

2021 ENGINE

Engine Mechanical - 3.6L (LGZ) - Diagnostic Information and Procedures - Canyon, Colorado

DIAGNOSTIC INFORMATION AND PROCEDURES

SYMPTOMS - ENGINE MECHANICAL

Strategy Based Diagnostics

1. Perform a [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](#) , [Engine Component Description](#) , [Drive Belt System 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 problem. The diagnostic flow is the place to start when repairs are necessary. For a detailed explanation, refer to [Strategy Based Diagnosis](#) .

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the engine. [Checking Aftermarket Accessories](#)
- 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](#)

DTC P06DA-P06DE

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: [Diagnostic System Check - Vehicle](#)
- Review the description of Strategy Based Diagnosis: [Strategy Based Diagnosis](#)
- An overview of each diagnostic category can be found here: [Diagnostic Procedure Instructions](#)

DTC Descriptor

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

DTC P06DD

Engine Oil Pressure Control Solenoid Valve Stuck Off

DTC P06DE

Engine Oil Pressure Control Solenoid Valve Stuck On

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	P06DA, P06DB*	P06DA, P06DB	-	-
Control	P06DB	P06DA	P06DC	P06DD, P06DE
*Additional DTCs may set.				

Circuit/System Description

Circuit	Description
Ignition	Supplied from a fuse.
Control	The output circuit is switched to ground to activate the component.

Component	Description
K20 Engine Control Module	The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.
Q44 Engine Oil Pressure Control Solenoid Valve	A solenoid valve is an electro-mechanically operated valve. The valve is controlled by an electric current through the solenoid.

The engine oil pressure control solenoid valve is used to control engine oil pressure inside the mechanical engine oil pump. The control module controls the commanded state of the solenoid valve based on the following inputs:

- Engine Speed
- Calculated Engine Oil Temperature
- Engine Oil Pressure
- Engine Run Time

When the solenoid valve is commanded Off, oil pressure is higher. When the solenoid valve is commanded On, oil pressure is lower.

Conditions for Running the DTC

P06DA, P06DB, P06DC

- Engine = Running
- Ignition Voltage = Greater than 11 V

Frequency the DTC runs = Continuously - After the running conditions are met

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, P2230 = Not set
- Engine Speed = 1, 500 to 2, 500 RPM

Frequency the DTC runs = Continuously - After the running conditions are met

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, P2230 = Not set
- Engine = Running - For greater than 1.5 s
- Engine Speed = 1, 500 to 2, 500 RPM
- Engine Oil Pressure Control Solenoid Valve = On - For greater than 1.5 s

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

P06DA, P06DB, P06DC

Control Circuit = Commanded state does not match the actual state - For greater than 1 s

P06DD

Engine Oil Pressure = Greater than a predefined threshold

P06DE

Engine Oil Pressure = Less than a predefined threshold

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B DTC - Exceptions listed below

DTC P06DB, P06DE = Type A DTC

- Engine Oil Pressure Control Solenoid Valve = Off
- Reduced Engine Power = Active

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B DTC - Exceptions listed below

DTC P06DB, P06DE = Type A DTC

Reference Information

Schematic Reference

Engine Mechanical Wiring Schematics

Connector End View Reference

Master Electrical Component List , or Inline Harness Connector End Views - Index or 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

Circuit/System Verification

NOTE: The engine oil level and condition is critical to the correct operation of the system.

1. Ignition - On / Vehicle - In Service Mode
2. Verify there are no DTCs set related to the following component/system:
 - B35B Engine Oil Level Sensor
 - B37B Engine Oil Pressure Sensor
 - B37 Engine Oil Pressure Switch
 - **If other DTCs are set**

Refer to: Diagnostic Trouble Code (DTC) List - Vehicle

- **Go to next step: If no other DTCs are set**
3. Verify the condition does not exist: Engine Oil - Contaminated/Dirty/Fill Level = Low
 - **If a condition exists**

Repair as necessary

- **Go to next step: If no condition exists**

4. Perform the scan tool control function: Engine Oil Pressure Control Solenoid Valve - On and Off

Verify the scan tool parameter:

- Engine Oil Pressure Control Solenoid Valve Control Circuit Low Voltage Test Status = OK or Not Run
- Engine Oil Pressure Control Solenoid Valve Control Circuit Open Test Status = OK or Not Run
- Engine Oil Pressure Control Solenoid Valve Control Circuit High Voltage Test Status = OK or Not Run
- **If not the specified state**

Refer to: Circuit/System Testing

- **Go to next step: If the specified state**

5. Engine - Running

6. Perform the following steps:

1. Increase the engine speed slowly to 1, 800 RPM.

NOTE: Using the scan tool line graph function may make it easier to identify if the value changes.

