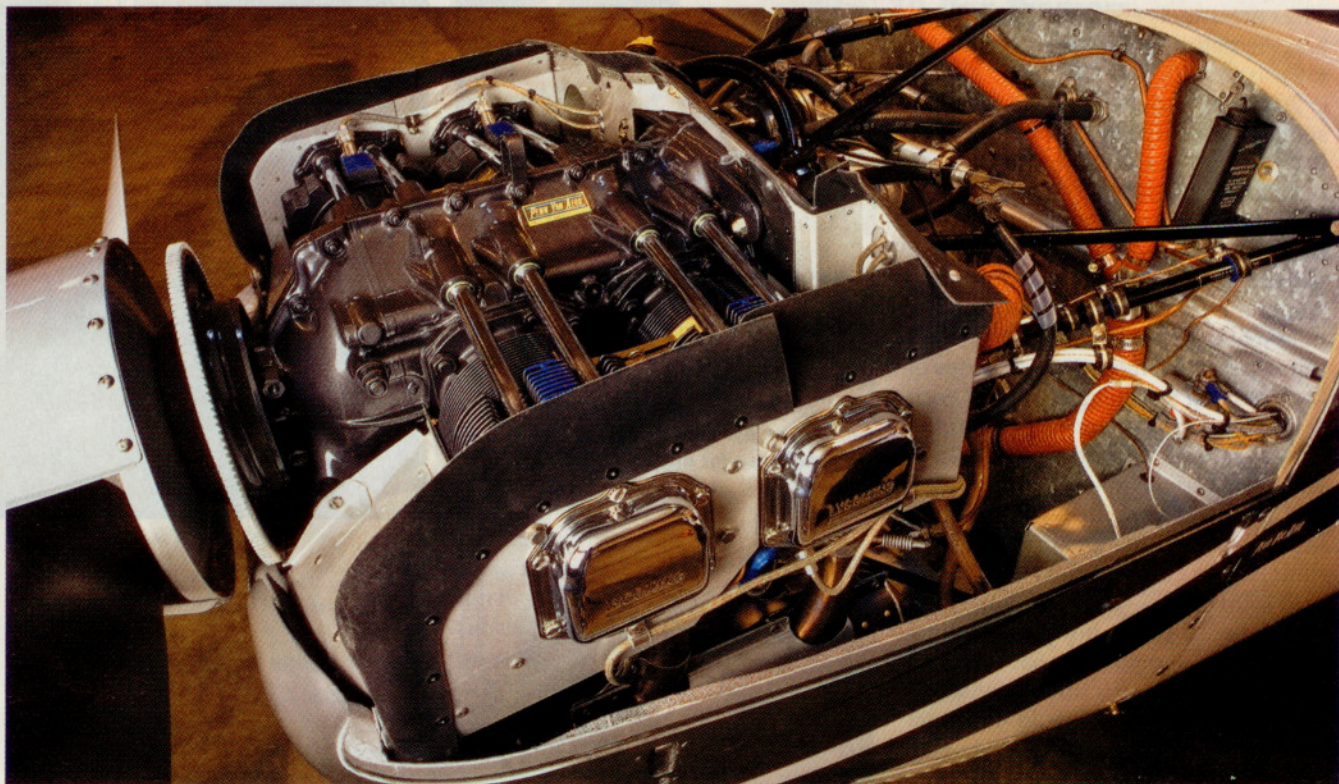




SWEEPS UPDATE

A MONTHLY UPDATE ON THE PROGRESS OF YOUR SWEEPSTAKES AIRPLANE



More than skin deep

Getting to the heart of the matter with an engine overhaul

BY IAN J. TWOMBLY

Engine overhaul. Just saying these two costly words strikes fear in the heart of aircraft owners everywhere. That ambiguous point when operating temperatures, oil analysis, and compression checks suggest a complete overhaul is never an easy pill to swallow. Choices abound. Do you get a full overhaul or will a top overhaul

do? And, who does the work? Are factory-remanufactured products worth the price or is a field overhaul a better deal? We recently faced these questions, and many more, when deciding how to treat the Lycoming O-360-A4M engine hung on the front of AOPA's "Get Your Glass Sweepstakes" Piper Archer II.

