

Crankcase Ventilation System Description

A closed crankcase ventilation system is used in order to provide a more complete scavenging of crankcase vapours. Filtered air from the air induction system duct is supplied to the crankcase, mixed with blow-by vapours, and passes through a crankcase ventilation metering device before entering the intake manifold. The primary component in the positive crankcase ventilation (PCV) system is the PCV flow metering device (or orifice). Vacuum changes within the intake manifold result in flow variations of the blow-by vapours. If abnormal operating conditions occur, the design of the PCV system permits above acceptable amounts of blow-by vapours to back flow through the crankcase vent tube and into the engine induction system to be consumed during normal combustion. This engine ventilation system design minimizes oil consumption and significantly reduces the potential for oil ingestion during vehicle limit handling manoeuvres.

L98 Engine

The L98 engine utilizes an integral positive crankcase ventilation (PCV) system which is located in the engines valley cover beneath the intake manifold. The engine valley cover contains composite oil separating baffles and PCV plumbing. Filtered fresh air is routed from up stream of the throttle plate to the front of the right valve rocker arm cover through a formed nylon tube. The design of the rocker cover shields rocker arm oil spray thereby reducing the potential for oil being drawn into the throttle bore area during back flow of the ventilation system. Blow-by vapours are routed from the valley cover through a fixed orifice (2.5 mm) within a steel PCV tube, then through a formed rubber hose before entering the intake manifold behind the throttle body.

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Drive Belt System Description

The drive belt system consists of the following components:

- The drive belt
- The drive belt tensioner
- The drive belt idler pulley
- The crankshaft balancer pulley
- The accessory drive component mounting brackets
- The accessory drive components
 - The power steering pump, if belt driven
 - The generator
 - The A/C compressor, if equipped
 - The engine cooling fan, if belt driven
 - The water pump, if belt driven
 - The vacuum pump, if equipped
 - The air compressor, if equipped

The drive belt system may use 1 belt or 2 belts. The drive belt is thin so that it can bend backwards and has several ribs to match the grooves in the pulleys. The drive belts are made of different types of rubbers, chloroprene or EPDM, and have different layers or plies containing either fiber cloth or cords for reinforcement.

Both sides of the drive belt may be used to drive the different accessory drive components. When the back side of the drive belt is used to drive a pulley, the pulley is smooth.

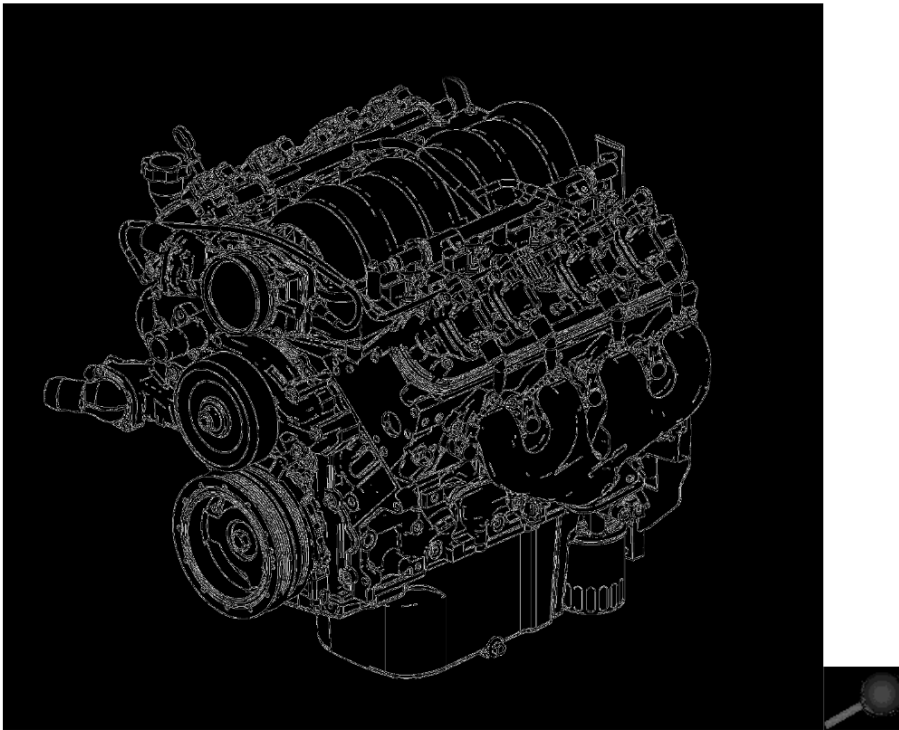
The drive belt is pulled by the crankshaft balancer pulley across the accessory drive component pulleys. The spring loaded drive belt tensioner keeps constant tension on the drive belt to prevent the drive belt from slipping. The drive belt tensioner arm will move when loads are applied to the drive belt by the accessory drive components and the crankshaft.

The drive belt system may have an idler pulley, which is used to add wrap to the adjacent pulleys. Some systems use an idler pulley in place of an accessory drive component when the vehicle is not equipped with the accessory.

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Engine Component Description (L77)

The 6.0 Liter V8 Engine



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The 6.0 liter V8 engine is identified as RPO L76 VIN Y.

Camshaft and Drive System

A billet steel 1 piece camshaft is supported by 5 bearings pressed into the engine block. The camshaft timing sprocket is mounted to the front of the camshaft and is driven by the crankshaft sprocket through the camshaft timing chain. The camshaft position (CMP) sensor lobes are incorporated into the front face of the camshaft sprocket, with the CMP sensor mounted in the engine front cover. A timing chain tensioner is mounted to the front of the engine block above the crankshaft sprocket. The externally splined crankshaft sprocket is positioned to the crankshaft by a key and keyway. The crankshaft sprocket external splines drive the oil pump drive gear. A retaining plate mounted to the front of the engine block maintains camshaft location.

Crankshaft

The crankshaft is cast nodular iron. The crankshaft is supported by 5 crankshaft bearings. The bearings are retained by crankshaft bearing caps, which are machined with the engine block for proper alignment and clearance. The crankshaft journals are undercut and rolled. The center main journal is the thrust journal. A crankshaft position (CKP) reluctor ring is press fit, mounted at the rear of the crankshaft. The reluctor ring is not serviceable separately.

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Cylinder Heads

The cylinder heads are cast aluminum and have pressed in place powdered metal valve guides and valve seats. Passages for the engine coolant air bleed system are at the front of each cylinder head. The valve rocker arm covers are retained to the cylinder heads by 4 center mounted rocker arm cover bolts.

Engine Block

The engine block is a cam-in-block deep skirt 90 degree V configuration with 5 crankshaft bearing caps. The engine block is cast aluminum. The 5 crankshaft bearing caps each have 4 vertical M10 and 2 horizontal M8 mounting bolts. The camshaft is supported by 5 camshaft bearings pressed into the block. The left bank of cylinders are number 1-3-5-7 (#1 is front left) and the right bank of cylinders are 2-4-6-8 (#2 is front right) viewed from the flywheel end of the engine. The engine firing order is 1-8-7-2-6-5-4-3.

Exhaust Manifolds

The exhaust manifolds are a 1 piece cast iron design. The exhaust manifolds direct exhaust gasses from the combustion chambers to the exhaust system. Each manifold also has an externally mounted heat shield that is retained by bolts.

Intake Manifold

The intake manifold is a 1 piece composite design that incorporates brass threaded inserts for mounting the fuel rail, throttle body, and wire harness studs. A non-serviceable cap with acoustic foam has been added to the top of the manifold to reduce engine noise. Each side of the intake manifold is sealed to the cylinder head by a non-reusable push-in-place silicone sealing gasket. The electronically actuated throttle body bolts to the front of the intake manifold. The throttle body is sealed by a 1 piece push-in-place silicone gasket. The fuel rail assembly, with 8 separate fuel injectors, is retained to the intake by 4 bolts. The injectors are seated into their individual manifold bores with O-ring seals to provide sealing. A fuel rail stop bracket is retained to the rear left of the intake manifold by mounting bolts. The manifold absolute pressure (MAP) sensor is installed and retained to the top front of the intake manifold and sealed by an O-ring seal. The evaporative emission (EVAP) canister purge solenoid valve is mounted to the front of the right cylinder head. There are no coolant passages within the intake manifold.

Oil Pan

The structural rear-sump oil pan is cast aluminum. Incorporated into the design is the oil filter mounting boss, drain plug opening, baffle, oil level sensor, and oil level indicator tube opening. The oil filter bypass valve is now internal to the oil filter. The active fuel management oil pressure relief valve is also internal to the oil pan. Alignment of the structural oil pan to the rear of the engine block and transmission housing is critical.

Piston and Connecting Rod Assembly

The pistons are cast aluminum. The pistons use 2 compression rings and 1 oil control ring assembly. The piston is a low friction, lightweight design with a flat or recessed top and barrel shaped skirt. The piston pins are chromium steel and are a full-floating design. The connecting rods are powdered metal. The connecting rods are fractured at the connecting rod journal and then machined for the proper clearance. All applications use a piston with a graphite coated skirt. The piston and pin are to be serviced as an assembly.

Valve Rocker Arm Cover Assemblies

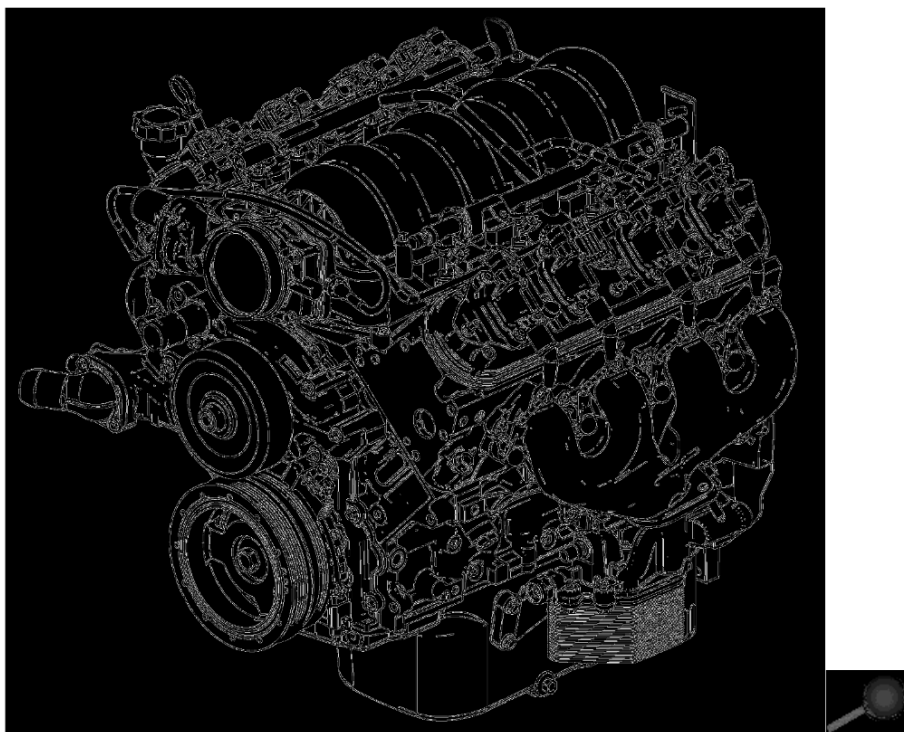
The valve rocker arm covers are cast aluminum and use a pre-molded silicon gasket for sealing. Mounted to each rocker cover are the coil and bracket assemblies. Incorporated into the right cover are the oil fill tube and the positive crankcase ventilation (PCV) fresh air passage.

Valve Train

Motion is transmitted from the camshaft, through the hydraulic roller valve lifters and tubular pushrods, to the roller type rocker arms. The nylon valve lifter guides position and retain the

valve lifters. The valve rocker arms for each bank of cylinders are mounted on pedestals or pivot supports. Each rocker arm is retained on the pivot support and cylinder head by a bolt. The inlet rocker arms are offset 6 mm (0.24 in) to enable more direct intake flow. Valve lash is net build. Cylinders 1, 4, 6, and 7 are Active Fuel Management. Refer to [Cylinder Deactivation \(Active Fuel Management\) System Description](#).

Engine Component Description (LS3)



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The 6.2 Liter V8 engine is identified as RPO LS3 VIN W.

Camshaft and Drive System

A hollow billet steel 1 piece camshaft is supported by 5 bearings pressed into the engine block. The camshaft timing sprocket is mounted to the front of the camshaft and is driven by the crankshaft sprocket through the camshaft timing chain. The camshaft position (CMP) sensor lobes are incorporated into the front face of the camshaft sprocket with the CMP sensor mounted in the engine front cover. A timing chain tensioner is mounted to the front of the engine block above the crankshaft sprocket. The externally splined crankshaft sprocket is positioned to the crankshaft by a key and keyway. The crankshaft sprocket external splines drive the oil pump drive gear. A retaining plate mounted to the front of the engine block maintains camshaft location.

Crankshaft

The crankshaft is cast iron. The crankshaft is supported by 5 crankshaft bearings. The bearings are retained by crankshaft bearing caps which are machined with the engine block for proper alignment and clearance. The crankshaft journals are undercut and rolled. The center main journal is the thrust journal. A crankshaft position (CKP) reluctor ring is press fit mounted at the rear of the crankshaft. The reluctor ring is not serviceable separately.

Cylinder Heads

The cylinder heads are cast aluminum and have pressed in place powdered metal valve guides and valve seats. Passages for the engine coolant air bleed system are at the front of each cylinder head. The valve rocker arm covers are retained to the cylinder heads by 4 center mounted rocker arm cover bolts. High-flow cylinder heads with modified intake and exhaust ports are used to increase flow.

Engine Block

The engine block is a cam-in-block deep skirt 90 degree V configuration with 5 crankshaft bearing caps. The engine block is cast aluminum. The 5 crankshaft bearing caps each have 4 vertical M10 and 2 horizontal M8 mounting bolts. The camshaft is supported by 5 camshaft bearings pressed into the block. The left bank of cylinders are number 1-3-5-7 (#1 is front left) and the right bank of cylinders are 2-4-6-8 (#2 is front right) viewed from the flywheel end of the engine. The engine firing order is 1-8-7-2-6-5-4-3.

Exhaust Manifolds

The exhaust manifolds are a 1 piece cast iron design. The exhaust manifolds direct exhaust gasses from the combustion chambers to the exhaust system. Each manifold also has an externally mounted heat shield that is retained by bolts.

Intake Manifold

The intake manifold is a 1 piece composite design that incorporates brass threaded inserts for mounting the fuel rail, throttle body, and wire harness studs. A non-serviceable cap with acoustic foam has been added to the top of the manifold to reduce engine noise. Each side of the intake manifold is sealed to the cylinder head by a non-reusable push-in-place silicone sealing gasket. The electronically actuated throttle body bolts to the front of the intake manifold. The throttle body is sealed by a 1 piece push-in-place silicone gasket. The fuel rail assembly, with 8 separate fuel injectors, is retained to the intake by 4 bolts. The injectors are seated into their individual manifold bores with O-ring seals to provide sealing. A fuel rail stop bracket is retained to the rear left of the intake manifold by mounting bolts. The manifold absolute pressure (MAP) sensor is installed and retained to the top front of the intake manifold and sealed by an O-ring seal. The evaporative emission (EVAP) canister purge solenoid valve is mounted to the front of the right cylinder head. There are no coolant passages within the intake manifold.

Oil Pan

The structural rear-sump oil pan is cast aluminum. Incorporated into the design are the oil filter mounting boss, drain plug opening, baffle, oil level sensor, oil pressure relief valve, and oil level indicator tube opening. The oil filter bypass valve is now internal to the oil filter. An external engine oil cooler assembly is mounted directly to the left side of the oil pan. The alignment of the structural oil pan to the rear of the engine block and transmission housing is critical.

Piston and Connecting Rod Assembly

The pistons are cast aluminum. The pistons use 2 compression rings and 1 oil control ring assembly. The piston is a low friction, lightweight design with a flat or recessed top and barrel shaped skirt. The piston pins are chromium steel and are a full-floating design. The connecting rods are powdered metal. The connecting rods are fractured at the connecting rod journal and then machined for the proper clearance. All applications use a piston with a graphite coated skirt. The piston and pin are to be serviced as an assembly.

Valve Rocker Arm Cover Assemblies

The valve rocker arm covers are cast aluminum and use a pre-molded silicon gasket for sealing. Mounted to each rocker cover are the coil and bracket assemblies. Incorporated into the right cover is the oil fill tube and the positive crankcase ventilation (PCV) fresh air passage.

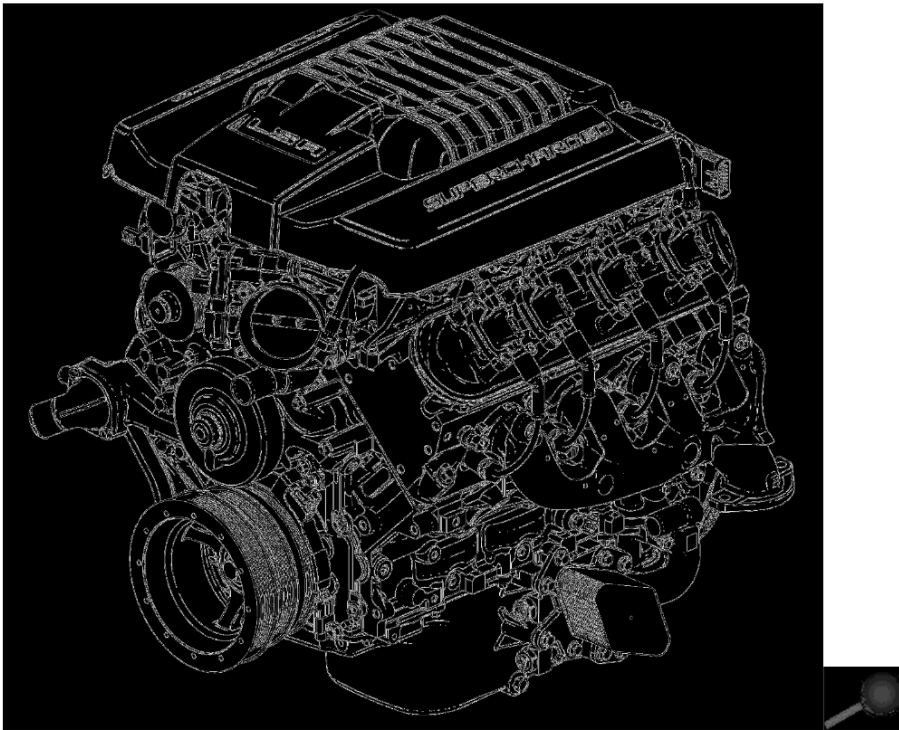
Valve Train

Motion is transmitted from the camshaft through the hydraulic roller valve lifters and tubular pushrods to the roller type rocker arms. The nylon valve lifter guides position and retain the

valve lifters. The valve rocker arms for each bank of cylinders are mounted on pivot supports. Each rocker arm is retained on the pivot support and cylinder head by a bolt. The inlet rocker arms are offset 6 mm (0.24 in) to enable more direct intake flow. Valve lash is net build.

Engine Component Description (LSA)

[The 6.2L LSA Liter V8 Engine](#)



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The 6.2L Liter V8 engine is identified as RPO LSA.

[Camshaft and Drive System](#)

A billet steel 1 piece camshaft is supported by 5 bearings pressed into the engine block. The camshaft timing chain sprocket is mounted to the front of the camshaft and is driven by the crankshaft sprocket through the camshaft timing chain. The camshaft position (CMP) sensor lobes are incorporated into the front face of the camshaft sprocket with the CMP sensor mounted to the engine front cover. A timing chain tensioner is mounted to the front of the engine block above the crankshaft sprocket. The externally splined crankshaft sprocket is positioned to the crankshaft by a key and keyway. The crankshaft sprocket external splines drive the gerotor type oil pump drive gear. A retaining plate mounted to the front of the engine block maintains camshaft location.

[Crankshaft](#)

The precision-balanced crankshaft is forged steel and is supported by 5 crankshaft bearings. The bearings are retained by forged steel crankshaft bearing caps, which are machined with the engine block for proper alignment and clearance. The crankshaft journals are undercut and rolled. The center main journal is the thrust journal. A crankshaft position (CKP) reluctor ring is press-fit mounted at the rear of the crankshaft. The reluctor ring is not serviceable separately.

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Cylinder Heads

The cylinder heads are cast aluminum and include pressed-in-place powdered metal valve guides, 55 mm (2.19 in) diameter solid intake valves, 40.4 mm (1.59 in) diameter solid exhaust valves, and 66.85 cubic centimeter combustion chambers. Passages for the engine coolant air bleed system are at the front of each cylinder head. The valve rocker arm covers are retained to the cylinder heads by 4 center mounted rocker arm cover bolts.

Engine Block

The engine block is a cam-in-block deep skirt 90 degree V configuration with 5 forged steel crankshaft bearing caps. The engine block is cast aluminum with press-in-place cast iron cylinder liners. The 5 crankshaft bearing caps each have 4 vertical M10 and 2 horizontal M8 mounting bolts. The camshaft is supported by 5 press-in-place camshaft bearings. Eight piston cooling oil nozzle assemblies are mounted between each of the opposing cylinders. The oil nozzles spray oil up the cylinder bore directing oil to the bottom of the pistons. The left bank of cylinders are number 1-3-5-7 (#1 is front left) and the right bank of cylinders are 2-4-6-8 (#2 is front right) viewed from the flywheel end of the engine. The engine firing order is 1-8-7-2-6-5-4-3.

Exhaust Manifolds

The exhaust manifolds are a 1 piece cast iron design. The exhaust manifolds direct exhaust gasses from the combustion chambers to the exhaust system. Each manifold also has an externally mounted heat shield that is retained by bolts.

Intake Manifold/Supercharger

Refer to [Supercharger Description and Operation](#).

Oil Pan

The structural rear-sump oil pan is cast aluminum. Incorporated into the design is the oil filter mounting boss, oil level sensor, and drain plug opening. An external oil cooler assembly is mounted directly to the left side of the oil pan. The alignment of the structural oil pan to the rear of the engine block and transmission housing is critical.

Piston and Connecting Rod Assembly

The pistons are cast aluminum. The pistons use 2 compression rings and 1 oil control ring assembly. The piston is a low friction, lightweight design with a flat or recessed top and barrel shaped skirt. The piston pins are chromium steel and are a full-floating design. The connecting rods are powdered metal. The connecting rods are fractured at the connecting rod journal and then machined for the proper clearance. All applications use a piston with a graphite coated skirt. The piston/pin and connecting rod may be serviced as individual components.

Valve Rocker Arm Cover Assemblies

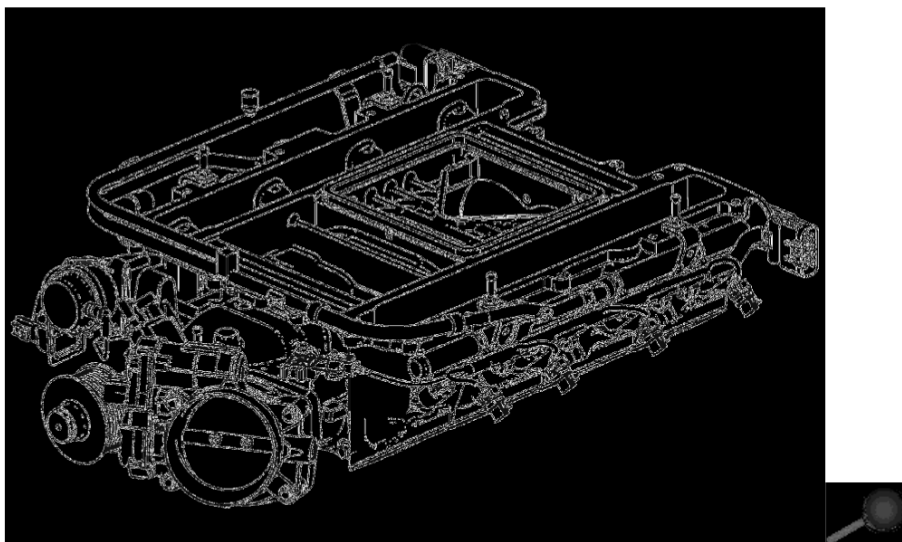
The valve rocker arm covers are cast aluminum and use a pre-molded silicon gasket for sealing. The ignition coils mount directly to the covers with no mounting bracket. Incorporated into the covers are the positive crankcase ventilation (PCV) system fresh air passages. The right rocker arm cover also includes the oil fill tube and cap.

Valve Train

Motion is transmitted from the camshaft, through the hydraulic roller valve lifters and tubular pushrods, to the roller type rocker arms. The nylon valve lifter guides position and retain the valve lifters. The valve rocker arms for each bank of cylinders are mounted on pedestals or pivot supports. Each rocker arm is retained on the pivot support and cylinder head by a bolt. Valve lash is net build. The intake rocker arms are of an off-set design.

Supercharger Description and Operation

[Intake Manifold/Supercharger Assembly](#)



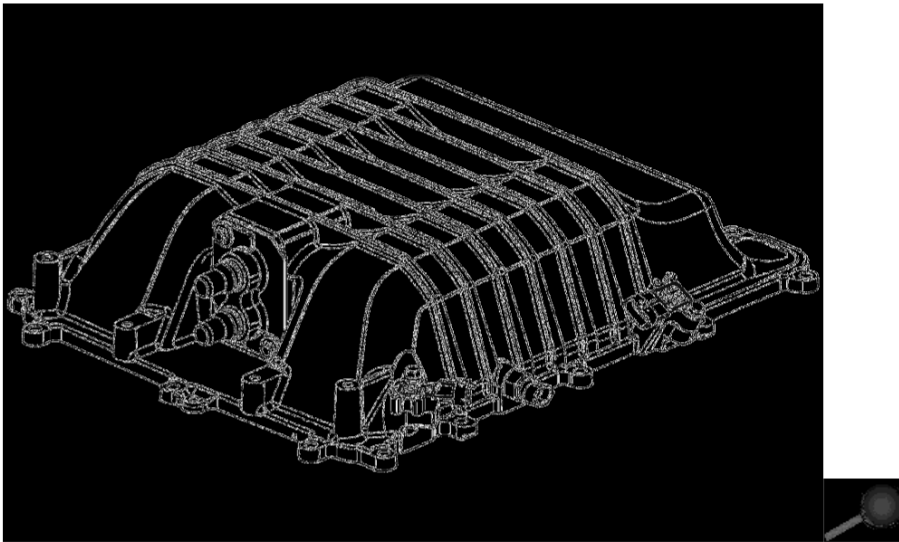
[Intake Manifold/Supercharger Assembly](#)

The LSA Roots-type supercharger is a positive displacement pump that consists of 2 counter-rotating rotors installed into the lower intake manifold housing. The rotors are designed with 4 lobes and a helical twist. The rotors of the supercharger are designed to run at a minimal clearance, not in contact with each other or the housing and are timed to each other by a pair of precision spur gears which are pressed onto the rotor shafts. The rotors are supported at each end by self-lubricating non-serviceable bearings. The drive belt pulley is pressed onto the input shaft. The input shaft is coupled to the rotor shaft. Both the belt pulley and torsional isolator are also non-serviceable.

The lower supercharger assembly consists of the following components:

- Lower Intake Manifold Housing, to include rotors, gears, bearings, torsional isolator, and drive belt pulley
- Bypass Valve
- Bypass Actuator
- Charged Air Bypass Valve
- Fuel Rail with Injectors
- Throttle Body Assembly
- Evaporative Emission Canister Purge Valve
- Inlet Air Pressure Sensor

[Cover/Intercooler](#)



Cover/Intercooler

The cover assembly has an integrated intercooler. Cooling the air enhances the effectiveness of the supercharger. The intercooler uses conventional coolant in a system that is separate from the engine cooling system. The intercooler assembly includes the cover, a charge air cooler/heat exchanger and a variety of sensors to monitor air temperature and pressure. The charge air cooler pipe assembly, located at the rear of cover transfers coolant to the intercooler cooling system via vehicle coolant hoses. The charge air cooler pipe assembly is sealed to the charge air cooler with O-rings and a press-in-place seal. Coolant enters the inlet port of the assembly, is directed into and through the charge air cooler/heat exchanger, and exits returning to the separate cooling system.

The cover/intercooler consists of the following components:

- Charge Air Cooler Pipe Assembly
- Charge Air Cooler Cover
- Charge Air Cooler/Heat Exchanger
- Intake Air Temperature (IAT) Sensor
- Barometric Pressure Sensor
- Air Outlet Pressure Sensor
- Isolator Pad

Operation

The supercharger is designed to increase the air pressure and density in the intake manifold. When this air is mixed with the correct amount of fuel the result is more power from the engine. This excess air creates a boost pressure in the intake manifold with a maximum engine boost of 69.6 kPa (10.1 psi). Because the supercharger is a positive displacement pump and is directly driven from the engine drive belt system, boost pressure is available at all driving conditions.

When boost is not required in situations such as idle or light throttle cruising, the excess air is routed through an internal bypass passage located between the intake manifold and the supercharger inlet. The bypass circuit is regulated by a bypass valve which is similar to a throttle plate. Spring force holds the bypass valve in a normally closed position to create boost.

The bypass actuator is a vacuum operated valve that is connected to the vacuum signal between the throttle and the supercharger inlet. Vacuum to the actuator pulls the bypass valve open during idle and light load conditions to decrease boost.

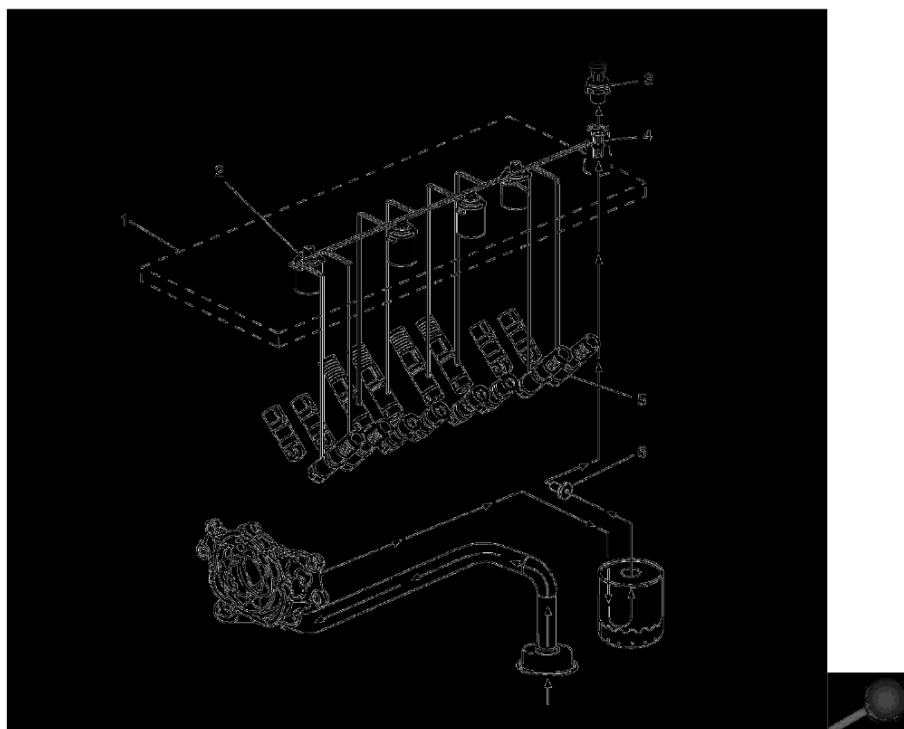
The charge air bypass valve is a vacuum/electrically operated solenoid valve that is attached to the supercharger housing. The three-way valve is controlled by the engine control module (ECM). The ECM determines when pressure from the manifold is routed to the bypass actuator. The charge air bypass valve allows pressure from the manifold to open the bypass valve and lower boost pressure during specific driving conditions. The open bypass valve reduces the pumping effort of the supercharger, thereby increasing the fuel efficiency in light load operations.

Cylinder Deactivation (Active Fuel Management) System Description

System Operation

General Motors Active Fuel Management engine control system has the ability, under certain light load driving conditions, to provide maximum fuel economy by deactivating 4 of the engine's 8 cylinders. The engine will normally operate on 8 cylinders in V8 mode during starting, idling, and medium or heavy throttle conditions. When commanded ON, the engine control module (ECM) will direct the active fuel management system and deactivate cylinders 1 and 7 on the left bank and cylinders 4 and 6 on the right bank, forcing V4 mode. Refer to [Lubrication Description](#) and [Cylinder Deactivation \(Active Fuel Management\) System Description](#).

Valve Lifter Oil Manifold Assembly



The valve lifter oil manifold assembly (1) is bolted to the top of the engine block beneath the intake manifold assembly. The oil manifold consists of 4 electrically operated and normally-closed solenoids (2). Each solenoid directs the flow of pressurized engine oil to the active fuel management intake and exhaust valve lifters (5). The active fuel management oil pressure relief valve (6), located in the oil pan, regulates engine oil pressure to the lubrication system and the oil manifold.

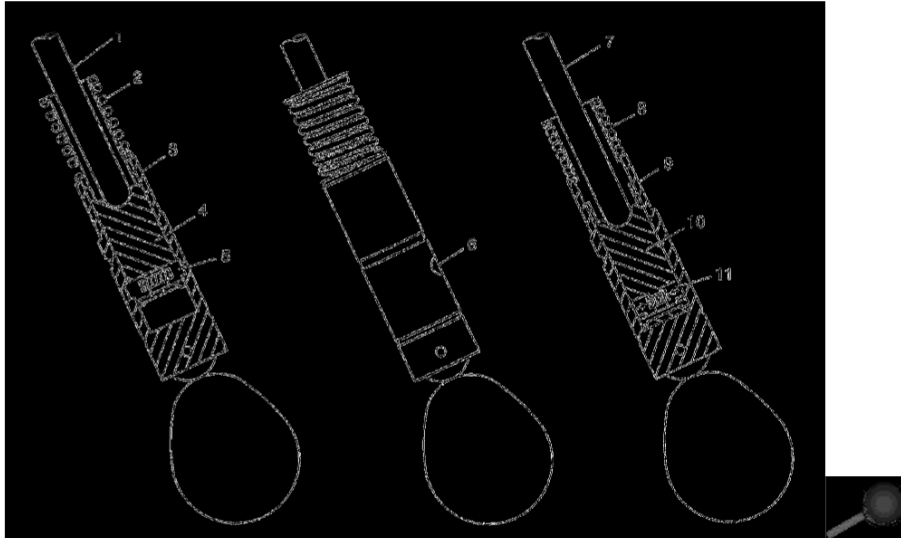
When enabling conditions are met for active fuel management operation, the ECM will ground each solenoid control circuit in firing order sequence, allowing current to flow through the

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solenoid windings. With the windings energized, the solenoid valves open and direct pressurized engine oil through the valve lifter oil manifold into 8 vertical passages in the engine block lifter valley. The 8 vertical passages, 2 per cylinder, direct pressurized oil to the valve lifter bores of the cylinders to be deactivated. When vehicle operating conditions require a return to V8 mode, the ECM will turn OFF the ground circuit for the solenoids, allowing the solenoid valves to close. When the solenoid valves are closed, remaining oil pressure is exhausted through the bleed passages of the valve lifter oil manifold into the engine block lifter valley. The housing of the oil manifold incorporates several oil bleed passages that continually purge trapped air from the manifold and engine block.

To help control contamination within the active fuel management hydraulic system, a small replaceable oil filter (4) is located in the valve lifter oil manifold oil inlet passage. The oil pressure sensor (3) monitors engine oil pressure and provides information to the ECM.

Active Fuel Management Valve Lifters



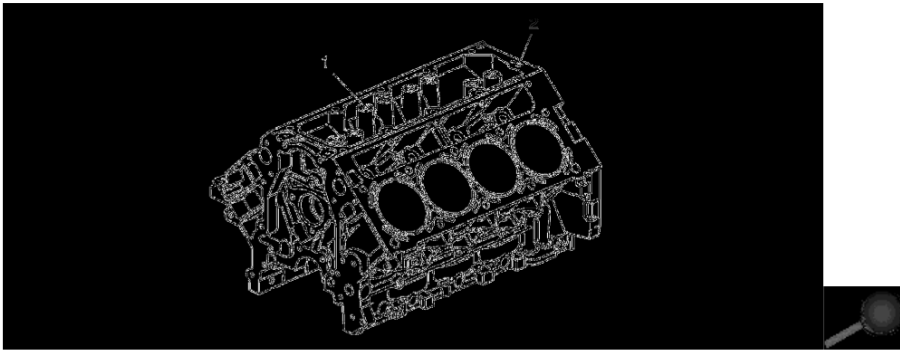
When operating in V8 mode, the active fuel management valve lifters function similar to the non-active fuel management valve lifters. The active fuel management oil manifold solenoids are in the closed position, with no pressurized oil directed to the valve lifters. The pushrod (1) travels upward and downward to actuate the rocker arm and valve. The spring loaded locking pins (5) of the lifter are extended outward and mechanically lock the pin housing (4) to the outer body of the valve lifter (3).

When the active fuel management system is commanded ON, the ECM will direct the solenoids of the oil manifold to open and direct pressurized oil to the valve lifters. Oil travels through the valve lifter oil manifold and engine block oil galleries and enters the inlet port (6) of the valve lifter.

When operating in V4 mode, pressurized oil forces the locking pins (11) inward. The pushrod (7) remains in a constant position and does not travel upward and downward. The outer body of the lifter (9) moves upward and downward independently from the pin housing (10). The valve lifter spring (8) retains tension on the valve train components to eliminate valve train noise.

When the active fuel management system is commanded OFF, the ECM directs the solenoids of the oil manifold to close, stopping the flow of pressurized oil to the valve lifters. The oil pressure within the lifter will decrease and the locking pins will move outward to mechanically lock the pin housing and outer body.

Engine Block

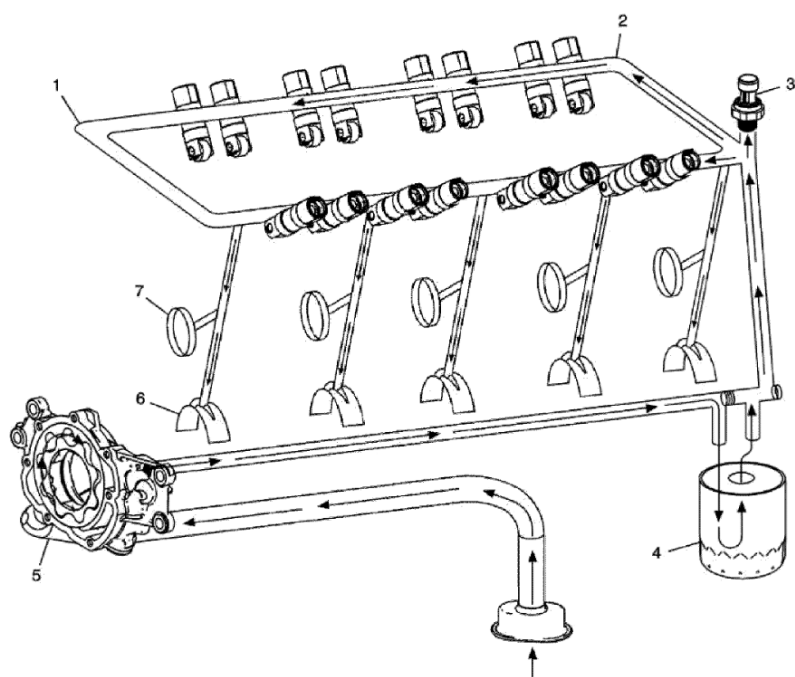


The active fuel management engine block incorporates additional features to support active fuel management system operation. Engine oil pressure is routed to the valve lifter oil manifold assembly from an oil gallery (2) in the rear of the cylinder block. Cylinders 1, 4, 6, and 7 each have 2 vertical, cast-in-block oil passages (1). The vertical oil passages permit oil flow from the manifold assembly to the valve lifter bores.

Engine Control Module (ECM)

Refer to [Cylinder Deactivation \(Active Fuel Management\) System Description](#).

Lubrication Description (LS3)

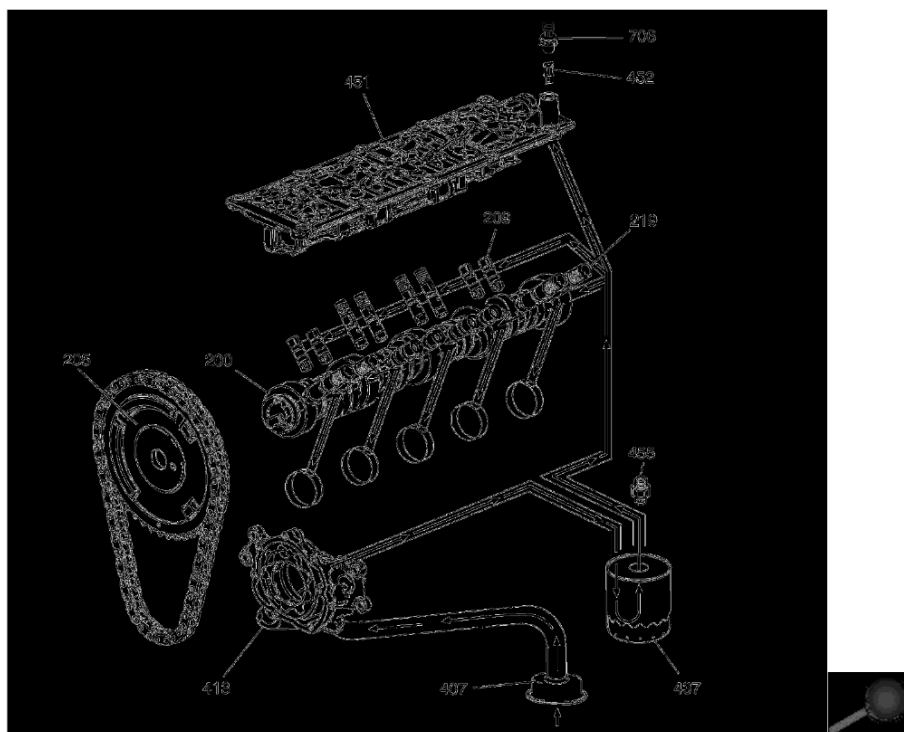


Engine lubrication is supplied by a gerotor type oil pump assembly (5). The pump is mounted on the front of the engine block and driven directly by the crankshaft sprocket. The pump gears rotate and draw oil from the oil pan sump through a pick-up screen and pipe. The oil is pressurized as it passes through the pump and is sent through the engine block lower oil gallery. Contained within the oil pump assembly is a pressure relief valve that maintains oil pressure within a specified range.

Pressurized oil is directed through the engine block lower oil gallery to the full flow oil filter (4) where harmful contaminants are removed. A bypass valve is incorporated into the new design oil filter, which permits oil flow in the event the filter becomes restricted.

Oil is then directed from the filter to the upper main oil galleries (1). Oil from the left upper oil gallery is directed to the crankshaft bearings (6) and camshaft bearings (7). Oil that has entered both the upper main oil galleries also pressurizes the valve lifter assemblies (2) and is then pumped through the pushrods to lubricate the valve rocker arms and valve stems. Oil returning to the pan is directed by the crankshaft oil deflector. The oil pressure sensor (3) is located at the top rear of the engine.

Lubrication Description (L77)



- (200) Camshaft
- (205) Camshaft Sprocket
- (209) Valve Lifter – Non-Active Fuel Management
- (219) Valve Lifter – Active Fuel Management
- (407) Oil Pump Screen
- (413) Oil Pump
- (437) Oil Filter
- (451) Valve Lifter Oil Manifold
- (452) Valve Lifter Oil Filter
- (455) Active Fuel Management Oil Pressure Relief Valve
- (706) Oil Pressure Sensor

Engine lubrication is supplied by a gerotor type oil pump assembly. The oil pump is mounted on the front of the engine block and driven directly by the crankshaft sprocket. The pump gears rotate and draw oil from the oil pan sump through a pick-up screen and pipe. The oil is pressurized as it passes through the pump and is sent through the engine block lower oil gallery. Contained within the oil pump assembly is a pressure relief valve that maintains oil pressure within a specified range.

Pressurized oil is directed through the engine block lower oil gallery to the full flow oil filter where harmful contaminants are removed. A bypass valve is incorporated into the oil filter, which permits

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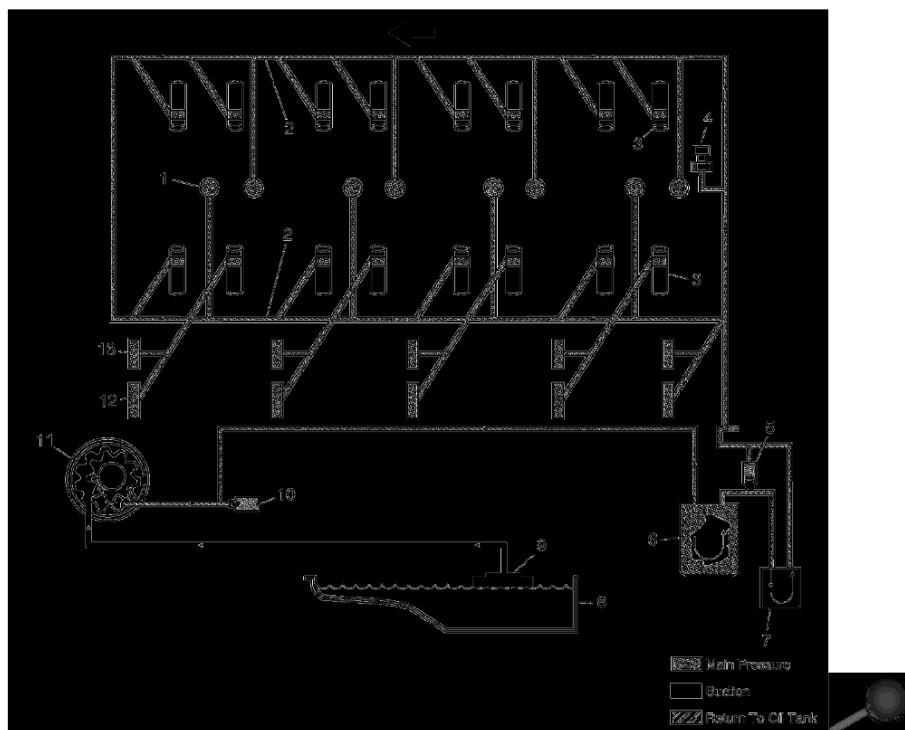
oil flow in the event the filter becomes restricted. A second valve, the active fuel management oil pressure relief valve is incorporated into the oil pan. The active fuel management oil pressure relief valve limits oil pressure directed to the upper oil galleries and valve lifter oil manifold assembly to 379–517 kPa (55–75 psi) maximum. When main oil pressure exceeds 379 kPa (55 psi), the oil pressure relief valve exhausts excess oil to the sump.

Oil is then directed from the filter to the upper main oil galleries and the valve lifter oil manifold assembly. Oil from the left upper oil gallery is directed to the crankshaft and camshaft bearings. Oil that has entered both the upper main oil galleries also pressurizes the valve lifter assemblies and is then pumped through the pushrods to lubricate the valve rocker arms and valve stems. Oil returning to the pan is directed by the crankshaft oil deflector. The oil pressure sensor is located at the top rear of the engine.

With active fuel management activated, the engine control module (ECM) commands the 4 solenoids to open, directing oil through the engine block oil galleries to the intake and exhaust valve lifters for cylinders 1, 4, 6, and 7. Refer to [Cylinder Deactivation \(Active Fuel Management\) System Description](#).

Lubrication Description (LSA)

Engine Lubrication Flow



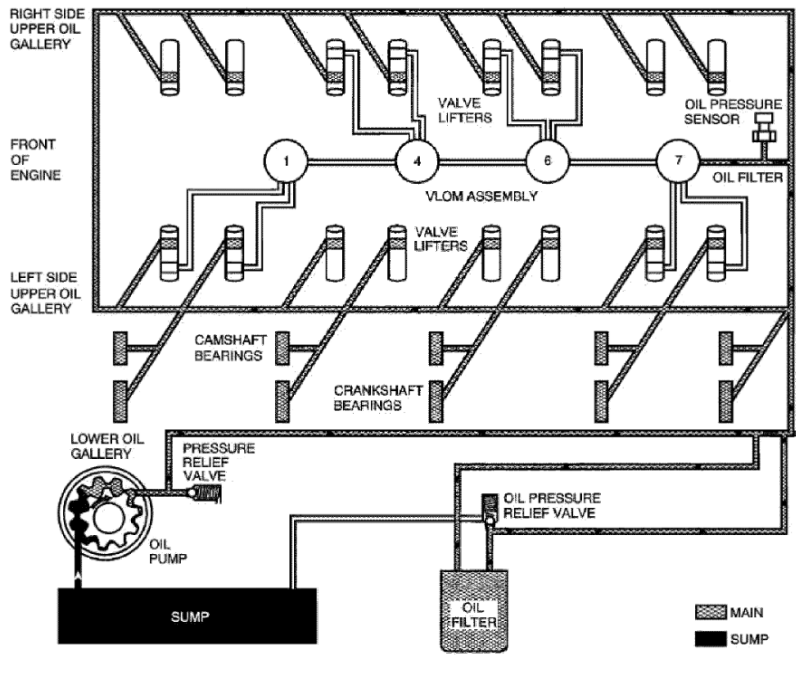
- (1) Piston Oil Nozzle
- (2) Upper Main Oil Galleries
- (3) Valve Lifters
- (3) Valve Lifters
- (4) Oil Pressure Sensor
- (5) Bypass Valve- Oil Cooler
- (6) Oil Filter
- (7) Engine Oil Cooler
- (8) Oil Pan Sump
- (9) Oil Pump Screen
- (10) Pressure Relief Valve- Oil Pump
- (11) Oil Pump
- (12) Crankshaft Bearings
- (13) Camshaft Bearings

Engine lubrication is supplied by a gerotor type oil pump assembly (11). The oil pump assembly consists of a pump housing, gear set, and pressure relief valve (10). Refer to Oil Pump Assembly in

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[Disassembled Views](#). The pump assembly is mounted at the front of the engine and driven directly by the crankshaft sprocket. The pump gears rotate and draw oil from the oil pan sump (8) through the oil tank screen (9). The oil is pressurized as it passes through the primary pump and is sent through the engine block lower oil gallery. Contained within the primary pump is a pressure relief valve (10) that maintains oil pressure within a specified range. Pressurized oil is directed through the engine block lower oil gallery to the full flow oil filter (6) where harmful contaminants are removed. A bypass valve is incorporated into the oil filter, which permits oil flow in the event the filter becomes restricted. Oil exits the oil filter and is then directed to the external oil cooler (7). A bypass valve (5) is incorporated into the oil cooler assembly in the event oil flow within the cooler is restricted. Oil returns from the oil cooler and is directed to the upper main oil galleries (2). Oil from the left upper oil gallery is directed to the crankshaft bearings (12), valve lifters 1, 3, 5, and 7, camshaft bearings (13), and piston oil nozzles 1, 3, 5, and 7. Oil from the right upper oil gallery is directed to the valve lifters 2, 4, 6, and 8 and piston oil nozzles 2, 4, 6, and 8. The piston oil nozzle assemblies are designed to provide oil to the bottom side of the piston for cooling purposes. The piston oil nozzles have an internal check ball that is held in the normally closed position by the spring until system oil pressure exceeds 20.7 kPa (43.5 psi). Refer to [Piston Oil Nozzle Cleaning and Inspection](#). Oil exits the valve lifters (3) and is then pumped through the pushrods to lubricate the valve rocker arms and valve stems. Oil then returns to the oil pan (8). The engine oil pressure sensor (4) is located at the top rear of the engine assembly.

Lubrication Description - Main Pressure Below 55 psi with Cylinder Deactivation (Active Fuel Management) Off

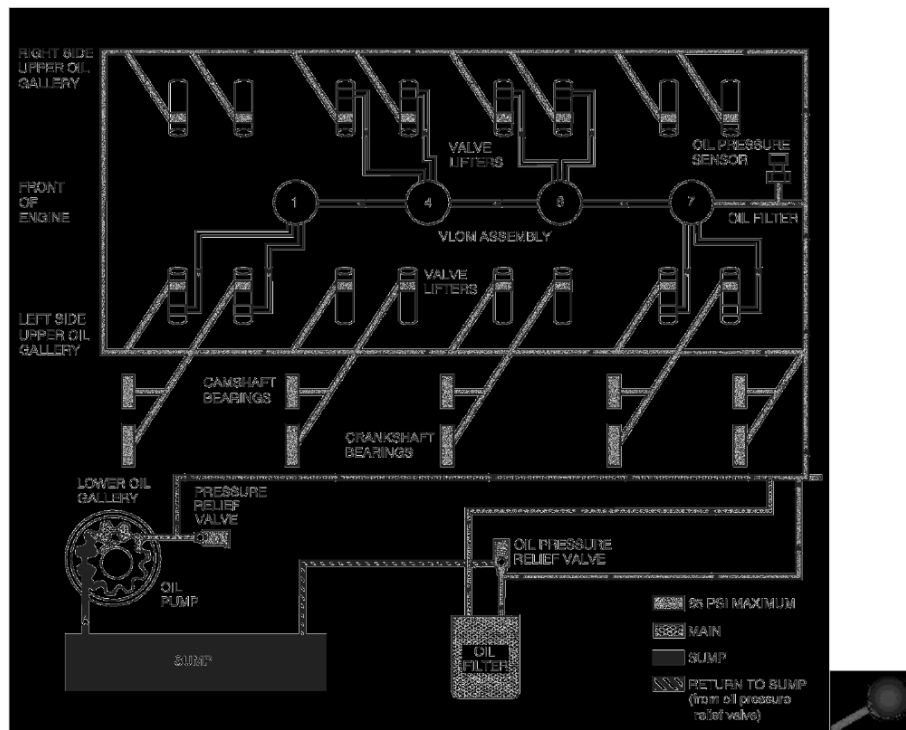


Engine lubrication is supplied by a gerotor type oil pump assembly. The oil pump is mounted on the front of the engine block and driven directly by the crankshaft sprocket. The pump gears rotate and draw oil from the oil pan sump through a pick-up screen and pipe. The oil is pressurized as it passes through the pump and is sent through the engine block lower oil gallery. Contained within the oil pump assembly is a pressure relief valve that maintains oil pressure within a specified range.

Pressurized oil is directed through the engine block lower oil gallery to the full flow oil filter where harmful contaminants are removed. A bypass valve is incorporated into the oil filter, which permits oil flow in the event the filter becomes restricted. A second valve, the active fuel management oil pressure relief valve is incorporated into the oil pan. The active fuel management oil pressure relief valve limits oil pressure directed to the upper oil galleries and oil manifold assembly to 379–517 kPa (55–75 psi) maximum.

Oil is then directed from the filter to the upper main oil galleries and the valve lifter oil manifold assembly. Oil from the left upper oil gallery is directed to the crankshaft and camshaft bearings. Oil that has entered both the upper main oil galleries also pressurizes the valve lifter assemblies and is then pumped through the pushrods to lubricate the valve rocker arms and valve stems. Oil returning to the pan is directed by the crankshaft oil deflector. The oil pressure sensor is located at the top rear of the engine. Refer to [Cylinder Deactivation \(Active Fuel Management\) System Description](#).

Lubrication Description - Main Pressure Above 55 psi with Cylinder Deactivation (Active Fuel Management) Off



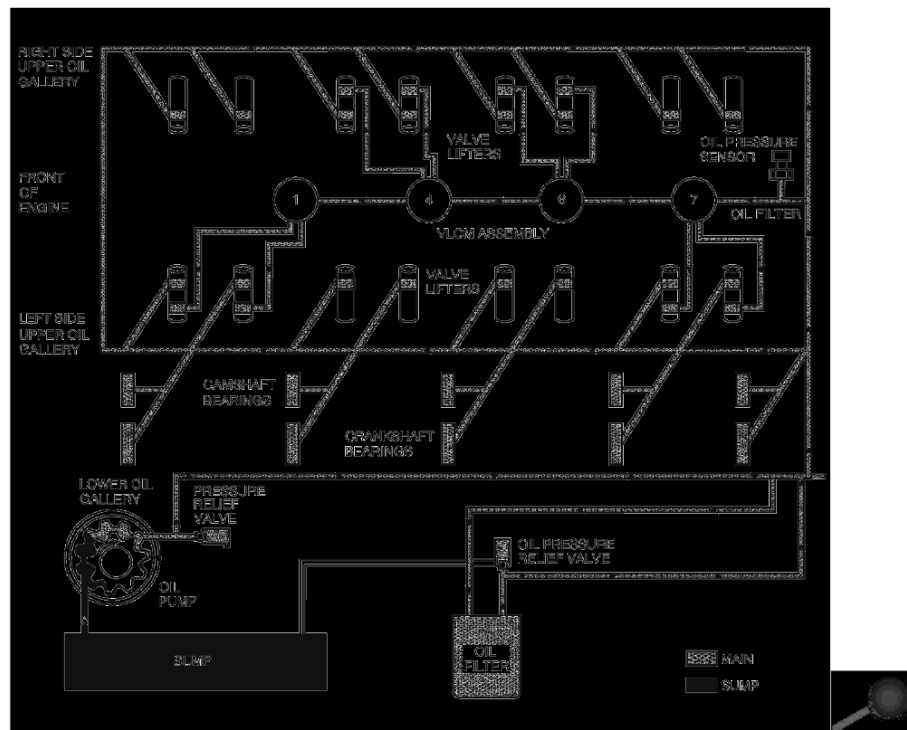
Engine lubrication is supplied by a gerotor type oil pump assembly. The oil pump is mounted on the front of the engine block and driven directly by the crankshaft sprocket. The pump gears rotate and draw oil from the oil pan sump through a pick-up screen and pipe. The oil is pressurized as it passes through the pump and is sent through the engine block lower oil gallery. Contained within the oil pump assembly is a pressure relief valve that maintains oil pressure within a specified range.

Pressurized oil is directed through the engine block lower oil gallery to the full flow oil filter where harmful contaminants are removed. A bypass valve is incorporated into the oil filter, which permits oil flow in the event the filter becomes restricted. A second valve, the active fuel management oil pressure relief valve is incorporated into the oil pan. The active fuel management oil pressure relief valve limits oil pressure directed to the upper oil galleries and valve lifter oil manifold assembly to 379–517 kPa (55–75 psi) maximum. When main oil pressure exceeds 379 kPa (55 psi), the oil pressure relief valve exhausts excess oil to the sump.

Oil is then directed from the filter to the upper main oil galleries and the valve lifter oil manifold assembly. Oil from the left upper oil gallery is directed to the crankshaft and camshaft bearings. Oil that has entered both the upper main oil galleries also pressurizes the valve lifter assemblies and is then pumped through the pushrods to lubricate the valve rocker arms and valve stems. Oil returning to the pan is directed by the crankshaft oil deflector. The oil pressure sensor is located at the top rear of the engine. Refer to [Cylinder Deactivation \(Active Fuel Management\) System Description](#).

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Lubrication Description - Main Pressure Below 55 psi with Cylinder Deactivation (Active Fuel Management) On



Engine lubrication is supplied by a gerotor type oil pump assembly. The oil pump is mounted on the front of the engine block and driven directly by the crankshaft sprocket. The pump gears rotate and draw oil from the oil pan sump through a pick-up screen and pipe. The oil is pressurized as it passes through the pump and is sent through the engine block lower oil gallery. Contained within the oil pump assembly is a pressure relief valve that maintains oil pressure within a specified range.

Pressurized oil is directed through the engine block lower oil gallery to the full flow oil filter where harmful contaminants are removed. A bypass valve is incorporated into the oil filter, which permits oil flow in the event the filter becomes restricted. A second valve, the active fuel management oil pressure relief valve is incorporated into the oil pan. The active fuel management oil pressure relief valve limits oil pressure directed to the upper oil galleries and oil manifold assembly to 379–517 kPa (55–75 psi) maximum.

Oil is then directed from the filter to the upper main oil galleries and the valve lifter oil manifold assembly. Oil from the left upper oil gallery is directed to the crankshaft and camshaft bearings. Oil that has entered both the upper main oil galleries also pressurizes the valve lifter assemblies and is then pumped through the pushrods to lubricate the valve rocker arms and valve stems. Oil returning to the pan is directed by the crankshaft oil deflector. The oil pressure sensor is located at the top rear of the engine.

With active fuel management activated, the engine control module (ECM) commands the 4 solenoids to open, directing oil through the engine block oil galleries to the intake and exhaust valve lifters for cylinders 1, 4, 6, and 7. Refer to [Cylinder Deactivation \(Active Fuel Management\) System Description](#).

Cleanliness and Care

- Throughout this section, it should be understood that proper cleaning and protection of machined surfaces and friction areas is part of the repair procedure. This is considered standard shop practice, even if not specifically stated.
- When any internal engine parts are serviced, care and cleanliness is important.
- When components are removed for service, they should be marked, organized or retained in a specific order for assembly. Refer to [Separating Parts](#).
- At the time of installation, components should be installed in the same location and with the same mating surface as when removed.
- An automobile engine is a combination of many machined, honed, polished and lapped surfaces with tolerances that are measured in millimeters or thousandths of an inch. These surfaces should be covered or protected to avoid component damage.
- A liberal coating of clean engine oil should be applied to friction areas during assembly.
- Proper lubrication will protect and lubricate friction surfaces during initial operation.

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Separating Parts

Important:

- Many internal engine components will develop specific wear patterns on their friction surfaces.
- When disassembling the engine, internal components MUST be separated, marked, or organized in a way to ensure installation to their original location and position.

Separate, mark, or organize the following components:

- Piston and the piston pin
- Piston to the specific cylinder bore
- Piston rings to the piston
- Connecting rod location and orientation to the crankshaft journal
- Connecting rod to the bearing cap
A paint stick or etching/engraving type tool are recommended. Stamping the connecting rod or cap near the bearing bore may affect component geometry.
- Crankshaft main and connecting rod bearings
- Camshaft and valve lifters
- Valve lifters, lifter guides, pushrods and rocker arm assemblies
- Valve to the valve guide
- Valve spring to the cylinder head location
- Engine block main bearing cap location and direction
- Oil pump drive and driven gears

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Replacing Engine Gaskets

Special Tools

J 28410 Gasket Remover

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

Gasket Use and Applying Sealants

- Do not use any gasket again unless specified.
- Gaskets that can be used again will be identified in the service procedure.
- Do not apply sealant to any gasket or sealing surface unless called out in the service information.

Separating Components

- Use a rubber mallet to separate components.
- Bump the part sideways to loosen the components.
- Bumping should be done at bends or reinforced areas to prevent distortion of parts.

Cleaning Gasket Surfaces

- Remove all gasket and sealing material from the part using the *J 28410* remover or equivalent.
- Care must be used to avoid gouging or scraping the sealing surfaces.
- Do not use any other method or technique to remove sealant or gasket material from a part.
- Do not use abrasive pads, sand paper, or power tools to clean the gasket surfaces.
 - These methods of cleaning can cause damage to the component sealing surfaces.
 - Abrasive pads also produce a fine grit that the oil filter cannot remove from the oil.
 - This grit is abrasive and has been known to cause internal engine damage.

Assembling Components

Caution: Refer to [Sealant Caution](#).

- When assembling components, use only the sealant specified or equivalent in the service procedure.
- Sealing surfaces should be clean and free of debris or oil.
- Specific components such as crankshaft oil seals or valve stem oil seals may require lubrication during assembly.
- Components requiring lubrication will be identified in the service procedure.
- When applying sealant to a component, apply the amount specified in the service procedure.
- Tighten bolts to specifications. Do not overtighten.

Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant

Cleaning Mating Part Surfaces for RTV Joints

RTV sealant depends greatly on adhesion to the mating parts in order to form and maintain a robust sealed joint. As with any adhesion system, proper surface preparation of the bonded parts is extremely important to ensure good adhesion over the life of the product.

Typical Applications

This procedure is intended for use in the following operations:

- Building of engines in a manual low volume build process where the use of assembly lubricants and other typical conditions exist which may contaminate the component sealing surfaces in an RTV joint.
- Cleaning of surfaces contaminated with oil or other substance during the assembly operation as a special case event.

In the typical situation, both the part being assembled, and the assembly to which it is to be sealed will be cleaned. An example is an oil pan assembled to a block/front cover/rear cover assembly using an RTV seal applied to the pan or the block. Both the pan and the block assembly should be cleaned prior to RTV application.

Any loose gaskets that are part of the RTV joint should not be cleaned unless it is known that they have been contaminated during the build process. Examples of loose gaskets are intake side and end seals which contact RTV used to seal a T-joint.

Assemblies supplied to GM with gaskets in place should not be cleaned unless they are known to be contaminated during the build process. Examples are rocker/cam covers with press in place gaskets using RTV at corners or T-joints.

Materials Needed

Use clean dry lint free cloths to wipe surface with approved solvent based cleaner. Examples are:

- GM Good Wrench Service Low VOC Brake Parts Cleaner
- AC Delco Non-Chlorinated Brake Parts Cleaner
- Loctite ODC -Free Cleaner & Degreaser

Procedure:

1. Identify the surfaces to which the RTV will come into contact in the assembled joint.
2. Using an approved solvent based cleaner, thoroughly soak an appropriate portion of a clean, dry cloth. Immediately wipe the surfaces with the cloth to remove any residue of oil, soap, etc.
3. Repeat step 2 using a clean portion of the cloth as many times as required until the cleanliness of the cloth after wiping the surface becomes constant in appearance. There is typically some discoloration of the cloth after wiping however a clean surface should produce the same level of discoloration with successive wiping with a clean cloth and solvent.
4. If crevices exist in the joint such that wiping the surface would not be sufficient to clean the crevice, the approved solvent based cleaner should be directly sprayed on the joint to ensure wetting of the surfaces and removal of the contaminant. DO NOT spray rubber components directly. Care must be used to avoid getting solvent in areas other than necessary to clean the joint. Then continue with step 2.

5. Allow the surfaces to dry for a minimum of 1 minute or longer if necessary for the solvent to evaporate from the surface.
6. Do not touch the cleaned surface with anything prior to RTV application.
7. The surface is now prepared for RTV application.

Sealant Types

Note: The correct sealant and amount of sealant must be used in the proper location to prevent oil leaks, coolant leaks, or the loosening of the fasteners. DO NOT interchange the sealants. Use only the sealant, or equivalent, as specified in the service procedure.

The following two major types of sealant are commonly used in engines:

- Room Temperature Vulcanizing (RTV)
- Anaerobic sealant, which include the following:
 - Gasket Eliminator
 - Pipe Sealant
 - Threadlock

Room Temperature Vulcanizing (RTV) Sealer

This type of sealant is used where two components, such as the intake manifold and the engine block, are assembled together.

Use the following information when using RTV sealant:

- Do not use RTV sealant in areas where extreme temperatures are expected. These areas include:
 - The exhaust manifold
 - The head gasket
 - Any other surfaces where a different type of sealant is specified in the service procedure
- Do not use RTV sealant unless the ambient air temperature is at least 18°C (65°F) degrees or higher.
- Always follow all the safety recommendations and the directions that are on the RTV sealant container.
- Use a plastic or wood scraper in order to remove all the RTV sealant from the components.

Caution: Do not allow the RTV sealant to enter any blind threaded hole. RTV sealant that is allowed to enter a blind threaded hole can cause hydraulic lock of the fastener when the fastener is tightened. Hydraulic lock of a fastener can lead to damage to the fastener and/or the components. Hydraulic lock of a fastener can also prevent the proper clamping loads to be obtained when the fastener is tightened. Improper clamping loads can prevent proper sealing of the components allowing leakage to occur. Preventing proper fastener tightening can allow the components to loosen or separate leading to extensive engine damage.

- The surfaces to be sealed must be clean and dry.
- Use a RTV sealant bead size as specified in the service procedure.
- Apply the RTV sealant bead to the inside of any bolt holes areas.
- **Note:** Do not wait for the RTV sealant to skin over.
- Assemble the components while the RTV sealant is still wet to the touch, within 10 minutes.
- **Note:** Do not overtighten the fasteners.
- Tighten the fasteners in sequence, if specified, and to the proper torque specifications.

Anaerobic Type Gasket Eliminator Sealant

Anaerobic type gasket eliminator sealant cures in the absence of air. This type of sealant is used where two rigid parts, such as castings, are assembled together. When two rigid parts are disassembled and no sealant or gasket is readily noticeable, then the two parts were probably assembled using an anaerobic type gasket eliminator sealant.

Use the following information when using gasket eliminator sealant:

- Always follow all the safety recommendations and directions that are on the gasket eliminator sealant container.
- Apply a continuous bead of gasket eliminator sealant to one flange.
- The surfaces to be sealed must be clean and dry.
- **Caution:** Do not allow the sealant to enter a blind hole. The sealant may prevent the fastener from achieving proper clamp load, cause component damage when the fastener is tightened, or lead to component failure.
- Do not allow the gasket eliminator sealed joint to cure more than 5 minutes before torquing to specification. This will result in an incorrect clamp load of assembled components.
- Do not overtighten the fasteners.
 - Apply the gasket eliminator sealant evenly to get a uniform thickness of the gasket eliminator sealant on the sealing surface.
 - Tighten the fasteners in sequence, if specified, and to the proper torque specifications.
 - After properly tightening the fasteners, remove the excess gasket eliminator sealant from the outside of the joint.

Anaerobic Type Threadlock Sealant

Anaerobic type threadlock sealant cures in the absence of air. This type of sealant is used for threadlocking and sealing of bolts, fittings, nuts, and studs. This type of sealant cures only when confined between two close fitting metal surfaces.

Use the following information when using threadlock sealant:

- Always follow all safety recommendations and directions that are on the threadlock sealant container.
- The threaded surfaces to be sealed must be clean and dry.
- Apply the threadlock sealant as specified on the threadlock sealant container.
- **Note:**
 - Do not allow the threadlock sealant to cure more than 5 minutes before torquing to specification. This will result in an incorrect clamp load of assembled components.
 - Do not overtighten the fasteners.
- Tighten the fasteners in sequence, if specified, and to the proper torque specifications.

Anaerobic Type Pipe Sealant

Anaerobic type pipe sealant cures in the absence of air and remains pliable when cured. This type of sealant is used where two parts are assembled together and require a leak proof joint.

Use the following information when using pipe sealant:

- Do not use pipe sealant in areas where extreme temperatures are expected. These areas include:
 - The exhaust manifold
 - The head gasket
 - Surfaces where a different sealant is specified
- Always follow all the safety recommendations and the directions that are on the pipe sealant container.
- The surfaces to be sealed must be clean and dry.

- Use a pipe sealant bead of the size or quantity as specified in the service procedure.
Caution: Do not allow the sealant to enter a blind hole. The sealant may prevent the fastener from achieving proper clamp load, cause component damage when the fastener is tightened, or lead to component failure.
- Apply the pipe sealant bead to the inside of any bolt hole areas.
- Apply a continuous bead of pipe sealant to one sealing surface.
Note: Do not overtighten the fasteners.
- Tighten the fasteners in sequence, if specified, and to the proper torque specifications.

Tools and Equipment

Special tools are listed and illustrated throughout this section, with a complete listing at the end of the section. These tools, or their equivalents, are specially designed to quickly and safely accomplish the operations for which they are intended. The use of these special tools also minimize possible damage to engine components. Some precision measuring tools are required for inspection of certain critical components. Torque wrenches and a torque angle meter are necessary for the proper tightening of various fasteners.

To properly service the engine assembly, the following items should be readily available:

- Approved eye protection and safety gloves
- A clean, well lit, work area
- A suitable parts cleaning tank
- A compressed air supply
- Trays or storage containers to keep parts and fasteners organized
- An adequate set of hand tools
- Approved engine repair stand
- An approved engine lifting device that will adequately support the weight of the components

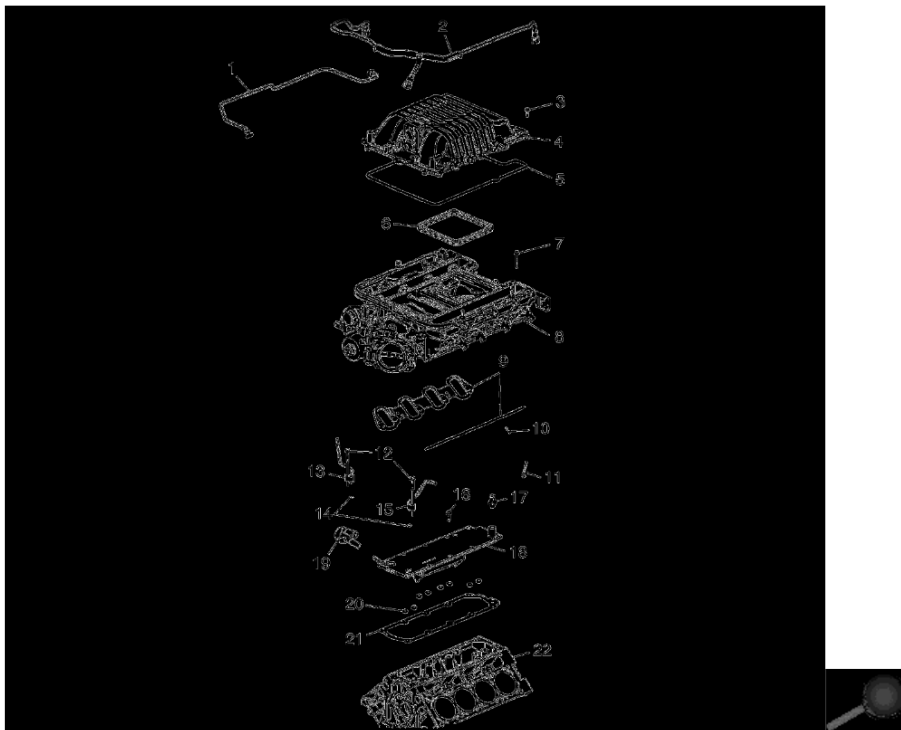
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Disassembled Views (LSA)

- Figure 1:** [Figure, Supercharger/Upper Engine](#)
- Figure 2:** [Figure, Cylinder Head/Upper Engine](#)
- Figure 3:** [Figure, Front of Engine](#)
- Figure 4:** [Rear of Engine](#)
- Figure 5:** [Figure, Lower Engine Assembly](#)
- Figure 6:** [Figure, Engine Block Plugs/Sensors](#)
- Figure 7:** [Figure, Supercharger Cover Assembly](#)
- Figure 8:** [Figure, Supercharger Assembly](#)
- Figure 9:** [Oil Pump Assembly](#)

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Supercharger/Upper Engine

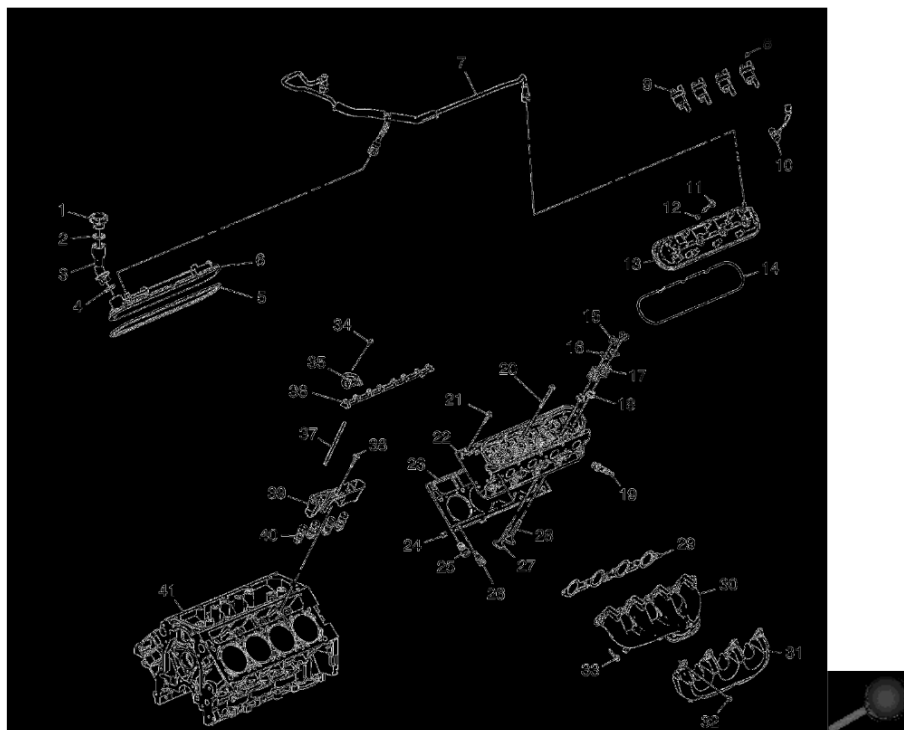


- (1) Evaporative (EVAP) Emission Canister Purge Tube
- (2) Positive Crankcase Ventilation (PCV) Tube – Fresh Air
- (3) Supercharger Cover Bolts
- (4) Supercharger Cover
- (5) Supercharger Cover Seal
- (6) Supercharger Insulator Seal
- (7) Supercharger Bolts
- (8) Supercharger
- (9) Supercharger Gasket
- (10) Supercharger Gasket Rivet
- (11) Engine Coolant Air Bleed Plug
- (12) Engine Coolant Air Bleed Pipe Bolt
- (13) Engine Coolant Air Bleed Pipe
- (14) Engine Coolant Air Bleed Pipe Seal
- (15) Engine Coolant Air Bleed Pipe
- (16) Valley Cover Bolt
- (17) Engine Oil Pressure Sensor
- (18) Valley Cover

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- (19) PCV Hose – Dirty Air
- (20) Valley Cover Seal
- (21) Valley Cover Gasket
- (22) Engine Block

Cylinder Head/Upper Engine

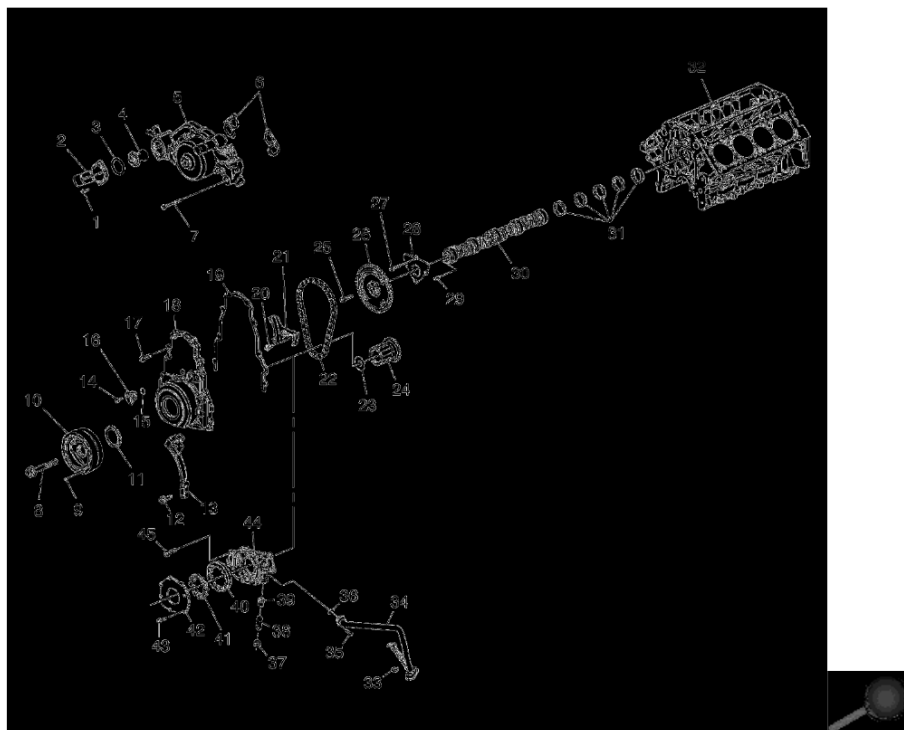


- (1) Oil Cap
- (2) Oil Cap O-ring Seal
- (3) Oil Fill Tube
- (4) Oil Fill Tube O-ring Seal
- (5) Valve Rocker Arm Cover Gasket
- (6) Valve Rocker Arm Cover
- (7) Positive Crankcase Ventilation (PCV) Tube- Fresh Air
- (8) Bolt
- (9) Ignition Coil
- (10) Spark Plug Wire
- (11) Bolt
- (12) Bolt Grommet
- (13) Valve Rocker Arm Cover
- (14) Valve Rocker Arm Cover Gasket
- (15) Valve Stem Key
- (16) Valve Spring Cap
- (17) Valve Spring
- (18) Valve Stem Oil Seal

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- (19) Spark Plug
- (20) Cylinder Head Bolt- M11
- (21) Cylinder Head Bolt- M8
- (22) Cylinder Head
- (23) Cylinder Head Gasket
- (24) Cylinder Head Locating Pin
- (25) Cylinder Head Plug
- (26) Coolant Temperature Sensor
- (27) Exhaust Valve
- (28) Intake Valve
- (29) Exhaust Manifold Gasket
- (30) Exhaust Manifold
- (31) Exhaust Manifold Heat Shield
- (32) Exhaust Manifold Heat Shield Bolt
- (33) Exhaust Manifold Bolt
- (34) Bolt
- (35) Valve Rocker Arm
- (36) Valve Rocker Arm Pivot Support
- (37) Valve Pushrod
- (38) Bolt
- (39) Valve Lifter Guide
- (40) Valve Lifter
- (41) Engine Block

Front of Engine

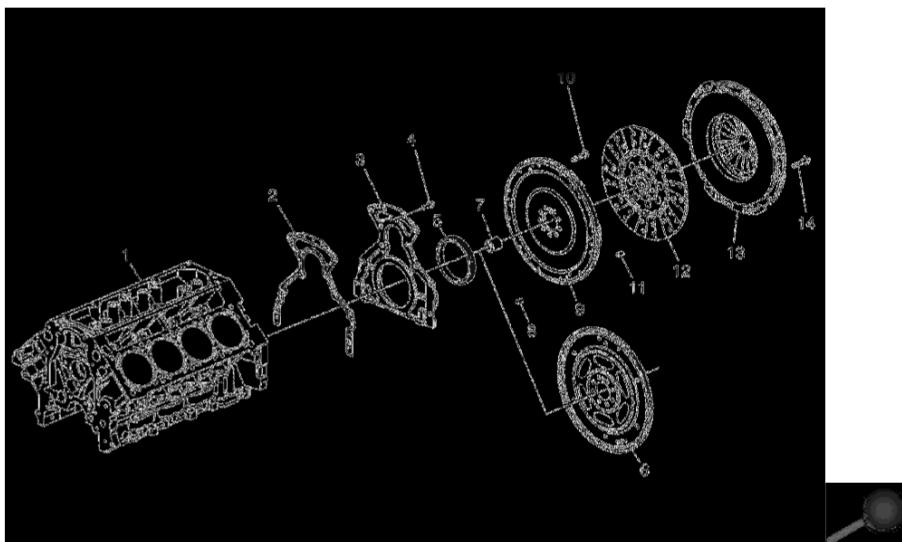


- (1) Bolt
- (2) Water Inlet Housing
- (3) Water Inlet Seal
- (4) Engine Coolant Thermostat
- (5) Water Pump
- (6) Water Pump Gasket
- (7) Bolt
- (8) Bolt
- (9) Balancer Weight- Crankshaft Balancer- Manual Transmission
- (10) Crankshaft Balancer
- (11) Crankshaft Front Oil Seal
- (12) Camshaft Position (CMP) Sensor Wire Harness Bolt
- (13) CMP Sensor Wire Harness
- (14) CMP Sensor Bolt
- (15) CMP Sensor Seal
- (16) CMP Sensor
- (17) Bolt
- (18) Engine Front Cover

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- (19) Engine Front Cover Gasket
- (20) Bolt
- (21) Timing Chain Tensioner
- (22) Timing Chain
- (23) Crankshaft Balancer Washer
- (24) Crankshaft Sprocket
- (25) Bolt
- (26) Camshaft Sprocket
- (27) Bolt
- (28) Camshaft Retainer
- (29) Camshaft Sprocket Locating Pin
- (30) Camshaft
- (31) Camshaft Bearings
- (32) Engine Block
- (33) Oil Pump Suction Pipe Nut
- (34) Oil Pump Suction Pipe
- (35) Oil Pump Suction Pipe Bolt
- (36) Oil Pump O-ring Seal
- (37) Oil Pressure Relief Valve Bore Plug
- (38) Oil Pressure Relief Valve Spring
- (39) Oil Pressure Relief Valve
- (40) Oil Pump Driven Gear
- (41) Oil Pump Drive Gear
- (42) Oil Pump Cover
- (43) Oil Pump Cover Bolt
- (44) Oil Pump
- (45) Oil Pump Bolt

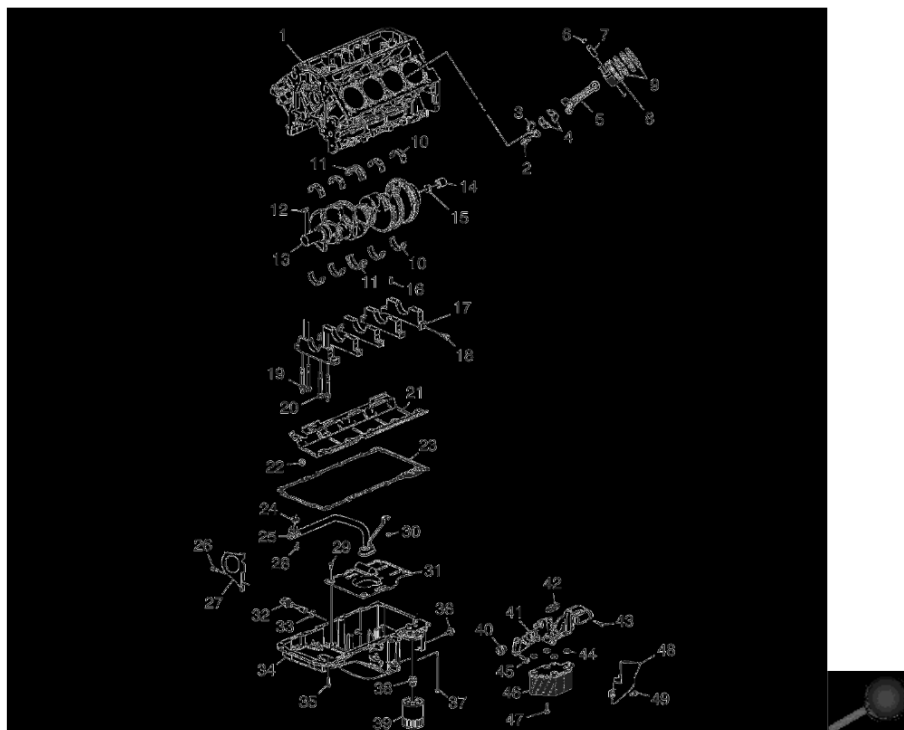
Rear of Engine



- (1) Engine Block
- (2) Crankshaft Rear Oil Seal Housing Gasket
- (3) Crankshaft Rear Oil Seal Housing
- (4) Bolt
- (5) Crankshaft Rear Oil Seal
- (6) Flexplate – Automatic Transmission
- (7) Transmission Pilot Bearing – Manual Transmission
- (8) Balance Weight – Flywheel – Manual Transmission
- (9) Flywheel – Manual Transmission
- (10) Bolt
- (11) Clutch Pressure Plate Locating Pin – Manual Transmission
- (12) Clutch Drive Plate – Manual Transmission
- (13) Clutch Pressure Plate – Manual Transmission
- (14) Bolt

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Lower Engine Assembly

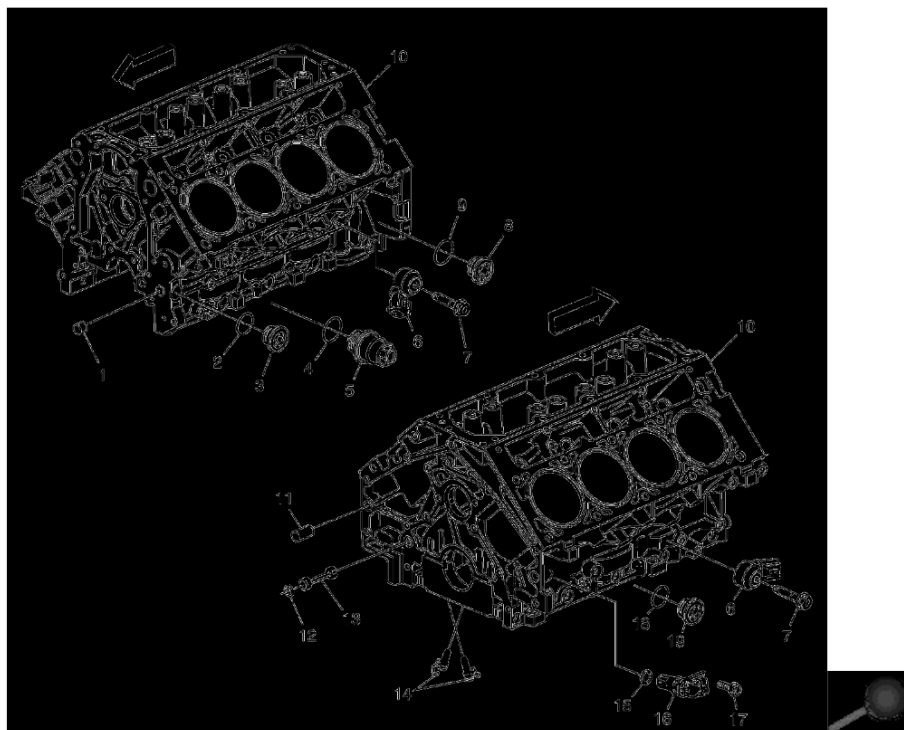


- (1) Engine Block
- (2) Bolt
- (3) Connecting Rod Cap
- (4) Connecting Rod Bearing
- (5) Connecting Rod
- (6) Piston Pin Retainer
- (7) Piston Pin
- (8) Piston
- (9) Piston Ring Set
- (10) Crankshaft Bearing
- (11) Crankshaft Bearing - Thrust
- (12) Crankshaft Sprocket Key
- (13) Crankshaft
- (14) Transmission Pilot Bearing - Manual Transmission
- (15) Crankshaft Hole Plug
- (16) Crankshaft Bearing Cap Locating Pin
- (17) Crankshaft Bearing Cap
- (18) Bolt - M8

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- (19) Stud – M10
- (20) Bolt – M10
- (21) Crankshaft Oil Deflector
- (22) Crankshaft Oil Deflector Nut
- (23) Oil Pan Gasket
- (24) Oil Pump Suction Pipe Seal
- (25) Oil Pump Suction Pipe
- (26) Bolt
- (27) Engine Cover – Right
- (28) Oil Pump Suction Pipe Bolt
- (29) Oil Pan Baffle Bolt
- (30) Oil Pump Suction Pipe Nut
- (31) Oil Pan Baffle
- (32) Engine Oil Level Sensor
- (33) Engine Oil Level Sensor Seal
- (34) Oil Pan
- (35) Oil Pan Bolt
- (36) Oil Pan Drain Plug
- (37) Oil Pan Bolt
- (38) Oil Filter Fitting
- (39) Oil Filter
- (40) Engine Oil Cooler Coolant Fitting
- (41) Engine Oil Cooler Housing
- (42) Engine Oil Cooler Gasket
- (43) Engine Oil Cooler-to-Oil Pan Bolt – M6
- (44) Engine Oil Cooler Core Seal
- (45) Engine Oil Cooler-to-Oil Pan Bolt – M8
- (46) Engine Oil Cooler Core
- (47) Engine Oil Cooler Core-to-Housing Bolt
- (48) Oil Pan Cover – Left
- (49) Bolt

Engine Block Plugs/Sensors



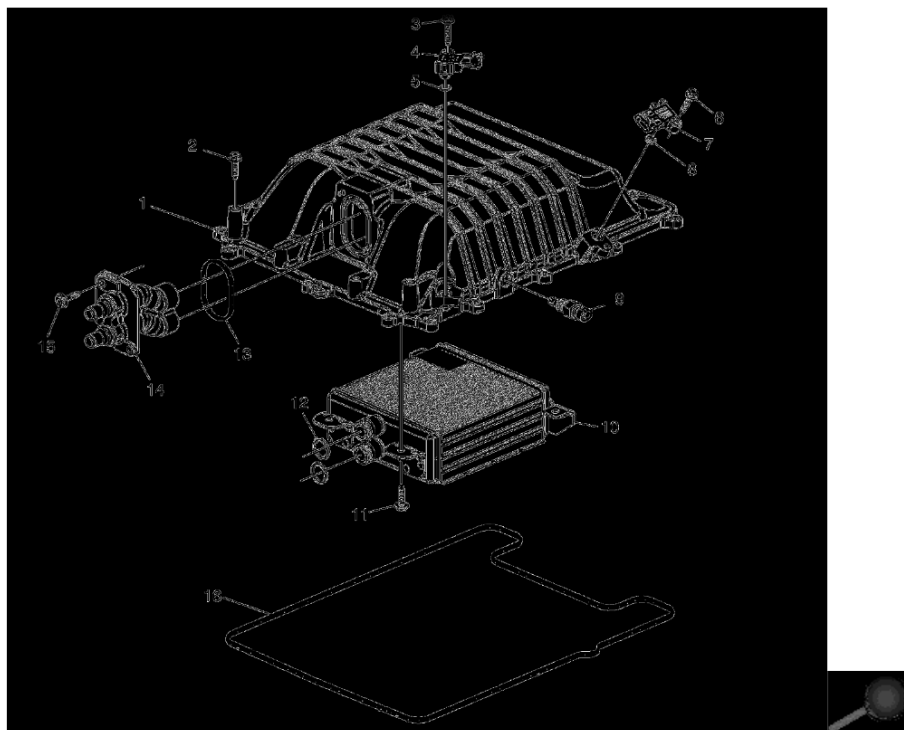
- (1) Engine Block Oil Gallery Plug – Front
- (2) Engine Block Oil Gallery Plug Seal
- (3) Engine Block Oil Gallery Plug – Side
- (4) Engine Block Coolant Heater Seal
- (5) Engine Block Coolant Heater
- (6) Knock Sensor
- (7) Bolt
- (8) Engine Block Oil Gallery Plug – Side
- (9) Engine Block Oil Gallery Plug Seal
- (10) Engine Block
- (11) Transmission Locating Pin
- (12) Engine Block Oil Gallery Plug Seal
- (13) Engine Block Oil Gallery Plug – Rear
- (14) Piston Oil Nozzle
- (15) Crankshaft Position (CKP) Sensor Seal
- (16) CKP Sensor
- (17) CKP Sensor Bolt
- (18) Engine Block Coolant Drain Hole Plug Seal

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(19) Engine Block Coolant Drain Hole Plug – Side

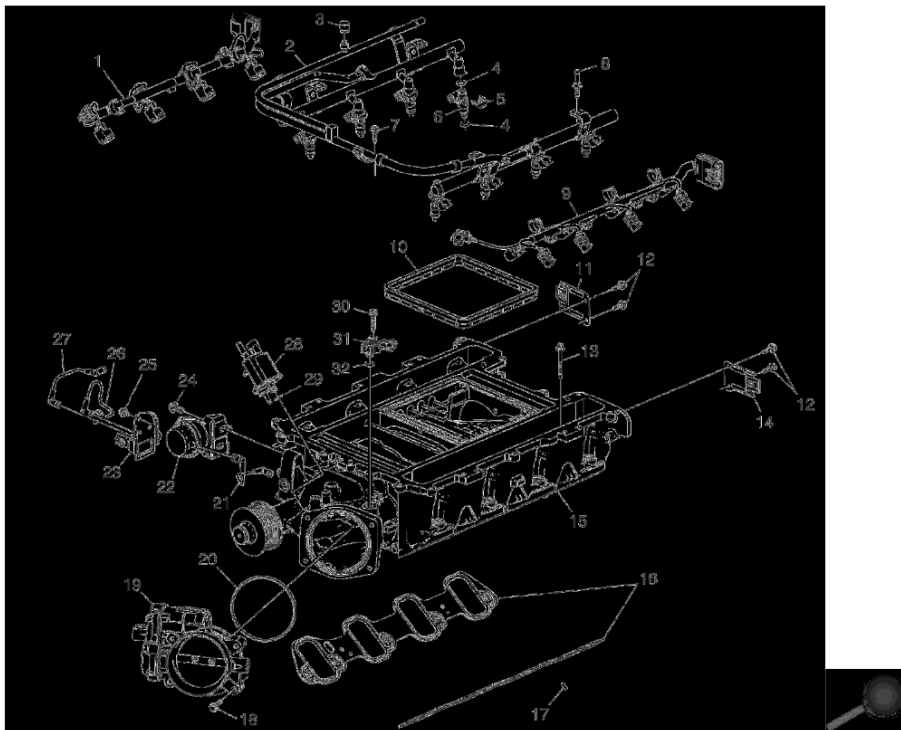
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Supercharger Cover Assembly



- (1) Charge Air Cooler Cover
- (2) Charge Air Cooler Cover Bolt
- (3) Barometric Pressure Sensor Bolt
- (4) Barometric Pressure Sensor
- (5) Barometric Pressure Sensor Seal
- (6) Supercharger Air Outlet Pressure Sensor Bolt
- (7) Supercharger Air Outlet Pressure Sensor
- (8) Supercharger Air Outlet Pressure Sensor Seal
- (9) Intake Air Temperature Sensor
- (10) Charge Air Cooler
- (11) Charge Air Cooler Bolt
- (12) Charge Air Cooler Coolant Pipe Seal
- (13) Charge Air Cooler Coolant Outlet Pipe Assembly Seal
- (14) Charge Air Cooler Coolant Outlet Pipe Assembly
- (15) Charge Air Cooler Coolant Outlet Pipe Assembly Bolt
- (16) Charge Air Cooler Cover Seal

Supercharger Assembly

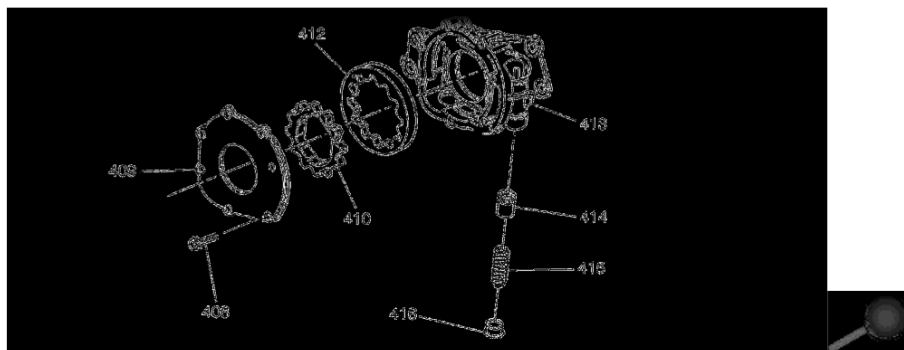


- (1) Fuel Injector Wiring Harness
- (2) Multiport Fuel Injection Fuel Rail
- (3) Fuel Rail Service Port Cap
- (4) Fuel Injector Seal
- (5) Fuel Injector Retainer
- (6) Fuel Injector
- (7) Fuel Injection Fuel Rail Bolt
- (8) Fuel Injector Fuel Rail Stud
- (9) Fuel Injector Wiring Harness
- (10) Charge Air Cooler Insulator
- (11) Fuel Injector Wiring Harness Connector Bracket- Right
- (12) Fuel Injector Wiring Harness Connector Bracket Bolt
- (13) Supercharger Bolt
- (14) Fuel Injector Wiring Harness Connector Bracket- Left
- (15) Supercharger
- (16) Intake Manifold Gasket
- (17) Intake Manifold Gasket Rivet
- (18) Throttle Body Bolt

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- (19) Throttle Body
- (20) Throttle Body Seal
- (21) Charge Air Bypass Valve Vacuum Tube
- (22) Supercharger Bypass Actuator
- (23) Charge Air Bypass Valve w/Bracket
- (24) Supercharger Bypass Actuator Bolt
- (25) Charge Air Bypass Valve Bolt
- (26) Charge Air Bypass Valve Tube
- (27) Bypass Valve Actuator Tube
- (28) Evaporative Emission Canister Purge Valve
- (29) Evaporative Emission Canister Purge Valve Seal
- (30) Supercharger Inlet Air Pressure Sensor Bolt
- (31) Supercharger Inlet Air Pressure Sensor
- (32) Supercharger Inlet Air Pressure Sensor Seal

Oil Pump Assembly



- (408) Bolt
- (409) Oil Pump Housing Cover
- (410) Oil Pump Drive Gear
- (412) Oil Pump Driven Gear
- (413) Oil Pump
- (414) Oil Pump Pressure Relief Valve
- (415) Oil Pump Pressure Relief Valve Spring
- (416) Oil Pump Housing Plug

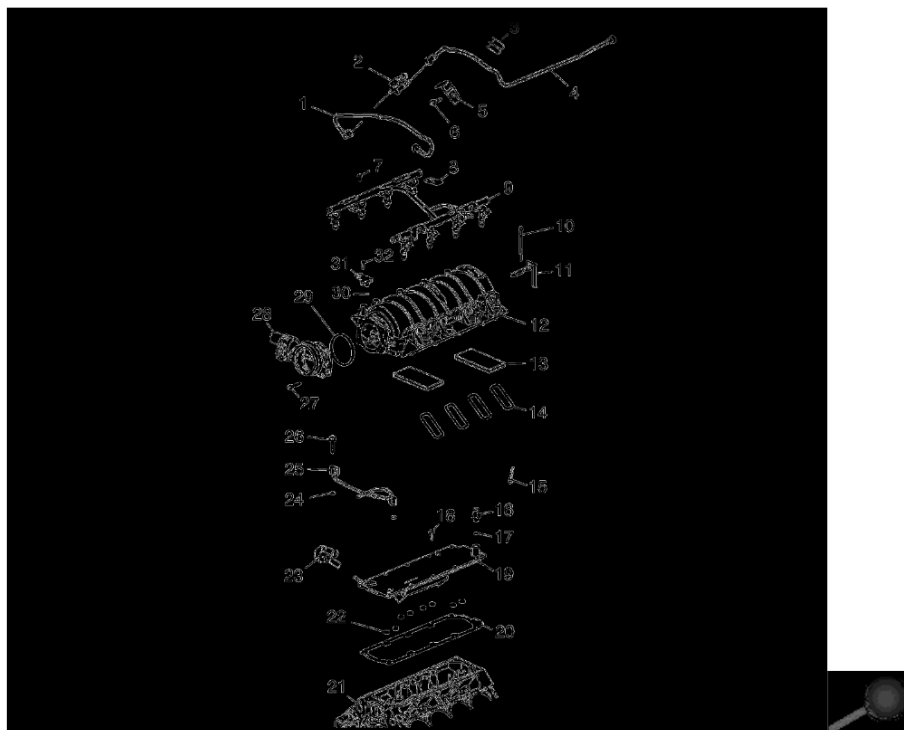
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Disassembled Views (LS3)

- Figure 1:** [Intake Manifold/Upper Engine](#)
Figure 2: [Cylinder Head/Upper Engine](#)
Figure 3: [Front of Engine](#)
Figure 4: [Rear of Engine](#)
Figure 5: [Lower Engine Assembly](#)
Figure 6: [Engine Block Plugs/Sensors](#)
Figure 7: [Oil Pump Assembly](#)

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Intake Manifold/Upper Engine

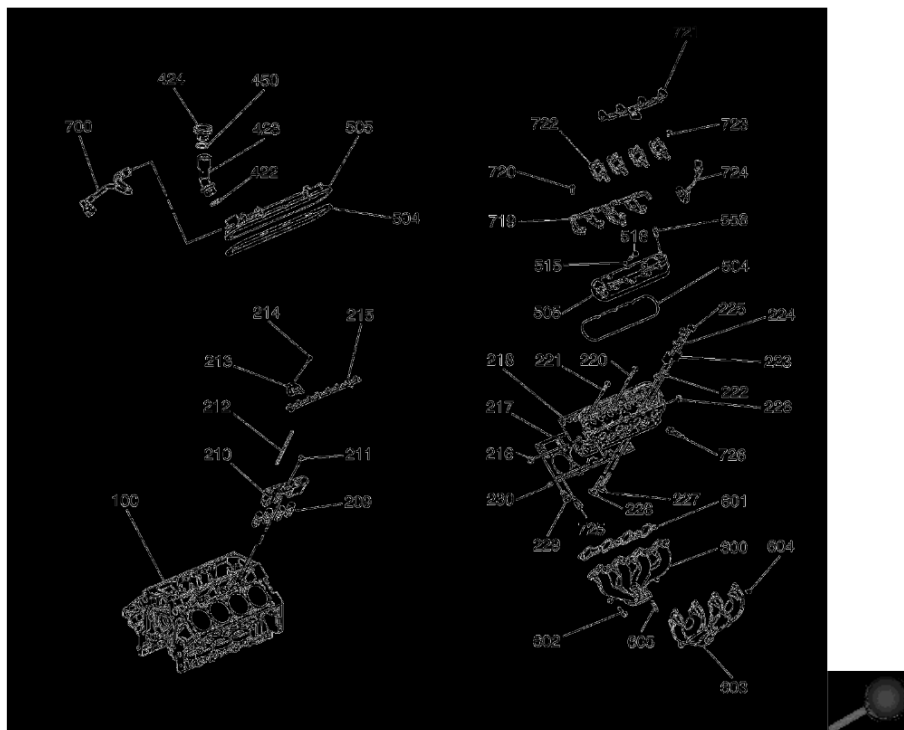


- (1) Evaporative Emission (EVAP) Canister Purge Tube
- (2) EVAP Canister Purge Solenoid Valve
- (3) EVAP Tube Clip
- (4) EVAP Canister Purge Tube
- (5) EVAP Purge Valve Bracket
- (6) Bolt
- (7) Bolt
- (8) Fuel Rail Ground Strap
- (9) Fuel Rail with Injectors
- (10) Bolt
- (11) Fuel Injection Fuel Rail Stop Bracket
- (12) Intake Manifold
- (13) Seal
- (14) Intake Manifold Gasket
- (15) Engine Coolant Air Bleed Plug
- (16) Oil Pressure Sensor
- (17) Washer
- (18) Bolt

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- (19) Valley Cover
- (20) Valley Cover Gasket
- (21) Engine Block
- (22) Seal
- (23) Positive Crankcase Ventilation (PCV) Hose – Dirty Air
- (24) Seal
- (25) Engine Coolant Air Bleed Pipe
- (26) Bolt
- (27) Bolt
- (28) Throttle Body
- (29) Throttle Body Gasket
- (30) Seal
- (31) Manifold Absolute Pressure (MAP) Sensor
- (32) MAP Sensor Bolt

Cylinder Head/Upper Engine



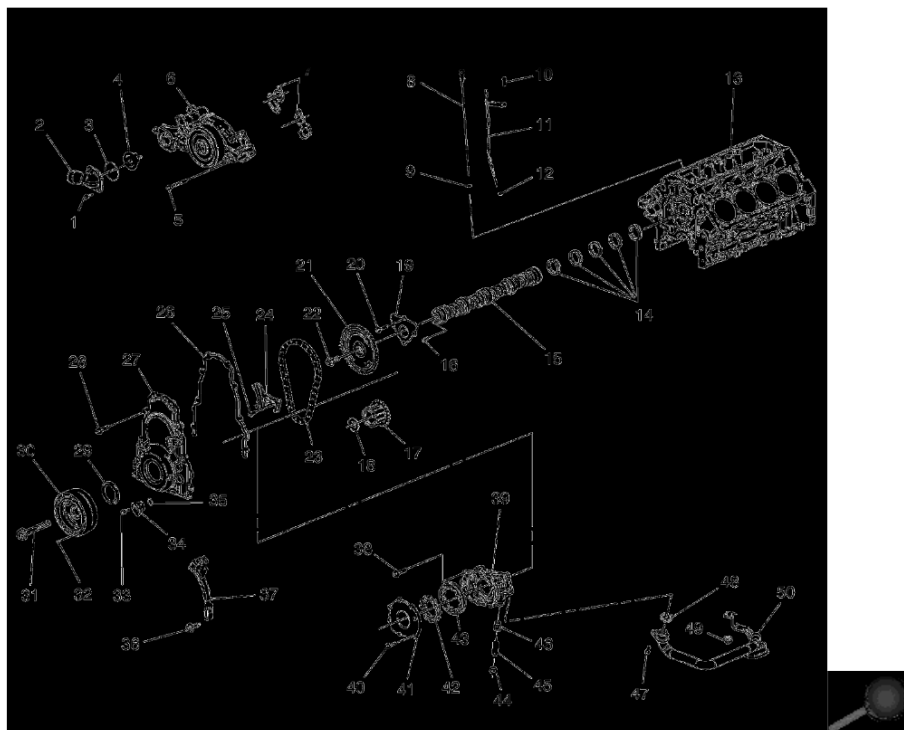
- (100) Engine Block
- (209) Valve Lifter
- (210) Valve Lifter Guide
- (211) Bolt
- (212) Pushrod
- (213) Valve Rocker Arm
- (214) Bolt
- (215) Valve Rocker Arm Pivot Support
- (216) Core Hole Plug
- (217) Cylinder Head Gasket
- (218) Cylinder Head
- (220) Cylinder Head Bolt - M11
- (221) Cylinder Head Bolt - M8
- (222) Valve Stem Oil Seal
- (223) Valve Spring
- (224) Valve Spring Cap
- (225) Valve Stem Key
- (226) Core Hole Plug

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- (227) Intake Valve
- (228) Exhaust Valve
- (229) Cylinder Head Plug
- (230) Cylinder Head Locating Pin
- (422) O-ring
- (423) Oil Fill Tube
- (424) Oil Fill Cap
- (450) O-ring
- (504) Valve Rocker Arm Cover Gasket
- (504) Valve Rocker Arm Cover Gasket
- (505) Valve Rocker Arm Cover
- (505) Valve Rocker Arm Cover
- (515) Bolt Grommet
- (516) Bolt
- (558) Plug
- (600) Exhaust Manifold
- (601) Exhaust Manifold Gasket
- (602) Bolt
- (603) Exhaust Manifold Heat Shield
- (604) Bolt
- (605) Stud
- (700) Positive Crankcase Ventilation (PCV) Hose – Fresh Air
- (719) Ignition Coil Bracket
- (720) Stud
- (721) Ignition Coil Wire Harness Assembly
- (722) Ignition Coil
- (723) Bolt
- (724) Spark Plug Wire
- (725) Coolant Temperature Sensor (CTS)
- (726) Spark Plug

Front of Engine



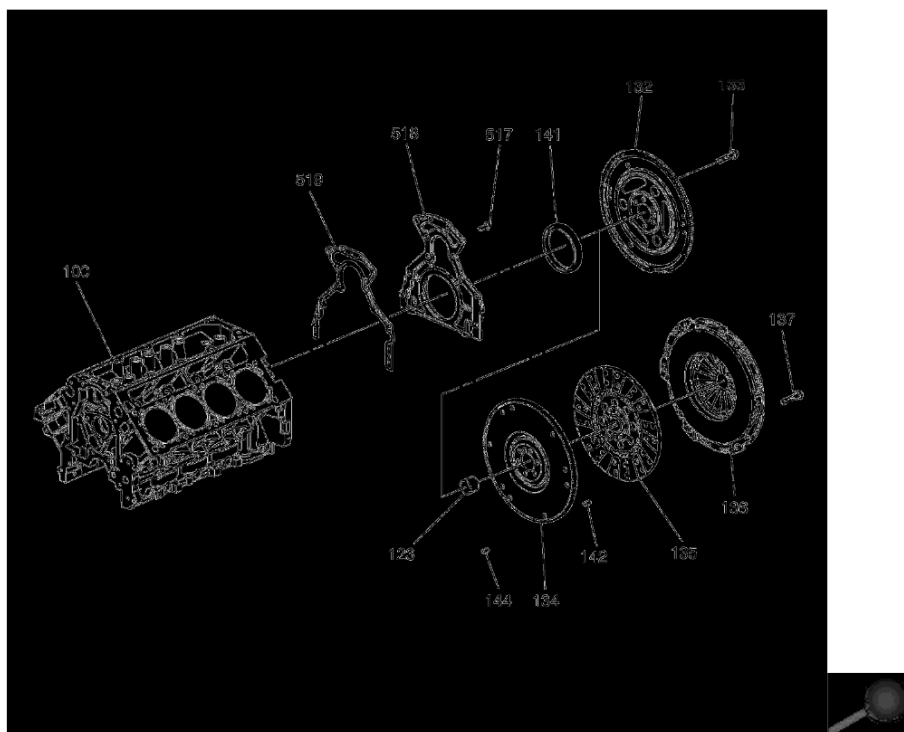
- (1) Bolt
- (2) Water Inlet Housing
- (3) O-Ring
- (4) Thermostat
- (5) Bolt
- (6) Water Pump
- (7) Water Pump Gasket
- (8) Oil Level Indicator
- (9) O-Ring
- (10) Bolt
- (11) Oil Level Indicator Tube
- (12) O-Ring
- (13) Engine Block
- (14) Camshaft Bearings
- (15) Camshaft
- (16) Camshaft Sprocket Locating Pin
- (17) Crankshaft Sprocket
- (18) Crankshaft Balancer Washer

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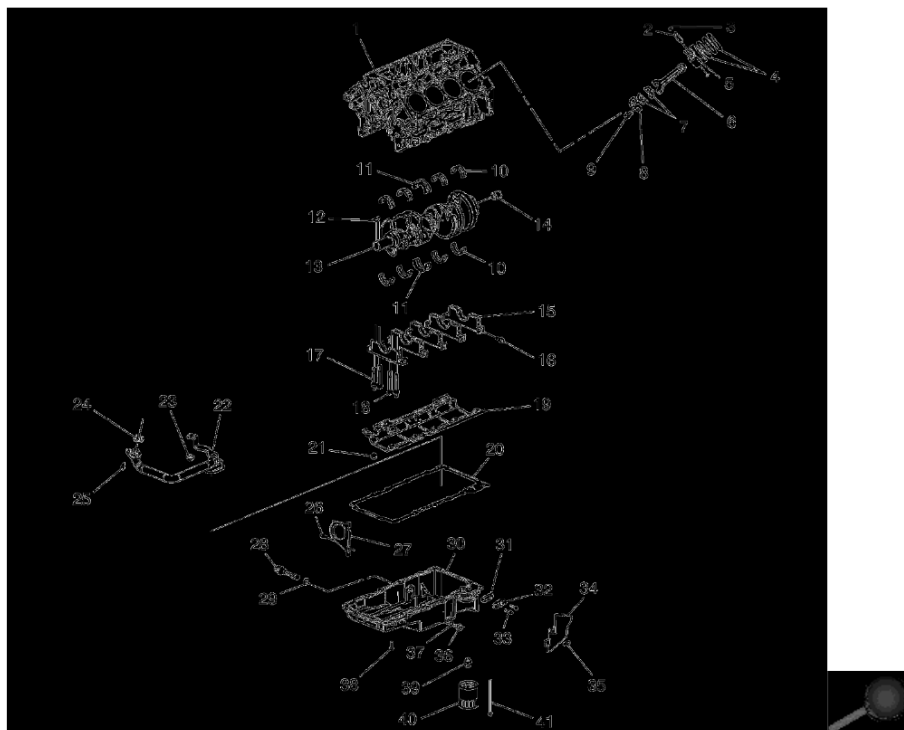
- (19) Camshaft Retainer
- (20) Bolt
- (21) Camshaft Sprocket
- (22) Bolt
- (23) Timing Chain
- (24) Timing Chain Tensioner
- (25) Bolt
- (26) Engine Front Cover Gasket
- (27) Engine Front Cover
- (28) Bolt
- (29) Crankshaft Front Oil Seal
- (30) Crankshaft Balancer
- (31) Bolt
- (32) Balance Weight- Crankshaft Balancer
- (33) Bolt
- (34) Camshaft Position (CMP) Sensor
- (35) O-Ring
- (36) Bolt
- (37) CMP Sensor Wire Harness
- (38) Bolt
- (39) Oil Pump
- (40) Bolt
- (41) Oil Pump Housing Cover
- (42) Oil Pump Drive Gear
- (43) Oil Pump Driven Gear
- (44) Oil Pump Housing Plug
- (45) Oil Pump Pressure Relief Valve Spring
- (46) Oil Pump Pressure Relief Valve
- (47) Bolt
- (48) O-Ring
- (49) Nut
- (50) Oil Pump Screen

Rear of Engine



- (100) Engine Block
- (123) Transmission Pilot Bearing – Manual Transmission
- (132) Flex Plate – Automatic Transmission
- (133) Bolt
- (134) Flywheel – Manual Transmission
- (135) Clutch Driven Plate – Manual Transmission
- (136) Clutch Pressure Plate – Manual Transmission
- (137) Bolt
- (141) Crankshaft Rear Oil Seal
- (142) Clutch Pressure Plate Locating Pin – Manual Transmission
- (144) Balance Weight – Flywheel
- (517) Bolt
- (518) Crankshaft Rear Oil Seal Housing
- (519) Crankshaft Rear Oil Seal Housing Gasket

Lower Engine Assembly

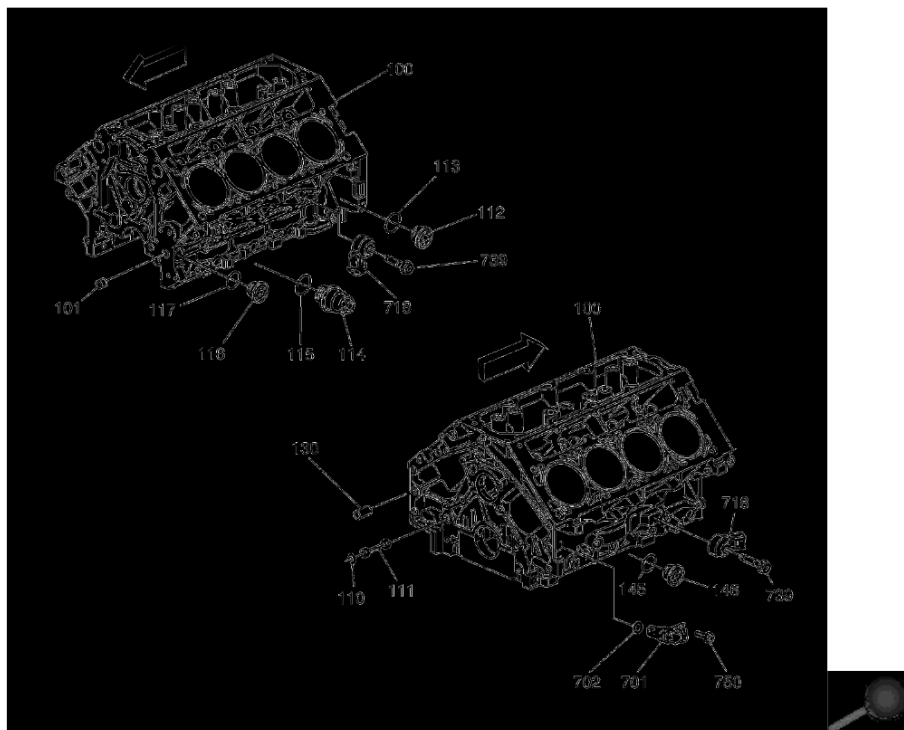


- (1) Engine Block
- (2) Piston Pin
- (3) Piston Pin Retainer
- (4) Piston Rings
- (5) Piston
- (6) Connecting Rod
- (7) Connecting Rod Bearings
- (8) Connecting Rod Cap
- (9) Bolt
- (10) Crankshaft Main Bearing
- (10) Crankshaft Main Bearing
- (11) Crankshaft Thrust Bearing
- (11) Crankshaft Thrust Bearing
- (12) Crankshaft Sprocket Key
- (13) Crankshaft
- (14) Transmission Pilot Bearing – Manual Transmission
- (15) Crankshaft Bearing Cap
- (16) Bolt – M8

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- (17) Stud – M10
- (18) Bolt – M10
- (19) Crankshaft Oil Deflector
- (20) Oil Pan Gasket
- (21) Nut
- (22) Oil Pump Screen
- (23) Nut
- (24) O-Ring
- (25) Bolt
- (26) Bolt
- (27) Engine Closeout Cover – Right
- (28) Oil Level Sensor
- (29) O-Ring
- (30) Oil Pan
- (31) Oil Pan Cover Gasket
- (32) Oil Pan Cover
- (33) Bolt
- (34) Engine Closeout Cover – Left
- (35) Bolt
- (36) Oil Pan Drain Plug
- (37) O-Ring
- (38) Bolt
- (39) Oil Filter Fitting
- (40) Oil Filter
- (41) Bolt

Engine Block Plugs/Sensors

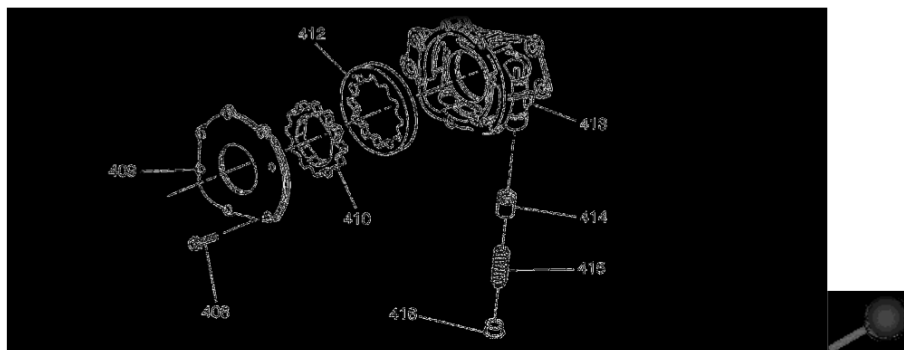


- (100) Engine Block
- (100) Engine Block
- (101) Oil Gallery Plug - Front
- (110) O-Ring
- (111) Oil Gallery Plug - Rear
- (112) Oil Gallery Plug - Side
- (113) Washer
- (114) Engine Coolant Heater
- (115) Washer
- (116) Oil Gallery Plug - Side
- (117) Washer
- (130) Transmission Housing Locating Pin
- (145) Washer
- (146) Engine Block Coolant Drain Hole Plug
- (701) Crankshaft Position (CKP) Sensor
- (702) O-Ring
- (718) Knock Sensor
- (718) Knock Sensor

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- (739) Bolt
- (739) Bolt
- (750) CKP Sensor Bolt

Oil Pump Assembly



- (408) Bolt
- (409) Oil Pump Housing Cover
- (410) Oil Pump Drive Gear
- (412) Oil Pump Driven Gear
- (413) Oil Pump
- (414) Oil Pump Pressure Relief Valve
- (415) Oil Pump Pressure Relief Valve Spring
- (416) Oil Pump Housing Plug

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Disassembled Views (L77)

Figure 1: [Intake Manifold/Upper Engine](#)

Figure 2: [Cylinder Head/Upper Engine](#)

Figure 3: [Front of Engine](#)

Figure 4: [Rear of Engine](#)

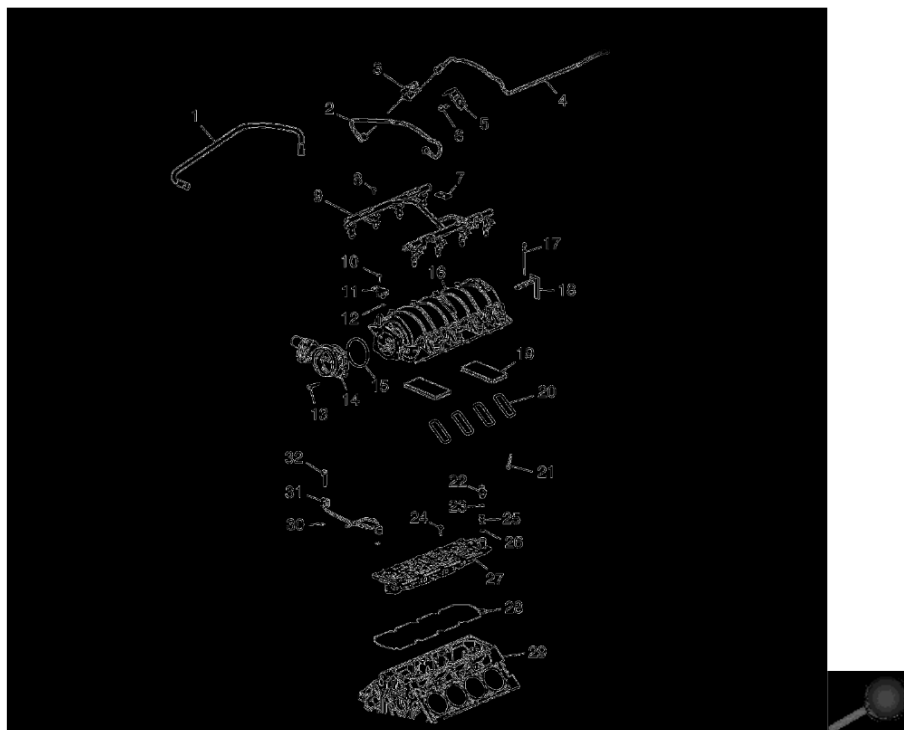
Figure 5: [Lower Engine Assembly](#)

Figure 6: [Engine Block Plugs/Sensors](#)

Figure 7: [Oil Pump Assembly](#)

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Intake Manifold/Upper Engine

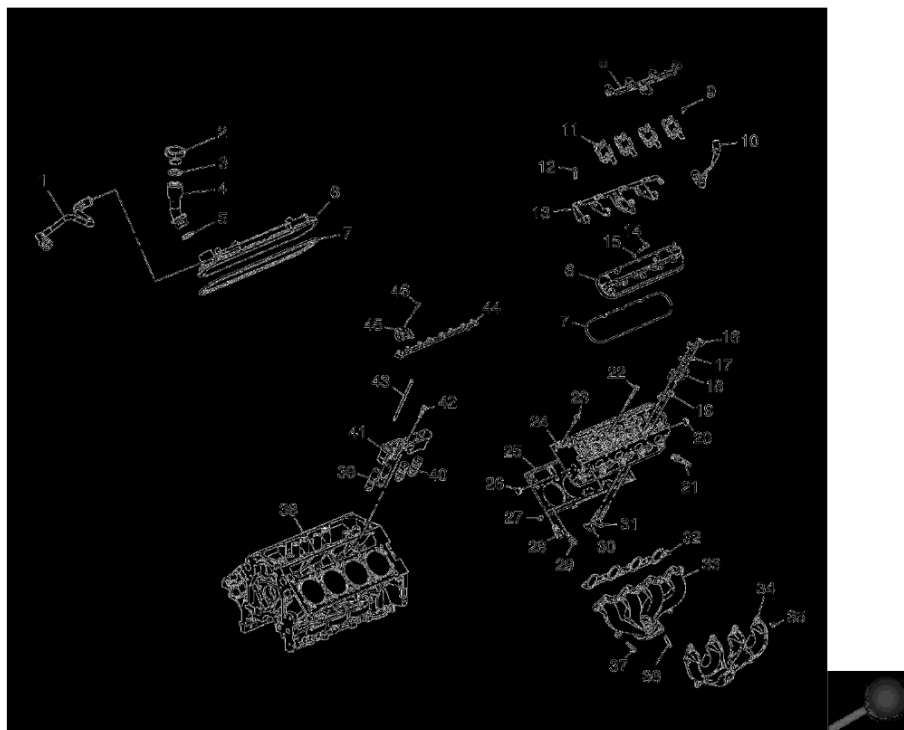


- (1) Positive Crankcase Ventilation (PCV) Tube – Dirty Air
- (2) Evaporative Emission (EVAP) Canister Purge Tube
- (3) EVAP Canister Purge Solenoid Valve
- (4) EVAP Canister Purge Tube
- (5) EVAP Purge Valve Bracket
- (6) Bolt
- (7) Fuel Rail Ground Strap
- (8) Bolt
- (9) Fuel Rail with Injectors
- (10) Manifold Absolute Pressure (MAP) Sensor Bolt
- (11) Manifold Absolute Pressure (MAP) Sensor
- (12) Seal
- (13) Bolt
- (14) Throttle Body
- (15) Throttle Body Gasket
- (16) Intake Manifold
- (17) Bolt
- (18) Fuel Injection Fuel Rail Stop Bracket

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- (19) Seal
- (20) Intake Manifold Gasket
- (21) Engine Coolant Air Bleed Plug
- (22) Oil Pressure Sensor
- (23) Washer
- (24) Bolt
- (25) Filter
- (26) O-ring
- (27) Valve Lifter Oil Manifold
- (28) Valve Lifter Oil Manifold Gasket
- (29) Engine Block
- (30) Seal
- (31) Engine Coolant Air Bleed Pipe
- (32) Bolt

Cylinder Head/Upper Engine

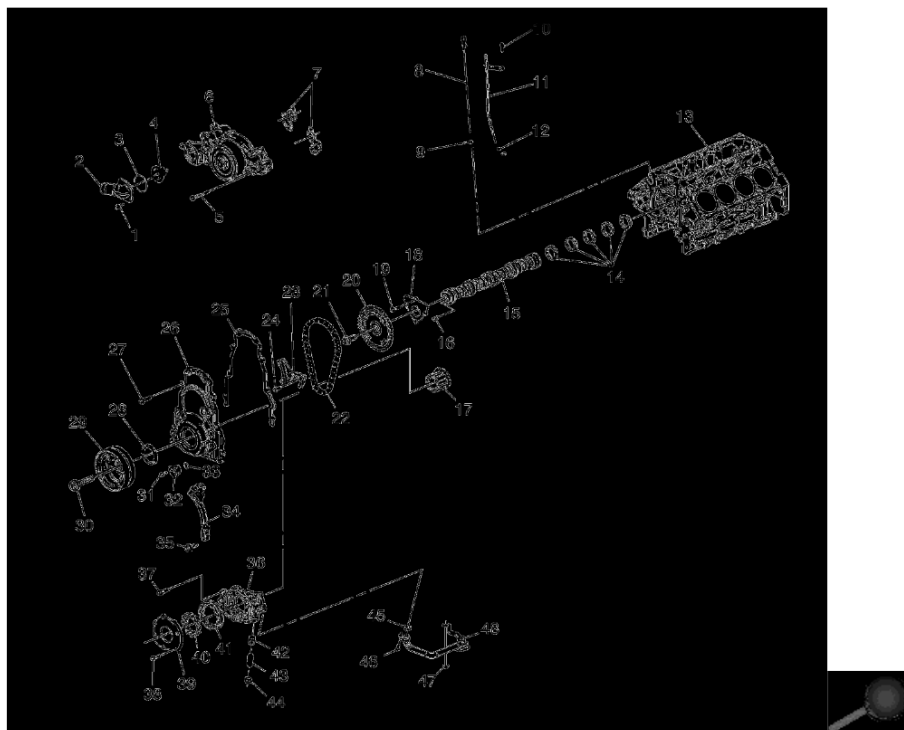


- (1) Positive Crankcase Ventilation (PCV) Hose – Fresh Air
- (2) Oil Fill Cap
- (3) O-ring
- (4) Oil Fill Tube
- (5) O-ring
- (6) Valve Rocker Arm Cover
- (6) Valve Rocker Arm Cover
- (7) Valve Rocker Arm Cover Gasket
- (7) Valve Rocker Arm Cover Gasket
- (8) Ignition Coil Wire Harness Assembly
- (9) Bolt
- (10) Spark Plug Wire
- (11) Ignition Coil
- (12) Bolt
- (13) Ignition Coil Bracket
- (14) Bolt
- (15) Bolt Grommet
- (16) Valve Stem Key

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- (17) Valve Spring Cap
- (18) Valve Spring
- (19) Valve Stem Oil Seal
- (20) Core Hole Plug
- (21) Spark Plug
- (22) Cylinder Head Bolt – M11
- (23) Cylinder Head Bolt – M8
- (24) Cylinder Head
- (25) Cylinder Head Gasket
- (26) Core Hole Plug
- (27) Cylinder Head Locating Pin
- (28) Cylinder Head Plug
- (29) Coolant Temperature Sensor (CTS)
- (30) Exhaust Valve
- (31) Intake Valve
- (32) Exhaust Manifold Gasket
- (33) Exhaust Manifold
- (34) Exhaust Manifold Heat Shield
- (35) Bolt
- (36) Stud
- (37) Bolt
- (38) Engine Block
- (39) Valve Lifter – Active Fuel Management
- (40) Valve Lifter – Non-Active Fuel Management
- (41) Valve Lifter Guide
- (42) Bolt
- (43) Pushrod
- (44) Valve Rocker Arm Pivot Support
- (45) Valve Rocker Arm
- (46) Bolt

Front of Engine

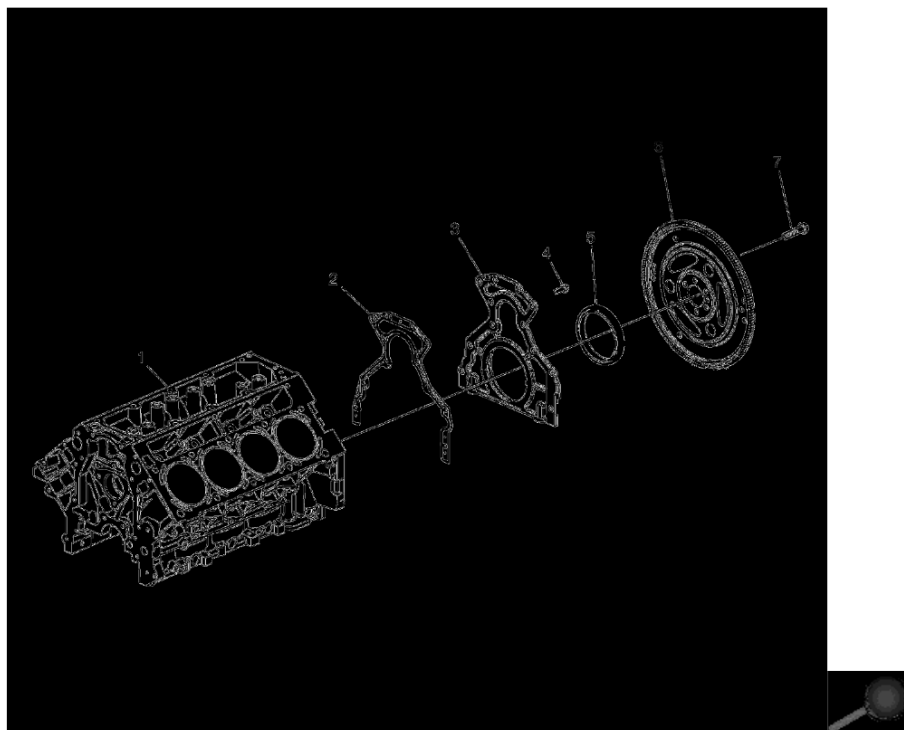


- (1) Bolt
- (2) Water Inlet Housing
- (3) O-Ring
- (4) Thermostat
- (5) Bolt
- (6) Water Pump
- (7) Water Pump Gasket
- (8) Oil Level Indicator
- (9) O-Ring
- (10) Bolt
- (11) Oil Level Indicator Tube
- (12) O-Ring
- (13) Engine Block
- (14) Camshaft Bearings
- (15) Camshaft
- (16) Camshaft Sprocket Locating Pin
- (17) Crankshaft Sprocket
- (18) Camshaft Retainer

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- (19) Bolt
- (20) Camshaft Sprocket
- (21) Bolt
- (22) Timing Chain
- (23) Timing Chain Tensioner
- (24) Bolt
- (25) Engine Front Cover Gasket
- (26) Engine Front Cover
- (27) Bolt
- (28) Crankshaft Front Oil Seal
- (29) Crankshaft Balancer
- (30) Crankshaft Balancer Bolt
- (31) Bolt
- (32) Camshaft Position (CMP) Sensor
- (33) O-Ring
- (34) CMP Sensor Wire Harness
- (35) Bolt
- (36) Oil Pump Housing
- (37) Bolt
- (38) Bolt
- (39) Oil Pump Housing Cover
- (40) Oil Pump Drive Gear
- (41) Oil Pump Driven Gear
- (42) Oil Pump Pressure Relief Valve
- (43) Spring
- (44) Oil Pump Housing Plug
- (45) O-Ring
- (46) Bolt
- (47) Nut
- (48) Oil Pump Screen

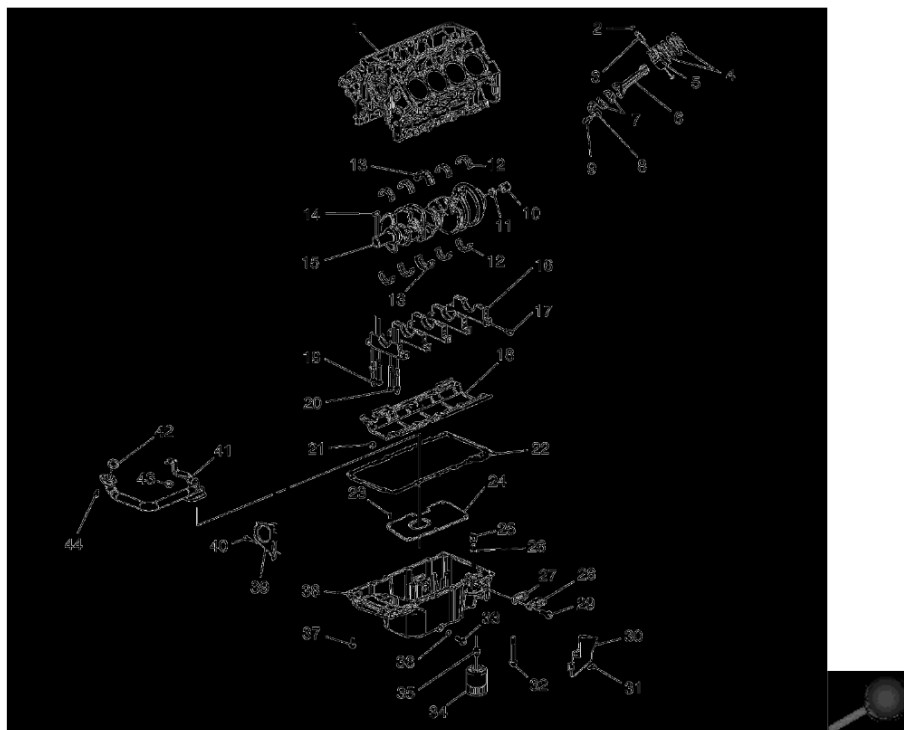
Rear of Engine



- (1) Engine Block
- (2) Crankshaft Rear Oil Seal Housing Gasket
- (3) Crankshaft Rear Oil Seal Housing
- (4) Crankshaft Rear Oil Seal Housing Bolt
- (5) Crankshaft Rear Oil Seal
- (6) Flex Plate- Automatic Transmission
- (7) Flywheel Bolt

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Lower Engine Assembly

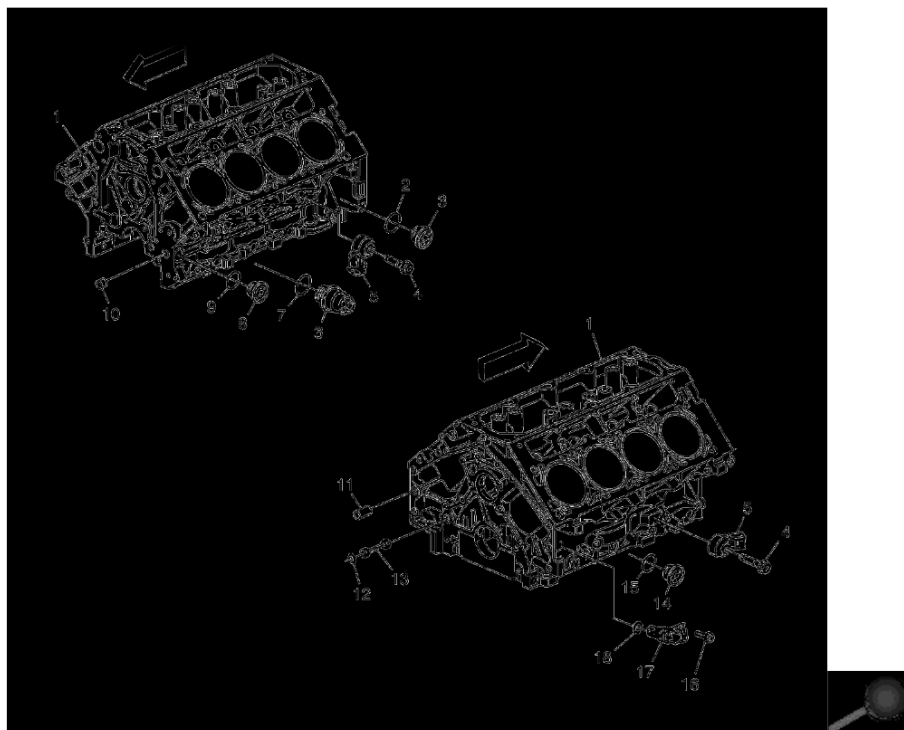


- (1) Engine Block
- (2) Piston Pin Retainer
- (3) Piston Pin
- (4) Piston Ring Set
- (5) Piston
- (6) Connecting Rod
- (7) Connecting Rod Bearings
- (8) Connecting Rod Cap
- (9) Connecting Rod Bolt
- (10) Transmission Pilot Bearing – Manual Transmission
- (11) Plug
- (12) Crankshaft Main Bearing
- (12) Crankshaft Main Bearing
- (13) Crankshaft Thrust Bearing
- (13) Crankshaft Thrust Bearing
- (14) Crankshaft Balancer Key
- (15) Crankshaft
- (16) Crankshaft Bearing Cap

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- (17) Crankshaft Bearing Cap Bolt – M8
- (18) Crankshaft Oil Deflector
- (19) Crankshaft Oil Deflector Stud – M10
- (20) Crankshaft Oil Deflector Bolt – M10
- (21) Nut
- (22) Oil Pan Gasket
- (23) Bolt
- (24) Oil Pan Baffle
- (25) Active Fuel Management Oil Pressure Relief Valve
- (26) Washer
- (27) Oil Pan Cover Gasket
- (28) Oil Pan Cover
- (29) Bolt
- (30) Oil Pan Closeout Cover – Left
- (31) Bolt
- (32) Oil Pan Bolt – M6
- (33) Oil Pan Drain Plug
- (34) Oil Filter
- (35) Oil Filter Fitting
- (36) O-Ring
- (37) Oil Pan Bolt – M8
- (38) Oil Pan
- (39) Engine Closeout Cover – Right
- (40) Bolt
- (41) Oil Pump Screen
- (42) O-Ring
- (43) Nut
- (44) Bolt

Engine Block Plugs/Sensors

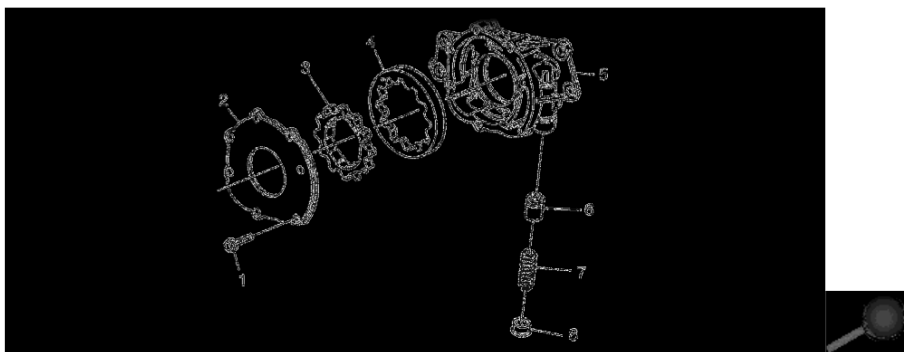


- (1) Engine Block
- (1) Engine Block
- (2) Washer
- (3) Oil Gallery Plug – Side
- (4) Bolt
- (4) Bolt
- (5) Knock Sensor
- (5) Knock Sensor
- (6) Engine Coolant Heater
- (7) Washer
- (8) Oil Gallery Plug – Side
- (9) Washer
- (10) Oil Gallery Plug – Front
- (11) Transmission Housing Locating Pin
- (12) O-Ring
- (13) Oil Gallery Plug – Rear
- (14) Engine Block Coolant Drain Hole Plug
- (15) Washer

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- (16) CKP Sensor Bolt
- (17) Crankshaft Position (CKP) Sensor
- (18) O-Ring

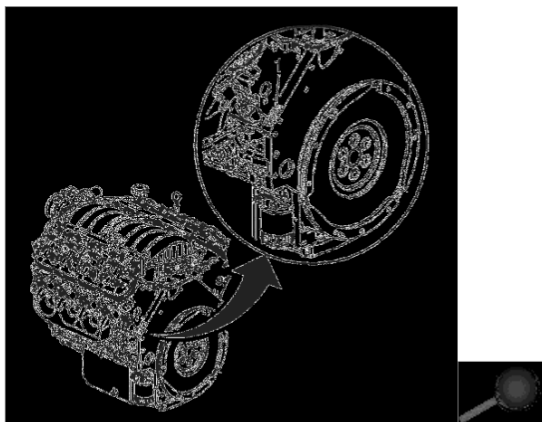
Oil Pump Assembly



- (1) Bolt
- (2) Oil Pump Housing Cover
- (3) Oil Pump Drive Gear
- (4) Oil Pump Driven Gear
- (5) Oil Pump
- (6) Oil Pump Pressure Relief Valve
- (7) Oil Pump Pressure Relief Valve Spring
- (8) Oil Pump Housing Plug

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Engine Identification (LSA)

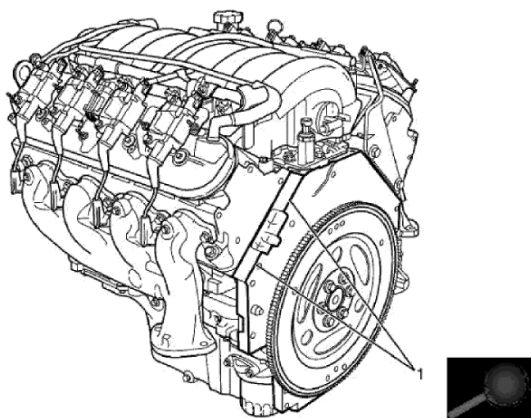


The vehicle identification number (VIN) (1) is located on the left side rear of the engine block and is typically a 9 digit number stamped or laser-etched onto the engine at the vehicle assembly plant.

- The first digit identifies the division.
- The second digit identifies the model year.
- The third digit identifies the assembly plant.
- The fourth through ninth digits are the last 6 digits of the VIN.

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Engine Identification (LS3, L77)



The vehicle identification number (VIN) (1) is located on the left side rear of the engine block and is typically a 9 digit number stamped or laser-etched onto the engine at the vehicle assembly plant.

Engine serial number L77141904500 is used as an example:

- The first three digits, L77, identify the prefixed RPO code of the engine.
- The next two digits, 14, identify the engine model year as 2014.
- The next three digits, 190, identify the Julian date the engine was manufactured as day 190.
- The next four digits, 4500, identify the assembly plant sequence number as 4500.

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Symptoms - Engine Mechanical (LS3)

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](#) and [Engine Component Description](#) and [Lubrication Description](#) and [Drive Belt System 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. For a detailed explanation, refer to [Strategy Based Diagnosis](#).

Visual/Physical Inspection

- Inspect for aftermarket devices which may affect the operation of the Engine. Refer to [Checking Aftermarket Accessories](#).
- Inspect the easily accessible or visible system components for obvious damage or conditions which may cause the symptom.
- Check for the correct oil level, correct oil viscosity, and correct oil filter.
- 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 correctly.

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](#).
- [Coolant in Combustion Chamber](#).
- [Coolant in Engine Oil](#).
- [Engine Compression Test](#).
- [Cylinder Leakage Test](#).

- [Oil Consumption Diagnosis.](#)
- [Oil Pressure Diagnosis and Testing.](#)
- [Oil Leak Diagnosis.](#)
- [Drive Belt Chirping, Squeal, and Whine Diagnosis.](#)
- [Drive Belt Chirping, Squeal, and Whine Diagnosis.](#)
- [Drive Belt Chirping, Squeal, and Whine Diagnosis.](#)
- [Drive Belt Rumbling and Vibration Diagnosis.](#)
- [Drive Belt Rumbling and Vibration Diagnosis.](#)
- [Drive Belt Falls Off and Excessive Wear Diagnosis.](#)
- [Drive Belt Falls Off and Excessive Wear Diagnosis.](#)
- [Drive Belt Tensioner Diagnosis.](#)

Symptoms - Engine Mechanical (L77)

Strategy Based Diagnostics

1. Perform the [Diagnostic System Check - Vehicle](#) before using the symptom tables.
2. Review the system operations in order to familiarize yourself with the system functions. Refer to [Disassembled Views](#), [Engine Component Description](#), [Lubrication Description](#), and [Cylinder Deactivation \(Active Fuel Management\) System 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. For a detailed explanation, refer to [Strategy Based Diagnosis](#).

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the engine. Refer to [Checking Aftermarket Accessories](#).
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Inspect 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](#)
- [Coolant in Combustion Chamber](#)
- [Coolant in Engine Oil](#)
- [Cylinder Deactivation \(Active Fuel Management\) System Diagnosis](#)
- [Engine Compression Test](#)

- [Cylinder Deactivation \(Active Fuel Management\) System Compression Test](#)
- [Cylinder Leakage Test](#)
- [Oil Consumption Diagnosis](#)
- [Oil Pressure Diagnosis and Testing](#)
- [Cylinder Deactivation \(Active Fuel Management\) Oil Pressure Relief Valve Diagnosis and Testing](#)
- [Cylinder Deactivation \(Active Fuel Management\) Valve Lifter Oil Manifold Diagnosis and Testing](#)
- [Oil Leak Diagnosis](#)
- [Crankcase Ventilation System Inspection/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
Fuel injector harness connectors are connected to the incorrect fuel injectors/cylinders	Relocate the fuel injector harness connectors, as necessary.
Abnormalities, such as 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 - Accessory .
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.
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 Engine Flywheel Replacement or Crankshaft Balancer Replacement .
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 manifold absolute pressure (MAP) sensor The sealing grommet of the MAP sensor should not be torn or damaged.	Repair or replace the MAP sensor, as required.
Worn or loose rocker arms	Replace the valve rocker arms, as required.

Cause	Correction
The rocker arm bearing end caps and/or needle bearings should be intact and the rocker arm in the proper position.	
Worn or bent pushrods	• Replace the pushrods. • Inspect the top of the pistons for valve contact. If the top of the piston shows valve contact, replace the piston and pin assembly.
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 lifters.
Excessive oil pressure A lubrication system with excessive oil pressure may lead to excessive valve lifter pump-up and loss of compression.	1. Perform an oil pressure test. Refer to Oil Pressure Diagnosis and Testing. 2. 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 Coolant consumption may or may not cause the engine to overheat.	1. Inspect for spark plugs saturated by coolant. Refer to Spark Plug Inspection. 2. Inspect the cylinder heads, engine block, and/or head gaskets. Refer to Coolant in Combustion Chamber. 3. Repair or replace, as required.
Worn piston rings Oil consumption may or may not cause the engine to misfire.	1. Inspect the spark plugs for oil deposits. Refer to Spark Plug Inspection. 2. Inspect the cylinders for a loss of compression. Refer to Engine Compression Test. 3. Perform cylinder leak down and compression testing to identify the cause. Refer to Cylinder Leakage Test. 4. 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	Replace the sensor and/or crankshaft, as required.

Cause	Correction
crankshaft position, stop delivering a signal, and then 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 DTC P0300 may be set. • Systems with mechanical communications, high voltage switch, and severe reluctor ring damage may cause additional pulses and affect fuel and spark delivery to the point of generating a DTC P0300 or DTC P0336.	

Base Engine Misfire with Abnormal Internal Lower Engine Noises

Base Engine Misfire with Abnormal Internal Lower Engine Noises

Cause	Correction
Abnormalities, such as 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.
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 and repair or replace, as required.
Loose or improperly installed engine flex plate or crankshaft balancer A misfire code may be present without an actual misfire condition.	Repair or replace the flex plate and/or balancer, as required. Refer to Automatic Transmission Flex Plate Removal and Automatic Transmission Flex Plate Installation , or Crankshaft Balancer Removal and Crankshaft Balancer Installation .
Worn piston rings Oil consumption may or may not cause the engine to misfire.	1. Inspect the spark plugs for oil deposits. Refer to Spark Plug Inspection. 2. Inspect the cylinders for a loss of compression. Refer to Engine Compression Test. 3. Perform cylinder leak down and compression testing to determine the cause. Refer to Cylinder Leakage Test. 4. 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.

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Base Engine Misfire with Abnormal Valve Train Noise (LSA)

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.
Worn or bent pushrods	• Replace the pushrods. • Inspect the top of the pistons for valve contact. If the top of the piston shows valve contact, replace the piston and pin assembly.
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 and valve lifters.
Sticking lifters	Replace, as required.
Cut or damaged oil pump screen O-ring seal which may cause aeration of the engine oil	Repair, as required. Refer to Oil Pressure Diagnosis and Testing .
Improper operation of the active fuel management oil pressure relief valve	Repair, as required. Refer to Cylinder Deactivation (Active Fuel Management) Oil Pressure Relief Valve Diagnosis and Testing .
Improper operation of the active fuel management system	Repair, as required. Refer to Cylinder Deactivation (Active Fuel Management) System Diagnosis .
Improper operation of the camshaft position (CMP) actuator and/or control system	Repair, as required. Refer to Camshaft Position Actuator and Solenoid Valve Diagnosis and Testing .

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Base Engine Misfire with Abnormal Valve Train Noise (L77)

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.
Worn or bent pushrods	• Replace the pushrods. • Inspect the top of the pistons for valve contact. If the top of the piston shows valve contact, replace the piston and pin assembly.
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 and valve lifters.
Sticking lifters	Replace, as required.
Cut or damaged oil pump screen O-ring seal which may cause aeration of the engine oil	Repair, as required. Refer to Oil Pressure Diagnosis and Testing .
Improper operation of the active fuel management oil pressure relief valve	Repair, as required. Refer to Cylinder Deactivation (Active Fuel Management) Oil Pressure Relief Valve Diagnosis and Testing .
Improper operation of the active fuel management system — RPO L76	Repair, as required. Refer to Cylinder Deactivation (Active Fuel Management) System Diagnosis .

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[2014 Holden VF Sedan](#) | [VF/WN - Sedan, Ute, Sportwagon, Caprice, Lumina, HSV Service Manual 5617662](#) | [Engine/Propulsion](#) | [Engine Mechanical - 6.0L L77 or 6.2L LS3 LSA](#) | [Diagnostic Information and Procedures](#) |

Document ID: 2209971

Base Engine Misfire with Abnormal Valve Train Noise (LS3)

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. Refer to Base Engine Misfire with Abnormal Valve Train Noise .
Worn or bent pushrods.	Replace the pushrods, as required. Refer to Valve Rocker Arm and Push Rod Replacement .
Stuck valves. Carbon buildup on the valve stem can cause the valve not to close correctly.	Repair or replace, as required. Refer to Cylinder Head Disassemble .
A worn or mis-aligned timing chain above acceptable tolerances.	Replace the timing chain and sprockets, as required. Refer to Cylinder Head Disassemble .
Worn camshaft lobes	Replace the camshaft and valve lifters. Refer to Camshaft Replacement .
Sticking lifters	Replace the camshaft and valve lifters. Refer to Camshaft Replacement .

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Base Engine Misfire with Coolant Consumption

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 Coolant consumption may or may not cause the engine to overheat.	1. Inspect for spark plugs saturated by coolant. Refer to Spark Plug Inspection. 2. Perform a cylinder leak down test. Refer to Cylinder Leakage Test. 3. Inspect the cylinder heads and engine block for damage to the coolant passages and/or a faulty head gasket. Refer to Coolant in Combustion Chamber. 4. Repair or replace, as required.

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[Engine/Propulsion](#) | [Engine Mechanical - 6.0L L77 or 6.2L LS3 LSA](#) | [Diagnostic Information and Procedures](#) |

Document ID: 1664259

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	1. Inspect the spark plugs for oil deposits. Refer to Spark Plug Inspection. 2. Repair or replace, as required.
Worn piston rings Oil consumption may or may not cause the engine to misfire.	1. Inspect the spark plugs for oil deposits. Refer to Spark Plug Inspection. 2. Inspect the cylinders for a loss of compression. Refer to Engine Compression Test. 3. Perform cylinder leak down and compression testing to determine the cause. Refer to Cylinder Leakage Test. 4. Repair or replace, as required.

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Document ID: 1715485

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	1. Drain the oil. 2. Install the correct viscosity oil.
High valve lifter leak down rate	Replace the lifters, as required.
Worn crankshaft thrust bearing	1. Inspect the crankshaft end play. 2. Inspect the thrust bearing and crankshaft. 3. Repair or replace, as required.
Damaged or faulty oil filter bypass valve The bypass valve is now internal to the oil filter.	1. Inspect the oil filter bypass valve for proper operation. 2. Repair or replace, as required.

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Supercharger Noise Diagnosis

Supercharger Noise Diagnosis

Cause	Correction
Whine	1. Whine noise is typical of all superchargers and is not a reason to replace the supercharger or other components. 2. Supercharger whine, inherent to the Roots design, results from eight pulses per engine revolution, 2:1 drive ratio x 4 lobes. Air induction system structure and acoustic resonators are designed to minimize whine.
Whistle	A whistle noise is generated by tooth contact of the spur gears between the rotors. For instance, a low level whistle may occur at 2,300–2,800 RPM at 80 percent load driving up a very long grade. Although most of these conditions are addressed by sound path isolation to the passenger compartment, some can still be heard by a very critical ear.
Supercharger rattle – growl	1. Supercharger growl may be heard at low speed or idle, with the engine under light load. 2. Minuscule crankshaft speed variations, influenced by the torque converter, transmission, drive shaft, differential, and tires, are transmitted through the flexible drive belt to the supercharger. Operating in very thin air, the rotors oscillate and cause the load to alternate from the drive to driven sides of the gear teeth, even precision parts have operating clearances. The entire supercharger drive system is tuned to minimize this noise.
Internal isolator	• The supercharger incorporates an internal isolator between the pulley and the rotor shaft, which has two functions. The first is to minimize a knocking sound when the engine is turned off and the mass of the supercharger rotor set is suddenly jerked to a stop. And second, the isolator is tuned to minimize the normal engine firing pulses passed on to the supercharger rotor drive gears.

Cause	Correction
	It is active only in an unloaded condition, low engine speed point where boost is not requested. • If the engine or one of the components in the driveline is not operating to design intent, the isolator may make a harsh intermittent rattle sound that often goes through cycles as the engine speed or other conditions change slightly.

Upper Engine Noise, Regardless of Engine Speed

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 valve rocker arm attachments	1. Inspect the valve rocker arm, bolt, and pedestal. 2. Repair or replace, as required.
Worn or damaged valve rocker arm	1. Inspect the rocker arm for wear or missing needle bearings 2. Replace the valve rocker arms, as required.
Bent or damaged push rod	Inspect the following components and replace, as required: • The valve rocker arm • The valve push rod • The valve lifter • The valve lifter guide • The piston Inspect the top of the pistons for valve contact. If the top of the piston shows valve contact, replace the piston and pin assembly.
Improper lubrication to the valve rocker arms	Inspect the following components and repair or replace, as required: • The valve rocker arm • The valve push rod • The valve lifter • The oil filter bypass valve The bypass valve is now internal to the oil filter. • The oil pump and pump screen • The engine block oil galleries
Broken valve spring	Replace the valve spring and spring shim.
Worn or dirty valve lifters	Replace the valve lifters.

Cause	Correction
Stretched or broken timing chain and/or damaged sprocket teeth	Replace the timing chain and sprockets.
Worn engine camshaft lobes	1. Inspect the engine camshaft lobes. 2. Replace the camshaft and 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

Lower 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 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 flex plate. 2. Repair or replace, as required.
Loose or damaged flywheel or flex plate	Repair or replace the flywheel or flex plate.
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, pin, and connecting rod. 2. Replace the piston and pin as an assembly, as required.
Excessive connecting rod bearing clearance	Inspect the following components and repair, as required: • The connecting rod bearings

Cause	Correction
	• 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. Refer to Piston, Connecting Rod, and Bearing Installation. 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 Oil Pressure Diagnosis and Testing. 2. 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	1. Inspect the torque converter bolts and flex plate. 2. Repair, as required.
Cracked flex plate- automatic transmission	1. Inspect the flex plate bolts and flex plate. 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

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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 the accessory drive belts. 2. Confirm that the engine will rotate. Rotate the crankshaft by hand at the crankshaft balancer or flex plate location. 3. Repair or replace the components, as required.
Seized automatic transmission torque converter	1. Remove the torque converter-to-flex plate bolts. 2. Confirm that the engine will rotate. Rotate the crankshaft by hand at the crankshaft balancer or flex plate location. 3. Repair or replace the components, as required.
Broken timing chain	1. Inspect the timing chain and sprockets. 2. Repair or replace the components, as required.
Seized timing chain or timing sprockets	1. Inspect the timing chain and sprockets for foreign material or a seized chain. 2. Repair or replace the components, as required.
Seized or broken camshaft	1. Inspect the camshaft and the camshaft bearings. 2. Repair or replace the components, as required.
Bent valve in the cylinder head	1. Inspect the valves and the cylinder heads. 2. Repair or replace the components, as required.
Seized oil pump	1. Inspect the oil pump assembly. 2. Repair or replace, as required.

Cause	Correction
Hydraulically locked cylinder - Coolant/antifreeze in the cylinder - Oil in the cylinder - Fuel in the cylinder	1. Remove the spark plugs and inspect for fluid in the cylinder. When rotating the engine with the spark plugs removed, the piston, on compression stroke, will push fluid from the combustion chamber. Refer to Coolant in Combustion Chamber. 2. Inspect for failed/broken head gaskets. 3. Inspect for a cracked engine block or cylinder head. 4. Inspect for a sticking fuel injector. 5. Repair or replace the components, as required.
Material in the cylinder - Broken valve - Broken piston rings - Piston material - Foreign material	1. Inspect the cylinder for damaged components and/or foreign materials. 2. Repair or replace the components, as required.
Seized crankshaft or connecting rod bearings	1. Inspect crankshaft and connecting rod bearings. 2. Repair or replace the components, as required.
Bent or broken connecting rod	1. Inspect the connecting rods. 2. Replace the piston and pin as an assembly, as required.
Broken crankshaft	1. Inspect the crankshaft. 2. Repair or replace the components, 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. Note: While not always conclusive, use of hydrocarbon block test kits may reveal hydrocarbons indicating combustion chamber gases in cooling system. It is important to follow the kit instructions. This is not a substitute for service information. Combustion leak tests are available from a wide variety of aftermarket suppliers. 1. A slower than normal cranking speed may indicate coolant entering the combustion chamber. Refer to Engine Will Not Crank - Crankshaft Will Not Rotate. 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 Engine Compression Test.	
Faulty cylinder head gasket	Replace the head gasket and components, as required. Refer to Cylinder Head Cleaning and Inspection and Cylinder Head Removal - Left Side and Cylinder Head Installation - Left Side , or Cylinder Head Removal - Right Side and Cylinder Head Installation - Right Side .
Warped cylinder head	Machine the cylinder head to the proper flatness, if applicable and replace the cylinder head gasket. Refer to Cylinder Head Cleaning and Inspection .
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.

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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 external engine oil cooler	Replace the components, as required.
Faulty cylinder head gasket	Replace the head gasket and components, as required. Refer to Cylinder Head Cleaning and Inspection and Cylinder Head Removal - Left Side and Cylinder Head Installation - Left Side , or Cylinder Head Removal - Right Side and Cylinder Head Installation - Right Side .
Warped cylinder head	Machine the cylinder head to proper flatness, if applicable, and replace the cylinder head gasket. Refer to Cylinder Head Cleaning and Inspection .
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.

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Cylinder Deactivation (Active Fuel Management) System Diagnosis

Important: Active Fuel Management System Diagnosis is applicable for RPO LC9/LY5/LMG/L76/L77.

1. Measure the engine oil level. Fill, as required.
2. Using the scan tool, inspect for diagnostic codes within the engine control module (ECM). Refer to [Diagnostic System Check - Vehicle](#). Repair, as required.
3. Verify proper engine oil pressure and operation of the active fuel management oil pressure relief valve. Refer to [Oil Pressure Diagnosis and Testing](#).
4. Verify proper operation of the active fuel management system components. Refer to [Cylinder Deactivation \(Active Fuel Management\) System Compression Test](#).
5. Remove the valve lifter oil manifold. Refer to [Valve Lifter Oil Manifold Replacement](#).
6. Verify proper operation of the valve lifter oil manifold. Refer to [Cylinder Deactivation \(Active Fuel Management\) Valve Lifter Oil Manifold Diagnosis and Testing](#).
7. Replace the active fuel management valve lifters, as required. Both intake and exhaust lifters should be replaced in pairs. Refer to [Valve Lifter Replacement](#).

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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 by removing the injector fuse or removing the injector electrical connectors.
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.

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Cylinder Deactivation (Active Fuel Management) System Compression Test

Important: Active Fuel Management System Compression Test is applicable for RPO LC9/LY5/LMG/L76/L77.

The Active Fuel Management System Compression Test is a functional test of the valve lifter oil manifold and valve lifters. Using a compression gauge, the technician can monitor the specific cylinders ability to go into and out of active fuel management as commanded by the scan tool. The actual pressure values on the compression gauge are not as critical as is observing the on-off switching action of the solenoid and valve lifters.

