A Flight Test Evaluation of the Discus Sailplane

By Richard H. Johnson, Published in Soaring Magazine, February 1986

The Discus is a new Standard Class competition sailplane from the well-known Schempp-Hirth Flugzeugbau factory in West Germany. The company's founders were Martin Schempp and Wolf Mirth. They produced many wonderful sailplanes in soaring's early years, including the famous wooden high performance gull-winged Minimoa. Now Klaus Holighaus is the proud owner of the company and equally famous for his modern composite-structured Cirrus, Ventus, Nimbus, Janus and now Discus high performance sailplanes.

An unusual characteristic of the Discus is its unique swept-back wingtip planform that was apparently inspired by WIl Schuemann's clever and innovative modification of his 15 Meter AS-W 12 (Ref. A.) Figure 1 shows a 3-view outline of the Discus along with its basic technical data. As with the 15 Meter Ventus, the Discus is available with either a large or a small size cockpit. The Discus Model A is the smaller one and its cockpit is about 21.25 inches (54 cm) wide inside at elbow height; the larger Model B is about 24.35 in. (62 cm) wide. The B fuselage is about 9 in. (23 cm) longer than the A and roughly 11 lbs. (5 kg) heavier.

Our test sailplane was the Discus A that Klaus Holighaus flew to a strong second place, behind Tom Beltz in another Discus, at the 1985 U.S. Standard Class Nationals at Hobbs. Subsequently, the sailplane's new owners, David Caron and Rick Howell of the Dallas area, brought the Discus to its new base at Caddo Mills, Texas and kindly offered it for flight testing.

The Discus A handbook indicated that this smaller cockpit model was suitable for pilots up to 5'9" (1.75 M) in height but my 5'10", 155 lb. frame fit into it comfortably with a Security 150 parachute, even with my shoes on. Mike Newgard, our 6'3" (1.90 M) tall, 205 lb. (93 kg) assistant, did not want to be left out of the flight testing, and he managed to fit in with a smaller Strong parachute, but without shoes or normal comfort.

This new sailplane was equipped with a fuselage nose towhook and that made aerotowing very easy. I could occasionally release the controls entirely while towing in smooth air for altitude to make our test measurements.

I made the first two flights to measure the wing profile drag probe indications, with the drag probe mounted on the left wing trailing edge about 51 inches (1.30 M) out from the fuselage side. During the first flight the wing was configured with a factory installed dimpled plastic turbulator strip located about 2/3 of the chord aft of the wing leading edge on the wing bottom surfaces. For the second flight we removed about 18 inches (46 cm) of the turbulator tape from each side of the drag probe location to compare readings and evaluate the turbulator system effectiveness.

As Figure 2 shows, the simple plastic turbulator strips appear to work just as well as the DG-300's much more complicated hypodermic needle blow hole turbulator system described in Ref. B. A significant 10 per cent wing profile drag reduction was indicated for the Discus between 45 and 65 knots with the turbulator strip installed, with decreasing benefits below 45 kts and above 65 kts. Only above 100 kts does a small drag penalty appear to be incurred with the turbulator strip.

Mike made the next two flights to calibrate the Discus airspeed and pitot systems for errors. Figure 3 shows the measured airspeed system error data plotted versus airspeed. They indicate that almost no error exists, which is unusual for most modern

At 5'10", co-owner David Caron fits comfortably in the relatively small Discus A cockpit. The excellent side-hinged canopy is well-sealed.

FIGURE 1

FIGURE 2

FIGURE 3
Schempp-Hirth designs. The pitot is located near the top of the vertical fin and its calibration flight indicated zero error, except at stall where airflow separation from the fuselage and/or wing or T.E. probe cause it to fluctuate toward zero pitot pressure. A total energy venturi was located about 5 inches (13 cm) below the vertical fin pitot, and since the vertical portion of the total energy venturi would likely interfere with the pitot pressure at all airspeeds, we installed it in a downward orientation as shown in Fig. 1 to minimize interference.

The handbook specifies that the aft fuselage side static sources are to be used for the airspeed indicator, and they appear to have very little error. However, the water ballast dump outlets are located on the bottom wing surfaces very close to the fuselage sides. During in-flight ballast dumping the airstream sprays the water onto the aft fuselage sides such that those static sources can easily become clogged. Flying in rain can also cause the small diameter aft static sources to clog. For that reason it is essential to install some sort of a selectable alternate static source or a momentary static blowout system in the Discus, just as it is with the similar Ventus and Nimbus 3 sailplanes for their instrument aft statics.

