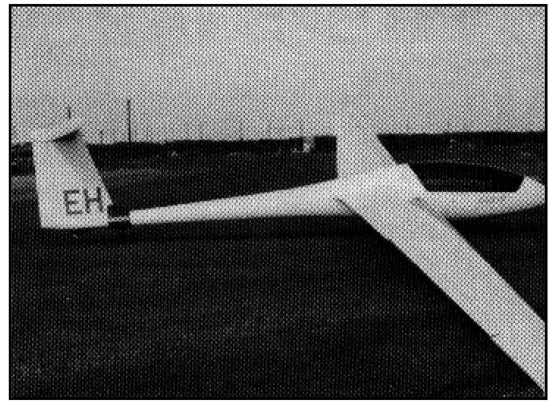
A FLIGHT TEST EVALUATION OF THE LS-3/17

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



The LS-3/17 is Rolladen-Schneider's new alternate version of their well-known 15-Meter Class high-performance LS-3 sailplane, where interchangeable wingtips provide either 15 or 17-meter wing configurations. This is an attractive option because a single sailplane may then be used as either a 15-Meter racer or high-performance Open Class machine. With the short wings the sailplane becomes an LS-3A and with the long wingtips installed it is designated an LS-3/17 sailplane.

This is not a new concept, but it is an increasingly attractive one because, for relatively little additional expense, one can enjoy flying essentially two separate sailplanes. The extended wingtips reduce minimum sinking rate and significantly improve maximum glide ratio. This permits the sailplane to successfully operate in weaker and more difficult soaring environments such as winter and early or late season conditions. With the short wingtips in place, the sailplane then qualifies for the popular 15-Meter Class competition flying, which generally occurs only during the summertime when thermals are stronger.

Wolf Lemke, the designer, tells me that the basic LS-3/17 wing panels are being offered in either a light or heavy-spar version. The light-spar model uses the LS-3A wing spar, so there is almost no weight penalty when flying with the short wingtips. Adding the long tips to the light wing naturally increases the spar stresses. Therefore this version is not permitted to carry water ballast and is restricted to an 11-knot lower placard maximum airspeed (135 knots) than the LS-3A. With the optional heavier spar, a weight penalty is incurred when flying the 15-meter version, but carrying water ballast is permissible with either the short or long wingtips.

Horst Eschenberg had recently taken delivery of a light-spar version when he called to kindly offer it for flight testing.

When it arrived at Caddo Mills, we immediately proceeded with flight test planning for it. Since the earlier LS-3A flight test of N339P (Reference 1) showed somewhat less-than-expected performance, it was decided to test Horst's new LS-3/17 in both 15 and 17-meter configurations. Both their 15-meter wing panels were assembled in the same molds; this was a good opportunity to observe how close their polars might measure during actual testing comparisons. The only physical exterior difference between the LS-3A and the LS-3/17 in its 15-meter configuration is one extra chordwise taped joint for the newer model. The joint is approximately four inches from each wingtip.

An airspeed system calibration flight in the 15-meter configuration showed that the measured airspeed errors were essentially identical to those of the earlier LS-3A (N339P, Reference 1). A total of eleven test flights were made with the LS-3/17 in its 15-meter configuration. Of these, two were made with its wing leading edges roughened by our 20 tape "bugs" per meter span to test its performance sensitivity to insect impact roughening. Two flights were made with 250 pounds of water ballast aboard to test performance at the higher Reynolds Numbers. Some airfoils show a quite measurable drag reduction when flying at higher airspeeds, and the installation of ballast causes the sailplane to fly faster at best L/D and all other given angles of attack. Seven flights were performed clean and unballasted in the 15-meter configuration.

