ACCIDENT

Aircraft Type and Registration:	Slingsby T.51 Dart 15 Glider, BGA1166
No & Type of Engines:	None
Year of Manufacture:	1964
Date & Time (UTC):	30 August 2006 at 1750 hrs
Location:	Sutton Bank, near Thirsk, Yorkshire
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Fatal) Passengers - N/A
Nature of Damage:	Aircraft destroyed
Commander's Licence:	Silver C gliding certificate
Commander's Age:	54 years
Commander's Flying Experience:	412 hours (of which 1:17 were on type) Last 90 days - 3:56 hours / 23 flights Last 28 days - 1:04 hours / 4 flights
Information Source:	AAIB Field Investigation, assisted by the British Gliding Association

Synopsis

During a local flight from a hill-top gliding site, the glider descended in weak ridge lift until it was too low to land safely back at the airfield. However, the pilot appears to have made an attempt to do so and, whilst turning at low height and low speed, lost control of the glider. It crashed on the steep slope just below the ridge line, and the pilot sustained injuries from which he later died.

History of the flight

The pilot was a member of a club which flew vintage gliders and which was visiting Sutton Bank gliding site as part of an annual event. The pilot had flown the glider on a twenty minute flight on the afternoon of the accident, and planned to fly a further flight that day. This later flight was originally intended to be a cross-country flight, but had been changed to a local flight for weather considerations.

The glider was launched by 'aerotow' at 1630 hrs and remained close to the airfield for the duration of the one hour and twenty minute flight. Towards the latter stages of the flight, onlookers became concerned that the glider was flying very low along the ridge line which is immediately adjacent to the gliding site. The glider was seen to descend to a height only just above the ridge line, apparently flying at an unusually slow speed. Witnesses saw it initiate a turn to the left, away from the ridge. However, it then began a turn to the

right, back towards the gliding site and, as it did so, rolled rapidly to the right and the nose pitched down. The glider appeared to be entering a spin but quickly disappeared from view and crashed into trees on the steep slope, a short distance below the top of the ridge. Onlookers were quickly on the scene and found the glider severely damaged, with the disrupted cockpit suspended nearly vertically from the trees. The pilot was unconscious and was prevented from falling from the wreckage by his four point harness.

The emergency services attended some 10 minutes after the accident. The pilot, who remained unconscious throughout, was extricated from the wreckage, though this process was protracted as it was made difficult by the steep slope and vegetation. He was airlifted to York General Hospital by an RAF Search and Rescue helicopter and subsequently underwent surgery for his injuries. Despite this, the pilot did not regain consciousness and died on 19 September 2006, 20 days after the accident.

Aircraft information

BGA1166 was one of the early Slingsby T.51 Dart 15s to be built, being of all wood construction, and was manufactured in 1964 at Kirkbymoorside, near to Sutton Bank. This version had a 15 m span wing but later versions had a 17 m span wing, with wood and metal bonded spars, metal tailplanes, and an optional retractable main landing gear. The primary flight controls are a rudder, ailerons and an 'all-flying' tailplane. Pitch trim is achieved by trim tabs situated at the trailing edge of both the left and right side of the tailplane, and these are actuated by moving a control handle in the cockpit. Two airbrake paddles deploy from the upper and lower surface of both wings, making four in total, and are also operated by moving a control handle in the cockpit.

The aircraft had flown for a total of 2,148 hours over 1,381 flights. The glider's Certificate of Airworthiness was valid until 5 June 2007.

Wreckage information

The wreckage was located some 50 ft below the ridge line, to the west of the gliding site, in an area of soft ground where the slope was approximately 1:2, and which was covered by birch trees and heather. The forward fuselage was aligned 175°(M), pitched almost vertically down and had sustained severe disruption to the nose. The rear fuselage structure had broken away from the forward fuselage, aft of the wings. The vertical and horizontal tail surfaces were intact, attached to the rear fuselage, and had sustained little damage. A 10 cm diameter branch had become detached from the tree; the geometry and fresh fracture surfaces were such that it was likely the branch had been struck by the forward fuselage and canopy during the impact.

