DHV Safety tests of LTF A- and B- Paragliders, Part 4

This article is a continuation of the safety test series first published in DHV-Info 174 (also available on the internet under www.dhv.de on the Safety and Technical page). Details on test criteria, practical relevance of the test manoeuvres with regard to accident statistics and current LTF airworthiness requirements can be found there.

The testing team from the DHV's Safety and Technical department chose current LTF-B paragliders available on the market designated as middle to high end gliders by their manufacturers for part 4 of the safety test series.

Safety testing was conducted at the top 25% of the weight range for the following gliders:

Glider	Certification number	Weight range
Gradient Nevada 28	DHV GS-01-2001-12	95-115 kg
Air Design Rise M	EAPR-GS-7474/11	85-105 kg
Icaro Wildcat TE M	EAPR-GS-7494/12	80-110 kg
Skywalk Chili 3 M	DHV GS-01-2017-13	90-114 kg
Mac Para Eden 5.28	EAPR-GS-7619/12	85-110 kg

Attention to detail

some may dismiss this as nit-picking, but a correct glider label with all 19 data fields fully completed as required by German law ought to be taken for granted these days. Particularly important are the manufacturers signature that the glider has been type tested. If the initial test date is not supplied, then the owner cannot know when the glider is due for a later check. Selling the glider may also be problematic, if no dates are available to verify the gliders age.

Glider	Glider label complete?	Missing entries
Gradient Nevada 28	No	Date of manufacture
Air Design Rise M	No	Date of manufacture
Icaro Wildcat TE M	Yes	
Skywalk Chili 3 M	No	Date of manufacture
Mac Para Eden 5.28	No	Date of manufacture

Launch preparations

What is tested:
In particular we look at the risers and line systems, how easy they are to sort, if looping or knots in the lines are easy to see or not and the functionality and ergonomics of the risers.

High end B class gliders focus on reducing line resistance and increasing performance. As a result, gliders have often thin risers and minimal lines. Three of the test gliders (Eden 5, Chili 3, Nevada) have a 3+1 riser configuration (split A-riser + B-riser + C/(D) riser), Rise and Wildcat both have an extra riser for the rear lines. The Skywalk Chilli 3 is a genuine 3-liner with only A, B and C line galleries. The Wildcat TE is a 4-liner (A, B, C and complete D-line gallery). All other gliders can be called 3-line hybrid constructions.

These have a common C line gallery which then splits at the top to support a few thin D lines. Most gliders only have D-lines supporting the middle of the canopy and not at the wingtips. Chili 3 and Nevada both have only two main A-lines per side, all other gliders have three. All gliders with the exception of the Eden 5 have the LTF requirement of a different coloured stabilizer line. None of the gliders had traditional mylar reinforcements at the leading edge, all used the newer plastic rod technology. Both the Chili 3 and Eden 5 have plastic rod reinforcements built in at the C line attachment points, the Chili 3 also at the stabilizer. All gliders with the exception of the Nevada, have mini ribs built in on the trailing edge of the canopy. Flat aspect ratios are between 5.7-5.8 (Nevada, Eden 5 and Rise) and 5.4-5.5 (Chili 3 and Wildcat TE).

Picture: The high-end B segment is packed full of high-tech: mini-ribs, diverse horizontal tapes, plastic rods at the nose and C-lines and aspect ratios approaching 6. Pictured is the Mac Para Eden 5.

Pilots choosing a glider from the high-end B class cannot expect behaviour suitable for school and novice pilots. This is also true for handling during launch preparation. All gliders have a lot of thin, mostly unsheathed upper gallery lines and at the stabilizer and brake lines, and some even at the middle line gallery. These require careful sorting, which is not a problem if there is sufficient wind to make a quick rear inflation. If you are preparing for a forward launch then more care is required. In particular, the low contrast brown-yellow coloured unsheathed aramid lines are often difficult to control for knots and tangles. A significant number of launch accidents are due to knotted or tangled lines. Remember to make a careful check every time you prepare to launch, even if it takes some time.

