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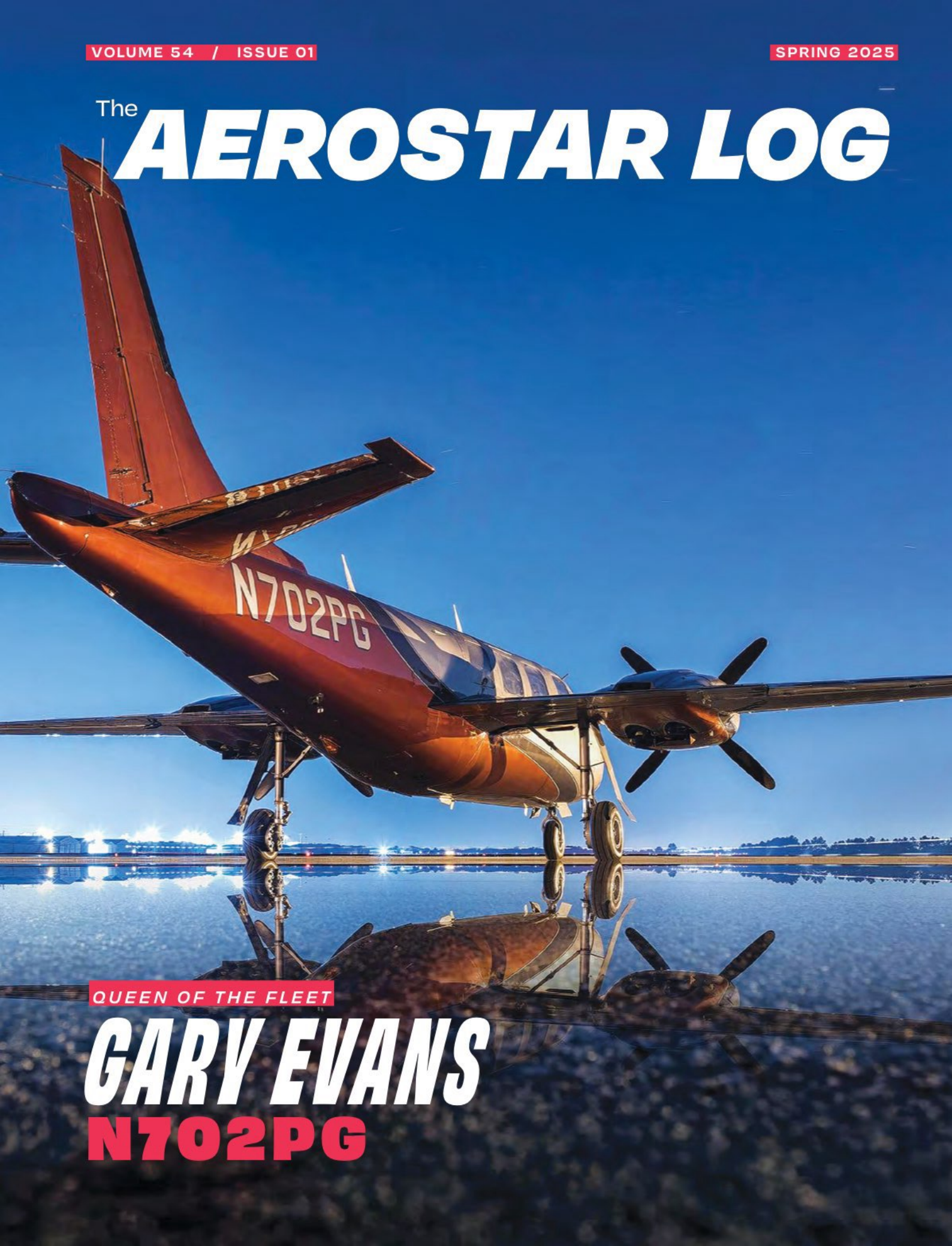
The AEROSTAR LOG



QUEEN OF THE FLEET

GARY EVANS

N702PG

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AEROSTAR ENGINE TREND MONITORING: PART 1 OF 3

Oil Analysis

How reading your oil tells the story of what's happening inside your Aerostar's engines.

