Avid MK4 Speedwing, G-BUSZ

AAIB Bulletin No: 3/2002	**Ref: EW/G2001/05/09**	**Category: 1.3**
Aircraft Type and Registration:	Avid MK4 Speedwing, G-BUSZ	
No & Type of Engines:	1 Rotax 582 piston engine	
Year of Manufacture:	1993	
Date & Time (UTC):	11 May 2001 at approximately 1300 hrs	
Location:	Full Sutton Airfield, Pocklington	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 1
Injuries:	Crew Serious	Passengers - Serious
Nature of Damage:	Major damage to both wings and the forward part of the fuselage including the cockpit, engine and propeller	
Commander's Licence:	Private Pilots Licence (Group A)	
Commander's Age:	47 years	
Commander's Flying Experience:	201 hours (of which 130 were on type)	
	Last 90 days	12 hours
	Last 28 days	3 hours
Information Source:	AAIB Field Investigation	

Aircraft description

The Avid Mark IV is constructed from a kit of parts supplied by the Avid Aircraft Company based in the USA. Its fuselage is very similar to the Kitfox fuselage. There are tricycle and tailwheel landing gear variants and two types of wing: a STOL version with a wingspan of almost 30 feet and a 'Speedwing' version with a wing span of almost 24 feet. All the variants have wings that fold rearwards to allow the aircraft to be towed or transported on a trailer. G-BUSZ had tricycle landing gear and the shorter wings. Pitch and yaw control were achieved with conventional elevator and rudder surfaces but roll control was effected by full-span flaperons. The cockpit had two seats, side-by-side, and dual controls. Pitch and roll were controlled by joystick and yaw by conventional rudder pedals. The elevator trim mechanism had been removed leaving the trim tab inhibited in a fixed, neutral position by large washers bolted across the gap between the elevator and the tab.

The aircraft had been kept in a hangar at Full Sutton and there was no need to disconnect the flying controls to fold the wings. It was classified as a Group A type and operated under a Permit to Fly renewed by the Popular Flying Association (PFA). It had recently received an annual airworthiness inspection by a PFA Inspector who was also a licensed aircraft engineer.

The empty weight of the aircraft was 233.5 kg. The quoted weight of the fuel and two occupants was 212.5 kg giving a take-off weight of 446 kg. The maximum take-off weight allowable is 464 kg (1020 lb)

Airfield

Full Sutton has an unlicensed asphalt runway aligned 34/16. There is a prison complex beside the airfield just to the north of the 16 threshold and over flight of the prison is forbidden. Runway 16 can be used for take-offs and landings when the wind conditions are favourable but much of the flying activity takes place from Runway 04/22. This runway is a licensed grass strip that can be used for landings and take-offs without overflying the prison. The strip is 722 metres long and 20 metres wide and the prevailing winds tend to favour Runway 22. However, on the day of the accident, Runway 04 was in use because of a north-easterly surface wind. The eastern part of Runway 04 (the latter part on take-off) has a line of shrubs, trees and bushes that parallel the strip about 40 metres from the centreline on its left-hand side. The height of the tree line varies between approximately 15 and 30 feet. Beyond the end of Runway 04 is a patch of rough ground extending about 100 metres beyond the prepared area.

Wind Conditions

The weather was fine with little cloud. According to the pilot, the surface wind was varying in direction between north and east at speeds between 3 and 6 knots. In deciding which runway to use, he chose Runway 04 because it was the designated runway in use, it was being used by the airfield's resident flying instructor, and the maximum crosswind component of 6 kt was acceptable. The pilot also stated that inexplicably vigorous turbulence was sometimes encountered over the latter part of Runway 04 after take-off.

Another witness stated that a change in wind conditions occurred that afternoon which he attributed to sea breeze effect. He stated that the wind speed was about 10 kt at the time of the accident and did not increase until later that afternoon. He thought the maximum wind speed that afternoon was of the order of 15 kt.

An aftercast from the Bracknell Meteorological Office concluded that the surface wind would have been from 090° at 7 to 10 kt with a 2,000 foot wind of 130° at 15 to 18 kt. Atmospheric conditions were reasonably stable, with no gusts reported in the York area. Along the East Coast the surface wind reached a maximum of 15 kt and any gusts at Full Sutton were unlikely to have exceeded 16 kt. Furthermore, there was no marked change in wind speed with height; the wind speed at 200 feet agl was between 12 and 16 kt.

History of flight

The pilot and his passenger boarded the aircraft at Full Sutton for a local flight at about 1300 hrs. This was only the second time the pilot had taken off from Runway 04. A Piper light aircraft departed ahead of G-BUSZ. The pilot of G-BUSZ stated that he did not taxi into position until the Piper was airborne and so the time difference between their take-offs would have been about one

minute. According to the pilot, the aircraft took off quite normally but when it was between 125 and 150 feet above the airfield, it failed to respond to either stick or rudder input. The pilot remembered checking the engine RPM, airspeed and vertical speed. The engine RPM gauge was still indicating 6,200 and the airspeed indicator was reading 68 mph but the vertical speed indicator showed a zero rate of climb. He recalled warning his passenger that they had a serious problem but remembered nothing more until he regained consciousness days later.

