CAFE Challenge

WITTMAN TAILWIND W10 AIRCRAFT PERFORMANCE REPORT

Comparative Aircraft Flight Efficiency, Inc.

A Non Profit, All Volunteer, Tax-exempt Educational Foundation

Co-sponsored and Funded by the Experimental Aircraft Association

4370 Raymonde Way, Santa Rosa, CA. 95404.
707-526-3925 FAX: 707-544-2734

CAFE Triaviathon

Jim Clement's beautiful Wittman Tailwind W-10, equipped with the *CAFE* Barograph flies over the Sonoma County dairylands.

Larry Ford

OVERVIEW
by
Brien A. Seeley M.D., President
CAFE Foundation
4370 Raymonde Way
Santa Rosa, CA. 95404.
707-526-3925 FAX: 707-544-2734

The Wittman Tailwind is an historic aircraft design. It first flew in 1953, a few weeks before the birth of the Experimental Aircraft Association. It demonstrated exceptional flight efficiency, incorporating a number of aerodynamic design features which Steve Wittman had gleaned from his extensive air racing experience. Prospective homebuilders at that time were both incredulous and inspired by the Tailwind. It was the stuff of which dreams were made and can be credited with helping the fledgling EAA to grow. Jack Cox's excellent history of the Tailwind was published in the September 1993 issue of Sport Aviation.[1]

Steve Wittman and his original Tailwind were called upon by the CAA to serve as the testbed for establishing G load limits for homebuilts. Steve, with parachute, performed the high speed dives and pullups with a Polaroid camera aimed at the G meter. The Tailwind was also the first homebuilt certified by the CAA for carrying non-revenue passengers.

Dr. August Raspet, a professor of aeronautics at Mississippi State University, conducted an elaborate drag polar evaluation of the Tailwind by towing a propeller-less example to 10,000' altitude with a 450 BHP Stearman, releasing it as a glider,

DESIGNER	OWNER/BUILDER N6168X
Steve Wittman Red Oak Ct., Box 2672-3811 Oshkosh, WI. 54903-1265 (414) 235-1265, May-Nov.	Jim Clement 396 Baraboo St. Merrimac, WI. 53561. 608-493-2402.

DESIGNER'S INFORMATION

Cost of plans	$180
Plans sold to date	1064
Number completed	approx. 375
Estimated hours to build, basic	2500-3500
Prototype first flew, date	Spring, 1953
Normal empty weight, with O-320	840-880 lb
Design gross weight, with O-320	1425 lb
Recommended engine(s)	Cont. O-200, O-300, Lyc. O-320, Olds V-8
Advice to builders:	Recreational spins not advise;, if in spin, "turn it loose"; avoid aft c.g.'s beyond 28% MAC; W10 wingtips are very worthwhile, keep it simple and lightweight.

CAFE FOUNDATION DATA N6168X

Wingspan	23 ft (plans = 24 ft)
Wing chord, root/root rib of wingtip	49.3/47.3 in
Wing area	86 sq ft (plans = 90 sq ft)
Wing loading, 1425 lb/86 sq ft	16.6 lb/sq ft
Power loading, 1425 lb/160 hp	8.9 lb/hp
Span loading, 1425 lb/23 ft	61.95 lb/ft
Airfoil, main wing	Custom modified by Wittman
Airfoil, design lift coefficient	NA
Airfoil, thickness to chord ratio	~ .105
Aspect ratio, 23 ft x 23 ft/86 sq ft	6.15
Wing incidence	0°
Thrust line incidence, crankshaft	0°
Wing dihedral	0°
Wing taper ratio, root/tip	.96
Wing twist or washout	0°
Steering	Differential braking, swiveling tail wheel
Landing gear	Tailwheel, spring steel, wheel pants
Horizontal stabilizer: span/area	74 in/9.38 sq ft
Horizontal stabilizer chord: root/tip	28.25 in/8.25 in
Elevator: total span/area	74 in/4.95 sq ft
Elevator chord: root/tip	12.5 in/6.75 in
Vertical stabilizer: span/area incl. rudder	48 in/12.66 sq ft
Vertical stabilizer chord: root/tip	48 in/20 in
Rudder: average span/area	27.75 in/2.4 sq ft
Rudder chord: top/bottom	9 in/16 in
Ailerons: span/chord, each	35 in/5.25 in
Flaps: span/chord, each	57 in/6.1 in
Tail incidence	NA
Total length	20 ft 6.75 in (plans = 19 ft 6 in)
Height, static with full fuel	5.4 ft
Minimum turning circle	Estimated 50 ft
Main gear track	70 in
Wheelbase, nose gear to main gear	15 ft 4 in
Acceleration Limits	NA

AIRSPEEDS PER OWNER'S P.O.H., IAS

Never exceed, V_{ne}	174 kt/200 mph
Maneuvering, V_a	130 kt/150 mph
Best rate of climb, V_y	104 kt/120 mph
Best angle of climb, V_x	NA
Stall, clean at 1300 lb GW, V_s*	*55 kt/63 mph
Stall, landing, 1300 lb GW, V_{so}*	*48 kt/55 mph
Flap Speed, V_f	91 kt/105 mph

* Compare to **CAFE** MEASURED PERFOR MANCE.

CAFE TEST SUMMARY

Vmax Cruise	216.9 mph
Drag Area	2.03 sq ft
Rate of Climb	1423 fpm
Stall Speed	66 mph
Useful Load	549 lb
Building time	2,000 hr

and measuring its gliding sink rate at known weights but differing airspeeds. This work, published in 1956[2], confirmed the Tailwind's remarkably low drag coefficient.

