DG - aktuell

the newest information about DG for glider pilots

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Special Edition

Thoughts on Safety Cockpits in Gliders

The cockpit of a DG glider is clearly different from the cockpits of other manufacturers because the canopy is much larger. This large canopy was an important factor in my choice to buy a DG-800. In spring I see the trouble and expense my colleagues go to with fur lined boots and electric insoles which drain their batteries in order to keep their feet warm. It is a pleasure to fly at 4000 m in thin, comfortable sport shoes with the sun shining on your feet and legs! In the summer, strong ventilation is available. In the community of internet users the majority opinion favors the large canopy concept. Very often we hear the suggestion: "Don't change your canopy. It is great!".

On the other hand, it would seem obvious that in the case of an accident, such a design would not offer the same degree of safety as one with a higher canopy rim and a more enclosed front fuselage. But is this really true? It is very doubtful if this view would stand up to careful examination.

The "Technical Supervision Company" of Rhineland, Germany looked at and tested extensively the crashworthiness of sailplane cockpits several years ago. He differentiates the following typical accidents:

1. Low speed, nose high, "pancake" landings.
2. Less steep hard landings at an angle of about 10 degrees at normal speeds.
3. Typical out-landing accident, nose 30 degrees down followed by a ground loop; normal speed.
4. Crash at 45 degrees at high speeds, for example from a spin or ramming an obstruction during roll-out.
5. Not considered were accidents which necessitated the use of a parachute.

The results in the 4th case indicated that no modern sailplane cockpit can protect the pilot. Since there is no crush zone in a glider as there is in an auto, a crash at higher velocities - mostly over 60 knots - is not survivable. In actual crash tests at "only" 30 knots and only directly on the nose, high loadings were measured with dire results for the pilot.

These results are valid for all cockpits available at that time. The same results were obtained by Prof. Roeger at the Technical University of Aachen. He is the same person who invented the Roeger Hook that is supposed to result in safe canopy ejection. Here the cockpit of a DG-800 was also tested and at the same time a newly constructed model from one of our competitors. The results show that the stability of the DG800 cockpit is greater than that of our competitors.

Pilots are reasonable protected by all modern cockpits in the first case of the of the hard "pancake" landing. The landing impact is taken mostly by the main gear support which is capable of absorbing a large amount of energy even when it is badly damaged in the process. The double walled fuselage around the cockpit gives further protection. Pilots are also assured by these results that the landing gear should be lowered for all landings. Plowed fields, water, and even a field which is too short. In this last case, it's best to do an intentional ground loop.

The effectiveness of a more or less specially built safety cockpit will show its effectiveness in the second and third cases: The 10 degree and 30 degree nose low landings at normal speed as well as the fourth case if the speed is not all too high.

The more enclosed cockpit of the same construction can certainly absorb a higher impact energy than one with a large canopy. It is evident that this advantage is effective only in special situations. But then every accident is a special situation.

Unfortunately, the presumed advantage comes with the price of a whole row of disadvantages. Cold feet are unavoidable when they are deep under the instrument cluster possibly near the ventilation. In addition, our cockpit is comparatively large and thereby comfortable. When a pilot has flown 6 hours, is still comfortable, and not exhausted, perhaps he will not make the critical mistake leading to an accident. Finally, the entry to a cockpit with large canopy is much easier than when one has to thread his legs in under an instrument panel. The hinged instrument panel solves the problem of the enclosed front fuselage section but carries the added danger of head injury in an accident.

It is evident then that the intended advantage of greater protection brings with it the price of a whole series of disadvantages. Naturally every new DG glider has all the safety components that are possible and meaningful. The cockpit has a continuously bonded inner shell as an additional stiffener and the whole fuselage of the DG-800B consists of Kevlar and carbon fiber (Hybrid-Construction). The cockpit rim is especially strengthened because it must withstand the greatest force.

The fifth type of accident involving exiting the aircraft with a parachute was not investigated by the Rhineland Company. But in this case the large canopy has a greater, perhaps life-saving advantage.

When I sat in a glider of a competitor I felt as protected as a baby in a womb with a canopy rim up to my armpits. But how should I get out when the glider is spinning uncontrollably toward the ground? Even normal entry and exit on the ground gave me problems. This type of accident occurs mostly as a result of mid-air collisions. It is self-evident that the danger of not being able to get out is minimized by the large canopy design with its excellent visibility.

