ACCIDENT

Aircraft Type and Registration:	MCR-01, G-TBEE
No & Type of Engines:	1 Rotax 912 ULS piston engine
Year of Manufacture:	2000
Date & Time (UTC):	2 October 2005 at 1159 hrs
Location:	Near Lymington, Hampshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - 1
Injuries:	Crew - 1 (Fatal) Passengers - 1 (Fatal)
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Private Pilot's Licence
Commander's Age:	53 years
Commander's Flying Experience:	1059 hours (estimated - of which 290 were on type) Last 90 days - 8:30 hours estimated Last 28 days - 6:30 hours estimated
Information Source:	AAIB Field Investigation

Synopsis

The aircraft was flying a route which took it along the north shore of the western Solent when the accident occurred. Within minutes of the pilot's last transmission to ATC, and without any indication that he was experiencing a problem, the aircraft deviated from its course and descended to low level in the vicinity of the town of Lymington in an apparent attempt to land. Whilst manoeuvring at low level the aircraft was seen to pitch up and depart from controlled flight before descending steeply to the ground. The technical examination eliminated mechanical or structural failure as a cause of the accident but concluded that a partial engine failure may have contributed to it. Post mortem results raised the possibility that the pilot may have been medically incapacitated prior to the accident itself.

History of the flight

The pilot had intended to fly from Shoreham Airport in Sussex where the aircraft was based, to Dunkeswell Airfield in Devon where a 'fly in' event was being held. The pilot was accompanied by a passenger with whom he had flown on numerous occasions. There were other aircraft owners present in the vicinity during the pilot's pre-flight preparations, some of whom spoke to the pilot, though none described anything unusual until the point of engine start. One of those present recalled that, at that point, G-TBEE's engine was started but then shut down again after a short while. It appeared to be a normal shutdown, without faltering. The engine was started again and the aircraft taxied to the fuel pumps, arriving there at 1116 hrs.

There was CCTV coverage of the refuelling area which was made available for the investigation. The pilot initially requested 40 ltr of Avgas 100LL, but subsequently revised his requirement to 35 ltr. The refuelling supervisor recalled nothing unusual about the fuelling process or the aircraft's two occupants. However, the pilot did not start the engine and taxi immediately after completion of the fuelling paperwork. Instead he manhandled G-TBEE to the edge of the refuelling area where he and the passenger boarded the aircraft, and sat with the canopy open for some 5 minutes before eventually starting the engine and taxiing away.

The aircraft taxied to the holding point of Runway 02. A Cessna aircraft was also at the holding point and its pilot, who was familiar with G-TBEE and its owner, saw G-TBEE but did not recall seeing anything unusual about the aircraft. The Cessna departed first and headed west from Shoreham, and G-TBEE took off 3 minutes later at 1135 hrs. As the Cessna was flying west at 2,000 ft, G-TBEE overtook it on its right hand side at the same height with a separation of about 200 m. When G-TBEE had drawn ahead of the Cessna, it was seen to rock its wings in a pronounced manner, which the Cessna pilot took to be an acknowledgement by the pilot of G-TBEE that he had seen his aircraft. As G-TBEE was rocking its wings, the Cessna pilot saw it pitch up suddenly and briefly before recovering again to level flight. The pitch-up appeared to be the result of a deliberate control input. The extent or duration of the pitch-up was insufficient to cause a marked change of height, but was regarded as unusual by the Cessna pilot.

G-TBEE then continued on a westerly track which took it close to Chichester and overhead Portsmouth. The pilot made routine radio contact with Goodwood Airfield at 1142 hrs, and reported that he was maintaining 3,000 ft amsl. At 1152 hrs the pilot contacted Solent Radar, based at Southampton Airport; at this time he was overhead Gosport and flying at a reported 2,300 ft amsl. The pilot declared that he was routing to Calshot then Sandbanks; both are visual reporting points, located near the entrances to Southampton Water and Poole Harbour respectively. The pilot requested, and was given, a Flight Information Service (FIS) and advised that he would have to be below 2,000 ft when passing abeam Calshot in order to remain below controlled airspace.

G-TBEE was seen from another aircraft as it flew past the entrance to the Beaulieu River and appeared to be flying normally in straight and level flight. At 1157 hrs the pilot reported that he was abeam Calshot at 1,300 ft amsl and was instructed to contact Bournemouth Radar. The pilot acknowledged the frequency change, but no further radio calls were received from the aircraft, either on the new Bournemouth frequency or the Solent Radar frequency. The aircraft's radio was found after the accident to be selected to the Bournemouth frequency.

Although several witnesses reported seeing the aircraft in a steep descent, the ground impact was not seen and none of the witnesses realised that the aircraft had crashed. The wreckage was discovered in a field nearly an hour later by the land owner who contacted the emergency services at 1305 hrs. The fire brigade arrived on scene at 1312 hrs, followed a few minutes later by the ambulance service. Both occupants of the aircraft had sustained immediately fatal injuries.

