

2006 ENGINE**Engine Controls - 2.4L - Troubleshooting - HHR****SYMPTOMS - ENGINE CONTROLS****IMPORTANT PRELIMINARY INSPECTIONS BEFORE STARTING**

Before using the Symptom tables, perform the following:

- Perform **Diagnostic System Check - Vehicle** and verify all of the following items:
 - Ensure that the engine control module (ECM) and malfunction indicator lamp (MIL) are operating correctly.
 - Ensure that there are no diagnostic trouble codes (DTCs) that are stored.
 - Scan tool data is within a normal operating range. Refer to **Scan Tool Data List**.
- Verify the customer concern.
- Perform the Visual/Physical Inspection in this section. The visual/physical inspection is extremely important, and can lead to correcting a condition without additional testing. It may also help reveal the cause of an intermittent condition.
- Locate the correct symptom. Perform the tests and inspections associated with the symptom.

IDENTIFYING INTERMITTENT CONDITIONS

Many intermittent conditions occur with harness or connector movement due to engine torque, rough pavement, vibration or physical movement of a component. Refer to the following for a list to help determine an intermittent condition:

- Moisture and water intrusion in connectors, terminals, and components
- Connector mating
- Terminal contact
- High circuit or component resistance-High resistance can include any resistance, regardless of the amount, which can interrupt the operation of the component.
- Harness that is located too tight, or chaffed circuits
- High or low ambient temperature
- High or low engine coolant temperatures
- High underhood temperatures
- Heat build up in component or circuit due to circuit resistance, poor terminal contact, or high electrical load
- High or low system voltage
- High vehicle load conditions

- Rough road surface
- Electro-magnetic interference (EMI)/circuit interference from relays, solenoids or other electrical surge
- Incorrect installation of non-factory, aftermarket, and after factory add on accessories

If an intermittent is determined, refer to **Testing for Intermittent Conditions and Poor Connections** for specific strategies in diagnosing intermittent conditions.

VISUAL/PHYSICAL CHECK

NOTE: Use the connector test adapter kit J 35616-A for any test that requires probing the following items:

- The PCM harness connectors
- The electrical center fuse/relay cavities
- The component terminals
- The component harness connector

Using this kit will prevent damage caused by the improper probing of connector terminals.

Several of the symptom procedures call for a careful visual and physical inspection. This can lead to correcting a condition without further tests and can save time. This inspection should include the following areas:

- Ensure that the control module grounds are clean, tight, and correctly located. Refer to **Master Electrical Component List** and **Power and Grounding Connector End Views**.
- Inspect vacuum hoses for splits, kinks, and proper connections, as shown on the Vehicle Emission Control Information label. Inspect thoroughly for any type of a leak or a restriction. Refer to Emission Hose Routing Diagram.
- Inspect for a dirty or restricted air filter.
- Inspect for water intrusion in the mass air flow (MAF)/intake air temperature (IAT) sensor connector, heated oxygen sensor (HO2S) connectors, control module connectors or any other harness connectors.
- Inspect the air intake ducts, particularly between the MAF sensor and the throttle body for the following conditions:
 - Collapsed
 - Damaged areas
 - Looseness

- Incorrect installation
- Leaking
- Inspect for air leaks at the throttle body mounting area, the MAF sensor and intake manifold sealing surfaces.
- Inspect the wiring harness for the following conditions:
 - Poor connections
 - Pinches
 - Cuts
- Inspect for loose, damaged, unseated, or missing sensors/components.
- Inspect terminals for corrosion and correct contact.

SYMPTOMS

Hard Start

Engine cranks OK, but does not start for a long time. Does eventually run, or may start but immediately stalls.

Surges/Chuggles

Engine power variation under steady throttle or cruise. Feels like the vehicle speeds up and slows down without a change in the accelerator pedal position.

Lack of Power, Sluggishness, or Sponginess

The engine delivers less than expected power. Little increase in speed, or a total lack of acceleration when the accelerator pedal is pushed down part way.

Detonation/Spark Knock

A mild to severe ping which usually occurs worse while under acceleration. The engine makes sharp metallic knocks that change with throttle opening.

Hesitation, Sag, Stumble

Momentary lack of response as the accelerator is pushed down. This condition can occur at any vehicle speed. This condition is usually more pronounced when first trying to make the vehicle move, as from a stop sign. This condition may cause the engine to stall if severe enough.

Cuts Out, Misses

A steady pulsation or jerking that follows engine speed, which is usually more

pronounced as the engine load increases. This condition is not normally felt above 1,500 RPM or 48 km/h (30 mph). The exhaust has a steady spitting sound at idle or at low speed.

Poor Fuel Economy

Fuel economy, as measured by an actual road test, is noticeably lower than expected. Also, the fuel economy is noticeably lower than it was on this vehicle at one time, as previously shown by an actual road test.

Rough, Unstable, or Incorrect Idle and Stalling

The engine runs unevenly at idle. If severe, the engine or the vehicle may shake. Engine idle may vary in speed. Either condition may be severe enough to stall the engine.

Dieseling, Run-On

The engine continues to run after the key is turned OFF, but runs very rough. If the engine runs smooth, inspect the ignition switch and the ignition switch adjustment.

Backfire

Fuel ignites in the intake manifold or in the exhaust system, making a loud popping noise.

Use the following symptoms in order to isolate possible systems that are associated with the condition:

Symptoms

Symptoms	Action/System
Find the symptom in the left column and perform the test/inspection procedure in the right column	
• Hard Start • Backfire	• <u>Symptoms - Fuel System</u> • <u>Symptoms - Ignition System</u> • <u>Symptoms - Sensors/Systems</u> • Engine exhaust-Refer to <u>Symptoms - Engine Exhaust</u> . • Inspect the engine mechanical for oil consumption, correct engine compression and correct base engine timing-Refer to <u>Symptoms - Engine Mechanical</u> . • Backfire-Inspect the intake and exhaust system and associated passages for casting flash.

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	• Inspect the engine cooling system for correct level and operation-Refer to <u>Symptoms - Engine Cooling</u> . • Inspect the engine electrical system for correct operation-Refer to <u>Charging System Test</u> .
Surges/Chuggles	• <u>Symptoms - Fuel System</u> • <u>Symptoms - Ignition System</u> • <u>Symptoms - Sensors/Systems</u> • Inspect the engine mechanical for oil consumption, correct engine compression and correct base engine timing-Refer to <u>Symptoms - Engine Mechanical</u> . • Inspect the engine electrical system for correct operation-Refer to <u>Charging System Test</u> . • Engine exhaust-Refer to <u>Restricted Exhaust</u> . • Ensure the customer understands the operation of the Automatic Transmission including the Tap shift option if applicable. • HVAC System operation-Ensure the customer understands the operation of the HVAC system.
Lack of Power, Sluggishness, or Sponginess	• <u>Symptoms - Fuel System</u> • <u>Symptoms - Ignition System</u> • <u>Symptoms - Sensors/Systems</u> • Inspect for a restricted air intake system. • Inspect for a dirty or restricted air filter. • Inspect the engine mechanical for oil consumption, correct engine compression and correct base engine timing-Refer to <u>Symptoms - Engine Mechanical</u> . • Inspect the engine electrical system for correct operation-Refer to <u>Charging System Test</u> . • Engine Exhaust-Refer to <u>Restricted Exhaust</u> . • Ensure the customer understands the operation of the Automatic Transmission including the Tap shift option if applicable. • Torque Management System, if applicable-Refer to <u>ABS Description and Operation</u> and <u>Symptoms - Antilock Brake System</u> . • HVAC System operation
• Hesitation, Sag,	• <u>Symptoms - Fuel System</u>

