# A FLIGHT TEST EVALUATION OF THE SINHA WING PERFORMANCE ENHANCING DETURBULATORS

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## INTRODUCTION

It is extremely rare that one has an opportunity to take part in a completely new aerodynamic performance enhancing technology. But that appeared to be the case when Dr. Sumon Sinha, a fluid dynamics teaching staff professor at the University Of Mississippi at Oxford, MS, considered that his patented deturbulator invention was ready for formal flight-testing on a sailplane at Caddo Mills. Jim Hendrix, also from Oxford, had been assisting Dr. Sinha for several years during the developmental testing with various deturbulator configurations mounted on the wing surfaces of his 1970 Std. Cirrus A 15 meter test-bed sailplane. Figure 1 presents a 3-view of Jim's Std. Cirrus. That sailplane was originally owned by Quentin "Ice" Berg, a well-known contest pilot who unfortunately died from a heart attack while he was helping to drive in tie-down stakes for the pilot's meeting tent at the 1973 U.S. Nationals.

Just what is a wing surface deturbulator? Here it is a full length, spanwise mounted, strip of very thin and flat, silvered Mylar hollow tubing that is about 50 mm (1.98 inches) wide. Mounted on the wing top surfaces at about .65 chord distance from the wing leading edge, it is designed to filter out small turbulence waves in the wing's boundary layer by a process called dynamic flow control. In addition to the 50 mm wide silvered deturbulator strips, the wing forward leading edges were treated with a proprietary coating, designed to improve the wing airflow boundary layer characteristics. Somehow that, in addition to the well aft mounted deturbulator strip, aided the wing chordwise airflow in creating less skin friction drag; thus significantly improving glide performance.

Its function is similar, but almost the opposite of the well-known and often used wing mounted turbulator strip. There, its action is to transition the chordwise laminar airflow to an attached turbulent flow, just before a high-drag separation bubble can form. When needed, we have successfully used drag-reducing turbulator strips on our sailplane wings for many years. Many of the modern sailplanes are equipped with them; usually on their wing bottom surfaces only.