GPS derived information (see Figure 1)

G-TBEE was equipped with a GPS navigation system that recorded the time, position, groundspeed, track and GPS altitude every 30 seconds during the flight. GPS altitude can be subject to substantial error but the recorded values suggested that for much of the flight, where the aircraft had apparently been flown approximately level,

the GPS altitude had been accurate to within ±100 ft. Data from the GPS showed that the aircraft flew a steady track of about 255º(M) which took it along the north shore of the western Solent towards Lymington, flying at between 124 kt and 129 kt ground speed. The GPS data showed that, at the time the pilot made his last confirmed radio transmission, the aircraft was actually 3 nm west-south-west of Calshot, and only 1.5 nm from the accident site, the lateness of this transmission having been caused by the Solent frequency being blocked for a while with other transmissions.

At about the time of this transmission from G-TBEE, and about 2 minutes before the estimated time of the accident, the data from the GPS showed deviations from the previous steady state. The GPS altitude first showed a dip to 1,153 ft, and then the next point, 30 seconds later was recorded as being 1,318 ft (Position A, Figure 1). Both of these values were outside the narrow height band within which the aircraft had been flying during the few minutes since the aircraft had completed the descent requested by ATC.

Point A was the last recorded point on the aircraft's original track. The next and penultimate point (B) showed a GPS altitude of 1,234 ft and a reduced groundspeed of 95 kt. The average rate of descent from A to B was less than 200 ft per minute (ft/min), though this increased to about 1,400 ft/min between B and C. The next and final recorded point was 800 m from the previous, and almost due north of it, though the aircraft's track at this stage was just south of west, similar to that of the previous position. Groundspeed at C was 80 kt and the recorded GPS altitude was 513 ft. Based on the position

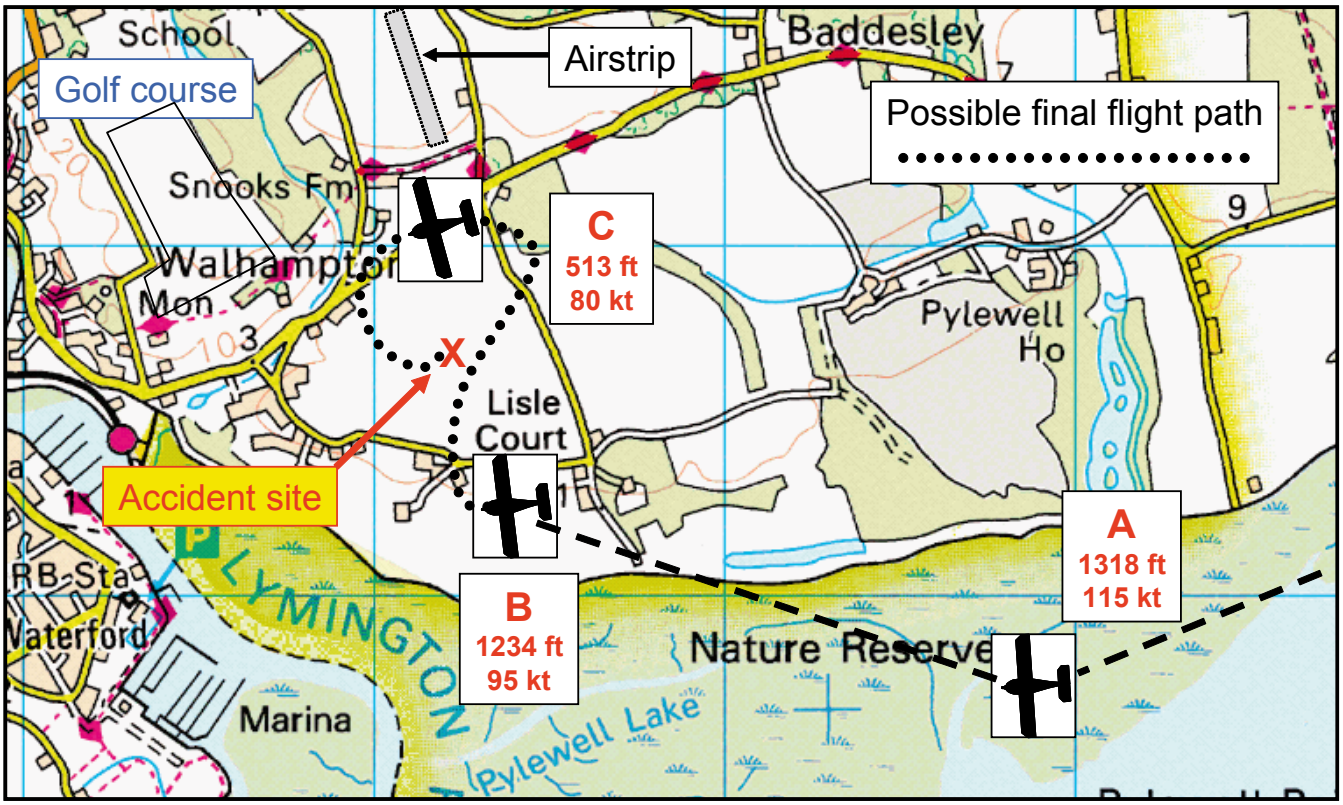

Figure 1

Accident area and GPS derived data

of the accident site and the time of the last recorded GPS position, the accident is estimated to have occurred at about 1159 hrs.

