

2013 ENGINE

Engine Mechanical - 2.0L (LTG) or 2.5L (LCV) - Diagnostic Information and Procedures - Malibu

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC P06DA-P06DC

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P06DA

Engine Oil Pressure Control Solenoid Valve Control Circuit

DTC P06DB

Engine Oil Pressure Control Solenoid Valve Control Circuit Low Voltage

DTC P06DC

Engine Oil Pressure Control Solenoid Valve Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open / High Resistance	Short to Voltage	Signal Performance
Ignition	P0031, P0132, P0134, P0135, P0137, P0443, P0597, P0598, P06DB	P06DA	-	-
Signal	P06DB	P06DC	P06DC	P06DD, P06DE

Circuit/System Description

The engine oil pressure control solenoid is a two port solenoid valve used to control engine oil pressure inside the mechanical engine oil pump. The ECM controls the commanded states of the engine oil pressure control solenoid with the following ECM input's.

- Engine Speed

- Engine Oil Temperature (calculated from the Engine Coolant Temperature Sensor)
- Engine Oil Pressure
- Engine Run Time

With the engine oil pressure control solenoid commanded Off, engine oil pressure is higher. When commanded On engine oil pressure is lower. The purpose of this diagnostic is to isolate an electrical problem with the engine oil pressure control solenoid or wiring.

Conditions for Running the DTC

- The system voltage is greater than 11 V.
- DTC P06DA, P06DB or P06DC runs continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for a minimum of 0.25 s.

Action Taken When the DTC Sets

- DTC P06DB is a Type A DTC.
- DTC P06DA and P06DC are Type B DTCs.
- ECM commands the engine oil pressure control solenoid valve OFF.
- ECM commands Reduced Engine Power.

Conditions for Clearing the MIL/DTC

- DTC P06DB is a Type A DTC.
- DTC P06DA and P06DC are Type B DTCs.

Reference Information

Schematic Reference

Engine Mechanical Schematics (LCV or LTG)

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the parameters listed below do not display Malfunction when commanding the Engine Oil Pressure Control Solenoid Valve ON and OFF with a scan tool.
 - Engine Oil Pressure Control Solenoid Valve Control Circuit Low Voltage Test Status
 - Engine Oil Pressure Control Solenoid Valve Control Circuit Open Test Status
 - Engine Oil Pressure Control Solenoid Valve Control Circuit High Voltage Test Status
 - **If Malfunction is displayed**

Refer to Circuit/System Testing below.

- **If Malfunction is not displayed**

3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
 - **If any DTC sets**

Refer to Circuit/System Testing below.

- **If the DTC does not set**

5. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the Q44 Engine Oil Pressure Control Solenoid Valve, ignition ON.
2. Verify that a test lamp illuminates between the ignition circuit terminal 1 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF, remove the test lamp.
 2. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms verify the fuse is not open and there is voltage at the fuse.

- **If the test lamp does not illuminate and the circuit fuse is open**

1. Ignition OFF, remove the test lamp.

NOTE: **An internal short in any component supplied by the fuse may cause the fuse to open and set a DTC when the component is activated.**

2.

3. Test for infinite resistance between the ignition circuit and ground

- If less than infinite resistance, repair the short to ground in the circuit.

- If infinite resistance, test all the components connected to fuse and replace as necessary.

- **If the test lamp illuminates**

3. Verify that a test lamp does not illuminate between the ignition circuit terminal 1 and the control circuit terminal 2.

- **If the test lamp illuminates**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.

2. Test for infinite resistance between the control circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.

- If infinite resistance, replace the K20 Engine Control Module.

- **If the test lamp does not illuminate**

4. Remove the test lamp, command the Q44 Engine Oil Pressure Control Solenoid Valve ON with a scan tool.

5. Verify the scan tool Engine Oil Pressure Control Solenoid Valve Control Circuit High Voltage Test Status parameter displays OK.

- **If OK is not displayed**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.

2. Test for less than 1 V between the control circuit and ground.

- If 1 V or greater, repair the short to voltage on the circuit.

- If less than 1 V, replace the K20 Engine Control Module.

- **If OK is not displayed**

6. Install a 3 A fused jumper wire between the control circuit terminal 2 and the ignition circuit terminal 1.

7. Verify the scan tool Engine Oil Pressure Control Solenoid Valve Circuit High Voltage Test Status parameter is displaying Malfunction when commanding the Engine Oil Pressure Control Solenoid Valve ON with a scan tool.

- **If Malfunction is not displayed**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.

2. Test for less than 2 ohms in the control circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.

- If less than 2 ohms replace the K20 Engine Control Module.

- **If Malfunction is displayed**

8. Test or replace the Q44 Engine Oil Pressure Control Solenoid Valve.

Component Testing

Static Test

1. Ignition OFF, disconnect the harness connector at the Q44 Engine Oil Pressure Control Solenoid Valve.
2. Test for 10-30 ohms between the control terminal 2 and the ignition voltage terminal 1.

- o **If not between 10.0-30.0 ohms**

Replace the Q44 Engine Oil Pressure Control Solenoid Valve.

- o **If between 10.0-30.0 ohms**

3. Test for infinite resistance between each terminal and the Q44 Engine Oil Pressure Control Solenoid Valve housing.

- o **If not between 10.0-30.0 ohms**

Replace the Q44 Engine Oil Pressure Control Solenoid Valve.

- o **If between 10.0-30.0 ohms**

4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Oil Pump Flow Control Valve Replacement** Engine Oil Pressure Control Solenoid Valve Replacement
- **Control Module References** for engine control module replacement, programming, and setup

DTC P06DD OR P06DE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P06DD

Engine Oil Pressure Control Solenoid Valve Stuck Off

DTC P06DE

Engine Oil Pressure Control Solenoid Valve Stuck On

Circuit/System Description

The engine oil pressure control solenoid is a two port solenoid valve used to control engine oil pressure inside the mechanical engine oil pump. The ECM controls the commanded states of the engine oil pressure control solenoid with the following ECM input's.

- Engine Speed
- Engine Oil Temperature (calculated from the Engine Coolant Temperature Sensor)
- Engine Oil Pressure
- Engine Run Time

With the engine oil pressure control solenoid commanded Off, engine oil pressure is higher. When commanded On engine oil pressure is lower. The purpose of this diagnostic is to isolate either a stuck on or stuck off engine oil pressure control solenoid.

Conditions for Running the DTC

P06DD

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0117, P0118, P0119, P0128, P0335, P0336, P0521, P0522, P0523, P06DA, P06DB, P06DC, P06DD, P06DE, P111E, P2227, P2228, P2229 or P2230 is not set.
- Engine speed within range of 1, 500 RPM to 2, 500 RPM.

P06DE

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0117, P0118, P0119, P0128, P0335, P0336, P0521, P0522, P0523, P06DA, P06DB, P06DC, P06DD, P06DE, P111E, P2227, P2228, P2229 or P2230 is not set.
- Engine running for greater than 20 s.
- Engine speed is within range of 1500 RPM to 2500 RPM.
- Engine oil pressure control solenoid in low pressure for greater than 1.5 s.

Conditions for Setting the DTC

P06DD or P06DE

Engine oil pressure is above or below a calibrated amount during the time the solenoid is changing from ON to OFF states.

Action Taken When the DTC Sets

P06DD

DTC P06DD is a Type B DTC.

P06DE

DTC P06DE is a Type A DTC.

Conditions for Clearing the DTC

P06DD

DTC P06DD is a Type B DTC.

P06DE

DTC P06DE is a Type A DTC.

Reference Information

Schematic Reference

Engine Mechanical Schematics (LCV or LTG)

Connector End View Reference

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Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify correct engine oil level and condition. Refer to **Engine Mechanical Specifications (LCV)** , **Engine Mechanical Specifications (LTG)** .
2. Engine Running, verify the scan tool Engine Oil Pressure parameter changes when commanding the

Engine Oil Pressure Control Solenoid On and Off.

- **If the parameter does not change**

Replace the Q44 Engine Oil Pressure Control Solenoid.

- **If the parameter changes**

3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.

- **If the DTC sets**

Refer to **Oil Pressure Diagnosis and Testing**.

- **If the DTC does not set**

5. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Oil Pump Flow Control Valve Replacement Engine Oil Pressure Control Solenoid Replacement

SYMPTOMS - ENGINE MECHANICAL (LCV)

Strategy Based Diagnostics

1. Perform the **Diagnostic System Check - Vehicle** before using the symptom tables, if applicable.
2. Review the system operations in order to familiarize yourself with the system functions. Refer to **Disassembled Views (LCV)** , **Engine Component Description** , and **Lubrication Description** .

