AAIB Bulletin No: 4/94 **Ref: EW/C93/11/2** **Category: 1.3**

Aircraft Type and Registration:	Auster J1N Alpha, G-APOA	
No & Type of Engines:	1 De Havilland Gipsy Major 1F piston engine	
Year of Manufacture:	1958	
Date & Time (UTC):	15 November 1993 at 1051 hrs	
Location:	Chelsfield, Orpington, Kent	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 1
Injuries:	Crew - Fatal	Passengers - Fatal
Nature of Damage:	Aircraft destroyed	
Commander's Licence:	Private Pilot's Licence	
Commander's Age:	18 years	
Commander's Flying Experience:	Approximately 400 hours (of which 372 were on type) Last 90 days - 34 hours Last 28 days - 4 hours	
Information Source:	AAIB Field Investigation	

History of the flight

The pilot had undertaken his initial flying training course on the accident aircraft, gaining his Private Pilot's Licence in June 1992. He also had extensive aviation knowledge gained through membership of the Air Training Corps and through frequent flying as a passenger in other types of light aircraft from Biggin Hill. Examination of the pilot's log book indicated that he had also been introduced to occasional aerobatics as a passenger in a Pitts Special biplane aircraft. His log book indicated that he had experienced around 10 hours in that type, although he had not flown the aircraft solo. There was no indication that the pilot had ever received any formal training, with a suitably qualified instructor, to carry out aerobatic manoeuvres in any type of aircraft. It was, however, apparent that he did, on occasions, carry out limited aerobatic manoeuvres in the Auster, knife edging, steep turns and stall turns being quoted by close acquaintances as favoured manoeuvres. From the pilot's log book, his most recent flight in G-APOA prior to the accident flight was on 17 October.

The pilot had planned to fly with his girlfriend during the weekend before the accident, but the weather conditions were unsuitable and the flight was postponed. However, on the morning of the accident, weather conditions were good and the pilot had arranged to undertake a flight with another friend who was also intending to obtain a Private Pilot's Licence. Witnesses indicated that it was the pilot's intention to overfly the school attended by his girlfriend at the morning break time. The school was located in Orpington, some 1.4 nm distant from the accident site.

The pilot and passenger were noted carrying out the pre-flight inspection of the aircraft at its hangar, and some 40 lb of loose articles (chocks, tie downs, life-jackets, tools etc) were removed from the aircraft prior to the flight.

They took off at 1047 hrs, having informed ATC that they would be carrying out a local flight to the north east of Biggin Hill Airport. The aircraft departed from Runway 29 and made a right turn out. A flying instructor at the airfield observed that the aircraft's take-off run was more "tail-up" than usual, and the ground roll was somewhat longer than usual, for this aircraft. Two minutes after departure, the pilot called Biggin Hill ATC by VHF R/T to advise them that he was leaving the area and "going on route". The recording of the VHF R/T from Biggin Hill Air Traffic Control was not available for this investigation as the tape recorder had developed an undetected fault, which has since been rectified. However, the ATC Controllers indicated that there were no further radio transmissions from the aircraft after it left the Biggin Hill circuit area. After the accident, the aircraft's VHF radio was found to be tuned to the Biggin Hill Tower frequency, 129.4 MHz.

Radar data was obtained from the primary radar heads at Gatwick and Pease Pottage (south of Gatwick). The Gatwick radar head had the most complete coverage of the flight and the first return from the aircraft appeared on the crosswind leg on climb out from Runway 29 at 10:48:10 hrs. A continuous sequence of returns was then obtained, until the final return from the aircraft occurred at 10:51:35 hrs in the vicinity of the accident site. There was no evidence to suggest that the aircraft had carried out any complete turns during the short flight, the aircraft generally proceeding on a north easterly track after completion of the crosswind leg. There was evidence of some lateral discontinuity in the aircraft's track, especially at a time between some 40 and 15 seconds before the final return. Because of the speed of the aircraft and the resolution of the radar data, it was not possible to positively identify the type of manoeuvre carried out at that time.

The aircraft was not equipped with a transponder, so no height information was available to produce a vertical profile. The aircraft's most recent air test report, for its Certificate of Airworthiness, notes that the best rate of climb measured was around 600 FPM. The controlled airspace around Biggin Hill has a base of 2,500 feet amsl, and Biggin Hill Airport has an elevation of 600 feet amsl. The elevation of the accident site was approximately 380 feet amsl.

