AAIB Bulletin No: 1/2005 **Ref: EW/C2004/01/03** **Category: 3**

Aircraft Type and Registration:	SZD 50-3 Puchacz Glider, HCD	
No & Type of Engines:	N/A	
Year of Manufacture:	1992	
Date & Time (UTC):	18 January 2004 at 1320 hrs	
Location:	700 metres NW of Husbands Bosworth Village, Leicestershire	
Type of Flight:	Training	
Persons on Board:	Crew - 2	Passengers - None
Injuries:	Crew - 2 (Fatal)	Passengers - N/A
Nature of Damage:	Glider destroyed	
Commander's Licence:	British Gliding Association Assistant Instructor Rating	
Commander's Age:	65 years	
Commander's Flying Experience:	1,120 gliding hours (of which nine were on type) Last 90 days - 10 hours Last 28 days - 1.5 hours	
Information Source:	AAIB Field Investigation	

Synopsis

The flight, with an instructor and student on-board, was planned from Husbands Bosworth. Although no-one overheard the pre-flight briefing, it is likely that the primary aim of the flight was spinning training. Witnesses saw the aircraft enter a spin at around 1,500 feet agl and continue in a normal, steeply nose-down, spin with no significant change in the flight path before it impacted the ground. A number of likely explanations for the accident were considered but no conclusive evidence was found. The investigation was unable to dismiss the possibility of pilot incapacitation or of a control restriction/malfunction, and so four Safety Recommendations are made.

History of the flight

The pilots involved in this accident were members of the Welland Gliding Club (GC) who normally operated from Lyveden Airfield near Corby, Northants. Lyveden is a grass airfield and in winter is subject to water-logging that frequently renders the airfield unuseable. The Club therefore has a

reciprocal agreement with the Soaring Society at Husbands Bosworth Airfield, Leicestershire, which allows Welland club members to fly from Husbands Bosworth in Soaring Society gliders on occasions when Lyveden is not fit for flying. On the day of the accident several members of Welland GC had independently arranged to travel to Husbands Bosworth Airfield to fly with the Soaring Society under the terms of this arrangement.

The weather on the day of the accident was generally fine with a light south-westerly breeze, but there had been an overnight frost and club members spent the early part of the morning removing frost from gliders.

On arrival at Husbands Bosworth those members of the Welland GC wishing to fly placed their names on a list and flew when their name came to the top of that list. Pilots under training would be paired with the next available instructor when it became the trainee's turn to fly and a suitable training aircraft became available. The student and instructor involved in this accident had arrived at Husbands Bosworth independently and had listed themselves to fly. By about 1240 hrs it had become the student's turn to fly and he was paired with the instructor to fly in glider 'HCD', a tandem seat Puchacz that had already flown five times that morning. The student had previously flown 50 flights, including two with the same instructor, and was at a stage in his training where he had already flown an introduction to spinning exercise and needed to fly further spins to complete his training in this area.

There were no witnesses to the pre-flight briefing, but the glider was towed uneventfully by a powered aircraft to a height of 3,000 feet and released normally. Several people, both airborne and on the ground, witnessed various stages of the rest of the flight. A Rotax Falke aircraft was approaching the village of Husbands Bosworth (about one mile north of the airfield) from the north-west at a height of about 1,500 feet. The right seat pilot saw the Puchacz enter a spin to the left from a nose high, wings level attitude and both pilots watched the glider complete a normal spin recovery after about one to one and a half turns. The Falke pilots then watched as the glider regained height in a moderately steep attitude before entering a second spin to the left from a "normal gliding attitude". The right seat pilot watched the spin and a normal spin recovery and both pilots recalled seeing the aircraft climbing away apparently under control. During this period the Falke and the glider had been on converging flight paths and so the commander of the Falke decided to achieve more separation and turned to his left. As the Falke rolled out of its left turn the right seat pilot looked over his shoulder and saw the glider in a "normal gliding attitude". After this, neither of the pilots saw the glider; however, both pilots recalled that the glider had descended below their height during the spin and that after the second spin recovery the glider appeared to be at or slightly above their height.

The pilot of a glider positioned about two kilometres north-west of Husbands Bosworth Airfield also saw the accident glider. He first noticed the aircraft "in a left turn" at "very low level" and his first thought was that it would have difficulty from that height in gliding back to the airfield. However, almost immediately he realised that it was much lower than his first impression and probably less than 100 feet above the ground. He watched the glider maintain its left turn, clear a hedge and then saw the left wing strike the ground followed by the aircraft nose. From his position, the impact angle did not look particularly steep.

A third group of witnesses, one of whom had flown in a glider, were carrying out road repairs to the A50 just to the north of Husbands Bosworth village. One of the witnesses saw the glider's nose pitch up steeply and enter a spin to the left. Several of the group saw the glider complete an estimated five turns before disappearing from view behind a ridge. One witness thought the rate of rotation might have speeded up slightly and all of these witnesses thought that the rotation continued until the glider disappeared from view. Some of these witnesses made their way on foot to the scene of the accident where they found the glider in a field with considerable damage to the nose and cockpit area forward of the wing leading edge. The student in the front seat was found dead at the scene while the instructor was alive when removed from the wreckage, but he later suffered a cardiac arrest and died on the way to hospital.

HCD was fitted with a radio, but no radio transmissions were received from the glider during its flight.

Pilots' Flying Experience

The instructor pilot had been flying gliders since 1986 and powered aircraft since 1998. He had amassed over 1,100 hours in gliders and about 87 hours in powered light aircraft. The Welland GC did not own a Puchacz glider, but the instructor had flown about 33 launches in a Puchacz, amassing a total of eight hours fifty five minutes on type. He had become an assistant instructor in 1994 and maintained his instructor rating up to the time of the accident. The instructor's last instructor rating renewal had been carried out in August 2003, which also happened to have been his last flight in a Puchacz prior to the accident. The renewal consisted of several flights and included a session of stalling and spinning in a Puchacz. Students who had flown with the instructor described him as being safe, punctilious and not prone to interfering unnecessarily when his students were flying.

