

2006 ENGINE**Engine Controls - 2.8L - Troubleshooting - CTS****SYMPTOMS - ENGINE CONTROLS****IMPORTANT PRELIMINARY INSPECTIONS BEFORE STARTING**

Before using this section, perform the **Diagnostic System Check - Vehicle** in Vehicle DTC Information and verify all of the following conditions:

- The engine control module (ECM) and the malfunction indicator lamp (MIL) are operating correctly.
- There are no DTCs stored.
- The scan tool data is within the normal operating range. Refer to **Scan Tool Data List**.
- Verify the customer concern and locate the correct symptom. Inspect the items indicated under that symptom.
- Several of the symptom procedures ask for a careful visual/physical inspection. This step is extremely important, and can lead to correcting a condition without further inspections and can save valuable time.
- If an intermittent condition exists as a start and then a stall, inspect for any DTCs related to the theft deterrent system. Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** in Vehicle DTC Information.
- Verify the proper installation of any of the following non-original equipment accessories:
 - Lights
 - Cellular phone
 - Remote starter system
 - Non-factory installed alarm

1. Use the following tables when diagnosing a symptom concern:

- **Hard Start**
- **Surges/Chuggles**
- **Lack of Power, Sluggishness, or Sponginess**
- **Detonation/Spark Knock**
- **Hesitation, Sag, Stumble**
- **Cuts Out, Misses**
- **Poor Fuel Economy**
- **Poor Fuel Fill Quality**
- **Rough, Unstable, or Incorrect Idle and Stalling**
- **Dieseling, Run-On**
- **Backfire**

2. If the condition cannot be isolated using the appropriate table, refer to **Intermittent Conditions** for further diagnosis.

INTERMITTENT CONDITIONS

Intermittent Conditions

Inspections	Action
DEFINITION: The condition is not currently present but is indicated in DTC history. OR There is a customer concern, but the symptom cannot currently be duplicated, if the condition is not DTC related.	
Preliminary	• The fault must be present to locate a condition using the DTC table. If a condition is intermittent, the use of DTC tables may result in the replacement of good parts. • Inspect the engine control system grounds for being clean, tight, and in the correct locations. Refer to <u>Engine Controls Schematics</u> . Ensure the resistance between the engine control module (ECM) housing and the battery negative cable is less than 0.5 ohms.
Visual/Physical	This step is an important aid for locating a condition without extensive testing. Perform a thorough inspection of the following items: • Inspect the wiring harness for damage. • Inspect for a mis-routed harness that is too close to high voltage or high current devices such as the following: ◦ Secondary ignition components ◦ Motors and generators. These components may induce electrical noise on a circuit which can interfere with normal circuit operation. • Inspect the vacuum hoses for splits or kinks. Verify that the connections and routing are as shown on the Vehicle Emission Control Information label. Refer to <u>Emission Hose Routing Diagram</u> . • Inspect for air leaks at the throttle body mounting and intake manifold sealing surfaces. • Inspect for air leaks at the air cleaner outlet resonator and verify the correct installation of the mass air flow (MAF) sensor. Refer to <u>Mass Air Flow (MAF)/Intake Air Temperature (IAT) Sensor Replacement</u> . • Verify that the engine control module (ECM) grounds and the body grounds are clean, tight and in the correct locations. Ensure the resistance between the ECM housing and the battery negative cable is less than 0.5 ohms. • Verify that the ECM and ECM bracket fasteners are at the correct torque. • Verify the battery connections are clean and tight.

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	• Test the charging system for the correct operation. Refer to <u>Symptoms - Engine Electrical</u> in Engine Electrical.
Harness/Connector Inspection	• Many intermittent conditions occur with harness/connector movement caused by vibration, engine torque, rough pavement, or component operation. Refer to <u>Testing for Electrical Intermittents</u> in Wiring Systems. • Excessive circuit resistance can cause a component to be inoperative. If a component does not respond to a scan tool command, test the related circuits for excessive resistance. Refer to <u>Testing for Continuity</u> in Wiring Systems.
Intermittent malfunction indicator lamp (MIL) with NO DTCs	The following conditions may cause an intermittent MIL and no DTCs: • Electromagnetic interference (EMI) caused by a malfunctioning relay, ECM controlled solenoid or switch. • The incorrect installation of non-factory or aftermarket add on accessories such as cellular phones, alarms, lights, or radio equipment. • The MIL control circuit is intermittently shorted to ground. • The ECM grounds are loose.
Temperature Sensitivity	• An intermittent condition may occur only when the component is cold, or only when the component is hot. The heat that affects the circuit can be engine generated or due to a poor connection in the circuit or a high electrical load. • Information from the customer may help to determine if the condition follows a pattern that is temperature related. The Freeze Frame/Failure Records or Snapshot data may help with this type of intermittent condition, where applicable. • If the intermittent is related to heat, review the data for a relationship with the following: ○ High ambient temperatures ○ Underhood/engine generated heat ○ Circuit generated heat due to a poor connection, or high electrical load ○ Higher than normal load conditions (towing, etc.) • If the intermittent is related to cold, review the data for the following: ○ Low ambient temperatures-In extremely low temperatures, ice may form in a connection or component. Inspect for water intrusion. ○ The condition only occurs on a cold start. ○ The condition goes away when the engine warms up.
Duplicating Failure Conditions	• Attempt to duplicate and/or capture the failure conditions. Freeze

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	Frame/Failure Records data contains the conditions that are present when a DTC sets. ○ Operate the vehicle within the same conditions that you observed in the Freeze Frame/Failure Records. The vehicle must also be operating within the Conditions for Running the DTC. Refer to Conditions for Running the DTC in the supporting text of the DTC being diagnosed. ○ Monitor DTC Status for the DTC being tested. The scan tool will indicate Ran when the enabling conditions have been satisfied long enough for the DTC to run. The scan tool will also indicate whether the DTC Passed or Failed. ● The scan tool can be set up to take a snapshot of parameters. The Snapshot function records live data over a period of time. The recorded data can be played back and analyzed. The scan tool can also graph parameters individually or in a combination with other parameters for comparison. The Snapshot can be triggered manually at the time the symptom is noticed, or set up in advance to trigger when the DTC sets. An abnormal value captured in the recorded data may point to a system or component that requires further investigation. Refer to scan tool user instructions for more information on the Snapshot function. ● An alternate method is to drive the vehicle with a DMM connected to a suspected circuit. An abnormal reading on the DMM when the problem occurs may help you locate the problem.
Additional Inspections	Some electrical components and circuits are sensitive to EMI or other types of electrical noise. Inspect for the following conditions: ● A mis-routed harness that is too close to high voltage and high current devices such as secondary ignition components, motors, generator. These components may induce electrical noise on a circuit that could interfere with normal circuit operation. ● Electrical system interference caused by a relay, ECM driven solenoid, or switch. The component can cause a sharp electrical surge. Normally, the condition occurs when the component is operating. ● Incorrect installation of non-factory, aftermarket, add-on accessories such as lights, 2-way radios, amplifiers, electric motors, remote starters, alarm systems, cell phones. ● Test for an open diode across the A/C compressor clutch and for other open diodes. Some relays may contain a clamping diode or

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resistor.

- Test the generator for a faulty rectifier bridge that may allow AC noise into the electrical system. Refer to **Symptoms - Engine Electrical** in Engine Electrical.

HARD START

Hard Start

Inspections	Action
DEFINITION: Engine cranks OK, but does not start for a long time. Does eventually run, or may start but immediately dies.	
Preliminary	• Refer to Important Preliminary Inspections Before Starting in <u>Symptoms - Engine Controls</u>. • Inspect the engine control system grounds for being clean, tight, and in the correct locations. Refer to <u>Engine Controls Schematics</u>. Ensure the resistance between the engine control module (ECM) housing and the battery negative cable is less than 0.5 ohms. • Verify that the ECM and ECM bracket fasteners are at the correct torque. • Search for service bulletins that may address this condition.
Sensor/System	IMPORTANT: Allow the engine to cool before performing this test. • Inspect the engine coolant temperature (ECT) sensor for being skewed in value. Compare the ECT sensor value to the intake air temperature (IAT) sensor value on a cold engine. The ECT and IAT sensor values should be within +/- 3°C (5°F). If the ECT sensor is out of range with the IAT sensor, test the resistance of the ECT sensor. Refer to <u>Temperature vs Resistance - Engine Coolant Temperature (ECT) Sensor</u> for resistance specifications. Replace the ECT sensor if the resistance is not within the specification. Refer to <u>Engine Coolant Temperature (ECT) Sensor Replacement</u>. If the sensor is within the specification, repair the high resistance in the ECT signal circuit. • Inspect the crankshaft position (CKP) sensor for the correct resistance. The sensor resistance may be out of range after a hot soak. Measure that the resistance remains within 700-1,200 ohms at all temperatures.
Fuel System	• Test the fuel pump relay operation. The fuel pump should turn ON for 2 seconds when the ignition is turned ON. Refer to <u>Fuel Pump Electrical Circuit Diagnosis</u>. • Test for incorrect fuel pressure. Refer to <u>Fuel System Diagnosis</u>.

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	• Test for a restricted fuel filter. Refer to <u>Fuel System Diagnosis</u>. • Test for leaking fuel injectors. Refer to <u>Fuel System Diagnosis</u>. • Test for plugged or restricted injectors. Refer to <u>Fuel Injector Balance Test with Special Tool</u> or <u>Fuel Injector Balance Test with Tech 2</u>. • Test for a contaminated fuel condition. Refer to <u>Alcohol/Contaminants-in-Fuel Diagnosis (w/o Special Tool)</u> or <u>Alcohol/Contaminants-in-Fuel Diagnosis (w/Special Tool)</u>.
Ignition System	• Inspect for the correct installation of the ignition coil seals. Incorrect installation may allow water to enter the spark plug area. Inspect for moisture and corrosion. • Test the ignition voltage output with J 26792 Spark Tester. See <u>Special Tools</u> . If you suspect an ignition system condition exists, refer to <u>Electronic Ignition (EI) System Diagnosis</u>. • Remove the spark plugs and inspect for the following conditions: ○ Correct heat range ○ Wet plugs ○ Cracks ○ Wear ○ Improper gap ○ Burned electrodes ○ Heavy deposits Refer to the following procedures: • <u>Spark Plug Replacement</u> • <u>Ignition System Specifications</u> • <u>Spark Plug Inspection</u> • If the spark plugs are gas, coolant or oil fouled, determine the cause before replacing the spark plugs. Refer to the following procedures: ○ For diagnosis of a rich condition, refer to <u>DTC P2178 or P2180</u> , <u>DTC P2188 or P2190</u> , and <u>DTC P2196 or P2198</u> . ○ For diagnosis of coolant contaminated spark plugs, refer to <u>Loss of Coolant (w/Manual Transmission)</u> or <u>Loss of Coolant (w/Automatic Transmission)</u> in Engine Cooling. ○ For diagnosis of oil fouled spark plugs, refer to <u>Oil Consumption Diagnosis</u> in Engine Mechanical - 2.8L (LP1). • Inspect the spark plug boots and terminals for burning or micro-

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Engine Mechanical	arcing, corrosion, and damage to the insulation. • Inspect for the following engine mechanical conditions: ○ Excessive oil in combustion chamber or leaking valve seals ○ Low cylinder compression ○ Sticking or leaking valves ○ Worn camshaft lobes ○ Camshaft timing ○ Broken valve springs ○ Excessive carbon buildup in the combustion chambers. Clean the chambers with top engine cleaner. Follow the instructions on the can. For more information, refer to the following procedures in Engine Mechanical - 2.8L (LP1): • <u>Oil Consumption Diagnosis</u> • <u>Engine Compression Test</u> • <u>Camshaft Timing Drive Chain Alignment Diagram (W/Primary Inverted Tooth (IT) Chain)</u> • <u>Setting Camshaft Timing</u> • <u>Symptoms - Engine Mechanical</u> • Inspect the following components for incorrect basic engine parts: ○ Camshafts ○ Cylinder heads ○ Pistons, connecting rods, or bearings. Refer to the following procedures in Engine Mechanical - 2.8L (LP1): • <u>Camshaft Timing Drive Components Cleaning and Inspection</u> • <u>Camshaft Cleaning and Inspection</u> • <u>Cylinder Head Cleaning and Inspection</u> • <u>Piston, Connecting Rod, and Bearings Cleaning and Inspection</u>
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SURGES/CHUGGLES

Surges/Chuggles

Inspections	Action
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DEFINITION: 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.

Preliminary	• Refer to Important Preliminary Inspections Before Starting in <u>Symptoms - Engine Controls</u>. • Search for bulletins. • Inspect the engine control system grounds for being clean, tight, and in the correct locations. Refer to <u>Engine Controls Schematics</u> . Ensure the resistance between the engine control module (ECM) housing and the battery negative cable is less than 0.5 ohms. • Verify that the engine control module (ECM) and ECM bracket fasteners are at the correct torque. • Ensure that the driver understands the operation of the transmission torque converter clutch (TCC) and A/C compressor operation as explained in the owner's manual. Inform the customer how the TCC and the A/C clutch operates.
Fuel System	• Test for incorrect fuel pressure. Refer to <u>Fuel System Diagnosis</u>. • Test for a restricted fuel filter. Refer to <u>Fuel System Diagnosis</u>. • Test for a contaminated fuel condition. Refer to <u>Alcohol/Contaminants-in-Fuel Diagnosis (w/o Special Tool)</u> or <u>Alcohol/Contaminants-in-Fuel Diagnosis (w/Special Tool)</u>. • Verify that each injector harness is connected to the correct injector/cylinder according to the firing order. • Test the fuel injectors. Refer to <u>Fuel Injector Coil Test</u>. • Test the items that cause an engine to run rich. For a rich condition, refer to <u>DTC P2178 or P2180</u> and <u>DTC P2188 or P2190</u> • Test the items that can cause an engine to run lean. For a lean condition, refer to <u>DTC P2177 or P2179</u> and <u>DTC P2187 or P2189</u>
Ignition System	• Inspect for the correct installation of the ignition coil seals. Incorrect installation may allow water to enter the spark plug area. Inspect for moisture and corrosion. • Test for proper ignition voltage output with a J 26792 Spark Tester. See <u>Special Tools</u> . If you suspect an ignition system condition exists, refer to <u>Electronic Ignition (EI) System Diagnosis</u>. • Remove the spark plugs and inspect for the following conditions: ○ Correct heat range ○ Wet plugs ○ Cracks ○ Wear

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- Improper gap
- Burned electrodes
- Heavy deposits

Refer to the following procedures:

- **Spark Plug Replacement**
- **Ignition System Specifications**
- **Spark Plug Inspection**
- If the spark plugs are gas, coolant or oil fouled, determine the cause before replacing the spark plugs. Refer to the following procedures:
 - Test the items that cause an engine to run rich. For a rich condition, refer to **DTC P2178 or P2180** and **DTC P2188 or P2190**
 - For diagnosis of coolant contaminated spark plugs, refer to **Loss of Coolant (w/Manual Transmission)** or **Loss of Coolant (w/Automatic Transmission)** in Engine Cooling.
 - For diagnosis of oil fouled spark plugs, refer to **Oil Consumption Diagnosis** in Engine Mechanical - 2.8L (LP1).
- Inspect the crankshaft position (CKP) sensor for the correct resistance. The sensor resistance may be out of range after a hot soak. Measure that the resistance remains within 700-1,200 ohms at all temperatures.
- Inspect the spark plug boots and terminals for burning or micro-arcing, corrosion, and damage to the insulation.

Additional

- Inspect the vacuum hoses for splits and kinks. Verify that the connections and routing are as shown on the Vehicle Emission Control Information Label, refer to **Emission Hose Routing Diagram**.
- Inspect for a condition with the camshaft actuator system. A camshaft actuator that is stuck in the full advance or retard position may cause this symptom. Refer to **DTC P0011, P0014, P0021, or P0024**.
- Test the transmission torque converter clutch (TCC) operation. A TCC applying too soon can cause the engine to spark knock, surge or chugle. Refer to **Torque Converter Diagnosis Procedure** in Automatic Transmission - 5L40-E/5L50-E.
- Test the A/C clutch for the correct operation. Refer to **Symptoms - HVAC Systems - Automatic** in HVAC Systems - Automatic.

LACK OF POWER, SLUGGISHNESS, OR SPONGINESS

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Lack of Power, Sluggishness, or Sponginess

Inspections	Action
DEFINITION: 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.	
Preliminary	• Refer to Important Preliminary Inspections Before Starting in <u>Symptoms - Engine Controls</u>. • Search for bulletins. • Inspect the engine control system grounds for being clean, tight, and in the correct locations. Refer to <u>Engine Controls Schematics</u> . Ensure the resistance between the engine control module (ECM) housing and the battery negative cable is less than 0.5 ohms. • Verify that the engine control module (ECM) and ECM bracket fasteners are at the correct torque. • Remove the air filter element and inspect for restrictions. Refer to <u>Air Cleaner Element Replacement</u> . • Inspect the intake air duct and air cleaner outlet resonator for the following conditions: ○ Restrictions ○ Improperly installed hoses ○ Leaks ○ Collapsed hoses
Fuel System	• Test for incorrect fuel system pressure. Refer to <u>Fuel System Diagnosis</u>. • Test for a restricted fuel filter. Refer to <u>Fuel System Diagnosis</u>. • Test for a contaminated fuel condition. Refer to <u>Alcohol/Contaminants-in-Fuel Diagnosis (w/o Special Tool)</u> or <u>Alcohol/Contaminants-in-Fuel Diagnosis (w/Special Tool)</u>. • Test the fuel injectors. Refer to <u>Fuel Injector Coil Test</u>. • Test the items that cause an engine to run rich. For a rich condition, refer to <u>DTC P2178 or P2180</u> and <u>DTC P2188 or P2190</u> • Test the items that can cause an engine to run lean. For a lean condition, refer to <u>DTC P2177 or P2179</u> and <u>DTC P2187 or P2189</u>
Sensor/System	Monitor the knock sensor (KS) system for excessive spark retard activity with a scan tool. Refer to <u>Knock Sensor (KS) System Description</u> , <u>DTC P0327 or P0332</u> , and <u>DTC P0328 or P0333</u> .
Ignition System	• Inspect for the correct installation of the ignition coil seals. Incorrect installation may allow water to enter the spark plug area. Inspect for moisture and corrosion.