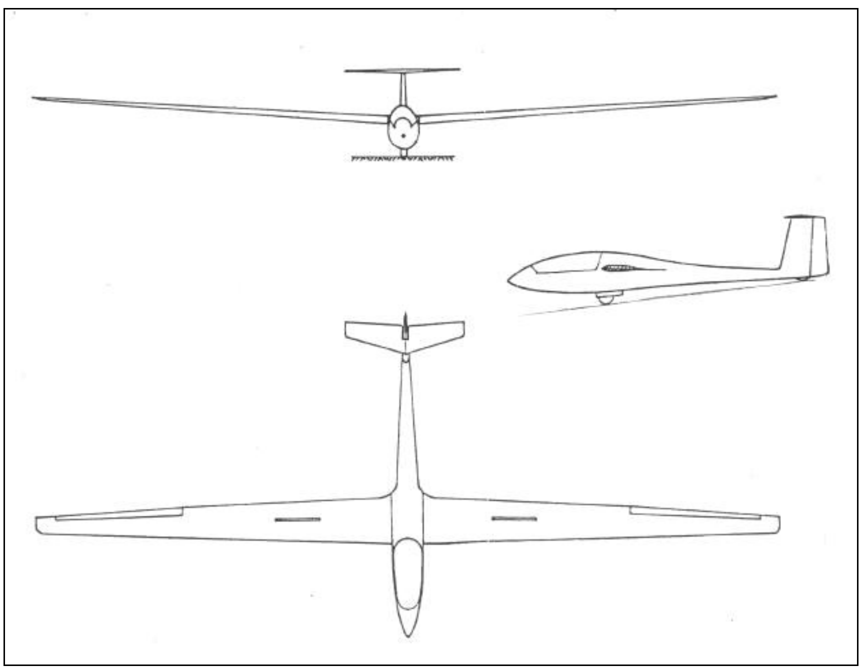

**Figure 1. Three-View Drawing of Standard Cirrus Sailplane**

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**AIRSPEED CALIBRATION**

The Std. Cirrus airspeed system uses a fuselage nose pitot tube that is located in the cockpit ventilation air inlet. Small vent holes on the fuselage sides below the wing serve as its static sources. First we checked the pitot and static system lines for leaks, and repaired a small one. Then, while inside the hangar and out of the wind, we calibrated the sailplane's **Winter airspeed indicator** by carefully comparing its readings to our calibrated reference ASI meter. The errors that we measured for the sailplane's Winter ASI were relatively low, less than about 2 knots over our entire planned flight test range. Those measured **airspeed indicator instrument error** data are shown in Figure 2.

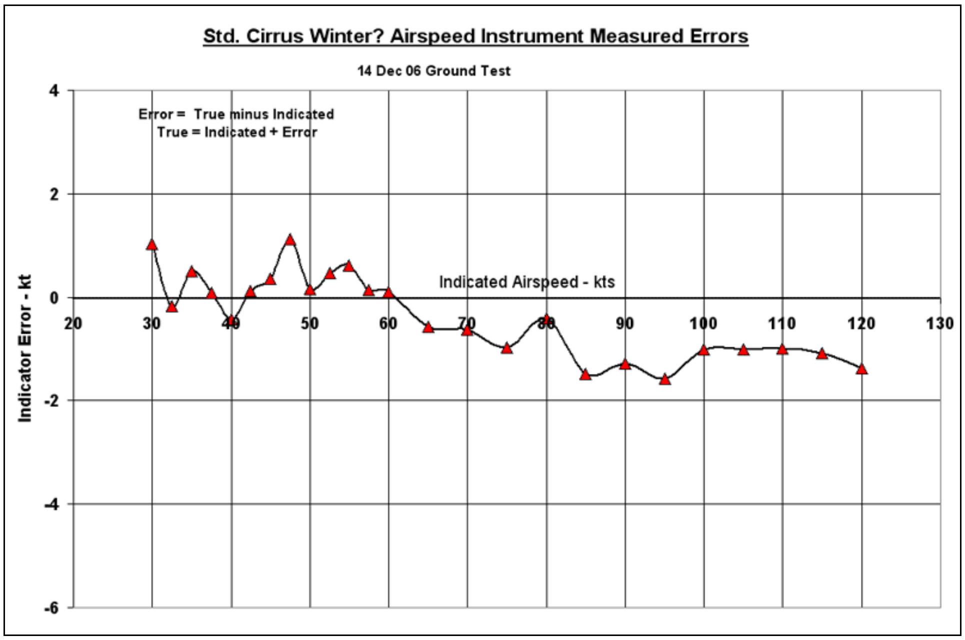


**Figure 2. Airspeed Indicator Instrument Error**

I then made our **airspeed system** flight calibration while descending from an 11,000-foot high tow. For that the sailplane was equipped with a Kiel tube reference pitot temporarily taped to one side of the canopy, and a trailing bomb static reference, deployed in flight after tow release. The flight test calibration was then steadily flown at indicated airspeeds between 35 and 100 kts, comparing our master reference indicated airspeeds to those of the sailplane's. Those test data were then used to compute the Std. Cirrus's **airspeed system errors** versus indicated airspeed. The Figure 3 chart presents the flight measured **Airspeed System** errors. In that figure it is assumed that the airspeed indicator has no errors, and that the errors shown would be those using a perfect ASI. The Std. Cirrus's airspeed system measured errors were small at relatively low airspeeds, but increased almost linearly to about 7 kts at 100 kts indicated airspeed. Those airspeed system errors are almost identical to those I measured 31 years ago with a then-new Std. Cirrus B sailplane (Ref. 1). In general, our test data measurements show that the Std. Cirrus is actually flying considerably slower than the indicated airspeed, but only when flying at airspeeds above 50 kts.

