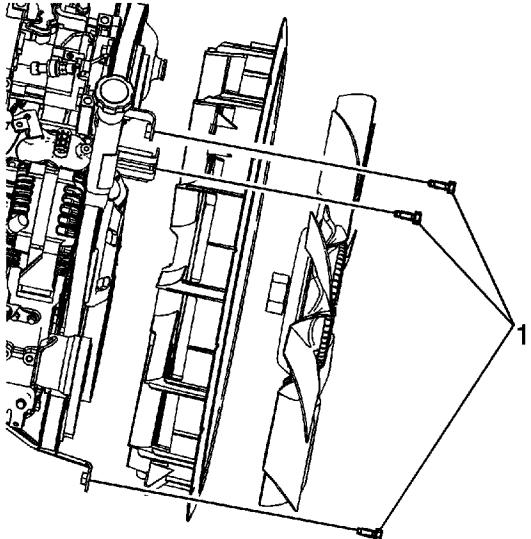


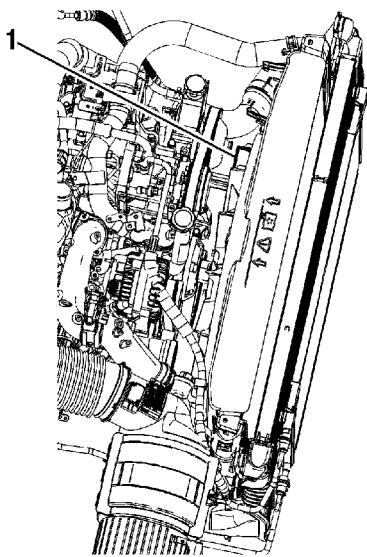
Drive Belt Replacement

Removal Procedure

1. Remove the upper fan shroud. Refer to [Engine Coolant Fan Upper Shroud Replacement](#).



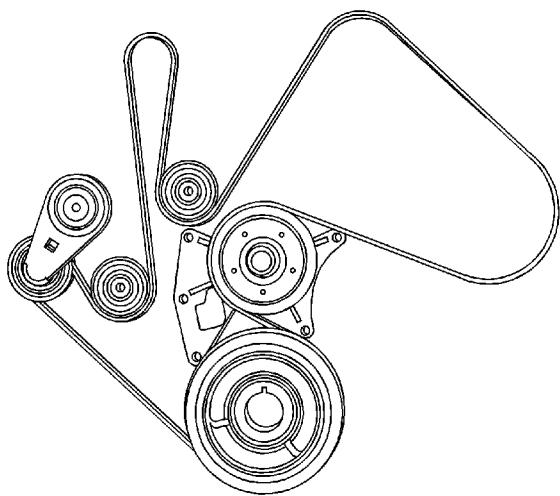
2. Remove the 3 engine cooling fan shroud bolts (1).



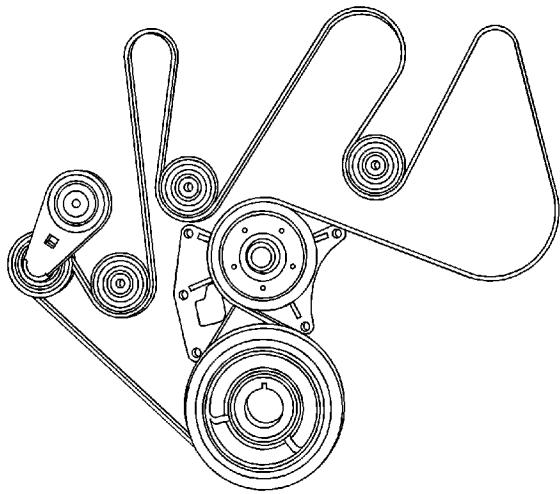
3. Position the engine cooling fan shroud (1) forward to the radiator.
4. Install a 1/2 inch breaker bar into the tensioner opening and rotate the tensioner counterclockwise.
5. Remove the belt from the tensioner.

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6. Slowly release the tension on the tensioner arm.

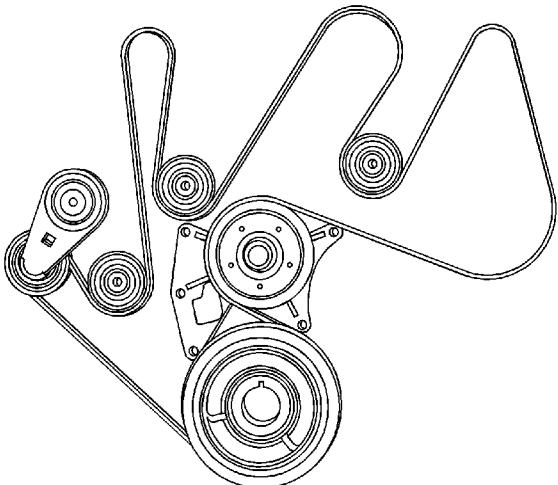


7. Remove the drive belt from the drive pulleys , if equipped with a single generator.

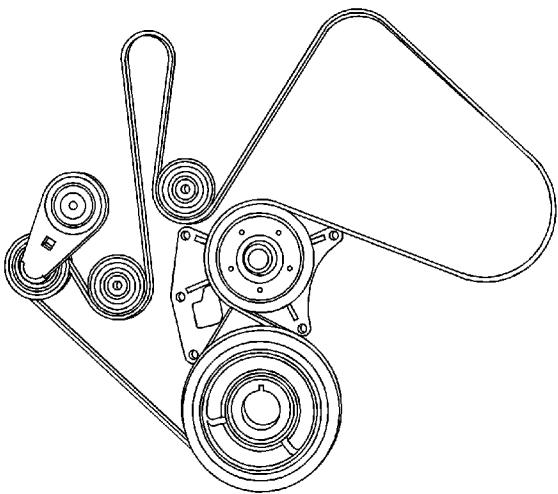


8. Remove the drive belt from the drive pulleys, if equipped with dual generators.
9. Inspect the drive belt for excessive cracking or any visible damage and replace if necessary.

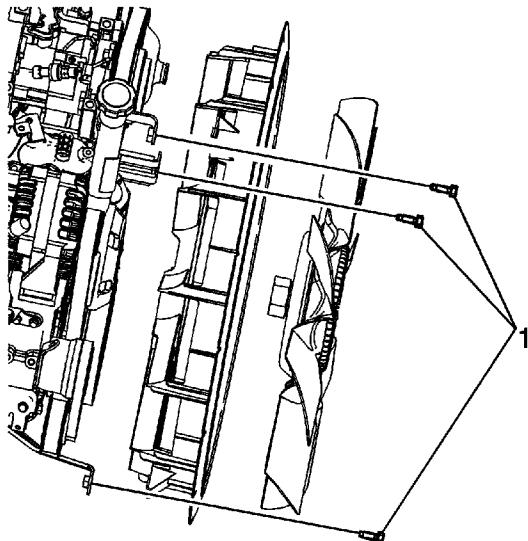
Installation Procedure



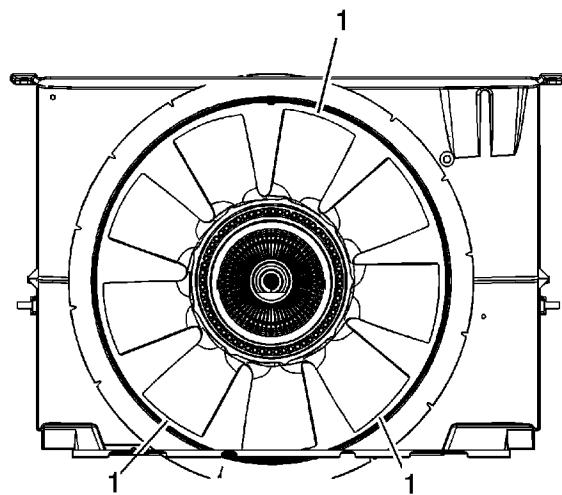
1. Install the drive belt, if equipped with dual generators.
2. Route the drive belt over and/or around all the drive pulleys except for the tensioner.



3. Install the drive belt, if equipped with a single generator.
4. Route the drive belt over and/or around all the drive pulleys except for the tensioner.
5. Install a 1/2 inch breaker bar into the tensioner opening and rotate the tensioner counterclockwise.
6. Install the belt over and/or around the tensioner.
7. Slowly release the tension on the tensioner arm.
8. Inspect the drive belt for proper installation on and/or around all pulleys.



9. Position the engine cooling fan shroud on the 3 mounting brackets (1).
10. Install the bolts. Loosely tighten the top mounting bolt at the oil filler neck.



11. Center the engine cooling fan shroud to the fan blade in 3 places (1).

Caution: Refer to [Fastener Caution](#) in the Preface section.

Note: Maintain a 6 mm (0.25 in) minimum clearance at all 3 places.

12. Fully tighten the 3 engine cooling fan shroud bolts (1).

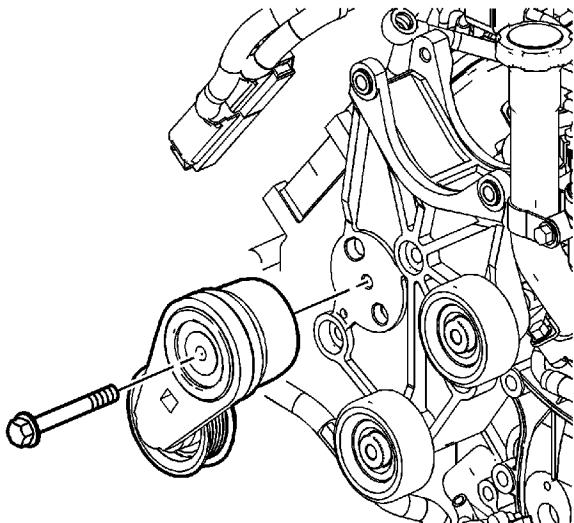
Tighten

Tighten the bolts to 8 N·m (71 lb in).

13. Install the upper fan shroud. Refer to [Engine Coolant Fan Upper Shroud Replacement](#).

Drive Belt Tensioner Replacement

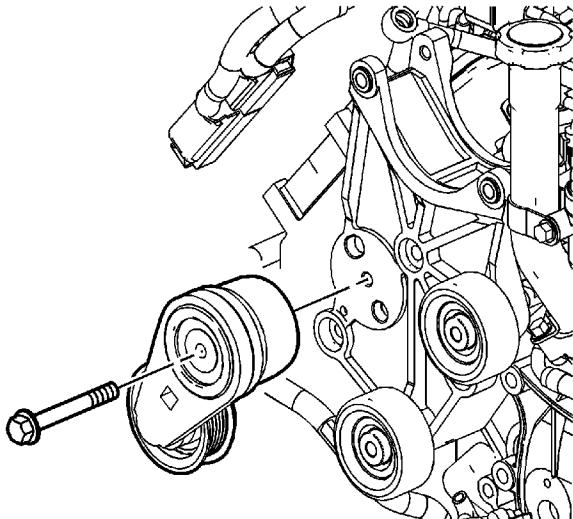
Removal Procedure



1. Remove the drive belt. Refer to [Drive Belt Replacement](#).
2. Remove the drive belt tensioner bolt.
3. Remove the drive belt tensioner.

Installation Procedure

Caution: Refer to [Fastener Caution](#) in the Preface section.



1. Install the drive belt tensioner. Align the pin with the hole in the generator bracket.
2. Install the drive belt tensioner bolt.

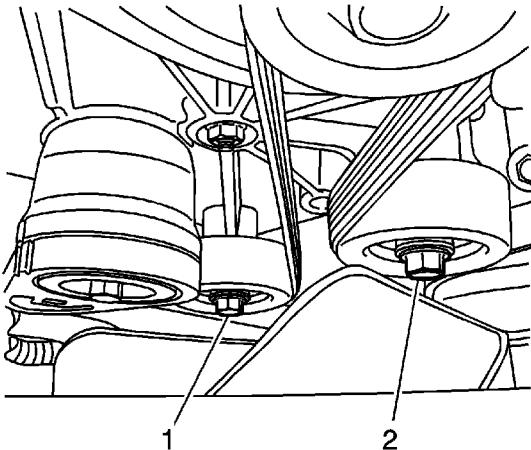
Tighten

Tighten bolt to 50 N·m (37 lb ft).

3. Install the drive belt. Refer to [Drive Belt Replacement](#).

Drive Belt Idler Pulley Replacement

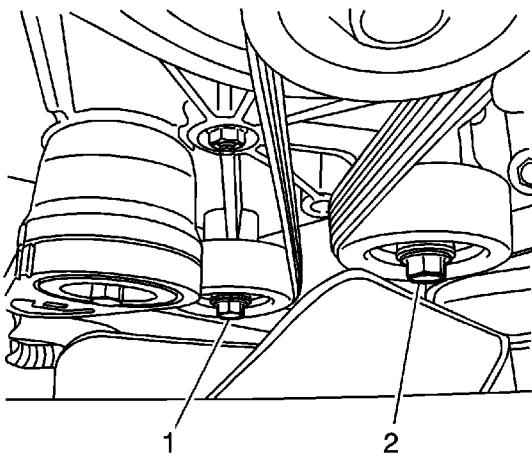
Removal Procedure



1. Remove the drive belt. Refer to [Drive Belt Replacement](#).
2. Remove the bolt (1) from the right side idler pulley.
3. Remove the idler pulley.
4. Remove the bolt (2) for the center idler pulley.
5. Remove the idler pulley.
6. If equipped with dual generators, remove the bolt from the left side idler pulley.
7. If equipped with dual generators, remove the idler pulley.

Installation Procedure

Caution: Refer to [Fastener Caution](#) in the Preface section.



1. Install the right side idler pulley and bolt (1).

Tighten

Tighten the bolt to 50 N·m (37 lb ft).

2. Install the center idler pulley and bolt (2).

Tighten

Tighten the bolt to 50 N·m (37 lb ft).

3. If equipped with dual generators, install the left side idler pulley and bolt.

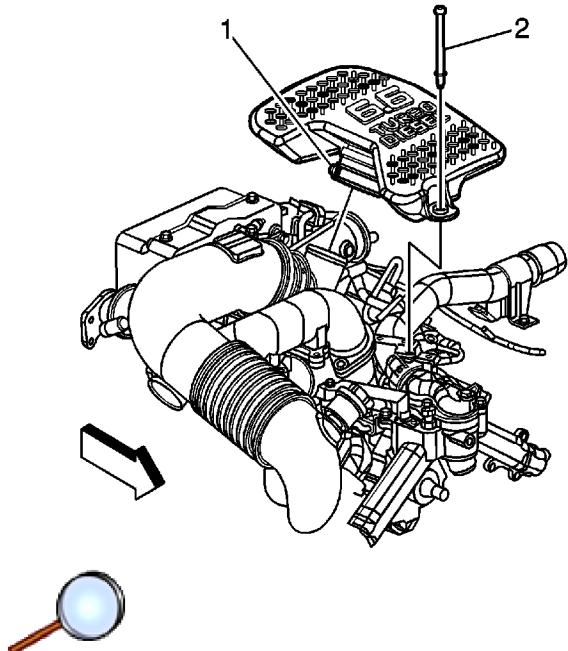
Tighten

Tighten the bolt to 50 N·m (37 lb ft).

4. Install the drive belt. Refer to [Drive Belt Replacement](#).

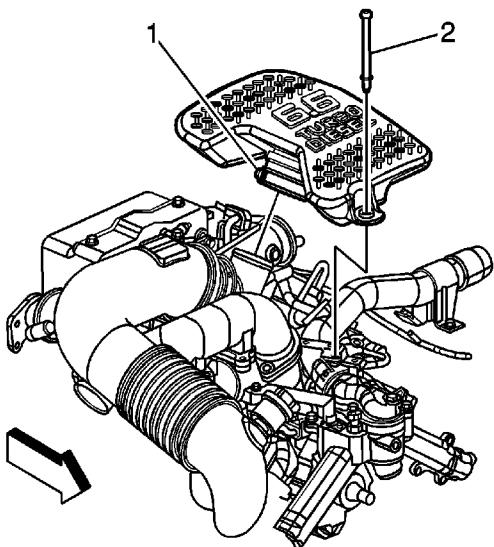
Intake Manifold Cover Replacement

Removal Procedure



1. Loosen the intake manifold cover clamp (1) at the resonator.
2. Loosen the intake manifold cover bolt (2).
3. Remove the intake manifold cover.

Installation Procedure



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1. Install the intake manifold cover.
2. Tighten the intake manifold cover bolt (2) until snug.

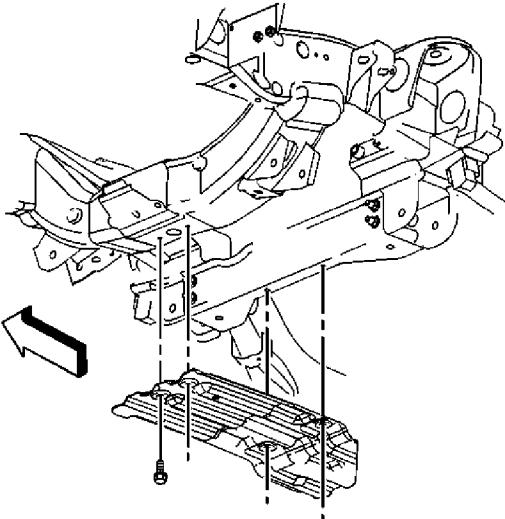
Caution: Refer to [Fastener Caution](#) in the Preface section.

3. Tighten the intake manifold cover clamp (1) at the resonator.

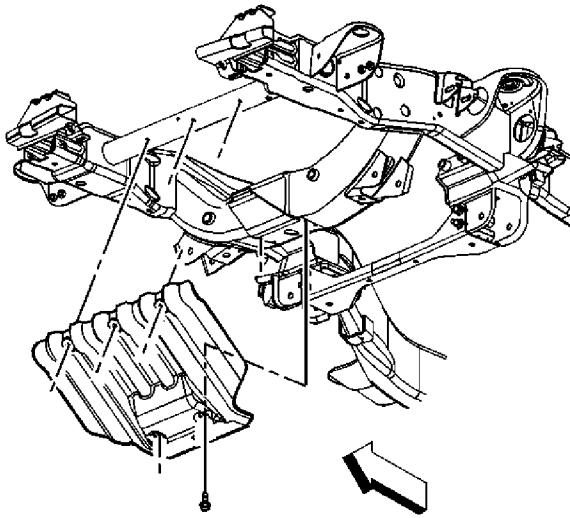
Tighten

Tighten the clamp to 6 N·m (53 lb in).

Engine Mount Inspection

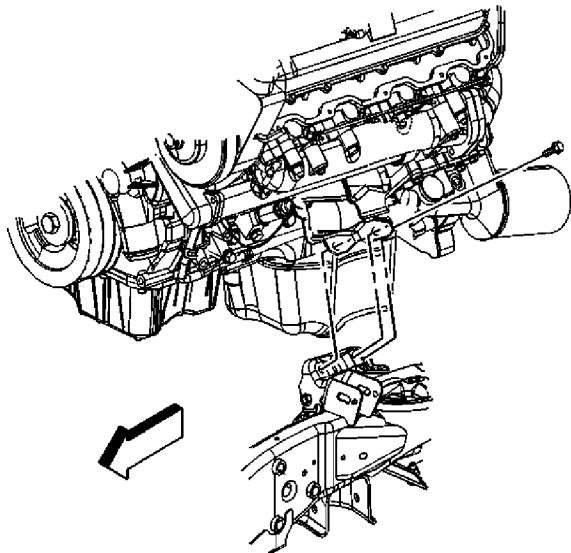


1. Raise the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
2. Remove the oil pan skid plate.



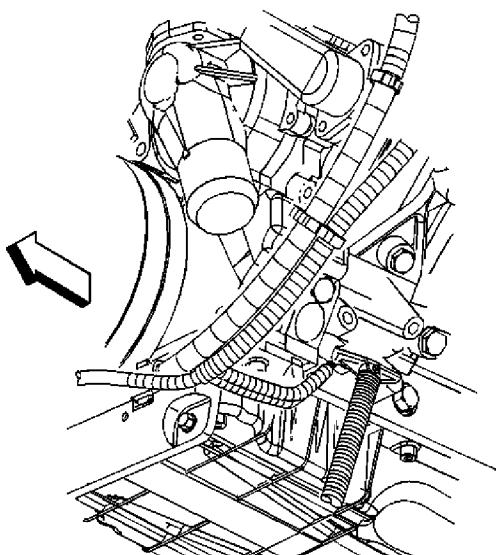
3. Remove the engine protection shield.

Caution: Refer to [Engine Mounting Caution](#) in the Preface section.



4. Inspect for loose or missing bolts at the following locations:
 - Engine mount bracket to engine
 - Engine mount frame bracket to frame
 - Engine mount to engine mount bracket
 - Engine mount to engine mount frame bracket
5. Replace missing or loose bolts. Refer to [Engine Mechanical Specifications](#).

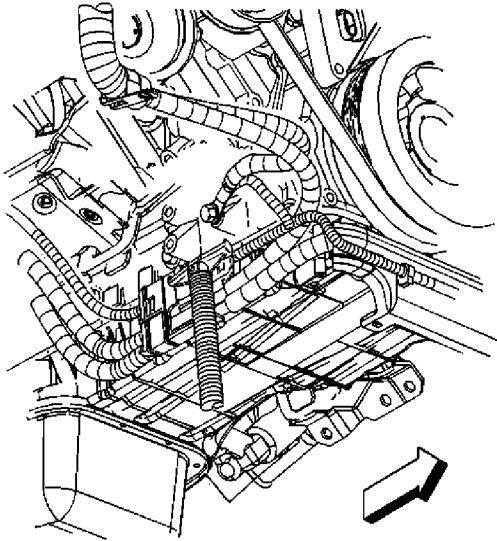
Caution: Refer to [Engine Lifting Caution](#) in the Preface section.



6. If the vehicle is 4-wheel drive (4WD), you will not be able to access the lifting points on the engine. In order to raise the engine, attach a chain to the front of the engine. Then follow the

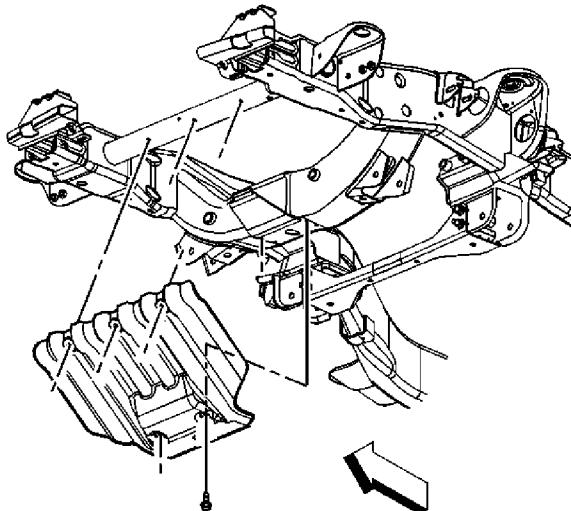
inspection steps.

7. If the vehicle is rear-wheel drive (RWD), in order to raise the engine to inspect the left engine mount, use a suitable jack on the ground wire bolt bosses on the left side of the engine



8. If equipped with an automatic transmission, remove the bolt retaining the transmission oil cooler line bracket.
9. Move the transmission oil cooler lines aside.
10. In order to raise the engine to inspect the right engine mount, use a suitable jack on the ground wire bolt bosses on the right side of the engine
11. Perform the following in order to inspect the engine mounts:
 - 11.1. Raise the engine to remove weight from the engine mount.
 - 11.2. Place a slight tension on the rubber cushion.
 - 11.3. Observe the engine mount for the following while raising the engine:
 - Heat check cracks covering the hard rubber surface
 - The rubber cushion is separated from the metal plate of the engine mount.
 - There is a split through the rubber cushion.
12. Replace the engine mount if any of the above conditions exist.

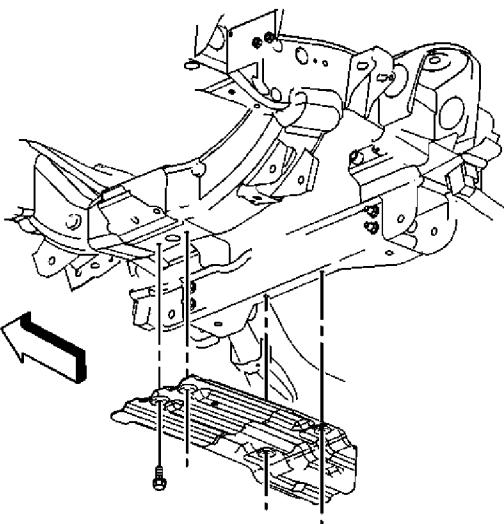
Caution: Refer to [Fastener Caution](#) in the Preface section.



13. Install the engine protection shield and bolts.

Tighten

Tighten the engine protection shield bolts to 20 N·m (15 lb ft).



14. Install the oil pan skid plate and bolts.

Tighten

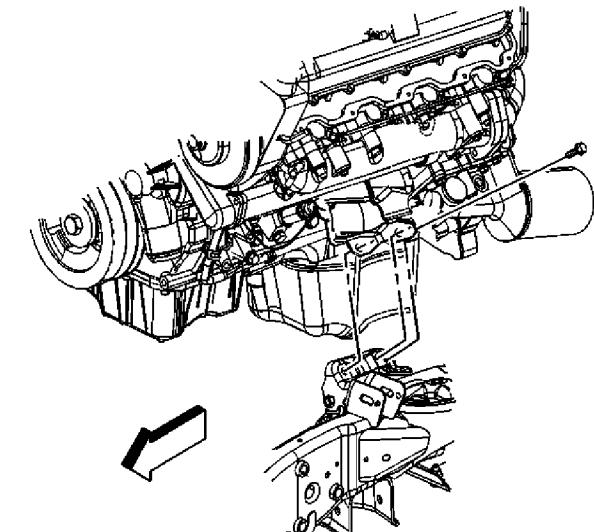
Tighten the oil pan skid plate bolts to 20 N·m (15 lb ft).

15. Lower the vehicle.

Engine Mount Replacement - Left Side

Removal Procedure

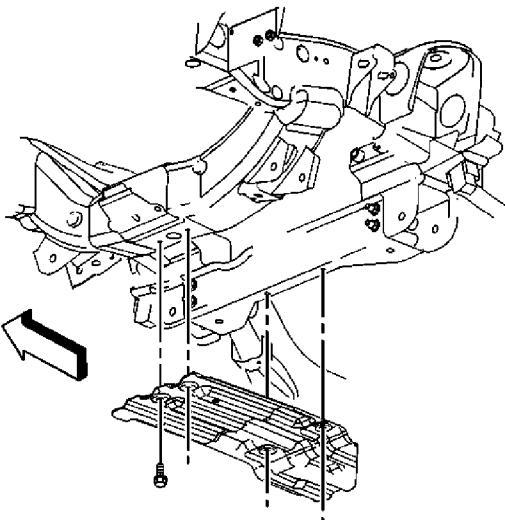
1. If RWD vehicle, raise the vehicle to a height to work through the front wheelhouse opening. Refer to [Lifting and Jacking the Vehicle](#).
2. If 4-wheel drive (4WD) vehicle, raise the vehicle in order to remove the front tires and wheels and support with jackstands.
3. Remove the wheelhouse inner panel. Refer to [Front Wheelhouse Liner Replacement - Left Side](#).



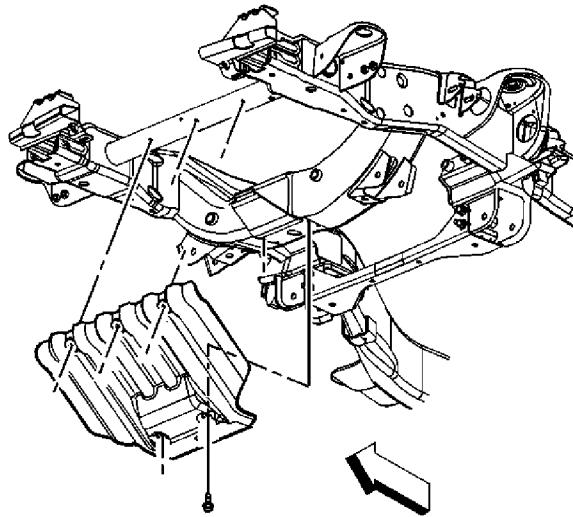
Caution: Broken engine mountings can cause misalignment of certain drive-train components. Misalignment of drive-train components causes eventual destruction of the drive-train components.

If one engine mount breaks, the rest of the engine mounts will have increased stress put on them. This could cause the rest of the engine mounts to break.

4. Working through the wheelhouse opening remove the 3 bolts retaining the engine mount to the engine mount frame bracket.

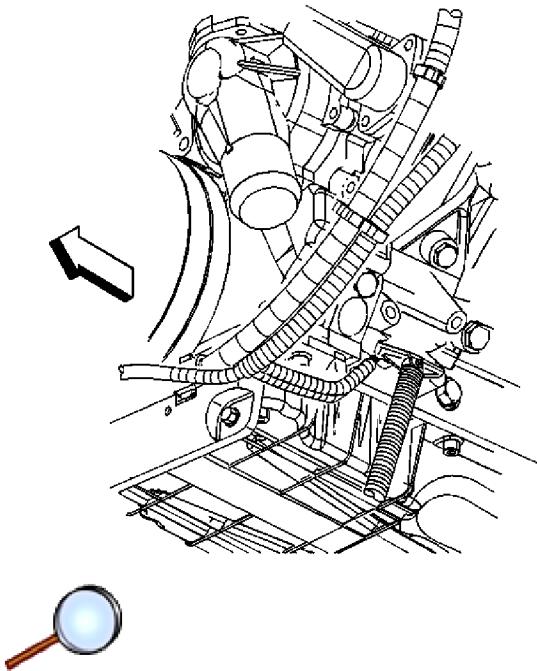


5. Remove the oil pan skid plate, if equipped.



6. Remove the engine protection shield from the vehicle, if equipped.

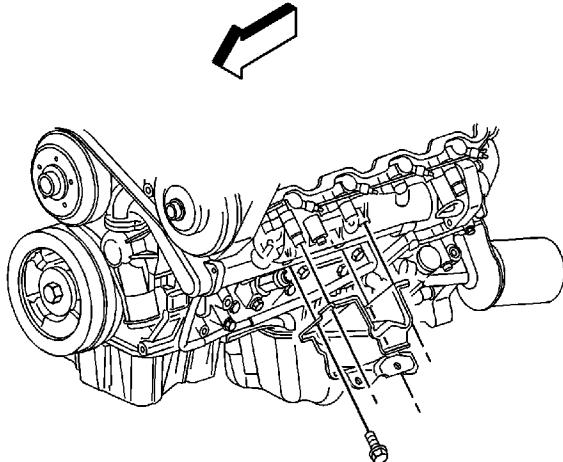
Caution: When raising or supporting the engine for any reason, do not use a jack under the oil pan, any sheet metal, or the crankshaft pulley. Lifting the engine in an unapproved manner may cause component damage.



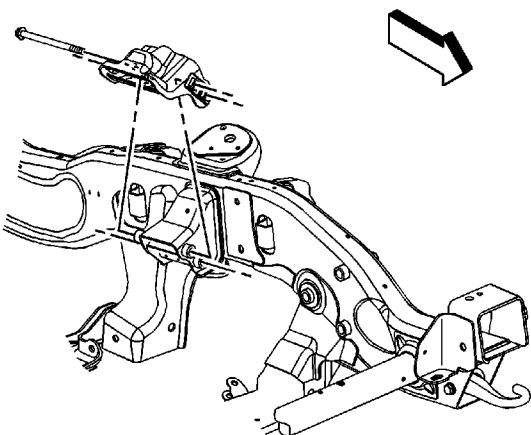
Note: When raising the engine only raise enough to separate the engine mount from the engine mount bracket. Raising any further will require removal of the fan shroud or the exhaust pipe.

7. If RWD vehicle, using a suitable jack on the ground wire bolt bosses, raise the engine.
Only raise the engine enough to separate the engine mount to engine mount bracket.
8. If 4WD vehicle, attach a chain to the front of the engine. Use accessible mounting bolts for the generator mounting bracket and the power steering pump mounting bracket.
9. Raise the engine with a suitable lifting device to remove the engine mount.

Only raise the engine enough to separate the engine mount to engine mount bracket.

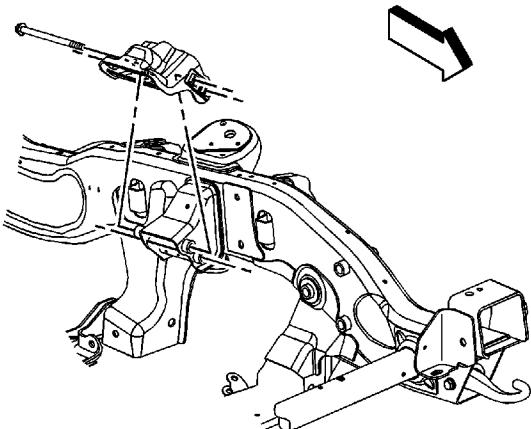


10. Remove the bolts holding the engine mount to the engine.

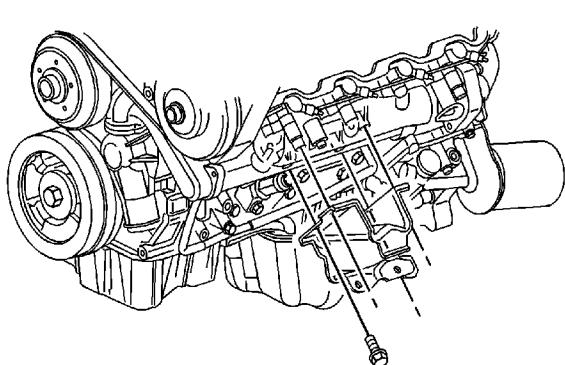


11. Remove the 2 through-bolts for the engine mount frame bracket.
12. Remove the engine mount frame bracket.
13. Remove the engine mount.

Installation Procedure



1. Position the engine mount frame bracket on the frame. Do not install the bolts.



2. Install the engine mount.
3. Perform the following procedure prior to installing the engine mount bracket bolts.
 - 3.1. Remove all traces of the original adhesive patch.
 - 3.2. Clean the threads of the bolt with denatured alcohol or equivalent and allow to dry.
 - 3.3. Apply threadlocker GM P/N 12345382 (Canadian P/N 10953489) or equivalent to the bolts.

Caution: Refer to [Fastener Caution](#) in the Preface section.

4. Install the 2 through-bolts.

Tighten

Tighten the through-bolts to 75 N·m (55 lb ft).

5. Install the bolts holding the engine mount to the engine.

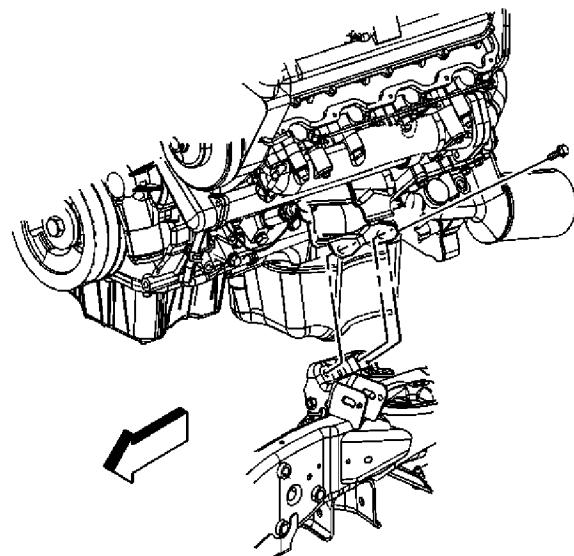
Tighten

Tighten the engine mount bolts to 58 N·m (43 lb ft).

6. Lower the engine.
7. If 4WD vehicle remove the chain from the front of the engine.
8. If 4WD vehicle, install the generator mounting bracket and the power steering mount bracket bolt.

Tighten

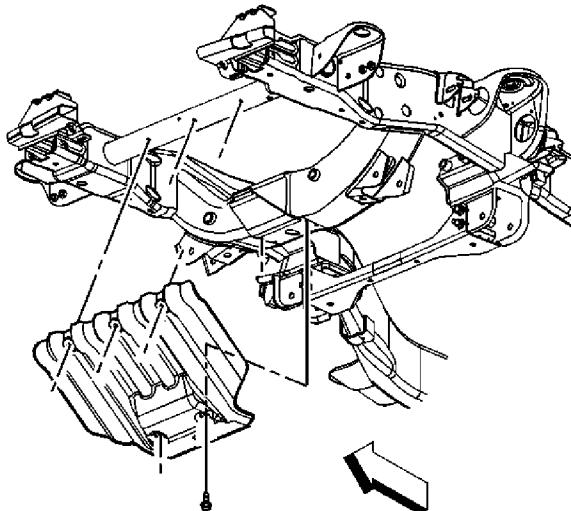
Tighten the mounting bracket bolts to 50 N·m (37 lb ft).



9. Install the 3 bolts holding the engine mount to the engine mount frame bracket.

Tighten

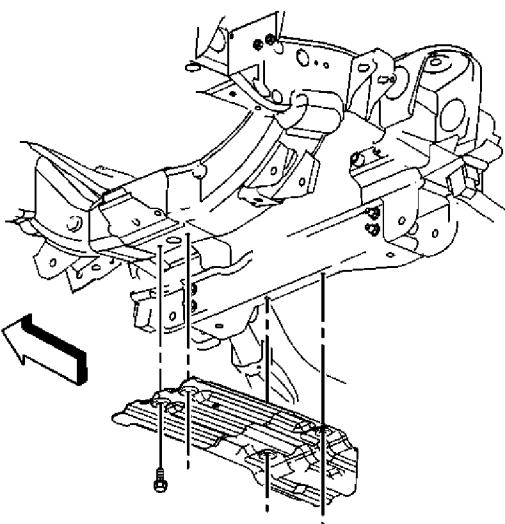
Tighten the engine mount to engine mount frame bracket bolts to 65 N·m (48 lb ft).



10. Install the engine protection shield and bolts.

Tighten

Tighten the engine protection shield bolts to 20 N·m (15 lb ft).



11. Install the oil pan skid plate.

Tighten

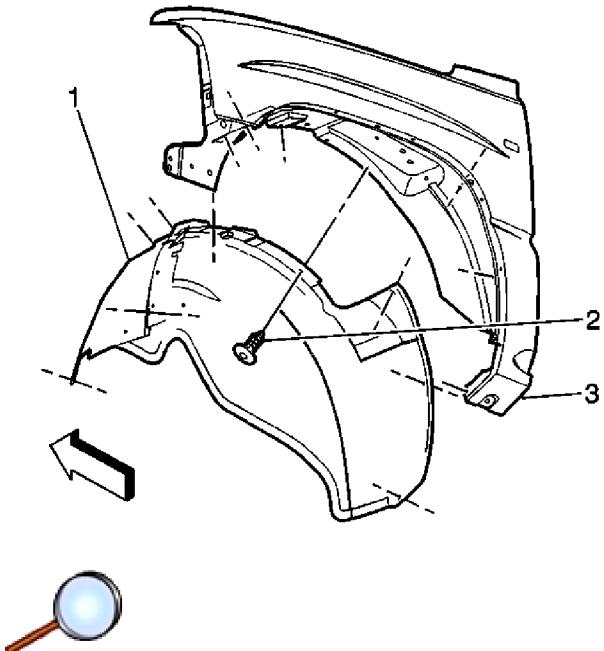
Tighten the bolts to 20 N·m (15 lb ft).

12. Remove the wheelhouse inner panel. Refer to [Front Wheelhouse Liner Replacement - Left Side](#).

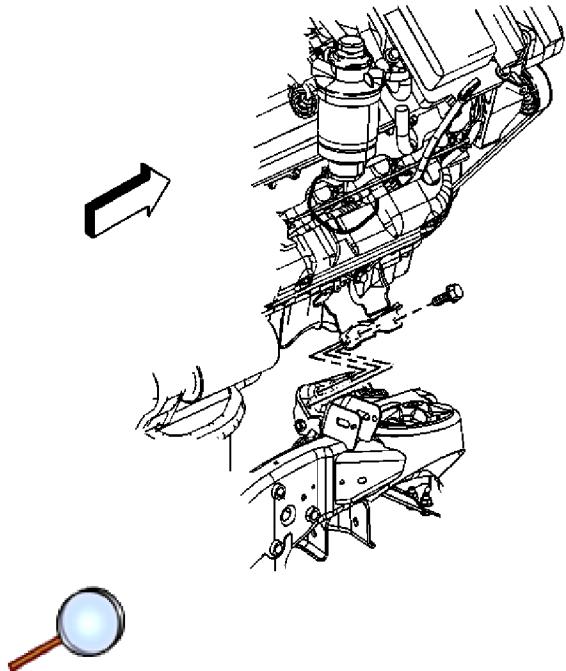
13. Lower the vehicle.

Engine Mount Replacement - Right Side

Removal Procedure



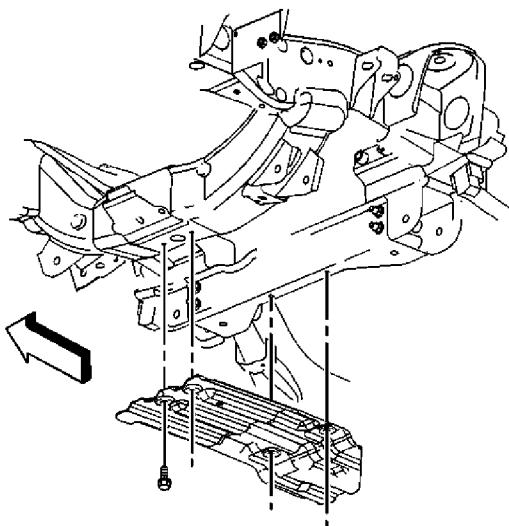
1. Remove the starter motor. Refer to [Starter Motor Replacement](#).
2. If RWD vehicle, raise the vehicle to a height to work through the front wheelhouse opening. Refer to [Lifting and Jacking the Vehicle](#).
3. If 4-wheel drive (4WD) vehicle, raise the vehicle in order to remove the front tires and wheels and support with jackstands.
4. Remove the right front tire and wheel, if necessary. Refer to [Tire and Wheel Removal and Installation](#).
5. Remove the pushpins holding the right front fender wheelhouse inner panel (1).
6. Remove the wheelhouse inner panel.



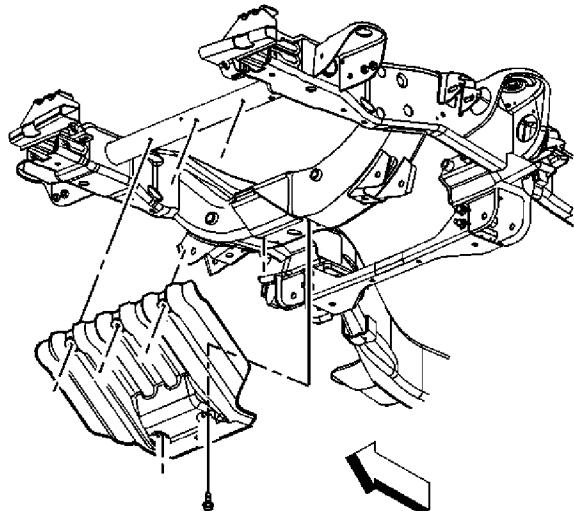
Caution: Broken engine mountings can cause misalignment of certain drive-train components. Misalignment of drive-train components causes eventual destruction of the drive-train components.

If one engine mount breaks, the rest of the engine mounts will have increased stress put on them. This could cause the rest of the engine mounts to break.

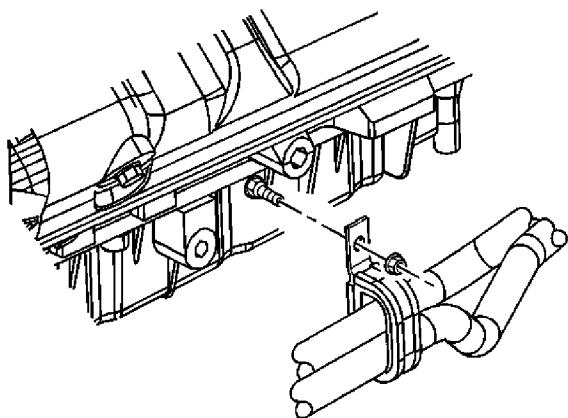
7. Working through the wheelhouse opening remove the 3 bolts retaining the engine mount to the engine mount frame bracket.



8. Remove the oil pan skid plate, if equipped.

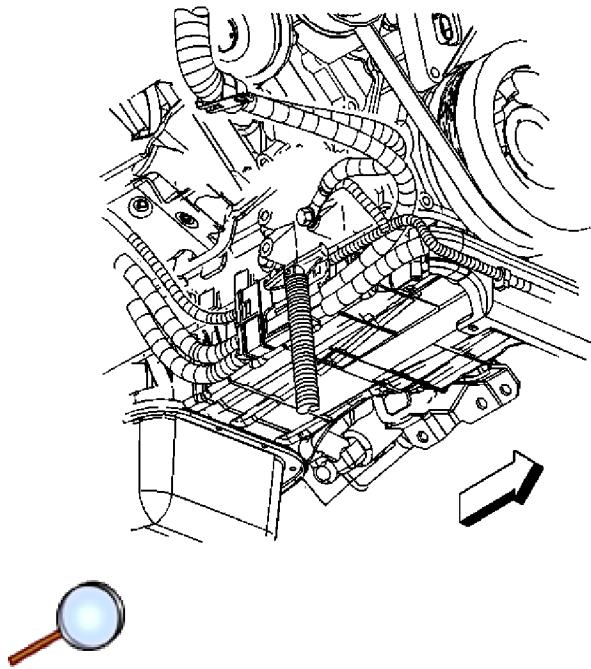


9. Remove the engine protection shield from the vehicle, if equipped.



10. If RWD vehicle and equipped with an automatic transmission, remove the bracket bolt for the transmission oil cooler lines to the engine.
11. Move the transmission oil cooler lines aside.