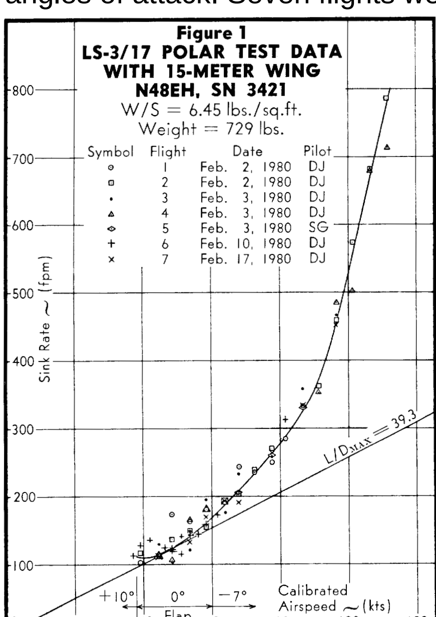


Figure 1
LS-3/17 POLAR TEST DATA WITH 15-METER WING N48EH, SN 3421

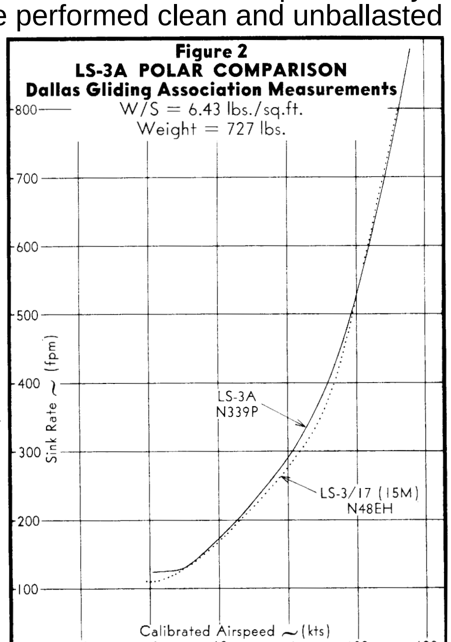


Figure 2
LS-3A POLAR COMPARISON
Dallas Gliding Association Measurements

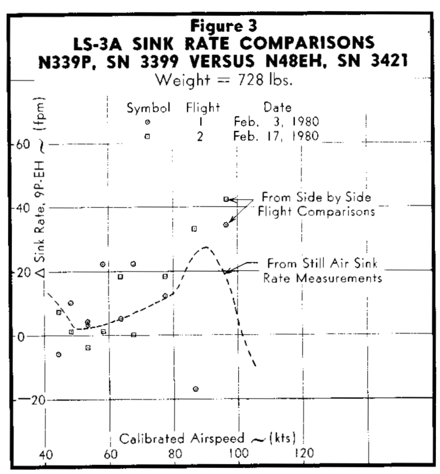
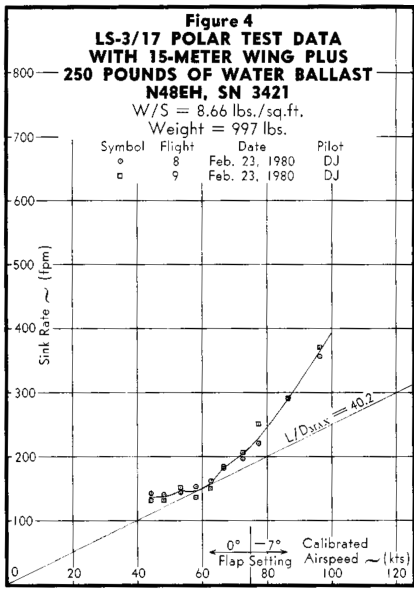
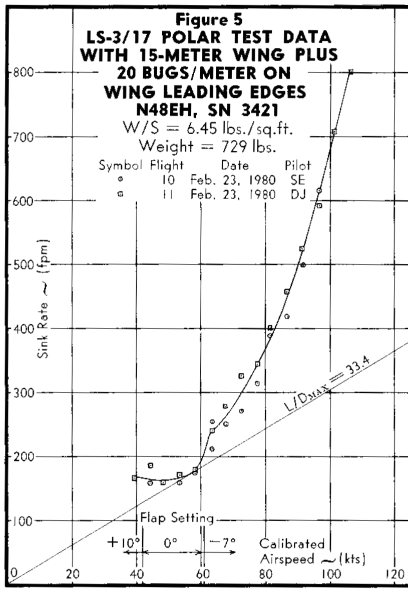
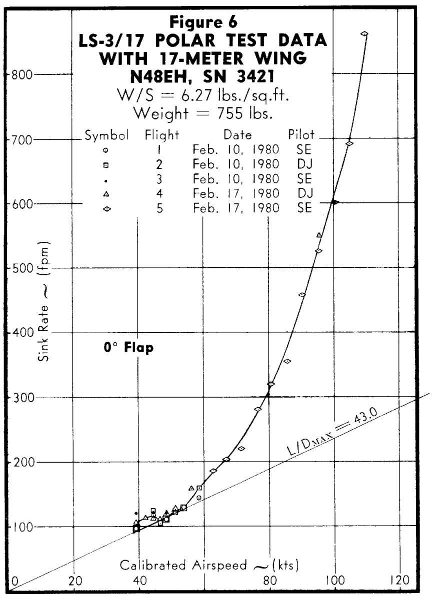
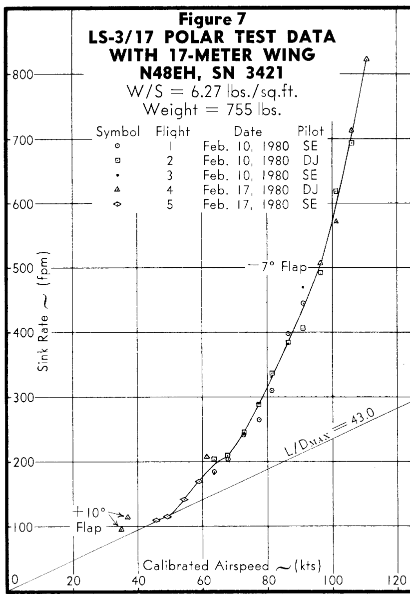


Figure 3
LS-3A SINK RATE COMPARISONS N339P, SN 3399 VERSUS N48EH, SN 3421





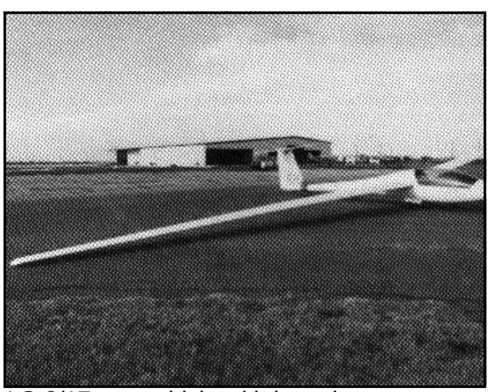




The 15-meter, clean, unballasted sink-rate data are shown in Figure 1. An L/D_{max} of about 39.3 is indicated, and this is about one percent better than the 38.g measured earlier with N339P. Throughout the 70 to 95-knot region, Horst's newer LS-3/17 (1 Sm) showed roughly 4 to 5 percent less sink rate than N339P. These differences were further confirmed by double-towing both sailplanes to 10,000 feet altitude and comparing their sink rates while flying side-by-side in smooth air. Figure 2 compares the single sailplane still-air measured polars for the two sailplanes; Figure 3 shows the side-by-side flight test comparison measurement data.

There is no obvious reason why one LS-3A should measure better than the other. If anything, Bob Parker's N339P was slightly cleaner because it lacked the extra taped joints near the LS-3/17's wingtips. Caliper measurements of the wings, fuselages, and tails indicated they were of the same dimensions to within one-millimeter (.04 inches). Both were identically well sealed and surface finished. Wave-gauge measurements of the wing surfaces of Horst's N48EH showed average upper surface peak values of about .0035 inches, and .003 inches peak-to-peak for the lower wing surfaces. Parker's N339P wings showed equal or slightly lower waviness values. The tail-fin-mounted total-energy venturi was removed during all of N339P's test flights, but it was installed during some of N48EH's tests.