Mark Henshall

Would it surprise you to know that the airline I fly for does not own the engines that power the fleet of Embraer 175 aircraft we fly?

They do own the airframes. But they RENT the engines. I bet there have been times you wished the engines on your Aerostar were rented. Got a blown cylinder? Good news. Repairing it is someone else's problem. It's always nice to dream.

Since the expensive engines on your Aerostar are certainly wholly owned by you, it pays to track their condition closely, not only for safety reasons but also so you can catch problems early and correct them before major surgery is required or a catastrophic breakdown occurs. Trend monitoring of engines has been practiced for decades by the airlines and military. These days, with readily available and affordable technology, owners of piston aircraft can also practice aggressive trend monitoring. The best part is you don't have to be an A&P mechanic to do it. In fact, most A&Ps don't even know HOW to practice the various components of trend monitoring, other than cutting open an oil filter because the regs mandate it. Most mechanics don't have much motivation to go beyond what the FAA requires in this regard. It's not their wallet on the line. But as the person paying the bills, you, as an owner, can empower yourself.

TREND MONITORING PUTS YOU, THE OWNER, ONE STEP AHEAD OF EXPENSIVE PROBLEMS.

Imagine this: As a result of effective trend monitoring, you may even be in a position to tell your mechanic early in the game that the exhaust valve on cylinder number 5 on the left engine needs to have the valve guide reamed, something he would have no way of knowing at this early stage. This can be done without cylinder removal if caught early and will correct a valve that is starting to stick before mechanical damage occurs. Or you may be in a position to tell him that, NO, cylinder number 2 on the right engine does NOT need to be pulled, despite his assertion that the cylinder is bad because even though the compression reading was below 60/80, borescope images reveal no internal cylinder issues. And you have solid proof. Compression tests are notoriously inaccurate and inconsistent, but having photographic evidence of a healthy cylinder in your hands is compelling. Wondering if you need to overhaul as you approach TBO? The airlines do not

