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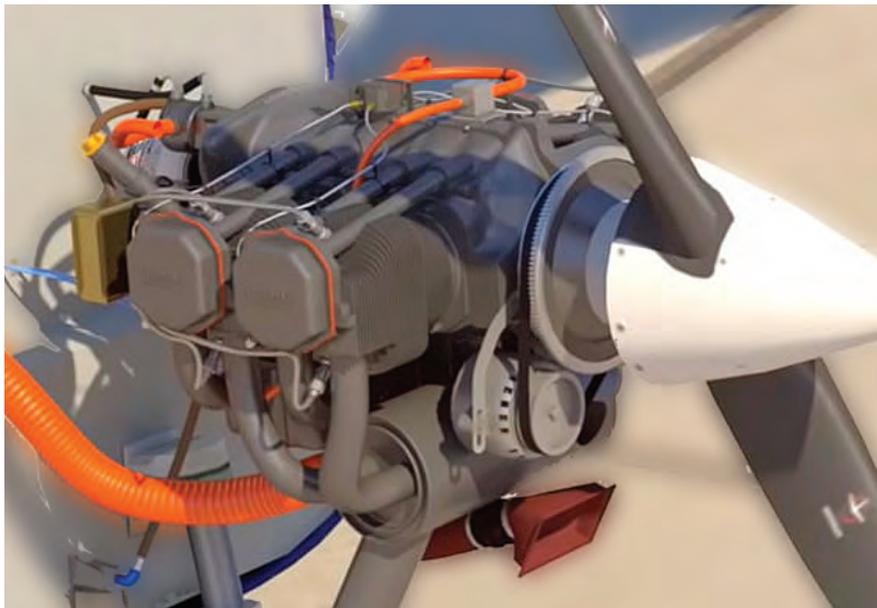


SAVVY MAINTENANCE / OPINION

TBO 5000

The engine is talking; when you should listen

BY MIKE BUSCH



WHAT FOLLOWS IS true, although the names have been changed.

It was 2011 and Unruly Flyers had a problem. This 14-member Midwest flying club's only aircraft—a 1997 Cessna 172R—had a Lycoming IO-360 engine that was rapidly approaching its 2,000-hour time between overhauls (TBO), forcing the club to make a decision. Overhaul would put Unruly Flyers on the ground for at least three months. Replacement with a Lycoming rebuilt might shorten the downtime but increase the cost.

Unruly's board was struggling with this decision and decided to coax the club's former maintenance officer Zachary "Whit" Whittington to come out of retirement. Whit wasn't an A&P, but he'd been flying general aviation for more than two decades and had proven himself to be exceptionally maintenance-savvy.

At the next Unruly board meeting (pun intended) Whit asked all the right questions:

Q: Are we having problems with the engine?

A: No.

Q: Why are we thinking about overhauling or replacing it?

A: It's at TBO.

Q: Are we required to do anything at TBO?

A: Guess not.

Q: Why not continue it in service?

A: Uh, for how much longer?

Q: Until there's some indication that overhaul or replacement is warranted.

A: Is that safe? How would we decide when it's warranted?

Several years earlier he'd attended a workshop where I made the case for doing maintenance "on condition" rather than on the fixed timetables recommended by

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manufacturers. I presented the results of a five-year study of GA engine-failure accident data from the NTSB showing that the greatest risk of an engine-failure accident exists when an engine is young, not when it's old.

"We should worry more about engine failure during the first 200 hours after the engine is overhauled or rebuilt than during the first 200 hours past recommended TBO," Whit explained. "Very few engine-failure accidents involve engines beyond TBO and 80 percent of those are due to maintenance errors rather than to any age-related cause."

Whit recommended that Unruly enroll its Skyhawk in my company's managed maintenance program where we help owners maintain their aircraft using this on-condition philosophy, working directly with their shops and mechanics. The board approved. One of my most experienced account managers—Eric Svelmoe, an A&P with inspection authorization—was assigned to Unruly's airplane.

The journey begins

The Skyhawk was averaging 300 flight hours per year and had flown as much as 600 hours in prior years. Unruly had acquired the airplane in 1998 with 500 hours since new, and had the Air Plains supplemental type certificate installed to upgrade the engine from 160 to 180 horsepower. The airplane was hanged and maintained by the local FBO.

