P0456-EVAP SYSTEM SMALL LEAK

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For a complete wiring diagram, refer to the Wiring Information.
Theory of Operation
EVAPORATIVE SYSTEM OVERVIEW: The Powertrain Control Module (PCM) monitors the Evaporative Emission System operation. The two main areas being monitored are the integrity of the system against leaks and the ability of the system to get fuel vapor from the canister to the Intake Manifold. The basic strategy used is that in a sealed system, pressure will naturally increase or decrease in relation to temperature. As temperature increases, so does pressure inside the system. And conversely, as temperature decreases, pressure in the system will decrease as well and will eventually turn into a vacuum if no leaks are present. Even the smallest of leaks can be accurately detected in this manner. The ESIM has multiple functions. There are two weighted seals that keep the system normally closed from the atmosphere. The weighted seals are used to maintain the system pressure between +1 inch of water and -2 inches of water. Anytime (engine-on or engine-off) that pressure or vacuum reaches these thresholds, the weights will lift and provide relief. There is also a vacuum actuated switch that closes when the vacuum reaches a calibrated value. This is beneficial because the induced vacuum during a subsequent declining temperature will achieve the switch closed (pass threshold) sooner than if the tank had to decay from a higher built up pressure.

ESIM SWITCH STUCK CLOSED MONITOR: At ignition off, the state of the ESIM switch is evaluated. If the switch is open, a pass flag will set so the PCM power down process can complete. If the switch is closed, the PCM will wait a calibrated delay time and open the Purge Solenoid. In a normally functioning system, this will relieve the vacuum in the Fuel Tank by drawing in air from the atmosphere from the Intake Manifold. When the switch opens, a pass flag is set and the PCM will power down. If the ESIM switch does not open, after a calibrated time, an error is detected and a switch stuck closed failure event is set. Two consecutive failed events will mature a fault.

SMALL LEAK MONITOR: This is an accumulative monitor and the data from each valid event is recorded and added to the previously recorded events. The PCM timer records the engine on/drive cycle and engine off time for each small leak monitor event. For an event to be valid the PCM must see;
1. An engine on/drive cycle for a minimum of 2 minutes.

**NOTE:** The Engine on timer is clipped to a maximum of 26 minutes on any given trip.

2. And, when the engine is shut down, an engine off timer starts. There is a 12 minute delay time in which the PCM will ignore ESIM Switch input. The engine off timer period will continue to count until one of the three conditions exist:
   - The engine is started without a switch closure during the event.
   - An ESIM Switch closed input is received after the 12 minute delay during the event.
   - After a maximum of 1051 minutes without an ESIM Switch closure during the event.

**NOTE:** At the next key on cycle a determination is made as to whether the event was valid and the information is kept.

- An ESIM Switch closed input is received after the 12 minute delay during the event.

**NOTE:** If the switch closed input is received, the PCM records that the switch has closed and stores the engine shut down time.

- If vacuum is created and the switch has closed, the PCM stops purge and monitors the switch closure time. If the switch opens before a calibrated time, a large leak is present. Two consecutive failure events will mature a fault (P0455).
- If vacuum is created and the switch has closed, the PCM stops purge and monitors the switch closure time. If the switch stays closed longer than a maximum calibrated time before opening, it is determined that a large leak is not present and the Small Leak Monitor will continue to run until the accumulative monitor increments. If no ESIM Switch closures were recorded during the entire accumulated timers, it is determined that a small leak is present (P0456).

**PURGE FLOW MONITOR:** The operation of the Purge Solenoid and evaporative purge flow is monitored using inputs from the Fuel Tank Pressure Sensor. The Purge Flow Monitor will only run if the previous engine of Small Leak event was a pass. Because the leak detection diagnostics can only verify that the fuel tank system is sealed while the purge valve is closed, it cannot determine if the purge line between the solenoid and Intake Manifold is pinched or leaking. The Purge Flow Monitor is needed to verify these failure modes. The Purge Flow Monitor works on the premise that as flow through the system increases, so does the pressure drop in the system. The PCM monitors the Fuel Tank Pressure Sensor and looks for increasing vacuum in the Fuel Tank with increasing purge flow. Conversely, it looks for decreasing vacuum in the Fuel Tank with decreasing flow.