All diagnosis on a vehicle should follow a logical process. Strategy based diagnostics is a uniform approach for repairing all systems. The diagnostic flow may always be used in order to resolve a system condition. The diagnostic flow is the place to start when repairs are necessary.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the engine.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Check for the correct oil level, proper oil viscosity, and correct filter application.
- Verify the exact operating conditions under which the concern exists. Note factors such as engine RPM, ambient temperature, engine temperature, amount of engine warm-up time, and other specifics.
- Compare the engine sounds, if applicable, to a known good engine and make sure you are not trying to correct a normal condition.

Intermittent

Test the vehicle under the same conditions that the customer reported in order to verify the system is operating properly.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- Base Engine Misfire without Internal Engine Noises
- Base Engine Misfire with Abnormal Internal Lower Engine Noises
- Base Engine Misfire with Abnormal Valve Train Noise
- Base Engine Misfire with Coolant Consumption
- Base Engine Misfire with Excessive Oil Consumption
- Engine Noise on Start-Up, but Only Lasting a Few Seconds
- Upper Engine Noise, Regardless of Engine Speed
- Lower Engine Noise, Regardless of Engine Speed
- Engine Noise Under Load
- Engine Will Not Crank - Crankshaft Will Not Rotate
- Engine Compression Test
- Oil Consumption Diagnosis
- Oil Pressure Diagnosis and Testing
- Oil Leak Diagnosis
- Drive Belt Chirping, Squeal, and Whine Diagnosis
- Drive Belt Rumbling and Vibration Diagnosis
- Drive Belt Falls Off and Excessive Wear Diagnosis
- Drive Belt Tensioner Diagnosis

SYMPTOMS - ENGINE MECHANICAL (LTG)

Strategy Based Diagnostics

1. Perform the Diagnostic System Check - Vehicle before using the symptom tables, if applicable.
2. Review the system operations in order to familiarize yourself with the system functions. Refer to Disassembled Views (LTG), Engine Component Description and Lubrication Description.

All diagnosis on a vehicle should follow a logical process. Strategy based diagnostics is a uniform approach for repairing all systems. The diagnostic flow may always be used in order to resolve a system condition. The diagnostic flow is the place to start when repairs are necessary.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the engine.

- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Check for the correct oil level, proper oil viscosity, and correct filter application.
- Verify the exact operating conditions under which the concern exists. Note factors such as engine RPM, ambient temperature, engine temperature, amount of engine warm-up time, and other specifics.
- Compare the engine sounds, if applicable, to a known good engine and make sure you are not trying to correct a normal condition.

Intermittent

Test the vehicle under the same conditions that the customer reported in order to verify the system is operating properly.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- Base Engine Misfire without Internal Engine Noises
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- Base Engine Misfire with Abnormal Valve Train Noise
- Base Engine Misfire with Coolant Consumption
- Base Engine Misfire with Excessive Oil Consumption
- Engine Noise on Start-Up, but Only Lasting a Few Seconds
- Upper Engine Noise, Regardless of Engine Speed
- Lower Engine Noise, Regardless of Engine Speed
- Engine Noise Under Load
- Engine Will Not Crank - Crankshaft Will Not Rotate
- Engine Compression Test
- Turbocharger Leaking Fluids Externally
- Turbocharger Noise
- Turbocharger Smoke or Smell
- Turbocharger Loss of Boost Pressure
- Oil Consumption Diagnosis
- Oil Pressure Diagnosis and Testing
- Oil Leak Diagnosis
- Drive Belt Chirping, Squeal, and Whine Diagnosis
- Drive Belt Rumbling and Vibration Diagnosis
- Drive Belt Falls Off and Excessive Wear Diagnosis
- Drive Belt Tensioner Diagnosis

BASE ENGINE MISFIRE WITHOUT INTERNAL ENGINE NOISES

Base Engine Misfire without Internal Engine Noises

Cause	Correction
Abnormalities, severe cracking, bumps, or missing areas in the accessory drive belt Abnormalities in the accessory drive system and/or components may cause engine RPM variations and lead to a misfire DTC. A misfire code may be present without an actual misfire condition.	Replace the drive belt.
Worn, damaged, or mis-aligned accessory drive components or excessive pulley runout may lead to a misfire DTC. A misfire code may be present without an actual misfire condition.	Inspect the components, and repair or replace as required.
A loose or improperly installed engine flywheel or crankshaft balancer A misfire code may be present without an actual misfire condition.	Repair or replace the flywheel and/or balancer as required.
Restricted exhaust system A severe restriction in the exhaust flow can cause significant loss of engine performance and may set a DTC. Possible causes of restrictions include collapsed or dented pipes or plugged mufflers and/or catalytic converters.	Repair or replace as required.
Improperly installed or damaged vacuum hoses	Repair or replace as required.
Improper sealing between the intake manifold and cylinder heads or throttle body.	Replace the intake manifold, gaskets, cylinder heads, and/or throttle body as required.
Improperly installed or damaged MAP sensor The sealing grommet of the MAP sensor should not be torn or damaged.	Repair or replace the MAP sensor as required.
Damage to the MAP sensor housing	Replace the intake manifold.
Worn or loose rocker arms The rocker arm bearing end caps and/or needle bearings should be intact and in the proper position.	Replace the valve rocker arms as required.
Stuck valves Carbon buildup on the valve stem can cause the valve not to close properly.	Repair or replace as required.
Excessively worn or mis-aligned timing chain	Replace the timing chain and sprockets as required.
Worn camshaft lobes	Replace the camshaft and valve lash adjusters.
Excessive oil pressure A lubrication system with excessive oil pressure may lead to excessive valve lifter pump up and loss of compression.	• Perform an oil pressure test. Refer to <u>Oil Pressure Diagnosis and Testing</u>. • Repair or replace the oil pump as required. • Replace the oil control valve solenoid as required.
Faulty cylinder head gaskets and/or cracking or other	

damage to the cylinder heads and engine block cooling system passages Coolant consumption may or may not cause the engine to overheat.	• Inspect for spark plugs saturated by coolant. • Inspect the cylinder heads, engine block, and/or head gaskets. • Repair or replace as required.
Worn piston rings Oil consumption may or may not cause the engine to misfire.	• Inspect the spark plugs for oil deposits. • Inspect the cylinders for a loss of compression. Refer to <u>Engine Compression Test</u>. • Perform cylinder leak down and compression testing to identify the cause. • Repair or replace as required.
A damaged crankshaft reluctor wheel A damaged crankshaft reluctor wheel can result in different symptoms depending on the severity and location of the damage. • Systems with electronic communications, DIS or coil per cylinder, and severe reluctor ring damage may exhibit periodic loss of crankshaft position, stop delivering a signal, and then re-sync the crankshaft position. • Systems with electronic communication, DIS or coil per cylinder, and slight reluctor ring damage may exhibit no loss of crankshaft position and no misfire may occur. However, a P0300 DTC may be set. • Systems with mechanical communications, high voltage switch, and severe reluctor ring damage may cause additional pulses and effect fuel and spark delivery to the point of generating a P0300 DTC or P0336.	Replace the sensor and/or crankshaft as required.

BASE ENGINE MISFIRE WITH ABNORMAL INTERNAL LOWER ENGINE NOISES

Base Engine Misfire with Abnormal Internal Lower Engine Noises

Cause	Correction
Abnormalities, severe cracking, bumps or missing areas in the accessory drive belt Abnormalities in the accessory drive system and/or components may cause engine RPM variations, noises similar to a faulty lower engine, and also lead to a misfire condition. A misfire code may be present without an	Replace the drive belt.

actual misfire condition.	
Worn, damaged, or mis-aligned accessory drive components or excessive pulley runout A misfire code may be present without an actual misfire condition.	Inspect the components, repair or replace as required.
Loose or improperly installed engine flywheel or crankshaft balancer A misfire code may be present without an actual misfire condition.	Repair or replace the flywheel and/or balancer as required.
Worn piston rings Oil consumption may or may not cause the engine to misfire.	• Inspect the spark plugs for oil deposits. • Inspect the cylinders for a loss of compression. Refer to <u>Engine Compression Test</u>. • Perform cylinder leak down and compression testing to determine the cause. • Repair or replace as required.
Worn crankshaft thrust bearings Severely worn thrust surfaces on the crankshaft and/or thrust bearing may permit fore and aft movement of the crankshaft, and create a DTC without an actual misfire condition.	Replace the crankshaft and bearings as required.

