Gulfstream Aerospace AA-5B, N28397, 23 November 1996

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Aircraft Type and Registration:	Gulfstream Aerospace AA-5B, N28397
No & Type of Engines:	1 Lycoming O-360-A4K piston engine
Year of Manufacture:	1977
Date & Time (UTC):	23 November 1996 at 1204 hrs
Location:	Denham, Middlesex
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:	46 years
Commander's Flying Experience:	1,948 hours (of which 1,011 were on type)
	Last 90 days - 23 hours
	Last 28 days - 5 hours
Information Source:	AAIB Field Investigation

History of the Flight

On the day of the accident the pilot intended to practice circuitflying at Denham airfield having not flown this aircraft since14 September 1996. The weather was ideal for his planned flightwith clear skies and excellent visibility, the temperature was+5_C, the dew point -1_C and the surface wind was 290_/10 to 15kt. Runway 24 was the runway in use; it has an asphalt surfaceand is 2,555 feet long. The pilot requested taxi clearance at1120 hrs and was cleared for take off at 1126 hrs. He thencompleted a number of circuits which included touch and go landings,full stop landings and at least one go-around. Throughout thisperiod the aircraft behaviour and all RTF transmissions were normal.

The pilot completed a full stop landing and requested clearanceto taxi, via the grass, to the holding point of Runway 24 fora further take off and circuit. On the subsequent take off, at1204 hrs, the

aircraft became airborne at the usual position,about half way along the runway. The acceleration and the initialclimb appeared to be normal. At an estimated height of 150 to200 feet the engine stuttered briefly and then stopped abruptly. The aircraft immediately commenced a turn to the left with arapidly increasing bank angle and at this stage there was a brief,indecipherable radio call from the pilot. With the bank anglenow approaching 90_ the nose of the aircraft snapped down sharplyand the aircraft entered a vertical descent and impacted the groundon the adjacent golf course about 100 metres from the end of therunway.

The fire crew on duty had witnessed the take off and subsequentcrash and were already on their way to the fire truck when thecrash alarm was sounded. On arrival at the crash site, approximatelyone minute later, one of the fire crew determined that the pilothad been fatally injured whilst the other member of the fire crewdischarged a fire extinguisher over the port wing which was visiblyleaking fuel; there was no fire. A post mortem examination ofthe pilot did not reveal any condition which may have led to pilotincapacitation.

Pilot's background

The pilot had completed his PPL training in 1985 on an AA-5A andhad begun flying the AA-5B the same year. He was one of a syndicateof three pilots that had purchased N28397 in 1991. His flying,mainly out of Denham Airfield, had been accrued at a constantrate of about 180 hours per year and since 1992 this had beenshared between the AA-5B, a Cessna 172 and a Beech Baron.

The aircraft had last been flown on 26 October 1996 by anotherpilot from the same syndicate for a total flying time of one hourand 25 minutes. Prior to that flight it had been topped up with60 litres of AVGAS but the pilot, who had conducted his ownrefuelling, could not be certain about the fuel state either afterrefuelling or at the end of the flight; there are no records ofany subsequent fuel uplift.

Significant aircraft design features

The two fuel tanks in this type of aircraft are integral withthe wing structure. They are bounded by the light gauge wingskins which form the continuous top and bottom surfaces and leadingedges, together with closure ribs bonded to the skins at inboardand outboard ends of the tank stations and bonded vertical websat the rear. (Main wing bending is carried by large diametertubular spars which pass through the tanks and are positionedat approximately wing mid-chord). The tanks are positioned withtheir inboard closure ribs approximately 9 inches outboard ofthe wing roots. The outboard closure ribs are attached by a numberof fasteners to the inboard ribs of similarly constructed drybays immediately outboard of the tanks.

Two fuel pipes pass through each of the inboard closure ribs. Each pipe connects to a finger strainer inside the tank positionedto collect fuel from points close to the forward and rear of eachtank respectively. The two pipes from each tank supply fuel toone of two sumps positioned within fairings inboard of each tankbelow the plane of the tank bottom skin. Each sump contains adrain valve at its lowest point. Individual fuel pipes then routefrom the lowest points on the rear faces of these sumps to a commonselector valve positioned on the centre line of the aircraft andoperated by a rotary lever in clear view of the pilot.

The fuel selector has three positions, the corresponding leverpositions being annotated respectively BOTH OFF, LEFT TANK andRIGHT TANK. They are selected in the above sequence by rotatingthe selector lever clockwise. Two electrically operated fuelgauges are positioned side by

side above the selector in sucha way that the selector lever points at the contents gauge appropriateto the selected tank. A single fuel pipe then routes to the carburettorvia the electric pump and the engine driven pump.

