

A FLIGHT TEST EVALUATION OF THE LET L-33 SOLO SAILPLANE

By Richard H. Johnson, Published in *Soaring Magazine*, July 1995

The L-33 Solo is an excellent 14-meter, single-seated metal sailplane, designed principally by Marian Meciar and manufactured in what is now the Czech Republic by the LET factory. They have long produced quality metal aircraft, including 2-seated aluminum sailplane trainers such as the Blanik L-13, and more recently the newer Super Blanik L-23. An L-33 prototype was delivered to Oerlinghausen, Germany for the

FAI-International Gliding Commission's flight trials and evaluation for the Olympic World Class Sailplane Design Competition during September of 1992.

There it was judged to be an excellent sailplane, but it did not win the design competition, principally for the following three reasons:

1. Manufacturing cost. It was a beautiful example of metal craftsmanship, with all flush rivets and some adhesive bonding to insure a smooth finish. It used proven construction techniques that appeared to require a factory with large machine tools, presses and special fixtures. It had many beautifully made small parts that were judged to be too labor intensive for successful kit or home building.

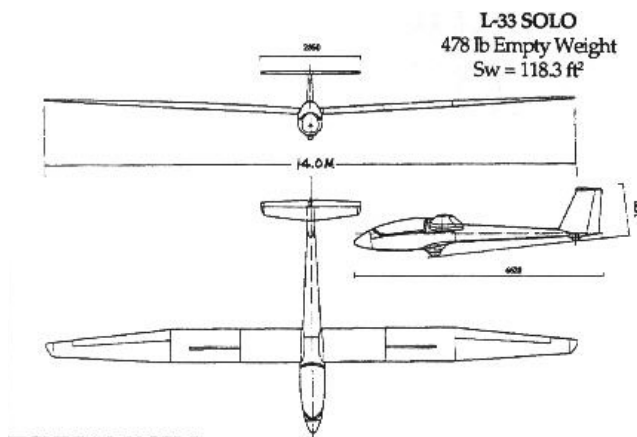


FIGURE 1. L-33 SOLO.

2. Stall speed. At full 750 lb gross weight it measured about 35 kts calibrated airspeed (CAS) with airbrakes retracted, and about 37.8 kts with its powerful airbrakes extended. With airbrakes extended the stalling speed exceeded the World Class Sailplane specified design goal of 35.1 kts by 2.7 kts.

3. Stall characteristics. Only about 1.5 kts of stall warning buffet was observed with the prototype, and the stall was accompanied by a sudden roll into a spin entry. The World Class judges considered those characteristics to be unsatisfactory for low time pilots.

Figure 1 is a 3-view of the prototype L-33, and it appears to closely match the current production models. Because of the favorable present currency exchange rate with the Czech Republic, the L-33 is currently being offered in the U.S. for about \$24,000 to \$26,000 (depending on options) complete with basic instruments, U.S. Standard Type Certificate, licensing, and a very well prepared Flight Manual. An excellent Slovakian made enclosed fiberglass trailer is also available. The glider's construction is almost entirely of aluminum alloy, and only the rudder is covered with fabric.

The prototype brought to Germany in 1992 for evaluation had just completed extensive certification flight testing in the Czech Republic, and it was somewhat degraded by that unusually harsh activity. Each wing panel had 4 large wrinkles in its upper surface wing skins, two on each side of each airbrake. That damage occurred, I was told, during beyond-redline 143 kt flutter testing, when the airbrakes accidentally deployed. Even with the damaged upper wing skins, we measured its maximum glide ratio at about 31.1:1 at 45 kts.

The aluminum wing skins were relatively thick and well supported such that they were quiet and did not normally "oil can" or wrinkle in flight. Wave gage chordwise measurements showed about .006 inches (.15 mm) maximum waviness, except in the above discussed damaged areas at each end of the airbrake upper surface skins, and that was excellent for a bare aluminum wing