Whit told Svelmoe that the club's primary maintenance concern was that the Skyhawk's factory-rebuilt Lycoming IO-360 had more than 2,000 hours. For Unruly to continue flying it a thorough condition monitoring program would need to be implemented. "The FBO isn't much of a believer in borescopes," Whit explained. "They've got an old clunky one that they hardly ever use, so we really don't know what our exhaust valves or cylinder barrels look like."

Bulletproof...almost

Svelmoe—who has decades of experience overhauling and maintaining Lycoming engines—told Whit that the Lycoming IO-360 is relatively bulletproof, but does have a few vulnerabilities that need to

be monitored closely. One involves the engine's hollow-stem, sodium-filled exhaust valves, which have a history of becoming eroded, pitted, and vulnerable to breakage after a couple of thousand hours. Another is the cam and lifters, which have a history of spalling if corrosion occurs during periods of disuse.

Svelmoe believed Unruly's Skyhawk was flying so regularly that this probably wouldn't occur. He suggested switching from Aeroshell 15W-50 to Phillips X/C 20W-50 and adding ASL CamGuard for improved protection against corrosion and wear.

A third vulnerability is sticking exhaust valves, a longstanding problem with Lycomings. Svelmoe recommended doing the exhaust valve "wobble test" every 400 hours per Lycoming Mandatory Service Bulletin No. 388C. He also urged that club members be trained to recognize "morning sickness"—rough running when the engine is started cold that smooths out once the engine warms up—and to report this immediately so that the valve guide can be reamed before sticking gets serious.

Annual inspection

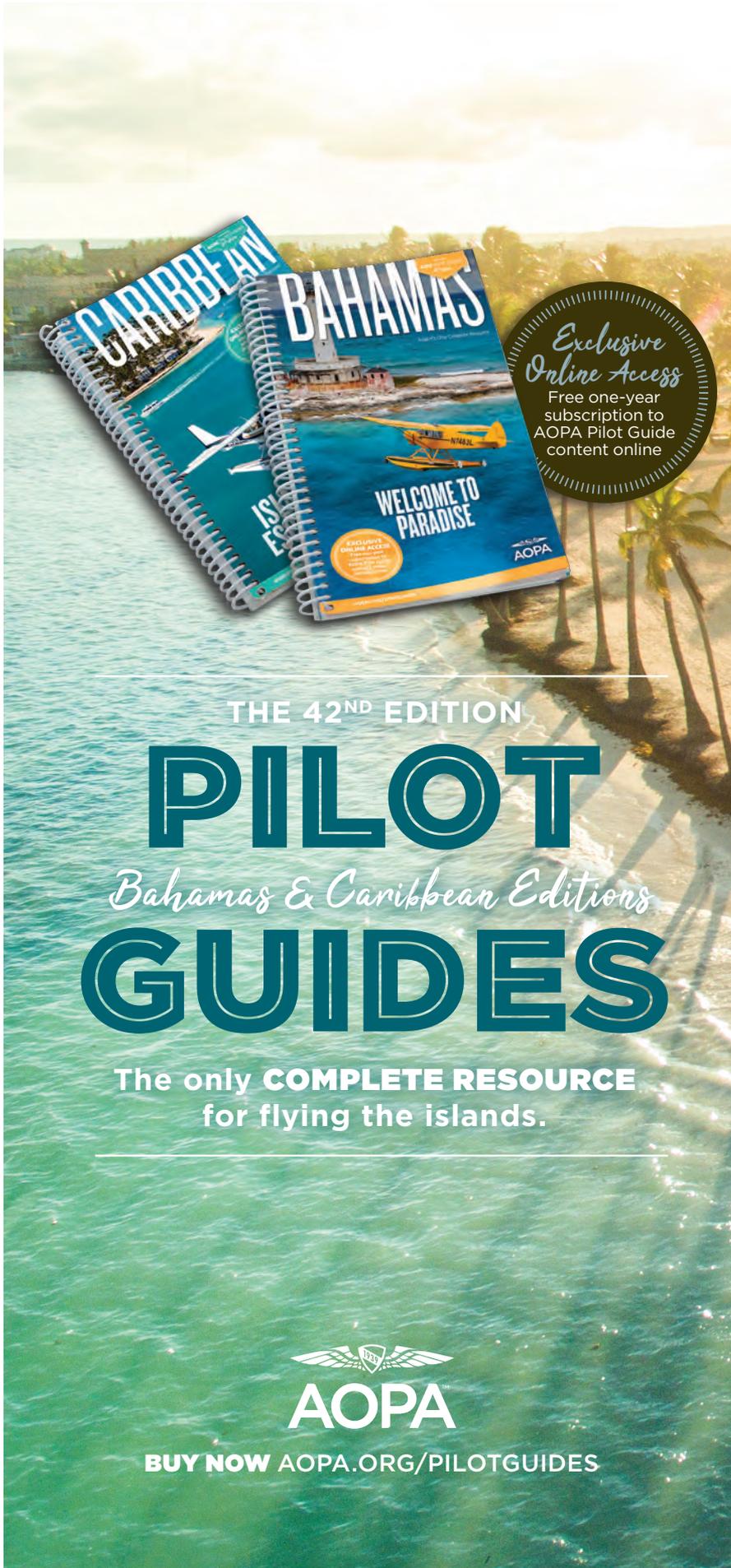
The Skyhawk's 2012 annual inspection began January 30. Engine time was now about 2,500 hours. The compression test went smoothly with all cylinders in the 70s. However, the borescope inspection was a big disappointment because the FBO's borescope—a Snap-On BK5500—was (in Whit's words) "pretty much of a joke."

