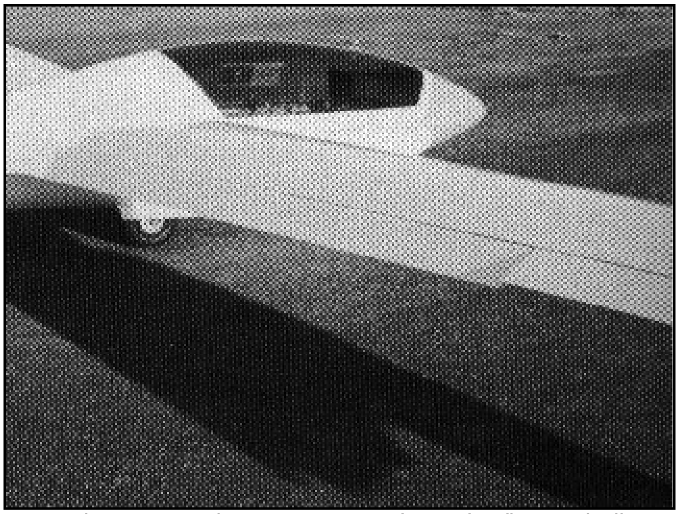
A FLIGHT TEST EVALUATION OF THE LS-3A

By Richard H. Johnson, published in *Soaring* Magazine, February, 1980

The LS-3A is Rolladen-Schneider's newest model of the previously reported 15-Meter Class LS-3 sailplane which showed an outstandingly high performance 41.8 L/D_{max} polar during flight testing *(Soaring,* November '78). The LS-3A first appeared in competitions during the summer 1978 season, and it was reported to be significantly lighter in weight than its predecessor but of equal performance.



LS-3A has returned to separate surfaces for flap and aileron. Flap is in +20° landing position here.

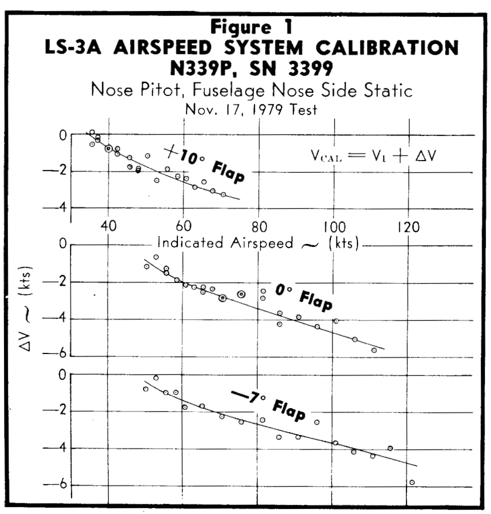
The principal change included in the LS-3A is the configuration of the wing trailing edge control surface. The LS-3 used one-piece flaperon control surfaces where the aileron and wing flap functions were combined into single long flap-aileron surfaces extending all the way from the fuselage sides to the wingtips. These were driven only at the fuselage end, and their flexibility required close to 23 pounds of lead to be attached to each flaperon leading edge to prevent flutter.

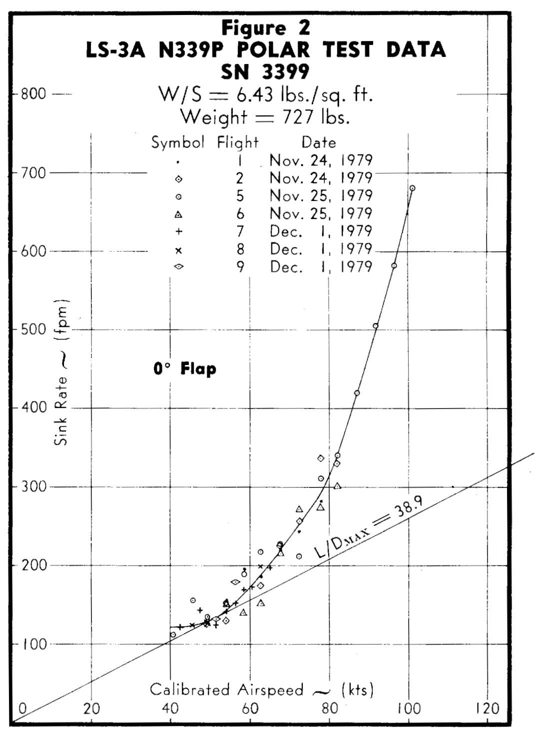
The LS-3A's big improvement was to eliminate the heavy flaperon counterbalance weights. This was done by dividing the long single-piece flap-aileron surfaces into separate conventional flap and aileron surfaces and driving the ailerons by separate control cranks located well outboard at the aileron surfaces. This greatly stiffened the wing control surface systems and apparently negated the need for the extensive mass balancing. A smaller change was a 4-inch increase in height of the vertical tail and span of the horizontal tail for improved pitch and yaw stability and control.