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- Test for the correct ignition voltage output with a **J 26792** Spark Tester. See **Special Tools** . If you suspect an ignition system condition exists, refer to **Electronic Ignition (EI) System Diagnosis**.
- Remove the spark plugs and inspect for the following conditions:
 - Incorrect heat range
 - Wet plugs
 - Cracks
 - Wear
 - Improper gap
 - Burned electrodes
 - Heavy deposits

Refer to the following procedures:

- **Spark Plug Replacement**
- **Ignition System Specifications**
- **Spark Plug Inspection**
- If the spark plugs are gas, coolant or oil fouled, determine the cause before replacing the spark plugs. Refer to the following procedures:
 - Test the items that cause an engine to run rich. For a rich condition, refer to **DTC P2178 or P2180** and **DTC P2188 or P2190**
 - For diagnosis of coolant contaminated spark plugs, refer to **Loss of Coolant (w/Manual Transmission)** or **Loss of Coolant (w/Automatic Transmission)** in Engine Cooling.
 - For diagnosis of oil fouled spark plugs, refer to **Oil Consumption Diagnosis** in Engine Mechanical - 2.8L (LP1).
- Inspect the crankshaft position (CKP) sensor for the correct resistance. The sensor resistance may be out of range after a hot soak. Measure that the resistance remains within 700-1,200 ohms at all temperatures.
- Inspect the spark plug boots and terminals for burning or micro-arcing, corrosion, and damage to the insulation.

Engine Mechanical

- Inspect for a condition with the camshaft actuator system. A camshaft actuator that is stuck in the full advance or retard position may cause this symptom. Refer to **DTC P0011, P0014, P0021, or P0024** .
- Inspect for the following engine mechanical conditions:

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	○ Excessive oil in combustion chamber or leaking valve seals ○ Incorrect cylinder compression ○ Sticking or leaking valves ○ Worn camshaft lobes ○ Camshaft timing ○ Broken valve springs ○ Excessive carbon buildup in the combustion chambers. Clean the chambers with top engine cleaner. Follow the instructions on the can. For more information, refer to the following procedures in Engine Mechanical - 2.8L (LP1): ● <u>Oil Consumption Diagnosis</u> ● <u>Engine Compression Test</u> ● <u>Camshaft Timing Drive Chain Alignment Diagram (W/Primary Inverted Tooth (IT) Chain)</u> ● <u>Setting Camshaft Timing</u> ● <u>Symptoms - Engine Mechanical</u> ● Inspect the following components for incorrect basic engine parts: ○ Camshafts ○ Cylinder heads ○ Pistons, connecting rods, or bearings. Refer to the following procedures in Engine Mechanical - 2.8L (LP1): ● <u>Camshaft Timing Drive Components Cleaning and Inspection</u> ● <u>Camshaft Cleaning and Inspection</u> ● <u>Cylinder Head Cleaning and Inspection</u> ● <u>Piston, Connecting Rod, and Bearings Cleaning and Inspection</u>
Additional	● Inspect the following exhaust system components: ○ The exhaust system for damage. ○ The mufflers for heat distress or possible internal failure. ○ The catalytic converter(s) for restrictions. For more information, refer to <u>Symptoms - Engine Exhaust</u> in Engine Exhaust.

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- Test for the correct operation of the intake manifold runner control solenoid.

Refer to **Intake Manifold Runner Control System Diagnosis**.

- Test the transmission torque converter clutch (TCC) for the correct operation. Refer to **Torque Converter Diagnosis Procedure** in Automatic Transmission - 5L40-E/5L50-E.
- Test for other transmission related faults that might cause the transmission to operate in a default mode.

DETONATION/SPARK KNOCK

Detonation/Spark Knock

Inspection	Action
DEFINITION: A mild to severe ping which usually occurs worse while under acceleration. The engine makes sharp metallic knocks that change with throttle opening.	
Preliminary	• Refer to Important Preliminary Inspections Before Starting in <u>Symptoms - Engine Controls</u>. • Inspect the engine control system grounds for being clean, tight, and in the correct locations. Refer to <u>Engine Controls Schematics</u> . Ensure the resistance between the engine control module (ECM) housing and the battery negative cable is less than 0.5 ohms. • Verify that the engine control module (ECM) and ECM bracket fasteners are at the correct torque. • If the scan tool readings are normal and there are not any engine mechanical faults, fill the fuel tank with a known high quality fuel that meets the vehicle's minimum octane requirements. Road test the vehicle and re-evaluate the vehicle's performance.
Fuel System	• Test for incorrect fuel pressure. Refer to <u>Fuel System Diagnosis</u>. • Test for a restricted fuel filter. Refer to <u>Fuel System Diagnosis</u>. • Test for a contaminated fuel condition. Refer to <u>Alcohol/Contaminants-in-Fuel Diagnosis (w/o Special Tool)</u> or <u>Alcohol/Contaminants-in-Fuel Diagnosis (w/Special Tool)</u>. • Test the fuel injectors. Refer to <u>Fuel Injector Coil Test</u>. • Test the items that can cause an engine to run lean. For a lean condition, refer to <u>DTC P2177 or P2179</u> and <u>DTC P2187 or P2189</u>
Sensor/System	Use a scan tool to monitor the knock sensor (KS) system. Refer to <u>Knock Sensor (KS) System Description</u> .
Ignition System	Ensure that the spark plugs are the correct heat range. Refer to <u>Ignition</u>

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	<u>System Specifications .</u>
Engine Cooling System	Test for obvious overheating conditions. Test or inspect for the following conditions: • Low engine coolant level • Incorrect engine coolant • Restricted air flow to the radiator or restricted coolant flow through the radiator • Engine coolant leaks. Refer to the following procedures in Engine Cooling: ○ <u>Draining and Filling Cooling System (LP1, LY7 Static Fill)</u> or <u>Draining and Filling Cooling System (LS2 Static Fill)</u> or <u>Draining and Filling Cooling System (GE 47716)</u> ○ <u>Engine Overheating (LP1, LY7)</u>
Engine Mechanical	• Inspect for the following engine mechanical conditions: ○ Excessive oil in combustion chambers and for leaking valve seals. ○ High cylinder compression. ○ Incorrect camshaft timing. ○ Excessive carbon buildup in the combustion chambers. Clean the chambers using top engine cleaner. Follow the instructions on the can. For more information, refer to the following procedures in Engine Mechanical - 2.8L (LP1): • <u>Oil Consumption Diagnosis</u> • <u>Engine Compression Test</u> • <u>Camshaft Timing Drive Chain Alignment Diagram (W/Primary Inverted Tooth (IT) Chain)</u> • <u>Setting Camshaft Timing</u> • <u>Symptoms - Engine Mechanical</u> • Inspect the following components for incorrect basic engine parts: ○ Camshafts ○ Cylinder heads ○ Pistons, connecting rods or bearings. Refer to the following procedures in Engine Mechanical - 2.8L (LP1):

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	• <u>Camshaft Timing Drive Components Cleaning and Inspection</u> • <u>Camshaft Cleaning and Inspection</u> • <u>Cylinder Head Cleaning and Inspection</u> • <u>Piston, Connecting Rod, and Bearings Cleaning and Inspection</u>
Additional	Test the transmission torque converter clutch (TCC) for the correct operation. Applying the TCC too soon can cause the engine to spark knock. Refer to <u>Torque Converter Diagnosis Procedure</u> in Automatic Transmission - 5L40-E/5L50-E.

HESITATION, SAG, STUMBLE

Hesitation, Sag, Stumble

Inspections	Action
DEFINITION: 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.	
Preliminary	• Refer to Important Preliminary Inspections Before Starting in <u>Symptoms - Engine Controls</u>. • Search for bulletins. • Inspect the engine control system grounds for being clean, tight, and in the correct locations. Refer to <u>Engine Controls Schematics</u> . Ensure the resistance between the engine control module (ECM) housing and the battery negative cable is less than 0.5 ohms. • Verify that the engine control module (ECM) and ECM bracket fasteners are at the correct torque. • Remove the air filter element and inspect for restrictions. Refer to <u>Air Cleaner Element Replacement</u> . • Inspect the intake air duct and air cleaner outlet resonator for the following conditions: ○ Restrictions ○ Improperly installed hoses ○ Leaks ○ Collapsed hoses
Sensor/System	• Test the heated oxygen sensors (HO2S). The HO2S should respond quickly to a change in throttle position. If the HO2S does not respond to different throttle positions, inspect for contamination from fuel, silicon, or incorrect use of RTV sealant. The sensors may have a white powdery coating. The coating causes a low, but false, signal voltage, which gives a rich exhaust

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	indication. The ECM reduces the amount of fuel delivered to the engine, causing a driveability condition. • Inspect the mass air flow (MAF) sensor for the correct operation. Refer to <u>DTC P0101</u>.
Fuel System	• Test for incorrect fuel pressure. Refer to <u>Fuel System Diagnosis</u>. • Test for a restricted fuel filter. Refer to <u>Fuel System Diagnosis</u>. • Test for a contaminated fuel condition. Refer to <u>Alcohol/Contaminants-in-Fuel Diagnosis (w/o Special Tool)</u> or <u>Alcohol/Contaminants-in-Fuel Diagnosis (w/Special Tool)</u>. • Test the fuel injectors. Refer to <u>Fuel Injector Coil Test</u>. • Test the items that cause an engine to run rich. For a rich condition, refer to <u>DTC P2178 or P2180</u> and <u>DTC P2196 or P2198</u>. • Test the items that can cause an engine to run lean. For a lean condition, refer to <u>DTC P2177 or P2179</u> and <u>DTC P2187 or P2189</u>.
Ignition System	• Inspect for the correct installation of the ignition coil seals. Incorrect installation may allow water to enter the spark plug area. Inspect for moisture and corrosion. • Test for the correct ignition voltage output with a J 26792 Spark Tester. See <u>Special Tools</u>. If you suspect an ignition system condition exists, refer to <u>Electronic Ignition (EI) System Diagnosis</u>. • Remove the spark plugs and inspect for the following conditions: ○ Incorrect heat range ○ Wet plugs ○ Cracks ○ Wear ○ Improper gap ○ Burned electrodes ○ Heavy deposits Refer to the following procedures: • <u>Spark Plug Replacement</u> • <u>Ignition System Specifications</u> • <u>Spark Plug Inspection</u> • If the spark plugs are gas, coolant or oil fouled, determine the cause before replacing the spark plugs. Refer to the following procedures: ○ Test the items that cause an engine to run rich. For a rich

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	condition, refer to <u>DTC P2178 or P2180</u> and <u>DTC P2196 or P2198</u> ○ For diagnosis of coolant contaminated spark plugs, refer to <u>Loss of Coolant (w/Manual Transmission)</u> or <u>Loss of Coolant (w/Automatic Transmission)</u> in Engine Cooling. ○ For diagnosis of oil fouled spark plugs, refer to <u>Oil Consumption Diagnosis</u> in Engine Mechanical - 2.8L (LP1). ● Inspect the crankshaft position (CKP) sensor for the correct resistance. The sensor resistance may be out of range after a hot soak. Measure that the resistance remains within 700-1,200 ohms at all temperatures. ● Inspect the spark plug boots and terminals for burning or micro-arcing, corrosion, and damage to the insulation.
Engine Cooling System	Test the engine thermostat for the correct operation and heat range. Refer to <u>Thermostat Diagnosis (LP1, LY7)</u> or <u>Thermostat Diagnosis (LS6)</u> in Engine Cooling.
Additional	● Inspect for a condition with the camshaft actuator system. A camshaft actuator that is stuck in the full advance or retard position may cause this symptom. Refer to <u>DTC P0011, P0014, P0021, or P0024</u>. ● Test for the correct operation of the intake manifold runner control solenoid. Refer to <u>Intake Manifold Runner Control System Diagnosis</u>. ● Test the generator output voltage. Refer to <u>Symptoms - Engine Electrical</u> in Engine Electrical. Repair the charging system if the generator output voltage is less than 9 volts or more than 16 volts.

CUTS OUT, MISSES

Cuts Out, Misses

Inspections	Action
DEFINITION: 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.	
Preliminary	● Refer to Important Preliminary Inspections Before Starting in <u>Symptoms - Engine Controls</u>. ● Search for bulletins.

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	• Inspect the engine control system grounds for being clean, tight, and in the correct locations. Refer to <u>Engine Controls Schematics</u> . Ensure the resistance between the engine control module (ECM) housing and the battery negative cable is less than 0.5 ohms. • Verify that the engine control module (ECM) and ECM bracket fasteners are at the correct torque. • Remove the air filter element and inspect for restrictions. Refer to <u>Air Cleaner Element Replacement</u> . • Inspect the intake air duct and air cleaner outlet resonator for the following conditions: ◦ Restrictions ◦ Improperly installed hoses ◦ Leaks ◦ Collapsed hoses
Fuel System	• Test for incorrect fuel pressure. Refer to <u>Fuel System Diagnosis</u>. • Test for a restricted fuel filter. Refer to <u>Fuel System Diagnosis</u>. • Inspect the fuel system. Refer to <u>Fuel System Diagnosis</u>. • Test for a contaminated fuel condition. Refer to <u>Alcohol/Contaminants-in-Fuel Diagnosis (w/o Special Tool)</u> or <u>Alcohol/Contaminants-in-Fuel Diagnosis (w/Special Tool)</u>. • Test the fuel injectors. Refer to <u>Fuel Injector Coil Test</u>. • Test the items that cause an engine to run rich. For a rich condition, refer to <u>DTC P2178 or P2180</u> and <u>DTC P2196 or P2198</u> • Test the items that can cause an engine to run lean. For a lean condition, refer to <u>DTC P2177 or P2179</u> and <u>DTC P2187 or P2189</u>
Sensor/System	Monitor the knock sensor (KS) system for excessive spark retard activity with a scan tool. Refer to <u>Knock Sensor (KS) System Description</u> , <u>DTC P0327 or P0332</u> , and <u>DTC P0328 or P0333</u> .
Ignition System	• Inspect for the correct installation of the ignition coil seals. Incorrect installation may allow water to enter the spark plug area. Inspect for moisture and corrosion. • Test for proper ignition voltage output with a <u>J 26792</u> Spark Tester. See <u>Special Tools</u> . If you suspect an ignition system condition, refer to <u>Electronic Ignition (EI) System Diagnosis</u>. • Remove the spark plugs and inspect for the following conditions: ◦ Incorrect heat range ◦ Wet plugs ◦ Cracks

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	○ Wear ○ Improper gap ○ Burned electrodes ○ Heavy deposits Refer to the following procedures: ● <u>Spark Plug Replacement</u> ● <u>Ignition System Specifications</u> ● <u>Spark Plug Inspection</u> ● If the spark plugs are gas, coolant or oil fouled, determine the cause before replacing the spark plugs. Refer to the following procedures: ○ Test the items that cause an engine to run rich. For a rich condition, refer to <u>DTC P2178 or P2180</u> and <u>DTC P2196 or P2198</u> ○ For diagnosis of coolant contaminated spark plugs, refer to <u>Loss of Coolant (w/Manual Transmission)</u> or <u>Loss of Coolant (w/Automatic Transmission)</u> in Engine Cooling. ○ For diagnosis of oil fouled spark plugs, refer to <u>Oil Consumption Diagnosis</u> in Engine Mechanical - 2.8L (LP1). ● Inspect the spark plug boots and terminals for burning or micro-arcing, corrosion, and damage to the insulation. ● Inspect the crankshaft position (CKP) sensor for the correct resistance. The sensor resistance may be out of range after a hot soak. Measure that the resistance remains within 700-1,200 ohms at all temperatures.
Engine Mechanical	● Inspect for a condition with the camshaft actuator system. A camshaft actuator that is stuck in the full advance or retard position may cause this symptom. Refer to <u>DTC P0011, P0014, P0021, or P0024</u>. ● Inspect for the following engine mechanical conditions: ○ Excessive oil in combustion chamber or leaking valve seals ○ Incorrect cylinder compression ○ Sticking or leaking valves ○ Worn camshaft lobes ○ Camshaft timing ○ Broken valve springs ○ Excessive carbon buildup in the combustion chambers. Clean the chambers with top engine cleaner. Follow the

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instructions on the can.

For more information, refer to the following procedures in Engine Mechanical - 2.8L (LP1):

- **Oil Consumption Diagnosis**
- **Engine Compression Test**
- **Camshaft Timing Drive Chain Alignment Diagram (W/Primary Inverted Tooth (IT) Chain)**
- **Setting Camshaft Timing**
- **Symptoms - Engine Mechanical**
- Inspect the following components for incorrect basic engine parts:
 - Camshafts
 - Cylinder heads
 - Pistons, connecting rods, or bearings.