The easiest glider to prepare for launching was the Icaro Wildcat TE. The advantage of its traditional 4 riser configuration is the easy sorting of the back line galleries. This is the area where tangles are most common. Mac Paras Eden 5 has very thin risers, which handle surprisingly well: not too stiff and not too floppy. The rear riser is however very long, and tends to get caught in the other lines. Mac Para only use unsheathed lines on the rear galleries, brakes and a few in the middle galleries, which makes line sorting relatively simple. A first look at Gradients Nevada or Skywalks Chili and you think the manufacturer has forgotten a few main support lines! Both manufacturers use only six main support lines (plus stabilizer) per riser. Our testers all remarked that this minimalist line configuration (as few as possible down below, normal numbers in the top galleries) required more time for careful checking and sorting than by other gliders. Air Designs Rise has a marked tendency for its lines to become twisted with themselves in the upper galleries compared with other gliders. Line sorting is however easy, as each line set has its own riser. In the safety test of Air Designs Vita (DHV Info 181) we criticised the riser material used there for being too clumsy and floppy. Here with the Rise we have the problem that the risers are too stiff. After several starts you'll notice grazes on your arms from the thin stiff materials used. One positive detail – the size of the brake loops can be adjusted to fit your hands exactly.

Launch preparations			
Glider	Easy	Average	Difficult
Icaro Wildcat TE M			
Gradient Nevada 28			
Air Design Rise M			
Skywalk Chili 3 M			
Mac Para Eden 5.28			

Launch characteristics

What is tested:
Inflation, climb rate, requirements to stabilise and necessary brake inputs.

A team of 4 instructors judged the launch characteristics of the gliders. Pilots who are used to launching high-end B class gliders shouldn't have any problems starting any of the tested gliders, there are however a few differences in the finer details. Our instructors found the **Icaro Wildcat TE** the easiest glider to launch – such that it is suitable for a school pilot. The glider climbs easily and constantly to the zenith, without overshooting and needs only minimal brake input to stabilise it there. **Skywalks Chili 3** also climbs constantly and not too fast to the zenith, but needs more brake input to stop it there and stabilise the canopy. **Air Designs Rise** is very similar. Both **Gradients Nevada** and **Mac Paras Eden 5** were more difficult to launch. At the beginning of inflation both gliders tend to hang back a little requiring careful pressure from the pilot on the risers. At the end of the climb, both gliders tend to accelerate and surprise the pilot with needing a good jab on the brakes to stop them at the zenith and stabilise there. Too much brake brings the canopy down quickly, but once our testers had gotten used to this behaviour, safe launching was no real problem.

Launch characteristics			
Glider	Delayed	Balanced	Dynamic
Icaro Wildcat TE M			
Skywalk Chili 3 M			
Air Design Rise M			
Mac Para Eden 5.28	At beginning of climb		At end of climb
Gradient Nevada 28	At beginning of climb		At end of climb

Picture: Typical for this class, canopies must be braked to prevent overshooting at the end of the climb phase when launching. Air Designs Rise is pictured here.

Test manoeuvres / recovery from instability

All test manoeuvres were filmed with onboard GoPro cameras, ground cameras and documented with the DHVs data loggers. Test manoeuvres were performed by the DHV test pilots Reiner Brunn and Harry Buntz.

Info Data loggers

The pilot data logger is firmly attached to a main suspension strap on the pilots harness.

A second smaller glider logger is attached to a cell wall inside the glider using two strong magnetic plates. The best position for data collection has been determined to be where the C-gallery lines are attached to the canopy at the 70% collapse marker points. Logger data is collected continually from the beginning to the end of the test flight and the two instruments are synchronized with each other via a low-range radio signal. Data sets are transferred from standard micro-SD memory cards to a PC after landing.

