DHV-Safety tests LTF A- and B- Paragliders, Part 10

This report extends the work publicised initially in DHV Info 174 which can also be found under www.dhv.de. Details on how we have classified the gliders, the relevance of different manoeuvres to accident statistics, German airworthiness requirements (LTF certification) and other information can be found there.

The DHV safety and technical department tested the following gliders in the 10th round of its ongoing safety test program:

Glider	DHV Safety Class	Pilot skill requirements (detailed description under www.dhv.de Safety-Class)	Weight range Tested weight
Ozone **Mojo 5 M** **LTF A**		Advanced piloting skills are needed to be able to immediately recognise instability and react precisely to prevent or minimise follow-on reactions.	80-100 kg 95/100 kg
Nova **Prion 3 M** **LTF A**		Piloting skills greater than those taught in standard training are required. Regular practice and SIV training is highly recommended.	90-110 kg 95/100 kg
MacPara **Muse 4 28** **LTF A**		Advanced piloting skills are needed to be able to immediately recognise instability and react precisely to prevent or minimise follow-on reactions.	85-110 kg 95/100 kg
Skywalk **Masala 2 M** **LTF A**		Piloting skills greater than those taught in standard training are required. Regular practice and SIV training is highly recommended.	85-110 kg 95/100 kg
UP **Ascent 3 M** **LTF A**		Piloting skills as taught in standard training are required. Additional practice is recommended.	75-120 kg 95/100 kg

How the tests are conducted
Two test pilots fly all manoeuvres in the test program. All tests are conducted within the certified weight range of the chosen model. Both test pilots always use their test harness to ensure comparisons between different models are as accurate as possible. Test harnesses used are standard certified harnesses where the pilot sits in an upright position (i.e. not supine or pod harnesses.)
Tests manoeuvres conducted are based on the current European Norm (EN 926-2.2103). Manoeuvres are flown at the maximum limits defined in this norm, in order to test as severely as possible within this framework. The manoeuvres asymmetric collapse, front collapse and spiral dive are evaluated and rated accordingly. Reactions to other manoeuvres are documented and described, but are not rated.
Asymmetric Collapses are performed both at trim-speed and full-speed. The canopy is collapsed to the maximum limit of the EN defined measurement field with the highest possible folding angle also within the measurement field. Only the collapses produced which fulfil these requirements are rated. Collapses which are larger than the EN measurement field are not rated. Should glider reactions to such collapses be markedly different, then these reactions are documented in the test pilots comments. *Background:* real life collapses

often deform the canopy with steep folding angles resulting in large collapses which include a large portion of the trailing edge. Reactions to such collapses are generally extremely severe, as often seen and recorded in accident analysis videos.
Front Collapses are performed both at trim-speed and full-speed. Collapses are performed at the EN minimum of 50% chord length (EN norm defines a minimum of 50%) and at the maximum possible with the canopy. *Background:* massive real life front collapses of 70-100% often produce markedly different reactions (e.g. collapse remains stable, front horseshoes or cravats) than those resulting from the EN/LTF norm tests. The “maximum possible collapse” test is designed to indicate if a glider is likely to react in this way.
Spiral dives: Tests are conducted in accordance with both the LTF 91-09 (reactions to a spiral dive at 14 m/s) and the EN 926-2.2103 norm (exit after two turns in a fully developed spiral dive). In addition to both these tests, exiting when the pilot remains sitting in a neutral position is tested, but the results are only documented, and not part of the glider rating. *Background:* Spiral dives are complex manoeuvres governed by several different parameters (entry technique, pilot reaction to G-forces, exit technique). Two different test methods and three differing exit methods are used to create a wide range of possible spirals and to indicate if the glider has any weaknesses regarding particular aspects of the tests.
Data loggers used during the test flights record pitch, roll and yaw angles and acceleration, horizontal and vertical velocities, G-force and height loss. Data is then synchronised with ground camera and on-board GoPro video footage. Analysis of all the data and video material is then performed together by the expert team. Manoeuvre ratings and overall DHV Safety-Class classification are then given by both the data analysis results, and test pilot comments.
Gliders are chosen in accordance with their market relevance, generally in the most sold size suitable for the mid weight range. Gliders are purchased from the market, and are not specially supplied or sponsored by manufacturers. Safety-Class ratings are only valid for the tested size of the glider.