1. Measure the engine oil level. Fill, as required.
2. Perform the Diagnostic System Check - Vehicle. Refer to [Diagnostic System Check - Vehicle](#).
3. Disable the ignition system for the cylinder to be tested, by disconnecting the electrical wire harness to the ignition coil.
4. Disable the fuel injection system for the cylinder to be tested, by disconnecting the electrical wire harness to the fuel injector.
5. Remove the spark plug and wire for the cylinder to be tested.
6. Install a 0-1 378 kPa (0-200 psi) compression gauge.
7. Start the engine.
8. Using the scan tool output controls, command the solenoid ON, for the cylinder to be deactivated.
9. Depress the Schrader valve on the compression gauge, in order to release the pressure and zero the gauge. With the engine running and the cylinder in active fuel management mode, the compression reading should be less than 172 kPa (25 psi).
10. Using the scan tool, de-energize the solenoid while observing the reading on the compression gauge. With the engine running and the cylinder NOT in active fuel management mode, the compression gauge reading should increase quickly to greater than 345 kPa (50 psi).

Important: Only 1 cylinder can be tested at a time. When testing has been completed on a specific cylinder, the wire harness electrical connectors, spark plug, and spark plug wire must be installed prior to testing of each additional cylinder.

11. Test each of the 4 active fuel management cylinders, 1 at a time. If the readings are not within specifications, remove and test the valve lifter oil manifold, as required. Refer to [Valve Lifter Oil Manifold Replacement](#) and [Cylinder Deactivation \(Active Fuel Management\) Valve Lifter Oil Manifold Diagnosis and Testing](#).
12. If the compression test has been performed and all active fuel management cylinders are operating within specifications, the active fuel management system is performing as designed and no repairs are required.
13. Clear the DTCs with a scan tool.

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Engine Balancing (LS3 or L77)

During the powertrain build process, balance weights may be added to the crankshaft balancer and/or manual transmission flywheel, as required.

In order to maintain engine/clutch assembly balance, it may be necessary to install or remove balance weights as detailed below:

Crankshaft Balancer

- Existing RPO-LS3/LS7 balancer onto existing engine: The balancer position must be marked prior to removal and installed to the original position. Refer to [Crankshaft Balancer Removal](#).
- Existing RPO-LS9 balancer onto existing engine: It is not necessary to mark the balancer prior to removal. The balancer is positioned by a key located in the front of crankshaft.
- New balancer onto an existing engine: Install the same size balance weights into the new balancer in the same location as the old balancer. Refer to [Crankshaft Balancer Cleaning and Inspection](#).

Engine Flywheel

- The RPO-LS3/LS7 flywheel, clutch disc, and pressure plate are each individually balanced components and are available separately. The pressure plate mounts, or locates, onto the flywheel dowel pins in the flywheel. If the pressure plate is not aligned properly onto the dowel pins and tightened down, the pins may bend and the plate may be incorrectly positioned, which will affect component balance.
- The RPO-LS9 clutch discs and pressure plate are a balanced assembly and not available separately. The pressure plate mounts, or locates, onto the six flywheel dowel pins. If the pressure plate is not aligned properly onto the dowel pins and tightened down, the pins may bend and the plate may be incorrectly positioned, which will affect component balance.
- Existing flywheel, clutch, and pressure plate onto the existing engine: Pressure plate position to flywheel must be marked prior to removal and installed to the original position. Flywheel position to crankshaft must be marked prior to removal and installed to the original position.
- Existing flywheel, clutch, and pressure plate onto a new engine: Pressure plate position to flywheel must be marked prior to removal and installed to the original position. Flywheel position to crankshaft must be marked prior to removal and installed to the similar position on the new engine. Do not remove balance weights from flywheel, if applicable.
- New flywheel onto an existing engine: Install the same size balance weights into the new flywheel in the same location as the old flywheel. Install the new flywheel to a similar position on the new engine.
- New flywheel, clutch, and pressure plate onto a new engine: Do not install balance weights.

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Engine Balancing (LSA)

During the powertrain build process, balance weights may be added to the crankshaft balancer and/or manual transmission flywheel, as required.

In order to maintain engine/clutch assembly balance, it may be necessary to install or remove balance weights as detailed below:

Crankshaft Balancer

- Existing RPO-LSA manual transmission applications, balancer onto existing engine: It is not necessary to mark the balancer prior to removal. The balancer is positioned by a key located in the front of the crankshaft. Refer to [Crankshaft Balancer Removal](#).
- New balancer onto an existing engine: Install the same size balance weights into the new balancer in the same location as the old balancer. Refer to [Crankshaft Balancer Cleaning and Inspection](#).

Engine Flywheel

- For RPO-LSA manual transmission applications, the flywheel, clutch disc, and pressure plate are each individually balanced components and the clutch and pressure plate are available only as a kit. The pressure plate mounts, or locates, onto the flywheel dowel pins in the flywheel. If the pressure plate is not aligned properly onto the dowel pins and tightened down, the pins may bend and the plate may be incorrectly positioned, which will affect component balance. Refer to [Engine Flywheel Removal](#).
- Existing flywheel, clutch, and pressure plate onto the existing engine: Pressure plate position to flywheel must be marked prior to removal and installed to the original position. Flywheel position to crankshaft must also be marked prior to removal and installed to the original position. Refer to [Engine Flywheel Removal](#).
- Existing flywheel, clutch, and pressure plate onto a new engine: Pressure plate position to flywheel must be marked prior to removal and installed to the original position. Flywheel position to crankshaft must be marked prior to removal and installed to the similar position on the new engine. Do not remove balance weights from flywheel, if applicable.
- New flywheel onto an existing engine: Install the same size balance weights into the new flywheel in the same location as the old flywheel. Install the new flywheel to a similar position on the new engine.
- New flywheel, clutch, and pressure plate onto a new engine: Do not install balance weights.

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Cylinder Leakage Test

Special Tools

J 35667-A Cylinder Head Leakdown Tester, or equivalent

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

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

- Worn or burnt valves
- Broken valve springs
- Stuck valve lifters
- Incorrect valve lash
- 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. Refer to [Spark Plug Replacement](#).
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 J 35667-A tester, or equivalent.

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

5. Apply shop air pressure to the J 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 noise at the throttle body or air inlet hose that may indicate a worn or burnt intake valve or a broken valve spring.
 - Air leakage noise at the exhaust system tailpipe that may indicate a worn or burnt exhaust valve or a broken valve spring.
 - Air leakage noise 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.

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Oil Consumption Diagnosis

Oil Consumption Diagnosis

Checks	Causes
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 measure 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 Refer to Crankcase Ventilation System Inspection/Diagnosis. - Worn valve guides and/or valve stems - Worn or improperly installed valve stem oil seals Refer to Spark Plug Inspection. - Piston rings broken, worn, or not seated properly Allow adequate time for the rings to seat. Replace worn piston rings, as necessary. Refer to Cylinder Leakage Test. - Piston and rings improperly installed or not fitted to the cylinder bore Refer to Lower Engine Noise, Regardless of Engine Speed.

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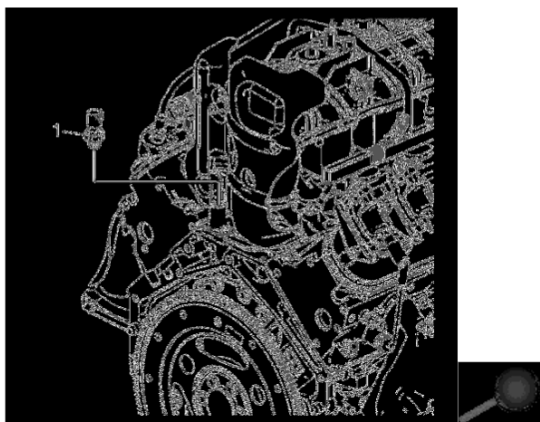
Oil Pressure Diagnosis and Testing (LS3)

Special Tools

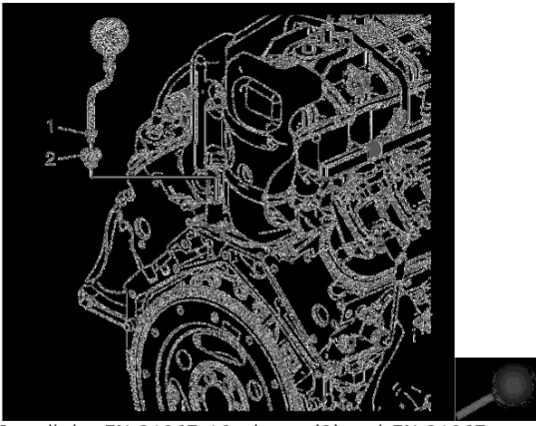
- EN-21867 Pressure Gauge
- EN-21867-16 Oil Pressure Adapter

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

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 the 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 conditions:
 - Oil diluted by water or glycol antifreeze
 - Foamy oil



6. Remove the oil pressure sensor (1).



7. Install the *EN-21867-16* adapter (2) and *EN-21867* pressure gauge (1), or equivalent.
8. Run the engine and measure the engine oil pressure.
9. Compare the readings to [Engine Mechanical Specifications](#).
10. If the engine oil pressure is below specifications, inspect the engine for 1 or more of the following conditions:
 - Oil pump worn or dirty. Refer to [Oil Pump Cleaning and Inspection](#).
 - Oil pump-to-engine block bolts loose. Refer to [Oil Pump, Screen and Crankshaft Oil Deflector Installation](#).
 - Oil pump screen loose, plugged, or damaged
 - Oil pump screen O-ring seal missing or damaged
 - Excessive debris in the oil pan and/or oil filter (possibly indicating internal engine damage).
 - Malfunctioning oil pump pressure relief valve
 - Excessive bearing clearance and/or bearing damage. Refer to [Crankshaft and Bearing Cleaning and Inspection](#) and [Camshaft and Bearings Cleaning and Inspection](#).
 - Cracked, porous, or restricted oil galleries
 - Oil gallery plugs missing or incorrectly installed. Refer to [Engine Block Plug Installation](#).
 - Broken valve lifters. Repair, as necessary.
11. If the oil pressure reading on the *J 21867* pressure gauge, or equivalent, is within specifications, inspect for the following conditions:
 - Plugged or incorrect oil filter and/or malfunctioning oil bypass valve. The bypass valve is now internal to the oil filter.
 - Malfunctioning oil pressure gauge or sensor. Repair, as necessary.

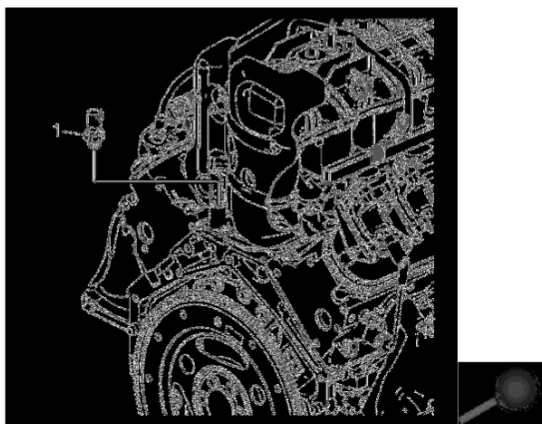
Oil Pressure Diagnosis and Testing (L77)

Special Tools

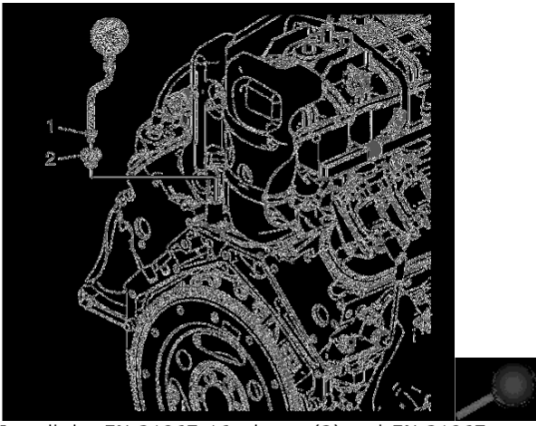
- EN-21867 Pressure Gauge
- EN-21867-16 Oil Pressure Adapter

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

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 the 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 conditions:
 - Oil diluted by water or glycol anti freeze
 - Foamy oil



6. Remove the oil pressure sensor (1).



7. Install the *EN-21867-16* adapter (2) and *EN-21867* pressure gauge (1), or equivalent.
8. Run the engine until the engine reaches normal operating temperature and measure the engine oil pressure.
9. Compare the readings to [Engine Mechanical Specifications](#).
10. If the engine oil pressure is below specifications, inspect the engine for one or more of the following conditions:
 - If equipped, valve lifter oil manifold filter plugged or damaged. Refer to [Valve Lifter Oil Manifold Cleaning and Inspection](#).
 - If equipped, check if the engine oil cooler or oil cooler lines are plugged or damaged.
 - Oil pump worn or dirty. Refer to [Oil Pump Cleaning and Inspection](#).
 - Oil pump-to-engine block bolts loose. Refer to [Oil Pump, Screen and Crankshaft Oil Deflector Installation](#).
 - Oil pump screen loose, plugged, or damaged. Refer to [Oil Pump Cleaning and Inspection](#).
 - Oil pump screen O-ring seal missing or damaged. Refer to [Oil Pump Cleaning and Inspection](#).
 - Excessive debris in the oil pan and/or oil filter (possibly indicating internal engine damage).
 - Oil filter loose or a leaking or damaged gasket. Refer to [Oil Filter, Adapter, and Pan Cover Installation](#).
 - Malfunctioning oil pump pressure relief valve. Refer to [Oil Filter, Adapter, and Pan Cover Installation](#).
 - Excessive bearing clearance and/or bearing damage. Refer to [Crankshaft and Bearing Cleaning and Inspection](#) and [Camshaft and Bearings Cleaning and Inspection](#).
 - Above acceptable bearing clearance. Refer to [Engine Block Plug Removal](#).
 - Cracked, porous, or restricted oil galleries. Refer to [Engine Block Plug Installation](#).
 - Oil gallery plugs missing or incorrectly installed. Refer to [Engine Block Plug Installation](#).
 - Broken valve lifters. Refer to [Valve Lifter Replacement](#).

Note: The following step applies to L76 engines equipped with active fuel management.

 - If equipped, improper operation of the active fuel management oil pressure relief valve. Refer to [Cylinder Deactivation \(Active Fuel Management\) Oil Pressure Relief Valve Diagnosis and Testing](#).

Repair as necessary.
11. If the oil pressure reading on the *J 21867* pressure gauge (2), or equivalent, is within specifications, inspect for the following conditions:
 - Plugged or incorrect oil filter and/or malfunctioning oil filter bypass valve. Refer to [Engine Oil and Oil Filter Replacement](#).

- Malfunctioning engine oil pressure sensor or switch. Refer to [Engine Oil Pressure Sensor and/or Switch Replacement](#).

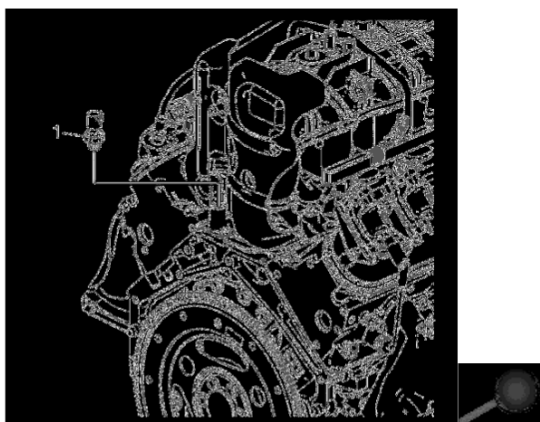
Oil Pressure Diagnosis and Testing (LSA)

Special Tools

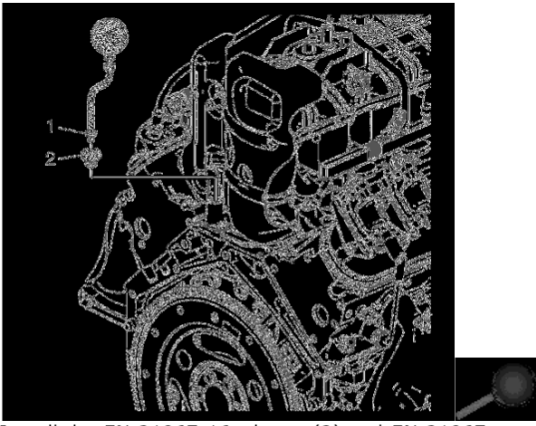
- EN-21867 Pressure Gauge
- EN-21867-16 Oil Pressure Adapter

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

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 the 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 conditions:
 - Oil diluted by water or glycol antifreeze
Refer to [Coolant in Engine Oil](#).
 - Foamy oil, which may be caused by a cut or damaged oil pump screen O-ring seal



6. Remove the oil pressure sensor (1).

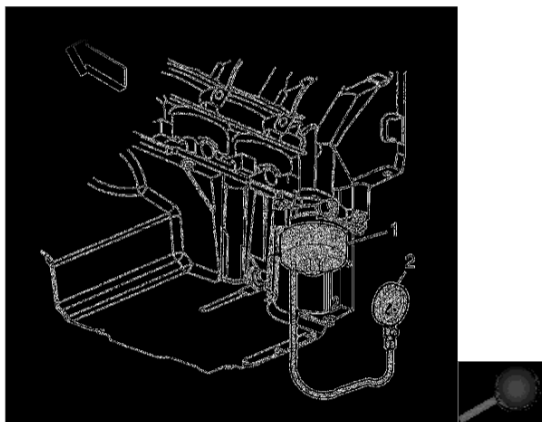


7. Install the *EN-21867-16* adapter (2) and *EN-21867* pressure gauge (1), or equivalent.
8. Run the engine until the engine reaches normal operating temperature and measure the engine oil pressure.
9. Compare the readings to [Engine Mechanical Specifications](#).
10. If the engine oil pressure is below specifications, inspect the engine for 1 or more of the following conditions:
 - If equipped, valve lifter oil manifold filter plugged or damaged. Refer to [Valve Lifter Oil Manifold Cleaning and Inspection](#).
 - If equipped, check if the engine oil cooler or oil cooler lines are plugged or damaged.
 - Oil pump worn or dirty. Refer to [Oil Pump Cleaning and Inspection](#).
 - Oil pump-to-engine block bolts loose. Refer to [Oil Pump, Screen and Crankshaft Oil Deflector Installation](#).
 - Oil pump screen loose, plugged, or damaged
 - Oil pump screen O-ring seal missing or damaged
 - Excessive debris in the oil pan and/or oil filter (possibly indicating internal engine damage).
 - Malfunctioning oil pump pressure relief valve
 - Excessive bearing clearance and/or bearing damage. Refer to [Crankshaft and Bearing Cleaning and Inspection](#) and [Camshaft and Bearings Cleaning and Inspection](#).
 - Cracked, porous, or restricted oil galleries
 - Oil gallery plugs missing or incorrectly installed. Refer to [Engine Block Plug Installation](#).
 - If equipped, improper operation of the active fuel management oil pressure relief valve. Refer to [Cylinder Deactivation \(Active Fuel Management\) Oil Pressure Relief Valve Diagnosis and Testing](#).
 - Restriction within the engine oil cooler.

Cylinder Deactivation (Active Fuel Management) Oil Pressure Relief Valve Diagnosis and Testing

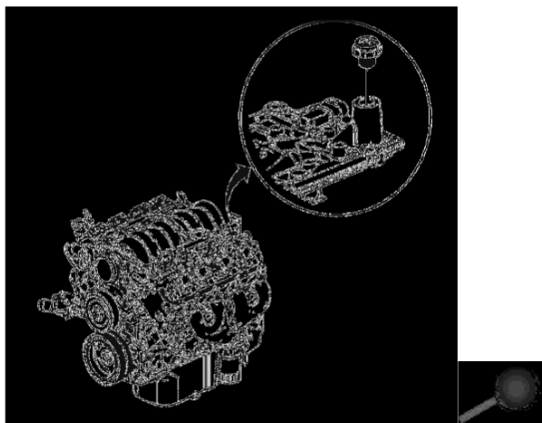
Special Tools

- EN-47971 Oil Pressure Gauge Adapter
- J 21867 Pressure Gauge
- J-21867-16 Oil Pressure Adapter

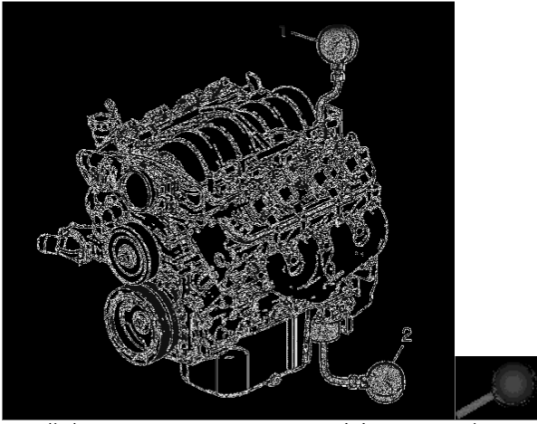


Note: This test is performed to verify the operation of the active fuel management oil pressure relief valve located in the oil pan. Refer to [Cylinder Deactivation \(Active Fuel Management\) System Description](#) and [Lubrication Description](#).

1. Remove the oil filter and install the EN-47971 oil pressure gauge adapter (1).
2. Install the J 21867 pressure gauge (2), or equivalent, to the EN-47971 oil pressure gauge adapter (1).



3. Remove the oil pressure sensor and install the J-21867-16 oil pressure adapter .



4. Install the *J 21867* pressure gauge (1), or equivalent, to the *J-21867-16* oil pressure adapter (2).
5. Run the engine and measure the engine oil pressure while observing both gauges.
Operate the throttle, as required, to increase and decrease the engine oil pressure.
 - With the engine running and the lower pressure gauge (2) measuring below 379 kPa (55 psi), both gauges should display the same pressure reading. If the readings are not the same and the lower gauge (2) has a higher reading, the active fuel management oil pressure relief valve is stuck in the open position or the valve lifter oil manifold filter is plugged.
 - With the engine running and the lower pressure gauge (2) measuring above 379 kPa (55 psi), the upper gauge (1) should display no greater than 379–517 kPa (55–75 psi). If the reading on the upper gauge (1) is greater than 517 kPa (75 psi), the active fuel management oil pressure relief valve is stuck in the closed position.
6. Repair, as required.

Cylinder Deactivation (Active Fuel Management) Valve Lifter Oil Manifold Diagnosis and Testing

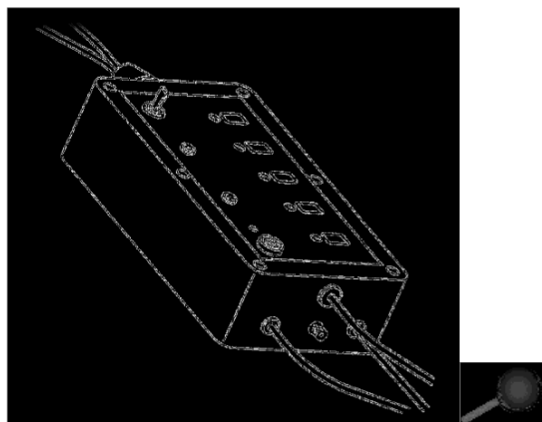
Special Tools

- EN-46999 Active Fuel Management Tester
- EN-46999-1 Active Fuel Management Tester Air Adapter
- EN-46999-5 Active Fuel Management Tester Harness – Small Block V8

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

Note:

- Active Fuel Management Valve Lifter Oil Manifold Diagnosis and Testing is applicable for RPO LC9/LY5/LMG/L76/L77.
- A minimum shop air source of 206 kPa (30 psi) is required for manifold testing.
- A water bleed is located on the side of the EN-46999 tester . Occasionally, depress the valve in order to remove excess water from the tool.



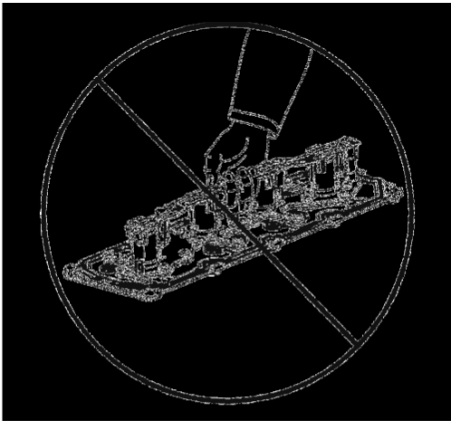
The manifold bench test provides a maximum 206 kPa (30 psi) of filtered shop air to the manifold and will test each solenoid/valve for the following conditions:

- Proper operation
- A stuck open condition – constant air flow
- A stuck closed condition – no air flow
- A flow restriction within the manifold

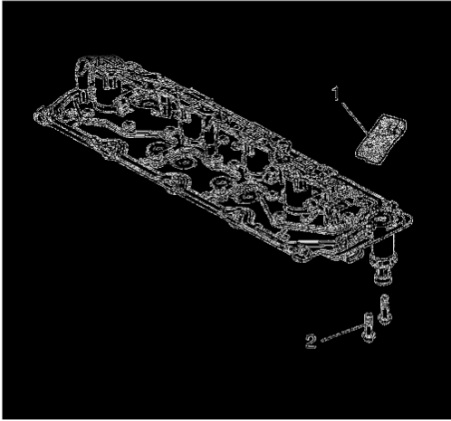
1. Individually depress each of the buttons 1–4 on the EN-46999 tester in order to activate each of the solenoid/valves. When activating each solenoid/valve, a loud click should be heard from the solenoid and an increased amount of air will exit the outlet ports.

- Button 1 will energize the solenoid/valve 1 for engine cylinder number 1.
- Button 2 will energize the solenoid/valve 2 for engine cylinder number 4.
- Button 3 will energize the solenoid/valve 3 for engine cylinder number 6.
- Button 4 will energize the solenoid/valve 4 for engine cylinder number 7.

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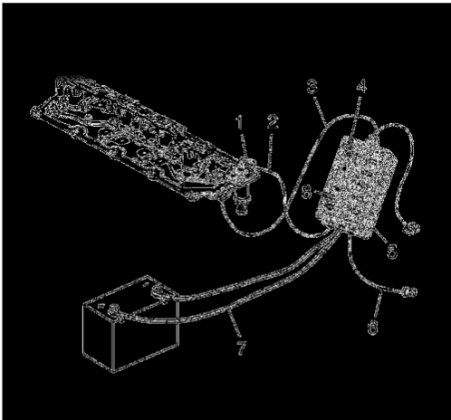
2. Do not lift the manifold assembly by the electrical lead frame.



3. Install the *EN-46999-1* adapter (1) to the manifold.

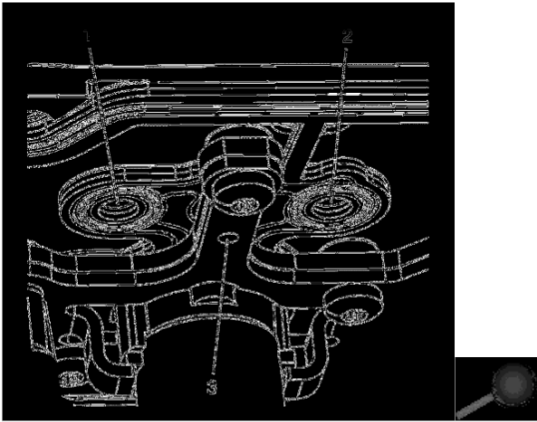
Caution: Refer to [Fastener Caution](#).

4. Install 2 of the manifold bolts (2) to the *EN-46999-1* adapter and tighten to **25 N•m (18 lb ft)**.

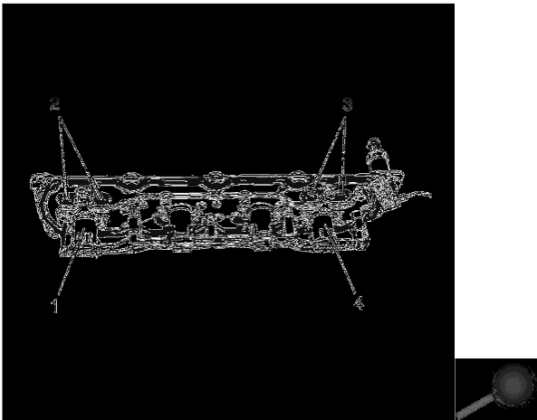


5. Connect the air out hose (2) of the *EN-46999* tester (5) to the *EN-46999-1* adapter (1). Verify the air supply switch (4) is in the off position.

6. Connect the air in hose (6) of the *EN-46999* tester (5) to a shop air source.
7. Connect the 12 volt power supply connectors (7) of the *EN-46999* tester (5) to a 12 volt power supply. Verify the Power light (8) on the tool is illuminated. If the light on the tool is not illuminated when connected to a 12 volt power supply, test and/or replace the 3 amp fuse.
8. Connect the *EN-46999-5* harness power cable (3) to the electrical connector of the manifold.

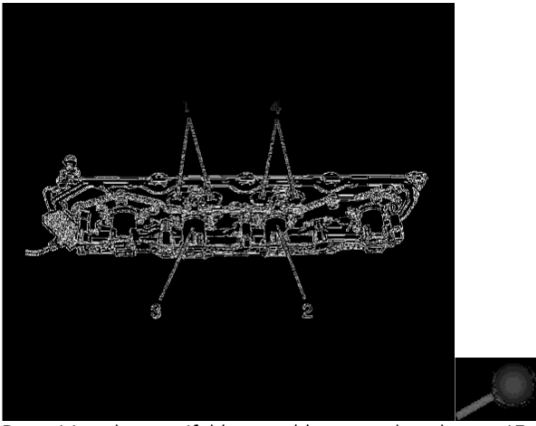


9. Turn the air supply switch of the *EN-46999* tester to the ON position. With the air supply connected to the manifold assembly and the solenoid/valves in the closed position, a limited amount of air will exit each of the bleed holes (3) and outlet ports (1, 2) of the manifold.



Note: The manifold must be tested in the proper position to ensure the solenoid/valves operate as designed.

10. Position the manifold assembly onto a bench at a 45 degree angle in order to test solenoid/valves 1 and 4.
11. Depress button number 1 on the tool to activate solenoid/valve 1. With button 1 depressed, the solenoid/valve (1) should open, allowing an increased amount of air to exit the outlet ports (2) of the manifold.
12. Depress button number 4 on the tool to activate solenoid/valve 4. With button 4 depressed, the solenoid/valve (4) should open, allowing an increased amount of air to exit the outlet ports (3) of the manifold.



13. Reposition the manifold assembly onto a bench at a 45 degree angle in order to test solenoid/valves 2 and 3.
14. Depress button number 2 on the tool to activate solenoid/valve 2. With button 2 depressed, the solenoid/valve (2) should open, allowing an increased amount of air to exit the outlet ports (4) of the manifold.
15. Depress button number 3 on the tool to activate solenoid/valve 3. With button 3 depressed, the solenoid/valve (3) should open, allowing an increased amount of air to exit the outlet ports (1) of the manifold.
16. When the test is completed, turn the air source switch on the *EN-46999* tester to the off position and disconnect the tool from the 12 volt power supply, shop air source and manifold assembly.
17. If after testing, it has been determined that one or more of the solenoid/valves is not functioning properly, replace the manifold as an assembly.
18. If after testing, it has been determined that the solenoid/valves are functioning properly, replace the valve lifters as required. Both intake and exhaust lifters should be replaced in pairs.

Camshaft Position Actuator and Solenoid Valve Diagnosis and Testing

Note: Camshaft Position (CMP) Actuator and Solenoid Valve Diagnosis and Testing is applicable for RPO L99.

1. Measure the engine oil level. Fill, as required.
2. Using the scan tool, inspect for diagnostic codes within the engine control module (ECM). Refer to [Diagnostic System Check - Vehicle](#). Repair, as required.
3. Verify proper engine oil pressure and operation of the active fuel management oil pressure relief valve. Refer to [Oil Pressure Diagnosis and Testing](#).
4. Inspect the CMP actuator solenoid valve for proper operation. Refer to [Camshaft Position Actuator Solenoid Valve Inspection](#).
 - If valve inspection confirms proper movement of the spool, replace the CMP actuator and CMP valve.
 - If valve inspection confirms improper movement of the spool, replace only the CMP valve.
5. Verify proper operation of the CMP actuator control system. Refer to [Diagnostic System Check - Vehicle](#).

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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	Signal Performance
Engine Oil Level Sensor Signal	2	1	—	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 Ground	—	Low	—

Circuit/System Description

The engine oil level sensor/switch is a 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 and a message is displayed on the driver information center.

The following information determines the message sent from the ECM to the instrument cluster. The Engine Oil Level Low message 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 min to greater than 50 min, depending on the engine oil temperature.

The Engine Oil Level Low message is turned OFF when the ECM detects a low voltage on the signal circuit after an ignition OFF event for greater than 90 s, followed by an ignition ON event for 1 s.

Reference Information

Schematic Reference

- [Engine Mechanical Schematics](#)
- [Instrument Cluster Schematics](#)

Connector End View Reference

[Component Connector End Views](#)

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.
↓ **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 Ω between the low reference circuit terminal C and ground.
⇒ **If 10 Ω or greater**
 - 2.1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 - 2.2. Test for less than 2 Ω in the low reference circuit end to end.
⇒ If 2 Ω or greater, repair the open/high resistance in the circuit.
⇒ If less than 2 Ω , replace the K20 Engine Control Module.↓ **If less than 10 Ω**
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 A 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 A and the ground circuit terminal C.
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 A 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 Sensor and/or Switch Replacement](#)
- [Control Module References](#) for the ECM replacement, programming, and setup

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Document ID: 2810851

Engine Oil Temperature 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	Signal Performance
Signal	1	2	2	—
Low Reference	—	2	—	—
1. Engine Oil Temperature Gauge High 2. Engine Oil Temperature Gauge Low				

Typical Scan Tool Data

Engine Oil Temperature Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running at various operating conditions Parameter Normal Range: -40 to +150°C (-40 to +302°F)			
Signal	150°C (302°F)	-40°C (-40°F)	-40°C (-40°F)
Low Reference	—	-40°C (-40°F)	—

Circuit/System Description

The Engine Oil and Temperature Sensor is a variable resistor that measures the temperature of the engine oil. The Engine Control Module (ECM) supplies 5 V to the Engine Oil and Temperature Sensor signal circuit and supplies a ground to the low reference circuit.

Reference Information

Schematic Reference

- [Engine Mechanical Schematics](#)
- [Instrument Cluster Schematics](#)

Connector End View Reference

[Component Connector End Views](#)

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)

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- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

Scan Tool Reference

[Control Module References](#) for scan tool information.

Circuit/System Verification

1. Engine operating.
2. Verify the scan tool Engine Oil Temperature Sensor parameter is between -40 to $+150^{\circ}\text{C}$ (-40 to $+302^{\circ}\text{F}$) and changes with engine temperature.
 - ⇒ **If not between -38 to $+148^{\circ}\text{C}$ (-36 to $+298^{\circ}\text{F}$) or does not change**
Refer to Circuit/System Testing.
 - ⇓ **If between -38 to $+148^{\circ}\text{C}$ (-36 to $+298^{\circ}\text{F}$) and changes**
3. All OK.

Circuit/System Testing

Note: You must perform the Circuit/System Verification before proceeding with Circuit/System Testing.

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B35C Engine Oil Level and Temperature Sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than $10\ \Omega$ between the low reference circuit terminal C and ground.
 - ⇒ **If $10\ \Omega$ or greater**
 - 2.1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 - 2.2. Test for less than $2\ \Omega$ in the low reference circuit end to end.
 - ⇒ If $2\ \Omega$ or greater, repair the open/high resistance in the circuit.
 - ⇒ If less than $2\ \Omega$, replace the K20 Engine Control Module.
 - ⇓ **If less than $10\ \Omega$**
3. Ignition ON.
4. Verify the scan tool Engine Oil Temperature Sensor parameter is warmer than 148°C (298°F).
 - ⇒ **If 148°C (298°F) or less**
 - 4.1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
 - 4.2. Test for infinite resistance between the signal circuit terminal B 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 warmer than 148°C (298°F)**
5. Install a 3A fused jumper between the signal circuit terminal B and the low reference circuit terminal C.
6. Verify the scan tool Engine Oil Temperature Sensor parameter is colder than -38°C (-36°F).
 - ⇒ **If -38°C (-36°F) or colder**
 - 6.1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
 - 6.2. Test for less than 1V between the signal circuit and ground.
 - ⇒ If 1V or greater, repair the short to voltage on the circuit.
 - ⇓ If less than 1V
 - 6.3. Ignition OFF.

6.4. Test for less than $2\ \Omega$ in the signal circuit end to end.

⇒ If $2\ \Omega$ or greater, repair the open/high resistance in the circuit.

⇒ If less than $2\ \Omega$, replace the K20 Engine Control Module.

↓ **If warmer than -38°C (-36°F)**

7. Test or replace the B35C Engine Oil and Temperature Sensor.

Component Testing

1. Ignition OFF, remove the B35C Engine Oil Level and Temperature Sensor.

2. Test the B35C Engine Oil Level and Temperature Sensor by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the [Temperature Versus Resistance](#) table and verify that the resistance is within 5% of the specification.

⇒ **If not within the specified range**

Replace the B35C Engine Oil Level and Temperature Sensor.

Repair Instructions

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

- [Engine Oil Level Sensor and/or Switch Replacement](#)
- [Control Module References](#) for the ECM replacement, programming, and setup

Oil Leak Diagnosis

Oil Leak Diagnosis

Step	Action	Yes	No
Important: 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 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 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		Go to Step 10	Go to Step 6

Step	Action	Yes	No
	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?		
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. 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. Inspect for leaks at the following locations: ◦ Sealing surfaces ◦ Fittings ◦ Cracked or damaged components	Go to Step 10	System OK

Step	Action	Yes	No
	Can you identify the type of fluid and the approximate location of the leak?		
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 ◦ 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. Does the engine still leak oil?	Go to Step 1	System OK

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Crankcase Ventilation System Inspection/Diagnosis

Crankcase Ventilation System Inspection/Diagnosis

Symptom	Correction
External oil leak	Inspect for any of the following conditions: • Restricted or kinked positive crankcase ventilation (PCV) hose or engine vent hose • Damaged, incorrect, or incorrectly installed PCV hose • Excessive crankcase pressure
Rough Idle	Inspect for any of the following conditions: • Restricted or kinked PCV hose or engine vent hose • Leaking (damaged) PCV hose • Vacuum hoses worn or not properly installed
Stalling or slow idle speed	Inspect for any of the following conditions: • Restricted or kinked engine vent hose • Leaking (damaged) PCV hose
High idle speed	Inspect for a leaking (damaged) PCV hose
Sludge in the engine	Inspect for restricted or kinked PCV hose or engine vent hose

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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, loose or misaligned pulley 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 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: • 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.	Go to Step 7	Go to Step 8

Step	Action	Yes	No
	Are any of the pulleys misaligned?		
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 . 1. Tighten any loose fasteners. Refer to Fastener Tightening Specifications . 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 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 - Accessory . Did you complete the repair?	Go to Step 20	Go to Diagnostic Aids
20	Operate the system in order to verify the repair.	System OK	Go to Step 3

Step	Action	Yes	No
	Did you correct the condition?		

Drive Belt Rumbling and Vibration Diagnosis

Diagnostic Aids

Vibration from the engine operating may cause a body component or another part of the vehicle to make a rumbling noise.

The drive belt may have a 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 belt is installed, there might be an inoperative accessory drive component. 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 the drive belt is causing the rumbling noise. A rumbling noise may be confused with an internal engine noise due to the similarity in the description. When removing the drive belt the water pump will 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 belt is to ensure that it is 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 extreme the drive belt does not have a smooth surface for correct operation.](#)

Drive Belt Rumbling and Vibration Diagnosis

Step	Action	Yes	No
Caution: Refer to Belt Dressing Caution . DEFINITION: - 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.			
1	Did you review the Symptoms – Engine Mechanical diagnostic information, and perform the necessary inspections?	Go to Step 2	Go to Symptoms - Engine Mechanical
2	Verify that there is a rumbling noise. Does the engine make the rumbling noise?	Go to Step 3	Go to Diagnostic Aids

Step	Action	Yes	No
3	Note: When removing the drive belt the water pump will not be operating and the engine may overheat. 1. Remove the drive belt. Refer to Drive Belt Replacement - Accessory. 2. Operate the engine for no longer than 30 to 40 seconds. Does the rumbling noise still exist?	Go to Symptoms - Engine Mechanical	Go to Step 4
4	Inspect the drive belt for damage, separation, or sections of missing ribs. Did you find any of these conditions?	Go to Step 7	Go to Step 5
5	Inspect for extreme pilling of more than 1/3 of the drive belt pulley grooves. Did you find extreme 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 belt. Refer to Drive Belt Replacement - Accessory. Did you complete the repair?	Go to Step 8	—
7	Install a new drive belt. Refer to Drive Belt Replacement - Accessory. Did you complete the replacement?	Go to Step 8	—
8	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Diagnostic Aids

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. [Inspection 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 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 - Accessory or Air Conditioning Compressor 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 Tightening 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 - Accessory . Does the drive belt continue to fall off?	Go to Step 11	System OK
11		Go to Step 12	

Step	Action	Yes	No
	Inspect for failed drive belt idler and drive belt tensioner pulley bearings. Did you find and repair the condition?		Go to Diagnostic Aids
12	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 13
13	Inspect the drive belt for the proper installation. Refer to Drive Belt Replacement - Accessory or Air Conditioning Compressor 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 - Accessory or Air Conditioning Compressor 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	—

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Drive Belt Tensioner Diagnosis

Drive Belt Tensioner Diagnosis

Step	Action	Yes	No
1	Remove the drive belt. Refer to Drive Belt Replacement - Accessory . 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% of the second torque reading?	System OK	Go to Step 4
4	Replace the drive belt tensioner. Refer to Drive Belt Tensioner Replacement - Accessory . Is the repair complete?	System OK	—

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Fastener Tightening Specifications (LSA)

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Camshaft Position (CMP) Sensor Bolt	10 N•m	89 lb in
CMP Sensor Wire Harness Bolt	10 N•m	89 lb in
Camshaft Retainer Bolts – TORX® Head Bolts	15 N•m	11 lb ft
Camshaft Sprocket Bolt		
• First Pass	75 N•m	55 lb ft
• Final Pass	50 degrees	
Clutch Pressure Plate Bolts – Manual Transmission	70 N•m	52 lb ft
Connecting Rod Bolts – First Pass	20 N•m	15 lb ft
Connecting Rod Bolts – Final Pass	85 degrees	
Coolant Air Bleed Pipe Bolts	12 N•m	106 lb in
Coolant Temperature Sensor	20 N•m	15 lb ft
Crankshaft Balancer Bolt – Installation Pass with Used Bolt – to Ensure the Balancer is Completely Installed	330 N•m	240 lb ft
Crankshaft Balancer Bolt – First Pass (1)	150 N•m	111 lb ft
Crankshaft Balancer Bolt – Second Pass – Loosen Bolt	360 degrees	
Crankshaft Balancer Bolt – Third Pass	80 N•m	59 lb ft
Crankshaft Balancer Bolt – Final Pass	200 degrees	
Crankshaft Bearing Cap M8 Bolts	25 N•m	18 lb ft
Crankshaft Bearing Cap M10 Bolts – First Pass in Sequence	20 N•m	15 lb ft
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80 degrees		

Application	Specification	
	Metric	English
Crankshaft Bearing Cap M10 Bolts – Final Pass in Sequence		
Crankshaft Bearing Cap M10 Studs – First Pass in Sequence	20 N•m	15 lb ft
Crankshaft Bearing Cap M10 Studs – Final Pass in Sequence	51 degrees	
Crankshaft Oil Deflector Nuts	25 N•m	18 lb ft
Crankshaft Position (CKP) Sensor Bolt	25 N•m	18 lb ft
Crankshaft Rear Oil Seal Housing Bolts	30 N•m	22 lb ft
Cylinder Head Coolant Plug	20 N•m	15 lb ft
Cylinder Head M11 Bolts – First Pass in Sequence	50 N•m	37 lb ft
Cylinder Head M11 Bolts – Second Pass in Sequence	80 degrees	
Cylinder Head M11 Bolts – Final Pass in Sequence	55 degrees	
Cylinder Head M8 Bolts – in Sequence	30 N•m	22 lb ft
Drive Belt Tensioner Bolt	58 N•m	43 lb ft
Engine Block Coolant Drain Hole Plug	60 N•m	44 lb ft
Engine Block Oil Gallery Plug	60 N•m	44 lb ft
Engine Mount Bracket to Engine Block Bolts	60 N•m	44 lb ft
Engine Mount Nut to Engine Mount Bracket	100 N•m	74 lb ft
Engine Mount Nut to Frame	100 N•m	74 lb ft
Engine Oil Cooler Coolant Fitting	50 N•m	37 lb ft
Engine Oil Cooler Coolant Hose Connector	35 N•m	26 lb ft
Engine Oil Cooler Core-to-Housing Bolts	25 N•m	18 lb ft
Engine Oil Cooler-to-Oil Pan M6 Bolts	10 N•m	89 lb in
Engine Oil Cooler-to-Oil Pan M8 Bolts	25 N•m	18 lb ft
Engine Oil Cooler Pipe Bolt	25 N•m	18 lb ft

Application	Specification	
	Metric	English
Engine Oil Level Sensor	13 N•m	115 lb in
Engine Oil Pressure Switch	35 N•m	25 lb ft
Engine-to-Transmission or Clutch Housing Bolts	50 N•m	37 lb ft
Evaporative Emission (EVAP) Canister Purge Solenoid Valve Bolt	10 N•m	89 lb in
Exhaust Manifold Bolts – First Pass	15 N•m	11 lb ft
Exhaust Manifold Bolts – Final Pass	20 N•m	15 lb ft
Exhaust Manifold Heat Shield Bolt	12 N•m	106 lb in
Exhaust Manifold Stud	20 N•m	15 lb ft
Flex Plate-to-Torque Converter Bolts	63 N•m	46 lb ft
Flex Plate Bolt (1)		
• First Pass	20 N•m	15 lb ft
• Second Pass	50 N•m	37 lb ft
• Final Pass	100 N•m	74 lb ft
Flywheel Bolt (1)		
• First Pass	50 N•m	37 lb ft
• Final Pass	45 Degrees	
Front Cover Bolts	30 N•m	22 lb ft
Fuel Injection Fuel Rail Bolt	10 N•m	89 lb in
Fuel Injection Fuel Rail Studs	10 N•m	89 lb in
Fuel Injector and Ignition Coil Wire Harness Bracket Bolt	10 N•m	89 lb in
Generator Bracket Bolts	50 N•m	37 lb ft

Application	Specification	
	Metric	English
Ignition Coil -to-Valve Rocker Arm Cover Bolts	12 N•m	106 lb in
Inlet Air Temperature Sensor	20 N•m	15 lb ft
J41798 M8 Bolt	25 N•m	18 lb ft
J41798 M10 Bolts	50 N•m	37 lb ft
Knock Sensor Bolts	25 N•m	18 lb ft
Motor Mount Bracket Bolts	50 N•m	37 lb ft
Oil Filter	3/4 to 1 full turn after gasket makes contact with the sealing surface on the filter mounting flange	
Oil Filter Fitting	55 N•m	40 lb ft
Oil Pan Closeout Cover Bolt – Left Side	9 N•m	80 lb in
Oil Pan Closeout Cover Bolt – Right Side	9 N•m	80 lb in
Oil Pan Drain Plug	25 N•m	18 lb ft
Oil Pan M6 Bolts – Oil Pan-to-Rear Oil Seal Housing	12 N•m	106 lb in
Oil Pan M8 Bolts – Oil Pan-to-Engine Block and Oil Pan-to-Front Cover	25 N•m	18 lb ft
Oil Pressure Sensor	35 N•m	26 lb ft
Oil Pump Cover Bolts	12 N•m	106 lb in
Oil Pump-to-Engine Block Bolts	25 N•m	18 lb ft
Oil Pump Relief Valve Plug	12 N•m	106 lb in
Oil Pump Screen-to-Oil Pump Bolt	12 N•m	106 lb in
Piston Oil Nozzle Bolts	20 N•m	15 lb ft
Spark Plugs	20 N•m	15 lb ft
Supercharger Air Outlet Pressure Sensor Bolt	10 N•m	89 lb in
Supercharger Barometric Pressure Sensor Bolt	10 N•m	89 lb in
Supercharger Belt Idler Pulley Bolt	58 N•m	43 lb ft

Application	Specification	
	Metric	English
Supercharger Belt Idler Pulley Bracket Bolt	22 N•m	16 lb ft
Supercharger Belt Tensioner Bolt	58 N•m	43 lb ft
Supercharger Belt Tensioner Bracket Bolt	58 N•m	43 lb ft
Supercharger Bypass Valve Actuator Bolts	25 N•m	18 lb ft
Supercharger Charge Air Bypass Regulator Solenoid Bolt	10 N•m	89 lb in
Supercharger Inlet Air Pressure Sensor Bolt	10 N•m	89 lb in
Supercharger Charge Air Cooler-to-Cover Bolts	10 N•m	89 lb in
Supercharger Charge Air Cooler Outlet Pipe Bolts	10 N•m	89 lb in
Supercharger Charge Air Cooler Isolator Bolts	5 N•m	44 lb in
Supercharger – Lower – Manifold-to-Cylinder Head Bolts - First Pass in Sequence	5 N•m	44 lb in
Supercharger – Lower – Manifold-to-Cylinder Head Bolts - Final Pass in Sequence	10 N•m	89 lb in
Supercharger – Upper – Charge Air Cooler Cover Bolts – First Pass in Sequence	5 N•m	44 lb in
Supercharger – Upper – Charge Air Cooler Cover Bolts – Final Pass in Sequence	10 N•m	89 lb in
Throttle Body Bolts	10 N•m	89 lb in
Timing Chain Tensioner Bolts	30 N•m	22 lb ft
Valley Cover Bolts	25 N•m	18 lb ft
Valve Lifter Guide Bolts	12 N•m	106 lb in
Valve Rocker Arm Bolts	30 N•m	22 lb ft
Valve Rocker Arm Cover Bolts	12 N•m	106 lb in
Water Inlet Housing Bolts	15 N•m	11 lb ft
Water Pump Bolts – First Pass	15 N•m	11 lb ft
Water Pump Bolts – Final Pass	30 N•m	22 lb ft

Application	Specification	
	Metric	English
1. Use NEW fastener.		

Fastener Tightening Specifications (LS3, L77)

Fastener Tightening Specifications

Application	Specification	
	Metric	English
A/C Compressor Bracket to Engine Block Retaining Bolt	58 N•m	43 lb ft
A/C Compressor to A/C Compressor Bracket Retaining Bolt	22 N•m	16 lb ft
A/C Drive Belt Tensioner Pulley to A/C Drive Belt Tensioner Retaining Bolt	50 N•m	37 lb ft
A/C Drive Belt Tensioner to A/C Compressor Bracket Retaining Bolt	22 N•m	16 lb ft
A/C Suction/Discharge Pipe Pad to A/C Compressor Retaining Bolt	16 N•m	12 lb ft
Air Cleaner Inlet Duct to Throttle Body Hose Clamp	7 N•m	62 lb in
Automatic Transmission Cooler Pipe Clamp to A/C Compressor Bracket Retaining Bolt	22 N•m	16 lb ft
Camshaft Position (CMP) Sensor to Engine Front Cover Retaining Bolt	9 N•m	80 lb in
Camshaft Retainer to Engine Block Retaining Bolt	25 N•m	18 lb ft
Camshaft Sprocket to Camshaft Retaining Bolt (L98, LS3, L76, L77)		
• First Pass	75 N•m	55 lb ft
• Second Pass	+ 50 Degrees	
Close Out Cover to Engine Block Retaining Bolt Left	10 N•m	89 lb in
Close Out Cover to Engine Block Retaining Bolt Right	10 N•m	89 lb in
Clutch Pressure Plate to Flywheel Retaining Bolt		
• First Pass	15 N•m	11 lb ft
• Second Pass	35 N•m	26 lb ft

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Application	Specification	
	Metric	English
Third Pass	55 N•m	41 lb ft
Final Pass	70 N•m	52 lb ft
Connecting Bearing Cap to Connecting Rod Retaining Bolt (L98, LS3, L76, L77)		
First Pass	20 N•m	15 lb ft
Second Pass	+ 85 Degrees	
Coolant Air Bleed Pipe and Hole Cover to Cylinder Head Retaining Bolt	12 N•m	106 lb in
Coolant Temperature Sensor	20 N•m	15 lb ft
Crankshaft Balancer to Crankshaft Retaining Bolt		
First Pass	150 N•m	110 lb ft
Second Pass	Loosen 360 Degrees	
Third Pass	80 N•m	59 lb ft
Fourth Pass (Bolt with flanged head.)	+ 125 Degrees	
Fourth Pass (Bolt with retained rotating washer.)	+ 200 Degrees	
Crankshaft Bearing Cap to Engine Block Side Retaining Bolt (M8)	25 N•m	18 lb ft
Crankshaft Bearing Cap to Engine Block Retaining Bolt (M10)		
First Pass in Sequence	20 N•m	15 lb ft
Second Pass in Sequence	+ 80 Degrees	
Crankshaft Bearing to Engine Block Retaining Stud (M10)		

Application	Specification	
	Metric	English
• First Pass in Sequence	20 N•m	15 lb ft
• Second Pass in Sequence	+ 51 Degrees	
Crankshaft Oil Deflector to Oil Pan Retaining Nut	10 N•m	89 lb in
Crankshaft Position (CKP) Sensor to Engine Block Retaining Bolt	25 N•m	18 lb ft
Crankshaft Rear Oil Seal Housing to Engine Block Retaining Bolt	30 N•m	22 lb ft
Cylinder Head Coolant Plug to Cylinder Head	20 N•m	15 lb ft
Cylinder Head to Engine Block Retaining Bolt (M8) - in sequence	30 N•m	22 lb ft
Cylinder Head to Engine Block Retaining Bolt (M11)		
• First Pass in sequence	30 N•m	22 lb ft
• Second Pass in sequence	+ 90 Degrees	
• Third Pass in sequence	+ 70 Degrees	
Engine Block Coolant Drain Hole Plug	60 N•m	44 lb ft
Engine Block Coolant Heater (LS3)	50 N•m	37 lb ft
Engine Block Oil Gallery Plug	60 N•m	44 lb ft
Engine Mount Bracket to Engine Block Retaining Bolt	58 N•m	43 lb ft
Evaporative Emission (EVAP) Canister Purge Solenoid Valve Bracket to Cylinder Head Retaining Bolt	20 N•m	15 lb ft
Exhaust Manifold to Cylinder Head Retaining Bolt		
• First Pass	15 N•m	11 lb ft
• Second Pass	20 N•m	15 lb ft

Application	Specification	
	Metric	English
Exhaust Manifold Heat Shield to Exhaust Manifold Retaining Bolt	10 N•m	89 lb in
Flywheel to Crankshaft Retaining Bolt (L98, LS3, L76, L77)		
• First Pass	20 N•m	15 lb ft
• Second Pass	50 N•m	37 lb ft
• Third Pass	100 N•m	74 lb ft
Front Cover to Engine Block Retaining Bolt	25 N•m	18 lb ft
Fuel Injection Fuel Rail to Inlet Manifold Retaining Bolt	10 N•m	89 lb in
Ignition Coil Bracket to Valve Rocker Arm Cover Stud	12 N•m	106 lb in
Ignition Coil to Ignition Coil Bracket Retaining Bolt	10 N•m	89 lb in
Intake Manifold to Cylinder Head Retaining Bolt		
• First Pass in sequence	5 N•m	44 lb in
• Second Pass in sequence	10 N•m	89 lb in
J41798 M10 Bolt	50 N•m	37 lb ft
J41798 M8 Bolt	25 N•m	18 lb ft
Knock Sensor to Engine Block Retaining Bolt	25 N•m	18 lb ft
Oil Filter	3/4 to 1 full turn after gasket makes contact with the sealing surface on the filter mounting flange	
Oil Filter Adapter	55 N•m	41 lb ft
Oil Level Indicator Tube to Cylinder Head Retaining Bolt (L98, LS3, L76, L77)	25 N•m	18 lb ft
Oil Level Sensor	20 N•m	15 lb ft
Oil Pan Baffle to Oil Pan Retaining Bolt	12 N•m	106 lb in

Application	Specification	
	Metric	English
Oil Pan Cover to Oil Pan Retaining Bolt	12 N•m	106 lb in
Oil Pan Drain Plug	25 N•m	18 lb ft
Oil Pan to Rear Oil Seal Housing Retaining Bolt (M6)	12 N•m	106 lb in
Oil Pan to Engine Block Retaining Bolt (M8)	25 N•m	18 lb ft
Oil Pan to Front Cover Retaining Bolt (M8)	25 N•m	18 lb ft
Oil Pressure Sensor	35 N•m	26 lb ft
Oil Pump Cover to Oil Pump Retaining Bolt	12 N•m	106 lb in
Oil Pressure Relief Valve Plug to Oil Pump	14 N•m	124 lb in
Oil Pump Screen to Crankshaft Oil Deflector Retaining Nut	10 N•m	89 lb in
Oil Pump Screen to Oil Pump Retaining Bolt	9 N•m	80 lb in
Oil Pump to Engine Block Retaining Bolt	25 N•m	18 lb ft
Spark Plug		
• Fit New Spark Plug	20 N•m	15 lb ft
• Refit Existing Spark Plug	15 N•m	11 lb ft
Throttle Body to Intake Manifold Retaining Bolt	10 N•m	89 lb in
Timing Chain Tensioner to Engine Block Retaining Bolt	25 N•m	18 lb ft
Valley Cover to Engine Block Retaining Bolt	25 N•m	18 lb ft
Valve Lifter Guide to Engine Block Retaining Bolt	12 N•m	106 lb in
Valve Rocker Arm Cover to Cylinder Head Retaining Bolt	12 N•m	106 lb in
Valve Rocker Arm to Cylinder Head Retaining Bolt	30 N•m	22 lb ft
Thermostat Housing to Water Pump Retaining Bolt	15 N•m	11 lb ft
Water Pump to Engine Block Retaining Bolt		

Application	Specification	
	Metric	English
• First Pass	15 N•m	11 lb ft
• Second Pass	30 N•m	22 lb ft

Engine Mechanical Specifications (LSA)

Engine Mechanical Specifications

Application	Specification	
	Metric	English
General		
• Engine Type	V8	
• Displacement	6.2L	376 CID
• RPO	LSA	
• VIN	P	
• Bore	103.241–103.259 mm	4.0065–4.0065 in
• Stroke	92.0 mm	3.622 in
• Compression Ratio	9.1:1	
• Supercharger Boost Ratio	10.1 :1	
• Firing Order	1–8–7–2–6–5–4–3	
• Spark Plug Gap	0.95–1.10 mm	0.037–0.043 in
Block		
• Camshaft Bearing Bore 1 and 5 Diameter	59.58–59.63 mm	2.345–2.347 in
• Camshaft Bearing Bore 2 and 4 Diameter	59.08–59.13 mm	2.325–2.327 in
• Camshaft Bearing Bore 3 Diameter	58.58–58.63 mm	2.306–2.308 in

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Application	Specification	
	Metric	English
• Crankshaft Main Bearing Bore Diameter	69.871–69.889 mm	2.75–2.751 in
• Crankshaft Main Bearing Bore Out-of-Round	0.006 mm	0.0002 in
• Cylinder Bore Diameter	103.241–103.259 mm	4.0065–4.0065 in
• Cylinder Head Deck Height – Measuring from the Centerline of Crankshaft to the Deck Face	234.57–234.82 mm	9.235–9.245 in
• Cylinder Head Deck Surface Flatness – Measured within a 152.4 mm (6.0 in) Area	0.11 mm	0.004 in
• Cylinder Head Deck Surface Flatness – Measuring the Overall Length of the Block Deck	0.22 mm	0.008 in
• Valve Lifter Bore Diameter	21.417–21.443 mm	0.843–0.844 in
Camshaft		
• Camshaft End Play	0.025–0.305 mm	0.001–0.012 in
• Camshaft Journal Diameter	54.990–55.015 mm	2.165–2.166 in
• Camshaft Bearing Diameter	55.063–55.088 mm	2.1678–2.1688 in
• Camshaft Journal-to-Bearing Clearance	0.048–0.098 mm	0.0002–0.0038 in
• Camshaft Journal Out-of-Round	0.025 mm	0.001 in
• Camshaft Lobe Lift – Intake	7.2 mm	0.283 in
• Camshaft Lobe Lift – Exhaust	7.2 mm	0.283 in
	0.05 mm	0.002 in

Application	Specification	
	Metric	English
Camshaft Runout – Measured at the Intermediate Journals		
Connecting Rod		
Connecting Rod Bearing Clearance – Production	0.023–0.065 mm	0.0009–0.0025 in
Connecting Rod Bearing Clearance – Service	0.023–0.076 mm	0.0009–0.003 in
Connecting Rod Bore Diameter – Bearing End	56.505–56.525 mm	2.224–2.225 in
Connecting Rod Bore Out-of-Round – Bearing End – Production	0.004–0.008 mm	0.00015–0.0003 in
Connecting Rod Bore Out-of-Round – Bearing End – Service	0.004–0.008 mm	0.00015–0.0003 in
Connecting Rod Side Clearance	0.11–0.51 mm	0.00433–0.02 in
Crankshaft		
Connecting Rod Journal Diameter – Production	53.318–53.338 mm	2.0991–2.0999 in
Connecting Rod Journal Diameter – Service	53.308 mm	2.0987 in
Connecting Rod Journal Out-of-Round – Production	0.005 mm	0.0002 in
Connecting Rod Journal Out-of-Round – Service	0.01 mm	0.0004 in
Connecting Rod Journal Taper – Maximum for 1/2 of Journal Length – Production	0.005 mm	0.0002 in
Connecting Rod Journal Taper – Maximum for 1/2 of Journal Length – Service	0.02 mm	0.00078 in

Application	Specification	
	Metric	English
• Crankshaft End Play	0.04–0.2 mm	0.0015–0.0078 in
• Crankshaft Main Bearing Clearance – Production	0.02–0.052 mm	0.0008–0.0021 in
• Crankshaft Main Bearing Clearance – Service	0.02–0.065 mm	0.0008–0.0025 in
• Crankshaft Main Journal Diameter – Production	64.992–65.008 mm	2.558–2.559 in
• Crankshaft Main Journal Diameter – Service	64.992 mm	2.558 in
• Crankshaft Main Journal Out-of-Round – Production	0.003 mm	0.000118 in
• Crankshaft Main Journal Out-of-Round – Service	0.008 mm	0.0003 in
• Crankshaft Main Journal Taper – Production	0.01 mm	0.0004 in
• Crankshaft Main Journal Taper – Service	0.02 mm	0.00078 in
• Crankshaft Rear Flange Runout	0.05 mm	0.002 in
• Crankshaft Reluctor Ring Runout – Measured 1.0 mm (0.04 in) Below Tooth Diameter	0.7 mm	0.028 in
• Crankshaft Thrust Surface – Production	26.14–26.22 mm	1.029–1.0315 in
• Crankshaft Thrust Surface – Service	26.22 mm	1.0315 in
• Crankshaft Thrust Surface Runout	0.025 mm	0.001 in
Cylinder Head		
	6.88–7.12 mm	0.271–0.283 in

Application	Specification	
	Metric	English
Cylinder Head Height/Thickness – Measured from the Cylinder Head Deck to Machining Pad Locations		
Surface Flatness – Block Deck – Measured within a 152.4 mm (6.0 in) Area	0.08 mm	0.003 in
Surface Flatness – Block Deck – Measuring the Overall Length of the Cylinder Head	0.1 mm	0.004 in
Surface Flatness – Exhaust Manifold Deck	0.1 mm	0.004 in
Surface Flatness – Intake Manifold Deck	0.08 mm	0.0031 in
Valve Guide Installed Height – Measured from the Spring Seat Surface to the Top of the Guide	17.08–17.57 mm	0.672–0.692 in
Lubrication System		
Oil Capacity – with Filter	5.7 liters	6.0 quarts
Oil Capacity – without Filter	5.2 liters	5.5 quarts
Oil Pressure – Minimum – Hot	165 kPa at 1,000 engine RPM 241 kPa at 2,000 engine RPM 262 kPa at 3,000 engine RPM	24 psig at 1,000 engine RPM 35 psig at 2,000 engine RPM 38 psig at 3,000 engine RPM
Oil Pan		
Front Cover Alignment – at Oil Pan Surface	+0.0 to –0.5 mm	+0.0 to –0.2 in
Crankshaft Rear Oil Seal Housing Alignment – at Oil Pan Surface	+0.0 to –0.5 mm	+0.0 to –0.2 in
Oil Pan Alignment – to Rear of Engine Block at Transmission Housing Mounting Surface	+0.0 to –0.5 mm	+0.0 to –0.2 in

Application	Specification	
	Metric	English
Piston Rings		
• Piston Ring End Gap – First Compression Ring – Measured in Cylinder Bore – Production	0.23–0.44 mm	0.009–0.017 in
• Piston Ring End Gap – First Compression Ring – Measured in Cylinder Bore – Service	0.23–0.5 mm	0.009–0.0196 in
• Piston Ring End Gap – Second Compression Ring – Measured in Cylinder Bore – Production	0.44–0.7 mm	0.017–0.027 in
• Piston Ring End Gap – Second Compression Ring – Measured in Cylinder Bore – Service	0.44–0.76 mm	0.0173–0.03 in
• Piston Ring End Gap – Oil Control Ring – Measured in Cylinder Bore – Production	0.18–0.75 mm	0.007–0.029 in
• Piston Ring End Gap – Oil Control Ring – Measured in Cylinder Bore – Service	0.18–0.81 mm	0.007–0.032 in
• Piston Ring to Groove Clearance – First Compression Ring – Production	0.04–0.085 mm	0.00157–0.00335 in
• Piston Ring to Groove Clearance – First Compression Ring – Service	0.04–0.085 mm	0.00157–0.00335 in
• Piston Ring to Groove Clearance – Second Compression Ring – Production	0.04–0.078 mm	0.00157–0.0031 in
• Piston Ring to Groove Clearance – Second Compression Ring – Service	0.04–0.078 mm	0.00157–0.0031 in
• Piston Ring to Groove Clearance – Oil Control Ring – Production	0.012–0.2 mm	0.0005–0.0078 in
• Piston Ring to Groove Clearance – Oil Control Ring – Service	0.012–0.2 mm	0.0005–0.0078 in

Application	Specification	
	Metric	English
Pistons and Pins		
• Pin – Piston Pin Clearance to Piston Pin Bore – Production	0.003–0.011 mm	0.0001–0.0004 in
• Pin – Piston Pin Clearance to Piston Pin Bore – Service	0.002–0.015 mm	0.0008–0.0006 in
• Pin – Piston Pin Diameter	24.997–25.0 mm	0.984–0.0984 in
• Pin – Piston Pin Fit in Connecting Rod Bore – Production	0.007–0.02 mm	0.00027–0.00078 in
• Pin – Piston Pin Fit in Connecting Rod Bore – Service	0.007–0.0022 mm	0.00027–0.00086 in
• Piston – Piston Diameter – Measured Over Skirt Coating	103.235–103.258 mm	4.064–4.065 in
• Piston – Piston to Bore Clearance – Production	–0.036 to +0.016 mm	–0.0014 to +0.0006 in
• Piston – Piston to Bore Clearance – Service Limit with Skirt Coating Worn Off	0.71 mm	0.0028 in
Valve System		
• Valves – Valve Face Angle	45 degrees	
• Valves – Valve Face Width	1.25 mm	0.05 in
• Valves – Valve Lash	Net Lash – No Adjustment	
• Valves – Valve Lift – Intake	12.24 mm	0.482 in
• Valves – Valve Lift – Exhaust	12.24 mm	0.482 in
	45 degrees	

Application	Specification	
	Metric	English
• Valves – Valve Seat Angle		
• Valves – Valve Seat Runout	0.05 mm	0.002 in
• Valves – Valve Seat Width – Exhaust	1.78 mm	0.07 in
• Valves – Valve Seat Width – Intake	1.02 mm	0.04 in
• Valves – Valve Stem Diameter – Production	7.955–7.976 mm	0.313–0.314 in
• Valves – Valve Stem Diameter – Service	7.95 mm	0.313 in
• Valves – Stem-to-Guide Clearance – Production – Intake	0.025–0.066 mm	0.001–0.0026 in
• Valves – Valve Stem-to-Guide Clearance – Service – Intake	0.093 mm	0.0037 in
• Valves – Valve Stem-to-Guide Clearance – Production – Exhaust	0.025–0.066 mm	0.001–0.0026 in
• Valves – Stem-to-Guide Clearance – Service – Exhaust	0.093 mm	0.0037 in
• Rocker Arms – Rocker Arm Ratio	1.70:1	
• Valve Springs – Valve Spring Free Length	53.1–53.7 mm	2.09–2.11 in
• Valve Springs – Valve Spring Installed Height	45.75 mm	1.8 in
• Valve Springs – Valve Spring Load – Closed	400 N at 45.75 mm	90 lb at 1.8 in
• Valve Springs – Valve Spring Load – Open	1175 N at 33.05 mm	264 lb at 1.30 in

Engine Mechanical Specifications (L77)

Engine Mechanical Specifications

Application	Specification	
	Metric	English
• Engine Type	V8	
• Displacement	6.0L	364 CID
• RPO	L77	
• Bore	101.6 mm	4.0 in
• Stroke	92.0 mm	3.622 in
• Compression Ratio	10.4:1	
• Idle Speed RPM (AT) • Idle Speed RPM (MT)	550 A/C ON/OFF 550 A/C ON/OFF	
• Firing Order	1-8-7-2-6-5-4-3	
• Active Fuel Management Cylinders	1-4-6-7	
• Spark Plug Gap	0.95-1.10 mm	0.037-0.043 in
Block		
• Camshaft Bearing Bore 1 and 5 Diameter	59.58-59.63 mm	2.345-2.347 in
• Camshaft Bearing Bore 2 and 4 Diameter	59.08-59.13 mm	2.325-2.327 in
• Camshaft Bearing Bore 3 Diameter	58.58-58.63 mm	2.306-2.308 in
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Application	Specification	
	Metric	English
• Crankshaft Main Bearing Bore Diameter	69.871–69.889 mm	2.75–2.751 in
• Crankshaft Main Bearing Bore Out-of-Round	0.006 mm	0.0002 in
• Cylinder Bore Diameter	101.618–101.636 mm	4.0007–4.0017 in
• Cylinder Head Deck Height – Measuring from the Centerline of Crankshaft to the Deck Face	234.7 mm	9.240 in
• Cylinder Head Deck Surface Flatness – Measured Within a 152.4 mm (6.0 in) Area	0.11 mm	0.004 in
• Cylinder Head Deck Surface Flatness – Measuring the Overall Length of the Block Deck	0.22 mm	0.008 in
• Valve Lifter Bore Diameter	21.417–21.443 mm	0.843–0.844 in
Camshaft		
• Camshaft End Play	0.025–0.305 mm	0.001–0.012 in
• Camshaft Journal Diameter	54.99–55.04 mm	2.164–2.166 in
• Camshaft Bearing Diameter	55.063–55.088 mm	2.1678–2.1688 in
• Camshaft Journal-to-Bearing Clearance	0.023–0.098 mm	0.0009–0.0038 in
• Camshaft Journal Out-of-Round	0.025 mm	0.001 in
• Camshaft Lobe Lift – Exhaust – Non Active Fuel Management Cylinders	7.17 mm	0.282 in
• Camshaft Lobe Lift – Exhaust – Active Fuel Management Cylinders	7.3 mm	0.287 in

Application	Specification	
	Metric	English
• Camshaft Lobe Lift – Intake – Non Active Fuel Management Cylinders	7.08 mm	0.279 in
• Camshaft Lobe Lift – Intake – Active Fuel Management Cylinders	7.2 mm	0.283 in
• Camshaft Runout – Measured at the Intermediate Journals	0.05 mm	0.002 in
Connecting Rod		
• Connecting Rod Bearing Clearance – Production	0.023–0.065 mm	0.0009–0.0025 in
• Connecting Rod Bearing Clearance – Service	0.023–0.076 mm	0.0009–0.003 in
• Connecting Rod Bore Diameter – Bearing End	56.505–56.525 mm	2.224–2.225 in
• Connecting Rod Bore Out-of-Round – Bearing End – Production	0.004–0.008 mm	0.00015–0.0003 in
• Connecting Rod Bore Out-of-Round – Bearing End – Service	0.004–0.008 mm	0.00015–0.0003 in
• Connecting Rod Side Clearance	0.11–0.51 mm	0.00433–0.02 in
Crankshaft		
• Connecting Rod Journal Diameter - Production	53.318–53.338 mm	2.0991–2.0999 in
• Connecting Rod Journal Diameter - Service	53.308 mm	2.0987 in
• Connecting Rod Journal Out - of - Round - Production	0.005 mm	0.0002 in
• Connecting Rod Journal Out - of - Round - Service	0.01 mm	0.0004 in

Application	Specification	
	Metric	English
• Connecting Rod Journal Taper (Maximum for 1/2 of Journal Length - Production)	0.005 mm	0.0002 in
• Connecting Rod Journal Taper (Maximum for 1/2 of Journal Length - Service)	0.02 mm	0.00078 in
• Crankshaft End Play	0.04–0.2 mm	0.0015–0.0078 in
• Crankshaft Main Bearing Clearance - Production	0.02–0.052 mm	0.0008–0.0021 in
• Crankshaft Main Bearing Clearance - Service	0.02–0.065 mm	0.0008–0.0025 in
• Crankshaft Main Journal Diameter - Production	64.992–65.008 mm	2.558–2.559 in
• Crankshaft Main Journal Diameter - Service	64.992 mm	2.558 in
• Crankshaft Main Journal Out - of - Round - Production	0.003 mm	0.000118 in
• Crankshaft Main Journal Out - of - Round - Service	0.008 mm	0.0003 in
• Crankshaft Main Journal Taper - Production	0.01 mm	0.0004 in
• Crankshaft Main Journal Taper - Service	0.02 mm	0.00078 in
• Crankshaft Rear Flange Runout	0.05 mm	0.002 in
• Crankshaft Reluctor Ring Runout (Measured 1.0 mm (0.04 in) Below Tooth Diameter)	0.7 mm	0.028 in
• Crankshaft Thrust Surface - Production	26.14–26.22 mm	1.029–1.0315 in
• Crankshaft Thrust Surface - Service	26.22 mm	1.0315 in

Application	Specification	
	Metric	English
Crankshaft Thrust Surface Runout	0.025 mm	0.001 in
Cylinder Head		
Cylinder Head Height/Thickness (Measured from the Cylinder Head Deck to the Valve Rocker Arm Cover Seal Surface)	120.2 mm	4.732 in
Surface Flatness - Block Deck (Measured within a 152.4 mm (6.0 in) Area)	0.08 mm	0.003 in
Surface Flatness - Block Deck (Measuring the Overall Length of the Cylinder Head)	0.1 mm	0.004 in
Surface Flatness - Exhaust Manifold Deck	0.13 mm	0.005 in
Surface Flatness - Intake Manifold Deck	0.08 mm	0.0031 in
Valve Guide Installed Height (Measured from the Spring Seat Surface to the Top of the Guide)	17.32 mm	0.682 in
Intake Manifold		
Surface Flatness (Measured at Gasket Sealing Surfaces and Measured Within a 200 mm (7.87 in) Area that Includes 2 Runner Port Openings)	0.3 mm	0.118 in
Lubrication System		
Oil Capacity - with Filter Change	7.6 Litres	8 Quarts
Oil Pressure - Minimum - Hot	165 kPa at 1,000 engine RPM 241 kPa at 2,000 engine RPM 262 kPa at 3,000 engine RPM	24 psig at 1,000 engine RPM 35 psig at 2,000 engine RPM 38 psig at 3,000 engine RPM
Active Fuel Management Relief Valve Oil Pressure – as Measured at Oil Pressure Sensor Location	379–517 kPa Maximum	55–75 psi Maximum

Application	Specification	
	Metric	English
Oil Pan		
• Front Cover Alignment - at Oil Pan Surface	0.0–0.5 mm	0.0–0.02 in
• Crankshaft Rear Oil Seal Housing Alignment - at Oil Pan Surface	0.0–0.5 mm	0.0–0.02 in
• Oil Pan Alignment - to Rear of Engine Block at Transmission Bell Housing Mounting Surface	0.0–0.1 mm	0.0–0.004 in
Piston Rings		
• Piston Ring End Gap - First Compression Ring (Measured in Cylinder Bore - Production)	0.20–0.41 mm	0.008–0.016 in
• Piston Ring End Gap - First Compression Ring (Measured in Cylinder Bore - Service)	0.20–0.41 mm	0.008–0.016 in
• Piston Ring End Gap - Second Compression Ring (Measured in Cylinder Bore - Production)	0.37–0.69 mm	0.015–0.027 in
• Piston Ring End Gap - Second Compression Ring (Measured in Cylinder Bore - Service)	0.37–0.69 mm	0.015–0.027 in
• Piston Ring End Gap - Oil Control Ring (Measured in Cylinder Bore - Production)	0.22–0.79 mm	0.009–0.031 in
• Piston Ring End Gap - Oil Control Ring (Measured in Cylinder Bore - Service)	0.22–0.79 mm	0.009–0.031 in
• Piston Ring to Groove Clearance - First Compression Ring - Production	0.030–0.10 mm	0.0012–0.0040 in
• Piston Ring to Groove Clearance - First Compression Ring - Service	0.030–0.10 mm	0.0012–0.0040 in
• Piston Ring to Groove Clearance - Second Compression Ring - Production	0.035–0.078 mm	0.0014–0.0031 in

Application	Specification	
	Metric	English
Piston Ring to Groove Clearance - Second Compression Ring - Service	0.035–0.078 mm	0.0014–0.0031 in
Piston Ring to Groove Clearance - Oil Control Ring - Production	0.013–0.201 mm	0.0005–0.0079 in
Piston Ring to Groove Clearance - Oil Control Ring - Service	0.013–0.201 mm	0.0005–0.0079 in
Pistons and Pins		
Pin - Piston Pin Clearance to Piston Pin Bore - Production	0.002–0.01 mm	0.0008–0.0004 in
Pin - Piston Pin Clearance to Piston Pin Bore - Service	0.002–0.015 mm	0.0008–0.0006 in
Pin - Piston Pin Diameter	23.952–23.955 mm	0.943–0.943 in
Pin - Piston Pin Fit in Connecting Rod Bore - Production	0.007–0.02 mm	0.00027–0.00078 in
Pin - Piston Pin Fit in Connecting Rod Bore - Service	0.007–0.022 mm	0.00027–0.00086 in
Piston - Piston Diameter - Measured Over Skirt Coating	101.611–101.642 mm	4.0–4.001 in
Piston - Piston to Bore Clearance - Production	–0.022–0.08 mm	–0.0009–0.0012 in
Piston - Piston to Bore Clearance (Service Limit with Skirt Coating Worn Off)	0.024–0.08 mm	0.00094–0.0031 in
Valve System		
Valves – Valve Face Angle	45 degrees	

Application	Specification	
	Metric	English
• Valves – Valve Face Width	1.25 mm	0.05 in
• Valves – Valve Lash	Net Lash – No Adjustment	
• Valve Lift – Exhaust – Active Fuel Management	12.16 mm Cyl: 2,3,5,8 12.39 mm Cyl: 1,4,6,7	0.479 in Cyl: 2,3,5,8 0.488 mm Cyl: 1,4,6,7
• Valve Lift – Intake – Active Fuel Management	12.16 mm Cyl: 2,3,5,8 12.39 mm Cyl: 1,4,6,7	0.479 in Cyl: 2,3,5,8 0.488 mm Cyl: 1,4,6,7
• Valves – Valve Seat Angle	46 degrees	
• Valves – Valve Seat Runout	0.05 mm	0.002 in
• Valves – Valve Seat Width – Exhaust	1.78 mm	0.07 in
• Valves – Valve Seat Width – Intake	1.02 mm	0.04 in
• Valves – Valve Stem Diameter – Production	7.955–7.976 mm	0.313–0.314 in
• Valves – Valve Stem Diameter – Service	7.95 mm	0.313 in
• Valves – Valve Stem-to-Guide Clearance – Production – Exhaust	0.025–0.066 mm	0.001–0.0026 in
• Valves – Valve Stem-to-Guide Clearance – Service – Exhaust	0.093 mm	0.0037 in
• Valves – Valve Stem-to-Guide Clearance – Production – Intake	0.025–0.066 mm	0.001–0.0026 in
• Valves – Valve Stem-to-Guide Clearance – Service – Intake	0.093 mm	0.0037 in

Application	Specification	
	Metric	English
• Valves – Valve Stem Height – Measured from Spring Seat – Intake and Exhaust	50.85 +/- 0.375 mm	2.00 +/- 0.015 in
• Rocker Arms – Valve Rocker Arm Ratio	1.70:1	
• Valve Springs – Valve Spring Free Length	52.9 mm	2.08 in
• Valve Springs – Valve Spring Installed Height	45.75 mm	1.8 in
• Valve Springs – Valve Spring Load – Closed	340 N at 45.75 mm	76 lb at 1.8 in
• Valve Springs – Valve Spring Load – Open	980 N at 33.55 mm	220 lb at 1.32 in

Engine Mechanical Specifications (LS3)

Engine Mechanical Specifications

Application	Specification	
	Metric	English
General		
• Engine Type	V8	
• Displacement	6.2L	376 CID
• RPO	LS3	
• Bore	103.25 mm	4.065 in
• Stroke	92.0 mm	3.622 in
• Compression Ratio	10.7:1	
• Idle Speed RPM (AT) • Idle Speed RPM (MT) HSV	550 A/C ON/OFF 650 A/C ON/OFF	
• Firing Order	1-8-7-2-6-5-4-3	
• Spark Plug Gap	0.95-1.10 mm	0.037-0.043 in
Block		
• Camshaft Bearing Bore 1 and 5 Diameter	59.58-59.63 mm	2.345-2.347 in
• Camshaft Bearing Bore 2 and 4 Diameter	59.08-59.13 mm	2.325-2.327 in
• Camshaft Bearing Bore 3 Diameter	58.58-58.63 mm	2.306-2.308 in
• Crankshaft Main Bearing Bore Diameter	69.871-69.889 mm	2.75-2.751 in

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Application	Specification	
	Metric	English
• Crankshaft Main Bearing Bore Out-of-Round	0.006 mm	0.0002 in
• Cylinder Bore Diameter	103.241–103.259 mm	4.0065–4.0065 in
• Cylinder Head Deck Height – Measuring from the Centerline of Crankshaft to the Deck Face	234.7 mm	9.240 in
• Cylinder Head Deck Surface Flatness – Measured within a 152.4 mm (6.0 in) Area	0.11 mm	0.004 in
• Cylinder Head Deck Surface Flatness – Measuring the Overall Length of the Block Deck	0.22 mm	0.008 in
• Valve Lifter Bore Diameter	21.417–21.443 mm	0.843–0.844 in
Camshaft		
• Camshaft End Play	0.025–0.305 mm	0.001–0.012 in
• Camshaft Journal Diameter	54.99–55.04 mm	2.164–2.166 in
• Camshaft Bearing Diameter	55.063–55.088 mm	2.1678–2.1688 in
• Camshaft Journal-to-Bearing Clearance	0.023–0.098 mm	0.0009–0.0038 in
• Camshaft Journal Out-of-Round	0.025 mm	0.001 in
• Camshaft Lobe Lift – Intake	8.24 mm	0.324 in
• Camshaft Lobe Lift – Exhaust	7.77 mm	0.306 in
• Camshaft Runout – Measured at the Intermediate Journals	0.05 mm	0.002 in

Application	Specification	
	Metric	English
Connecting Rod		
• Connecting Rod Bearing Clearance – Production	0.023–0.065 mm	0.0009–0.0025 in
• Connecting Rod Bearing Clearance – Service	0.023–0.076 mm	0.0009–0.003 in
• Connecting Rod Bore Diameter – Bearing End	56.505–56.525 mm	2.224–2.225 in
• Connecting Rod Bore Out-of-Round – Bearing End – Production	0.004–0.008 mm	0.00015–0.0003 in
• Connecting Rod Bore Out-of-Round – Bearing End – Service	0.004–0.008 mm	0.00015–0.0003 in
• Connecting Rod Side Clearance	0.11–0.51 mm	0.00433–0.02 in
Crankshaft		
• Connecting Rod Journal Diameter – Production	53.318–53.338 mm	2.0991–2.0999 in
• Connecting Rod Journal Diameter – Service	53.308 mm	2.0987 in
• Connecting Rod Journal Out-of-Round – Production	0.005 mm	0.0002 in
• Connecting Rod Journal Out-of-Round – Service	0.01 mm	0.0004 in
• Connecting Rod Journal Taper – Maximum for 1/2 of Journal Length – Production	0.005 mm	0.0002 in
• Connecting Rod Journal Taper – Maximum for 1/2 of Journal Length – Service	0.02 mm	0.00078 in
• Crankshaft End Play	0.04–0.2 mm	0.0015–0.0078 in

Application	Specification	
	Metric	English
• Crankshaft Main Bearing Clearance – Production	0.02–0.052 mm	0.0008–0.0021 in
• Crankshaft Main Bearing Clearance – Service	0.02–0.065 mm	0.0008–0.0025 in
• Crankshaft Main Journal Diameter – Production	64.992–65.008 mm	2.558–2.559 in
• Crankshaft Main Journal Diameter – Service	64.992 mm	2.558 in
• Crankshaft Main Journal Out-of-Round – Production	0.003 mm	0.000118 in
• Crankshaft Main Journal Out-of-Round – Service	0.008 mm	0.0003 in
• Crankshaft Main Journal Taper – Production	0.01 mm	0.0004 in
• Crankshaft Main Journal Taper – Service	0.02 mm	0.00078 in
• Crankshaft Rear Flange Runout	0.05 mm	0.002 in
• Crankshaft Reluctor Ring Runout – Measured 1.0 mm (0.04 in) Below Tooth Diameter	0.7 mm	0.028 in
• Crankshaft Thrust Surface – Production	26.14–26.22 mm	1.029–1.0315 in
• Crankshaft Thrust Surface – Service	26.22 mm	1.0315 in
• Crankshaft Thrust Surface Runout	0.025 mm	0.001 in
Cylinder Head		
• Cylinder Head Height/Thickness – Measured from the Cylinder Head Deck to the Valve Rocker Arm Cover Seal Surface	120.2 mm	4.732 in

Application	Specification	
	Metric	English
Surface Flatness – Block Deck – Measured within a 152.4 mm (6.0 in) Area	0.08 mm	0.003 in
Surface Flatness – Block Deck – Measuring the Overall Length of the Cylinder Head	0.1 mm	0.004 in
Surface Flatness – Exhaust Manifold Deck	0.13 mm	0.005 in
Surface Flatness – Intake Manifold Deck	0.08 mm	0.0031 in
Valve Guide Installed Height – Measured from the Spring Seat Surface to the Top of the Guide	17.32 mm	0.682 in
Intake Manifold		
Surface Flatness – Measured at Gasket Sealing Surfaces and Measured Within a 200 mm (7.87 in) Area that Includes 2 Runner Port Openings	0.3 mm	0.118 in
Lubrication System		
Oil Capacity – with Filter Change	7.6 Litres	8 Quarts
Oil Pressure - Minimum - Hot	165 kPa at 1,000 engine RPM 241 kPa at 2,000 engine RPM 262 kPa at 3,000 engine RPM	24 psig at 1,000 engine RPM 35 psig at 2,000 engine RPM 38 psig at 3,000 engine RPM
Relief Valve Oil Pressure (Measured at Oil Pressure Sensor Location)	379 - 517 kPa Maximum	55 - 75 psig Maximum
Oil Pan		
Front Cover Alignment – at Oil Pan Surface	0.0–0.5 mm	0.0–0.02 in
Crankshaft Rear Oil Seal Housing Alignment – at Oil Pan Surface	0.0–0.5 mm	0.0–0.02 in
	0.0–0.1 mm	0.0–0.004 in

Application	Specification	
	Metric	English
Oil Pan Alignment – to Rear of Engine Block at Transmission Bell Housing Mounting Surface		
Piston Rings		
Piston Ring End Gap – First Compression Ring – Measured in Cylinder Bore – Production	0.17–0.38 mm	0.0067–0.0150 in
Piston Ring End Gap – First Compression Ring – Measured in Cylinder Bore – Service	0.17–0.44 mm	0.0067–0.0173 in
Piston Ring End Gap – Second Compression Ring – Measured in Cylinder Bore – Production	0.32–0.63 mm	0.0126–0.0248 in
Piston Ring End Gap – Second Compression Ring – Measured in Cylinder Bore – Service	0.32–0.69 mm	0.0126–0.0272 in
Piston Ring End Gap – Oil Control Ring – Measured in Cylinder Bore – Production	0.22–0.79 mm	0.0086–0.0311 in
Piston Ring End Gap – Oil Control Ring – Measured in Cylinder Bore – Service	0.22–0.85 mm	0.0086–0.0335 in
Piston Ring to Groove Clearance – First Compression Ring – Production	0.030–0.083 mm	0.0012–0.0033 in
Piston Ring to Groove Clearance – First Compression Ring – Service	0.030–0.083 mm	0.0012–0.0033 in
Piston Ring to Groove Clearance – Second Compression Ring – Production	0.040–0.083 mm	0.0016–0.0033 in
Piston Ring to Groove Clearance – Second Compression Ring – Service	0.040–0.083 mm	0.0016–0.0033 in
Piston Ring to Groove Clearance – Oil Control Ring – Production	0.013–0.201 mm	0.0005–0.0079 in
	0.013–0.201 mm	0.0005–0.0079 in

Application	Specification	
	Metric	English
Piston Ring to Groove Clearance – Oil Control Ring – Service		
Pistons and Pins		
Pin – Piston Pin Clearance to Piston Pin Bore – Production	0.002–0.01 mm	0.00008–0.0004 in
Pin – Piston Pin Clearance to Piston Pin Bore – Service	0.002–0.015 mm	0.00008–0.0006 in
Pin – Piston Pin Diameter	23.952–23.955 mm	0.9430–0.9431 in
Pin – Piston Pin Fit in Connecting Rod Bore – Production	0.007–0.02 mm	0.00027–0.00078 in
Pin – Piston Pin Fit in Connecting Rod Bore – Service	0.007–0.022 mm	0.00027–0.00086 in
Piston – Piston Diameter – Measured Over Skirt Coating	103.258–103.289 mm	4.0653–4.0665 in
Piston – Piston to Bore Clearance – Production	–0.048 to +0.001 mm	–0.0019 to +0.000 in
Piston – Piston to Bore Clearance – Service Limit with Skirt Coating Worn Off	0.055 mm	0.0022 in
Valve System		
Valves – Valve Face Angle	45 degrees	
Valves – Valve Face Width	1.25 mm	0.05 in
Valves – Valve Lash	Net Lash – No Adjustment	
Valves – Valve Lift – Intake	13.99 mm	0.551 in

Application	Specification	
	Metric	English
• Valves – Valve Lift – Exhaust	13.25 mm	0.522 in
• Valves – Valve Seat Angle	46 degrees	
• Valves – Valve Seat Runout	0.05 mm	0.002 in
• Valves – Valve Seat Width – Exhaust	1.78 mm	0.07 in
• Valves – Seat Width – Intake	1.02 mm	0.04 in
• Valves – Valve Stem Diameter – Production	7.955–7.976 mm	0.313–0.314 in
• Valves – Valve Stem Diameter – Service	7.95 mm	0.313 in
• Valves – Valve Stem-to-Guide Clearance – Production – Intake	0.025–0.066 mm	0.001–0.0026 in
• Valves – Valve Stem-to-Guide Clearance – Service – Intake	0.093 mm	0.0037 in
• Valves – Valve Stem-to-Guide Clearance – Production – Exhaust	0.025–0.066 mm	0.001–0.0026 in
• Valves – Valve Stem-to-Guide Clearance – Service – Exhaust	0.093 mm	0.0037 in
• Rocker Arms – Valve Rocker Arm Ratio	1.70:1	
• Valve Springs – Valve Spring Free Length	52.9 mm	2.08 in
• Valve Springs – Valve Spring Installed Height	45.75 mm	1.8 in
• Valve Springs – Valve Spring Load – Closed	400 N at 45.75 mm	90 lb at 1.8 in
		264 lb at 1.30 in

Application	Specification	
	Metric	English
• Valve Springs – Valve Spring Load – Open	1175 N at 33.05 mm	

Adhesives, Fluids, Lubricants, and Sealers

Adhesives, Fluids, Lubricants, and Sealers

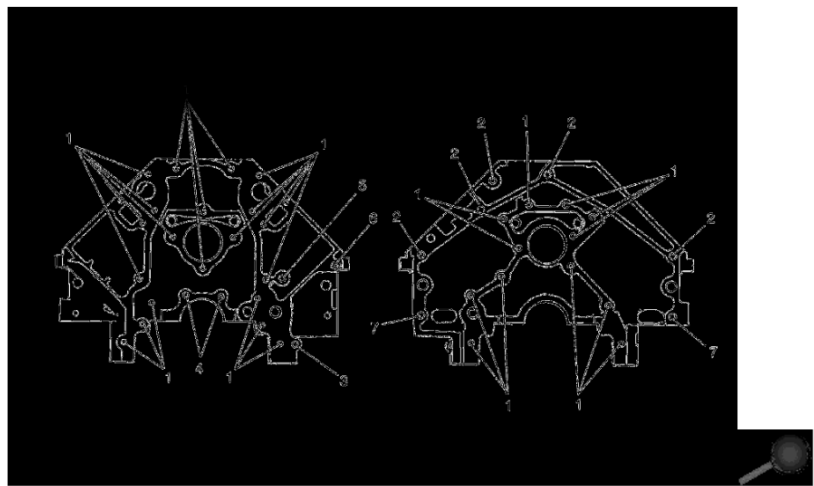
Application	Type of Material	GM Part Number	
		United States	Canada
Coolant Temperature Sensor Threads	Sealant	12346004	10953480
Cylinder Head Core Hole Plug	Threadlocker	12345382	10953489
Cylinder Head Plug	Threadlocker	12345382	10953489
Engine Block Coolant Drain Hole Plug Sealing Washer	Sealant	12346004	10953480
Engine Block Front Oil Gallery Plug	Threadlocker	12345382	10953489
Engine Block Oil Gallery Plug Sealing Washers	Sealant	12346004	10953480
Engine Oil	5W-30	19293000	19286321
Engine Oil Pressure Sensor Threads	Sealant	12346004	10953480
Engine Oil Supplement	Fluorescent Dye	88861206	88861259
Exhaust Manifold Bolts	Threadlocker	89021297	10953488
Flywheel/Flex Plate Bolts	Threadlocker	12345382	10953489
Fuel Injection Fuel Rail Bolts	Threadlocker	12345382	10953489
Ignition Coil Bracket-to-Valve Cover Studs	Threadlocker	12345382	10953489
Ignition Coil-to-Bracket Bolts	Threadlocker	12345382	10953489
Intake Manifold Bolts	Threadlocker	12345382	10953489
Oil Pan Oil Gallery Plug Threads	Sealant	12346004	10953480
Oil Pan Surface at Front Cover and Rear Housing	Sealant	12378521	88901148
Spark Plug Wires	Lubricant	19260901	19260902
Thread Repair Component Cleaner	Cleaner	88862650	88901247
Thread Repair Cutting Oil	Lubricant	1052864	992881

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Thread Repair Specifications (LSA)

- Table 1: [Engine Block – Front/Rear Views](#)
Table 2: [Engine Block – Left/Right Side Views](#)
Table 3: [Engine Block – Top/Bottom Views](#)
Table 4: [Cylinder Head – Top/End Views](#)
Table 5: [Cylinder Head – Intake/Exhaust Side Views](#)

Engine Block – Front/Rear Views



Engine Block – Front/Rear Views

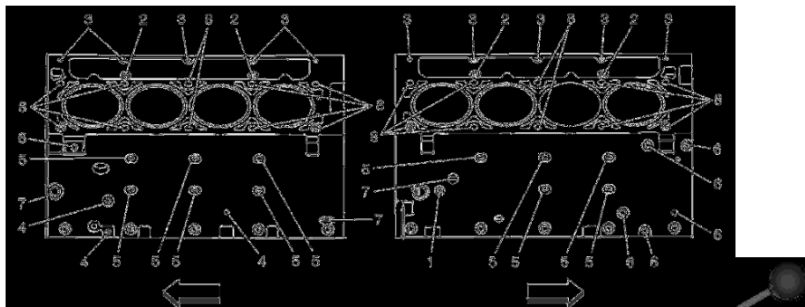
Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
—	—	J 42385—						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	22.5	(0.885)	17.5	(0.688)
2	M10 x 1.5	211	212	N/A	213	214	215	27.5	(1.08)	22.0	(0.866)
3	M10 x 1.5	211	212	N/A	213	214	215	Through		Through	
4	M8 x 1.25	206	207	N/A	208	209	210	Through		Through	
5	M10 x 1.5	211	212	N/A	213	214	215	25.0	(0.984)	19.5	(0.767)
6	M10 x 1.5	211	212	N/A	213	214	215	32.5	(1.279)	25.0	(0.984)
7	M10 x 1.5	211	212	N/A	213	214	215	Through		Through	

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Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
—	—	J 42385-						MM	(IN)	MM	(IN)
Bolt hole 6 is drilled and tapped for aluminium block applications only.											

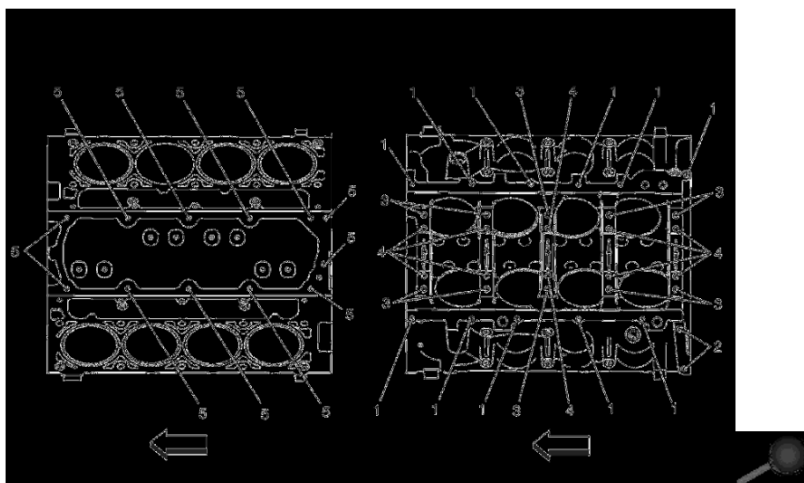
Engine Block – Left/Right Side Views



Engine Block – Left/Right Side Views

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
—	—	J 42385-						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	22.5	(0.885)	17.5	(0.688)
2	M8 x 1.25	206	207	N/A	208	209	210	28.5	(1.122)	23.0	(0.905)
3	M8 x 1.25	206	207	N/A	208	209	210	21.5	(0.846)	16.0	(0.629)
4	M10 x 1.25	211	212	N/A	213	214	215	29.0	(1.141)	23.0	(0.905)
5	M10 x 1.5	211	212	N/A	213	214	215	27.0	(1.062)	21.5	(0.846)
6	M16 x 1.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	
7	M28 x 1.25	N/A	N/A	N/A	N/A	N/A	N/A	Through		Through	
8	M11 x 2.0	105	N/A	N/A	106	107	108	69.0	(2.72)	60.0	(2.36)
Bolt hole 8 has a 30 mm (1.18 in) counterbore included in the 69.0 mm (2.72 in) drill depth. Use sleeve J 42385-315 with the drill and tap.											

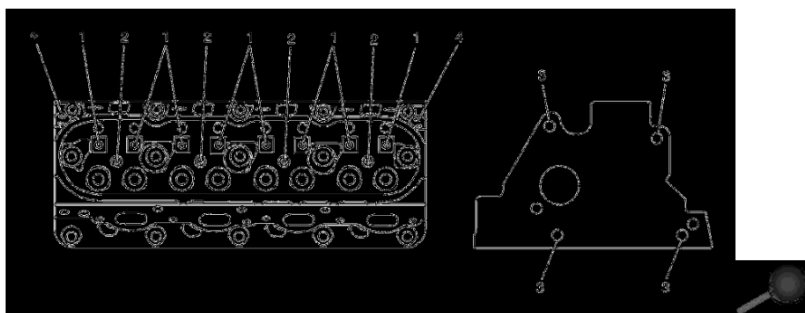
Engine Block – Top/Bottom Views



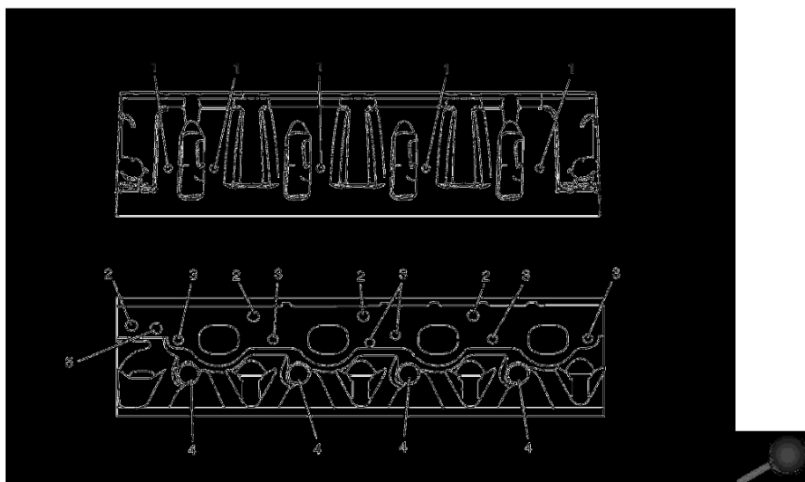
Engine Block – Top/Bottom Views

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
—	—	J42385–						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	22.5	(0.885)	17.5	(0.688)
2	M10 x 1.5	211	212	N/A	213	214	215	42.5	(1.67)	37.0	(1.45)
3	M10 x 2.0	101	N/A	N/A	102	103	104	31.0	(1.22)	25.5	(1.0)
4	M10 x 2.0	101	N/A	N/A	102	103	104	53.5	(2.10)	44.0	(1.73)
5	M8 x 1.25	206	207	N/A	208	209	210	26.5	(1.043)	19.0	(0.748)
- Bolt hole 2 has an 11.5 mm (0.452 in) counterbore included in the 42.5 mm (1.67 in) drill depth. Use sleeve J42385-311 with the drill and tap. - Bolt hole 3 has a 1.5 mm (0.059 in) counterbore included in the 31.0 mm (1.22 in) drill depth. Use sleeve J42385-316 with the drill and tap. - Bolt hole 4 has a 20.5 mm (0.807 in) counterbore included in the 53.5 mm (2.10 in) drill depth.											

Cylinder Head – Top/End Views

**Cylinder Head – Top/End Views**

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
—	—	J 42385–						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	26.5	(1.04)	19.0	(0.784)
2	M6 x 1.0	201	202	N/A	203	204	205	20.05	(0.789)	16.05	(0.632)
3	M10 x 1.5	211	212	N/A	213	214	215	28.0	(1.10)	20.0	(0.787)
4	M6 x 1.0	201	202	N/A	203	204	205	22.5	(0.885)	15.0	(0.688)

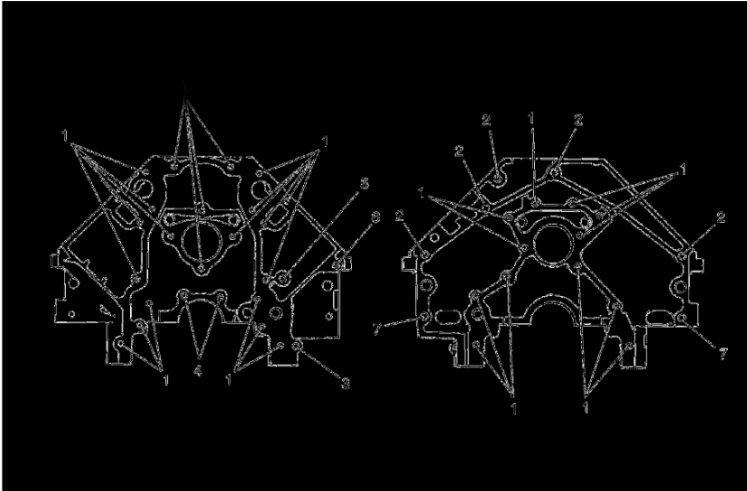
Cylinder Head – Intake/Exhaust Side Views**Cylinder Head – Intake/Exhaust Side Views**

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
—	—	J 42385—						MM	(IN)	MM	(IN)
1	M6 x 1.0	201	202	N/A	203	204	205	Through		Through	
2	M10 x 1.5	211	212	N/A	213	214	215	28.0	(1.10)	20.0	(0.787)
3	M8 x 1.25	206	207	N/A	208	209	210	21.0	(0.826)	16.0	(0.629)
4	M14 x 1.25	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	
5	M12 x 1.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	

Thread Repair Specifications (L77)

- Table 1: [Engine Block – Front/Rear Views](#)
Table 2: [Engine Block – Left/Right Side Views](#)
Table 3: [Engine Block – Top/Bottom Views](#)
Table 4: [Cylinder Head – Top/End Views](#)
Table 5: [Cylinder Head – Intake/Exhaust Side Views](#)

Engine Block – Front/Rear Views



Engine Block – Front/Rear Views

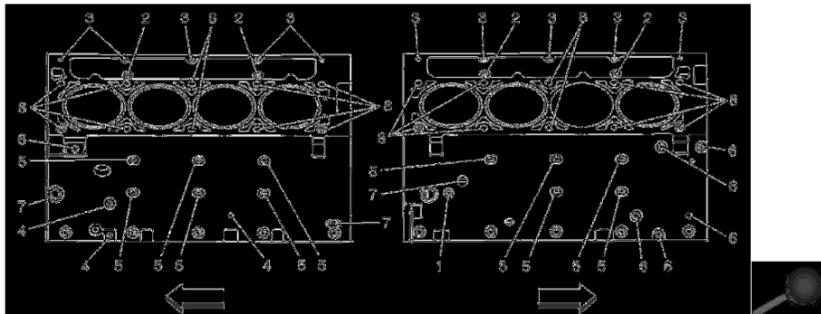
Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
—	—	J 42385–						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	22.5	0.885	17.5	0.688
2	M10 x 1.5	211	212	N/A	213	214	215	27.5	1.08	22.0	0.866
3	M10 x 1.5	211	212	N/A	213	214	215	Through		Through	
4	M8 x 1.25	206	207	N/A	208	209	210	Through		Through	
5	M10 x 1.5	211	212	N/A	213	214	215	25.0	0.984	19.5	0.767
6	M10 x 1.5	211	212	N/A	213	214	215	32.5	1.279	25.0	0.984
7		211	212	N/A	213	214	215	Through		Through	

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Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
—	—	J 42385-						MM	(IN)	MM	(IN)
	M10 x 1.5										

Bolt hole 6 is drilled and tapped for aluminium block applications only.

Engine Block – Left/Right Side Views

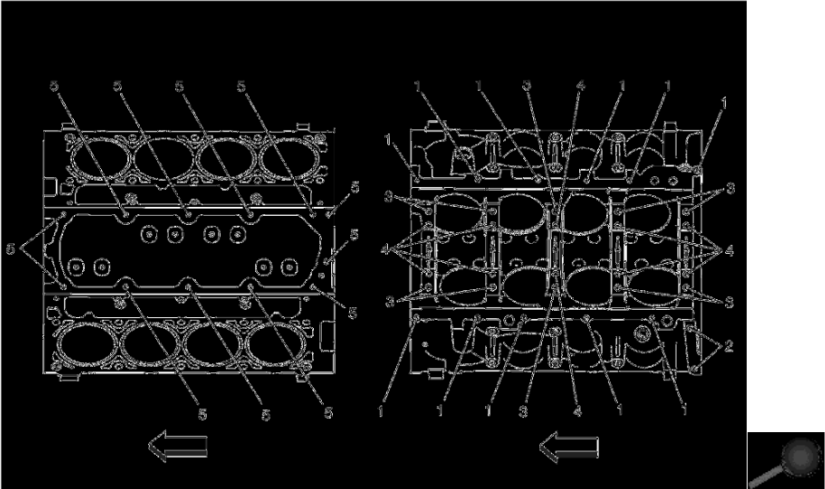


Engine Block – Left/Right Side Views

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
—	—	J 42385-						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	22.5	0.885	17.5	0.688
2	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.122	23.0	0.905
3	M8 x 1.25	206	207	N/A	208	209	210	21.5	0.846	16.0	0.629
4	M10 x 1.25	211	212	N/A	213	214	215	29.0	1.141	23.0	0.905
5	M10 x 1.5	211	212	N/A	213	214	215	27.0	1.062	21.5	0.846
6	M16 x 1.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	
7	M11 x 2.0	105	N/A	N/A	106	107	108	69.0	2.72	60.0	2.36
8	M28 x 1.25	N/A	N/A	N/A	N/A	N/A	N/A	Through		Through	

Bolt hole 7 has a 30 mm (1.18 in) counterbore included in the 69.0 mm (2.72 in) drill depth. Use sleeve J 42385-315 with the drill and tap.

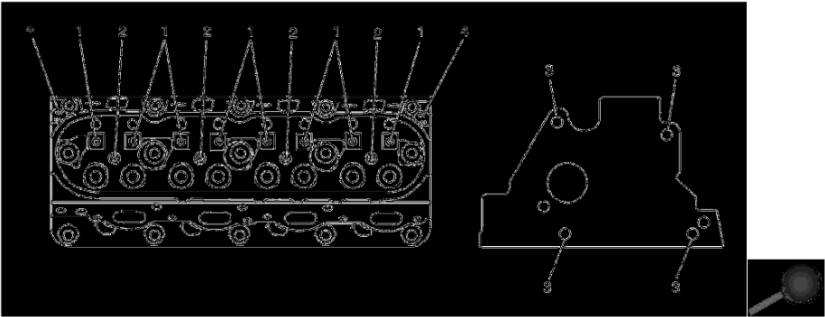
Engine Block – Top/Bottom Views



Engine Block – Top/Bottom Views

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
—	—	J 42385—						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	22.5	0.885	17.5	0.688
2	M10 x 1.5	211	212	N/A	213	214	215	42.5	1.67	37.0	1.45
3	M10 x 2.0	101	N/A	N/A	102	103	104	31.0	1.22	25.5	1.0
4	M10 x 2.0	101	N/A	N/A	102	103	104	53.5	2.10	44.0	1.73
5	M8 x 1.25	206	207	N/A	208	209	210	26.5	1.043	19.0	0.748
• Bolt hole 2 has an 11.5 mm (0.452 in) counterbore included in the 42.5 mm (1.67 in) drill depth. Use sleeve J 42385-311 with the drill and tap. • Bolt hole 3 has a 1.5 mm (0.059 in) counterbore included in the 31.0 mm (1.22 in) drill depth. Use sleeve J 42385-316 with the drill and tap. • Bolt hole 4 has a 20.5 mm (0.807 in) counterbore included in the 53.5 mm (2.10 in) drill depth.											

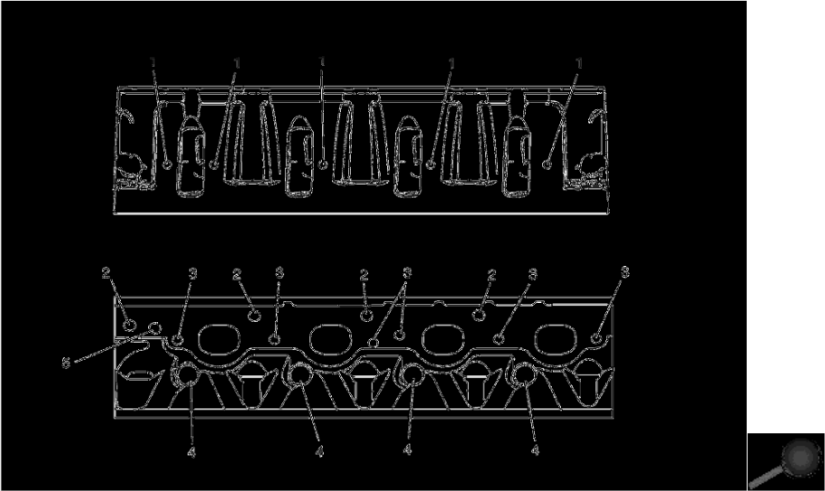
Cylinder Head – Top/End Views



Cylinder Head – Top/End Views

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
—	—	J 42385-						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	26.5	1.04	19.0	0.784
2	M6 x 1.0	201	202	N/A	203	204	205	20.05	0.789	16.05	0.632
3	M10 x 1.5	211	212	N/A	213	214	215	28.0	1.10	20.0	0.787
4	M6 x 1.0	201	202	N/A	203	204	205	22.5	0.885	15.0	0.688

Cylinder Head – Intake/Exhaust Side Views



Cylinder Head – Intake/Exhaust Side Views

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
—	—	J 42385—						MM	(IN)	MM	(IN)
1	M6 x 1.0	201	202	N/A	203	204	205	Through		Through	
2	M10 x 1.5	211	212	N/A	213	214	215	28.0	1.10	20.0	0.787
3	M8 x 1.25	206	207	N/A	208	209	210	21.0	0.826	16.0	0.629
4	M14 x 1.25	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	
5	M12 x 1.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	

Thread Repair Specifications (LS3)

Table 1: [Engine Block- Front/Rear Views](#)

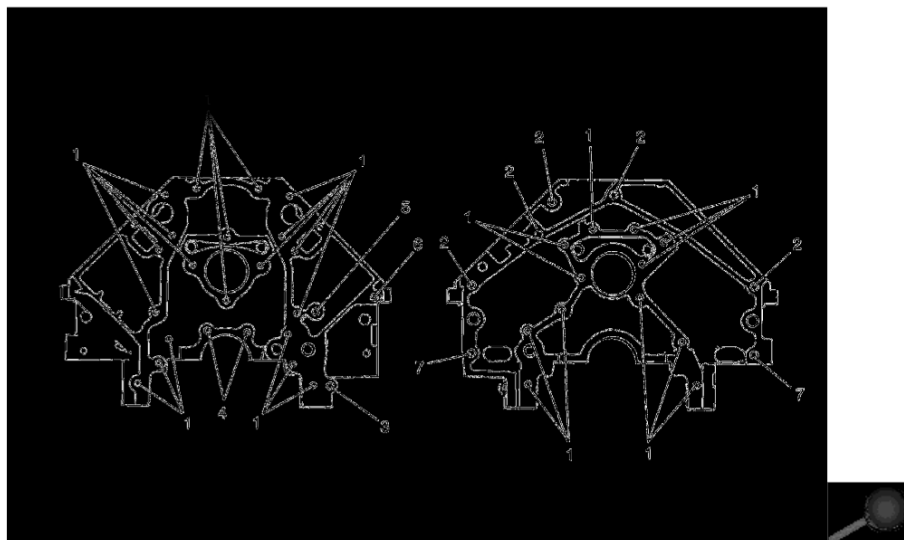
Table 2: [Engine Block- Left/Right Side Views](#)

Table 3: [Engine Block- Top/Bottom Views](#)

Table 4: [Cylinder Head- Top/End Views](#)

Table 5: [Cylinder Head- Intake/Exhaust Side Views](#)

Engine Block- Front/Rear Views



Engine Block- Front/Rear Views

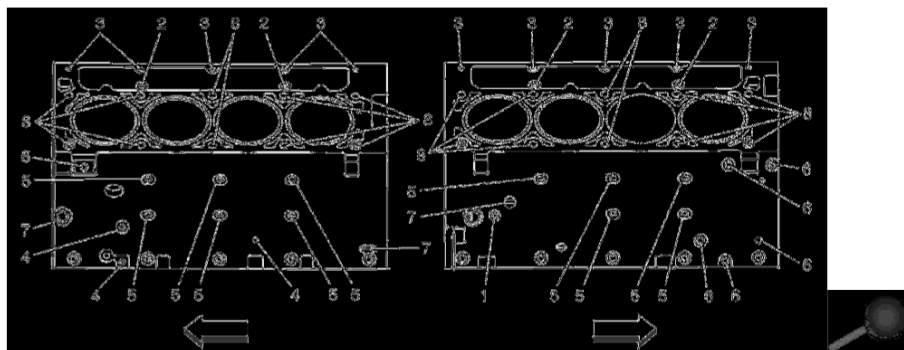
Hole	Thread Size	Insert	Drill	Counter Bore Tool	Tap	Driver	Drill Depth- Maximum mm (in)	Tap Depth- Maximum mm (in)
J42385-								
1	M8 x 1.25	210	206	207	208	209	22.5 (0.885)	17.5 (0.688)
2	M10 x 1.5	215	211	212	213	214	27.5 (1.08)	22.0 (0.866)
3	M10 x 1.5	215	211	212	213	214	Thru	Thru
4	M8 x 1.25	210	206	207	208	209	Thru	Thru
5		215	211	212	213	214		

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Hole	Thread Size	Insert	Drill	Counter Bore Tool	Tap	Driver	Drill Depth- Maximum mm (in)	Tap Depth- Maximum mm (in)
	M10 x 1.5						25.0 (0.984)	19.5 (0.767)
6	M10 x 1.5	215	211	212	213	214	32.5 (1.279)	25.0 (0.984)
7	M10 x 1.5	215	211	212	213	214	Thru	Thru

Bolt hole 6 is drilled and tapped for aluminum block applications only.

Engine Block- Left/Right Side Views



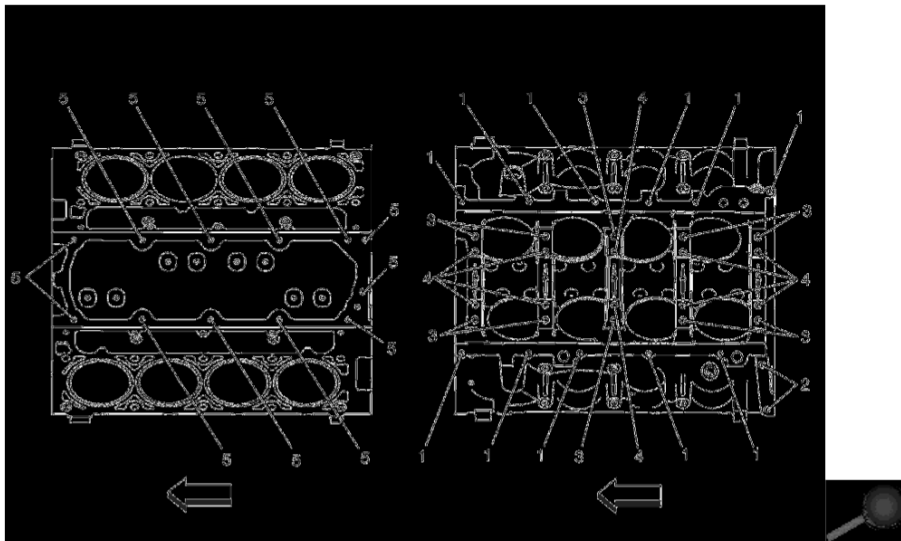
Engine Block- Left/Right Side Views

Hole	Thread Size	Insert	Drill	Counter Bore Tool	Tap	Driver	Drill Depth- Maximum mm (in)	Tap Depth- Maximum mm (in)
J42385-								
1	M8 x 1.25	210	206	207	208	209	22.5 (0.885)	17.5 (0.688)
2	M6 x 1.0	205	201	202	203	204	22.5 (0.885)	15.0 (0.688)
3	M8 x 1.25	210	206	207	208	209	28.5 (1.122)	23.0 (0.905)
4	M8 x 1.25	210	206	207	208	209	21.5 (0.846)	16.0 (0.629)
5	M10 x 1.25	215	211	212	213	214	29.0 (1.141)	23.0 (0.905)
6		215	211	212	213	214		

Hole	Thread Size	Insert	Drill	Counter Bore Tool	Tap	Driver	Drill Depth- Maximum mm (in)	Tap Depth- Maximum mm (in)
	M10 x 1.5						27.0 (1.062)	21.5 (0.846)
7	M16 x 1.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8	M11 x 2.0	108	105	N/A	106	107	69.0 (2.72)	60.0 (2.36)

Bolt hole 8 has a 30 mm (1.18 in) counterbore included in the 69.0 mm (2.72 in) drill depth. Use sleeve J42385-315 with the drill and tap.

Engine Block- Top/Bottom Views



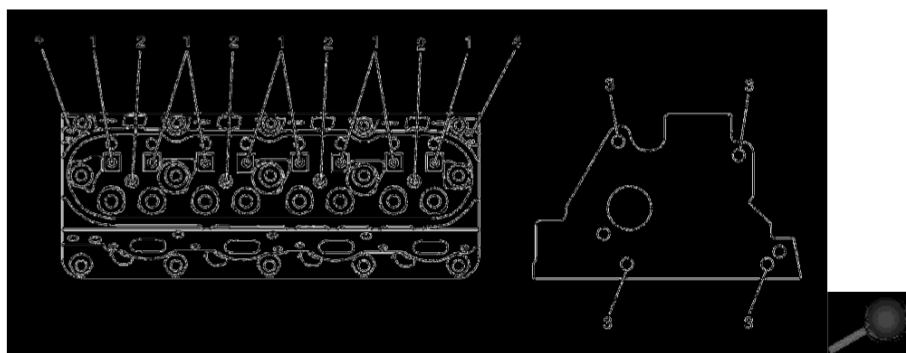
cardiagn.com

Engine Block- Top/Bottom Views

Hole	Thread Size	Insert	Drill	Counter Bore Tool	Tap	Driver	Drill Depth- Maximum mm (in)	Tap Depth- Maximum mm (in)
J42385-								
1	M8 x 1.25	210	206	207	208	209	22.5 (0.885)	17.5 (0.688)
2	M10 x 1.5	215	211	212	213	214	42.5 (1.67)	37.0 (1.45)
3		104	101	N/A	102	103		25.5 (1.0)

Hole	Thread Size	Insert	Drill	Counter Bore Tool	Tap	Driver	Drill Depth- Maximum mm (in)	Tap Depth- Maximum mm (in)
	M10 x 2.0						31.0 (1.22)	
4	M10 x 2.0	104	101	N/A	102	103	53.5 (2.10)	44.0 (1.73)
5	M8 x 1.25	210	206	207	208	209	26.5 (1.043)	19.0 (0.748)
- Bolt hole 2 has an 11.5 mm (0.452 in) counterbore included in the 42.5 mm (1.67 in) drill depth. Use sleeve J 42385-311 with the drill and tap. - Bolt hole 3 has a 1.5 mm (0.059 in) counterbore included in the 31.0 mm (1.22 in) drill depth. Use sleeve J 42385-316 with the drill and tap. - Bolt hole 4 has a 20.5 mm (0.807 in) counterbore included in the 53.5 mm (2.10 in) drill depth.								

Cylinder Head- Top/End Views

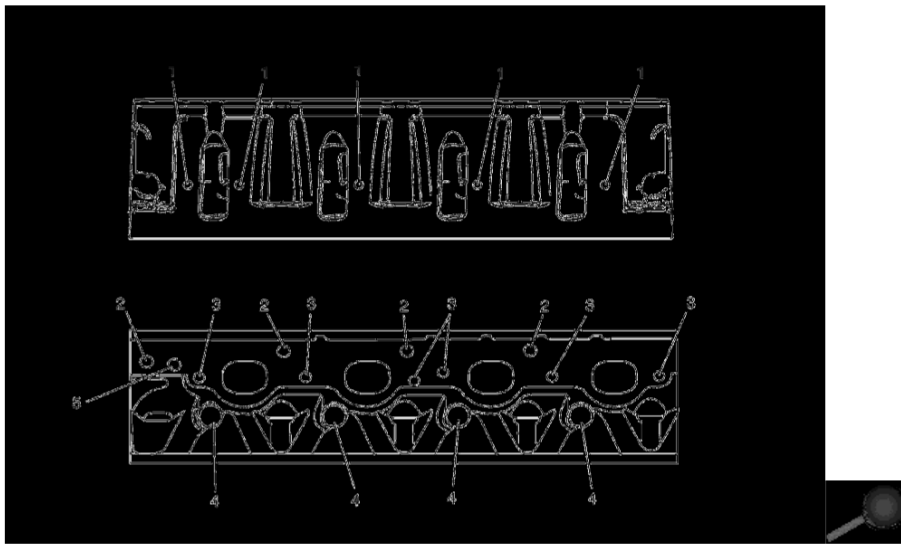


Cylinder Head- Top/End Views

Hole	Thread Size	Insert	Drill	Counter Bore Tool	Tap	Driver	Drill Depth- Maximum mm (in)	Tap Depth- Maximum mm (in)
J 42385-								
1	M8 x 1.25	210	206	207	208	209	26.5 (1.04)	19.0 (0.784)
2	M6 x 1.0	205	201	202	203	204	20.05 (0.789)	16.05 (0.632)
3	M10 x 1.5	215	211	212	213	214	28.0 (1.10)	20.0 (0.787)

Hole	Thread Size	Insert	Drill	Counter Bore Tool	Tap	Driver	Drill Depth- Maximum mm (in)	Tap Depth- Maximum mm (in)
4	M6 x 1.0	205	201	202	203	204	22.5 (0.885)	15.0 (0.688)

Cylinder Head- Intake/Exhaust Side Views

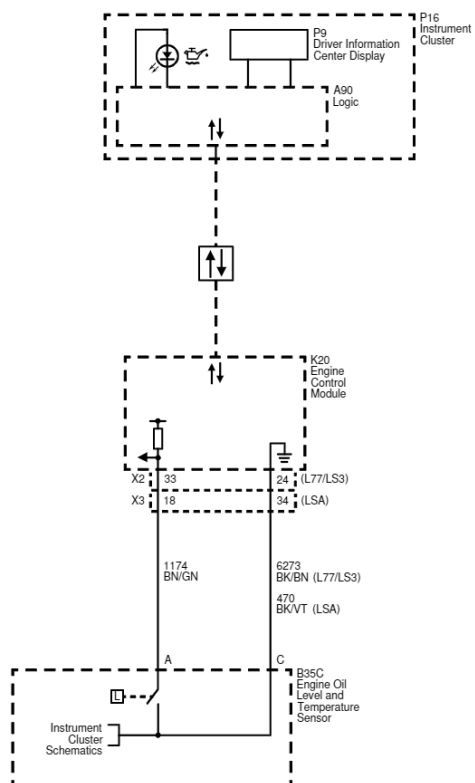


Cylinder Head- Intake/Exhaust Side Views

Hole	Thread Size	Insert	Drill	Counter Bore Tool	Tap	Driver	Drill Depth- Maximum mm (in)	Tap Depth- Maximum mm (in)
J42385-								
1	M6 x 1.0	205	201	202	203	204	Thru	Thru
2	M10 x 1.5	215	211	212	213	214	28.0 (1.10)	20.0 (0.787)
3	M8 x 1.25	210	206	207	208	209	21.0 (0.826)	16.0 (0.629)
4	M14 x 1.25	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5	M12 x 1.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A

LOG

DES



Special Tools

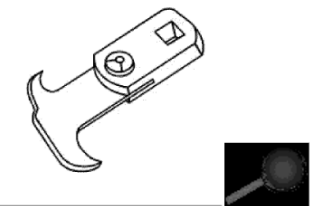
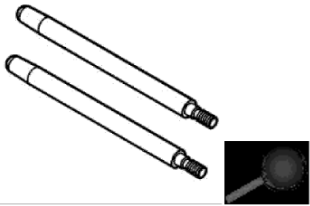
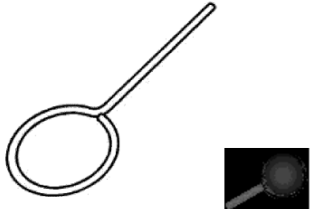
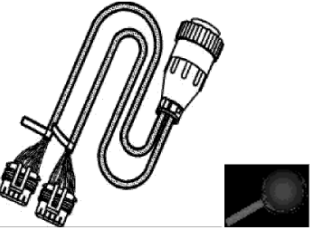
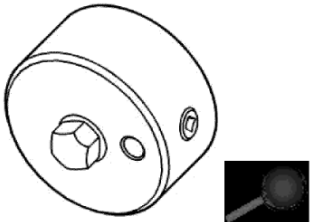
Illustration	Tool Number/Description
	E-308 Seal Remover
	EN46121 Connecting Rod Guide Pin Set
	EN46330 Timing Belt Tensioner Retaining Pin
	EN-46999-5 Active Fuel Management Tester Harness - Small Block V8
	EN-47971 Oil Pressure Gauge Adapter

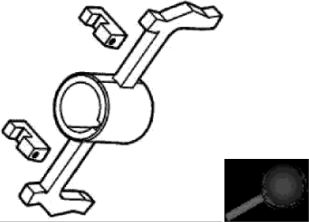
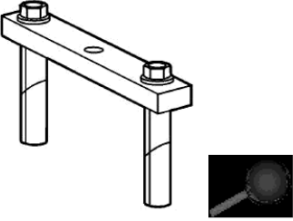
Illustration	Tool Number/Description
	EN-48853 Front Cover Alignment Tool
	EN-49102 Crankshaft Bearing Cap Remover
	J 6125-1B Slide Hammer with Adapter
	J 7872 Magnetic Base Dial Indicator
	J 8037 Ring Compressor
	J 8062 Valve Spring Compressor - Head Off

Illustration	Tool Number/Description
	
	J 8087 Cylinder Bore Gauge
	J 8089 Carbon Removal Brush
	J 8433 Two Jaw Puller
	J 8520 Cam Lobe Lift Indicator
	J 9290-A Valve Lifter Remover

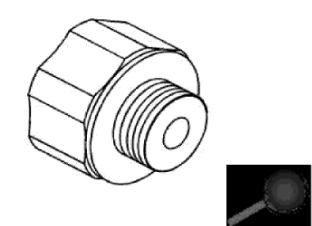
Illustration	Tool Number/Description
	
	J 9666 Valve Spring Tester
	J 21867 Pressure Gauge
	J 21867-16 Oil Pressure Adapter
	J 22794 Spark Plug Port Adapter
	J 23907 Slide Hammer with Bearing Adapter

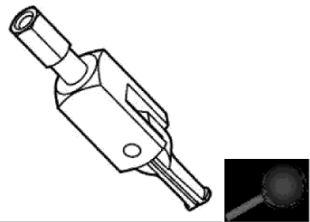
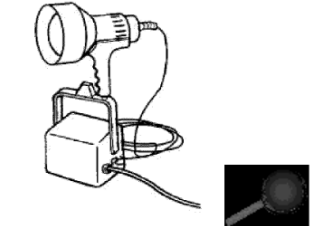
Illustration	Tool Number/Description
	
	J 24270 Cylinder Bore Ridge Reamer
	J 28410 Gasket Remover
	J 28428-E High-Intensity Black Light Kit
	J 28467-B Universal Engine Support Fixture
	J 33049 Camshaft Bearing Service Set

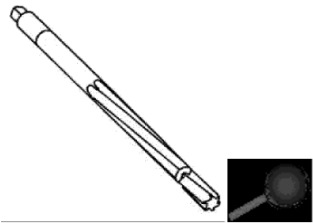
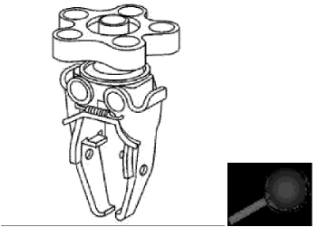
Illustration	Tool Number/Description
	
	J 35667-A Cylinder Head Leakdown Tester
	J 37378-1 Valve Guide Reamer
	J 38606 Valve Spring Compressor
	J 38836 Bushing Installer and Clutch Arbor
	J 39400-A Halogen Leak Detector

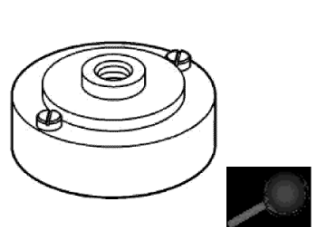
Illustration	Tool Number/Description
	
	J 41476 Front and Rear Cover Alignment Tool
	J 41478 Crankshaft Front Oil Seal Installer
	J 41479-B Crankshaft Rear Oil Seal Installer
	J 41479-2B Crankshaft Rear Oil Seal Installation Guide
	J-41480-A Front and Rear Cover Alignment

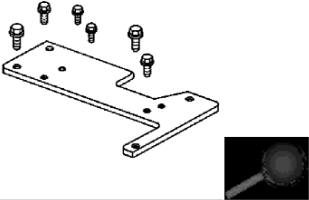
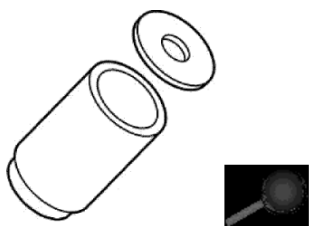
Illustration	Tool Number/Description
	
	J 41556 Connecting Rod Guide
	J 41558 Crankshaft Sprocket Remover
	J 41665-A Crankshaft Balancer and Sprocket Installer
	J 41712 Oil Pressure Switch Socket
	J 41798 Engine Lift Bracket

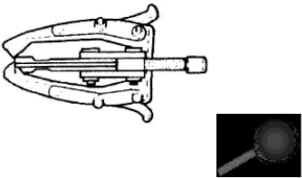
Illustration	Tool Number/Description
	
	J 41803 Engine Support Fixture
	J 41816 Crankshaft Balancer Remover
	J 41816-2 Crankshaft End Protector
	J 41818 Crankshaft Bearing Cap Remover
	J 42385-100 Head/Main Bolt Thread Repair Kit

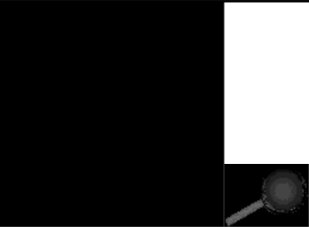
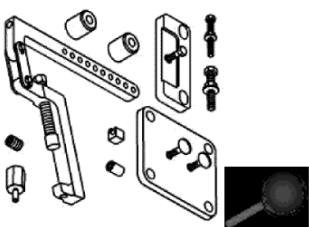
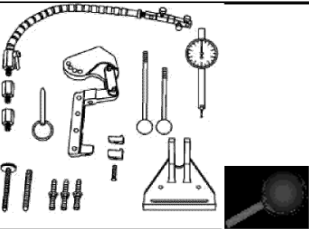
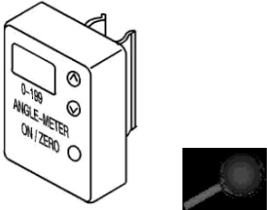
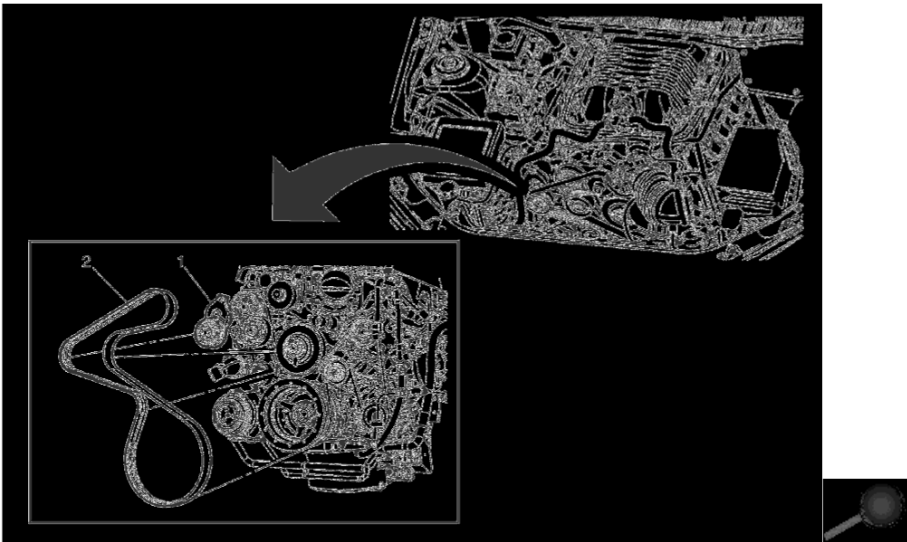
Illustration	Tool Number/Description
	
	J 42385-200 Common Threads Repair Kit
	J 42385-300 Fixtures and Hardware Kit
	J 42386-A Flywheel Holding Tool
	J 43690-100 Rod Bearing Clearance Checking Tool - Adapter Kit
	J 43690-A Rod Bearing Clearance Checking Tool

Illustration	Tool Number/Description
	
	J 45059 Angle Meter
	J 45299 Engine Pre-Luber

Supercharger Belt Replacement

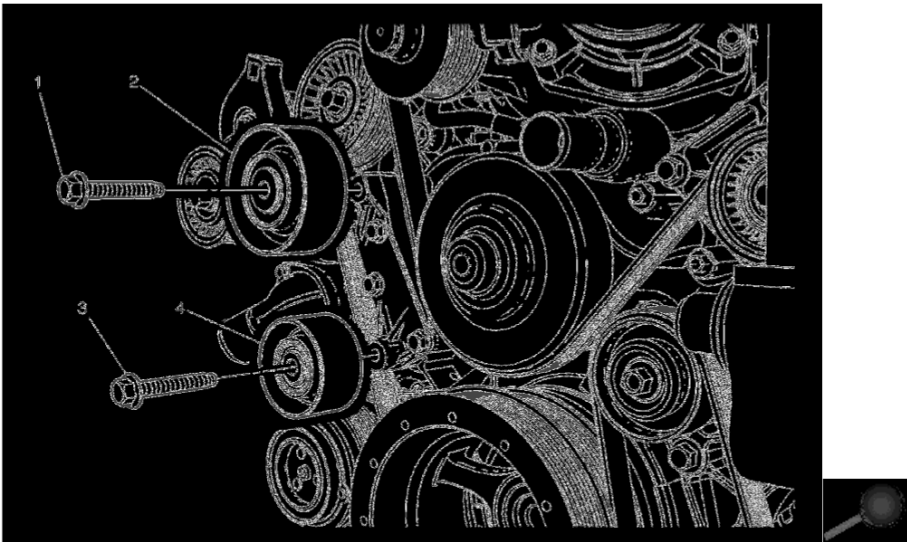


Supercharger Belt Replacement

Callout	Component Name
Preliminary Procedure Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement	
1	Supercharger Tensioner Procedure 1. Use a 1/2 inch breaker bar to rotate the supercharger belt tensioner counter clockwise. 2. Slide the belt off the upper supercharger idler pulley.
2	Supercharger Belt Procedure 1. Clean and inspect the supercharger belt surfaces of all the pulleys. 2. Inspect the supercharger belt for correct alignment.

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Supercharger Belt Idler Pulley Replacement

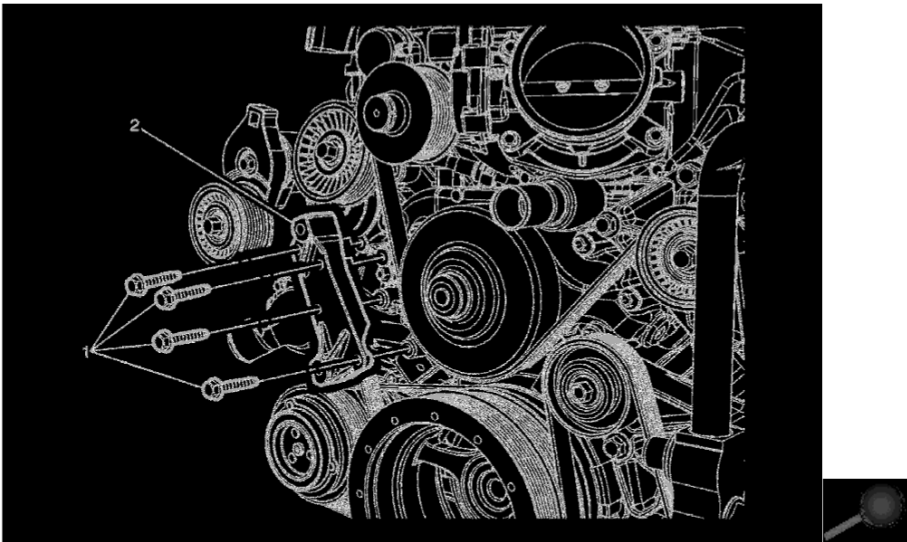


Supercharger Belt Idler Pulley Replacement

Callout	Component Name
Preliminary Procedure Remove the supercharger belt. Refer to Supercharger Belt Replacement .	
1	Supercharger Belt Idler Pulley Fastener Caution: Refer to Component Fastener Tightening Caution . Tighten 58 N•m (43 lb ft)
2	Supercharger Belt Idler Pulley
3	Supercharger Belt Idler Pulley Fastener Tighten 58 N•m (43 lb ft)
4	Supercharger Belt Idler Pulley

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Supercharger Belt Idler Pulley Bracket Replacement

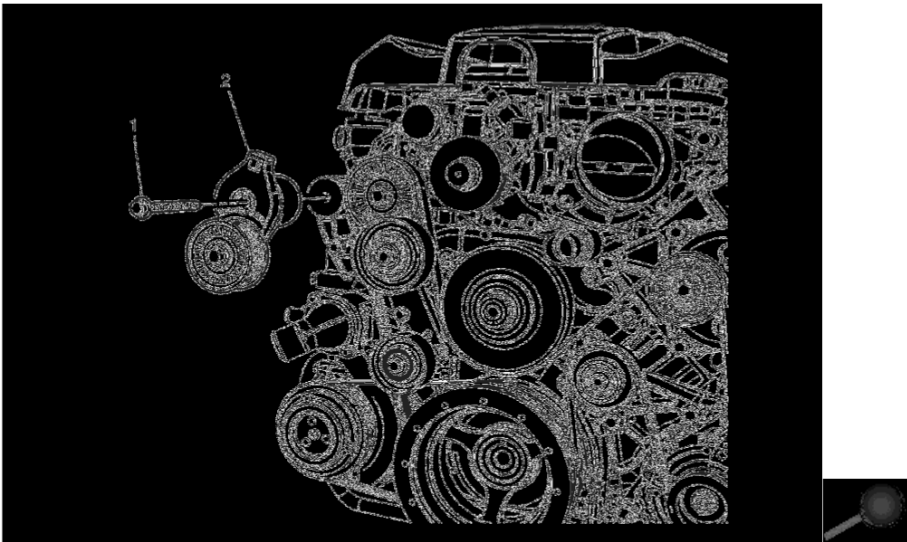


Supercharger Belt Idler Pulley Bracket Replacement

Callout	Component Name
Preliminary Procedure Remove the supercharger belt idler pulley. Refer to Supercharger Belt Idler Pulley Replacement .	
1	Supercharger Belt Idler Pulley Bracket Fastener (Qty: 4) Caution: Refer to Fastener Caution . Tighten 22 N•m (16 lb ft)
2	Supercharger Belt Idler Pulley Bracket

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Supercharger Belt Tensioner Replacement

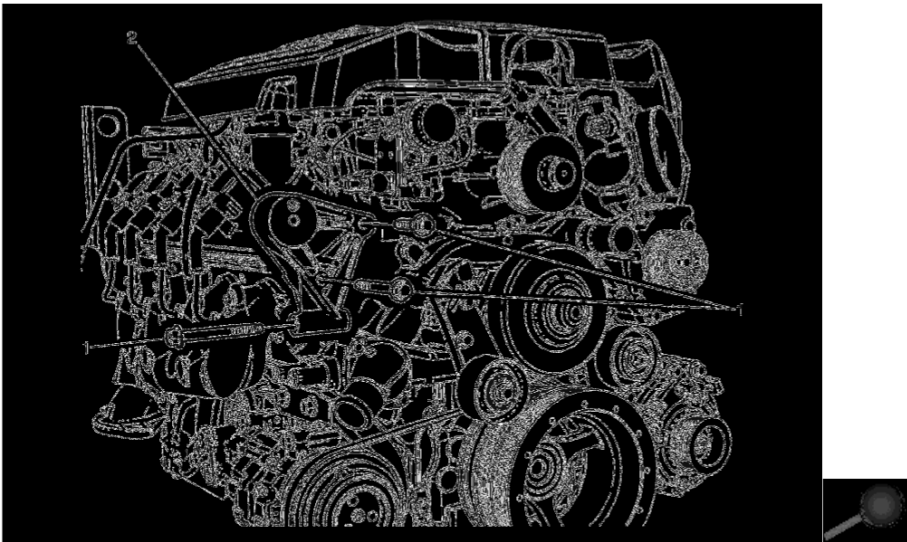


Supercharger Belt Tensioner Replacement

Callout	Component Name
Preliminary Procedure Remove the supercharger belt. Refer to Supercharger Belt Replacement .	
1	Supercharger Belt Tensioner Fastener Caution: Refer to Fastener Caution . Tighten 58 N•m (43 lb ft)
2	Supercharger Belt Tensioner

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Supercharger Belt Tensioner Bracket Replacement

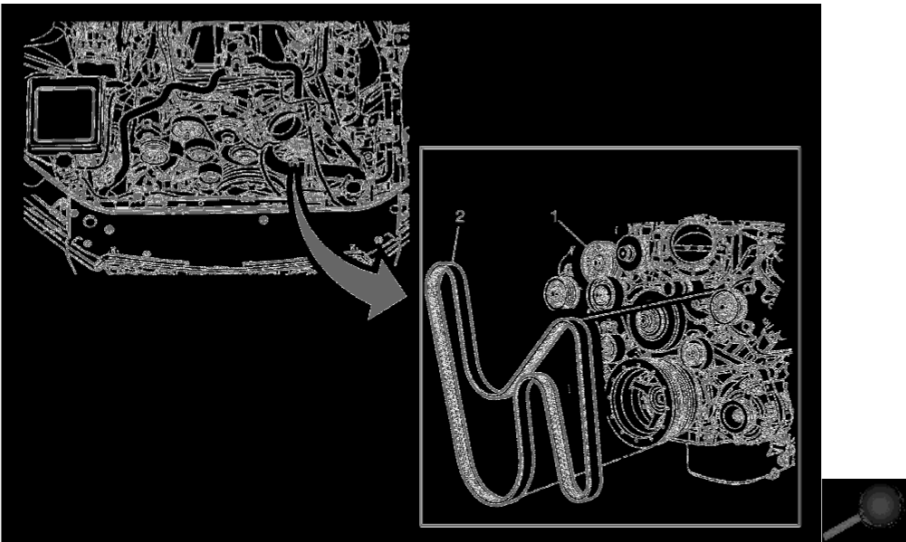


Supercharger Belt Tensioner Bracket Replacement

Callout	Component Name
Preliminary Procedures 1. Remove the supercharger belt tensioner. Refer to Supercharger Belt Tensioner Replacement . 2. Remove the drive belt tensioner. Refer to Drive Belt Tensioner Replacement - Accessory .	
1	Supercharger Belt Tensioner Bracket Fastener (Qty: 3) Caution: Refer to Fastener Caution . Tighten 58 N•m (43 lb ft)
2	Supercharger Belt Tensioner Bracket

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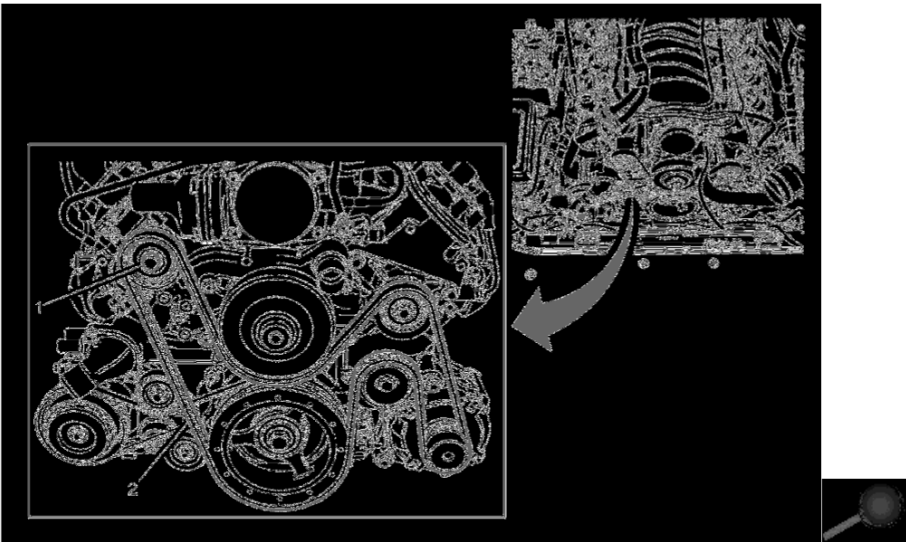
Drive Belt Replacement - Accessory (LSA)



Drive Belt Replacement - Accessory

Callout	Component Name
Preliminary Procedure 1. Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement . 2. Remove the supercharger belt. Refer to Supercharger Belt Replacement .	
1	Drive Belt Tensioner Procedure 1. Use the proper tool to rotate the drive belt tensioner. 2. Remove the drive belt from the pulleys and tensioner.
2	Drive Belt Procedure 1. Clean and inspect the drive belt surfaces of all the pulleys. 2. Inspect the drive belt for correct alignment.

Drive Belt Replacement - Accessory (L77 or LS3)



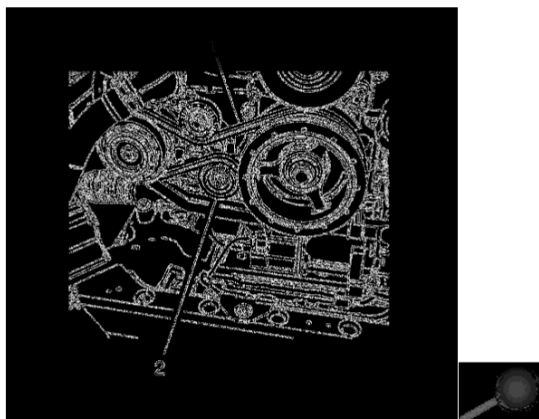
Drive Belt Replacement - Accessory

Callout	Component Name
Preliminary Procedure Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement .	
1	Drive Belt Tensioner Procedure 1. Use the proper tool to rotate the drive belt tensioner. 2. Remove the drive belt from the pulleys and tensioner.
2	Drive Belt Procedure 1. Clean and inspect the drive belt surfaces of all the pulleys. 2. Inspect the drive belt for correct alignment.

Air Conditioning Compressor Belt Replacement (L77 or LS3)

Removal Procedure

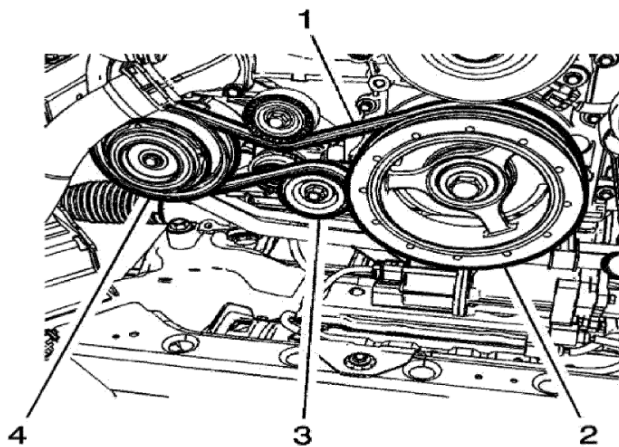
1. Remove the accessory drive belt. Refer to [Drive Belt Replacement - Accessory](#).



2. Using a suitable tool, rotate the air conditioner (A/C) belt tensioner (2) clockwise.
3. Remove the A/C belt (1).
4. Slowly release the A/C belt tensioner (2).
5. Clean and inspect the belt surfaces of all the pulleys.

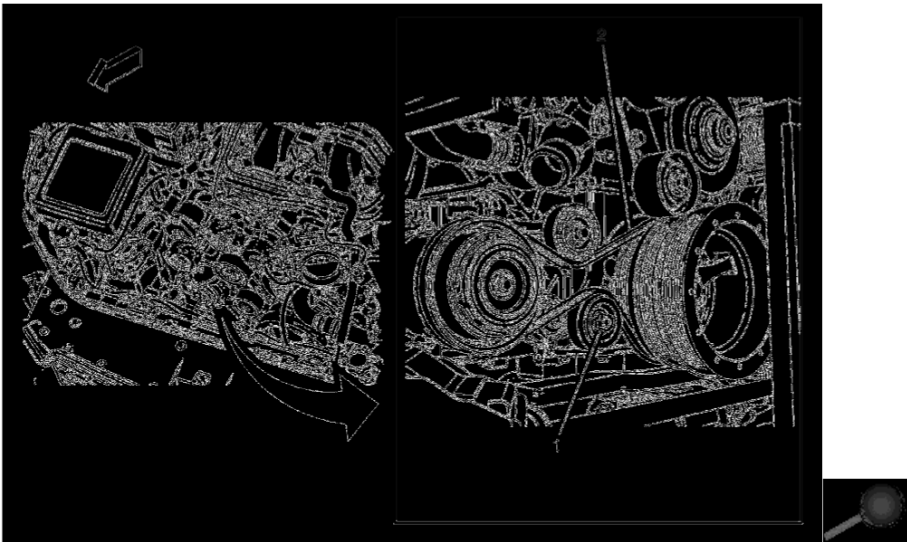
Installation Procedure

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1. Install the A/C belt (1) around the crankshaft balancer (2).
2. Using a suitable tool, rotate the A/C belt tensioner (3) clockwise.
3. Install the A/C belt (1) over the A/C belt tensioner (3) idler pulley.
4. Install the A/C belt (1) around the A/C compressor pulley (4).
5. Slowly release the tension on the A/C belt tensioner (3).
6. Inspect the A/C belt (1) for correct installation and alignment.
7. Install the accessory drive belt. Refer to [Drive Belt Replacement - Accessory](#).

Air Conditioning Compressor Belt Replacement (LSA)

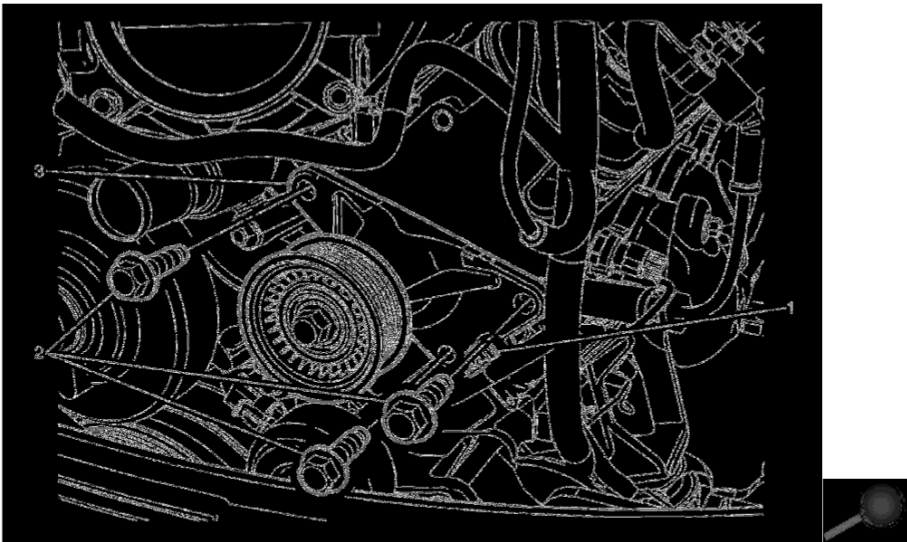


Air Conditioning Compressor Belt Replacement

Callout	Component Name
Preliminary Procedure Remove the accessory drive belt. Refer to Drive Belt Replacement - Accessory .	
1	Air Conditioning Belt Tensioner Procedure 1. Use the proper tool to rotate the air conditioning belt drive belt tensioner. 2. Remove the drive belt from the pulleys and the air conditioning drive belt tensioner.
2	Drive Belt Procedure 1. Clean and inspect the drive belt surfaces of all the pulleys. 2. Inspect the drive belt for correct alignment.

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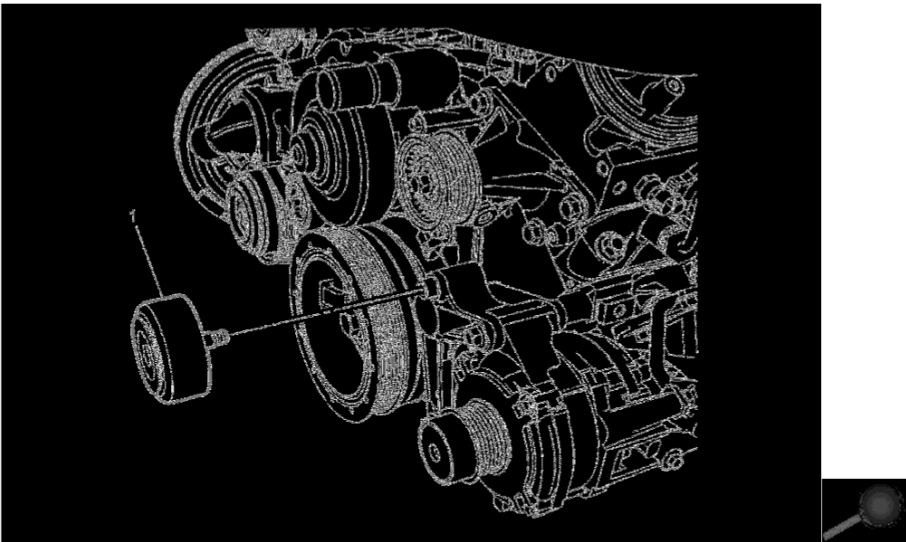
Belt Idler Pulley Bracket Replacement



Belt Idler Pulley Bracket Replacement

Callout	Component Name
Preliminary Procedure Remove the accessory drive belt. Refer to Drive Belt Replacement - Accessory .	
1	Wiring Harness Retainer Procedure Remove the wiring harness retainer from the idler puller bracket then reposition the wiring harness as needed.
2	Belt Idler Pulley Bracket Fastener (Qty: 3) Caution: Refer to Fastener Caution . Tighten 58 N•m (43 lb ft)
3	Belt Idler Pulley Bracket

Drive Belt Idler Pulley Replacement (L77 or LS3 Lower)

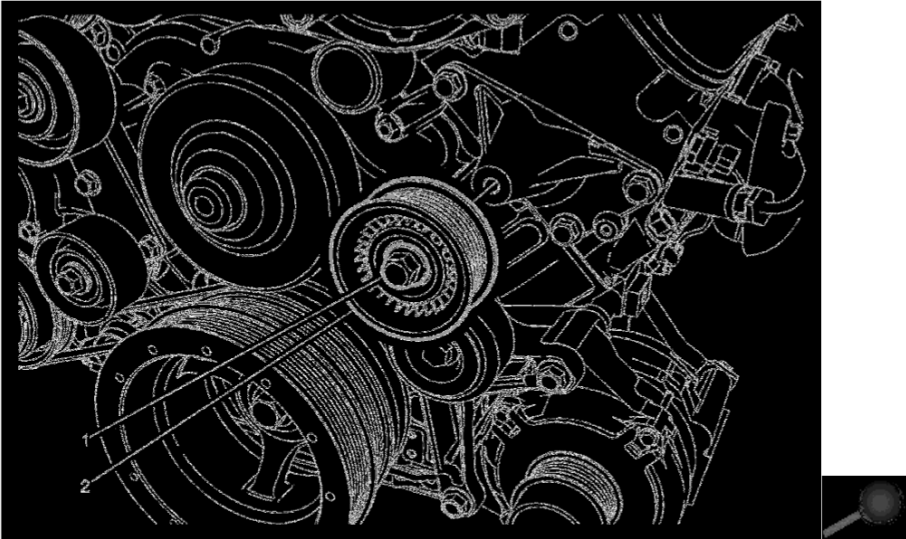


Drive Belt Idler Pulley Replacement

Callout	Component Name
Preliminary Procedure Remove the drive belt. Refer to Drive Belt Replacement - Accessory .	
1	Lower Drive Belt Idler Pulley Assembly Caution: Refer to Fastener Caution . Tighten 50 N•m (37 lb ft)

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Drive Belt Idler Pulley Replacement (LSA Upper)

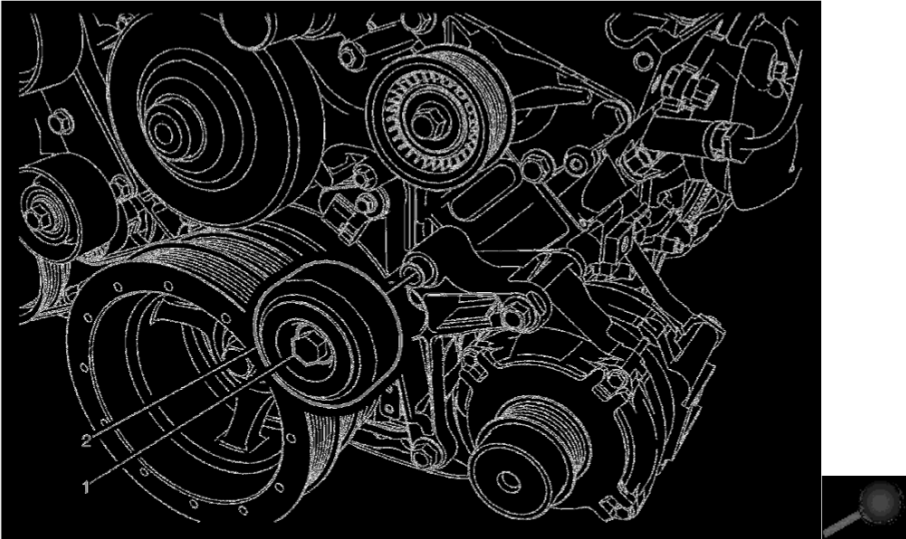


Drive Belt Idler Pulley Replacement

Callout	Component Name
Preliminary Procedure Remove the drive belt. Refer to Drive Belt Replacement - Accessory .	
1	Upper Drive Belt Idler Pulley Fastener Caution: Refer to Fastener Caution . Tighten 58 N•m (43 lb ft)
2	Upper Drive Belt Idler Pulley

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Drive Belt Idler Pulley Replacement (LSA Lower)

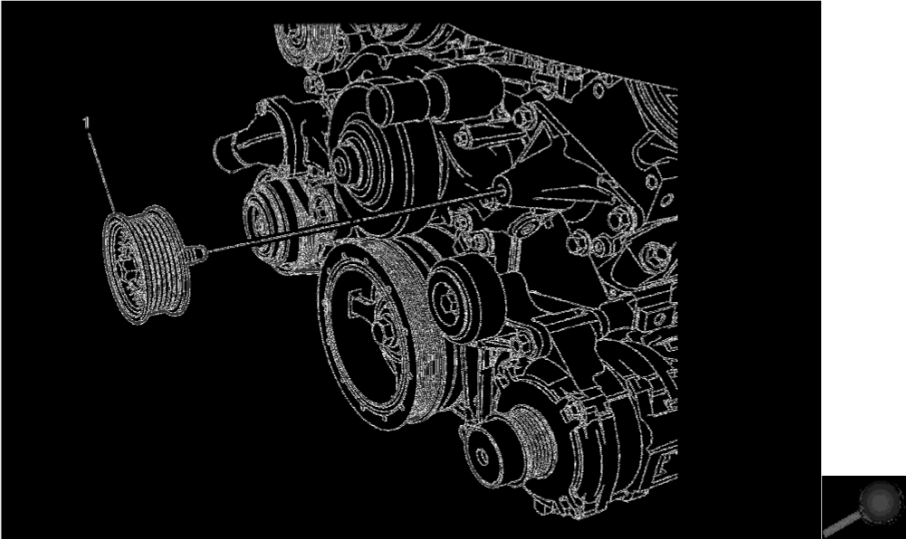


Drive Belt Idler Pulley Replacement

Callout	Component Name
Preliminary Procedure Remove the drive belt. Refer to Drive Belt Replacement - Accessory .	
1	Lower Drive Belt Idler Pulley Fastener Caution: Refer to Fastener Caution . Tighten 45 N•m (33 lb ft)
2	Lower Drive Belt Idler Pulley

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Drive Belt Idler Pulley Replacement (L77 or LS3 Upper)

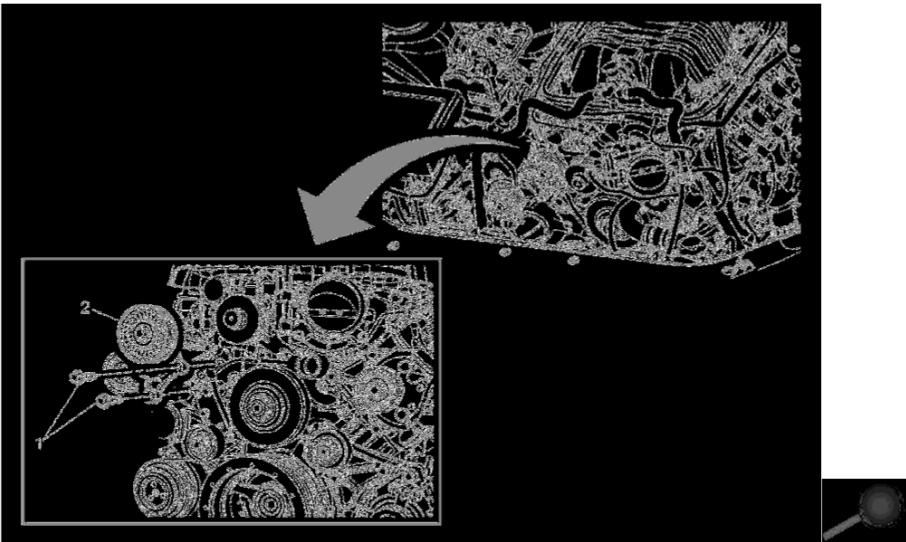


Drive Belt Idler Pulley Replacement

Callout	Component Name
Preliminary Procedure Remove the drive belt. Refer to Drive Belt Replacement - Accessory .	
1	Lower Drive Belt Idler Pulley Assembly Caution: Refer to Fastener Caution . Tighten 58 N•m (43 lb ft)

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Drive Belt Tensioner Replacement - Accessory (LSA)



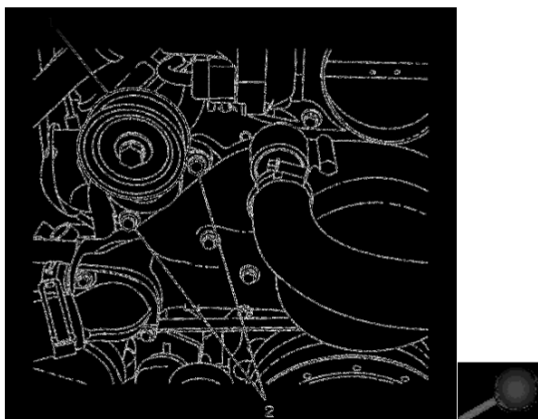
Drive Belt Tensioner Replacement - Accessory

Callout	Component Name
Preliminary Procedures 1. Remove the upper supercharger belt idler pulley. Refer to Supercharger Belt Idler Pulley Replacement . 2. Remove the accessory drive belt. Refer to Drive Belt Replacement - Accessory .	
1	Drive Belt Tensioner Fastener (Qty: 2) Caution: Refer to Fastener Caution . Tighten 58 N•m (43 lb ft)
2	Drive Belt Tensioner

Drive Belt Tensioner Replacement - Accessory (L77 or LS3)

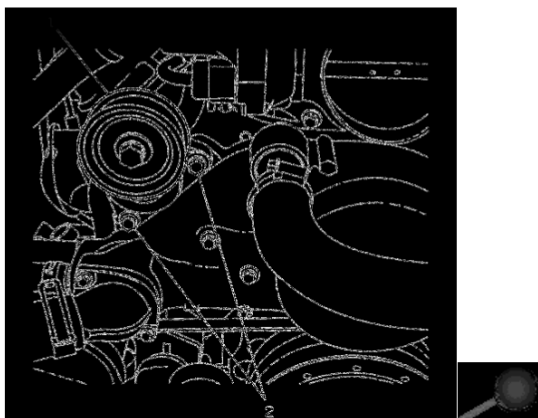
Removal Procedure

1. Remove the accessory drive belt. Refer to [Drive Belt Replacement - Accessory](#).



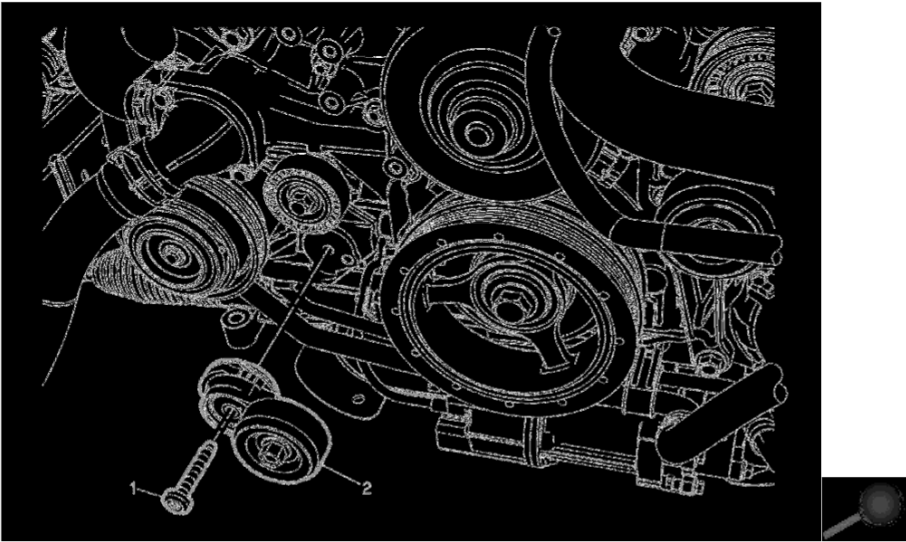
2. Remove the accessory drive belt tensioner to cylinder head retaining bolts (2).
3. Remove the accessory drive belt tensioner (1).