BASE ENGINE MISFIRE WITH ABNORMAL VALVE TRAIN NOISE

Base Engine Misfire with Abnormal Valve Train Noise

Cause	Correction
Worn or loose rocker arms The rocker arm bearing end caps and/or needle bearings should be intact within the rocker arm assembly.	Replace the valve rocker arms as required.
Stuck valves Carbon buildup on the valve stem can cause the valve to not close properly.	Repair or replace as required.
Excessively worn or mis-aligned timing chain	Replace the timing chain and sprockets as required.
Worn camshaft lobes	Replace the camshaft, valve lash adjusters, and roller finger followers.
Sticking valve lash adjusters	Replace as required.
Malfunctioning camshaft position actuators - improper oil viscosity or contamination.	1. Verify correct oil pressure. If low, inspect the bottom of the oil filter for oil filter drain back feature. Refer to <u>Oil Pressure Diagnosis and Testing</u>. 2. Isolate the noise to a specific camshaft position actuator. Disconnect the electrical connector on the camshaft position actuator solenoid valves and start

the vehicle. If noise is gone, repeat procedure to limit to an individual actuator. Refer to **Camshaft Position Actuator and Camshaft Replacement - Intake** , or **Camshaft Position Actuator and Camshaft Replacement - Exhaust** .

BASE ENGINE MISFIRE WITH COOLANT CONSUMPTION

Base Engine Misfire with Coolant Consumption

Cause	Correction
Faulty cylinder head gasket and/or cracking, or other damage to the cylinder head and engine block cooling system passages. Coolant consumption may or may not cause the engine to overheat.	- Inspect for spark plugs saturated by coolant. - Perform a cylinder leak down test. - Inspect the cylinder head and engine block for damage to the coolant passages and/or a faulty head gasket. - Repair or replace as required.

BASE ENGINE MISFIRE WITH EXCESSIVE OIL CONSUMPTION

Base Engine Misfire with Excessive Oil Consumption

Cause	Correction
Worn valves, valve guides and/or valve stem oil seals	- Inspect the spark plugs for oil deposits. - Repair or replace as required.
Worn piston rings Oil consumption may or may not cause the engine to misfire.	- Inspect the spark plugs for oil deposits. - Inspect the cylinders for a loss of compression. Refer to <u>Engine Compression Test</u>. - Perform cylinder leak down and compression testing to determine the cause. - Repair or replace as required.

ENGINE NOISE ON START-UP, BUT ONLY LASTING A FEW SECONDS

Engine Noise on Start-Up, but Only Lasting a Few Seconds

Cause	Correction
Incorrect oil filter without anti-drainback feature	Install the correct oil filter.
Incorrect oil viscosity	- Drain the oil. - Install the correct viscosity oil.
High valve lash adjuster leak down rate	Replace the lash adjusters as required.
Worn crankshaft thrust bearing	- Inspect the thrust bearing and crankshaft. - Repair or replace as required.

Damaged or faulty oil filter by-pass valve	1. Inspect the oil filter by-pass valve for proper operation. 2. Repair or replace as required.
Malfunctioning camshaft position actuators - improper oil viscosity or contamination.	1. Verify correct oil pressure. If low, inspect the bottom of the oil filter for oil filter drain back feature. Refer to <u>Oil Pressure Diagnosis and Testing</u>. 2. Isolate the noise to a specific camshaft position actuator. Disconnect the electrical connector on the camshaft position actuator solenoid valves and start the vehicle. If noise is gone, repeat procedure to limit to an individual actuator. Refer to <u>Camshaft Position Actuator and Camshaft Replacement - Intake</u> , or <u>Camshaft Position Actuator and Camshaft Replacement - Exhaust</u> .

UPPER ENGINE NOISE, REGARDLESS OF ENGINE SPEED

Upper Engine Noise, Regardless of Engine Speed

Cause	Correction
Low oil pressure	• Perform an oil pressure test. Refer to <u>Oil Pressure Diagnosis and Testing</u>. • Repair or replace as required.
Worn valve rocker arm	Replace the valve rocker arm.
Improper lubrication to the valve rocker arms	Inspect the following components, and repair or replace as required: • The valve rocker arm • The valve lifter • The oil filter bypass valve • The oil pump and pump screen • The engine block oil galleries
Broken valve spring	Replace the valve spring.
Worn or dirty valve lash adjusters	Replace the valve lash adjusters.
Stretched or broken timing chain and/or damaged sprocket teeth	Replace the timing chain and sprockets.
Worn, damaged, or faulty timing chain tensioners	Replace tensioners
Worn engine camshaft lobes	• Inspect the engine camshaft lobes. • Replace the camshaft and valve lash adjusters as required.
Worn valve guides or valve stems	Inspect the following components, and repair as required:

	• The valves • The valve guides
Stuck valves Carbon on the valve stem or valve seat may cause the valve to stay open.	Inspect the following components, and repair as required: • The valves • The valve guides

LOWER ENGINE NOISE, REGARDLESS OF ENGINE SPEED

Lower Engine Noise, Regardless of Engine Speed

Cause	Correction
Low oil pressure	• Perform an oil pressure test. Refer to <u>Oil Pressure Diagnosis and Testing</u>. • Repair or replace damaged components as required.
Worn accessory drive components - abnormalities, such as severe cracking, bumps, or missing areas in the accessory drive belt and/or misalignment of system components	1. Inspect the accessory drive system. 2. Repair or replace as required.
Loose or damaged crankshaft balancer	1. Inspect the crankshaft balancer. 2. Repair or replace as required.
Detonation or spark knock	Verify the correct operation of the ignition system. Refer to <u>Symptoms - Engine Controls</u> .
Loose torque converter bolts	1. Inspect the torque converter bolts and flywheel. 2. Repair or replace as required.
Loose or damaged flywheel	Repair or replace the flywheel.
Damaged oil pan, contacting the oil pump screen - an oil pan that has been damaged, may improperly position the oil pump screen, preventing proper oil flow to the oil pump.	1. Inspect the oil pan. 2. Inspect the oil pump screen. 3. Repair or replace as required.
Oil pump screen loose, damaged or restricted	1. Inspect the oil pump screen. 2. Repair or replace as required.
Excessive piston-to-cylinder bore clearance	1. Inspect the piston and cylinder bore. 2. Repair as required.
Excessive piston pin-to-bore clearance	1. Inspect the piston, piston pin, and the connecting rod. 2. Repair or replace as required.
Excessive connecting rod bearing clearance	Inspect the following components, and repair as required:

	• The connecting rod bearings • The connecting rods • The crankshaft • The crankshaft journals
Excessive crankshaft bearing clearance	Inspect the following components, and repair as required: • The crankshaft bearings • The crankshaft journals
Incorrect piston, piston pin, and connecting rod installation - pistons must be installed with the mark or dimple on the top of the piston, facing the front of the engine. Piston pins must be centered in the connecting rod pin bore.	1. Verify the pistons, piston pins and connecting rods are installed correctly. 2. Repair as required.

ENGINE NOISE UNDER LOAD

Engine Noise Under Load

Cause	Correction
Low oil pressure	1. Perform an oil pressure test. Refer to <u>Oil Pressure Diagnosis and Testing</u>. 2. Repair or replace as required.
Detonation or spark knock	Verify the correct operation of the ignition. Refer to <u>Symptoms - Engine Controls</u> .
Loose torque converter bolts	1. Inspect the torque converter bolts and flywheel. 2. Repair as required.
Cracked flywheel, automatic transmission	1. Inspect the flywheel bolts and flywheel. 2. Repair as required.
Excessive connecting rod bearing clearance	Inspect the following components, and repair as required: • The connecting rod bearings • The connecting rods • The crankshaft
Excessive crankshaft bearing clearance	Inspect the following components, and repair as required: • The crankshaft bearings • The crankshaft journals • The cylinder block crankshaft bearing bore
	1. Verify correct oil pressure. If low, inspect the bottom of the oil filter for oil filter drain back feature. Refer to <u>Oil Pressure Diagnosis and Testing</u>.

Malfunctioning camshaft position actuators
- improper oil viscosity or contamination.

2. Isolate the noise to a specific camshaft position actuator. Disconnect the electrical connector on the camshaft position actuator solenoid valves and start the vehicle. If noise is gone, repeat procedure to limit to an individual actuator. Refer to **Camshaft Position Actuator Intake Solenoid Valve Replacement** , or **Camshaft Position Actuator Exhaust Solenoid Valve Replacement** .

