Library item # 324

($4.35)

0-320 CONVERSION - N888EZ

WHY:

First of all, we want to go on record that for most people, and in most situations, the 118 horsepower 0-235 is the best engine for the Long-Ez. It is an extremely reliable and proven design with all of the tough installation details worked out. We flew our Long for 700 hours with the 0-235 and it never failed to be economical, 100% reliable transportation. The performance we obtained with this engine allowed our Long to outfly conventional (spam can) aircraft with twice the horsepower! We consistenly obtained 172 knots true @ 75% full throttle cruise (2850 RPM), a more typical flight, however, was at 11 to 13 thousand feet with a TAS of 166/168 knots. Note that this is somewhat faster than the handbook says you can expect.

O.K., sez you, if the 0-235 was so good, why did you jerk it out? Simply, we wanted better take off performance. Both of us tip the scales at just under/over 200 pounds. Now add a passenger, fuel, baggage and survival gear (Always!) to a relatively heavy plane (888 pounds empty) and we often found ourselves flying at 1500 pound gross weight and occasionally higher. Also, the parts of the country we seem to gravitate to have airports at density altitudes above 6000'. Sam and Dick once departed Rock Springs, Wyoming on a long flight to Dayton, Ohio at almost 1600 pounds gross, the density altitude on that memorable day was just over 11,000' with a 10,000' runway ahead of us. We rolled 6,000 before the nosewheel cleared, then dropped to the runway for another 2000' before it again lifted and we staggered off. This was not smart and we certainly wouldn't do it again, but due to our weight and where we fly to, slightly less dramatic departures are not unusual.

In general, the climb performance once off the runway is more than adequate and never was an issue with the 0-235.

HOW:

We obtained a runout 0-320-D3G from a Piper Cherokee that was on the flight line at a local FBO. It had been flown regularly, with TBO reached in 4 years. The engine had an excellent service history and Sam had flown this particular airplane as an IFR trainer and was able to make the last flight with this engine just as the tach turned over 2000 hours. The only repairs this engine has seen was 2 new magnetos at 1800 hours; we replaced the mag harness, exhaust valve keepers, valve cover gaskets, intake tube hoses and installed a new set of spark plugs. We sold our 0-235 complete with exhaust, propellers, spinner, extension, baffling, etc. to another Squadron I member.

The engine mount was removed and the upper aluminum extrusions were carefully (with a 5# sledge hammer!) removed. This was done from the rear of the plane and the extrusions driven forward. The

lower extrusions were left intact since most of the thrust load is carried by the upper mounts and that replacement of the lower ones would require major surgery to the sump blisters. The new extrusions were 3/16 x 1¼ x 1¼ 2024-T3 which provided increased bending moment, shear and bearing stress resistance. The hole pattern from the old extrusions were very carefully layed out and transferred to the new parts. These were floxed in place and some minor glass repair was completed inside the aft canopy fairing.

There are a couple of new problems introduced by using the 3/16" thick section extrusions. First, these parts had a large fillet radius which required use of a spot face to insure that the bolts seat properly. Second, special external wrenching 12 point fasteners were required since it was impossible to get a wrench or socket on the standard AN bolts. These special bolts are perfect for this job since their heads are 5/16" 12 point hex which just cleared the heavier extrusions. The mount was installed to get a rough fit check and the next problem surfaced before the bolts were torqued up. We kept the brake master cylinders in the original position on the firewall and found that the brake arms "BA" had a serious interference with the 3/16" thick extrusion. We quickly found that we ran out of edge distance on the pivot holes and had to work out the problem. If the horizontal fastener through the mount which serves as the pivot point for "BA" is slightly below center or is even at a 1° or 2° angle, an even bigger problem results. If you keep the brake cylinders on the firewall you should make the brake arms from steel instead of aluminum so you can reduce the edge distance of the hole and still sleep at night.

