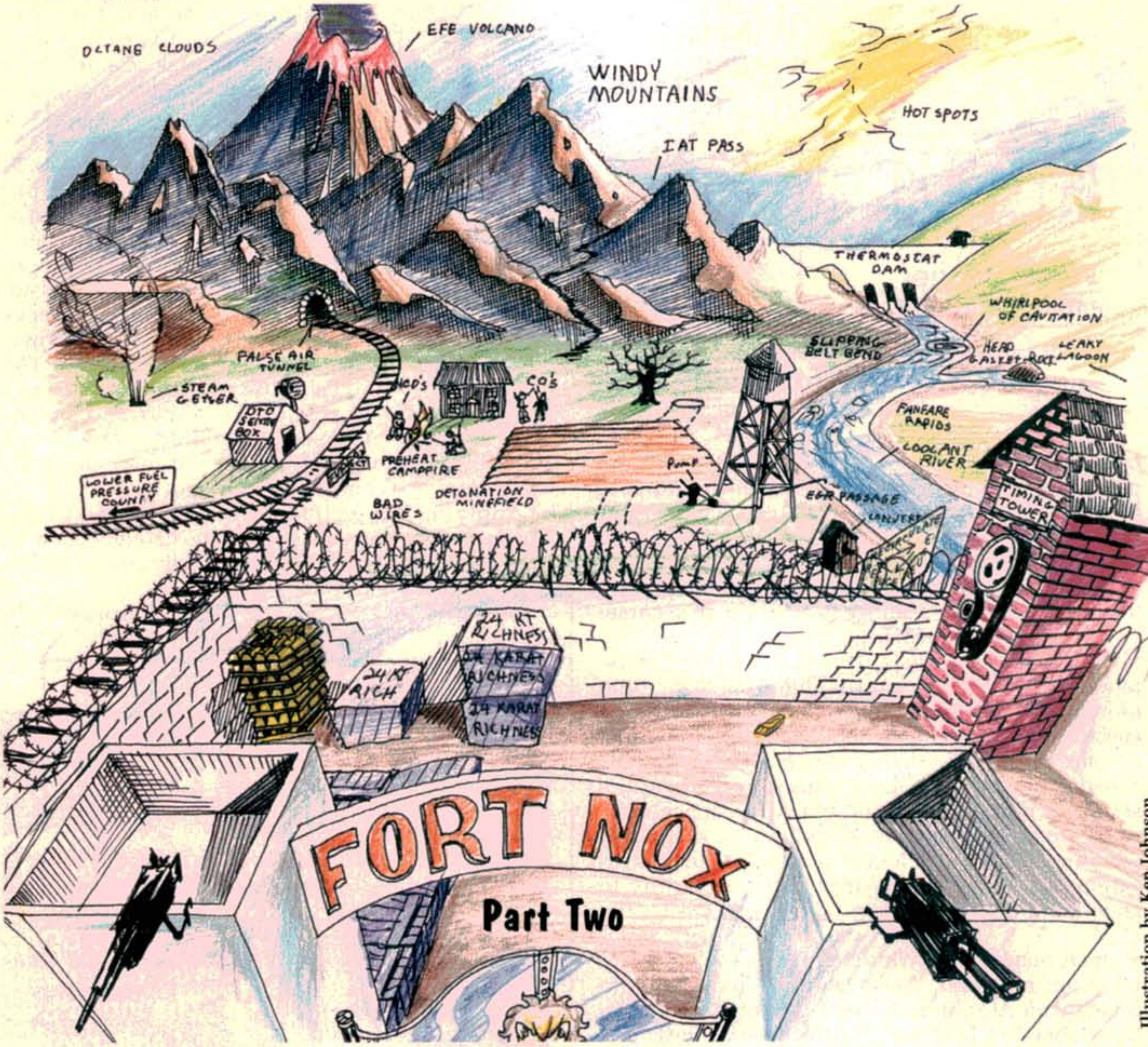


Illustration by Ken Johnson

Last month we introduced you to some of the terrain surrounding "Fort NO_x" and showed you how an errant EGR valve caused a non-NO_x related problem. This month, we'll tackle a real-life NO_x failure fresh from our Ohio EPA I/M 240 testing program. The car in question is a 1986 Honda Civic.

Ohio is in its first year of a voluntarily initiated I/M 240 program. Perhaps in an effort to ease the driving public into the program, most of the emission limits for this program have been set at very lenient levels. We've been told that CO and HC levels are set at three times the original Federal specifications, while the NO_x pass level is *six times* the original Federal spec. When a car with a small displacement engine like our Civic still manages to emit enough NO_x per mile to fail the test, something has got to be seriously wrong.