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Stumble • Cuts Out, Misses • Rough, Unstable, or Incorrect Idle and Stalling	• <u>Symptoms - Ignition System</u> • <u>Symptoms - Sensors/Systems</u> • Inspect for a restricted air intake system. • Inspect for a dirty or restricted air filter. • Inspect the engine mechanical for oil consumption, correct engine compression and correct base engine timing-Refer to <u>Symptoms - Engine Mechanical</u> . • Inspect the engine electrical system for correct operation-Refer to <u>Charging System Test</u> . • Engine Cooling System-Refer to <u>Symptoms - Engine Cooling</u> . • Engine Exhaust-Refer to <u>Restricted Exhaust</u> . • Inspect the engine mounts. Refer to <u>Engine Mount Inspection</u> . • Inspect the crankcase ventilation system-Refer to <u>Crankcase Ventilation System Inspection/Diagnosis</u> . • Inspect the air intake system for leaks and unmetered air • HVAC System operation • Inspect the automatic transmission for proper shifting and TCC engagement.
Detonation/Spark Knock	• Excessive heavy loads or review owner's driving habits-Consult the Vehicle Owner's Manual. • Ensure quality fuel is used-Consult the Vehicle Owner's Manual • <u>Symptoms - Fuel System</u> • <u>Symptoms - Ignition System</u> • Inspect the engine mechanical for the following: ○ Oil consumption ○ Carbon build up or other hot point within the combustion chamber ○ Correct engine compression ○ Correct base engine timing Refer to <u>Symptoms - Engine Mechanical</u> . • Engine Cooling System-Refer to <u>Engine</u>

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	<u>Overheating</u> . • Inspect the automatic transmission for proper shifting and TCC engagement.
Poor Fuel Economy	• Proper tire inflation-Refer to Tires in Service and Appearance Care in the vehicle Owner's Manual. • Inspect for a dirty or restricted air filter. • Fuel Quality-Refer to the following: ◦ <u>Alcohol/Contaminants-in-Fuel Diagnosis</u> ◦ Fuel Service and Appearance Care in the vehicle Owner's Manual • <u>Symptoms - Fuel System</u> • <u>Symptoms - Ignition System</u> • <u>Symptoms - Sensors/Systems</u> • Inspect the engine mechanical for oil consumption, correct engine compression and correct base engine timing-Refer to <u>Symptoms - Engine Mechanical</u> . • Inspect the crankcase ventilation system-Refer to <u>Crankcase Ventilation System Inspection/Diagnosis</u> . • Inspect the engine cooling system for correct level and operation-Refer to <u>Symptoms - Engine Cooling</u> . • Engine Electrical System operation-Refer to <u>Charging System Test</u> . • Engine Exhaust-Refer to <u>Symptoms - Engine Exhaust</u> . • HVAC System operation-Ensure the customer understands the operation of the HVAC system • Ensure the customer understands the operation of the Automatic Transmission including the Tap shift option if applicable. • Inspect the Braking System-Refer to <u>Brakes Drag</u> .
Dieseling/Run-On	• <u>Symptoms - Fuel System</u> • <u>Symptoms - Ignition System</u> • Inspect the engine mechanical for the following: ◦ Carbon build up or other hot point within the combustion chamber ◦ Correct engine compression

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- Correct base engine timing

Refer to **Symptoms - Engine Mechanical** .

- Inspect the intake and exhaust system and associated passages for casting flash.

SYMPTOMS - FUEL SYSTEM

Fuel System

Symptoms	Fuel System
Find the symptom in the left column and perform the test/inspection procedure in the right column, be sure to review each cell of the table to identify all tests for a symptom.	
● Hard Start ● Surges /Chuggles ● Lack of Power, Sluggishness, or Sponginess ● Detonation/Spark Knock ● Hesitation, Sag, Stumble ● Cuts Out, Misses ● Poor Fuel Economy ● Rough, Unstable, or Incorrect Idle and Stalling ● Backfire	● Test the fuel system for correct operation, restriction, volume, and pressure. Refer to <u>Fuel System Diagnosis</u> and <u>Fuel Pump Electrical Circuit Diagnosis</u>. ● Inspect for a contaminated fuel condition. Refer to <u>Alcohol/Contaminants-in-Fuel Diagnosis</u>. ● Inspect the throttle body for coking. Refer to <u>Throttle Body Cleaning Procedure</u> . ● Inspect for lean or rich conditions. Refer to P0171, P0172, P0173, or P0174 conditions for running the DTC.
Dieseling/Run On	Test the fuel system for excessive fuel pressure. Refer to <u>Fuel System Diagnosis</u> .
● Hard Start ● Surges /Chuggles ● Lack of Power, Sluggishness, or Sponginess ● Detonation/Spark Knock ● Hesitation, Sag, Stumble	Test for proper operation of the fuel injectors. Refer to <u>Fuel Injector Diagnosis</u> .

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• Cuts Out, Misses • Poor Fuel Economy • Rough, Unstable, or Incorrect Idle and Stalling • Dieseling, Run-On	
• Surges /Chuggles • Lack of Power, Sluggishness, or Sponginess • Hesitation, Sag, Stumble • Cuts Out, Misses • Rough, Unstable, or Incorrect Idle and Stalling	Inspect the evaporative emission (EVAP) system for the following: • Excess fuel in the EVAP lines and/or in the EVAP canister-Refer to Evaporative Emissions (EVAP) Hose Routing Diagram . • Integrity-Refer to System Testing in DTC P0442 .

SYMPTOMS - IGNITION SYSTEM

Ignition System

Symptoms	Ignition System
Find the symptom in the left column and perform the test/inspection procedure in the right column, be sure to review each cell of the table to identify all tests for a symptom.	
• Hard Start • Surges /Chuggles • Lack of Power, Sluggishness, or Sponginess • Detonation/Spark Knock • Hesitation, Sag, Stumble • Cuts Out, Misses • Poor Fuel Economy • Rough, Unstable, or Incorrect Idle and Stalling • Dieseling, Run-On	• Inspect for proper Ignition System operation. Refer to Electronic Ignition (EI) System Diagnosis. • Inspect spark plugs and spark plug boots. Refer to Spark Plug Inspection . • Inspect the spark plugs for correct application. Refer to Ignition System Specifications .

• Backfire	
• Hard Start • Surges /Chuggles • Lack of Power, Sluggishness, or Sponginess • Hesitation, Sag, Stumble • Cuts Out, Misses • Poor Fuel Economy • Rough, Unstable, or Incorrect Idle and Stalling • Backfire	Inspect the crankshaft position (CKP) sensor for the following: • CKP sensor for damage and proper installation- Refer to <u>Crankshaft Position (CKP) Sensor Replacement</u> . • Inspect the CKP Sensor and corresponding harness for electro-magnetic interference (EMI).

SYMPTOMS - SENSORS/SYSTEMS

Sensor/System

Symptoms	Sensor/System
Find the symptom in the left column and perform the test/inspection procedure in the right column, be sure to review each cell of the table to identify all tests for a symptom.	
• Hard Start • Surges /Chuggles • Hesitation, Sag, Stumble • Cuts Out, Misses • Poor Fuel Economy • Rough, Unstable, or Incorrect Idle and Stalling • Backfire	• Inspect the mass air flow (MAF) sensor for proper installation, obstruction, contamination, and damage. Refer to <u>Mass Air Flow (MAF)/Intake Air Temperature (IAT) Sensor Replacement</u> . • Inspect the MAF sensor for proper seating of the connector and terminals. • Inspect the manifold absolute pressure (MAP) sensor for proper installation, obstruction, and damage. Refer to <u>Manifold Absolute Pressure (MAP) Sensor Replacement</u> . • Ensure the quality of the MAP sensor vacuum source.
• Hard Start • Detonation/Spark Knock • Hesitation, Sag, Stumble	• Inspect for vacuum leaks and other unmetered air. • Test the engine coolant temperature (ECT) sensor for being shifted in value. Refer to the <u>Temperature vs Resistance</u> .