Fig. 6
Metal in filter

Fig. 1
Cutting open an oil filter

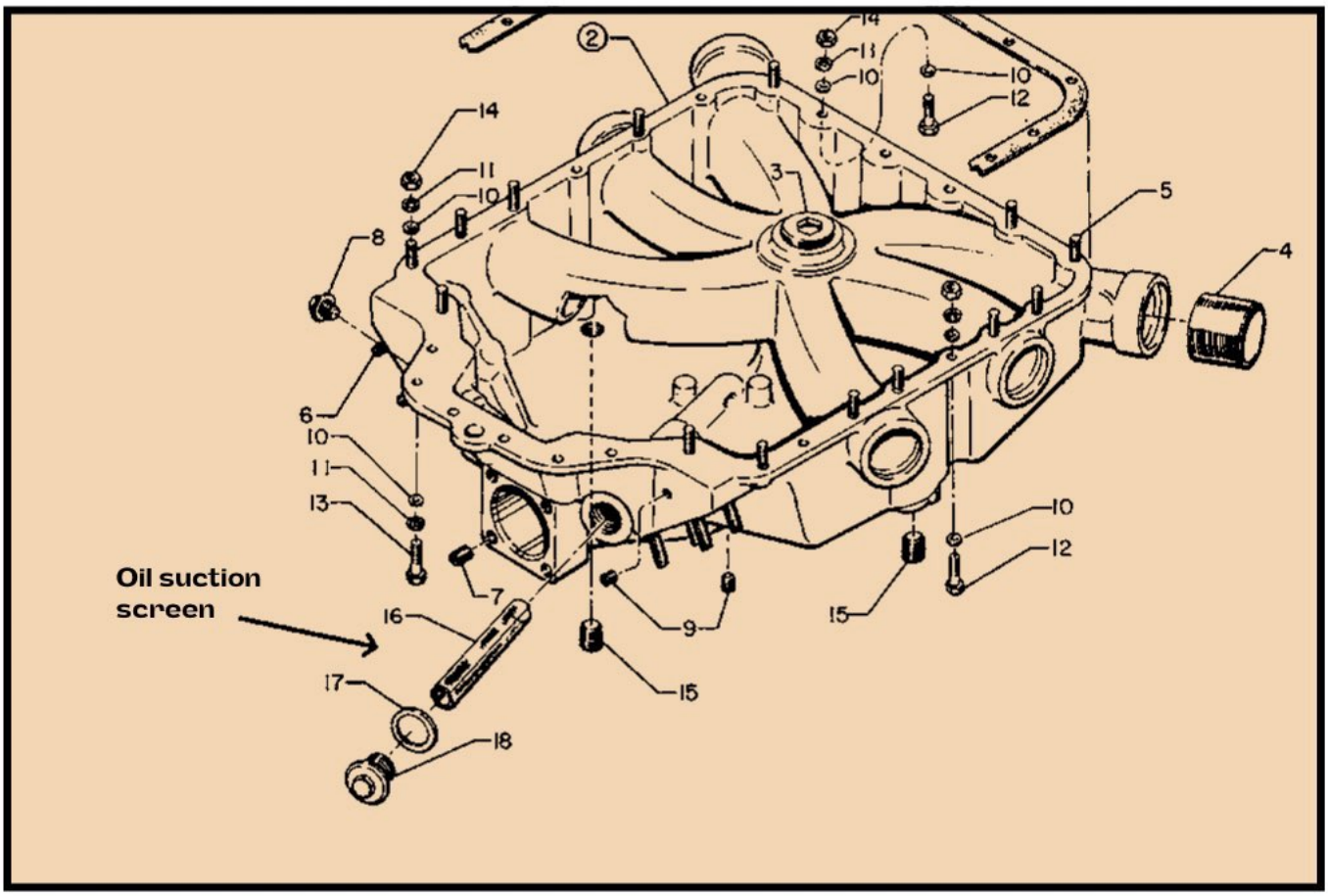


Fig. 2
Oil suction screen

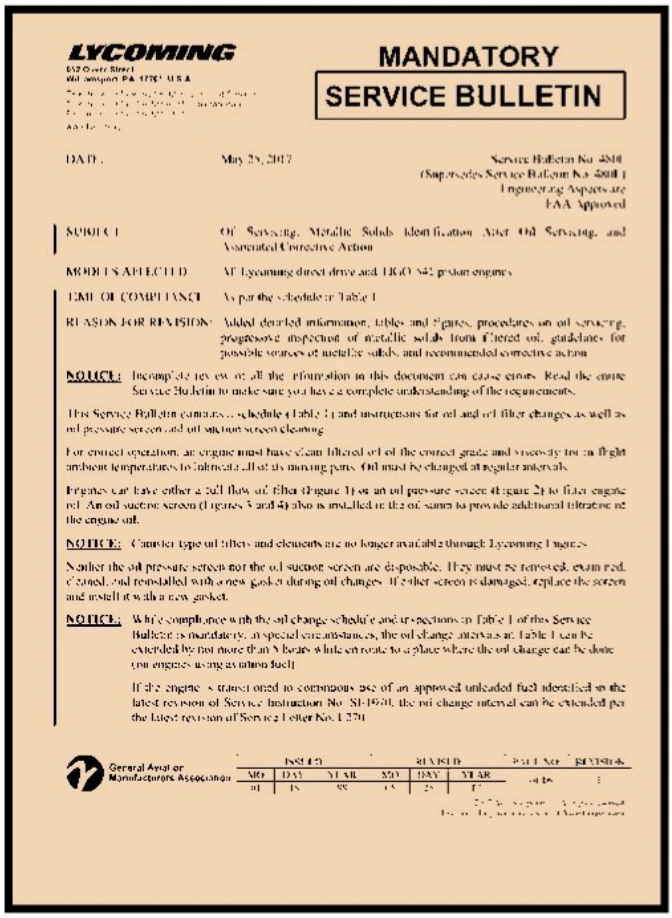
Fig. 4
Identifying metal

Fig. 5
How much metal is too much?

overhaul engines when they reach a certain hour mark. The decision to overhaul is based on condition. You may save yourself from needlessly euthanizing an engine that is in perfectly acceptable condition because you have had your finger on the pulse of the engine's health all along. It's not at all unheard of for even turbocharged engines to far exceed TBO, provided they aren't abused or exposed to corrosion and effective trend monitoring is practiced. Like what you're hearing? Read on.

