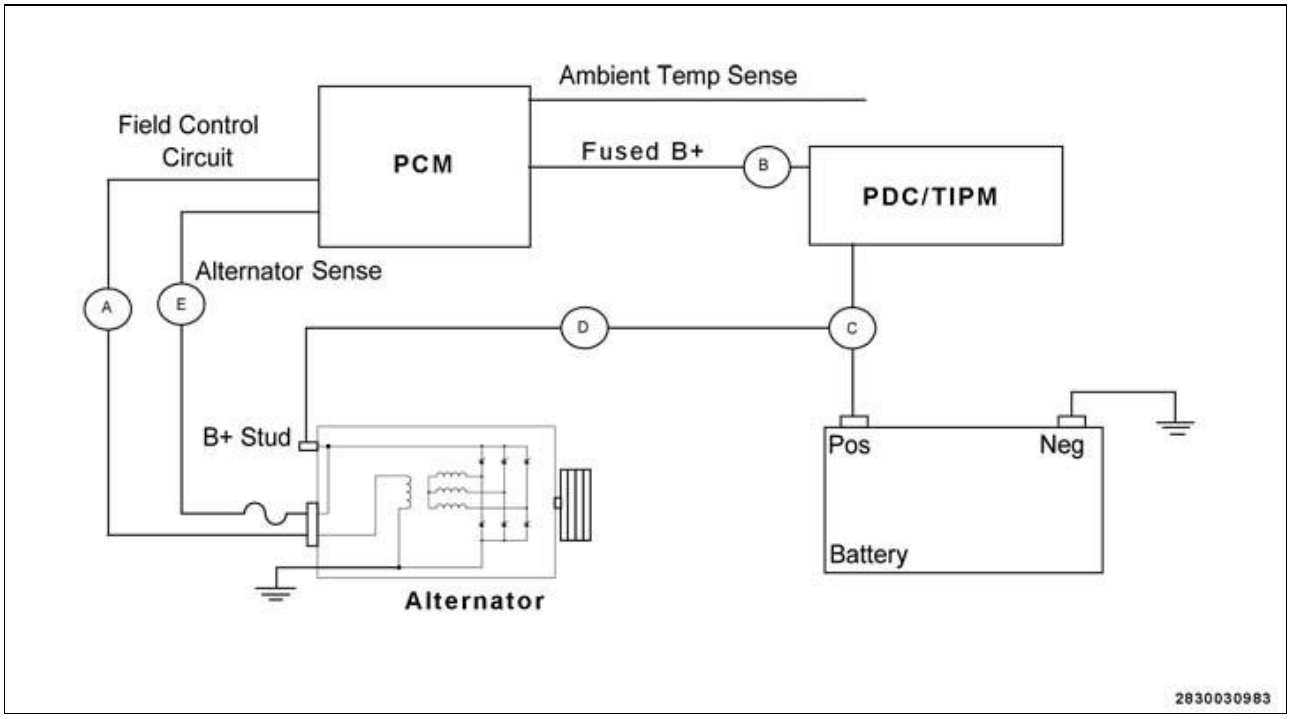
DIAGNOSIS AND TESTING > CHECKING THE CHARGING SYSTEM OPERATION

For a complete wiring diagram, **refer to SYSTEM WIRING DIAGRAMS article** .

DIAGNOSIS AND TESTING > CHECKING THE CHARGING SYSTEM OPERATION > THEORY OF OPERATION

Fig 1: Battery/System Circuit Diagram



Courtesy of CHRYSLER GROUP, LLC

The Electronic Voltage Regulation (EVR) system maintains the system voltage at a desired level by turning the Pulse Width Modulated (PWM) Alternator Field Control circuit (A) on and off. When the Alternator field is turned on, the system voltage increases. When the Alternator field is turned off, the system voltage slowly drops. The rate at which this happens is dependent upon the existing electrical loads, ambient under hood temperature, and the engine RPM. A constant system voltage (D, C, B) can be maintained only when the Alternator field is switched on and off at a duty cycle that very accurately emulates the existing electrical loads given the existing ambient under hood temperature and engine RPM.

During normal operation, the voltage reading at the Alternator output stud will be very close to the target charging voltage viewed on the scan tool. This is the system voltage and is sensed by the PCM through the Fused B+ circuit (B). With the Alternator connector plugged in and back probing the Alternator Sense circuit (E), the voltage reading will be approximately 3.5 volts less than the voltage at the Alternator output stud due the resistor inside the Alternator. This is the Alternator Sense (E) input to the PCM. These two voltage sense inputs are used and compared during the different diagnostics

performed on the EVR System by the PCM.

DIAGNOSIS AND TESTING > CHECKING THE CHARGING SYSTEM OPERATION > DIAGNOSTIC TEST

1. **CHARGING SYSTEM INSPECTION**

> *NOTE:*
>
> *This procedure is a general check of the entire charging system as a whole. It is designed to check all phases of a malfunctioning charging system that has no faults codes or in some cases, multiple fault codes.*

   1. Inspect the Battery terminals and cable ends for poor connection or corrosion.
   2. Test the Battery with the Midtronics Battery Tester or equivalent for a shorted or dead cell.
   3. Inspect the Alternator drive belt and tensioner for proper alignment and adjustment.
   4. Inspect the vehicle for aftermarket accessories that may exceed the Alternator system output.
   5. Inspect the fusible link in the charge wire or fuses in the PDC depending on application. If an open fusible link or fuse is found, use the wire diagram/schematic as a guide and inspect the wiring and connectors for damage.

      Were any problems found?

      Yes

      1. Perform the appropriate repair.
      2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

      No

      1. Go To Step 2

2. **CHECK FOR HIGH RESISTANCE IN THE BATTERY GROUND CABLE**

   1. Perform a voltage drop test on the Battery Negative (-) cable from the Battery cable end;
      1. to the engine ground eyelet.
      2. to the body ground eyelet.

      Is the voltage reading above 0.2 volts for either measurement?

      Yes

1. Repair the Battery ground circuit for high resistance.
2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

No

1. Go To Step 3

3. **CHECK THE PCM POWER AND GROUND CIRCUITS**

1. Perform the CHECKING THE PCM POWER AND GROUND CIRCUITS test procedures. Refer to CHECKING THE PCM POWER AND GROUND CIRCUITS .

   Were any problems found?

   Yes

   1. Repair the PCM power and ground circuit(s) as necessary.
   2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

   No

   1. Go To Step 4

4. **CHECK THE ALTERNATOR OUTPUT AT THE ALTERNATOR OUTPUT STUD**

> *NOTE:*
>
> *Make sure all testing equipment and cables are clear of any engine parts before starting the engine.*

1. Start the engine.

> *WARNING:*
>
> *When the engine is operating, do not stand in direct line with the fan. Do not put your hands near the pulleys, belts or fan. Do not wear loose clothing. Failure to follow these instructions may result in possible serious or fatal injury.*

2. Hold the engine speed above 1157 RPM.
3. With the scan tool, navigate to data display and monitor the target charging voltage.
4. Using a voltmeter, measure the voltage between ground and the Alternator Output Stud.

   Is the Alternator overcharging or undercharging as compared to the target voltage?

Alternator is overcharging

1. Go To Step 5

Alternator is undercharging

1. Go To Step 12

5. **CHECK THE PCM FUSED B+ VOLTAGE**

    1. With the scan tool, monitor the Battery voltage reading to the PCM.
    2. Compare the reading to the voltage at the Alternator Output Stud.

    Is the voltage at the Alternator Output Stud equal to or above the Battery voltage reading on the scan tool?

    Above

    1. Go To Step 6

    Equal

    1. Go To Step 8

6. **CHECK FOR HIGH RESISTANCE IN THE BATTERY POSITIVE CIRCUIT**

    1. Perform a voltage drop test between the Battery Positive (+) Post;
        1. and the Alternator Output Stud.
        2. and the PDC B+ terminal.

    Is the voltage reading above 0.2 volts for either measurement?

    Yes

    1. Repair the Battery Positive (+) circuit for high resistance.
    2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

    No

    1. Go To Step 7

7. **CHECK THE FUSED B+ CIRCUIT FOR HIGH RESISTANCE**

    1. Turn the ignition off.

    > ⚠ *CAUTION:*
    >
    > *Do not probe the PCM harness connectors. Probing the PCM harness connectors will damage the PCM terminals resulting in poor terminal to pin connection. Install the GPEC Diagnostic Adaptor to perform the diagnosis.*

2. Disconnect the PCM C1 harness connector and connect the (special tool #10436, Adapter, GPEC Diagnostic) in-line with the PCM C1 harness connector.
3. Start the engine and allow it to idle.
4. Measure the voltage between ground and the Fused B+ circuit at the GPEC Adaptor.

   Does the voltage read equal to the Battery voltage reading on the scan tool or equal to the voltage reading at the Alternator Output Stud?

   Voltage is equal to scan tool reading

   1. Repair the Fused B+ circuit for high resistance.
   2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

   Voltage is equal to the Alternator Output Stud

   1. Replace and program the Powertrain Control Module in accordance with the Service Information. Refer to MODULE, POWERTRAIN CONTROL, REMOVAL AND INSTALLATION .
   2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

8. **CHECK THE ALTERNATOR DUTY CYCLE**

   1. With the scan tool, check the Duty Cycle reading for the Alternator.

      NOTE:

      During normal operation the typical duty cycle of the field control at idle with minimal loads is approximately 35-40%, which will equate to between 4.0 and 5.0 volts. Depending on the charging issue, the PCM can drive the duty cycle to off (0%), which will equate to zero volts, or full field (100%), which will equate to between 11.0 and 12.0 volts.

      What is the Alternator duty cycle on the scan tool?

      0%

      1. Go To Step 9

      100%

      1. Go To Step 10

9. **CHECK THE (K20) ALTERNATOR FIELD CONTROL CIRCUIT FOR A SHORT TO VOLTAGE**

   1. Back probe the (K20) Alternator Field Control circuit at the Alternator harness connector.

      WARNING:

When the engine is operating, do not stand in direct line with the fan. Do not put your hands near the pulleys, belts or fan. Do not wear loose clothing. Failure to follow these instructions may result in possible serious or fatal injury.

2. Measure the voltage between ground and the (K20) Alternator Field Control circuit at the Alternator harness connector.

   Is there any voltage present?

   Yes

   1. Repair the (K20) Alternator Field Control circuit for a short to voltage.
   2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

   No

   1. Verify that there is good pin to terminal contact in the Alternator and Powertrain Control Module connectors. If no problems are found, replace the Alternator. Refer to GENERATOR, REMOVAL AND INSTALLATION .
   2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

10. **CHECK THE (A804) ALTERNATOR SENSE CIRCUIT FOR AN OPEN/HIGH RESISTANCE**

    1. Turn the ignition off.
    2. Disconnect the Alternator harness connector.
    3. Disconnect the PCM C2 harness connector.