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• Poor Fuel Economy • Rough, Unstable, or Incorrect Idle and Stalling	
• Surges /Chuggles • Lack of Power, Sluggishness, or Sponginess • Detonation/Spark Knock • Poor Fuel Economy • Backfire	Monitor the Knock Sensor (KS) System for excessive spark retard activity. Refer to the Knock Sensor description within in the <u>Electronic Ignition (EI) System Description</u> .
Hesitation, Sag, Stumble	Inspect the accelerator pedal position (APP) sensor and the related wiring. Inspect the Throttle Actuator Control (TAC) System for proper operation.
• Surges /Chuggles • Lack of Power, Sluggishness, or Sponginess • Hesitation, Sag, Stumble • Cuts Out, Misses • Poor Fuel Economy • Rough, Unstable, or Incorrect Idle and Stalling • Backfire	Inspect for contaminated oxygen sensor (O2S).
Poor Fuel Economy	Inspect for proper operation of the speedometer. Refer to <u>Speedometer and/or Odometer Inaccurate or Inoperative</u> .
• Hard Start • Surges /Chuggles • Poor Fuel Economy • Rough, Unstable, or Incorrect Idle and Stalling • Backfire	Inspect the camshaft actuator for correct operation. Refer to <u>Camshaft Actuator System Description</u> .

MALFUNCTION INDICATOR LAMP (MIL) DIAGNOSIS

DIAGNOSTIC FAULT INFORMATION

IMPORTANT: Always perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.

CIRCUIT/SYSTEM DESCRIPTION

Ignition voltage is supplied to the malfunction indicator lamp (MIL). The engine control module (ECM) turns the MIL ON by grounding the MIL control circuit.

REFERENCE INFORMATION

Schematic Reference

- Instrument Cluster Schematics
- Engine Controls Schematics

Connector End View Reference

- Instrument Panel, Gages, and Console Connector End Views
- Engine Control Module (ECM) Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

- Scan Tool Data List
- Scan Tool Output Controls

CIRCUIT/SYSTEM VERIFICATION

The MIL should turn ON and OFF when commanded with a scan tool.

CIRCUIT/SYSTEM TESTING

1. Turn OFF the ignition.
2. Disconnect the ECM.

3. Turn ON the ignition with the engine OFF.
 - If the MIL is still ON, test the MIL control circuit for a short to ground.
 - If the MIL control circuit tested OK and the MIL stayed ON, replace the instrument panel cluster (IPC).
 - If the MIL control circuit tested OK and the MIL went out when the ECM was disconnected, replace the ECM.
4. Measure for 12 volts from the MIL ignition voltage circuit in the ECM harness connector to a ground.
 - If there is less than 12 volts, test the MIL ignition voltage circuit for an open, or a short to ground and an open fuse.
5. Remove the fuse that supplies voltage to the MIL.
6. Measure for less than one volt from the MIL control circuit in the ECM harness connector to a good ground.
 - If there is more than one volt, test the MIL control circuit for a short to voltage.
7. Install the fuse that supplies voltage to the MIL.
8. The MIL should illuminate with a 3-amp fused jumper wire connected between the MIL control circuit in the ECM harness connector and a good ground.
 - If the MIL does not illuminate, test the MIL control circuit for an open or high resistance.
 - If the MIL control circuit tests OK, replace the IPC.
 - If the MIL does illuminate, but does not when commanded ON with a scan tool, replace the ECM.

REPAIR PROCEDURES

IMPORTANT: Always perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Control Module References for ECM replacement, setup, and programming
- Instrument Panel Cluster (IPC) Replacement

ENGINE CRANKS BUT DOES NOT RUN

DIAGNOSTIC FAULT INFORMATION

IMPORTANT: Always perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.

CIRCUIT/SYSTEM DESCRIPTION

This Engine Cranks but Does Not Run is an organized approach to identify a condition

which causes the engine to crank but not start. This diagnostic directs the technician to the appropriate system diagnosis.

This diagnostic assumes the system voltage levels are adequate for starter motor operation. Refer to **Battery Inspection/Test** , and **Engine Cranks Slowly** . Fuel level and fuel quality should be determined for correct diagnosis.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Engine Control Module (ECM) Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**
- **Starting System Description and Operation**

Scan Tool Reference

Scan Tool Data List

Special Tools Required

J 34730-1A Fuel Pressure Gage

CIRCUIT/SYSTEM VERIFICATION

Attempt to start the engine. Engine should start and run.

CIRCUIT/SYSTEM TESTING

1. Crank the engine for up to 30 seconds.
2. Observe the Engine DTC information with a scan tool.
 - If any of the following DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** to diagnose those DTCs P0201-P0206, P0335, P0336, P0351-P0353, P0601, P0602, P0603, P0604, P0606, P0607, P060E, P062F, P0685, P0689, P0690, P1516, P2610.

3. Observe the engine speed parameter while cranking the engine.
 - If engine RPM is not indicated, refer to **Electronic Ignition (EI) System Diagnosis**.
4. Install a spark tester.
5. Crank the engine for 15 seconds. Spark should be observed from the Spark Tester.
 - If spark is not observed refer to **Electronic Ignition (EI) System Diagnosis**.
6. With the ignition ON and the engine OFF, test the fuses that are supplied by the powertrain relay for voltage. The test lamp should illuminate at each fuse test point.
 - Emission Fuse
 - Ignition 1 Fuse
 - If the test lamp does not illuminate on at least one side of each fuse refer to **DTC P0685, P0689, or P0690** .

IMPORTANT: Additional DTCs may set when using the fuel pump output control.

7. Command the fuel pump ON and OFF. Fuel pump should energize when commanded ON and De-energize when commanded OFF
 - If the fuel pump does not respond refer to **Fuel Pump Electrical Circuit Diagnosis**.
8. Turn OFF the ignition.
9. Install the **J 34730-1A** Fuel Pressure Gage. Turn ON the ignition and command the fuel pump ON while observing the **J 34730-1A** . The fuel pressure should be between 345-414 kPa (50-60 psi).
 - If the fuel pressure is not within 345-414 kPa (50-60 psi) refer to **Fuel System Diagnosis**.
10. Inspect for the following conditions:
 - Compare the actual engine coolant temperature to the ECT parameter.
 - Air filter and air intake system for restrictions and obstructions
 - Test the fuel for contamination. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis**.
 - Inspect the spark plug and spark plug wires. Refer to **Spark Plug Inspection** .
 - Test the exhaust system for restrictions. Refer to **Restricted Exhaust** .

REPAIR PROCEDURES

IMPORTANT: Always perform the Diagnostic Repair Verification after completing the diagnostic procedure.

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FUEL PUMP ELECTRICAL CIRCUIT DIAGNOSIS

DIAGNOSTIC FAULT INFORMATION

Always perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.