While the under-wing fuselage side static pressure orifices provide a highly biased static pressure source, it is reliable and almost impossible to clog when flying in rain. That is a good point and it adds to flight safety. In the past, a number of sailplanes have had crashes when trying to land in rain with an inoperative airspeed indicator.

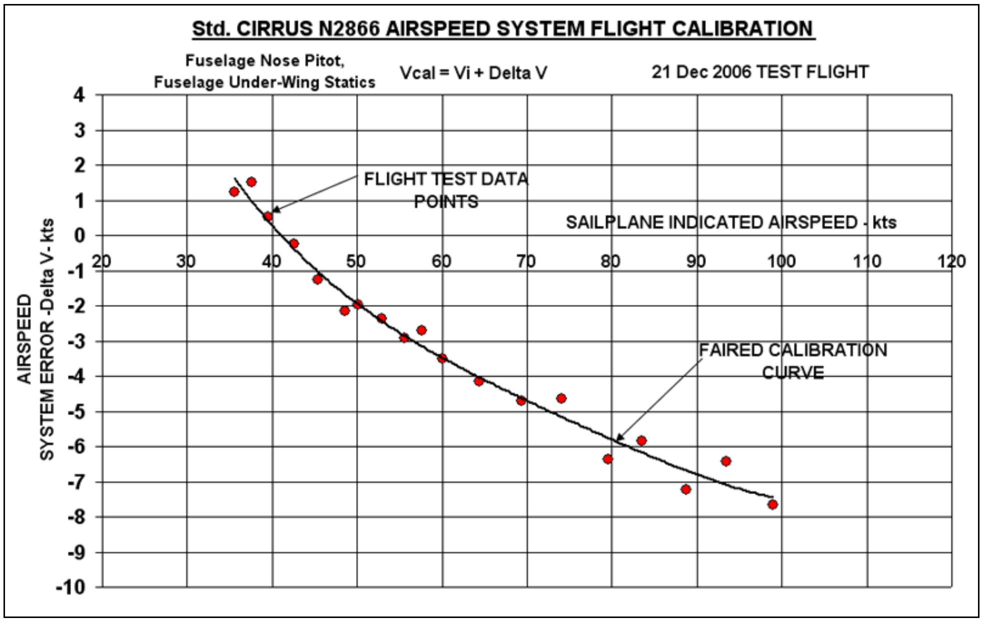


**Figure 3. Airspeed System Errors**

**SINK RATE TEST FLIGHTS**

The first 6 flight sink rate measurement tests were made with the full-span Sinha deturbulator tapes carefully mounted on Std. Cirrus's wing top surfaces. I made the first test flight during the morning of 13 December. The atmosphere appeared to be relatively calm that day with little vertical air motion or horizontal wind shear at the flight test altitudes during my tow to 12,000 ft. On the way down I measured the Std. Cirrus sink rates at various airspeeds between 35 and 100 kts indicated airspeed. During that afternoon, Jeff Baird and I alternately flew 3 more sink rate test flights. However, by then the test atmosphere was not as calm, and it had taken on a little bit of shear and turbulence. For that reason, we waited until the next day to complete our deturbulated-wing sink rate testing. Jeff and I each made a high tow that day, and the atmosphere appeared to be relatively still.

To determine how much benefit the deturbulators provided, it was necessary to re-test our Std. Cirrus test-bed sailplane with the deturbulators removed. Therefore, 3 more high-tow sink rate test flights were made during December 23, with the deturbulators removed. The weather appeared to be relatively calm that day.

With a total of 9-sink rate and 1 airspeed calibration test flights in-hand, it was now time to correct the sink-rate data to standard 59 deg F sea level conditions, as is customary. Figure 4 shows the averaged sink-rates measured during the 6 deturbulated-wing test flights, and Figure 5 shows their corresponding L/D ratios. Also shown are the similar test data for the 3 deturbulator-removed test flights.