    ⚠ *CAUTION:*

    Do not probe the PCM harness connectors. Probing the PCM harness connectors will damage the PCM terminals resulting in poor terminal to pin connection. Install the GPEC Diagnostic Adaptor to perform the diagnosis.

    4. Connect the (special tool #10436, Adapter, GPEC Diagnostic).
    5. Measure the resistance of the (A804) Alternator Sense circuit between the Alternator harness connector and the GPEC Adaptor.

       Is the resistance below 3.0 Ohms?

       Yes

       1. Go To Step 11

       No

1. Repair the (A804) Alternator Sense circuit for an open or high resistance.
2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

11. **CHECK THE (A804) ALTERNATOR SENSE CIRCUIT FOR A SHORT TO GROUND**

    1. Check for continuity between ground and the (A804) Alternator Sense circuit at the Alternator harness connector.

       Is there continuity between ground and the (A804) Alternator Sense circuit?

       Yes

       1. Repair the (A804) Alternator Sense circuit for a short to ground.
       2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

       No

       1. Replace and program the Powertrain Control Module (PCM) in accordance with the service information. Refer to MODULE, POWERTRAIN CONTROL, REMOVAL AND INSTALLATION .
       2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

12. **CHECK THE DUTY CYCLE REQUESTED BY THE PCM**

> *NOTE:*
>
> *Before condemning an Alternator or PCM for a charging issue, it is important check the Battery Temperature Sensor reading. A Battery Temperature Sensor that is reading too high or too low can cause an undercharge or overcharge issue.*

    1. With the scan tool, check the Duty Cycle reading for the Alternator.

> *NOTE:*
>
> *During normal operation the typical duty cycle of the field control at idle with minimal loads is approximately 35-40%, which will equate to between 4.0 and 5.0 volts. Depending on the charging issue, the PCM can drive the duty cycle to off (0%), which will equate to zero volts, or full field (100%), which will equate to between 11.0 and 12.0 volts.*

       What is the Alternator duty cycle on the scan tool?

       0%

       1. Go To Step 13

Duty cycle is reading between normal and 100%

1. Go To Step 15

13. **CHECK THE (A804) ALTERNATOR SENSE CIRCUIT VOLTAGE**

    1. Back probe and measure the voltage between ground and the (A804) Alternator Sense circuit at the Alternator harness connector.

       > *NOTE:*
       >
       > *With the Alternator connector plugged in, the voltage reading on the Alternator Sense circuit should be approximately 3.5 volts less that the voltage at the Alternator Output Stud due to the resistor inside the Alternator.*

       Is the voltage reading for the (A804) Alternator Sense circuit equal to the voltage reading at the Alternator Output Stud?

       Yes

       1. Go To Step 14

       No

       1. Repair the (A804) Alternator Sense circuit for an open or high resistance.
       2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

14. **CHECK THE (A804) ALTERNATOR SENSE CIRCUIT FOR A SHORT TO VOLTAGE**

    1. Turn the ignition off.
    2. Disconnect the Alternator harness connector.
    3. Measure the voltage between ground and the (A804) Alternator Sense circuit at the Alternator harness connector.

       Is the voltage reading for the (A804) Alternator Sense circuit equal to the voltage reading at the Alternator Output Stud?

       Yes

       1. Repair the (A804) Alternator Sense circuit for a short to voltage.
       2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

       No

       1. Replace the Alternator in accordance with the Service Information. Refer to GENERATOR, REMOVAL AND INSTALLATION .
       2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate

TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

15. **CHECK DUTY CYCLE VOLTAGE AT THE ALTERNATOR**

    1. Back probe the (K20) Alternator Field Control circuit at the Alternator harness connector.
    2. Measure the voltage between ground and the (K20) Alternator Field Control circuit at the Alternator harness connector.

    > *NOTE:*
    >
    > *Duty cycle of the field control at idle with minimal loads is approximately 35-40%, which will equate to between 4.0 and 5.0 volts, off (0%) will equate to zero volts, and full field (100%) will equate to between 11.0 and 12.0 volts.*

    Does the voltage reading match up with the Alternator duty cycle on the scan tool?

    Yes

    1. Replace the Alternator in accordance with the Service Information. Refer to GENERATOR, REMOVAL AND INSTALLATION .
    2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

    No

    1. Go To Step 16

16. **CHECK THE (K20) ALTERNATOR FIELD CONTROL CIRCUIT FOR AN OPEN/HIGH RESISTANCE**

    1. Turn the ignition off.
    2. Disconnect the Alternator harness connector.
    3. Disconnect the PCM C2 harness connector.

    > *CAUTION:*
    >
    > *Do not probe the PCM harness connectors. Probing the PCM harness connectors will damage the PCM terminals resulting in poor terminal to pin connection. Install the GPEC Diagnostic Adaptor to perform the diagnosis.*

    4. Connect the (special tool #10436, Adapter, GPEC Diagnostic).
    5. Measure the resistance on the (K20) Alternator Field Control circuit between the Alternator harness connector and the GPEC Adaptor.

    Is the resistance below 3.0 Ohms?

Yes

1. Go To Step 17

No

1. Repair the (K20) Alternator Field Control circuit for an open or high resistance. Make sure to check for a spread terminal at the PCM harness connector.
2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

17. **CHECK THE (K20) ALTERNATOR FIELD CONTROL CIRCUIT FOR A SHORT TO GROUND**

1. Check for continuity between ground and the (K20) Alternator Field Control circuit at the GPEC Adaptor.

   Is there continuity between ground and the (K20) Alternator Field Control circuit?

   Yes

   1. Repair the (K20) Alternator Field Control circuit for a short to ground.
   2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

   No

   1. Go To Step 18

18. **CHECK RELATED PCM AND COMPONENT CONNECTIONS**

1. Perform any Service Bulletins that apply.
2. Disconnect all PCM harness connectors.
3. Disconnect all related in-line harness connections (if equipped).
4. Disconnect the related component harness connectors.
5. Inspect harness connectors, component connectors, and all male and female terminals for the following conditions:
   1. Proper connector installation.
   2. Damaged connector locks.
   3. Corrosion.
   4. Other signs of water intrusion.
   5. Weather seal damage (if equipped).
   6. Bent terminals.
   7. Overheating due to a poor connection (terminal may be discolored due to excessive current draw).
   8. Terminals that have been pushed back into the connector cavity.

9. Check for spread terminals and verify proper terminal tension.

Repair any conditions that are found.

6. Reconnect all PCM harness connectors. Be certain that all harness connectors are fully seated and the connector locks are fully engaged.
7. Reconnect all in-line harness connectors (if equipped). Be certain that all connectors are fully seated and the connector locks are fully engaged.
8. Reconnect all related component harness connectors. Be certain that all connectors are fully seated and the connector locks are fully engaged.
9. With the scan tool, erase DTCs.
10. Test drive or operate the vehicle in accordance with the when monitored and set conditions.
11. With the scan tool, read DTCs.

    Did the DTC return?

    Yes

    1. Replace the Powertrain Control Module in accordance with the Service information. (Refer to MODULE, POWERTRAIN CONTROL, REMOVAL AND INSTALLATION).
    2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

    No

    1. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .
    2. Test complete.

DIAGNOSIS AND TESTING > CHECKING THE ENGINE MECHANICAL SYSTEM

For a complete wiring diagram, **refer to SYSTEM WIRING DIAGRAMS article** .

DIAGNOSIS AND TESTING > CHECKING THE ENGINE MECHANICAL SYSTEM > DIAGNOSTIC TEST

CHECKING THE ENGINE MECHANICAL SYSTEM

1. Turn the ignition off.
2. Check for any of the following conditions/mechanical problems:
    1. ENGINE VACUUM - must be at least 13 inches in neutral

2. ENGINE VALVE TIMING - must be within specifications
3. ENGINE COMPRESSION - must be within specifications
4. CYLINDER LEAKAGE TEST - must be within specifications
5. ENGINE EXHAUST SYSTEM - must be free of any restrictions or leaks
6. ENGINE PCV SYSTEM - must flow freely
7. TORQUE CONVERTER STALL SPEED - must be within specifications
8. POWER BRAKE BOOSTER - no internal vacuum leaks
9. FUEL - must be free of contamination
10. VALVE SPRINGS - cannot be weak or broken
11. CAM LOBES - must not be worn excessively
12. CAM SHAFTS - must not be worn or have excessive end play

Are there any engine mechanical problems?

Yes

1. Repair as necessary in accordance with the Service Information.
2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

No

1. Test Complete.

DIAGNOSIS AND TESTING > CHECKING THE EXHAUST SYSTEM FOR LEAKS > CHECKING THE EXHAUST SYSTEM FOR LEAKS

YouTube	A multimedia supplement to the instructions contained in this article is available. To view the multimedia example of the condition described go to; **http://www.youtube.com/user/Mitchell1Tips then type "A00603031.vid1" into the "Search Channel" box.**

DIAGNOSIS AND TESTING > CHECKING THE EXHAUST SYSTEM FOR LEAKS > DIAGNOSTIC TEST

CHECK THE EXHAUST SYSTEM FOR LEAKS

1. Turn the ignition off.

2. Raise and support the vehicle in accordance with the service information. Refer to HOISTING, STANDARD PROCEDURE .

> *WARNING:*
>
> *The normal operating temperature of the exhaust system is very high. Never work around or attempt to service any part of the exhaust system until it has cooled. Special care should be taken when working near the catalytic converter. The temperature of the converter rises to a high level after a short period of engine operating time.*

3. Connect Exhaust Cone (special tool #8404-ECT, Exhaust Cone, Truck) to Air Pressure Regulator (with hose) W-18-MIL-1146AS.

> *CAUTION:*
>
> *The air pressure must not exceed 27.6 kPa (4 psi), otherwise engine damage can occur.*

4. Attach shop air to the air pressure regulator.
5. Adjust the Air Pressure Regulator to 27.6 kPa (4 psi)
6. Insert the exhaust cone into the vehicle tail pipe.
7. If the vehicle is equipped with dual exhaust, use a second Exhaust Cone (special tool #8404-ECT, Exhaust Cone, Truck) equipped with the attached plug and plug one side of the dual exhaust pipe. Pressurize the other as described above.
8. Apply Mopar® Air Leak Detector PN 05191804AA (or an equivalent leak finder liquid) to the following areas:
    1. All welded joints from the exhaust manifold to 45.72 cm (18 inches) behind the downstream O2 Sensor
    2. O2 Sensor seal points
    3. O2 Sensor boss welds
    4. Flange/joint connection(s)
    5. Exhaust manifold to cylinder head connection(s)
    6. EGR solenoid gasket base and tube seal points (if equipped)
9. Watch for the Mopar® Air Leak Detector PN 05191804AA (or the equivalent leak finder liquid) to bubble.
10. Use the following definitions to help determine if system or component repair/replacement is necessary:
    1. **Type 1 Leak** is defined as a leak where very small foam like bubbles 1 mm (0.04 of an

inch) or less appear. Any Type 1 or greater leaks found in welded joints, O2 sensor seal points or O2 sensor boss welds must be repaired or the component must be replaced.

