# Accident Investigation Nevada 2020

**Introduction**

This accident report has been compiled by the Ozone team with the consultation of several key pilots who were centrally involved with the SAR effort.

Following the accident Ozone was asked to examine the glider. The investigation studied the available information including track-log files, evidence from the crash site and the wing itself. The aim was to try to understand the circumstances of the incident, how the wing failed and what can be learned.

Following consultation with the pilot's family, and following the convention of accident reporting in many countries, we have anonymised the pilot involved in the accident. He is known throughout as 'Pilot A'.

Also following consultation with the pilot's family no digital files from Pilot A's flight instrument, phone or other electronic devices will be released.

Date of accident: 22 August 2020
Location: Nevada, USA. Strong desert conditions
Pilot: Male, age 56
Pilot experience: The pilot was experienced and current in high-level competition and cross-country flying. He had been flying since the early 1990s.
Injuries: Fatal
Glider: Ozone Zeno L
Date of manufacture: January 2017

**In brief:** This report will look in detail at Pilot A's flight instrument data, paraglider, paraglider lines and attachment points, harness and reserve. We suggest a likely scenario of what we think may have happened in the air, based on the evidence. At the end we offer our conclusions and highlight some recommendations.

The ultimate aim of this report, in line with the wishes of the pilot's family is to inform and educate the wider paragliding community to reduce the chances of similar accidents occurring in the future.

## The track log:

IGC and KML files downloaded from Pilot A's XC Tracer Mini II.

On 22.08.2020 Pilot A attempted a long distance XC flight in Nevada, USA.

In the middle of the day, at around 2.27 pm and after 3 hrs of flying, Pilot A had an incident whilst climbing in a thermal at an altitude of 4230m asl, 2200m agl.

The thermal was relatively strong, averaging +5.4 m/s for the last 20 seconds with a reasonable drift due to the 25 km/h WSW wind. It is impossible to assess the level of turbulence from the track log, reports from other pilots flying through the same area on the same day suggest that conditions were not particularly rough or demanding due to the general damping effect of the smoke cover caused by the wildfires upwind. However, considering the time of day, terrain, and recorded thermal strengths, there would have been strong levels of localised turbulence.

Whilst thermalling, at 2:27:28 pm the track records a peak of +13m/s, immediately followed by an abrupt change of trajectory. The track log had recorded several similar strong vario peaks throughout the day, so it may well be that these peaks are within the 'normal operating range' of the instrument and therefore should not be used as absolute values. We can however safely conclude that he hit a strong gust at the time of the initial incident.

Between 2:27:28 – 2:27:39 pm there is a short, straight, and almost horizontal flight record of 100m downwind with a very low groundspeed - 32km/h average, minus 25km/h wind = 7km/h horizontal airspeed. This suggests that the loss of normal flight occurred within the uplifting turbulence of the thermal, probably caused by either a spin or collapse which then possibly developed into a stalled/back-fly configuration. It is not possible to be more conclusive with the information available.

The track log then shows that he entered a spiral dive at 2.27.39 pm with a tight radius, probably close to a SAT in character, averaging -12m/s before accelerating to a peak of -23m/s. At 2.28.03 pm it is suspected that the lines failed. The track log indicates that the pilot then entered an unstable freefall and that the parachute was not deployed at any stage.

There was around 35 seconds from the start of the incident to the line failure.

## The wing

Ozone Zeno L serial: ZENL-R-47A-045 manufactured in January 2017.

The Zeno is flight tested to the EN 926-2 standard and rated EN D. It is also load tested to the EN 926-1 standard @8g with at a maximum permitted total load of 125 kg.

Pilot A owned this wing from new, but we are unsure of the total hours flown. The line set was replaced by himself in February 2019. We also do not know how many hours were flown on this particular line set.

It is uncertain exactly what the total weight in flight was on the day of the accident. Pilot A's estimated body weight was between 110-115kg and he was fully geared up for high altitude, long distance XC flying in extreme desert conditions. He was flying a GIN Genie Lite 3 harness with an Ozone Angel SQ 140 parachute, at least 2kg of drinking water and approximately 2kg of supplementary oxygen equipment, in addition to his normal flying attire. It is estimated that his total weight in flight to be somewhere in the region of 130 to 140 kg. He was overloaded, but we do not know by exactly how much.

