Statens haverikommission
Swedish Accident Investigation Board

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Report RL 2005:15e

Accident involving paraglider Gin Boomerang III in Valle de Bravo, Mexico, on 22 January 2004

Case L-01/04

SHK investigates accidents and incidents with regard to safety. The objective of the investigations is the prevention of similar occurrences in the future. It is not the purpose of this activity to apportion blame or liability.

The report is also available on our website: www.havkom.se.

Translated by Tim Crosfield, M.A., from the original Swedish at the request of the Swedish Accident Investigation Board. Should there be any discrepancies between the English and the Swedish texts, the Swedish text is to be considered the authoritative version.

Statens haverikommission (SHK) Swedish Accident Investigation Board

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2005-05-10 L-01/04

Swedish Civil Aviation Authority

SE-601 73 NORRKÖPING

Sweden

Report RL 2005:15e

The Swedish Accident Investigation Board (Statens haverikommission, SHK) has investigated an incident that occurred on 22 January 2004 in Valle de Bravo, Mexico, involving a paraglider type Gin Boomerang III.

In accordance with section 14 of the Ordinance on the Investigation of Accidents (1990:717) the Board herewith submits a report on its investigation.

The Board will be grateful to receive, by 9 November 2005 at the latest, particulars of how the recommendations included in this report are being followed up.

Carin Hellner Dan Åkerman

Contents

Report RL 2005:15e

L-01/04
Report finalised 10-05-2005

Aircraft: type	Paraglider: Gin Boomerang III Harness: Advance Winner
Class, airworthiness	Paraglider
Owner/operator	Private
Time of event	22-01-2004 14.30 hrs local time, in daylight
Place	Valle de Bravo, Mexico
Type of flight	Private
Weather	Local weather according to witnesses: wind 4-6 knots, clear weather. In Mexico City according to SMHI analysis: wind 090°/6 knots, visibility 10 km, high, scattered clouds, temp./dew point +21/0 °C, QNH 1011 hPa
Numbers on board; crew	1
Injuries	1 fatal
Damage to aircraft	Extensive
Other damage	None
Pilot:	
Sex, age, certificate	Man, 36 yrs, SSFF licence, pilot 3, instructor
Total flying time	> 1 000 hours, of which approximately 30 on type.
Flights previous 90 days	Several

The Swedish Accident Investigation Board (SHK) was informed on 23 January 2004 that an accident involving a Gin Boomerang III paraglider had occurred in Valle de Bravo, Mexico, on 22 January at 14.30 hrs local time.

The accident was investigated by SHK represented by Carin Hellner, Chair, and Dan Åkerman, Chief Investigator.

SHK was assisted by Katarina Åkerman as operational expert and Tommy Åkerblom as medical expert.

The investigation was followed by the Civil Aviation Authority in the person of Magnus Axelsson.

Summary

The pilot was a member of a group of European paraglider pilots visiting Valle de Bravo in Mexico for training flights and competition. The accident flight, a training flight, started at about 11.25 hrs local time. When the pilot after flying for some three hours was approaching the landing area, he still had excess altitude. He therefore initiated a spiral, i.e. a continuous turn with a large load factor and high rate of sink. After a few turns he increased the bank somewhat. Shortly thereafter the lines on one side between the pilot’s harness and the canopy broke, whereupon the paraglider collapsed. The pilot released his emergency parachute. According to witnesses this did

not open but came loose from the harness, and the pilot fell helpless to the lake beneath. His altitude was then about 100 metres.

The accident occurred because the emergency parachute was inadequately connected to the harness.

A contributory cause was that the paraglider's lines broke due to overloading.

A second contributory cause was that the paraglider was fitted with competition lines, the strength of which probably decreased during use.

Thirdly, competition lines are not tested to withstand the loads that can occur during normal flight.