2. **Type 2 Leak** is defined as a leak where larger bubbles pea size, 8 mm (0.3 of an inch) or greater appear. Any Type 2 or greater leaks found in flange or joint connections, exhaust manifold to cylinder head connections, or EGR gasket and tube seal points must be repaired or the components must be replaced.

Leak Location	Repair required if results at 27.6 kPa (4 psi) reveal bubble size:
Welded joints	Type 1, 1 mm (0.04 of an inch) or greater
O2 Sensor seal points	Type 1, 1 mm (0.04 of an inch) or greater
O2 Sensor boss welds	Type 1, 1 mm (0.04 of an inch) or greater
Flange / joint connections	Type 2, 8 mm (0.3 of an inch) or greater
Exhaust Manifold to cylinder head connections	Type 2, 8 mm (0.3 of an inch) or greater
EGR gasket and tube seal points	Type 2, 8 mm (0.3 of an inch) or greater

11. If a leak is found that matches the above definition, repair or replace the component as necessary.
12. Once the repair is complete, repeat the procedure to verify that all leaks have been repaired.

    Were any exhaust leaks found?

    Yes

    1. Repair or replace the leaking exhaust parts as necessary.
    2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

    No

    1. Test complete.

DIAGNOSIS AND TESTING > CHECKING THE FUEL DELIVERY SYSTEM (HARD START)

For a complete wiring diagram, **refer to SYSTEM WIRING DIAGRAMS article** .

DIAGNOSIS AND TESTING > CHECKING THE FUEL DELIVERY SYSTEM (HARD START) > ?

Possible Causes
FUEL DELIVERY SYSTEM LEAKING OR DAMAGED

RESTRICTED FUEL SUPPLY LINE
FUEL PUMP INLET STRAINER PLUGGED
FUEL PUMP CONTROL OUTPUT CIRCUIT OPEN
FUEL INJECTOR(S)
FUEL PUMP MODULE

WARNING:

Follow these safety precautions to reduce the risk of fire and possible serious or fatal injury when performing this test procedure.

- *Fuel or fuel vapors are highly flammable. A fire could occur if an ignition source is present. Do not expose the fuel or the test equipment used in this procedure to open flames or sparks.*
- *Inhalation of fuel vapors could lead to disorientation and personal injury. Keep the service area well ventilated, or perform this test procedure in an area where there is a building exhaust removal system.*
- *Relieve fuel system pressure before servicing fuel system components.*
- *Use extreme caution when connecting and disconnecting fuel lines.*
- *Considerable fuel leakage may occur when servicing the fuel system. Wear protective eye wear and clothing to protect from fuel splash, and take suitable fuel containment measures.*
- *Wrap a shop towel around the fuel pressure gauge connection to absorb fuel leakage that occurs when connecting the test equipment. Place the towel in an approved container when complete.*
- *Never store fuel in an open container due to the possibility of fire or explosion. Have a dry chemical (Class B) fire extinguisher nearby.*

DIAGNOSIS AND TESTING > CHECKING THE FUEL DELIVERY SYSTEM (HARD START) > DIAGNOSTIC TEST

1. **CHECK THE FUEL DELIVERY SYSTEM FOR LEAKS AND DAMAGE**

WARNING:

The fuel system is under a constant pressure (even with the engine off). Before testing or servicing any fuel system hose, fitting, or line, the fuel system pressure must be released. Failure to follow these instructions can result in possible serious or fatal injury.

1. Visually and physically inspect the fuel delivery system for external leaks and damage.

   Is the system leaking or damaged?

   Yes

   1. Repair or replace as necessary.
   2. Perform the PCM VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

   No

   1. Go To Step 2

2. **CHECK FUEL PUMP OPERATION**

   1. Ignition on, engine not running.
   2. With a scan tool, actuate the Fuel System test.

      NOTE:

      It may be necessary to use a mechanics stethoscope in the next step.

   3. Listen for fuel pump operation at the Fuel Tank.

      Does the Fuel Pump operate?

      Yes

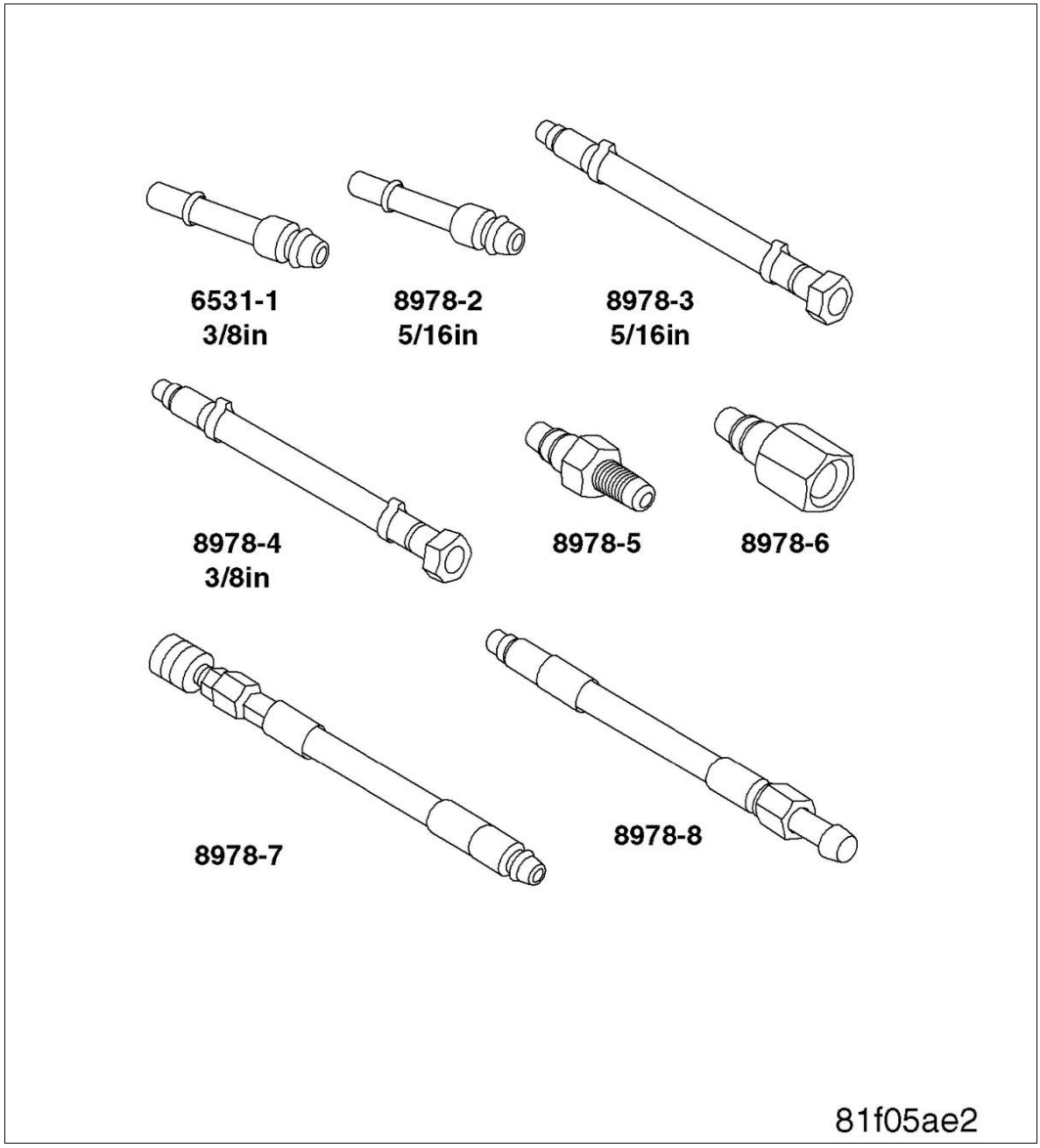
      1. Go To Step 3

      No

      1. Check the power and ground circuits to the Fuel Pump Module assembly. If the circuits test good, replace the Fuel Pump Module assembly.
      2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

3. **INSTALL APPROPRIATE FUEL LINE ADAPTERS/FITTING FROM THE GAS AND DIESEL FUEL PRESSURE/DECAY TESTER 8978A**

Fig 1: Fuel Line Adapters/Fitting



Courtesy of CHRYSLER GROUP, LLC

1. Turn the ignition off.

> *WARNING:*
>
> *The fuel system is under a constant pressure (even with the engine off). Before testing or servicing any fuel system hose, fitting, or line, the fuel system pressure must be released. Failure to follow these instructions can result in possible serious or fatal injury.*

2. Release the fuel system pressure. Refer to FUEL DELIVERY, STANDARD

PROCEDURE .

