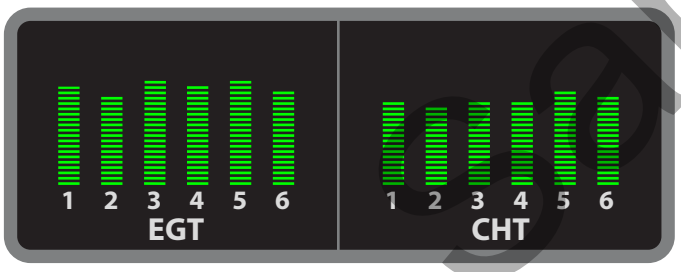
Interpret Problem EGT/CHT Readings

Many engine issues have similar presentations on your engine monitor. However, the immediate risk to safety can usually be determined without expertise. That means your job is two-fold: Notice that something doesn't look right, and take any corrective action needed to ensure a safe outcome to the flight. High CHTs, high oil temps, and low oil pressure are generally "act now" items.

Exploring the problem to get more information is secondary and only done presuming there's no imminent danger. That's why it's important to understand what the engine monitor is telling you in general, rather than memorizing a bunch of patterns. Is one EGT rising much higher than the others important? It depends on what else you see.

That said, studying some common situations can expand your understanding of what the monitor is telling you about conditions under the cowling. When you report what you saw to your mechanic, you become a partner in fixing the problem which can save a lot of time … and money.

Normal Indications



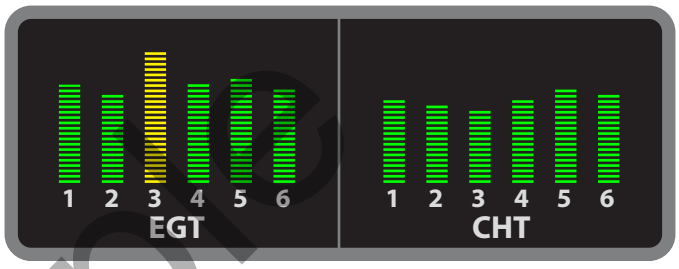
If you don't know what's normal for your airplane, how will you know what's abnormal? Record typical values for fuel flow, RPM, MP (if you have that), oil temperature, oil pressure, and CHTs over many flights. EGTs will likely vary enough that it's not worth tracking their values, but knowing the typical spread or pattern for richer and leaner cylinders is worthwhile. Be sure to try a few different power profiles and note the altitude and OAT for all your baselines.

This is also a good time for an airborne ignition check (page 56), a mixture distribution test (page 58), and an induction leak test (page 59). If the plane is new to you, or you just installed the engine monitor, you might discover that your "normal" baseline isn't normal at all, and you've discovered a problem already.

TIP

If you see high CHTs on just one or two cylinders on a new engine, have your mechanic make sure there's no leftover metal from the cylinder casting that's interfering with cooling right where the CHT probe plugs in. Lycoming had an issue with this for several years, but seems less common today.

One High EGT, with Low or Normal CHT



You have poor combustion in that cylinder. The likely culprits are a fouled spark plug, or failure of the spark plug or wire. Here's a way to think about it that's a bit simplistic, but can be helpful. You could say that heat going out the exhaust is energy from combustion that's not spinning the prop for you.

The high EGT means that heat is escaping out the exhaust rather than exerting pressure on the piston. Less combustion inside the sealed cylinder means lower (or normal CHTs). You can verify the bad plug with an airborne ignition check.

It's also possible this cylinder's exhaust valve isn't fully seating.

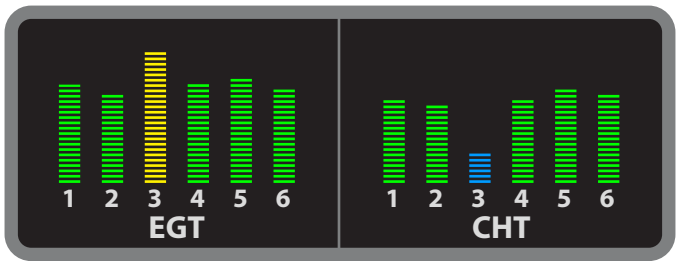
One Rising EGT, Low or Normal CHT

While this could be one slowly failing plug or wire, if the slow rise is over many flights, it's more likely an exhaust valve that's burned or not seating well. Again, heat energy is escaping the cylinder, so the EGT is higher but CHT is normal or low.