The student pilot started gliding in April 2003 and by the time of the accident had flown 50 launches totalling about 10 hours flying. His experience in a Puchacz was limited to his last four flights before the accident, one of which was in the accident aircraft, and the latest of which was seven days before the accident. His introduction to spinning had been carried out in August 2003 in a K13 glider, but he had not spun in a Puchacz. The student had been shown one spin and had

attempted to put the aircraft into a spin himself, but without success. (The K13's spinning characteristics are known to be relatively benign compared to those of the Puchacz and it can be difficult for an inexperienced pilot to persuade a K13 to spin). His instructors considered him to be a bright student who would have qualified easily for solo flying but who was, at the time of the accident, below the minimum legal age of 16 years.

Glider information

The aircraft had been given a daily inspection in accordance with BGA Operational Procedures prior to the first flight of the day and had flown five times uneventfully prior to the accident flight. The pilot of one of these flights had spun the aircraft and reported nothing unusual about the aircraft's spinning characteristics.

Accident site details

The aircraft had crashed in a steep nose-down attitude into a grass field at the base of a small hill. It had come to an immediate halt in an upright position. The presence of earth inside an air inlet in the nose suggested that the pitch attitude at impact was approximately 60° below the horizontal.

The fuselage ahead of the wing leading edge, which included the cockpit, had suffered extensive disruption in the impact, with the remainder of the aircraft substantially damaged although essentially intact. The damage had extended to the wing-to-fuselage joints, which had disrupted the aileron and airbrake controls. The left airbrake was found in the deployed position, with the right one being retracted.

The canopy had been extensively fragmented in the impact, and an examination indicated that it had been latched at the time; thus there was no indication of either of the occupants having attempted to bale out of the aircraft.

Detailed examination of the aircraft

The aircraft wreckage was recovered to the AAIB's facility at Farnborough for detailed examination.

It was established that no pre-impact disconnect had occurred in any of the primary flight control systems. The possibility of a control jam caused by a loose article was considered, particularly in the light of reports of a plastic ballpoint pen that had been observed loose in the cockpit on an earlier flight (11 January) whilst the aircraft was performing aerobatics. No trace of the item was found in the wreckage. Whilst the possibility of a control jam could not entirely be discounted, the general design of the controls was considered to be tolerant of such loose articles.

Each rudder pedal on this type of aircraft is mounted on a horizontal shaft close to the heel position. The right side pedal shaft in the front cockpit had broken off in a forward direction, which suggested that the front seat pilot's foot might have been braced against the pedal at impact. This in turn suggested that right (ie out of spin) rudder might have been applied at the time.

The elevator range of movement was assessed from wear patterns on the control rods where they passed through fairleads/steady bearings in the rear fuselage. (The disruption of the cockpit area meant that the elevator primary stops, which were located on the control columns, could not be used.) It was found that the up and down limits broadly corresponded with the maintenance manual figures.

The left airbrake was found in the extended position after the accident, which clearly could have had an effect on the ability of the aircraft to recover from a left-hand spin had it been deployed in flight. Accordingly, a detailed examination was conducted in order to establish whether the deployment occurred during flight or as a consequence of the ground impact.

The design of the airbrake system is such that fore and aft movement of the airbrake lever in the two cockpits results in the rotation of a torque tube located across the fuselage, between the wings. The torque tube ends are connected via dog-clutches to mechanisms in each wing, which transmit the drive through a bevel gear assembly to span-wise control rods. These in turn are connected, via an over-centre mechanism, to the airbrake surfaces. The over-centre mechanism provides a 'lock' and 'unlock' function respectively during airbrake stowage and deployment. As a consequence, the forces exerted by the pilot on the control linkage are considerably higher during these parts of airbrake operation.

It was found that a plywood web supporting one of the bevel gears in the left airbrake system had become disbonded from the inner surface of the wing root rib, see Figure 1. This had allowed the web/gear wheel assembly to lean away from the mating gear, resulting in the gear wheel teeth no longer being in full engagement. In addition, the reaction forces between the teeth acted to push the web-mounted wheel further away when the airbrake mechanism was operated, with an associated risk of the teeth coming momentarily out of engagement and in consequence, a loss of synchronisation.

The bevel gear assembly and the surrounding structure were examined by the composites department of QinetiQ (formerly the Royal Aerospace Establishment) at Farnborough. The plywood web had been attached to the root rib by means of adhesive applied to glass fibre cloth that overwrapped both the web and rib. Examination of the disbonded area revealed two distinct areas: one was a clean, cohesive fracture within the surface plies of the wood, with the fracture surfaces being clean,

indicating that the fracture was new. The nature of the failure suggested a peeling action, indicating a span-wise load direction. The other area had been poorly bonded and had partially covered a steel flange that formed part of a fitting on the root rib. A gap was evident between the glass fibre cloth and the rib, with a long-term accumulation of dirt, indicating that this had most probably arisen during manufacture.

In addition to the support structure, the gear wheels, which were made of a Nylon material, were examined for evidence of wear patterns. This indicated that the teeth were fully engaged at the time of the impact. The range of movement of the airbrake mechanism was such that each gear wheel rotated through approximately 90° only; thus relatively few teeth meshed during normal operation. A thin film of undisturbed grease was evident on the 'unused' teeth, indicating an absence of tooth engagement outside the normal range of operation. Examination of the meshing teeth showed expected evidence of wear on the walls, but there was no scoring over the tops of any of the teeth, such as could have occurred had they slipped over each other.

The main spar of each wing extended beyond the root rib and they were off-set such that they overlapped one behind the other, and were pinned together in the fuselage aft of the cockpit. The dissimilar chord-wise locations of these spar extensions thus resulted in an asymmetric arrangement of the compartments in the inboard wing sections in which the bevel gear assemblies were located. For this reason, the gear assembly in the right wing was supported in a manner that dispensed with the plywood web; there was thus no useful comparison to be made between the left and right hand beval gear supports. All the right side bevel gear support structure had remained intact.

