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# **CESSNA FLYER**

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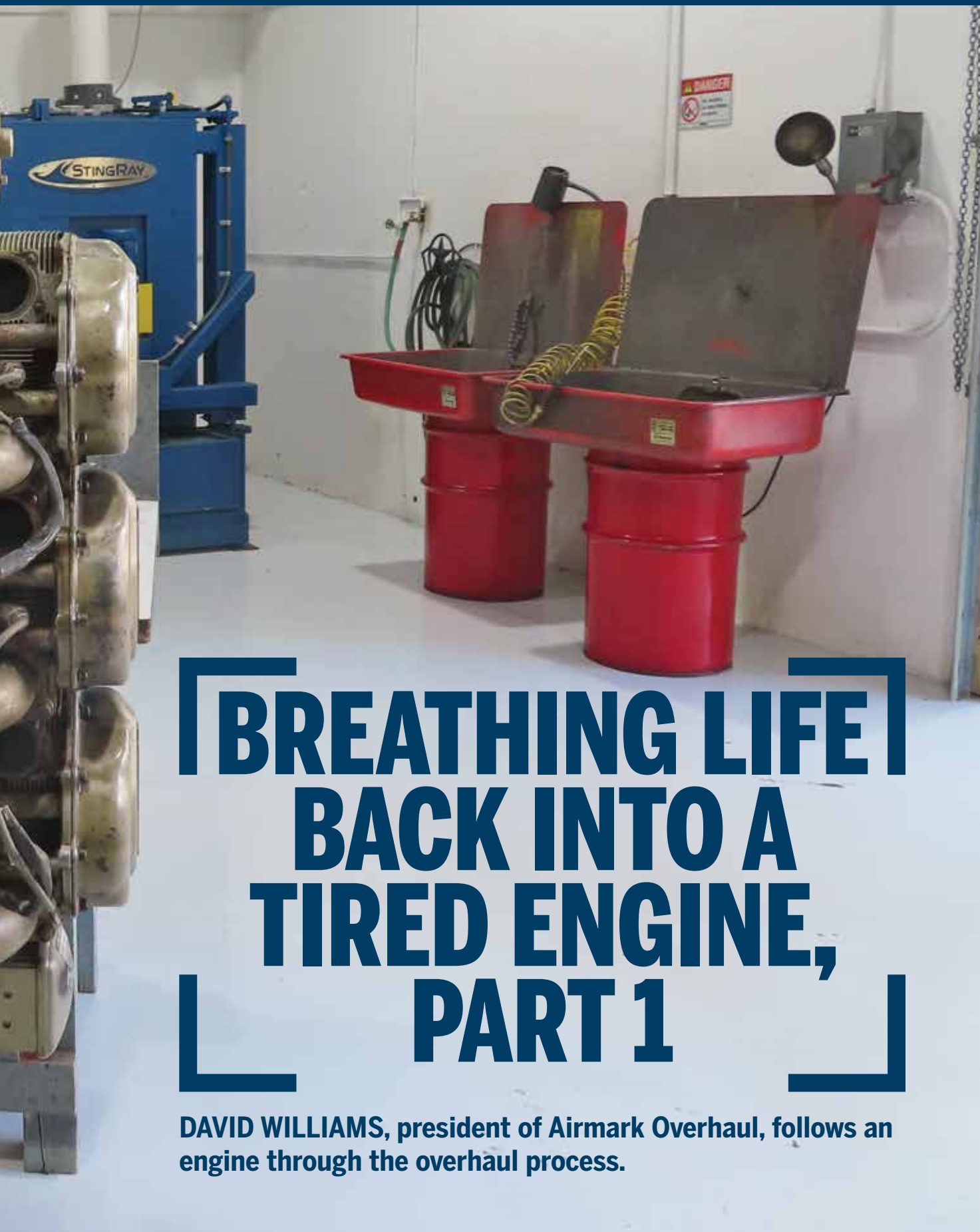
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# BREATHING LIFE BACK INTO A TIRED ENGINE, PART 1

DAVID WILLIAMS, president of Airmark Overhaul, follows an engine through the overhaul process.