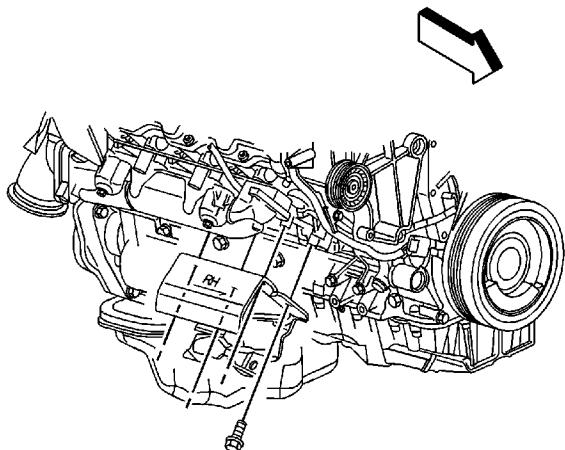
Caution: When raising or supporting the engine for any reason, do not use a jack under the oil pan, any sheet metal, or the crankshaft pulley. Lifting the engine in an unapproved manner may cause component damage.



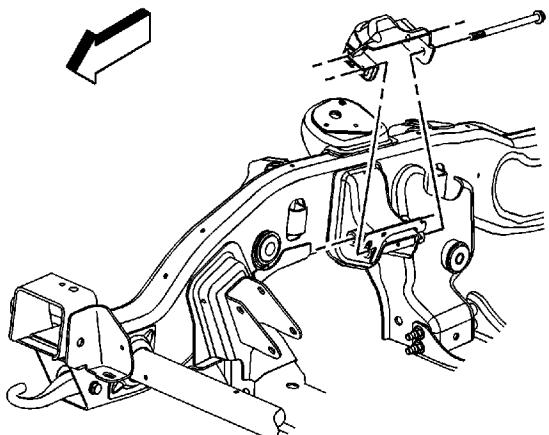
Note: When raising the engine only raise enough to separate the engine mount from the engine mount bracket. Raising any further the fan shroud or the exhaust pipe will require removal.

12. If RWD vehicle, using a suitable jack on the ground wire bolt bosses, raise the engine.
Only raise the engine enough to separate the engine mount to engine mount bracket.
13. If 4WD vehicle, attach a chain to the front of the engine. Use accessible mounting bolts for the generator mounting bracket and the power steering pump mounting bracket.
14. Raise the engine with a suitable lifting device to remove the engine mount.

Only raise the engine enough to separate the engine mount to engine mount bracket.

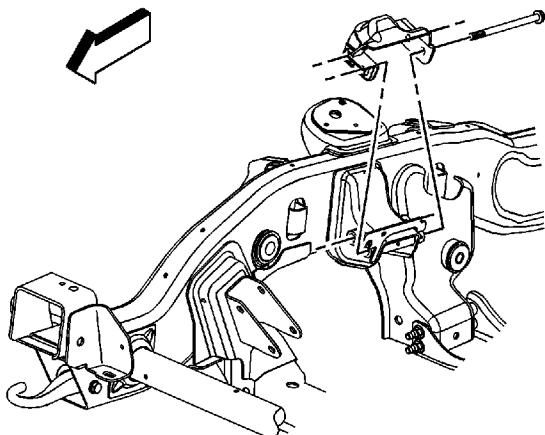


15. Remove the bolts holding the engine mount to the engine.



16. Remove the 2 through-bolts for the engine mount frame bracket.
17. Remove the engine mount frame bracket.
18. Remove the engine mount.

Installation Procedure

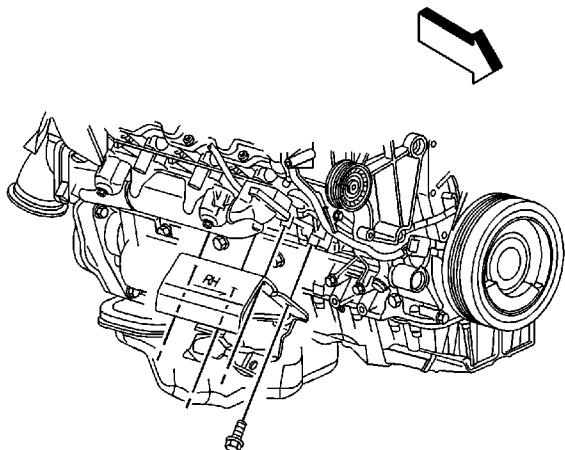


1. Position the engine mount frame bracket on the frame. Do not install the bolts.
2. Install the engine mount.
3. Perform the following procedure prior to installing the engine mount bracket bolts.
 - 3.1. Remove all traces of the original adhesive patch.
 - 3.2. Clean the threads of the bolt with denatured alcohol or equivalent and allow to dry.
 - 3.3. Apply threadlocker GM P/N 12345382 (Canadian P/N 10953489) or equivalent to the bolts.
4. Install the 2 through-bolts.

Caution: Refer to [Fastener Caution](#) in the Preface section.

Tighten

Tighten the through-bolts to 75 N·m (55 lb ft).



5. Install the bolts holding the engine mount to the engine.

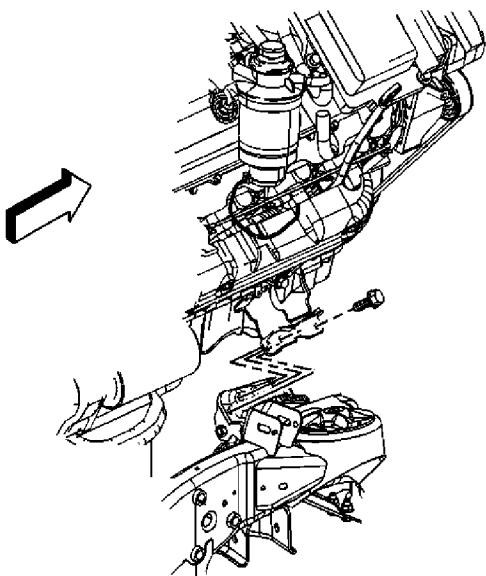
Tighten

Tighten the engine mount bolts to 58 N·m (43 lb ft).

6. Lower the engine.
7. If 4WD vehicle, remove the chain from the front of the engine.
8. If 4WD vehicle, install the generator mounting bracket and the power steering mount bracket bolt.

Tighten

Tighten the mounting bracket bolts to 50 N·m (37 lb ft).

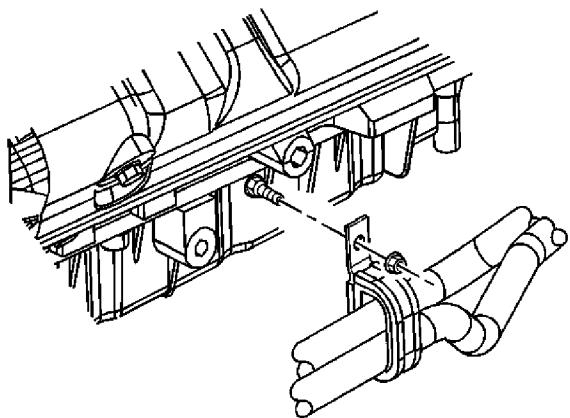




9. Install the 3 bolts holding the engine mount to the engine mount frame bracket.

Tighten

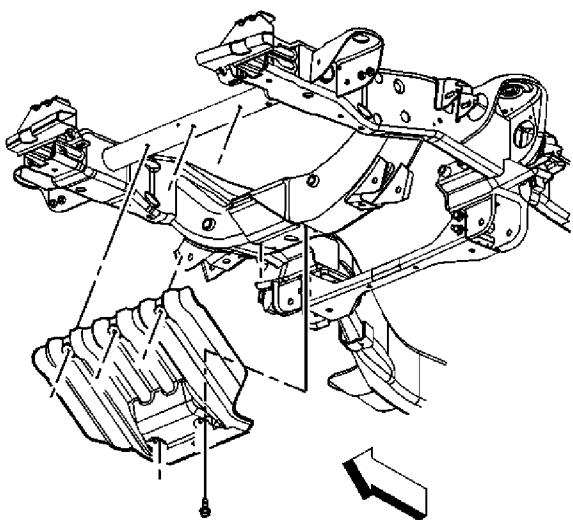
Tighten the engine mount to engine mount frame bracket bolts to 65 N·m (48 lb ft).



10. If RWD vehicle with an automatic transmission, install the bolt for the transmission oil cooler line bracket.

Tighten

Tighten the transmission oil cooler line bracket bolt to 9 N·m (80 lb in).

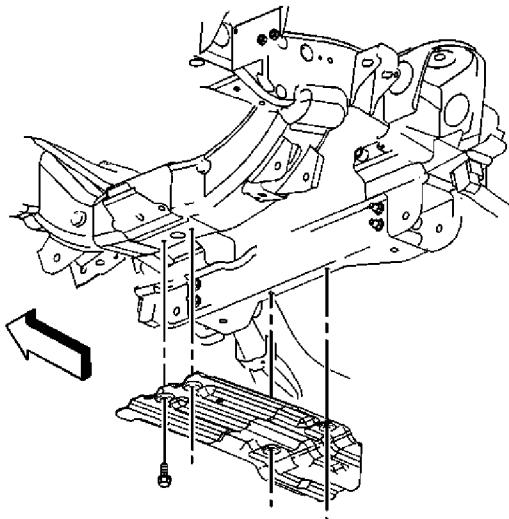




11. Install the engine protection shield and bolts.

Tighten

Tighten the engine protection shield bolts to 20 N·m (15 lb ft).



12. Install the oil pan skid plate.

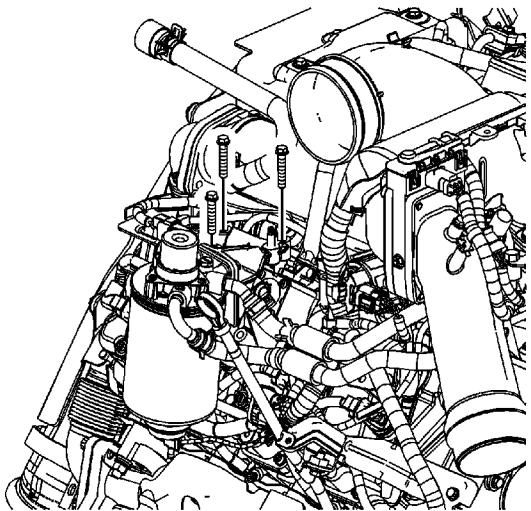
Tighten

Tighten the bolts to 20 N·m (15 lb ft).

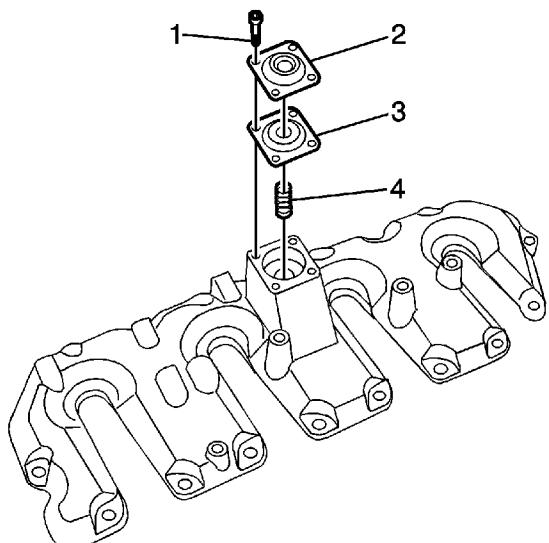
13. Install the right front tire and wheel. Refer to [Tire and Wheel Removal and Installation](#).
14. Install the front fender wheelhouse inner panel.
15. Install the starter motor. Refer to [Starter Motor Replacement](#).
16. Lower the vehicle.

Positive Crankcase Ventilation Valve Replacement (Passenger Side)

Removal Procedure



1. Remove the air cleaner outlet duct. Refer to [Air Cleaner Assembly Replacement](#).
2. Remove the fuel filter bracket bolts.
3. Position the fuel filter assembly out of the way.

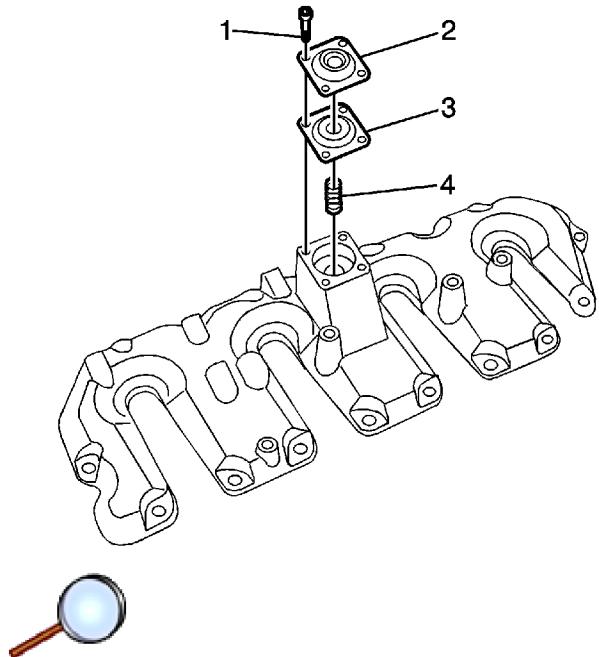


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4. Remove the positive crankcase ventilation (PCV) cover screws.
5. Remove the PCV cover, diaphragm, and spring.
6. Clean and inspect the cover, diaphragm and spring.
7. Discard the diaphragm if damage is found.

Installation Procedure

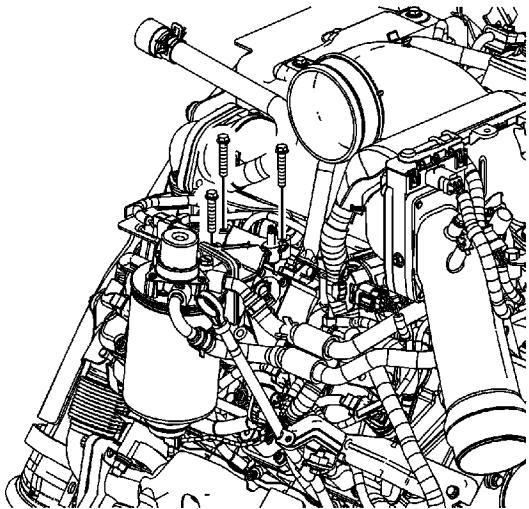
Caution: Refer to [Fastener Caution](#) in the Preface section.



1. Install the spring, diaphragm and cover.
2. Install the PCV cover screws.

Tighten

Tighten the screws to 4 N·m (35 lb in).



3. Position the fuel filter assembly to the engine.
4. Install the fuel filter bracket bolts.

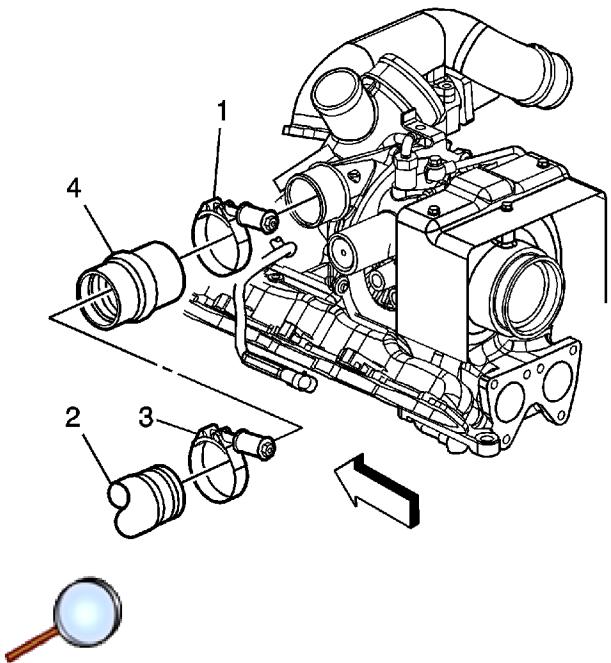
Tighten

Tighten the bolts to 21 N·m (15 lb ft).

5. Install the air cleaner outlet duct. Refer to [Air Cleaner Assembly Replacement](#).

Positive Crankcase Ventilation Valve Replacement (Driver Side)

Removal Procedure

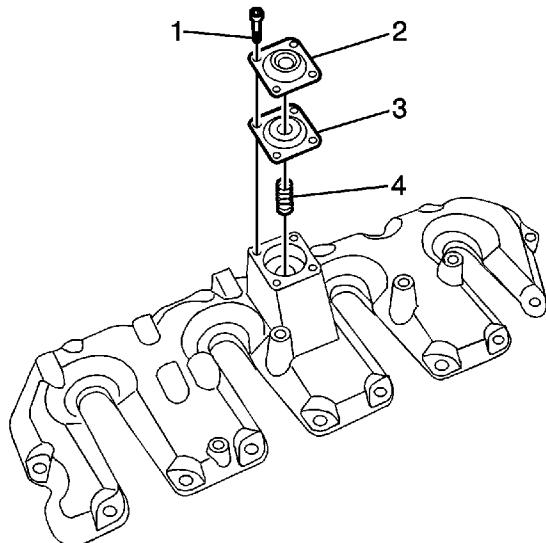


Note: After removing the charged air cooler duct, cover the turbocharger opening with tape in order to prevent entry of objects.

1. Loosen the charged air cooler inlet duct connector to turbocharger clamp (1).

Note: Do not use a screwdriver or other tool to pry the hose loose. The hose can be torn or damaged. Loosen the hose by twisting.

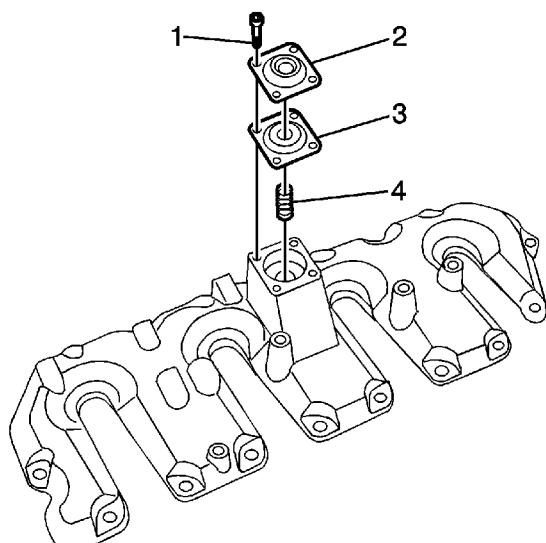
2. Remove the charged air cooler inlet duct connector (4) from the turbocharger.



3. Remove the positive crankcase ventilation (PCV) cover screws.
4. Remove the PCV cover, diaphragm, and spring.
5. Clean and inspect the cover, diaphragm, and spring.
6. Discard the diaphragm if damage is found.

Installation Procedure

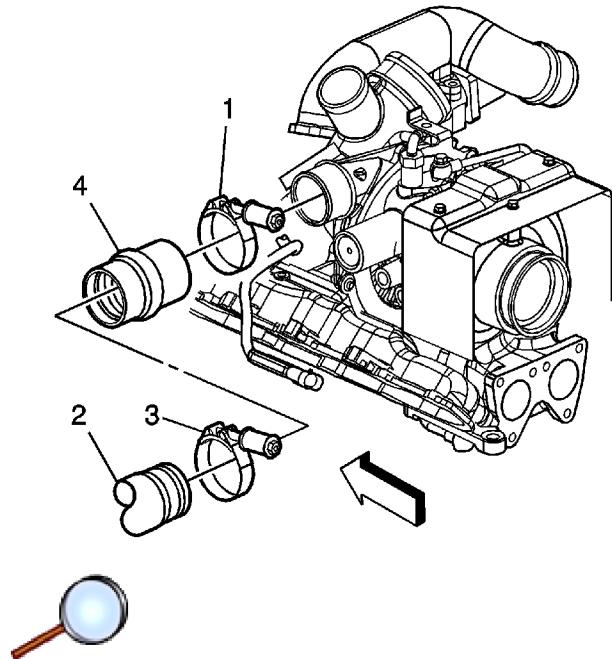
Caution: Refer to [Fastener Caution](#) in the Preface section.



1. Install the spring, diaphragm, and cover.
2. Install the PCV cover screws.

Tighten

Tighten the screws to 4 N·m (35 lb in).



3. Remove the tape from the turbocharger openings.

Note: Lubricate the end of the duct prior to installation.

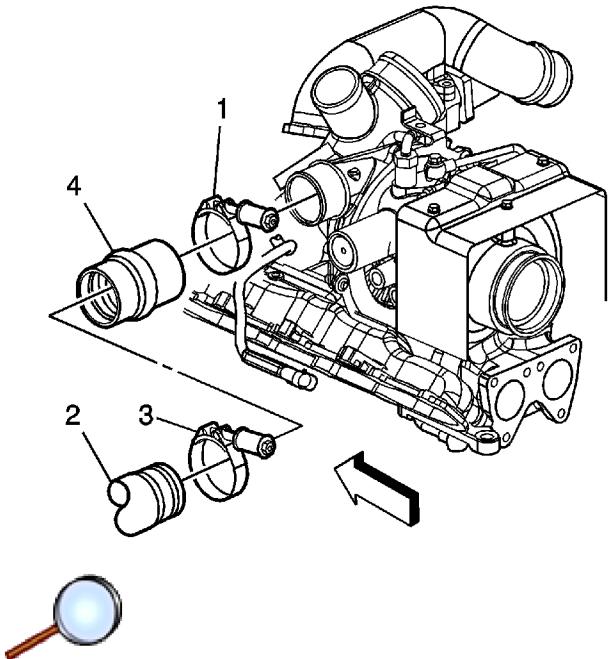
4. Install the charged air cooler inlet duct connector (4) to the turbocharger.
5. Tighten the charged air cooler inlet duct connector to turbocharger clamp (1).

Tighten

Tighten the clamp to 6 N·m (53 lb in).

Positive Crankcase Ventilation Hose/Pipe/Tube Replacement

Removal Procedure



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

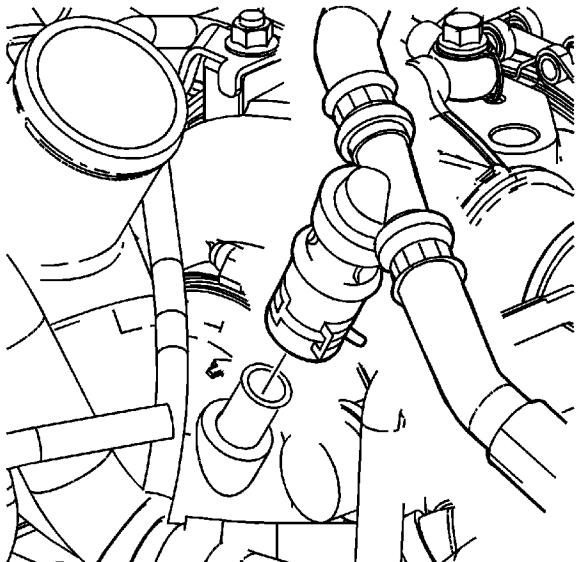
Note: After removing the charged air cooler duct, cover the turbocharger opening with tape in order to prevent entry of objects.

2. Loosen the charged air cooler inlet duct connector to turbocharger clamp (1).

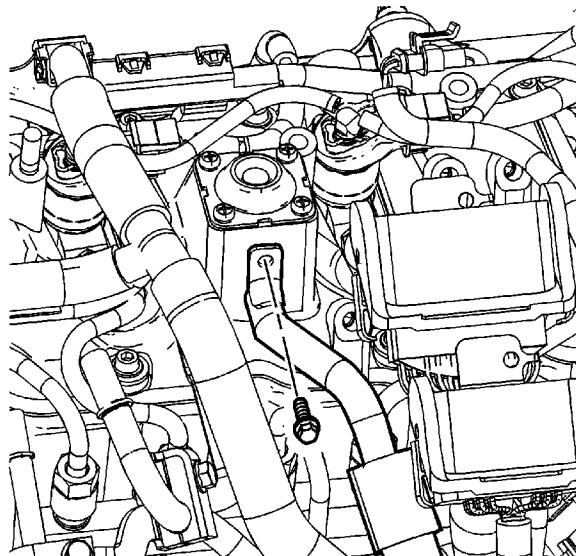
Note: Do not use a screwdriver or other tool to pry the hose loose. The hose can be torn or damaged. Loosen the hose by twisting.

3. Remove the charged air cooler inlet duct connector (4) from the turbocharger.

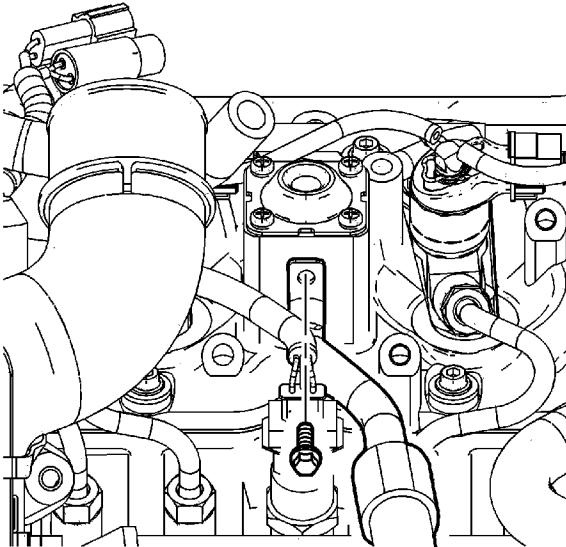
4. Remove the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).



5. Reposition the positive crankcase ventilation (PCV) hose clamp.
6. Remove the PCV hose from the air inlet pipe.
7. Remove the PCV hose from the clip on the top of the turbocharger.



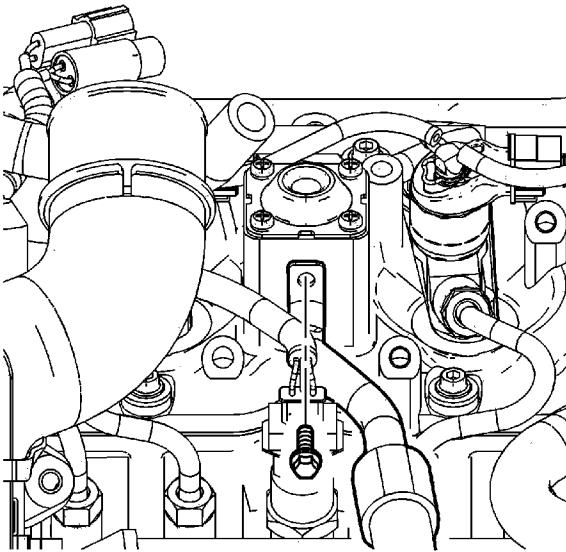
8. Remove the left PCV hose/pipe bolt.



9. Remove the right PCV hose/pipe bolt.
10. Remove the PCV hose/pipe.

Installation Procedure

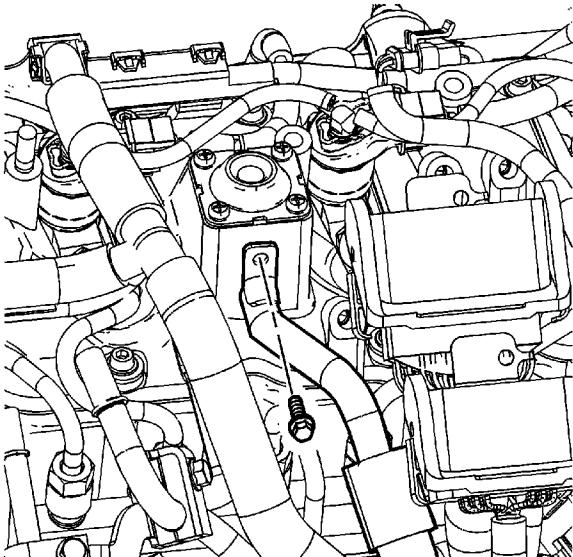
Caution: Refer to [Fastener Caution](#) in the Preface section.



1. Install the PCV hose/pipe.
2. Install the right PCV hose/pipe bolt.

Tighten

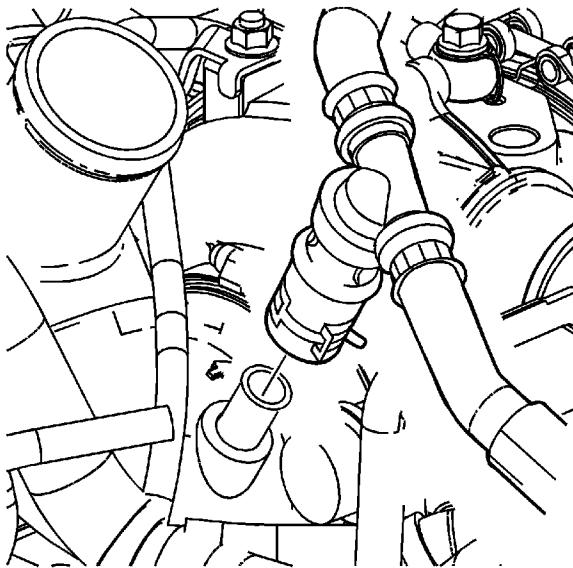
Tighten the bolt to 18 N·m (13 lb ft).



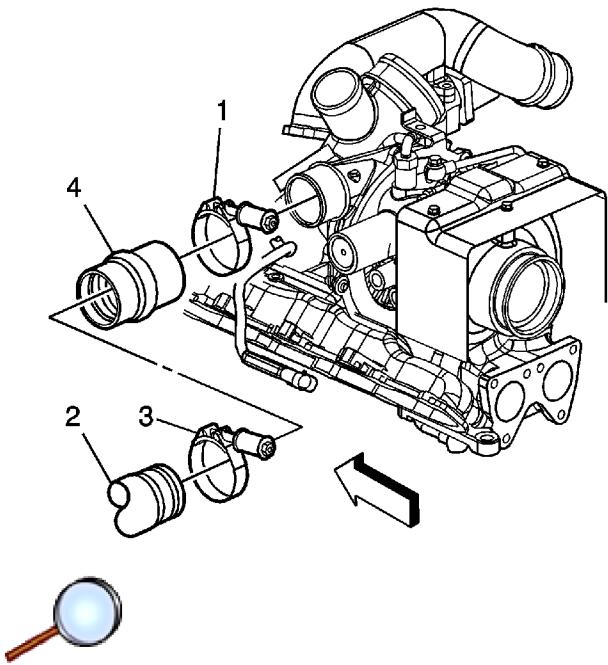
- 
3. Install the left PCV hose/pipe bolt.

Tighten

Tighten the bolt to 18 N·m (13 lb ft).



- 
4. Install the PCV hose to the air inlet pipe.
 5. Position the PCV hose clamp.
 6. Install the PCV hose to the clip on the top of the turbocharger.
 7. Install the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).



8. Remove the tape from the turbocharger openings.

Note: Lubricate the end of the duct prior to installation.

9. Install the charged air cooler inlet duct connector (4) to the turbocharger.
10. Tighten the charged air cooler inlet duct connector to turbocharger clamp (1).

Tighten

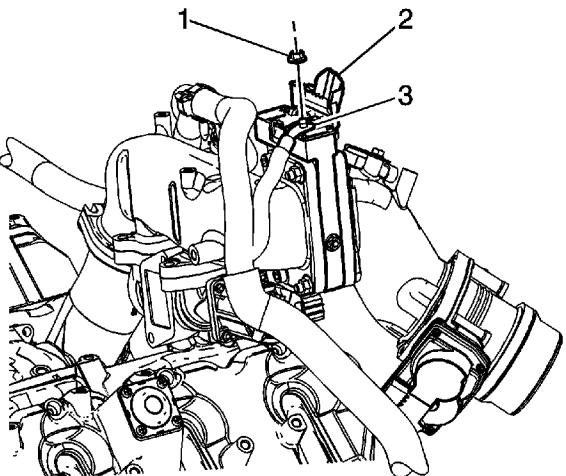
Tighten the clamp to 6 N·m (53 lb in).

11. Install the intake manifold cover. Refer to [Intake Manifold Cover Replacement](#).

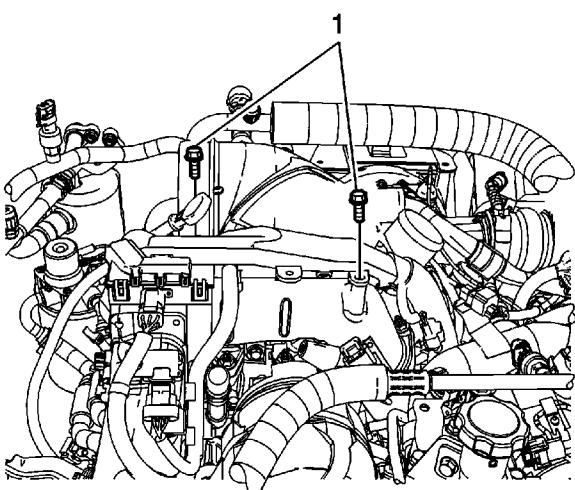
Intake Manifold Tube Replacement

Removal Procedure

1. Disconnect the negative battery cables. Refer to [Battery Negative Cable Disconnection and Connection](#).



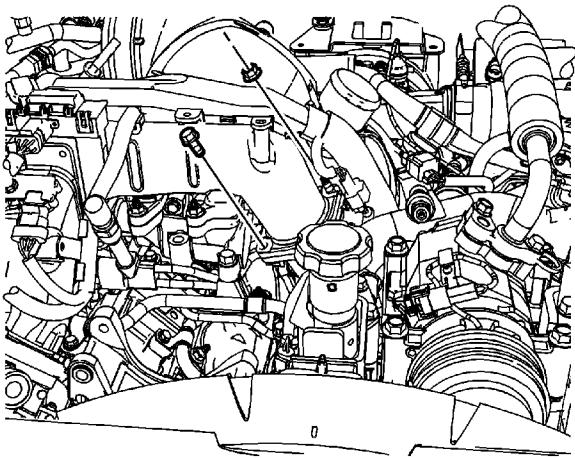
2. Open the intake air heater (IAH) harness lead cover (2).
3. Remove the engine wiring harness lead nut (1) from the IAH stud.
4. Remove the engine wiring harness lead (3) from the IAH stud.



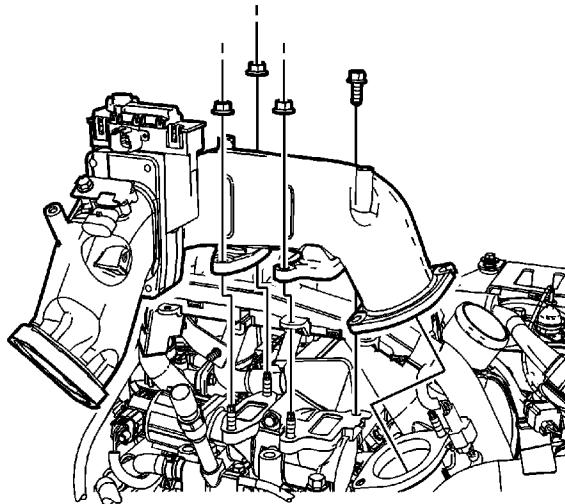
5. Remove the electrical harness bolts (1).

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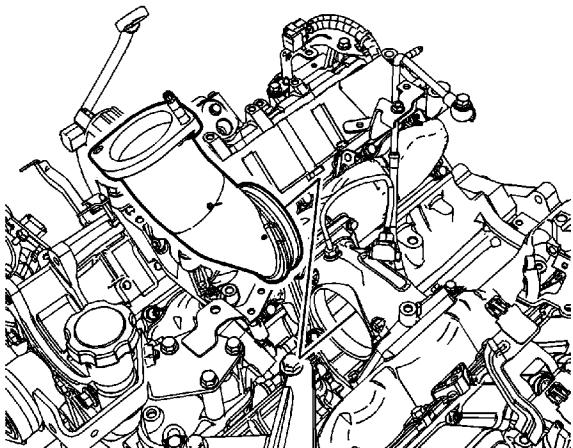
6. Reposition the harness clip from the intake manifold tube, as needed.



7. Remove the air inlet tube to intake manifold tube bolt and nut.

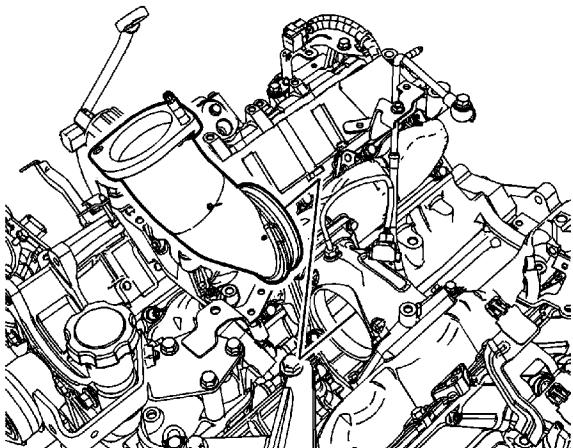


8. Disconnect the intake air heater electrical connector.
9. Disconnect the manifold absolute pressure (MAP) sensor electrical connector.
10. Remove the engine harness clip from the air inlet tube.
11. Remove the air inlet tube nuts and bolt.
12. Remove the air inlet tube.



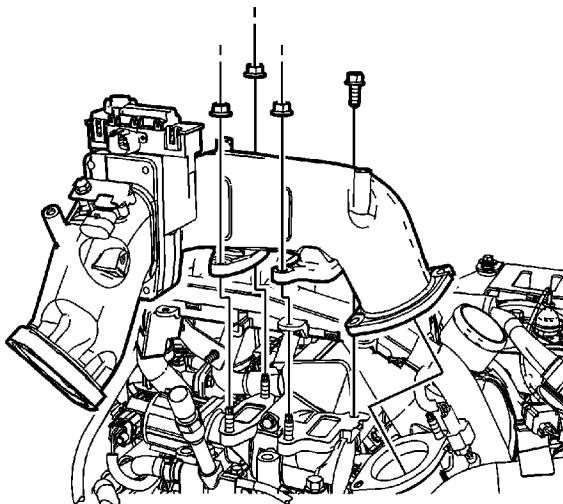
13. If necessary, remove the intake manifold tube.
14. If necessary, remove and discard the 2 O-ring seals from the tube.
15. Clean the gasket surfaces of the exhaust gas recirculation (EGR) cooler tube, intake manifold tube and inlet tube.

Installation Procedure



1. If necessary, install NEW O-ring seals onto the tube.
2. If necessary, install the intake manifold tube.

Caution: Refer to [Fastener Caution](#) in the Preface section.

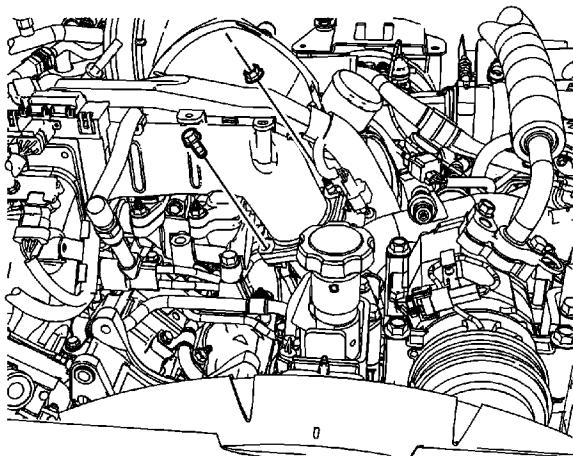


3. Install the air inlet tube and NEW gaskets.
4. Install the air inlet tube nuts and bolt.

Tighten

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

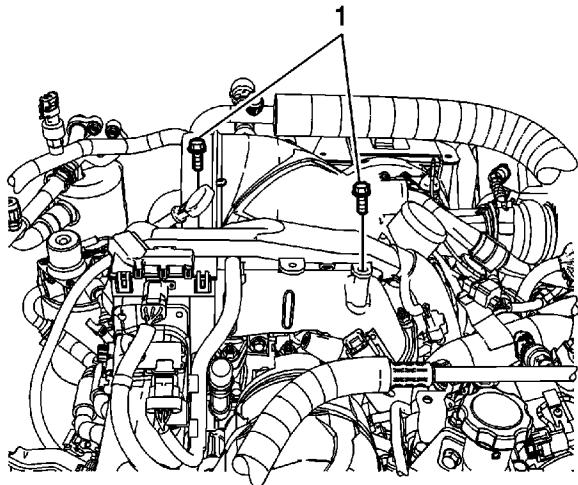
5. Connect the intake air heater electrical connector.
6. Connect the MAP sensor electrical connector.
7. Install the engine harness clip to the air inlet tube.



8. Install the air inlet tube to intake manifold tube bolt and nut.

Tighten

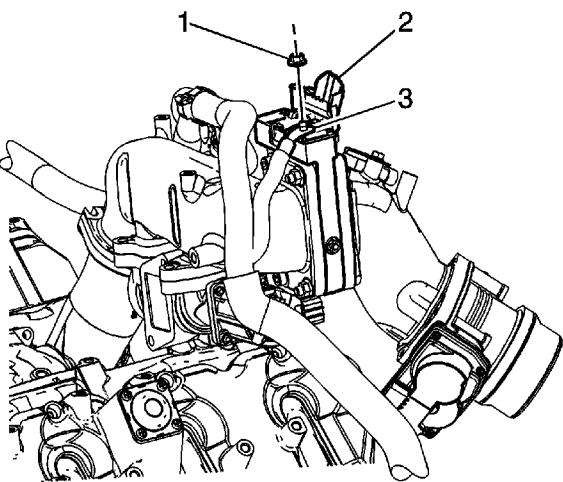
Tighten the bolt/nut to 10 N·m (89 lb in).



9. Install the electrical harness bolts (1).

Tighten

Tighten the bolts to 4 N·m (35 lb in).



10. Install the engine wiring harness lead (3) to the IAH stud.
11. Install the engine wiring harness lead nut (1) to the IAH stud.

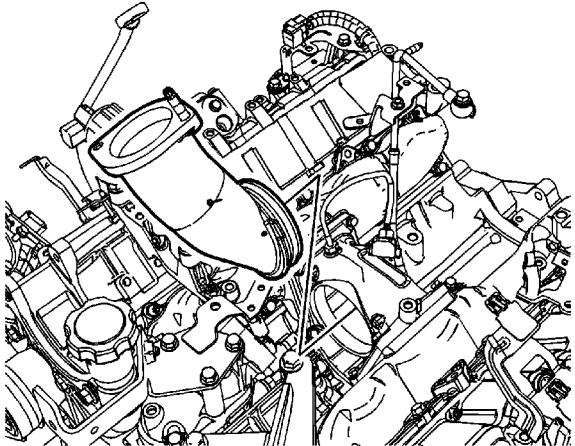
Tighten

Tighten the nut to 10 N·m (89 lb in).

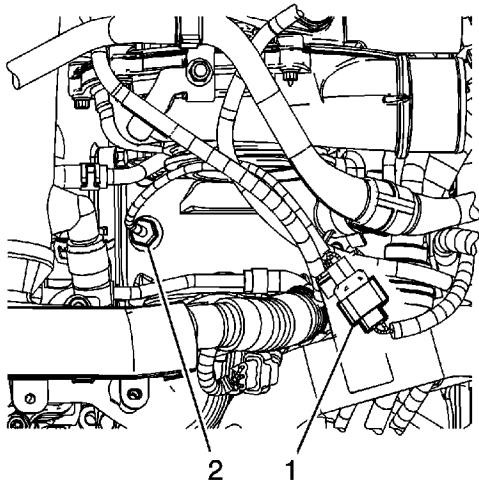
12. Close the IAH harness lead cover (2).
13. Connect the negative battery cables. Refer to [Battery Negative Cable Disconnection and Connection](#).

Center Intake Manifold Replacement

Removal Procedure

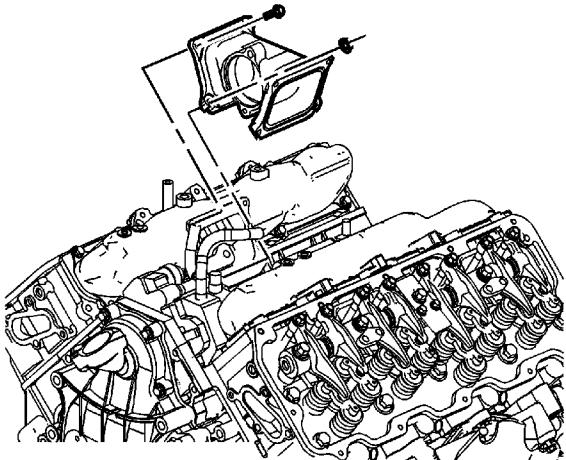


1. Remove the exhaust gas recirculation (EGR) valve cooler tube. Refer to [Exhaust Gas Recirculation Valve Cooler Replacement](#).
2. Remove the water outlet tube. Refer to [Water Outlet Tube Replacement](#).
3. Remove the intake manifold tube.
4. Remove and discard the 2 intake manifold tube gaskets.
5. Remove the turbocharger. Refer to [Turbocharger Replacement](#).



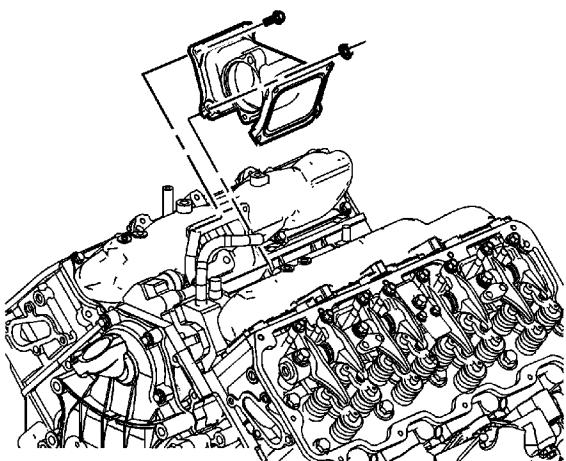


6. Disconnect the intake air temperature (IAT) sensor electrical connector (1).
7. Remove the IAT sensor (2).



8. Remove the center intake manifold bolts/nuts.
9. Pull-up the center intake manifold in order to remove.
10. Remove and discard the gaskets.
11. Clean the center intake manifold in cleaning solvent and air dry.

