ACCIDENT

Aircraft Type and Registration:	Cessna F150L, G-HFCI
No & Type of Engines:	1 Continental Motors Corp O-200-A piston engine
Year of Manufacture:	1972
Date & Time (UTC):	8 July 2007 at 1500 hrs
Location:	Clutton Hill Farm Strip, Bristol
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:	34 Years
Commander's Flying Experience:	79 hours (of which 60 were on type) Last 90 days - 7 hours Last 28 days - 0 hours
Information Source:	AAIB Field Investigation

Synopsis

The aircraft took off and was seen to climb away at an unusually steep attitude to a height of approximately 200 ft. Witnesses reported that the engine appeared to stop and the aircraft rolled rapidly to the left and entered a vertical descent. The aircraft struck the ground and there was an extensive post-impact fire. Both occupants were fatally injured.

History of the flight

The pilot and his passenger travelled to the airfield by car early in the afternoon of 8 July 2007. Shortly after 1410 hrs the pilot was seen to be standing on top of the fuselage of his aircraft passing a white plastic drum down to the passenger. At approximately 1445 hrs the pilot spoke to the pilot of another aircraft that had just landed, and they discussed the weather conditions. A short while later G-HFCI's engine was started and the aircraft taxied to Runway 25. Eyewitnesses reported that the takeoff appeared normal and that the aircraft became airborne approximately 150 ft before the end of the runway. The aircraft climbed away steadily, but at a higher pitch attitude and with a lower airspeed than normal.

At 1500 hrs the pilot made radio contact with Bristol radar. After his initial call the pilot stated "WE'RE A CESSNA ONE FIFTY JUST LEFT FROM CLUTTON GONNA CROSS OVER BATH TOWA--!" The transmission, which lasted 14 seconds, ended abruptly at this point.

Eyewitnesses reported that when the aircraft was at a height of approximately 200 ft, some 350 m after crossing the end of the runway, the engine appeared to stop. The aircraft rolled to the left and entered a vertical descent. It struck the ground and there was an extensive post-impact fire.

Eyewitness testimony

Several eyewitnesses saw portions of the accident flight. Two eyewitnesses on the airfield described the start and taxi out as normal, although neither witness could be positive as to whether or not the pilot conducted the engine power checks prior to takeoff. A local pilot described the takeoff run as normal, with the aircraft becoming airborne in about the usual place. Several witnesses, both on the airfield and in the surrounding area, reported that after becoming airborne the aircraft adopted an unusually high nose-up attitude, with a lower airspeed than normal.

Witness assessments suggest that the aircraft reached a peak height of approximately 200 ft. They then described the engine going silent and the aircraft's left wing dropping rapidly, although there was no consensus on the sequence of these two events and it is possible that the wing dropped before the engine noise stopped. The aircraft then descended almost vertically and went out of sight, behind either trees or buildings, depending on the witness's position. No witness saw the ground impact. One witness, positioned almost directly below the flight path, described the engine noise as struggling then total silence followed five seconds later by a pop, "like a shotgun being fired".

Pilot information

The pilot conducted his flying training in Florida and gained his Private Pilot's Licence (PPL) during 2002. On his return to the UK he flew for 90 minutes in 2003 and then did not fly again until June 2006 when he completed a PPL proficiency check. In November 2006 he completed a check flight on a PA-28 aircraft at a flight training organisation near Bristol. He then flew two solo flights; one in November 2006 and one in January 2007. During the second of these flights he experienced navigation and airmanship difficulties, which resulted in the flight training organisation revoking his privileges to fly their aircraft solo.

In February 2007 the pilot purchased G-HFCI and flew approximately 20 hours in it before his PPL lapsed in May 2007. His revalidated PPL was issued on the 4 July 2007 and this was issued on the basis of the check flight in 2006. The flight on 8 July was his first since 20 May. During the 20 hours flown in G-HFCI between February and the end of May the pilot had been reported to the CAA's Aviation Regulation Enforcement branch because a number of ATC units were concerned about his navigation, radio communications and airmanship.

The pilot held a valid JAA Class 2 medical certificate issued on the 28 April 2007.

Airfield information

Clutton Hill farm strip is located 7.5 nm east-south-east of Bristol Airport. It is situated on a hilltop 600 ft amsl, and the grass runway is orientated 07/25. Runway 25 is approximately 1,936 ft long and 88 ft wide and has an upslope, most particularly in the final third of the runway. At a point approximately 150 ft before the end of the runway there is a small ridge which local pilots suggest acts as a ramp, effectively projecting aircraft into the air. The ground drops away from the departure end of Runway 25 and to the west the terrain forms a wide valley. The accident site was 50 ft below the level of the runway.

