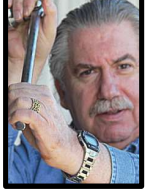

MIKE BUSCH
COMMENTARY / SAVVY AVIATOR

Don't Go Overboard

Suppressing the urge to overreact to and overkill problems

A BONANZA OWNER ENCOUNTERED an engine problem 11 hours after his aircraft came out of annual. He had crossed the Sierra Nevada Mountains VFR at 12,500 feet westbound en route to the Bay Area, and was descending through 11,000 feet when he felt a bit of engine roughness. After doing an in-flight mag check and studying his JPI engine analyzer, his initial guess was that he had a bad spark plug in the No. 3 cylinder.

But the problem got worse, and so after landing the pilot took the plane to a local mechanic and asked him to perform a compression check. Sure enough, the No. 3 cylinder measured 20/80 with air whistling past the exhaust valve. Clearly the cylinder was going to have to come off and the exhaust valve and seat be replaced.

So far, nothing unusual here. Happens all the time.

What I found interesting about this story was how the owner reacted to this burned valve episode. Here's a brief excerpt of the e-mail he sent to his A&P:

"I think the valve may have been burning itself (or the valve seat) to a worse condition as I continued to fly. I am glad I did not tempt myself with the idea of flying it home. It may have burned right through and started an engine compartment fire. No thanks!

"At annual, you told me one of the cylinders had a hint of exhaust leak and that the Continental service bulletin said this was okay, but that we should keep an eye on it. Which cylinder was that? I could not find it in the logs.

"Assuming a stuck exhaust valve, how do we determine if the cylinder can be saved for a while longer? If it can't, I think our cylinders are old enough that we should do all six, and the bottom is far enough along toward TBO that it might be time for a major."

Whoa! Change all six cylinders because of *one* burned exhaust valve? Pull the engine for major overhaul? Give me a break!

TOP OVERHAUL?

When a mid-TBO engine is found to have one or two "soft" cylinders, owners are often advised by their mechanics to consider replacing all six cylinders—a procedure commonly referred to as a "top overhaul." The cost of "topping" a six-cylinder engine is generally about $14,000 give or take—six new cylinder assemblies at about $1,800 each plus $3,000 in labor for removal and reinstallation. (If reconditioned cylinders are used instead of new ones, the cost might be $9,000 or $10,000.)

PHOTOGRAPHY COURTESY OF **MIKE BUSCH**

The assumption implicit in an owner's decision or a mechanic's advice to "top" an engine is that if one or two cylinders are unairworthy and require replacement now, the other cylinders are likely to follow suit shortly, and so the owner would be wise to "bite the bullet" and replace them all at once, rather than prolonging the agony by doing it on the installment plan. It's not uncommon for mechanics to tell owners that it's "normal" or "typical" for big-bore Continental engines (particularly turbocharged ones) to need a top overhaul at mid-TBO.

In my experience, such advice is simply wrong.

But the problem got worse, and so after landing the pilot took the plane to a local mechanic and asked him to perform a compression check. Sure enough, the No. 3 cylinder measured 20/80 with air whistling past the exhaust valve.

I have owned my TSIO-520-powered Cessna T310R for nearly three decades and put 6,000 hours on its two engines during that time. In that same time period, I've replaced only four of the 12 cylinders, and those four cylinder changes occurred many years apart. The four cylinders that needed replacement became unairworthy for a variety of different reasons.

A TALE OF FOUR CYLINDERS

The first of these cylinders was replaced when a sharp-eyed IA discovered a faint blue fuel stain on a cylinder head during an annual inspection decades ago. Dye penetrant revealed clearly that there was a crack in the cylinder head between the fuel injector boss and the top spark plug hole, a very common place for Continental cylinder heads to crack.

Naturally, when this head crack was discovered, I wondered how long it would be before head cracks started showing up on my 11 other cylinders. As it turned out, those cylinders ran thousands more hours without developing any more head cracks.

The second cylinder was replaced several years later when it "swallowed" an exhaust valve. When we removed the cylinder and extracted the broken exhaust valve, it was apparent that the valve failed because of an improperly manufactured Nitralloy exhaust valve guide that had gouged large quantities of chrome plating from the exhaust valve stem.