Installation Procedure



1. Install the accessory drive belt tensioner (1).
- Caution:** Refer to [Fastener Caution](#).
2. Install the accessory drive belt tensioner to cylinder head retaining bolts (2) and tighten to **58 N·m (43 lb ft)**.
3. Install the accessory drive belt. Refer to [Drive Belt Replacement - Accessory](#).

Drive Belt Tensioner Replacement - Air Conditioning
(L77 or LS3)

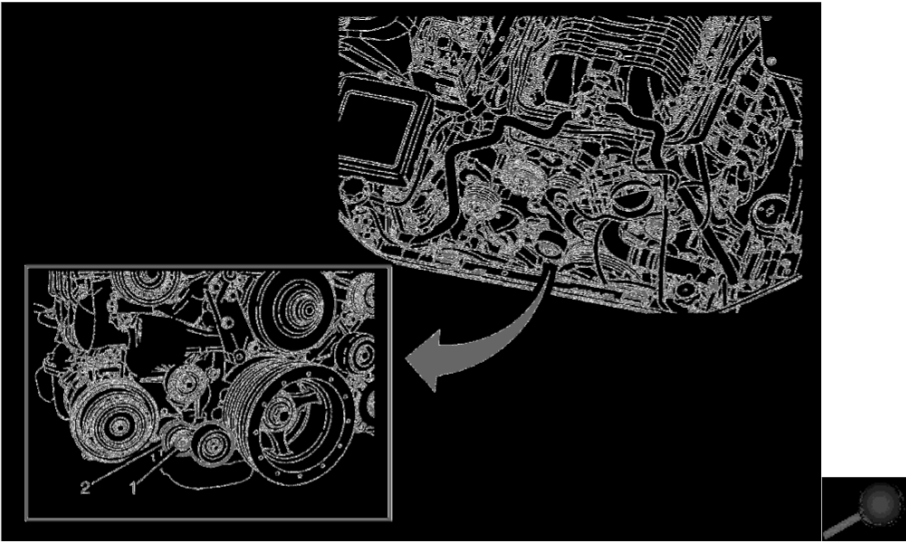


Drive Belt Tensioner Replacement - Air Conditioning

Callout	Component Name
Preliminary Procedure Remove the air conditioning compressor belt. Refer to Air Conditioning Compressor Belt Replacement .	
1	Air Conditioning Drive Belt Tensioner Fastener Caution: Refer to Fastener Caution . Tighten 50 N•m (37 lb ft)
2	Air Conditioning Drive Belt Tensioner

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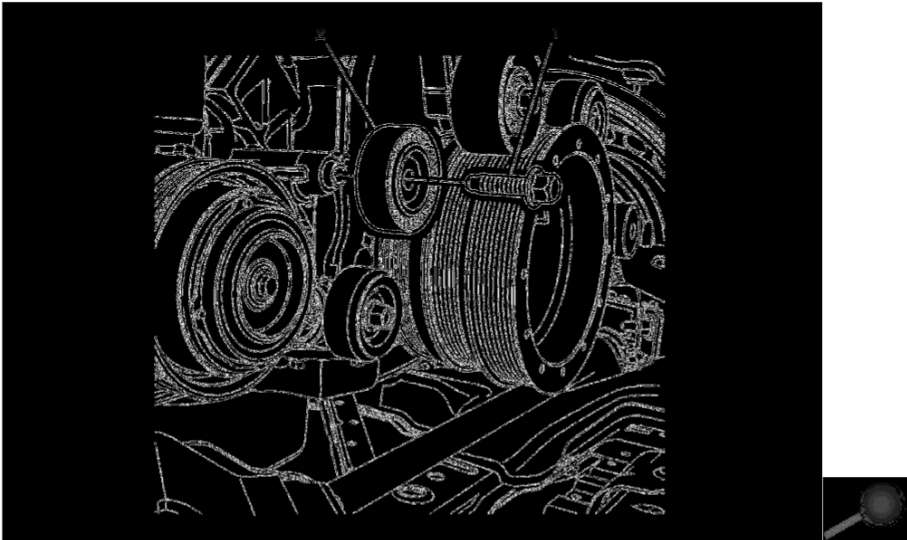
Drive Belt Tensioner Replacement - Air Conditioning (LSA)



Drive Belt Tensioner Replacement - Air Conditioning

Callout	Component Name
Preliminary Procedure Remove the A/C drive belt. Refer to Air Conditioning Compressor Belt Replacement .	
1	Drive Belt Tensioner- Air Conditioning Fastener Caution: Refer to Fastener Caution . Tighten 50 N•m (37 lb ft)
2	Drive Belt Tensioner- Air Conditioning

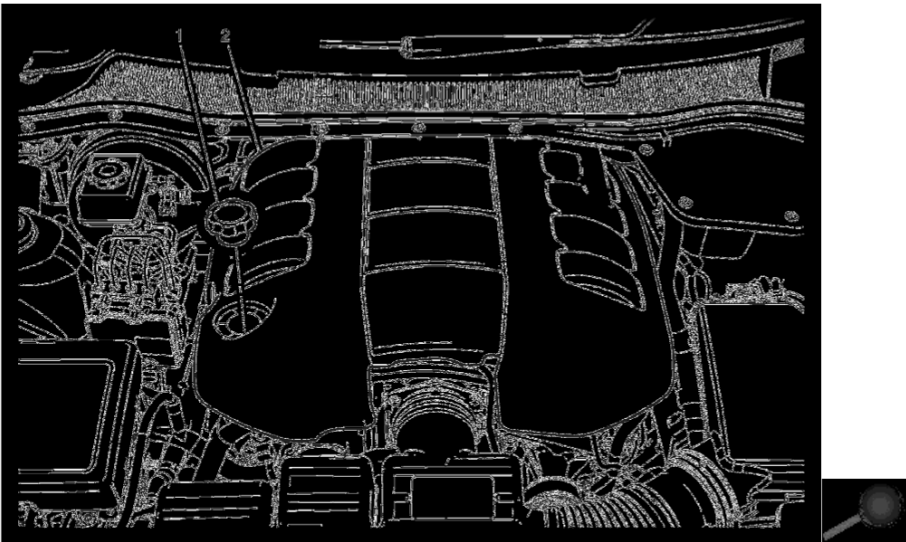
Air Conditioning Compressor Belt Idler Pulley Replacement



Air Conditioning Compressor Belt Idler Pulley Replacement

Callout	Component Name
Preliminary Procedure Remove the air conditioning compressor belt. Refer to Air Conditioning Compressor Belt Replacement .	
1	Air Conditioning Compressor Belt Idler Pulley Fastener Caution: Refer to Fastener Caution . Tighten 58 N•m (43 lb ft)
2	Air Conditioning Compressor Belt Idler Pulley

Engine Cover Replacement



Engine Cover Replacement

Callout	Component Name
1	Oil Cap
2	Engine Cover Procedure Pull upward on the front of the engine cover to detach the engine cover to fuel injector rail retaining clips.

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Engine Mount Inspection

Caution: Broken or deteriorated mounts can cause misalignment and destruction of certain drive train components. When a single mount breaks, the remaining mounts are subjected to abnormally high stresses.

Caution: When raising or supporting the engine for any reason, do not use a jack under the oil pan, any sheet metal, or the crankshaft pulley. Due to the small clearance between the oil pan and the oil pump screen, jacking against the oil pan may cause the pan to be bent against the pump screen. This will result in a damaged oil pickup unit.

Visual/Physical Inspection

1. Support the powertrain using the appropriate support method; refer to the powertrain mount replacement procedure. Raising the powertrain removes the weight from the engine mount and creates slight tension in the rubber.
2. Clean the mount and surrounding area to ensure good visibility of the mount condition.
3. Verify all attaching fasteners are present and at the correct torque. Refer to [Engine Mount Replacement - Left Side](#) and/or [Engine Mount Replacement - Right Side](#) for any torque sequencing and/or torque specifications.

Note: Observe the engine mount while raising the engine. If the engine mount exhibits any of the following conditions the mount may require replacement. Refer to [Engine Mount Replacement - Left Side](#) and/or [Engine Mount Replacement - Right Side](#).

4. Slightly raise the engine approximately 5-7 mm.
 5. Inspect the mount for any of the following conditions:
 - Hard rubber surfaces - covered with extreme heat check cracks.
 - Rubber separation from the metal plate of the engine mount.
 - Rubber is split through the center of the engine mount.
- Note:** Before replacing any engine mount due to suspected fluid loss, verify that the source of the fluid is from the engine mount, and not the engine or an external source.
- If equipped with a hydraulic mount, inspect for GLYCOL™ fluid leaking from the engine mount.

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[Engine/Propulsion](#) | [Engine Mechanical - 6.0L L77 or 6.2L LS3 LSA](#) | [Repair Instructions - On Vehicle](#) |

Document ID: 3248292

Engine Mount Replacement - Left Side

Special Tools

- J 28467-B Universal Engine Support Fixture
- J 41798 Engine Lift Bracket
- J 41803 Engine Support Fixture

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

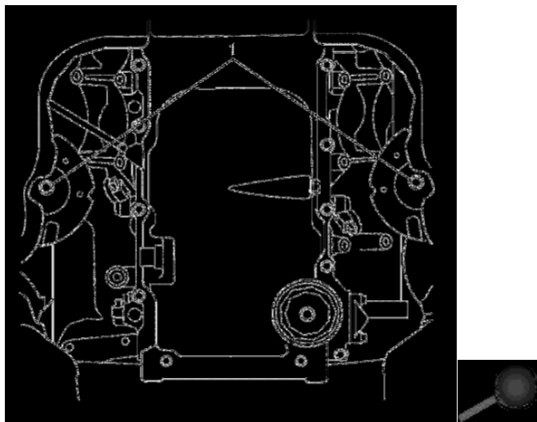
Removal Procedure

1. Remove the engine cover. Refer to [Engine Cover Replacement](#).

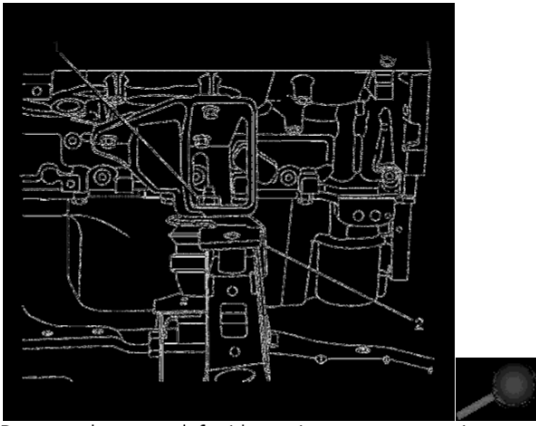
Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

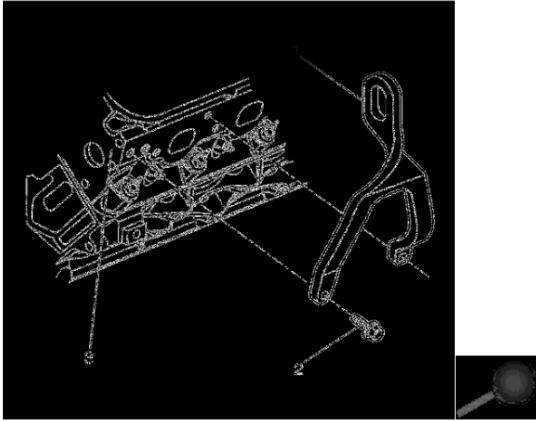
2. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
3. Remove the oil pan shield. Refer to [Oil Pan Shield Replacement](#).



4. Remove the lower engine mount to front sub-frame retaining nut (1) from both engine mounts.
5. Lower the vehicle.



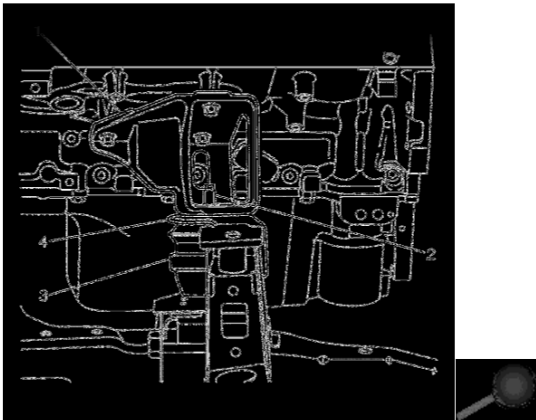
6. Remove the upper left side engine mount to engine mount bracket retaining nut (1).



7. Position the J 41798 engine lift bracket (1) on the cylinder head (3).

Caution: Refer to [Fastener Caution](#).

8. Install the J 41798 engine lift bracket to cylinder head retaining bolts (2) and tighten to **50 N·m (37 lb ft)**.



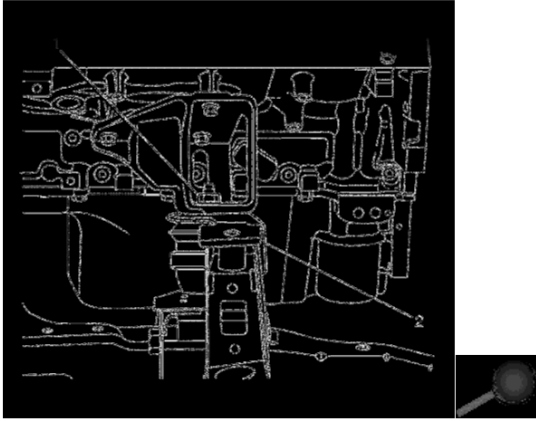
Note: When lifting the engine assembly, observe the clearance between the rear of the engine assembly and the dash panel.

9. Install *J 41803* engine support fixture and *J 28467-B* universal engine support fixture and raise the engine assembly until the left side engine mount bracket (1) is clear of the left side engine mount retaining stud (2).

Note: DO NOT bend or distort the engine mount heat shield (4).

10. Remove the left side engine mount assembly (3).

Installation Procedure

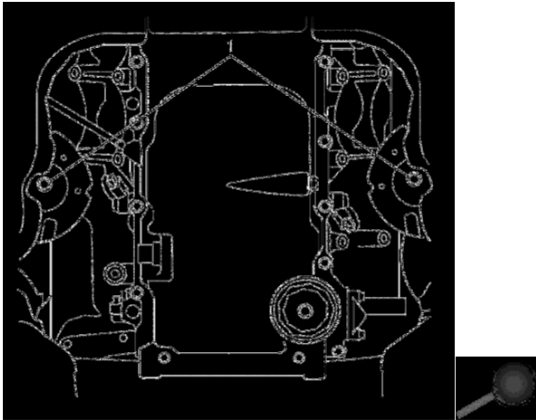


Note: DO NOT bend or distort the engine mount heat shield (4).

1. Position the left side engine mount assembly (3).
2. Lower the engine and remove *J 41803* engine support fixture, *J 28467-B* universal engine support fixture and *J 41798* engine lift bracket from the engine.

Caution: Refer to [Fastener Caution](#).

3. Install the upper engine mount to engine mount bracket retaining nut (1) and tighten to **80 N·m (59 lb ft)**.



Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

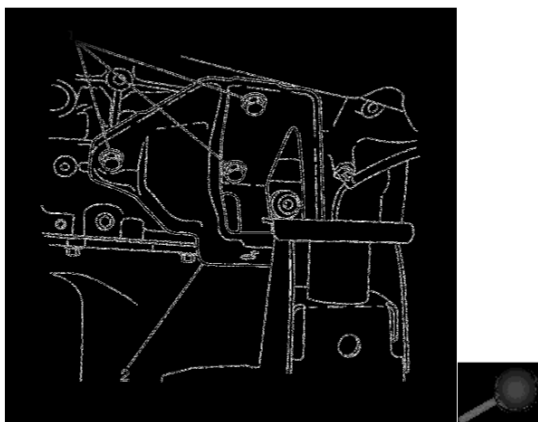
4. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).

5. Install the lower engine mount to front sub-frame retaining nut (1) on both engine mounts and tighten to **80 N·m (59 lb ft)**.
6. Install the oil pan shield. Refer to [Oil Pan Shield Replacement](#).
7. Lower the vehicle.
8. Install the engine cover. Refer to [Engine Cover Replacement](#).

Engine Mount Bracket Replacement - Left Side

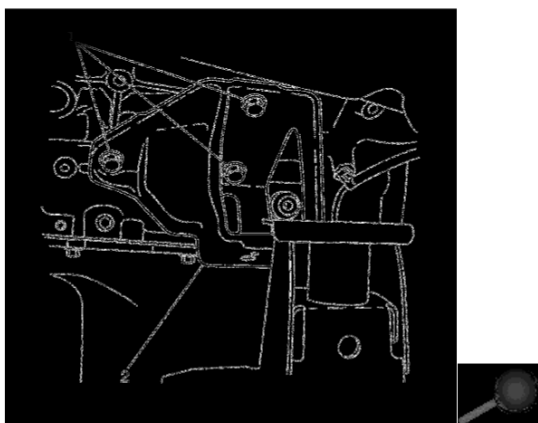
Removal Procedure

1. Remove the left side engine mount. Refer to [Engine Mount Replacement - Left Side](#).



2. Remove the left side engine mount bracket to cylinder block retaining bolts (1).
3. Remove the left side engine mount bracket (2).

Installation Procedure



1. Install the left side engine mount bracket (2).
- Caution:** Refer to [Fastener Caution](#).
2. Install the left side engine mount bracket to cylinder block retaining bolts (1) and tighten to **58 N·m (43 lb ft)**.
3. Install the left side engine mount. Refer to [Engine Mount Replacement - Left Side](#).

Engine Mount Replacement - Right Side

Special Tools

- J 28467-B Universal Engine Support Fixture
- J 41798 Engine Lift Bracket
- J 41803 Engine Support Fixture

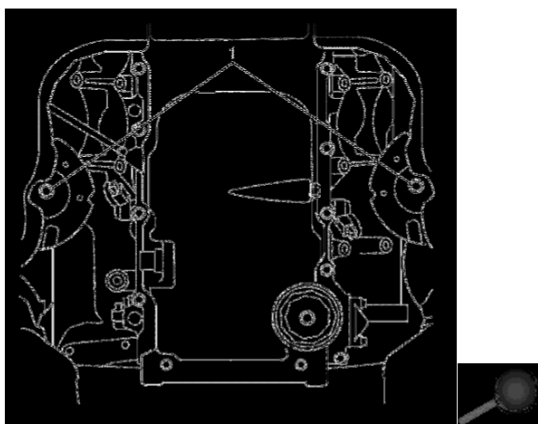
For equivalent regional tools, refer to [Special Tools](#).

Removal Procedure

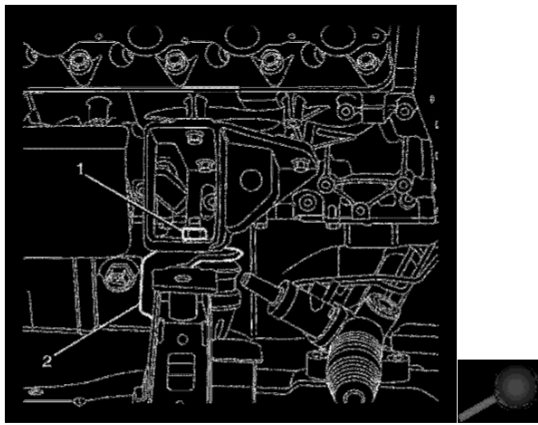
1. Remove the engine cover. Refer to [Engine Cover Replacement](#).

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

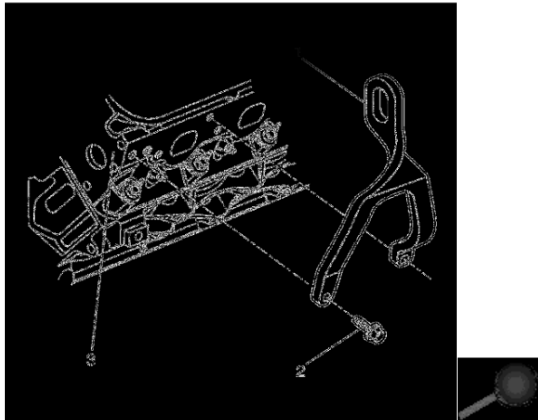
2. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
3. Remove the oil pan shield. Refer to [Oil Pan Shield Replacement](#).



4. Remove the lower engine mount to front sub-frame retaining nut (1) from both engine mounts.
5. Lower the vehicle.



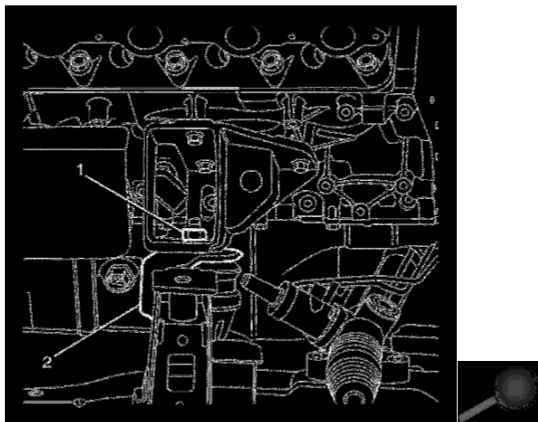
6. Remove the upper right side engine mount to engine mount bracket retaining nut (1).



7. Position the J 41798 engine lift bracket (1) on the cylinder head (3).

Caution: Refer to [Fastener Caution](#).

8. Install the J 41798 engine lift bracket to cylinder head retaining bolts (2) and tighten to **50 N·m (36 lb ft)**.



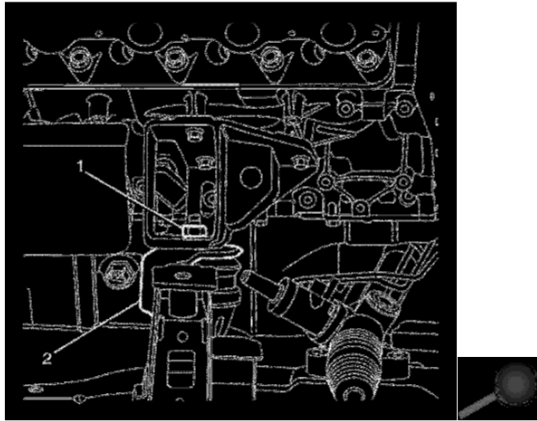
Note: When lifting the engine assembly, observe the clearance between the rear of the engine assembly and the dash panel.

9. Install *J 41803* engine support fixture and *J 28467-B* universal engine support fixture and raise the engine assembly until the right side engine mount bracket (1) is clear of the right side engine mount retaining stud (2).

Note: DO NOT bend or distort the right side engine mount heat shield (4).

10. Remove the right side engine mount assembly (3).

Installation Procedure



Note: DO NOT bend or distort the right side engine mount heat shield (4).

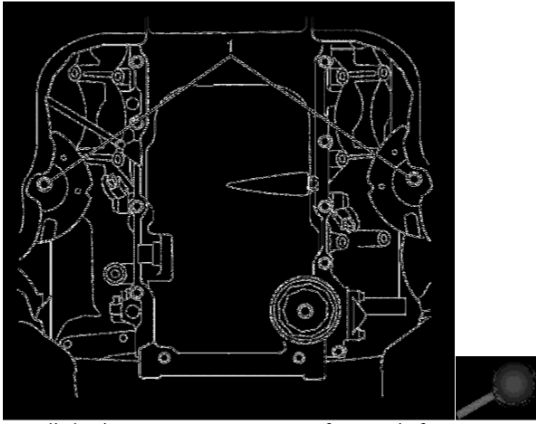
1. Install the right side engine mount assembly (3).
2. Lower the engine assembly until the right side engine mount retaining stud (2) is installed through the right side engine mount bracket (1).
3. Remove *J 41803* engine support fixture, *J 28467-B* universal engine support fixture and *J 41798* engine lift bracket from the engine.

Caution: Refer to [Fastener Caution](#).

4. Install the upper right side engine mount to engine mount bracket retaining nut (1) and tighten to **80 N·m (59 lb ft)**.

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

5. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).

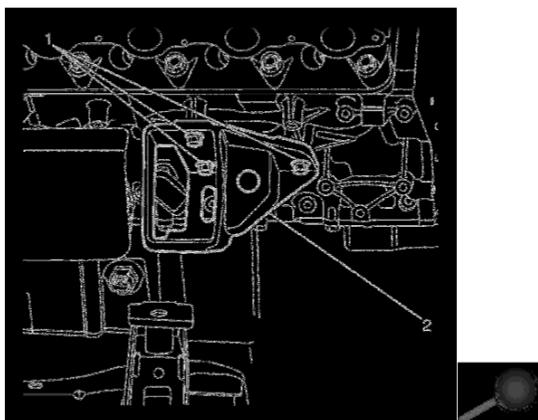


6. Install the lower engine mount to front sub-frame retaining nut (1) on both engine mounts and tighten to **80 N·m (59 lb ft)**.
7. Install the oil pan shield. Refer to [Oil Pan Shield Replacement](#).
8. Lower the vehicle.
9. Install the engine cover. Refer to [Engine Cover Replacement](#).

Engine Mount Bracket Replacement - Right Side

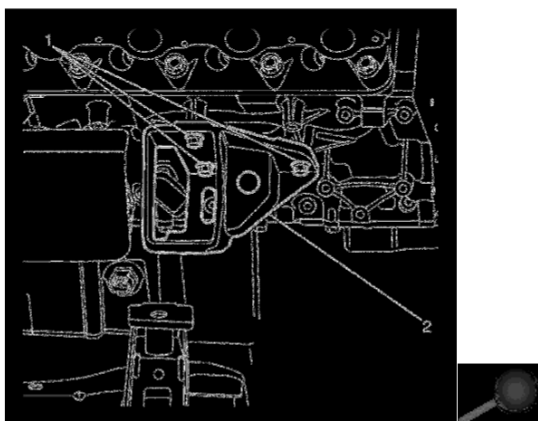
Removal Procedure

1. Remove the right side engine mount. Refer to [Engine Mount Replacement - Right Side](#).



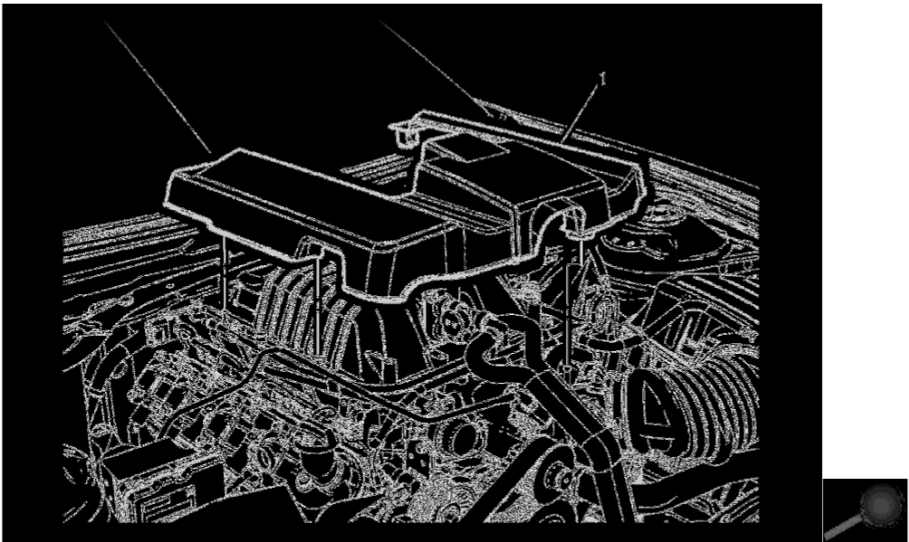
2. Remove the right side engine mount bracket to cylinder block retaining bolts (1).
3. Remove the right side engine mount bracket (2).

Installation Procedure



1. Install the right side engine mount bracket (2).
- Caution:** Refer to [Fastener Caution](#).
2. Install the right side engine mount bracket to cylinder block retaining bolts (1) and tighten to **58 N·m (43 lb ft)**.
3. Install the right side engine mount. Refer to [Engine Mount Replacement - Right Side](#).

Intake Manifold Cover Replacement - Front (LSA)

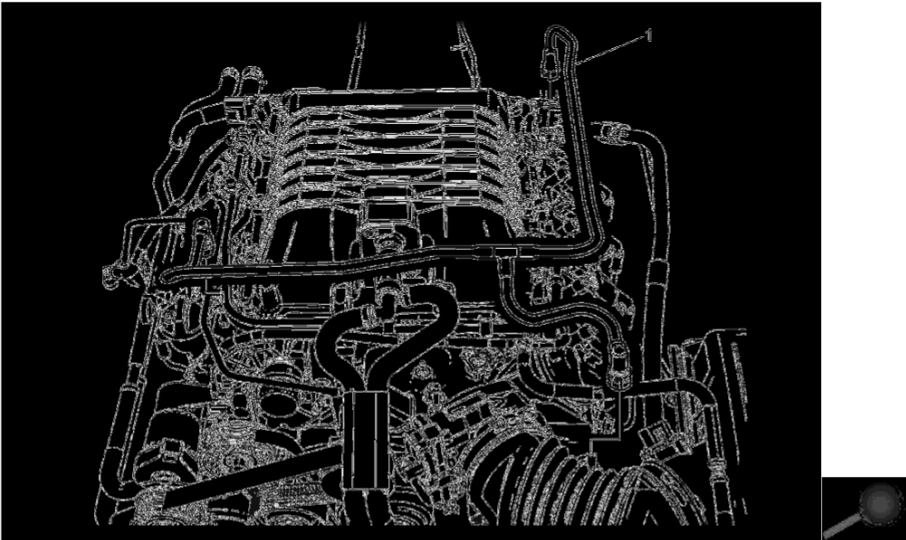


Intake Manifold Cover Replacement - Front

Callout	Component Name
1	Intake Manifold Cover - Front Procedure Grasp the outside edges and lift upward to remove cover grommets from the studs.

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Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LSA Clean Air)

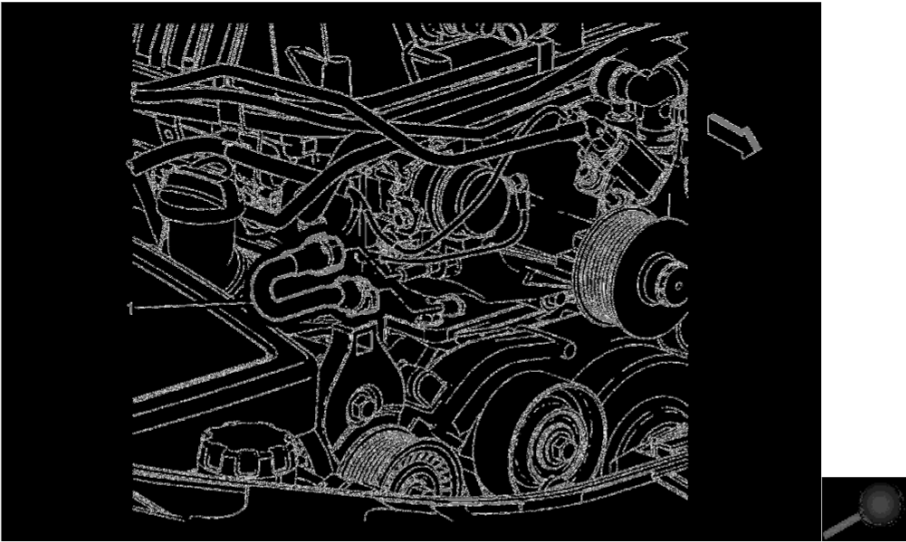


Positive Crankcase Ventilation Hose/Pipe/Tube Replacement

Callout	Component Name
Preliminary Procedure Remove the front intake manifold cover. Refer to Intake Manifold Cover Replacement - Front .	
1	Positive Crankcase Ventilation Hose/Pipe/Tube Procedure 1. Disconnect the electrical connectors, as needed. 2. Route the PCV hose under the air charge cooler lines. Note: It is not necessary to disconnect the air charge cooler lines from the air charge cooler.

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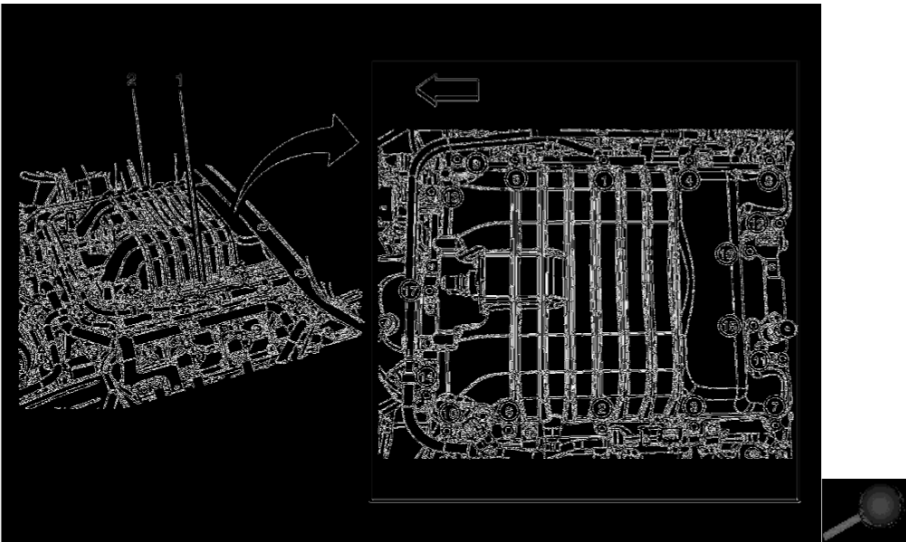
Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (LSA Dirty Air)



Positive Crankcase Ventilation Hose/Pipe/Tube Replacement

Callout	Component Name
Preliminary Procedures 1. Remove the drive belt tensioner. Refer to Drive Belt Tensioner Replacement - Accessory . 2. Remove the charge air bypass regulator solenoid valve. Refer to Charge Air Bypass Regulator Solenoid Valve Replacement .	
1	Positive Crankcase Ventilation Tube (Dirty Air) 1. Reposition the charge air bypass solenoid valve hoses and electrical connections in order to gain access to the positive crankcase ventilation tube. 2. Remove the positive crankcase ventilation tube. Refer to Plastic Collar Quick Connect Fitting Service .

Charge Air Cooler Cover Replacement



Charge Air Cooler Cover Replacement

Callout	Component Name
Preliminary Procedures 1. Remove the front intake manifold cover. Refer to Intake Manifold Cover Replacement - Front . 2. Remove the positive crankcase ventilation hose/pipe/tube. Refer to Positive Crankcase Ventilation Hose/Pipe/Tube Replacement . 3. Remove the charge air cooler coolant hoses from the cooler. Refer to Charge Air Cooler Coolant Hose Replacement .	
1	Charge Air Cooler Cover Fastener (Qty: 17) Caution: Refer to Fastener Caution . Procedure To access the rear charge air cooler cover bolts the engine will need to be lowered. The front suspension crossmember fasteners will need to be loosened 3/4 of the way to allow the assembly to be lower approximately 25 mm (1 in) . Refer to Drivetrain and Front Suspension Frame Replacement . Tighten 10 N•m (89 lb in)
2	Charge Air Cooler Cover Procedure 1. Do not reuse old gasket a NEW gasket must be used. 2. Disconnect any electrical connectors.

Callout	Component Name
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Supercharger and Gasket Replacement

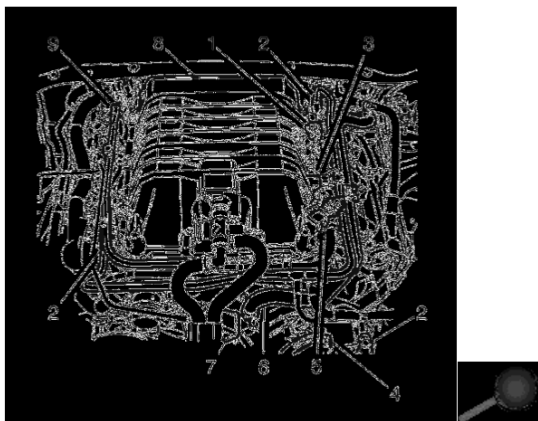
Special Tools

- EN-48898 Supercharger Lift Fixture
- J-37088-A Fuel Line Disconnect Tool Set

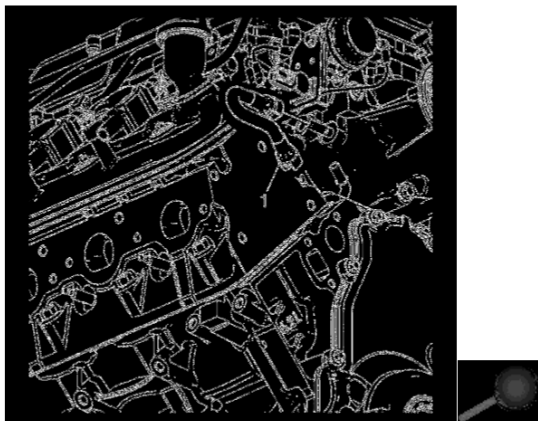
For equivalent regional tools, refer to [Special Tools](#).

Removal Procedure

1. Remove the supercharger belt. Refer to [Supercharger Belt Replacement](#).
2. Remove the intake manifold cover. Refer to [Intake Manifold Cover Replacement - Front](#).

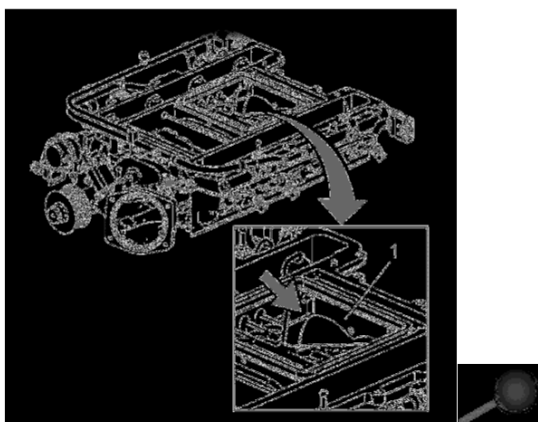


3. Disconnect the supercharger pressure (1), intake air temperature (3) and barometric pressure (5) sensors.
4. Disconnect and remove the PCV fresh air tube (2).
5. Disconnect the brake booster vacuum hose (6).
6. Disconnect and remove the EVAP line from the canister purge solenoid (7).
7. Loosen the clamp (4) and remove the air cleaner outlet duct.
8. Remove the fuel injection fuel rail assembly (9). Refer to [Fuel Injection Fuel Rail Assembly Replacement](#).
9. Remove the charge air cooler cover (8). Refer to [Charge Air Cooler Cover Replacement](#).

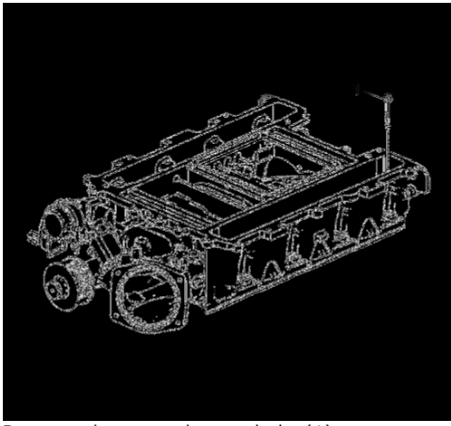
**Note:**

- The supercharger, throttle body and sensors may be removed as an assembly. If not servicing the individual components, remove the supercharger as an assembly.
- Cover the inlet area of the supercharger to prevent dirt or debris contamination onto the rotors.

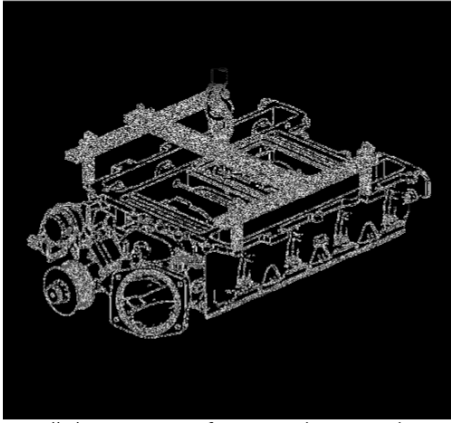
10. Remove the positive crankcase ventilation (PCV) dirty air hose (1) from the valley cover and supercharger.



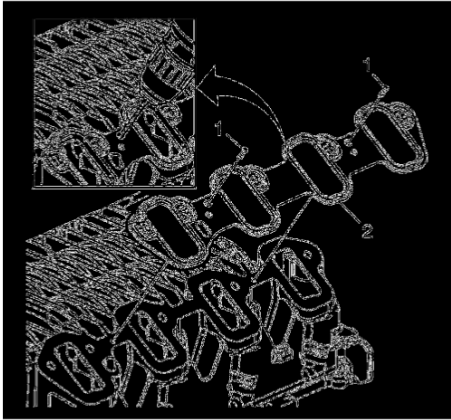
11. Cover the supercharger rotors area (1) to prevent dirt or debris contamination onto the rotors.



12. Remove the supercharger bolts (1).



13. Install the *EN-48898* fixture to the supercharger and tighten the *EN-48898* fixture studs and nuts until snug.
14. Using a lifting device, remove the supercharger from the engine.



Note:

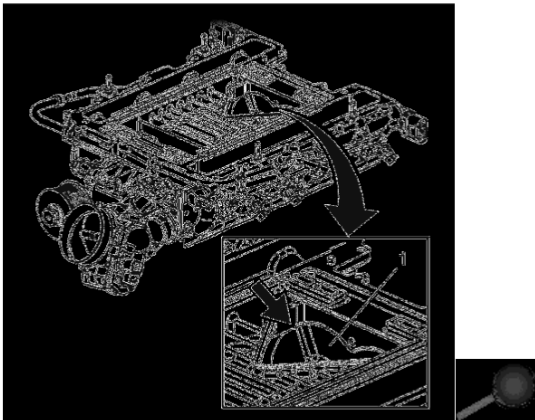
- Do not allow dirt or debris to enter the passages of the supercharger. Cover the intake ports as required.
 - With the manifold positioned upside down on a bench, the lower assembly may be positioned onto the intercooler cover dowel pins. Use care not to reposition or bend the dowel pins.
15. Drill out the gasket rivets (1) using a drill bit with an outside diameter no larger than 3.2 mm (0.125 in). Remove the gasket (2).
 16. For supercharger disassembly, refer to [Supercharger Disassemble](#).
 17. For supercharger cleaning and inspection, refer to [Supercharger Cleaning and Inspection](#).

Installation Procedure

1. For supercharger assembly, refer to [Supercharger Assemble](#).



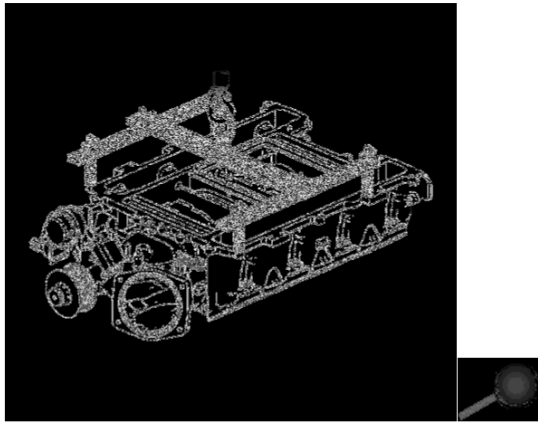
2. Install the NEW gaskets (2).
3. Install NEW gasket rivets (1).



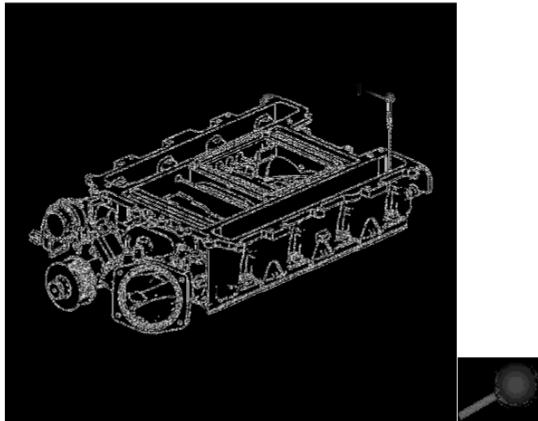
Note:

- The supercharger, throttle body and sensors may be removed as an assembly. If not servicing the individual components, remove the supercharger as an assembly.
- Cover the inlet area of the supercharger to prevent dirt or debris contamination onto the rotors.

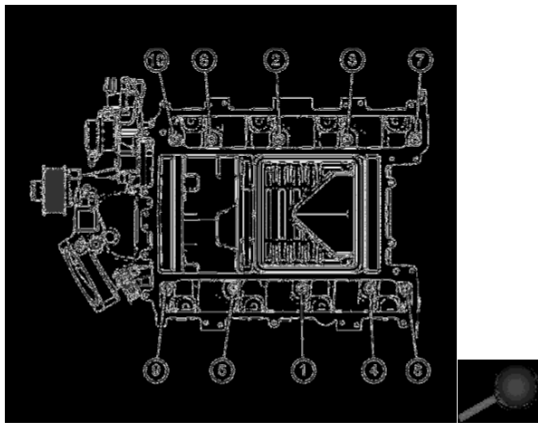
4. Cover the supercharger rotors area (1) to prevent dirt or debris contamination onto the rotors.



5. Install the *EN-48898* fixture to the supercharger.
6. Tighten the *EN-48898* fixture bolts and nuts until snug.
7. Using a lifting device, install the supercharger onto the engine. Align the dowel pin at the right front of the supercharger to the cylinder head.



8. Apply a 5 mm (0.2 in) band of threadlocker to the threads of the bolts. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#).
9. Install the supercharger bolts (1).

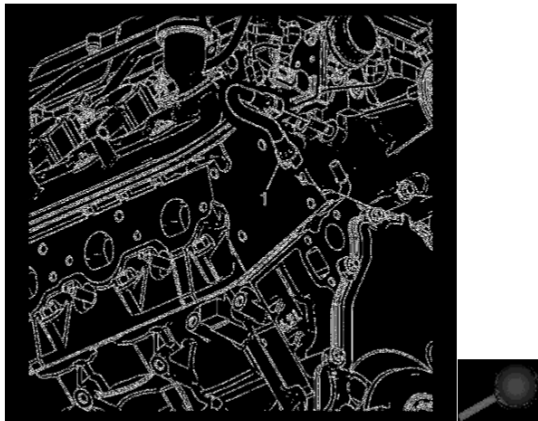


Caution: Refer to [Fastener Caution](#).

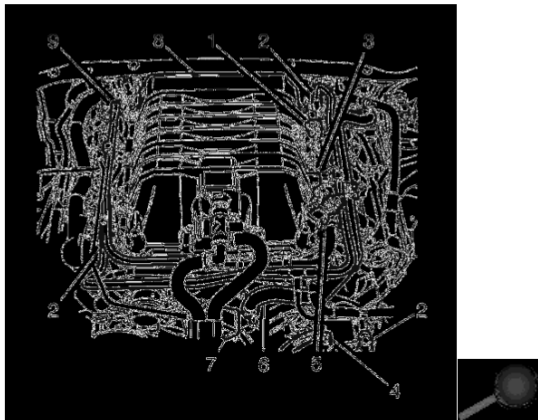
10. Tighten the bolts.

10.1. Tighten the bolts a first pass in sequence to **5 N•m (44 lb in)**.

10.2. Tighten the bolts a final pass in sequence to **10 N•m (89 lb in)**.

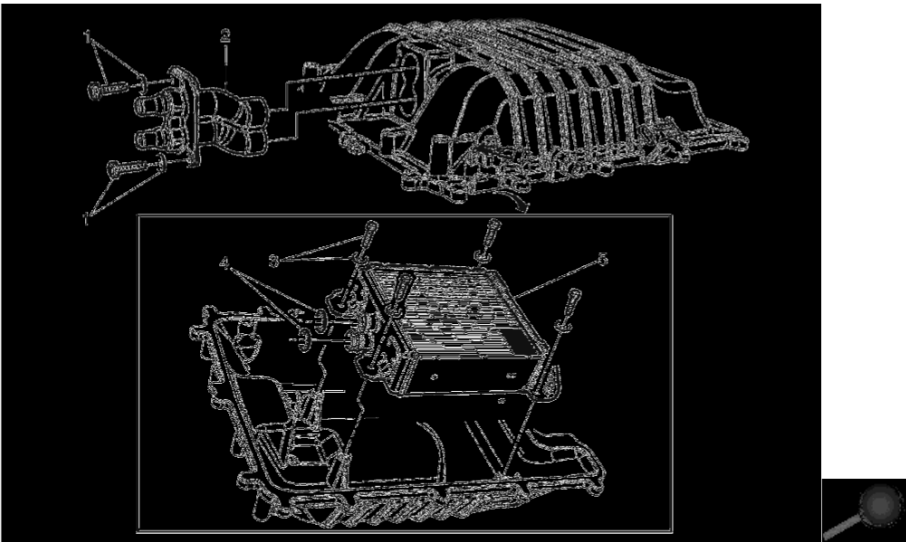


11. Install the PCV dirty air hose (1) to the valley cover and supercharger.



12. Install the charge air cooler cover. Refer to [Charge Air Cooler Cover Replacement](#).
13. Install the fuel injection fuel rail assembly (9). Refer to [Fuel Injection Fuel Rail Assembly Replacement](#).
14. Connect the brake booster vacuum hose (6).
15. Connect the connector and the EVAP line to the canister purge solenoid (7).
16. Connect the air cleaner outlet duct and tighten the clamp (4).
17. Connect the supercharger pressure (1), intake air temperature (3) and barometric pressure (5) sensors.
18. Install and connect the PCV fresh air tube (2).
19. Install the intake manifold cover. Refer to [Intake Manifold Cover Replacement - Front](#).
20. Install the supercharger belt. Refer to [Supercharger Belt Replacement](#).

Charge Air Cooler Replacement



Charge Air Cooler Replacement

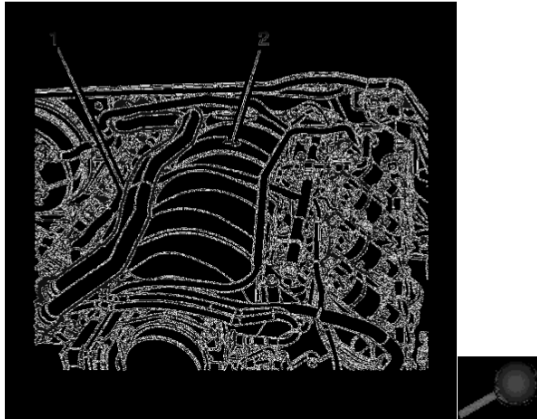
Callout	Component Name
Preliminary Procedure 1. Remove the charge air cooler coolant hoses from the cooler. Refer to Charge Air Cooler Coolant Hose Replacement . 2. Remove the charge air cooler cover. Refer to Charge Air Cooler Cover Replacement .	
1	Charge Air Cooler Outlet Fastener (Qty: 2) Caution: Refer to Fastener Caution . Tighten 10 N•m (89 lb in)
2	Charge Air Cooler Outlet
3	Charge Air Cooler Fastener (Qty: 4) Note: Apply threadlocker before installing the fastener. Tighten 10 N•m (89 lb in)
4	Charge Air Cooler Outlet Seals Note: Do not reuse seals.
5	Charge Air Cooler

Intake Manifold Replacement (L77 or LS3)

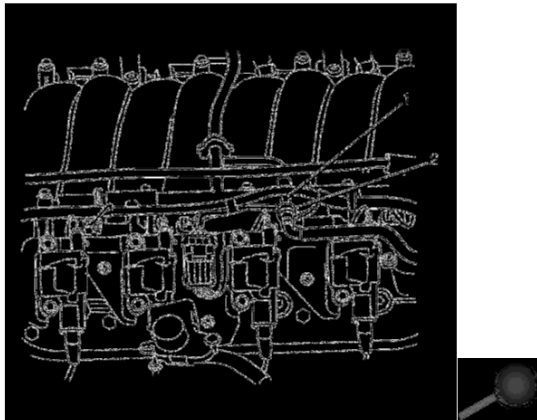
Removal Procedure

Note: The intake manifold, throttle body, fuel injection rail, and injectors may be removed as an assembly. If not servicing the individual components, remove the manifold as a complete assembly.

1. Remove the engine cover. Refer to [Engine Cover Replacement](#).
2. Depressurize the fuel system. Refer to [Fuel Pressure Relief](#).
3. Disconnect the battery ground cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
4. Drain the cooling system. Refer to [Cooling System Draining and Filling](#).
5. Remove the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).

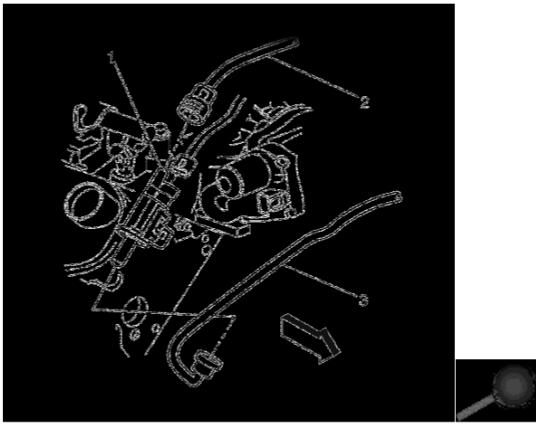


6. Reposition and secure the heater hoses (1) away from the intake manifold (2).



Note: Plug or cap the fuel feed pipe (2) and fuel rail tube (1) ends to prevent fuel leaks and/or contamination.

7. Disconnect the fuel rail feed pipe (2) quick connect fitting. Refer to [Metal Collar Quick Connect Fitting Service](#) or [Plastic Collar Quick Connect Fitting Service](#).

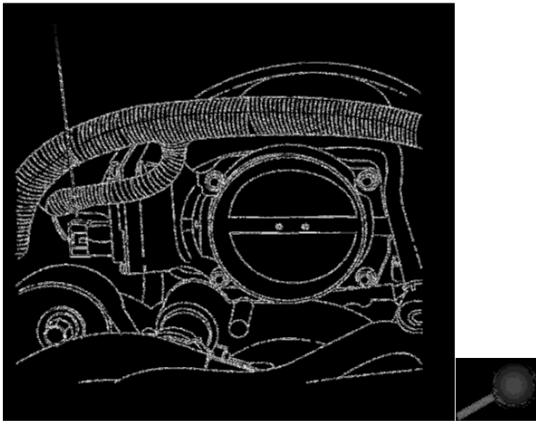


Note: Plug or cap the throttle body to EVAP purge valve hose (3) and EVAP purge valve (1) ends to prevent fuel leaks and/or contamination.

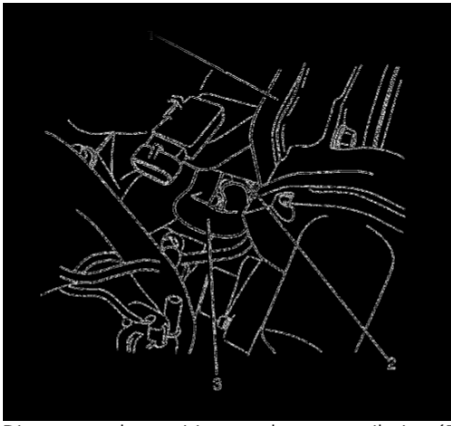
8. Disconnect the throttle body to EVAP purge valve hose (3) from the EVAP purge valve (1).

Note: Plug or cap the EVAP purge valve to fuel tank hose (2) and EVAP purge valve (1) ends to prevent fuel leaks and/or contamination.

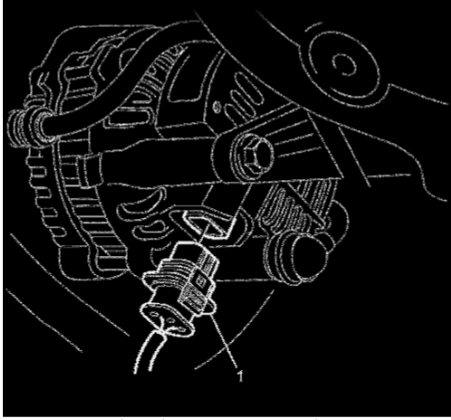
9. Disconnect the EVAP purge valve to fuel tank hose (2) from the EVAP purge valve (1).



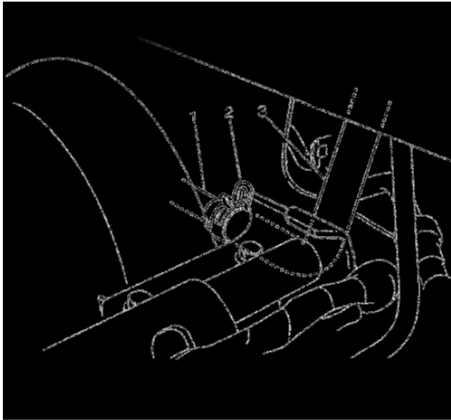
10. Disconnect the electronic throttle body wiring harness connector (1).



11. Disconnect the positive crankcase ventilation (PCV) hose (3) from the intake manifold (1) and the valley cover (2).



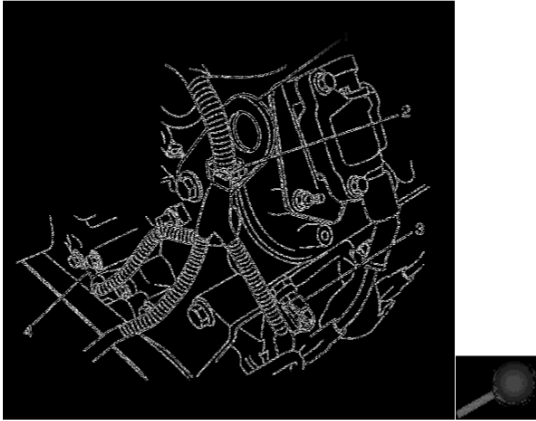
12. Disconnect the alternator wiring harness connector (1) from the alternator.



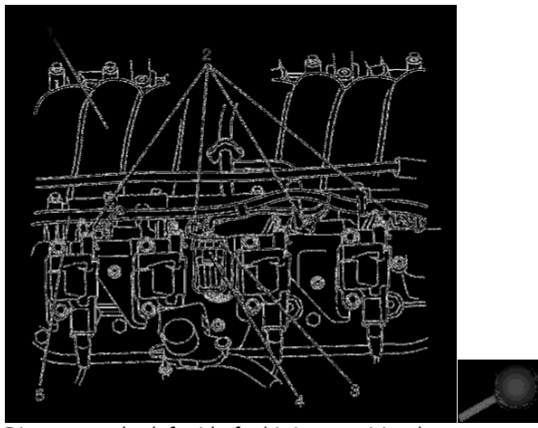
13. Compress the vacuum hose retaining clamp (2) at the intake manifold vacuum port (1) and slide 50 mm (2 in) back along the vacuum hose (3).
14. Disconnect the vacuum hose (3) from the intake manifold vacuum port (1).



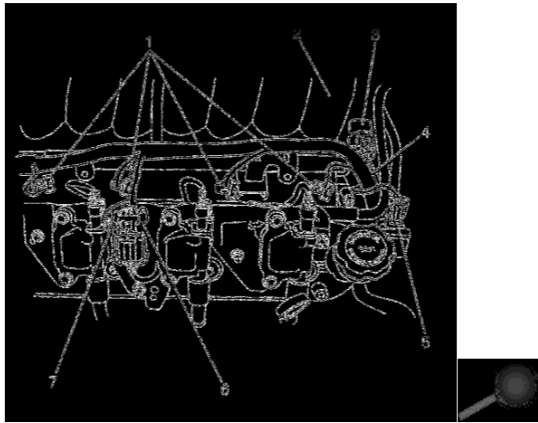
15. Disconnect the oil pressure sensor wiring harness connector (1) from the oil pressure sensor.
16. Disconnect the HVAC vacuum hose (2) from the intake manifold.



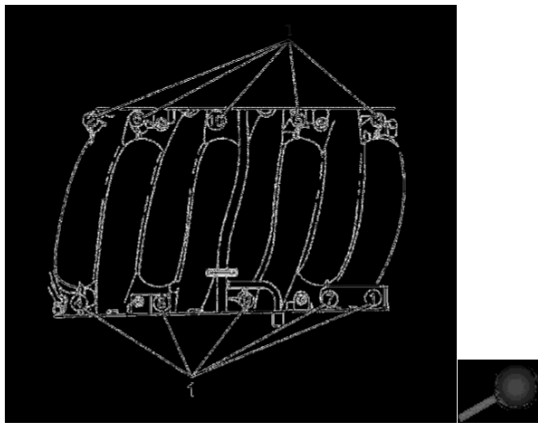
17. Disconnect the camshaft position sensor connector (4) from the camshaft position sensor.
18. Disconnect the coolant temperature sensor connector (3) from the coolant temperature sensor.
19. Detach the wiring harness retaining clip (2) from the engine lifting bracket (1).



20. Disconnect the left side fuel injector wiring harness connectors (2) from the fuel injectors.
21. Remove the connector position assurance (CPA) lock (4) from the left side ignition coil main connector (3).
22. Disconnect the left side ignition coil main connector (3) from the ignition coil wiring harness.
23. Reposition and secure the left side fuel injector wiring harness (5) away from the intake manifold (1).



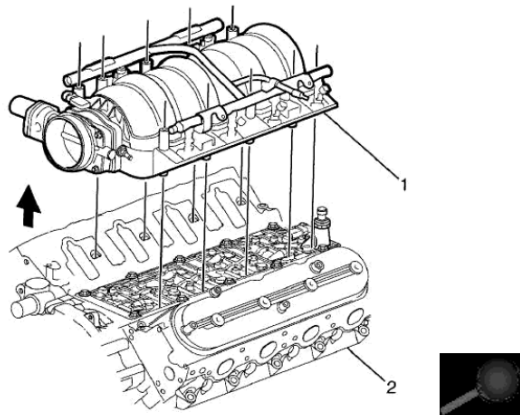
24. Disconnect the right side fuel injector wiring harness connectors (1) from the fuel injectors.
25. Remove the CPA lock (7) from the right side ignition coil main connector (6).
26. Disconnect the right side ignition coil main connector (6) from the ignition coil wiring harness.
27. Disconnect the canister purge valve (5) wiring harness connector.
28. Disconnect the manifold absolute pressure (MAP) sensor wiring harness connector (3) from the MAP sensor.
29. Reposition and secure the right side fuel injector wiring harness (4) away from the intake manifold (2).



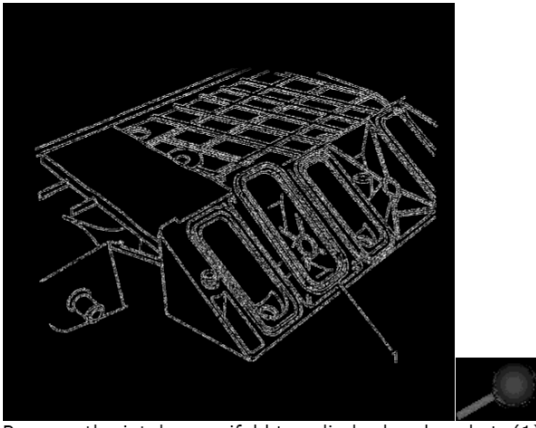
Note: The intake manifold, throttle body, fuel injection rail, and fuel injectors may be removed as an assembly. If not servicing the individual components, remove the manifold as a complete assembly.

Note: Removal of the intake manifold to cylinder head retaining bolts (1) should be performed in sequence. Failing to do so may distort the intake manifold.

30. Remove the intake manifold to cylinder head retaining bolts (1) in sequence.

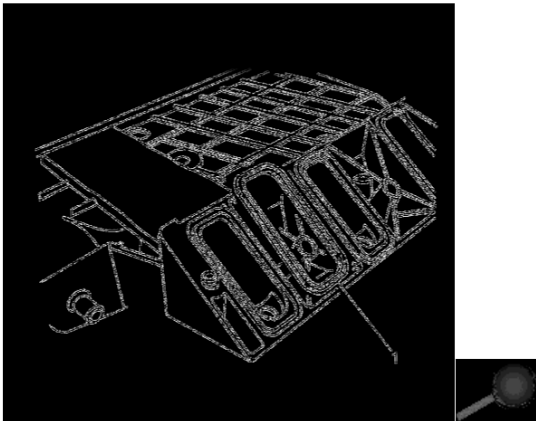


31. Remove the intake manifold (1) from the engine (2).
32. Plug the engine (2) with a clean lint free cloth.



33. Remove the intake manifold to cylinder head gaskets (1).
Discard the intake manifold to cylinder head gaskets (1).
34. Clean and inspect the intake manifold. Refer to [Intake Manifold Cleaning and Inspection](#).

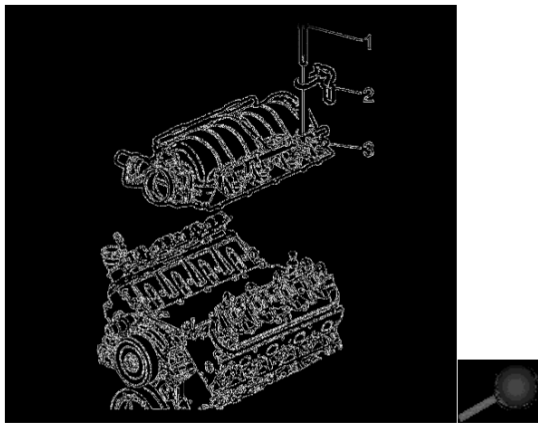
Installation Procedure



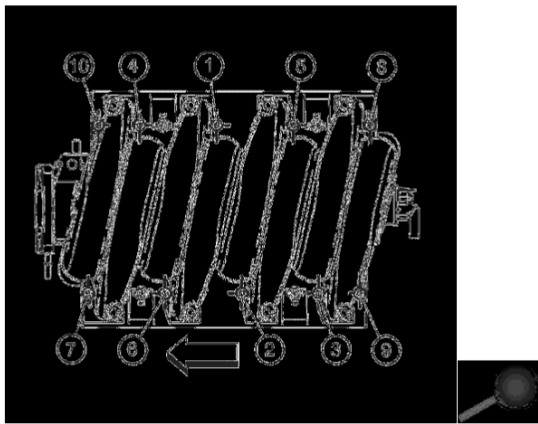
Note:

- The intake manifold, throttle body, fuel injection rail, and fuel injectors may be removed as an assembly. If not servicing the individual components, install the intake manifold as a complete assembly.
- DO NOT use the intake manifold gaskets again. Install NEW intake manifold-to-cylinder head gaskets.

1. Install NEW intake manifold-to-cylinder head gaskets (1).

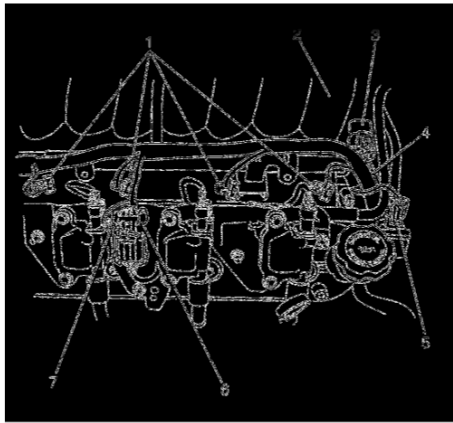


2. Install the intake manifold (3).
3. Apply a **5 mm (0.20 in)** band of threadlock to the threads of the intake manifold bolts (1).
Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended threadlock.
4. Install the intake manifold bolts (1) and fuel rail stop brackets (2).

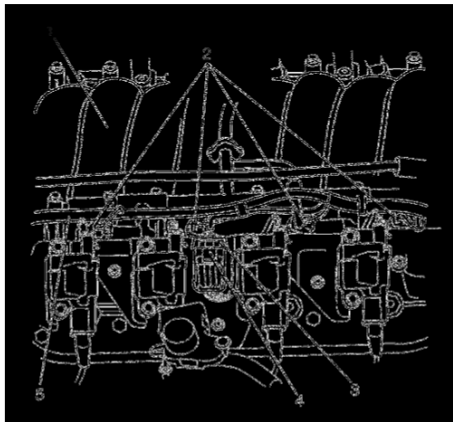


Caution: Refer to [Fastener Caution](#).

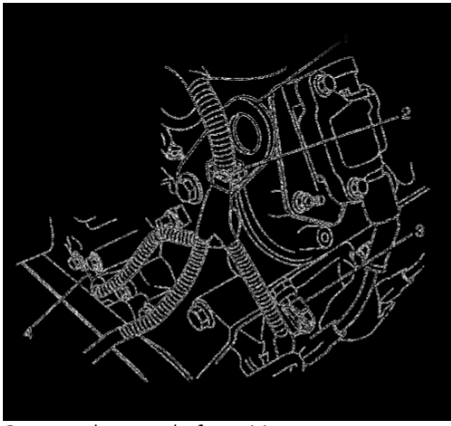
5. Tighten the intake manifold bolts.
 - 5.1. Tighten the intake manifold bolts (1-10) a first pass in sequence to **5 N•m (44 lb in)**.
 - 5.2. Tighten the intake manifold bolts (1-10) a final pass in sequence to **10 N•m (89 lb in)**.



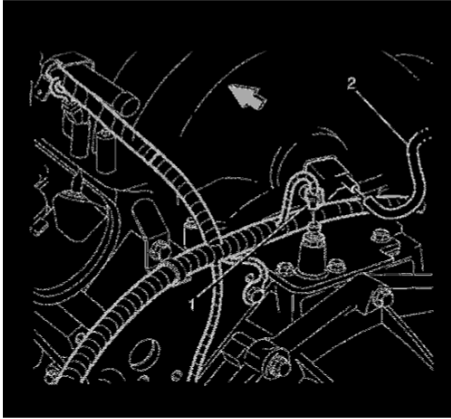
6. Position the right side fuel injector wiring harness (4) on the intake manifold (2).
7. Connect the MAP sensor wiring harness connector (3) to the MAP sensor.
8. Connect the canister purge valve wiring harness connector (5).
9. Connect the right side ignition coil main connector (6) to the ignition coil wiring harness.
10. Install the CPA lock (7) from the right side ignition coil main connector (6).
11. Connect the right side fuel injector wiring harness connectors (1) to the fuel injectors.



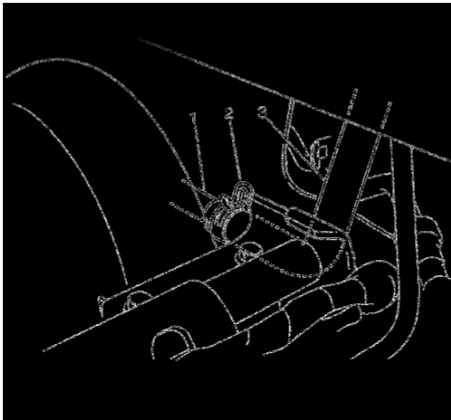
12. Position the left side fuel injector wiring harness (5) back to its original location the intake manifold (1).
13. Connect the left side ignition coil main connector (3) ignition coil wiring harness.
14. Install the CPA lock (4) from the left side ignition coil main connector (3).
15. Connect the left side fuel injector wiring harness connectors (2) to the fuel injectors.



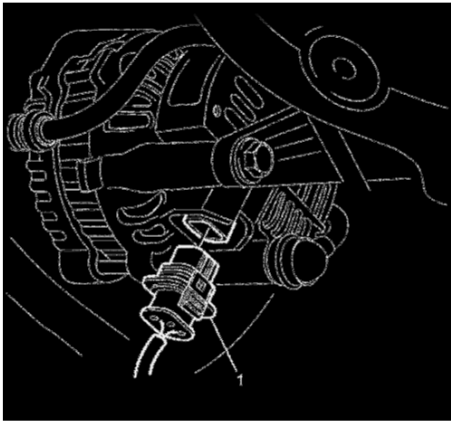
16. Connect the camshaft position sensor connector (4) to the camshaft sensor.
17. Connect the coolant temperature sensor connector (3) to the coolant sensor.
18. Attach the wiring harness retaining clip (2) to the engine lifting bracket (1).



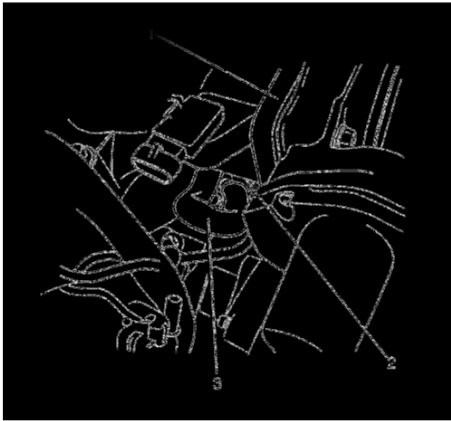
19. Connect the oil pressure sensor wiring harness connector (1) to the oil pressure sensor.
20. Connect the HVAC vacuum hose (2) to the intake manifold.



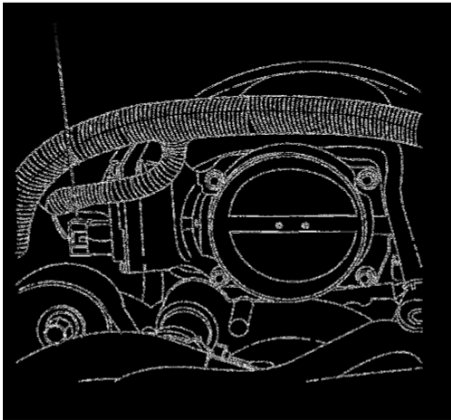
21. Compress the vacuum hose retaining clamp (2) at the intake manifold vacuum port (1) and slide 50 mm (2 in) back along the vacuum hose (3).
22. Connect the vacuum hose (3) to the intake manifold vacuum port (1).



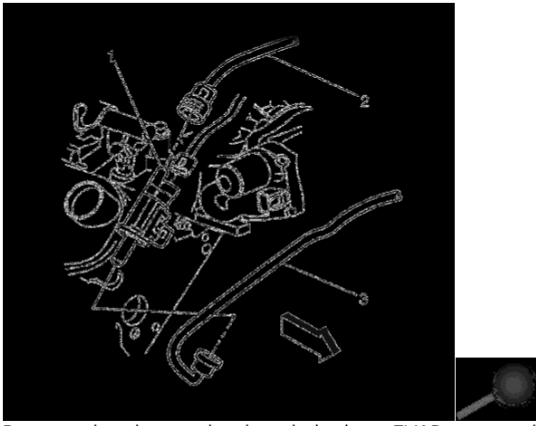
23. Connect the alternator wiring harness connector (1) to the alternator.



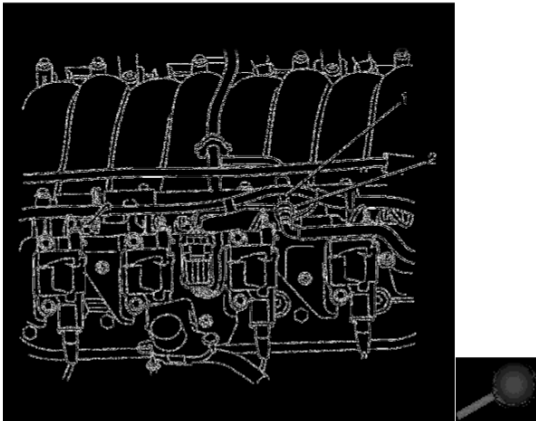
24. Connect the PCV hose (3) to the intake manifold (1) and the valley cover (2).



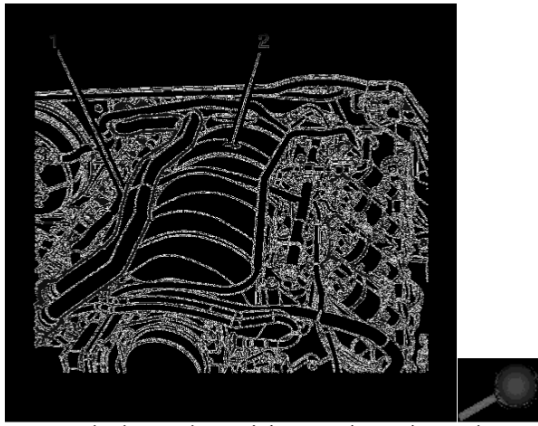
25. Connect the electronic throttle body wiring harness connector (1) to the throttle body.



26. Remove the plug on the throttle body to EVAP purge valve hose (3) and EVAP purge valve (1) ends.
27. Connect the throttle body to EVAP purge valve hose (3) to the EVAP purge valve (1).
28. Remove the plug on the throttle body to the EVAP purge valve to fuel tank hose (2) and EVAP purge valve (1) ends.
29. Connect the EVAP purge valve to fuel tank hose (2) to the EVAP purge valve (1).



30. Remove the plug on the fuel feed pipe (2) and fuel rail tube (1) end.
31. Connect the fuel rail feed pipe (2) quick connect fitting. Refer to [Metal Collar Quick Connect Fitting Service](#) or [Plastic Collar Quick Connect Fitting Service](#).

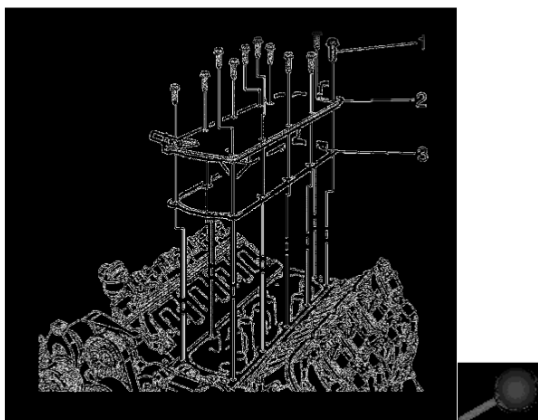


32. Position the heater hoses (1) correctly on the intake manifold (2).
33. Install the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
34. Fill the cooling system. Refer to [Cooling System Draining and Filling](#).
35. Connect the battery ground cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
36. Run engine and check for leaks.
37. Install the engine cover. Refer to [Engine Cover Replacement](#).

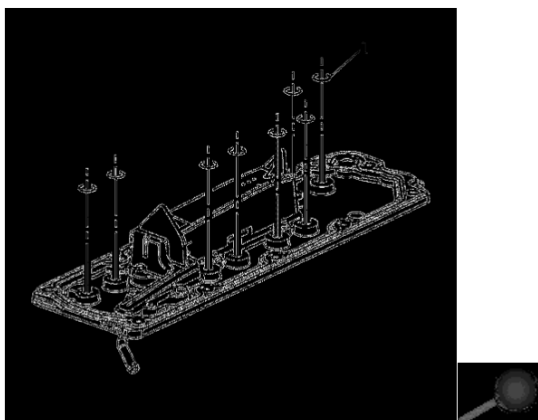
Engine Block Valley Cover Replacement (LSA)

Removal Procedure

1. Remove the supercharger. Refer to [Supercharger Replacement](#).
2. Remove the oil pressure sensor. Refer to [Engine Oil Pressure Sensor and/or Switch Replacement](#).

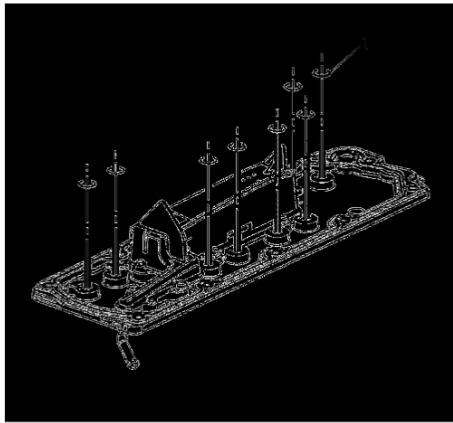


3. Remove the engine block valley cover to cylinder block retaining bolts (1).
4. Remove the engine block valley cover (2).
5. Remove and discard the engine block valley cover gasket (3).

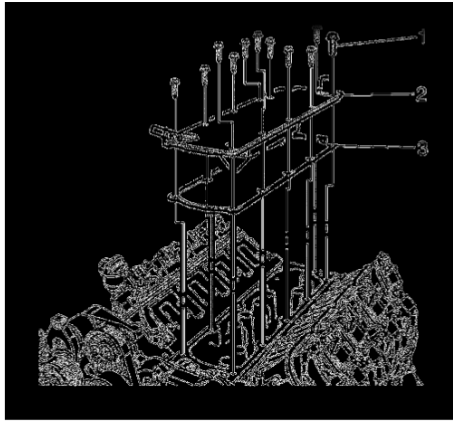


6. Remove the seals (1) from the cover and discard.
7. For engine block valley cover cleaning, refer to [Engine Block Valley Cover Cleaning and Inspection](#)

Installation Procedure



1. Lubricate NEW seals (1) with clean engine oil and install on the engine block valley cover.



2. Install NEW engine block valley cover gasket (3).
3. Install the engine block valley cover (2).
4. Install the engine block valley cover to cylinder block retaining bolts (1) and tighten to 25 N•m (18 lb ft)
5. Install the oil pressure sensor. Refer to [Engine Oil Pressure Sensor and/or Switch Replacement](#).
6. Install the supercharger. Refer to [Supercharger Replacement](#).

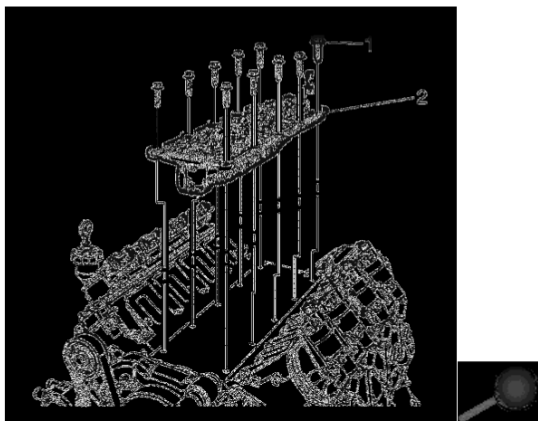
Valve Lifter Oil Manifold Replacement (L77 or LS3)

Removal Procedure

1. Remove the intake manifold. Refer to [Intake Manifold Replacement](#).



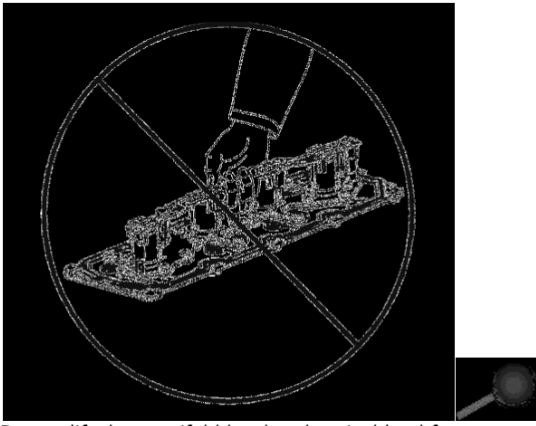
2. Disconnect the electrical connectors (1).



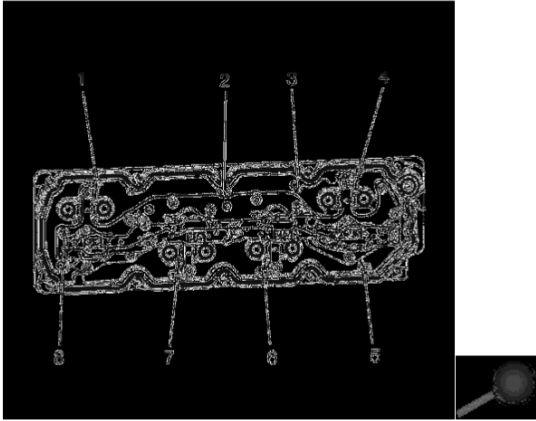
3. Remove the valve lifter oil manifold bolts (1).

Important: Do not allow dirt or debris to enter the oil passages of the manifold. Plug, as required.

4. Remove the valve lifter oil manifold (2).

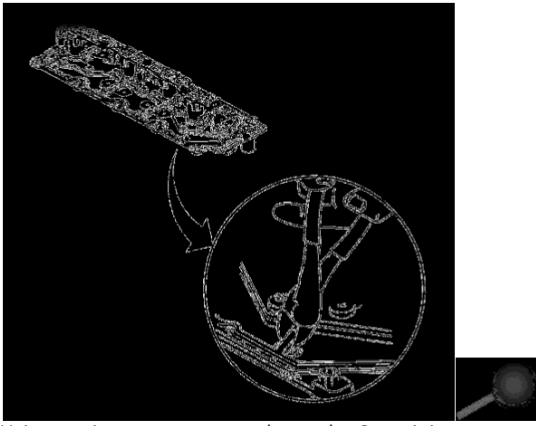


5. Do not lift the manifold by the electrical lead frame.

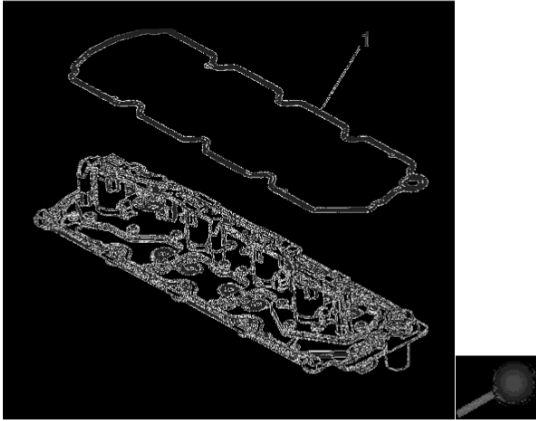


Important: Remove only the outer gasket from the manifold. Do not disassemble any of the internal components of the manifold in an attempt to remove the 8 inner sealing gaskets. If the inner gaskets are cut or damaged, replace the manifold as an assembly. Only use a wire-cutter type tool in order to minimize the amount of debris. Do not use a rotary-type cutting tool on the retaining straps.

6. Identify the 8 gasket retaining strap locations (1-8).

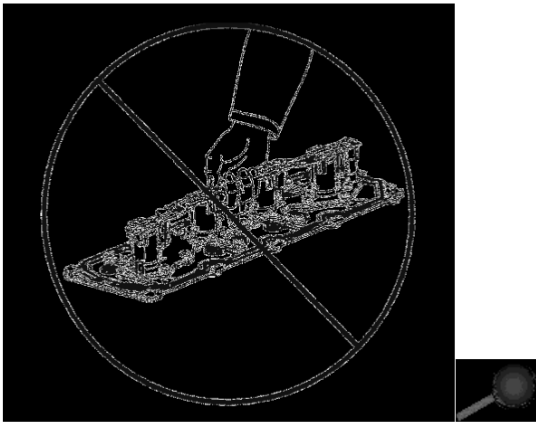


7. Using a wire-cutter type tool, cut the 8 retaining straps.

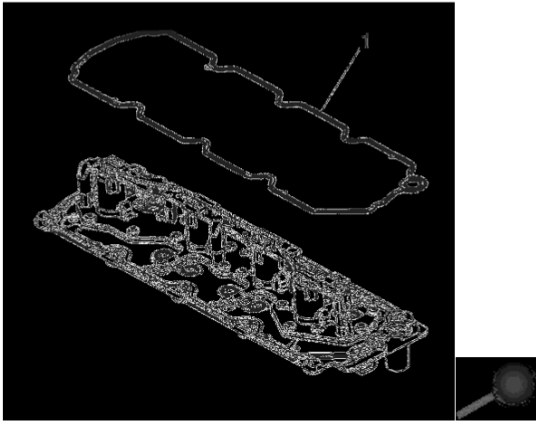


8. Remove the outer gasket (1) from the manifold.
9. For valve lifter oil manifold cleaning, refer to [Valve Lifter Oil Manifold Cleaning and Inspection](#)

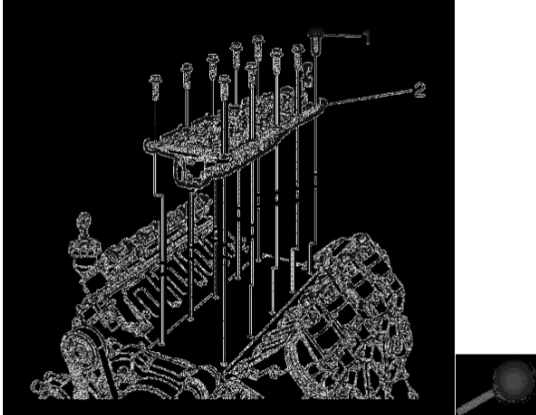
Installation Procedure



1. Do not lift the manifold by the electrical lead frame.



2. Install the outer gasket (1) to the manifold.



3. Installed the valve lifter oil manifold (2).
4. Install the valve lifter oil manifold bolts (1) and tighten to 25 N·m (18 lb ft).

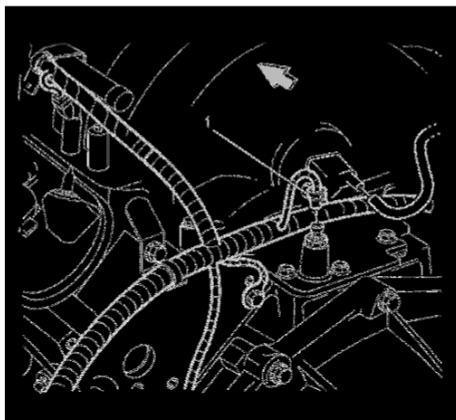


5. Connect the electrical connectors (1).

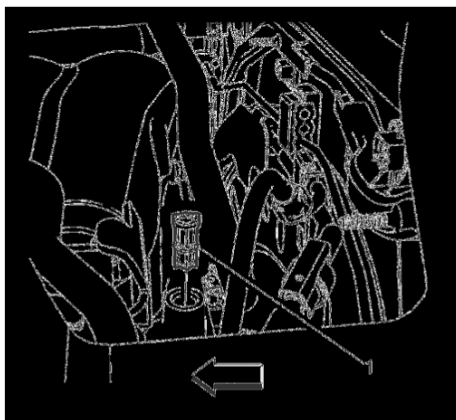
6. Install the intake manifold. Refer to [Intake Manifold Replacement](#).

Valve Lifter Oil Filter Replacement

[Removal Procedure](#)

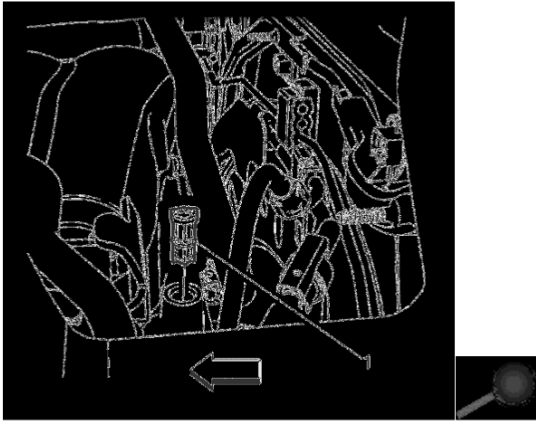


1. Disconnect the oil pressure sensor wiring harness connector (1).
2. Remove the engine oil pressure sensor. Refer to [Engine Oil Pressure Sensor and/or Switch Replacement](#).



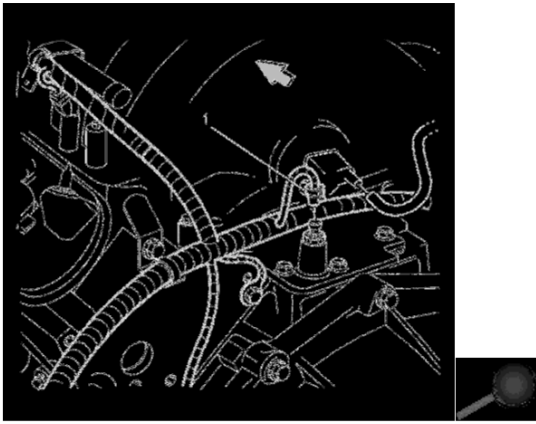
3. Remove the valve lifter oil filter (2) from the valve lifter oil manifold.

[Installation Procedure](#)



Note: Lubricate the seal of the valve lifter oil filter with clean engine oil to aid in inserting it into the valve lifter oil manifold.

1. Install the valve lifter oil filter (2) into the valve lifter oil manifold.
2. Install the engine oil pressure sensor. Refer to [Engine Oil Pressure Sensor and/or Switch Replacement](#).

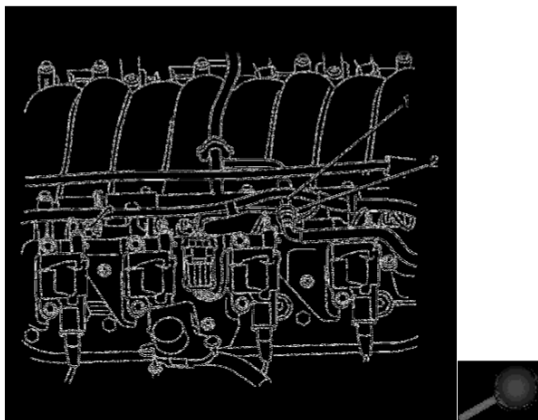


3. Connect the oil pressure sensor electrical connector (1).

Valve Rocker Arm Cover Replacement - Left Side (L77 or LS3)

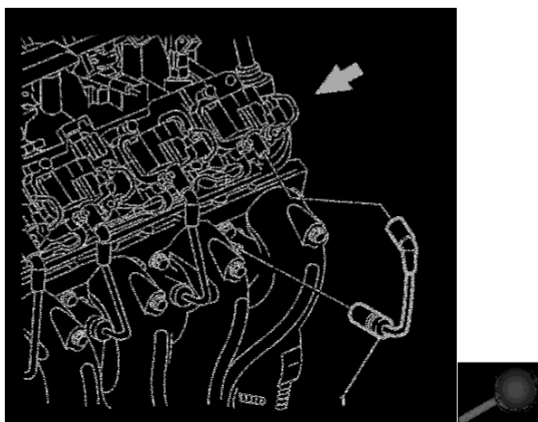
Removal Procedure

1. Remove the dress engine cover. Refer to [Engine Cover Replacement](#).
2. Depressurize the fuel system. Refer to [Fuel Pressure Relief](#).
3. Disconnect the battery ground cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

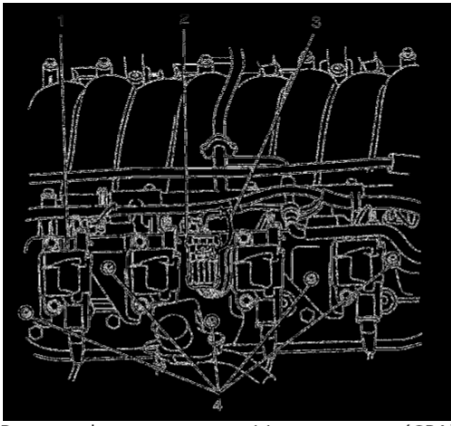


Note: Plug or cap the fuel feed pipe (2) and fuel rail tube (1) ends to prevent fuel leaks and/or contamination.

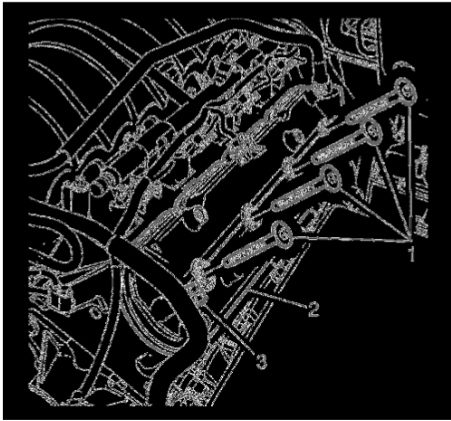
4. Disconnect the fuel rail feed pipe (2) quick connect fitting. Refer to [Metal Collar Quick Connect Fitting Service](#) or [Plastic Collar Quick Connect Fitting Service](#).



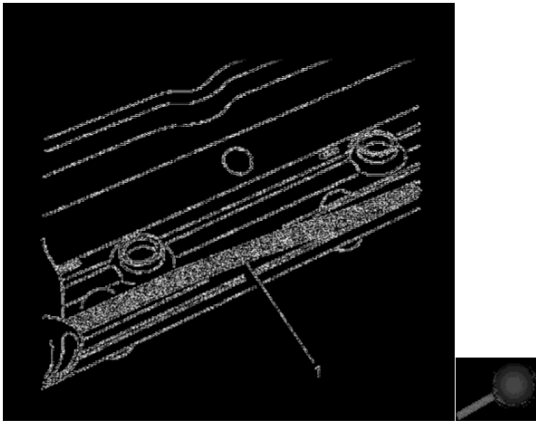
5. Remove the spark plug leads (1).



6. Remove the connector position assurance (CPA) lock (3) from the ignition coil main connector (2).
7. Disconnect the ignition coil main connector (2).
8. Remove the ignition coil assembly to valve rocker arm cover retaining studs (4).
9. Remove the ignition coil assembly (1).



10. Remove the valve rocker arm cover to cylinder head retaining bolts (1).
 - 10.1. Remove the engine wiring harness retainer (3) from the valve rocker cover and reposition the wiring harness.
 - 10.2. Remove the valve rocker arm cover (2).



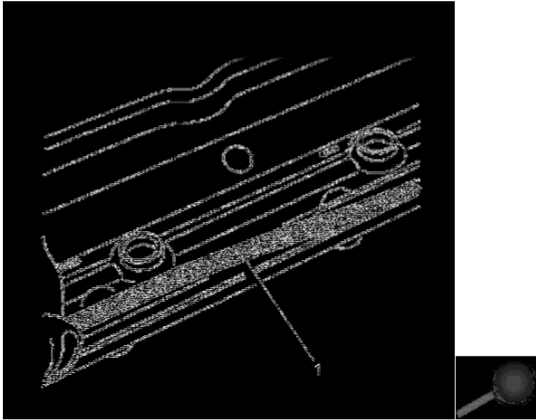
Note: The valve rocker arm cover gasket is a single use only component and must be replaced whenever the valve rocker arm cover is removed from the cylinder head.

11. Remove the valve rocker arm cover gasket (1).
Discard the valve rocker arm cover gasket (1).

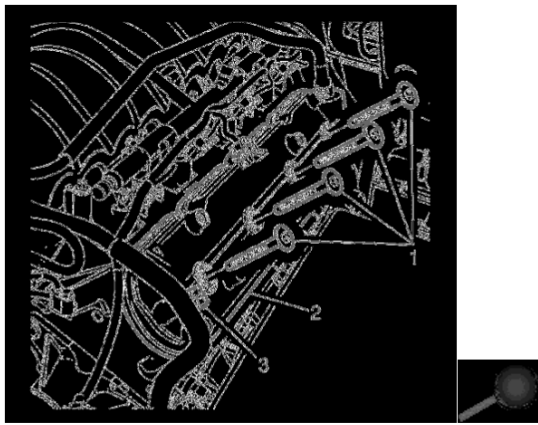
Installation Procedure

Note:

- All gasket surfaces should be free of oil and other foreign material during assembly.
- DO NOT reuse the valve rocker arm cover gasket.
- The valve rocker arm cover bolt grommets may be reused.
- If the positive crankcase ventilation (PCV) valve grommet has been removed from the rocker arm cover, install a NEW grommet during assembly.
- If the valve rocker arm cover grommets are cracked or damaged, replace the valve rocker arm cover bolts. The grommet is serviced with the rocker arm cover bolt.



1. Install a NEW valve rocker arm cover gasket (1).

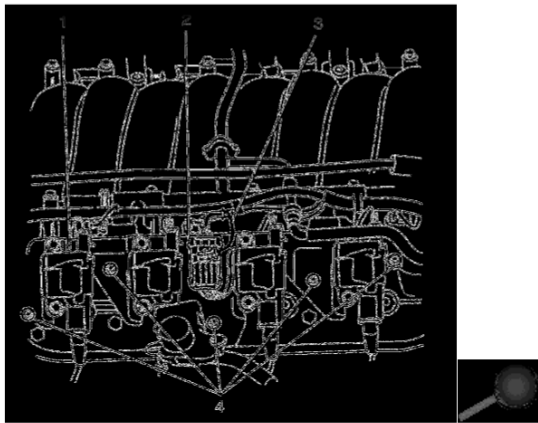


2. Install the valve rocker arm cover (2).

Caution: Refer to [Fastener Caution](#).

2.1. Install the rocker arm cover to cylinder head retaining bolts (1) and tighten to **12 N·m (106 lb in)**.

2.2. Install the engine wiring harness retainer (3) and reposition the wiring harness.



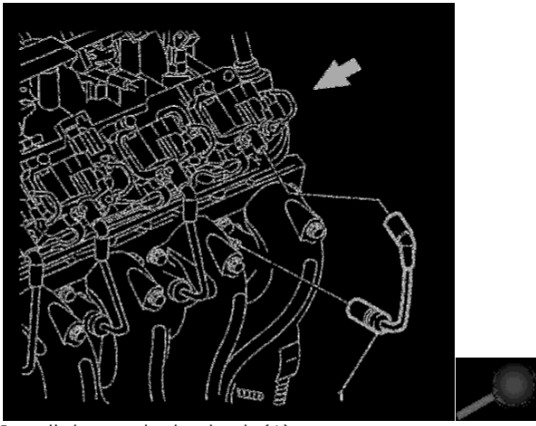
3. Install the ignition coil assembly (1).

Caution: Refer to [Fastener Caution](#).

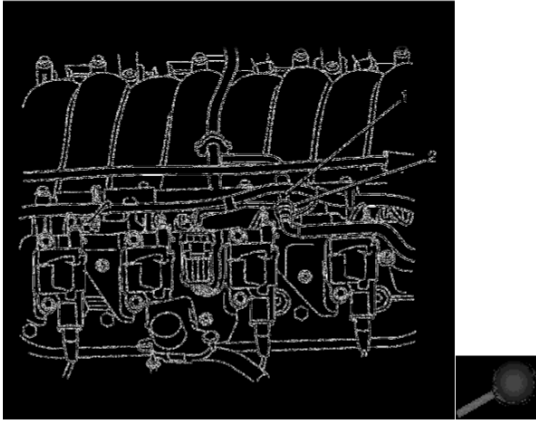
4. Install the ignition coil bracket to valve rocker arm cover retaining studs (4) and tighten to **12 N·m (106 lb in)**.

5. Connect the ignition coil main connector (2).

6. Install the CPA lock (3) from the ignition coil main connector (2).



7. Install the spark plug leads (1).



8. Remove the plug on the fuel feed pipe (2) and fuel rail tube (1) ends.

9. Connect the fuel rail feed pipe (2) quick connect fitting. Refer to [Metal Collar Quick Connect Fitting Service](#) or [Plastic Collar Quick Connect Fitting Service](#).

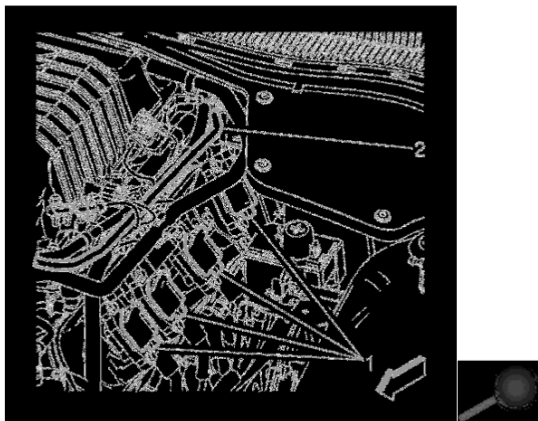
10. Connect the battery ground cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

11. Install the dress engine cover. Refer to [Engine Cover Replacement](#).

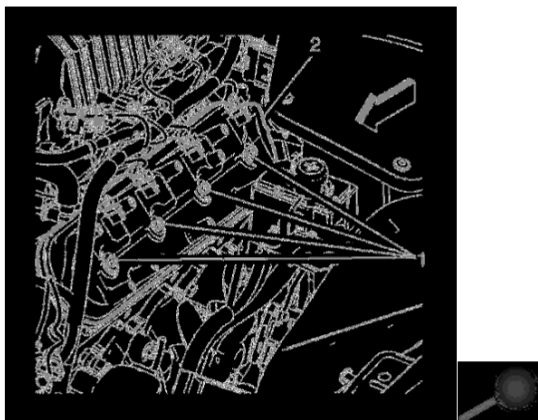
Valve Rocker Arm Cover Replacement - Left Side (LSA)

Removal Procedure

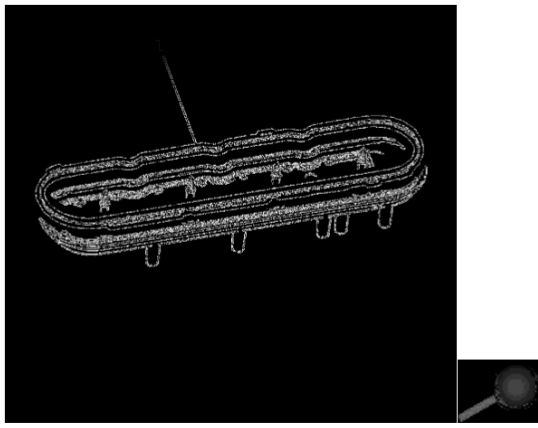
1. Disconnect the battery ground cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
2. Remove the intake manifold cover. Refer to [Intake Manifold Cover Replacement - Front](#).



3. Remove the ignition coil (1). Refer to [Ignition Coil Replacement](#).
4. Disconnect the positive crankcase ventilation tube from the valve rocker arm cover. Refer to [Positive Crankcase Ventilation Hose/Pipe/Tube Replacement](#).



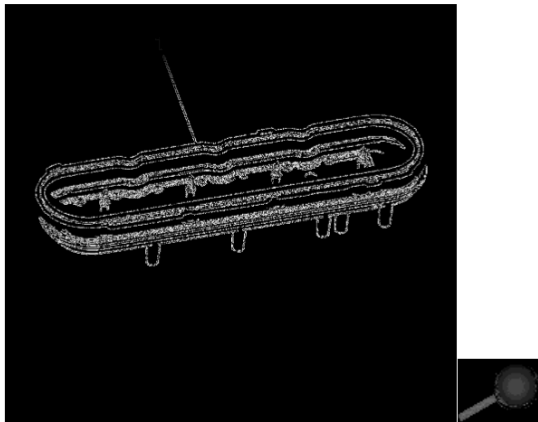
5. Remove the valve rocker arm cover fasteners (1).
6. Disconnect and reposition engine harness as necessary.
7. Remove the valve rocker arm cover (2).



Note: The valve rocker arm cover gasket is a single use only component and must be replaced whenever the valve rocker arm cover is removed from the cylinder head.

8. Remove the valve rocker arm gasket (1) and DISCARD.
9. For clean and inspect the rocker arm cover. Refer to [Valve Rocker Arm Cover Cleaning and Inspection](#).

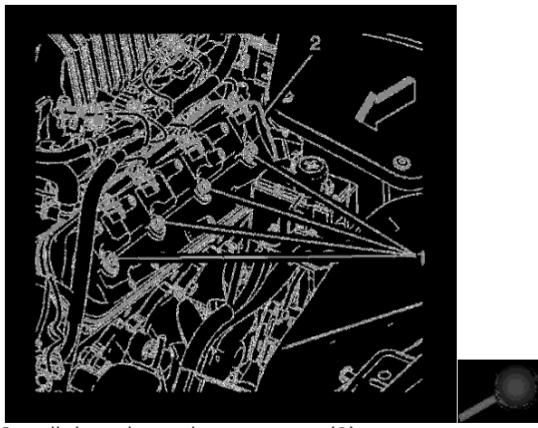
Installation Procedure



Note:

- All gasket surfaces should be free of oil or other foreign material during assembly.
- If the valve rocker arm cover grommets are cracked or damaged, replace the valve rocker arm cover bolts. The grommet is serviced with the rocker arm cover bolt.

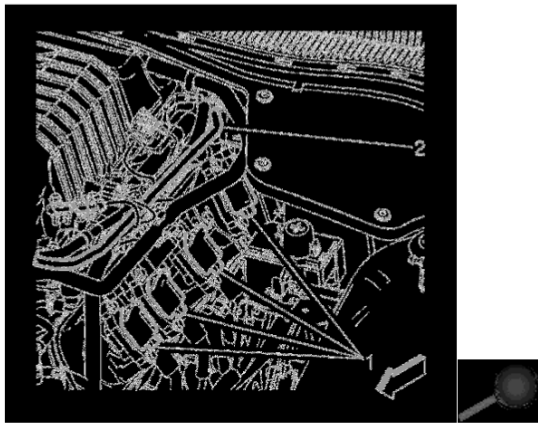
1. Install a NEW valve rocker arm gasket (1).



2. Install the valve rocker arm cover (2).

Caution: Refer to [Fastener Caution](#).

3. Install the valve rocker arm cover fasteners (1) with grommets and tighten to **12 N·m (9 lb ft)**.
4. Reconnect electrical connectors.

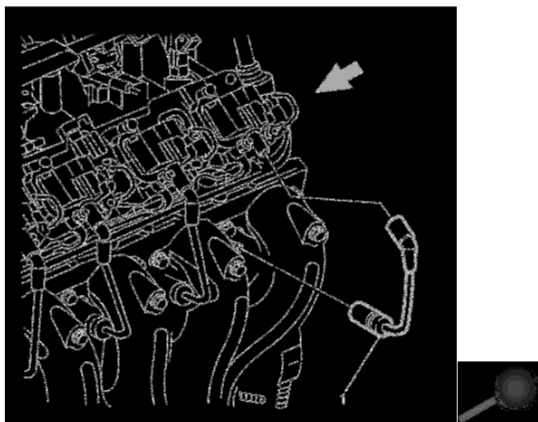


5. Install the ignition coil (1). Refer to [Ignition Coil Replacement](#).
6. Connect the positive crankcase ventilation tube onto the valve rocker arm cover. Refer to [Positive Crankcase Ventilation Hose/Pipe/Tube Replacement](#).
7. Install the intake manifold cover. Refer to [Intake Manifold Cover Replacement - Front](#).
8. Connect the battery ground cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

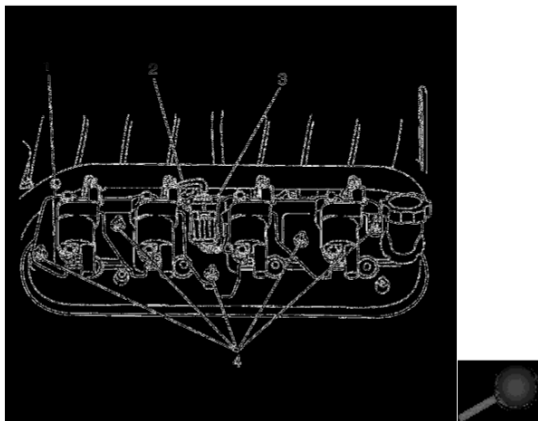
Valve Rocker Arm Cover Replacement - Right Side (L77 or LS3)

Removal Procedure

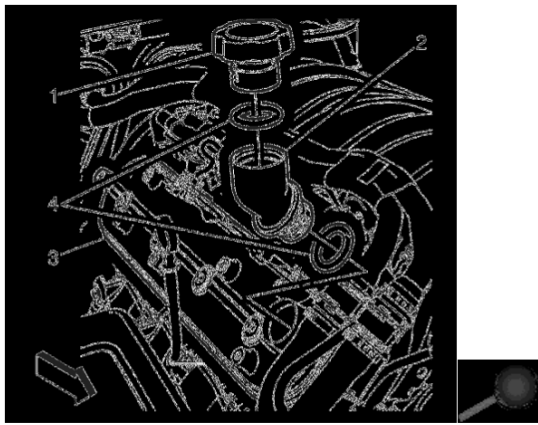
1. Disconnect the battery ground cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
2. Remove the engine cover. Refer to [Engine Cover Replacement](#).



3. Remove the spark plug leads (1).



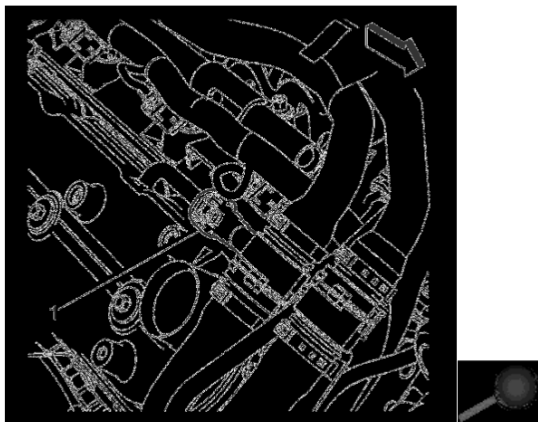
4. Remove the CPA lock (2) from the ignition coil main connector (3).
5. Disconnect the ignition coil main connector (3).
6. Remove the ignition coil assembly to valve rocker arm cover retaining studs (4).
7. Remove the ignition coil assembly (1).



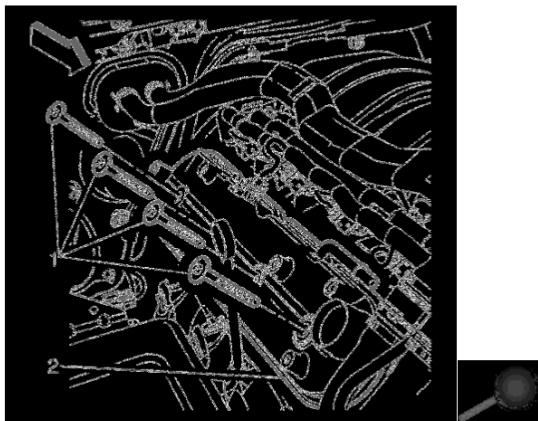
Note: Do not remove the oil fill tube from the cover, unless service is required. If the oil fill tube has been removed from the cover, install a NEW tube during assembly.

Note: Inspect the oil filler tube and cap seals (4) for damage or wear and replace as needed.

8. Remove the oil fill tube from the right hand valve rocker arm cover (3) if required.
9. Remove the oil fill tube (2), from the right hand valve rocker arm cover (3) if required.
10. Remove the oil fill cap (1) from the oil fill tube (2).
11. Discard the oil fill tube (2).



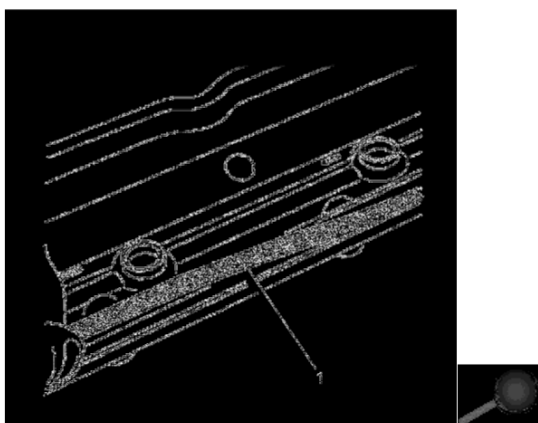
12. Disconnect the PCV tube from the rocker arm cover. Refer to [Plastic Collar Quick Connect Fitting Service](#).



13. Remove the valve rocker arm cover retaining bolts (1) and valve rocker arm cover (2).

13.1. Reposition the engine wiring harness and hoses as needed.

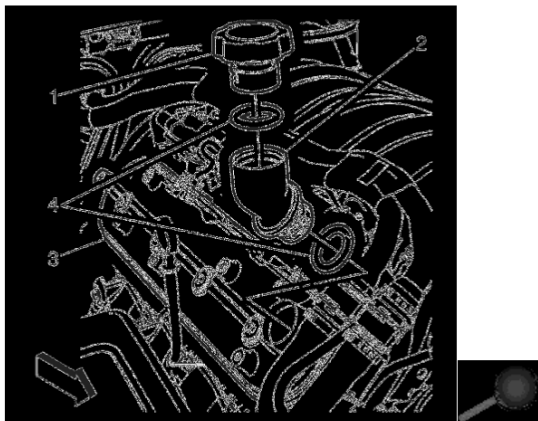
13.2. Remove the valve rocker arm cover (2).



Note: The valve rocker arm cover gasket is a single use only component and must be replaced whenever the valve rocker arm cover is removed from the cylinder head.

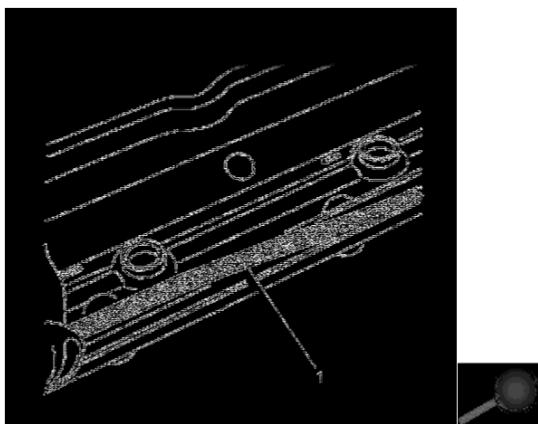
14. Remove and DISCARD the valve rocker arm cover gasket (1).

Installation Procedure



Note: If the valve rocker arm cover grommets are cracked or damaged, replace the valve rocker arm cover bolts. The grommet is serviced with the rocker arm cover bolt.

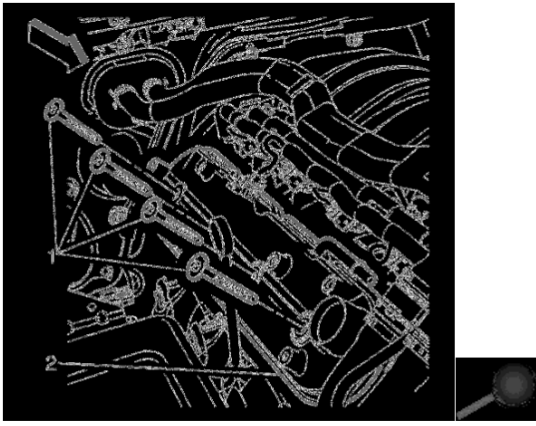
1. Install the NEW oil fill tube (2), to the right hand valve rocker arm cover (3) if required.
2. Install the oil fill cap (1) to the oil fill tube (2).



Note:

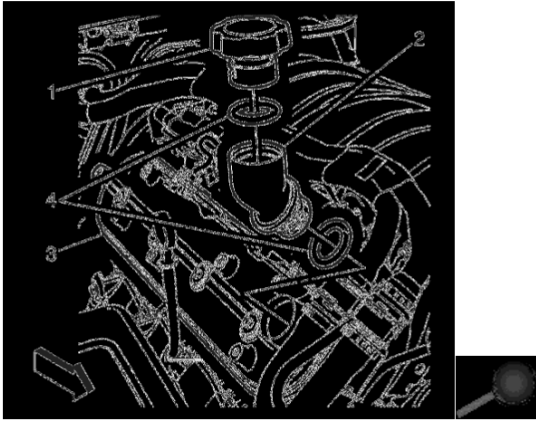
- All gasket surfaces should be free of oil and other foreign material during assembly.
- DO NOT reuse the valve rocker arm cover gasket.
- The valve rocker arm cover bolt grommets may be reused.

3. Install a NEW valve rocker arm cover gasket (1).

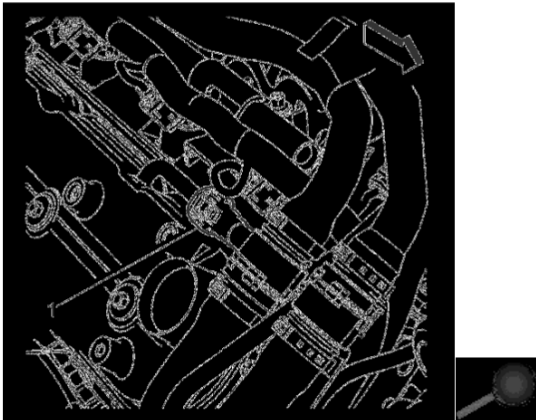


Caution: Refer to [Fastener Caution](#).

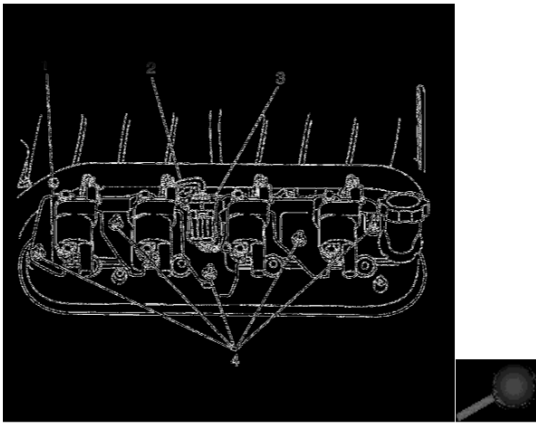
4. Install the valve rocker arm cover (2) and the rocker arm cover fasteners (1). Tighten to **12 N·m (106 lb in)**.



5. Install the oil fill tube (2) and oil seals (4) into the rocker arm cover.
6. Install the oil fill cap (1) in fill tube.



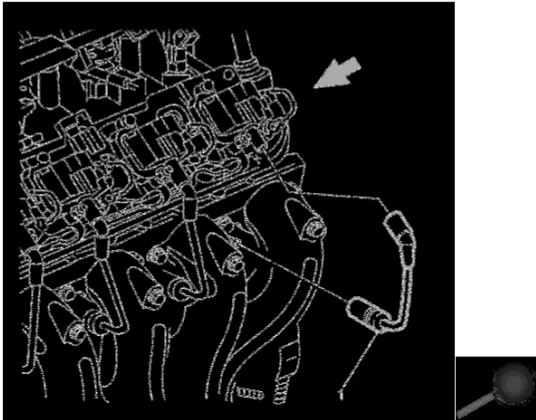
7. Connect the PCV tube to the rocker arm cover. Refer to [Plastic Collar Quick Connect Fitting Service](#).



8. Install the ignition coil assembly (1).

Caution: Refer to [Fastener Caution](#).

9. Install the ignition coil bracket to valve rocker arm cover retaining studs (4) and tighten to **12 N•m (106 lb in)**.
10. Connect the ignition coil main connector (3).
11. Install the CPA lock (2) from the ignition coil main connector (3).



12. Install the spark plug leads (1).
13. Install the engine cover. Refer to [Engine Cover Replacement](#).

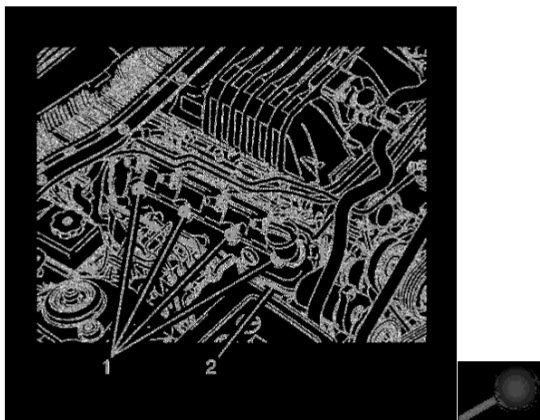
Valve Rocker Arm Cover Replacement - Right Side (LSA)

Removal Procedure

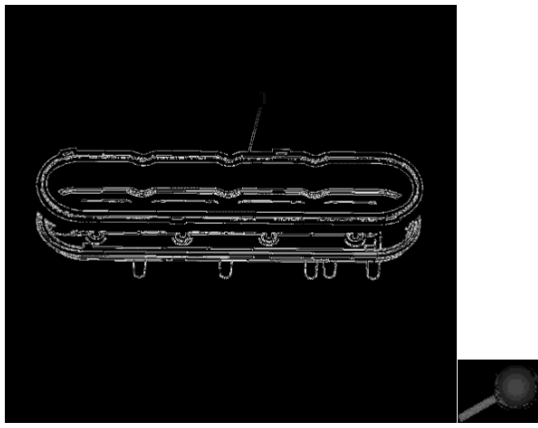
1. Disconnect the battery ground cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
2. Remove the intake manifold cover. Refer to [Intake Manifold Cover Replacement - Front](#).



3. Remove the ignition coil (1). Refer to [Ignition Coil Replacement](#).



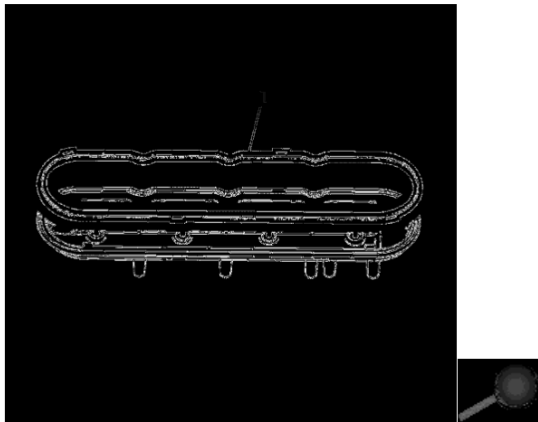
4. Remove the valve rocker arm bolts (1).
5. Disconnect and reposition engine harness as necessary.
6. Remove the valve rocker arm cover (2).



Note: The valve rocker arm cover gasket is a single use only component and must be replaced whenever the valve rocker arm cover is removed from the cylinder head.

7. Remove the valve rocker arm gasket (1) and DISCARD.
8. For cleaning and inspecting the rocker arm cover, refer to [Valve Rocker Arm Cover Cleaning and Inspection](#).

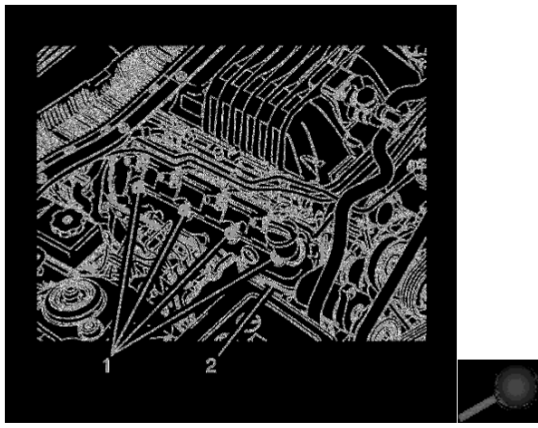
Installation Procedure



Note:

- All gasket surfaces should be free of oil or other foreign material during assembly.
- If the valve rocker arm cover grommets are cracked or damaged, replace the valve rocker arm cover bolts. The grommet is serviced with the rocker arm cover bolt.

1. Install a NEW valve rocker arm gasket (1).



Caution: Refer to [Fastener Caution](#).

2. Install the valve rocker arm cover (2).
3. Install the cover bolts (1) with grommets and tighten to **12 N·m (9 lb ft)**.
4. Reconnect electrical connectors.



5. Install the ignition coil (1). Refer to [Ignition Coil Replacement](#).
6. Install the intake manifold cover. Refer to [Intake Manifold Cover Replacement - Front](#).
7. Connect the battery ground cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

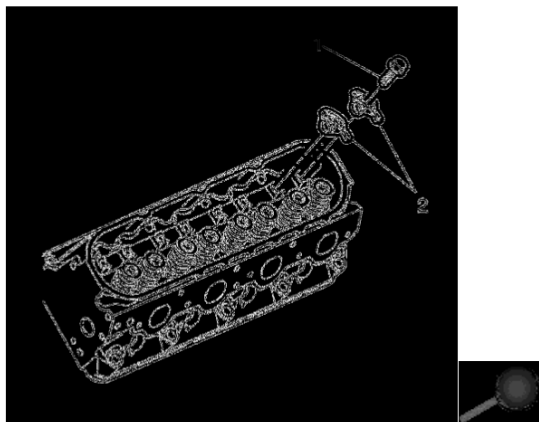
Valve Rocker Arm and Push Rod Replacement

Removal Procedure

1. Remove the rocker arm cover. Refer to [Valve Rocker Arm Cover Replacement - Left Side](#) or [Valve Rocker Arm Cover Replacement - Right Side](#).

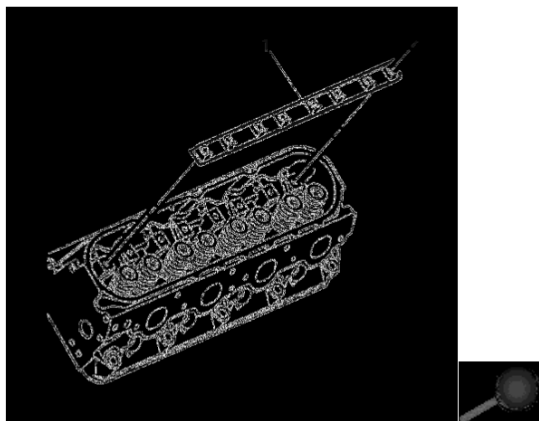
Note: The engine firing order is 1, 8, 7, 2, 6, 5, 4, 3. Cylinders 1, 3, 5 and 7 are the left bank.

2. Remove the number one cylinder spark plug. Refer to [Spark Plug Replacement](#).

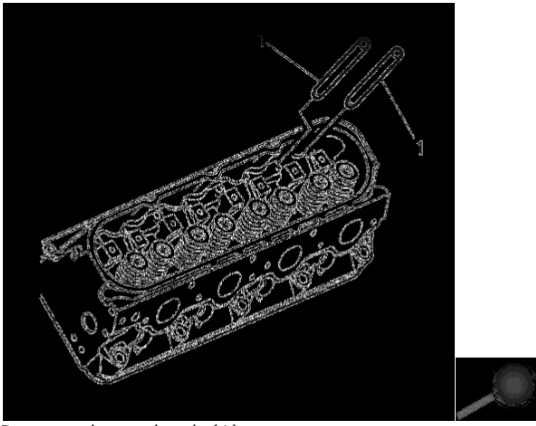


Note: Place the rocker arms, pushrods, and pivot support, in a rack so that they can be installed in the same location from which they were removed.

3. Remove the rocker arm bolts (1).
4. Remove the rocker arms (2).



5. Remove the rocker arm pivot support (1).



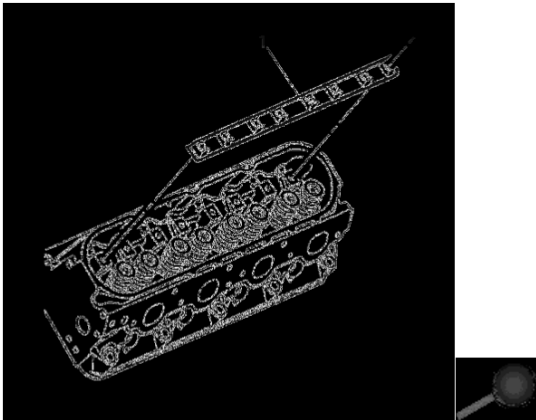
6. Remove the pushrods (1).
7. Clean and inspect the rocker arms and pushrods, if required. Refer to [Valve Rocker Arm and Push Rod Cleaning and Inspection](#).

Installation Procedure

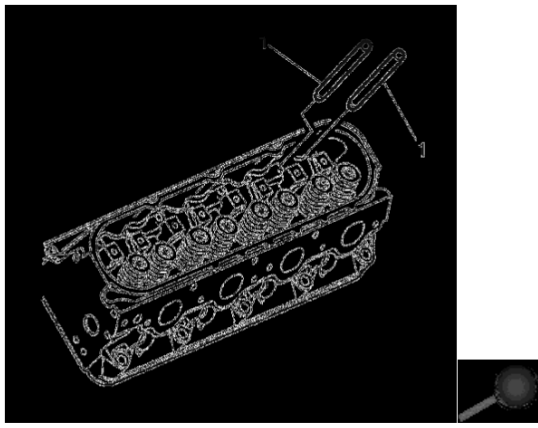
Note: When reusing the valve train components, always install the components to the original location and position.

Valve lash is net build, no valve adjustment is required.

1. Lubricate the rocker arms and pushrods with clean engine oil.
2. Lubricate the flange of the rocker arm bolts with clean engine oil. Lubricate the flange or washer surface of the bolt that will contact the rocker arm.

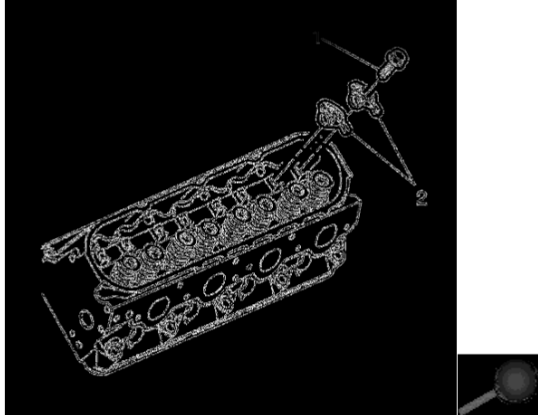


3. Install the rocker arm pivot support (1).



Note: Make sure that the pushrods seat properly to the valve lifter sockets.

4. Install the pushrods (1).



Note: Make sure that the pushrods seat properly to the ends of the rocker arms. DO NOT tighten the rocker arm bolts at this time.

5. Install the rocker arms (2) and bolts (1).

Note: The engine firing order is 1, 8, 7, 2, 6, 5, 4, 3. Cylinders 1, 3, 5 and 7 are the left bank. Cylinders 2, 4, 6 and 8 are the right bank.

6. Rotate the crankshaft until the number one piston is at top dead center (TDC) of the compression stroke. In this position, the number one cylinder rocker arms will be off lobe lift.

Caution: Refer to [Fastener Caution](#).

7. With the engine in the number one firing position, tighten the following rocker arm bolts:

Tighten

- Tighten cylinders 1,2,7 and 8 exhaust valve rocker arm bolts to **30 N•m (22 lb ft)**.
- Tighten cylinders 1,3,4 and 5 intake valve rocker arm bolts to **30 N•m (22 lb ft)**.

8. Rotate the crankshaft 360 degrees.

9. Tighten the following rocker arm bolts:

Tighten

- Tighten cylinders 3, 4, 5 and 6 exhaust valve rocker arm bolts to **30 N•m (22 lb ft)**.
- Tighten cylinders 2, 6, 7 and 8 intake valve rocker arm bolts to **30 N•m (22 lb ft)**.

10. Install the number one cylinder spark plug. Refer to [Spark Plug Replacement](#).

11. Install the rocker arm cover. Refer to [Valve Rocker Arm Cover Replacement - Left Side](#) or [Valve Rocker Arm Cover Replacement - Right Side](#).

Valve Stem Oil Seal and Valve Spring Replacement

Special Tools

- J-22794 Spark Plug Port Adapter
- J-38606 Valve Spring Compressor

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

Removal Procedure

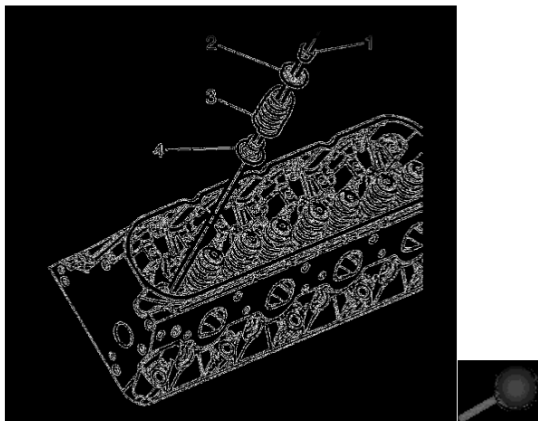
1. Remove the rocker arm. Refer to [Valve Rocker Arm and Push Rod Replacement](#).



2. Install the J-22794 spark plug port adapter into the spark plug hole.
3. Attach an air hose to the J-22794 spark plug port adapter.
4. Apply compressed air to the J-22794 spark plug port adapter in order to hold the valves in place.

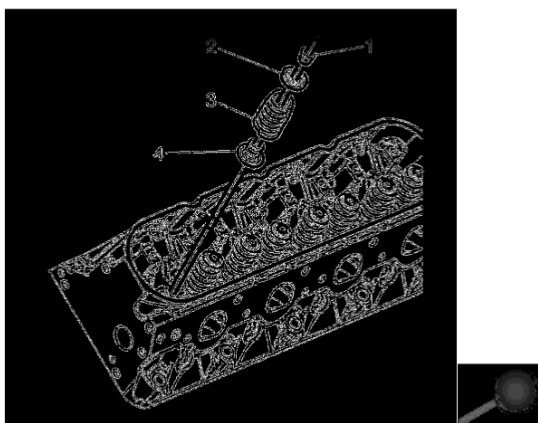


5. Use the J-38606 valve spring compressor in order to compress the valve spring.



6. Carefully release the valve spring tension.
7. Remove the J-38606 valve spring compressor.
8. Remove the valve spring cap (2).
9. Remove the valve spring (3).
10. Remove the valve stem oil seal (4).

Installation Procedure



1. Clean the cylinder head valve spring seat area.
2. Lubricate the valve guide and valve stem oil seal with clean engine oil.
3. Install the valve stem oil seal (4).
4. Install the valve spring (3).
5. Install the valve spring cap (2).



6. Compress the valve spring using the *J-38606* valve spring compressor.

7. Install the valve keys.

- Use grease in order to hold the valve keys in place.
- Make sure the keys seat properly in the groove of the valve stem.
- Carefully release the valve spring pressure, making sure the valve keys stay in place.
- Remove the *J-38606* valve spring compressor .
- Tap the end of the valve stem with a plastic faced hammer to seat the keys, if necessary.



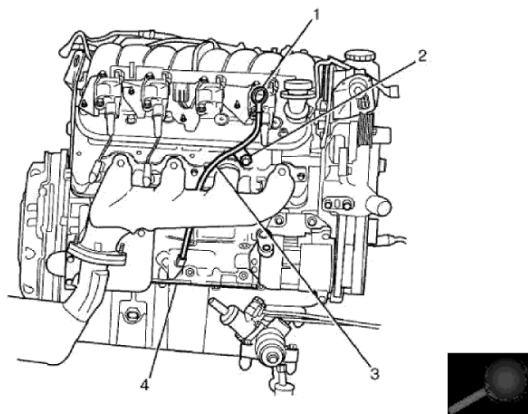
8. Remove the *J-22794* spark plug port adapter from the spark plug port.

9. Install the rocker arm. Refer to [Valve Rocker Arm and Push Rod Replacement](#).

Oil Level Indicator Tube Replacement (L77 or LS3)

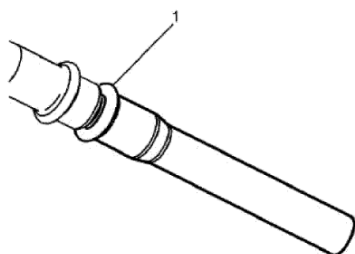
Removal Procedure

1. Remove the engine cover. Refer to [Engine Cover Replacement](#).
2. Remove the number 4 cylinder spark plug wire. Refer to [Spark Plug Wire Replacement](#).

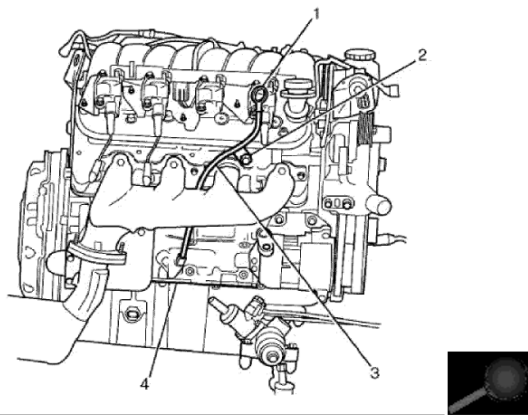


3. Remove the oil level indicator (1) from the oil level indicator tube (3).
4. Remove the oil level indicator tube to cylinder head retaining bolt (2).
5. Remove the oil level indicator tube (3) from the engine block (4).

Installation Procedure



1. Lubricate the oil level indicator tube O-ring seal (1) with clean engine oil.



Note: Make sure the oil level indicator tube (3) seats securely into the engine block (4).

2. Install the oil level indicator tube (3) into the engine block (4).

Caution: Refer to [Fastener Caution](#).

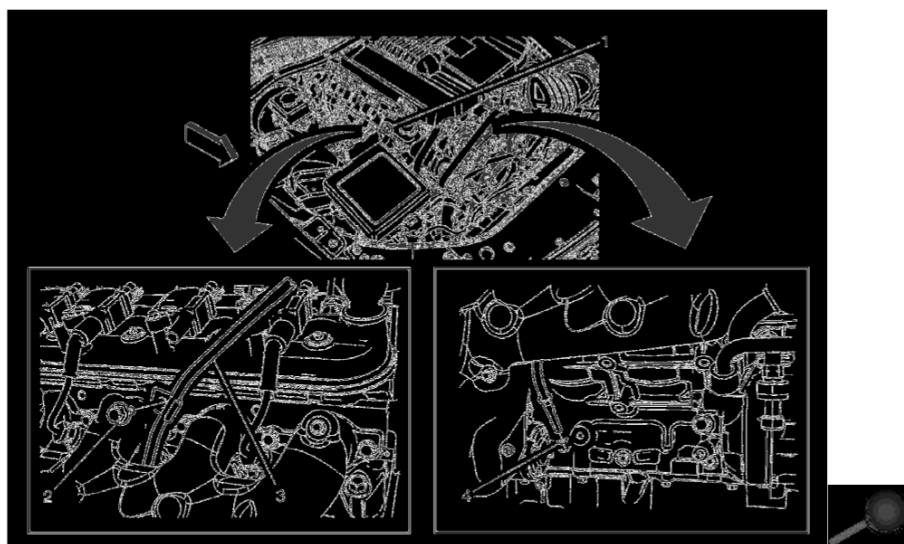
3. Install the oil level indicator tube to cylinder head retaining bolt (2).

Tighten

Tighten the bolt to 25 N·m (18 lb ft).

4. Install the oil level indicator (1) into the oil level indicator tube (2).
5. Install the number 4 cylinder spark plug wire. Refer to [Spark Plug Wire Replacement](#).
6. Install the engine cover. Refer to [Engine Cover Replacement](#).

Oil Level Indicator Tube Replacement (LSA)



Oil Level Indicator Tube Replacement

Callout	Component Name
Preliminary Procedure Remove the cylinder number 4 spark plug wire. Refer to Spark Plug Wire Replacement	
1	Oil Level indicator Procedure Remove the oil level indicator from the oil level indicator tube.
2	Oil Level indicator Tube Fastener Caution: Refer to Fastener Caution . Tighten 25 N·m (18 lb ft)
3	Oil Level Indicator Tube
4	Oil Level Indicator Tube Seal Note: Make sure that the oil level indicator tube (3) seats securely into the engine block. Procedure 1. Inspect the oil level indicator tube seal for damage or cuts. 2. Replace the oil level indicator tube seal as needed. 3. Use clean engine oil to lubricate the oil level indicator tube seal prior to installing the oil level indicator tube.

Callout	Component Name
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Cylinder Head Replacement - Left Side (L77 or LS3)

Special Tools

- J 42385-100 Head/Main Bolt Thread Repair Kit
- J 45059 Angle Meter

Removal Procedure

1. Remove the air inlet grille panel. Refer to [Air Inlet Grille Panel Replacement](#).
2. Remove the intake manifold assembly. Refer to [Intake Manifold Replacement](#).
3. Remove the engine coolant air bleed pipe. Refer to [Engine Coolant Air Bleed Pipe Replacement](#).
4. Remove the accessory drive belt. Refer to [Drive Belt Replacement - Accessory](#).
5. Remove the left side ignition coils. Refer to [Ignition Coil Replacement](#).
6. Remove the spark plugs. Refer to [Spark Plug Replacement](#).
7. Remove the left side exhaust manifold. Refer to [Exhaust Manifold Replacement - Left Side](#).

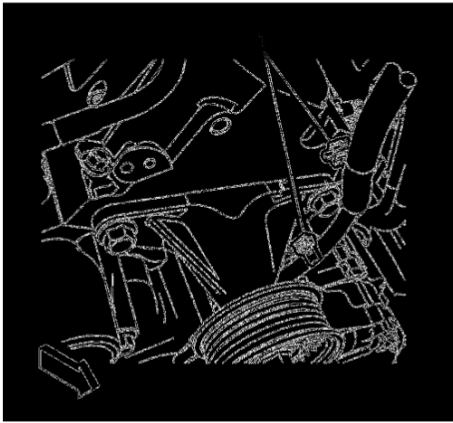


8. Detach the powertrain wiring harness connector (1) from the rear cylinder head bracket (2).
9. Detach the powertrain wiring harness retainer (3) from the rear cylinder head (6).
10. Remove the powertrain wiring harness ground cable to cylinder head retaining bolt (4) and position ground strap (5) aside.

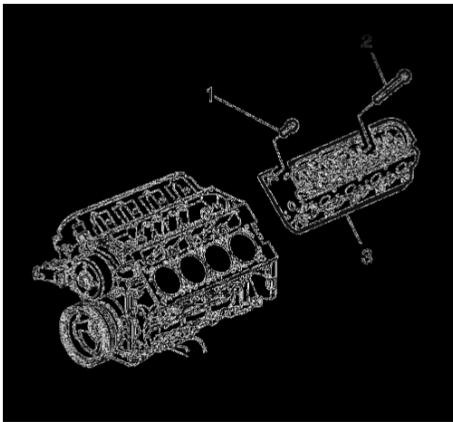
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11. Disconnect the coolant temperature sensor electrical connector (1).



12. Detach the powertrain wiring harness retainers (1) from the cylinder head.
13. Remove the left side valve rocker arms and pushrods. Refer to [Valve Rocker Arm and Push Rod Replacement](#).

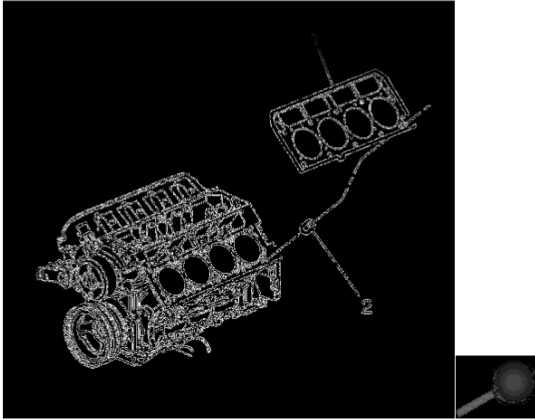


Note: The cylinder head bolts are of a torque-to-yield design and are NOT to be used again. Install NEW cylinder head bolts during assembly.

14. Remove and discard the cylinder head bolts (1, 2).

Caution: After removal, place the cylinder head on 2 wood blocks in order to prevent damage to the sealing surfaces.

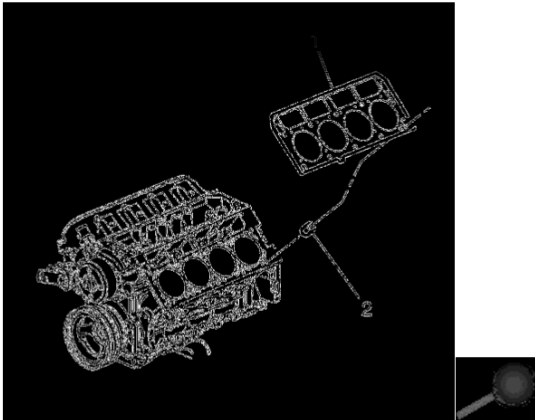
15. Remove the cylinder head (3).



16. Remove the gasket (1) and locating pins (2).

Installation Procedure

1. Transfer parts as necessary.



Warning: Refer to [Safety Glasses Warning](#).

Caution: Clean all dirt, debris, and coolant from the engine block cylinder head bolt holes. Failure to remove all foreign material may result in damaged threads, improperly tightened fasteners or damage to components.

Note:

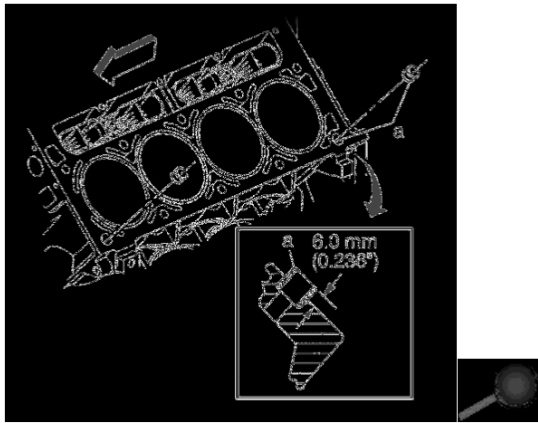
- Do not use the cylinder head bolts again. Install NEW cylinder head bolts during assembly.
- Do not use any type of sealant on the cylinder head gasket, unless specified.

2. Clean the engine block cylinder head bolt holes, if required.

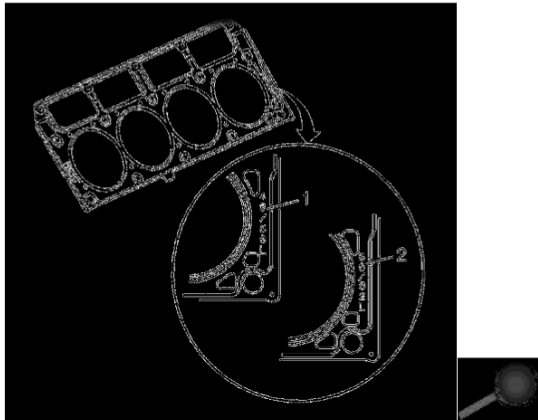
J42385-107 thread repair tool may be used to clean the threads of old threadlocking material.

3. Spray cleaner into the hole. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#).

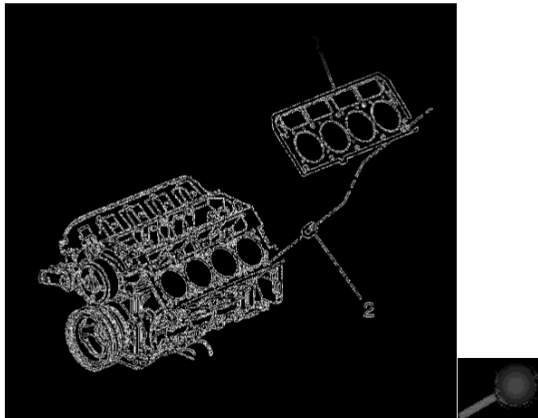
4. Clean the cylinder head bolt holes with compressed air.
5. Install the cylinder head locating pins (2).



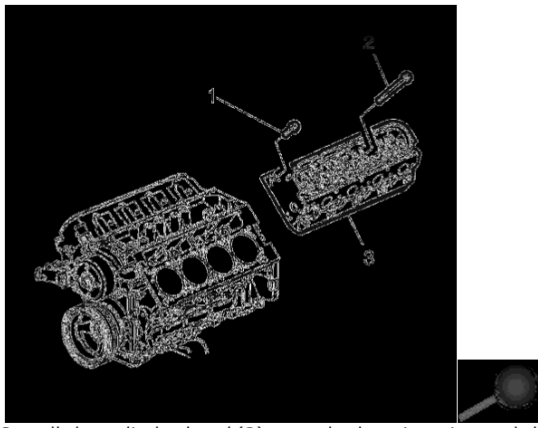
6. Inspect the locating pins for proper installation.



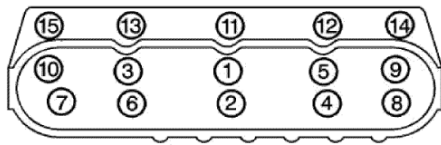
7. Inspect the displacement markings (1, 2) on the gasket, for proper usage.



8. Install the NEW cylinder head gasket (1) onto the locating pins.

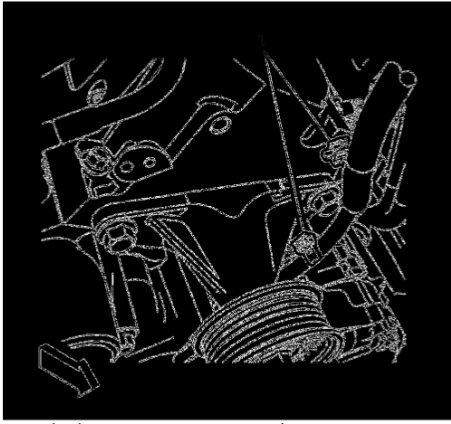


9. Install the cylinder head (3) onto the locating pins and the gasket.
10. Install the NEW cylinder head bolts (1, 2).



Caution: Refer to [Fastener Caution](#).

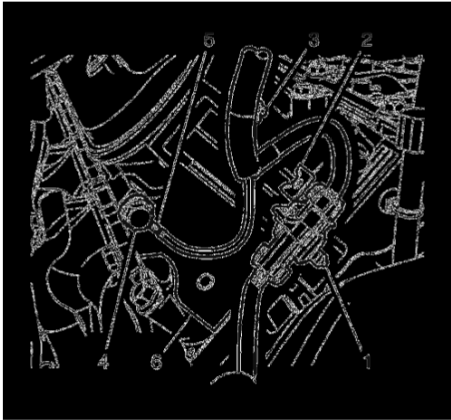
11. Tighten the cylinder head bolts.
 - 11.1. Tighten the M11 cylinder head bolts (1-10) a first pass in sequence to **30 N·m (22 lb ft)**.
 - 11.2. Tighten the M11 cylinder head bolts (1-10) a second pass in sequence to **90 degrees** using the *J 45059* meter.
 - 11.3. Tighten the M11 cylinder head bolts (1-10) a final pass in sequence to **70 degrees** using the *J 45059* meter.
 - 11.4. Tighten the M8 cylinder head bolts (11-15) to **30 N·m (22 lb ft)**. Begin with the center bolt (11) and alternating side-to-side, work outward tightening all of the bolts.
12. Install the left side valve rocker arms and pushrods. Refer to [Valve Rocker Arm and Push Rod Replacement](#).



13. Attach the powertrain wiring harness retainers (1) to the cylinder head.



14. Connect the coolant temperature sensor electrical connector (1).



Caution: Refer to [Fastener Caution](#).

15. Install the ground strap (5) and the powertrain wiring harness ground cable to cylinder head retaining bolt (4). Tighten the bolt to 10N·m (89 lb in).

16. Attach the powertrain wiring harness connector (1) to the rear cylinder head bracket (2).
17. Attach the powertrain wiring harness retainer (3) to the rear cylinder head (6).
18. Attach the powertrain wiring harness strap (3) to the rear cylinder head bracket (1).
19. Install the left side exhaust manifold. Refer to [Exhaust Manifold Replacement - Left Side](#).
20. Install the spark plugs. Refer to [Spark Plug Replacement](#).
21. Install the left side ignition coils. Refer to [Ignition Coil Replacement](#).
22. Install the engine coolant air bleed pipe. Refer to [Engine Coolant Air Bleed Pipe Replacement](#).
23. Install the accessory drive belt. Refer to [Drive Belt Replacement - Accessory](#).
24. Install the intake manifold assembly. Refer to [Intake Manifold Replacement](#).
25. Refill the cooling system. Refer to [Cooling System Draining and Filling](#).
26. Install the air inlet grille panel. Refer to [Air Inlet Grille Panel Replacement](#).

Cylinder Head Replacement - Left Side (LSA)

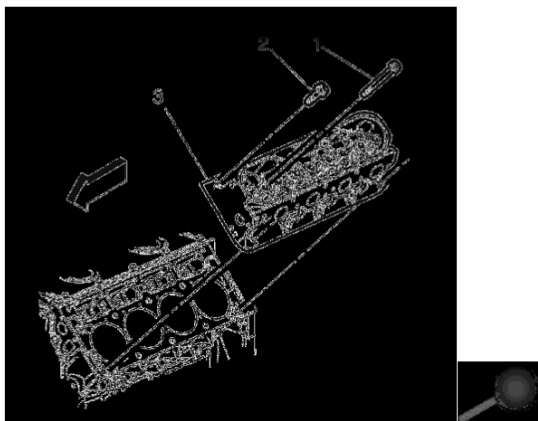
Special Tools

- J 42385-100 Head/Main Bolt Thread Repair Kit
- J 45059 Angle Meter

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

Removal Procedure

1. Remove the valve rocker arms and pushrods. Refer to [Valve Rocker Arm and Push Rod Replacement](#).
2. Remove the exhaust manifold. Refer to [Exhaust Manifold Replacement - Left Side](#).
3. Remove the supercharger. Refer to [Supercharger Replacement](#).
4. Remove the engine wiring harness ground bolt from the rear of the left cylinder head.
5. Reposition the engine wire harness ground strap away from the cylinder head.



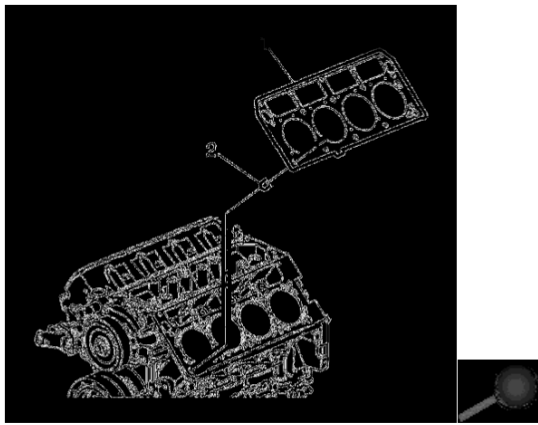
Note: The cylinder head bolts are NOT reusable.

6. Remove and DISCARD the cylinder head bolts (1, 2).

Caution: After removal, place the cylinder head on 2 wood blocks in order to prevent damage to the sealing surfaces.

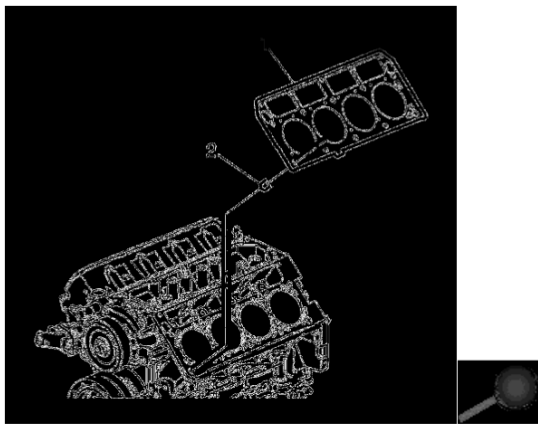
7. Remove the cylinder head (3).

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8. Remove the cylinder head gasket (1).
9. Remove the cylinder head locator pins (2).
10. Clean and inspect the cylinder head. Refer to [Cylinder Head Cleaning and Inspection](#).

Installation Procedure



Warning: Refer to [Safety Glasses Warning](#).

Caution: Clean all dirt, debris, and coolant from the engine block cylinder head bolt holes. Failure to remove all foreign material may result in damaged threads, improperly tightened fasteners or damage to components.

Note: If installing a new cylinder head it is necessary to install a new engine coolant air bleed plug into the rear coolant passage of the cylinder head. Refer to [Cylinder Head Assemble](#).

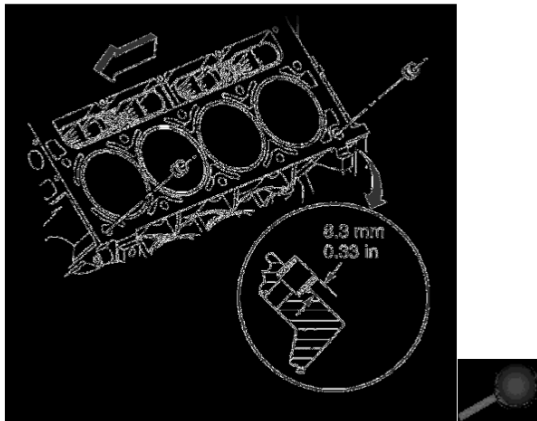
Note:

- Do not use the cylinder head bolts again. Install NEW cylinder head bolts during assembly.
- Do not use any type of sealant on the cylinder head gasket, unless specified.
- The cylinder head gaskets must be installed in the proper direction and position.

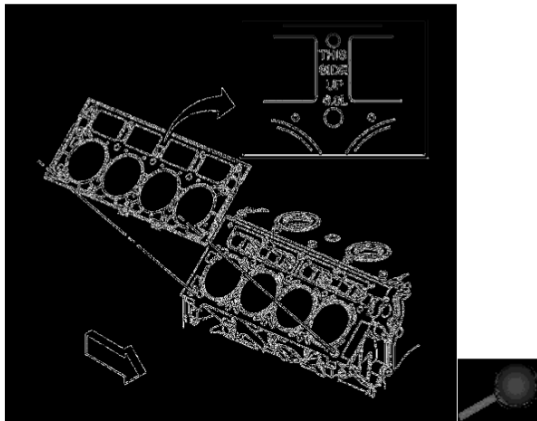
1. Clean the engine block cylinder head bolt holes, if required.

Thread repair tool J-42385-107 may be used to clean the threads of old threadlocking material.

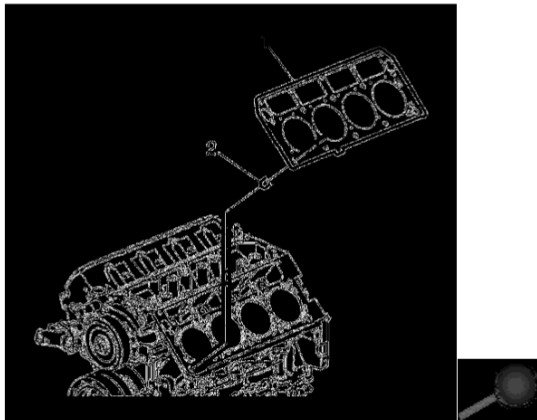
2. Spray cleaner GM P/N 12346139 (Canadian P/N 10953463), GM P/N 12377981 (Canadian P/N 10953463) or equivalent into the hole.
3. Clean the cylinder head bolt holes with compressed air.
4. Install the cylinder head locating pins (2).