Asymmetric Collapses

Reactions to massive collapses on Ozone's Mojo 5 were very benign. If the collapse was even bigger than shown, but the folding angle less steep then pitch forward angles were less than 45°.

Ozone's Mojo 5 M collapses benignly even when the canopy is massively deformed at a high folding angle and with corresponding high collapse area. Collapses and recoveries are generally very gentle, but on occasion can also be more impulsive. Impulsive recoveries were associated with more dynamics, but remained relatively benign. Both at trim speed and full speed, asymmetric collapses resulted in course changes of not more than 100°. Low area collapses were associated with pitch forward angles of less than 45°, maximum sized collapses could result in forward pitching to 60°.


At the top end of the measurement field. Forward pitching around 60°, course change of under 180°.


Massive collapses larger than the measurement field (not recognisable in the picture) were accompanied with more forward pitching, unto 70°.

Nova's Prion 3 M: collapses within the measurement field regularly produced forward pitching around 60°, the border to the next higher Safety-Class. Should more than the measurement field be collapsed, then the glider pitches markedly forward, up to 70°. Low area collapses generally produce course changes of less than 90° whereby high area collapses are often accompanied by 180° course change or more. The open side of the canopy often rolls in somewhat at the wing tip, which helps reduce dynamics. Sink velocities are generally under 10 m/s, or for massive collapses up to 12 m/s.


Low area but with a large amount of the leading edge: the Muse 4 is difficult to collapse within the measurement field.


Steep folding angle, large collapse area and well within the measuring field. Here the Muse 4 often opens impulsively with large course changes.

MacPara's Muse 4 28 has a high resistance to induced asymmetric collapses. Once a high area collapse at steep folding angle has been achieved, its reactions are dynamic forward pitching. Impulsive re-inflations create some additional dynamics and may result in a follow-on deformation on the collapsed side. Generally the glider recovered between 90° and 180° course change, and then turned a further 90° to a maximum of 270°

Difficult to collapse with steep folding angles and high areas. The trailing edge often remains unaffected and produces benign reactions.

On steeper collapses the glider reacts more dynamically and has a marked course change of up to 180°.

Skywalk's Masala 2 M was difficult to collapse at a high folding angle and with a large area. Both test pilots noted having to use maximum force to collapse the canopy. Forward pitching on massive collapses was around 60°, borderline to Safety-Class 4. Course changes of generally under 180° are at the lower end of Safety-Class 3.

Maximum area collapse on the Ascent 3. Reactions produced only low dynamics.

UP's Ascent 3 M also needed maximum force from the test pilots to produce high area collapses at steep folding angles. The glider then demonstrated the lowest pitch and yaw dynamics in this test series. Forward pitching was slow and within the Safety-Class 2 limits, recoveries were soft and progressive, cell for cell.

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**
Ozone Mojo 5 M	30-39 m	45°-60°	75°	2-2,5 G	90°-180°	-14 m/s	Glider as low forward pitching and course changes for low area collapses, on occasion less than 45° pitch. Maximum area collapses at high folding angles result in forward pitching up to 60° and course changes mostly under 100°. Should the canopy impulsively re-inflate, then this process is relatively benign and does not create additional dynamics. Course changes are then less than 90°
Nova Prion 3 M	30-39 m	60-75°	75°	2-2,5 G	90°-180°	-12 m/s	Collapses within the measurement field regularly produced forward pitching around 60°, the border to Safety-Class 4. Should more than the measurement field be collapsed, then the glider pitches markedly forward, up to 70°. Low area collapses generally produce course changes of less than 90° whereby high area collapses are often accompanied by 180° course change or more. Sink velocities are generally under 10 m/s, or for massive collapses up to 12 m/s.
MacPara Muse 4 28	40-49 m	60-75°	75-90°	2-2,5 G	180-270°	-15 m/s	High resistance to induced asymmetric collapses. Simulated high area collapses at steep folding angles are accompanied by dynamic forward pitching. Impulsive re-inflations create some additional dynamics and may result in a follow-on deformation on the collapsed side. Generally the glider recovered between 90° and 180° course change, and then turned a further 90° to a maximum of 270°
Skywalk Masala 2 M	30-39m	45°-60°	75-90°	2-2,5 G	100- 270°	-14 m/s	Glider was difficult to collapse at a high folding angle and with a large area, particularly at top end of weight range. Re-inflation was rapid but not impulsive. Forward pitching on massive collapses was around 60° with course changes of generally under 180°.