There were over 35 eyewitnesses to the aircraft's final flight path. The majority of those interviewed only noticed the aircraft after hearing a loud bang. They noted that the aircraft had been fairly low, but not initially such as to cause concern. The descriptions of the aircraft's manoeuvring varied markedly, but a consensus suggested that the aircraft had performed some form of aerobatic manoeuvre. Four witnesses positively identified the manoeuvre as a complete roll to the left (including two people who saw the aircraft approaching from head on), and a further three described the manoeuvre as a loop (these witnesses viewed the aircraft's flight path from the side). On completion of the first manoeuvre, the aircraft was seen to pull up steeply, as though about to enter a second manoeuvre. Most witnesses reported hearing a loud bang, described as a back firing or rifle shot sound, at about this time. Some also observed the appearance of a puff of black smoke from the underside of the aircraft. (Other pilots familiar with this type of aircraft and engine combination have since stated that it was not unusual for the engine to "backfire" if the throttle was closed rapidly). No further sounds of the engine under power were heard by the witnesses interviewed. The aircraft was then seen to enter a steep spiral or spin to the right for 3 or 4 revolutions. Several witnesses observed that part of the upper surface of the left wing appeared to be "flapping", and some reported hearing sounds consistent with loose fabric flapping in the airflow. An inspection panel, believed to have come from the underside of the left wing, was found in a garden under the aircraft's flight path, some 0.25 miles from the accident site.

The aircraft impacted the ground in the back garden of a house, apparently with an almost vertical trajectory. There was no fire, and the post mortem results indicated that the multiple injuries sustained by the occupants were consistent with a severe vertical impact. No medical or pathological conditions were identified that could have affected the flight.

The final flight path was also observed by the two occupants of another aircraft which had taken off from Biggin Hill one minute after G-APOA. The Auster was observed to be descending rapidly as though spinning or spiralling steeply. The following aircraft attempted to locate the crashed aircraft but was not able to do so and continued on its flight. Observations from the radar replay indicated that the second aircraft was some 1.6 nm distant at the time of the final return from the Auster.

The Biggin Hill METAR for 1050 hrs gave the surface wind as 340°/6 kt, CAVOK, temperature +7°C, dewpoint -1°C, QNH 1033 mb.

Flight documentation recovered from the aircraft consisted of a Southern England topographical chart, a radio frequency guide, and an Aerobatics text book.

The aircraft did not have a Flight Manual, but was operated by reference to limitations attached to the CAA Certificate of Airworthiness. In that document, the aircraft was cleared to perform limited aerobatic manoeuvres, namely stall turns, loops, spins, and tight turns, provided loading was

maintained within the +4 g to -2 g envelope. In order to carry out such manoeuvres however, the aircraft was required to be fitted with 'Aerobatic Seats' (Auster modification No. 1693), and such manoeuvres were prohibited whenever the aircraft was fitted with an external auxiliary fuel tank (Auster modification No. 1984). The accident aircraft was not fitted with the 'Aerobatic Seats', and was fitted with the external auxiliary fuel tank, therefore aerobatic manoeuvres were prohibited at the time of the accident.

The aircraft was believed to have been refuelled such that both tanks were full, having uplifted 51 litres (11.3 gallons) of Avgas 80/87 at Biggin Hill on 18 October. The maximum tank capacities were 15 gallons in the main forward tank, and 13.75 gallons in the external auxiliary tank. The aircraft did not fly after refuelling until 12 November, when it was flown by the owner on a return trip to North Weald, a total of some 40 minutes flying time. During that trip, it was estimated to have used some 6 gallons from the total fuel contents. The remaining fuel was therefore around 22 gallons at the start of the accident flight, with some 7 gallons in the auxiliary tank. There was no system of fuel contents gauging available for the external auxiliary tank.

A Weight & Balance calculation was performed during the investigation, based upon the weight and centre of gravity schedule produced after the aircraft's rebuild. This quoted the basic weight to be 1,315 lb, but did not take into account the external auxiliary fuel tank, the structure of which weighed approximately 32 lb. Based on these figures, the known weights of the two occupants, and the assumed fuel status of the aircraft, calculations suggest that at the time of the accident the aircraft weight was approximately 1,820 lb, with a centre of gravity of 16.6 inches aft of datum. The limitations quoted in the Certificate of Airworthiness document for the performance of approved aerobatic manoeuvres are a maximum weight of 782 kg (1,724 lb) and an aft centre of gravity position of 16.0 inches aft of datum.

