AIRCRAFT PERFORMANCE REPORT

Sponsored and Funded by the Experimental Aircraft Association

Lancair Legacy

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

LARRYFORD

"Here are the keys, please bring it back to us in two weeks", is what they told CAFE Foundation Chief Test Pilot, C.J. Stephens after his 15 minute checkride in the Lancair Legacy factory prototype, N199L. Such is the confidence inspired by C.J.'s piloting skills as well as Lancair's faith in their new design. C.J. has flown over 100 different types of aircraft, including many military jets, and is well known as an instructor for race pilots at the Reno Air Races. He is not easily impressed by any aircraft. But the Legacy got his attention right away when he flew it from Lancair's Redmond, Oregon plant to Santa Rosa alongside the Glasair III that he built with partner Jim Reinemer. The Legacy required only 17 inches of manifold pressure to stay abreast of the Glasair III running at about 22 inches M.P..

Legacy N199Lis one of roughly ten that have been completed out of about 100 kits that Lancair has sold since the kit was introduced in October 2000. It should be emphasized that, though the Legacy's performance impressed all of us at the CAFE Foundation, even more remarkable was the nifty elegance evident in every feature of its design. No aircraft ever tested by CAFE has scored such high marks in all areas. The name Legacy is appropriate for an aircraft that so clearly incorporates the best in current available technology for light aircraft. From its excellent new Continental engine and new design prop to its highly efficient airfoil and flap system and the structural efficiency of its graphite skins, the Legacy design team has created a new benchmark in kit aircraft sophistication.

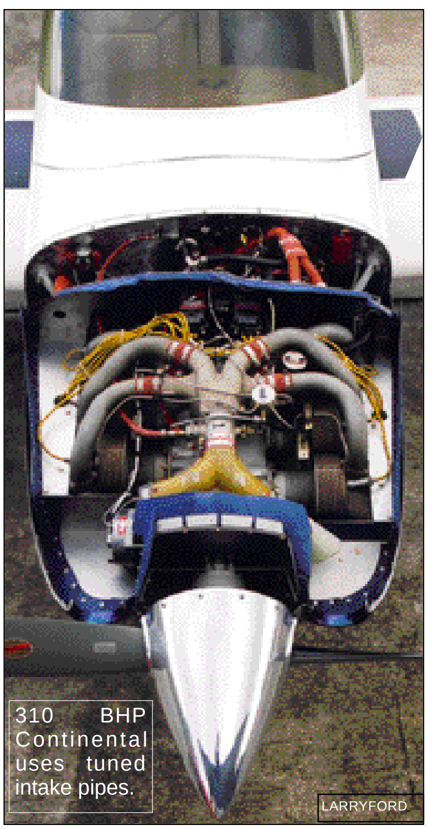
Lancair, founded in 1984 by Lance Neibauer, has successfully evolved kit production techniques through the development of the Lancair 235, Lancair 360, Lancair IV and Lancair ES to be a leader in today's efforts to help builders assemble their aircraft in less time with more consistent quality. The several fastbuild options for the Legacy include the airframe, engine/accessories/baffling, and firewall. Visit www.lancair.com for details.

The designer of the Legacy airfoils, flaps and other aerodynamic features is Greg Cole. The magic in the Legacy's lift to drag characteristics, reflected in this report, affirm that he should be considered among the best of today's aerowizards.

This is the first CAFE Aircraft Performance Report to present the concept of "speed for best CAFE fuel flow", or V_{bC}. This new way of choosing ideal cruise power is explained in the sidebar that follows and we hope will become as familiar a speed concept to pilots as V_{ne}, V_y, etc. A detailed Legacy report is available at www.cafefoundation.org.

Legacy N199L

Handling Qualities



310 BHP Continental uses tuned intake pipes.

CAFE Chief Test Pilot, C.J. Stephens

By: C.J. Stephens

Introduction

The data reported in this portion of the APR was recorded on a camcorder during flight . Stick force was obtained using a handheld stick force gauge and temporarily installed 'g' meter. The airplane was loaded with ballast to obtain the desired center of gravity and takeoff weight before each flight.

First Impression

Awesome performance!

The Legacy looks beautiful in every respect sitting on the ramp with the bright sun bringing to life the Flex paint that constantly changes colors with each different angle of perspective. Its sleek lines flow into a very graceful, 'aerodynamic' shape. The most noticeable features are the larger than standard cowl, which encloses a 310HP engine, and the large Plexigas canopy that offers the pilot station an unobstructed view.

This aircraft calls to all who pass to take a second look and at each fuel stop attracts people to come closer to admire and comment. The windshield requires regular cleaning before flight to remove the nose prints of the many curious spectators. The Legacy has a beauty that is state of the art in both design and performance. Not long into my first flight the thought "awesome" was forming in my mind.

External Appearance

The plane sits level on its tricycle landing gear. The double sweep of the leading edge and the curved wing tips give it a distinctive look of its own that stands out from other designs.

Cockpit

The wing height is low enough that it is not difficult to step up on the wing non-slip strip while still being careful not to step on the flap. Once standing on the wing, it is easy to step into the cockpit because the huge bubble of plexiglass that forms the windshield and canopy swings well up out of the way on its forward mounted hinges. There is no need for stooping or crawling when entering this cockpit. Once settled into a sitting position the cockpit is comfortable and gives good freedom of movement with adequate shoulder room. The side-by-side seating arrangement provides a wide instrument panel with enough room to install almost any equipment desired for flight. The Lancair-Legacy prototype had enough instruments to fly light-duty IFR, having no de-icing except for pitot heat.

N199L had three-axis electric trim which operated tabs on the various surfaces. Four buttons on the top of the stick grip operated the rudder trim and the elevator trim. Since I am more used to having the roll trim on the stick grip than the rudder trim this took some getting used to. The elevator trim worked quite well but was very sensitive and called for just a tap of the button in the desired direction to adjust the pitch trim. I also found that operating our flight test equipment in the cockpit occasionally caused things to rest on top of these trim buttons, which caused sudden and excessive inputs of unwanted trim. We have been told that the final version of the kit will use a different stick grip configuration for trim control. The roll trim was operated by a spring-loaded toggle switch located on the center console. Both pitch and yaw trim had indicators to show their position but the aileron was easily positioned by simply looking at the left aileron to see trim tab position.

The large baggage compartment is accessible while seated in the cockpit. When fully open, the canopy frame blocks the forward view and must be lowered most of the way before starting the engine. With the canopy in the nearly closed position the visibility during taxiing is good and the ventilation and windshield defogging are excellent. Prior to takeoff the canopy is simply lowered the last small amount and a large lever located between the shoulders of the occupants is rotated downward to engage stout hooks that hold the aft canopy frame securely down and locked. There are no other cockpit indication that the canopy has been locked other than observing that the hooks have engaged their receivers. I was told by Lancair that if takeoff was performed with the canopy unlocked, it would not be a major concern since the airplane flies just fine in such a case. However, it would be necessary to land in order to re-lock the hooks since the upward aerodynamic force would makes it impossible to close during flight.

Once the canopy is fully closed, totally surrounding the occupants, the real beauty of this design becomes apparent. There are no obstructions in any direction, giving a field of view that probably surpasses even that of the F-16.

Ground operations

Even at maximum allowed gross weight the airplane starts rolling quickly with minimum power application. The toe brakes work well and steering, even with cross winds, is very easy to master.

The nose gear design is superb. It is an internally damped strut with no external scissors. This small package fits nicely into the small gear well. It tracks very well using only light brake application, and showed no tendency to shimmy.

Takeoff And Climb

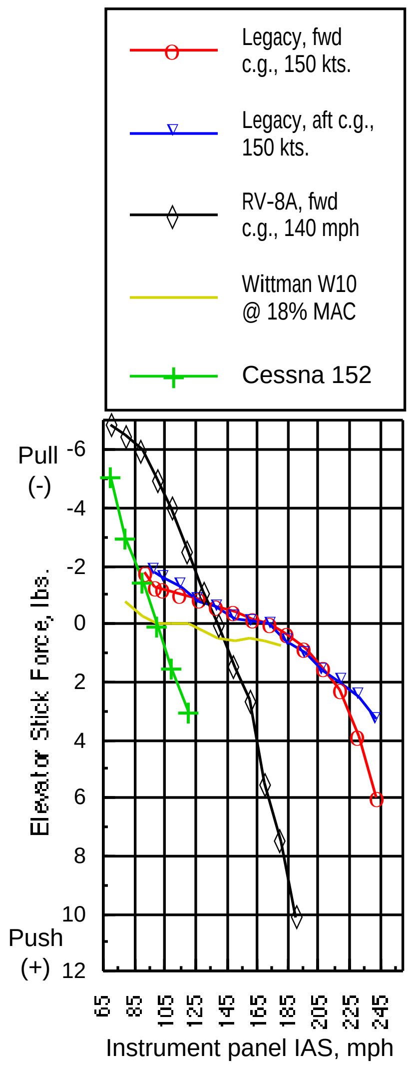
The pre-takeoff checks are all of the normal items for an airplane of this type. The flaps are set to a 15 degree down position visually by looking at their trailing edge.

