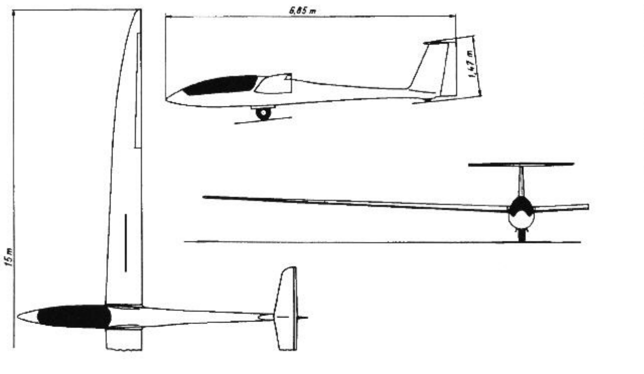
A FLIGHT TEST EVALUATION OF THE SZD-55-1

By Richard H. Johnson, Published in *Soaring* Magazine, March 1992

Perhaps the newest production Standard Class sailplane in the world, the Polish SZD-55-1 is a serious contender for the title of the world's best. It is a very modem high performance single-seat sailplane constructed of fiberglass/ epoxy composite, and its construction, workmanship and design details appear to be outstandingly good.



TECHNICAL DATA

Wing span		15 m
Length overal		6.85 m
Height overall		1.47 m
Wing area		9.6 m²
Aspect ratio		23.4
Empty weight		210 kg
Maximum weight including water ballast		500 kg
Design performance at		
wing loading:	31.25 kg/m²	50.5 kg/m²
Gliding ratio	43.0	44.1
at speed	88.4 km/h	119.4 km/h
Minimum rate of descent	0.54 m/s	0.68 m/s
at speed	79.4 km/h	100.4 km/h
Minimum airspeed	66 km/h	84 km/h
Never-exceed speed	250 km/h	250 km/h
g limits		+5.3/−2.65

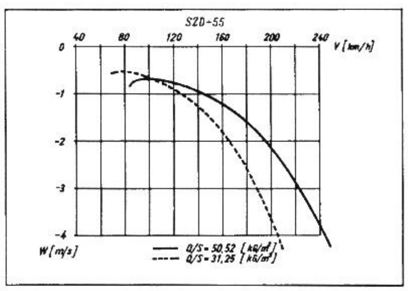


FIGURE 1.

The SZD-55-1 was first flown at Bielsko, Poland during mid-1988. Though widely flown and very successful in Europe during the last two years, it has only recently made its way to the U.S.A. The lure that first brought them here was the recent World Gliding Championships held at Uvalde, Texas last summer, where several European teams flew the SZD-55-1 in the Standard Class competition there. The Polish team pilot Janusz Trzeciak flying production serial numberl5 won the Championship's 11th day and ended up in a very commendable second placing overall.

The Polish registration of Trzeciak's sailplane was SP-3052. With the kind assistance of Ed Anderson and Lee Logan, I was permitted temporary custody of SN15 after the Championships, and relicensed that same sailplane as N3176T. The FAA review and experimental certification process involved a thorough inspection of the sailplane, and we were all impressed with the quality of the design and workmanship that we observed. As best we could determine, there were absolutely no wooden parts used in the sailplane's construction, which is unusual.

Also, considerable care had been taken to not waste weight where it was possible and to do so without sacrificing normal robustness. As a result, the sailplane is certified to JAR-22 semiacrobatic category, (loops, spins, half roll and split 5), yet its empty weight equipped with radio, instruments and battery is only about 478 pounds. That is remarkable considering that no carbon or other exotic fibers were used in its construction, just high strength glass fibers.

Another remarkable characteristic of the SZD-55 is the relatively small wing area of only 103.3 square feet. That small wing area, combined with its 15 meter span, results in an aspect ratio of 23.4, which is unusually high for a modem Standard Class sailplane.

Figure 1 includes a 3-view, technical data, and factory glide polars for both dry and ballasted weight conditions. The 210 kg empty weight shown there is 463 lb in English units, refreshingly low for a modeml5Msailplane. Each wing panel weighs only about 120 lbs. making assembly and handling unstressful.

N3176T's measured thickness-to-chord ratios averaged a nearly constant .1653 over the entire wingspan. Chordwise wave guage measurements showed remarkably low values of only about .002 inches peak-to-peak, except for the leftwing root lower surface where about .020 inches was measured at the spar region. That deformity disappeared within about 6 spanwise inches, and being close to the disturbed airflow of the wing root joint, it probably did not affect the sailplane's glide performance significantly.