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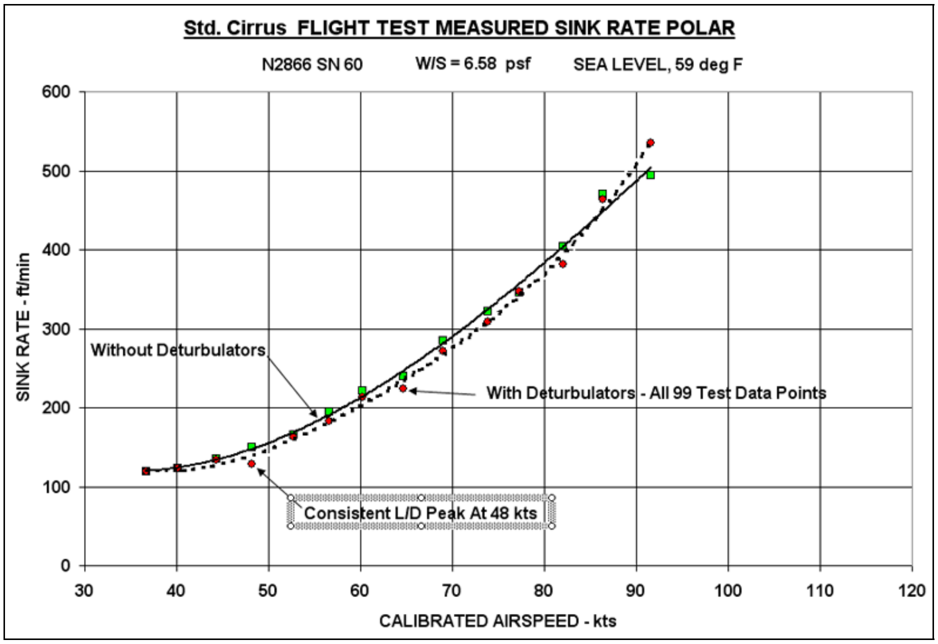


**Figure 4. Average Sink-Rate Data**

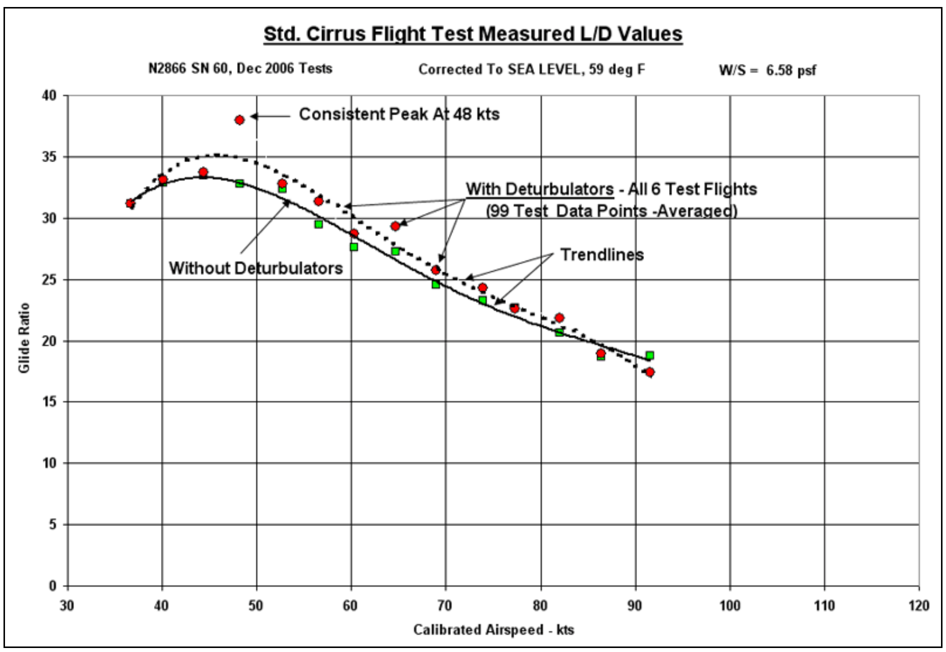


**Figure 5. Average L/D Ratios**

Those test data indicate that the deturbulators improved the Std. Cirrus best glide performance from about 33.5:1 at 44 kts, to about 35.2:1 at 46 kts, an improvement of about 5 or 6%. These numbers are derived from a 4$^{th}$ order trend-line drawn through the test data points. For some reason, the many-point averaged deturbulated wing test data at 48 kts shows a well-above trend-line L/D point of almost 38:1, an improvement of about 13%. Above 90 kts the deturbulators showed a slightly higher drag than with the clean wings.