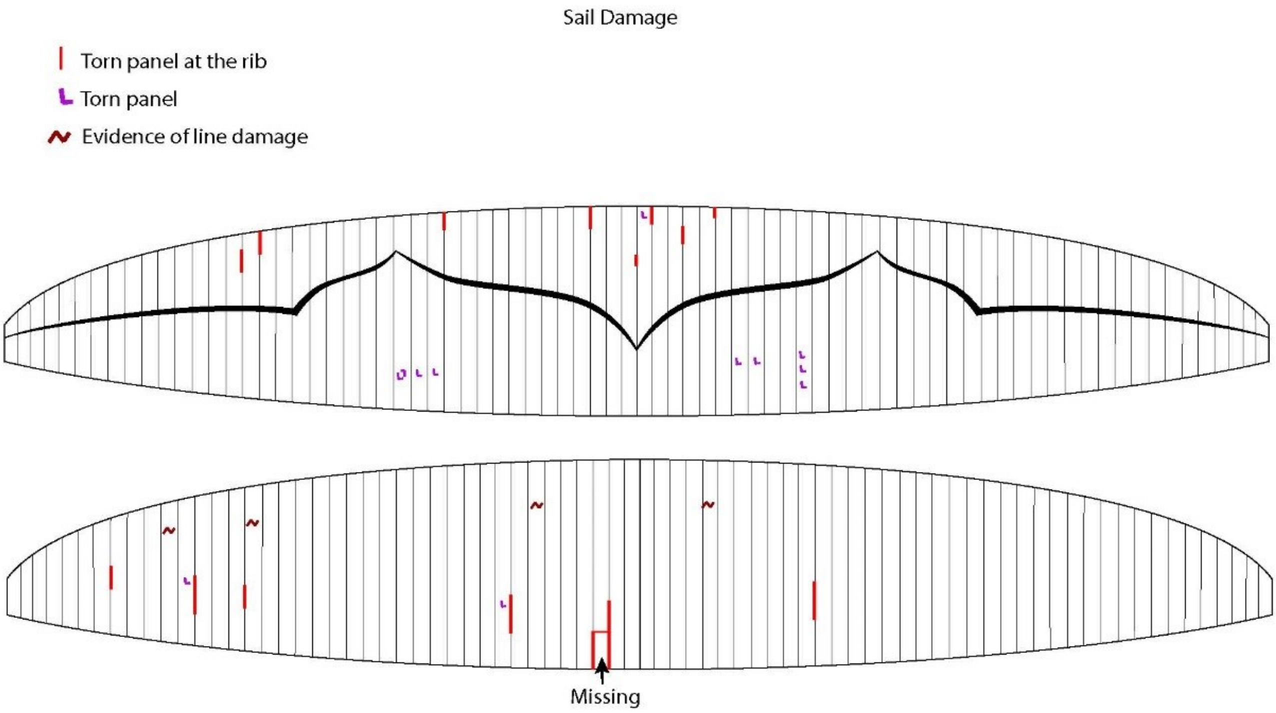
**<u>The Sail</u>**


Despite 3 seasons of flying and having spent 25 days exposed in the desert, the cloth is still in relatively good condition. The average lower surface porosity reading is 73 seconds with a tear strength of 1000g (5mm tear measured with a Bettsometer). The upper surface leading edge has an average porosity of 239s and a similar tear strength of 1000g.

In terms of porosity and tear strength, we would consider the sail to be in an airworthy condition.

The leading edge shows signs of friction wear near the plastic reinforcements on most of the ribs, this is probably due to the age and natural use of the wing. 6x upper panels were torn in this area (identified by the red line in the diagram below), we believe this was caused by excessive tension running through the leading edge as a result of the initial line failure/ high g spiral dive.

There are multiple small tears and puncture marks in the upper and lower panels. We do not believe these contributed to, or were a consequence of the incident and probably occurred during the 25 days in the desert.




A few lower surface panels exhibit evidence of serrated tears caused by line damage, identifiable by the red marks left by the lines in the area of the tear. These marks are typical evidence of line failures after extremely high loads and are caused by the whiplash effect of the broken lines. We regularly observe exactly the same type of damage on wings that have been subjected to a destructive load tested. See photos below:

There is no evidence on the top surface panels of tears caused by the cutting action of lines during cravats or aggressive collapses. These normally resemble the tears seen above, often serrated and usually accompanied by the tell-tale red marks. Such damage has been seen regularly during testing and is not uncommon after a cascading event or aggressive collapse/cravat on any high performance wing with thin lines. The lack of any such evidence on the top surface suggests that the wing was fully open and inflated during the spiral stage of the incident.