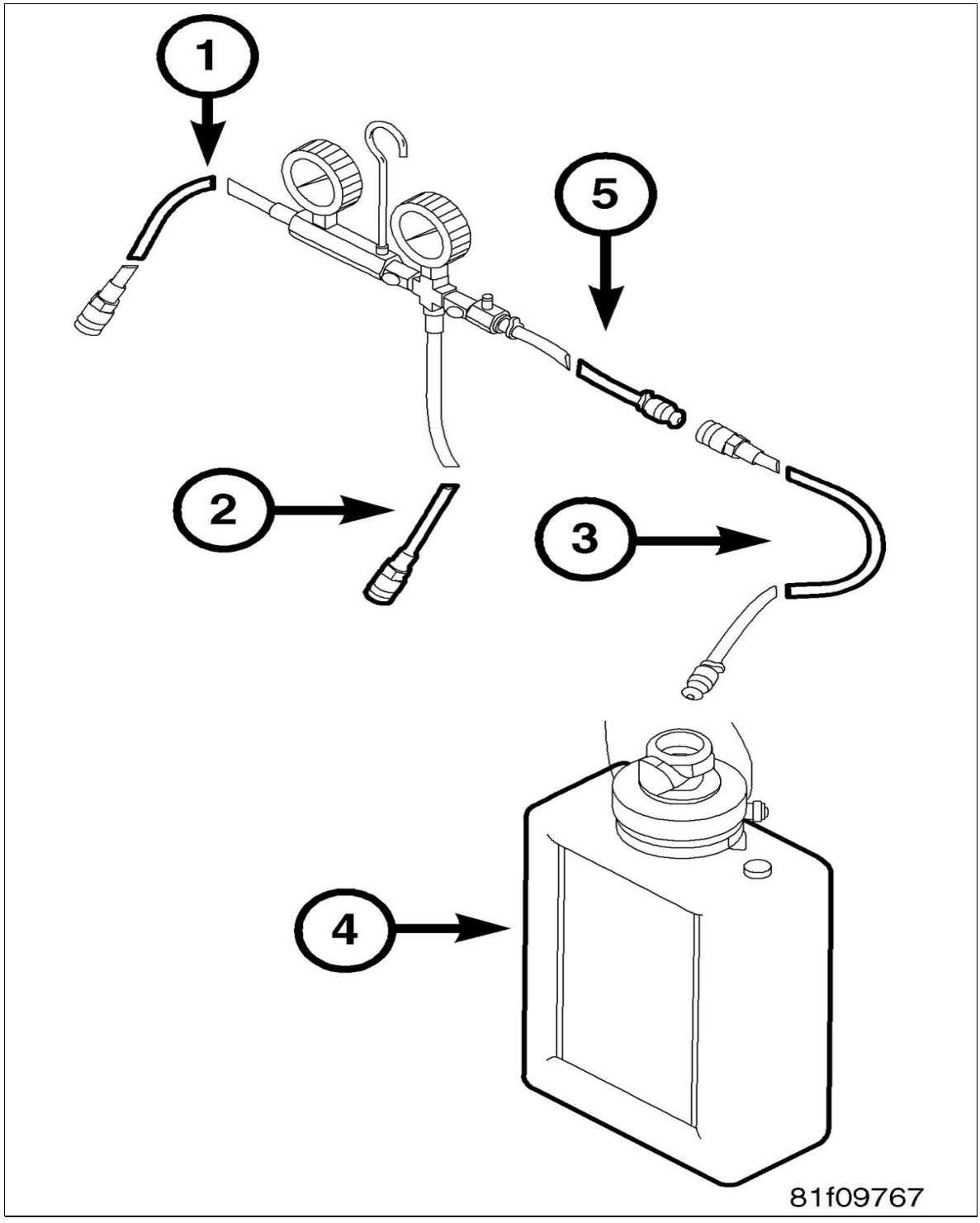
3. Disconnect the rail fuel supply line connector between the fuel supply line and the fuel rail. (Refer to LINES, FUEL).
4. Install the appropriate Fuel Line Adapters/Fitting from the Gas and Diesel Fuel Pressure/Decay Tester (special tool #8978A, Decay Tool, Fuel).

Proceed

1. Go To Step 4

4. **INSTALL THE FUEL PRESSURE GAUGE ASSEMBLY**

Fig 2: Identifying Fuel Pressure Gauge Assembly



Courtesy of CHRYSLER GROUP, LLC

1. Connect the (special tool #8978A, Decay Tool, Fuel), with the Fuel Inlet Hose (1) toward the Fuel tank side and the Fuel Outlet Hose (2) toward the fuel rail side of the system using the Fuel Line Adapters/Fitting as needed.

2. Connect special tool Drain Extension Hose 535680 (3) to the Fuel Pressure Gauge Assembly Drain Hose (5).

3. Connect Reservoir Assembly 534960 (4) to Drain Extension Hose 535680 (3).

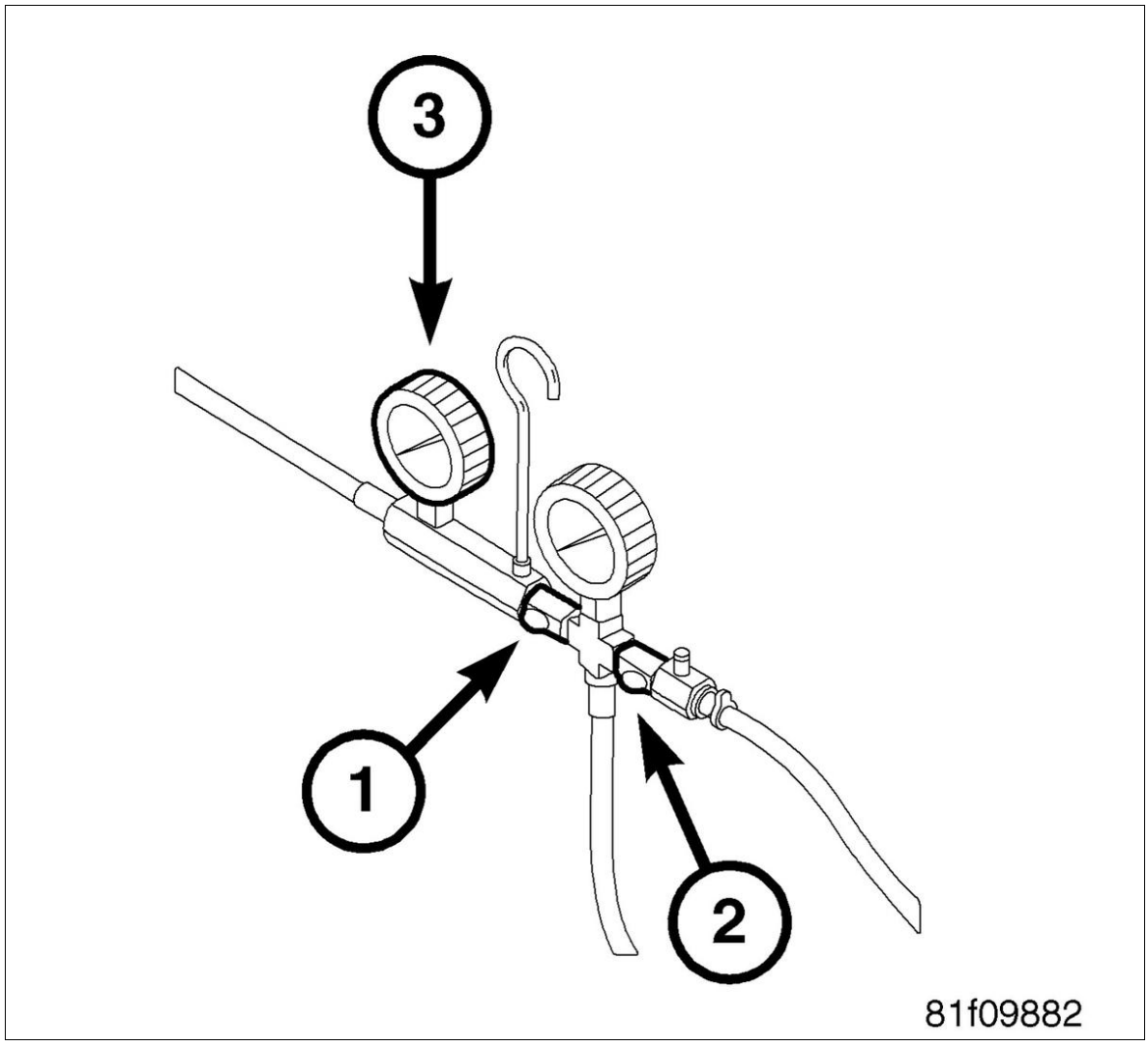
> *WARNING:*
>
> *To reduce the risk of fire and possible serious or fatal injury, place Reservoir Assembly 534960 (4) on the floor and out of the way so that it is not a trip hazard.*

Proceed

1. Go To Step 5

5. **CHECK THE FUEL PRESSURE**

Fig 3: Checking Fuel Pressure



Courtesy of CHRYSLER GROUP, LLC

1. Perform the following procedure to purge air from the system:
    1. Open the Fuel System Isolation Valve (1).

2. Close the Flow Test Valve (2).
3. Ignition on, engine not running.
4. With the scan tool, actuate the Fuel Pump.
5. Open the Flow Test Valve (2) for 10 seconds, then close the Valve.
6. **CAUTION: Stop All Actuations.**
7. Turn the ignition off.
8. Disconnect, empty and then reconnect the Reservoir Assembly.

2. Turn the ignition on.
3. With the scan tool, actuate the Fuel Pump.

> *NOTE:*
>
> *On vehicles equipped with a PWM Fuel Pump, actuate the Fuel Pump at or above 60%.*

4. Read the Fuel Pressure Gauge (3) and record the reading.

> *NOTE:*
>
> *The fuel pressure specification for all engines, including a **Non SRT-4** is 407 kPa +/- 34 kPa (59 psi +/- 5 psi). **SRT-4** fuel pressure specification is 552 kPa +/- 34 kPa (80 psi +/- 5 psi).*

Choose a conclusion that best matches your fuel pressure reading.

Below Specification

1. Go To Step 10

Within Specification

1. Go To Step 6

Above Specification

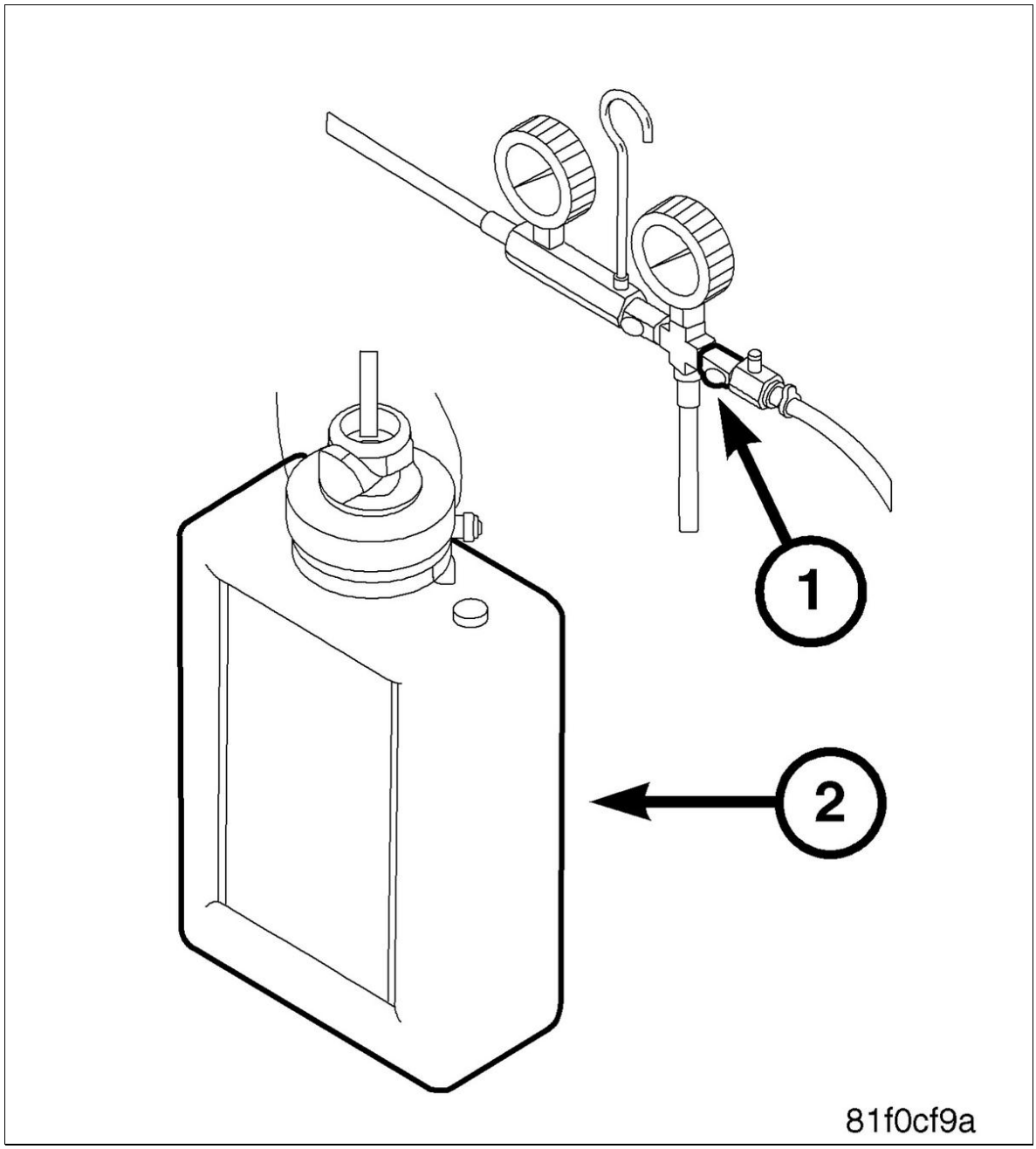
1. Replace the fuel filter/fuel pressure regulator.
2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

