Casting a Thermodiagnostic Spell

Solution-Sorcery with a Noncontact Thermometer

What secrets does that brake disk or bearing hub conceal? Where's that mystery miss?

Thanatopsic thaumaturgy, nebulous necromancy or pedestrian prestidigitation? Hardly matters, actually. Arthur C. Clarke (2001: A Space Odyssey) *said any sufficiently advanced technology looks like magic to those who don't understand it. That includes the noncontact thermometer. So don your sorcerer's cloak, brandish your magic noncontact thermal wand and undertake the tasks of an automotive wizard. Shazam!*

Can you wave the mystic laser to extract information about a car's condition, standing at a distant remove, without a single finger's touch? Well, let's waffle on that question for a couple of pages. The key to the spells we'll cast here and a symptom of many things that can go wrong with any kind of machine is heat — in the wrong quantity, in the wrong place — produced by friction, by excess electric current, by flame, by acidic chemistry. And heat is something we can detect and measure with a thermometer.

But any thermometer is a passive instrument, reacting to the temperature of the material measured, not casting spells or anything else. The seventeen-point laser pattern the Raytek gun in our photos projects is a targeting aid merely. It does nothing beyond letting us see graphically exactly where the temperature measurement comes from. The thermal activity is in the object measured, in the energy sensed at a distance by the noncontact thermometer. All the 'magic' is applied science.

There are two advantages to using a noncontact thermometer over either a regular thermometer or a thermocouple: *speed* and *distance.* You don't need to explain the need for speed; many jobs you just wouldn't do with a temperature measurement at all if it took longer or more trouble than other methods. Distance, however, might call for explanation. Everything you're doing with a thermometer involves heat, and heat can be brief and unexpectedly local. Sometimes temperatures can be unpleasantly hot, even dangerous, as on exhaust systems. Sometimes the temperature can quickly 'evaporate' into the ambient background or conduct into adjacent metal before you can get close enough to measure it with a regular thermometer — checking brake disk temperatures right after a fast stop, for example. Those are the advantages of a noncontact thermometer.

The Raytek noncontact thermometers were designed for industrial use, so the range and capacities may exceed what you expect to find in automotive tools. For example, since different materials radiate heat differently, you can adjust the sensor for the variable infrared emissivity of different materials: a chrome or glass surface radiates less heat than a flat black surface at the same temperature. This is doubtless very important if you're checking the temperature of a vat of molten steel to tell just when to pour it into a casting die: You really do want to know that temperature precisely. For most automotive purposes, though, we're looking for relative differences in temperature, say between different brake rotors on the same axle or different exhaust runners on the same engine. The exact temperature is not as important to us as the temperature difference between several measurement points. And to get that temperature difference, you don't need to adjust the emissivity on your noncontact thermometer. It's nice to know there's a deeper level of accuracy available, though.

Thermodiagnostic Spells

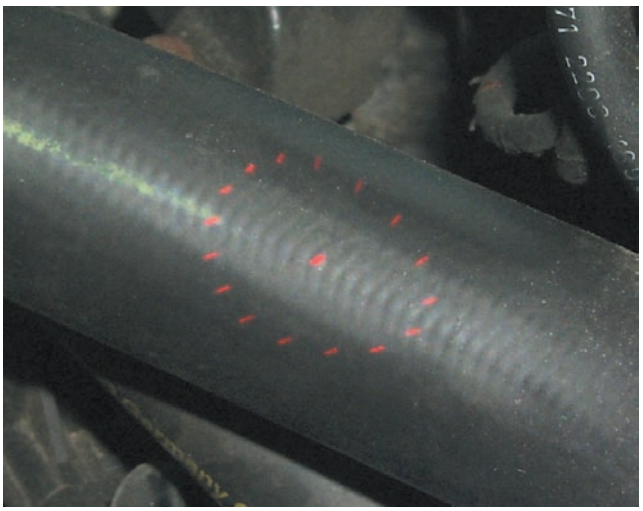
1. *You can identify cylinder miss, either on Diesel engines or on gasoline engines with difficult, hard to access ignition systems or fuel injectors. The exhaust runner on the cylinder with the miss will be cooler than the adjacent ones. This can also tag a cylinder that's not putting out the same power as the others. While the cooler runner ordinarily marks the cylinder with a miss, keep in mind there are other factors that can affect the temperature at that point. Some exhaust runners are closer to the coolant waterjacket; some are exposed to more ram air from the road; some are just thicker or thinner slabs of cast iron or tubes of sheetmetal. Headers and other sheet metal exhaust systems change temperature more and more quickly than a solid cast iron manifold. What's more, there are obviously no relevant specifications for these heat numbers. All sorts of conditions can influence the temperature of an exhaust runner at a particular place. Nonetheless, by noticing the differences from one to the other, you should have a better clue than you otherwise would which cylinders are doing more and which less of the work.*

