-aktuell

the newest information about DG for glider pilots

DG-Flugzeugbau GmbH
D-76646 Bruchsal, Germany
Special Edition

The New Two-Seater from DG Flugzeugbau

DG-1000

In the beginning, there were only three 20 meter class two-seaters on the market; all with very different characteristics:

- The ASK 21 was considered to be the ideal glider for flight training: robust, docile, and suitable for aerobatics.
- The Duo-Discus was the most modern two-seater and was designed especially for cross-country flying.
- The DG-505 ORION was multitalented and combined good training capabilities, and very good performance in both cross-country and aerobatic flying.

In the Spring of 1997 we got together to discuss the long term plans for DG Flugzeugbau. During these discussions it became clear to us that we could design and construct a glider that combines all the positive characteristics of the three models mentioned above.

The result was a plan for a two-seater glider, the DG-1000.

The Airfoil

The selection of an appropriate wing section was a collaborative event which occupied many well-known professors and their respective aerodynamic labs for many weeks.

The final result is a laminar wing section designed by Horstmann/Quast from DLR Braunschweig. This section was reviewed and measured at Stuttgart University. The Technical University of Delft then completed the design with the addition of Winglets and by optimizing the wing- fuselage intersection.

In the end, two possible wing sections were left to choose from. One of them represented ultimate performance at best L/D speed , however it showed a strong drop in performance at higher speeds and likely possessed nasty stalling characteristics.

The other option was slightly less efficient at best L/D, however much better above 160 km/h. This was combined with very docile stalling characteristics and low bug- and rain-sensitivity.

We believe that the small advantage of the glide ratio of the first profile is unattainable in normal flight, and that the docile stall characteristics and the low bug- and rain-sensitivity of the second option were much more important. Naturally, we chose the second wing section.

Now that the Maiden Flight is done, we can already say that these theoretical prophecies were totally fulfilled!

The Wing

The DG-1000 can be flown with 2 wing-spans. For easier rigging each wing features a parting device at y=8600 m that is, at about the 17.2 meter point. For flying at the 18 meter span a set of 0.4 meter long wing tips with "miniwinglets" are added (similar to the standard DG-800 18m tips). This configuration is designed to produce good rolling qualities and predictable flight behaviour.

For cross-country flying the 20m wing tip extensions with integral winglets are added.

Doubtless, the wing-planform will show some similarities to the Duo-Discus. It should be noted, however, that the selection of planform and dihedral was lead principally by aesthetics. Whether or not the wing has a single or double contour break, or if it is bent forwards or backwards makes little difference in performance.

So of course we designed our glider to be sleek and pleasing to the eye. A perfect marriage of aesthetics and performance. We like to think of the DG-1000 as an aerodynamic work of art!

In addition the four-part trapezoidal wing of the DG-1000 has a small advantage over a two-part trapezoidal plan form at low speeds.

The carbon wings of the DG-505 are not heavy at all. But the weight of each DG-1000 wing is about 13KG (!) less, (approx 83 KG!).

On April 14th the spectacular wing test to destruction was conducted in Stuttgart.

The Fuselage

The fuselage originates from the DG-505 and incorporates a variety of enhancements. The positive characteristics were carried over . The high seating position of the rear seat was not changed. This gives the rear pilot (usually the flight instructor) an excellent view. That is also why we have decided to keep the two-piece canopy. You can read our thoughts on why not to change to a single canopy on our website. Safety reasons were the main factor in our decision.

With regard to safety, the fuselage of the DG-1000 will show decisive changes. To a large extent, it will meet today's standards of a consummate safety cockpit, as was described for the DG-800. There is no loss of cockpit space worth mentioning due to the reinforcements. For a two-seater, such a cockpit is especially important! Because of the compressed development time a special cockpit will come a little later. Please understand that it will cost an additional price, too.