Both wings were still attached to the forward fuselage and both were broken outboard of the inboard end of their respective ailerons; the right wing was supported 2 m above the ground by a tree. Above the wreckage there were freshly broken branches and twigs that were consistent with the right wing having struck the tree with the glider at an attitude of 70º to 85º nose down. The outboard part of the left wing was lying on the ground, and had sustained only minor damage, consistent with the left wing tip striking the ground at low speed.

The airbrake paddles on the upper and lower surfaces of both wings were partially deployed, and foliage was lodged on the forward side of the airbrake on the upper surface of the right wing.

On-site checks were made of the continuity of aileron,

all-flying tailplane, rudder and airbrake controls with no discontinuities being found. It was not possible to check the continuity of the pitch trim system at the accident site.

Engineering investigation

The glider was transported to the AAIB headquarters at Farnborough for detailed examination.

Flight controls

The continuity of aileron, all-flying tailplane, rudder and airbrake controls were all confirmed, and the pitch trim system was found to have been serviceable. No evidence of any pre-accident control jams or restrictions was found in any of these systems.

Air speed indicator (ASI) system

The ASI system featured a 'pot' pitot mounted in the glider's nose, a static port mounted on the left forward fuselage and the ASI instrument mounted in the instrument panel. The ASI was removed and taken to an engineering organisation experienced with testing similar units. The unit was tested in the range from 30 kt to 100 kt and then back to 30 kt using appropriately calibrated test equipment. All the readings were within 2 kt of the calibrated values. A general inspection of the pitot/static system failed to determine with any certainty if any leaks had been present prior to the accident, due to the disruption of the forward fuselage.

Glider structure

There was no evidence of any structural failure prior to the accident. However, evidence of corrosion was found on the bolts that attach the wing root attachment fittings to the wooden spars, in both wing roots. Whilst this was not causal to the accident, the British Gliding Association (BGA) was informed and undertook to consider the findings with a view to issuing advice to their inspectors regarding the inspection of vintage and ageing gliders.

Pilot information

The pilot had begun flying gliders in 1995, and had joined the flying group in 1996. His total flying experience of 412 hrs was gained almost exclusively on gliders, with the occasional flight as a passenger in a self-launching motor glider. Although the pilot had learnt to fly at a gliding site located at the base of the ridge at Dunstable, Bedfordshire, the majority of his experience had been gained at flat sites. His flying logbook recorded only 17 flights, over 10 years, which contained an element of hill soaring. Only two (total 43 minutes flight time) were solo flights. One of these solo flights was during the pilot's only other visit to Sutton Bank, in 2005. The second was the pilot's penultimate flight on the day of the accident. In the year leading up to the accident, the pilot's only experience of hill soaring had been during a dual 'site check' the previous day, and on the day of the accident itself.

The majority of the pilot's gliding had been done in a mix of older gliders that were operated by his flying group. His experience on the Dart 15 was limited; he had flown it twice in June 2005 and not again until the day of the accident - a total recorded time of one hour and 17 minutes. The pilot had qualified to the Bronze gliding certificate level, with cross country endorsement, in 1996, and had further qualified to Silver C certificate standard in 1998.

Airborne photographs

The pilot was known to have been a keen photographer and to have frequently taken photographs whilst airborne. Two cameras were recovered from the glider wreckage: a digital camera and a compact 'wet-film' type. The

'wet-film' camera was in its case when found, while the digital camera was found with its zoom lens extended. Damage to the lens indicated that the camera had been switched on at the time of the accident.

Aerial photographs had been taken with both cameras, and recorded information showed that they had been taken on the day of the accident. The digital camera images also had an associated time stamp which indicated that 27 images had been taken during the accident flight, with recorded times between 1738 hrs and 1845 hrs local time. Of these, 15 images were of other gliders in flight. As it was nearing the end of the gliding day, very few other gliders were airborne, and it was possible to identify the gliders in the photographs as being two that were airborne at the time of the accident. These were also ridge soaring, though were higher than the accident glider when the photographs were taken.

