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GROUP: Vehicle Performance

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SUBJECT:

Cummins Diesel Diagnostics

OVERVIEW:

This bulletin provides diagnostic procedures for the fuel injection system.

MODELS:

2003 - 2007 (DR/DH/D1/DC) Ram Truck (2500 / 3500)

NOTE: This bulletin applies to vehicles equipped with a 5.9L Cummins 24-valve diesel engine (sales code ETH or ETC).

SYMPTOM/CONDITION:

Revised diagnostic procedures are available for the following Symptom/Conditions:

- White smoke and/or misfire after starting when the engine temperature is below 66° C (150° F).
- Engine surges at idle
- Engine sounds
- Engine cranks for a long time or will not start.

SPECIAL TOOLS / EQUIPMENT REQUIRED:

CH6000A	Scan Tool (DRBIII®)
CH7000A	J1962 Cable with red DRBIII® connector
CH9401	StarSCAN® Tool
CH9404	StarSCAN® Vehicle Cable
9007	Adapter, Compression Test
9011	Adapter, Fuel Pressure Test
9012	Fitting, Fuel System Test
9013	Adapter, Fuel Pressure Test



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9014	Adapter, Fuel Pressure Test
9022	Adapter, Turbo Test

DIAGNOSIS:

CAUTION: Do NOT disconnect the Electronic Fuel Control (EFC) actuator or the Fuel Rail Pressure Sensor while the engine is running. Damage to the rail pressure relief valve may occur.

PRE-DIAGNOSTIC TROUBLESHOOTING PROCEDURE:

1. Check TechCONNECT for any Service Bulletins related to the customer concern.
2. Verify that the ECM software is at the latest level.
3. Perform the existing "Pre-diagnostic Troubleshooting Procedures" available in TechCONNECT under: Service Info tab > 9 - Engine > Diagnosis & Testing.
4. For the engine circuit diagram, refer to the detailed service information available in TechCONNECT under: Service Info tab > 9 - Engine > Schematics and Diagrams.
5. For a complete wiring diagram, refer to the detailed wiring diagrams available in TechCONNECT under: Service Info tab > Wiring > 14 - Fuel System > Fuel Injection > (component).

NOTE: Refer to the appropriate section below (A, B, C, or D) to diagnose the customer specific symptom / condition.

SECTION A - WHITE SMOKE AND/OR MISFIRE AFTER COLD START:

Possible Causes
Air in fuel supply
Coolant leaking into combustion chamber
Active Diagnostic Trouble Codes (DTC's)
In very cold ambient temperatures, engine block heater is malfunctioning (if equipped)
Engine Coolant Temperature sensor malfunctioning
Engine Control Module (ECM) incorrect calibration
Fuel filter restricted
Fuel grade not correct or fuel quality is poor
Fuel heater element or fuel heater temperature sensor malfunctioning
Fuel Injector malfunctioning
Fuel injector hold-downs loose
Fuel injector protrusion not correct
High pressure fuel pump malfunctioning
Intake/Exhaust valve adjustment not correct (too tight)
Intake manifold air temperature sensor malfunctioning
Intake manifold heater circuit not functioning correctly in cold weather
Internal engine damage
Restricted fuel supply side of fuel system

Perform the Pre-Diagnostic Troubleshooting Procedure before proceeding.

1. Preliminary checks:

- a. Repair active DTC's before proceeding.
- b. Ensure the customer's concern is not related to situations which may increase normal white smoke; idle time, engine temperature, fuel source, cold ambient temperature, high altitude.

2. DTC / Product Improvement: Check for any service bulletins related to the customer's concern or Diagnostic Trouble Codes (DTC's) present. Follow appropriate guidelines in the diagnostic procedures outlined in TechCONNECT. **Is the vehicle repaired?**

- a. Yes >> Go to Step #14.
- b. No >> Go to Step #3.

