Foreign Service

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Evap system vacuum switching valves (VSVs) are an invaluable aid to system diagnosis. In this series installment, Dan details VSV and vapor pressure sensor functional checks.

This is the fourth installment of our multipart series on Toyota's early or nonintrusive evaporative emissions systems. Last time I described how you could use the vehicle and its engine to perform simple but effective evap leak tests. At the very least, these checks screen out the larger leaks and larger problems without concern for trouble codes or monitors. Now we can apply what those tests taught us to functional checks of the vacuum switching valves (VSVs) as well as the vapor pressure sensor. Live, accurate tests of these components are much simpler than many technicians realize.

Peek once again at the illustration on page 18 of the January 2006 issue. The vapor pressure sensor is plumbed into the vapor pressure VSV, which is sometimes called the *three-way* VSV. One hose connects the VSV to the charcoal canister; another connects it to the fuel tank. When this VSV is electrically shut off, it connects the vapor pressure sensor to the canister. Therefore, the pressure sensor normally senses canister pressure. Periodically, the ECM turns on the three-way VSV by grounding it. Energizing the VSV connects the pressure sensor with the fuel tank for tank-side pressure checks.

If you were paying attention to previous installments of this series, you probably noticed that canister-side and tank-side vapor pressures *usually* aren't the same. Go figure; the ECM knows this, too. Suppose the ECM turns on the three-way VSV for its periodic tank pressure check. If the vapor pressure sensor reports that tank pressure is the same as canister pressure, the ECM flags a bad VSV. It concludes that the VSV didn't *mechanically* switch over to the tank side.

Combine this knowledge with what you've already learned about the vapor pressure sensor and you'll see that testing the three-way VSV is fairly easy. First, you can control any of the system's VSVs with the appropriate scan tool. For example, I've been doing our tests with a Vetronix Mastertech fitted with OE-style software for Toyotas. This scan tool also displays vapor pressure in millimeters of mercury (mm/Hg). However, comparable scan tools equipped with Asian-vehicle test software should be able to read vapor pressure in mm/Hg, too.

Second, you can simply energize the VSV of choice with a backprobe and jumper wire. Just turn on the ignition switch and ground the negative side of the VSV's solenoid.

Third, you don't necessarily need a scanner to monitor system pressure. You can tee the appropriate pressure gauge into the hose between the vapor pressure sensor and the vapor pressure VSV. You can also read system pressure indirectly by measuring the vapor pressure sensor signal with a digital voltmeter.

We'll start with the vapor pressure (three-way) VSV. It's not uncommon for this VSV to stick (fail *mechanically*), especially if it's exposed to the elements. As I explained in previous columns, the vapor pressure VSV on a later nonintrusive system is mounted under the rear of the vehicle.

One approach is to create an obvious pressure

continued on page 22

Photo: Dan Marinucci

Suppose you pinpoint a leaking purge VSV. Check this port for dark, granular debris, indicating a disintegrating charcoal canister.

difference between the canister and the fuel tank. Then energize the VSV and look for that pressure change. For example, atmospheric pressure is 762mm/Hg (absolute pressure) at sea level. So you can easily make the fuel tank a relatively high pressure just by removing the gas cap. In previous articles, I've explained that canister vapor pressure is usually lower than fuel tank pressure. Canister pressure also increases much *slower* than fuel tank pressure does. Anyway, the cooler the evap system is, the easier it is to see this potential pressure change. Turn the ignition switch on, engine off. Depending on the prevailing conditions, canister pressure (mm/Hg) will probably be somewhere between the high 740s and the 750s.

Next, turn on the vapor pressure VSV with your scan tool or jumper wire. The pressure reading should instantly change to fuel tank pressure. Of course, tank pressure is 762mm/Hg (atmospheric pressure) because you removed the gas cap. If you suspect that the vapor pressure VSV might be sticking intermittently, repeatedly toggle it on and off. The pressure reading should change as soon as you turn the VSV on and off. If vapor pressure doesn't change accordingly, you know the VSV is either stuck or sticking intermittently.

Suppose you're performing the same test but you're monitoring the vapor pressure signal with a digital voltmeter. At atmospheric pressure, the sensor's signal is 3.33 volts. Therefore, the voltmeter should display something noticeably less when the vapor pressure VSV is turned off; that's canister pressure. But every time you energize this VSV, the voltage reading should instantly change to 3.33 because you're switching the pressure sensor VSV—as well as the sensor—over to the tank side. Remember that the tank is wide open to the great outdoors because we removed the gas cap.

Creating a purge condition is another way to create a major pressure difference between the two sides of a nonintusive system. To do this, start the engine and let it idle. Then turn on the purge VSV with your scan tool or jumper wire. In last month's column, I emphasized that canister-side pressure usually drops into the mid-740s (mm/Hg) during a purge. So, your pressure reading will be 740-something. The vapor pressure sensor signal likely will be 1.60 to 1.90 volts.

Now turn on the vapor pressure VSV at the same time. With the gas cap removed, the pressure reading instantly should change to 762mm/Hg, and the pressure sensor signal should change to 3.33 volts. If the pressure or signal voltage doesn't change accordingly, the three-way VSV didn't "switch over" to the tank side. Is that easy enough for you?

Usually, you don't encounter many problems with the purge VSV, sometimes labeled the EVAP VSV. But sometimes the purge VSV does leak. No matter, it's still relatively easy to check. For example, start the engine and turn on the purge VSV with a scan tool or jumper wire. Assume for the moment that there aren't any gaping holes in the canister side of the system. If the purge VSV opens mechanically, canister-side pressure (mm/Hg) drops *immediately*—usually down into the mid-740s. At the same time, the vapor pressure sensor signal drops into the 1.60- to 1.90-volt range. If the system doesn't react this way, the purge VSV didn't open mechanically.

From here, you can treat the purge VSV like any old electrically controlled vacuum valve. For example, be sure power and ground are applied to it and start the engine. Then connect a gauge to the canister side of the purge VSV. If there's no reading on the gauge, the VSV didn't operate mechanically. Naturally, a VSV that opens mechanically should pass air or smoke.

Okay, suppose canister-side pressure and/or pressure sensor voltage drops normally when you turn on the purge VSV with the engine idling. In that case, disconnect the wiring harness connector from the purge VSV. Mechanically, the purge VSV should close tight as a drum. Canister-side pressure and the pressure sensor signal should remain steady. But if they drop, the purge VSV may be leaking. Shut off the engine, reconnect the purge VSV harness connector and then restart the engine. This time, carefully clamp off the hose on the canister side of the purge VSV with a good pair of pinch-off pliers. If the canister side of the system now holds pressure, it proves the purge VSV is leaking. M