The outboard 6 inches of the right wing's airbrake trailing edge protruded roughly .04 inches above the airfoil con-. tour. We could have corrected this, but did not, due to time constraints. Being an aft facing step, its importance was not nearly so great as if it had been a forward facing step, and it was located well aft of the wing span.

Darrel Watson made our initial test flights, towing to 9000 feet twice on November 24, 1991, in an attempt to measure N3176T's dry condition polar. Unfortunately, no usable data was obtained then because both the test atmosphere was not still enough, and our newly designed instrument panel vibrator performed erratically.

SZD-55-1 N3176T POLAR TEST DATA
CLEAN CONFIGURATION

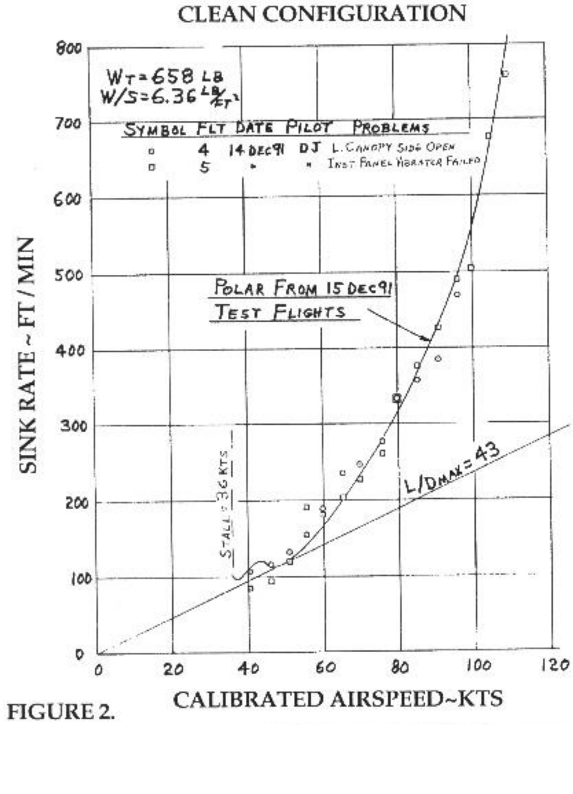
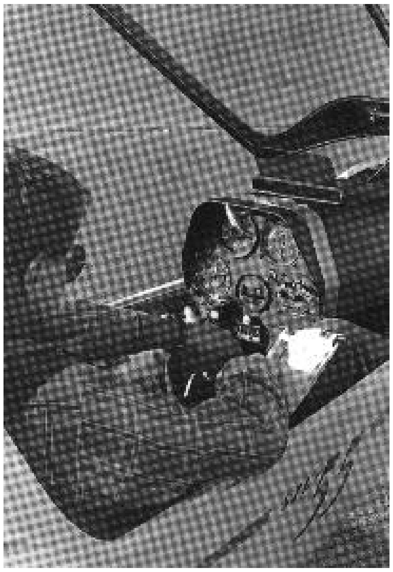


FIGURE 2.



A clear view of the instrument panel of the SZD-55-1 sailplane.

The air had calmed considerably on December 14th and I made two more high tows to measure the SZD-55's polar. Those data are shown in Figure 2. Those test data look fairly good, but they lacked full credibility because:

a. During the first flight, I failed to properly latch the left side of the canopy and its aft portion protruded about one-half inch during the test runs. (Being a forward hinged canopy, that error was not very hazardous in my opinion.) The instrument panel vibrator failed completely during the second flight and I had to resort to bumping the panel with my knees during most of the runs.

I repaired the vibrator and the following day everything went well. 3 tows to 10,000 feet were made in relatively calm Texas air. Those data are shown in Figure 3. There appears to be a slight higher-drag knee in the polar at about 43 kts. but all three flights showed an L/D of about 43, at 46 kts. Surprisingly, all three flights showed a sink rate of less than 100 fpm at 37.5 kts, which is only 1.5 kts above measured level flight stall at 36 kts.

During climb tests in weak winter thermals, the SZD-55's climb performance was excellent, as indicated by the Figure 3, level flight test data's low stall speed and sink rates at airspeeds below 53 kts. The sink rate polar deduced from the Figure 3 flight test data was added to the tainted Figure 2 data plot for comparisons and still a 43 L/D maximum glide ratio can be justified by the data points taken below 52 kts.