During the investigation, the glider manufacturer was advised of the above findings. Their response was that the disconnection of the gear support structure resulted from the crash. Thus, when all of the above evidence is considered, it seems unlikely that that there had been a loss of synchronisation of the airbrakes prior to the impact.

Weight and balance

The glider was within the weight and centre of gravity limits laid down by the manufacturer. The centre of gravity was approximately 7.63 inches aft (acceptable range is 3.6 inches aft to 13.1 inches aft).

BGA medical requirements

The British Gliding Association (BGA) is the national authority for sporting gliding in the United Kingdom, under delegation from the Royal Aero Club, and controls all aspects of gliding, including medical requirements. Apart from the Rules of the Air, defined within the *Air Navigation Order*

(ANO), aviation safety regulation does not apply to private gliding activities and the CAA has no legal powers or responsibility for the conduct of private gliding. In practice, the BGA seeks to ensure the safety of private gliding but has no legal status or legal powers.

Until 1 March 2003, medical standards in gliding were controlled simply by a medical declaration from the individual wishing to fly in which he/she declared that they did not suffer from any medical disorder that could result in their flying being a danger either to themselves or others. No renewal was required and there was no professional medical endorsement of the declaration. In response to changes in public expectations of safety and a renewed focus on safety by the European Aviation Safety Agency (EASA), the BGA decided to align the medical requirements for flying in gliders with those required to fly powered aircraft under the National Private Pilot's Licence (NPPL) scheme.

The medical standards for the NPPL are based on the standards of fitness for professional and private vehicle drivers laid down by the Driving and Vehicle Licence Authority (DVLA). DVLA Group 2 standards apply to professional drivers and DVLA Group 1 to private drivers. Pilots able to maintain Group 2 standards of fitness may carry passengers and instruct (other than professionally), while pilots maintaining Group 1 fitness standards may fly, but are not permitted to take responsibility for other persons in the air. Fitness to fly is the personal and legal responsibility of the pilot and, as with the BGA requirements, is subject to a declaration of fitness by the pilot; however, the NPPL scheme also requires a periodic endorsement of fitness by the pilot's General Practitioner (GP). The purpose of the latter is to confirm from records that the declaration is accurate with regard to serious disease.

The CAA Medical Division have taken the view, as far as the NPPL is concerned, that an accurate knowledge by a GP of a pilot's medical history is often more likely than a physical examination to predict the risk of a future in-flight medical incapacitation.

The BGA requires a medical declaration to be made before the first solo flight and periodically thereafter depending on age, or after serious illness. The GP is not required to carry out a medical examination before endorsing a pilot's declaration and, in case of doubt, the GP may obtain aeromedical advice from a BGA Medical Adviser. BGA instructors aged over 70 years of age, or who cannot maintain DVLA Group 2 fitness standards, may not fly with students who could not land the aircraft safely in the event of an incapacitation.

The DVLA scheme includes information to doctors on how certain diseases affect ability to maintain the two fitness standards. Some of the diseases have different physiological implications for flying and, under the NPPL scheme, these conditions have been highlighted and information sheets for GPs have been published. A pilot either suffering or having suffered from one of the listed diseases and wishing to obtain his GPs endorsement must present his GP with the relevant information sheet prior to requesting an endorsement.

Historically, aviation medical standards have developed for three reasons: to predict success in training, to ensure a long and productive career following expensive training and to reduce accidents from incapacity in the air. For gliding, the first two are largely irrelevant and the emphasis for a medical scheme in sporting aviation is focussed on the possibility of incapacitation. However, no medical examination, however extensive, can entirely exclude the possibility of incapacitation and the problem therefore becomes one of risk management.

The JAR medical standard is based on the risk of incapacity during the next year being no greater than 1%. This approximates to a risk of 1:876,000. The NPPL scheme accepts the DVLA standards but the NPPL is only available to non-professional pilots and licence privileges are restricted when compared to the full JAR PPL. Although the level of risk for the DVLA scheme is not defined, the BGA advises that the generally accepted level of risk for the DVLA Group 2 standard is 2% and about 20% for Group 1 standard. Statistically, this implies a level of risk 1:438,000 for Group 2 standards and 1:43,800 for Group 1 standards. However, medical advice indicates that incapacity should not be assumed in an accident simply because of a lower medical standard and that positive medical evidence should exist either in the form of pathological evidence or an indication of unusual flight characteristics pointing toward pilot incapacity.

Pilots' medical histories

The student pilot was 15 years old and in good health. Although a detailed medical history was not available to the pathologist, it is understood that there was nothing significant in the student's medical history.

The instructor pilot had a long medical history, most of which was not relevant to the possible cause of this accident. In December 2002 the pilot underwent a medical examination by an AME for a renewal of his JAA-FCL Class 2 PPL medical. During the examination the doctor found a heart condition which, after specialist consultation, was deemed by the CAA as making him "long term unfit" and which precluded him from holding a medical certificate for a PPL. At this time, there was no BGA medical requirement for glider pilots who wished to undertake solo flying, other than to 'self certify' that they did not suffer from any condition which might cause incapacitation. However, to instruct or to carry a passenger in gliders required, after the age of 60 years, that a Declaration of Medical Fitness to fly be countersigned by the GP to the DVLA Group 2 standard. In anticipation of the change that was to occur on 1 March 2003, when all glider pilots, irrespective of age were to be required to complete a Declaration endorsed by their GP to at least the DVLA Group 1 standard, the pilot approached his GP on 13 January 2003 with a request that he be 'signed off' to the Group 1 standard, which was done. However, in March 2003, the CAA wrote to the instructor advising him of the situation but also suggesting that he might still be able to fly powered light aircraft if he could

meet the NPPL medical standard. The instructor contacted his cardiologist to check if his heart condition would allow him to hold the NPPL. Under the DVLA scheme, the instructor's particular heart condition allowed him to maintain a Group 2 standard, provided he was not displaying symptoms of the condition, and the CAA's information sheet on Cardiological Disease imposed no further restriction for the condition. The cardiologist confirmed that he showed no symptoms of the condition, so the pilot approached his GP for the second time for endorsement of a BGA/NPPL Group 2 Medical Declaration. The instructor's GP consulted the DVLA and the medical specialists involved and, on 28 March 2003, the GP endorsed the instructor's Medical Declaration. At the age of 65, this Declaration was only valid for one year. Thus, at the time of the accident, the instructor was allowed under the BGA rules to fly gliders with passengers and to act as an instructor.