3x C line attachment tabs have been pulled out of the sail completely, one of which pulled out a portion of the panel from the tab to the trailing edge (marked missing in the diagram above, photo below). The C line attachment tabs are not heavily reinforced as they are not normally subjected to significant loads. All of the load bearing A and B line attachment tabs are still in place on the wing.

**The lines**

The line set was replaced by Pilot A in February 2019. The overall condition of the lines is acceptable, without obvious signs of serious ageing due to excessive use.

However some of the main riser lines (lowest line level) are seriously worn by friction a few cm above the risers (left side: AR1, AR2, AR3, BR2, BR3).

This type of damage indicates a strong possibility of a “twisted line” incident. Broken fibres and discolouration caused by excessive frictional forces during a twisted spiral can significantly reduce the strength of individual lines.

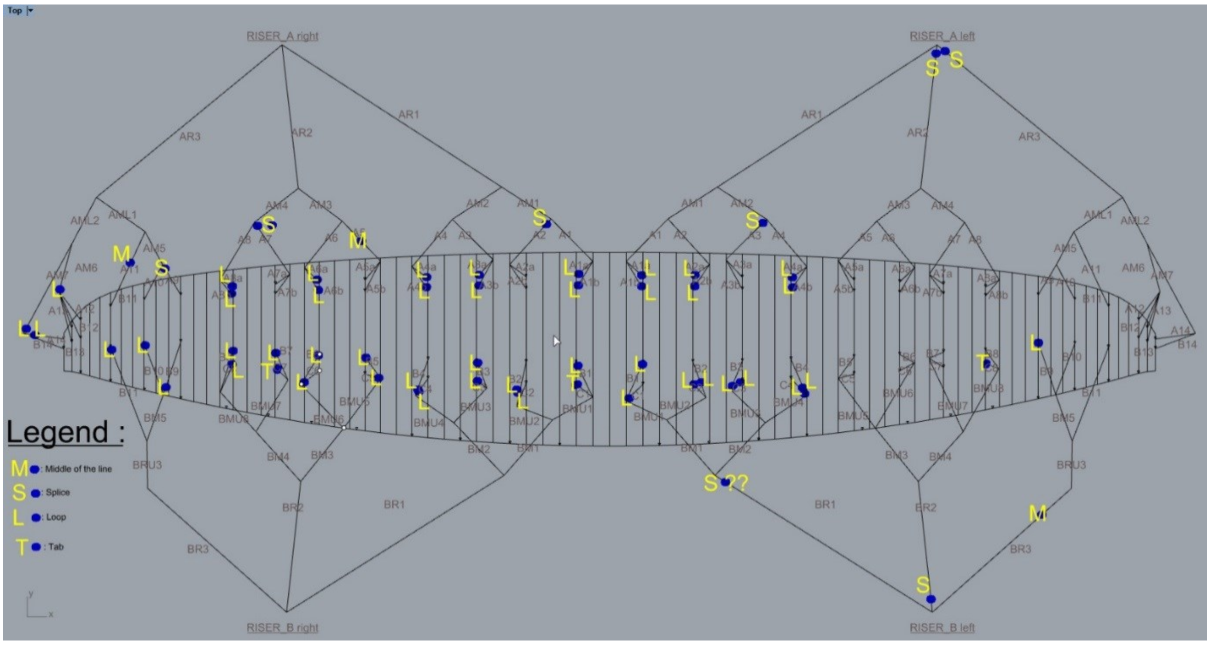
Alternatively, this damage may have occurred before the flight by dragging across rocks or being accidently stood upon, but in our opinion these are hallmark signs of stress caused by a twisted spiral.

3x of the riser lines of the left-hand side broke in the friction damaged area (AR2, AR3, & BR2). We believe these were the first lines to break during the incident and caused the remaining lines to fail. BR3 broke higher up, suggesting it was damaged by the whipping effect of one of the initial lines to fail.