Telltale of an exhaust valve problem is that the EGT actually oscillates one or two times a minute (page 79). With a minor leak, the change could be too small to see without doing an engine analysis. As the leak worsens, the temperature oscillations grow and you can see them in flight.

It's also possible to have a valve stick open intermittently. This would show as a quick rise in one EGT and then back to normal. Verification of a failing valve is best done with a borescope inspection. The burning may be difficult to see if it's still minor.

High EGT/Low CHT on Individual Cylinders



There's low power generated in that cold cylinder, which could be a badly clogged injector or fouling of both spark plugs. You probably have at least somewhat rough operations as well.

It could also be poor compression due to a sticking or poorly seated valve. If it's worse at low RPM but better at higher RPM, its likely an exhaust valve or a fuel/ignition problem. If it's rough at all RPMs, it's likely an intake valve. A popping sound from combustion in the exhaust system or intake manifold might accompany a stuck valve. Consider a popping sound an inflight emergency, where you should deviate for landing ASAP.

Loss of EGT, Low/No CHT, Engine Rough

There's no combustion in that cylinder, so complete injector blockage is likely. The roughness is caused by one cylinder producing no power. You could try full rich and boost to clear it in some engines. This pattern could also be no compression due to a stuck valve, which would be even more serious.

SOME COMMON EGT/CHT ABSOLUTES

It's often said by some engine evangelists that absolute values for EGT don't matter. That's true for the most part, but it's worth knowing a few common EGT values.

- EGTs for a warmed up, idling engine are usually 900-1000°F. Of course, the value will be lower the further the probe is from the exhaust valve. (See "Probe Placement Matters" on page 7.)
- EGTs at full power and full rich at sea level are usually 1250-1300°F. The same caveat about probe placement applies here.
- The absolute value of peak EGT doesn't matter—so long as you're below 1650°F. Above that, even a stainless steel exhaust system can weaken. EGTs this high are uncommon except for turbocharged engines at altitude. If you see EGTs this high, consider throttling back, and check your turbine inlet temperature (TIT) because it's probably also too high.
- Some engine designs have notoriously high EGT spreads (a.k.a. "lean range" page 47). Fuel injected engines with stock injectors are usually 80-100°F, but the Continental IO-470 and IO-520 are commonly over 110°. Carbureted engines usually have a spread within 150°F, but the Continental 0-470 and 0-520 regularly exceed 200°F between richest and leanest.

CHT absolute values certainly do matter. Unless you're breaking in an engine (page 74), you should take action as soon as practical for CHTs over 400°F on Continentals and 420°F on Lycomings. See "Increasing Cooling During Climb: Air Flow, Fuel Flow, and Power Setting" on page 41 about bringing down CHTs.

You should take immediate action—so long as it doesn't compromise safety—for temps over 420°F on Continentals and 440°F on Lycomings. Not compromising safety means that if CHTs are critical, but you must also outclimb an obstacle ... outclimb the obstacle. High CHTs won't be helped by a post-crash fire.

FUEL INJECTOR AERATORS

Fuel injectors meter the amount of fuel entering the engine by the size of the orifice, and they atomize liquid fuel into a spray of droplets for combustion.

To picture atomization, picture the spray bottle you use on your kitchen counters. When you squeeze the trigger, the liquid in the bottle becomes a spray out the nozzle. That's atomization.

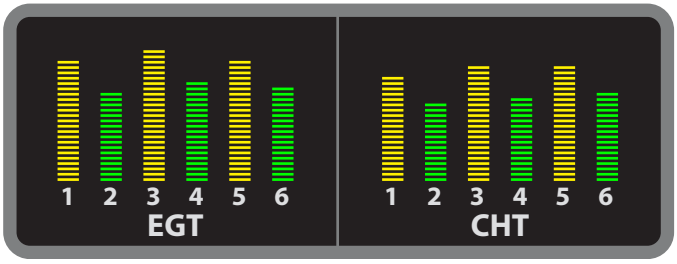
This process requires some ambient air to mix in at the injector. Injectors for normally aspirated engines have a fine screen on the side that's just open to the air under the cowling. In time, the screen can get clogged, interfering with atomization and causing the same effect as insufficient fuel at that injector: a partial clog. In this case, the fuel is still flowing, but it's in too liquid a state for good combustion and passes through the engine.