As wide open throttle is applied to the Continental IO-550-N engine, the exhilaration of 310 HP coupled to a lightweight and aerodynamically clean airframe first becomes apparent. Takeoff roll is brisk with lift-off occurring at 76 KIAS. The electric/hydraulic landing gear system raises the landing gear quickly making a smooth transition to the climb schedule. Full power climbs are phenomenal and 25" X 2500 RPM climbs are impressive. Climbs routinely seem to show well over 2,000 fpm. See climb performance data in other part of this report for greater detail.

The view over the nose, especially during climb, is improved with proper sitting height. This should be checked prior to engine start by closing the canopy and adding seat cushions to adjust the height. There are literally no visual obstructions in the cockpit and by climbing at an indicated airspeed of 160 KIAS adequate forward visibility is obtained.

Static Longitudinal Stability

With the airplane properly trimmed at its maneuvering speed (Va) of 150 kts, the stick force was measured as the airspeed was increased or decreased in 10 KIAS intervals



Static longitudinal stability

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

over its useable airspeed range. This was done to determine the propensity of the airplane to return to trimspeed. The push or pull stick force measurements in pounds were recorded at both forward Cg and, on subsequent flights, Aft Cg. See graph. for details.

Maneuvering Stability

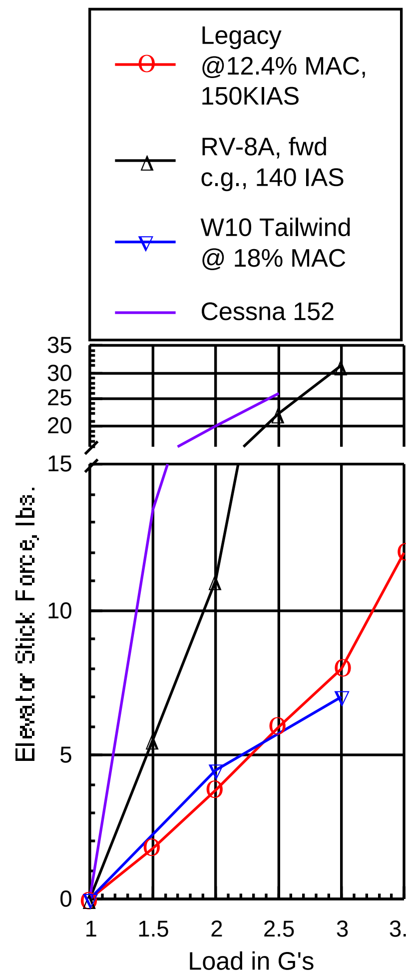
With the airplane trimmed for Va (150 KIAS) a turn was initiated and stick forces were measured at various 'g' forces as the turn rate was increased. (see graph.)

Spiral Stability

With the airplane trimmed for 150 KIAS, a 15 degrees bank was established and all controls were released to observe if the airplane would over bank or roll out of the turn. Turns in each direction continued at the same bank angle for in excess of 30 seconds. The aircraft thus exhibited neutral spiral stability.

Dynamic Stability

After establishing stable level flight at 190, 150, or 120 KIAS, I introduced a 2g pitch input doublet and released the control stick, recording the resulting aircraft response. In all cases the



Maneuvering stability at Va.

Removable glare shield gave good access to instruments.

The double tapered leading edge and sheared wingtip.

results were deadbeat and showed no residual pitching. Rapid roll inputs were similarly introduced and the airplane stopped instantly when the control was released (deadbeat).

Dihedral normally causes an airplane to roll at some rate with the input of rudder, especially as the angle of attack is increased. Wing sweep will also cause this dihedral effect.

The Legacy only has 3.7 degrees of dihedral so one would expect it to have a low roll-due-to-yaw response. Before testing this airplane I expected it to have a strong tendency to roll with yaw since it has such an interesting double leading edge sweepback; however, to my surprise, it had nearly zero roll-due-to yaw at any of the airspeeds tested.

The aircraft's nose showed minimal overshoot of the zero yaw position upon releasing the rudder from a full ball-width displacement yaw input.

Roll Rates

The roll rate was evaluated by timing, with a stop watch, the time to change from a 60 degree bank in one direction to a 60 degree bank in the other direction while using maximum deflection of the aileron and coordinating rudder. The resulting time includes the time to accelerate the roll and therefore reflects a slightly slower roll rate than the steady state rolling rate that the airplane is capable of sustaining. The roll rates in both directions at Va (150 KIAS) calculated to 80 degrees per second, which certainly seemed brisk.

Trim Adequacy

With the airspeed at 150 KIAS roll trim had the capacity of producing 2.6 lbs of force to the left and 0.9 lbs of force to the right. This amount of trimming force seemed sufficient for normal flight.

Stalls

Stalls were explored at 9,000 ft using 8" MP to establish an approximately a 1 knot per second rate of deceleration. The clean configuration stalls occurred crisply after mild aft stick force build-up and with little advanced warning. At the moment of stall the right wing dropped approximately 30 degrees but this became controllable using both rudder and aileron as the angle-of-attach was reduced. The resulting nose drop would cause only about 150 feet of altitude loss provided that the stall recovery input was commenced immediately.

Stalls with full flaps were explored with results similar to those obtained in the clean configuration. The deceleration was quicker due to the drag of the flaps and the nose attitude was lower prior to the stall. The wings maintained a more level attitude during the stall and recovery than they had during the clean configuration stalls. The stall was equally crisp and warning was very brief (less than one knot). Altitude loss during recovery was 400 feet due to the nose-low attitude obtained during the post-stall phase of controlling angle of attack.

Accelerated stalls and high angle-of-attack maneuvering were sampled at airspeeds as high as 130 KIAS. Mild buffet occurs just prior to accelerated stalls and the stick position is well aft giving the pilot an excellent cue as to the wing's aerodynamic condition.

Stalls in both configurations were comfortable and controllable throughout. Stick force build up and stick movement were mild but adequate during stalls.

Field of View

Full landing gear doors cover the oleo gear and tires.

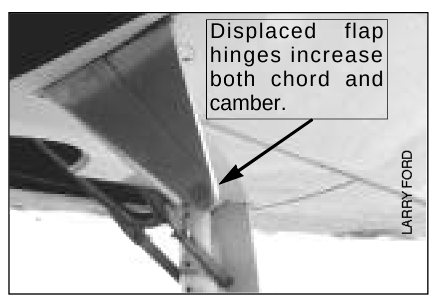
FABULOUS. Steep banked lazy eights were performed with several different flight engineers on board. All persons that experienced the highly banked pivot at the top of this maneuver agreed that the view was just fabulous. The totally unobstructed in the upward direction is similar to the view that a sky diver must experience when first jumping from an airplane, only in the Legacy there is no strong wind in your face.

Descents

The Legacy has a very wide range operating airspeeds. This helps give it the capability to descend very quickly to any desired altitude once the power is reduced and the nose is lowered. N199L did not have a speed brake installed nor do I feel that one is called for in this design.

Traffic Patterns

Entering the traffic pattern is very satifying due to the sense of an excellent view of traffic. The



Displaced flap hinges increase both chord and camber.

Stall speeds-- Legacy N199L	Flight/Date	Mode	MP/RPM	Weight, lb	CAS, kt/mph
fwd c.g. at various	#2--2/23/02	clean	8.5/1821	2218	72.4/83.4
M.P. and RPM's	#2--2/23/02	full flaps	9.7/2027	2217	59.2/68.2
Wing Baro #3	#2--2/23/02	full flaps	10.2/1842	2128	56.9/65.6 **
**panel read 57 kts					

cockpit workload is minimal and is easily understood with very little training. Advanced planning is required so as to be able to reduce airspeed to the landing gear extension airspeed of 122 KIAS. This instrument panel was arranged so that the landing gear handle and indication were at eye level just below the glareshield, making them easy to operate and monitor. On downwind at gear speed the forward view is adequate and improves as the flaps are extended. The extra drag with gear and flaps down requires only modest additional power to maintain level flight. Yet the available surplus of drag is sufficient to steepen a the glide slope to well beyond the norm. To me, it felt like an ideal combination of available drag and power to comfortably manage any traffic pattern.

Landing

The Legacy has a surprisingly slow landing speed for its wing loading. It achieves this mainly by virtue of its highly effective and well designed displaced-hinge slotted flap.

Several factors go into what makes some airplanes easier to learn to land than other designs. These factors include its approach speed, rate of deceleration, field of view, sitting height on the ground (due to gear length), control feel and sensitivity. Because the Legacy balances all of these factors so as to readily put pilots in the comfort zone, it will undoubtedly gain a reputation as an airplane with nice landing characteristics.