The CAFE Foundation, 1993 recipient of the Thirty Third August Raspet Memorial Award, felt it was particularly appropriate that the latest version of the Tailwind, the W10, be the subject of this Aircraft Performance Report, wherein a new zero thrust glide testing method is used to evaluate its drag characteristics.

Direct comparisons of the drag characteristics of this Tailwind with the one tested by Professor Raspet, unfortunately, are not pure due to the evolution of the design since 1956. The earlier version had no wheel pants, a shorter fuselage, stabilizer end plates, no spinner, a shorter span, shorter landing gear, a different cooling and exhaust system, different wing tips, 350 lb less gross weight and a different airfoil.

The W10 version was longer than the W8 in having 5.5" longer chord in its tail surfaces. It also had slightly taller landing gear to accomodate the larger engines.

As is our practice in selecting aircraft for testing, we consulted the designer, Steve Wittman, for his reccomendations as to the current best representative of the W-10 Tailwind. He offered a list of those who had purchased W10 plans, and several were contacted. The most outstanding candidate was Jim Clement of Merrimac, Wisconsin. Jim used a week's vacation and flew to the CAFE Aircraft Performance Evaluation Center in Santa Rosa via Albuquerque, arriving on 3-3-94.

C.J. Stephens flew his subjective flight test evaluation the following afternoon, on 3-4-94, after the aircraft had been drained of all fuel and an empty weight c.g. had been obtained.

The next 36 hours were spent by a crew of 7 CAFE Board Members installing the DAD, CAFE Barograph, camcorder and all the attendant sensors.

Five performance evaluation flights were conducted on 3-6-94, be-

Owner/builder Jim Clement, congratulates CAFE Chief Test Pilot, C.J. Stephens, right, after a very successful test flight.

CAFE MEASURED PERFORMANCE

Propeller static RPM, 28.3 in Hg M.P.	2280 RPM
Takeoff distance, 1431.9 lb, 120' MSL	700 ft @ 73° F with 19 mph headwind
Liftoff speed, per barograph data, CAS	66 kt/76 mph
Touchdown speed, barograph, CAS	64 kt/74 mph
Rate of climb, 2500-3500 ft, Std Day, V_y	1423 fpm
Rate of climb, 9500-10,500 ft, Std Day, V_y	948 fpm
Cabin Noise, climb/max cruise	109.0/107.5 dBA, slow
Stall speed, V_{s1}, clean, 1 G, CAS	61.4 kt/70.6 mph @ 1396 lb
Stall speed, V_{so}, landing, 1 G, CAS	57.3 kt/65.9 mph @ 1395 lb
Vc @ 6,952' dens/2809 RPM/F.T./ 9.2 gph/TAS**	187.7 kt/215.9 mph @ 1409 lb
Vc @ 8,666' dens/2784 RPM/ F.T./ 11.8 gph/TAS	188.6 kt/216.9 mph @ 1400 lb
Vc @ 10,832' dens/2724 RPM/F.T./11.6 gph/TAS	183.7 kt/211.3 mph @ 1415 lb
Vmax @ 1186' dens/2828 RPM/F.T./ 16.2 gph/ TAS	*184 kt/211.7 mph, @ 1417 lb

**F.T. = full throttle.

* denotes speed at V_{ne}, where it was still accelerating. Estimated Vmax = 218 mph.

ginning at 5:40 AM. Multiple attempts were required to obtain usable zero thrust data. That evening, the test equipment was removed and the aircraft was returned to original condition. The following morning, Jim departed in his Tailwind homeward to Wisconsin.

Tailwind N6168X is not "stock". It has 1 ft less span, 4 sq ft less wing area and the firewall was moved 2 inches forward from the cabin to provide greater leg room. The door openings are 2" wider on their aft edges than the standard plans. This aircraft has a custom modified Sterba propeller on a 4" prop extension. The wingtips are of the latest design, which Steve Wittman claims improves the performance significantly. The wingtip lights are concealed in custom-built flush lens covers. The wheel pants are also customized to reduce drag.

FLIGHT TEST METHODS

This flight test was conducted using equipment and techniques as described in the May 1994 issue of Sport Aviation[3].

Takeoff distance was measured at a weight of 1431.9 lb by observers stationed at 100 ft intervals along a 1° downhill runway into an 17 kt headwind.

Maximum level speeds at altitude were obtained in smooth air with the CAFE Barograph using full throttle with mixture leaned for best power, and are compensated for the known flat plate drag due to the barograph wing cuffs with 4' boom (.09 sq ft).

Rates of climb are computed based upon the calculated geometric altitude change which would obtain on a standard day at the recorded aircraft weights.

A 1 G clean stall was performed from level flight with less than 18" of manifold pressure and less than 1750 RPM, using a 1 kt per second deceleration. The stall was then repeated using full flaps.

The zero thrust glide information is considered an approximation on this aircraft due to post-frontal atmospheric disturbances and technical problems in detecting the zero thrust crank position amidst the .011" endplay of this engine. The flat plate drag equivalent for this aircraft is deemed accurate to plus or minus .1 sq ft .

Confidence values were applied to the data points before curve fitting the drag polar to the glide data. Consideration was given to the flat plate drag value implied by the low altitude Vmax demonstrated by this aircraft, 211.7 mph TAS. During that speed run, the aircraft was still accelerating strongly when it reached its 200 mph redline IAS. At that point the pilot terminated the run because the CAFE Foundation test program is confined to the normal operational envelope of the aircraft.