- The non-intrusive purge monitor runs during normal operation once the enable conditions are met and looks for a calibrated increase in vacuum in the fuel tank with increased purge flow, referred to as phase 1. If phase 1 passes, the purge monitor looks for a calibrated decrease in vacuum in the Fuel Tank with decreasing purge flow, referred to as phase 2. If phase 2 passes, the purge monitor is complete. If the purge flow monitor fails either phase, or does not complete both phases within a specified time, an intrusive test is initiated to verify the results from the non-intrusive test.
- The intrusive diagnostic uses the same two phases to analyze the system. However, the intrusive test actuates the Purge Solenoid in a further controlled manner allowing a more accurate test result. If the PCM detects a failure during the intrusive test, a purge system performance fault is set (P0441).

**When Monitored and Set Conditions**

- **When Monitored:** This diagnostic runs continuously when the following conditions are met:
  - After the ignition is off for a calibrated time.
  - Fuel level less than 88%.
  - Ambient temperature between 4°C and 43°C (39°F and 109°F).
  - Elevation is below 8000 feet.

- **Set Conditions:** If no ESIM Switch closures were recorded during an entire accumulative increment, it is determined that a small leak is present.

**Default Actions:**

- The MIL light will illuminate.
Always perform the PRE-DIAGNOSTIC TROUBLESHOOTING PROCEDURE before proceeding. See: Computers and Control Systems > Initial Inspection and Diagnostic Overview > PCM Pre-Diagnostic Troubleshooting Procedure.

Diagnostic Test

1. CHECK FOR AN ACTIVE CONDITION

NOTE: Before proceeding with this test procedure, perform any Service Bulletins or PCM Flash updates that relate to this fault code.

WARNING: Keep lit cigarettes, sparks, flames, and other ignition sources away from the test area to prevent the ignition of explosive gases. Keep the test area well ventilated. Failure to do so may result in possible serious or fatal injury.

1. To continue testing you will need the (8404C).

NOTE: The fuel tank should have less than 95% of fuel tank capacity to properly test the Evap system.

2. Connect the red power lead of the EELD to the battery positive terminal and the black ground lead to battery negative terminal.
3. Connect shop air to the EELD.
4. Set the smoke/air control switch to AIR.
5. Insert the tester’s AIR supply tip (clear hose) into the appropriate calibration orifice on the tester’s control panel (based on DTC leak size).
6. Press the remote smoke/air start button.
7. Position the red flag on the air flow meter so it is aligned with the indicator ball.
8. When the calibration is complete, release the remote button. The EELD flow meter is now calibrated in liters per minute to the size leak indicated by the DTC set in the PCM.
9. Connect the service adapter (8404-ADP) to the ESIM.

NOTE: If not connecting the EELD to the ESIM, the vent must be capped or plugged. The pressure developed by the EELD will overcome the weights in the ESIM, causing the vent seal to open allowing the system to vent. This could lead to a false failure condition.

10. Connect the AIR supply hose from the EELD to the adapter.
11. Press the remote button to activate AIR flow.

NOTE: Depending on the vehicles fuel level, or vehicle venting configuration, it can take up to five minutes to fill the system.

12. Compare the flow meter indicator ball reading to the red flag.
13. ABOVE the red flag indicates a leak present.
14. BELOW the red flag indicates a sealed system.

Did the Small Leak test pass or fail?

Passed
- Go To 2

Failed
- Go To 3

2. EVAP SYSTEM INSPECTION

NOTE: Temperature changes during testing can yield poor results. For best results, allow the vehicle to achieve ambient temperature and retest for leaks.