3. Temperature sensors: Using the appropriate scan tool, **before starting engine** after an overnight soak, verify that the Intake Air Temperature (IAT), Engine Coolant Temperature (ECT), Inlet Air Temperature, and the Battery Temperature sensors are showing similar and appropriate temperatures. **Are the sensors showing similar and appropriate temperatures?**

- a. Yes >> Go to [Step #4](#).
- b. No >> Repair the appropriate sensor or circuit as necessary. Refer to the diagnostic procedures available in TechCONNECT under: Service Info tab > 9 - Engine > Diagnosis & Testing. >> Go to [Step #14](#).

4. Pressure sensors: Using the appropriate scan tool, **before starting engine** after an overnight soak, verify that the Intake Manifold Pressure and Inlet Air Pressure sensors are showing similar and appropriate pressure. **Are the sensors showing similar and appropriate pressures?**

- a. Yes >> Go to [Step #5](#).
- b. No >> Repair the appropriate sensor or circuit as necessary. Refer to the diagnostic procedures available in TechCONNECT under: Service Info tab > 9 - Engine > Diagnosis & Testing. >> Go to [Step #14](#).

NOTE: The Inlet and Baro sensors will read in Inches of Mercury (Hg) while the Intake and Boost sensors will read Pounds per Square Inch (PSI). The values displayed on the scan tool will not be the same, 2 in. Hg = 1 PSI.

5. Fuel Rail Pressure sensor: Using the appropriate scan tool, **before starting engine** after an overnight soak, verify that the fuel rail pressure reads 0 (+/- 500 PSI). **Does the fuel rail pressure read 0 (+/- 500 PSI)?**

- a. Yes >> Go to [Step #6](#).
- b. No >> Repair the fuel rail pressure sensor or circuit as necessary. Refer to the diagnostic procedures available in TechCONNECT under: Service Info tab > 9 - Engine > Diagnosis & Testing. >> Go to [Step #14](#).

6. Intake Air Heater: Verify the intake air heater is operating properly. Refer to the detailed service information available in TechCONNECT under: Service Info tab > 14 - Fuel System > Fuel Injection > Intake Air Heater > Operation. **Is the intake air heater operating properly?**

- a. Yes >> Go to [Step #7](#).
- b. No >> Repair the intake air heater or intake air heater circuit as necessary. Refer to the diagnostic procedures available in TechCONNECT under: Service Info tab > 9 - Engine > Diagnosis & Testing. >> Go to [Step #14](#).

7. **Start the engine:** Start the engine following normal starting procedures and allow the engine to run at idle. Determine when the white smoke disappears. If the white smoke disappears within one minute, it is normal. If the engine is operated in cold ambient conditions and/or at altitude, white smoke at start-up is expected.
8. **Test for injector misfire:** Using the appropriate scan tool, perform a “Cylinder Kill” test. Cancel each cylinder one-at-a-time. Note any change in smoke and/or misfire.
Does a single cylinder show a difference in smoke or misfire?
 - a. Yes >> Go to [Step #9](#).
 - b. No >> Go to [Step #10](#).
9. **Diagnose single cylinder white smoke/misfire:**
 - a. Remove the valve cover.
 - b. Inspect the valve lash.
 - c. Remove the injector.
 - d. Inspect the injector seal washer and High Pressure Connector (HPC). Replace the HPC if it is damaged.
 - e. Install Miller Special Tool 9007 (Compression Test Adapter) and perform a cylinder compression test. Cylinder pressure should be 350 PSI minimum.
 - f. Install the injector. Refer to the detailed service information available in TechCONNECT under: Service Info tab > 14 - Fuel System > Fuel Injection > Fuel Injector > Installation.
 - g. Repeat test for injector misfire. >> Go to [Step #8](#).

NOTE: If the same single cylinder is still the cause of the miss or white smoke, replace that single injector and HPC.

NOTE: Perform the following test if a single cylinder was not identified by the cylinder cutout test to be causing the white smoke.