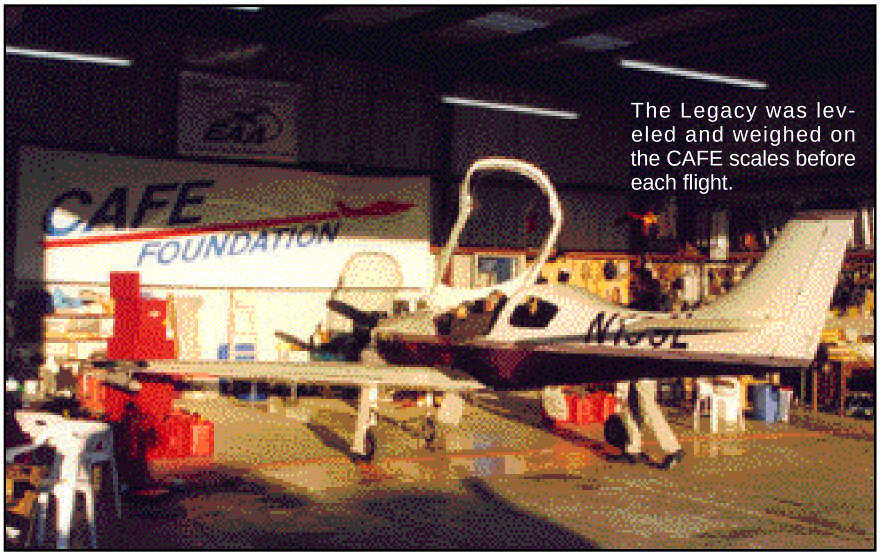
Summary

The Legacy is one of the next generation of 'fast glass' designs that take advantage of knowledge gained from those that have gone before them. It has superior performance and handling qualities. Although it is not the plane for a beginner, I am confident that pilots with modest experience and adequate training will be able to fly it safely. During the 14 hours that I flew this airplane, I did not find a single thing that I didn't like about it. It was with great reluctance that I delivered this airplane back to the factory when our testing was complete.

Fixed, non-adjustable cowl exits give 38 sq in of total outlet area.

CAFE MEASURED PERFORMANCE, N199L

Vmax, TAS, 8493' dens. alt., 2205 lb, 23.5", 2550 rpm, 15.7 gph	253.7/292.31 kt/mph
Stall speed, 2128 lb, 10.2" MP, 1842 RPM, dirty, CAS	56.9 kt/65.6 mph
Maximum rate of climb, 2158 lb, 2690 RPM, 27.2" MP, 18 gph	2632 fpm@155 mph CAS
T.O. distance., 0 mph wind, 51°F, 12 ft MSL, 2150 lb, 87.1" c.g.	1018 ft
Liftoff speed, by Barograph, 2182 lb, CAS	73.8/85 kt/mph
Touchdown speed, Barograph, 2046 lb, CAS	79/91 kt/mph
Min. sink rate, 2217 lb, 96 mph CAS, 101 mph TAS, flat pitch, 5.9"	1038 fpm
Glide ratio, idle, 158 CAS, 168 TAS, coarse pitch, 980 RPM, 9.6", 2127 lb	13.3 to 1
Noise levels, ambient//full power climb/75% cruise	39/101/100 dBA
Peak oil temp. in climb, 155 mph CAS, full power, 13,000' density	196° F
Cowl exit air temp, max., 140 mph CAS, 55°F OA	177° F
Cooling system ram recovery, %, climb/cruise	117% in climb, 60% in cruise
Propeller max. static RPM	2662 RPM
Empty weight, per CAFE scales	1493.95 lb



The Legacy was leveled and weighed on the CAFE scales before each flight.

ROLL RATE, deg./second, includes input time

	Va	1.3 Vso
Legacy N199L	80 Rt./ 80 Lt.^^	na
Lancair IVP N114L	79 Rt./ 90 Lt.	70 Rt./ 56 Lt.
RV-8A N58VA	109 Rt./102 Lt.	78 Rt./80 Lt.**
Cessna 152	47	34
RANS S-7C	61 Rt./63 Lt.	50 Rt./53 Lt.
GlaStar	52 Rt./50 Lt.	47 Rt./43 Lt.
**full flaps, 80 mph		
^^ 150 KIAS		

Darrel Harris, left, and C.J. Stephens crewed the flight testing.

Legacy N199L, Feb. 2002	Flight/Date	Start time	Presalt., ft.	Densalt range	Weight, lb	CAS, mph	TAS, mph	Rate of climb, fpm	comment
All data "wing cuffs on".	Climbs								
full power, 2665 RPM, 27", 27.8 gph, full rich	#2-2/23/02	17:15:38	2030	2014.3-2521.6	2172	152	158	2337	130K panel
full power, 2678 RPM, 27.7", 27.8 gph, full rich	#2-2/23/02	17:18:09	2015	2053.7-2555.7	2167	164	169	2392	140K panel
full power, 2692 RPM, 28.1", 28.0 gph, full rich	#2-2/23/02	17:20:42	2030	2087.1-2620	2163	178	184	2350	150K panel
full power, 2690 RPM, 27", 28.1 gph, full rich	#2-2/23/02	17:23:29	2048	2039.6-2516.4	2158	155	161	2632	135K panel
full power, 2690 RPM, 26", 26.0 gph Triaviathon	#2-2/23/02	17:31:01	2483	2510.5-3532.6	2143	158	165	2299	137K panel
full power, 2700 RPM, 27.5", 28.0 gph, full rich	#3-2/24/02	07:41:59	905	505.6-1525.1	2202	156	160	2546	135K panel
full power, 2698 RPM, 26", 25.0 gph Triaviathon	#3-2/24/02	07:42:42	2504	2677-3800.8	2200	160	168	2455	135K panel
full power, 2677 RPM, 22", 20.7 gph, 200° rich	#3-2/24/02	07:45:04	6950	8006.4-8518.9	2195	159	180	1618	135K panel
full power, 2662 RPM, 19.1", 17.7 gph, 175° rich	#3-2/24/02	07:47:25	10324	11517.8-12509.7	2190	158	190	1488	135K panel
GR = glide ratio	**Descents**	**Start time**	**Presalt., ft.**	**Densalt range**	**Weight, lb**	**CAS, mph**	**TAS, mph**	**Rate of sink, fpm**	**comment**
closed throttle, flat pitch, 1970 RPM, 3.2", 2.4 gph	#2-2/23/02	16:14:20	8679	9200-8206	2232	138	157	1316	120K panel, GR: 10.45
closed throttle, flat pitch, 1700 RPM, 4.2", 2.2 gph	#2-2/23/02	16:15:36	7193	7515.4-664.2	2231	126	140	1253	110K panel
closed throttle, flat pitch, 1720 RPM, 3.9", 2.2 gph	#2-2/23/02	16:21:23	9929	10508.9-9828	2225	121	141	1216	105K panel, GR: 10.15
closed throttle, flat pitch, 1588 RPM, 4.4", 2.1 gph	#2-2/23/02	16:22:15	8964	9420.3-8939.8	2224	115	132	1156	100K panel, GR: 9.27
closed throttle, flat pitch, 1450 RPM, 5.2", 2.0 gph	#2-2/23/02	16:23:02	8091	8427.8-7980.5	2224	109	123	1358	95K panel
closed throttle, flat pitch, 1345 RPM, 5.9", 1.9 gph	#2-2/23/02	16:23:42	7317	7590.2-7136.1	2224	103	115	1085	90K panel, Vx ??
closed throttle, flat pitch, 1260 RPM, 5.9", 1.9 gph	#2-2/23/02	16:31:22	8914	9227.9-8997.8	2217	96	110	1038	83.5K panel, Vx ??
closed throttle, flat pitch, 1180 RPM, 6.7", 1.8 gph	#2-2/23/02	16:31:55	8322	8534.8-8090.1	2216	92	105	1083	80K panel
closed throttle, flat pitch, 2074 RPM, 3.6", 2.6 gph	#2-2/23/02	16:33:05	6354	6637.1-6108.7	2216	150	165	1599	130K panel, GR: 9.0
closed throttle, steep pitch, 980 RPM, 9.6", 1.9 gph	#2-2/23/02	17:41:22	4676	4803.3-3912.7	2127	158	168	1112	135K panel, GR: 13.3

FLIGHT TEST DETAILS

11 flights including 4 data collection flights were made during February 2002, all during day VFR conditions.

A Flowscan 201A 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 top of the instrument panel. Performance data flights were conducted with pilot and flight engineer aboard. Flying qualities were evaluated using an analog G meter and Brooklyn Tool & Machine Co., Inc. NJ hand-held stick force gauge.

Cruise flight data were 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 airpseed indicator to produce the airspeed correction table shown herein.

