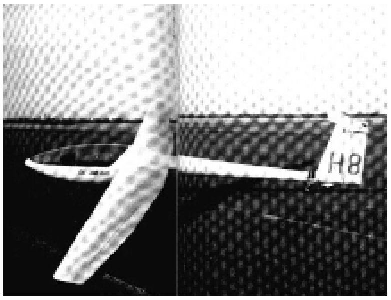
# A FLIGHT TEST EVALUATION OF THE DG-300

By Richard H. Johnson, Published in *Soaring* Magazine, August 1985

The DG-300 is the third series of modern fiberglass sailplanes designed principally by Wilhelm Dirks, a very talented young German designer with a keen interest in sailplane development. He and fellow enthusiast Gerhard Glaser manage Glaser-Dirks Flugzeugbau in Bruchsal, West Germany, which in turn has a licensing! manufacturing agreement with the ELAN company of northern Yugoslavia, and this firm fabricates both the DG101 and the DG-300 series. Their workmanship appears to be excellent in all regards, and they can be proud of their finely crafted sailplanes.



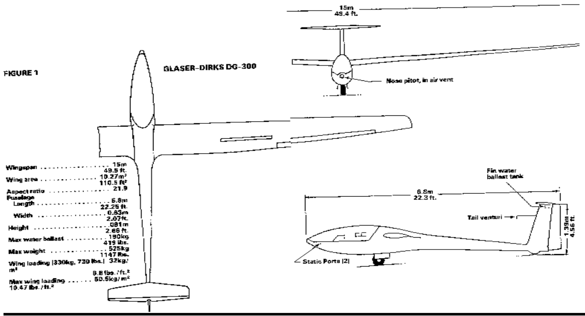
*The clean lines of the new ship grace the Caddo Mills flightline.*

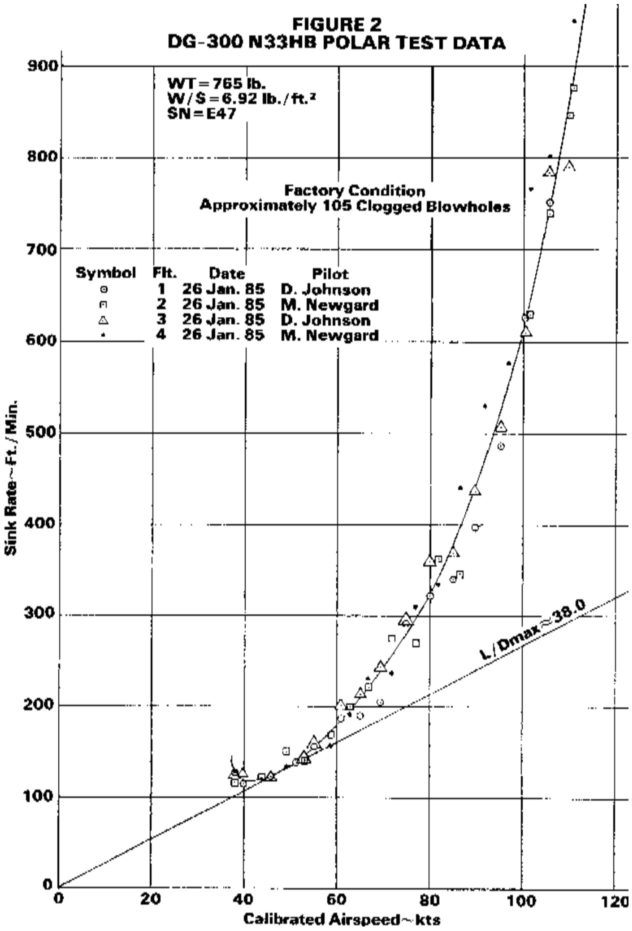
When Travis and Holly Bailey of San Antonio, Texas, received their new DG-300 last winter, they generously offered it for flight testing. Travis was a WW II glider, B-25 and P-38 pilot, and he personally delivered the sailplane to our Caddo Mills, Texas, test site. An outline and factory technical data tabulation of the DG-300 is shown in Figure 1. Note the unique tail fin water ballast tank that is used to counter the nose heaviness created by filling the two large wing leading edge water ballast tanks.

