CAFE FOUNDATION

AIRCRAFT PERFORMANCE REPORT

Sponsored and Funded by the Experimental Aircraft Association

COZY MARK IV

BY BRIEN A. SEELEY, C.J. STEPHENS AND THE CAFE BOARD

CAFE Chief Test Pilot, C.J. Stephens shows off the Cozy Mk. IV's planform over Pt. Reyes national Seashore.

In the evolution of modern homebuilt canard aircraft, beginning with Burt Rutan's VariEze in 1974, we see steady progress toward the designs available today. The VariEze had a Volkswagen engine and no ailerons. It evolved to have a bigger engine, ailerons, NACA inlet cowlings, wheel pants other amenities. The Long-EZ, with its greater wing area, range and payload, more powerful engine and larger interior, represented Rutan's next generation canard design.

It gained wide acceptance as people got used to its unusual looks and were attracted to its exceptional efficiency. There was, however, a demand for an aircraft with more than two seats.

Nat Puffer of Mesa, Arizona, the Cozy Mark IV designer, originally modified Rutan's Long-EZ to a side-by-side two plus one configuration called the Cozy 3. Later, demand for 4 seats led to Nat's Cozy Mark IV. It uses the Lycoming 0-360 180 hp engine, has two rear seats, a thicker wing spar and larger wing area than the Cozy 3. Rutan agreed to provide Nat's company, Co-Z Development of Mesa, with a license agreement to sell plans that use Rutan's technology.

The Cozy's solid foam core composite design utilizes a hot-wire saw construction technique and is the simplest, least expensive four-place design on the market. Like most modern canard homebuilts, it is designed to be "stall resistant".

Mark Beduhn, the builder of our test aircraft, began working on his kit at 3:00 a.m. every morning before work for two years, worked alone, and finished his aircraft in 2,300 hours.

Nat Puffer sells Cozy plans, and directs his builders to suppliers. Many fast-build options are available. Website information is available at:

www.cozyaircraft.com

MY EXPERIENCE WITH CAFE

BY MARK BEDUHN, OWNER N949CZ

I was sitting under the wing of my plane at EAA AirVenture '98 when Brien Seeley came by and introduced himself as a member of the CAFE Foundation. He said they were interested in testing a Cozy Mark IV, and he asked me to consider allowing them to use my plane. Brien explained that they would do a weight and balance on electronic scales, have a professional test pilot explore the flight envelope of the plane, and then publish the results in ***Sport Aviation***. He then gave me a packet of information, and asked me to think about it. It didn't take me long to conclude that this was a unique opportunity.

The information that Brien gave me included instructions on building the wing cuffs that hold some sophisticated instruments to the wing of the plane. Although they didn't look too difficult to make, I decided to allow myself a couple of months, to make sure that I had enough time. I confirmed a test date with Brien, and then ordered the materials that I needed. It took me about three weeks to build the wing cuffs which I shipped to CAFE. I then got ready for the 1,600 nm trip from Conway, Arkansas to Santa Rosa, California.

The weather for the trip was perfect, and I arrived on a Friday afternoon at around 3:00 p.m. The first thing that had to be done was to determine the empty weight of the plane. My Cozy was emptied, the fuel was drained, and we then rolled it on to the electronic scales which were built into the floor of the hangar. The scales are so sensitive that we had to close all of the doors and practically stop breathing while the measurements were taken. A laptop computer was attached to the scales so that the CG of the plane could be instantly calculated whenever the plane was being weighed. After the initial weight and CG. were measured, the fuel truck came and topped off the tanks. After filling the tanks C.J. Stephens (the CAFE test pilot) and I went for a familiarization flight. Since C.J. has flown practically everything with wings, and also owned a VariEze for ten years, I did not expect it to take long for him to get used to my plane. I was correct. He seemed very comfortable with the plane after only a few minutes. We flew for a half hour or so, landed the plane, and rolled it back into the hangar. Several more CAFE volunteers had arrived while we were flying and immediately started working on the plane after we climbed out. Everyone had their assigned task. It was like watching a racing pit crew in action. The cowling was removed and numerous instruments were installed. A video camera and laptop computer were mounted in the cockpit for gathering data. The wing cuffs that I had built were attached to each wing, and the sensors were installed in them. At about 7:00 p.m. I went to the hotel, exhausted, but the CAFE people continued to work on the plane until around midnight.

When I arrived back at the hangar on Saturday morning, C.J. was already on the third test flight. Every time he landed a flight parameter was changed. They changed either the weight, the CG or both. The intent was to test as much of the flight envelope as possible. Having the scale hooked up to a computer made these changes very quick and efficient. C.J. continued flying all day, and finished just after dark. On Sunday he flew two more times for his subjective analysis, and was done around 10:00 a.m. When the last flight was completed, the plane was swarmed by CAFE volunteers removing all of the instruments they had previously installed. By 2:00 p.m. the plane was back in its original condition and ready to go. Whew! A lot was accomplished in only a couple of days!

My experience with the CAFE Foundation was very positive. I met some very nice people and learned a lot about my plane. I consider myself very fortunate to have had my plane tested by this very professional group of volunteers. I would highly recommend that if you are ever offered this same opportunity, don't pass it up!

Subjective Evaluation

COZY MARK IV N 494CZ

BY C.J. STEPHENS

CHIEF TEST PILOT

Having built and flown my own VariEze made me curious about what our flight tests of the Cozy would reveal:

WEIGHT AND BALANCE

The Cozy pilot must be particularly vigilant of center of gravity and loading conditions before each flight. As with all canard aircraft, the complex aerodynamic relationship between the canard and main wing is significantly affected by changes in CG location, which must be kept within limits for safe operation. A thorough discussion of this topic is outside the scope of this report, but stated simply, it is crucial that the canard be loaded so as to ensure that it stalls at a significantly lower angle of attack than the main wing. This feature provides "stall resistance" that usually distinguishes canard homebuilt aircraft from conventional aircraft. The wing leading edge vortilons and lower winglets are needed to achieve the desired stall resistance over the approved CG range.

The importance of CG in the Cozy is emphasized by the following cautionary note from the Cozy Mark IV owner's manual:

"Some variation in stall characteristics may be expected from one airplane to another. Inaccurate airfoil shapes, incidence errors, or weight and balance errors can result in a degradation of the normal stall resistant characteristics. At some point aft of the aft CG limit, the Mark IV may be susceptible to a main wing stall which, while easily recovered if forward stick is applied immediately, can result in a stall break with high sink rate.

"Experience with other aircraft of similar configuration has shown that if the CG is far enough aft and the main wing is stalled and recovery controls are not employed soon enough (before the airspeed drops to zero), the aircraft could become 'locked in,' and recovery would become very difficult with a large loss of altitude. As of this writing, no attempt has been made to stall

the main wing, of the Mark IV and hold full aft stick until airspeed dropped to zero to see how easy or difficult would be the recovery."