2. Perform the scan tool control function: Engine Oil Pressure Control Solenoid Valve - On

Verify the scan tool parameter: Engine Oil Pressure = Change is greater than 30 kPa (4 PSI)

- If the change is 30 kPa (4 PSI) or less - Replace the component: Q44 Engine Oil Pressure Control Solenoid Valve
- Go to next step: If the change is greater than 30 kPa (4 PSI)

7. 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.

Verify the DTC does not set.

- **If the DTC sets**

Refer to: Circuit/System Testing

- **Go to next step: If the DTC is not set**

8. All OK.

Circuit/System Testing

1. Ignition/Vehicle & All vehicle systems - Off
2. Disconnect the electrical connector: Q44 Engine Oil Pressure Control Solenoid Valve
3. Ignition - On / Vehicle - In Service Mode
4. Verify a test lamp turns On between the test points: Ignition circuit terminal 1/A & Ground
 - **If the test lamp does not turn On and the circuit fuse is OK**
 1. Ignition/Vehicle - Off & Remove - Test lamp
 2. Test for less than 2 ohms between the test points: Ignition circuit terminal 1/A & Output terminal @ Fuse
 - If 2 ohms or greater - Repair the open/high resistance in the circuit.
 - If less than 2 ohms - Verify the fuse is OK and there is voltage at the fuse.

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

1. Ignition/Vehicle - Off & Remove - Test lamp

NOTE: **The ignition circuit supplies voltage to other components. Test all circuits for a short to ground or test all components for being shorted.**

2. Test for infinite resistance between the test points: Ignition circuit terminal 1/A & Ground

- If less than infinite resistance - Repair the short to ground on the circuit.
- If infinite resistance - Replace the component: Q44 Engine Oil Pressure Control Solenoid Valve

- **Go to next step: If the test lamp turns On**

5. Verify a test lamp does not turn On between the test points: Control circuit terminal 2/B & B+

- **If the test lamp turns On**

1. Ignition/Vehicle - Off & Remove - Test lamp

2. Disconnect the electrical connector: K20 Engine Control Module

3. Test for infinite resistance between the test points: Control circuit terminal 2/B @ Component harness & Ground

- If less than infinite resistance - Repair the short to ground on the circuit.
- If infinite resistance - Replace the component: K20 Engine Control Module

- **Go to next step: If the test lamp does not turn On**

6. Remove - Test Lamp

7. Perform the scan tool control function: Engine Oil Pressure Control Solenoid Valve - On

Verify the scan tool parameter: Engine Oil Pressure Control Solenoid Valve Control Circuit High Voltage Test Status = OK or Not Run

- **If not the specified state**

1. Ignition/Vehicle - Off

2. Disconnect the electrical connector: K20 Engine Control Module

3. Ignition - On / Vehicle - In Service Mode

4. Test for less than 1 V between the test points: Control circuit terminal 2/B @ Component harness & Ground

- If 1 V or greater - Repair the short to voltage on the circuit.
- If less than 1 V - Replace the component: K20 Engine Control Module

- **Go to next step: If the specified state**

8. Connect a 3 A fused jumper wire between the test points: Control circuit terminal 2/B & Ignition circuit terminal 1/A

9. Perform the scan tool control function: Engine Oil Pressure Control Solenoid Valve - On

Verify the scan tool parameter: Engine Oil Pressure Control Solenoid Valve Control Circuit High Voltage Test Status = Malfunction

- **If not the specified state**

1. Ignition/Vehicle - Off & Remove - Jumper wire(s)

2. Disconnect the electrical connector: K20 Engine Control Module

3. Test for less than 2 ohms between the test points: Control circuit terminal 2/B @ Component harness & The other end of the circuit @ Control module harness

- If 2 ohms or greater - Repair the open/high resistance in the circuit.
- If less than 2 ohms - Replace the component: K20 Engine Control Module