Cowl exit temp (C.X.T.) is a function of the OAT & CHT and serves as a key number for calculating the cooling system performance.

Cooling ram recovery was measured in both climb and cruise.

The Legacy flaps are very effective. They reduce the stall speed from 83.4 smph clean at 2218 lb to 65.6 smph with full flaps and gear up at 2128 lb. Computation shows this to represent an astounding increase in CLmax due to flap deployment from 1.51 clean to 2.54

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
Dick VanGrunsven--RV-8A
Derek Hine--Lancair IVP
Kim Prout--Europa
Neal Roach--Glasair Super IIS FT
Lancair, Inc.--Legacy 2000

Stock Legacy N199L ASI was pessimistic at high speeds.

Legacy N199L	KIAS panel	KIAS Barograph	CAS, Baro, smph	Config.
ASI calibration	230.0	239.5	275.9	Flaps up, gear up
Feb 23, 2002	220.0	228.0	262.6	Flaps up, gear up
Wing Baro #3	210.0	216.2	249.1	Flaps up, gear up
weight ~~2300 lb.	200.0	198.6	228.8	Flaps up, gear up
	190.0	185.6	213.8	Flaps up, gear up
	180.0	178.6	205.7	Flaps up, gear up
Wing Baro #3 uses	170.0	170.6	196.5	Flaps up, gear up
a calibrated, certified	160.0	162.0	186.6	Flaps up, gear up
gimbaled pitot/static	150.0	152.9	176.1	Flaps up, gear up
	140.0	141.3	162.8	Flaps up, gear up
	130.0	130.7	150.6	Flaps up, gear up
	120.0	120.7	139.0	Flaps up, gear up
	110.0	109.0	125.6	Flaps up, gear up
	100.0	97.7	112.5	Flaps up, gear up
	90.0	87.7	101.0	Flaps up, gear up
	85.0	82.0	94.5	Flaps up, gear up
	120.0	118.0	135.9	Full flaps, gear up
	110.0	108.6	125.1	Full flaps, gear up
	100.0	98.1	113.0	Full flaps, gear up
	90.0	87.2	100.4	Full flaps, gear up
	85.0	82.1	94.6	Full flaps, gear up
	80.0	76.7	88.4	Full flaps, gear up
	75.0	71.5	82.4	Full flaps, gear up
	70.0	67.6	77.9	Full flaps, gear up
	65.0	64.3	74.1	Full flaps, gear up
	61.0	60.3	69.5	Full flaps, gear up

Fully enclosed landing gear and large flap hinges.

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707.545.CAFE (hangar, message)
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IMPORTANT NOTICE

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OWNER/BUILDER N199L
Lancair Factory Prototype

ENGINE MANUFACTURER
Teledyne Continental Motors
PO Box 90, Mobile, AL. 36601.
1-251-438-3411

DESIGNER'S INFORMATION

Cost of kit, no engine, prop, avionics, paint	$44,900 fastbuild, $48,900 w/bldr asst.
Kits sold to date of 310 BHP version (10/2000)	101
Number completed	8-10
Estimated hours to build, fastbuild kits	700 hr. , no body work
Prototype first flew, date	June 1999 w/ Lyc. 360
Normal empty weight, with 310 BHP engine	1450 lb
Design gross weight, with 310 BHP engine	2200 lb
Recommended engine(s)	6 cyl. Continental IO-550-N 310 BHP or 6 cyl. Lycoming IO-540-V4A5 260 BHP Lyc. IO-360-C1D6, 200BHP
Advice to builders: 3-4 months to kit delivery, multiple fastbuild options, visit website.	Perform your own careful weight and balance upon completing your aircraft

CAFE FOUNDATION DATA, N199L

Wingspan	25 ft 4.875 in
Wing chord, root/tip,	47.5 in/26.125 in at aileron tip
Wing area,	82.5 sq ft
Wing loading	26.66 lb/sq ft
Power loading	7.096 lb/hp
Span loading	86.6 lb/ft
Wetted area fuselage/wing/hor./vert./total	160/165/31.8/23/379.8 sq ft
Airfoil, main wing, CLmax	(by Greg Cole) GC 10/ GC11 at root,/tip, 2.2
Airfoil, design lift coefficient	"low"
Airfoil, thickness to chord ratio, max thick @	18% root, 15% tip, 45% of chord
Aspect ratio, span^2/ sq ft wing area	7.95
Wing incidence	+ 1.2 °
Thrust line incidence, crankshaft	0.75 ° down, 0.5 ° right
Wing dihedral	7.4°, (3.7° per side)
Wing taper ratio, root to tip	na
Wing twist or washout	0 ° but has aerodynamic twist
Wing sweep	na °
Steering	differntial braking
Landing gear	retractable oleopneumatic tricycle, hydraulic act.
Horizontal stab: span/area/section	99.75 in/16.16 sq ft/ NACA64012
Horizontal stabilator chord, root/tip/incidenc	28 in/18.08 in/ -0.5 °
Elevator: total span/area	101 in/ 6.49 sq ft
Elevator chord: root/tip	11.25 in/ 7.25 in
Vertical stabilizer: section/area incl. rudder	NACA64009 of 13.9 sq ft
Vertical stabilizer chord: average	34 in
Rudder: area	3.6 sq ft
Rudder chord: bottom/ top	14 in/ 7 in
Ailerons: span/chord at root/tip, each	46.7 in/ 6.9 in root/ 4.45 in tip
Flaps: span/chord at root/tip, each	67 in/ 11.5 in root/ 10 in tip
Flaps: max deflection angle, up/down	0° / 40°
Tail incidence	-0.5 °
Total length	22 ft 4 in
Height, static with full fuel	92.25 in
Minimum turning circle	na
Main gear track	109.25 in
Wheelbase, nosewheel to main gear	53.31 in
Acceleration Limits	+4.4 and -2.2 "g" at gross weight

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

Never exceed, V_{ne}	274/ 316 kt/ mph
Maneuvering, V_a , by weight	158 kt @ 1900 lb, 170 kt @ 2200 lb
Best rate of climb, V_y	135/ 156 kt/ mph
Best angle of climb, V_x, CAFE est.	100/ 115 kt/ mph
Stall, clean, 2200 lb GW, V_s	68/ 78 kt/ mph
Stall, dirty, 2200 lb, GW, V_{so}	56/ 65 kt/ mph
Flap extension speed, V_f	111/ 128 kt/ mph
Gear operation/extended, V_{ge}	140/ 161 kt/ mph

Legacy N199L Specifications:

Empty weight/gross wt.,,	1493.95/2200 lb
Payload, full fuel	304.8 lb
Useful load	706.05 lb
ENGINE:	
Engine make, model	6 cyl. Continental IO-550-N
Engine horsepower, weight	310 BHP, normally aspirated, 412 lb dry
Engine TBO/compression ratio	2000 hr/ 8.5 to one
Engine RPM, maximum	2700 RPM
Man. Pressure, maximum	29.6 in Hg
Cyl head temp., maximum	460˚ F
Oil pressure range	30-60 psi, 100 psi on startup/ 10 psi
Oil temp., operating, max./ min	170-200°/ 240° F
Fuel pressure range, pump inlet	na
Induction system	unfiltered inlet, pitot nostrils
Induction inlet area	off of cold air cooling plenum
Exhaust system	ss, 1.75 in O.D. 3 into 1 to 2.75" tailPx2
ave. header/collector lengths	11 in/ 27 in
Oil capacity, type	8qt., 50W detergent
Ignition system	Dual magneto, Teledyne S6RSC-25, 2 ea.
Cooling system	dual pitot inlets, downdraft
Cooling inlet area	50 sq. in. pitot inlets, downdraft
Cooling outlet area	~~38 sq in, fixed, no cowl flap
PROPELLER:	
Make	Hartzell BHC-J2YF-1BF, F7694-4Tx blades
Material	Aluminum
Diameter	69 in, 2 blades
Prop extension, length	3.0 in nominal, 7.25 in crank to blade axis
Prop ground clearance, empty of fuel	6.0 in
Spinner diameter/length	14.0/ 17.25 in
Electrical system	12V , ALX-9524 alternator
Fuel system	one tank in each wing w/Andair selector L/R/off
Fuel type	100 LL
Fuel capacity, by CAFE scales	66.875 gal
Fuel unusable	approximately 1 gallon per side
Braking system	Cleveland discs, hydraulic
Flight control system	all push-pull tubes except distal rudder (cable)
Hydraulic system	Electrohydraulic pump
Tire size, main/nose	5.00-5 (6 ply)/ 11-4.00 Cheng-Shen (8 P.R.)
CABIN DIMENSIONS:	
Seats	2
Cabin entry	one piece 1/4" thick canopy, fwd hinged
Width at hips	18.25 in per seat
Width at elbows	41.75 in
Width at shoulders	40.75 in
Height, seat pan to canopy, torso axis	40.5 in
Legroom, rudder pedal to seatback*	40 in
Baggage dimen. to height of seatback	26Lx 35W x 21H in
Baggage weight limit	50 lb
Liftover height to baggage area	behind rear seatback
Step-up height to wing T.E.	32.5 in
*adjustable	
Demonstrated maneuvers:	Chandell, Lazy eight, Aileron rolls, Barrel rolls Split-S

Equipment list:
Oil cooler: Niagara P/N 10281A
Governor: McCauley CZ90D 3M/T45
Starter: Teledyne energizer 646238
Vacuum pump: Airborne 216CW
Engine instruments: VisionMicro
Strobes: Whelen
Shoulder harnesses: Am-Safe
OAT/Voltmeter: Davtron
Radios: Garmin GMA340 mixer panel Garmin GNS 430 GPS, Garmin GNC 250XL, Garmin GTX 320 txp., Insight Strike Finder, Artex ELT, Alpine CDA7873 CD deck/receiver, Bose AHX-04 headsets, avionics master sw.

