Glider Type and Registration (Tail No):	Discus CS	Lak 17
BGA No:	G-IDER (W4)	G-CKOI (170)
Engine:	None	1 (turbo)
Year of Manufacture:	1992	2006
Time (local) and Date:	16:02 hrs on 26 July 2014	
Location:	Lt. Paxton, Nr. St. Neots, Cambs.	
Type of flight (actual/intended):	Competition task (both gliders)	
Type of launch:	Aerotow	Aerotow
Persons on Board:	1	1
Nature of Damage:	Glider destroyed	Serious
Injuries:	Minor	Minor
P1's Qualifications:	Silver C	3 diamonds
P2's Qualifications:	N/A	N/A
Commander's Age:	70 years	60 years
Commanders' Flying Experience :		
Total all types:	800 hrs	5000 hrs
Total on Type:	200 hrs	1000 hrs
Last 6 months:	15 hrs	100 hrs
Information Source(s):	BGA Accident Report Forms, Club Investigation, witness statements and follow-up enquiries	

Synopsis

On 26th July 2014, gliders W4 (Discus CS) and 170 (Lak 17) were both taking part in a competition organised by The Gliding Centre at Husbands Bosworth. At 16:02 hrs, whilst over fields adjacent to the A1 trunk road near Little Paxton, Cambs, the two gliders collided at a height of around 4000 ft. The collision resulted in the outer portion of the left wing becoming detached from W4, which precipated a structural failure of the same wing at its attachment at the fuselage. The pilot was left with no option but to bail out and, although the parachute deployed successfully, the breast strap rose up over his head. He landed safely in a crop field but had to move away from an approaching combine-harvester. He was taken by ambulance to Addenbrooke's Hospital, Cambridge, and given an extensive examination but was found not to have sustained any serious injuries.

Glider 170 was capable of flying after the collision. The pilot initially intended to bail out, but decided to remain with his glider after assuring himself as best he could that structural damage was limited to the cockpit and outer right wing. He landed without further incident at Bedford (disused) airfield.

History of the flight

Both gliders were flying from the gliding site at Husbands Bosworth were taking part in the HB Challenge Cup (Regional) Competition. The Distance Handicap task set was 178 km with turning points at NPT and OAK. The start line had opened at 15:00 hrs BST, with 170 starting the task at 15:09 hrs, W4 at 15:02 hrs. The following is taken from reports made by each pilot after the accident.

Discus CS (W4)

The pilot had seen another glider flying in the same area as his on several occasions while on the competition task. He thought he saw a glider prior to the accident circling in what seemed to be a poor thermal about half a mile away. He didn't recollect seeing any more of this glider until immediately before the impact, when it appeared from his left side and above, impacting with W4's raised left wing. As it did so, there was a very loud noise and the glider went into a tumbling spin, photo (a). The pilot realised that he had no option but to get out, so operated the normal canopy-opening knob and thought that the canopy flew off[1]. He then pulled the seat harness release lever and with no effort he fell from the glider into a tumbling free fall, photo (b)

(a)

(b)

He pulled the parachute 'rip-cord' and, as the canopy deployed with a sharp tug, it pulled the breast strap over his head, photo (c). He was then surprised that he still held the unattached parachute release handle in his right hand so dropped it to pull the breast strap back across his chest. He then took hold of the parachute cords and attempted to manoeuvre the parachute, as there were power lines, a river and trees below him. However, the parachute didn't respond and he landed heavily into standing crop in a field that was being harvested. He saw a combine harvester bearing down upon him and so crawled out of the uncut crop into a cut area, pulling the parachute after him. A farm worker came to his aid at that point.

(c)

The pilot was taken by ambulance to Addenbrooke's Hospital, Cambridge, for an extensive examination. He was kept there

[1] Photo (b) shows that the glider canopy had opened, but that the frame remained attached to the glider. The apparently complete transparency can be seen to the left of the glider's tail.

overnight for observation and discharged the following morning. He experienced some trauma and was advised he had suffered only minor cuts and grazes.[2]

Lak 17 (170)

The pilot stated that his recollection of what happened before the collision is unreliable. He recalled being in a thermal and circling to the left for a while, and that there were 2 gliders close by, one approximately 1000ft above him and one 2-300ft below, some 500m to the North-East. His rate of climb was tailing off and he was thinking of leaving or trying to find another core. He did not recall whether or not he left the thermaI, but did recall seeing the other glider only a second or so before the impact as it came out of the sun from above. The pilot pushed the stick fully forward and instinctively 'ducked' as part of the other glider went close by his head.