BR1 of the left hand side broke in an unusual way – all of the upper lines corresponding to it broke close to their attachment tabs, which must of happened before BR1 itself broke (see S?? in the diagram below). We believe BR1 was either broken by the whipping effect, or during the impact with the ground. It was not one of the initial lines to break.

Of the remaining lines, the failure occurred mostly in the upper gallery, with a few mids failing instead. This is a typical failure pattern seen during extremely high loads and have been observed during EN 926-1 sustained load tests that lead to full destruction.

The normal pattern of a catastrophic line failure, observed with slow motion cameras during a load test is as follows: The initial failure is normally a main A or B riser line, immediately after this, the remaining riser lines along the same chord position fail and then the canopy detaches as the upper lines across the span/chord fail one by one, in a very fast “unzipping” action. This type of failure is only likely under extremely high sustained loads. We have never seen this type of failure during a dynamic shock test, so in this case, the point of total line failure was, we believe, unlikely to have been caused by a violent reopening or a short fall past the lines, although it is impossible to rule this out completely.



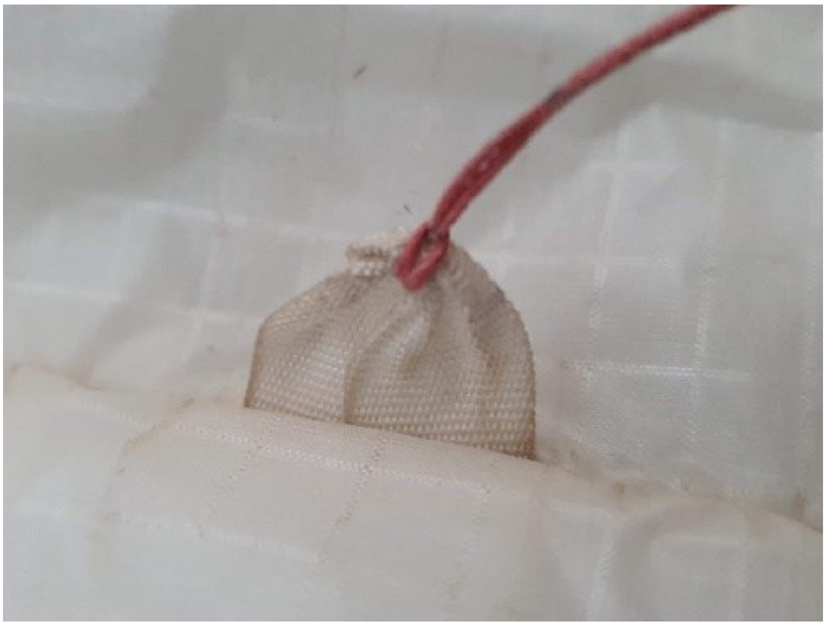

We tested the breaking strength of some of the intact right hand side riser lines:

| Name | Material | Value | Breaking place | Original Strength | Loss |
|---|---|---|---|---|---|
| AR1 | 8000U-470 | 397.9 daN. | Splice | 499.7 daN | -20.4% |
| AR2 | 8000U-360 | 257.2 daN. | Splice | 315.5 daN | -21.6% |
| AR3 | 8000U-190 | 171.8 daN | Splice | 194.7 daN | -11.7% |
| BR1 | 8000U-190 | 164.9 daN | Loop | 194.7 daN | -15.3% |

Considering the age of the lines, there is nothing abnormal in these values. We also cannot rule out the possibility they may have been accidently damaged before, during or after the accident whilst in the desert.

## Attachment mounting

Of the upper lines still attached to the canopy, we can see that the vast majority were incorrectly mounted. See photo below.



We conducted a breaking test study on the line/attachment tab mounting with a static (sustained) and dynamic (shock) load to see the influence of the mounting method to the overall strength.

In total we broke 78 lines and using average values, the incorrect mounting results in:

- 8000U-090: no loss in static load, 31% loss in shock load.
- 8000U-070: no loss in static load, 27% loss in shock load.
- 8000U-050: 22% loss in static load, 25% loss in shock load.