2. *You can diagnose brake pull and uneven brake wear by residual disk heat. With the wheelcovers removed or through the spokes, use the noncontact thermometer to check brake temperatures at the disks and drums right after a sustained stop. While again, there are no manufacturer's specifications for these measurements (or for much else automotive you test with the noncontact thermometer), you can test for variations between sides or for dramatic differences from the results you see on other similar vehicles. Results may not be as obvious as you think, though. Suppose you find, after a controlled stop, the fronts are evenly warm, but the rears are at the same temperature as the ambient sheet metal around the fender? This indicates the rear brakes aren't applying, of course, but why? Is something in the proportioning valve malfunctioning? Did the last replacement of the rear shoes or pads somehow jam the hardware so nothing can move? All it really does is to point you at one range of possibilities, not the unique answer.*

3. *Find radiator problem locations. If several tubes in a radiator plug with deposits, you can find them using the noncontact thermometer over the surface of the radiator once the engine has grown warm enough to circulate the coolant. Radiator surface temperature should vary, of course, but there should be a smooth progression to the temperature change, not abrupt changes or pockets that stay at near-ambient conditions whatever else happens.*

4. *Does coolant circulate through the heater core? No heat? Is the heater core plugged or the valve stuck, or do you have a blend-door problem? Checking the temperatures of the hoses in and out can tell you whether any heat has been released in the core. If not, you have a plug. If so, you have more tests of other components to run. Coolant coming out of the heater core at nearly the same temperature it went in can indicate jammed mixture doors or a bubble of air trapped in the heater core, blocking heat transfer from the coolant.*

5. *Here's how you can accurately test the thermostat opening setting. Many vehicles won't run in closed loop until the coolant temperature reaches a specific minimum. While thermostats are supposed to keep the engine warmer than that, with a noncontact thermometer, you can find out in precise, quantified detail. Measure directly at the thermostat housing or at the upper radiator hose on engines with more limited access.*

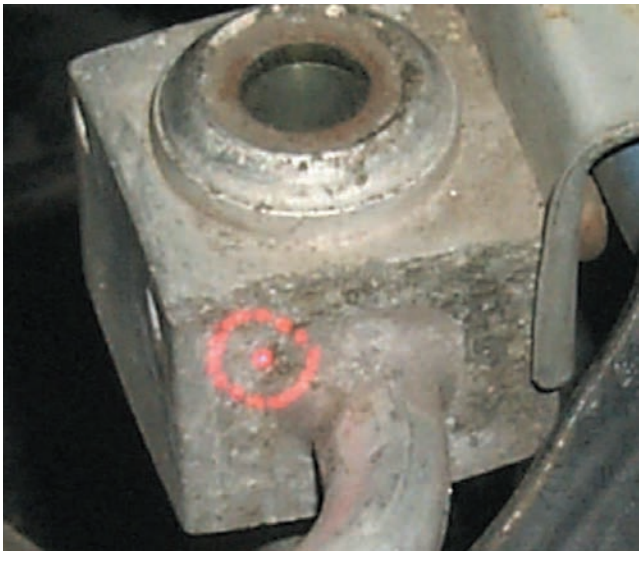


6. *Check the temperature of the coolant as it goes back into the engine block. Is the engine overheating? There are half a dozen potential causes, but if the water going back into the engine is still warmer than it should be, there's a circulation block, a ram-air restriction or a radiator problem.*