An airspeed system calibration flight was performed after a moderately high tow on December 8th, and those system error data points are shown in Figure 4. Less than 1 kt of airspeed system error is shown at airspeeds below 115 kts, and that is extraordinarily good, especially considering that fuselage nose side static sources were used (as required by the Flight Handbook).

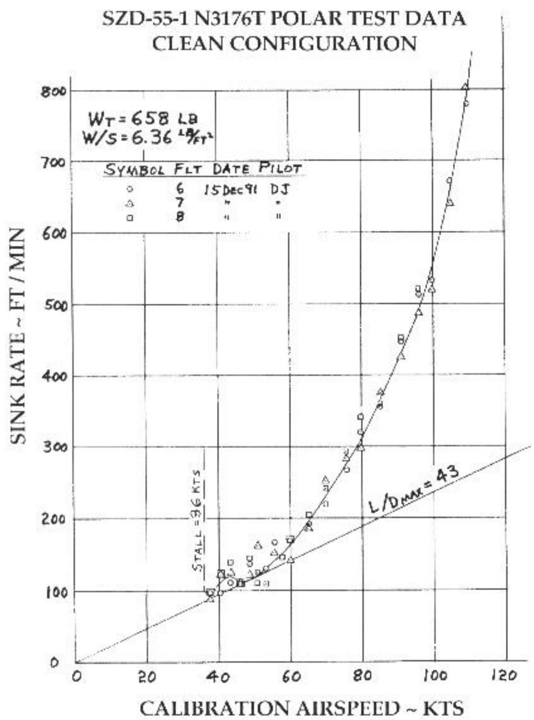


FIGURE 3.

To test the SZD's sensitivity to leading edge roughening, 20 duct tape simulated bugs were applied to each meter of the wing leading edges in our standard pattern. Two high tows were made to measure the sailplane sink rates thus encumbered. Ron Tabery made the first flight and Ken Jacobs the second. Ron said the planned 37.5 kt low speed test point was too close to stall and that 38 kts was as slow as he could measure data. Jacobs started his data run at 40.5 kts.

Their test sink rate data points are shown in Figure 5. The data indicates that the SZD-55 still attains a respectable glide ratio of about 36.4, or only about a 15% reduction in best glide angle. That is a relatively low wing roughness sensitivity because many modem sailplanes degrade by close to 25% with 20 "Bugs" per meter on the wing leading edges.

Next, the wing profile drag rake instrumentation system was installed to measure the wing airfoil drag characteristics. The SZD-55 is equipped with a new airfoil—designated NN-27—that was developed at the Warsaw Technical University by Jerzy Ostrowski especially for this sailplane. It appears to function well.

The wing drag rake was installed on N3176T's left wing trailing edge, 1.0 meters outboard from the wing root joint. Four moderately high tows were made to measure wing relative profile drag values, versus airspeed, for various wing surface configurations. Figure 6 shows the drag data measured with the 20 tape "Bugs" per meter on the wing leading edge, and compares those to the smooth clean wing configuration. When compared with the earlier sink rate measurements, the effect of the leading edge roughening was not very large, at least at airspeeds below 76 knots.

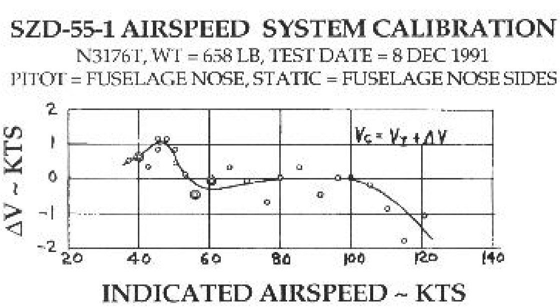
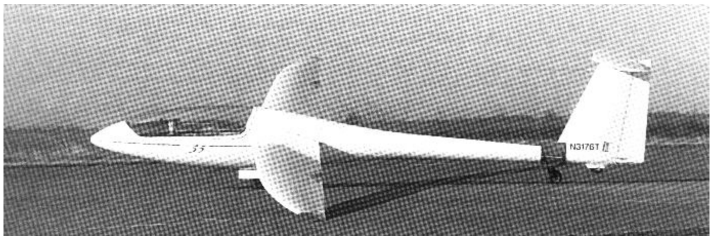


FIGURE 4.

Most modern sailplanes require turbulator strips on their lower wing surfaces to reduce drag created by unwanted airflow separation bubbles that often exist there. For that reason, wing drag measurements were made with a conventional dimpled turbulator strip attached to the wing lower surface at .70 chord aft of the leading edge, and at .60 chord on another flight. Figure 7 presents those data and compares them to the clean wing data. Note that only below 45 kts did the turbulators reduce the wing drag, and that above that airspeed they added an unacceptable amount of drag. Apparently, the NN-27 airfoil was cleverly optimized to function



The SZD-55-1 on the runway ready for testing.

well without turbulators.