These screens can be cleaned. Some argue it causes more problems than it solves. Others say it's good practice, especially if you routinely operate from grass or gravel, where small grit is more likely. If you have trouble with smooth engine ops, especially when leaning for cruise, ask about it.

Turbocharged engine injectors have air inlets (without screens) that are pressurized slightly higher than the pressure coming into the engine. That's accomplished by piping air from the turbocharger, which means it's filtered air. Turbos are susceptible to blockages when work is done on the induction system and material dislodged. That's usually so big a blockage they run rough at any leaning.

Note that the EGT and CHT together confirm this is a real problem and not a bad sensor (page 67). The amount of roughness determines how serious this is, but reducing power as much as you can could help reduce the power imbalance.

High EGT and CHT on Individual Cylinders



In this case, there's more heat coming out the exhaust, but there's also more heat generated inside the cylinder during combustion (hence the high CHT), so there must be significantly more heat generated in this cylinder.

If you're running ROP, you likely have an overlean condition in that cylinder. This is common when a fuel-injected engine has a partially clogged injector. If the CHT isn't too high, it's a minor problem that could require running extra rich until it's fixed. If CHT is dangerously high (See "Some Common EGT/CHT Absolutes" on page 61.) do whatever combination of enrichening, reducing power, and increasing cooling airflow best cools it down. Land as soon as practical if you can't get it under control.

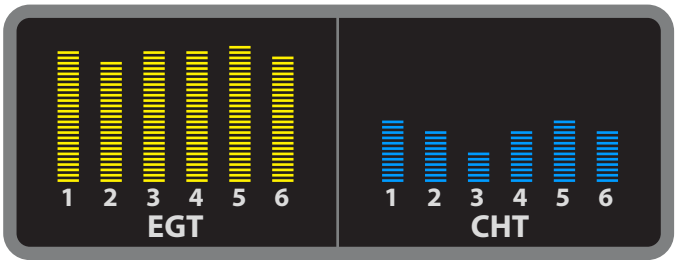
In a carbureted engine this could be an induction leak near the lean cylinder ... or normal. Fuel distribution is commonly poor with carbs. This pattern is unlikely LOP. In fact, look for this pattern before leaning for cruise on an engine that used to run smoothly LOP and now won't.

The lean cylinder can be confirmed with a mixture distribution test looking at the lean range. A cylinder that's just running leaner due to a clogged injector may have a lower peak EGT than the others and will have a lower CHT once running LOP (if it will run LOP at all).

TIP

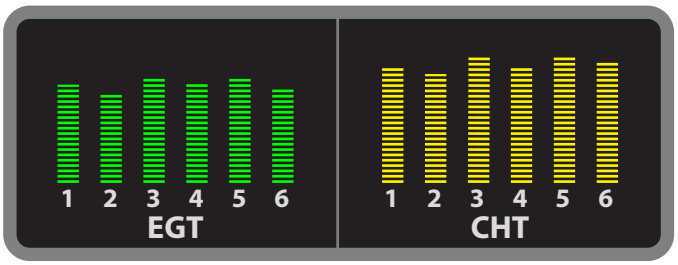
If you use MP to set power, periodically check that the gauge shows the current atmospheric pressure before engine startup. Pressure altitude is also the altimeter setting corrected for actual altitude MSL.

EGTs High, CHTs Low



This could be retarded timing or failure of one magneto. The airborne ignition check could clarify. Know that if a mag has failed, the engine may cease to run when switching to that mag.