NOTE: It is possible that the Fuel Filler Cap (if applicable) or Capless Fuel Filler Assembly was previously leaking.
1. Perform a visual inspection of the entire Evaporative Emission System for any of the following conditions but not limited to:
   - Damaged seal points on the Fuel Filler Cap (if applicable) or Capless Fuel Filler Assembly
   - Small holes or cracks
   - Loose seal points
   - Damaged components
   - Incorrect routing of hoses and tubes

Were any problems found?

Yes

- Repair as necessary.
- Perform the POWERTRAIN VERIFICATION TEST. See: A L L Diagnostic Trouble Codes (DTC) > Verification Tests > Powertrain Verification Test.

No

- Replace the ESIM.

NOTE: During testing an internal ESIM seal leak will be hidden with the EELD connected to the ESIM.

- Perform the POWERTRAIN VERIFICATION TEST. See: A L L Diagnostic Trouble Codes (DTC) > Verification Tests > Powertrain Verification Test.

3. EVAPORATIVE EMISSION LEAK DETECTION

NOTE: A thorough visual inspection of the Evap system hoses, tubes, and connections may save time in your diagnosis. Look for any physical damage or signs of wetness at connections. The strong smell of fuel vapors may aid diagnosis also.

1. Remove the Air supply hose from the adapter.
2. Connect the SMOKE supply tip (black hose) to the adapter.
3. Set the smoke/air control switch to SMOKE.

NOTE: The flow meter indicator ball will not move in the smoke mode.

4. Press the remote smoke/air start button.

NOTE: Make sure that smoke has filled the Evap System by continuing to press the remote smoke/air start button, remove the vehicle fuel cap (if applicable) or open the flap (capless), and wait for the smoke to exit. Once smoke is indicated reinstall the fuel cap or close the flap.

NOTE: For optimal performance, introduce smoke into the system for an additional 60 seconds; continue introducing smoke at 15 second intervals, as necessary.

5. While still holding the remote smoke/air start button, use the white light (8404-CLL) to follow the Evap system path, and look for the source of the leak indicated by exiting smoke.
6. If a leak is concealed from view (i.e., top of fuel tank), release the remote smoke/air start button, and use the ultraviolet (UV) black light (8404-UVL) and the yellow goggles (8404-20) to look for residual traces of dye that is left behind by the smoke.
7. The exiting smoke deposits a residual fluid that is either bright green, yellow or purple in color when viewed with a UV light.

NOTE: Carefully inspect the vent side of the Evap Canister. Due to the filtering system in the canister the smoke may not be as thick. Introducing smoke into the filtered side of the canister may assist in locating the leak.

Select the appropriate response from the list below:

A leak was found at the Fuel Cap (if applicable) or Fuel Filler Tube Assembly

- Perform the appropriate repair by replacing the Fuel Filler Tube Assembly and/or the Fuel Cap (if applicable).
- Perform the POWERTRAIN VERIFICATION TEST. See: A L L Diagnostic Trouble Codes (DTC) > Verification Tests > Powertrain Verification Test.

A leak was found in the Evap System.

- If the leak is at a hose connection, remove the hose then reconnect the hose and check for a leak again. All other leaks, repair as
necessary.
- Perform the POWERTRAIN VERIFICATION TEST. See: A L L Diagnostic Trouble Codes (DTC) > Verification Tests > Powertrain Verification Test.

No leaks were detected
- Go To 4

4. PURGE SOLENOID
1. Disconnect the vacuum hose that connects to the Intake Manifold at the Purge Solenoid.

NOTE: After disconnecting the Purge Solenoid vacuum connection, inspect the line and solenoid for signs of contamination.

2. Check for smoke coming through the Purge Solenoid.

NOTE: The solenoid should be sealed with the ignition off.

Smoke is leaking passed the Purge Solenoid?

Yes
- Replace the Purge Solenoid.
- Perform the POWERTRAIN VERIFICATION TEST. See: A L L Diagnostic Trouble Codes (DTC) > Verification Tests > Powertrain Verification Test.

No
- If the system failed the small leak test in step one, a leak is present but was not found during testing. Perform system leak test found in step three over again. While performing test verify all system connection and seal points. Inspect system lines for small cracks that may open with line movement.

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