Recommendations

It is recommended that the Civil Aviation Authority should:

- act to ensure that paragliders, harnesses and emergency parachutes are inspected and maintained according to established documentation and at suitable intervals. *(RL 2005:15e R1).*

- introduce jointly with delegated organisations logbooks or maintenance sheets for paragliders, harnesses and emergency parachutes. *(RL 2005:15e R2).*

- through research projects or similar investigate the characteristics of paragliders in advanced flight so as to be able to assess with greater security the loads to which components of the paraglider are subjected.
  (RL 2005:15e R3).

- seek to ensure that methods of testing paragliders are reviewed and adapted to the results of the previous recommendation.
  (RL 2005:15e R4).

- promote the introduction of a programme for testing canopies and lines after they have been in use so as to provide a basis for assessing their useful life. *(RL 2005:15e R5).*

1 FACTUAL INFORMATION

1.1 History of the flight

The pilot was a member of a group of European paraglider pilots visiting Valle de Bravo in Mexico for training flights and competition. The accident flight, a training flight, started at about 11.25 hrs local time. When after flying for some three hours the pilot was approaching the landing area he still had excess altitude. He therefore initiated a spiral, i.e. a continuous turn with a large load factor and high rate of sink. After a few turns he increased his angle of bank somewhat. Shortly thereafter the lines on one side between the pilot's harness and the canopy broke, whereupon the paraglider collapsed. The pilot released his emergency parachute. According to witnesses this did not open but came loose from the harness and the pilot fell helpless to the lake beneath. His altitude was then about 100 metres.

Spiral

Persons hurrying to the site in a boat picked up the pilot and gave first aid. It was soon established, however, that he has died immediately in the fall to the surface of the water.

The accident occurred at Valle de Bravo, Mexico, about 650 km west of Mexico City.

1.2 Injuries to persons

	Crew members	*Passengers*	*Others*	*Total*
Fatal	1	–	–	1
Serious	–	–	–	–
Minor	–	–	–	–
None	–	–	–	–
Total	1	–	–	1

1.3 Damage to aircraft

Extensive.

1.4 Other damage

None.

1.5 Personnel information

1.5.1 The pilot

The pilot, a man, was 36 years old and had a valid SSFF licence pilot 3, instructor.

Flying time (hours)			
latest	*24 hours*	*90 days*	*Total*
All types	unknown	unknown	>1 000
This type	unknown	unknown	approx. 30

1.6 The aircraft

1.6.1 The paraglider

PARAGLIDER	
Manufacturer	Gin Gliders Inc.
Type	Boomerang III
Serial number	KL02-130083E
Year of manufacture	2003
Approval rating	AFNOR ”Competition”
Flying weight	Max permitted takeoff/landing weight 125 kg, actual approx. 120 kg
Centre of gravity	Not applicable
Total flying time	Approx. 80 hours
Lines, type	Aramid
Manufacturer	Edelmann & Ridder GmbH & Co KG
HARNESS	
Manufacturer	Advance
Type	Winner
Serial number	27WL
Year of manufacture	1999
Approval	None
EMERGENCY PARACHUTE	
Manufacture	Sky Paragliders S.R.O.
Type	Sky Spare XL
Year of manufacture	Unknown
Approval	EN12491
Latest repacked	New

A paraglider is an aircraft that obtains its lift from its motion through the air. Despite similarities in appearance it has very little in common with a traditional parachute, the sole function of which is to brake a downward fall. Seen from above, the canopy of the paraglider resembles an aircraft wing, and consists of an upper and a lower fabric surface with upright partitions to give the wing a lift-generating profile. To maintain this form the space between the upper and the lower sheet is open in the direction of travel, and the wing is held inflated by the dynamic pressure arising from the motion through the air. This design permits the wing to collapse wholly or partly if exterior air forces grow greater locally than what the inner pressure in the wing can resist. This also means that the paraglider cannot always brake a vertical fall. To retain possibilities for safe landing even after a total collapse of the canopy, the pilot usually has an emergency parachute.

