LEAK DETECTION PUMP (LDP) OPERATION AND DIAGNOSIS

TECHNICAL SERVICE BULLETIN

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CHRYSLER/DODGE/PLYMOUTH/JEEP/EAGLE: All vehicles with Leak Detection System

INTRODUCTION

NOTE: THE GENERAL PRINCIPLES DISCUSSED IN THIS DOCUMENT CAN BE USED ON EARLIER MODEL YEAR VEHICLES.

NOTE: This bulletin describes the theory of operation for the leak detection system. In addition, information is provided for each of the Diagnostic Trouble Codes (DTC's) as follows:

P0442-EVAP LEAK MONITOR 0.040" LEAK DETECTED
P0455-EVAP LEAK MONITOR LARGE LEAK DETECTED
P0456-EVAP LEAK MONITOR 0.020" LEAK DETECTED
P1486-EVAP LEAK MONITOR PINCHED HOSE FOUND
P1494-LEAK DETECTION PUMP SW OR MECHANICAL FAULT
P1495-LEAK DETECTION PUMP SOLENOID CIRCUIT

The evaporative emission system is designed to prevent the escape of fuel vapors from the fuel system. Leaks in the system, even small ones, can allow fuel vapors to escape into the atmosphere. Government regulations require onboard testing to make sure that the evaporative (EVAP) system is functioning properly. The leak detection system tests for EVAP system leaks and blockage. It also performs self-diagnostics.

During self-diagnostics, the Powertrain Control Module (PCM) first checks the Leak Detection Pump (LDP) for electrical and mechanical faults. If the first checks pass, the PCM then uses the LDP to seal the vent valve and pump air into the system to pressurize it. If a leak is present, the PCM will continue pumping the LDP to replace the air that leaks out. The PCM determines the size of the leak based on how fast/long it must pump the LDP as it tries to maintain pressure in the system.

EVAP LEAK DETECTION SYSTEM COMPONENTS (FIGURE 1)

Service Port : Used with special tools like the Miller Evaporative Emissions Leak Detector (EELD) to test for leaks in the system.

EVAP Purge Solenoid : The PCM uses the EVAP purge solenoid to control purging of excess fuel vapors stored in the EVAP canister. It remains closed during leak testing to prevent loss of pressure.

EVAP Canister : The EVAP canister stores fuel vapors from the fuel tank for purging.

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EVAP Purge Orifice : Limits purge volume.

EVAP System Air Filter : Provides air to the LDP for pressurizing the system. It filters out dirt while allowing a vent to atmosphere for the EVAP system.

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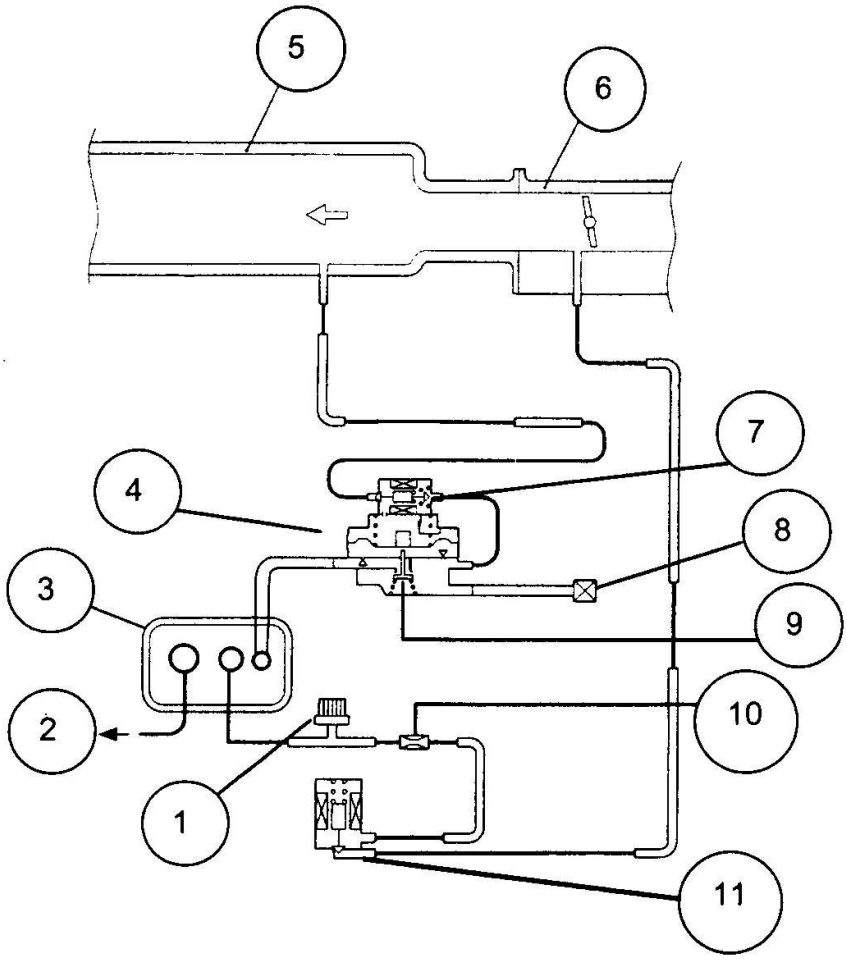