Installation Procedure



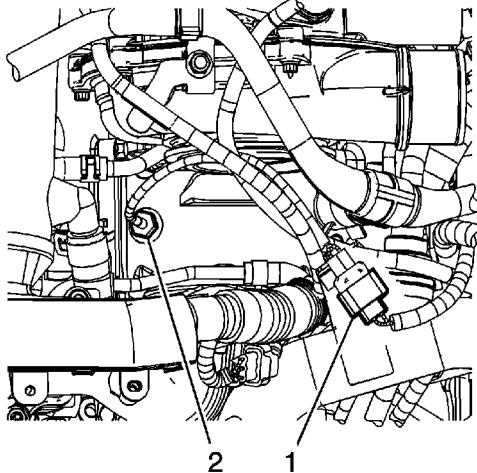
1. Install NEW center intake manifold gaskets.

Caution: Refer to [Fastener Caution](#) in the Preface section.

2. Install the center intake manifold.
3. Install the center intake manifold bolts/nuts.

Tighten

Tighten the bolts/nuts to 10 N·m (89 lb in).

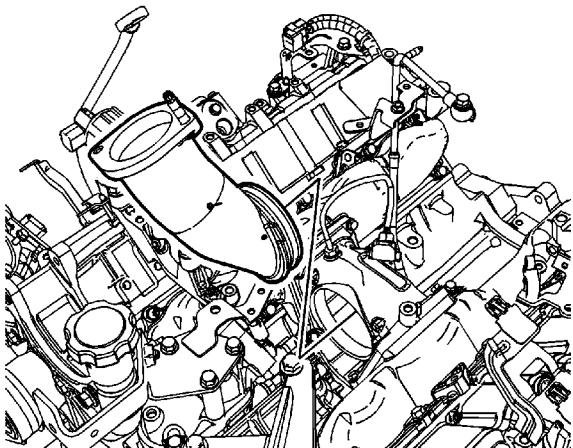


4. Install the IAT sensor (2).

Tighten

Tighten the sensor to 10 N·m (89 lb in).

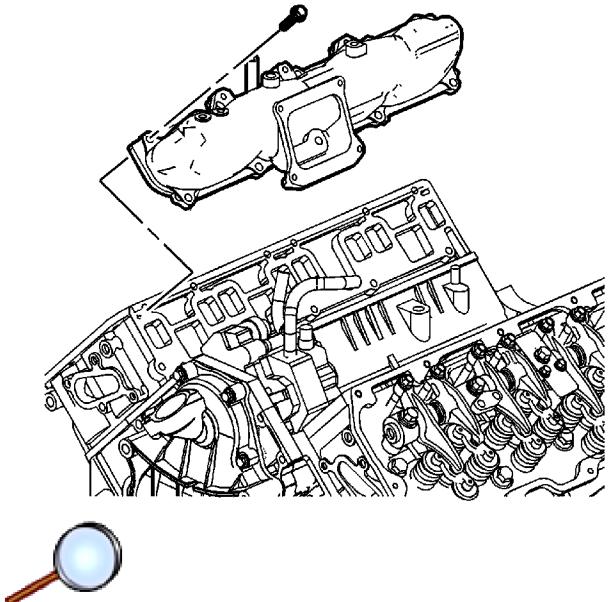
5. Connect the IAT sensor electrical connector (1).
6. Install the turbocharger. Refer to [Turbocharger Replacement](#).



7. Install 2 NEW O-rings onto the intake manifold tube.
8. Lubricate the O-rings with clean engine oil to aid in the installation.
9. Install the intake manifold tube.
10. Install the water outlet tube. Refer to [Water Outlet Tube Replacement](#).
11. Install the EGR valve cooler tube. Refer to [Exhaust Gas Recirculation Valve Cooler Replacement](#).

Intake Manifold Replacement - Left Side

Removal Procedure

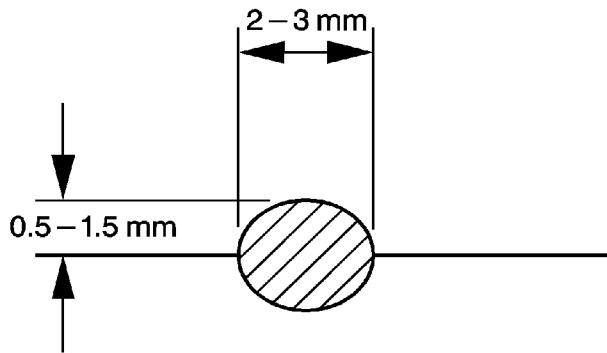


1. Remove the center intake manifold. Refer to [Center Intake Manifold Replacement](#).
2. Remove the glow plug module and bracket. Refer to [Glow Plug Control Module Replacement](#).
3. Remove the left fuel rail. Refer to [Fuel Injection Fuel Rail Assembly Replacement - Bank 1](#).
4. Remove the intake manifold bolts/nuts.

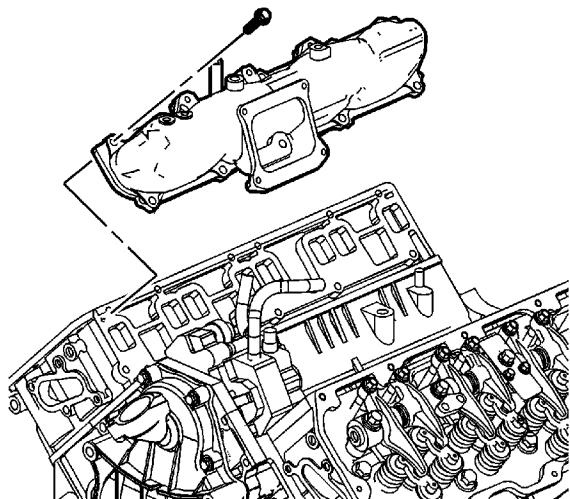
Note: The intake manifold uses sealer. Pry at the area by the fuel rail bolt holes in order to avoid damage to the sealing surfaces.

5. Remove the intake manifold.
6. To prevent entry of debris in the cylinder head tape the openings.
7. If required, clean and inspect the intake manifold. Refer to [Intake Manifold Cleaning and Inspection](#).

Installation Procedure

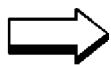
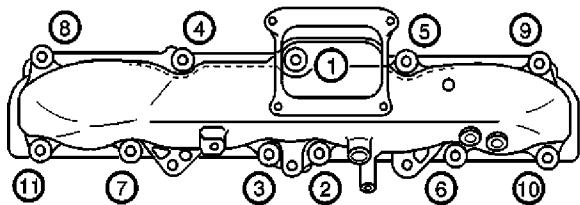


-  1. Apply a 2-3 mm (1/8 in) wide, by 0.5-1.5 mm (1/16 in) high bead of sealant to the intake manifold. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for the correct part number.



-  2. Install the intake manifold.
- 3. Install the intake manifold bolts/nuts.

Caution: Refer to [Fastener Caution](#) in the Preface section.



4. Tighten the intake manifold bolts/nuts in the sequence shown.

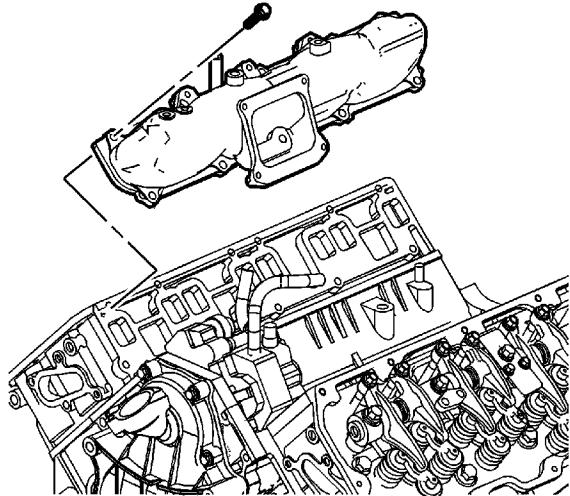
Tighten

Tighten the bolts/nuts to 21 N·m (15 lb ft).

5. Install the left fuel rail. Refer to [Fuel Injection Fuel Rail Assembly Replacement - Bank 1](#).
6. Install the glow plug module and bracket. Refer to [Glow Plug Control Module Replacement](#).
7. Install the center intake manifold. Refer to [Center Intake Manifold Replacement](#).

Intake Manifold Replacement - Right Side

Removal Procedure

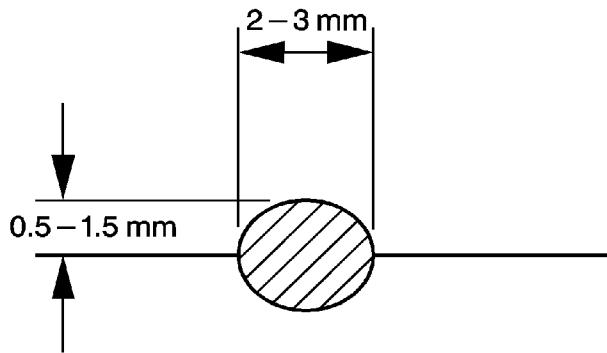


1. Remove the center intake manifold. Refer to [Center Intake Manifold Replacement](#).
2. Remove the right fuel rail. Refer to [Fuel Injection Fuel Feed Front Pipe Replacement - Right Side](#).
3. Remove the intake manifold bolts/nuts.
4. Remove the fuel return junction block. Refer to [Fuel Injection Fuel Feed Manifold Replacement](#).

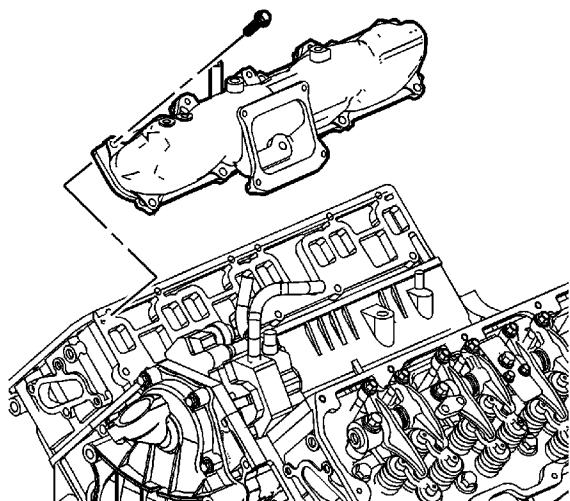
Note: The intake manifold uses sealer. Pry at the area by the fuel rail bolt holes in order to avoid damage to the sealing surfaces.

5. Remove the intake manifold.
6. To prevent entry of debris in the cylinder head tape the openings.
7. If required, clean and inspect the intake manifold. Refer to [Intake Manifold Cleaning and Inspection](#).

Installation Procedure

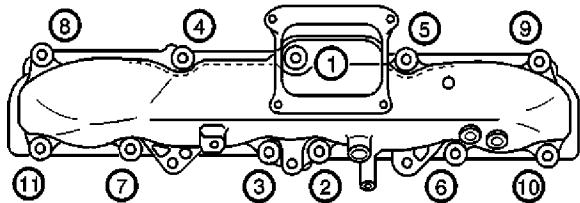


-  1. Apply a 2-3 mm (1/8 in) wide, by 0.5-1.5 mm (1/16 in) high bead of sealant to the intake manifold. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for the correct part number.



-  2. Install the intake manifold.
- 3. Install the intake manifold bolts/nuts.

Caution: Refer to [Fastener Caution](#) in the Preface section.



4. Tighten the intake manifold bolts/nuts in the sequence shown.

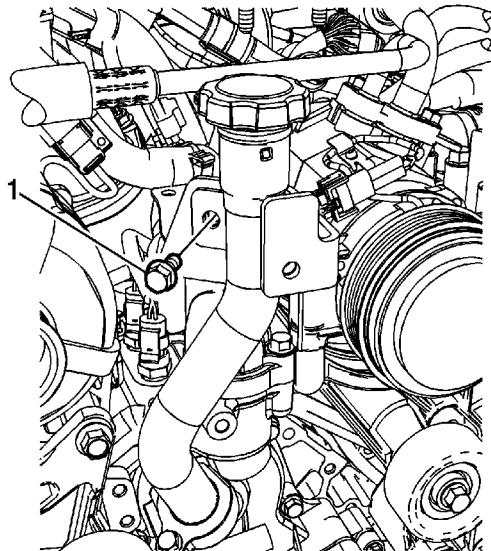
Tighten

Tighten the bolts/nuts to 21 N·m (15 lb ft).

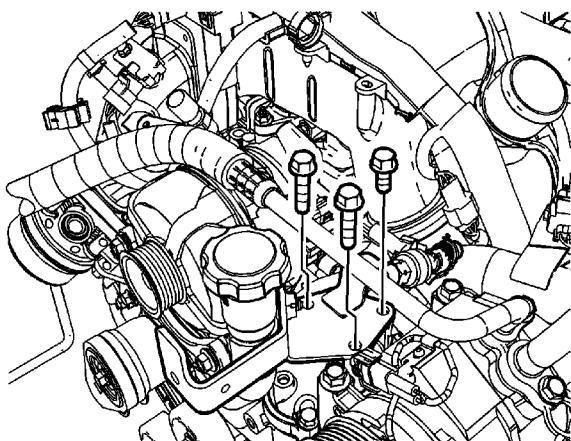
5. Install the fuel return junction block. Refer to [Fuel Injection Fuel Feed Manifold Replacement](#).
6. Install the right fuel rail. Refer to [Fuel Injection Fuel Feed Front Pipe Replacement - Right Side](#).
7. Install the center intake manifold. Refer to [Center Intake Manifold Replacement](#).

Oil Filler Tube Replacement

Removal Procedure

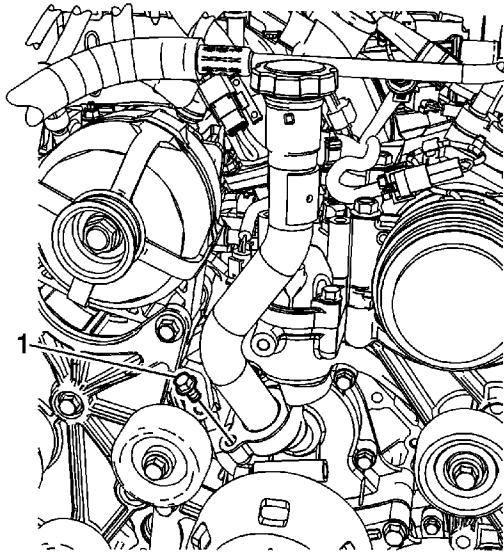


1. Remove the fan and clutch assembly. Refer to [Cooling Fan and Shroud Replacement](#).
2. Remove the drive belt. Refer to [Drive Belt Replacement](#).
3. Remove the upper oil fill tube bolt (1).

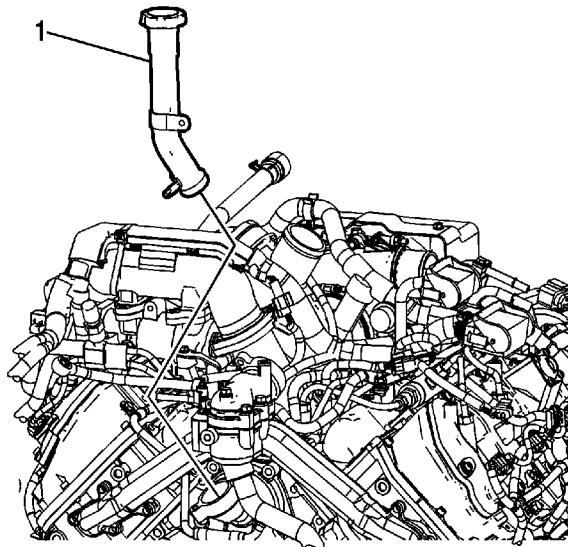


4. Remove the oil filler tube bracket bolts.
5. Remove the oil fill tube bracket.

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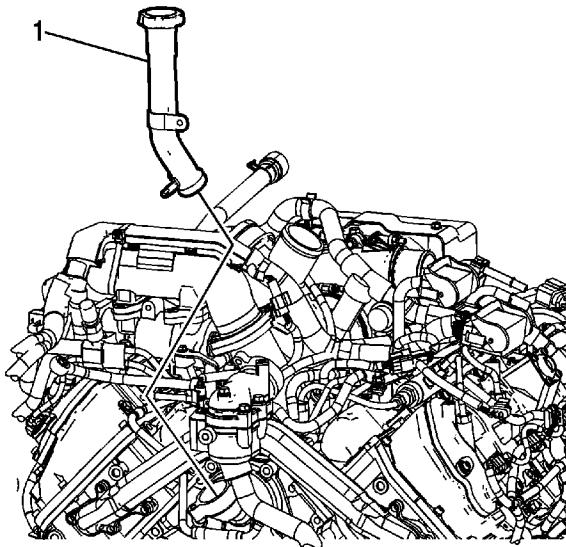


6. Remove the lower oil fill tube bolt (1).



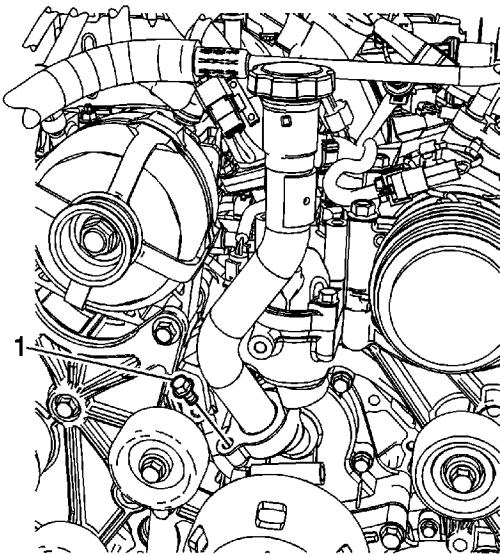
7. Remove the oil fill tube.
8. Remove and discard the oil fill tube O-ring seal.

Installation Procedure



1. Install a NEW O-ring seal onto the oil fill tube.
2. Install the oil fill tube.

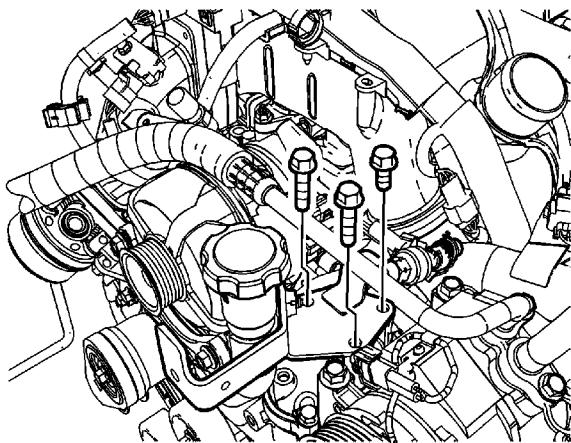
Caution: Refer to [Fastener Caution](#) in the Preface section.



3. Install the lower oil fill tube bolt (1).

Tighten

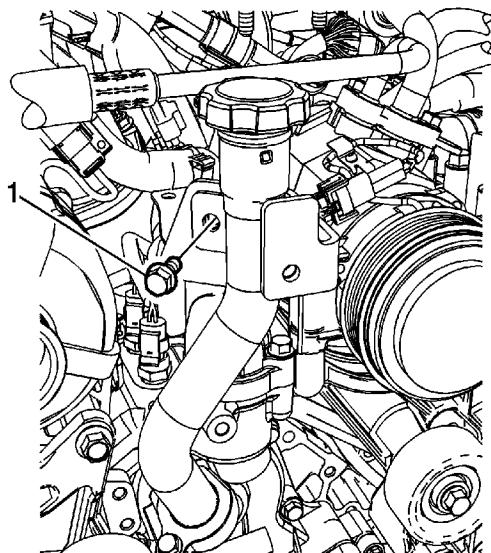
Tighten the bolts to 21 N·m (15 lb ft).



4. Install the oil fill tube bracket.
5. Install the oil filler tube bracket bolts.

Tighten

Tighten the bolts to 21 N·m (15 lb ft).



6. Install the upper oil fill tube bolt (1).

Tighten

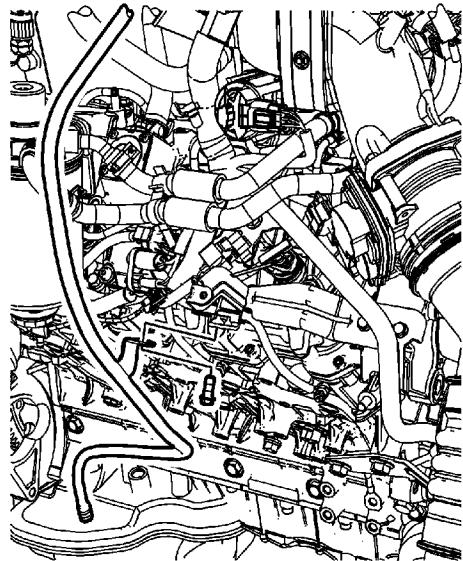
Tighten the bolts to 21 N·m (15 lb ft).

7. Install the drive belt. Refer to [Drive Belt Replacement](#).

8. Install the fan and clutch assembly. Refer to [Cooling Fan and Shroud Replacement](#).

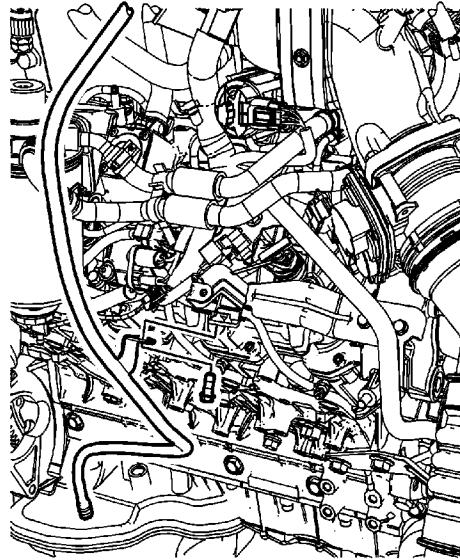
Oil Level Indicator Tube Replacement

Removal Procedure



1. Remove the oil level indicator.
2. Remove the exhaust manifold. Refer to [Exhaust Manifold Replacement - Right Side](#).
3. Remove the starter motor. Refer to [Starter Motor Replacement](#).
4. Remove the oil level indicator tube bolt at the indicator tube bracket.
5. Remove the oil level indicator tube and O-ring seals.
6. Remove and discard the O-ring seals.

Installation Procedure



1. Install NEW O-ring seals onto the oil level indicator tube.
2. Lightly lubricate the O-ring seals with engine oil.

Caution: Refer to [Fastener Caution](#) in the Preface section.

3. Install the oil level indicator tube.
4. Install the oil level indicator tube bolt at the indicator tube bracket.

Tighten

Tighten the bolt to 21 N·m (15 lb ft).

5. Install the starter motor. Refer to [Starter Motor Replacement](#).
6. Install the exhaust manifold. Refer to [Exhaust Manifold Replacement - Right Side](#).
7. Install the oil level indicator.

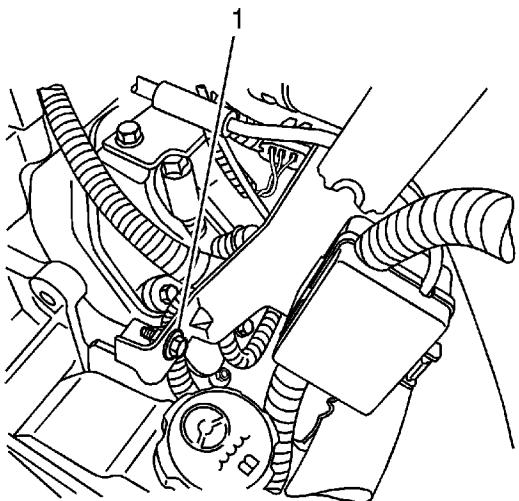
Valve Rocker Arm Cover Replacement - Upper Left Side

Removal Procedure

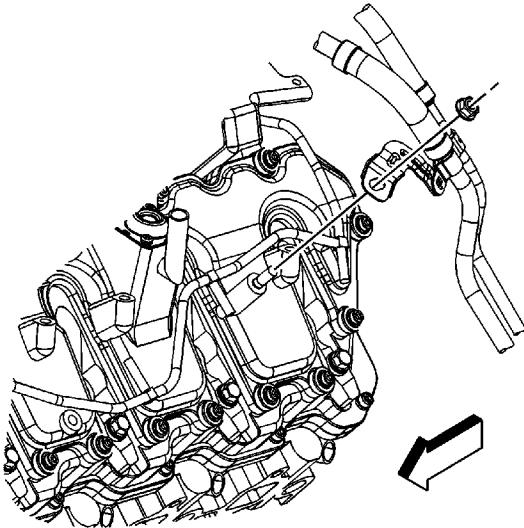
1. Remove the intake manifold cover. Refer to [Intake Manifold Cover Replacement](#).
2. Drain the cooling system. Refer to [Cooling System Draining and Filling](#).
3. Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

Note: After removing the charged air cooler duct, cover the turbocharger opening with tape in order to prevent entry of objects.

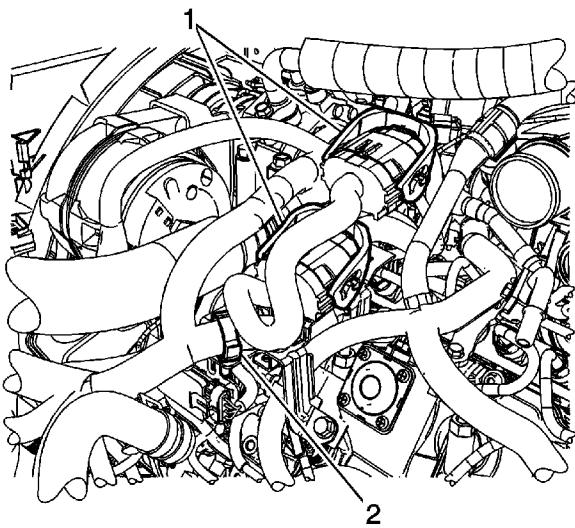
4. Remove the charged air cooler inlet duct. Refer to [Charge Air Cooler Inlet Pipe Replacement](#).



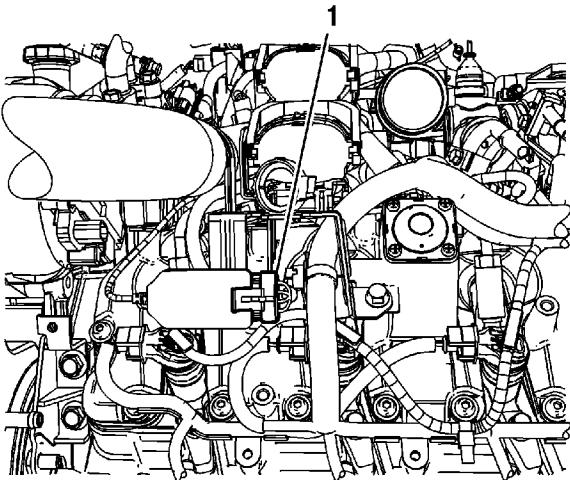
5. Remove the battery cable to generator nut.
6. If equipped, remove the battery cable to the auxiliary generator.
7. Remove the battery cable harness clip from the bracket.
8. Remove the battery cable junction block bolt (1) from the power steering pump.
9. Move and secure the battery cables out of the way.



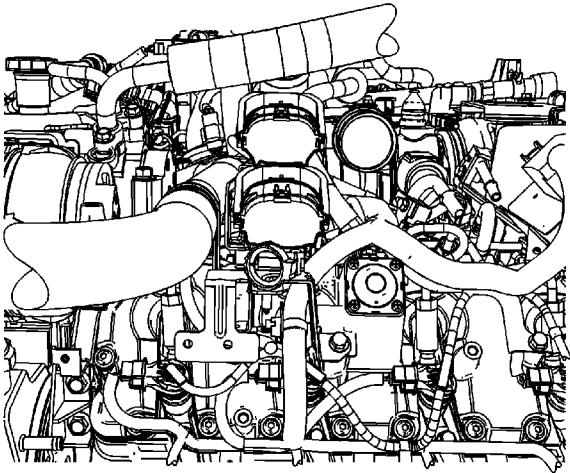
10. Disconnect the fuel lines. Refer to [Metal Collar Quick Connect Fitting Service](#).
11. Remove the fuel hose bracket nut.



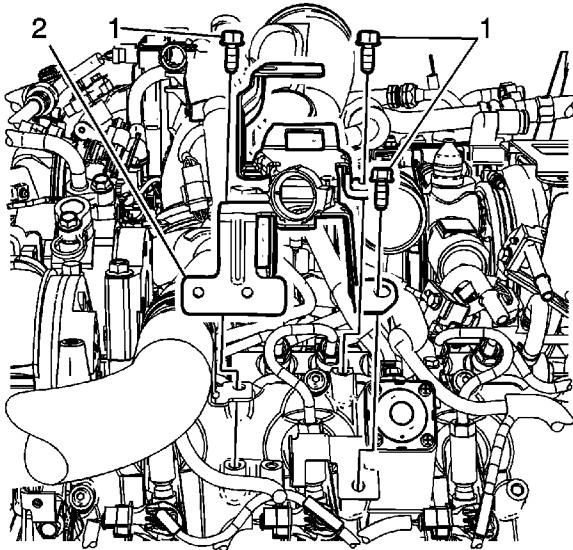
12. Disconnect the main engine electrical harness connectors. Lift up on the latches (1) in order to disconnect the connectors.
13. Open the harness clip (2).
14. Remove the main engine electrical harness connectors.



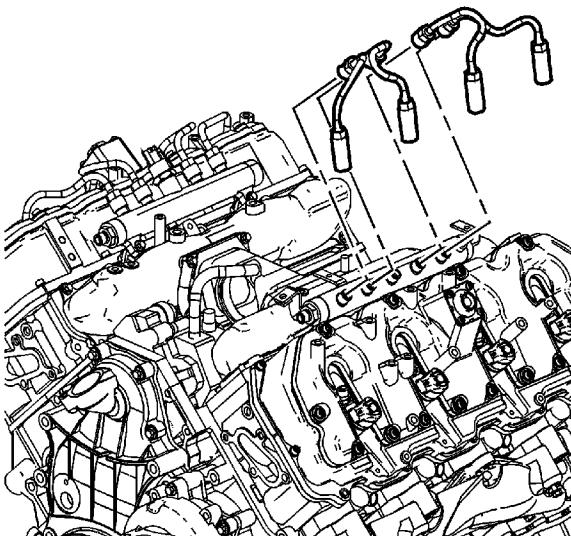
15. Disconnect the turbocharger vane position sensor electrical connector (1).



16. Unclip the main engine electrical harness connectors from the main electrical connector harness bracket.



17. Remove the main electrical connector harness bracket bolts (1).
18. Remove the main electrical connector harness bracket (2).
19. Remove the water outlet tube. Refer to [Water Outlet Tube Replacement](#).
20. Remove the auxiliary generator, if equipped. Refer to [Auxiliary Generator Replacement](#).
21. Remove the positive crankcase ventilation (PCV) hose/pipe. Refer to [Positive Crankcase Ventilation Hose/Pipe/Tube Replacement](#).

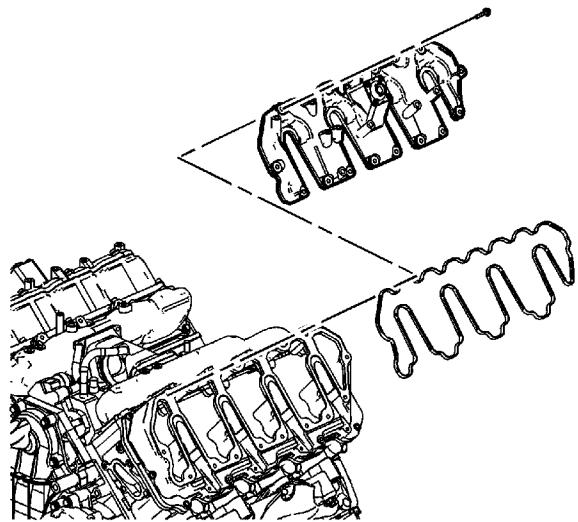


22. Prior to removing the fuel injector pipes, use compressed air to blow any debris from between the injector line and fittings. Wipe the fittings clean of debris.
23. Spray lithium grease between the fuel injector line and fittings to assist in containing any debris during removal. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for the correct part number.

Caution: DO NOT use compressed air to clean debris from the fuel injector inlet after the fuel line is removed. Using compressed air can allow debris to enter the fuel injector inlet and

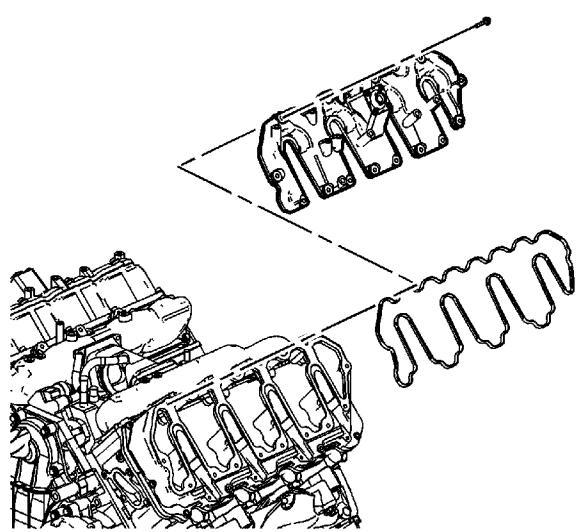
damage the fuel injector.

24. Remove the left fuel injector pipes.



25. Remove the upper valve rocker arm cover bolts.
26. Remove the upper valve rocker arm cover.
27. Remove the upper valve rocker arm cover gasket.
28. Inspect the upper valve rocker arm cover gasket for damage, replace if necessary. Otherwise reuse the old gasket.
29. If required, clean and inspect the upper valve rocker arm cover. Refer to [Valve Rocker Arm Cover Cleaning and Inspection - Upper](#).

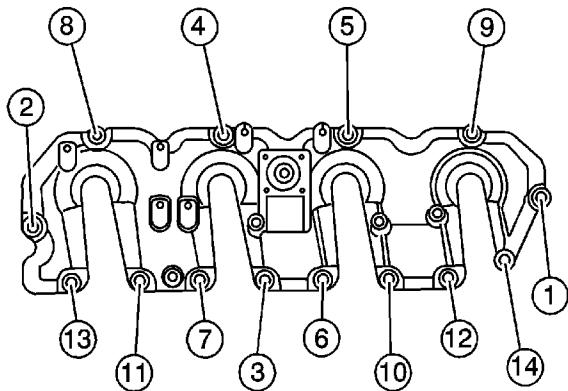
Installation Procedure





1. Install the valve rocker arm cover gasket.
2. Install the upper valve rocker arm cover.
3. Install the upper valve rocker arm cover bolts.

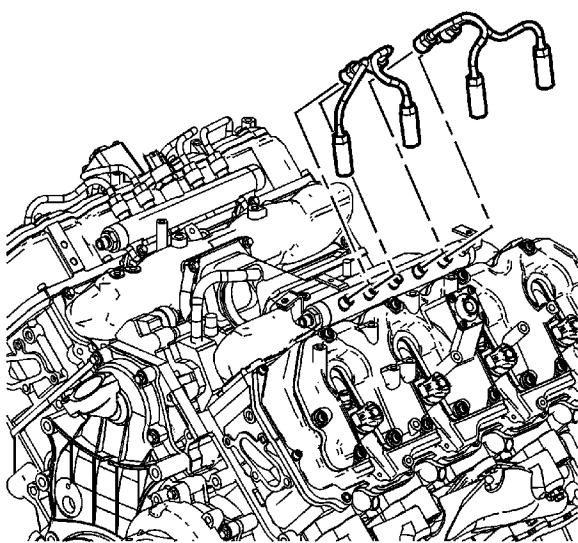
Caution: Refer to [Fastener Caution](#) in the Preface section.



4. Tighten the upper valve rocker arm cover bolts in the sequence shown.

Tighten

Tighten the bolts to 8 N·m (71 lb in).





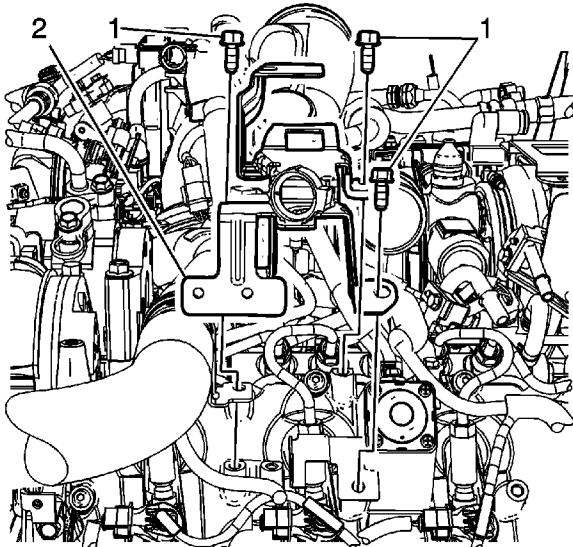
Caution: Ensure proper torquing of the fuel injector line. An under-torqued fuel injector line will not seal properly and an over-torqued fuel injector line may damage the fuel injector fitting. An improperly sealed or damaged fuel injector line or fuel injector fitting will cause a fuel leak.

5. Install the left fuel injector pipes.

Tighten

Tighten the pipes to 41 N·m (30 lb ft).

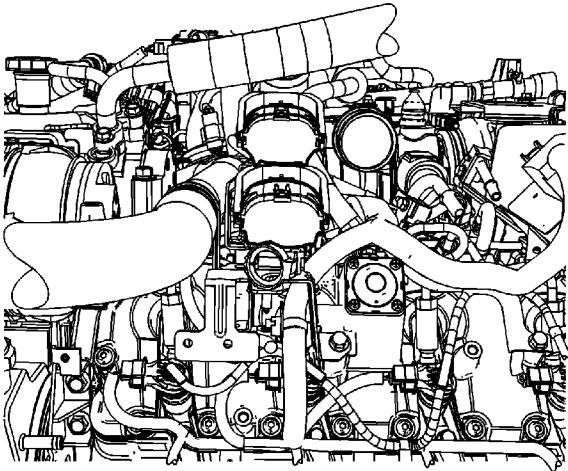
6. Install the water outlet tube. Refer to [Water Outlet Tube Replacement](#).
7. Install the auxiliary generator, if equipped. Refer to [Auxiliary Generator Replacement](#).
8. Install the PCV hose/pipe. Refer to [Positive Crankcase Ventilation Hose/Pipe/Tube Replacement](#).



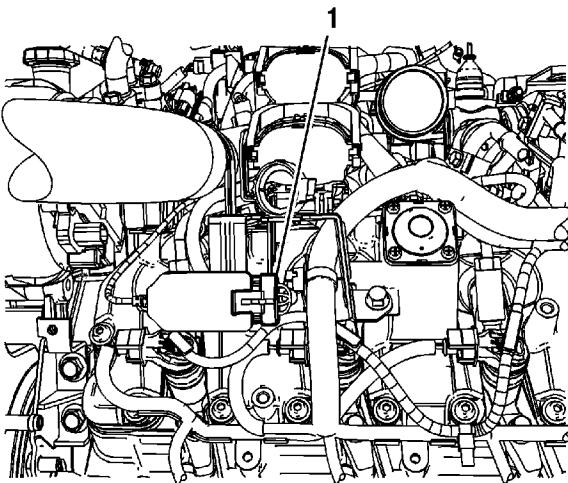
9. Install the main electrical connector harness bracket (2).
10. Install the main electrical connector harness bracket bolts (1).

Tighten

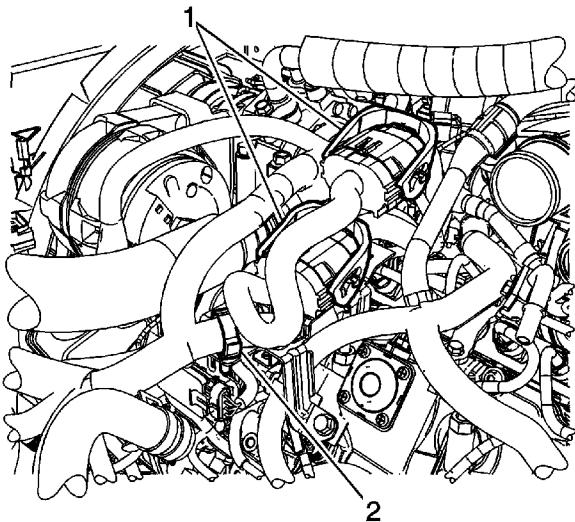
Tighten the bolts to 21 N·m (15 lb ft).



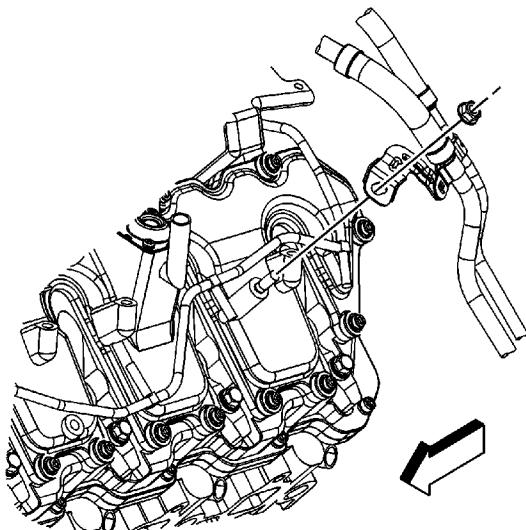
11. Clip the main engine electrical harness connectors to the main electrical connector harness bracket.



12. Connect the turbocharger vane position sensor electrical connector (1).



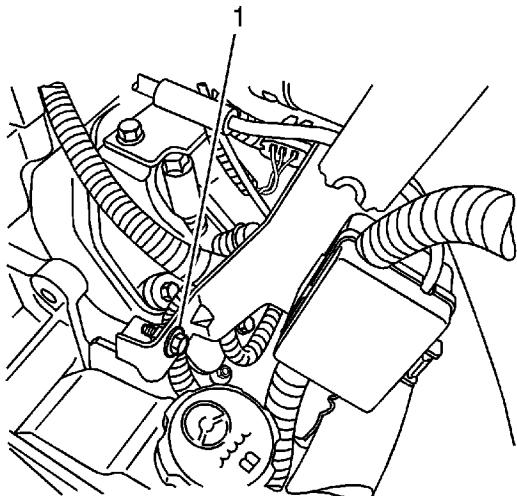
13. Connect the main engine electrical harness connectors.
14. Push down on the latches (1) in order to connect the connectors.
15. Close the harness clip (2).



16. Connect the fuel lines. Refer to [Metal Collar Quick Connect Fitting Service](#).
17. Install the fuel hose bracket nut.

Tighten

Tighten the nut to 21 N·m (15 lb ft).



18. Position the generator positive cable.
19. Install the generator positive cable in the clip on the engine front cover.
20. Install the generator positive cable and nut.

Tighten

Tighten the nut to 9 N·m (80 lb in).

21. Install the positive battery cable junction block bracket and bolt (1) to the power steering pump.

Tighten

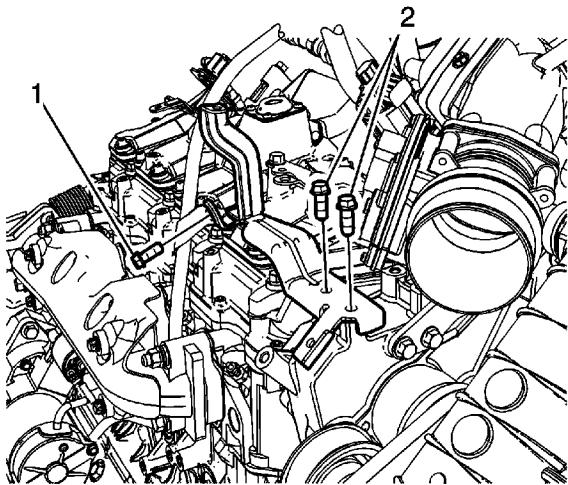
Tighten the bolt to 9 N·m (80 lb in).

22. Remove the tape from the turbocharger openings.
23. Install the charged air cooler inlet duct. Refer to [Charge Air Cooler Inlet Pipe Replacement](#).
24. Fill the cooling system. Refer to [Cooling System Draining and Filling](#).
25. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
26. Install the intake manifold cover. Refer to [Intake Manifold Cover Replacement](#).

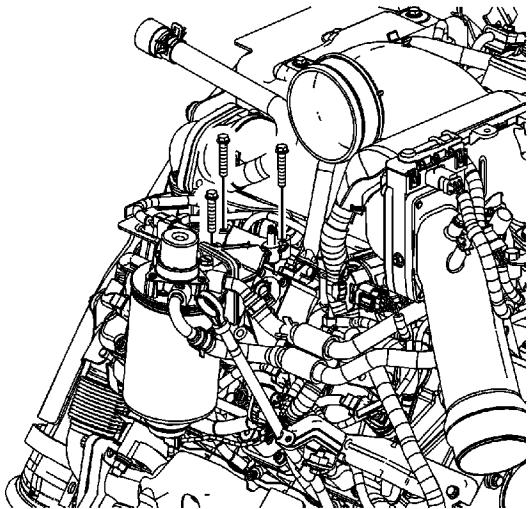
Valve Rocker Arm Cover Replacement - Upper Right Side

Removal Procedure

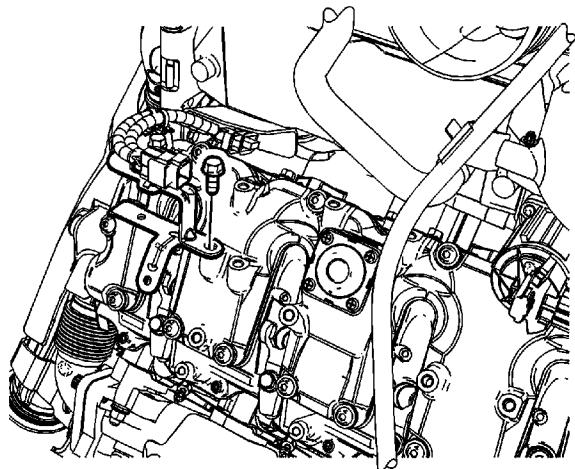
1. Remove the intake manifold cover. Refer to [Intake Manifold Cover Replacement](#).
2. Remove the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
3. Remove the charged air cooler outlet duct. Refer to [Charge Air Cooler Outlet Pipe Replacement](#).
4. Remove the exhaust gas recirculation (EGR) cooler tube. Refer to [Exhaust Gas Recirculation Valve Cooler Replacement](#).
5. Remove the heater outlet hose bolt from the bracket.
6. Position the heater outlet hose out of the way.



