

## More advice on engines ~ the Lycoming IO-540

From Monty Barrett

"Let's all understand a couple of things at the git-go so we are all playing off the same page of music.

1. The subject engine is going to be limited to the Lycoming IO-540- models. It seems to be the most desired engine for the most builders and I agree with that selection.
2. An engine that is available from a Salvage Yard, an Insurance Under-writer, or an accident airplane is there for a reason, that reason being the airplane crashed and / or was not repairable from a natural disaster such as wind-hail damage. An exception to this is when an engine is Time Expired. If it is an Insurance engine, it has sat in someone's salvage yard for at least 6 months and likely longer. It takes that long for all the players, including the FAA - NTSB, to get all the releases done. In most of these cases the logbooks are NOT available. The cause of a majority of airplane crashes is power-plant stoppage, whether lack of fuel or a catastrophic failure, the engine was the first component to the scene of the accident, therefore it has a more than likely chance of sustaining damage, even internally that cannot be detected without disassembly.
3. Log Books, Yellow Tags, and Factory Statements pertaining to the " Manufacture and Inspection per FAR 21.303 " only mean that the person who executed the document can write. That's all. The WORST quality control in history is taking place right now with the manufacturers.

Now lets get on to the meat of the subject. Engine overhaul is for INSPECTION PURPOSES! There are just certain parts the manufacturer does NOT want you to use again. Notice I didn't say anything about a " REPAIRED" engine. The parts Lycoming does not want you to use over are spelled out in Service Bulletin 240. It includes the obvious things like locking devices, seals and gaskets, but also includes a whole list of stuff to be retired from service.

By INSPECTION, I mean that each part is visually inspected, has NDI performed on it, is measured precisely, reworked ( when specific approved methods are employed ), re-assembled IAW p/n 60294-7 OHM, and tested. Unless the test is done with calibrated stuff, FAR Pt 43.9 says that IT CANNOT BE CALLED OVERHAULED. A lot of repair stations have lost their certificate, been fined, etc. for violation of this rule. So have a lot of A & P mechanics. That is only ONE of the differences between an OVERHAULED engine and a REPAIRED engine.

In the previously mentioned OHM there is a section called " TABLE of LIMITS ". The p/n number of this special section is SSP 1776 and it contains ALMOST all the data you need to assemble an engine with the appropriate clearances, torques, etc. The rest of the data is contained in Service Bulletins, Service Instructions, Service Letters, and FAA-AD's. The AD's almost always refer you to a Service Bulletin, but not all Service Bulletins are AD's. Service Bulletins are considered " Safety of Flight Items ". Service Instructions and Service letters are for Owner / Operator / Maintenance Convenience.

In the Table of Limits there are 2 columns under fits and tolerances and are labelled " New Engines " and Service Limits. Service Limits means 2 things:

1. A midlife REPAIRED engine can be returned to service with parts that meet Service Limits. It also means that the Factory or another facility may return to service a part that meets Service Limits. It does NOT mean that a " zero time since overhauled engine " meets NEW ENGINE CLEARANCE LIMITS ". I realize that we may be playing on words here but there are those who will take advantage of the above verbiage to call an engine overhauled and put it out in service. We refer to these type shops as " Strip and Dip " or " Paint it Black and Send it Back " shops. They are on the bottom of the spectrum of overhaul facilities and there are a bunch of them. I'm not going to give out names because I don't want to get sued but I will tell you that Florida is full of them. Not all in Florida, but a bunch. I am not referring to the Kimballs' as they are not an engine overhaul facility.
2. At the present time it takes about \$19,000 worth of parts to Overhaul a Lycoming 540 if you comply with SB 240. This includes NEW cylinder assemblies, fuel system, magnetos, ignition harness, all the damaged hardware, but does NOT include crank-grinding, cam regrind, crankcase repair or labor. The FIXED labor fee at my shop for a 6 cyl, direct drive, normally aspirated 540 is \$5200. At a shop rate of \$50.00, that's 104 Hrs and that is what it takes when I include a 1 1/2 Hr test cell run, and crate it. Along with those charges are the sublet stuff ( crank, cam ) which averages \$3300.00 Add all this up, plus the freight both ways, one way insured ( you better do that ) and you have spent 30 G's. There is a difference of only about \$200 per cylinder between an overhauled cylinder and a new cylinder. Most cylinders that reach TBO have a cracked head SOMEWHERE. On the parallel head engine it is usually the exhaust port on the inside wall. On the angle head engine it is usually the lower plug boss and that crack will propagate to the threaded area at the barrel and WILL COME OFF AT THE MOST IN-OPPORTUNE TIME. I had a 1200 Hr Time since NEW cylinder head come off in the test cell and I can tell you, you will not make it back to the airport. For this reason we don't put out overhauled engines without new cylinders. Factory doesn't either If I can't build a better one than they do, I'm in the wrong business. Another big mistake is to take a new or reworked part and assume that it is airworthy. You DAMN sure better measure everything on it. We do this with new cylinders and reject 30% of them.

Lycoming crankshafts can be reground to -.003,-.006,-.010. If it is ground more than -.003, it must be re-nitrided. These dimensions are applicable to the main journals and the rod journals and can be either or both. As a matter of practice, we do not sell an engine outright with a -.010 crank in it. There is no grind left and you have a one time engine. That is why we are so

emphatic about the seller of a core guaranteeing the crank to be repairable.