He initially decided to bail out, released his harness and stood up. However, the glider remained controllable and the broken canopy allowed the pilot to quickly inspect the glider's tail, which appeared to be undamaged, so he made the decision to strap himself back in. He flew the glider 10-15km from the point of impact to Bedford disused airfield and landed without further incident.

Neither pilot recollected seeing the other glider until a second or two before the collision.

Meterological conditions

At the time of the accident the wind was quoted at 5-10 kt/340 deg, visibility 30 km, and 3/8 cloud with a base of 5,500 ft.

Wreckage assessment

A hard impact had occurred between W4's left outer wing (d) and 170's cockpit (e). This removed the outermost part of the wing, and precipitated a structural failure at its inboard end, and forced the instrument binnacle downwards causing structural damage to the cockpit section. Secondary damage resulted to the right outer leading edge of 170's wing and the root section of W4's left tailplane, probably from impacts with debris from W4's broken wing. This led to a structural failure of the tailplane but this remained loosely attached until the glider struck the ground.

(d) *Failure region of W4's outer left wing*

(e) *Damage to 170's right cockpit edge and instrument binnacle*

The relative attitudes of the gliders at the time support the statement by the pilot of 170 that

[2] The following day the same hospital contacted him to advise him that he had a stable fracture of his L1 vertebrae, but that this did not require treatment, only a check again at the hospital in several weeks time.

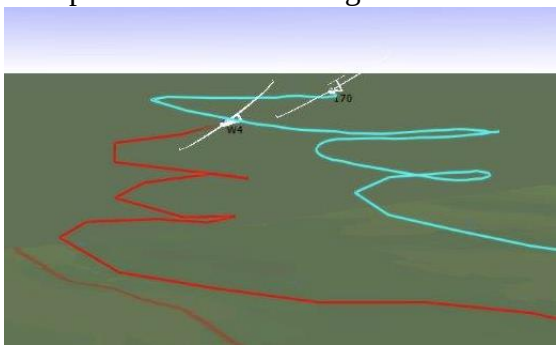
his glider had been put into a steep dive, in his attempt to avoid the collision. All damage seen was judged as a result of the collision and, in W4's case, impact with the ground. Neither pilot reported any problems with their flying controls prior to the collision, and this is supported by examination of the wreckages by various parties during recovery/repair.

Both gliders possessed an EASA Certificate of Airworthiness and had current Airworthiness Review Certificates, and both pilots were flying within their glider's weight and balance limits.

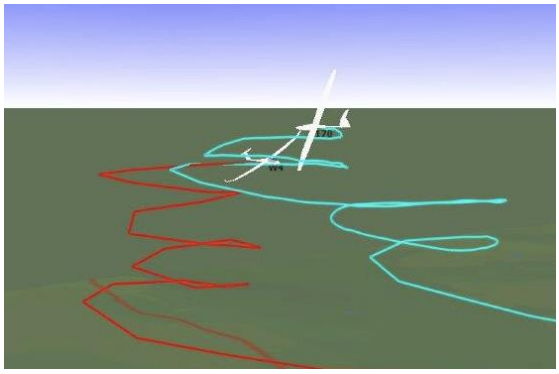
The collision

Each glider was equipped with a data logger, which provided good evidence of their flights. Figures (g) and (h) show screen shots from SeeYou of the flight paths of the gliders (W4 red, 170 blue) shortly before the collision, and figure (i) a plan view of their estimated relative positions for the 12 seconds before the collision. As may be seen, the gliders were circling in the same direction (to the right) but initially not about the same vertical axis. As glider 170 approached the same level as W4, it moved closer to W4's orbit. At 6 seconds before the collision, the gliders were about 480ft apart. Glider 170 was moving from right to left in the field of view of W4 so that at 4 seconds it was 20° to the left and at 2 seconds 50° left. At 2 seconds the gliders were approximately 250ft apart. The position of W4 relative to 170 hardly changed between 12 seconds and 6 seconds. At 4 seconds W4 would have been just behind the right wing tip of 170. At 2 seconds W4 was 70° R viewed from the cockpit of 170.