Unfortunately I must tell you that the foregoing theoretical-sounding discussion has a sad history to me. A club member of mine died in the summer of 1996 as a result of a botched outlanding in an ASW-19. In spite of extensive experience in cross country soaring, he made almost every mistake one could make.

First, too long a task for the weather, second, leaving the airfield with too little height toward a possibly better area for thermals, and finally, desperate seeking lift until 100 meters above ground. Finally he decided to land in a corn field after having passed all the good grain fields.

Apparently he didn't notice the power line at the end of the field until he was on short final and then he panicked. Although the flat part of the field would have been long enough, he rammed the glider into the ground at about a 30 degree angle. One wing and the landing gear broke and the canopy flew away. The front part of the fuselage must have been bent upwards but not beyond its elastic limit because, although there were many tears in the laminate, it wasn't destroyed. The pilot suffered no broken bones.

The accident would normally have been survivable but the last mistake he made probably lead to catastrophe.

His shoulder harness was loose and under load, slipped down his arm to his elbow allowing his upper body to be accelerate forward. The canopy was gone and had pulled the instrument panel up. The pilot hit his face on the panel, in particular the radio, which caused brain damage and lead to his death a few days later.

With a fixed instrument cluster, he would have hit his head on the softer upper edge of the panel and had a better chance of surviving the accident.

Please take note:

Don't subject yourself to unnecessary stress!

Look for a landable field early and stay over it!

Even if you have a motor, stay within gliding distance of a landable field; fly as if you did not have a motor!

Tighten your straps securely before an outlanding!

- K.-F. Weber

translated by D. Noyes - "NL"

The Consummate Safety Cockpit

A word to the History:

When Wilhelm Dirks designed the DG-100 in the 70's it came with a dual-walled cockpit. This proved to be much stiffer than the usual cockpit designs then in use and offered the pilot real additional protection in case of a crash.

With the passage of time this type of Cockpit became the standard with other manufacturers, too, and the designation "Safety Cockpit" came into common usage for this design. From time to time there were improvement of details, but the basic concept has changed little. Only the use of carbon fiber or a hybrid construction of carbon fiber+Aramid, such as in the DG-800B brought substantial progress once again.

In 1994 the Technical Supervisory Association of the Rhineland received a research commission to investigate means of improving the pilot safety in sailplanes in the event of a crash. Within the framework of this research commission it was necessary to investigate the conditions in a typical sailplane crash under laboratory conditions.

For this purpose the TSA asked the German sailplane manufacturers to furnish a test fuselage - for proper compensation, of course! There were only refusals. Apparently many manufacturers feared that such a test would show unwanted surprises, and they were not entirely wrong, as we shall see. Only Glaser-Dirks was willing to build a test fuselage, probably because Wilhelm Dirks was convinced of the durability and quality of his design.

And that is how the fuselage for the crash test came about. It is the newest version of the DG-800 in series construction, but without canopy, rear fuselage and fin.

A crash test was conducted of the type like used for new cars , a high speed film was made, and Glaser-Dirks was the only company to receive a copy. Basically the results were secret until all investigations were concluded, but as a "participant" Glaser-Dirks was given access to the results. The film was lost for unexplained reasons in the turbulent times of the firm going bankrupt. However, the results of the test have now available to all manufacturers for some time.

Three years later I read an article in "Aerokurier" about the still running research project, called the TSA,

spoke to Martin Sperber, a very cooperative expert, and heard for the first time that Glaser-Dirks had furnished the test fuselage, that he would go over the results with me, and that we also could view the "secret" test film.
That is how the already described visit came about..

The Crashtest

After discussing the problems of a relatively safe Cockpit during the morning, the high speed film was shown after lunch. There were really three films: from the right, from the left, and from above - each about a minute long and showing a crash according to "case 4" of our previous article.

The beginning was the same expected. At least until the front end of the fuselage contacted the grassy ground in the test container. But after that the following ensued:

The fuselage nose burrows into the grassy surface. After a few centimeters it bends in an upward direction. The fuselage nose comes up out of the ground again and starts to slide up along the surface. This can't be done without overloading the cockpit structure. Bulges run backwards along the sides, and the canopy frame shatters.