Earlier in the flight (probably soon after release from the aerotow) the pilot had captured a portion of the instrument panel in the first photograph, which showed the ASI reading 45 kt. This speed was in the normal operating range for the glider, although the group's Chief Flying Instructor (CFI) recommended a minimum airspeed of 50 kt for non-turning flight.

Medical and pathological information

As required by BGA regulations, the pilot held a valid medical declaration form which was countersigned by his General Practitioner. A post-mortem examination did not identify any disease or existing medical condition that may have contributed to the accident, but confirmed that the pilot had died as a result of head injuries sustained during the impact sequence.

Gliding site information

The Sutton Bank Gliding Site has been used for gliding since 1933. The site forms part of the western edge of an extensive plateau, effectively forming a corner at the junction of the steep escarpments along the western and southern edges of the North York Moors. The ridge on which the glider was soaring was at a mean 940 ft amsl, rising higher to the north. The site is some 650 ft higher than the low ground to the west, with the slope of the ridge varying between 1:4 and vertical.

On the day of the accident the site was operating to a standard configuration of takeoffs and landings, according to the prevailing wind. This configuration was promulgated at a routine briefing, given by the club duty instructor on the morning of the accident. In this configuration, launches and landings were both being made on the 'short run', with a secondary landing area available on the 'long run', see Figure 1.

Witness information

The accident was seen by a number of witnesses, many of whom were experienced glider pilots and familiar with gliding operations at the site. They reported that the glider had been at an unusually low height on the ridge for a considerable time before the accident, and appeared to be gradually losing height with each traverse of the ridge line. It was the glider's low height (generally reported as between 100 ft and 300 ft above the ridge when most witnesses first became aware of the glider) which alerted them to the fact that the pilot may have been getting into difficulties. They also described the glider as flying unusually slowly.

Witnesses considered that there had been ample opportunity for the pilot to land the glider on the secondary landing area, even after it had become too low to land

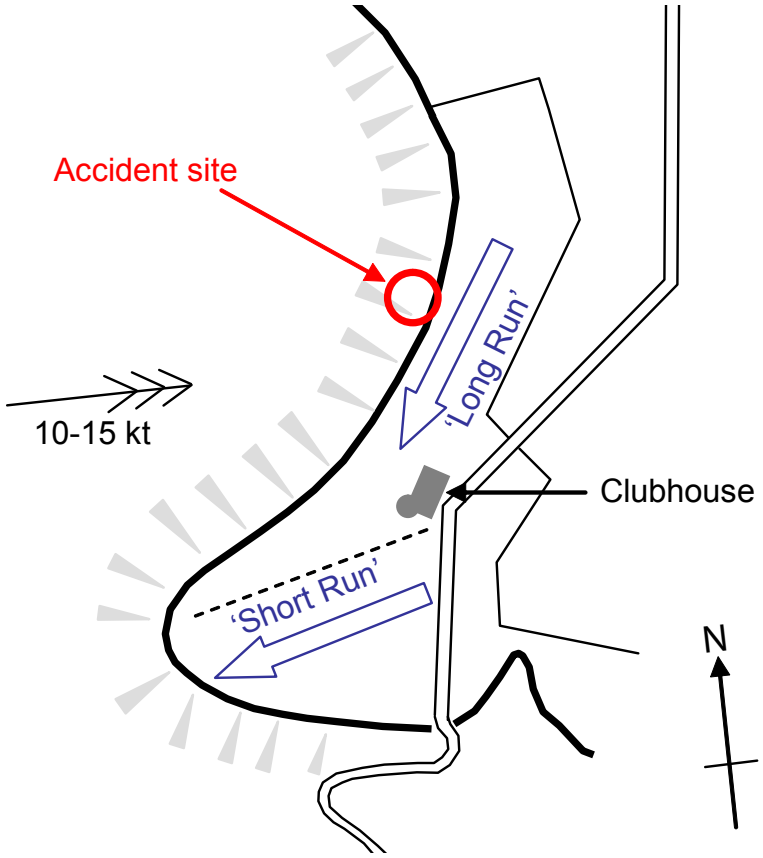

Figure 1

Gliding site showing main and secondary landing areas

on the main landing area. On the penultimate traverse southwards, the glider flew approximately down the centre of the secondary landing area at between 100 and 150 ft; witnesses were surprised and concerned when the glider did not land, but instead turned northwards again on its final traverse along the ridge line. During this time the glider descended to a very low height, probably less than 50 ft above the ridge, and appeared to be flying very slowly with an unusually nose-high pitch attitude.

