be about 3 minutes 40 seconds which converts to 0.05 hours Tacho time. This would leave 0.03 hours Tacho time, about 3 minutes 30 seconds at low RPM ground operation, for pre-flight checks, taxiing and the take-off run. The error in the calculations in converting from Tacho time to real time is about plus or minus 0.01 Tacho hours (converting to about plus or minus 1 minute) so perhaps 4 minutes 30 seconds would be available for pre-flight activities. On the flight performed by the Chief Flying Instructor these took at least 1 minute longer.

These calculations show that, even if the pilot carried out his pre-flight checks very quickly, the time available for the actual flight would allow only a very direct track to the site of the crash, probably more direct than the one shown, and that the aircraft diverged from a rational track (say, a bad weather circuit) about 2 minutes before it crashed.

If the aircraft turned right immediately after take off it would shorten the required flight time and allow more time for the pre-flight activities but there seems to be no rationale for this. If it turned left and then continued to turn to the left once it had climbed to circuit height as shown on the map then this could have been due to pilot disorientation on entering cloud or distraction due to (say) an engine problem. If there was a problem with the engine at the point at which it diverged from the circuit pattern then it could not have been a total power loss. From 700 feet the aircraft could have glided as far as the airfield or from 1,000 feet as far as Shobdon village but not as far as the crash site, about 1 mile further on. There may have been a partial power loss but the witness who heard an aircraft fly over at about the right time and heading towards the crash site about half a mile away recognised it as an AA5-B because of her familiarity with the aircraft at Shobdon and recalled that the engine appeared to be running smoothly. There was no radio call from the pilot, particularly no 'Mayday' call, to show that he had a problem.