UP Ascent 3 M	30-39 m	45°-60°45°-60°	60°	2 G	[3]90°-180°	-12 m/s	The glider demonstrated the lowest pitch and yaw dynamics in this test series. Forward pitching velocities were very slow and maximum angles were 60° for massive collapses, otherwise 50°. All reactions generally very slow.

Front collapses

None of gliders tested here demonstrated critical behaviour when reacting to frontal collapses. Ozone's Mojo 5 M and Skywalk's Masala 2 M reacted very benignly to collapses, but it was not possible to perform a 100% deformation in straight flight without pitching. Re-infaltion and recovery was rapid, at times over the entire wing span, or progressively from the canopy middle. Nova's Prion 3 M was similar, and would not deform to 100%. Reactions to front collapses were again benign, re-inflation and recovery was slightly delayed compared to the above gliders. MacPara's Muse 4 28 requires a large amount of force to collapse frontally, the middle of the glider is particularly resistant and deformations here are delayed. Together with wing-tips which re-inflate rapidly, this creates front horseshoes on collapse. Low- or mid-area collapses re-inflate and recover automatically, either rapidly or with a slight delay. Large area collapses result in marked front horseshoes, which then re-inflated and recovered on occasion with a marked delay. No cravats were noted during testing.
UP's Ascent 3 M reacts similarly to front collapses, but this behaviour is not problematic. Horseshoe deformations do not develop completely, and recover quickly and symmetrically. On occasion the glider re-inflated from the middle, leaving wing-tips collapsed for longer and delaying the return to normal flight a little. The low wing loading of the glider enhances this effect.

100% collapses were not possible on the Mojo 5. Re-inflation starts at the wing-tips, but no front horseshoes were noted.

Frontal collapses larger than in the photo are not possible on the Prion 3 M. Reactions were harmless.


The glider middle is particularly resistant to collapses on the Muse 4 28 and results in a marked front horseshoe tendency which is enhanced by the rapid wing tip re-inflation.

Masala 2 only low- to mid-sized collapses could be performed with this glider. Reactions were very benign.


Maximum area collapse on the Ascent 3. The glider middle is delayed on deformation resulting in front horseshoes, but without any tendency to cravat.

Front Collapse						
Glider	**Height-loss in m**	**Pitch-back angle in °**	**Pitch forward angle in °**	**Rotation, G-Force in G**	**V/sink maximum in m/s**	**Notes**
Ozone Mojo 5 M						
40% collapse	20–29 m	30-45°	15-30°	No	-8 m/s	
Maximum collapse presented by construction	30-39 m	30-45°	15-30°	No	-10 m/s	Only low area collapses were possible to induce. Re-inflation generally rapid, on occasion progressive from canopy mid-point with greater height loss.
Nova Prion 3 M						
40% collapse	20–29 m	15-30°	15-30°	No	-7 m/s	
Maximum collapse presented by construction	30-39 m	~~60°~~30-45°	15-30°	No	-10 m/s	Only low area collapses were possible to induce. Re-inflation and recovery generally rapid over the entire wingspan. On occasion re-inflation was delayed until the pilot had swung back under the glider, resulting in greater height loss.
MacPara Muse 4 28						
40% collapse	20–29 m	45-60°	30-45°	No	-10 m/s	
Maximum collapse presented by construction	30-39 m	~~50~~45-60°	30-45°	No	-15 m/s	High resistance to deformation via the A-risers. Glider mid-point very stable resulting in delayed collapsing. Together with rapid wing tip re-inflation, glider exhibits marked tendency to front horseshoe. Recovery automatic, no pilot input required.
Skywalk Masala 2 M						
40% collapse	20–29 m	15-30°	15-30°	No	-9 m/s	
Maximum collapse presented by construction	30-39 m	30-45°	15-30°	No	-10 m/s	Only low area collapses were possible to induce. Re-inflation generally rapid, on occasion progressive from canopy mid-point.
UP Ascent 3 M						
40% collapse	20–29 m	15-30°	15-30°	No	-9 m/s	
Maximum collapse presented by construction	30-39 m	30-45°	15-30°	No	-11 m/s	Glider generally re-inflates from the middle with delayed wing tip re-inflation. Glider can be collapsed such that front horseshoes result. Recovery is automatic and symmetrical. No pilot input required.

