Pitts S-1E Special, G-BOIH

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Aircraft Type and Registration:	Pitts S-1E Special, G-BOIH
No & Type of Engines:	1 Lycoming O-360-A4A piston engine
Year of Manufacture:	1989
Date & Time (UTC):	25 July 1997 at 1430 hrs
Location:	Meppershall Airfield, Bedfordshire
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:	38 years
Commander's Flying Experience:	570 hours (of which 193 were on type)
	Last 90 days - 8 hours
	Last 28 days - 4 hours
Information Source:	AAIB Field Investigation

The pilot gained his Private Pilot's Licence in 1976. He beganto fly competition aerobatics in September 1989 and came fourthat Standard competition level in 1991 flying a Pitts S2A. He won two competitions in 1992 and moved up to Intermediatelevel in 1993 achieving top three placings in three competitionsduring that year.

Since 1994, he had flown in aerobatic competitions at Advancedlevel with a good degree of success. During 1997, the pilot hadcompeted in three Advanced level competitions, winning one andbeing runner-up in the other two. He had also won a glider aerobaticcompetition at Standard level. The pilot was intending to competein the British National Championships taking place from 30 Julyto 2 August at Sywell Aerodrome.

The pilot's own aircraft, a Pitts S-1S registration G-BKDR, wasstill undergoing repair at Meppershall after a forced landingaccident following an engine failure on 8 November 1996

(reportedin the AAIB Bulletin 5/97). In order to continue flying duringthe repair period, the pilot had arranged the use of G-BOIH. The accident flight was the pilot's eighteenth flight in thisaircraft, his log book indicating that aerobatics featured prominentlyduring these flights.

The aircraft was normally based at Benington Airstrip, near Stevenage. On the morning of the accident, the pilot left home in Lutonat about 0930 hrs with the intention of flying G-BOIH from Beningtonto Meppershall in order to clean the aircraft in preparation forthe following week's competition flying, before returning it toits base. He also stated his intention to carry out two aerobaticpractice sessions during the positioning flights. Fuel was notavailable at either Benington or Meppershall, so a refuellingstop at Panshanger was also planned for the return sector.

There was no official record of the departure time from Benington. A witness in Baldock noted a Pitts Special 'going fast' and doingcontinuous aileron rolls but his memory of the timing was notprecise. Recordings from Debden Primary Radar were examined inorder to establish the precise flight timings but no trace ofthe aircraft was found.

The aircraft arrived at Meppershall between 1130 and 1230 hrs,while the hangar staff were having lunch. The pilot spent abouttwo hours cleaning the aircraft. At about 1415 hrs, it was thehangar staff tea break and they were sitting outside the hangarwatching the pilot preparing to depart. A group of young childrenwere also watching proceedings from a gap in the airfield boundaryhedge in front of the hangar.

The aircraft taxied out for departure from Runway 02, which hasa 600 metre take-off run with a 100 metre overrun area. About 10 minutes elapsed during which the engine run up was heard. This was out of sight of the observers over the curvature ofthe strip. Engine power was heard to increase and as the aircraftcame into sight over the brow of the hill it was already airborne,being held low to gain speed. About 50 metres before reachinga point abeam the hangar (about 550 metres from the start of thetake-off run), the aircraft pulled up sharply into a 45°pitch up climb and completed two continuous rolls to the rightwhile continuing to climb. The aircraft was then seen to continuethe roll to a wing's vertical attitude, right wing down. Witnessesreported that the engine noise decayed at this time and the aircraftbegan to sideslip to the right. It was seen to yaw and roll asif in an incipient spin. It rolled right and pitched down. Therewas insufficient height to effect a recovery and ground impactfollowed moments later in a steep nose down/right wing down attitude. The pilot was wearing a full harness which did not fail duringthe impact, but he sustained fatal impact injuries. Hangar staffrushed to the scene but were unable to assist. There was no fire.

No unusual noises were heard coming from the engine prior to theaccident. One witness indicated that he could hear the enginerunning throughout the final descent. All witnesses agreed thatthe propeller had been turning just prior to impact. Estimatesof the maximum height achieved by the aircraft were between 150and 250 feet.