**A run-out engine in a shipping crate, as received by Airmark.**



**The engine is placed on a stand for disassembly.**



**The first items removed and cataloged are external accessories and parts.**

cringed the day I received the telephone call from Sal Staiano, who was looking to overhaul the Continental O-470-L engine from his 1958 Cessna 182A Skylane. The engine was about 800 hours over TBO...and hadn't been overhauled since 1970!

The images started to flash through my head of bearings worn down through the babbitt material, heat surface cracks along the bearing journals of the crankshaft, cracks throughout the crankcase, and of course, the new requirements and guidelines Continental Aerospace Technologies has set forth as defined in their new M-O manual.

Experience has shown that the manufacturer's guidelines for TBO are a good timeline to follow. Just like our bodies, nothing lasts forever, even the bulletproof Continental O-470 series engine.



### **What time is the right time?**

When the time for your engine to be overhauled comes, no pilot is ever ready. The thought of putting your aircraft on the ground for any period tends to make pilots put off this task. But, as in life, all good things must come to an end.

Perhaps it is easier to think of it this way; better things are yet to come. Yes... more power, a more responsive engine, less oil consumption, and a smoother and more enjoyable flight. These can all be improvements which spark the thought to say "Yes, it is time to let the moths out of my wallet and do this!"

If you have telltale signs of the coming day, such as lowering oil pressure readings, excessive blow-by past the piston rings or out the breather, and/or loss of power, these could be your wake-up call. If pushing the limits now seems to be the





Some parts won't be reused; note the crack in the housing near the bolt at lower right.



The right tools, such as the crowfoot wrench shown here, make the disassembly process easier.



The O-470-L case before cleaning.



right choice, you may later be faced with devastating results.

The entire process of selecting an overhaul facility can be intimidating, but you have to do some homework. If possible, visit the facility of your choice. Think of it as a vacation opportunity and an education at the same time.

This could be a real eye-opener in some instances, and might save you a lot of headaches and years of frustration down the road. A well-organized and well-run facility is a window into how your engine will be overhauled.

The facility of choice for Staiano was Airmark Overhaul Inc. in Fort Lauderdale, Florida, where I work. In this

series of articles, we will go through the overhaul process for his O-470-L engine at Airmark.

### **The groundwork begins**

Airmark (and many other overhaul facilities) can offer an empty crate shipment if needed, so boxing the engine is a bit simpler. In this instance, the customer's FBO, State Line Aviation in New Jersey, fabricated their own crate for the engine. Airmark can also arrange with a freight company to pick up and deliver the crated engine to Airmark.

It is best to ship your engine secured inside a wooden crate. This reduces the risk of damage, as sometimes the freight

companies can treat your crate like a hockey puck. It is always a good idea to drain your oil before shipping the engine as an oil spill during transit never makes the trucking companies happy.

Once we received the shipment, we carefully removed the O-470-L from the crate. The engine was stood up, and pictures were immediately taken documenting the engine with photographs and a log sheet.

We record all the items on the engine with serial numbers if applicable. This way, if some non-related engine part(s) are left installed, the part(s) can be addressed or just returned as-is with no work accomplished at the customer's request.