Spiral dives

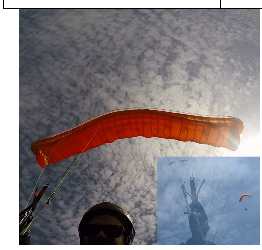
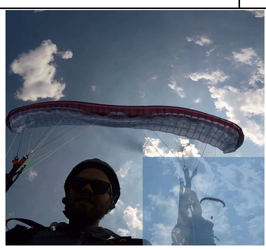
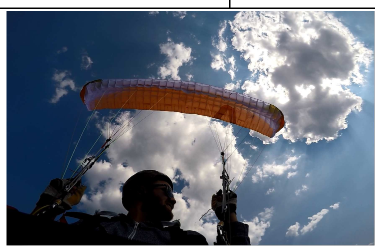
Entering a spiral on Ozone's Mojo 5 M is easy, thanks to its responsive handling characteristics. Exiting is rapid (270°) when pilot bodyweight tips to the outer edge of the spiral. The border between automatic exit and stable spiral dive was quite small at the top end of the weight range. Keeping bodyweight neutral in the harness was sufficient for stable dives with accelerations in sink velocities up to 22 m/s.
Nova's Prion 3 M reacted very benignly to spiral dives. The glider is easy to manoeuvre step-for-step into a spiral with no tendency for surprising accelerations. Exiting and recovery generally occurs immediately with very little acceleration once the brakes are released. Recovery was within 180°. Exiting was even possible with pilot weight-shift to the inside of the spiral, once the brakes were released.
MacPara's Muse 4 28 was also behaved benignly in spiral dives – automatic exiting and recovery with little course change. Exits were possible with actively held neutral weight-shift, weight-shift to the spiral inside was very difficult, and stable spirals could not be provoked.
At the top end of the weight range, Skywalk's Masala 2 M is enters a spiral rapidly, but the border between automatic exiting and delayed recovery is rather small. The canopy accelerates uniformly, and spirals with moderate sink velocities. On brake release, the glider quickly accelerates to a sink velocity of 18 m/s for a moment, before self exiting and recovering.
UP's Ascent 3 M is easy to control in a spiral dive. Exiting is automatic but recovery may be delayed up to 360° course change if a neutral weight-shift position is maintained in the harness by the pilot.

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**	**Action after brake release**	**Notes**
Ozone Mojo 5 M	7m/s 16 m/s 22 m/s	2,0 G 3,0 G 3,6 G	25 m 65 m	60 m	Short acceleration from 16 to 22 m/s for <180°, then exit and self recovery within the next 180°	Agile steering characteristics enable rapid spiral entry. Automatic exit within 270° only with active weight-shift to outer side of spiral. Neutral pilot positions delay exiting and increase tendency to stable spiral dive. Enhanced at upper weight limit of glider.
Nova Prion 3 M	6 m/s 14 m/s 17 m/s	1,9 G 2,9 G 4 G	25 m 55 m	50 m	Acceleration from 14 to 17 m/s for very short time. Then exit and self recovery within the next 90°	Easy entry. Spiral dives are easy to control. Immediate self exiting and recovery on brake release. Largest course change to recovery: 180°.
MacPara Muse 4 28	7 m/s 12 m/s 18 m/s	2,0 G 3,5 G 3,6 G	25 m 65 m	60 m	Acceleration from 15 to 18 m/s within the next 180°. Then deceleration, exit and self recovery within the next 90°. Largest course change on brake release: 270°	Spiral dives are easy to control. No abrupt acceleration or pitching. Rapid self exit and recovery on brake release. Not tendency to stable spiral dive.
Skywalk Masala 2 M	6 m/s 9 m/s 18 m/s	1,6 G 2,4 G 3,5 G	20 m 50 m	60 m	Acceleration from 14 to 18 m/s within 90°. Then exit and self recovery within the next 90°	At top end of weight range and by neutral pilot weight-shift positions tendency for delayed recovery, slight tendency to stable spiral dive. Immediate self exit and recovery within 180° on brake release for EN/LTF conform test spirals.
UP Ascent 3 M	6 m/s 13 m/s 16 m/s	2,6 G 3,0 G 3,4 G	30 m 65 m	60 m	Glider accelerates slowly from 13 to 16 m/s within 90°. Then exit and self recovery within the next 90°	Glider enters spiral slowly and achieves only moderate sink velocities. Immediate self exit and recovery for EN/LTF conform test spirals. Neutral or pilot weight-shift to the inside of the spiral result in delayed exiting and recovery within 360°