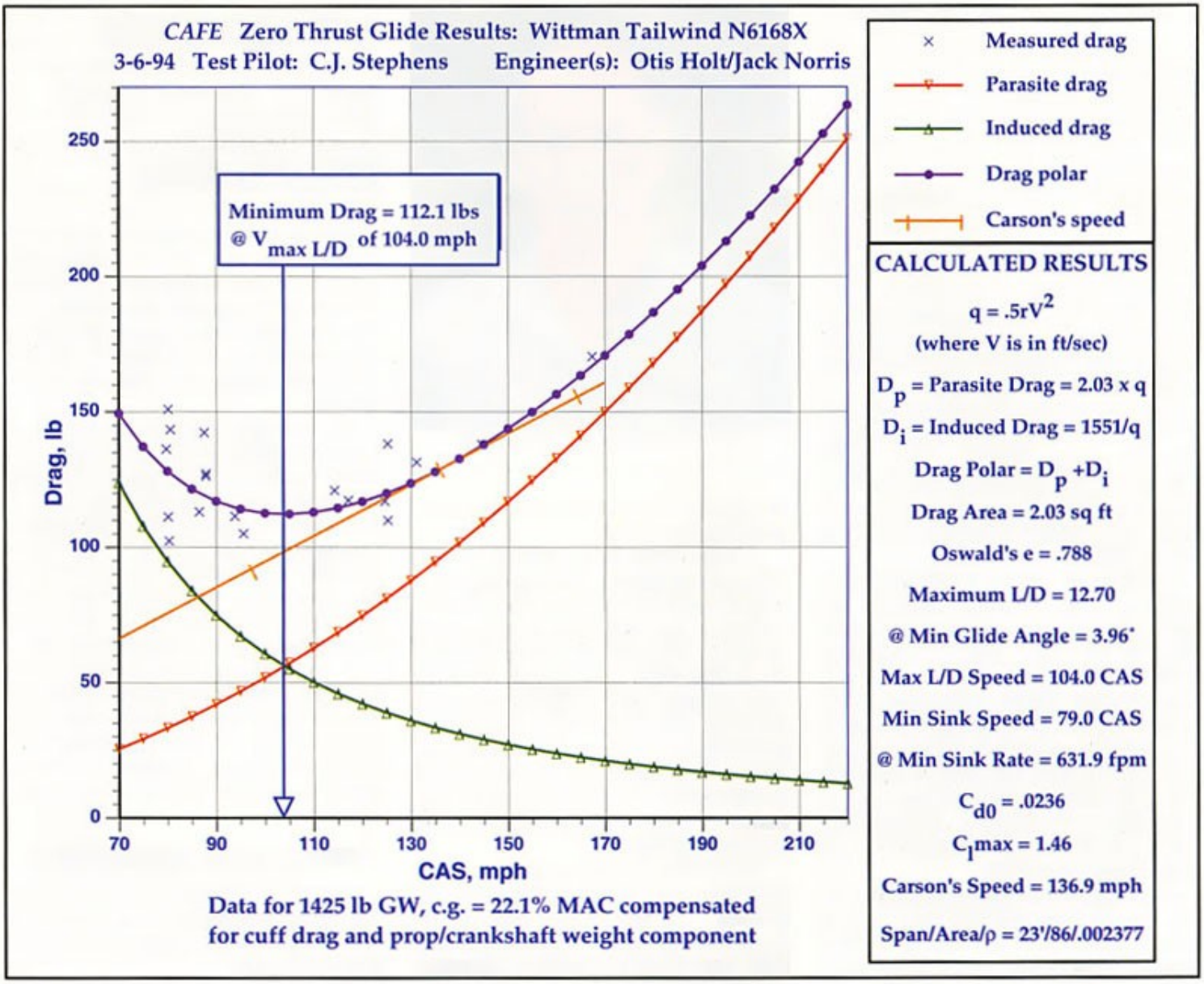
The high altitude cruise speeds of this Tailwind would imply that it is capable of 220 mph at sea level. The owner has reported near 220 mph IAS in level flight at 2900 RPM at low altitude. With 16.2 gph at 2828 rpm, our test implies 180 BHP at .54 bsfc. This stock Lycoming O-320 B1B (nominally 160 BHP) had accumulated 80 hours since overhaul. It had a crossover type exhaust system and showed extremely stiff compression when hand turning the propeller. A "dipstick" tool was used to check this engine's piston height at TDC. The height was identical to the known stock piston height value on Steve Barnes' O-320 B1B, confirming that normal compression pistons were in use.

The Vetter Digital Acquisition Device (DAD) was used to record engine parameters. PropTach rpm's are plus or minus 1 RPM. Fuel flows were calibrated to better than .5% accuracy. Noise levels were measured on a TES1350 Digital Sound Meter placed adjacent to the pilot's right ear with a forward facing microphone.

All altitudes are accurate to plus or minus 1 ft . CAFE Barograph airspeeds are CAS, obtained with the pitot-static source positioned 51.4" forward of wing L.E. and 72.5" outboard of the propeller diameter. A chart comparing CAS to the aircraft's airspeed indicator readings is provided at the end of this report. The IAS errors at low speeds are presumed to be due to the placement of N6168X's static port on the midline of the fuselage belly 4' forward of the rudder trailing edge.

Test equipment totaled 57 lb including barograph #2 and pitot missile #2, computer, camcorder, DAD, fuel pump and batteries. The 1 amp barograph heater was powered from the wingtip light wire, while barograph data reached the cockpit via an .5" x .003" copper foil adhesive applied at the 60% chord on the bottom wingskin.