Flights 3, 4, and 5 shown in Figure 1 had the venturi installed, whereas 1, 2, 6, and 7 had it removed. The added drag of the standard German Braunschweiger Duse venturi did not appear to have a discernible effect upon the measured sink rates for N48EH. It is quite likely that small differences in the wing profiles are causing the differences shown between the two sailplanes' polar measurements. Very little profile deviation can cause laminar separation bubbles and! or other drag-producing phenomena. Full-scale wing templates would be needed to check this, but fabricating these required more time and effort than we could afford for the project at that time.

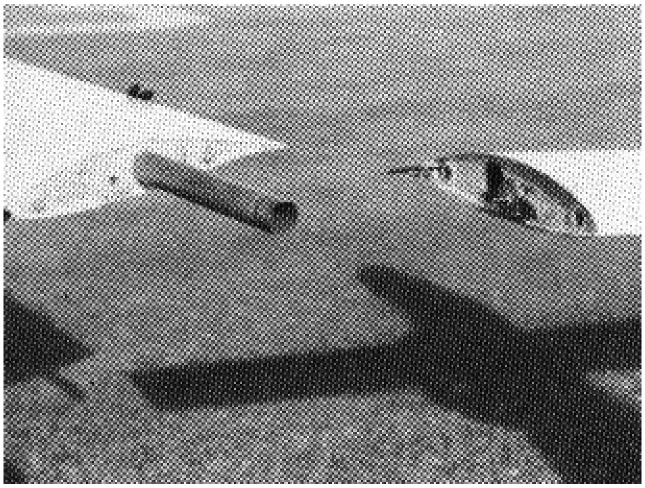


LS-3/17 test vehicle with long tips.

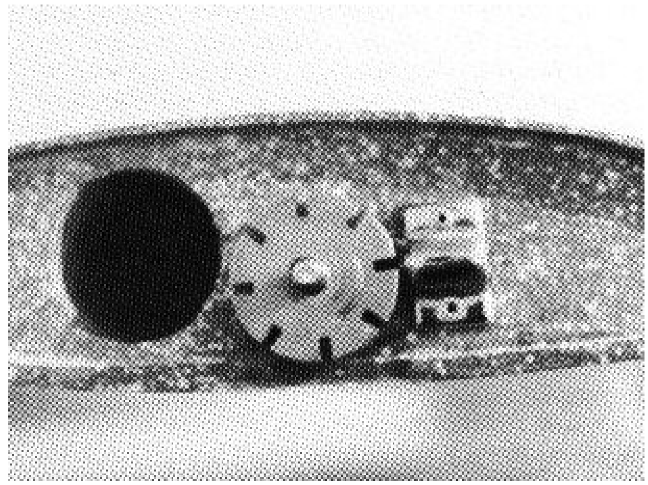
Wolf Lemke requested that we test the LS-3/17 (15m) performance with water ballast to measure possible performance improvements associated with the higher Reynolds Number airflows. The second and third test weekends were too cold to permit carrying of water ballast without adding an anti-freeze, but the fourth weekend was finally warm enough. Thirty gallons (approx. 250 pounds) of water were loaded into the wing ballast tanks, and two more high tows were made to measure the ballasted sink rates. The data from these two flights are shown in Figure 4. Though two flights are not enough to define the polar with a very high confidence level, these data do indicate an L/D_{max} of about 40.2 was achieved, which is roughly a 2.2 percent improvement over the unballasted polar.

To further test the 15-meter wing's airfoil performance, two flights were dedicated to measuring sink rates with the wing leading edges roughened by imitation tape bugs attached in our standard 20-meter pattern.