This article is part one of a three-part series that describes how to perform all the various components of engine trend monitoring. This part covers oil analysis and inspecting the oil filter and oil pump suction screen for contaminants. Parts two and three will cover electronic engine data analysis and borescope analysis of engine internals in order to get high-resolution pictures of engine conditions. Again, everything I'm about to teach you can be performed by you as an owner under your preventive maintenance authority granted to you by FAR part 43 appendix A. You do not need to be supervised by an A&P for any of these steps.

Every single time the oil is changed in your engines, the oil filters should be cut open and examined for metal and other contaminants. Outlets



LYCOMING

652 Oliver Street
Williamsport, PA 17701 U.S.A.

MANDATORY
SERVICE BULLETIN

DATE: May 25, 2017

Service Bulletin No: 480F
(Supersedes Service Bulletin No: 480E)
Engineering Aspects are
FAA Approved

SUBJECT: Oil Servicing, Metallic Solids Identification After Oil Servicing, and Associated Corrective Action

MODELS AFFECTED: All Lycoming direct drive and LIGO-542 piston engines

TIME OF COMPLIANCE: As per the schedule in Table 1

REASON FOR REVISION: Added detailed information, tables and figures, procedures on oil servicing, progressive inspection of metallic solids from filtered oil, guidance for possible sources of metallic solids, and recommended corrective action

NOTICE: Incomplete review of all the information in this document can cause errors. Read the entire Service Bulletin to make sure you have a complete understanding of the requirements.

This Service Bulletin contains a schedule (Table 1) and instructions for oil and oil filter changes as well as oil pressure screen and oil suction screen cleaning.

For correct operation, an engine must have clean filtered oil of the correct grade and viscosity for its flight ambient temperatures to lubricate all of its moving parts. Oil must be changed at regular intervals.

Engines can have either a full flow oil filter (Figure 1) or an oil pressure screen (Figure 2) to filter engine oil. An oil suction screen (Figures 3 and 4) also is installed in the oil sump to provide additional filtration of the engine oil.

NOTICE: Canister type oil filters and elements are no longer available through Lycoming Engines.

Neither the oil pressure screen nor the oil suction screen are disposable. They must be removed, examined, cleaned, and reinstalled with a new gasket during oil changes. If either screen is damaged, replace the screen and install it with a new gasket.

NOTICE: While compliance with the oil change schedule and inspections in Table 1 of this Service Bulletin is mandatory, in special circumstances, the oil change intervals in Table 1 can be extended by not more than 5 hours while en route to a place where the oil change can be done (on engines using aviation fuel).

If the engine is transitioned to continuous use of an approved unleaded fuel identified in the latest revision of Service Instruction No. SI-1070, the oil change interval can be extended per the latest revision of Service Letter No. L 220.

General Aviation Manufacturers Association

ISSUED			REVISED			PAGE NO.	REVISION
MO	DAY	YEAR	MO	DAY	YEAR	of 16	1
01	15	98	05	25	17		

Fig. 3
Lycoming Service Bulletin 480F

such as Aircraft Spruce sell tools for cutting open filters. There are YouTube videos that demonstrate how to unfold the pleats of the filter element for inspection [See Fig. 1]. This is required by regulation at each annual but not mandated for routine oil changes. If you skip this step, though, you are throwing away vital data. You should also take an oil sample at each oil change for analysis by a qualified lab. But did you also know that on the sump at the bottom of your Aerostar's engine, there is an oil suction screen for the oil pump's inlet? This gets missed a lot, but it should also be removed at each oil change and inspected [See Fig. 2].