Refer to the following procedures in Engine Mechanical - 2.8L (LP1):

- **Camshaft Timing Drive Components Cleaning and Inspection**
- **Camshaft Cleaning and Inspection**
- **Cylinder Head Cleaning and Inspection**
- **Piston, Connecting Rod, and Bearings Cleaning and Inspection**

Additional

- Inspect the following exhaust system components:
 - The exhaust system for damage
 - The mufflers for heat distress or possible internal failure
 - The three-way catalytic converter(s) for restrictions.

For more information, refer to **Symptoms - Engine Exhaust**.

- Electromagnetic interference (EMI) on the crankshaft position (CKP) sensor signal circuits can cause an engine misfire condition. You can usually detect EMI with a scan tool by monitoring the engine speed parameter. A sudden increase in the engine speed parameter, with little change in actual engine speed indicates that EMI is present. Inspect for high voltage components near the ignition control circuits if a condition exists. Also, inspect the engine ground shield of the CKP sensor circuits.

POOR FUEL ECONOMY

Poor Fuel Economy

Inspections	Action
DEFINITION: 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.	
Preliminary	• Refer to Important Preliminary Inspections Before Starting in <u>Symptoms - Engine Controls</u>. • Search for bulletins. • Inspect the engine control module (ECM) grounds for being clean, tight, and in the correct locations. Refer to <u>Engine Controls Schematics</u>. • Verify that the ECM and ECM bracket fasteners are at the correct torque. • Verify the owner's driving habits, by asking the following questions: ○ Is the A/C or the Defroster mode ON full time? ○ Are the tires at the correct pressure? ○ Is there excessively heavy loads being carried? ○ Is the acceleration rate too much, too often? ○ Is the vehicle used for towing? • Remove the air filter element and inspect for restrictions. Refer to <u>Air Cleaner Element Replacement</u>. • Inspect the intake air duct and air cleaner outlet resonator for the following conditions: ○ Restrictions ○ Improperly installed hoses ○ Leaks ○ Collapsed hoses
Fuel System	• Determine the type, quality, and alcohol content of the fuel. Oxygenated fuels have lower energy and may deliver reduced fuel economy. Refer to <u>Alcohol/Contaminants-in-Fuel Diagnosis (w/o Special Tool)</u> or <u>Alcohol/Contaminants-in-Fuel Diagnosis (w/Special Tool)</u>. • Test for incorrect fuel pressure. Refer to <u>Fuel System Diagnosis</u>. • Test for a restricted fuel filter. Refer to <u>Fuel System Diagnosis</u>. • Verify that each injector harness is connected to the correct injector/cylinder according to the firing order. • Test the fuel injectors. Refer to <u>Fuel Injector Coil Test</u>.

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	- Inspect for foreign material accumulation in the throttle bore, coking on the throttle valve, or on the throttle shaft. Refer to <u>Throttle Body Service</u> . Also inspect for throttle body tampering. - Test the items that cause an engine to run rich. For a rich condition, refer to <u>DTC P2178 or P2180</u> and <u>DTC P2196 or P2198</u>
Sensor/System	- Inspect the air intake system and the crankcase for air leaks. - Test the crankcase ventilation system for proper operation. Refer to <u>Crankcase Ventilation System Inspection/Diagnosis</u> in Engine Mechanical - 2.8L (LP1). - Test for correct calibration of the speedometer. Incorrect tire size or axle ratios can affect speedometer calibration and vehicle mileage. Refer to <u>MPH (Km/h) Indicator Inoperative or Symptoms - Instrument Panel, Gages and Console</u> in Instrument Panel, Gages, and Console. - Monitor the knock sensor (KS) system for excessive spark retard activity with a scan tool. Refer to <u>Knock Sensor (KS) System Description</u> , <u>DTC P0327 or P0332</u> , and <u>DTC P0328 or P0333</u> .
Ignition System	- Inspect for the correct installation of the ignition coil seals. Incorrect installation may allow water to enter the spark plug area. Inspect for moisture and corrosion. - Test for the correct ignition voltage output with a J 26792 Spark Tester. See <u>Special Tools</u> . If you suspect an ignition system condition, refer to <u>Electronic Ignition (EI) System Diagnosis</u>. - Remove the spark plugs and inspect for the following conditions: - Incorrect heat range - Wet plugs - Cracks - Wear - Improper gap - Burned electrodes - Heavy deposits Refer to the following procedures: <u>Spark Plug Replacement</u> <u>Ignition System Specifications</u> <u>Spark Plug Inspection</u> - If the spark plugs are gas, coolant or oil fouled, determine the cause before replacing the spark plugs. Refer to the following procedures:

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	○ Test the items that cause an engine to run rich. For a rich condition, refer to <u>DTC P2178 or P2180</u> and <u>DTC P2196 or P2198</u> ○ For diagnosis of coolant contaminated spark plugs, refer to <u>Loss of Coolant (w/Manual Transmission)</u> or <u>Loss of Coolant (w/Automatic Transmission)</u> in Engine Cooling. ○ For diagnosis of oil fouled spark plugs, refer to <u>Oil Consumption Diagnosis</u> in Engine Mechanical - 2.8L (LP1). ● Inspect the spark plug boots and terminals for burning or micro-arcing, corrosion, and damage to the insulation.
Engine Cooling System	● Inspect the engine coolant level for being low. Refer to <u>Draining and Filling Cooling System (LP1, LY7 Static Fill)</u> or <u>Draining and Filling Cooling System (LS2 Static Fill)</u> or <u>Draining and Filling Cooling System (GE 47716)</u> in Engine Cooling. ● Test the engine thermostat. Verify the correct operation and heat range. Refer to <u>Thermostat Diagnosis (LP1, LY7)</u> or <u>Thermostat Diagnosis (LS6)</u> in Engine Cooling.
Engine Mechanical	● Inspect for the following engine mechanical conditions: ○ Excessive oil in combustion chamber or leaking valve seals ○ Incorrect cylinder compression ○ Sticking or leaking valves ○ Worn camshaft lobes ○ Camshaft timing ○ Broken valve springs ○ Excessive carbon buildup in the combustion chambers. Clean the chambers with top engine cleaner. Follow the instructions on the can. For more information, refer to the following procedures in Engine Mechanical - 2.8L (LP1): ● <u>Oil Consumption Diagnosis</u> ● <u>Engine Compression Test</u> ● <u>Camshaft Timing Drive Chain Alignment Diagram (W/Primary Inverted Tooth (IT) Chain)</u> ● <u>Setting Camshaft Timing</u> ● <u>Symptoms - Engine Mechanical</u> ● Inspect the following components for incorrect basic engine parts: ○ Camshafts

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	○ Cylinder heads ○ Pistons, connecting rods, or bearings Refer to the following procedures in Engine Mechanical - 2.8L (LP1): ● <u>Camshaft Timing Drive Components Cleaning and Inspection</u> ● <u>Camshaft Cleaning and Inspection</u> ● <u>Cylinder Head Cleaning and Inspection</u> ● <u>Piston, Connecting Rod, and Bearings Cleaning and Inspection</u>
Additional	● Inspect the vacuum hoses for splits and kinks. Verify that the connections and routing are as shown on Vehicle Emission Control Information Label. Refer to <u>Emission Hose Routing Diagram</u> . ● Test the transmission torque converter clutch (TCC). The scan tool should indicate a drop in engine speed, when the system commands the TCC ON. Refer to <u>Torque Converter Diagnosis Procedure</u> in Automatic Transmission - 5L40-E/5L50-E. ● Inspect the following exhaust system components: ○ The exhaust system for damage ○ The mufflers for heat distress or possible internal failure ○ The three-way catalytic converter(s) for restrictions For more information, refer to <u>Symptoms - Engine Exhaust</u> in Engine Exhaust. ● Electromagnetic interference (EMI) on the crankshaft position (CKP) sensor signal circuits can cause an engine misfire condition. You can usually detect EMI with a scan tool by monitoring the engine speed parameter. A sudden increase in the engine speed parameter, with little change in actual engine speed indicates that EMI is present. Inspect for high voltage components near the ignition control circuits if a condition exists. Also, inspect the engine ground shield of the CKP sensor circuits. ● Inspect the brake system, including the parking brake, for dragging or incorrect operation. Refer to <u>Symptoms - Hydraulic Brakes</u> in Hydraulic Brakes. Ensure that the vehicle operator does not drive with a foot on the brake pedal.

POOR FUEL FILL QUALITY

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Poor Fuel Fill Quality

Condition	Causes
DEFINITION: Difficulty when refueling the vehicle.	
Difficult to fill	Inspect for the following conditions: • Restricted vent lines • The evaporative emission (EVAP) vent valve is stuck closed • High fuel temperature • A condition with the internal components of the fuel tank assembly. For more information, refer to: ○ <u>Fuel Hose/Pipes Routing Diagram</u> ○ <u>Evaporative Emissions (EVAP) Hose Routing Diagram</u> ○ <u>Fuel System Description</u> ○ <u>Evaporative Emission (EVAP) Control System Description</u>
Over fill	A condition with the internal components of the fuel tank assembly. Refer to <u>Fuel System Description</u> .
Pre-mature shut-off of the fuel dispensing nozzle	Inspect for the following conditions: • The EVAP vent valve is stuck closed • Restricted vent lines • High Reid vapor pressure or high fuel temperature • A condition with the internal components of the fuel tank assembly For more information, refer to <u>Fuel System Description</u> and <u>Evaporative Emission (EVAP) Control System Description</u> .
Fuel Spitback	Inspect the fuel system for the following conditions: • High Reid vapor pressure or high fuel temperature • A condition with the internal components of the fuel tank assembly. For more information, refer to <u>Fuel System Description</u> .
Fuel Odor	Inspect for the following conditions: • Saturated EVAP canister-Refer to <u>Evaporative Emission (EVAP) Control System Description</u> . • A condition with the internal components of the fuel tank assembly-Refer to <u>Fuel System Description</u> .

ROUGH, UNSTABLE, OR INCORRECT IDLE AND STALLING

Rough, Unstable, or Incorrect Idle and Stalling

Inspections	Action
DEFINITION: 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.	
Preliminary	• Refer to Important Preliminary Inspections Before Starting in <u>Symptoms - Engine Controls</u>. • Search for bulletins. • Inspect the engine control system grounds for being clean, tight, and in the correct locations. Refer to <u>Engine Controls Schematics</u>. Ensure the resistance between the engine control module (ECM) housing and the battery negative cable is less than 0.5 ohms. • Verify that the engine control module (ECM) and ECM bracket fasteners are at the correct torque. • Remove the air filter element and inspect for restrictions. Refer to <u>Air Cleaner Element Replacement</u>. • Inspect the intake air duct and air cleaner outlet resonator for the following conditions: ○ Restrictions ○ Improperly installed hoses ○ Leaks ○ Collapsed hoses
Fuel System	• Test for incorrect fuel pressure. Refer to <u>Fuel System Diagnosis</u>. • Test for a restricted fuel filter. Refer to <u>Fuel System Diagnosis</u>. • Test for a contaminated fuel condition. Refer to <u>Alcohol/Contaminants-in-Fuel Diagnosis (w/o Special Tool)</u> or <u>Alcohol/Contaminants-in-Fuel Diagnosis (w/Special Tool)</u>. • Verify that each injector harness is connected to the correct injector/cylinder according to the firing order. • Test the fuel injectors. Refer to <u>Fuel Injector Coil Test</u>. • Test the items that cause an engine to run rich. For a rich condition, refer to <u>DTC P2178 or P2180</u> and <u>DTC P2196 or P2198</u>. • Test the items that can cause an engine to run lean. For a lean condition, refer to <u>DTC P2177 or P2179</u> and <u>DTC P2187 or P2189</u>.
Sensor/System	• Test the throttle actuator control (TAC) system. Refer to <u>DTC P0506, P0507, or P050A</u>. • Test the crankcase ventilation system. Refer to <u>Crankcase</u>

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	<u>Ventilation System Inspection/Diagnosis</u> in Engine Mechanical - 2.8L (LP1). • Monitor the knock sensor (KS) system for excessive spark retard activity with a scan tool. Refer to <u>Knock Sensor (KS) System Description</u> , <u>DTC P0327 or P0332</u> , and <u>DTC P0328 or P0333</u> .
Ignition System	• Inspect for the correct installation of the ignition coil seals. Incorrect installation may allow water to enter the spark plug area. Inspect for moisture and corrosion. • Test for the correct ignition voltage output with a J 26792 Spark Tester. See <u>Special Tools</u> . If you suspect an ignition system condition, refer to <u>Electronic Ignition (EI) System Diagnosis</u>. • Remove the spark plugs and inspect for the following conditions: ○ Incorrect heat range ○ Wet plugs ○ Cracks ○ Wear ○ Improper gap ○ Burned electrodes ○ Heavy deposits Refer to the following procedures: • <u>Spark Plug Replacement</u> • <u>Ignition System Specifications</u> • <u>Spark Plug Inspection</u> • If the spark plugs are gas, coolant or oil fouled, determine the cause before replacing the spark plugs. Refer to the following procedures: ○ Test the items that cause an engine to run rich. For a rich condition, refer to <u>DTC P2178 or P2180</u> and <u>DTC P2196 or P2198</u> ○ For diagnosis of coolant contaminated spark plugs, refer to <u>Loss of Coolant (w/Manual Transmission)</u> or <u>Loss of Coolant (w/Automatic Transmission)</u> in Engine Cooling. ○ For diagnosis of oil fouled spark plugs, refer to <u>Oil Consumption Diagnosis</u> in Engine Mechanical - 2.8L (LP1). • Inspect the spark plug boots and terminals for burning or micro-arcing, corrosion, and damage to the insulation. • Inspect the crankshaft position (CKP) sensor for the correct resistance. The sensor resistance may be out of range after a hot

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	soak. Measure that the resistance remains within 700-1,200 ohms at all temperatures.
Engine Mechanical	• Inspect for a condition with the camshaft actuator system. A camshaft actuator that is stuck in the full advance or retard position may cause this symptom. Refer to <u>DTC P0011, P0014, P0021, or P0024</u>. • Inspect for the following engine mechanical conditions: ○ Excessive oil in combustion chamber or leaking valve seals ○ Incorrect cylinder compression ○ Sticking or leaking valves ○ Worn camshaft lobes ○ Camshaft timing ○ Broken valve springs ○ Excessive carbon buildup in the combustion chambers. Clean the chambers with top engine cleaner. Follow the instructions on the can. For more information, refer to the following procedures in Engine Mechanical - 2.8L (LP1): • <u>Oil Consumption Diagnosis</u> • <u>Engine Compression Test</u> • <u>Camshaft Timing Drive Chain Alignment Diagram (W/Primary Inverted Tooth (IT) Chain)</u> • <u>Setting Camshaft Timing</u> • <u>Symptoms - Engine Mechanical</u> • Inspect the following components for incorrect basic engine parts: ○ Camshafts ○ Cylinder heads ○ Pistons, connecting rods, or bearings. Refer to the following procedures in Engine Mechanical - 2.8L (LP1): • <u>Camshaft Timing Drive Components Cleaning and Inspection</u> • <u>Camshaft Cleaning and Inspection</u> • <u>Cylinder Head Cleaning and Inspection</u> • <u>Piston, Connecting Rod, and Bearings Cleaning and Inspection</u>

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Additional

- Inspect the vacuum hoses for splits and kinks. Verify that the connections and routing are as shown on the Vehicle Emission Control Information Label, refer to **Emission Hose Routing Diagram** . Inspect for vacuum leaks in the following areas:
 - The upper and lower intake manifolds.
 - The throttle body
 - The positive crankcase ventilation (PCV) system
 - The vacuum brake booster
- Inspect the evaporative emissions (EVAP) canister purge solenoid for the following:
 - A stuck open condition
 - Charcoal contamination due to a defective EVAP canister.

For more information, refer to **Evaporative Emission (EVAP) Control System Description** .

- Inspect the following exhaust system components:
 - The exhaust system components for damage
 - The mufflers for heat distress or possible internal failure
 - The three-way catalytic converter(s) for restrictions.

For more information, refer to **Symptoms - Engine Exhaust** in Engine Exhaust.

- Electromagnetic interference (EMI) on the crankshaft position (CKP) sensor signal circuits can cause an engine misfire condition. You can usually detect EMI with a scan tool by monitoring the engine speed parameter. A sudden increase in the engine speed parameter, with little change in actual engine speed indicates that EMI is present. Inspect for high voltage components near the ignition control circuits if a condition exists. Also, inspect the engine ground shield of the CKP sensor circuits.
- Inspect for a condition with the engine mounts. Refer to **Engine Mount Inspection** in Engine Mechanical - 2.8L (LP1).

DIESELING, RUN-ON

Dieseling, Run-On

Inspections	Action
DEFINITION: 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.	
Preliminary	• Refer to Important Preliminary Checks Before Starting in

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	<u>Symptoms - Engine Controls.</u> • Search for bulletins. • Verify that the engine control module (ECM) and ECM bracket fasteners are at the correct torque. • Inspect the engine control system grounds for being clean, tight, and in the correct locations. Refer to <u>Engine Controls Schematics</u> . Ensure the resistance between the engine control module (ECM) housing and the battery negative cable is less than 0.5 ohms.
Fuel System	Test the fuel system for the following conditions: • High fuel system pressure • Leaking fuel injectors For more information, refer to <u>Fuel System Diagnosis.</u>

BACKFIRE

Backfire

Inspections	Actions
DEFINITION: Fuel ignites in the intake manifold or in the exhaust system, making a loud popping noise.	
Preliminary	• Refer to Important Preliminary Inspections Before Starting in <u>Symptoms - Engine Controls.</u> • Search for bulletins. • Inspect the engine control system grounds for being clean, tight, and in the correct locations. Refer to <u>Engine Controls Schematics</u> . Ensure the resistance between the engine control module (ECM) housing and the battery negative cable is less than 0.5 ohms. • Verify that the engine control module (ECM) and ECM bracket fasteners are at the correct torque.
Fuel System	• Test for incorrect fuel pressure. Refer to <u>Fuel System Diagnosis.</u> • Test for a restricted fuel filter. Refer to <u>Fuel System Diagnosis.</u> • Test for a contaminated fuel condition. Refer to <u>Alcohol/Contaminants-in-Fuel Diagnosis (w/o Special Tool)</u> or <u>Alcohol/Contaminants-in-Fuel Diagnosis (w/Special Tool).</u> • Inspect that each injector harness is connected to the correct injector/cylinder according to the firing order. • Test the fuel injectors. Refer to <u>Fuel Injector Coil Test.</u> • Test the items that can cause an engine to run lean. For a lean condition, refer to <u>DTC P2177 or P2179</u> and <u>DTC P2187 or P2189</u> .