Just before the accident, the glider turned left, away from the ridge, and witnesses initially assumed that the pilot was committing to a landing in one of many suitable fields in the valley below. However, the glider then began a turn to the right, and as it did so the right wing dropped and the glider rolled rapidly to the right as it departed from controlled flight. Witnesses described the glider appearing to enter a spin or spiral dive and descending steeply, disappearing from view below the ridge line.

Some witnesses described a 'wallowing' once the glider was very low and clearly flying slowly, or that there was a period just before the accident when the glider's motion became erratic. It was also reported that the glider was flying shallow turns in the latter stages of flight (presumed to be because of its low height), and that the pilot was applying excess rudder, producing a skidding turn. Witnesses who expressed an opinion about the airbrakes thought they remained retracted.

Meteorological information

At the time of the accident, Met Office information indicated that a ridge of high pressure was moving eastwards away from the area, with frontal rain moving into western and central areas of the country. At the time of the accident the weather was generally fine, with small amounts of cumulus cloud at 3,500 ft and broken cloud layers at higher levels. The wind at Mean Sea Level would have been from 240º(T) at 11 kt and the wind at 1,000 ft amsl would have been from 270º(T) at 15 kt. The Met Office data corresponds with the recall of witnesses, most of whom stated that the wind was westerly or south-westerly at about 10 kt.

Gliding site operations

A document held at the local gliding club, titled '*Gliding at Sutton Bank'* contained details of the various site configurations. Concerning operations in a westerly wind, the document stated:

> *'A wind strength of at least 12 kts is needed for the hill to work, although much depends upon the glider and its pilot. The area of best lift in the bowl will depend upon wind direction. If it is insufficient to maintain 400 ft you should land.'*

Gliders positioning for an approach to the 'short run' would generally fly a downwind leg to the north of the site before turning right to position onto final approach. Club members stated that a comfortable minimum height for crossing the ridge downwind was 700 to 800 ft. The '*Gliding at Sutton Bank*' document also stated:

> *'400 ft is the minimum safe height for crossing the ridge on an approach to the Short Run. If you cannot ensure this, use the Long Run'.*

The local gliding club, which was hosting the event, had no formal arrangements for briefing visiting pilots about site operations. However, the club did require that all visiting pilots undergo a flying 'site check' with an appropriately qualified pilot before being allowed to fly solo. As well as weather information, the morning flying briefing included the site configuration and any special requirements or issues particular to the day. Additionally, it was a club requirement that all pilots not holding a Silver C qualification were briefed by an instructor prior to every flight.

On this occasion, and because of the large number of visitors attending the event, the responsibility for the accident pilot's site check was delegated by the club duty instructor to the group's CFI, once he himself had flown a check flight with the duty instructor. The accident pilot's check flight had been carried out on the day before the accident, in a relatively modern, two-seat training glider. During the 34 minute flight, salient features of the site were covered by the CFI, who was satisfied that the pilot was competent to fly solo. The document '*Gliding at Sutton Bank'* was not required reading and it is not certain whether the pilot was fully aware of the cautionary information it contained regarding minimum heights.

Glider handling qualities

The handling qualities of most gliders are such that the rudder is used to a greater extent when turning, in comparison with many powered aircraft. However, the use of too much rudder in a turn can lead to a well-recognised scenario in which the glider may depart from controlled flight and possibly enter a spin. Typically, this is likely to occur at a low height (during the final turn is a frequently quoted scenario), when the pilot is reluctant to use large angles of bank to turn the glider. Instead, a shallow angle of bank is used but, as this leads to a relatively poor turn rate, the pilot is tempted to apply more rudder in the direction of the turn.

Although the increased rudder deflection increases the turn rate by a small amount, it has the affect of markedly increasing the glider's drag. If the glider is already flying too slowly, it may stall. Because of the yawing motion, the 'inside' wing will stall first and the glider enters an autorotative manoeuvre in which it rolls rapidly in the direction of the turn.