In tandem canard designs the aft seat is located near the CG, so once the aircraft is ballasted to accommodate the pilot up front, a wide range of passenger weights can be tolerated safely. The existence of a co-pilot's seat in the Cozy, located about forty inches forward of the center of gravity, complicates things a bit. The subject Cozy has a front seat minimum weight of about 250 pounds. A compartment in the nose can be used to carry ballast, each pound of which has the CG effect of 2.5 pounds carried in the front seat. Thus, in routine operation, a 150 pound pilot must carry 40 pounds of ballast in the nose. An inconvenience for the pilot can arise when he or she wishes to carry a plane load of passengers to a distant location, drop the passengers off, and continue or return solo. It is imperative that the aircraft be re-balanced before further flight, even if it means obtaining ballast locally.

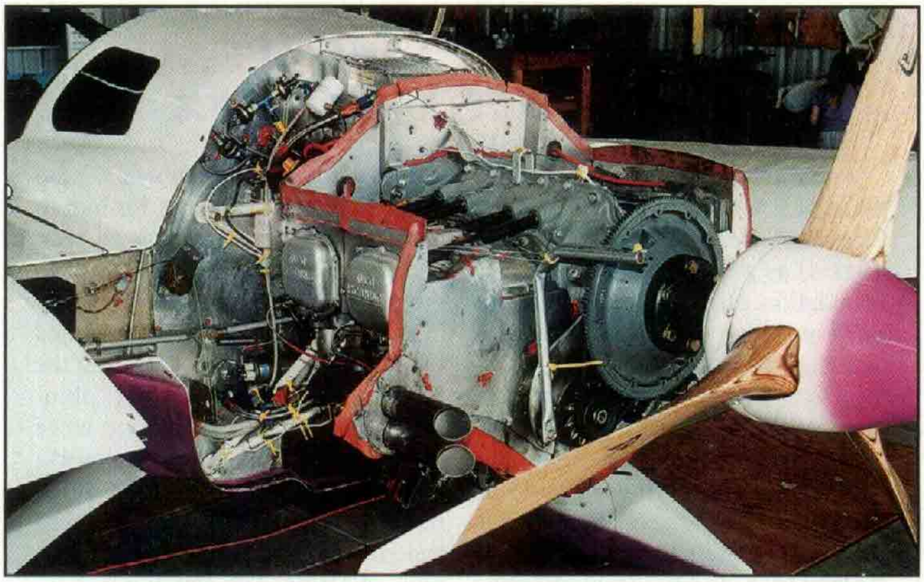
FIRST IMPRESSION

This aircraft was built to meet Mark Beduhn's personal needs for a VFR-only, efficient, traveling family airplane. His goals were well met. The instrument panel and internal finish were simple yet effective and very light weight.

The flight profiles were organized to measure all pertinent aspects throughout the flight envelope anticipated for normal safe operations. After five flights, all data sensors and equipment were removed and the aircraft was loaded to the most forward, safe CG for the stability and handling qualities evaluation. The final flight was loaded to the most aft condition that (with respect to the POH and test pilot opinion) can be safely flown.

EXTERNAL APPEARANCE

To people that have not seen a Cozy, or one of the other canard designs parked nose down on the ground with the swept wings, winglets on the wing tips and the engine in the rear, it appears at first to be a strange beast. Nothing seems to be in the right place. The elevators are in the front, the rudders are on the wingtips (and only deflect outward at the wing tips), and the engine pushes rather than pulls the craft through the air. The horizontal stabilizer (canard) provides an upward force instead of downward force (as on the conventional-tailed plane). These strange features that add to the safety and efficiency of this design, create a striking, almost alien look about it.



JO DEMPSEY

COCKPIT

The large bubble canopy is hinged from the right side and moves well out of the way for cockpit entry. The gas shock absorber strut that holds the canopy open has a simple snap locking device to prevent unplanned canopy closure. The weight of the canopy is not excessive for a person with normal agility and strength to open. During entry to both the front and rear of the Cozy it is necessary to step on the seat before sitting in it. There was an extendible step available to help get up over the side of the fuselage, although I found that hopping up on the strake and swinging my legs over into the front cockpit worked equally well. The step was tubular and extended out horizontally from under the front left seat, retracting for flight.

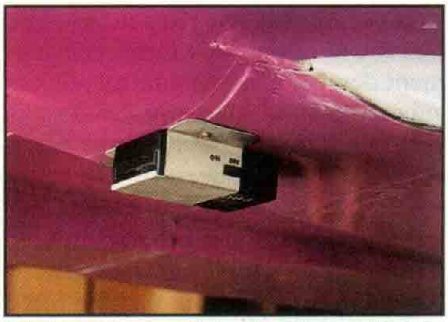
On sunny days, both front seats were in direct sunlight under the full bubble canopy. Wearing a hat and sunglasses are definitely in order and worked just fine to make the flights very comfortable. The field of view was fantastic from the front seats. In a climb, however, at less than 115 kts. the nose blocked the view of the flight path and called for clearing turns or increasing the airspeed for visibility. The view from the rear seats was limited downward due to the large size of the strake and the height of the seats above the strake. There were two small windows installed on the underside of the strake just forward of the elbows of the rear seat occupants to allow seeing below the aircraft in flight. Though somewhat limited, these look-down windows do allow passengers to see the passing terrain. Forward visibility while seated in the rear passenger seats was mostly blocked by the front seats.

Side-by-side seating has some real advantages in conjunction with side stick controls. It gives an immense amount of open lap space to do such things as unfold maps, eat lunch or even operate a laptop computer. The throttle quadrant was well forward and within easy reach from both front seats.

The retractable nose gear is operated electrically by a switch located on the center panel. The landing gear switch and the speed brake switch are the same type and color and are located close to each other. I feel that this is a potential problem since, in a moment of inattention, the pilot could operate the incorrect switch and experience an unfortunate gear up landing.

An electrically operated dragbrake is installed on the fuselage below the cockpit to increase the drag of the airplane during the traffic pattern and landing. It is not a true speedbrake since it cannot be deployed above 86 kts. but is effective in increasing the drag in the landing configurations. The Cozy has such low drag that it would be difficult to fly a normal glide slope without this drag device. It would also require increased braking during the landing roll if this dragbrake was not available.