ENGINE WILL NOT CRANK - CRANKSHAFT WILL NOT ROTATE

Engine Will Not Crank - Crankshaft Will Not Rotate

Cause	Correction
Seized accessory drive system component	1. Remove accessory drive belts. 2. Rotate crankshaft by hand at the balancer or flywheel location.
Hydraulically locked cylinder • Coolant/antifreeze in cylinder • Oil in cylinder • Fuel in cylinder	1. Remove spark plugs and check for fluid. 2. Inspect for broken head gasket. 3. Inspect for cracked engine block or cylinder head. 4. Inspect for a sticking fuel injector. 5. Inspect for cracked cylinder wall.
Seized automatic transmission torque converter	1. Remove the torque converter bolts. 2. Rotate crankshaft by hand at the balancer or flywheel location.
Seized manual transmission	1. Disengage the clutch. 2. Rotate crankshaft by hand at the balancer or flywheel location.
Broken timing chain and/or gears	1. Inspect timing chain and gears. 2. Repair as required.
Seized balance shaft	1. Inspect balance shaft. 2. Repair as required.
Material in cylinder • Broken valve • Piston material • Foreign material • Cracked cylinder wall	1. Inspect cylinder for damaged components and/or foreign materials. 2. Inspect for fallen cylinder wall. 3. Repair or replace as required.
Seized crankshaft or connecting rod bearings	1. Inspect crankshaft and connecting rod

	bearings. 2. Inspect for fallen cylinder wall. 3. Repair as required.
Bent or broken connecting rod	1. Inspect connecting rods. 2. Repair as required.
Broken crankshaft	1. Inspect crankshaft. 2. Repair as required.

COOLANT IN COMBUSTION CHAMBER

Coolant in Combustion Chamber

Cause	Correction
DEFINITION: Excessive white smoke and/or coolant type odor coming from the exhaust pipe may indicate coolant in the combustion chamber. Low coolant levels, an inoperative cooling fan, or a faulty thermostat may lead to an "overtemperature" condition which may cause engine component damage.	
1. A slower than normal cranking speed may indicate coolant entering the combustion chamber. Refer to <u>Engine Will Not Crank - Crankshaft Will Not Rotate</u> . 2. Remove the spark plugs and inspect for spark plugs saturated by coolant or coolant in the cylinder bore. 3. Inspect by performing a cylinder leak-down test. During this test, excessive air bubbles within the coolant may indicate a faulty gasket or damaged component. 4. Inspect by performing a cylinder compression test. Two cylinders "side-by-side" on the engine block, with low compression, may indicate a failed cylinder head gasket. Refer to <u>Engine Compression Test</u> .	
Faulty cylinder head gasket	Replace the head gasket and components as required. Refer to <u>Cylinder Head Cleaning and Inspection</u> , and <u>Cylinder Head Replacement</u> .
Warped cylinder head	Replace the cylinder head and gasket. Refer to <u>Cylinder Head Cleaning and Inspection</u> .
Cracked cylinder head	Replace the cylinder head and gasket.
Cylinder head or block porosity	Replace the components as required.

COOLANT IN ENGINE OIL

Coolant in Engine Oil

Cause	Correction
DEFINITION: Foamy or discolored oil or an engine oil "overfill" condition may indicate coolant entering the engine crankcase. Low coolant levels, an inoperative cooling fan, or a faulty thermostat may lead to an "overtemperature" condition which may cause engine component damage. Contaminated engine oil and oil filter should be changed.	
1. Inspect the oil for excessive foaming or an overfill condition. Oil diluted by coolant may not	

properly lubricate the crankshaft bearings and may lead to component damage. Refer to **Lower Engine Noise, Regardless of Engine Speed**.

2. Inspect by performing a cylinder leak-down test. During this test, excessive air bubbles within the cooling system may indicate a faulty gasket or damaged component.
3. Inspect by performing a cylinder compression test. Two cylinders "side-by-side" on the engine block with low compression may indicate a failed cylinder head gasket. Refer to **Engine Compression Test**.

Faulty cylinder head gasket	Replace the head gasket and components as required. Refer to <u>Cylinder Head Cleaning and Inspection</u> , and <u>Cylinder Head Replacement</u> .
Warped cylinder head	Replace the cylinder head and gasket. Refer to <u>Cylinder Head Cleaning and Inspection</u> .
Cracked cylinder head	Replace the cylinder head and gasket.
Cylinder head or block porosity	Replace the components as required.

ENGINE COMPRESSION TEST

1. Charge the battery if the battery is not fully charged.
2. Disable the ignition system.
3. Disable the fuel injection system.
4. Remove all spark plugs.
5. Turn the ignition to the ON position.
6. Depress the accelerator pedal to position the throttle plate wide open.
7. Start with the compression gauge at zero and crank the engine through 4 compression strokes, 4 puffs.
8. Measure the compression for each cylinder. Record the readings.
9. If a cylinder has low compression, inject approximately 15 ml (1 tablespoon) of engine oil into the combustion chamber through the spark plug hole. Measure the compression again and record the reading.
10. The minimum compression in any 1 cylinder should not be less than 70 percent of the highest cylinder. No cylinder should read less than 690 kPa (100 psi). For example, if the highest pressure in any 1 cylinder is 1 035 kPa (150 psi), the lowest allowable pressure for any other cylinder would be 725 kPa (105 psi). ($1\ 035 \times 70\% = 725$) ($150 \times 70\% = 105$).
 - Normal - Compression builds up quickly and evenly to the specified compression for each cylinder.
 - Piston Rings Leaking - Compression is low on the first stroke. Compression builds up with the following strokes, but does not reach normal. Compression improves considerably when you add oil.
 - Valves Leaking - Compression is low on the first stroke. Compression usually does not build up on the following strokes. Compression does not improve much when you add oil.
 - If 2 adjacent cylinders have lower than normal compression, and injecting oil into the cylinders does not increase the compression, the cause may be a head gasket leaking between the cylinders.

TURBOCHARGER LEAKING FLUIDS EXTERNALLY

Turbocharger Leaking Fluids Externally

Condition	Action
Leaking Coolant from Coolant interfaces; Feed and/or Return Pipe	- Inspect Seal Surfaces on Bearing Housing, Pipes, and Banjo Bolt - If Turbo Seal Surface is damaged replace turbo - If Pipe Seal Surface is damaged replace Pipe - If Banjo Bolt Seal Surface is damaged replace Banjo Bolt - Reassemble with new seals in all cases
Leaking Coolant from area other than Coolant interfaces; NOT Feed and/or Return Pipe	Replace component that is leaking
Leaking Oil from Oil interfaces; Feed and/or Return Pipe	- Inspect Seal Surfaces on Bearing Housing, Pipes, and Bolts - If Turbo Seal Surface is damaged replace turbo - If Pipe Seal Surface is damaged replace Pipe - If Bolt Seal Surface is damaged replace Bolt - Reassemble with new seals in all cases
Oil on Compressor Cover	- Check for correct PCV System functionality, refer to <u>Crankcase Ventilation System Inspection/Diagnosis (LCV), Crankcase Ventilation System Inspection/Diagnosis (LTG)</u> - Check Turbocharger Oil Drain Pipe for restriction - Check PCV connection in Compressor Housing, inspect O-ring - Check Fresh Air Duct connection at Compressor inlet, look for damage and replace if necessary - Check Compressor Outlet connection, look for damage and replace if necessary
All Other External Turbocharger Leaks	Replace Turbocharger

TURBOCHARGER NOISE

Some noise is normal. Compare to a known good vehicle.

Turbocharger Noise

Condition	Action
Compressor Inlet leaks or Obstructions	Inspect for leaks or obstructions in the Turbocharger inlet.
Compressor Outlet Leaks or Obstruction	Inspect for leaks or obstructions in the Turbocharger outlet.
Charge Air Cooler and Engine Intake system Leaks or Obstructions	- Inspect for leaks - Inspect for obstructions
Damaged Electric Recirculation Valve	- Check Seal to Compressor Cover - Check DTCs for Bypass/Recirculation codes, replace

	if necessary
Compressor/Turbine Wheel Damage - Bent or Broken Blades	Replace the Turbocharger.
Compressor/Turbine Wheel to Housing contact	Replace the Turbocharger.

TURBOCHARGER SMOKE OR SMELL

Turbocharger Smoke or Smell

Condition	Action
Oil or Coolant Leak	Correct the leak.
Exhaust Leak	- Inspect Gaskets and Sealing Surfaces - Correct Leak - Look for external cracks in Turbocharger components NOTE: Cracks in the Turbine Inlet Partition Wall are acceptable. - Replace turbocharger assembly if external cracks found
Nearby Component Out of Position/Touching Turbocharger	Check for Turbine housing for contact with nearby components.