The situation may be triggered or aggravated if the ailerons are deflected near the point of stall. The extra applied rudder will cause a rolling tendency which requires opposite aileron to correct. The down-going aileron on the 'inside' wing increases the effective angle of attack of the wing tip, either causing it to stall or ensuring that the wing remains stalled.

It is also possible for a pilot to apply an inappropriately large rudder input at low heights because of a visual

illusion. As a glider turns at normal operating heights the 'inside' wing tip appears to the pilot to move backwards relative to the distant ground. However, at low heights, the glider's forward speed is much more apparent when looking at the ground, and hence the wing tip appears to move forwards relative to the ground (though the glider is still turning). This creates a perception that the glider is not turning as expected, and the temptation for the pilot is to apply more rudder to increase the turn rate.

The Dart 15 glider belonged to a generation of gliders which, in some cases, were less forgiving in their handling qualities than many modern gliders. The Pilots' Notes for the Dart 15 included the following comment, in relation to a 30º banked turn:

> *'The minimum speed in a 30º banked turn is between 38 and 40 knots depending on C.G. position. Airframe buffet tends to be present and opposite aileron is required to hold off bank. Any additional "bottom rudder" causes the inner wing to drop; followed by the nose; and a spiral dive ensues, from which recovery is rapid on easing the control column forward.'*

Analysis

The engineering investigation concluded that there was no failure of the glider's structure before impact, and that the glider's flying controls were capable of being operated normally. Foliage in the airbrakes indicated that they were probably partially deployed at or during the impact. No witnesses reported seeing the airbrakes extended, nor would it have been appropriate for them to be used. Airbrake operation is normal when landing a glider and it is not unknown for pilots to select them inadvertently prior to landing when the situation does not warrant their use, particularly if under stress. It is perhaps more likely that the airbrakes extended as a result of an instinctive action by the pilot just before impact, but the reason for their partial extension remains unexplained.

The satisfactory calibration of the ASI supports the photographic evidence that the instrument was working normally during the flight. A leak in the pitot line would have caused the ASI to under-read (ie the aircraft would be flying faster than the indicated speed), and a leak in the static line would produce only a small error at the altitude at which the glider was flying. Hence it is very unlikely that the ASI would have been over-reading the actual airspeed.

Although the pilot had a reasonable experience level, he had only very limited experience of hill or ridge soaring, and was inexperienced in the type of glider he was flying at the time of the accident. Although the pilot had demonstrated his ability to fly safely from the site on the day before the accident during the site check with his CFI, this check flight was made in a relatively modern, two-seat training glider, which has less demanding handling characteristics than the Dart 15 glider.

The pilot had been soaring on the ridge for some time before his glider became low enough to cause onlookers concern. It is possible that the wind strength or direction may have changed subtly whilst he was airborne, and reduced the amount of lift the ridge was capable of producing. The pilot may not have been aware of the recommended minimum height of 400 ft on the ridge to commence a landing pattern to the 'short run'. However, it should be expected that he would have had a minimum height in mind; it is likely this would have been higher than 400 ft, which was considered an absolute minimum by most club members. Even when below 400 ft, when it should have been apparent that a landing on the 'short

run' was not possible, there were several opportunities for the pilot to land safely on the secondary 'long run', though he did not. It is not known why the pilot remained on the ridge when it was producing inadequate lift. Apart from the increasing difficulty in landing, a well-used public footpath ran along the ridge line which made soaring at low height inadvisable (notwithstanding that ridge-soaring gliders are exempt from the minimum height requirements of the Air Navigation Order).

The photographic evidence does indicate a potential source of distraction. The date/time stamp on the digital photographs show that the pilot had been taking air-to-air photographs until the last minutes of the flight, and it is known that his camera was switched on at the time of the accident. From the times of launch and accident, it was possible to determine that the camera time was accurate to within 4 minutes, and the pilot's keen interest in photography would also suggest that the camera time was set reasonably accurately. It follows that the pilot had been taking photographs of gliders above him at the same time that his own glider's height was causing onlookers concern. Given that opportunities to land were not taken, it is possible that the pilot allowed himself to become distracted from his prime task of piloting the glider, and descended to a lower height than he had intended. Witness accounts of the glider's speed and behaviour just before the accident suggest that the glider was flying at just above its stalling speed as it flew northwards on its final traverse. This is indicative of the pilot attempting to minimise the descent rate, although the gently up-sloping ridge line ahead of him may have produced an incorrect perception of the true horizon, leading the pilot to select a higher pitch attitude than was required.