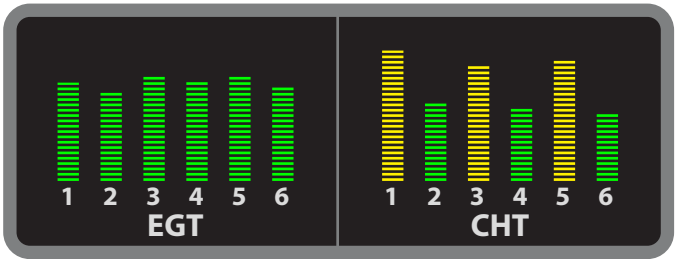
EGTs Normal or Low, All CHTs High



This could be normal on a high density altitude summer day, if it's minor. However, advanced timing could cause this, which is why you should look for this behavior during runup (page 29). The early spark is creating greater heat during combustion. This would be more likely after engine work where the magnetos were touched. If the timing is seriously advanced, it's possible EGTs could be higher than normal, but this would be so far advanced that detonation may become an issue.

It could also be mild fuel contamination. An airborne ignition check would help clarify this. Presuming you do suspect a problem, higher RPM with a constant-speed prop could alleviate advanced timing a bit, but mostly you'll need to reduce power until you can land and get it fixed.

CHT High on One Cylinder or Side of Engine

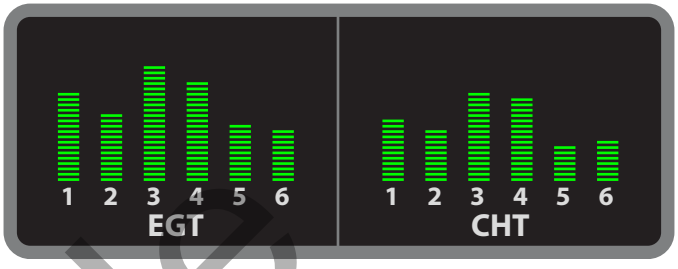


This is likely a cooling issue., especially if EGTs are normal for your engine. CHTs will never all be the same, but anything over 70°F between the coolest and hottest cylinder is worth investigating.

Make sure your engine baffling is in good shape (page 88) and that no one left a rag on top of a cylinder (it happens). Also, check that cowl flaps actually open all the way when you move the handle.

Incidentally, cold CHTs on one side of the engine at idle can indicate an induction leak on that side (page 59).

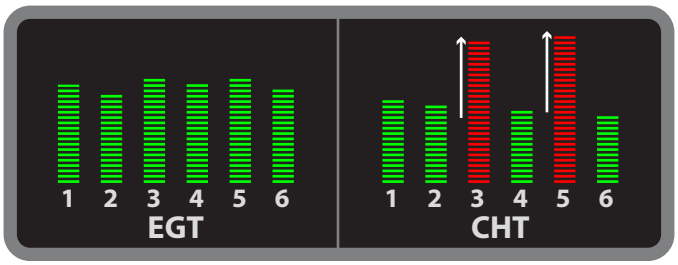
Large EGT and CHT Disparities



This is common with poor fuel distribution in large, six-cylinder carbureted engines. However, dirty injectors or multiple fouled spark plugs can cause this pattern.

Here's an odd special case: One high CHT adjacent to a cylinder with a low EGT could be a cracked exhaust blowing hot combustion gasses on the hot cylinder. Due to how cylinders are numbered, adjacent cylinders are both even or both odd. Cylinder 4 is between 2 and 6, for example.

Rapid CHT Rise on Individual Cylinders



Because this may be detonation, reduce power if it's at all safe to do so. Increase cooling with full rich mixture (which will also help suppress detonation), and open cowl flaps. If the CHTs reached the danger zone, you should consider diverting for landing now. Note that EGTs may remain normal throughout.

Stratospheric CHT rise (like 50°F per second) may mean preignition and may precede engine failure unless dramatic power reduction is made.

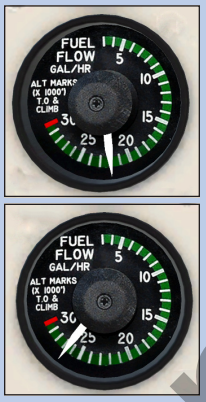
Of course, instantaneous rise of one cylinder to redline CHT is probably a failed probe (page 67).

OTHER FAILURE PRESENTATIONS

The classic combination no pilot wants to see is low oil pressure and high oil temperature. You're likely low on oil and need to get on the ground ASAP. Most pilots never see this combination in the real world, but it's worth knowing what it means.

