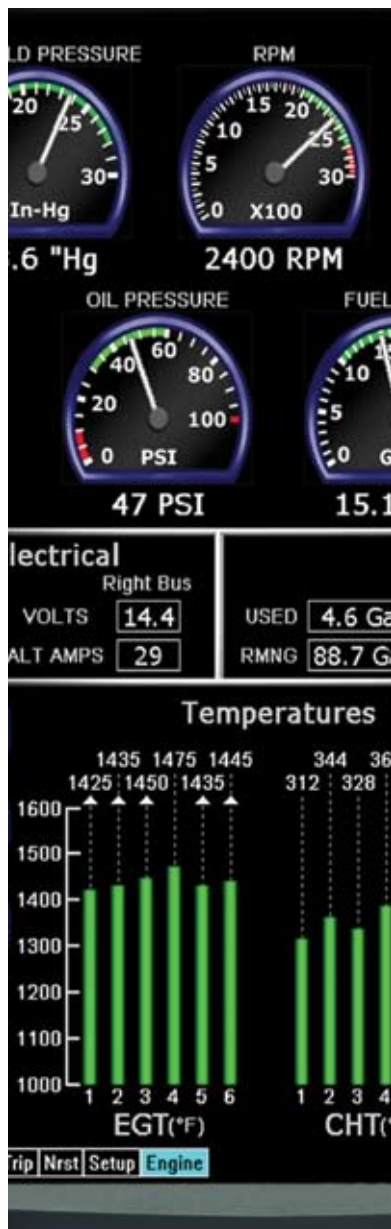


Why You Need an Engine Monitor

BY JOSEPH E. "JEB" BURNSIDE



For most operators, engines remain the most expensive and complicated single component in an aircraft. Even the smallest uncertified two-cylinder engine powering an ultralight is made from a dizzying array of parts that must work and play well together for hours at a time — then they sit around, unused, for days or weeks.

These parts are forged, machined, cast or stamped from a wide variety of different metals and alloys, all of which have different properties. Sometimes described as rotating masses of fatigued metal, powerplant care and feeding can be an aircraft owner's greatest triumph — or a source of endless frustration and financial downfall. If you're a twin driver and have two of them to tend to, well, I feel for you.

Until recently, the instrumentation most airframe manufacturers provided to help monitor engines was little different from what might be found on an early John Deere tractor. If you're flying an older airplane, it is from a John Deere. But, thankfully, it doesn't have to be that way.

The miracle of today's micro-processors and software, which has helped us navigate with greater accuracy than ever before, also has been applied to

engine instrumentation. Long gone are the days of single-probe exhaust gas temperature (EGT) gauges with an adjustable peak needle.

Nowadays, it's rare to see a high-performance piston single or light twin that doesn't at least have a multi-probe EGT gauge — many feature full-blown digital instruments that monitor each cylinder's EGT, cylinder head temperature (CHT), oil pressure and fuel flow, to name but a few of the more popular parameters. Today's standalone engine monitors also graphically display all this information on a standard-size (2 1/4 inches or 3 1/8 inches) instrument while storing it in a memory chip for subsequent download and analysis.

If you're in the market for an engine monitor — and if you have an engine, you should be — there are a few things you should think about and a few more things you should know before taking the plunge. But taking the plunge for such a product is definitely something you should consider.

How Hot Is It?

Engines generate heat. That's a simple and predictable result of incinerating several gallons of liquefied dinosaur juice each

hour. Because the vast majority of the engines we fly behind or between are air-cooled, monitoring and managing, heat is a basic part of airmanship.

The traditional CHT gauge sometimes installed as standard equipment in even the newest airplanes only measures what some engineer decided was the engine's hottest cylinder. With this arrangement, there's no way to know what's going on in the other cylinders. Those same new airplanes often completely lack an EGT gauge.

One result is, the pilot is probably getting inaccurate — or, at best, misleading — information as to what's going on under the cowling. Given the expense of engines and engine repairs, that's false economy, and the safety implications are obvious. A modern engine monitor can quickly remedy this shortcoming.

Instead of these single-point CHT and EGT gauges, any engine monitor worthy of the name will be wired to thermocouples, or probes, installed at each cylinder. One probe, either threaded into a standard fitting in the cylinder or mounted as a washer beneath a spark plug, measures that individual jug's CHT. Similarly, an EGT probe is



inserted into the exhaust pipe a few inches downstream of the cylinder and clamped into place.

Each probe is wired to the engine monitor and the minute electrical energy produced by the dissimilar metals in them is measured and converted into a temperature value. A typical engine monitor installation for a four-cylinder engine will involve eight probes: four for each cylinder's CHT and another four to cover EGT. But that's just for starters.

How They Work

The miracle of the modern engine monitor revolves around how that basic temperature information is used. For example, they can determine — usually to one degree — how rich or how lean the fuel/air mixture is, or whether the engine is experiencing “shock cooling” after a major power reduction. Using the monitor, the magneto switch and some basic knowledge of the engine's systems, a pilot can advise a mechanic exactly which spark plug might need to be cleaned or changed.

And, if something goes wrong or “automatic rough” develops at night, over water or far from a suitable airport, using an engine monitor can help decide if there's really a problem. More than one engine and airframe — and untold hours of a technician's time — has been saved with shrewd analysis of an engine monitor's information.

Most engine monitors available for aftermarket installation in piston-engine aircraft use a basic presentation, combining a vertical bar graph with alphanumeric data on a 2 1/4-inch or 3 1/8-inch



screen. With a four- or six-cylinder engine, the instrument graphically presents the data for each jug using four or six vertical bars. Many monitors also can display an additional bar dedicated to another engine parameter, like oil temperature or turbine inlet temperature (TIT) for a turbocharged aircraft.