The lift of the paraglider in question is transferred to the pilot's harness through a system of lines designated A, B, C and D according to their placing, counting from the leading edge of the canopy. Seen from the harness each A and B line branches into twelve attachment points in the canopy. The C lines have sixteen attachment points, and the D lines eight. A further set of lines is connected to the trailing edge of the canopy and their main function is to enable the pilot to pull down either the whole of the trailing edge symmetrically and thus brake the paraglider or only one side, thus initiating a turn.

1.6.2 *The emergency parachute*

The emergency parachute was attached to the harness with a 25 mm wide synthetic fibre belt sewed onto each shoulder strap.

1.7 Meteorological information

According to the SMHI analysis of the weather in Mexico City, approximately 650 km east of the accident site: wind 090°/6 knots, visibility 10 km, scattered high cloud, temp./dew point +21/0 °C, QNH 1011 hPa.

Locally according to witnesses at the site: wind 4-6 knots, clear weather.

1.8 Navigational aids

Not applicable.

1.9 Radio communications

Not applicable.

1.10 Aerodrome data

Not applicable.

1.11 Flight recorders

Not fitted. Not required.

1.12 Accident site and aircraft wreckage

1.12.1 *Accident site*

Presa Valle de Bravo is an artificial fresh-water reservoir. The settlement of Valle de Bravo is on the eastern side of the lake.

The landing site (sandy beach) from the air

1.12.2 Aircraft wreckage

The paraglider, harness and emergency parachute were recovered by the local police and eventually sent to Sweden where they were examined by the Board of Accident Investigation.

1.13 Medical information

The pilot probably died immediately from internal injuries sustained in the fall to the surface of the water.

Nothing has emerged to indicate that the pilot's physical or mental condition was impaired before or during the flight.

1.14 Fire

Not applicable.

1.15 Survival aspects

As mentioned earlier, paraglider fliers normally carry an emergency parachute that can be thrown out by hand from its container, which in this case was placed under the seat. In normal cases the pilot can in this way save himself from a hazardous situation. In the present event the emergency parachute became detached from the harness during the opening phase.

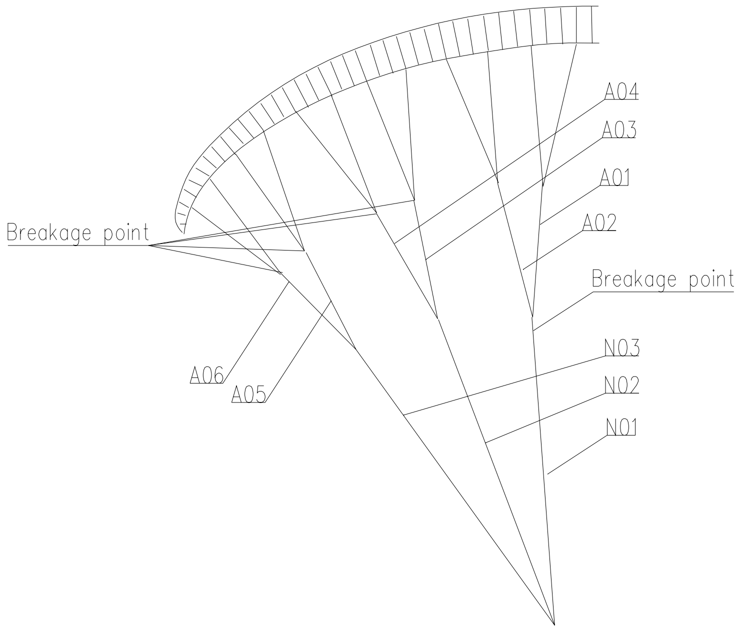
The chances of surviving once the emergency parachute had come loose were small or non-existent.

1.16 Tests and research

1.16.1 The paraglider

The paraglider was bought second-hand by the pilot some time before the event. When sold it had, according to the vendor, been flown for about 50 hours. The present pilot had then flown the paraglider for about 30 hours.