PTT, electric trim, and A/P disconnect on stick, fwd cabin fresh air ball vents, heated pitot, gyro panel, circuit breaker panel, cabin heat, fuel selector, electric flaps, fixed cowl flap exit size, 12 battery, sheared wingtips, Flextone paint, flush wingtip nav antennae.

ALWAYS CRUISE AT "VBC"

This report introduces a new term that the CAFE Foundation believes is very useful for pilots in selecting their cross-country power settings. The term "V_{bC} " can be used much like the other "V's" with which pilots are familiar, such as Vne and Vy.

What V_{bC} defines is the "velocity for best CAFE" or best Comparative Aircraft Flight Efficiency. This is the velocity that was the quest of all the CAFE 400 air racers in the 1980's. It occurs at the particular mixture setting that delivers the best CAFE score for a given RPM, altitude and throttle position.

Each aircraft has a theoretical *single* absolute best power, mixture, RPM setting for achieving V_{bC} at a given altitude. This special power setting depends on the drag curve of the aircraft, the torque and fuel economy characteristics of its engine, the propeller efficiency, etc. More practical is to find the V_{bC} that pertains to an RPM setting and altitude that seem reasonable to the pilot on a given mission. Those are what are depicted in the several cruise performance graphs that follow in this report.

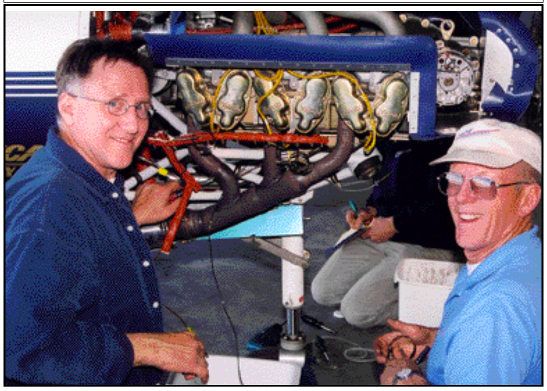
Finding V_{bC} is not difficult if a pilot records the whole range of level cruise airspeeds that occur as the mixture is leaned from rich settings to very lean settings. The CAFE score for each such speed is simply determined by calculating the velocity to the 1.3 power and then multiplying it times the MPG that occurs at that velocity.

Why the 1.3 power exponent? Consider 3 mathematical expressions: V^1/gph V^2/gph and V^3/gph Their exponents for velocity are either 1, 2 or 3 and this determines where on the speed range of the aircraft these expressions optimize or reach their peak. V^1/gph is the same as MPG and this peaks at around V_y , which is too slow for cruise. Likewise, V^2/gph is V times MPG, which peaks at at Carson speed or 32% above Vy, still too slow for cruise. V^3/gph corresponds to the flat plate drag and peaks at max power, too fast for cruise. $V^{1.3}$ times MPG turns out to be just right, peaking at cruise power settings of about 55-65% power.

Legacy N199L: CAFE Foundation Level Flight Cruise Data Summary, February 2002.