7. *Check air temperatures at vents, heater and A/C outlets, more quickly and accurately than with a bimetallic-spring thermometer. In fact, since the surface of the duct is usually plastic and right in the path of the outrushing air, most frequently it will be at exactly the temperature of the heated or cooled air.*

8. *Find unexpected hot spots at U-joints, differentials, fuel pumps and wheel bearings. Anywhere there might be friction, it should be detectable at a nearby surface. A CV joint with lost lubricant or internal wear will often run hotter than the joint on the opposite side. This can sometimes solve the problem of determining whether it's really a CV joint clicking or something else, as well as which one.*

9. *Check ignition modules and coils for unusually high temperatures. Darlington stacks in modules and power transistors of all kinds used as drivers produce a certain amount of heat naturally, requiring heat sinks, heat conductive grease and so on. If you cast an occasional diagnostic thermal spell over normal, functional units, however, you'll soon get a sense of what kinds of temperature might signal an imminent failure.*



10. *An air conditioning line can often reveal the location of a block by the point where frost begins to form on the steel tube. Somewhat less of a restriction can still be a problem, one easily discoverable by tracing along the metal lines with a thermal sensor. For this photo, we used Raytek's new 'close-focus' noncontact thermometer, which can sense a narrow heat source, down to about 0.25-inch in diameter. This same technique could also indicate the position of vapor lock in a carbureted vehicle.*

11. *(left and bottom left) Check oxidation/reduction functions of catalytic converter. This is not as simple a matter as you might think, though. Up to about 1985 catalytic converters were basically oxidizers, afterburning the residual fuel in the exhaust either with air still in the stream or with injected air through the AIR system. After 1985, converters also chemically 'reduced' the exhaust, a process that re-absorbs a certain amount of heat. Current converters, downstream of engines kept clean-burning by far more capable fuel and ignition systems, hardly change the temperature of the gas going through them at all, certainly not enough to confidently determine whether the catalyst is still working.*

12. *All relays produce some heat as they work because the wiring in their coil works as a heater as well as an electromagnet, the main job. If the insulation between the coil windings starts to short through, however (and in most coils of every kind, it's little more than varnish), resistance goes down; current goes up, and with the current, heat.*

13. *Friction in a wheel bearing will always generate heat. By the time you can hear noise as well, the bearing is not only worn out but even dangerous. Wheel bearings should ordinarily be just about at ambient temperatures unless heated by the brakes; if one is much warmer than its mate on the other side of the axle, something's amiss with that first bearing.*

14. *Combine various ground and connection resistance problems with an overcharging alternator, and you can have more problems than easily fall to solution. An alternator that's overcharging, though, will have to be hotter than one that's working normally, and that should be detectable at the case.*

15. *Are you hearing belt slip or wear in the bearings of the alternator or another accessory drive? Quicker than pulling most belts is just taking a quick thermal reading right after shutting down the engine. If the belt has been slipping, it should be considerably hotter than the surrounding material. If the problem was in a bearing, you may be able to locate that as well, given that the housing allows you a straight laser shot.*

In general, every machine has components that generate internal friction. Good design tries to either minimize the friction or provide a means to carry off the resultant heat. While there are as yet few or no manufacturer's specifications for what heat to expect in different places, bar certain settings like the thermostat opening or the A/C cycling threshold, many of the typical results you can learn from a couple hours' play with a noncontact thermometer.

'Specs? We doan need no steenking specs!' Trust me on this one: it's impossible to get one and resist the inclination to go around measuring the temperature of everything in the shop. Keep in mind, of course, that the laser-sighted versions of these noncontact thermometers can damage the retinas of people's eyes, not only when triggered directly but also when reflected off mirrors, vehicle chrome and even windowglass at the right angle. Thermometers, of course, even industrial thermometers, are relatively delicate instruments. Don't keep them in your hammer drawer or drop them on a concrete floor.

But when you're using them, there's no reason to let on how they work or what you're doing. Let a few people fall for your abracadabra illusion! The occult may be a crock, but your diagnostic wizardry is certainly real. ■

—By Joe Woods