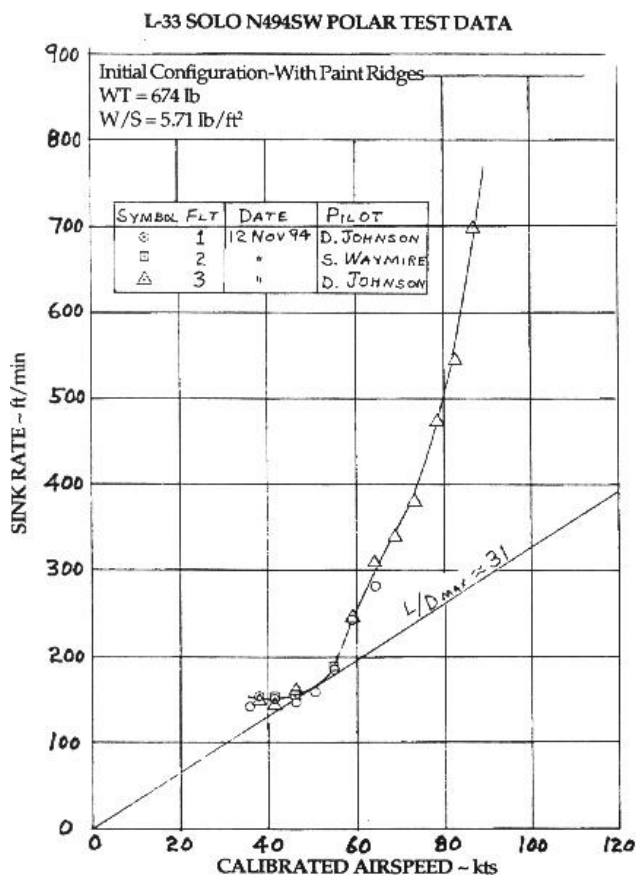


FIGURE 2.

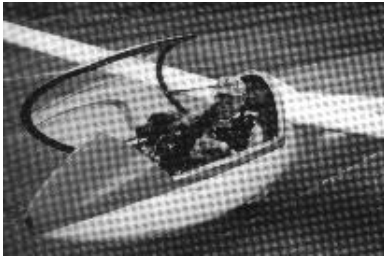


Photo 1: Author in L-33 cockpit, with airspeed calibration Kiel tube pitot mounted on canopy left side window.



Photo 2: Fuselage wing attachment area, showing wing spar opening, forward and aft shear pins, and aileron and airbrake automatic control connection sockets.



Photo 3: Aluminum wing spars joined at the fuselage centerline behind pilot by 2 longitudinal steel shear pins. Bracket forward of left wing spar retains that wing during assembly/disassembly operations.

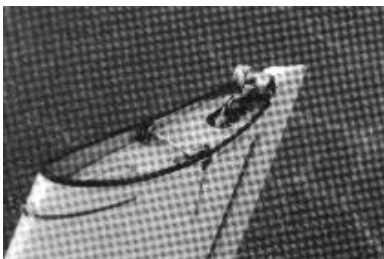


Photo 4: Horizontal tail interface at top of vertical fin. Automatic elevator control connection pin at aft, and lateral steel shear pin near mid-chord to support horizontal stabilizer.

skins. In the damaged airbrake areas, .025 to .035 inches (.63 to .90 mm) of chordwise waviness was measured with a 2 inch long gage. The wing airfoils were reported to be modern Wortmann designs, with thickness-to-chord ratios of .180 at the root tapering to .126 at the tips.

Steve Waymire of Stillwater, Oklahoma received his new L-33, SN 940214 during May of 1994, and he kindly offered to bring it to Caddo Mills, Texas, late that year for flight testing. SN 214 came complete with a beautiful white enamel paint on all its exterior surfaces, and an optional red starburst trim on both the wing and horizontal tail outboard portions to enhance its visibility (better red than dead, as the all white sailplane anti-collision phrase goes). No doubt, the red trim enamel was too fresh and soft to sand at the factory, therefore SN 214 came with a total of 32 sharp edged diagonal paint ridges, measuring about .004 inches (.10 mm) high across a large portion of its wing and tail surfaces.

The initial 3 sink rate measurement flights were made with the as delivered paint ridges somewhat spoiling the airflows, and those polar data are presented in Figure 2. There a maximum glide ratio of about 31:1 is shown at 50 kts CAS, a minimum sink rate of about 150 ft/min at 42 kts, and a high speed sink rate of about 500 ft/min at 80 kts. That is fairly good performance, considering the paint ridges. There did appear to be a high drag knee in the polar at 59 kts, possibly due to the paint ridges discussed above.