However, between January 2003, when the pilot was described as being asymptomatic of his condition, and August the same year, when he returned for his second consultation with his cardiologist, his condition had apparently worsened, as evidenced by a change in the findings on echocardiography (ultrasound of the heart). This was described as "worsening mitral regurgitation" together with some "left ventricular enlargement". This led the pilot to be referred for further cardiac investigation (cardiac catheterisation) with a view to valve surgery. In the August consultation, it was reported that the question of fitness for driving was not discussed by the cardiologist; the consultation was purely a clinical one. Notwithstanding this, it remains the responsibility of any 'pilot-in-command' to assess their fitness to fly at any time and, if in any doubt, they should ground themselves and discuss the situation with an appropriate medical practitioner (CAA NPPL Adviser, GP etc), reference the ANO, Section 1, Part IV 26.3(a).

In January 2004, when the pilot saw the surgeon three days before the accident, his condition was now described as "severe", when previously it had been categorised as "moderate". Thus, although there been a deterioration in the pilot's condition during 2003, since his last declaration of fitness dated 28 March 2003, the pilot apparently took the view following the consultation, that under the terms of the NPPL scheme and the ANO, that he remained fit to fly.

The consultant, subsequent to this accident, has indicated that "there was a loose discussion", not recorded in his notes, principally with the pilot's wife "about the fact that he was a glider pilot" in which the consultant expressed the view that he should not fly with his heart condition. However, the pilot's wife has stated clearly that although she attended the hospital with her husband on that occasion, she did not attend the actual brief consultation and has, in fact, never spoken to the consultant. She has also stated that at no time afterwards did her husband mention any advice from the consultant that he should not fly with his heart condition, and that she would have expected him to do so, should that advice have been given.

Pathological information

Post mortem examination of both pilots found that they had died of multiple injuries. No evidence of any alcohol, drugs or toxic substance which may have caused or contributed to the cause of the accident was found. However, the pathologist stated that with the instructor's heart condition there was a risk of incapacitation or sudden death and that examination of medical literature indicated that the sudden death rate from this condition was 1.8% per year[1]. Nevertheless, the emergency services reported that the instructor was still alive when he was removed from the aircraft, and the pathologist found no evidence to support the contention that the instructor had collapsed or suffered significant distraction. However, the nature of any distraction or collapse could have involved a disturbance of the heart rhythm and this would not have been detectable at the post mortem examination. Although the instructor was asymptomatic, the medical literature indicates that the onset of symptoms is most frequently seen in patients aged between 60 and 70 years and that rhythm disturbance accounts for over half the cases where patients become symptomatic[2]. Thus, although the instructor clearly did not die in flight, it was possible that some cardiac episode associated with his condition had caused him to become distracted or incapacitated.

The pathologist investigated the medical procedures that were followed during the issue of the instructor's BGA/NPPL medical certificate and found that the instructor complied with the published medical standards and that the endorsing GP had acted properly. However, with a sudden death rate of 1.8% per year from this condition alone and an unknown frequency of heart rhythm disturbance, the pathologist believed it would be appropriate to consider whether a restricted medical certificate should be issued to pilots with a similar heart condition. He further suggested that the CAA Medical Department should take advice from a national expert in the condition to determine whether it was appropriate to issue an unrestricted NPPL medical certificate in similar cases under the NPPL scheme.

The pathologist also examined both pilots for evidence that might indicate which pilot had been in control at impact. Injuries to the hands were inconclusive, but injuries to the student's legs suggested that the right leg was extended at impact. The instructor had injuries to both legs.

[1] Ref. Sudden Death in Mitral Regurgitation due to Flail Leaflet. Grigioni F, Enriquez-Sarano M, Ling LH, Bailey KR, Seward JB, Tajik AJ, Frye RL. Journal of the American Collage of Cardiology 1999. 2078-2085

[2] The Oxford Textbook of Medicine states: '*Ventricular ectopic beats are common with mild mitral regurgitation of any cause. Much less frequently, recurrent ventricular arrythmias mar occur; very rarely these may be life threatening. It is these unusual cases that appear to be the basis of a small number of reports of sudden death in this condition. Approximately half of these cases had a history of syncopal or presyncopal episodes* [fainting attacks]'.

Puchacz spinning characteristics

In response to three fatal Puchacz spinning accidents between 1990 and 1993 the BGA sponsored a low speed handling trial of the aircraft. The trial had four main aims:

1. To reassess the aircraft's low speed handling characteristics against the requirements of JAR 22 (Sailplanes).

2. To provide deeper flight test insight into the stall/spin handling characteristics beyond those required by JAR 22.

3. To observe pupils' and instructors' reactions to carrying out spin training with a view to examining the interrelation of training with the JAR 22 requirements or to highlight any limitations in the requirements.

