

Investigation Report

3X164-0/03
April 2006

Identification

Type of occurrence:	Accident
Date:	25 July 2003
Location:	Heppenheim
Aircraft:	Sailplane
Manufacturer / Type:	Schempp-Hirth / Duo-Discus
Injuries to persons:	No injuries
Damage:	Aircraft severely damaged
Other damage:	Minor damage to forest
Information Source:	Investigation by BFU

Factual information

History of the flight

On the day of the accident at 16:30 hrs¹, the Duo-Discus with two persons aboard was on a thermal flight in the surroundings of Heppenheim. According to the pilot's statement and analysis of the GPS logger recording, the sailplane was heading west at a height of approximately 2,000 m AGL after circling in a thermal. This flight phase was characterized by a straight flight path (picture 1) and a ground speed of not more than 150 km/h.

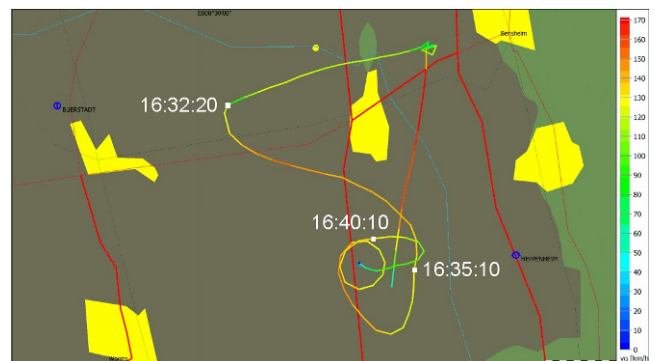
The pilot stated that he intended to reduce airspeed by pulling the elevator when the left outer wing broke. The fragment swung upwards and the sailplane abruptly changed direction to the left. The pilot applied full aileron deflection to the right and was able to stabilise

the sailplane insofar that it did not become uncontrolled.

The two occupants decided to bail out because of the restricted controllability. According to the pilot's statement, he had great difficulties with the canopy when bailing out because it did not separate, as expected, from the fuselage. Finally both occupants reached the ground safely with their parachutes.

Flight Recorders

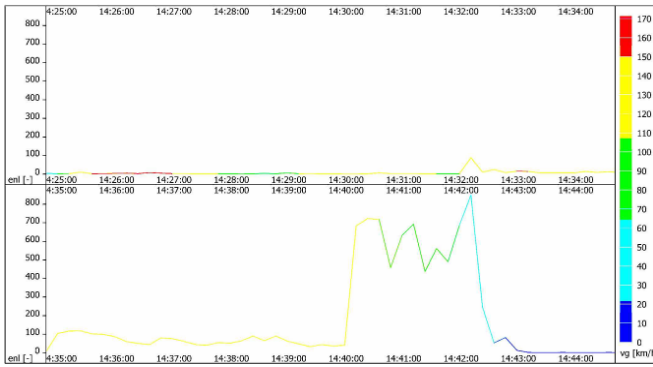
A GPS logger LX7000 was aboard the sailplane. The memory of the logger was read out and contained the data of the last flight. At intervals of 12 seconds the parameters time, coordinates (WGS), altitude (barometric) and height (according to GPS) and sound (as an indicator for optional engine operation) were recorded. The software *SeeYou* was used to illustrate the flight path with the ground speeds marked in different colours (picture 1).



Picture 1: Abrupt end of straight flight at 16:32:20 hrs

From 16:32:20 hrs, the graph of the sound parameters shows sudden rises and different levels (picture 2).

¹ Unless otherwise specified, all times are indicated in local time



Picture 2: Sudden high sound level in the sonogram

Weather

The weather report (METAR) of Mannheim aerodrome issued at 16:20 hrs stated that surface wind was blowing from 190° at 9 kt. Visibilities were classified as good with few clouds (CAVOK). QNH was 1,012 hPa.

Personnel information

Both occupants held licences for sailplanes. The pilot in the front seat controlled the sailplane.