Another important change was to the landing gear:

We have designed a sophisticated new mechanism providing high comfort. The problem with two-seaters is that the rear pilot sits exactly where the main wheel should be. As a result the glider is nose-heavy on the ground. For this reason most tandem two-seaters have a nose wheel as well as a main wheel. This is a disadvantage for winch launching, as the tail wheel can often hit the ground when the winch cable tightens. This is not necessarily good for the structure, and is very unsettling for the flight student because the glider's attitude changes suddenly.

Our wheel extends forward from the landing gear compartment beyond the centre of gravity. The DG-1000 therefore tends to sit up, even with a pilot in the front cockpit. The sudden pitch up on winch launch is avoided because the glider always rests on the tail wheel.

To remember: The Duo comes with a main wheel without any spring - like a Ka 7 or Ka 13!

The Tail plane

The sailplane has also been completely redesigned with new profile sections and optimized to the size of the wings. We want to install a small fin tank to compensate the C.G. shift due to water ballast in the wings.

Furthermore we thought that it should be easy to adjust the C.G. depending on the cockpit loads in order to achieve the best handling and performance characteristics.

There is a large difference between two heavy adults or one light juvenile flying, especially if they fly right after one another.

Therefore we created a compartment in the vertical fin for ballast weights which is accessible via a removable panel. After removing the panel you can easily install one to nine brass weights into specified compartments to adjust the C.G. point as required.

Flight Performance

We believed we could predict that the DG-1000 would feature noticeable performance advantages in comparison to other gliders:

- The wing section is state-of-the-art.
- The wing-fuselage intersection was optimized for optimal boundary layer conditions with special airfoils in this area.
- Winglets are standard for the 20m span which performance-wise will result in a wingspan of approx. 21 meters.
- The drag of the nose wheel has been eliminated.

Exact performance figures are available since flight comparison tests have been done. A flight with the Duo Discus proved these results!

The theoretical calculations looked very promising:

- The min. rate of sink should be 0.51 m/sec at 28 kg/m2 wing loading (Solo flying).
- The best glide ratio was calculated at 1:46.5 with 42.8kg/m2; (max. weight)!

Motorization / Wingflaps /22 Meter span

We plan to offer the DG-1000 with an engine later on as a turbo or self-launcher. But we have just finished the development of the DG-505MB, which is the only motorized two-seater glider in its class on the market. At the moment there is no need to design and type certify a motorized DG-1000, not to mention that the available production capacity for the "normal version" will be at its limit as soon as the DG-1000 is type certified. So the DG-1000M will come ....but not before 2004 at least.

There are also plans to develop a version with wingflaps... but not in the near future.

There will not be a version with larger wingspan (22 meters or more). To prepare for a span larger than 20m, the necessary reinforcements of the inner wingpanels would result in higher mass for all versions and reduced rigging comfort.

To compare the price you should have in your mind that the DG-1000 has the following improvements:

- A modern airfoil with especially good gliding characteristics. This has been convincingly proven.
- The standard-equipment winglets are an enhancement that would normally cost a lot of extra money.
- A trim box in the fin for quicker and precise C.G. adjustment.
- A main gear situated in front of the C. G. Even with a solo pilot in the front cockpit, the glider rests on the tail wheel. This prevents the tail slamming down in the initial accelleration of a winch launch.
- Two wingtip wheels are standard, too.
- A quick trimming device

Marketing:

We plan to offer three models at the beginning of production, two others will follow.

DG-1000S

This is the standard model with a 20 m span, winglets, retractable main gear (as described above), trim box, and water ballast. As an option the undercarriage system of the well known DG-505 Orion is available too.

DG-1000S-18/20
For this variation wing tips for an 18 m wingspan can be delivered. 1.4 meter extensions, including winglets are available as another options. The 18 configuration is ideal for clubs that want to teach. The extensions transform the ship into a high-performance cross-country machine.