Fuel Pump Electrical Circuit Diagnosis

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Battery Voltage - Relay Switch Side	1	2	-	-
Fuel Pump Supply Voltage	1	2	3	-
Fuel Pump Relay Control	P0230	P0230	P0230	-
Fuel Pump Relay Ground	P0230	P0230	P0230	-
Fuel Pump Ground	-	2	-	-
¹ Open fuel pump fuse, cranks no start ² Cranks no start ³ Fuel pump operates continuously, then discharged battery				

CIRCUIT/SYSTEM DESCRIPTION

The control module enables the fuel pump relay when the ignition switch is turned ON. The control module will disable the fuel pump relay within 2 seconds unless the control module detects ignition reference pulses. The control module continues to enable the fuel pump relay as long as ignition reference pulses are detected. The control module disables the fuel pump relay within 2 seconds if ignition reference pulses cease to be detected and the ignition remains ON.

DIAGNOSTIC AIDS

The following conditions may cause the fuel pump fuse to open:

- The fuse is faulty.
- There is an intermittent short to ground in the supply voltage circuit of the fuel pump.
- The fuel pump has an intermittent internal condition.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

- Engine Control Module (ECM) Connector End Views
- Engine Controls Connector End Views
- Electrical Center Identification Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

- Scan Tool Data List
- Scan Tool Data Definitions
- Scan Tool Output Controls

Special Tools Required

J 43244 Relay Puller Pliers

CIRCUIT/SYSTEM VERIFICATION

1. With the ignition ON, engine OFF, command the fuel pump relay ON and OFF several times using the scan tool output control function. You should either hear or feel the relay click and the fuel pump should turn ON and OFF with each command.
 - If the fuel pump operates continuously, test for a faulty relay or a short to voltage in the supply voltage circuit of the fuel pump.

CIRCUIT/SYSTEM TESTING

1. With the ignition OFF, remove the fuel pump relay from the underhood electrical center.
2. With the ignition ON, engine OFF, probe the control circuit of the fuel pump relay with a test lamp that is connected to a good ground. Command the fuel pump relay ON and OFF with a scan tool. The test lamp should turn ON and OFF with each command.
 - If the test lamp does not turn ON and OFF, test for an open, high resistance, or a short to ground in the fuel pump relay control circuit, an intermittent or a poor connection at the engine control module (ECM) or a faulty ECM.
 - If the test lamp remains illuminated with each command, test for a short to voltage in the control circuit of the fuel pump relay, an intermittent or a poor connection

at the ECM, or a faulty ECM.

3. Connect a test lamp between the control circuit of the fuel pump relay and the ground circuit of the fuel pump relay. Command the fuel pump relay ON and OFF with a scan tool.
 - If the test lamp does not turn ON and OFF, repair the open or the high resistance in the ground circuit of the fuel pump relay.
 - If the test lamp does turn ON and OFF, test for an intermittent and for a poor connection at the fuel pump relay, or a faulty fuel pump relay.
4. Inspect the fuel pump fuse.
 - If the fuel pump fuse is open, test for a short to ground in the supply voltage circuit of the fuel pump, or a faulty fuel pump module.
5. With the ignition ON, engine OFF, probe the battery positive voltage circuit of the fuel pump relay with a test lamp that is connected to a good ground.
 - If the test lamp does not illuminate, repair the open in the battery positive voltage circuit.
6. Connect a 15-amp fused jumper wire between the battery positive voltage circuit of the fuel pump relay and the supply voltage circuit of the fuel pump.
 - If the fuel pump operates, test for an intermittent or poor connection at the fuel pump relay, or a faulty fuel pump relay.
 - If the fuel pump does not operate, test for an open or high resistance in the supply voltage circuit of the fuel pump, an open or high resistance in the ground circuit of the fuel pump, an intermittent or poor connection at the fuel pump module cover, or a faulty fuel pump module.

REPAIR PROCEDURES

IMPORTANT: Always perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Control Module References for ECM replacement, setup, and programming.
- Fuel Pump Module Replacement
- Relay Replacement (Within an Electrical Center) or Relay Replacement (Attached to Wire Harness)

FUEL SYSTEM DIAGNOSIS

DIAGNOSTIC FAULT INFORMATION

Always perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.

CIRCUIT/SYSTEM DESCRIPTION

The control module enables the fuel pump relay when the ignition switch is turned ON. The control module will disable the fuel pump relay within 2 seconds unless the control module detects ignition reference pulses. The control module continues to enable the fuel pump relay as long as ignition reference pulses are detected. The control module disables the fuel pump relay within 2 seconds if ignition reference pulses cease to be detected and the ignition remains ON.

The fuel system is a returnless on-demand design. The fuel pressure regulator is a part of the fuel pump module, eliminating the need for a return pipe from the engine. A returnless fuel system reduces the internal temperature of the fuel tank by not returning hot fuel from the engine to the fuel tank. Reducing the internal temperature of the fuel tank results in lower evaporative emissions.

The fuel tank stores the fuel supply. An electric turbine style fuel pump attaches to the fuel pump module inside the fuel tank. The fuel pump supplies high pressure fuel through the fuel feed pipe to the fuel injection system. The fuel pump provides fuel at a higher rate of flow than is needed by the fuel injection system. The fuel pump also supplies fuel to a venturi pump located on the bottom of the fuel pump module. The function of the venturi pump is to fill the fuel pump module reservoir. The fuel pressure regulator, a part of the fuel pump module, maintains the correct fuel pressure to the fuel injection system. The fuel pump module contains a reverse flow check valve. The check valve and the fuel pressure regulator maintain fuel pressure in the fuel feed pipe and the fuel rail in order to prevent long cranking times.

REFERENCE INFORMATION

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

- **Scan Tool Data List**
- **Scan Tool Data Definitions**
- **Scan Tool Output Controls**

Special Tools Required

- **J 34730-1A Fuel Pressure Gage**
- **J 37287 Fuel Line Shut-off Adapter**

CIRCUIT/SYSTEM VERIFICATION

- IMPORTANT:**
- Inspect the fuel system for damage or external leaks before proceeding.
 - Verify that adequate fuel is in the fuel tank before proceeding.

1. Turn ON the ignition, with the engine OFF.
2. Command the fuel pump relay ON with a scan tool.
 - If the fuel pump does not operate, refer to **Fuel Pump Electrical Circuit Diagnosis**.
3. Turn OFF the ignition.
4. Turn OFF all accessories.
5. Install a **J 34730-1A**. Refer to **Fuel Pressure Gage Installation and Removal**.
6. Turn ON the ignition, with the engine OFF.

- IMPORTANT:**
- The fuel pump relay may need to be commanded ON a few times in order to obtain the highest possible fuel pressure.
 - DO NOT start the engine.

7. Command the fuel pump relay ON with a scan tool.
8. Observe the **J 34730-1A** with the fuel pump commanded ON. The fuel pressure should be 345-414 kPa (50-60 psi).
 - If the fuel pressure is less than 345 kPa (50 psi), inspect for a restricted fuel feed pipe, poor connections at the harness connectors and ground circuits of the fuel pump, or a faulty fuel pump module.
 - If the fuel pressure is more than 414 kPa (60 psi), replace the fuel pump module.

IMPORTANT: The fuel pressure may vary slightly when the fuel pump stops operating. After the fuel pump stops operating, the fuel pressure should stabilize and remain constant.

9. Monitor the **J 34730-1A** for 1 minute. The fuel pressure should not decrease more than 34 kPa (5 psi).
 - If the fuel pressure decreases more than 34 kPa (5 psi), refer to Circuit/System Testing.
10. Relieve the fuel pressure to 69 kPa (10 psi).
11. Monitor the **J 34730-1A** for 5 minutes. The fuel pressure should not decrease more than 14 kPa (2 psi).