- **Go to next step: If the specified state**

10. Test or replace the component: Q44 Engine Oil Pressure Control Solenoid Valve

Component Testing

Static Test

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector: Q44 Engine Oil Pressure Control Solenoid Valve
3. Test for 10 to 30 ohms between the test points: Control terminal 2/B & Ignition terminal 1/A

- **If not between 10 and 30 ohms**

Replace the component: Q44 Engine Oil Pressure Control Solenoid Valve

- **Go to next step: If between 10 and 30 ohms**

4. Test for infinite resistance between the test points: Each terminal of the component & The component's housing

- **If less than infinite resistance**

Replace the component: Q44 Engine Oil Pressure Control Solenoid Valve

- **Go to next step: If infinite resistance**

5. All OK.

Dynamic Test

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector: Q44 Engine Oil Pressure Control Solenoid Valve
3. Connect a 3 A fused jumper wire between the test points: Ignition terminal 1/A & 12 V

CAUTION: Complete the testing as quickly as possible in order to prevent overheating and damaging the component.

4. Momentarily connect a jumper wire between the test points: Control terminal 2/B & Ground

Verify the component turns On and Off when connecting and disconnecting the jumper wire: Q44 Engine Oil Pressure Control Solenoid Valve

- **If the component does not turn On and Off**

Replace the component: Q44 Engine Oil Pressure Control Solenoid Valve

- **Go to next step: If the component turns On and Off**

5. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: [Diagnostic Repair Verification](#)

- [Oil Pump Flow Control Valve Replacement](#) - Q44 Engine Oil Pressure Control Solenoid Valve
- For control module replacement, programming, and setup refer to: [Control Module References](#)

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. Refer to Drive Belt Replacement .
Worn, damaged, or mis-aligned accessory drive components or excessive pulley runout and may lead to a misfire DTC. 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. Refer to Automatic Transmission Flex Plate Replacement , or Crankshaft Balancer Replacement (without Bison) , or Crankshaft Balancer Replacement (with Bison) .
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, intake manifold and plenum duct, plenum duct and water crossover, water crossover and throttle body and/or pressure relief valve and intake manifold.	Replace the intake manifold, plenum duct, gaskets, cylinder heads, throttle body and/or pressure relief valve as required.
Improperly installed or damaged MAP sensor and/or seal The sealing grommet of the MAP sensor should not be torn or damaged.	Repair or replace the MAP sensor as required.
Improperly installed or damaged EVAP purge solenoid and/or O-ring seal	Repair or replace the EVAP purge solenoid as required.
Worn or loose followers, valve rocker arms The follower, valve rocker arm, roller bearing should be intact and in the proper position.	Replace the followers, 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 or chains	Replace the timing chain or chains and sprockets as required.
Worn camshaft lobes	Replace the camshaft or camshafts and SHLAs (valve lifters).
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 Oil Pressure Diagnosis and Testing. - Repair or replace the oil pump as required.
Faulty cylinder head gaskets and/or cracking or other damage to the cylinder heads and engine block cooling system passages. Refer to Diagnostic Starting Point - Vehicle . Coolant consumption may or may not cause the engine to overheat.	- Inspect for spark plugs saturated by coolant. Refer to Coolant in Combustion Chamber for the 3.6L engine. - Inspect the cylinder heads, engine block, and/or head gaskets.

Cause	Correction
	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 Engine Compression Test. - 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 SEVERE reluctor ring damage may exhibit periodic loss of crankshaft position, stop delivering a signal, and then re-sync the crankshaft position. - Systems with SLIGHT reluctor ring damage may exhibit no loss of crankshaft position and no misfire may occur. However, a P0300 DTC may be set.	Replace the crankshaft as required.

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 actual misfire condition.	Replace the drive belt. Refer to Drive Belt Replacement.
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 engine flywheel and/or crankshaft balancer as required. Refer to Automatic Transmission Flex Plate Replacement, or Crankshaft Balancer Replacement (without Bison), or Crankshaft Balancer Replacement (with Bison).
Worn or broken 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 Engine Compression Test. - Perform cylinder leak down and compression testing to determine the cause. - Repair or replace as required.

Cause	Correction
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

Cause	Correction
Worn or loose followers, valve rocker arms The follower, valve rocker arm, and roller bearing should be intact and in the proper position.	Replace the followers and/or valve rocker arms, as required.
Stuck valves Carbon buildup on the valve stem can cause the valve not to close properly.	Repair or replace the valves as required.
Excessively worn or mis-aligned timing chain or chains	Replace the timing chain or chains and sprockets as required.
Worn camshaft lobes	Replace the camshaft or camshafts and (Stationary Hydraulic Lash Adjuster) SHLAs (valve lifters).
Sticking SHLAs (valve lifters)	Replace the SHLAs as required.