DG-1000S Club
This intended for clubs wanting a less expensive entry model. The span is fixed at 18 m, the gear is non-retractable, and there is no water ballast system. Although the price is higher than that of the competition model ASK-21, the 1000 has an airfoil which is newer in design by about 20 years, has a trim box in the fin, and carbon wings which make rigging considerably easier.

As an extra, the Club Model can be ordered with the "normal" retractable gear, water ballast system, and with removable tips. This gives the option of later adding the wing extensions, including winglets thus giving you a complete DG-1000S-18/20m!

Another possibility might interest instructors. They often complain that fibre glass two-seaters can not be used for spin training. But when students later fly a single place glider, they can easily get into a spin by mistake and have not been taught proper recovery techniques. The DG-1000, with the help of the trim box and fin tank, can be set up with a suitably rearward C.G. for spin training.

DG-1000 Competition
This is the DG-1000S with flaps which will come some time after the beginning of production - probably not before 2004. The DG-1000 with flaps will be even better for cross country flying.

DG-1000T/M
The motorized version - as a self-launcher or a turbo - will be available sometime but certainly not before 2004 and until then we still have the DG-505MB available.

So we are offering a complete line of two-place gliders from the DG-1000 Club to the DG-1000M which should fill every possible need.

DG-1000 vs Duo Discus – Comparison Flight

Comparison tests do not explore the far corners of the performance envelope, this is done in isolation for each aircraft by the Idaflieg using very sophisticated, exacting and expensive tests.

Comparison flights give you a relative measure of the simultaneous performance of two sailplanes at various speeds. This is the only means of directly comparing the performance of two competing designs.

We are convinced that you cannot determine the relative merits of aircraft by examining competition results since the skill of the pilot is a significant variable. If aircraft performance were based on race results then it should be the designer who is honoured and not the pilot.

Only side-by-side flights on parallel courses can be used to judge the relative merits of two aircraft.

This is achieved by starting both gliders in formation at exactly the same height. The gliders fly at the same speed on the same course. Once one of the gliders has descended a set distance, for example 100m, a snapshot of the relative height gives us exactly the L/D performance comparison.

Important:
Believe it or not, I personally certify that the measured results presented here are true and without bias. No special preparations or performance enhancements were carried out on the DG-1000.

The Object of Comparison

As previously mentioned, only the Duo-Discus was compared because this glider presently dominates all competition in the 20m class. Why is this so? Because the Duo-Discus is an excellent glider! As the owner of DG-Flugzeugbau I freely admit this. To best this glider would be a considerable achievement.

When a sailplane such as the Duo-Discus dominates a complete class it is natural that it be the benchmark against which all other designs are compared. That is the philosophy behind this test.

The test article was a relatively new Duo-Discus of a neighbouring club. The glider was washed and even polished prior to the comparison. The sailplane was flown by a highly experienced pilot who used all of the skill at his command to exact every possible ounce of performance from the Duo-Discus.

There was, therefore, no difference in the quality of the aircraft.

The Conduct of the Test

The comparison test was held on August 14th 2000 at Karlsruhe-Forchheim. It was a hot day with nearly calm air above 600m. The test director was our engineer Swen Lehner in the DG-1000. The Duo-Discus was the "lead" ship. That means that the Duo-Discus only had to fly a given constant course and speed while Swen Lehner had to try to fly formation side-by-side.

Both gliders were prepared with the same C.G. position and wing loading. Although the empty weight of both gliders is nearly the same it was necessary to load 36 Litres of water ballast in the DG-1000 because of it's greater wing area and the different pilot weight. The DG-1000 will be certified for a maximum weight of 750 Kg as compared with the 720Kg of the Duo. This means that the DG can be flown with the same wing loading in normal conditions, but the advantage appears in conditions of marginal lift. Then the DG-1000 can be flown without water ballast with a lower wing loading than the Duo-Discus.