Accident site details

The aircraft had crashed close to the end of the grass strip butdisplaced approximately 60 metres to the right, and had come torest in a hedge which separated the airfield from a road. Theimpact was less than 30 metres from a house belonging to the ownerof the airfield. The impact area consisted of short grass growingon hard ground, and it was possible to discern impressions madeby the leading edges of both upper and lower wings. The pitotprobe, which was mounted on the leading edge of the lower leftwing, had been driven into the earth before breaking off at itsbase. This, together with the impact marks, indicated that theaircraft had struck the ground pitched down at an

angle of around70° on a heading of approximately 290°. The aircrafthad apparently then bounced in a south-easterly direction, twistedalmost 180° about its longitudinal axis in the process, beforebecoming balanced on its nose, with the cockpit area leaning againstthe hedge. The fact that the aircraft moved in a direction thatwas significantly different to the heading following the initialimpact suggested the aircraft had struck the ground in a stalledcondition.

The fuselage aft of the cockpit, together with the empennage,were almost undamaged. However, the forward fuselage and cockpithad been considerably compressed, with aft movement of the enginefirewall and significant buckling of the floor around the rudderpedals. The wings had been badly damaged, effectively becomingwrapped around the fuselage as the aircraft came to rest.

The mark in the ground caused by the propeller, together withchordwise scuff marks on the blades themselves, indicated thatthe propeller had been rotating, although the lack of leadingedge damage suggested a low power condition at impact.

Following an on-site inspection, the wreckage was removed to theAAIB facility at Farnborough for a more detailed examination.

Examination of the wreckage

An examination of the airframe revealed no evidence of a pre-impactstructural failure or detachment. Similarly, the flying controloperating system showed no evidence of a pre-impact disconnect,although it was not possible to discount the possibility of acontrol jam. However, no loose articles, such as tools, werefound which could have caused such an event.

The fuel tank, which had split open during the impact, was mountedahead of the instrument panel, with fuel off-take being via a'flop tube'. This was a flexible, weighted tube, mounted at therear of the tank such that the open end of the tube moved withthe fuel in response to the applied 'g' forces. The tube wasexamined for splits which could have resulted in air being entrainedinto the fuel lines; none was found. Other elements of the fuelsystem were examined, including the gascolator, which was foundto be full of fuel containing a small amount of sediment. Thefuel cock was found selected to the open position, and the fuellines to and from the engine driven fuel pump were primed withfuel.

The fuel was delivered to the engine via a throttle body injector,rather than a conventional float-type carburettor. The essentialcomponents of this were a throttle slider moving within a blockcontaining the venturi. The slider was operated by means of ateleflex-type cable, and performed the throttle function by varyingthe exposed area of the venturi. This arrangement was consideredresistant to movement during a sudden impact. Thus the fact thatthe mechanism was found jammed in the throttle closed positionwas considered a reasonably reliable indication of the settingat impact. Mixture control was by means of a rotating spray barpositioned across the venturi. As found, the control was freeto move and it was not possible to identify the position at thetime of impact. However, there was no reason to suppose thatit was at anything other than the fully rich setting. The carburettorhot air control box had been severely distorted during the impact,with the position of the moveable flap suggesting that 'cold'air had been selected.

The engine accessory gearbox had suffered no internal failuresthat could have affected the operation of such components as theengine driven fuel pump or the magnetos. The latter were damagedalthough it was possible to mount the left-hand unit on a testrig, where it produced sparks on all four high tension (HT) leads. The fuel pump was disassembled, with no defects being found.

The engine was subjected to a strip examination and was mostlyfound to be in reasonable condition. The exception was a severelyworn cam lobe which operated Nos 1 and 2 cylinder inlet valves. Measurement revealed that the amount of wear, and in consequence,the loss of valve lift, was approximately 0.125 inches. The associatedcam followers had suffered pitting damage. A small amount ofmetallic debris was found in the oil screen, with rather morebeing found in the sump. It is probable that this material originatedfrom the cam lobe. There was no evidence of any lubrication failureelsewhere in the engine. The engine log book recorded more than2,200 operating hours since the last overhaul.

