A customer arrives with the Check Engine light on. It looks like a piece of cake: just hook up your trusty scan tool, retrieve the diagnostic trouble code (DTC) and solve the problem. In this case, the DTC retrieved is for an evaporative emissions system fault. How are you feeling at this point? For many technicians, an evaporative emissions DTC is like the kiss of death. The diagnosis might take a few minutes or a few days, depending on your understanding of the system and available diagnostic equipment.

In discussions with technicians around the country, the majority state that evaporative emissions systems problems are the most difficult to understand and diagnose. Vehicle manufacturers all have the same goals: check for leaks and validate the system's ability to purge fuel vapors. But their test methods vary significantly, so a technician's diagnostic strategy will change based on the system and tools available.

In my earlier evaporative emissions article—“Vapor Trails: Finding & Fixing Evaporative System Faults” (February 2006)—I explained how to develop a good diagnostic strategy and introduced some basic testing techniques. If you did not get a chance to read the article, check out the MOTOR website (www.motor.com) under “Back Issues.”

Preparing for this article, I had a good idea about common concerns, but wanted some additional data. Worldwide Vapor provides a toll-free technical hotline for customers who purchase the company's evaporative emissions test equipment, and they keep track of the questions their customers ask. I asked for the most common questions and, as expected, they were very similar to the questions I'm asked. The top four questions were:

• I have an evaporative emissions leak DTC and want to test the system, but cannot locate the service port. What should I do?
• The instructions tell me to locate and close the vent solenoid. How do I do this?
• I'm working on a Chrysler system with a leak detection pump. How do I test the pump and close the vent on this system?
• I've heard discussions about using nitrogen instead of shop air. Why should I use nitrogen?

Let's work our way through these questions:

First, what should you do if no service port is found? The majority of vehicles manufactured today do not have test ports. On most vehicles, the purge solenoid is accessible under the hood. Photo 1 on page 48 shows a purge solenoid and related components on a 2007 GM HHR. The purge solenoid has two hose connections and an electrical connection. Locate the hose that travels to the back of the vehicle. This will allow you to test the largest portion of the system. Connect the evaporative emissions test equipment to this hose. Also, don't forget to test the purge solenoid for leaks. This was discussed in the February 2006 article.

The second question deals with locating and closing the vent solenoid. Locating the vent solenoid is fairly simple on most vehicles. A component locator will point it out. If you don't have a component locator, a visual inspection at the back of the vehicle around the

By Bob Pattengale
The fuel tank will normally reveal the solenoid. In cases where the solenoid is difficult to locate, connect a smoke machine to the service port and pump smoke into the system. When you see smoke coming from the back of the vehicle, follow the source of the smoke to the vent solenoid. Keep in mind that a remote hose might be connected to the solenoid or to the frame rail to prevent dust and moisture from getting into the fuel tank.

Closing the solenoid is a little more difficult. One of the best ways to control the solenoid is with a scan tool. If one is not available, you can perform this test manually with a DVOM. Locate and unplug the connector on the vent solenoid. Turn the ignition key on, engine not running. Connect the black lead to a known-good ground and use the red lead to determine which pin on the connector is ground and which has system voltage. Reconnect the vent solenoid. Place your DVOM in the mA position. Connect the red lead to the pin on the solenoid connector that was identified as ground and connect the black lead to a known-good ground. This will energize the vent solenoid, closing the evaporative emissions system for testing. Do not leave the solenoid energized for more than five minutes at a time.

If you're unable to close the vent solenoid with a scan tool or jumper wires, to quickly test the system for leaks, simply plug the vent solenoid outlet with a cap or plug. Unfortunately, this does not allow you to properly test one of the most common sources of leaks—the vent solenoid.

The third question deals with the Chrysler LDP systems. We won't discuss the full operation of the LDP system here. The focus will be on how to test the LDP solenoid and how to close the vent plunger for testing purposes.

Fig. 1 above is a cutaway drawing of a typical LDP, including the solenoid. In the normally open vent mode, air can enter and exit the system around the vent plunger. The yellow arrows at the bottom of the illustration show the path. The pump plunger is blocking off the vacuum source to the LDP solenoid.

The LDP solenoid has a three-wire connection. One wire provides system voltage to the LDP solenoid and reed contact signal switch with the key on, engine off (KOEO). The reed contact input signal provides feedback to the powertrain control module (PCM) when the diaphragm reaches its full upward travel. The third wire is controlled by the PCM to cycle the LDP solenoid.

The LDP solenoid can be tested with a voltmeter and hand vacuum pump. Using your service information, determine the solenoid wire configuration. If a wiring diagram is not available, use the voltmeter to determine which wires
have system voltage KEO and which wire is the solenoid control.

Next, disconnect the intake manifold vacuum hose from the LDP solenoid and connect the hand vacuum pump. Connect the DVM red lead to the reed contact input signal/voltage sense wire and the black lead to a known-good ground.

The LDP solenoid will need to be energized with a jumper wire. Connect one end of the jumper wire to the LDP solenoid wire identified as the solenoid control wire, then connect the other end of the jumper wire to a known-good ground. The goal is to move the LDP solenoid plunger, allowing vacuum to enter the diaphragm. The solenoid should be energized only long enough to test the LDP—not longer than five minutes at a time.

Using the hand pump, apply vacuum to the intake manifold vacuum hose. The LDP must be able to hold vacuum above 5 in. or the vent plunger will not stay closed. As vacuum is applied to the LDP solenoid, monitor the DVM voltage at the reed contact input signal. The DVM should show system voltage at first. As the vacuum increases, the LDP diaphragm will continue to move upward until the reed contact switch opens and the voltage goes away. If the LDP solenoid holds vacuum and the voltage changes, then the LDP is working correctly. Fig. 2 shows the position of the LDP solenoid and the flow of vacuum.