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- If the fuel pressure decreases more than 14 kPa (2 psi), replace the fuel pump module.
- 12. Remove the **J 34730-1A** . Refer to **Fuel Pressure Gage Installation and Removal** .
- 13. Operate the vehicle within the conditions to reproduce the original symptoms.
- 14. Monitor the O2 and the Fuel Trim parameters with a scan tool.
 - If the scan tool parameters indicate a lean condition, inspect for a restricted fuel feed pipe, poor connections at the harness connectors and ground circuits of the fuel pump, or a faulty fuel pump module.
 - If the scan tool parameters do not indicate a lean condition, go to **Symptoms - Engine Controls**.

CIRCUIT/SYSTEM TESTING

1. Turn OFF the ignition.
2. Relieve the fuel pressure. Refer to **Fuel Pressure Relief Procedure** .
3. Disconnect the chassis fuel hose from the fuel rail. Refer to **Quick Connect Fitting(s) Service (Metal Collar)** .
4. Install the **J 37287** between the chassis fuel hose and the fuel rail.
5. Open the valve on the **J 37287** .
6. Turn ON the ignition, with the engine OFF.
7. Command the fuel pump relay ON with a scan tool.
8. Bleed the air from the **J 34730-1A** .
9. Command the fuel pump relay ON and then OFF with a scan tool.
10. Close the fuel feed pipe shut-off valve.
11. Monitor the **J 34730-1A** for one minute.
 - If the fuel pressure remains constant, replace the fuel pump module.
 - If the fuel pressure does not remain constant, locate and replace the leaking fuel injectors.

REPAIR PROCEDURES

IMPORTANT: Always perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Fuel Injector Replacement**
- **Fuel Pump Module Replacement**

FUEL INJECTOR DIAGNOSIS

DIAGNOSTIC FAULT INFORMATION

IMPORTANT: Always perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.

CIRCUIT/SYSTEM DESCRIPTION

The control module enables the appropriate fuel injector pulse for each cylinder. The ignition voltage is supplied directly to the fuel injectors. The control module controls each fuel injector by grounding the control circuit via a solid state device called a driver. A fuel injector coil winding resistance that is too high or too low will affect the engine driveability. A fuel injector control circuit DTC may not set, but a misfire may be apparent. The fuel injector coil windings are affected by temperature. The resistance of the fuel injector coil windings will increase as the temperature of the fuel injector increases.

When performing the fuel injector balance test, the scan tool is first used to energize the fuel pump relay. The fuel injector tester or the scan tool is then used to pulse each injector for a precise amount of time, allowing a measured amount of the fuel to be injected. This causes a drop in the system fuel pressure that can be recorded and used to compare each injector.

DIAGNOSTIC AIDS

- Monitoring the misfire current counters, or misfire graph, may help to isolate the fuel injector that is causing the condition.
- Operating the vehicle over a wide temperature range may help isolate the fuel injector that is causing the condition.
- Perform the fuel injector coil test within the conditions of the customers concern. A fuel injector condition may only be apparent at a certain temperature, or under certain conditions.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

Engine Controls Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

- Scan Tool Data List
- Scan Tool Data Definitions
- Scan Tool Output Controls

Special Tools Required

- **J 34730-1A** Fuel Pressure Gage
- **J 39021** Fuel Injector Coil and Balance Tester
- **J 44602** Injector Test Adapter

COMPONENT TESTING

Fuel Injector Coil Test

1. Observe the ECT Sensor parameter with a scan tool. The ECT sensor should be 10-32°C (50-90°F).
 - If the ECT Sensor parameter is not within 10-32°C (50-90°F), go to step 3.
2. Measure the resistance of each fuel injector with a DMM. The resistance of each fuel injector should be 11-14 ohms.
 - If the resistance of any fuel injector is not 11-14 ohms, replace the fuel injector.
3. Measure and record the resistance of each fuel injector with a DMM. Subtract the lowest resistance value from the highest resistance value. The difference between the lowest value and the highest value should be equal to or less than 3 ohms.
 - If the difference is equal to or less than 3 ohms, perform the Fuel Injector Balance Test-Fuel Pressure Test.
 - If the difference is more than 3 ohms, continue with the Fuel Injector Coil Test.
4. Add all of the fuel injector resistance values to obtain a total resistance value. Divide the total resistance value by the number of fuel injectors to obtain an average resistance value. Subtract the lowest individual fuel injector resistance value from the average resistance value. Compute the difference between the highest individual fuel injector resistance value and the average resistance value.
 - Replace the fuel injector that displays the greatest resistance difference above or below the average.
5. Perform the Fuel Injector Balance Test-Fuel Pressure Test.

IMPORTANT: DO NOT perform this test if the engine coolant temperature (ECT) is above 94°C (201°F). Irregular fuel pressure readings may result due to hot soak fuel boiling.

IMPORTANT: Verify that adequate fuel is in the fuel tank before proceeding with this diagnostic.

Fuel Injector Balance Test-Fuel Pressure Test

1. Install a fuel pressure gage. Refer to Fuel Pressure Gage Installation and Removal .
2. Turn ON the ignition, with the engine OFF.

IMPORTANT:

- The fuel pump relay may need to be commanded ON a few times in order to obtain the highest possible fuel pressure.
- DO NOT start the engine.

3. Command the fuel pump relay ON with a scan tool.
4. Observe the fuel pressure gage with the fuel pump commanded ON. The fuel pressure should be 345-414 kPa (50-60 psi).

- If the fuel pressure is not 345-414 kPa (50-60 psi), refer to Fuel System Diagnosis.

IMPORTANT: The fuel pressure may vary slightly when the fuel pump stops operating. After the fuel pump stops operating, the fuel pressure should stabilize and remain constant.

5. Monitor the fuel pressure gage for one minute. The fuel pressure should not decrease more than 34 kPa (5 psi).
 - If the fuel pressure decreases more than 34 kPa (5 psi), refer to Fuel System Diagnosis.
6. Perform the Fuel Injector Balance Test with Special Tool or the Fuel Injector Balance Test with Tech 2.

Fuel Injector Balance Test with Special Tool

1. Set the amperage supply selector switch on the fuel injector tester to the Balance Test 0.5-2.5 amp position.
2. Connect the **J 39021** to a fuel injector with a **J 44602** .
3. Command the fuel pump relay ON and then OFF with a scan tool.
4. Record the fuel pressure indicated by the fuel pressure gage after the fuel pressure stabilizes. This is the first pressure reading.

IMPORTANT: The fuel pressure may rise after the fuel injector stops pulsing. Record the fuel pressure value immediately after

the fuel injector stops pulsing. DO NOT record the higher fuel pressure value.

5. Energize the fuel injector by depressing the Push to Start Test button on the fuel injector tester.
6. Record the fuel pressure indicated by the fuel pressure gage after the fuel injector has stopped pulsing. This is the second pressure reading.
7. Repeat steps 2-6 for each fuel injector.
8. Perform the Pressure Drop Calculation.

Fuel Injector Balance Test with Tech 2

1. With a scan tool, select the Fuel Injector Balance Test function within the Special Functions menu.
2. Select an injector to be tested.
3. Press Enter to prime the fuel system.
4. Record the fuel pressure indicated by the fuel pressure gage after the fuel pressure stabilizes. This is the first pressure reading.

IMPORTANT: Record the fuel pressure value immediately after the fuel injector stops pulsing. The fuel pressure may rise after the fuel injector stops pulsing. DO NOT record the higher fuel pressure value.