TURBOCHARGER LOSS OF BOOST PRESSURE

Turbocharger Loss of Boost Pressure

Condition	Action
Perceived Loss of Boost	- Check DTC codes - No Codes Present - Do not replace Turbocharger

CYLINDER LEAKAGE TEST

Special Tools

EN 35667-A Cylinder Head Leakdown Tester

For equivalent regional tools, refer to [Special Tools](#) .

NOTE: A leakage test may be performed in order to measure cylinder/combustion chamber leakage. High leakage may indicate one or more of the following:

- Worn or burnt valves

- Broken valve springs
- Stuck valve lash adjusters
- Incorrect valve lash/adjustment
- Damaged piston
- Worn piston rings
- Worn or scored cylinder bore
- Damaged cylinder head gasket
- Cracked or damaged cylinder head
- Cracked or damaged engine block

WARNING: Unless directed otherwise, the ignition and start switch must be in the OFF or LOCK position, and all electrical loads must be OFF before servicing any electrical component. Disconnect the negative battery cable to prevent an electrical spark should a tool or equipment come in contact with an exposed electrical terminal. Failure to follow these precautions may result in personal injury and/or damage to the vehicle or its components.

For Vehicles equipped with OnStar® (UE1) with Back Up Battery:

The Back Up Battery is a redundant power supply to allow limited OnStar® functionality in the event of a main vehicle battery power disruption to the VCIM (OnStar® module). Do not disconnect the main vehicle battery or remove the OnStar® fuse with the ignition key in any position other than OFF. Retained accessory power should be allowed to time out or be disabled (simply opening the driver door should disable retained accessory power) before disconnecting power. Disconnecting power to the OnStar® module in any way while the ignition is On or with retained accessory power activated may cause activation of the OnStar® Back-Up Battery system and will discharge and permanently damage the back-up battery. Once the Back-Up Battery is activated it will stay on until it has completely discharged. The back-up battery is not rechargeable and once activated the back-up battery must be replaced.

1. Disconnect the battery ground negative cable.
2. Remove the spark plugs. Refer to **Spark Plug Replacement** in Engine Controls.
3. Rotate the crankshaft to place the piston in the cylinder being tested at Top Dead Center (TDC) of the compression stroke.
4. Install the **EN 35667-A** tester or equivalent.

NOTE: It may be necessary to hold the crankshaft balancer bolt to prevent the engine from rotating.

5. Apply shop air pressure to the **EN 35667-A** tester and adjust according to the manufacturers instructions.
6. Record the cylinder leakage value. Cylinder leakage that exceeds 25 percent is considered excessive and may require component service. In excessive leakage situations, inspect for the following conditions:
 - Air leakage sounds at the throttle body or air inlet hose that may indicate a worn or burnt intake valve or a broken valve spring.
 - Air leakage sounds at the exhaust system tailpipe that may indicate a worn or burnt exhaust valve or a broken valve spring.
 - Air leakage sounds from the crankcase, oil level indicator tube, or oil fill tube that may indicate worn piston rings, a damaged piston, a worn or scored cylinder bore, a damaged engine block or a damaged cylinder head.
 - Air bubbles in the cooling system may indicate a damaged cylinder head or a damaged cylinder head gasket.
7. Perform the leakage test on the remaining cylinders and record the values.

ENGINE OIL LEVEL SENSOR DIAGNOSIS

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Engine Oil Level Sensor Signal	2	1	-
Engine Oil Level Sensor Ground	-	1	-
1. DIC message Engine Oil Level Low always ON 2. DIC message Engine Oil Level Low always OFF			

Typical Scan Tool Data

Engine Oil Level Switch

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON Parameter Normal Range: OK			
Engine Oil Level Sensor/Switch Signal	OK	Low	OK
Engine Oil Level Sensor/Switch Ground	-	Low	-

Circuit/System Description

The engine oil level sensor/switch is normally-closed with proper engine oil level. The switch opens when the engine oil level drops below a calibrated level. The engine control module (ECM) monitors the engine oil level

signal circuit when the ignition is ON, and the engine is OFF. With the switch in the closed position, the ECM detects a low voltage on the signal circuit. With the switch in the open position, the ECM detects a high voltage on the signal circuit. When high voltage is detected on the signal circuit, the ECM will send a serial data message to the instrument panel cluster (IPC). The IPC will then display a message on the driver information center (DIC) or illuminate a low engine oil level lamp.

The following information determines the message sent from the ECM to the IPC:

- The Low Engine Oil Level message lamp is displayed only after the ECM detects a high voltage on the signal circuit for three consecutive ignition cycles, followed by an ignition OFF event from 15 minutes to greater than 50 minutes, depending on engine oil temperatures.
- The Low Engine Oil Level message is turned OFF when the ECM detects a low voltage on the signal circuit after an ignition OFF event for greater than 90 seconds, followed by an ignition ON event for less than 1 second.

Reference Information

Schematic Reference

- **Engine Mechanical Schematics (LCV or LTG)**
- **Instrument Cluster Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **Instrument Cluster Description and Operation**
- **Indicator/Warning Message Description and Operation**

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information.

Circuit/System Verification

1. Verify proper engine oil level.
 - **If not at proper level**

Add oil as necessary.

- **If at proper level**

2. Ignition ON, verify the scan tool Engine Oil Level parameter reads OK.

- **If not OK**

Refer to Circuit/System Testing below.

- **If OK**

3. All OK.

Circuit/System Testing

NOTE: **Verify proper engine oil level before continuing with diagnosis.**

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B35 Engine Oil Level Switch. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 ohms between the low reference circuit terminal 1 and ground.

- **If 10 ohms or greater**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K20 Engine Control Module.

- **If less than 10 ohms**

3. Ignition ON.
4. Verify the scan tool Engine Oil Level Switch parameter reads Low.

- **If the Engine Oil Level Switch parameter reads OK**

Test the signal circuit terminal 2 for a short to ground. If the circuit tests normal, replace the K20 Engine Control Module.

- **If the Engine Oil Level Switch parameter reads Low**

NOTE: **If a short to voltage is found on the signal circuit, the fuse in the 3A jumper wire will open.**

5. Install a 3A fused jumper wire between the signal circuit terminal 2 and the ground circuit terminal 1.
6. Verify the scan tool Engine Oil Level Switch parameter reads OK.

- **If the Engine Oil Level Switch parameter reads Low**

Test the signal circuit terminal 2 for an open/high resistance. If the circuit tests normal, replace the K20 Engine Control Module.

- If the Engine Oil Level Switch parameter reads OK

7. Test or replace the engine oil level sensor and/or switch.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

- Engine Oil Level Indicator Switch Replacement
- Control Module References for the ECM replacement, programming, and setup

OIL CONSUMPTION DIAGNOSIS

Excessive oil consumption, not due to leaks, is the use of 0.9 L (1 qt) or greater of engine oil within 3 200 kilometers (2, 000 miles). The causes of excessive oil consumption include the following conditions:

- External oil leaks

Tighten bolts and/or replace gaskets and oil seals as necessary.

- Incorrect oil level or improper reading of oil level indicator

With the vehicle on a level surface, allow adequate drain down time and inspect for the correct oil level.

- Improper oil viscosity

Use recommended SAE viscosity for the prevailing temperatures.

- Continuous high speed driving and/or severe usage
- Crankcase ventilation system restrictions or malfunctioning components
- Valve guides and/or valve stem oil seals worn, or the seal omitted

Ream guides and install oversize service valves and/or new valve stem oil seals.

- Piston rings broken, improperly installed, worn, or not seated properly

Allow adequate time for rings to seat. Replace broken or worn rings, as necessary.

- Piston improperly installed or mis-fitted

OIL PRESSURE DIAGNOSIS AND TESTING

Special Tools

- CH-48027 Digital Pressure Gauge
- EN-21867-850 Oil Pressure Gauge Adapter

For equivalent regional tools, refer to **Special Tools** .

1. With the vehicle on a level surface, allow adequate drain down time of 2-3 minutes and measure for a low oil level.

Add the recommended grade engine oil and fill the crankcase until the oil level measures full on the oil level indicator.

2. Run the engine, and verify low, or no oil pressure on the vehicle gauge or light.

Listen for a noisy valve train or a knocking noise.