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Sensor/System	• Inspect the air intake system and the crankcase for air leaks. • Test the crankcase ventilation system. Refer to <u>Crankcase Ventilation System Inspection/Diagnosis</u> in Engine Mechanical - 2.8L (LP1). • Monitor the knock sensor (KS) system for excessive spark retard activity with a scan tool. Refer to <u>Knock Sensor (KS) System Description</u> , <u>DTC P0327 or P0332</u> , and <u>DTC P0328 or P0333</u> .
Ignition System	• Inspect for the correct installation of the ignition coil seals. Incorrect installation may allow water to enter the spark plug area. Inspect for moisture and corrosion. • Test for the correct ignition voltage output with a J 26792 Spark Tester. See <u>Special Tools</u> . If you suspect an ignition system condition, refer to <u>Electronic Ignition (EI) System Diagnosis</u>. • Remove the spark plugs and inspect for the following conditions: ◦ Incorrect heat range ◦ Wet plugs ◦ Cracks ◦ Wear ◦ Improper gap ◦ Burned electrodes ◦ Heavy deposits Refer to the following procedures: • <u>Spark Plug Replacement</u> • <u>Ignition System Specifications</u> • <u>Spark Plug Inspection</u> • If the spark plugs are gas, coolant or oil fouled, determine the cause before replacing the spark plugs. Refer to the following procedures: ◦ Test the items that cause an engine to run rich. For a rich condition, refer to <u>DTC P2178 or P2180</u> and <u>DTC P2196 or P2198</u> ◦ For diagnosis of coolant contaminated spark plugs, refer to <u>Loss of Coolant (w/Manual Transmission)</u> or <u>Loss of Coolant (w/Automatic Transmission)</u> in Engine Cooling. ◦ For diagnosis of oil fouled spark plugs, refer to <u>Oil Consumption Diagnosis</u> in Engine Mechanical - 2.8L (LP1). • Inspect the spark plug boots and terminals for burning or micro-

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	arcing, corrosion, and damage to the insulation. • Inspect the crankshaft position (CKP) sensor for the correct resistance. The sensor resistance may be out of range after a hot soak. Measure that the resistance remains within 700-1,200 ohms at all temperatures.
Engine Cooling System	• Inspect the engine coolant level for being low. Refer to <u>Draining and Filling Cooling System (LP1, LY7 Static Fill)</u> or <u>Draining and Filling Cooling System (LS2 Static Fill)</u> or <u>Draining and Filling Cooling System (GE 47716)</u> in Engine Cooling. • Inspect the engine thermostat for the correct operation and heat range. Refer to <u>Thermostat Diagnosis (LP1, LY7)</u> or <u>Thermostat Diagnosis (LS6)</u> in Engine Cooling.
Engine Mechanical	• Inspect for the following engine mechanical conditions: ○ Excessive oil in combustion chamber or leaking valve seals ○ Incorrect cylinder compression ○ Sticking or leaking valves ○ Worn camshaft lobes ○ Camshaft timing ○ Broken valve springs ○ Excessive carbon buildup in the combustion chambers. Clean the chambers with top engine cleaner. Follow the instructions on the can. For more information, refer to the following procedures in Engine Mechanical - 2.8L (LP1): • <u>Oil Consumption Diagnosis</u> • <u>Engine Compression Test</u> • <u>Camshaft Timing Drive Chain Alignment Diagram (W/Primary Inverted Tooth (IT) Chain)</u> • <u>Setting Camshaft Timing</u> • <u>Symptoms - Engine Mechanical</u> • Inspect the following components for incorrect basic engine parts: ○ Camshafts ○ Cylinder heads ○ Pistons, connecting rods, or bearings. Refer to the following procedures in Engine Mechanical - 2.8L (LP1):

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	• <u>Camshaft Timing Drive Components Cleaning and Inspection</u> • <u>Camshaft Cleaning and Inspection</u> • <u>Cylinder Head Cleaning and Inspection</u> • <u>Piston, Connecting Rod, and Bearings Cleaning and Inspection</u>
Additional	• Inspect the vacuum hoses for splits and kinks. Verify that the connections and routing are as shown on the Vehicle Emission Control Information Label, refer to <u>Emission Hose Routing Diagram</u> . • Inspect the intake manifold and the exhaust manifold passages for casting flash. • Test the transmission torque converter clutch (TCC). The scan tool should indicate a drop in engine speed when the TCC is commanded ON. Refer to <u>Torque Converter Diagnosis Procedure</u> in Automatic Transmission - 5L40-E/5L50-E. • Inspect the following exhaust system components: ○ The exhaust system for damage ○ The exhaust manifold for a collapsed inner wall. ○ The mufflers for heat distress or possible internal failure ○ The three-way catalytic converter(s) for restrictions. For more information, refer to <u>Symptoms - Engine Exhaust</u> in Engine Exhaust. • Electromagnetic interference (EMI) on the crankshaft position (CKP) sensor signal circuits can cause an engine misfire condition. You can usually detect EMI with a scan tool by monitoring the engine speed parameter. A sudden increase in the engine speed parameter, with little change in actual engine speed indicates that EMI is present. Inspect for high voltage components near the ignition control circuits if a condition exists. Also, inspect the engine ground shield of the CKP sensor circuits. • Test the park neutral position (PNP) switch circuit. Refer to <u>DTC P0850</u> in Automatic Transmission - 5L40-E/5L50-E.

ENGINE CRANKS BUT DOES NOT RUN

DESCRIPTION

The Engine Cranks but Does Not Run diagnostic table is an organized approach to identifying a condition that causes an engine not to start. The Engine Cranks but Does Not Run diagnostic table directs the service technician to the appropriate system diagnosis.

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The Engine Cranks but Does Not Run diagnostic table assumes the following:

- The battery is completely charged. Refer to **Battery Inspection/Test** .
- The engine cranking speed is within specifications. Refer to **Engine Cranks Slowly** .
- There is adequate fuel in the fuel tank.

DIAGNOSTIC AIDS

- The engine control module (ECM) uses the camshaft position (CMP) sensors to determine engine speed and position when there is a crankshaft position (CKP) sensor condition.
- The engine will operate with a CKP sensor condition only if the ECM has stored the learned reference position of the camshafts in memory. With a CKP sensor condition in the signal circuit, the engine will go into a limp home mode after a hard restart. The ECM then calculates engine speed from one of the CMP sensors. During a limp home mode, the following additional DTCs may set and should be ignored:
 - DTC P0324 Knock Sensor (KS) Module Performance
 - DTC P1011 Intake Camshaft Position Actuator Park Position Bank 1
- Refer to **Symptoms - Engine Controls** and **Hard Start** for further diagnosis.

TEST DESCRIPTION

The numbers below refer to the step numbers on the diagnostic table.

2: This step determines if there is a concern with the main relay causing the no start condition. Use the Capture Info function to store any DTC information that may have set previously, before clearing the DTC information.

3: This step determines if there is an internal ECM condition, or sub-system component DTC causing the no start.

5: This step determines if the fuel pump is turning ON. An audible sound can be heard at the fuel injector rail when the fuel pump is turned ON.

Engine Cranks but Does Not Run

Step	Action	Values	Yes	No
Schematic Reference: <u>Engine Controls Schematics</u> Connector End View Reference: <u>Engine Control Module (ECM) Connector End Views</u> or <u>Engine Controls Connector End Views</u>				
1	Did you perform the Diagnostic System Check - Vehicle?	-	Go to Step 2	Go to <u>Diagnostic System Check - Vehicle</u>
	1. Turn ON the ignition, with the engine OFF. 2. Select Capture Info in order to store the Powertrain DTC information with a scan tool.			

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2	3. Clear the DTCs with a scan tool. 4. Turn OFF the ignition for 30 seconds. IMPORTANT: Do not crank the engine. 5. Turn ON the ignition, with the engine OFF. 6. Observe the DTC information with a scan tool. Did DTC P0685, P0686, P0687, P0689, or P0690 set?	-	Go to <u>DTC P0685, P0686, P0687, P0689, or P0690</u>	Go to Step 3
3	1. Crank the engine over for 15 seconds. 2. Turn ON the ignition, with the engine OFF. 3. Observe the Engine DTC information with a scan tool. Does the scan tool display DTC P0116, P0118, P0119, P0201-P0206, P0335, P0336, P0337, P0338, P0351-P0356, P0601, P0602, P0604, P0606, P0627, P0628, P0629, P1629, P1630, P1631, or P2105?	-	Go to <u>Diagnostic Trouble Code (DTC) List - Vehicle</u>	Go to Step 4
4	Observe the Theft Deterrent DTC Information with a scan tool. Does the scan tool display any Theft Deterrent DTCs?	-	Go to <u>Diagnostic Trouble Code (DTC) List - Vehicle</u>	Go to Step 5
5	IMPORTANT: Additional DTCs may set when using the fuel pump output control. With a scan tool, command the fuel pump ON. Does the fuel pump turn ON?	-	Go to Step 6	Go to <u>Fuel Pump Electrical Circuit Diagnosis</u>
6	1. Turn OFF the ignition. 2. Install the J 34730-1A Fuel Pressure Gage. See <u>Special Tools</u> . Refer to <u>Fuel Pressure Gage Installation and Removal</u> . 3. Turn ON the ignition, with the engine OFF. 4. Command the fuel pump ON with a scan tool. Is the fuel pressure within the specified range while the fuel pump is operating?	380-410 kPa (55-60 psi)	Go to Step 7	Go to <u>Fuel System Diagnosis</u>

Inspect for the following conditions:

- Collapsed air intake duct between the mass air flow (MAF) sensor and the throttle body
- Restricted air filter element
- Test for water or alcohol contaminated fuel. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis (w/o Special Tool)** or **Alcohol/Contaminants-in-Fuel Diagnosis (w/Special Tool)**.
- Spark plugs for being gas or coolant fouled-If the spark plugs are fouled, determine what caused the condition, refer to the following procedures:
 - **Spark Plug Replacement**
 - **Spark Plug Inspection**
- Inspect for a malfunctioning MAF sensor causing a no start or a stall after a start. If this condition is suspected, use the following procedure:
 - Disconnect the MAF sensor. The engine control module (ECM) will ignore the MAF sensor and default to the calculated air flow.
 - If disconnecting the MAF sensor corrects the condition and the connections are OK, replace the MAF sensor. Refer to **Mass Air Flow (MAF)/Intake Air Temperature (IAT) Sensor Replacement** .
- Engine mechanical condition, for example, worn timing chain and gears, low compression - Refer to **Symptoms - Engine Mechanical** .
- Restricted exhaust system.
- The engine coolant temperature (ECT) sensor is NOT close to the actual engine temperature. Refer to **DTC P0125** .

Did you complete the action?

Go to **Step 8**

1. With a scan tool, clear the DTCs.

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8	2. Attempt to start the engine. Does the engine start and continue to operate?	-	Go to Step 9	Go to Step 2
9	1. Idle the engine. 2. Allow the engine to reach operating temperature. 3. Observe the DTC information with a scan tool. Are there any DTCs that have not been diagnosed?	-	Go to <u>Diagnostic Trouble Code (DTC) List - Vehicle</u>	System OK

FUEL PUMP ELECTRICAL CIRCUIT DIAGNOSIS

CIRCUIT DESCRIPTION

When the ignition switch is turned ON, the control module energizes the fuel pump relay which applies power to the in-tank fuel pump. The fuel pump relay will remain on as long as the engine is running or cranking and the control module is receiving reference pulses. If no reference pulses are present, the control module de-energizes the fuel pump relay within 2 seconds after the ignition is turned ON or the engine is stopped.

DIAGNOSTIC AIDS

Listen for an audible hiss from the fuel pump when the fuel pump relay is commanded ON. A vibration in the fuel feed line when the fuel pump relay is commanded ON indicates that the fuel pump is operating.

For an intermittent condition, refer to **Intermittent Conditions**.

TEST DESCRIPTION

The numbers below refer to the step numbers on the diagnostic table:

- 2:** Command both the ON and OFF states. Repeat the commands as necessary.
- 3:** This step determines if the condition is located on the coil side or the switch side of the circuit.
- 7:** This step tests for a grounded voltage supply circuit. The fuel pump fuse supplies power to fuel pump. Disconnecting the fuel pump in-line harness connector isolates the fuel pump voltage supply circuit.
- 9:** This step verifies that the fuel pump fuse is providing voltage to the fuel pump relay.
- 10:** This step jumps the fuel pump relay in order to activate the fuel pump.
- 15:** This step determines if the condition with the circuit is intermittent. If the fuse does not open, inspect the supply voltage circuit between the fuse and the fuel pump for an intermittent condition.

Fuel Pump Electrical Circuit Diagnostic

Step	Action	Yes	No

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Schematic Reference: Engine Controls Schematics

1	Did you perform the Diagnostic System Check-Vehicle?	Go to Step 2	Go to <u>Diagnostic System Check - Vehicle</u> in Vehicle DTC Information
2	1. Turn ON the ignition, with the engine OFF. IMPORTANT: • Fuel pump DTCs may set when using the Fuel Pump output control. • It may be necessary to install a fuel pressure gage to determine if the fuel pump is operating. 2. Command the fuel pump ON and OFF with a scan tool. Does the fuel pump turn ON and OFF?	Go to Diagnostic Aids	Go to Step 3
3	Command the fuel pump relay ON and OFF with a scan tool. Do you hear a click when you command the fuel pump relay ON and OFF?	Go to Step 4	Go to Step 16
4	Turn ON the ignition, with the engine OFF. Does the fuel pump operate continuously?	Go to Step 5	Go to Step 6
5	1. Turn OFF the ignition. 2. Disconnect the fuel pump relay. 3. Turn ON the ignition, with the engine OFF. Does the fuel pump operate continuously?	Go to Step 17	Go to Step 20
6	Is the fuel pump fuse open?	Go to Step 7	Go to Step 9
7	1. Disconnect the fuel pump harness in-line connector located near the fuel tank. 2. Test the supply voltage circuit of the fuel pump for a grounded circuit. Refer to <u>Wiring Repairs</u> and <u>Connector Repairs</u> in Wiring Systems. 3. Replace the fuel pump fuse if necessary. Did you find and correct the condition?	Go to Step 21	Go to Step 8
	1. Lower the fuel tank if necessary. Refer to <u>Fuel Tank Replacement</u> . 2. Test or inspect the fuel tank electrical harness for the following conditions: • Damage to the harness		

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8	• A grounded circuit-Refer to <u>Wiring Repairs</u> and <u>Connector Repairs</u> in Wiring Systems. 3. Replace the fuel pump fuse if necessary. Did you find and correct the condition?	Go to Step 21	Go to Step 15
9	1. Turn OFF the ignition. 2. Disconnect the fuel pump relay. 3. Turn ON the ignition, with the engine OFF. 4. Probe the battery positive voltage circuit of the fuel pump relay with a test lamp connected to a good ground. Does the test lamp illuminate?	Go to Step 10	Go to Step 18
10	Connect a 15-amp fused jumper wire between the battery positive voltage circuit and the fuel pump supply circuit of the fuel pump relay. Does the fuel pump operate?	Go to Step 16	Go to Step 11
11	1. Disconnect the fuel pump harness in-line connector located near the fuel tank. Refer to Power and Grounding Component Views in Wiring Systems. 2. Test the supply voltage circuit of the fuel pump for an open or for high resistance between the fuel pump relay and the in-line connector. Refer to <u>Wiring Repairs</u> and <u>Connector Repairs</u> in Wiring Systems. Did you find and correct the condition?	Go to Step 21	Go to Step 12
12	IMPORTANT: Inspect the ground circuit for being tight, for corrosion on the terminals, or for damage to the wiring harness. Test the ground circuit of the fuel pump for an open or for high resistance between the body pass through connector and the ground. Refer to <u>Wiring Repairs</u> and <u>Connector Repairs</u> in Wiring Systems Did you find and correct the condition?	Go to Step 21	Go to Step 13
13	Inspect for poor connections at the fuel pump in-line connector to the body pass through connector. Refer to <u>Testing for Intermittent Conditions and Poor Connections</u> and <u>Connector Repairs</u> in Wiring Systems.		