The airfield is situated underneath the Bristol Control Area (CTA), which commences at 1,500 ft amsl. It is normal practice when departing this farm strip to attempt to call Bristol Radar while still on the ground in order to obtain clearance into the Bristol CTA. There is, however, no requirement to do so, and when pilots are unable to contact Bristol prior to departure they call them shortly after becoming airborne.

Takeoff performance

The pilot's operating handbook for G-HFCI provided figures to enable the takeoff performance to be calculated. To take off from this farm strip, at the maximum permitted weight of 1,600 lbs, and allowing for the ambient conditions, the aircraft required a ground roll of 832 ft and the total distance to attain a height of 50 ft was 1,482 ft.

The CAA issued Change Sheet number 1, dated February 1993 [issue 1], to the Cessna 150 G-HFCI 1972 Owners Manual 'Performance' and this was attached to the Manual. It states: '*Increase the take-off distances by 15%*'. Based on this adjustment G-HFCI required a ground roll of 956 ft and a total distance to a height of 50 ft of 1,704 ft.

In General Aviation Safety Sense leaflet 7, entitled '*Aeroplane Performance*' the CAA suggests factoring performance data by 20% when taking off from grass runways, and then adding an overall safety factor of 33%. The use of these factors results in a calculated ground roll of 1,526 ft.

The aircraft manufacturer specifies a speed for the best rate of climb (76 mph for G-HFCI). This is higher than the best glide speed of 70 mph and considerably higher than the flaps up stall speed of 55 mph. This means that should the engine stop during the climb the pilot has sufficient time to lower the nose before the aircraft approaches an aerodynamic stall.

Meteorology

The Met Office provided an aftercast covering the period of the flight. The estimated surface wind at Clutton Hill, at the time of the accident, was from 230º at 9 kt, the surface temperature was 16ºC, the dew point was 9ºC and the relative humidity was 63%. The visibility was 25 to 40 km outside of rain showers, which were scattered throughout the region.

The latest forecast the pilot could reasonably be expected to have received for Bristol Lulsgate (the closest airport) was issued at 1200 hrs on the day of the accident, and was valid from 1300 hrs to 2200 hrs. It forecast a surface wind from 260º at 12 kt, visibility greater than 10 km and scattered cloud at 2,000 ft, with a temporary reduction to 7,000 m visibility in rain showers. It also included a 30% probability of a reduction to 4,000 m visibility in heavy showers of rain with broken cumulonimbus cloud at 2,000 ft.

Eyewitnesses located near the accident site confirmed that at the time of the accident there was no rain in the immediate area.

Post-mortem examination and toxicology

A post-mortem examination conducted by a specialist aviation pathologist confirmed that both occupants died of multiple injuries sustained on impact. With regards to the pilot, there was no evidence of natural disease which could have caused or contributed to the accident. It was of note he exhibited no injuries to suggest that his harness had been used at the time of the accident.

There was no evidence of drugs or alcohol in the passenger's blood or urine. The pilot had no evidence

of alcohol in his blood, but toxicology revealed the presence of methylenedioxymethylamphetamime (MDMA, or 'Ecstasy') in the blood, at a concentration of 0.28 milligrams per litre. No other drugs were present. The level of MDMA measured in the pilot's blood was slightly above that usually seen following a typical recreational dose. The results suggest, therefore, that the drug is likely to have been taken within a few hours of the flight, rather than being present as a residue of a dose taken the night before.

The accident site

The aircraft crashed into the corner of a field some 370 m beyond the upwind end of the runway, slightly to the left of the extended centre line. The point of impact was about 50 ft below the runway level. Beyond it, along-track, the ground sloped steeply away towards floor of a wide valley some 500 m away, and about 50 m below it.

At the time of impact, the aircraft was pitched approximately 30° below the horizon, slightly banked to the right and sideslipping to the right, and was falling with a very high rate of descent, with negligible forward velocity and no discernible yaw rate, consistent with it having been in a fully developed stall. Upon impact, the fuel tanks in each wing ruptured and a severe post-impact fire developed, which consumed the whole of the upper section of the cabin and centre fuselage, and the inboard regions of both wings.

Wreckage examination at the site

Examination of the aircraft at the site showed that it was structurally intact and complete when it struck the ground, and all control surfaces and their respective control cables and cranks were intact and connected. The wing flaps were fully retracted and the elevator trim was set to a neutral position.

The leading edges of the propeller were undamaged, and neither blade exhibited any evidence to suggest that the engine was under significant power at impact; rather, a pattern of parallel score markings evident across the faces of the lower blade, running at an angle to the chordwise axis, was consistent with the propeller having been stopped at the time it was plunged into the soil. The carburettor hot air flap was set to the COLD position, but it was not possible to determine reliably the impact settings of the throttle or mixture controls.

