

# TECH TOPICS



*Tech Topics is a monthly column written by Mike Busch of CPA's technical staff. Mike is a regular contributor to CPA Magazine, as well as editor-in-chief of AVweb, the Internet's aviation magazine and news service (<http://www.avweb.com>). A 6000-hour pilot, instrument and multiengine flight instructor, and A&P mechanic, Mike owns, flies and maintains a pristine 1979 Cessna T310R.*

## Jug Economics 101

It's annual time, and your IA finds a soft cylinder ... or maybe two. Decision time! Should you replace the bad jug(s) with a new or reconditioned? Top overhaul? Major overhaul? Before you do anything else, do the math.

By Mike Busch <[mbusch@cessna.org](mailto:mbusch@cessna.org)>

I just wrapped up another annual on my Cessna T310R. Geez, it sure didn't seem like a year since the last one! This year's annual was my first since I earned my A&P ticket, and although I've been doing pretty much 100% of the maintenance on the airplane for more than a decade now, this time I was "on my own" to a far greater degree than ever before.

This year's annual didn't turn up all that much wrong—and after last year's "annual from hell" I figured I deserved a break. Actually, the inspection turned up only one item of significant bad news, and that turned up on the very first day of the inspection when I did a brief pre-maintenance flight to warm up the engines, pulled the airplane into the hangar, re-

moved the top cowls and top spark plugs, and did a hot compression check.

Despite the fact that the TS10-520-BB engines were at 1402 SMOH—two hours past TCM's published TBO of 1400 hours—almost all of the cylinders still measured in the mid-70s. Not too shabby.

But the #4 cylinder on the right engine was clearly in deep kimshee. The compression tester read 52/80, and from the roar I heard when I put my ear to the tailpipe, it didn't take rocket science (or a borescope) to figure out that I had a fried exhaust valve. No question that jug was coming off.

### So now what?

Some folks might say that with an engine at "manufacturer's recommended TBO" and a dead cylinder, the time had obviously come to do a major overhaul or exchange it for a factory rebuilt. Sorry, I don't think so. The way I look at it, the engines are running great, not making metal in the filters or oil analysis, not leaking, not burning oil, and 11 out of 12 jugs are just fine, thank you. With any luck at all, these engines have a few hundred more hours left in them—and at the 120 hours/year I average, that's a couple more years of flying. Knock on wood.

No, my plan would definitely be to replace the soft jug and keep on trucking. But replace it with what?

Given the high time on the engines, I had no illusions that this cylinder would still measure up within service limits and be able to be re-valved and reinstalled. I had to assume that the jug was basically trash and couldn't reasonably be reconditioned.

At the same time, it didn't seem to make sense to pony up \$1,200 or so for a new cylinder assembly from TCM, Superior or ECI. After all, I'm not so optimistic that I expect to get another 1,000 hours out of these engines. All I really needed was a jug that would take me for another few hundred hours—500 hours tops—until major overhaul time.

So I phoned up Ken Tunnell at Lycon Aircraft Engines ([www.lycon.com](http://www.lycon.com))—a top-notch engine shop in Visalia, Calif.—and asked him if he could fix me up with a decent serviceable jug that would take me to overhaul time. He said he was sure he could. I shipped him my soft jug (which he con-

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firmed was "beyond economic repair" just as I suspected), and he shipped me back a "continued-time" cylinder assembly with about 500 hours on it. The cost was about \$650, just over half of what a new cylinder assembly would have cost. No guarantees, of course, but I think it's a pretty good bet that this jug will last me until overhaul time. At least that's the theory.

### Pushing TBO

If you've been reading my articles for awhile, or if you've attended one of CPA's Systems & Procedures Courses, you know that we at CPA are strong believers in overhauling "on condition" rather than at some arbitrary number of hours. The engine—not the tach or

But if you're unlucky enough to have to yank a jug (as I just did), you wind up with a big hole in the side of your engine. That gives you a unique opportunity to peer inside and inspect what's inside the crankcase—at least the stuff visible through the hole—and get another data point on the condition of your bottom end.

When I yanked the #4 cylinder off the right engine at this year's annual, I conducted a careful inspection of the cam lobes, tappets, and everything else I could see and feel. There was no sign of cam or lifter spalling, no visible corrosion, and nothing else that would put up a red flag. Combined with the clean oil filters and good oil analysis reports, I came away reassured that my right en-

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Hobbs—will tell you when the time has come to overhaul. So long as the engine isn't making metal, isn't leaking, isn't burning excessive oil, and isn't exhibiting any other disturbing symptoms or alarming trends, there's no reason not to keep on flying.