The final step is checking the LDP vent plunger. The procedure also can be used to close the plunger to check for system leaks. Fig. 3 shows the animated LDP solenoid. This test can be performed with the key off. Disconnect the vacuum hose from the LDP solenoid next to the three-wire connector. Connect the hand vacuum pump to the vacuum port. Apply approximately 12 in. of vacuum to the LDP solenoid, which will pull the diaphragm upward, closing the vent valve plunger. The vacuum applied
will slowly decay; if the vacuum drops below 5 in., the vent plunger will open. You may need to pump up the solenoid several times during the leak test. Once the vent valve plunger is closed, you can use the evaporative emissions tester to check for leaks in the system.

The last question deals with which gas should be used to test evaporative emissions systems. Two options have been recommended by various equipment suppliers—shop air and nitrogen. Nitrogen is the safest and cleanest gas to use with your evaporative emissions machine. The majority of vehicle manufacturers using smoke technology for evaporative emissions testing recommend using nitrogen. In fact, some vehicle manufacturers have designed their new leak-detection machines with built-in nitrogen generators.

What are the issues when using shop air? One of the first is easy to understand: How clean is the air coming out of your air hoses? Is the shop air introducing water, oil and debris into the evaporative emissions system? If you have an excellent filtering system that removes water, oil and debris, this will not be a problem.

The next issue—and the primary concern—is safety. The evaporative emissions system is designed to trap gasoline vapors in the fuel system, preventing them from escaping into the atmosphere. The question that needs to be considered is flammability of the fuel system gases during testing.

The following quoted passage is taken from an SAE paper titled “Gasoline Vapor Behavior During Leak Detection Activities on a Motor Vehicle,” written by Dr. David Checkel, dated 1/17/05:

“The hazard inside a vehicle's fuel tank vapor space and evap system relates to the quantity of fuel vapor/air mixture that is in the flammable range. Gasoline fuel is designed to have a vapor pressure sufficiently high that the vapor concentration in a closed vessel is always above the upper flammable limit. However, leak detection systems may force some flow through the fuel tank vapor space and purge this too-rich-to-burn mixture out of the tank. As this happens, the vapor concentration will drop towards a lower value. This lower concentration is determined by the rate of flow through the system and the rate of gasoline evaporation at the liquid surface. If air is used as the driving gas for the leak detection process (or if the leak detection equipment draws a vacuum which pulls atmospheric air into the tank vapor space), there will be some ratio of air flow rate relative to gasoline evaporation rate that generates a significant amount of flammable mixture. The rate of gasoline evaporation in a fuel tank during purge flows similar to those used in leak detection is uncertain and this leads to uncertainty in the maximum safe flows for leak detection equipment.

Dr. Checkel has continued his research and presented his latest findings and released a new SAE paper at the 2007 SAE World Congress, held last month in Detroit.

In simple terms, the gas vapor in the gas tank is normally too rich to burn. When using an evaporative emissions machine, the flow from most units is 10 to 15 liters per minute. The extremely rich vapors are pushed from the fuel system and replaced with either shop air or nitrogen, depending on the supply gas. If the fuel tank cap is not removed, the gas vapors escape from the vent hose through the charcoal canister. In the early stages, the charcoal canister will absorb the gas vapors. But after a few minutes the canister reaches a saturation point, allowing gas vapors to escape in larger quantities.

If the gas cap is removed, the gas vapors escape at a significant rate, which makes the mixture in the tank reach a potential flammable point more quickly. Nitrogen or another inert gas is recommended as a safer alternative to shop air. On page 31, the EPA IM 240 & Evap. Technical Guidance (EPA420-R-98-010, dated August 1998) states, "Nitrogen, or an equivalent non-toxic, non-greenhouse, inert gas shall be used for pressurizing the evaporative system. Air should only be used if the pressurized vapor space is outside the combustible limits for the vehicle fuel type."

It has been mentioned by some that Chrysler uses air as a method of testing the evaporative emissions system. We discussed the leak-detection pump earlier in this article. The key difference is the quantity of air used and the time.
Looking for small leaks can be a challenge, and leaks under .010 in. can be difficult to see with a smoke machine. The ultraviolet leak-detection dye can help locate small leaks (left photo). The photo above right shows the SPX/OTC Flex View UV optic, which allows you to see into hard-to-reach areas and spot dye traces.

Another interesting development related to small leak detection are ultrasonic listening devices. The All-view ultrasonic ears shown here can locate very small leaks with precision. In order to get the best results, an evaporative emissions tester should be used to add pressure to the system. This will enhance the hissing sound from the leak.

Looking for small leaks can be a challenge, and leaks under .010 in. can be difficult to see with a smoke machine. The ultraviolet leak-detection dye can help locate small leaks (left photo). The photo above right shows the SPX/OTC Flex View UV optic, which allows you to see into hard-to-reach areas and spot dye traces.

Another interesting development related to small leak detection are ultrasonic listening devices. The All-view ultrasonic ears shown here can locate very small leaks with precision. In order to get the best results, an evaporative emissions tester should be used to add pressure to the system. This will enhance the hissing sound from the leak.

Looking for small leaks can be a challenge, and leaks under .010 in. can be difficult to see with a smoke machine. The ultraviolet leak-detection dye can help locate small leaks (left photo). The photo above right shows the SPX/OTC Flex View UV optic, which allows you to see into hard-to-reach areas and spot dye traces.

Another interesting development related to small leak detection are ultrasonic listening devices. The All-view ultrasonic ears shown here can locate very small leaks with precision. In order to get the best results, an evaporative emissions tester should be used to add pressure to the system. This will enhance the hissing sound from the leak.