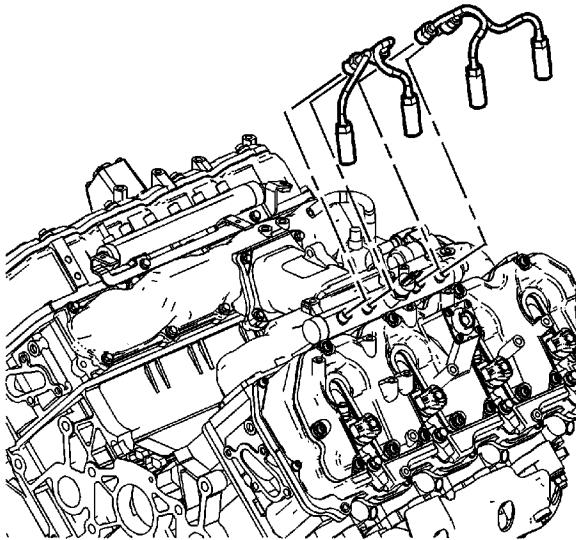
7. Remove the wiring harness retainer from the bracket.
8. Remove the oil level indicator tube bolt (1).
9. Remove the oil level indicator tube bracket bolts (2).
10. Remove the bracket.



11. Remove the fuel filter bracket bolts.
12. Reposition the fuel filter with bracket.
13. Remove the positive crankcase ventilation (PCV) hose/pipe. Refer to [Positive Crankcase Ventilation Hose/Pipe/Tube Replacement](#).



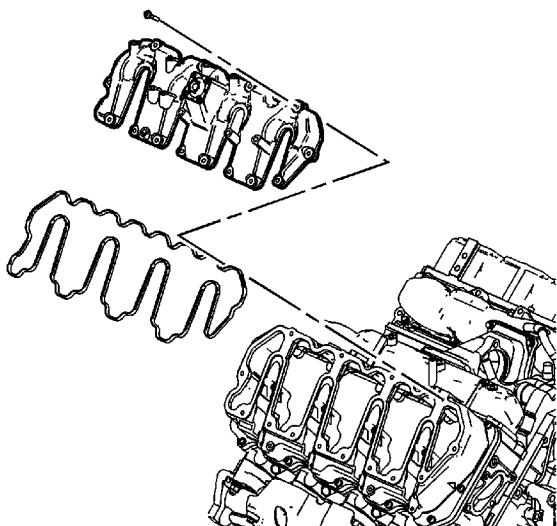
14. Remove the engine harness bracket bolt.
15. Position engine harness brackets aside.



16. Prior to removing the fuel injector pipes, use compressed air to blow any debris from between the injector line and fittings. Wipe the fittings clean of debris.
17. Spray lithium grease between the fuel injector line and fittings to assist in containing any debris during removal. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for the correct part number.

Caution: DO NOT use compressed air to clean debris from the fuel injector inlet after the fuel line is removed. Using compressed air can allow debris to enter the fuel injector inlet and damage the fuel injector.

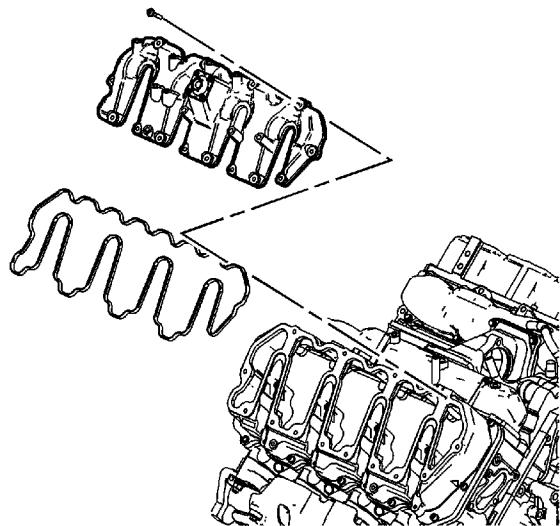
18. Remove the right fuel injector pipes.



19. Remove the upper valve rocker arm cover bolts.
20. Remove the upper valve rocker arm cover.

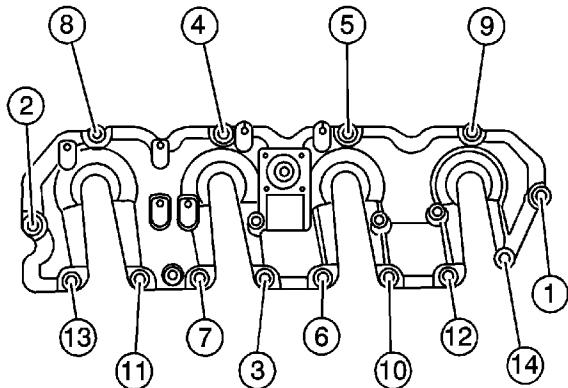
21. Remove the upper valve rocker arm cover gasket.
22. Inspect the upper valve rocker arm cover gasket for damage, replace if necessary. Otherwise reuse the old gasket.
23. If required, clean and inspect the upper valve rocker arm cover. Refer to [Valve Rocker Arm Cover Cleaning and Inspection - Upper](#).

Installation Procedure



1. Install the upper valve rocker arm cover gasket.
2. Install the upper valve rocker arm cover.
3. Install the upper valve rocker arm cover bolts.

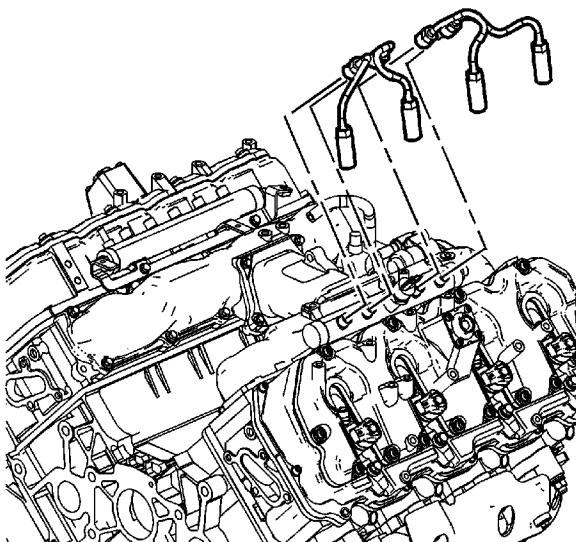
Caution: Refer to [Fastener Caution](#) in the Preface section.



4. Tighten the upper valve rocker arm cover bolts in the sequence shown.

Tighten

Tighten the bolts to 8 N·m (71 lb in).

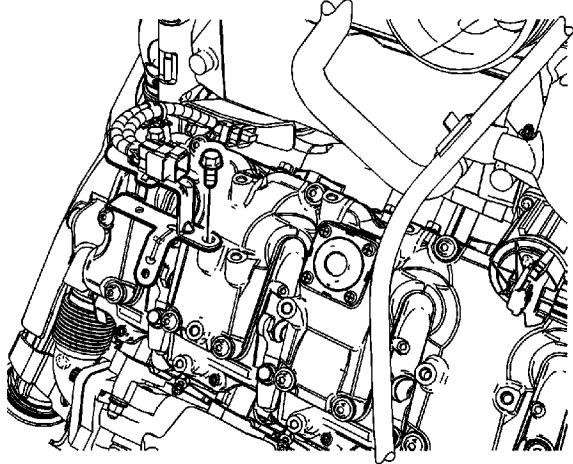


Caution: Ensure proper torquing of the fuel injector line. An under-torqued fuel injector line will not seal properly and an over-torqued fuel injector line may damage the fuel injector fitting. An improperly sealed or damaged fuel injector line or fuel injector fitting will cause a fuel leak.

5. Install the fuel injector pipes.

Tighten

Tighten the pipes to 41 N·m (30 lb ft).

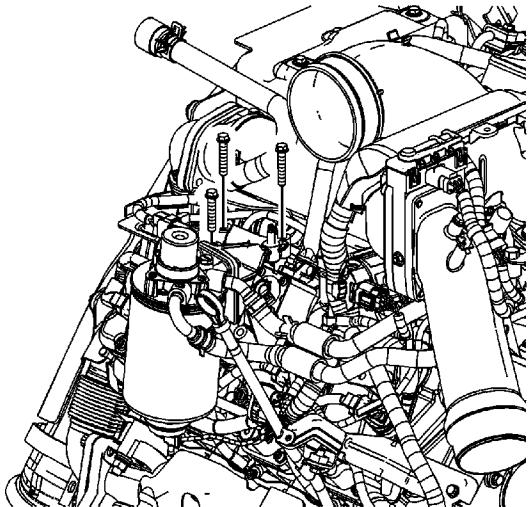


6. Position engine harness brackets.
7. Install the engine harness bracket bolt.

Tighten

Tighten the bolt to 21 N·m (15 lb ft).

8. Install the PCV hose/pipe. Refer to [Positive Crankcase Ventilation Hose/Pipe/Tube Replacement](#).



9. Position the fuel filter with bracket to the rocker cover.

10. Install the fuel filter bracket bolts.

Tighten

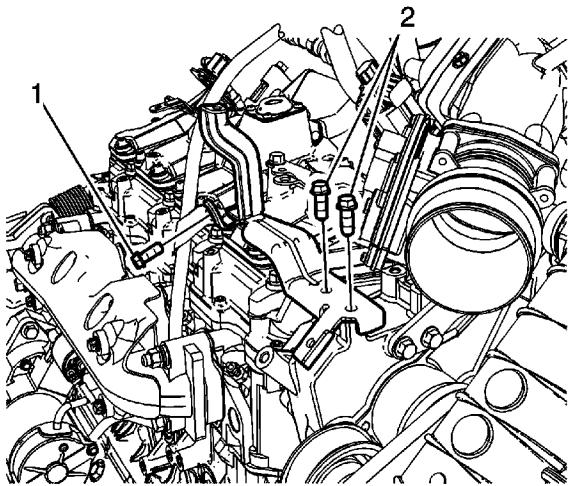
Tighten the bolts to 21 N·m (15 lb ft).

11. Position the heater outlet hose.
12. Install the heater hose bracket bolt to the bracket.

Tighten

Tighten the bolt to 21 N·m (15 lb ft).

13. Install the EGR cooler tube. Refer to [Exhaust Gas Recirculation Valve Cooler Replacement](#).



14. Install the bracket.
15. Install the oil level indicator tube bracket bolts (2).

Tighten

Tighten the bolts to 21 N·m (15 lb ft).

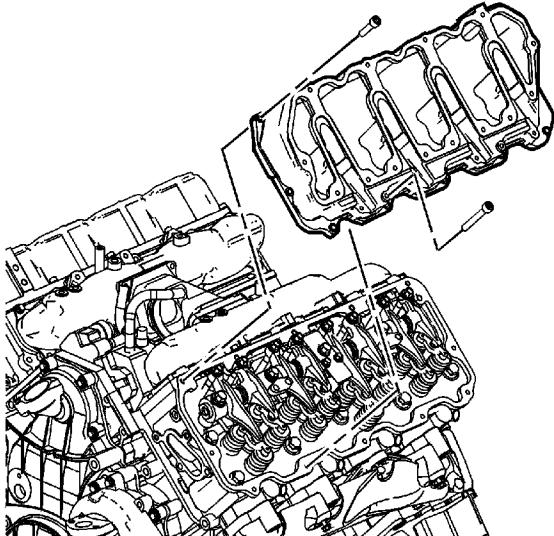
16. Install the oil level indicator tube bolt (1).

Tighten

Tighten the bolt to 21 N·m (15 lb ft).

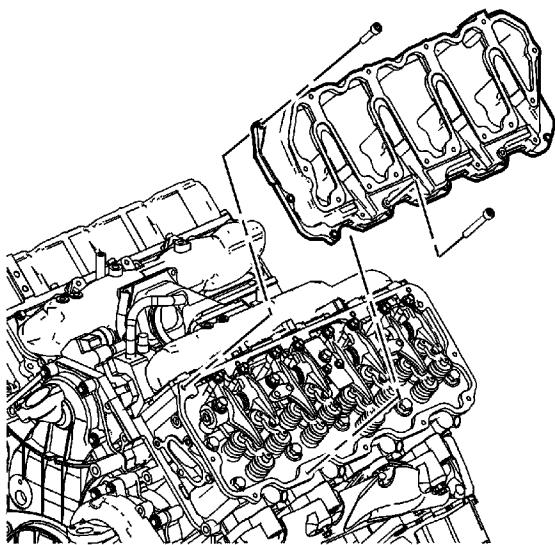
17. Install the wiring harness retainer to the bracket.
18. Install the charged air cooler outlet duct. Refer to [Charge Air Cooler Outlet Pipe Replacement](#).
19. Install the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
20. Install the intake manifold cover. Refer to [Intake Manifold Cover Replacement](#).

Valve Rocker Arm Cover Replacement - Lower Left Side Removal Procedure



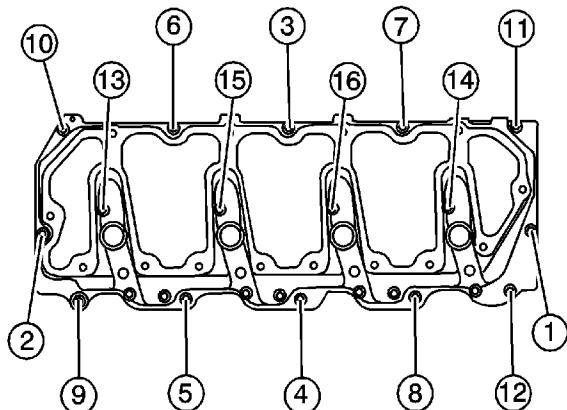
1. Remove the upper left valve rocker arm cover. Refer to [Valve Rocker Arm Cover Replacement - Upper Left Side](#).
2. Remove the fuel injectors. Refer to [Fuel Injector Replacement](#).
3. Remove the lower valve rocker arm cover bolts.
4. Remove the lower valve rocker arm cover.
5. Remove the gasket from the lower valve rocker arm cover.
6. Inspect the lower valve rocker arm cover gasket for damage, replace if necessary. Otherwise reuse the old gasket.
7. If required, clean and inspect the lower valve rocker arm cover. Refer to [Valve Rocker Arm Cover Cleaning and Inspection - Lower](#).

Installation Procedure



1. Install the lower valve rocker arm cover gasket.
2. Install the lower valve rocker arm cover.
3. Install the lower valve rocker arm cover bolts.

Caution: Refer to [Fastener Caution](#) in the Preface section.



4. Tighten the lower valve rocker arm cover bolts in the sequence shown.

Tighten

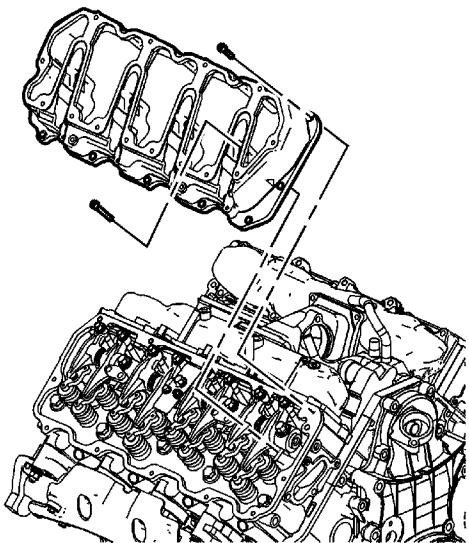
Tighten the bolts to 10 N·m (89 lb in).

5. Install the fuel injectors. Refer to [Fuel Injector Replacement](#).

6. Install the upper left valve rocker arm cover. Refer to [Valve Rocker Arm Cover Replacement - Upper Left Side.](#)

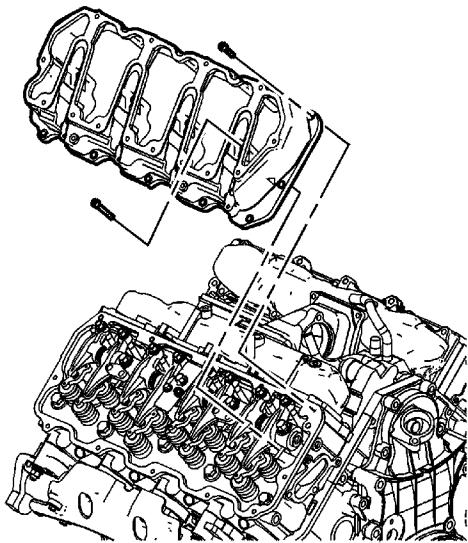
Valve Rocker Arm Cover Replacement - Lower Right Side

Removal Procedure



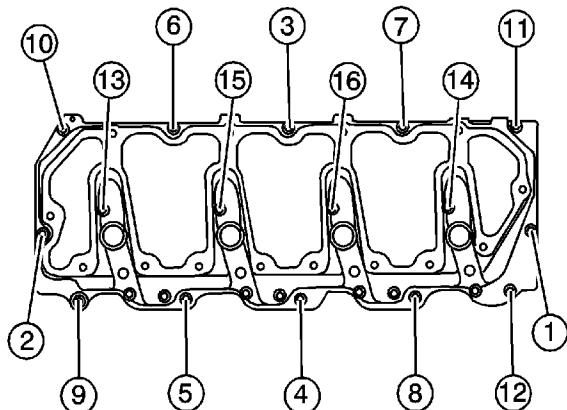
1. Remove the upper right valve rocker arm cover. Refer to [Valve Rocker Arm Cover Replacement - Upper Right Side](#).
2. Remove the fuel injectors. Refer to [Fuel Injector Replacement](#).
3. Remove the lower valve rocker arm cover bolts.
4. Remove the lower valve rocker arm cover.
5. Remove the gasket from the lower valve rocker arm cover.
6. Inspect the lower valve rocker arm cover gasket for damage, replace if necessary. Otherwise reuse the old gasket.
7. If required, clean and inspect the lower valve rocker arm cover. Refer to [Valve Rocker Arm Cover Cleaning and Inspection - Lower](#).

Installation Procedure



1. Install the lower valve rocker arm cover gasket.
2. Install the lower valve rocker arm cover.
3. Install the lower valve rocker arm cover bolts.

Caution: Refer to [Fastener Caution](#) in the Preface section.



4. Tighten the bolts in the sequence shown.

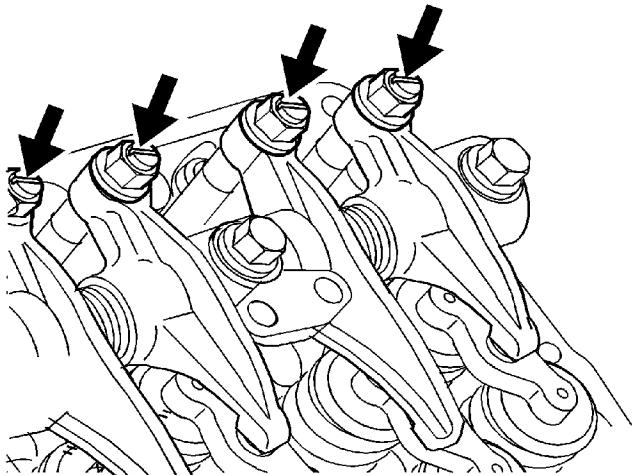
Tighten

Tighten the bolts to 10 N·m (89 lb in).

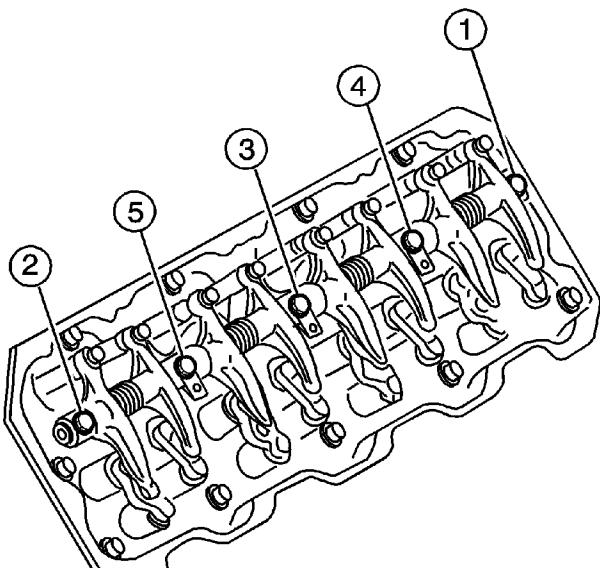
5. Install the fuel injectors. Refer to [Fuel Injector Replacement](#).

6. Install the right upper valve rocker arm cover. Refer to [Valve Rocker Arm Cover Replacement - Upper Right Side.](#)

Valve Rocker Arm, Shaft, and Push Rod Replacement Removal Procedure

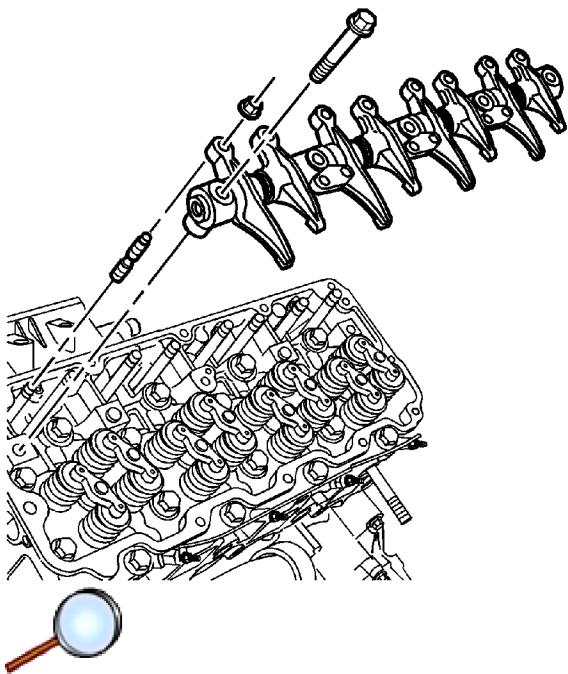


1. Remove the lower valve rocker arm covers. Refer to [Valve Rocker Arm Cover Replacement - Lower Left Side](#) or [Valve Rocker Arm Cover Replacement - Lower Right Side](#).
2. Loosen the valve clearance lock nuts on each rocker arm.
3. Loosen the valve clearance adjusting screw on each rocker arm in order to relieve tension on the valvetrain.

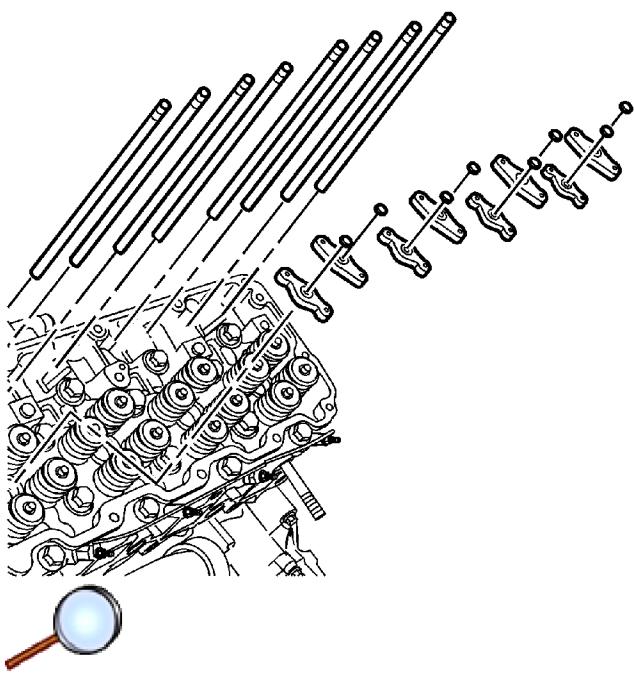


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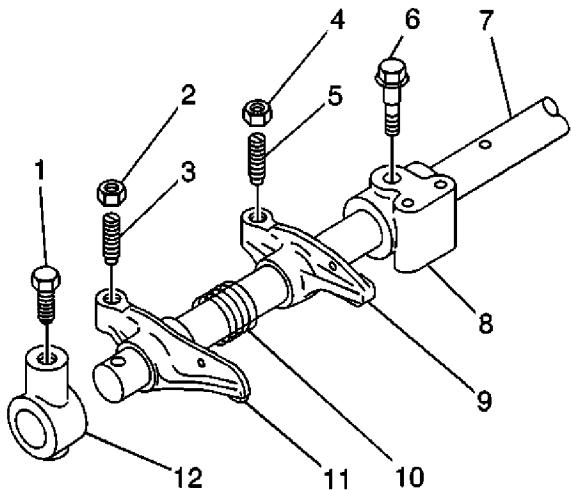
4. Remove the rocker arm shaft assembly bolts in the sequence shown. Leave the bolts in the rocker arm shaft brackets.



5. Remove the rocker arm shaft assembly from the cylinder head.

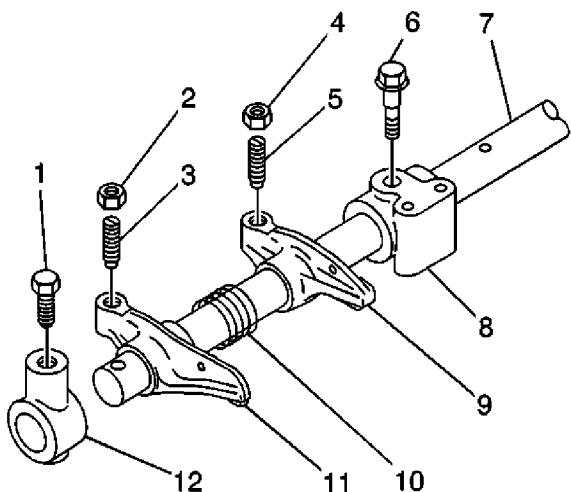


6. Remove the valve bridge pins.
7. Remove the valve bridges.
8. Remove the pushrods.



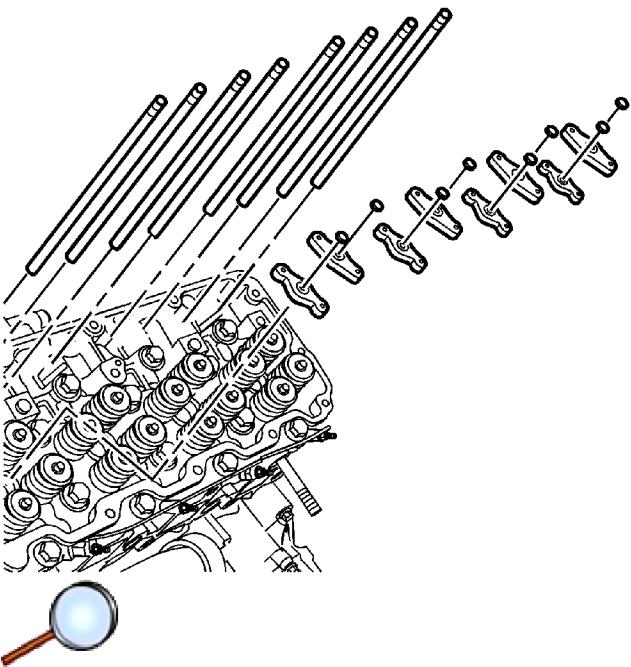
9. Remove the rocker arm shaft bracket bolts (1), if necessary.
10. Remove the bracket (12), rocker arm (11), and spring (10), if necessary.
11. Remove the remaining rocker arms, springs, and brackets, if necessary.
12. If required, clean and inspect the valve rocker arm and shaft. Refer to [Valve Rocker Arm and Shaft Cleaning and Inspection](#).

Installation Procedure



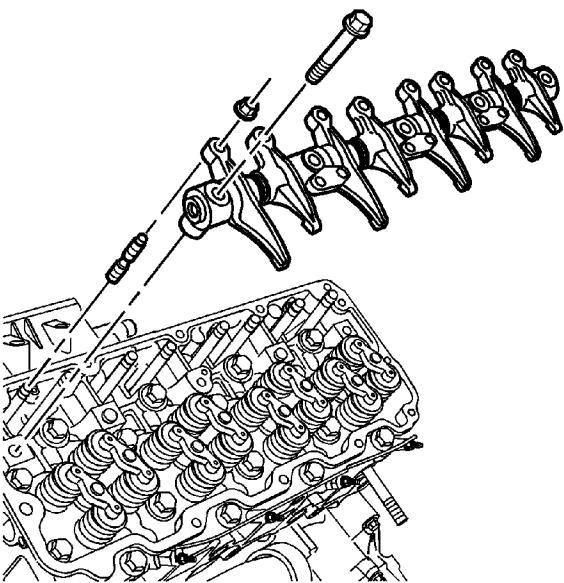
1. Lubricate the rocker arm shaft (7) and the inside of the rocker arms with clean engine oil, if necessary.
2. Install the rocker arm bracket (12) and bolt (1) on one end of the rocker arm shaft, if necessary.

3. Install the intake rocker arm (9), spring (10), exhaust rocker arm (11), and bracket (12) with bolt (1). Continue in the same sequence to the last bracket, if necessary.
4. Push the bracket (12) to compress the springs and then install the bolt (1), if necessary.



5. Lubricate the top of the valves, the valve bridge stem, the valve lifter bridge, and the valve spring caps with clean engine oil.
6. Install the valve bridge.
7. Install the valve bridge pins.
8. Lubricate the valve lifter end of the pushrod with clean engine oil.
9. Install the pushrods.

To ensure the pushrod is properly installed, gently pull up on the pushrod. Resistance should be felt from the pushrod trying to lift the valve lifter.

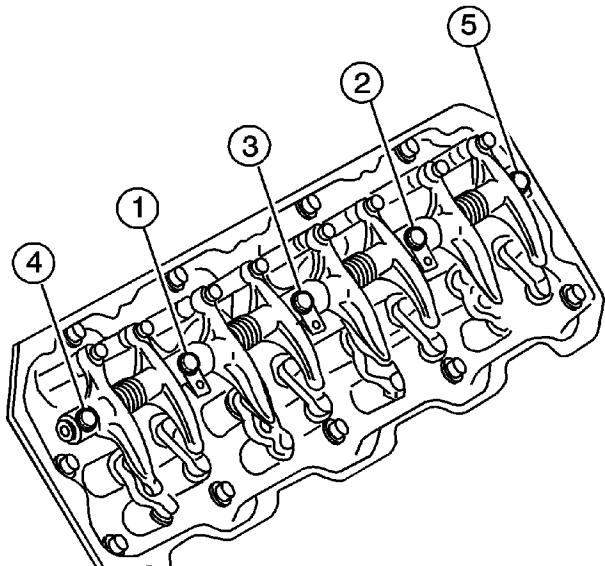




Caution: The pushrods must be correctly seated in the valve lifter and valve rocker arms before the rocker arm shaft assembly is torqued into place. Improper seating of the pushrods can cause damage to the pushrods or the valve rocker arm shaft assembly components.

10. Install the rocker arm shaft assembly.

Caution: Refer to [Fastener Caution](#) in the Preface section.



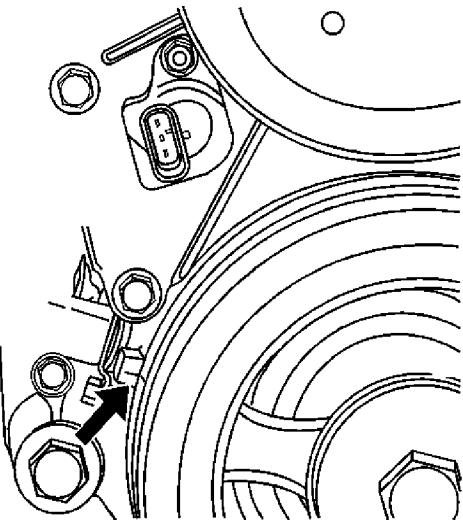
11. Tighten the rocker arm shaft bolts in the sequence shown.

Tighten

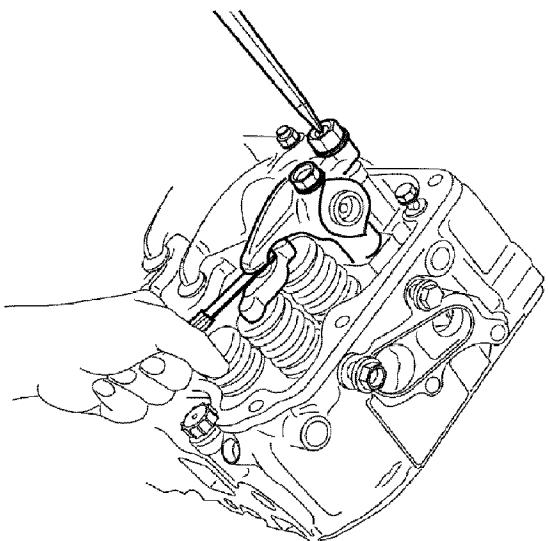
Tighten the bolts to 41 N·m (30 lb ft).

12. Adjust the valve clearance. Refer to [Valve Clearance Adjustment](#).
13. Install the lower valve rocker arm covers. Refer to [Valve Rocker Arm Cover Replacement - Lower Left Side](#) or [Valve Rocker Arm Cover Replacement - Lower Right Side](#).

Valve Clearance Adjustment

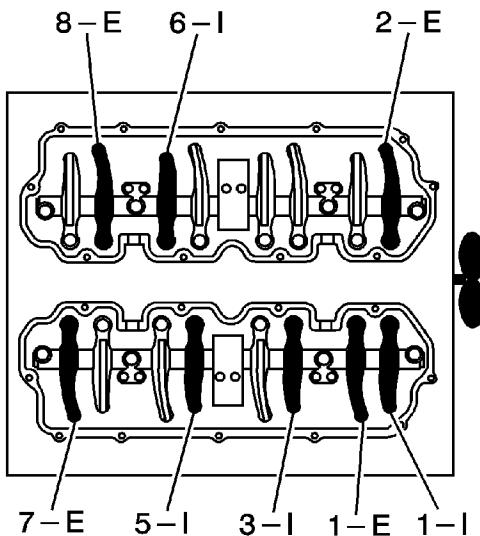


1. Remove the fan clutch. Refer to [Fan Clutch Replacement](#).
2. Remove the upper valve rocker arm covers. Refer to [Valve Rocker Arm Cover Replacement - Upper Left Side](#) and [Valve Rocker Arm Cover Replacement - Upper Right Side](#).
3. Rotate the crankshaft in order to bring the number 1 cylinder to top dead center (TDC) of the compression stroke. The number 1 cylinder is the front cylinder on the right bank. The mark on the crankshaft balancer should be aligned with the mark on the engine.



4. Loosen the valve adjusting screws.
5. Insert a feeler gage between the tip of the rocker arm and the valve bridge.

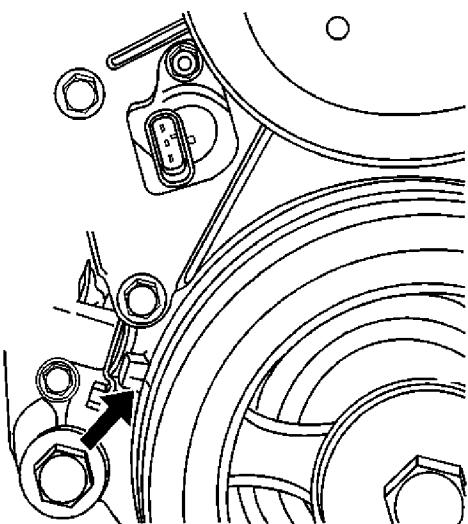
Caution: Refer to [Fastener Caution](#) in the Preface section.



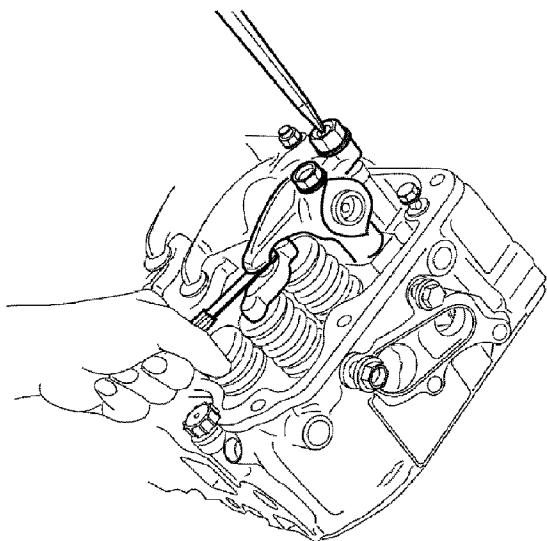
6. Adjust the valve lash to 0.3 mm (0.012 in). Refer to [Valve Clearance Adjustment Specifications](#) to determine which valves can be adjusted when the engine is at TDC.
7. Tighten the lock nut.

Tighten

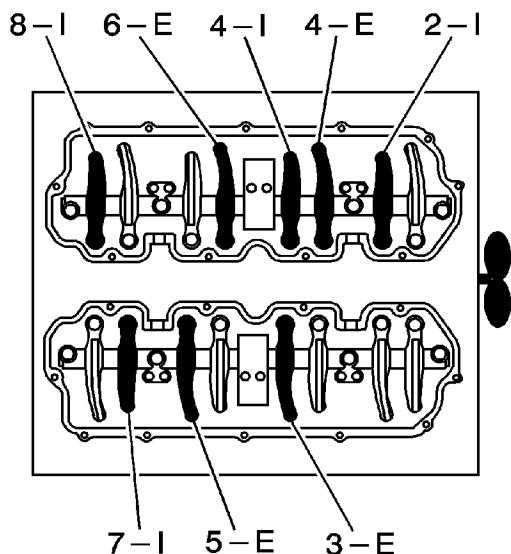
Tighten nut to 22 N·m (16 lb ft).



8. Rotate the crankshaft one revolution in order to bring the number 1 cylinder to TDC of the exhaust stroke.



9. Loosen the valve adjusting screws.
10. Insert a feeler gage between the tip of the rocker arm and the valve bridge.



11. Adjust the valve clearance to 0.3 mm (0.012 in). Refer to [Valve Clearance Adjustment Specifications](#) to determine which valves can be adjusted when the engine is at TDC.
12. Tighten the lock nut.

Tighten

Tighten nut to 22 N·m (16 lb ft).

13. Install the upper valve rocker arm cover. Refer to [Valve Rocker Arm Cover Replacement - Upper Left Side](#) and [Valve Rocker Arm Cover Replacement - Upper Right Side](#).
14. Install the fan clutch. Refer to [Fan Clutch Replacement](#).

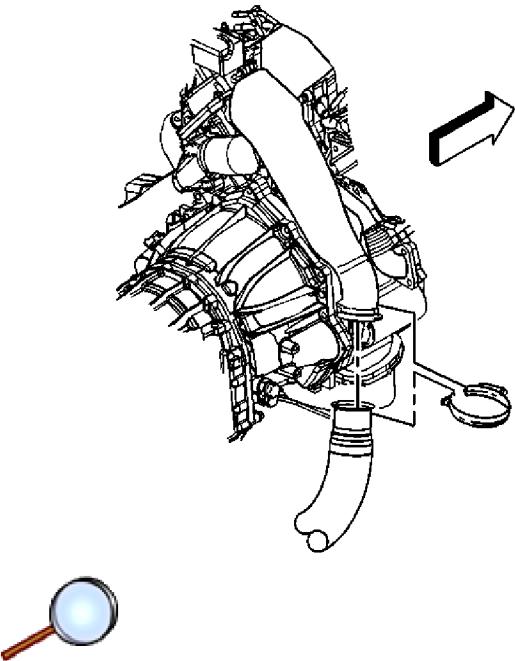
Turbocharger Replacement

Removal Procedure

Caution: If a turbocharger has failed, clean any turbocharger debris or excessive oil from the charge air cooler system before installing the new turbocharger. Failure to clean debris from the charge air cooler system will cause severe turbocharger and engine damage upon startup. Failure to clean excessive oil from the charge air cooler system may cause an engine runaway condition on startup, resulting in severe engine damage.

Note: If a turbocharger failure is thought to be caused due to lack of oil, the camshaft bearing should be checked. The number 4 camshaft bearing bore feeds the turbocharger oil supply (feed) pipe. If this camshaft bearing spins in the bore, the turbocharger will be starved for oil. This will cause a failure of the turbocharger. Failure to diagnosis this condition will result in repeat turbocharger failures.

1. Remove the transmission. Refer to [Transmission Replacement](#).
2. Remove the left and right wheelhouse liners. Refer to [Front Wheelhouse Liner Replacement - Right Side](#) and [Front Wheelhouse Liner Replacement - Left Side](#).



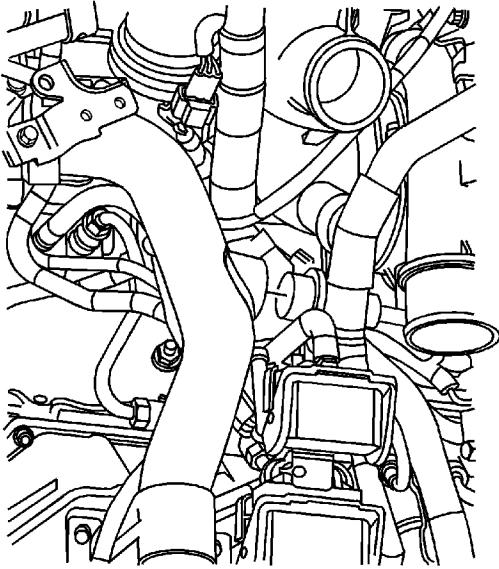
3. Loosen the exhaust pipe clamp. Slide the clamp onto the exhaust pipe.
4. Remove the left exhaust pipe. Refer to [Exhaust Pipe Replacement - Left Side](#).
5. Remove the turbocharger exhaust pipe. Refer to [Turbocharger Exhaust Pipe Replacement](#).
6. Remove the right exhaust pipe. Refer to [Exhaust Pipe Replacement - Right Side](#).
7. Remove the exhaust gas recirculation (EGR) valve cooler. Refer to [Exhaust Gas Recirculation Valve Cooler Replacement](#).
8. Remove the air conditioning (A/C) suction hose. Refer to [Suction Hose Replacement](#).
9. Reposition the suction hose aside.

Note: After removing the charged air cooler duct, cover the turbocharger opening with tape

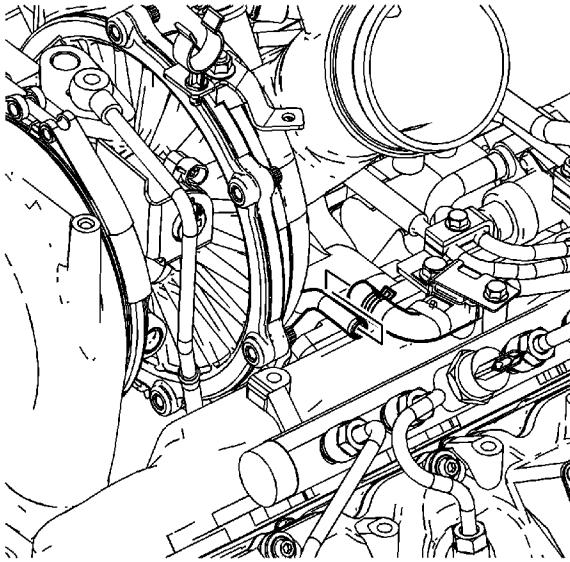
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in order to prevent entry of objects.

10. Remove the charge air cooler inlet pipe. Refer to [Charge Air Cooler Inlet Pipe Replacement](#).

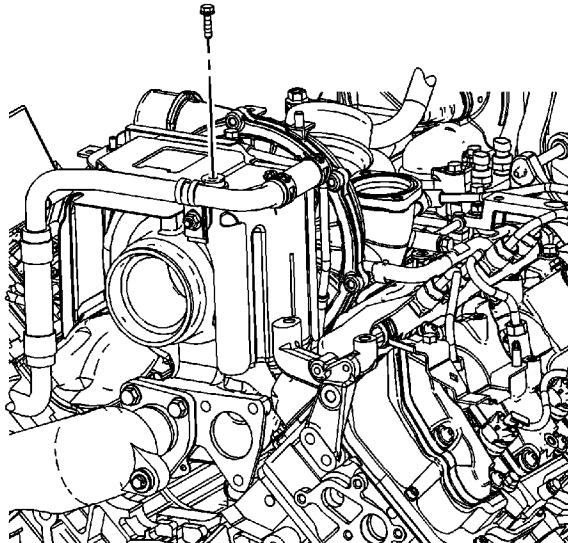


11. Remove the turbocharger inlet coolant hose from the turbocharger coolant bypass valve.

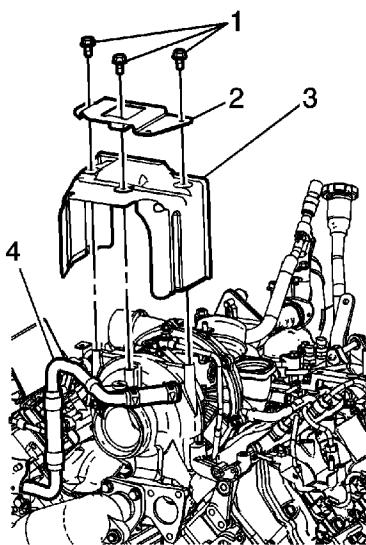


Note: Use care not to damage this hose during the procedure.

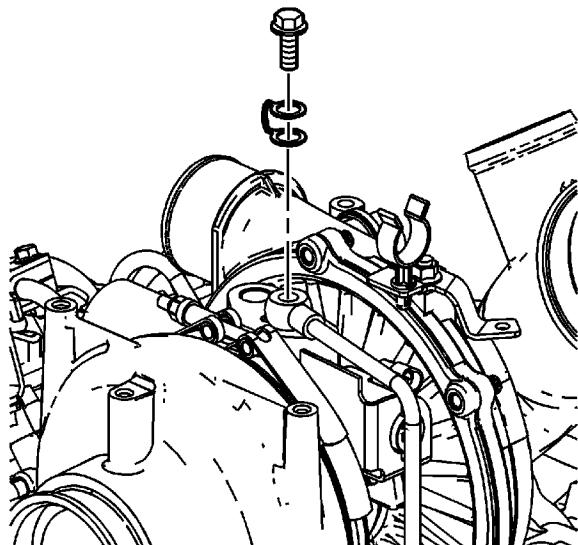
12. Reposition the hose clamp and remove the turbocharger outlet coolant hose from the turbocharger.
13. Remove the positive crankcase ventilation (PCV) hose/pipe. Refer to [Positive Crankcase Ventilation Hose/Pipe/Tube Replacement](#).