BASE ENGINE MISFIRE WITH COOLANT CONSUMPTION

Cause	Correction
Faulty cylinder head gaskets and/or cracking or other damage to the cylinder heads and engine block cooling system passages. Refer to Diagnostic Starting Point - Vehicle . Coolant consumption may or may not cause the engine to overheat.	- Inspect for spark plugs saturated by coolant. Refer to Coolant in Combustion Chamber for the 3.6L engine. - Perform a cylinder leak down test. - Inspect the cylinder heads 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

Cause	Correction
Worn valves, valve guides and/or valve stem oil seals	- Inspect the spark plugs for oil deposits - Repair or replace valves, valve guides and/or valve stem oil seals 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. Engine Compression Test - Perform cylinder leak down and compression testing to determine the cause. - Repair or replace piston rings as required.

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. Maintenance Items
Incorrect oil viscosity	Drain the engine oil and replace with the correct viscosity oil. Adhesives, Fluids, Lubricants, and Sealers
High stationary hydraulic lash adjuster (SHLA), valve lifter, leak down rate	Replace the SHLAs, valve lifters, as required.
Worn crankshaft thrust bearing	1. Inspect the thrust bearing and crankshaft. 2. Repair or replace as required.
Damaged or faulty oil filter bypass valve	1. Inspect the oil filter bypass valve for proper operation. 2. Repair or replace as required.
Malfunctioning camshaft position actuators - improper oil viscosity or contamination.	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. Camshaft Position Actuator Replacement - Bank 1 , or Camshaft Position Actuator Replacement - Bank 2

UPPER ENGINE NOISE, REGARDLESS OF ENGINE SPEED

Cause	Correction
Low oil pressure	1. Perform an oil pressure test. Refer to Oil Pressure Diagnosis and Testing. 2. Repair or replace as required.
Loose and/or worn follower, valve rocker arm	1. Inspect the follower, valve rocker arm. 2. Repair or replace as required.
Improper lubrication to the followers, valve rocker arms	Inspect the following components, and repair or replace as required: • The follower, valve rocker arm • The SHLA, valve lifter • The oil filter bypass valve • The oil pump and pump screen • The cylinder head oil galleries • The engine block oil galleries
Broken valve spring	Replace the valve spring.
Worn or dirty stationary hydraulic lash adjusters (SHLAs), valve lifters	Replace the SHLAs, valve lifters.
Stretched or broken timing chain or chains and/or damaged sprocket teeth	Replace the timing chain or chains and sprockets.
Worn timing chain tensioner or tensioners	Replace the timing chain tensioner or tensioners as required.
Worn timing chain shoe or shoes	Replace the timing chain shoe or shoes as required.
Worn timing chain guide or guides	Replace the timing chain guide or guides as required.

Cause	Correction
Worn engine camshaft lobes	1. Inspect the engine camshaft lobes. 2. Replace the camshaft or camshafts and SHLAs, valve lifters, 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

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Cause	Correction
Low oil pressure	1. Perform an oil pressure test. Refer to Oil Pressure Diagnosis and Testing. 2. 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 controls system. Refer to Symptoms - Engine Controls .
Loose torque converter bolts	1. Inspect the torque converter bolts and engine flywheel. 2. Repair or replace as required.
Loose or damaged engine flywheel	Repair or replace the engine 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

Cause	Correction
- 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.	- Verify the pistons, piston pins and connecting rods are installed correctly. - Repair as required.

ENGINE NOISE UNDER LOAD

Cause	Correction
Low oil pressure	- Perform an oil pressure test. Refer to Oil Pressure Diagnosis and Testing. - Repair or replace as required.
Detonation or spark knock	Verify the correct operation of the ignition controls. Refer to Symptoms - Engine Controls .
Loose torque converter bolts	- Inspect the torque converter bolts and engine flywheel. - Repair as required.
Cracked engine flywheel	- Inspect the engine flywheel and bolts. - 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

ENGINE WILL NOT CRANK - CRANKSHAFT WILL NOT ROTATE

Cause	Correction
Seized accessory drive system component	- Remove the accessory drive belt or belts. - Rotate the crankshaft by hand at the crankshaft balancer or the engine flywheel location. - Repair or replace as required.
Hydraulically locked cylinder - Coolant/antifreeze in cylinder - Oil in cylinder	- Remove the spark plugs and check for fluid. - Inspect for broken head gasket or gaskets.