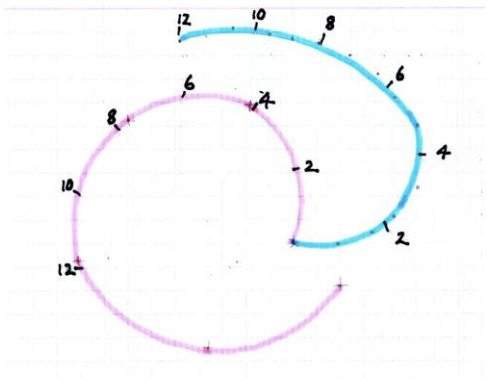
At 4 seconds from impact both pilots may have tightened their turns slightly (i), possibly in response to the same surge of lift.



(g)



(h)



(i)

Based upon the above, an assessment of the relative visibility of each glider from the opposite cockpit available to the pilots, and their estimate distance apart, is shown in the following table:

time to impact seconds	170 from W4	170 view from W4	W4 from170	W4 view from 170	range ft
12	45° R	good	130° R	difficult	600
10	30° R	good	130° R	difficult	570
8	20° R	good	135° R	difficult	510
6	7° R	good	135° R	difficult	480
4	20° L	good	95° R	possible	410
2	50° L	good	70° R	moderate	250

(i)

Lookout issues

The prime means of avoiding mid-air collisions in open airspace in VMC is lookout, ie, the see-and-be-seen method, but this cannot be considered a perfect method. When thermalling, situational awareness in addition to a good lookout is vital and, if sight is lost of a glider in close proximity, then serious consideration should be given to leaving the thermal in an appropriate manner. (See the Soaring Protocol below.)

There are limitations in the human visual system that serve to make collision avoidance difficult by visual means alone. The capacity of the human eye to resolve detail is not distributed evenly across the retina. The most central part of the retina is termed the fovea, and is composed only of cones - the light sensitive cells used for day vision. Cones provide high visual acuity, colour vision and contrast discrimination. Although there is good resolving power at the fovea, this ability drops rapidly outside the fovea. Normal visual reflexes adjust the direction of gaze to ensure that the image of an observed object falls on the fovea for optimum resolution. Such vision, sometimes termed 'focal' vision, requires a stable image and the viewer's attention. Away from the fovea, the density of cones reduces, and the density of rod cells increases. Rods are more sensitive to light than cones, and are used for day, night and low intensity vision. Rod vision is monochromatic and of low acuity, giving only outlines or shapes. It is, however, responsive to movement. It does not require the same degree of attention as focal vision, and is important for spatial orientation and 'flow vision', which gives a sense of speed. Rod vision is sometimes referred to as 'peripheral' vision. A distant aircraft will be perceptible to a pilot if it is acquired at or near the fovea, a near one by peripheral vision, especially if there is good relative motion. As an area of sky is scanned by the pilot, the eye naturally makes a series of jumps, or saccades, with intervening rests. The scene is only interrogated by the brain during the rest periods. A very small object may therefore be 'jumped over' or fall on an area away from the fovea – in either case it will not be detected. Each saccade-rest cycle takes a finite time and a full scan of an area of sky will take several seconds. An object missed early in the scan may approach hazardously close or even collide before that area is scanned again by the pilot. The effectiveness of visual air-to-air acquisition also depends on the contrast of an aircraft with its background. Increased contrast improves visual acquisition but contrast degrades exponentially with visual range. If contrast reduces to approximately 5% the target disappears.

Another of the characteristics of the human eye is potentially more relevant here. The human visual system is particularly attuned to detecting movement, this being accomplished largely using peripheral vision, but is less effective at detecting objects that appear stationary. The outer boundaries of peripheral vision correspond to the boundaries of the visual field as a whole. For a single eye, the extent of the visual field can be defined in terms of four angles, each measured from the fixation point, i.e., the point at which one's gaze is directed. These angles, representing four cardinal directions, are around 60° superior (up), 60° nasal (towards the nose), 70-75° inferior (down), and 100-110° temporal (away from the nose and towards the temple), ie, 130/135° in the vertical sense, and 160/170° in the lateral sense.

However, this field of vision begins to contract after about the age of 35 years. In males, this reduction accelerates markedly after 55 years of age and for males aged 70 years is likely to be less than 130° for a single eye in the lateral sense.

When flying, the eyes and head are very rarely still for very long except, critically perhaps,

when looking at the instrument panel. Although head/eye movement will compensate to an extent, in a given situation a reduction in the time for an older pilot to become aware of the presence of another aircraft using peripheral vision will be present, particularly so if there is little or no apparent relative motion.