14. Remove the glow plug module and both brackets. Refer to [Glow Plug Control Module Replacement](#).
15. Remove the EGR cooler pipe bolt.

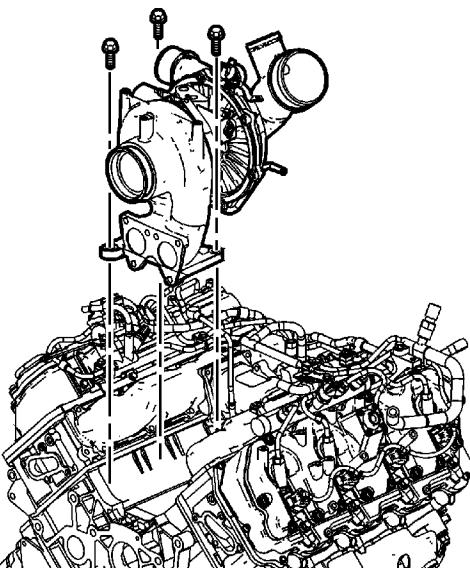


16. Reposition the EGR cooler pipe (4) out of the way.
17. Remove the EGR valve adapter pipe bracket bolts (1).
18. Remove the EGR valve adapter pipe bracket (2) and turbocharger heat shield (3).



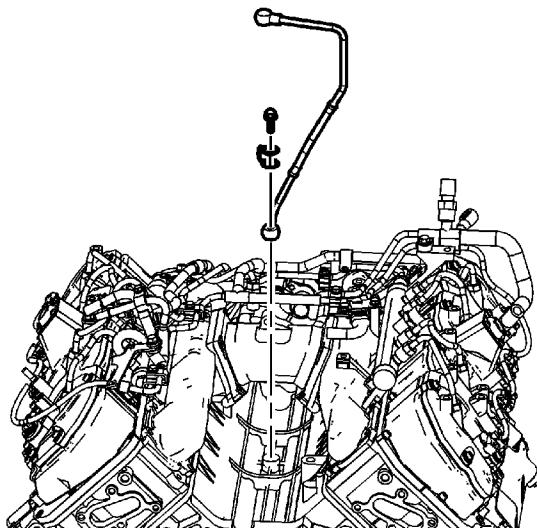
Caution: Do not twist the turbocharger oil feed pipe. Twisting of the feed pipe will result in the collapse and deformation of the plastic pipe, restricting oil flow and causing turbocharger damage. During turbocharger replacement, gently push the oil feed pipe towards the front of the engine to clear the turbocharger. Assistance may be required to keep the pipes clear of the turbocharger during removal or installation.

19. Remove the turbocharger oil feed pipe banjo bolt and washer.
20. Reposition the oil feed pipe out of the way.
21. Remove the turbocharger oil return pipe nuts at the top of the flywheel housing.
22. Disconnect the turbocharger vane position sensor electrical connector.

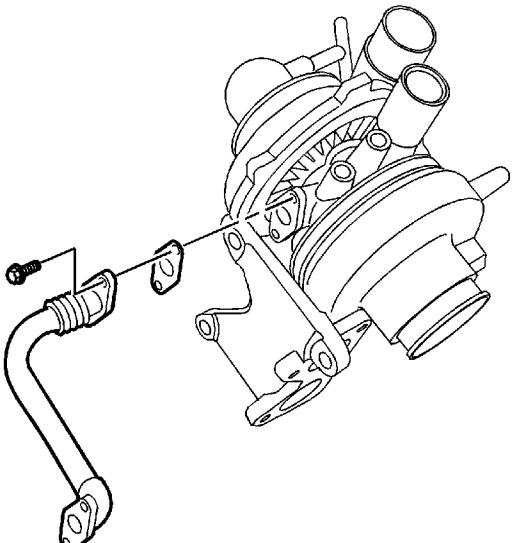


23. Remove the turbocharger bolts.
24. Remove the turbocharger (with the oil return pipe).

25. Remove and discard the turbocharger oil return pipe gasket at the flywheel housing.



26. Remove the turbocharger lower heat shield, if necessary.
27. Remove the oil feed pipe bolt, washer, and pipe, if necessary.
28. If the turbocharger has failed, perform the following steps to verify the condition of the number 4 camshaft bearing before installing a new turbocharger:
28.1. Visually inspect for correct alignment of the number 4 camshaft bearing oil hole through the turbocharger oil supply hole in the block.
28.2. Turn the engine over by hand 1/2 turn and inspect for camshaft bearing movement, indicating a spun camshaft bearing.
28.3. If the bearing is spun the engine MUST be replaced.



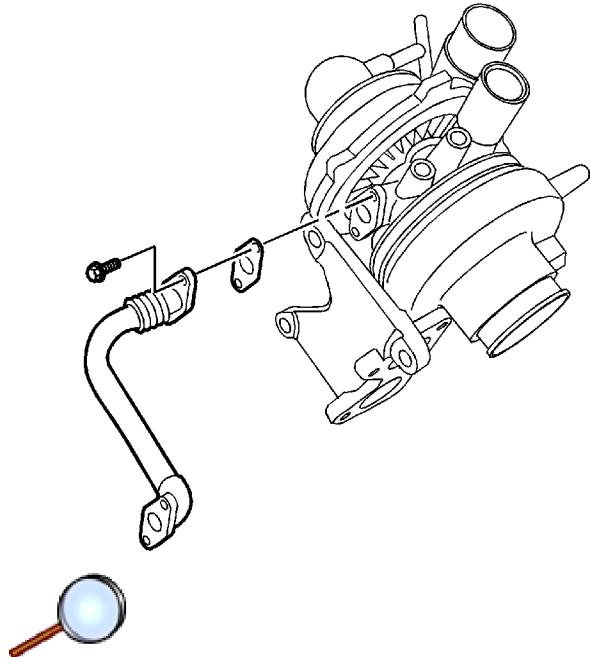
29. Remove the turbocharger outlet coolant pipe banjo bolt and washers.
30. If replacing the turbocharger, remove the oil return pipe bolts, pipe and gasket. Discard the

gasket.

31. Clean all turbocharger to engine gasket mating surfaces.
32. If required, clean and inspect the turbocharger. Refer to [Turbocharger Cleaning and Inspection](#)

Installation Procedure

Caution: Refer to [Fastener Caution](#) in the Preface section.



1. If the turbocharger was replaced, install the oil return pipe, bolts, and a NEW gasket.

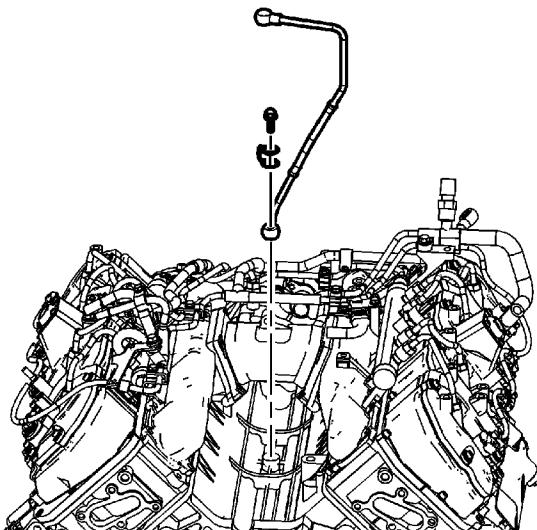
Tighten

Tighten the bolts to 21 N·m (15 lb ft).

2. Install the turbocharger outlet coolant pipe banjo bolt and washers.

Tighten

Tighten the bolt to 26 N·m (19 lb ft).



Caution: Do not twist the turbocharger oil feed pipe. Twisting of the feed pipe will result in the collapse and deformation of the plastic pipe, restricting oil flow and causing turbocharger damage. During turbocharger replacement, gently push the oil feed pipe towards the front of the engine to clear the turbocharger. Assistance may be required to keep the pipes clear of the turbocharger during removal or installation.

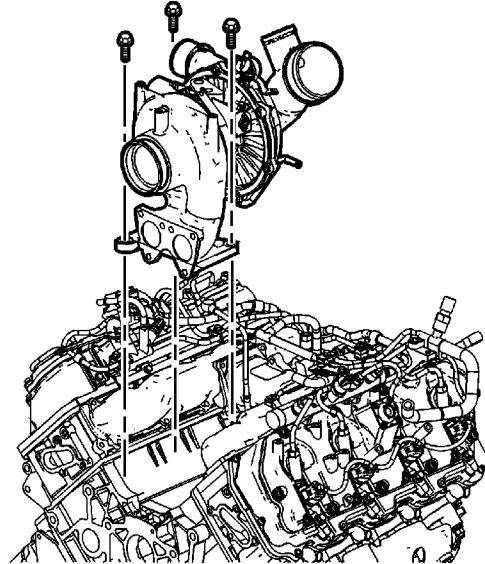
Note: Lubricate the washer with diesel fuel prior to installing.

3. Install the oil feed pipe, washer, and bolt, if necessary.

Tighten

Tighten the bolt to 34 N·m (25 lb ft).

4. Install the turbocharger lower heat shield, if necessary.





5. Install a NEW turbocharger oil return pipe gasket at the flywheel housing.
6. Install the turbocharger (with the oil return pipe).
7. Install the turbocharger bolts.

Tighten

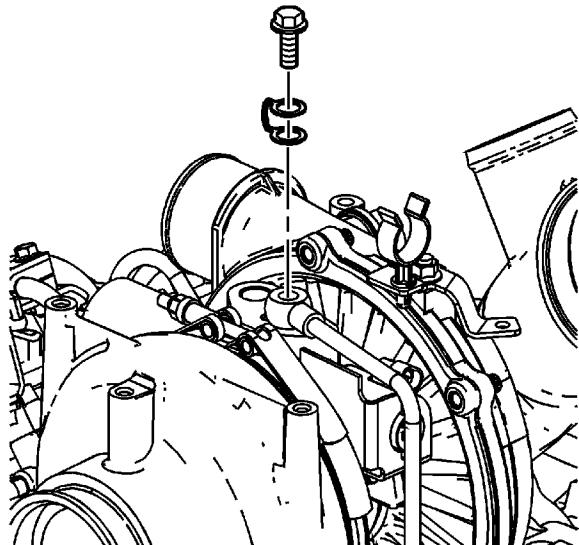
Tighten the bolts to 108 N·m (80 lb ft).

8. Install the turbocharger oil return pipe nuts at the top of the flywheel housing.

Tighten

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

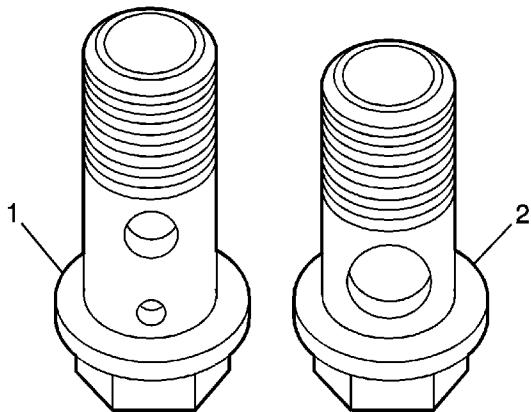
9. Connect the turbocharger vane position sensor electrical connector.



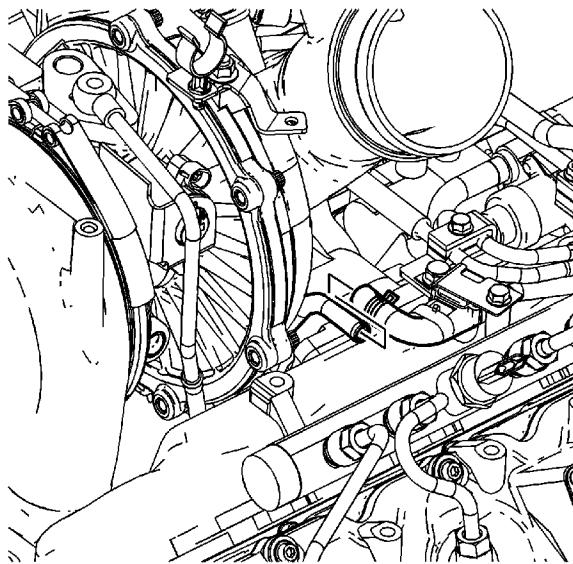
10. If installing a NEW turbocharger, add about 120-150 cc (4-5 oz) of clean engine oil in the turbocharger oil feed pipe opening while rotating the impeller.
11. Position the oil feed pipe to the turbocharger.
12. Install a NEW turbocharger oil feed pipe washer and the banjo bolt.

Tighten

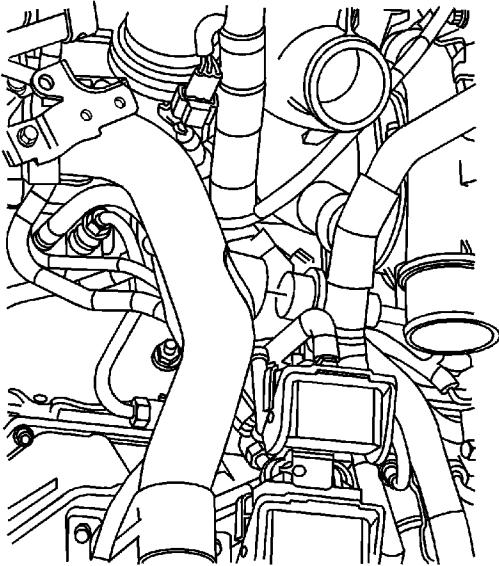
Tighten the bolt to 34 N·m (25 lb ft).



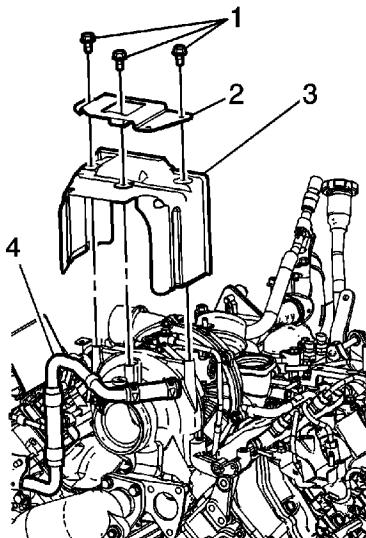
13. Install the PCV hose/pipe. Refer to [Positive Crankcase Ventilation Hose/Pipe/Tube Replacement](#).
14. If the cooling outlet hose eye bolts were removed, install the longer bolt (1) with 2 holes, in the top location. Install the shorter bolt (2) in the lower location.



15. Install the turbocharger outlet coolant hose to the turbocharger and position the hose clamp.



16. Install the turbocharger inlet coolant hose to the turbocharger coolant bypass valve.

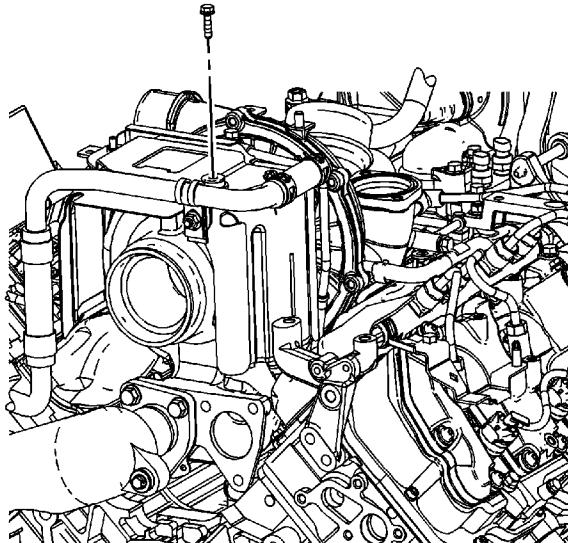


17. Install the turbocharger heat shield (3) and EGR valve adapter pipe bracket (2).
18. Install the EGR valve adapter pipe bracket bolts (1).

Tighten

Tighten the bolts to 9 N·m (80 lb in).

19. Install the EGR cooler. Refer to [Exhaust Gas Recirculation Valve Cooler Replacement](#).
20. Install the glow plug module and both brackets. Refer to [Glow Plug Control Module Replacement](#).



21. Install the EGR cooler pipe bolt.

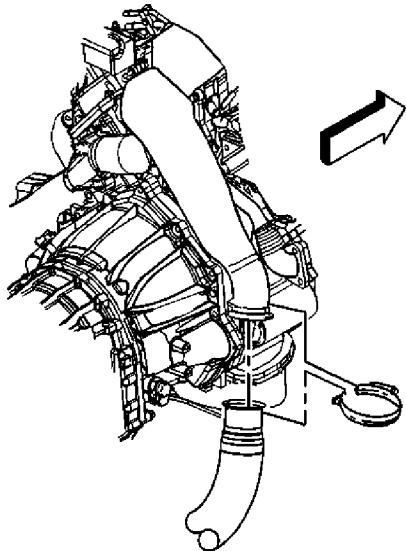
Tighten

Tighten the bolt to 9 N·m (80 lb in).

22. Remove the tape from the turbocharger openings.

Note: Lubricate the end of the duct prior to installation.

23. Install the charge air cooler inlet pipe. Refer to [Charge Air Cooler Inlet Pipe Replacement](#).
24. Install the A/C suction hose. Refer to [Suction Hose Replacement](#).
25. Install the air intake pipe. Refer to [Air Intake Pipe Replacement](#).
26. Fill the cooling system. Refer to [Cooling System Draining and Filling](#).



27. Install the right exhaust pipe. Refer to [Exhaust Pipe Replacement - Right Side](#).
28. Install the turbocharger exhaust pipe. Refer to [Turbocharger Exhaust Pipe Replacement](#).
29. Install the left exhaust pipe. Refer to [Exhaust Pipe Replacement - Left Side](#).
30. Slide the clamp onto the exhaust pipe. Tighten the exhaust pipe clamp.

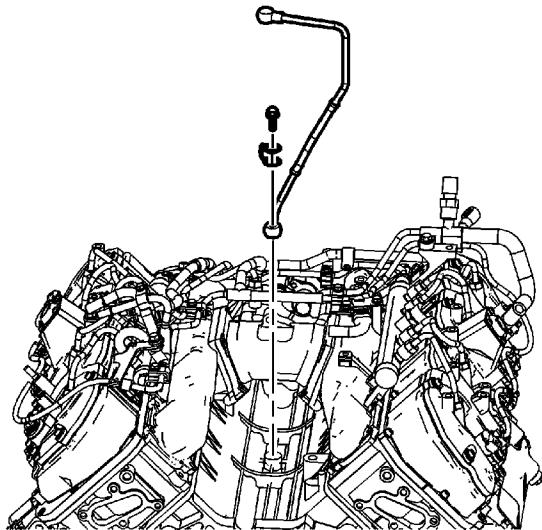
Tighten

Tighten the clamp to 40 N·m (30 lb ft).

31. Install the left and right wheelhouse liners. Refer to [Front Wheelhouse Liner Replacement - Right Side](#) and [Front Wheelhouse Liner Replacement - Left Side](#).
32. Install the transmission. Refer to [Transmission Replacement](#).
33. If a NEW turbocharger was installed, perform the turbocharger learn procedure. Refer to [Turbocharger Learn](#).
34. Road test the vehicle for normal operation.
35. Inspect for coolant, oil, or exhaust leaks. Correct as necessary.

Turbocharger Oil Feed Pipe Replacement

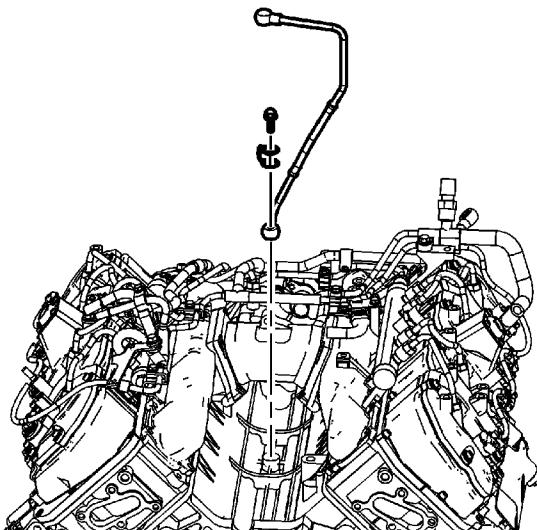
Removal Procedure



1. Remove the turbocharger. Refer to [Turbocharger Replacement](#).
2. Remove the turbocharger oil feed pipe bolt.
3. Remove the oil feed pipe and washer.

Installation Procedure

Caution: Refer to [Fastener Caution](#) in the Preface section.



Caution: Do not twist the turbocharger oil feed pipe. Twisting of the feed pipe will result in the collapse and deformation of the plastic pipe, restricting oil flow and causing turbocharger damage. During turbocharger replacement, gently push the oil feed pipe towards the front of the engine to clear the turbocharger. Assistance may be required to keep the pipes clear of the turbocharger during removal or installation.

Note: Lubricate the NEW washer with diesel fuel before installing.

1. Position the oil feed pipe and a NEW washer into place.
2. Install the oil feed pipe bolt.

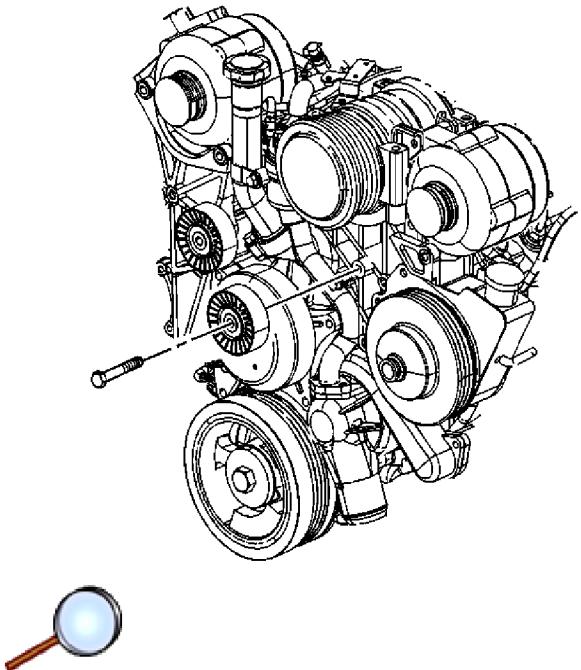
Tighten

Tighten the bolt to 34 N·m (25 lb ft).

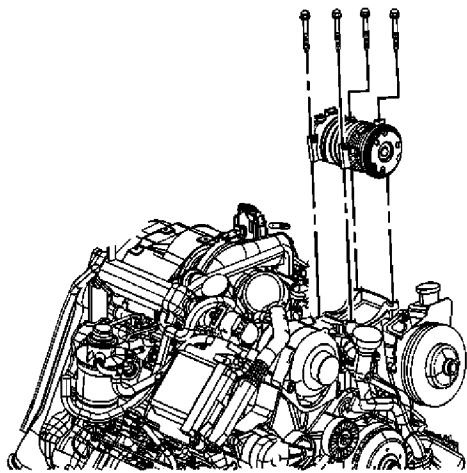
3. Install the turbocharger. Refer to [Turbocharger Replacement](#).

Air Conditioning (A/C) Compressor and Power Steering Pump Bracket Replacement

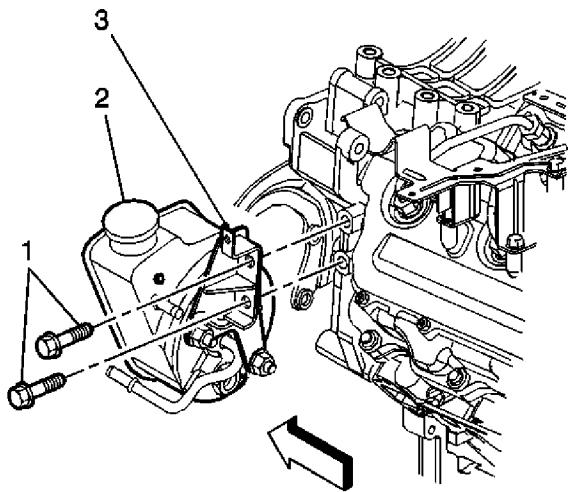
Removal Procedure



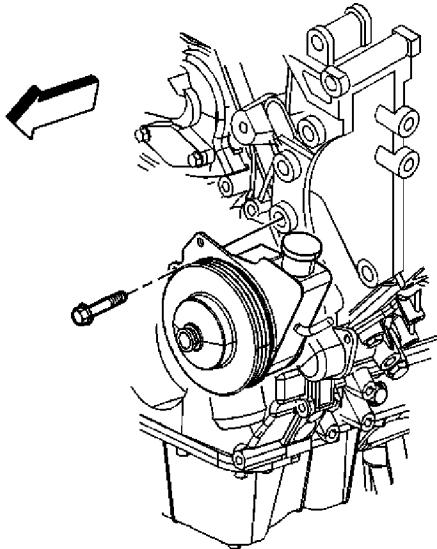
1. Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
2. Remove the cooling fan and shroud. Refer to [Cooling Fan and Shroud Replacement](#).
3. Remove the drive belt. Refer to [Drive Belt Replacement](#).
4. If equipped, remove the auxiliary generator. Refer to [Auxiliary Generator Replacement](#).
5. If equipped with dual generators, remove the bolt from the left side idler pulley (smooth pulley).
6. Remove the idler pulley.



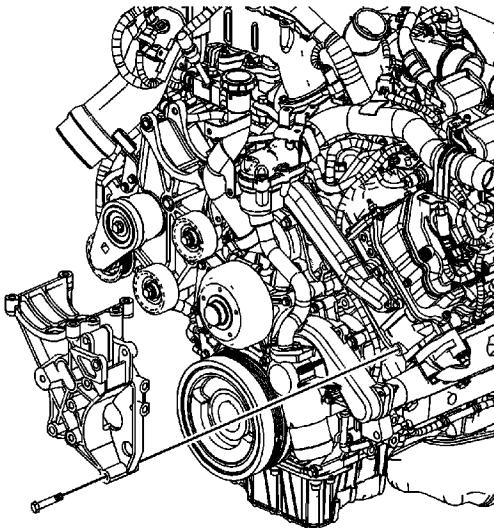
7. Disconnect the air conditioning (A/C) compressor clutch electrical connector.
8. Disconnect the A/C cut out switch electrical connector.
9. Remove the A/C compressor bolts.
10. Move the A/C compressor with the hoses attached to the right side of the engine compartment.



11. Remove the rear power steering pump bracket bolts (1).

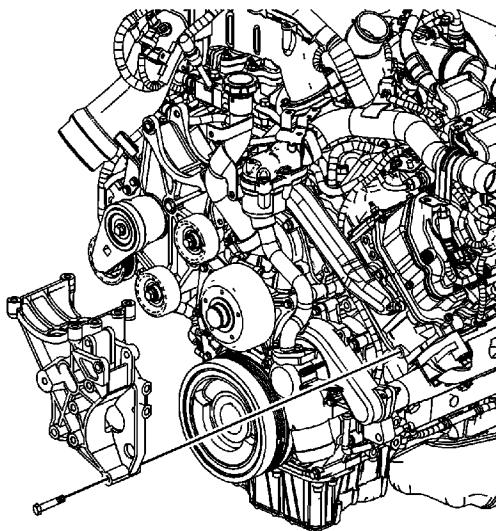


12. Remove the power steering pump front bracket bolts.
13. Move and secure the power steering pump out of the way. The hoses and battery cables can remain attached to the pump.



14. Remove the A/C compressor and power steering pump bracket bolts and nuts.
15. Remove the A/C compressor and power steering pump bracket.

Installation Procedure



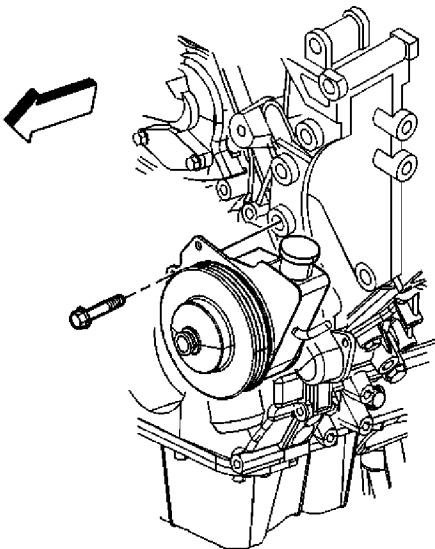
1. Position the A/C compressor and power steering pump bracket.

Caution: Refer to [Fastener Caution](#) in the Preface section.

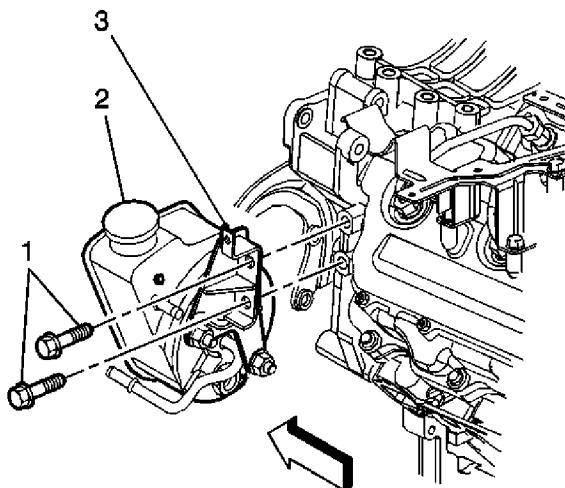
2. Install the A/C compressor and power steering pump bracket bolts and nuts.

Tighten

Tighten the bolts to 46 N·m (34 lb ft).



3. Install the power steering pump and loosely install the front bracket bolts.

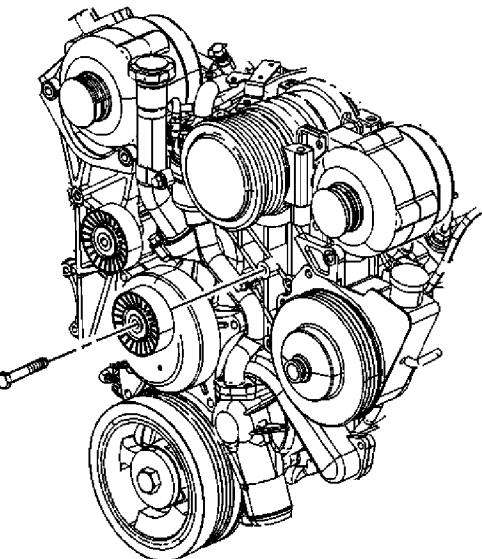


Note: Tighten the front bracket bolts before the rear bracket bolts to ensure pulley alignment.

4. Loosely install the rear power steering pump bracket bolts (1).

Tighten

1. Tighten the front bracket bolts to 50 N·m (37 lb ft).
2. Tighten the rear bracket bolts to 50 N·m (37 lb ft).

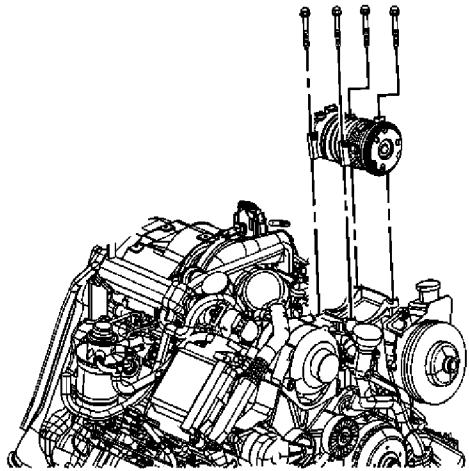


5. If equipped with dual generators, install the left side idler pulley and bolt.

Tighten

Tighten the bolt to 43 N·m (32 lb ft)

6. Install the auxiliary generator. Refer to [Auxiliary Generator Replacement](#).



7. Position the A/C compressor.
8. Install the A/C compressor bolts.

Tighten

Tighten the bolts to 50 N·m (37 lb ft).

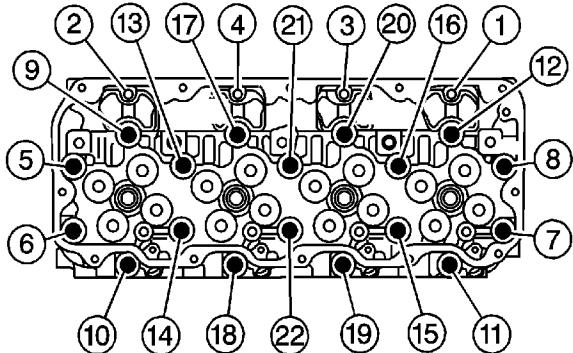
9. Connect the A/C cut out switch electrical connector.
10. Connect the A/C clutch electrical connector.
11. Install the drive belt. Refer to [Drive Belt Replacement](#).
12. Install the cooling fan and shroud. Refer to [Cooling Fan and Shroud Replacement](#).
13. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

Cylinder Head Replacement - Left Side

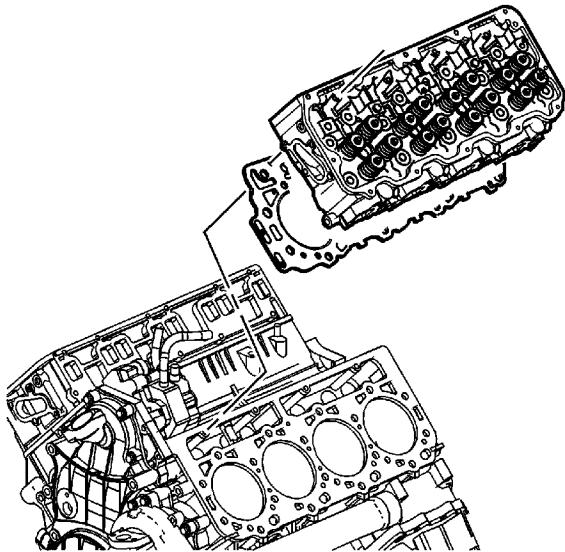
Special Tools

[J 45059](#) Angle Meter

Removal Procedure



1. Remove the engine assembly. Refer to [Engine Replacement](#).
2. Remove the thermostat housing crossover. Refer to [Thermostat Housing Crossover Replacement](#).
3. Remove the intake manifold. Refer to [Intake Manifold Replacement - Left Side](#).
4. Remove the exhaust manifold. Refer to [Exhaust Manifold Removal - Left Side](#).
5. Remove the valve rocker arm shaft, pushrods, and valve bridges. Refer to [Valve Rocker Arm, Shaft, and Push Rod Replacement](#).
6. Remove the glow plugs. Refer to [Glow Plug Replacement - Bank 2](#).
7. Remove the cylinder head bolts in the sequence shown.
8. Discard the large M12 bolts.

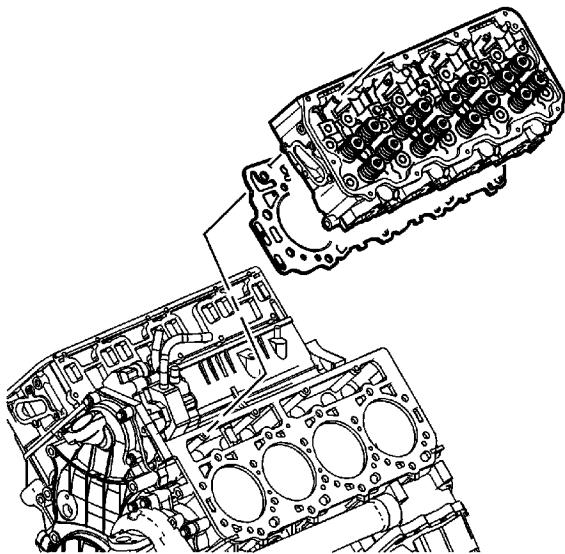


9. Remove the cylinder head.
10. Remove and discard the cylinder head gasket.
11. Clean the sealing surface of the engine block and the cylinder head.

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.

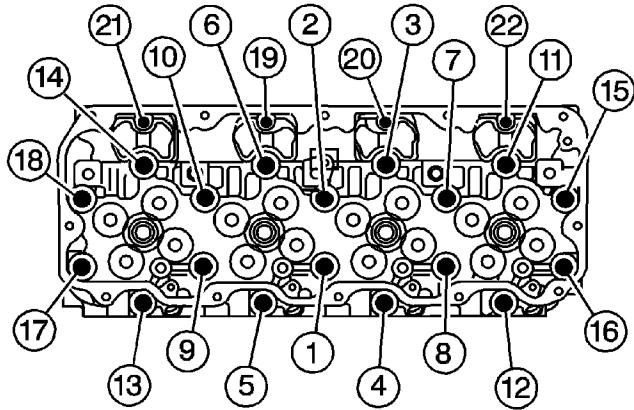
12. Clean the cylinder head bolt holes in the engine block.
13. For service to the cylinder head refer to the following:
 - [Cylinder Head Disassemble](#)
 - [Cylinder Head Cleaning and Inspection](#)
 - [Cylinder Head Assemble](#)

Installation Procedure



Caution: The left and right cylinder head gaskets are not interchangeable. Improper placement of the cylinder head gasket will block coolant and oil passages. Blocked coolant and oil passages will cause severe engine damage.

1. Install the cylinder head gasket of the correct grade. Refer to [Cylinder Head Gasket Selection Specifications](#).
2. Install the cylinder head.



Caution: This component uses bolts with a preapplied molybdenum disulfide coating for thread lubrication. Do not remove the coating or use any additional lubricant. Improperly lubricated threads will adversely affect the bolt torque and clamp load. Improper bolt torque and clamp load can lead to engine damage.

3. Install NEW M12 cylinder head bolts.
4. Reuse the M8 cylinder head bolts.

Caution: Refer to [Fastener Caution](#) in the Preface section.

5. Tighten the cylinder head bolts in the following steps using the sequence shown:

Tighten

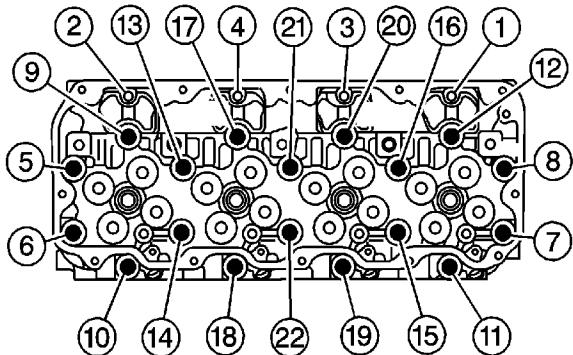
1. Tighten the M12 bolts a first pass to 50 N·m (37 lb ft).
2. Tighten the M12 bolts a second pass to 80 N·m (59 lb ft)
3. Tighten the M12 bolts a third pass to 60 degrees, using [J 45059](#).
4. Tighten the M12 bolts a final pass to 60 degrees, using [J 45059](#).
5. Tighten the M8 bolts to 25 N·m (18 lb ft).
6. Install the glow plugs. Refer to [Glow Plug Replacement - Bank 2](#).
7. Install the valve rocker arm shaft, pushrods, and valve bridges. Refer to [Valve Rocker Arm, Shaft, and Push Rod Replacement](#).
8. Install the exhaust manifold. Refer to [Exhaust Manifold Installation - Left Side](#).
9. Install the intake manifold. Refer to [Intake Manifold Replacement - Left Side](#).
10. Install the thermostat housing crossover. Refer to [Thermostat Housing Crossover Replacement](#).
11. Install the engine assembly. Refer to [Engine Replacement](#).
12. Road test the vehicle for normal operation.

Cylinder Head Replacement - Right Side

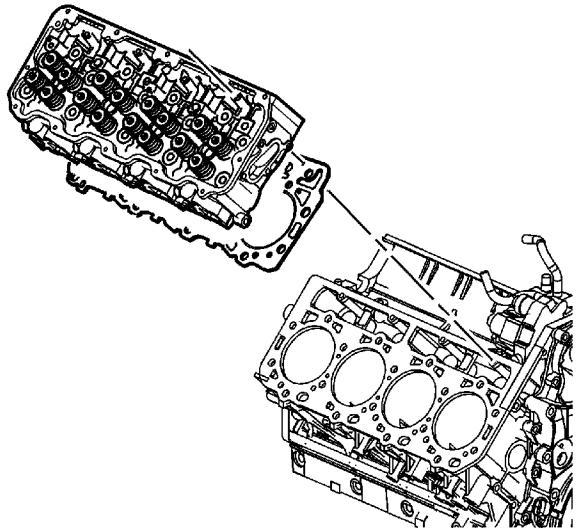
Special Tools

[J 45059](#) Angle Meter

Removal Procedure



1. Remove the engine assembly. Refer to [Engine Replacement](#).
2. Remove the thermostat housing crossover. Refer to [Thermostat Housing Crossover Replacement](#).
3. Remove the intake manifold. Refer to [Intake Manifold Replacement - Right Side](#).
4. Remove the exhaust manifold. Refer to [Exhaust Manifold Removal - Right Side](#).
5. Remove the valve rocker arm shaft, pushrods, and valve bridges. Refer to [Valve Rocker Arm, Shaft, and Push Rod Replacement](#).
6. Remove the glow plugs. Refer to [Glow Plug Replacement - Bank 1](#).
7. Remove the cylinder head bolts in the sequence shown.
8. Discard the large M12 bolts.

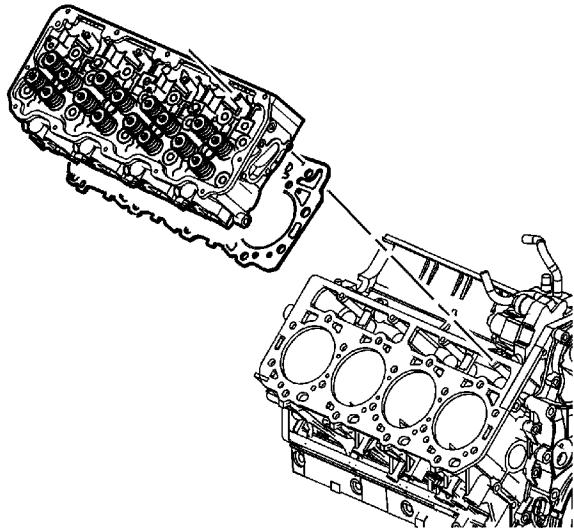


9. Remove the cylinder head.
10. Remove and discard the cylinder head gasket.
11. Clean the sealing surface of the engine block and the cylinder head.

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.

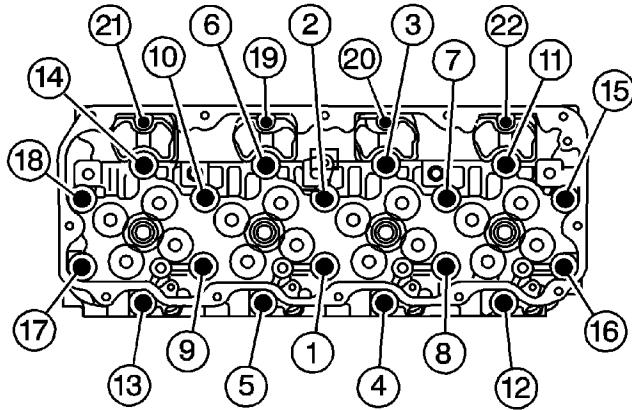
12. Clean the cylinder head bolt holes in the engine block.
13. For service to the cylinder head, refer to the following procedures:
 - [Cylinder Head Disassemble](#)
 - [Cylinder Head Cleaning and Inspection](#)
 - [Cylinder Head Assemble](#)

Installation Procedure



Caution: The left and right cylinder head gaskets are not interchangeable. Improper placement of the cylinder head gasket will block coolant and oil passages. Blocked coolant and oil passages will cause severe engine damage.

1. Install the cylinder head gasket of the correct grade. Refer to [Cylinder Head Gasket Selection Specifications](#).
2. Install the cylinder head.



Caution: This component uses bolts with a preapplied molybdenum disulfide coating for thread lubrication. Do not remove the coating or use any additional lubricant. Improperly lubricated threads will adversely affect the bolt torque and clamp load. Improper bolt torque and clamp load can lead to engine damage.

3. Install the NEW M12 cylinder head bolts.
4. Reuse the M8 cylinder head bolts.

Caution: Refer to [Fastener Caution](#) in the Preface section.

5. Tighten the cylinder head bolts in the following steps using the sequence shown:

Tighten

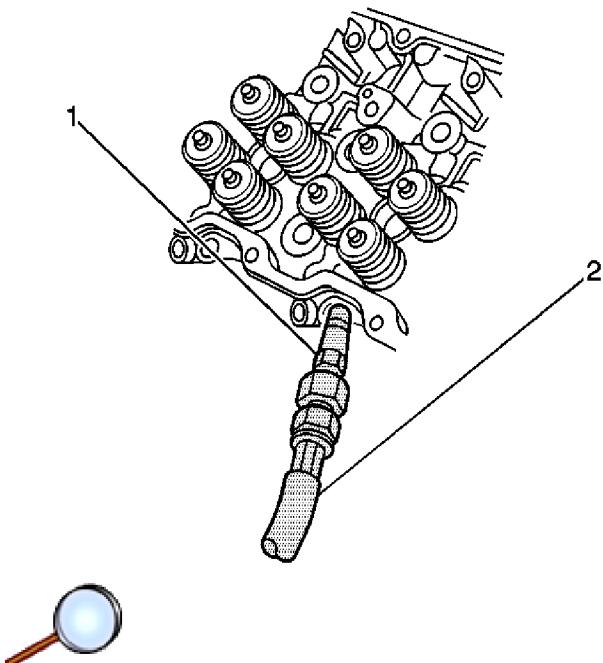
1. Tighten the M12 bolts a first pass to 50 N·m (37 lb ft).
2. Tighten the M12 bolts a second pass to 80 N·m (59 lb ft)
3. Tighten the M12 bolts a third pass to 60 degrees, using [J 45059](#).
4. Tighten the M12 bolts a final pass to 60 degrees, using [J 45059](#).
5. Tighten the M8 bolts to 25 N·m (18 lb ft).
6. Install the valve rocker arm shaft, pushrods, and valve bridges. Refer to [Valve Rocker Arm, Shaft, and Push Rod Replacement](#).
7. Install the glow plugs. Refer to [Glow Plug Replacement - Bank 1](#).
8. Install the right exhaust manifold. Refer to [Exhaust Manifold Installation - Right Side](#).
9. Install the right intake manifold. Refer to [Intake Manifold Replacement - Right Side](#).
10. Install the thermostat housing crossover. Refer to [Thermostat Housing Crossover Replacement](#).
11. Road test the vehicle for normal operation.
12. Install the engine assembly. Refer to [Engine Replacement](#).