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	Did you find and correct the condition?	Go to Step 21	Go to Step 14
14	1. Lower the fuel tank. Refer to <u>Fuel Tank Replacement</u>. 2. Test or inspect the fuel tank electrical harness for the following conditions: • Damage to the harness • An open circuit-Refer to <u>Wiring Repairs</u> and <u>Connector Repairs</u> in Wiring Systems		
	Did you find and correct the condition?	Go to Step 21	Go to Step 19
15	1. Connect all disconnected components. 2. Install a new fuel pump fuse. 3. Command the fuel pump ON with a scan tool.		
	Is the fuel pump fuse open?	Go to Step 19	Go to Diagnostic Aids
16	Inspect for poor connections at the fuel pump relay. Refer to <u>Testing for Intermittent Conditions and Poor Connections</u> and <u>Connector Repairs</u> in Wiring Systems.		
	Did you find and correct the condition?	Go to Step 21	Go to Step 20
17	Repair the supply voltage circuit of the fuel pump for a short to voltage. Refer to <u>Wiring Repairs</u> and <u>Connector Repairs</u> in Wiring Systems.		
	Did you complete the repair?	Go to Step 21	-
18	Repair the battery positive voltage circuit of the fuel pump relay for an open. Refer to <u>Wiring Repairs</u> and <u>Connector Repairs</u> in Wiring Systems		
	Did you complete the repair?	Go to Step 21	-
19	IMPORTANT: Inspect for poor connections at the fuel pump, within the fuel tank, before replacing the fuel pump. 1. Replace the fuel tank module. Refer to <u>Fuel Tank Module Replacement - Primary</u>. 2. Replace the fuel pump fuse if necessary.		
	Did you complete the replacement?	Go to Step 21	-
20	Replace the fuel pump relay.		
	Did you complete the replacement?	Go to Step 21	-
21	Operate the system in order to verify the repair.		
	Did you correct the condition?	System OK	Go to Step 2

FUEL SYSTEM DIAGNOSIS

SYSTEM DESCRIPTION

When you turn the ignition switch to the ON position, the control module enables the fuel pump relay, which in turn powers the fuel pump. The fuel pump remains ON as long as the engine is cranking or running and the control module receives ignition reference pulses. If there are no ignition reference pulses, the control module shuts the fuel pump OFF within 2 seconds after the ignition was switched to the ON position, or if the engine stops.

The fuel tank stores the fuel supply. The fuel pump is an electric pump that is attached to the primary fuel tank module assembly. The fuel pump also supplies fuel to the siphon jet pump, also attached to the primary fuel tank module. The siphon jet pump draws fuel from the secondary side of the fuel tank to the primary side of the fuel tank. The fuel pump is designed to provide fuel at a pressure above the pressure that is needed by the fuel injectors. A fuel pressure regulator, which is also located in the fuel tank, is attached to the primary fuel tank module. The fuel pressure regulator keeps the fuel available to the fuel injectors at a regulated pressure. The fuel pressure regulator does not compensate for changes in intake manifold vacuum. Unused fuel is returned from the fuel filter to the fuel tank by a separate fuel return pipe.

TEST DESCRIPTION

The numbers below refer to the step numbers on the diagnostic table.

3: This step verifies that the fuel pump is operating.

5: This step verifies that the vehicle is not out of fuel. If the right fuel sender is below 0.8 V, and the left fuel sender is above 0.8 V, a fuel transfer condition exists.

8: This step tests for an internal fuel leak. If the fuel pressure drops during this test, then an internal loss of pressure is indicated.

11: This step isolates the condition. Replace the primary fuel tank module assembly, if the fuel pressure remains constant, after closing the valve on the fuel pipe shut-off adapter. Locate and replace the leaking fuel injector if the pressure continues to decrease after closing the valve on the adapter.

14: This step isolates the condition. Replace the primary fuel tank module assembly for a stuck open or leaking fuel pressure regulator, if the fuel pressure increases above the specified value.

17: This step verifies that a circuit condition is not the cause of a fuel pressure concern. Inspect all fuel pump electrical circuits thoroughly.

Fuel System Diagnosis

Step	Action	Values	Yes	No
Schematic Reference: <u>Fuel Hose/Pipes Routing Diagram</u>				
1	Did you perform the Diagnostic System Check-Vehicle?	-	Go to Step 2	Go to <u>Diagnostic System Check - Vehicle</u> in Vehicle DTC Information

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2	1. Turn ON the ignition, with the engine OFF. 2. Observe the DTC information with a scan tool. Did DTC P0461, P0462, P0463, P2066, P2067, P2068, or P2636 fail the last test?	-	Go to <u>Diagnostic Trouble Code (DTC) List - Vehicle</u> in Vehicle DTC Information	Go to Step 3
3	IMPORTANT: • Additional DTCs may set when using the Fuel Pump output control. • Inspect the fuel system for the following conditions before proceeding with this diagnostic procedure: ○ Damage to the fuel system ○ External fuel leaks Command the fuel pump ON with a scan tool. Does the fuel pump operate?	-	Go to Step 4	Go to <u>Fuel Pump Electrical Circuit Diagnosis</u>
4	Observe the Fuel Level Sensor Right voltage parameter with a scan tool. Is the voltage less than the specified value?	0.8 V	Go to Step 5	Go to Step 7
5	Observe the Fuel Level Sensor Left voltage parameter with a scan tool. Is the voltage less than the specified value?	0.8 V	Go to Step 6	Go to Step 15
6	1. Add the specified amount of fuel. 2. Operate the vehicle within the conditions of the customer's concern. 3. Monitor the fuel trim related parameters with a scan tool. Refer to <u>Scan Tool Data List</u>. Do any of the scan tool parameters indicate a lean condition?	19 liters (5 gallons)	Go to Step 16	Go to <u>Symptoms - Engine Controls</u>
7	1. Turn OFF the ignition. 2. Install the fuel pressure gage. Refer to <u>Fuel Pressure Gage Installation and Removal</u>. 3. Turn ON the ignition, with the engine OFF. 4. External fuel leaks IMPORTANT: • The fuel pump may need to be commanded ON a few times in order to obtain the highest	380-410 kPa (55-60 psi)		

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	possible fuel pressure. • DO NOT start the engine. Command the fuel pump ON with a scan tool. 5. Observe the fuel pressure gage, while the fuel pump is operating. Is the fuel pressure within the specified range?		Go to Step 8	Go to Step 12
8	IMPORTANT: The fuel pressure will drop when the fuel pump stops operating. After the fuel pump stops operating, the fuel pressure should stabilize and remain constant. 1. Allow the fuel pressure to stabilize. 2. Monitor the fuel pressure gage for 1 minute. Does the fuel pressure decrease by more than the specified value?	34 kPa (5 psi)	Go to Step 11	Go to Step 9
9	1. Relieve the fuel pressure to the first specified value. 2. Monitor the fuel pressure gage for 5 minutes. Does the fuel pressure decrease by more than the second specified value?	69 kPa (10 psi) 14 kPa (2 psi)	Go to Step 20	Go to Step 10
10	1. Operate the vehicle within the conditions of the customer's concern. 2. Monitor the fuel related parameters with a scan tool. Do any of the scan tool parameters indicate a lean condition?	-	Go to Step 16	Go to Symptoms - Engine Controls
	1. Turn OFF the ignition. 2. Relieve the fuel pressure. Refer to Fuel Pressure Relief Procedure . 3. Disconnect the fuel feed pipe from the fuel rail. Refer to Quick Connect Fitting(s) Service (Metal Collar) . 4. Install the appropriate J 37287 Fuel Pipe Shut-Off Adapter between the fuel feed			

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11	pipe and the fuel rail inlet. See Special Tools . - Open the valve on the fuel feed pipe shut-off adapter. - Command the fuel pump ON with a scan tool. - Bleed the air from the fuel system. - Command the fuel pump ON, with a scan tool. - Close the fuel pipe shut-off valve. - Monitor the fuel pressure gage for 1 minute. Does the fuel pressure remain constant?	-		
12	Is the fuel pressure more than the specified value?	410 kPa (60 psi)	Go to Step 20	Go to Step 19
13	Inspect the fuel return hose/pipe for a restriction. Did you find and correct the condition?	-	Go to Step 13	Go to Step 14
14	- Turn OFF the ignition. - Relieve the fuel system pressure. Refer to Fuel Pressure Relief Procedure . - Disconnect the fuel return hose from the fuel return outlet of the fuel filter. Refer to Quick Connect Fitting(s) Service (Plastic Collar) . - Install the appropriate J 37287 between the return outlet of the fuel filter and the fuel return hose. See Special Tools . - Open the valve in the fuel pipe shut-off adapter. - Turn ON the ignition, with the engine OFF. - Command the fuel pump ON, with a scan tool. - Bleed the air from the fuel system. - Monitor the fuel pressure gage. - Slowly close the valve in the fuel pipe shut-off adapter. - Command the fuel pump ON, with a scan tool. Does the fuel pressure increase to more than the specified value?	380-410 kPa (55-60 psi)	Go to Step 21	Go to Step 20
	1. Remove both fuel tank modules. Refer to		Go to Step 20	Go to Step 16

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15	<u>Fuel Tank Module Replacement - Primary</u> and <u>Fuel Tank Module Replacement - Secondary</u> . 2. Inspect the fuel feed pipe of the siphon jet pump for a restriction. 3. Inspect the fuel strainer for contaminants. Refer to <u>Alcohol/Contaminants-in-Fuel Diagnosis (w/o Special Tool)</u> or <u>Alcohol/Contaminants-in-Fuel Diagnosis (w/Special Tool)</u>. Did you find and correct the condition?	-		
16	Inspect the following components for a restriction: • The fuel filter • The fuel feed pipe Did you find and correct the condition?	-		
17	Inspect the harness connectors and ground circuits of the fuel pump for poor connections. Refer to Testing for Intermittent and Poor Connections and Connector Repairs in Wiring Systems. Did you find and correct the condition?	-		
18	1. Remove the primary fuel tank module. Refer to <u>Fuel Tank Module Replacement - Primary</u> . 2. Inspect the following items: • The fuel pump flex hose for damage • The in-tank fuel pump harness connectors for poor connections • The fuel strainer for a restriction • For contaminates in the fuel tank Refer to <u>Alcohol/Contaminants-in-Fuel Diagnosis (w/o Special Tool)</u> or <u>Alcohol/Contaminants-in-Fuel Diagnosis (w/Special Tool)</u>. Did you find and correct the condition?	-		
	1. Turn OFF the ignition. 2. Raise the fuel rail, with the fuel lines			

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19	connected. Refer to <u>Fuel Injectors and Fuel Rail Replacement</u> . 3. Turn ON the ignition, with the engine OFF. 4. Command the fuel pump ON with a scan tool. 5. Locate and replace the leaking fuel injector. Refer to <u>Fuel Injectors and Fuel Rail Replacement</u> . Did you complete the replacement?	-	Go to Step 21	-
20	Replace the primary fuel tank module. Refer to <u>Fuel Tank Module Replacement - Primary</u> . Did you complete the replacement?	-	Go to Step 21	-
21	Operate the system in order to verify the repair. Did you correct the condition?	-	System OK	Go to Step 3

FUEL INJECTOR COIL TEST

CIRCUIT DESCRIPTION

The engine control module (ECM) enables the appropriate fuel injector on the intake stroke for each cylinder. A voltage is supplied directly to the fuel injectors. The ECM 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 low, will affect 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.

DIAGNOSTIC AIDS

- Monitoring the misfire current counters, or misfire graph, may help 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.
- If the fuel injector coil test does not isolate the condition perform the fuel injector balance test. Refer to **Fuel Injector Balance Test with Special Tool** or **Fuel Injector Balance Test with Tech 2**.

TEST DESCRIPTION

The numbers below refer to the step numbers on the diagnostic table.

3: This step tests each fuel injector resistance within a specific temperature range. If any of the fuel injectors display a resistance outside of the specified value, replace the fuel injector.

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4: This step determines if all of the fuel injectors are within 3 ohms of each other. If the highest resistance value is within 3 ohms of the lowest resistance value, then all of the fuel injector coil windings are OK.

5: This step determines which fuel injector is faulty. After subtracting the highest and lowest resistance values from the average value, replace the fuel injector that has the greatest resistance difference from the average.

Fuel Injector Coil Test

Step	Action	Values	Yes	No
Schematic Reference: <u>Engine Controls Schematics</u> Connector End View Reference: <u>Engine Control Module (ECM) Connector End Views</u> or <u>Engine Controls Connector End Views</u>				
1	Did you perform the Diagnostic System Check-Vehicle?	-	Go to Step 2	Go to <u>Diagnostic System Check - Vehicle</u> in Vehicle DTC Information
2	Observe the engine coolant temperature (ECT) with a scan tool. Is the ECT value within the specified range?	10-32°C (50-90°F)	Go to Step 3	Go to Step 4
3	1. Disconnect the fuel injector multi-way harness connector. 2. Measure the resistance of each fuel injector between the ignition feed circuit and the fuel injector control circuit, at the multi-way connector, with the DMM. Refer to <u>Testing for Continuity</u> in Wiring Systems. Do any of the fuel injectors display a resistance outside the specified range?	11-14 ohms	Go to Step 6	Go to Diagnostic Aids
4	1. Disconnect the fuel injector multi-way connector. 2. Measure the resistance of each fuel injector between the ignition feed circuit and the fuel injector control circuit, at the multi-way connector, with the DMM. Refer to <u>Testing for Continuity</u> in Wiring Systems. 3. Record each fuel injector value. 4. Subtract the lowest resistance value from the highest resistance value. Is the difference equal to, or less than, the	3 ohms	Go to	

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	specified value?		Diagnostic Aids	Go to Step 5
5	1. Add all of the fuel injector resistance values, to obtain a total resistance value. 2. Divide the total resistance value by the number of fuel injectors, to obtain an average resistance value. 3. Subtract the lowest, and the highest, individual fuel injector resistance values from the average resistance value. 4. Replace the fuel injector that displays the greatest resistance difference, above or below the average. Refer to <u>Fuel Injectors and Fuel Rail Replacement</u>.	-		
	Did you complete the replacement?		Go to Step 7	-
6	Replace the fuel injector or fuel injectors that are out of the specified range. Refer to <u>Fuel Injectors and Fuel Rail Replacement</u> . Did you complete the replacement?	-	Go to Step 7	-
7	Operate the system in order to verify the repair. Did you correct the condition?	-	System OK	Go to Step 2

FUEL INJECTOR BALANCE TEST WITH SPECIAL TOOL

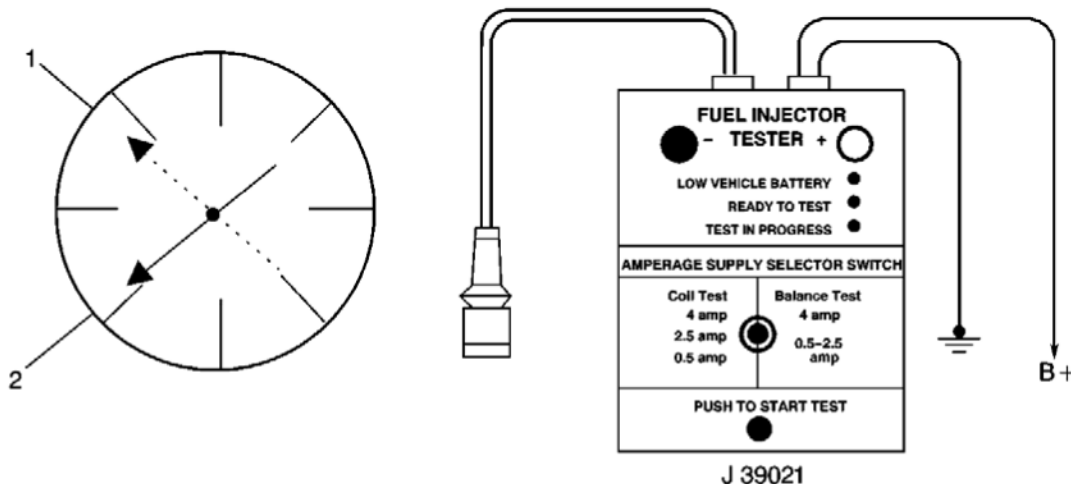


Fig. 1: Performing Fuel Injector Balance Test With Special Tool
 Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 31

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Callout	Component Name
1	First Fuel Pressure Gage Reading
2	Second Fuel Pressure Gage Reading

Fuel Injector Balance Test Example (Typical)

Cylinder	1	2	3	4
1st Reading	360 kPa (52 psi)	360 kPa (52 psi)	360 kPa (52 psi)	360 kPa (52 psi)
2nd Reading	155 kPa (22 psi)	111 kPa (16 psi)	155 kPa (22 psi)	249 kPa (36 psi)
Amount of Drop	205 kPa (30 psi)	249 kPa (36 psi)	205 kPa (30 psi)	151 kPa (22 psi)
Average Range: 156-176 kPa (22.5- 25.5 psi)	Injector OK	Replace fuel injector - too much fuel pressure drop	Injector OK	Replace fuel injector - too little fuel pressure drop

TEST DESCRIPTION

The numbers below refer to the step numbers on the diagnostic table.

3: The engine coolant temperature must be below the operating temperature in order to avoid irregular fuel pressure readings due to hot soak fuel boiling.

5: This step tests for an internal fuel leak. If the fuel pressure drops during this test, then an internal loss of pressure is indicated. The fuel pressure should reach a steady value.

6: If the pressure drop value for each fuel injector is within 10 kPa (1.5 psi) of the average pressure drop value, the fuel injectors are flowing properly. Calculate the pressure drop value for each fuel injector by subtracting the second pressure reading from the first pressure reading. Refer to the illustration above.