And now, the tip extender: *The concept of increasing wingspan with tip extensions is not new, but it has recently become a viable option on production sailplanes. "For very little additional expense," observes Dick Johnson, "one can enjoy flying essentially two separate sailplanes." Skip Epp's accompanying photos detail the arrangement on the LS-3/17 test vehicle.*



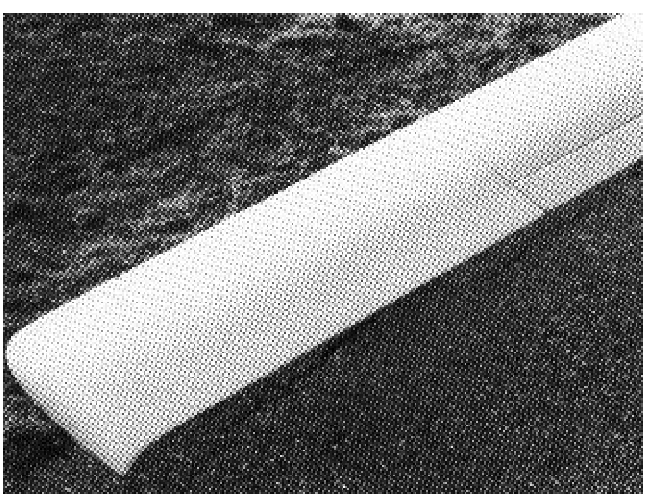
Long tip spar carry-through tube about to be inserted into inner-panel tip socket.



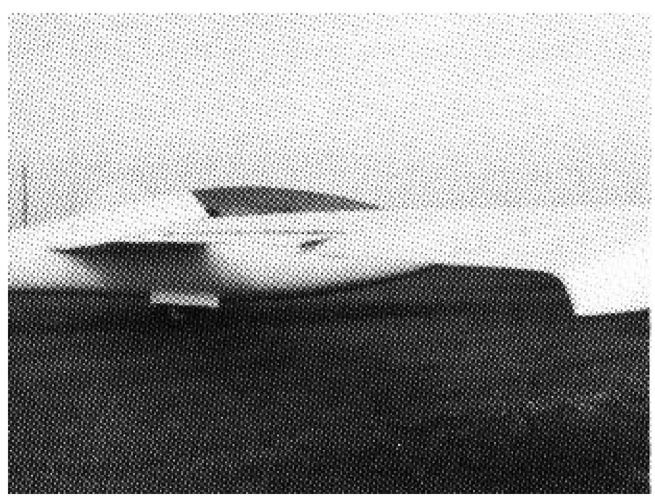
Threaded stud wheel-tip retainer with spring back detent lock.

Attaching long tip.

Turning threaded stud tip retainer wheel.



Long tip installed; zero flap setting.

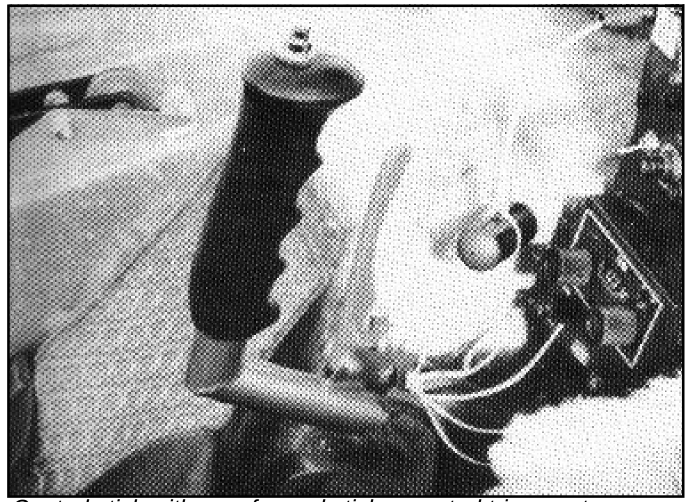


Flap cum aileron at -7° setting. Tip extension is without control surface.