Installed in the nose were both a

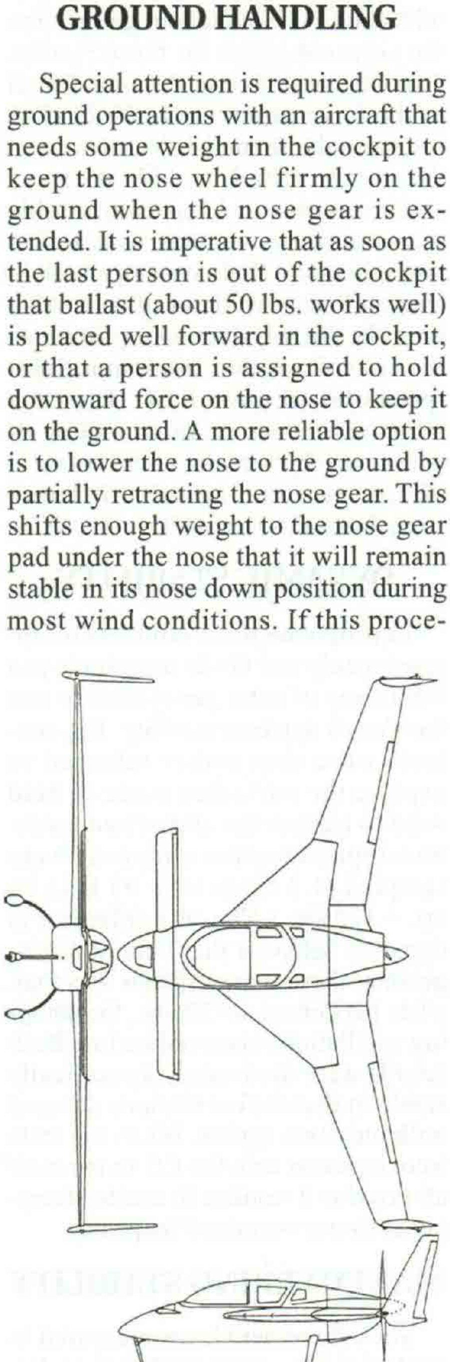


Flight engineer Chris Hawkins built this special mount to face the PropTach to the rear of the aircraft.

taxi light and landing light which I used during one late flight and found them both to be very effective.

GROUND HANDLING

Special attention is required during ground operations with an aircraft that needs some weight in the cockpit to keep the nose wheel firmly on the ground when the nose gear is extended. It is imperative that as soon as the last person is out of the cockpit that ballast (about 50 lbs. works well) is placed well forward in the cockpit, or that a person is assigned to hold downward force on the nose to keep it on the ground. A more reliable option is to lower the nose to the ground by partially retracting the nose gear. This shifts enough weight to the nose gear pad under the nose that it will remain stable in its nose down position during most wind conditions. If this procedure is not followed, the nose of the aircraft will rise and the plane will fall over on its tail, doing damage to the propeller and other expensive items.



Once on board and the nose gear extended, all other ground operations are normal. The canopy is lowered manually after releasing the hold-open lock on the gas strut. Once it is down there is a hook locking system that positively holds the canopy in place. There is a microswitch that indicates that the lock is engaged properly and a safety lock that only allows the canopy to raise about an inch should all else fail. It latches each time the canopy passes toward the closed position and requires positive action to release it and open the canopy. Should the canopy not be correctly latched and pop open in flight, the safety mechanism would stop the opening at about 1″ open. It is a good "fail-safe" item that has always been installed on many of these designs.

START/TAXI/RUNUP

The start up was normal for Lycoming type engines. Hot starts required no prime and started best with the mixture in the cut off position. It was recommended that only the installed electronic ignition be used during the start. On all my test flights the engine sprang to life and operated flawlessly.

Steering is controlled by differential braking and is very effective. The first part of the rudder pedal movement operates the rudder only and the wheel brakes become effective during the last part of the rudder pedal travel. The rudders are independent of each other and both can be deflected simultaneously. The free castering nose gear has an adjustable friction point that produces a break out force that controls shimmy of the nose wheel. During taxi operations, in cross winds, light tapping of the brake is required to control direction.

The runup and ground operations were conventional using a routine checklist. It was easy to see the elevator trim settings in that the elevators are just in front of the pilot and the amount of the elevator depression can be easily judged by comparison with the canard tip.

TAKEOFF AND CLIMB

The aircraft sits very nearly level prior to brake release — a low drag attitude for the acceleration during take off. With the engine in the rear of the airplane, the rudders on the winglets and the elevators in the front, there is no propeller blast over the control surfaces. This causes the airplane to be lethargic about directional control until sufficient airspeed is gained. The elevators produce lift only when sufficient airspeed has been achieved. This means that an early high nose up pitch attitude cannot be accomplished during short or soft field takeoffs as would be possible in conventional-tailed aircraft. Directional control during the early part of the takeoff must be maintained with the tapping of the brakes which lengthens the takeoff roll. Once airspeed reaches about 50 kts. the rudder alone has sufficient authority to control directional tracking for take off. (All airspeeds in this report are indicated airspeeds from the aircraft's stock instrumentation.) The nose rises quickly at 70 kts. and the Cozy deftly lifts off at 80 kts. At a forward CG, during takeoff the nose remained planted on the runway until the elevators were able to unstick the nose. Then, an abrupt rotation was observed, requiring nose down elevator input to stop the increasing nose up pitch at the proper takeoff attitude.

At aft CG, when taxiing the reduced compression of the nose strut caused more difficulty in tracking straight on the taxiway. The nose was more willing to lift off at a lower airspeed than during the forward CG flight. In addition, the liftoff was more gentle with no tendency for over rotation.

Climbing at 105 kts. seems fairly nose high but provides a good rate of climb. After takeoff the nose gear retracts with a flip of the switch. During the aft CG flights it was easier to establish the takeoff attitude at a lower airspeed.

TURBULENCE

The Cozy provides a better ride in turbulence than conventional aircraft of the same wing loading. This is due in part to the self correcting tendency of the canard's elevator when it encounters an upgust. The elevator, when upwardly deflected by the gust, imparts a corrective nose down pitch response. This same effect also occurs when the gust strikes the main wing, which, because its center of lift is aft of the CG, responds with a nose down pitch response. These pitch responses reduce the lift on both the main wing and canard at just the time a reduction can help soften the turbulence. The main wing's lift coefficient is already low due to sweepback while that of the canard is high by design. This means that the canard's wing loading is higher than the main wing's and its area is much less, allowing it to 'soften the blow' before the upgust strikes the more lightly loaded main wing. The flexibility and damping of the non-graphite fiberglass/foam structure also helps soften the turbulence.

STATIC LONGITUDINAL

The airplane uses a side stick which is operated with a wrist movement fore and aft to operate the elevators to control pitch rather that a fore and aft motion of the entire arm as in a center stick aircraft. The forces available with wrist action are considerably less than those of the entire arm. The mechanical advantage of the Cozy's stick control lever is also considerably different hence the stick forces measured with the handheld stick force gauge will reflect these differences. The placement of the stick force measurement device upon the control stick is subject to variation since the stick is short, and this can influence the measured forces significantly. The main objective of a designer in creating static margin is that the stick forces build steadily as the plane is displaced from its trim speed and that the force is ample, but not excessive. The airplane, when released to the stick free condition after being manually displaced from trim speed, should seek its stable trim speed.

The Cozy was trimmed to Va of 120 kts. and stick force measurements were taken at each 10 kt. increment with the CAFE handheld gauge. See the adjacent graph for these results. Two CGs were flown; the first 7% aft of the forward limit (97.82" @ 1736 lbs.) and the second 18% forward of the aft limit (101.2" @ 1575 lbs.).