The first decision is whether to actually do an overhaul. Although the Archer's Lycoming O-360-A4M has a recommended time before overhaul (TBO) of 2,000 hours, there's no guarantee it will make it to that point—or, conversely, no requirement that it has to be overhauled upon reaching the magic number. Owners flying their aircraft under Part 91 are free to overhaul their engine as they please. Typically, the decision to overhaul

The finished engine is a sight to behold (top). Penn Yan Aero's Jud Dean welds a crankcase repair (right).



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comes from a combination of factors, some of them more esoteric than others. Higher operating temperatures, excessive metal in the oil, and most important, compression test results, are all factors. Cylinder compression is tested at each annual inspection. Roughly speaking, it's the cylinder's ability to contain the air pressure that builds inside. A lower number indicates pressure is escaping somewhere, and theoretically, the engine won't perform as well.

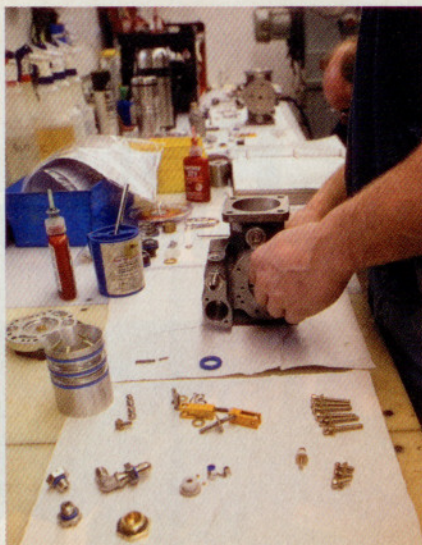
Although each engine manufacturer sets limits, as a general rule anything less than 60 out of 80 (maintenance technicians use a device that measures pounds per square inch, just like on a tire) is considered a poor result and usually leads to further investigation. Sometimes that means a new cylinder, new seals, or a new valve, and sometimes it means an overhaul. A series of compression tests over time, and each cylinder's compression relative to the others, are also good indicators of when an overhaul might be due.

The Archer's engine was last tested in May 2007 during an annual inspection. Engine compressions were in the mid to high 70s—a great result. That was to be expected, however, as there were only a bit more than 650 hours on its factory-remanufactured engine. Although most owners would never get an overhaul at this point, we want to give away the best glass cockpit airplane in the sky. A newly overhauled engine is part of that package.

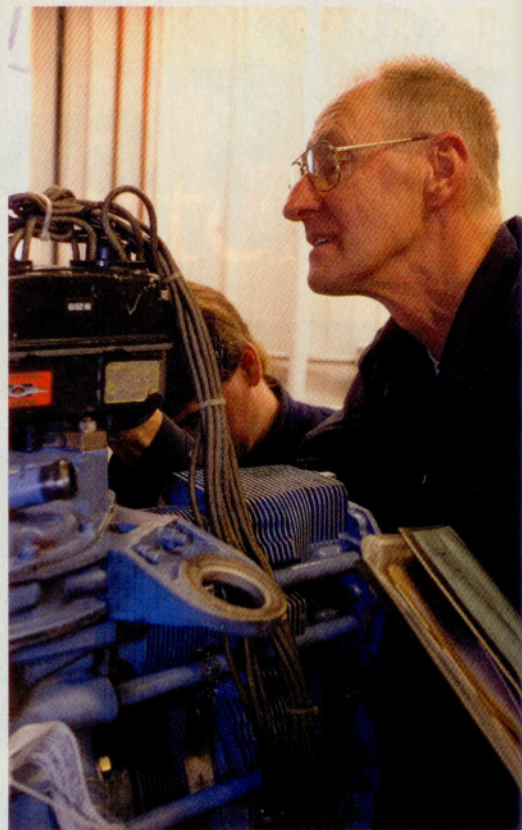
When it came time to choose the best way to overhaul the engine, we faced the same dilemmas that all owners face. Cost, time, quality of work, and reputation are all key considerations when deciding on how to bring a tired engine back to life.