The engine was then installed and the accessories bolted on to see what wouldn't fit inside the existing Task cowlings. One problem we knew of ahead of time was that the lower surface of the 0-320 MA-4 carburetor would be 5/8" lower than the MA3PA on the 0-235 and that we originally had only 3/8" clearance between the fiberglass carb elbow and the lower cowl. Our plane has the NACA flush duct (12" wide by 3-3/8 deep) and we had intentionally carved the lower cowl to hug close to the engine to reduce drag. Had we retained the original "scoop" type inlet or allowed a more generous clearance on the 0-235, we would have been o.k. A problem we had not anticipated was the interference of the intake tubes on the #1, #2, & #4 cylinders. This interference was much more difficult to resolve than the simple blister required for the carb elbow.

Our experience with the 0-235 indicated that #1 cylinder ran much too cool and that #4 ran too hot and required additional airflow. We applied some of the knowledge we gained balancing the airflow on the 0-235 to our new situation and elected to relocate the air filter/carb heat valve from the firewall to an area between the oil sump and aft baffle, adjacent to the starter. There was ample room for an Amsoil permanent foam filter obtained from Wes Gardner to be used and this set up works really great! The carburetor elbow points straight back and the carb heat SCAT duct runs below the left side of the oil sump. This really cleaned up the path for airflow to #4 cylinder, positioned the air filter where we knew there was a-lot of stagnation pressure, and generally made a nicer installation.

We believe that the 0-235 would benefit from this also.

The carburetor on the 0-320 is mounted further aft on the sump than the 0-235, so we rotated the carb 90° and fabricated a special plate to allow use of existing throttle and mixture control cables. We did replace, however, the carb heat cable due to the relocation of the valve. By far the biggest maintenance headache on the 0-235 was the frequent cleaning of the oil pressure screen on the accessory case. Lycoming recommends that this be done every 50 hours and since we were flying about 350 hours per year it seemed that I was always removing that damn thing. Those who fly less perhaps will not be so aggravated by "four little screws". Since our 0-320 came equipped with a full flow oil filter and the parts to convert it to a screen type filter would cost $250, we elected to make an effort to mount a remote filter. We got a good look at a similar installation on another Long that had proven successful, so we charged ahead. This is not as easy as it first appears, and was the source of great effort to make a safe installation. Several special machined adapters were required and an already tight area around the magnetos/brake cylinders became much worse.

None of the baffling for the 0-235 fits the 0-320 so here you are on your own. We may make full size patterns and instructions available after we prove out our set. We built the baffling utilizing some changes that we found helpful in our efforts to properly cool the 0-235 and a few new "pet" theories. A Brock 6" extension with 7" diameter prop end and 3/4" diameter x 1" long drive lugs was installed. This is the same extension that is specified for the 160/180 HP Defiant engines except is 2" shorter. A prop crush plate was made from 1/2" plate 7075-T6 and big (read: heavy) 1/2" diameter prop bolts were used. A Great American 62 x 74 propeller and a new Brock spinner was installed and we were ready for a new weight and balance episode....

THE BAD NEWS:

We had not weighed our plane since its completion in July of 1983 so we knew we had picked up a little weight. This time, headsets, tools, survival gear, etc. were not removed for the weigh-in, since these items are always onboard and as such are really part of our normal empty weight. I believe that all of the previous additions to the plane plus these items amounted to 24.5 pounds so our "true" empty weight with the 0-235 would have been 888 pounds. N888EZ now weighs 934 pounds so we picked up 46 pounds in the conversion. My original estimate was 43 pounds so we weren't too surprised. The center of gravity problem is another issue. We had always flown 888EZ at a rear biased CG because I enjoyed the way it handled; we decided to maintain the CG in approximately the same location that we were used to. A copy of our new weight and balance is attached so you can see for yourself that this is no small problem. Even with a 195 pilot we have to add ballast to remain within the allowable CG range. You can substitute your own weight and evaluate the consequences. Also, you should know that the fuel loading

curve shown in the owners manual is not correct, and that the average fuel "arm" is at F.S. 106, not 104.5. This information was provided by R.A.F. Be sure to run your calculations, therefore, at full fuel load since F.S. 106 is aft of the aft limit (F.S. 103).