Witness information

Several witnesses reported seeing an aircraft matching the general description of G-TBEE but the accounts of its behaviour and how long it had been in the area differed. In general terms, witnesses reported seeing an aircraft manoeuvring at low altitude in the area of the accident site before pitching up and entering a steep final descent which it maintained until it disappeared from view behind trees. A witness on a nearby golf course (see Figure 1) reported seeing an aircraft flying in a left turn near to the south-eastern part of the course. It was quite low and gave the impression that it was in a gradual descent. Although there was some noise associated with the aircraft, it was not possible to say whether this was engine or airframe noise. As the aircraft was flying away from the witness, it was seen to pitch up with the left wing slightly low, until it reached a quite steep nose-up attitude. The aircraft then yawed and rolled to the left, eventually pointing steeply down as the aircraft descended quickly.

Some witnesses reported seeing the aircraft flying with a 'porpoising' motion prior to the final pitch up and some of these reported the aircraft being in view for several minutes beforehand. Other witnesses were not aware of the aircraft until shortly before seeing either a final pitch-up, roll and steep descent, or just the aircraft in its final descending attitude.

The timings of the various reports differed quite markedly, only two sightings being accurately matched to known times. One was from a car being driven along the road to the north of the accident site, which matched closely the last recorded GPS position and time. This witness saw the aircraft at an unusually low height in substantially straight flight, but with a gentle 'wing rock.' The other sighting was by a deck hand on a ferry in the Lymington River, who saw an aircraft circling at low level in the area for up to 5 minutes. The recorded docking time of the ferry showed that this sighting had been a few minutes before G-TBEE was known to have been in the area.

The accident site was 6.5 nm from Southampton Airport, but because the radar there was not recorded, it was not possible to trace or identify any other light aircraft in the area. Enquiries were made with local flying clubs and flying training organisations, in an attempt to establish if any of their aircraft were in the area at the time, but these were inconclusive.

Personnel information

The pilot had begun flying microlight aircraft in 1983 and accumulated approximately 700 hrs on microlights before converting to single engine piston types. During that time the pilot had undertaken a number of long distance or otherwise remarkable flights and had become well-known in microlight circles. The pilot trained on Cessna 152 aircraft and gained his Private Pilot's Licence (Aeroplanes) in 1999. He then flew Cessna 152 and Piper PA-28 aircraft until G-TBEE was completed in November 2000.

The pilot's last logbook entry was on 29 May 2005; last entries in the aircraft and engine logbooks were in February 2005. An assessment of total hours and recent flying experience was made with help from ATC records and the GPS memory log. Since the last logbook entry, the pilot is believed to have flown some 11 hours, taking his total hours on type to 360 hrs. In the 3 months preceding the accident the pilot had flown an estimated 8:30 hrs over 6 flights. Much of the pilot's flying time was spent touring, with frequent flights to Europe.

The passenger had flown in the aircraft on a number of occasions. In June 2004 she had commenced training towards a Private Pilot's Licence but completed only three lessons in a Cessna 152 before withdrawing from training due, it was believed, to work pressures. There is no record of her having undergone any further formal flying training.

Aircraft description

The MCR-01 VLA Sportster is one of a family of very light kit-built aircraft; the type is popularly referred to as a 'Banbi'. It has two seats, side by side, and is predominantly a carbon fibre composite structure with aluminium skinned wings and horizontal stabiliser. It is a high performance aircraft, marketed as having handling qualities akin to a fighter aircraft, with powerful and sensitive flying controls.

It is powered by a Rotax 912 ULS, horizontally-opposed water-cooled four-cylinder piston engine which drives a three-bladed variable pitch propeller through a reduction gearbox. The fuel system consists of a single fuel tank located between the cockpit instrument panel and the engine firewall. The fuel is fed through a coarse fuel filter to a stopcock, on the floor, located in the centre of the cockpit. It then passes through to the electric fuel pump, containing a fine fuel filter and the gascolator, forward to the mechanical fuel pump located on the side of the reduction gearbox. From there, the fuel is fed back through the firewall into the cockpit and passes through a fuel flow transducer and fuel pressure sensor, before returning forward through the firewall to the two carburettors. Unused fuel is routed back to the fuel tank by the use of a return line; this reduces the chance of vapour lock by ensuring a continuous flow of cool fuel through the system.

G-TBEE was equipped with a carburettor heat system which is an optional fit; aircraft kits are normally provided without such a system. The manufacturer, during development work, had taken measurements of the air temperature within the carburettors of the MCR-01, during normal operation. These were found to be some 15 to 20°C higher than the ambient air temperature. With this increased air inlet temperature, the likelihood of carburettor icing is considerably reduced and the addition of a carburettor heat system, when used, further reduces the chances of such icing.

The aircraft has manual flying controls, with feel augmentation by the use of elastic bands. The aileron and flap functions are combined using a single flaperon on each wing. The aileron function is controlled via push rods from the two control sticks, and the flap function is operated by an electric motor rotating a screwjack driving a flap carriage that transfers motion to the flaperon surface. The electric flap motor is controlled by two push buttons on each control stick. Microswitches, operated by the flap carriage, act as the flap travel limiters.