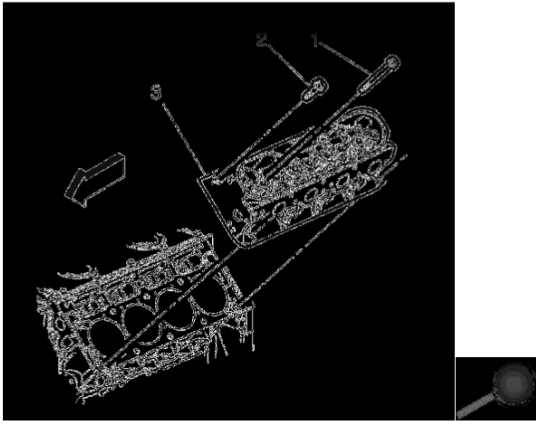
5. Inspect the locating pins for proper installation.



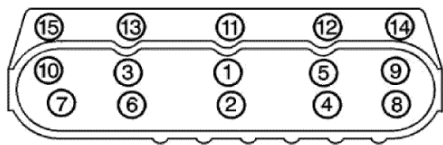
6. Inspect the displacement markings on the gasket for proper usage.



7. Install the NEW cylinder head gasket (1) onto the locating pins.



8. Install the cylinder head (3) onto the locating pins and the gasket.
9. Install the NEW cylinder head bolts (2, 1).



Caution: Refer to [Fastener Caution](#).

10. Tighten the cylinder head bolts.
- 10.1. Tighten the M11 cylinder head bolts (1-10) a first pass in sequence to **50 N·m (37 lb ft)**.
 - 10.2. Tighten the M11 cylinder head bolts (1-10) a second pass in sequence to **80 degrees** using the *J 45059* angle meter.
 - 10.3. Tighten the M11 cylinder head bolts (1-10) a final pass in sequence to **55 degrees** using the *J 45059* angle meter.
 - 10.4. Tighten the M8 cylinder head bolts (11-15) to **30 N·m (22 lb ft)**. Begin with the center bolt (11) and alternating side-to-side, work outward tightening all of the bolts.
11. Install the supercharger. Refer to [Supercharger Replacement](#).
12. Position the engine wire harness ground strap against the cylinder head.
13. Install the engine wiring harness ground bolt to the rear of the left cylinder head. Tighten the engine wire harness ground bolt to **32 N·m (24 lb ft)**.
14. Install the exhaust manifold. Refer to [Exhaust Manifold Replacement - Left Side](#).
15. Install the valve rocker arms and pushrods. Refer to [Valve Rocker Arm and Push Rod Replacement](#).

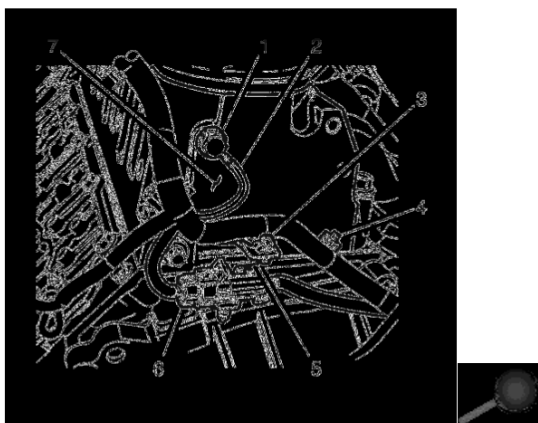
Cylinder Head Replacement - Right Side (L77 or LS3)

Special Tools

- J 42385-100 Head/Main Bolt Thread Repair Kit
- J 45059 Angle Meter

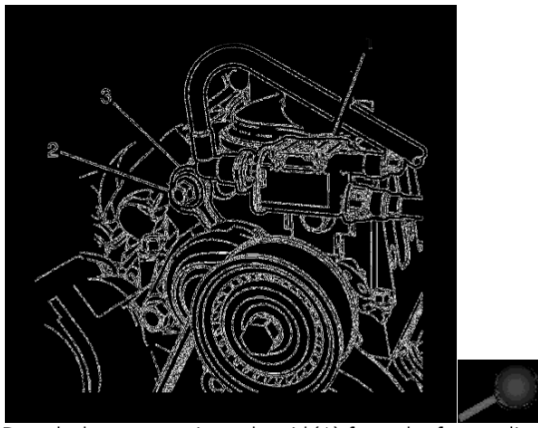
Removal Procedure

1. Remove the air inlet grille panel. Refer to [Air Inlet Grille Panel Replacement](#).
2. Remove the intake manifold assembly. Refer to [Intake Manifold Replacement](#).
3. Remove the engine coolant air bleed pipe. Refer to [Engine Coolant Air Bleed Pipe Replacement](#).
4. Remove the accessory drive belt. Refer to [Drive Belt Replacement - Accessory](#).
5. Remove the right side exhaust manifold. Refer to [Exhaust Manifold Replacement - Right Side](#).

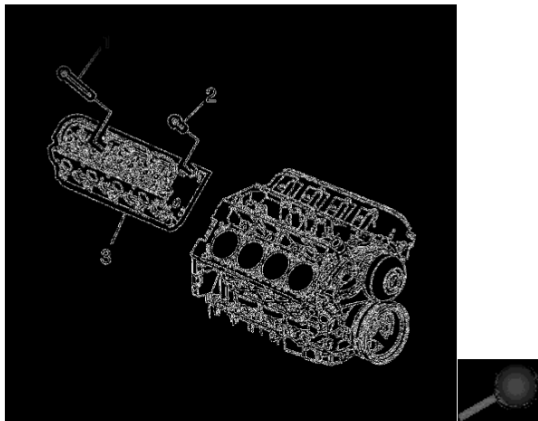


6. Remove the vehicle body ground cable to cylinder head retaining fastener (1) and position ground strap (2) aside.
7. Detach the powertrain wiring harness retainer (3) and connector (6) from the rear cylinder head bracket (5).
8. Detach the powertrain wiring harness retainer (4) from the rear cylinder head (7).

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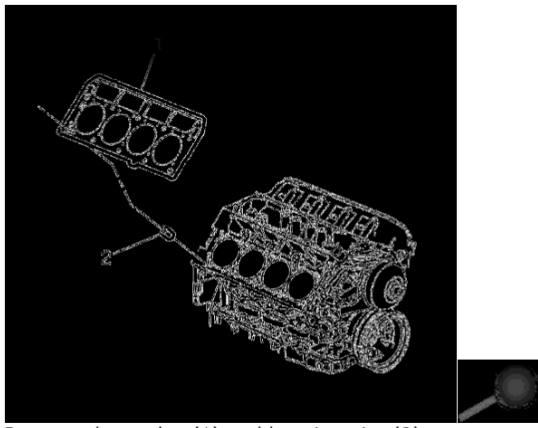


9. Detach the evaporative solenoid (1) from the front cylinder head bracket.
10. Remove the vehicle body ground cable to cylinder head retaining fastener (2) and position ground strap (3) aside.
11. Remove the right side valve rocker arms and pushrods. Refer to [Valve Rocker Arm and Push Rod Replacement](#).



Note: The cylinder head bolts are of a torque-to-yield design and are NOT to be used again. Install NEW cylinder head bolts during assembly.

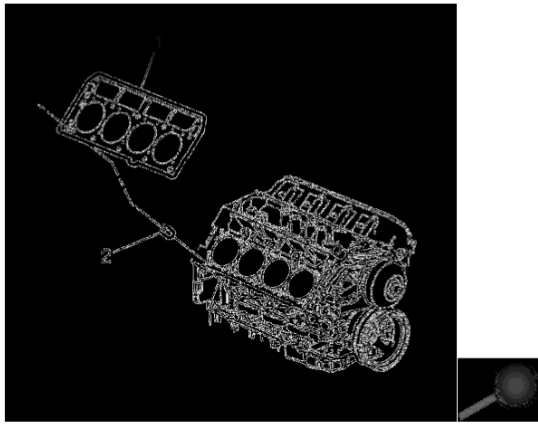
12. Remove and discard the cylinder head bolts (1, 2).
- Caution:** After removal, place the cylinder head on 2 wood blocks in order to prevent damage to the sealing surfaces.
13. Remove the cylinder head (3).



14. Remove the gasket (1) and locating pins (2).

Installation Procedure

1. Transfer parts as necessary.

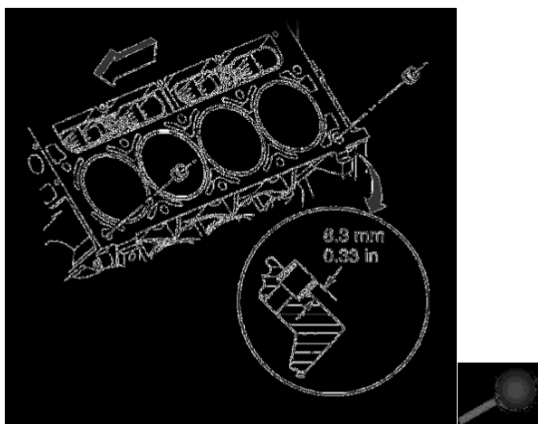


Warning: Refer to [Safety Glasses Warning](#).

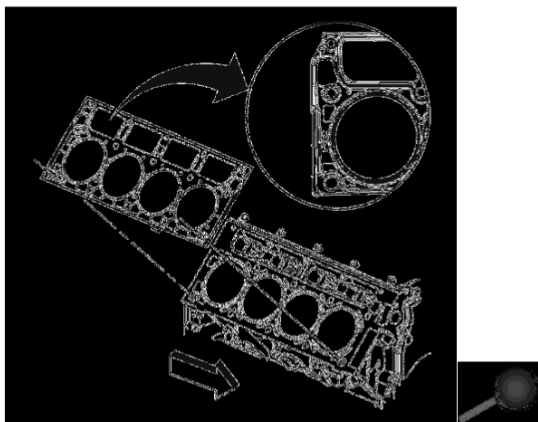
Caution: Clean all dirt, debris, and coolant from the engine block cylinder head bolt holes. Failure to remove all foreign material may result in damaged threads, improperly tightened fasteners or damage to components.

Note:

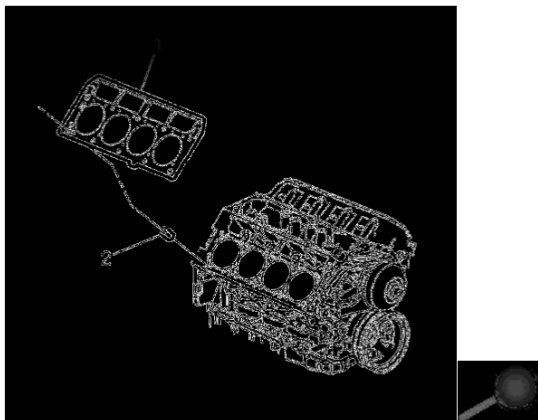
- Do not use the cylinder head bolts again. Install NEW cylinder head bolts during assembly.
 - Do not use any type of sealant on the cylinder head gasket, unless specified.
 - The cylinder head gaskets must be installed in the proper direction and position.
2. Clean the engine block cylinder head bolt holes, if required.
Thread repair tool J42385-107 may be used to clean the threads of old threadlocking material.
3. Spray cleaner into the hole. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended cleaner.
4. Clean the cylinder head bolt holes with compressed air.
5. Install the cylinder head locating pins (2).



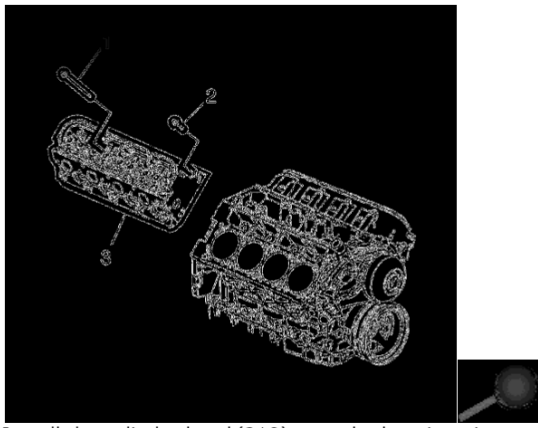
6. Inspect the locating pins for proper installation.



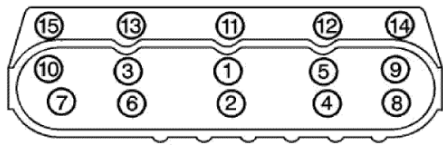
7. Inspect the displacement markings on the gasket for proper usage.



8. Install the NEW cylinder head gasket (1) onto the locating pins.

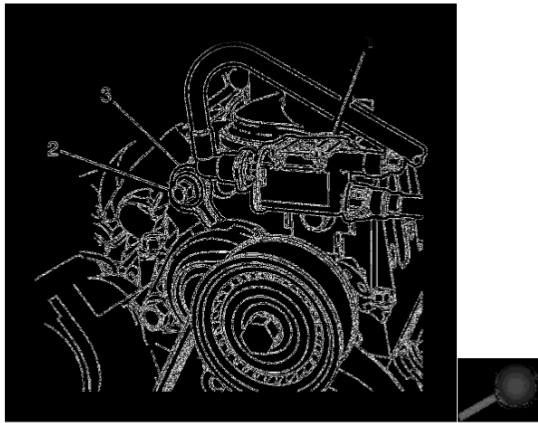


9. Install the cylinder head (218) onto the locating pins and the gasket.
10. Install the NEW cylinder head bolts (1, 2).



Caution: Refer to [Fastener Caution](#).

11. Tighten the cylinder head bolts:
 - 11.1. Tighten the M11 cylinder head bolts (1–10) a first pass in sequence to **30 N•m (22 lb ft)**.
 - 11.2. Tighten the M11 cylinder head bolts (1–10) a second pass in sequence to **90 degrees** using the *J 45059* meter.
 - 11.3. Tighten the M11 cylinder head bolts (1–10) a final pass in sequence to **70 degrees** using the *J 45059* meter.
 - 11.4. Tighten the M8 cylinder head bolts (11–15) to **30 N•m (22 lb ft)**. Begin with the center bolt (11) and alternating side-to-side, work outward tightening all of the bolts.
12. Install the right side valve rocker arms and pushrods. Refer to [Valve Rocker Arm and Push Rod Replacement](#).



Caution: Refer to [Fastener Caution](#).

13. Install the vehicle body ground cable to cylinder head retaining fastener (2) and position ground strap (3) aside.

Tighten

Tighten the fastener to 30N•m (22 lb ft).

14. Attach the evaporative solenoid (1) to the front cylinder head bracket.



15. Attach the powertrain wiring harness retainer (4) to the rear cylinder head (7).
 16. Attach the powertrain wiring harness retainer (3) and connector (6) to the rear cylinder head bracket (5).
 17. Position ground strap (2) and install the vehicle body ground cable to cylinder head retaining fastener (1).
- Tighten**
Tighten the fastener to 12N•m (106 lb ft).
18. Install the right side exhaust manifold. Refer to [Exhaust Manifold Replacement - Right Side](#).
 19. Install the accessory drive belt. Refer to [Drive Belt Replacement - Accessory](#).
 20. Install the engine coolant air bleed pipe. Refer to [Engine Coolant Air Bleed Pipe Replacement](#).
 21. Install the intake manifold assembly. Refer to [Intake Manifold Replacement](#).
 22. Refill the cooling system. Refer to [Cooling System Draining and Filling](#).
 23. Install the air inlet grille panel. Refer to [Air Inlet Grille Panel Replacement](#).

Cylinder Head Replacement - Right Side (LSA)

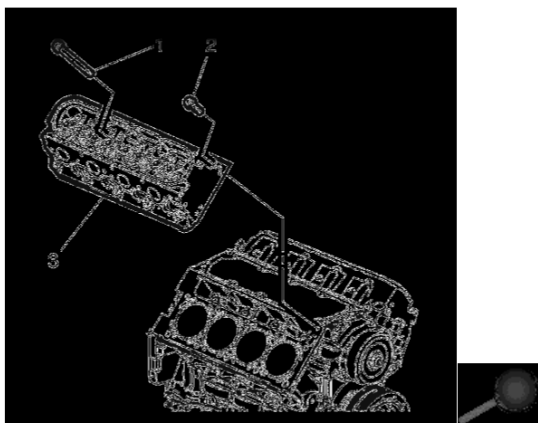
Special Tools

- J 42385-100 Head/Main Bolt Thread Repair Kit
- J 45059 Angle Meter

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

Removal Procedure

1. Remove the valve rocker arms and pushrods. Refer to [Valve Rocker Arm and Push Rod Replacement](#).
2. Remove the supercharger belt tensioner bracket. Refer to [Supercharger Belt Tensioner Bracket Replacement](#).
3. Remove the exhaust manifold. Refer to [Exhaust Manifold Replacement - Right Side](#).
4. Remove the oil level indicator tube bolt.
5. Remove the oil level indicator tube. Refer to [Oil Level Indicator Tube Replacement](#).
6. Remove the supercharger. Refer to [Supercharger Replacement](#).
7. Remove the wiring harness from the clip at the rear of the cylinder head.

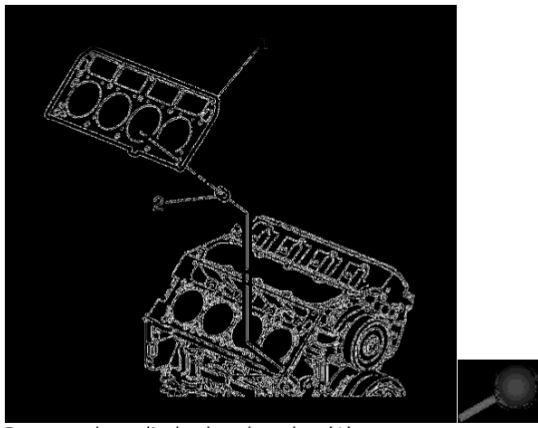


Note: The cylinder head bolts are NOT reusable.

8. Remove and DISCARD the cylinder head bolts (1) and (2).

Caution: After removal, place the cylinder head on 2 wood blocks in order to prevent damage to the sealing surfaces.

9. Remove the cylinder head (3).



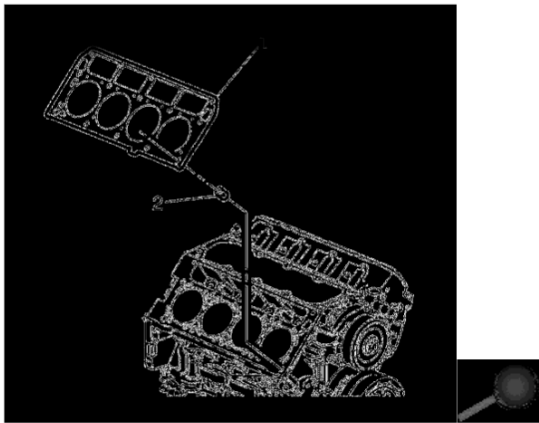
10. Remove the cylinder head gasket (1).
11. Discard the gasket.
12. Discard the cylinder head bolts.
13. Clean and inspect the cylinder head. Refer to [Cylinder Head Cleaning and Inspection](#).

Installation Procedure

Warning: Refer to [Safety Glasses Warning](#).

Caution: Clean all dirt, debris, and coolant from the engine block cylinder head bolt holes. Failure to remove all foreign material may result in damaged threads, improperly tightened fasteners or damage to components.

Note: If installing a new cylinder head it is necessary to install a new engine coolant air bleed plug into the rear coolant passage of the cylinder head. Refer to [Cylinder Head Assemble](#).



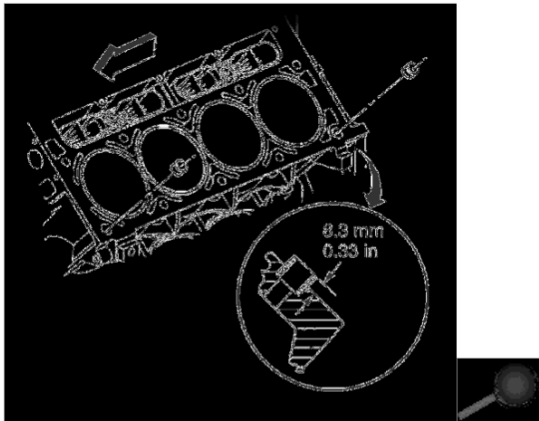
Note:

- Do not use the cylinder head bolts again. Install NEW cylinder head bolts during assembly.
- Do not use any type of sealant on the cylinder head gasket, unless specified.
- The cylinder head gaskets (1) must be installed in the proper direction and position.

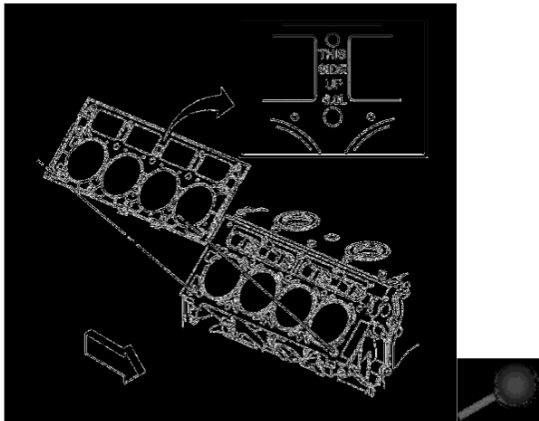
1. Clean the engine block cylinder head bolt holes, if required.

Thread repair tool J 42385-107 may be used to clean the threads of old threadlocking material.

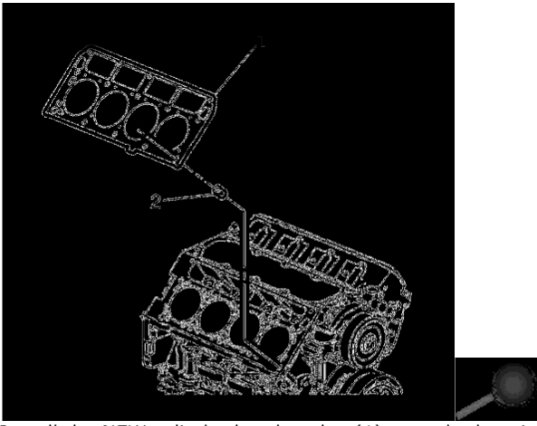
2. Spray cleaner GM P/N 12346139 (Canadian P/N 10953463), GM P/N 12377981 (Canadian P/N 10953463) or equivalent into the hole.
3. Clean the cylinder head bolt holes with compressed air.
4. Install the cylinder head locating pins (2).



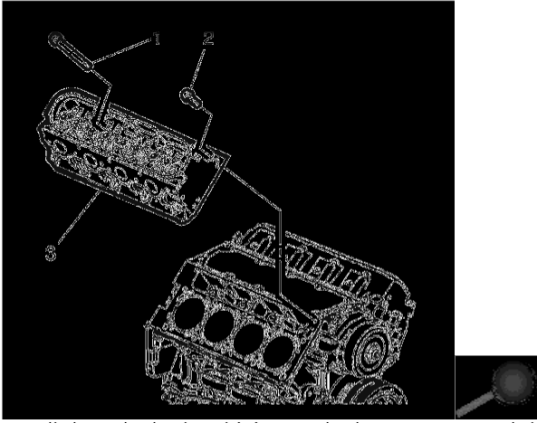
5. Inspect the locating pins for proper installation.



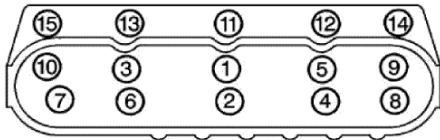
6. Inspect the displacement markings on the gasket for proper usage.



7. Install the NEW cylinder head gasket (1) onto the locating pins (2).



8. Install the cylinder head (3) onto the locating pins and the gasket.
9. Install the NEW cylinder head bolts (1) and (2).



Caution: Refer to [Fastener Caution](#).

10. Tighten the cylinder head bolts.

10.1. Tighten the M11 cylinder head bolts (1–10) a first pass in sequence to **50N•m (37 lb ft)**.

- 10.2. Tighten the M11 cylinder head bolts (1–10) a second pass in sequence to **80 degrees** using the *J 45059* angle meter.
- 10.3. Tighten the M11 cylinder head bolts (1–10) a final pass in sequence to **55 degrees** using the *J 45059* angle meter.
- 10.4. Tighten the M8 cylinder head bolts (11–15) to **30 N·m (22 lb ft)**. Begin with the center bolt (11) and alternating side-to-side, work outward tightening all of the bolts.
11. Install the supercharger. Refer to [Supercharger Replacement](#).
12. Install the oil level indicator tube. Refer to [Oil Level Indicator Tube Replacement](#).
13. Install the exhaust manifold. Refer to [Exhaust Manifold Replacement - Right Side](#).
14. Install the valve rocker arms and pushrods. Refer to [Valve Rocker Arm and Push Rod Replacement](#).
15. Install the supercharger belt tensioner bracket. Refer to [Supercharger Belt Tensioner Bracket Replacement](#).

Valve Lifter Replacement

Special Tools

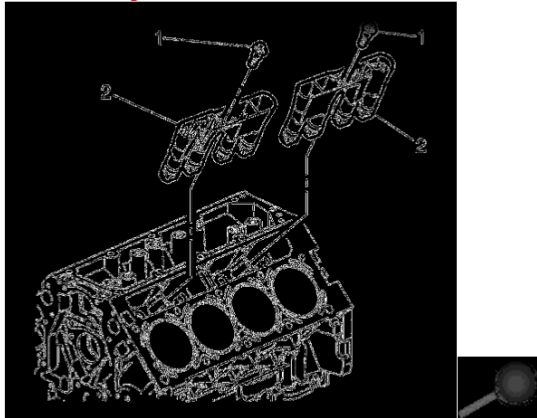
J-3049-A Valve Lifter Remover

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

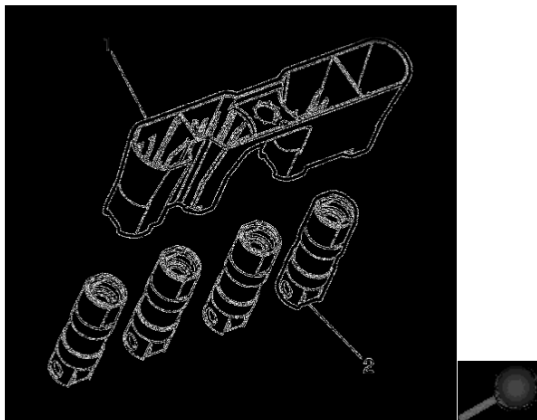
Removal Procedure

1. Remove the cylinder head. Refer to [Cylinder Head Replacement - Left Side](#) or [Cylinder Head Replacement - Right Side](#).

Note: Installed position of the guides. The notched area of the guide is to align with the locating tab on the block.

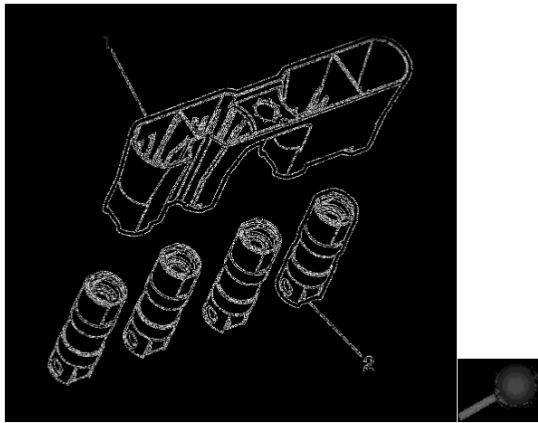


2. Remove the guide bolts (1).
3. Remove the guides (2) with lifters.



4. Remove the valve lifters (2) from the guide (1).
5. Organize or mark the components so they can be installed in the same location from which they were removed. Refer to [Separating Parts](#).

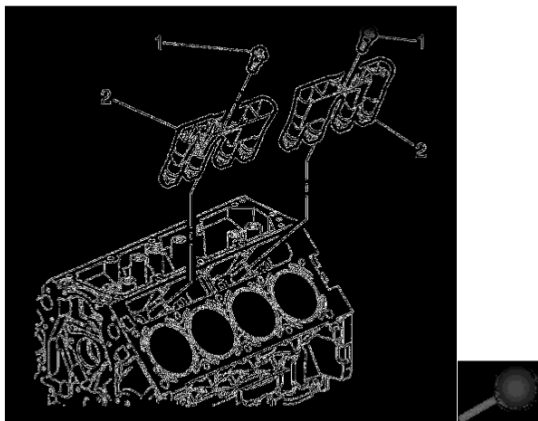
Installation Procedure



Note:

- When using the valve lifters again, install the lifters to their original locations.
- If camshaft replacement is required, the valve lifters must also be replaced.

1. Lubricate the valve lifters (2) and engine block valve lifter bores with clean engine oil.
2. Insert the valve lifters into the lifter guides (1).
Align the flat area on the top of the lifter with the flat area in the lifter guide bore. Push the lifter completely into the guide bore.



3. Install the valve lifters and guide assembly (2) to the engine block.

Caution: Refer to [Fastener Caution](#).

4. Install the valve lifter guide bolts (1).

Tighten

Tighten the valve lifter guide bolts to **10 N·m (89 lb in)**.

5. Install the cylinder head. Refer to [Cylinder Head Replacement - Left Side](#) or [Cylinder Head Replacement - Right Side](#).

Crankshaft Balancer Replacement (LSA)

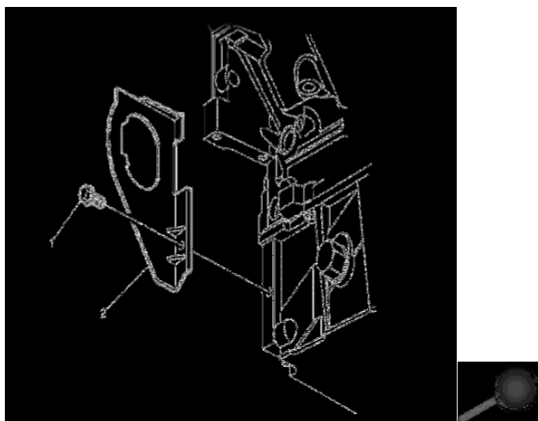
Special Tools

- *EN-47812* Installer Bolt
- *J 41665* Crankshaft Balancer and Sprocket Installer
- *J 41816* Crankshaft Balancer Remover
- *J 41816-2* Crankshaft End Protector
- *J 42386-A* Flywheel Holding Tool
- *J 45059* Angle Meter

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

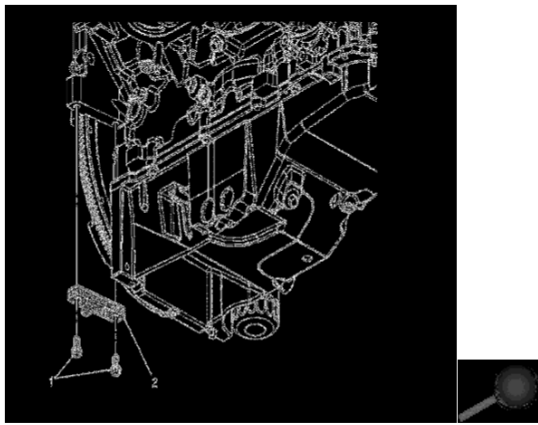
Removal Procedure

1. Remove the air conditioning (A/C) drive belt. Refer to [Air Conditioning Compressor Belt Replacement](#).
2. Remove the starter motor. Refer to [Starter Replacement](#).



3. Remove the right transmission cover (2) and bolt (1).

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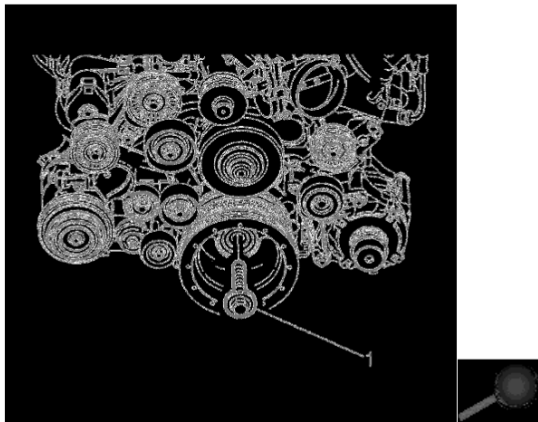
Caution: Refer to [Fastener Caution](#).

Note:

- If replacing the crankshaft balancer on manual transmission applications, note the location of any existing balance weights, if applicable. Crankshaft balance weights must be installed into the new balancer in the same location as the old balancer. A properly installed balance weight will be either flush or below flush with the face of the balancer. Refer to [Engine Balancing](#).
- Do not use the crankshaft balancer bolt again. Install a NEW crankshaft balancer bolt during final assembly.

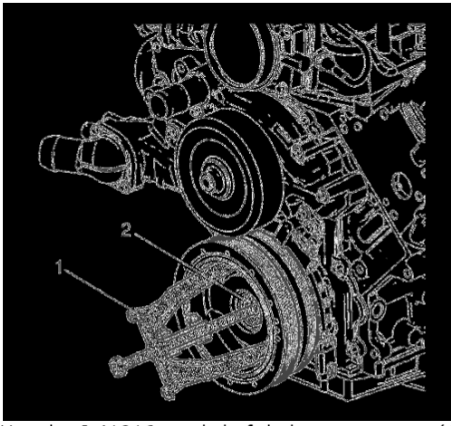
4. Install the J-42386-A flywheel holding tool (2) and bolts (1).

Use one M10 – 1.5 x 120 mm and one M10 – 1.5 x 45 mm bolt for proper tool operation. Tighten the J-42386-A flywheel holding tool (2) bolts (1) to **50 N•m (37 lb ft)**.

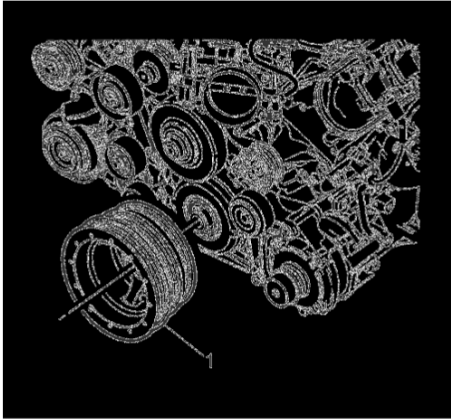


Note: Do not discard the crankshaft balancer bolt. The balancer bolt will be used during the balancer installation procedure.

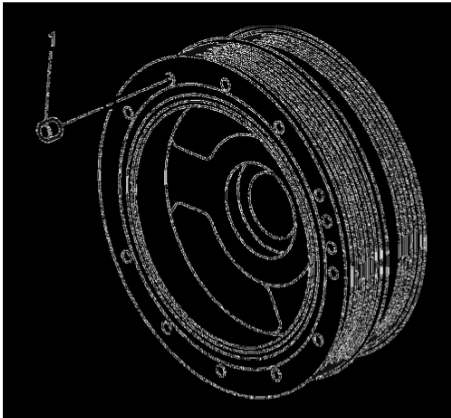
5. Remove the crankshaft balancer bolt (1).



6. Use the *J 41816* crankshaft balancer remover (1) and the *J 41816-2* crankshaft end protector (2) in order to remove the crankshaft balancer.

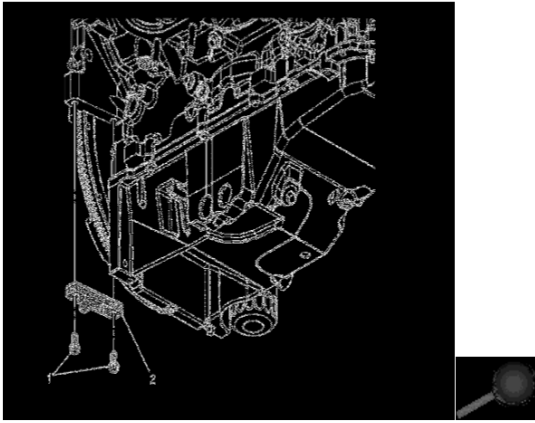


7. Remove the crankshaft balancer (1).



8. Note the position of the crankshaft balance weights (1), if applicable. Refer to [Engine Balancing](#) and [Crankshaft Balancer Cleaning and Inspection](#).

Installation Procedure

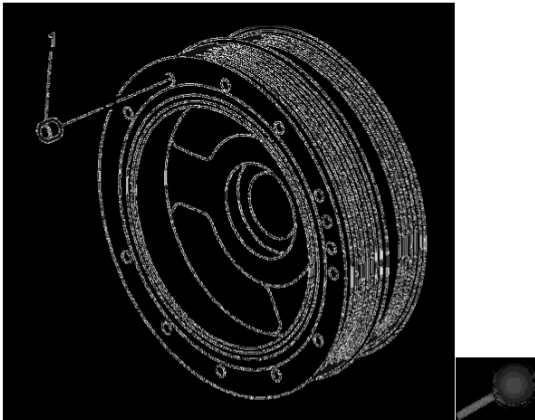


Note:

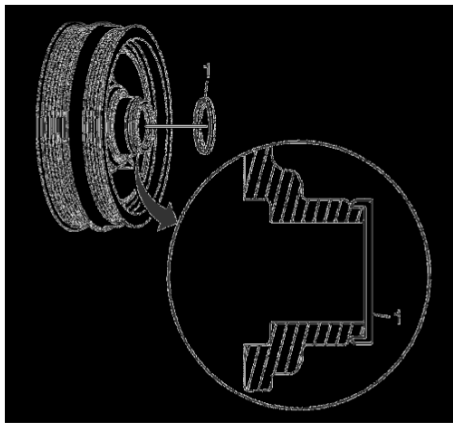
- If replacing the crankshaft balancer, note the location of any existing balance weights, if applicable. Install new balance weights into the new crankshaft balancer, if applicable. Crankshaft balance weights must be installed into the new balancer in the same location as the old balancer. A properly installed balance weight will be either flush or below flush with the face of the balancer. Refer to [Engine Balancing](#) and [Crankshaft Balancer Cleaning and Inspection](#).
- The crankshaft balancer installation and bolt tightening involves a four step tightening process. The first pass ensures that the balancer is installed completely onto the crankshaft. The second, third and fourth passes tighten the NEW bolt to the proper torque.

1. Install the J 42386-A flywheel holding tool (2) and bolts (1).

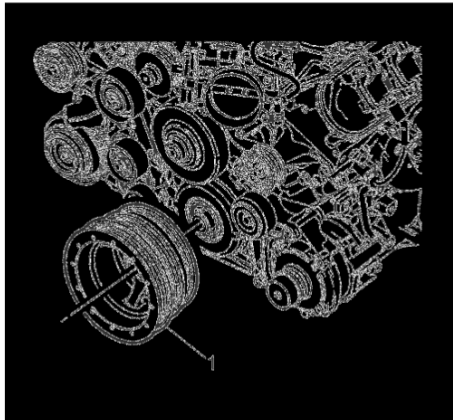
Use one M10 – 1.5 x 120 mm and one M10 – 1.5 x 45 mm bolt for proper tool operation. Tighten the J 42386-A flywheel holding tool bolts to **50N•m (37 lb ft)**.



2. Using the old balancer as a reference, mark or scribe the new balancer in the same location, if applicable. Refer to [Crankshaft Balancer Cleaning and Inspection](#)
3. Install balance weights (1) into the new balancer, if applicable.

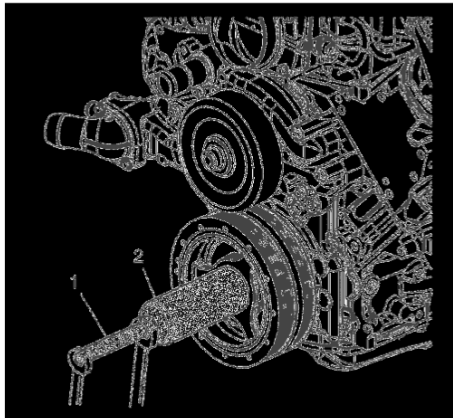


4. Install the crankshaft balancer washer (1) onto the crankshaft balancer.



Note: The balancer should be positioned onto the end of the crankshaft as straight as possible prior to tool installation.

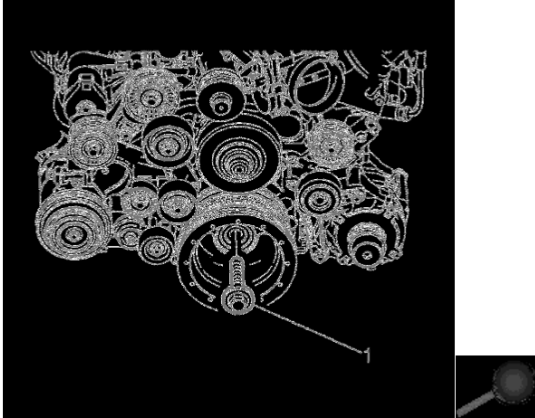
5. Position the balancer (1) onto the end of the crankshaft.



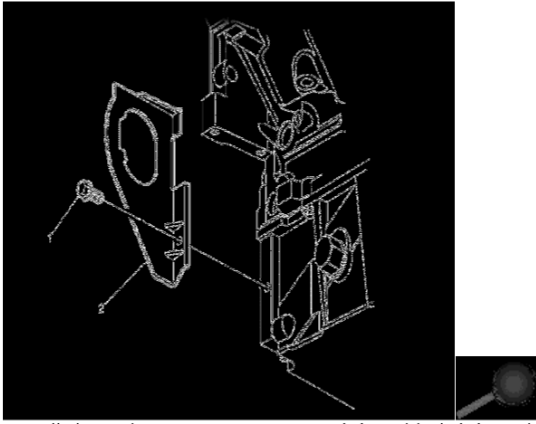
6. Use the J 41665 crankshaft balancer and sprocket installer (2) and the EN-47812 installer bolt (1) in order to install the balancer.

Assemble the *EN-47812* installer bolt (1), nut, washer and the *J 41665* crankshaft balancer and sprocket installer.

7. Insert the smaller end of the *J 41665* crankshaft balancer and sprocket installer (2) into the front of the balancer.
 - 7.1. Use a wrench and hold the hex end of the *EN-47812* installer bolt (1).
 - 7.2. Use a second wrench and rotate the installation tool nut clockwise until the balancer is started onto the crankshaft.
 - 7.3. Remove the *J 41665* crankshaft balancer and sprocket installer (2) and reverse the installation tool.
8. Position the larger end of the *J 41665* crankshaft balancer and sprocket installer (2) against the front of the balancer.
 - 8.1. Use a wrench and hold the hex end of the *EN-47812* installer bolt (1).
 - 8.2. Use a second wrench and rotate the installation tool nut clockwise until the balancer is installed onto the crankshaft.
 - 8.3. Remove the balancer installation tools.



9. Install the NEW crankshaft balancer bolt (1).
 - Tighten the crankshaft balancer bolt a first pass to **150 N•m (110 lb ft)**.
 - Loosen the crankshaft balancer bolt a second pass to **360 degrees**.
 - Tighten the crankshaft balancer bolt a third pass to **50 N•m (37 lb ft)**.
 - Tighten the crankshaft balancer bolt a final pass to **200 degrees** using the *J 45059* angle meter.
10. Remove the *J 42386-A* flywheel holding tool.



11. Install the right transmission cover (2) and bolt (1). Tighten bolt to 10N•m (7 lb ft).
12. Install the starter motor. Refer to [Starter Replacement](#).
13. Install the A/C drive belt. Refer to [Air Conditioning Compressor Belt Replacement](#).

Crankshaft Balancer Replacement (L77 or LS3)

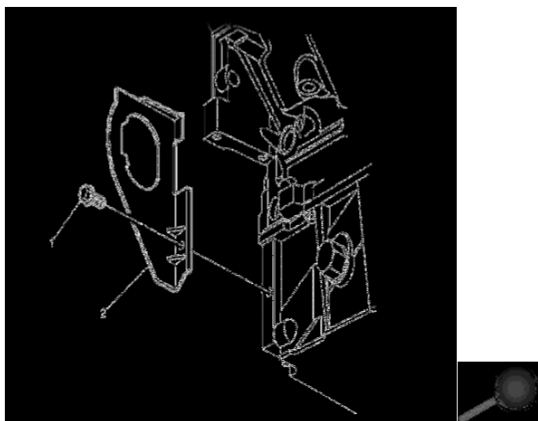
Special Tools

- *EN-47812* Installer Bolt
- *J 41665* Crankshaft Balancer and Sprocket Installer
- *J 41816* Crankshaft Balancer Remover
- *J 41816-2* Crankshaft End Protector
- *J 42386-A* Flywheel Holding Tool
- *J 45059* Angle Meter

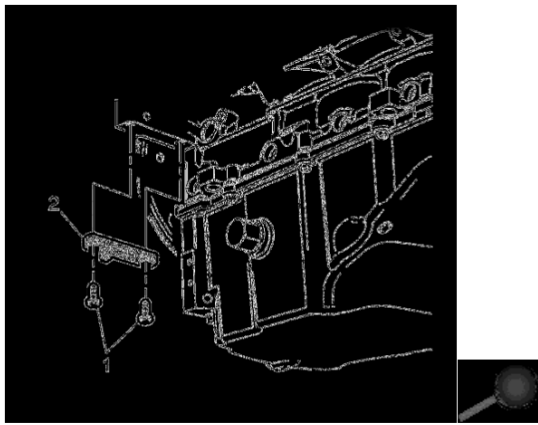
For equivalent regional tools, refer to [Special Tools](#).

Removal Procedure

1. Remove the air conditioning (A/C) drive belt. Refer to [Air Conditioning Compressor Belt Replacement](#).
2. Remove the starter motor. Refer to [Starter Replacement](#).



3. Remove the right transmission cover (2) and bolt (1).



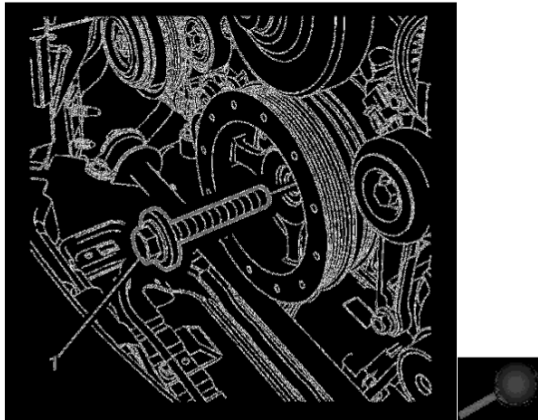
Caution: Refer to [Fastener Caution](#).

Note:

- If replacing the crankshaft balancer on manual transmission applications, note the location of any existing balance weights, if applicable. Crankshaft balance weights must be installed into the new balancer in the same location as the old balancer. A properly installed balance weight will be either flush or below flush with the face of the balancer. Refer to [Engine Balancing](#).
- Do not use the crankshaft balancer bolt again. Install a NEW crankshaft balancer bolt during final assembly.

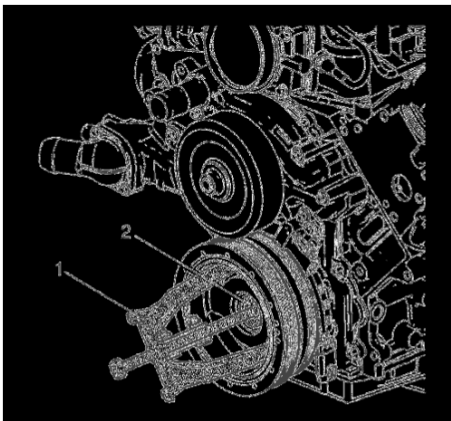
4. Install the J-42386-A flywheel holding tool (2) and bolts (1).

Use one M10 – 1.5 x 120 mm and one M10 – 1.5 x 45 mm bolt for proper tool operation. Tighten the J-42386-A flywheel holding tool (2) bolts (1) to **50 N•m (37 lb ft)**.

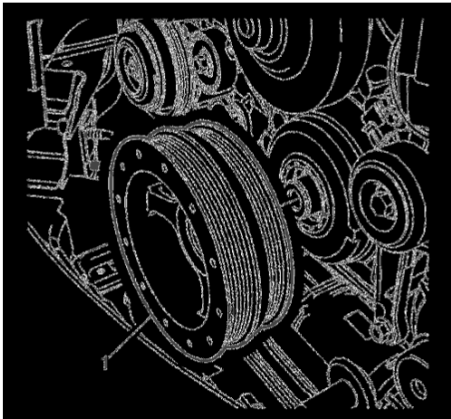


Note: Do not discard the crankshaft balancer bolt. The balancer bolt will be used during the balancer installation procedure.

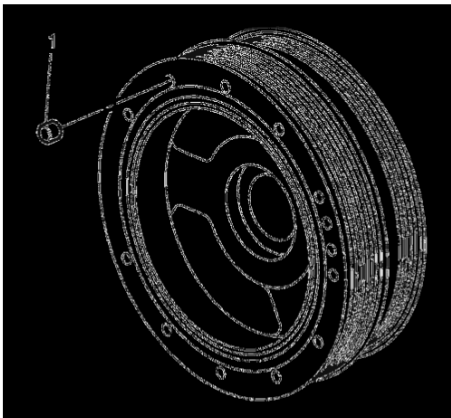
5. Remove the crankshaft balancer bolt (1).



6. Use the *J 41816* crankshaft balancer remover (1) and the *J 41816-2* crankshaft end protector (2) in order to remove the crankshaft balancer.

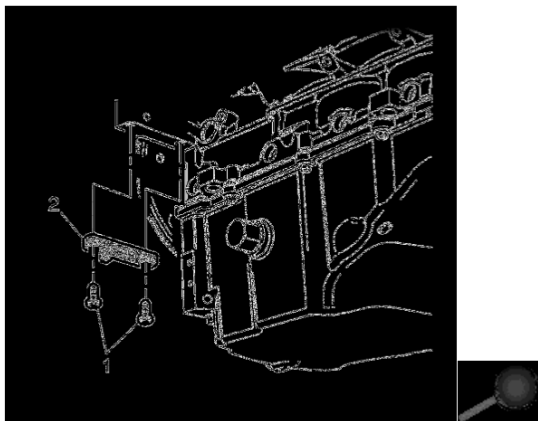


7. Remove the crankshaft balancer (1).



8. Note the position of the crankshaft balance weights (1), if applicable. Refer to [Engine Balancing](#) and [Crankshaft Balancer Cleaning and Inspection](#).

Installation Procedure

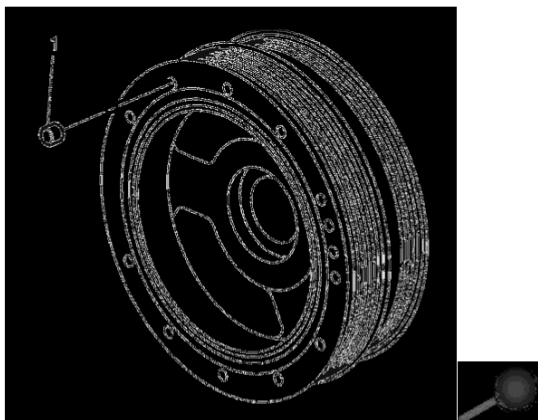


Note:

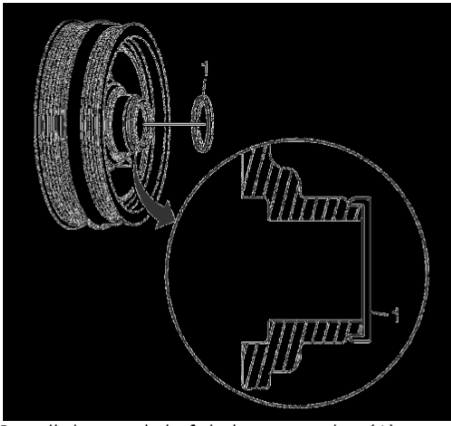
- If replacing the crankshaft balancer, note the location of any existing balance weights, if applicable. Install new balance weights into the new crankshaft balancer, if applicable. Crankshaft balance weights must be installed into the new balancer in the same location as the old balancer. A properly installed balance weight will be either flush or below flush with the face of the balancer. Refer to [Engine Balancing](#) and [Crankshaft Balancer Cleaning and Inspection](#).
- The crankshaft balancer installation and bolt tightening involves a four step tightening process. The first pass ensures that the balancer is installed completely onto the crankshaft. The second, third and fourth passes tighten the NEW bolt to the proper torque.

1. Install the J 42386-A flywheel holding tool (2) and bolts (1).

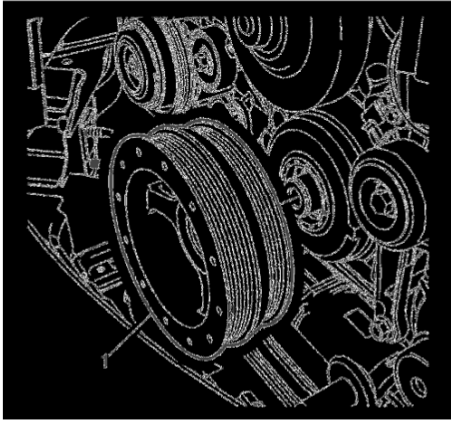
Use one M10 – 1.5 x 120 mm and one M10 – 1.5 x 45 mm bolt for proper tool operation. Tighten the J 42386-A flywheel holding tool bolts to **50N•m (37 lb ft)**.



2. Using the old balancer as a reference, mark or scribe the new balancer in the same location, if applicable. Refer to [Crankshaft Balancer Cleaning and Inspection](#)
3. Install balance weights (1) into the new balancer, if applicable.

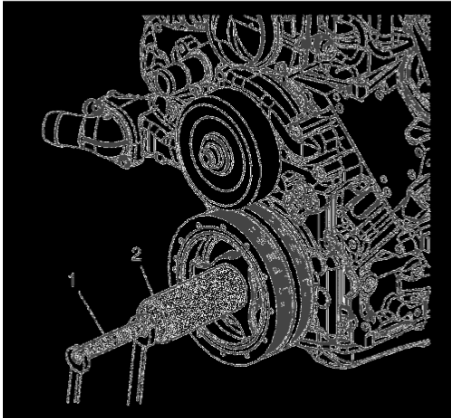


4. Install the crankshaft balancer washer (1) onto the crankshaft balancer.



Note: The balancer should be positioned onto the end of the crankshaft as straight as possible prior to tool installation.

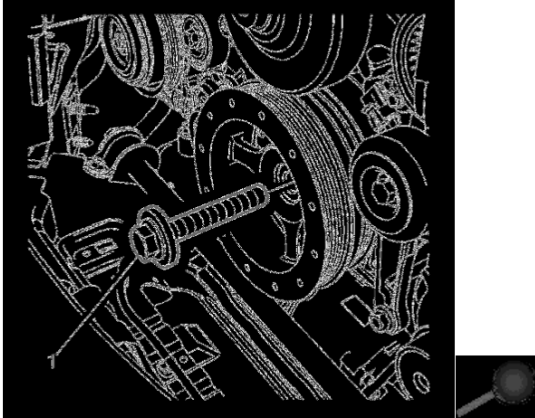
5. Position the balancer (1) onto the end of the crankshaft.



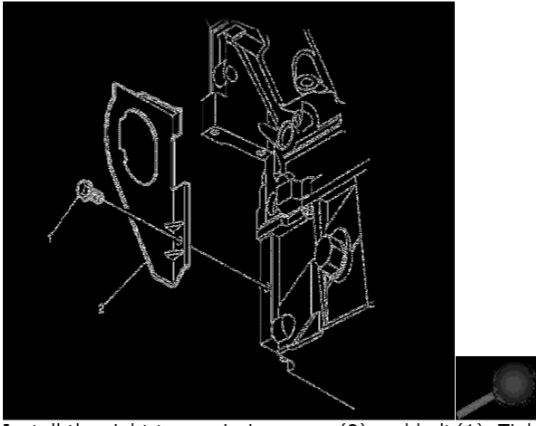
6. Use the J 41665 crankshaft balancer and sprocket installer (2) and the EN-47812 installer bolt (1) in order to install the balancer.

Assemble the *EN-47812* installer bolt (1), nut, washer and the *J 41665* crankshaft balancer and sprocket installer.

7. Insert the smaller end of the *J 41665* crankshaft balancer and sprocket installer (2) into the front of the balancer.
 - 7.1. Use a wrench and hold the hex end of the *EN-47812* installer bolt (1).
 - 7.2. Use a second wrench and rotate the installation tool nut clockwise until the balancer is started onto the crankshaft.
 - 7.3. Remove the *J 41665* crankshaft balancer and sprocket installer (2) and reverse the installation tool.
8. Position the larger end of the *J 41665* crankshaft balancer and sprocket installer (2) against the front of the balancer.
 - 8.1. Use a wrench and hold the hex end of the *EN-47812* installer bolt (1).
 - 8.2. Use a second wrench and rotate the installation tool nut clockwise until the balancer is installed onto the crankshaft.
 - 8.3. Remove the balancer installation tools.



9. Install the NEW crankshaft balancer bolt (1).
 - Tighten the crankshaft balancer bolt a first pass to **150N•m (110 lb ft)**.
 - Loosen the crankshaft balancer bolt a second pass to **360 degrees**.
 - Tighten the crankshaft balancer bolt a third pass to **50N•m (37 lb ft)**.
 - Tighten the crankshaft balancer bolt a final pass to **200 degrees** using the *J 45059* angle meter.
10. Remove the *J 42386-A* flywheel holding tool.



11. Install the right transmission cover (2) and bolt (1). Tighten bolt to 10N•m (7 lb ft).
12. Install the starter motor. Refer to [Starter Replacement](#).
13. Install the A/C drive belt. Refer to [Air Conditioning Compressor Belt Replacement](#).

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Crankshaft Front Oil Seal Replacement

Special Tools

J-41478 Crankshaft Front Oil Seal Installer

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

Removal Procedure

1. Remove the crankshaft balancer. Refer to [Crankshaft Balancer Replacement](#).



2. Gently pry the crankshaft oil seal (1) from the front cover.

Installation Procedure

Important:

- Do not lubricate the oil seal sealing surface.
- Do not reuse the crankshaft oil seal.



1. Lubricate the outer edge of the oil seal (1) with clean engine oil.

2. Lubricate the front cover oil seal bore with clean engine oil.



3. Install the crankshaft front oil seal onto the *J 41478* crankshaft front oil seal installer guide.
4. Install the *J 41478* crankshaft front oil seal installer threaded rod (with nut, washer, guide, and oil seal) into the end of the crankshaft.
5. Use the *J 41478* crankshaft front oil seal installer in order to install the oil seal into the cover bore.
 - 5.1. Use a wrench and hold the hex on the installer tool.
 - 5.2. Use a second wrench and rotate the installer nut clockwise until the seal bottoms in the cover bore.
 - 5.3. Remove the tool.
 - 5.4. Inspect the oil seal for proper installation. The oil seal should be installed evenly and completely into the front cover bore.
6. Install the crankshaft balancer. Refer to [Crankshaft Balancer Replacement](#).

Engine Front Cover Replacement

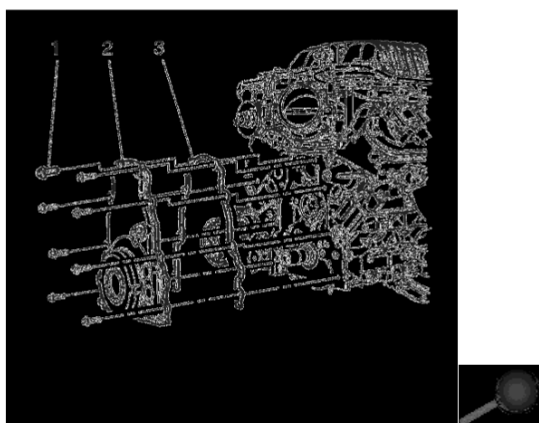
Special Tools

- EN-48853 Front Cover Alignment Tool
- J-41480-A Front and Rear Cover Alignment

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

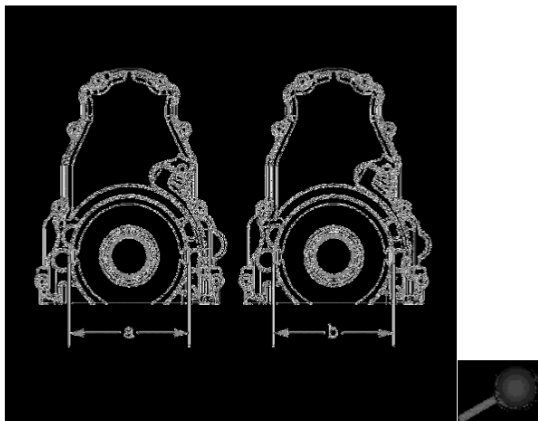
Removal Procedure

1. Remove the oil pan. Refer to [Oil Pan Replacement](#).
2. Remove the crankshaft balancer. Refer to [Crankshaft Balancer Replacement](#).
3. Remove the water pump. Refer to [Water Pump Removal](#).
4. Remove the generator bracket. Refer to [Generator Bracket Replacement](#).
5. Remove the air conditioning compressor belt tensioner. Refer to [Drive Belt Tensioner Replacement - Air Conditioning](#).



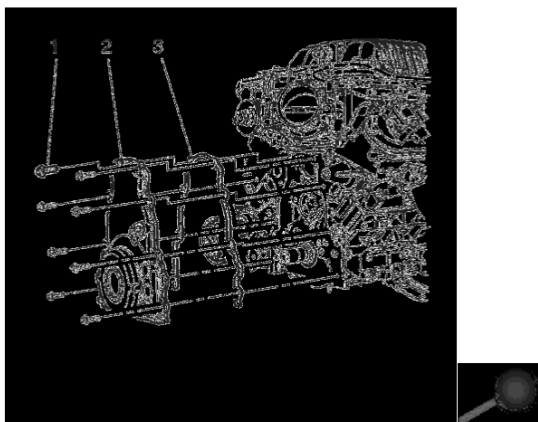
6. Remove the engine front cover to cylinder block retaining bolts (1).
Note: The engine front cover gasket (3) is a single use only component and must be replaced whenever the engine front cover (2) is removed.
7. Remove the engine front cover (2).
8. Remove and discard the engine front cover gasket (3).
9. Clean and inspect the engine front cover. Refer to [Engine Front Cover Cleaning and Inspection](#).
10. Transfer parts as necessary.

Installation Procedure



1. Measure the alignment tab distance on the front cover.

For 2009 model year, the engine front cover may have either a **141 mm (5.55 in)** dimension (a) or **159 mm (6.26 in)** dimension (b) alignment tab distance. The *EN-48853* front cover alignment tool is designed to properly align both design front covers. For the **141 mm (5.55 in)** cover, the *EN 48853-2* adapters must be used.



Caution: Refer to [Fastener Caution](#).

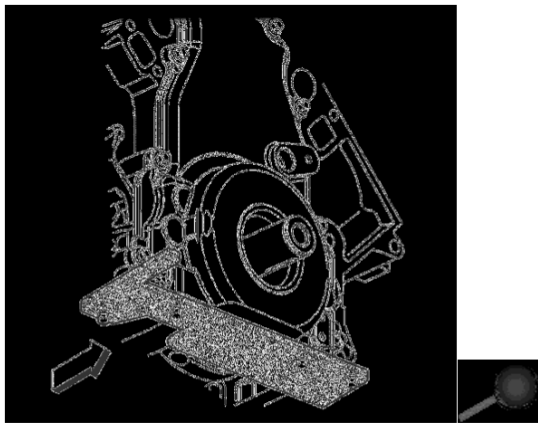
Note:

- Do not use the crankshaft oil seal or the engine front cover gasket again.
- Do not apply any type of sealant to the front cover gasket, unless specified.
- The special tools in this procedure are used to properly align the engine front cover at the oil pan surface and to center the crankshaft front oil seal.
- All gasket surfaces should be free of oil or other foreign material during assembly.

The crankshaft front oil seal **MUST** be centered in relation to the crankshaft.

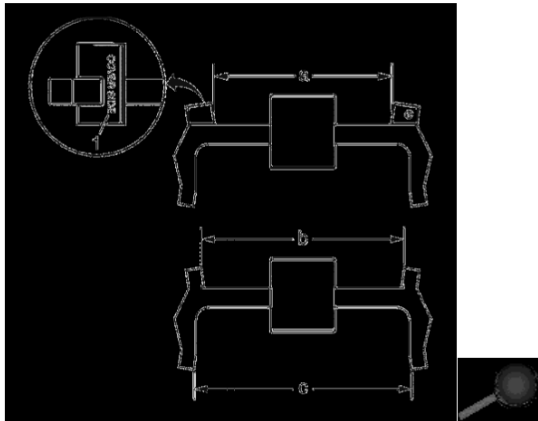
- The oil pan sealing surface at the front cover and engine block **MUST** be aligned within specifications.
- An improperly aligned front cover may cause premature front oil seal wear and/or engine assembly oil leaks.

2. Install the front cover gasket (3), front cover (2), and bolts (1).
3. Tighten the cover bolts finger tight. Do not overtighten.

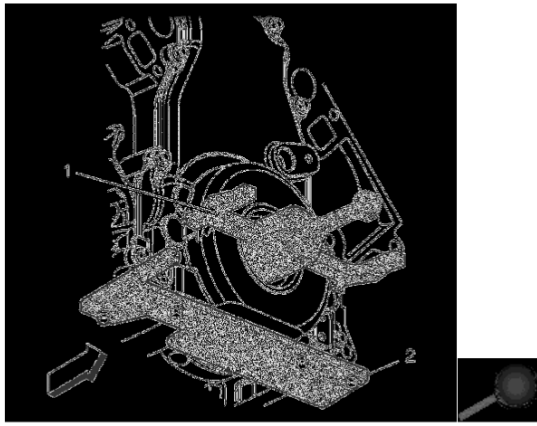


Note: Start the tool-to-front cover bolts. Do not tighten the bolts at this time.

4. Install the *J 41480* alignment tool. Tighten the tool-to-engine block bolts to **25 N·m (18 lb ft)**.

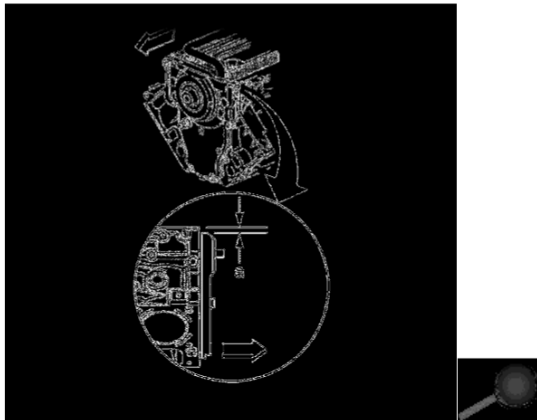


5. Install the *EN 48853-2* adapters as required for usage on the **141 mm (5.55 in)** dimension (a) front cover. Position the adapters against the legs of the *EN-48853* alignment tool with the words "cover side" (1) facing away from the tool.



Note: Align the tapered legs of the tool with the machined alignment surfaces on the front cover.

6. Install the *EN-48853* alignment tool (1).
7. Install the crankshaft balancer bolt.
 - 7.1. Tighten the crankshaft balancer bolt by hand until snug. Do not overtighten.
 - 7.2. Tighten the *J 41480* alignment tool (2).
 - 7.3. Tighten the engine front cover bolts to **25 N•m (18 lb ft)**.
8. Remove the tools.



9. Measure the oil pan surface flatness, front cover-to-engine block.
 - 9.1. Place a straight edge across the engine block and front cover oil pan sealing surfaces. Avoid contact with the portion of the gasket that protrudes into the oil pan surface.
 - 9.2. Insert a feeler gauge between the front cover and the straight edge tool. The cover must be flush with the oil pan surface, or no greater than **0.5 mm (0.02 in)** (a) below flush.

Note: If the correct front cover-to-engine block alignment cannot be obtained, replace the front cover.

10. If the front cover-to-engine block oil pan surface alignment is not within specifications, repeat the cover alignment procedure.
11. Install the water pump. Refer to [Water Pump Installation](#).
12. Install the crankshaft balancer. Refer to [Crankshaft Balancer Replacement](#).

13. Install the oil pan. Refer to [Oil Pan Replacement](#).
14. Install the air conditioning compressor belt tensioner. Refer to [Drive Belt Tensioner Replacement - Air Conditioning](#).
15. Install the generator bracket. Refer to [Generator Bracket Replacement](#).

Crankshaft Rear Oil Seal Replacement

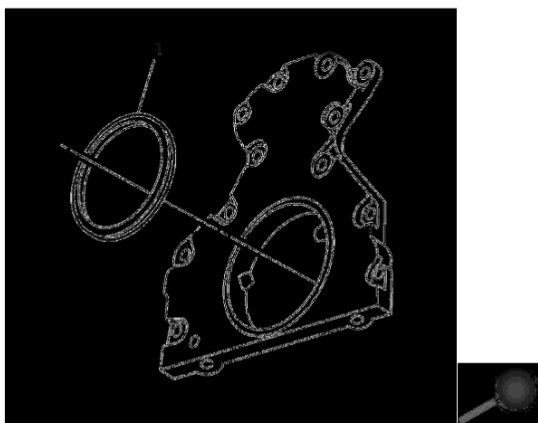
Special Tools

J-41479 Crankshaft Rear Oil Seal Installer

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

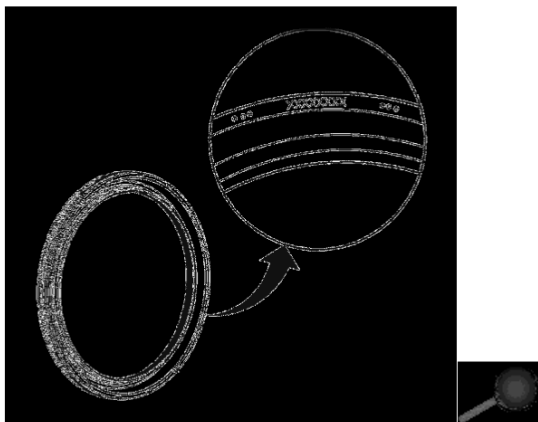
Removal Procedure

1. If equipped with a manual transmission, remove the engine flywheel. Refer to [Engine Flywheel Replacement](#).
2. If equipped with a automatic transmission, remove the automatic transmission flex plate. Refer to [Automatic Transmission Flex Plate Replacement](#).



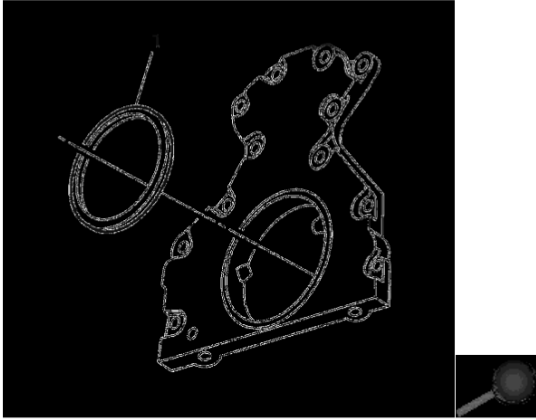
3. Gently pry the crankshaft rear oil seal (1) from the rear cover.

Installation Procedure



Note: For proper orientation, note the installation direction of the oil seal. The oil seal is a reverse-lip design. The part number is applied to the outside face of the seal, as shown.

1. Inspect the seal and identify the part number markings for proper orientation.



Note:

- Do not lubricate the oil seal inside diameter (ID) of the crankshaft surface.
- Do not reuse the crankshaft rear oil seal.

2. Lubricate the outside diameter (OD) of the oil seal (1) with clean engine oil.
DO NOT allow oil or other lubricants to contact the seal surface.
3. Lubricate the rear cover oil seal bore with clean engine oil.
DO NOT allow oil or other lubricants to contact the crankshaft surface.



4. Install the J-41479 crankshaft rear oil seal installer cone (2) and bolts onto the rear of the crankshaft.
5. Tighten the bolts until snug. Do not overtighten.
6. Install the rear oil seal onto the tapered cone (2) and push the seal to the rear cover bore.
7. Thread the J-41479 crankshaft rear oil seal installer threaded rod into the tapered cone until the tool (1) contacts the oil seal.
8. Align the oil seal onto the tool (1).
9. Rotate the handle of the tool (1) clockwise until the seal enters the rear cover and bottoms into the cover bore.
10. Remove the J-41479 crankshaft rear oil seal installer.

11. If equipped with a automatic transmission, Install the automatic transmission flex plate.
Refer to [Automatic Transmission Flex Plate Replacement](#).
12. If equipped with a manual transmission, install the engine flywheel. Refer to [Engine Flywheel Replacement](#).

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Document ID: 2218571

Crankshaft Rear Oil Seal Housing Replacement

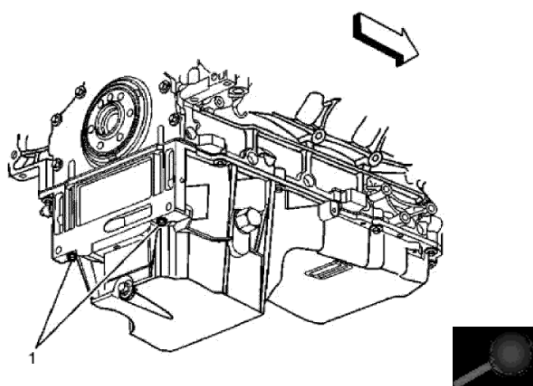
Special Tools

- J 41476 Front and Rear Cover Alignment Tool
- J-41479-B Crankshaft Rear Oil Seal Installer

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

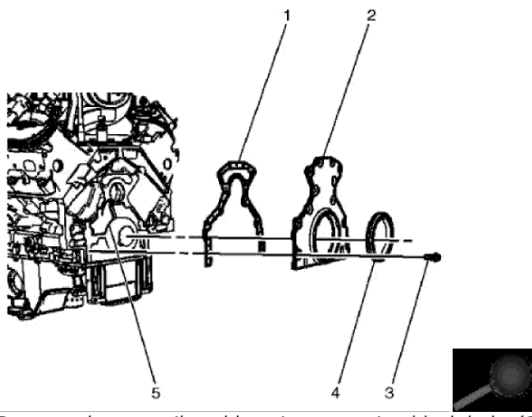
Removal Procedure

1. Remove the transmission. Refer to one of the following procedures:
 - [Transmission Replacement](#) for the 6L50/6L80/6L90 transmission.
 - [Transmission Replacement](#) for the Tremec 6-Speed transmission.
2. Remove the automatic transmission flex plate or engine flywheel. Refer to one of the following procedures:
 - [Automatic Transmission Flex Plate Replacement](#).
 - [Engine Flywheel Replacement](#).



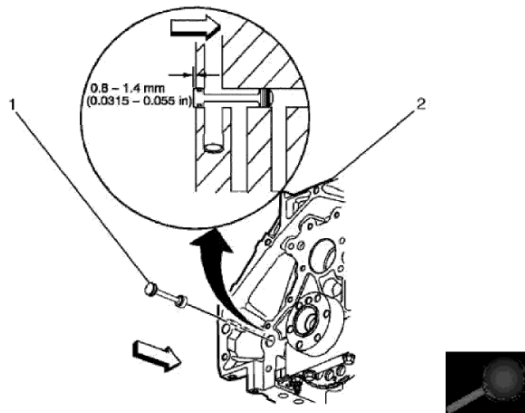
3. Remove the oil pan to rear oil seal housing bolts (1).

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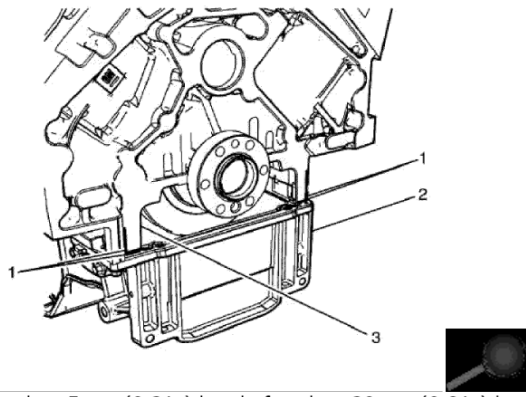


4. Remove the rear oil seal housing to engine block bolts (3).
5. Remove the rear oil seal housing (2) from the engine block (5).
6. Remove the rear oil seal housing gasket (1) from the engine block (5).
Discard the rear oil seal housing gasket (1).
7. Remove the rear crankshaft oil seal (4) from the rear oil seal housing (2).
Discard the rear oil seal (4).

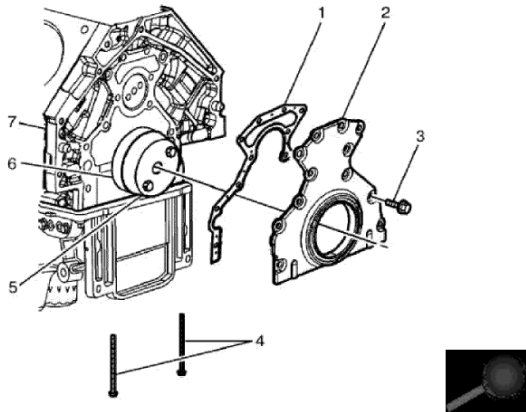
Installation Procedure – Cover with Seal



1. Inspect the rear oil gallery plug (1) for correct installation to the engine block (2).



2. Apply a 5 mm (0.2 in) bead of sealant 20 mm (0.8 in) long to the surfaces (1) of the oil pan (2) and engine block (3).



3. Install the J-41479-B crankshaft rear oil seal installer (5) to the crankshaft (6).

Note: Install a new rear oil seal housing gasket (1). Failure to comply may lead to an oil leak.

Note: Make sure that the rear oil seal housing gasket contact surfaces are clean and dry. Failure to comply may lead to an oil leak.

4. Install the new rear oil seal housing gasket (1) to the engine block (7).

Note: The rear oil seal housing must be aligned with J-41479-B crankshaft rear oil seal installer. Failure to comply may cause the rear crankshaft seal to wear prematurely.

5. Install the rear oil seal housing (2) to the engine block (7).

Caution: Refer to [Fastener Caution](#).

6. Install the rear oil seal housing to engine block bolts (3). Finger tighten only at this stage.

7. Install the oil pan to rear oil seal housing bolts (4) and tighten to **12 N·m (106 lb in)**.

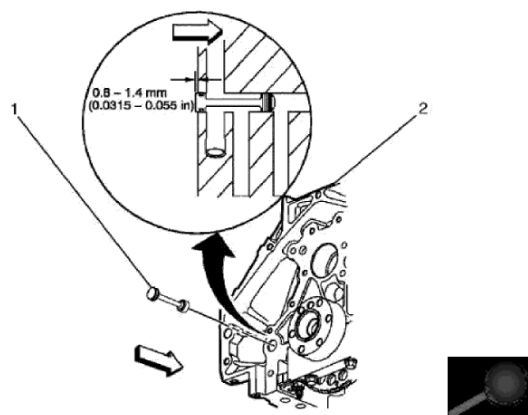
8. Tighten the rear oil seal housing to engine block bolts (3) and tighten to **30 N·m (22 lb ft)**.

9. Remove the J-41479-B crankshaft rear oil seal installer (5) from the crankshaft (6).

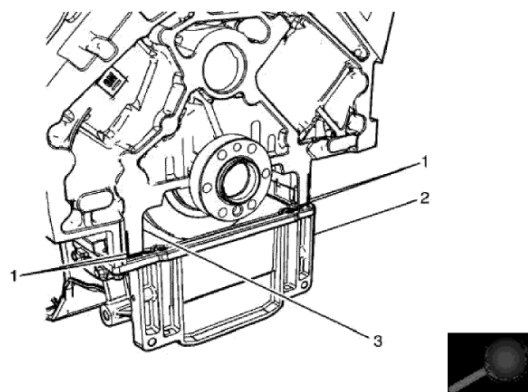
10. Install the flywheel or flex plate assembly. Refer to [Engine Flywheel Replacement](#) or [Automatic Transmission Flex Plate Replacement](#).

11. Install the transmission assembly. Refer to [Transmission Replacement](#) for automatic transmission replacement or [Transmission Replacement](#) for manual transmission replacement.

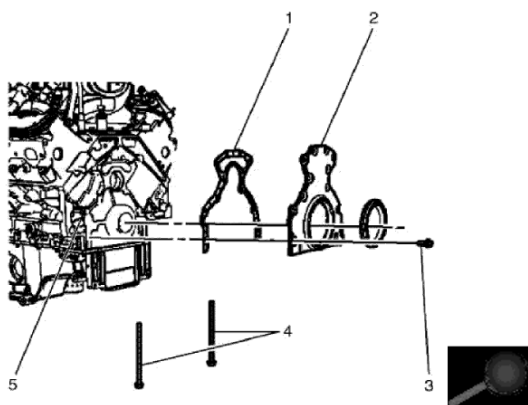
Installation Procedure – Cover without Seal



1. Inspect the rear oil gallery plug (1) for correct installation to the engine block (2).

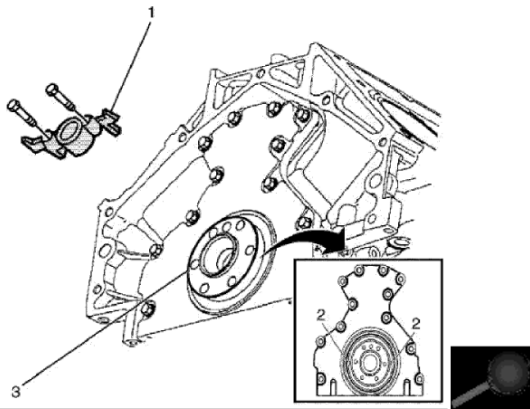


2. Apply a 5 mm (0.2 in) bead of sealant 20 mm (0.8 in) long to the surfaces (1) of the oil pan (2) and engine block (3).



Note: Make sure that the rear oil seal housing gasket contact surfaces are clean and dry.

3. Install the new rear oil seal housing gasket (1) to the engine block (5).
4. Install the rear oil seal housing (2) to the engine block (5).
- Caution:** Refer to [Fastener Caution](#).
5. Install the rear oil seal housing to engine block bolts (3). Finger tighten only at this stage.
6. Install the oil pan to rear housing bolts (4). Finger tighten only at this stage.

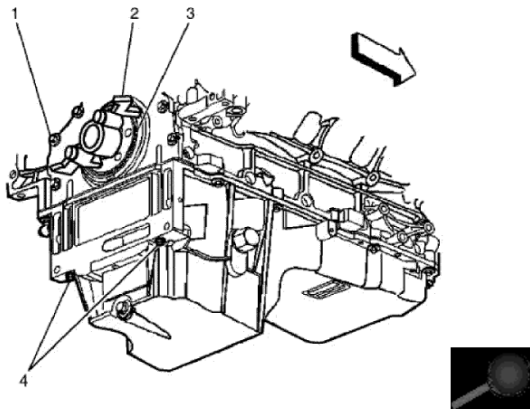


Note: The rear oil seal housing **MUST** be aligned to the crankshaft using J 41476 front and rear cover alignment tool (1). Failure to comply may cause the rear crankshaft seal to wear prematurely.

Note: Align the J 41476 front and rear cover alignment tool (1) with the slots (2).

Note: The legs of the J 41476 front and rear cover alignment tool (1) must enter the oil seal bore.

7. Install the J 41476 front and rear cover alignment tool (1) to the crankshaft (3).



8. Tighten the oil pan to rear housing bolts (4) and tighten to **12 N·m (106 lb in)**.
9. Tighten the rear oil seal housing to engine block bolts (1) and tighten to **30 N·m (22 lb ft)**.
10. Remove the J 41476 front and rear cover alignment tool (2) from the crankshaft (3).
11. Install a new crankshaft rear oil seal. Refer to [Crankshaft Rear Oil Seal Replacement](#).
12. Install the automatic transmission flex plate or engine flywheel. Refer to one of the following procedures:
 - [Automatic Transmission Flex Plate Replacement](#).

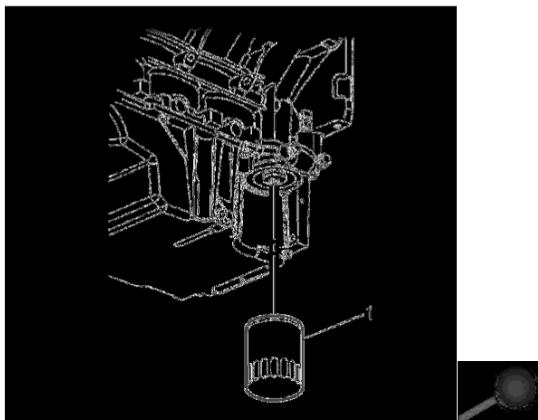
- [Engine Flywheel Replacement](#).

13. Install the transmission. Refer to one of the following procedures:

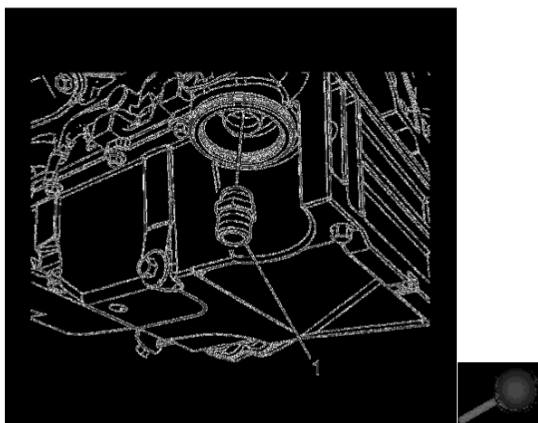
- [Transmission Replacement](#) for the 6L50/6L80/6L90 transmission.
- [Transmission Replacement](#) for the Tremec 6-Speed transmission.

Oil Filter Adapter Replacement

[Removal Procedure](#)

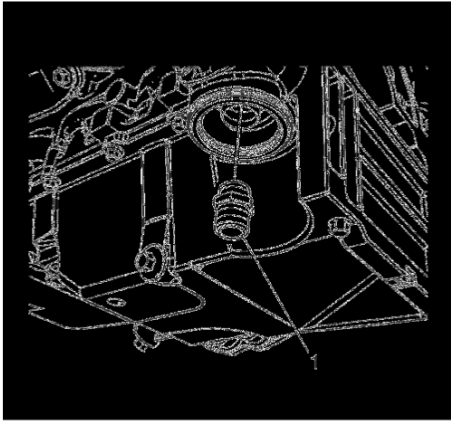


1. Remove the oil filter (1). Refer to [Engine Oil and Oil Filter Replacement](#).



2. Remove the oil filter adapter (1).

[Installation Procedure](#)

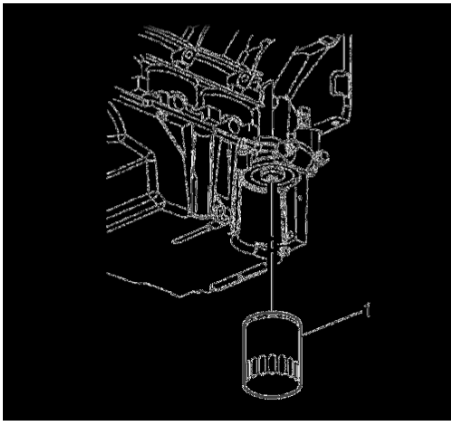


Caution: Refer to [Component Fastener Tightening Caution](#).

1. Install the oil filter adapter (1).

Tighten

Tighten the oil filter adapter to **55 N·m (41 lb ft)**.



2. Install the oil filter (1). Refer to [Engine Oil and Oil Filter Replacement](#).

Oil Pan Cover Replacement

[Removal Procedure](#)



1. Raise the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
2. Remove the oil pan cover to oil pan retaining bolts (2).
3. Remove the cover (1).
4. Remove the gasket (3).

[Installation Procedure](#)



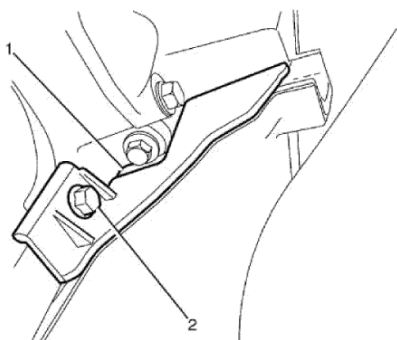
1. Position the gasket (3) and cover (1) on the engine block.
- Caution:** Refer to [Fastener Caution](#).
2. Install the retaining bolts (2) for the cover and tighten to **12 N•m (106 lb in)**.
3. Lower the vehicle.

Oil Pan Replacement

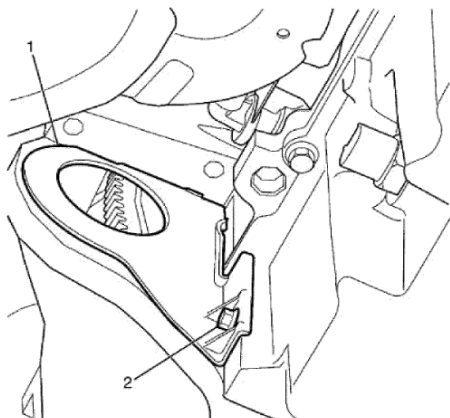
Removal Procedure

Warning: Refer to [Battery Disconnect Warning](#).

1. Disconnect the battery ground cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
2. Remove the drivetrain and front suspension frame Refer to [Drivetrain and Front Suspension Frame Replacement](#).
3. Drain the engine oil and remove the oil filter. Refer to [Engine Oil and Oil Filter Replacement](#).
4. Remove the engine oil cooler, if equipped. Refer to [Engine Oil Cooler Removal](#).
5. Remove the starter motor. Refer to [Starter Replacement](#).

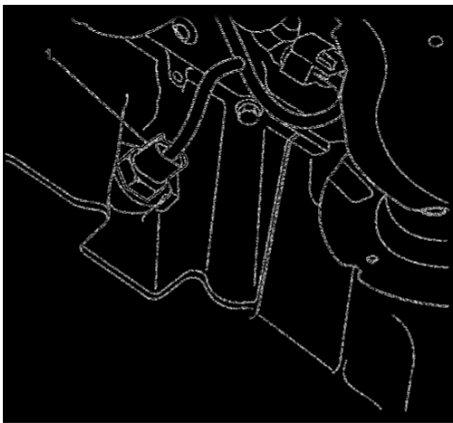


6. Remove the left side close out cover to cylinder block retaining bolt (2).
7. Remove the left side close out cover (1).

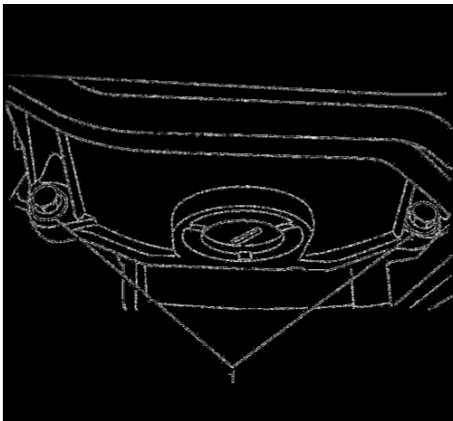


8. Remove the right side close out cover to cylinder block retaining bolt (2).
9. Remove the right side close out cover (1).

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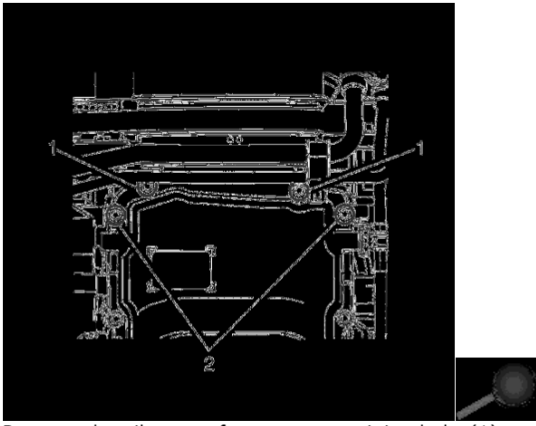
10. Disconnect the oil level/temperature sensor electrical connector (1) from the oil level/temperature sensor.



11. Remove the transmission to oil pan retaining bolts (1).



12. Remove the bracket retaining bolt (1).

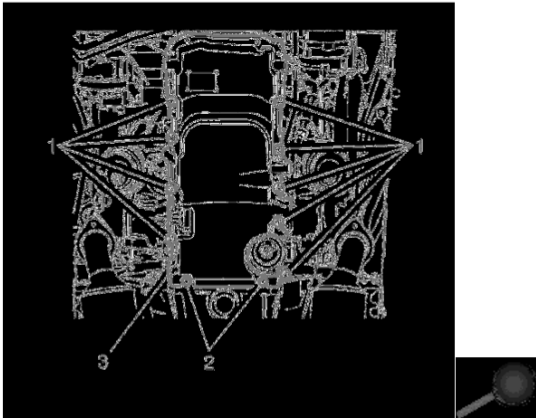


13. Remove the oil pan to front cover retaining bolts (1).

14. Remove the oil pan to cylinder block front retaining bolts (2).



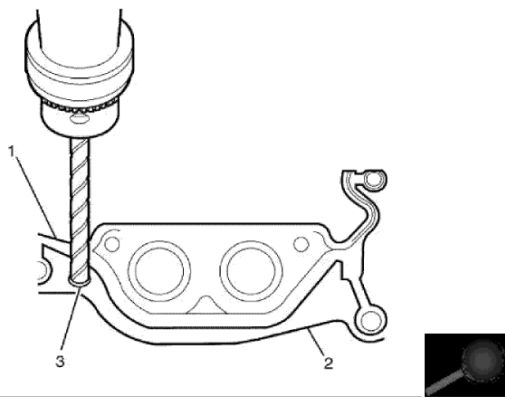
15. Remove the bracket retaining bolt (1).



16. Remove the oil pan to engine rear cover retaining bolts (2).

17. Remove the oil pan to cylinder block retaining bolts (1).

18. Remove the oil pan (3).



Note: DO NOT allow foreign material to enter the oil passages of the oil pan, cap, or cover the openings, as required.

Note: Take care not to gouge, score, or damage the oil pan sealing surface.

19. Drill out the retaining rivets (3) from the oil pan, if required.

Note: The oil pan gasket and rivets are single use only components and must be replaced whenever the oil pan is removed from the cylinder block.

20. Remove the oil pan gasket (1) from the oil pan (2).

Discard the gasket and rivets.

21. Clean and inspect the oil pan as necessary. Refer to [Oil Pan Cleaning and Inspection](#).

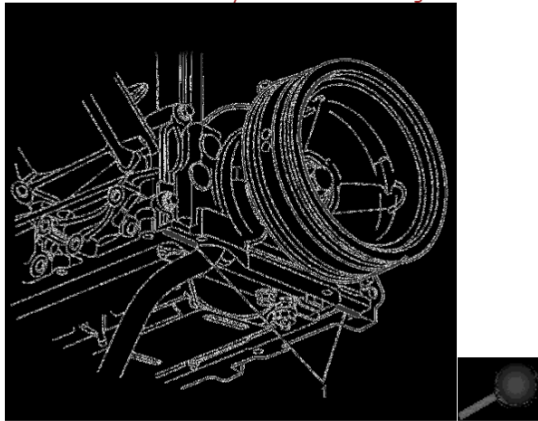
22. Clean the base of the engine block. Refer to [Replacing Engine Gaskets](#).

Installation Procedure

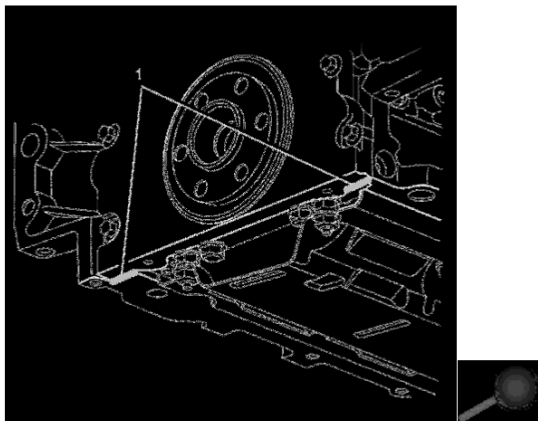
Note: The alignment of the structural oil pan is critical. The rear bolt hole locations of the oil pan provide mounting points for the transmission housing. To ensure the rigidity of the powertrain and correct transmission alignment, it is important that the rear of the block and the rear of the oil pan are flush. The rear of the oil pan must NEVER protrude beyond the engine block and transmission housing plane.

Note: The original oil pan gasket is retained and aligned to the oil pan by rivets. When installing a new gasket, it is not necessary to install new oil pan gasket rivets.

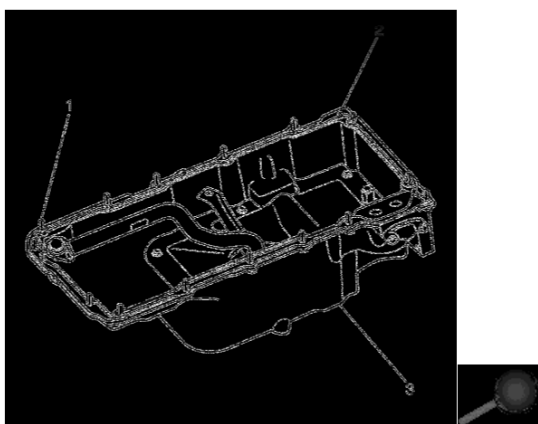
It is not necessary to rivet the NEW gasket to the oil pan.



1. Apply a 5 mm (0.2 in) bead of sealant 20 mm (0.8 in) long to the engine block (1). Apply the sealant directly onto the tabs of the front cover gasket that protrude into the oil pan surface. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#).

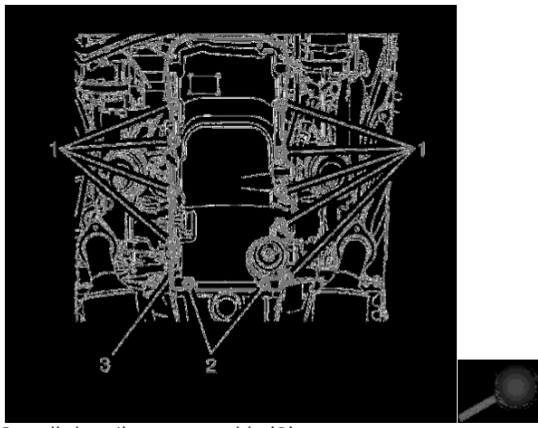


2. Apply a 5 mm (0.2 in) bead of sealant 20 mm (0.8 in) long to the engine block (1). Apply the sealant directly onto the tabs of the rear cover gasket that protrude into the oil pan surface. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#).

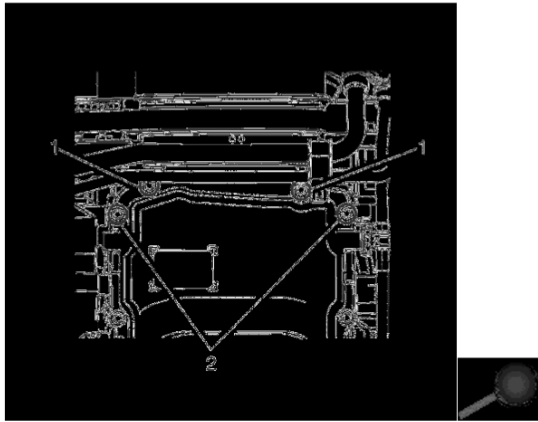


Note: Make sure to align the oil gallery passages in the oil pan and engine block correctly, with the oil pan gasket.

3. Preassemble the oil pan gasket (2) to the oil pan (3).
 - 3.1. Install the oil pan gasket (2) to the oil pan (3).
 - 3.2. Install the oil pan retaining bolts (1) to the oil pan (3) and through the oil pan gasket (2).

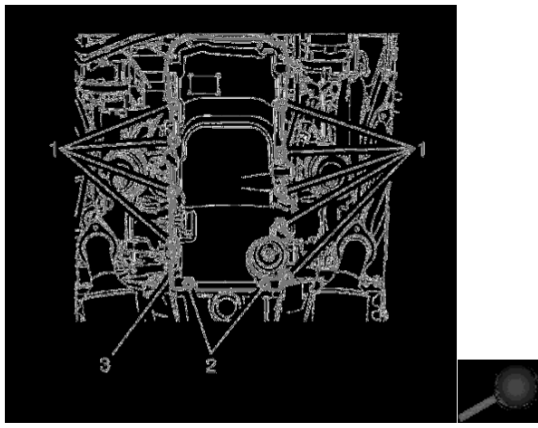


4. Install the oil pan assembly (3).
5. Install the oil pan to cylinder block retaining bolts (1) finger tight. Do not over tighten.
6. Install the oil pan to engine rear cover retaining bolts (2) finger tight. Do not over tighten.



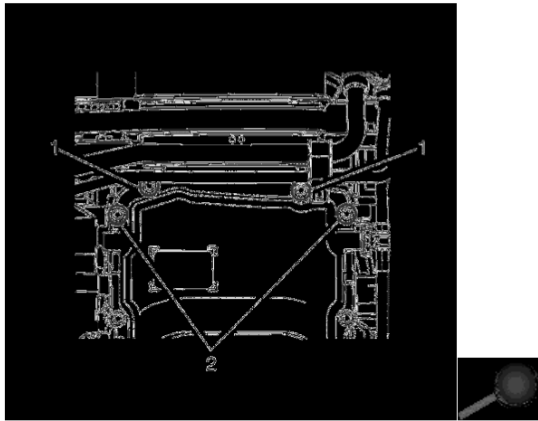
7. Install the oil pan to front cover retaining bolts (1) finger tight. Do not over tighten.
8. Install the oil pan to cylinder block retaining bolts (2) finger tight. Do not over tighten.
9. Place a straight edge across the rear of the engine block and the rear of the oil pan at the transmission housing mounting surfaces.
10. Align the oil pan until the rear of engine block and the rear of oil pan are flush or even.
11. Measure the oil pan-to-engine block alignment.
 - 11.1. Place a straight edge across the rear of the engine block and rear of the oil pan at the transmission housing mounting surfaces.

Note: The rear of the oil pan must NEVER protrude beyond the engine block and transmission housing mounting surfaces.
 - 11.2. Insert a feeler gauge between the straight edge and the oil pan transmission housing mounting surface and check to make sure that there is no more than a 0.25 mm (0.01 in) gap between the pan and the straight edge.
 - 11.3. If the oil pan alignment is not within specifications, repeat steps 9–11.

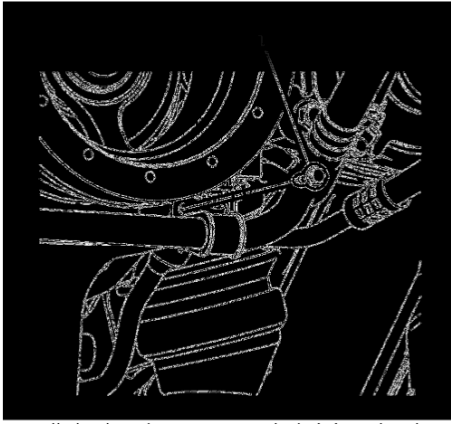


Caution: Refer to [Fastener Caution](#).

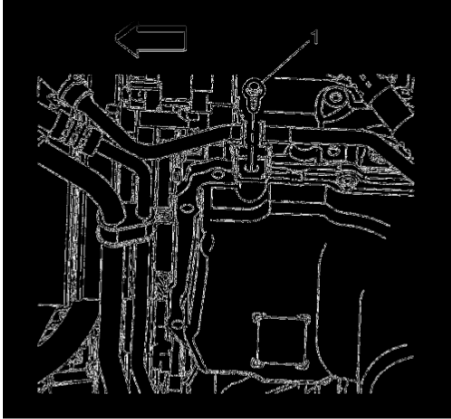
12. Tighten the oil pan to cylinder block retaining bolts (1) to **25 N•m (18 lb ft)**.
13. Tighten the oil pan to engine rear oil seal housing retaining bolts (2) to **12 N•m (9 lb ft)**.



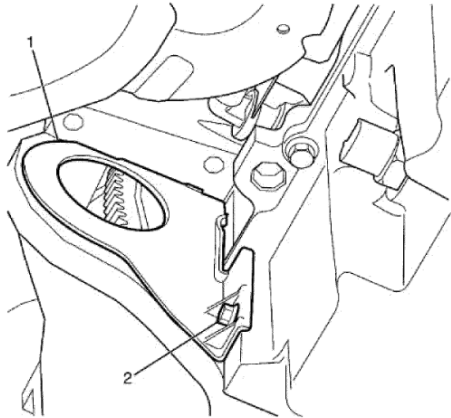
14. Tighten the oil pan to cylinder block retaining bolts (2) to **25 N•m (18 lb ft)**.
15. Tighten the oil pan to front cover retaining bolts (1) to **25 N•m (18 lb ft)**.



16. Install the bracket retaining bolt (1) and tighten to **12N·m (9 lb ft)**.

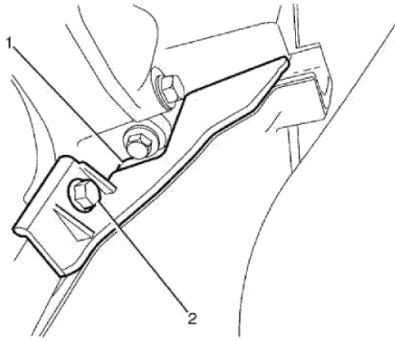


17. Install the bracket retaining bolt (1) and tighten to **12N·m (9 lb ft)**.

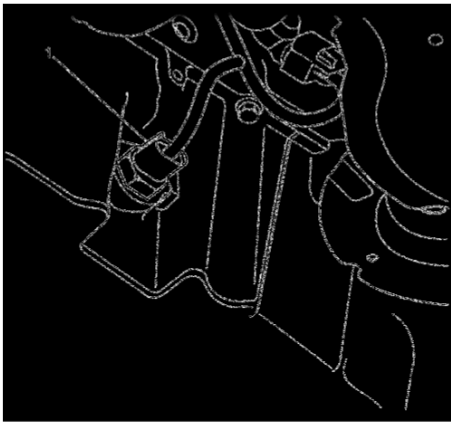


18. Install the right side close out cover (1).

19. Install the right side close out cover to cylinder block retaining bolt (2) and tighten to **12 N•m (9 lb ft)**.



20. Install the left side close out cover (1).
21. Install the left side close out cover to cylinder block retaining bolt (2) and tighten to **12 N•m (9 lb ft)**.



22. Connect the oil level/temperature sensor electrical connector (1) to the oil level/temperature sensor.
23. Install the starter motor. Refer to [Starter Replacement](#).
24. Install the engine oil cooler, if equipped. Refer to [Engine Oil Cooler Removal](#).
25. Install the drivetrain and front suspension frame Refer to [Drivetrain and Front Suspension Frame Replacement](#).
26. Install the front underbody air deflector. Refer to [Underbody Front Air Deflector Replacement](#).
27. Connect the battery ground cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
28. Replace the engine oil and oil filter. Refer to [Engine Oil and Oil Filter Replacement](#).

Engine Oil Pressure Sensor and/or Switch Replacement (L77 or LS3)

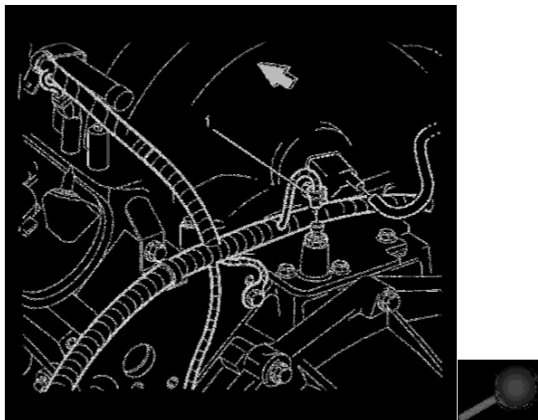
Tools Required

J 41712 Oil Pressure Switch Socket

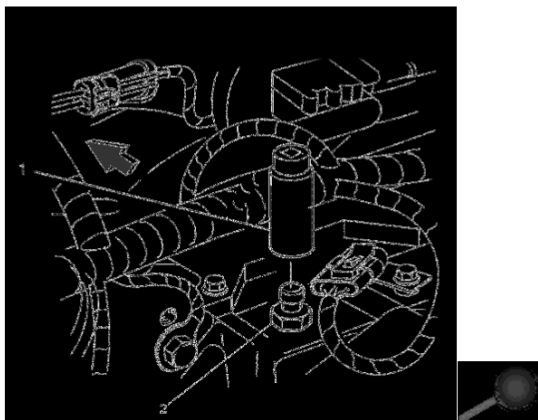
For equivalent regional tools, refer to [Special Tools](#).

Removal Procedure

1. Remove the air inlet grille panel. Refer to [Air Inlet Grille Panel Replacement](#).



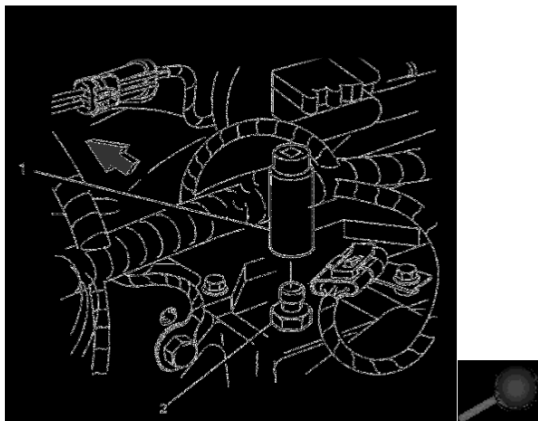
2. Disconnect the oil pressure sensor wiring harness connector (1).



Note: Clean the area around the oil pressure sensor (2) before removal. This prevents debris from entering the engine.

3. Use the J 41712 oil pressure switch socket (1) to remove the oil pressure sensor (2).

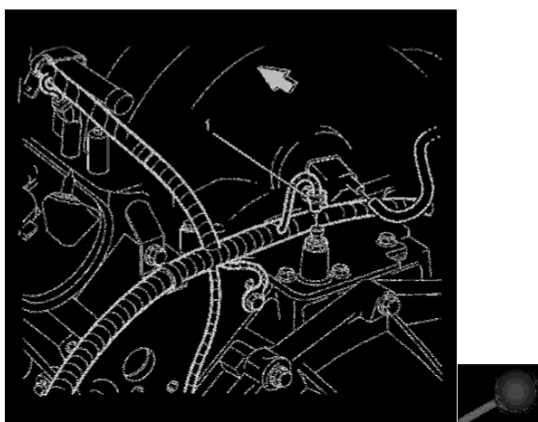
Installation Procedure



Caution: Refer to [Fastener Caution](#).

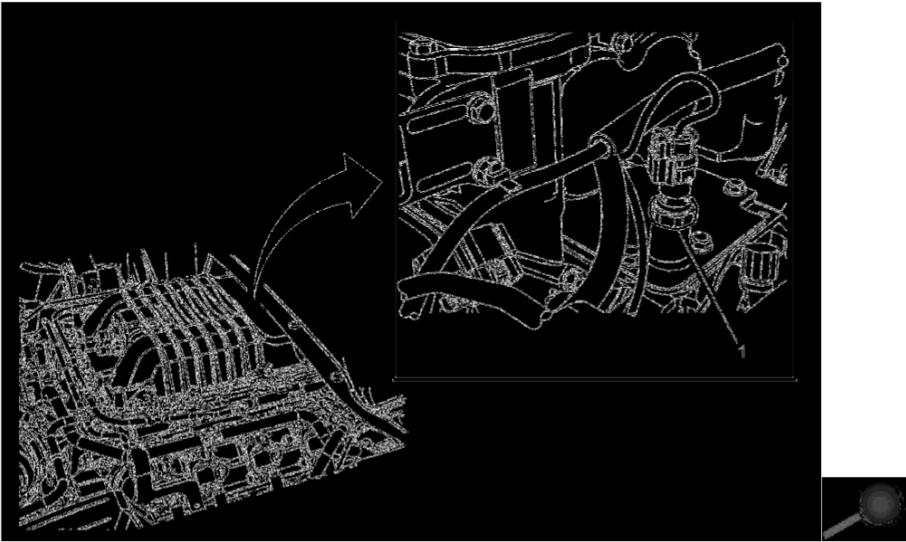
Note: If installing the old oil pressure sensor (2), apply sealant GMP/N 12346004 (Canadian P/N 10953480) or equivalent to the cleaned oil pressure sensor (2) thread.

1. Install the oil pressure sensor (2) using the J 41712 oil pressure switch socket (1) and tighten to **35 N·m (26 lb ft)**.



2. Connect the oil pressure sensor electrical connector (1).
3. Install the air inlet grille panel. Refer to [Air Inlet Grille Panel Replacement](#).

Engine Oil Pressure Sensor and/or Switch Replacement (LSA)



Engine Oil Pressure Sensor and/or Switch Replacement

Callout	Component Name
Preliminary Procedure Remove the front intake manifold cover. Refer to Intake Manifold Cover Replacement - Front . Special Tools J 41712 Oil Pressure Sensor Socket For equivalent regional tools, refer to Special Tools .	
1	Engine Oil Pressure Sensor Caution: Refer to Component Fastener Tightening Caution . Procedure 1. To access the oil pressure sensor the engine will need to be lowered. The front suspension crossmember fasteners will need to be loosened 3/4 of the way to allow the assembly to be lower approximately 25 mm (1 in). Refer to Drivetrain and Front Suspension Frame Replacement. 2. Disconnect the electrical connector. 3. Using the J 41712 oil pressure sensor socket (1) , remove the oil pressure sensor. Tighten 35 N•m (26 lb ft)

Engine Oil Level Sensor and/or Switch Replacement

Removal Procedure

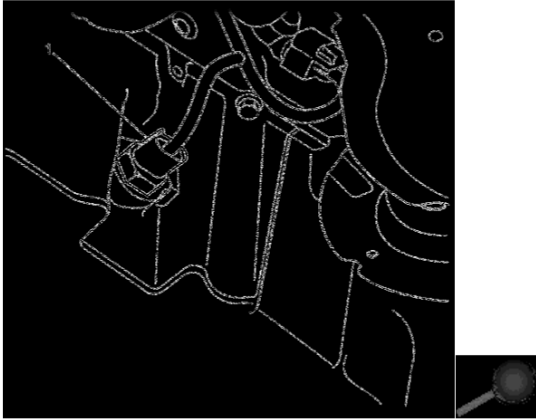
Warning: Refer to [Battery Disconnect Warning](#).

1. Disconnect the battery ground cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

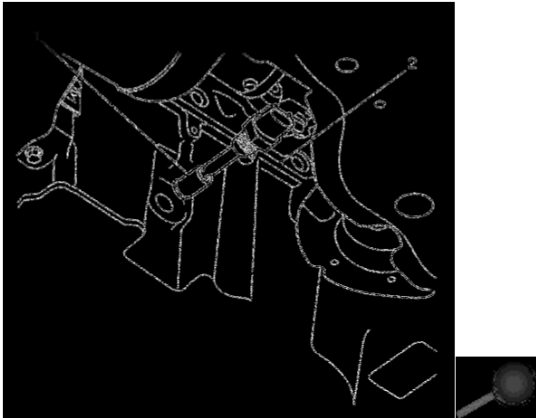
Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

2. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
3. Drain the engine oil. Refer to [Engine Oil and Oil Filter Replacement](#).

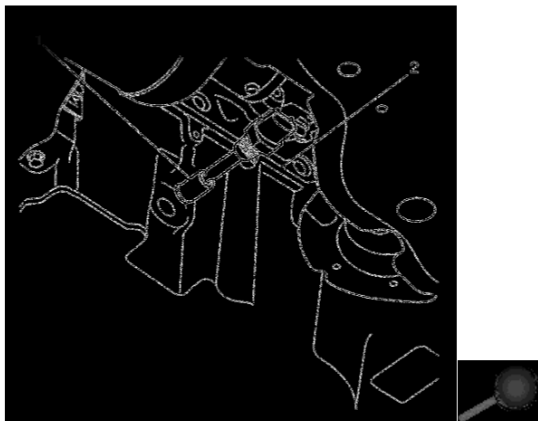


4. Disconnect the oil level/temperature sensor electrical connector (1).



5. Remove the engine oil level sensor (1) from the oil pan (2).

Installation Procedure



Caution: Refer to [Fastener Caution](#).

1. Install the engine oil level sensor (1) to the oil pan (2) and tighten to **20 N•m (15 lb ft)**.

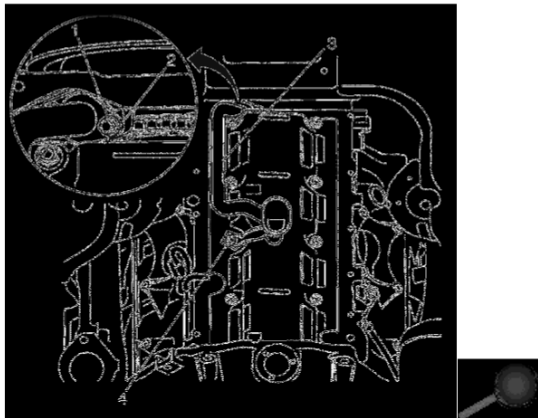


2. Connect the oil level/temperature sensor electrical connector (1).
3. Lower the vehicle.
4. Replace the engine oil and oil filter. Refer to [Engine Oil and Oil Filter Replacement](#).
5. Reset the GM Oil Life System. Refer to [GM Oil Life System Resetting](#).

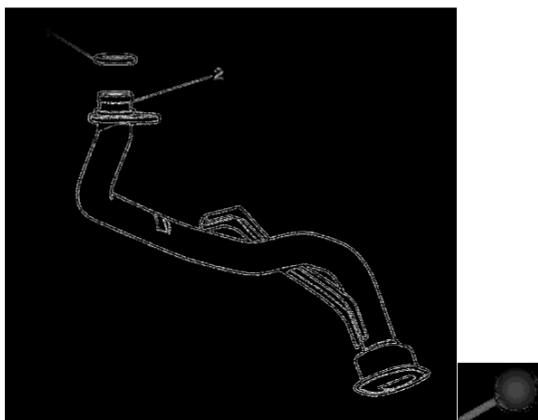
Oil Pump, Screen, and Crankshaft Oil Deflector Replacement

Removal Procedure

1. Remove the engine oil pan. Refer to [Oil Pan Replacement](#).
2. Remove the engine front cover. Refer to [Engine Front Cover Replacement](#).



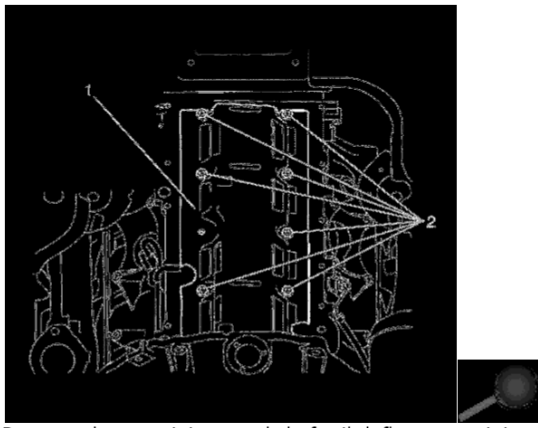
3. Remove the oil pump screen and tube assembly to oil pump retaining bolt (1).
4. Remove the oil pump screen and tube assembly to crankshaft oil deflector retaining nut (4).
5. Remove the oil pump screen and tube assembly (3) from the oil pump (2).



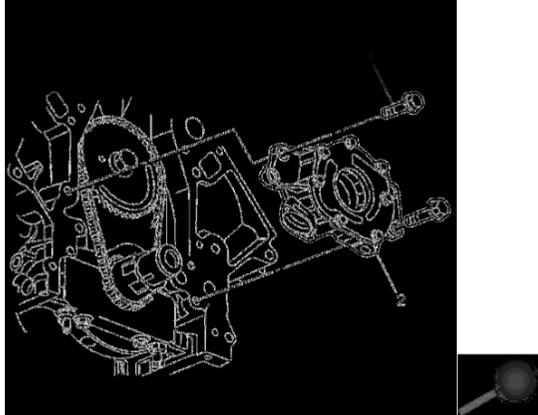
Note: The oil pump screen and tube assembly O-ring seal (1) is a single use only component and must be replaced whenever the oil pump screen and tube assembly (2) is removed.

6. Remove the oil pump screen and tube assembly O-ring seal (1) from the oil pump screen and tube assembly (2).
- Discard the oil pump screen and tube assembly O-ring seal (1).

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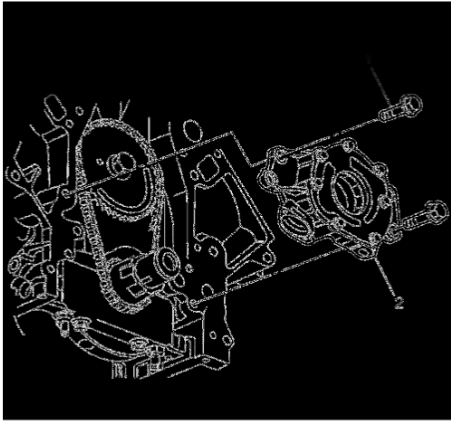


7. Remove the remaining crankshaft oil deflector retaining nuts (2).
8. Remove the crankshaft oil deflector (1).



9. Remove the oil pump bolts (1).
- Note:** Do not allow dirt or debris to enter the oil pump. Cap the ends as necessary.
10. Remove the oil pump (2).
 11. Clean and inspect the oil pump. Refer to [Oil Pump Cleaning and Inspection](#).

Installation Procedure

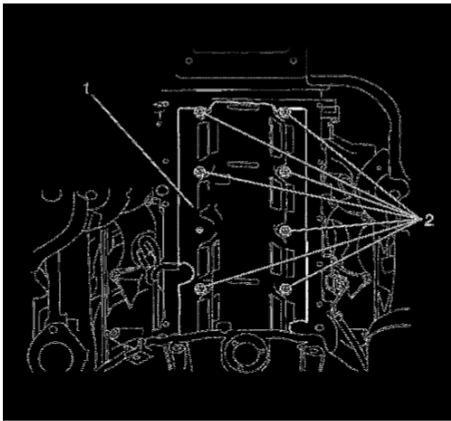


Note: Inspect the engine block oil gallery passages. These surfaces must be clear and free of debris or restrictions.

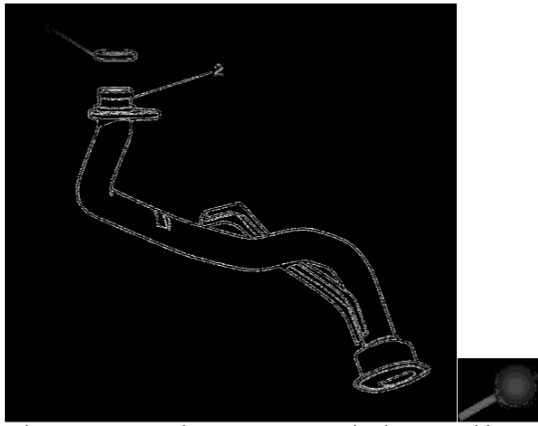
1. Align the splined surfaces of the crankshaft sprocket and the oil pump drive gear and install the oil pump (1).

Caution: Refer to [Fastener Caution](#).

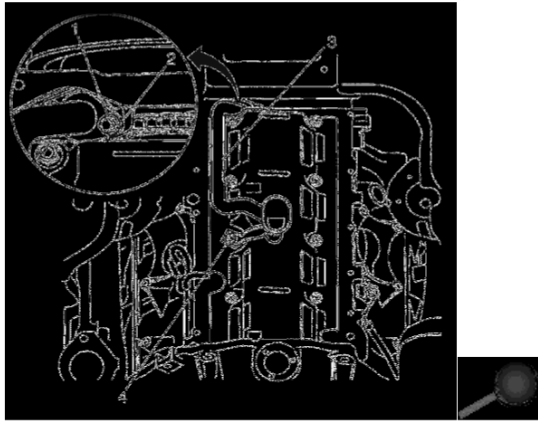
2. Install the oil pump to engine block retaining bolts (2) and tighten to **25 N·m (18 lb ft)**.



3. Install the crankshaft oil deflector (1).
4. Install the crankshaft oil deflector retaining nuts (2) and tighten to **10 N·m (89 lb in)**.



5. Lubricate a NEW oil pump screen and tube assembly O-ring seal (1) with clean engine oil.
6. Install the NEW oil pump screen and tube assembly O-ring seal (1) onto the oil pump screen and tube assembly (2).



Note: Push the oil pump screen and tube assembly (3) completely into the oil pump (2) prior to tightening the oil pump screen and tube assembly to oil pump retaining bolt (1). Do not allow the oil pump screen and tube assembly to oil pump retaining bolt (1) to pull the oil pump screen and tube assembly (3) into the oil pump (2).

Note: Align the oil pump screen brackets with the correct crankshaft bearing cap studs.

7. Install the oil pump screen and tube assembly (3).
8. Install the oil pump screen and tube assembly to oil pump retaining bolt (1) and tighten to **9 N·m (80 lb in)**.
9. Install the oil pump screen and tube assembly to crankshaft oil deflector retaining nut (4) and tighten to **10 N·m (89 lb in)**.
10. Install the engine front cover. Refer to [Engine Front Cover Replacement](#).
11. Install the engine oil pan. Refer to [Oil Pan Replacement](#).

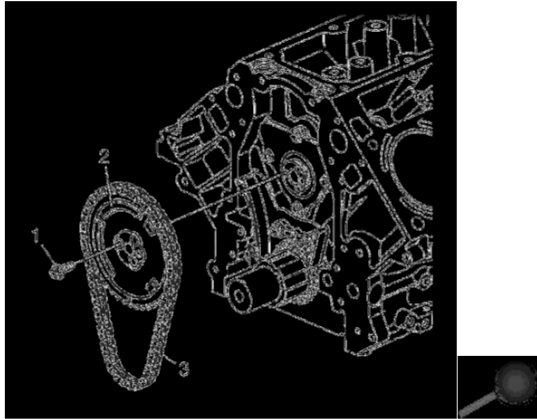
Camshaft Timing Chain and Sprocket Replacement

Special Tools

- *EN 46330* Timing Belt Tensioner Retaining Pin
- *J 8433* Pulley Puller
- *J 41478* Crankshaft Front Oil Seal Installer
- *J 41558* Crankshaft Sprocket Remover
- *J 41665* Crankshaft Balancer and Sprocket Installer
- *J 41816-2* Crankshaft End Protector

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

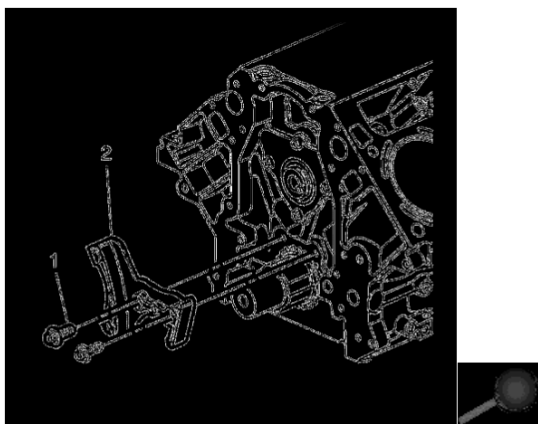
Removal Procedure



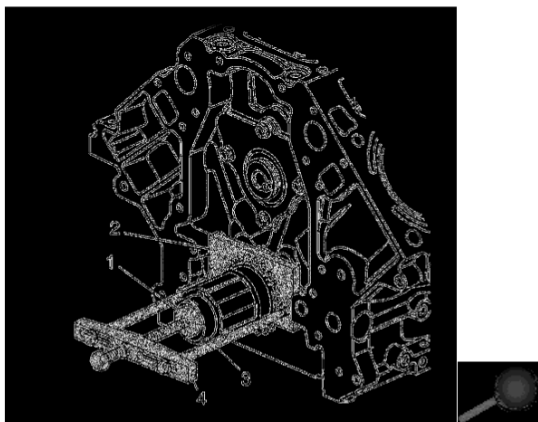
Caution: Do not turn the crankshaft assembly after the timing chain has been removed in order to prevent damage to the piston assemblies or the valves.

1. Remove the oil pump. Refer to [Oil Pump, Screen and Crankshaft Oil Deflector Removal](#).
2. Remove and discard the camshaft sprocket bolt (1).
3. Remove the camshaft sprocket (2) and timing chain (3).

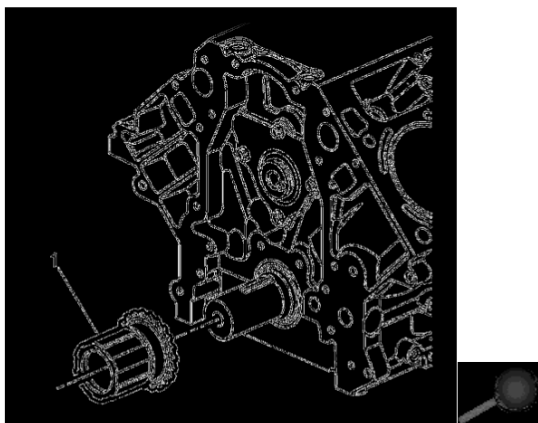
cardiagn.com



4. Remove the bolts (1) and timing chain tensioner (2).



5. Use the *J 41816-2* crankshaft end protector (1), the *J 41558* crankshaft sprocket remover (2), bolts (3), and the *J 8433* pulley puller (4) in order to remove the crankshaft sprocket.



6. Remove the crankshaft sprocket (1).

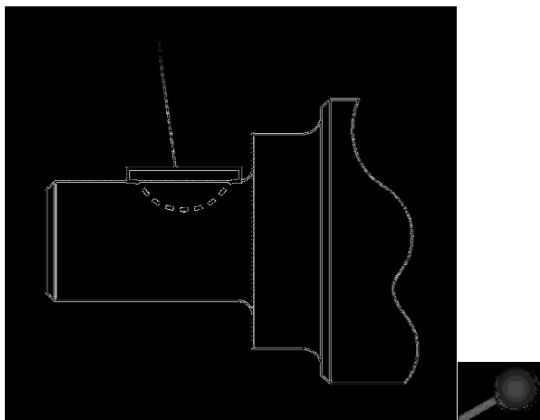


7. Remove the crankshaft sprocket key, as required.

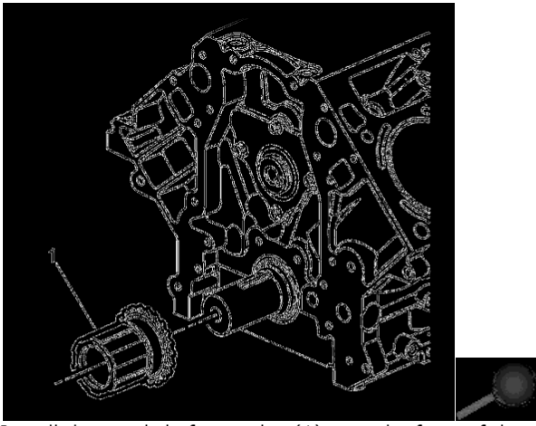
Installation Procedure



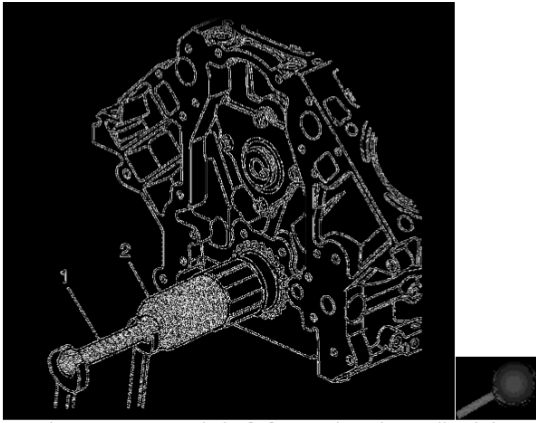
1. Install the key into the crankshaft keyway, if previously removed.



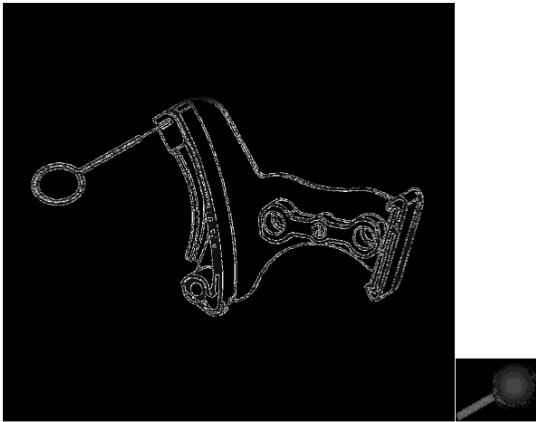
2. Tap the key (1) into the keyway until both ends of the key bottom onto the crankshaft.



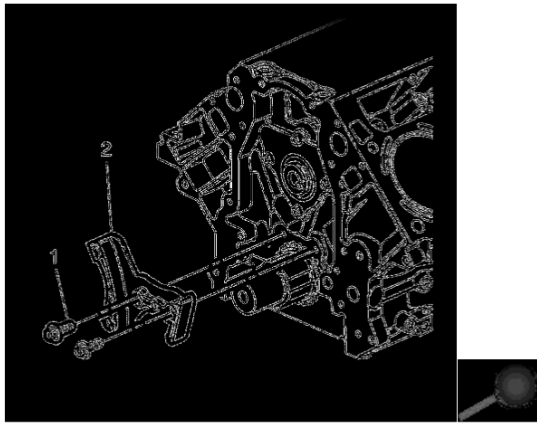
3. Install the crankshaft sprocket (1) onto the front of the crankshaft. Align the crankshaft key with the crankshaft sprocket keyway.



4. Use the *J 41478* crankshaft front oil seal installer (1) and the *J 41665* crankshaft balancer and sprocket installer (2) in order to install the crankshaft sprocket.
Install the sprocket onto the crankshaft until fully seated against the crankshaft flange.
5. Rotate the crankshaft sprocket until the alignment mark is in the 12 o'clock position.

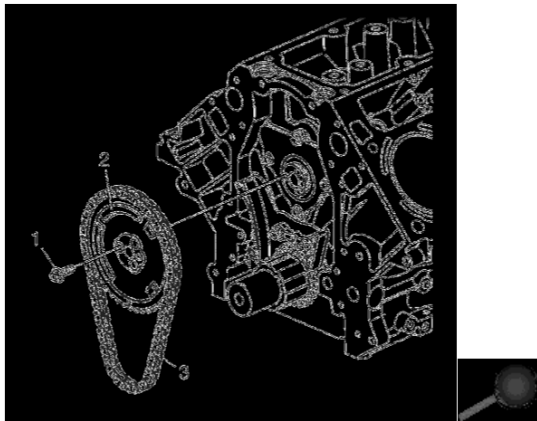


6. Compress the timing chain tensioner guide and install the *EN 46330* timing belt tensioner retaining pin.



Caution: Refer to [Fastener Caution](#).

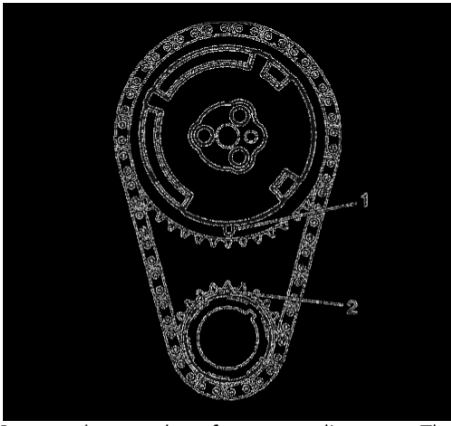
7. Install the timing chain tensioner (2) and bolts (1) and tighten the bolts to **25 N·m (18 lb ft)**.



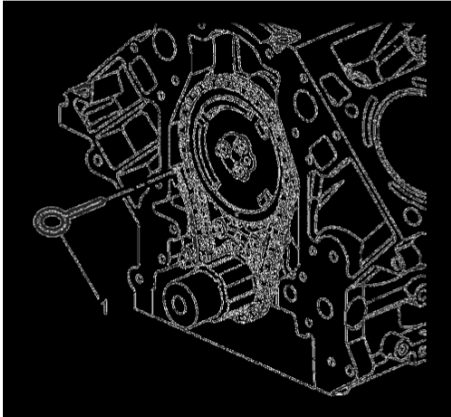
Note:

- The sprocket teeth and timing chain must mesh.
- The camshaft and the crankshaft sprocket alignment marks **MUST** be aligned properly.

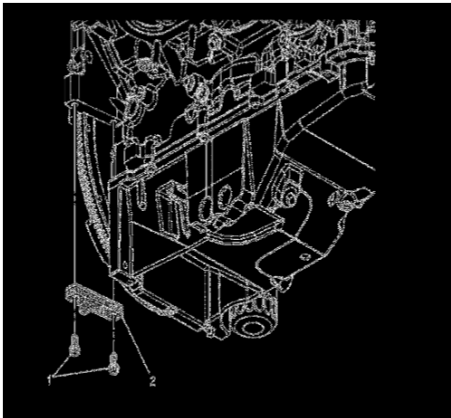
8. Install the camshaft sprocket (2), timing chain (3), and bolt (1).



9. Inspect the sprockets for proper alignment. The mark on the camshaft sprocket (1) should be located in the 6 o'clock position and the mark on the crankshaft sprocket (2) should be located in the 12 o'clock position.

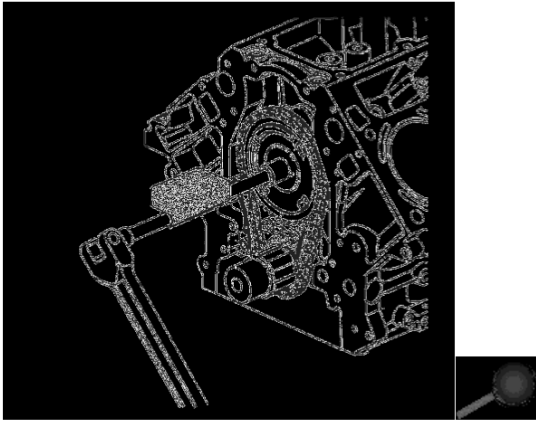


10. Remove the *EN 46330* timing belt tensioner retaining pin (1).



Note: Do not apply threadlock to the flex plate bolts at this time.

11. Temporarily install the automatic transmission flex plate or manual transmission flywheel and bolts. Refer to [Engine Flywheel Installation](#).
12. Install the J 42386-A flywheel holding tool (2) and bolts (1). Use 1 M10-1.5 x 120 mm bolt and 1 M10-1.5 x 45 mm bolt for proper tool operation.
Tighten the J 42386-A flywheel holding tool bolts to **50 N·m (37 lb ft)**.



13. Tighten the camshaft sprocket bolt.
 - Tighten the camshaft sprocket bolt a first pass to **75 N·m (55 lb ft)**.
 - Tighten the camshaft sprocket bolt a final pass an additional **50 degrees** using the J 45059 angle meter.
14. Remove the J 42386-A flywheel holding tool and bolts.
15. Remove the automatic transmission flex plate or manual transmission flywheel and bolts.
Refer to [Engine Flywheel Removal](#).
16. Install the oil pump. Refer to [Oil Pump, Screen and Crankshaft Oil Deflector Removal](#).

Camshaft Replacement

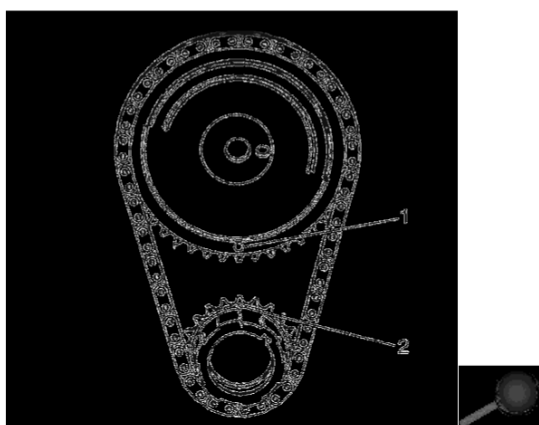
Special Tools

- EN-45059 Angle Meter
- EN-46330 Timing Belt Tensioner Retaining Pin

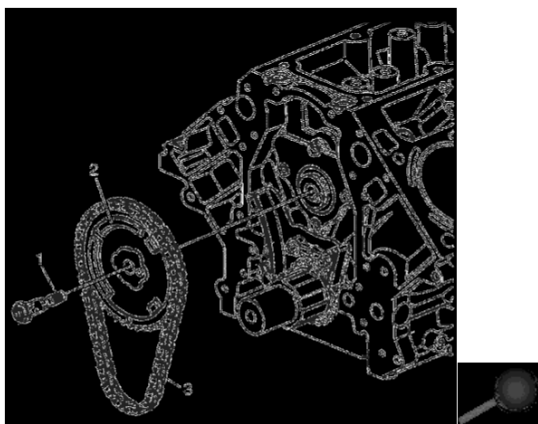
For equivalent regional tools, refer to [Special Tools](#).

Removal Procedure

1. Remove the engine assembly. Refer to [Engine Replacement](#).
2. Remove the oil level indicator tube. Refer to [Oil Level Indicator and Tube Removal](#).
3. Remove the left and right cylinder heads. Refer to [Cylinder Head Replacement - Left Side](#) and [Cylinder Head Replacement - Right Side](#).
4. Remove the valve lifters. Refer to [Valve Lifter Removal](#).
5. Remove the water pump. Refer to [Water Pump Removal](#).
6. Remove the crankshaft balancer. Refer to [Crankshaft Balancer Removal](#).
7. Remove the oil pump, screen, and crankshaft oil deflector. Refer to [Oil Pump, Screen, and Crankshaft Oil Deflector Replacement](#).



8. Inspect the sprockets for correct alignment. The mark on the camshaft sprocket (1) should be located in the 6 o'clock position and the mark on the crankshaft sprocket (2) should be located in the 12 o'clock position.



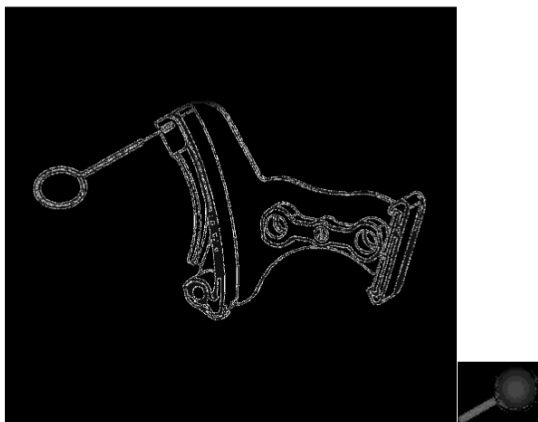
Caution: Do not turn the crankshaft assembly after the timing chain has been removed in order to prevent damage to the piston assemblies or the valves.

9. Remove the camshaft sprocket bolt (1).
10. Remove the camshaft sprocket (2) and timing chain (3).
11. Remove the camshaft. Refer to [Camshaft Removal](#).

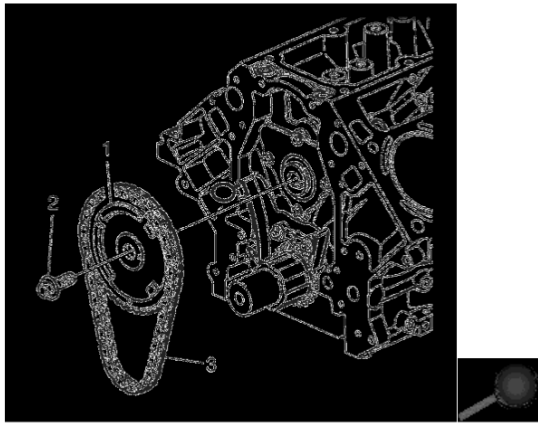
Installation Procedure

Note: If camshaft replacement is required, the valve lifters must also be replaced.

1. Install the camshaft. Refer to [Camshaft Installation](#).

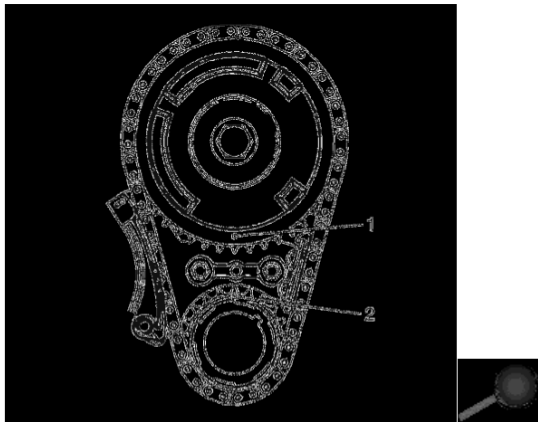


2. Compress the timing chain tensioner guide and install the *EN-46330* retaining pin.

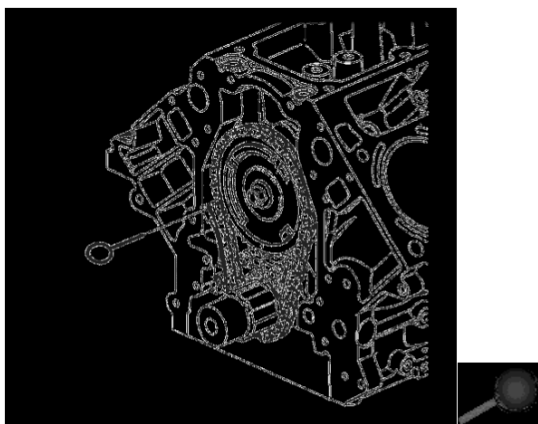
**Note:**

- The sprocket teeth and timing chain must mesh.
- The camshaft and the crankshaft sprocket alignment marks **MUST** be aligned properly.
- Ensure the camshaft sprocket alignment mark is in the 6 o'clock position.

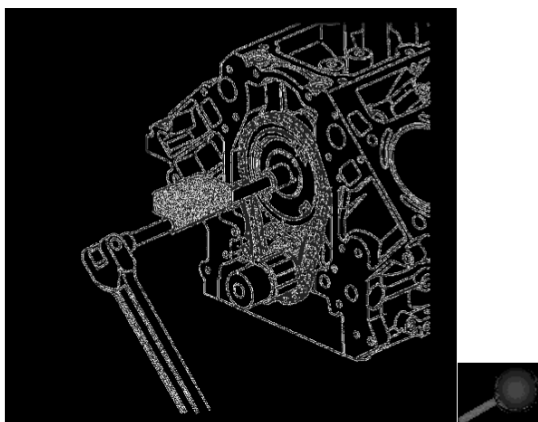
3. Install the camshaft sprocket (1), timing chain (3), and bolt (2).



4. Inspect the sprockets for proper alignment. The mark on the camshaft sprocket (1) should be located in the 6 o'clock position and the mark on the crankshaft sprocket (2) should be located in the 12 o'clock position.



5. Remove the *EN-46330* retaining pin.



Caution: Refer to [Fastener Caution](#).

6. Tighten the camshaft sprocket bolt.
 - 6.1. Tighten the camshaft sprocket bolt a first pass to **75 N·m (55 lb ft)**.
 - 6.2. Tighten the camshaft sprocket bolt a final pass an additional **50 degrees** using the *EN-45059* meter.
7. Install the oil pump, screen, and crankshaft oil deflector. Refer to [Oil Pump, Screen, and Crankshaft Oil Deflector Replacement](#).
8. Install a NEW crankshaft front oil seal. Refer to [Crankshaft Front Oil Seal Installation](#).
9. Install the crankshaft balancer. Refer to [Crankshaft Balancer Installation](#).
10. Install the water pump. Refer to [Water Pump Installation](#).
11. Install the valve lifters. Refer to [Valve Lifter Installation](#).
12. Install the right side and left side cylinder heads. Refer to [Cylinder Head Replacement - Left Side](#) and [Cylinder Head Replacement - Right Side](#).
13. Install the oil level indicator tube. Refer to [Oil Level Indicator and Tube Installation](#).
14. Install the engine assembly. Refer to [Engine Replacement](#).

Engine Flywheel Replacement

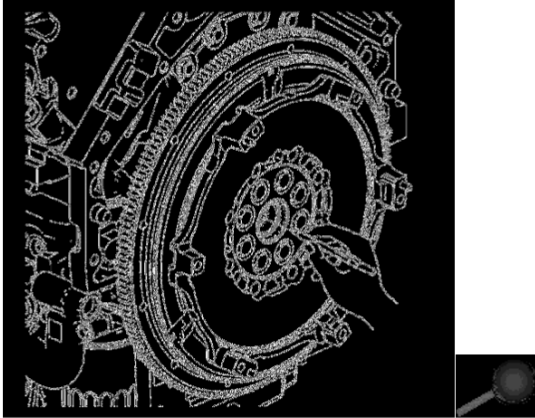
Special Tools

J-42386-A Flywheel Holding Tool

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

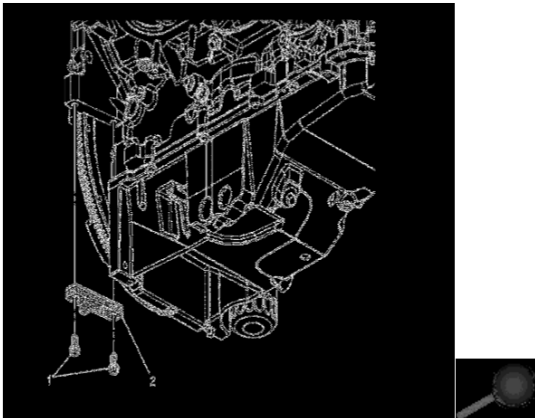
Removal Procedure

1. Remove the clutch assembly. Refer to [Clutch Assembly Replacement](#).



Note: Note the position and direction of the engine flywheel before removal. The flywheel does not use a locating pin for alignment. Mark or scribe the end of the crankshaft and the flywheel before component removal. The existing manual transmission engine flywheel must be installed to the original position and direction.

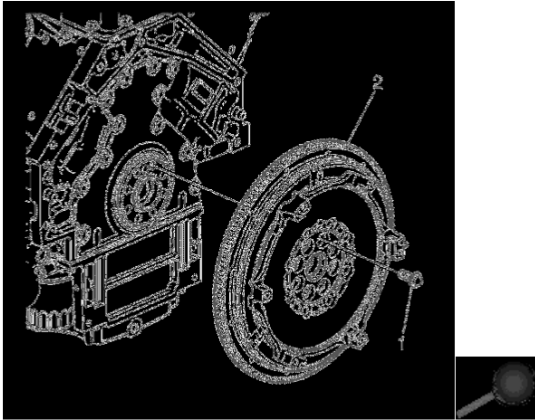
2. Mark or scribe the end of the crankshaft and the manual transmission flywheel. Refer to [Engine Balancing](#).



Caution: Refer to [Fastener Caution](#).

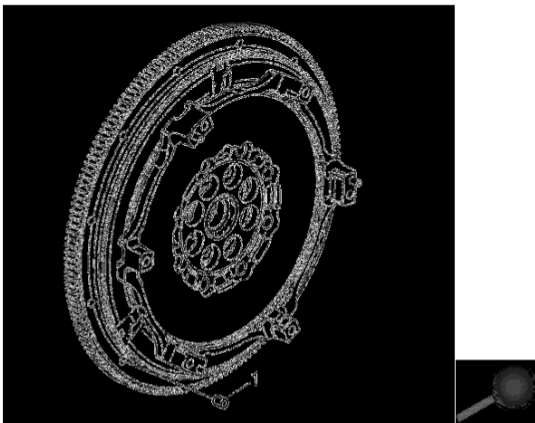
© 2014 General Motors. All rights reserved.

3. Install the J-42386-A flywheel holding tool (2) and bolts (1).
Use 1 M10 – 1.5 x 120 mm and 1 M10 – 1.5 x 45 mm bolt for proper tool operation.
Tighten the J-42386-A flywheel holding tool and bolts to **50N•m (37 lb ft)**.



Note: Do NOT reuse the flywheel bolts.

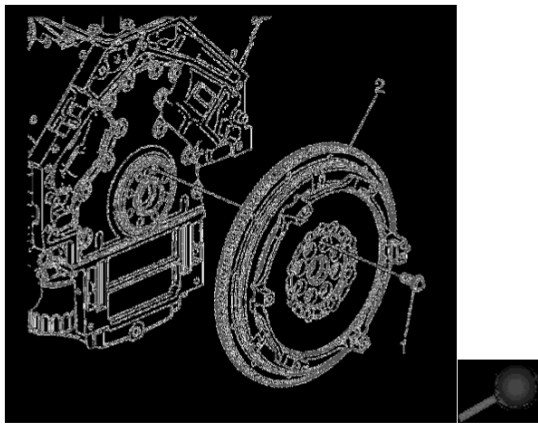
4. Remove and discard the flywheel bolts (1).
5. Remove the manual transmission flywheel (2).



6. Note the location of the manual transmission flywheel balance weights (1), if applicable.
Refer to [Engine Balancing](#).
7. Remove the J-42386-A flywheel holding tool.

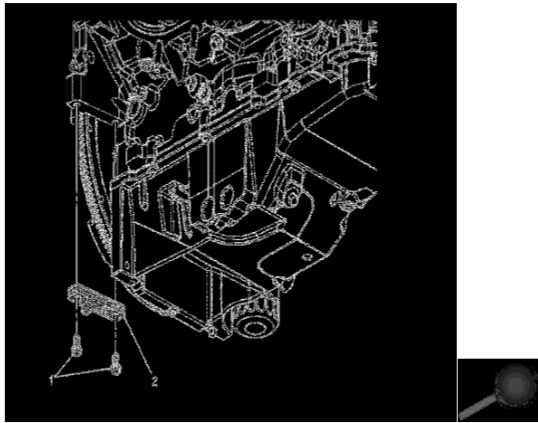
Installation Procedure

Note: For manual transmission applications, note the position and direction of the engine flywheel before removal. The flywheel does not use a locating pin for alignment. Mark or scribe the end of the crankshaft and the flywheel before component removal. The engine flywheel must be reinstalled to the original position and direction. The engine flywheel will not initially seat against the crankshaft flange, but will be pulled onto the crankshaft by the engine flywheel bolts. This procedure requires a 3 stage tightening process.



Note: The flywheel does not use a locating pin for alignment and will not initially seat against the crankshaft flange, but will be pulled onto the crankshaft by the engine flywheel bolts.

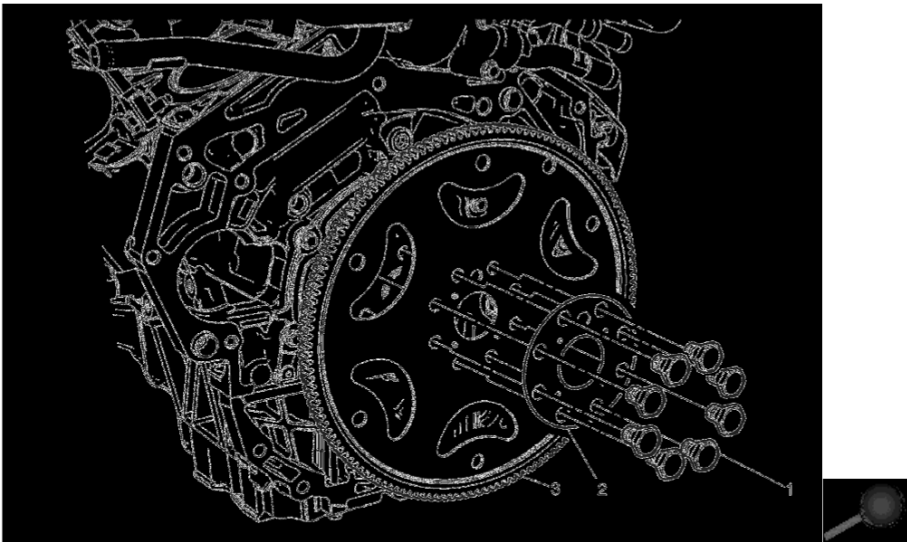
1. Install the flywheel (2) to the crankshaft.
2. Apply threadlocker to the threads of the flywheel bolts (1). Refer to [Adhesives, Fluids, Lubricants, and Sealers](#).
3. Install and hand tighten the NEW flywheel bolts (1).



Caution: Refer to [Fastener Caution](#).

4. Install the J-42386-A flywheel holding tool (2) and bolts (1).
Use 1 M10-1.5 x 120 mm and 1 M10-1.5 x 45 mm bolt for proper tool operation.
Tighten the J-42386-A flywheel holding tool and bolts to **50N•m (37 lb ft)**.
5. Tighten the flywheel bolts (1).
 - 5.1. Tighten the bolts a first pass to **50N•m (37 lb ft)**.
 - 5.2. Tighten the bolts a final pass an additional **45 degrees**.
6. Remove the J-42386-A flywheel holding tool.
7. Install the clutch assembly. Refer to [Clutch Assembly Replacement](#).

Automatic Transmission Flex Plate Replacement



Automatic Transmission Flex Plate Replacement

Callout	Component Name
Preliminary Procedure Remove the transmission. Refer to Transmission Replacement. Special Tools • EN 45059 Angle Meter • EN 46106 Flywheel Holding Tool For equivalent regional tools, refer to Special Tools.	
1	Automatic Transmission Flex Plate Fastener (Qty: 8) Caution: Refer to Fastener Caution. Procedure New bolts must be used whenever removing the automatic transmission flex plate. Tighten 50 N·m (37 lb ft) plus 45 degrees
2	Flex Plate Washer
3	Automatic Transmission Flex Plate Procedure 1. For cleaning and inspection, refer to Automatic Transmission Flex Plate Cleaning and Inspection.

Callout	Component Name
	2. Transfer parts as necessary.

Engine Replacement (L77 or LS3)

Special Tools

- J 39400-A Halogen Leak Detector
- J 41623-B Cooler Quick Connect Tool
- J 41798 Engine Lifting Brackets

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

Removal Procedure

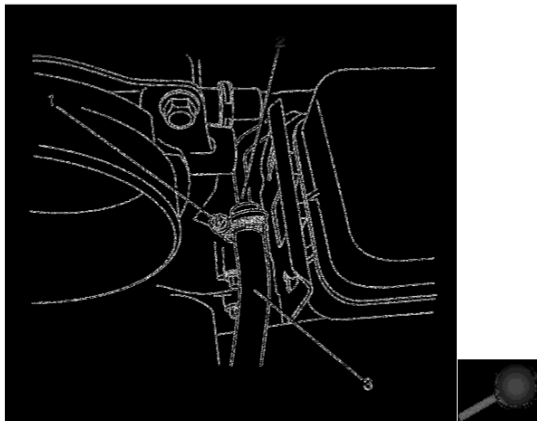
Note: Observing the orientation of the intermediate steering shaft (1) with reference to the pinion shaft (3) will minimize the potential of incorrect steering column assembly alignment.

Note: The front wheels of the vehicle must be maintained in the straight ahead position and the steering column must be in the LOCK position before disconnecting the steering column or intermediate shaft. If these procedures are not followed incorrect alignment of some components during installation will result and damage to the SIR coil assembly will occur.

1. Turn the ignition key to the LOCK position.

Warning: Refer to [Battery Disconnect Warning](#).

2. Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
3. Remove the engine cover. Refer to [Engine Cover Replacement](#).
4. Recover the air conditioning (A/C) refrigerant. Refer to [Refrigerant Recovery and Recharging](#).
5. Remove the air intake duct. Refer to [Air Cleaner Inlet Duct Replacement](#).
6. Depressurize the fuel system. Refer to [Fuel Pressure Relief](#).
7. Drain the cooling system. Refer to [Cooling System Draining and Filling](#).
8. Remove the radiator outlet hose. Refer to [Radiator Outlet Hose Replacement](#).

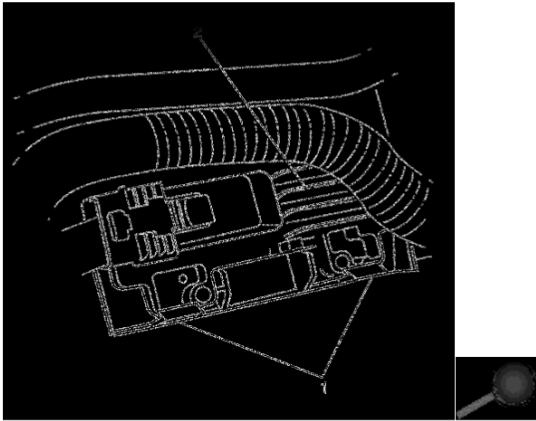


9. Loosen the coolant bleed hose retaining clamp (1) at the cylinder head end and slide 50 mm (2 in) along the coolant bleed hose (3).
10. Disconnect the coolant air bleed hose (3) from the coolant bleed pipe (2).



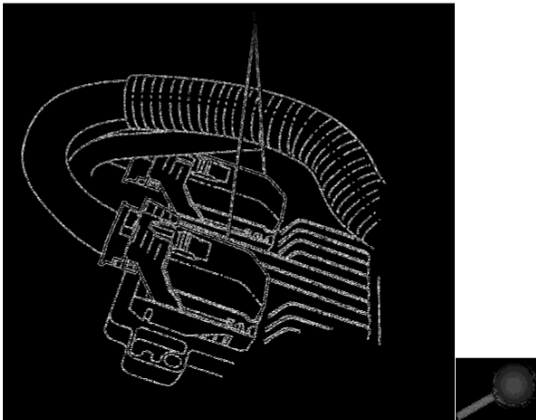
Note: Disconnect the heater hose assembly quick connect fittings (1) by releasing the retaining clips (2) using a suitable tool.

11. Disconnect the inlet and outlet heater hoses (3) from the heater hose assembly quick connect fittings (1).

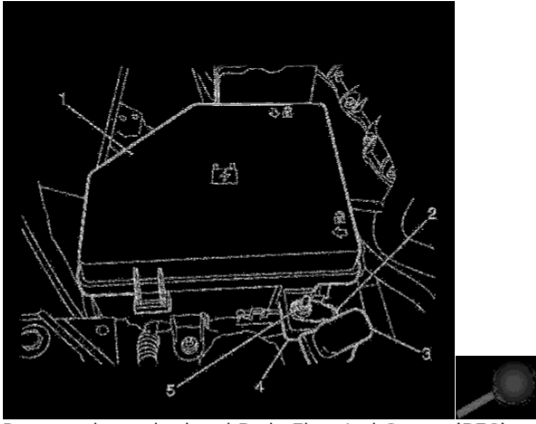


Caution: Refer to [Powertrain Control Module and Electrostatic Discharge Caution](#).

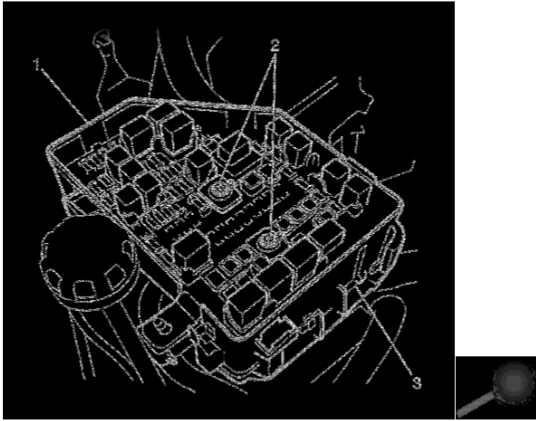
12. Release the ECM retaining clips (1) and detach the ECM (2).



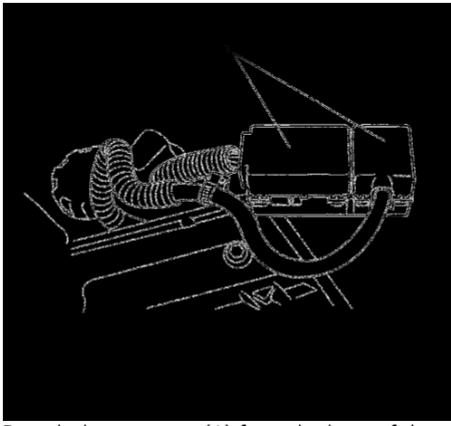
13. Move the connector lock levers to the unlock position and disconnect the ECM electrical connectors (1).



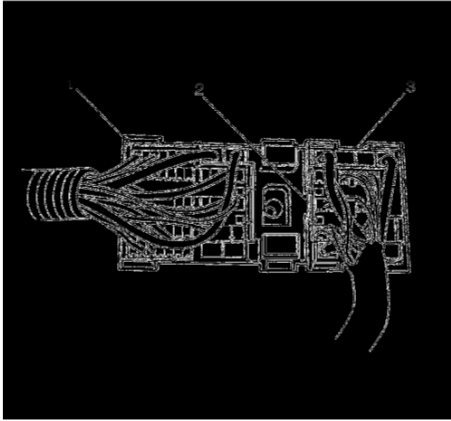
14. Remove the under hood Body Electrical Centre (BEC) cover (1).
15. Remove the positive cable protective cover (3).
16. Remove the positive cable to under hood BEC plate retaining bolt (5).
17. Disconnect the positive cable (2) from the upper under hood BEC plate (4).



18. Remove the under hood BEC upper plate to lower plate retaining bolts (2).
19. Raise the upper under hood BEC plate (1) from the lower under hood BEC plate (3).

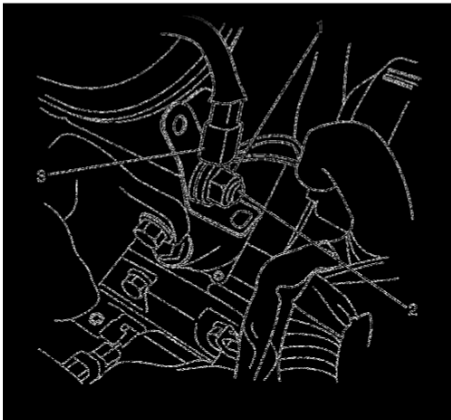


20. Detach the protector (1) from the base of the under hood BEC connector (2).

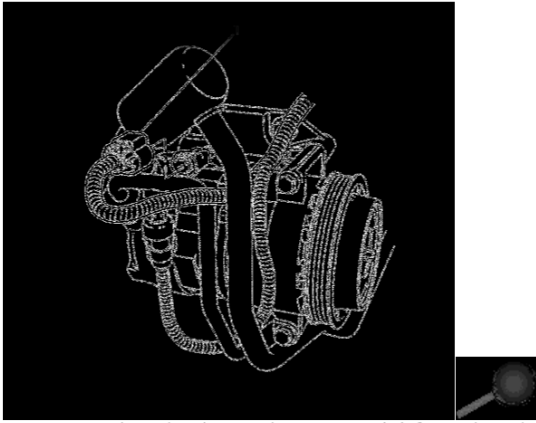


Note: Use a suitable tool to depress the connector locking tang (2), then pull the body harness connector (1) upward and the engine connector (3) downward to separate the body harness connector (1) from the engine connector (3).