1-SERVICE PORT
2-TO FUEL TANK
3-EVAPORATIVE CANISTER
4-LEAK DETECTION PUMP (LDP)
5-INTAKE AIR PLENUM
6-THROTTLE BODY
7-LDP SOLENOID
8-EVAPORATIVE SYSTEM AIR FILTER
9-LDP VENT VALVE
10-EVAPORATIVE PURGE ORIFICE (model specific)
11-EVAPORATIVE PURGE SOLENOID

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Fig. 1: EVAP Leak Detection System Components

LEAK DETECTION PUMP (LDP) COMPONENTS

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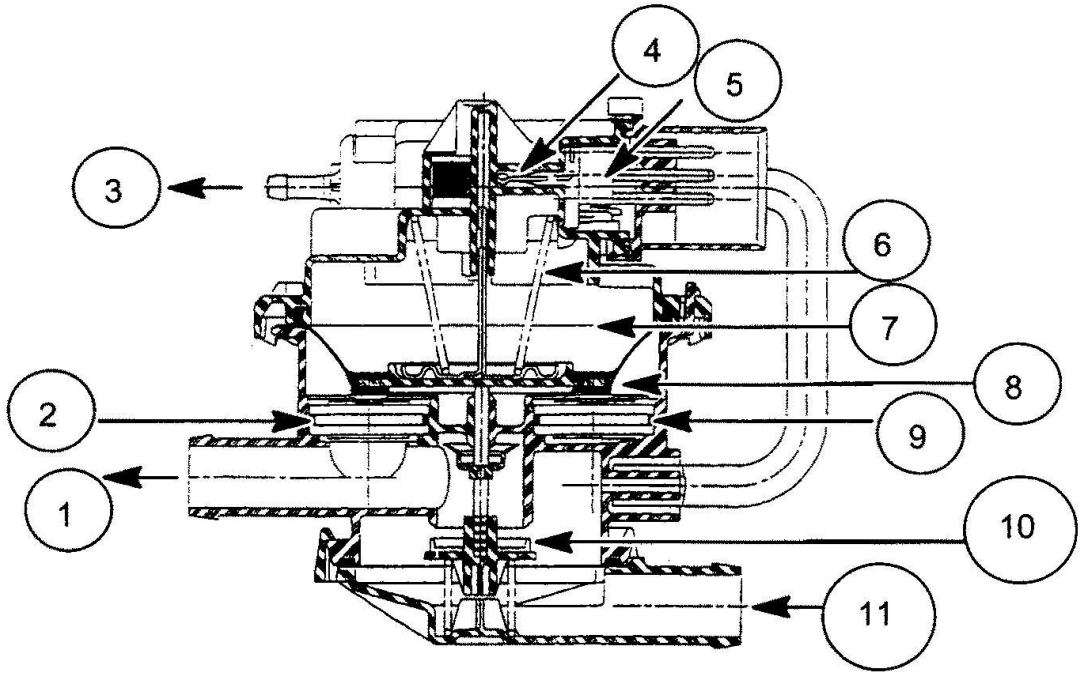
The main purpose of the LDP is to pressurize the fuel system for leak checking. It closes the EVAP system vent to atmospheric pressure so the system can be pressurized for leak testing. The diaphragm is powered by engine vacuum. It pumps air into the EVAP system to develop a pressure of about 7.5" H20 (1/4) psi. A reed switch in the LDP allows the PCM to monitor the position of the LDP diaphragm. The PCM uses the reed switch input to monitor how fast the LDP is pumping air into the EVAP system. This allows detection of leaks and blockage.