The paraglider and its lines were examined by the Board together with staff from the Swedish Paragliding Association, SSFF. The examinations showed that all A, B, C and D-lines on the left-hand side were broken, most at the last branch nearest the canopy. A majority of the lines on the right-hand side had also broken.



The left-hand A lines showing numbering and breakage points.

The lines were competition lines manufactured of aramid and designed to give the least air resistance, i.e. as thin as possible and without the protective sheathing standard lines have. They have a nominal strength of approximately 60-65 % of the standard lines'. It is apparently common to replace competition lines after about 100 flying hours. The use of competition lines has increased over the years because of their favourable effect on paraglider performance.

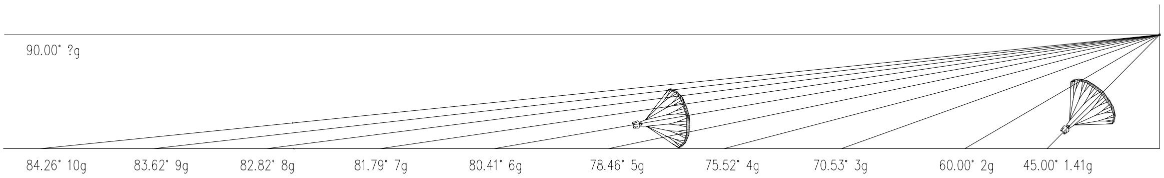
To gain some idea of the ability of the present lines to withstand the loads to which they were subjected during flying, a number of lines from the crashed paraglider were tested for tensile strength at CSM Materialteknik AB. The result is shown below, together with the manufacturer's specified values for the sake of comparison. When the pilot was removed from the lake most of the lines were cut at one point at least. For this reason it has not been possible to identify individual lines, and hence the dispersion of the results may be considered as an uncertain quantity in the calculations. However, it was possible in most cases to see the difference in the rupture point between cut lines and broken lines.

Line diameter	Numbering (A-lines)	Value given by manufacturer	Measured breaking strength, line	Measured breaking strength, branch
0.9 mm	N01-N03	1 200N	627-812N	-
0.7 mm	A01-A06	800N	671-683N	307-445N

It will be seen that the test values are considerably lower than those stated by the manufacturer.

1.16.2 *Loads on the lines during flight*

In forward flight without manoeuvering the paraglider's lift equals the weight of pilot and aircraft together. In a turn the paraglider banks and lift is directed inwards towards the centre of the turn. The horizontal component of the lift force causes the paraglider to turn. The vertical component must remain equal to the weight of the craft, so the banked lift force must be increased. This is achieved by increasing speed and/or the paraglider's angle of attack. The relation between the increase in lift and the angle of bank is: L/W=1/cos Ø, where W=weight of vehicle, L=lift force and Ø = angle of bank. The expression L/W can also be specified as numbers of "g", i.e. how many times greater the experienced gravity force is compared to what is normal on ground.



An estimate of the load distribution between lines A, B, C and D, respectively shows that the A lines take up approximately 46 %, the B lines 36 %, the C lines 11 %, and the D lines 6 % of the total lift. Since the A lines are the most heavily loaded and are of the same type as the others, the analysis will be limited to them.

If the distribution of lift force across the (wing) span is assumed to be mainly elliptical and the strength of the line is within the area stated in 1.16.1, line N01 breaks at 5.6 g - 7.3 g, corresponding to a turn bank of 80° or 82°, respectively. Note the large increase in load for an increase in bank angle of only two degrees.

It is probable that the lift force borne by line N01 at the moment of breaking was transferred momentarily to N02, whereupon the breaking strain of line A03 was exceeded and that line broke at the branch. A similar process continued outwards towards the wing-tip until one line in each load train had broken and the canopy collapsed. The course of events probably seemed more or less instantaneous. According to the paraglider handbook the paraglider is tested to withstand 8 g with standard lines. It is however recommended that the pilot does not perform aerobatics.