*Front-hinged canopy of DG-300 offers a fine view and easy access to seat or panel.*

Our test sailplane came equipped with optional large sized water ballast bags of 25 gallons (95 L) in each wing panel plus the 1.5-gallon (5.5 L) tail fin tank. Standard sized wing water ballast bags are rated at 17 gallons (65 L) each, and that provides about 280 pounds of ballast compared to the 430 pounds with the optional large bags. Because of cold weather and time limitation problems, we did not perform any flight tests with water ballast installed. We did, however, measure the ca-

FIGURE 1





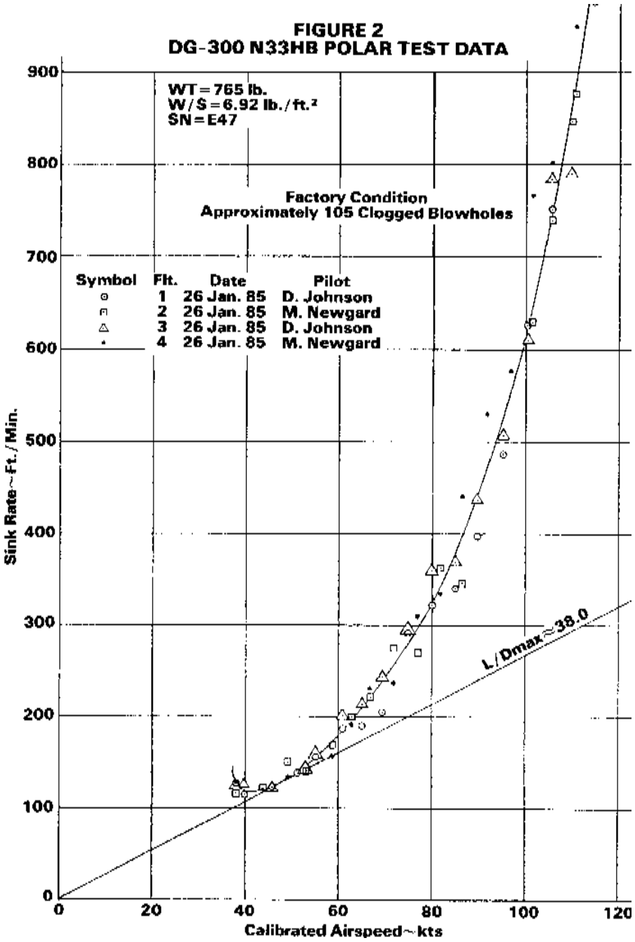
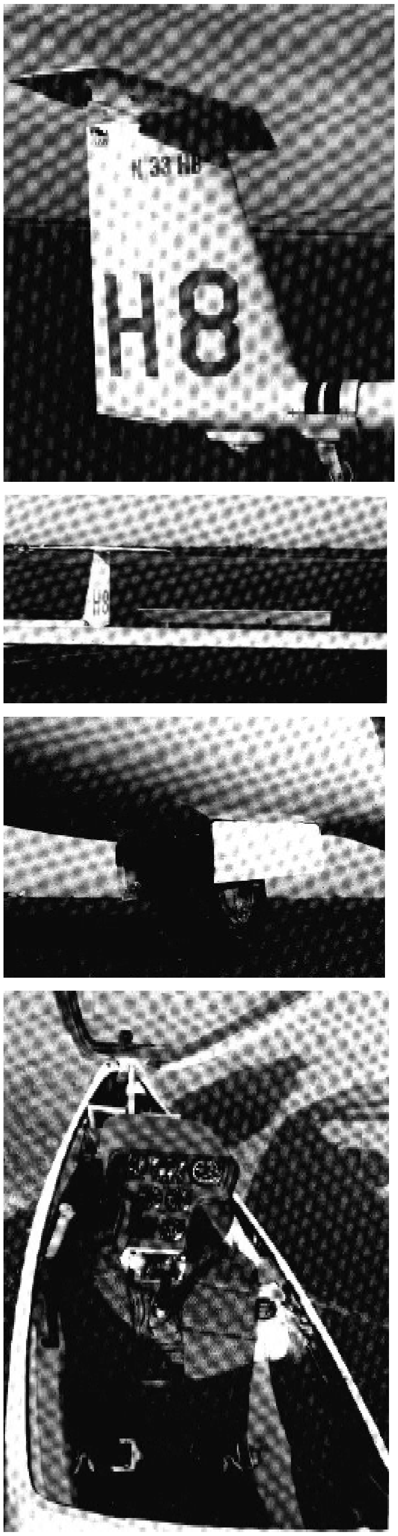


FIGURE 2
DG-300 N33HB POLAR TEST DATA



*Top down: Small Elan logo on rudder marks DG as built in Yugoslavia. And vertical tail houses a 1.5 gal. water tank. Author judged cockpit excellent and spoilers powerful but noted that the low-aft towhook just ahead of the main gear could cause pitch-up hazard if recommended full-down trim on takeoff were inadvertently not applied.*

pacity of each wing bag and found that we could load about 23.5 (89 L) gallons in the right wing and 22.8 gallons (86 L) in the left. These ballast bags are filled through wing bottom surface dump ports, and we may not have gotten all the air out during the filling process. It is quite possible that a more experienced person could install the full 25 gallons per wing rated capacity. Dumping took a reasonable three minutes or so during our ground test.