3. Inspect for the following:

- Correct oil filter with anti-drain back feature and O-ring on the cylinder block side of the filter
- Oil diluted by moisture or unburned fuel mixtures
- Improper oil viscosity for the expected temperature
- Incorrect or malfunctioning oil pressure sender
- Incorrect or malfunctioning oil pressure gauge
- Plugged oil filter
- Malfunctioning oil bypass valve

4. Remove the oil pressure sender or another engine block oil gallery plug.

5. Install **EN-21867-850** adapter and **CH-48027** gauge and measure the engine oil pressure.

6. Compare the readings to specifications. Refer to **Engine Mechanical Specifications (LCV)** , **Engine Mechanical Specifications (LTG)** .

7. If the engine oil pressure is below specifications, inspect the engine for one or more of the following:

- Correct oil filter with anti-drain back feature and O-ring on the cylinder block side of the filter
- Oil pump worn or dirty

Refer to **Balancer With Oil Pump Shaft Cleaning and Inspection** .

- Oil pump screen loose, plugged, or damaged
- Oil pump screen O-ring seal missing or damaged
- Malfunctioning oil control valve solenoid
- Excessive bearing clearance

Refer to **Crankshaft and Bearing Cleaning and Inspection** .

- Cracked, porous or restricted oil galleries
- Oil gallery plugs missing or incorrectly installed

Refer to **Engine Block Assemble** .

- Broken lash adjusters

OIL LEAK DIAGNOSIS

Oil Leak Diagnosis

Step	Action	Yes	No
DEFINITION: You can repair most fluid leaks by first, visually locating the leak, repairing or replacing the component, or by resealing the gasket surface. Once the leak is identified, determine the cause of the leak. Repair the cause of the leak as well as the leak itself.			
1	1. Operate the vehicle until it reaches normal operating temperature. Refer to <u>Engine Mechanical Specifications (LCV)</u> , <u>Engine Mechanical Specifications (LTG)</u> . 2. Park the vehicle on a level surface, over a large sheet of paper or other clean surface. 3. Wait 15 minutes. 4. Check for drippings. Are drippings present?	Go to Step 2	System OK
2	Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 3
3	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Check for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 4
4	1. Completely clean the entire engine and surrounding components. 2. Operate the vehicle for several miles at normal operating temperature and at varying speeds. 3. Park the vehicle on a level surface, over a large sheet of paper or other clean surface. 4. Wait 15 minutes. 5. Identify the type of fluid, and the approximate location of the leak. Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 5
	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas.		

5	2. Check for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 6
6	1. Completely clean the entire engine and surrounding components. 2. Apply an aerosol-type powder, for example, baby powder or foot powder, to the suspected area. 3. Operate the vehicle for several miles at normal operating temperature and at varying speeds. 4. Identify the type of fluid, and the approximate location of the leak, from the discolorations in the powder surface. Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 7
7	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Check for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 8
8	Use EN 28428-E Dye and Light Kit, in order to identify the type of fluid, and the approximate location of the leak. Refer to the manufacturer's instructions when using the tool. Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 9
9	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Check for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	System OK

10	1. Inspect the engine for mechanical damage. Special interest should be shown to the following areas: • Higher than recommended fluid levels • Higher than recommended fluid pressures • Plugged or malfunctioning fluid filters or pressure bypass valves • Plugged or malfunctioning engine ventilation system • Improperly tightened or damaged fasteners • Cracked or porous components • Improper sealants or gaskets where required • Improper sealant or gasket installation • Damaged or worn gaskets or seals • Damaged or worn sealing surfaces 2. Inspect the engine for customer modifications. Is there mechanical damage, or customer modifications to the engine?	Go to Step 11	System OK
11	Repair or replace all damaged or modified components. Did you complete the repair?	Go to Step 1	-

CRANKCASE VENTILATION SYSTEM INSPECTION/DIAGNOSIS (LCV)

Special Tools

EN 23951 Valve Manometer

For equivalent regional tools, refer to **Special Tools** .

1. Verify clean air cleaner.
2. Verify oil fill cap is in place.
3. Verify oil level indicator is installed.
4. Remove the oil level indicator. Install a **EN 23951** valve manometer or equivalent into the oil level indicator hole.
5. Start the engine.
6. Check for slight vacuum. The vacuum level should be less than 3.377 kPa (1 in Hg).
7. If vacuum is higher, inspect and verify that the clean air hose from cam cover to air intake is not blocked or kinked.
8. If vacuum is in the normal range, remove PCV line from fresh air valve near the oil fill cap. Block the fresh air valve and also plug the fresh air hose. Vacuum should increase on the manometer. If held too long, vacuum will be drawn through the crankshaft seals creating a sucking sound.
9. If vacuum does not increase, the orifice between the camshaft cover assembly and the cylinder head

assembly could be plugged.

10. If there is zero vacuum or pressure, verify compression of the engine.
11. If compression is normal, check for a blocked orifice between the camshaft cover assembly and the cylinder head assembly. Clean the orifice.

CRANKCASE VENTILATION SYSTEM INSPECTION/DIAGNOSIS (LTG)

Special Tools

EN 23951 Valve Manometer

For equivalent regional tools, refer to **Special Tools** .

1. Verify clean air cleaner.
2. Verify oil fill cap is in place.
3. Verify oil level indicator is installed.
4. Remove the oil level indicator. Install a **EN 23951** valve manometer or equivalent, into the oil level indicator hole.
5. Start the engine.
6. Check for slight vacuum. The vacuum level should be less than 3.377 kPa (1 in Hg).
7. If vacuum is higher, inspect and verify that the clean air hose from cam cover to air intake is not blocked or kinked.
8. If vacuum is in the normal range, remove the PCV line from the fresh air valve near oil fill cap. Block fresh air valve and also plug the fresh air hose. Vacuum should increase on the manometer. If held too long, vacuum will be drawn through the crankshaft seals creating a sucking sound.
9. If vacuum does not increase, the orifice in the camshaft cover assembly could be plugged. The valve is between the camshaft cover assembly and the cylinder head assembly.
10. If there is zero vacuum or pressure, verify compression of the engine.
11. If compression is normal, check for a blocked orifice at the camshaft cover assembly. Clean the orifice.
12. The hose from valve cover to the turbo is also for the positive crankcase ventilation (PCV) and is used for PCV flow under normal operation and only PCV flow during turbo boost conditions. If the hose is plugged, replace the PCV hose assembly and PCV fitting assembly at the turbocharger.

Concern	Action
External Oil Leak	Inspect for any of the following conditions: ● Plugged air intake system ● Plugged positive crankcase ventilation (PCV) orifice/check valve in the camshaft cover assembly ● Plugged or kinked PCV hoses ● Damaged or incorrectly installed PCV hoses ● Excessive crankcase pressure

	• Plugged PCV hose from camshaft cover to turbocharger
Rough Idle	Inspect for any of the following conditions: • Plugged or incorrectly installed air intake system • Plugged PCV orifice/check valve in the camshaft cover assembly • Plugged or kinked PCV hoses • Leaking or damaged PCV hoses • Leaking PCV hose from camshaft cover to turbocharger
Stalling or Slow Idle Speed	Inspect for any of the following conditions: • Plugged air intake system • Plugged PCV orifice in the camshaft cover assembly • Plugged or kinked PCV hoses • Leaking or damaged PCV hoses • Leaking PCV hose from camshaft cover to turbocharger
High Idle Speed	Inspect for any of the following conditions: • Air intake system incorrectly installed • Leaking or damaged PCV hoses
Sludge in the Engine	Inspect for any of the following conditions: • Plugged or incorrectly installed air intake system • Plugged PCV orifice in the camshaft cover assembly • Plugged or kinked PCV hoses • Plugged PCV hose from camshaft cover to turbocharger

DRIVE BELT CHIRPING, SQUEAL, AND WHINE DIAGNOSIS

Diagnostic Aids

- A chirping or squeal noise may be intermittent due to moisture on the drive belts or the pulleys. It may be necessary to spray a small amount of water on the drive belts in order to duplicate the customers concern. If spraying water on the drive belt duplicates the symptom, cleaning the belt pulleys may be the probable solution.
- If the noise is intermittent, verify the accessory drive components by varying their loads making sure they are operated to their maximum capacity. An overcharged A/C system, worn, misaligned drive belt pulleys

or a generator failing are suggested items to inspect.

- A chirping, squeal or whine noise may be caused by a loose or improper installation of a body or suspension component. Other items of the vehicle may also cause the noise.
- The drive belts will not cause a whine noise.

Test Description

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

2

The noise may not be engine related. This step is to verify that the engine is making the noise. If the engine is not making the noise do not proceed further with this table.