The LDP assembly consists of several parts (**Fig. 2**). The solenoid is controlled by the PCM, and it connects the upper pump cavity to either engine vacuum or atmospheric pressure. A vent valve closes the EVAP system to atmosphere, sealing the system during leak testing. The pump section of the LDP consists of a diaphragm that moves up and down to bring air in through the air filter and inlet check valve, and pump it out through an outlet check valve into the EVAP system.



1-TO CANISTER
2-ONE-WAY CHECK VALVE (OUTLET)
3-VACUUM FROM INTAKE MANIFOLD
4-REED SWITCH
5-PRESSURE/VACUUM SOLENOID
6-DIAPHRAGM SPRING
7-PUMP CAVITY
8-DIAPHRAGM
9-ONE-WAY CHECK VALVE (INLET)
10-VENT VALVE
11-TO AIR FILTER

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Fig. 2: LDP Assembly

The diaphragm is pulled up by engine vacuum, and pushed down by spring pressure, as the LDP solenoid turns on and off. The LDP also has a magnetic reed switch to signal diaphragm position to the PCM. When the diaphragm is down, the switch is closed, which sends a 12 V (system voltage) signal to the PCM. When the diaphragm is up, the switch is open, and there is no voltage sent to the PCM. This allows the PCM to monitor LDP pumping action as it turns the LDP solenoid on and off.

DIAGNOSTIC TIPS

During diagnosis, you can compare the LDP solenoid activity with the monitor sequence in **Fig. 6** . If the PCM detects a problem that could set a DTC, the testing is halted and LDP solenoid activity will stop. As each section of the test begins, it indicates that the previous section passed successfully. By watching to see which tests complete, you can see if any conditions are present that the PCM considers abnormal.

For example, if the LDP solenoid is energized for the test cycles to test for blockage (P1486), it means that the LDP has already passed its test for P1494. Then, if the PCM detects a possible blockage, it will set a temporary fault without turning on the MIL and continue the leak portion of the test. However, the PCM will assume that the system is already pressurized and skip the rapid pump cycles.

Always diagnose leaks, if possible, before disconnecting connections. Disconnecting connections may mask a leak condition.

Keep in mind that if the purge solenoid seat is leaking, it could go undetected since the leak would end up in the intake manifold. Disconnect the purge solenoid at the manifold when leak checking. In addition, a pinched hose fault (P1486) could set if the purge solenoid does not purge the fuel system properly (blocked seat). The purge solenoid must vent the fuel system prior to the LDP system test. If the purge solenoid cannot properly vent the system the LDP cannot properly complete the test for P1486 and this fault can set due to pressure being in the EVAP system during the test sequence.

Multiple actuations of the DRB III(R) Leak Detection Pump (LDP) Monitor Test can hide a 0.020" leak because of excess vapor generation. Additionally, any source for additional vapor generation can hide a small leak in the EVAP system. Excess vapor generation can delay the fall of the LDP diaphragm thus hiding the small leak. An example of this condition could be bringing a cold vehicle into a warm shop for testing or high ambient temperatures.

Fully plugged and partially plugged underhood vacuum lines have been known to set MIL conditions. P1494 and P0456 can be set for this reason. Always, thoroughly, check plumbing for pinches or blockage before condemning components.

LDP AT REST (NOT POWERED)

When the LDP is at rest (no electrical/vacuum) the diaphragm is allowed to drop down if the internal (EVAP system) pressure is not greater than the return spring. The LDP solenoid blocks the engine vacuum port and opens the atmospheric pressure port connected through the EVAP system air filter. The vent valve is held open by the diaphragm. This allows the canister to see atmospheric pressure (**Fig. 3**).