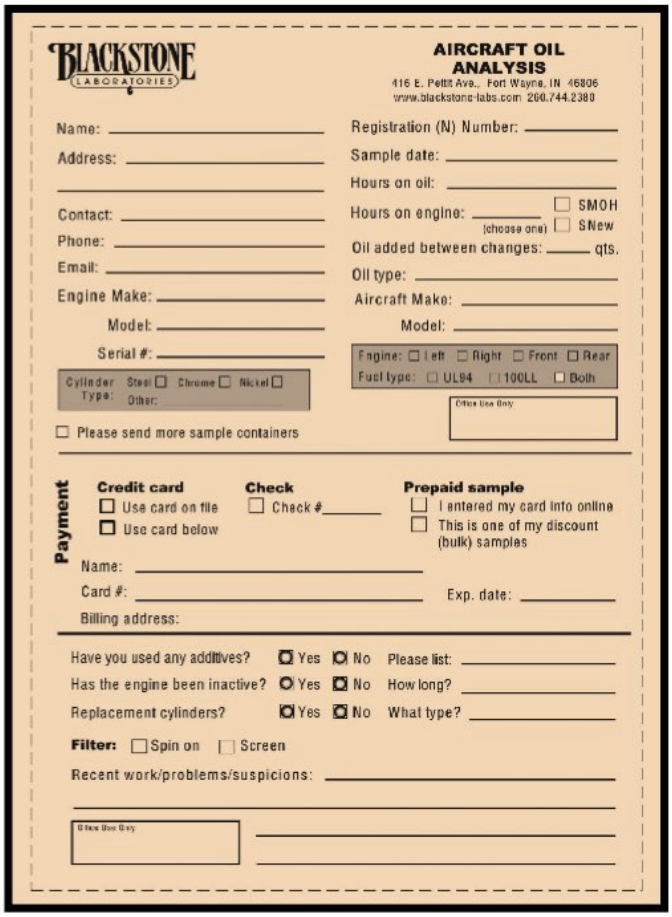
Why do we need to do all three inspections? What can we learn from one that we can't learn from the other two? The oil pump suction screen on the sump catches larger particles that might damage the oil pump. After the oil pump, the oil goes under pressure to the oil filter, which traps smaller particles that wouldn't be trapped by the oil suction screen. Sending an oil sample to the lab for analysis will catch microscopic particles too small to be seen by the naked eye, which would not be trapped by the oil filter. Doing all three of these steps means you have a much more comprehensive picture of internal health, giving you the best chance of catching problems early because

EVERY OIL CHANGE IS A DIAGNOSTIC OPPORTUNITY YOU CAN'T AFFORD TO WASTE.

Fig. 7A
Left engine analysis report

Fig. 7B
Right engine analysis report

WHAT'S HIDING IN YOUR OIL FILTER COULD SAVE YOU THOUSANDS — OR COST YOU AN ENGINE.



BLACKSTONE LABORATORIES

AIRCRAFT OIL ANALYSIS

416 E. Pettit Ave., Fort Wayne, IN 46806
www.blackstone-labs.com 260.744.2380

Name: _____ Registration (N) Number: _____
Address: _____ Sample date: _____
_____ Hours on oil: _____
Contact: _____ Hours on engine: _____ ☐ SMOH ☐ SNew (choose one)
Phone: _____ Oil added between changes: _____ qts.
Email: _____ Oil type: _____
Engine Make: _____ Aircraft Make: _____
Model: _____ Model: _____
Serial #: _____ Engine: ☐ Left ☐ Right ☐ Front ☐ Rear
Fuel type: ☐ UL94 ☐ 100LL ☐ Both
Cylinder Type: Steel ☐ Chrome ☐ Nickel ☐ Other:
Office Use Only
☐ Please send more sample containers

Payment

Credit card
☐ Use card on file
☐ Use card below

Check
☐ Check #_____

Prepaid sample
☐ I entered my card into online
☐ This is one of my discount (bulk) samples

Name: _____
Card #: _____ Exp. date: _____
Billing address: _____

Have you used any additives? ☐ Yes ☐ No Please list: _____
Has the engine been inactive? ☐ Yes ☐ No How long? _____
Replacement cylinders? ☐ Yes ☐ No What type? _____
Filter: ☐ Spin on ☐ Screen
Recent work/problems/suspicions: _____

Office Use Only

Fig. 8
Blackstone Oil Analysis Form

each inspection can catch a problem missed by the other two. Skip any one of the three, and you could miss something significant that you would want to know about. So what are we looking for? We are primarily looking for damaged parts and wear metals.