Both gliders were towed together up to 3,000 Meters and were synchronized in position. The first comparison run was conducted at medium speed (120 Km/H or 65Kts). When the result of a comparison run was obvious after one of the aircraft had lost 100m in height, the data were measured and accepted. In cases where the result was close, the aircraft continued the run until a further 100m of height was lost. The estimation of the relative

heights of the two gliders was made by using the 1.51m high tail fin of the Duo-Discus as a reference.

Comparison runs at the most common, and therefore significant, speeds of 84, 100 and 110 Km/H were flown twice. The reported results are the average of these two runs and are considered statistically more accurate.

The Result

The following table presents our results in convincing fashion:

Comparison Flight Duo Discus ./. DG-1000

No.	V km/h	V knots	Diff %	Diff L/D
1.	75	40	- 3	- 1,2
2.	78	42	+ 3	+ 1,3
3.	84	45	+ 3	+ 1,3
4.	100	54	+ 5,25	+ 2,5
5.	110	59	+ 5,25	+ 2,4
6.	120	65	+ 2,3	+ 0,9
7.	140	76	+ 3,8	+ 1,2
8.	160	86	+/- 0	+ /-0
9.	180	96	+ 8	+ 1,5

At first glance, it is hard to understand that for flights near the stall speed the Duo-Discus performed better than the DG-1000 and that at 160 Km/H it's performance was the same. For all other points of the flight regime the DG-1000's performance was better. This is not an anomaly, but indeed confirms theoretical modeling and predictions.

We took the theoretical DG-1000 L/D polar curve and subtracted from it the observed performance differences. When we fit the data points and drew the resultant curve we found that it matched the published L/D polar curve of the Duo-Discus.

This means that we found the predicted characteristics and it also indicates that we did not make any systematic errors.

Interpretation

Near the stall speed at point No. 1 the DG-1000's performance was inferior. This means that the drag at speeds under Minimum Sink (Vx) increases earlier but more gently than that of the Duo-Discus. This leads to very smooth and benign stall characteristics and was a design objective of ours. But then again….who flys under Minimum Sink ??

From point No. 2 onwards, the DG-1000's performance is better. This is significant at point No. 3, because this represents the most common thermaling speed.

The most important points describing the performance of a glider are the points No. 3 to No. 7 presenting the speeds flown most of the time. It is in this specific regime – a area where the comparison runs were flown twice and the data meticulously collected – that the DG-1000 showed noticeable superiority to the Duo-Discus. We are absolutely convinced that every pilot will notice this advantage of greater than 5%.

Also when we express the DG-1000's advantage in L/D points it boils down to 2.5 and corresponds to "half a glider generation's" worth of development.

Just imagine a 3-hour cross-country flight. What these results mean is that at the end the flight the DG-1000 would be 400 – 500m above the Duo- Discus. Really!

At point No. 8 at 160 Km/H the performance of both gliders was the same.

It was difficult for Swen Lehner to estimate the height difference at point No. 9 because the vertical change was so large. In order to report his impression, Swen Lehner said:

"At 180 Km/H the Duo-Discus seemed to fall out of the sky".

We were unable to fly at higher speeds because we had yet to complete the flutter test. When you examine the L/D polar curve you will note that the superiority of the DG-1000 is even more pronounced at higher speeds. But this is, admittedly, not all that significant since these high speeds are not commonly flown.

We must, however, point out another issue:
As we described above, the DG-1000 flew formation on the Duo-Discus. This arrangement was chosen so as to give full benefit of the doubt to the Duo-Discus. When any aircraft is flying formation on another, the pilot must constantly make small corrections to remain in position. This increases drag and decreases the efficiency of the run somewhat. The test staff of the Idaflieg will confirm this.

In free flight, the performance results of the DG-1000 would be even better!

Final Result

Of course, this comparison flight was conducted using only two similar gliders. Because of the manufacturers high quality-control and the precision of the product these tests will be representative of all gliders of that type.

Our prototype was not groomed or specially prepared in any way. For this we would have used a second DG-1000 for comparison purposes to determine the optimal position of the tapes and turbulators. You can expect another performance increase once this fine- tuning has been completed.