Both fuel tanks exhibited characteristic hydrodynamic deformation, indicating that each had contained a substantial quantity of liquid at the time of impact with the ground. Both tanks had split in the impact and, in the case of the left tank, the whole of its contents had been lost and the aft portion of the tank burned away by the post-impact fire. The right tank was less badly damaged by fire and contained a small quantity of trapped liquid residues, which was collected for later analysis. Subjectively, the residues exhibited the characteristic aroma and pale blue colouration of AVGAS. Separated water was also evident in the residue, but the whole of the wreckage had been covered by fire-fighting foam and water from this had undoubtedly penetrated the tank through impact ruptures in the tank wall. Both fuel filler caps were locked, but their seals were damaged by heat and their effectiveness prior to the accident could not be determined.

Detailed examination of the wreckage

The wreckage was recovered to the AAIB at Farnborough where it was the subject of more detailed examination. This yielded no further technical evidence regarding the airframe or flying controls, but evidence was found which showed that one of the seat harnesses was not being worn at the time of impact. Specifically, the 'housing' and 'tongue' portions of one of the harness buckles were

found widely separately from one another – the buckle portion incorporated in fire debris between the two front seats, and the tongue portion incorporated in debris just forward of the right seat squab. Because none of the associated harness webbing survived the fire, it was not possible to ascertain from the wreckage-evidence whether the disconnected buckle was that from the pilot's or the passenger's harness. (The remains of a buckle, with both halves connected normally, were recovered during post-mortem examination of the passenger, suggesting that it was the pilot's harness that was not being worn at the time of the accident.) Both seats were still attached their respective floor rails, and the fore/aft position-adjustment lock-pins of each of the seats were engaged at positions well forward of the rearmost seat position, suggesting that the pilot's seat had not jumped its locking mechanism and slid rearwards at any point during the takeoff or climbout.

The engine was removed and taken to an approved overhaul agency, where it was subject to bulk disassembly and examination, and key components were stripped, inspected, and, where appropriate, rig tested, under AAIB supervision. The engine was severely damaged both by the impact and the post-impact fire, but no evidence of any mechanical failure or defect was found. Except for some post-impact contamination with oil, the appearance of all spark plugs was within the normally expected range in terms of colouration and sooting. It was not possible to determine the pre-impact integrity of the induction system because of impact and fire damage, but the burnt remains of all the rubber connectors and associated hardware were present in their correct locations. The oil filter contained no significant debris, and the condition of the camshaft and all pistons, rings, cylinder bores, valves and associated hardware appeared normal for an in-service engine.

Both magnetos had suffered significant heat damage, including partial melting of casing plugs and other plastic components. The mechanical timing of the left magneto was checked in situ and found to be correct; the right magneto could not be checked in situ. Each was removed for more detailed bench-inspection and functional checks. Both were equipped with impulse drives, each of which was intact and functioned normally. Removal of the fire-damaged covers revealed evidence of significant heat damage internally, caused by the post-impact fire, which had partially melted and fused capacitor casings and some of the low tension wiring insulation. After replacement of the fire-damaged covers and HT leads with serviceable equivalents, the magnetos were installed in a standard test rig and functionally checked throughout their full operating range, from impulse-start through to maximum speed. Both functioned flawlessly throughout.

The carburettor was disassembled and visually examined. The fuel strainer at the inlet to the float chamber was clean and the fuel inlet passage unobstructed. The float was serviceable, the float chamber inlet valve opened and closed correctly with no perceptible leakage, and the main jet was clear of obstruction.

Search of the airfield

A number of items associated with G-HFCI were found at the airfield where the aircraft had been parked. These included two 5 gallon plastic containers, one containing what appeared to be residues of AVGAS and the other containing a small quantity of a greyish liquid, which neither looked nor smelled like gasoline. Both these containers were retrieved by the AAIB for further study, together with a third container of similar type, filled almost to the top with a clear liquid of unidentified origin, that had been taken from the same region of the airfield by the emergency services for safe keeping,

prior to AAIB arrival. The other items comprised two improvised funnels, one large and the other medium sized, fashioned from cut-back plastic mineral water containers; a stilson pipe wrench, of new and unused appearance; and a fabric tie-on protective cover for the canopy and forward fuselage.

A search of the surroundings and a nearby temporary hangar revealed other equipment and materials which suggested that the owner of G-HFCI was planning a refurbishment of the fuselage transparencies and/or its paintwork and interior trim. No further containers were found similar to those at the tie-down location, or that were likely to have been used to transport or store fuel for the aircraft.