As stated earlier, the atmosphere appeared less calm during the afternoon when the deturbulated test Flights 2, 3, & 4 were flown. Therefore, I re-analyzed the test data after eliminating those 3 flights, using only the test data from Flights 1, 5, & 6. The deturbulated wing test data from those 3 test flights show considerably less data scatter than did Flights 2, 3, & 4. Figure 6 shows the averaged sink-rates measured during the selected 3 deturbulated-wing test flights. Figure 7 shows their corresponding L/D ratios. Also shown in both figures, for comparison, are the test data for the deturbulator-removed test flight data.

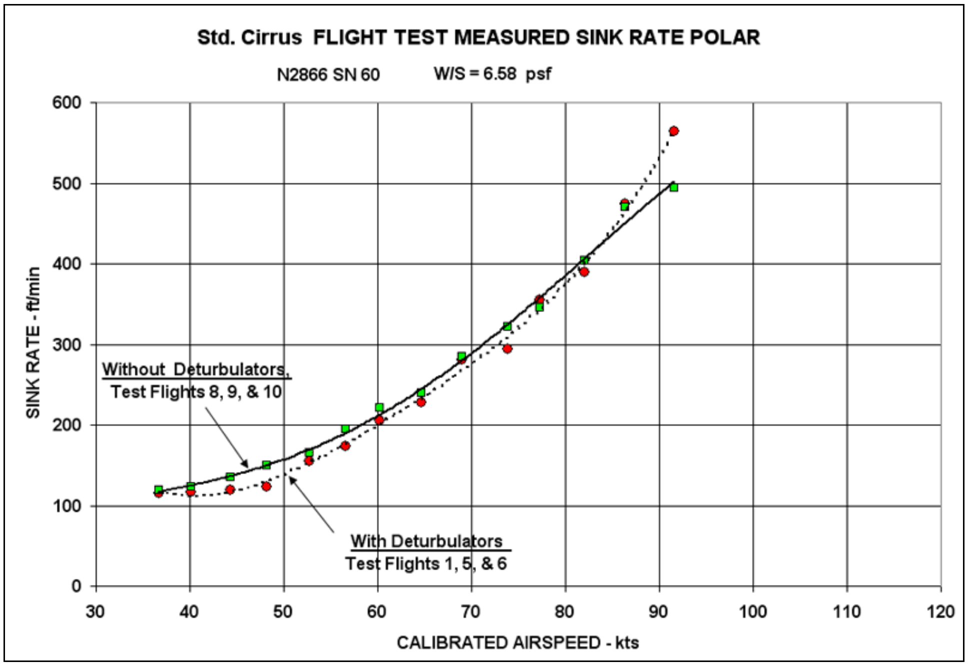


**Figure 6. Average Sink-Rate Data for Flights 1, 5 & 6**

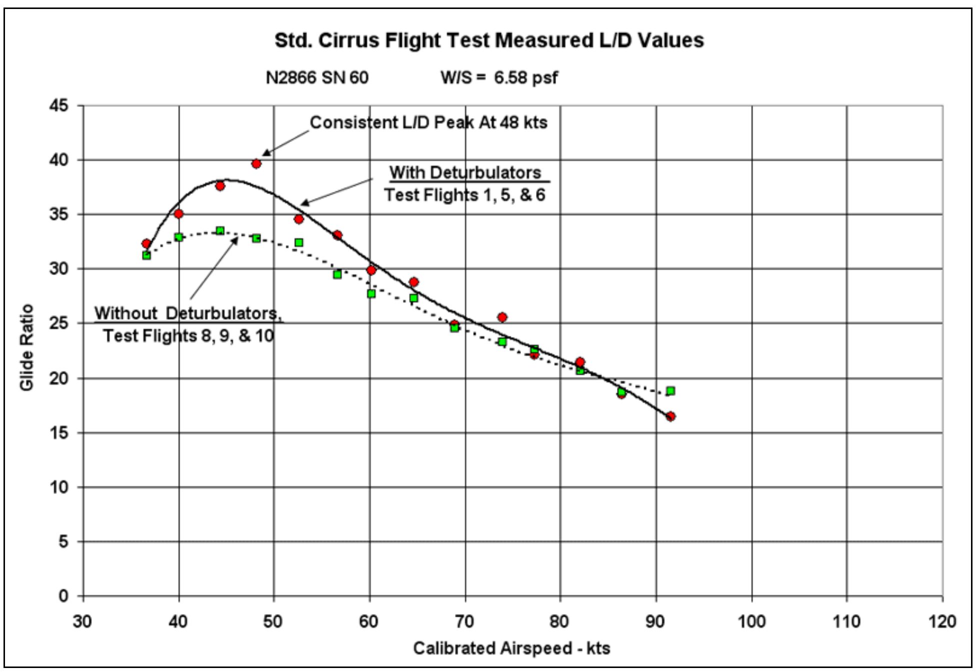


**Figure 7. Average L/D Ratios for Flights 1, 5 & 6**

Those test data indicate that the deturbulators improved the Std. Cirrus best glide performance from about 33.5:1 at 44 kts, to about 38:1 at 46 kts; an improvement of about 13% in L/Dmax. These numbers are again derived from a 4$^{th}$ order trend-line drawn through the less-scattered test data points. The many-point averaged deturbulated wing test data at 48 kts still


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shows a well-above trend-line L/D point of almost 40:1, an improvement of about 18% over that of the clean-wing data. The above-90 kt data with the deturbulators still showed a slightly higher drag than with the clean wings.

**WING SURFACE WAVINESS MEASUREMENTS**

Using our standard 2-inch long wave gage, we made chordwise waviness measurements of our test Std. Cirrus's wing top and bottom surfaces at 14 spanwise stations along each wing panel,. The magnitudes of the 36-year old wing's surface waves were quite nominal, averaging only about .0044 inches peak-to-peak. That is relatively good, especially considering the sailplane's age. Only on the outer wing panel did our measurements much exceed that value. Those waviness measurements are for peak-to-peak magnitudes –from valleys to peaks. Those data are shown plotted in Figure 8.