The loggers collect the following information:

Pitch, roll and yaw angle,

Pitch, roll and yaw acceleration,

Vertical velocity calculated over a 0.5 second window from the barometric altitude sensor,

Velocity: the pilot data logger contains a 5 Hz GPS, from which the velocity over ground is calculated,

G-Force: from the accelerometers contained in the pilot data logger the G-force acting on the pilot is calculated,

Altitude: both the barometric height (recorded at 100Hz) and the GPS height (5Hz) are recorded.

Data processing: the processing software is written to automatically recognize the beginning and end of a test manoeuver. Pilot and glider movements are simulated from the recorded data, and this simulation is synchronized with the video material of the test flight. Test pilots check the synchronized results for plausibility. Data loggers are instruments to assist test pilots and provide additional objective information on parameters which are difficult to judge in the air such as roll and pitch angles, height loss, course changes and durations.

Flight stability

What is tested:
Through induced pitch testing a measurement of a gliders pitch stability and pitch-damping can be made. The angle to which a canopy dives forward during pitch testing is a good indicator of the potential dynamics which may develop during such circumstances. Pitch angels were measured after the third pitch cycle during testing.

Pitch forward angle				
Gerät	< 30°	30-45°	45-60°	> 60°
Mac Para Eden 5.28				
Icaro Wildcat TE M				
Gradient Nevada 28				
Skywalk Chili 3 M*				
Air Design Rise M**				

* Frontal collapse after third pitch cycle at approx. 65° pitch forward angle.
** Massive collapse after third pitch cycle at approx. 70° pitch forward angle.

Asymmetric Collapses

What is tested:
Asymmetric collapses are conducted at trim speed and at full speed with no pilot action. Canopies are collapsed to the top limit of the field defined in the LTF airworthiness requirements (visible from the tapes stuck to the lower sail), i.e. the maximum possible for certified gliders. During LTF testing it is also possible to certify a glider collapsed at the minimum limit of the LTF field, but this generally results in less dynamic behaviour. For this reason we often see differing results here in safety testing, when compared with those of the certification tests.
Note: Paragliders in the LTF B certification class are permitted to pitch forward to 45° after collapsing. This test regulation is verified in LTF testing using only video film shot from the ground and therefore subject to large error margins, as no clear reference points can be used to calibrate the measurements in any way. When a glider collapses assymetrically, the dive experienced is always a combination of pitching forward and rolling to one side. This again makes judging the pitch forward angle from video film very inprecise. The data loggers used by the DHV record pitching and rolling movements separately. It has been determined that only a few gliders in the LTF A and B classes actually fulfill the test requirements of diving forward to less than 45° when measured with the data loggers.

Similar to its predecessor, the Skywalk Chili 3 has it's own special collapse behaviour. The canopy only folds along a shallow collapse angle across the leading

edge. Even when pulling massive collapses, the canopy does not fold steeply, so most of the trailing edge remains flying. To provoke LTF norm collapses, the test pilot must use both hands and lots of dynamic force to make the trailing edge deform. If this is performed, then the glider dives well forward and often then cascades with a collapse on the opposite wingtip. We didn't note any tendency for the canopy to cravat, as with the Chili 2, where the wingtip would often catch between the upper gallery lines. Mac Paras Eden 5 and Gradients Nevada react similarly to assymetric collapses. Compared with other gliders in this class both gliders slow on collapsing and course change is delayed. The rate of course change and pitch forward angle begin to increase markedly after about 90°, moreso with the Eden 5 than the Nevada. This type of behaviour gives a pilot more time to react and prevent further difficulties but may also lead to a spin or stall if the pilot brakes too early to recover. Icaros Wildcat TE is quite different. The canopy folds steeply, creating a lot of resistance and turns abruptly and dives forward steeply. Total height loss was average for the class. Generally the canopy shows a tendency to dive forward steeply which often leads to cascades and cravats. These did not occur during testing. Air Designs Rise had the most challenging behaviour to assymetric collapsing. Collapsing to the middle of the LTF norm field provoked reactions average for the class. As soon as the maximum end of the norm field is reached, the Rise then dives forward massively and cascades with a collapse on the opposite wingtip. Rapid course changes were noted and the cascade collapses cravated easily in the upper gallery lines. Recovering from the cravat was relatively easily done by applying a little brake, but had to be performed actively. The canopy folds steeply on collapsing which is always associated with more negative dynamic reactions in test results.