The CAFE Scale was used to determine all aircraft weights. The takeoff weight and c.g. were determined for each of the 7 flights. Practical loading considerations precluded flights at extreme forward



c.g.'s. Weighing after each flight allowed an accurate calibration of the DAD's fuel totalizer and gph.

The DAD, camcorder and barograph clocks were all synchronized just prior to each flight.

The graph above was obtained in accordance with the zero thrust glide method developed by CAFE Board Member Jack Norris working with his partner, Dr. Andrew B. Bauer. A zero thrust sensor, installed on the engine crankcase so as to detect fore-aft movement of the crankshaft during flight, senses the transition point from tractoring to windmilling, i.e., the zero thrust condition. At zero thrust, the propeller effectively becomes "invisible" and the aircraft becomes a "pure" glider. The wing cuff-mounted CAFE Barograph accurately records time, airspeed and sink rate while gliding in the zero thrust condition. Synchronized recording of fuel flow, computed instantaneous aircraft weight, RPM, and incline angle of the crankshaft at each different airspeed, yields data, which, when corrected for crankshaft incline vector, can be entered into the following formula:

W x Sink Rate = Drag x TAS

Where W = instantaneous aircraft weight, lbs.
TAS = true airspeed in feet per second
Sink Rate is in feet per second
and Drag is in pounds.

The "J" shaped curve is a plot of calibrated indicated airspeed (CAS) at gross weight versus drag and is called the aircraft's "drag polar". The drag polar, wingspan, wing area, gross weight and r, the air density at sea level, provide the information needed for the calculated results above. The term Carson's speed refers to the excellent paper, "Fuel Efficiency of Small Aircraft", (AIAA-80-1847, 1980) by Professor Bud Carson of the U.S. Naval Academy, which, using prior work by Gabrielli and von Karman, defines this speed, as the maximum speed per unit of fuel burned. Carson's speed can be calculated as 1.316 times the speed for maximum lift to drag ratio, which, in turn, is 1.316 times the speed for minimum power and minimum sink rate. Carson's speed is also defined as the tangent point on a line which is tangent to the drag polar and passes through the origin.

The lowest point on the drag polar is the point of minimum drag and this occurs at 104 mph CAS, which is the speed for maximum lift to drag ratio. . The value of 2.03 sq ft, the drag area from the parasite drag equation in the legend above, is here deemed accurate to plus or minus .1 sq ft .

FLYING QUALITIES EVALUATION BY C.J. STEPHENS

Tailwind N6168X

INTRODUCTION

During the period March 3rd through 7th, 1994 the CAFE Foundation completed a thorough evaluation of Jim Clement's Tailwind, N6168X. The first flight of the series was my subjective evaluation of the stability and handling qualities in addition to the airplane's general accommodations.

PREFLIGHT INSPECTION

I had not flown a Tailwind prior to this evaluation. At first look it was a very impressive airplane. The wings had an extremely smooth, clean appearance with no bumps, antennae or other objects to interrupt the airflow. The entire wing surface, with as nice a finish as I have ever seen, was hindered only by the single wing strut attach point. Even the wingtip lights were faired in with smooth precision. It was obvious that the builder was extremely conscientious during its construction. The aircraft was only recently completed and had logged only 80 hours of flying time.

The aircraft was fueled and ballasted to 18.2% MAC c.g. at the maximum allowable gross weight. The CAFE doctrine of not exceeding any specified limit or previously demonstrated capability was followed throughout the series of test flights.

Like many pilots, I have seen this square-looking plane over the years and given it little attention since it lacked the rounded lines which one associates with modern high performance aircraft. The outwardly boxlike appearance of the design belied its actual performance. The preflight inspection quickly showed that Jim Clement had done an excellent job of keeping the plane simple, just as intended by the designer. He had carefully avoided the installation of unnecessary equipment.

The instrument panel contained a basic set of instruments plus a turn coordinator that could be switched on if needed. The radios were limited to an intercom, VHF comm and a loran. All were quality equipment and worked perfectly throughout the period of the evaluation.

The fuel filler spout was located externally in the forward right lower corner of the windshield. The fuel quantity could be easily checked by dipstick and the cap security could be seen even from the cockpit. All 33 gallons of fuel were in one tank located forward of and below the instrument panel. A short fuel line and one on/off valve controlled the fuel flow. Big tank, short line, and an on/off... now that is a simple fuel system. One could argue against the safety aspect of having a large fuel tank in the cockpit, however, it is difficult to dispute the principle that simplicity, when dealing with fuel management, is a major design priority.

I am 5'-10" weighing 170 lb and I found the cockpit to have adequate room. During some of the test flights I was accompanied by an engineer of about my size. It was 'snug' but not uncomfortable. Another CAFE test pilot who is 6'-3" found his head just in contact with the overhead structure. His leg room was also at a minimum even though the seat did allow for some adjustment fore and aft.

Otis Holt

Chief Test Pilot, C.J. Stephens

A large cabin door, located on each side, opened widely. No boarding steps seemed necessary and the wing strut attachment was well forward and out of the way. Entrance to and egress from the cockpit were unhampered, requiring only one large step to slide into the cockpit seats. The seats were comfortable, providing good support in the proper places. Even the longer flights produced no discomfort. Very nice shoulder harnesses were provided for both the pilot and the passenger.

The O-320 started quickly on every start using only the accelerator pump for priming. The field of view while on the ground is somewhat limited with the high nose position typical in tailwheel aircraft. There is a need to stretch to see over the nose, but depending on your sitting height, full view of the taxiway is available to within 150' in front of the plane. Field of view up and to the left or right (as in clearing prior to takeoff at an uncontrolled airport) is restricted and less than desirable. By raising slightly in my seat, my field of view was good enough so there was no need to use S-turns to taxi.