The rudder is cable-operated from adjustable foot pedals mounted to the floor. Pitch control is effected by an all moving horizontal stabiliser with a coupled anti-balance trim tab. The stabiliser is controlled by carbon fibre push rods operated by the control sticks. The anti-balance tab is operated by a fixed push rod connected between the tab drive-arm and a fixed bracket in the vertical fin. Pitch trim is effected by an electric motor driving a screwjack which positions a carriage connected to the stabiliser control push rod, via elastic bands. A second set of elastic bands connect between the stabiliser control push rod and the airframe structure at frame 7. These balance the forces exerted on the push rod by the pitch trim control elastic bands. As the trim motor drives the trim

carriage, the spring forces of the elastic bands change the neutral position of the stabiliser control push rod and in turn change the trimmed position of the stabiliser. The pitch trim motor is operated by push button switches on each of the control sticks; there is no cockpit pitch trim position indication except for the control stick position and feel.

G-TBEE was fitted with an Angle of Attack (AOA) indication and warning system which was based on the angle of attack of the wing to the airflow. The system utilised the pressures from two ports on the wing, one on the upper surface and the other on the lower surface, and the pressures from the aircraft's static and pitot ports. The pressures were correlated, in a control unit, to calculate the wing's coefficient of pressure (C_{pw}), which had an almost linear relationship with the wing's angle of attack, over the measured range. For the system to operate correctly, two specific values of C_{pw} had to be determined during a calibration flight. One value was the C_{pw} in the 'zero lift' condition. The other was the C_{pw} at the AOA related to about 1.15 times the wing stalling airspeed; this was known as the 'angle advisory' C_{pw}. Having calibrated the device, it would have provided two means of identifying an impending stall. The first was by a visual indicator consisting of a bank of eight LEDs (two green, three amber and three red) in the cockpit; the LEDs illuminated in a sequence based on the calculated angle of attack, with green being normal flight through to the red showing a high angle of attack near the stall. The other was an audio voice warning, "ANGLE, ANGLE, PUSH", which was triggered when the 'angle advisory' C_{pw} was reached.

Accident site

The accident site was just over 1 km east of Lymington town, in a large open field amongst other fields and wooded areas. Immediately to the north of the field, across a small road, was a private grass airstrip, originally part of a wartime airfield. The airstrip was orientated north-south and was equipped with a small hangar and a windsock (Figure 1).

Evidence from the accident site indicated that the aircraft struck the ground with some left roll, yawed about 20° to the left and at a significant nose-down attitude. The aircraft's heading was about 005°M and the initial ground marks indicated a very high rate of vertical descent but with a small amount of horizontal speed; the aircraft travelled only 12 m before finally coming to rest. Following the initial contact with the ground, the aircraft bounced and yawed further to the left with the right wing pointing in the direction of travel. The nose leg then dug into the ground, causing the right wing to hit the ground. The main fuselage pitched over toward the right wing, detached from the left wing and the engine rolled over until it was inverted. During this sequence the fuel tank ruptured and spilt fuel across the field. Later wilting of the vegetation revealed that a large quantity of fuel was being carried but there was no fire. The aircraft finally came to rest on a heading of 319° M.

The propeller remained attached to the engine reduction gearbox. However, one of the three blades exhibited no signs of any damage; of the other two, only one blade was extensively damaged as this had entered the ground as the engine had inverted. The remaining blade had a large nick on its tip but otherwise was relatively undamaged. The propeller damage was consistent with an engine producing little or no power at the point of initial contact with the ground.

Detailed wreckage examination

The aircraft was taken to the AAIB at Farnborough for further investigation.

Engine and propeller

The engine was examined in detail with the assistance of the UK representatives for the engine manufacturer. A strip examination of the engine and carburettors did not reveal any pre-existing defects and their condition was consistent with an engine of its age running with Avgas 100LL as the main fuel. Because the engine had rolled inverted, any fuel in the carburettor float bowls had already dissipated; there were, however, no signs of debris in them. Due to the disruption to the engine and cockpit, it was not possible to establish the position of the throttle or the choke position at the time of the accident. This was also true of the carburettor heat control. A test of a sample of the coolant showed it to be a mixture of 42% water to 58% ethylene glycol.

The propeller examination did not reveal any pre-existing defects. During the accident the forces on the damaged propeller blade had caused the swash plate within the variable pitch mechanism to be forced onto the mechanical stop for coarse pitch; this was beyond the electrical stop microswitch. Witness marks on the shank of the damaged propeller blade revealed that the propeller blade pitch was set at its mid-range of about 24° at the time the propeller blade had made contact with the ground. The magneto ignition switch was found in the ON position and selected to BOTH. Later testing of the magnetos showed them to be satisfactory and the battery master switch was also found ON.

Flying controls

The rudder and flaperon controls were established to have been without fault and continuous prior to the accident. Measurements of the flap screwjack carriage, when compared to those on a similar MCR-01, indicated that the flaps had been set to a position of about 5° flap down. However, after allowing for minor differences in construction and set up between the two aircraft, the measurements indicated that the flaps had been positioned within the range between fully up and 5°.

The horizontal stabiliser control system was also determined to be continuous prior to the accident. During the examination of the system it was established that the aft-most pushrod, between the aft bell crank and the stabiliser, had been constructed from two pieces with an aluminium insert connecting the two halves. The upper half of the rod was found detached from the insert in a manner consistent with the probable forces on the rod as the aircraft struck the ground. The build manual for the aircraft indicates that the aft-most push rod should be constructed from a single carbon fibre tube.

