Piper PA -25-235 Pawnee, G-ASLK, 14 September 2001

AAIB Bulletin No: 2/2003	**Ref: EW/C2001/09/03**	**Category: 1.3**	
Aircraft Type and Registration:	(i)	Piper PA -25-235 Pawnee, G-ASLK	
	(ii)	Standard Class Cirrus Glider, GAL, (BGA No 3678)	
No & Type of Engines:	(i)	1 Lycoming 0-540-B2C5 piston engine	
	(ii)	N/A	
Year of Manufacture:	(i)	1963	
	(ii)	1973	
Date & Time (UTC):	14 September 2001 at 1438 hrs		
Location:	Aston Down Airfield		
Type of Flight:	(i)	Private (Aerotow)	
	(ii)	Private	
Persons on Board:	(i)	Crew - 1	Passengers - N/A
	(ii)	Crew - 1	Passengers - N/A
Injuries:	(i)	Crew - 1 Fatal	Passengers - N/A
	(ii)	Crew - 1 Fatal	Passengers - N/A
Nature of Damage:	Both aircraft destroyed		
Commander's Licence:	(i)	Private Pilots Licence	
	(ii)	Gliding Certificate (Bronze)	
Commander's Age:	(i)	57 years	
	(ii)	61 years	
Commander's Flying	(i)	1,520 hours	

Experience:

		Last 90 days - 28 hours
		Last 28 days - 16 hours
	(ii)	287 hours
		Last 90 Days - 16 hours
		Last 28 Days - 8 hours

Information Source: AAIB Field Investigation

History of the flight

The gliding club at Aston Down normally used a winch to launch its gliders. On the morning of the accident, however, after successfully launching four gliders from asphalt Runway 03, the winch became unserviceable. In order to continue gliding, inquiries were made of the nearby gliding club at Nympsfield for the use of their Piper Pawnee tug aircraft. The Nympsfield club agreed and at approximately midday an Aston Down club instructor (a qualified tug pilot), who had flown three of the winch launched flights that morning, drove to Nympsfield to ferry the aircraft back to Aston Down. The weather was fine with scattered cumulus cloud at 3,000 feet, visibility in excess of 10 km, and a surface wind of approximately 315°/15 kt.

During the afternoon the instructor carried out nine aerotows following the prescribed departure routes as detailed in the club briefing material. On returning to the airfield after each launch the tug aircraft varied its rejoining procedure carrying out both left and right hand circuits to land diagonally across the grass area to the south of Runway 03 threshold. It is thought that these variations in approach path were to cater for the noise sensitive areas within the local community and landing diagonally across the grass landing area was probably to allow for a more controllable into wind touchdown.

The Cirrus was the seventh glider to be aerotowed. Initially the launch was aborted after approximately six feet of tow due to wing instability caused by the cross-wind. A successful launch however was subsequently carried out, at 1510 hrs, with the Cirrus glider releasing from the tug at approximately 2,000 feet agl up-wind to the west of the field. The tug aircraft then returned to the field and towed a further two gliders up to 2,000 feet.

Witnesses on the ground, both at the launch point and in adjacent fields, saw the tug aircraft and the Cirrus glider as they returned to the airfield and positioned for their respective approaches. The glider was seen to fly a right hand circuit for an approach to land on the southern grass area parallel to the runway centreline. The tug aircraft appeared to join the landing pattern on a left base leg with the intention of crossing the extended centreline of the approach to turn closer into wind and land diagonally across the southern grass area as it had done before. The two aircraft approached each other at a height estimated by witnesses to be between 150 and 400 feet. The glider was turning to line up to land with slight right bank applied. The tug aircraft was carrying out a 20° banked continuous level left turn (see Figure 1 *(jpg 229kb)*). Neither pilot was seen to take avoiding action before the two aircraft collided. After the collision both aircraft descended out of control. Both pilots were fatally injured on impact with the ground.

Wreckage examination

The wreckage of the two aircraft lay in ploughed fields approximately half a kilometre to the south of the intended landing area, and were separated from one another by a distance of approximately 160m, the tug being to the east of the glider (see Figure 2 *(jpg 229kb)*).