The air was relatively still during the first day of our performance testing, and we were able to make four high tows to measure the DG-300's sink rates at various steady airspeeds. Mike Newgard and I each made a morning and an afternoon test flight, and those test data are shown in Figure 2. A well shaped polar is shown there with no drag knees indicated by those data. A minimum sink rate of about 119 feet per minute (.60 M/s) at 42 knots airspeed and an L/DMAx of about 38 at 47 knots are shown by this initial test data.

With parachute I weighed close to the DG-300's minimum allowable cockpit loading of 176 pounds (80 kg). Therefore my test data were taken while flying at near aft cg limit. On the other hand, Mike's 60 pounds' greater weight placed the cg close to forward limit. Data from the heavier flight were corrected by the square-root-of-the-weight-ratio method to my lighter flight gross weight. Note that the flight test sink rate data taken at forward cg location (Mike's flights 2 and 4) compare very well to those at aft cg condition (my flights 1 and 3). Only during Mike's last flight, and at airspeeds above 85 knots, did his measured sink rates slightly exceed mine. That last tow was made during the middle of the afternoon, and it is quite possible that he encountered some wing leading edge insect contamination (bugs) during his tow up through the convective surface layer.

The 38-to-l measured maximum glide ratio was about 10 per cent below that which the manufacturer claimed, and we looked for reasons for that discrepancy. The DG-300 wing lower surfaces are equipped with a single .55-inch (14-mm) inlet diameter ram air source pitot at about mid-span on each wing panel, near the aileron root leading edges. These pitot inlets lead to a single spanwise duct located inside each wing at about two-thirds chord aft of the leading edge, and running nearly the full length of each wing panel. About 900 hypodermic needle tubes of .024 inch diameter (.6 mm) installed through the bottom wing surface provide a path for the pitot pressurized duct air to blow very gently through flush outlets into the wing lower surface boundary layer. The theory is that the wing lower surface laminar flow needs to be forced into transition to normal turbulent flow at that chordwise point, and the small holes can do that with minimum drag losses.

Many modern highly laminar airfoils tend to suffer from laminar separation bubbles, which are spanwise vortices of initially laminar flow that distort the desired chordwise flow such that the bubble causes drag which is higher than turbulent air drag. The function of the DG-300's 900-odd blowholes is to reduce wing drag by forcing a transition of the lower surface airflow from laminar to turbulent at the optimum *x* .65 c chordwise hole location and with minimum drag losses.

Two test flights were made to test that theory, using the wing drag monitor probe described in Reference A. The first flight measured the DG-300 wing profile drag with the blow

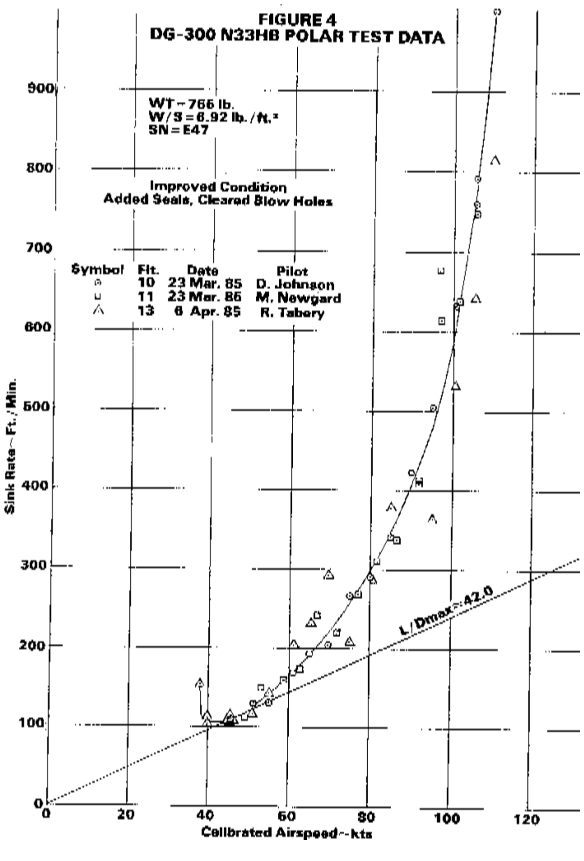
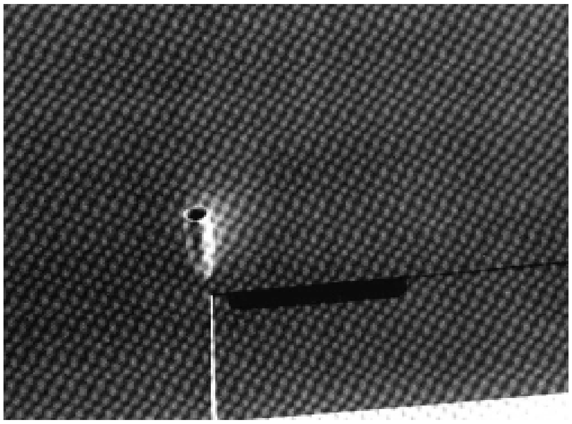