Besides its graceful lines, the most striking feature of the SZD-55 is its elliptical wing leading edge planform combined with its completely straight trailing edge. In my opinion, its stall characteristics are about equal to those of the Ventus and other modem high performance sailplanes that I have flown. Perhaps a half knot of stall warning buffet before a moderate roll-off to the left or right, with quick recovery through forward stick. The nose has to be quite high to effect a stall unless significant uncoordinated rudder is applied.

The SZD-55 is nicely coordinated and stable with excellent pitch and yaw control, and stability. It handled so well that I had planned to do some long unpracticed spins when the opportunity arose. However, N3176T left for its new home in South Carolina before I could accomplish that.

45- degree-to-45 degree rolls required about 4.5 seconds to perform at 50 kts dry, and there was plenty of rudder control to keep the yaw string centered. However, roll control during the early part of crosswind takeoffs is somewhat marginal until the tail can be lifted. As with most Standard Class sailplanes, this is because the SZD's wing incidence angle has been optimized for cruise flight, and therefore the tail down early takeoff roll attitude places the wing at too high an angle of attack for good roll control.

The Flight Handbook suggests using partially open airbrake to alleviate that problem, but I could see little improvement through that technique. As soon as the tail can be raised strong roll control is available. Even if the wing tip does scrape, the down deflected aileron near the runway appears to have a strong ground effect lifting force and the wing is soon lifted. We did not encounter any yawing problems during the few light tip scrapes that we encountered because good rudder control was available, and because the SZD's large pneumatic tail wheel kept the sailplane on a straight track. The aileron tips are far enough inboard to protect them from scraping. The main landing wheel has a generously sized 5 X 5 inch hub that supports a 14 inch diameter tire. In addition, the wheel is supported almost a full diameter below the fuselage when extended, thus providing excellent ground clearance. The wheel is equipped with a drum brake that is mechanically actuated through a squeeze grip on the airbrake actuation handle. Its effectiveness appeared to be moderate, and not being new it likely needed some adjustment.

SZD-55-1 N3176T POLAR TEST DATA
20 BUGS/METER ON WING LEADING EDGES

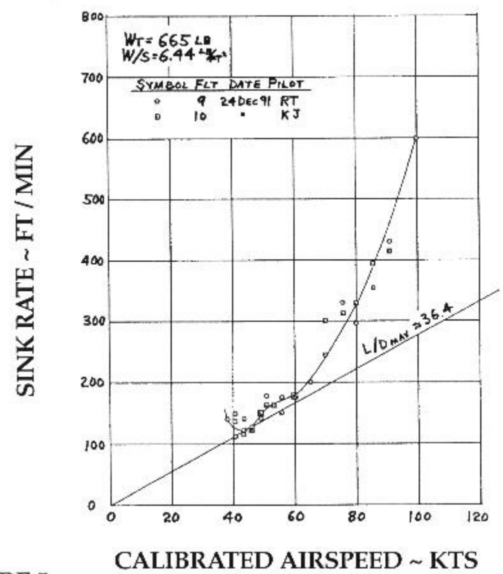


FIGURE 5.

The SZD-55 carries three water ballast tanks, totaling about 51.6 U.S. gallons. Large ones in each wing leading edge reportedly hold close to 24.5 U.S. gallons. and a tail tank with 2.5 gallon capacity is provided for maintaining ballasted C.G.'s in optimum position. A single cockpit control knob mechanically opens the dump valves of all three ballast tanks simultaneously. We did not fill test or flight test the water ballast system, but the system appears to be well designed. The two underwing dump valves are of relatively large diameter and are sealed by easily accessible "0" rings. The Handbook states a relatively short 3.5 minute dump time for a full ballast load. The wing tanks are integral types and appear to be provided with internal baffles to limit ballast shifting when partial water ballast is carried.

The top-surface-only airbrakes are generously sized dual plated Schempp Hirth type devices that perform well. Their effectiveness is relatively high, and full deployment provides steeper than usual descent angles. The airbrakes and all other controls connect automatically upon assembly, as they should.