Technical examination

At the accident site the aircraft was found facing approximately 270°M, with the empennage only slightly damaged and the right-hand wing in its correct orientation relative to the fuselage (Figure 1). Broken branches and a detached piece of fabric wing covering (Ceconite) showed that the aircraft had descended through the top of nearby deciduous trees. The broken branches at a height of 70 feet indicated a trajectory of some 65° below the horizon in a direction of 144°M. Ground marks showed that, as the aircraft continued towards the ground, it had rotated to the right through about 125° from its first impact. The second, and major, impact occurred when the left-hand wingtip struck a substantial tree trunk 4 feet above ground level (Figure 2); this impact collapsed the left-hand wing to a length of approximately 6 feet although it had clearly still been in its correct orientation at impact. The main impact of the fuselage on the ground had been with the aircraft nearly level, causing very high vertical impact loads in the cabin area.

The engine was removed from the wreckage and taken to an overhaul agency for strip examination with the AAIB in attendance. The examination showed that the engine was mechanically sound prior to its impact with the ground and had not seized. It was possible to test both magnetos, the spark plugs and the carburettor, all of which performed satisfactorily. The oil filters showed no significant debris and inspection of the mechanical fuel pump showed that it had been intact and functional. Overall, there was no evidence of any engine problem prior to the ground impact.

Damage to the left-hand wing suggested in-flight structural failure; distinctive features included a number of structural failures in the forward and aft wing spars and extensive damage to the fabric wing covering (Figure 2). A number of the tears in the fabric were along the rib-stitching lines of the wing ribs and these tears showed frayed or 'teased' edges, indicating that the tears had occurred in flight. The in-flight tearing damage was most severe in the mid-span portion of the wing and less severe towards the wingtip and the wing root. Matching the tearing damage were very large areas over which the distinctive gold paint finish had become detached from the Ceconite fabric (Figure 2). This delamination was not matched in areas in which the fabric was contorted due to the wing's impact with the tree trunk, or on the right-hand wing, showing that the areas of missing paint finish had separated due to flapping of the fabric in flight. The portion of fabric recovered from the trees which the aircraft had first contacted was identified as being a complete panel of upper surface fabric between adjacent ribs, approximately two-thirds of the distance between the wing root and the strut attachment point.

Examination of the wooden wing spars showed them to be formed from good quality Sitka Spruce and there was no evidence of fungal attack or other deterioration. When the failures in the left-hand wing spars were examined, it became apparent that almost all these failures had occurred when the wingtip struck the tree trunk: the failures were either pure compressive failures or chord-wise bending failures, not consistent with flight loads on the wing. It was also apparent that, had these failures occurred in flight, the left-hand wing would not have been in its correct orientation at the impact with the tree trunk. One failure in the forward (that is, main) spar did, however, show characteristics consistent with failure under high flight loads as well as secondary impact damage on the outboard fracture face, indicating that the spar failed in flight. This failure in the forward spar was approximately 22 inches inboard of the wing strut attachment point, close to the outboard edge of the fabric panel recovered from the trees.

In this design, on each side of the aircraft a single bolt acts as the attachment pin between the lower fuselage frame, the inboard lugs of both wing struts and the cabin step. In this accident, this bolt had failed on the left-hand side of the aircraft and the bolt was found in two parts. Detailed examination showed that the bolt had suffered a shear failure at the position of shank corresponding to the forward strut attachment lug but that there was no pre-existing damage on the bolt. This indicated that the bolt had sheared when the left-hand wingtip suffered its 'end on' impact with the tree and that, therefore, the wing structure outboard of the strut attachment points was intact at this stage.

In summary, therefore, it appears most likely that the initial structural failure had occurred in the left-hand wing forward spar, approximately 22 inches inboard of the wing strut attachment point and that the left-hand wing was then subjected to large distortions, loading the upper and lower wing surfaces and causing the extensive damage to the fabric coverings.

Examination of the strut attachments, at the fuselage and at the wing, showed evidence of permanent elongation of the bolt holes and distortion of the lugs in the direction indicating tension in the strut and hence lift on the wing; this damage was evident on both sides of the aircraft but was greater on the left-hand attachments. This confirmed that the struts were still attached when the left-hand forward wing spar failed and that the failure had occurred due to structural overload on the wing; it could not be confirmed how much of this damage may have occurred during previous flights.