On our initial test drive, we heard a noticeable "ping." The amount and severity varied with load as we drove a local course designed to simulate the I/M 240 drive cycle. We know where there's ping, there's NO_x; but it's also true that NO_x can exist without ping. In this case, we were pretty sure that getting rid of the ping would put us back into compliance with the state's NO_x limits.

The gas tank was at about half full, and our customer told us she had used the lowest octane fuel available. We slipped in a few dollars worth of high test to see if the extra octane would make an appreciable difference. Unfortunately, it didn't, so we knew we'd have to start at the very beginning.

As before, we began with our NO_x checklist.

NO_x Checklist

We've checked the boxes that apply to our vehicle.

Preliminary Checks

_____Fluid levels (especially oil and coolant).
_____Possible DTCs at MIL lamp: EVP, low O_2S volts, lean exhaust, ECT or IAT out of range.

NO_x Prevention

__X__EGR: stalls engine if added at idle, engine runs rough if EGR added at 2000 RPM, check vacuum supply at cruise. Check EGR valve temperature.
__X__Intake air temperature. Are the EFE and intake air preheat systems functioning properly?
_____Cooling System: Check head temperature, circulation, hot spots, plugged passages, air pockets, antifreeze quantity and concentration, thermostat, belts, hoses, radiator flow, cooling fan and controls
__X___Timing: Check base timing, timing advance (check for sticking), timing control system, knock sensor, TCSA system.
__X__EGO: verify O_2 sensor function (cross counts), check for false air/vacuum leaks, fuel pressure and volume tests, other lean of condition causes.
_____Engine Mechanical: valve timing, hot spots, excessive compression, spark plug heat range.
_____Load Factors: Proper tire size, differential final drive ratios, payload exceeded?
_____Fuel: Correct octane level?

Treatment

_____Check catalytic converter reduction bed efficiency, measure external temperature difference before and after catalytic converter.

Symptoms:

__X__Ping
_____Dieseling
__X__Lean exhaust
_____Backfires through exhaust
__X__I/M 240 failure
_____Low EGR temperature
_____stalling, rough idle, high HC, low CO_2, possibly high O_2 and CO, high EGR temperature

I/M 240 Traces

The beauty of the I/M 240 test lies in its repeatability and ease of interpretation. If you haven't yet had the pleasure of making its acquaintance, here's a little introduction to I/M 240 trace analysis. To begin with, the I/M 240 test takes its name from the 240 second test cycle, which is the same for all cars. The car is driven on a dynamometer which has been calibrated to provide a load mimicking that which would actually be experienced by the engine if it were being driven on the road. The speed trace, reproduced in **Figure 1**, is the same for all cars. The horizontal scale represents time [in 240 one-second intervals], while the vertical scale at the right represents vehicle speed in MPH. The operator at the test center "drives the trace" using the accelerator to match the vehicle's speed to the prescribed speed trace.

Figure 1

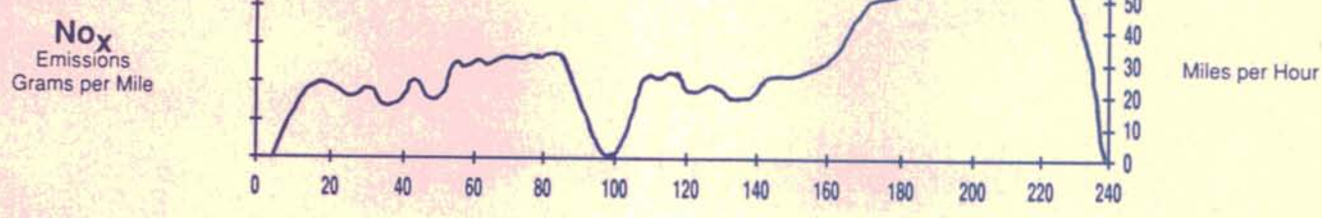
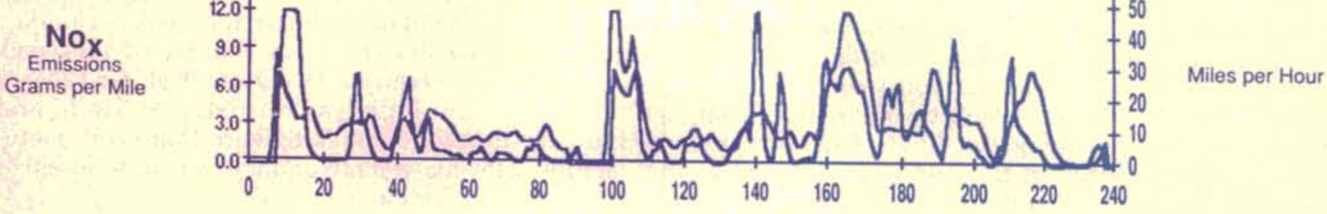