PERFORMANCE:

I'am sure some of you jumped ahead to read about this part first, now go back and read about the C.G. problem! Preliminary numbers with about 40 hours of flight time indicate that we have gained a small increase in airspeed and a substantial increase in climb performance. We also have become great buddies with the fuel supplier on the field. One peculiar characteristic we have uncovered is that the true airspeed is almost constant from sea level to 14,000 MSL. A low level, full throttle blast down the Santa Barbara coast produced indicated airspeeds of 189 knots, just a heartbeat short of the 190 knot red line speed. Full throttle at 8,000 feet (75% power) varies between 188 and 190 KTAS and full throttle cruise at 14,500 is 186 to 188 KTAS. The engine RPM varies only 50 RPM from sea level to 10,000 feet so Great American has really pulled a rabbit out of the hat with their excellent propellers. Climb and take-off distance is improved and allows comfortable cruise climb (120 KIAS) at about 1800 FPM up to 10,000 MSL where it drops to about 1200 FPM. Best rate of climb @ 90 knots pegs out VSI and gives a ridiculous deck angle. We seem to be using 140 KIAS @ 1200 FPM climb since you can get somewhere fast and still see where you are going. After we fly some distances to determine our normal cruise conditions we will report on our fuel burn rate.

MORE BAD NEWS....

1. COOLING

Initially we had moderate cooling problems for both cylinders and oil temperature. We had 125°F spread between the hottest and coolest cylinder with the oil pushing the red line. After 25 hours of experimentation with at least 20 different baffle and/or flow diverter configurations we have achieved an excellent temperature profile; even better than we could obtain on the 0-235. All the cylinders remain below 385°F on a long climb to 15,000 feet with the oil @ 220°F. Full throttle cruise has the hottest cylinder (#3) at 365°F and the coolest (#4) at 340°F with the oil temperature down to 190°F.

So, it can be done if you are willing to experiment and spend the head scratching time necessary to divert 200 MPH air where you want it. We believe that the 3-1/2" x 12" NACA duct is o.k. for the 150/160 H.P. engines but you will have to work hard to utilize all the energy

available. A larger duct would give you a higher mass flow rate but at the expense of increased drag. You pay your money and take your choice.

2. DESCENTS

Don't laugh, this is no small problem! Indicated speeds at cruise are in the 160 knot range at least 40 knots over maneuvering speed (119 KIAS). The Long is such a clean design that the smallest nose down attitude results in an immediate and potentially dangerous speed increase. When you are already cruising half way into the yellow arc you don't have much to play with unless you pull way back on the throttle and that really raises hell with thermal shock on those expensive cylinders. You must maintain a slow temperature gradient to avoid immediate and very costly damage to your engine. Therefore, you must plan your descents carefully since you may be restricted to 300/400 FPM descents while you juggle indicated airspeed versus cylinder temperatures. I can't emphasize too strongly how different this is than with the 0-235, and is an area of serious concern. At 4 miles a minute in descent you may be 80-100 miles from your destination when you must start down. Also, consider the risks involved in flying so much faster than maneuvering speed, especially with regard to turbulent air and gust loads.

3. BRAKES

If you build a 750# 0-235 Long the Cleveland 500 x 5 brakes are great. If you have an 850# airplane the brakes are marginal (in our opinion) and when the weight exceeds 925# things really get dicey. You can tell yourself that you won't fly it that heavy, but I guarantee that you will and that your brakes won't hold up. Don't forget, those brakes were originally designed for airplanes like the C-150 that has lots of aero braking and a slow touch-down. If you have a big engine, plan on very frequent brake pad replacement and problems with warped or coned brake discs due to overheating. Also, you will have to take extra precautions to prevent main gear strut failure after a high energy stop and subsequent heat soak.

IN SUMMARY:

You've heard it all before, any airplane is a compromise. Now, our Long is a more special purpose machine ; we have traded some utility, range and economy for climb performance. As of this writing (Dec. 31) we aren't sure we did the right thing and have a few reservations about the swap. You, the builder, must evaluate your

own needs and honestly decide whether you can handle the negatives about the larger engine. I think the best advice we can offer is to fly first with the 0-235 and then, if you must and if you can handle the operational and weight limitations, consider the larger engines. We would be happy to help you separate fact from fantasy on this major change.