4. To advise on particular aspects of the design and operating envelope with a view to improving operating safety.

The trial was flown by test pilots and instructors in early 1994 under the control of the then DRA Farnborough. The spin recovery was judged against the following standard spin recovery technique outlined in JAR 22 Acceptable Means of Compliance:

1. *Check ailerons neutral.*

2. *Apply rudder opposite spin.*

3. *Ease control column forward until rotation ceases.*

4. *Centralise rudder and ease out of ensuing dive.*

The trial confirmed that the glider was compliant with JAR 22; however, it considered that two areas were worthy of additional comment. The trial considered the aircraft to be only marginally compliant in respect of stalls during turns and noted that avoidance of uncontrolled rolling and spinning off a turn was reliant on pilot awareness and skill. The trial also noted that height loss in a spin was significantly greater than on other types and that this was largely due to the steep attitude (70° nose down) of the developed spin.

The trial also investigated the aircraft's recovery characteristics when using non-standard spin recovery techniques. The only action that appeared to delay immediate spin recovery was the

retention of full aft stick. Releasing the controls or failing to apply opposite rudder resulted in a recovery from the spin, although there were other handling issues such as high sideslip angles and recoveries from very steep attitudes. Critically the report highlighted the following human factors related issue:

> *The JAR recovery procedure first introduces full opposite rudder to counter the yaw rate. This use of rudder on the Puchacz leads (to) a pitch down in the spin which reduces incidence sufficient to facilitate auto recovery at forward CG where recovery then occurs. As the established spin is already estimated at 60-70 degrees, this pitch down gives a very steep exit, perceived to be over vertical but probably not so. It also contributes to the extensive height loss during exit. In a tense or panic situation, particularly at low level, the involuntary reaction could be expected to be retention of full aft stick. This will sustain a spin against full opposite rudder at CG aft of 6.0 inches aft of datum.*

The report further stated in bold:

> ***It can reasonably be concluded that the only control mishandling of the PUCHACZ that can lead to delay in spin exit is the retention of full pro spin elevator….***

The trial made several recommendations. The following were relevant to this accident:

1. *BGA recommended practice RP 35 should be rigorously enforced. Fixed ballast installation in the forward cockpit should remain filled unless maximum all up weight limits are prejudiced.*

2. *Puchacz operators should limit the entry height of deliberate spin training to a minimum of 1,500 feet.*

In addition to the above, the AAIB approached a number of BGA instructors experienced on the Puchacz, and a BGA accident investigator flew the aircraft on a spinning sortie. The widely held view amongst the instructors was broadly that, unlike some other modern gliders, the Puchacz would readily enter a spin, but equally readily it would come out of a spin when the recovery technique was applied. The rate of rotation was higher than in other gliders and in particular the Puchacz spins with a steep nose down attitude losing about 300 feet per full rotation. One of the BGA's professional instructors noted that out-of-spin aileron tended to flatten the spin and the recovery from a flat spin can take slightly longer than a normal spin but, if the controls were held in the anti-spin position, the aircraft recovered normally.

Previous Puchacz spinning accidents

Prior to this accident, the Puchacz had been involved in five UK spinning accidents, four of which had resulted in fatalities. The majority of these accidents were the result of inadvertent spins. One accident during spin training with two instructors on board was attributed to a low level spin entry and lack of height awareness on the part of the crew. None of the UK accidents involved a deliberate spin entry in which the aircraft apparently stayed in a stable spin all the way to impact. Overseas spinning accidents follow a broadly similar profile.

Glider flying control and regulation

Although the BGA seeks to ensure the safety of private gliding and currently has no legal status or legal powers, BGA members and member clubs (which covers almost all the gliding activity in the UK) are obliged to comply with BGA Operational Procedures. Recommended Practices and Codes of Practice are not mandatory but state that*' a prudent pilot would do well to observe them'.* BGA clubs are required by Operational Regulations to maintain local (club) regulations.

Recommended Practice 18 suggests that:

> '*The CFI should lay down minimum heights for aerobatics at his club and no aerobatics should be done below this height without special permission.'*

Consultation with gliding clubs revealed that minimum heights are not normally laid down for spinning.

Paragraph 7.9 of the BGA Operational Regulation requires that:

> *'All flying instruction shall be given in accordance with the BGA regulations and syllabus'.*

Detailed requirements and procedures for glider instructors are published in the BGA Instructor's Manual. Although gliding club Chief Flying Instructors are responsible for approving individuals to instruct at his/her club, the procedures for, and standardisation of, instruction are centrally controlled by the BGA Instructors sub-committee, rather than at club level.

The following extracts from the BGA Instructors' Manual are relevant to this accident:

> *'In the initial stages of spin training, continuous spins of two or three turns are mainly to allow the trainee time to study the characteristics of the spin and give confidence that the recovery action from a stabilised spin is effective'.*
>
> *'The majority of spin training will then involve brief spins of about a half a turn with the primary aim of recognising the circumstances in which the spin can occur, correctly identifying the spin/spiral dive, and practising the correct recovery action'.*
>
> *'As this training progresses, it is necessary to introduce brief spins where the ground is noticeably close. This is to ensure that the trainee will take the correct recovery action even when the nose is down and the ground approaching. A very experienced instructor flying a docile two seater in ideal conditions may be prepared to initiate a brief spin from 800 feet. A less docile two-seater with a less experienced instructor or less than ideal conditions should raise the minimum height considerably'.*
>
> *'**The crucial action** is to move the stick forward to unstall the glider EVEN though the nose is dropping or pointing steeply downwards.'*
>
> *'Instructors should be aware that **very few pilots recover from inadvertent low level spins**, and that **stall/spin avoidance is the training's main aim.'***

The BGA Instructor's manual recommends that pre-aerobatic (HASLL) checks are completed prior to each spinning exercise. The HASLL check is published in the manual and starts as follows:

> *'Height*
>
> *Make allowance for the height used during the manoeuvre, and allow sufficient to return afterwards to the airfield……. Set a minimum height for entry to any manoeuvre, and don't be tempted to make it any lower. Some account should be taken of the height of the terrain below….'*

Analysis

From the above, it is apparent that no conclusive evidence of a cause of the accident was discovered during the investigation. The main feature of the third spin, from which the glider did not recover, is that there was no apparent attempt at recovery. This analysis therefore concentrates upon the most likely technical and operational reasons for this failure to recover from the spin.