This pilot's open-ended PPL(C) was initially issued in 1985. The pilot's last check flight took place on 19 May 2002. According to his own statement, he had a total flight experience of about 500 hours. The flight on the day of the accident was his first flight on a Duo-Discus sailplane.

Aircraft information

The sailplane Duo-Discus is a fibre composite two-seater with a four piece wing, a wing span of 20 m and a T-tail. The wing spar has flat caps made of carbon fibre rovings or bands and a I-shaped web consisting of two GFRP profiles and a foam core.

The Duo-Discus of the German manufacturer was type approved by the Luftfahrt-Bundesamt in 1994 on the basis of the airworthiness requirements for sailplanes (JAR 22) with the type certificate data sheet no. 396.

Operating limitations		Value
Maximum allowable take-off mass	m	700 kg
Limit load factor for positive manoeuvres	n	+ 5,3 G
Maximum allowable airspeed	V _{NE}	250 km/h
With turbulence	V _{RA}	180 km/h
For full elevator deflection (manoeuvring speed)	V _A	180 km/h

Table 1: Operating limitations

According to the data sheets of the certification authorities, there are several types and variants with the designation Discus (see table 2). The design drawings show great conformity between them as to the design, especially the wing structure.

The sailplane concerned with the MSN 387 was manufactured in 2003, certificated and registered with a certificate of airworthiness and certificate of registration dated 11 July 2003. According to the sailplane's flight log the failure of the wing occurred after 16 launches, 15 landings and a total flight time of 18 hours. All launches were aerotows with two occupants.

On the day of the accident, no water ballast was carried along. The pilot in the front seat weighed approximately 80 kg and the pilot in the back seat approximately 70 kg. The empty mass of the sailplane was approximately 410 kg.

Accident site

The sailplane was found in the town forest of Lampertheim. The right wing had come to rest in the branches of trees and the stub of the left wing on the ground (picture 3). The fuselage nose pointed downwards and the fuselage tube upwards. The empennage, which had broken off and the canopy were also found in this area. The fragment of the left wing and the left aileron were recovered some distance from the main wreckage.



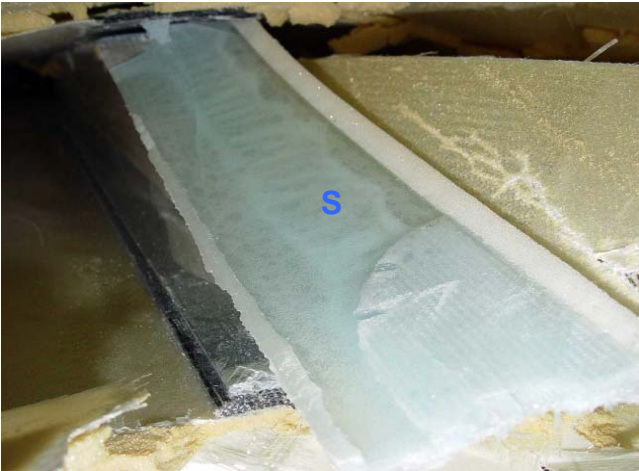
Picture 3: Left wing's point of rupture

Findings on the aircraft

The left wing's fragments were transported to Braunschweig to the BFU for further investigation. The inspection carried out together with representatives of the manufacturer and the LBA resulted in the following:

The left wing's fracture is characterized mainly by the fracture of the main spar 10 cm to 30 cm beyond the aileron drive. The fracture face of the lower spar cap of CFRP sticking to the sandwich shell is somewhat fibrous and the fracture face of the upper spar cap is edgeless. The upper flange of the spar web made of GFRP (I-profile) is detached from the upper spar cap made of CFRP and bent downwards. The shear web is destroyed.

The uncovered surface of the adhesive on the bent part of the flange is extremely smooth and lower as the area showing a fibrous texture (picture 4).