Bob Parker of Dallas graciously offered his new LS-3A for flight testing, and when it arrived during the fall of 1979, it was quickly put to use for flight test measurements. It was beautifully finished with all details showing top craftsmanship. The wings were well smoothed, with wave gage chordwise measurements showing about .002 to .003-inch maximum peak-to-peak waves on the bottom surfaces, and .003 to .004 inches on the top surfaces. Excellent factory seals were included at the flap-to-fuselage junctures and along the hinge lines of all the control surfaces. Small gaps did exist between the outboard ends of the wing flap surfaces and the inboard ends of the aileron surfaces. I filled these with light foam plastic weatherstrip material to ensure maximum possible performance.

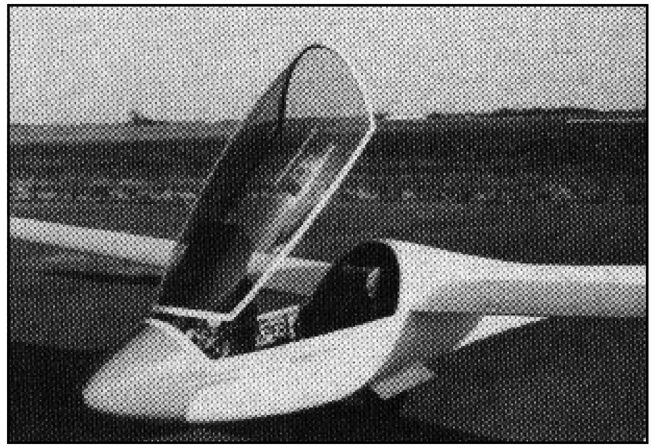
Clouds and winds made weather conditions unsuitable for sink-rate testing during the initial weekend, but they were good enough for the airspeed system calibration flight. Figure 1 shows the test date from that flight for calibrations with +10°, 0°, and –7° flap settings. The measured airspeed system errors are within about 1 knot of those measured with the earlier LS-3 and are typical of those of other sailplanes with fuselage nose side static sources. At indicated airspeeds above about 40 knots, the calibrated airspeed is increasingly less than indicated, with about 5 knots error measured at 120 knots with the –7° flap setting.

The weather improved during the following weekend and flight testing to measure the LS-3A sink rate polars began in earnest. Three high tows were made on both Saturday and Sunday, and an additional three were flown during the following Saturday. A total of nine high tows were made to measure polars with the wing flaps set at their 0°, -7° and +10° positions.

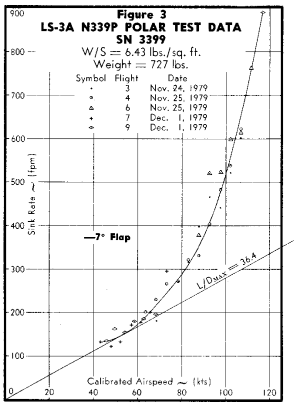


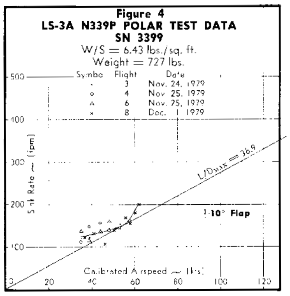


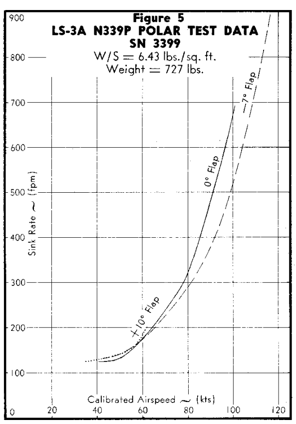
Dick examines the '3A's slightly larger tail surface.