Cause	Correction
Fuel in cylinder	- Inspect for cracked engine block or cylinder head. - Inspect for a sticking fuel injector. - Repair or replace as required.
Seized automatic transmission torque converter	- Remove the torque converter bolts. - Rotate the crankshaft by hand at the crankshaft balancer or the engine flywheel location. - Repair or replace as required.
Material in cylinder - Broken valve - Piston material - Foreign material	- Inspect the cylinder for damaged components and/or foreign materials. - Repair or replace as required.
Seized crankshaft or connecting rod bearings	- Inspect the crankshaft and the connecting rod bearings. - Repair as required.
Bent or broken connecting rod	- Inspect the connecting rods. - Repair as required.
Broken crankshaft	- Inspect the crankshaft. - Repair as required.
Seized or broken camshaft	- Inspect the camshaft or camshafts. - Inspect the cylinder head camshaft journals for damage. - Repair as required.
Seized or broken balance shaft	- Inspect the balance shaft. - Inspect the block for damaged balance shaft bearings. - Repair as required.
Seized or broken camshaft timing components	- Inspect the following sprockets: - The crankshaft sprocket - The exhaust sprockets - The intake sprockets - Inspect the following chains: - The primary camshaft drive chain - The secondary camshaft drive chains - Inspect the following guides: - The lower primary camshaft drive chain guide

Cause	Correction
	- The upper primary camshaft drive chain guides - Inspect the secondary camshaft drive chain shoe. - Inspect the following tensioners: - The primary camshaft drive chain tensioner - The secondary camshaft drive chain tensioners - Repair as required.
Seized or broken valve train components	- Inspect the followers, rocker arms. - Inspect the lifters. - Inspect the valves. - Inspect the valve springs. - Repair as required.

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. NOTE: While not always conclusive, use of hydrocarbon block test kits may reveal hydrocarbons indicating combustion chamber gases in the cooling system. It is important to follow the kit instructions. This is not a substitute for the service information. Combustion leak tests are available from a wide variety of	

Cause	Correction
aftermarket suppliers. 1. A slower than normal cranking speed may indicate coolant entering the combustion chamber. <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 <u>Cylinder Leakage Test</u>. 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. <u>Engine Compression Test</u>	
Cracked intake manifold or failed gasket	Replace the components as required.
Faulty cylinder head gasket	Replace the head gasket and components as required. • <u>Cylinder Head Replacement - Left Side</u> • <u>Cylinder Head Replacement - Right Side</u> • <u>Cylinder Head Overhaul</u>
Warped cylinder head	Machine the cylinder head to the proper flatness, if applicable and replace the cylinder head gasket. <u>Cylinder Head Overhaul</u>
Cracked cylinder head	Replace the cylinder head and gasket.
Cracked cylinder liner or engine block	Replace the components as required.
Cylinder head or engine block porosity	Replace the components as required.

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. <u>Lower Engine Noise, Regardless of Engine Speed</u> 2. Inspect by performing a <u>Cylinder Leakage Test</u>. 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. <u>Engine Compression Test</u>	
Faulty external engine oil cooler	Replace the components as required.
Faulty cylinder head gasket	Replace the head gasket and components as required. • <u>Cylinder Head Replacement - Left Side</u> • <u>Cylinder Head Replacement - Right Side</u> • <u>Cylinder Head Overhaul</u>
Warped cylinder head	Machine the cylinder head to proper flatness, if applicable, and replace the cylinder head gasket. <u>Cylinder Head Overhaul</u>

Cause	Correction
Cracked cylinder head	Replace the cylinder head and gasket.
Cracked cylinder liner or engine block	Replace the components as required.
Cylinder head, block, or manifold porosity	Replace the components as required.

ENGINE COMPRESSION TEST

Special Tools

EN-51749 Compression Gauge Tester Kit

Equivalent regional tools: [Special Tools](#)

A compression pressure test of the engine cylinders determines the condition of the piston rings, the valves and the head gaskets.

