Circuit/System Description

Fuel is drawn by the fuel injection pump from the tank to the engine through the fuel supply lines. Fuel flows to the fuel filter/heater element housing, which combines a water separator, a prime pump, fuel heater element and a filter element. A mechanical fuel injection pump at the front of the engine valley includes the fuel supply pump and the high-pressure pump. The small section of the fuel pump assembly is the supply pump, which creates a vacuum to pull fuel from the fuel tank to the high-pressure pump. The vacuum varies with engine load and speed as indicated by the table below. The pump is engine-driven by the camshaft gear. From the high-pressure pump, the pressurized fuel flows to the left fuel rail. A balance pipe from the center of the left rail then feeds the right fuel rail. Each fuel rail supplies one bank of 4 fuel injectors. The fuel rail pressure sensor is mounted in the end of the right fuel rail. Fuel is used to cool and lubricate the fuel injectors and fuel injection pump. The fuel return system is designed to return this fuel to the fuel tank. If the high side fuel pressure becomes excessive, the fuel rail pressure relief valve releases the fuel into the fuel return system. The return fuel travels through the fuel cooler and then to the fuel tank.

<table>
<thead>
<tr>
<th>Engine Speed/Load</th>
<th>Vacuum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cranking</td>
<td>1.5 in Hg</td>
</tr>
<tr>
<td>Idle Speed</td>
<td>1.3 in Hg</td>
</tr>
<tr>
<td>Hard Accelerations</td>
<td>6-10 in Hg</td>
</tr>
<tr>
<td>3000 RPM - No Load</td>
<td>3-5 in Hg</td>
</tr>
<tr>
<td>2750-3000 RPM - Full Load</td>
<td>10-12 in Hg</td>
</tr>
</tbody>
</table>

Diagnostic Aids

An Engine Cranks but Will Not Run or Hard Start symptom may exist if air is being drawn into the fuel injection system due to the following conditions:
* Deformed or cut O-rings at the fuel supply line connections
* Improperly seated fuel supply line fittings
* Porous or weathered rubber fuel supply lines
* Fuel filter vent screw not tighten or cross threaded
* Fuel filter not tighten properly

Reference Information

Special Tools

* J-23738-A MityVac
* EN-47969 Fuel Supply Diagnostic Hose
* CH-48027 Digital Pressure Gauge
* J 44581 Fuel Line Disconnect Tool

Circuit/System Verification

Observe the Actual Fuel Rail Pressure parameter with a scan tool. During engine cranking, the pressure should be at least 10 MPa. With the engine running at idle the pressure should be close to the Desired Fuel Rail Pressure. As the engine speed increase, the
Desired Fuel Rail Pressure and the Actual Fuel Rail Pressure should be within 2 MPa of each other.

**Circuit/System Testing**

**Note:** Ensure that a sufficient amount of fuel is in the fuel tank to run the vehicle.

1. Install the CH-48027 to the fuel system service port on the right front side of the engine.
2. Prime the fuel system until 10 psi is indicated on the CH-48027. Fuel pressure should not drop below 2 psi in less than one minute.
   - If fuel pressure drops below 2 psi in less than one minute, go to step 4.

**Note:** It may be necessary to remove engine components for the visual inspections.

3. Attempt to start and idle the engine. Observe the CH-48027 during idle. The vacuum should be between 1-3 in Hg.
   - If more than 3 in Hg is observed at idle, visually inspect the following items:
     * Fuel filter element for a restriction
     * Hoses and lines that are flattening when the engine is running, or have kinks that would restrict the flow of fuel
   - If engine did not start and no vacuum was observed, refer to Fuel Injection Pump Replacement (See: Fuel Delivery and Air Induction/Fuel Pump/Service and Repair).

4. Disconnect the fuel supply line at the engine and install a J-23738-A using the J 44581 to the engine side of the fuel supply line.
5. Apply vacuum to the fuel supply pipe until 25 in Hg has been reached. Wait for at least one minute to allow the fuel system to stabilize. Vacuum should not drop below 8 in Hg within 10 minutes.
   - If vacuum cannot be obtained or the vacuum drops below 8 in Hg within 10 minutes, repair the air leak at fuel filter/heater element housing connections or at the fuel hoses/pipes on the engine supply line.

6. Remove both hoses from the fuel filter/heater element housing assembly. Cap the suction side port of the fuel filter/heater element housing assembly. Apply 25 in Hg to the discharge port of the fuel filter/heater element housing assembly. Vacuum should not drop below 8 in Hg within 10 minutes.
   - If vacuum drops below 8 in Hg within 10 minutes, replace the fuel filter/heater element housing assembly.
   **Note:** The engine may start and then stall after briefly running.

7. Remove the J-23738-A from the fuel filter/heater element housing assembly. Install the removed fuel filter/heater element housing assembly, and cap off the fuel supply pipe on the engine. Crank the engine in 15-second intervals while observing the CH-48027. More than 5 in Hg vacuum should be observed during cranking.
   - If less than 5 in Hg was observed on the vacuum gauge during cranking, replace
the fuel injection pump.

**Note:** The engine may start, and then stall after briefly running.

8. Install the fuel supply line at the engine, and disconnect the chassis fuel supply line at the fuel tank. Install a J-23738-A to the supply hose at the fuel tank using the J 44581.

9. Apply vacuum to the supply hose at the fuel tank until 25 in Hg has been reached. Wait for at least one minute for the fuel system to stabilize. Vacuum should not drop below 8 in Hg within 10 minutes.

   ○ If vacuum cannot be obtained, or the vacuum drops below 8 in Hg within 10 minutes, repair the air leak in the fuel supply line between the engine and fuel tank, or the connection of the supply line to the engine.

10. Install all components and lines that were previously removed or disconnected.

11. Install the EN-47969 on the fuel supply line at the engine. Create a vertical loop in the hose to observe the incoming fuel for air bubbles.

12. Open the bleed screw on top of the fuel filter/heater element housing. Prime the system until fuel appears at the bleed screw. Continue to prime the fuel system until the engine starts and runs.

13. Run the engine for at least 10 minutes to allow the fuel system to stabilize, and purge any air from the system.

   **Note:** Changes in engine speed can cause an increase of air bubbles that enter the EN-47969. An air pocket at the top of the EN-47969 loop is considered a normal condition.

14. At a stabilized idle, observe the fuel entering the EN-47969 for air bubbles.

   ○ If air bubbles were observed entering the transparent hose, test the fuel sender for leaks. Refer to Fuel Sender Assembly Replacement (See: Fuel Delivery and Air Induction/Fuel Tank/Fuel Gauge Sender/Service and Repair).

15. Install the fuel sender, fuel tank, and all fuel system connections and components that were previously disconnected. Leave the EN-47969 connected to the fuel supply line. Prime the fuel system 30 times to remove the air from the fuel hoses. Continue to prime the fuel system until the engine starts and runs. Observe the fuel entering the transparent hose.

   ○ If air bubbles are still present, refer to Diagnostic Aids.

   ○ If no air bubbles are present, remove the EN-47969 and run the engine to ensure no fuel leaks exist.