The Discus came equipped with an alternate static source on the fuselage sides about 7 inches (18 cm) below the wing spars. My Ventus and Nimbus 3 flight experience with similar under-wing statics indicates that neither rain nor ballast dumping will clog those orifices. However, the pressure errors associated with most under-wing statics are large, as shown in References C and D for the Ventus and Nimbus 3. Caution must be used in determining the correct airspeeds for safe flight when alternate ASI static sources are used because of errors associated with their use. Remember, the airspeed placards in any sailplane are correct only when its handbook specified pitot and static sources are used, and they and the instrument itself are in good condition.

Next, the two Discus owners and I each made a high tow in relatively smooth air to measure the sailplane’s sink rates at airspeeds between 40 and 100 kts. Those test data are shown in Figure 4, where an L/DMAX of about 39 is shown at 52 kts and a minimum sink rate of roughly 119 fpm is indicated at 42 kts. Those values are somewhat less than the 42.2 L/DMAX and 116 fpm minimum sink performance values shown in the Discus brochure. There the testing was discontinued until we could find a reason for this less than-expected performance.

Chordwise wave measurements showed incredibly small \( \pm .002 \) inch (.05 mm) average maximum waves despite the Discus having been exposed to a full summer of Texas heat. This is the best factory smoothness that we have seen to date; so that certainly was not the problem. However, the wing roots were not sealed around the control push rods, and that would allow air to flow from the fuselage out into the wing. That in itself is not too detrimental unless the air is allowed to exit the wing in a critical location such as along an aileron hinge or an airbrake gap.

The ailerons are hinged...
near their top surfaces and they did have the normal tape seal bridging the spanwise gaps between the wing and the aileron leading edges. However, a curved piece of Mylar plastic strip was attached to the wing portion by an adhesive layer at its leading edge. It curved downward in its aft direction to maintain a sliding contact with the aileron top surface. With the aileron in neutral the Mylar strips created a small but perhaps significant upward bulge in the critical airfoil profile. Also, these Mylar strips cannot be observed from the cockpit in flight, and it is possible that airstream suction force over their cambered top surfaces caused the strip trailing edges to ride high and above the aileron, thereby adding drag.

For the above reasons the Mylar aileron seals were removed and Ceconite polyester airseals were installed at the wing root aileron control rod openings. Simpler plastic foam seals were deemed adequate for the airbrake push-rods there. The Discus always exhibited a quiet cockpit, but the addition of the wing root seals quieted the cockpit even more, and roll rates also improved. ± 450 rolls at 50 kts took about 5.0 seconds to accomplish before the seal changes and about 4.2 seconds afterwards, according to my stopwatch.

When the next calm weather appeared, 3 more high tows were made to measure the Discus sink rates with the wing root seals installed and the external Mylar aileron seals re moved. The data from those flights are shown in Figure 5, where significant improvements are shown in the 45 to 55kt airspeed range. Now the L/D MAX appears to be about 42.5 at 53 kts and the minimum sink rate about 115 fpm at 45 kts, both close to brochure values.

It was recognized that three flights were not really adequate to accurately determine the improved condition polar with high confidence, and possibly the improved 42.5 L/D MAX performance was a result of optimistic test data scatter. More testing was needed. Since the test atmosphere was still adequately above freezing, it was decided to remeasure the Discus polar with partial water ballast. Klaus Holighaus had urged us to include that test because recent Idaflieg test data had shown excellent 43 L/D MAX performance with about 13 gallons (50 liters) of water ballast.

The Discus can carry more water ballast than it can efficiently use under any but strong conditions. The ballast is carried in two large wing tanks plus a small balancing tank in the vertical fin. For our partial ballast test we loaded 10.6 gal. (40 liters) in each wing tank and .77 gal. (2.9 liters) into the tail fin tank; a total ballast load of about 183 lbs. (83 kg).