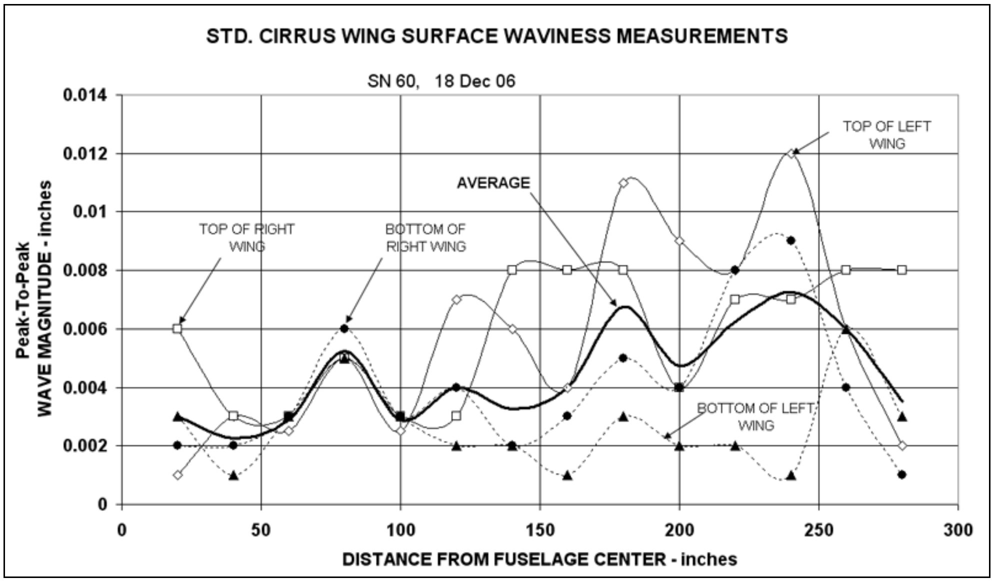


**Figure 8. Wing Waviness**

**DISCUSSION**

The reason for the unusually low drag indicated at 48 kts with the deturbulated wing is open for discussion. Dr. Sinha explained that he had purposely chosen to place the deturbulators on the Std. Cirrus's wing where they would optimize their effectiveness at that airspeed. Would it then be possible to add a 2$^{nd}$ deturbulator strip at another location, and thereby widen the very low drag airspeed range? Maybe next year's testing can explore that on the Sparrow Hawk sailplane that is now entering the Phase 2 of this interesting deturbulator flight testing.

I think I can explain the higher deturbulated wing drag at the highest airspeeds. At high descent rates the stretched Mylar cover film suffers from inadequate outside venting of the hollow cavity below the silvered Mylar film. Therefore, the rapidly increasing ambient air pressure forces the Mylar film down hard enough to prevent it from flexing and functioning properly at high sailplane sink rates. If that is the case, it should not be difficult to increase the deturbulator venting somewhat, and allow it to continue its good work at higher speeds. Dr. Sinha is currently working to improve the deturbulator cavity-venting problem.

As best that I can measure, the thickness of the basic hollow uninflated deturbulator strip is only about .3 mm (.012 inches) plus about .1 mm (.004 inches) for the thin layer of adhesive that attaches it to the wing surface. That total thickness of .4 mm (.0158 inches) is surprisingly thin, and that equals the thickness of about 4 sheets of computer printing paper. It is amazing that such a thin strip can produce such significant improvements to a sailplane's performance!

For more information, go to Jim's and Sumon's websites at: http://www.oxaero.com/ and http://www.sinhatech.com/.

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**SUMMARY**

The new Sinha Deturbulator could be the first really significant drag-reducing aerodynamic invention since the development of the now-common laminar-flow airfoils that were developed some 65 years ago. Its small size and lightweight make it easy to apply on a sailplane wing. However, its location on a sailplane wing is critical, and it will be interesting to see if similar performance improvements can be achieved with the current generation of high performance sailplanes.

Many thanks go to Jim Hendrix for bringing his good Std. Cirrus sailplane many miles from his East Arkansas Gliderport for our flight tests in Texas, and to the Dallas Gliding Association for providing both the hangaring and the high tows needed to accomplish it. Also to Dr. Sumon Sinha of Oxford, MS, for his participation in the testing, and for his honoring us by agreeing to let us test his fine new invention.

Also to test pilot Jeff Baird, and to Southwest Soaring's new manager, Paula Lara and her Caddo Mills tow pilots, David Cheek and Howard Hughes, who did the excellent towing. They usually required only about 20 minutes to tow the Std. Cirrus test-bed sailplane to 12,000 ft AGL with the powerful Pawnee.

**REFERENCES**

A. Johnson, R.H., A Flight Test Evaluation Of The Std. Cirrus B Sailplane; Soaring- March 1976

**FIGURES**



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PHOTOGRAPHS


**Figure 9. Test pilot Jeff Baird in Std. Cirrus cockpit**

**Figure 10. Dick Johnson and Jeff Baird calibrating the airspeed indicator**

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**Figure 11. Jeff Baird on runway, ready for takeoff**

**Figure 12. Dr. Sumon Sinha and Jim Hendrix**

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**Figure 13. Deturbulator inventor Dr. Sumon Sinha**

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