Since it was obvious that the paint ridges were detrimental to the L-33's performance, they were carefully sanded down to about .001 to .002 inches (.025 to .05 mm) before 3 additional high tow sink rate measurement flights were performed. Those data are shown versus calibrated airspeed in Figure 3. The maximum glide ratio appeared to be unchanged and still at about 31, but the minimum sink rate appeared to be reduced to about 135 ft/min at 38 kts. The high speed sink rate was significantly improved, with the 80 kt point decreasing about 50 ft/min, to 450 ft/min.

After that, oil flow studies were performed on the wing. Dirty 10W-40 motor oil was sprayed on the left wing upper and lower wing surfaces at 4 spanwise stations, starting near its root and ending near the tip. The L-33 was then flown by Steve for about 24 minutes at airspeeds between 50 to 60 kts. The oil flow patterns formed well during that flight, and they indicated that low drag laminar flow was being achieved on both the top and bottom surfaces, from the leading edge aft to about half of the wing chord. Laminar flow was also indicated in the sanded down paint ridge areas. Normal laminar-to-turbulent airflow transitions were shown near the 50% chord locations, and no significant separation bubbles were indicated, except on the bottom surfaces ahead of the ailerons. If turbulator strips were installed slightly ahead of the bubble leading edge, a further improvement of the L-33's performance is possible. Unsuitable weather prevented that testing for the present time.

Chordwise wing surface waviness measurements showed SN 214's surfaces to be relatively smooth, for metal construction, with about .010 inch maximum waves shown. Its wing thickness-to-chord measurements showed .185 from its root out to the inboard end of the ailerons, then tapering to about .118 at the aileron tips.

Excellent top and bottom surface mylar seals had been installed by the factory over



Photo 5: Inflight adjustable rudder pedals, ahead of instrument pedestal.

L-33 SOLO N494SW POLAR TEST DATA

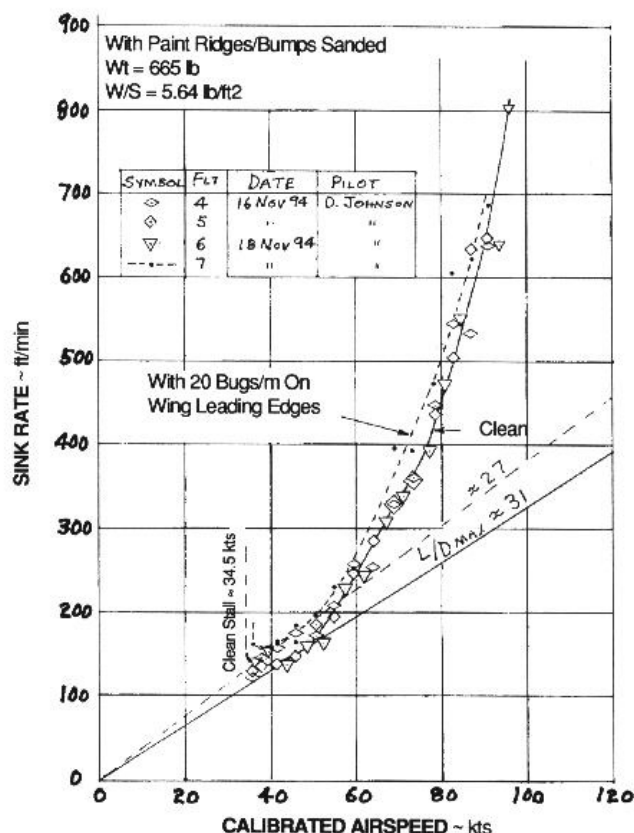


FIGURE 3.

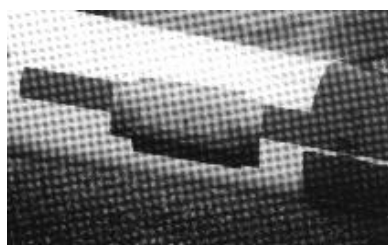


Photo 6: Cardboard taped around aft fuselage side airspeed system static port, for flush static port configuration testing.