What if you find metal in the oil filter? Does that automatically mean an overhaul is required? Not necessarily. Same thing for metal in the oil suction screen or the oil analysis report. What it means is that you need to investigate further. Lycoming publishes Service Bulletin 480F, available courtesy of Google, which outlines what steps you should take based on the amount of metal you find and the type of metal [See Fig. 3]. A magnet will tell you if the metal is ferrous or non-ferrous. You can also send the metal itself to a lab to identify which metal it is so that the source of the metal can be narrowed down. That service bulletin has a table that tells you, based on what metal was found, what the likely source is [See Fig. 4]. As an example, did you find bronze? The source could be bearing material, rocker bushings, intake valve guide wear, or piston pin plugs. Chrome, on the other hand, might send you looking for issues with the piston rings if you have steel cylinders. Chrome cylinders, on the other hand, do not use chrome rings. They use steel or cast iron. Aluminum would send us looking in yet a completely different direction.

The service bulletin has a table entitled "Guidelines For Particle Quantity And Size on Oil Filter, or Oil Suction Screen [See Fig. 5]." Based on how big the particles are and how much material you find, recommended corrective action might be to change the oil and filter, fly for 25 more hours, and recheck the filter again for metal, or in some cases don't fly but run it on the ground for a specified period and recheck, or it might be to disassemble specific parts of the engine to identify the source of the metal prior to further flight.

Usually, you will not tear an engine down based solely on a single oil analysis by a lab or a single instance of metal in the filter. When we bought the Aerostar that I used to fly corporately, the right engine had a scary amount of metal in the oil filter, even though it only had 14 hours since the major overhaul [See Fig. 6]! We pulled a cylinder and several accessories and couldn't find any smoking gun. We then sent the engine back to the overhaul shop for a teardown inspection, and they found no problems whatsoever. We later de-

termined that the original mechanic had previously installed the newly overhauled engine without changing the oil cooler, which had been harboring wear metals from before the overhaul. We changed the cooler and subsequently put hundreds of hours on the engine before we sold it with no further issues. We probably could have gotten away without a teardown by just changing the oil cooler and then shortening the oil change interval for a few oil changes to monitor and verify it wasn't making any new metal.

If you do find metal in the oil filter, how can you determine if any of it got past the filter and into the bearings? Have your mechanic pull the prop governor. It receives oil downstream of the filter. The gasket between the governor and its mounting pad contains an integral fine mesh oil screen. If that screen is clear, you can be pretty confident that metal most likely did not get past the oil filter and into the bearings. If, on the other hand, the governor screen DOES have metal, you may have a more serious issue that would require a teardown.

As for oil analysis reports, save them. You are looking to establish baseline norms for each metal reported on. After several samples, you can then spot trends if something is starting to develop inside the engine [See Fig. 7A for the left engine and Fig. 7B for the right engine].

Oil changes are a messy job. But what a golden opportunity to personally administer one essential component of a health checkup on your engine! If you always hire out your oil changes, be sure to insist that the mechanic not only cuts open the filter for inspection but also checks the oil suction screen and collects an oil sample for analysis by a lab. I highly recommend Blackstone Labs because their reports are the most comprehensive I have seen. Make sure you or your mechanic fills out the oil analysis form completely and accurately. The accuracy of the lab report greatly depends on having complete contextual information such as how many hours on the oil, what additives you are using, what kind of cylinders are installed, and so forth. [See Fig. 8]

If your mechanic finds metal, direct him to follow the corrective steps in Lycoming Service Bulletin 480F. Most mechanics are spring-loaded to want to do unnecessary surgery on an engine at the first sign of metal. Don't allow him to do that unless the condition truly warrants it. To learn more about this topic, google "Help! My Engine Is Making Metal" on Savvy Aviation's YouTube channel.

In the next article, we'll explore electronic engine data and what we can learn about your engine's health from it.

Mark Henshall
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