A reground camshaft is better than a new one if properly done. Reason: the metallurgy is KNOWN GOOD if it has previously made TBO. It only takes .002-.003 inches regrind to restore the proper profile on a reground cam. The IGGIES on reground camshafts are no chatter, no base circle run-out, and the proper taper on the lobe. Lyc. camshafts are made from AISI 8620 forgings and are carburized on the lobes only. The copper color you see on a camshaft is a resist plated on then ground thru where they want the cam to be hard. Under the copper flashing, it is fairly malleable, but tough. Carburizing it typically .030 Deep. I have never seen a 540 Lycoming crankcase at overhaul that did not need parting surface machined, then line bored. They fret BAD, worse with heavy props and aerobatics. 9 of 10 sets are also cracked somewhere.

There is a lot of HYPE in the engine business. Overhaulers have all kinds of marketing gimmicks; Black Edition, Gold Medallion, Red Autographed ones, on and on. Believe it if you want, there are some 400 HP 540 Lycs out there. I've never seen one. But I can tell you this for a hard core fact. They will make 375 HP!, KEEP READING! It takes 2700 RPM, 43 IN. Hg, 44 GPH, cylinder pressures are in excess of 1200 PSI ( 1000 is considered the limit ) and the engine is going to run about 10 hrs. That has been done, at my shop, recently, including the 10 hrs. The failure was a cylinder head, at 1200 PSI. I have also been asked about a couple of specific engines, one being the Hale Wallace Engine, the other being Patty Wagstaff's.

I'll start with Hale's. Hale sent me an O-540-B2B5, Time X, dis-assembled and a whole box of new parts. Hale had an OEM agreement with Lycoming and he could buy parts cheaper than the distributors. I gave Hale a BPA Cold Air Induction system and the labor. Hale BOUGHT, from me, a set of 9.5:1 pistons, provided an Airflow Performance FM-200 fuel system and that engine produced 295 HP. Real, not hyped. Hale built me a set of short Skybolt wings and that is how that deal went down. I can't tell you what the cost is because Hale furnished most of the parts. I also can't give you a price on Wagstaff's because her parts come from Lycoming. We do that engine every year, there is usually nothing wrong with it, but it gets done for scheduling convenience, ( hers, not mine ). Every 3rd year it gets a new set of cylinders. We use a factory piston, p/n LW-11487 ( 10:1 ), do some flow work on the heads, balance it, applied SI 1123 ( thru-bolt dowels ) and her engine does about 320 HP. It is a AE10-540-L1B5, weighs 460 lbs. Hale's engine weighed 380 Lbs. Lycoming has NEVER fussed about what I ordered for her engine as she is a " High Visibility " personality and an engine failure would do Lycoming a lot of harm. The engine that is on the airplane in the Smithsonian is a parallel engine with BPA Cold Air, is 10.5:1, with TCM intake valves, seats and that engine did 325 HP. We don't do the TCM valves anymore. The seats are too close together and the head will crack between seats. But man, it would flow some air. Takes 6 lbs air per Hr, per HP. It doesn't take a rocket scientist to figure out that " porting - polishing " does NOT increase the power very much. It is done to make the engines run smoother. The " A " in the suffix means it left the factory with the inverted oil stuff which used to be made by Frank Christianson, now Aviat. It has Lyc. p/n's on the components. In the case of a small crank engine, the "A " also means it had an " aerobatic crankshaft " which, at that time meant the flange was .45 thick instead of .38 thick. NOW, all flanges are .45 thick so on a newworked engine an " aerobatic crankshaft " is a moot point.

The " E " in the suffix means that it is a wet sump engine. There were a few AIO prefixed engines built and those engine were dry sump, like most radials. The -L1B5 engine is similar to the " K " series, i.e. has angle head cyls, big main crank, but is equipped with an aerobatic sump and induction very similar to the BPA Cold Air Induction. In my shop, anyway, there is NO difference between an experimental engine and a certified one as far as the dimensions, inspection, record keeping, tolerances and so forth are concerned. The difference is in what parts we put in the engine. Some of them MAY not be PMA.

There is also only 1 grade of engine and that is NEW CLEARANCE LIMITS. It will say exactly that in the records and it will stand an inspection by any place you want to send it. Exception is to a mid-time repaired engine ( like a prop strike inspection ). Then we will use the " SERVICE LIMITS " tolerances to return the engine to service FOR TIME TO CONT. Currently, our engine prices are approximately 10% below the Factory Net price for a REMAN except the modified ones are higher because of the flow work, Cold Air, and the forged HC pistons. I want to give you something to think about.

Scenario: you send in a core engine to the factory for a REMAN. They dis-assemble your core, rework your rods, etc. put all these parts in a parts bin and build another REMAN. Do you really think you got a " ZERO TIME ENGINE ". Only the Factories can get away with that crap. The reason for all this dissertation is to alarm you to the fact that a \$7000-8000- " Overhauled " 540 Lycoming is probably not going to be very much of an engine. It's your call; It's your Airplane; It's your hard work and money: I personally would like to eliminate at least one of the unknowns on the first flight of a home built airplane. The only thing you can be absolutely sure of is the engine, and then only when it has been inspected and overhauled by reputable people, or yourself, if you have the skill, knowledge, and resources."

This article was written c. 2003