CAUTION:

Stop all actuation tests before proceeding.

6. **CHECK THE FUEL DELIVERY SYSTEM OUTPUT**

Fig 4: Checking Fuel Delivery System Output



Courtesy of CHRYSLER GROUP, LLC

WARNING:

The fuel system is under a constant pressure (even with the engine off). Before

testing or servicing any fuel system hose, fitting, or line, the fuel system pressure must be released. Failure to follow these instructions can result in possible serious or fatal injury.

1. With the scan tool, continue to actuate the fuel pump.
2. Open the Flow Test Valve (1) for 20 seconds, then close the Valve.

> ⚠ *CAUTION:*
>
> *Stop all actuation tests before proceeding.*

3. Turn the ignition off.
4. Measure the amount of fuel in the Reservoir Assembly (2). The fuel output specification is ml/s X 20 seconds = fuel flow in ml.

FUEL FLOW		
ENGINE	ml/s	ml per 20 Seconds
4 Cylinder and 6 Cylinder	20.8333	417
8 Cylinder	38.88889	778
SRT-4	50	1000
10 cylinder	55.5	1110

Does the amount of fuel in the reservoir meet or exceed the specification?

Yes

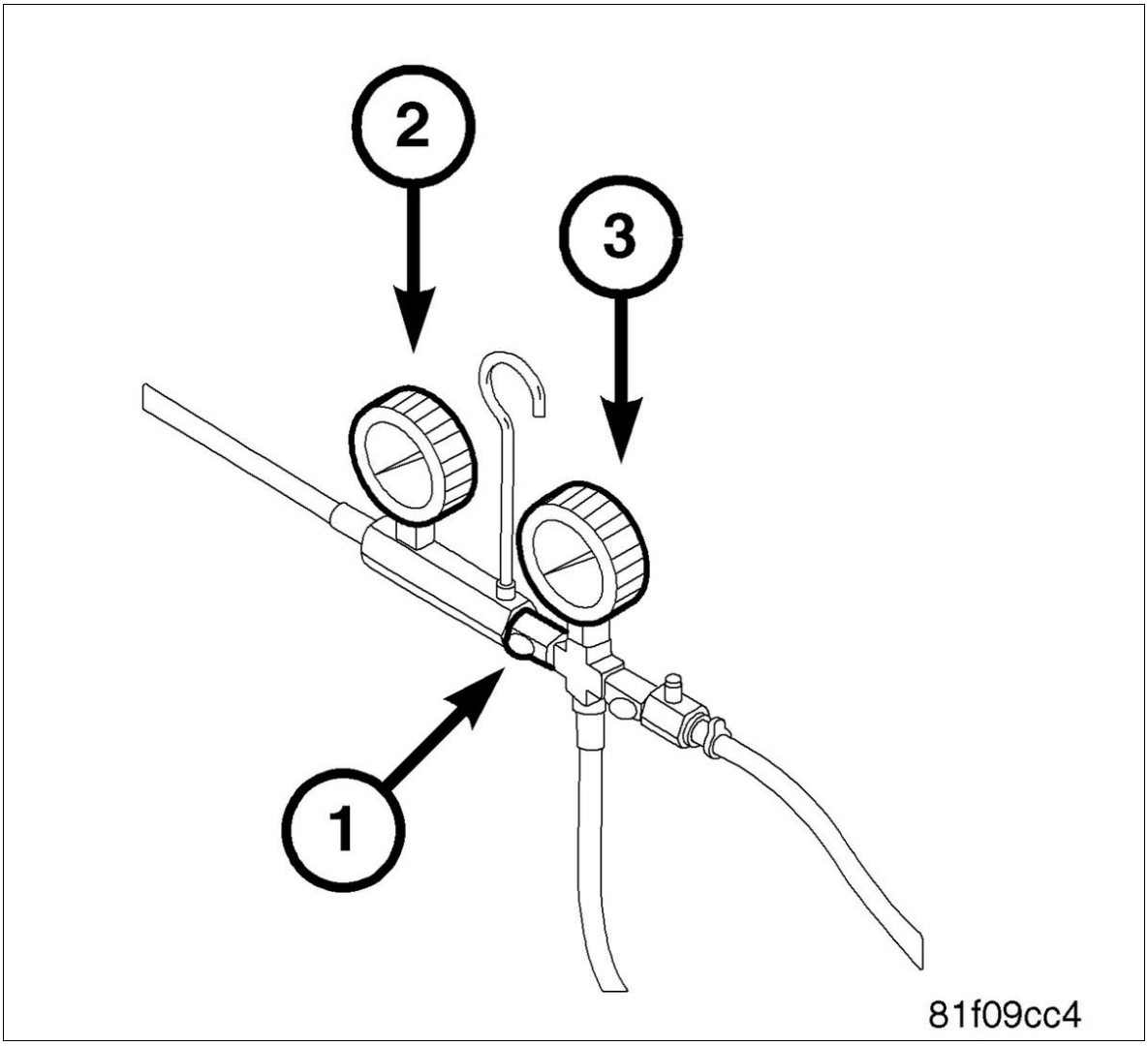
1. Go To Step 7

No

1. Go To Step 8

7. **CHECK THE FUEL DELIVERY SYSTEM FOR LEAK DOWN**

Fig 5: Checking Fuel Delivery System For Leak Down



Courtesy of CHRYSLER GROUP, LLC

WARNING:

The fuel system is under a constant pressure (even with the engine off). Before testing or servicing any fuel system hose, fitting, or line, the fuel system pressure must be released. Failure to follow these instructions can result in possible serious or fatal injury.

1. Ignition on, engine not running.
2. With the scan tool, actuate the fuel pump.
3. Close the Fuel System Isolation Valve (1).

CAUTION:

Stop all actuation tests before proceeding.

4. Turn the ignition off and then wait five minutes before proceeding.
5. Read the Fuel Inlet (2) and Fuel Outlet (3) Pressure Gauges. The pressure should not drop more than 10 psi on either gauge.

   Does the fuel pressure drop more than 10 psi?

   Yes - On Fuel Inlet Gauge (2)

   1. Replace the Fuel Pump Module.
   2. Perform the PCM VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

   Yes - On Fuel Outlet Gauge (3)

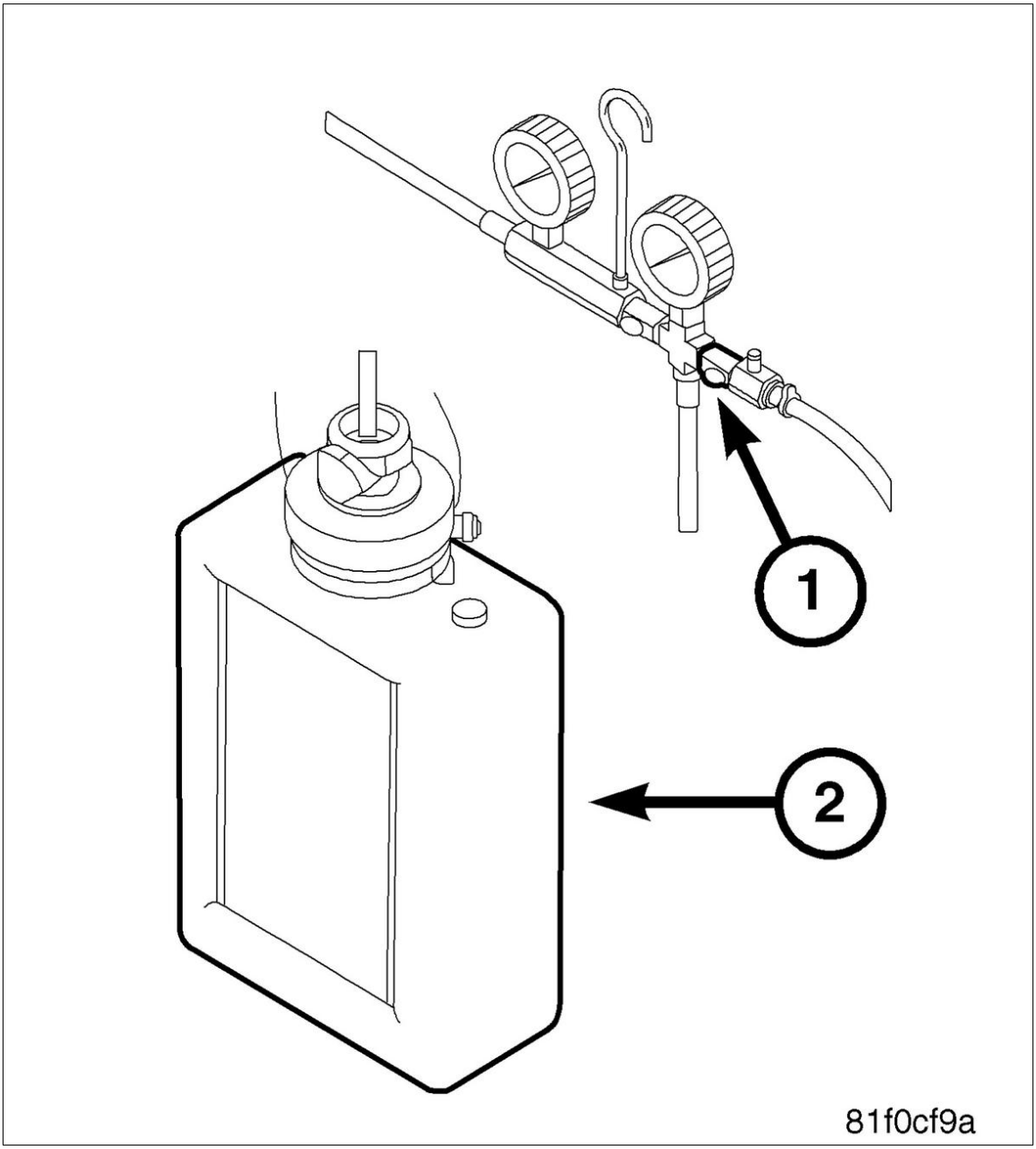
   1. Replace the leaking Fuel Injector(s).
   2. Perform the PCM VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

   No

   1. If directed here by another test, return to that test. Otherwise, test complete.

8. **CHECK FOR RESTRICTED FUEL SUPPLY LINE**

Fig 6: Checking Fuel Delivery System Output



Courtesy of CHRYSLER GROUP, LLC

WARNING:

The fuel system is under a constant pressure even with the engine off. Before testing or servicing any fuel system hose, fitting or line, the fuel system pressure must be released.