Figure 2



Fort NO_x Part Two

Next come the traces for individual pollutants. Ohio currently supplies traces for HC, CO, NO_x, and CO2 for all vehicles that have failed the I/M 240 test. These values are superimposed on the speed trace, with the left vertical scale indicating the emission levels for each pollutant in GRAMS PER MILE. For comparison purposes, traces representing the "typical" emissions for a car of a similar type are also superimposed on each graph.

The example in **Figure 2** on page 15 shows a NO_x reading of more than 12 Grams per Mile at time-stamp 103, which is compared to a reading of approximately 7.0 Grams per Mile for a "typical" car of this type at the same point in the test.

The increase in the NO_x reading that shows up on the trace occured about eight seconds after the transition from idle to hard acceleration that began at the 95 second time-stamp. This is the approximate amount of time that is needed for the exhaust sample to travel through the exhaust system and into the testing center's analyzer.

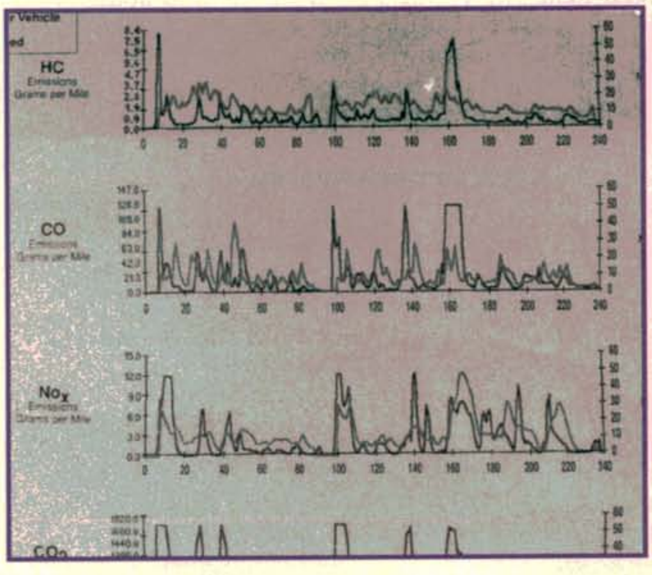
This same eight second offset will remain relatively constant throughout the test for this automobile. Changes that show up on the chart are not occuring in "real time." They are actually a reflection of events that occured approximately eight seconds before. Other vehicles may display a longer or shorter time offset when they are tested. As you gain more experience "reading the trace," you'll be able to easily determine the time lapse for a given test vehicle.

Now, a word about the units of measurement. The equipment you and I are using is calibrated in percentages and parts-per-million, whereas the test center is calibrated to read the exhaust sample in Grams per Mile. Don't panic! There's no need to try to convert Grams per Mile in-to percentages or percentages into Grams per Mile. To try to do so would be like trying to figure out how many apples make a pine tree.

The best and most reliable way of dealing with this difference in units of measure is to take your own "baseline" readings on each car before doing any repairs whatsoever. Get to know your equipment and you will begin to see a relationship between the readings you are taking and the readings you are seeing on the I/M 240 traces from the testing centers.

If you don't baseline your customer cars, you'll have no way of knowing where you started. This will make it very difficult to determine whether your repairs to the vehicle have produced enough of an improvement for the vehicle to pass the I/M 240 test or retest.