The Piper PA-25 Pawnee (tug aircraft)

The tug had struck the ground almost vertically, causing total disruption and break-up of the nose structure and forward fuselage back as far as the instrument panel. It had rotated through approximately 90° from its initial impact position before collapsing down onto its left side and coming to rest, indicating that the aircraft was falling in a spinning motion to the left prior to impact with the ground. All of the wreckage from the tug lay within its ground impact area, and it was evident that nothing of substance had become separated from the aircraft prior to its impact with the ground. The tow rope lay separately on the ground, adjacent to the tow hook on the aircrafts tail section, which was in the released condition. The post impact position of the rope and the condition of the cable operated hook mechanism suggested that the latter had opened, and released the rope, as a result of forces imposed on it during the impact sequence.

Clear witness marks were left in the ground by each of the wing leading edges during the initial impact. The impression produced by the left wing, however, was not in its expected (symmetrically opposite) position relative to that from the right wing; instead, it lay approximately at right angles to it, consistent with the whole of the left wing having folded upwards relative to the fuselage, so as to lie against the fuselage side, prior to ground impact. Both of the primary lift struts which support the left wing were bent upwards having failed in a compression buckling mode. Evidence of heavy pre-impact damage was noted on the leading edge regions of these struts in the area where they had buckled. The smaller stabilising struts which support the main lift struts in this same area also exhibited evidence of heavy pre-impact deformation and buckling, with associated red paint transfer (smearing) overlaying the white paint finish. Furthermore, localised regions of red paint transfer were found on the lower surfaces of the inboard sections of the main lift struts of the left wing, in the area of the pre-impact buckling, and on skin panels immediately adjoining the leading edge root. A small isolated area of red paint transfer was also noted on the left side of the cockpit roof.

Both main lift struts on the left wing, together with their associated stabilising struts, had suffered extensive damage during the collision with the glider which compromised their ability to carry the imposed flight loads. As a direct consequence, these struts failed in a compression buckling mode, allowing the left wing to fold upwards at its pinned attachments to the fuselage. Such a failure sequence would have caused the aircraft to roll violently and irretrievably to the left and enter a steep spiralling dive to the left.

The aircrafts controls were examined in situ and no evidence was found of any pre-impact defect or malfunction. It was established that the flaps were set to the mid position. The four bladed wooden propeller had fragmented during the ground impact, and it was not possible to make any reliable assessment of engine power at impact from their remains. It was apparent however, from collision damage observed on the gliders remains that the propeller was rotating under power at the time of the collision.

The Cirrus glider

The greater part of the glider, comprising the entire fuselage together with the fin and rudder, the whole of the right tailplane and right wing (the latter broken into two pieces), and the greater part of the left wing, lay within the gliders ground impact area. The rest of the aircraft was scattered over a separate region (measuring some 150 metres by 60 metres) to the south east of the gliders ground impact point, and approximately 50 metres to the south of the tug wreckage.

The glider had struck the ground in a very steep nose down attitude, slightly beyond the vertical, resulting in the complete disruption of the nose and cockpit. The aircraft had come to rest inverted, having turned slightly from the initial impact witness marks. This indicated rotational momentum to the left (viewed from above) prior to impact. Both wings remained securely attached to the fuselage and each had produced clear leading-edge impressions in the ground during the impact. It was apparent from these impressions that the wings had been in their correct relationship to one another at impact (ie neither wing had folded). The impression left by the left wing however, terminated (short) at the fractured outboard end of the wing, confirming that the outboard section of left wing had separated from the glider prior to impact with the ground. The right outer wing had broken away from the inboard wing section, but lay over the top of its initial impact mark in the ground, and it was evident that the right wing had been intact prior to impact with the ground.

The rear fuselage had broken apart during the impact at a position approximately mid way between the wing and tail. The tail section, comprising the rear fuselage, fin and rudder, the tailplane centre section and right tailplane (the latter still attached by its hinge point to the top of the fin), was laying separately adjacent to the inboard right wing. A small segment of the inboard left tailplane lay on the ground close by the tail section, but most of the left tailplane was missing.

Only two areas of pre-impact damage, both at the tail of the aircraft, were found on items of glider wreckage found at the impact site. The first comprised distinct chordwise cuts, characteristic of propeller strikes, at the points of separation of the small piece of inboard left tailplane. The second was a lozenge shaped area of paint transfer (smearing) on the lower fuselage left side, which extended rearwards and partially up onto the fin and rudder. This region extended longitudinally from a point approximately 1m ahead of the rudder hinge line aft to a position just behind the hinge line, and contained distinct areas of green, blue, and red paint transfer, together with more generalised smearing of an indeterminate grey colour. The direction of the smearing was uniform at approximately 12° to the fuselage longitudinal axis.