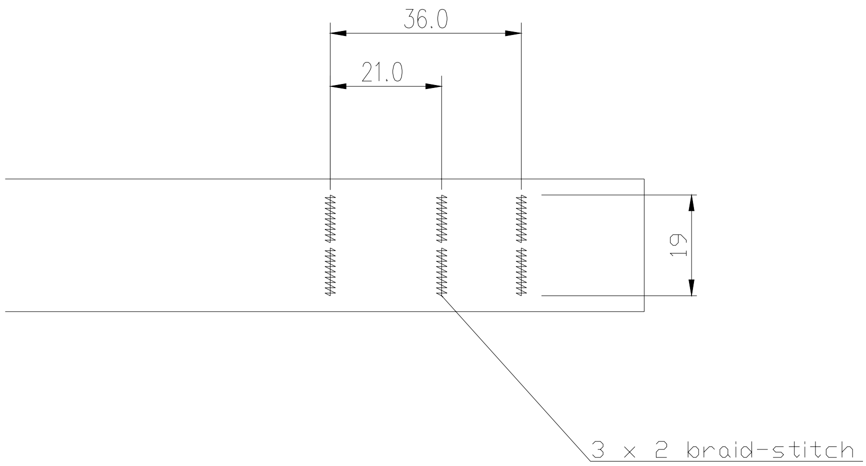
1.16.3 *The harness*

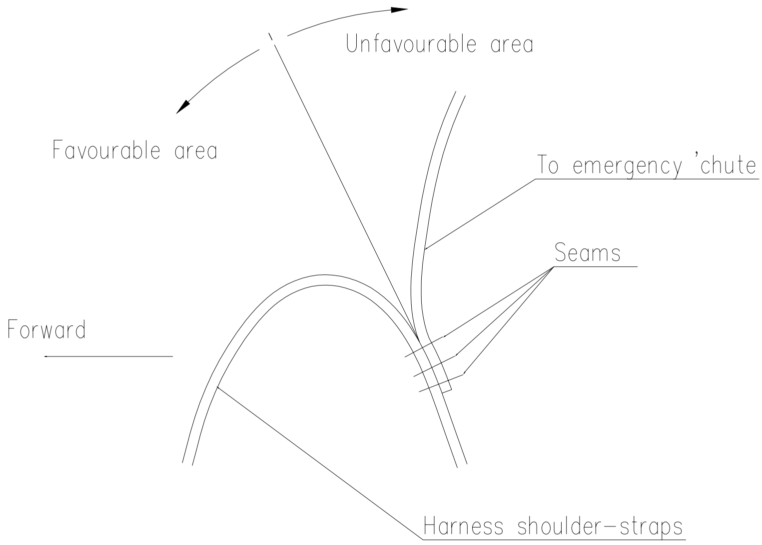
The harness was produced by the firm of Advance Thun AG. According to them it was made in 1999. The harness has not been tested or approved by any independent body.

The pilot had owned the harness since it was new and had earlier saved himself on one occation by using the emergency parachute.

The harness was examined by the Accident Investigation Board. It was noted that the seams between the harness and the strap connecting the harness and the emergency parachute had ruptured.

The connection between the harness and the strap to which the emergency parachute is connected is effected by placing the strap over the harness shoulder straps and then fixing it with three rows of braid-stitch, as illustrated below. This arrangement means that the seams are subjected to tear loads if the strap is loaded within the unfavourable area in the lower illustration. Tear loads cause one row of stitching at a time to take up the load, dramatically reducing the strength of the joint.





The firm Airsafe AB has carried out a theoretical analysis of the seams and run practical tests to verify the calculations. Their report is attached as Appendix 1. In brief it states that when the seams are loaded within the favourable area the strength of the connection is approximately half what is customary in the design of parachute equipment. For loads within the unfavourable area the strength may, depending on direction, be further reduced by as much as 50%.