An additional factor which could influence the time taken to recognise a collision threat is the time taken for the eye to 'accommodate'.

Accommodation is the process of focussing on an object. Whereas a camera is focussed by moving the lens, the eye is brought into focus by muscle movements which change the shape of the lens. A young person will (typically) require about one second to accommodate to a stimulus, however, the speed and degree of accommodation decreases with age. The average pilot probably takes several seconds to accommodate to a distant object. Shifting the focus of the eyes, like all muscular processes, is also affected by fatigue.

Flarm

Flarm is a useful aid to lookout, when used appropriately, and one of its features is to alert the pilot to potential collisions, but only if both gliders in a potential conflict situation are equipped with serviceable systems. Glider 170 was so equipped, W4 was not. Therefore, there was no possibility of either pilot detecting the close proximity of the other glider by electronic means. This raises the possibility that where only a proportion of gliders in relative close proximity are equipped, the attention of the pilot of a Flarm equipped glider may be divided between observing the Flarm output following an audio warning and subsequently searching for the identified target, and general visual lookout. Therefore it is particularly important when in proximity to other gliders that the best possible lookout is maintained, with 'head down' time reduced to an absolute minimum.

Previous mid-air collision

In 2014, four glider-on-glider mid-air collisions occurred. All the pilots involved survived by either parachuting or landing the damaged gliders. However, there was a high degree of luck associated in these events in that none of the pilots were incapacitated or killed in the collision itself. The pilot of 170 was, literally, within inches of being hit in the chest/head by W4's wing.

On 14 May, one of these collisions occurred between an Arcus and a Discus B close to the gliding site at Gransden Lodge airfield. Both gliders had launched from this site with the intention of carrying out recreational flights in the local area. The report relating to this accident identified the following:

The gliders sharing the thermal were clearly operating in accordance with published guidelines in that they maintained safe relatively static positions relative to each other. The Flarm units on both aircraft gave frequent audio warnings throughout the 5 minutes before impact. However, during the final minute before impact, the warnings ceased (for unknown reasons) and this may have led to an assumption that one of the gliders had departed the thermal. Obscuration of the Flarm signal by the airframe did not appear to be a factor but could not be totally discounted.

This report made the following Safety Recommendation

> *SAFETY RECOMMENDATION BGA 2014/XX*
>
> *That the BGA examine a mechanism for a check of understanding of soaring procedures during bi-annual pilot competency checks.*

Discussion

Effective lookout and awareness of any other glider(s) in close proximity is paramount. Although this may be supported by the appropriate use of electronic means, such as Flarm, their non-universal use (and possibly their reliability) means that it is unwise to use them as a prime means of collision avoidance over good visual lookout. However, in the collision scenario between 170/W4, had both gliders had Flarm installed, then an appropriate warning could have alerted the pilots to each other's close proximity, possibly in time to avoid the collision.

It is generally accepted that however good a pilot's lookout may be, with or without the support of electronic means, it cannot be considered to be 100% effective in removing the risk of a mid-air collision. Limitations of the human visual system and when looking towards the sun are two of various factors which can degrade optimal lookout.

The wearing by of parachutes by glider pilots is an acknowledgement of these factors and that a risk of collision exists, particularly when thermal soaring, and they are worn largely to mitigate this risk. As demonstrated by this and other recent mid-air collisions, their successful deployment has saved several lives in 2014 alone. Being aware of how to best exit a damaged glider before such an event, and regular servicing of parachutes, must be considered prudent.

Following a collision where the glider apparently remains controllable, a difficult decision has to be made by the pilot of whether to remain or to leave the glider, assuming the collision occurs at a height to give sufficient time to bale out and for the parachute to deploy. Remaining with an apparently controllable, but damaged, glider brings its own risks, as it is almost impossible to fully assess its airworthiness following a serious collision, even if a handling check is carried out. At least one previous collision resulted in a fatality where the pilot elected to land the glider, but where structural integrity was lost at a height too low to use the parachute. A damaged glider structure may deteriorate before landing under normal aerodynamic loading from, for example, gusts/turbulence, use of the flight controls, deployment of flaps, landing gear and airbrakes.