Published TBO should be thought of as an actuarial statistic, much like human life expectancy figures. Some engines won't make it to published TBO. Some will happily go for hundreds of hours past it (unless arbitrarily euthanized). It's clearly a bad idea to push an engine that's obviously tired or sick, but it's a waste of money to retire one that's elderly but still spry.

Cylinders are expendable. They bolt on and they're relatively inexpensive and easy to change. (We'll quantify that shortly.) If the "bottom end" of the engine—case, crank, cam, main bearings, and gears—are in good shape, there's really no reason to consider a major overhaul.

Ah, but how do you know if the bottom end is in good shape? Most of the time, you have to rely on indirect indicators—oil filter inspection and spectrographic oil analysis being the most important.

gine was not likely to give up the ghost any time soon, despite the 1402 SMOH on the hourmeter.

### Doing the math

The list price of a factory rebuilt TSIO-520-BB engine for my airplane is about \$29,000—and the "street price" from a discount distributor like Van Bortel's Air Power, Inc. ([www.factoryengines.com](http://www.factoryengines.com)) is about \$25,000. Add a few thousand bucks for hoses, engine mounts, and other stuff that is normally replaced at overhaul and you come up with about \$28,000. If the engine makes published TBO of 1,400 hours, the "depletion allowance" comes to about \$20 an hour.

Actually, that figure is too low. The infamous Airworthiness Directive 2000-01-16 basically requires turbocharged twin Cessnas to get a new or overhauled exhaust system at each engine overhaul, which adds a good \$5,000 per engine, bringing the allowance up to around \$24 an hour per engine.

(Of course, this hourly figure varies dramatically depending on what you're

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flying. A straight-leg Skylane with a 2,000-hour-TBO O-470-U engine has a reserve of just over \$10 an hour, while a Cessna 421C with its exotic GTSIO-520-N engine comes in at close to \$40 an hour per engine.)

So even if it cost \$2,000 to change out a soft jug on my 1,400-hour engine (and that assumes a factory-new cylinder and reasonable shop labor for removal and installation), it would only take about 80 hours (at \$24/hour) to break even, and anything more would be

gravy. Flying 120 hours a year, I could change one cylinder per year per engine and be money ahead, compared to doing a major overhaul sooner rather than later. (Fortunately, I've done a lot better than that—three cylinders total in 14 years.)

And if I lower the cost to \$1,000 by using a reconditioned cylinder and some do-it-yourself sweat equity, the break-even point becomes just 40 hours. At that price, it's a no-brainer.

### What stuff costs

To do the math yourself for your own airplane, you need to know what stuff costs so you can do the calculations. Fortunately, the Internet puts all this stuff right at your fingertips.

In today's world, the cost of a factory-rebuilt engine and the cost of a first-rate field overhaul aren't much different. There are pros and cons of rebuilds and field overhauls, but that's a topic for another article. Costwise, it's about a push. You can look up the street price of any TCM or Lycoming

under prices this low, it generally doesn't make sense to fool with reconditioned cylinders (which cost between half and two-thirds of new jugs) unless you've got a high-time engine and are just trying to buy a few hundred more hours as cheaply as possible (as I was).

Unless you do your own maintenance, labor can be a significant cost factor in cylinder replacement calculations. Changing a cylinder involves removing baffles and dropping the exhaust and induction plumbing on the affected side of the engine. As a general rule-of-thumb figure around four hours of labor to change one jug, and add two more hours for each additional jug changed on the same side of the engine at the same time. If your shop charges \$75 an hour, that comes to \$300 for the first jug and \$150 for each additional same-side neighbor. These figures can vary a fair amount depending on make and model—my Cessna T310R is exceptionally easy to work on, but some high-perfor-

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rebuilt engine on the Air Power Inc. site ([www.factoryengines.com](http://www.factoryengines.com)), and you'll find prices ranging from \$13,000 for a Skyhawk engine (Lycoming O320) to \$19,000 for a Skylane engine (TCM O470) to \$25,000 for a Turbo 210 or 310 (TCM TSIO-520) to \$45,000 for a Cessna 421C (TCM GTSIO-520).