Initial site examination

The impact site showed clear evidence that the aircraft had struckthe ground at a steep nose down angle whilst banked to the lefton a heading more than 180_ to the left of the runway centre lineand approximately 150 metres south of it. Initial impact hadoccurred on the nose and left wing. The ground impact impressionproduced by the propeller, together with the nature of the damageto its blades, showed that it was either stationary or revolvingvery slowly at the time. The force of the impact caused the forwardfuselage to telescope and break away from the engine bulkhead,allowing the majority of the fuselage, wings and tail to reboundand come to rest a short distance from the engine which remainedwith the bulkhead close to its initial impact point. The absenceof engine and bulkhead coupled with the largely undamaged stateof the main landing gear allowed the remainder of the aircraftto come to rest in a steep nose down attitude.

Examination of the flap actuator indicated that approximatelyone third of the total flap extension was set at the time of impact. The fuel selector was found in the BOTH OFF position.

Examination of the fuel tank areas approximately one and a halfhours after the accident revealed no evidence of fuel in eithertank. Considerable fire extinguishant powder was visible on andaround the left tank which was heavily disrupted by the impactof the leading edge with the ground. The right tank had sufferedno damage as a direct result of ground impact although some distortionwas present at the outboard end of its leading edge where theinboard rib of the dry bay was attached to the outboard tank closurerib. This tank rib was distorted by tension in the fastenersattaching it to the adjacent rib as a result of ground impactand damage to the leading edge of the dry bay. In the processof inflicting this damage fasteners had pulled out of the outboardclosure rib of the tank creating small punctures.

Subsequent detailed examination

The wreckage was taken to the AAIB facility at Farnborough. Atotal of 120 milli-litres of fuel were recovered from the drainpoint of the right sump with the remaining aircraft structuremounted horizontally on trestles. Very little fuel was recoveredfrom the left tank sump. At no time during the lifting and transportfrom the accident site was any fuel seen to escape from the aircraft.

The right tank was then filled with three gallons of keroseneand no leakage was noted. Only when the aircraft was tipped forwardto a nose down angle approaching that at which it came to restafter the impact was any kerosene observed to flow from the areasof the broken fasteners in the outboard closure rib of the tank.

It is known that constituents of aviation petroleum fuel willcause a staining of vegetation to become evident a few days afterbeing spilt on the latter. This characteristic has been usefulon many occasions in estimating approximate pre-impact fuel distributionin crashed aircraft tanks after they have been disrupted and thefuel lost. Some days after the accident the ground at the accidentsite was examined for such staining. Considerable staining wasobserved in the ground area identified as having been occupiedby the left tank immediately after the impact together with signsof a residue of the fire extinguishant used. Careful examinationof the area known to have been occupied by the right tank revealeda complete absence of any such staining.

An examination of the profile of the inboard leading edge areaof the right wing (*ie* the boundary of the fuel tank) andthe inboard tank boundary rib revealed no evidence of the 'hydraulicing'type bulging distortion normally evident in the forward partof a tank containing fuel when subjected to rapid deceleration.

Examination of the available elements of the fuel system revealedno evidence of pre-impact damage. The engine and carburettorwere subjected to strip examination. The magnetos were run ona test rig and the ignition harnesses and plugs were tested. No defects were found in any of these items other than those consistentwith impact effects.

Tests on a similar aircraft

Another AA5B aircraft was flown at identical weights and in similarweather conditions. Two full power take offs were timed frombrake release to an height of 150 feet and the mean time for thisevent was 40 seconds. Whilst on the ground the throttle was thenadvanced to full power and the fuel selector moved to the BOTHOFF position, the engine ran for 12 seconds before stopping abruptly.

The position, orientation and movement range of the fuel selectorwere examined. It was concluded that its characteristics madeit very unlikely for it to have moved from either of the selectedtank positions to the BOTH OFF position as a result of impactforces.

Summary

A loss of engine power undoubtedly occurred, although no mechanicalor electrical explanation for that loss has been found. Thereis little doubt from the evidence that at the time of the impactthe right fuel tank was effectively empty. A sudden loss ofengine power in the climb is consistent with the final take offhaving occurred with the selector set to the RIGHT TANK positionwith virtually no fuel remaining in that tank.

Fuel tank gauge systems of this design are insufficiently accurateto enable one tank to be used to the minimum quantity before selectingthe other tank. Similarly, calculations based upon the initialcontents and subsequent fuel consumption would also have beeninsufficiently accurate to guarantee a safe re-selection of theleft tank. Although the fuel selector was found in the BOTH OFFposition tests carried out on a similar aircraft make it clearthat the aircraft could not have become airborne and climbed ona normal flight path to a height of 150 to 200 feet had the take-offrun commenced with the selector set to that position.

It is probable that the take-off run began with the fuel selectorset to the RIGHT TANK, which was virtually empty. Fuel starvationoccurred during the initial climb and the pilot moved the fuelselector to BOTH OFF as part of the emergency drill for an EngineFailure After Take off. The pilot then attempted to turn backtowards the airfield but had insufficient height to execute thismanoeuvre.