By using the DG-1000's integral trim box, one is able to precisely adjust the C.G.. This feature will generate another increase in performance.

Swen Lehner is a flight instructor who knows the Duo-Discus from the front and from the rear seat. He says that the handling of both sailplanes is comparable. The Duo-Discus' harmonious controls and low control forces are well known. Our test pilot considers that we have reached the same standard. To top this standard would be nearly impossible and not necessary.

The visibility from the rear seat of the DG-1000 is better affording instructors a clearer – and therefore safer - view.

Swen Lehner reported that the DG-1000 main-wheel spring does a good job absorbing bumps and landing loads. This leads to comfortable taxing and smooth landings. This is in contrast to the Duo-Discus. The instructors' lumbar regions will say thank you!

Our engineer has carefully summarized the results of the test as follows:

Irrespective of the exact data points, the DG-1000 flew higher than the Duo-Discus for all important test runs. The differences are very clear and obvious to any pilot.

The handling characteristics of the DG-1000 are comparable to those of the Duo Discus.

The comfort afforded by the main-wheel spring of the DG-1000 is noticeably better.

DG-1000T
our Two Seater with Turbo Engine

A. Concept

In the course of developing the DG-1000 into a whole product family, introduction of a variant with wing flaps was planned as the next step , together with the self-launching DG-1000M.

But to our surprise, ongoing discussions with prospective customers revealed the strong interest in an inexpensive auxiliary engine to allow save return to the home base during a cross country flight. Particularly clubs are interested in this return capability to intensify cross country training and cross country flying without the risk of outlandings. Their established launching capabilities by winch or tow would not justify the higher cost of the self-launch capability.

We listened carefully to our customers and changed our planning. The next addition to the DG-1000 family will be the DG-1000 Turbo, the variant with the auxiliary engine for return flights.

B. The Power Plant

We did an extensive market research for existing modern auxiliary power plants, not to invent the wheel again. This lead us to the power unit of the ultra light glider APIS, developed and currently under test by Martin Wezel of Wezel Flugzeugtechnik (Wezel Aircraft Technologies). Since this engine allows self-launches of the APIS, we are confident it is well suited to add the return flight capabilities to our two-seater. Therefore we started the collaboration between Wezel Flugzeugtechnik and DG Flugzeugbau.

Core of the power unit is a single cylinder two-stroke engine from Goebler-Hirth, with a directly attached 2.5:1 reduction gear. The engine is currently certified for ultra lights, we need to extend this certification.

Martin Wezel found a particular interesting solution for the exhaust line, which snakes around the engine pylon. This results in a perfect resonator length, boosting the engine power to approximately 30 HP. The engine drives a comparable large two blade propeller, custom designed for our use case. This arrangement provides a much better efficiency than a smaller, fast rotating two blade, or even smaller five blade propeller.

Of course we had investigated different solutions, in particular the use of four stroke engines. Two-stroke engines are less optimal than four stroke engines in terms of fuel efficiency and emission characteristics, but this is in our case not of significant importance. However, air cooled two-stroke engines excel by unbeatable simplicity. We don't need a coolant or an oil system and save the associated two pumps. We also avoid cold-start problems and oil leakage when retracting the engine. A four stroke engine would therefore be much more expensive.

C. Engine Control

It is already “corporate tradition” that DG seeks for an optimum solution. The DEI in the DG-808B provides already outstanding comfortable engine control, contributing to improved safety. In the DG-1000 Turbo we go even a step further. The following list itemizes the actions required by the pilot to start the engine:

1. Ignition On

The DEI in the DG-1000 Turbo is always on, even in glider configuration (we will report on this feature in a later report). Therefore after switching the ignition on, the following sequence happens automatically:

- The fuel pump and the extension spindle actuator start concurrently
- The engine doors open and the engine is extended
- The possibly required fuel valve opens
- When the engine is fully extended, the engine decompression valve is opened
- The possibly required primer injects the exact cold-start fuel quantity
- The propeller windmills in the slipstream and the engine fires
- The decompression valve closes and the engine develops full power