5. Energize the fuel injector by depressing the Pulse Injector button on the scan tool. This will energize the injector and decrease the fuel pressure.
6. Record the fuel pressure indicated by the fuel pressure gage after the fuel injector has stopped pulsing. This is the second pressure reading.
7. Press Enter again to bring you back to the Select Injector screen.
8. Repeat steps 2-7 for each fuel injector.
9. Perform the Pressure Drop Calculation.

Pressure Drop Calculation

1. Subtract the second pressure reading from the first pressure reading for one fuel injector. The result is the pressure drop value.
2. Obtain a pressure drop value for each fuel injector.
3. Add all of the individual pressure drop values. This is the total pressure drop.
4. Divide the total pressure drop by the number of fuel injectors. This is the average pressure drop. The difference between any individual pressure drop and the average pressure drop should not be more than 20 kPa (3 psi).

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- If the difference between any individual pressure drop and the average pressure drop is more than 20 kPa (3 psi), replace the fuel injector.

REPAIR PROCEDURES

IMPORTANT: Always perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Fuel Injector Replacement

FUEL INJECTOR CIRCUIT DIAGNOSIS

DIAGNOSTIC FAULT INFORMATION

IMPORTANT: Always perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.

Fuel Injector Circuit Diagnosis

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition 1 Voltage - Fuse to Splice	1	2	-	-
Ignition 1 Voltage - Splice to Injector	1	P0201, P0202, P0203, or P0204	-	-
Fuel Injector 1 Control	P0201	P0201	P0201	-
Fuel Injector 2 Control	P0202	P0202	P0202	-
Fuel Injector 3 Control	P0203	P0203	P0203	-
Fuel Injector 4 Control	P0204	P0204	P0204	-
¹ Open fuse, cranks no start ² Cranks no start				

CIRCUIT/SYSTEM DESCRIPTION

The control module enables the appropriate fuel injector pulse for each cylinder. Ignition voltage is supplied to the fuel injectors. The control module controls each fuel injector by grounding the control circuit via a solid state device called a driver.

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

- Engine Control Module (ECM) Connector End Views
- Engine Controls Connector End Views

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

- Scan Tool Data List
- Scan Tool Data Definitions
- Scan Tool Output Controls

Special Tools Required

J 44603 Injector Test Lamp

CIRCUIT/SYSTEM TESTING

1. Remove the air cleaner outlet resonator. Refer to **PSD SIE TITLE Error: SIE linked to empty Cell ID 18864**.
2. Disconnect a fuel injector.
3. With the ignition ON, engine OFF, probe the ignition 1 voltage circuit of the fuel injector with a test lamp that is connected to a good ground. The test lamp should illuminate.
 - If the test lamp does not illuminate, repair the open in the ignition 1 voltage circuit between the fuse and the splice.
4. Remove the INJ IGN MOD fuse.
5. Measure the resistance between the INJ IGN MOD fuse to the ignition 1 voltage circuit terminal of a fuel injector with a DMM. All wire circuit resistance should measure less than 2 ohms.
 - If the resistance is more than 2 ohms, repair the high resistance in the ignition 1 voltage circuit.
6. Connect the **J 44603** into each fuel injector connector one at a time. Crank the engine.
 - If the test lamp flashes for each injector, perform the Fuel Injector Diagnosis.

Refer to **Fuel Injector Diagnosis**.

- If the test lamp does not flash for each injector, test for an open or a short to voltage in the control circuit of the fuel injector, an intermittent or poor connection at the engine control module (ECM), or a faulty ECM.
- If the test lamp remains illuminated at all times for any injector circuit, test for a short to ground in the control circuit of the fuel injector, or a faulty ECM.

REPAIR PROCEDURES

IMPORTANT: Always perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References

FUEL TANK LEAK TEST

DIAGNOSTIC FAULT INFORMATION

Always perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.

TEST DESCRIPTION

The fuel tank leak test is used to locate any fuel or fuel vapor escaping the fuel tank area. Fuel vapors escaping above the fuel level will be detected, if more than the calibrated amount, when the evaporative emission (EVAP) diagnostics complete one test cycle. The malfunction indicator lamp (MIL) will illuminate after the EVAP diagnostics have failed 2 test cycles.

DIAGNOSTIC AIDS

- Operate the vehicle under the condition of the customer concern. Under high temperature conditions fuel vapors may increase to the point of EVAP canister vapor saturation. Fuel vapors would then be released into the atmosphere. Once the engine is running and the EVAP purge is enabled, all fuel vapor release would be eliminated.
- Movement of the EVAP pipes or the fuel pipes may help find an intermittent condition.
- If the fuel level is low, a liquid fuel leak may not be evident.

REFERENCE INFORMATION

Special Tools Required

- **J 41413-200** Evaporative Emissions System Tester (EEST)
- **GE-41415-50** Interrupted Thread Cap Adapter. See **Special Tools**.

SYSTEM VERIFICATION

CAUTION: Gasoline or gasoline vapors are highly flammable. A fire could occur if an ignition source is present. Never drain or store gasoline or diesel fuel in an open container, due to the possibility of fire or explosion. Have a dry chemical (Class B) fire extinguisher nearby.

- Inspect the fuel tank and the fuel pipes for damage or external leaks.
- Turn ON the ignition, with the engine OFF. Command the fuel pump relay ON with a scan tool. Inspect for fuel leaking from the fuel pipes.

SYSTEM TESTING

IMPORTANT: If the floating indicator registers any flow after stabilizing, a leak is evident.

1. Turn OFF the ignition. Install the **J 41413-200** and the **GE-41415-50**. See Special Tools. Test for a fuel leak while the system is under pressure referring to the J 41413-210 Operation Manual.

IMPORTANT: It may be necessary to partially lower the fuel tank.

2. Using the **J 41413-200** and the J 41413-210 Operation Manual, introduce smoke into the evaporative emission (EVAP) system. Inspect for leaks in any of the following locations:
 - The fuel tank, the fill limiter vent valve, the pressure relief valve, and the grade vent valves
 - The fuel pump module housing, the fuel pump module seal, the fuel pipe, and the EVAP pipes
 - The fuel tank pressure (FTP) sensor seal
 - The fuel fill pipe and hose

REPAIR PROCEDURES

IMPORTANT: Always perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Evaporative Emission (EVAP) Hoses/Pipes Replacement - Engine/Chassis
- Filler Tube Replacement
- Fuel Feed Intermediate Pipe Replacement

- **Fuel Hose/Pipes Replacement - Chassis**
- **Fuel Pump Module Replacement**
- **Fuel Tank Replacement**
- **Fuel Tank Vent Pipe Replacement**

ALCOHOL/CONTAMINANTS-IN-FUEL DIAGNOSIS

TEST DESCRIPTION

Water contamination in the fuel system may cause driveability conditions such as hesitation, stalling, no start, or misfires in one or more cylinders. Water may collect near a single fuel injector at the lowest point in the fuel injection system and cause a misfire in that cylinder. If the fuel system is contaminated with water, inspect the fuel system components for rust or deterioration.

Ethanol concentrations of greater than 10 percent can cause driveability conditions and fuel system deterioration. Fuel with more than 10 percent ethanol could result in driveability conditions such as hesitation, lack of power, stalling, or no start. Excessive concentrations of ethanol used in vehicles not designed for it may cause fuel system corrosion, deterioration of rubber components, and fuel filter restriction.

REFERENCE INFORMATION

Special Tool

J 44175 Fuel Composition Tester

SYSTEM VERIFICATION

The fuel sample should be drawn from the bottom of the tank so that any water present in the tank will be detected. The sample should be bright and clear.