From a position only just above the ridge line, and with minimal flying speed, the pilot's only safe option was to fly out into the valley and land there. The initial turn away from the ridge line just before the accident lead witnesses to think this was the pilot's intention. As all turns whilst ridge soaring should be made away from the ridge, into the prevailing wind, the only plausible reason for him to reverse the turn at that point would have been to try to land back at the airfield. It is reasonable to assume that this was the pilot's intention, in which case the initial turn to the left may have been an attempt to gain some separation from the ridge (and thus gain separation from the steeply sloping ground), prior to turning back to the landing area. It should have been clear to the pilot that there was insufficient height to achieve a normal landing on the 'long run' but he may have thought he could land diagonally across it.

The final manoeuvre, as seen by many witnesses, is consistent with the inner (right) wing stalling first, leading to an uncontrollable right roll and departure from controlled flight. The departure may have been solely due to the aircraft's airspeed being too low for the manoeuvre, or may have been as a result of an inappropriate rudder input. Recovery from such a departure is possible, and the pilot would have had considerable practice of such recoveries. However, recovery would initially involve moving the control column forward to unstall the wings. Faced with such a situation unexpectedly and at very low height, the pilot's probable instinctive reaction would be to use aileron to correct the roll, and possibly aft stick movement to arrest the descent. Both of these actions would ensure that the aircraft would not recover and would enter a spin or spiral dive, given sufficient height. The glider's situation was such that, once it had begun to depart from controlled flight, it is not certain that even prompt and positive actions would have prevented the glider from striking the ground, although such actions may have reduced the extreme nose down attitude at impact.

The head injuries suffered by the pilot were probably caused by a section of tree branch which penetrated the glider's canopy. As was common practice, the pilot was not wearing a helmet, although it is not certain that a helmet would have afforded sufficient protection to the front of the pilot's head to alter the fatal outcome. The BGA has previously reviewed the issues surrounding the wearing of helmets in gliders. It was determined that wearing a helmet in the confined space of a glider's cockpit represented a significant hazard in terms of restricted head mobility, and therefore of lookout, as well as raising possible issues of reduced auditory reception.

Safety action

Although the local gliding club at Sutton Bank required a site check for visiting pilots, there was no requirement that such pilots be briefed or self-brief on the local procedures and guidance, such as was included in the *'Gliding at Sutton Bank'* document. Prior to this accident the local club had produced a draft document containing Standard Operating Procedures (SOPs), which was subsequently issued in hard copy and also placed on the club's web site. The SOPs contain rules and procedures pertaining to all aspects of flying operations at Sutton Bank, and detail the requirements for flying currency and check flying. In addition to specific daily and site briefings, all pilots at Sutton Bank are now required to sign as having read the SOPs on joining the club and annually at membership renewal.

Safety Recommendations

For some years, the BGA has been encouraging its associated clubs to use documents such as SOPs as a means of passing essential information to their members and visitors. Despite this, there was no demonstrated requirement for ground briefing of visiting pilots in force at the Gliding Club at Sutton bank at the time of the accident.

The following safety recommendation is therefore made:

Safety Recommendation 2007-001

The British Gliding Association should review the guidance it gives to its associated gliding clubs in respect of the briefing requirements for visiting pilots, with a view to ensuring that such pilots are adequately briefed on all aspects of site operations.

Conclusion

The pilot continued to fly on the ridge line in conditions of reduced lift, despite earlier opportunities to land his glider safely. The accident occurred when the pilot attempted to turn his glider at low height and low airspeed, probably in a late attempt to land. The glider's right wing stalled first, and the glider departed from controlled flight with insufficient height for the pilot to make a recovery.