FINAL NOTES:

1. The FAA regards an engine swap such as this a major modification and therefore you are required by your operating limitations to formally apply for approval for this mod before you fly. You will again be required to complete a test period within a specified test area. We were given 5 hours and a 25 mile radius from Chino with a one-time departure approval from Brackett to the Chino area. If you are contemplating ignoring the Feds and just go flying, we urge you to re-consider for 3 reasons: first, violation of that operating limitation is punishable by a $1,000 fine per flight; secondly, your insurance is invalid if you make a major mod and do not notify the FAA and obtain approval, and lastly, irresponsible actions such as this can only harm relations between FAA and the home building movement. FAA approval was quite easy to do, cost nothing and can be accomplished through the mail. Mr. Leroy Blum of the Riverside GADO was very cooperative and helpful.

2. Some of the 0-320 variants will not fit on the Brock engine mounts without modification due to the large number of oil sump and intake tube configurations. If we haven't scared you off so far you should take your mount with you to verify that there are no problems on the specific engine you are considering. This will save a lot of swearing and grief later.

PLEASE BUILD AND FLY SAFELY!

Dick Kreidel

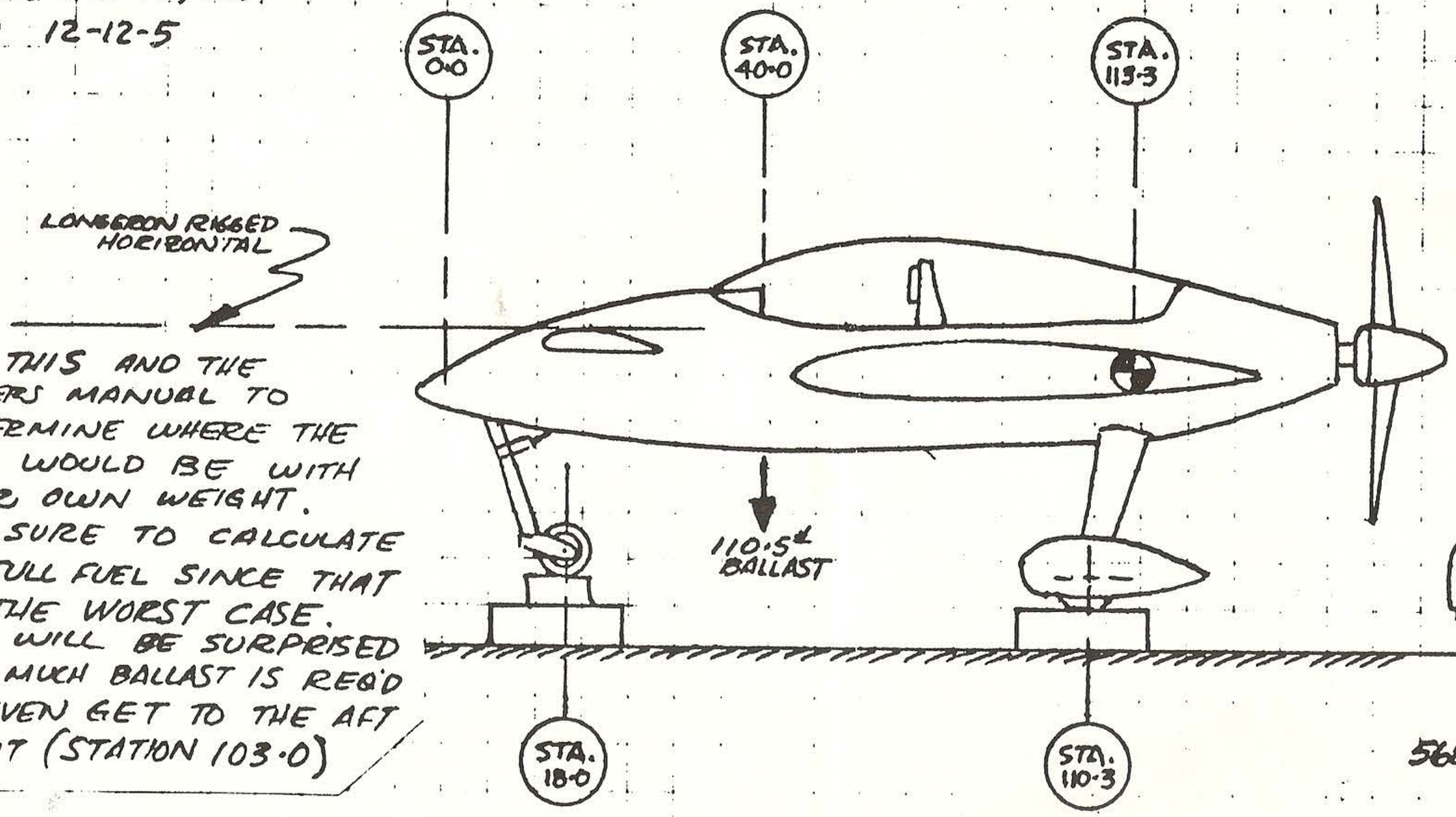
EDITORIAL COMMENT:

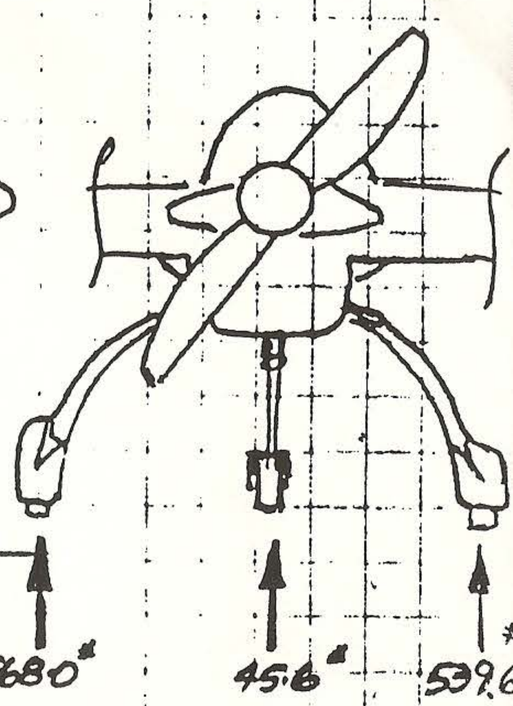
N888EZ is an exceptionally clean airplane and a lot of the performance that the Kreidel's enjoy is due to that fact & not the big engine. Most people who have 150/160 H.P. engines fly about 7-10 knots slower than 888EZ, so don't get real excited about the performance numbers stated here, you probably won't be able to match them.

"THE MANAGEMENT"

WEIGHT & C.G. ANALYSIS

A/C : N88BEZ
LOC'N : MOJAVE, CA.
DATE : 12-12-5





USE THIS AND THE OWNERS MANUAL TO DETERMINE WHERE THE C.G. WOULD BE WITH YOUR OWN WEIGHT. BE SURE TO CALCULATE AT FULL FUEL SINCE THAT IS THE WORST CASE. YOU WILL BE SURPRISED HOW MUCH BALLAST IS REQ'D TO EVEN GET TO THE AFT LIMIT (STATION 103.0)

A/C CONFIGURATION AS WEIGHED -

- 17 GALLONS FUEL
- 9 QTS OIL W/ REMOTE FILTER
- LAMB TIRES/SPORT FLIGHT PANTS
- GREAT AMERICAN 62x74 PROP
- 6" PROP EXTENSION
- BROCK SPINNER
- ELT INSTALLED
- H-10-40 HEADSETS INSTALLED
- SURVIVAL GEAR & TOOLKIT INSTALLED
- LYC O-320-D3G W/STARTER
- REBAT S-25M BATTERY (21#)

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#	GROSS	ARM	MOMENT
SCALE R MAIN	539.6	110.3	59517.9
SCALE L MAIN	568.0	110.3	62650.4
SCALE NOSE	45.6	18.0	820.8
BALLAST	-100.5	40.0	-4020.0
FUEL	-102.0	*106.0	-10812.0
OIL	-15.8	140.0	-2212.0
EMPTY WT.	934.9	113.32	105945.1

* MANUAL SAYS 104.5, BUT ACTUAL ARM IS 106.0 PER RAF