1. Run the engine until it reaches normal operating temperature. The battery must be at or near full charge. You may wish to connect a battery charger for the duration of the test to maintain an adequate battery level.
2. Turn the engine OFF.
3. Remove the intake manifold cover.
4. Remove the ignition coils and spark plugs from all cylinders. [Ignition Coil Replacement - Bank 1](#) , and [Ignition Coil Replacement - Bank 2](#)
5. Connect the GDS2 to the vehicle and select "Compression Test". Enabling the Compression Test will disable the fuel pump, fuel injectors, and spark. The throttle body is opened to a Wide Open Throttle (WOT) position. The GDS2 will also automatically control the cranking procedure for many applications. If cranking control is not available use a remote start switch in place of the Starter Relay to control cranking.
6. Measure the engine compression, using the following procedure:
 1. Thread the **EN-51749** adapter into the spark plug hole.
 2. Thread the compression gauge into the **EN-51749** adapter.
 3. Enable cranking via the GDS2 or remote start switch. Record the reading after the cranking cycle completes.
 4. When the compression measurement is normal, the compression builds up quickly and evenly to the specified compression on each cylinder.
 5. Repeat the compression test for each cylinder.
7. Compare the compression readings from all of the cylinders.
 - The lowest reading should not be less than 70 percent of the highest reading.
 - Turbocharger equipped engines - No cylinder reading should be less than 690 kPa (100 psi).
 - Non-Turbocharger equipped engines - No cylinder reading should be less than 965 kPa (140 psi).
8. The following are indicators of potential problems:
 - When low compression is caused by the piston rings, compression is low on the first stroke and tends to build up on the following strokes, but does not reach normal. Compression improves considerably with the addition of oil to the cylinder. Use approximately 3 squirts of oil from a plunger-type oiler into the cylinder and replace the gauge and measure again.
 - When low compression is caused by the valves, the measurement is low on the first stroke and does not build up even with the addition of oil.
 - Leaking head gaskets will provide the same results as worn valves but engine coolant may be identified in the crankcase. In addition, a leaking head gasket will give low readings on paired cylinders.
9. Disconnect GDS2 diagnostic tool or remote start switch.
10. Install the spark plugs. [Gas Engine Ignition Spark Plug Replacement](#)

11. Install the ignition coils and spark plugs from all cylinders. [Ignition Coil Replacement - Bank 1](#) , and [Ignition Coil Replacement - Bank 2](#)
12. Install the intake manifold cover.

CYLINDER LEAKAGE TEST

Special Tools

- EN-35667 - A Cylinder Head Leakdown Tester
- EN-51749 Compression Gauge Tester Kit

Equivalent regional tools: [Special Tools](#)

Procedure

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

- Worn or burnt valves
- Broken valve springs
- Stuck valve lifters
- 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: Refer to [Battery Disconnect Warning](#) .

1. Disconnect the battery ground negative cable.
2. Remove the spark plugs. [Gas Engine Ignition Spark Plug Replacement](#)

CAUTION: Only turn the engine in a **CLOCKWISE** direction as viewed from the crankshaft balancer. Counterclockwise rotation may result in the timing chain jumping a tooth, causing poor running, DTCs, or severe engine damage.

3. Rotate the crankshaft to place the piston in the cylinder being tested at top dead center (TDC) of the compression stroke.
4. Thread the EN-51749 adapter into the spark plug hole.
5. 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.

6. Apply shop air pressure to the EN-35667-A tester and adjust according to the manufacturers instructions.
7. 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.

8. Perform the leakage test on the remaining cylinders and record the values.

OIL CONSUMPTION DIAGNOSIS

Checks	Causes
DEFINITION: Excessive oil consumption (not due to leaks) is the use of 0.946 L (1 qt) or more of engine oil within 3 200 km (2, 000 mi). The causes of excessive oil consumption may include the following conditions:	
Preliminary	• External oil leaks - Refer to Oil Leak Diagnosis. • Incorrect oil level or improper reading of the oil level indicator With the vehicle on a level surface, run the engine for a few minutes, allow adequate drain down time (2 - 3 minutes) and check for the correct engine oil level. • Improper oil viscosity Refer to the vehicle owners manual and use the recommended SAE grade and viscosity for the prevailing temperatures. • Continuous high speed driving and/or severe usage • Crankcase ventilation system restrictions or malfunctioning components • Worn valve guides and/or valve stems • Worn, missing or improperly installed valve stem oil seals • Piston rings broken, worn, not seated properly Allow adequate time for the rings to seat. Replace worn piston rings as necessary. • Piston and rings improperly installed or miss-fitted to the cylinder bore