B-Stall

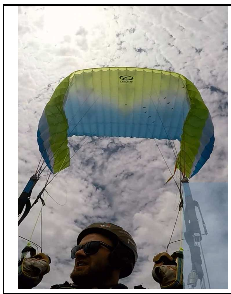
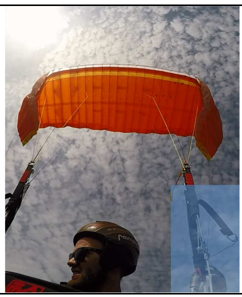
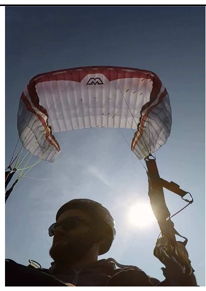
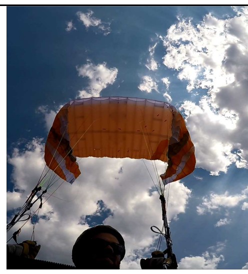
None of the test pilots found any safety relevant problems with B-stalls on the tested gliders. Nova's Prion 3 M was somewhat unstable if deep B-stalls were held, and began to oscillate making holding the manoeuvre very difficult. Moderate B-stalls were not a problem. MacPara's Muse 4 28 was also a little unstable, and had a tendency to enter a front horseshoe if deep B-stalls were initiated.

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**
Ozone Mojo 5 M	8,3 m/s no no	15°-30° -15°	-30 m	Low pitching back and forward on entry and exit. Canopy somewhat unstable on maximum B-stalls. No tendency to deform.
Nova Prion 3 M	7,5 m/s no no	30°-45° 15°-30°	-30 m	Marked pitch back on entry, moderate pitch forward on exit. Unstable and difficult to maintain in maximum B-stall. Marked oscillation. No tendency to deform. Stable sink phase for moderate B-stalls.
MacPara Muse 4 28	8,5 m/s yes no	30°-45° 30°-45°	-20 m	Marked pitch back on entry and marked pitch forward on exit. Maximum B-stalls and stalls held for longer periods have a tendency to enter front horseshoe.
Skywalk Masala 2 M	7,5 m/s no no	15-30° 15-30°	-20 m	Stable sink phase, moderate pitching back and forward.
UP Ascent 3 M	7 m/s no no	15-30° 15-30°	-20 m	Very stable sink phase, moderate pitching back and forward. Minimal height loss on exit.


Big Ears
This manoeuvre could be performed easily and effectively on all gliders tested here. As Skywalk's Masala 2 M does not have split A-risers, gathering in the appropriate lines on entry may be a little more difficult for beginners. Nova's Prion 3 M was difficult to deform, and has correspondingly reduced sink velocities in this test.

Big Ears					
Glider	**Entry**	**Exit**	**Vsink (trim)** **Vsink (full)**	**Speed difference trim - full**	**Notes**
Ozone Mojo 5 M	Easy	Automatic, immediate	3 m/s 4 m/s	Approx.3-5 km/h less than trim speed Approx. 0-3 km/h more than trim speed	Problem free
Nova Prion 3 M	Easy	Automatic, immediate	2,5 m/s 3,5 m/s	Approx.3-5 km/h less than trim speed Approx. 0-3 km/h more than trim speed	Problem free
MacPara Muse 4 28	Easy	Automatic, immediate	2,5 m/s 4 m/s	Approx.0-3 km/h less than trim speed Approx. 5-8 km/h more than trim speed	Problem free
Skywalk Masala 2 M	Easy	Automatic, delayed	3,5 m/s 4,5 m/s	Approx.0-3 km/h less than trim speed Approx. 5-8 km/h more than trim speed	No split A-risers make entry slightly more difficult, otherwise problem free.
UP Ascent 3 M	Easy	Automatic, delayed	2,8 m/s 4 m/s	Approx.3-5 km/h less than trim speed Approx. 0-3 km/h more than trim speed	Problem free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