Circuit/System Description

High Pressure System

The fuel injection pump at the front of the engine valley includes a fuel supply pump and a high-pressure pump. Fuel is drawn by the fuel supply pump from the primary fuel tank and delivered to the high-pressure pump. The pump is engine-driven by the camshaft gear. High pressure fuel is regulated by the fuel pressure regulator mounted on the fuel injection pump. From the high-pressure pump, the fuel moves to the left and right fuel rails through high pressure metal lines. Each fuel rail distributes high pressure fuel to one bank of 4 fuel injectors. The fuel pressure relief valve is located on the left rail, and relieves excessive fuel pressure which returns to the fuel tank.

Return System

The fuel return system routes fuel from the fuel injectors, the pressure relief valve, and the fuel injection pump. The return fuel travels to the fuel cooler and then to the fuel tank. This fuel is used to cool and lubricate the injection pump and the injectors.

Diagnostic Aids

* The fuel return volumes vary based on the American Petroleum Institute (API) rating of the diesel fuel.
* A fuel injector may have high fuel return flow only at higher engine temperatures.

Reference Information

Special Tools

* J 45873  Fuel Return Volume Test Kit
* J-45873-30  Injector Flow Test Adapter

Circuit/System Verification

With the engine running at idle the Actual Fuel Pressure should be close to the Desired Fuel Rail Pressure. During engine cranking the Actual Fuel Pressure should be at least 10 MPa. Inspect the fuel return hoses and lines for external leaks or damage.

Circuit/System Testing

Important: If you were not referred to this test from another diagnostic, do not perform this procedure. Only perform this test when the fuel is more than 18°C (65°F).

Important: Before replacing the fuel pressure relief valve, ensure that the break-away torque is within specifications. Refer to Fastener Tightening Specifications (See: Specifications).

1. Remove the fuel pressure relief valve return hose and plug the hose to prevent fuel leakage.
2. Install a section of rubber fuel hose on the fuel pressure relief valve connection and place loose end of hose into a clean fuel container.

Important: Fuel that is contaminated with gasoline may cause permanent damage to the fuel pressure relief valve. Refer to Contaminants-in-Fuel Diagnosis (See: Computers and Control Systems/Testing and
Inspection/Component Tests and General Diagnostics/Contaminants-in-Fuel Diagnosis).

* If the engine cranks but does not start, crank engine for 15 seconds. Observe for fuel leaking from fuel pressure relief valve.
  ○ If fuel leaks from the fuel pressure relief valve, replace the pressure relief valve. Refer to Fuel Pressure Relief Valve Replacement (See: Fuel Filter/Fuel Pressure Release/Service and Repair).

* If the engine starts and runs, idle the engine while commanding the fuel rail pressure to 180 MPa with a scan tool. Observe for fuel leaking from fuel pressure relief valve.
  ○ If fuel leaks from the fuel pressure relief valve, replace the pressure relief valve. Refer to Fuel Pressure Relief Valve Replacement (See: Fuel Filter/Fuel Pressure Release/Service and Repair).

Important: Always replace the fuel return hose retaining clips on the fuel injectors with new clips after removing.

4. Connect the yellow hoses from the J 45873 to the J-45873-30.
5. Connect the J-45873-30 with yellow hoses to each fuel injector return port of the right cylinder bank, and install the retaining clips.
6. Install the 4 yellow hoses in the J 45873 graduated cylinders in numerical order.
7. Connect the fuel return hoses to the J-45873-30 to prevent leakage.
  ○ If the engine starts and runs, idle the engine until fuel start dripping into all the graduated cylinders and yellow hoses are full of fuel.

Important: The engine cranking speed must be more than 150 RPM during the cranking portion of this test.
  ○ If the engine does not start, crank the engine in 15-second intervals, with 1 minute cooling time between intervals, until fuel starts to flow into all of the graduated cylinders.

8. Elevate the 4 yellow hoses to retain the fuel in the hoses, and empty the 4 graduated cylinders into a suitable container.
9. Install the 4 yellow hoses in the J 45873 graduated cylinders in numerical order.
  ○ If the engine starts and runs, idle the engine for 15 seconds.
  ○ If the engine does not start, crank the engine for 15 seconds.

Important: During replacement of the injectors, inspect the inlet and outlet fittings for corrosion or contamination. Refer to Contaminants-in-Fuel Diagnosis (See: Computers and Control Systems/Testing and Inspection/Component Tests and General Diagnostics/Contaminants-in-Fuel Diagnosis).

10. Measure the quantity of fuel in each of the graduated cylinders. Refer to Fuel
System Specifications (See: Fuel Delivery and Air Induction/Specifications) for the desired quantities.

- If high return flows were recorded, replace those fuel injectors that had high return flow and retest the fuel return flow, referring to Fuel System Specifications (See: Fuel Delivery and Air Induction/Specifications). Replace any additional high return flow injectors and proceed to the next number step.

11. Install and connect all fuel system components that were previously removed or disconnected.

12. Remove the fuel return pipes from the fuel injectors of the left cylinder bank and repeat the fuel return flow test previously performed on the right cylinder bank.

- If high return flows were recorded, replace those fuel injectors that had high return flow and retest the fuel return flow, referring to Fuel System Specifications (See: Fuel Delivery and Air Induction/Specifications). Replace any additional high return flow injectors and proceed to the next number step.

13. Install and connect all fuel system components that were previously removed or disconnected.

14. Start and idle the engine. You may have to prime the fuel system before the engine will start. Command the fuel pressure control to 180 MPa with a scan tool. The actual fuel pressure should be the same as the commanded pressure.

- If the engine does not start or the fuel pressure is less than 145 MPa when commanded, replace the fuel injection pump.

15. Command the fuel pressure control to 180 MPa with a scan tool. The fuel pressure should be able to reach 145 MPa when commanded.

- If the fuel pressure is less than the specified value, refer to Fuel System Diagnosis (See: Computers and Control Systems/Testing and Inspection/Component Tests and General Diagnostics/Fuel System Diagnosis).

16. Operate the vehicle in order to verify the repairs.