OIL PRESSURE DIAGNOSIS AND TESTING

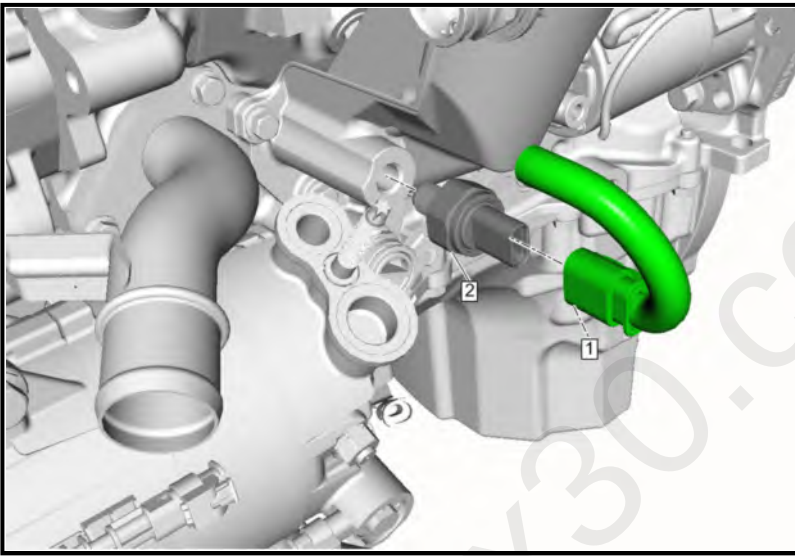
Tools Required

- **J-21867** Pressure Gauge
 - **EN-21867-850** Active Fuel Management Oil Pressure Adapter
1. With the vehicle on a level surface, run the vehicle for a few minutes, allow adequate drain down time, 2 - 3 minutes, and measure for a low oil level.
 2. If required, add the recommended grade engine oil and fill the crankcase until the oil level measures full on the oil level indicator.
 3. Run the engine briefly, 10 - 15 seconds, and verify low or no oil pressure on the vehicle gauge or light.
 4. Listen for a noisy valve train or a knocking noise.

5. Inspect for the following:

- Foamy oil
- Slow idle speed
- Plugged oil filter
- Oil diluted by the following:
 - Water
 - Engine coolant
 - Unburned fuel mixtures
- Malfunctioning oil filter bypass valve
- Incorrect or faulty oil pressure gauge
- Incorrect or faulty oil pressure gauge sensor
- Improper engine oil viscosity for the expected temperature

6. Disconnect the oil pressure sensor wiring harness (1).



7. Remove the oil pressure sensor (2) from the oil filter adapter.

8. Install the **J-21867** Pressure Gauge with the **EN-21867-850** Active Fuel Management Oil Pressure Adapter.

9. Measure the engine oil pressure.

10. Compare the readings to the [Engine Mechanical Specifications](#) .

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

- Loose oil filter adapter bolts
- Missing or damaged oil filter adapter O-ring seal or seals
- Worn or dirty oil pump
- Loose oil pump-to-engine block bolts
- Loose, plugged or damaged oil pump screen
- Missing or damaged oil pump screen O-ring seal
- Damage or leak in the oil pump screen suction tube
- Malfunctioning oil pump pressure regulator valve
- Missing or incorrectly installed oil gallery plugs
- Loose camshaft intermediate drive shaft bolts
- Excessive bearing clearance for the following:
 - Connecting rod or rods
 - Crankshaft

- Camshaft or camshafts
- Camshaft intermediate drive shaft sprocket
- Cracked, porous or restricted oil galleries
- Broken valve lifters

12. Repair or replace components as necessary.

OIL LEAK DIAGNOSIS

Step	Action	Yes	No
NOTE: 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. 2. Park the vehicle on a level surface, over a large sheet of paper or other clean surface. 3. Wait 15 minutes. 4. Inspect 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. Inspect for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components	Go to Step 10	Go to Step 4

Step	Action	Yes	No
	Can you identify the type of fluid and the approximate location of the leak?		
4	1. Completely clean the entire engine and surrounding components. 2. Operate the vehicle for several kilometers, 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
5	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Inspect 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, baby powder, foot powder, etc., to the suspected area. 3. Operate the vehicle for several kilometers, 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. Inspect 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 the J 28428-E High-Intensity Black 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.	Go to Step 10	Go to Step 9