Valve Stem Oil Seal and Valve Spring Replacement

Special Tools

- [J 26999](#) Compression Gage
- [J 26999-20](#) Compression Gage Adapter
- [J 44646](#) Valve Spring Compressor
- [J 44640](#) Valve Stem Seal Installer

Removal Procedure

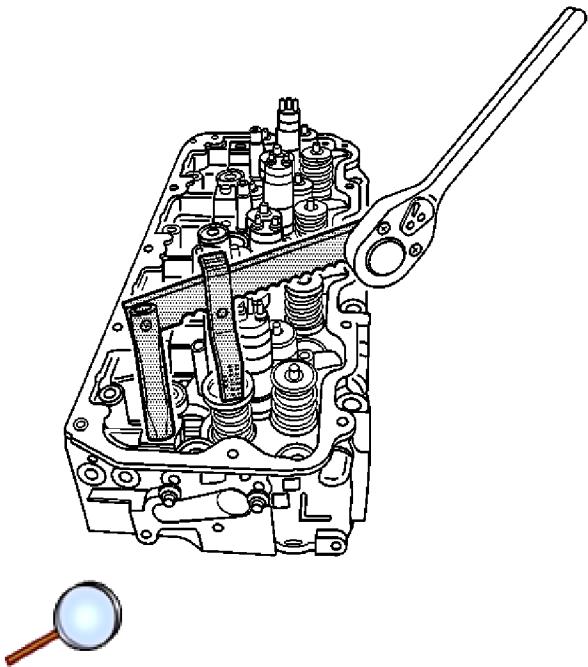


1. Remove the upper and lower fan shroud. Refer to [Engine Coolant Fan Lower Shroud Replacement](#) and [Engine Coolant Fan Upper Shroud Replacement](#).
2. Remove the valve rocker arm shaft, valve bridges, and pushrods for the cylinder head being serviced. Refer to [Valve Rocker Arm, Shaft, and Push Rod Replacement](#).
3. Remove the glow plug for the cylinder requiring service. Refer to [Glow Plug Replacement - Bank 1](#) or [Glow Plug Replacement - Bank 2](#).
4. In order to apply shop air to the cylinders use the following procedures to modify [J 26999-20](#) (1) and [J 26999](#) (2):
 - 4.1. Remove the valve core from [J 26999-20](#) to allow air to flow.
 - 4.2. Remove the quick connect fitting from [J 26999](#).
 - 4.3. Adapt the quick connect fitting in order to use for shop air.
 - 4.4. Connect the quick connect fitting to [J 26999-20](#).

Note: Rotate the cylinder to be serviced to the bottom of the stroke. This is to ensure that the engine does not rotate when the compressed air is applied to the cylinder being serviced.

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5. Install [J 26999-20](#) into the glow plug hole for the cylinder being serviced.
6. Apply compressed air to hold the valves in place. If the compressed air is released, the valves can drop into the cylinder.

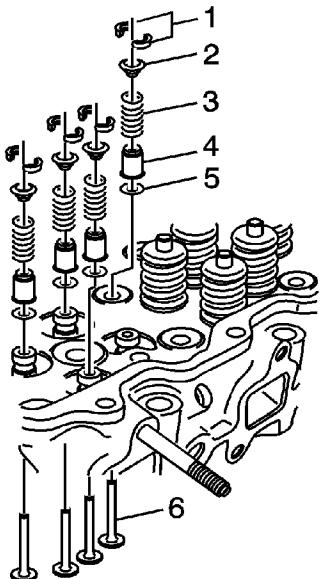


Warning: Compressed valve springs have high tension against the valve spring compressor. Valve springs that are not properly compressed by or released from the valve spring compressor can be ejected from the valve spring compressor with intense force. Use care when compressing or releasing the valve spring with the valve spring compressor and when removing or installing the valve stem keys. Failing to use care may cause personal injury.

7. Install [J 44646](#) to the rocker arm bosses on the cylinder head.

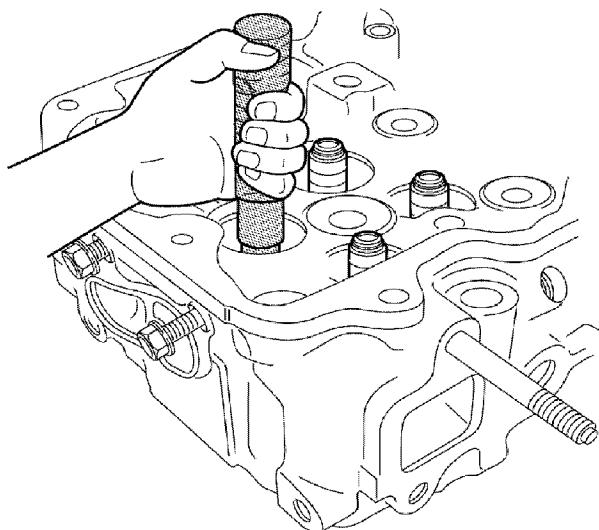
[J 44646](#) should be installed in the rocker arm boss next to the cylinder being serviced. The pivot pin can be removed from the stand to allow the stand to be installed. The lever has different locating holes for the pivot pin depending on available clearance. The lever is also notched for different locations of the compressor.

8. Using [J 44646](#) compress the valve spring.



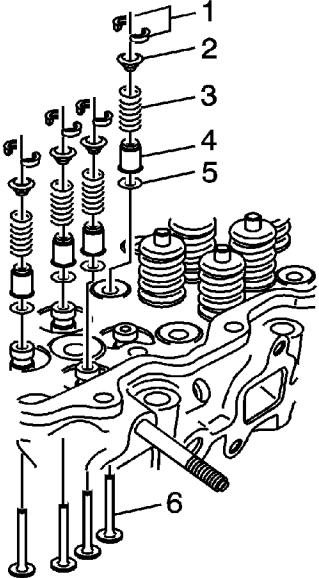
9. Remove the valve keys (1) from the valve stem.
10. Carefully release the valve spring tension.
11. Remove the valve spring upper seat (2) and the valve spring (3).
12. Remove the valve stem oil seal (4).
13. Remove the valve spring lower seat (5).
14. Continue removing the remaining valve stem seals for the cylinder using the above procedure.

Installation Procedure

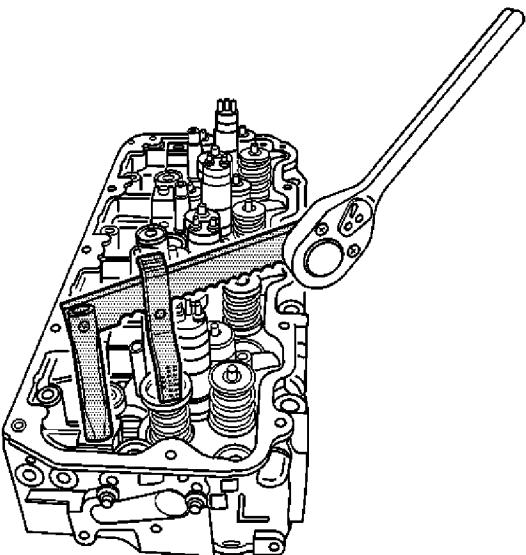


Caution: Air pressure should remain applied to the cylinder for installation.

1. Install the valve spring lower seat.
2. Install the valve stem seal using [J 44640](#).



3. Install the valve spring (3), the painted end of the valve spring goes toward the cylinder head.
4. Install the valve spring upper seat (2).



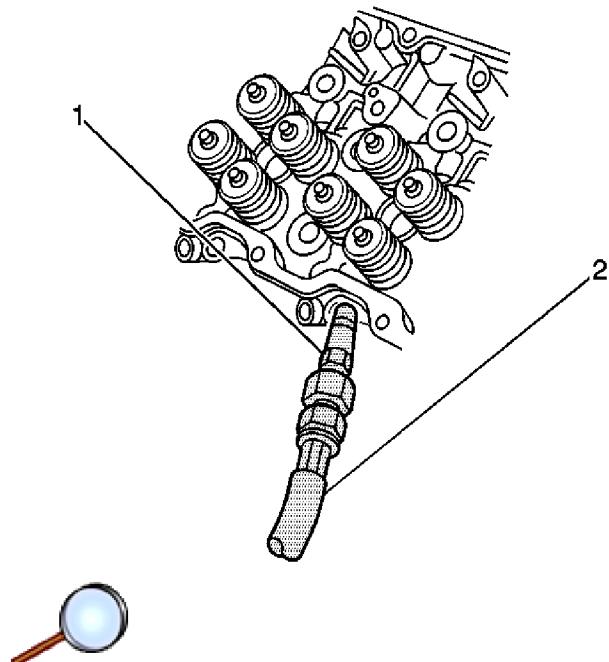
Warning: Compressed valve springs have high tension against the valve spring compressor. Valve springs that are not properly compressed by or released from the valve spring compressor can be ejected from the valve spring compressor with intense force. Use care when compressing or releasing the valve spring with the valve spring compressor and when removing or installing the valve stem keys. Failing to use care may cause personal injury.

5. Using [J 44646](#) compress the valve spring.

6. Install the valve keys to the valve stem.

Caution: The valve stem keys must correctly seat in the valve spring cap. Engine damage may occur by not installing properly.

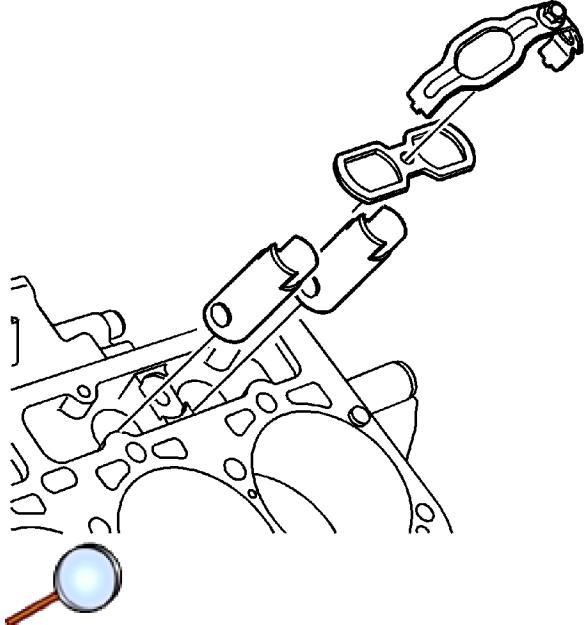
7. Carefully release the valve spring pressure. Make sure the valve keys stay in place.
8. Continue to install the 3 remaining valve stem seals for the cylinder.



9. Release the compressed air holding the valves in place.
10. Remove [J 26999-20](#) (1) from the glow plug hole.
11. Continue to replace the valve stem seals on the remaining cylinders using the above procedures.
12. Install the glow plug. Refer to [Glow Plug Replacement - Bank 1](#) or [Glow Plug Replacement - Bank 2](#).
13. Install the valve rocker arm shaft, the valve bridges, and the push rods. Refer to [Valve Rocker Arm, Shaft, and Push Rod Replacement](#).
14. Install the upper and lower fan shroud. Refer to [Engine Coolant Fan Lower Shroud Replacement](#) and [Engine Coolant Fan Upper Shroud Replacement](#).

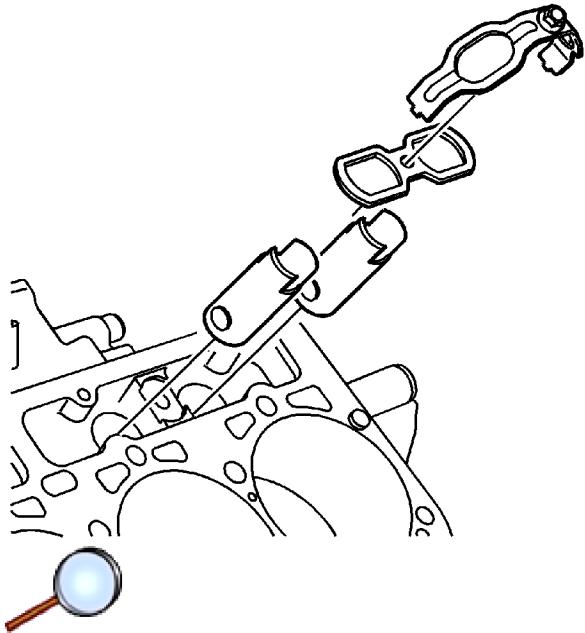
Valve Lifter Replacement

Removal Procedure



1. Remove the cylinder head. Refer to [Cylinder Head Replacement - Left Side](#) or [Cylinder Head Replacement - Right Side](#).
2. Loosen the valve lifter guide retainer bolts.
3. Remove the valve lifter guide retainers.
4. Remove the valve lifter guides.
5. Remove the valve lifters.
6. If required, clean and inspect the lifters. Refer to [Valve Lifters Cleaning and Inspection](#).

Installation Procedure



1. Apply clean engine oil to the roller and outside of the valve lifter.
2. Install the valve lifter.
3. Install the valve lifter guides.

Caution: Refer to [Fastener Caution](#) in the Preface section.

4. Install the valve lifter guide retainer.
5. Install the valve lifter guide retainer bolt.

Tighten

Tighten the bolt to 11 N·m (97 lb in).

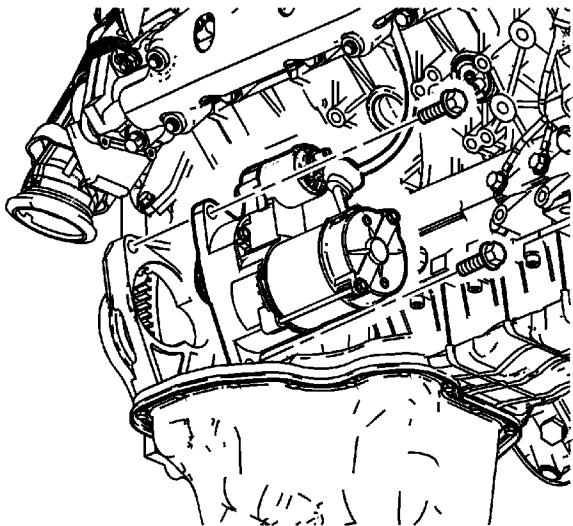
6. Install the cylinder head. Refer to [Cylinder Head Replacement - Left Side](#) or [Cylinder Head Replacement - Right Side](#).

Crankshaft Balancer Replacement

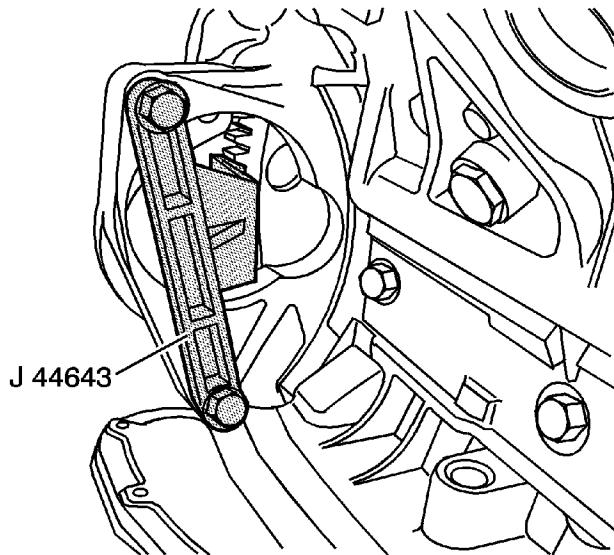
Special Tools

[J 44643](#) Flywheel Holding Tool

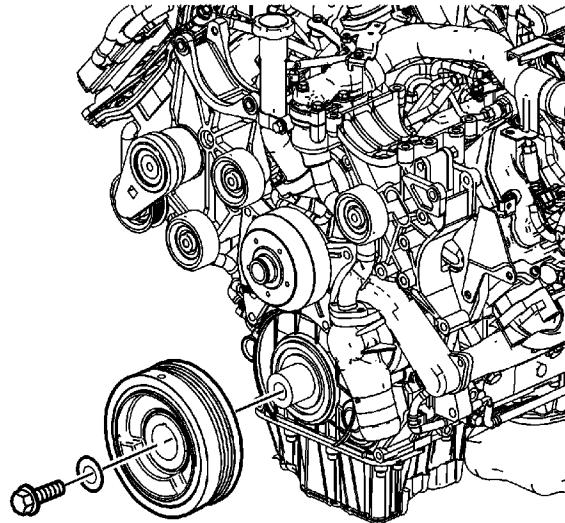
Removal Procedure



1. Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
2. Remove the right wheelhouse panel. Refer to [Front Wheelhouse Liner Replacement - Right Side](#).
3. Remove the starter motor bolts. Reposition the starter aside. The wiring to the starter does not require removal.

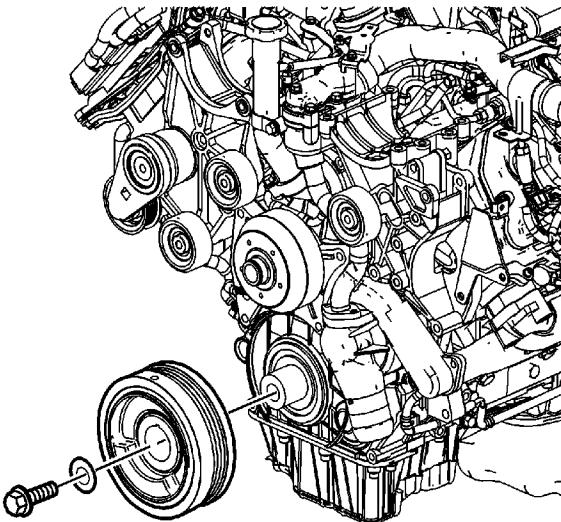


4. Install [J 44643](#) in order to hold the flywheel.
5. Remove the lower fan shroud. Refer to [Engine Coolant Fan Lower Shroud Replacement](#).



6. Remove the crankshaft balancer bolt.
7. Remove the crankshaft balancer.
8. If required, clean and inspect the crankshaft balancer. Refer to [Crankshaft Balancer Cleaning and Inspection](#).

Installation Procedure



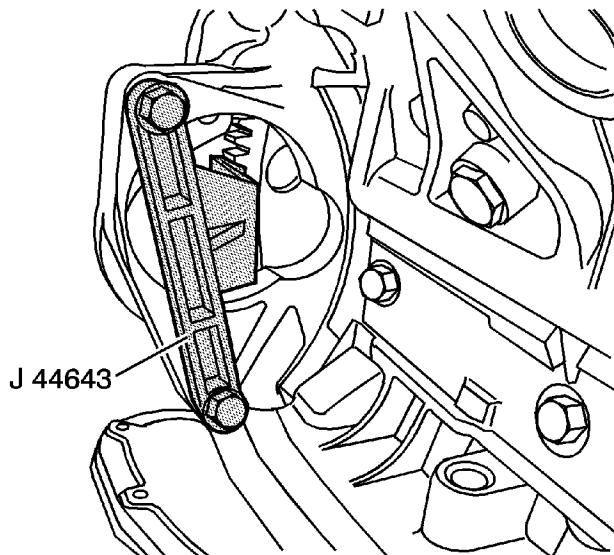
1. Lubricate the crankshaft balancer internal hub with clean engine oil.
2. Install the crankshaft balancer on the crankshaft.

Caution: Refer to [Fastener Caution](#) in the Preface section.

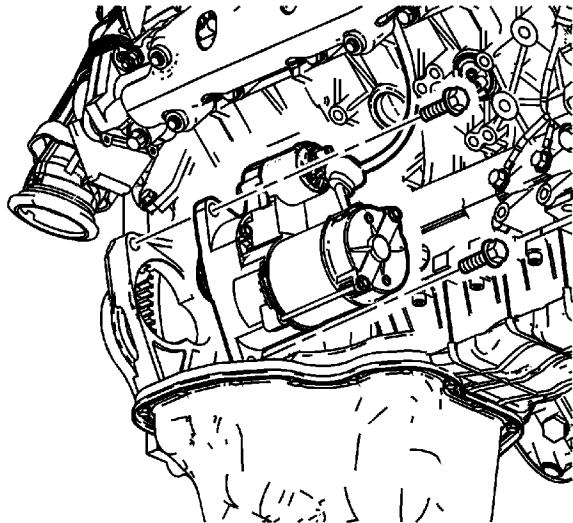
3. Lubricate the crankshaft balancer bolt with clean engine oil.
4. Install the crankshaft balancer bolt and washer.

Tighten

Tighten the bolt to 353 N·m (260 lb ft).



5. Remove [J 44643](#).



6. Position the starter motor.
7. Install the starter motor bolts.

Tighten

Tighten the bolts to 78 N·m (58 lb ft).

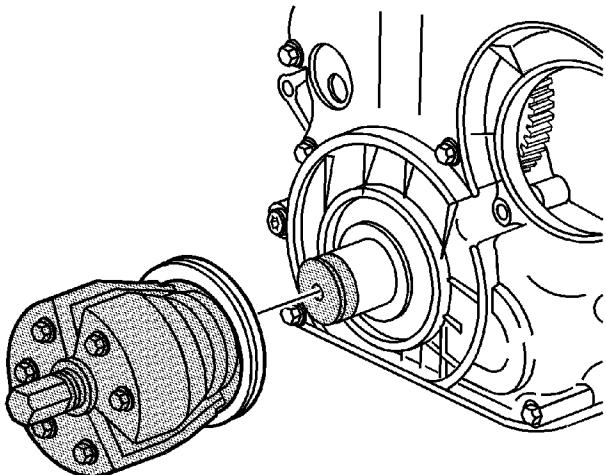
8. Install the right wheelhouse panel. Refer to [Front Wheelhouse Liner Replacement - Right Side](#).
9. Install the lower fan shroud. Refer to [Engine Coolant Fan Lower Shroud Replacement](#).
10. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

Crankshaft Front Oil Seal Replacement

Special Tools

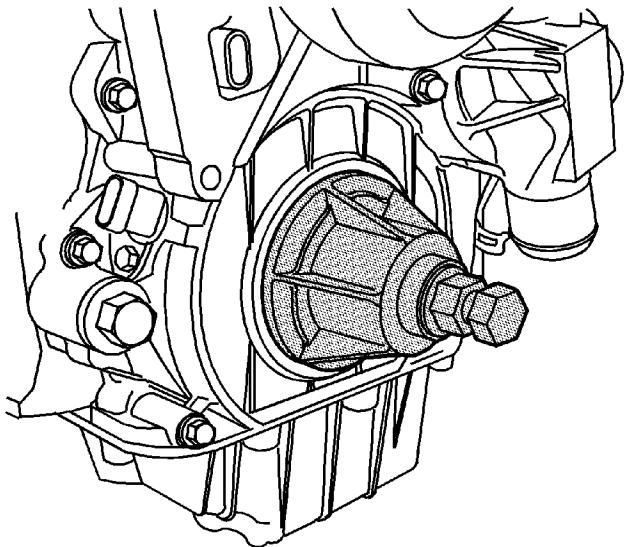
- [J 44644](#) Crankshaft Front Oil Seal Remover
- [J 44645](#) Crankshaft Front Oil Seal Installer

Removal Procedure



1. Remove the crankshaft balancer. Refer to [Crankshaft Balancer Replacement](#).
2. Install the button of [J 44644](#) into the crankshaft.
3. Press the jaws of [J 44644](#) into the felt portion of the seal far enough to engage the inner lip of the seal.
4. While holding the [J 44644](#) tightly to the seal inner sleeve, tighten the jaw bolts.
5. Using [J 44644](#), remove the crankshaft front oil seal.

Installation Procedure



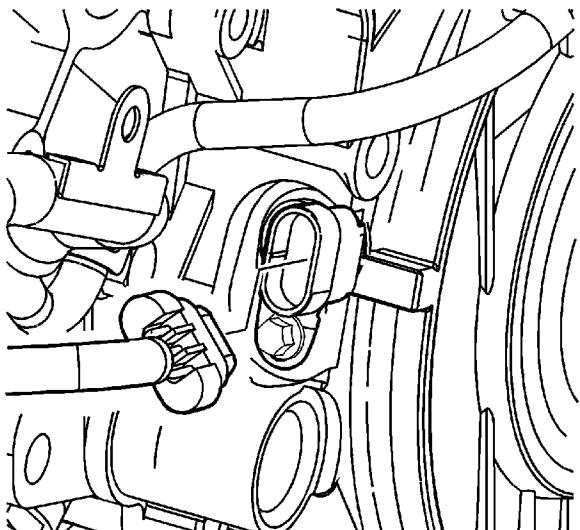
1. Clean the front crankshaft seal bore and the crankshaft.
2. Lubricate the crankshaft sealing surface with clean engine oil.
3. Place the crankshaft front oil seal onto the crankshaft.
4. Install [J 44645](#) to the crankshaft.
5. Press the crankshaft front oil seal onto the crankshaft using [J 44645](#) until the tool bottoms out.
6. Remove [J 44645](#).
7. Install the crankshaft balancer. Refer to [Crankshaft Balancer Replacement](#).

Engine Front Cover Replacement

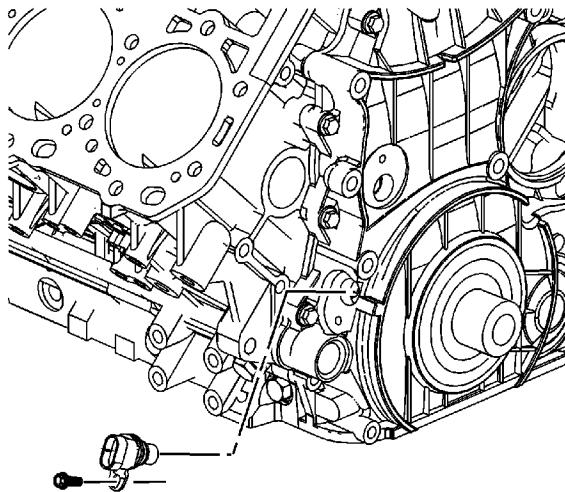
Special Tools

[J 37228](#) Seal Cutter

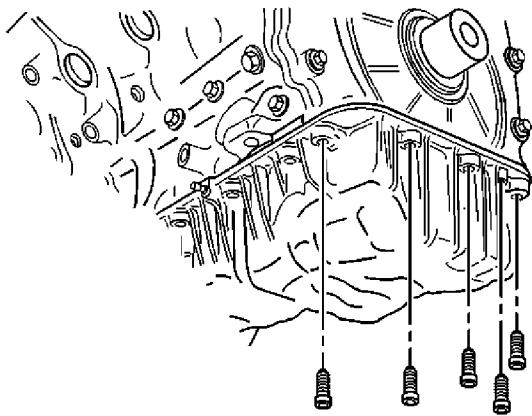
Removal Procedure



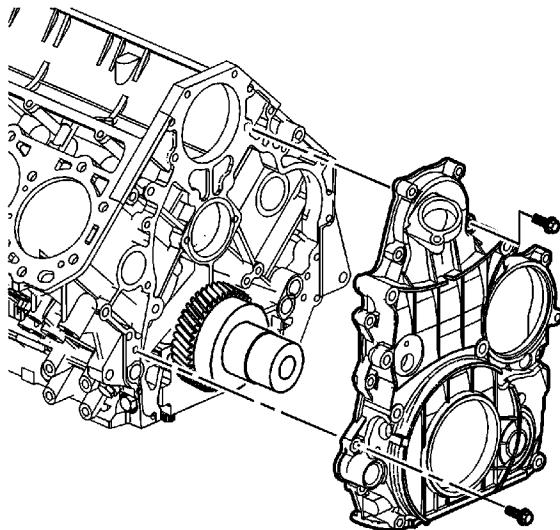
1. Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
2. Remove the water pump. Refer to [Water Pump Replacement](#).
3. Remove the crankshaft front oil seal. Refer to [Crankshaft Front Oil Seal Replacement](#).
4. Remove the right wheelhouse panel. Refer to [Front Wheelhouse Liner Replacement - Right Side](#).
5. Disconnect the crankshaft position (CKP) sensor electrical connector.



6. Remove the CKP sensor bolt and sensor.
7. Remove the CKP sensor spacer bolts and spacer.
8. Remove and discard the O-rings from the sensor and the spacer.



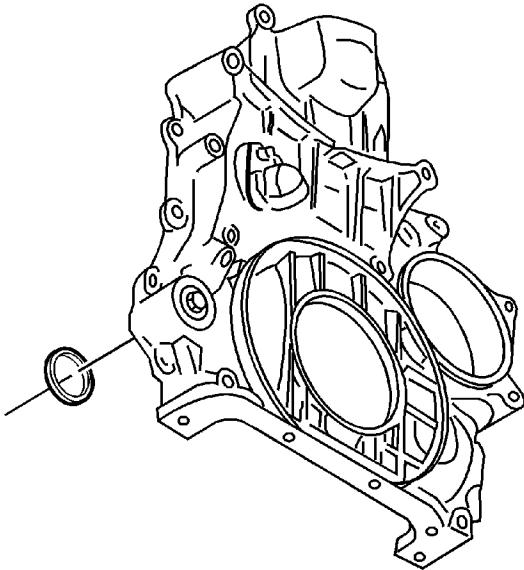
9. Remove the upper oil pan to engine front cover bolts.



10. Remove the engine front cover bolts.
11. Separate the engine front cover from the cylinder block and upper oil pan using [J 37228](#).

Note: Do not bend the turbocharger coolant pipe.

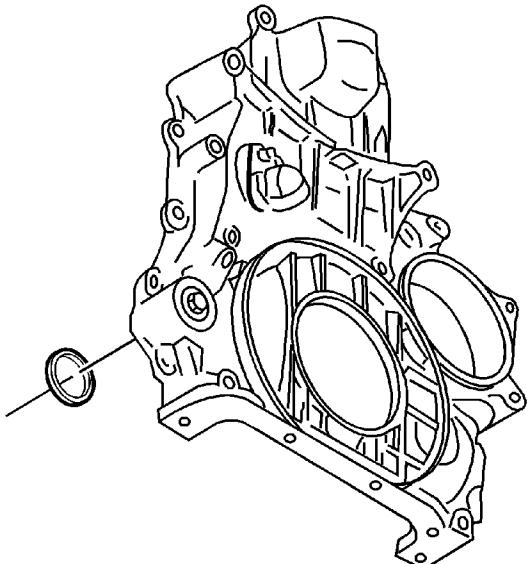
12. Remove the engine front cover.



13. If necessary, remove the pressure relief valve O-ring.
14. Clean and inspect the front cover. Refer to [Engine Front Cover Cleaning and Inspection](#).

Installation Procedure

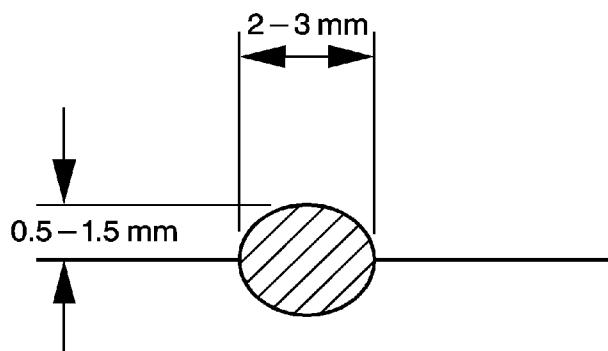
Caution: Refer to [Fastener Caution](#) in the Preface section.



1. If necessary, install a NEW pressure relief valve O-ring.
2. Lubricate the O-ring with engine oil.

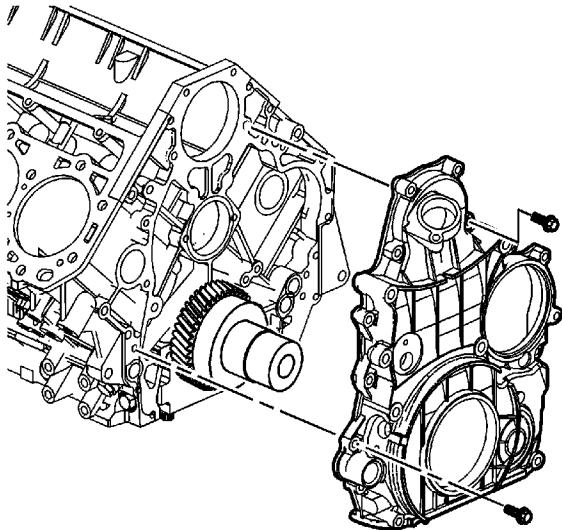
Tighten

Tighten the valve to 39 N·m (29 lb ft).



3. Apply a 2-3 mm (1/8 in) wide by 0.5-1.5 mm (1/16 in) high, bead of sealant to the engine front cover sealing surface to the engine block. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for the correct part number.
4. Apply a 2-3 mm (1/8 in) wide by 0.5-1.5 mm (1/16 in) high, bead of sealant to the engine front cover sealing surface to the upper oil pan. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#)

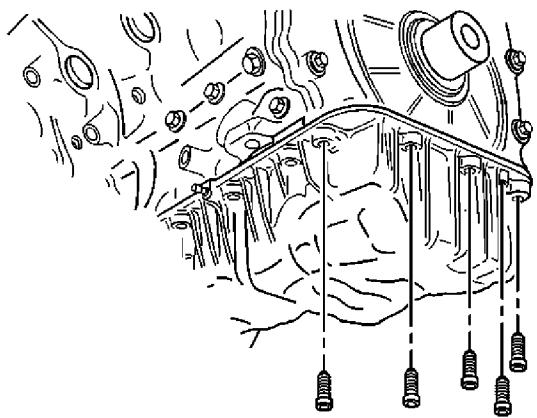
[Sealers](#) for the correct part number.



5. Install the engine front cover.
6. Install the engine front cover bolts.

Tighten

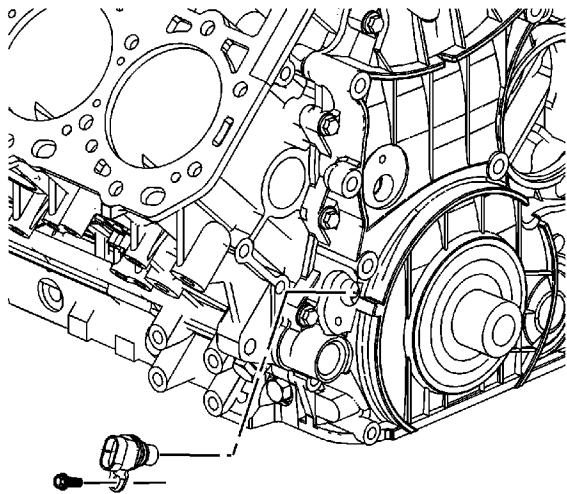
Tighten the bolts to 25 N·m (18 lb ft).



7. Install the upper oil pan to engine front cover bolts.

Tighten

Tighten the bolts to 21 N·m (15 lb ft).



8. Install a NEW O-ring to the CKP sensor spacer.
9. Lubricate the O-ring with clean engine oil.

Note: The crankshaft position sensor spacers are machined with different timing positions. However, if the crankshaft position sensor spacer requires replacement, replace with a grade "C" spacer.

10. Install the CKP sensor spacer and bolts.

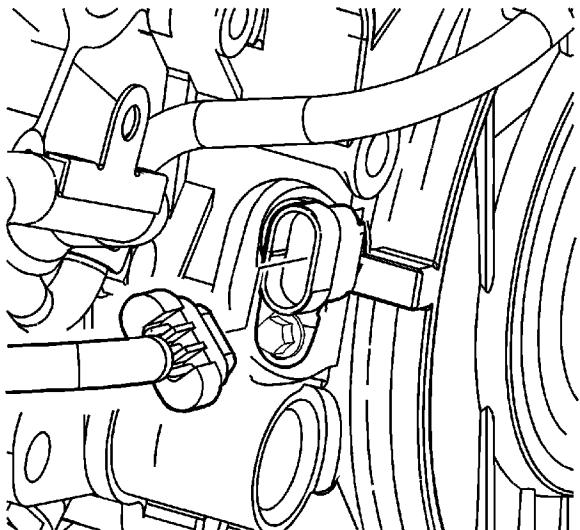
Tighten

Tighten the bolts to 10 N·m (89 lb in).

11. Install a NEW O-ring to the CKP sensor.
12. Lubricate the O-ring with clean engine oil.
13. Install the CKP sensor and bolt.

Tighten

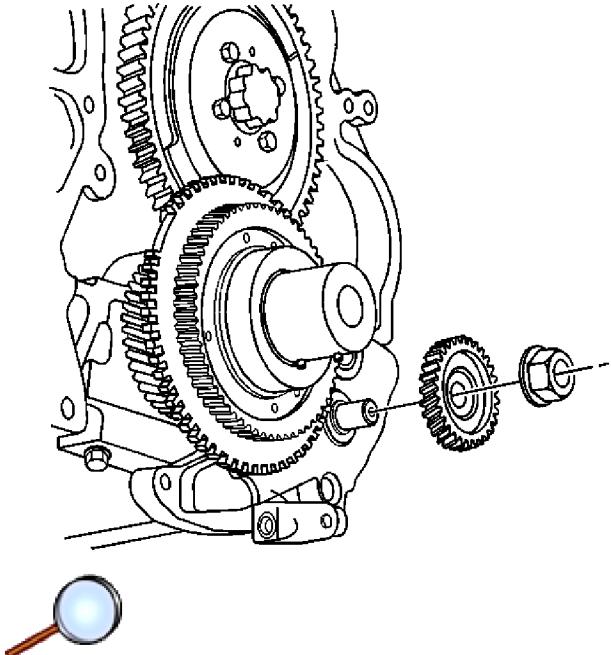
Tighten the bolt to 10 N·m (89 lb in).



14. Connect the CKP sensor electrical connector.
15. Install the right wheelhouse panel. Refer to [Front Wheelhouse Liner Replacement - Right Side](#).
16. Install the crankshaft front oil seal. Refer to [Crankshaft Front Oil Seal Replacement](#).
17. Install the water pump. Refer to [Water Pump Replacement](#).
18. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

Camshaft Position Sensor Exciter Ring Replacement

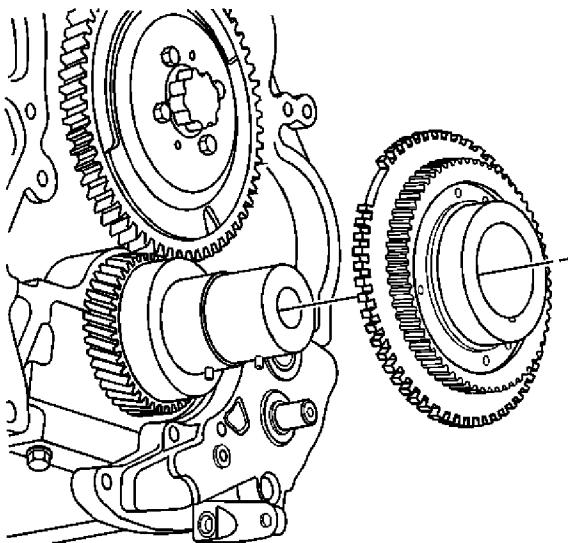
Removal Procedure



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

Caution: Do not use an impact driver to remove or install the oil pump driven gear nut. Use of an impact driver may shear the oil pump drive gear pin in the crankshaft.

2. While holding the secondary oil pump shaft with a hex driver, remove the oil pump driven gear nut.
3. Remove the oil pump driven gear.

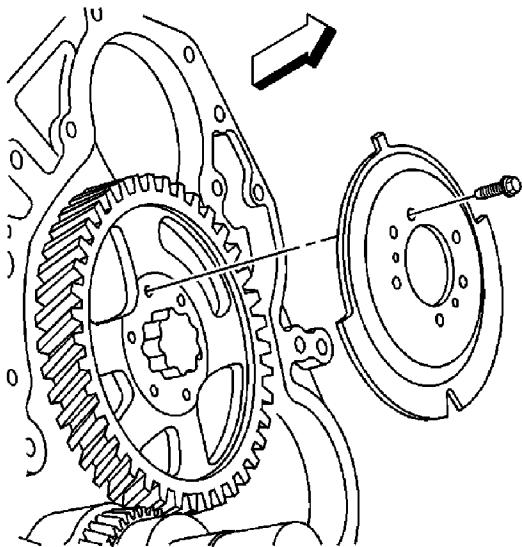


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Note: DO NOT remove the reluctor from the oil pump drive gear. The reluctor is timed to the gear and once removed the correct timing will be lost.

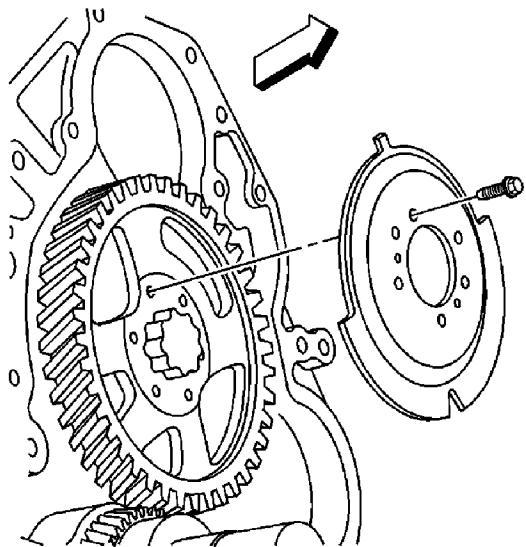
4. Remove the oil pump drive gear and crankshaft sensor reluctor.



5. Remove the camshaft reluctor screws.
6. Remove the camshaft reluctor.
7. Clean and inspect the camshaft reluctor for damage. Replace the reluctor if damage is found.

Installation Procedure

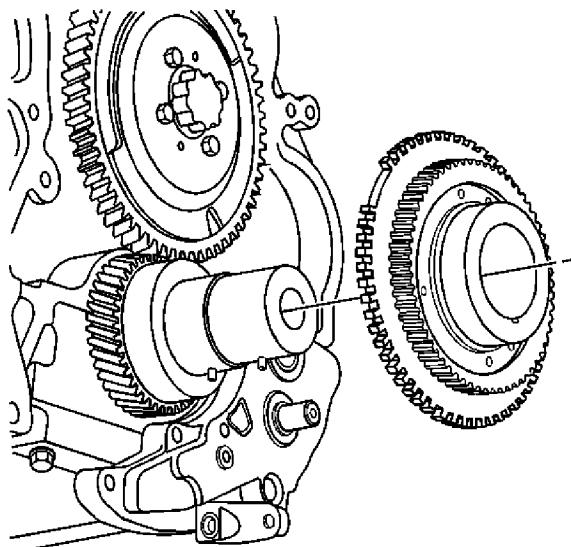
Caution: Refer to [Fastener Caution](#) in the Preface section.



- 1. Position the camshaft reluctor to the camshaft gear.
- 2. Install the camshaft reluctor bolts.

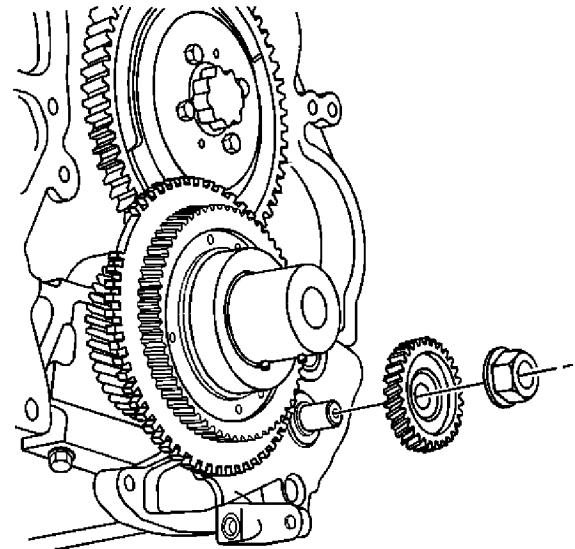
Tighten

Tighten the bolts to 9 N·m (80 lb in).



Note: Do not damage the teeth on the reluctor.

- 3. Install the oil pump drive gear and reluctor to the crankshaft.



4. Install the oil pump driven gear.

Caution: Do not use an impact driver to remove or install the oil pump driven gear nut. Use of an impact driver may shear the oil pump drive gear pin in the crankshaft.

5. While holding the secondary oil pump shaft with a hex driver, install the oil pump driven gear nut.

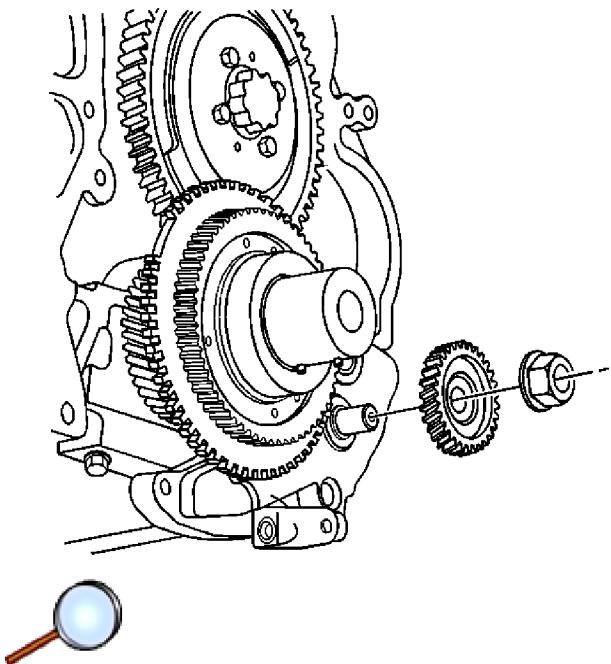
Tighten

Tighten the nut to 100 N·m (74 lb ft).