Asymmetric Collapses							
Glider	Height-loss in m	Pitch-angle in °	Pitch change rate in °/sec	G-Force in G	Course-change angle in °	V/sink maximum in m/s	Notes
Skywalk Chili 3 M	40-49 m	>75°	>75°	2,5 G	180°-360°	>20 m/s	This glider collapses with a shallow collapse angle. Behaviour is relatively moderate with course changes of approx. 180° and height loss under 40 m but with marked diving forward. Massive collapses with high collapse angles result in dynamic reactions with large dive forward angles and cascade collapses on the opposite wingtip without cravats.
Mac Para Eden 5.28	40-49 m	-65°	-75°	2,5 G	90-180°	15-20m/s	This canopy has relatively moderate reactions for its class, even for massive collapses. Course changes start slowly and then begin to accelerate after approx. 90° with marked forward diving.
Icaro Wildcat TE M	40-49 m	>75°	>75°	2,6 G	-270°	>20 m/s	Height loss is average for its class, but reactions are very dynamic, dive forward angles are severe and course changes are rapid.
Gradient	40-49 m	-65°	-65°	2,2G	90-180°	15-20 m/s	This canopy has relatively

Nevada 28							moderate reactions for its class, even for massive collapses. The glider decelerates on collapsing more than others in its class (care needed on brake input). Course changes are comparitively slow and non-dynamic. Relatively low G-Forces.
Air Design Rise M	40-49m[1] 70-79m[2] after pilot action	>75°	>75°	2,5 G	270°-360°+	>20 m/s	Average behaviour for its class for collapses to the middle of the test field. For massive collapses to the maximum of the test field the glider dives forward extremely, changes course very rapidly and cascades with a collapse on the opposite wingtip and further course changes. Height loss high.

Skywalks Chili 3 generally collapses at a shallow angle where most of the trailing edge remains inflated. Test pilot Reiner Brunn must use massive force and both hands to produce a steep collapse angle where the trailing edge also deflates. Nevertheless, reactions to collapses are far more moderate for shallow collapse angles when compared with gliders that collapse steeply. A big advantage for the Chili 3 in this test, but in practice things may turn out a lot differently.

Mac Paras Eden 5 and Gradients Nevada have similar relatively moderate collapse behaviour for high end B class gliders.

Assymetric collapse on an Icaro Wildcat TE. Compared with the Eden 5 and Nevada, this glider reacts more dynamically to deformations. Total height loss was not more than for other gliders.

Air Designs Rise reacts challengingly to assymetric collapses. Collapses angles are steep (Picture top left), and cascades after diving forward on the opposite wingtip (picture top right) which may cravat (Picture bottom left). The glider demonstrates some instability at full bar, here we see the deformation in the wing middle (picture bottom right).

Front collapses

What is tested:
Front collapses are performed at trim speed and at full speed in different configurations: firstly by collapsing to a depth of only 40% of canopy (marked with tapes on the lower sail), and then by collapsing the maximum that the gliders construction presents. Maximum front collapses on full bar generally exceed the LTF certification limits. From accident analysis and diverse video footage, we know that front collapses in practice often effect 100% of the canopy. Many gliders are certified at the minimum 40% limit without looking for construction weaknesses. We often see large deviations to certification behaviour when gliders are tested at the upper limit. Pilot action to recover is only performed when the glider does not self-recover.