The control feel was comfortable and sensitive yet not overactive throughout the flight envelope both in trim and when well out of trim. Also note the steeply increasing force as the aircraft reaches minimum flight speed when at forward CG. These are all good traits in aircraft handling. It is noteworthy that the stick forces at aft CG were not radically different from those at forward CG.

DYNAMIC STABILITY

I introduced pitch doublets of approximately two G's in magnitude at a frequency of once per second to test the Cozy's dynamic stability. The controls were then either released to explore the stick-free mode or held solid to explore the stick-fixed mode. Two representative airspeeds were sampled (1.3 times Vs = 93 kts.; Va kts. = 120 kts.). The only difference in dynamic behavior that I could distinguish at these two airspeeds was that, when performed at 120 kts., the damping oscillations occurred earlier. Both speeds were moderately dynamically stable in that the oscillations damped with only two cycles. When the tests were repeated with the CG in the most aft position it resulted in similar damping at slower overshoot frequency.

MANEUVERING STABILITY

Stick force per G was measured in banked turns and plotted in the adja-

CAFE MEASURED PERFORMANCE, N494CZ

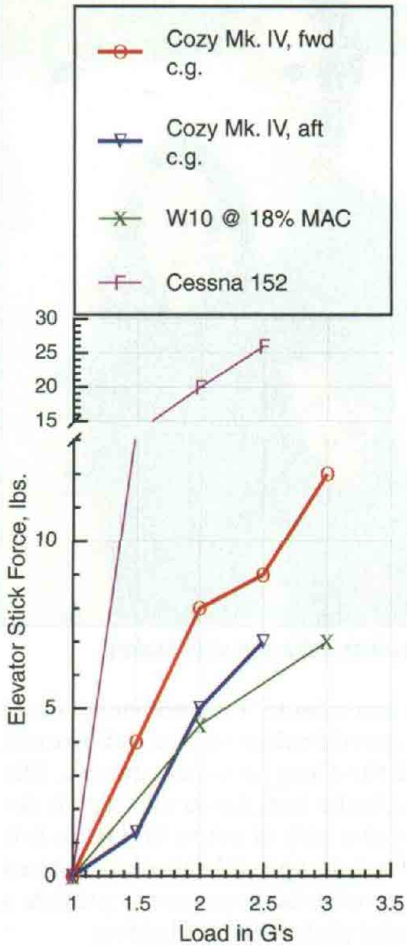
Propeller max. static RPM	2350 RPM
Vmax, TAS, 854' dens.alt., 1668 lb, 29.2", 2691 rpm, 12.9 gph	182.1/209.8 kt/mph
Stall speed, 1903 lb, 8" M.P., 1200 RPM, nosegear up, CAS	71.4 kt/82.3 mph
Stall speed, 1672 lb, 11" M.P., 1260 RPM, nosegear up, CAS	61.5 kt/70.9 mph
T.O. dist., 5 mph headwind, 71° F, 125 ft MSL, 1900 lb/1680 lb	1600 ft/960 ft
Liftoff speed, by Barograph, 1900 lb, CAS	71.7/82.6 kt/mph
Touchdown speed, Barograph, 1855 lb, CAS	79.4/91.5 kt/mph
Minimum sink rate, 1857 lb, 94 mph CAS, 108 mph TAS	641 fpm
Glide ratio, idle, 106 mph CAS, 116 mph TAS	14.25
Noise levels, ambient/idle/full power climb/75% cruise	62/81/92/96 dB
Peak CHT in climb, 90 kt, full power	491°F
Cowl exit air temp@491°F CHT, 58°F OAT	180°F

Cozy N494CZ Sample c.g.

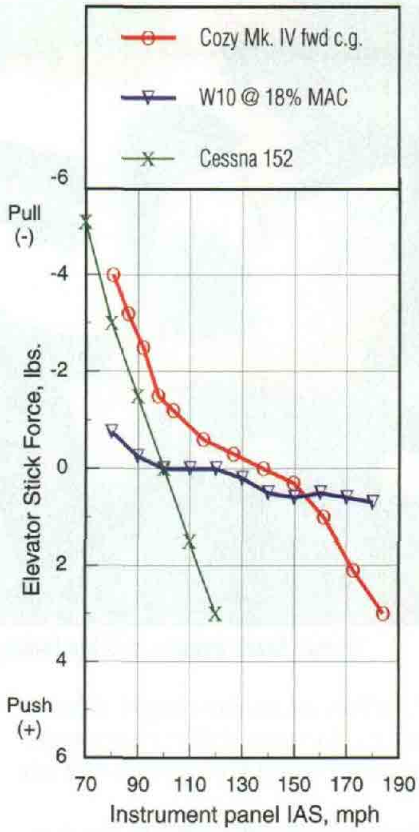
Sample c.g.	Weight, lb	Arm	Moment
Main gear	1203.8	110.2	132644
Noeswheel	33.4	19.2	641
Pilot, front	170.0	59.0	10030
Co-pilot, front	170.0	59.0	10030
Passenger, rear	70.0	101.0	7070
Fuel,wing tanks full 51.7 gal.	310.4	104.5	32442
Oil, included 7 qt.	0.0	0.0	0
Nose weight	-57.9	19.2	-1111
Baggage, none	0.0	136.0	0
TOTALS	1899.7	100.9	191746
Datum: 113.9"fwd			
of rear wing/strake intersection			
c.g. this flight, in.	100.9		
c.g., % MAC	na		
c.g., % aft of fwd limit	76%		
Gross weight, lb	1900.0		
Empty weight, lb	1179.3		
Useful load, lb	720.7		
Payload, lb, full fuel	410.3		
Fuel capacity, gallons*	51.74		
Empty weight c.g.	112.1		
c.g. range, inches	97.5-102		
c.g. range, % MAC	na		
*as weighed by CAFE			

Panel IAS, mph	CAS, mph. CAFE Barograph #3
80.6	82.3
92.2	93.4
103.7	104.2
115.2	115.3
126.7	126.8
138.2	137.3
149.8	148.4
161.3	160.3
172.8	170.3
184.3	182.7
195.8	193.6

Cozy Mk. IV N494CZ Airspeed calibration



Maneuvering stability at Va



Static longitudinal stability

Trimmed to zero pounds with stick- free and flaps up at Va.

cent graph. The force required increased steadily with increasing Gs and was comfortable to manage. The force input was primarily from wrist action rather than a pulling from the upper arm. Control when using this side stick was more precise than typically experienced with center stick or yoke control and was able to deal accurately with small movements.

SPRIAL STABILITY

Spiral stability was examined by trimming the aircraft to level flight then setting it into a 15 degree bank and observing its tendency to increase or decrease the bank. The tests were performed twice in both directions. After 30 seconds, both left and right banked turns showed no significant change in bank. The airplane thus exhibited neutral spiral stability.

ROLL RATES

It has been our practice to measure the time to roll through 120 degrees of bank change by starting the timing at the first input of the ailerons. Therefore, the elapsed time includes the acceleration time to establish the roll. It should be noted that the sustained roll rate would be in excess of published here. There were no reversing or other adverse roll tendencies noted.