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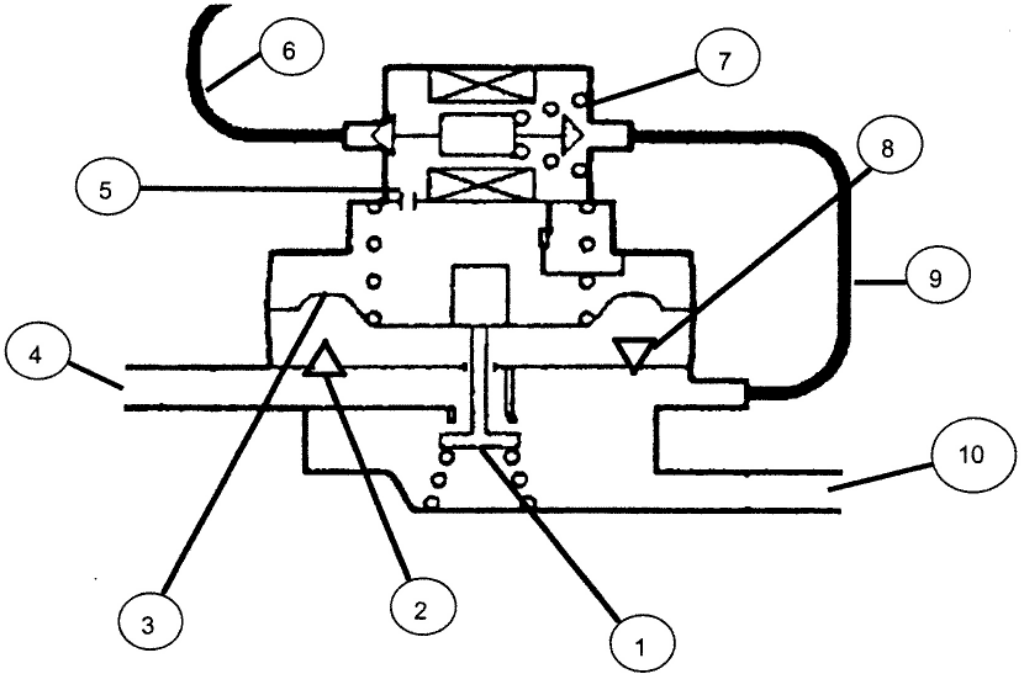

1-VENT VALVE (PUSHED OPEN BY DIAPHRAGM)
2-OUTLET CHECK VALVE (CLOSED)
3-DIAPHRAGM (FULLY DOWN/PUSHES VENT VALVE OPEN)
4-TO CANISTER
5-DIAPHRAGM PORT TO SOLENOID
6-VACUUM LINE
7-SOLENOID (CLOSES VACUUM PORT/OPENS ATMOSPHERIC PORT TO FILTER)
8-INLET CHECK VALVE (CLOSED)
9-ATMOSPHERIC PRESSURE LINE
10-TO AIR FILTER (ATMOSPHERIC PRESSURE)

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Fig. 3: LDP At Rest (Not Powered)

DIAPHRAGM UPWARD MOVEMENT

When the PCM energizes the LDP solenoid, the solenoid blocks the atmospheric port leading through the EVAP air filter and at the same time opens the engine vacuum port to the pump cavity above the diaphragm. The diaphragm moves upward when vacuum above the diaphragm exceeds spring force. This upward movement closes the vent valve. It also causes low pressure below the diaphragm, unseating the inlet check valve and allowing air in from the EVAP air filter. When the diaphragm completes its upward movement, the LDP reed switch turns from closed to open (**Fig. 4**).

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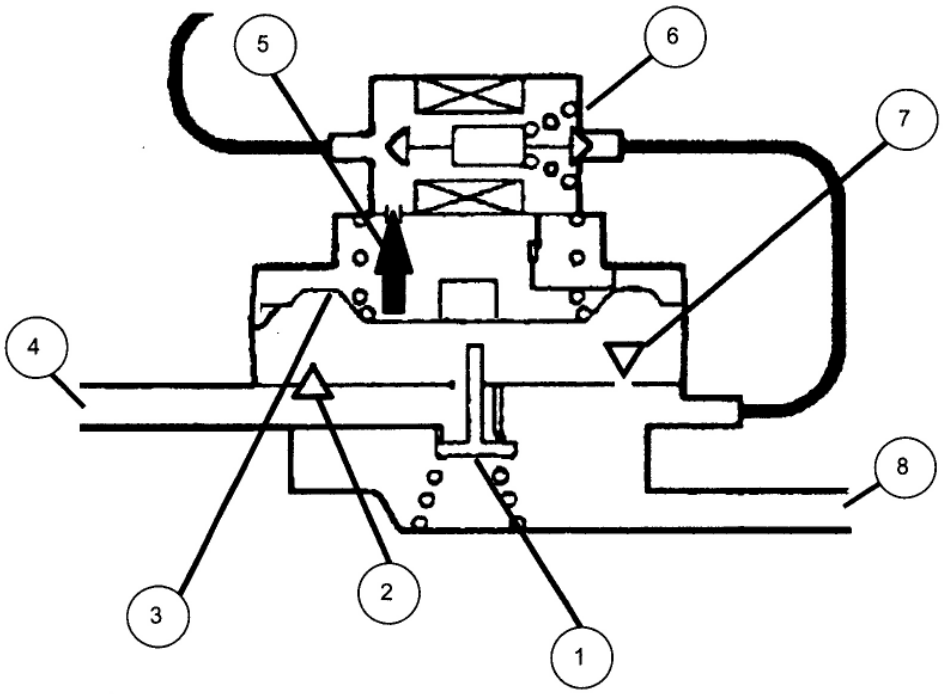

