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Top end overhaul tips

Vibration analysis

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The engine doctors

This father and son team share wealth of knowledge on top-end overhauls

In seeking out information for a top-end overhaul story for this issue, Aircraft Maintenance Technology magazine had the pleasure of meeting two individuals, Ed Rachanski Sr. and Ed Rachanski Jr. They are the principles of a well-established engine overhaul facility Blueprint Engines Inc. located in Chicago Ridge, Illinois.

Between them, their experience overhauling engines and providing technical expertise to the industry spans well over 60 years. What follows is the sharing of a wealth of knowledge, related to top-end overhauls and inspections that these two individuals have gained in the engine overhaul business throughout the years.

Ed Rachanski Sr.

The Book Work Comes First

I find that good technicians are often poor administrators – not all of them, but many are. They don't like book work or record keeping. They really enjoy working with their hands, but when it comes to using a pen, they don't care for it. And I've seen where this is really coming back and biting them.

So take the case of a customer that comes in and says "my Arrow, it's a little sluggish. I've lost 5 or 6 miles per hour. It sounds OK, but over the last few months it seems like it's losing a little power." What should the technician do initially with this complaint?

What technicians should do, before they even put their hands on the engine is get the engine logbook, and sit down and study it – just like a doctor does when you go for a physical and they ask you questions about your medical and family history. So in order to do proper maintenance on an engine, we've got to ask questions.

When was it last overhauled? How many hours are on the engine? Are fresh, remanufactured, new cylinders installed on the engine? Who worked on it last? What kind of quality can you expect from the last place that worked on the engine? Was it a factory manufacture? Is it a brand new engine? How old was the last rebuild? Was it last year, five years ago, 10 years ago, 20 years ago (rusty cylinders)? And how many hours are on the engine total? Where has the engine been flown and in what kind of environment was it flown? When were the magnetos last rebuilt, and/or when were they taken off? Eight years ago? Six years ago? Just because the engine only has a couple hundred hours on it and the last annual was done recently doesn't mean that it's OK.

There are many clues in the logbook that can enlighten you about problems. For instance: "No. 4 cylinder was removed six months ago", No. 4 cylinder was removed five years ago." You should ask yourself at this point, "Why are we losing the No. 4 cylinder?"

Take notes while you're going through the logbook, and when you have a general idea of the condition and where this engine came from, you can then roll your toolbox up to the aircraft and start going through your checklist procedures.

Most technicians don't do this. Instead, the first thing that they do is roll the toolbox out to the aircraft.

The only exception to this rule is if you have been taking care of the airplane for the last five years, and you know that no one else has touched the aircraft since its last visit. But, you should still check the logbook to be sure that no one else has performance maintenance that you're not aware of.

The 43.13(a) Credo

If there should be a credo hanging on everyone's walls, it's about a 60-word paragraph in the FARs – 43.13(a). It basically says that you have to use all of the methods, practices, and techniques prescribed in the current manufacturer's maintenance manual or that the administrator makes available to us. This means following manufacturer's instructions. And that includes current overhaul manuals, current repair manuals, current service bulletins, service instructions, service letters, and ADs.

What the technician should do, before he even puts his hand on the engine is get the engine logbook, and sit down and study it…

If you follow FAR 43.13, your chances of staying out of trouble and properly correcting problems

and properly maintaining aircraft are very good.

Time to Take a Look

So you've checked the logbooks. Next, you want to open up the cowlings and take a good look at the engine for clues of what's wrong. Take a really good look at it, especially where you can't see – where the baffling is. Use a very good light and look for two things: fuel stains and oil leaks – these are clues.

Let's say that in this case the engine is losing speed. We find that the magnetos are OK, wires are OK, and the fuel system is OK, and all the accessories are OK. At the last annual, two freshly rebuilt mags were installed.

At this point, you should check the spark plugs. You have no idea how many planes are crashing because of combustion failure due to worn, eroded spark plugs. This can be eliminated through the use of a simple erosion gauge that is provided by the spark plug manufacturer.