BGA advice on thermalling

Uniquely in aviation, glider pilots fly in close proximity to other gliders without the benefit of a pre-flight briefing. The nature of the sport dictates that gliders congregate in areas of rising air enabling them to climb and then use the height gained to proceed to other areas of lift. After a fatal mid-air collision in the early 1990s all of the interested parties governing gliding in the United Kingdom met to formulate a protocol for safe flying in thermals to improve understanding and minimise risk in this facet of the sport. This Soaring Protocol (below) generated by the meeting has survived un-amended since its inception:

BGA THERMAL SOARING PROTOCOL

Joining a thermal

- *Gliders established in a thermal have right of way*
- *All pilots shall circle in the same direction as any gliders already*
- *If there are gliders thermalling in opposite directions, the joining glider shall turn in the same direction as the nearest glider (least vertical separation)*
- *The entry to the turn should be planned so as to keep continual visual contact with all other aircraft at or near the planned entry height*
- *The entry should be flown at a tangent to the circle so that no aircraft already turning will be required to manoeuvre in order to avoid the joining aircraft*

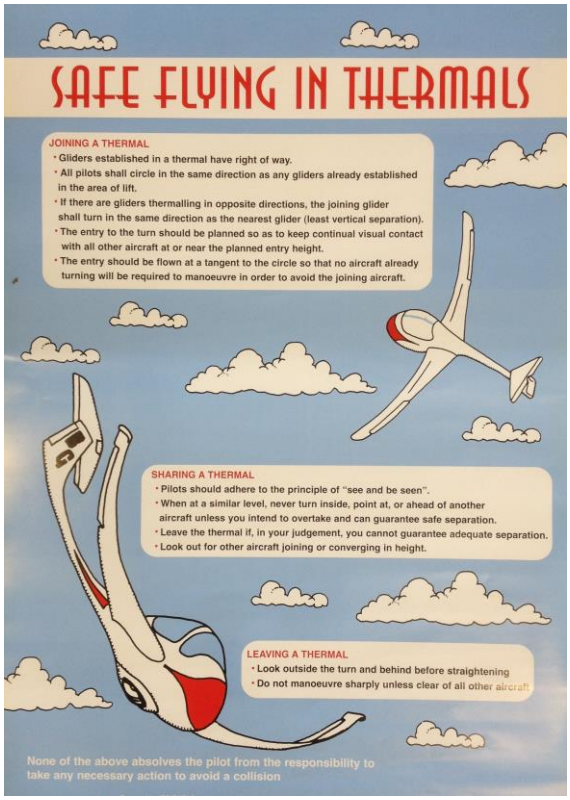
Sharing a thermal

- *Pilots should adhere to the principle of see and be seen*
- *When at a similar level, never turn inside, point at, or ahead of another aircraft unless you intend to overtake and can guarantee safe separation*
- *Leave the thermal if, in your judgement, you cannot guarantee adequate separation*
- *Look out for other aircraft joining or converging in height*

Leaving a thermal

- *Look outside the turn and behind before straightening*
- *Do not manoeuvre sharply unless clear of all other aircraft*

A poster (j) reflecting this was developed and issued some years ago to clubs, but like most 'safety' related material, maintenance of its effectiveness requires that such material is 'refreshed' on a regular basis.



Safety Action

The following text is a recently agreed statement by the BGA Executive Committee on the use of traffic and collision warning systems

The BGA encourages the widespread use of traffic and collision-warning systems in gliders and tugs.
FLARM is an increasingly popular system. Pilots should make their own decision on equipage based on compatibility with other systems and as to whether such a system is appropriate for their particular operation.
Pilots are reminded that whilst electronic collision warning equipment can enhance pilots' awareness by providing most useful warnings, such equipment cannot and must not replace a good systematic visual lookout scan, and that it is necessary to avoid any in-cockpit equipment from distracting from the visual lookout scan.

In consideration of the Safety Recommendation made in the report on the Gransden collision on 14 May 2014, and the fact that the BGA is currently reviewing the content and presentation of the Thermal Soaring Protocol, no further recommendations are made here concerning the protocol.

In consideration of the initial difficulty that the pilot of W4 had with his parachute, the following Safety Recommendation is made to the BGA:

Safety Recommendation 2015-xx

> *It is recommended that the BGA should remind all glider pilots of the high importance of properly adjusting their parachute harness to ensure as far a possible that it will deploy correctly and avoid the possibility of the breast strap 'riding up' upon deployment.*

Conclusion

The collision occurred close to the village of Little Paxton, near St Neots, Cambs, at around a height of 4000 ft. Only one of the two gliders was equipped with Flarm so collision avoidance relied upon good visual lookout and situational awareness.
However, neither of the pilots involved saw the other glider in sufficient time to avoid the collision.