Legacy N199L Cruise	Config./flight #	CAS	CAS, no cuffs	KCAS	Densalt.	TAS w/cuffs	New TAS	M.P.	RPM	GPH	MPG	Weight	Range	**CAFE score	Endur.	OAT	Oil temp	CHT1	CHT2	CHT3	CHT5	EGT1	EGT2	EGT3	EGT5	CXT	Cyl#1, peak EGT
	#2, with cuffs	275.9	284.0	239.5	1383	281.4	289.9	28.6	2673	25.6	11.3	2147	700	18	2.4	62.6	169	375	382	354	376	1422	1400	1374	1380	131	
2/23-24/2002	#2, with cuffs	253.7	260.6	220.2	6478	283.9	287.1	24.0	2677	21.4	13.4	2133	830	21	2.9	51.6	177	389	399	371	396	1422	1404	1375	1381	136	
cuff drag = 8.12 mph	#1, with cuffs	246.2	252.7	213.7	8062	277.9	285.3	23.3	2404	17.5	16.3	2313	1008	25	3.5	46.4	177	382	401	349	376	1394	1374	1347	1334	132	
at 275.9 CAS	#2, with cuffs	250.4	257.1	217.4	8515	284.5	292.3	23.4	2545	16.4	17.8	2206	1103	29	3.8	47.8	177	376	393	363	385	1559	1550	1510	1511	138	
	#2, with cuffs	250.5	257.2	217.4	8493	284.6	292.3	23.5	2550	15.7	18.6	2205	1152	30	3.9	48.2	177	377	394	363	385	1534	1542	1508	1510	142	1561°@8.5K
66.866 gallons fuel cap.	#2, with cuffs	247.9	254.5	215.2	8476	281.6	289.1	23.5	2551	15.2	19.0	2203	1177	30	4.1	48.2	177	372	385	357	379	1502	1503	1483	1487	138	
with 5 gallons as 30 min.		244	250.4	211.8	8490	277.2	284.5	23.4	2552	14.7	19.4	2202	1197	30	4.2	48.0	176	366	379	356	381	1471	1477	1455	1458	136	
reserve	#2, with cuffs	242.2	248.5	210.2	8486	275.1	282.4	23.3	2551	14.2	19.9	2201	1230	31	4.4	47.8	176	358	370	354	372	1433	1425	1412	1413	134	
TAS^1.3 x MPG/1000	#2, with cuffs	232.4	238.2	201.7	8526	264.2	270.8	23.4	2217	15.2	17.8	2196	1102	26	4.1	46.4	179	375	381	349	378	1416	1414	1380	1371	131	
is relative CAFÉ score	#2, with cuffs	233.5	239.3	202.7	8474	265.2	271.9	23.5	2217	14.7	18.5	2195	1144	27	4.2	46.2	179	376	384	350	379	1455	1431	1402	1396	132	
	#2, with cuffs	232.2	238.0	201.6	8507	263.8	270.5	23.4	2215	14.1	19.2	2194	1187	28	4.4	45.9	179	377	386	350	380	1478	1473	1418	1414	132	1517°@8.5K
Dew pt. 9° on flt. #2	#2, with cuffs	233.2	239.0	202.4	8488	264.9	271.6	23.4	2216	13.2	20.6	2191	1273	30	4.7	45.7	179	376	380	349	375	1507	1504	1462	1454	134	
Temp. 13° on flt. #2	#3, with cuffs	226.8	232.3	196.9	8516	257.8	264.1	22.6	2298	16.2	16.3	2136	1009	23	3.8	54.7	169	381	392	348	372	1409	1392	1356	1350	147	
	#3, with cuffs	226.1	231.6	196.3	8528	257.0	263.3	22.6	2298	15.7	16.8	2134	1038	24	3.9	54.5	169	380	387	348	373	1418	1402	1368	1358	146	
Dew pt. 3° on flt. #3	#3, with cuffs	226.9	232.4	197.0	8497	257.8	264.1	22.7	2294	15.1	17.5	2130	1082	25	4.1	54.7	169	385	387	348	372	1432	1421	1394	1382	148	
Temp. 3° on flt. #3	#3, with cuffs	227.9	233.4	197.8	8483	258.9	265.3	22.7	2294	14.7	18.0	2130	1116	26	4.2	54.9	169	381	387	347	373	1462	1438	1410	1412	148	
	#3, with cuffs	228.4	234.0	198.3	8485	259.5	265.9	22.6	2301	14.3	18.6	2125	1150	26	4.3	54.9	169	381	393	358	379	1502	1483	1430	1427	150	
C.XT. = cowl exit temp.	#3, with cuffs	227.2	232.7	197.2	8485	258.1	264.5	22.7	2298	13.7	19.3	2121	1194	27	4.5	55.0	169	381	395	360	379	1525	1508	1468	1457	151	
	#3, with cuffs	226.2	231.7	196.4	8487	257.0	263.3	22.6	2300	13.2	19.9	2120	1234	28	4.7	55.0	169	381	395	359	378	1535	1525	1495	1493	152	1540°@8.5K
All CHT for 100° day	#3, with cuffs	225	230.4	195.3	8518	255.8	262.0	22.6	2299	12.6	20.8	2118	1286	29	4.9	54.7	169	382	392	351	375	1524	1526	1489	1500	151	
	#3, with cuffs	223.1	228.4	193.7	8533	253.6	259.8	22.6	2300	12.0	21.6	2117	1339	30	5.2	54.3	171	365	385	347	367	1478	1493	1430	1458	150	
Barograph #3 data.	#3, with cuffs	218.8	223.9	189.9	8546	248.7	254.7	22.5	2302	11.5	22.1	2113	1370	30	5.4	53.8	168	343	361	326	349	1432	1438	1399	1415	145	
	#3, with cuffs	220	225.2	191.0	12587	266.6	273.0	19.1	2548	15.3	17.8	2101	1104	26	4.0	44.4	174	386	398	363	377	1436	1421	1391	1389	146	
Range in statute	#3, with cuffs	222.1	227.4	192.8	12504	268.8	275.3	19.2	2546	14.7	18.7	2099	1158	28	4.2	44.6	175	386	398	361	380	1489	1465	1430	1416	148	
Endurance in hours	#3, with cuffs	221.4	226.6	192.2	12518	268.0	274.4	19.2	2547	14.2	19.3	2097	1196	29	4.4	44.4	176	386	400	363	373	1520	1494	1479	1432	143	
M.P. = in. Hg.	#3, with cuffs	219.8	225.0	190.8	12533	266.2	272.5	19.1	2551	13.7	19.9	2093	1230	29	4.5	43.2	176	386	403	369	373	1535	1515	1495	1471	151	1542
All temps in °F	#3, with cuffs	219.9	225.1	190.9	12523	266.2	272.6	19.1	2549	13.2	20.6	2091	1277	30	4.7	42.8	174	383	402	362	371	1535	1534	1492	1501	140	
Altitude in feet	#3, with cuffs	217.2	222.2	188.5	12519	262.9	269.1	19.1	2549	12.6	21.4	2089	1321	31	4.9	42.6	173	368	392	346	364	1500	1516	1432	1493	136	
Speed in smph	#3, with cuffs	215.1	220.0	186.7	12495	260.2	266.4	19.1	2551	12.0	22.2	2085	1373	32	5.2	42.3	170	348	383	328	359	1466	1483	1405	1462	132	
New TAS = with no cuffs	#3, with cuffs	211.1	215.9	183.2	12504	255.5	261.3	19.1	2549	11.6	22.5	2083	1394	31	5.3	41.9	168	333	368	302	354	1423	1434	1374	1417	129	
Weight in lb.	#3, with cuffs	207.2	211.8	179.9	12557	251.0	256.6	19.0	2550	11.1	23.1	2081	1430	31	5.6	42.1	165	318	345	283	335	1403	1417	1352	1388	129	
	#3, with cuffs	208.2	212.8	180.7	12574	252.2	258.0	19.3	2295	15.2	17.0	2055	1050	23	4.1	43.5	170	356	365	325	340	1300	1288	1276	1232	127	
	#3, with cuffs	208.6	213.2	181.1	12532	252.5	258.3	19.3	2295	14.7	17.6	2057	1087	24	4.2	44.1	171	361	367	331	343	1321	1303	1294	1264	129	
	#3, with cuffs	209	213.7	181.4	12491	252.9	258.6	19.3	2295	14.1	18.3	2059	1135	25	4.4	44.6	169	366	373	333	352	1362	1346	1326	1299	128	
	#3, with cuffs	210.5	215.2	182.7	12497	254.7	260.6	19.3	2293	13.8	18.9	2061	1168	26	4.5	45.1	169	368	378	334	353	1383	1364	1350	1312	131	
	#3, with cuffs	210.6	215.3	182.8	12499	254.9	260.7	19.3	2293	13.2	19.7	2062	1222	27	4.7	45.3	169	370	379	332	355	1411	1402	1384	1352	131	
	#3, with cuffs	210.6	215.3	182.8	12511	254.9	260.7	19.3	2295	12.8	20.4	2063	1260	28	4.8	45.3	169	368	379	333	356	1432	1414	1403	1377	132	1507°@12.5
	#3, with cuffs	211.6	216.4	183.7	12569	256.4	262.2	19.3	2296	12.3	21.3	2067	1319	30	5.0	45.5	169	362	377	328	354	1477	1458	1426	1402	131	
	#3, with cuffs	211.5	216.3	183.6	12611	256.4	262.3	19.3	2295	11.6	22.6	2069	1399	32	5.3	45.3	168	345	362	317	341	1506	1492	1449	1425	129	
	#3, with cuffs	208.3	212.9	180.8	12595	252.5	258.2	19.3	2294	11.2	23.1	2071	1426	32	5.5	44.1	167	324	337	296	331	1479	1483	1407	1460	129	
	#3, with cuffs	203.9	208.3	177.0	12606	247.2	252.6	19.2	2300	10.8	23.4	2072	1447	31	5.7	43.3	166	316	334	291	325	1455	1469	1390	1448	132	
	#3, with cuffs	200.7	205.0	174.2	12538	243.1	248.3	19.2	2300	10.4	23.9	2074	1477	31	5.9	43.0	164	300	317	263	307	1406	1413	1350	1399	128	
	#3, with cuffs	193.2	197.2	168.0	12518	233.8	238.8	19.1	2300	9.5	25.1	2076	1555	31	6.5	42.0	164	286	305	263	294	1378	1390	1304	1344	114	

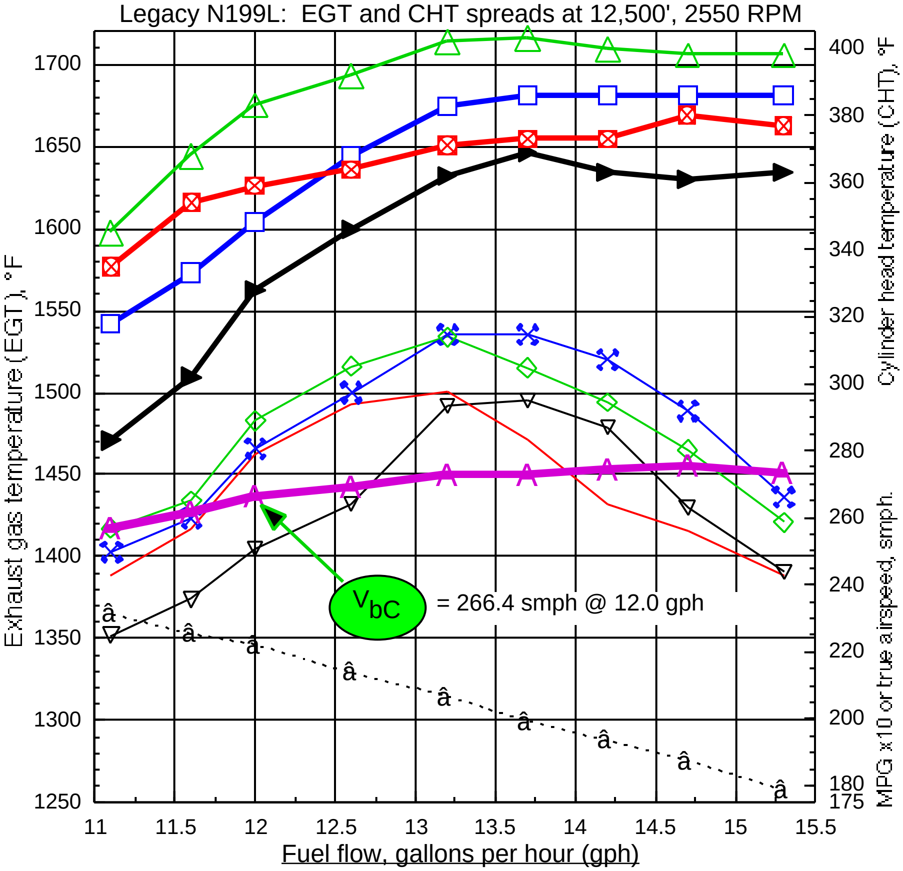
Darrel Harris, left, and Bill Bourns installed the test equipment on Legacy N199L.