- If the sample appears cloudy, or contaminated with water, as indicated by a water layer at the bottom of the sample, perform the Particulate Contaminants in Fuel Testing Procedure.
- If alcohol contamination is suspected, perform the Alcohol in Fuel Testing procedure.

ALCOHOL IN FUEL TESTING WITH SPECIAL TOOL

1. Test the fuel composition using **J 44175** and Instruction Manual.
2. If water appears in the fuel sample, clean the fuel system.
3. Subtract 50 from the reading on the DMM in order to obtain the percentage of alcohol in the fuel sample.
4. If the fuel sample contains more than 15 percent ethanol, add fresh, regular gasoline to

the vehicle's fuel tank.

5. Test the fuel composition.
6. If testing shows the ethanol percentage is still more than 15 percent, replace the fuel in the vehicle.

ALCOHOL IN FUEL TESTING WITHOUT SPECIAL TOOL

1. Using a 100 ml (3.38 oz) specified cylinder with 1 ml (0.034 oz) graduation marks, fill the cylinder with fuel to the 90 ml (3.04 oz) mark.
2. Add 10 ml (0.34 oz) of water in order to bring the total fluid volume to 100 ml (3.38 oz) and install a stopper.
3. Shake the cylinder vigorously for 10-15 seconds.
4. Carefully loosen the stopper in order to release the pressure.
5. Re-install the stopper and shake the cylinder vigorously again for 10-15 seconds.
6. Put the cylinder on a level surface for approximately 5 minutes in order to allow adequate liquid separation. If alcohol is present in the fuel, the volume of the lower layer, which would now contain both alcohol and water, will be more than 10 ml (0.34 oz). For example, if the volume of the lower layer is increased to 15 ml (0.51 oz), this indicates at least 5 percent alcohol in the fuel. The actual amount of alcohol may be somewhat more because this procedure does not extract all of the alcohol from the fuel.

PARTICULATE CONTAMINANTS IN FUEL TESTING PROCEDURE

1. Using an approved fuel container, draw approximately 0.5 liter (0.53 qt) of fuel.
2. Place the container on a level surface for approximately 5 minutes in order to allow settling of the particulate contamination. Particulate contamination will show up in various shapes and colors. Sand will typically be identified by a white or light brown crystals. Rubber will appear as black and irregular particles.
3. Observe the fuel sample. If any physical contaminants or water are present, clean the fuel system.

REPAIR PROCEDURES

IMPORTANT: Always perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Fuel System Cleaning

ELECTRONIC IGNITION (EI) SYSTEM DIAGNOSIS

DIAGNOSTIC FAULT INFORMATION

IMPORTANT: Always perform the Diagnostic System Check - Vehicle prior to

using this diagnostic procedure.

CIRCUIT/SYSTEM DESCRIPTION

The ignition system uses individual ignition coil/module assemblies for each cylinder. The engine control module (ECM) controls the individual coils by transmitting timing pulses on the ignition control (IC) circuit of each ignition coil/module to enable a spark event. Each ignition coil/module has the following circuits:

- An ignition voltage circuit
- A ground circuit
- An IC control circuit
- A low reference circuit

REFERENCE INFORMATION

Schematic Reference

Engine Controls Schematics

Connector End View Reference

- **Engine Controls Connector End Views**
- **Engine Control Module (ECM) Connector End Views**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

- **Scan Tool Data List**
- **Scan Tool Output Controls**

CIRCUIT/SYSTEM VERIFICATION

Observe the Engine Controls Schematic for the ignition coils/modules, and review the Ignition System Specifications and the spark plug inspection procedure to verify the following:

- The ignition coil/modules are correctly connected

- The proper firing order
- The proper spark plug type
- The proper spark plug gap and torque

Refer to **Ignition System Specifications** and **Spark Plug Inspection** .

- A high resistance on any IC control circuit can cause a misfire before DTC P0351-P0354 sets.

CIRCUIT/SYSTEM TESTING

IMPORTANT: Verify that the engine is in good mechanical condition before continuing with this diagnostic.

1. Turn ON the ignition.
2. Inspect the fuse that supplies voltage to the ignition coil/modules.
 - If the fuse is open, then test the spliced circuits and the individual ignition coil/modules for a short to ground.
3. Disconnect the affected ignition coil/module.
4. Connect a test lamp between the ignition coil/module ignition 1 voltage circuit and a good ground.
5. With the test lamp still connected, measure for battery voltage between the ignition 1 voltage circuit and a good ground.
 - If the voltage is not within 1 volt of battery voltage, repair the high resistance or the open in the ignition 1 voltage circuit.
6. Turn OFF the ignition, and all electrical accessories. Allow sufficient time for all of the control modules to power down before taking a resistance measurement.
7. Measure for a proper value of less than 5 ohms of resistance between the ground circuit of the affected ignition coil/module and a good ground.
 - If the resistance is more than 5 ohms, repair the high resistance or the open in the ground circuit.
8. Exchange the affected ignition coil/module with the ignition coil/module of a good cylinder.
9. Start the engine and observe the scan tool.
 - If the misfire transfers with the suspect ignition coil/module, replace as needed.
 - If the misfire does not transfer with the suspect ignition coil/module, observe the component testing procedures below, and replace the spark plug if needed.

COMPONENT TESTING

- Use the Spark Plug Inspection procedure to verify the integrity of the spark plugs.

Refer to **Spark Plug Inspection** .

- Use the **J 26792** Spark Tester to verify the output of each ignition coil/module.

REPAIR PROCEDURES

IMPORTANT: Always perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Ignition Coil(s) Replacement**
- **Spark Plug Replacement**

INSPECTION/MAINTENANCE (I/M) SYSTEM CHECK

DIAGNOSTIC FAULT INFORMATION

IMPORTANT: Always perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.

DESCRIPTION

Several states require that a vehicle pass on-board diagnostic (OBD) system tests and the inspection/maintenance (I/M) emission inspection in order to renew license plates. This is accomplished by viewing the I/M System Status display on a scan tool. Using a scan tool, the technician can observe the I/M System Status in order to verify that the vehicle meets the criteria that comply with the local area requirements.

CONDITIONS FOR UPDATING THE I/M SYSTEM STATUS

Each system monitor requires at least one, and sometimes several diagnostic tests. The result of each test is reported by a diagnostic trouble code (DTC). A system monitor is complete when either all of the DTCs composing the monitor have Run and Passed, or when any one of the DTCs comprising the monitor has illuminated the malfunction indicator lamp (MIL). Once the system monitor is complete, the I/M System Status display will indicate YES in the Completed column.

For example, when the HO2S Heater Status indicates YES, either all of the oxygen sensor heater tests have passed or one of the tests has illuminated the MIL. If the vehicle has four heated oxygen sensors, either all four heater circuit tests have passed or one of the heater circuit tests has illuminated the MIL. The I/M System Status will indicate NO under the Completed column when any of the required tests for that system have not run. The following is a list of conditions that would set the I/M System Status indicator to NO:

- The vehicle is new from the factory and has not yet been driven through the necessary drive conditions to complete the tests.

- The battery has been disconnected or discharged below operating voltage.
- The control module power or ground has been interrupted.
- The control module has been reprogrammed.
- The control module DTCs have been cleared.