For prices on new cylinders from Lycoming or TCM, check Air Power's parts site ([www.factorycylinders.com](http://www.factorycylinders.com)). You'll find cylinder prices ranging from \$900 for a Lycoming O320 to \$1,200 for big-bore TCM cylinders. These prices are for complete cylinder assemblies that include valves, rings, piston, rocker shafts, and even gaskets. Prices from Superior and ECI are pretty comparable. With new cyl-

mance singles are considerably tougher due to poorer maintenance access.

### What about top overhauls?

A "top overhaul" generally refers to replacing all the cylinders at once—usually around mid-TBO. Many an owner whose engine has one or two soft cylinders has been talked into replacing them all, on the theory that if one or two cylinders are bad, the others can't be far behind.

My experience is that this isn't necessarily (or even often) the case. The fact that the #4 cylinder on my right engine burned an exhaust valve doesn't suggest to me that more cylinders are likely to follow suit any time soon. The fact is that in the 3,300 hours that I've been operating

my Cessna T310R, I've only ever had one other burned exhaust valve—and believe it or not, that occurred on the #4 cylinder of the right engine (about five years and 600 hours ago)! If I'd replaced the other five (or eleven) cylinders then on the theory that they would soon suffer the same fate, I would have wasted a whole lot of money. In most

horror stories about TCM "Top Care" cylinders that croaked after 500 or 600 hours, but I've heard similar stories about Superior and ECI cylinders as well. Plenty of folks are making it all the way to published TBO or beyond with each of these brands.

It seems to me that airplanes that fly a lot (like freight haulers and flight school

warranty for high-utilization operators—and because at the moment, TCM is offering some mighty attractive cash rebates on their cylinders.

But with regular use, careful powerplant management techniques, and a little luck, any of these cylinders can make it to TBO. From time to time, some won't—and that's why they make the things bolt-on units that are relatively easy to change. But before you change 'em, do the math.



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cases, there's no reason to replace a cylinder unless there's actually something wrong with it.

A full top overhaul on a big-bore TCM engine would cost around \$7,200 for the cylinders (six jugs at \$1,200 each) and \$1,200 for labor (16 hours at \$75/hour), or a total of \$8,400, give or take. At a \$20/hour depletion rate, the break-even point would be at 420 hours (less if it's a twin Cessna with a \$24/hour depletion rate). So if your cylinders are in serious trouble but you're convinced that the bottom end is good for another 500 hours or more, a top overhaul can be cost-justified.

Every case is different, and without a crystal ball it's impossible to know with certainty what the best course of action will be. But in general, I'd advise an owner with one or two bad jugs to replace only those jugs. On the other hand, if four out of six are bad, then the handwriting would seem to be on the wall and replacing all six might be a good decision.

#### **Whose cylinders are best?**

Every time the subject of cylinder replacement comes up, the discussion quickly turns to the question of whose cylinders are best: factory cylinders (TCM and Lycoming), Superior (Millennium), or ECI (Classic Cast, Cerminil). If you talk to a bunch of owners or a bunch of A&Ps, you'll find passionate supporters of each and passionate critics of each.

Personally, I don't think it makes a lot of difference. I've heard lots of hor-

airplanes) tend to get good life from their cylinders. Most of the horror stories about low-time cylinder failures seem to come from owner-flown airplanes that fly 50 to 150 hours a year.

The problem with these stories is that they are a severely lagging indicator. A 100-hour-a-year owner/operator who has his factory new TCM Top Care cylinders go south after only 600 hours will cry that TCM just doesn't know how to make decent jugs any more. But the cylinders that he's complaining about were made by TCM six years ago. In the last six years, just about everything about the way TCM manufactures its jugs has changed—new equipment, new processes, new coatings, new hone patterns, and so forth. So even if it were true that TCM made lousy jugs six years ago, that doesn't really tell you anything about the quality of the jugs they're turning out now. The same applies to the PMA suppliers (Superior and ECI). These things are a moving target, and old news doesn't provide reliable guidance.

Despite all the debate, I've seen no conclusive evidence that anyone's cylinders are convincingly better or worse than anyone else's.

The choice may be driven by other considerations. If I were operating seasonally and/or in a high-corrosion environment (e.g., a floatplane in Florida), I'd probably opt for Cerminil cylinders because of their corrosion resistance. On the other hand, if I were flying 500 hours a year, I'd probably go for TCM factory jugs because they offer a better