The first step is to decide what type of overhaul to get. There are five basic choices—factory new, factory remanufactured, factory overhaul, dedicated overhaul facility, or a field overhaul. Each has its advantages and disadvantages. Most owners don't opt for factory new, primarily because the increased cost doesn't offer many advantages. Although factory new means the new engine will be manufactured with new, updated techniques, and typically, this option comes with the best warranty.

Factory remanufactured is a common option, and strictly speaking, going through such a factory process is



New or overhauled carburetors are part of Penn Yan Aero's overhaul package (above). Ron Christensen completes what will be the first of many visual inspections prior to an engine's disassembly (right). Penn Yan Aero's Jason Fox washes off a penetrating dye that's used to check the crankcase for cracks (below).



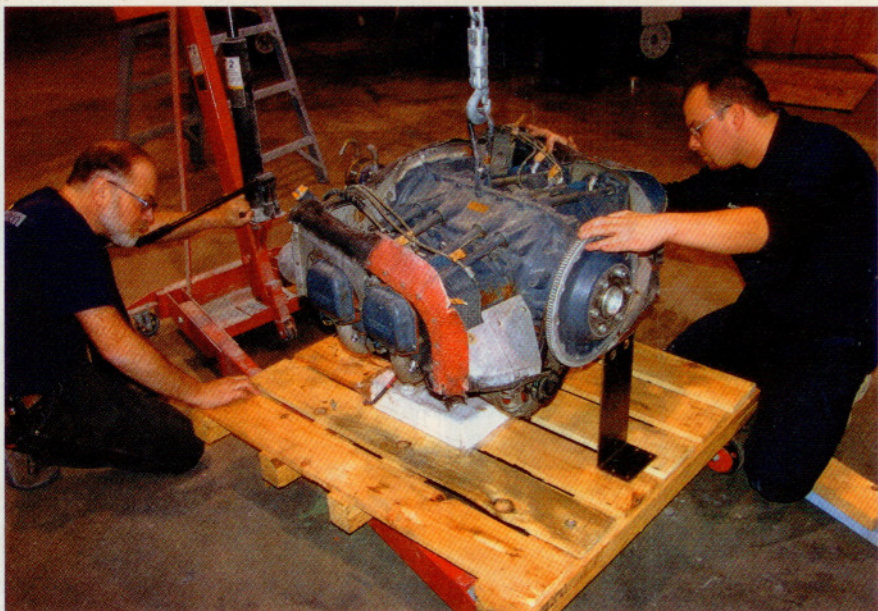
the only source by which an older engine can be officially called zero time. Dedicated overhaul facilities are probably the most popular option and there are many around the country that do great work and offer lots of options. Finally, since any powerplant mechanic can overhaul an engine, it is possible to have a local mechanic do the work. Lack of tooling and documentation, lack of experience, and negative impact on resale value are common pitfalls with this option.

One crucial part of the decision between a factory reman and an overhaul

is the life of the engine. A typical overhaul shop will attempt to repair and reuse the bottom end of the engine—generally defined as the crankcase and crankshaft. Over time, these parts become worn, and although they may be repairable, saving them might not make financial sense over the long term. When faced with multiple crankcase repairs or other expensive issues, a factory reman starts to make sense.

Powered by Penn Yan Aero

In the case of the "Get Your Glass Sweepstakes" Archer, we turned to one



Prior to the overhaul, the Archer's engine sported hints of corrosion and other signs of age, despite having little more than 650 hours since factory remanufacture.

of the country's most reputable engine overhaul facilities, Penn Yan Aero in Penn Yan, New York. Penn Yan Aero has clients from all over the world, and the shop has gained an international reputation for quality. Owner Bill Middlebrook and his staff were eager to take on our O-360, and we were excited to see what they could do.

One of the first decisions that has to be made after settling on a shop is what level of part limits to overhaul to—new limits or service limits. With new limits, the cylinders, pistons, valves, and other major components are restored to like-new condition, either through the use of factory-new parts or overhauled used parts. Either way, the engine parts meet the same specs as those in a new engine.