1. Turn the ignition off.
2. Disconnect the Fuel Pressure Decay Tester.

3. Raise the vehicle on a hoist, and disconnect the fuel pressure line at the Fuel Pump Module.
4. Install the Fuel Pressure Decay Tester between the fuel supply line and the Fuel Pump Module.
5. Again, purge air from the system.
6. Ignition on, engine not running.
7. With the scan tool, actuate the Fuel Pump.
8. Open the Flow Test Valve (1) for 20 seconds, then close the Valve.

> ⚠ *CAUTION:*
>
> *Stop all actuation tests before proceeding.*

9. Turn the ignition off.
10. Measure the amount of fuel in the Reservoir Assembly (2). The fuel output specification is ml/s X 20 seconds = fuel flow in ml.

FUEL FLOW		
ENGINE	ml/s	ml per 20 Seconds
4 Cylinder and 6 Cylinder	20.8333	417
8 Cylinder	38.88889	778
SRT-4	50	1000
10 cylinder	55.5	1110

Does the amount of fuel in the reservoir meet or exceed the specification?

Yes

1. Repair/replace fuel supply line as necessary.
2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

No

1. Go To Step 9

> ⚠ *CAUTION:*
>
> *Stop all actuation tests before proceeding.*

9. **CHECKING THE FUEL INLET STRAINER**

> *WARNING:*
>
> *The fuel system is under a constant pressure (even with the engine off). Before testing or servicing any fuel system hose, fitting or line, the fuel system pressure must be released. Failure to follow these instructions can result in possible serious or fatal injury.*

1. Turn the ignition off.
2. Remove the Fuel Pump Module and inspect the Fuel Inlet Strainer.

   Is the Fuel Inlet Strainer plugged?

   Yes

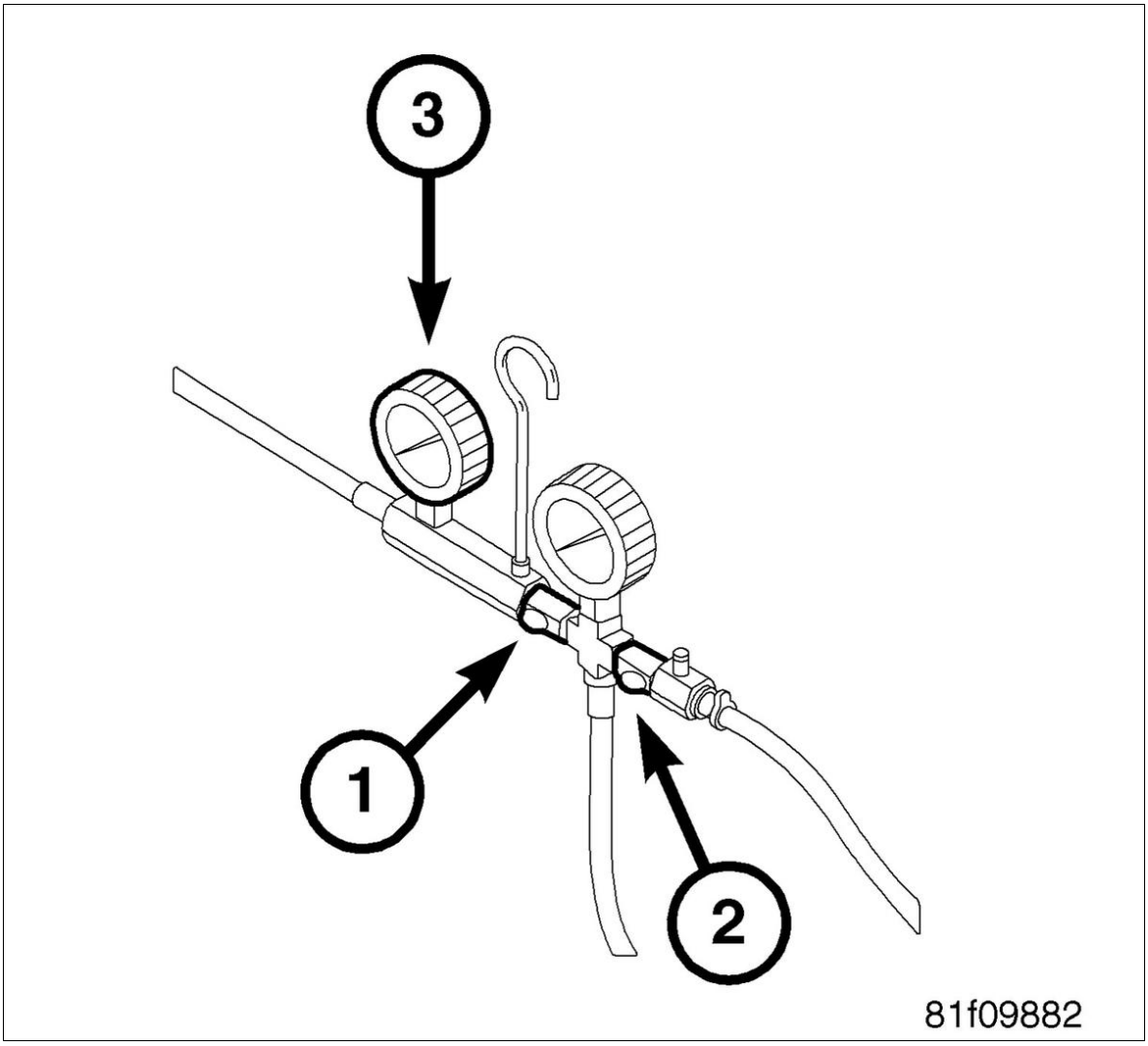
   1. Replace the Fuel Pump Inlet Strainer.
   2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

   No

   1. Replace the Fuel Pump Module.
   2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

10. **CHECK FOR RESTRICTED FUEL SUPPLY LINE**

Fig 7: Checking Fuel Pressure



Courtesy of CHRYSLER GROUP, LLC

WARNING:

The fuel system is under a constant pressure even with the engine off. Before testing or servicing any fuel system hose, fitting or line, the fuel system pressure must be released.

1. Turn the ignition off.
2. Disconnect the Fuel Pressure Decay Tool.
3. Raise the vehicle on a hoist, and disconnect the fuel pressure line at the fuel pump module.
4. Install the Fuel Pressure Decay Tool between the fuel supply line and the fuel pump module.
5. Again, purge air from the system.

6. Turn the ignition on.
7. With the scan tool, actuate the Fuel Pump.

> *NOTE:*
>
> *On vehicles equipped with a PWM Fuel Pump, actuate the Fuel Pump at or above 60%.*

8. Read the Fuel Pressure Gauge (3) and record the reading.

> *NOTE:*
>
> *The fuel pressure specification for all engines, including a **Non SRT-4** is 407 kPa +/- 34 kPa (59 psi +/- 5 psi). **SRT-4** fuel pressure specification is 552 kPa +/- 34 kPa (80 psi +/- 5 psi).*

Is the fuel pressure now within specification?

Yes

1. Repair/replace fuel supply line as necessary.
2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

No

1. Go To Step 11

> *CAUTION:*
>
> *Stop all actuation tests before proceeding.*

11. **CHECKING FUEL INLET STRAINER**

> *WARNING:*
>
> *The fuel system is under a constant pressure (even with the engine off). Before testing or servicing any fuel system hose, fitting or line, the fuel system pressure must be released. Failure to follow these instructions can result in possible serious or fatal injury.*

1. Turn the ignition off.
2. Remove the Fuel Pump Module and inspect the Fuel Inlet Strainer.

Is the Fuel Inlet Strainer plugged?

Yes

1. Replace the Fuel Pump Inlet Strainer.
2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

No

1. Replace the Fuel Pump Module.
2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

DIAGNOSIS AND TESTING > CHECKING THE IGNITION COIL OPERATION

For a complete wiring diagram, **refer to SYSTEM WIRING DIAGRAMS article** .

DIAGNOSIS AND TESTING > CHECKING THE IGNITION COIL OPERATION > DIAGNOSTIC TEST

1. **IGNITION COIL WIRING OR CONNECTORS**

> *NOTE:*
>
> *Diagnose and repair any ignition coil, CMP sensor, or CKP sensor DTCs before proceeding with this test.*

1. Turn the ignition off.
2. Using the wiring diagram/schematic as a guide, inspect the wiring and connectors between the Ignition Coil for the cylinder being tested and the PCM.
3. Look for any chafed, pierced, pinched, or partially broken wires.
4. Look for broken, bent, pushed out or corroded terminals.

> *NOTE:*
>
> *If the vehicle is not equipped with the coil on plug ignition system, check the resistance of the ignition wire(s) before checking the cylinder with a spark tester. The resistance should be below 10k ohms.*

Were any problems found?

Yes

1. Repair as necessary in accordance with the Service Information.
2. Perform the Powertrain Verification Test. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

No

1. Go To Step 2

2. **IGNITION COIL OPERATION**

> *NOTE:*
>
> *Inspect the ignition coil for damage, carbon tracking on the coil or a damaged spark plug insulator boot. If a problem is found, replace the ignition coil.*

> *NOTE:*
>
> *Some coils must have a spark tester installed on both sides of the coil during the following test. During the test, each side of the coil should output a crisp blue spark that is able to jump the gap of the spark tester.*

> *NOTE:*
>
> *On some engines, it may be necessary to remove the upper intake manifold to access the ignition coils. Once the ignition coil has been removed, the intake must be installed in order to crank the engine. Move the ignition coil harness connector through the slots in the upper intake and then connect the coil to the harness connector. Secure the upper intake to the lower intake in accordance with the Service Information.*

1. Turn the ignition off.
2. If the vehicle is equipped with coil on plug ignition system, remove the ignition coil for the cylinder being tested.
3. Disconnect the fuel injector harness connector for the cylinder being tested.
4. For coil on plug ignition systems, install a spark tester(s) on the ignition coil, otherwise install the spark tester to the ignition wire.
5. While cranking the engine observe the spark coming from the spark tester.