Gliders in the LTF-A class generally do not have significant difficulties with front collapses. High end B class gliders generally have aspect ratios of 5.5 and more, and this leads to far more chaotic recovery behaviour than what we see on compact gliders. Particularly chaotic reactions in this test were displayed by the **Air Design Rise** and the **Icaro Wildcat TE**. Both of these gliders do not self recover from front collapses which deform a moderate amount of depth from the leading edge. Pilot action is required to regain normal flight. On the other end of the scale, **Gradients Nevada** displayed moderate reactions even to front collapses which deformed almost the entire canopy. The canopy recovers quickly with only slight assymetric or chaotic tendencies.

Front Collapse						
Glider	Height-loss in m	Pitch-angle in °	Pitch change rate in °/sec	Rotation, G-Force in G	Course-change angle in °	V/sink maximum in m/s
Skywalk Chili 3 M						
40% collapse	20-29 m	30-45°	-30°	no	-10 m/s	Moderate pitch back, low pitch forward, immediate recovery, no course change, low sink rates
Maximum collapse presented by construction	40-49 m	45-55°	45-55°	Yes, 90-180° 2 G	10-14 m/s	Marked pitch back and pitch forward.

Mac Para Eden 5.28						
Einklapptiefe 40%	20-29 m	30-45°	30-45°	no	-10 m/s	Moderate pitch back, moderate pitch forward, slight delayed recovery, no course change, low sink rates
Maximum collapse presented by construction	50-59 m	30-45°	30-45°	Yes, 90-180° 1,9 G	10-14 m/s	Moderate pitch back, moderate pitch forward
Icaro Wildcat TE M						
40% collapse	30-39 m	30-45°	30-45°	no	10-14 m/s	Rapid recovery only for collapses <40% depth. Collapses >50% have marked deformation tendencies even when performed at trim speed. Marked chaotic recovery with wingtips forward. Marked twist and cravat danger. Pilot action often required to recover, without marked tendecy to cravat.
Maximum collapse presented by construction	Pilot action required to recover after approx. 60 m height loss	>60°	>60°	Yes, 90-180°	10-14 m/s	
Gradient Nevada 28						
40% collapse	20-29 m	30-45°	30-45°	no	10-14 m/s	Moderate pitch back, moderate pitch forward, immediate recovery, no course change
Maximum collapse presented by construction	30-39 m	45-55°	30-45°	Yes, <90°	10-14 m/s	Marked pitch back, moderate pitch forward, slight delayed assymetric recovery
Air Design Rise M						
40% collapse	40-49 m	-30°	30-45°	no	10-14 m/s	Marked delayed recovery with marked height loss even for smaller front collapses. Larger collapses resulted in reproducable stable front horseshoe deformations with rotation. Pilot action required to recover. No self recovery.
Maximum collapse presented by construction	Pilot action required to recover after approx. 60 m height loss	30-45°	30-45°	Yes, marked	15-20 m/s	

Reaction behaviour of Air Designs Rise is not acceptable for the B class. Although collapse depth is not more than 50% (picture top right), chaotic reactions occur as shown (pictures top right and bottom left) and may lead to a stable front horseshoe with no self recovery. Recovery must be performed by pilot action on the brakes (picture bottom right).

Icaros Wildcat TE reacts correctly for the B class only for smaller fron collapses (picture top left). Larger collapses (pictures top right, bottom left) produce chaotic reations and may result in twists and cravats which need to be immediately recovered from via pilot actions on the brakes (picture bottom right).

Spiral dives

What is tested:
Spirals are flown such that after at least 5 seconds and before the 540° point the canopy is fully locked in the rotation. The testpilot then keeps the glider in the spiral using the brakes for a further 2 turns (720°) before releasing the inside brake to start recovery.

The spiral test produced no great surprises. No glider demonstrated tendencies to remain in a stable dive after the brakes had been released to initiate recovery. High end B class gliders do tend to collapse on the outer wingtip when spiralling due to their higher aspect ratios. These small collapses produce sufficient resistance to prevent the gliders accelerating further in the spiral. Here all spirals were flown according to LTF test regulations without using weight shifting. Spirals flown in practice by pilots using weight shifting and stabilising the outer wingtip sufficiently to prevent it collapsing may well lead to further acceleration in the dive and produce a stable spiral dive once the brakes are released to initiate recovery.