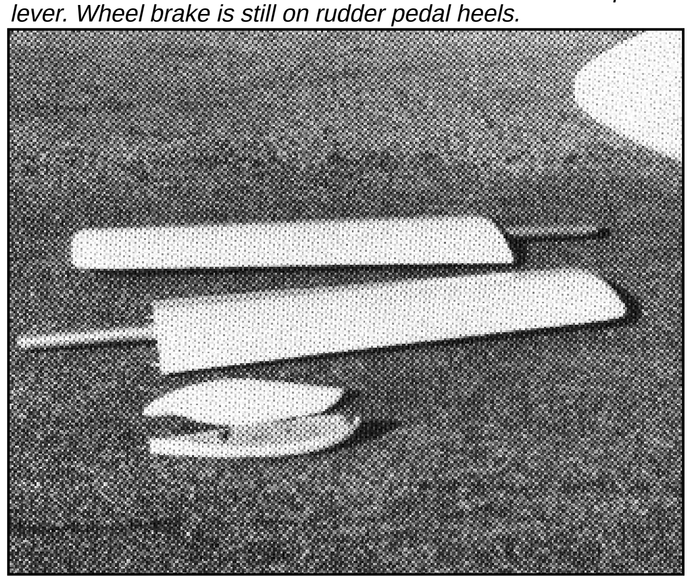
These test data are given in Figure 5. The L/D_{max} is about 33.4 at 57 knots with roughened wings, which is 15 percent less than that shown in Figure 1 for the smooth 15-meter wing. At 80 knots the bug roughening increased the LS-3A's sink rate by about 32 percent, which is a relatively large performance penalty. It appears that the hook in the sink rate polar at 63 knots was caused by changing from 0° flap to -7° at too low an airspeed. Without bugs the best flap setting for 63 knots appeared to be -7°, but with the roughened leading edges, lower drag could have likely been achieved with 0° flap. When changing from 0° to -7° flap (the next flap-handle notch), the sailplane's angle of attack must be increased to maintain lift, and that apparently causes the effects of the bug roughness to be more severe.

In the 17-meter span configuration five test flights were flown with the long wingtips installed. The sink-rate data measured with 0° flap setting are shown in Figure 6. A best L/D of 43 is shown at 48 knots, and a low 105 fpm minimum sink rate occurred at 39 knots. The test data show an unusual upward bulge in the polar at 42 and 44 knots. This indicates increased drag in that region that is probably caused by airflow changes over the wing surfaces at those airspeeds.

The LS-3/17's flight handbook prohibits the use of negative flap settings with the light-spar version of the sailplane in its long 17-meter wingspan configuration. This may seem to be an unreasonable restriction to the sailplane's operation. However, when one understands that the 1.1-meter wingtip extensions are fixed cambered surfaces having no aileron movable portions (see photos), it becomes clear that the tip portions may carry disproportionally large airloadings when negative flap/aileron settings are used. The ailerons raise and lower on a one-to-one basis over the +10° to -7-degree flap travel range, just as with the earlier reported LS-3A model.



Control stick with new formed stick-mounted trim reset squeeze lever. Wheel brake is still on rudder pedal heels.



Tip kit includes 17-meter extensions and 15-meter tip trimmers.