Fuel Injector Balance Test Procedure

Step	Action	Values	Yes	No
1	Did you perform the Diagnostic System Check-Vehicle?	-	Go to Step 2	Go to <u>Diagnostic System Check - Vehicle</u> in Vehicle DTC Information
2	Did you perform the Fuel Injector Coil Test?	-	Go to Step 3	Go to <u>Fuel Injector Coil Test</u>
3	IMPORTANT: Do not perform this test if the engine coolant temperature (ECT) is above 94°C (201°F). Observe the ECT sensor parameter with a scan tool. Does the scan tool indicate that the ECT parameter is less than the specified value?	94°C (201°F)	Go to Step 4	-
	IMPORTANT:			

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Verify there is adequate fuel in the fuel tank before proceeding with this diagnostic. 1. Turn OFF the ignition. 2. Install the fuel pressure gage. Refer to <u>Fuel Pressure Gage Installation and Removal</u>. 3. Turn ON the ignition, with the engine OFF. IMPORTANT: Additional DTCs may set when using the Fuel Pump output control. 4. Command the fuel pump ON with a scan tool. IMPORTANT: • It may be necessary to command the fuel pump ON a few times, in order to obtain the highest possible fuel pressure. • Do not start the engine. 5. Observe the fuel pressure gage, with the fuel pump commanded ON. Is the fuel pressure within the specified range?	380-410 kPa (55-60 psi)	Go to Step 5	Go to <u>Fuel System Diagnosis</u>
IMPORTANT: The fuel pressure will drop when the fuel pump stops operating. After the fuel pump stops operating, the fuel pressure should stabilize and remain constant. 1. Allow the fuel pressure to stabilize. 2. Monitor the fuel pressure gage for 1 minute. Does the fuel pressure decrease by more than the specified value?	34 kPa (5 psi)	Go to <u>Fuel System Diagnosis</u>	Go to Step 6
1. Turn OFF the ignition. 2. Connect the J 39021 Fuel Injector Tester, and the EL-39021-460 Fuel Injector Test Harness to the fuel injector connector. See			

Special Tools . If the upper intake manifold is removed, use the **J 44602** Injector Test Adapter. See **Special Tools** .

3. Set the amperage supply selector switch on the fuel injector tester to the Balance Test 0.5-2.5 amp position.
4. Turn ON the ignition, with the engine OFF.
5. Command the fuel pump on and then off with a scan tool.
6. 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.

6

7. Turn ON the fuel injector by depressing the Push to Start Test button on the fuel injector tester. 10 kPa (1.5 psi)
8. Record the fuel pressure indicated by the fuel pressure gage. This is the second fuel pressure reading.
9. Repeat steps 1 through 6 for each fuel injector.
10. Subtract the second pressure reading from the first pressure reading for one fuel injector. The result is the pressure drop value.
11. Obtain a pressure drop value for each fuel injector.
12. Add all of the individual pressure drop values. This is the total pressure drop.
13. Divide the total pressure drop by the number of fuel injectors. This is the average pressure drop.

Does any fuel injector have a pressure drop value that is more than the average pressure drop or less than the average pressure drop by the

Go to **Step 7**

Go to
**Symptoms -
Engine
Controls**

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	specified value?			
7	Replace the affected fuel injector. Refer to <u>Fuel Injectors and Fuel Rail Replacement</u> . Did you complete the replacement?	-	Go to Step 8	-
8	Operate the vehicle in order to verify the repair. Does a driveability condition still exist?	-	Go to <u>Symptoms - Engine Controls</u>	System OK

FUEL INJECTOR BALANCE TEST WITH TECH 2

CIRCUIT DESCRIPTION

The scan tool first energizes the fuel pump and then the injectors for a precise amount of time allowing a measured amount of fuel into the manifold. This causes a drop in system fuel pressure that can be recorded and used to compare each injector.

TEST DESCRIPTION

The numbers below refer to the step numbers on the diagnostic table.

3: The engine coolant temperature must be below the operating temperature in order to avoid irregular fuel pressure readings due to hot soak fuel boiling.

4: The fuel pressure should be within the specified range.

5: This step tests for an internal fuel leak. If the fuel pressure drops during this test, then an internal loss of pressure is indicated. The fuel pressure should reach a steady value.

6: If the pressure drop value for each fuel injector is within 10 kPa (1.5 psi) of the average pressure drop value, the fuel injectors are flowing properly. Calculate the pressure drop value for each fuel injector by subtracting the second pressure reading from the first pressure reading.

Fuel Injector Balance Test Procedure

Step	Action	Values	Yes	No
1	Did you perform the Diagnostic System Check-Vehicle?	-	Go to Step 2	Go to <u>Diagnostic System Check - Vehicle</u> in Vehicle DTC Information
2	Did you perform the Fuel Injector Coil Test?	-	Go to Step 3	Go to <u>Fuel Injector Coil Test</u>
3	IMPORTANT: Do not perform this test if the engine coolant temperature (ECT) is above 94°C (201°F).	94°C (201°F)		-

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	Observe the ECT parameter with a scan tool. Does the scan tool indicate that the ECT parameter is less than the specified value?		Go to Step 4	
4	IMPORTANT: Verify there is adequate fuel in the fuel tank before proceeding with this diagnostic. - Turn OFF the ignition. - Install the fuel pressure gage. Refer to <u>Fuel Pressure Gage Installation and Removal</u> - Turn ON the ignition, with the engine OFF. - Command the fuel pump ON with a scan tool. IMPORTANT: - It may be necessary to command the fuel pump ON a few times, in order to obtain the highest possible fuel pressure. - Do not start the engine. - Observe the fuel pressure gage, with the fuel pump commanded ON. Is the fuel pressure within the specified range?	380-410 kPa (55-60 psi)	Go to Step 5	Go to <u>Fuel System Diagnosis</u>
5	IMPORTANT: The fuel pressure will drop when the fuel pump stops operating. After the fuel pump stops operating, the fuel pressure should stabilize and remain constant. - Allow the fuel pressure to stabilize. - Monitor the fuel pressure gage for 1 minute. Does the fuel pressure decrease by more than the specified value?	34 kPa (5 psi)	Go to <u>Fuel System Diagnosis</u>	Go to Step 6
	- With a scan tool, select the Fuel Injector Balance Test function, within the Special Functions menu. - Select an injector to be tested. - Press Enter. This will prime the fuel			

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6	system. - Record the fuel pressure indicated by the fuel pressure gage after the fuel pressure stabilizes. This is the 1st 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. - Energize the fuel injector by depressing the Pulse Injector button on the scan tool. This will energize the injector and decrease the fuel pressure. - Record the fuel pressure indicated by the fuel pressure gage after the fuel injector has stopped pulsing. This is the 2nd pressure reading. - Press Enter again to bring you back to the Select Injector screen. - Repeat for each fuel injector. - Subtract the 2nd pressure reading from the 1st pressure reading for one fuel injector. The result is the pressure drop value. - Obtain a pressure drop value for each fuel injector. - Add all of the individual pressure drop values. This is the total pressure drop. - Divide the total pressure drop by the number of fuel injectors. This is the average pressure drop. Does any fuel injector have a pressure drop value that is either higher than the average pressure drop or lower than the average pressure drop by the specified value?	10 kPa (1.5 psi)	Go to Step 7	Go to <u>Symptoms - Engine Controls</u>
7	Replace the affected fuel injector. Refer to <u>Fuel Injectors and Fuel Rail Replacement</u> . Did you complete the replacement?	-	Go to Step 8	-
8	Operate the vehicle in order to verify the repair. Does a driveability condition still exist?	-	Go to <u>Symptoms - Engine Controls</u>	System OK

FUEL TANK LEAK 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 when the EVAP leak diagnostic completes one test cycle. The MIL will illuminate after the EVAP leak diagnostic completes two test cycles for a large leak or up to eight test cycles for a small leak, only when a condition is detected.

DIAGNOSTIC AIDS

- Operate the vehicle under the condition of the customers 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 EVAP purge is enabled, all fuel vapor release would be eliminated.
- Movement of the EVAP pipes or fuel pipes may help find an intermittent condition.

TEST DESCRIPTION

3: This step tests for location of fuel leakage in the fuel lines.

4: This step tests for fuel leaks below the fuel level in the fuel tank.

5: This step tests for a location of fuel vapors escaping above the fuel level in the fuel tank.

Fuel Tank Leak Test

Step	Action	Yes	No
1	Did you perform the Diagnostic System Check-Vehicle?	Go to Step 2	Go to <u>Diagnostic System Check - Vehicle</u> in Vehicle DTC Information
2	CAUTION: Refer to Gasoline/Gasoline Vapors Caution in Cautions and Notices. 1. Raise the vehicle. Refer to <u>Lifting and Jacking the Vehicle</u> in General Information. 2. Inspect the fuel tanks and the fuel pipes for damage or external leaks. Did you find fuel leaking from the fuel tank?	Go to Step 7	Go to Step 3
3	1. Turn ON the ignition, with the engine OFF. 2. Command the fuel pump ON with a scan tool. 3. Inspect for fuel leaking from the fuel pipe. Did you locate a fuel leak from the fuel pipes?	Go to Step 8	Go to Step 4

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4	1. Install the J 41415-40 Fuel Tank Cap Adapter. See Special Tools . 2. Connect the J 41413-200 Evaporative Emissions System Tester to the J 41415-40 . See Special Tools . 3. Command the EVAP vent valve ON with a scan tool. 4. Pressurize the fuel tank with the J 41413-200 . See Special Tools . 5. Inspect for a fuel leak from the fuel tank.		
	Did you locate a fuel leak from the fuel tank?	Go to Step 7	Go to Step 5
5	1. Turn the Nitrogen/Smoke valve on the J 41413-200 control panel to SMOKE. See Special Tools . 2. Use the remote switch to introduce smoke into the sealed system. 3. Inspect the entire system with the with the J 41413-SPT High Intensity White Light for exiting smoke. See Special Tools .		
	Did you locate a leak source?	Go to Step 6	Go to Diagnostic Aids
6	Repair the system as necessary. Did you complete the repair?	System OK	-
7	Replace the fuel tank. Refer to Fuel Tank Replacement . Did you complete the repair?	System OK	-
8	Replace the leaking fuel pipe. Refer to Fuel Hoses/Pipes Replacement - Filter to Tank and Fuel Hose/Pipes Replacement - Chassis . Did you complete the replacement?	System OK	-

ALCOHOL/CONTAMINANTS-IN-FUEL DIAGNOSIS (W/O SPECIAL TOOL)

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 rail, and cause a misfire in that cylinder. If the fuel system is contaminated with water, inspect the fuel system components for rust, or deterioration.

Alcohol concentrations more than 10 percent in the fuel can be detrimental to fuel system components. Alcohol contamination may cause fuel system corrosion, deterioration of rubber components, and subsequent fuel filter restriction. Fuel contaminated with alcohol may cause driveability conditions such as hesitation, lack of power,

stalling, or no start. Some types of alcohol are more detrimental to fuel system components than others.

ALCOHOL IN FUEL TESTING PROCEDURE

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 alcohol contamination is suspected then use the following procedure to test the fuel quality.

1. Using a 100 ml (3.38 oz) specified cylinder with 1 ml (0.34 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, that now contains both alcohol and water, will be more than 10 ml (0.37 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

The fuel sample should be drawn from the bottom of the tank so that any contaminants 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, use the following procedure to diagnose the fuel.

1. Using an approved fuel container, draw approximately 0.5 liter (0.53 qt) of fuel.
2. Place the cylinder 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. If particles are found, clean the entire fuel system thoroughly. Refer to **Fuel System Cleaning** .

ALCOHOL/CONTAMINANTS-IN-FUEL DIAGNOSIS (W/SPECIAL TOOL)

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.

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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.

TEST PROCEDURE

1. Test the fuel composition using **J 44175** Fuel Composition Tester and J44175-3 Instruction Manual. See **Special Tools** .
2. If water appears in the fuel sample, perform the following steps:
 1. Clean the fuel system. Refer to **Fuel System Cleaning** .
 2. Replace the fuel filter. Refer to **Fuel Filter Replacement** .
3. Subtract 50 from the reading on the DMM in order to obtain the percentage of alcohol in the fuel sample. Refer to the examples in the Fuel Composition Test Examples table.
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. Refer to **Fuel Tank Draining Procedure** .

Fuel Composition Test Examples

-	Frequency (Hz)	Subtract 50	Ethanol Percent
Example A	50 Hz	-50	0
Example B	65 Hz	-50	15
Example C	129 Hz	-50	79

INTAKE MANIFOLD RUNNER CONTROL SYSTEM DIAGNOSIS

CIRCUIT DESCRIPTION

An intake manifold runner control (IMRC) valve is used to change the intake manifold plenum configuration. When the IMRC valve is open, the intake manifold is configured to one large plenum. When the IMRC valve is closed, the intake manifold is configured to two smaller plenums. The IMRC valve improves engine performance at low and high engine speeds.

Ignition voltage is supplied directly to the IMRC solenoid. The engine control module (ECM) controls the solenoid by grounding the control circuit with a solid state device called a driver. The driver is equipped with a feedback circuit that is pulled-up to a voltage. The ECM can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage.

DIAGNOSTIC AIDS

Inspect the IMRC solenoid valve for witness marks that indicate that the valve was hitting the intake manifold. This condition may be temperature related.

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TEST DESCRIPTION

The number below refer to the step number on the diagnostic table.

2: This diagnostic table will only diagnose the mechanical portion of the IMRC solenoid. If there is a DTC set for the IMRC solenoid, refer to the appropriate DTC table.

Intake Manifold Runner Control System Diagnosis

Step	Action	Values	Yes	No
1	Did you perform the Diagnostic System Check-Vehicle?	-	Go to Step 2	Go to <u>Diagnostic System Check - Vehicle</u> in Vehicle DTC Information
2	1. Turn ON the ignition, with the engine OFF. 2. Observe the DTC information with a scan tool. Is DTC P2008, P2009, or P2010 set?	-	Go to <u>Diagnostic Trouble Code (DTC) List - Vehicle</u> in Vehicle DTC Information	Go to Step 3
3	1. Remove the IMRC solenoid from the intake manifold, but leave the electrical connector connected. Refer to <u>Intake Manifold Runner Control Solenoid Replacement</u>. 2. Command the IMRC solenoid ON and OFF with a scan tool. 3. Observe the valve of the IMRC solenoid while you command the IMRC solenoid ON and OFF. Does the valve of the IMRC solenoid move in both directions?	-	Go to Step 4	Go to Step 5
4	1. Inspect the inside of the intake manifold for the following conditions: • For carbon build-up that limits the movement of the IMRC valve • For casting flash that limits the movement of the IMRC valve • For foreign material that limits the movement of the IMRC valve 2. Clean or replace the upper intake	-		

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	manifold. Refer to <u>Intake Manifold Replacement - Upper</u> in Engine Mechanical - 2.8L (LP1).			
	Did you find and correct the condition?		Go to Step 6	Go to Diagnostic Aids
5	Replace the IMRC solenoid. Refer to <u>Intake Manifold Runner Control Solenoid Replacement</u> . Did you complete the replacement?	-	Go to Step 6	-
6	1. Connect all disconnected components. 2. Clear the DTCs with a scan tool. 3. Start the engine. 4. Operate the system in order to verify the repair. Did you correct the condition?	-	Go to Step 7	Go to Step 2
7	Observe the capture info with a scan tool. Are there any DTCs that have not been diagnosed?	-	Go to <u>Diagnostic Trouble Code (DTC) List - Vehicle</u> in Vehicle DTC Information	System OK

ELECTRONIC IGNITION (EI) SYSTEM DIAGNOSIS

CIRCUIT DESCRIPTION

The engine control module (ECM) controls the ignition coils by pulsing the ignition control (IC) circuits, which triggers an ignition coil and fires the spark plug. The ECM controls the sequencing and the timing of each ignition coil. The ignition system consist of the following components:

- The six ignition coils
- The crankshaft position (CKP) sensor
- The four camshaft position (CMP) sensors
- The ECM

The ignition coils use the following circuits:

- An IC circuit
- An ignition 1 voltage circuit
- Two ground circuits

DIAGNOSTIC AIDS

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- Use the **J 35616** Connector Test Adapter Kit for any test that requires probing the ECM harness connector or a component harness connector.
- The lower connector of the ECM is connector C1 and the upper connector of the ECM is connector C2. Refer to **Engine Controls Component Views**.
- Inspect the ignition coils for aftermarket devices. An aftermarket device connected to the ignition coil circuits, may cause a condition with the ignition coils.
- For an intermittent condition, refer to **Intermittent Conditions**.

TEST DESCRIPTION

The numbers below refer to the step numbers on the diagnostic table.

4: The ignition coils for each bank are fused separately. If a fuse opens or the ignition 1 voltage circuit opens between the fuse and the splice, all the ignition coils for one bank of the engine would be inoperative. If the ground circuit opens at the engine block, the ignition coils would be inoperative for one bank of the engine.

5: This step tests for an open or a high resistance in the ignition 1 voltage circuit of the ignition coil. If the DMM does not display near battery voltage there is an open or a high resistance in the circuit.

6: This step determines if the ground circuit is open. If the circuit is open, the ignition coils would be inoperative for one bank of the engine.

7: This step determines if the ignition 1 voltage circuit is shorted to ground. If the fuse is open, the ignition coils would be inoperative for one bank of the engine.