1-VENT VALVE (CLOSED BY UPWARD MOVEMENT OF DIAPHRAGM)
2-OUTLET CHECK VALVE (CLOSED)
3-DIAPHRAGM (MOVES UPWARD/CLOSES VENT VALVE)
4-TO CANISTER
5-VACUUM ABOVE DIAPHRAGM (MOVES DIAPHRAGM UPWARD)
6-SOLENOID (OPENS VACUUM PORT TO DIAPHRAGM/CLOSES ATMOSPHERIC PORT TO FILTER)
7-INLET CHECK VALVE (OPEN)
8-TO AIR FILTER
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Fig. 4: Diaphragm Upward Movement

DIAPHRAGM DOWNWARD MOVEMENT

Based on reed switch input, the PCM de-energizes the LDP solenoid, causing it to block the vacuum port, and open the atmospheric port. This connects the upper pump cavity to atmosphere through the EVAP air filter. The spring is now able to push the diaphragm down. The downward movement of the diaphragm closes the inlet check valve and opens the outlet check valve pumping air into the evaporative system. The LDP reed switch turns from open to closed, allowing the PCM to monitor LDP pumping (diaphragm up/down) activity (**Fig. 5**). During the pumping mode, the diaphragm will not move down far enough to open the vent valve.

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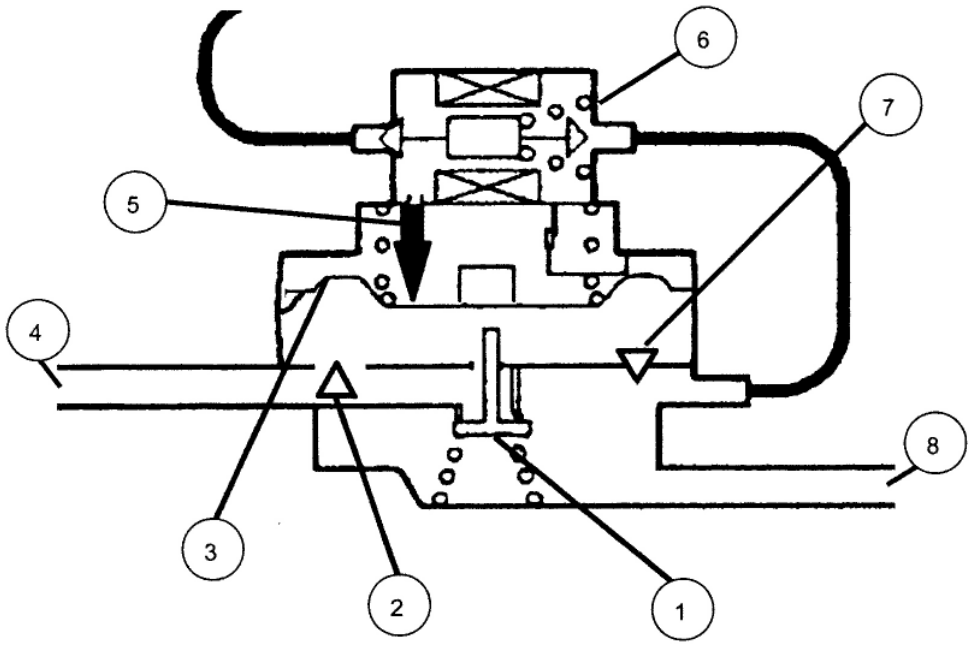