FIGURE 4
DG-300 N33HB POLAR TEST DATA



*Intake pitot under each wing feeds ram air to duct system: pressurized air is injected through hypodermic needles into boundary layer, controlling separation to reduce drag.*

hole system functioning normally, and the second with the inlet pitot sources taped shut, thus cutting off the supply of pressurized air to the blowholes. The wing section profile drag vs. airspeed values measured during those two flights are shown in Figure 3. Significantly, about one knot less indicated wing drag is shown at all airspeeds below 80 knots with the boundary layer control system operating. Above that airspeed the blow hole air appeared to have little effect on drag, and that is in agreement with wind tunnel data that indicates laminar separation bubbles are not a problem at the higher airspeeds (Reynolds number effect).

We were told that some DG-300 owners had found that a number of their wing blowholes were clogged, especially toward the wing tips. Speculation is that a final factory polishing of the wing may have clogged some of these very small pneumatic turbulator holes. We tested *each* of the 900 holes for flow rate by gently pressurizing the inlet pitots with regulated shop air and measuring the minute outflow at each hole. To do this we tested inside a closed hangar using a smoldering fireworks ignition punk held close to each hole being tested. A bright glow of the punk indicated good airflow, whereas a dull glow indicated a partially clogged tube and no glow indicated a fully clogged tube.

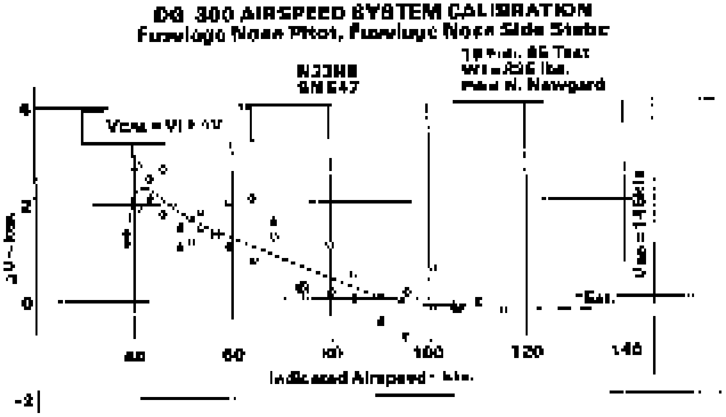
Of the 900-odd blowholes, we counted 105 as being partially or fully clogged. Most were toward the tips, and only one was found clogged near the Figure 3 drag probe test locations. We then cleared the clogged holes with a small piece of fine wire and repeated the punk test until all holes were cleared.

The cold air at our winter test altitudes had caused the canopy to shrink slightly during flight, allowing some air leakage at its aft joint near the wing root leading edge. Light insulation stripping (open cell foam) was installed along the canopy frame edges, and additional sealing of the under-seat tow release was accomplished before we began a second phase of performance testing.

Three additional high tow test flights were then made to re-test the DG-300 in its improved condition with the added seals and cleared flow holes. As Figure 4 shows, the data from those flights indicates a significant increase in performance. A minimum sink rate of about 106 feet per minute (.54 M/s) is now shown at 42 knots, and a splendid L/DMAX of about 42 at 48 knots was measured. No high drag knees are indicated by the test data, and the polar appears to have a smooth classical shape.