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There's something wrong with the way some technicians today view spark plugs. If you're such a really good A&P and a good maintenance technician and you care about the safety of your customers, come 250 to 300 hours, throw the plugs away – just get rid of them. Plugs should really be viewed as a consumable, they're inexpensive enough that it just doesn't make sense to try to squeeze hours out of them. It's just not worth the safety risk. All you need to do is have one misfire, or malfunction, and you have a failed cylinder.

If you're in a four cylinder airplane, and you need 200 hp, and you lose one cylinder, and you have four big people on the plane with 50 pounds of fish, and you're trying to get up over the tree line in northern Wisconsin, the cost of a spark plus seems minuscule. You've got to put it all into perspective.

The Compression Check

Too many people are failing to run up the engines prior to a compression check (ref. Lycoming service instruction 1191 on doing the compression check). A compression check is an art form. Not everyone does them the same.

Especially in colder climates, when they pull the aircraft in the hangar and it sat overnight, and there's 3 feet of snow outside. Many people will go ahead and perform a cold compression check – and that's a big mistake. If you do a cold compression check and something happens after you sign off the engine, you've got potential problems from a legal standpoint.

You've best follow the engine manufacturer's service instructions to the letter. Do it the right way. Move the airplane out, run it up, and get it good and hot. Push it back in the hangar and then do the check. You have to expand the piston rings, pistons, you have to get the cylinder barrel hot to simulate operating conditions. This is necessary to correctly check for leakage past the piston rings, the piston, and valves. Also, the oil is thinner with the engine at operating temperature. Cold, thick oil will always give you a faulty compression reading.

In my opinion, I feel that the most accurate method for checking compression is to perform an automotive-style compression check where you screw a gauge in the spark plus boss, turn the engine over and take a reading. The rings are moving, the valves are moving, and you're not staking the valves and cheating to move it into position or spraying a little oil in the cylinder.

What's Acceptable Compression?

Lycoming says 75/80 is satisfactory. AC65012A, however, says that 60/80 is acceptable. Let me tell you, though, that the AC65-12A 80/60 statement won't hold water for two seconds in any court of law.

AC65-12A is out the door in such an instance. FAR 43.13 says to follow manufacturer's maintenance manual instructions, which in this case says that 75/80 is satisfactory. They go further into it and say that with anything under 70/80, further investigation is warranted. Remember that the regulations take precedence over advisory circulars and training manuals.

Let's look at what letting an engine go at 60/80 means and why it just isn't acceptable. Take a 200-hp Cherokee Arrow. Piper manufacturers this airframe and its engineers say that with 200 hp, this aircraft, loaded, will carry four passengers safely with X amount of fuel and that you'll need X amount of runway at a specific density altitude for the aircraft to perform. The key here is that it's performance is based on 200 hp – not 190, or 180, or not 175 hp. Remember that when you let the compres-

sion slip beyond the manufacturer's recommendations, you're allowing the horsepower rating to slip as well.

So let's go back in the hangar. You've got 60/80 and some noise blowing out the exhaust valve. If you've got 60/80, you probably have 25 or 30 hp out of that one cylinder – not 50. You may even only have 15 hp while it's running because the loose exhaust valve is flopping around in the guide and hitting the seat and bouncing around.

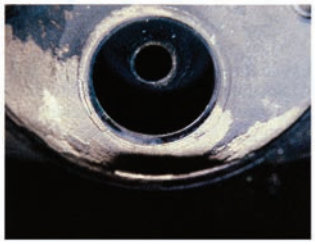
In my opinion, a 60/80 cylinder should come off immediately. You shouldn't even go five minutes further with the job. You should call the owner and tell them that the cylinder should come off and be rebuilt or repaired.

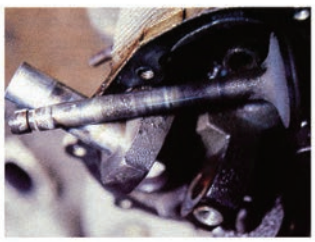
There may occasionally be a rare instance where there's a piece of carbon holding a valve open and staking might take care of it. But you should be absolutely sure of the problem. If you run into one of these instances, you at least need to borescope the cylinder to see if everything else appears to be OK

If you do a cold compression check and something happens after you sign off the engine and it goes out, you've got potential problems from a legal standpoint.