Analysis of fuel tank, and plastic container content and residues

Samples from each of the three plastic containers recovered from the airfield, together with the residue sample recovered from the right fuel tank, were submitted to the QinetiQ Fuels Laboratory for analysis and comment. The laboratory reported that each of the samples from the plastic containers consisted of a mixture of AVGAS and another organic material that could not be identified, but which contained much higher concentrations of toluene and higher-boiling point aliphatic hydrocarbons. The sample from the fuel tank was chemically consistent with the samples from the plastic containers, ie notwithstanding their very different appearances and aromas, the liquids in all three plastic containers were essentially the same, chemically, as the residue recovered from the right fuel tank. Lead was also found in all of the samples tested, consistent with the presence of AVGAS in each. It was not possible to determine the origin of these unknown liquids, but it is believed that they may have been solvents of some kind, possibly paint thinner.

Further testing

In light of the post-mortem toxicological finding of high levels of a recreational drug in the pilot's bloodstream, it was considered possible that the pilot may have mistakenly filled, or topped up, one or both fuel tanks with the unknown solvent like liquid(s) from the plastic drums found at the aircraft's tie-down point, notwithstanding their very different appearance and aroma compared with AVGAS. The practical implications, both for engine function and performance, of contamination of AVGAS with this liquid was therefore investigated in a program of tests using the facilities of a leading automotive engine research establishment. The engine used for the tests was a specialised single-cylinder research engine, installed in a test cell equipped with a dynamometer and instrumented to output real-time data for a range of parameters of relevance, including cylinder pressure. A special fuel supply was built into the rig enabling the fuel supply to the engine to be switched, with the engine running, between four separate tanks containing the following pre-mixed fuel/solvent concentrations:

a) 100% AVGAS;
b) 20% solvent/80% AVGAS
c) 50% solvent/50% AVGAS
d) 100% solvent.

Prior to the start of testing, the engine's compression ratio and ignition timing were set to values comparable to those of the aircraft's, and a series of initial runs carried out using 100% AVGAS with the engine operating at maximum power at 2,750 rpm, in order to prove the instrumentation and establish base-line data and test-rig settings. The testing was then carried out in a single extended run during which the engine was supplied for a period of 10 minutes from each tank in succession, in the order listed above, with no other change being made.

The engine was monitored throughout for any change in operating characteristics, both subjectively and via the instrumentation, and data records made five minutes after tank change-over, and again after 10 minutes. The exhaust plume was also monitored for any change in its visual characteristics.

In the event, no perceptible change was detected in the engine's performance at any stage during the tests, either subjectively or in the data: the engine performed identically, including power (torque and rpm) and cylinder pressure, whether fuelled by AVGAS or neat solvent. This result confirmed the similarity between the solvent and AVGAS found during the laboratory analysis of the samples, and rendered moot - in terms of accident causation - the issue of whether or not solvent had been added to the aircraft's fuel tanks.

Analysis

The weather conditions for the flight were good. The takeoff appeared normal and the aircraft became airborne at about its usual position and was seen to be climbing away, albeit in a nose-high attitude and at a slow speed. Eyewitness accounts suggest that the aircraft suffered a stall and wing drop shortly after take off, at a height that offered no possibility of recovery before ground impact.

Examination of the wreckage indicates that the damage was consistent with it having been in a fully developed stall at impact. Evidence from the propeller blades suggests that the engine was not under significant power at impact and that the propeller had stopped, but there was no technical evidence to explain why. The liquids from the plastic drums associated with the aircraft were analysed and subsequently tested in a research engine but they were, in all regards, similar to AVGAS and would have had no detrimental effect on the engine's performance.

In adopting a low speed, high nose-up attitude close to the ground the pilot placed the aircraft in a position where there was little margin for error when dealing with unforeseen events. A nose-high attitude reduces forward visibility and means that, in the event of an engine failure, the pilot has to lower the nose rapidly to prevent the aircraft decelerating to below its stalling speed. In this instance, it is conceivable that the pitch attitude was so high that the aircraft stalled even with the engine still operating.

The pilot had completed very little flying since 2002 and had not flown for 6 weeks prior to the accident. He completed a PPL revalidation with no significant problems in November 2006 but later experienced navigation and airmanship difficulties. This resulted in the flight training organisation revoking his privileges to fly their aircraft solo. The pilot was later reported to the Aviation Regulation Enforcement branch because of concerns about his navigation, radio communications and airmanship. His overall piloting abilities must therefore be considered to be variable, if not marginal, and this is considered to be a causal factor in this accident since a pilot should not lose control of an aircraft after takeoff, even if the engine does stop. In addition, the post-mortem examination revealed that the pilot's blood held quantities of MDMA, an illegal drug. This had probably been taken within a few hours of the flight, and may have impaired both his judgement and his ability to complete complex tasks, which would have further reduced his ability to operate the aircraft safely.