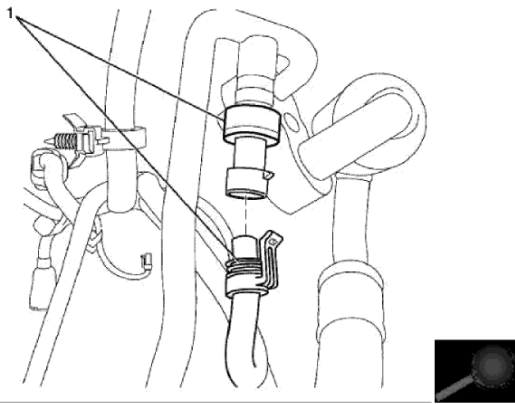
21. Separate the body harness connector (1) from the engine connector (3).
22. Reposition and secure the engine wiring harness and connector (3) on the engine.



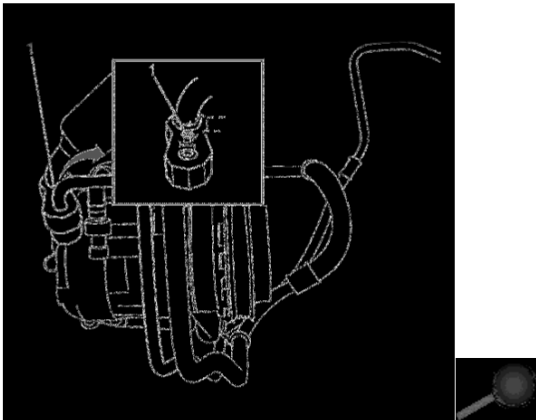
23. Remove the vehicle body ground cable to cylinder head retaining nut (1).
24. Remove the vehicle body ground cable (3) from the cylinder head stud (2).



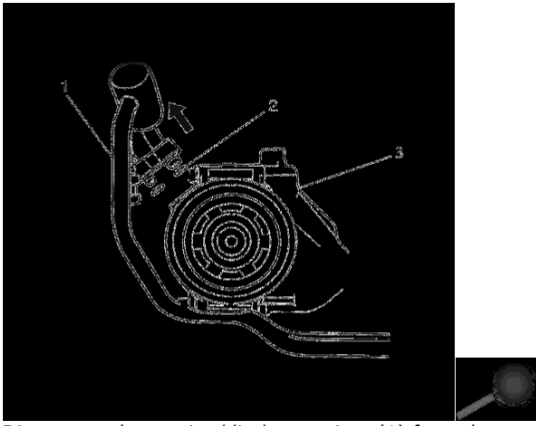
25. Disconnect the A/C electrical connector (1) from the A/C compressor.



26. Disconnect the electrical connector from the A/C Refrigerant Pressure Sensor (1).



27. Remove the suction/discharge pipes pad (1) to compressor retaining bolt.



28. Disconnect the suction/discharge pipes (1) from the compressor (3).

Note: Sealing washers are single use and must be discarded after use.

Note: Seal pipes immediately to prevent absorption of moisture from the atmosphere.

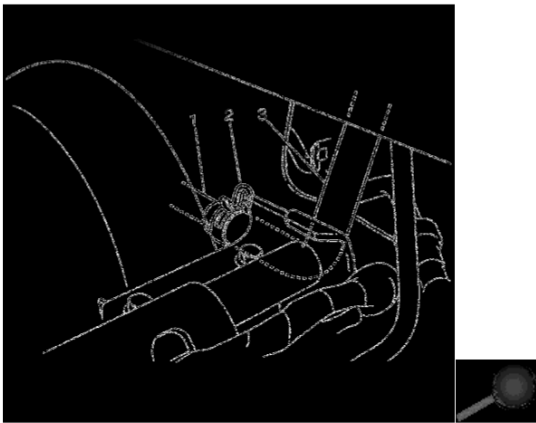
Note: The plugs for A/C compressor ports must be sufficient to stop oil escaping when tilting A/C compressor for removal.

29. Remove and discard the port sealing washers (2).
Discard the port sealing washers (2).

Note: Cap or plug the ports immediately to prevent absorption of moisture from the atmosphere.

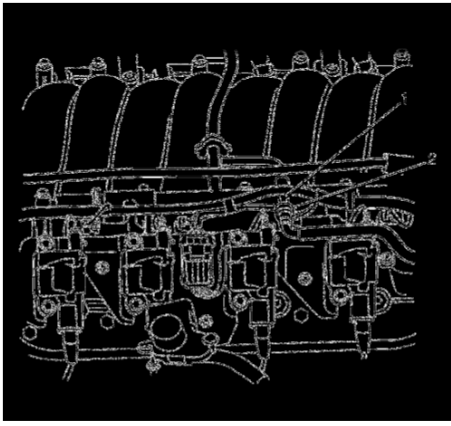
30. Cap or plug the A/C compressor (3) ports.

31. Cap or plug the A/C hoses (1).



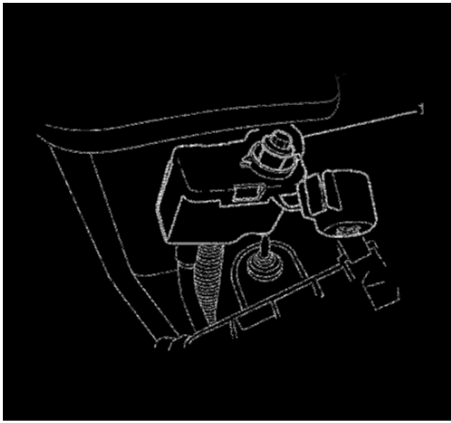
32. Compress the vacuum hose retaining clamp (2) at the intake manifold vacuum port (1) and slide 50 mm (2 in) back along the vacuum hose (3).

33. Disconnect the vacuum hose (3) from the intake manifold vacuum port (1).

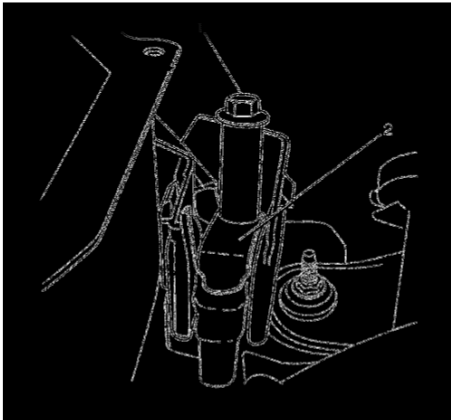


Note: Plug or cap the fuel feed pipe (2) and fuel rail tube (1) ends to prevent fuel leaks and/or contamination.

34. Disconnect the fuel rail feed pipe (2) quick connect fitting. Refer to [Metal Collar Quick Connect Fitting Service](#) or [Plastic Collar Quick Connect Fitting Service](#).

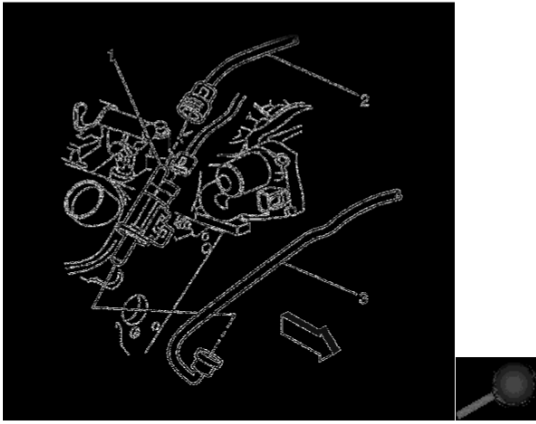


35. Remove the remote positive battery post cover (1) from the remote positive battery post.



36. Remove the remote positive battery post to wiring harness retaining nut (1).

37. Remove the wiring harness (2) from the remote positive battery post.

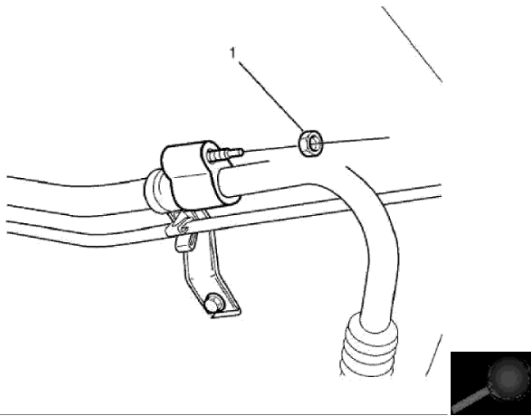


Note: Plug or cap the throttle body to EVAP purge valve hose (3) and EVAP purge valve (1) ends to prevent fuel leaks and/or contamination.

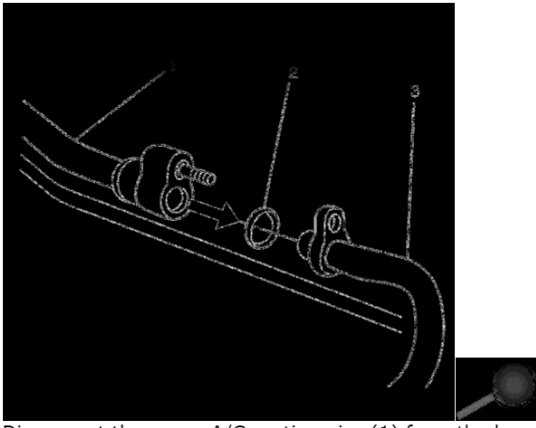
38. Disconnect the throttle body to EVAP purge valve hose (3) from the EVAP purge valve (1).

Note: Plug or cap the EVAP purge valve to fuel tank hose (2) and EVAP purge valve (1) ends to prevent fuel leaks and/or contamination.

39. Disconnect the EVAP purge valve to fuel tank hose (2) from the EVAP purge valve (1).



40. Remove the A/C suction pipe pad to lower A/C suction pipe retaining nut (1).



41. Disconnect the upper A/C suction pipe (1) from the lower A/C suction pipe (3).

Note: Plug or cap the A/C suction pipe ends (1 and 3) immediately to prevent contamination and absorption of moisture from the atmosphere.

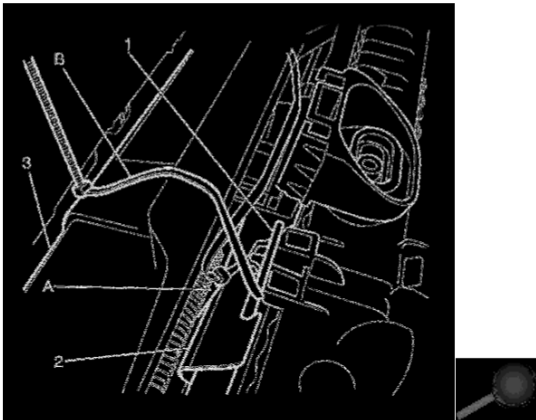
42. Plug or cap the A/C suction pipe ends.

Note: The A/C suction pipe sealing O-ring (2) is a single use component and will not reseal. Install a NEW A/C suction pipe sealing O-ring (2) whenever the upper A/C suction pipe (1) is removed from the lower A/C suction pipe (3).

43. Remove and discard the A/C suction pipe sealing O-ring (2).

Discard the A/C suction pipe sealing O-ring (2).

44. Reposition and retain the A/C suction/discharge pipes away from the engine.



Note: It is necessary to secure the radiator and condenser assembly (2) to the front end assembly (3) as the radiator and condenser assembly is supported to the subframe.

Note: Thread zip tie A around the front end assembly and zip tie B through the radiator and condenser mount (1). Insert zip tie A into the retainer of zip tie B and insert zip tie B into the retainer of zip tie A.

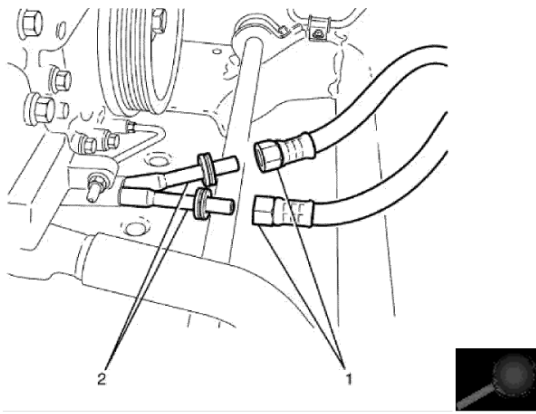
45. Secure radiator and condenser assembly (2) to the front end assembly (3) with large zip ties or equivalent.

Note: Ignore steps 47–49 for vehicles equipped with a manual transmission.

Note: The flexible hoses are not serviced separately. Therefore if the hose's require replacement, then the hose and radiator to hose cooler hose assembly must be fitted.

Note: When removal is complete plug hose openings with a clean lint free cloth to prevent foreign matter entry.

46. Place a suitable container beneath the radiator and engine.



47. Using the J 41623-B cooler quick connect tool, disconnect the automatic transmission cooler pipe (2) from the flexible hose (1).

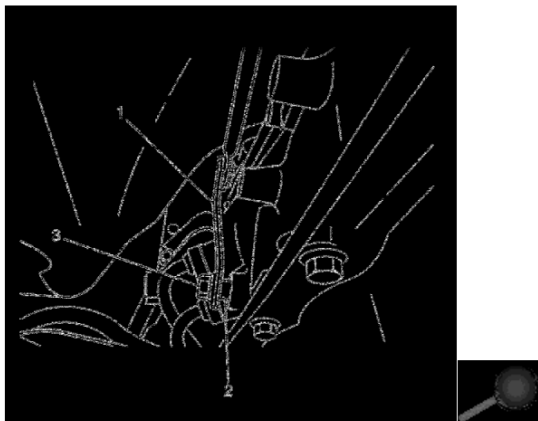
- Open the J 41623-B cooler quick connect tool, then close and clip around the hose to be disconnected.
- While holding the flexible hose (1) push the hose inwards with one hand, then pull back to separate from the steel hose piping (2).
- Repeat for the second fitting if required.

48. Reposition and secure the flexible hoses (1) away from the engine and subframe.

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

Warning: Refer to [Safety Glasses Warning](#).

49. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
50. Remove the underbody front air deflector. Refer to [Underbody Front Air Deflector Replacement](#).
51. Remove the oil pan shield. Refer to [Oil Pan Shield Replacement](#).
52. Disconnect and reposition the electrical connections away from the power steering rack.
53. Remove the exhaust system. Refer to [Exhaust System Replacement](#).
54. Remove the center heat shield. Refer to [Exhaust Heat Shield Replacement - Center](#).
55. Remove the propeller shaft. Refer to [Propeller Shaft Replacement](#).
56. Remove the starter. Refer to [Starter Replacement](#).



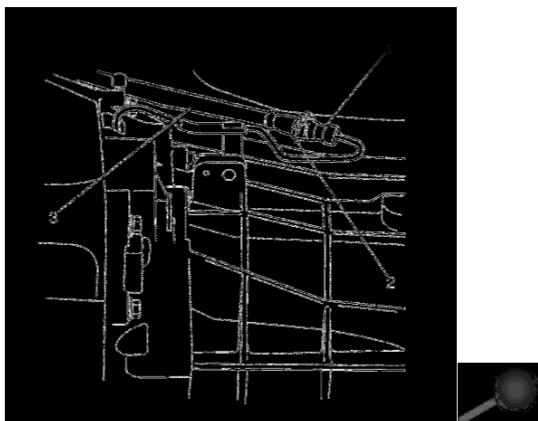
Note: Ignore steps 60 to 61 for vehicles fitted with an manual transmission.

57. Remove the shift selector linkage rod to shift selector shaft retaining nut (3).

58. Remove the shift selector linkage rod (1) from the shift selector shaft (2).

Note: Ignore steps 62 to 64 for vehicles fitted with an automatic transmission.

59. Remove the shift control assembly. Refer to [Shift Control Assembly Replacement](#).

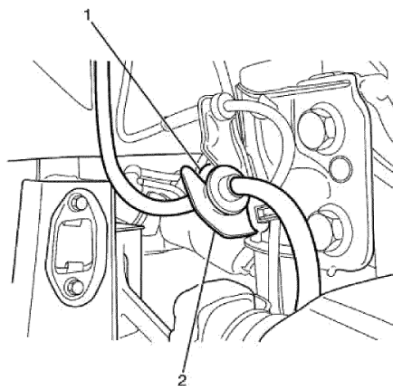


Note: Use a suitable tool to remove the flexible hose securing clip (2), take care not to lose the flexible hose securing clip (2) on removal.

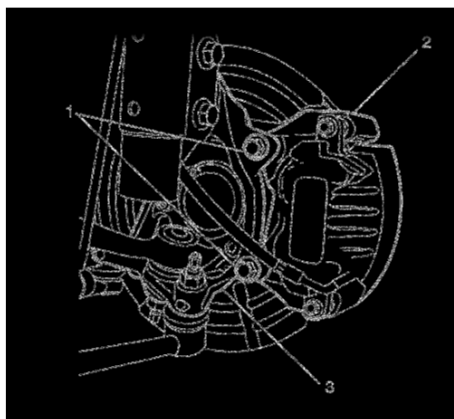
60. Remove the flexible hose securing clip (2).

61. Disconnect the to concentric actuator cylinder feed hose (3) from the concentric actuator cylinder feed pipe (1).

62. Remove the front wheels. Refer to [Tire and Wheel Removal and Installation](#).



63. Detach the front brake hose (1) from the front strut mounted brake hose retaining bracket (2). Repeat for opposite side.

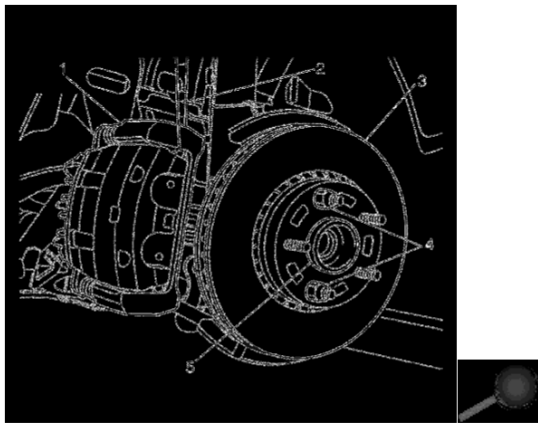


Note: Nuts with micro-encapsulated thread sealant must be discarded after removal.

64. Remove the front brake caliper anchor plate to knuckle retaining bolts (1). Repeat for opposite side.
Discard the bolts.

Note: DO NOT disconnect the hydraulic brake flexible hose from the brake caliper otherwise complete bleeding of the braking system will be necessary.

65. Remove the front brake caliper (2) from the front steering knuckle (3). Repeat for opposite side.

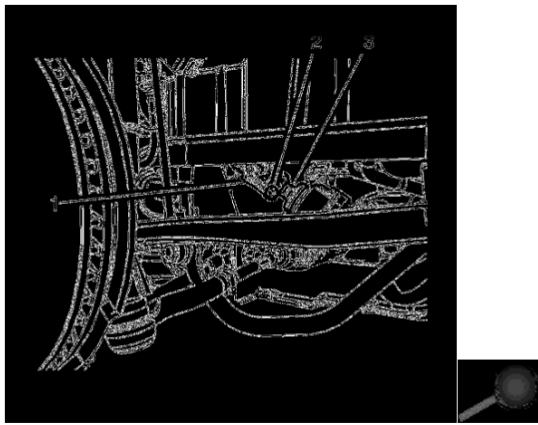


Caution: Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak.

66. Support the front brake caliper (1) with heavy mechanic's wire, or equivalent (2). Repeat for opposite side.
67. Remove the two wheel nuts (4) retaining the front brake disc (3) to the hub (5). Repeat for opposite side.



68. Disconnect the front wheel speed sensor jumper harness electrical connector (1) and secure away from the front subframe and suspension components. Repeat for opposite side.



Note: Observing the orientation of the intermediate steering shaft (1) with reference to the pinion shaft (3) will minimize the potential of incorrect steering column assembly alignment.

69. Mark the intermediate steering shaft (1) in relation to the pinion shaft (3).

70. Remove the intermediate steering shaft to pinion shaft retaining bolt (2).

Note: Bolts with micro-encapsulated thread sealant must be discarded after removal.

71. Disconnect the intermediate shaft (2) from the pinion shaft (3).

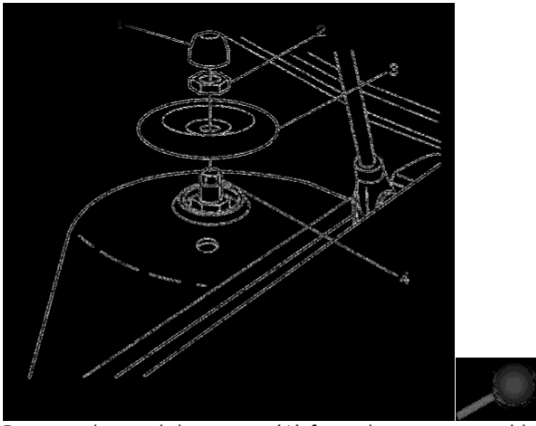
Discard the bolt.

72. Lower the vehicle.



Note: The strut assembly (1) must be secured to the subframe (3) to prevent damage to the front wheelhouse liner, fenders and suspension components.

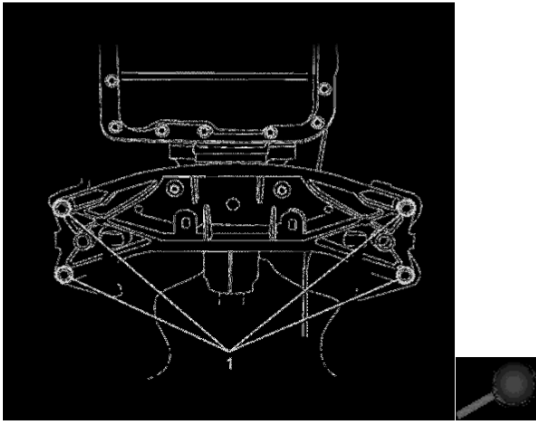
73. Retain the front strut assembly (1) to the front subframe (3) using heavy mechanics wire or equivalent (2). Repeat for opposite side.



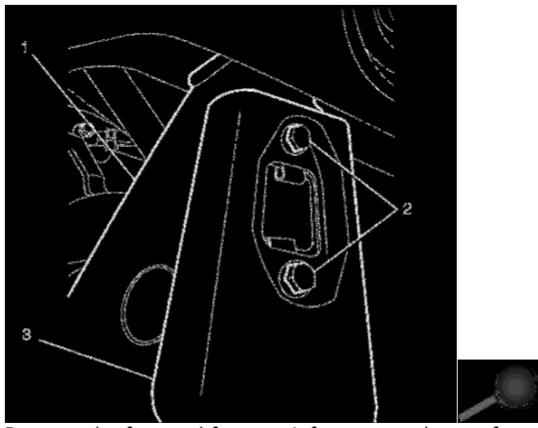
74. Remove the stud dust cover (1) from the strut assembly to front wheelhouse retaining nut (2). Repeat for opposite side.

Note: The strut assembly (4) must be supported from underneath before the strut assembly to body retaining nut (2) is removed.

75. Remove the strut assembly to front wheelhouse retaining nut (2) while holding the strut piston shaft (4). Repeat for opposite side.
Discard the nut.
76. Remove the strut assembly to front wheelhouse retaining plate (3). Repeat for opposite side.
77. Position a suitable powertrain and/or engine lift table below the frame, engine and transmission.
78. Raise the lift table and/or lower the vehicle to support the frame, engine and transmission.

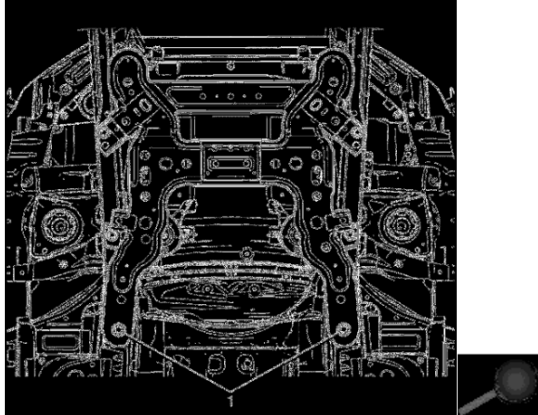


79. Remove the transmission support to body retaining bolts (1).

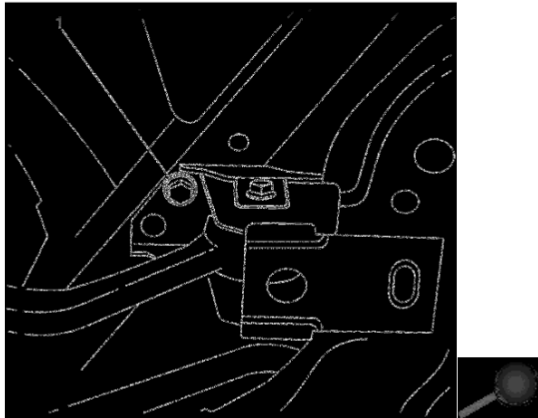


80. Remove the front subframe reinforcement plate to front subframe retaining bolts (2).

81. Remove the front subframe reinforcement plate (3) from the front subframe (1).

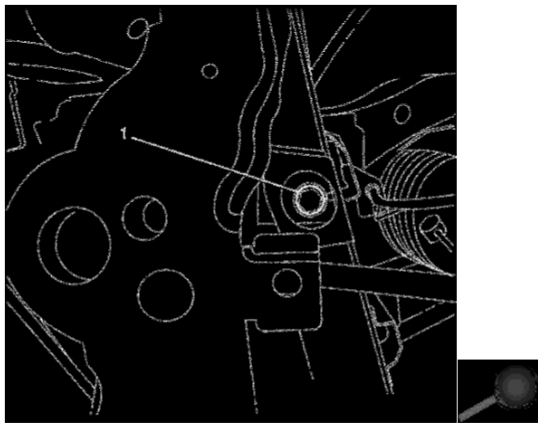


82. Remove the front subframe to body rear retaining bolts (1).



Note: Only right side depicted in graphic, left side similar.

83. Remove the front subframe to body front retaining bolt (1). Repeat for opposite side.

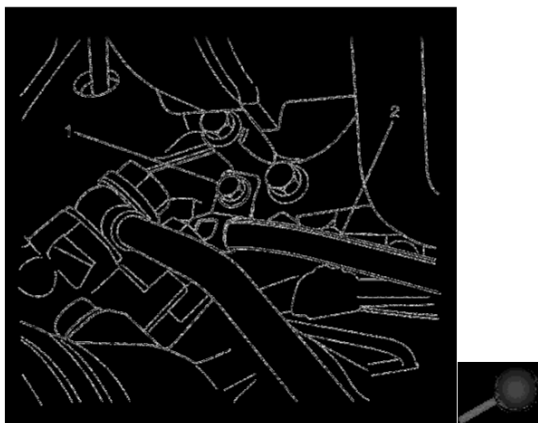


Note: Only right side depicted in graphic, left side similar.

84. Remove the front subframe to body retaining bolt (1). Repeat for opposite side.

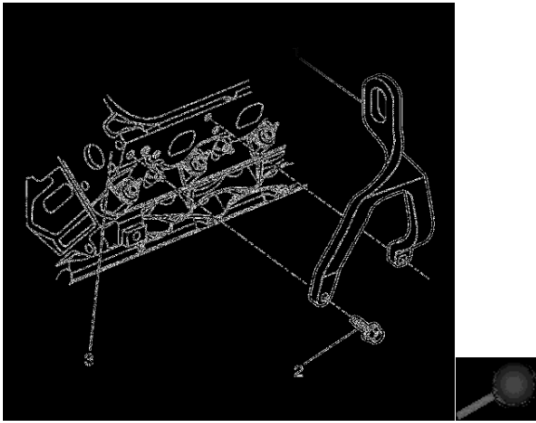
Note: Make sure that all the hoses, wires, pipes and front struts clear the vehicle during the removal process.

85. With the aid of an assistant, lower the table and/or raise the vehicle to remove the engine, transmission, front suspension and subframe assembly from the vehicle.
86. Remove the engine and transmission wiring harness and related components. Refer to [Engine Wiring Harness Assembly Removal](#).

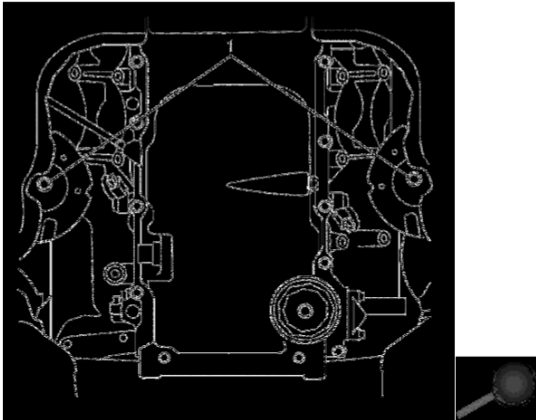


87. Remove the automatic transmission cooler pipe clamp to A/C bracket bolt (1) and position the automatic transmission cooler pipes (2) aside.
88. Connect a suitable lifting crane to the engine lift brackets and raise the suitable lifting crane to support the engine.
89. Position a second powertrain lift table below the transmission.
90. Remove the transmission. Refer to one of the following procedures:
- [Transmission Replacement](#) for the 6L50/6L80/6L90 transmissions
 - [Transmission Replacement](#) for the Tremec 6-Speed transmission
91. Remove the automatic transmission flex plate or engine flywheel. Refer to one of the following procedures:
- [Automatic Transmission Flex Plate Removal](#)
 - [Engine Flywheel Removal](#)

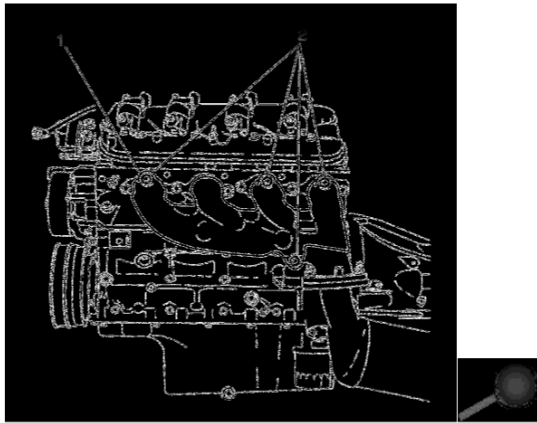
92. Remove the accessory drive belt. Refer to [Drive Belt Replacement - Accessory](#).
93. Remove the A/C drive belt. Refer to [Air Conditioning Compressor Belt Replacement](#).



94. Position the J 41798 engine lift bracket (1) on the cylinder head (3).
- Caution:** Refer to [Fastener Caution](#).
95. Install the J 41798 engine lift bracket to cylinder head retaining bolts (2).
Tighten
Tighten the bolts to 50 N•m (36 lb ft).
96. Attach a suitable lifting chain and hooks to the engine lifting brackets (1).



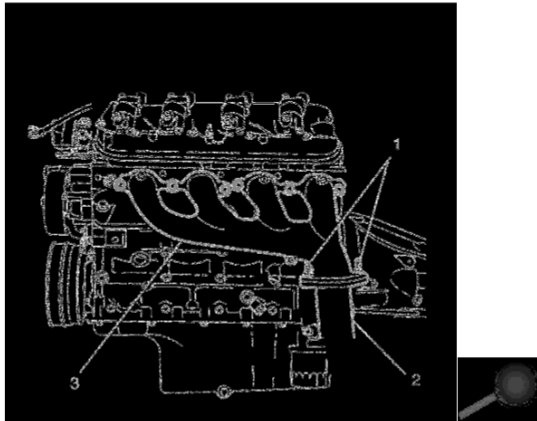
97. Remove the lower engine mount to front subframe retaining nut (1) from both engine mounts.
98. Using a suitable lifting crane, raise the engine to clear the engine mount stud.
99. Remove the engine from the subframe.
If required mount the engine on a suitable engine stand.
100. Remove the left side spark plug leads. Refer to [Spark Plug Wire Replacement](#).
101. Remove the left side spark plugs from the cylinder head. Refer to [Spark Plug Replacement](#).



Warning: Refer to [Exhaust Service Warning](#).

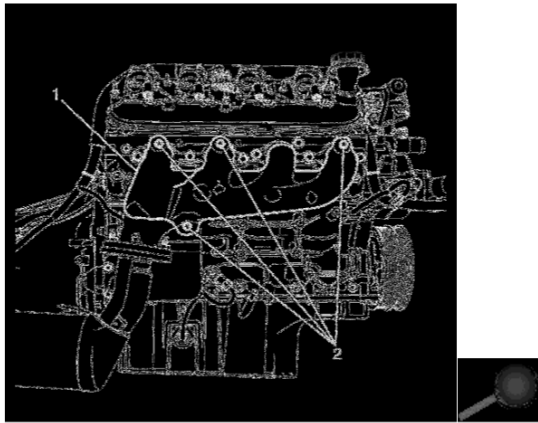
Warning: Refer to [Protective Goggles and Glove Warning](#).

102. Remove the left side exhaust manifold heat shield to left side exhaust manifold retaining bolts (2).
103. Remove the left side exhaust manifold heat shield (1).



Note: The left side catalytic converter to exhaust manifold retaining nuts (1) are single use parts. They must be discarded after removal.

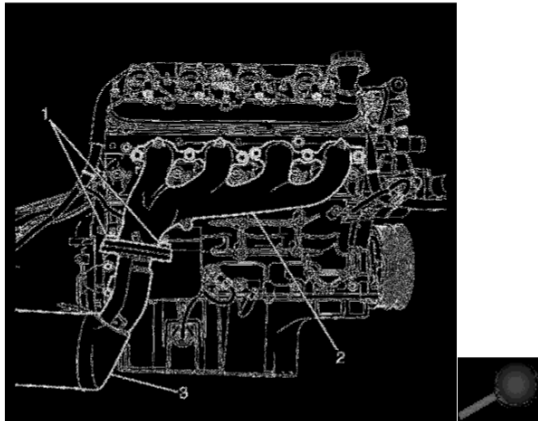
104. Remove the left side catalytic converter to exhaust manifold retaining nuts (1).
Discard the nuts.
105. Disconnect the left side catalytic converter (2) from the exhaust manifold (3).
Discard the gasket.
106. Remove the right side spark plug leads. Refer to [Spark Plug Wire Replacement](#).
107. Remove the right side spark plugs from the cylinder head. Refer to [Spark Plug Replacement](#).



Warning: Refer to [Exhaust Service Warning](#).

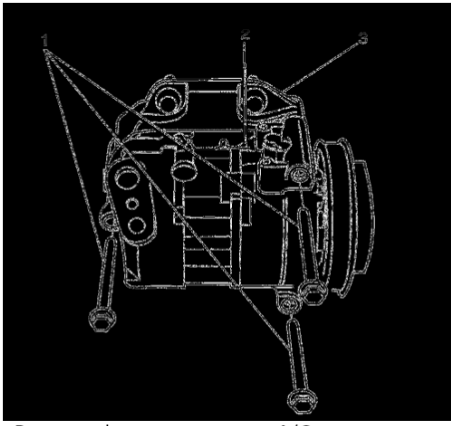
Warning: Refer to [Protective Goggles and Glove Warning](#).

108. Remove the right side exhaust manifold heat shield to right side exhaust manifold retaining bolts (2).
109. Remove the right side exhaust manifold heat shield (1).



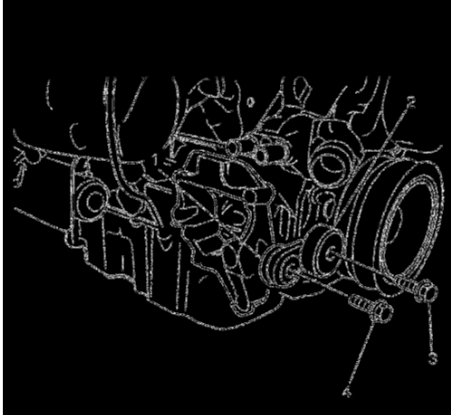
Note: The right side catalytic converter to exhaust manifold retaining nuts (1) are single use parts. They must be discarded after removal.

110. Remove the right side catalytic converter to exhaust manifold retaining nuts (1).
Discard the nuts.
111. Disconnect the right side catalytic converter (3) from the exhaust manifold (2).
Discard the gasket.



112. Remove the compressor to A/C compressor mounting bracket retaining bolts (1).

113. Remove the compressor (2) to the A/C compressor bracket (3).

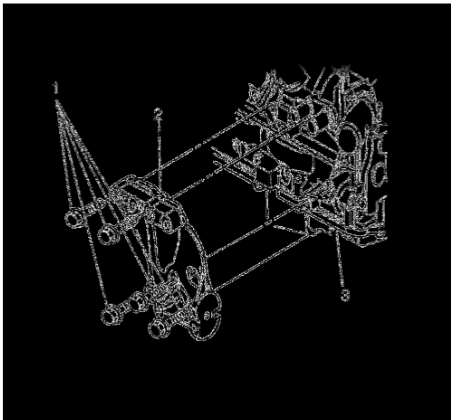


114. Remove the A/C tensioner pulley to A/C tensioner retaining bolt (3).

115. Remove the A/C tensioner pulley (2).

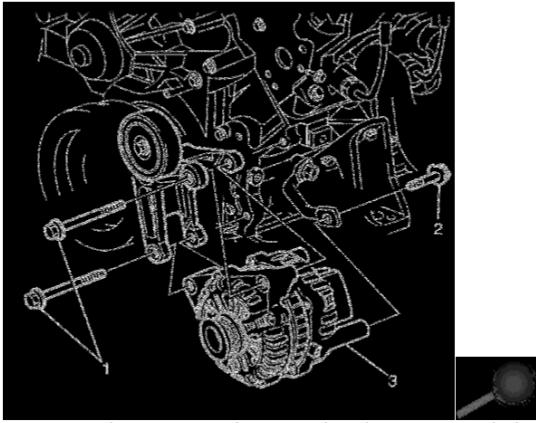
116. Remove the A/C drive belt tensioner to A/C compressor bracket retaining bolt (4).

117. Remove the A/C drive belt tensioner (1).



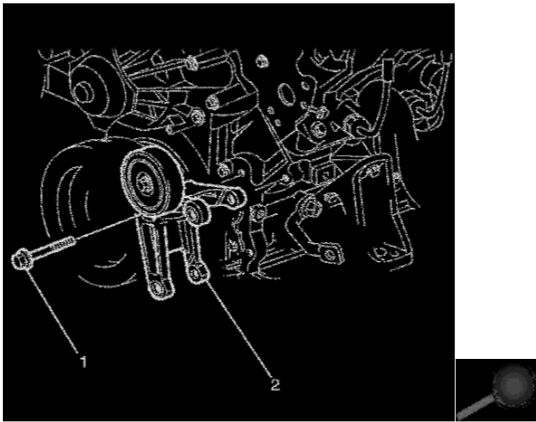
118. Remove the A/C compressor bracket to cylinder head retaining bolts (1).

119. Remove the A/C compressor bracket (2).



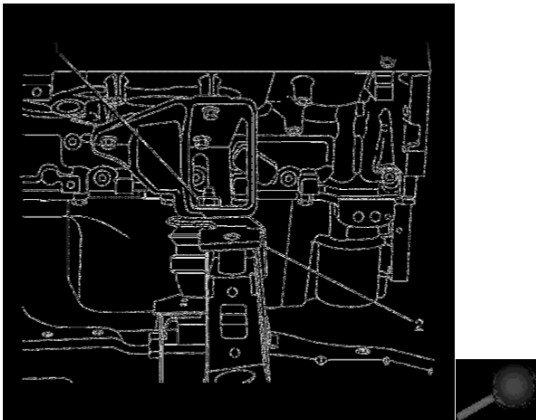
120. Remove alternator to alternator bracket retaining bolts (1 and 2).

121. Remove the alternator (3) from the alternator bracket.



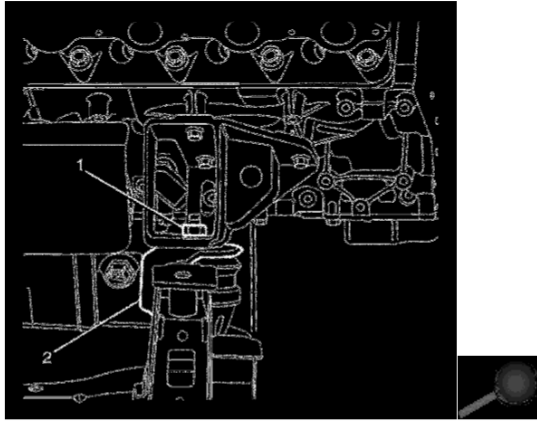
122. Remove the alternator bracket to engine block retaining bolt (1).

123. Remove the alternator bracket (2) from the engine.



Note: DO NOT bend or distort the left side engine mount heat shield (2).

124. Remove the left side engine mount to engine mount bracket retaining nut (1).



Note: DO NOT bend or distort the right side engine mount heat shield (2).

125. Remove the right side engine mount to engine mount bracket retaining nut (1).
126. Attach a suitable lifting chain and hooks to the 2 J 41798 engine lift brackets.
127. Using a suitable lifting crane, remove the engine from the subframe.
If required, mount engine to a suitable engine stand.
128. Remove the lifting equipment as required.

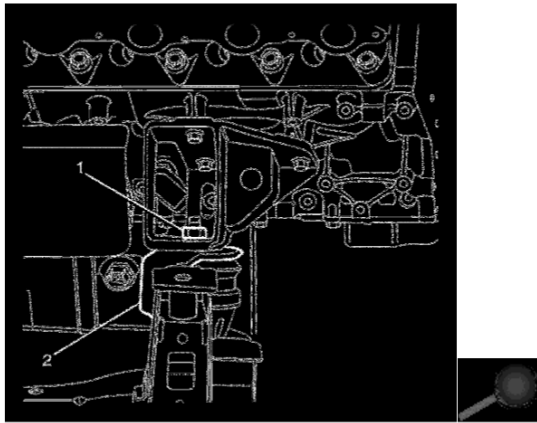
Installation Procedure



Caution: Refer to [Fastener Caution](#).

Note: DO NOT bend or distort the left side engine mount heat shield.

1. Install the left side engine mount to engine mount bracket retaining nut (1)
Tighten
Tighten the nut to 80 N•m (59 lb ft).



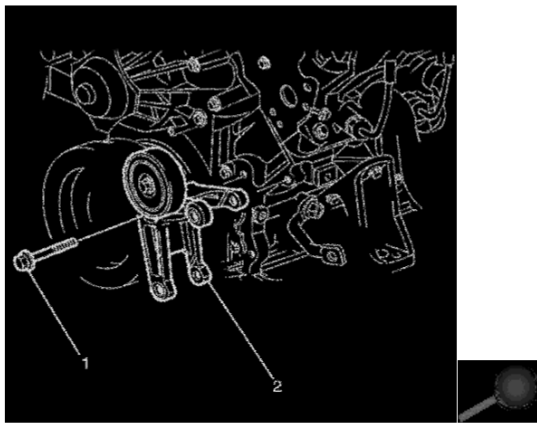
Note: DO NOT bend or distort the right side engine mount heat shield.

2. Install the right side engine mount to engine mount bracket retaining nut (1).

Tighten

Tighten the nut to 80 N·m (59 lb ft).

3. Remove the lifting equipment as required and the J 41798 engine lift bracket from the cylinder heads.

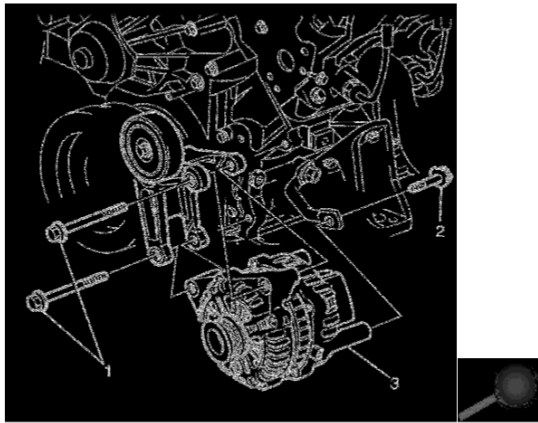


4. Install the alternator bracket (2) to the engine.

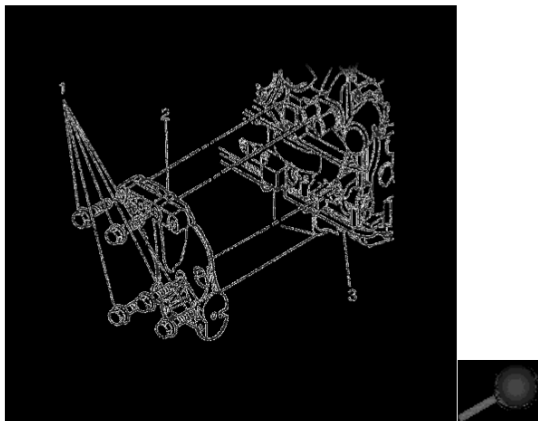
5. Install the alternator bracket to engine block retaining bolt (1).

Tighten

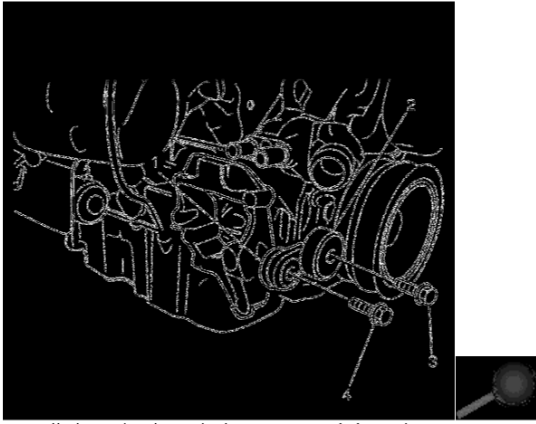
Tighten the bolt to 58 N·m (43 lb ft).



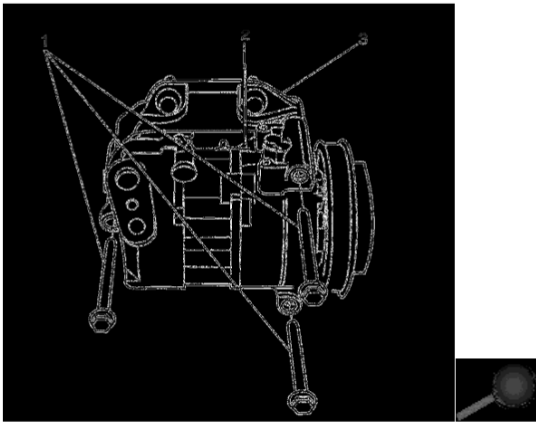
6. Install the alternator (3) to the alternator bracket.
7. Install alternator to alternator bracket retaining bolts (1 and 2).
Tighten
Tighten the bolts to 58 N•m (43 lb ft).



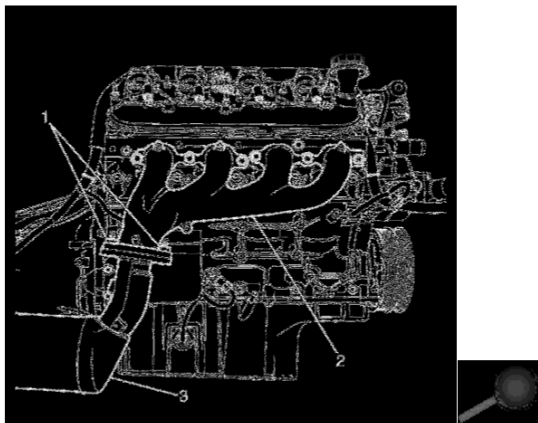
8. Install the A/C compressor bracket (2) to the engine.
9. Install the A/C compressor bracket to the cylinder block retaining bolts (1).
Tighten
Tighten the bolts to 58 N•m (43 lb ft).



10. Install the A/C drive belt tensioner (1) to the engine.
11. Install the A/C drive belt tensioner to A/C compressor bracket retaining bolt (4).
Tighten
Tighten the bolt to 22 N·m (16 lb ft).
12. Install the A/C tensioner pulley (2) to the A/C tensioner.
13. Install the A/C tensioner pulley to A/C tensioner retaining bolt (3).
Tighten
Tighten the bolt to 50 N·m (37 lb ft).
14. If you are replacing the compressor, balance the compressor oil. Refer to [Air Conditioning Compressor Oil Balancing](#).



15. Install the A/C compressor (2) to the A/C compressor bracket (3).
16. Install the A/C compressor to A/C compressor bracket retaining bolts (1).
Tighten
Tighten the bolts to 22 N·m (16 lb ft).

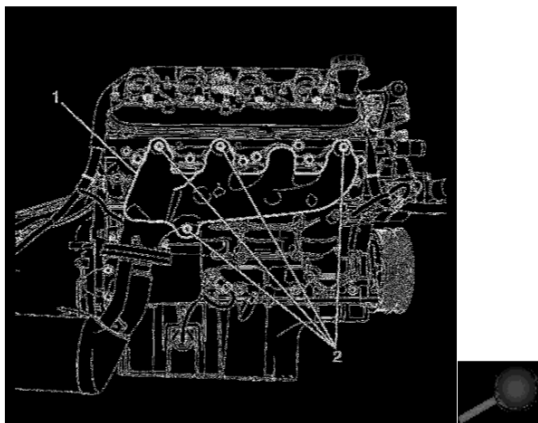


Note: Make sure that a new sealing ring is fitted prior to installation. If not the exhaust system may perform poorly.

17. Install a NEW sealing ring to the right side catalytic converter.
18. Connect the right side catalytic converter (3) to the right side exhaust manifold (2).
19. Install the right side catalytic converter to right side exhaust manifold retaining nuts (1).

Tighten

Tighten the nuts to 45N•m (33 lb ft).

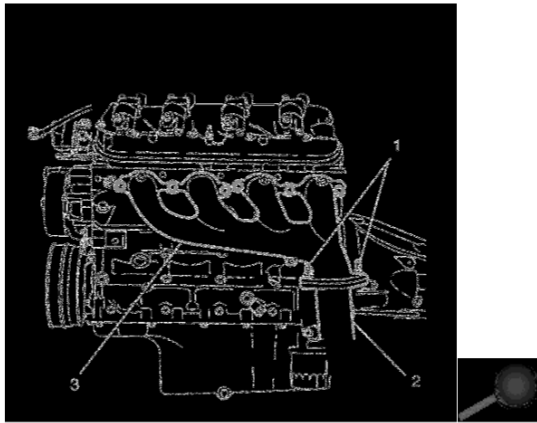


20. Install the right side exhaust manifold heat shield (1) to the right side exhaust manifold.
21. Install the right side exhaust manifold heat shield to right side exhaust manifold retaining bolts (2).

Tighten

Tighten the bolts to 10N•m (89 lb in).

22. Install the right side spark plugs to the cylinder head. Refer to [Spark Plug Replacement](#).
23. Install the right side spark plug leads. Refer to [Spark Plug Wire Replacement](#)

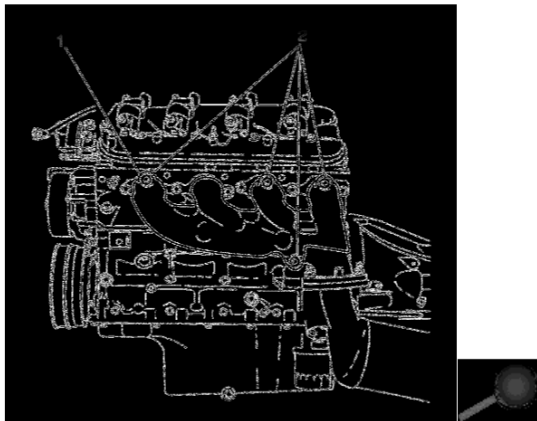


Note: Make sure that a new sealing ring is fitted prior to installation. If not the exhaust system may perform poorly.

24. Install a NEW sealing ring to the left side catalytic converter.
25. Connect the left side catalytic converter (2) to the left side exhaust manifold (3).
26. Install the left side catalytic converter to left side exhaust manifold retaining nuts (1).

Tighten

Tighten the nuts to 45N•m (33 lb ft).

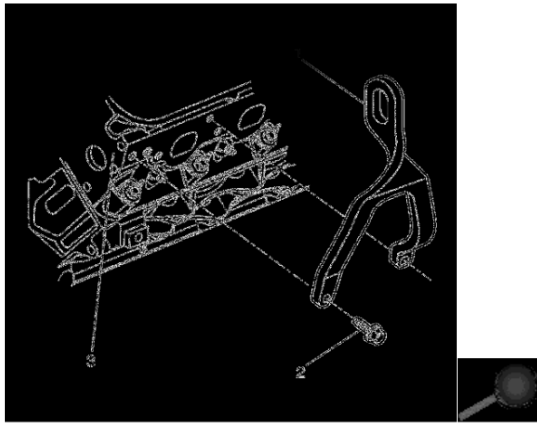


27. Install the left side exhaust manifold heat shield (1) to the left side exhaust manifold.
28. Install the left side exhaust manifold heat shield to left side exhaust manifold retaining bolts (2).

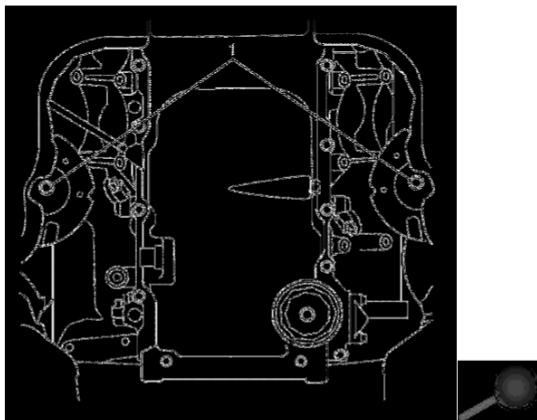
Tighten

Tighten the bolts to 10N•m (89 lb in).

29. Install the left side spark plugs to the cylinder head. Refer to [Spark Plug Replacement](#).
30. Install the left side spark plug leads. Refer to [Spark Plug Wire Replacement](#).



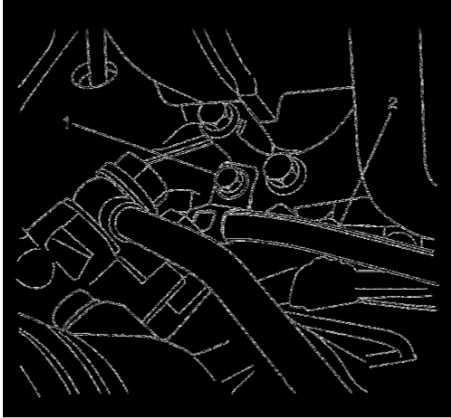
31. Position the J 41798 engine lift bracket (1) on the cylinder heads (3).
32. Install the J 41798 engine lift bracket to cylinder head retaining bolts (2).
Tighten
 Tighten the bolts to 50 N·m (36 lb ft).
33. Using a suitable lifting crane and the J 41798 engine lift bracket raise the engine slightly.
34. Remove the engine from the engine stand.
35. Lower the engine onto the front subframe.
36. Position the engine mounts to the front subframe.



37. Install the lower engine mount to front subframe retaining nuts (1) on both engine mounts.
Tighten
 Tighten the nuts to 80 N·m (59 lb ft).
38. Install the A/C drive belt. Refer to [Air Conditioning Compressor Belt Replacement](#).
39. Install the accessory drive belt. Refer to [Drive Belt Replacement - Accessory](#).
40. Install the automatic transmission flex plate or engine flywheel. Refer to one of the following procedures:
 - [Automatic Transmission Flex Plate Installation](#)
 - [Engine Flywheel Installation](#)
41. Connect a suitable lifting crane to the engine lift brackets and raise the suitable lifting crane to support the engine.

42. Install the transmission. Refer to one of the following procedures:

- [Transmission Replacement](#)
- [Transmission Replacement](#) for the Tremec 6-Speed transmission



43. Position the automatic transmission cooler pipes (2) to the engine.

44. Install the automatic transmission cooler pipe clamp to A/C bracket retaining bolt (1).

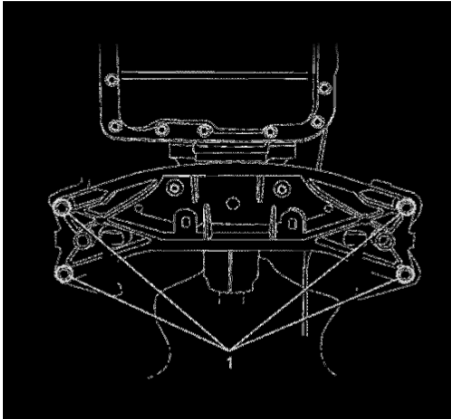
Tighten

Tighten the bolt to 22 N·m (16 lb ft).

45. Install the engine and transmission wiring harness and related components. Refer to [Engine Wiring Harness Assembly Removal](#).

Note: Make sure that all the hoses, wires, pipes and shock modules clear the vehicle during the installation process.

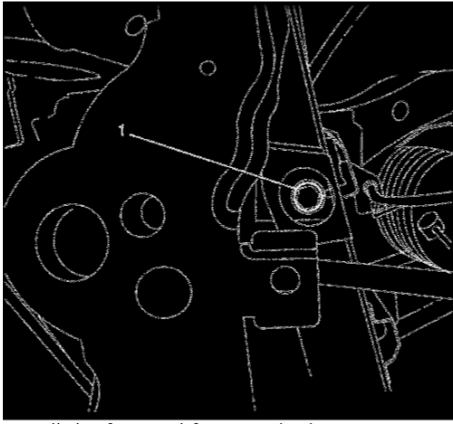
46. With the aid of an assistant, raise the table and/or lower the vehicle to install the engine, transmission, front suspension and subframe assembly to the vehicle.



47. Install the transmission support to body retaining bolts (1).

Tighten

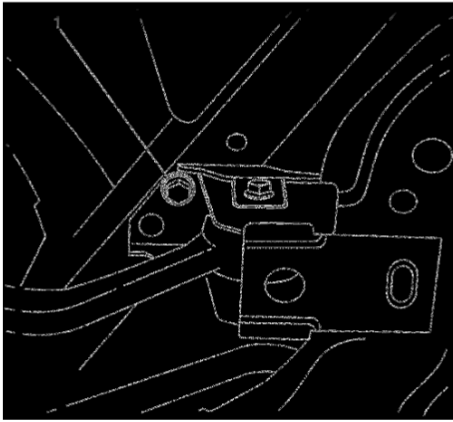
Tighten the bolts to 58 N·m (43 lb ft).



48. Install the front subframe to body center retaining bolt (1). Repeat for opposite side.

Tighten

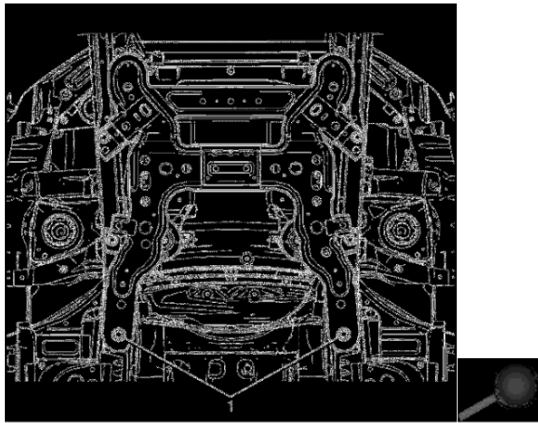
Tighten the bolts to 160 N•m (118 lb ft).



49. Install the front subframe to body front retaining bolt (1). Repeat for opposite side.

Tighten

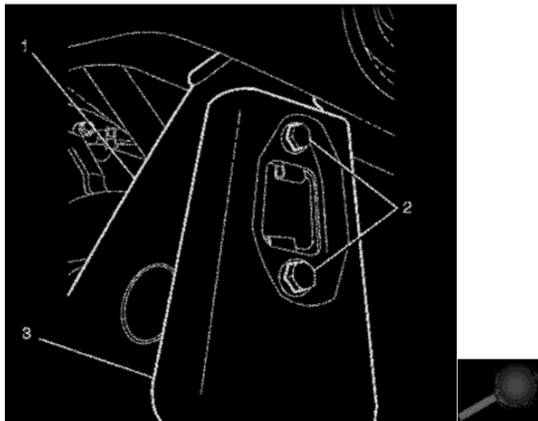
Tighten the bolts to 160 N•m (118 lb ft).



50. Install the front subframe to body rear retaining bolts (1).

Tighten

Tighten the bolts to 240 N•m (178 lb ft).

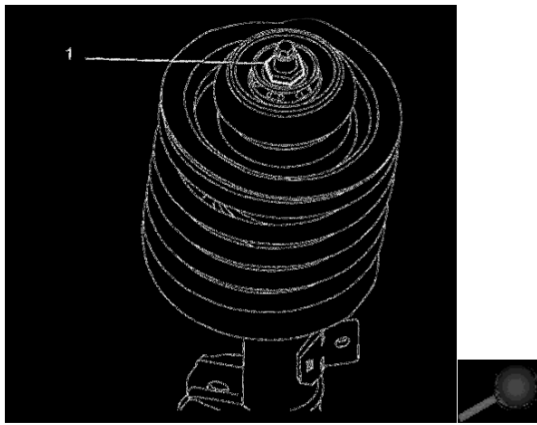


51. Install the front subframe reinforcement plate (3) to the subframe (1).
52. Install the front subframe reinforcement plate to front subframe retaining bolts (2).

Tighten

Tighten the bolts to 17 N•m (13 lb ft).

53. Lower the lift table and/or raise the vehicle to remove the support from the frame, engine and transmission.
54. Remove the powertrain and/or engine lift table from the frame, engine and transmission.
55. Lower the vehicle.

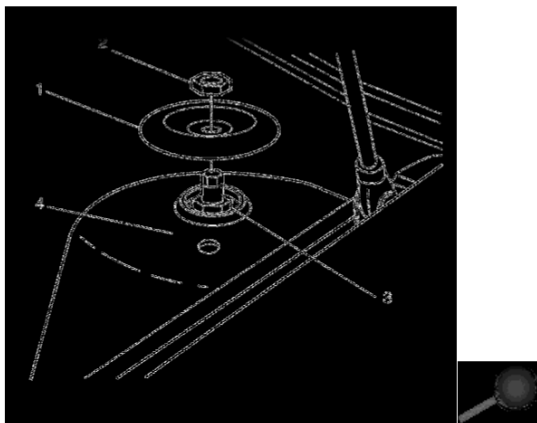


Note: The strut assembly retaining nut (1) must be checked for correct torque before installing the strut assembly into the vehicle. The strut assembly retaining nut torque must be 75 N•m (55 lb ft).

56. Check the torque of the strut assembly retaining nut (1), correct if necessary. Repeat for opposite side.

Tighten

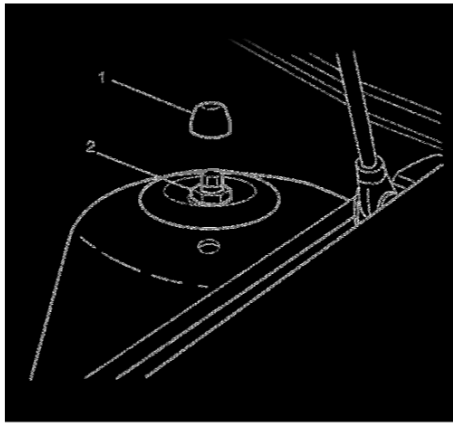
Tighten the nut to 75 N•m (55 lb ft).



57. Install the front strut assembly (3) to the front wheelhouse (4). Repeat for opposite side.
 58. Install front strut assembly to front wheelhouse retaining plate (1). Repeat for opposite side.
 59. Tighten the NEW front strut assembly to front wheelhouse retaining nut (2). Repeat for opposite side.

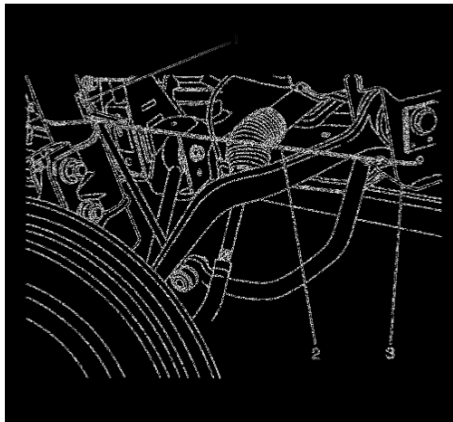
Tighten

Tighten the nut to 55 N•m (41 lb ft).

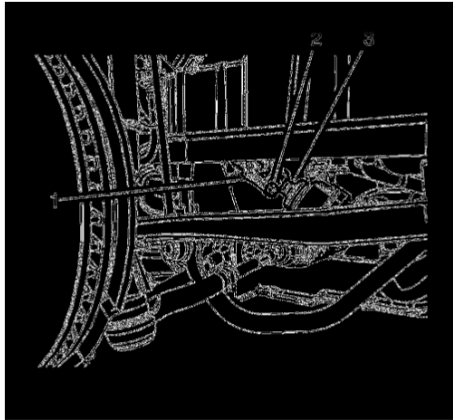


60. Install the dust cover (1) to the front strut assembly to front wheelhouse retaining nut (2).

61. Raise the vehicle.



62. Remove the heavy mechanics wire or equivalent (2) retaining the front strut assembly (1) to the front subframe (3).



Note: The intermediate steering shaft and pinion shaft splines must be installed in the position recorded during removal and aligned with the marks previously made.

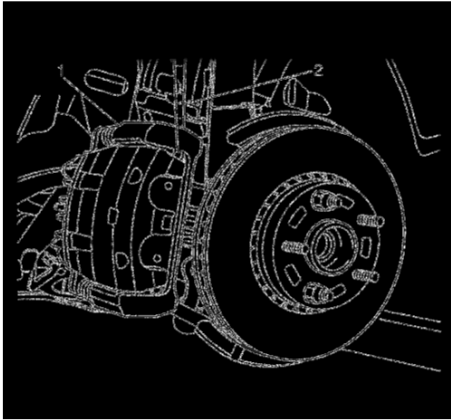
63. Connect the intermediate steering shaft (1) to the pinion shaft (3).
64. Install NEW the intermediate steering shaft to pinion shaft retaining bolt (2).

Tighten

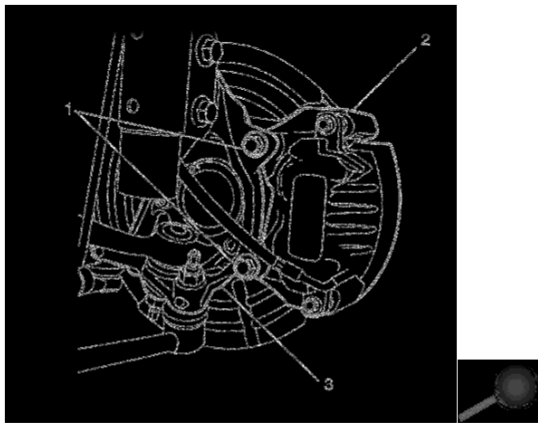
Tighten the bolt to 25 N·m (18 lb ft).



65. Connect the front wheel speed sensor jumper harness electrical connector (1) to the front wheel speed sensor. Repeat for opposite side.



66. Remove the heavy mechanic's wire, or equivalent support (2) from the brake caliper (1). Repeat for opposite side.

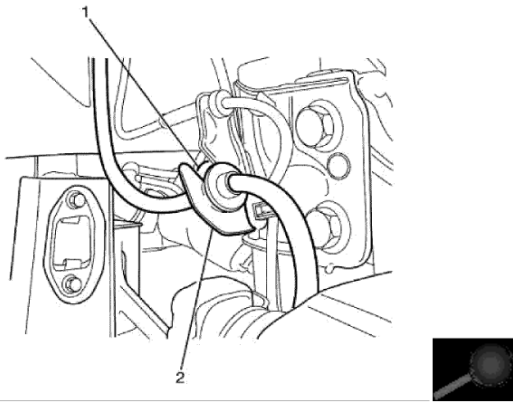


Caution: Make sure the brake hose is not twisted or kinked after installation. Damage to the hose could result.

67. Install the front brake caliper assembly (2) to the front steering knuckle (3). Repeat for opposite side.
68. Install the NEW front brake caliper anchor plate to front steering knuckle retaining bolts (1).

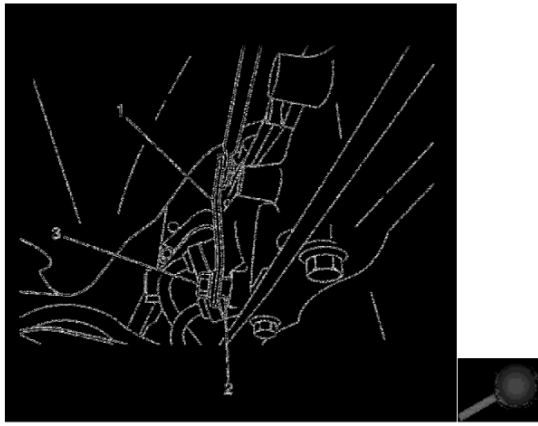
Tighten

Tighten the bolts to 60 N·m +120° (44 lb ft +120°).



Caution: Make sure the brake hose is not twisted or kinked after installation. Damage to the hose could result.

69. Attach the front brake hose (1) to the strut mounted brake hose retaining bracket (2). Repeat for opposite side.
70. Install the front wheels. Refer to [Tire and Wheel Removal and Installation](#).



Note: Ignore steps 76 and 77 for vehicles fitted with an manual transmission.

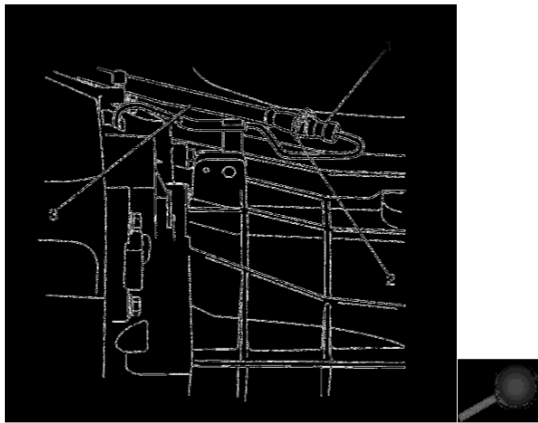
71. Install the shift selector linkage rod (1) to the shift selector shaft (2).
72. Install the shift selector linkage rod to shift selector shaft retaining nut (3).

Tighten

Tighten the nut to 23N·m (17 lb ft).

Note: Ignore steps 78 through to 80 for vehicles fitted with an automatic transmission .

73. Install the shift control assembly. [Shift Control Assembly Replacement](#).

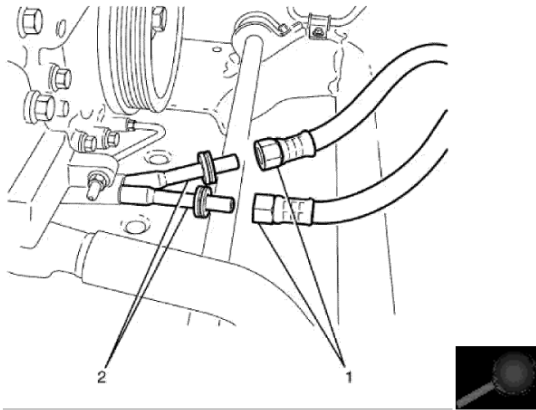


74. Connect the to concentric actuator cylinder feed hose (3) to the concentric actuator cylinder feed pipe (1).

Note: Listen for an audible click to confirm fitting.

75. Install the flexible hose securing clip (2).
76. Install the starter motor. Refer to [Starter Replacement](#).
77. Install the propeller shaft. Refer to [Propeller Shaft Replacement](#).
78. Install the center exhaust heat shield. Refer to [Exhaust Heat Shield Replacement - Center](#).
79. Install the exhaust system. Refer to [Exhaust System Replacement](#).
80. Connect the power steering system electrical connections.
81. Install the oil pan shield. Refer to [Oil Pan Shield Replacement](#).
82. Install the underbody front air deflector. Refer to [Underbody Front Air Deflector Replacement](#).

83. Lower the vehicle.



Note: Ignore steps 94 through to 97 for vehicles equipped with a manual transmission.

84. Remove the clean lint free cloth at the automatic transmission cooler pipes (2) and the flexible hoses (1).

Note: The flexible hoses are not serviced separately. Therefore if the hose's require replacement, then the hose and radiator to hose cooler hose assembly must be fitted.

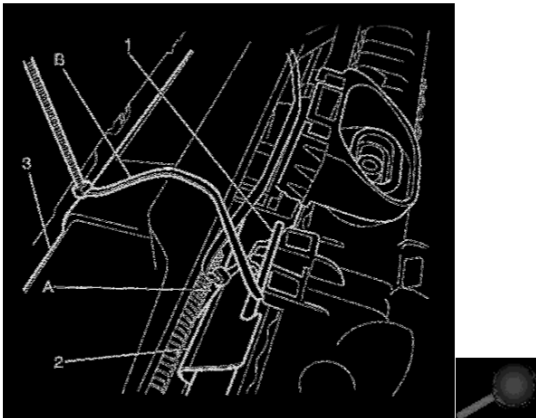
85. Align both flexible hose's with both steel cooler lines.

Note: Listen for an audible click to confirm fitting.

86. Hold the cooler line (2) and connect the flexible hose (1) by pushing together. Repeat procedure for other hose.

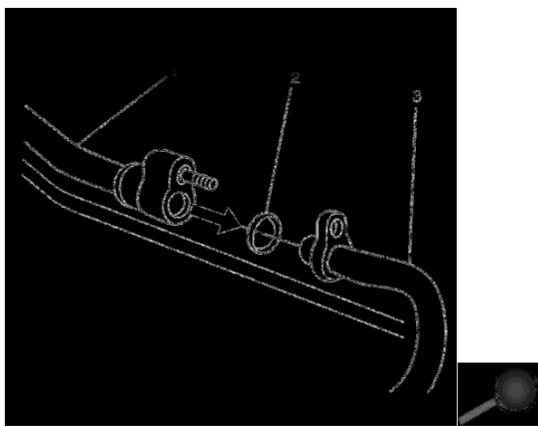
Note: When adding or changing transmission fluid use only recommend automatic transmission fluid.

87. Check and top up transmission fluid level if required. Refer to [Transmission Fluid Level Inspection](#) for the Aisin AY6 transmission or [Transmission Fluid Level Inspection](#) for the Tremec 6-Speed transmission.



Note: Cut zip tie A and zip tie B and remove from around the front end assembly (3) and the radiator and condenser mount (1).

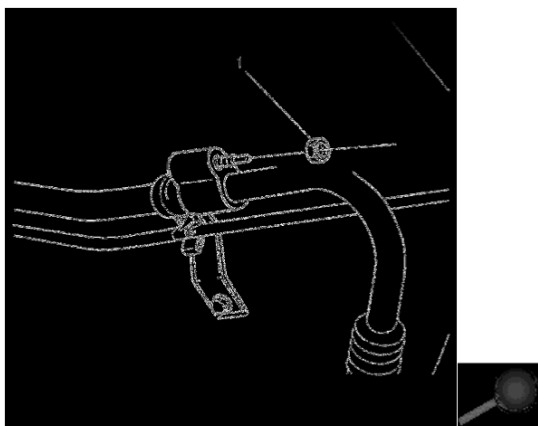
88. Remove the large zip ties or equivalent securing the radiator and condenser assembly (2) to the front end assembly (3).



89. Remove the plug or cap at the A/C suction pipe ends (1 and 3)

Note: The A/C sealing O-rings must be fitted dry. DO NOT lubricate the A/C sealing O-rings.

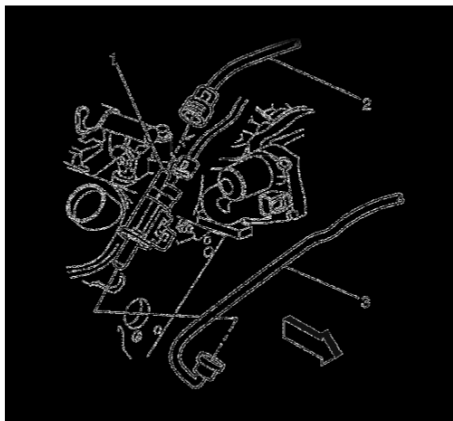
90. Fit the NEW A/C suction pipe sealing O-ring (2) to the suction pipe.
91. Install the upper A/C suction pipe (1) to the lower A/C suction pipe (3).



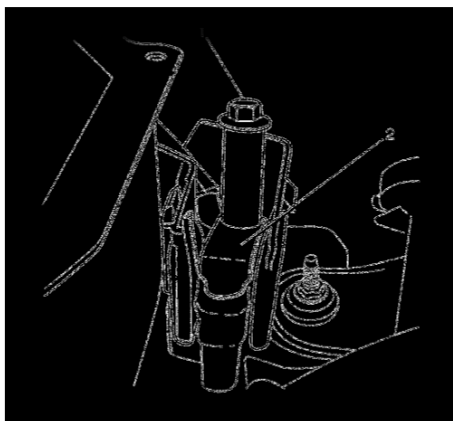
92. Install the A/C suction pipe pad to A/C suction pipe retaining nut (1).

Tighten

Tighten the nut to 22N•m (16 lb ft).



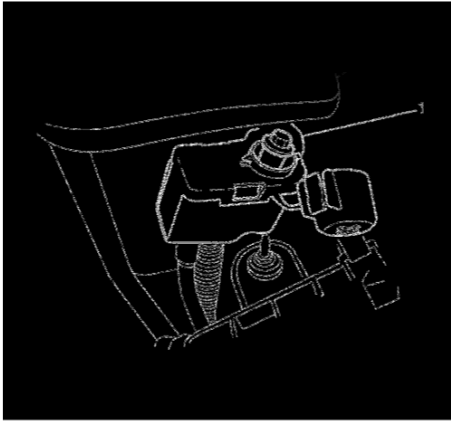
93. Remove the plug from the throttle body to EVAP purge valve tube (3) and EVAP purge valve (1) ends.
94. Connect the throttle body to EVAP purge valve tube (3) to the EVAP purge valve (1).
95. Remove the plug from the EVAP purge valve to fuel tank tube (2) and EVAP purge valve (1) ends.
96. Connect the EVAP purge valve to fuel tank tube (2) to the EVAP purge valve (1).



97. Install the wiring harness (2) to the remote positive battery post.
98. Install the remote positive battery post to wiring harness retaining bolt (1).

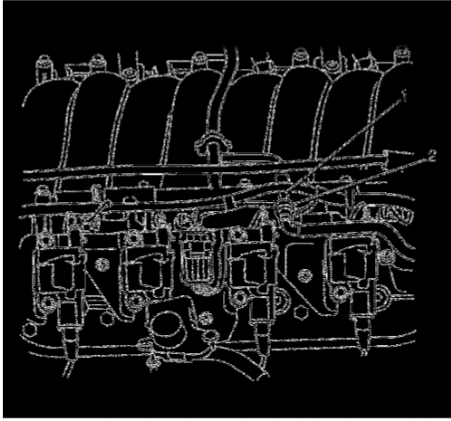
Tighten

Tighten the bolt to 15 N·m (11 lb ft).



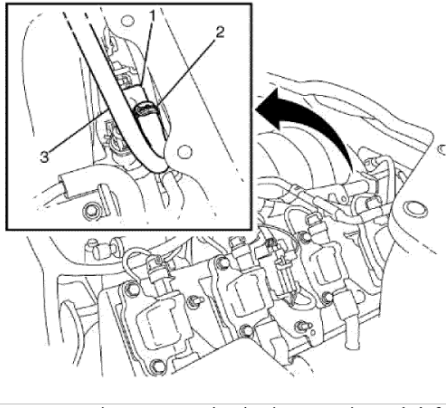
Note: Make sure the clips on the remote positive battery post cover (1) are engaged to avoid an induced rattle condition.

99. Install the remote positive battery post cover (1).

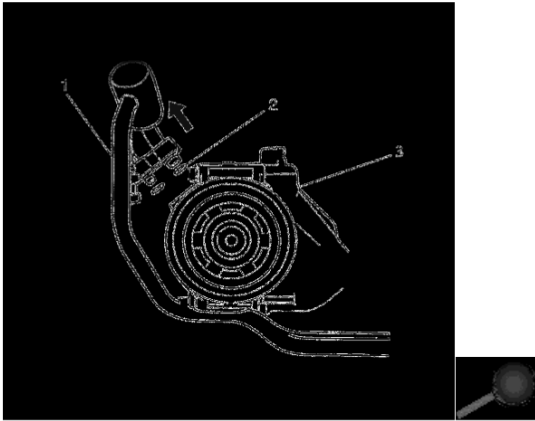


100. Remove the plug from the fuel feed pipe (2) and fuel rail pipe (1) ends.

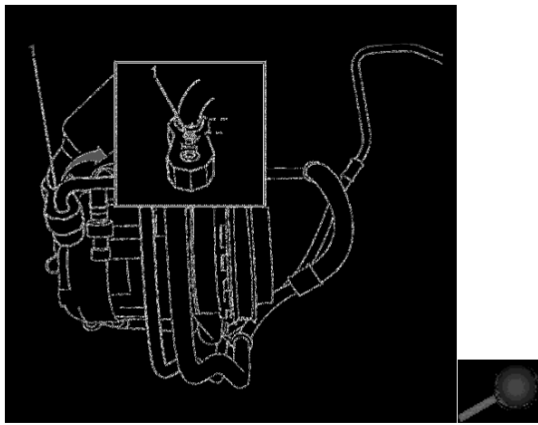
101. Connect the fuel rail feed pipe (2) quick connect fitting. Refer to [Metal Collar Quick Connect Fitting Service](#) or [Plastic Collar Quick Connect Fitting Service](#).



102. Connect the vacuum brake booster hose (3) from the intake manifold vacuum port (1).
103. Compress the vacuum brake booster hose retaining clamp (2) and return to its original position on the vacuum brake booster hose (3).



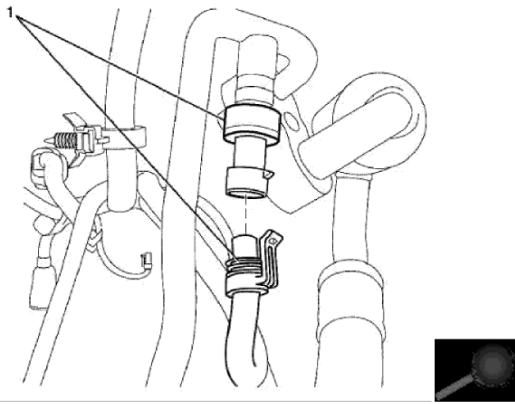
104. Remove the plug from the compressor (3) ports.
105. Remove the plug from the pipes (1).
- Note:** The A/C sealing O-rings must be fitted dry. DO NOT lubricate the A/C sealing O-rings.
106. Fit the NEW A/C suction/discharge pipe O-rings (2) to the suction/discharge pipes (1).
107. Connect the A/C suction/discharge line pad (1) to the A/C compressor (3).



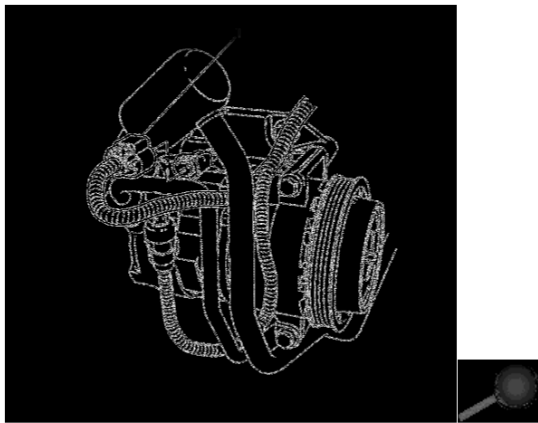
108. Install the suction/discharge line pad (1) to compressor and tighten the retaining bolt (1) to the correct torque specification.

Tighten

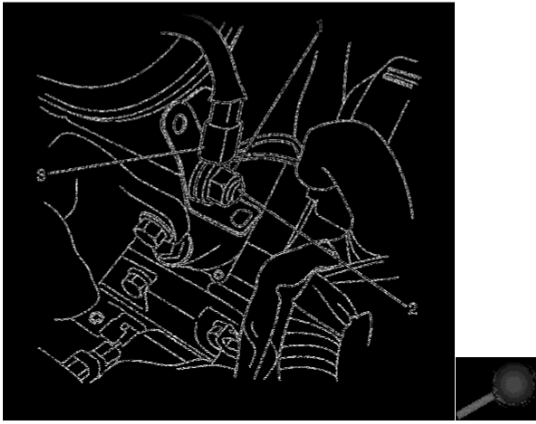
Tighten the bolt to 22 N·m (16 lb ft).



109. Connect the electrical connector to the A/C Refrigerant Pressure Sensor (1) to the A/C refrigerant sensor.



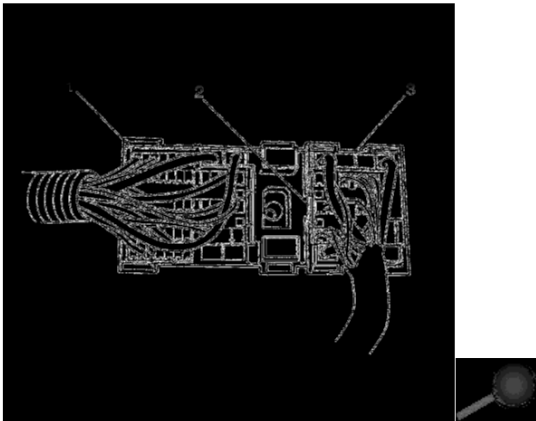
110. Connect the A/C electrical connector (1) to the A/C compressor.



111. Install the vehicle body ground cable (3) to the cylinder head stud (2).
112. Install the vehicle body ground cable to cylinder head retaining nut (1).

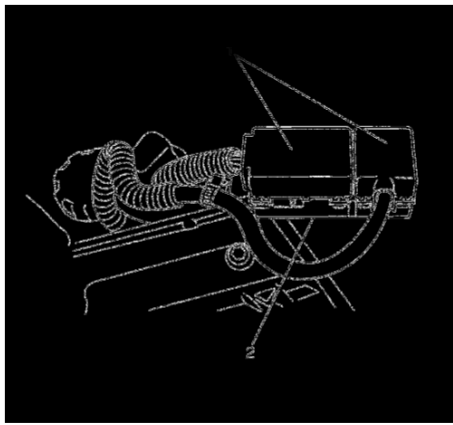
Tighten

Tighten the bolt to 25 N·m (18 lb ft).

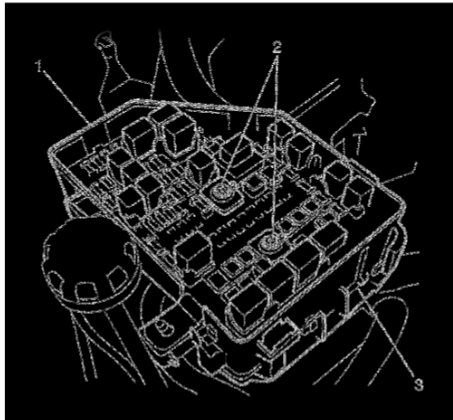


Note: Listen for a audible click from the locking tang (2) to confirm fitting.

113. Slide the engine connector (3) into the body harness connector (1) to join.



114. Install the protector (1) to the base of the under hood BEC connector (2).

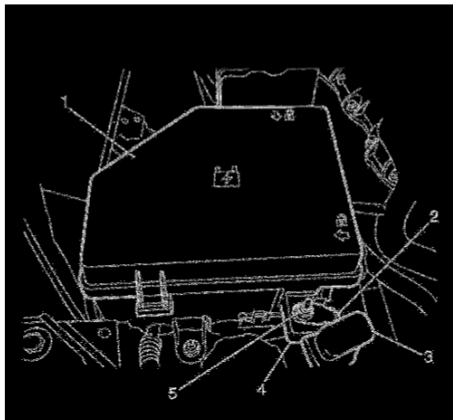


115. Install the upper under hood BEC plate (1) to the lower under hood BEC plate (3).

Note: The under hood BEC upper plate to lower plate retaining bolts (2) DO NOT have a torque specification. Listen for an audible clicking sound whilst tightening the under hood BEC upper plate to lower plate retaining bolts (2) to confirm correct fitting.

116. Install the under hood BEC upper plate to lower plate retaining bolts (2).

Listen for an audible click for correct tension.



117. Connect the positive cable (2) to the upper under hood BEC plate (4).

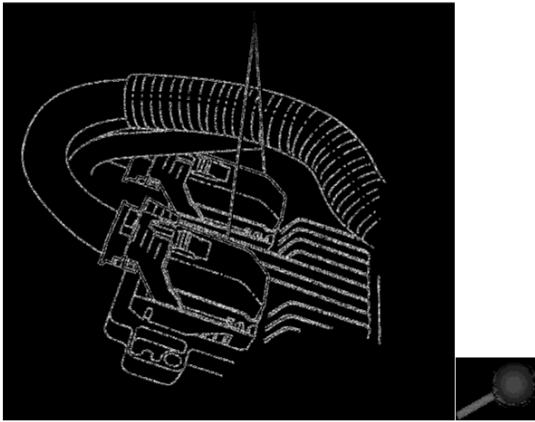
118. Install the positive cable to under hood BEC plate retaining bolt (5).

Tighten

Tighten the bolt to 10 N·m (89 lb in).

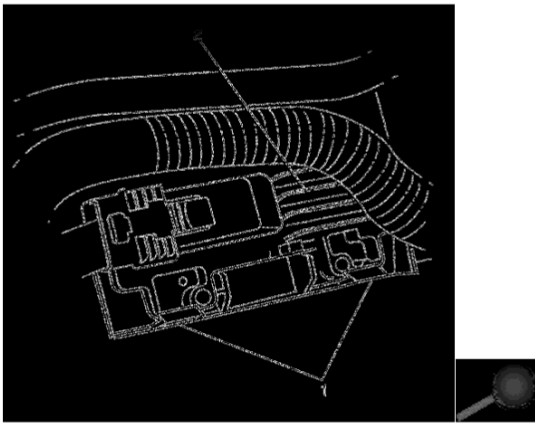
119. Install the positive cable protective cover (3) to the positive cable.

120. Install the under hood body electrical centre (BEC) cover (1).



Caution: Refer to [Powertrain Control Module and Electrostatic Discharge Caution](#).

121. Connect the ECM electrical connectors (1) to the ECM.

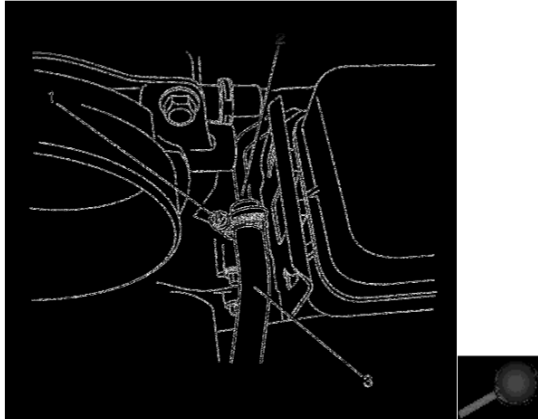


122. Engage the ECM retaining clips (1) to secure the ECM (2).



Note: Listen for a audible click to confirm fitting.

123. Connect the inlet and outlet heater hoses (3) at the heater hose assembly quick connect fittings (1).



124. Connect the coolant air bleed hose (3) to the coolant bleed pipe (2).
 125. Reposition the coolant bleed hose retaining clamp (1) to its original position on the coolant bleed hose (3).
 126. Tighten the coolant bleed hose retaining clamp (1).
 127. Install the radiator outlet hose. Refer to [Radiator Outlet Hose Replacement](#).
 128. Fill the cooling system. Refer to [Cooling System Draining and Filling](#).
 129. Install the air intake duct. Refer to [Air Cleaner Inlet Duct Replacement](#).

Note: The receiver and dehydrator is a single use only component. A NEW receiver and dehydrator must be installed whenever a closed A/C system is opened or exposed to atmosphere. If the receiver and dehydrator has been replaced following a service/repair and it is deemed necessary to immediately re-open the A/C system it is not necessary to replace the receiver and dehydrator again providing the A/C system is plugged/capped correctly.

130. Replace the receiver and dehydrator. Refer to [Receiver and Dehydrator Replacement](#).
 131. Recharge the air conditioning (A/C) system. Refer to [Refrigerant Recovery and Recharging](#).

Note: Prelube is necessary if the engine is replaced or overhauled.

132. If the engine is replaced with a new engine or has been overhauled, perform the Engine Prelubing procedure. Refer to [Engine Prelubing](#).

133. Install the engine cover. Refer to [Engine Cover Replacement](#).
134. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
135. Bleed the clutch. Refer to [Hydraulic Clutch System Bleeding](#).
136. Disable the ignition system.
137. Crank the engine several times. Listen for any unusual noises or evidence that parts are binding.
138. Enable the ignition system.
139. Start the engine and listen for unusual noises.
140. Check the vehicle oil pressure gauge and confirm that the engine has acceptable oil pressure.
If necessary, install an oil pressure gauge and measure the engine oil pressure.
141. Run the engine speed at about 1,000 RPM until the engine has reached normal operating temperature.
142. Listen for sticking lifters and other unusual noises.
143. Inspect for fuel, oil, and/or other coolant leaks while the engine is running.
144. Leak test the A/C system using the J 39400-A halogen leak detector.

Engine Replacement (LSA)

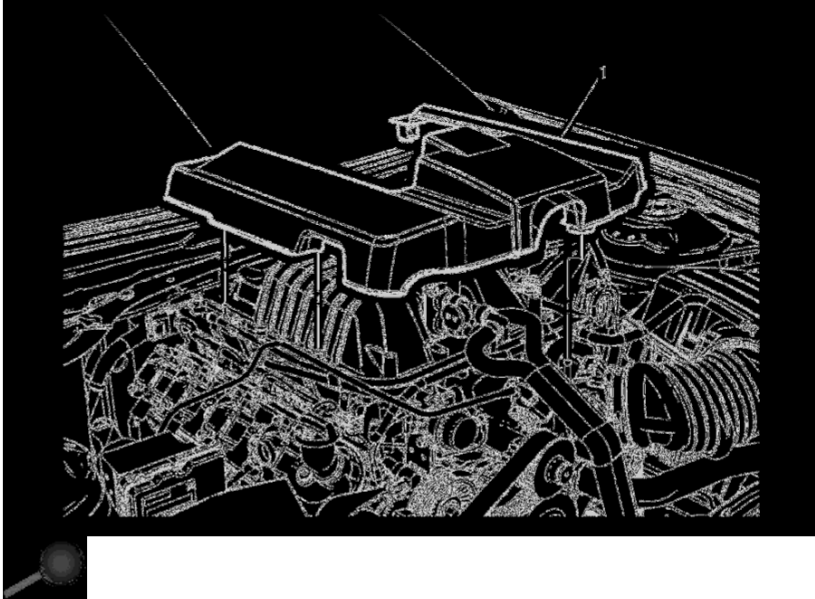
Special Tools

- J 39580 Engine Support Stand
- EN 46114 Engine Lift Brackets

Removal Procedure

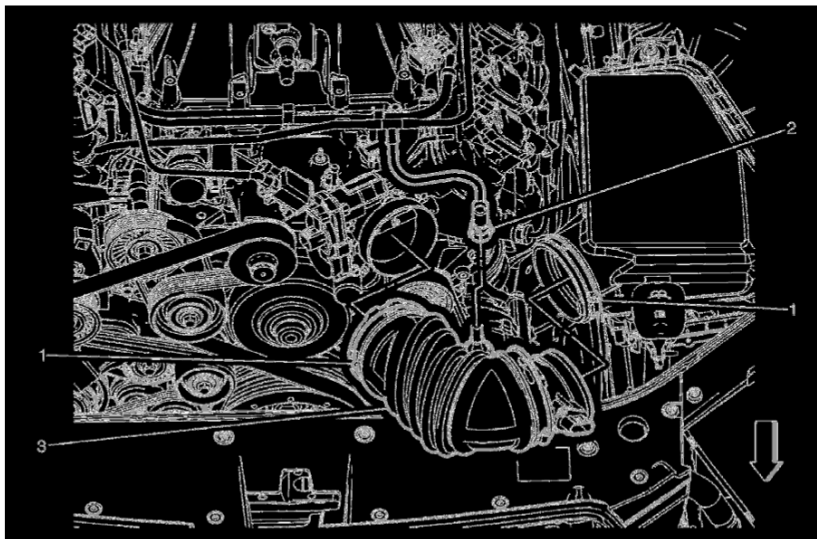
Warning: Refer to [Battery Disconnect Warning](#).

1. Disconnect the battery ground cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

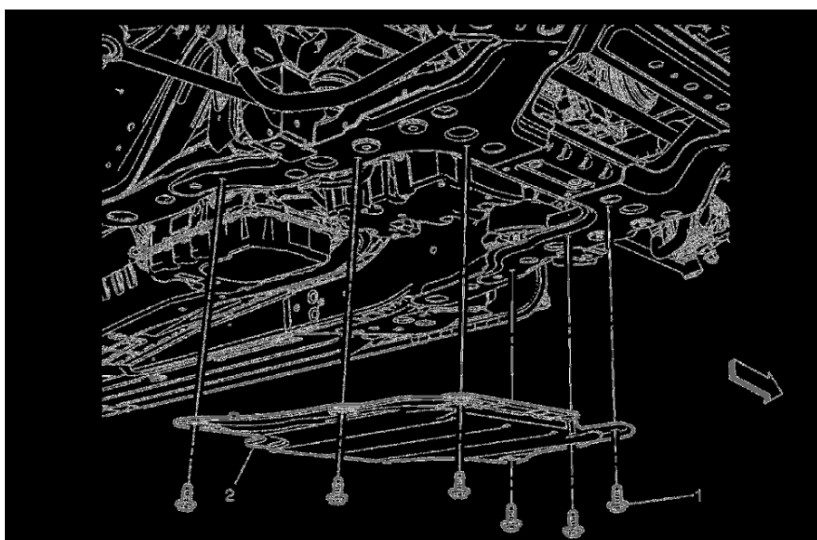


2. Remove the intake manifold cover. Refer to [Intake Manifold Cover Replacement - Front](#).

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3. Remove the air cleaner outlet duct (3). Refer to [Air Cleaner Outlet Duct Replacement](#).
4. Discharge the air conditioning (A/C) system. Refer to [Refrigerant Recovery and Recharging](#).

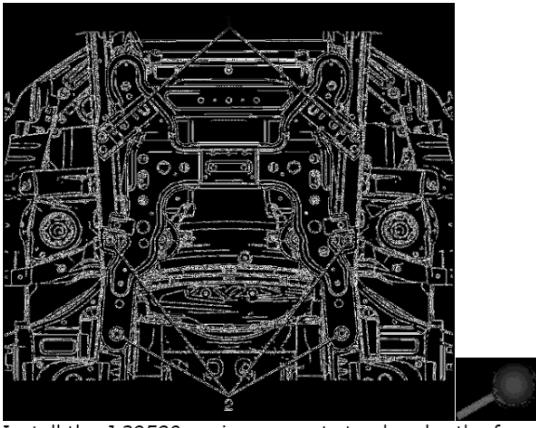


5. Remove the oil pan shield (2). Refer to [Oil Pan Shield Replacement](#).
6. Drain the supercharger cooling system. Refer to [Charge Air Cooling System Draining and Filling](#).
7. Drain the engine cooling system. Refer to [Cooling System Draining and Filling](#).

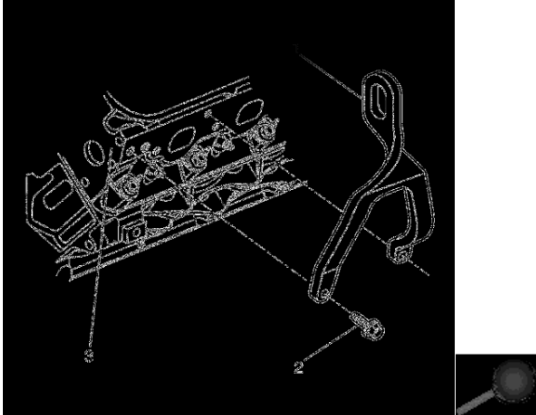
8. Drain the engine oil and remove the oil filter. Refer to [Engine Oil and Oil Filter Replacement](#).
9. Remove the front tires. Refer to [Tire and Wheel Removal and Installation](#).
10. Remove the right and left catalytic converters . Refer to [Catalytic Converter Replacement - Right Side](#) and [Catalytic Converter Replacement - Left Side](#).
11. Remove the transmission. Refer to [Transmission Replacement](#).



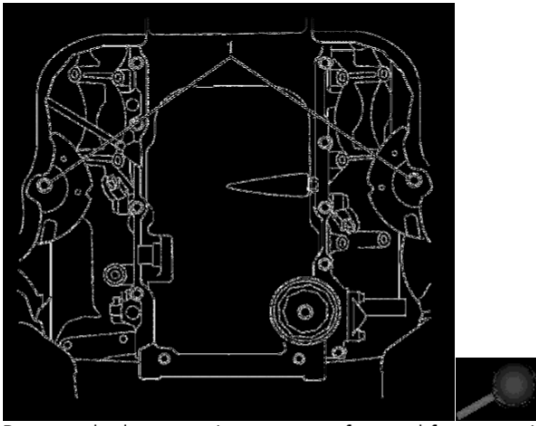
12. Disconnect the supercharger intercooler cooling hoses (1).
13. Remove the radiator inlet hose. Refer to [Radiator Inlet Hose Replacement](#).
14. Remove the radiator outlet hose. Refer to [Radiator Outlet Hose Replacement](#).
15. Disconnect and reposition all necessary engine harness electrical connectors.
16. Remove the brake pipes from the frame.
17. Remove the brake pressure modulator valve (BPMV) from the bracket assembly. Refer to [Brake Pressure Modulator Valve Replacement](#).
18. Using mechanics wire, support the radiator and A/C condenser assembly to the vehicle body.
19. Remove the washer bottle bracket from the frame. Refer to [Windshield Washer Solvent Container Replacement](#).
- Note:** Mark the stabilizer shaft to ensure the correct position when reinstalling.
20. Loosen the stabilizer shaft mounting bolts.
21. Remove the lower stabilizer shaft link from the lower control arm. Refer to [Stabilizer Shaft Link Replacement](#).
22. Separate the outer tie rod from the steering knuckle.



23. Install the *J 39580* engine support stand under the frame.
24. Lower the vehicle to the frame support table.

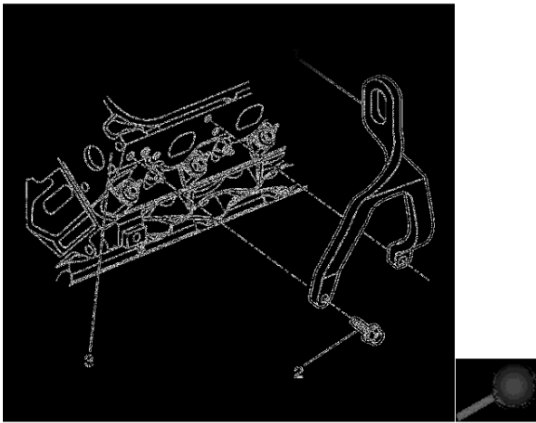


25. Position the *J 41798* engine lift bracket (1) on the cylinder head (3).
- Caution:** Refer to [Fastener Caution](#).
26. Install the *J 41798* engine lift bracket to cylinder head retaining bolts (2).
Tighten
Tighten the bolts to 50 N·m (36 lb ft).
27. Attach a suitable lifting chain and hooks to the engine lifting brackets (1).

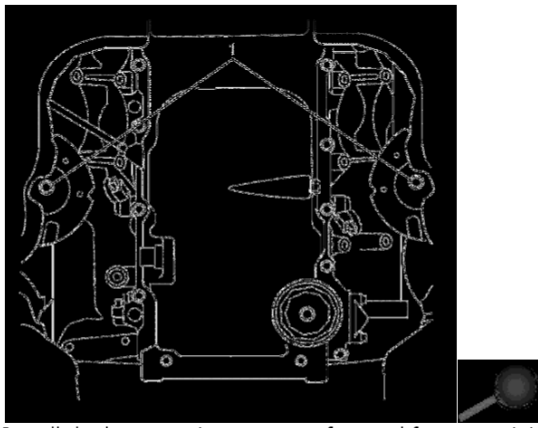


28. Remove the lower engine mount to front subframe retaining nut (1) from both engine mounts.
29. Using a suitable lifting crane, raise the engine to clear the engine mount stud.
30. Remove the engine from the subframe.
If required mount the engine on a suitable engine stand.

Installation Procedure



1. Position the J 41798 engine lift bracket (1) on the cylinder heads (3).
2. Install the J 41798 engine lift bracket to cylinder head retaining bolts (2).
Tighten
Tighten the bolts to 50 N·m (36 lb ft).
3. Using a suitable lifting crane and the J 41798 engine lift bracket raise the engine slightly.
4. Remove the engine from the engine stand.
5. Lower the engine onto the front subframe.
6. Position the engine mounts to the front subframe.

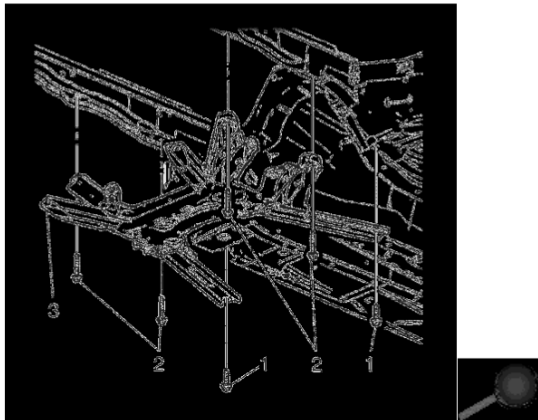


7. Install the lower engine mount to front subframe retaining nuts (1) on both engine mounts.

Tighten

Tighten the nuts to 80 N·m (59 lb ft).

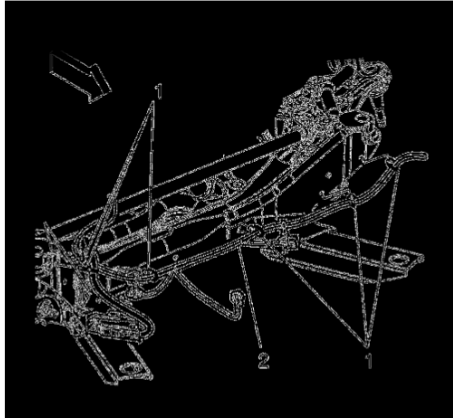
8. With the aid of an assistant, position and secure the frame assembly to the support fixture.
9. With the aid of an assistant, carefully lower the body to the frame.
10. Ensure the following components are clear from the frame:
- Electrical wiring harness
 - Steering knuckle assembly
 - Brake pipes



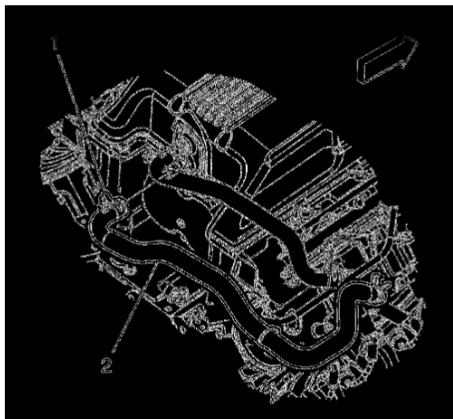
Caution: Refer to [Fastener Caution](#).

11. Install the frame mounting bolts (2) and tighten to 191 N·m (141 lb ft).
12. Raise the vehicle.
13. Install the engine mount lower retaining nuts and tighten to 50 N·m (37 lb ft).
14. Remove the J 39580 engine support stand from under the vehicle.
15. Install the outer tie rod to the steering knuckles.
- Note:** Ensure the correct position from the previously marked spots.
16. Tighten the stabilizer shaft bolts to 60 N·m (44 lb ft).
17. Install the stabilizer shaft link to the lower control arms. Refer to [Stabilizer Shaft Link Replacement](#).
18. Install the BPMV to the bracket. Refer to [Brake Pressure Modulator Valve Replacement](#).

19. Install the brake pipes to the frame.
20. Install the washer bottle bracket to the frame. Refer to [Windshield Washer Solvent Container Replacement](#).
21. Remove the mechanics wire supporting the radiator.
22. Install the wheel speed sensor wire harness to the frame.



23. Install the electrical harness retainers (1) securing the engine harness (2) to the frame.
24. Install the oil pan shield. Refer to [Oil Pan Shield Replacement](#).
25. Install the front tires and wheels. Refer to [Tire and Wheel Removal and Installation](#).
26. Install the transmission. Refer to [Transmission Replacement](#).
27. Install the right and left catalytic converters . Refer to [Catalytic Converter Replacement - Right Side](#) and [Catalytic Converter Replacement - Left Side](#).
28. Install the radiator inlet hose. Refer to [Radiator Inlet Hose Replacement](#).
29. Install the radiator outlet hose. Refer to [Radiator Outlet Hose Replacement](#).
30. Install the supercharger intercooler cooling hoses.



31. Install all necessary engine harness electrical connectors.
32. Install the air cleaner resonator outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
33. Refill the coolant system. Refer to [Cooling System Draining and Filling](#).
- Note:** **Prelube is necessary if the engine is replaced or overhauled.**
34. If the engine is replaced with a new engine or has been overhauled, perform the Engine Prelubing procedure. Refer to [Engine Prelubing](#).

35. Refill the charge air cooling system. Refer to [Charge Air Cooling System Draining and Filling](#).
36. Charge the A/C system. Refer to [Refrigerant Recovery and Recharging](#).
37. Align the vehicle. Refer to [Wheel Alignment Measurement](#).

Engine Oil and Oil Filter Replacement

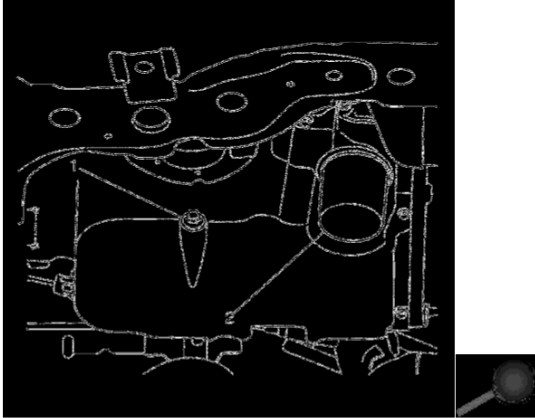
Removal Procedure

1. Remove the oil fill cap.

Danger: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

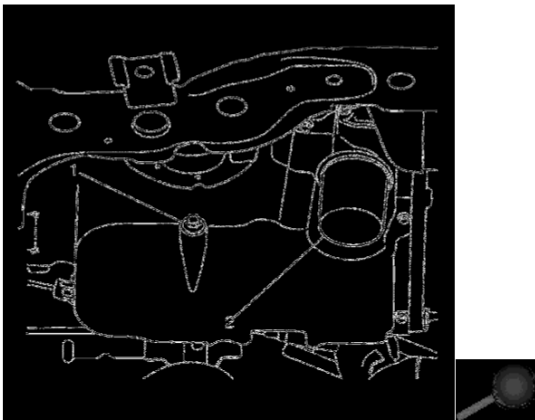
Warning: Refer to [Safety Glasses Warning](#).

2. Remove the oil pan shield. Refer to [Oil Pan Shield Replacement](#).



3. Remove the oil pan drain plug (1).
4. Drain the engine oil into an appropriate container.
5. Remove the engine oil filter (2).

Installation Procedure



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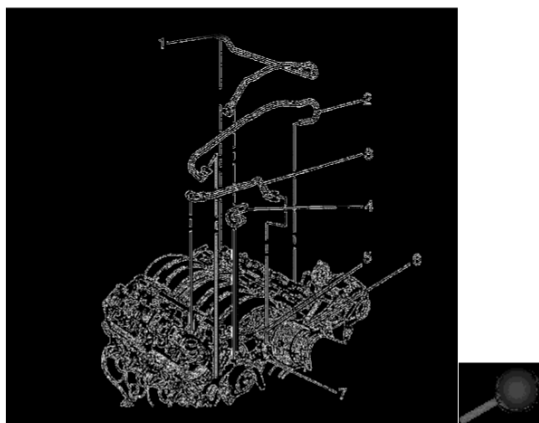
Caution: Refer to [Fastener Caution](#).

Note: Before installing the new oil filter, ensure that the old oil filter gasket has been removed. If not, remove the old gasket.

1. Install the oil filter (2) and tighten to **30 N•m (22 lb ft)**.
2. Install the oil pan drain plug (1) and tighten to **25 N•m (18 lb ft)**.
3. Install the oil pan shield. Refer to [Oil Pan Shield Replacement](#).
4. Fill the engine with a suitable amount and type of engine oil.
5. Check the oil level.
6. Install the oil fill cap.
7. Reset the engine oil life display. Refer to [GM Oil Life System Resetting](#).

Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (L77 or LS3 Clean & Dirty Air)

Removal Procedure

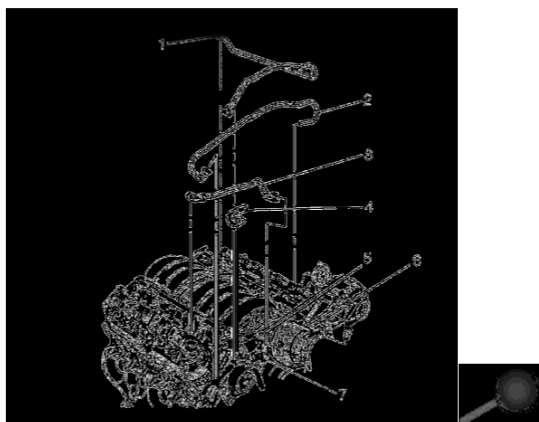


1. Remove the engine cover. Refer to [Engine Cover Replacement](#).

Note: In the following service procedure, it may be necessary to remove the evaporative emission (EVAP) valve assembly to gain access to the positive crankcase ventilation hose.

2. Remove the evaporative emission canister purge valve (5). Refer to [Evaporative Emission Canister Purge Solenoid Valve Replacement](#).
3. Remove the EVAP pipes (1) and (2).
4. Remove the EVAP pipe (3) from the air intake duct (6) and the valve cover.
5. Remove the hose (4) from the throttle body (7) and the engine valley cover.

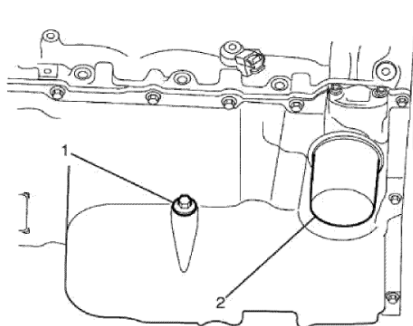
Installation Procedure



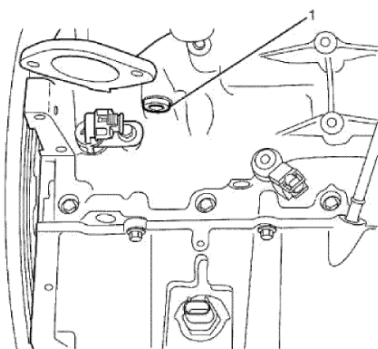
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1. Install the hose (4) from the throttle body (7) and the engine valley cover.
2. Install the EVAP pipe (3) from the air intake duct (6) and the valve cover.
3. Install the evaporative emission canister purge valve (5). Refer to [Evaporative Emission Canister Purge Solenoid Valve Replacement](#).
4. Install the EVAP pipes (1) and (2).
5. Install the engine cover. Refer to [Engine Cover Replacement](#).

Draining Fluids and Oil Filter Removal (LS3 or L77)

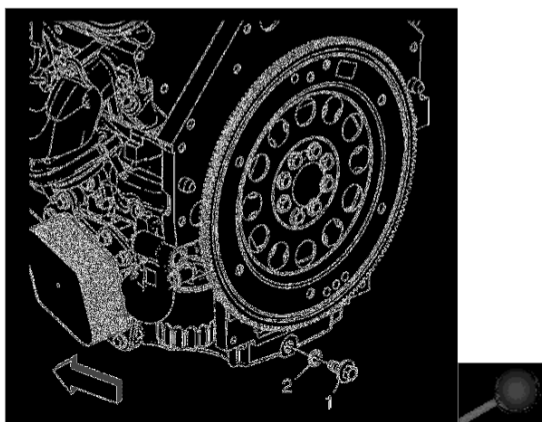


1. Remove the oil pan drain plug (1).
2. Drain the engine oil into an appropriate container.
3. Remove the engine oil filter (2).

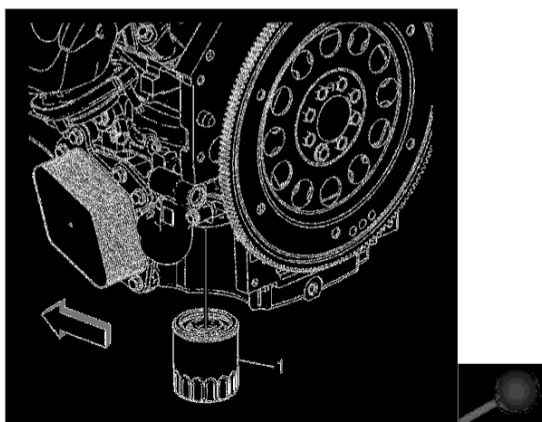


4. Remove the right side rear engine block coolant drain hole plug and washer (1).

Draining Fluids and Oil Filter Removal (LSA)

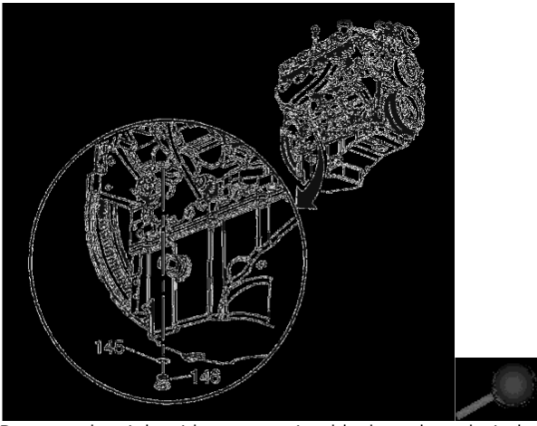


1. Remove the oil pan drain plug (1) with O-ring (2).

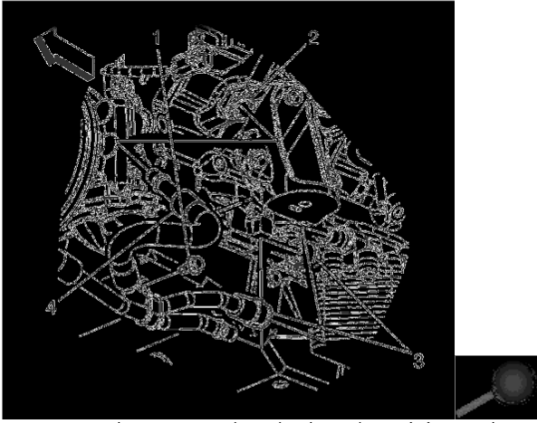


2. Remove the engine oil filter (1).

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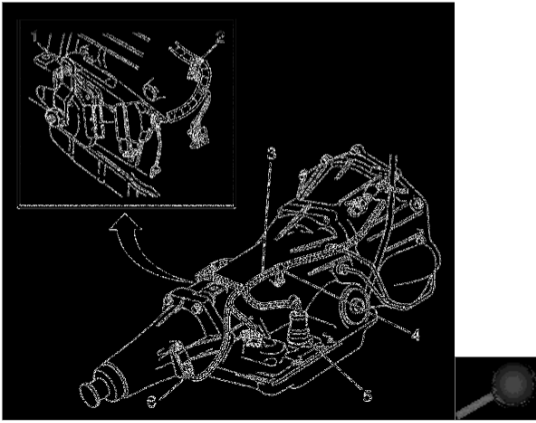


3. Remove the right side rear engine block coolant drain hole plug (146) with washer (145).



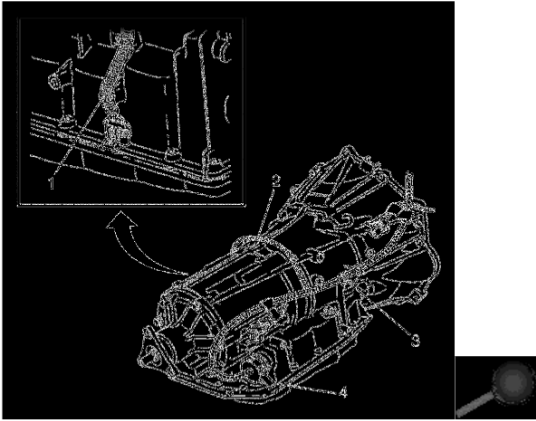
4. Disconnect the engine oil cooler hose/pipe (1) in order to drain coolant from the left side of block.

Engine Wiring Harness Assembly Removal



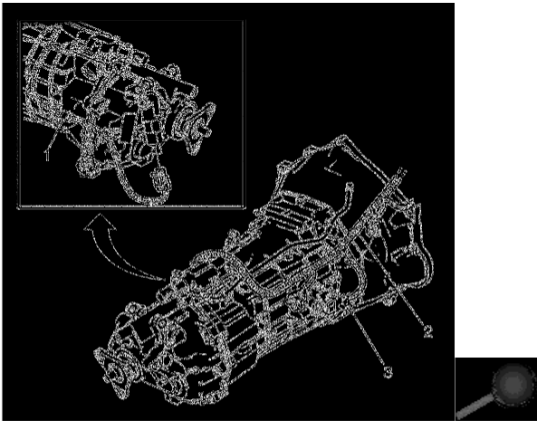
Note: Steps 1 to 5 refer to the 4L60E 4 speed automatic transmission only.

1. Disconnect the park/neutral position switch electrical connector (1).
2. Detach the engine wiring loom assembly (3) from the retaining clip (2).
3. Detach the engine wiring loom assembly (3) from the retaining clip (4).
4. Disconnect the main transmission electrical connector (5).
5. Disconnect the vehicle speed sensor electrical connector (6).



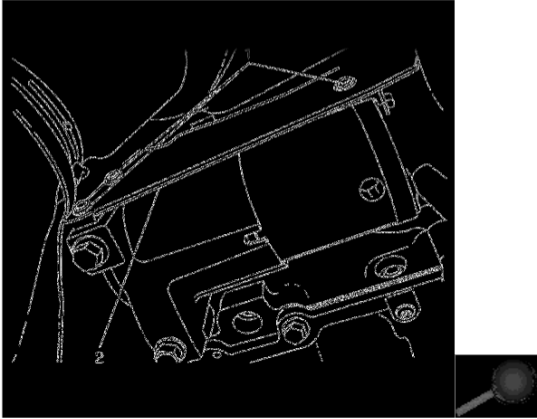
Note: Steps 6 to 8 refer to the 6L80E 4 speed automatic transmission only.

6. Disconnect the heated oxygen sensor electrical connector (1).
7. Detach the engine wiring loom assembly (2) from the retaining clip (3).
8. Disconnect the main transmission electrical connector (4).

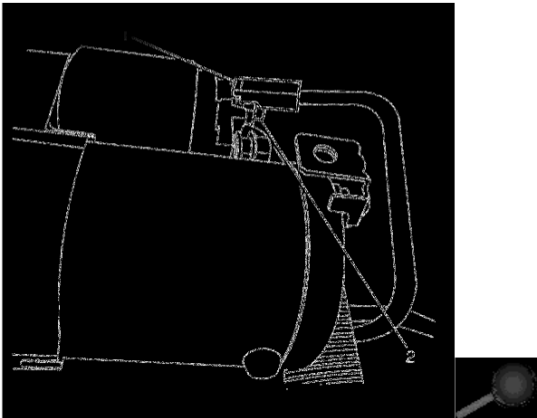


Note: Steps 9 and 10 refer to the T56 6 speed manual transmission only.

9. Detach the engine wiring loom assembly (2) from the retaining clip (1).
10. Disconnect the reverse switch assembly electrical connector (3).

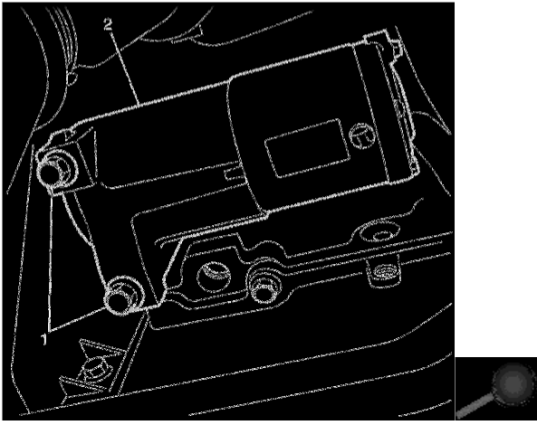


11. Remove the starter motor heat shield to starter motor retaining bolts (1).
12. Remove the heat shield from the vehicle (2).



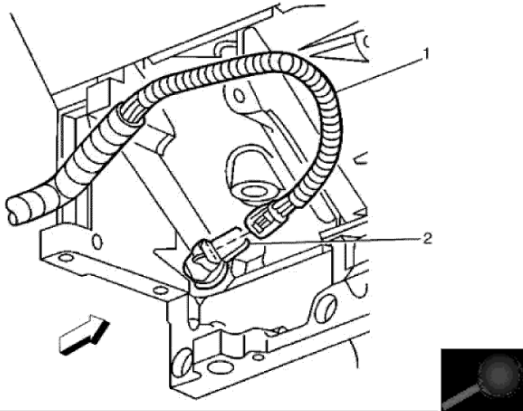
13. Disconnect the starter motor solenoid electrical connector (1).

14. Remove battery positive cable retaining nut (2) from the starter motor.

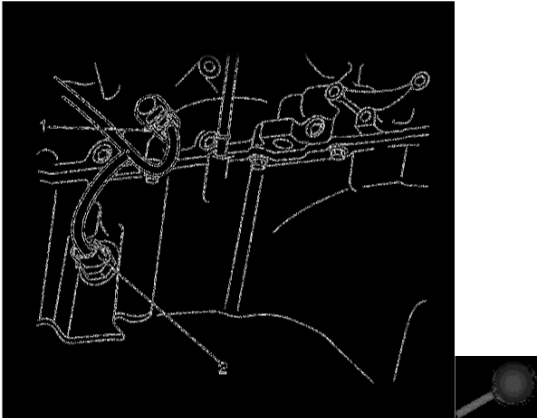


15. Remove starter motor to bell housing retaining bolts (1).

16. Remove the starter motor (2).

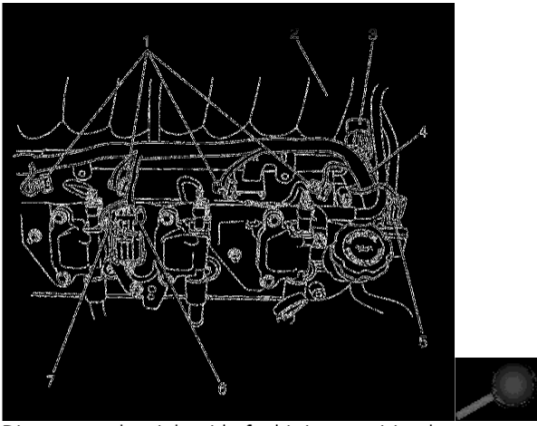


17. Disconnect the crankshaft position (CKP) sensor electrical connector (1).



18. Disconnect the oil level/temperature sensor electrical connector (2).

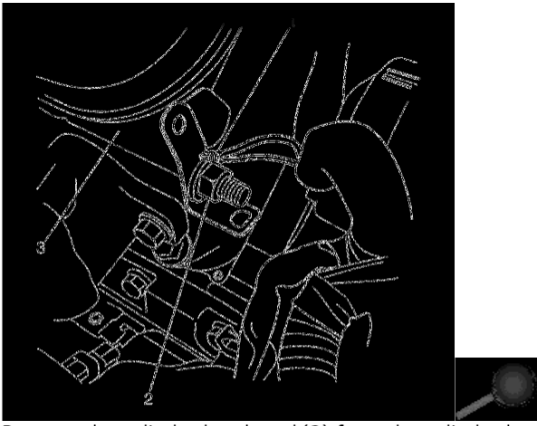
19. Disconnect the right side knock sensor electrical connector (1).



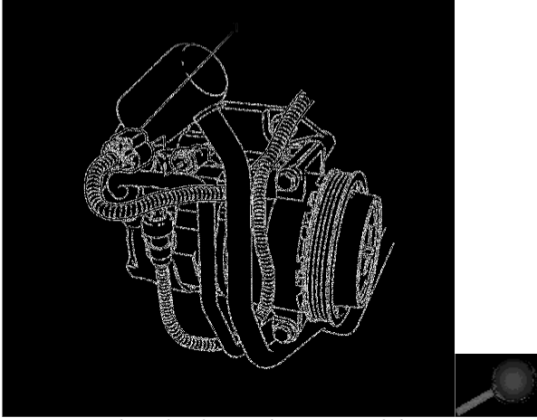
20. Disconnect the right side fuel injector wiring harness connectors (1).
21. Remove the CPA lock (7) from the right side ignition coil main connector (6).
22. Disconnect the right side ignition coil main connector (6).
23. Disconnect the canister purge valve (5) wiring harness connector.
24. Disconnect the manifold absolute pressure (MAP) sensor wiring harness connector (3).
25. Reposition and secure the right side fuel injector wiring harness (4) away from the intake manifold (2).



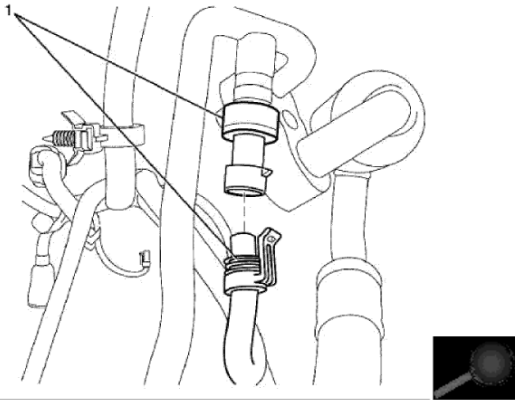
26. Remove the vehicle body ground cable to cylinder head retaining nut (1).
27. Remove the vehicle body ground cable (3) from the cylinder head stud (2).



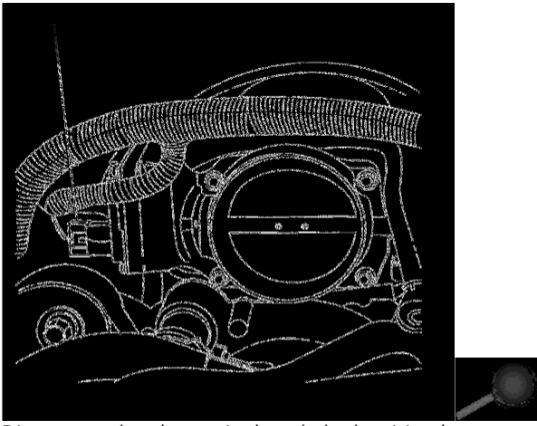
28. Remove the cylinder head stud (3) from the cylinder head (2) and secure the wiring harness ground (1) away from the cylinder head (2).



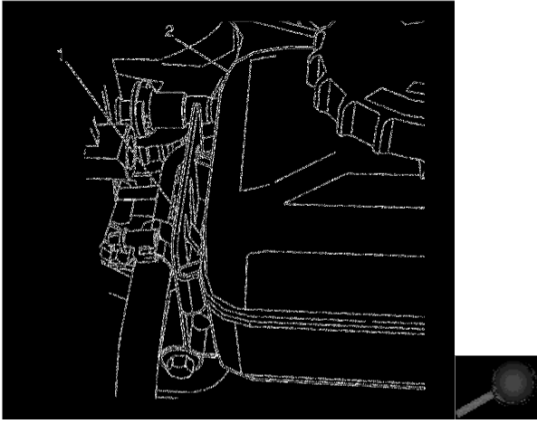
29. Disconnect the A/C electrical connector (1).



30. Disconnect the electrical connector from the A/C Refrigerant Pressure Sensor (1).

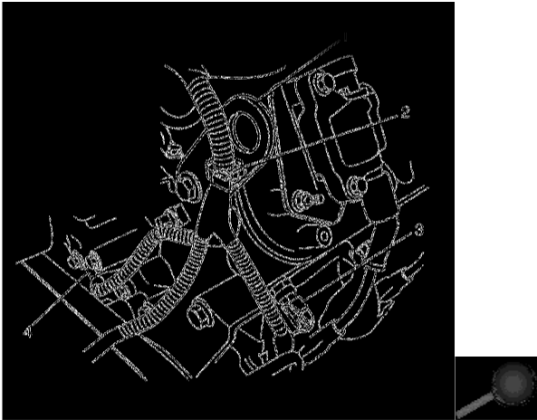


31. Disconnect the electronic throttle body wiring harness connector (1).



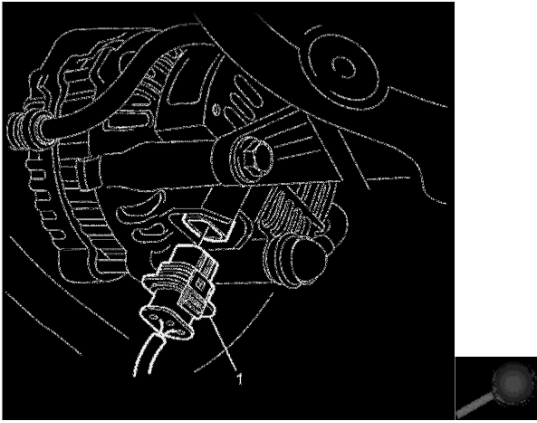
Note: The locking tang on the power steering reservoir bracket (1) must be released before removing the power steering reservoir (2).

32. Remove the power steering reservoir (2) from the power steering pump power steering reservoir bracket (1) and position the power steering reservoir (2) aside.



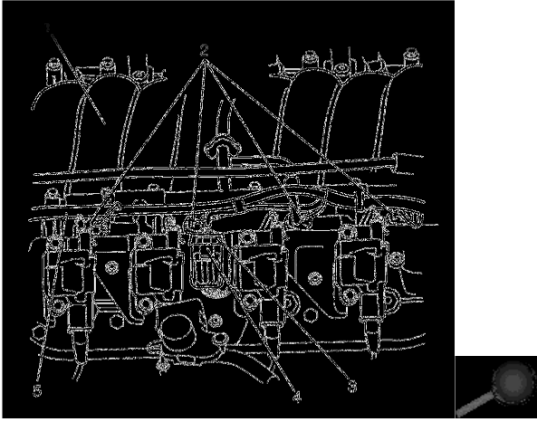
33. Disconnect the camshaft position sensor connector (4).

34. Disconnect the coolant temperature sensor connector (3).
35. Detach the wiring harness retaining clip (2) from the engine lifting bracket (1).

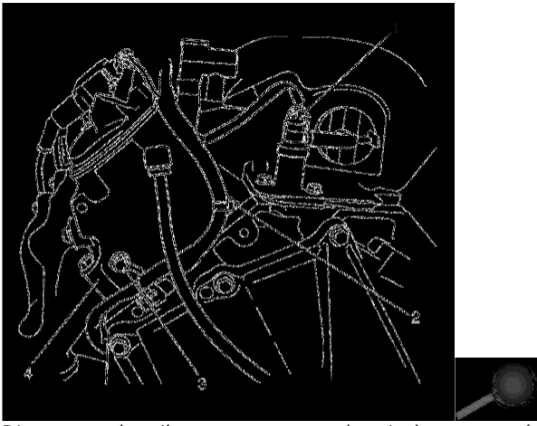


Note: Press the retainer tabs to remove electrical connector.

36. Disconnect the alternator electrical connector (1).



37. Disconnect the left side fuel injector wiring harness connectors (2).
38. Remove the CPA lock (4) from the left side ignition coil main connector (3).
39. Disconnect the left side ignition coil main connector (3).
40. Reposition and secure the left side fuel injector wiring harness (5) away from the intake manifold (1).



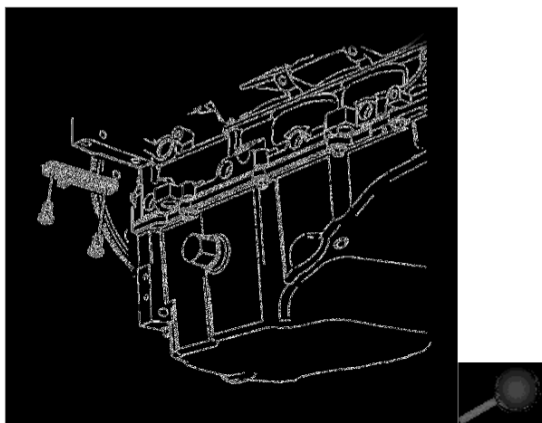
41. Disconnect the oil pressure sensor electrical connector (1).
42. Detach the wiring harness assembly retaining clip (2) from the left side cylinder head (4).
43. Remove the wiring harness assembly earth to cylinder head retaining bolt (3)

Crankshaft Balancer Removal

Special Tools

- J 41816-A Crankshaft Balancer Remover
- J 41816-2 Crankshaft End Protector
- J 42386-A Flywheel Holding Tool

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



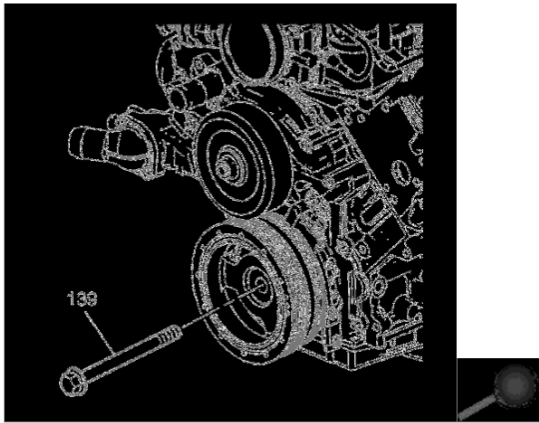
Caution: Refer to [Fastener Caution](#).

Note:

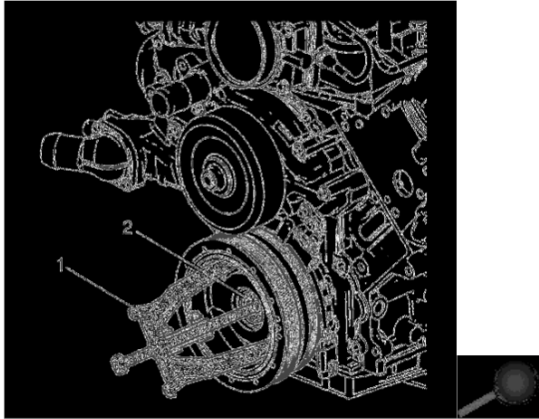
- If replacing the crankshaft balancer on manual transmission applications, note the location of any existing balance weights, if applicable. Crankshaft balance weights must be installed into the new balancer in the same location as the old balancer. A properly installed balance weight will be either flush or below flush with the face of the balancer. Refer to [Engine Balancing](#).
- Do not use the crankshaft balancer bolt again. Install a NEW crankshaft balancer bolt during final assembly.

1. Install the J 42386-A tool and bolts.

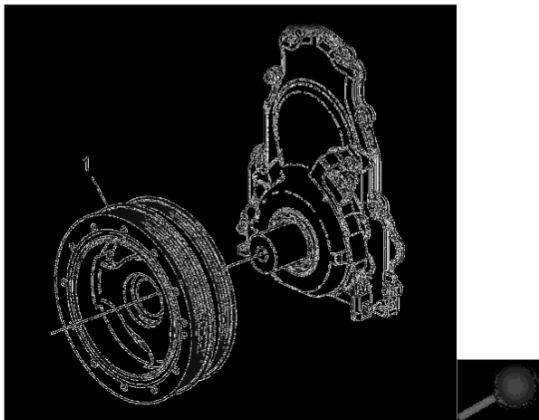
Use 1 M10 – 1.5 x 120 mm and 1 M10 – 1.5 x 45 mm bolt for proper tool operation and tighten the J 42386-A tool bolts to **50N·m (37 lb ft)**.



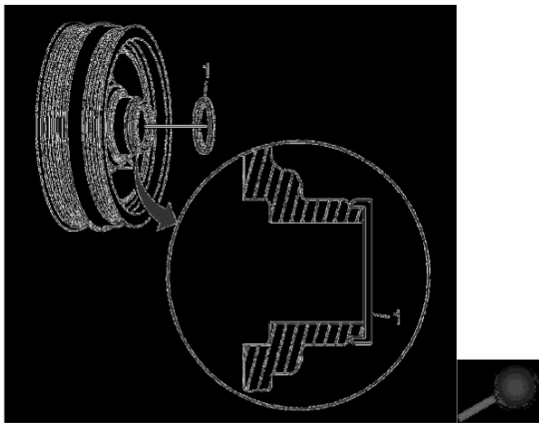
2. Remove the crankshaft balancer bolt (139). Do not discard the crankshaft balancer bolt. The balancer bolt will be used during the balancer installation procedure.



3. Use the *J 41816-A* remover (1) and the *J 41816-2* protector (2) in order to remove the crankshaft balancer.



4. Remove the crankshaft balancer (1).



5. Remove the crankshaft balancer washer (1) from the balancer, as required.



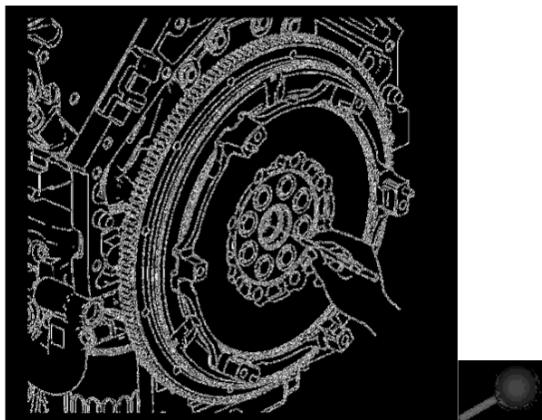
6. Note the position of the crankshaft balance weights, if applicable for manual transmission applications. Refer to [Engine Balancing](#) and [Crankshaft Balancer Cleaning and Inspection](#).

Engine Flywheel Removal (LSA)

Special Tools

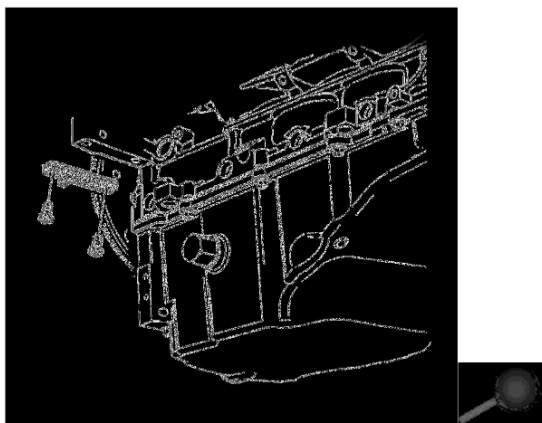
J-42386-A Flywheel Holding Tool

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



Note: Note the position and direction of the engine flywheel before removal. The flywheel does not use a locating pin for alignment. Mark or scribe the end of the crankshaft and the flywheel before component removal. The existing manual transmission engine flywheel must be installed to the original position and direction.

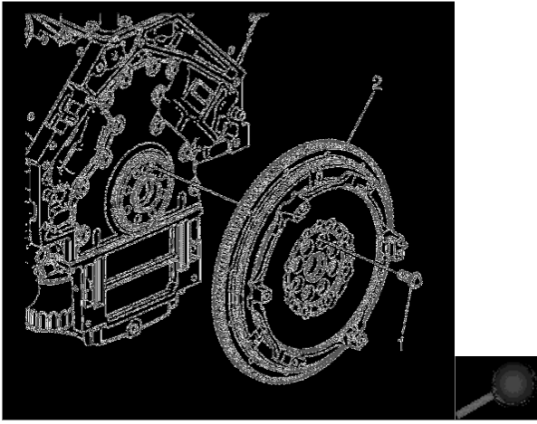
1. Mark or scribe the end of the crankshaft and the manual transmission flywheel. Refer to [Engine Balancing](#).



Caution: Refer to [Fastener Caution](#).

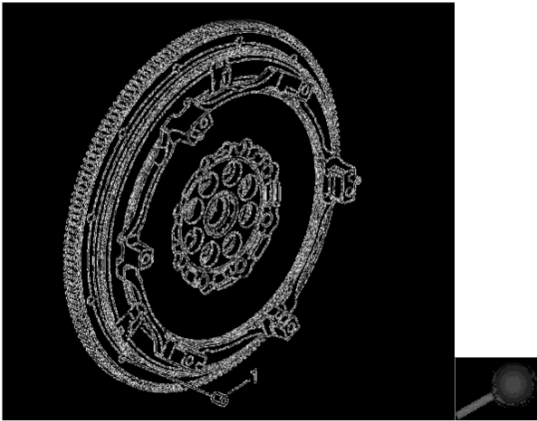
2. Install the J-42386-A flywheel holding tool and bolts.
Use 1 M10-1.5 x 120 mm and 1 M10-1.5 x 45 mm bolt for proper tool operation.
Tighten the J-42386-A flywheel holding tool and bolts to **50 N·m (37 lb ft)**.

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Note: Do NOT reuse the flywheel bolts.

3. Remove and discard the flywheel bolts (1).
4. Remove the manual transmission flywheel (2).

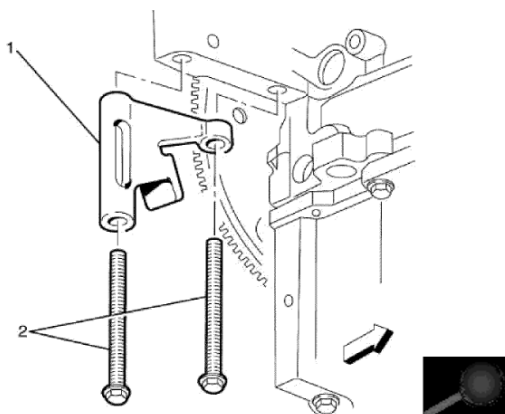


5. Note the location of the manual transmission flywheel balance weights (1), if applicable. Refer to [Engine Balancing](#).
6. Remove the J-42386-A flywheel holding tool

Engine Flywheel Removal (LS3 or L77)

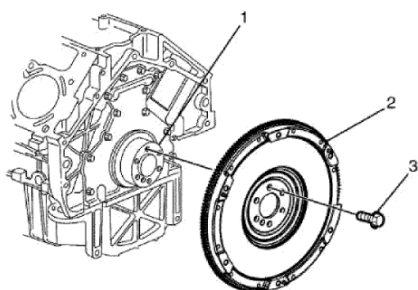
Special Tools

J 42386-A Flywheel Holding Tool



Note: Make sure the J 42386-A flywheel holding tool (1) engages securely with the ring gear teeth.

1. Install the J 42386-A flywheel holding tool (1) using the two starter motor to engine block retaining bolts (2).

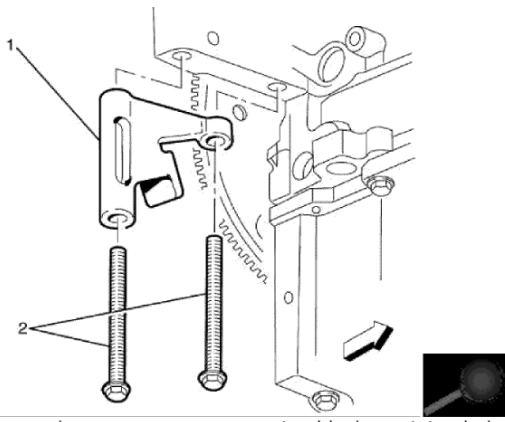


Note: Bolts with micro-encapsulated thread sealant must be discarded after removal.

2. Remove and discard the engine flywheel to crankshaft retaining bolts (3).
3. Remove the engine flywheel (2) from the crankshaft (1).

Note: Make sure all the engine flywheel to crankshaft retaining bolt hole threads on the crankshaft are thoroughly cleaned of any micro-encapsulated thread sealant.

4. Clean the engine flywheel to crankshaft retaining bolt hole threads on the crankshaft.

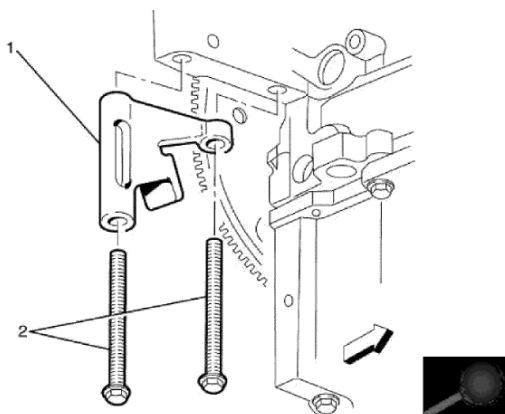


5. Remove the starter motor to engine block retaining bolts (2).
6. Remove the *J* 42386-A flywheel holding tool (1).

Automatic Transmission Flex Plate Removal

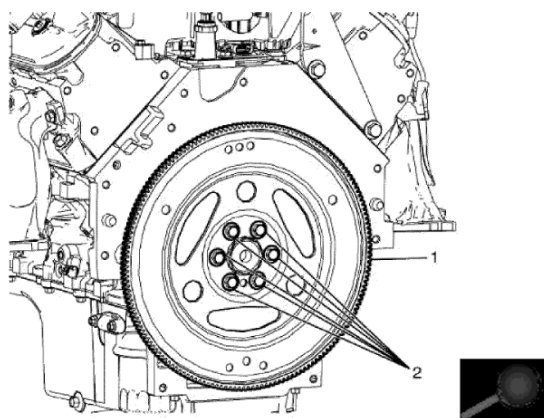
Special Tools

J 42386-A Flywheel Holding Tool



Note: Make sure the J 42386-A flywheel holding tool (1) engages securely with the ring gear teeth.

1. Install the J 42386-A flywheel holding tool (1) using the two starter motor to engine block retaining bolts (2).

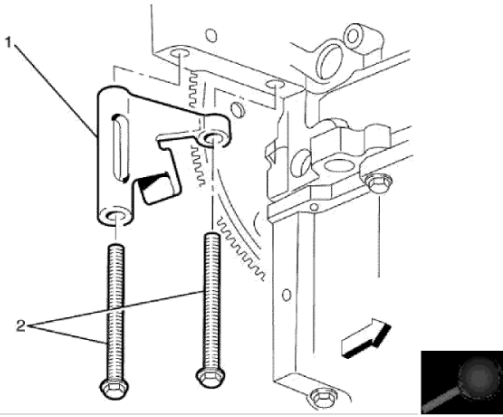


Note: Bolts with micro-encapsulated thread sealant must be discarded after removal.

2. Remove and discard the automatic transmission flex plate to crankshaft retaining bolts (2).
3. Remove the automatic transmission flex plate (1) from the crankshaft.

Note: Make sure all the automatic transmission flex plate to crankshaft retaining bolt hole threads on the crankshaft are thoroughly cleaned of any micro-encapsulated thread sealant.

4. Clean the automatic transmission flex plate to crankshaft retaining bolt hole threads on the crankshaft.



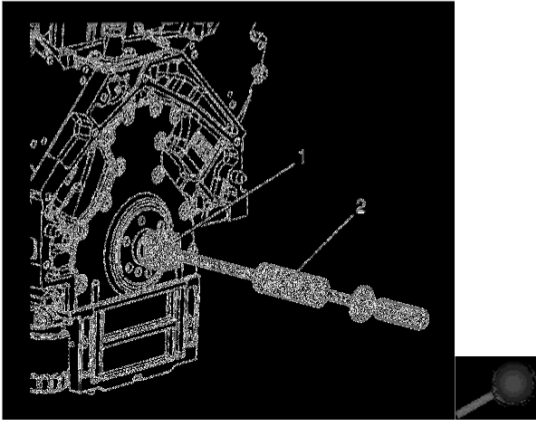
5. Remove the starter motor to engine block retaining bolts (2).
6. Remove the J 42386-A flywheel holding tool (1).

Clutch Pilot Bearing Removal

Special Tools

- J2619-01 Slide Hammer
- J23907 Slide Hammer with Bearing Adapter
- J23907-1 Slide Hammer

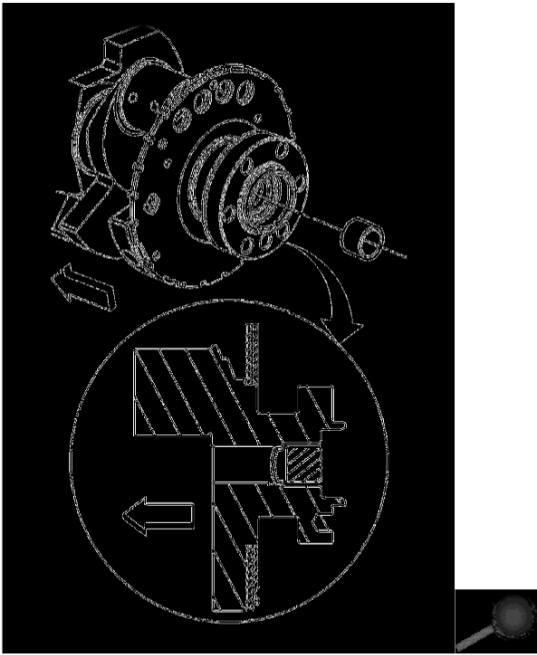
For equivalent regional tools, refer to [Special Tools](#).



Note: J23907-1 slide hammer was part of the J23907 slide hammer with bearing adapter set. The adapter is still available as J23907 adapter.

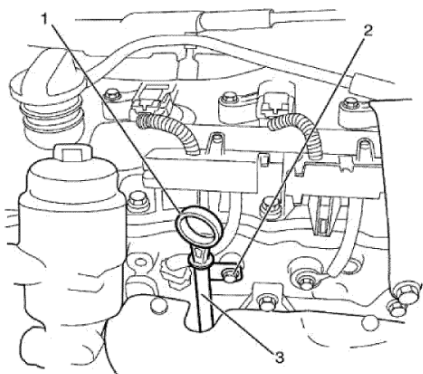
1. Remove the clutch pilot bearing using the J23907 adapter (1) and J23907-1 slide hammer (2).
 - 1.1. Install the legs of the J23907 adapter (1) into the clutch pilot bearing.
 - 1.2. Rotate the shaft of the tool until the legs of the tool are snug and contacting the I.D. surface of the bearing.
 - 1.3. Install the J23907-1 slide hammer (2) to the J23907 adapter (1).
 - 1.4. Remove the bearing from the rear of the crankshaft.
 - 1.5. Remove the special tools from the bearing.

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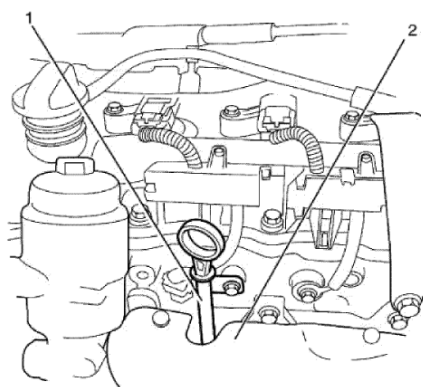


2. Discard the bearing.

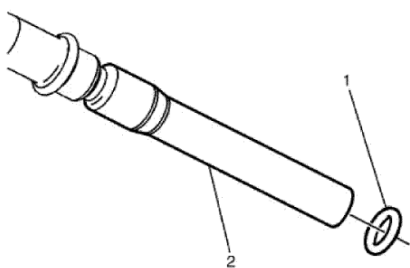
Oil Level Indicator and Tube Removal



1. Remove the oil level indicator tube bracket to cylinder head retaining bolt (2).
2. Remove the oil level indicator (1) from the oil level indicator tube (3).
3. Remove the knock sensor. Refer to [Knock Sensor Replacement](#).



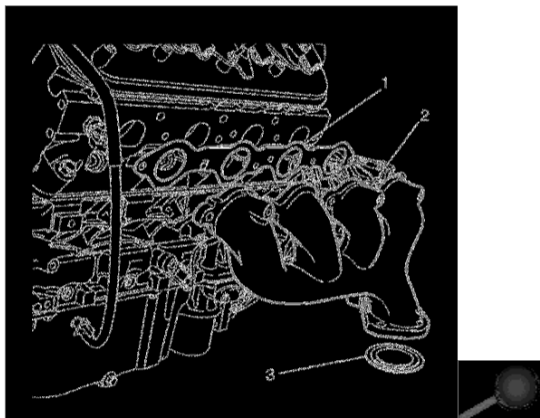
4. Remove the oil level indicator tube (1) up through the exhaust manifold (2).



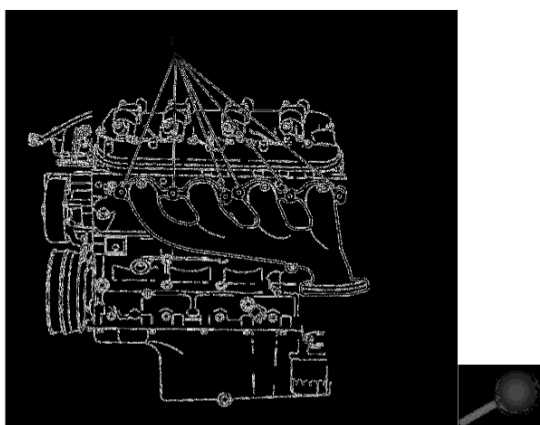
5. Remove and discard the O-ring (1) from the oil level indicator tube (2) if damaged.

Exhaust Manifold Removal - Left Side (Except HSV)

Warning: Refer to [Hot Exhaust System Warning](#).



1. Install the exhaust manifold (2), NEW exhaust manifold gasket (1) and sealing ring (3).



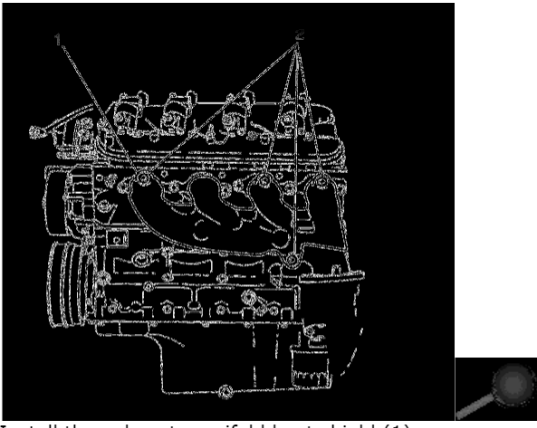
2. Apply a 5 mm (0.2 in) wide band of threadlock, or equivalent, to the threads of the exhaust manifold to cylinder head retaining bolts (1). Refer to [Adhesives, Fluids, Lubricants, and Sealers](#).

Caution: Refer to [Fastener Caution](#).

3. Install the exhaust manifold to cylinder head retaining bolts (1).

Tighten

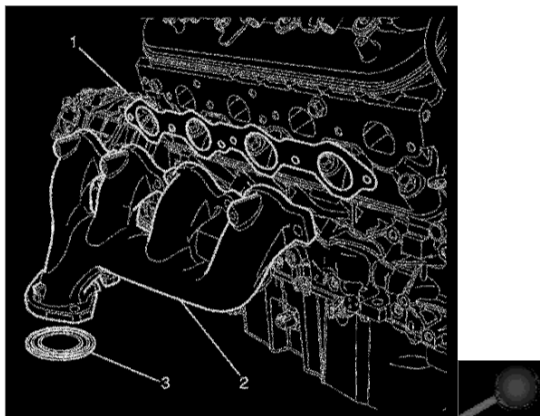
- First Pass: Tighten the bolts to 15 N·m (11 lb ft). Tighten the exhaust manifold bolts beginning with the centre 2 bolts. Alternate from side-to-side, and work toward the outside bolts.
 - Final Pass: Tighten the bolts to 20 N·m (15 lb ft). Tighten the exhaust manifold bolts beginning with the centre 2 bolts. Alternate from side-to-side, and work toward the outside bolts.
4. Using a flat punch, bend over the exposed edge of the exhaust manifold gasket at the rear of the left cylinder head.



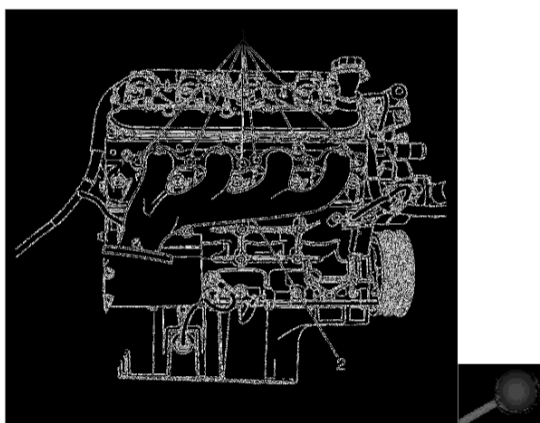
5. Install the exhaust manifold heat shield (1).
 6. Install the exhaust manifold heat shield to exhaust manifold retaining bolts (2).
- Tighten**
Tighten the bolts to 10 N•m (89 lb in).

Exhaust Manifold Removal - Right Side (Except HSV)

Warning: Refer to [Hot Exhaust System Warning](#).



1. Install NEW exhaust manifold gasket (1) and NEW sealing ring (3) to the exhaust manifold (2).
2. Install the exhaust manifold assembly to engine.



Note: Do not fully tighten the exhaust manifold to cylinder head retaining bolts (1) at this stage.

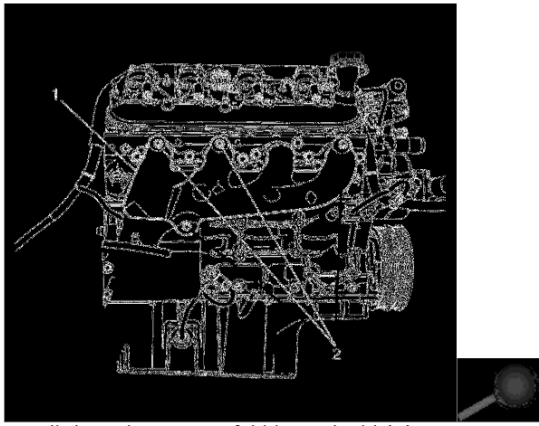
3. Install the NEW exhaust manifold to cylinder head retaining bolts (1).

Caution: Refer to [Fastener Caution](#).

4. Tighten the exhaust manifold to cylinder head retaining bolts (1) working from the centre to the outside.

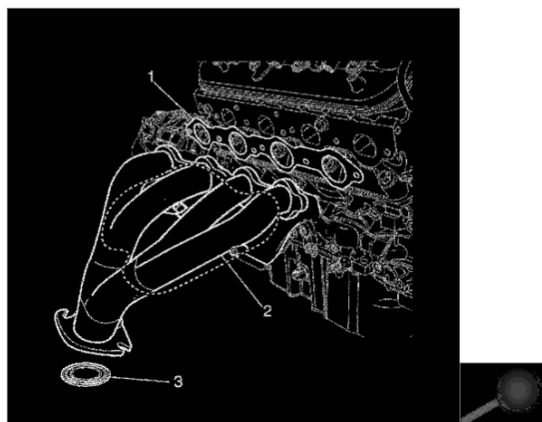
Tighten

- First Pass: Tighten the bolts to 15 N·m (11 lb ft). Tighten the exhaust manifold bolts beginning with the centre 2 bolts. Alternate from side-to-side, and work toward the outside bolts.
- Final Pass: Tighten the bolts to 20 N·m (15 lb ft). Tighten the exhaust manifold bolts beginning with the centre 2 bolts. Alternate from side-to-side, and work toward the outside bolts.



5. Install the exhaust manifold heat shield (1).
 6. Install the exhaust manifold heat shield to exhaust manifold retaining bolts (2).
- Tighten**
Tighten the bolts to 10 N·m (89 lb in).

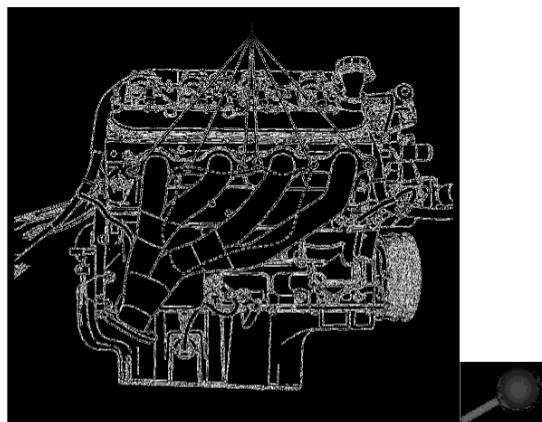
Exhaust Manifold Removal - Right Side (HSV)



1. Install a NEW exhaust manifold gasket (1) and a NEW sealing ring (3) onto the exhaust manifold (2).

Caution: Refer to [Exhaust System Inspection Caution](#).

2. Install the exhaust manifold assembly to engine.



Note: Do not fully tighten the exhaust manifold to cylinder head retaining bolts (1) at this stage.