1-VENT VALVE (CLOSED)
2-OUTLET CHECK VALVE OPEN
3-DIAPHRAGM (MOVING DOWNWARD BY SPRING PRESSURE - VACUUM BLOCKED)
4-TO CANISTER
5-ATMOSPHERIC PRESSURE ABOVE DIAPHRAGM (SPRING PUSHES DIAPHRAGM DOWNWARD)
6-SOLENOID (CLOSES VACUUM PORT/OPENS ATMOSPHERIC PORT TO FILTER)
7-INLET CHECK VALVE (CLOSED)
8-FROM AIR FILTER

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Fig. 5: Diaphragm Downward Movement

The pumping cycle is repeated as the solenoid is turned on and off. When the evaporative system begins to pressurize, the pressure on the bottom of the diaphragm will begin to oppose the spring pressure, slowing the pumping action. The PCM watches the time from when the solenoid is de-energized, until the diaphragm drops down far enough for the reed switch to change from opened to closed. If the reed switch changes too quickly, a leak may be indicated. The longer it takes the reed switch to change state, the tighter the evaporative system is sealed. If the system pressurizes too quickly, a restriction somewhere in the EVAP system may be indicated.

PUMPING ACTION

During portions of this test, the PCM uses the reed switch to monitor diaphragm movement. The solenoid is only turned on by the PCM after the reed switch changes from open to closed, indicating that the diaphragm has moved down. At other times during the test, the PCM will rapidly cycle the LDP solenoid on and off to quickly pressurize the system. During rapid cycling, the diaphragm will not move enough to change the reed switch state. In the state of rapid cycling, the PCM will use a fixed time interval to cycle the solenoid.

If the system does not pass the EVAP Leak Detection Test, the following DTC's may be set:

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P0442 - EVAP LEAK MONITOR 0.040" LEAK DETECTED
P0455 - EVAP LEAK MONITOR LARGE LEAK DETECTED
P0456 - EVAP LEAK MONITOR 0.020" LEAK DETECTED
P1486 - EVAP LEAK MON PINCHED HOSE FOUND
P1494 - LEAK DETECTION PUMP SW OR MECH FAULT
P1495 - LEAK DETECTION PUMP SOLENOID CIRCUIT

ENABLING CONDITIONS TO RUN EVAP LEAK DETECTION TEST

1. Cold start with ambient temperature (obtained from modeling the inlet air temperature sensor on passenger vehicles and the battery temperature sensor on Jeep & truck vehicles) between 4°C (40°F) and 32°C (90° F) for 0.040" leak. Between 4°C (40°F) and 29°C (85°F) for 0.020" leak.
2. Engine coolant temperature within: -12° to -8°C (10° to 18°F) of battery/ambient.
3. Battery voltage between 10 and 15 volts.

NOTE: IF BATTERY VOLTAGE DROPS BELOW 10 VOLTS FOR MORE THAN 5 SECONDS DURING ENGINE CRANKING, THE EVAP LEAK DETECTION TEST WILL NOT RUN.

4. Low fuel warning light off (fuel level must be between 15% and 85% for 0.040" leak and 30% and 85% for 0.020" leak).
5. MAP sensor reading 22 in Hg or above (This is the manifold absolute pressure, not vacuum).
6. No engine stall during test.

NOTE: THE FOLLOWING VALUES ARE APPROXIMATE AND VEHICLE SPECIFIC. USE THE VALUES SEEN IN PRE TEST/MONITOR TEST SCREEN ON THE DRB III(R). SEE TSB 25-02-98 FOR MORE DETAIL.

DTC will not be set if a one-trip fault is set or if the MIL is illuminated for any of the following:

Purge Solenoid Electrical Fault
All TPS Faults
All Engine Controller Self Test Faults
LDP Pressure Switch Fault
All Cam and/or Crank Sensor Fault
EGR Solenoid Electrical Fault
All MAP Sensor Faults
All Injector Faults
Ambient/Battery Temperature Sensor Electrical Faults
Baro Out of Range
Vehicle Speed Faults