TRIM ADEQUACY

A very effective electric elevator and aileron trim system were installed, which was thumb operated by a hat switch on top of the control stick. In the roll mode it was able to induce 4 lbs. of stick force in either direction at Va. This amount would not be difficult to counteract should a runaway trim be experienced. The pitch trim system was fully capable, trimming out the control pressure at all airspeeds in level flight. Full nose up trim would hold the airspeed just above the minimum controllable airspeed.

ADVERSE YAW

A swept wing aircraft is designed with the ailerons set inboard to maintain their effectiveness during stalls since a swept wing stall typically begins nearer the wing tip. In testing for adverse yaw I introduce full aileron input with no rudder input after setting up level flight at both Va and 1.3 Vs. During this maneuver I observe the compass heading, or outside references, to determine the amount of turn caused by the drag of the down-going aileron as it pulls the aircraft's nose in the reverse direction of the bank just prior to the aircraft starting to turn. The results showed that the airplane only hesitated three degrees with right and one degree with left aileron inputs. This minimal adverse yaw is partially an effect of the inboard location of the ailerons and their consequently reduced moment. The amount of hesitation adverse yaw was very similar at all of the airspeeds evaluated.

STALLS

All stalls were performed with nose gear up and dragbrake retracted. In the typical canard homebuilt aircraft, with increasing angle of attack, the canard stalls prior to the main wing and thus this prevents the aircraft from reaching any higher angle of attack than that at which the canard stalls. This stall of the canard causes the aircraft's nose to drop slightly reducing its angle of attack and causing the canard to recover its lift again. This, in turn, causes the nose to rise again and leads to a repeating cycle of canard stalls and recoveries known to many as "nose

ROLL RATE, degrees/second, includes input time		
	Va	1.3 Vso
Cozy Mk. IV	44 Rt./40 Lt.	36 Rt./33 Lt.
RV-6A	80	36
Cessna 152	47	34
RANS S-7C	61 Rt./63 Lt.	50 Rt./53 Lt.
GlaStar	52 Rt./50 Lt.	47 Rt./43 Lt.

bobbing." During the "bobbing," the nose just bobs up and down a few degrees while the main wing remains unstalled with full aileron control. To those pilots of conventional aircraft who experience white knuckles at the mention of stalls, this bobbing would be a non-threatening event. It is perfectly comfortable to fly around holding the stick nearly full back while commanding turns with full aileron. All the while the nose just continues to exhibit mild bobbing. It is all very pleasant and interesting to watch.

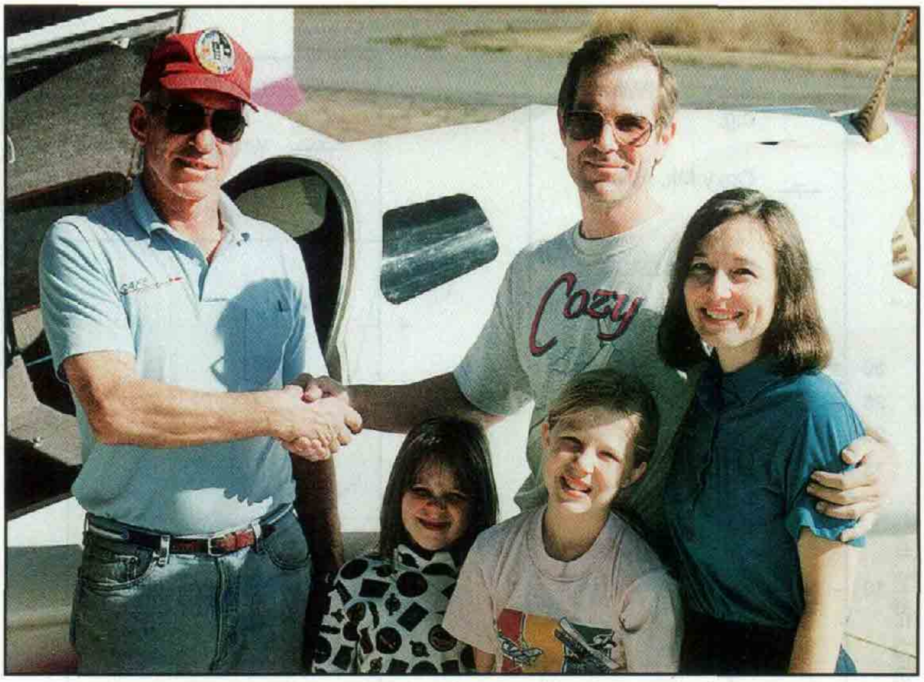
FORWARD C.G.

During the forward CG flight test (97.82"), as the airspeed was slowed through 75 kts. IAS, an electric tone activated in the headset to warn of the low airspeed and the airspeed indicator started to flash the digital IAS numbers. At 68 kts. the aircraft began the gentle bobbing. The elevators (clearly in view just in front) were depressed about 3/4" at their trailing edge during the bobbing. Any effort to slow the aircraft beyond this point, with further elevator input, would only cause the nose to bob more vigorously but had little effect on the airspeed.

AFT CG

Swept wings tend to start to stall at the tip, rather than at the root. As tip stall separation occurs with increasing angle of attack, the remaining effective center of lift moves inboard and forward. Since the CG remains relatively constant, the aircraft becomes progressively tail heavy as the swept wing begins to stall. This basic concept should be understood when flying an aircraft with swept wings.

The second handling qualities flight was performed at 1575 lbs. g.w. and the CG at 101.2" or 18% forward of the aft limit. This aircraft should definitely not be flown beyond the published aft CG limit due to the aft CG's effect on its slow flight characteristics. Several differences were noticeable when flying with the aft CG.



Owner Mark Beduhn and his family - Jennifer, Julie and wife Regina.

During the flight at aft CG, the minimum attainable airspeed showed a more mild bob amplitude than at forward CG and it occurred at a lower frequency. Upon reaching high angle of attack at below 65 kts., the canard elevator reached a deflection angle where normally a canard stall would have occurred. When no stall occurred, I began to suspect that the main wing may have been reaching a critical angle of attack. For this reason, I did not apply any further stick back pressure and terminated this maneuver.

FIELD OF VIEW

From the two front seats, with the full bubble canopy, the field of view is unrestricted by any structure. The canard just outside the window gives perfect horizon reference both in roll and pitch. When the air is smooth, in the cool of the morning, it is truly a joy to watch the earth slips quickly by under the nose.

DESCENTS

Arriving back at the airport takes little planning more than ensuring that the descent is started in ample time to reach the desired altitude and airspeed. The Cozy's airspeed to builds quickly in descents and any excess altitude is not easily dissipated at the last minute. I am not an advocate of speed brakes on non-jet aircraft and the Cozy is no exception. The drag brake installed in the Cozy is deployable only at below 86 kts. so it is not a true speed brake but is used along with the nose gear to provide a normal glide slope for landing.