The resolution and lighting were horrible, and there was no way to manipulate the camera to view the condition of the exhaust valve stems, so it was necessary to drop the exhaust system to inspect them.



The Snap-On BK5500 (above) was "pretty much of a joke" so the club acquired a \$250 Vividia Ablescope VA-400, which was a huge improvement.

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“I think I’d better purchase a decent bore-scope,” Whit said. Svelmoe recommended the Vividia Ablescope VA-400 from Oasis Scientific for \$250.

Engine hiccupping and popping

Fast forward two and a half years to September 2014. Engine time was about 3,250 hours. The club organized a spot-landing contest, and several members reported the engine was hiccupping and making loud popping sounds when throttled back for landing. Whit asked Svelmoe for advice.

“Hiccupping and popping suggests one cylinder is intermittently not firing, so unburned air-fuel mixture is being pumped out the exhaust port and combusting in the manifold,” Svelmoe explained. “Not likely an ignition problem; that would require both plugs not to fire. More likely a sticking exhaust valve, so I recommend we have the shop do a wobble test ASAP?”

All four exhaust valves passed the test with flying colors, but in the process of removing the rockers and exhaust valve springs for the test, the shop discovered a rocker shaft bushing in cylinder No. 2 was cracked and broken. A new bushing was installed and the hiccupping and popping disappeared.

Oil consumption rising

Fast forward to September 2016. Engine time about 3,700 hours.

“The engine used eight quarts of oil since the oil change 35 hours ago,” Whit reported to Svelmoe, “and I’m starting to get concerned.”

“That’s 4.4 hours per quart,” Svelmoe said. “While that’s a bit higher than ideal, it’s not a problem beyond tolerating some oil on the belly.” He explained that in high-time engines, that type of oil consumption often is because of the accumulation of sludge in the oil control rings and piston oil feed holes. A solvent flush procedure can sometimes clear the sludge if it isn’t too bad. If a piston can’t be cleaned up via the solvent flush, he added, the only cure is to remove the cylinder.

A couple of months later, Whit reported oil consumption was 3.3 hours per quart.

“This won’t affect compression or engine power,” Svelmoe reassured Whit. “But it’ll slowly get worse. Eventually you will start fouling plugs and spooking pilots. Then you’ll have to address it. Right now, there is no safety concern. The oil control ring solvent flush procedure may help improve things if they haven’t gotten too bad. If you’d like to try this, the sooner the better.”

“Great guidance,” replied Whit. “It is reassuring to know we’re not affecting safety of flight as long as we diligently watch the oil level. I think it certainly would make sense to take a \$400 gamble on the solvent flush versus spending \$40,000 on an overhaul and being down for heaven knows how long.”

Since the FBO had never done the flush procedure, Svelmoe suggested Whit fly the airplane to Paul New’s shop Tennessee Aircraft Services in Jackson, Tennessee, which did the procedure regularly. Svelmoe asked New to do a borescope inspection while he had the top spark plugs out for the solvent flush.

Tennessee flush

“The front cylinders No. 1 and No. 2 cleaned up very nicely, but the rear cylinders No. 3 and No. 4 wouldn’t pass solvent very well even after multiple attempts,” New said of the solvent flush. “I’m pretty sure those two are responsible for most of the remaining oil consumption.”