> *NOTE:*

A crisp blue spark that jumps the gap of the spark tester should be generated.

Is good spark present?

Yes

1. Go To Step 7

No

1. Go To Step 3

3. **CHECK THE ASD RELAY OUTPUT CIRCUIT FOR AN OPEN/HIGH RESISTANCE**

    1. Turn the ignition off.
    2. Disconnect the Ignition Coil harness connector.
    3. Turn the ignition on.
    4. With the scan tool, actuate the ASD Relay to on.
    5. Using a 12-volt test light connected to ground, check the ASD Relay output circuit at the ignition coil harness connector.

    NOTE:

    The test light should be illuminated and bright. Compare the brightness to that of a direct connection to the battery.

    Is the test light illuminated and bright during the actuation?

    Yes

    1. Go To Step 4

    No

    1. Repair the ASD Relay output circuit for an open or high resistance.
    2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

4. **IGNITION COIL**

WARNING:

When the engine is operating, do not stand in direct line with the fan. Do not put your hands near the pulleys, belts, or fan. Do not wear loose clothing. Failure to follow these instructions can result in possible serious or fatal injury.

1. Using a 12-volt test light connected to 12 volts, check the Ignition Coil Control circuit for the cylinder being tested in the Ignition Coil harness connector.
2. Crank the engine for five seconds.

> *NOTE:*
>
> *The test light should blink each time the circuit is activated by the PCM.*

Does the test light blink each time the circuit is activated by the PCM?

Yes

1. Replace the Ignition Coil in accordance with the Service Information.
2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

No

1. Go To Step 5

5. **CHECK THE IGNITION COIL CONTROL CIRCUIT FOR AN OPEN/HIGH RESISTANCE**

1. Measure the resistance of the Ignition Coil control circuit for the cylinder being tested between the Ignition Coil harness connector and the PCM harness connector.

Is the resistance below 3.0 Ohms?

Yes

1. Go To Step 6

No

1. Repair the Ignition Coil Control circuit for an open or high resistance.
2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

6. **POWERTRAIN CONTROL MODULE (PCM)**

1. Using the wiring diagram/schematic as a guide, inspect the wiring and connectors between the Ignition Coil for the cylinder being tested and the PCM.
2. Look for any chafed, pierced, pinched, or partially broken wires.
3. Look for broken, bent, pushed out or corroded terminals.
4. Perform any Service Bulletins that may apply.

Were any problems found?

Yes

1. Repair as necessary.

2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

No

1. Replace and program the Powertrain Control Module (PCM) in accordance with the Service Information. Refer to MODULE, POWERTRAIN CONTROL, REMOVAL AND INSTALLATION .
2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

7. **SPARK PLUG(S)**

1. Turn the ignition off.
2. Remove the spark plug.
3. Inspect the spark plug for any of the following conditions:
    1. Cracks or damage
    2. Carbon tracking
    3. Foreign material
    4. Gap not within specification
    5. Loose or broken electrode
    6. Fuel fouled

> *NOTE:*
>
> *Lightly tap the bottom of the spark plug on a solid surface. The electrode in the spark plug should not move.*

Were any problems found?

Yes

1. Replace the spark plug.
2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

No

1. Test Complete.

DIAGNOSIS AND TESTING > CHECKING THE MAP SENSOR OPERATION

For a complete wiring diagram, **refer to SYSTEM WIRING DIAGRAMS article** .

DIAGNOSIS AND TESTING > CHECKING THE MAP SENSOR OPERATION > DIAGNOSTIC TEST

1. **MAP SENSOR WIRING OR CONNECTORS**

> *NOTE:*
>
> *Diagnose and repair any MAP Sensor circuit DTCs before proceeding with this test.*

> *NOTE:*
>
> *Diagnose and repair any sensor supply or system voltage DTCs before proceeding with this test.*

    1. Turn the ignition off.
    2. Using the wiring diagram/schematic as a guide, inspect the wiring and connectors between the MAP Sensor and the PCM.
    3. Look for any chafed, pierced, pinched, or partially broken wires.
    4. Look for broken, bent, pushed out or corroded terminals.
    5. Turn the ignition on.
    6. Monitor the scan tool data relative to the sensor and wiggle test the wiring and connectors.
    7. Look for the data to change or for a DTC to set during the wiggle test. If necessary, check each sensor circuit for high resistance or a shorted condition.

       Were any problems found?

       Yes

        1. Repair as necessary in accordance with the Service Information.
        2. Perform the Powertrain Verification Test. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

       No

        1. Go To Step 2

2. **MAP VACUUM/BAROMETRIC PRESSURE**

    1. With a scan tool, read the Barometric Pressure.

> *NOTE:*
>
> *The Barometric Pressure should be approximately equal to the actual barometric pressure. If necessary, compare the Barometric Pressure value of the tested vehicle to the value of a known good vehicle of a similar make and model.*

2. Connect a vacuum gauge to a manifold vacuum source.
3. Start the engine.

> *NOTE:*
>
> *If the engine will not idle, maintain a constant RPM above idle.*

> *WARNING:*
>
> *When the engine is operating, do not stand in direct line with the fan. Do not put your hands near the pulleys, belts, or fan. Do not wear loose clothing. Failure to follow these instructions can result in possible serious or fatal injury.*

4. With the scan tool, read the MAP Sensor value.

> *NOTE:*
>
> *The scan tool reading for MAP vacuum should be within 1" of the vacuum gauge reading.*

Were any problems found?

Yes

1. Go To Step 4

No

1. Go To Step 3

3. **CHECK THE MAP SENSOR VOLTAGE**

1. With the scan tool, monitor the MAP Sensor signal voltage.
2. With the engine idling in neutral or park, snap the throttle.

> *NOTE:*
>
> *The MAP Sensor signal voltage should change from below 2.0 volts at idle to above 3.5 volts at wide open throttle.*

Were any problems found?

Yes

1. Go To Step 4

No

1. Test complete.

4. **CHECK THE 5-VOLT SUPPLY CIRCUIT FOR HIGH RESISTANCE**

1. Turn the ignition off.
2. Using a voltmeter, perform a voltage drop test on the MAP Sensor 5-Volt Supply circuit between the MAP Sensor harness connector and the PCM harness connector. Make sure the voltmeter leads are connected so that positive polarity is displayed on the voltmeter.

> *WARNING:*
>
> *When the engine is operating, do not stand in direct line with the fan. Do not put your hands near the pulleys, belts, or fan. Do not wear loose clothing. Failure to follow these instructions can result in possible serious or fatal injury.*

3. Start the engine.

Is the voltage reading below 0.1 volt?

Yes

1. Go To Step 5

No

1. Repair the 5-Volt Supply circuit for excessive resistance.
2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

5. **CHECK THE MAP SENSOR SIGNAL CIRCUIT FOR HIGH RESISTANCE**

1. Turn the ignition off.
2. Using a voltmeter, perform a voltage drop test on the MAP Sensor Signal circuit between the MAP Sensor harness connector and the PCM harness connector. Make

sure the voltmeter leads are connected so that positive polarity is displayed on the voltmeter.

> *WARNING:*
>
> *When the engine is operating, do not stand in direct line with the fan. Do not put your hands near the pulleys, belts, or fan. Do not wear loose clothing. Failure to follow these instructions can result in possible serious or fatal injury.*

3. Start the engine.

   Is the voltage reading below 0.1 volt?

   Yes

   1. Go To Step 6

   No

   1. Repair the MAP Sensor Signal circuit for excessive resistance.
   2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

6. **CHECK THE MAP SENSOR GROUND CIRCUIT FOR HIGH RESISTANCE**

   1. Turn the ignition off.
   2. Using a voltmeter, perform a voltage drop test on the MAP Sensor Ground circuit between the MAP Sensor harness connector and the PCM harness connector. Make sure the voltmeter leads are connected so that positive polarity is displayed on the voltmeter.

      > *WARNING:*
      >
      > *When the engine is operating, do not stand in direct line with the fan. Do not put your hands near the pulleys, belts, or fan. Do not wear loose clothing. Failure to follow these instructions can result in possible serious or fatal injury.*

   3. Start the engine.

      Is the voltage below 0.1 volt?

      Yes

      1. Go To Step 7

      No

      1. Repair the MAP Sensor Ground circuit for excessive resistance.

2. Perform the Powertrain Verification Test. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

7. **MAP SENSOR**

    1. Using the wiring diagram/schematic as a guide, inspect the wiring and connectors between the MAP Sensor and the Powertrain Control Module (PCM).
    2. Look for any chafed, pierced, pinched, or partially broken wires.
    3. Look for broken, bent, pushed out or corroded terminals.
    4. Perform any Service Bulletins that may apply.

    Were any problems found?

    Yes

    1. Repair as necessary.
    2. Perform the Powertrain Verification Test. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

    No

    1. Replace the MAP Sensor in accordance with the Service Information. Refer to SENSOR, MANIFOLD AIR PRESSURE (MAP), REMOVAL AND INSTALLATION .
    2. Perform the Powertrain Verification Test. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

DIAGNOSIS AND TESTING > CHECKING THE OXYGEN SENSOR OPERATION

For a complete wiring diagram, **refer to SYSTEM WIRING DIAGRAMS article** .

DIAGNOSIS AND TESTING > CHECKING THE OXYGEN SENSOR OPERATION > THEORY OF OPERATION

The 4-Wire Oxygen Sensor is equipped with a galvanic battery that typically generates a voltage signal between 0.0 volts and 1.0 volts. The 4-Wire O2 Sensor also includes a heating element that keeps the sensor at proper operating temperature during all operating modes. Maintaining correct sensor temperature at all times allows the system to enter into closed loop operation sooner. Also, it allows the system to remain in closed loop operation during periods of extended idle.

A bias voltage in the Powertrain Control Module (PCM) shifts the signal voltage to fluctuate between 2.5 volts and 3.5 volts, depending upon the oxygen content of the exhaust gas. When a large amount of oxygen is present (caused by a lean air/fuel mixture) the sensor produces a low voltage. When there is a lesser amount of oxygen present (caused by a rich air/fuel mixture) it produces a higher voltage. By monitoring the oxygen content and converting it to electrical voltage, the sensor acts as a rich-lean switch.