3

The noise may be an internal engine noise. Removing the drive belts one at a time and operating the engine for a brief period will verify the noise is related to the drive belt. When removing the drive belt the water pump may not be operating and the engine may overheat. Also DTCs may set when the engine is operating with the drive belts removed.

4

Inspect all drive belt pulleys for pilling. Pilling is the small balls or pills or it can be strings in the drive belt grooves from the accumulation of rubber dust.

6

Misalignment of the pulleys may be caused from improper mounting of the accessory drive component, incorrect installation of the accessory drive component pulley, or the pulley bent inward or outward from a previous repair. Test for a misaligned pulley using a straight edge in the pulley grooves across two or three pulleys. If a misaligned pulley is found refer to that accessory drive component for the proper installation procedure for that pulley.

10

Inspecting of the fasteners can eliminate the possibility that a wrong bolt, nut, spacer, or washer was installed.

12

Inspecting the pulleys for being bent should include inspecting for a dent or other damage to the pulleys that would prevent the drive belt from not seating properly in all of the pulley grooves or on the smooth surface of a pulley when the back side of the belt is used to drive the pulley.

14

This test is to verify that the drive belt tensioner operates properly. If the drive belt tensioner is not operating properly, proper belt tension may not be achieved to keep the drive belt from slipping which could cause a squeal noise.

15

This test is to verify that the drive belt is not too long, which would prevent the drive belt tensioner from working properly. Also if an incorrect length drive belt was installed, it may not be routed properly and may be turning an accessory drive component in the wrong direction.

16

Misalignment of the pulleys may be caused from improper mounting of the accessory drive component, incorrect installation of the accessory drive component pulley, or the pulley bent inward or outward from a previous repair. Test for a misaligned pulley using a straight edge in the pulley grooves across two or three pulleys. If a misaligned pulley is found refer to that accessory drive component for the proper installation procedure for that pulley.

17

This test is to verify that the pulleys are the correct diameter or width. Using a known good vehicle compare the pulley sizes.

19

Replacing the drive belt when it is not damaged or there is not excessive pilling will only be a temporary repair.

Drive Belt Chirping, Squeal, and Whine Diagnosis

Step	Action	Yes	No
CAUTION: Refer to <u>Belt Dressing Caution</u> .			
DEFINITION: The following items are indications of chirping:			
• A high pitched noise that is heard once per revolution of the drive belt or a pulley. • Chirping may occur on cold damp start-ups and will subside once the vehicle reaches normal operating temp.			
DEFINITION: The following items are indications of drive belt squeal:			
• A loud screeching noise that is caused by a slipping drive belt. This is unusual for a drive belt with multiple ribs. • The noise occurs when a heavy load is applied to the drive belt, such as an air conditioning compressor engagement snapping the throttle, or slipping on a seized pulley or a faulty accessory drive component.			

DEFINITION: The following items are indications of drive belt whine:

- A high pitched continuous noise.
- The noise may be caused by an accessory drive component failed bearing.

1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Engine Mechanical
2	Verify that there is a chirping, squeal or whine noise. Does the engine make the chirping squeal or whine noise?	Go to Step 3	Go to Diagnostic Aids
3	1. Remove the drive belt. If the engine has multiple drive belts, remove the belts one at a time and perform the test below each time a belt is removed. 2. Operate the engine for no longer than 30-40 seconds. 3. Repeat this test if necessary by removing the remaining belt(s). Does the chirping, squeal or whine noise still exist?	Go to Symptoms - Engine Mechanical	Go to Step 4
4	If diagnosing a chirping noise, inspect for severe pilling exceeding 1/3 of the belt groove depth. If diagnosing a squeal or whine noise, proceed to step 13. Do the belt grooves have pilling?	Go to Step 5	Go to Step 6
5	Clean the drive belt pulleys with a suitable wire brush. Did you complete the repair?	Go to Step 20	Go to Step 6
6	Inspect for misalignment of the pulleys. Are any of the pulleys misaligned?	Go to Step 7	Go to Step 8
7	Replace or repair any misaligned pulleys. Did you complete the repair?	Go to Step 20	Go to Step 8
8	Inspect for bent or cracked brackets. Did you find any bent or cracked brackets?	Go to Step 9	Go to Step 10
9	Replace any bent or cracked brackets. Did you complete the repair?	Go to Step 20	Go to Step 10
10	Inspect for improper, loose or missing fasteners. Did you find the condition?	Go to Step 11	Go to Step 12

	CAUTION: Refer to <u>Fastener Caution</u> .		
11	1. Tighten any loose fasteners. Refer to <u>Fastener Tightening Specifications</u> . 2. Replace any improper or missing fasteners. Did you complete the repair?	Go to Step 20	Go to Step 12
12	Inspect for a bent pulley. Did you find the condition?	Go to Step 18	Go to Step 19
13	Inspect for an accessory drive component seized bearing or a faulty accessory drive component. If diagnosing a whine noise and the condition still exist, proceed to Diagnostic Aids. Did you find and correct the condition?	Go to Step 20	Go to Step 14
14	Test the drive belt tensioner for proper operation. Refer to <u>Drive Belt Tensioner Diagnosis</u> . Did you find and correct the condition?	Go to Step 20	Go to Step 15
15	Inspect for the correct drive belt length. Did you find and correct the condition?	Go to Step 20	Go to Step 16
16	Inspect for misalignment of a pulley. Did you find and correct the condition?	Go to Step 20	Go to Step 17
17	Inspect for the correct pulley size. Did you find and correct the condition?	Go to Step 20	Go to Diagnostic Aids
18	Replace the bent pulley. Did you complete the repair?	Go to Step 20	Go to Step 19
19	Replace the drive belt. Refer to <u>Drive Belt Replacement</u> . Did you complete the repair?	Go to Step 20	Go to Diagnostic Aids
20	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

DRIVE BELT RUMBLING AND VIBRATION DIAGNOSIS

Diagnostic Aids

The accessory drive components can have an affect on engine vibration. Vibration from the engine operating may cause a body component or another part of the vehicle to make rumbling noise. Vibration can be caused by, but not limited to the A/C system over charged, the power steering system restricted or the incorrect fluid, or an extra load on the generator. To help identify an intermittent or an improper condition, vary the loads on the accessory drive components.

The drive belt may have a rumbling condition that can not be seen or felt. Sometimes replacing the drive belt may be the only repair for the symptom.

If replacing the drive belt, completing the diagnostic table, and the noise is only heard when the drive belts are installed, there might be an accessory drive component with a failure. Varying the load on the different accessory drive components may aid in identifying which component is causing the rumbling noise.

Test Description

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

2

This test is to verify that the symptom is present during diagnosing. Other vehicle components may cause a similar symptom.

3

This test is to verify that one of the drive belts is causing the rumbling noise or vibration. Rumbling noise may be confused with an internal engine noise due to the similarity in the description. Remove only one drive belt at a time if the vehicle has multiple drive belts. When removing the drive belts the water pump may not be operating and the engine may overheat. Also DTCs may set when the engine is operating with the drive belts removed.

4

Inspecting the drive belts is to ensure that they are not causing the noise. Small cracks across the ribs of the drive belt will not cause the noise. Belt separation is identified by the plies of the belt separating and may be seen at the edge of the belt or felt as a lump in the belt.

5

Small amounts of pilling is normal condition and acceptable. When the pilling is severe the drive belt does not have a smooth surface for proper operation.

9

Inspecting of the fasteners can eliminate the possibility that the wrong bolt, nut, spacer, or washer was installed.

11

This step should only be performed if the water pump is driven by the drive belt. Inspect the water pump shaft for being bent. Also inspect the water pump bearings for smooth operation and excessive play. Compare the water pump with a known good water pump.

12

Accessory drive component brackets that are bent, cracked, or loose may put extra strain on that accessory component causing it to vibrate.