Calculated tensile strength in the favourable area was approximately 9300 N, while in the tension test the strap broke at 9 200 N. On tearing (tension within the unfavourable area) the seams gave at approximately 1 900 N.

The Board has studied a film sequence of the earlier occasion when the pilot saved himself with the emergency parachute. As far as can be judged, the load when the parachute opened acted almost at right angles to the pilot's back, i.e. very unfavourably.

1.16.4 The emergency parachute

The emergency parachute, of SKY manufacture, was new and unused.
The parachute was found in the water near the pilot. It had no visible damage or anything observable to suggest malfunction. The strap that was originally attached to the harness was still attached to the parachute lines.

1.17 Paragliding and equipment maintenance

The regulations governing paragliding in Sweden are the ”Regulations for Civil Aviation (BCL)”, section ”Operational Regulations BCL-D 4.4”. The edition in force at the time of the accident and referred to here was LFS 2000:28, dated 1 May 2000.
The Civil Aviation Authority has delegated the tasks and the powers of supervising paragliding to SSFF, the Swedish Paraglider Federation. SSFF has produced more detailed regulations, to be found in the Federation's publication ”Provisions and Definitions” (FoD). At the time of the accident, version 5.3, 1 July 2003 was in force. This is the version referred to here.

1.17.1 Paragliders

According to FoD article 600:5 Airworthiness, it is incumbent on the pilot to maintain the equipment in airworthy condition and to ensure that it is checked/inspected according to manufacturers' recommendations.
The Owner's Manual for the paraglider in question recommends having an authorised Gin agent inspect the paraglider every 100th flying hour and at least once a year. Inspections are usually documented by the person carrying out the check, but the inspection protocol does not always accompany the paraglider.

1.17.2 Harnesses

In the Swedish regulations paragliders and harnesses are treated as one unit even though they may come from different manufacturers. There are no special inspection requirements, nor are any inspections documented.

1.17.3 Emergency parachutes

The Civil Aviation Authority distinguishes between parachutes intended for saving lives, termed ”rescue parachutes” and those intended for use in malfunctions of sports parachutes, termed ”reserve parachutes”. The parachute accompanying paraglider flights is now termed by SSFF ”emergency parachute”, the designation used in this report.
Design and maintenance requirements for rescue parachutes and reserve parachutes, respectively, are dealt with in BCL-M 5:3, while emergency parachutes are treated in SSFF's FoD manual.
It is not entirely clear whether emergency parachutes are in a class of their own or whether they should be considered as rescue parachutes or reserve parachutes. Manufacturing, testing and maintenance requirements are substantially more stringent for the latter types. One example of this is that an emergency parachute can be repacked by the owner, after training. A rescue or reserve parachute, on the other hand, must be repacked by a parachute technician or packer. On such occasions both parachute and harness are inspected according to an established protocol. These measures are then entered on a log sheet that accompanies the parachute. Inspections of emergency parachutes are most often documented by the person who carried out the check, but the protocol does not always accompany the parachute.

1.17.4 Flying with large load factors

In normal paragliding, load factors greater than 3-4 g are seldom reached. This corresponds to a bank of about 70-75°.

Turns with greater bank angles can have considerable effect on both the paraglider and the pilot (see 1.16.2). As will be seen below the French Standards Association (AFNOR) and also the German Hanggliding and Paragliding Federation(D H V) test that the canopy and its lines withstand a load that is eight times greater than the maximum weight they are intended to bear. This load is reached at a bank angle of 83°.

As mentioned earlier the manufacturers of the paraglider advise in their handbook against ”Aerobatics”. The definitions in the DHV and the SSFF regulations of ”Kunstflug” (aerobatics) and ”Akrobatisk” (acrobatic flying) include bank angles exceeding 90°.

It should be mentioned that if in a turn the bank angle is increased from 83° (8g) to 90° the load increases very rapidly from 8 g to a theoretically infinitely large value.