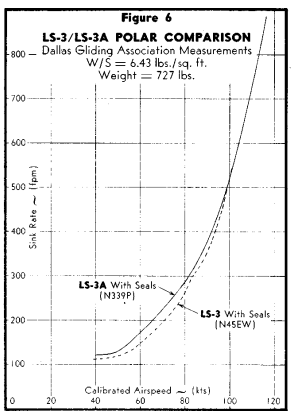


"The gas-spring-supported, forward-hinged canopy and its sealing and latching are superb". Dick reports.









The sink rate data measured during those nine flights are shown in Figures 2 through 4.

Figure 2 shows the 0° flap setting test data, where the best maximum L/D should be achieved. These data indicate a maximum L/D of about 38.9 which is good but well below that measured with the earlier model LS-3 with sealed flaperon roots. Figure 3 presents the measured LS-3A sink rate data with full negative –7° flap setting. An L/D_{max} of 36.4 is indicated, and the high-speed sink rates are significantly better than with the 0° flap setting.

The +10° thermaling flap setting data are shown in Figure 4. Here an L/D_{max} of about 36.9 is achieved as well as a minimum sink rate of about 122 fpm at 35 knots. Although the test LS-3A was about 48 pounds lighter than the earlier tested LS-3, its minimum sink rate is about 5 percent higher. Subsequent flight comparisons while flying in weak winter thermals showed the LS-3A to have good climb performance, but not quite the outstanding capability shown by the earlier LS-3.

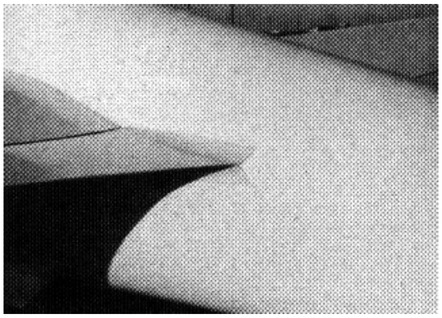
Figure 5 presents the measured LS-3A polars on a single plot, less the test data points. This plot gives a clear indication asto, which of the three test flap settings is optimum at various airspeeds. Above 60 knots the -7° should be used, and 0° should be best at lower speeds except when thermaling. Minimum sink rate is not achieved with the +10° flap setting, but its lowered minimum airspeeds provide tighter circling radii.

Figure 6 compares the optimum flap setting polar measured with the new LS-3A to that of the previously measured LS-3. The LS-3 was about 48 pounds heavier, so its polar was corrected by the square root of the weight ratio factor so as to present both polars at the LS-3A's wing loading. The measured wing areas were essentially identical at 113 sq. ft. As Figure 6 shows, the LS-3 was significantly better in performance at airspeeds below 98 knots.

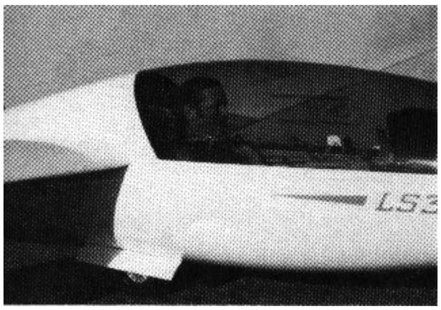
The reason for the LS-3A's higher indicated drag values is not obvious. Its wing smoothness and other configuration details appear to be excellent. The tail size increase should have a relatively small polar performance penalty because only a small increase in total wetted area is involved. The LS-3A's test center of gravity was near its aft limit, so trim drag could not be the culprit. Even the total energy venturi was removed from the LS-3A before the tests.

The cockpit of the LS-3A is excellent. The gas-spring-supported, forward-hinged canopy is superb, as is its sealing and latching. The cam-operated, left-side-mounted landing gear lever is the best of any sailplane I have ever flown, being easy to operate and positive in action. The aileron controls are fantastically light and pleasant to operate. The elevator control forces are light and pitch response characteristics could hardly be better. An adequately sized fixed horizontal stabilizer is used along with a conventional moveable trailing edge elevator surface.

The wing flap control system is slightly improved over that of the LS-3 by intermediate flap setting handle

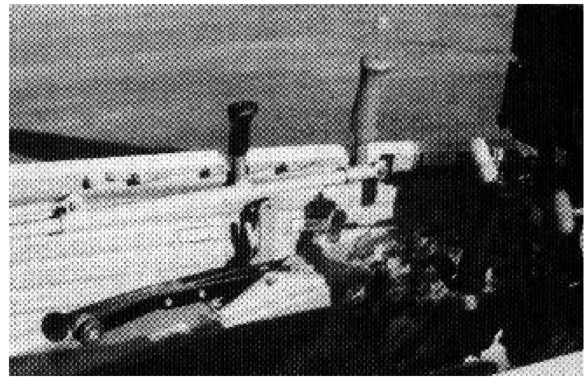


Flap-root seals are factory installed.