Engineering Analysis

Examination of the glider wreckage, both at the scene and later at Farnborough, indicated that its structure had been intact prior to impact and that no jam or disconnection of the flying controls was likely to have occurred prior to the accident. The expert examination of the fracture noted in part of the left airbrake bevel gear mounting structure, which, had it occurred prior to the impact with the ground, could have allowed the left airbrake to be deployed in flight despite being selected in, indicated that the failure was most probably the result of the impact, with corroborative evidence being provided from an examination of the gear teeth and an assessment by of the manufacturer.

The failure of the bonded joint occurred in tension, rather than shear, which would have required loading to have been applied in the span-wise direction. At the moment the aircraft nose struck the ground, it is likely that considerable deflection of the wings occurred, in the form of either a downward bending, or a shock wave which travelled along the span. Since the airbrake control rods were mounted above the main spar, these would be loaded in tension when the wing was deflected downwards, which in turn would have acted to unlock the over-centre mechanism and thus allow the associated airbrake to deploy. If the deflection was excessive, it is likely that the tensile snatch load in the control rods could have caused the bonded joint to fail.

The reaction forces between the gear teeth loaded the gear support web in a manner that imposed a shear force in the bond between the web and wing root. Since the bond would have been inherently stronger in shear than in tension, it increases the probability that the failure occurred as a result of wing deflection at impact, as opposed to a progressive failure over a period of time. Nevertheless, it was not possible to be completely certain on this issue. The dissimilar arrangement of the left and right bevel gear support structure meant that the web that was the focus of this examination was used only on the left side. It was considered that as a result, the left side gear support was less robust than the right. However, both sides are difficult to inspect, the only access being via holes in the wing root web. A Safety Recommendation (2004-68) is made later in this report to the BGA concerning inspections of the airbrake bevel gear mechanism in the left wing.

Operational analysis

Although no-one overheard the pre-flight briefing for the accident flight, the eyewitness evidence of successive spins and controlled recoveries, together with the student's stage of training and the suitability of this aircraft for spinning, strongly suggested that the primary aim of the flight was spinning training.

The total number of practice spins carried out on the sortie has not been established for certain, but given that the aircraft was towed to 3,000 feet and that two successful spins and recoveries were witnessed prior to the final spin, it appears likely that the final spin was the third of the flight. The entry height, according to the witnesses in the Rotax Falke, would have been about 1,500 feet and this appears to be corroborated by the five turns of the final spin witnessed from the ground.

Critical to an understanding of this accident is the evidence of witnesses on the ground who saw the glider spinning until it went out of sight. At this point it would have been about 90 feet above the ground. The evidence indicated that the glider was in a normal, steeply nose-down spin and, apart from the rate of spin perhaps speeding up (which would be normal in a Puchacz multi-turn spin), the flight path did not change up to the moment the witnesses lost sight of it. There was a slight conflict with the evidence of the glider pilot who saw the Puchacz hit the ground from his position to the north-west of Husbands Bosworth. He did not consider that the aircraft was in a spin and he thought the nose attitude was quite shallow. However, he was some distance away and only witnessed the last few seconds of the flight. Nevertheless it raises the possibility that the aircraft had started to recover after sight of it was lost by the ground witnesses.

The 1994 flight test report for the Puchacz stated clearly that the only "mishandling" that could lead to a delayed recovery was the retention of full pro-spin (up) elevator. Given the lack of technical evidence for such a condition it might be assumed that one or both pilots either held the stick fully aft or was unable to move the stick forward for most, if not all, of the spin.

Although there has been a previous case of lack of height awareness causing a spinning accident, it seems unlikely that the final spin was intended to be any longer than the previous two short, one and a half turn, spins. Thus, intentionally maintaining the spin with the control column fully aft due to lack of height awareness would seem an unlikely cause of the accident. Although no evidence was found of a control restriction, there remains a possibility that the control column was jammed in the fully aft position by a loose article. However, it is reasonable to assume that, had this been the case, the instructor would have attempted to use either aileron or rudder or both to recover from the spin and in all probability, this would have affected the flight path of the spin. Given witness evidence of a continuous spin with no discernible change to the flight path, the fact that no 'loose articles' were discovered in the wreckage, and the tolerant nature of the flight controls to a loose object, a control jam would also seem to have been unlikely as a cause of the accident.

There have been instances of student's 'freezing' on the controls in high stress situations and instructors have needed to intervene aggressively to regain control. This is obviously more difficult in a tandem aircraft than one with side-by-side seating. However, the student had previously been given an introduction to spinning in a K13 glider and been in two Puchacz spins during the accident

flight. The only difference for the final spin was a lower entry height. Whilst this might have caused the student some concern it seems unlikely, with his experience, that it was low enough to cause him to 'freeze', particularly as it was likely that the spin would have only continued for one to one and a half turns, as with the two previous spins. Moreover, although the student was quite large for his age, the instructor was not a small man and had a weight advantage. It therefore seems improbable that the instructor would have been unable to overcome the student had the need arisen, although had he been distracted or partially incapacitated, then his full abilities to do so may have been impaired. This scenario, however, requires that the student 'froze' co-incidentally with the instructor becoming incapacitated.

Thus, there remains the more likely possibility that one of the pilots was incapacitated. The student's reported good health, the lack of pathological evidence and the arguments outlined above make it unlikely that the student became incapacitated and prevented the instructor from recovering from the spin. Although there was no evidence from the post mortem examination to indicate incapacitation of the instructor, the pathologist stated that the instructor could have temporarily become distracted or lost consciousness, and that one mechanism for this might be by way of a heart rhythm disturbance associated with his known heart condition.