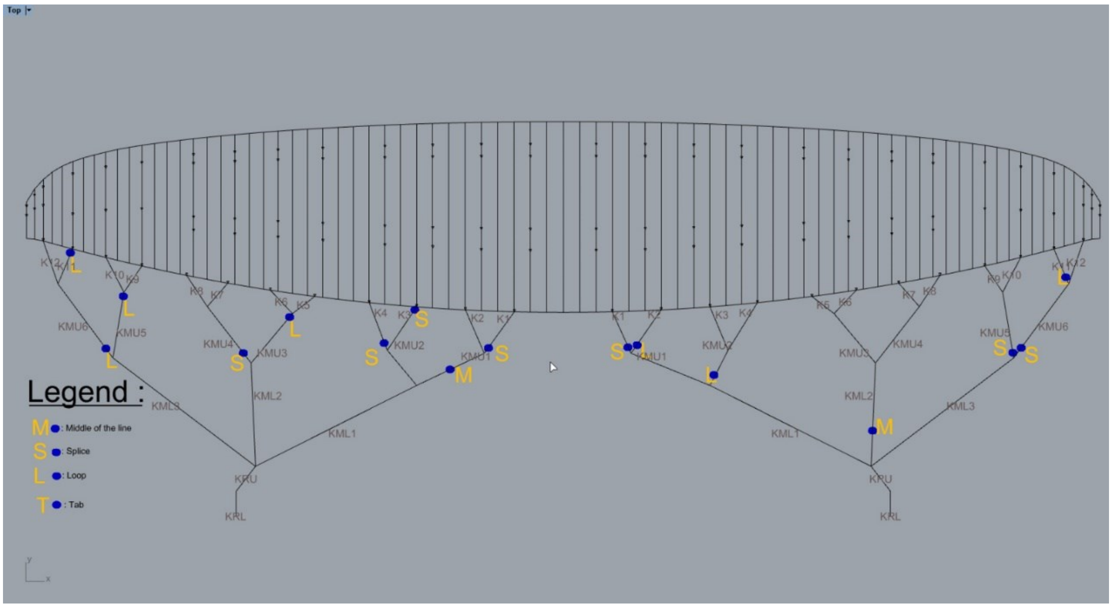
50% of the upper lines broke at their line/attachment tab junctions. The remaining broke either at the loop at the other end (where they attach to the mid lines) or at the end of a splice – the weakest point - or the upper line remained intact and the mid line on the level below failed (see map above).

In the tests we made, 8000U-070 and 8000U-090 lose more strength during a dynamic shock load than the 8000U-050. On the wing 87% of the 8000U-090 and 8000-070 (upper A lines) have broken at the tab junction while only 41% for 8000U-050. This also suggests there was a sudden peak in the already high sustained load and reinforces the “unzipping” scenario.

The incorrectly mounted lines may have been a contributing factor to the complete line failure, by facilitating the secondary unzipping failure.

There are 5 lines which have broken in the middle of the line between the splices. This is unusual since a line normally breaks at its weakest point near the end of the splice or at the line junction, unless of course they were already damaged. We have only seen lines break in the middle like this due to the whiplash effect in a catastrophic line failure during a destructive load test. Other lines also had signs of local damage points, also probably a result of whiplash events.

The brake lines were also completely detached from the canopy, Group2 left side has broken in the middle of a lowest line so probably from AR2 or BR2 breaking whiplash. The rest of the brake fan is broken on upper lines or middle upper lines, probably the same “unzipping” mode than the rest of the lines.




## Harness / Reserve parachute

When he was found the parachute handle pins were still securely in place, as was the small piece of Velcro that secured the handle to the harness. A test deployment was carried out to confirm the operation of the system. At zero G the parachute exited easily without any resistance, confirming the system was functioning perfectly. We are confident that the lack of deployment was not caused by a ‘bag lock’ or other harness/reserve system failure.

The pilot was therefore unable to reach the handle, probably due to loss of consciousness or perhaps because he was physically unable to do so during the unstable freefall.

The piece of cloth ripped from the wing was about 0.2m² and descended with him attached to the risers. At minus 44m/s this would have dragged at least 10 daN and may have hindered his efforts to reach the handle.

## Likely scenario

It is impossible to be certain of the exact course of events, leaving us only able to speculate on the most likely scenarios based on the information available.

The incident occurred during a very strong thermal gust at high altitude, it was initiated by either an accidental spin or stall, a gust stall, or most likely an asymmetric / frontal collapse. The abrupt change in direction logged by the GPS, along with the evidence found on the main riser lines, strongly suggests that riser twists were involved.