10. **Test for injector leaking fuel into the cylinder:** Using Miller Special Tool, 9011, block the high pressure fuel line at the rail, one injector at a time. **Is a single injector the cause of the white smoke and/or miss?**
 - a. Yes >> Replace that injector and HPC. - Go to [Step #14](#).
 - b. No >> Go to [Step #11](#).
11. **Test for high injector return flow:** Perform the “Injector Return Flow Test”. Refer to the detailed diagnostic information available in TechCONNECT under: Service Info tab > 9 - Engine > Diagnosis & Testing. **Do the injectors pass the “Injector Return Flow Test”?**
 - a. Yes >> Go to [Step #13](#).
 - b. No >> Go to [Step #12](#).

NOTE: Maximum leakage allowable for all injectors combined is 160 mL (5.4 fl. oz.): taken when engine coolant temperature is greater than 82°C (180°F), engine speed is equal to 1,200 RPM's, and fuel rail pressure is equal to 1400 bar (20,305 psi.).

NOTE: It is critical that all HPC nuts are tightened to the correct torque. Refer to the detailed tightening information available in TechCONNECT under: Service Info tab > 14 - Fuel System > Fuel Injection > Fuel Injector > Installation. Retest when all HPC nuts are properly torqued.

NOTE: Any injector contributing more than 40 mL (1.4 fl. oz.) is excessive (Example: If total injector leakage is 200mL (6.7 fl. oz.) and blocking cylinder #1 reduces the leakage to 160 mL (5.4 fl. oz.), cylinder #1 has excessive leakage).

NOTE: Test should be repeated to confirm measurements.

12. If the injector return from any cylinder(s) is deemed excessive:

- a. Check HPC tip for damage, replace HPC if damaged. Refer to the detailed service information available in TechCONNECT under: Service Info tab > 14 - Fuel System > Fuel Injection > Fuel Injector > Removal/Installation. >> Go to [Step #14](#).
- b. If HPC tip is undamaged, replace the injector and HPC. Refer to the detailed service information available in TechCONNECT under: Service Info tab > 14 - Fuel System > Fuel Injection > Fuel Injector > Removal/Installation. >> **Verify that a quality fuel filter is used.** >> Go to [Step #14](#).

13. If the engine passes the previous tests and still exhibits white smoke that clears with a warm engine, check the following:

- a. **Idle Time:** More than 20% is excessive.
- b. **Engine Temperature:** Verify that the thermostat allows the engine to reach operating temperature.
- c. **Fuel Source (Cetane):** Check with fuel supplier or try another source.
- d. **Fuel Quality (lubricants/detergents):** May benefit by using a fuel detergent with a lubricity additive.
- e. **Winter Fuels :** No. 2 diesel not blended for winter conditions.
- f. **Cold Ambient:** Use block heater where appropriate, limit warm-up time in winter.
- g. **High Altitude:** Effect will be worse with altitude and cold ambient temperatures.
- h. **Refer to Service Information:** Refer to the detailed diagnostic information available in TechCONNECT under: Service Info tab > 9 - Engine > Diagnosis & Testing > Smoke Diagnosis Charts > Excessive White Smoke. >> Go to [Step #14](#).

14. Repair Complete: Perform Powertrain Verification Test VER - 1 (Diesel). Refer to the detailed service information available in TechCONNECT under: Service Info tab > 8 - Electrical/Electronic Control Modules/Engine Control Module > Diagnosis And Testing.

SECTION B - ENGINE SURGES AT IDLE:

Possible Causes
Fuel Supply (Low Pressure) System Fuel Injection (High Pressure) System Fuel Return Air Intake System Other Vehicle Systems Base Engine

Perform the Pre-Diagnostic Troubleshooting procedure before proceeding.

- 1. **DTC / Product Improvement:** Check for any service bulletins related to the customer's concern or Diagnostic Trouble Codes (DTC's) present. Follow appropriate guidelines in the diagnostic procedures outlined in TechCONNECT. **Is the vehicle repaired?**
 - a. Yes >> Go to [Step #15](#).
 - b. No >> Go to [Step #2](#).