Picture 4: Defective bonding between the spar web (S) and the upper spar cap

Additional information

During a thermal flight on 29 July 2003 in France the right outer wing of a Discus CS broke off. The failure occurred after more than 900 launches and more than 900 flight hours. The spar showed a bonding surface similar to picture 4 over more than 40 cm of its length. The BEA (French Aircraft Accidents Investigation Bureau) delegated further investigations to the BFU (file no. 4X022-03).

Survival aspects

The large canopy of the Duo-Discus is laterally hinged. According to the flight manual the hinges on the right-hand side are not to be unlocked in an emergency. As can be proved, they are designed as predetermined breaking points.

On the wreckage investigated the front hinge pin on the fuselage wall was bent and the rear fitting had been torn out of the canopy frame. The lever to remove the canopy was still secured by a pin.

The crew stated that in order to bail out they needed a lot of energy to push the canopy open in flight whereas the canopy did not separate from the sailplane.

There is a study of the Fachhochschule Aachen recorded on video concerning the problem of canopy jettisoning.

Information about organizations

The following details are based on reports and information given by the type support engineer at the LBA and the head of the design department of SHK:

SHK cooperated with SHVL (Shempp-Hirth vyroba letadel s.r.o.) in Chocen / Czech Republic. SHVL emerged in 1997 from Orlican akciova spolecnost (OAS) as production organisation with a Czech certification. OAS and SHVL produced components and whole sailplanes by order of Schempp-Hirth, when the factory at Kirchheim was used to capacity.

Type/ variant	x	Type certificate data sheet	Authorit y	Approval date	Manufacture production	see below	Year of manu factu re	MSN	Production inspection warranty	Service Bulletin	AD
Discus a		360	LBA	17.01.1985	SH Kirchheim		1984 bis 1996	001 bis 563	SH Kirchheim		
Discus b		360	LBA		SH Kirchheim		1984 bis 1997	001 bis 550	SH Kirchheim		
					OAS Chocen	A	1995 bis 1997	551 bis 554 und 568 bis 577	SH Kirchheim	360-21	2003-266-2
Discus bT		863	LBA	24.08.1994	SH Kirchheim			077 und 106 und 146 und 151 bis 162	SH Kirchheim	863-9	2003-265-2
Discus CS		90-01 (360)	CAA-CR (LBA)	15.08.1990 (31.01.1991)	OAS Chocen	L	1990 bis 1997	001 CS bis 224 CS	OAS Chocen	360-21	T-074/2003
					SHVL Chocen	L	1997 bis 2003	225 CS bis 308 CS	SHVL Chocen		
DuoDiscus		396	LBA	21.03.1994	SH Kirchheim		1993 bis 1998	001 bis 164	SH Kirchheim	396-9	2004-084
					SHVL Chocen	A	1998 bis 2003	165 bis 387	SH Kirchheim	396-8	2003-246/2
DuoDiscus T		890	LBA	21.12.2001	SHVL Chocen	A		001 bis 078	SH Kirchheim	890-3 396-8	2003-245/2
DuoDiscus C		98-02 (396)	CAA-CR (LBA)		SHVL Chocen	L	1998 bis 2003	170 CS bis 300 CS und 350 CS	SHVL Chocen		T-070/2003

Table 2: SH = Schempp-Hirth, OAS = Orlican akciova spolecnost, SHVL = Shempp-Hirth vyroba letadel, A = manufacture by order, L = manufacture under licence

OAS and SHVL manufactured and still manufacture sailplanes of the types and variants CS and C under licence.

Manufacture of the wings was based on the knowledge of Schempp-Hirth at Kirchheim which was not available as written instructions. This was true for the processes during manufacture, the specification of materials (e.g. adhesives) and the criteria for quality assurance (tolerances).

Staff members of the Czech sub-contractors and/or licensees obtained the “know-how” through familiarization and assistance of several weeks' duration in the German factory of Schempp-Hirth at Kirchheim/Teck.