Spiral dives							
Glider	Vsink after 360°, 720°, max.	G-Force after 360°, 720°, max.	Height loss after 360°, 720°, max.	Height loss from brake release to regaining normal flight	Time to 360° 720° Total	Action after brake release	Notes
Skywalk Chili 3 M	8 m/s 15 m/s 15 m/s	2,3 G 3,8 G 3,8 G	30m 80	30m	0-9 s 9-13 s	No further acceleration, immediate automatic exit, recovery within the next 180°	Relatively dynamic transition from entry to spiral. Glider collapses on outer ear at 15 m/s which resists further acceleration. Exit relatively simple.
Mac Para Eden 5.28	7 m/s 15 m/s 17m/s	2,2 G 3,3 G 3,7 G	30m 70m	40 m	0-7s 7-12s	Short acceleration from 15m/s to 17 m/s in the	Dynamic transition from entry to spiral. Exit relatively simple. Glider deforms on

						next 90°, then automatic exit and recovery in the next 180°	outer wingtip.
Icaro Wildcat TE M	6 m/s 15 m/s 18 m/s	1,8 G 3,1 G 3,8 G	30 m 70 m	60m	0-7s 9-13s	Acceleration from 15m/s to 18 m/s which remains constant for the next 270°, then automatic exit and recovery in the next 180°	Glider does not easily bank into the spiral during the first rotation, then followed by a rapid acceleration.
Gradient Nevada 28	7 m/s 14m/s 18 m/s	2,5 G 2,7 G 2,9 G	30 m 70 m	50 m	0-7s 7-11s	Acceleration from 14 m/s to 18 m/s in the next 90° which remains constant for the next 270°, then automatic exit and recovery within the next 180°.	Marked outer wingtip collapse.
Air Design Rise M	9 m/s 16m/s 21m/s	2,6 G 3,5 G 3,7 G	40m 90 m	50 m	0-6s 6-10	Acceleration from 16 m/s to 21 m/s in the next 270° then automatic exit and recovery	Rapid and dynamic entry, slight deformation on outer wingtip. Accelerates slightly after brake release to initiate recovery.

B-Stall

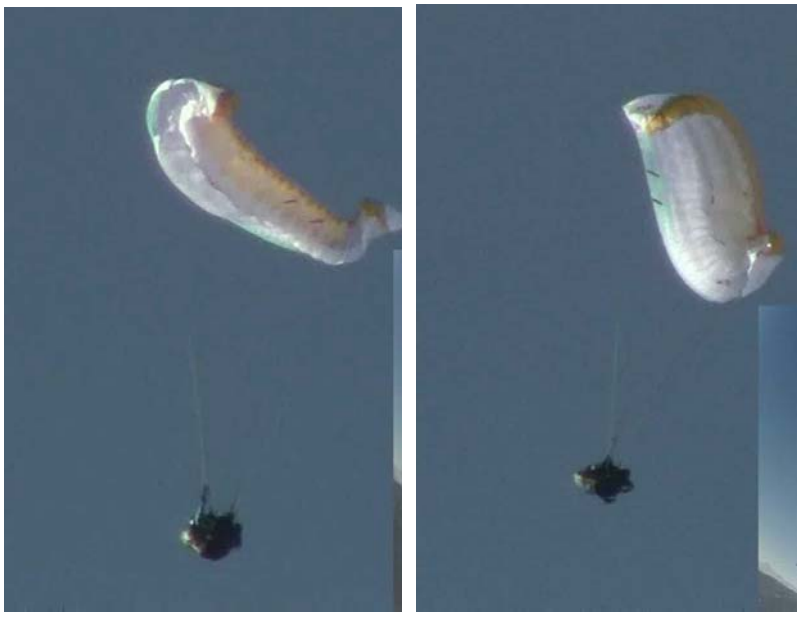
What is tested:
Pitch back behaviour on entry, pitch forward behaviour on exiting and sink velocities. In particular we look at the canopy stability and tendencies to deform on longer B-Stalls (>10s) and any recovery problems.