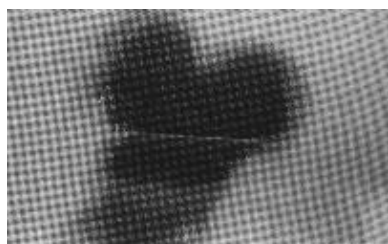


Photo 7: Oil flow on bottom surface of right wing near fuselage. Laminar flow is indicated to about 4 inches aft of white wing skin butt joint line at main spar, where thinning of oil indicates higher shear turbulent flow is initiated.

that functions well, and commendably, the wheel is mounted to an oleo-hydraulic shock absorber. Much of the L-33's main gear system uses hardware that is common to the L-23. A nicely sized 7.9 by 2 inch (200 by 50 mm) pneumatic tail wheel helps keep the takeoff and landing rolls straight. Our test sailplane was equipped with optional 1.7 inch diameter by .55 inch wide wingtip wheels, instead of .60 inch wide steel skids. Their drag penalty was estimated to be very small.

Our test sailplane's assembled empty weight was 486 lbs. That included basic instruments, optional cockpit upholstery, two tow hooks, and external paint. The L-33 comes with a C.G. hook mounted just forward of the main landing wheel, for either ground or aero towing. An optional nose tow hook for aero towing only can be included, and both tow hooks were installed on our test sailplane. We did not perform any ground tows, but that was well tested at Oerlinghausen during the 1992 prototype evaluations.

All the internal aluminum parts of the sailplane are anodized by the factory before assembly, for corrosion protection. The basic sailplane comes with a white enamel exterior finish, but a lighter weight gold or silver anodized exterior finish is offered for those who desire that option. Our test sailplane included the standard external enamel paint plus the bright red sunburst trim, adding about 14 pounds to the sailplane's weight.

The final test flights made with SN 214

the aileron, elevator and rudder gaps. The .010 inch (.25 mm) high blunt leading edges on all the mylar seals were beveled somewhat before Flights 6 and 7.

The effect of roughness on the L-33's wing leading edges was evaluated during one final sink rate measurement flight, with 20 small duct tape "bugs" per meter of span attached to the wing leading edges. Those test data are included in Figure 3, and they indicate that the sailplane's minimum sink rate increased to about 155 ft/min at 38 kts, and that its maximum glide ratio decreased to about 27 at 45 kts. That is not a very serious degradation considering the degree of roughening used during that test. Later oil flow testing showed that significant laminar flow on the wing leading edges continued to exist between the tape bugs.

The L-33's cockpit is adequately large and is quite comfortable for most pilots. The canopy is an excellent side hinged design that provides the pilot with exceptionally good visibility. All the control handles are easy to reach, and their operating forces are adequately low. The controls all connect automatically on assembly, as they should. The wings weigh about 115 lbs each, thus allowing fairly easy assembly with two persons.

The main landing wheel mounts a generously sized 13.8 inch diameter by 5.3 inch wide (350 by 135 mm) tire. The wheel is equipped with an internal drum brake



Photo 8: Oil flow on top surface of right wing near fuselage. Dark oil band behind main wing spar indicates a separation bubble, followed by high shear turbulent flow to trailing edge.

L-33 SOLO AIRSPEED SYSTEM CALIBRATION
 N494 SW, SN 214, 667 lbs, 23 Nov 94 Test
 Fuselage Nose Pitot, Aft Fuselage Side Statics

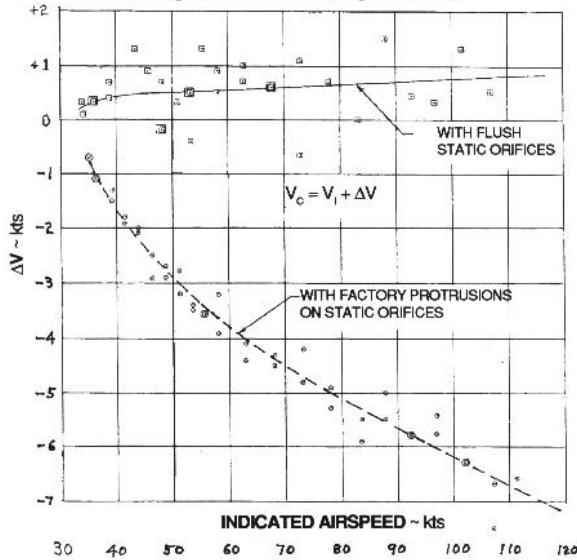


FIGURE 4.

air-speed and SN 214's was greater than usual. In general, it is basically a good airspeed system, but biased to indicate about 6% higher airspeeds than it should. The ASI system showed fairly good performance during side-slip approaches, where the indicated airspeed dropped only about 5 kts or so. Crossflow at the flush nose pitot is the likely cause when indicated airspeed drops during constant true airspeed sideslips.