Electronic Ignition (EI) System Diagnosis

Step	Action	Values	Yes	No
Schematic Reference: <u>Engine Controls Schematics</u>				
1	Did you perform the Diagnostic System Check-Vehicle?	-	Go to Step 2	Go to <u>Diagnostic System Check - Vehicle</u> in Vehicle DTC Information
2	Were you sent here from DTC P0300 or P0301-P0306?	-	Go to Step 3	Go to <u>DTC P0300</u> or <u>DTC P0301-P0306</u>
3	1. Start the engine. 2. Allow the engine to reach operating temperature. 3. Operate the engine at 2,000 RPM. 4. Monitor all of the Misfire Current Counters with a scan tool. There are a total of 6 counters, 1 counter per cylinder.	-		Go to

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	Are any of the Misfire Current Counters incriminating?		Go to Step 4	<u>Intermittent Conditions</u>
4	Are all the misfire counters incriminating for one bank of the engine?	-	Go to Step 7	Go to Step 5
5	1. Turn OFF the ignition. 2. Disconnect the appropriate ignition coil. 3. Turn ON the ignition, with the engine OFF 4. Connect a test lamp between the ignition 1 voltage circuit of the ignition coil and a good ground. 5. Measure the voltage between the probe of the test lamp and a good ground with a DMM. Refer to <u>Measuring Voltage Drop</u> in Wiring Systems. Is the voltage at the specified value?	B+	Go to Step 6	Go to Step 9
6	Connect the test lamp between the ignition 1 voltage circuit of the ignition coil and to each ground circuit of the ignition coil. Does the test lamp illuminate at each ground circuit?	-	Go to Step 8	Go to Step 10
7	Test the ignition 1 voltage circuit for an open or high resistance at the splice of the affected bank of ignition coils. Refer to <u>Circuit Testing</u> and <u>Wiring Repairs</u> in Wiring Systems. Did you find and correct the condition?	-	Go to Step 12	Go to Step 10
8	Test for an intermittent and for a poor connection at the ignition coil. Refer to <u>Testing for Intermittent Conditions and Poor Connections</u> and <u>Connector Repairs</u> in Wiring Systems. Did you find and correct the condition?	-	Go to Step 12	Go to Step 11
9	IMPORTANT: The ignition 1 voltage circuit is shared with other components. Disconnecting a component on the shared ignition 1 voltage circuit may isolate a shorted component. Review the electrical schematic and diagnose the shared circuits and components. 1. Repair a short to ground, an open or high resistance in the ignition 1 voltage circuit. Refer to <u>Wiring Repairs</u> in Wiring	-		

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	Systems. 2. Replace the fuse as necessary.			
	Did you complete the repair?		Go to Step 12	-
10	Repair the open or high resistance in the ground circuit. Refer to <u>Wiring Repairs</u> in Wiring Systems. Did you complete the repair?	-	Go to Step 12	-
11	Replace the ignition coil. Refer to the appropriate procedure: • <u>Ignition Coil(s) Replacement - Bank 1</u> • <u>Ignition Coil(s) Replacement - Bank 2</u>	-		
	Did you complete the replacement?		Go to Step 12	-
12	1. Connect all disconnected components. 2. Clear the DTCs with a scan tool. 3. Start the engine. 4. Monitor the misfire current counters with the scan tool.	-		
	Do any of the misfire counters increment?		Go to Step 2	Go to Step 13
13	Observe the Capture Info with a scan tool. Are there any DTCs that have not been diagnosed?	-	Go to <u>Diagnostic Trouble Code (DTC) List - Vehicle</u> in Vehicle DTC Information	System OK

INSPECTION/MAINTENANCE (I/M) SYSTEM CHECK

DESCRIPTION

Several states require that a vehicle pass on-board diagnostic (OBD) system tests and the 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 complies with the local area requirements.

CONDITIONS FOR UPDATING THE I/M SYSTEM STATUS

Each system requires at least one, and sometimes several, diagnostic tests. The results of these tests are reported by a diagnostic trouble code (DTC). A system monitor is complete when either all of the DTCs comprising the

monitor have Run and Passed, or any one of the DTCs comprising the monitor have illuminated the malfunction indicator lamp (MIL). Once all of the tests are completed, the I/M System Status display will indicate YES in the Completed column. For example, when the heated oxygen sensor (HO2S) Heater Test indicates YES, all of the oxygen sensor heaters have been diagnosed. If the vehicle has four heated oxygen sensors, all four heater circuits have been diagnosed. 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 as part of a service procedure.

MONITORED EMISSION CONTROL SYSTEMS

The OBD II system monitors all emission control systems that are on-board. Not all vehicles need every possible emission control system. For example, a vehicle may not be equipped with secondary air injection (AIR) or exhaust gas recirculation (EGR). The OBD II regulations require monitoring of the following; if equipped:

- Air conditioning system refrigerant
- Catalytic converter efficiency
- Comprehensive component monitoring-Emission related inputs and outputs
- Evaporative emissions (EVAP) system
- Fuel delivery system
- Heated catalyst monitoring
- Misfire monitoring
- Oxygen sensor system (O2S or HO2S)
- Oxygen sensor heater system (HO2S Heater)

For the specific DTCs required for each system, refer to **Inspection/Maintenance (I/M) System DTC Table**. Systems such as fuel delivery, misfire, and comprehensive components may not be listed in a system status list. These tests run continuously on some vehicles and may not require an indicator.

DIAGNOSTIC AIDS

The I/M System Status display provides an indication of when the control module has completed the required tests. This does not necessarily mean that the test has passed, only that a decision was made. If the diagnostic fails, a DTC will indicate the failure. If a failure indication is present for a DTC associated with one of the I/M regulated systems, it may prevent other required tests from running. For example, a DTC for the control circuit of the EVAP purge solenoid may not be listed in the Inspection/Maintenance System DTC Table because it is a continuous test. If this DTC is set, the Active Tests for the EVAP system may not run.

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The I/M System Status information may be useful for a technician to determine if diagnostics have run when verifying repairs.

TEST DESCRIPTION

The numbers below refer to the step numbers on the diagnostic table.

1: Any DTCs set, even those that are not listed in the Inspection/Maintenance System DTC Table, may prevent the required DTCs from running. If there is any question as to whether a set DTC is disabling the required I/M diagnostic, review the Conditions for Running in the diagnostic procedures for the DTC required by the I/M diagnostic. A list of disabling DTCs, if applicable, is contained in the supporting text for that DTC.

2: Anytime a control module is reprogrammed or the diagnostic trouble codes are cleared as part of a repair procedure, all the I/M System Status indicators will reset to NO.

3: Use discretion when determining whether the entire system set procedure needs to be performed. For example, if the only tests that have not run are those that require the engine to be at operating temperature, then only those individual tests need to be run. There is no need to allow the engine to completely cool in order to run these tests.

Inspection/Maintenance (I/M) System Check

Step	Action	Yes	No
1	1. Perform the <u>Diagnostic System Check - Vehicle</u> in Vehicle DTC Information. IMPORTANT: Many DTC related repairs will instruct the technician to clear the DTC information. This procedure will reset ALL of the I/M System Status indicators to NO, and require performing the I/M Complete System Set Procedure. 2. Repair any DTCs or driveability concerns that would prevent the I/M System Status tests from completing. Did you find and repair a DTC or driveability concern?	Go to Step 3	Go to Step 2
2	1. Review any service bulletins for software updates that may prevent I/M readiness. 2. Perform any reprogramming or repairs indicated by the service bulletins. Was a reprogramming or repair service required?	Go to <u>Inspection/Maintenance (I/M) Complete System Set Procedure</u>	Go to Step 3
	With a scan tool, observe the I/M System Status	Go to	Go to the I/M

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3	display. Is more than one test indicating a NO status?	Inspection/Maintenance	System Set Procedure for the indicated system
		(I/M) Complete System	
		Set Procedure	

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

DESCRIPTION

The purpose of this procedure is to satisfy the criteria necessary to execute all of the inspection/maintenance (I/M) readiness diagnostics. This includes completing the trips for those particular diagnostics. When all diagnostic tests are completed, the I/M System Status indicators are set to YES. Perform this test if more than one of the I/M System Status indicators is set to NO.

CONDITIONS FOR RUNNING

- The barometric pressure (BARO) is more than 75 kPa.
- The engine coolant temperature (ECT) at start-up is less than 42°C (108°F).
- The intake air temperature (IAT) is between 2-32°C (36-90°F).
- The battery voltage is between 11-15 volts.
- The fuel level is between 1/4 and 3/4.

DIAGNOSTIC AIDS

Rough road conditions may prevent some of the tests from running. Extreme high or low ambient temperatures may prevent tests such as heated oxygen sensor (HO2S) heater and evaporative emission (EVAP) system from initiating. If a step is interrupted before completion, perform the remaining portion of the set procedures. Any portion of the set procedure that requires the engine at operating temperature may be repeated. This allows most of the diagnostics to run and the remaining tests can be performed using the individual System Set Procedures.

If the vehicle has recently run, start this procedure at step 3. This will allow the tests that require the engine at operating temperature to run. Using this method allows shorter cool down periods if the tests requiring a cold start do not initiate.

The scan tool can be used to monitor each of the I/M System Status indicators during the I/M Complete System Set Procedure. When all of the indicators for a test step have updated to YES, testing can move on to the next step even if the remaining portion of the test is not complete. For example, step 3 is designed to run the catalyst and HO2S tests. The procedure instructs the technician to operate the vehicle in the enable conditions for 8-10 minutes. If both tests have updated to YES within 4 minutes, it is not necessary to continue with the enable conditions and testing can advance to the next step.

TEST DESCRIPTION

The numbers below refer to the step numbers on the diagnostic table.

1: Make sure you perform the I/M system check before performing this test. Failure to do so may result in

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difficulty updating the status to YES.

2: This step is to initiate the HO2S heater tests.

3: This step is to run the oxygen sensor, and the catalyst tests. The oxygen sensor tests begin once the engine is at operating temperature, in Closed Loop fuel control, and a calibrated amount of time has elapsed. The catalyst test will run during the specified cruise period.

4: This step is to run the EVAP tests. This test runs during the idle period immediately following a cruise period that meets a minimum calibrated RPM and time period.

5: Perform the individual system test for any of the systems that do not update to YES.

6: The I/M system status only reports on whether or not a diagnostic has run, not what the outcome of the test was. If any emission related DTC sets after the tests are complete, the DTC will require diagnosis.

Inspection/Maintenance (I/M) Complete System Set Procedure

Step	Action	Values	Yes	No
1	Did you perform the Inspection/Maintenance (I/M) System Check?	-	Go to Step 2	Go to <u>Inspection/Maintenance (I/M) System Check</u>
2	IMPORTANT: Whenever the ignition is turned ON, ignition positive voltage is supplied to the 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. - Preprogram the scan tool with the vehicle information before the ignition is turned ON. - Ensure the vehicle is within the Conditions for Running specified in the supporting text. - Turn OFF all of the accessories, e.g., the A/C system and the blower fan. - Set the vehicle parking brake. - Verify the transmission is in Park or Neutral. - Start the engine. - Allow the engine to idle for the specified time. Is the action complete?	2 minutes	Go to Step 3	-

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3	CAUTION: Refer to Road Test Caution in Cautions and Notices. In order for the next group of tests to run, the vehicle must operate in the following conditions: 1. Acceleration at part throttle to 72-80 km/h (45-50 mph) with this speed maintained until the engine reaches operating temperature. This may be up to 8-10 minutes depending on the start-up coolant temperature. 2. Continued operation under these conditions for an additional 6 minutes. Is the action complete?	-	Go to Step 4	-
4	CAUTION: Refer to Road Test Caution in Cautions and Notices. In order for the next group of tests to run, the vehicle must operate in the following conditions: 1. Acceleration at part throttle to 90 km/h (55 mph) with this speed maintained for 2 minutes. 2. Deceleration with the throttle closed for more than 10 seconds to 0 km/h (0 mph). 3. Engine idling for 2 minutes while the following criteria is maintained: • Service brake depressed • Automatic transmission in Drive Is the action complete?	-	Go to Step 5	-
5	With a scan tool, observe the I/M System Status display. Did all of the I/M System Status indicators update to YES?	-	Go to Step 6	Go to the I/M System Set Procedure for the indicated systems
	With a scan tool, observe the Emission		Go to	

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6	Related DTC portion of the I/M System Status display. Does the scan tool indicate any Emission Related DTCs set?	-	<u>Diagnostic Trouble Code (DTC) List - Vehicle in Vehicle DTC Information</u>	System OK
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INSPECTION/MAINTENANCE (I/M) SYSTEM DTC TABLE

Inspection/Maintenance (I/M) System DTC Table

System	DTCs Required to Set System Status to YES
Catalyst	<u>DTC P0420 or P0430</u>
EVAP	<u>DTC P0442</u> <u>DTC P0446</u> <u>DTC P0455</u> <u>DTC P0496</u>
Oxygen Sensor	<u>DTC P0130 or P0150</u> <u>DTC P0131 or P0151</u> <u>DTC P0132 or P0152</u> <u>DTC P0133 or P0153</u> <u>DTC P0137 or P0157</u> <u>DTC P0138 or P0158</u> <u>DTC P0140 or P0160</u> <u>DTC P167A</u> <u>DTC P167B</u> <u>DTC P2096 or P2098</u> <u>DTC P2097 or P2099</u> <u>DTC P2195 or P2197</u> <u>DTC P2196 or P2198</u> <u>DTC P2232 or P2235</u> <u>DTC P2237 or P2240</u> <u>DTC P2243 or P2247</u> <u>DTC P2251 or P2254</u> <u>DTC P2270 or P2272</u> <u>DTC P2271 or P2273</u> <u>DTC P2297 or P2298</u> <u>DTC P2626 or P2629</u>
Oxygen Sensor Heater	<u>DTC P0030, P0036, P0050, or P0056</u> <u>DTC P0031, P0037, P0051, or P0057</u> <u>DTC P0032, P0038, P0052, or P0058</u> <u>DTC P0053</u> <u>DTC P0059</u> <u>DTC P0135 or P0155</u> <u>DTC P0141 or P0161</u>

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

DESCRIPTION

The purpose of this test is to satisfy the enable criteria necessary to execute inspection/maintenance (I/M) readiness diagnostics for the catalyst system. The test may be used to set the I/M System Status indicators to YES. Ensure the vehicle meets the requirements listed in Conditions for Running before performing this test. Failure to meet the necessary requirements may produce inaccurate test results.

CONDITIONS FOR RUNNING

- The engine coolant is at an operating temperature of 90-100°C (194-212°F).
- The engine is in closed loop fuel control.

DIAGNOSTIC AIDS

If the status does not update, repeat this test until the I/M System Status updates to YES.

The I/M System Status does not indicate whether the test has passed or failed, only that a decision was made. When all of the diagnostics for a specific system have run and passed, the I/M System Status will update to YES. If a test for a specific system has failed, the I/M System Status will update to YES, indicating a determination was made, even if all of the required tests have not run. When a failure occurs, the Emission Related DTC portion of the I/M System Status display will indicate the malfunction indicator lamp (MIL) is requested. The I/M System Status also registers the number of diagnostic trouble codes (DTCs).

The first failure of a type B DTC does not constitute a final determination of pass or fail, and will not update the I/M System Status to YES. A second trip is required, and all the conditions to run must be met in order for the test to run again. These conditions may include a partial to complete engine cool down.

The I/M System Status will update only when an emission related DTC fails the second time, or when all of the tests pass.

If there is an impending failure, the system may require more time to run the diagnostic than was allotted in the set procedure. If the test does not run after numerous attempts and no DTC is set, review the appropriate scan tool data list and the service information for an indication of why the test does not complete. Some tests may abort due to changes in the conditions while the test is running. For example, changes in engine load, such as a cooling fan or an A/C compressor clutch turning ON, may cause the test to abort.

If a diagnostic test is difficult to run, maintain necessary enable conditions until the system status updates to YES.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

- 1:** Perform the I/M System Check before performing this test. Failure to do so may result in difficulty updating the status to YES.
- 2:** The Catalyst Test runs during the specified cruise period.

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3: This step is to identify a first failure of a type B DTC. A DTC only appears on the I/M System Status display when it becomes a MIL illuminating DTC. This occurs on the second failure of a type B DTC. A first failure of a type B DTC will not allow the I/M System Status to update to YES. Refer to Diagnostic Aids.

4: This step is to help identify any unique or unusual criteria required to run the diagnostic test in the event the universal set procedure does not. This information is located in the service information under Conditions for Running the DTC.

5: The I/M System Status only reports on whether or not a diagnostic has run, not what the outcome of the test was. If any emission related DTC sets after the tests are complete, the DTC will require diagnosis.

Inspection/Maintenance (I/M) Catalyst System Set Procedure

Step	Action	Yes	No
1	Did you perform the Inspection/Maintenance (I/M) System Check?	Go to Step 2	Go to <u>Inspection/Maintenance (I/M) System Check</u>
2	1. Verify that the vehicle is operating within the Conditions for Running the DTC. 2. Turn OFF all of the accessories, e.g., the A/C system and the blower fan. 3. Start and idle the engine. CAUTION: Refer to Road Test Caution in Cautions and Notices. IMPORTANT: In order for this test to run, the vehicle must operate in the following conditions: • Acceleration at part throttle to 72-80 km/h (45-50 mph) • This speed maintained for 8-10 minutes or until the I/M System Status updates to YES 4. With a scan tool, observe the I/M System Status display. Did the Catalyst System Status update to YES?	Go to Step 5	Go to Step 3
3	With a scan tool, observe the DTC Information. Does the scan tool indicate any failed DTCs?	Go to <u>Diagnostic Trouble Code (DTC) List - Vehicle</u> in Vehicle DTC Information	Go to Step 4

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4	1. Refer to the <u>Inspection/Maintenance (I/M) System DTC Table</u> to determine which DTCs are required to run in order to complete this test. 2. With a scan tool, observe the Not Ran Since Code Cleared display. 3. Determine which of the DTCs required for a YES status has not run. 4. Enter the DTC number in the Specific DTC menu of the scan tool. 5. Operate the vehicle within the Conditions for Running the DTC, located in the supporting text for the diagnostic table of the DTC. 6. Repeat the procedure until the scan tool indicates the diagnostic test has run. 7. Repeat steps 4-6 for any additional required DTCs that have not run. 8. With a scan tool, observe the I/M System Status display.		
	Did the Catalyst System Status update to YES?	Go to Step 5	Go to Diagnostic Aids
5	With a scan tool, observe the Emission Related DTC portion of the I/M System Status display. Does the scan tool indicate any Emission Related DTCs set?	Go to <u>Diagnostic Trouble Code (DTC) List - Vehicle in Vehicle DTC Information</u>	System OK

INSPECTION/MAINTENANCE (I/M) EVAPORATIVE EMISSION (EVAP) SYSTEM SET PROCEDURE

DESCRIPTION

The purpose of this test is to satisfy the enable criteria necessary to execute inspection/maintenance (I/M) readiness diagnostics for the evaporative emission (EVAP) system. The test may be used to set the I/M System Status indicators to YES. Ensure the vehicle meets the requirements listed in Conditions for Running before performing the EVAP System Test. Failure to meet the necessary requirements may produce inaccurate test results.