Step	Action	Yes	No
	Can you identify the type of fluid and the approximate location of the leak?		
9	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Inspect 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 attention 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 in area of leak • Cracked or porous components • 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. Does the engine still leak oil?	Go to Step 1	System OK

CRANKCASE VENTILATION SYSTEM INSPECTION/DIAGNOSIS

Crankcase Ventilation (CV) System Inspection

- Test for vacuum at the vacuum hose where it connects to the crankcase ventilation housing. There should be manifold vacuum present at the hose. If there is no vacuum, inspect for a plugged hose, leaking hose or a plugged vent adapter.
- Plug the end of the vacuum hose while the engine is running. Inspect the hose for any areas that collapse when the end of the hose is blocked. Replace the hose if it collapses when blocked.
- If oil has accumulated in the intake air duct, inspect for the following conditions:
 - Plugged vacuum orifice in the crankcase ventilation housing
 - Plugged or restricted crankcase ventilation housing
 - Excessive crankcase pressure or blow-by, refer to [Oil Consumption Diagnosis](#).
- Additional items to inspect:
 - Plugged or leaking fresh air vent hose assembly or vent adapter
 - Plugged or restricted passages in the throttle body
 - Missing or damaged O-ring seals on the vent adapter

- Inspect the cam covers, the oil pan gasket, and other sealing areas for leaks

Results of Incorrect Operation

A plugged crankcase ventilation housing or hose may contribute to the following conditions:

- A rough idle
- Stalling or a slow idle speed
- Oil leaks
- Oil accumulation in the intake air duct
- Sludge in the engine

A leaking housing or hose may contribute to the following conditions:

- A rough idle
- Stalling
- Unstable idle speed

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, power steering system with a pinched hose or wrong fluid, 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.

Step	Action	Yes	No
CAUTION: Refer to Belt Dressing Caution .			
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:			

Step	Action	Yes	No
	- 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
11	CAUTION: Refer to Fastener Caution .	Go to Step 20	Go to Step 12

Step	Action	Yes	No
	1. Tighten any loose fasteners. Refer to Fastener Specifications . 2. Replace any improper or missing fasteners. Did you complete the repair?		
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. Did you find and correct the condition?	Go to Step 20	Go to Step 14
14	If diagnosing a whine noise and the condition still exist, proceed to Diagnostic Aids. Test the drive belt tensioner for proper operation. Refer to Drive Belt Tensioner Diagnosis . 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 Drive Belt Replacement . 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 plys 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.

Step	Action	Yes	No
CAUTION: Refer to Belt Dressing Caution .			
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 Symptoms - Engine Mechanical

Step	Action	Yes	No
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 Symptoms - Engine Mechanical or Go to Vibration Analysis - Engine	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 Drive Belt Replacement . Did you correct the condition?	Go to Step 8	Go to Step 7
7	Install a new drive belt. Refer to Drive Belt Replacement . 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	1. Tighten any loose fasteners. Refer to Fastener Specifications . 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 Water Pump Replacement (LGZ) . 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 two or three 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.

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.

Step	Action	Yes	No
CAUTION: Refer to Belt Dressing Caution .			
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 Symptoms - Engine Mechanical
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 Drive Belt Replacement . 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
8	CAUTION: Refer to Fastener Caution . 1. Tighten any loose fasteners. Refer to Fastener Specifications . 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 Drive Belt Tensioner Diagnosis . Does the drive belt tensioner operate correctly?	Go to Step 11	Go to Step 10
10	Replace the drive belt tensioner. Refer to Drive Belt Tensioner Replacement . 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

Step	Action	Yes	No
13	Inspect the drive belt for the proper installation. Refer to Drive Belt Replacement . 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 Drive Belt Replacement . 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

Step	Action	Yes	No
1	Remove the drive belt and inspect the drive belt tensioner pulley. Is the drive belt tensioner pulley loose or misaligned?	Go to Step 4	Go to Step 2
2	Rotate the drive belt tensioner. Does the tensioner rotate without any unusual resistance or binding?	Go to Step 3	Go to Step 4
3	1. Use a torque wrench in order to measure the torque required to move the tensioner off of the 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?	System OK	Go to Step 4
4	Replace the drive belt tensioner. Is the repair complete?	System OK	-