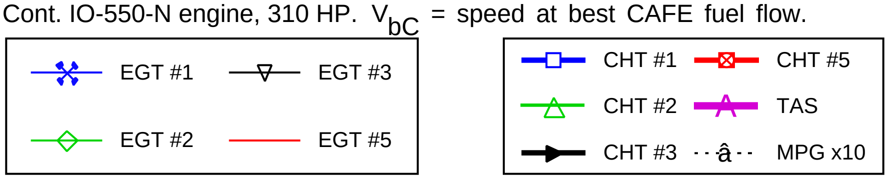
The following level flight cruise data graphs show V_{bC} as a green oval. This is the speed for best CAFE score meaning the speed that gives the highest number when MPG is multiplied times speed to-the-1.3-power. It will be a regular feature of CAFE performance reports and should become as familiar to pilots as are V_x and V_y . The mathematical reasoning behind this basically comes down to having V_{bC} serve as a succinct way to choosing the bestl economy cruise speed. See sidebar.

Legacy N199L, Sample c.g.

Legacy N199L center of gravity	Weight, lb	Arm*	Moment	c.g.
Main gear, empty	985.4	99.25	97796	
Nosewheel, empty	508.6	45.94	23364	
Pilot	170.0	108.61	18464	
Passenger	170.0	108.61	18464	
Fuel, 61 gallons	366.0	99.02	36241	
Oil, included 6.5 qt.	0.0	0.00	0	
Baggage, aft limit	0.0	125.43	0	
TOTALS	2200.0		194329	88.33
Datum = tip of spinner				
c.g. this sample:	88.3			
c.g. range, inches	6.02			
c.g. range, % MAC	10-25%			
c.g., % aft of fwd limit	74%			
Gross weight, lb	2200.0			
Gross weight, landing, lb	1900.0			
Empty weight, lb	1494.0			
Useful load, lb	706.1			
Payload, lb, full fuel	304.8			
Fuel capacity, gallons*	66.87			
Empty weight c.g., inches	81.10			
c.g. range	83.86-89.88			
*as determined by CAFE				



Legacy N199L; wide open throttle, CAFE data 2/23/02. CHT for 100 °F day. Cont. IO-550-N engine, 310 HP. V_{bC} = speed at best CAFE fuel flow.



12.5K/2550: This graph depicts the impressive ability of the Legacy to deliver over 270 smph while achieving over 20 mpg. Because these values occur at a fuel flow of 13.3 gph and this causes the EGT values to be at or near their peak, it is more desirable to operate at a leaner setting. If the mixture is set for 12.0 gph, the TAS drops to 266 smph and the mpg increases to 22.2. Note also that, at this mixture setting, the range increases by 10% over that obtained at 13.3 gph. Likewise, the CHT values are reduced by from 10-30 °F, and the exhaust gas temperature falls by somewhere between 50-70 °F.

The Legacy Cont. IO-550-N engine continued to run smoothly at just 11.1 gph, where a further reduction in temperatures and increase in range occur.

The spread of these temperature values is greater than that for ideal efficiency. The hottest of the EGTs, likely being the leanest cylinders, also tend to have the highest CHTs. Cylinder #2's CHT appears to run significantly hotter than the rest. This suggests that both the cooling airflow to that area of the engine should be examined.

Similarly, the CHT/EGT values for cylinder #3 suggest that it is running leaner than the others, peaking earliest and giving the lowest CHT at every mixture setting. Its low CHT may reflect locally better cooling airflow or a relative lack of induction volume.

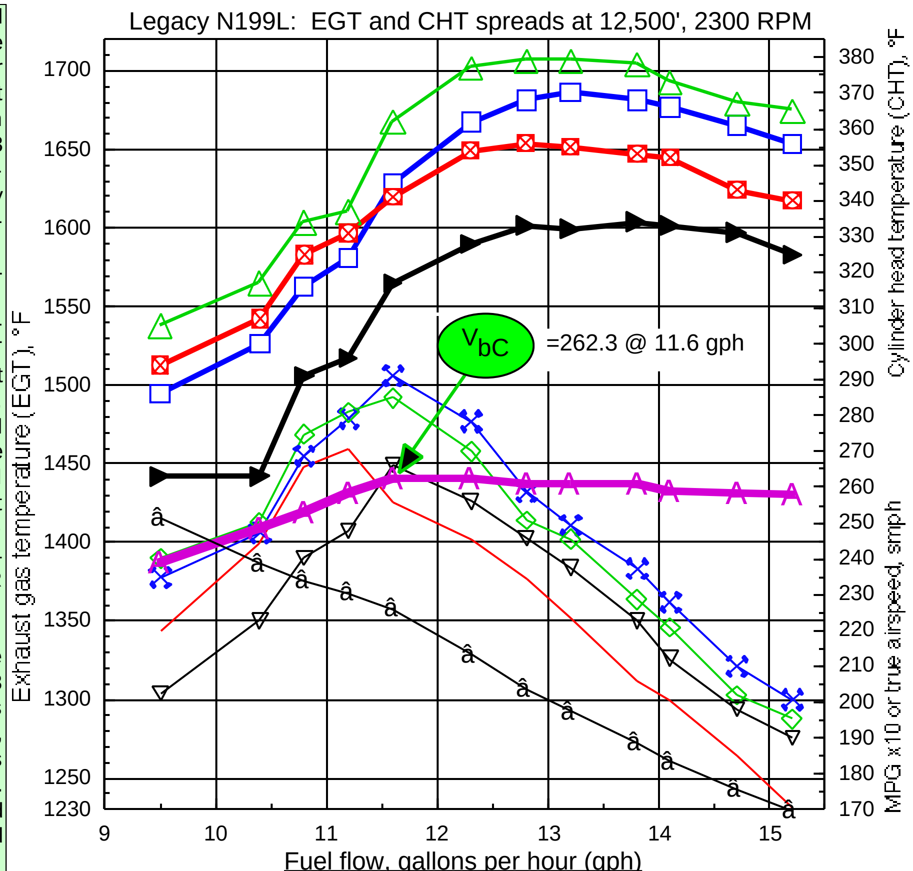
The fact that the hottest cylinder's CHT, even for a 100 °F day, ran at all times nearly 60 degrees below redline suggests a surplus of cooling which, if remedied, would increase airspeed.

The green oval, V_{bC} , points to the speed whose fuel mixture setting delivers the best CAFE score, a score computed as the speed to the 1.3 power times MPG.See VBCIsidebar.

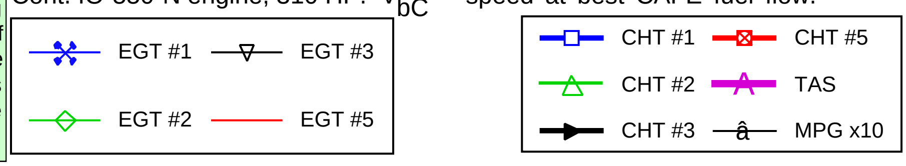
12.5K/2300: This graph shows several noteworthy trends. First is the fact the the CHT and EGT of cylinder #3 are far cooler than all others tested. This suggests that either cylinder #3 is not getting as much inducted charge air as the others or that #3 is getting a relative surplus of cooling air-flow, has diminished compression from any number of causes or that the #3 temperature probe is in error. This latter is doubtful because the CAFE test probes were carefully calibrated in a test oven prior to use.

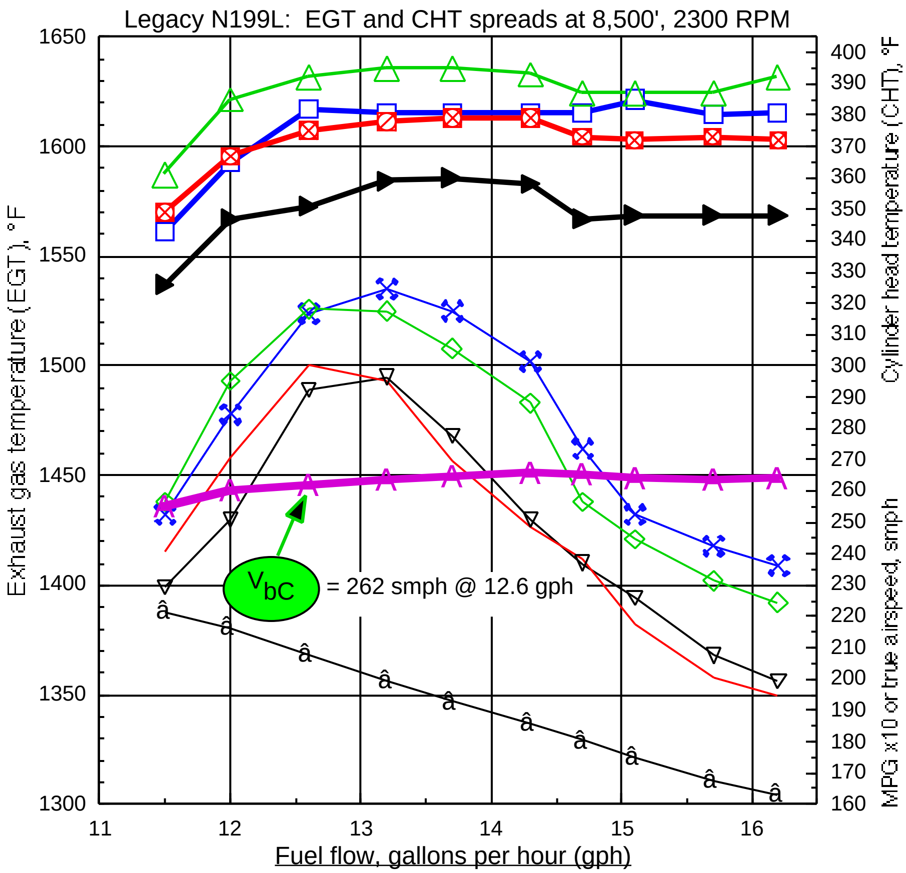
The second noteworthy trend is the otherwise close clustering of the both the CHT and EGT values of cylinders 1, 2 and 5 at the lean fuel flows (lean of peak EGT). This condition generally favors high fuel efficiency and smooth running of the engine and is a tribute to the Teledyne Continental engine design team. A particular "sweet spot" is evident at 10.4 gph where the Legacy achieves 248.3 smph at nearly 24 mpg. Thus, the Legacy achieves a VFR range of 1478 statute miles with an endurance of 5.95 hours at this setting!! Here, the EGT spread is only 14° F while the CHT spread is just 17 °F for these 3 cylinders. It is worth noting that, at this 10.4 gph setting, the hottest cylinder's CHT, corrected for a 100° day, is nevertheless 140 °F cooler than the 'redline' CHT limit. A closable cowl flap at such settings could significantly increase engine effiiciency and airspeed.