2. **Verify complaint:** Verify proper fuel quality, grade, and level in the fuel tank. Operate the engine at idle speed. Using the appropriate scan tool, log the fuel pressure set point and actual fuel pressure. A good system will have actual fuel pressure that is +/- 500 PSI from the set pressure. (Example: If the fuel pressure set point at idle is 6500 PSI, the actual fuel pressure on a good system is expected to be between 6000 - 7000 PSI). If fuel pressure variation is excessive, an audible surge will be present. If the variation is severe, a slight engine speed variation may also be noticed. **Does the actual fuel rail pressure fluctuate more than +/- 500 PSI?**
 - a. Yes >> Go to [Step #3](#).
 - b. No >> Go to [Step #8](#).

NOTE: A loud “knock” and black smoke that exists with an actual fuel pressure drop may be an injector issue and should be identified using the single cylinder cut out test.

3. **Verify proper low pressure fuel supply to the injection pump:** Perform the appropriate fuel supply system flow test. **NOTE: This procedure may be slightly different depending on if the vehicle has an engine mounted transfer pump or the in-tank transfer pump.** In a good low pressure fuel system, fuel flow of 560 mL in 10 seconds or better is expected for model years 2003 and early 2004. The fuel volume for the model years late 2004 through 2007 is 590mL in 10 seconds. Be sure there is no air in the system. **Is the low pressure fuel supply sufficient?**
 - a. Yes >> Go to [Step #4](#).
 - b. No >> Repair the low pressure fuel supply system. Refer to the detailed diagnostic information available in TechCONNECT under: Service Info tab > 9 - Engine > Diagnosis & Testing > Fuel Lift Pump - Diesel. >> Go to [Step #15](#).
4. **Test for high injector return flow:** Refer to the detailed diagnostic information available in TechCONNECT under: Service Info tab > 9 - Engine > Diagnosis and Testing > Injector Return Flow Test. **Do the injectors pass the “Injector Return Flow Test”?**
 - a. Yes >> go to [Step #6](#).
 - b. No >> go to [Step #5](#).
5. **If the injector return from any cylinder(s) is deemed excessive:**
 - a. Check HPC tip for damage, replace HPC if damaged. Refer to the detailed service information available in TechCONNECT under: Service Info tab > 14 - Fuel System > Fuel Injection > Fuel Injector > Removal/Installation. >> Go to [Step #15](#).
 - b. If HPC tip is undamaged, replace the injector and HPC. Refer to the detailed service information available in TechCONNECT under: Service Info tab > 14 - Fuel System > Fuel Injection > Fuel Injector > Removal/Installation. >> **Verify that a quality fuel filter is used.** >> Go to [Step #15](#).
6. **Verify high pressure pump output volume:** Remove the high pressure fuel line from the high pressure pump outlet port to the fuel rail. Connect a suitable hose to the high pressure outlet port of the high pressure pump and route it to a graduated container. Disconnect the Electronic Fuel Control Actuator. Crank the engine until fuel exits the hose. **NOTE: With the discharge line routed to atmosphere, fuel will discharge at 0 PSI.** Crank the engine for three 10 second intervals, pausing to allow the starter to cool between each crank event. High pressure pump output volume must be greater than 70 mL in 30 seconds. **Is the high pressure pump output flow sufficient?**
 - a. Yes >> go to [Step #7](#).
 - b. No >> Replace the high pressure pump. Refer to the detailed service information available in TechCONNECT under: Service Info tab > 14 - Fuel System > Fuel Injection > Fuel Injection Pump. >> Go to [Step #15](#).