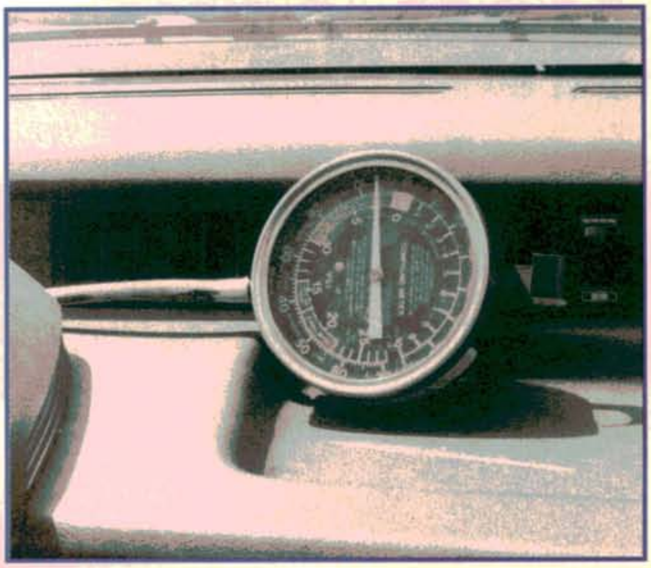
—By Sam Bell



It's hard to resist the temptation to just jump in and start fixing things as you find them. Instead, we analyzed the conditions under which the NO_x failure was most pronounced. As you would imagine with a Civic, the car was running moderately lean at all times, and, as the graph shows, NO_x production was consistently on the high side. The problem didn't appear to be mixture-ratio related.

We sincerely hoped our problem wouldn't turn out to reside in the maze of hoses that makes Honda a good nominee for the pasta factory of the week award. Is there really a Department of Air Cleaner Control in the Japanese Ministry of Trade and Industry devoted to making sure that each manufacturer uses his weekly quota of vacuum hoses, or is this merely a vicious rumor?

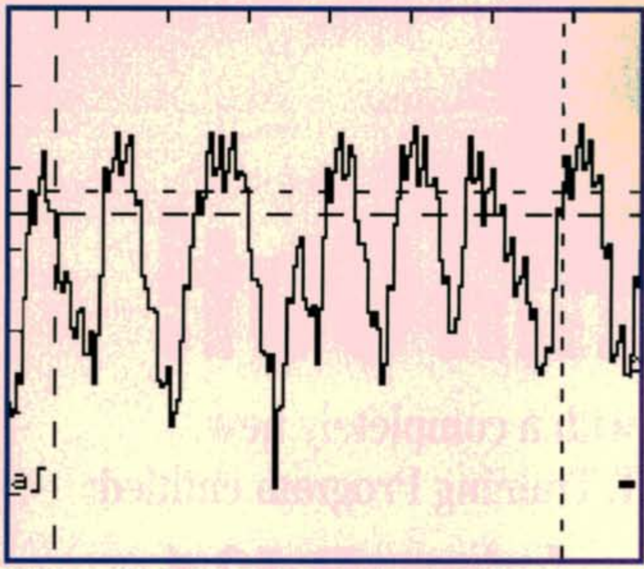
We suspected otherwise, but consistently high NO_X readings would normally point us toward the EGR system. We didn't want to overlook anything, so we performed a quick test of the EGR valve and its passages. The engine ran noticeably rougher at 2000 RPM with full vacuum applied to the EGR valve. The diaphragm didn't leak, and the valve opened and closed reliably. Time to look elsewhere.



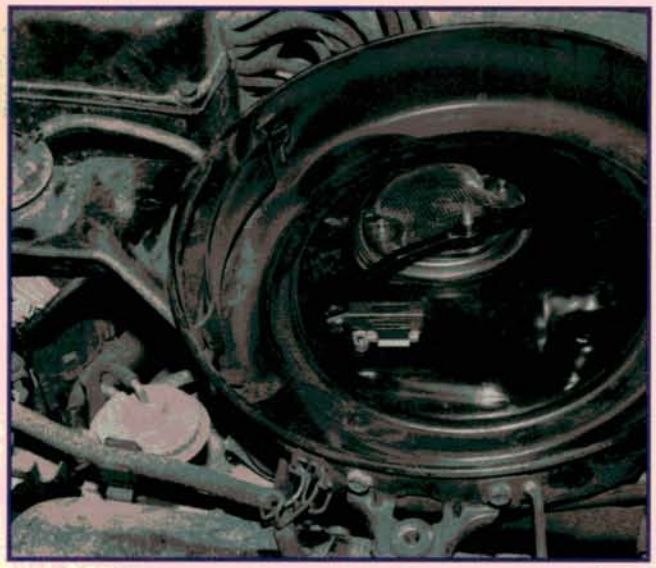
To make sure the EGR valve was getting vacuum under actual driving conditions, we teed in a vacuum gauge just ahead of the EGR valve. Look for (2 to 4 inches) Hg on back-pressure type systems and more (10+ inches) on non-backpressure types like this one. The presence of a varying vacuum signal means the cylinder head thermoswitch is closed and the EGR control solenoid is working.