In Open Loop operation the PCM ignores input from the O2 Sensors. In Closed Loop operation the PCM monitors the O2 Sensor's input (along with other inputs) and adjusts the injector pulse width accordingly based on pre-programmed (fixed) values and inputs from other sensors. The PCM also compares upstream and downstream O2 Sensor inputs to calculate the catalytic convertor oxygen storage capacity and converter efficiency.

The 4-Wire Downstream O2 Sensor serves two functions. The first function is to measure the catalyst efficiency. If the Catalytic Converter is working properly, the oxygen content of the exhaust gases at the converter outlet fluctuate significantly less than the converter inlet. The PCM compares the switching rates of both Downstream and Upstream O2 Sensors under specific operating conditions to determine if the catalyst is functioning properly. Anytime the upstream to downstream switching ratio exceeds a calibrated value, a catalyst efficiency DTC is set.

The second function of the Downstream O2 Sensor is downstream fuel control and is active only during downstream closed loop operation. This function trims the 4-Wire upstream O2 Sensor goal voltage within the range of Upstream O2 Sensor operation. The Upstream O2 Sensor goal voltage is modified to ensure long Catalytic Converter life by allowing the PCM to control the amount of oxygen that is supplied to the catalytic converter. The downstream O2 Sensor is a good indicator of how much oxygen remains after all of the reactions take place in the converter.

If the O2 Sensor is powered up by the PCM and operating normally, the voltage readings should be as follows;

- Key on engine off.
    - Measured voltage on the Signal circuit with the sensor at ambient temperature should be near 35mv.
    - Measured voltage on the Return circuit with the sensor at ambient temperature should be near 15mv.
- Key on engine running.
    - Measured voltage on the Fused ASD Output circuit (at the PCM) should be the same as battery voltage.
    - Measured voltage on the Heater Control circuit should be near 7 volts.

DIAGNOSIS AND TESTING > CHECKING THE OXYGEN SENSOR OPERATION > DIAGNOSTIC TEST

1. **TEST FOR A RICH O2 SENSOR CONDITION**
    1. Start the engine.
    2. Allow the engine to reach normal operating temperature.
    3. Disconnect engine vacuum lines to create a lean running condition.
    4. With the engine vacuum lines disconnected monitor the O2 Sensor graph on the scan tool.

       Did the O2 Sensor graph show a change from rich to lean?

Yes

1. Check for any of the following conditions/mechanical problems that can cause a O2 Sensor stuck rich condition:
2. AFTERMARKET equipment or software effecting emissions.
3. AIR INDUCTION SYSTEM - must be free from blockage.
4. ENGINE VALVE TIMING - must be within specifications.
5. ENGINE COMPRESSION - must be within specifications.
6. ENGINE EXHAUST SYSTEM - must be free of any restrictions or leaks.
7. ENGINE PCV SYSTEM - must flow freely.
8. FUEL - must be free of contamination.
9. FUEL INJECTOR - plugged, stuck open or restricted injector.

No

1. Replace the Oxygen Sensor in accordance with the Service Information. Refer to SENSOR, OXYGEN, REMOVAL AND INSTALLATION .
2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

2. **TEST FOR A LEAN O2 SENSOR CONDITION**

1. Start the engine.
2. Allow the engine to reach normal operating temperature.
3. Create a rich running condition.
4. With the rich running condition, monitor the O2 Sensor graph on the scan tool.

   Did the O2 Sensor graph show a change from lean to rich?

   Yes

   1. AFTERMARKET equipment or software effecting emissions.
   2. AIR INDUCTION SYSTEM - must be free from leaks.
   3. ENGINE VACUUM - must be at least 13 inches in neutral.
   4. ENGINE VALVE TIMING - must be within specifications.
   5. ENGINE COMPRESSION - must be within specifications.
   6. ENGINE EXHAUST SYSTEM - must be free of any restrictions or leaks.
   7. ENGINE PCV SYSTEM - must be free of leaks and flow freely.
   8. POWER BRAKE BOOSTER - no internal vacuum leaks.

9. FUEL - must be free of contamination.
10. FUEL INJECTOR - plugged or restricted injector; control wire not connected to correct injector.

No

1. Replace the Oxygen Sensor in accordance with the Service Information. Refer to SENSOR, OXYGEN, REMOVAL AND INSTALLATION .
2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

DIAGNOSIS AND TESTING > CHECKING THE PCM POWER AND GROUND CIRCUITS

For a complete wiring diagram, **refer to SYSTEM WIRING DIAGRAMS article** .

DIAGNOSIS AND TESTING > CHECKING THE PCM POWER AND GROUND CIRCUITS > DIAGNOSTIC TEST

1. **PCM WIRING OR CONNECTORS**
    1. Turn the ignition off.
    2. Using the wiring diagram/schematic as a guide, inspect the wiring and each connector at the PCM.
    3. Look for any chafed, pierced, pinched or partially broken wires.
    4. Look for broken, bent, pushed out or corroded terminals.

    Were any problems found?

    Yes

    1. Repair as necessary.
    2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

    No

    1. Go To Step 2
2. **CHECK THE PCM GROUND CIRCUITS**
    1. Turn the ignition off.
    2. Using a 12-volt test light connected to 12 volts, probe the PCM ground circuits.
    3. Wiggle test the wiring during the test to check for an intermittent open in the circuit.

> *NOTE:*
>
> *The test light should be illuminated and bright. Compare the brightness to that of a direct connection to the battery.*

Is the test light illuminated and bright?

Yes

1. Go To Step 3

No

1. Repair the PCM ground circuit(s) for an open or high resistance.
2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

3. **CHECK THE PCM FUSED B+ CIRCUIT**

1. Using a 12-volt test light connected to ground, probe the PCM Fused B+ circuit.
2. Wiggle test the wiring during the test to check for an intermittent open in the circuit.

> *NOTE:*
>
> *The test light should be illuminated and bright. Compare the brightness to that of a direct connection to the battery.*

Is the test light illuminated and bright?

Yes

1. Go To Step 4

No

1. Repair the PCM Fused B+ circuit for an open or high resistance.
2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

4. **CHECK THE FUSED IGNITION SWITCH CIRCUITS**

1. Turn the ignition on.
2. Using a 12-volt test light connected to ground, probe the Fused Ignition Switch circuit.
3. Check the circuit with the ignition off, ignition on/engine not running position and during cranking.

4. Wiggle test the wiring during the test to check for an intermittent open in the circuit.

> *NOTE:*
>
> *The test light should be illuminated and bright with the ignition on and during cranking. The test light should not be illuminated with the ignition off. Compare the brightness to that of a direct connection to the battery.*

Is the test light illuminated as described above?

Yes

1. Test complete.

No

1. Repair the PCM Fused Ignition Switch circuit for as necessary.
2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

DIAGNOSIS AND TESTING > ENGINE CRANKS BUT DOES NOT START

For a complete wiring diagram, **refer to SYSTEM WIRING DIAGRAMS article** .

DIAGNOSIS AND TESTING > ENGINE CRANKS BUT DOES NOT START > POSSIBLE CAUSES

Possible Causes
5-VOLT SUPPLY CIRCUIT OPEN OR SHORTED
UNDERCHARGED BATTERY
SYSTEM DTCS PRESENT
POWERTRAIN POWER AND GROUND CIRCUIT(S) OPEN OR HIGH RESISTANCE
POWERTRAIN FUSES OPEN
FUEL DELIVERY SYSTEM
FUEL CONTAMINATION
INADEQUATE SPARK
ENGINE MECHANICAL PROBLEM

Always perform the PRE-DIAGNOSTIC TROUBLESHOOTING PROCEDURE before proceeding. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

DIAGNOSIS AND TESTING > ENGINE CRANKS BUT DOES NOT START > DIAGNOSTIC TEST

1. **UNDERCHARGED BATTERY**

> *NOTE:*
>
> *Diagnose any 5-Volt Supply DTCs before continuing*

> *NOTE:*
>
> *The Battery must be fully charged and in good condition. An undercharged Battery may produce invalid test results.*

    1. Test the battery in accordance with the Service Information.

       Were any problems found?

       Yes

        1. Charge or replace the Battery as necessary and retest.
        2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

       No

        1. Go To Step 2

2. **OPEN FUSE(S)**

    1. Inspect all of the fuses in the Fuse Panel. If any open fuses are found, check the related circuit(s) for a short to ground or high resistance.

       Were any problems found?

       Yes

        1. Repair as necessary.
        2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

       No

        1. Go To Step 3

3. **SYSTEM DTCS PRESENT**

    1. With the scan tool, select System DTCs to read DTCs in all modules. If any DTCs

are present, perform the appropriate diagnostic procedure before continuing with this test. If a no response condition is detected in any module, and perform the appropriate No Response diagnostic procedure.

Were any problems found?

Yes

1. Perform the appropriate diagnostic procedure and repair as necessary. If any pending DTCs are detected, perform the diagnostic procedure as if the DTC is active.
2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

No

1. Go To Step

4. **PCM POWER OR GROUND CIRCUIT OPEN OR HIGH RESISTANCE**

1. Perform the CHECKING THE PCM POWER AND GROUND CIRCUIT test procedure. Refer to CHECKING THE PCM POWER AND GROUND CIRCUITS .

Were any problems found?

Yes

1. Repair as necessary in accordance with the Service Information.
2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

No

1. Go To Step

5. **CHECKING THE FUEL DELIVERY SYSTEM**

> *NOTE:*
>
> *Verify that the fuel tank is not empty before continuing.*

1. Perform the CHECKING THE FUEL DELIVERY SYSTEM test procedure. Refer to CHECKING THE FUEL DELIVERY SYSTEM (HARD START) .

Were any problems found?

Yes

1. Repair as necessary in accordance with the Service Information.
2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

No

1. Go To Step 6

6. **FUEL CONTAMINATION**

1. Check the fuel system for contamination in accordance with the Service Information.

   Was any evidence of fuel contamination found?

   Yes

   1. Clean and repair the fuel system as necessary in accordance with the Service Information.
   2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

   No

   1. Go To Step 7

7. **CHECKING THE IGNITION COIL OPERATION**

1. Perform the diagnostic procedure for CHECKING THE IGNITION COIL OPERATION. Refer to CHECKING THE IGNITION COIL OPERATION .

   Were any problems found?

   Yes

   1. Repair as necessary in accordance with the Service Information.
   2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

   No

   1. Go To Step 8

8. **CHECKING THE ENGINE MECHANICAL SYSTEM**

1. Perform the diagnostic procedure for CHECKING THE ENGINE MECHANICAL SYSTEM. Refer to CHECKING THE ENGINE MECHANICAL SYSTEM .

   Were any problems found?

   Yes

   1. Repair as necessary in accordance with the Service Information.
   2. Perform the POWERTRAIN VERIFICATION TEST. Refer to the appropriate TESTING & DIAGNOSTICS article in ENGINE PERFORMANCE .

   No

   1. Test complete. Perform any Service Bulletins that may apply.