When overhauling to service limits, the shop simply takes the existing parts and ensures that they fall within the manufacturer's ultimate dimensional limits. If so, they are left alone. If not, they are usually replaced or reworked to make that limit. Although the engine is still considered overhauled, most of the parts contained within are effectively used. One notable exception is exhaust valves. Because of the massive amounts of stress the valves experience, Lycoming recommends replacing them at overhaul.

Penn Yan Aero took our Lycoming to new limits, as it does with every engine that comes through its doors. This means the sweepstakes winner will have a great chance of making it to 2,000 hours—or longer—before the

next overhaul, if the engine is properly operated and maintained.

After deciding on limits, the next round of choices center on accessories. As part of the overhaul, Penn Yan provides new or overhauled magnetos (go for new), a refurbished carburetor or fuel injectors, a new fuel pump, a new wiring harness, new spark plugs, and a lightweight starter from Sky-Tec. Knowing Sky-Tec makes a great starter that weighs less than the factory version, we had contacted them prior to going with Penn Yan. The result is that we received a flashy chrome model that will look great set against the engine and airplane colors.

How it's done

Once the basic accessory decisions are made, the shop gets to work. Overhauling an engine is akin to refurbishing an antique airplane. The engine is torn down, cleaned, inspected, and rebuilt. Of course, the steps are much more detailed than that.

Middlebrook took us on a tour of his shop for a close look at what happened to the Archer's engine. After a full inventory, the engine was completely disassembled and cleaned in a high-temperature and high-pressure wash rack. "Think of it like a big dishwasher," Middlebrook said. It's a treat to see the engine at this point. Totally devoid of dirt, oil, and years of grime, the true nature of the components come through. Here each part is inspected for limits using a variety of techniques, from a simple visual inspection to sophisti-

cated instruments that use air to measure distance.

Next comes the crankcase. This is where overhaul shops start to diverge in their business practices. Although many shops send cases out to be repaired, Penn Yan Aero repairs them in house. We wanted to "take control of our destiny," said Middlebrook. Doing so allows the shop to move the engine through faster because they aren't waiting for another shop to finish a component. "The more we produced, the harder it was to get them repaired in a timely fashion," he said. In all, they

are allowed to repair three defects on each case before an owner is forced to buy a new one, which is not a good thing. Buying a new case translates to significantly more money and additional time.

As the case is undergoing inspection and repair, the cylinders are addressed. Here again, the owner is faced with a number of choices. Penn Yan Aero offers factory new cylinders, aftermarket cylinders from sources such as ECI and Superior, and in-house overhauled cylinders. According to Middlebrook, Penn Yan was one of the

first shops in the country authorized to perform cylinder head welding. They can also bore out cylinders. "If we can't do it right, we don't do it at all," Middlebrook said. A new set of Lycoming factory new cylinders went into the Archer's engine.

After the cylinders are done, the crankshaft is dynamically balanced, much in the same way as a car wheel. Middlebrook said Penn Yan Aero has an advantage in this step because, although most shops balance the crankshaft, they complete the step without the flywheel attached. Bolt that on and everything is now out of balance, he said. That's why Penn Yan balances all crankshafts with the flywheel attached at the beginning of the process.

After all the replacement parts come from the factory, the entire engine is re-assembled and run for 90 minutes in a test cell. Here everything from cylinder head temperature to horsepower is tested. Then the engine goes through a final quality control check and heads to the dock to be shipped back to the owner. In all, the process takes approximately four to six weeks. That is, assuming parts are available. Middlebrook said parts supply can be challenging, depending on engine type.