Our test drive also gave us an opportunity to monitor the cylinder head coolant temperature, using the dash gauge. Hot spots, clogged, or scaly cooling system passages can't be completely ruled out on this basis alone, but the temp gauge certainly gives a fair overall indication of the general temperature range. Beware of temperature readings that stray into the upper end of the normal zone.

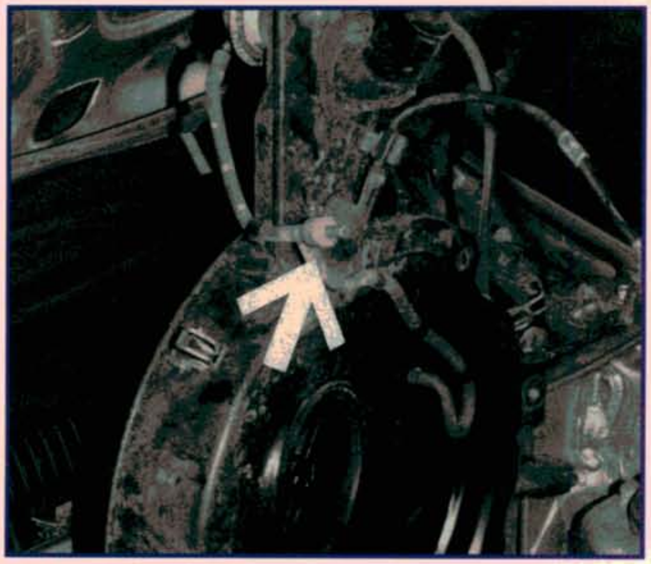
Overly advanced timing can cause excessive NO_X production too, so we made sure to check base timing as well as the operation of the vacuum and centrifugal advance units. Vacuum advance units are notorious for failure on these models, so we were extra careful. Someone in the past might have compensated for a leaky advance or retard diaphragm. Either way, base timing could be off.



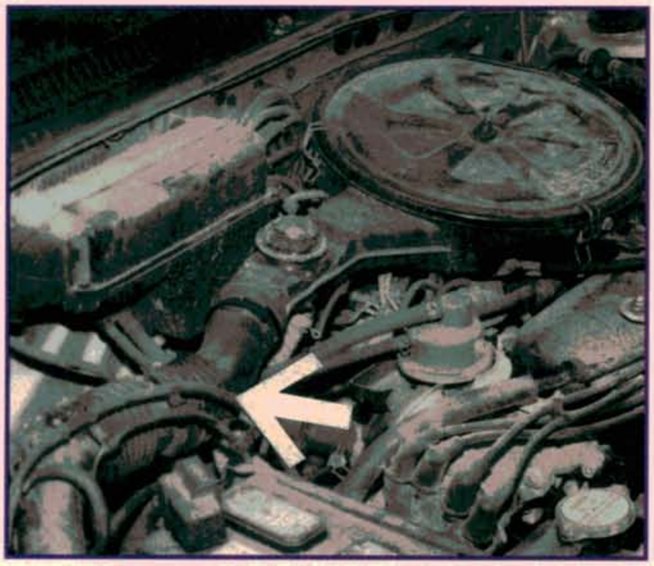
A very lean mixture can raise combustion temperatures high enough to cause excessive NO_x production. The easiest way to check the mixture is to run the engine at approximately 2000 RPM while monitoring the activity of the oxygen sensor. Look for the crosscounts that indicate rich/lean mixture switching. For more on this subject, see "Exhausted" in the December 1995 *Import Service*.



As often happens, there turned out to be a simple explanation. The carb was being fed a steady diet of hot air. (We'll refrain from the obvious rejoinders if you will, okay?) The constant stream of heated air was drawn through the preheat stove and tube, then compressed to about one-eighth of its original volume. This was giving rise to some very high combustion chamber temperatures.



Most manufacturers control the preheat door using a two-port thermoswitch in the air cleaner housing. Honda supplies vacuum to a tee through a check valve. One hose leads to the preheat door diaphragm, the other to a thermovent valve. The valve opens at about 37 degrees C, which vents the vacuum to atmosphere as a hot idle compensated bleed. The preheat door returns to the cold air inlet position.



Just as important as a functioning preheat system thermovacuum switch is the *presence* of this air intake duct. If the intake duct is missing, the whole underhood environment can function as a huge preheat stove on a hot day. Remember to also check for obstructions in the ductwork. There seems to be something about the type of plastic used in these ducts that attracts homeless mice.