Naturally, when this defective exhaust valve guide was found, I wondered how long it would be before my other 11 cylinders started to swallow their exhaust valves. But thousands of hours later, I've experienced no more burned or swallowed exhaust valves.

The third cylinder was replaced in 2002 when a compression check at annual revealed compressions in the high 50s with air audibly leaking past the exhaust valve. In accordance with Continental's Service Bulletin M84-15 (which stated that no leakage past the valves was acceptable), I removed the cylinder but couldn't see anything wrong with it. Nevertheless, I had a local cylinder shop re-valve the cylinder, and I reinstalled it.

Naturally, this made me wonder whether this was the portent of leaky exhaust valves in my other 11 cylinders. As things turned out, it was not. In fact, over the next several annual inspections, my compression readings actually *improved* each year. My engines made it to well over 200 percent of TBO without any more low-compression cylinders.

Less than a year later, Continental superseded Service Bulletin M84-15 with Service Bulletin SB03-3 removing the prohibition against minor valve leakage and permitting such cylinders to continue in service.

Then finally, thousands of hours after the first cylinder was retired because of a head crack between the top spark plug and injector boss, another cylinder developed a similar crack and had to be retired.

As a result of this experience, I've become convinced that trying to use what happens to one cylinder to forecast what's likely to happen to the others is an exercise in futility. I've come to believe that a six-cylinder engine is best thought of as six one-cylinder engines flying in close formation. What happens to one cylinder has little or no predictive value with respect to the other five (or in a twin, the other 11).

Consequently, I have come to believe that when a soft cylinder shows up at annual, the best course is simply to repair or replace the jug in question and leave the others alone.

MAJOR OVERHAUL?

The idea of majoring a near-TBO engine because of a weak cylinder strikes me as even more ludicrous. Our engines are built with bolt-on cylinders for a good reason: so that bad cylinders can be replaced without having to remove the engine and split the case.

As a result of this experience, I've become convinced that trying to use what happens to one cylinder to forecast what's likely to happen to the others is an exercise in futility.

Cylinders should be thought of as bolt-on engine accessories, just like alternators, vacuum pumps, and magnetos. Would you major your engine just because an alternator failed? Of course not! You'd simply replace the bad alternator. A worn-out cylinder is no different. Just replace the bad jug and keep on flying.

The principal reason for removing an engine for overhaul is when it develops a problem with some bottom-end component—crankcase, crankshaft, camshaft, main bearings, accessory gears—that cannot be repaired without pulling the engine and splitting the case. From where I sit, overhauling because of a problem with a bolt-on accessory—cylinder alternator, magneto, prop governor, vacuum pump, etc.—makes absolutely no sense at all. Cylinder problems should *never* influence an aircraft owner's decision about when to perform a major engine overhaul.

If a big-bore Continental engine costs $40,000 to overhaul (including R&R labor, new engine mounts, new hoses, etc.) and has a 2,000-hour TBO, then each hour the overhaul can be prudently deferred is worth $20. If it costs $2,200 to replace a cylinder ($1,800 for the new cylinder plus $400 for labor), then the break-even point for cylinder replacement is $2,200/$20 or about 110 hours. Thus, if you can extend the life of the engine by more than 110 hours by replacing a cylinder, you're money ahead to do so.

If you install a reconditioned cylinder instead of a new one (which is what I've always done when I needed to replace a jug), the cost is less and the break-even point drops to about 75 hours. The replacement cylinder literally pays for itself in two oil-change intervals!

It is not unusual for a cylinder to go south from time to time. Nobody likes it, but it's hardly a major catastrophe. When it happens to you (and it will), simply change the cylinder and keep flying. That's why they bolt 'em on.

If your annual inspection reveals one or two cylinders with weak compression and your mechanic suggests that it would be a good idea to replace all six, he's probably not doing you any favors. If the engine is nearing TBO (but still running well and not making metal) and he suggests majoring the engine now instead of just replacing the weak jugs, he's probably giving you terrible advice. In either case, you'd be wise to seek a second opinion from an engine expert before you decide how to proceed. EAA

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