CONDITIONS FOR RUNNING

- The barometric pressure (BARO) is more than 75 kPa.
- The engine coolant temperature (ECT) is 0-42°C (32-107°F).
- The intake air temperature (IAT) is between 2-32°C (36-88°F).

- The fuel level is between 1/4 and 3/4.
- The battery voltage is between 11-16 volts.
- The engine is in Closed Loop fuel control.
- The vehicle has been driven for 10 minutes for at least 10 km (6 miles) and then the engine idles for 1 minute.

DIAGNOSTIC AIDS

- Extreme high or low ambient temperatures may prevent the EVAP system tests from initiating. Performing a visual inspection prior to running the EVAP test may prevent having to repeat the test. A loose fuel cap may cause the test to abort or fail and prevent the I/M System Status from updating. A failed or aborted test will require the engine to cool down in order to meet the enable criteria to run another test.
- The I/M System Status does not indicate whether the test has passed or failed, only that a decision was made. When all of the diagnostics for a specific system have run and passed, the I/M System Status will update to YES. If a test for a specific system has failed, the I/M System Status will update to YES, indicating a determination was made, even if all of the required tests have not run. When a failure occurs, the Emission Related DTC portion of the I/M System Status display will indicate the malfunction indicator lamp (MIL) is requested. The I/M System Status also registers the number of DTCs.
- The first failure of a type B DTC does not constitute a final determination of pass or fail, and will not update the I/M System Status to YES. A second and third trip is required, and all the conditions to run must be met in order for the test to run again. These conditions require a complete engine cool down before the EVAP I/M ready status changes to YES.
- The I/M System Status will update only when an emission related DTC fails the second time, or when all of the tests pass.
- If there is an impending failure, the system may require more time to run the diagnostic than was allotted in the set procedure. If the test does not run after numerous attempts and no DTC is set, review the appropriate scan tool data list and the service information for an indication of why the test does not complete. Some tests may abort due to changes in the conditions while the test is running. For example, changes in engine load, such as a cooling fan or an A/C compressor clutch turning ON, may cause the test to abort.
- If a diagnostic test is difficult to run, maintain necessary enable conditions until the system status updates to YES.

TEST DESCRIPTION

The numbers below refer to the step numbers on the diagnostic table.

1: Make sure you perform the I/M system check before performing this test. Failure to do so may result in difficulty updating the status to YES.

2: The ECT must be less than 42°C (107°F) for the EVAP test to run. The ignition can be turned ON to monitor the engine coolant temperature with a scan tool, without starting the engine. This will determine if another test will run. This must be performed 3 times before going to the next portion of the EVAP test.

4: This step is to identify a first failure of a type B DTC. A DTC only appears on the I/M System Status

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display when it becomes a MIL illuminating DTC. This occurs on the second failure of a type B DTC. A first failure of a type B DTC will not allow the I/M System Status to update to YES. Refer to Diagnostic Aids.

5: This step is to help identify any unique or unusual criteria required to run the diagnostic test in the event the universal set procedure does not. This information is located in the service information under Conditions for Running the DTC.

6: The I/M System Status only reports on whether or not a diagnostic has run, not what the outcome of the test was. If any emission related DTC sets after the tests are complete, the DTC will require diagnosis.

Inspection/Maintenance (I/M) Evaporative Emission (EVAP) System Set Procedure

Step	Action	Yes	No
1	Did you perform the Inspection/Maintenance (I/M) System Check?	Go to Step 2	Go to <u>Inspection/Maintenance (I/M) System Check</u>
2	CAUTION: Refer to Road Test Caution in Cautions and Notices. 1. Ensure the vehicle is within the Conditions for Running specified in the supporting text. 2. Turn OFF all of the accessories, e.g., the A/C system and the blower fan. IMPORTANT: Once the engine is started, DO NOT turn OFF the engine for the remainder of the procedure until the test is complete. In order for this test to run, the vehicle must operate in the following conditions: 3. Start the engine. 4. Operate the engine for 10 minutes for at least 10 km (6 miles). 5. Deceleration to 0 km/h (0 mph). 6. Engine idling for 1 minute. 7. Turn OFF the engine. IMPORTANT: You can monitor the engine coolant temperature (ECT) with the ignition ON and the engine OFF. The ECT must be less than 42°C (107°F) to run another EVAP test. 8. Allow the engine to cool for 4-8 hours.		

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	IMPORTANT: To reset the EVAP I/M status, 2 additional cold starts are required. 9. Repeat steps 3-6 for two more times. Did you complete the 3 cold starts?	Go to Step 3	-
3	1. Allow the engine to cool for 1 hour. 2. Start the engine. 3. Operate the engine for 10 minutes for at least 10 km (6 miles). 4. Decelerate to 0 km/h (0 mph). 5. Engine idling for 1 minute. 6. With a scan tool, observe the I/M System Status display. Did the EVAP System Status update to YES?	Go to Step 6	Go to Step 4
4	With a scan tool, observe the DTC Information. Does the scan tool indicate any failed DTCs?	Go to Diagnostic Trouble Code (DTC) List - Vehicle in Vehicle DTC Information	Go to Step 5
5	1. Refer to the Inspection/Maintenance (I/M) System DTC Table to determine which DTCs are required to run in order to complete this test. 2. Operate the vehicle within the Conditions for Running the DTC, located in the supporting text for the diagnostic table of the DTC. 3. Repeat the procedure until the scan tool indicates the diagnostic test has run. 4. With a scan tool, observe the I/M System Status display. Did the EVAP System Status update to YES?	Go to Step 6	Go to Diagnostic Aids
6	With a scan tool, observe the Emission Related DTC portion of the I/M System Status display. Does the scan tool indicate any Emission Related DTCs set?	Go to Diagnostic Trouble Code (DTC) List - Vehicle in Vehicle DTC Information	System OK

INSPECTION/MAINTENANCE (I/M) HEATED OXYGEN SENSOR/OXYGEN SENSOR (HO2S/O2S) SYSTEM SET PROCEDURE

DESCRIPTION

The purpose of this test is to satisfy the enable criteria necessary to execute inspection/maintenance (I/M) readiness diagnostics for the oxygen sensor (O2S, HO2S) system. The test may be used to set the I/M System Status to YES. Ensure the vehicle meets the requirements listed in Conditions for Running before performing this test. Failure to meet the necessary requirements may produce inaccurate test results.

CONDITIONS FOR RUNNING

- The engine OFF time is more than 5 minutes.
- The ignition 1 voltage is between 11-15 volts.

DIAGNOSTIC AIDS

If the status does not update, repeat this test until the I/M System Status updates to YES.

The I/M System Status does not indicate whether the test has passed or failed, only that a decision was made. When all of the diagnostics for a specific system have run and passed, the I/M System Status will update to YES. If a test for a specific system has failed, the I/M System Status will update to YES, indicating a determination was made, even if all of the required tests have not run. When a failure occurs, the Emission Related DTC portion of the I/M System Status display will indicate the malfunction indicator lamp (MIL) is requested. The I/M System Status also registers the number of diagnostic trouble codes (DTCs).

The first failure of a type B DTC does not constitute a final determination of pass or fail, and will not update the I/M System Status to YES. A second trip is required, and all the conditions to run must be met in order for the test to run again. These conditions may include a partial to complete engine cool down.

The I/M System Status will update only when an emission related DTC fails the second time, or when all of the tests pass.

If there is an impending failure, the system may require more time to run the diagnostic than was allotted in the set procedure. If the test does not run after numerous attempts and no DTC is set, review the appropriate scan tool data list and the service information for an indication of why the test does not complete. Some tests may abort due to changes in the conditions while the test is running. For example, changes in engine load, such as a cooling fan or an A/C compressor clutch turning ON, may cause the test to abort.

If a diagnostic test is difficult to run, maintain necessary enable conditions until the system status updates to YES.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

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1: Make sure you perform the I/M System Check before performing this test. Failure to do so may result in difficulty updating the status to YES.

2: The oxygen sensor tests begin shortly after the indicated speed is achieved. The engine RPM may be too low in overdrive on manual transmission vehicles. If difficulty is encountered updating the status, operate the vehicle in the recommended gear during the test.

3: This step is to identify a first failure of a type B DTC. A DTC only appears on the I/M System Status display when it becomes a MIL illuminating DTC. This occurs on the second failure of a type B DTC. A first failure of a type B DTC will not allow the I/M System Status to update to YES. Refer to Diagnostic Aids.

4: This step is to help identify any unique or unusual criteria required to run the diagnostic test in the event the universal set procedure does not. This information is located in the service information under Conditions for Running the DTC.

5: The I/M System Status only reports on whether or not a diagnostic has run, not what the outcome of the test was. If any Emission Related DTC sets after the tests are complete, the DTC will require diagnosis.

Inspection/Maintenance (I/M) Heated Oxygen Sensor/Oxygen Sensor (HO2S/O2S) System Set Procedure

Step	Action	Yes	No
1	Did you perform the Inspection/Maintenance (I/M) System Check?	Go to Step 2	Go to <u>Inspection/Maintenance (I/M) System Check</u>
2	- Verify that the vehicle is within the Conditions for Running this DTC. - Turn OFF all of the accessories, e.g., the A/C system and the blower fan. - Start the engine. - Allow the engine to idle for 10 minutes. CAUTION: Refer to Road Test Caution in Cautions and Notices. IMPORTANT: In order for this test to run, the vehicle must operate in the following conditions: - Acceleration at part throttle to 75-90 km/h (45-55 mph). The vehicle speed must be maintained for 6-10 minutes. - Release the throttle for 10 seconds. This is a closed throttle decel/fuel shut-off test. - With a scan tool, review the I/M System Status		

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	display.		
	Did the HO2S/O2S System Status update to YES?	Go to Step 5	Go to Step 3
3	With a scan tool, observe the DTC Information. Does the scan tool indicate any failed DTCs?	Go to <u>Diagnostic Trouble Code (DTC) List - Vehicle</u> in Vehicle DTC Information	Go to Step 4
4	1. Refer to <u>Inspection/Maintenance (I/M) System DTC Table</u> to determine which DTCs are required to run in order to complete this test. 2. With a scan tool, observe the Not Ran Since Code Cleared display. 3. Determine which of the DTCs required for a YES status has not run. 4. Enter the DTC number in the Specific DTC menu of the scan tool. 5. Operate the vehicle within the Conditions for Running the DTC, located in the supporting text for the diagnostic table of the DTC. 6. Repeat the procedure until the scan tool indicates the diagnostic test has run. 7. Repeat steps 4-6 for any additional required DTCs that have not run. 8. With a scan tool, observe the I/M System Status display.		
	Did the HO2S/O2S System Status update to YES?	Go to Step 5	Go to Diagnostic Aids
5	With a scan tool, observe the Emission Related DTC portion of the I/M System Status display. Does the scan tool indicate any Emission Related DTCs set?	Go to <u>Diagnostic Trouble Code (DTC) List - Vehicle</u> in Vehicle DTC Information	System OK

INSPECTION/MAINTENANCE (I/M) HEATED OXYGEN SENSOR (HO2S) HEATER SYSTEM SET PROCEDURE

DESCRIPTION

The purpose of this test is to satisfy the enable criteria necessary to execute inspection/maintenance (I/M) readiness diagnostics for the heated oxygen sensor (HO2S) system. The test may be used to set the I/M System

Status to YES. Ensure the vehicle meets the requirements listed in Conditions for Running before performing this test. Failure to meet the necessary requirements may produce inaccurate test results.

CONDITIONS FOR RUNNING

- The engine is running.
- The battery voltage is between 11-15 volts.

DIAGNOSTIC AIDS

The HO2S Heater Tests will normally run within the 2 minutes allotted in the procedure. If there is an indeterminate condition, the test may take up to 8 minutes on some vehicles before a decision of pass or fail is made. If the test does not update within the allotted period of time, continue operation within the enable conditions until the test updates to YES. If the test does not update to YES, it may have failed or aborted due to the loss of enabling conditions. Extremely high ambient temperatures may prevent the HO2S Heater Test from initiating. The oxygen sensor heaters are operated by the engine control module (ECM). The control module has the ability to monitor the current required by the heaters and does this on a continuous basis.

The I/M System Status does not indicate whether the test has passed or failed, only that a decision was made. When all of the diagnostics for a specific system have run and passed, the I/M System Status will update to YES. If a test for a specific system has failed, the I/M System Status will update to YES, indicating a determination was made, even if all of the required tests have not run. When a failure occurs, the Emission Related DTC portion of the I/M System Status display will indicate the malfunction indicator lamp (MIL) is requested. The I/M System Status also registers the number of diagnostic trouble codes (DTCs).

The first failure of a type B DTC does not constitute a final determination of pass or fail, and will not update the I/M System Status to YES. A second trip is required, and all the conditions to run must be met in order for the test to run again. These conditions may include a partial to complete engine cool down.

The I/M System Status will update only when an emission related DTC fails the second time, or when all of the tests pass.

If there is an impending failure, the system may require more time to run the diagnostic than was allotted in the set procedure. If the test does not run after numerous attempts and no DTC is set, review the appropriate scan tool data list and the service information for an indication of why the test does not complete. Some tests may abort due to changes in the conditions while the test is running. For example, changes in engine load, such as a cooling fan or an A/C compressor clutch turning ON, may cause the test to abort.

If a diagnostic test is difficult to run, maintain necessary enable conditions until the system status updates to YES.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

1: Make sure you perform the I/M System Check before performing this test. Failure to do so may result in difficulty updating the status to YES.

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2: Preprogramming the scan tool will reduce the amount of time the oxygen sensor heaters operate while verifying the enable criteria. The HO2S Heater Tests may not complete when initiated from a cold start and may require running under a load in order to complete the tests.

3: This step is to identify a first failure of a type B DTC. A DTC only appears on the I/M System Status display when it becomes a MIL illuminating DTC. This occurs on the second failure of a type B DTC. A first failure of a type B DTC will not allow the I/M System Status to update to YES. Refer to Diagnostic Aids.

4: This step is to help identify any unique or unusual criteria required to run the diagnostic test in the event the universal set procedure does not. This information is located in the service information under Conditions for Running the DTC.

5: The I/M System Status only reports on whether or not a diagnostic has run, not what the outcome of the test was. If any emission related DTC sets after the tests are complete, the DTC will require diagnosis.

Inspection/Maintenance (I/M) Heated Oxygen Sensor (HO2S) Heater System Set Procedure

Step	Action	Values	Yes	No
1	Did you perform the Inspection/Maintenance (I/M) System Check?	-	Go to Step 2	Go to <u>Inspection/Maintenance (I/M) System Check</u>
2	IMPORTANT: If the ignition is turned ON, ignition positive voltage is supplied to the 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. - Preprogram the scan tool with the vehicle information before the ignition is turned ON. - Verify that the vehicle is within the Conditions for Running for the DTC. - Set the vehicle parking brake. - Verify the transmission is in Park or Neutral. - Turn OFF all of the accessories, e.g., the A/C system and the blower fan. - Start the engine. - Allow the engine to idle for the specified time. IMPORTANT: In order for the remaining portion	15-20 minutes		

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	of this test to run, the vehicle must operate in the following conditions: • Increase the engine speed to 1,500 RPM. • The engine speed maintained for 5-10 minutes or until the I/M System Status indicator updates to YES. 8. With a scan tool, observe the I/M System Status display. Did the HO2S Heater System Status update to YES?			
3	With a scan tool, observe the DTC information. Does the scan tool indicate any failed DTCs?	-	Go to Step 5 Go to <u>Diagnostic Trouble Code (DTC) List - Vehicle</u> in Vehicle DTC Information	Go to Step 3 Go to Step 4
4	1. Refer to the <u>Inspection/Maintenance (I/M) System DTC Table</u> to determine which DTCs are required to run in order to complete this test. 2. With a scan tool, observe the Not Ran Since Code Cleared display. 3. Determine which of the DTCs required for a YES status has not run. 4. Enter the DTC number in the Specific DTC menu of the scan tool. 5. Operate the vehicle within the Conditions for Running the DTC, located in the supporting text for the diagnostic table of the DTC. 6. Repeat the procedure until the scan tool indicates the diagnostic test has run. 7. Repeat steps 4-6 for any additional required DTCs that have not run. 8. With a scan tool, observe the I/M System Status display. Did the HO2S Heater System Status update	-		

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	to YES?		Go to Step 5	Go to Diagnostic Aids
5	With a scan tool, observe the Emission Related DTC portion of the I/M System Status display. Does the scan tool indicate any Emission Related DTCs set?	-	Go to <u>Diagnostic Trouble Code (DTC) List - Vehicle</u> in Vehicle DTC Information	System OK