Another anomaly was rub marks on the forward-most push rod consistent with contact with a cut-out in frame 7, just behind the seats. It was established that the cut-out was not to the dimensions stated in the build manual and that, when the rod was at its highest position, it rubbed against the right upper quadrant of the cut-out. The rubbing on the rod only occurred over a short distance and was in the mid-range of the horizontal stabiliser movement. As this error in construction had been in existence since the original manufacture of the aircraft and the friction forces it would have induced would have been negligible, it is unlikely that the pilot was aware of the rubbing.

The stabiliser trim system was also tested and found to be satisfactory. The elastic bands which attach between the trim carriage and the stabiliser push rod were still attached and consisted of the required five doubled-up bands at the upper and lower rod trim attachment points. The trim position was compared with a similarly constructed MCR-01 and was found to be about 9° stabiliser trailing edge down (aircraft nose down) compared to a full nose

down position of 10° stabiliser trailing edge down. Differences in construction between the two aircraft could account for some error in the comparison. There was no evidence of any work having recently taken place on the anti-balance trim tab; however, there were signs of wear between the trailing edge of the stabiliser and the top of the leading edge of the trim tab, with little clearance between the two.

The AOA indication system was recovered from the aircraft, but damage sustained as a result of the accident forces precluded determination of its serviceability prior to the accident. An account from a friend of the pilot who had flown with him in G-TBEE, five or six weeks before the accident, indicated that the AOA system was not providing the appropriate alerts.

Fuel system

The fuel system was closely examined. Due to the accident, the fuel feed and return lines had become detached from the fuel tank. However, it was possible to establish that all the fuel lines, unions and fuel cock were free of any pre-existing defects. The fuel lines were checked for blockages and found to be clear. The coarse fuel filter and the fine fuel filter in the electric fuel pump were both clean. A test of the mechanical engine driven fuel pump was carried out and it was found to have a flow rate greater than that required by the engine.

Due to the rupture of the fuel tank and the engine being inverted, the only fuel from the aircraft that was available for a fuel sample was about 5 ml taken from the bottom of the electric fuel pump. This was analysed and found to be similar to Avgas 100LL, but the sample also contained Butylated Hydroxytoluene, a substance found in mineral oil. It was not possible to determine where this contamination may have come from, or what effect it would have had on the engine operation. A sample of fuel from the fuel bowser used to refuel G-TBEE on the morning of the accident was free of any contamination and conformed to the specification for Avgas 100LL.

Aircraft history

The aircraft was built, by the pilot, in 2000 and had completed approximately 300 flying hours. The last annual inspection, required for the renewal of the aircraft's Permit to Fly, had been completed in April 2005 at 286 flying hours. In September 2004, the aircraft suffered an engine failure in flight, resulting in a forced landing in a field. The examination of the engine, following this event, revealed contaminated spark plugs and severe corrosion in the carburettor float chamber. Extensive work was carried out on the engine, fuel system and the propeller which resulted in the aircraft not flying again until 12 January 2005. In April 2005, to resolve problems with engine starting, some components including the spark plug leads were replaced.

In May 2004, following problems with the electrical earth of the engine indication system, the AOA indication and warning system control unit was replaced. There was no record that a calibration flight had taken place following the installation of the new unit.

As part of the process for the initial issue of a Permit to Fly, G-TBEE was subjected to a flight test which was satisfactory in all respects. The flight test included exploration of the aircraft's stalling characteristics. It was determined that natural pre-stall buffet occurred at 69 kt with the wing flaps retracted and engine at idle power, and the stall itself occurred at 65 kt. The aircraft exhibited a wings-level, gentle nose-down pitch at the point of the stall.

Medical and pathological information

Post mortem examinations were carried out on the pilot and passenger. Toxicological analysis revealed no evidence of carbon monoxide inhalation and excluded the effects of alcohol intoxication or drugs as contributory factors in the accident. Both occupants had sustained severe multiple injuries, any of which could have been sufficient to cause death. Bruising on the body of the pilot was consistent with him wearing his four-point harness at the moment of impact.

The pilot was found to have been suffering from a liver condition in which excess fat accumulates within the liver cells. Medical opinion is that, particularly when combined with chemical imbalances in the body, this condition can be associated with collapse and sudden death, which is attributed to cardiac arrhythmia. Enquiries were made with the pilot's general practitioner into his medical history, but there was no record of the pilot having complained of any symptoms that may have been associated with the condition.

Meteorological information

An aftercast was obtained from the Met Office which described the weather conditions at the time of the accident. An area of high pressure was lying to the south-west of the British Isles feeding a fine, dry, northerly flow over southern England. There was scattered cumulus cloud in the area with a base of 3,500 ft to 4,000 ft, and very good visibility. The surface wind was from the north at about 12 kt. The surface temperature was 14ºC; the temperature and humidity at 1,000 ft and 2,000 ft, when plotted on the accepted chart to predict the likelihood of carburettor icing, indicated that there was a serious risk of such icing at all power settings.

Survival aspects

Harnesses

The accident was not survivable. The injuries to the two occupants indicated a high energy impact with very high peak deceleration. The pilot and passenger had both been wearing four-point harnesses and despite the high forces involved, the harness attachment points had remained intact. However, the pilot's harness became detached at the right lap strap adjustment buckle, with the harness pulling through the buckle. Similarly, the passenger's harness had also detached from the right lap strap adjustment buckle. In addition, the stitching between the shoulder straps and the piece of harness which attaches to the upper structural attachment point had totally failed on the passenger's harness and was stretched on the pilot's harness. The forces of the crash were outside the limits of human tolerance and, had the harnesses remained intact, this would not have altered the fatal outcome.