2. Next step

There is no next step! This was already everything needed! At DG Flugzeugbau we call this

“On-and-Go”

Stopping and retracting the engine is similar “complicated”:

Switching the ignition off with closed decompression valve will bring engine and propeller to a full stop

- The propeller stopper is extended into the propeller plane
- The decompression valve is momentarily opened
- The propeller turns until it reaches the propeller stopper
- The spindle actuator retracts the engine
- The potential fuel valve closes and the engine compartment doors close

Again here is switching the ignition off the only required action, everything else happens fully automatic. In case of a malfunction allows a manual system to retract the engine without the need for any electronic support.

Such a sophisticated control system is not only a convenience for the pilot. It is even more an important safety improvement. An immediate response of the engine is typically needed at low altitudes, when the pilot is exhausted from unsuccessful search for thermal lift. In this stressful situation can any single mistake with a conventional engine control system prevent the engine from immediate starting and result in a dangerous situation for the pilot. Auxiliary engines are usually much less frequently used compared to engines of self-launching gliders. Particularly club pilots tend to be less fluent and trained in the usage of the auxiliary engine systems. The operation of the engine must therefore be as simple as ever possible.

D. Usage Spectrum

The DG-1000 is already known for its universal talent for cross country flying, pilot training and aerobatics. However, there are limitations. So is it already decided that the DG-1000T will not be certified for aerobatics. The additional effort for an invertible fuel system and the locking mechanism to hold the retracted engine in place during negative g-forces would be too extensive.

Also is it at this stage unclear if the DG-1000T will be certified with 18m wings. It is possible that the increased weight will affect the landing speed too much. But such a nice glider is too valuable for local “touch and go” anyhow.

E. Open Questions

Several technical questions are currently not yet solved, like:

- What speed will start the engine?
- At which speed will it come to a full stop?
- Do we need a second automated fuel valve (operated by the retraction mechanism) in addition to the mandatory fuel valve in the cockpit?
- Do we need a primer?
- And of course – is it possible to realize the On-and-Go system as planned?

We will clarify this all during development and certification.

An important question is also: when will it be available? The following can only be an estimate; it is obvious that unexpected problems can affect the timing of such a project.

The CAD design will be completed in March 2003. The maiden flight is planned for late summer. Certification of the glider and the engine will be done concurrently in fall or winter. First deliveries will then be in 2004. But please remember, this is the current planning and not an official commitment!

And the Price:

We will decide this later. Let us first get this “super-ship” into the air!