To confirm that the protruding static ports were the cause for the relatively high airspeed system errors discussed earlier, an additional airspeed system calibration flight was performed with SN 214's static ports flush with the fuselage sides. Instead of actually cutting off the static port protrusions, they were made aerodynamically flush by taping a 10 inch long cardboard sheet around the static port, equal in thickness to the .06 inch static port protrusion. That appeared to fix the airspeed system error problem, as indicated by the test data shown in the upper portion of Figure 4. With that modification the airspeed system showed less than 1 kt of error over the entire airspeed test range. In order to not violate L-33's Certificate of Airworthiness, the static port protrusions should not be cut off or aerodynamically flushed without factory approval.

Level flight stall testing of the new L-33 showed the control stick to be well aft as stall was approached, with mushy control responses and a nose high attitude, but little to no pre-stall warning buffet was observed. In smooth air, I was able to maintain steady flight down to about 34.5 kts CAS (35.5 kts indicated) without any significant buffeting being felt. At stall, a wing drops rather suddenly, and unless corrective action is taken promptly, a spin will start, just as with most high performance sailplanes. Recovery from the incipient spin stage is positive, and quickly achieved thru application of forward stick to reduce the sailplane's angle of attack and unstall the wing. At my 664 lb test gross weight, the level flight stalling speeds varied from about 34 kts calibrated when the wings were clean, to 35.5 kts with the 20 bugs/meter on the wing leading edges, to about 37 kts with the airbrakes fully open. In my opinion the excellent glide path control offered by the strong airbrakes more than offset their 3 kt increase in stalling airspeed.

Overall the L-33 is an outstandingly well-constructed sailplane with good performance, and well worth its present attractive low price. However, in my opinion, its stall characteristics make it questionable for low-time pilots, unless they have been carefully checked out in a suitable trainer with similar stalling characteristics. In any case, recent low-speed handling and full spin training is highly recommended.

Thanks go to Stephen Waymire for kindly bringing his fine new sailplane to Caddo Mills for testing, the Dallas Gliding Association for providing the hangarage and high test tow funding, and especially to Carol Walker who did almost all of the towing.

were for its airspeed calibrations. The ASI pitot is at the fuselage nose, and it appears to function well there. The ASI static ports are located on the aft fuselage sides, and unlike the prototype L-33 tested in Germany, SN 214's static ports were not flush with the fuselage surface, but protruded about .06 inches (1.5 mm) into the airstream. The extended static ports caused the airflow to be faster than it should be at the static orifices. That in turn caused the airspeed system to indicate higher airspeeds than it should, as indicated in the lower curve in Figure 4.

It had been noted that the discrepancy between the towplane's indicated air-

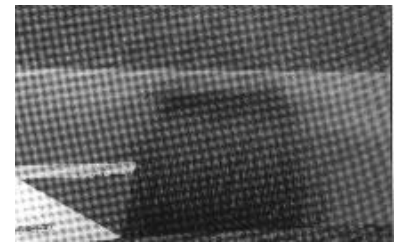
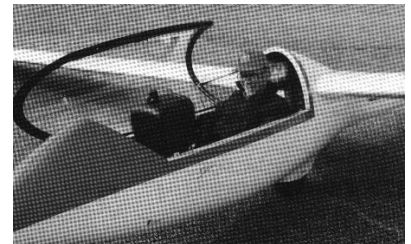


Photo 9: Oil flow on top surface of right wing near aileron tip. Low shear laminar flow is indicated by thickening oil to about 2 inches aft of main wing spar, followed by normal higher shear turbulent flow to trailing edge.



Author ready to takeoff on a sink rate measurement flight.