The aerodynamics and motions of paragliders under the influence of aerial and mass forces do not appear to be known or to have been previously investigated in detail. The Board’s study of film sequences showing advanced flying indicate that their motions are hard to analyse, and that experience from conventional aircraft is not always applicable.

For example, a paraglider can be steered into, or inadvertently enter a spiral that is almost comparable with a vertical tunnel roll and in which the leading edge of the canopy is largely parallel with the horizon. The paraglider’s lift is then directed mainly towards the centre of rotation and the rate of sink is determined by the total air resistance of paraglider and pilot. The pilot, whose face is turned towards the ground, is almost horizontal and experiences large g forces. Accidents in which the pilot has lost consciousness or simply not been strong enough to lift his arms against the g forces to operate the paraglider has occurred, the pilot has thus been unable to exit the manoeuvre and has lost his life in the ensuing crash.

The reason why spirals in paragliding are not viewed as advanced flying is reportedly that every pilot can at some time be forced to use the manoeuvre to increase his rate of sink, in order to stop a climb in a thermal before entering cloud.

A number cases of multiple line breakage, of which at least one with a fatal outcome, have occurred internationally during recent years. Lines have broken during spiral flying and during thermal flying with its accompanying turbulence. Most cases have involved competition lines.

1.18 Testing and approval of equipment

1.18.1 Paragliders

To be legally used in Sweden a paraglider must be approved by the appropriate authority or organisation in one of the member-states of the European Economic Sphere, EES.

The paraglider in question partly fulfils this requirement in that is approved by AFNOR, when fitted with standard lines. Common to DHV and AFNOR is that the paragliders tested are, as far as is known, always equipped with standard lines.

Apart from investigating the paraglider’s flight characteristics and classifying it as Standard, Performance or Competition according to performance and requirements on pilot’s experience, AFNOR also tests structural strength. This is done in first part with a ”Shock Test” in which the paraglider is rapidly pulled up by a vehicle with the line kept under a tension of

6 000 N. The canopy and lines are considered to have passed this test if no damage is evident.

The other part of the test is the ”Loading Test” and is conducted in a similar manner. The difference is that the paraglider is filled at normal speed and the vehicle then maintains such a speed that the load on the line is equivalent to 8 times the paraglider's maximum permitted flying weight.. This load is maintained for five seconds, whereafter the paraglider is inspected. The canopy with its lines is considered to have passed the test if no damage is evident.

Older-model paragliders are not tested, nor are those with competition lines.

The DHV test methods are similar.

1.18.2 Harnesses

Before use, harnesses must be approved in the same way as paragliders. The harness in question lacked approval and was thus to be considered as not airworthy according to the regulations.

Since the harness was not approved by either AFNOR or DHV, it is immaterial which of the documentations its calculated strength is compared with.

The Board has had access to the DHV documentation. Section 4.2, Structural Strength (Harness) prescribes that the harness must, for 10 seconds, withstand a load corresponding to 9 times the pilot's weight or 9 000N if the latter value is higher. This load must also be applied to such fixing points for the emergency parachute as can lead to the parachute being inadvertently connected there.

In general the harness must possess ”sufficient strength to stand up to all types of flying and configurations”.

1.18.3 Emergency parachutes

According to the FoD manual, emergency parachutes must be approved by a testing organisation approved by SSFF. One such organisation is DHV, which in Lufttüchtigkeitsanweisung (Airworthiness Directive) 13-11-1997 also prescribes that the combination of harness-emergency parachute must be tested and approved by one of the two manufacturers. The emergency parachute in question appears to have been approved according to EN12491, but the combination with the harness appears not to have been tested and approved.

2 ANALYSIS

2.1 The accident

It is likely that the lines broke because of overloading. It is particularly serious that the sequence probably started with one line breaking, whereafter the others became overloaded and broke one after another. Such a sequence means that the design lacks alternative load paths and is therefore very vulnerable if a line breaks.