There is ample cockpit room. (note clearance about Dick's head)

notches, but it still leaves much to be desired. The flap control push-pull tube is still concentric with the airbrake control push-pull tube, and the flap control handle is immediately aft of the airbrake handle when the flap is in its -7° high-speed setting (see photo). Even though the handbook placards prohibit deflecting the flaps to positive settings at high airspeeds, there is no way to avoid this. Pulling the airbrake handle aft to open the airbrakes automatically forces the flap handle aft, thereby deflecting the wing flaps to positive settings.



Cockpit views: The landing-gear lever is "the best I've ever flown," says Dick Johnson. But the concentric-tube mounting of the flap (black) and airbrake (gray) handles "still leave much to be desired." Trim handle is just below flap handle.

Except for the above flap control interference problem, the airbrake system is powerful and quite adequate. Double air-brake plates extend above each wing, creating high drag forces. This system is unchanged from the LS-3. The excellent wheel brake system is also unchanged, with positive braking achieved by pressing forward on both rudder pedal heels simultaneously.

The LS-3As roll rate is very good and about equal to that of the older model. The +45° degree to -45° degree rolls required about 45 seconds when flying at 45 knots with +10° thermaling flap setting. Good stall characteristics were exhibited in both straight and turning flight.

The wing panels weigh roughly 148 pounds each, and they are relatively easy to handle during assembly. Water ballast bags capable of holding about 20 U.S. gallons are installed in each wing panel leading edge. A maximum takeoff gross weight of 1041 pounds is permitted, which brings the ballasted wing loading to about 9.2 lbs./sq. ft.

Wing panel thickness and chord measurements showed the max. root thickness-to-chord ratio to be .172. At the inboard end of the ailerons .170 t/c_{max} was measured and near the wingtips the figures showed .155 t/c_{max}. The tip and midwing thickness-to-chord measured values are almost exactly the same as those measured with the test LS-3. However, the root ends of the LS-3A wings measured almost 6mm (.23") thicker than those of the flight-tested LS-3.

The slightly thickened wing roots may be the cause of the LS-3A's higher drag. Thickness itself, in moderation, does not increase drag significantly. However, if it is done indiscriminately such as through warped or deformed wing molds, then the drag penalty can be large. (More on this subject will be published soon, detailing large performance gains achieved by correcting the poorly formed wing profiles of a PIK-20B sailplane.)

Caution should be exercised in assuming that all LS-3A's have the same performance polars as the one measured here. I understand that at least two sets of wing molds exist for the LS-3A's, and it is quite possible that these molds differ enough to cause performance differences. Also, manufacturing techniques can cause changes in wing profiles, especially if the wing molds lack sufficient rigidity.

In summary, the new LS-3A is a beautifully built sailplane with many excellent features. Good performance combined with fine control, handling, and stability characteristics make a real pleasure to fly.

Many thanks go to Bob Parker for both making the LS-3A available for testing and for piloting the towplane on many of the high flights. Also to the Dallas Glider Association for providing the tow funding, Skip Epp who provided the photos, and to others who kindly assisted with the testing activities.

**When apprised of the results of Dick Johnson's flight test on the LS-3A, a spokesman for Rolla den-Schneider (the sailplane manufacturer) expressed surprise at Dick's findings. "Akaflieg Braunschweig flight tests using a calibrated test vehicle for comparison showed a max LID of 41, whereas 38.9 was the best measured by Johnson," he said. "This spread is felt to be excessive by Wolfe Lemke and Walter Schneider, the '3A's designers. As a result, they will come by Dallas on their way to the Seattle Convention to* see *if they* *can ascertain the problem. If the difficulty is found to be in the aircraft rather than testing procedures, they will make corrections."*

The spokesman discounted aging or warped wing molds as a source of the problem, saying his own LS-3D had been made from the same molds later in the production run and had been measured at "better than 41."

As he has in the past, Dick points out that LID ratio differences can occur between different aircraft of the same model, and states that he and the Dallas Gliding Association have, and will continue to make further tests of sailplanes where this condition is suspected. A second test (of the spokesman's LS-3A) is scheduled for the near future.