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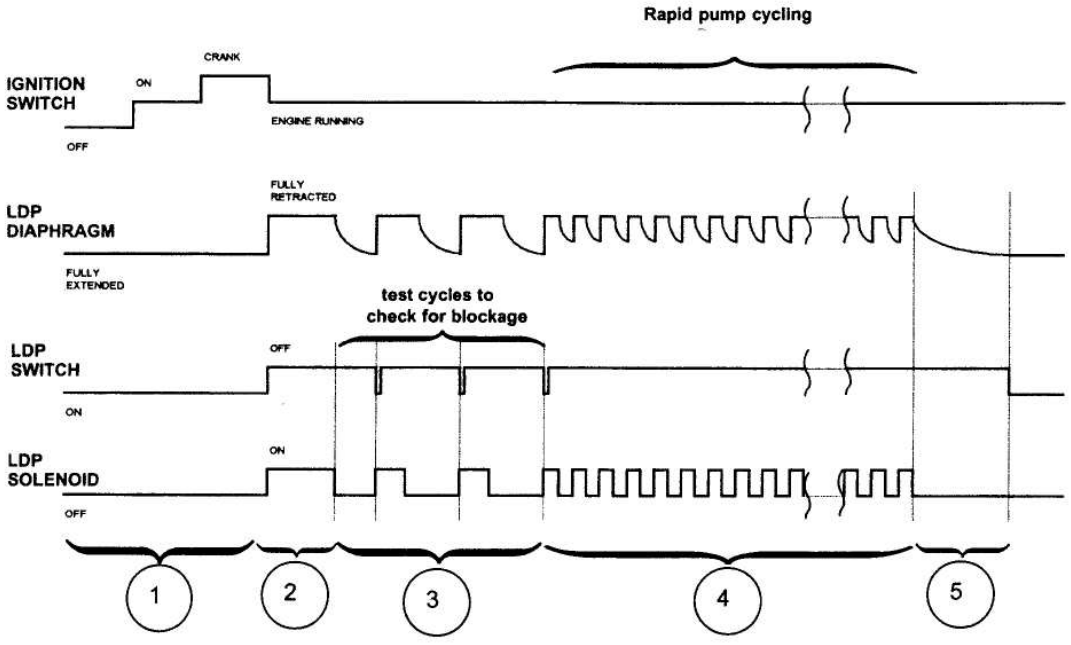
All Coolant Sensor Faults
LDP Solenoid Circuit



1-P1495 LEAK DETECTION PUMP SOLENOID CIRCUIT can set (key "ON")
2-P1494 LEAK DETECTION PUMP SW OR MECH FAULT can set
3-P1486 EVAP LEAK MON PINCHED HOSE FOUND can set
4-No DTC can set during this time
5-P0456 EVAP LEAK MONITOR 0.020 LEAK DETECTED/P0442 - EVAP LEAK MONITOR 0.040 LEAK DETECTED/P0455 - EVAP LEAK MONITOR LARGE LEAK DETECTED can set - times will vary
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Fig. 6: EVAP Leak Detection Test Sequence

FIGURE 6, SECTION 1

When the ignition key is turned to "ON", the LDP diaphragm should be in the down position and the LDP reed switch should be closed. If the EVAP system has residual pressure, the LDP diaphragm may be up. This could result in the LDP reed switch being open when the key is turned to "ON" and a P1494 fault could be set because the PCM is expecting the reed switch to be closed.

After the key is turned "ON", the PCM immediately tests the LDP solenoid circuit for electrical faults. If a fault is detected, DTC P1495 will set, the MIL will illuminate, and the remaining EVAP Leak Detection Test is canceled.

NOTE: IF BATTERY TEMPERATURE IS NOT WITHIN RANGE, OR IF THE ENGINE COOLANT TEMPERATURE IS NOT WITHIN A SPECIFIED RANGE OF THE BATTERY TEMPERATURE, THE PCM WILL NOT RUN TESTS FOR DTC P1494, P1486, P0442, P0455 AND P0441. THESE TEMPERATURE CALIBRATIONS MAY

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BE DIFFERENT BETWEEN MODELS.

FIGURE 6, SECTION 2

If DTC P1495 is not set, the PCM will check for DTC P1494. If the LDP reed switch was closed when the key was turned to "ON", the PCM energizes the LDP solenoid for up to 8 seconds and monitors the LDP switch. As the LDP diaphragm is pulled up by engine vacuum, the LDP reed switch should change from closed to open. If it does not, the PCM sets a temporary fault (P1494) in memory, and waits until the next time the Enabling Conditions are met to run the test again. If this is again detected, P1494 is stored and the MIL is illuminated. If the problem is not detected during the next enabling cycle, the temporary fault will be cleared.