The business end

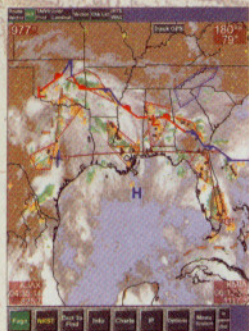
The Archer's engine looks great and it was delivered in less time than the estimate. But a solid engine is just the beginning. In addition to the lightweight



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Featured contributor

Penn Yan Aero

Bill Middlebrook's grandfather started Penn Yan Aero in a small shop in central New York more than 60 years ago. Now the third-generation owner, Middlebrook—and his crew of highly experienced employees—are dedicated to providing a reliable product at a reasonable price. Penn Yan Aero has built an international reputation for quality over the years, something Middlebrook attributes to excellent customer service and a skilled and knowledgeable workforce. The company can provide full overhaul services, factory new or remanufactured engines, and it holds STCs to convert older engines for more power. Visit the Web site (www.pennyanero.com) or call 800-727-7230.

starter from Sky-Tec, we also replaced the alternator and voltage regulator with new parts from Plane-Power. Vintage voltage regulators are notoriously unreliable and alternators are high-failure items. It made sense to change them both out with superior aftermarket options.

Any overhaul shop will also tell you that overhaul is a perfect time to change the hoses. There's simply no good reason to put old hoses on a new engine, especially when companies like Precision Hose Technology specialize in complete hose kits that are affordable, available quickly, and reliable. Hoses and fittings is all they do, and they have a reputation for doing it well. Concorde also graciously supplied us with a new battery, which we think will serve the winner for years to come. Finally, on the mechanical end, Pacific Oil Cooler Service provided a new oil cooler, a key component not to be overlooked when overhauling an engine. Pacific is the world's largest distributor of Aero-Classics oil coolers, something that allows them to ship quickly.

Although it is important to upgrade or replace mechanical items such as the hoses, battery, and alternator, good looks are not to be ignored. That's why we turned to Gee-Bee Baffle Seals for our new engine baffling seals, Kosola and Associates for our engine mount, and Aerospace Welding Minneapolis for our exhaust.

Gee-Bee manufacturers baffle seals in a number of colors and we've found through various sweepstakes projects over the years that their product is a good one. Thankfully, they agreed to help us again this year with the Archer. Kosola and Associates is a small but experienced aeronautical engineering company that specializes in various STCs, engineering and airworthiness approvals and consulting, and engine mount refurbishment. They did great work on our engine mount, and also supplied us with the hardware for the one-piece windshield.

Aerospace Welding Minneapolis is a new sweepstakes contributor that offered to refurbish the exhaust system. Sure, it's not a tuned exhaust and the winner won't be flying any faster (this is an Archer after all), but he or she is going to look good getting there. You practically have to wear sunglasses to look at the exhaust after they were done refurbishing and polishing it.

Finally, a project like this simply wouldn't be possible without the support of the manufacturer. Piper supplied us with many parts forward of the firewall including cowl plugs, engine

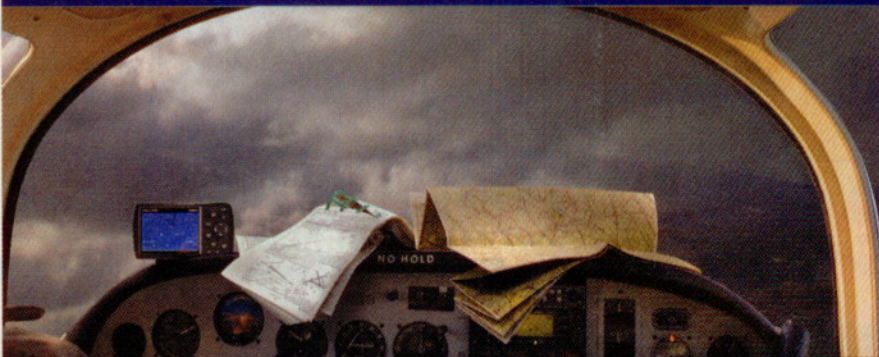
mounts, and other fittings. The service was fast and almost every part we requested was in stock. That's saying something on a 32-year-old airplane.

But none of this would matter without a great engine, which is exactly what we think we got with Penn Yan Aero. Their work has proven to be a great asset to the project and has produced a beautiful engine—words not often used to describe your typical piston power plant.

ACPA

E-mail the author at ian.twombly@aopa.org.

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