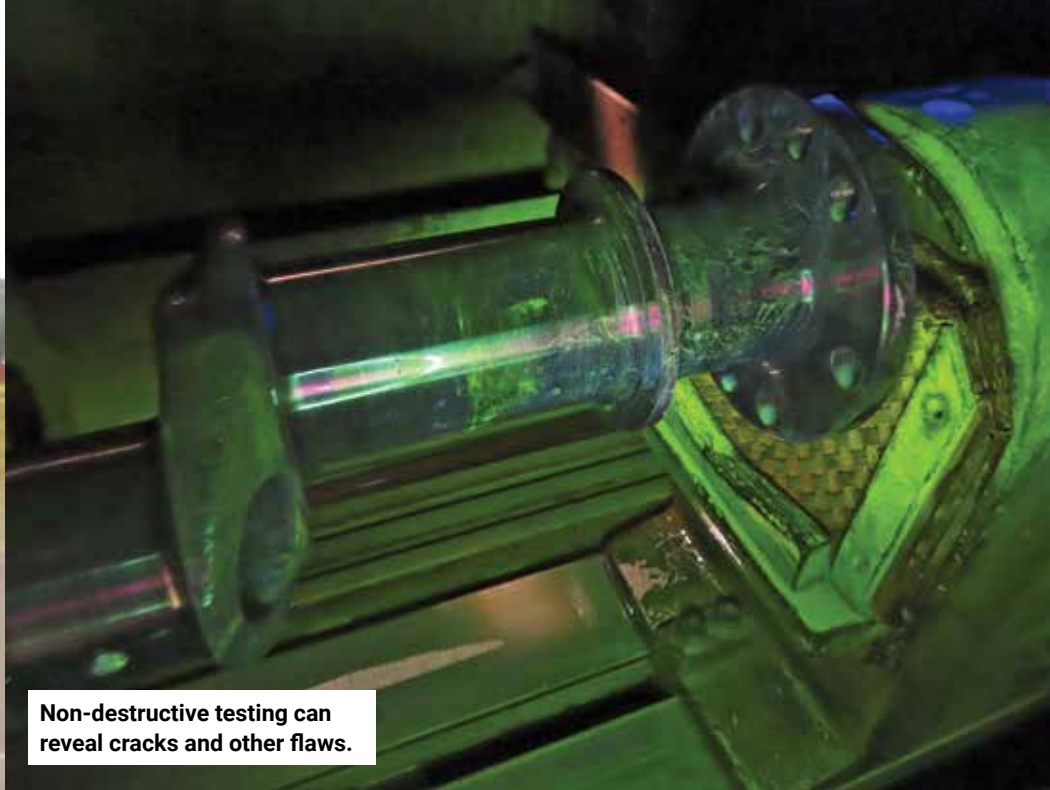




During the teardown process, detailed hidden damage inspections are accomplished to be sure nothing was happening behind the scenes that the pilot was unaware of, such as a broken part, excessive wear, loose hardware, contamination, or spun bushings. Items such as this could mean deeper issues and causes.

### **Cleaning and inspection**

Once the disassembly is finished, off the parts go to the cleaning process. Airmark is equipped with a high-pressure cleaning booth that works with high water pressure and heat to remove all paint and carbon deposits.



**Non-destructive testing can reveal cracks and other flaws.**



**Thorough cleaning of all parts before inspection is a must.**





**Organization and cataloging of parts after disassembly saves time and avoids potential headaches.**

After the high-pressure cleaning booth, the parts are then directed to an assigned mechanic to further inspect and clean the parts by mechanical means, thus prepping for the non-destructive testing (NDT) of the parts.

The ferrous parts (such as the steel parts) are directed to the magnetic particle inspection station and the non-ferrous parts (such as aluminum and magnesium castings) are directed to the liquid penetrant inspection station. This is a particularly important step that can save future heartache when cracks are caught during these inspections.

Continental's new M-O manual is very specific about the NDT requirements for inspecting an engine's parts, which believe it or not, some shops still do not accomplish. A minimum Level II inspector is required for all these inspections.

Remember, red dye penetrant is *not* an approved method of inspection and can cause corrosion on the parts if a residue remains. Continental requires all six-cylinder crankshafts to be ultrasonic tested (UT) to verify that there are no subsurface defects in the crankshaft, as they take quite the stress pushing

against the forces of six pistons in their firing process. All these inspections will lay the groundwork for an awesome and trouble-free engine overhaul that you will enjoy for years to come.

Once the NDT inspections are completed, Airmark's Quality Assurance (QA) manager steps in and begins the process of checking and recording all the pertinent clearances, measurements, and run-outs.

If the crankcase passes the NDT inspections, it is bolted together and all pertinent inspections are done such as checking the deck heights to be sure that the minimum deck height is maintained. All cylinder studding is checked with minimum torques to be sure no studs are pulling out of the crankcase.