There is no evidence on the wing, lines, or track log suggesting a mid-air collision with another aircraft.

After the initial incident the pilot then entered a steep spiral dive / SAT with a very small, tight radius. There is no evidence on the sail to suggest that a cravat was involved, it is therefore likely that the wing was fully inflated as the spiral developed into a high sink rate, high G rotation that he was unable to recover from. Twisted risers with the pilot facing the wrong way is very disorientating and if not stopped can result in the brakes becoming locked, hindering any further control. It is very possible, in fact highly likely, that during this period he lost consciousness due to the sustained and increasing G forces.

It is our belief that the AR2 line on the left-hand side broke first, immediately followed by the left side BR2 and AR3. BR3 and KML2 on the left were likely broken by the whiplash of the first failure. The loss of these lines would have added significant extra load on the remaining lines which mostly failed in the top gallery close to the attachment points in a very fast “unzipping” event at around 2:28:03 pm.

This may have been the result of the wing attempting to exit from the spiral / SAT, the track log shows a brief reduction in sink rate before accelerating into freefall. This anomaly could be caused by a sudden shock loading, e.g., steep exit followed by inversion/collapse, or it could be from the exit of a fast rotational event.

Regardless, the remaining lines reached their strength limit and failed, predominantly in the upper cascades.

Subsequently, the pilot entered an unstable freefall and was unable to reach his rescue handle. The most likely scenario in our opinion is that he lost consciousness during the high G stage of the initial incident and did not recover consciousness during the free fall.

## Conclusions

The wing suffered a complete line failure under extreme G loads, probably caused by a combination of the following three factors listed in order of importance:

- Damaged left riser lines – the damage occurred either before the incident - accidental damage weakening the line(s) - or during the incident as a result of twists.
- Excessive total weight in-flight (up to approximately 15kg over the maximum permitted weight).
- Incorrectly mounted lines on the attachment tabs.

## Recommendations

This tragic event highlights several important factors:

- Although load tested to the EN 926-1 standard (8G at maximum load), when a certified wing is flown near or above the maximum weight tested during the load test – normally the maximum weight of the largest size of the model - under certain rare and extreme circumstances a line failure can occur. This is especially relevant to heavy pilots flying L and XL sizes at or near the top of the weight range, they are much closer to the physical limit than those flying at the top of the weight range of the smaller sizes.
- Irrespective of wing size, respect the manufacturer’s maximum recommended weight. Never fly overloaded, above the certified weight.
- Ensure the lines are regularly checked for length, condition, and strength (see owner’s manual for inspection and service interval recommendations).
- After any cascading incident involving riser/line twists, you should presume the lines are weakened and in need of replacement. This is especially important for those flying high end EN D / CCC competition 2 liner wings with unsheathed line sets.
- When re-lining a wing, ensure the lines are placed on the attachment tabs correctly. The loop of the lines must be held by the attachment tabs. Lines should not be attached with a lark’s foot as this significantly reduces their strength. If you are unsure of the correct procedure, always consult with a professional.
- The colour of the wing severely hindered the SAR effort. High visibility colour combinations are available so we should consider the terrain we mostly fly in and choose colours that contrast strongly.
- When flying at high altitudes the effects of G force are more pronounced, pilots have less G tolerance due to the reduced levels of oxygen.
- Never allow an incident to progress to an out of control situation, especially on a high performance EN D or competition wing. G forces build fast and can quickly result in a loss of consciousness. If you are in a situation where an unwanted spiral is developing your first course of action, within 180 degrees of the start of the turn, should be to control/reduce/stop the rotation. This has to take priority over anything else, e.g if you are twisted, get directional control before attempting to untwist. If necessary stall the wing, the aim is to kill the energy and associated G forces whilst you still have the ability to do so.
- If you are unable to regain directional control and the G forces are mounting, throw your reserve parachute immediately. This reminder is especially pertinent for experienced pilots –

it is easy to believe that when high, it is possible to recover from any situation. The loss of our dear friend clearly illustrates that this is not always the case.

## **Our personal condolences**

Pilot A was not an anonymous pilot to us, he was a close friend to many in Ozone. We would like to take the opportunity to wish his family and friends our deepest condolences. We would also like to express our sincere gratitude for all of those involved with the SAR effort.