Drive Belt Rumbling and Vibration Diagnosis

Step	Action	Yes	No
CAUTION: Refer to <u>Belt Dressing Caution</u> .			
DEFINITION: The following items are indications of drive belt rumbling: • A low pitch tapping, knocking, or thumping noise heard at or just above idle. • Heard once per revolution of the drive belt or a pulley. • Rumbling may be caused from: ○ Pilling, the accumulation of rubber dust that forms small balls (pills) or strings in the drive belt pulley groove ○ The separation of the drive belt ○ A damaged drive belt			
DEFINITION: The following items are indications of drive belt vibration: • The vibration is engine-speed related. • The vibration may be sensitive to accessory load.			
1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to Step 2	Go to <u>Symptoms - Engine Mechanical</u>
2	Verify that there is a rumbling noise or that the vibration is engine related. Does the engine make the rumbling noise or vibration?	Go to Step 3	Go to Diagnostic Aids
3	1. Remove the drive belt. If the engine has multiple drive belts, remove the belts one at a time and perform the test below each time a belt is removed. 2. Operate the engine for no longer than 30-40 seconds. 3. Repeat this test if necessary by removing the remaining belt(s). Does the rumbling or vibration still exist?	Go to <u>Symptoms - Engine Mechanical</u> or <u>Vibration Analysis - Engine</u>	Go to Step 4
4	Inspect the drive belts for wear, damage, separation, sections of missing ribs, and		

	debris build-up. Did you find any of these conditions?	Go to Step 7	Go to Step 5
5	Inspect for severe pilling of more than 1/3 of the drive belt pulley grooves. Did you find severe pilling?	Go to Step 6	Go to Step 7
6	1. Clean the drive belt pulleys using a suitable wire brush. 2. Reinstall the drive belts. Refer to <u>Drive Belt Replacement</u> . Did you correct the condition?	Go to Step 8	Go to Step 7
7	Install a new drive belt. Refer to <u>Drive Belt Replacement</u> . Did you complete the replacement?	Go to Step 8	Go to Step 9
8	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 9
9	Inspect for improper, loose or missing fasteners. Did you find any of these conditions?	Go to Step 10	Go to Step 11
10	CAUTION: Refer to <u>Fastener Caution</u> . 1. Tighten any loose fasteners. Refer to <u>Fastener Tightening Specifications</u> . 2. Replace improper or missing fasteners. Did you complete the repair?	Go to Step 13	Go to Step 11
11	Inspect for a bent water pump shaft. Refer to <u>Water Pump Replacement (LUK)</u> , <u>Water Pump Replacement (LCV)</u> , <u>Water Pump Replacement (LTG)</u> . Did you find and correct the condition?	Go to Step 13	Go to Step 12
12	Inspect for bent or cracked brackets. Did you find and correct the condition?	Go to Step 13	Go to Diagnostic Aids
13	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

DRIVE BELT FALLS OFF AND EXCESSIVE WEAR DIAGNOSIS

Diagnostic Aids

If the drive belt repeatedly falls off the drive belt pulleys, this is because of pulley misalignment.

An extra load that is quickly applied on released by an accessory drive component may cause the drive belt to fall off the pulleys. Verify the accessory drive components operate properly.

If the drive belt is the incorrect length, the drive belt tensioner may not keep the proper tension on the drive belt.

Excessive wear on a drive belt is usually caused by an incorrect installation or the wrong drive belt for the application.

Minor misalignment of the drive belt pulleys will not cause excessive wear, but will probably cause the drive belt to make a noise or to fall off.

Excessive misalignment of the drive belt pulleys will cause excessive wear but may also make the drive belt fall off.

Test Description

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

2

This inspection is to verify the condition of the drive belt. Damage may of occurred to the drive belt when the drive belt fell off. The drive belt may of been damaged, which caused the drive belt to fall off. Inspect the belt for cuts, tears, sections of ribs missing, or damaged belt plys.

4

Misalignment of the pulleys may be caused from improper mounting of the accessory drive component, incorrect installation of the accessory drive component pulley, or the pulley bent inward or outward from a previous repair. Test for a misaligned pulley using a straight edge in the pulley grooves across 2 or 3 pulleys. If a misaligned pulley is found refer to that accessory drive component for the proper installation procedure of that pulley.

5

Inspecting the pulleys for being bent should include inspecting for a dent or other damage to the pulleys that would prevent the drive belt from not seating properly in all of the pulley grooves or on the smooth surface of a pulley when the back side of the belt is used to drive the pulley.

6

Accessory drive component brackets that are bent or cracked will let the drive belt fall off.

7

Inspecting of the fasteners can eliminate the possibility that a wrong bolt, nut, spacer, or washer was installed. Missing, loose, or the wrong fasteners may cause pulley misalignment from the bracket moving under load. Over tightening of the fasteners may cause misalignment of the accessory component bracket.

13

The inspection is to verify the drive belt is correctly installed on all of the drive belt pulleys. Wear on the drive belt may be caused by mis-positioning the drive belt by one groove on a pulley.

14

The installation of a drive belt that is too wide or too narrow will cause wear on the drive belt. The drive belt ribs should match all of the grooves on all of the pulleys.

15

This inspection is to verify the drive belt is not contacting any parts of the engine or body while the engine is operating. There should be sufficient clearance when the drive belt accessory drive components load varies. The drive belt should not come in contact with an engine or a body component when snapping the throttle.

Drive Belt Falls Off and Excessive Wear Diagnosis

Step	Action	Yes	No
CAUTION: Refer to <u>Belt Dressing Caution</u> .			
DEFINITION: The drive belt falls off the pulleys or may not ride correctly on the pulleys. DEFINITION: Wear at the outside ribs of the drive belt due to an incorrectly installed drive belt.			
1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to Step 2	Go to <u>Symptoms - Engine Mechanical</u>
2	If diagnosing excessive wear, proceed to step 13. If diagnosing a drive belt that falls off, inspect for a damaged drive belt. Did you find the condition?	Go to Step 3	Go to Step 4
3	Install a new drive belt. Refer to <u>Drive Belt Replacement</u> . Does the drive belt continue to fall off?	Go to Step 4	System OK
4	Inspect for misalignment of the pulleys. Did you find and repair the condition?	Go to Step 12	Go to Step 5
5	Inspect for a bent or dented pulley. Did you find and repair the condition?	Go to Step 12	Go to Step 6
6	Inspect for a bent or a cracked bracket. Did you find and repair the condition?	Go to Step 12	Go to Step 7
7	Inspect for improper, loose or missing fasteners. Did you find loose or missing fasteners?	Go to Step 8	Go to Step 9
	CAUTION: Refer to <u>Fastener Caution</u> .		

8	1. Tighten any loose fasteners. Refer to <u>Fastener Tightening Specifications</u> . 2. Replace improper or missing fasteners. Does the drive belt continue to fall off?	Go to Step 9	System OK
9	Test the drive belt tensioner for operating correctly. Refer to <u>Drive Belt Replacement</u> . Does the drive belt tensioner operate correctly?	Go to Step 11	Go to Step 10
10	Replace the drive belt tensioner. Refer to <u>Drive Belt Replacement</u> . Does the drive belt continue to fall off?	Go to Step 11	System OK
11	Inspect for failed drive belt idler and drive belt tensioner pulley bearings. Did you find and repair the condition?	Go to Step 12	Go to Diagnostic Aids
12	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 2
13	Inspect the drive belt for the proper installation. Refer to <u>Drive Belt Replacement</u> . Did you find this condition?	Go to Step 16	Go to Step 14
14	Inspect for the proper drive belt. Did you find this condition?	Go to Step 16	Go to Step 15
15	Inspect for the drive belt rubbing against a bracket, hose, or wiring harness. Did you find and repair the condition?	Go to Step 17	Go to Diagnostic Aids
16	Replace the drive belt. Refer to <u>Drive Belt Replacement</u> . Did you complete the replacement?	Go to Step 17	-
17	Operate the system in order to verify the repair. Did you correct the condition?	System OK	-

DRIVE BELT TENSIONER DIAGNOSIS

Drive Belt Tensioner Diagnosis

Step	Action	Yes	No
1	1. Remove the drive belt. Refer to <u>Drive Belt Replacement</u> . 2. Inspect the drive belt tensioner pulley. Is the drive belt tensioner pulley loose or misaligned?	Go to Step 6	Go to Step 2
2	Rotate the drive belt tensioner pulleys. Do the pulleys rotate without any unusual resistance or binding?	Go to Step 3	Go to Step 6
	1. Use a torque wrench in order to measure the torque required to move the tensioner off of the		

3	stop. 2. Use a torque wrench on a known good tensioner in order to measure the torque required to move the tensioner off of the stop. Is the first torque reading within 10 percent of the second torque reading?	Go to Step 4	Go to Step 6
4	Inspect tensioner for indication of oil leaks. Does it show signs of oil leaking?	Go to Step 6	Go to Step 5
5	Remove top tensioner bolt, above hydraulic tensioner and verify tensioner assembly moves about center pivot by applying light force. Does the tensioner Asm move without binding?	System OK	Go to Step 6
6	Replace the drive belt tensioner. Refer to <u>Drive Belt Tensioner Replacement</u> . Is the repair complete?	System OK	-