The short wings made taxiing in tight places quite easy. The tailwheel was steerable, but not full swiveling, and very effective for ground operations. The brakes were excellent and were used to assist during the tight turns on the ground. The plane could pivot at about the wing tip by using rudder, brake and some power.

Ground handling without the engine running was easily accomplished by manually picking up the 50 lb. tail and pivoting the plane to the desired position. This was even done several times with two people in the cockpit when moving it on and off the scales, although it required two people to raise the tail with a full payload aboard.

In keeping with the simplicity theme, no parking brake was installed, nor were any cowl flaps. The magneto switch was located on the far left of the instrument panel. This was inconvenient. On tailwheeled airplanes in which the throttle is in the right hand and the stick must be held back during the run-up, the magneto switch should be accessible to the right hand.

The pitch trim, located under the seat, was very nice. It had friction washers to hold the setting and it loaded a tension spring against the elevators by use of a small lever. I used the setting recommended by the builder for takeoff, which was done by feel, and was easy to operate.

The roll trim annoyed me at first. It involved a sliding washer fit on a tube which loaded a spring against the right aileron rod behind the passenger seat. It took some practice to fully understand and operate this system. The initial tendency was to work it backwards. It was, however, a simple device and light in weight. With enough practice one could adequately trim the plane in roll.

A conventional vernier throttle was installed. This is not my preference of throttle types especially if the flying includes a lot of power changes or formation flying. Vernier throttles, however, are very nice on cross country flights.

FIRST FLIGHT IMPRESSIONS

As I taxied the Tailwind onto the runway for my first flight I was eager to see what it held in store. There was a 7 knot direct headwind.

The control stick was floor-mounted just forward of the seats in the center of the cockpit. The top of the center stick curled to the left over the pilots right thigh and downward so as to create the conventional feel of holding a stick that was directly between your legs. It worked very well except that it took a little practice to find a neutral aileron position.

The radio transmit button was on the end of the stick, pointed downward at the floor. It presented no problem as long as you knew where to find it. Since it was not visible from the normal sitting position, you could look in all normal places and never find it.

The aircraft accelerated rapidly due to the high power to weight ratio. Directional control was very quick initially during the takeoff roll, but once the tailwheel came off the ground, it was less sensitive. Very light stick forces were obvious right from liftoff. These were more noticeable in pitch than roll.

Liftoff occurred naturally at an indicated 65 mph. Initially with 2400 RPM and 28.3" manifold pressure, it was climbing at an impressive indicated 1600 fpm. Even though stick forces

WITTMAN TAILWIND N6168X

Estimated Cost: $12,000 for parts/materials/engine
Estimated hours to build: 2000 hours in 11 months
Completion date: Oct. 12, 1993

SPECIFICATIONS N6168X

Empty weight, no oil/gross weight	862.9 lb/1425 lb
Payload with full fuel	350 lb
Useful load	549 lb
ENGINE:	
Engine make, model	Lycoming, O-320 B1B
Engine horsepower	160 BHP
Engine TBO	2000 hr
Engine RPM, maximum	2700 RPM
Man. Pressure, maximum	29 in Hg
Turbine Inlet, maximum	NA
Cyl head temp., maximum	500° F
Oil pressure range	25-100 psi
Oil temp., maximum	245° F
Fuel pressure, range	.5-8.0 psi
Weight of prop/spinner/crank	57.2 lb
Induction system	MA4-SPA carb, bottom mount
Induction inlet	4.9 sq in
Exhaust system	2 into 1 crossover, stainless, exit nozzles
Oil capacity, type	8 qt, 15W-50
Ignition system	Bendix magneto S4LN20
Cooling system	Pitot inlets, downdraft
Cooling inlet	37.5 sq in
Cooling outlet	36 sq in
Propeller:	Fixed pitch
Make	Ed Sterba, with custom graphite tips
Material	Maple, 5 laminations
Diameter/pitch @ 75% span	68 x 74 in
Prop extension, length	4 in
Prop ground clearance, full fuel	13 in
Spinner diameter	11.375 in

Electrical system	40 amp alternator
Fuel system	1 tank in forward fuselage, gravity
Fuel type	91 octane
Fuel capacity	198.6 lb/33.1 US gal
Fuel unusable	1 oz
Braking system	Cleveland discs, single caliper
Flight control system	Dual center sticks, push-pull tubes, rudder cables
Hydraulic system	NA
Tire size, main/tail	5:00 x 5, 6" tailwheel
Cabin Dimensions:	
Seats	2
Cabin entry	left and right side doors
Width at hips	36.5 in
Width at shoulders	37 in
Height, seat to headliner	35.25 in
Baggage capacity/size	80 lb/ 26L x 36W x 25H
Baggage door size	None
Approved maneuvers:	NA

Center of gravity:	
Range, % MAC	14% to 28% MAC
Range, in. from datum	68.5 in to 75.4 in
Empty weight c.g., by CAFE	68.77 in
From datum location	forward tip of spinner
Main landing gear moment arm	57.4 in
Taukwheel moment arm	243.75 in
Fuel tank moment arm	57.4 in
Front seat occupants moment arm	84 in

were light, it was easy to hold a constant 120 mph IAS.

The owner had recommended leaning the mixture during the climb. This was done, although, with no CHT installed, it was only "best guess" and experience to achieve a workable mixture setting.

With the small size of the plane and the relatively high power, P-factor was noticeable but was easy to control with a light application of rudder. During the climb it was necessary to briefly level off at 4500' to fly out from under a cloud shelf. At 2550 rpm at 4500' the cockpit airspeed indicator went right to 180 mph. The noise level in the aircraft at this point was substantial, and demanded the 20 dB noise protection provided by my headset.