The film runs silently except for the hum of the 16mm camera, which makes the whole event even more ghostly. Amazed and speechless I stared at the wingroot with the weights simulating the rest of the aircraft. I expected the rear part of the fuselage to brake and decelerate. It was hard to believe, but the fuselage on it's undercarriage keeps going almost without slowing, while the nose is bent still higher.

Now at a bending angle of about 45 degrees of the canopy frame the instrument panel contacts the forward bent head of the crash dummy and pushes it backward. The weights simulating the aircraft mass push the seat back further forward. Finally the crash dummy sits wedged in between the acutely upwardly bent cockpit nose and the seat back like the proverbial salami in a sandwich. Only now does the rear of the fuselage decelerate abruptly by the fuselage bottom being pressed against the ground, which also compresses the crash dummy. It transmits with it's body the force into the seat back. The crash dummy does not have a compression zone, <u>it is the compression zone!</u>

The end of the film was almost as surprising. The rear fuselage sprang backwards, the elastic fuselage bottom flattened out, and the crash dummy sat "peacefully" in the canopy frame, with slightly soiled pant legs and a bit of grass in the canopy frame, in a cockpit that looked almost undisturbed.

<u>But he was "completely dead!"</u>

The film from the other side showed roughly the same picture. But in the top view one can see how the cockpit is compressed, becomes almost round like a pancake, before it bends up and crushes the crash dummy to a point where a human could not possibly withstand it. It was depressing and fearful.

Finally we saw a second crash film with a special cockpit, built like a tank and not usable in this form. It was not meant to be practical, but only to test if a "survival cockpit" for sailplane pilots is possible. And it held together.

It has to be remembered that some of the materials used came from the Formula 1 sport, which are not at this time licensed for aircraft. This involves especially the "Dyneema" fiber. But at least the test showed what improvements are possible.

To get Things Straight:

It really was a disappointing film - disappointing mainly because our cockpit failed.

This however does not mean that our cockpit is worse than any other. It only means that no one would have been able to survive a crash as simulated by TÜV (Technical Supervisory Association). Based on the experts, no cockpit available to date would have offered even a slight chance of survival. This is the exact purpose for the TÜV investigation. It was intended to show the deficits as can been found everywhere, and to search for new possibilities to increase the safety standards.

The Consequences.

When the lights came on there was a stunned silence. My question was: "You knew all this? What did you do with this knowledge?" The answer: "At that time Glaser-Dirks ran out of funds."

This is without a doubt as true as it is unnerving.

What could have been done? From a design point of view it is a solvable problem. We do not have a compression zone worthy of it's name in sailplanes. But we often have a "soft adversary". In other words, we can use the impact surface as a compression zone, because it is not another car but usually the more or less soft ground. This is where the cockpit must intrude without bending, and the resulting forces have to be guided around the pilot into the wing root to the rear spar mount.

For this we need two powerful stringers, two belts as massive spars which strengthen the sides of the cockpit and transfer the impact forces rearward. The stringers have to start at the nose and reach the rear of the cockpit without being weakened by holes, attached parts etc.

A strong horizontal rib at the instrument panel which prevents the stringers to bend sideways and break.

A strong rib behind the backrest rib, which prevents the fuselage from bulging, which would then overstress the stringers.

<u>These three measures would go a long way!</u>

At my next visit to Bruchsal we had the calculations, and we concluded:

We offer a safety cockpit for the DG-800 - designed to the present state of the art.

We don't want to live with the knowledge that a pilot had a survivable accident, if we had only converted the present knowledge into practical use.

And what does one call such a cockpit designed to the state of the art? The designation "Safety Cockpit" is already being used. Therefore we call ours the "Consummate Safety Cockpit"

What is the Cost of a Consummate Safety Cockpit?

Development from construction drawings to form construction to all the changes necessary to the control mechanism took about 10 months. The cost is difficult to pin down.

A number of additional parts have to be attached during production.

The powerful connection of the fuselage halves by the horizontal rib is difficult to do.

The cockpit becomes about 9.7 kg heavier, which increases the weight of the "non-lead bearing parts".

Around the right upper arm the cockpit becomes about 1.5 cm narrower. On the left side the stringer disappears behind the inner wall and does not interfere.