The passenger stated that all was normal until just after take-off when the pilot asked him to pass a map. The passenger removed the map from the door pocket, placed it on his lap and then located Full Sutton on the map. Next he looked up and saw the aircraft bank to the left. Shortly afterwards the pilot began moving the stick from left to right and vice versa quite aggressively. The passenger's overall impression was of a loss of speed.

The aircraft crashed into the rough ground beyond the end of the grass strip, about 50 metres beyond the end of the strip, still within the airfield boundary. It struck the ground in a steep nose-down attitude with its right wingtip and nose, coming to rest inverted, having shattered the propeller and crushed the forward fuselage and cockpit. Both occupants suffered multiple serious injuries. The pilot was in hospital for about 25 days and his passenger was hospitalised for 9 days.

Examination of the aircraft

The aircraft was examined by two qualified persons before it was moved from the accident site to a storage building on the airfield. One was a loss adjuster instructed by the pilot's insurers; the other was a licensed aircraft engineer and PFA Inspector. Neither person found any damage consistent with a pre-impact structural failure. In their opinion, all the damage was consistent with ground impact and there had been no pre-impact failures such as a disconnection of the elevator, rudder or flaperon control runs. After making a number of enquiries, the AAIB discovered that there had been a mechanical failure of an elevator push-pull rod attachment at a known vulnerable point in the cockpit. In order to confirm that this damage was indeed post-impact damage, the wreckage was recovered to the AAIB facility for detailed specialist examination.

Airframe

The disruption to the cockpit area was significant but inspection of the rudder and flaperon control runs revealed that these had been intact and appeared correctly assembled. The flaperon bearings on either side of the 'turtle deck' were still functional although both flaperons had detached from the wings. The damage to the plywood spar extensions supporting the flaperons (the hangers) was consistent across both flaperons and the damage to each hanger broadly similar to that of its neighbour. The failures and distortions of the forward fuselage structure were consistent with a low speed, steeply nose-down impact.

Elevator control linkage

The only significant damage to the flight control mechanisms was the fracture in the elevator control run at the threaded portion of a fitting that connected the elevator push-pull tube to the control column torque tube. The exposed threaded portion had been bent through some 45° before separating into two parts. The broken pieces were removed and sent for specialist metallurgical examination. The bending had occurred as the fuselage structure deformed and the fracture was assessed as a post-impact failure.

Powerplant

The engine was intact and there was no evidence of any pre-impact damage or incorrect assembly. The crankshaft was free to rotate and the exhaust was still connected. All four spark plugs were of the same appearance and in good condition. They had dark and slightly 'sooty' deposits around their electrodes suggesting a slightly rich mixture but otherwise they were typical of a two-stroke engine. There was fuel in one wing tank. The push-pull type throttle was closed and its shaft was bent consistent with it being closed at impact. The propeller gearbox was dismantled to check the drive gear integrity; there were no signs of slippage or damage. The three 'Arplast Ecoprop' propeller blades were intact although the metal hub had disintegrated and one blade had been liberated. The pitch of these blades can be adjusted on the ground by slackening their hub retaining bolts; the two blades still retained in their hub segments had similar pitch angle settings. Only one of the blades had any tip damage; there were small indentations to the leading edge and chordwise scoring on the outer few inches of the blade. The other two blades had pristine leading edges but significant damage to their trailing edges. The propeller parts were sent for examination by the UK importer who confirmed the suitability of the propeller for the powerplant (Rotax 582 with C type gearbox and 3.00 :1 reduction ratio). The blades that had assessable pitch angles were set to a pitch angle of 16.5° which was very close to the PFA recommended angle for the installation of 16°. The examiner stated that normal practice is to install the blades at the PFA recommended angle and then to run the engine at full throttle to establish the static RPM. If necessary, the blade angles can then be fine-tuned to produce the anticipated full power RPM which, in this installation, was 6,200.

Analysis

The pilot's report of feeling that roll and yaw control inputs were having no effect could have been consistent with one of the following: wake-turbulence from another aircraft; strong turbulence due to disturbed airflow downwind of an obstacle; malfunction of the controls or insufficient airspeed.

Although the preceding Piper aircraft was heavier than the Speedwing, wake turbulence was discounted because of the one minute elapsed time between the take-offs. According to the pilot the surface wind was lighter than the meteorologist's post-flight assessment but it was unlikely to have exceeded 10 knots until later that afternoon. The degree of turbulence in the lee of an obstruction depends on wind speed and the shape and size of the obstacle. However, 10 knots is most probably insufficient to create turbulence sufficiently vigorous to overpower the Speedwing's roll control power at climb speed. Moreover, with a surface wind between north and east, the airflow over the strip could not have been disturbed by the tree line to the north-west of the strip.

The spanwise consistency of the damage to the flaperon hangers and indentations in their leading edges indicated that the flaperons had almost certainly broken free at ground impact due to inertial forces. Consequently, there was no evidence of any control malfunction that could have affected roll or yaw and the complete fracture on the pitch control rod was undoubtedly a post-impact phenomenon.