7. **Electronic Fuel Control Actuator (FCA):** Replace the Electronic Fuel Control Actuator. Refer to the detailed service information available in TechCONNECT under: Service Info tab > 14 - Fuel System > Fuel Injection > Fuel Injection Pump. >> Go to [Step #15](#).
8. **Verify High Pressure System Is Functioning Normally:** Using the appropriate scan tool watch the fuel rail pressure set point. **Does the fuel rail pressure set point fluctuate at idle?**
 - a. Yes >> Check the vehicle for signs of parasitic load causing the ECM to adjust fuel pressure set point.
 - b. No >> Go to [Step #9](#).
9. **Idle speed fluctuation:** Using the appropriate scan tool watch idle speed. Compare the idle speed shown on the scan tool to the reading on the tachometer. **Does the idle speed on the scan tool fluctuate more than 20 RPM while the engine is at idle?**
 - a. Yes >> Go to [Step #10](#).
 - b. No >> Investigate fuel quality. Look for evidence of fuel contamination. Investigate for aftermarket performance devices.
10. **Verify proper low pressure fuel supply to the high pressure pump:** Perform the appropriate fuel supply system flow test. **NOTE: This procedure can be slightly different depending on if the vehicle has an engine-mounted transfer pump or the in-tank transfer pump.** In a good low pressure fuel system, fuel flow of 560 mL in 10 seconds or better is expected for model year 2003 and early 2004 vehicles. In a good low pressure fuel system, fuel flow of 590 mL in 10 seconds or better is expected for late model year 2004 through 2007 vehicles. Be sure there is no air in the system. **Is the low pressure fuel supply volume sufficient?**
 - a. Yes >> Go to [Step #11](#).
 - b. No >> Repair the low pressure fuel supply system as necessary. **Vehicles equipped with an in tank fuel pump:** Refer to the detailed diagnostic information available in TechCONNECT under: Service Info tab > 9 - Engine > Diagnosis & Testing > In-Tank Fuel Lift Pump Flow/Diagnostic Test Procedure . **Vehicles equipped with an engine mounted fuel transfer pump:** Refer to the detailed diagnostic information available in TechCONNECT under: Service Info tab > Diagnostics tab, Powertrain Gas, Driveability Diesel, Fuel Lift Pump Flow And Inlet Restriction Test >> Go to [Step #15](#).
11. **Fuel Return:** Check for kinked or restricted fuel return lines. Check the fuel tank venting. **Does a fuel return system restrictions exist?**
 - a. Yes >> Repair as necessary. Go to [Step #15](#).
 - b. No >> go to [Step #12](#).
12. **Intake / Exhaust Systems:** Check for inlet restriction, inspect air filter for excessive dirt/debris. Verify air intake tubes and hoses are not kinked or restricted. Check for charge air cooler air system leaks. Perform "INTAKE AIR SYSTEM PRESSURE TEST - DIESEL". Refer to the detailed service information available in TechCONNECT under: Service Info tab > 11 - Exhaust System > Turbocharger System > Turbocharger > Inspection. Inspect Turbocharger for excessive compressor wheel movement and proper waste gate operation. Check for exhaust restriction. Check for kinked or blocked exhaust pipes. Verify proper exhaust brake operation (if equipped). **Were any issues found with the Intake/Exhaust Systems?**
 - a. Yes >> Repair as necessary - Go to [Step #15](#).
 - b. No >> Go to [Step #13](#).
13. **Other Vehicle Systems:** Verify proper operation of the Transmission Clutch. Verify proper operation of the Transmission. Verify proper operation of the Vehicle brakes (check for dragging). Verify proper operation of the Cooling fan operation cycle time. Verify proper operation of the Engine driven accessories. **Were any issues found with the Vehicle System?**

- a. Yes >> Repair as necessary. Go to [Step #15](#).
 - b. No >> Go to [Step #14](#).
14. **Base Engine:** Check for internal engine damage. Valve lash settings, engine compression, cylinder leak down, etc. **Were any issues found with the Base Engine?**
- a. Yes >> Repair as necessary. Go to [Step #15](#).
 - b. No >> Go to [Step #15](#).
15. **Repair Complete:** Perform Powertrain Verification Test VER - 1 (Diesel). Refer to the detailed service information available in TechCONNECT under: Service Info tab > 8 - Electrical/Electronic Control Modules/Engine Control Module > Diagnosis And Testing.

SECTION C - ENGINE NOISE:

Perform the Pre-Diagnostic Troubleshooting Procedure before proceeding.

When standing in front of the vehicle with engine running, several distinct noises may be heard. These noises may vary depending on listener location, 2WD vs. 4WD, engine temperature and miles on the vehicle.