The loss of valve lift would have been partly compensated forby the hydraulic tappets. Nevertheless there must have been areduction in the power output of the engine, although it was notpossible to quantify this. With a fixed pitch propeller installation,a reduction in maximum power would be most obvious during thetake-off roll, when a drop of RPM would be apparent compared tothat usually obtained at full throttle. However, the cam wearwould probably have occurred over a considerable number of operatinghours, and would not have resulted in a large RPM drop (at fullthrottle) over successive flights.

In the experience of an engine overhaul agent who was contactedon the matter, worn cam lobes in the manner noted above have beenencountered occasionally on this type of engine. The wear inalmost all cases was confined to the cam operating Nos 1 and 2inlet valves and/or the cam operating Nos 3 and 4 inlet valves. Each of these cams is in contact with two cam followers comparedto the exhaust valve cams, which operate only one valve each. The agent noted that all affected engines had been returned foroverhaul, as opposed to investigation for maximum power reduction,thereby suggesting that significant cam wear did not result inany dramatic indications. The cam wear was thought to originateduring the engine start cycle, before oil had been pumped roundto the cams, thus leading to brief periods of metal-to metal contactbetween the cams and followers.

Operational considerations

A post-mortem examination did not find any evidence to suggestpilot incapacitation and there were no indications of the presenceof either alcohol or drugs. The pathology report indicated thatthe nature of the injuries showed that considerable lateral forcehad been present, with the right-side down. It was consideredthat the impact was non-survivable.

The weather at the time was good, with a light north-westerlyairstream established over the area giving a surface wind from320° at 10 kt. Therefore, the crosswind component on takeoff was about 8 kt from the left. The visibility was greaterthan 10 km, with scattered to broken cloud base 3,500 to 4,500feet. The ambient temperature was +21°C.

Checking of the aircraft's previous flying and refuelling recordsgave an estimated fuel load on departure from Benington as 43litres. Because the fuel system consisted of a 'flop' tube fueltank feed line and no collector tank, the aircraft was subjectto an operating limitation (quoted in the Aircraft Flight Manualfor the type, but not re-iterated on this aircraft's Permit toFly) indicating that no low altitude aerobatics are recommendedwith less than one quarter of a tank of fuel (18 litres) on board. The aircraft would have needed to be airborne for about 45 minutesduring the flight from Benington to Meppershall to achieve thisminimum. Using straight line tracks with only a 'dog-leg' aroundthe corner of the Luton Control Zone at Baldock and with an allowancefor a circuit before landing, the estimated flight time to Meppershallwas 15 minutes. It is therefore likely that the aircraft hadmore than one quarter of a tank of fuel on board at the time ofthe accident.

A weight and balance calculation was carried out by the AAIB,based upon the calculated fuel state of the aircraft. This indicatedthat, at the time of the accident, the aircraft was operatingwell within the permitted centre of gravity envelope and was about86 lb below the maximum permitted operating weight.

Whilst being highly experienced and accomplished at aerobatics,the pilot did not hold any form of CAA Display Authorisation,nor was any evidence found to suggest that the pilot regularlyconducted low level aerobatic manoeuvres. The aerobatic competitionsare normally flown at 'medium' levels, with a base of 200 metres(650 feet) at Advanced standard. The pilot's Aresti manoeuvresequence card was recovered from the instrument panel after theaccident. This indicated that his intended 'free' programme sequencefor the British National Championships contained a large numberof rolling manoeuvres.

The observed flight profile was discussed with a number of otheraerobatic pilots with extensive Pitts S-1 experience. All ofthem expressed the opinion that the speed attained prior to thepull up may have been between 120 to 130 mph, being sufficientfor perhaps a single roll, and that the speed would decay withthe aircraft in such a steep climbing attitude. Their opinionswere that after two rolls, the speed would have decayed to around80 mph. The recorded stall speed of G-BOIH was 58 mph but incipientspin entry is possible at higher speeds when sideslip is present.

Although no evidence was found to indicate that a flight controlabnormality or major engine failure had occurred, the possibilityof a temporary control restriction, or some other transient problemcausing pilot distraction, could not be totally dismissed.