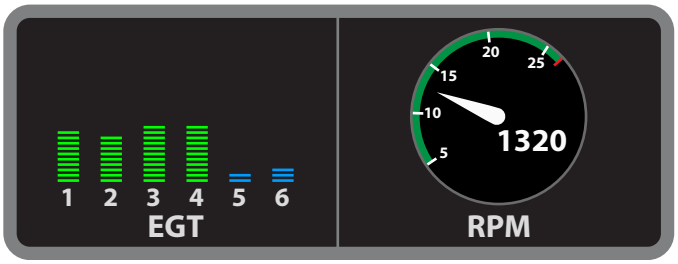
There are some other situations worth noting even if they're uncommon, including these:

- **High CHT and low EGT after engine maintenance.** Have your mechanic check for swapped probe leads.
- **High fuel flow with an analog gauge in older fuel-injected engines.** These fuel flow gauges are actually pressure gauges. The more fuel delivered to the engine, the higher the fuel pressure at the sensor and the higher the fuel flow reads. However, a blocked injector will create back-pressure and show a *higher* fuel flow even though less fuel is getting to into the engine.



- **Oil dripping on your ankles from behind the panel**. Older oil pressure gauges use a "Bourdon tube" where actual engine oil comes all the way up to the gauge. If your oil pressure gauge works even with the master switch off, you have one of these. When the gauge or tube leaks, you'll get oil in the cockpit. It's not an emergency. The loss of oil is trivial. But it makes a mess.
- **Seasonal changes.** It's not a failure mode, but if you add and remove winterization kits every year, watch for high temps in the swing season indicating the oil cooler and related parts need more cooling airflow. These kits usually use metal plates to partially block airflow into the top cowling or over part of the front cylinder cooling fins. They may also include plates to block part of the airflow over an oil cooler (or coolant radiator if applicable).

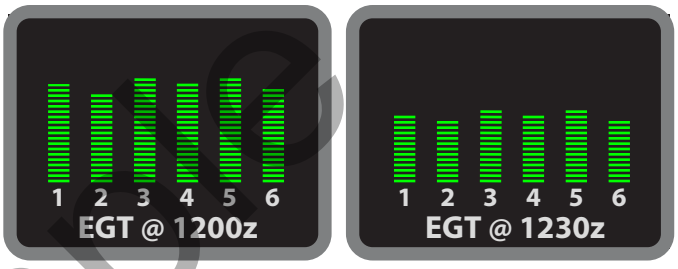
Wide EGT Spread Only at Low RPM



Check for blow-by in the cylinders with the lower EGT(s) by conducting a compression test.

Note: Some engine monitors have "Dif" warnings that are triggered by really wide EGT or CHT spreads.

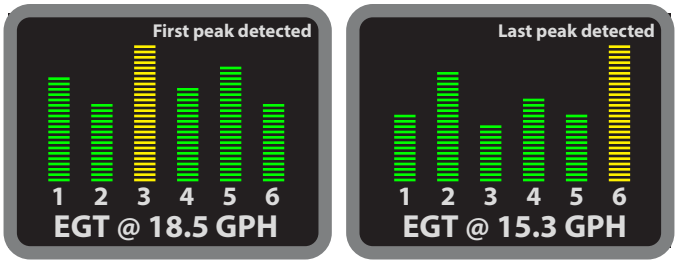
Drop in EGT for All Cylinders



EGTs will drop like this if you've climbed without leaning for cruise again (page 46). Even cruising to an area of high density altitude will do this. This is true if you are operating ROP, since the thinner air results in a richer (and thus cooler) mixture.

However, if that's not the issue, it could mean carburetor or induction icing, or some other obstruction of air input or combustion. This would be more likely in steady cruise flight. Try carb heat or alternate air, adjusting mixture as needed.

Excessively Wide Spread in Peak EGTs



You'd only see this if attempting LOP operations, because you'd need all cylinders to pass through peak EGT (or have the engine go rough by the time all cylinders should have passed through peak EGT).

However, excessive peak EGT spread can be an indication of mild detonation. Fuel contamination could be an issue.