No evidence was found to suggest any pre-impact defect or malfunction of the gliders primary controls except for the fracture and separation of the left aileron at the point where the left outer wing panel had broken away and separated prior to the ground impact. Witness marks were found on the wing surfaces, adjacent to the airbrake/spoiler recesses on each wing, suggesting that the air brakes had been extended (partially, at least) at the time of impact. The pattern of smearing at the rudder hinge line suggested that the rudder trailing edge had been deflected approximately 13cm to the right at the time the marks were produced. The Cirrus rudder surface, however, is hinged on its right side and the forces acting upon it during the paint transfer process would have tended to push the rudder across to the right. The position of the rudder indicated by the marks therefore is likely to be spurious.

A separate region of scattered debris from the glider contained three separate segments of left tailplane (making up the whole of the (missing) left tailplane) together with the remains of the outermost 1.7 metres of the gliders left wing. The latter comprised one large piece extending from the main separation (airborne fracture) point out as far as the outboard end of the aileron cut-out, and a number of smaller pieces from the tip section. A small number of yet smaller fragments from

the left wing tip region were dispersed widely over ground just to the east of the larger pieces. The remains of both the left tailplane and the outer left wing were gathered together and reconstructed in situ, to establish the modes and direction of structural separation in each case.

It was apparent that the three segments of left tailplane were separated by clearly defined spanwise cuts, each cut approximately normal to the surface and at similar spanwise separations of approximately 31 cm, consistent with successive strikes by the tug aircrafts propeller blades.

Reconstruction of the fragmented outer left wing and tip region revealed evidence of a predominantly cleaving action by some blade-shaped object acting in the plane of the wing. It had effectively cut inwards from the tip, separating the upper and lower panels of the wing and breaking up the internal structure. Score marks were noted on the internal cleavage surfaces, all orientated approximately 45° inward and rearward.

Gliding Club procedures

The club briefing sheets for aircraft movements at Aston Down explain, amongst other details, the procedures to be used by gliders and tug aircraft when Runway 03 is in use. It states that gliders should make a right circuit to land on the grass to the south of the runway. It also states that everyone else will be using this area, so keep a good lookout at all times for both gliders and tugs. The briefing notes also depict, by means of arrows on a map of the airfield, the landing areas for gliders and the routes to be flown by tugs both on departure and when recovering to the airfield. The route for tugs landing, when Runway 03 is in use (see Figure 1), is depicted as a right hand circuit with the aircraft landing on the grass to the right and parallel to Runway 03.

Other published material, available on the club's internet website, describes the procedures to be adopted for circuits. The relevant extract is reproduced below:

> Glider circuits in either direction. Powered aircraft right hand circuits at 700 feet aal outside the glider circuit. No dead side, no overhead joins. Active runway not available for landing. Landing aircraft to use grass areas indicated but grass east of 03/21 is used as winch track and is only available for landing when clear of gliders waiting to launch. Non-active runway also available for landing but aircraft must keep well clear of runway intersection to avoid winch cables on the active runway.

Rules of the Air

Section 2 of the Air Navigation Order details The Rules of the Air Regulations. Paragraph 17 is titled Rules for avoiding aerial collisions. The relevant entries relating to this accident are reproduced below:

> 17
>
> (1)General
>
> > (a)Notwithstanding that the flight is being made with air traffic control clearance it shall remain the duty of the commander of an aircraft to take all possible measures to ensure that his aircraft doe not collide with any other aircraft.

(b)An aircraft shall not be flown in such proximity to other aircraft as to create a danger of collision.....

(2)Converging

(a)Subject to the provisions of paragraphs (3) and (4), an aircraft in the air shall give way to other converging aircraft as follows:

(i)flying machines shall give way to airships, gliders and balloons;.....

(b)(i) Subject to the provisions of sub-paragraphs (a) and (b)(ii), when two aircraft are converging in the air at approximately the same altitude, the aircraft which has the other on its right shall give way.....

(5)Flight in the vicinity of an aerodrome

Without prejudice to the provisions of rule 39, a flying machine, glider or airship while flying in the vicinity of what the commander of the aircraft knows or ought reasonably to know to be an aerodrome or moving on an aerodrome, shall unless, in the case of an aerodrome having an air traffic control unit that unit otherwise authorises:

(a)conform to the pattern of traffic formed by other aircraft intending to land at that aerodrome, or keep clear of the airspace in which the pattern is formed; and

(b)make all turns to the left unless ground signals otherwise indicate.