Skywalk Chili 3, Mac Para Eden 5 and Icaro Wildcat did not have any difficulties with this manoeuvre. In less than 10 seconds, the wingtips of Gradients Nevada begin to bend to the back, but this tendency is clearly indicated. For even short B-stalls of <3 seconds, the wingtips on Air Designs Rise bend forward and cravat in the lines. It is only possible to achieve a stable B-stall here with a very careful dosed pull on the B-risers. Too much and the canopy deforms.

B-Stall					
Glider		Sink rate in stable B-stall. Deformation tendencies Rotation	Pitch back on entry / pitch forward on exit	Height loss on exit	Notes
Skywalk Chili 3 M		8 m/s no no	15°-30° 15°-30°	-20 m	stable sink phase

Mac Para Eden 5.28		8 m/s no no	15°-30° 30°-45°	-30 m	stable sink phase, marked pitch forward on exit
Icaro Wildcat TE M		8 m/s no no	15°-30° 15°-30°	- 20 m	stable sink phase
Gradient Nevada 28		9 m/s yes -	30°-45° 30°-45°	- 30 m	Marked pitch back on entry, wingtip deformation to the back begins after short sink phase, marked pitch forward on exit.
Air Design Rise M		7 m/s/ 8m/s yes yes	15°-30° 15°-30°	Pilot action	Immediate deformation when normal entry techniques are used. (Both wingtips deform to the front). Cravat on exit. B-stall only possible with very exact B-riser handling, then deformation after a few seconds.

B-Stalls are not a problem for Skywalks Chili 3 (top left), Icaros Wildcat TE (top right) and Mac Paras Eden 5 (bottom left). Wingtips deform after a few seconds on Gradients Nevada (bottom right).



The wingtips of the Air Design Rise deform to the front shortly after entry and cravat there in the lines.

Big Ears

What is tested:
Big ears at trim speed and at full speed. Glider sink and speed is measured. Any entry difficulties or deep stall tendencies on exiting from trim speed big ears are noted.

The two gliders with only two main A Lines (Gradient Nevada and Skywalk Chili 3) had the most effective sink rates. Air Designs Rise also has relatively large areas which are collapsed at the wingtips. Inspite of the additional large resistance produced by the wingtips no deep-stall tendencies could be observed. Nevertheless, it is always a good idea to use the speed bar when applying this descent method. With the exception of Icaros Wildcat TE, all gliders demonstrated tendencies to flap their wingtips when collapsed.

Big Ears					
Glider	Entry	Exit	Vsink (trim) Vsink (full)	Speed difference trim - full	Notes
Skywalk Chili 3 M	simple	Automatic with marked delay	3 m/s 4 m/s	approx.5 km/h less than trim speed approx. 8-10 km/h more than trim speed	Ears flap at full speed
Mac Para Eden 5.28	simple	At times not automatic	2,5 m/s 3 m/s	approx.5 km/h less than trim speed approx. 8 km/h more than trim speed	Active recovery sometimes necessary

Icaro Wildcat TE M	simple	Automatic	2,5 m/s 3,5 m/s	approx.5 km/h less than trim speed approx. 8 km/h more than trim speed	
Gradient Nevada 28	simple	Automatic, delayed	3 m/s 4 m/s	approx.5 km/h less than trim speed approx. 8-10 km/h more than trim speed	Ears flap at trim and full speed
Air Design Rise M	simple	Automatic	3 m/s 4 m/s	approx.5 km/h less than trim speed approx. 8-10 km/h more than trim speed	Ears flap at full speed