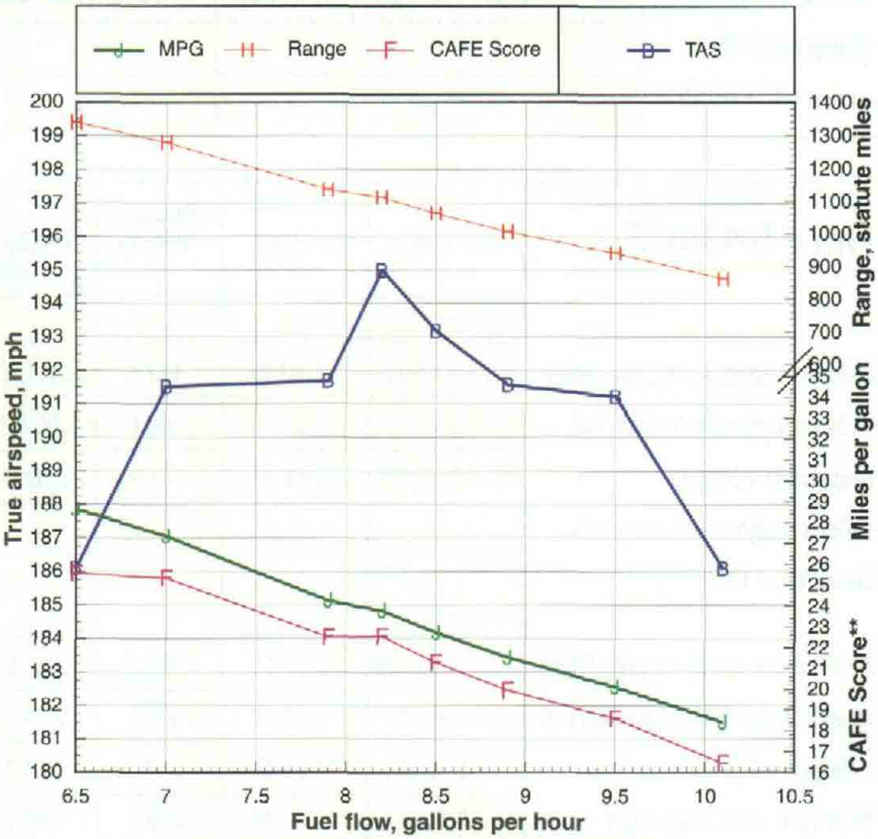
TRAFFIC PATTERNS

The work load is minimal in the Cozy. On downwind, one needs to activate the fuel boost pump and extend the landing brake and nose gear. These items are accomplished with the flip of three electrical switches. Once configured and slowed to traffic pattern airspeeds the nose is slightly high, but with a little stretch one can see well enough to spot any traffic conflict. The base turn and flight path on final are different than in conventional airplanes in that one must pay attention to not allow the airplane to get established on a steeper than normal glide path. In the normal approach with the Cozy, it takes little power (1,500 rpm) to hold a normal approach angle. If the pilot allows the plane to get high on the glide slope there is little available drag, or power reduction, to correct the situation. The pilot can deploy both rudders simultaneously to increase the drag. This helps steepen the glide. Since the wheel brakes are operated at the last part of the travel of the rudder pedals, caution must be used to not touch down with the rudders deployed or some tire scuffing will occur.

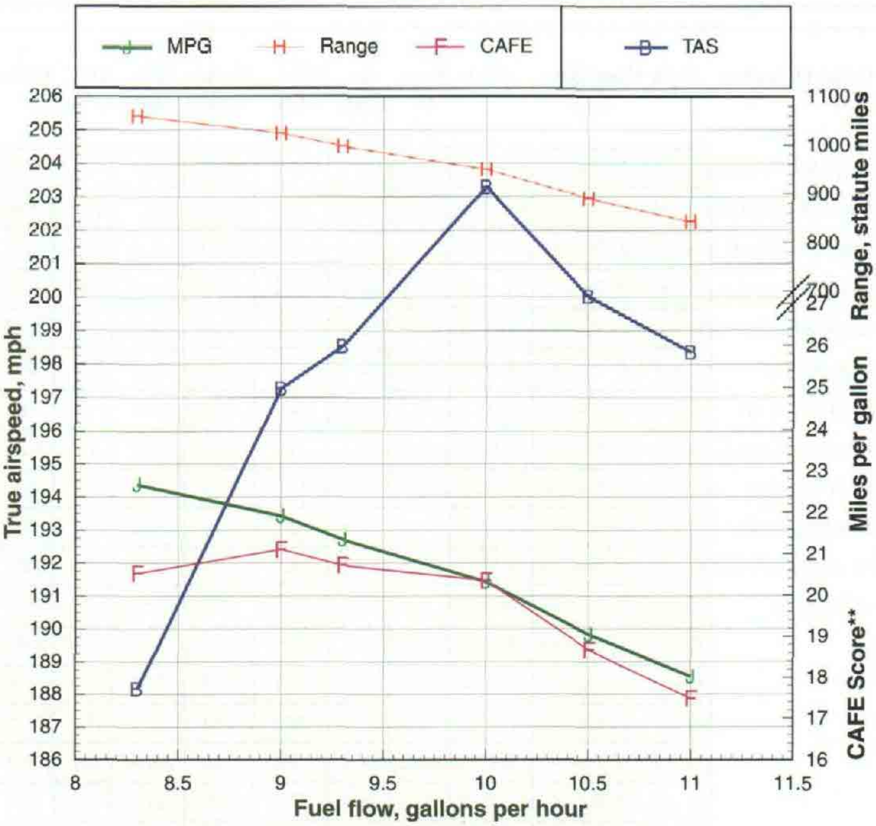
LANDING

The aircraft must be flown at the correct airspeed on final for best results. I found that 85 kts. worked quite well. The Cozy's landing nose attitude is higher than in a conventional aircraft making it harder to see over the nose. There is a tendency to fly canard type aircraft faster on final than their optimum approach speed simply because it is easier to see the runway. A better method is to sit forward in the seat during this part of the flight. Control authority is adequate and the airplane flies easily right onto the ground, touching down on the main gear first. At forward CG, the nose wheel then tends to drop and touch the pavement unless an elevator input is used to hold it off. However, at the most aft CG, the nose wheel tends to stay high in the air after touch down just like an Air Force F-15. The added aerodynamic drag during the nose high roll out helps to slow the aircraft during landing roll out. I touched down at 78 kts. at the 4,500 feet remaining marker with the nose high and let it roll. At the 1,500 feet remaining marker I still had 50 kts. on the airspeed indicator losing only 28 kts. in 3,000 feet of landing roll. The aircraft, when flown correctly, is capable of operating out of most improved airfields; however, landing at shorter fields requires good technique. The tires are small for the weight of the aircraft and a hard surfaced runway is a must.