History of aircraft

The aircraft was built in 1958, and by 1987 it had accumulated some 1,680 hours of operation. It was damaged during a wind storm in the autumn of that year and, after a period of storage, was bought by an engineer enthusiast who worked on the aircraft as a restoration project. During this period the right wing was re-covered. The aircraft was then bought and a licensed engineer was commissioned to complete the restoration; the work was inspected by another licensed engineer, holding a CAA B engineer's licence. It was during this period that the left-hand wing was repaired and re-covered. Slightly different methods had been used in the re-covering of the two wings and the method used on the left-hand wing was likely to give slightly improved resistance to tearing of the fabric along the rib lines than that on the right-hand wing. This further confirms that the tearing of the fabric on the left-hand wing was a result of the wing's structural failure and not a cause.

Figure 1 - G-APOA, 15/11/93 - View looking forward

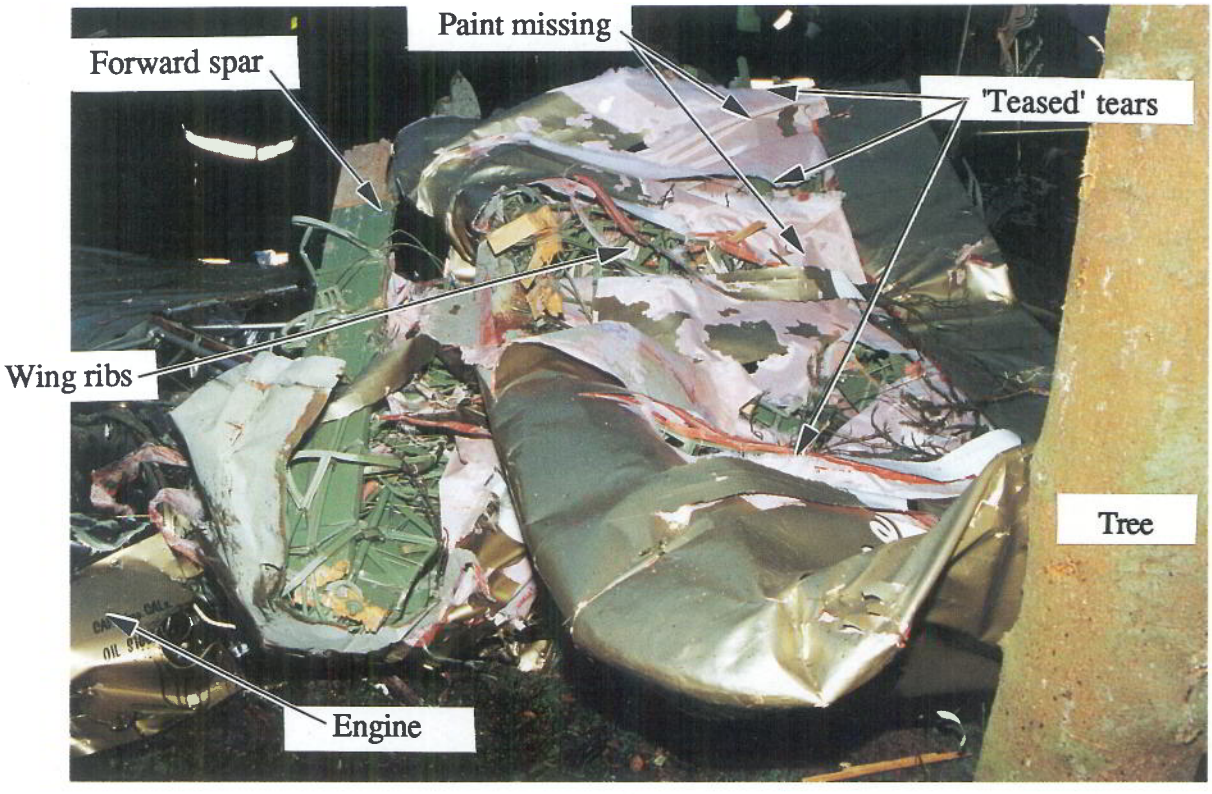

Figure 2 - G-APOA, 15/11/93 - Left-hand wing, looking inboard