(6)Order of landing

(a)An aircraft while landing or on final approach to land shall have the right-of-way over other aircraft in flight or on the ground or water.

(b)(i)Subject to sub-paragraph (ii), in the case of two or more flying machines, gliders or airships approaching any place for the purpose of landing, the aircraft at the lower altitude shall have the right-of-way, but it shall not cut in front of another aircraft which is on final approach to land or overtake that aircraft.....

Collision analysis

The orientation of the propeller cuts into the left tailplane of the glider is consistent with the propeller disc being approximately at right angles to the tailplane surface, and parallel with the gliders fuselage axis. The two aircraft, at the time of collision, therefore, were approximately at right angles to one another with the tug approaching the gliders left side with its fuselage positioned just behind the glider's left wing. The spacing of the propeller cuts in the tailplane would suggest a relative speed of closure between the tug and the glider of approximately 70 mph at an engine

speed of 1500 RPM, or 78 mph at 1700 RPM; broadly consistent with the tugs expected airspeed during the approach.

The heavy damage to the tug aircrafts left wing struts and the abundance of red paint smearing in this same region is consistent with a heavy contact on some part of the glider painted red. (The nose and wing tips were painted red). Given the approach by the tug into the gliders left side (evident from the pattern of propeller cuts) and the heavy damage to the red painted wing tip of the glider, it is evident that the primary structural contact between the two aircraft was between the gliders left wing tip and the left wing strut of the tug. The relative motion between the two aircraft at the point of collision would therefore be expected to lie somewhere in the range 35° to 45°, depending upon the actual airspeeds being flown by the two aircraft. This approximates to the observed angle of the score lines noted on the cleavage surfaces in the outer wing. The splitting apart and subsequent fragmentation of the gliders wing tip would have resulted in more generalised contacts on the undersides of the struts and the wing and fuselage skins near the tugs wing root. This process would have produced the more generalised pattern of red paint smearing noted in these areas. As the collision progressed and the gliders wing penetrated further back between the wing struts, and the tip section finally broke away, it is likely that one of the red painted segments struck the cockpit roof left side, producing the single isolated paint smear in that area.

Fields of view

A simple 3D computer model was constructed of each aircraft type to explore the potential field of view of each pilot. The two models were brought together and adjusted so as to provide the best fit with the collision-damage features noted on each aircraft, with the distribution of wreckage on the ground, and with the position of the intended landing area. The most coherent fit was achieved with the tug aircraft in a descending balanced 25° banked turn to the left and at an airspeed of approximately 70 mph. The glider was in a balanced descending turn to the right, at an airspeed of approximately 50 mph and a bank angle of approximately 20°.

Using the computer model, each pilots potential field of view at 1 second and 2 seconds prior to impact and at the instant of collision, was simulated (see Figure 3 *(jpg 229kb)*). This suggested that during the period immediately preceding the collision, neither aircraft would have been physically obscured from the view of the other by a wing or the edge of the cockpit glazing. However, in each case the aspect presented by each aircraft was poor, presenting a small profile that would have been difficult to see even when looking at it directly.

From the gliders cockpit, the tug would have been visible only in the pilots peripheral field of view towards his left wing tip. If he had not turned to look directly towards his left wing tip, and particularly if he had been concentrating on the landing area ahead, the tug would not only have been positioned outside his foveal field of vision, but the rate of movement of its image across his retina would have been very small. In such circumstances therefore, he could not easily have discerned the tugs presence prior to the collision.

From the tugs cockpit, the glider would have been positioned ahead, and slightly to the right side of the nose, in side-on silhouette. Initially, the image would have been very small, moving progressively towards the straight-ahead position and growing slowly in size until about a quarter of a second before the collision, when it would have become partially obscured by the nose of the tug. If the tug pilot had been concentrating on the landing area down to his left, the small profile of the glider would have been positioned in his right side peripheral field. In such circumstances, and

without a deliberate scan ahead to bring the glider into his foveal field of view, the gliders presence would not be apparent to the tug pilot.

British Gliding Association (BGA) safety initiatives

The BGA have the responsibility for the control of glider operations within the BGA movement. They have, however, no absolute authority. The BGA Safety Committee endeavours to instill a safety culture into glider pilots and at the time of the accident had in place the following safety programmes.