1. **Gear Train Noise Evaluation**
 - a. **Normal:** Gear noises noticeable when standing in front of the engine, may vary from engine to engine.
 - b. **Abnormal:** Gears are visually damaged or have backlash or end clearance out of specification. The cause should be identified and corrected.
2. **Fuel Pump Noise Evaluation**
 - a. **Normal:** Pumping noise may vary - the fuel pump is producing between 5,000 and 20,000 psi depending on operating conditions.
 - b. **Abnormal:** A fuel pump with excessive pressure variation (+/- 500 psi from set point) is abnormal. The cause should be identified and corrected. Refer to Engine Surge or Engine Difficult to Start symptoms.
3. **Injector Noise Evaluation**
 - a. **Normal:** Combustion noise may vary at different operating conditions. Maybe more noticeable on throttle tip-in and vary from engine to engine.
 - b. **Abnormal:** Loud knock with smoke and vibration. Cylinder cut out test or mechanical blocking of injectors (Special Tool #9011) should be used to identify failed injectors.
4. **Valve Train Noise Evaluation**
 - a. **Normal:** Valve settings are correct and no visual damage to parts.
 - b. **Abnormal:** If valve settings are out of specification, they should be reset. Also, correct any damage to rocker levers, push rods, or cross heads.
5. Refer to the detailed diagnostic information available in TechCONNECT under: Service Info tab > 9 - Engine > Diagnosis & Testing > Engine Diagnosis - Mechanical.

SECTION D - ENGINE WILL NOT START / HARD TO START:

Possible Causes
Battery voltage
Starting Accessories
Fuel Supply (Low Pressure) System
Fuel Injection (High Pressure) System
Fuel Return
Air Intake System
Other Vehicle Systems
Base Engine

Perform the Pre-Diagnostic Troubleshooting Procedure before proceeding.

1. **DTC / Product Improvement:** Check for any service bulletins related to the customer's concern or Diagnostic Trouble Codes (DTC's) present. Follow appropriate guidelines in the diagnostic procedures outlined in TechCONNECT. **Is the vehicle repaired?**
 - a. Yes >> Go to [Step #17](#).
 - b. No >> Go to [Step #2](#).
2. **Verify Battery Voltage:** Measure the battery voltage and load capability. **Is the battery voltage sufficient?**
 - a. Yes >> Go to [Step #3](#).
 - b. No >> Repair low battery voltage condition. Go to [Step #17](#).
3. **Verify Starting Accessories:** Verify the ignition switch, vehicle theft system, starter, intake manifold grid heater, and fuel heater are functioning properly. **Are all starting accessories functioning properly?**
 - a. Yes >> Go to [Step #4](#).
 - b. No >> Repair or replace accessories as necessary >> Go to [Step #17](#).
4. **Check the supply fuel in the vehicle:** Verify fuel level in the fuel tank. Also verify fuel quality. Remove, inspect and replace the fuel filter (if necessary). Investigate for evidence of fuel contamination and improper fuel type. Refer to the vehicle owners manual fuel requirements section. **Is the fuel quality within specification?**
 - a. Yes >> Go to [Step #5](#).
 - b. No >> Follow fuel contamination process (drain contaminated fuel, replace damaged components, fill with proper fuel). >> Go to [Step #17](#).
5. **Verify complaint:** Using the appropriate scan tool log the fuel pressure set point and actual fuel pressure. Verify the rail pressure versus set point, this can be done while cranking or with the engine idling. A good system will have actual fuel pressure that is +/- 500 PSI from the set pressure. (Example: If the fuel pressure set point at idle is 6500 PSI, the actual fuel pressure on a good system is expected to be between 6000 - 7000 PSI). **Does the actual fuel rail pressure meet the set fuel pressure +/- 500 PSI?**
 - a. Yes >> Go to [Step #6](#).
 - b. No >> Go to [Step #9](#).
6. **Check the engine oil level:** Check the engine oil level. **Is the engine oil level over filled?**
 - a. Yes >> Go to [Step #7](#).
 - b. No >> Go to [Step #8](#).
7. **Remove the engine valve cover:** Inspect for injectors leaking fuel into the valve train area while cranking the engine. If the engine will start and idle, actuate the Fuel Pressure Override Test on the appropriate scan tool **NOTE: This feature is not available on 2003 MY vehicles.** Use the fuel manifold blocking tool, Miller special tool #9011, to isolate suspected leaking injectors. If the leak is still present with the suspected injector isolated, remove the injector and inspect the O-ring on the body of the injector for cuts or damage. Inspect the injector bore for burrs or other cause for a cut O-ring. Correct the cause of the damaged O-ring and replace the O-ring. Use copper sealing gasket when reinstalling the injector. Refer to the detailed removal and installation procedures available in TechCONNECT under: Service Info tab > 14 - Fuel System > Fuel Injection > Fuel Injector. **Are there any leaking injectors?**
 - a. Yes >> Replace the leaky injector(s). Refer to the detailed removal and installation procedures available in TechCONNECT under: Service Info tab > 14 - Fuel System > Fuel Injection > Fuel Injector. >> Go to [Step #17](#).
 - b. No >> Determine the source of fuel/coolant/other substance in the crankcase causing the system to be over full. Repair as necessary. >> Go to [Step #17](#).