However, if the PCM detects the reed switch open when the key is turned to "ON", the PCM must determine if this condition is due to residual pressure in the EVAP system, or an actual fault. The PCM stores information in memory on EVAP system purging from previous engine run or drive cycles.

If little or no purging took place, residual pressure could be holding the LDP diaphragm up, causing the LDP switch to be open. Since this is not a malfunction, the PCM cancels the EVAP Leak Detection Test without setting the temporary fault.

If there was sufficient purging during the previous cycle to eliminate EVAP system pressure, the PCM judges that this is a malfunction and sets a temporary fault in memory. The next time that the Enabling Conditions are met, the test will run again. If the fault is again detected, the MIL will illuminate and DTC 1494 will be stored. If the fault is not detected, the temporary fault will be cleared.

FIGURE 6, SECTION 3

If no fault has been detected so far, the PCM begins testing for possible blockage in the EVAP system between the LDP and the fuel tank. This is done by monitoring the time required for the LDP to pump air into the EVAP system during two to three pump cycles. If no blockage is present, the LDP diaphragm is able to quickly pump air out of the LDP each time the PCM turns off the LDP solenoid. If a blockage is present, the PCM detects that the LDP takes longer to complete each pump cycle. If the pump cycles take longer than expected (approximately 6 to 10 seconds) the PCM will suspect a blockage. On the next drive when Enabling Conditions are met, the test will run again. If blockage is again detected, P1486 is stored, and the MIL is illuminated.

FIGURE 6, SECTION 4

After the LDP blockage tests are completed, the PCM then tests for EVAP system leakage. First, the PCM commands the LDP to rapidly pump for 20 to 50 seconds (depending on fuel level) to build pressure in the EVAP system. This evaluates the system J18-24-0 to see if it can be sufficiently pressurized. This evaluation (rapid pump cycling) may occur several times prior to leak checking. The LDP reed switch does not close and open during rapid pumping because the diaphragm does not travel through its full range during this part of the test.

FIGURE 6, SECTION 5

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Next, the PCM performs one or more test cycles by monitoring the time required for the LDP reed switch to close (diaphragm to drop) after the LDP solenoid is turned off.

If the switch does not close, or closes after a long delay, it means that the system does not have any significant leakage and the EVAP Leak Detection Test is complete.

However, if the LDP reed switch closes quickly, there may be a leak or the fuel level may be low enough that the LDP must pump more to finish pressurizing the EVAP system. In this case, the PCM will rapidly pump the LDP again to build pressure in the EVAP system, and follow that by monitoring the time needed for several LDP test cycles. This process of rapid pumping followed by several LDP test cycles may repeat several times before the PCM judges that a leak is present.

When leaks are present, the LDP test cycle time will be inversely proportional to the size of the leak. The larger the leak, the shorter the test cycle time. The smaller the leak, the longer the test cycle time. DTC's may be set when a leak as small as 0.5 mm (0.020") diameter is present.

If the system detects a leak, a temporary fault will be stored in PCM memory. The time it takes to detect a .020", .040", or Large leak is based on calibrations that vary from model to model. The important point to remember is if a leak is again detected on the next EVAP Leak Detection Test, the MIL will illuminate and a DTC will be stored based on the size of leak detected. If no leak is detected during the next test, the temporary fault will be cleared.

TEST EQUIPMENT

The Evaporative Emission Leak Detector (EELD) Miller Special Tool 8404 is capable of visually detecting leaks in the evaporative system and will take the place of the ultrasonic leak detector 6917A. The EELD utilizes shop air and a smoke generator to visually detect leaks down to 0.020" or smaller. The food grade oil used to make the smoke includes an UV trace dye that will leave telltale signs of the leak under a black light. This is helpful when components have to be removed to determine the exact leak location. For detailed test instructions, follow the operators manual packaged with the EELD.

IMPORTANT

Be sure that the PCM has the latest software update. Reprogram as indicated by any applicable Technical Service Bulletin. After LDP repairs are completed, verify the repair by running the DRB III(R) Leak Detection Pump (LDP) Monitor Test as described in Technical

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