The graphs below use a Power-Performance data plotting technique developed by Klaus Savier. The peak CAFE score occurs at the fuel flow and cruise velocity, V, which optimize the trade-off between speed and MPG and is typically lean of peak EGT. The relative CAFE scores shown here, scaled to fit the graph's Y axis, are based on the computation ($V^{1.3}$ x MPG), which is part of the CAFE Challenge formula.



Cozy N494CZ: 12000' density altitude, w.o.t..
**Comparative aircraft flight efficiency score



Cozy N494CZ: 8000' density altitude,
**Comparative aircraft flight efficiency score

Stall speeds-- Cozy Mk. IV	Flight/Clock	Mode	MP/RPM	Weight, lb	CAS, kt/mph
fwd c.g. at various	#1--13:17:33	Clean	8.0/1200	1903	71.4/82.3
M.P. and RPM's	#3--17:48:54	Clean	11.3/1260	1672	61.5/70.9
Wing Baro #3					
gross wt. = 1900					

SUMMARY

The Cozy is an excellent cross country aircraft. It is efficient and can carry up to four persons, although the two back seats are best suited for smaller persons. Ample baggage can be stowed in various locations throughout the cabin. It is not designed for aerobatics and is not a short

Cozy N494CZ	Flight/Date	Start time	Pressure altitude, ft.	Density altitude range	Weight, lb	CAS, mph	TAS, mph	Rate of climb, fpm
	Climbs							
Climbs at various altitudes using	#3--10/10/98	17:40:00	1778	2511.9-3506.9	1680	103	107	1171
wide open throttle (w.o.t.) and	#2--10/10/98	16:08:00	9682	11000.6-12009.6	1882	101	120	526
best power mixture	#2--10/10/98	15:52:11	1798	2502.3-3505.7	1897	102	107	860
various weights and airspeeds,								
Gross Wt = 1900	Descents							Rate of sink
All descents at idle throttle Flight	**#2--10/10/98**	16:22:20	9816	11150.9-9531.3	**1871**	138	162	1313
#2 and #3 used Baro #3 on wing cuff	#2--10/10/98	16:38:20	8479	9704.3-8964.9	1857	94	108	641**
**Vx gear + dive brake up	#2--10/10/98	16:39:50	7477	8691.1-8197.3	1857	95	108	794##
##Vx, gear +dive brake down	#2--10/10/98	16:41:40	5980	7090.9-6284.0	1857	106	116	716^^
^^14.25 glide ratio	#2--10/10/98	16:43:00	3979	4806.9-3771.0	1857	200	213	3439

Cruise flight data	Flight #/drag/Bar#	Clock	CAS Baro #3 mph	CAS, no cuffs, mph	Dens. alt.ft.	Density ratio	TAS, mph	M.P., in. Hg.	RPM	GPH	MPG	Weight, lb.	Range	Endurance, hrs.	Comment
Cozy Mk.IV N494CZ	#2 with cuff, Baro #3	04:13:40	153.7	155.3	11847	0.70	186.1	20.1	2495	10.1	18.4	1877.4	861	4.6	Vmax 12000'
New TAS computed	#2 with cuff, Baro #3	04:15:14	157.4	159.1	12043	0.69	191.2	20.0	2530	9.5	20.1	1875.9	941	4.9	w.o.t.
based on CAS and	#2 with cuff, Baro #3	04:15:32	157.7	159.4	12040	0.69	191.6	20.0	2535	8.9	21.5	1875.6	1006	5.3	430°CHT
density altitude and	#2 with cuff, Baro #3	04:16:34	158.9	160.6	12082	0.69	193.2	20.0	2538	8.5	22.7	1874.7	1062	5.5	
compensated for	#2 with cuff, Baro #3	04:17:55	160.5	162.3	12032	0.69	195.0	20.1	2545	8.2	23.8	1873.5	1111	5.7	
wing cuff drag	#2 with cuff, Baro #3	04:18:29	157.8	159.5	12038	0.69	191.7	20.0	2515	7.9	24.3	1873.1	1134	5.9	slight roughness
51.74 gallons fuel	#2 with cuff, Baro #3	04:19:21	157.8	159.5	11980	0.69	191.5	20.1	2460	7.0	27.4	1872.4	1279	6.7	
for computing range	#2 with cuff, Baro #3	04:19:47	153.4	155.0	11971	0.69	186.1	20.0	2405	6.5	**28.6**	1872.1	**1338**	7.2	felt power loss
for VFR reserve.	#2 with cuff, Baro #3	04:27:31	173.7	175.8	8031	0.79	198.4	23.5	2600	11.0	18.0	1866.6	843	4.2	w.o.t. 8000'
3 kts drag penalty	#2 with cuff, Baro #3	04:28:12	175.3	177.4	7975	0.79	200.0	23.5	2605	10.5	19.1	1865.9	890	4.5	
for wing cuffs @Vmax	#2 with cuff, Baro #3	04:30:12	178.0	180.2	8021	0.79	203.3	23.5	2607	10.0	20.3	1863.9	950	4.7	Best Power
of 209.8 mph	#2 with cuff, Baro #3	04:31:54	174.0	176.1	7975	0.79	198.5	23.5	2580	9.3	21.3	1862.2	998	5.0	Lean of peak EGT
	#2 with cuff, Baro #3	04:32:22	173.0	175.1	7938	0.79	197.3	23.5	2555	9.0	21.9	1861.9	1024	5.2	Lean of peak EGT
	#2 with cuff, Baro #3	04:33:44	164.7	166.6	8102	0.78	188.2	23.5	2500	8.3	22.7	1860.7	1060	5.6	Lean of peak EGT
	#2 with cuff, Baro #3	03:59:35	184.6	187.0	5880	0.84	204.1	25.1	2615	10.7	19.1	1889.9	892	4.4	Vmax 6000'
	#2 with cuff, Baro #3	05:53:43	204.3	207.2	854	0.98	**209.8**	29.2	2691	12.9	16.3	1668.6	760	3.6	Vmax 1000'
	#2 with cuff, Baro #3	01:43:49	89.9	90.5	7758	0.79	101.6	13.5	1530	4.3	23.6	1886.1	1105	**10.9**	Max endurance
	#2 with cuff, Baro #3	01:40:56	103.9	104.6	7844	0.79	117.7	14.7	1740	4.7	25.1	1887.3	1171	9.9	Vy level flt.

field or rough field aircraft. The pilot must be aware of the intricacies of its center of gravity management and use discipline to operate it correctly.

The Cozy Mk. IV is a pretty aircraft and draws favorable comments from nearly everyone who sees it. It is also a lesson in aerodynamics. Its cross country efficiency places it among the top homebuilts in its class.

Flight Test Details

Seven flights were made over the course of a weekend beginning October 9, 1998, all during day VFR conditions. A Flowscan fuel flow transducer was used for the gph determinations and was calibrated by measuring the weight of fuel burned on each flight. A PropTach digital tachometer was mounted on the fuselage belly to look aftward through the prop disc. Performance data flights were conducted with pilot and flight engineer aboard and flying qualities were evaluated with solo flights using an analog G meter and Brooklyn Tool & Machine Co., Inc. NJ hand-held stick force gauge.