Search and Rescue

This accident was unusual in that the aircraft crashed in fine weather at a weekend, in a relatively well-populated area and, despite the pilot's recent contact with ATC, it was not realised that the aircraft had crashed until it was discovered by chance nearly an hour later. Although the two occupants suffered immediately fatal injuries in the accident, had they been less seriously injured their chances of survival may have been seriously prejudiced by the delay in attending to them.

The pilot had told friends of his intention to fly to Dunkeswell but he had not contacted the airfield itself, so his aircraft was not expected there. During the flight, the pilot was not required to contact Solent Radar provided he remained below 2,000 ft, which was the base of controlled airspace in the area. However, he requested

and received a Flight Information Service (FIS) from Solent Radar. As the pilot was only receiving a FIS, which is a non-radar service, there was no requirement for the Solent Radar controller to formally identify the aircraft. For handover to Bournemouth, the arrangement was for the controller's assistant at Bournemouth to be passed the basic details of the aircraft, so that the controller there would at least have some information about the aircraft and its route when the pilot made initial contact. On this occasion it was actually the controller at Bournemouth who took the details of G-TBEE by telephone from Solent Radar.

Although the controller had been notified of G-TBEE's presence and intentions, there was no requirement for the pilot of G-TBEE to contact Bournemouth. However, other than deliberate failure to do so would have been poor practice. Nevertheless, the controller at Bournemouth stated that it was not unknown for pilots in similar circumstances to fail to make contact. It was only some time later that she realised that the pilot had not in fact done so and she became concerned. The controller contacted Dunkeswell at 1255 hrs and established that the aircraft had not landed there. The controller then contacted Solent Radar to say that the aircraft had not called, and learnt that the pilot had been transferred to Bournemouth at 1157 hrs. The Bournemouth controller instructed her assistant to contact other airfields in the area to see if the aircraft had landed at any of them. When this proved not to be the case, the assistant phoned the Distress and Diversion (D&D) centre at West Drayton at 1330 hrs. At 1339 hrs D&D called back to report that an incident had occurred in the New Forest, and then confirmed shortly afterwards that G-TBEE had been involved in an accident.

Analysis

General

The accident occurred to an experienced private pilot, in fine weather, over flat terrain. Within a minute of the pilot's last transmission to ATC, the aircraft deviated from the flight path which the pilot had stated he intended to follow and was seen by witnesses to be flying low and perhaps erratically in the accident area. The final descent as described by witnesses, and supported by evidence at the accident site, indicated that the aircraft suffered an aerodynamic stall after an exaggerated pitch up manoeuvre, leading to a departure from controlled flight. It is probable that whatever event prompted the route deviation and initial descent was also a causal factor in the accident itself. This analysis therefore concentrates primarily on the likely reasons for the apparently unplanned deviation from the stated intended flight path.

The route deviation

It is possible that the pilot deviated from his route intentionally, to practise a forced landing pattern, or simply to have a closer look at a ground feature. However, the pilot's normal practice when flying from one airfield to another was to do so expeditiously and he would rarely combine such flights with training exercises. Additionally, there was little of interest in the immediate accident area and neither occupant had any connection with the locality. There was also no record of G-TBEE ever having visited the private airstrip nearby. Indeed, the presence of the airstrip and the proximity of the town of Lymington would have acted to discourage unnecessary low flying in the area. The pilot had notified Solent Radar of his routeing, which was consistent with his known intentions of a transit flight to Dunkeswell. Although he was not required to, the pilot gave no indication to ATC that he might deviate from his

route, and acknowledged the last instruction from Solent Radar to change to the Bournemouth Radar frequency without further comment. It is therefore very unlikely that the pilot had planned to depart from his route at the point he did.

If the route deviation was unplanned, it must have been brought about by an event which appeared to threaten the safety of the aircraft to the extent that an immediate landing was considered necessary, and the handling of which made a radio call to ATC a lower priority. Such events may include a significant engine malfunction, a serious control problem which prevented the pilot from maintaining cruise conditions, an in-flight fire and a medical incapacitation. The investigation considered the likelihood of each of these events being responsible for the aircraft's deviation from its route.

Engine malfunction

Examination of the engine ruled out a catastrophic failure but concluded that a partial power loss or a rough running engine remained a possibility, whether caused by carburettor icing, vapour lock in the carburettors or contamination of the fuel system. Had the pilot been experiencing engine problems for some time, and had he anticipated a precautionary or forced landing, then he might have tried to increase altitude initially (the aircraft was at 1,300 ft, some 700 ft below controlled airspace) and inform ATC of the problem, though neither of these occurred. If engine problems were encountered then the onset must have been sudden and severe enough to warrant an immediate landing. However, the engine magneto switch and master electrical switch were found in their normal 'flight' positions; if a forced landing without power were being attempted, these switches would normally have been selected off.

Carburettor icing

From the weather conditions on the day of the accident and using the generally accepted carburettor icing prediction chart, the aircraft was operating in a region which would give serious carburettor icing at any power.