8. **Check the fuel pressure limiting valve:** Perform the “Checking Pressure Limiting Valve On The Fuel Rail For Internal Leaks” test. Perform the existing diagnostic procedure available in TechCONNECT under: Service Info tab > 9 - Engine > Diagnosis and Testing. No leakage is expected while cranking or while at idle speed.
Does the pressure limiting valve leak internally?
 - a. Yes >> Replace the fuel pressure limiting valve. - Refer to the detailed service information available in TechCONNECT under: Service Info tab > 14 - Fuel System > Fuel Delivery > Fuel Pressure Regulator. >> Go to [Step #17](#).
 - b. No >> Go to [Step #9](#).
9. **Test for high injector return flow:** Refer to the detailed diagnostic information available in TechCONNECT under: Service Info tab > 9 - Engine, Diagnosis and Testing > Injector Return Flow Test. **Do the injectors pass the “Injector Return Flow Test”?**
 - a. Yes >> Go to [Step #11](#).
 - b. No >> Go to [Step #10](#).

NOTE: Torque all High Pressure Connector (HPC) nuts to the correct torque and retest. Refer to the detailed service information available in TechCONNECT under: Service Info tab > 14 - Fuel System > Fuel Injection > Fuel Injector.

NOTE: Test should be repeated to confirm measurements.

10. **If the injector return from any cylinder(s) is deemed excessive:**
 - a. Check HPC tip for damage, replace HPC if damaged. Refer to the detailed service information available in TechCONNECT under: Service Info tab > 14 - Fuel System > Fuel Injection > Fuel Injector > Removal/Installation. >> Go to [Step #17](#).
 - b. If HPC tip is undamaged, replace the injector and HPC. Refer to the detailed service information available in TechCONNECT under: Service Info tab > 14 - Fuel System > Fuel Injection > Fuel Injector > Removal/Installation. >> **Verify that a quality fuel filter is used.** >> Go to [Step #17](#).
11. **Verify proper low pressure fuel supply to the high pressure pump:** Perform the appropriate fuel supply system flow test. **NOTE: This procedure can be slightly different depending on if the vehicle has an engine-mounted transfer pump or the in-tank transfer pump.** In a good low pressure fuel system, fuel flow of 560 mL in 10 seconds or better is expected for model year 2003 and early 2004 vehicles. In a good low pressure fuel system, fuel flow of 590 mL in 10 seconds or better is expected for model year late 2004 through 2007 vehicles. Be sure there is no air in the system.
Is the low pressure fuel supply volume sufficient?
 - a. Yes >> Go to [Step #12](#).
 - b. No >> Repair the low pressure fuel supply system. **Vehicles equipped with an in tank fuel pump:** Refer to the detailed diagnostic information available in TechCONNECT under: Service Info tab > 9 - Engine > Diagnosis & Testing > In-Tank Fuel Lift Pump Flow/Diagnostic Test Procedure. **Vehicles equipped with an engine mounted fuel transfer pump:** Refer to the detailed diagnostic information available in TechCONNECT under: Service Info tab > Diagnostics tab, Powertrain Gas, Driveability Diesel, Fuel Lift Pump Flow And Inlet Restriction Test >> Go to [Step #17](#).