F: Options

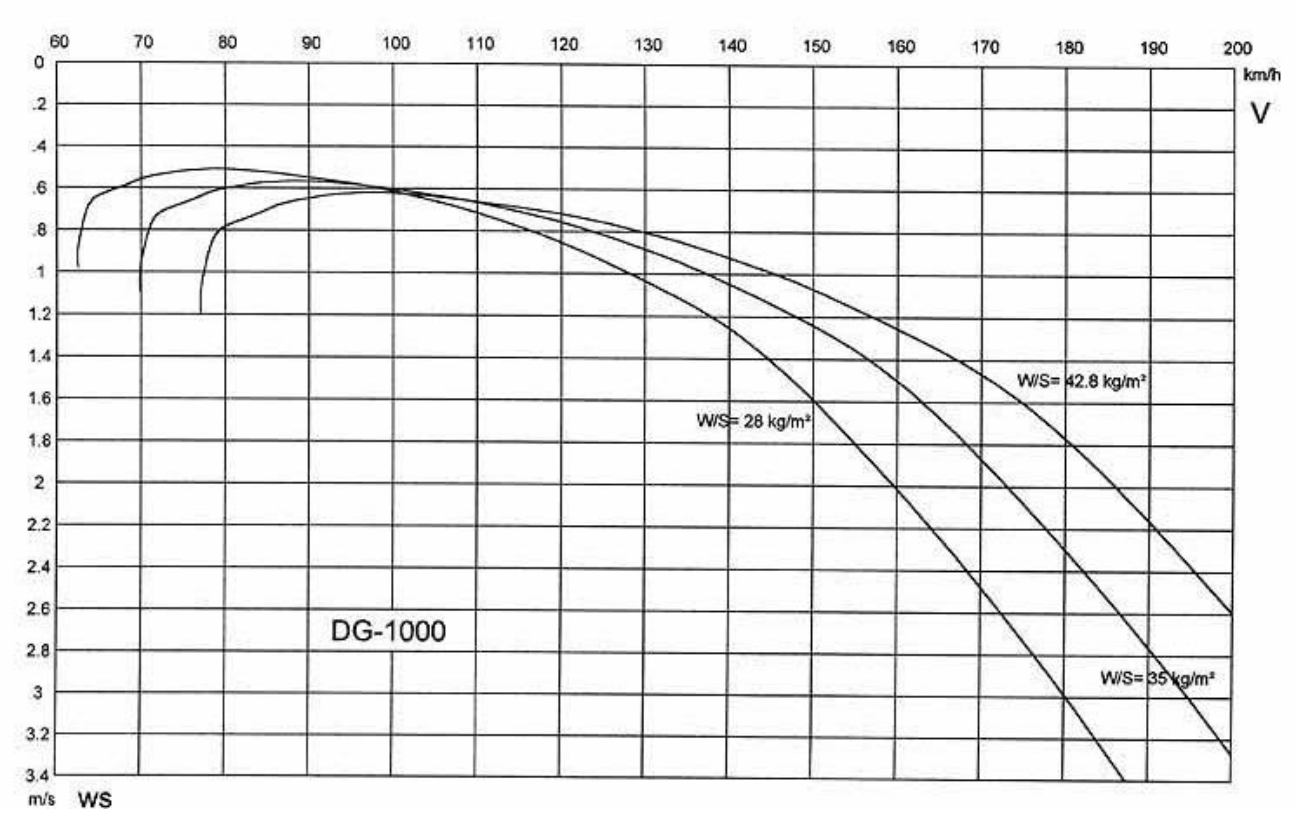
Options may be signed to secure an early delivery date. The option escrow will be refunded in case the development cannot be completed. Please consider also that the first several DG-1000T will need to operate under temporary certification. This might affect the delivery possibilities outside of Germany.