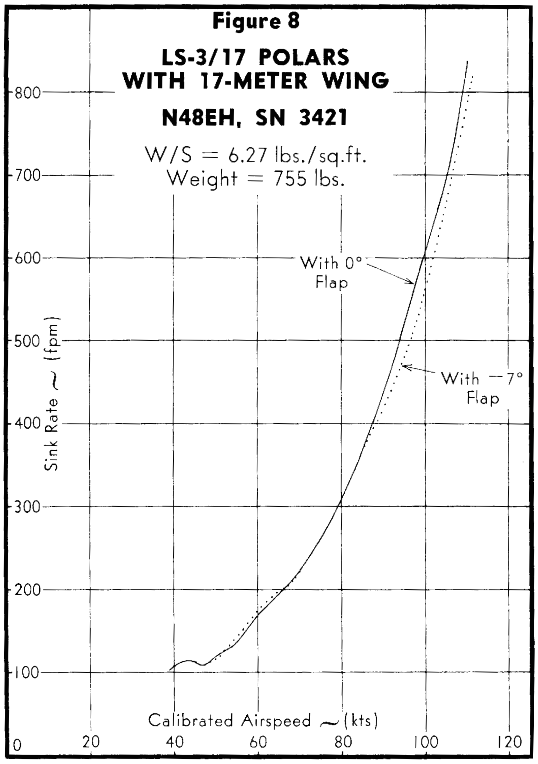
Since our performance testing was confined to smooth-air operations, we decided that a limited amount of long-wing testing should be performed with the LS-3/17 flaps set to the full negative -7° flap position. It is very probable that the heavy-spar version will not be placarded against the use of negative flap settings, so it would be useful to make those measurements. High-speed flight with the full -7° flap setting caused the LS-3/17's wingtips to bend upward significantly, therefore we limited our testing to 111 knots calibrated airspeed. With the flaps set to 0°, less wing bending was apparent and full 135 knots indicated airspeeds are permissible (about 129 knots calibrated).

Figure 7 presents the -7° flap sink-rate test data for the 17-meter wingspan configuration. An L/D_{max} of about 43 is shown at 48 knots, but the high airspeed sink rates are only slightly improved over those measured with the 0-degree flap setting. Figure 8 compares these two polars. The reason that such little performance improvement is achieved by the use of negative flap at high airspeeds is that the highly-cambered wingtip extensions are lifting much harder than they should, thereby causing added induced and profile drag. An obvious improvement all around would be to extend the wing ailerons out through the long wingtips. This would reduce wing bending and drag at high airspeeds and also improve roll control.

Even with the no-aileron long wingtips attached, the LS-3/ 17's roll rate was a respectable 6 seconds for 45-to-45 degree rolls at 45 knots with + 10° thermaling flap setting. With the short tips, the 15-meter configuration rolls measured 5 seconds at the same 45-knot airspeed and + 10° flap setting.

Only two sink-rate data points were measured with the +10° flap setting in the 17-meter configuration, and these are included in Figure 7. A minimum sink rate of about 95-fpm is shown at 35 knots, and this provides the LS-3/17 with remarkably good climb performance in weak conditions. I did not find an opportunity to thermal the long-wing configuration, but several others did. Marion Griffith observed that it climbed right with his unballasted Nimbus I in the weak winter thermals at Caddo Mills.

An improvement included in the new LS-3 models is that the elevator trim adjust handle has been moved to the forward side of the control stick (see photo). It looks just like a normal squeeze-type wheel brake



handle. However, it functions the same as the Kestrel and Libelle top stick-mounted trim-reset button. Pressing the squeeze handle allows the trim spring to release, and releasing allows the elevator trim spring to be engaged in the desired new position. It is a quick and easy system to use.

Overall, the LS-3/17 is an excellent sailplane, lacking only slightly in high-speed performance with the extended tips attached. Workmanship is top-rate throughout, and I believe new owners will be pleased with their acquisitions. I personally would like to see the ailerons extended through the long tip extensions. Stability, control, handling, and stall characteristics are all very good.

Many thanks are due Rolladen-Schneider and DGA who shared the towing expenses, to Southwest Soaring personnel who performed the many tows, to Skip Epp who assisted with the photography and flight testing, and to Sherman Griffith, Marion Griffith, and Bob Parker who piloted some of the test-flight sailplanes.

REFERENCES

Johnson, R.H., A Flight Test Evaluation at the LS-3A," *Soaring,* Feb., 1980