2.2 The paraglider

The tests described in 1.18.1 give no information as to the margin to breaking after a successful test. Considering how fast the load increases at large bank angles (see 1.16.2) this information must be seen as vital.

Nor do the tests give any information on remaining structural strength after, for example, one section of a line has broken.

The Board's calculations of loads on the lines are very superficial and may very well include errors. They nevertheless show that the lines can be calculated to break at loads that are not excessively large, indeed at loads far below the test levels.

The structural strength tests of the lines which the Board arranged to be done show that lines that have been in use may have considerably less strength than new lines.

Given how important it appears to replace competition lines, in particular, after a period of use the need for log or other sheets on which such measures are noted appears appreciable.

The paraglider was not tested by any organisation or authority with competition lines mounted, and for this reason was not airworthy.

2.3 Paragliding with large load factors

The fact that DHV and AFNOR test the structural strength of paragliders to 8 g, which corresponds to a turn bank angle of 83° and at the same time consider bank angles under 90° as normal flying probably indicates that understanding of and respect for the loads that can arise are not so widespread as could be wished. In addition it appears that the characteristics of paragliders in advanced flight have not been sufficiently studied in theory. For this reason there is a risk that, particularly when using competition lines, these will be overloaded. The fact that steep spirals are a more or less unavoidable manoeuvre in thermal flying, and that the use of competition lines is increasing, present a dangerous combination.

2.4 The harness

As noted in 1.16.3 a braid-stitch seam of the type in question is calculated to withstand 9 300 N under favourable tension. The practical tests support this, but also show that under unfavourable tension the strength can decrease to 1 900 N. The fact that the harness was being used on a previous occasion when the emergency parachute was released, may have weakened the seams even before the accident.

The event shows that harnesses ought to be inspected at suitable intervals, and it follows from this that log sheets or maintenance sheets should be introduced.

2.5 The emergency parachute

The emergency parachute was reportedly new and unused and its characteristics appear not to have affected the course of events. The emergency parachute is an important part of the pilot's safety equipment and should therefore have a log or maintenance sheet on which maintenance and inspections are noted.

3 CONCLUSIONS

3.1 Findings

a) *The pilot was authorised to carry out the flight.*
b) *The paraglider was not tested or approved in the configuration in which it crashed.*
c) *The paraglider's competition-type lines had been forcibly broken.*
d) *The lines were appreciably weaker than the values specified by the manufacturer.*
e) *The paraglider harness was not approved.*
f) *The strap connecting the harness and the emergency parachute was attached to the harness in an inadequate manner.*
g) *Shortcomings in the scope and documentation of maintenance and inspection of paragliders, harnesses and emergency parachutes have been noted.*
h) *The level of knowledge regarding the behaviour of paragliders under the influence of aerial and mass forces should be generally raised.*

3.2 Causes of the accident

The accident was caused by the connection of the emergency parachute to the harness being manufactured in an inadequate way.

A contributory cause was that the paraglider lines broke because of overloading.

Also contributing was the fact that the paraglider was equipped with competition lines, the strength of which probable decreased during operation.

A further contributory cause was that competition lines are not tested to withstand the loads that can arise during normal flight.

4 RECOMMENDATIONS

It is recommended that the Civil Aviation Authority should:

- act to ensure that paragliders, harnesses and emergency parachutes are inspected and maintained according to established documentation and at suitable intervals. *(RL 2005:15e R1).*

- introduce jointly with delegated organisations log sheets or maintenance sheets for paragliders, harnesses and emergency parachutes. *(RL 2005:15e R2).*

- through research projects or similar investigate the characteristics of paragliders in advanced flight so as to be able to assess with greater security the loads to which components of the paraglider are subjected. *(RL 2005:15e R3).*

- seek to ensure that methods of testing paragliders are reviewed and adapted to the results of the previous recommendation. *(RL 2005:15e R4).*

- promote the introduction of a programme for testing canopies and lines after they have been in use so as to provide a basis for assessing their useful life. *(RL 2005:15e R5).*