The highest CHTs shown in this graph occur at 13.2 gph where EGT values are about 100 °F rich of peak EGT, a setting that conventional wisdom calls the point of 'best power'. Note that at this setting, the Legacy range is 250 miles less and its CHTs are about 70 °F hotter that at the 10.4 gph 'sweet spot'.

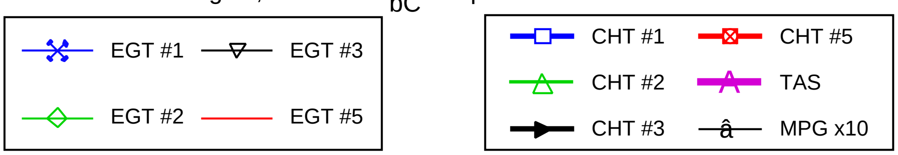


Legacy N199L; wide open throttle, CAFE data 2/23/02. CHT for 100 °F day. Cont. IO-550-N engine, 310 HP. V_{bC} = speed at best CAFE fuel flow.





Legacy N199L; wide open throttle, CAFE data 2/23/02. CHT for 100 °F day. Cont. IO-550-N engine, 310 HP. V_{bC} = speed at best CAFE fuel flow.



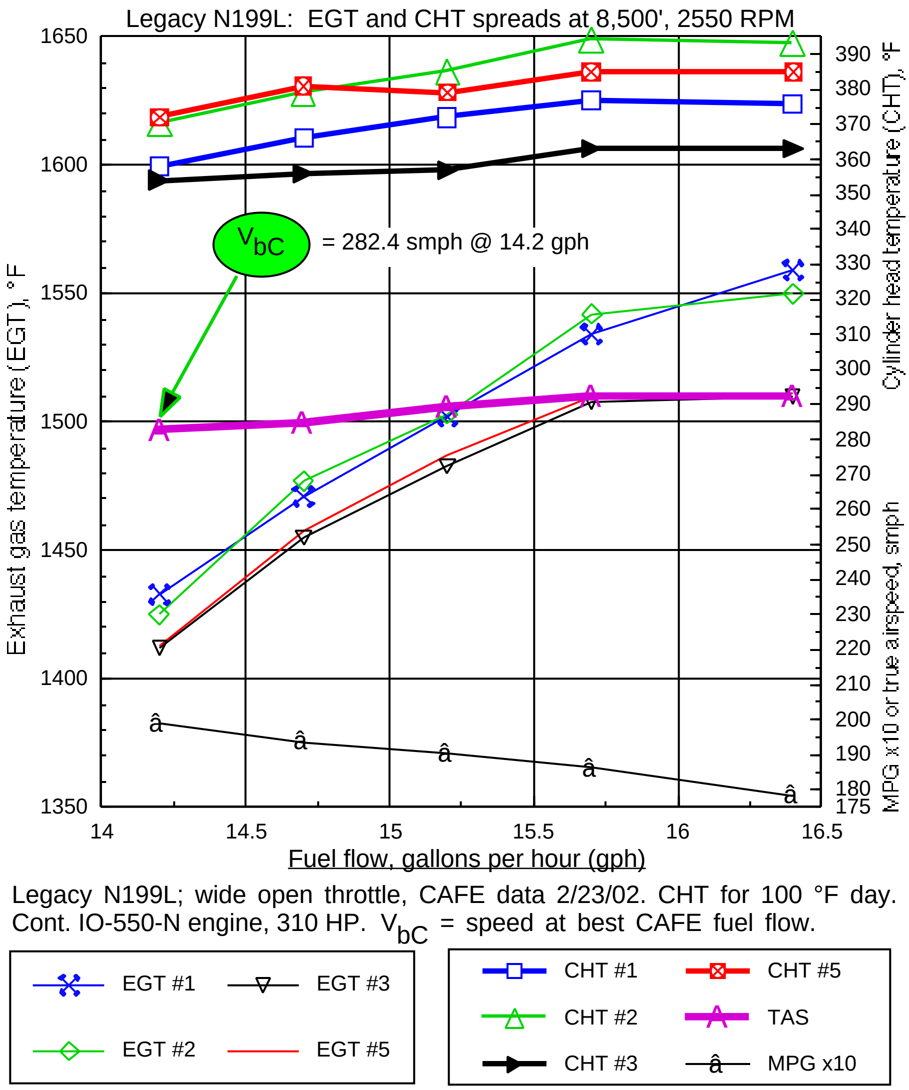
8.5K/2300: The striking result evident in this graph is the very flat curve of TAS (true airspeed in smph) across a wide range of mixture settings--with very little speed penalty in running lean mixtures. Because the MPG values steadily increase and both the CHT and EGT steadily *decrease* as the fuel flow is reduced, it is sensible to fly the Legacy using just 12 gph with wide open throttle and 2300 RPM and 8,500 feet.

Cylinder #3 again shows itself to be the coolest in CHT and EGT. EGT spreads are about 50 °F at all fuel flows, somewhat better than is typical of fuel injected horizontally opposed aircraft engines.

All of the CHT values, which as shown are corrected for a 100 °F day, are well below the 460 °F redline for CHT. It is interesting that the CHTs of cylinders #1 and #5 are so very similar at all fuel flows, while their EGT values differ markedly. Cylinder #2 is consistently runs hottest at all the power settings tested.

The Legacy engine continued to run smoothly at all of the fuel flow settings presented here.

That the Legacy can loaf along at just 12.0 gph and still deliver 260 smph is very impressive. However, its V_{bC} at this RPM and altitude is 262 smph and this occurs at 12.6 gph, as shown. The V_{bC} setting offers the best compromise between speed, fuel economy and engine heat stresses. It is a function of many interacting factors including throttle position, RPM, propeller efficiency, altitude and the speed versus drag of the aircraft as a whole.



Legacy N199L; wide open throttle, CAFE data 2/23/02. CHT for 100 °F day. Cont. IO-550-N engine, 310 HP. V_{bC} = speed at best CAFE fuel flow.

8.5K/2550: This graph depicts the very high cruise speeds that the Legacy can achieve at 8,500' density altitude. Due to concerns about leaning the mixture at relatively high power settings, the range of fuel flows examined here is more limited. Nevertheless, it is evident that the tests did explore lean of peak mixture settings which yielded some reduction in CHT in all cylinders. The engine ran smoothly at all settings presented here.

The CHT values here show that the Legacy cooling system is more than adequate at the high cruise speeds at which it normally operates. The high level of ram air pressure available at such speeds affords such fast aircraft a substantial cooling advantage. However, an ineffiicient cooling system at such high pressures can cause large speed penalties that go unnoticed unless the system is critically examined.

The Legacy's cooling system was tested in both climb and cruise mode to determine its ram recovery. We define ram recovery as that percentage of freestream total pressure that is 'captured'in the cold air cooling plenum inside the cowling. The measurement was made using a pair of probes inside the cold air plenum. One probe was a piccolo tube that sampled average static pressure in the plenum. The other probe was a forward facing pitot tube placed just above cylinder #3's cooling fins inside the cowl.

The test results showed that the Legacy achieves 60% ram recovery in cruise at 240 KCAS but 117% ram recovery in climb at 138 KCAS . The readings of the piccolo and pitot were essentially identical in cruise. In climb, the piccolo read 12.4 inches of water versus 14.2 on the pitot probe.