3. Install the NEW exhaust manifold to cylinder head retaining bolts (1).
Do not fully tighten at this stage.
4. Clean the threads of the exhaust manifold to catalytic converter retaining studs with a suitable cleaning solvent.

Caution: Refer to [Fastener Caution](#).

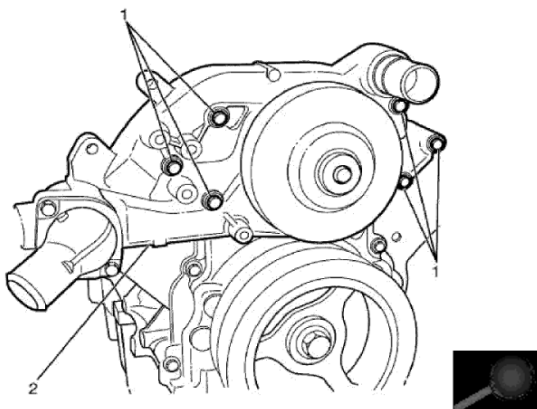
5. Tighten the exhaust manifold to cylinder head retaining bolts (1) working from the centre to the outside.

Tighten

Tighten the bolts to 20 Nm (15 lb ft).

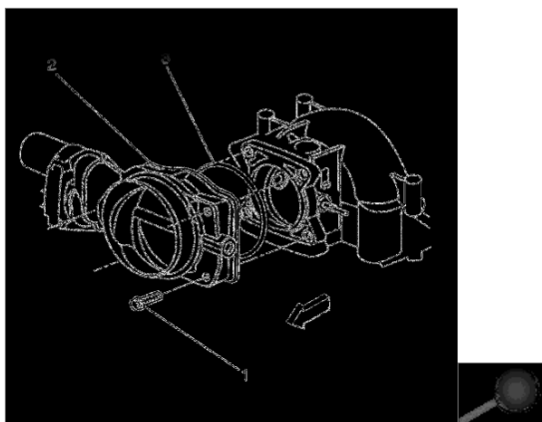
Water Pump Removal

1. Remove drive belt tensioner. Refer to [Drive Belt Tensioner Replacement - Air Conditioning](#) and [Drive Belt Tensioner Replacement - Accessory](#).



2. Remove the water pump to engine retaining bolts (1).
- Note:** Use of a soft peen hammer will aid in the removal of the water pump (2).
3. Remove the water pump (2).

Throttle Body Assembly Removal (LS3 or L77)



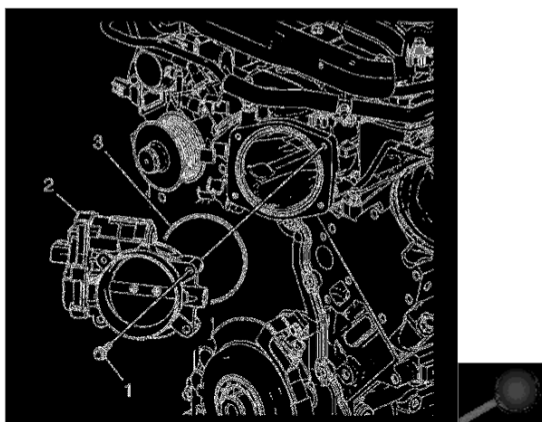
Caution: Handle the electronic throttle control components carefully. Use cleanliness in order to prevent damage. Do not drop the electronic throttle control components. Do not roughly handle the electronic throttle control components. Do not immerse the electronic throttle control components in cleaning solvents of any type.

Note: The intake manifold, throttle body, fuel injection rail, and fuel injectors may be removed as an assembly. If not servicing the individual components, remove the manifold as a complete assembly.

1. Remove the throttle body to intake manifold retaining bolts (3).
2. Remove the throttle body (1).
3. Remove the throttle body gasket (2).
Discard the throttle body gasket (2).

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Throttle Body Assembly Removal (LSA)



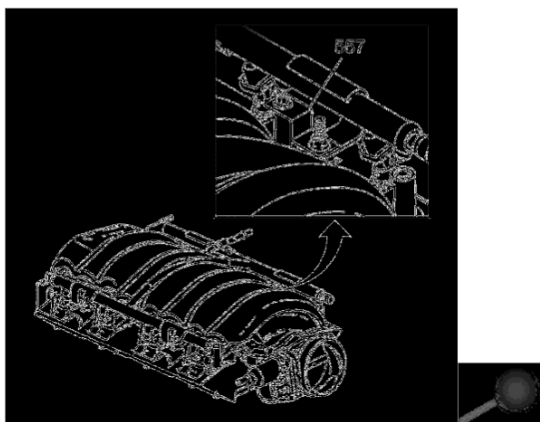
Caution: Handle the electronic throttle control components carefully. Use cleanliness in order to prevent damage. Do not drop the electronic throttle control components. Do not roughly handle the electronic throttle control components. Do not immerse the electronic throttle control components in cleaning solvents of any type.

Note: The intake manifold, throttle body, fuel injection rail, and fuel injectors may be removed as an assembly. If not servicing the individual components, remove the manifold as a complete assembly.

1. Remove the throttle body bolts (1).
2. Remove the throttle body (2).
3. Remove the throttle body seal (3).
4. Discard the seal.

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Fuel Rail and Injectors Removal (LS3 or L77)

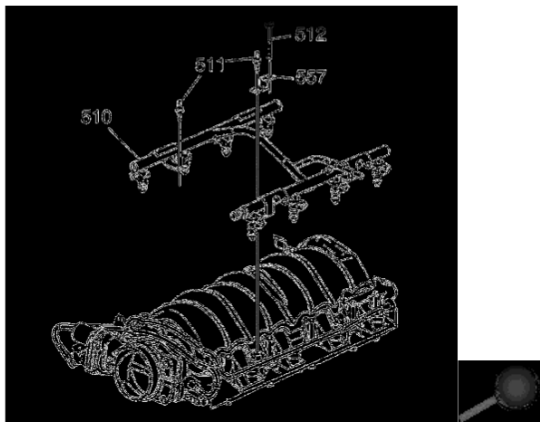


Warning: Refer to [Fuel Rail Stop Bracket Installation Warning](#).

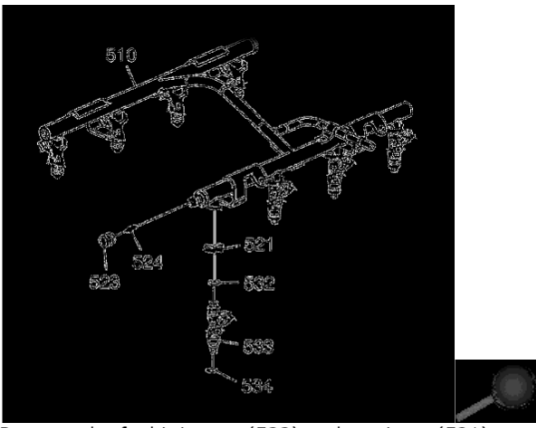
Note:

- The intake manifold, throttle body, fuel injection rail and fuel injectors may be removed as an assembly. If not servicing the individual components, remove the intake manifold as a complete assembly.
- Do not separate the fuel injectors from the fuel rail unless component service is required.
- Use cleanliness and care when handling the fuel system components. Do not allow dirt or debris to enter the fuel injectors or fuel rail components. Cap ends as necessary.

1. Note the location of the fuel rail ground strap (557).

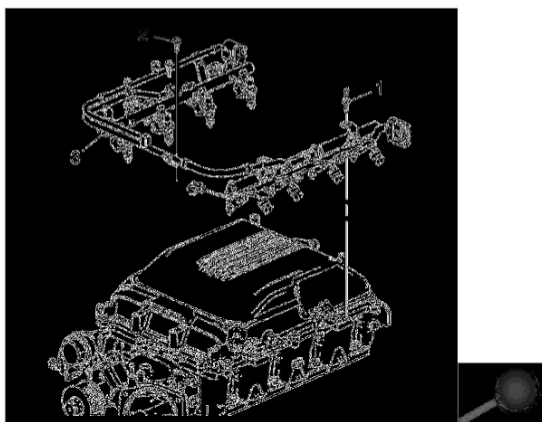


2. Remove the bolts (511 and 512), ground strap (557), and fuel rail with injectors (510). Lift evenly on both sides of the fuel rail until all injectors have left their bores.



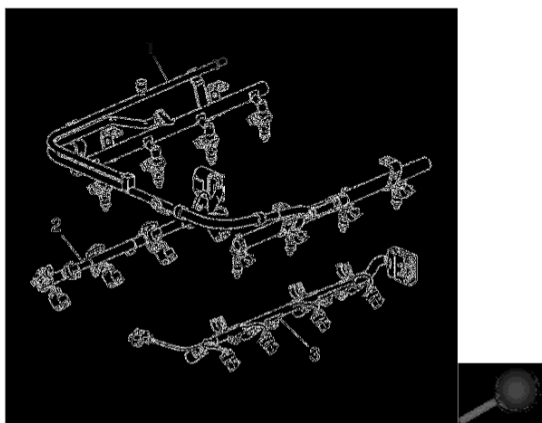
3. Remove the fuel injectors (533) and retainers (521).
4. Remove the O-rings (532 and 534), as required.
5. Remove the cap (523) and service valve (524), as required.

Fuel Rail and Injectors Removal (LSA)

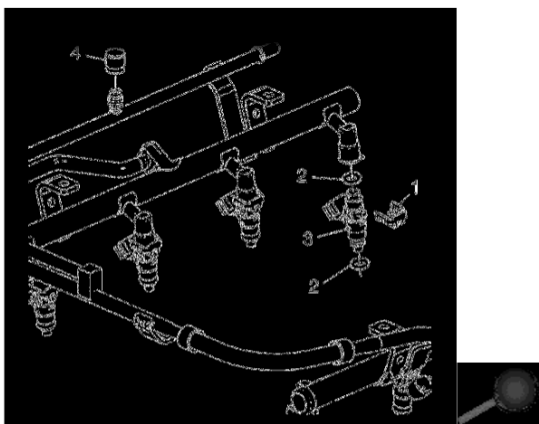
**Note:**

- The supercharger, throttle body, fuel injection rail and fuel injectors may be removed as an assembly. If not servicing the individual components, remove the supercharger as an assembly.
- Do not separate the fuel injectors from the fuel rail, unless component service is required.
- Use cleanliness and care when handling the fuel system components. Do not allow dirt or debris to enter the fuel injectors or fuel rail components. Cap ends as necessary.

1. Remove the studs (1), bolt (2) and fuel rail (3). Remove the left side of the fuel rail with flex-hose first, then remove the right side of the fuel rail until all injectors have left their bores.

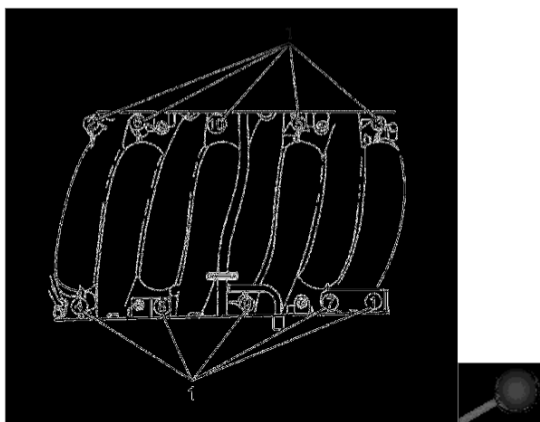


2. Remove the wiring harnesses (2) and (3) from the fuel rail (1).



3. Remove the retainers (1) and fuel injectors (3).
4. Remove the O-rings (2), as required.
5. Remove the service port cap (4), as required.

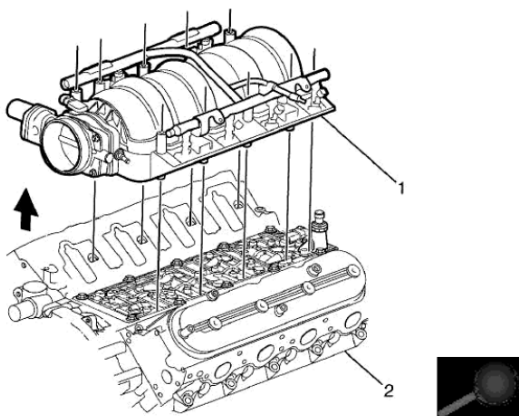
Intake Manifold Removal



Note: The intake manifold, throttle body, fuel injection rail, and fuel injectors may be removed as an assembly. If not servicing the individual components, remove the manifold as a complete assembly.

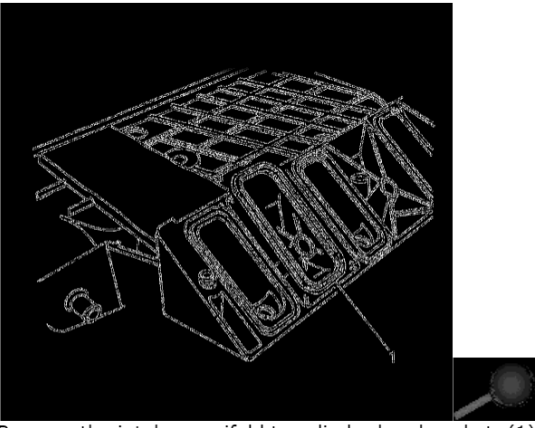
Note: Removal of the intake manifold to cylinder head retaining bolts (1) should be performed in sequence. Failing to do so may distort the intake manifold.

1. Remove the intake manifold to cylinder head retaining bolts (1) in sequence.



2. Remove the intake manifold (1) from the engine (2).
3. Plug the engine (2) with a clean lint free cloth.

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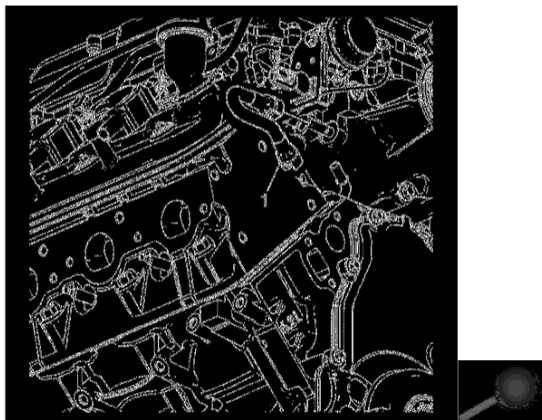
4. Remove the intake manifold to cylinder head gaskets (1).
Discard the intake manifold to cylinder head gaskets (1).
5. Clean and inspect the intake manifold. Refer to [Intake Manifold Cleaning and Inspection](#).

Supercharger Removal

Special Tools

EN 48898 Supercharger Lift Fixture

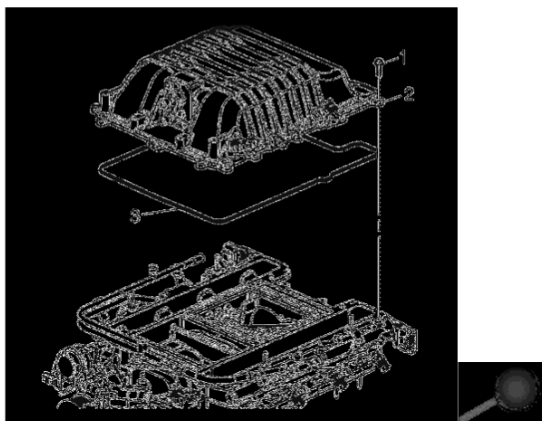
For equivalent regional tools, refer to [Special Tools](#)



Note:

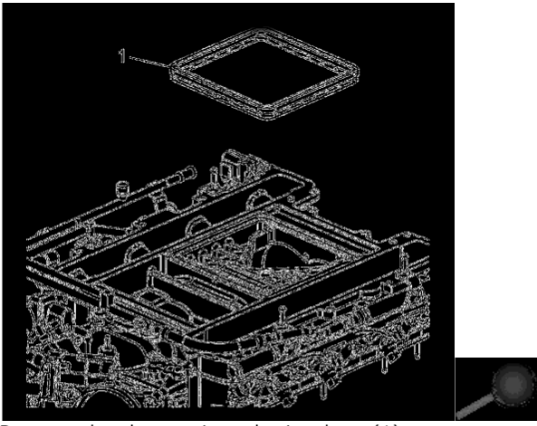
- The supercharger, throttle body, fuel injection rail and fuel injectors may be removed as an assembly. If not servicing the individual components, remove the supercharger as an assembly.
- Cover the inlet area of the supercharger to prevent dirt or debris contamination onto the rotors.

1. Remove the positive crankcase ventilation (PCV) – dirty air hose (1) from the valley cover and supercharger.

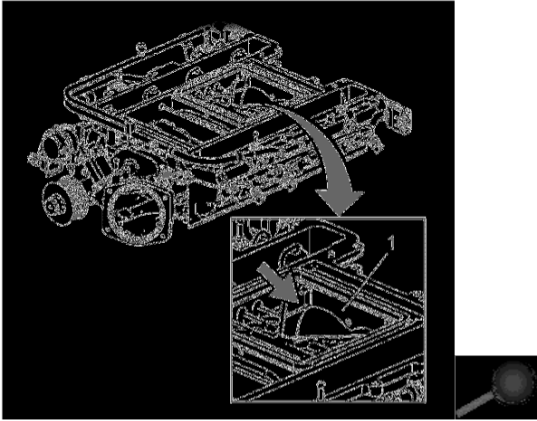


2. Remove the supercharger cover bolts (1) and the supercharger cover (2).
3. Remove the supercharger cover seal (3).

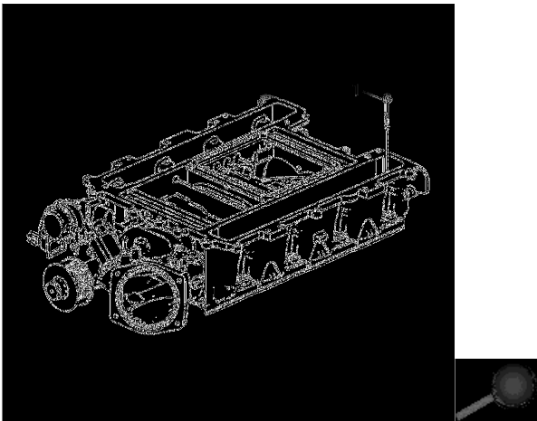
© 2014 General Motors. All rights reserved.



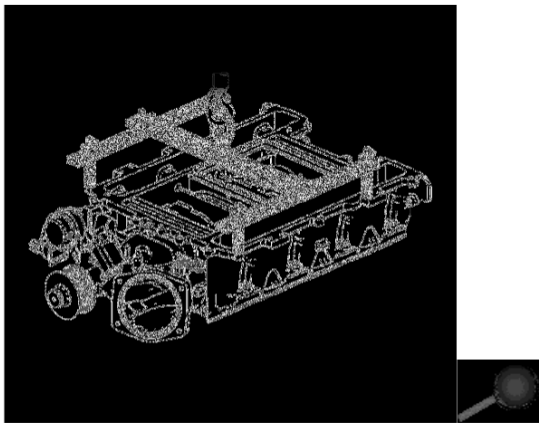
4. Remove the charge air cooler insulator (1).



5. Cover the supercharger rotors area (1) to prevent dirt or debris contamination onto the rotors.



6. Remove the supercharger bolts (1).

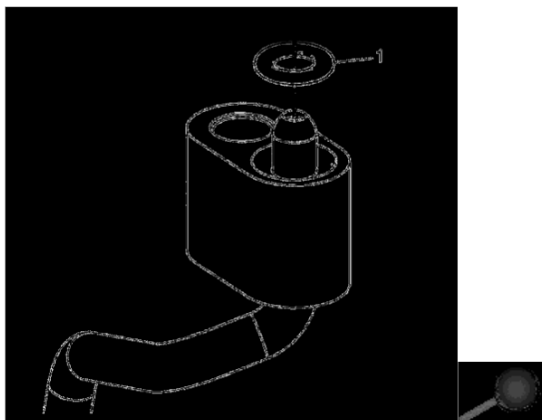


7. Install the *EN 48898* fixture to the supercharger and tighten the *EN 48898* fixture studs and nuts until snug.
8. Using a lifting device, remove the supercharger from the engine.

Engine Coolant Air Bleed Pipe and Hole Cover Removal (LSA)



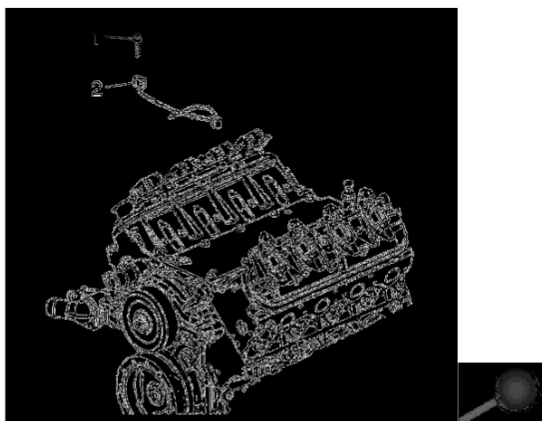
1. Remove the engine coolant air bleed pipe bolts (1).
2. Remove the pipes (2 and 3).



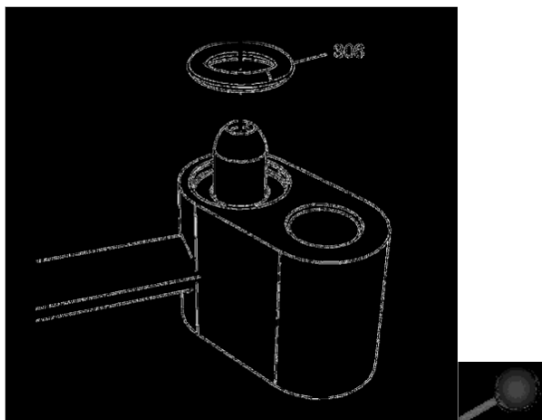
3. Remove the seals (1) from the pipes.
4. Discard the seals.

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Engine Coolant Air Bleed Pipe and Hole Cover Removal (LS3 or L77)



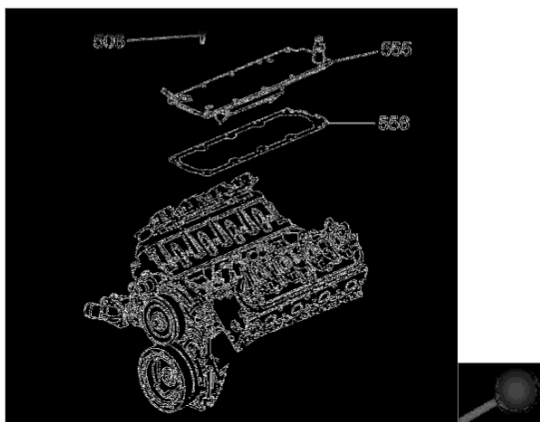
1. Remove the engine coolant air bleed pipe bolts (1).
2. Remove the pipe (2).



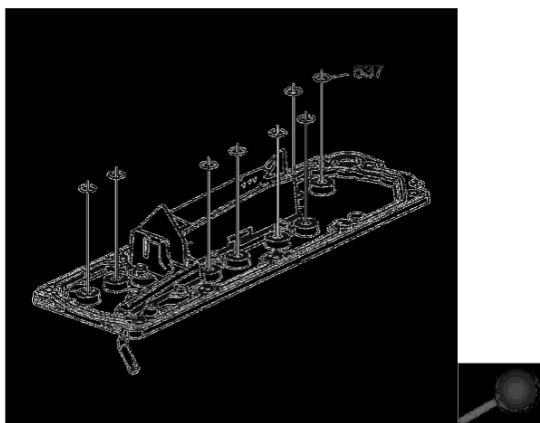
3. Remove the seals (308) from the pipe.
4. Discard the seals.

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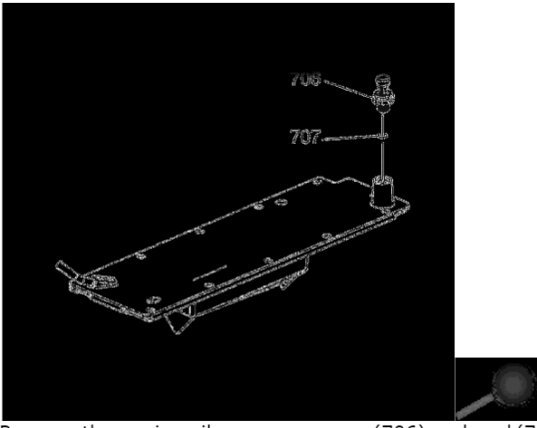
Engine Block Valley Cover Removal



1. Remove the engine block valley cover bolts (506).
2. Remove the valley cover (555) and gasket (556).

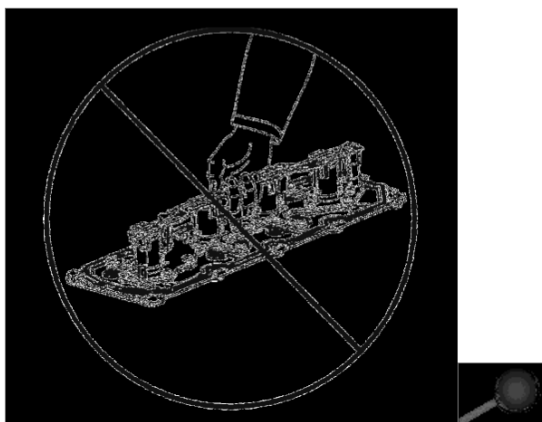


3. Remove the seals (537) from the cover.

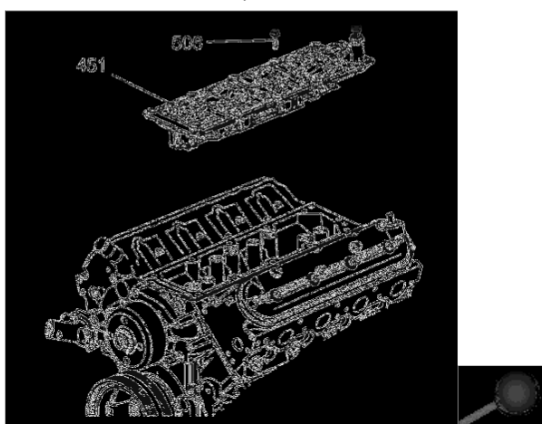


4. Remove the engine oil pressure sensor (706) and seal (707), as required.

Valve Lifter Oil Manifold Removal



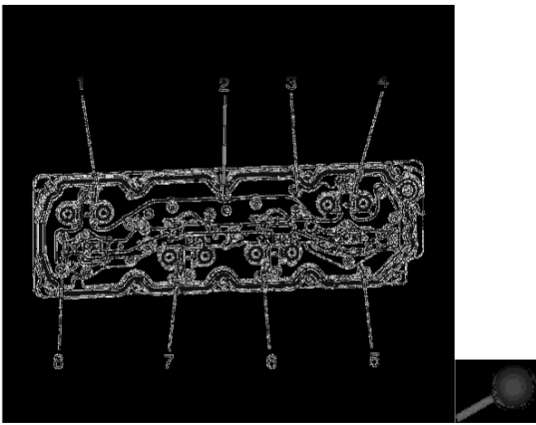
1. Do not lift the manifold by the electrical lead frame.



2. Remove the valve lifter oil manifold bolts (506).

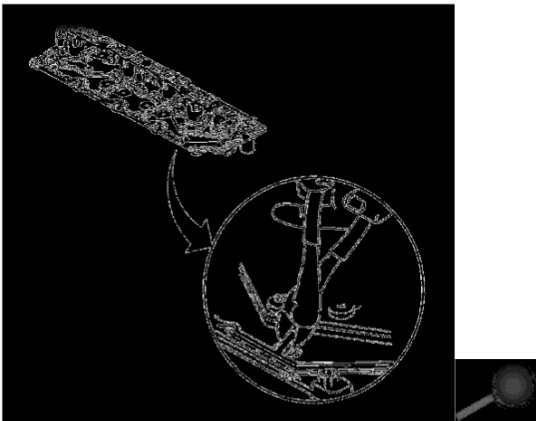
Important: Do not allow dirt or debris to enter the oil passages of the manifold. Plug, as required.

3. Remove the valve lifter oil manifold (451).

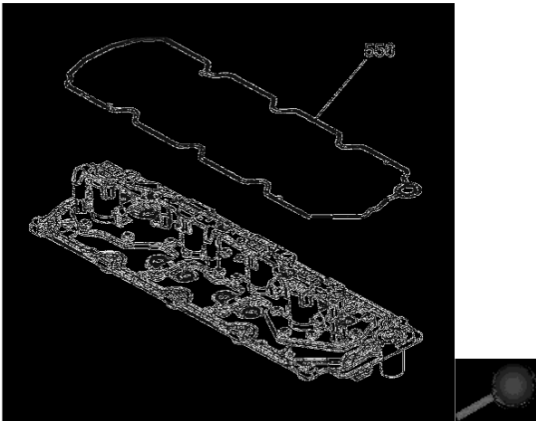


Important: Remove only the outer gasket from the manifold. Do not disassemble any of the internal components of the manifold in an attempt to remove the 8 inner sealing gaskets. If the inner gaskets are cut or damaged, replace the manifold as an assembly. Only use a wire-cutter type tool in order to minimize the amount of debris. Do not use a rotary-type cutting tool on the retaining straps.

4. Identify the 8 gasket retaining strap locations (1-8).

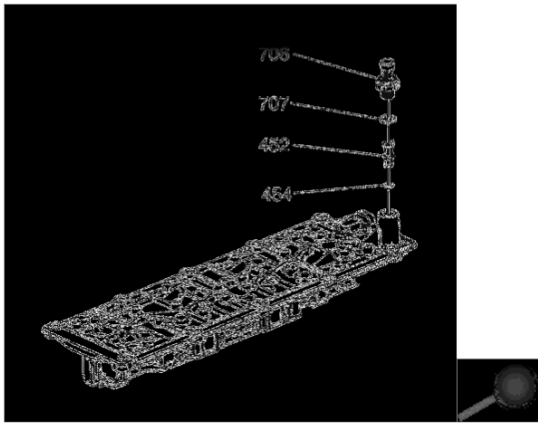


5. Using a wire-cutter type tool, cut the 8 retaining straps.



6. Remove the outer gasket (556) from the manifold.

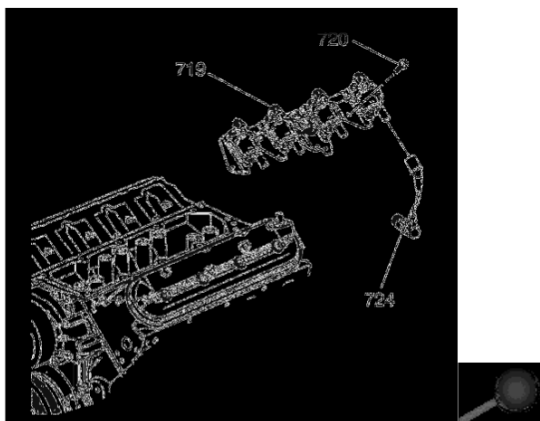
Valve Lifter Oil Filter Removal



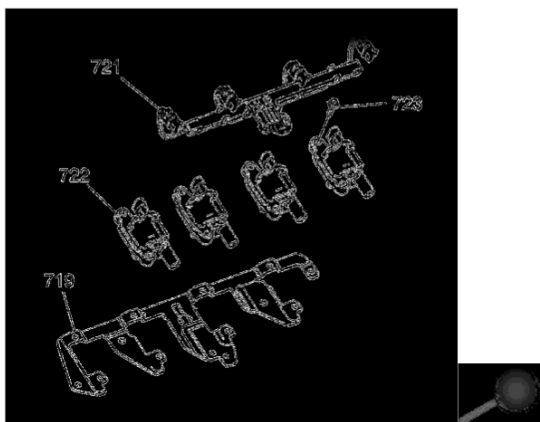
Important: Do not allow dirt or debris to enter the oil passages of the manifold. Plug, as required.

1. Remove the oil pressure sensor (706) and washer (707).
2. Remove the oil filter (452).
3. Inspect the O-ring (454) for cuts or damage. If the filter is plugged or the O-ring is cut or damaged, replace the filter and O-ring as an assembly.

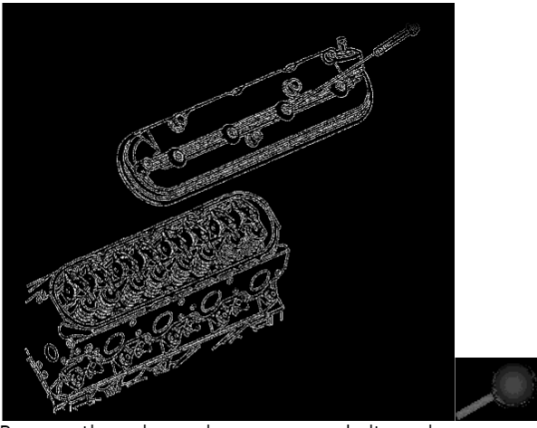
Valve Rocker Arm Cover Removal - Left Side (LS3 or L77)



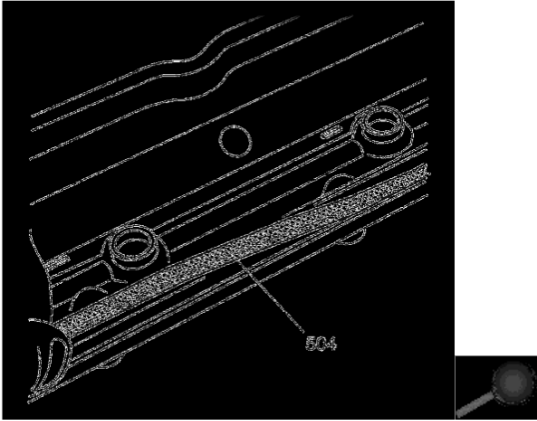
1. Remove the spark plug wires (724).
2. Remove the ignition coil bracket studs (720).
3. Remove the ignition coil and bracket assembly (719).



4. Disconnect the ignition coil electrical connectors.
5. Remove the bolts (723), coils (722), and wire harness (721) from the bracket (719), as required.

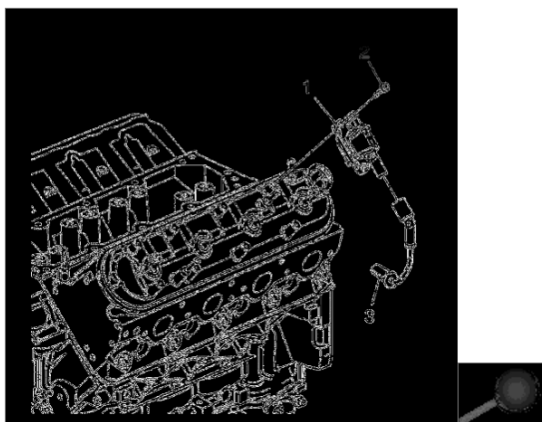


6. Remove the valve rocker arm cover bolts and cover.
7. If the valve rocker arm cover grommets are cracked or damaged, replace the valve rocker arm cover bolts. The grommet is serviced with the rocker arm cover bolt.

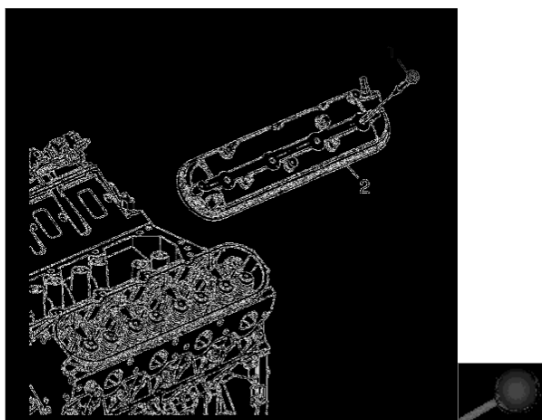


8. Remove and discard the valve rocker arm cover gasket (504) from the cover.

Valve Rocker Arm Cover Removal - Left Side (LSA)



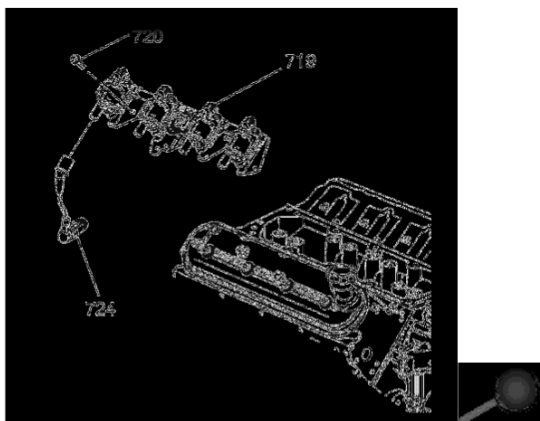
1. Remove the spark plug wires (3), as required.
2. Remove the ignition coil bolts (2) and ignition coils (1).



3. Remove the valve rocker arm cover bolts (1) and cover (2).
4. Remove and discard the valve rocker arm cover gasket, valve rocker arm cover grommets and valve rocker arm cover bolts if they are serviced with the grommet.

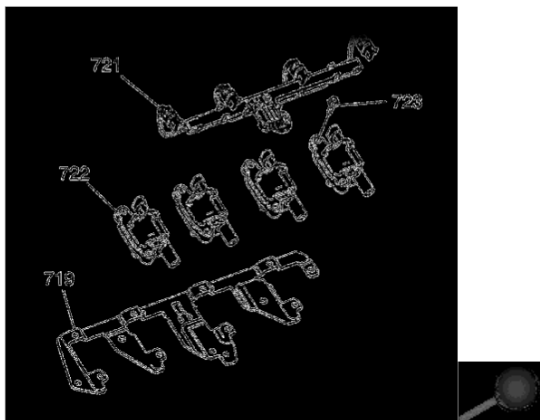
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Valve Rocker Arm Cover Removal - Right Side (LS3 or L77)



Important: Do not remove the oil fill tube from the cover, unless service is required. If the oil fill tube has been removed from the cover, install a NEW tube during assembly.

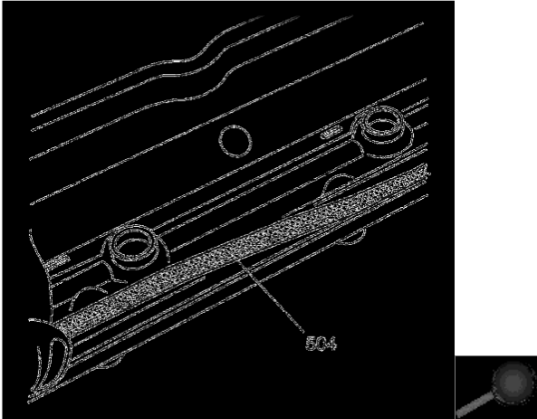
1. Remove the spark plug wires (724).
2. Remove the ignition coil bracket studs (720).
3. Remove the ignition coil and bracket assembly (719).



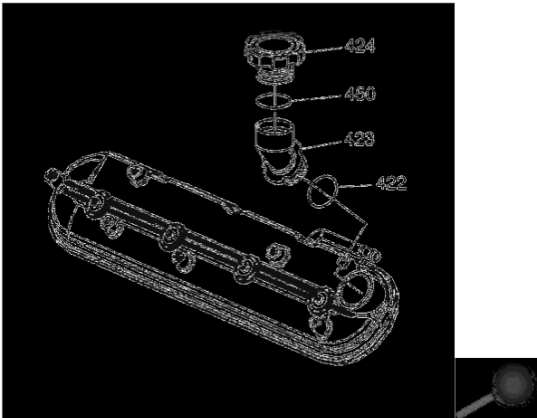
4. Disconnect the ignition coil electrical connectors.
5. Remove the bolts (723), coils (722), and wire harness (721) from the bracket (719), as required.



6. Remove the valve rocker arm cover bolts and cover.
7. If the valve rocker arm cover grommets are cracked or damaged, replace the valve rocker arm cover bolts. The grommet is serviced with the rocker arm cover bolt.



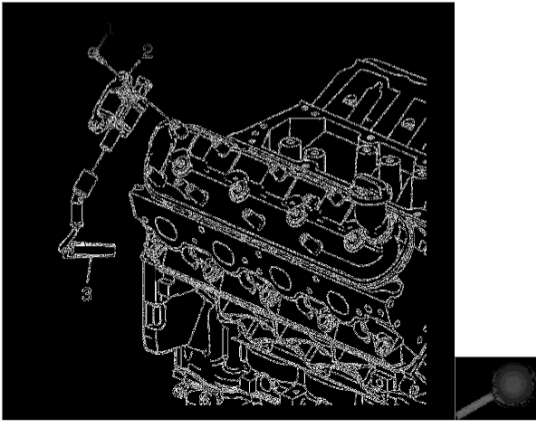
8. Remove and discard the valve rocker arm cover gasket (504) from the cover.



9. Remove the oil fill cap (424) from the oil fill tube (423).
10. Remove the oil fill tube, as required.

11. Discard the oil fill tube.

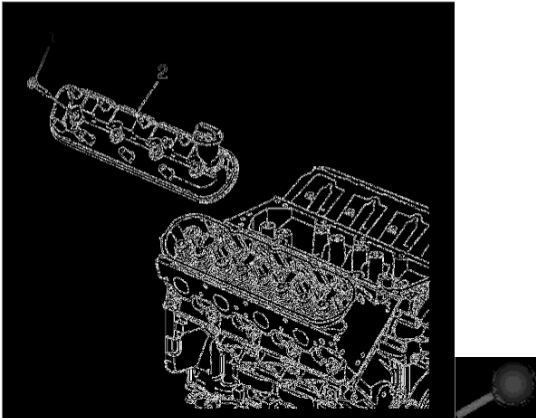
Valve Rocker Arm Cover Removal - Right Side (LSA)



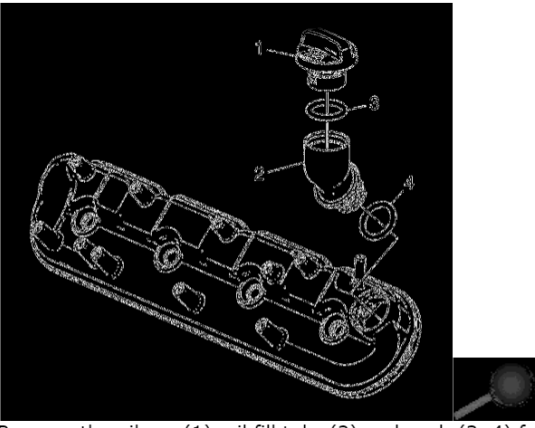
Note: Do not remove the oil fill tube from the cover unless service is required. If the oil fill tube has been removed from the cover, the locking features of the tube will be damaged and no longer functional.

If the oil fill tube has been removed, install a NEW oil fill tube during assembly.

1. Remove the spark plug wires (3), as required.
2. Remove the ignition coil bolts (1) and ignition coils (2).



3. Remove the valve rocker arm cover bolts (1) and cover (2).
4. Remove and discard the valve rocker arm cover gasket, valve rocker arm cover grommets and valve rocker arm cover bolts if they are serviced with the grommet.



5. Remove the oil cap (1), oil fill tube (2) and seals (3, 4) from the cover, as required.

Valve Rocker Arm and Push Rod Removal



Note: Place the valve rocker arms, valve pushrods, and pivot support in a rack so they can be installed in the same location from which they were removed.

1. Remove the valve rocker arm bolts.
2. Remove the valve rocker arms.

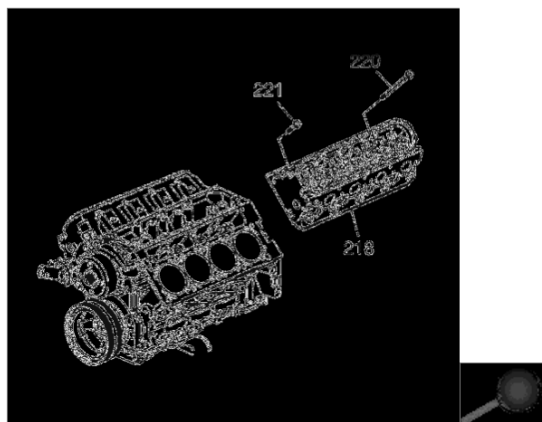


3. Remove the valve rocker arm pivot support.



4. Remove the pushrods.

Cylinder Head Removal - Left Side



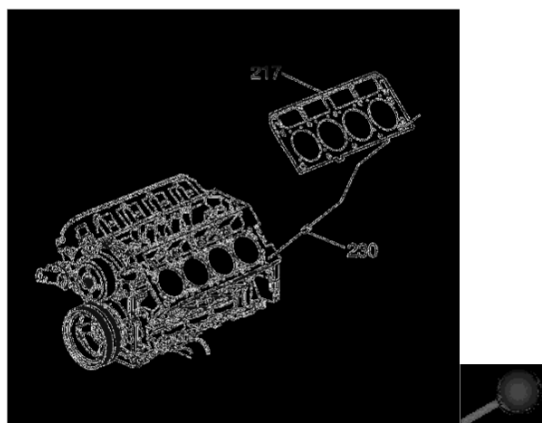
1. If camshaft lobe lift measurement is required, perform measurement prior to removal of the cylinder heads. Refer to [Camshaft and Bearings Cleaning and Inspection](#).

Note: The cylinder head bolts are of a torque-to-yield design and are NOT to be used again. Install NEW cylinder head bolts during assembly.

2. Remove the cylinder head bolts (220, 221).

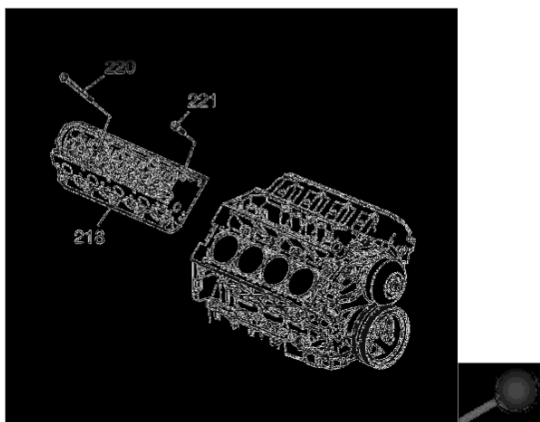
Caution: After removal, place the cylinder head on 2 wood blocks in order to prevent damage to the sealing surfaces.

3. Remove the cylinder head (218).



4. Remove the gasket (217) and locating pins (230).
5. Discard the gasket and cylinder head bolts.

Cylinder Head Removal - Right Side



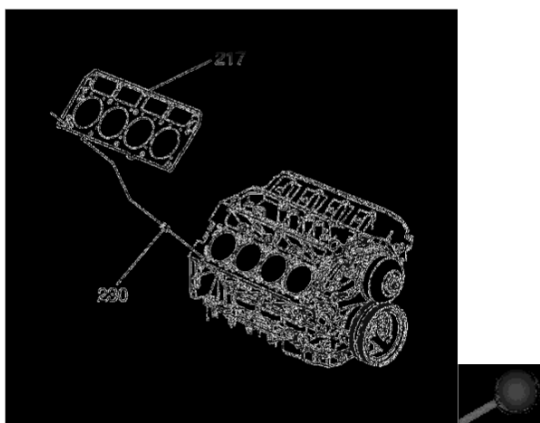
1. If camshaft lobe lift measurement is required, perform measurement prior to removal of the cylinder heads. Refer to [Camshaft and Bearings Cleaning and Inspection](#).

Note: The cylinder head bolts are of a torque-to-yield design and are NOT to be used again. Install NEW cylinder head bolts during assembly.

2. Remove the cylinder head bolts (220, 221).

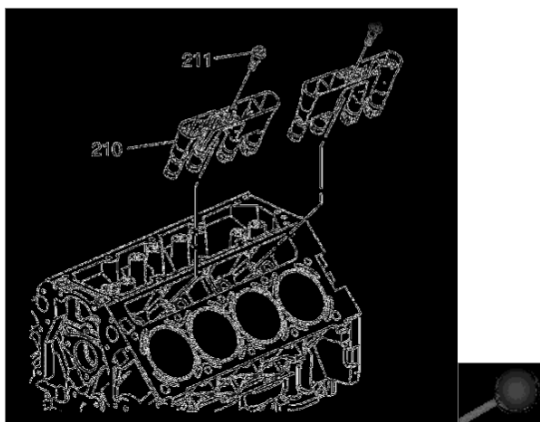
Caution: After removal, place the cylinder head on 2 wood blocks in order to prevent damage to the sealing surfaces.

3. Remove the cylinder head (218).



4. Remove the gasket (217) and locating pins (230).
5. Discard the gasket and cylinder head bolts.

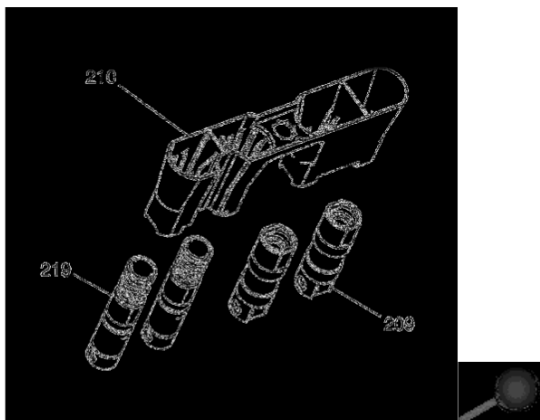
Valve Lifter Removal (L77)



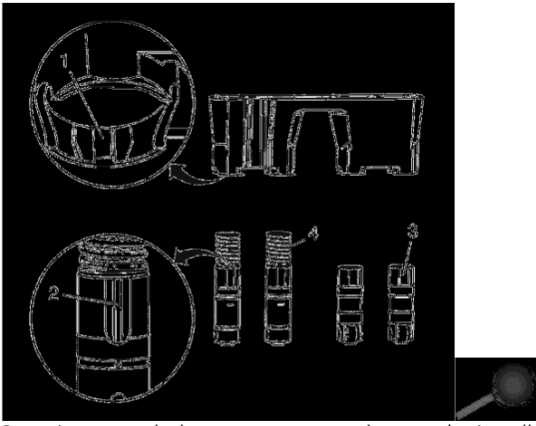
1. Remove the bolts (211).

Note: Observe the installed position of the guides. The notched area of the guide is to align with the locating tab of the block.

2. Remove the guides (210) with lifters.

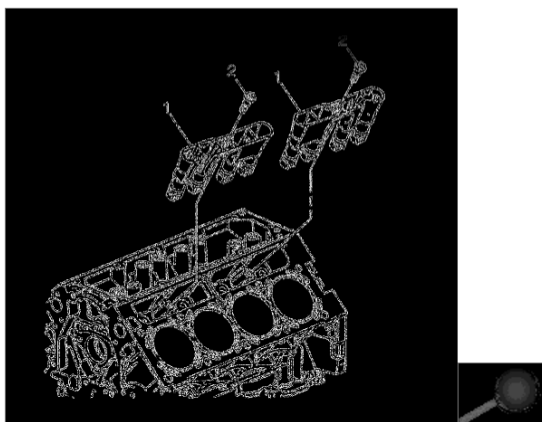


3. Remove the valve lifters (209, 219) from the guide (210).



4. Organize or mark the components so they can be installed in the same location from which they were removed. The active fuel management lifters (4) are installed into the guide by aligning the notched area of the guide (1) with the raised surface on the side of the lifter (2). Refer to [Separating Parts](#).

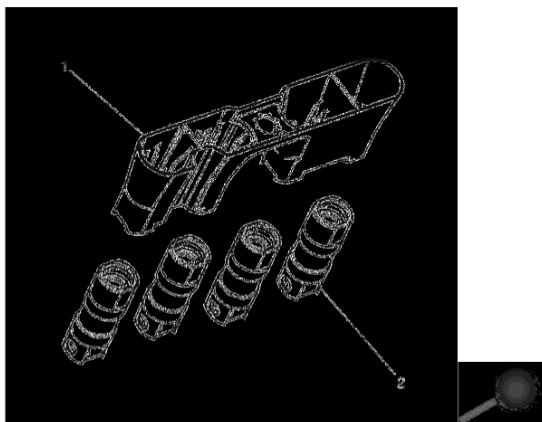
Valve Lifter Removal (LS3 or LSA)



1. Remove the lifter guide (1) to cylinder block retaining bolts (2).

Note: Note the installed position of the guides. The notched area of the guide is to align with the locating tab on the block.

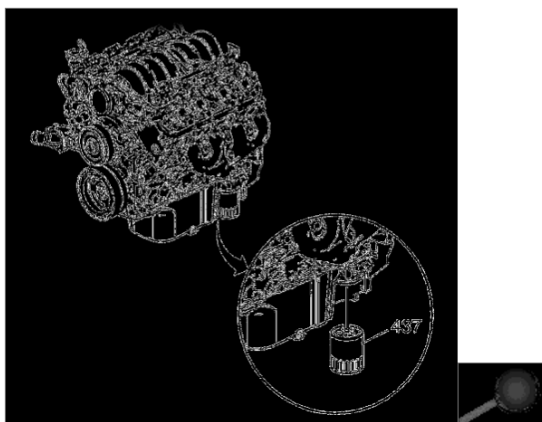
2. Remove the valve lifter guides (1) with valve lifters.



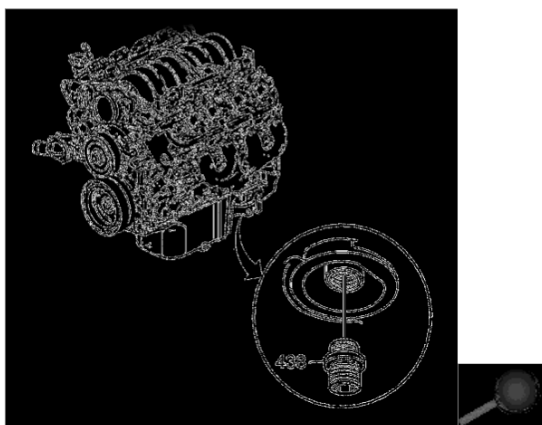
Note: When using the valve train components again, always install the components to the original location and position. Refer to [Separating Parts](#).

3. Remove the valve lifters (1) from the valve lifter guide (2).

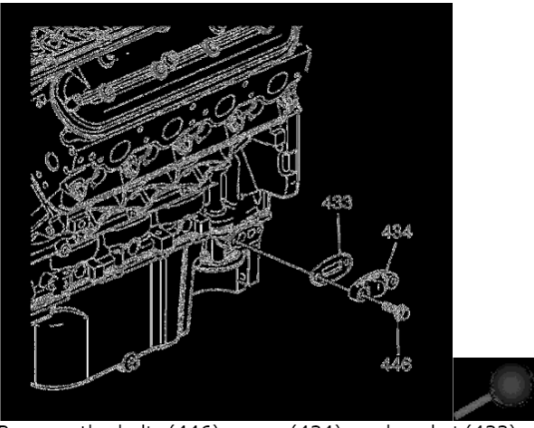
Oil Filter, Adapter, and Pan Cover Removal



1. Remove the oil filter (437).

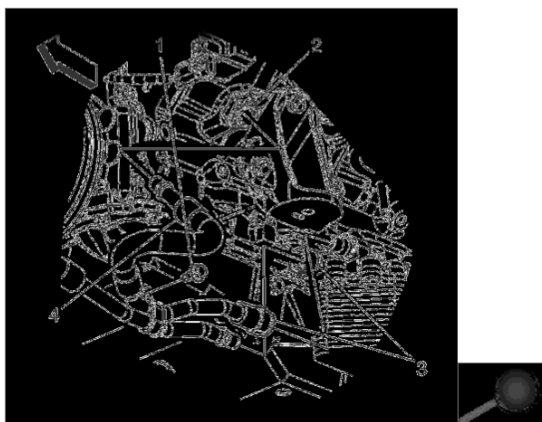


2. Remove the oil filter fitting (438) as required.

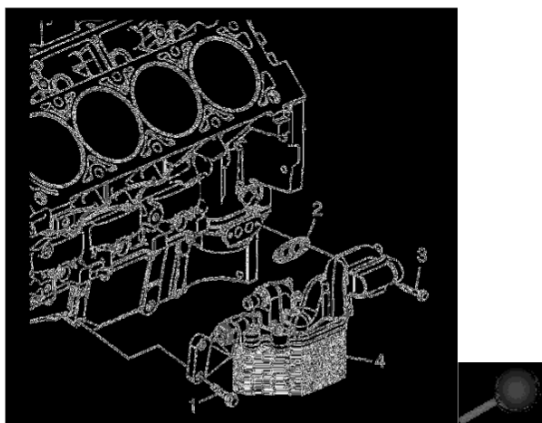


3. Remove the bolts (446), cover (434), and gasket (433).

Engine Oil Cooler Removal



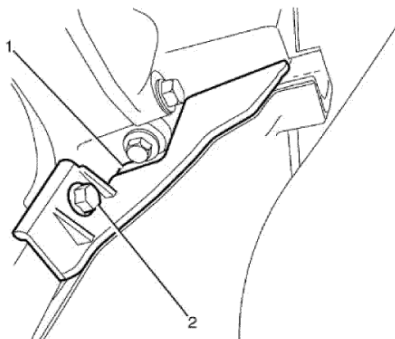
1. Remove the engine oil cooler coolant hose/pipe bolt (1).
2. Disconnect the hose/pipe (4) from the engine block coolant fitting (2) and oil cooler (3).
3. Remove the hose/pipe.



4. Remove the oil cooler M8 (1) and M6 (3) bolts.
5. Remove the oil cooler (4).
6. Remove the oil cooler gasket (2).

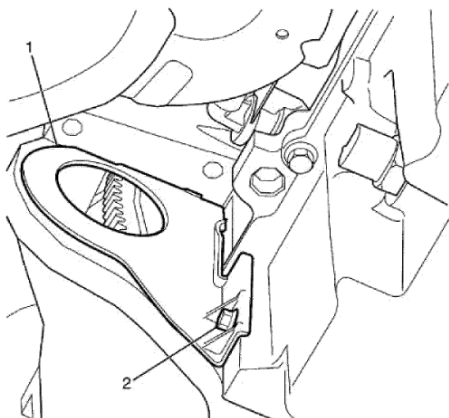
Oil Pan Removal

Removal Procedure

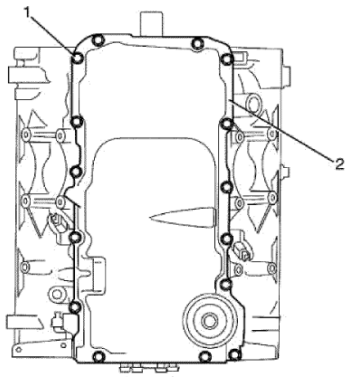
**Note:**

- The original oil pan gasket is retained and aligned to the oil pan by rivets. When installing a new gasket, it is not necessary to install new oil pan gasket rivets.
- DO NOT use the oil pan gasket again. When installing the oil pan, install a NEW oil pan gasket.

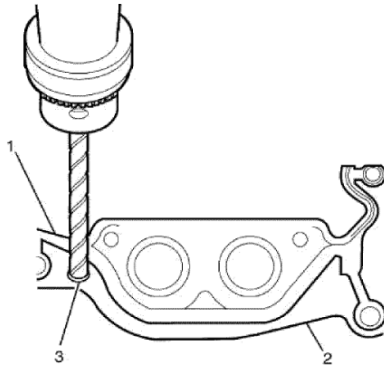
1. Remove the left side close out cover to cylinder block retaining bolt (2).
2. Remove the left side close out (1).



3. Remove the right side close out cover to cylinder block retaining bolt (2).
4. Remove the right side close out (1).



5. Remove the oil pan to cylinder block retaining bolts (1).
6. Remove the oil pan (2).



Note:

- DO NOT allow foreign material to enter the oil passages of the oil pan. Cap or cover the openings, as required.
- Use care not to gouge, score, or damage the oil pan sealing surface.

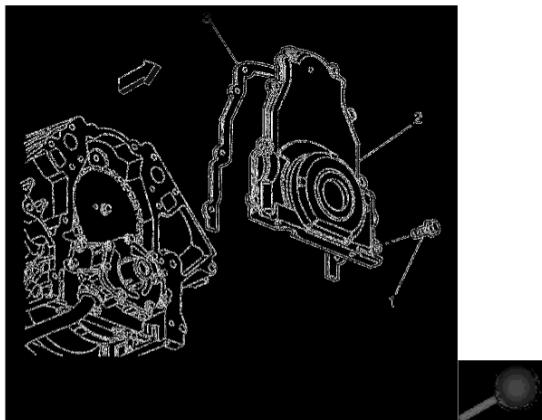
7. Drill (3) out the retaining rivets, if required.

Note: The oil pan gasket and rivets are single use only components and must be replaced whenever the oil pan is removed from the cylinder block.

8. Remove the oil pan gasket (1) from the oil pan.
Discard the gasket and rivets.

Engine Front Cover Removal

1. Remove the camshaft position sensor (CMP). Refer to [Camshaft Position Sensor Replacement](#).

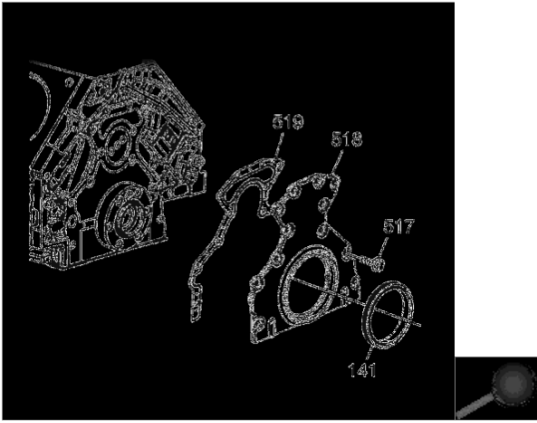


2. Remove the engine front cover to cylinder block retaining bolts (1).

Important: The engine front cover gasket (3) is a single use only component and must be replaced whenever the engine front cover (2) is removed.

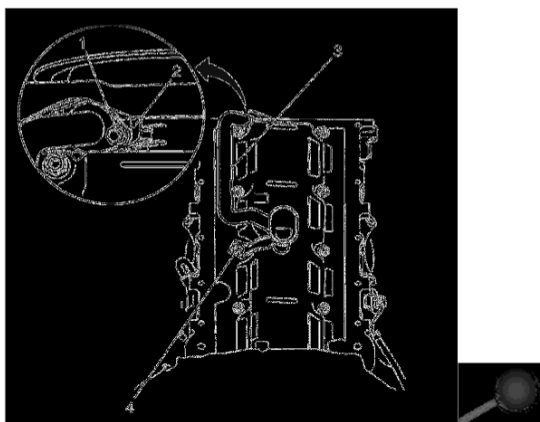
3. Remove the engine front cover (2) and gasket (3).
4. Remove the engine front cover gasket (3).
Discard the engine front cover gasket (3).
5. Clean and inspect the engine front cover. Refer to [Engine Front Cover Cleaning and Inspection](#)

Crankshaft Rear Oil Seal Housing Removal

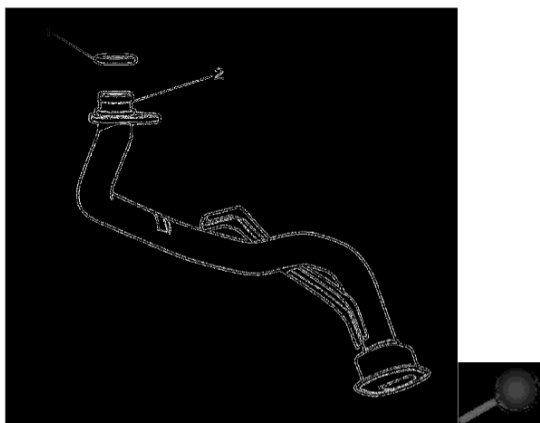


1. Remove the rear oil seal housing bolts (517).
2. Remove the housing (518) and gasket (519).
3. Remove the rear oil seal (141).

Oil Pump, Screen and Crankshaft Oil Deflector Removal



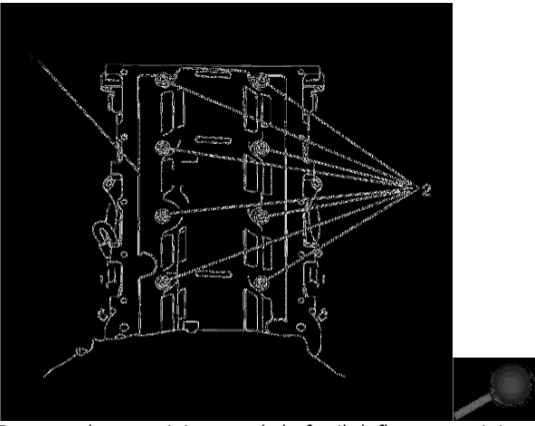
1. Remove the oil pump screen and tube assembly to oil pump retaining bolt (1).
2. Remove the oil pump screen and tube assembly to crankshaft oil deflector retaining nut (4).
3. Remove the oil pump screen and tube assembly (3) from the oil pump (2).



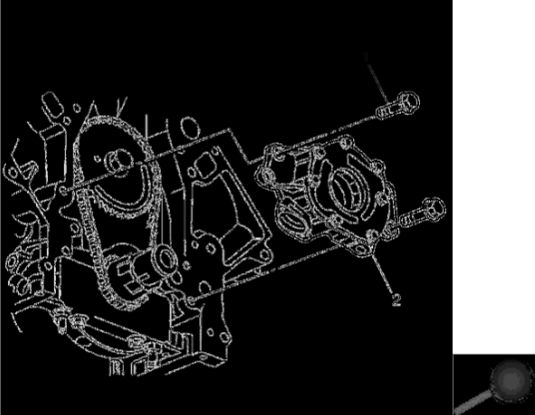
Important: The oil pump screen and tube assembly O-ring seal (1) is a single use only component and must be replaced whenever the oil pump screen and tube assembly (2) is removed.

4. Remove the oil pump screen and tube assembly O-ring seal (1) from the oil pump screen and tube assembly (2).

Discard the oil pump screen and tube assembly O-ring seal (1).



5. Remove the remaining crankshaft oil deflector retaining nuts (2).
6. Remove the crankshaft oil deflector (1).



7. Remove the oil pump bolt (1).

Important: Do not allow dirt or debris to enter the oil pump, cap the ends as necessary.

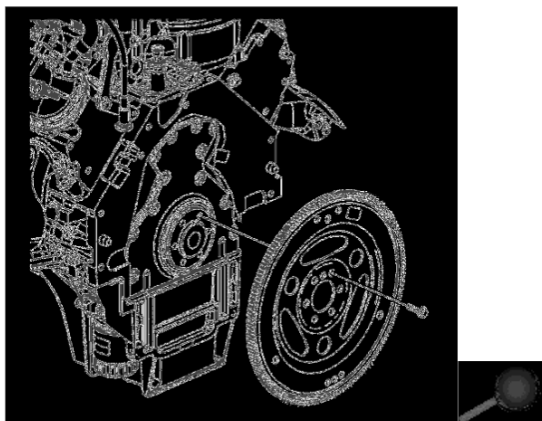
8. Remove the oil pump (2).
9. Clean and inspect the oil pump. Refer to [Oil Pump Cleaning and Inspection](#).

Timing Chain and Sprocket Removal

Special Tools

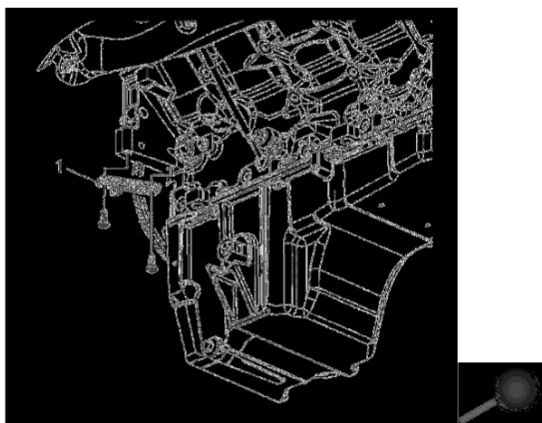
- J 8433 Two Jaw Puller
- J 41558 Crankshaft Sprocket Remover
- J 41816-2 Crankshaft End Protector
- J 42386-A Flywheel Holding Tool

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



Note: Do not apply threadlock to the flex plate bolts at this time.

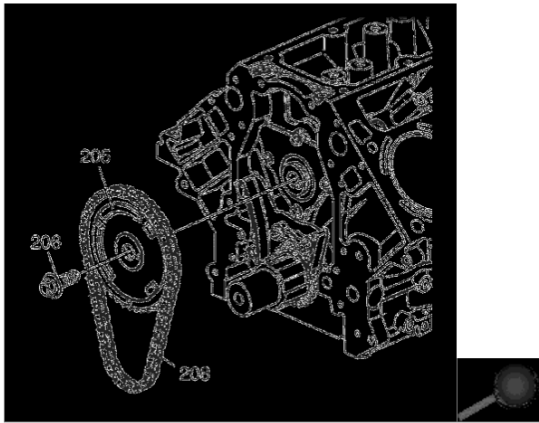
1. Temporarily install the automatic transmission flex plate and bolts. Refer to [Automatic Transmission Flex Plate Installation](#).



Caution: Refer to [Fastener Caution](#).

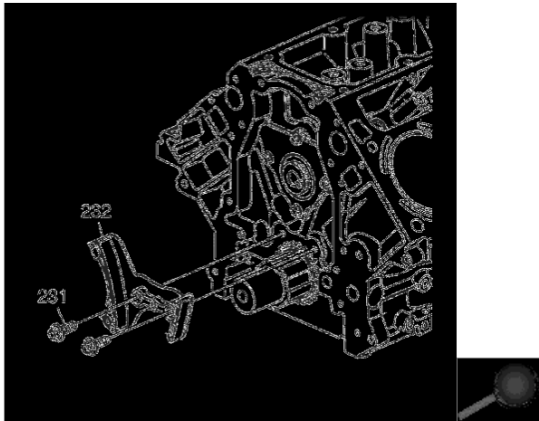
2. Install the J 42386-A tool (1) and bolts. Use 1 M10 – 1.5 x 120 mm and 1 M10 – 1.5 x 45 mm bolt for proper tool operation. Tighten the J 42386-A tool bolts to **50 N·m (37 lb ft)**.

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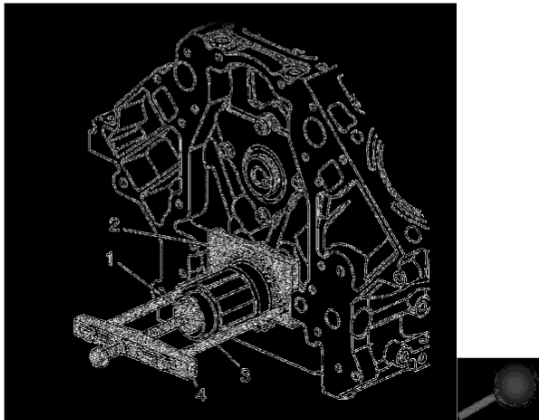


Caution: Do not turn the crankshaft assembly after the timing chain has been removed in order to prevent damage to the piston assemblies or the valves.

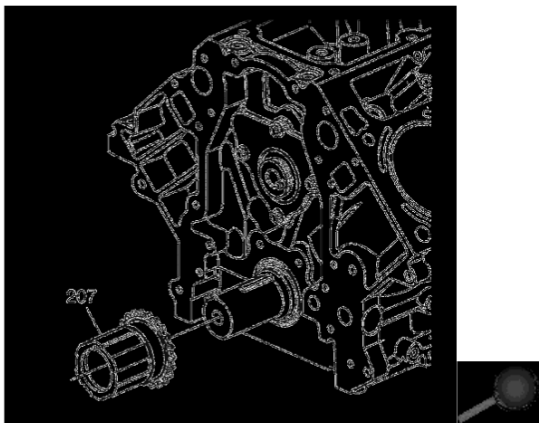
3. Remove and discard the camshaft sprocket bolt (206).
4. Remove the camshaft sprocket (205) and timing chain (208).



5. Remove the bolts (231) and timing chain tensioner (232).



6. Use the *J 41816-2* protector (1), the *J 41558* remover (2), bolts (3), and the *J 8433* puller (4) in order to remove the crankshaft sprocket.

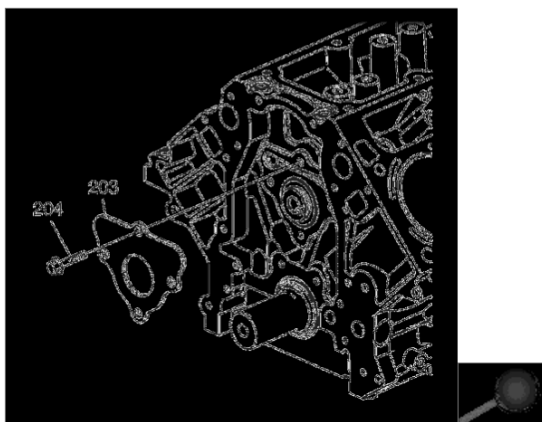


7. Remove the crankshaft sprocket (207).

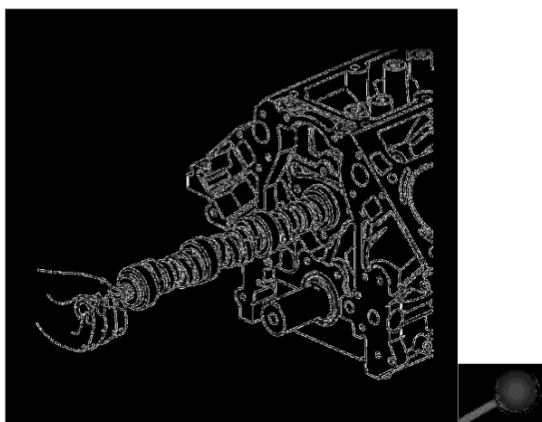


8. Remove the crankshaft sprocket key, as required.
9. Remove the automatic transmission flex plate and bolts. Refer to [Automatic Transmission Flex Plate Removal](#).
10. Remove the *J 42386-A* tool and bolts.

Camshaft Removal



1. Remove the camshaft retainer bolts (204) and retainer (203).



Caution: All camshaft journals are the same diameter, so care must be used in removing or installing the camshaft to avoid damage to the camshaft bearings.

2. Remove the camshaft.
 - 2.1. Install the camshaft sprocket bolt or solenoid valve into the camshaft front bolt hole.
 - 2.2. Using the bolt or solenoid valve as a handle, carefully rotate and pull the camshaft out of the engine block.
 - 2.3. Remove the bolt or solenoid valve from the front of the camshaft.

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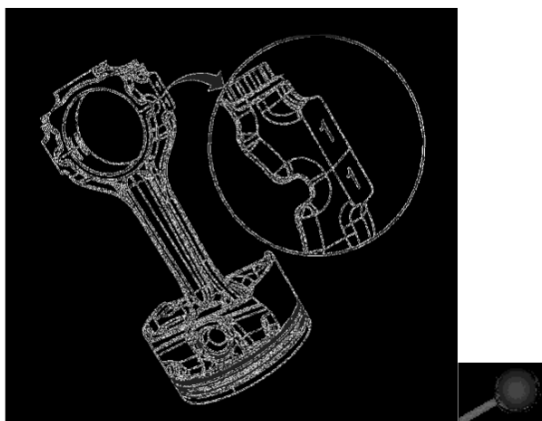
Piston, Connecting Rod, and Bearing Removal

Special Tools

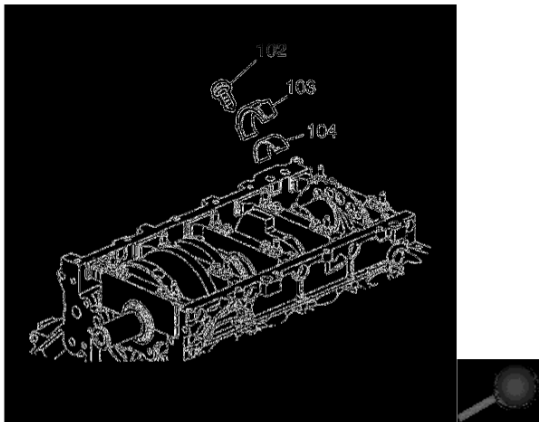
- J 24270 Cylinder Bore Ridge Reamer
- J 41556 Connecting Rod Guide



1. Use the J 24270 cylinder bore ridge reamer in order to remove the cylinder bore ring ridge, if required.
 - 1.1. Turn the crankshaft until the piston is at the bottom of the stroke.
 - 1.2. Place a cloth on top of the piston.
 - 1.3. Use the J 24270 cylinder bore ridge reamer , or equivalent, in order to remove a cylinder ring ridge.
 - 1.4. Turn the crankshaft so the piston is at the top of the stroke.
 - 1.5. Remove the cloth.
 - 1.6. Remove the cutting debris from the cylinder and piston.

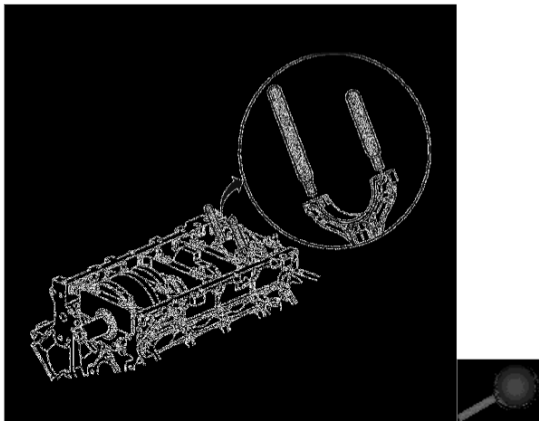


2. Using a paint stick or etching tool, place matchmarks or numbers on the connecting rods and the connecting rod caps. The connecting rods and caps **MUST** be assembled to their original position and direction.
 - A stamping mark on the side of the connecting rod, at the crankshaft journal, may affect component geometry.
 - Mark the top of the piston to the specific cylinder bore.

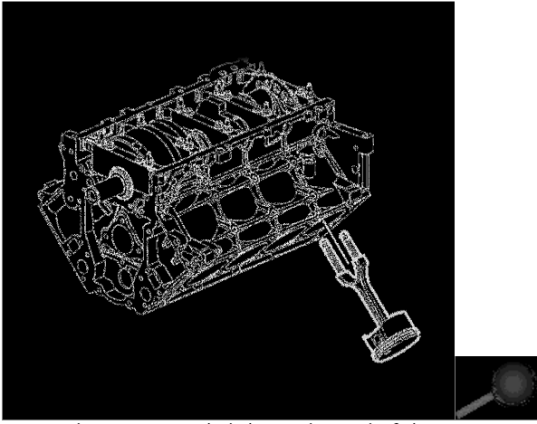


Important: Mark, sort, or organize the connecting rod bearings so they may be installed to their original position and location. The connecting rods and the bearing caps are **NOT** interchangeable. Refer to [Separating Parts](#).

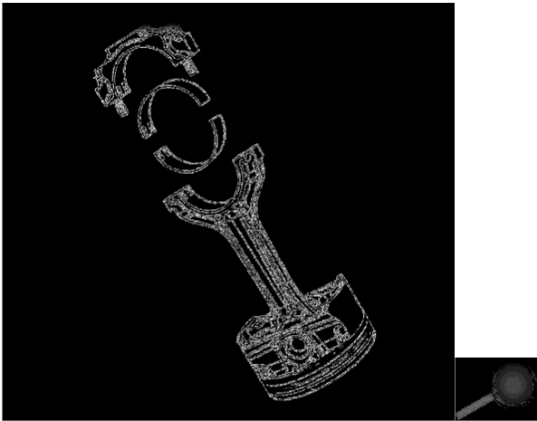
3. Remove the connecting rod bolts (102), cap (103) and bearing (104).



4. Install the J 41556 connecting rod guide to the connecting rod.



5. Using a hammer, tap lightly on the end of the *J 41556* connecting rod guide in order to remove the piston and connecting rod assembly from the cylinder bore.
6. Remove the *J 41556* connecting rod guide.



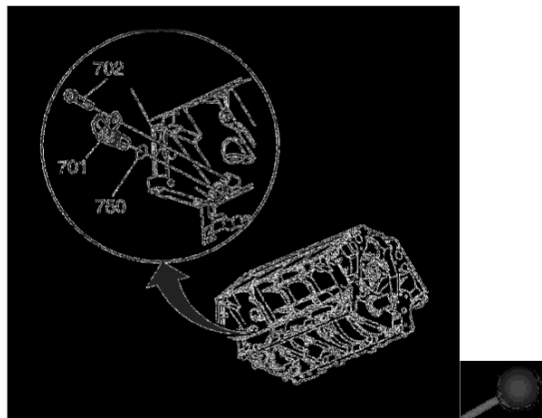
7. Upon removal of the piston and connecting rod assembly, assemble the connecting rod cap and bolts onto the matching connecting rod.

Crankshaft and Bearing Removal

Special Tools

- J 6125-1B Slide Hammer
- J 41818 Crankshaft Bearing Cap Remover

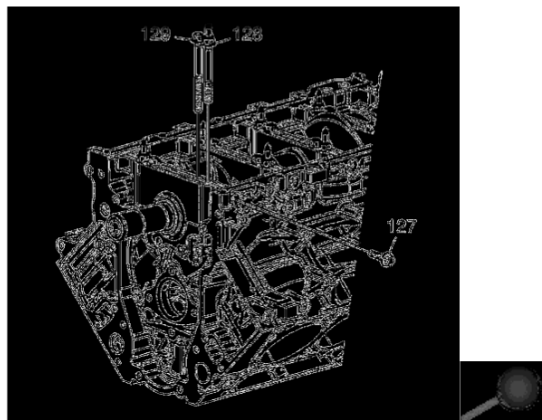
For equivalent regional tools, refer to [Special Tools](#)



Note:

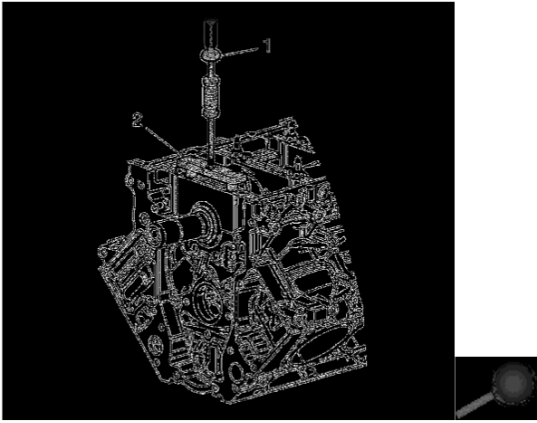
- The crankshaft bearing caps are machined with the engine block, for the proper clearances. Mark or identify each crankshaft bearing cap location and direction before removal. The crankshaft bearing caps **MUST** be installed to their original position and direction.
- Do not use the bearing cap M8 side bolts again.

1. Remove the crankshaft position (CKP) sensor bolt (702).
2. Remove the CKP sensor (701).
3. Remove the O-ring (750) from the sensor, as required.



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4. Remove the crankshaft bearing cap M8 bolts (127).
5. Remove the bearing cap M10 bolts (129) and studs (128).



Caution: Refer to [Fastener Caution](#).

6. Install the J 41818 remover (2). Tighten the J 41818 remover (2) bolts to **11 N•m (100 lb in)**.
7. Install the J 6125-1B hammer (1) to the J 41818 remover (2) in order to remove the crankshaft bearing caps.



8. Remove the bearing caps.



9. Remove the crankshaft.



Note: Use care when handling the crankshaft. Avoid damage to the CKP sensor reluctor ring teeth. Nicks, burrs or other damage to the teeth may effect on-board diagnostics (OBD) II system performance.

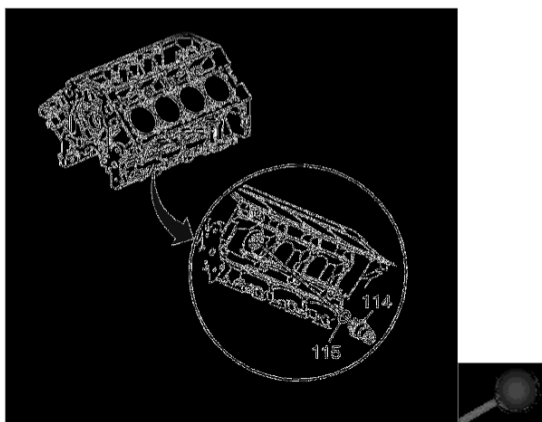
10. Lay the crankshaft onto 2 wooden V-blocks or other protective surface.



11. Remove the crankshaft bearings from the bearing caps and the engine block.

12. Mark, sort, or organize the crankshaft bearings so they may be installed to their original position and location. Refer to [Separating Parts](#).

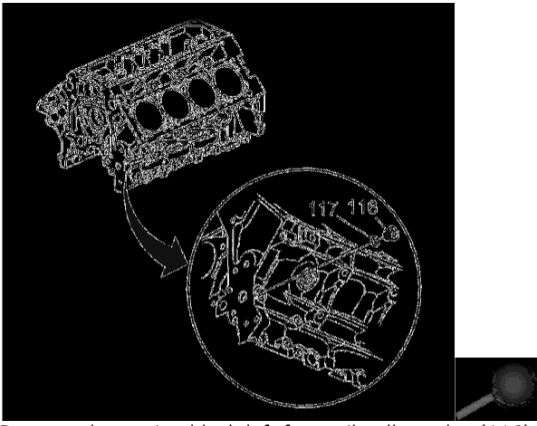
Engine Block Plug Removal (LS3 or L77)



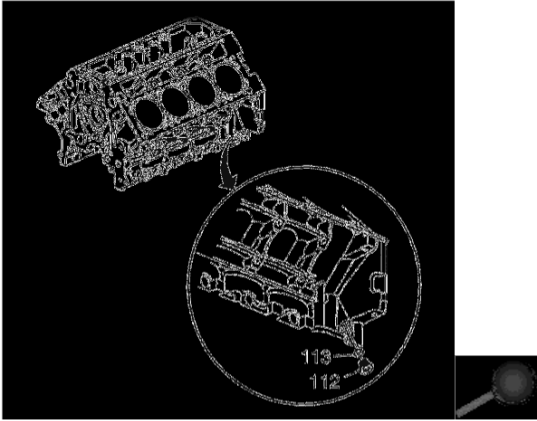
1. Remove the engine block coolant heater (114) and seal (115).



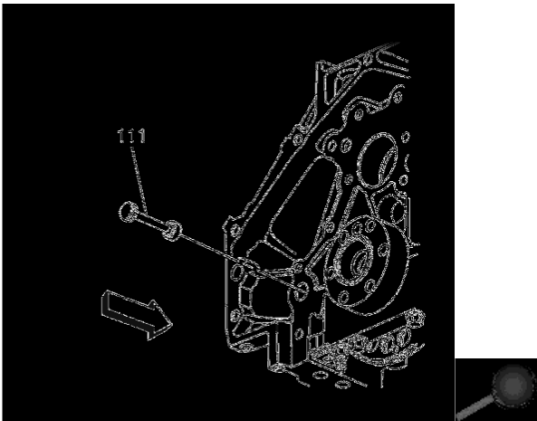
2. Remove the engine block right rear coolant drain hole plug and seal.



3. Remove the engine block left front oil gallery plug (116) and seal (117).

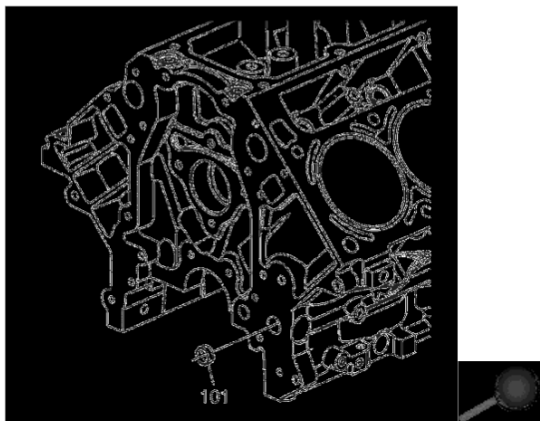


4. Remove the engine block left rear oil gallery plug (112) and seal (113).
If the block plug and coolant heater sealing washers are not damaged, they may be used during assembly.



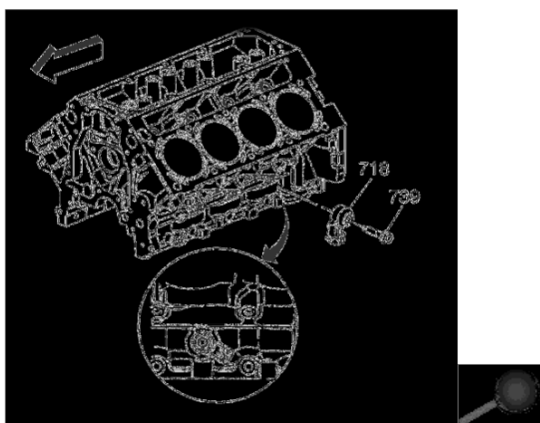
5. Remove the engine block rear oil gallery plug (111) and seal.
6. Inspect the O-ring seal of the rear oil gallery plug.

If the O-ring seal is not cut or damaged, the plug and O-ring seal may be used during assembly.

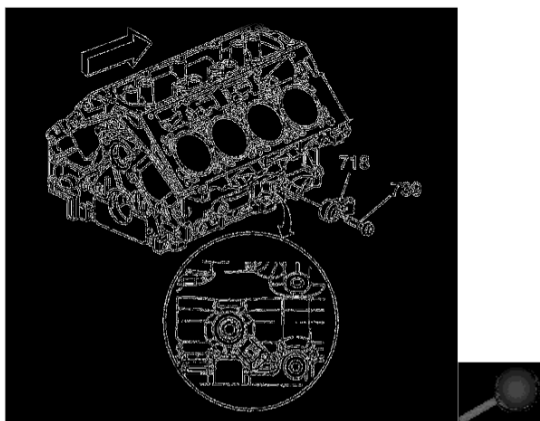


Important: Remove the front oil gallery plug, only if service is required. If the front oil gallery plug is removed, a NEW oil gallery plug must be installed.

7. Remove the engine block front oil gallery plug (101).



8. Remove the left side knock sensor (718) and bolt (739).



9. Remove the right side knock sensor (718) and bolt (739).

Engine Block Plug Removal (LSA)

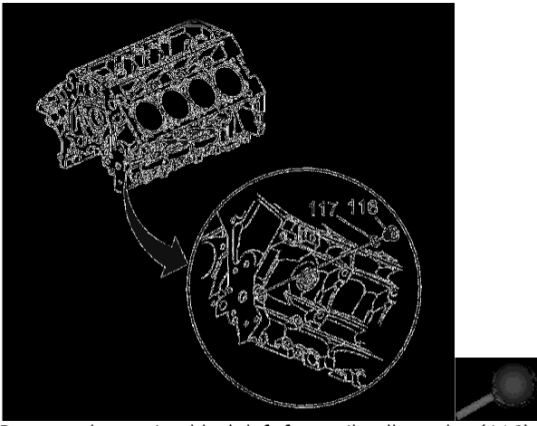


1. Remove the engine oil cooler coolant fitting (2).

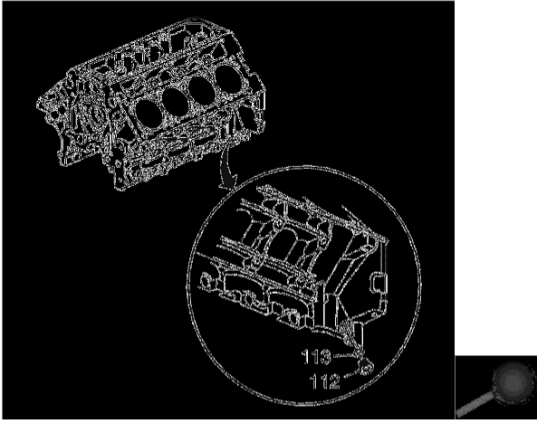


2. Remove the engine block right rear coolant drain hole plug and seal.

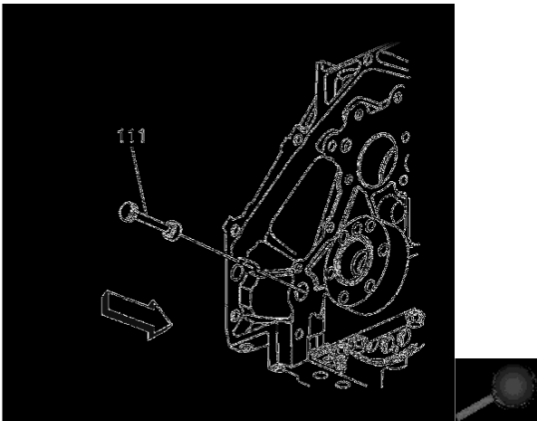
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3. Remove the engine block left front oil gallery plug (116) and seal (117).

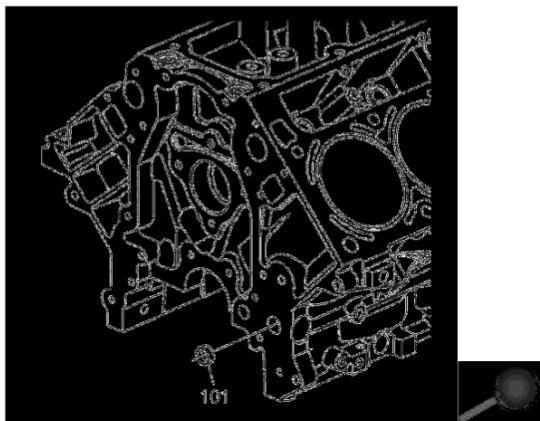


4. Remove the engine block left rear oil gallery plug (112) and seal (113).
If the block plug and coolant heater sealing washers are not damaged, they may be used during assembly.



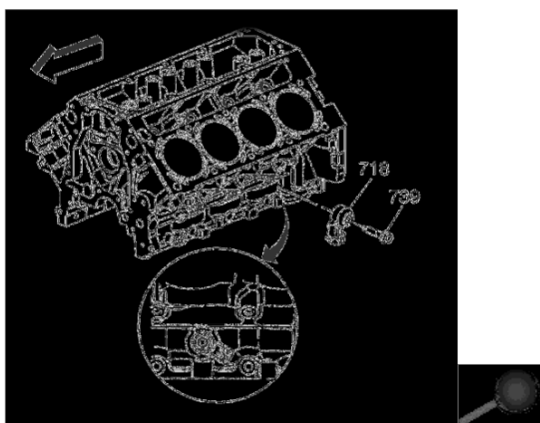
5. Remove the engine block rear oil gallery plug (111) and seal.
6. Inspect the O-ring seal of the rear oil gallery plug.

If the O-ring seal is not cut or damaged, the plug and O-ring seal may be used during assembly.

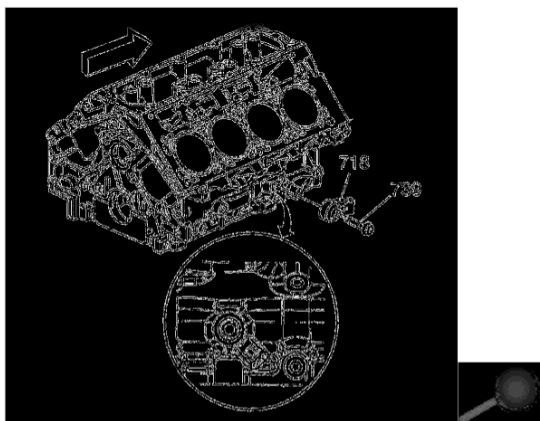


Note: Remove the front oil gallery plug, only if service is required. If the front oil gallery plug is removed, a NEW oil gallery plug must be installed.

7. Remove the engine block front oil gallery plug (101).



8. Remove the left side knock sensor (718) and bolt (739).



9. Remove the right side knock sensor (718) and bolt (739).



10. Remove the piston oil nozzles (1) from the block – 6.2L LS9/LSA.

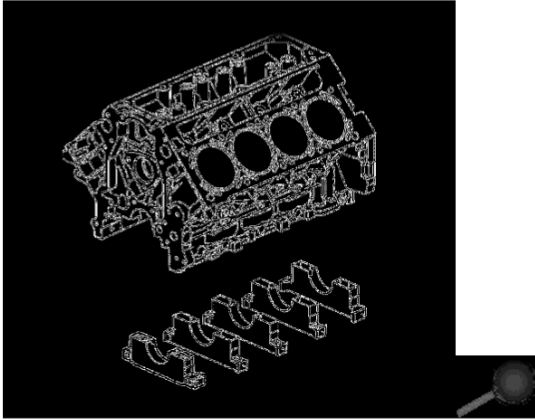
Engine Block Cleaning and Inspection

Special Tools

- J 8087 Cylinder Bore Gauge
- 42385-100 Head/Main Bolt Thread Repair Kit

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

Cleaning Procedure



Caution: Do not use a caustic solution to clean the aluminum engine block.

Note: When cleaning the engine block in a thermal type oven, do not exceed 232°C (450°F).

Clean the following components:

- Remove all sludge, dirt, or debris using a cleaning solvent or thermal type oven. Refer to [Cleanliness and Care](#).
- Gasket surfaces
Refer to [Replacing Engine Gaskets](#).
- Coolant passages
- Oil galleries
- Main bearing caps
- Cylinder head bolt holes to remove threadlocking material
Thread repair tool J 42385-107 may be used to clean the threads of any residual threadlocking material.

Inspection Procedure

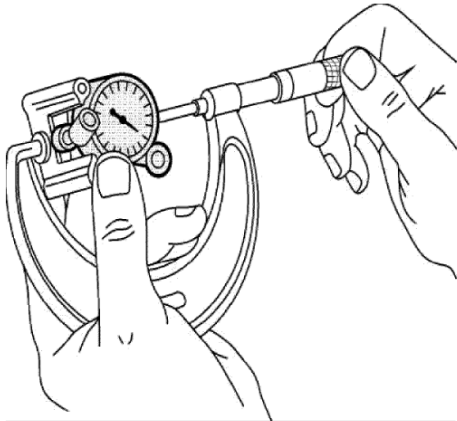
1. Inspect the following components:
 - Cylinder walls for excessive scratches, gouging, or ring ridge
 - Cylinder bores for excessive ring ridge at the top of the cylinder
 - Coolant jacket for cracks
 - Valve lifter bores for excessive scoring or wear

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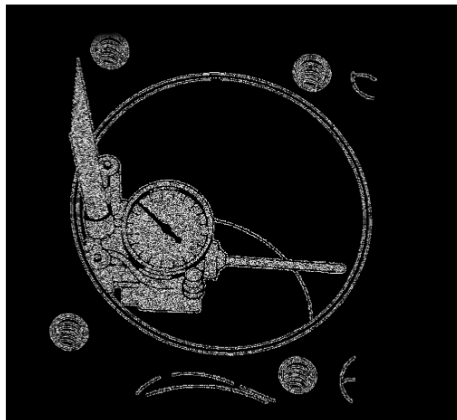
- Crankshaft bearing webs for cracks
- Gasket sealing surfaces for excessive scratches or gouging
Refer to [Replacing Engine Gaskets](#).
- Oil galleries for restrictions
- Threaded bolt holes for damaged threads
- Cylinder bores for excessive ring ridge at the top of the cylinder

2. Measure the cylinder bores for an oversize condition:

Measuring the Cylinder for Oversize



1. Adjust the micrometer to a dimension slightly smaller than the bore size. Refer to [Engine Mechanical Specifications](#).
2. Insert the J 8087 gauge into the micrometer and zero the bore gauge dial.



3. Use the J 8087 gauge and measure the cylinder bore for oversize.
Slide the bore gauge up and down throughout the length of the cylinder bore. Measure the bore, both parallel and perpendicular to the centerline of the crankshaft, at the top, center, and bottom of the bore. A cylinder bore that exceeds the maximum diameter must be serviced with an oversized piston. Refer to [Engine Mechanical Specifications](#).

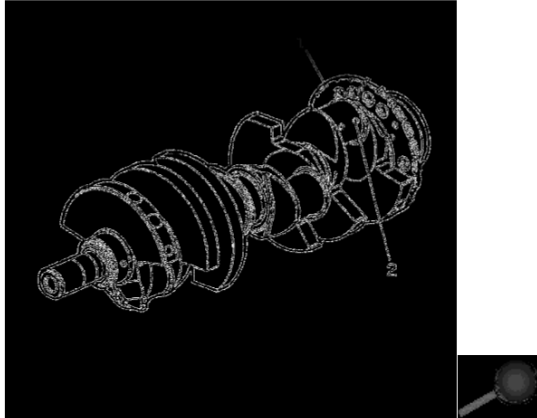
Crankshaft and Bearing Cleaning and Inspection

Special Tools

- J 7872 Magnetic Base Dial Indicator Set
- J 43690 Rod Bearing Checking Tool
- J 43690-100 Rod Bearing Checking Tool - Adapter Kit

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

Cleaning Procedure



Note: Use care when handling the crankshaft. Avoid damage to the bearing surfaces or the lobes of the crankshaft position (CKP) reluctor ring. Damage to the teeth of the CKP reluctor ring may affect on-board diagnostics (OBD) II system performance.

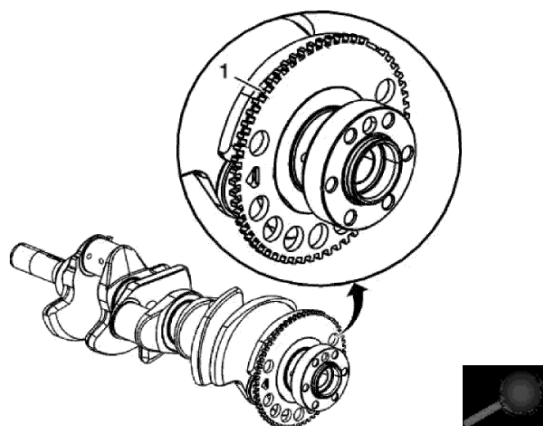
1. Clean the crankshaft with solvent.
2. Thoroughly clean all oil passages (2) and inspect for restrictions or burrs.

Warning: Refer to [Safety Glasses Warning](#).

3. Dry the crankshaft with compressed air.

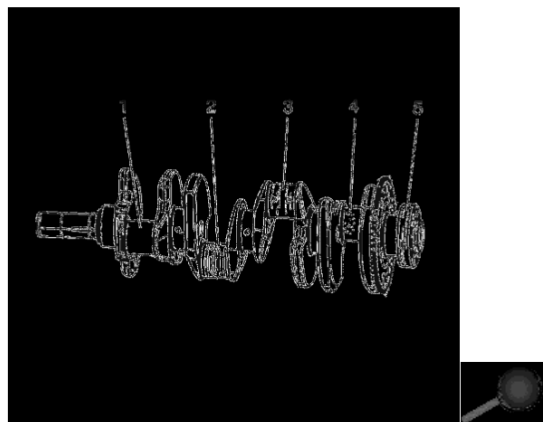
Inspection Procedure

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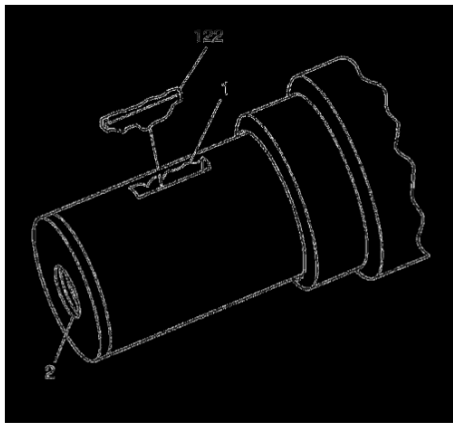


Note: The reluctor ring teeth should not have imperfections on the rising or falling edges. Imperfections of the reluctor ring teeth may affect OBD II system performance.

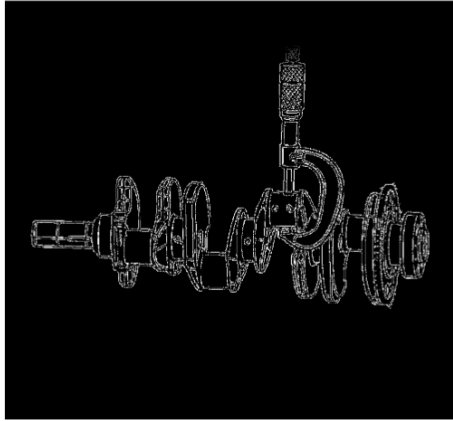
1. Inspect the CKP reluctor ring teeth (1) for damage.



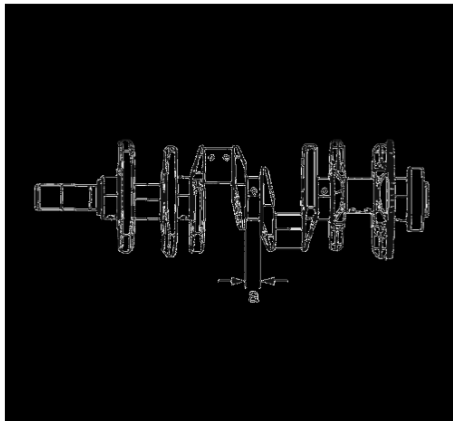
2. Inspect the crankshaft journals for wear.
Journals should be smooth (1) with no signs of scoring, wear, or damage.
3. Inspect the crankshaft journals for grooves or scoring (2).
4. Inspect the crankshaft journals for scratches or wear (3).
5. Inspect the crankshaft journals for pitting or imbedded bearing material (4).
6. Inspect the crankshaft rear oil seal surface (5) for grooves or scoring.



7. Inspect the crankshaft key (122), keyway (1), and threaded hole (2) for damage.

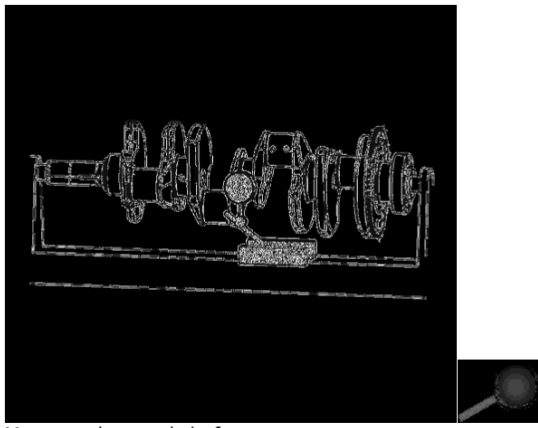


8. Measure the connecting rod journals for out-of-round and taper.



9. Measure the crankshaft thrust wall width.

A crankshaft with a thrust wall width in excess of 26.2 mm (1.0315 in) (a) must be replaced.



10. Measure the crankshaft runout.
Use wooden V-blocks or a fixture to support the crankshaft on the front and rear journals.
11. Use the *J 7872* set in order to measure the crankshaft runout at the front and rear intermediate journals.
12. Use the *J 7872* set in order to measure the runout of the crankshaft rear flange.
13. Use the *J 7872* set in order to measure the runout of the crankshaft position reluctor ring. Reluctor ring runout should be measured 1.0 mm (0.04 in) below the ring teeth.
If the front and rear intermediate journals, crankshaft rear flange, or reluctor ring runout exceeds specification, replace the crankshaft. Refer to [Engine Mechanical Specifications](#).



14. Inspect crankshaft bearings for craters or pockets. Flattened sections on the bearing halves also indicate fatigue.



15. Inspect the crankshaft bearings for excessive scoring or discoloration.
16. Inspect the crankshaft bearings for dirt or debris imbedded into the bearing material.



17. Inspect the crankshaft bearings for improper seating, indicated by bright, polished sections of the bearing.
If the lower half of the bearing is worn or damaged, both upper and lower halves should be replaced.
Generally, if the lower half is suitable for use, the upper half should also be suitable for use.

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[Measuring Main Bearing Clearance – Gaging Plastic Method](#)

**Note:**

- The crankshaft main bearings are a precision insert type. Main bearing caps are machined with the engine block, for proper clearance, and cannot be shimmed or filed for bearing fit. If the clearances are found to be excessive, new bearings and/or engine block and cap repair or replacement may be required.
- Do not rotate the crankshaft while gaging plastic is between the crankshaft journal and the bearing surface.
- The crankshaft bearing clearances are critical. Excessive bearing clearance may affect crankshaft position sensor signals and may affect OBD II system operation.
- Remove the bearing cap side bolts prior to cap removal.

1. Remove the bearing caps, bearing half, and bolts. Refer to [Crankshaft and Bearing Removal](#).
2. Install gaging plastic onto the crankshaft journal. Install the gaging plastic the full width of the crankshaft bearing journal.
3. Install the bearing caps, bearing half, and bolts. Refer to [Crankshaft and Bearing Installation](#).
4. Remove the bearing caps, bearing half, and bolts. Refer to [Crankshaft and Bearing Removal](#).



5. Using the scale supplied with the plastic gaging kit, measure the gaging plastic at its widest area.

- If the gaging plastic shows irregularity in the journal, exceeding 0.025 mm (0.001 in), remove the crankshaft and measure the journal with a micrometer.
- If clearance cannot be brought to specifications, replace the crankshaft or engine block as required. Refer to [Engine Mechanical Specifications](#).

Measuring Connecting Rod Bearing Clearance – Gaging Plastic Method



Note:

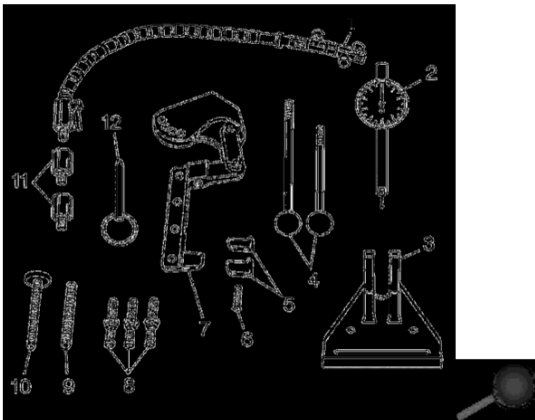
- Connecting rod bearings are a precision insert type. Connecting rods are of a powdered metal design and cannot be shimmed or filed for bearing fit. If clearances are found to be excessive, a new bearing and/or connecting rod is required.
 - Do not rotate the crankshaft while gaging plastic is between the crankshaft journal and the bearing surface.
1. Remove the bearing cap, bearing half, and bolts. Refer to [Piston, Connecting Rod, and Bearing Removal](#).
 2. Install the gaging plastic onto the connecting rod bearing journal. Install the gaging plastic the full width of the journal.
 3. Install the bearing cap, bearing half, and bolts. Refer to [Piston, Connecting Rod, and Bearing Installation](#).
 4. Remove the bearing cap, bearing half, and bolts. Refer to [Piston, Connecting Rod, and Bearing Removal](#).



5. Using the scale supplied with the plastic gaging kit, measure the gaging plastic at its widest area. Refer to [Engine Mechanical Specifications](#).

Measuring Connecting Rod Bearing Clearance – Using J 43690/J 43690-100

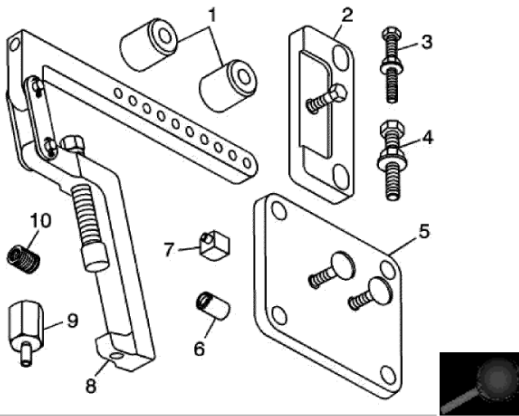
J 43690 tool and J 43690-100 kit have been developed as a more accurate method to measure connecting rod bearing clearances. The instructions below provide an overview of tool set-up and usage. For more detailed information, refer to the tool instruction sheets supplied by the tool manufacturer.



J 43690 tool

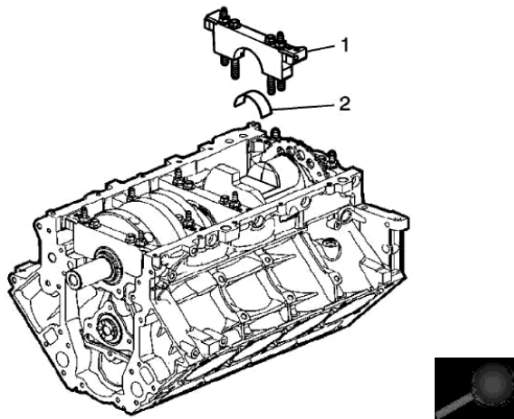
- J 43690-20 Swivel Base (1)
- J 43690-19 Dial Indicator (2)
- J 43690-2 Base (3)
- J 43690-5, J 43690-6 Handle (4)
- J 43690-10, J 43690-11 Foot (5)
- 280307 Screw (6)
- J 43690-1 Pivot Arm Assembly (7)
- J 43690-3, J 43690-7, J 43690-8 Screws (8)
- 280319 Screw (9)

- 280311 Screw (10)
- J43690-17, J43690-18 Adapter (11)
- 280310 Pin (12)



J 43690 Rod Bearing Checking Tool

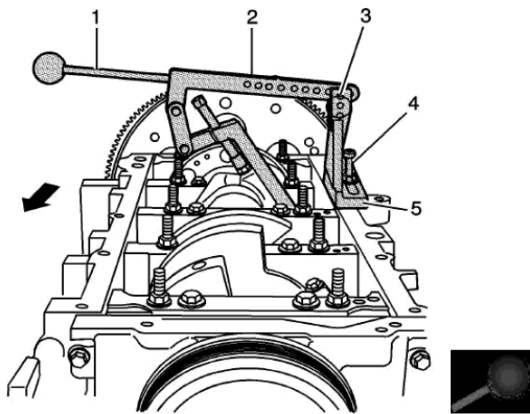
- J43690-104 Spacer (1)
- J43690-105 Retainer Plate (2)
- 505478 Bolt (3)
- 511341 Bolt (4)
- J43690-106 Retainer Plate (5)
- J43690-107 Cap (6)
- J43690-102 Foot (7)
- J43690-101 Pivot Arm Assembly (8)
- J43690-103 Adapter (9)
- 505439 Adapter (10)



Note: The crankshaft must be secure, with no movement or rotation, in order to obtain an accurate reading.

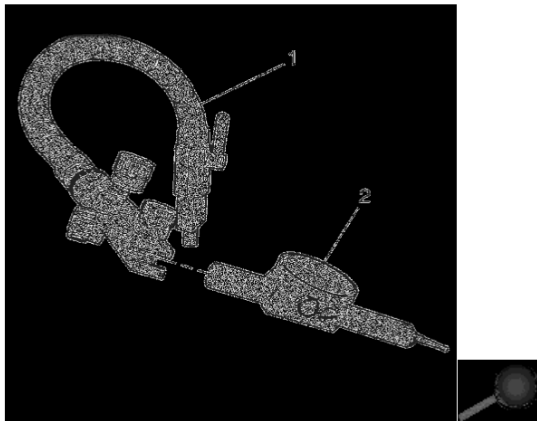
1. Rotate the crankshaft until the journal/connecting rod to be measured is in the 12 o'clock position.

2. Remove a bearing cap and bolts (1).
3. Remove the bearing half (2).
4. Insert a piece of paper card stock onto the crankshaft journal.
5. Install the bearing half (2) and cap and bolts (1). Refer to [Fastener Tightening Specifications](#).



6. Install the following:

- 6.1. J 43690-2 (5)
- 6.2. J 43690-3 (4)
- 6.3. J 43690-101 (2)
- 6.4. 280310 (3)
- 6.5. J 43690-5 (1)



7. Install the swivel base (1) and dial indicator (2).
8. Adjust per the manufacturers instructions and measure the connecting rod bearing clearance.
A connecting rod with a clearance in excess of 0.076 mm (0.003 in) is considered excessive. Service components, as required.

Crankshaft Balancer Cleaning and Inspection



1. Clean the crankshaft balancer in solvent.
2. Clean the belt grooves of all dirt or debris with a wire brush.
3. Dry the crankshaft balancer with compressed air.
4. Inspect the crankshaft balancer for the following conditions:
 - Worn, grooved, or damaged hub seal surface
A crankshaft balancer hub seal surface with excessive scoring, grooves, rust or other damage must be replaced.
Minor imperfections on the hub seal surface may be removed with polishing compound or fine grade emery cloth.
Important: In order for the belt to track properly, the belt grooves should be free of all dirt or debris.
 - Dirty or damaged belt grooves
The balancer belt grooves should be free of any nicks, gouges, or other damage that may not allow the belt to track properly.
Minor imperfections may be removed with a fine file.
 - Worn, chunking, or deteriorated rubber between the hub and pulley

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Engine Flywheel Cleaning and Inspection

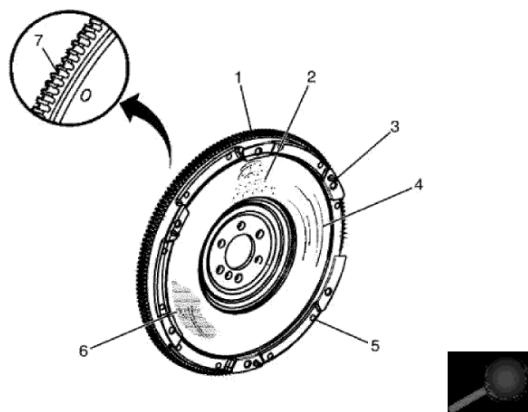
Cleaning Procedure

1. Clean the engine flywheel in solvent.

Warning: Refer to [Safety Glasses and Compressed Air Warning](#).

2. Dry the engine flywheel with compressed air.

Inspection Procedure



Note: The ring gear is not replaceable and flywheel surface machining is not permitted as this may effect the component balance, contact surface taper and heat transfer.

1. Inspect the engine flywheel for the following conditions:

- Damaged pressure plate to flywheel retaining bolt threaded holes (5)
- Pitted surface (2)
- Scoring or grooves (4)
- Rust or other surface damaged (6)
- Damaged ring gear teeth (7)
- Loose or incorrectly positioned ring gear (1)

The ring gear (1) has an interference fit onto the engine flywheel and should be positioned completely against the flange of the engine flywheel.

- Missing, bent or damaged pressure plate locating pins (3)

The 3 locating pins are installed into the flywheel and spaced 120 degrees apart to ensure proper orientation of the clutch pressure plate to the engine flywheel during assembly.

2. Replace the engine flywheel as necessary.

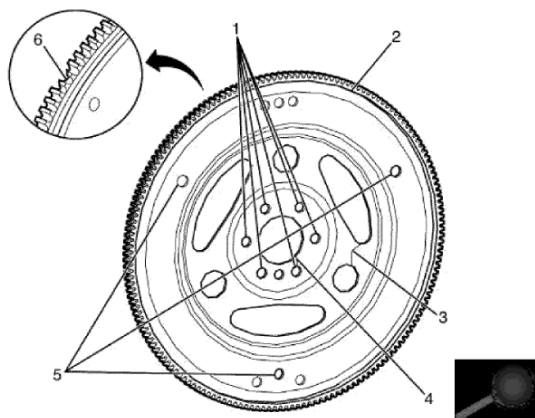
Automatic Transmission Flex Plate Cleaning and Inspection

Cleaning Procedure

1. Clean the automatic transmission flex plate in solvent.
2. Dry the automatic transmission flex plate with compressed air.

Warning: Refer to [Safety Glasses and Compressed Air Warning](#).

Inspection Procedure

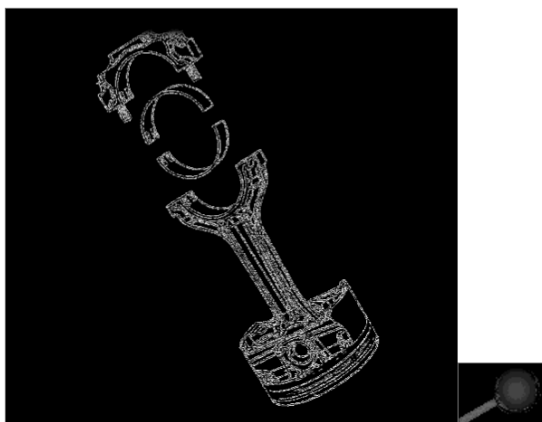


Note: Do not repair any stress fractures on the automatic transmission flex plate (2) or the ring rear (6). If any of the following conditions are found replace the automatic transmission flex plate (2).

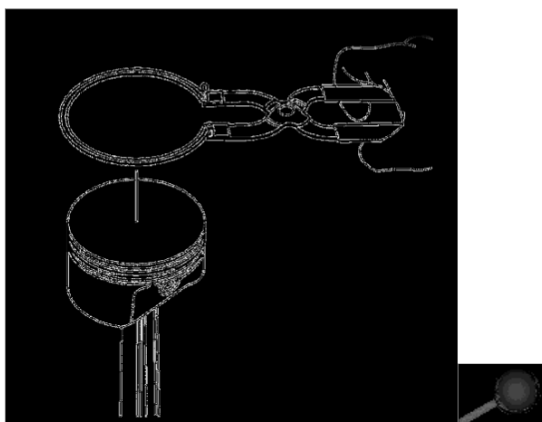
1. Inspect the automatic transmission flex plate (2) for the following conditions:
 - Stress fractures around the automatic transmission flex plate to engine crankshaft retaining bolt holes (4).
 - Stress fractures on or around the automatic transmission flex plate to ring gear welds.
 - Stress fractures between the automatic transmission flex plate pressed holes (3).
 - Elongation of the automatic transmission flex plate to torque converter retaining bolt holes (5).
 - Elongation of the automatic transmission flex plate to engine crankshaft retaining bolt holes (1).
 - Damaged or missing ring gear teeth (6).
2. Replace the automatic transmission flex plate (2) as necessary.

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Piston and Connecting Rod Disassemble

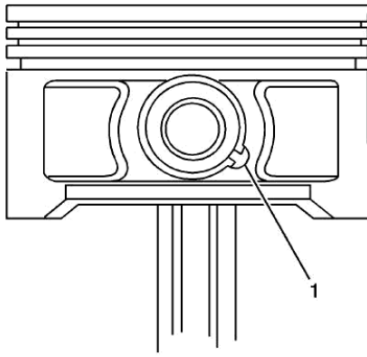


1. Remove the connecting rod bearings from the rod and cap.

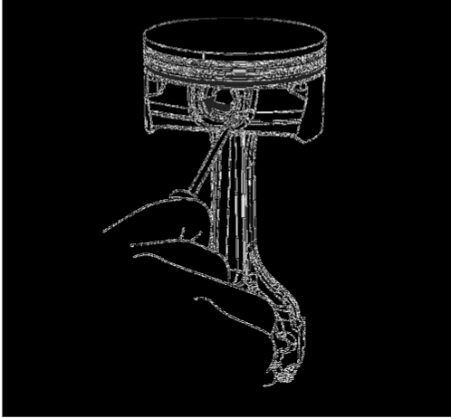


2. Using piston ring pliers, remove the piston rings from the piston.

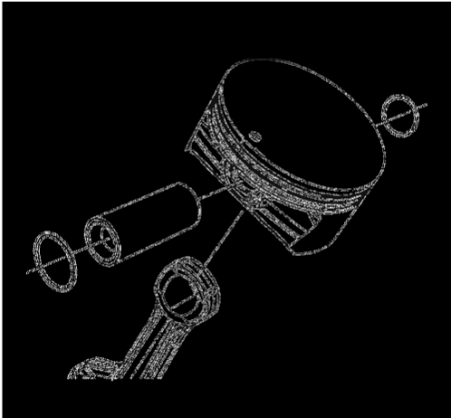
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3. Rotate the piston pin retainers until the ring end gaps are positioned in the cutout area (1) of the pin bore.



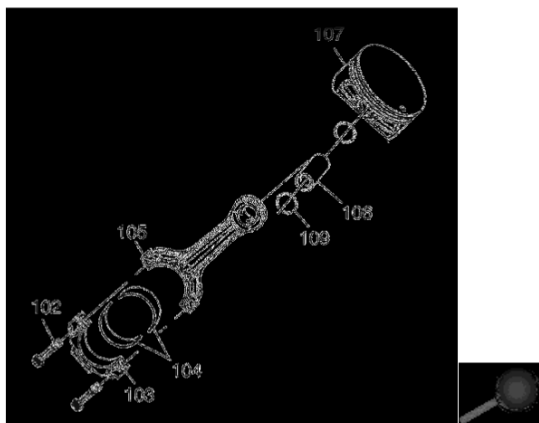
4. Remove the retainers starting in the cutout area of the pin bore.



5. Remove the pin from the piston and connecting rod.
6. The piston and pin are a matched set and are not to be serviced separately.
Mark, sort, or organize the piston and the matching piston pin.

Piston, Connecting Rod, and Bearing Cleaning and Inspection

Piston, Pin, and Piston Rings



Note:

- Replace pistons, pins, and connecting rods that are damaged or show signs of excessive wear.
- The piston and pin are to be serviced as an assembly.
- Do not wire brush any part of the piston.
- Measurement of the components should be taken with the components at normal room temperature.

1. Clean the varnish and carbon from the piston (107) using cleaning solvent.

Warning: Refer to [Safety Glasses Warning](#).

2. Dry the components with compressed air.



3. Clean the piston ring grooves with a suitable ring groove cleaning tool.

4. Clean the oil lubrication holes and slots.



5. Inspect the piston for the following conditions:

- Cracks in the piston ring lands, the piston skirt, or pin bosses
- Piston ring grooves for nicks, burrs, or warpage which may cause the piston ring to bind
MINOR imperfections may be removed from the piston with a fine file.
- Eroded areas at the top of the piston (1)
- Scuffed or damaged skirts (2)
- Scoring to the piston pin bore (3) or piston pin



6. Insert the edge of the piston ring into the piston ring groove.

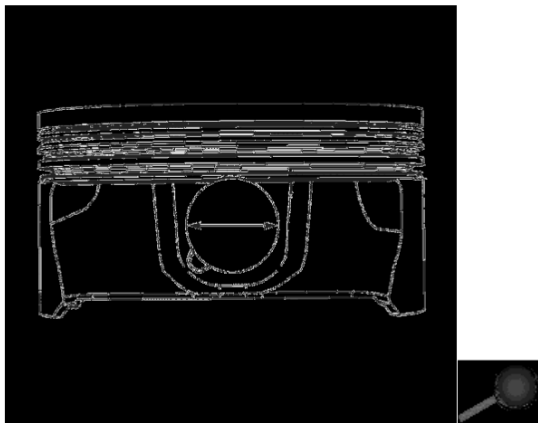
Roll the piston ring completely around the piston. If binding is caused by a distorted ring groove, MINOR imperfections may be removed with a fine file. If binding is caused by a distorted piston ring, replace the rings, as required.



7. Measure the piston ring side clearance with a feeler gauge. If side clearance is not within specifications, try another piston ring. If the proper ring-to-groove clearance cannot be obtained, replace the piston and pin as an assembly. Refer to [Engine Mechanical Specifications](#).



8. To determine piston pin-to-bore clearance, use a micrometer and measure the piston pin outside diameter (OD).



9. To determine the piston pin-to-bore clearance, use an inside micrometer and measure the piston pin bore inside diameter (ID).
10. Subtract the piston pin OD measurement from the piston pin bore ID measurement to determine pin-to-bore clearance. Refer to [Engine Mechanical Specifications](#).

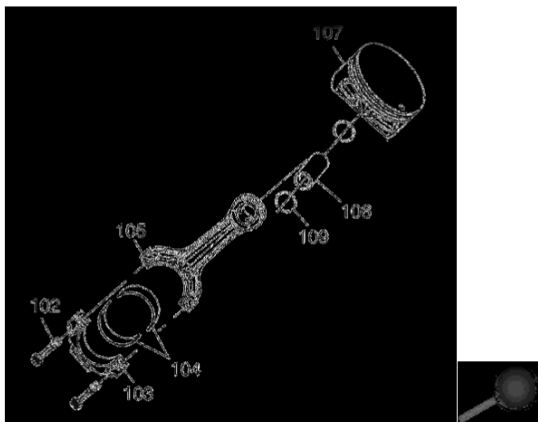
Measuring Piston Ring End Gap



Note:

- Do not attempt to file the end of the piston ring to achieve the proper end gap clearance.
 - Measure the piston ring in the cylinder in which it will be used.
1. Place the piston ring into the cylinder bore 6.5 mm (0.25 in) below the top of the ring travel area. Both rings should be installed with the orientation marks facing the top of the piston.
 2. Insert a feeler gauge and measure the piston ring end gap. Refer to [Engine Mechanical Specifications](#).

Connecting Rod and Bearings



Note:

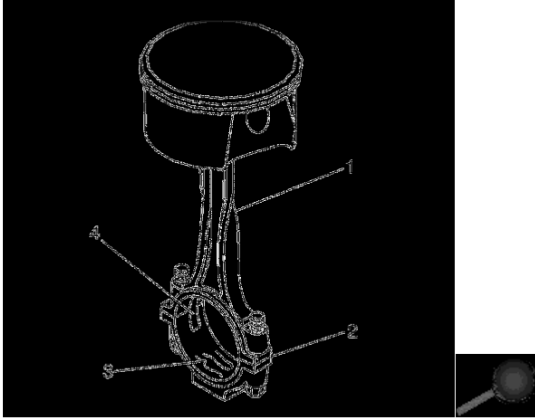
- The powdered metal connecting rod and cap are machined for proper clearances. The connecting rod and cap must be used as an assembly with no repair or modifications to either mating surface. Do not attempt to repair the rod or cap. If service is required, replace the rod and cap as an assembly.

- Do not attempt to repair the bolt hole threads of the connecting rod.

1. Clean the connecting rod (105) and cap (103) in solvent.

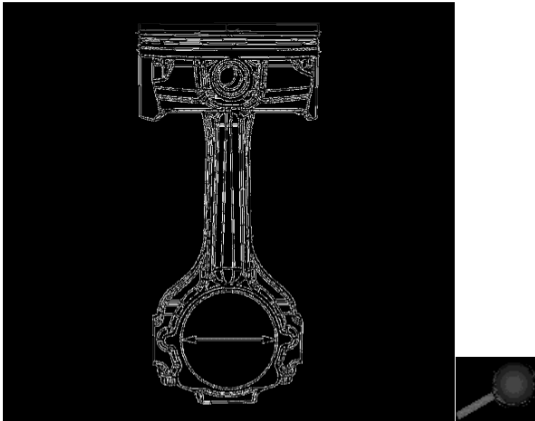
Warning: Refer to [Safety Glasses Warning](#).

2. Dry the components with compressed air.



3. Inspect the connecting rod for the following conditions:

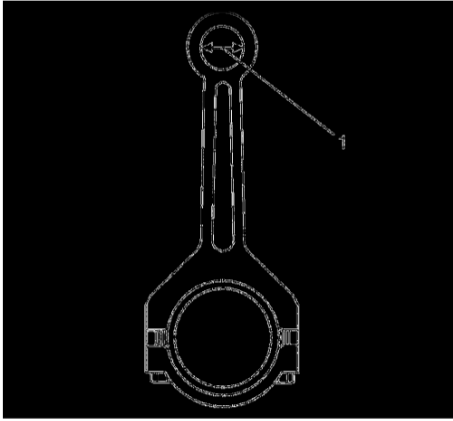
- Twisting (1)
- Proper fit of the connecting rod and cap mating surfaces (2)
- Nicks or gouges in the bearing bore (3)
- Damage to the bearing locating slots (4)



4. Measure the connecting rod bearing bore for an out-of-round condition. Refer to [Engine Mechanical Specifications](#).



5. To determine piston pin-to-connecting rod bore clearance, use a micrometer and measure the piston pin OD.



6. To determine the piston pin-to-connecting rod bore clearance, use a micrometer and measure the connecting rod pin bore (1) ID.
7. Subtract the piston pin OD measurement from the connecting rod pin bore ID measurement to determine pin-to-bore clearance. Refer to [Engine Mechanical Specifications](#).



8. Inspect the connecting rod bearings for craters or pockets. Flattened sections on the bearing halves indicate fatigue.



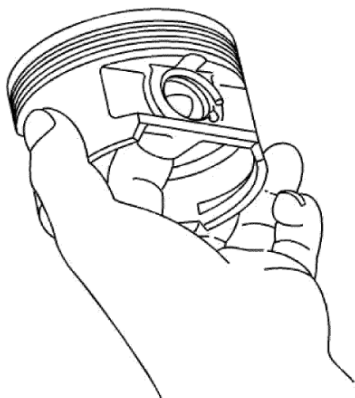
9. Inspect the connecting rod bearings for excessive scoring or discoloration.
10. Inspect the connecting rod bearings for dirt or debris imbedded into the bearing material.



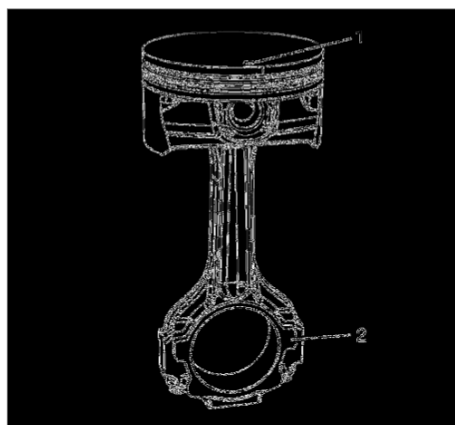
11. Inspect the connecting rod bearings for improper seating indicated by bright, polished sections of the bearing surface.

12. Measure the connecting rod bearings for excessive connecting rod bearing-to-crankshaft journal clearance. Refer to [Crankshaft and Bearing Cleaning and Inspection](#).

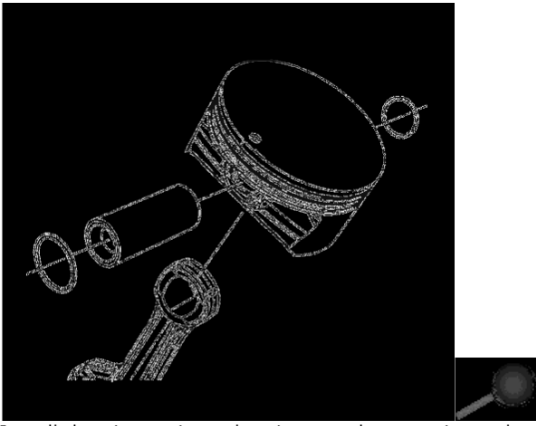
Piston and Connecting Rod Assemble



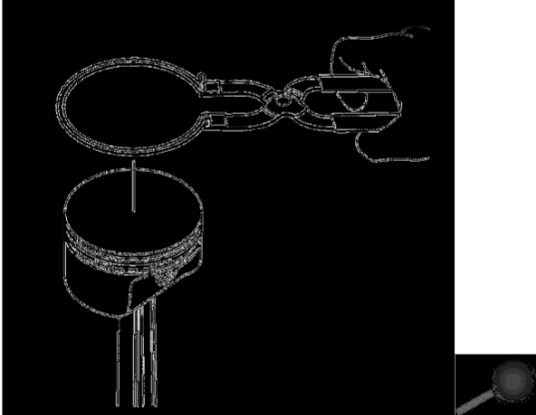
1. Install the retainer. The retainer should be seated in the groove of the pin bore.



2. The mark (1) on the top of the piston and the large set of tabs (2) on the side of the connecting rod should be facing the same direction.



3. Install the piston pin to the piston and connecting rod.
4. Install the retainers. The retainers should be seated in the groove of the pin bore.

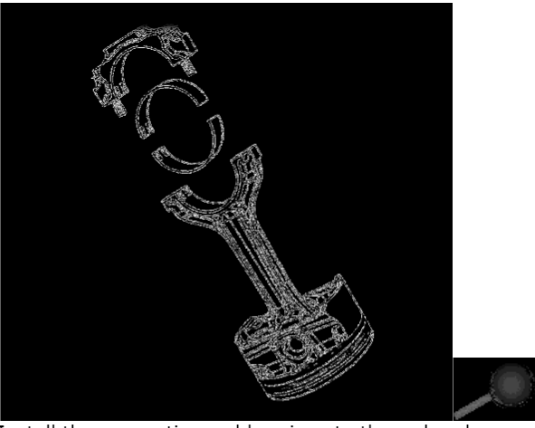


Important: When installing piston rings, use a ring expander plier type tool. Do not roll the rings into the grooves of the piston. Use caution and care to expand the rings only slightly larger than the outside diameter (OD) of the piston.

Important:

- For the 4.8L and 5.3L engines the cylinder contact face, outboard edge, of the top compression ring has a shinier finish than the lower compression ring. The dimple or mark on the lower compression ring should face the top of the piston and the chamfer on the inboard edge of the bottom side of the ring should face the bottom of the piston. There is no dimple, or mark, on the top compression ring, and it may be installed in either direction.
- For the 6.0L and 6.2L engines the cylinder contact face, outboard edge, of the top compression ring has a shinier finish than the lower compression ring. The dimple or mark on the upper and lower compression rings should face the top of the piston. The lower compression ring has a grooved channel along the entire bottom face of the ring and should face the bottom of the piston.

5. Using piston ring pliers, install the piston rings onto the piston.
6. Position the oil control ring end gaps 180 degrees opposite each other.
7. Position the compression ring end gaps 180 degrees opposite each other.



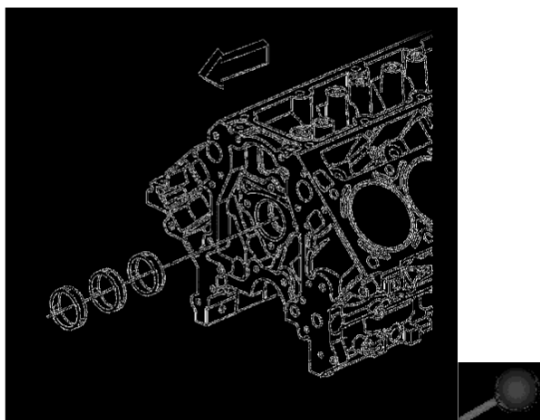
8. Install the connecting rod bearings to the rod and cap.

Camshaft Bearing Removal

Special Tools

J33049 Camshaft Bearing Service Set

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

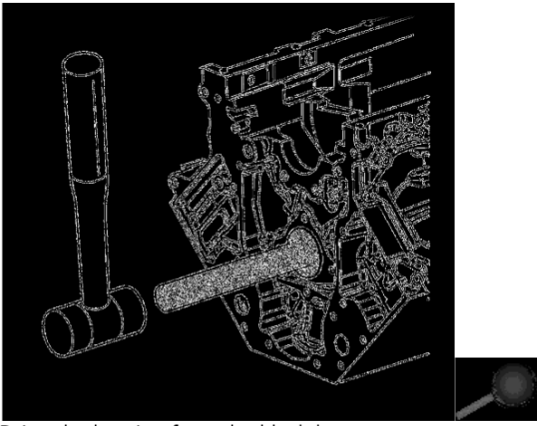


Important: A loose camshaft bearing may be caused by an enlarged, out of round, or damaged engine block bearing bore.

1. Prior to bearing removal, inspect the camshaft bearings for loose fit in the engine block bearing bores. Refer to [Camshaft and Bearings Cleaning and Inspection](#).
2. Repair or replace the components, as required.



3. Select the expanding driver (4-8) and washer (2 or 3) from the J33049 service set .
4. Assemble the tool.
5. Insert the tool through the front of the engine block and into the bearing.
6. Tighten the expander assembly (15) nut until snug.
7. Push the guide cone (1) into the front camshaft bearing in order to align the tool.



8. Drive the bearing from the block bore.

Important: In order to remove the inner camshaft bearings, operate the tool from either end of the block, using the driver bar extension and the guide cone in the front or rear camshaft bearing bore.

9. Repeat the above procedures in order to remove the remaining bearings.

Tool Usage Information

Bearing, Expander, and Expander Driver Information



- The tool consists of a guide cone (1), driving washers (2 or 3), expander bearing drivers (4–8), driver bars (9 or 10), expander jaws (11), expander sleeve (12), expander cone (13), expander shaft (14), and expander assembly (15).

Note: The expander bearing drivers (4–8) in the J33049 service set are stamped with a number (1–5) to assist in identifying the appropriate diameter driver.

- Expander assembly (15) is used as a driver for the bearing when inside diameter is 28.575–37.465 mm (1.125–1.475 in) and is used with the small washer.
- Expander bearing driver number 1 inside diameter is 37.465–43.18 mm (1.475–1.7 in) and is used with the expander assembly (15) and the small washer.
- Expander bearing driver number 2 inside diameter is 43.18–48.895 mm (1.7–1.925 in) and is used with the expander assembly (15) and the large washer.
- Expander bearing driver number 3 inside diameter is 48.895–54.61 mm (1.925–2.15 in) and is used with the expander assembly (15) and the large washer.

- Expander bearing driver number 4 inside diameter is 54.61–60.325 mm (2.150–2.375 in) and is used with expander assembly (15) and the large washer.
- Expander bearing driver number 5 inside diameter is 60.325–68.326 mm (2.375–2.69 in) and is used with expander assembly (15) and the large washer.

Tool Assembly and Operation

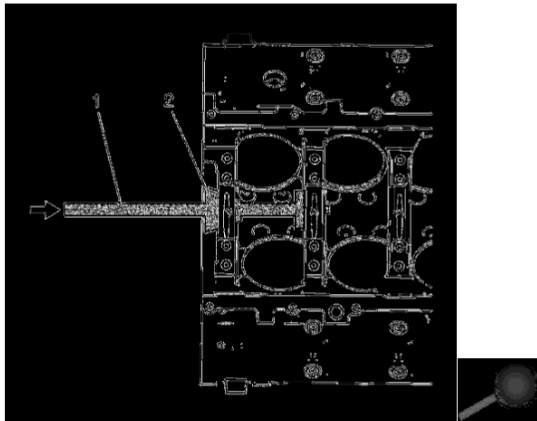
1. Select the proper expanding driver and washer from the expanding driver and washer information.

Important: To install or remove the expanding driver, always push on or pull from the ends.

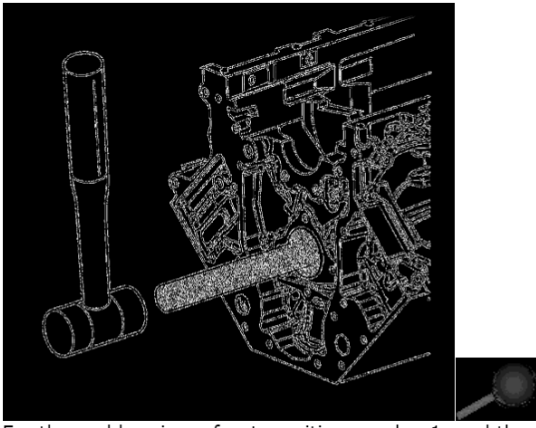
Pressure on the outside diameter may cause a bind against the rubber expanding sleeve.

2. Place the expanding driver onto the expander assembly.
3. Ensure the separation lines between the segments of the expanding driver align with the separation lines of the expander assembly.
4. With the small end of the cone facing the driver assembly, place the guide cone over the driving bar.
5. Place the driving washer over the threaded portion of the expander assembly.
6. Screw the expander assembly, with driving washer, onto the driving bar.

For removal of the inner bearings, it may be necessary to install the driver bar extension.



7. Insert the tool (1) into an inner camshaft bearing and tighten until snug.
Operate the tool from the front or rear of the engine block.
On some engine blocks, the nut on the expander assembly is inaccessible, except from either end. In this case, you must use a socket and extension to enlarge and reduce the expander assembly.
8. Slide the nylon cone (2) into the front or rear camshaft bearing. This will properly align the tool.
9. Drive the bearing out of or into the engine block.
10. Repeat the procedure for the additional inner bearings.



11. For the end bearings, front, position number 1, and the rear, position number 5, remove the nylon cone and driver bar extension.
12. Drive the bearings out of or into the engine block.

Camshaft and Bearings Cleaning and Inspection

Special Tools

- J 7872 Magnetic Base Dial Indicator Set
- J 8520 Camshaft Lobe Lift Indicator

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

Measuring Camshaft Lobe Lift



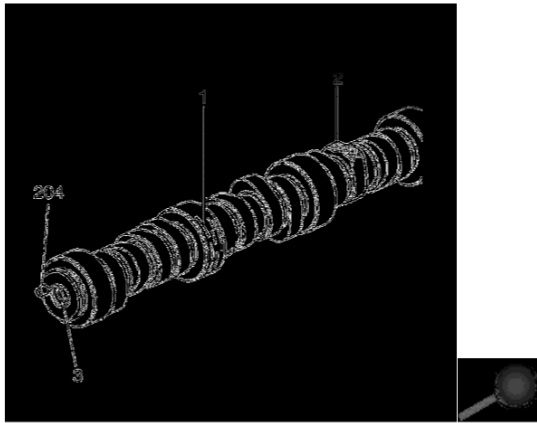
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Note: Measuring camshaft lobe lift is a procedure used to determine if the camshaft lobes have worn. This test is to be performed prior to engine disassembly and with the camshaft and valve train components installed in the engine.

1. Using the J 8520 camshaft lobe lift indicator, measure camshaft lobe lift.
2. Remove the valve rocker arms and bolts.
3. Install the dial indicator mounting stud into the valve rocker arm bolt hole.
4. Assemble the components of the J 8520 camshaft lobe lift indicator and position onto the stud.
5. Position the shaft of the dial indicator onto the end of the pushrod.
6. Rotate the face of the dial indicator to zero.
7. Slowly rotate the crankshaft clockwise, until the dial indicator obtains its highest and lowest readings.
8. Compare the total to specifications. Refer to [Engine Mechanical Specifications](#).

Camshaft and Bearings Cleaning and Inspection

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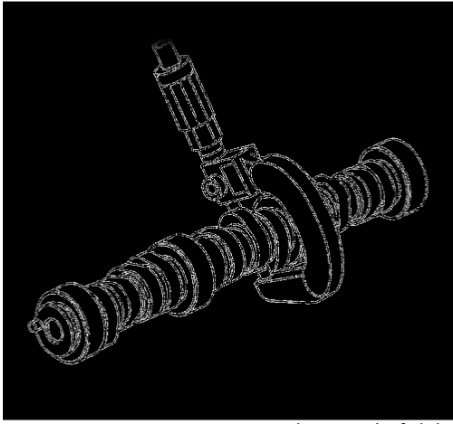
1. Clean the components in solvent.

Warning: Refer to [Safety Glasses Warning](#).

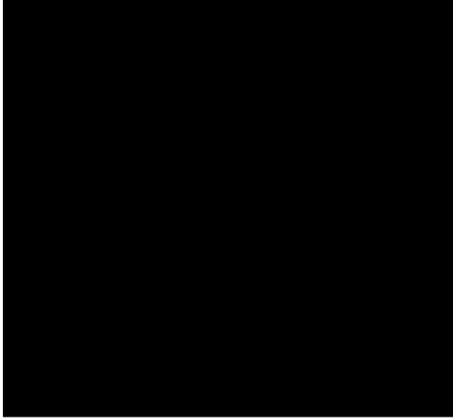
2. Dry the components with compressed air.
3. Inspect the camshaft bearing journals (1) for scoring or excessive wear.
4. Inspect the camshaft valve lifter lobes (2) for scoring or excessive wear.
5. Inspect the threaded bolt holes (3) in the front of the camshaft for damaged threads or debris.
6. Inspect the camshaft sprocket pin (204) for damage.
7. Inspect the camshaft retainer plate for wear or a damaged sealing gasket.
If the camshaft retainer plate sealing gasket is not cut or damaged, it may be used again.



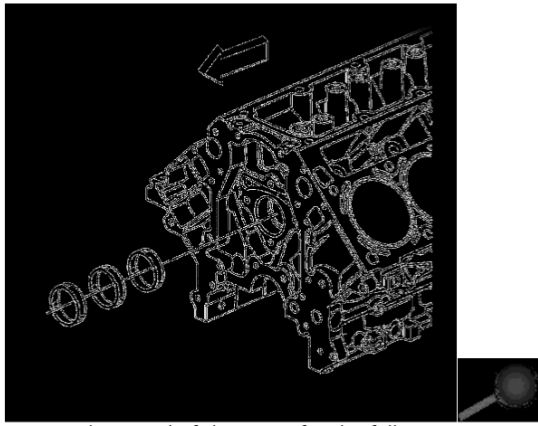
8. Using a micrometer, measure the camshaft journals for wear and out-of-round.
 - If the camshaft bearing journals are greater than **0.025 mm (0.001 in)** out-of-round, replace the camshaft.
 - If the camshaft bearing journal diameter is less than **54.99 mm (2.164 in)**, replace the camshaft.



9. Using a micrometer, measure the camshaft lobes for wear. Refer to [Engine Mechanical Specifications](#).



10. Measure the camshaft runout.
- 10.1. Mount the camshaft in wooden V-blocks or between centers on a fixture.
 - 10.2. Using the J 7872 dial indicator set, measure the runout of the intermediate camshaft bearing journals.
 - 10.3. If camshaft runout exceeds **0.05 mm (0.002 in)**, the camshaft is bent and should be replaced.



11. Inspect the camshaft bearings for the following:

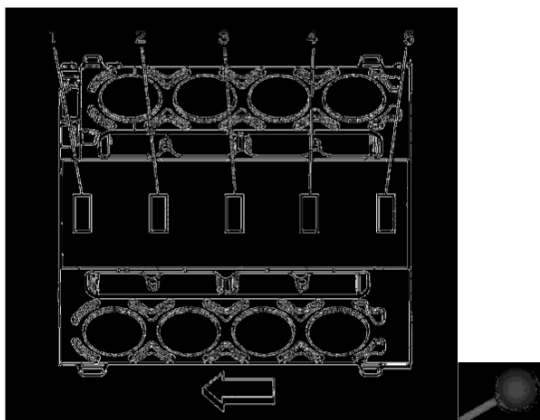
- Excessive wear or scoring. The presence of the copper color bearing material should be considered normal and not a guideline for bearing replacement. Measure the bearing inside diameter (ID) as required for an over-sized condition. Refer to [Engine Mechanical Specifications](#).
 - Proper fit in the engine block. Camshaft bearings have an interference fit to the engine block and should not be loose in the engine block bearing bores.
 - Oil lubrication hole plugged by debris.
- Bearings with excessive wear or scoring must be replaced.

Camshaft Bearing Installation

Special Tools

J33049 Camshaft Bearing Service Set

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

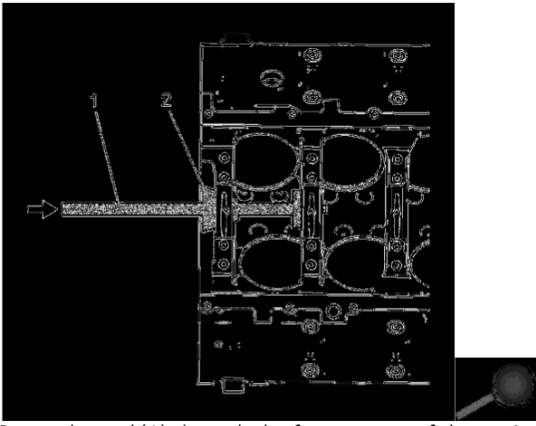


Note: The engine block camshaft bearing bores are machined for 3 different outside diameter (OD) size bearings. Position 1 and 5 are the largest diameter bores. Position 3 is the smallest diameter bore. Position 2 and 4 are the intermediate size bores. The inside diameter (ID) for all camshaft bearings is the same size.

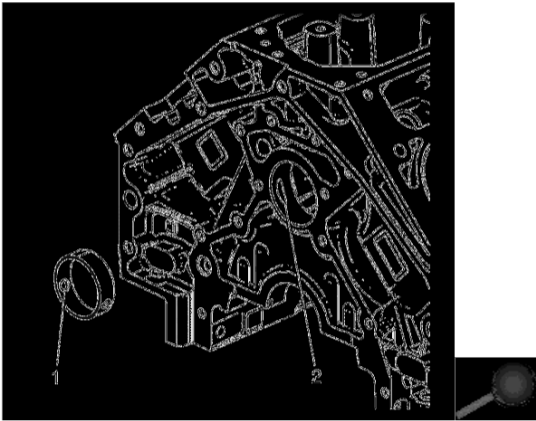
1. Measure the engine block camshaft bearing bores (1-5) in order to identify the correct OD size bearing for each position. Refer to [Engine Mechanical Specifications](#).



2. Select the expanding driver (4-8) and washer (2 or 3) from the J33049 set. Refer to [Camshaft Bearing Removal](#).
3. Assemble the tool.

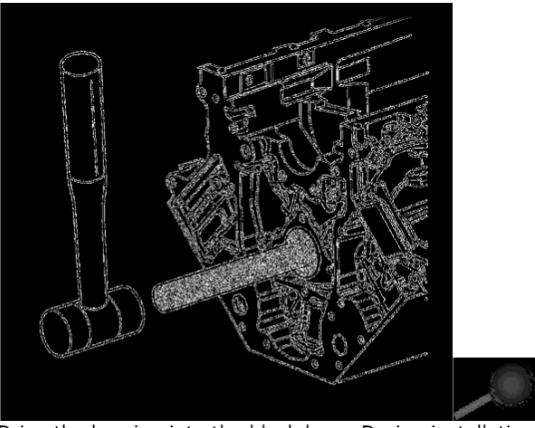


4. Insert the tool (1) through the front or rear of the engine block and into the bearing. For installation of inner bearings, it may be necessary to install the driver bar extension.
5. Tighten the expander assembly nut until snug.
6. Push the guide cone (2) into the front camshaft bearing in order to align the tool.



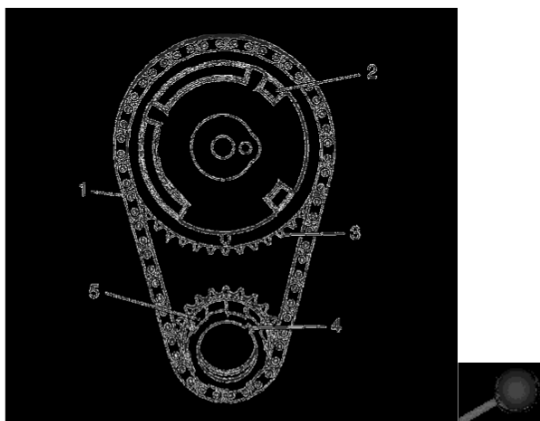
Caution: Camshaft bearings must be installed with bearing oil feed hole in alignment with the drilled oil passage in the block bore to ensure proper oil flow to the camshaft. The split seam in the bearing must be installed in the 12 o'clock position towards the top of the block. Improperly installed bearings may restrict oil flow causing engine damage.

7. Position the camshaft bearing with oil feed hole (1) in alignment with drilled oil passage in block bore (2).



8. Drive the bearing into the block bore. During installation, ensure the bearing is installed straight.
9. Remove J33049 service set, inspect bearing to confirm the oil hole in the bearing is in alignment with the drilled oil passage in the block bore.
10. Repeat procedure to install the remaining bearings into the block.

Camshaft Timing Chain and Sprocket Cleaning and Inspection



1. Clean the components with cleaning solvent.

Warning: Refer to [Safety Glasses and Compressed Air Warning](#).

2. Dry the components with compressed air.

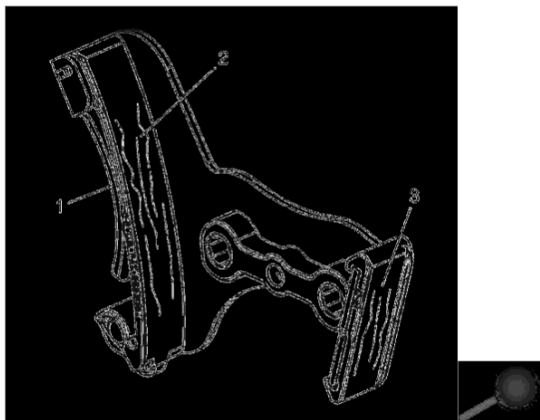
3. Inspect the timing chain (1) for binding or wear.

4. Inspect the camshaft position (CMP) sensor raised areas (2) for nicks or damage.

5. Inspect for worn, damaged, or chipped teeth (3).

6. Inspect for a damaged keyway (4).

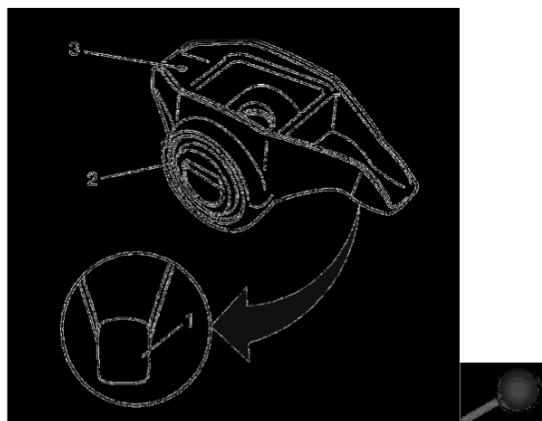
7. Inspect for worn oil pump drive splines (5).



8. Inspect the timing chain tensioner for the following conditions:

- Damaged or broken tension spring (1)
- Excessive wear or scoring on the chain guide surfaces (2, 3)

Valve Rocker Arm and Push Rod Cleaning and Inspection



Note: Parts that are to be used again must be marked, sorted or organized for assembly.

1. Mark, sort, or organize the components for assembly. Refer to [Separating Parts](#).
2. Clean the components with cleaning solvent.

Warning: Refer to [Safety Glasses and Compressed Air Warning](#).

3. Dry the components with compressed air.
4. Inspect the valve rocker arm bearings (2) for binding or roughness.
5. Inspect the valve rocker arm pushrod sockets (3) and valve stem mating surfaces (1). These surfaces should be smooth with no scoring or exceptional wear.
6. Inspect the pushrods for worn or scored ends. These surfaces should be smooth with no scoring or exceptional wear.
7. Inspect the pushrods for bends. Roll the pushrod on a flat surface to determine if the pushrod is bent.
8. Inspect the pushrod oil passages for restrictions.
9. Inspect the rocker arm pivot supports for cracks, wear, or other damage.

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Valve Lifter and Guide Cleaning and Inspection

Non Active Fuel Management Valve Lifters



Note: Components that are to be used again must be marked, sorted or organized for assembly.

1. Clean the components in cleaning solvent.

Warning: Refer to [Safety Glasses and Compressed Air Warning](#).

2. Dry the components with compressed air.

3. Inspect the valve lifters for the following conditions:

- Bent or broken clip (1)
- Worn pushrod socket (2)
- Scuffed or worn sides (3)

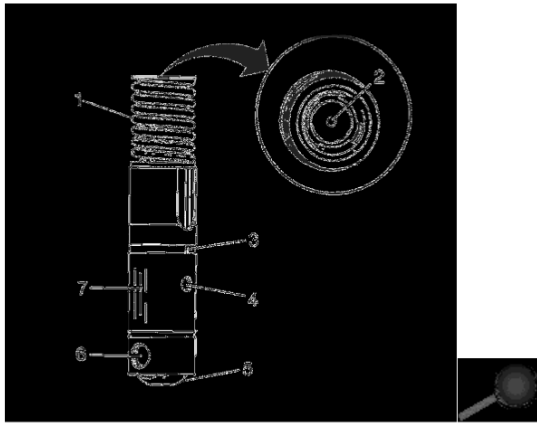
If the valve lifter shows wear, inspect the engine block lifter bores for wear or damage.

- Flat spots on the roller (4)
- Loose or damaged pin (5)
- Plugged oil hole (6)
- Worn or damaged roller bearing

The roller should rotate freely with no binding or roughness.

Active Fuel Management Valve Lifters

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Note: Components that are to be used again must be marked, sorted or organized for assembly.

1. Clean the components in cleaning solvent.

Warning: Refer to [Safety Glasses and Compressed Air Warning](#).

2. Dry the components with compressed air.

3. Inspect the valve lifters for the following conditions:

- Broken or collapsed spring (1)
- Worn pushrod socket (2)
- Plugged lubrication hole (3)
- Plugged lifter oil-switching hole (4)
- Flat spots on the roller (5)
- Worn or damaged roller bearing (6)
The roller should rotate freely with no binding or roughness.
- Scuffed or worn sides (7)

Valve Guides

Inspect the valve lifter guides for the following conditions:

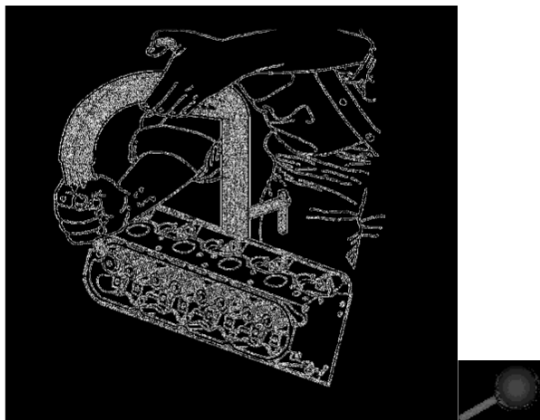
- Cracks or damage
- Excessive wear in the lifter mounting bores

Cylinder Head Disassemble

Special Tools

J8062 Valve Spring Compressor - Head Off

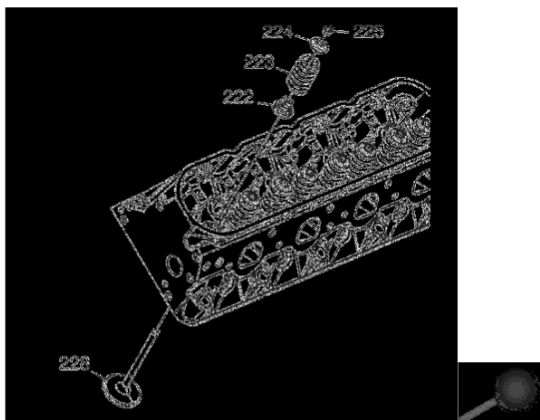
For equivalent regional tools, refer to [Special Tools](#).



Note:

- With the components at room temperature, remove the spark plugs from the cylinder head.
- Mark, organize, or sort the cylinder head components for assembly. Return the components to their original location during assembly.

1. Remove the spark plugs from the cylinder heads.
2. Use the J8062 valve spring compressor - head off in order to compress the valve spring.

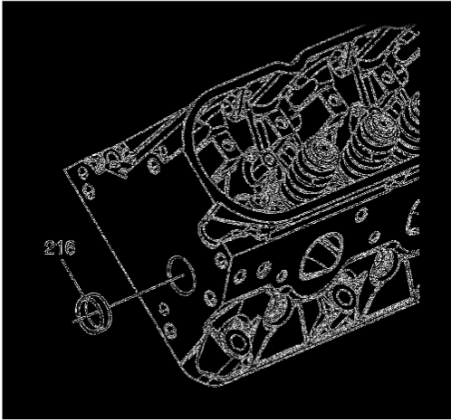


3. Remove the valve stem keys (225).

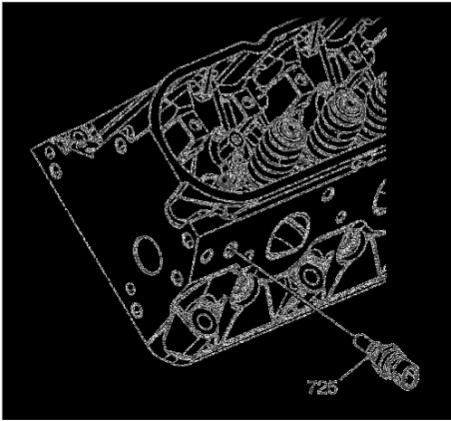
4. Remove the valve spring cap (224).

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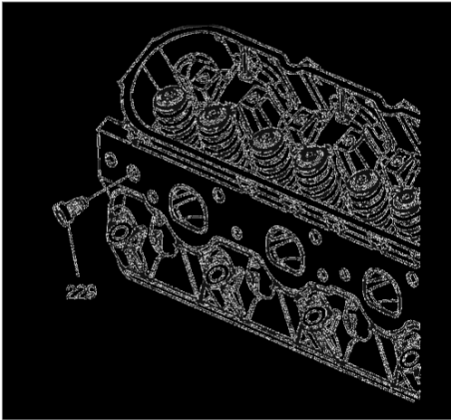
5. Remove the valve spring (223).
6. Remove the valves (228).
7. Remove the valve stem oil seal (222). Refer to [Separating Parts](#).



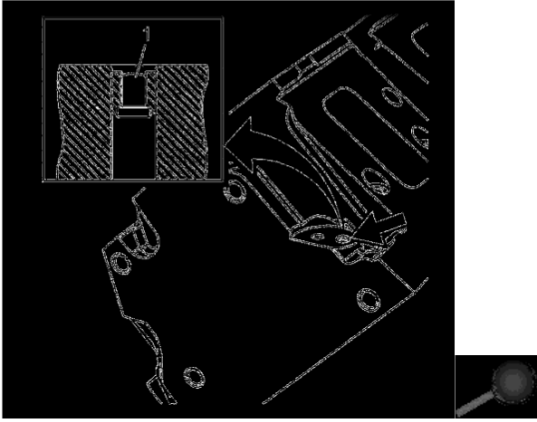
8. Remove the cylinder head core hole plugs (216), as required.



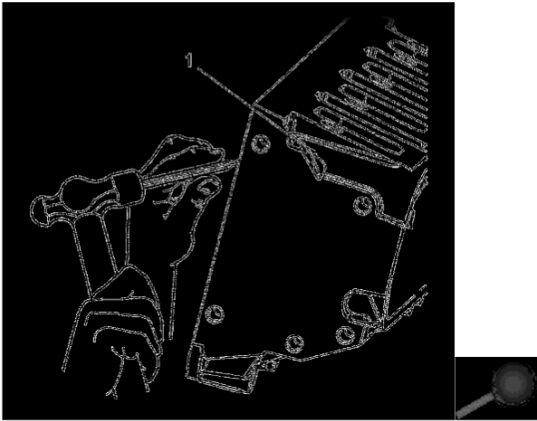
9. Remove the coolant temperature sensor (725) from the left cylinder head.