6. Install the engine front cover. Refer to [Engine Front Cover Replacement](#).

Crankshaft Reluctor and Oil Pump Drive Gear Replacement

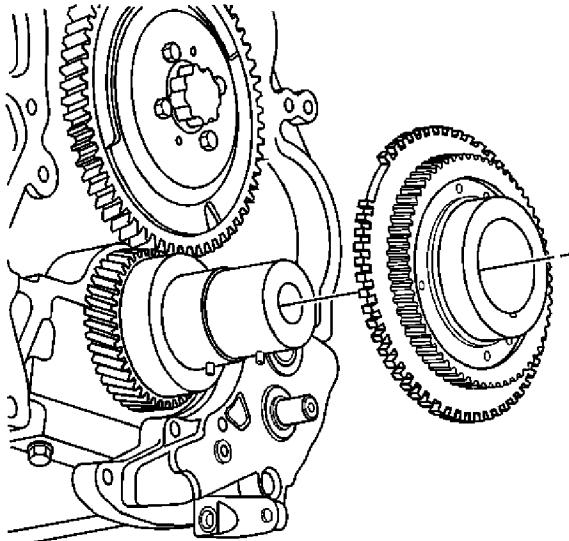
Removal Procedure



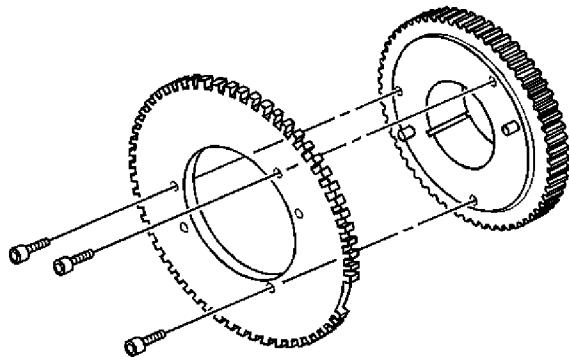
1. Remove the engine front cover. Refer to [Engine Front Cover Replacement](#).
2. Remove the upper oil pan. Refer to [Upper Oil Pan Replacement](#).

Caution: Do not use an impact driver to remove or install the oil pump driven gear nut. Use of an impact driver may shear the oil pump drive gear pin in the crankshaft.

3. While holding the secondary oil pump shaft with a hex driver, remove the oil pump driven gear nut.
4. Remove the oil pump driven gear.



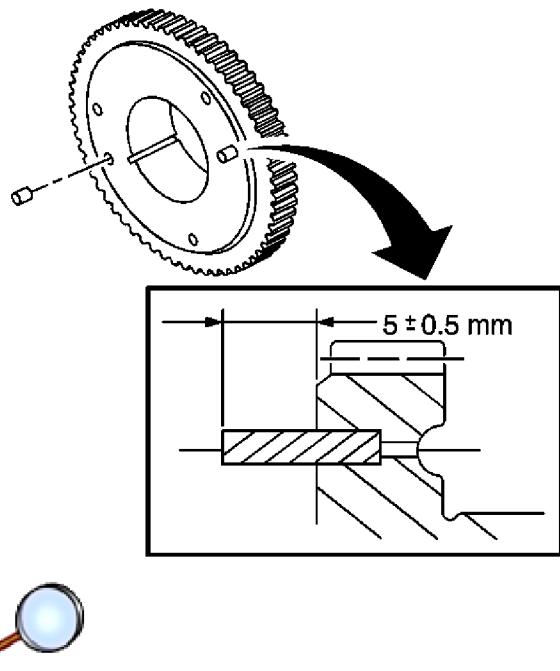
5. Remove the oil pump drive gear and crankshaft sensor reluctor. Do not damage the crankshaft reluctor teeth.



Note: Do not remove the reluctor from the oil pump drive gear unless replacing the reluctor or the oil pump drive gear. The reluctor is timed to the gear and once removed the correct timing will be lost.

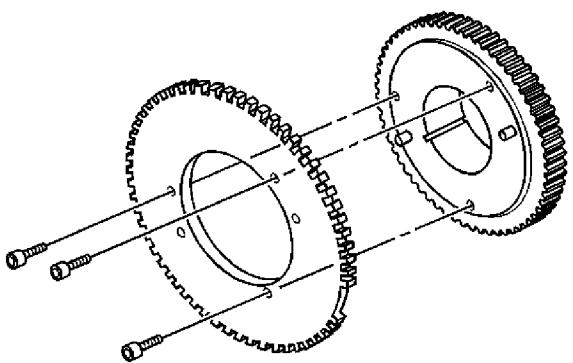
6. Remove the crankshaft reluctor to oil pump drive gear bolts.
7. Inspect the crankshaft reluctor for the damage, bent teeth, being bent or warped.
8. Inspect the oil pump drive gear for damaged or worn teeth.
9. Inspect the oil pump drive gear crankshaft pin for wear.
10. Inspect the groove of the crankshaft pin in the oil pump drive gear for wear.
11. Replace any parts that are damaged or worn.

Installation Procedure



Note: The crankshaft reluctor and the oil pump drive gear are timed at the factory. In order to re-establish proper timing, install knock pins in the oil pump drive gear if the crankshaft reluctor was removed from the oil pump drive gear. The knock pins are available through the parts department.

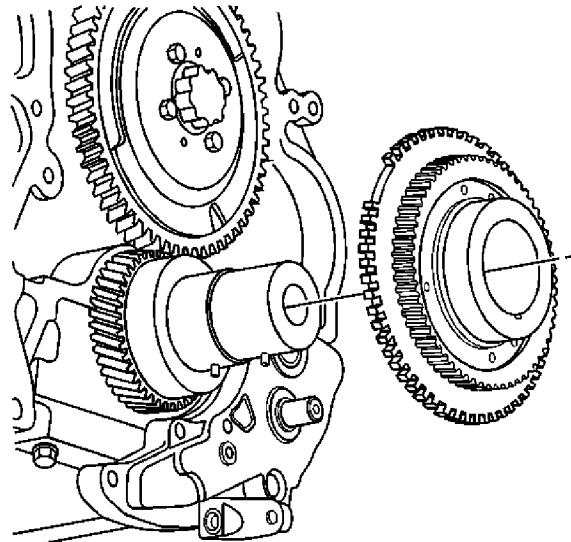
1. Install the knock pins in the oil pump drive gear to a height of 4.5-5.5 mm (0.177-0.217 in)



2. Install the crankshaft reluctor on the oil pump drive gear. Ensure the reluctor is aligned on the knock pins.

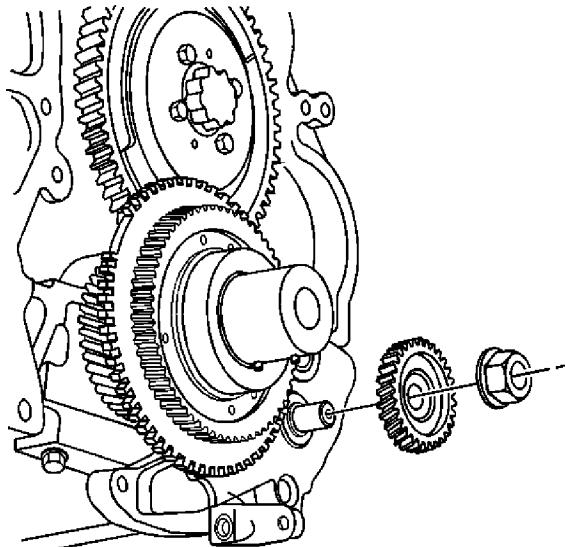
Caution: Refer to [Fastener Caution](#) in the Preface section.

3. Install the crankshaft reluctor bolts and tighten to **8 N·m (71 lb in)**.



Note: Do not damage the teeth on the crankshaft reluctor.

4. Install the oil pump drive gear and reluctor to the crankshaft.



5. Install the oil pump driven gear.

Caution: Do not use an impact driver to remove or install the oil pump driven gear nut. Use of an impact driver may shear the oil pump drive gear pin in the crankshaft.

6. While holding the secondary oil pump shaft with a hex driver, install the oil pump driven gear

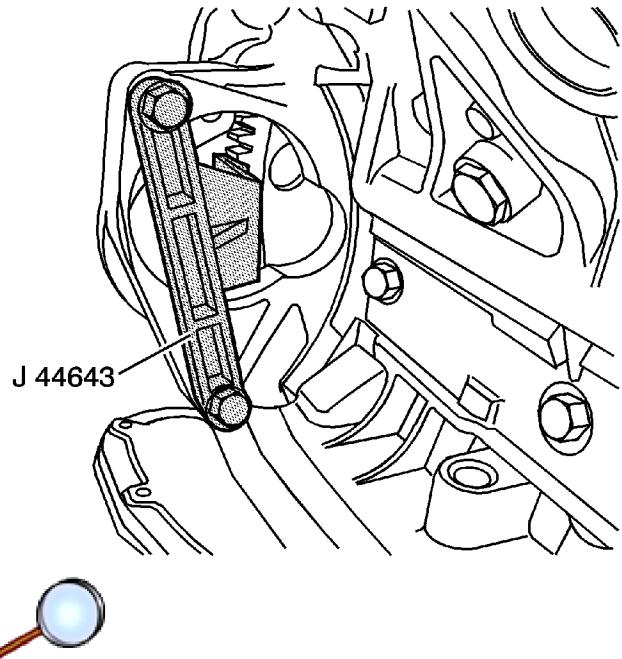
- nut and tighten to **100 N·m (74 lb ft)**.
7. Install the upper oil pan. Refer to [Upper Oil Pan Replacement](#).
 8. Install the engine front cover. Refer to [Engine Front Cover Replacement](#).

Camshaft Replacement

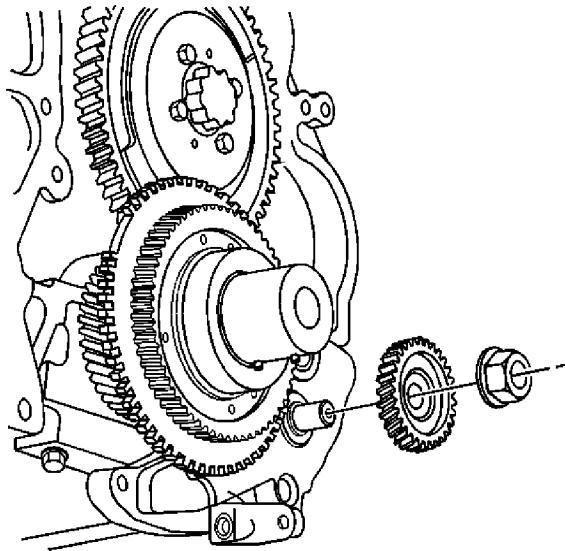
Special Tools

- [J 26900-12](#) Dial Indicator
- [J 26900-13](#) Magnetic Base
- [J 44643](#) Flywheel Holding Tool

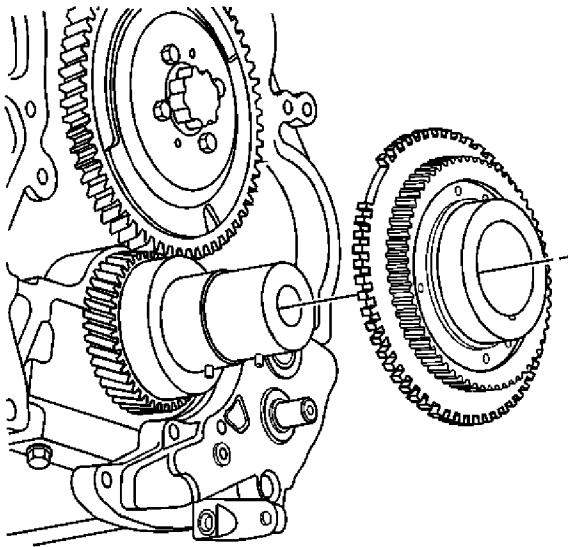
Removal Procedure



1. Remove the engine assembly. Refer to [Engine Replacement](#).
2. Remove the valve lifters. Refer to [Valve Lifter Replacement](#).
3. Install [J 44643](#) flush to the flywheel opening.
4. Remove the engine front cover. Refer to [Engine Front Cover Replacement](#).

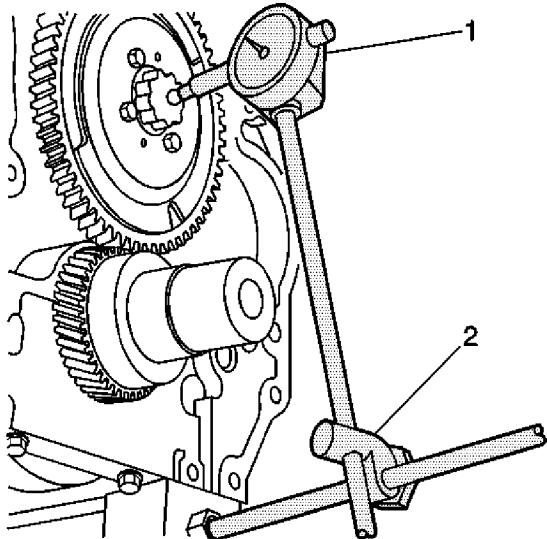


5. Remove the oil pump driven gear nut.
6. Remove the oil pump driven gear.

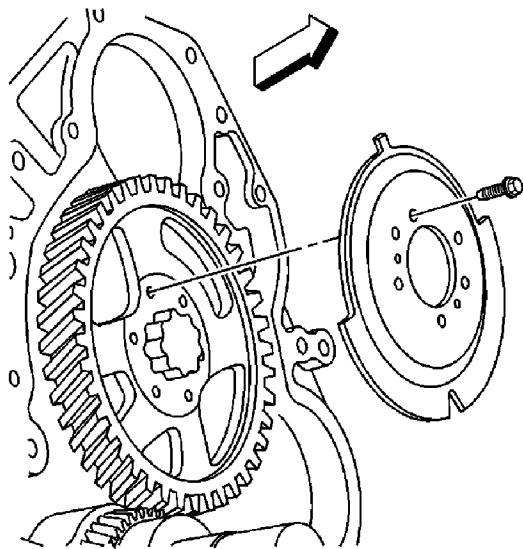


Note: The crankshaft reluctor and the oil pump drive gear are timed together at the factory. Do not remove the crankshaft reluctor from the oil pump drive gear.

7. Remove the oil pump drive gear and crankshaft reluctor.
 - Do not remove the crankshaft reluctor bolts.
 - Do not damage the reluctor teeth.



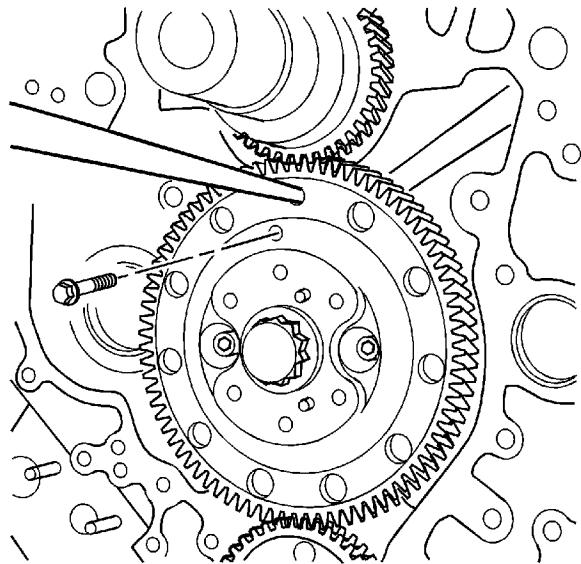
8. Using [J 26900-12](#) (1) and [J 26900-13](#) (2), measure the camshaft end play.
 - The production value is 0.050-0.114 mm (0.002-0.0045 in) and service limit is 0.20 mm (0.008 in).
 - Replace the camshaft gear or the camshaft thrust plate if measured value exceeds service limit.



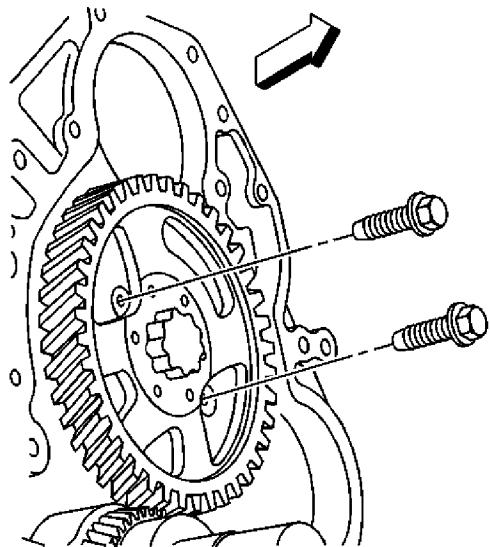
9. Remove the camshaft reluctor screws.
10. Remove the camshaft reluctor.

Note: The two piece cam gear must be bolted together to prevent the spring tension from unloading upon removal.

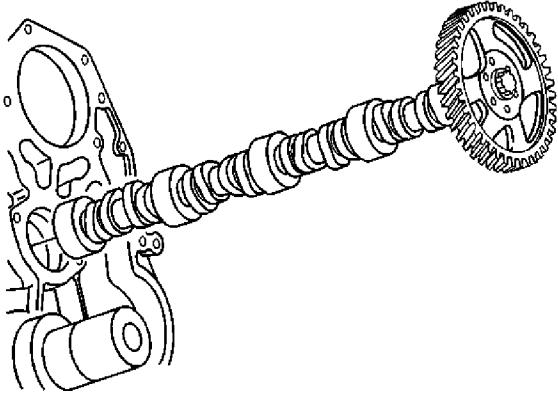
11. Remove the camshaft exciter ring.



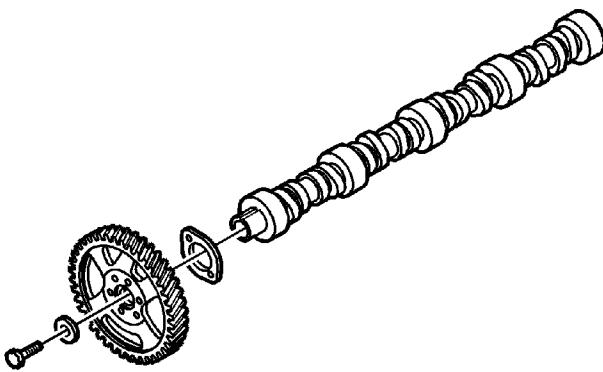
12. Align the threaded hole with a suitable tool and install an exciter ring bolt to secure the spring tension.
13. Remove the camshaft thrust plate bolts through the holes in the camshaft gear.



14. In order to loosen the camshaft gear bolt use [J 44643](#) in order to hold the engine from turning.
15. Loosen the camshaft gear bolt and leave the bolt finger tight.
16. Remove the camshaft thrust plate bolts through the holes in the camshaft gear.

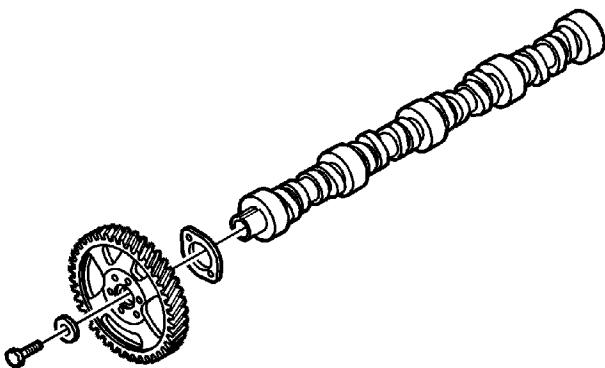


17. Remove the camshaft with the camshaft gear attached.



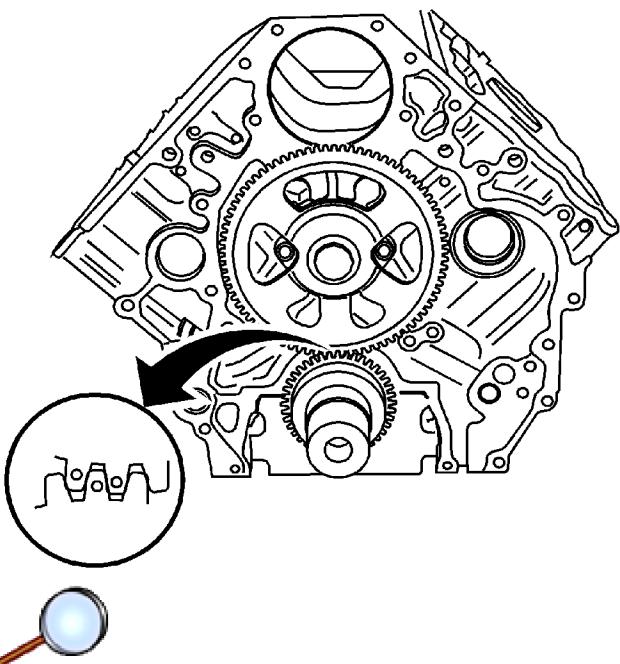
18. Remove the camshaft gear bolt and discard.
19. Remove the camshaft gear.
20. Remove the camshaft thrust plate.
21. Clean and inspect the camshaft and bearings. Refer to [Camshaft and Bearings Cleaning and Inspection](#).

Installation Procedure



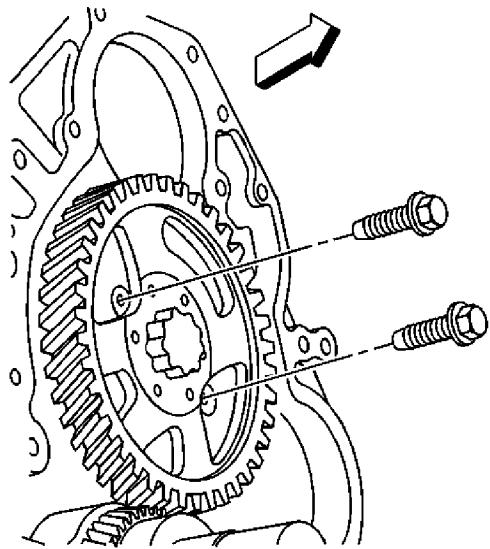
1. Install the camshaft thrust plate to the camshaft.
2. Install the camshaft driven gear.
3. Install a NEW camshaft driven gear bolt.

Leave the bolt finger tight.



4. Install the camshaft into the cylinder block, align the camshaft gear to the crankshaft gear as shown.

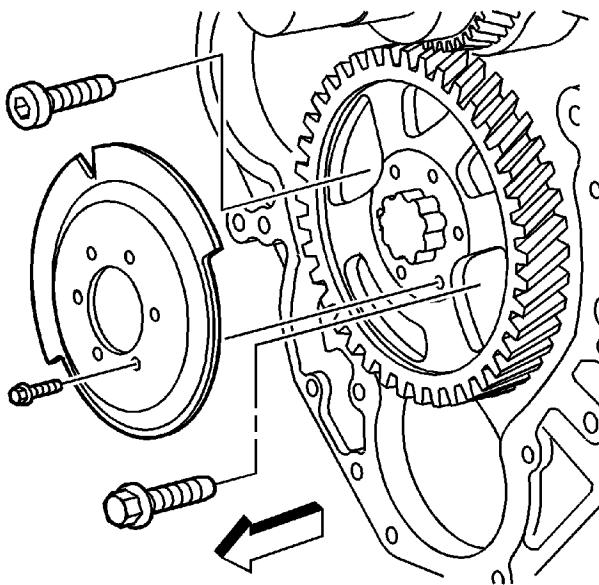
Caution: Refer to [Fastener Caution](#) in the Preface section.



5. Apply threadlock to the threads of the camshaft thrust plate bolts. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for the correct part number.
6. Install the camshaft thrust plate bolts.

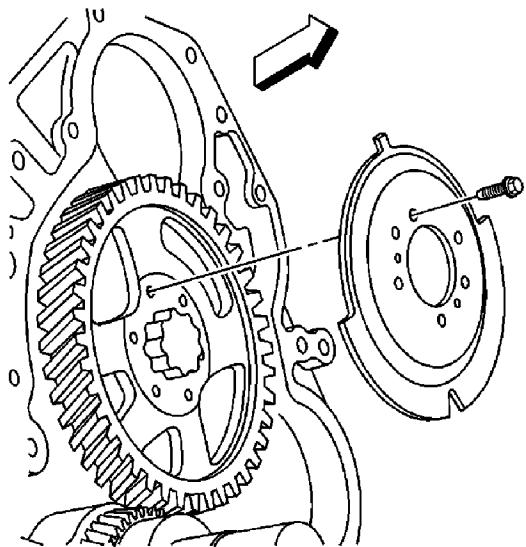
Tighten

Tighten the bolts to 22 N·m (16 lb ft).



Note: Use a suitable tool to relieve the spring tension while removing the locking bolt.

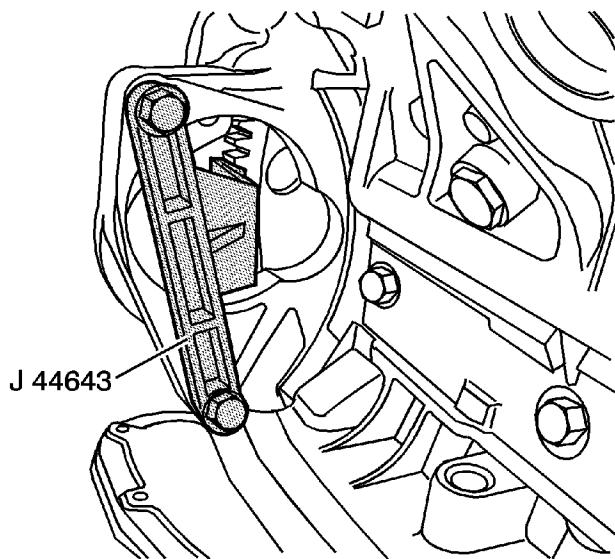
7. Remove the exciter ring bolt that was installed to hold the spring tension of the two piece cam gear.



8. Install the camshaft reluctor to the camshaft gear.
9. Install the camshaft reluctor bolts.

Tighten

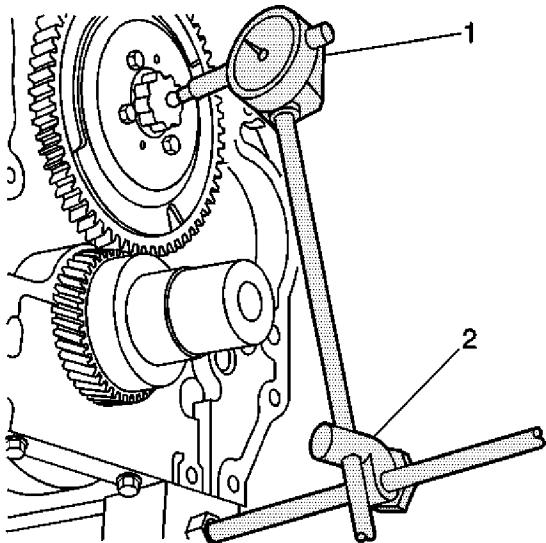
Tighten the bolts in a cross-bolt pattern to 9 N·m (80 lb in).



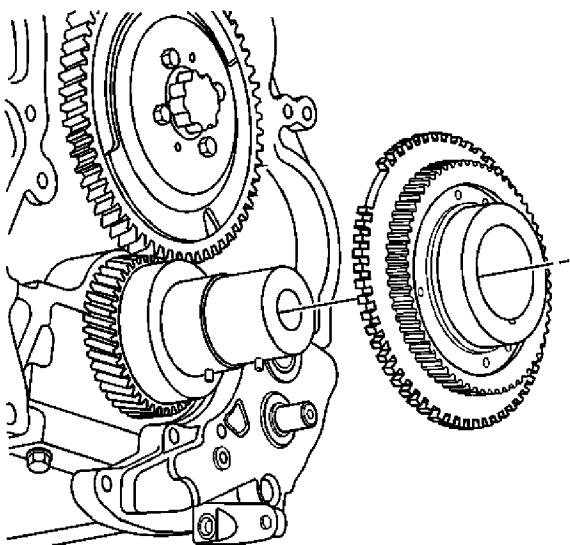
10. Reinstall [J 44643](#) in the starter opening, if removed.
11. Install a NEW camshaft gear bolt.

Tighten

Tighten the bolt to 234 N·m (173 lb ft).

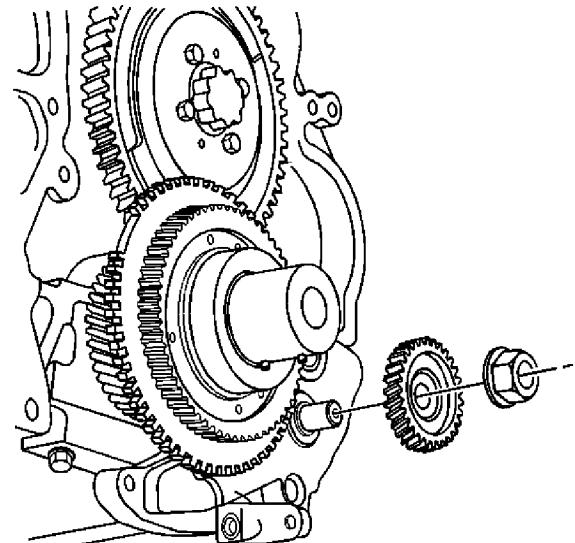


12. Using [J 26900-12](#) (1) and [J 26900-13](#) (2) measure the camshaft end play.
- The production value is 0.050-0.114 mm (0.002-0.0045 in) and service limit is 0.20 mm (0.008 in).
 - Replace the camshaft gear or the camshaft thrust plate if measured value exceeds the service limit.



Important: Do not damage the teeth on the crankshaft reluctor.

13. Install the oil pump drive gear and reluctor to the crankshaft.



14. Install the oil pump driven gear.
15. Install the oil pump driven gear nut.

Tighten

Tighten the nut to 100 N·m (74 lb ft).

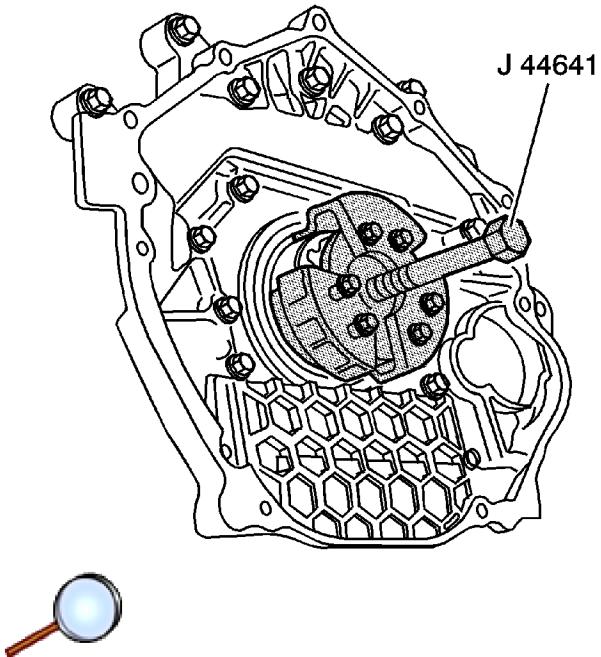
16. Install the engine front cover. Refer to [Engine Front Cover Replacement](#).
17. Install the engine assembly. Refer to [Engine Replacement](#).
18. Install the valve lifters. Refer to [Valve Lifter Replacement](#).

Crankshaft Rear Oil Seal Replacement

Special Tools

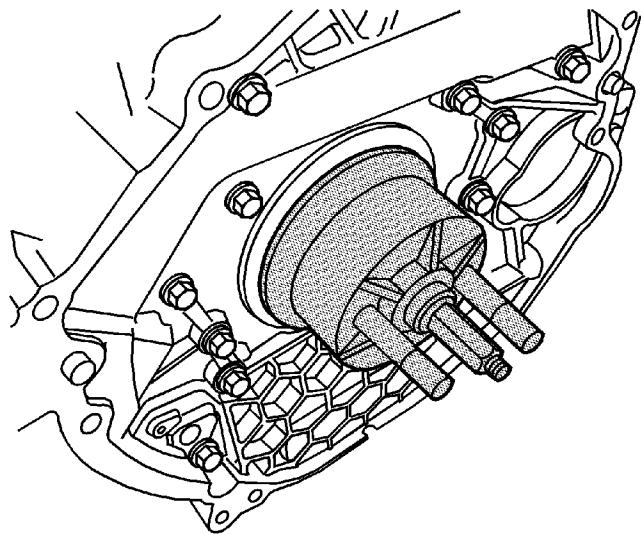
- [J 44641](#) Crankshaft Rear Oil Seal Remover
- [J 44642](#) Crankshaft Rear Oil Seal Installer

Removal Procedure



1. Remove the flywheel. Refer to [Engine Flywheel Replacement](#).
2. Clean the area around the crankshaft rear oil seal.
3. Install the button of [J 44641](#) into the crankshaft.
4. Press the jaws of [J 44641](#) into the felt portion of the seal far enough to engage the inner lip of the seal.
5. While holding the [J 44641](#) tightly to the seal inner sleeve, tighten the jaw bolts.
6. Remove the crankshaft rear oil seal using [J 44641](#).

Installation Procedure



1. Ensure that the crankshaft is free of oil and dirt.
2. Clean the seal bore in the flywheel housing.
3. Position the crankshaft rear oil seal onto the crankshaft.

Important: [J 44642](#) must be fully secured to the crankshaft to ensure proper seal depth.

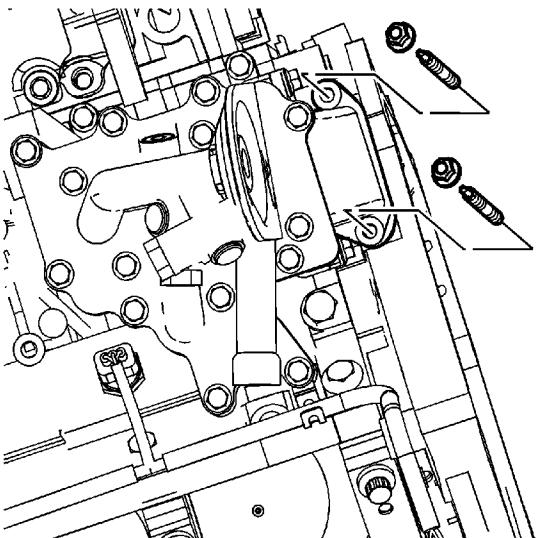
4. Install [J 44642](#) to the crankshaft.
5. Press the crankshaft rear oil seal into position using [J 44642](#), the tool will bottom out when the seal reaches the proper depth.
6. Remove [J 44642](#).
7. Install the flywheel. Refer to [Engine Flywheel Replacement](#).

Engine Flywheel Housing Replacement

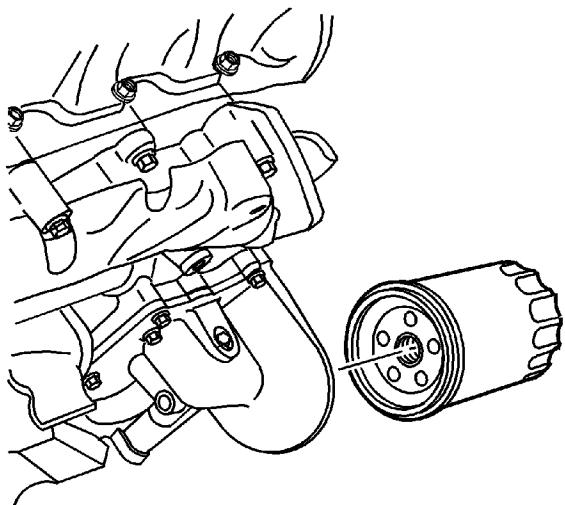
Special Tools

[J 37228](#) Seal Cutter

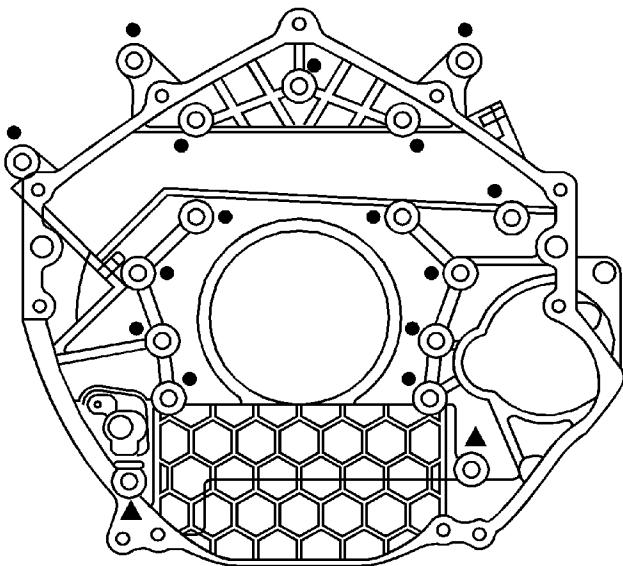
Removal Procedure



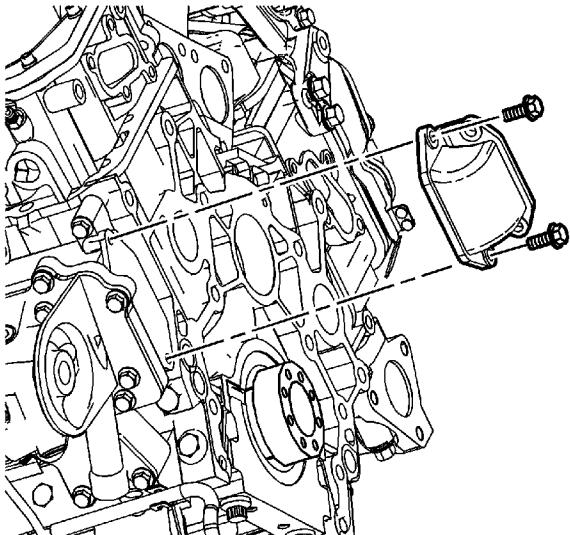
1. Drain the cooling system. Refer to [Cooling System Draining and Filling](#).
2. Remove the crankshaft rear oil seal. Refer to [Crankshaft Rear Oil Seal Replacement](#).
3. Remove the turbocharger oil return pipe nuts from the top of the flywheel housing.
4. Remove the oil cooler adapter studs and nuts from the flywheel housing.



5. Remove the upper oil pan. Refer to [Upper Oil Pan Replacement](#).
6. Remove the oil filter.

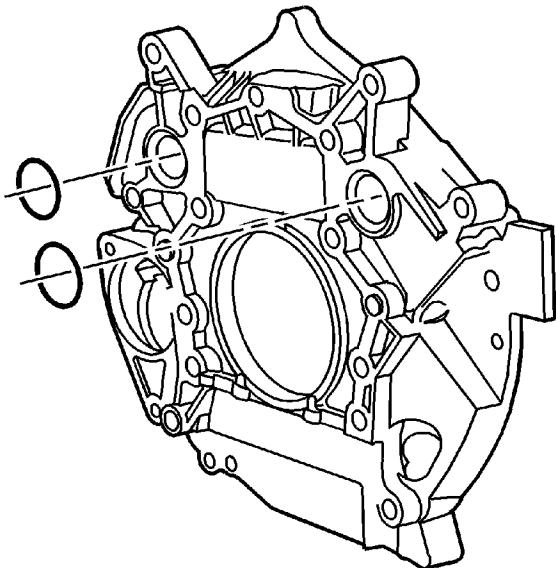


7. Remove the flywheel housing bolts, denoted by the black circles.
8. Separate the flywheel from the cylinder block using [J 37228](#).
9. Remove the flywheel housing.

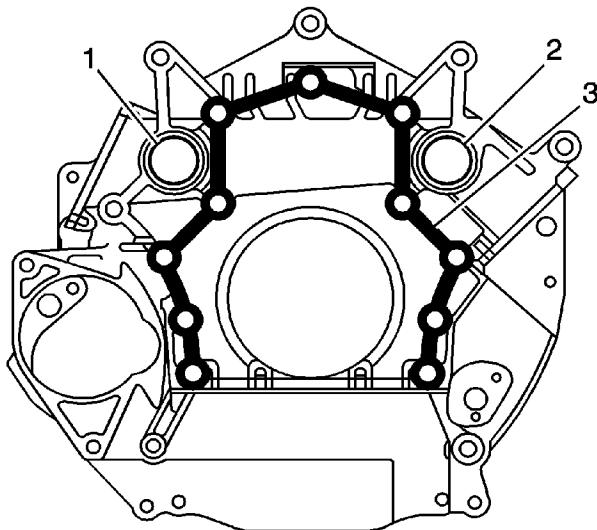


10. Remove the turbocharger oil return pipe gasket from the flywheel housing.
11. Remove the oil cooler adapter bolts.
12. Remove the oil cooler adapter and gaskets.
13. If required, clean and inspect the flywheel housing. Refer to [Engine Flywheel Housing Cleaning and Inspection](#).

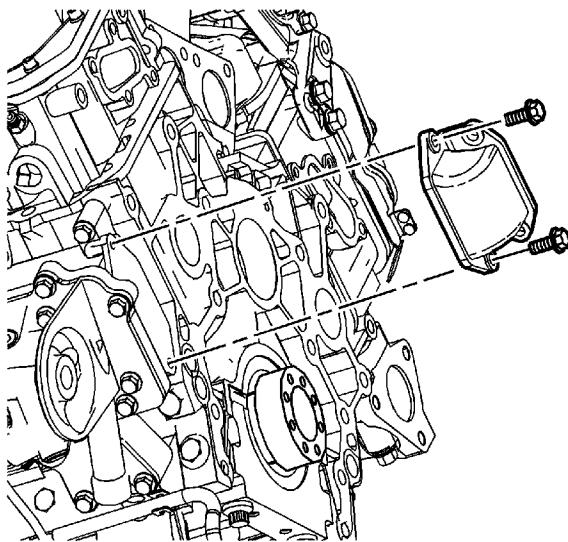
Installation Procedure



1. Install NEW O-ring seals to the flywheel housing, if necessary.



2. Apply a 2 mm (1/8 in) wide bead of sealant (3) to the flywheel housing sealing surfaces. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for the correct part number.



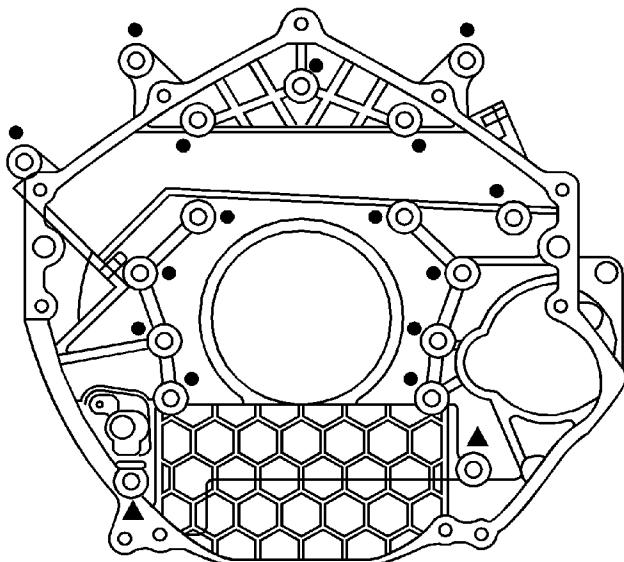
3. Install a NEW oil cooler adapter gasket.
4. Install a NEW oil cooler adapter to flywheel housing gasket.
5. Install the oil cooler adapter to the flywheel housing.

Caution: Refer to [Fastener Caution](#) in the Preface section.

6. Install the oil cooler adapter bolts.

Tighten

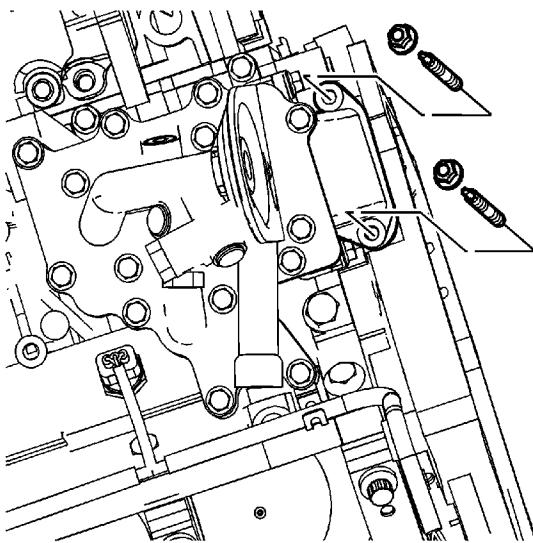
Tighten the bolts/nuts to 21 N·m (15 lb ft).



7. Install the flywheel housing bolts, denoted by the black circles.

Tighten

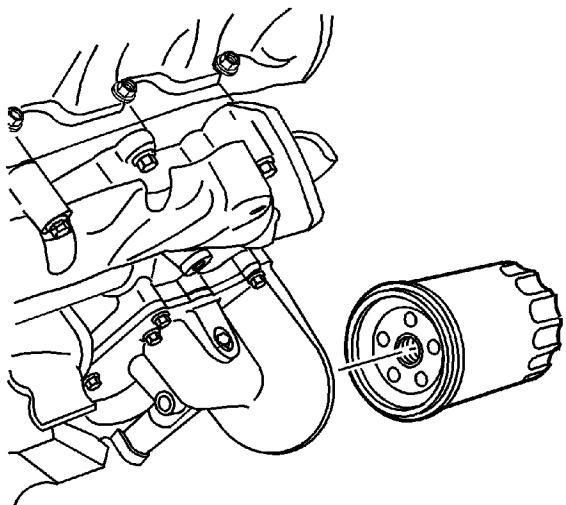
Tighten the bolts to 90 N·m (67 lb ft).



8. Install the oil cooler adapter studs and nuts to the flywheel housing.

Tighten

- Tighten the oil cooler adapter studs to 10 N·m (89 lb in).
- Tighten the oil cooler adapter nuts to 25 N·m (18 lb ft).



9. Install the oil filter.
10. Install the upper oil pan. Refer to [Upper Oil Pan Replacement](#).
11. Install a NEW gasket to the turbocharger oil return pipe.
12. Install the turbocharger oil return pipe to flywheel housing nuts.

Tighten

Tighten the nuts to 21 N·m (15 lb ft).