Communications

(a)Articles published in the bi-monthly gliding magazine Sailplane and Gliding

(b)A Gliding Safety insert with every other issue of Sailplane and Gliding

(c)Grapevine; the RAFGSA safety awareness newsletter sent directly to all gliding clubs and posted on the BGA website, (www.gliding.co.uk).

(d)Safety Flashes sent directly to the clubs.

(e)Safety lectures focussed, on gliding issues.

(f)Guidance material for Clubs outlining procedures to deal with accidents or incidents.

Oversight

(a)Regional Safety Officers available to assist club officials with independent safety reviews - a recent initiative set up to visit all clubs every 3-4 years, but also to encourage the clubs to formulate a framework of their own in which they can improve their basic safety structure.

(b)Safety Committee input to student and instructor training syllabi and manuals.

Tug pilot training and testing

Pilots of tug aircraft have to hold a UK CAA Private Pilots Licence (PPL), with a Single Engine Piston (SEP) rating, which has to be renewed every two years. The qualification of tug pilot is not classed as a separate rating attached to the PPL (as for example a sea plane rating). There is no formal training syllabus and the only requirement to qualify as a tug pilot is to have been checked by a local tug instructor as competent. The only rating therefore that needs to be renewed is that for SEP aircraft. This renewal can be carried out with any CAA approved instructor. For convenience, and because of the specialised nature of the activity, the CAA have approved several named BGA tug pilots to carryout SEP renewals using two - seat tug aircraft. When the pilot's SEP rating is renewed by a tug pilot one of the elements of the check flight includes the consideration of collision avoidance. A tug pilot, however, need not make use of this facility to have his SEP rating renewed and thus having been approved as a tug pilot need never have his tug pilot operational standard assessed.

Conclusion

The glider was carrying out a right hand circuit and approach to land on the grass area parallel and adjacent to Runway 03 at Aston Down. This was in accordance with the guidance material published by the gliding club. The tug aircraft was returning to the airfield on a left base to cross the extended centreline of Runway 03 and land diagonally on an approximate heading of 340° across a grass area to the south of Runway 03 threshold. This flight path crossed the final approach path of the glider and was at variance to the procedures published by the club.

The evidence suggests that both aircraft were serviceable prior to impact. Whilst turning from opposing directions onto final approach towards a common landing area, both aircraft collided. The collision caused the break up and separation of the gliders left outer wing and aileron, and the loss of its left tailplane due to successive propeller strikes by the tug aircraft. This probably caused it to yaw to the left and fly on momentarily before pitching steeply down into a spiralling left hand descent to the ground slightly to left of its original track. The collision also deformed the tug aircrafts left wing strut, which failed in compression overload. As a direct consequence, the left wing folded upward and the tug immediately followed a ballistic trajectory with an increasingly steep nose down spiralling descent to the left before impacting the ground a short distance down track from the collision point.

Whilst neither aircraft would have been obscured from the view of the opposing pilot, if either pilot had been concentrating on the landing area moments before the collision, then the other aircraft would have presented a small quasi-static image in his peripheral field of view. In such conditions, the opposing aircraft is not likely to have registered visually until the instant of the collision, or fractionally before it.

The Rules of the Air detail which aircraft has the right of way when aircraft are on converging tracks and/or involved in making an approach to land. In order to determine their respective responsibilities in such circumstances however the commander of an aircraft has to see and be aware of conflicting traffic. In this case it is clear that neither pilot saw the other until it was too late to avoid a collision. Operations involving approaches from opposing directions to common or closely adjacent landing areas can be considered inherently vulnerable to accidents of this kind.

The following three recommendations are made as a result of this accident:

Recommendations 2002-26

It is recommended that the BGA advise gliding clubs, who use aerotows as a means of launching gliders, to review their procedures with a view to ensuring that appropriate separation between powered aircraft and gliders is maintained under all operating conditions and that best use is made of external lighting on tug aircraft to enhance their conspicuity.

Recommendations 2002-27

It is recommended that the BGA review the use of radio procedures to be used by tug aircraft and those gliders fitted with radios, with a view to improving the awareness of all pilots, involved in glider operations, of the presence of other aircraft in the vicinity of airfields involved in glider operations.

Recommendation 2002-28

It is recommended that the BGA oversee the introduction of a standard core syllabus for the training of tug pilots and ensure that all BGA approved tug pilots, who wish to maintain their tug pilot status, carry out their bi-annual PPL SEP rating renewal with a CAA authorised BGA tug instructor.