10. Remove the cylinder head plug (229) from the right cylinder head.



11. Inspect for a leaking plug. Second design applications use a rivet-type plug (1) at the top rear coolant passage of each cylinder head. If service of a leaking plug is required, it is necessary to remove the cylinder head from the engine to properly remove the plug.



12. Using a 6.43 mm (0.25 in) or smaller punch, remove the plug assembly (1) from the cylinder head.

Cylinder Head Cleaning and Inspection

Special Tools

- J 8089 Carbon Removal Brush
- J 9666 Valve Spring Tester

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



Warning: Refer to [Safety Glasses Warning](#).

Note:

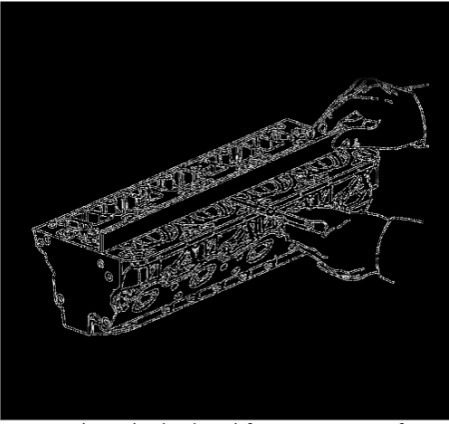
- When cleaning a cylinder head in a thermal type oven, do not exceed 204°C (400°F).
- Be careful not to scuff the chamber.

1. Clean the following components:

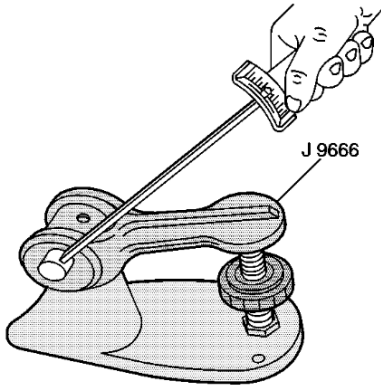
- Use the J 8089 brush in order to remove the carbon from the combustion chambers.
- Gasket surfaces
Refer to [Replacing Engine Gaskets](#).
- Valve stems and heads on a buffing wheel
- Bolt hole threads
Remove all dirt, debris, or threadlocking material from the bolt holes.

2. Inspect the cylinder head for the following conditions:

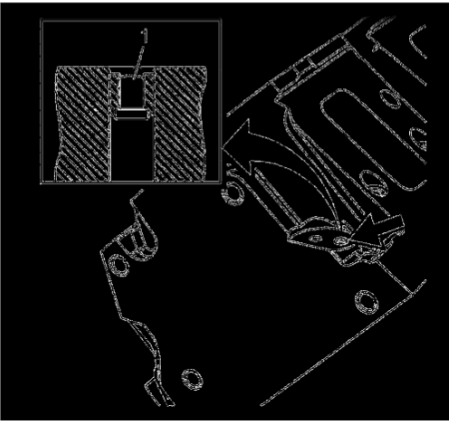
- 2.1. Cracks in the exhaust ports and combustion chambers
- 2.2. External cracks in the water chambers
- 2.3. Gasket surfaces for excessive scratches or gouging
Refer to [Replacing Engine Gaskets](#).
- 2.4. Bolt hole threads for debris or damaged threads
Refer to [Thread Repair](#) or [Thread Repair Specifications](#).



3. Inspect the cylinder head for warpage. Refer to [Engine Mechanical Specifications](#).



4. Use the J 9666 tester in order to measure the valve spring tension. Refer to [Engine Mechanical Specifications](#).



5. Inspect for a leaking plug (1) at the top rear coolant passage of each cylinder head. If service of a leaking plug is required, it is necessary to remove the cylinder head from the engine to properly remove the plug. Refer to [Cylinder Head Disassemble](#).

Valve Guide Reaming, and Valve and Seat Grinding

Special Tools

J8001 Dial Indicator Set

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

[Valve Guide Reaming](#)

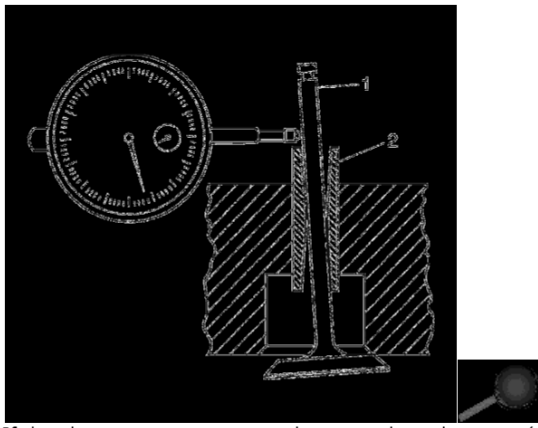


Caution: Excessive valve stem-to-guide clearance may cause a noisy valve train, premature valve stem oil seal wear, component damage, and/or excessive engine oil consumption.

Caution: Insufficient valve stem-to-guide clearance will result in noisy or sticking valves. Valves that are too tight may disturb engine smoothness or lead to component damage.

1. Using the J8001 dial indicator, measure the valve stem-to-guide clearance. Position the tip of the dial indicator at the top of the valve guide.

Valve stem-to-guide clearance may also be obtained by using a micrometer to measure the valve stem diameter and a ball type measuring gauge to measure the guide bore.



2. If the clearance measurement between the valve stem (1) and guide (2) is not within specification, the valve and/or the cylinder head must be replaced. Refer to [Engine Mechanical Specifications](#).



3. Inspect the valve stems for excessive scoring, wear, or warpage.
- A valve stem that has excessive scoring (3 or 4) or wear (4 or 6) must be replaced.
 - If a valve guide is worn or has excessive stem-to-guide clearance, the cylinder head should be replaced.
4. Measure the valve stem diameter. If the valve stem diameter is not within specification, the valve must be replaced. Refer to [Engine Mechanical Specifications](#).
- If the valve stem diameter is within specifications, and the stem-to-guide clearance is excessive, the cylinder head must be replaced.

[Valve and Seat Grinding](#)

**Note:**

- Reconditioning the valve seats is very important. The seating of the valves must be perfect for the engine to deliver optimum power and performance. Several different types of equipment are available for grinding valve seats.
- Another important factor is the cooling of the valve head. Good contact between the valve and the seat will ensure that heat will be properly dissipated.
- The recommendations of the equipment manufacturer should be followed carefully to obtain the proper results. Regardless of the type of equipment used, it is essential that valve guide bores be free of carbon or dirt to ensure proper centering of the tool pilot in the guide.
- Valves that are pitted must be refaced to the proper angle. Valve stems that show excessive wear, or valves that are warped excessively must be replaced. When a valve head that is warped excessively is refaced, a knife edge may be ground on part or all of the valve head due to the amount of metal that must be removed. Knife edges lead to breakage, burning or pre-ignition due to heat localizing on this knife edge. If the edge of the valve head, margin, is not within specification after grinding, replace the valve.
- Several different types of equipment are available for refacing valves. The recommendation of the equipment manufacturer should be carefully followed to obtain the proper results.
- DO NOT reface intake valves. Intake valves with excessive wear or damage MUST be replaced.

1. Inspect the valve for the following conditions:

- Burnt or eroded areas (1)
- A worn margin (2)
- A bent stem (3)
- A worn or scored stem (4)
- A worn key groove (5)
- A worn stem tip (6)



2. Inspect the valve face for the following conditions:

- Worn or no margin (1 or 4)
- Pitted surfaces (2)
- Burnt or eroded areas (3)



3. Inspect the valve margin.

The exhaust valve may be refaced if the margin is within specification before grinding.
Refer to [Engine Mechanical Specifications](#).

4. Reface pitted exhaust valves on a suitable valve refacing machine.

5. Replace the valve if the margin is not within specification after grinding. Refer to [Engine Mechanical Specifications](#).

6. If the valve face has been ground, measure the valve spring installed height after reassembly of the cylinder head. The valve, and/or cylinder head must be replaced if the valve spring installed height is not within specification. Refer to [Cylinder Head Assemble](#).

7. Inspect for a loose valve seat in the cylinder head. The valve seat has an interference fit to the cylinder head.

8. Clean the valve guide bores with a suitable tool. Remove all carbon or dirt from the bores.
The valve guide must be clean for the seat grinding tool to obtain proper results.

9. Grind the valve seat.

The recommendations of the equipment manufacturer should be followed carefully to obtain the proper results. Regardless of the type of equipment used, it is essential that

valve guide bores be free from carbon or dirt to ensure proper centering of the tool pilot in the guide.

10. Inspect the valve seats.

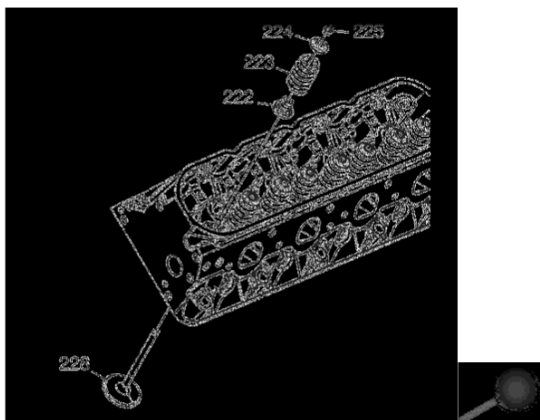
- The valve seats should be concentric to the centerline of the guide, measure valve seat runout. The total indicator runout reading must be within specification. Refer to [Engine Mechanical Specifications](#).
- If the valve seat has been ground, measure the valve spring installed height after reassembly of the cylinder head. The cylinder head, and/or valve must be replaced if the valve spring installed height is not within specification after seat grinding. Refer to [Cylinder Head Assemble](#).

Cylinder Head Assemble

Special Tools

J 8062 Valve Spring Compressor – Head Off

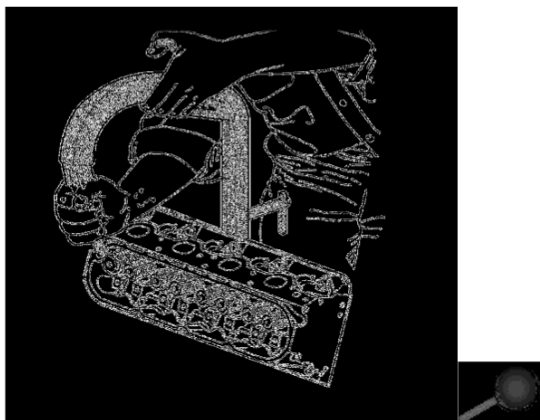
For equivalent regional tools, refer to [Special Tools](#).



1. Clean the cylinder head valve spring shim area.

Note: When using the valves and related components again, install the parts to their original location.

2. Install the valves (228) into the proper port. Refer to [Separating Parts](#).
3. Install the valve stem oil seal (222).
4. Install the valve spring (223).
5. Install the valve spring cap (224).



6. Using the J 8062 compressor, compress the valve spring.
7. Install the valve stem keys.
 - 7.1. Use grease in order to hold the keys in place and remove the J 8062 compressor.

7.2. Ensure the keys seat properly in the groove of the valve stem.

7.3. Tap the end of the valve stem with a plastic face hammer to seat the keys, if necessary.



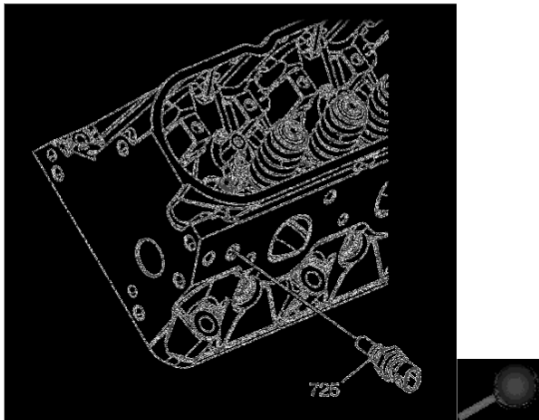
8. Using a ruler, measure the valve spring installed height.

Measure from the base of the valve spring to the top of the valve spring.

Specification

- If the installed height exceeds 46.25 mm (1.82 in), install a valve spring shim of approximately 0.5 mm (0.02 in) thick.
- Do not shim the valve spring to obtain less than the specified height.
- Do not assemble the components without a spring shim on the cylinder head.

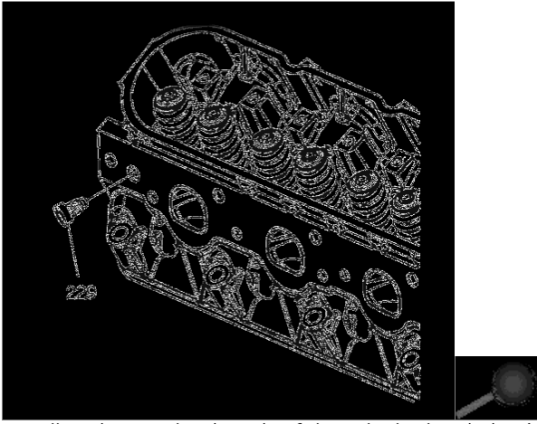
9. Install the remaining valves, springs, and other components.



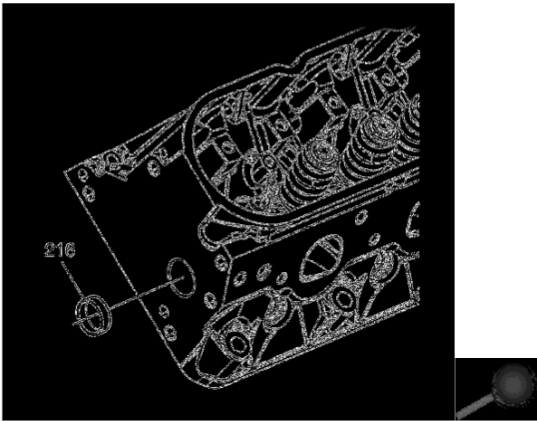
10. Install sealant to the threads of the coolant temperature sensor (725). Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended sealant.

Caution: Refer to [Fastener Caution](#).

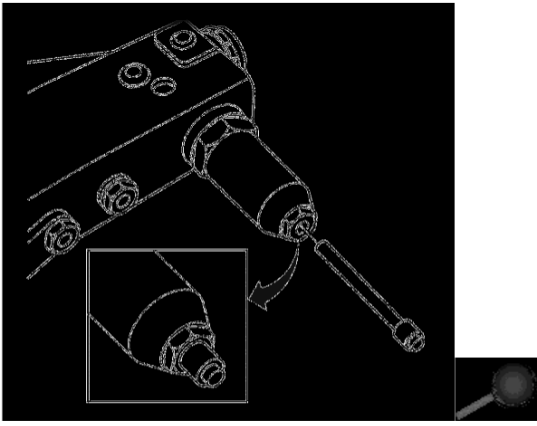
11. Install the coolant temperature sensor into the left cylinder head and tighten to **20 N·m (15 lb ft)**.



12. Install sealant to the threads of the cylinder head plug (229). Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended sealant.
13. Install the cylinder head plug to the right cylinder head. Tighten the cylinder head plug to **20 N•m (15 lb ft)**.

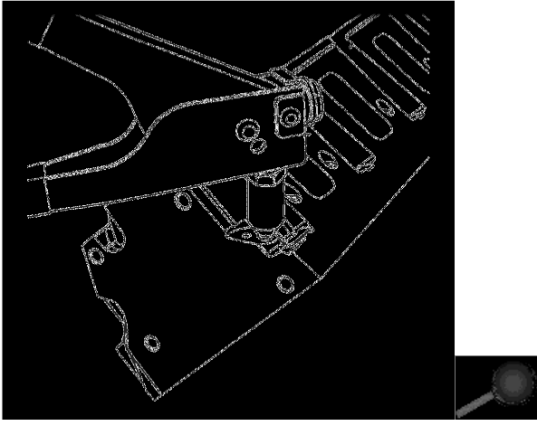


14. Apply threadlock to the sides of the cylinder head plugs (216). Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended threadlock.
15. Install the cylinder head plugs into the cylinder head.
A properly installed plug should be installed 2.5 mm (0.1 in) below the end face of the head.



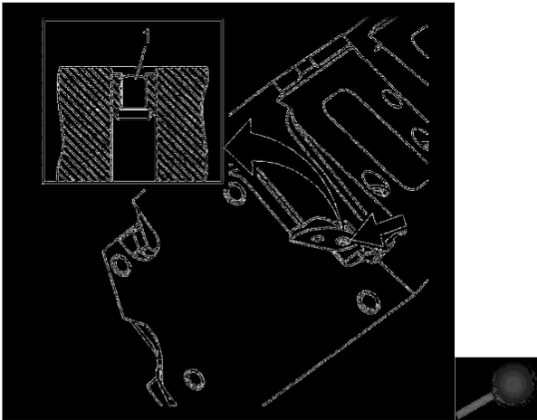
Note: Second design applications use a rivet type plug at the top rear coolant passage of each cylinder head.

16. Install the rivet plug into a rivet gun.



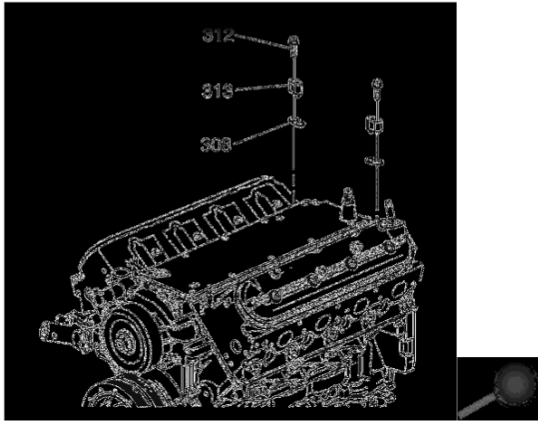
17. Insert the rivet into the coolant passage of the cylinder head.

18. Squeezing the handle of the tool, install the rivet.



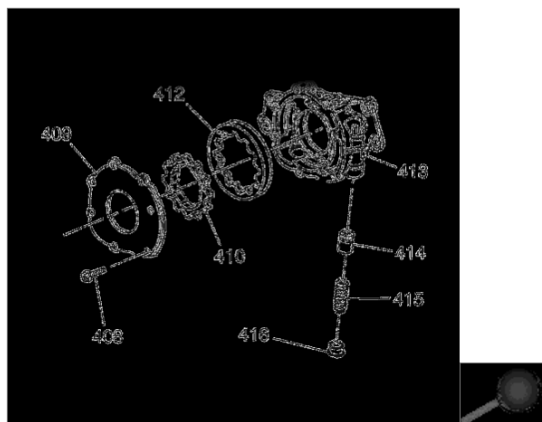
19. Inspect for proper installation of the rivet (1).

A properly installed plug should be installed flush with the surface of the head.



20. Installation of the first design coolant air bleed cover (313) and bolt (312) may be used instead of the rivet plug to complete the repair.

Oil Pump Disassemble



Important: The internal parts of the oil pump assembly are not serviced separately, excluding the spring. If the oil pump components are worn or damaged, replace the oil pump as an assembly.

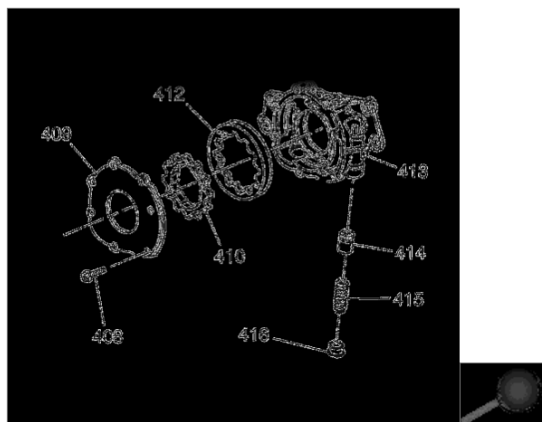
1. Remove the oil pump cover bolts (408).
2. Remove the oil pump cover (409).

Important: Mark or identify the gears for assembly. Refer to [Separating Parts](#).

3. Remove the drive gear (410).
4. Remove the driven gear (412).
5. Remove the pressure relief valve plug (416).
6. Remove the pressure relief valve spring (415).
7. Remove the pressure relief valve (414).
8. Inspect the oil pump components. Refer to [Oil Pump Cleaning and Inspection](#).

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Oil Pump Cleaning and Inspection (LSA)



Note:

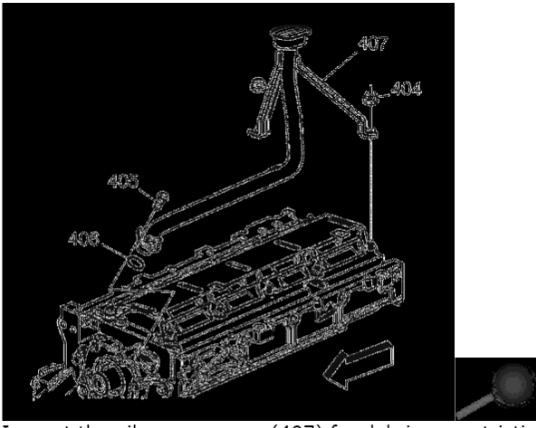
- The internal components of the oil pump assembly are not serviced separately, excluding the spring. If the oil pump components are worn or damaged, replace the oil pump as an assembly.
- The oil pump pipe and screen are to be serviced as an assembly. Do not attempt to repair the wire mesh portion of the pump and screen assembly.

1. Clean the parts in solvent.

Warning: Refer to [Safety Glasses Warning](#).

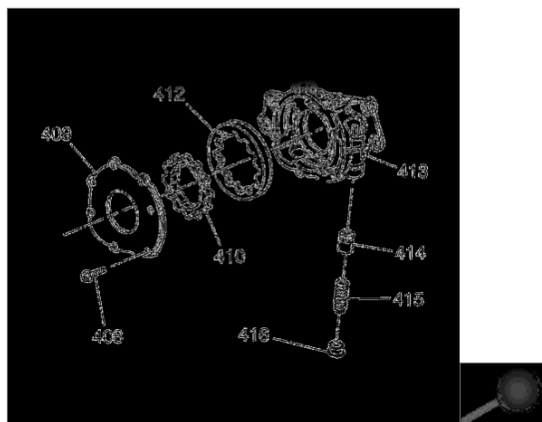
2. Dry the parts with compressed air.
3. Inspect the oil pump housing (413) and the cover (409) for cracks, excessive wear, scoring, or casting imperfections.
4. Inspect the oil pump housing-to-engine block oil gallery surface for scratches or gouging.
5. Inspect the oil pump housing for damaged bolt hole threads.
6. Inspect the relief valve plug (416) and plug bore for damaged threads.
7. Inspect the oil pump internal oil passages for restrictions.
8. Inspect the drive gear (410) and driven gear (412) for chipping, galling, or wear.
Minor burrs or imperfections on the gears may be removed with a fine oil stone.
9. Inspect the drive gear splines for excessive wear.
10. Inspect relief valve spring (415) for cracks, scratches, and wear to coils in spring.
11. Inspect the pressure relief valve (414) and bore for scoring or wear.
The valve must move freely in the bore, with no restrictions.

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12. Inspect the oil pump screen (407) for debris or restrictions.
13. Inspect the oil pump screen for broken or loose wire mesh.

Oil Pump Cleaning and Inspection (LS3 or L77)



Note:

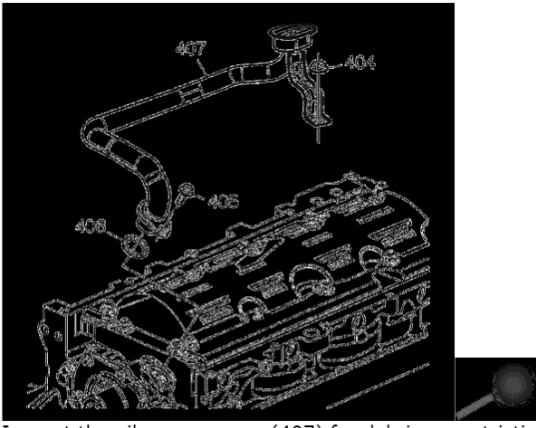
- The internal parts of the oil pump assembly are not serviced separately, excluding the spring. If the oil pump components are worn or damaged, replace the oil pump as an assembly.
- The oil pump pipe and screen are to be serviced as an assembly. Do not attempt to repair the wire mesh portion of the pump and screen assembly.

1. Clean the parts in solvent.

Warning: Refer to [Safety Glasses Warning](#).

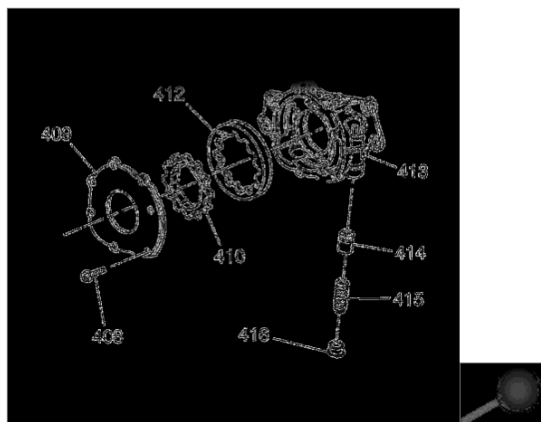
2. Dry the parts with compressed air.
3. Inspect the oil pump housing (413) and the cover (409) for cracks, excessive wear, scoring, or casting imperfections.
4. Inspect the oil pump housing-to-engine block oil gallery surface for scratches or gouging.
5. Inspect the oil pump housing for damaged bolt hole threads.
6. Inspect the relief valve plug (416) and plug bore for damaged threads.
7. Inspect the oil pump internal oil passages for restrictions.
8. Inspect the drive gear (410) and driven gear (412) for chipping, galling, or wear.
Minor burrs or imperfections on the gears may be removed with a fine oil stone.
9. Inspect the drive gear splines for excessive wear.
10. Inspect the pressure relief valve (414) and bore for scoring or wear.
The valve must move freely in the bore, with no restrictions.

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11. Inspect the oil pump screen (407) for debris or restrictions.
12. Inspect the oil pump screen for broken or loose wire mesh.

Oil Pump Assemble



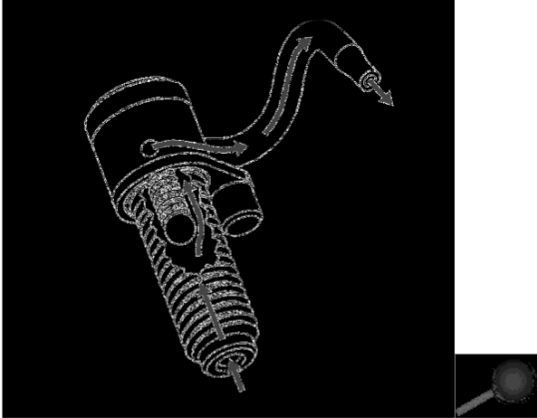
Note: Prior to assembling the oil pump, coat all wear or internal surfaces with clean engine oil.

1. Install the driven gear (412) into the pump housing (413).
Install the driven gear with the orientation mark facing the pump cover.
2. Install the drive gear (410) into the pump housing.
3. Install the oil pump cover (409).
4. Install the oil pump cover bolts (408) and tighten to **12 N·m (106 lb in)**.
5. Install the relief valve (414).
6. Install the relief valve spring (415).
7. Install the relief valve plug (416) and tighten to **14 N·m (124 lb in)**.
8. Inspect the oil pump for smooth operation by rotating the drive gear.

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Piston Oil Nozzle Cleaning and Inspection

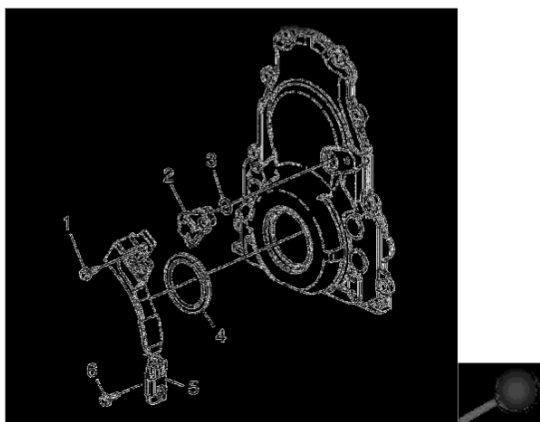
Note: The piston oil nozzle assembly is designed to provide oil to the bottom side of the piston for cooling purposes. The internal check ball is held in the normally closed position by the spring until system oil pressure exceeds 20.7 kPa (43.5 psi).



1. Clean the nozzle assembly in solution.
2. Inspect the nozzle assembly for the following:
 - damaged bolt threads
 - damaged or cut O-ring seal
 - bent nozzle
 - A restricted or stuck-open nozzle assembly
3. With no oil pressure, the check ball should be seated and not permit flow through the nozzle tube. Using a blow gun, apply air pressure to the inlet portion of the bolt. Air pressure should unseat the check ball and permit flow through and out of the nozzle tube.

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Engine Front Cover Cleaning and Inspection



Note:

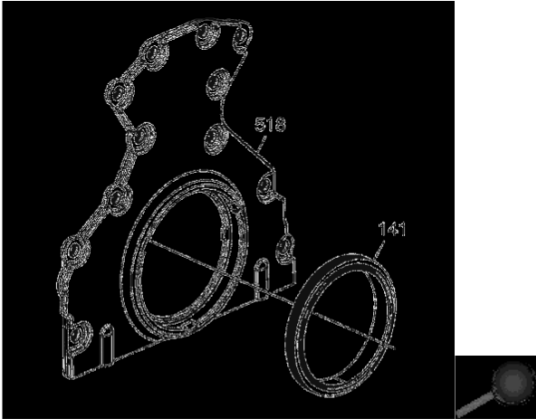
- Do not use the crankshaft oil seal again. Install a NEW crankshaft oil seal during assembly.
- Do not use the front cover-to-engine block gasket again. Install a NEW gasket during assembly.

1. Remove the crankshaft oil seal (4) from the front cover.
2. Clean the cover in solvent. Remove the sealant from the cover oil pan surface. Refer to [Replacing Engine Gaskets](#).

Warning: Refer to [Safety Glasses and Compressed Air Warning](#).

3. Dry the cover with compressed air.
4. Inspect the gasket sealing surfaces for excessive scratches or gouging.
5. Inspect the threaded bolt holes for damaged threads or debris.
6. Inspect the crankshaft oil seal and camshaft position (CMP) sensor mounting bores for damage.

Crankshaft Rear Oil Seal Housing Cleaning and Inspection



Note:

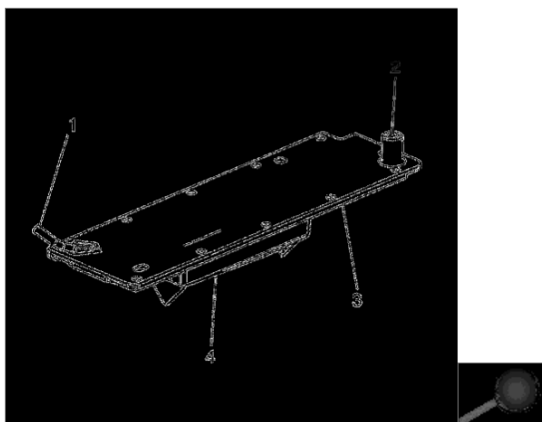
- Do not use the crankshaft rear oil seal again. Install a NEW crankshaft oil seal during assembly.
- Do not use the rear housing-to-engine block gasket again. Install a NEW gasket during assembly.

1. Remove the crankshaft oil seal (141) from the rear housing.
2. Clean the housing in solvent. Remove the sealant from the housing oil pan surface. Refer to [Replacing Engine Gaskets](#).

Warning: Refer to [Safety Glasses Warning](#).

3. Dry the housing with compressed air.
4. Inspect the gasket sealing surfaces for excessive scratches or gouging.
5. Inspect the housing-to-oil pan threaded bolt holes for damaged threads or debris.
6. Inspect the crankshaft oil seal mounting bore for damage.

Engine Block Valley Cover Cleaning and Inspection



1. Clean the valley cover in solvent.

Warning: Refer to [Safety Glasses and Compressed Air Warning](#).

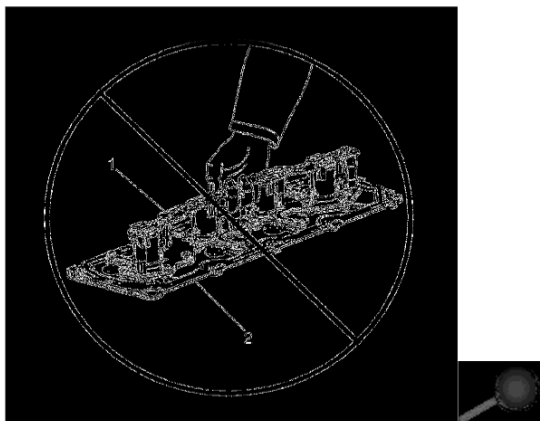
2. Dry with compressed air.
3. Inspect for restrictions within the positive crankcase ventilation (PCV) passages (1, 4).
4. Inspect for damaged threads (2) and damaged sealing surfaces (3).

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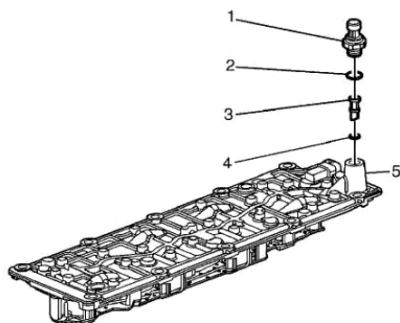
Valve Lifter Oil Manifold Cleaning and Inspection

Note:

- DO NOT allow dirt or debris to enter the oil passages of the Valve Lifter Oil Manifold (VLOM). Plug, as required.
- DO NOT disassemble the electrical components from the VLOM.
- DO NOT submerge the electrical components in cleaning solvent.
- DO NOT use the VLOM outer gasket again. Remove the VLOM outer gasket and install a NEW VLOM outer gasket during assembly.



1. DO NOT lift the VLOM (2) by the electrical lead frame (1).



2. Remove the oil pressure sensor (1) and washer (2) from the VLOM (5).

Note: The valve lifter oil filter (3) should be replaced whenever the oil pressure sensor (1) is removed.

3. Remove the valve lifter oil filter (3). Discard the filter.

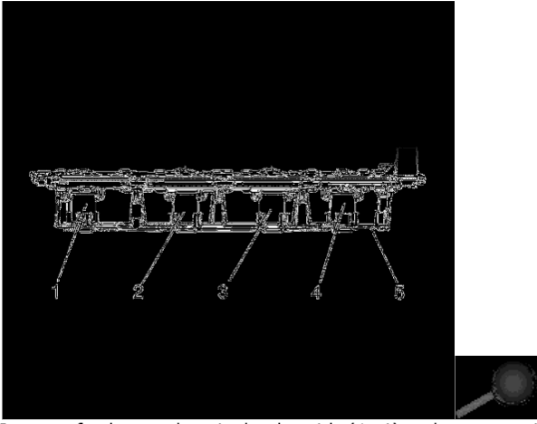
Note: The valve lifter oil filter O-ring seal (4) is a single use only part and must be replaced whenever the valve lifter oil filter (3) is removed.

4. Remove and discard the valve lifter oil filter O-ring seal (4). Discard the O-ring seal.

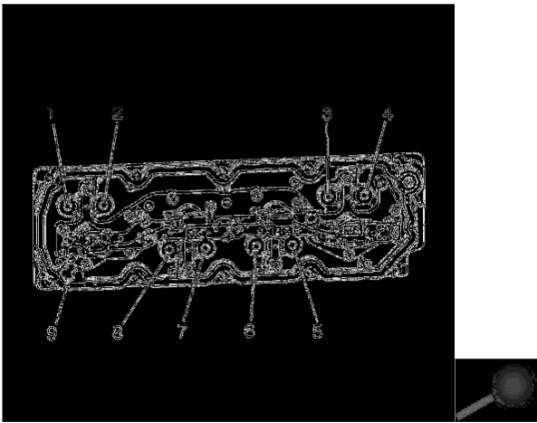
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Warning: Refer to [Safety Glasses and Compressed Air Warning](#).

5. Clean the VLOM (5) with compressed air.

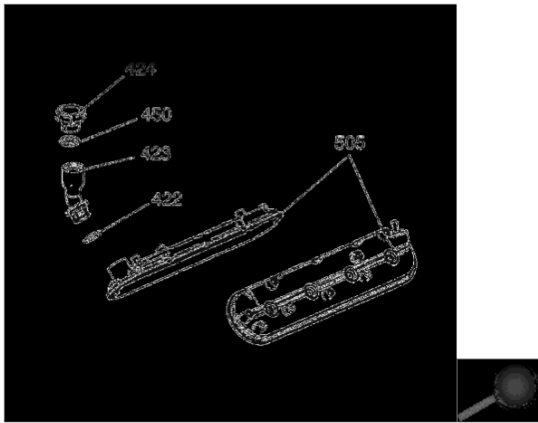


6. Inspect for loose electrical solenoids (1–4) or loose or missing bolts.
7. Inspect for damage to the electrical lead frame (5).
8. Inspect for a damaged electrical connector, for bent or corroded pins.



9. Inspect for damaged VLOM inner gaskets (1–8). If the VLOM inner gaskets are damaged, the VLOM must be replaced as an assembly.
10. Inspect for a damaged VLOM outer gasket (9) or scored gasket surfaces.
11. Inspect for debris or restrictions within the oil passages of the VLOM. Refer to [Cylinder Deactivation \(Active Fuel Management\) Valve Lifter Oil Manifold Diagnosis and Testing](#).

Valve Rocker Arm Cover Cleaning and Inspection

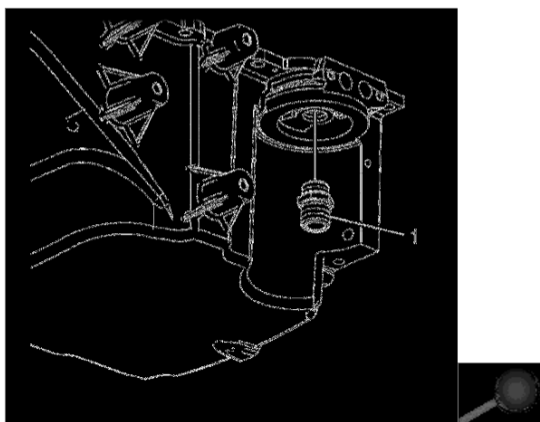
**Important:**

- Do not use the valve rocker arm cover gasket again. Install a NEW gasket during assembly.
- Remove the ignition coils before cleaning the cover in solvent. Do not submerge the ignition coils in solvent.
- Do not remove the oil fill tube from the covers unless service is required. If the tube is removed from the cover, install a NEW tube (423) and seal (422) during assembly.

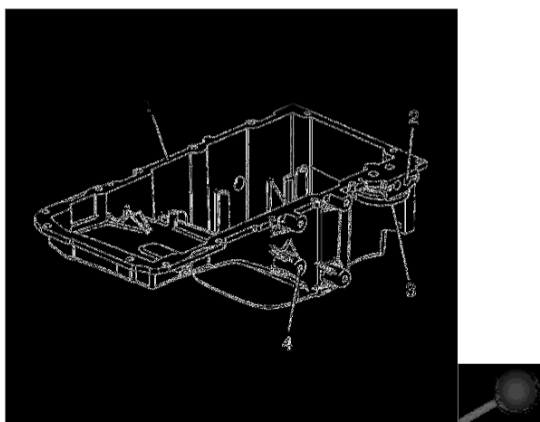
1. Inspect the oil fill tube (423) for a loose fit or damage.
2. Inspect the covers (505) for the following conditions:
 - Scoring or damage to the gasket surfaces
 - Ventilation system passages for restrictions
 - Threaded bolt holes for damage or debris

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Oil Pan Cleaning and Inspection (LSA)



1. Remove the oil filter fitting (1), as required.



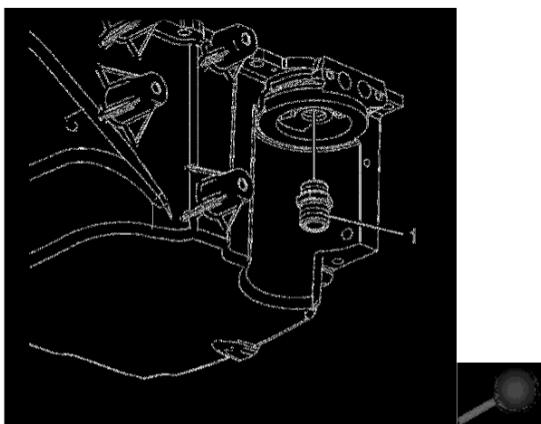
2. Clean the oil pan in solvent.

Warning: Refer to [Safety Glasses Warning](#).

3. Dry the oil pan with compressed air.

4. Inspect the oil pan for the following conditions:

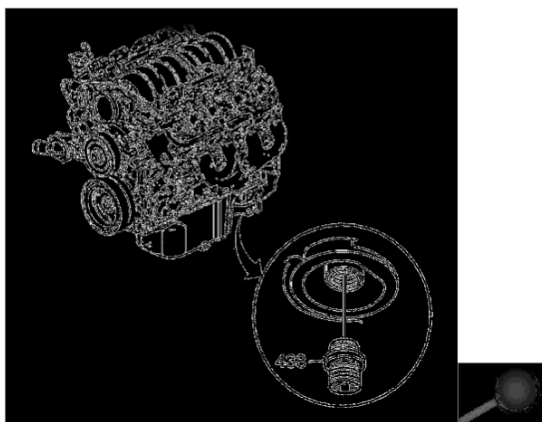
- Damaged gasket surfaces (1)
- Restrictions within the oil passages (2) of the pan
- Damaged oil filter seal surface (3)
- Threaded bolt holes (4) for damage



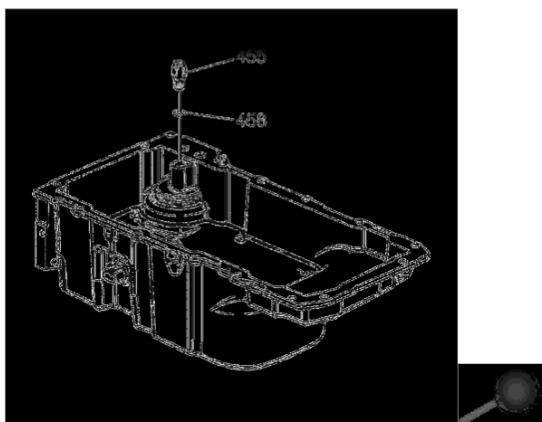
Caution: Refer to [Fastener Caution](#).

5. Install the oil filter fitting (1), as required, and tighten to **55 N·m (40 lb ft)**.

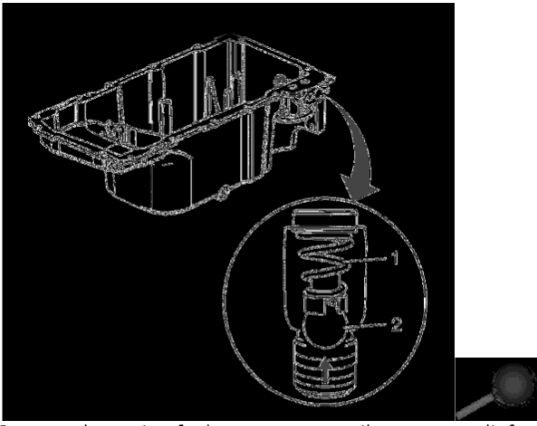
Oil Pan Cleaning and Inspection (LS3 or L77)



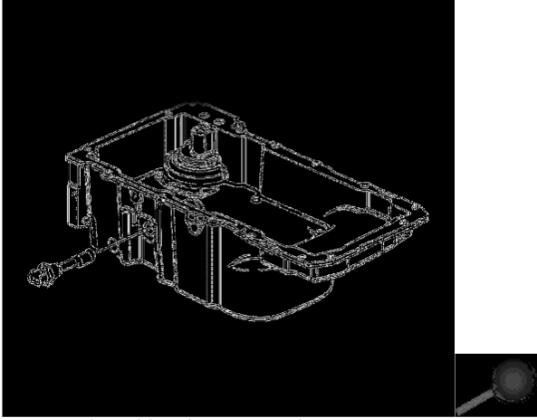
1. Remove the oil filter fitting (438) as required.



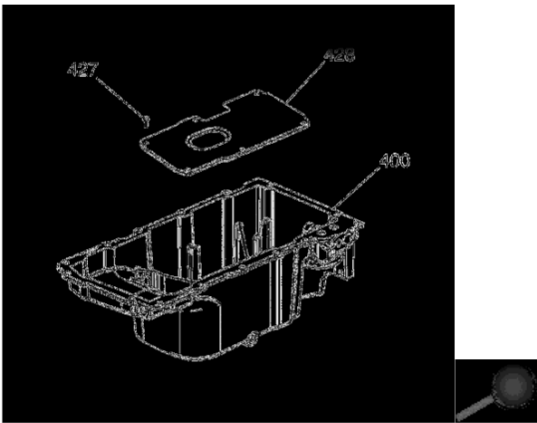
2. Remove the active fuel management oil pressure relief valve (455) and washer (458).



3. Inspect the active fuel management oil pressure relief valve for proper operation. Lightly depress the ball (2). The valve spring (1) should seat the ball to the proper closed position.



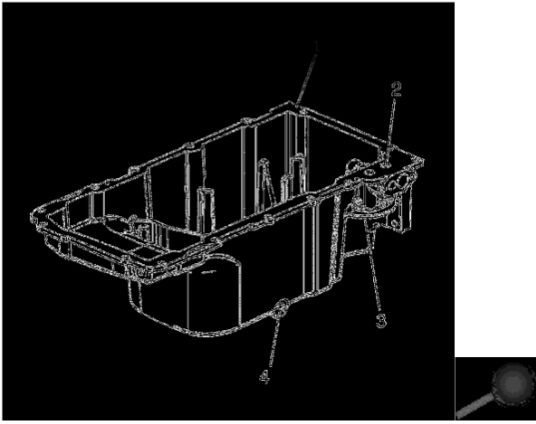
4. Remove the oil level sensor and O-ring.



5. Remove the bolts (427) and baffle (428).
6. Clean the oil pan in solvent.

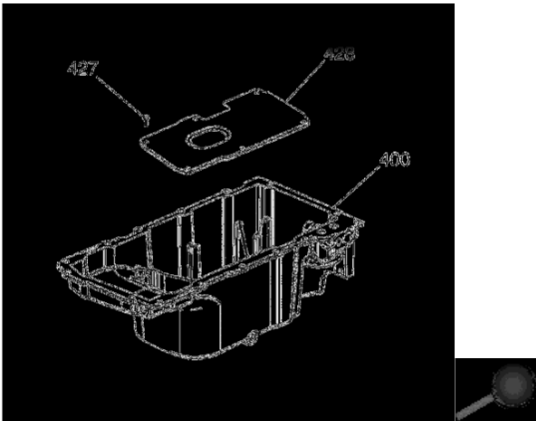
Warning: Refer to [Safety Glasses and Compressed Air Warning](#).

7. Dry the oil pan with compressed air.



8. Inspect the oil pan for the following conditions:

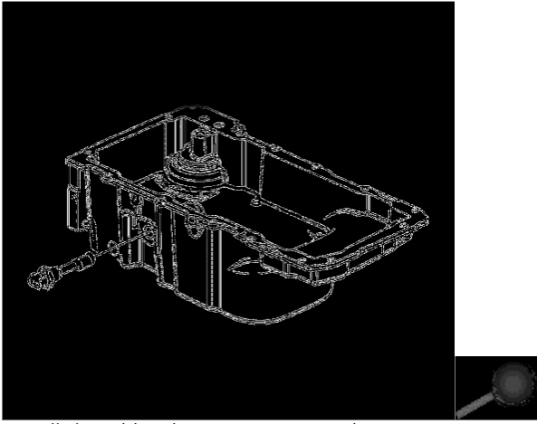
- Damaged gasket surfaces (1)
- Restrictions within the oil passages (2) of the pan
- Damaged oil filter seal surface (3)
- Threaded bolt holes (4) for damage



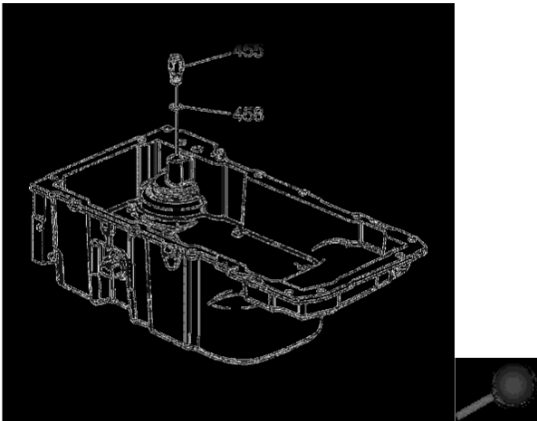
9. Install the baffle (428) and baffle bolts (427).

Caution: Refer to [Fastener Caution](#).

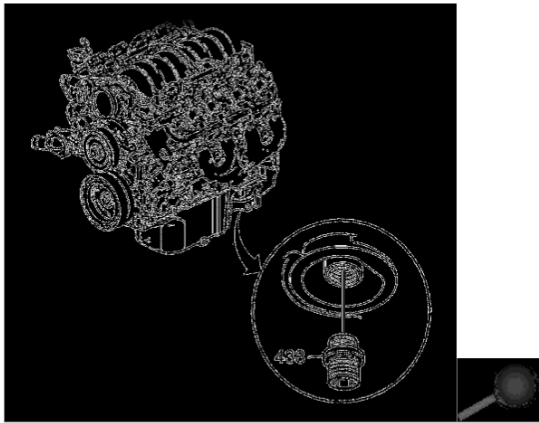
10. Tighten the baffle bolts (427) to **10N·m (89 lb in)**.



11. Install the oil level sensor O-ring seal.
12. Install the oil level sensor and tighten to **20 N•m (15 lb ft)**.

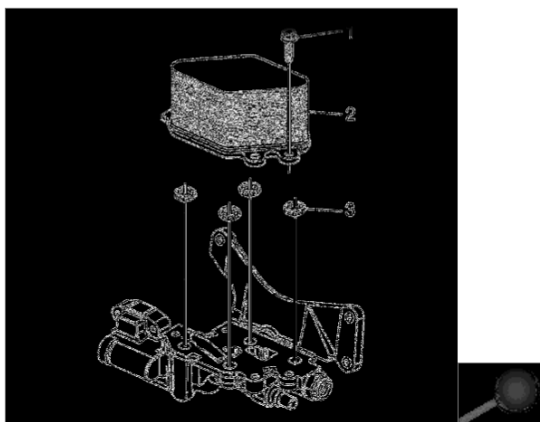


13. Install the active fuel management oil pressure relief valve (455) and washer (458).
14. Tighten the active fuel management oil pressure relief valve (455) to **27 N•m (20 lb ft)**.



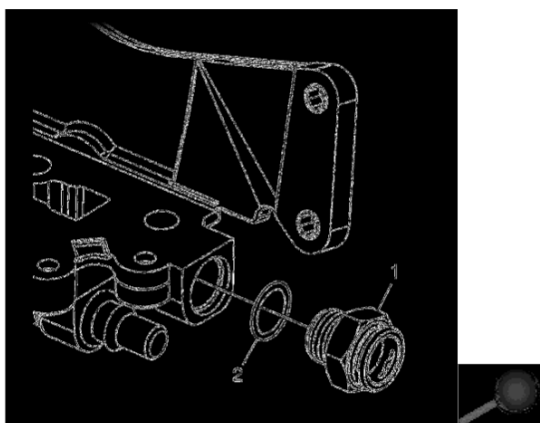
15. Install the oil filter fitting (438) as required.
16. Tighten the oil filter fitting to **55 N·m (40 lb ft)**.

Engine Oil Cooler Disassemble



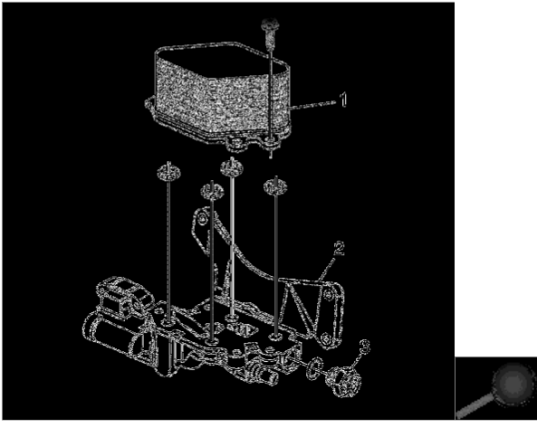
Caution: Refer to [Engine Oil Cooler Debris Caution](#).

1. Remove the oil cooler core bolts (1).
2. Remove the oil cooler core (2).
3. Remove the oil cooler core seals (3).



4. Remove the coolant fitting (1), as required.
5. Remove the coolant fitting seal (2).
6. Discard the seal.

Engine Oil Cooler Cleaning and Inspection

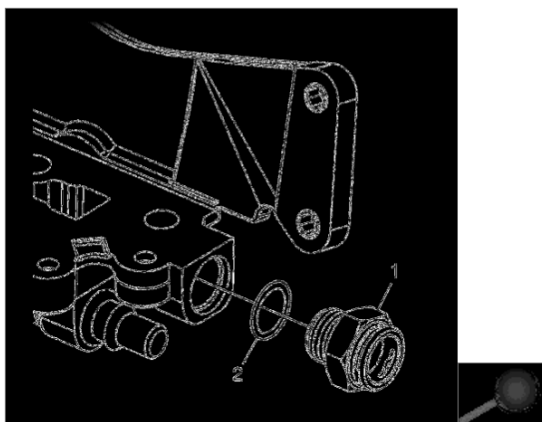


Caution: Refer to [Engine Oil Cooler Debris Caution](#).

1. Inspect the oil cooler housing (2) and the oil cooler core (1) for cracks or casting imperfections.
2. Inspect the oil cooler housing for damaged bolt hole threads.
3. Inspect the oil cooler housing and core for damaged seal surfaces.
4. Inspect the oil cooler core for damaged or broken cooling fins.
5. Inspect for restrictions within the coolant passages of the core or housing.
6. Inspect for restrictions within the oil passages of the core or housing.
7. Inspect for a leaking coolant hose fitting (3).

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Engine Oil Cooler Assemble

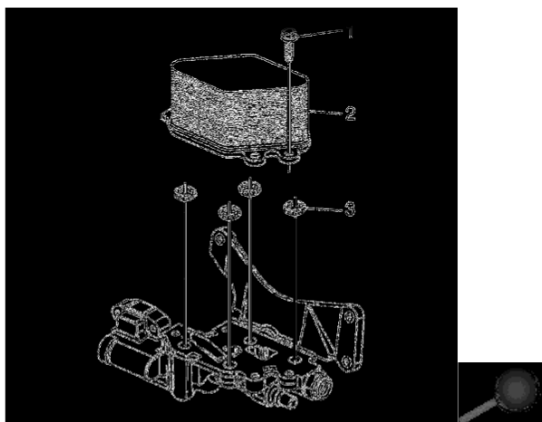


Caution: Refer to [Engine Oil Cooler Debris Caution](#).

1. Install a NEW coolant fitting seal (2).

Caution: Refer to [Fastener Caution](#)

2. Install the coolant fitting (1) and tighten to **35 N•m (26 lb ft)**.



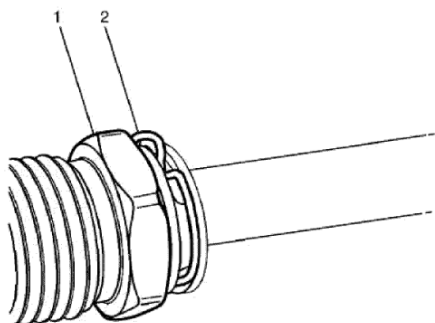
3. Install the NEW oil cooler core seals (3).

4. Install the oil cooler core (2).

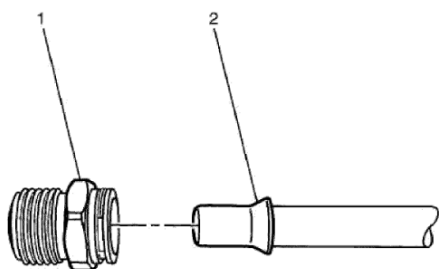
5. Install the oil cooler core bolts (1) and tighten to **25 N•m (18 lb ft)**.

Engine Oil Tank Hose/Pipe Quick-Connect Fitting Disconnection and Connection

[Removal Procedure](#)

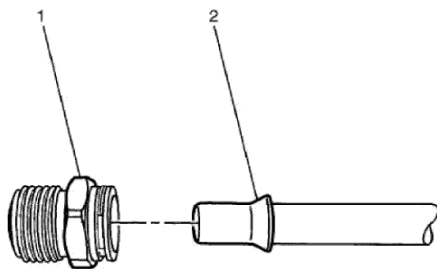


1. Using a suitable tool lift and remove the quick connect fitting circlip (2) from the quick connect fitting (1).



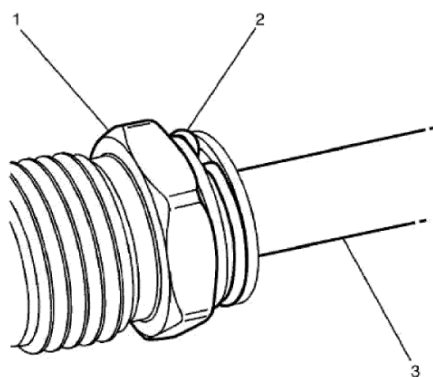
2. Disengage the oil hose/pipe (2) from the quick connect fitting (1).
3. Inspect the oil hose/pipe (2) and the quick connect fitting (1) for signs of wear or damage. Replace the components if necessary.

[Installation Procedure](#)



Note: Apply a few drops of clean engine oil to the oil hose/pipe (2) prior to engaging it into the quick connect fitting (1).

1. Engage the oil hose/pipe (2) into the quick connect fitting (1).



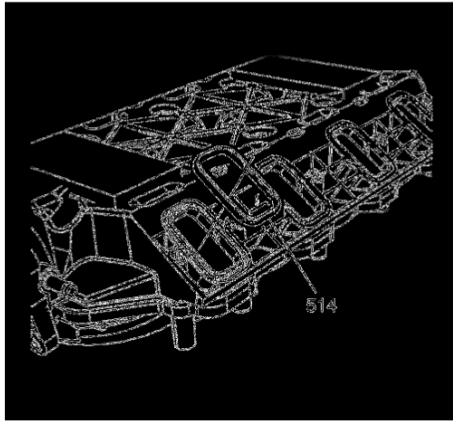
Note: Make sure the quick connect fitting circlip (2) securely seats into the quick connect fitting (1).

Note: To ensure the oil hose/pipe (3) has securely engaged into the quick connect fitting (1) push and pull on the oil hose/pipe to ensure the it is securely installed into the quick connect fitting.

2. Install the quick connect fitting circlip (2) to the quick connect fitting (1)

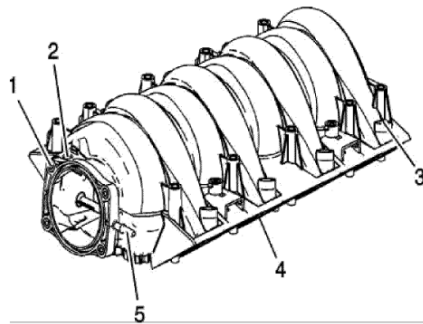
Intake Manifold Cleaning and Inspection

[Cleaning Procedure](#)



1. Remove and discard the intake manifold-to-cylinder head gaskets (514).
 2. Remove the manifold absolute pressure (MAP) sensor. Refer to [Intake Manifold Removal](#).
 3. Remove the evaporative emission (EVAP) canister purge solenoid valve, EVAP tubes, and fuel rail with injectors. Refer to [Fuel Rail and Injectors Removal](#).
 4. Remove the throttle body and gasket. Refer to [Throttle Body Assembly Removal](#).
 5. Clean the intake manifold in solvent.
- Warning:** Refer to [Safety Glasses and Compressed Air Warning](#).
6. Dry the intake manifold with compressed air.

[Inspection Procedure](#)



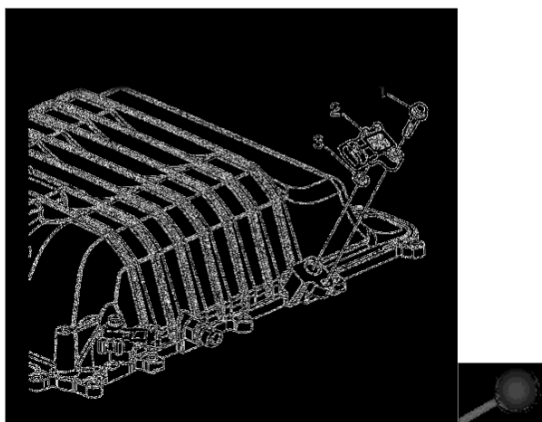
1. Inspect the manifold for the following conditions:

- Loose threaded inserts (1)

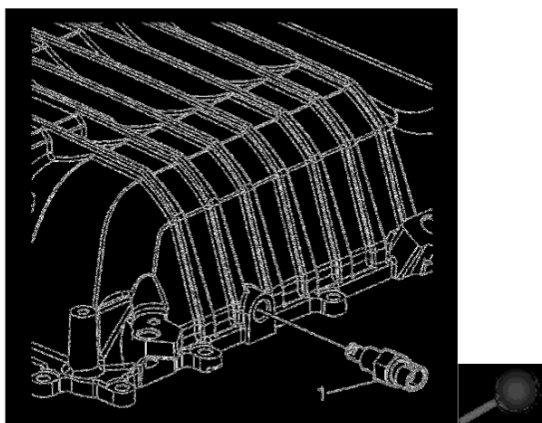
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- Damaged MAP sensor bore (2)
 - Damaged fuel injector bore (3)
 - Damaged gasket or sealing surfaces (4)
 - Damaged or broken vacuum fittings (5)
 - Debris or restrictions within the passages of the manifold
 - Inspect the composite intake manifold assembly for cracks or other damage.
2. Inspect the intake manifold cylinder head deck for warpage.
- 2.1. Locate a straight edge across the intake manifold cylinder head deck surface.
Position the straight edge across a minimum of two runner port openings.
- 2.2. Insert a feeler gauge between the intake manifold and the straight edge.
An intake manifold with warpage in excess of **3 mm (0.118 in)** over a **200 mm (7.87 in)** area is warped and should be replaced.

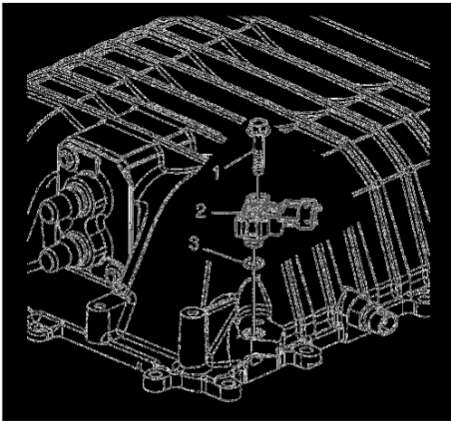
Supercharger Disassemble



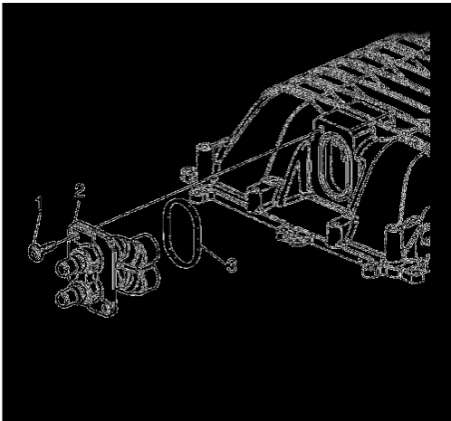
1. Remove the air outlet pressure sensor bolt (1).
2. Remove the sensor (2).
3. Inspect the sensor seal (3) for damage, do not remove the seal from the sensor. If the seal is damaged, replace the sensor. The seal is serviced with the sensor.



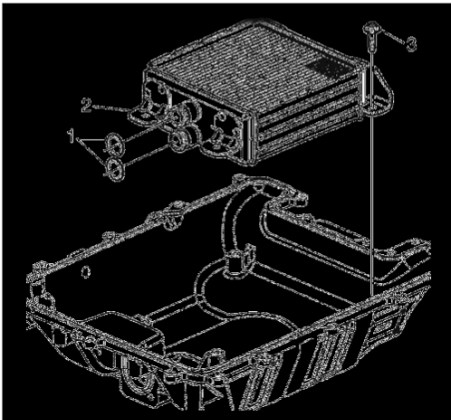
4. Remove the inlet air temperature sensor (1).



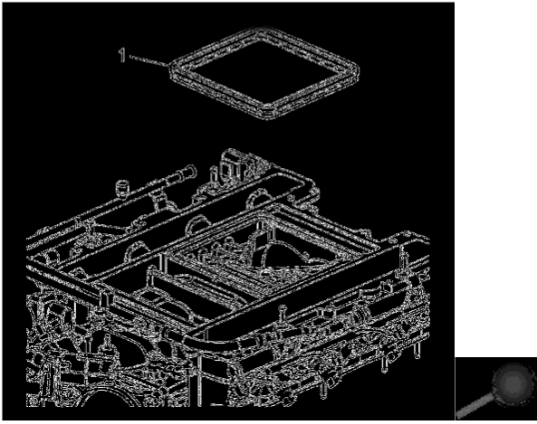
5. Remove the barometric pressure (BARO) sensor bolt (1).
6. Remove the BARO sensor (2).
7. Inspect the BARO sensor seal (3) for damage, do not remove the seal from the sensor. If the seal is damaged, do not remove the seal from the sensor. If the seal is damaged replace the sensor. The seal is serviced with the sensor.



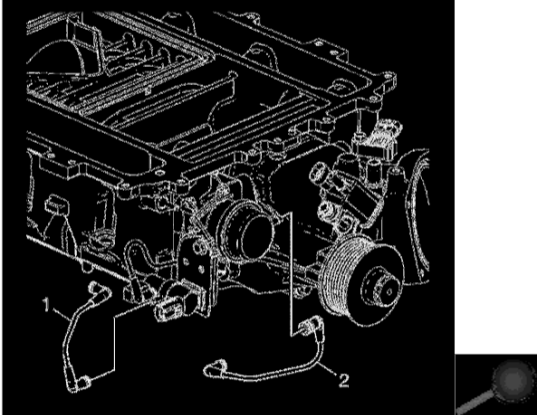
8. Remove the bolts (1), plate (2), and seal (3), from the cooler. Discard the seals.



9. Remove the charge air cooler (2), seals (1), and bolts (3).

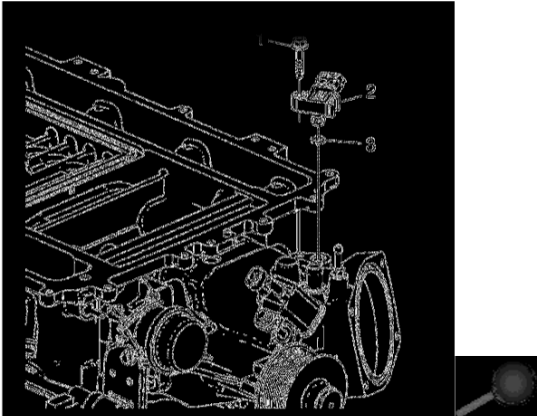


10. Remove and discard the insulator seal (1).



11. Remove the charge air bypass valve tube (1).

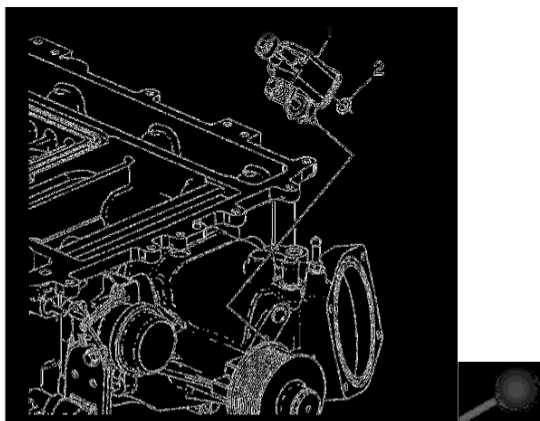
12. Remove the charge air bypass valve vacuum tube (2).



13. Remove the inlet air pressure sensor bolt (1).

14. Remove the inlet air pressure sensor (2).

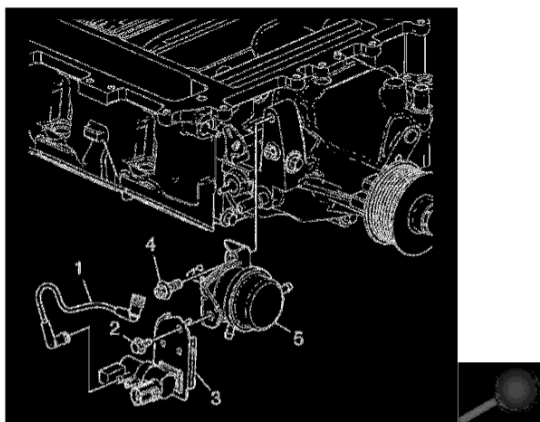
15. Inspect the sensor seal (3) for damage, do not remove the seal from the sensor. If the seal is damaged, replace the sensor. The seal is serviced with the sensor.



16. Loosen the evaporative emissions (EVAP) bolt.

17. Remove the EVAP valve (1).

18. Inspect the sensor seal (2) for damage, do not remove the seal from the sensor. If the seal is damaged, replace the sensor. The seal is serviced with the sensor.



19. Remove the bypass actuator tube (1).

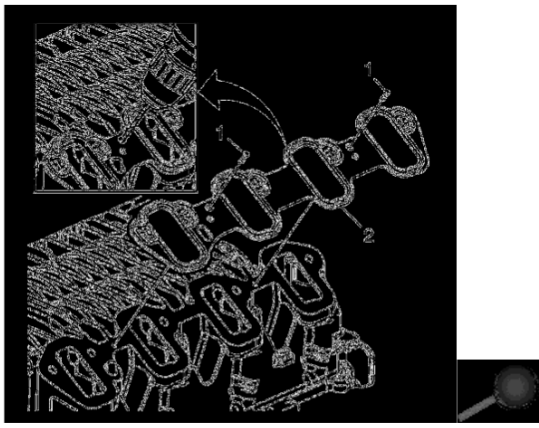
20. Remove the charge air bypass valve bolt (2).

21. Remove the charge air bypass valve (3).

22. Remove the bypass actuator bolts (4).

23. Rotate the actuator upward and remove the rod from the lever of the supercharger.

24. Remove the bypass actuator (5).

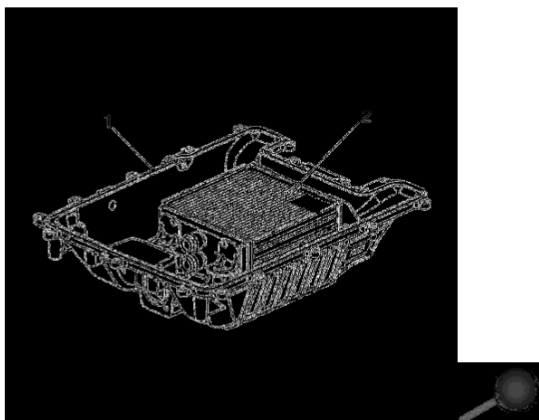
**Note:**

- Do not allow dirt or debris to enter the passages of the supercharger. Cover the intake ports as required.
- With the manifold positioned upside down on a bench, the lower assembly may be positioned onto the intercooler cover dowel pins. Use care not to reposition or bend the dowel pins.

25. Drill out the gasket rivets (1) using a drill bit with an outside diameter (OD) no larger than 3.2 mm (0.125 in).
26. Remove the gaskets (2).

Supercharger Cleaning and Inspection

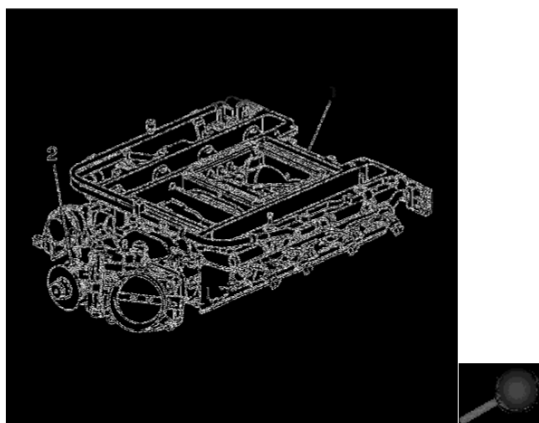
Charge Air Cooler Cover Cleaning and Inspection



Inspect the cover for the following:

- Damaged seal surfaces (1)
- Leaking, restricted, or damaged charge air cooler (2). Refer to [Supercharger Assemble](#).

Supercharger Cleaning and Inspection



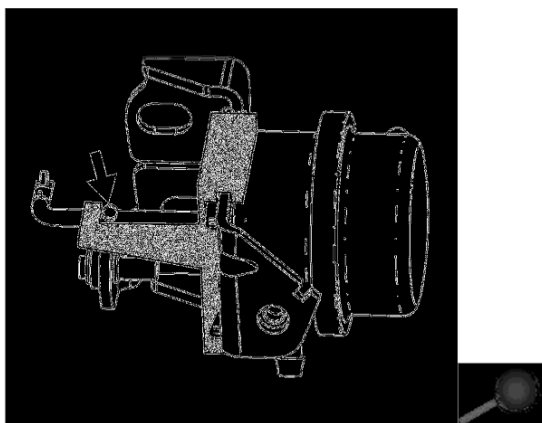
1. Inspect the supercharger for the following:
 - Damaged seal surfaces (1)
 - Worn or damaged belt pulley grooves (2)
2. Rotate the pulley of the supercharger by hand. The pulley and rotors should rotate freely with no binding.

3. Operate the boost bypass valve by hand. The bypass valve should operate within the full range of motion with no sticking or binding.

Supercharger Assemble

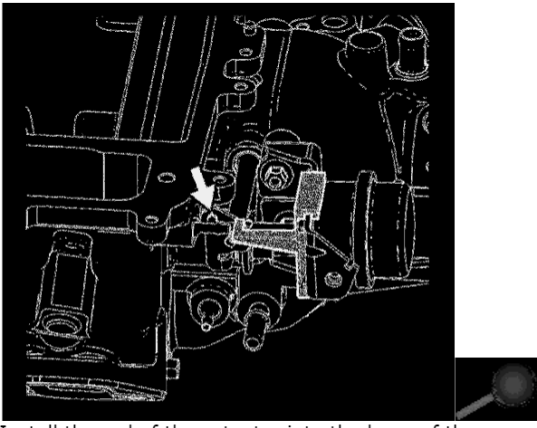


1. Install the NEW gaskets (2).
2. Install NEW gasket rivets (1).

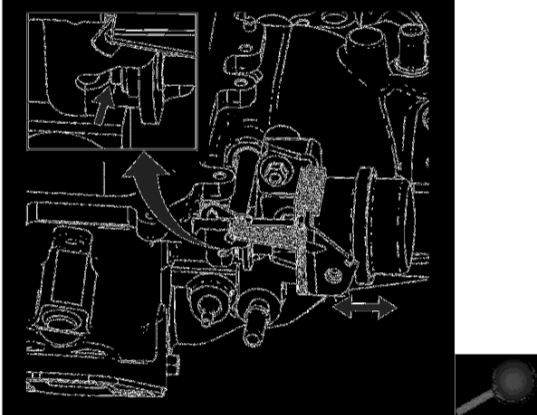


Note: The actuator adjustment tool is provided within the actuator parts kit.

3. Install the actuator adjustment tool onto the actuator. Position the raised portion of the rod in the proper position.



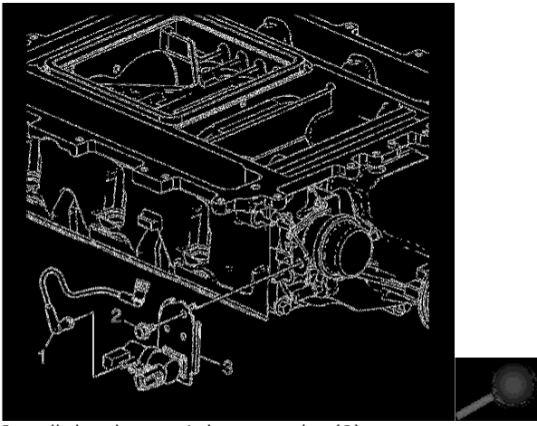
4. Install the rod of the actuator into the lever of the supercharger.
5. Rotate the actuator and install the bolts. Do not tighten the bolts at this time.



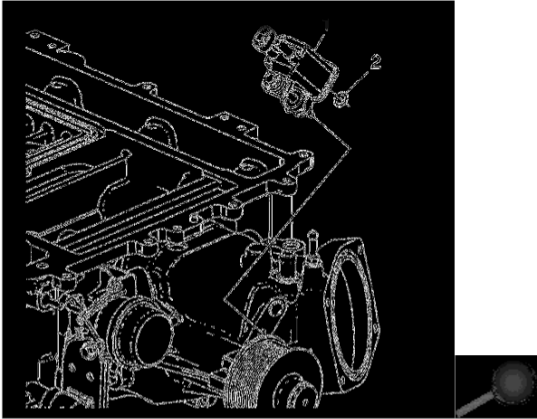
6. Moving the actuator forward or rearward as required, ensure that the supercharger lever is in contact with the adjustment screw on the actuator and that the lever is rotated to the fully closed position.

Caution: Refer to [Fastener Caution](#).

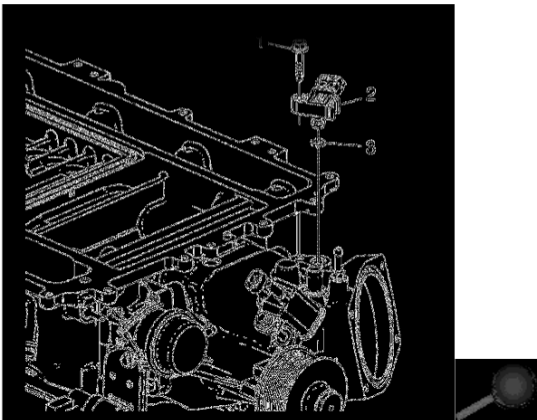
7. Tighten the actuator bolts to **25 N•m (18 lb ft)**.
8. Remove the adjustment tool from the actuator.
9. Rotate the adjustment screw on the actuator clockwise ¼ turn.



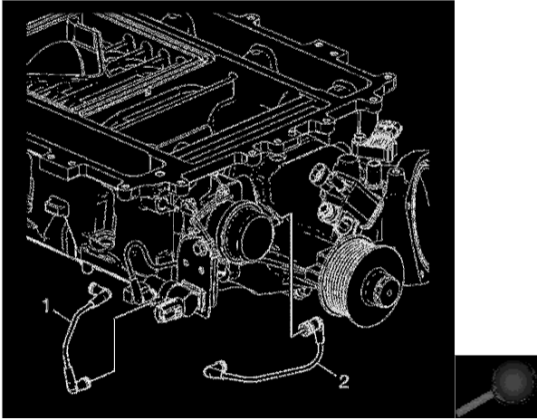
10. Install the charge air bypass valve (3).
11. Install the charge air bypass valve bolt (2) and tighten to **12 N·m (108 lb ft)**.
12. Install the bypass actuator tube (1).



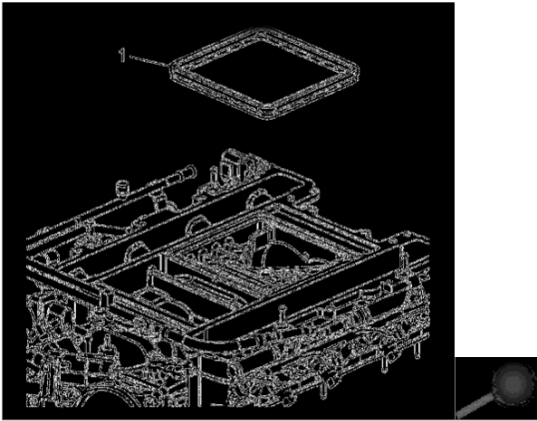
13. Confirm that the evaporative emission (EVAP) valve seal (2) is installed on the EVAP valve (1).
14. Install the EVAP valve (1) and tighten to **10 N·m (89 lb in)**.



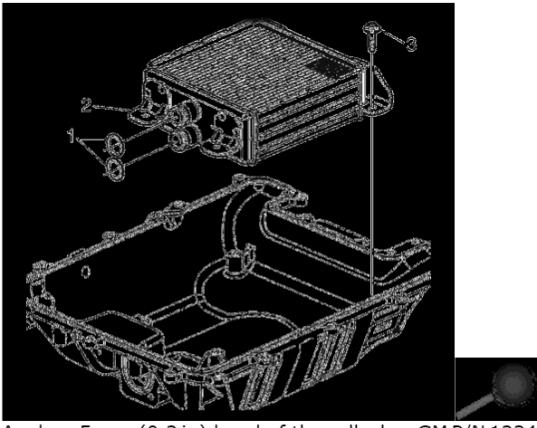
15. Confirm that the inlet air pressure sensor seal (3) is installed on the sensor (2).
16. Install the inlet air pressure sensor (2).
17. Install the inlet air pressure sensor bolt (1) and tighten to **10 N•m (89 lb in)**.



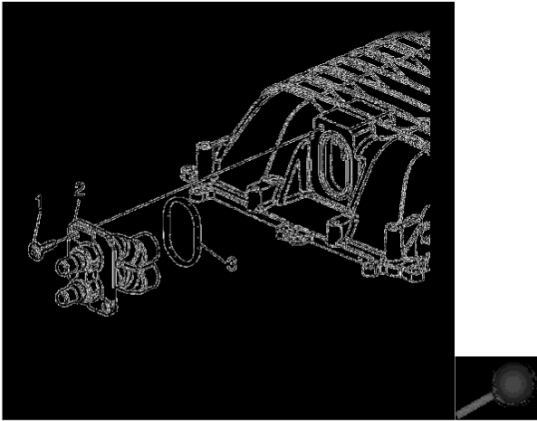
18. Install the bypass valve vacuum tube (2).
19. Install the bypass valve tube (1).



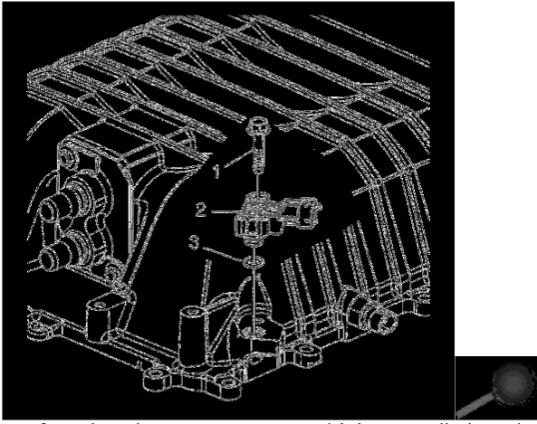
20. Install the NEW insulator seals (1).



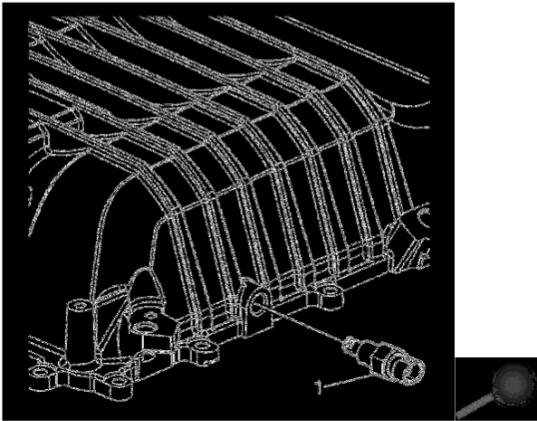
21. Apply a 5 mm (0.2 in) band of threadlocker GM P/N 12345382 (Canadian P/N 10953489), or equivalent, to the threads of the bolts.
22. Install the NEW O-ring seals (1), charger air cooler (2) and bolts (3) and tighten to **10 N·m (89 lb in)**.



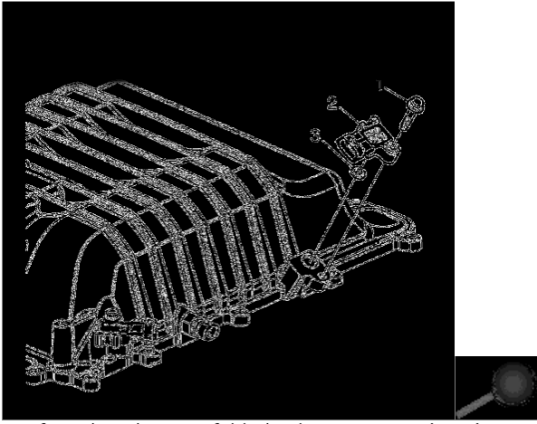
23. Lubricate the seals with clean engine oil.
24. Install NEW seal (3), the plate (2), the bolts (1) and tighten to **10 N·m (89 lb in)**.



25. Confirm that the BARO sensor seal (3) is installed on the BARO sensor (2).
26. Install the BARO sensor (2).
27. Install the BARO sensor bolt (1) and tighten to **10N·m (89 lb in)**.



28. Install sealant GM P/N 12346004 (Canadian P/N 10953480), or equivalent, to the threads of the sensor (1).
29. Install the IAT sensor (1) and tighten to **20N·m (15 lb ft)**.



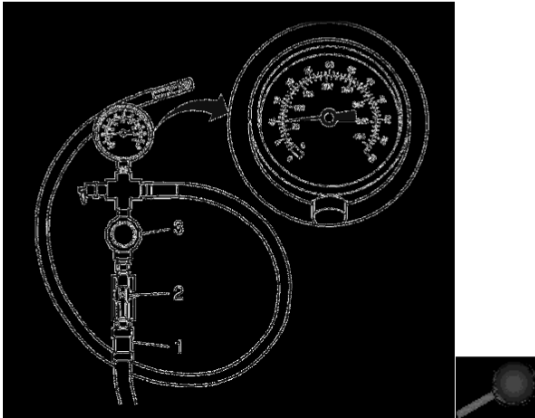
30. Confirm that the manifold absolute pressure (MAP) sensor seal (3) is installed on the MAP sensor (2).
31. Install the MAP sensor (2).
32. Install the MAP sensor bolt (1) and tighten to **10 N•m (89 lb in)**.

Supercharger Intercooler Pressure Testing

Special Tools

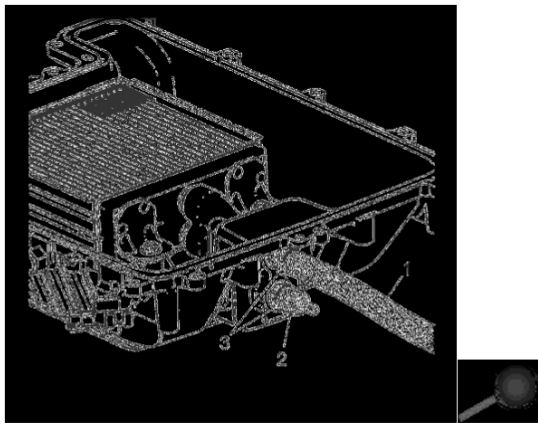
- EN-48974 Adapter Kit
- J 46091 Charge Air Cooler Tester

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

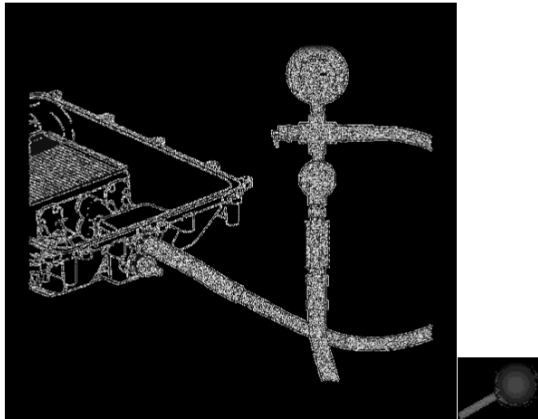


Warning: Do not apply greater than 69 kPa (10 psi) to the supercharger intercooler, this may damage the charge air cooler and other internal components within the intercooler.

1. Rotate the regulator knob (3) counterclockwise until stop to reduce pressure to 0 kPa (0 psi).
2. Connect the J 46091-1 to a shop air source (1).

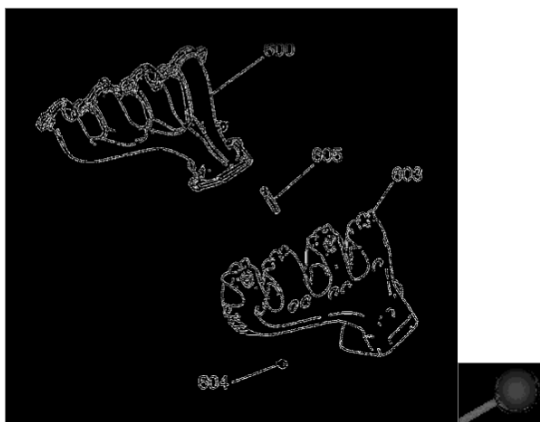


3. Install the *EN-48974* kitadapter hose (1), cap (2) and clamps (3) to the coolant inlet and outlet connections of the intercooler water manifold. Tighten the clamps until snug.



4. Install the J 46091-1 to the *EN-48974* kitadapter hose.
5. Rotate the knob of the regulator slowly clockwise to increase pressure.
- Note:** The gauge value should not exceed 69 kPa (10 psi). Adjust the pressure regulator as required.
6. With the intercooler pressurized to 69 kPa (10 psi) maximum, close the air inlet valve of the J 46091-1.
7. Inspect for a drop in air pressure on the gauge.
- If a drop in pressure is noted, inspect for leaks at the tool connections, the charge air coolers, service bleed ports, assembly plant fill port, and water manifold-to-charge air cooler seal locations.
 - If no drop in pressure is noted, the intercooler can be installed onto the engine assembly.

Exhaust Manifold Cleaning and Inspection



Note: Do not use the exhaust manifold-to-cylinder head gaskets again. Upon installation of the exhaust manifold, install a NEW gasket. An improperly installed gasket or leaking exhaust system may affect on-board diagnostics (OBD) II system performance.

1. Clean the exhaust manifold (600) and heat shield (603) in solvent.

Warning: Refer to [Safety Glasses Warning](#).

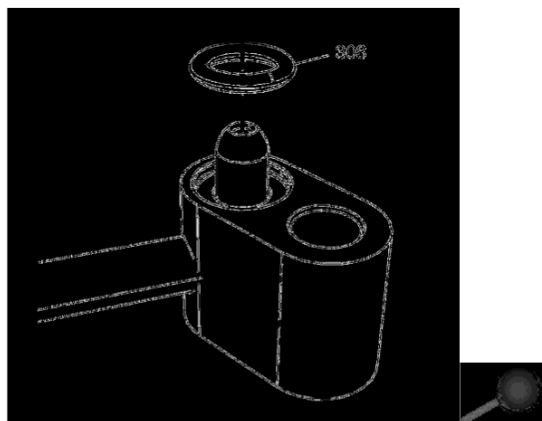
2. Dry the exhaust manifold with compressed air.
3. Inspect the exhaust manifold-to-cylinder head gasket surface for excessive scratches or gouging.
4. Inspect for a loose, damaged, or cracked heat shield (603).
5. Inspect the studs (605) for damaged threads.



6. Use a straight edge and a feeler gauge and measure the exhaust manifold cylinder head deck for warpage.

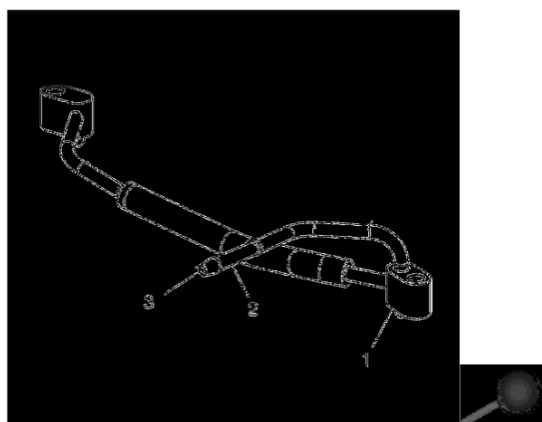
An exhaust manifold deck with warpage in excess of 0.25 mm (0.01 in) within the 2 front or 2 rear runners or 0.5 mm (0.02 in) overall, may cause an exhaust leak and may affect OBD II system performance. Exhaust manifolds not within specifications must be replaced.

Engine Coolant Air Bleed Pipe and Hole Cover Cleaning and Inspection



Note: Do not use the engine coolant air bleed pipe seals again. Upon installation of the pipe, install NEW seals.

1. Remove the seals (308) from the pipe.

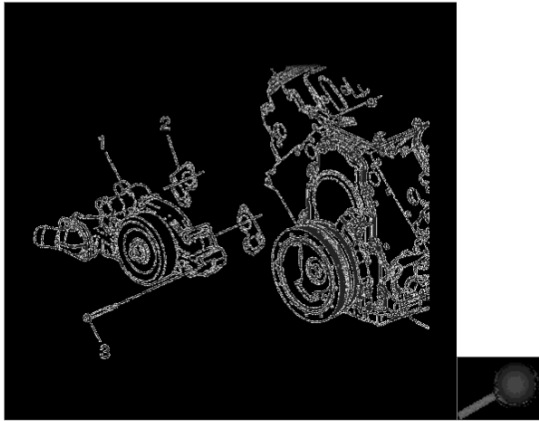


2. Clean the pipe in solvent.

Warning: Refer to [Safety Glasses and Compressed Air Warning](#).

3. Dry the pipe with compressed air.
4. Inspect the pipe for damaged sealing surfaces (1, 2) or restrictions within the pipe (3).

Water Pump Cleaning and Inspection



1. Remove the old gasket from the water pump sealing surfaces. Refer to [Replacing Engine Gaskets](#).
2. Clean all excess dirt and debris from the water pump housing.
3. Inspect the water pump (1) for the following conditions:
 - Gasket and hose sealing surfaces for excessive scratches or gouging
 - Restrictions within the internal coolant passages
 - Excessive side-to-side play in the pulley shaft
 - Leakage at the water inlet housing or rear cover gasket
 - Leakage at the water pump vent hole
A stain around the vent hole is acceptable. If leakage, dripping, occurs with the engine running and the cooling system pressurized, replace the water pump.
 - Wear or damage in the belt tracking area of the pulley

Thread Repair

Special Tools

- J 42385-100 Head/Main Bolt Thread Repair Kit
- J 42385-300 Fixtures and Hardware Kit

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

General Thread Repair



The thread repair process involves a solid, thin walled, self-locking, carbon steel, bushing type insert (1). During the bushing installation process, the driver tool expands the bottom external threads of the insert into the base material (2). This action mechanically locks the insert in place. Also, when installed to the proper depth, the flange of the insert will be seated against the counterbore of the repaired hole.



Warning: Refer to [Safety Glasses Warning](#).

Note:

- The use of a cutting type fluid, WD 40®, or equivalent, is recommended when performing the drilling, counterboring, and tapping procedures. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended fluid.
- Driver oil MUST be used on the installer driver tool.
- The tool kits are designed for use with either a suitable tap wrench or drill motor.

1. Drill out the threads of the damaged hole (1).
 - M6 inserts require a minimum drill depth of 15 mm (0.59 in).
 - M8 inserts require a minimum drill depth of 20 mm (0.79 in).
 - M10 inserts require a minimum drill depth of 23.5 mm (0.93 in).
2. Using compressed air, clean out any chips.



3. Counterbore the hole to the full depth permitted by the tool (1).
4. Using compressed air, clean out any chips.



5. Using a tap wrench (2), tap the threads of the drilled hole.
 - M6 inserts require a minimum tap depth of 15 mm (0.59 in).
 - M8 inserts require a minimum tap depth of 20 mm (0.79 in).
 - M10 inserts require a minimum tap depth of 23.5 mm (0.93 in).
6. Using compressed air, clean out any chips.
7. Spray cleaner into the hole. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended cleaner.
8. Using compressed air, clean any cutting oil and chips out of the hole.



Note: Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.

9. Lubricate the threads of the installer tool (2) with the driver oil (1).



10. Install the insert (2) onto the driver tool (1).



11. Apply threadlock LOCTITE™ 277, J42385-109 (1), or equivalent, to the insert OD threads (2).



12. Install the insert (2) into the hole.

Install the insert until the flange of the insert contacts the counterbored surface. Continue to rotate the installer tool (1) through the insert.

The installer tool will tighten up before screwing completely through the insert. This is acceptable. You are forming the bottom threads of the insert and mechanically locking the insert to the base material threads.



13. Inspect the insert for proper installation into the hole.

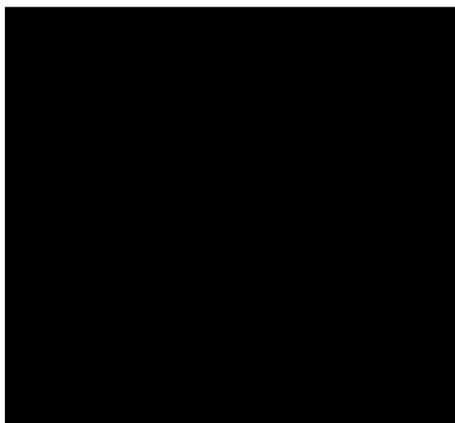
A properly installed insert (1) will be either flush or slightly below flush with the surface of the base material (2).

[Cylinder Head Bolt Hole Thread Repair](#)



1. The cylinder head bolt hole thread repair kit consists of the following items:

- The drill (1)
- The tap (2)
- The installer (3)
- The sleeve (4)
- The alignment pin (5)
- The bushing (6)
- The bolts (7)
- The fixture plate (8)



Warning: Refer to [Safety Glasses Warning](#).

Note:

- The use of a cutting type fluid, WD 40®, or equivalent, is recommended when performing the drilling and tapping procedures. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended fluid.
 - Driver oil MUST be used on the installer driver tool.
 - The tool kits are designed for use with either a suitable tap wrench or drill motor.
2. Install the fixture plate (3), bolts (1), and bushing (2) onto the engine block deck. Position the fixture plate and bushing over the hole that is to be repaired (4).



3. Position the alignment pin (1) through the bushing and into the hole.
4. With the alignment pin in the desired hole, tighten the fixture retaining bolts (2).
5. Remove the alignment pin from the hole.



6. Install the sleeve (2) onto the drill (1).



Note: During the reaming process, it is necessary to repeatedly remove the drill and clean the chips from the hole.

7. Drill out the threads of the damaged hole.

Drill the hole until the stop collar of the drill bit or the sleeve contacts the bushing.

8. Using compressed air, clean out any chips.



9. Using a tap wrench, tap the threads of the drilled hole.



10. In order to tap the new threads to the proper depth, rotate the tap into the hole until the mark (1) on the tap aligns with the top of the drill bushing (3).
11. Remove the fixture plate (2), bushing (3), and bolts.
12. Using compressed air, clean out any chips.
13. Spray cleaner into the hole. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended cleaner.
14. Using compressed air, clean any cutting oil and chips out of the hole.



Note: Do not allow oil or foreign material to contact the OD of the insert.

15. Lubricate the threads of the installer tool (2) with the driver oil (1).



16. Install the insert (2) onto the driver tool (1).



17. Apply threadlock LOCTITE™ 277, J42385-109 (1), or equivalent, to the insert OD threads (2).



18. Install the insert and driver (1) into the hole.

Rotate the driver tool until the mark on the tool aligns with the deck surface of the engine block.

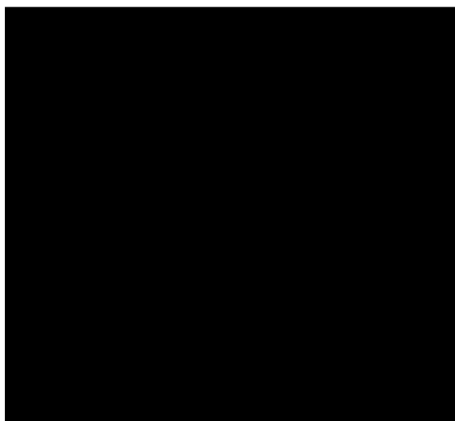
The installer tool will tighten up before screwing completely through the insert. This is acceptable. You are forming the bottom threads of the insert and mechanically locking the insert to the base material threads.

[Main Cap Bolt Hole Thread Repair](#)



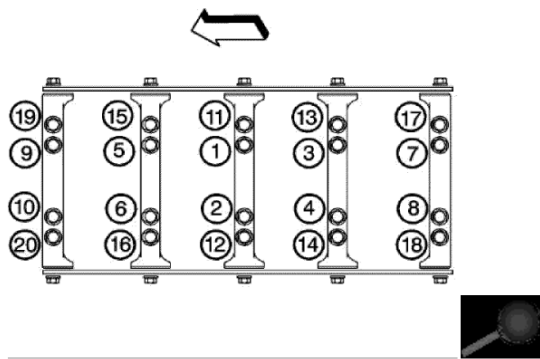
1. The main cap bolt hole thread repair kit consists of the following items:

- The drill (1)
- The tap (2)
- The installer (3)
- The fixture plate (4)
- The long bolts (5)
- The short bolts (6)
- The alignment pin (7)
- The bushing (8)



2. Install the fixture plate, bolt, and bushing onto the engine block.
Position the fixture plate and bushing over the hole that is to be repaired.

3. Position the alignment pin in the desired hole and tighten the fixture retaining bolts.



4. Drill out the damaged hole.

The outer bolt hole locations 11–20 have the shallower counterbores. Use sleeve J 42385-316 with the drill.

Drill until the stop collar of the drill bit or the sleeve contacts the bushing.

5. Using compressed air, clean out any chips.



6. Using a tap wrench, tap the threads of the drilled hole.

In order to tap the new threads to the proper depth, rotate the tap into the hole until the mark on the tap aligns with the top of the bushing.

For the deeper main cap holes 1–10, rotate the tap until the upper mark (4) on the tap aligns with the top of the bushing (3).

For the shallower main cap holes 11–20, rotate the tap until the lower mark (1) on the tap aligns with top of the bushing (3).

7. Using compressed air, clean out any chips.

8. Spray cleaner into the hole. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended cleaner.

9. Using compressed air, clean any cutting oil and chips out of the hole.



Note: Do not allow oil or foreign material to contact the OD of the insert.

10. Lubricate the threads of the installer tool (2) with the driver oil (1).



11. Install the insert (2) onto the driver tool (1).



12. Apply threadlock LOCTITE™ 277, J42385-109 (1), or equivalent, to the insert OD threads (2).



Note: The fixture plate and bushing remains installed onto the engine block during the insert installation procedure.

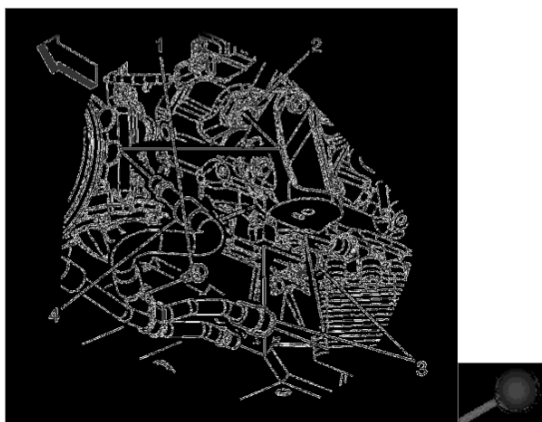
13. Install the insert and driver (1) through the fixture plate and bushing and into the hole. Rotate the driver tool until the mark on the tool (3) aligns with the top of the bushing (2). The installer tool will tighten up before screwing completely through the insert. This is acceptable. You are forming the bottom threads of the insert and mechanically locking the insert to the base material threads.

Service Prior to Assembly

- Dirt or debris will cause premature wear of the rebuilt engine. Clean all components. Refer to [Cleanliness and Care](#).
- Use the proper tools to measure components when inspecting for excessive wear. Components that are not within the manufacturers specifications must be repaired or replaced.
- When the components are installed into an engine, return the components to their original location, position and direction. Refer to [Separating Parts](#).
- During assembly, lubricate all moving parts with clean engine oil. This provides initial lubrication when the engine is first started.

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Engine Block Plug Installation (LSA)



Note: Engine block plug, oil gallery, and coolant sealing washers may be used again if not bent, scored or otherwise damaged.

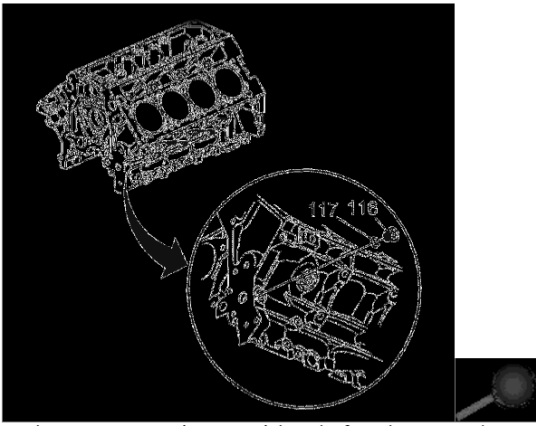
1. Apply a 3.175 mm (0.125 in) bead of sealant GM P/N 12346004 (Canadian P/N 10953480) to the threads of the engine oil cooler coolant fitting (2). Refer to [Adhesives, Fluids, Lubricants, and Sealers](#).

Caution: Refer to [Fastener Caution](#).

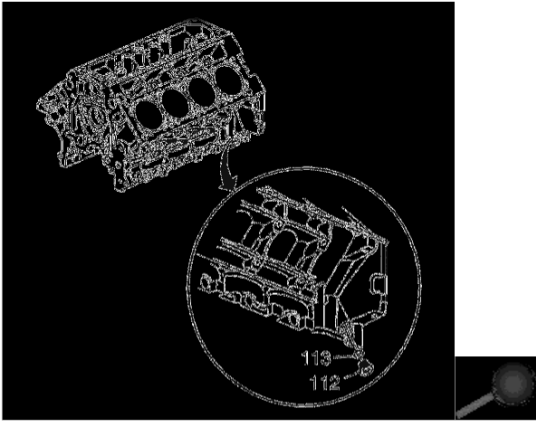
2. Install the engine oil cooler coolant fitting (2) and tighten to **50 N•m (37 lb ft)**.



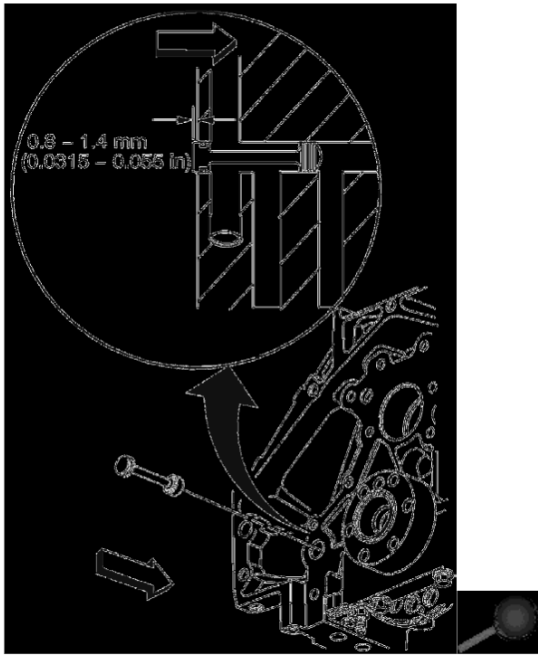
3. Apply a 3.175 mm (0.125 in) bead of sealant GM P/N 12346004 (Canadian P/N 10953480) to the engine block right rear coolant drain hole plug sealing washer.
4. Install the engine block right rear coolant drain hole plug and tighten to **60 N•m (44 lb ft)**.



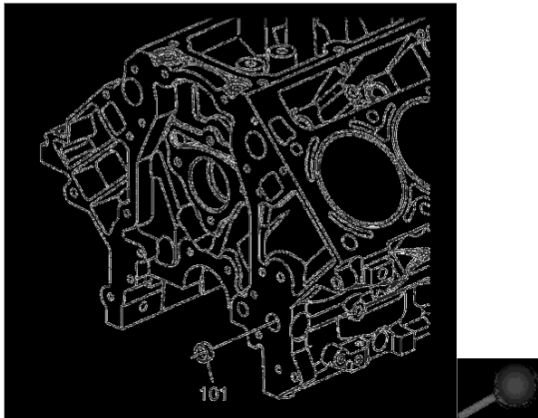
5. Apply a 3.175 mm (0.125 in) bead of sealant GM P/N 12346004 (Canadian P/N 10953480) to the engine block left front oil gallery plug sealing washer (117).
6. Install the engine block left front oil gallery plug (116) and tighten to **60 N•m (44 lb ft)**.



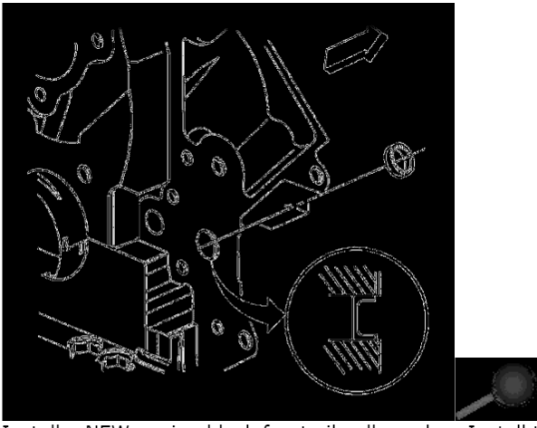
7. Apply a 3.175 mm (0.125 in) bead of sealant GM P/N 12346004 (Canadian P/N 10953480) to the engine block left rear oil gallery plug sealing washer (113).
8. Install the engine block left rear oil gallery plug (112) and tighten to **60 N•m (44 lb ft)**.



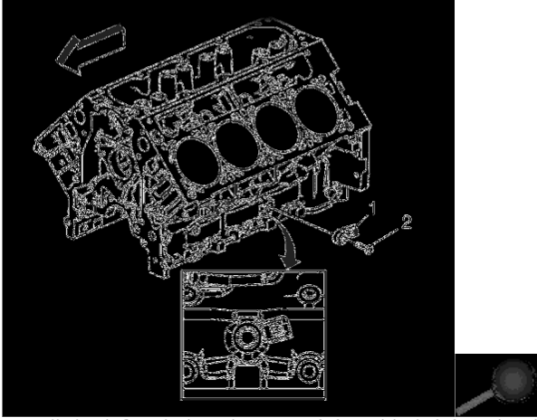
9. Inspect the engine block rear oil gallery plug and O-ring seal. If the O-ring seal on the plug is not cut or damaged, the rear oil gallery plug may be used again.
10. Lubricate the O-ring seal with clean engine oil.
11. Install the O-ring seal onto the plug.
12. Install the engine block rear oil gallery plug into the oil gallery bore. A properly installed block plug will protrude 0.8–1.4 mm (0.0315–0.055 in) beyond the rear face of the block.



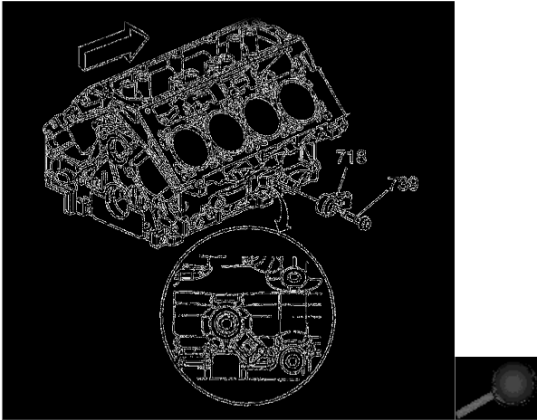
13. Apply threadlock GM P/N 12345382 (Canadian P/N 10953489) to the sides of the NEW front oil gallery plug (101).



14. Install a NEW engine block front oil gallery plug. Install the plug into the oil gallery bore 2.2–2.8 mm (0.0086–0.011 in) below flush.



15. Install the left side knock sensor (1) and bolt (2) and tighten to **25 N•m (18 lb ft)**.



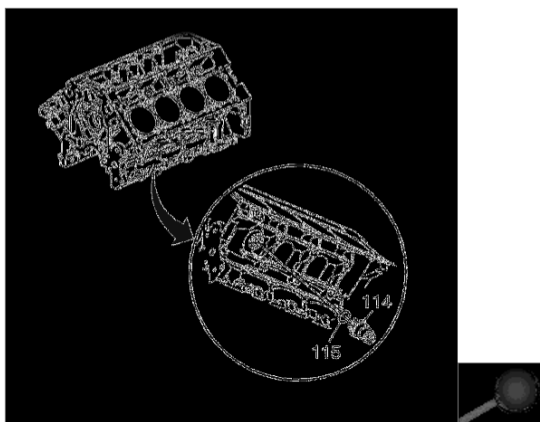
16. Install the right side knock sensor (718) and bolt (739) and tighten to **25 N•m (18 lb ft)**.



17. Install the piston oil nozzles (1) to the block – 6.2L LS9/LSA.

18. Tighten the bolts to **20 N•m (15 lb ft)**.

Engine Block Plug Installation (LS3 or L77)



Note: Engine block plug, oil gallery, and coolant sealing washers may be used again if not bent, scored or otherwise damaged.

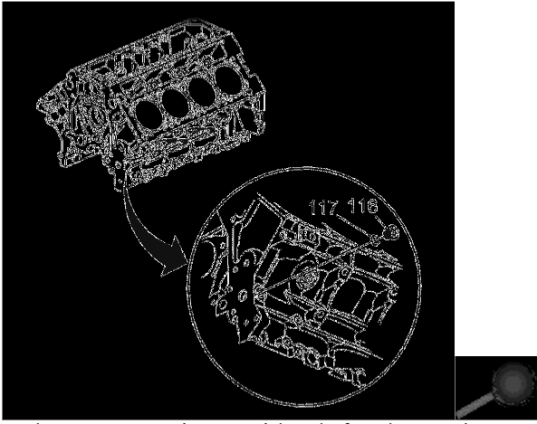
1. Apply a 3.175 mm (0.125 in) bead of sealant to the engine block coolant heater sealing washer (115), if applicable. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended sealant.

Caution: Refer to [Fastener Caution](#).

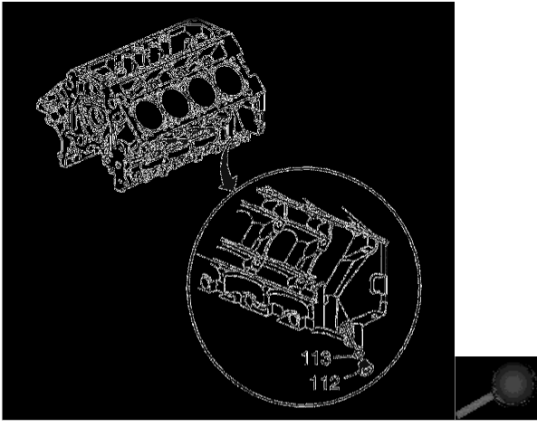
2. Install the engine block coolant heater (114) to the engine block and tighten to **50N•m (37 lb ft)**.



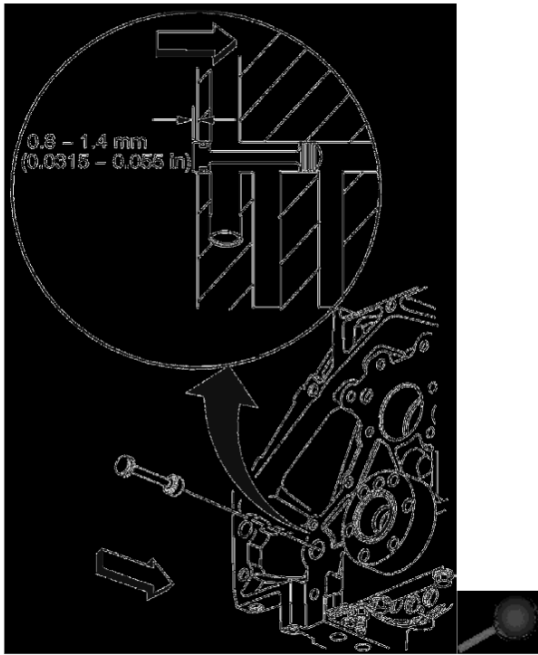
3. Apply a 3.175 mm (0.125 in) bead of sealant to the engine block right rear coolant drain hole plug sealing washer. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended sealant.
4. Install the engine block right rear coolant drain hole plug and tighten to **60N•m (44 lb ft)**.



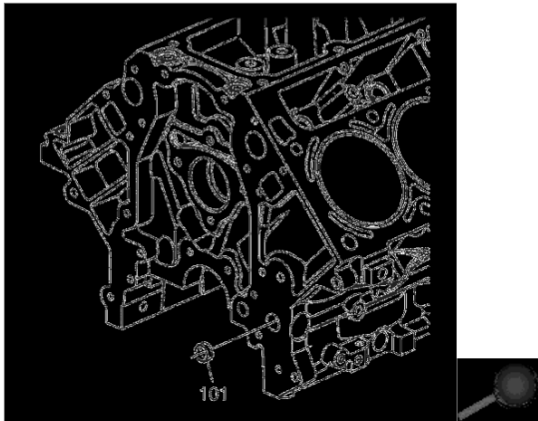
5. Apply a 3.175 mm (0.125 in) bead of sealant to the engine block left front oil gallery plug sealing washer (117). Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended sealant.
6. Install the engine block left front oil gallery plug (116) and tighten to **60 N•m (44 lb ft)**.



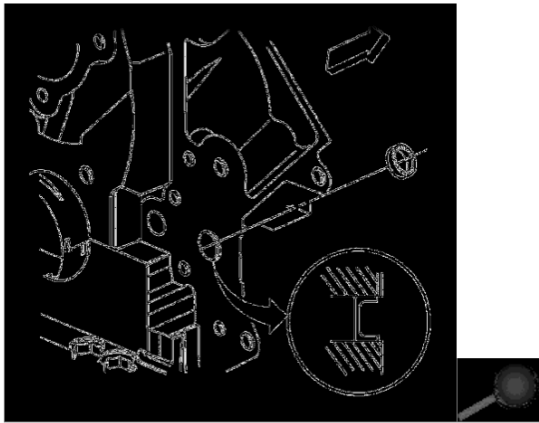
7. Apply a 3.175 mm (0.125 in) bead of sealant to the engine block left rear oil gallery plug sealing washer (113). Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended sealant.
8. Install the engine block left rear oil gallery plug (112) and tighten to **60 N•m (44 lb ft)**.



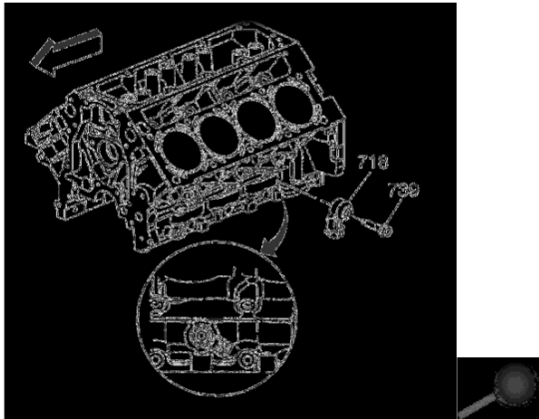
9. Inspect the engine block rear oil gallery plug and O-ring seal. If the O-ring seal on the plug is not cut or damaged, the rear oil gallery plug may be used again.
10. Lubricate the O-ring seal with clean engine oil.
11. Install the O-ring seal onto the plug.
12. Install the engine block rear oil gallery plug into the oil gallery bore. A properly installed block plug will protrude 0.8–1.4 mm (0.0315–0.055 in) beyond the rear face of the block.



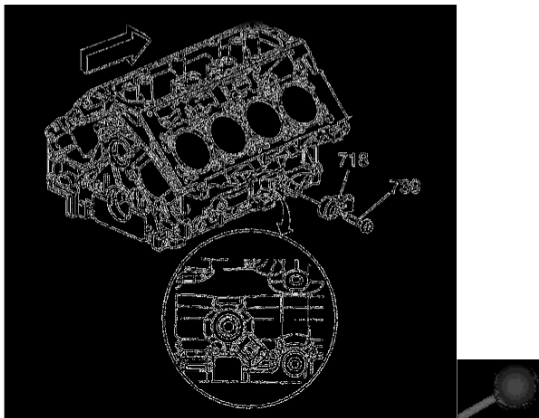
13. Apply threadlock to the sides of the NEW front oil gallery plug (101). Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended threadlock.



14. Install a NEW engine block front oil gallery plug. Install the plug into the oil gallery bore 2.2–2.8 mm (0.0086–0.011 in) below flush.

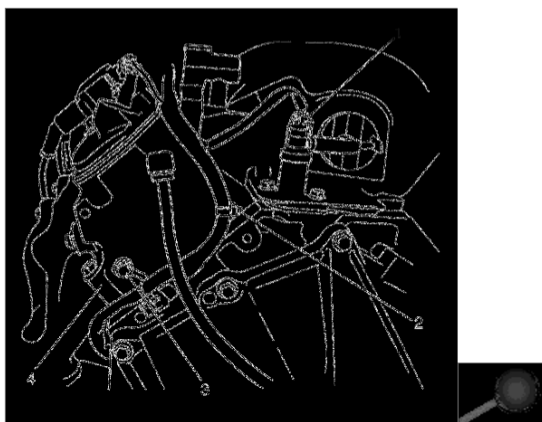


15. Install the left side knock sensor (718) and bolt (739) and tighten to **25 N·m (18 lb ft)**.

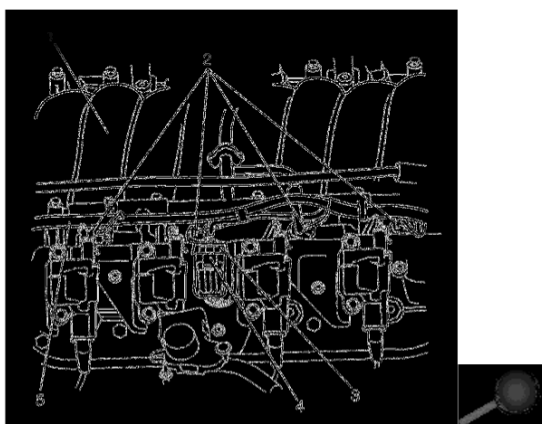


16. Install the right side knock sensor (718) and bolt (739) and tighten to **25 N·m (18 lb ft)**.

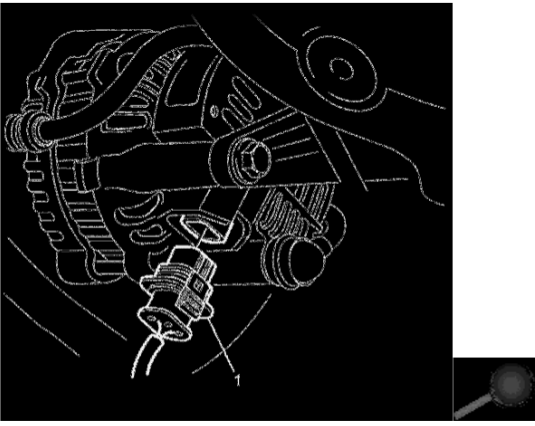
Engine Wiring Harness Assembly Installation



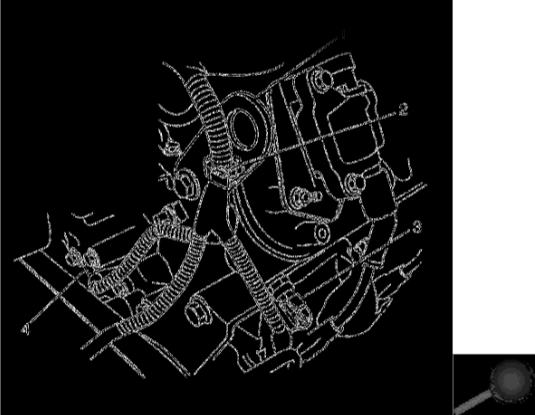
1. Connect the oil pressure sensor electrical connector (1).
- Caution:** Refer to [Fastener Caution](#).
2. Install the wiring harness assembly earth to cylinder head retaining bolt (3) and tighten to **4 N•m (35 lb in)**.
3. Attach the wiring harness assembly retaining clip (2) to the left side cylinder head (4).



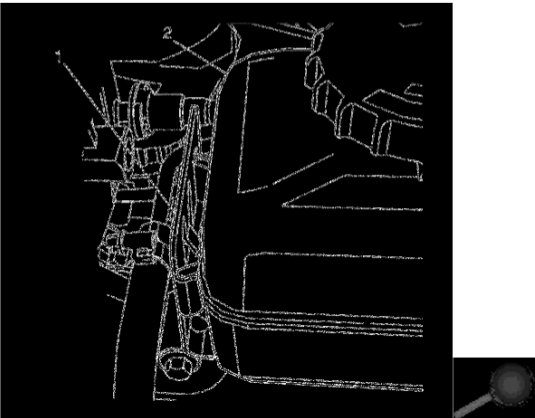
4. Position and secure the left side fuel injector wiring harness (5) away from the intake manifold (1).
5. Connect the left side ignition coil main connector (3).
6. Install the CPA lock (4) from the left side ignition coil main connector (3).
7. Connect the left side fuel injector wiring harness connectors (2).



- Note:** Listen for an audible click to confirm fitting of the electrical connector.
8. Connect the alternator electrical connector (1).

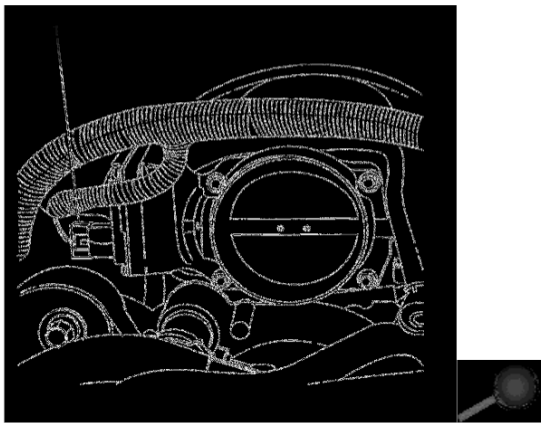


9. Connect the camshaft position sensor connector (4).
10. Connect the coolant temperature sensor connector (3).
11. Attach the wiring harness retaining clip (2) to the engine lifting bracket (1).

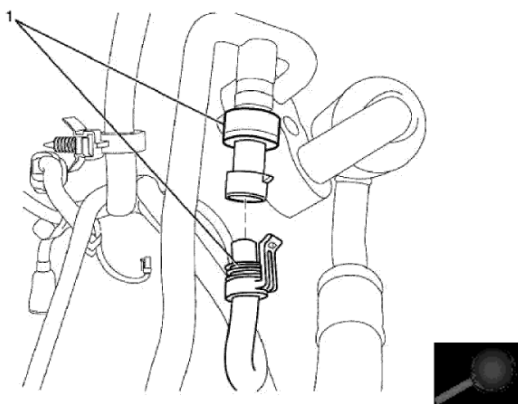


Note: Make sure the power steering reservoir (2) and the power steering reservoir bracket locking tang (1) are engaged to avoid an induced rattle condition.

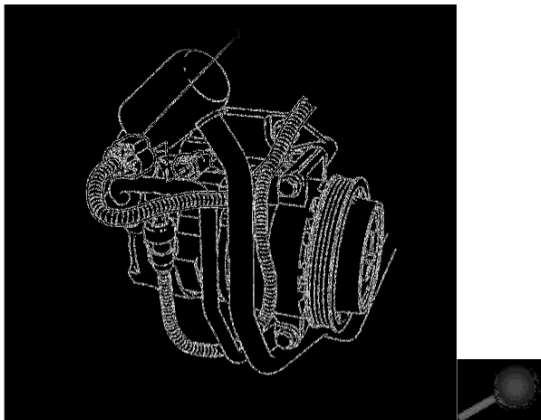
12. Install the power steering reservoir (2) to the power steering pump power steering reservoir bracket (1).



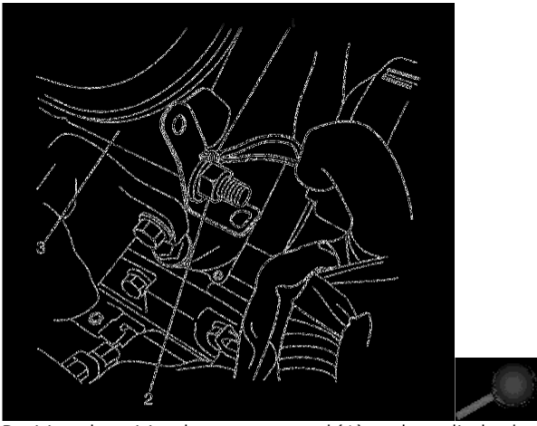
13. Connect the electronic throttle body wiring harness connector (1).



14. Connect the electrical connector to the A/C Refrigerant Pressure Sensor (1).

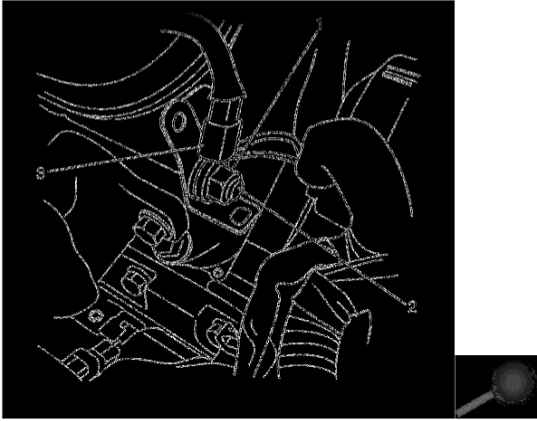


15. Connect the A/C electrical connector (1).



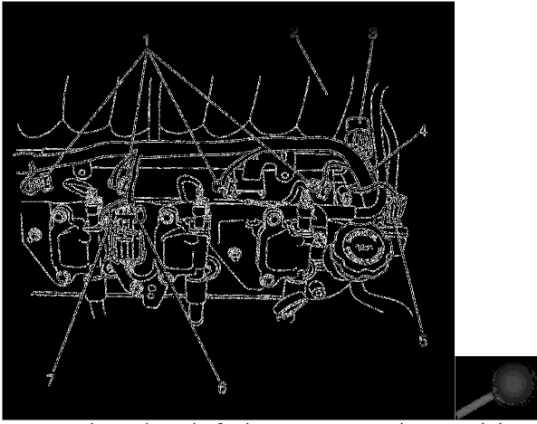
16. Position the wiring harness ground (1) on the cylinder head (2).

17. Install the cylinder head stud (3) to the cylinder head (2) and tighten to **30 N·m (22 lb ft)**.

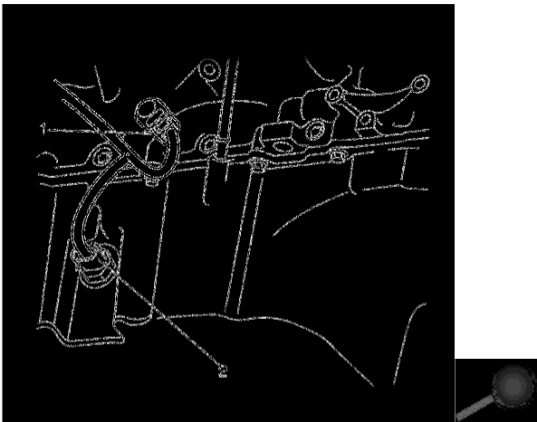


18. Position the vehicle body ground cable (3) on the cylinder head stud (2).

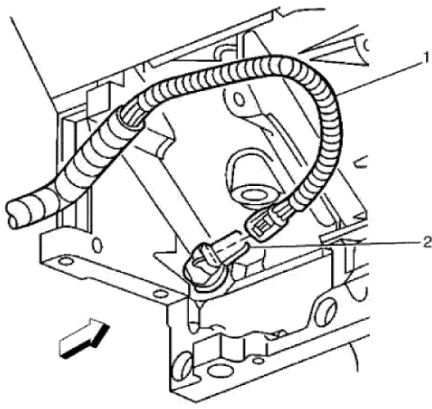
19. Install the vehicle body ground cable to cylinder head retaining nut (1) and tighten to **25 N·m (18 lb ft)**.



20. Position the right side fuel injector wiring harness (4) on the intake manifold (2).
21. Connect the manifold absolute pressure (MAP) sensor wiring harness connector (3).
22. Connect the canister purge valve wiring harness connector (5).
23. Connect the right side ignition coil main connector (6).
24. Install the CPA lock (7) from the right side ignition coil main connector (6).
25. Connect the right side fuel injector wiring harness connectors (1).

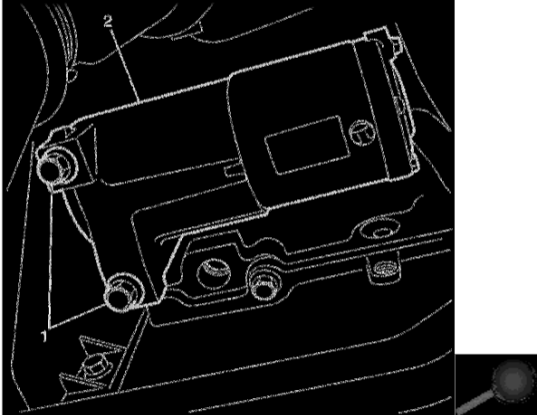


26. Connect the right side knock sensor electrical connector (1).



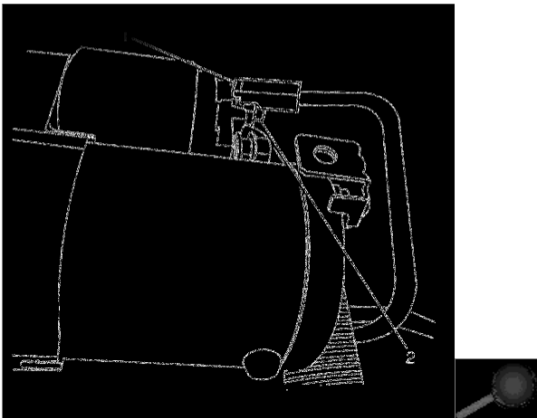
27. Connect the crankshaft position (CKP) sensor electrical connector (1).

28. Connect the oil level/temperature sensor electrical connector (2).



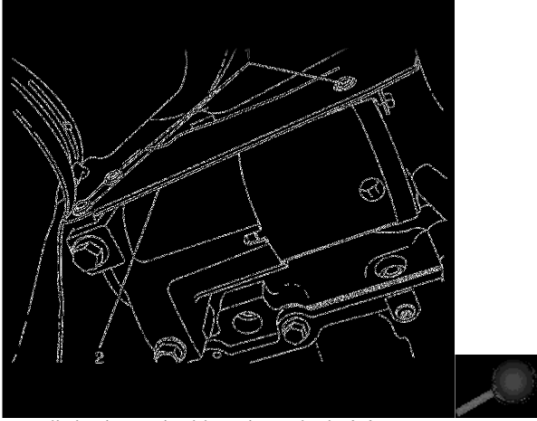
29. Install the starter motor (2) into position.

30. Install starter motor to bell housing retaining bolts (1) and tighten to **50 N•m (37 lb ft)**.



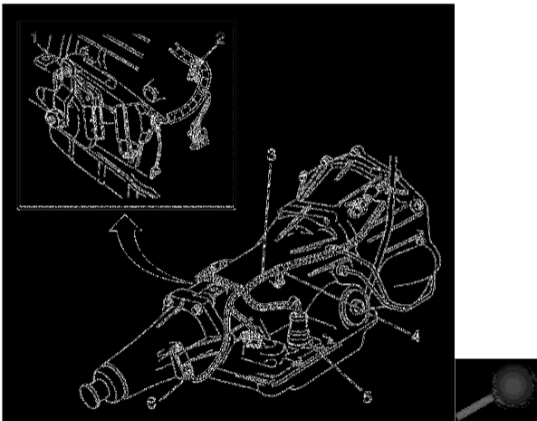
31. Connect the starter motor electrical connector (2)

32. Install the battery positive cable and retaining nut (1) and tighten to **10 N•m (89 lb in)**.



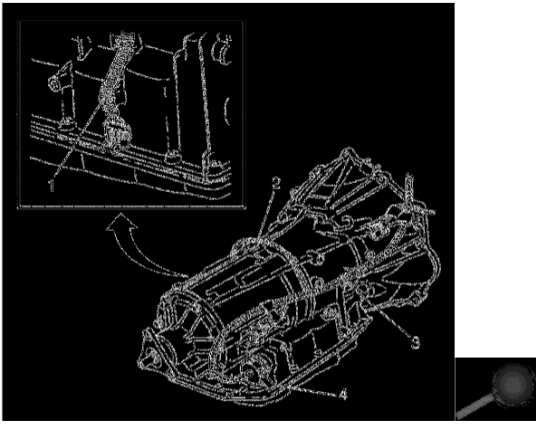
33. Install the heat shield to the vehicle (2).

34. Install the heat shield to starter motor retaining bolts (1) and tighten to **5 N•m (44 lb in)**.



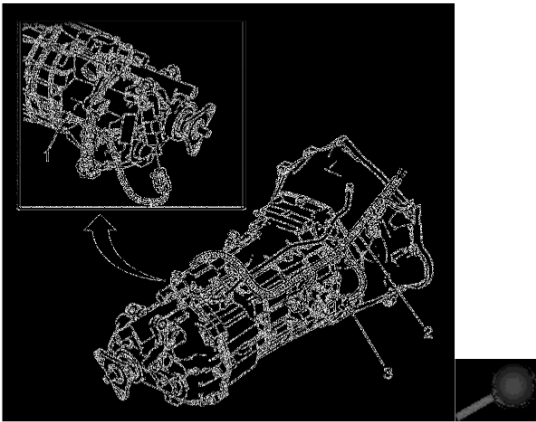
Note: Steps 35 to 39 refer to the 4L60E 4 speed automatic transmission only.

35. Connect the vehicle speed sensor electrical connector (6).
36. Connect the main transmission electrical connector (5).
37. Connect the park/neutral position switch electrical connector (1).
38. Attach the engine wiring loom assembly (3) from the retaining clip (4).
39. Attach the engine wiring loom assembly (3) from the retaining clip (2).



Note: Steps 40 to 42 refer to the 6L80E 4 speed automatic transmission only.

- 40. Connect the main transmission electrical connector (4).
- 41. Connect the heated oxygen sensor electrical connector (1).
- 42. Attach the engine wiring loom assembly (2) to the retaining clip (1).



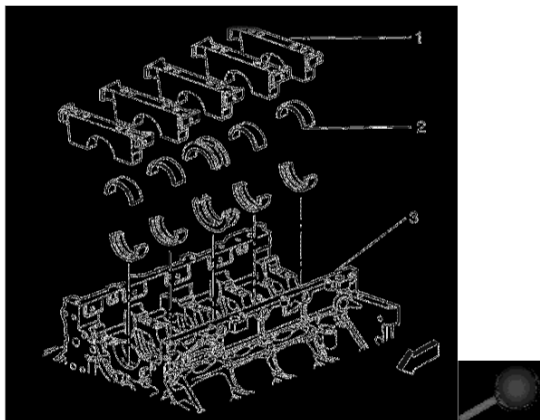
Note: Steps 43 and 44 refer to the T56 6 speed manual transmission only.

- 43. Connect the reverse switch assembly electrical connector (3).
- 44. Attach the engine wiring loom assembly (2) to the retaining clip (1).

Crankshaft and Bearing Installation

Special Tools

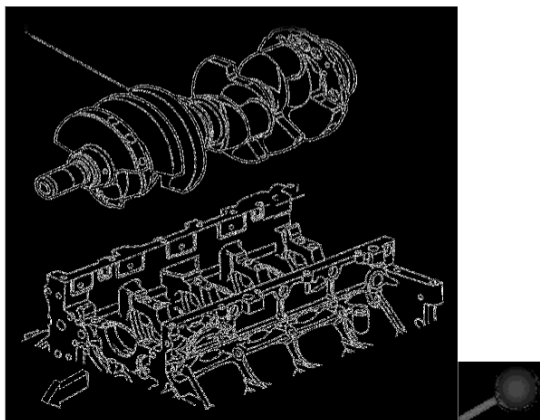
J 45059 Angle Meter



Note: The crankshaft bearings (2) **MUST** be installed to their original position after performing an oil clearance check.

Note: Do not apply engine oil to the back of the crankshaft bearings (2).

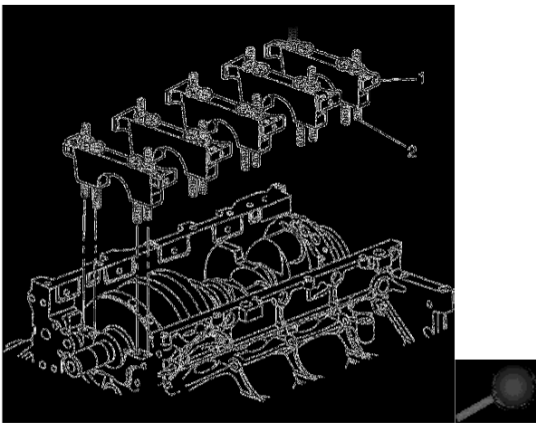
1. Install the crankshaft bearings (2) into the bearing caps (1) and the cylinder block (3).
2. Apply clean engine oil to the bearing halves and crankshaft journals.



Note: Make sure the crankshaft (1) is held square to avoid damaging the centre main thrust bearing or the reluctor ring teeth. Nicks, burrs or other damage to the teeth may effect on-board diagnostics (OBD) II system performance.

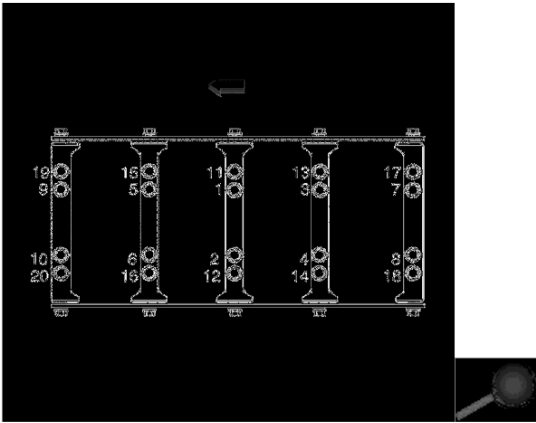
3. Install the crankshaft (1).

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Note: The crankshaft bearing caps are machined with the engine block for the correct clearances. The crankshaft bearing caps **MUST** be installed to their original position and direction.

4. Install the crankshaft bearing caps (1).
5. Install the crankshaft bearing cap bolts and studs (2).



Caution: Refer to [Fastener Caution](#).

Note: Perform the Stage 1 for bolts and studs 1–20 and then continue with Stage 2. Use the *J 45059* angle meter to achieve an accurate second reading, noting the different turn angles for the bolts and the studs.

6. Tighten the crankshaft bearing cap bolts and studs (2) in the sequence shown.

Tighten

- Tighten the crankshaft bearing cap to cylinder block inner retaining bolts (1 – 10) a first pass in sequence to 20 N•m (14 lb ft).
- Tighten the crankshaft bearing cap to cylinder block inner retaining bolts (11 – 20) a first pass in sequence to 20 N•m (14 lb ft).
- Tighten the crankshaft bearing cap to cylinder block inner retaining bolts (1 – 10) a second pass in sequence an additional 80 degrees using the *J 45059* angle meter.
- Tighten the crankshaft bearing cap to cylinder block inner retaining bolts (11 – 20) a second pass in sequence an additional 53 degrees using the *J 45059* angle meter.

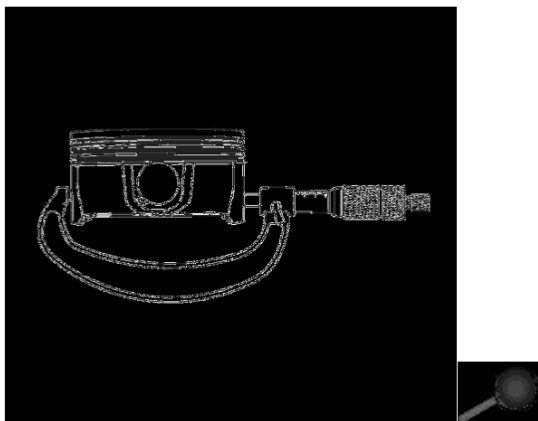
Piston, Connecting Rod, and Bearing Installation

Special Tools

- J 8037 Piston Ring Compressor
- J 8087 Cylinder Bore Gauge
- J 41556 Connecting Rod Guide
- J 45059 Angle Meter

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

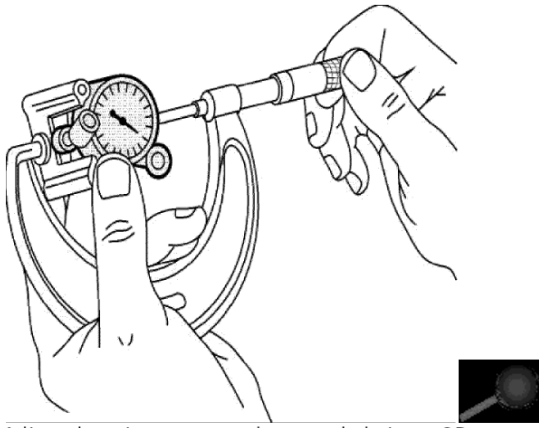
Piston Selection



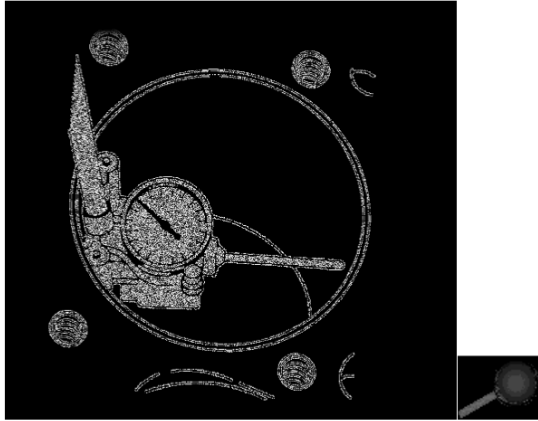
Note: Measurements of all components should be taken with the components at normal room temperature. For proper piston fit, the engine block cylinder bores must not have excessive wear or taper. A used piston, pin, and connecting rod assembly may be installed if, after inspection is within specifications.

1. With a micrometer at a right angle, measure the piston outside diameter (OD). Measure the diameter 43 mm (1.69 in) from the top of the piston. Refer to [Engine Mechanical Specifications](#).
2. Record the piston OD.

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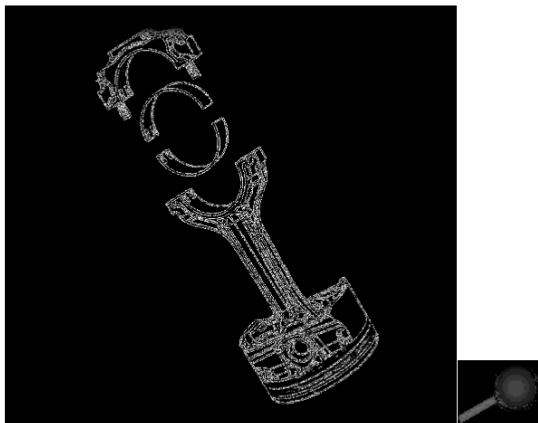


3. Adjust the micrometer to the recorded piston OD.
4. Insert the *J 8087* bore gauge into the micrometer and zero the gauge dial.

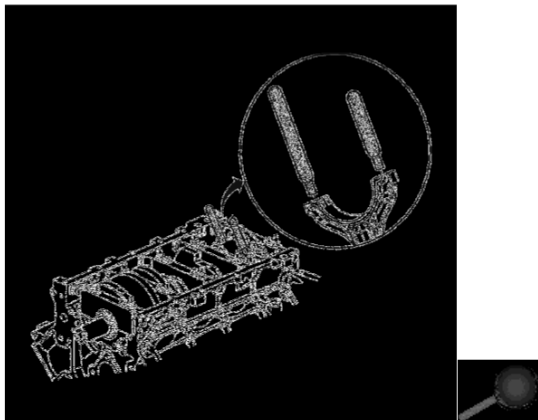


5. Using the *J 8087* bore gauge, measure the cylinder bore inside diameter (ID). Measure at a point 64 mm (2.5 in) from the top of the cylinder.
6. Record the cylinder bore ID.
7. Subtract the piston OD from the cylinder bore ID in order to determine the piston-to-bore clearance. Refer to [Engine Mechanical Specifications](#).
8. If the proper clearance cannot be obtained, select another piston and pin assembly and measure the clearances again. If the proper fit cannot be obtained, the cylinder bore may require honing for an oversize piston.

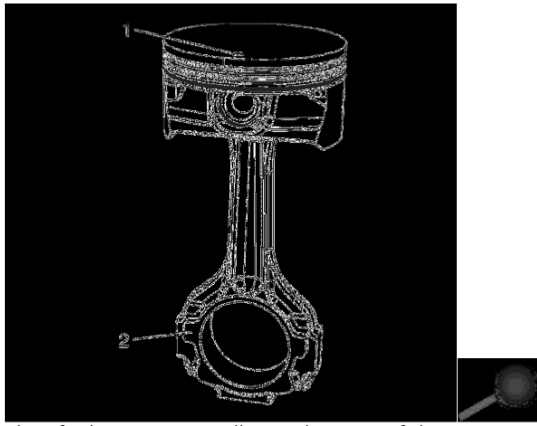
Piston, Pin, and Connecting Rod Installation



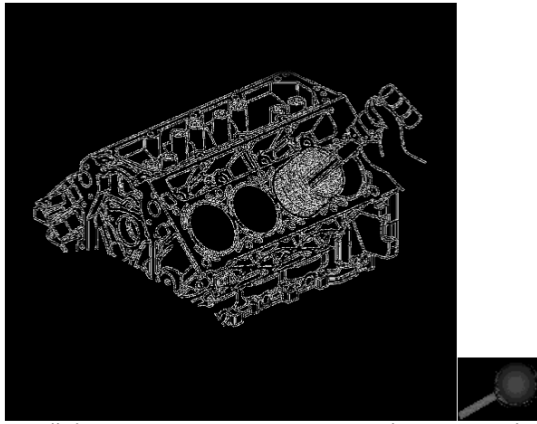
1. Lubricate the following components with clean engine oil:
 - Piston
 - Piston rings
 - Cylinder bore
 - Bearings and bearing surfaces
2. Install the bearings to the connecting rod and cap.
3. Position the oil control ring end gaps a minimum of 25 mm (1.0 in) from each other.
4. Position the compression ring end gaps 180 degrees opposite each other.



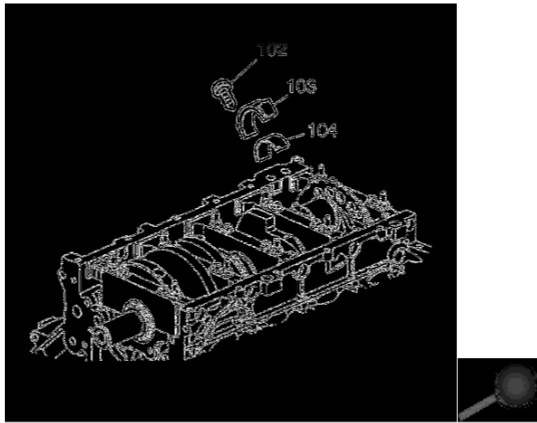
5. Install the *J 41556* rod guide to the connecting rod.



6. Identify the proper installation direction of the piston and connecting rod assembly. When installing the piston and connecting rod assembly, the mark on the top of the piston (1) and the large tabs (2) on the side of the connecting rod should face the front of the engine.



7. Install the J 8037 ring compressor onto the piston and compress the piston rings.
- Note:** The piston alignment mark **MUST** face the front of the engine block.
8. Install the piston, pin, and connecting rod assembly into the cylinder bore. Hold the piston ring compressor firmly against the engine block. Using a wooden hammer handle, lightly tap the top of the piston until all piston rings have entered the cylinder bore.
9. Use the J 41556 rod guide to guide the connecting rod onto the crankshaft journal.
10. Remove the J 41556 rod guide from the connecting rod.



Caution: Refer to [Fastener Caution](#).

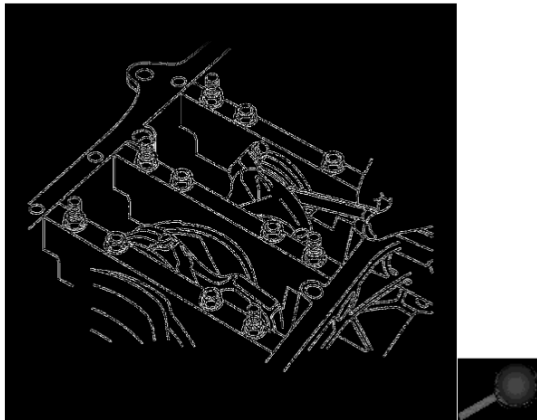
Note:

- The connecting rod and cap must be assembled with the mating surfaces properly aligned.
- If re-using connecting rods, DO NOT re-use connecting rod fasteners. During an installation procedure, the new connecting rod bolts can be re-tightened a maximum of 3 times.

11. Install the bearing cap (103), bearing (104), and bolts (102).

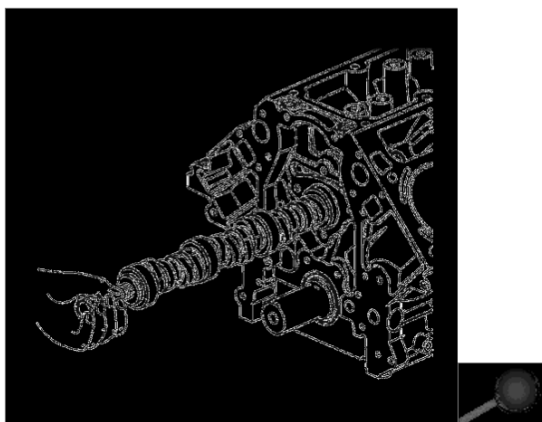
11.1. Tighten the bolts a first pass to **20 N·m (15 lb ft)**.

11.2. Tighten the bolts a final pass to **85 degrees** using the J 45059 angle meter .



12. Measure the connecting rods for the proper side clearance. Refer to [Engine Mechanical Specifications](#).

Camshaft Installation

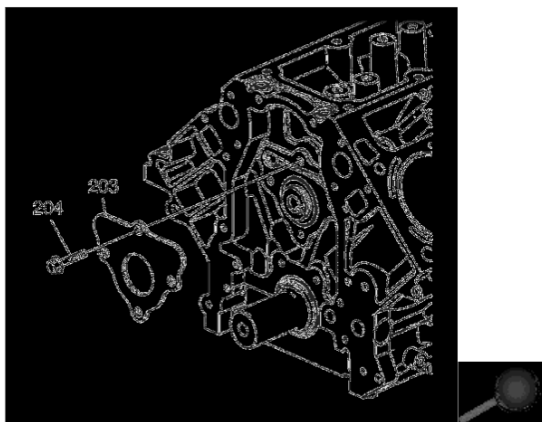


Note: If camshaft replacement is required, the valve lifters must also be replaced.

1. Lubricate the camshaft journals and the bearings with clean engine oil.
2. Install the camshaft sprocket bolt into the camshaft front bolt hole.

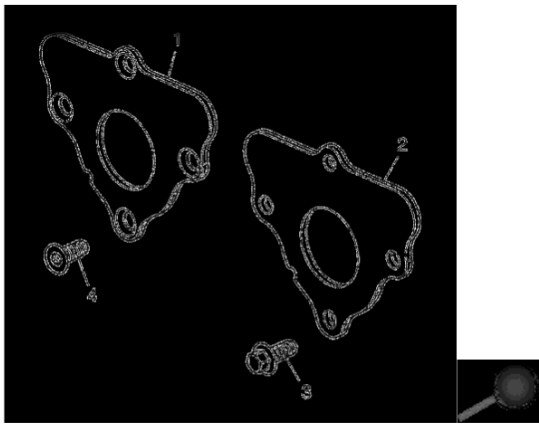
Caution: All camshaft journals are the same diameter, so care must be used in removing or installing the camshaft to avoid damage to the camshaft bearings.

3. Using the bolt as a handle, carefully install the camshaft into the engine block.
4. Remove the bolt from the front of the camshaft.



Note: The gasket surface on the engine block should be clean and free of dirt or debris.

5. Install the camshaft retainer (203) and the bolts (204). Install the retainer with the sealing gasket facing the front of the engine block.



Caution: Refer to [Fastener Caution](#).

6. Tighten the camshaft retainer bolts.

- Tighten the first design hex head bolts (3) to **25 N•m (18 lb ft)**.
- Tighten the second design TORX® head bolts (4) to **15 N•m (11 lb ft)**.

Timing Chain and Sprocket Installation

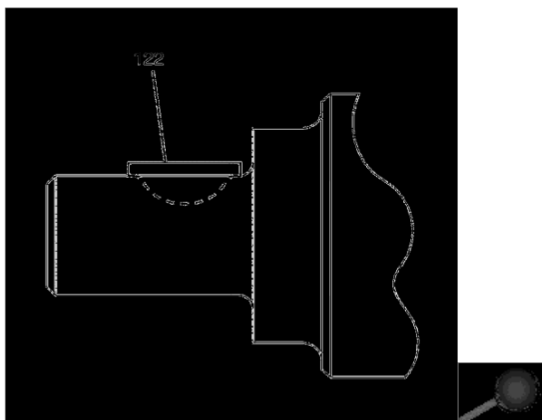
Special Tools

- *EN 46330* Timing Belt Tensioner Retaining Pin
- *J 41478* Crankshaft Front Oil Seal Installer
- *J 41665* Crankshaft Balancer and Sprocket Installer
- *J 42386-A* Flywheel Holding Tool
- *J 45059* Angle Meter

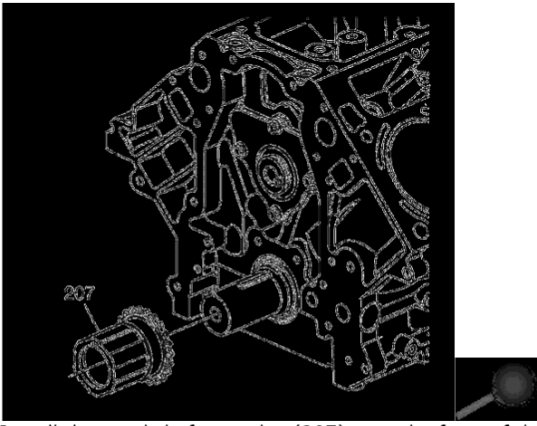
For equivalent regional tools, refer to [Special Tools](#)



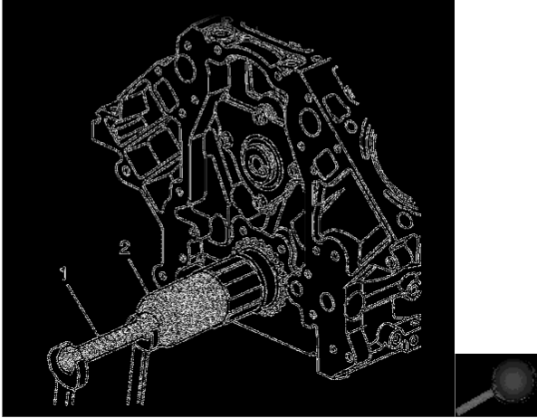
1. Install the key into the crankshaft keyway, if previously removed.



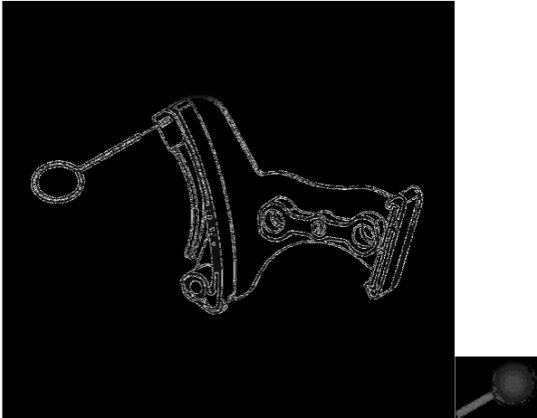
2. Tap the key (122) into the keyway until both ends of the key bottom onto the crankshaft.



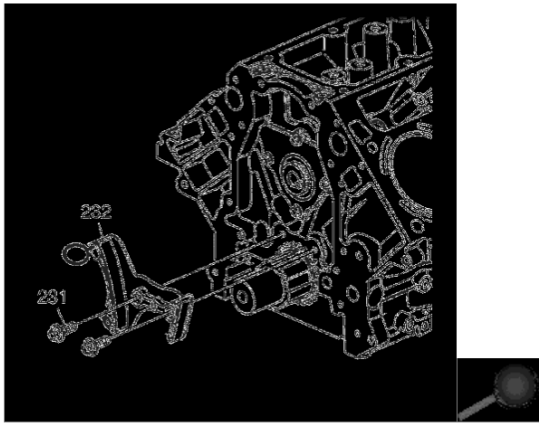
3. Install the crankshaft sprocket (207) onto the front of the crankshaft. Align the crankshaft key with the crankshaft sprocket keyway.



4. Use the *J 41478* installer (1) and the *J 41665* installer (2) in order to install the crankshaft sprocket.
Install the sprocket onto the crankshaft until fully seated against the crankshaft flange.
5. Rotate the crankshaft sprocket until the alignment mark is in the 12 o'clock position.

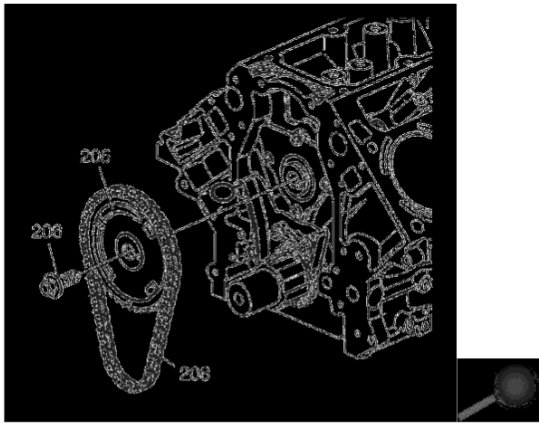


6. Compress the timing chain tensioner guide and install the *EN 46330* pin .



Caution: Refer to [Fastener Caution](#).

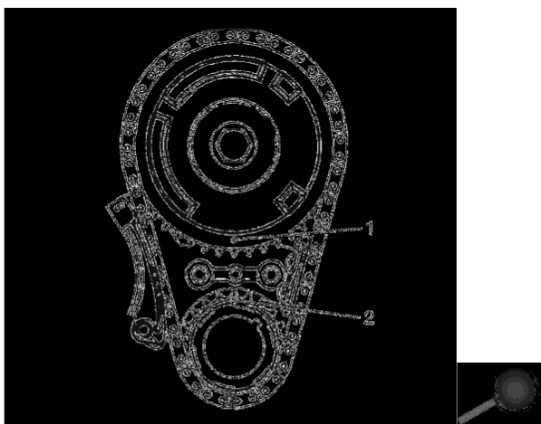
7. Install the timing chain tensioner (232) and bolts (231). Tighten the timing chain tensioner bolts to **30 N·m (22 lb ft)**.



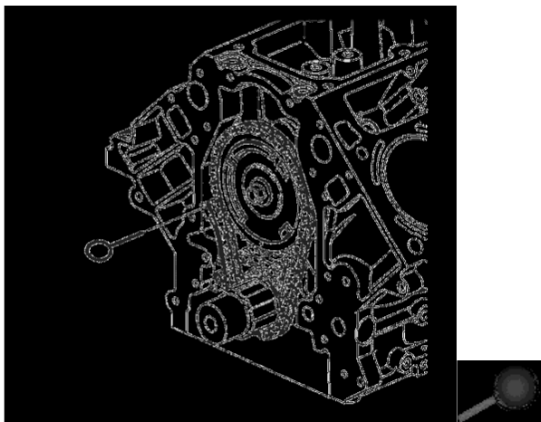
Note:

- Do not use the camshaft sprocket bolt again. Install a NEW bolt during assembly.
- The sprocket teeth and timing chain must mesh.
- The camshaft and the crankshaft sprocket alignment marks **MUST** be aligned properly.

8. Install the camshaft sprocket (205), timing chain (208), and NEW bolt (206).



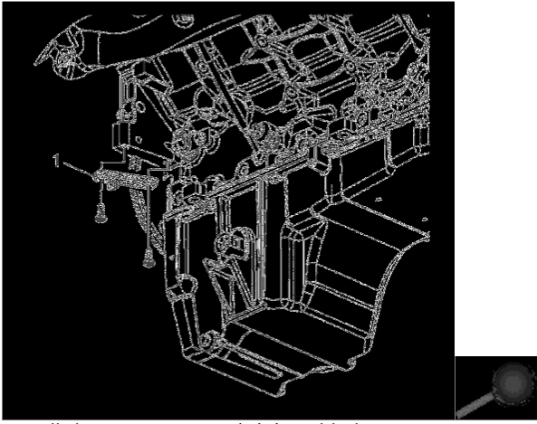
9. Inspect the sprockets for proper alignment. The mark on the camshaft sprocket (1) should be located in the 6 o'clock position and the mark on the crankshaft sprocket (2) should be located in the 12 o'clock position.