12. **Verify high pressure pump output volume:** Remove the high pressure fuel line from the high pressure pump outlet port to the fuel rail. Connect a suitable hose to the high pressure outlet port of the high pressure pump and route it to a graduated container. Disconnect the Electronic Fuel Control Actuator. Crank the engine until fuel exits the hose. **NOTE: With the discharge line routed to atmosphere, fuel will discharge at 0 PSI.** Crank the engine for three 10 second intervals, pausing to allow the starter to cool between each crank event. High pressure pump output volume must be greater than 70 mL in 30 seconds. **Is the high pressure pump output flow sufficient?**
 - a. Yes >> Go to [Step #13](#).
 - b. No >> Replace the high pressure pump. Refer to the detailed service information available in TechCONNECT under: Service Info tab > 14 - Fuel System > Fuel Injection > Fuel Injection Pump. >> Go to [Step #17](#).
13. **Fuel Return:** Check for kinked or restricted fuel return lines. Check the fuel tank venting. **Where any problems found in the Fuel Return system?**
 - a. Yes >> Repair as necessary. >> Go to [Step #17](#).
 - b. No >> Go to [Step #14](#).
14. **Intake/Exhaust Systems:** Check for inlet restriction, inspect air filter for excessive dirt/debris. Verify air intake tubes and hoses are not kinked or restricted. Check for charge air cooler air system leaks. Perform the "INTAKE AIR SYSTEM PRESSURE TEST - DIESEL". Refer to the detailed service information available in TechCONNECT under: Service Info tab > 11 - Exhaust System > Turbocharger System > Turbocharger > Inspection. Inspect the Turbocharger for excessive compressor wheel movement and proper waste gate operation. Check for exhaust restriction. Check for kinked or blocked exhaust pipes. Verify proper exhaust brake operation (if equipped). **Were any issues found with the Intake/Exhaust Systems?**
 - a. Yes >> Repair as necessary. >> Go to [Step #17](#).
 - b. No >> Go to [Step #15](#).
15. **Other Vehicle Systems:** Verify proper operation of the Transmission Clutch. Verify proper operation of the Transmission. Verify proper operation of the Vehicle brakes (check for dragging). Verify proper operation of the Cooling fan operation cycle time. Verify proper operation of the Engine driven accessories. **Were any issues found with the Other Vehicle Systems?**
 - a. Yes >> Repair as necessary. >> Go to [Step #17](#).
 - b. No >> Go to [Step #16](#).
16. **Base Engine:** Check for internal engine damage. Valve lash settings, engine compression, cylinder leak down, etc. **Were any issues found with the Base Engine?**
 - a. Yes >> Repair as necessary. >> Go to [Step #17](#).
 - b. No >> Go to [Step #17](#).
17. **Repair Complete:** Perform Powertrain Verification Test VER - 1 (Diesel). Refer to the detailed service information available in TechCONNECT under: Service Info tab > 8 - Electrical/Electronic Control Modules/Engine Control Module > Diagnosis And Testing.

POLICY:

Reimbursable within the provisions of the warranty.

TIME ALLOWANCE:

Usage of these labor operations must follow the guidelines outlined in the Global Warranty Administration Manual.

NOTE: The following diagnostic labor operations can only be used in conjunction with the main (prime) repair labor operation that corrected the condition.

Labor Operation No:	Description	Amount
14-01-10-70	Diagnostic Time for Section A - White Smoke and/or Misfire After Cold Start.	Actual Time
14-01-10-71	Diagnostic Time for Section B - Engine Surges At Idle.	Actual Time
14-01-10-72	Diagnostic Time for Section C - Engine Noise.	Actual Time
14-01-10-73	Diagnostic Time for Section D - Engine Will Not Start / Hard To Start	Actual Time

FAILURE CODE:

ZZ	Service Action
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