Three more high tows were then made to measure the partially ballasted Discus A polar, and those sink rate data are shown in Figure 6. There is an L/D MAX of about 42.5 is shown at 58 kts, which is excellent performance for a modern Standard Class sailplane. Note that the 183 lbs. of ballast decreased the sink rate at 100 kts from its 650 fpm (3.30 m/s) unballasted value to only 440 fpm (2.24 m/s) with partial ballast; an impressive 48 per cent improvement in glide ratio at that airspeed.

The high-speed sink rates can be reduced even further by larger ballast loads, but of course at the expense of reduced climb performance. Our measurements of the Discus ballast tank capacities showed 21.7 gal. (82 liters) for the left wing tank, 23.5 gal. (89 liters) for the right wing tank, and 1.6 gal. (6.0 liters) for the tail fin tank. The total achievable
ballast load was 46.8 gallons (177 liters), which is certainly adequate for the 113.88-sq./ft. (10.58 M2) wing area of the Discus. The higher capacity of the right tank is probably due to the spars forming the aft side of the tanks, and the right spar being farther aft than the left at the root, required by the overlapping wing spar center section design. Although we did not flight test the Discus with full ballast, its lateral imbalance did not appear to be of sufficient magnitude to be much of a problem for takeoff or flight.

The wing ballast tanks are an excellent integral leading edge type design similar to those of most modern Schempp-Hirth sailplanes. They are easily filled through top surface plugs located at the outboard end of the tanks, just ahead of the wing spars and near the aileron roots. Several chordwise baffles are sensibly installed in each tank, and these prevent a partially filled ballast load from rapidly shifting laterally during takeoff or during flight in turbulent air.

The tail fin ballast system is apparently new because our test sailplane's handbook contained no information about it. I understand indirectly from Klaus that about one liter of tail ballast water is added for each 38 liters placed in the wing tanks. This is necessary because the wing leading edge ballast tanks are located slightly forward of normal cg; ballast added there does tend to shift the sailplane's cg forward to some degree. Adding one unit of water ballast to the tail fin tank effectively counterbalances about 38 units in the wing tanks.

The functional design of the Discus tail fin ballast tank system is indeed unique and outstanding. First and most importantly the horizontal tail surface does not require removal for filling the tank. Instead a simple insertion of a plastic tube into an inlet under the elevator allows filling through either a funnel or a bucket siphon. An ingenious feature is that the tail fin tank can be gauged externally. It is oriented vertically in the lower portion of the vertical fin and is equipped with five equally spaced small holes leading through the tail fin right hand surface. These five holes are used to automatically gauge the amount of water ballast in the tank because the excess water simply drains out through the holes. If only about 1 liter of water is needed, all five holes are left open. If about two liters are desired, then the bottom hole is taped closed, and so on until all five holes are closed and the tank can then be filled up to its full 6 liter capacity.

A single dump valve control lever is located on the right side of the cockpit, and it both opens and closes the wing tank valves and the tail ballast tank valve simultaneously. The dump rates of all three-ballast tanks are roughly equalized such that they each empty a full load in about four minutes. In that way the sailplane should maintain a near constant cg location at all times even if a partial dump is performed. Our ground dump test measurements showed full tanks took about 3.0 minutes for the left wing tank to empty, 3.8 minutes for the right wing tank, and about 4.5 minutes for the tail fin tank, although the tail fin tank flow slowed considerably after about two minutes.

Another outstanding feature of the Discus is that all controls including the wing dump valves connect automatically upon assembly of the wings and tail. That and the tail-installed ballast filling add considerably to the safety of operation of this excellent sailplane. Its stability, control and stall characteristics are all first class in my opinion; at least for a competition class sailplane. However, there is little or no buffeting prior to stall and there is very little airstream noise in the cockpit. Therefore care must be taken to insure that adequate airspeeds are maintained, especially when flying close to the ground.

Our test Discus was fully equipped, except for an oxygen system; only the mount for a 22 cu. ft. bottle was provided. Its equipped empty weight was about 528 lbs. (240 kg). Only the wing spar caps are of carbon fiber and the remainder of the sailplane was of glass fiber, and epoxy resin of course. The wing panels each weighed about 136 lbs. (62 kg) which is light enough for two normal sized people to handle for assembly. The workmanship was excellent throughout, at least for the parts that I could inspect. I believe that new Discus owners will have reason to be very pleased with their sailplanes.

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REFERENCES