The wing panels are of fiberglass/epoxy with apparently no carbon fiber components. Each wing panel weighs about 152 pounds (69 kg), which is typical of modern fiberglass 15-meter wing panels and is a full load for two average people to handle. The wing surfaces had a faint fabric weave pattern visible principally on the lower surfaces, but that did not appear to be of sufficient magnitude to effect drag. Wing surfaces were quite smooth otherwise, with chordwise wave gauge measurements showing average peak-to-peak values of about .003 inches (.08 mm) on the top surfaces and .005 inches (.12 mm) on the bottom surfaces. The sailplane handbook lists the planform wing area as 110.5 square feet (10.27 M2), but our measurements indicated a slightly smaller 108.9 square feet (10.12 M2). Wing thickness-to-chord measurements showed about .176 near the wing roots, .1723 at the aileron roots and .1730 at the aileron tips. Those are fairly thick wing profiles and quite likely wing leading edge insect roughening will have a significant effect on the DG-300's performance. Lack of time precluded our performing a standard tape "bug" leading edge roughening test.

The airspeed system uses a fuselage nose pitot that is located inside the nose air vent inlet. Left and right side static vents are located on the lower fuselage nose, about 14.3 inches (360 mm) aft of the tip. A high tow was made by Mike to measure the DG-300 airspeed system errors, and those data are shown in Figure 5. Surprisingly little error is shown, considering that fuselage nose static sources generally are not noted for accuracy. About +2 knots error was shown in the 40 to 50 knot region, but at higher airspeeds the airspeed system errors approached a perfect zero!



The cockpit and control layout of the DG-300 is excellent in my opinion, and except for the added tail fin water ballast release lever on the right sidewall, it was essentially identical to the DG-101 reported in Reference B. The control stick is nicely mounted on a parallelogram linkage such that vertical accelerations on the pilot's arm do not tend to feed into the elevator control system. All the controls connect automatically upon assembly of the sailplane, and this provides excellent safety insurance! The cockpit controls are easily reached, and they function well with relatively little control system friction being apparent anywhere. I was told that early DG-300's suffered from excessive aileron control system friction, but that was not so with our new test sailplane.

The stall characteristics appear to be gentle, from both straight and turning flight conditions. There was no tendency to drop a wing during stall, and recovery was quick and positive in all cases. However, as with practically all modern sailplanes, almost no buffeting precedes a stall, only quietness and low response to control inputs. The airbrakes are relatively large Schempp-Hirth type top surface only devices that function well and cause a slight nose-down pitch change when opened. They are powerful enough to permit steep approaches when needed yet are easily operated from the cockpit.

As with the DG-101, the towhook is located on the bottom of the fuselage, only about three inches (76 mm) ahead of the main landing wheel. Because of that low and far-aft tow hook location, the DG-300 tends to pitch nose-up during aerotow takeoffs, at least when flown at aft cg as I flew it. Mike said it was not very noticeable with his more forward cg. To counter nose-up pitch, the handbook recommends initiating takeoff with the trim set to full nose-down, and that worked fairly well for me. The single Tohoku is intended for both winch and aerotow launches, but it does not provide very satisfactory characteristics for aerotowing because the low aft hook location causes an unwanted nose-up pitch that is proportional to towline tension. Hopefully a fuselage nose aerotow hook will be made available, and that should make aerotowing much easier and safer, especially for pilots of limited experience.

The thermaling characteristics of our test DG-300 appeared to be good, but not outstanding in our relatively weak winter thermals. Rolls from + 45 degrees to - 45 degrees could be performed in about 4.0 seconds when flying at 50 knots thermaling airspeed. Level flight stall speed was about 37 knots calibrated and indicated at my unballasted 765 pounds (347 kg) gross weight. That airspeed corresponds to a maximum lift coefficient of 1.50, which is quite good for an unflapped sailplane.

Overall the DG-300 appears to be an excellent modern sailplane with high performance and the capability of winning top Standard Class competitions. Its excellent performance, craftsmanship and attractive price will no doubt find a large niche in the American and world markets.

Thanks go to Holly and Travis Bailey for loaning their splendid new DG-300 for testing, and to Oliver Dyer-Bennet, Mike Newgard and Ron Tabery who assisted with the flight-testing. Also to Oliver and the Dallas Gliding Association who provided towing funds.

## REFERENCES

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B. Johnson, R.H., A Flight Test Evaluation of the DG-1 01”, *Soaring,* May 1985.