The location of the wing root leading edge is well forward and slightly above the pilot's visual line of sight from a normal sitting position. During turns this obstructed the pilot's view. It was more noticeable in a left turn than a right turn. As the bank is increased the large window above the pilot can be used to see what is ahead in the turn, so that with greater than 40 degrees of bank, a full field of view is again available. During shallow bank turns I felt a little uncomfortable with the limited view and would compensate by occasionally raising the wing to look under, or, increase the bank to look out the top window. Due to the limited amount of horizon in view, there may be an increased possibility of spatial disorientation while flying in reduced visibility conditions.

ACCOMMODATIONS

During several subsequent flights the humidity was high and windshield fogging occurred. The cabin was very well sealed and afforded little natural airflow, which kept it nice and warm but allowed for the accumulation of the condensation. With a handkerchief, some of the accumulation could be removed, but without unstrapping, most of the windshield was just too far away to reach. Two small vents from the engine compartment had been installed to help the fog problem, but had been capped off for the trip to Santa Rosa. The cabin heater worked very well. There was a very simple cuff around the exhaust manifold which could be controlled with an on/off valve on the instrument panel. Turning the heater up to full volume helped some with defogging the windshield.

The only gyro was a turn coordinator that was switched so it could be left off when it was unneeded. No yaw trim system was installed.

A small flap was installed on the aircraft with a three position manual extension system. The first two notches of flaps were easy to use, however quite

Larry Ford

Jim Clement and his Tailwind on the CAFE Scales.

a twist of the body was required to get the handle far enough aft to catch the last notch. The forces of flap extension/retraction were light.

STATIC LONGITUDINAL STABILITY

The aircraft was trimmed for 120 mph at 8500' to evaluate the speed stability. A hand-held stick force gauge was used to measure the elevator stick force. Without re-trimming, the stick force was measured every 10 mph over the entire range from 80 mph to 180 mph. The resulting stick force gradient is plotted on the graph in Figure 1. The results show a change of only 1.45 lb stick force over the entire speed range. This amount of stick force is considered extremely light. An inexperienced pilot may find it difficult to fly with so little feedback. The pilot must rely on other inputs such as the indicators to control pitch accurately. A temporary lack of attention, even by a more experienced pilot, could result in a dangerous loss of airspeed control.

DYNAMIC STABILITY

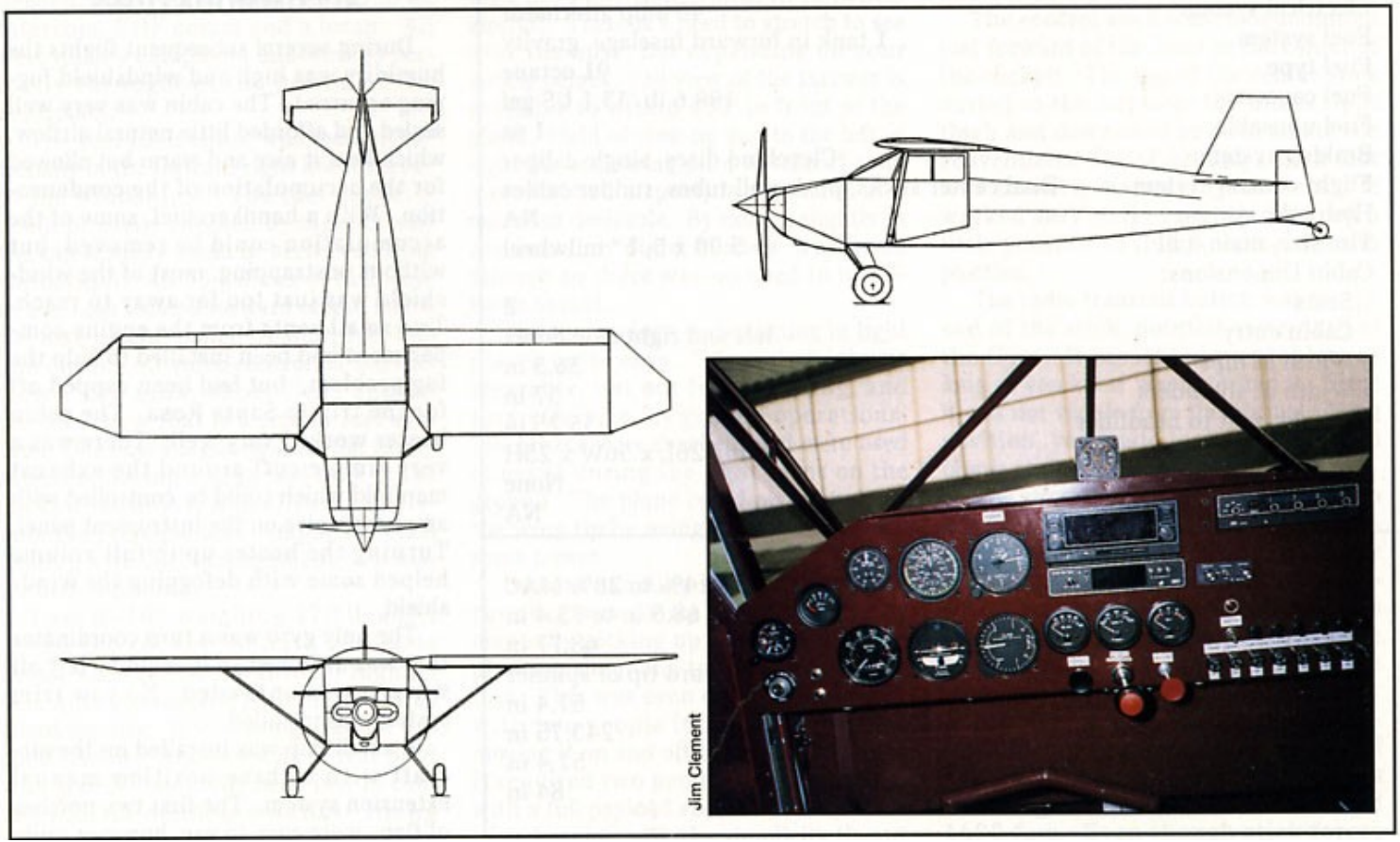
Pitch doublets, first down then up were introduced to evaluate the natural damping qualities of the airplane. Both stick-free and stick-fixed methods across the full speed range were evaluated. The results showed deadbeat response; that is no overshoot or oscillatory tendency was observed. Displacing the airplane in yaw and roll to explore the Dutch roll tendencies also showed quick damping with no tendency to persist. Thus, even though the stick forces are very light, the plane exhibits excellent natural dynamic stability qualities.