Cruise flight data was obtained with the wingtip CAFE Barograph (#3) mounted on a wing cuff with a dummy barograph and cuff mounted on the opposite wing. These were correlated with the panel airspeed indicator to produce the airspeed correction table shown here. Our data suggest that V_y is 105 mph CAS and V_x is 87 mph CAS. Stalls were performed with the nosegear retracted. 56 pounds of nose ballast was used to obtain forward CG.

Cowl exit temp is a function of the OAT & CHT and is a measure of the efficiency with which the cooling system removes heat from the hot engine. This can be expressed as the temp rise relative to the hottest CHT observed during climb:

$$(180 - 58) / 491 = 0.25$$

The CAFE scales were used to determine the moment/arm of the aircraft's fuel. This was found to be 104.5" aft of datum rather than the 103.0" described in Owner's Manual.

CAFE HONORARY ALUMNI

Steve Barnard–RV-6A
Jim Clement–Wittman Tailwind
Jim Lewis–Mustang II
Ken Brock–Thorp T-18
Larry Black–Falco F.8L
Chuck Hautamaki–Glasair III
Jeff Ackland–Legend
Jerry Sjostrand–Express
Randy Schlitter–RANS S-7C
Stoddard Hamilton Aircraft, Inc. –GlaStar
Fred Baron–Lancair 320
Mark Beduhn–Cozy Mark IV

COZY MARK IV N494CZ

Privately built and owned by Mark Beduhn
Construction: Composite fiberglass and foam core.
Equipment: Vision Micro engine monitor

SPECIFICATIONS

Empty weight/gross weight	1179.3 lb/1900 lb
Payload, full fuel	410.2 lb
Useful load	720.7 lb
ENGINE:	
Engine make, model	Lycoming IO-360Ex, MB-1
Engine horsepower	180 BHP
Engine TBO	na
Engine RPM, maximum	2700 RPM
Man. Pressure, maximum	atmospheric
Turbine inlet, maximum	na
Cyl head temp., maximum	500° F
Oil pressure range	60 - 90 psi
Oil temp., maximum	245° F
Fuel pressure range, pump inlet	5 - 28psi
Weight of prop/spinner/crank	na
Induction system	Bendix RSA-5 fuel injection
Induction inlet area	6 sq in
Exhaust system	1 into 1, 4 separate pipes
Oil capacity, type, cooler	8 qt., 15W-50, Stewart-Warner cooler
Ignition system	1 Slick, 1 Lasar magnetos
Cooling system	Belly NCACA scoop, updraft
Cooling inlet area	50 sq in (stock cowl)
Cooling outlet area	100 sq in, fixed, no cowl flap
Propeller:	fixed pitch
Make	Performance 3-Bladed
Material	wood
Diameter/Pitch	64/76 in
Prop extension, length	8 in
Prop ground clearance, full fuel	13.5 in
Spinner diameter	11 in
Electrical system	12 V battery/35 amp alternator
Starter	lightweight Skytech starter 49-12pm
Fuel system	2 wing tanks - fuel injection
Fuel pump	engine driven pump, elect. boost pump
Fuel type	100 LL
Fuel capacity, by CAFE scales	51.74 gal
Fuel unusable	0.5 gal. each side
Flight control system	pitch-canard/ailerons on rear wing/rudders on winglets
Tire size, mains/nose	500 x 5 /4.00 x 4
Cabin Dimensions:	
Seats	4
Cabin entry	side-hinged canopy over rear wing
Width at hips	36.5 in
Width at shoulders	39 in
Height, seat to headliner	37 in
Baggage capacity, rear cabin	27 in L x 26 in W x 24 in H
Baggage door size	rear wing strake pockets for small bags
Lift over height to baggage area	47.5 in
Rear baggage capacity	70 lbs
Step-up height to wing T.E.	26.5 in step/ 21" rail

KIT SUPPLIER

Co-Z Development Corp.
2046 N. 63rd Place
Mesa AZ 852115
602.981.6401

OWNER/BUILDER N494CZ

Mark Beduhn
16 Tanglewood Drive
Greenbrier AK

DESIGNER'S INFORMATION

Cost of airframe materials, no engine or inst.	$14,000
Plans sold to date	744
Number completed	35
Estimated hours to build, from prefab kits	2500
Prototype first flew	October, 1997
Normal empty wt. per Owner's Manual	1050 lb
Design gross weight, lb, Takeoff/Landing	2050/1900 lb
Recommended engine(s)	O-320 to O-360 Lycoming
Advice to builders:	No spins, abrupt maneuvers, or rough field operation. Chandelles, laxy eights, steep turns ok.

CAFE FOUNDATION DATA, N494CZ

Wingspan	28.1 ft
Wing chord @ root/tip, Strake chords	41.5/21 and 93.5/41.5 in
Wing area	101.4 sq ft
Wing loading	18.7 lb/sq ft
Power loading	10.55 lb/hp
Span loading	67.6 lb/ft
Airfoil, main wing/canard	Modified Eppler from Long-Eze/Roncz 1145
Airfoil, design lift coefficient	0.2
Airfoil, thickness to chord ratio	15 %
Aspect ratio, wing area	7.26:1
Wing incidence	0 °
Thrust line incidence, crankshaft	na
Wing dihedral	0 °
Wing taper ratio, root/tip,	+.75 °/-.25 °=1 ° Total
Wing twist or washout	1.5°
Wing sweep	23°
Steering	Differential braking, castoring nosewhee
Landing gear	Tricycle, retractable nosegear (elect.)
Canard span/area/taper ratio/aspect ratio	12 .1 ft/13.1 sq ft/1.0/11.2
Canard chord	13 in
Elevator: total span	54 in
Elevator chord	4 in
Winglet span/area incl. rudder	57 in x 20 in (ea.)/228 sq in
Winglet chord: average	20 in
Rudder: average span	50 in
Rudder chord, average	6 in
Ailerons: span/average chord, each	71.3 in/6.5/4.2 in
Canard incidence	0 °
Total length	17 ft
Height, static with full fuel	7.9 ft
Minimum turning circle	18.5 ft
Main gear track	6.5 ft
Wheelbase, nosewheel to main gear	7 ft
Acceleration Limits per factory:	+3.8/-1 g
Airspeeds per Owner's Manual	
Never exceed, Vne	190 kt/219 mph
Maneuvering, Va	120 kt/138 mph
Best angle of climb, Vx	80 kt/92 mph
Best rate of climb, Vy	90 kt/104 mph
Stall, clean, 1900 lb GW, Vs	na
Stall, dirty, 1900 lb, GW, Vso	na
Gear operation/extended, Vge	150 kt/173 mph
Airbrake max. extension	85 kt/ 98 mph

Not approved for spins

IMPORTANT NOTICE

ACKNOWLEDGEMENTS

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COMPARATIVE AIRCRAFT FLIGHT EFFICIENCY, INC.

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