G-TBEE had been equipped with a carburettor heat system; this is an optional fit as the aircraft kits are normally provided without such a system. Discussing the issue of carburettor icing with the manufacturer revealed that they had previously undertaken measurements of the air temperature within the carburettors of the MCR-01, during normal operation, and found these to be some 15 to 20°C higher than the ambient air temperature. With this increased air inlet temperature the likelihood of carburettor icing moves to the area of 'light icing at any power', and the addition of a carburettor heat system, when used, further reduces the chances of such icing.

Vapour lock

Another consideration was the possibility of vapour lock within the twin carburettors; this was because of the close routing of the exhaust to the tops of the carburettors. Discussions with the manufacturer revealed that vapour lock does sometimes occur, but is limited to ground operations and is usually experienced when attempting an engine start shortly after the engine has already been run and shut down which allows a heat soak of the engine due to the lack of a cooling air flow or a full flow of cool fuel. It is also of note that the vapour lock is more prevalent on aircraft operating with Mogas; G-TBEE was operated with the less volatile Avgas 100LL. Had vapour lock been evident this would have exhibited symptoms a lot earlier in the flight. Therefore, vapour lock was considered extremely unlikely.

Fuel contamination

Butylated Hydroxytoluene was found in the very small fuel sample taken from the aircraft's electric fuel pump. However, due to the size of the sample it was not possible to establish if the fuel was indeed contaminated or whether the contamination occurred during the accident sequence. It is known that the fuel that was used to refuel G-TBEE on the morning of the accident was clean, so any contamination would have had to have been present some time prior to the accident flight. The examination of the engine did not show any signs of contaminated fuel and the fuel tank, although completely destroyed and split open, also appeared clean.

Flying control malfunction

An extensive examination of the flight control systems identified no technical defect of the pitch control, pitch trim or flap systems that could have accounted for the pitching motion described by witnesses in the accident area or by the aircraft which left Shoreham at about the same time as G-TBEE. The trim and flap switches for this type are located on each control column top and, although it was known that they could be operated inadvertently, it is very unlikely that such inadvertent operation could have produced the described manoeuvres.

Had the pilot experienced a severe and un-commanded pitch excursion shortly after takeoff, it is probable that he would have returned to Shoreham as a precaution. In the event, he continued the flight and, from GPS data, the cruise appears to have been at normal cruise speed and at a steady altitude. Had there been a control problem in pitch which manifested itself again shortly before the accident, the pilot's most probable course of action would have been to maintain a safe altitude, if possible, while assessing the problem, and quite possibly notifying ATC.

The aircraft was positively identified flying low in slow, mainly straight flight in the region of the last recorded GPS position. If a malfunction of the flying control system had occurred then it was either intermittent in nature, or was not sufficiently serious to cause a loss of control from cruise flight. It is therefore improbable that a flying control malfunction could have been responsible for the pilot's decision to depart from his route and descend to low level in the accident area.

In-flight fire

There were no signs of a pre-impact fire either within the engine compartment or the cockpit area, and so an event of this nature could not have contributed to the accident.

Medical incapacitation

The pilot's extensive microlight background would have given him a great deal of experience of flying into unprepared sites. Combined with his considerable number of hours on type and the good weather and favourable wind of the day, this would make it improbable that he would have had significant difficulty making a successful landing in the area in the event of an engine malfunction, which is considered the most likely of technical scenarios. The investigation therefore considered the possibility of a medical incapacitation of some nature. It is unlikely that it was the passenger who would have been affected, since in this case the pilot would have tried to land at a place where medical help was available and, as two airports were close by, he would most probably have diverted to one of them.

The passenger's limited flying training had been carried out in Cessna 152 aircraft, a popular training type with appropriate handling qualities. In contrast, G-TBEE was a high performance aircraft, not suited to a novice pilot. Nevertheless, it is probable that the passenger would have

been able to maintain the aircraft in straight and level flight if the pilot had suffered a complete incapacitation, though the undoubted stress of such a situation would make this uncertain. As the radio had been in recent use and she had obviously heard the exchanges with Solent Radar, there is the possibility that she would have attempted a radio call on either the Solent or Bournemouth frequency, but this did not happen. Given the passenger's very limited flying training, it would seem doubtful that she would immediately commit to a landing, although her familiarity with the aircraft as a passenger, combined with her training and the urgency of such a situation may have encouraged her to make an attempt.

It is possible that the pilot, recognising a developing situation and being aware of his passenger's dependence on his skills, initiated a landing attempt. The initial departure from the route appears to have been controlled and was towards a suitable area, suggesting that the pilot was either in control at this point or was able to influence the flight path. If this were the case, his condition must have further deteriorated, to the extent that his judgement and handling of the aircraft suffered, or the passenger had no option but to assume control. The eye witness account that the aircraft appeared to be rocking its wings when it was seen to the north of the accident site may indicate that the passenger was indeed in control of the aircraft, which was known to be sensitive in roll. Additionally, the pitch trim setting, at nearly full applied 'nose down' is not one which an experienced pilot would be expected to get to, given the known flight conditions.

The short-term effects of inhaling fuel fumes or exhaust gasses may have affected the pilot's ability to control the aircraft. However, although some fuel lines and components were located within the cockpit area, these were found to be free of pre-existing faults, and toxicological tests on the two occupants did not show that they had been exposed to carbon monoxide. The possibility that noxious fumes may have contributed to the accident is therefore considered unlikely. The post mortem examination raised the possibility that the liver condition from which the pilot was suffering could, in certain circumstances, be associated with incapacitation or sudden death. However, cases of this association being made as a cause of death are relatively few, and are generally restricted to those instances when no other potential cause of death is detected.