SPIRAL STABILITY

The aircraft was trimmed for level flight at 130 mph and bank was established at 15 degrees, first right then left, to determine if it would over bank or level out on its own. The aircraft held the bank angle exactly during these maneuvers. It seemed as if it were connected to an automatic pilot. After completing nearly 360 degree turns the test was ended, noting the absolute neutrality of the spiral stability.

ROLL DUE TO YAW

With the aircraft in trim at 100 mph, stick forces to maintain level flight were measured in roll with first 1/2, then with full rudder deflection. Approximately 1.5 lb of force was required in each direction with 1/2 rudder displacement. With full right rudder a 5 lb left aileron force was required and with full left rudder a 4.5 lb right aileron force was required to keep the plane in level flight. Considering the otherwise very light stick forces of this plane, these values show a very strong dihedral



Jim Clement

effect. To further explore the dihedral effect, a 45 degree bank was established. Then, with rudder alone, the wings were leveled keeping the ailerons neutral. This airplane exhibited, without a doubt, the fastest rate of roll that I have seen in a straight winged airplane using rudder only. This tendency was consistent in both directions at all airspeeds explored. This strong roll due to yaw may be caused by the tapered wing tip design since the wings have no geometric dihedral.

ROLL PERFORMANCE

Full deflection aileron maneuvers were examined to measure both the roll rate and stick force. In one G flight, the time required to change bank angle from 45 degrees in one direction to 45 degrees in the other, including the acceleration, was measured. Roll rates of 47 degrees per second at 120 mph, and 45 degrees per second at 100 mph were observed in both directions. The stick forces steadily increased with greater deflection up to 9 lb at full displacement. This amount of natural feedback, though light, blends well with the very light elevator force. It would prove undesirable to fly if the ailerons were heavy and the elevators very light.

Adverse yaw was evaluated by using aileron only to establish a bank, then observing the yaw displacement/hesitation. The Tailwind showed mild adverse yaw in that it would only yaw about 5 degree and hesitate slightly before starting the turn.

MANEUVERING PERFORMANCE

Maneuvering performance was evaluated at 120 mph at 2 and 3 G's. The results were 4.5 lb and 7 lb of elevator stick force, respectively. Full flap maneuvering at 87 mph produced a stick force of 4.0 lb No overshooting tendencies or stick force lightening were observed during any of the maneuvers. These stick forces were consistent with the very light stick forces noted during other phases of the evaluation. Though enjoyable to fly the Tailwind requires a gentle hand.

STALLS

It was fascinating to perform the stall evaluation in this airplane. The stall test flight had been loaded to maximum allowable gross weight. The actual stall would occur with the airspeed indicator's needle dropping to below 41 mph. Later flights with the CAFE Barograph showed a large error in the low speed accuracy of the cockpit airspeed indicator.

There was a very pleasant and mild aerodynamic buffet with onset 4-5 mph above stall, and it increased to the point of stall. Power setting was not a factor in the stalls since low power settings were used to decelerate at about 1 mph per second. All stalls broke straight ahead with neither wing wanting to stall ahead of the other. Recovery occured with the slightest bit of power or relaxation of stick backpressure. All recoveries resulted in less than 100 feet of altitude loss.

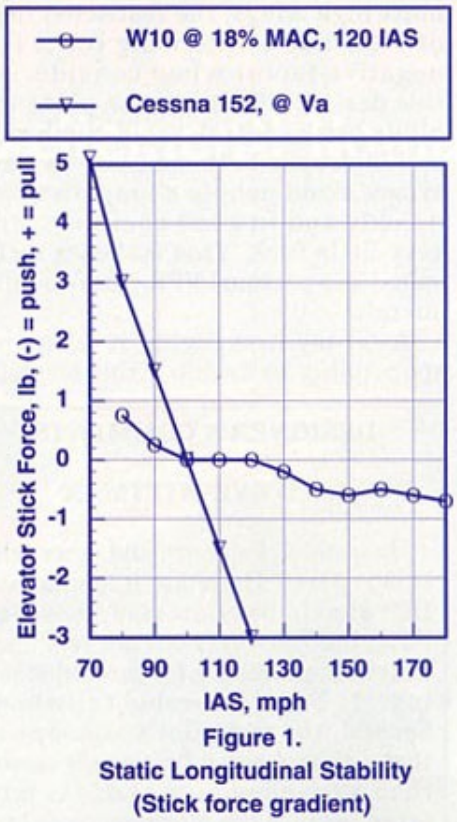


Figure 1.
Static Longitudinal Stability
(Stick force gradient)