MONITORED EMISSION CONTROL SYSTEMS

The OBD II System monitors all emission control systems that are on-board. The OBD II regulations require monitoring of the following:

- The air conditioning system
- The catalytic converter efficiency
- Comprehensive component monitoring-Emission related inputs and outputs
- The evaporative emission (EVAP) system
- The fuel delivery system
- Heated catalyst monitoring
- Misfire monitoring
- The oxygen sensor system (O₂S or HO₂S)
- The oxygen sensor heater system (HO₂S heater)

For the specific DTCs required for each system, refer to. Systems such as fuel delivery, misfire, and comprehensive components may not be listed in a system status list. These tests run continuously and do not require an I/M System Status indicator.

CIRCUIT/SYSTEM VERIFICATION

Review the I/M System Status indicators. All I/M System Status indicators should report YES.

CIRCUIT/SYSTEM TESTING

IMPORTANT: Many DTC related repairs will instruct the technician to clear the DTC information. Clearing the DTC will reset the I/M System Status indicators to NO. Performing the I/M Complete System Set Procedure will set each of the I/M System Status indicators to YES.

1. Observe the Engine DTC information with a scan tool.
 - If a DTC is set that would prevent the I/M System Status tests from completing, diagnose that DTC before continuing. Refer to **Inspection/Maintenance (I/M) System DTC Table**.
2. Review applicable service bulletins for software updates that would prevent the I/M

System Status tests from completing.

- If a control module re-program or other repair is required, perform the **Inspection/Maintenance (I/M) Complete System Set Procedure**.

3. Observe the I/M System Status indicators.

- If any I/M System Status indicators report NO, perform the **Inspection/Maintenance (I/M) Complete System Set Procedure**.

INSPECTION/MAINTENANCE (I/M) COMPLETE SYSTEM SET PROCEDURE

DIAGNOSTIC FAULT INFORMATION

IMPORTANT: Always perform the **Inspection/Maintenance (I/M) System Check** prior to using this diagnostic procedure.

DESCRIPTION

The purpose of the Inspection/Maintenance (I/M) complete system set procedure is to satisfy the enable criteria necessary to execute all of the I/M readiness diagnostics and complete the trips for those particular diagnostics. When all I/M monitored diagnostic tests are completed, the I/M System Status indicators are set to YES. Perform the I/M Complete System Set Procedure if any I/M System Status indicators are set to NO.

I/M DATA LIST

To determine if the I/M readiness diagnostic tests can be run this ignition cycle, use a scan tool to observe the I/M monitor enabled parameters in the I/M Data List.

CONDITIONS FOR MEETING A COLD START

- The ignition voltage between 11-18 volts.
- The barometric pressure (BARO) is more than 75 kPa.
- The start-up engine coolant temperature (ECT) is between 4-30°C (39-86°F).
- The start-up intake air temperature (IAT) is between 4-30°C (39-86°F).
- The difference between the IAT and the ECT is 6°C (10.8°F)
- The ambient air temperature is between 4-30°C (39-86°F).
- The fuel level is between 15-85 percent.
- Vehicle has NOT been refueled since the last cold start ignition cycle.

CIRCUIT/SYSTEM VERIFICATION

Review the I/M System Status indicators. All I/M System Status indicators should report YES.

INSPECTION/MAINTENANCE (I/M) SYSTEM SET PROCEDURE

IMPORTANT: Whenever the ignition is turned ON, ignition positive voltage is supplied to the heated oxygen sensor (HO2S) heaters. After verifying the enable criteria, turn OFF the ignition for approximately 5 minutes to allow the sensors to cool before continuing with the test. Once the engine is started, do NOT turn the engine OFF for the remaining portion of the set procedure.

1. Ensure that the vehicle meets the conditions for a cold start listed above.
 - If the evaporative emission (EVAP) I/M System Status indicator displays NO, perform the EVAP Service bay test if applicable.
 - If the EVAP Service Bay Test is NOT available, it may take up to 6 drive cycles, with up to 17 hours between drive cycles, for the EVAP I/M System Status indicator to transition to YES.
 - If the O2S Heater System Status indicator displays NO, ensure that the ignition has been turned OFF for at least 10 hours.
2. Turn OFF all accessories; HVAC system, other electrical loads, including aftermarket/add-on equipment, etc.
3. Set the vehicle parking brake and ensure the vehicle is in park for automatic transmission or neutral for manual transmission.
4. Turn the ignition ON with the engine OFF for 1 minute.
5. Start and idle the engine for 2 minutes and until 65°C (149°F) is achieved.
6. Run the engine for 8 minutes within the following conditions:
 - MAF parameter between 4-30 g/s
 - Engine speed steady between 1,000-3,000 RPM
7. Apply and hold brake pedal, and shift to Drive for automatic, or apply clutch pedal for manual and operate the vehicle within the following conditions for 2 minutes:
 - Mass air flow (MAF) signal between 15-30 g/s
 - RPM steady between 1,200-1,500 RPM

IMPORTANT: Do NOT touch the accelerator pedal during the idle period. A change in throttle position (TP) Sensor angle or an increase in engine speed may invalidate this portion of the test.

8. Release the accelerator pedal and allow the engine to idle for 2 minutes.

CAUTION: Refer to Road Test
Caution .

9. Release the parking brake and drive vehicle at 24 km/h (15 mph) or slower for 2 minutes.
10. Continue to drive the vehicle for at least 5.5 miles between 45 km/h-112 km/h (28-70 mph) with the vehicle reaching at least 80 km/h (50 mph).
11. Safely stop the vehicle, apply the parking brake and shift to Park for automatic, or Neutral and release clutch pedal for manual.

IMPORTANT: Do NOT disturb the vehicle or turn ON the ignition until told to do so. Disturbing the vehicle may invalidate this portion of the test.

12. Turn OFF the ignition and exit the vehicle. Do NOT disturb the vehicle for 45 minutes.
13. Observe the I/M System Status with a scan tool. All of the I/M System Status indicators should display YES.
 - If the EVAP I/M System Status indicator displays NO turn OFF the ignition for 17 hours, ensure that the vehicle meets the conditions for a cold start, and repeat steps 10-13 six more times, or until the EVAP I/M System Status indicator transitions to YES. If the indicator continues to display NO, refer to the **Inspection/Maintenance (I/M) System DTC Table** to identify the DTCs that did not run.
- If any of the I/M System Status indicators display NO, refer to the **Inspection/Maintenance (I/M) System DTC Table** for the indicator which did not display YES. The I/M System DTC Table identifies the DTCs associated with each I/M System Status Indicator.

INSPECTION/MAINTENANCE (I/M) SYSTEM DTC TABLE

Inspection/Maintenance (I/M) System DTC Table

System	DTCs Required to Set System Status to YES
Catalyst Monitor If an I/M System Status indicator did NOT update to YES during the <u>Inspection/Maintenance (I/M) System Check</u> , review each indicator and reference this table to determine each DTC associated with the I/M System Status Indicator. Each DTC listed below has specific conditions that must be met for the diagnostic to run. Included in these conditions are additional DTCs which, if set, will inhibit these DTCs from running. Reviewing and operating the vehicle within the Conditions for Running for each DTC listed below will allow the I/M System Status Indicators to transition to YES.	
Catalyst	<u>DTC P0420</u>
EVAP	<u>DTC P0442</u>

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	<u>DTC P0443 or P0449</u> <u>DTC P0446</u> <u>DTC P0451, P0452, P0453, or P0454</u> <u>DTC P0455</u> <u>DTC P0496</u>
Oxygen Sensor	<u>DTC P0131, P0132, P0137, P0138, P2A00, or P2A01</u> <u>DTC P0133, P0134, P0140, or P1133</u>
Oxygen Sensor Heater	<u>DTC P0030, P0036, P0053, P0054, P0135, or P0141</u>