Final flight path

Analysis of the GPS data provided information regarding the final stages of the flight. The average ground speed between points A and B (Figure 1) is 105 kt, and a direct time/distance calculation between the points provides a groundspeed of 105.6 kt. Therefore it is probable that the aircraft flew a fairly direct line between A and B, and in this case point A is the point at which the aircraft deviated from its initial track.

Based on the available evidence, the most likely flight path between points B and C was in the form of an 'S' turn, whilst descending. The maximum time from point C to the point of impact is 30 seconds, since this is the time interval of the GPS recordings. The minimum time, based on a groundspeed of 80 kt and the most direct feasible flight path to the accident site is about13 seconds. Information from a witness that the aircraft appeared to cross the extreme south-eastern edge of the golf course in a left turn whilst descending only gradually suggests that the aircraft flew the longer of the two options. This would also mean that at least some power was being produced by the engine and this is supported by the cockpit switch positions. As the aircraft turned through a south or south-easterly heading, it appears to have entered the final manoeuvre which resulted in the accident.

A general view of the accident area from about point A is at Figure 2. The accident site can be seen to be in the largest field in the area and would have been an obvious choice for a landing, even before the aircraft reached point A. With the northerly wind, the pilot would have been well positioned to land in the field without extended manoeuvring. At this point, it is doubtful whether the airstrip to the north would have been obvious and, in any case, it would not necessarily have presented a better option than the large field.

As the field in which the aircraft crashed appears to be the largest and most suitable in the area, it may be expected that, if an immediate landing was desired, then by point B the aircraft would be lower and manoeuvring for a landing in a northerly direction, which does not appear to be the case. A view of the accident area from about 1,200 ft at point B is at Figure 3, which shows that, as well as the field itself, the airstrip and field to the north would have been available.

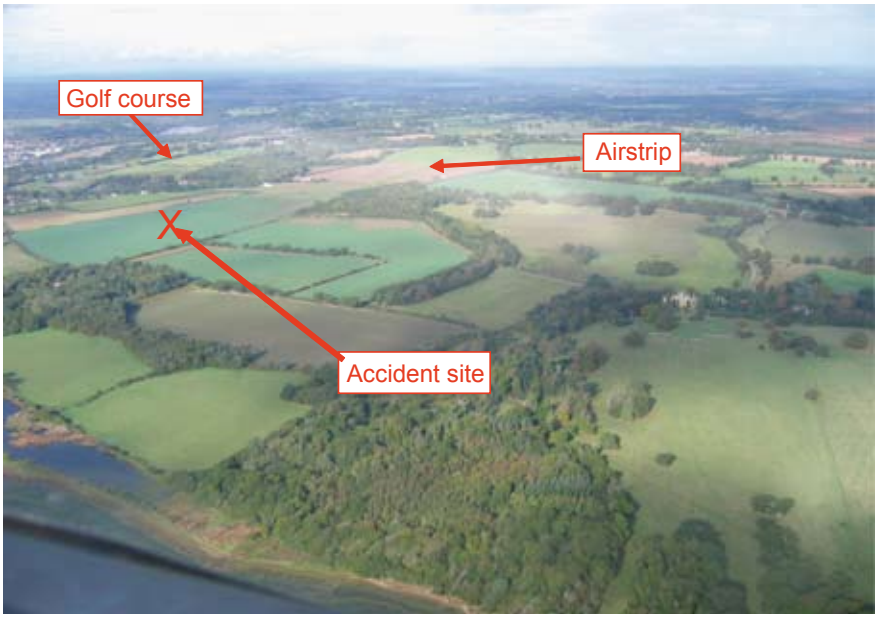

Figure 2 (left)

Accident area as seen from point 'A' of Figure 1 (page 96)

Figure 3

Accident area as seen from point 'B' of Figure 1 (page 96)

Eye witness accounts

Information from some witnesses indicated that G-TBEE had been in the area for several minutes before the actual accident, although this was not supported by the GPS data. The possibility that electrical power to the GPS failed, or that the aircraft electrical supply was deliberately isolated after the aircraft had arrived at low level in the accident area was considered but was not supported by the available technical evidence, including cockpit switch selections, and therefore thought improbable. Witness information from the ferry hand, which could be positively tied to the recorded docking time of the ferry, indicated that another aircraft had been in the area very shortly before G-TBEE. No witness reported seeing two aircraft together before the accident so, although it is unlikely that the presence of another aircraft in the area contributed to the accident in any way, it may have influenced the recall of some witnesses.

Conclusions

The aircraft may have suffered a partial loss of engine power, but this alone would not account for the accident. Furthermore, the nature of the terrain, the weather conditions and the pilot's experience would all suggest a more successful outcome to any forced or precautionary landing attempt. Alternatively, the pilot may have suffered from a medical incapacitation which either seriously degraded his ability to fly the aircraft to the extent that he lost control, or which forced his passenger to take control of the aircraft. The final aircraft manoeuvre is consistent with an aerodynamic stall and departure from controlled flight, resulting in an abrupt loss of lift at a height from which recovery was not possible.