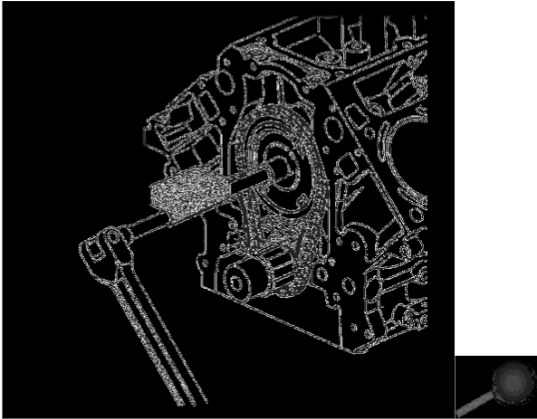
10. Remove the *EN 46330* pin .

Note: Do not apply threadlock to the flex plate bolts at this time.

11. Temporarily install the automatic transmission flex plate and bolts. Refer to [Automatic Transmission Flex Plate Installation](#).

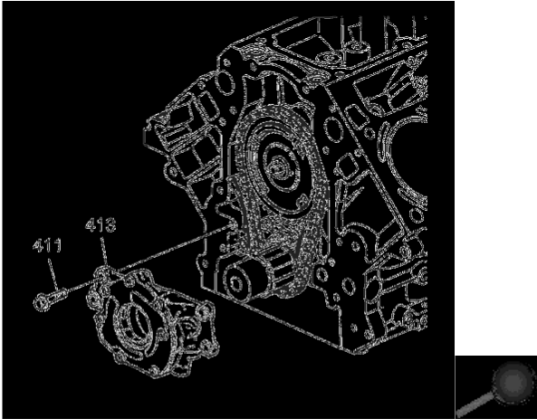


12. Install the *J 42386-A* tool (1) and bolts. Use 1 M10-1.5 x 120 mm bolt and 1 M10-1.5 x 45 mm bolt for proper tool operation. Tighten the *J 42386-A* tool bolts to **50 N·m (37 lb ft)**.



13. Tighten the camshaft sprocket bolt.
- 13.1. Tighten the camshaft sprocket bolt a first pass to **75 N·m (55 lb ft)**.
 - 13.2. Tighten the camshaft sprocket bolt a final pass an additional **50 degrees** using the *J 45059* meter .
14. Remove the *J 42386-A* tool and bolts.
15. Remove the automatic transmission flex plate and bolt. Refer to [Automatic Transmission Flex Plate Removal](#).

Oil Pump, Screen and Crankshaft Oil Deflector Installation

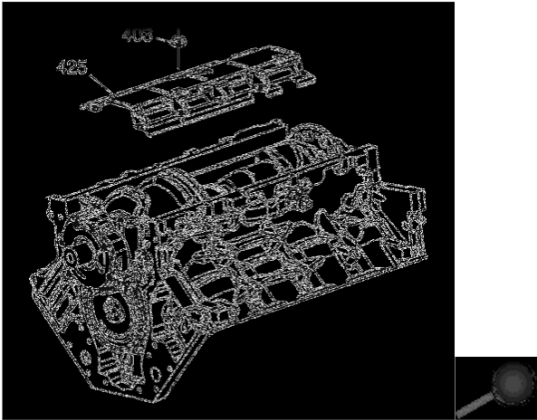


Note: Inspect the oil pump and engine block oil gallery passages. These surfaces must be clear and free of debris or restrictions.

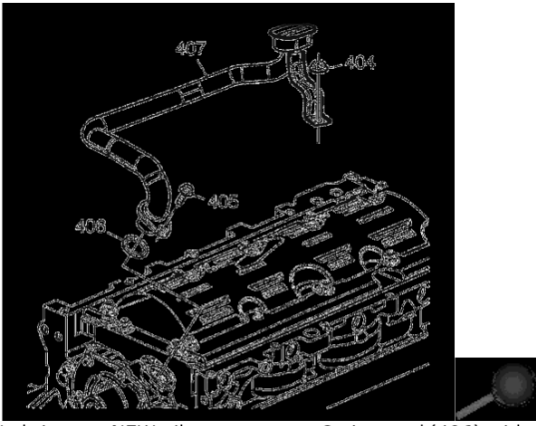
1. Align the splined surfaces of the crankshaft sprocket and the oil pump drive gear and install the oil pump (413).
2. Install the oil pump onto the crankshaft sprocket until the pump housing contacts the face of the engine block.

Caution: Refer to [Fastener Caution](#).

3. Install the oil pump bolts (411) and tighten to **25 N·m (18 lb ft)**.



4. Install the crankshaft oil deflector (425).



5. Lubricate a NEW oil pump screen O-ring seal (406) with clean engine oil.
6. Install the NEW O-ring seal onto the oil pump screen.

Note:

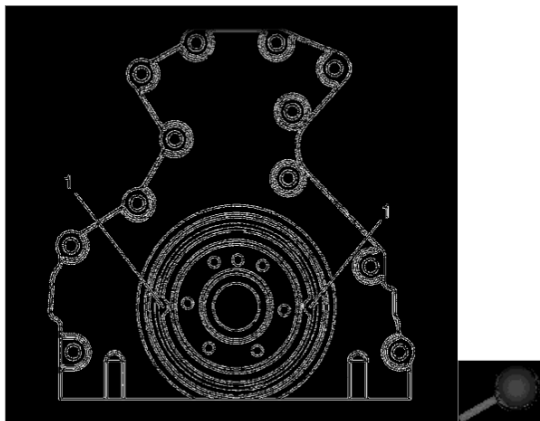
- Push the oil pump screen tube completely into the oil pump prior to tightening the bolt. Do not allow the bolt to pull the tube into the pump.
- Align the oil pump screen mounting brackets with the correct crankshaft bearing cap bolt/studs.

7. Install the oil pump screen (407).
8. Install the oil pump screen bolt (405) and the deflector nut (404).
 - 8.1. Tighten the oil pump screen bolt to **12 N•m (106 lb in)**.
 - 8.2. Tighten the crankshaft oil deflector nut to **25 N•m (18 lb ft)**.

Crankshaft Rear Oil Seal Housing Installation

Special Tools

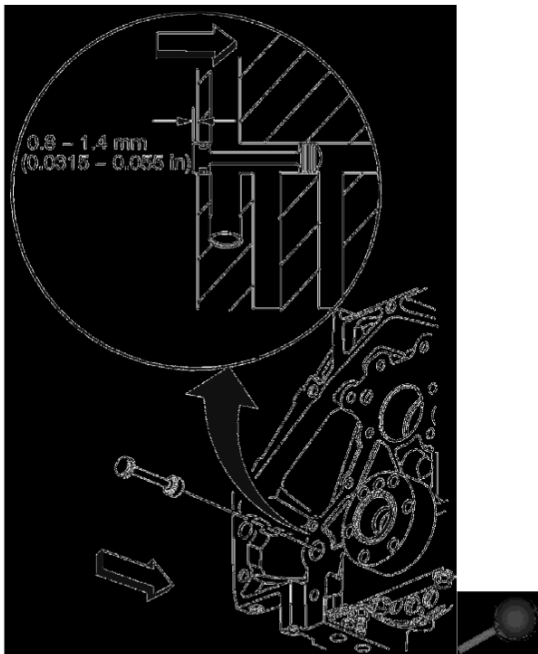
- *J 41476* Front and Rear Cover Alignment Tool
- *J 41479-2A* Crankshaft Rear Oil Seal Installation Guide
- *J 41480* Front and Rear Cover Alignment



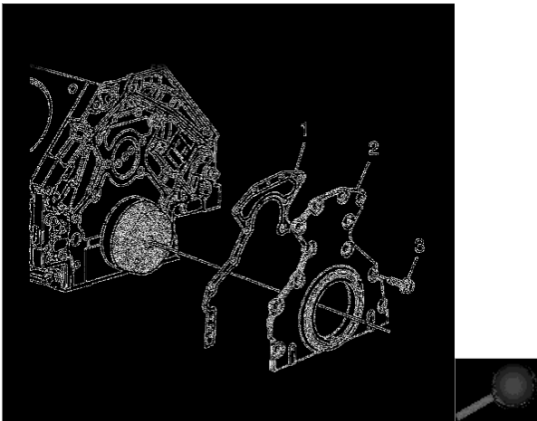
Note:

- Do not use the crankshaft rear oil seal or the engine rear housing gasket again.
- Do not apply any type of sealant to the rear housing gasket, unless specified.
- The special tool in this procedure is used to properly align the engine rear housing at the oil pan surface.
- Current design rear housings have alignment tabs for horizontal alignment. *J 41476* tool is not required for proper alignment of current design rear housings. The housing may be installed and aligned with or without the seal already installed into the housing.

1. Inspect the rear housing to identify for alignment tabs (1).



2. Inspect the rear oil gallery plug for proper installation.



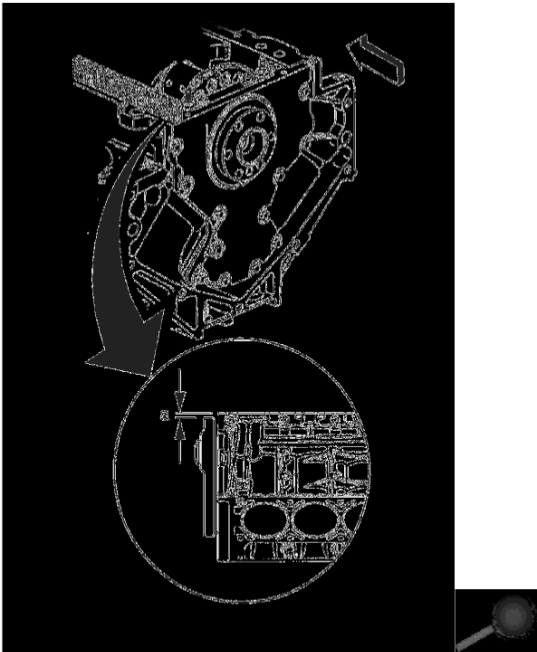
Note: The J 41479-2A guide is required when installing the rear housing with the rear oil seal. The J 41479-2A guide is used to guide and protect the rear seal sealing surface as it is installed over the rear flange of the crankshaft. The J 41479-2A guide is NOT required when installing the rear housing without rear oil seal.

3. Install the J 41479-2A guide cone and bolts onto the rear of the crankshaft.
4. Tighten the bolts until snug. Do not overtighten.
5. Install the rear housing gasket (1), rear housing with seal (2), and bolts (3).
6. Tighten the bolts finger tight. Do not overtighten.
7. Remove the J 41479-2A guide and bolts.



Caution: Refer to [Fastener Caution](#).

8. Install the *J 41480* cover alignment and bolts.
 - 8.1. Tighten the tool-to-engine block bolts to **25 N•m (18 lb ft)**.
 - 8.2. Tighten the *J 41480* cover alignment tool-to-rear housing bolts evenly to **12 N•m (106 lb in)**.
 - 8.3. Tighten the rear housing-to-engine block bolts to **30 N•m (22 lb ft)**.
9. Remove the *J 41480* cover alignment and bolts.



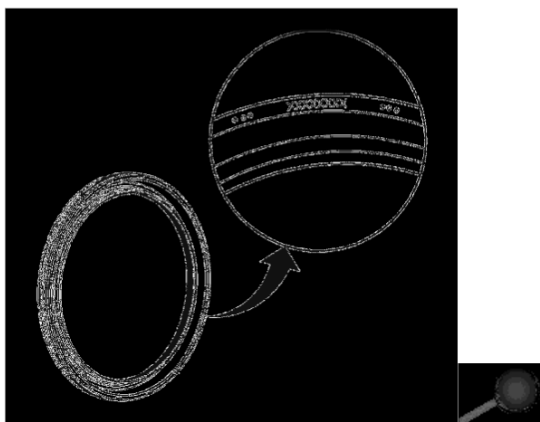
10. Measure the rear housing-to-engine block oil pan surface for flatness.
 - 10.1. Place a straight edge onto the engine block and rear housing oil pan sealing surfaces.
Avoid contact with the portion of the gasket that protrudes into the oil pan surface.

- 10.2. Insert a feeler gauge between the rear housing and the straight edge. The housing must be flush with the oil pan or no greater than 0.3 mm (0.0118 in) below flush (a).
11. If the rear housing-to-engine block oil pan surface alignment is not within specifications, repeat the housing alignment procedure.
12. If the correct rear housing-to-engine block alignment at the oil pan surface cannot be obtained, replace the rear housing.

Crankshaft Rear Oil Seal Installation

Special Tools

- J 41479 Crankshaft Rear Oil Seal Installer
- J 41479-2A Crankshaft Rear Oil Seal Installation Guide



Important: For proper orientation, note the installation direction of the oil seal. The oil seal is a reverse-lip design. The part number is applied to the outside face of the seal, as shown.

1. Inspect the seal and identify the part number markings for proper orientation.



2. Install the J 41479 Crankshaft Rear Oil Seal Installer or the J 41479-2A Crankshaft Rear Oil Seal Installation Guide cone (2) and bolts onto the rear of the crankshaft. The J 41479-2A Crankshaft Rear Oil Seal Installation Guide may be required for manual transmission or 5.3L LS4 applications.
3. Tighten the bolts until snug. Do not overtighten.
4. Install the rear oil seal onto the tapered cone (2) and push the seal to the rear seal bore. Install the oil seal with the part number markings facing away from the engine.

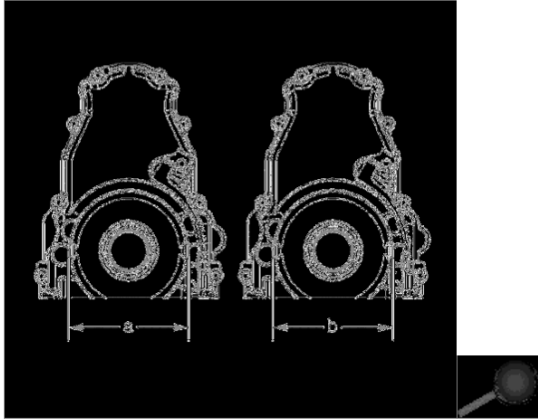
5. Thread the *J 41479* Crankshaft Rear Oil Seal Installer threaded rod into the tapered cone until the tool (1) contacts the oil seal.
6. Align the oil seal onto the tool (1).
7. Rotate the handle of the tool (1) clockwise until the seal enters the rear housing and bottoms into the seal bore.
8. Remove the tool.

Engine Front Cover Installation

Special Tools

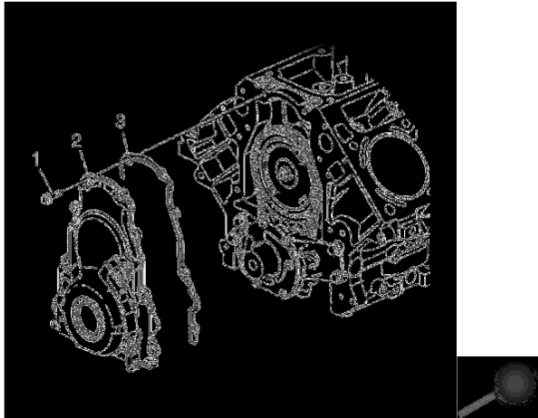
- *EN-48853* Front Cover Alignment Tool
- *J-41478* Crankshaft Front Oil Seal Installer
- *J-41480* Front and Rear Cover Alignment

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



1. Measure the alignment tab distance on the front cover.

For 2009 model year, the engine front cover may have either a **141 mm (5.55 in)** dimension (a) or **159 mm (6.26 in)** dimension (b) alignment tab distance. The *EN-48853* front cover alignment tool is designed to properly align both design front covers. For the **141 mm (5.55 in)** cover, the *EN 48853-2* adapters must be used.



Caution: Refer to [Fastener Caution](#).

Note:

- Do not use the crankshaft oil seal or the engine front cover gasket again.

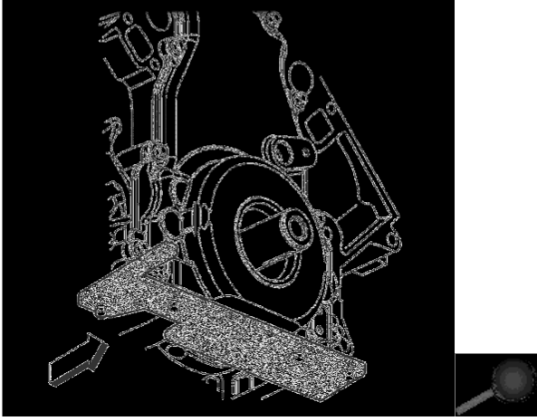
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- Do not apply any type of sealant to the front cover gasket, unless specified.
- The special tools in this procedure are used to properly align the engine front cover at the oil pan surface and to center the crankshaft front oil seal.
- All gasket surfaces should be free of oil or other foreign material during assembly.

The crankshaft front oil seal **MUST** be centered in relation to the crankshaft.

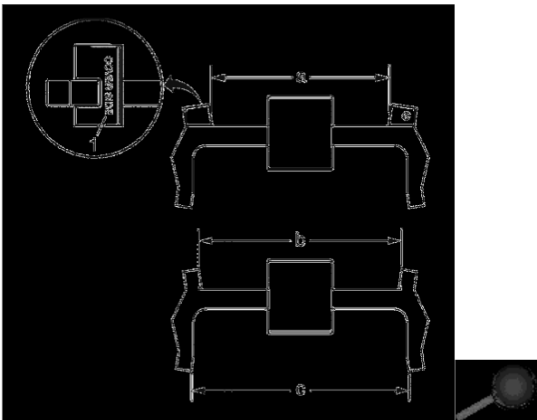
- The oil pan sealing surface at the front cover and engine block **MUST** be aligned within specifications.
- An improperly aligned front cover may cause premature front oil seal wear and/or engine assembly oil leaks.

2. Install the front cover gasket (3), front cover (2), and bolts (1).
3. Tighten the cover bolts finger tight. Do not overtighten.

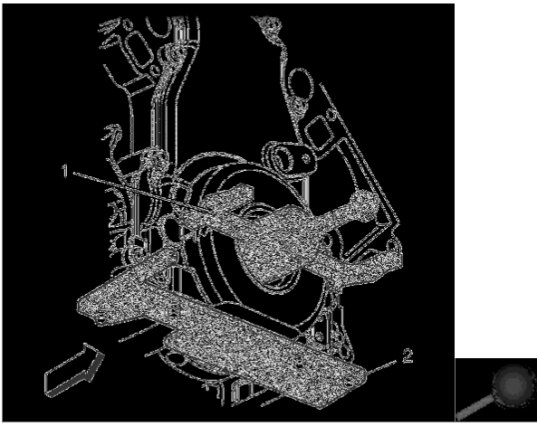


Note: Start the tool-to-front cover bolts. Do not tighten the bolts at this time.

4. Install the *J-41480* alignment tool. Tighten the tool-to-engine block bolts to **25 N•m (18 lb ft)**.

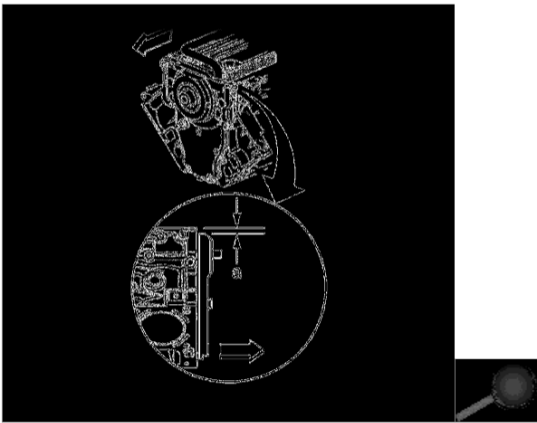


5. Install the *EN-48853-2* adapters as required for usage on the **141 mm (5.55 in)** dimension (a) front cover. Position the adapters against the legs of the *EN-48853* alignment tool with the words "cover side" (1) facing away from the tool.

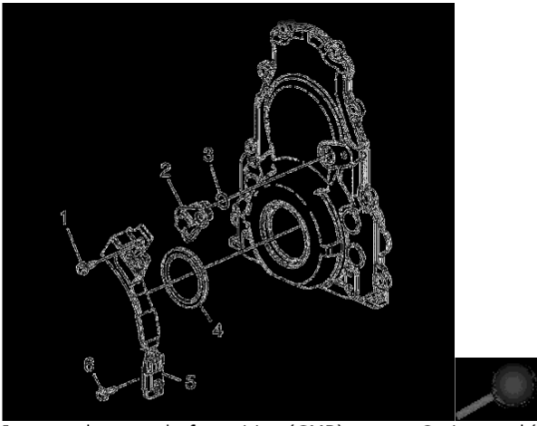


Note: Align the tapered legs of the tool with the machined alignment surfaces on the front cover.

6. Install the *EN-48853* alignment tool (1).
7. Install the threaded rod, washer and nut from *J-41478* crankshaft front oil seal installer.
8. Tighten the nut until snug, holding *EN-48853* alignment tool firmly in place. Do not overtighten.
9. Tighten the engine front cover bolts to **25 N·m (18 lb ft)**.
10. Remove the tools.



11. Measure the oil pan surface flatness, front cover-to-engine block.
 - 11.1. Place a straight edge across the engine block and front cover oil pan sealing surfaces. Avoid contact with the portion of the gasket that protrudes into the oil pan surface.
 - 11.2. Insert a feeler gauge between the front cover and the straight edge tool. The cover must be flush with the oil pan surface, or no greater than **0.5 mm (0.02 in)** (a) below flush.
12. If the front cover-to-engine block oil pan surface alignment is not within specifications, repeat the cover alignment procedure.
13. If the correct front cover-to-engine block alignment cannot be obtained, replace the front cover.

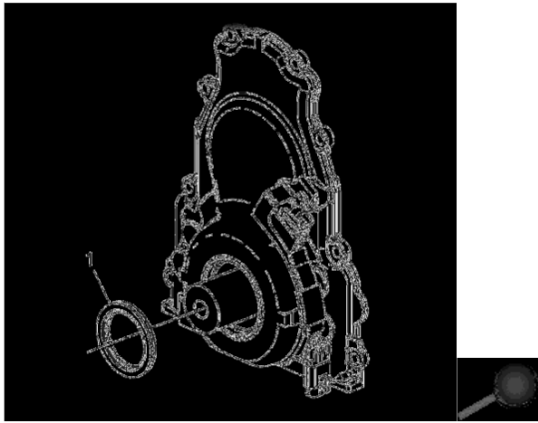


14. Inspect the camshaft position (CMP) sensor O-ring seal (3) for cuts or damage. If the seal is not cut or damaged, it may be used again.
15. Lubricate the O-ring seal with clean engine oil.
16. Install the O-ring seal onto the sensor (2).
17. Install the sensor to the cover.
18. Install the CMP sensor wire harness (5) and bolts (1, 6). Tighten the bolts to **12 N•m (106 lb in)**.

Crankshaft Front Oil Seal Installation

Special Tools

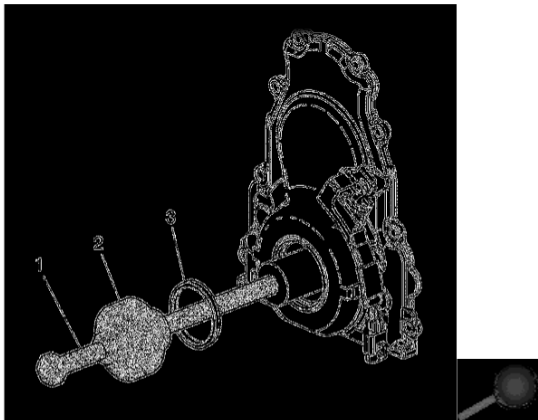
- *EN-47812* Installer Bolt
 - *J 41478* Crankshaft Front Oil Seal Installer
 - *J 41478-1A* Crankshaft Front Oil Seal Installer Cone
- For equivalent regional tools, refer to [Special Tools](#)



Note:

- Do not lubricate the oil seal sealing surface.
- Do not use the crankshaft front oil seal again.

1. Lubricate the outer edge of the oil seal (1) with clean engine oil.
2. Lubricate the front cover oil seal bore with clean engine oil.

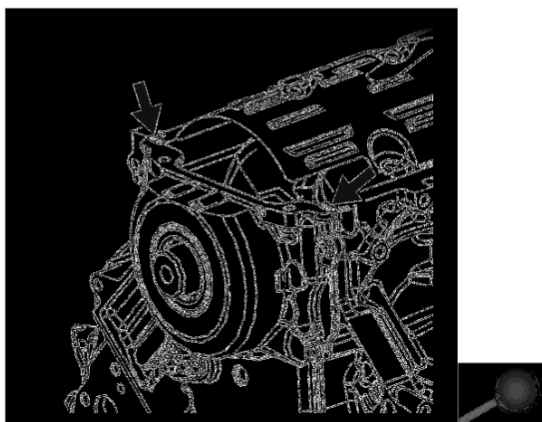


3. Using the *EN-47812* bolt and the *J 41478* installer , install the crankshaft front oil seal.
4. Install the *EN-47812* bolt threaded rod (1), nut, washer, the *J 41478-1A* installer cone (2), and oil seal (3) into the end of the crankshaft.

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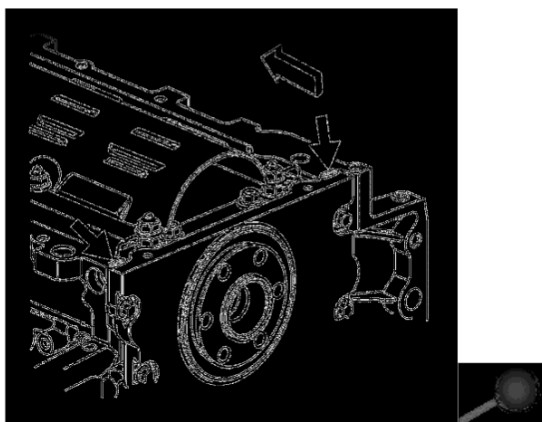
5. Use the *J 41478* installer in order to install the oil seal into the cover bore.
 - 5.1. Use a wrench and hold the hex on the installer bolt.
 - 5.2. Use a second wrench and rotate the installer nut clockwise until the seal bottoms in the cover bore.
 - 5.3. Remove the tool.
 - 5.4. Inspect the oil seal for proper installation. The oil seal should be installed evenly and completely into the front cover bore.

Oil Pan Installation

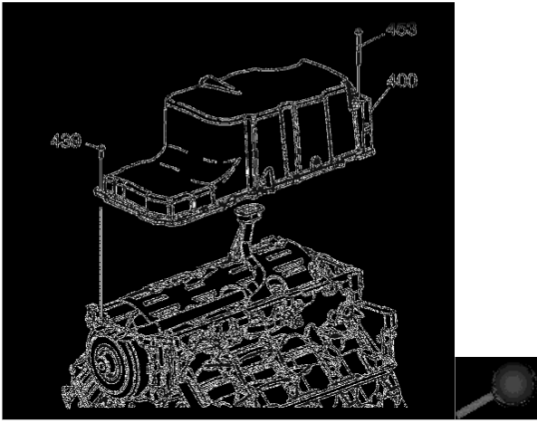
**Note:**

- The alignment of the structural oil pan is critical. The rear bolt hole locations of the oil pan provide mounting points for the transmission housing. To ensure the rigidity of the powertrain and correct transmission alignment, it is important that the rear of the block and the rear of the oil pan are flush, or even. The rear of the oil pan must NEVER protrude beyond the engine block and transmission housing plane.
- Do not use the oil pan gasket again.
- It is not necessary to rivet the NEW gasket to the oil pan.

1. Install the baffle, as required. Refer to [Oil Pan Cleaning and Inspection](#).
2. Apply a **5 mm (0.2 in)** bead of sealant **20 mm (0.8 in)** long to the engine block. Apply the sealant directly onto the tabs of the front cover gasket that protrude into the oil pan surface. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended sealant.

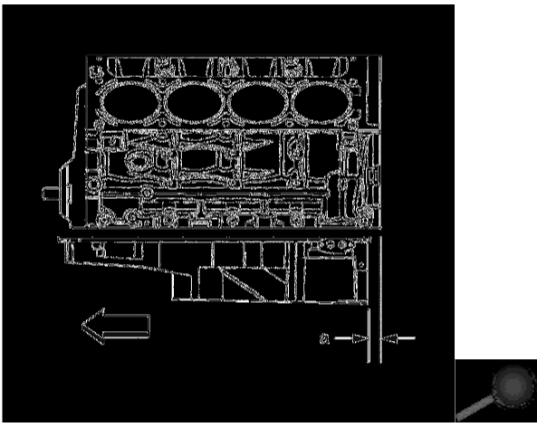


3. Apply a **5 mm (0.2 in)** bead of sealant **20 mm (0.8 in)** long to the engine block. Apply the sealant directly onto the tabs of the rear housing gasket that protrude into the oil pan surface. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended sealant.



Note: Ensure the oil gallery passages in the oil pan and engine block properly align with the oil pan gasket.

4. Pre-assemble the oil pan gasket to the pan.
 - 4.1. Install the gasket onto the oil pan.
 - 4.2. Install the oil pan bolts to the pan and through the gasket.
5. Install the oil pan (400), gasket, and bolts (439 and 453) to the engine block.
6. Tighten the bolts finger tight. Do not overtighten.

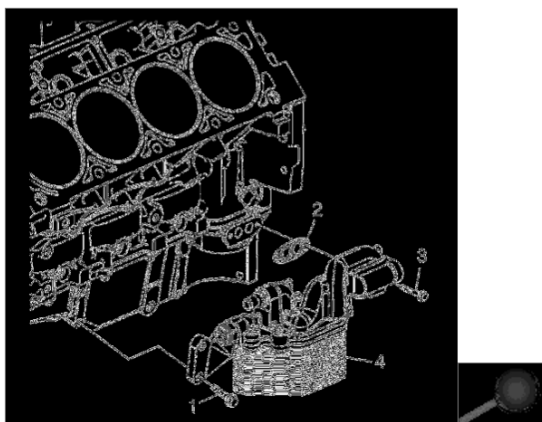


7. Place a straight edge across the rear of the engine block and the rear of the oil pan at the transmission housing mounting surfaces.
- Caution:** Refer to [Fastener Caution](#).
8. Align the oil pan until the rear of engine block and rear of oil pan are flush or even.
 - 8.1. Tighten the oil pan-to-block and oil pan-to-front cover bolts to **25 N·m (18 lb ft)**.
 - 8.2. Tighten the oil pan-to-rear housing bolts to **12 N·m (106 lb in)**.
9. Measure the oil pan-to-engine block alignment (a).
 - 9.1. Place a straight edge across the rear of the engine block and rear of oil pan at the transmission housing mounting surfaces.

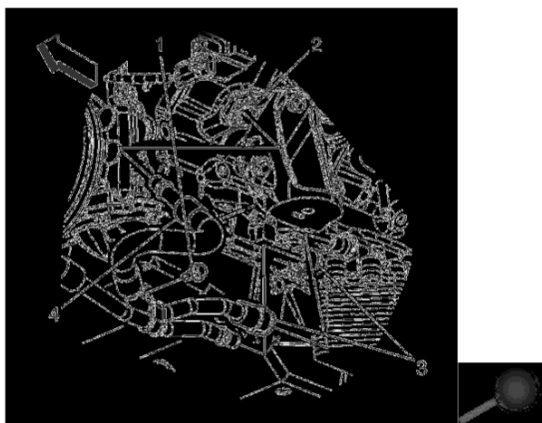
Note: The rear of the oil pan must NEVER protrude beyond the engine block and transmission housing mounting surfaces.

- 9.2. Insert a feeler gauge between the straight edge and the oil pan transmission housing mounting surface, and inspect to ensure there is no greater than a **0.1 mm (0.004 in)** gap (a) between the pan and straight edge.
- 9.3. If the oil pan alignment is not within specifications, remove the oil pan and repeat the above procedure.

Engine Oil Cooler Installation

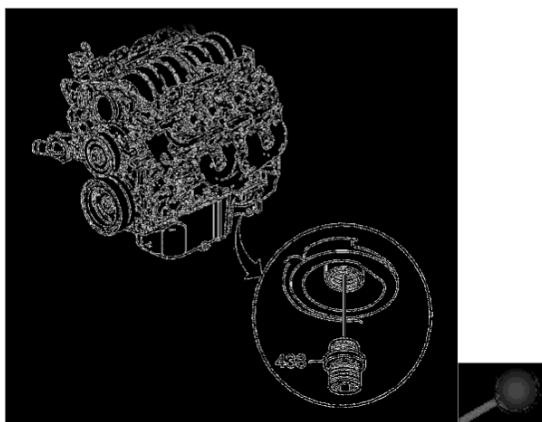


1. Install the oil cooler gasket (2).
2. Install the oil cooler (4).
- Caution:** Refer to [Fastener Caution](#).
3. Install the oil cooler M8 (1) and M6 (3) bolts.
4. Tighten the M6 bolts to **10 N•m (89 lb in)**.
5. Tighten the M8 bolts to **25 N•m (18 lb ft)**.



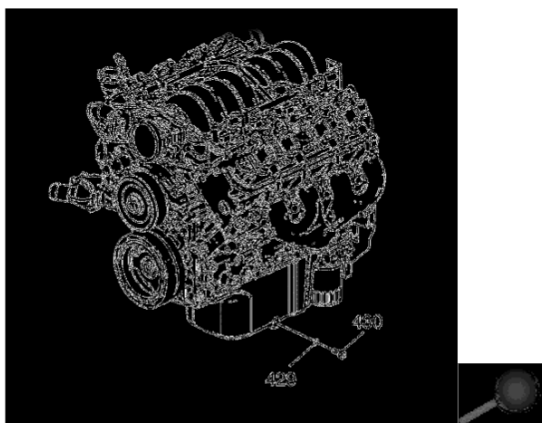
6. Install the engine oil cooler coolant fitting (2) to the block, as required and tighten to **50 N•m (37 lb ft)**.
7. Install the hose/pipe (4) to the fitting (2) and cooler (3).
8. Install the bolt and tighten to **25 N•m (18 lb ft)**.

Oil Filter, Adapter, and Pan Cover Installation

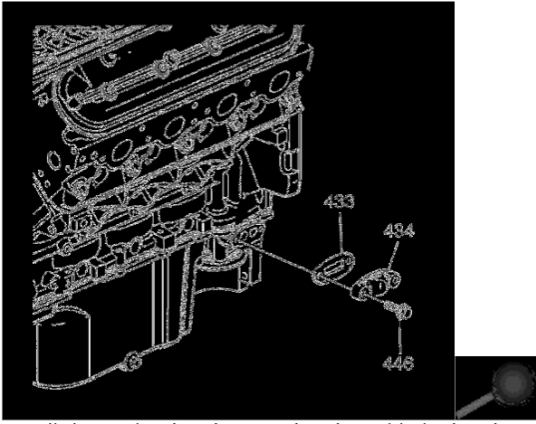


Caution: Refer to [Fastener Caution](#).

1. Install the oil filter fitting (438) and tighten to **55 N•m (40 lb ft)**.

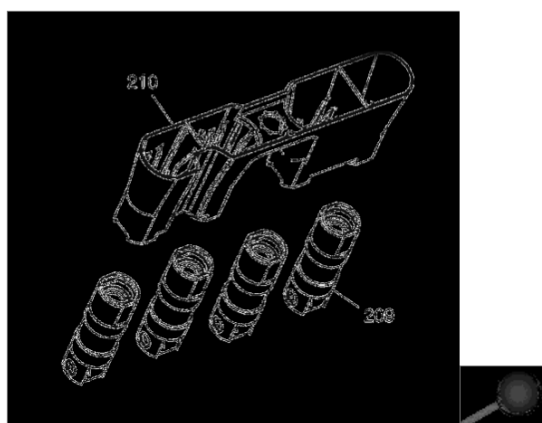


2. Install the oil pan drain plug (430) and O-ring (429) and tighten to **25 N•m (18 lb ft)**.



3. Install the gasket (433), cover (434), and bolts (446) and tighten to **12 N•m (106 lb ft)**.

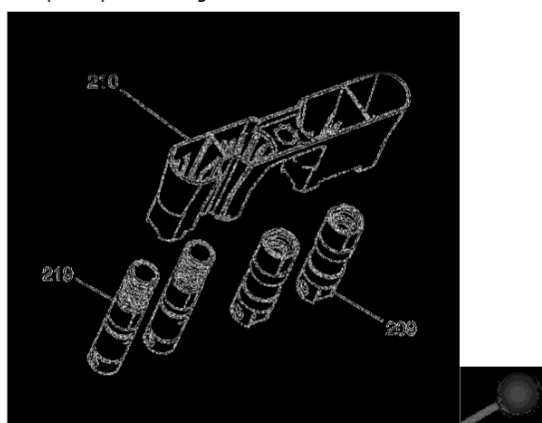
Valve Lifter Installation



Note:

- When using the non-Active Fuel Management (AFM) valve lifters again, install the lifters to their original locations.
- If camshaft replacement is required, the valve lifters must also be replaced.

1. Lubricate the valve lifters (209) and engine block valve lifter bores with clean engine oil.
2. Insert the valve lifters into the lifter guides (210).
Align the flat area on the top of the lifter with the flat area in the lifter guide bore. Push the lifter completely into the guide bore.

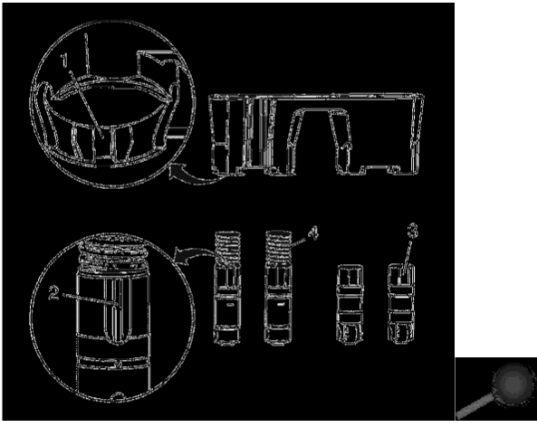


Note:

- When using the AFM valve lifters again, install the lifters to their original locations.
- If camshaft replacement is required, the valve lifters must also be replaced.
- Each of the 4 valve guide assemblies will contain 2 active fuel management valve lifters and 2 non-active fuel management valve lifters.

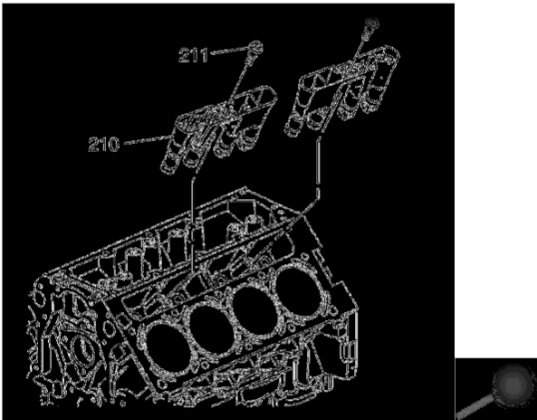
- With the lifters and guides properly installed, cylinders 1, 4, 6, and 7 lifter bores will each contain 2 active fuel management valve lifters.

3. Lubricate the valve lifters (209, 219) and engine block valve lifter bores with clean engine oil.



4. Insert the valve lifters into the lifter guides.

- Align the flat area (3) on the top of the non-active fuel management lifter with the flat area in the lifter guide bore. Push the lifter completely into the guide bore.
- The active fuel management lifters (4) are to be installed into the guide, with the notch in the guide (1) aligned with the raised area (2) of the lifter.



5. Install the valve lifters and guide assembly (210) to the engine block.

Caution: Refer to [Fastener Caution](#).

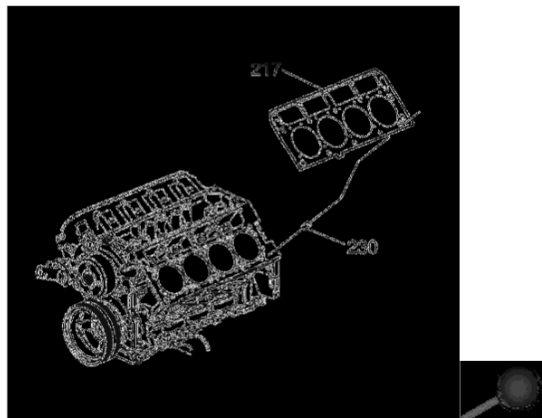
6. Install the valve lifter guide bolts (211) and tighten to **12 N·m (106 lb in)**.

Cylinder Head Installation - Left Side (L77)

Special Tools

- J 42385-100 Head/Main Bolt Thread Repair Kit
- J 45059 Angle Meter

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



Warning: Refer to [Safety Glasses Warning](#).

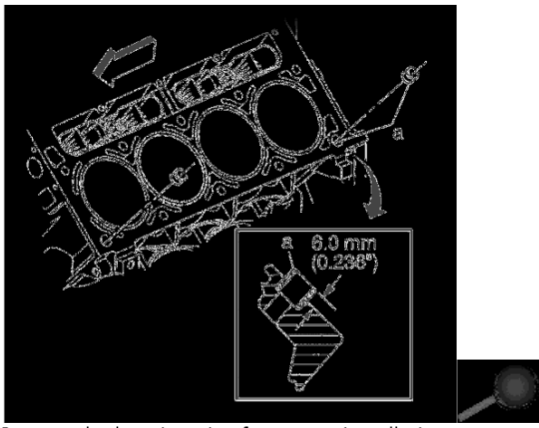
Caution: Clean all dirt, debris, and coolant from the engine block cylinder head bolt holes. Failure to remove all foreign material may result in damaged threads, improperly tightened fasteners or damage to components.

Note:

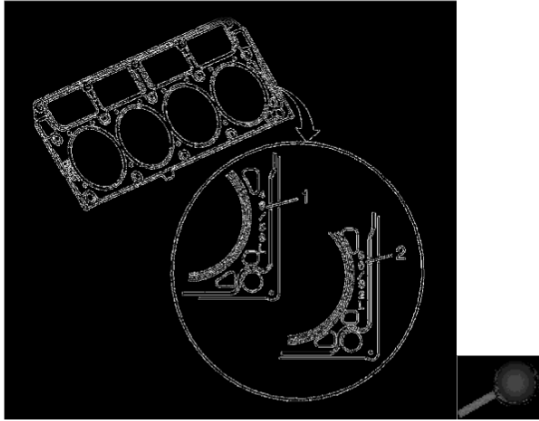
- Do not use the cylinder head bolts again. Install NEW cylinder head bolts during assembly.
- Do not use any type of sealant on the cylinder head gasket, unless specified.

1. Clean the engine block cylinder head bolt holes, if required.
J 42385-107 thread repair tool may be used to clean the threads of old threadlocking material.
2. Spray cleaner into the hole. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#).
3. Clean the cylinder head bolt holes with compressed air.
4. Install the cylinder head locating pins (230).

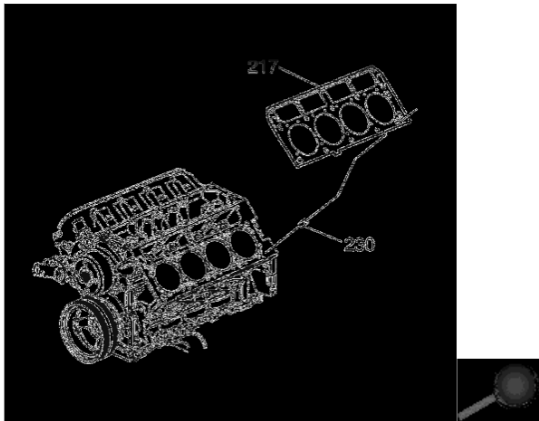
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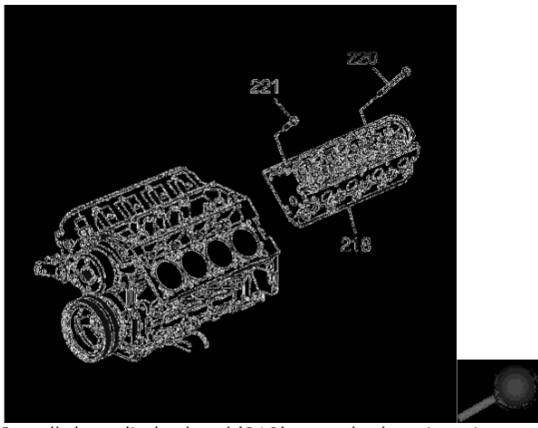
5. Inspect the locating pins for proper installation.



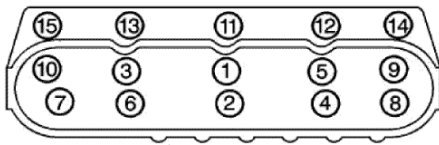
6. Inspect the displacement markings (1, 2) on the gasket, for proper usage.



7. Install the NEW cylinder head gasket (217) onto the locating pins.



8. Install the cylinder head (218) onto the locating pins and the gasket.
9. Install the NEW cylinder head bolts (220, 221).



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Caution: Refer to [Fastener Caution](#).

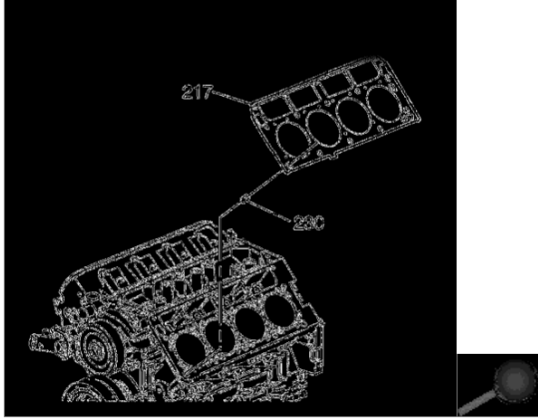
10. Tighten the cylinder head bolts.
 - 10.1. Tighten the M11 cylinder head bolts (1-10) a first pass in sequence to **30 N•m (22 lb ft)**.
 - 10.2. Tighten the M11 cylinder head bolts (1-10) a second pass in sequence to **90 degrees** using the *J 45059* meter .
 - 10.3. Tighten the M11 cylinder head bolts (1-10) a final pass in sequence to **70 degrees** using the *J 45059* meter .
 - 10.4. Tighten the M8 cylinder head bolts (11-15) to **30 N•m (22 lb ft)**. Begin with the center bolt (11) and alternating side-to-side, work outward tightening all of the bolts.

Cylinder Head Installation - Left Side (LS3 or LSA)

Special Tools

- J 42385-100 Thread Repair Kit
- J 45059 Angle Meter

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



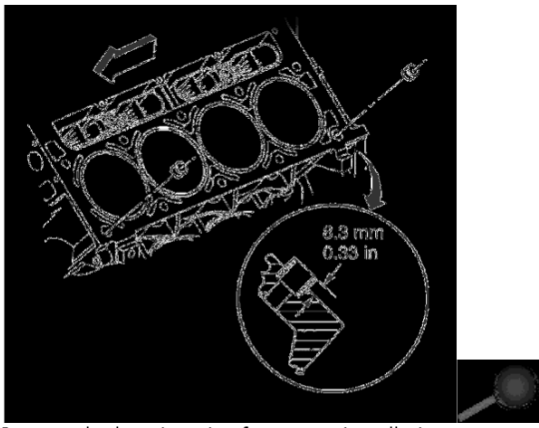
Warning: Refer to [Safety Glasses Warning](#).

Caution: Clean all dirt, debris, and coolant from the engine block cylinder head bolt holes. Failure to remove all foreign material may result in damaged threads, improperly tightened fasteners or damage to components.

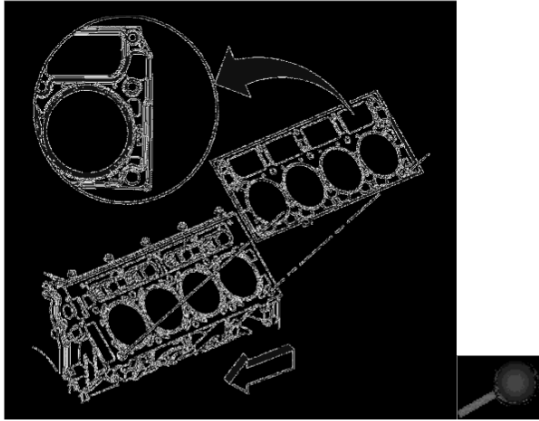
Note:

- Do not use the cylinder head bolts again. Install NEW cylinder head bolts during assembly.
 - Do not use any type of sealant on the cylinder head gasket, unless specified.
 - The cylinder head gaskets must be installed in the proper direction and position.
1. Clean the engine block cylinder head bolt holes, if required.
Thread repair tool J 42385-107 may be used to clean the threads of old threadlocking material.
 2. Spray cleaner into the hole. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended cleaner.
 3. Clean the cylinder head bolt holes with compressed air.
 4. Install the cylinder head locating pins (230).

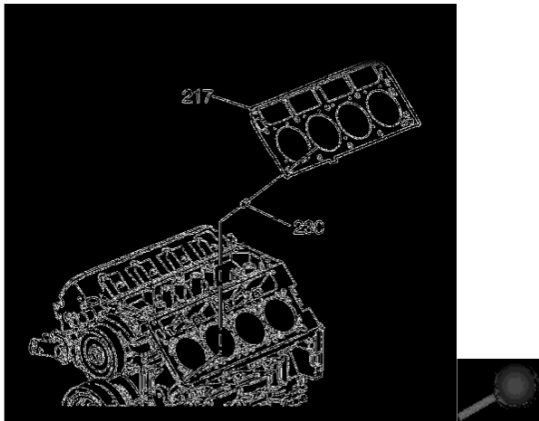
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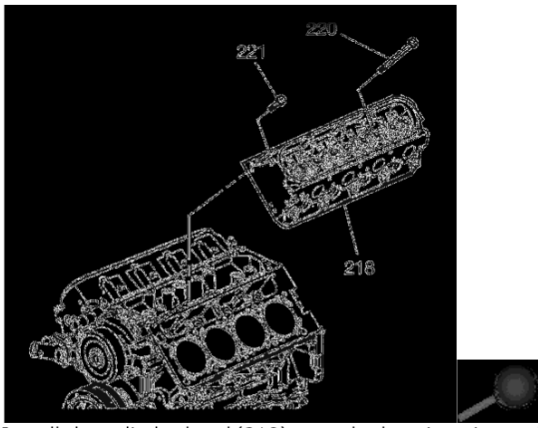
5. Inspect the locating pins for proper installation.



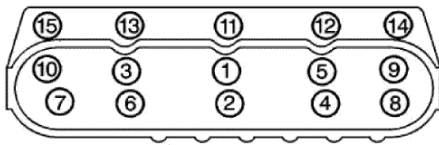
6. Inspect the displacement markings on the gasket for proper usage.



7. Install the NEW cylinder head gasket (217) onto the locating pins.



8. Install the cylinder head (218) onto the locating pins and the gasket.
9. Install the NEW cylinder head bolts (220, 221).



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Warning: Refer to [Safety Glasses Warning](#).

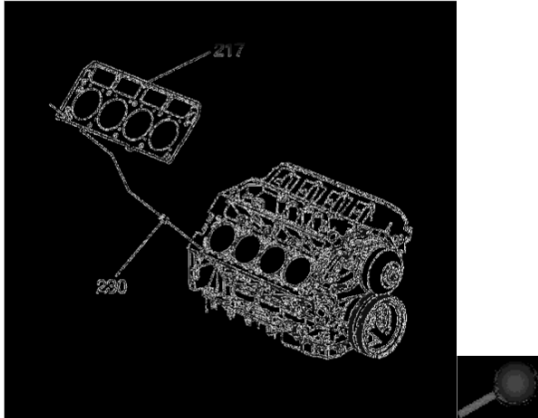
10. Tighten the cylinder head bolts:
 - 10.1. Tighten the M11 cylinder head bolts (1-10) a first pass in sequence to **30 N•m (22 lb ft)**.
 - 10.2. Tighten the M11 cylinder head bolts (1-10) a second pass in sequence to **90 degrees** using the *J 45059* meter.
 - 10.3. Tighten the M11 cylinder head bolts (1-10) a final pass in sequence to **70 degrees** using the *J 45059* meter.
 - 10.4. Tighten the M8 cylinder head bolts (11-15) to **30 N•m (22 lb ft)**. Begin with the center bolt (11) and alternating side-to-side, work outward tightening all of the bolts.

Cylinder Head Installation - Right Side (L77)

Special Tools

- J 42385-100 Head/Main Bolt Thread Repair Kit
- J 45059 Angle Meter

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



Warning: Refer to [Safety Glasses Warning](#).

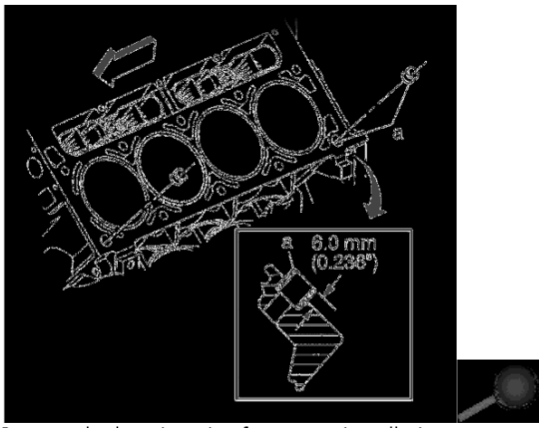
Caution: Clean all dirt, debris, and coolant from the engine block cylinder head bolt holes. Failure to remove all foreign material may result in damaged threads, improperly tightened fasteners or damage to components.

Note:

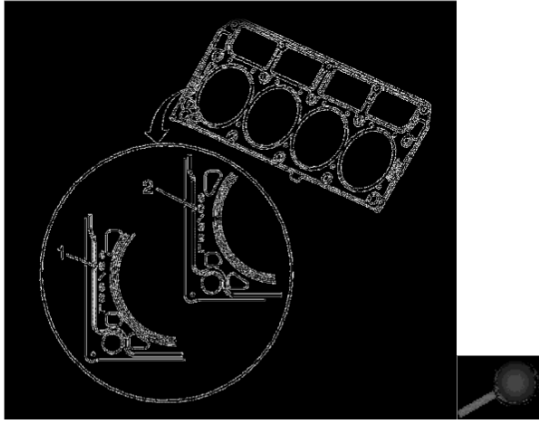
- Do not use the cylinder head bolts again. Install NEW cylinder head bolts during assembly.
- Do not use any type of sealant on the cylinder head gasket, unless specified.

1. Clean the engine block cylinder head bolt holes, if required.
J 42385-107 thread repair tool may be used to clean the threads of old threadlocking material.
2. Spray cleaner into the hole. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#).
3. Clean the cylinder head bolt holes with compressed air.
4. Install the cylinder head locating pins (230).

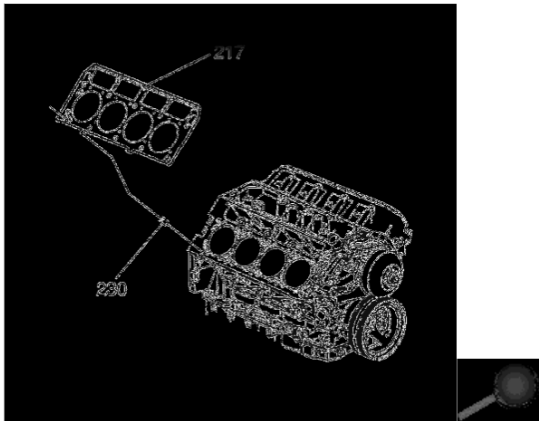
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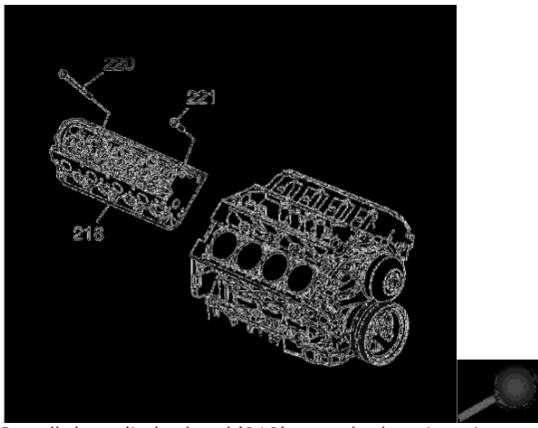
5. Inspect the locating pins for proper installation.



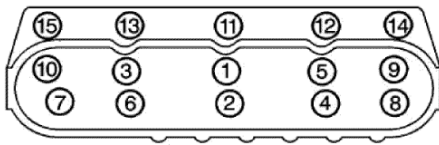
6. Inspect the displacement markings (1, 2) on the gasket, for proper usage.



7. Install the NEW cylinder head gasket (217) onto the locating pins.



8. Install the cylinder head (218) onto the locating pins and the gasket.
9. Install the NEW cylinder head bolts (220, 221).



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Caution: Refer to [Fastener Caution](#).

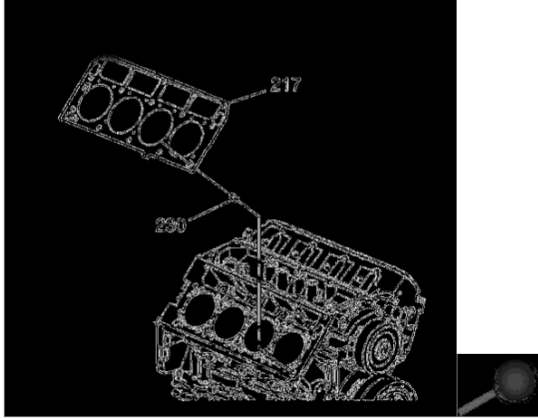
10. Tighten the cylinder head bolts.
 - 10.1. Tighten the M11 cylinder head bolts (1-10) a first pass in sequence to **30 N•m (22 lb ft)**.
 - 10.2. Tighten the M11 cylinder head bolts (1-10) a second pass in sequence to **90 degrees** using the *J 45059* meter .
 - 10.3. Tighten the M11 cylinder head bolts (1-10) a final pass in sequence to **70 degrees** using the *J 45059* meter .
 - 10.4. Tighten the M8 cylinder head bolts (11-15) to **30 N•m (22 lb ft)**. Begin with the center bolt (11) and alternating side-to-side, work outward tightening all of the bolts.

Cylinder Head Installation - Right Side (LS3 or LSA)

Special Tools

- J 42385-100 Thread Repair Kit
- J 45059 Angle Meter

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



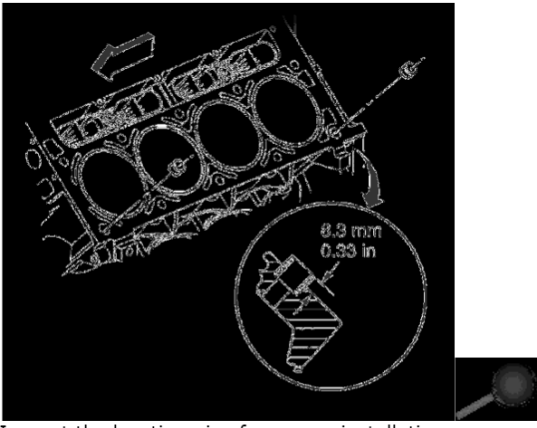
Warning: Refer to [Safety Glasses Warning](#).

Caution: Clean all dirt, debris, and coolant from the engine block cylinder head bolt holes. Failure to remove all foreign material may result in damaged threads, improperly tightened fasteners or damage to components.

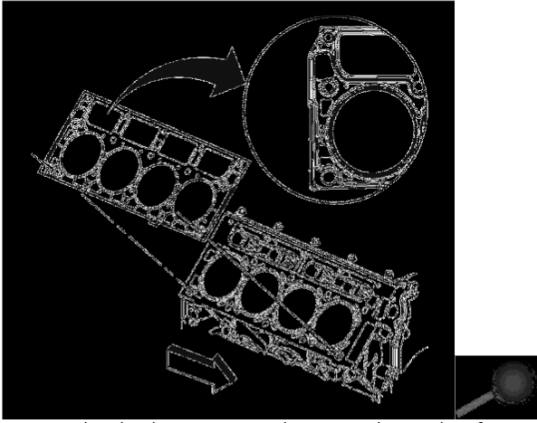
Note:

- Do not use the cylinder head bolts again. Install NEW cylinder head bolts during assembly.
 - Do not use any type of sealant on the cylinder head gasket, unless specified.
 - The cylinder head gaskets must be installed in the proper direction and position.
1. Clean the engine block cylinder head bolt holes, if required.
Thread repair tool J 42385-107 may be used to clean the threads of old threadlocking material.
 2. Spray cleaner into the hole. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended cleaner.
 3. Clean the cylinder head bolt holes with compressed air.
 4. Install the cylinder head locating pins (230).

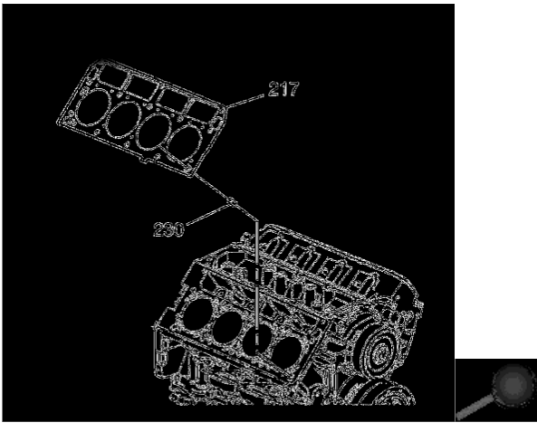
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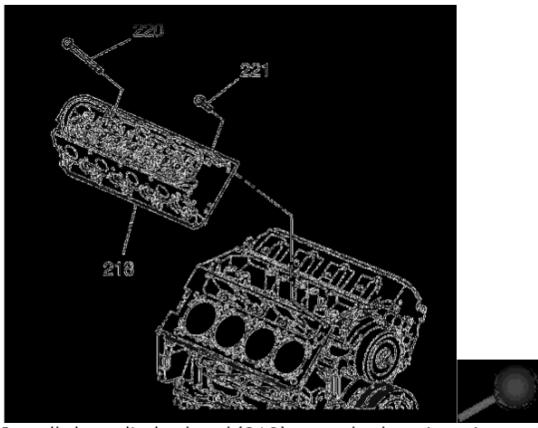
5. Inspect the locating pins for proper installation.



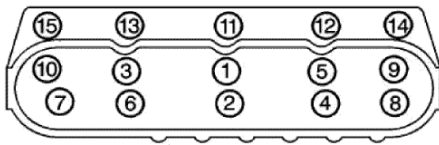
6. Inspect the displacement markings on the gasket for proper usage.



7. Install the NEW cylinder head gasket (217) onto the locating pins.



8. Install the cylinder head (218) onto the locating pins and the gasket.
9. Install the NEW cylinder head bolts (220, 221).



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Caution: Refer to [Fastener Caution](#).

10. Tighten the cylinder head bolts:
 - 10.1. Tighten the M11 cylinder head bolts (1–10) a first pass in sequence to **30 N•m (22 lb ft)**.
 - 10.2. Tighten the M11 cylinder head bolts (1–10) a second pass in sequence to **90 degrees** using the *J 45059* meter .
 - 10.3. Tighten the M11 cylinder head bolts (1–10) a final pass in sequence to **70 degrees** using the *J 45059* meter .
 - 10.4. Tighten the M8 cylinder head bolts (11–15) to **30 N•m (22 lb ft)**. Begin with the center bolt (11) and alternating side-to-side, work outward tightening all of the bolts.

Valve Rocker Arm and Push Rod Installation

**Note:**

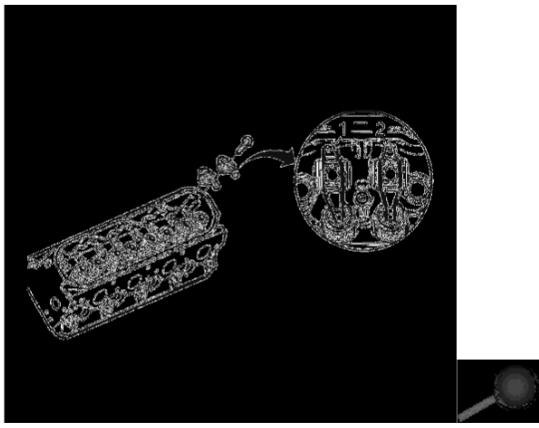
- When using the valve train components again, always install the components to the original location and position.
- Valve lash is not built. No valve adjustment is required.

1. Lubricate the valve rocker arms and pushrods with clean engine oil.
2. Lubricate the flange of the valve rocker arm bolts with clean engine oil.
3. Install the valve rocker arm pivot support.



Note: Ensure the pushrods seat properly to the valve lifter sockets.

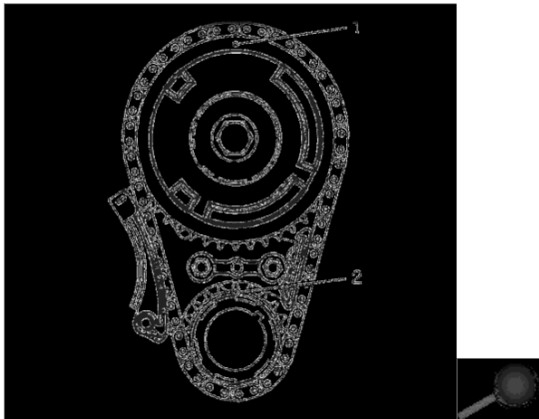
4. Install the pushrods.

**Note:**

- Ensure the pushrods seat properly to the ends of the rocker arms.
- **DO NOT** tighten the rocker arm bolts at this time.

5. Install the rocker arms and bolts.

The intake rocker arms (1) have an offset design.



6. Rotate the crankshaft until number 1 piston is at top dead center of compression stroke.

In this position, cylinder number 1 rocker arms will be off lobe lift, and the crankshaft sprocket key will be at the 1:30 position. The camshaft and crankshaft sprocket alignment marks (1, 2) will be in the 12 o'clock position. If viewing from the rear of the engine, the additional crankshaft pilot hole, non-threaded, will be in the 10:30 position.

The engine firing order is 1, 8, 7, 2, 6, 5, 4, 3.

Cylinders 1, 3, 5 and 7 are left bank.

Cylinders 2, 4, 6, and 8 are right bank.

Caution: Refer to [Fastener Caution](#).

7. With the engine in the number 1 firing position, tighten the following valve rocker arm bolts:

7.1. Tighten the exhaust valve rocker arm bolts 1, 2, 7, and 8 to **30 N·m (22 lb ft)**.

7.2. Tighten the intake valve rocker arm bolts 1, 3, 4, and 5 to **30 N·m (22 lb ft)**.

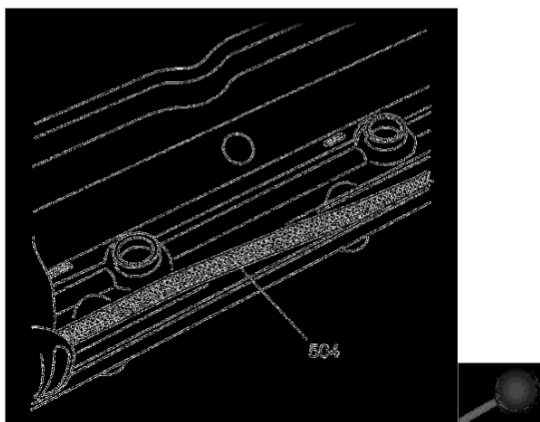
8. Rotate the crankshaft 360 degrees.

9. Tighten the following valve rocker arm bolts:

9.1. Tighten the exhaust valve rocker arm bolts 3, 4, 5, and 6 to **30 N·m (22 lb ft)**.

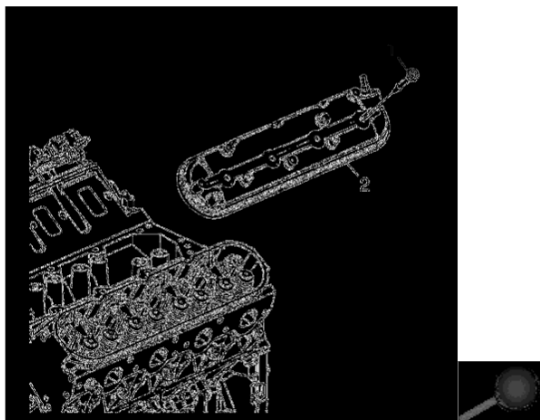
9.2. Tighten the intake valve rocker arm bolts 2, 6, 7, and 8 to **30 N•m (22 lb ft)**.

Valve Rocker Arm Cover Installation - Left Side (LSA)

**Note:**

- All gasket surfaces should be free of oil or other foreign material during assembly.
- **DO NOT** use the valve rocker arm cover gasket again.

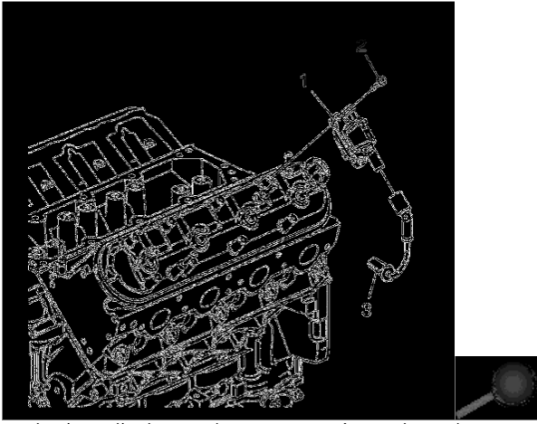
1. Install NEW valve rocker arm cover grommets and use NEW valve rocker arm cover bolts if they are serviced with the grommet.
2. Install a NEW gasket (504) into the valve rocker arm cover.



3. Install the valve rocker arm cover (2) onto the cylinder head.

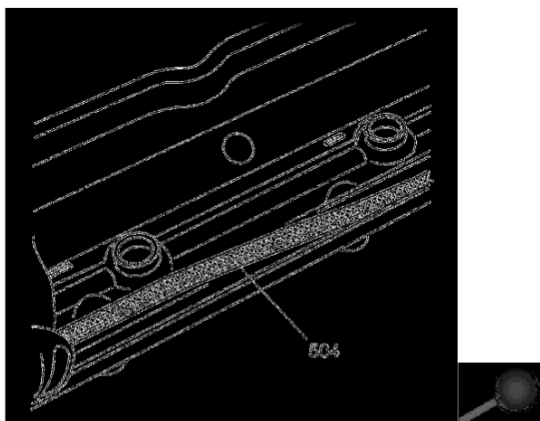
Caution: Refer to [Fastener Caution](#).

4. Install the cover bolts (1) with grommets and tighten to **12N·m (106 lb in)**.



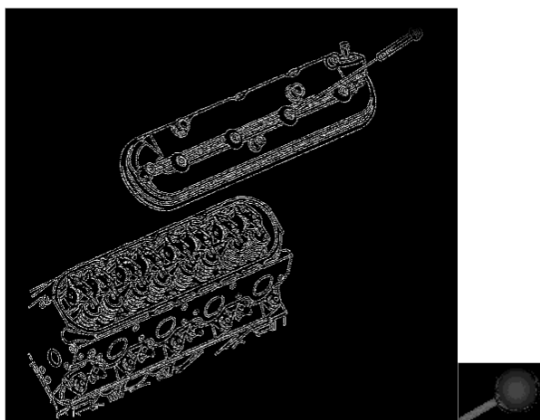
5. Apply threadlock GM P/N 12345382 (Canadian P/N 10953489), or equivalent, to the threads of the ignition coil bolts (2).
6. Install the ignition coils (1) and bolts (2) and tighten to **12 N•m (106 lb in)**.
7. Install the spark plug wires (3).

Valve Rocker Arm Cover Installation - Left Side (LS3 or L77)

**Note:**

- All gasket surfaces should be free of oil or other foreign material during assembly.
- DO NOT use the valve rocker arm cover gasket again.

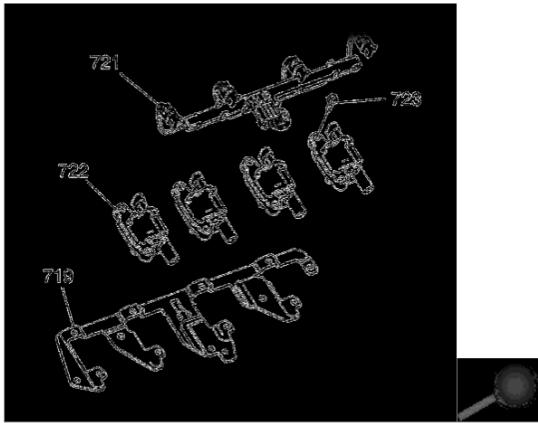
1. Install NEW valve rocker arm cover grommets and use NEW valve rocker arm cover bolts if they are serviced with the grommet.
2. Install a NEW gasket (504) into the valve rocker arm cover.



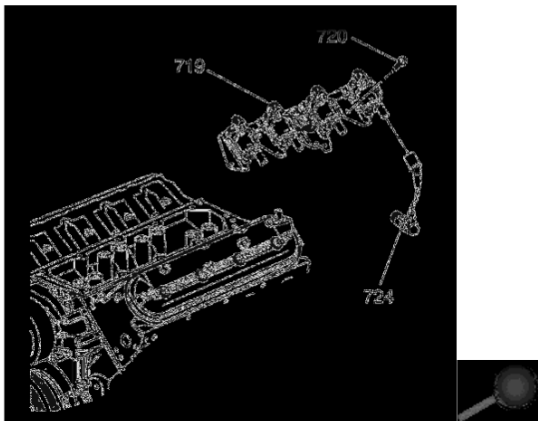
3. Install the valve rocker arm cover onto the cylinder head.

Caution: Refer to [Fastener Caution](#).

4. Install the cover bolts with grommets and tighten to **12N•m (106 lb in)**.

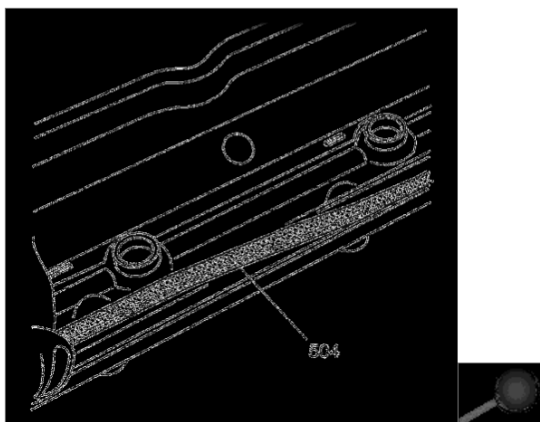


5. Apply threadlock to the threads of the ignition coil bolts (723). Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended threadlock.
6. Install the ignition coils (722), wire harness (721), and bolts (723) to the bracket (719). Tighten the ignition coil bolts to **10 N·m (89 lb in)**.



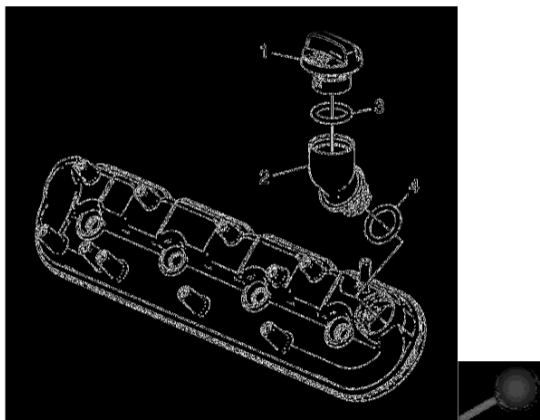
7. Apply threadlock to the threads of the ignition coil bracket studs (720). Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended threadlock.
8. Install the ignition coil and bracket assembly (719) and studs (720). Tighten the bracket studs to **12 N·m (106 lb in)**.

Valve Rocker Arm Cover Installation - Right Side (LSA)

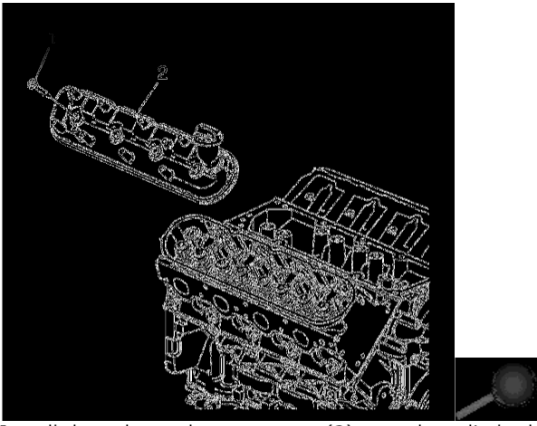
**Note:**

- All gasket surfaces should be free of oil or other foreign material during assembly.
- DO NOT use the valve rocker arm cover gasket again.

1. Install NEW valve rocker arm cover grommets and use NEW valve rocker arm cover bolts if they are serviced with the grommet.
2. Install a NEW gasket (504) into the valve rocker arm cover.



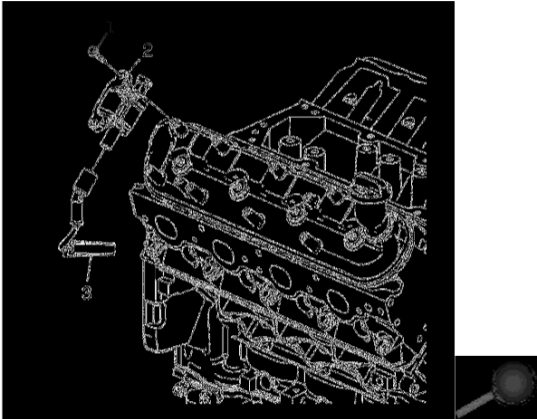
3. Install a NEW oil cap (1), oil fill tube (2) and seals (3, 4) to the valve rocker arm cover, as required.



4. Install the valve rocker arm cover (2) onto the cylinder head.

Caution: Refer to [Fastener Caution](#).

5. Install the cover bolts (1) with NEW grommets and tighten to **12 N·m (106 lb in)**.

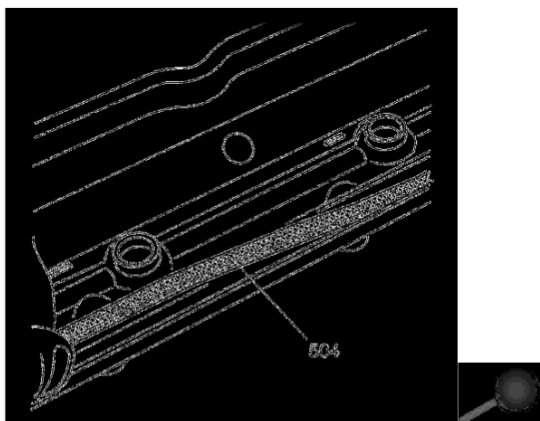


6. Apply threadlock GM P/N 12345382 (Canadian P/N 10953489), or equivalent, to the threads of the ignition coil bolts (1).

7. Install the ignition coils (2) and bolts (1) and tighten to **12 N·m (106 lb in)**.

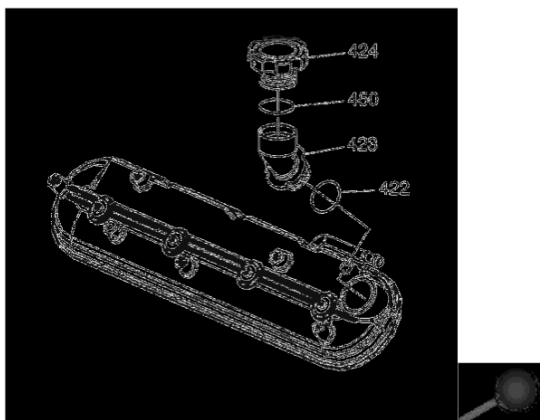
8. Install the spark plug wires (3).

Valve Rocker Arm Cover Installation - Right Side (LS3 or L77)

**Note:**

- All gasket surfaces should be free of oil or other foreign material during assembly.
- DO NOT use the valve rocker arm cover gasket again.

1. Install NEW valve rocker arm cover grommets and use NEW valve rocker arm cover bolts if they are serviced with the grommet.
2. Install a NEW gasket (504) into the valve rocker arm cover.



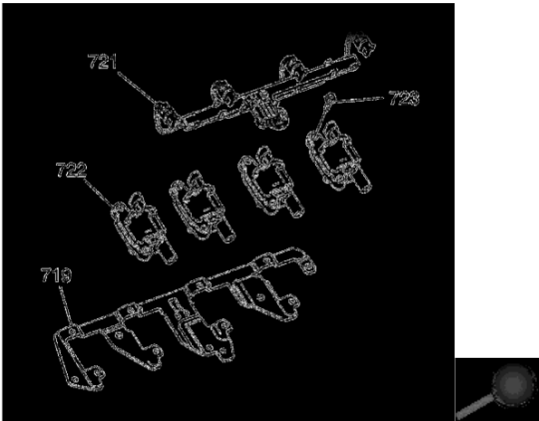
3. Install a NEW oil fill tube (423) to the valve rocker arm cover.
4. Install the oil fill cap (424).



5. Install the valve rocker arm cover onto the cylinder head.

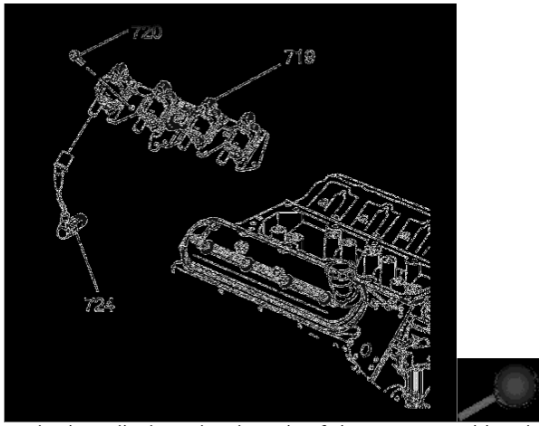
Caution: Refer to [Fastener Caution](#).

6. Install the cover bolts with grommets and tighten to **12 N·m (106 lb in)**.



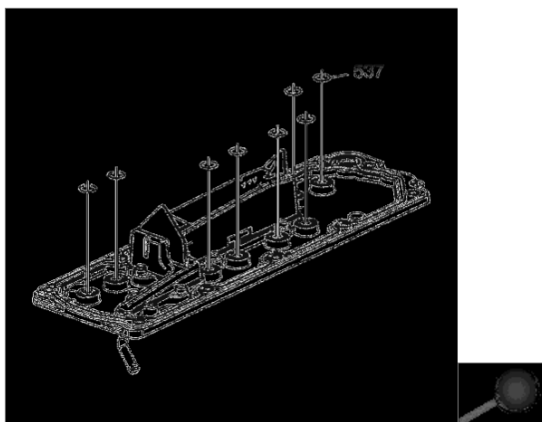
7. Apply threadlock to the threads of the ignition coil bolts (723). Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended threadlock.

8. Install the ignition coils (722), wire harness (721), and bolts (723) to the bracket (719). Tighten the ignition coil bolts to **10 N·m (89 lb in)**.



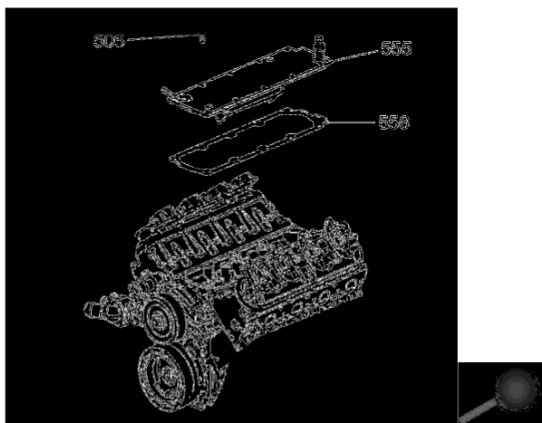
9. Apply threadlock to the threads of the ignition coil bracket studs (720). Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended threadlock.
10. Install the ignition coil and bracket assembly (719) and studs (720). Tighten the bracket studs to **12 N•m (106 lb in)**.

Engine Block Valley Cover Installation



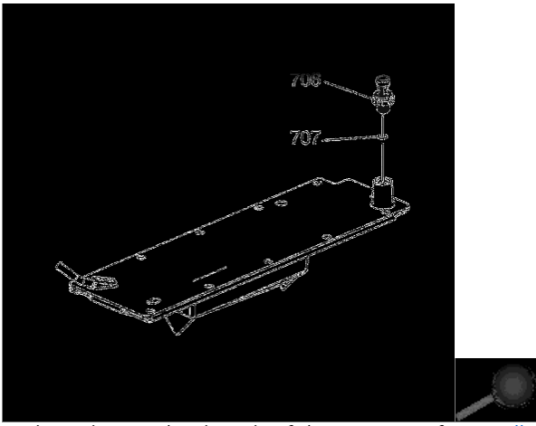
Note: All gasket surfaces should be free of oil or other foreign material during assembly.

1. Lubricate the O-ring seals (537) with clean engine oil.
2. Install the O-ring seals (537) to the cover.



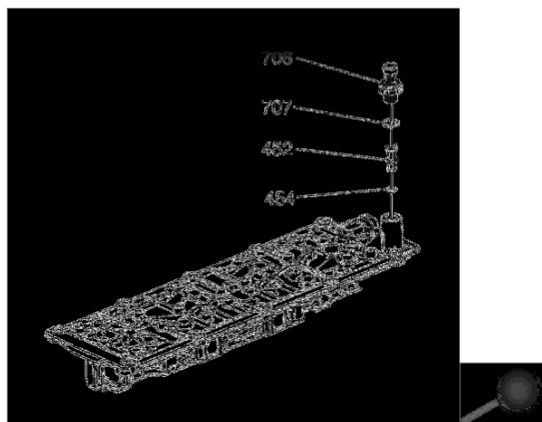
Caution: Refer to [Fastener Caution](#).

3. Install the cover (555), gasket (556), and bolts (506). Tighten the cover bolts to **25 N·m (18 lb ft)**.



4. Apply sealant to the threads of the sensor. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended sealant.
5. Install the oil pressure sensor (706) and sealing washer (707). Tighten the sensor to **35 N•m (26 lb ft)**.

Valve Lifter Oil Filter Installation



Note: Do not allow dirt or debris to enter the oil passages of the manifold. Plug, as required.

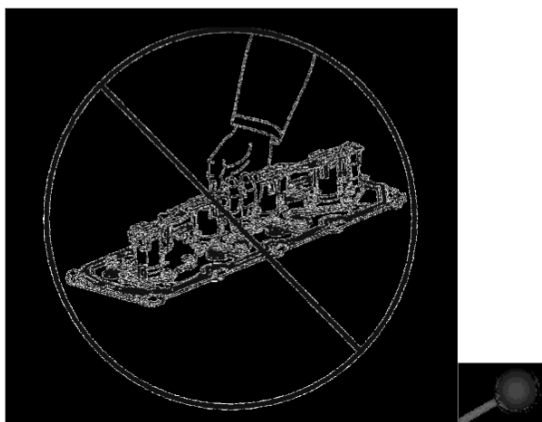
1. Install a NEW oil filter (452) and O-ring (454) assembly.
2. Apply sealant to the threads of the sensor. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended sealant.

Caution: Refer to [Fastener Caution](#).

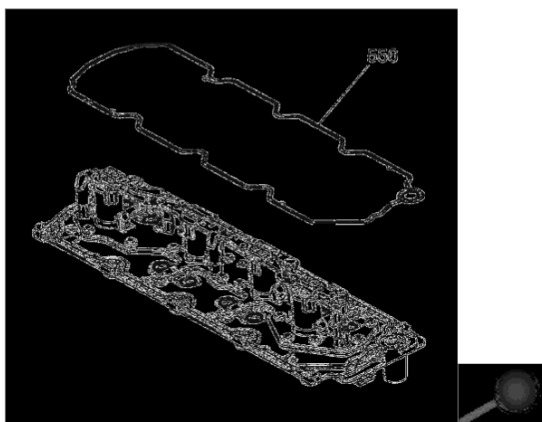
3. Install the oil pressure sensor (706) and washer (707). Tighten the oil pressure sensor to **35 N•m (26 lb ft)**.

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Valve Lifter Oil Manifold Installation



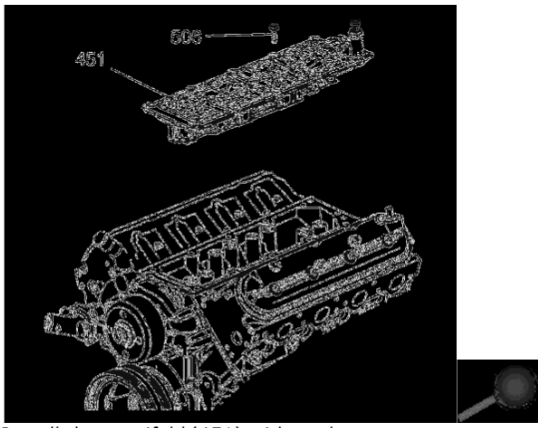
1. Do not lift the manifold assembly by the electrical lead frame.



Note:

- All gasket surfaces should be free of oil or other foreign material during assembly.
- Do not allow dirt or debris to enter the manifold. Plug, as required.

2. Install the service gasket (556) onto the manifold.

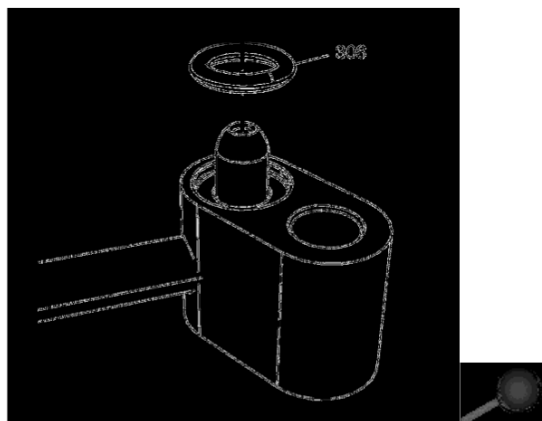


3. Install the manifold (451) with gasket.

Caution: Refer to [Fastener Caution](#).

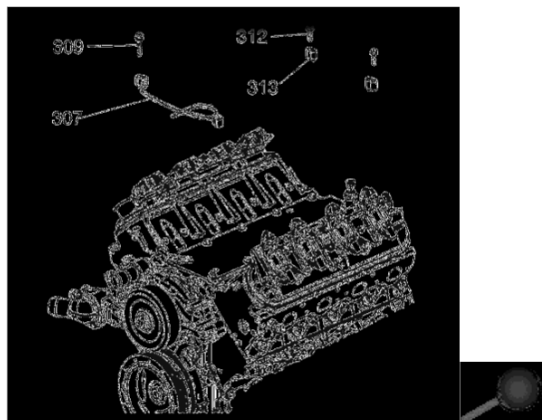
4. Install the manifold bolts (506) and tighten to **25 N·m (18 lb ft)**.

Engine Coolant Air Bleed Pipe and Hole Cover Installation (LS3 or L77)



Note: Position the O-ring seal (308) onto the nipple portion of the pipe.

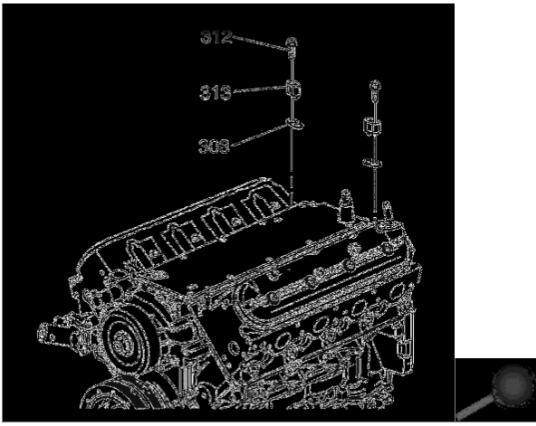
1. Install the seals onto the engine coolant air bleed pipe and covers.



2. Install the pipe (307) and seals (308).

Caution: Refer to [Fastener Caution](#).

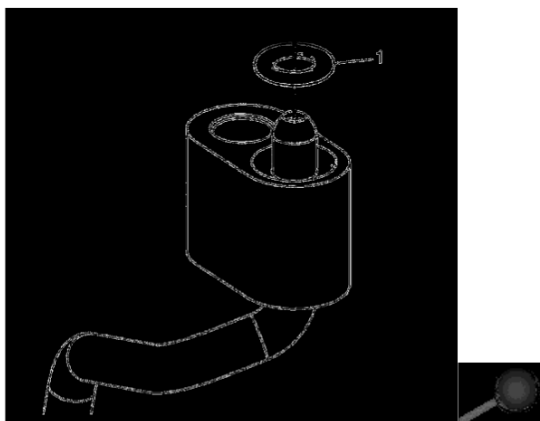
3. Install the bolts (309) and tighten to **12 N•m (106 lb in)**.



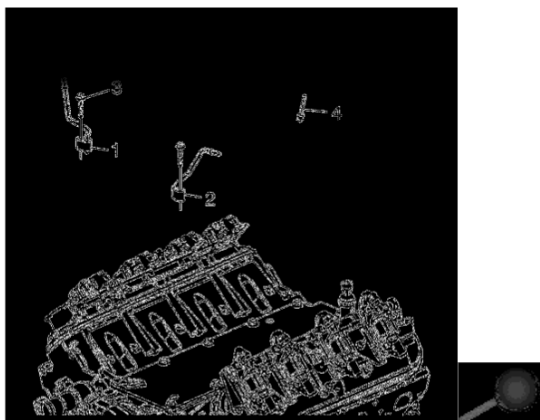
Note: Production engines use a rivet-type plug at the top rear coolant passage of each cylinder head. If service of a leaking plug is required, it is necessary to remove the cylinder head from the engine to properly remove the plug prior to cover installation.

4. Install the covers (313) and seals (308).
5. Install the bolts (312) and tighten to **12 N•m (106 lb in)**.

Engine Coolant Air Bleed Pipe and Hole Cover Installation (LSA)



1. Install the seals (1) onto the engine coolant air bleed pipe.

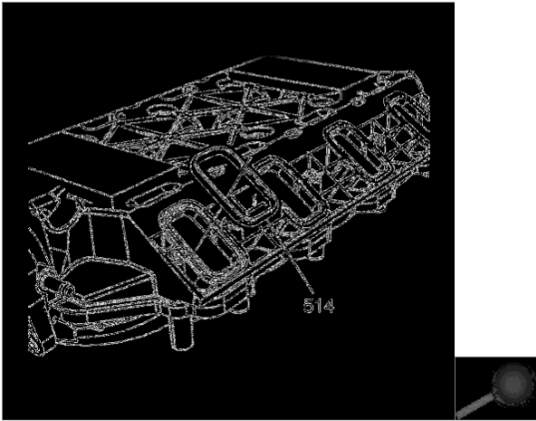


Caution: Refer to [Fastener Caution](#).

Note: Production engines use a rivet-type plug at the top rear coolant passage of each cylinder head. If service of a leaking plug is required, it is necessary to remove the cylinder head from the engine to properly remove the plug. Refer to [Cylinder Head Disassemble](#).

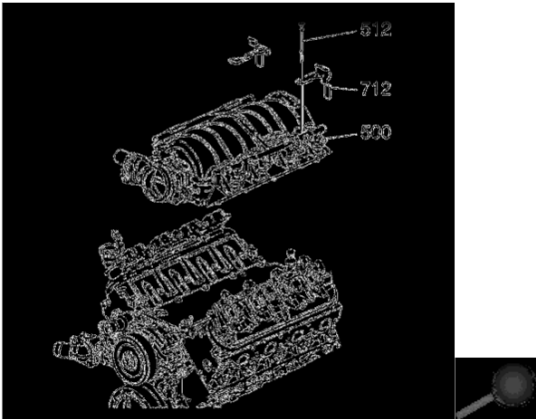
2. Install the pipes (1 and 2) and bolts (3) and tighten to **12 N•m (106 lb in)**.
3. As required, install either a NEW plug (4), or the earlier design coolant air bleed covers, bolts and gaskets. Refer to [Cylinder Head Assemble](#). If required, tighten the cover bolts to **12 N•m (106 lb in)**.

Intake Manifold Installation

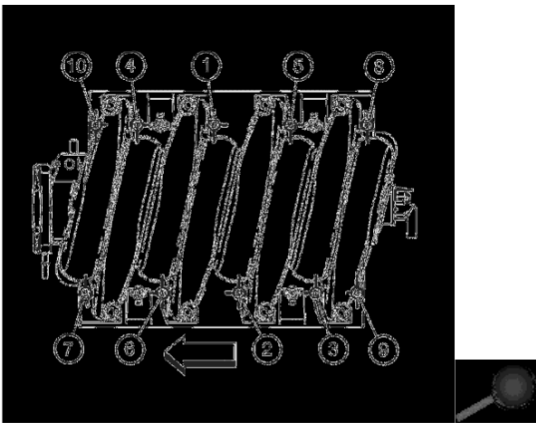
**Note:**

- The intake manifold, throttle body, fuel injection rail, and fuel injectors may be removed as an assembly. If not servicing the individual components, install the intake manifold as a complete assembly.
- DO NOT use the intake manifold gaskets again. Install NEW intake manifold-to-cylinder head gaskets.

1. Install NEW intake manifold-to-cylinder head gaskets (514).



2. Install the intake manifold (500).
3. Apply a **5 mm (0.20 in)** band of threadlock to the threads of the intake manifold bolts (512). Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended threadlock.
4. Install the intake manifold bolts (512) and fuel rail stop brackets (712).

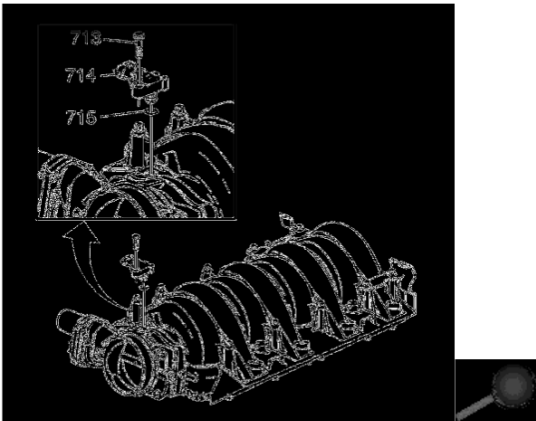


Caution: Refer to [Fastener Caution](#).

5. Tighten the intake manifold bolts.

5.1. Tighten the intake manifold bolts (1-10) a first pass in sequence to **5 N·m (44 lb in)**.

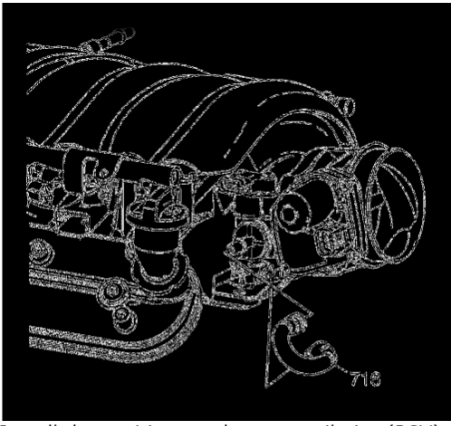
5.2. Tighten the intake manifold bolts (1-10) a final pass in sequence to **10 N·m (89 lb in)**.



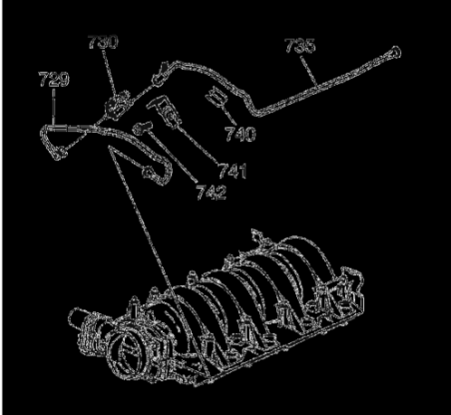
6. Lubricate the manifold absolute pressure (MAP) sensor grommet (715) with clean engine oil.

7. Install the MAP sensor (714) and grommet (715).

8. Install the MAP sensor bolt (713).



9. Install the positive crankcase ventilation (PCV) – dirty air hose (716).
10. Install the PCV – fresh air hose.



11. Install the evaporative emission (EVAP) canister purge solenoid valve (730), bracket (741), and bolt (742). Tighten the bolt to **50N·m (37 lb ft)**.
12. Install the EVAP tubes (729 and 735).
13. Install the fuel rail. Refer to [Fuel Rail and Injectors Installation](#).

Supercharger Installation

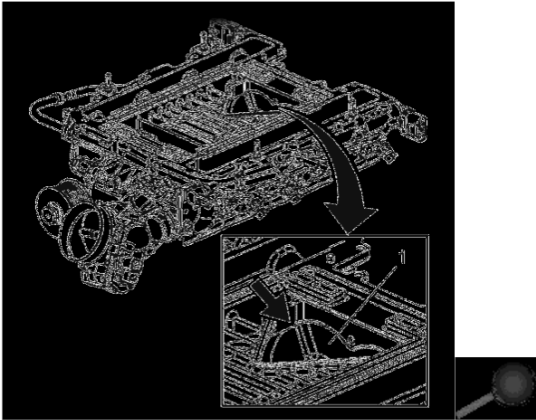
Special Tools

EN 48898 Supercharger Lift Fixture

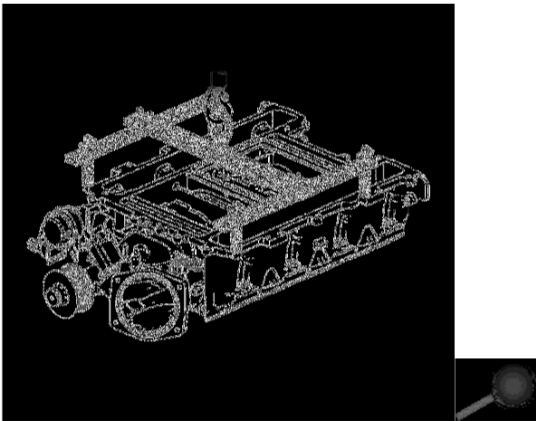
For equivalent regional tools, refer to [Special Tools](#)

Note:

- The supercharger, throttle body, fuel injection rail and fuel injectors may be removed as an assembly. If not servicing the individual components, remove the supercharger as an assembly.
- Cover the rotors area of the supercharger to prevent dirt or debris contamination onto the rotors.

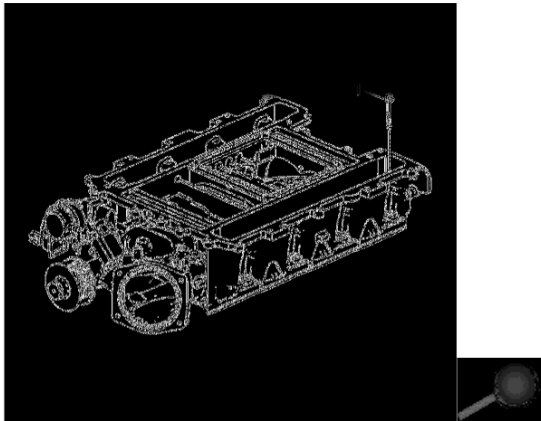


1. Cover the inlet area of the supercharger (1) to prevent dirt or debris contamination onto the rotors.

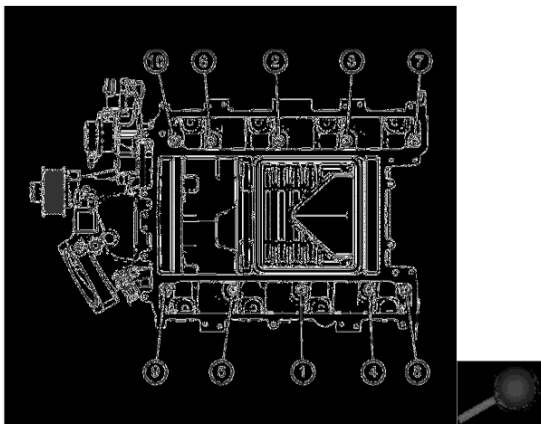


2. Install the EN 48898 fixture to the supercharger.
3. Tighten the EN 48898 fixture bolts and nuts until snug.

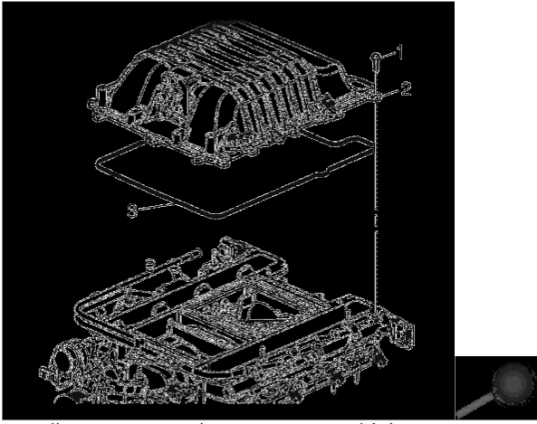
4. Using the lifting device, install the supercharger onto the engine. Align the dowel pin at the right front of the supercharger to the cylinder head.



5. Apply a 5 mm (0.2 in) band of threadlocker GM P/N 12345382 (Canadian P/N 10953489) or equivalent to the threads of the bolts.
6. Install the supercharger bolts (1).

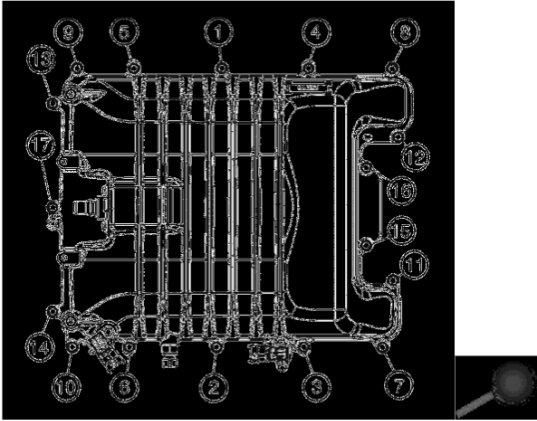


7. Tighten the bolts.
8. Tighten the bolts a first pass in sequence to **5 N·m (44 lb in)**.
9. Tighten the bolts a final pass in sequence to **10 N·m (89 lb in)**.



10. Install a NEW supercharger cover seal (3).

11. Install the supercharger cover bolts (1) and the supercharger cover (2).

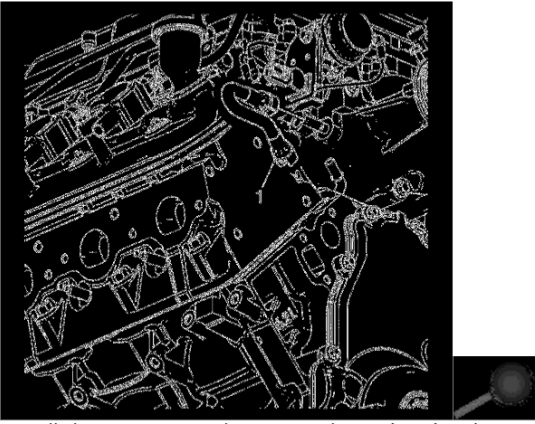


12. Tighten the bolts.

13. Tighten the bolts a first pass in sequence to **5 N·m(44 lb in)**.

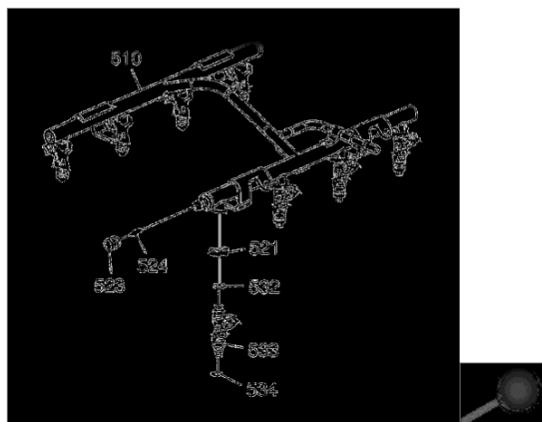
14. Tighten the bolts a final pass in sequence to **10 N·m(89 lb in)**.

15. Install the fuel rail with injectors as required. Refer to [Fuel Rail and Injectors Installation](#).



16. Install the positive crankcase ventilation (PCV) – dirty air hose (1) to the valley cover and supercharger.

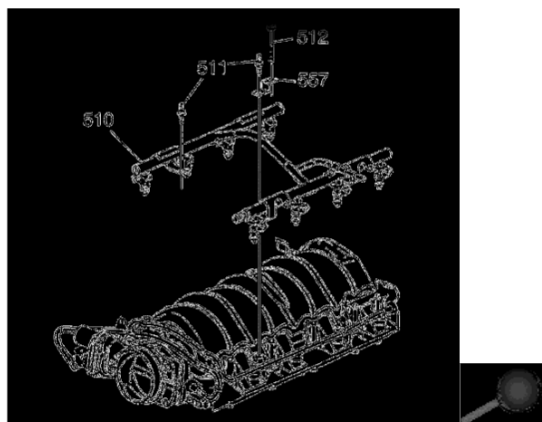
Fuel Rail and Injectors Installation



Warning: Refer to [Fuel Rail Stop Bracket Installation Warning](#).

Note: DO NOT use the fuel injector O-ring seals again. Install NEW fuel injector O-ring seals during assembly.

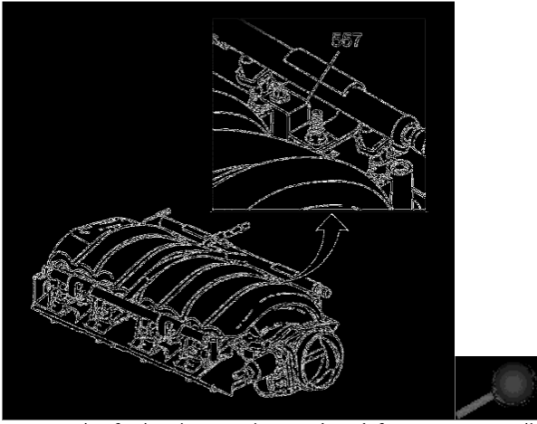
1. Lubricate the NEW fuel injector O-ring seals (532 and 534) with clean engine oil.
2. Install the O-ring seals to the fuel injectors.
3. Install the fuel injectors (533) and retainers (521).



4. Install the fuel rail assembly (510) to the manifold. Push firmly on both sides of the rail until all injectors have entered their bores.
5. Apply a **5 mm (0.2 in)** band of threadlock to the threads of the fuel rail bolts. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended threadlock.

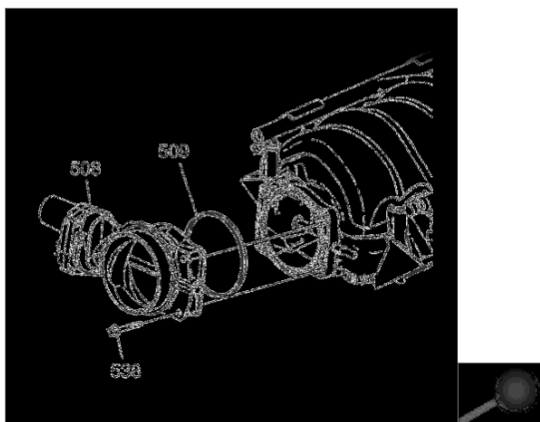
Caution: Refer to [Fastener Caution](#).

6. Install the fuel rail bolts (511 and 512) and fuel rail ground strap (557). Tighten the fuel rail bolts to **10N·m (89 lb in)**.



7. Inspect the fuel rail ground strap (557) for proper installation.

Throttle Body Assembly Installation (LS3 or L77)



Note: DO NOT use the throttle body gasket again. Install a NEW gasket during assembly.

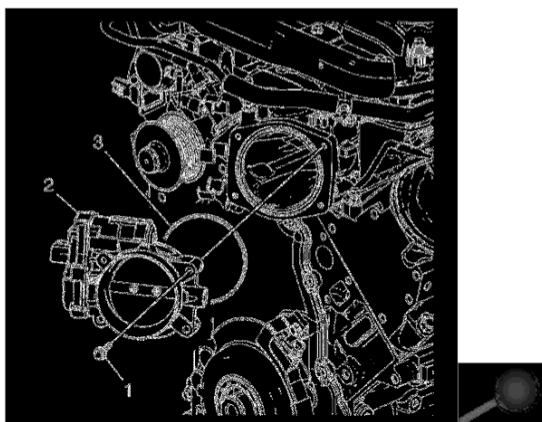
1. Install the throttle body gasket (509) to the intake manifold. Align the locating tab of the gasket with the notch in the manifold.

Caution: Refer to [Fastener Caution](#).

2. Install the throttle body (508) and bolts (538). Tighten the throttle body bolts to **10 N•m (89 lb in)**.

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Throttle Body Assembly Installation (LSA)



Note: DO NOT use the throttle body gasket again. Install a NEW gasket during assembly.

1. Install the throttle body gasket (3) to the supercharger.

Caution: Refer to [Fastener Caution](#).

2. Install the throttle body (2) and bolts (1) and tighten to **10N•m (89 lb in)**.

Water Pump Installation

Caution: DO NOT use cooling system seal tabs, or similar compounds, unless otherwise instructed. The use of cooling system seal tabs, or similar compounds, may restrict coolant flow through the passages of the cooling system or the engine components. Restricted coolant flow may cause engine overheating and/or damage to the cooling system or the engine components/assembly.

Note: Ensure all mating surfaces are clean and free of grease.

1. Insert two water pump to engine retaining bolts (1) at each end of the water pump (2), place the new gasket on the bolts and use this as a guide to install the water pump (2).
2. Install the water pump (2).

Caution: Refer to [Fastener Caution](#).

3. Install and tighten the remaining water pump to engine retaining bolts (1).

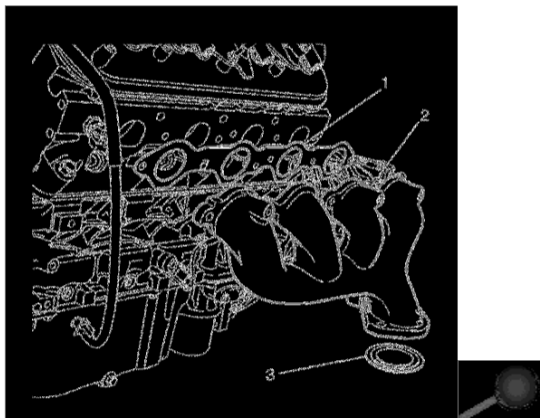
Tighten

- Tighten the bolts at first pass to 15 N•m (11 lb ft).
- Tighten the bolts at final pass to 30 N•m (22 lb ft).

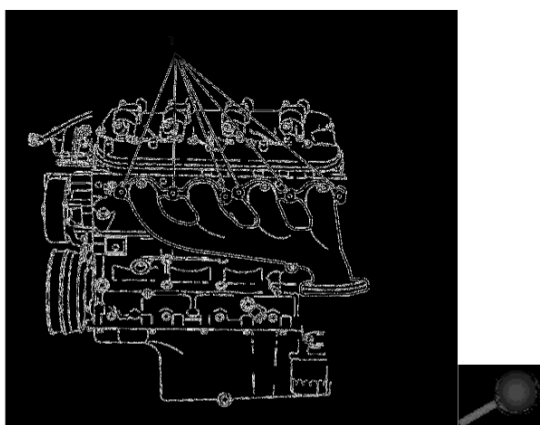
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Exhaust Manifold Installation - Left Side (Except HSV)

Warning: Refer to [Hot Exhaust System Warning](#).



1. Install the exhaust manifold (2), NEW exhaust manifold gasket (1) and sealing ring (3).



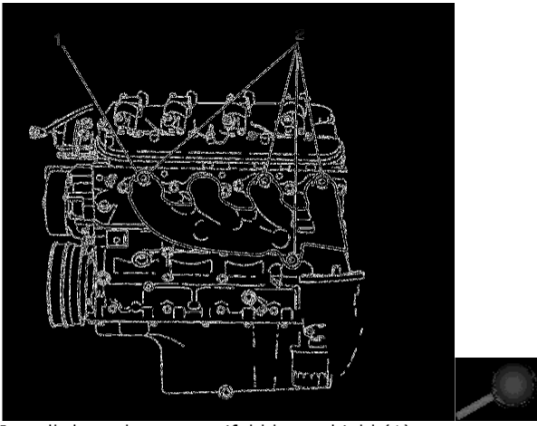
2. Apply a 5 mm (0.2 in) wide band of threadlock, or equivalent, to the threads of the exhaust manifold to cylinder head retaining bolts (1). Refer to [Adhesives, Fluids, Lubricants, and Sealers](#).

Caution: Refer to [Fastener Caution](#).

3. Install the exhaust manifold to cylinder head retaining bolts (1).

Tighten

- First Pass: Tighten the bolts to 15 N·m (11 lb ft). Tighten the exhaust manifold bolts beginning with the centre 2 bolts. Alternate from side-to-side, and work toward the outside bolts.
 - Final Pass: Tighten the bolts to 20 N·m (15 lb ft). Tighten the exhaust manifold bolts beginning with the centre 2 bolts. Alternate from side-to-side, and work toward the outside bolts.
4. Using a flat punch, bend over the exposed edge of the exhaust manifold gasket at the rear of the left cylinder head.



5. Install the exhaust manifold heat shield (1).
6. Install the exhaust manifold heat shield to exhaust manifold retaining bolts (2).

Tighten

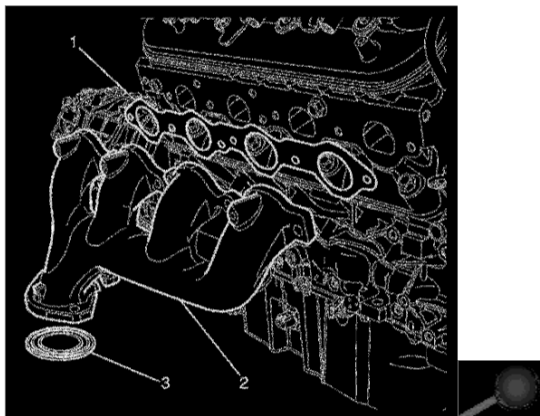
Tighten the bolts to 10 N·m (89 lb in).

Note: Only apply dielectric grease to the spark plug side of the spark plug wire boot.

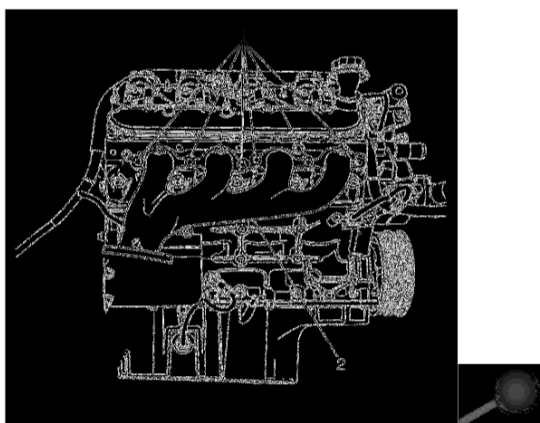
7. Inspect the inside of the spark plug wire boot for a thin, even coat of grease. If there is no grease present or additional grease is necessary, complete the following procedure:
 - 7.1. Apply a thin coating of dielectric grease evenly to the inside of the spark plug wire boot, up to a depth of 15 mm from the end of the boot. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#).
 - 7.2. Remove any excess grease from around the end of the boot, and ensure there is not an excessive amount within the boot.
8. Install the spark plug wires onto the spark plugs.

Exhaust Manifold Installation - Right Side (Except HSV)

Warning: Refer to [Hot Exhaust System Warning](#).



1. Install NEW exhaust manifold gasket (1) and NEW sealing ring (3) to the exhaust manifold (2).
2. Install the exhaust manifold assembly to engine.



Note: Do not fully tighten the exhaust manifold to cylinder head retaining bolts (1) at this stage.

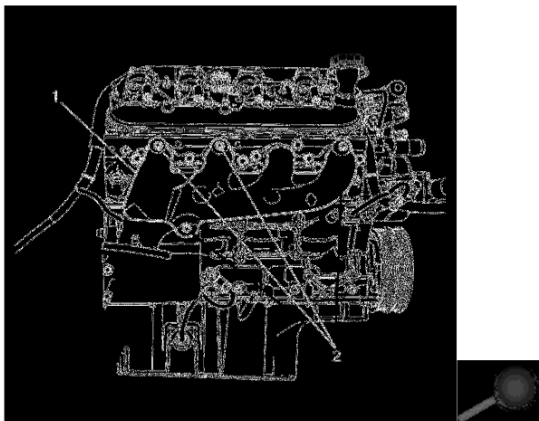
3. Install the NEW exhaust manifold to cylinder head retaining bolts (1).

Caution: Refer to [Fastener Caution](#).

4. Tighten the exhaust manifold to cylinder head retaining bolts (1) working from the centre to the outside.

Tighten

- First Pass: Tighten the bolts to 15N·m (11 lb ft). Tighten the exhaust manifold bolts beginning with the centre 2 bolts. Alternate from side-to-side, and work toward the outside bolts.
- Final Pass: Tighten the bolts to 20N·m (15 lb ft). Tighten the exhaust manifold bolts beginning with the centre 2 bolts. Alternate from side-to-side, and work toward the outside bolts.



5. Install the exhaust manifold heat shield (1).
6. Install the exhaust manifold heat shield to exhaust manifold retaining bolts (2).

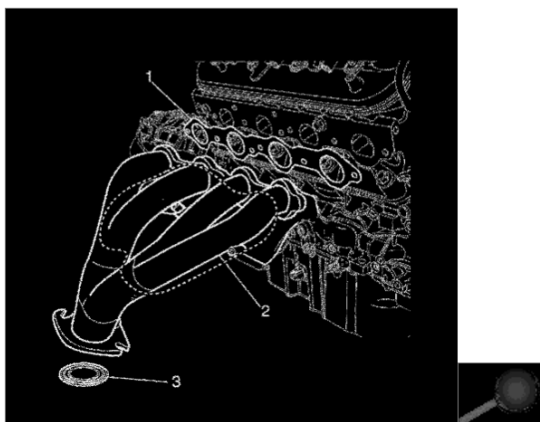
Tighten

Tighten the bolts to 10 N·m (89 lb in).

Note: Only apply dielectric grease to the spark plug side of the spark plug wire boot.

7. Inspect the inside of the spark plug wire boot for a thin, even coat of grease. If there is no grease present or additional grease is necessary, complete the following procedure:
 - 7.1. Apply a thin coating of dielectric grease evenly to the inside of the spark plug wire boot, up to a depth of 15 mm from the end of the boot. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#).
 - 7.2. Remove any excess grease from around the end of the boot, and ensure there is not an excessive amount within the boot.
8. Install the spark plug wires onto the spark plugs.

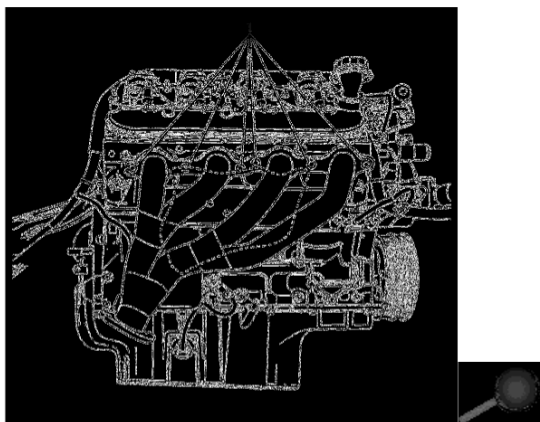
Exhaust Manifold Installation - Right Side (HSV)



1. Install a NEW exhaust manifold gasket (1) and a NEW sealing ring (3) onto the exhaust manifold (2).

Caution: Refer to [Exhaust System Inspection Caution](#).

2. Install the exhaust manifold assembly to engine.



Note: Do not fully tighten the exhaust manifold to cylinder head retaining bolts (1) at this stage.

3. Install the NEW exhaust manifold to cylinder head retaining bolts (1).
Do not fully tighten at this stage.

4. Clean the threads of the exhaust manifold to catalytic converter retaining studs with a suitable cleaning solvent.

Caution: Refer to [Fastener Caution](#).

5. Tighten the exhaust manifold to cylinder head retaining bolts (1) working from the centre to the outside.

Tighten

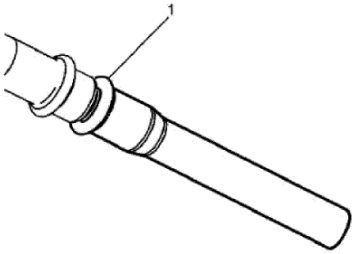
Tighten the bolts to 20 Nm (15 lb ft).

Note: Only apply dielectric grease to the spark plug side of the spark plug wire boot.

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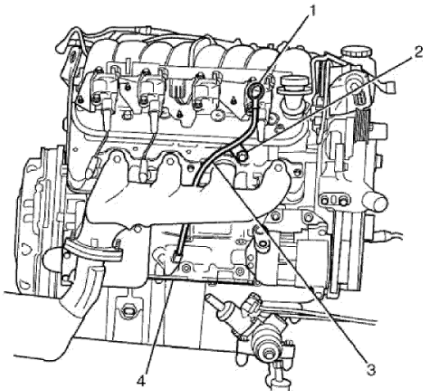
6. Inspect the inside of the spark plug wire boot for a thin, even coat of grease. If there is no grease present or additional grease is necessary, complete the following procedure:
 - 6.1. Apply a thin coating of dielectric grease evenly to the inside of the spark plug wire boot, up to a depth of 15 mm from the end of the boot. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#).
 - 6.2. Remove any excess grease from around the end of the boot, and ensure there is not an excessive amount within the boot.
7. Install the spark plug wires onto the spark plugs.

Oil Level Indicator and Tube Installation



Note: Inspect the O-ring seal (1) for wear or damage. Replace as necessary.

1. Lubricate the O-ring seal (1) with clean engine oil.
2. Install the O-ring seal (1) onto the oil level indicator tube (2).



Note: Make sure the oil level indicator tube (3) seats securely into the engine block (4).

3. Install the oil level indicator tube (3) into the engine block (4).

Caution: Refer to [Fastener Caution](#).

4. Install the oil level indicator tube to cylinder head retaining bolt (2).

Tighten

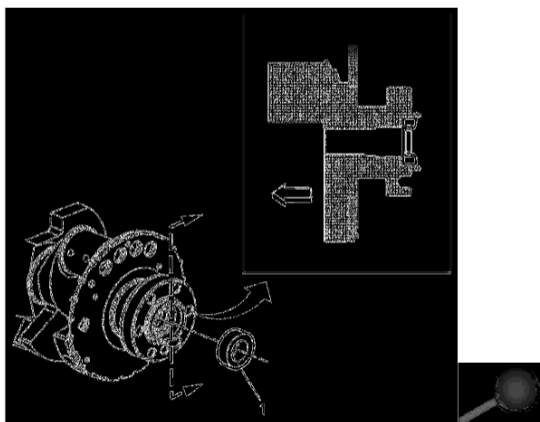
Tighten the bolt to 25 N·m (18 lb ft).

5. Install the oil level indicator (1) into the oil level indicator tube (2).
6. Install the number 4 cylinder spark plug wire. Refer to [Spark Plug Wire Replacement](#).

Clutch Pilot Bearing Installation

Tools Required

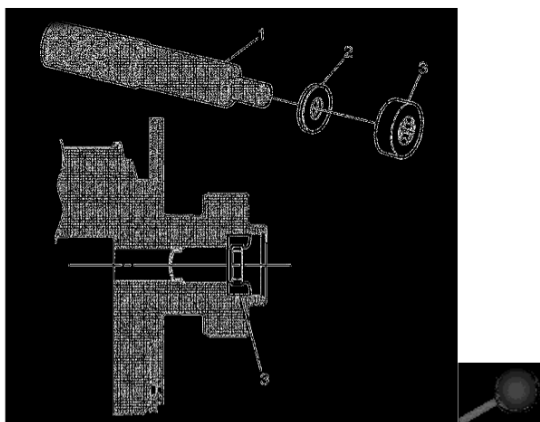
J 38836 Bushing Installer and Clutch Arbor



Important: Make sure that the crankshaft rear oil gallery plug (1) is not a loose fit, damaged or leaking.

Important: The correct depth (a) for the oil gallery plug is 31.2 to 31.6 mm.

1. Apply sealant LOCTITE R 242 and install it to the correct depth. If replacing the oil gallery plug (1).



Important: Use a 5/8 inch flat washer (2) against the tool to support the bearing races.

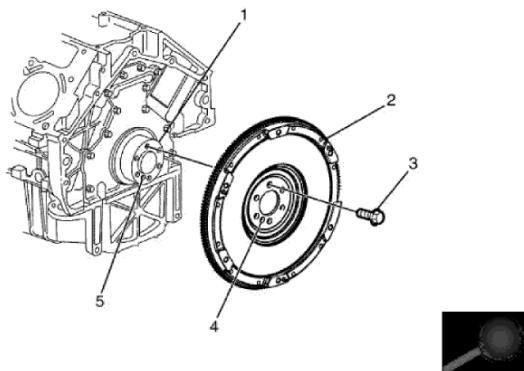
Important: When installed correctly the bearing should be flush with the crankshaft counter-bore.

2. Install the clutch pilot bearing (3) to the rear of the crankshaft, using J 38836 bushing installer and clutch arbor (1).

Engine Flywheel Installation (LS3 or L77)

Special Tools

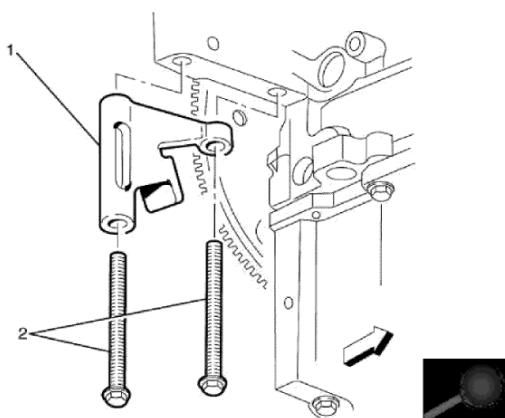
J 42386-A Flywheel Holding Tool



1. Install the engine flywheel (2) to the crankshaft (1).
2. Align the alignment hole on the engine flywheel (4) with the alignment hole on the crankshaft (5).

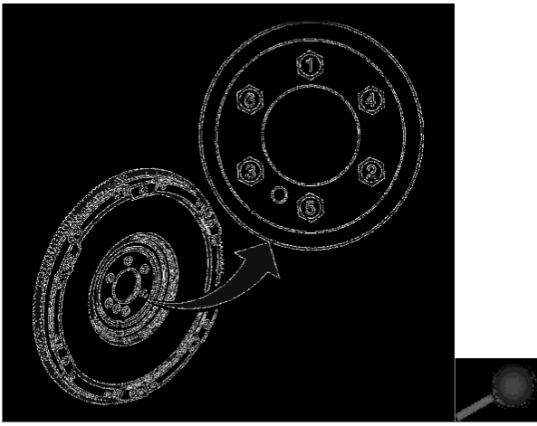
Note: Do not tighten at this stage.

3. Install the NEW engine flywheel to crankshaft retaining bolts (3).



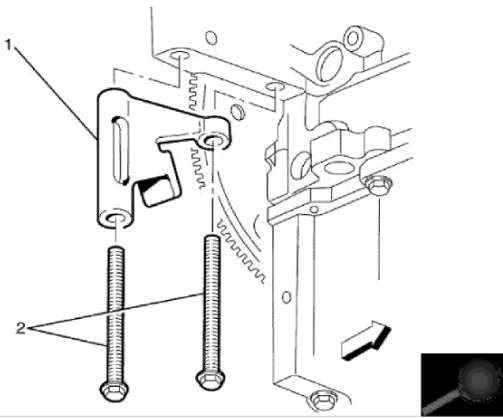
Note: Make sure the J 42386-A flywheel holding tool (1) engages securely with the ring gear teeth.

4. Install the J 42386-A flywheel holding tool (1) using the two starter motor to engine block retaining bolts (2).



Caution: Refer to [Fastener Caution](#).

5. Tighten the engine flywheel to crankshaft retaining bolts (1) in sequence from 1 to 6.
 - 5.1. Tighten the bolts a first pass in sequence to **20 N·m (15 lb ft)**.
 - 5.2. Tighten the bolts a second pass in sequence to **50 N·m (37 lb ft)**.
 - 5.3. Tighten the bolts a final pass in sequence to **100 N·m (74 lb ft)**.



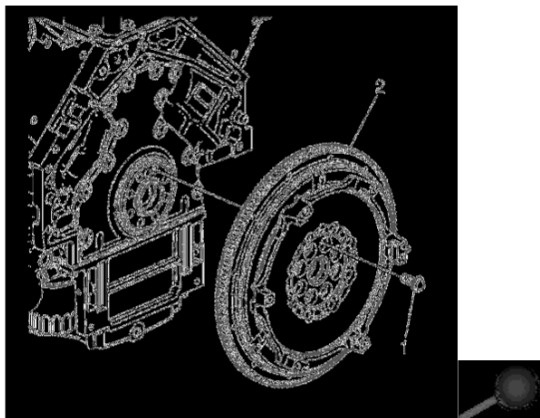
6. Remove the starter motor to engine block retaining bolts (2).
7. Remove the J 42386-A flywheel holding tool (1).

Engine Flywheel Installation (LSA)

Special Tools

J-42386-A Flywheel Holding Tool

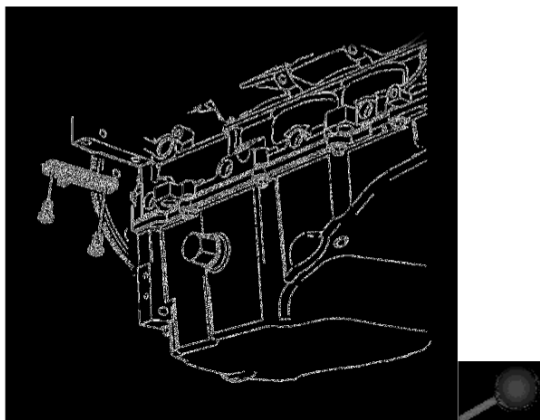
For equivalent regional tools, refer to [Special Tools](#).



Caution: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

Note: The flywheel does not use a locating pin for alignment and will not initially seat against the crankshaft flange, but will be pulled onto the crankshaft by the engine flywheel bolts.

1. Install the flywheel (2) to the crankshaft.
2. Apply threadlocker to the threads of the flywheel bolts (1). Refer to [Adhesives, Fluids, Lubricants, and Sealers](#).
3. Install and hand tighten the NEW flywheel bolts (1).



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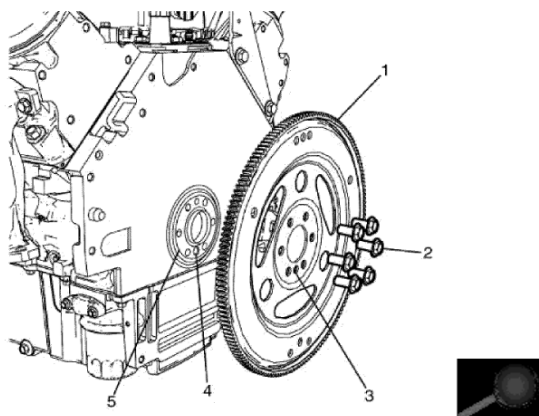
Caution: Refer to [Fastener Caution](#).

4. Install the J-42386-A flywheel holding tool and bolts.
Use 1 M10 –1.5 x 120 mm and 1 M10 –1.5 x 45 mm bolt for proper tool operation.
Tighten the J-42386-A flywheel holding tool and bolts to **50 N•m (37 lb ft)**.
5. Tighten the flywheel bolts (1).
 - 5.1. Tighten the bolts a first pass to **50 N•m (37 lb ft)**.
 - 5.2. Tighten the bolts a final pass an additional **45 degrees**.
6. Remove the J-42386-A flywheel holding tool

Automatic Transmission Flex Plate Installation

Special Tools

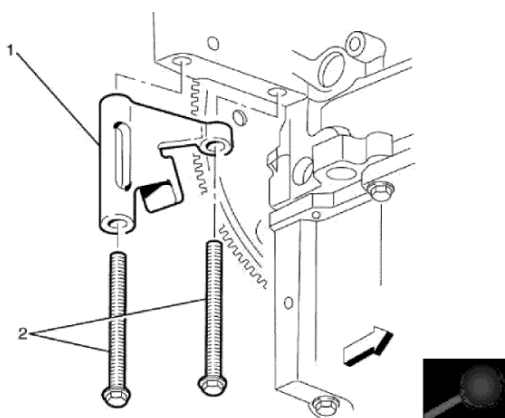
J 42386-A Flywheel Holding Tool.



1. Install the automatic transmission flex plate (1) to the crankshaft (5).
2. Align the alignment hole on the automatic transmission flex plate (3) with the alignment hole in the crankshaft (4).

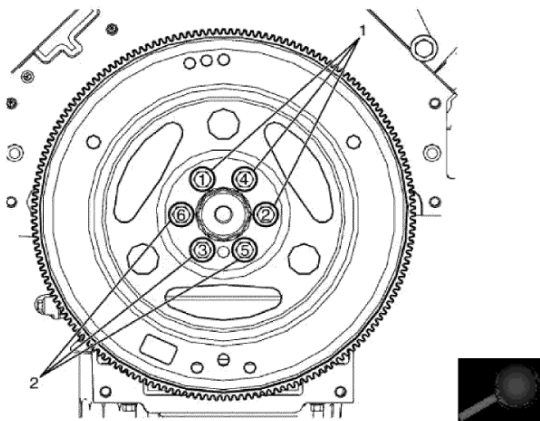
Note: Do not tighten at this stage.

3. Install the NEW automatic transmission flex plate to crankshaft retaining bolts (2).



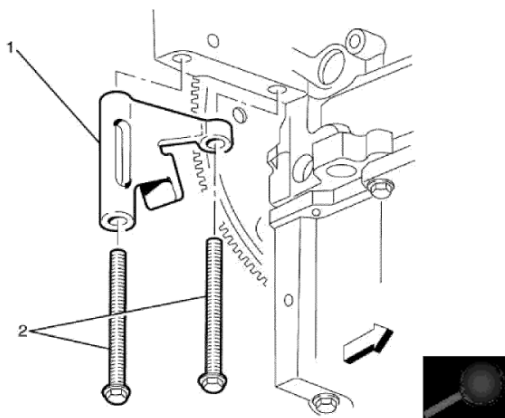
Note: Make sure the J 42386-A flywheel holding tool (1) engages securely with the ring gear teeth.

4. Install the J 42386-A flywheel holding tool (1) using the two starter motor to engine block retaining bolts (2).



Caution: Refer to [Fastener Caution](#).

5. Tighten the automatic transmission flex plate to crankshaft retaining bolts (1) in sequence from 1 to 6.
 - 5.1. Tighten the bolts (1 - 6) a first pass in sequence to **20 N·m (15 lb ft)**.
 - 5.2. Tighten the bolts (1 - 6) a second pass in sequence to **50 N·m (37 lb ft)**.
 - 5.3. Tighten the bolts (1 - 6) a final pass in sequence to **100 N·m (74 lb ft)**.



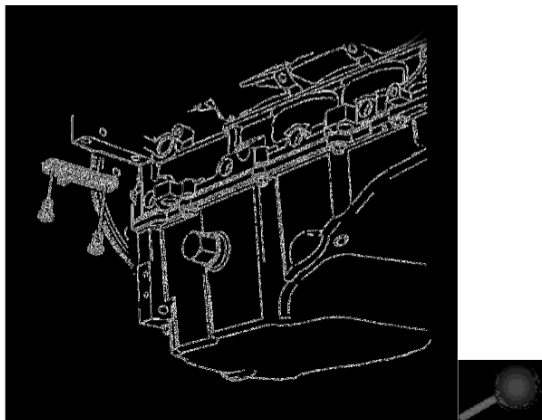
6. Remove the starter motor to engine block retaining bolts (2).
7. Remove the J 42386-A flywheel holding tool (1).

Crankshaft Balancer Installation (LSA)

Special Tools

- J41478 Crankshaft Front Oil Seal Installer
- J41665 Crankshaft Balancer and Sprocket Installer
- J42386-A Flywheel Holding Tool
- J45059 Angle Meter

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



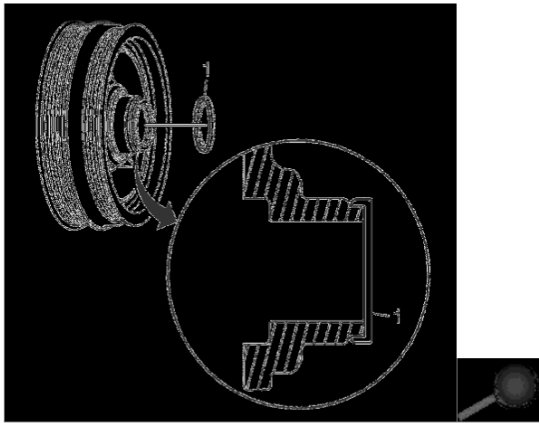
Caution: Refer to [Fastener Caution](#).

Note:

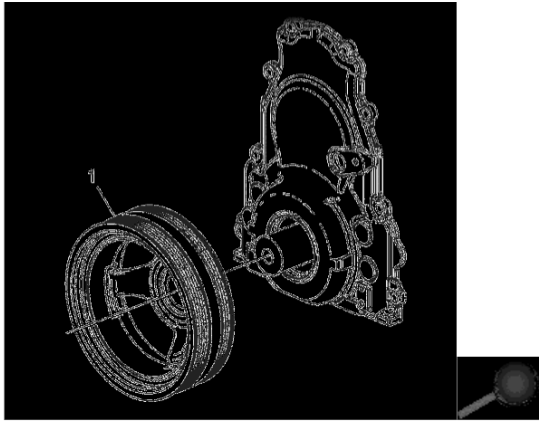
- Ensure the teeth of the tool engage the engine flywheel teeth.
- The used crankshaft balancer bolt is used only during the installation procedure. Install a NEW crankshaft balancer bolt during final assembly.

1. Install the J42386-A holding tool and bolts.

Use 1 M10 – 1.5 x 120 mm and 1 M10 – 1.5 x 45 mm bolt for proper tool operation. Tighten the J42386-A holding tool bolts to **50N·m (37 lb ft)**.

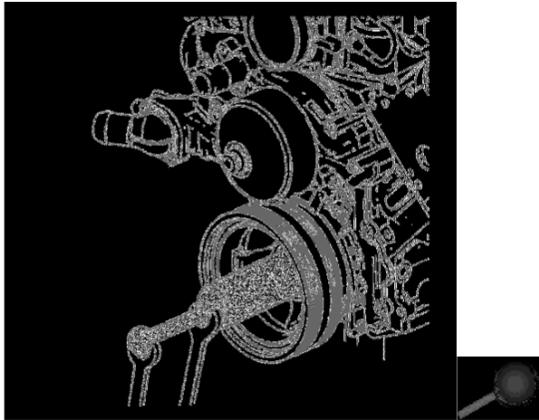


2. Install the crankshaft balancer washer (1) onto the crankshaft balancer.



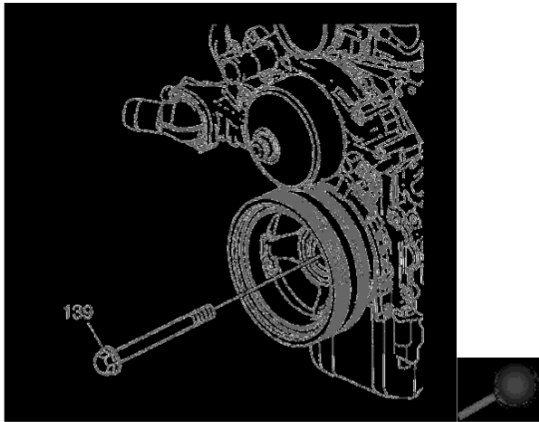
Note: The balancer should be positioned onto the end of the crankshaft as straight as possible prior to tool installation.

3. Position the balancer (1) and washer onto the end of the crankshaft.

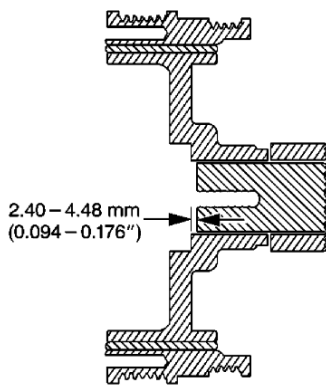


4. Use the J41665 balancer and sprocket installer and the J41478 oil seal installer in order to install the balancer.

- 4.1. Assemble the *J41478* oil seal installer threaded rod, nut, washer and the *J41665* balancer and sprocket installer.
Insert the smaller end of the installer into the front of the balancer.
- 4.2. Use a wrench and hold the hex end of the threaded rod.
- 4.3. Use a second wrench and rotate the installation tool nut clockwise until the balancer is started onto the crankshaft.
- 4.4. Remove and reverse the installation tool.
Position the larger end of the installer against the front of the balancer.
- 4.5. Use a wrench and hold the hex end of the threaded rod.
- 4.6. Use a second wrench and rotate the installation tool nut clockwise until the balancer is installed onto the crankshaft.
- 4.7. Remove the balancer installation tools.

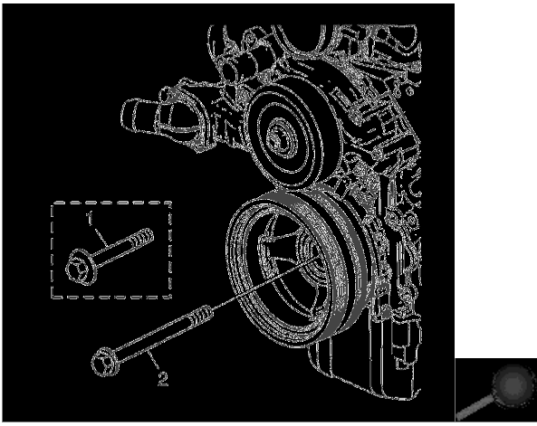


5. Install the used crankshaft balancer bolt (139) and tighten to **330N·m (240 lb ft)** to fully seat the balancer.
6. Remove the used crankshaft balancer bolt.



Note: The nose of the crankshaft should be recessed **2.4–4.48 mm (0.094–0.176 in)** into the balancer bore.

7. Measure for a correctly installed balancer.
If the balancer is not installed to the proper dimensions, install the *J41665* balancer and sprocket installer and repeat the installation procedure.



Note: There are two crankshaft balancer bolt designs, one has a flanged head, no washer, and the other has a retained rotating washer. There are two different torque specifications for the final pass; the final torque angle is dependent on the bolt design.

8. Install the NEW crankshaft balancer bolt.

8.1. Tighten the crankshaft balancer bolt to **150 N·m (110 lb ft)**.

8.2. Loosen the crankshaft balancer bolt **360 degrees**.

8.3. Tighten the crankshaft balancer bolt to **80 N·m (59 lb ft)**.

8.4. Tighten the crankshaft balancer bolt a final pass to:

- Balancer bolt with flanged head (1) tighten to **125 degrees** using the *J45059* angle meter.
- Balancer bolt with retained rotating washer (2) tighten to **200 degrees** using the *J45059* angle meter.

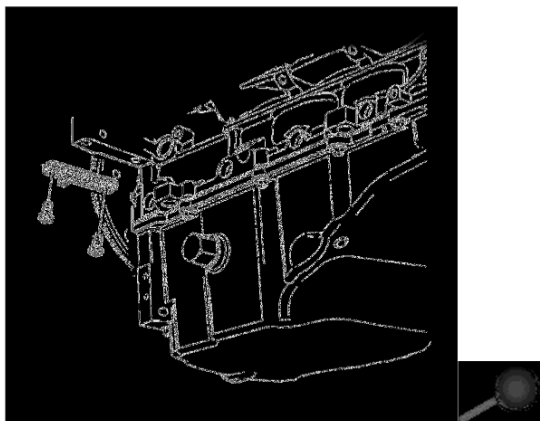
9. Remove the *J42386-A* holding tool.

Crankshaft Balancer Installation (L77)

Special Tools

- J 41478 Crankshaft Front Oil Seal Installer
- J 41665 Crankshaft Balancer and Sprocket Installer
- J 42386-A Flywheel Holding Tool
- J 45059 Angle Meter

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

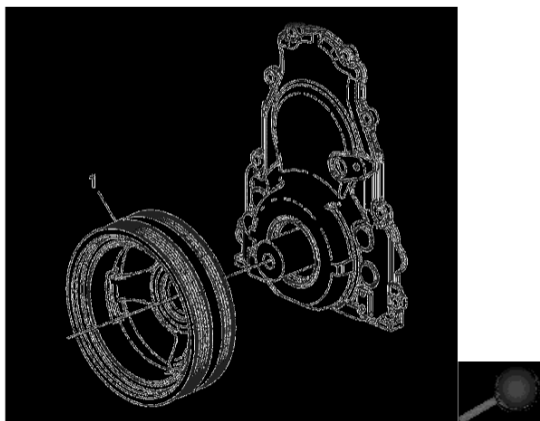


Caution: Refer to [Fastener Caution](#).

Note: The used crankshaft balancer bolt is used only during the installation procedure. Install a NEW crankshaft balancer bolt during final assembly.

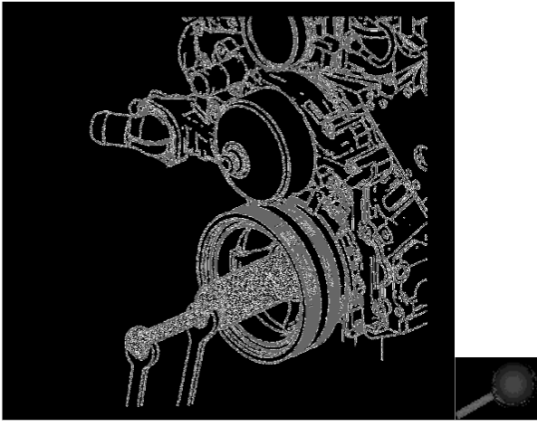
1. Install the J 42386-A holding tool and bolts.

Use 1 M10 – 1.5 x 120 mm and 1 M10 – 1.5 x 45 mm bolt for proper tool operation. Tighten the J 42386-A holding tool bolts to **50N·m (37 lb ft)**.

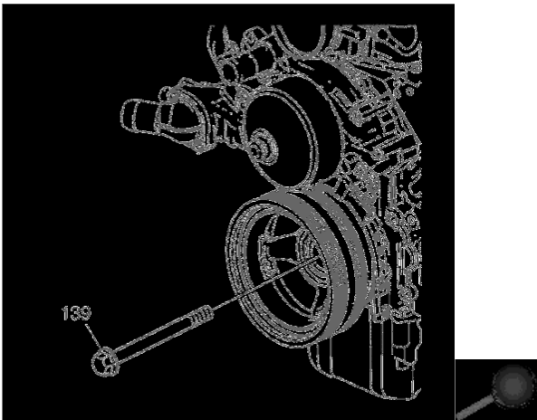


Note: The balancer should be positioned onto the end of the crankshaft as straight as possible prior to tool installation.

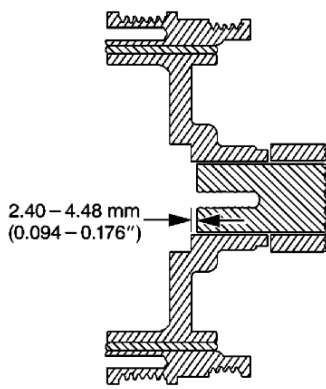
2. Position the balancer (1) onto the end of the crankshaft.



3. Use the J 41665 installer and the J 41478 seal installer in order to install the balancer.
 - 3.1. Assemble the J 41478 seal installer threaded rod, nut, washer and the J 41665 installer .
Insert the smaller end of the installer into the front of the balancer.
 - 3.2. Use a wrench and hold the hex end of the threaded rod.
 - 3.3. Use a second wrench and rotate the installation tool nut clockwise until the balancer is started onto the crankshaft.
 - 3.4. Remove and reverse the installation tool.
Position the larger end of the installer against the front of the balancer.
 - 3.5. Use a wrench and hold the hex end of the threaded rod.
 - 3.6. Use a second wrench and rotate the installation tool nut clockwise until the balancer is installed onto the crankshaft.
 - 3.7. Remove the balancer installation tools.



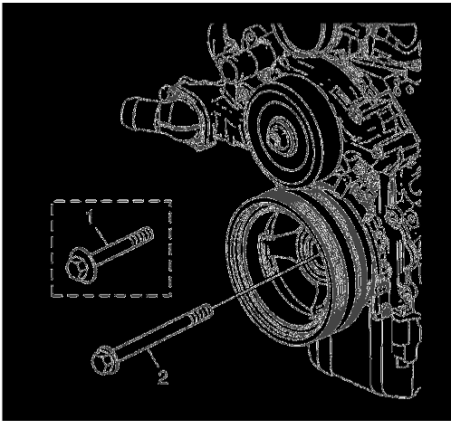
4. Install the used crankshaft balancer bolt (139) and tighten to **330N•m (240 lb ft)**.
5. Remove the used crankshaft balancer bolt.



Note: The nose of the crankshaft should be recessed **2.4–4.48 mm (0.094–0.176 in)** into the balancer bore.

6. Measure for a correctly installed balancer.

If the balancer is not installed to the proper dimensions, install the *J 41665* installer and repeat the installation procedure.



Note: There are two crankshaft balancer bolt designs, one has a flanged head, no washer, and the other has a retained rotating washer. There are two different torque specifications for the final pass; the final torque angle is dependent on the bolt design.

7. Install the NEW crankshaft balancer bolt.

7.1. Tighten the crankshaft balancer bolt to **150 N·m (110 lb ft)**.

7.2. Loosen the crankshaft balancer bolt **360 degrees**.

7.3. Tighten the crankshaft balancer bolt to **80 N·m (59 lb ft)**.

7.4. Tighten the crankshaft balancer bolt a final pass

- Balancer bolt with flanged head (1) tighten to **125 degrees** using the *J 45059* angle meter .
- Balancer bolt with retained rotating washer (2) tighten to **200 degrees** using the *J 45059* angle meter .

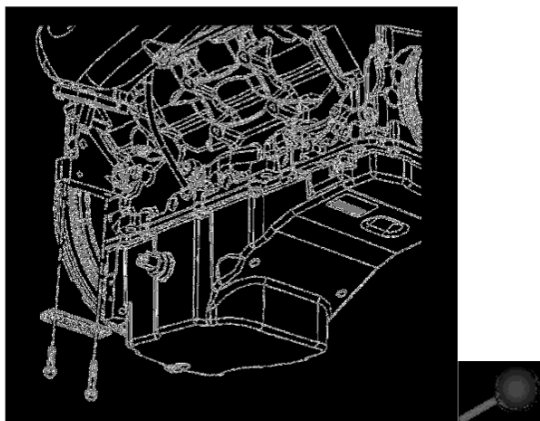
8. Remove the *J 42386-A* holding tool .

Crankshaft Balancer Installation (LS3)

Special Tools

- J 41478 Crankshaft Front Oil Seal Installer
- J 41665 Crankshaft Balancer and Sprocket Installer
- J 42386-A Flywheel Holding Tool
- J 45059 Angle Meter

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



cardiagn.com

Caution: Refer to [Fastener Caution](#).

Note:

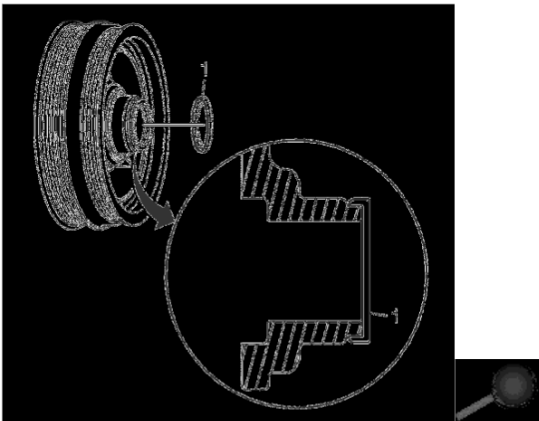
- For manual transmission applications, note the position of the crankshaft balancer before removal. The balancer does not use a key or keyway for positioning. Mark or scribe the end of the crankshaft and the balancer before removal. The crankshaft balancer must be installed to the original position. If replacing the crankshaft balancer, note the location of any existing balance weights, if applicable. Install new balance weights into the new crankshaft balancer, if applicable. Crankshaft balance weights must be installed into the new balancer in the same location as the old balancer. A properly installed balance weight will be either flush or below flush with the face of the balancer.
- The crankshaft balancer installation and bolt tightening involves a 4 stage tightening process. The first pass ensures that the balancer is installed completely onto the crankshaft. The second, third and fourth passes tighten the NEW bolt to the proper torque.

1. Install the J 42386-A holding tool and bolts.

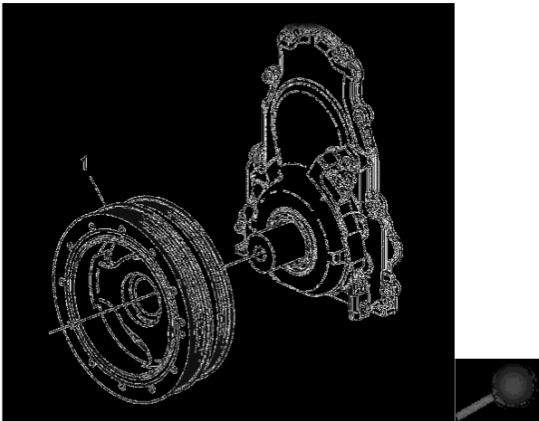
Use 1 M10 – 1.5 x 120 mm and 1 M10 – 1.5 x 45 mm bolt for proper tool operation. Tighten the J 42386-A holding tool bolts to **50N•m (37 lb ft)**.



2. Using the old balancer as a reference, mark or scribe the new balancer in the same location, if applicable.
3. Install balance weights into the new balancer, if applicable. Refer to [Engine Balancing](#) and [Crankshaft Balancer Cleaning and Inspection](#).

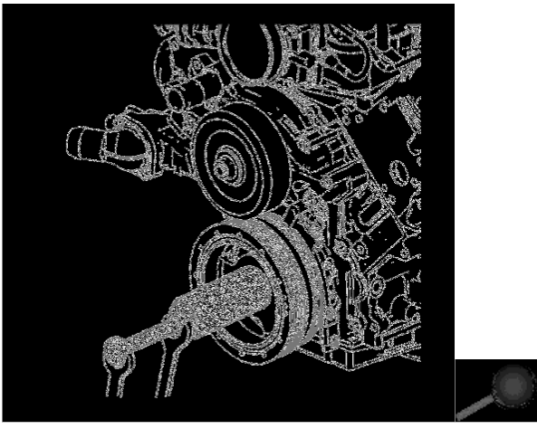


4. Install the crankshaft balancer washer (1) onto the crankshaft balancer.



Note: The balancer should be positioned onto the end of the crankshaft as straight as possible prior to tool installation.

5. Position the balancer (1) onto the end of the crankshaft.



6. Use the J 41665 installer and the J 41478 installer in order to install the balancer.

- 6.1. Assemble the J 41478 installer threaded rod, nut, washer, and the J 41665 installer installer.

Insert the smaller end of the installer into the front of the balancer.

- 6.2. Use a wrench and hold the hex end of the threaded rod.

- 6.3. Use a second wrench and rotate the installation tool nut clockwise until the balancer is started onto the crankshaft.

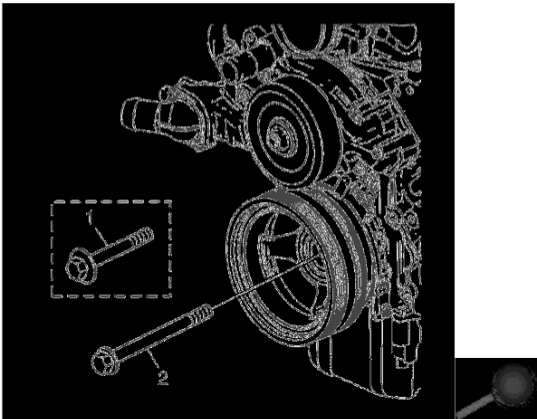
- 6.4. Remove the tool and reverse the installation tool.

Position the larger end of the installer against the front of the balancer.

- 6.5. Use a wrench and hold the hex end of the threaded rod.

- 6.6. Use a second wrench and rotate the installation tool nut clockwise until the balancer is installed onto the crankshaft.

- 6.7. Remove the balancer installation tools.



Note: There are two crankshaft balancer bolt designs, one has a flanged head, no washer, and the other has a retained rotating washer. There are two different torque specifications for the final pass; the final torque angle is dependent on the bolt design.

7. Install the NEW crankshaft balancer bolt.

- 7.1. Tighten the crankshaft balancer bolt to **150N•m (110 lb ft)**.

- 7.2. Loosen the crankshaft balancer bolt **360 degrees**.
- 7.3. Tighten the crankshaft balancer bolt to **80 N•m (59 lb ft)**.
- 7.4. Tighten the crankshaft balancer bolt a final pass
 - Balancer bolt with flanged head (1) tighten to **125 degrees** using the J 45059 angle meter .
 - Balancer bolt with retained rotating washer (2) tighten to **200 degrees** using the J 45059 angle meter .
8. Remove the J 42386-A holding tool .

[2014 Holden VF Sedan](#) | [VF/WN - Sedan, Ute, Sportwagon, Caprice, Lumina, HSV Service Manual 5617662](#) |
[Engine/Propulsion](#) | [Engine Mechanical - 6.0L L77 or 6.2L LS3 LSA](#) | [Repair Instructions - Off Vehicle](#) |

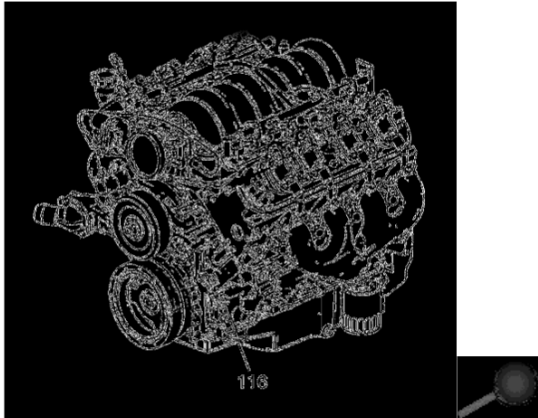
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Engine Prelubing (LS3 or L77)

Special Tools

J 45299 Engine Preluber

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



Note: A constant and continuous flow of clean engine oil is required in order to properly prime the engine. Be sure to use an approved engine oil as specified in the owners manual.

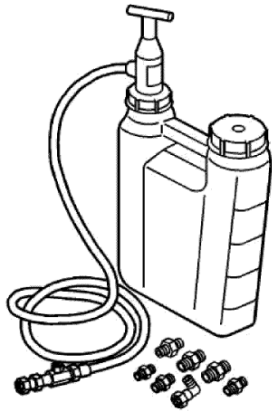
1. Remove the engine oil filter, and fill with clean engine oil.

Caution: Refer to [Fastener Caution](#).

2. Install the oil filter and tighten to **30 N•m (22 lb ft)**.

3. Locate the engine block left front oil gallery plug (116).

4. Install the M16 x 1.5 adapter P/N 509375.



5. Install the flexible hose to the adapter and open the valve.

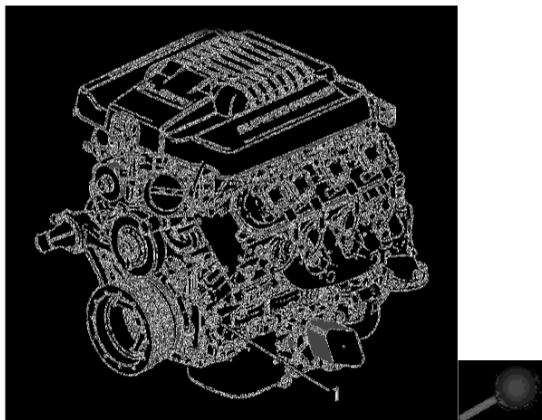
6. Pump the handle on the *J 45299* preluber in order to flow a minimum of **1.0–1.9 liters (1–2 quarts)** engine oil. Observe the flow of engine oil through the flexible hose and into the engine assembly.
7. Close the valve and remove the flexible hose and adapter from the engine.
8. Install the gallery plug to the engine and tighten to **60 N•m (44 lb ft)**.
9. Top-off the engine oil to the proper level.

Engine Prelubing (LSA)

Special Tools

J 45299 Engine Preluber

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



Note: A constant and continuous flow of clean engine oil is required in order to properly prime the engine. Be sure to use an approved engine oil as specified in the owners manual.

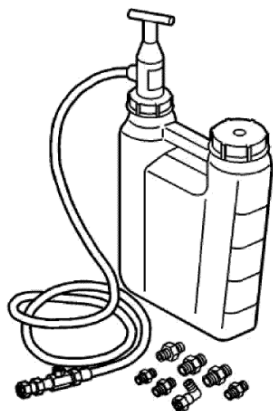
1. Remove the engine oil filter, and fill with clean engine oil.

Caution: Refer to [Fastener Caution](#).

2. Install the oil filter and tighten to **30 N•m (22 lb ft)**.

3. Locate the engine block left front oil gallery plug (1).

4. Install the M16 x 1.5 adapter P/N 509375.



5. Install the flexible hose to the adapter and open the valve.

6. Pump the handle on the *J 45299* preluber in order to flow a minimum of 1–1.9 liters (1–2 quarts) engine oil. Observe the flow of engine oil through the flexible hose and into the engine assembly.
7. Close the valve and remove the flexible hose and adapter from the engine.
8. Install the gallery plug to the engine and tighten to **60 N•m (44 lb ft)**.
9. Top-off the engine oil to the proper level.