The most likely cause of the accident was insufficient airspeed and this deduction is consistent with the passenger's impression of low speed. The aircraft's stall speed at 444 kg is typically about 54 mph (47 kt). Moreover, in the opinion of the AAIB, the loss of control had to have occurred at a very low height for the occupants to have survived the crash.

The aircraft had travelled more than the full 722 metre length of the strip whilst taking off into a headwind component. Although no formal take-off performance data are available for the type,

recent climb performance data for G-BUSZ were recorded during a formal flight test on 5 May for renewing the Permit To Fly. The climb conditions were a take-off weight of 460 kg and a climb speed of 70 mph at 6200 engine RPM. The test report recorded a rate of climb equivalent to 570 ft/min (9.5 ft/sec).

The aircraft type is frequently operated from grass strips 350 to 400 metres long at maximum take-off weight. Consequently, the aircraft should have been airborne for at least the latter 320 metres of the strip. Assuming no significant headwind component (although there probably was a small headwind component) and an average climbing speed of 68 mph (60 kt), the aircraft should have been airborne for not less than 10 seconds. In that time it should have gained at least 95 feet in height but the damage to the aircraft suggests that it did not do so.

It is difficult to envisage why the aircraft failed to gain more height unless the engine was not producing full power or the aircraft was mishandled. The pilot's report of seeing 6,200 engine RPM just before losing control, coupled with the proper adjustment of the propeller blades, indicates that there was no significant reduction in engine power.

The most likely form of mishandling would be to rotate at too low an airspeed and to fly the aircraft in ground effect, accelerating only slowly because of the induced drag of the relatively short wingspan. Given the pilot's experience on type and previous flights with two passengers, and his recollection of 68 mph, this seems unlikely. However, after the aircraft became airborne, the passenger had time to remove a map from its stowage at the pilot's bidding and unfold it. This must have taken several seconds and yet the aircraft was still within the airfield boundary when it crashed.

The cockpit of the Avid Speedwing is a tight squeeze for two adults and care must be taken by the occupants not to restrict control column movement with their knees. It is possible that in reaching for the map, the passenger may inadvertently have moved or restricted the lateral travel of the control column but neither he nor the pilot reported any such interference.

Vulnerability of pitch control linkage

Although the fracture of the pitch control attachment fitting to the control column torque tube was assessed as post-accident, it was not possible to discount some measure of pre-impact bending of the threaded rod. Bending could have occurred because there was no elevator travel stop in the aircraft nose-down sense. After the accident the elevator was free to move to about 80° trailing edge down but it should not have done so before the accident because of the geometry of the pitch control mechanism which is illustrated below in a diagram *(jpg 60kb)* supplied by a PFA inspector.

This mechanism would have limited the elevator travel to less than 80°. The diagram shows that the limit of elevator down travel is reached when the push-pull tube hits the control column torque tube. Any forcing of the stick or the jolting of the push-pull tube (due to forces generated at the elevator) tends to bend the threaded rod. Opportunities to bend the rod might occur through careless stick positioning or forcing whilst entering or leaving the cockpit, or when the aircraft was being towed, particularly over rough terrain, although G-BUSZ had not been towed since its annual inspection.

Over-travel of the pitch control mechanism is a known problem with the Avid Speedwing. There have been at least three instances of failure or significant bending damage of this threaded rod end. Fortunately all three instances were detected on the ground, although, apparently, none were

reported to the PFA or the CAA. A recent occurrence is illustrated in the photograph below which was provided by the PFA recognised 'type expert'.

Recommendation

Design deficiencies in the Speedwing's flight control systems have been identified and simple modifications developed to alleviate these deficiencies. For instance, Avid Directive AD004 concerns the aileron control linkage at the port end of the control column torque tube and MOD/189/002 provides enhanced protection against a control jam arising from collapse of the seats onto the control runs beneath. However, at the time of the accident there was no formal modification that addressed the vulnerability of the pitch control linkage.

According to the PFA, the kit manufacturer developed an elevator stop assembly in the early 1990s which they issued to constructors. Some UK Speedwings have the stops fitted but the down stop assembly did not reach all the constructors in time to be embodied. This explains why G-BUSZ and some other UK examples were built without an elevator down stop.

Recommendation 2001- 95

In view of the potential for serious damage to the pitch control linkage within Avid Speedwing aircraft that lack an elevator travel stop in the elevator trailing edge downwards direction, on 29 November 2001 the AAIB wrote to the Popular Flying Association recommending that the Association should:

a. Identify a modification that introduces an effective and durable pitch control stop in the elevator trailing edge downwards direction.

b. Classify the modification as a Mandatory Permit Directive.

Response to recommendation 2001-95

As a result of this accident, the PFA have now issued MOD/189/006 to all Avid owners. This modification requires owners either to fit the standard Avid elevator stop assembly or an equivalent stop (made to a drawing and fitted in accordance with instructions provided) within the next 5 flying hours. The PFA stated that an approved stop is effective, durable and operates in the elevator down direction.