ROLL RATE, degrees/sec.		
Speed. IAS	Va	1.3 Vso
Tailwind W10	47	45
Cessna 152	47	34

Panel IAS	Barograph CAS
41	66
48	67
50	68
55	70
60	72
65	76
70	80
80	87
90	94
100	103
110	113
120	123
130	132
140	141
160	162
182	186
187	191
200	202

Panel Altitude	Barograph Alt.
1000	992
2000	2022
3000	3031
4000	4025
5000	5030
6000	6050
7000	7041
8000	8050
9000	9087

TRIM AUTHORITY

The aircraft could be trimmed to level flight at all airspeeds from Vne down to 86 mph. I would consider this to be good trim authority. Roll trim was adequate.

APPROACH AND LANDING

During the flight it became evident that careful planning was required to set up a proper approach to the airfield. The plane was clean, fast and did not give up airspeed easily.

My first arrival on the base leg position was about where I thought it should be but as I got closer it became evident that a slip would be necessary. A moderate slip was called for to correct for my slight miscalculation of glide angle. By holding 100 mph, an excellent glide angle for a power off approach was established.

The light wooden propeller allowed quick response of the engine to all power applications. With even the smallest of amount of power applied, the glide range became deceptively long. My first landings were wheel landings and caused no appreciable problems as long as the flare speed was about 80 mph. Any excess speed would set up conditions likely to cause porpoising in a normal wheel landing.

On subsequent flights, three-point landings were explored. The plane handles very nicely in these provided the tail wheel is the first to contact the runway. The positive steering of the tail wheel helps with the directional control immediately upon touchdown.

Braking and post flight operations were straight forward.

CONCLUSIONS

This Tailwind, by keeping the 'extras' to a minimum and doing quality construction, is a simple, inexpensive plane with excellent performance. N6168X, as we evaluated it, contained only equipment essential for safe, efficient flight. The flying qualities were brisk and light.

Inexperienced pilots should be cautioned about the light stick force gradient of the Tailwind. As with most high wings, the restricted field of view due to the wing roots is a negative factor when considering this design. However, the plane exhibits brisk control, rapid climb rate and high speed. It can carry two average- sized people a long distance quickly and in good comfort using very little fuel. This makes it well-suited as a personal VFR cross-country aircraft.

After my first flight, it is my responsibility to decide if this airplane is an acceptable candidate to proceed with a full CAFE evaluation. It seemed like an outstanding choice.

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ABOUT THE BUILDER

Jim Clement runs an auto body shop in Merrimac when he is not building Tailwinds. He has built 3 of them and feels that this one, with its 160 hp Lycoming, is his best. He just sold his Continental O-300 powered version in April, 1994.

Jim learned to fly in a J-4 Cub in 1957 during high school, when he lost his drivers license! He first met Steve Wittman in 1962 while involved in Formula I air racing. Jim raced and served as crew member at many races. He specialized in building fiberglass cowls for Cassutt racers.

N6168X was built in only 11 months and for only $12,000 including the engine. Jim says, "You can do it for that ($12,000) if you build every piece yourself." During that time, Jim's auto body business was largely set aside in favor of building this airplane. A few of the months were spent entirely on aircraft building, with the day starting at 6 AM and finishing at 10 PM. Jim credits his wife, who also works full time for Rayovac, with a sizable contribution to the building of this aircraft.

The Tailwind is a plans-built aircraft, and in several areas, Jim made modifications to suit his needs. For example, he shortened the span 1 ft in order to have a higher cruise speed and moved the firewall forward 2 " for more legroom. He used reduced inlet and outlet areas on his custom cowl, copies of which are now available from Edge Concepts.

This aircraft is a showplane. Jim's career in auto refinishing has equipped him with exceptional skill in painting and fabrication, and this is evident everywhere on N6168X.

FUTURE TESTS

The CAFE Foundation is now formulating its calendar for flight testing other aircraft. The primary criteria for testing are that they representative examples of popular, currently available designs. An Aircraft Performance Report will be published in Sport Aviation on each tested aircraft. This is an excellent opportunity for the owner to obtain detailed insights into his or her aircraft, and provides a service to EAAer's who may be considering building that design. EAA generously funds this flight test program.

DESIGNER'S COMMENTS

By STEVE WITTMAN

In general, I enjoyed and agree with this report. There are a few details that should be addressed, however. First, the Tailwind does not rely upon differential braking for ground steering. It has a steerable tailwheel. Second, the test pilot's assumption that a square-sided fuselage is slower than a rounded or oval one is mistaken because the interference drag at the wing's juncture with a rounded fuselage is greater than with a square one . . . excepting mid-fuselage wing junctures, which I have used in racing.

The newer wingtips I have been using in recent years do not improve the ability to lift a wing with rudder; they actually worsened it slightly. The tips were intended to improve the climb, glide and high altitude performance, and my flight testing proved this to be the case. I had expected at least a small decrease in cruise and top speed at low altitude, but to my pleasant surprise, the indicated speed was about the same as before. The new tips have a slight dihedral effect due to their bottom surfaces sloping upward. The Tailwind has always been a good rudder airplane. On cross countries, I seldom touch the stick and just fly with rudder.

The light forces on the controls are by design. I worked at achieving that and I like the plane much better with the light forces. Most pilots like it after 10 to 15 hours of flying. It is manageable, too. I taught my wife to fly in my Tailwind recently. There is quite a bit of stick travel, which makes the light forces manageable.

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