It is not an unusual instructional technique in the early stages of spinning training for the instructor to brief the student to enter the spin and to carry out the recovery on the instructor's command. The evidence to support incapacitation is far from conclusive but, if the instructor had become distracted or lost consciousness, it seems credible that the student could have been in control in the spin and awaiting a command to recover that did not come. The instructor was known not to interfere unnecessarily whilst his students were flying and there was a significant inter-cockpit age and experience gradient. It is possible, therefore, to imagine that the student would have taken some time to realise that something was wrong. Even though the student was clearly a very able young man, a low level spin recovery for a pilot of his experience would have been extremely difficult. Moreover, by the time he was likely to have appreciated the problem, the glider would have been at such a low height that, as outlined in the 1994 Puchacz spinning report, he would have found it psychologically very difficult to move the control column forward as the ground 'approached'. This may explain the more or less continuous spin to impact and the possibility that the student was only applying anti-spin rudder at the time the glider hit the ground.

Safety Recommendations

Whilst the issue of pilot incapacitation in this investigation has proved inconclusive, it is questionable how well the BGA Operational Regulations, and the advice contained in the BGA Instructor's Manual at the time of the accident, contributed to situational awareness and thus how

well a student of any experience level would cope with an incapacitation of the instructor in a spin. Whilst the Operational Regulations require clubs to specify minimum heights for aerobatics, it appears that this has not generally been applied to spinning. Furthermore by specifying a minimum height of 800 feet to commence a spin in a benign glider type, the Instructors' Manual gave some advice on one of the extremes of the spinning envelope but provided little advice on how situational awareness might be aided in a spin. For example, there was no requirement to specify minimum entry heights or minimum recovery heights. Clearly these will vary by glider type, but the discipline of stating each before a spin would at least raise questions in pilots' minds if they saw one or other limit approaching or passing.

Since this accident the BGA have issued the following information to their members and Clubs.

> *The BGA Instructors Committee has recently agreed that all pilots and instructors should be reminded of the need to take note of a number of factors when considering the height at which spinning should be initiated. Some gliders have particular characteristics that can sometimes cause a delayed recovery and/or a significant height loss in the recovery phase. The potential, significant height loss should be carefully taken into consideration when deciding when it is safe to initiate a spin. The glider type Flight Manual is a vital source of information. The recommendation in the BGA Instructors Manual, page 19-3, to initiate a 'brief' spin at 800 feet during pilot training will be removed by appropriate amendment action in due course. You are urged to bring this note to the attention of your club pilot and instructor colleagues. ……..'*

Notwithstanding this, the following recommendation is made.

Safety Recommendation 2004-65

It is recommended that the British Gliding Association require all Gliding Clubs to ensure that instructors and pilots establish and brief students on, minimum entry heights, minimum recovery initiation heights and minimum recovery heights, whenever intentional spinning is planned. These heights should take into account the characteristics of the glider type being flown, the experience and ability of the crew, and the possible need to abandon the glider.

The pathologist carried out a comprehensive investigation into the medical procedures that resulted in the instructor obtaining a countersigned BGA unrestricted Medical Declaration. He concluded that "it was entirely proper" that this had been done. There is a difference of recall between the consultant and the pilot's wife about the circumstances surrounding the consultation three days before the accident. Nevertheless, given some of the medical evidence regarding the rate of sudden death and the unknown rate of heart rhythm disturbance in patients with the instructor's heart

condition, the pathologist remained concerned whether someone with that condition should be allowed to instruct or fly with passengers. The pathologist suggested that the Civil Aviation Authority Medical Department should take advice from a national expert in this heart condition to determine whether it is appropriate for sufferers to be issued an unrestricted National Private Pilot's Licence. Whilst the pathologist's suggestion addresses this instructor's condition, there remains the possibility that other conditions might present unacceptable risk of airborne incapacitation. The following recommendation is therefore made:

Safety Recommendation 2004-66

The Civil Aviation Authority should review the National Private Pilot's Licence medical standards to confirm that the combination of the Driver and Vehicle Licensing Agency (DVLA) Scheme and National Private Pilot's Licence Information Sheets adequately address the risk of medically induced distraction or incapacitation for instructors and pilots authorised to carry passengers.

The apparent difference of understanding over the severity of the pilot's condition between the instructor pilot and the consultants, highlights the need for any pilot to openly discuss, or initiate discussion with their treating physician and/or GP, any medical condition, or change in a condition, that might impact on their ability to fly safely. On the occurrence of such an event, pilots should be reminded that they have the responsibility to initiate such a discussion, since their medical adviser may not be aware that they are flying as a pilot. Therefore the following recommendation is made.

Safety Recommendation 2004-100

The Civil Aviation Authority should re-emphasise the advice to pilots concerning the need to discuss with their treating physician and/or GP, any changes in medical condition, treatment, or the need for additional investigations not previously thought necessary when renewing or applying for medical documentation in relation to a flying licence.

In order to possess a valid JAA-FCL Private Pilot's Licence in the UK and act as commander a light aircraft, with or without passengers, a pilot is required to hold a valid JAA-FCL medical certificate. In order to give flying instruction in such aircraft, if payment for such instruction is given, a pilot would require an appropriate 'Commercial' Pilot's Licence and Instructors Rating but, particularly, a valid JAA-FCL Class 1 medical certificate. However, if flying instruction is given, but not for payment, then a JAA-FCL Class 2 medical certificate would be required as a minimum. Apart from the obvious difference between light aircraft and gliders, in that most flying instruction in gliders is given without the use of an engine, there can be no difference in the 'duty of care' that any flying instructor has for the welfare of a passenger or student, particularly one who has not achieved a 'solo' standard of flying, and who could not be expected to land the aircraft safely, should the need arise.

This seems inconsistent with the different medical standards required by the CAA and the BGA for flying instructors in powered light aircraft and gliders respectively[1]. In the case of HCD, the instructor pilot was allowed, under the BGA system, to give flying instruction to a pre-solo standard student whilst, due to his medical condition, he did not meet the standards of the JAA-FCL Class 2 medical. This meant that had he been an instructor in powered light aircraft, the loss of his JAA-FCL Private Pilot's Licence due to his medical condition becoming known, would have prevented him from giving flying instruction to the same student, or to carry passengers, in such aircraft.