Try Not to Let Outside Pressures Influence You

So you've got your reading (60/80) and have a lot going through your mind. What are you going to say to the owner? Is the owner telling you that the aircraft is going to be sold and pressuring you by saying "I'll watch it and we'll come back in a month?" It's all happening real fast and the owner is trying to control the situation.





Worn valve stems and seats are the most common type of damage to an engine. If you suspect any leakage from this area, remove the valve covers and comply with any service bulletins related to inspection of the valve stems and guides.

You are now being pulled from your obligation under FAR 43.13. You are walking into a violation right here. You've got to understand that you, the A&P technician, have the authority to declare the aircraft unairworthy.

You simply write in the logbook that "this aircraft is not airworthy according to a low compression check on the No. 4 cylinder" and sign your name and give it to the owner. Then when he goes down in the cornfield, you're covered. You ultimately can't stop him from flying his own airplane – but you can discourage him and protect yourself from legal action.

We're talking about giving your customer the best possible maintenance available. And resistance to any pressure that may force you to make unsafe decisions is all part of this service.

We have made it standard policy in our shop not to accept anything below 73/80 on a compression check. We also like to encourage proper leaning procedures. Oil changes should be done at average times of 30 to 35 hours or every four months.

We also warn our customers to avoid shock cooling, keeping little power on the engine while descending. If we can get the owner to control all of these things, they'll increase their chances of making it to TBO.

Common Failures

The most common area of cylinder failure, by far, is in the exhaust valves. People think that cams are the biggest problem area, but the biggest problem area by far is the exhaust valves and guides.

The temperatures in most areas of the engine are such that, relatively speaking, we just don't see that many problems elsewhere. You rarely see problems with the crankshaft bearing areas, and the cylinder wall and piston areas really give us a small percentage of failures. The exhaust valve and guide areas, however, typically run in the 2000 F temperature range and the guides in the 400 F range. And these temperatures contribute to the highest numbers of failures.

This area is also the most difficult area in the engine to lubricate. Oil oxides and cakes up in this area and prevents lubrication to the guide. So any air leakage at all past the exhaust valves should be reason to suspect wear on the valve guides. In fact, Lycoming SB 388B, which involves placing a dial indicator on the valve stem to check the guide for wear, should be done as a matter of procedure whenever any wear whatsoever is suspected.

Ed Rachanski Jr

We don't believe that an engine needs to be "broken in" after a top overhaul. If you "break in" an engine, you are breaking the engine.

Many overhaul shops recommend breaking in cylinders because of the way they hone them.

Standard hones that are used in most shops produce a surface with microscopic peaks and valleys. The objective of breaking in these cylinders is to break down tops of the peaks. This results in metallic particles being distributed throughout the oil system and excessive wear on the rings.

We feel that this "break-in" process, that everyone seems to accept, is really unnecessary and detrimental to the life of the engine. The honing process that we use incorporates a silicone flex-hone and eliminates the "break-in" process by creating plateaus instead of peaks. It results in honed surface that essentially simulates a cylinder that's already broken in.

You still have to run in our cylinders, but this is simply to remove any of the flashing that's on the rings and to make sure that everything's operating properly.

With flex honing, we simply recommend that you install the cylinders and fly the aircraft.

Volumetric Matching of Cylinders

Another thing that we do as a matter of practice, and recommend for all top overhauls is to "CC" the cylinders and arrange the cylinders according to the volume and the firing order.

Basically, CC-ing involves measuring the volumes of the cylinder by pouring the liquid into the cylinders to a mark that is a specific distance from the flange of the cylinder. We measure the volume of the liquid to determine the volume of air/fuel intake mixture that the cylinder will take in. Based on that we end up with cylinders of varying volumes that we can strategically place on the engine.

Our goal is to place the cylinders so that the volumetric differences between the cylinders are kept to a minimum as the firing order progresses. The objective is not, as some people think, to place exact volume cylinders opposite each other – but to place them so that the volumes of the cylinders progress and distress smoothly along with the firing order. This is the one of the most important things that you can do to ensure a smooth-running engine. AMT