“If oil consumption becomes intolerable, I’d suggest pulling cylinder No. 3 first and inspecting the cam and lifters,” New said. “If the cam and lifters look OK, then pull cylinder No. 4 and clean up both pistons and replace the rings. Alternatively, if the cam and

lifters look bad, you may want to bite the bullet and overhaul.”

New provided a series of borescope images of the exhaust valves, none of which provided any reason for concern.

On the four-hour flight back from Tennessee, Whit said, the engine used only one quart of oil. “Since we’re nowhere close to Lycoming’s maximum oil consumption threshold of one quart in two hours, it’s not clear we need to do anything further at this time.”

1,200 hours later

The IO-360 kept on trucking without major issues for another four and a half years and 1,200 hours. In June 2021 with the engine at 4,800 hours, Whit told Svelmoe: “I think we’re finally between the proverbial rock and a hard place. The engine is now burning a quart every three hours. It’s hard to start, we’re having oil-fouling problems with bottom spark plugs, and cylinder No. 2 compression is decreasing.”

The club wanted to replace the engine with another Lycoming rebuilt, and Svelmoe suggested they order it directly from Air Power Inc. in Texas rather than through the FBO. “If you order it through the shop, they’ll mark it up—that can really add up on something as expensive as a factory engine.”

Air Power quoted exchange prices for the Lycoming IO-360-L2A as \$29,199 for a factory overhauled engine and \$33,699 for a factory rebuilt. Unruly Flyers opted for the rebuilt and placed an order with a deposit.

While the club waited out delivery delays on the new engine, the IO-360 hit 5,000 hours, and was having such hard starting and bad plug fouling issues that the Unruly board of directors reluctantly agreed to ground the Skyhawk until the new engine could be installed. The newly rebuilt engine arrived in mid-February, and the airplane was back in the air on March 10.

Examining the old engine

Naturally, everyone was dying to see what the bottom end of a Lycoming engine looks like after 5,000 hours. The FBO pulled the No. 2 cylinder, piston, and connecting rod so Whit could look inside and take a few



The Lycoming’s exhaust valves all looked fine under the borescope.

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RUDDER & WRENCH



The No. 2 piston was severely clogged with sludge, but the cylinder was in great shape with plenty of visible crosshatch.



The inside of the crankcase was astonishingly clean, and the crankpin and rod bearing looked good.



The cam and lifters still looked healthy after 5,000 hours.

photos before the old engine was returned for core credit.

The No. 2 piston predictably had its oil-control ring horribly sludged up, explaining the high oil consumption. Yet the No. 2 cylinder barrel was in remarkably good condition, with lots of the original crosshatch hone pattern still visible.

The inside of the crankcase was astonishingly clean and free of deposits. The No. 2 rod journal (crankpin) was in excellent condition, while the connecting rod bearing exhibited some wear but was still in pretty good shape.

The cam lobes had minor wear but no pitting or corrosion damage, and no distress deep enough to flunk the fingernail test. Had it not been for the sludged-up oil control rings, this 5,000-hour engine could

have easily gone another 1,000-plus hours. (Had the engine been run on unleaded fuel, it would probably still be flying!)

If you ever wondered why these four-cylinder Lycomings have a reputation for being “bulletproof,” wonder no longer. Unruly Flyers certainly got their money’s worth from that engine.

Takeaways

Now, not every Lycoming is going to make it to 5,000 hours—although a surprising number of them make it 3,000 to 4,000 hours if flown regularly and given a chance. Unruly’s Skyhawk was the poster child for TBO extension: It averaged 300 hours a year, lived in an area of moderate corrosion risk, was always hangared, always preheated in the wintertime, never

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cold-started, and meticulously maintained. It had a lot going for it.

But every engine deserves the chance to continue in service “until its time comes” the way Unruly’s IO-360 did. Wouldn’t it have been felony to euthanize this engine at its 2,000-hour TBO? That’s exactly what would have happened if Whit and Svelmoe hadn’t teamed up to continue the engine in service until it started showing signs of being old and cantankerous. There was no way of knowing in advance whether this would happen at 3,000 or 4,000 or 5,000 hours, and no reason to guess. The engine will start talking when its time approaches, you just need to make sure you’re listening.

By extending its engine’s life from 2,000 to 5,000 hours, Unruly saved roughly \$60,000 from what they would have spent had they dutifully replaced the Skyhawk’s engine each time it reached its 2,000-hour TBO. I’d call that savvy maintenance. ■ mike.busch@savvyaviation.com
▶ savvyaviation.com

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