The following recommendation is therefore made.

Safety Recommendation 2004-67

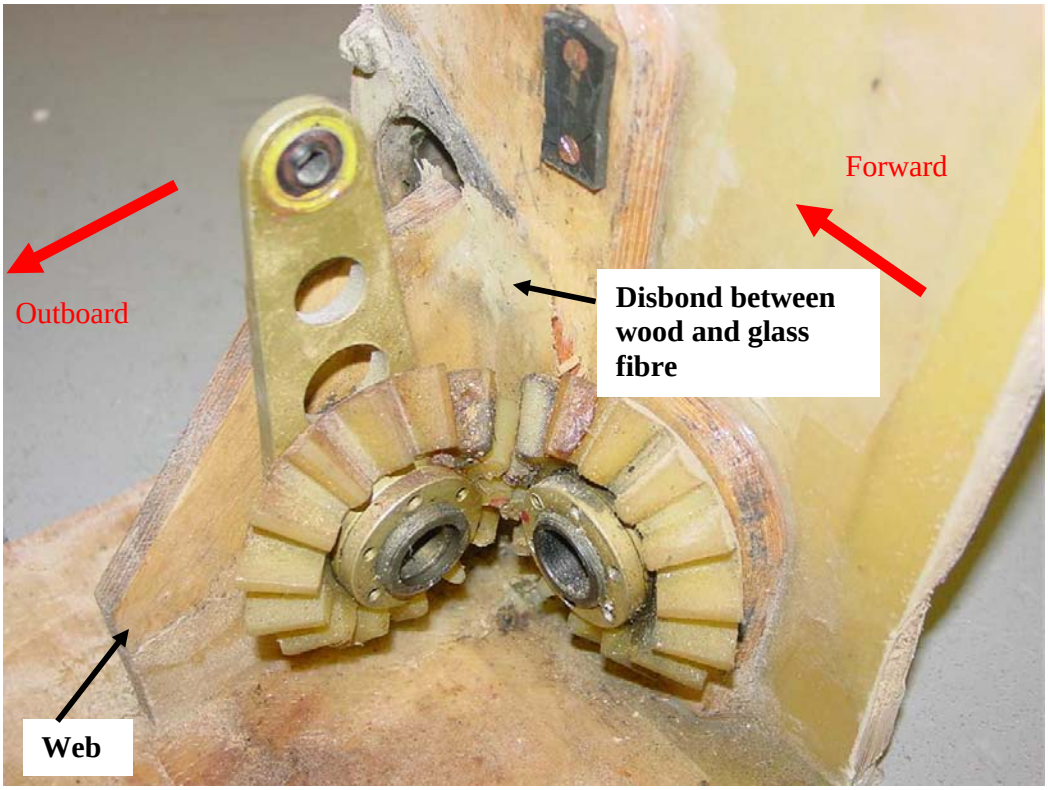
It is recommended that the British Gliding Association should undertake a review of their medical standard requirements to assess whether it remains appropriate for glider pilots with any valid instructional ratings to give flying instruction in gliders whilst only in possession of a valid DVLA Class 2 Medical Declaration.

The dissimilar arrangement of the bevel gear assemblies in the airbrake actuation mechanisms of the right and left wings meant that the gear support web that was the focus of the examination by QinetiQ, was used only in the left wing. It was considered that, as a result, the left side gear support structure was less robust than the right. However, both sides are difficult to inspect, the only normal access being via holes in the wing root web. As it was not established with complete certainty that the failure of the bonded joint associated with the bevel gear support structure occurred as a result of wing deflection at impact, and that the bond appeared to be of poor quality, the following recommendation is made:

Safety Recommendation 2004-68

It is recommended that the British Gliding Association require regular inspections to be conducted on the left wing bevel gear support structure associated with the airbrake actuation system of the SZD Puchacz glider, paying particular attention to the bond between the gear support web and the inner face of the wing root rib.

[1] N.B. Microlight aircraft instructors have been permitted to give flying instruction whilst only in possession of a '150 A/B medical form (Declaration of Health) with GP countersignature, for some 20 years.



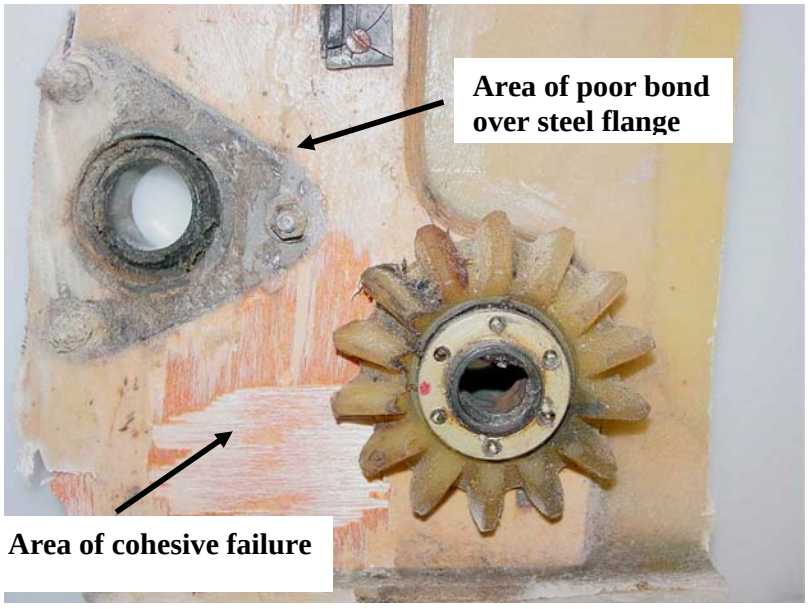


Figure 1. Details of the left hand airbrake bevel gear assembly, after being cut out of the aircraft

Below: view of inner rib after removal of web

(photos: QinetiQ)