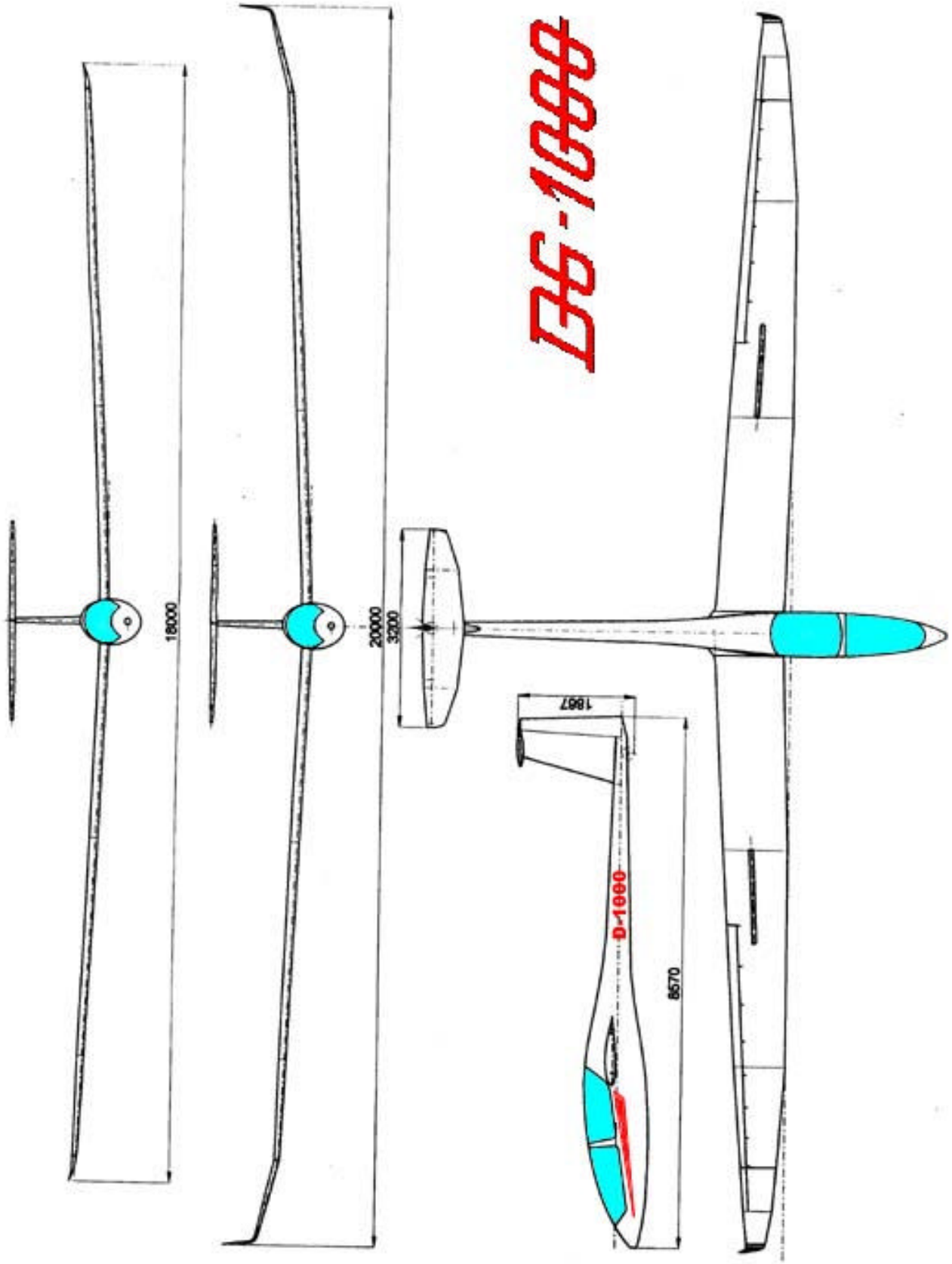
Technical Data of the

DG-1000

Wingspan	m / ft	18 / 59,1	20 / 65,6
wing surface	m^2 / ft^2	16,72 / 180	17,51 / 188
aspect ration	/	19,38	22,84
Length	m / ft		8,66 / 28,4
fuselage width	m / ft		0,73 / 2,4
fuselage height	m / ft		1,0 / 3,3
tail wingspan	m / ft		3,2
water ballast	ca. kg		160
empty weight with min. instruments	ca. kg / lbs	410 / 904	420 / 926
wing loading with 80 kg loading	ca. kg/m^2 / lbs/ft^2	29,3 / 6,0	28.6 / 5,86
max. TOW	kg / lbs	750 / 1653	750 / 1653
max. wing loading	kg / m^2 / lbs/ft^2	44,9 / 9,20	42,8 / 8,76
Performance:			
VNE	km/h / kts	270 / 146	270 / 146
Acrobatic		unlimited	limited
best L/D with max. TOW:	ca.:		1:46,5
min. sink (with W= 625 kg)	m/sec / ft/min		0,51 / 100,3

The calculated Polars:





DG Flugzeugbau GmbH Otto Lilienthal Weg 2 D-76646 Bruchsal
Tel.: 0049 (0)7251 3020-0 Fax: 0049 (0)7251 3020-200 eMail: dg@dg-flugzeugbau.de.de
Internet: www.dg-flugzeugbau.de