Staiano's particular crankcase passed all the necessary checks and NDT inspections with flying colors. We had suspicions of possible problems when the engine came through our doors; it had not been overhauled since 1970 and has been pushed to over 800 hours over TBO. I will say that the older O-470 crankcases seem to be stronger castings, and this probably contributed to

its condition, though the owner stated he meticulously took care of the engine throughout its years of operation.

### **Mandated changes**

During the inspection process, the QA manager researches all Airworthiness Directives and Service Bulletins, paying particular attention to Mandatory Service Bulletins, as these are normally tied to an AD. This list guides the technician through the overhaul process and exactly what deficiencies need to be addressed.

The O-470-L engine has had changes stipulated by Continental over the years, specifically concerning the crankshaft gear and camshaft gear, requiring replacement to newer styles. Of course, this particular engine fell into both those requirements, and replacement of both gears was necessary. The starter adapter was updated to the new style as the older, sleeve-style adapter has a clearance issue with the newer, thicker crankshaft gear.

### **Other required replacement parts**

The phase of the crankcase required the installation of flanged bearings. Flanged bearing requirements are

The O-470's case, split for inspection.



detailed in Continental's SB97-5. The crankcase thru studs are another 100% replacement part required by Continental, so these were also added to the parts list requirements for this engine.

The parts list is produced by utilizing Continental's 100% parts list, now found in Section C1 of the M-O manual, not a separate standalone service bulletin as before. This is the minimum parts replacement guideline Airmark will use to overhaul an engine.

Regarding the M-O manual, in April 2016, Continental assembled a Master Standard Practice Maintenance Manual; more commonly known as the M-O manual. This manual, in conjunction with the revised model-specific overhaul manual, must be utilized to comply with a legal overhaul.

Make sure whatever facility overhauls your engine states the overhaul manual number and revision date utilized, and make sure this information is entered onto the FAA Form 8130-3 document issued for the engine. If the facility is not willing to do this, it's a red flag. You can

check with Continental for the latest revision date of the manuals.

Non-factory overhaulers like Airmark have the freedom to use parts that have performed the best in service and have been found to be trouble-free. The parts can be either OEM or FAA/PMA. This makes Airmark's engines (in my opinion) to be a superior choice, as we can utilize the best of best parts.

The parts list is now complete and sent to the purchasing office, and the countdown begins for parts procurement. A completion date is then determined for the engine.

### **Balancing for optimal performance**

Next, the crankshaft and connecting rods are directed to the balancing station. The balancing process is a service I feel sets Airmark apart from the rest of the pack. Continental specifies static balancing of the piston sets and connecting rod sets. Airmark takes this a step further and also dynamically balances the engine's rotational parts.

This is especially effective on coun-

terweighted engines like the O-470-L. The weight combinations of roller pins and counterweights are the key to this process, as all these parts can vary ever so slightly in weight.

The crankshaft with the counterweights installed are rotated and balanced to operational speeds on Airmark's crankshaft balancing machine. This process produces a very smooth-running engine. A well-balanced engine, statically and dynamically, will reduce the effects that vibration can have on the engine, airframe, and the pilot.

Next time, we discuss the reassembly process for Mr. Staiano's engine.

**David Williams**, president of Airmark Overhaul Inc., is an A&P mechanic and has been involved in the General Aviation industry for over 35 years. He began working at AeroCraft Accessories Inc. as an accessory technician. AeroCraft was combined with Airmark Engines Inc., where he worked as an engine mechanic and managed the





facility. The combination of the two companies created what is now called Airmark Overhaul Inc., a full-service engine overhaul and repair facility with powerplant, accessory, and NDT capabilities. When not at his passion he calls work, he enjoys spending time with his wife and fishing the South Florida saltwater. Send questions or comments to [editor@cessnaflyer.org](mailto:editor@cessnaflyer.org).

## RESOURCES

### CFA SUPPORTERS

#### **AIRMARK OVERHAUL INC.**

[airmarkoverhaul.com](http://airmarkoverhaul.com)

#### **CONTINENTAL AEROSPACE TECHNOLOGIES**

[continental.aero](http://continental.aero)

### OTHER

#### **STATE LINE AVIATION LLC**

[alexandriafield.com/maintenance\\_shop](http://alexandriafield.com/maintenance_shop)