For the bonding surfaces between spar web and upper spar cap, the engineers had calculated with the full value of the components' bonding surface. The thickening of the resin through flakes and a surplus of adhesive were to ensure full bonding of the glued joints during manufacture.

The mixing ratio resin and hardener was observed precisely. The content of filler in the resin could vary depending on the room temperature. A viscosity value of the adhesive for checking purposes was not provided. The surplus of adhesive was to appear on a plastic film placed within the wing box and pulled out later through the wing root. This verification was not documented in detail by actual and target values.



Picture 5: Flawed bonding (x) and excessive (v) adhesive

Analysis

History of the flight

Analysis of the logger recordings did not indicate any inadmissible aerobatic flight manoeuvres and improper airspeeds. However, due to the poor signal sampling,

short-term and narrow manoeuvres cannot be precluded.

Weather

Meteorological conditions had no influence on the wing's failure.

Survival aspects

The occupants had trouble opening the laterally hinged canopy, and the features designed to break in order to remove the canopy from the aircraft failed to do so.

The two persons were in danger to be injured by the kickback of the canopy during their bail out.

The crew's difficulties in bailing out may still be considered an isolated case.

Findings on the aircraft

Quite obviously there was a flawed bonding of almost 20 cm in length in the bonding between the flange of the spar web made of GFRP and the upper spar cap made of CFRP. The interrupted bonding between the web and the upper cap of the main spar led to a stability failure of the upper spar cap. This occurs as soon as the wing is subject to a sufficiently high upward bending load. The Duo-Discus concerned was almost new.

The accident to the Discus CS in France revealed an even more extensive bonding defect on the wing spar. On this sailplane the failure did not occur until after some time in service.

The BFU is of the opinion that both failures could have occurred with flight loads still within normal operating ranges. For sailplanes, the positive aerodynamic load for which the wings are to be designed according to JAR 22 is + 5.3 g and thus relatively high. In normal operation, lower load factors are to be expected, e.g. + 2.0 g during steep turns (60°) and + 2.3 g in winch launching (+ 910 daN). Extreme accelerations are possible when pulling up in high speed flight and when recovering from an uncontrolled flight attitude, but also in high speed flight through gusts.

Aircraft type

It could not be excluded that other sailplanes of the aircraft type Duo-Discus and other wings of the same design had the defect described above. Therefore SHK and the LBA had to:

- a) find the sailplanes which most probably could be affected by the same production deficiency as MSN 387;
- b) develop and issue an appropriate inspection instruction suitable for identification and assessment of the bonding defect on the wing spar;

c) question further operation of sailplanes of the aircraft type Duo-Discus and if necessary to prohibit or restrict operation until the production inspection would clarify the matter.

Organization

At the manufacturer Schemp-Hirth design (type or variant), manufacture (component or assembly), production inspection (assembly or sailplane) and responsibility (product) were distributed to separate companies for some of the sailplanes of the aircraft types *Discus* (single-seater) and *Duo-Discus* (two seater).

Manufacture of the sailplane was predominantly manual work. The quality checks conducted throughout this process were not suitable to detect bonding defects prior to commissioning of the aircraft.

Safety precautions to preclude quality deficiencies of the product in individual cases were absent in some places. The problem became evident through the accidents. The Service Bulletins (table 2) show that corrective measures were possible. The introduced procedure of an inspection using a video probe represents a useful innovation.

Conclusions

The accident is to be attributed to deficiencies in the production of the wing and to an insufficient inspection.

Safety Recommendation

The BFU recommended the following immediate action:

Recommendation no.: 10/2003

The Luftfahrt-Bundesamt should restrict operation of the aircraft type Duo-Discus until the sailplanes which may have defective bondings also are identified and inspected.

The LBA responded on 31 July 2003 with the ADs 2003-246/2 and 2004-084. Schempp-Hirth responded with the SBs 396-8 and 396-9 (see table 2).

Investigator in charge	Frank Stahlkopf
Assistance	Uwe Pitz Gernot Leibe
Field investigation	Gerd Fleischmann