Each of the four or six vertical bars is comprised of segments representing a specific temperature value, which varies from manufacturer to manufacturer. A gap in the vertical segments represents that cylinder's CHT value. The seventh vertical bar, if any, does not have a gap.

If you have the panel space and the checkbook, you can splurge on more sophisticated units featuring full-color screens capable of replacing all your airplane's engine instruments with more modern, reliable and accurate sensors. Many of these “all-in-one” units are FAA-approved to replace the factory engine instruments. They are increasingly popular in homebuilt aircraft as well.

What They Do

Today's engine monitors can

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do much more than just track EGT and CHT values. Even entry-level models can monitor voltage to advise pilots on the electrical system's health. Some popular options include monitoring oil temperature, outside air temperature, fuel flow, induction air or carburetor temperature, turbine inlet temperature for turbocharged engines, manifold pressure and engine RPM, to name a few. For the most part, these options can be added long after the instrument's initial installation.

In normal operation, each cylinder's specific EGT and CHT values are displayed sequentially, starting with cylinder No. 1, in what we'll call "scan" mode. In this scan mode, temperatures read by the probes are displayed to the exact degree for a few seconds, then the monitor automatically moves to the next cylinder, displaying its data and so on. These values are displayed along with the basic bar graph.

Once the monitor has sequenced through each of the cylinders, it then displays the other available information. For example, once the last cylinder is displayed, the monitor might then display oil temperature or the ship's voltage, depending on which monitor is in use, which probes are attached and how it's configured.

Buttons on the face of the instrument are used to configure and manage the instrument. The buttons also are used to select various modes, like "scan," "normalize" or "lean find," the exact workings of which vary from instrument to instrument and how the pilot configures them.

Additionally, some monitors may be installed with separate, remote-mounted switches and annunciators used to configure fuel-flow data or to alert pilots to out-of-bounds parameters.

Beyond the Basics

While all modern engine monitors present an "at-a-glance" picture of each cylinder's health using bar graphs and numeric values, the real value — and one of the major differences between monitor manufacturers — involves what the instrument does with the data. For example, by "flattening" out, or standardizing, each element of the instrument's basic bar graph and comparing one cylinder's values to the others, a monitor can alert a pilot to any changes in engine operation requiring immediate action.

One of the most popular features is automatically finding the leanest cylinder to set up the desired fuel/air mixture. As the mixture is leaned, the bars representing each cylinder's EGT value increases until a maximum, or "peak," value is reached. By flashing or inverting the vertical bar for that cylinder, the monitor alerts the pilot its EGT value has peaked. It's then up to the pilot to decide how far rich or lean of peak each cylinder should be and to adjust the mixture accordingly.

Another feature that has become expected in engine monitors is the instrument's ability to generate a data stream for each monitored parameter. The data can be either stored in non-volatile memory for periodic download or sent to a portable computer (laptop or palmtop) for real-time analysis or storage. This option can be invaluable

when troubleshooting.

In essence, a modern engine monitor brings to the panel what should have been there in the first place: accurate engine instrumentation. Installing one provides a wealth of information on an engine's health that, most likely, just wasn't economically feasible when the plane was built.

There are exceptions to every rule, of course, and if you're fortunate enough to be flying a well-optioned newer airplane, you may have a factory-installed unit, either as a standalone instrument or with its data displayed on a multi-function display. Eventually, a full-capability engine monitor will become as commonplace in piston-powered airplanes as headsets are today.

What To Look For

If you're in the market for an engine monitor, there are several things you should consider before whipping out your charge card.

The first is how and where you'll be mounting the instrument. To be useful, the new monitor should be mounted somewhere within the normal scan of the engine and flight instruments. Often, this is determined more by the number of empty mounting spots available, if any. Also, because most monitors require some minimal pilot interaction to get the most from them, the instrument's buttons must be easily accessible.

Once you determine you have the need and the panel space for an engine monitor, your next decision is what engine and system parameters you want to monitor. Of course, EGT and CHT values comprise the most common data monitored, but

there are many other parameters you may want to consider adding, either now or in the future. Be sure the monitor has the ability to connect all the probes you may want to install.

Before deciding on a monitor with all the available options, you probably will need to retain your existing engine instruments, since most monitors are not approved to replace these factory-installed items. However, don't let that dissuade you from adding those optional sensors. The additional information and its resolution likely will be more accurate than the factory gauges.

Another decision to make is whether or not you'll want to store and retrieve the monitor's data stream, and how you'll do that. Some monitors feature internal storage; others require an additional interface. Unfortunately, this is an area in which many monitor manufacturers have fallen behind the state-of-the-art.

Because some monitors still rely on outdated serial communications or long-orphaned hardware, it can be too cumbersome for the average owner/operator to extract this data and use it consistently. Thankfully, the market is demanding more seamless options and manufacturers are responding with data-card interfaces similar to digital cameras. Still, the process needs to be more streamlined and less dependent on a pilot's computer skills.

If you're lucky enough to be building an experimental aircraft, or if your panel has the real estate to replace or supplement the factory instruments, the sky is pretty much the limit when it comes to engine monitor capabilities and options, not to mention price. Do your planning, then do

your homework on what's available and how the latest engine monitors can meet your needs.

Be sure to involve an AEA member repair shop in this process; after all, they will have to install and maintain whatever you decide to buy.

Are You Missing Out?

The revolution in microprocessors has long since found its way into GA instrument panels in the form of color moving maps, electronic databases crammed with every approach and intersection known to man, and hyper-accurate GPS navigators simplifying just about every aspect of navigation. That same revolution is being used to provide huge amounts of utility and capability when it comes to monitoring engines and many other systems of even the most basic airplanes.

If you haven't investigated the latest in engine monitoring technology, you simply don't know what you're missing. ■