In another article an approximate price is mentioned. In reality the consummate safety cockpit is cheaper.

But what price your life or health?

In view of the next to last point we offer the consummate safety cockpit as an option. Pilots taller than 1.85 m or weights around 100 KG might want to forego it for reasons of comfort, and we don't want to force it on them. Otherwise we would have made this new development standard equipment.

We would like to mention that DG as of now is the first company to make the consequent changes necessary to improve cockpit safety, based on the results of the tests done by TÜV.

When can you order this cockpit?
Right now.

All aircraft of the series DG-800 with delivery dates as of March 1999 can be built with the consummate safety cockpit.

For the series DG-505 the development is not as pressing, because the backrest of the front seat reinforces the cockpit structure considerably. Of course, in future new designs we shall include improvements, but at the moment this is not crucial.

For the DG-300 the financial feasibility comes into play. It would have the same increased costs as the DG-800. , and present sales volume does not justify it.

What about the other Manufacturers?

During the development phase of our new cockpit we had the opportunity to inspect sailplanes of the type ASH-26, ASW-27, Ventus2, Discus 2, LS 6 and LS 8. The solutions they offer are all similar.

The cockpit sides are higher than the DG sailplanes. The large canopy is one of our "Trade Marks" and leads to, we must admit, slightly less strength than the higher cockpits. On the other hand the larger canopy contributes to active safety - especially by lessening the danger of mid-air collision. That is why all designs seem to be about equal in terms of safety.

Several types had quite strong fairings in the sides, which could divert forces around the pilot in the event of a crash. But unfortunately all theses fairings had several "weak link" spots. For one they terminate at the rear end of the canopy frame and would let the wings without a braking force relative to the pilot. Secondly, they are full of holes. Control rods are put through the stringer, slots for ballast levers destroy the static strength, or a large air vent is put right through the stringer. In an accident the stringers would break on these spots and become virtually useless.

What Actually Happens in an Accident?

The test on the crash track of the TSA is not completely realistic, because the last test speed of 70 km/h is often exceeded in real crashes.

But on the other hand the reality can be viewed more optimistically:

The test was conducted with a gross weight of 525 kg. This is undoubtedly correct, but often sailplanes are flown without water ballast and are then considerably lighter.

The test simulated an impact nose first. But every accident is different, and often the wing absorbs much of the impact, slews around and only then does the nose hit the ground. This absorbs much of the impact energy in the wing and does no longer reach the cockpit.

The test was done without a canopy. Of course it is destroyed in a heavy crash. But it too absorbs some energy before it flies off.

In reality the sailplane will be mostly dismantled. If the fuselage without a consummate safety cockpit impacts, the wings will fly on almost without braking, as we saw in the film. Only the pilot brakes the wing "with his life", as macabre as this may sound.

With strong stringers the wings will be slowed down noticeably, and their structure will fail almost immediately. The spar will tolerate very high vertical stresses, because it was designed to do that. But for horizontal bending moments they are comparatively weak, because these stresses are much less in flight. As a result, the wings will break forward and continue to "fly" after separation, until they crash into the ground. This is especially true if the wings carry a heavy load of water. At the same time the fuselage will break and the fin fly off. A sailplane with a gross weight of 525 kg is suddenly reduced to a front part of the fuselage of about 190 kg, including the pilot - in the case of a motor glider perhaps 280 kg. This remaining mass can be decelerated much more before the cockpit structure collapses. The resulting acceleration forces will probably be much higher for the pilot than in the crash test, but with properly worn seat belts this should not be a problem.

A pilot in a real sailplane in a crash at more than 70 km/h should be able to survive relatively unharmed. But there can be no guarantees.

What Conclusions can we draw for the Pilot?

If you read Bruno Gantenbrinks speech on our homepage, you will realize that our sport can be dangerous, much more dangerous than driving a car. In a car you have a compression zone, designed after hundreds of crash tests. Perhaps you also have an airbag (which you don't need in a sailplane) and seat belt retractors. Your sailplane is a greater risk to your health than your car, as Bruno Gantenbrink has realistically demonstrated.

This bring the following conclusions:

A Consummate safety cockpit will increase your personal safety and survivability very considerably more than all the safety features of your car combined. How much is your personal safety worth to you?

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