The inside of the cockpit is about 23 inches (584 mm) which is adequate for almost all pilots. In-flight adjustable rudder pedals shifts over a 7.4 inch (188 mm) range. The seatback base is ground adjustable over a 5.5 inch (140 mm) range, and it also adjusts in tilt over approximately a 27 degree range. If needed, the seatback can be removed easily to accommodate extraordinarily tall pilots. There appears to be adequate cockpit room for large pilots and placards permit cockpit weights from 132 lbs (60 kg) to 242.5 lbs (110 kg).

SZD-55-1 INDICATED WING PROFILE DRAG
PROBE LOCATION = 1.00 M OUT FROM L. WING ROOT
PROBE HEIGHT = ±21.2 MM (± .0265 c) 24 DEC 91 TESTS

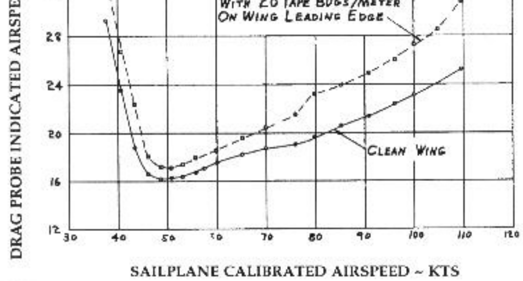


FIGURE 6.

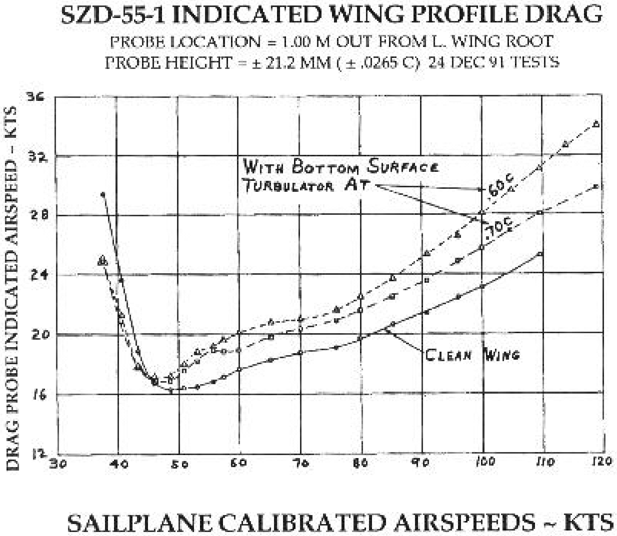
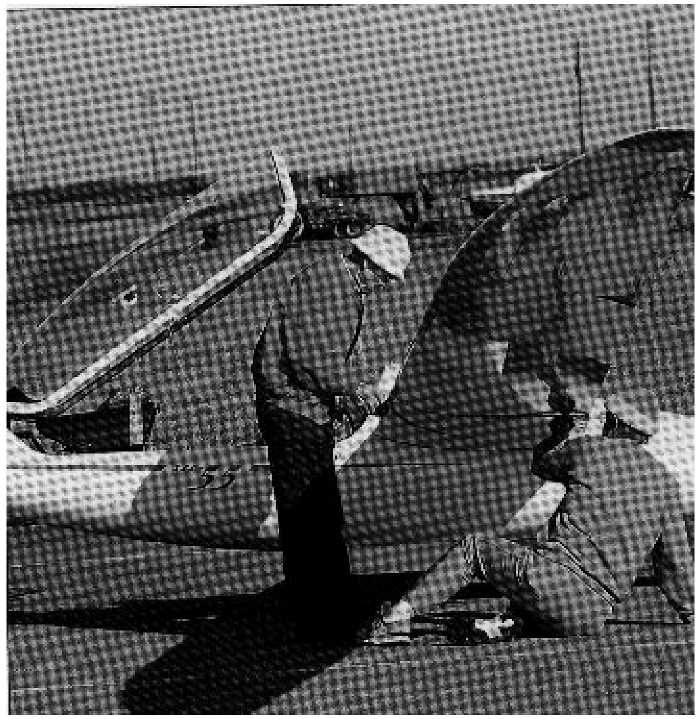


FIGURE 7.



Richard Johnson (at left) stands beside canopy of the SZD-55-1 sailplane.

Overall the SZD-55-1 appears to be one of the best new sailplane designs to emerge in recent years. Its construction and improved VORGELAT T-35 gel coat finish is beautifully applied. The SZD factory can be justifiably proud of their latest production model, and likely a long series of that model will be produced for world-wide use.

Thanks again go to the Dallas Gliding Association and its members for providing the high tows needed for this flight testing, and especially to tow pilot Ted Hunt who patiently performed most of the long tows. Also to Ed Anderson and Lee Logan who kindly loaned the use of their fine new sailplane.