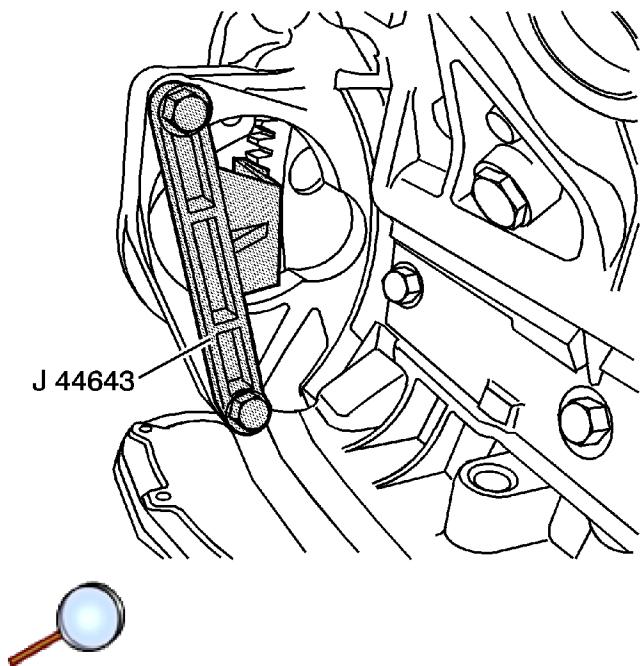
13. Install the crankshaft rear oil seal. Refer to [Crankshaft Rear Oil Seal Replacement](#).
14. Fill the cooling system. Refer to [Cooling System Draining and Filling](#).

Engine Flywheel Replacement

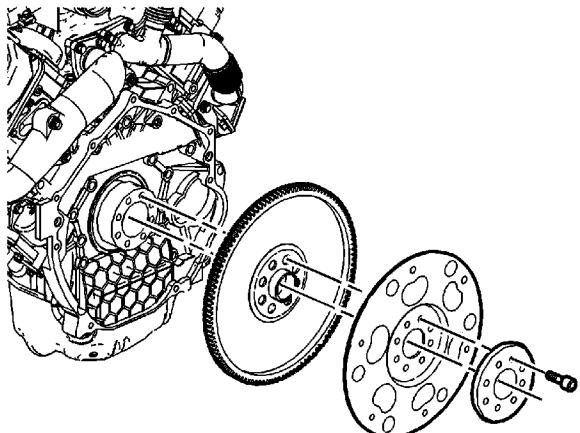
Special Tools

- [J 44643](#) Flywheel Holding Tool
- [J 45059](#) Angle Meter

Removal Procedure



1. Remove the transmission. Refer to [Transmission Replacement](#) for the 4L60-E /4L65-E/4L70-E transmission, [Transmission Replacement](#) for the 4L50/4L80/4L90 transmission, or [Transmission Replacement](#) for the Allison transmission.
2. Install [J 44643](#) in order to hold the flywheel.

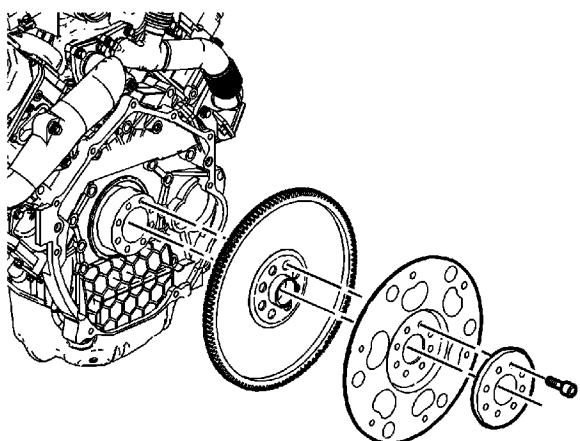


Warning: When removing, handling or installing this component wear protective gloves. The sharp edges on the component may be very sharp and may cause injury.

3. Remove and discard the flywheel bolts.
4. Remove the flywheel washer and flywheel.

Installation Procedure

Warning: When removing, handling or installing this component wear protective gloves. The sharp edges on the component may be very sharp and may cause injury.





Note: When installing the flywheel, ensure that the tapered side of the teeth are facing the starter.

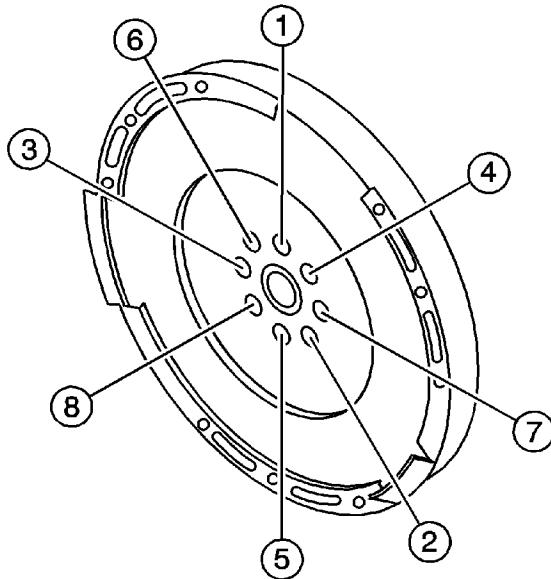
1. Install the flywheel.

Caution: Refer to [Fastener Caution](#) in the Preface section.

2. Install the flywheel washer with the beveled side facing the engine.

Caution: This component uses bolts with a preapplied molybdenum disulfide coating for thread lubrication. Do not remove the coating or use any additional lubricant. Improperly lubricated threads will adversely affect the bolt torque and clamp load. Improper bolt torque and clamp load can lead to engine damage.

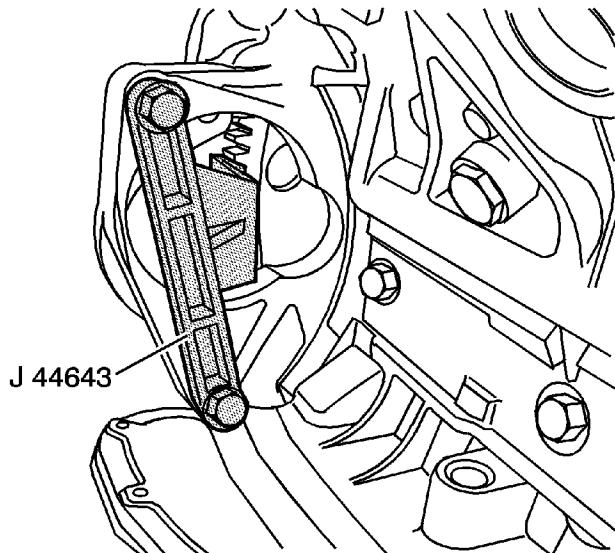
3. Install NEW flywheel bolts.



4. Tighten the flywheel bolts in the proper sequence.

Tighten

1. Tighten the bolts a first pass to 79 N·m (58 lb ft).
2. Tighten the bolts a second pass to 60 degrees using [J 45059](#).
3. Tighten the bolts a final pass an additional 60 degrees using [J 45059](#).



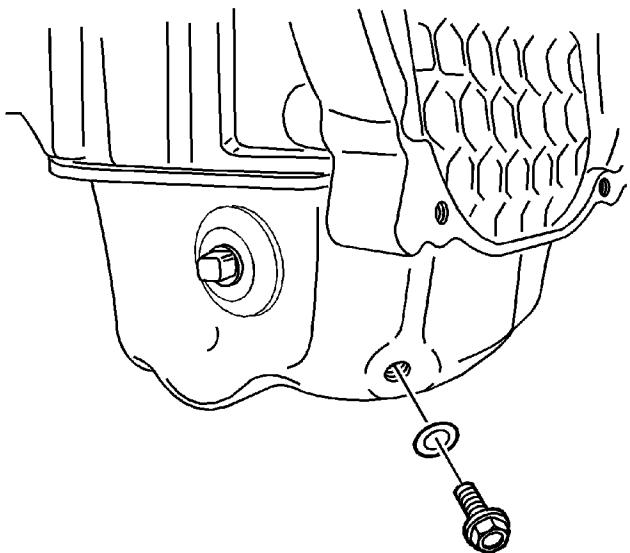
5. Remove [J 44643](#) from the flywheel.
6. Install the transmission. Refer to [Transmission Replacement](#) for the 4L60-E/4L65-E/4L70-E transmission, [Transmission Replacement](#) for the 4L50/4L80/4L90 transmission, or [Transmission Replacement](#) for the Allison transmission.

Lower Oil Pan Replacement

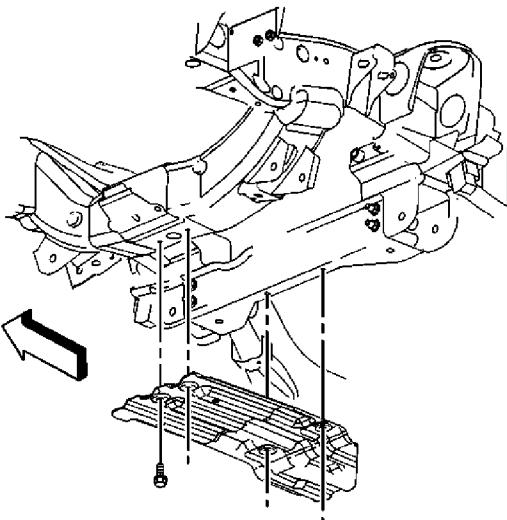
Special Tools

[J 37228](#) Seal Cutter

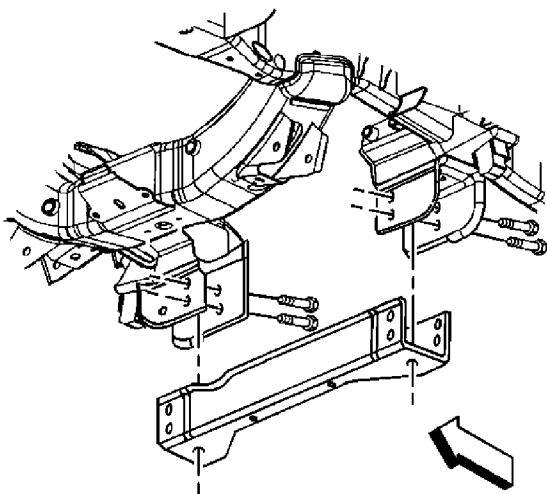
Removal Procedure



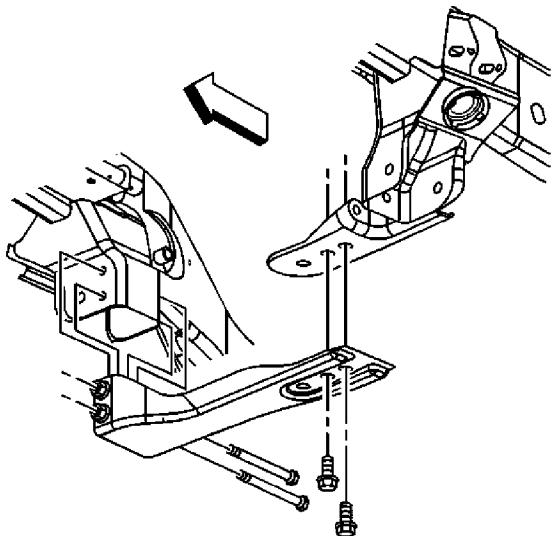
1. Raise and suitably support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
2. Place a suitable container under the engine in order to drain the oil.
3. Remove the oil drain plug.
4. Drain the engine oil.



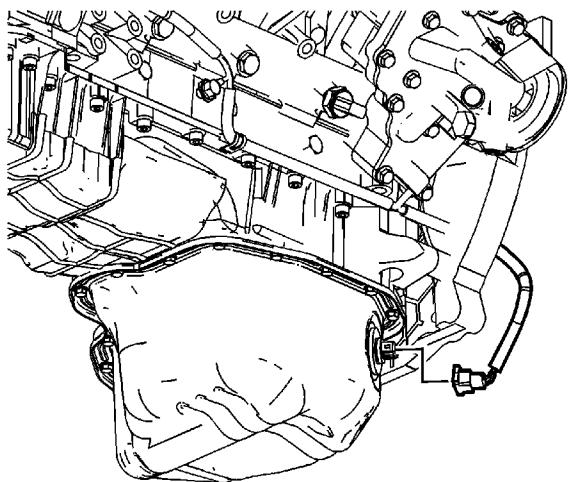
5. Remove the oil pan skid plate bolts and plate, if equipped.



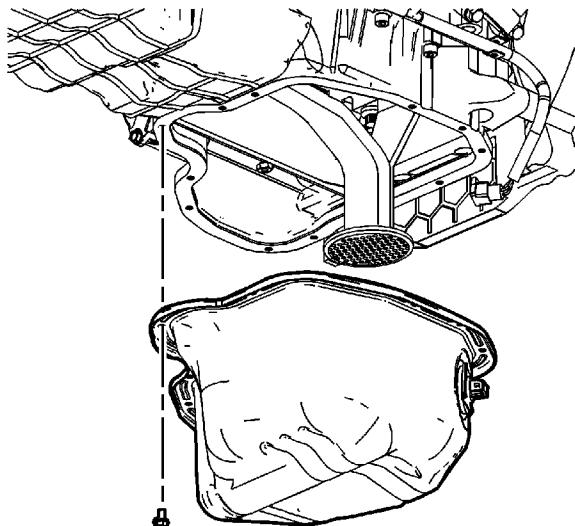
6. If equipped with a 2-wheel drive (2WD) vehicle, remove the crossmember bolts and crossmember.



7. If equipped with a 4-wheel drive (4WD) vehicle, remove the crossmember bolts and crossmember.



8. Disconnect the oil level sensor electrical connector.

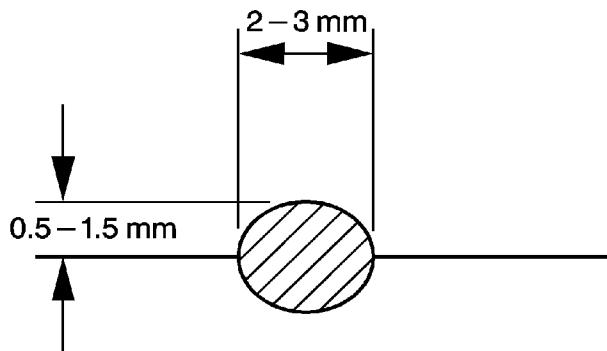


9. Remove the lower oil pan bolts/nuts.

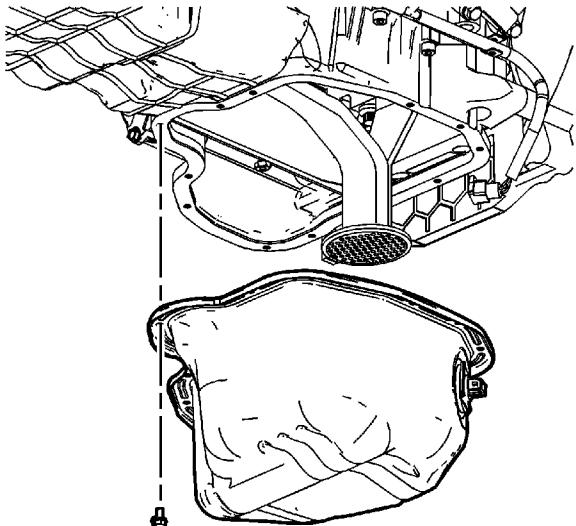
Note: DO NOT damage the sealing surfaces when separating the lower oil pan from the upper oil pan.

10. Separate the lower oil pan from the upper oil pan using [J 37228](#) .
11. Remove the lower oil pan.
12. If necessary, clean and inspect the lower oil pan. Refer to [Lower Oil Pan Cleaning and Inspection](#).

Installation Procedure

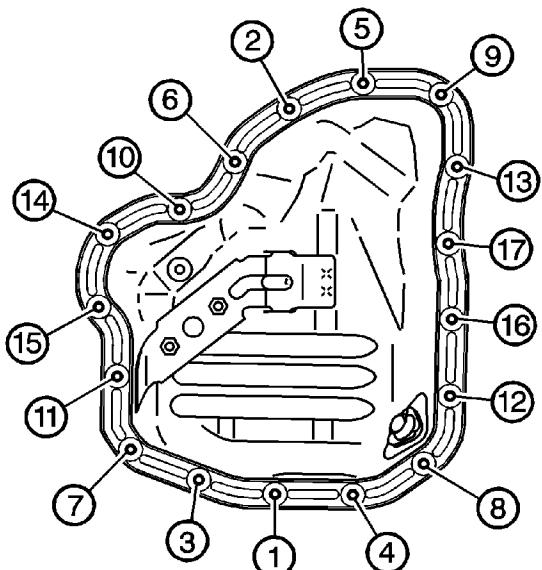


1. Apply a 2-3 mm (0.79-0.118 in) by 0.5-1.5 mm (0.02-0.06 in) wide bead of sealant to the lower oil pan mating surface. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for the correct part number.



2. Install the lower oil pan.
3. Install the lower oil pan bolts/nuts.

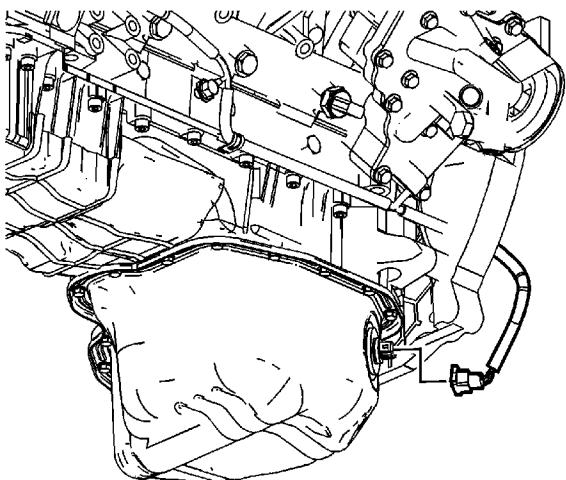
Caution: Refer to [Fastener Caution](#) in the Preface section.



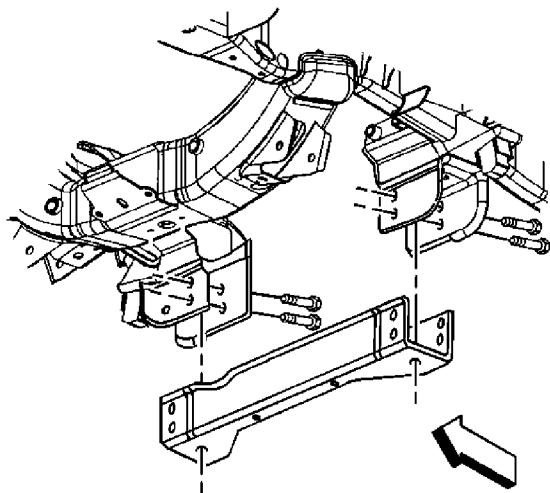
4. Tighten the oil pan bolts/nuts in the sequence shown.

Tighten

Tighten the bolts/nuts to 10 N·m (89 lb in).



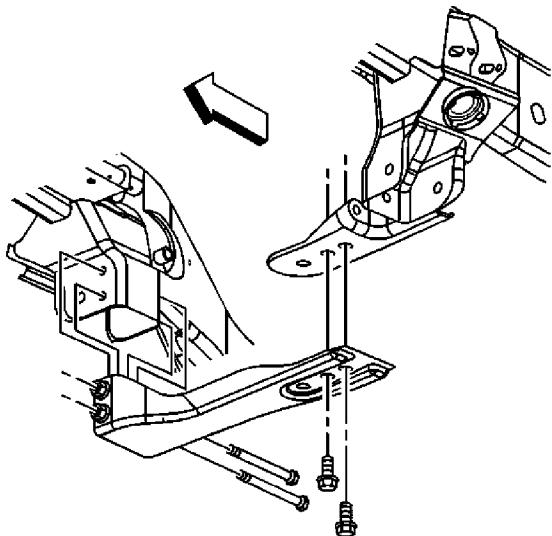
5. Connect the oil level sensor electrical connector.



6. If equipped with a 2WD, install the crossmember and bolts.

Tighten

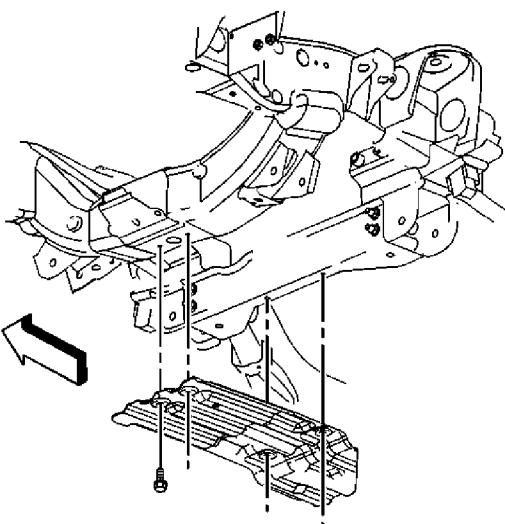
Tighten the bolts to 100 N·m (74 lb ft).



-  7. If equipped with a 4WD, install the crossmember and bolts.

Tighten

Tighten the bolts to 100 N·m (74 lb ft).



-  8. Install the oil pan skid plate and bolts, if equipped.

Tighten

Tighten the bolts to 20 N·m (15 lb ft).

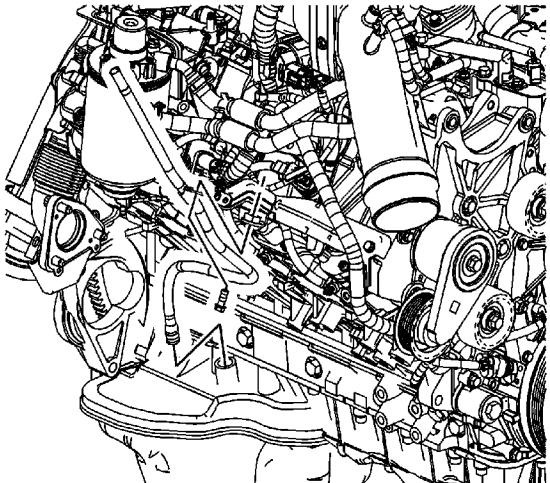
9. Install NEW engine oil and a oil filter. Refer to [Engine Oil and Oil Filter Replacement](#).
10. Lower the vehicle.

Upper Oil Pan Replacement

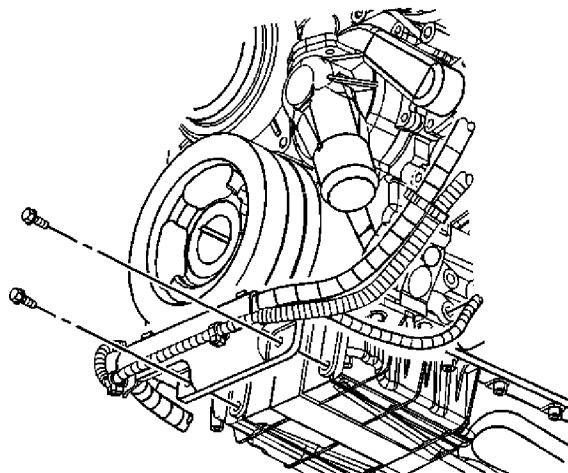
Special Tools

[J 37228](#) Seal Cutter

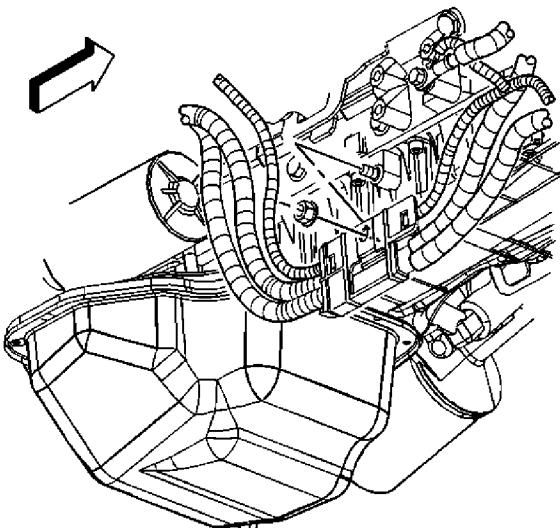
Removal Procedure



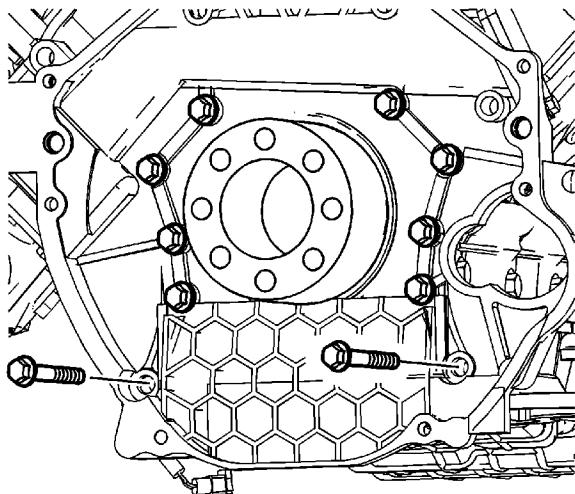
1. Remove the oil level indicator.
2. Remove the oil level indicator tube bolt from the indicator tube bracket.
3. If vehicle is a 4-wheel drive (4WD), remove the front differential carrier. Refer to [Differential Carrier Assembly Replacement](#).
4. If vehicle is a 2-wheel drive (2WD), disconnect the relay rod from the pitman arm and idler arm. Refer to [Relay Rod Replacement](#).
5. Remove the lower oil pan. Refer to [Lower Oil Pan Replacement](#).
6. Remove the engine flywheel. Refer to [Engine Flywheel Replacement](#).



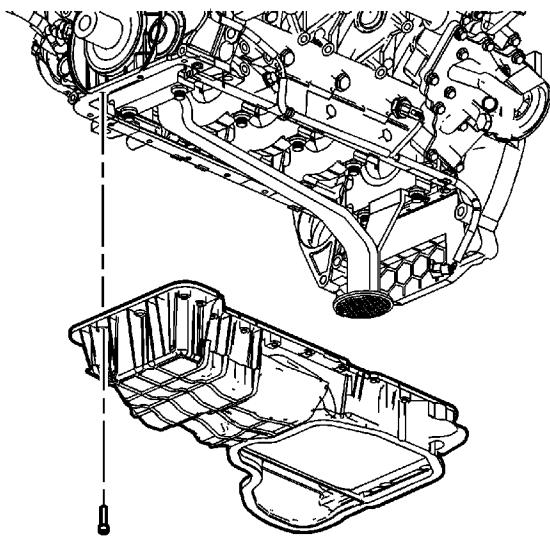
7. Remove the battery cable bracket bolts.



8. Remove the battery cable bracket nut.

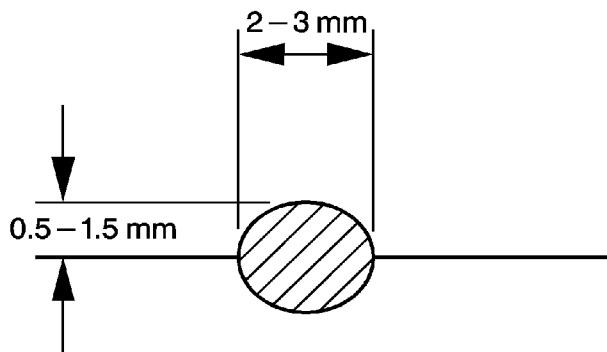


9. Remove the two flywheel housing to upper oil pan bolts.

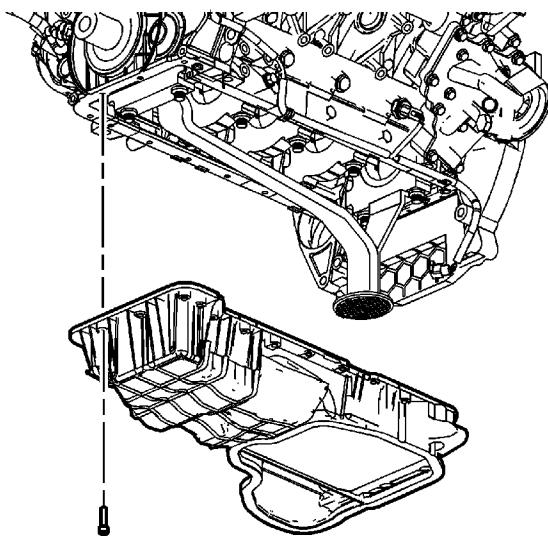


10. Remove the upper oil pan bolts and any brackets. Mark the bolt location of the bracket.
11. Separate the upper oil pan from the engine block using [J 37228](#).
12. Remove the upper oil pan. The oil level indicator tube needs to be removed while lowering the upper oil pan.
13. If required, clean and inspect the upper oil pan. Refer to [Upper Oil Pan Cleaning and Inspection](#).

Installation Procedure

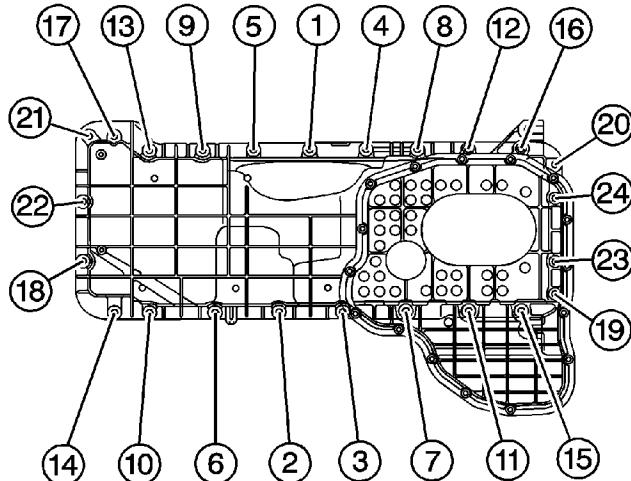


1. Apply a 2-3 mm (0.79-0.118 in) wide by 0.5-1.5 mm (0.02-0.06 in) bead of sealant to the upper oil pan mating surfaces. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for the correct part number.
2. Apply a 2-3 mm (0.79-0.118 in) wide by 0.5-1.5 mm (0.02-0.06 in) bead of sealant to the flywheel housing sealing surface. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for the correct part number.



3. Install the upper oil pan to the engine block. Ensure the oil level indicator tube is installed into the upper oil pan.

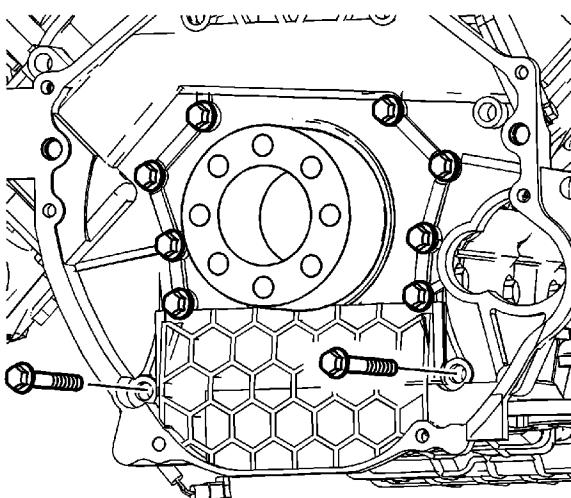
Caution: Refer to [Fastener Caution](#) in the Preface section.



4. Install any brackets and the upper oil pan bolts in the sequence shown.

Tighten

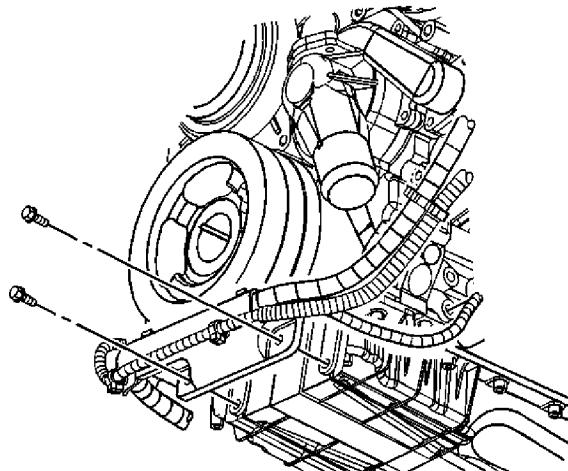
Tighten the bolts to 20 N·m (15 lb ft).



5. Install the two flywheel housing to upper oil pan bolts.

Tighten

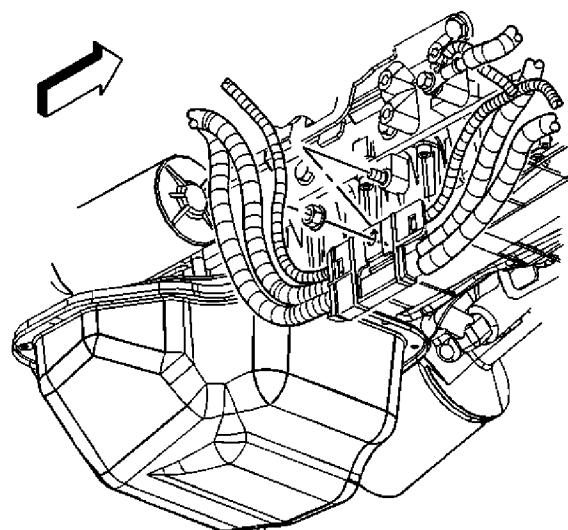
Tighten the bolts to 50 N·m (37 lb ft).



-  6. Install the battery cable bracket bolts.

Tighten

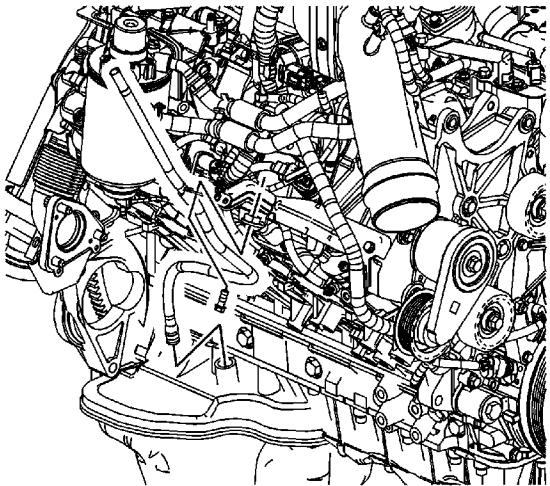
Tighten the bolts to 12 N·m (106 lb in).



-  7. Install the battery cable bracket nut.

Tighten

Tighten the nut to 8 N·m (71 lb in).



8. Install the engine flywheel. Refer to [Engine Flywheel Replacement](#).
9. Install the lower oil pan. Refer to [Lower Oil Pan Replacement](#).
10. If vehicle is a 4WD, install the front differential carrier. Refer to [Differential Carrier Assembly Replacement](#).
11. If vehicle is a 2WD, Connect the relay rod to the pitman arm and idler arm. Refer to [Relay Rod Replacement](#).
12. Lower the vehicle.
13. Install the oil level indicator tube bolt to the indicator tube bracket.

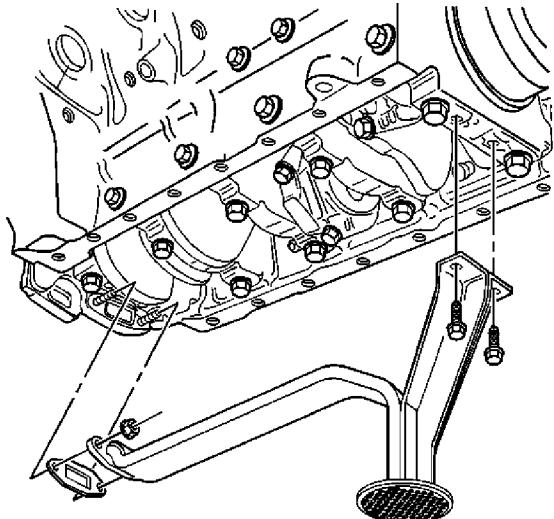
Tighten

Tighten the bolt to 21 N·m (15 lb ft).

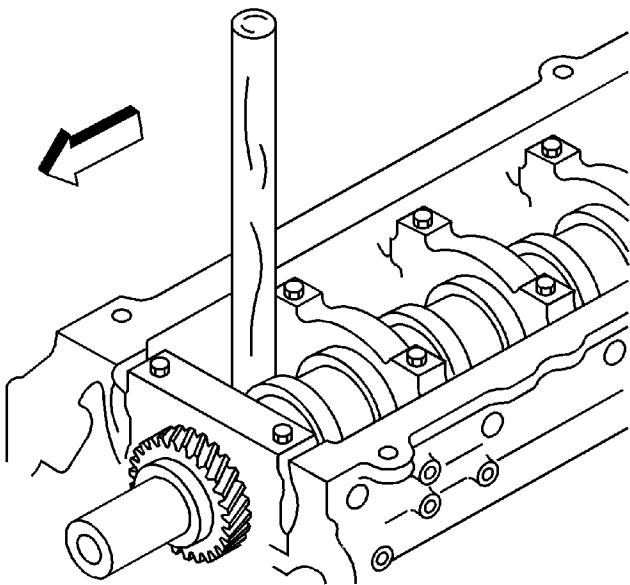
14. Install the oil level indicator.
15. Fill the engine with oil. Refer to [Engine Oil and Oil Filter Replacement](#).

Oil Pump Replacement

Removal Procedure

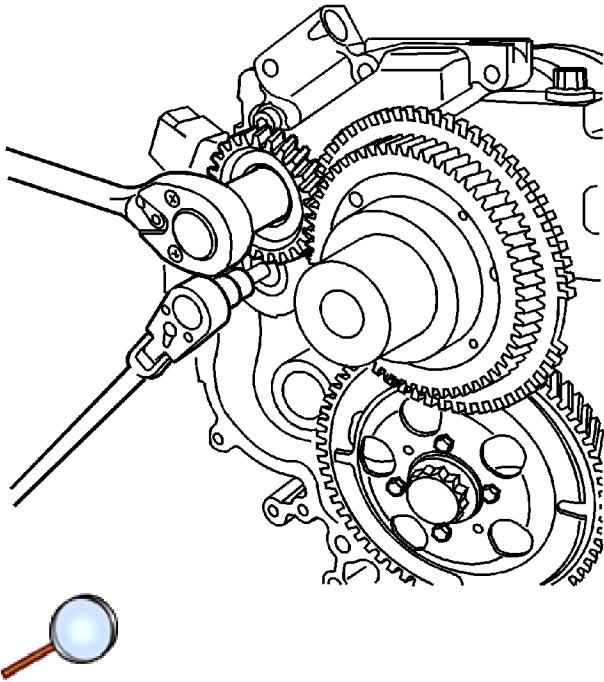


1. Remove the engine front cover. Refer to [Engine Front Cover Replacement](#).
2. Remove the upper oil pan. Refer to [Upper Oil Pan Replacement](#).
3. Remove the oil pump screen bolts and nuts.
4. Remove the oil pump screen.
5. Remove and discard the oil pump screen gasket.



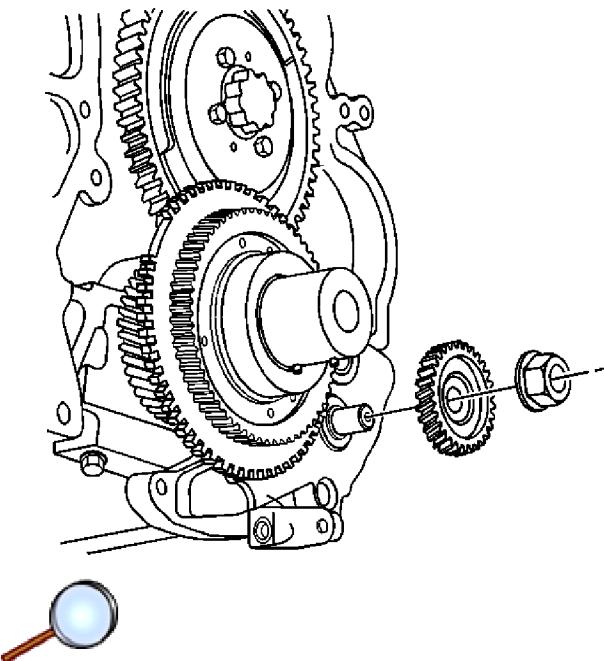
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6. Block the crankshaft from turning with a wooden handle.

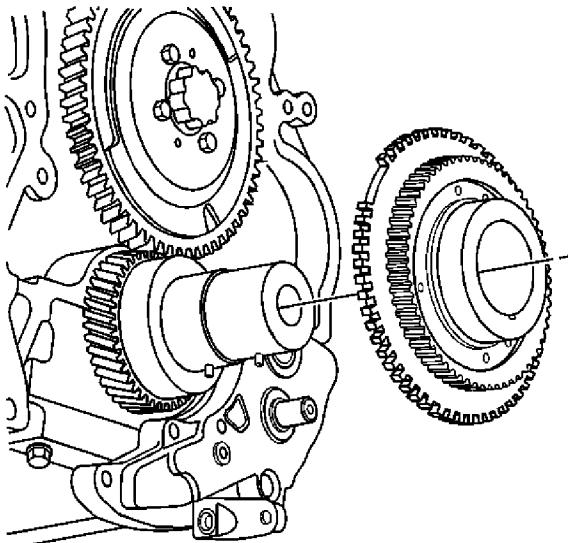


Note: Look for an "L" on the end of the oil pump shaft. If there is an "L" present, the nut and shaft have left hand threads. Service the nut accordingly.

7. While holding the secondary oil pump shaft with a hex driver, remove the oil pump driven gear nut.

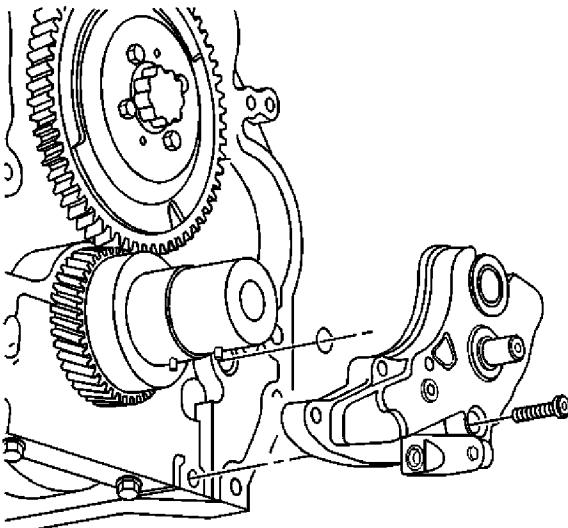


8. Remove the oil pump driven gear.



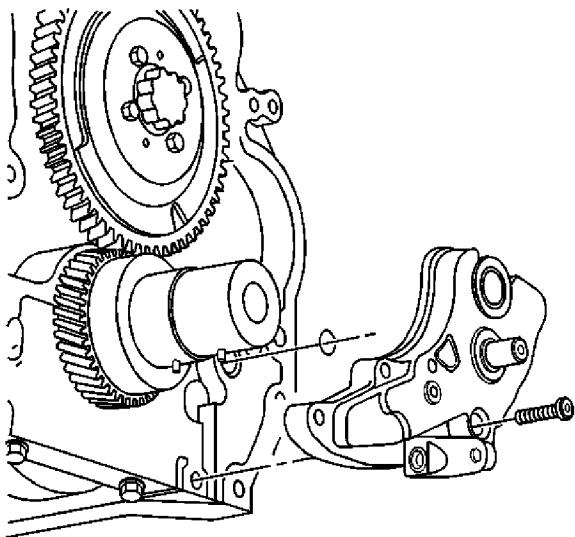
Note: Do not damage the crankshaft reluctor. Do not remove the crankshaft reluctor to oil pump drive bolts.

9. Remove the oil pump drive gear and crankshaft reluctor.
 - Use a brass drift.
 - Tap on the back as close to the center of the reluctor.



10. Remove the hex head and the allen head bolt in order to remove the oil pump.
11. Remove the oil pump.
12. Remove the O-ring seal for the oil pump.
13. If required, clean and inspect the oil pump. Refer to [Oil Pump Cleaning and Inspection](#).

Installation Procedure



1. Install a NEW oil pump O-ring seal.

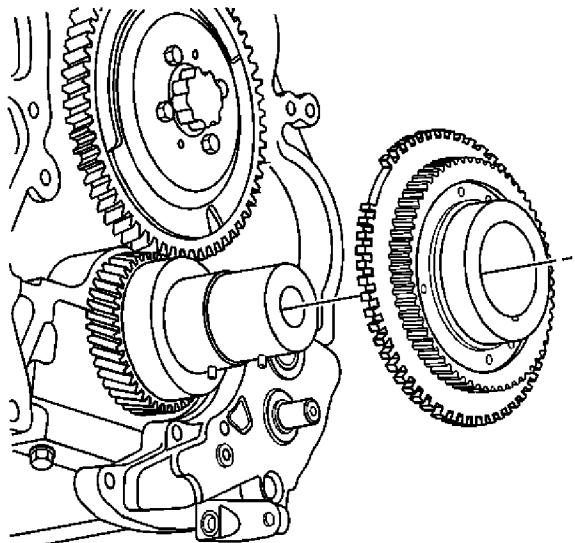
Caution: Refer to [Fastener Caution](#) in the Preface section.

2. Install the oil pump.
3. Install the oil pump bolts.

Tighten

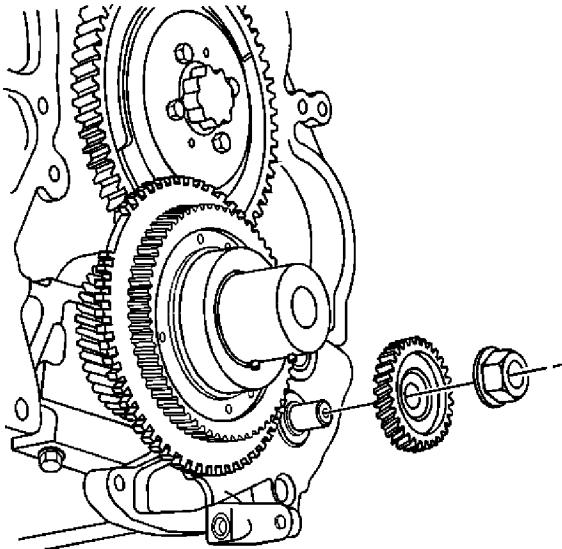
Tighten the bolts to 21 N·m (15 lb ft).

4. Inspect the oil pump drive gear for wear.
5. Replace the oil pump drive gear pin if worn.

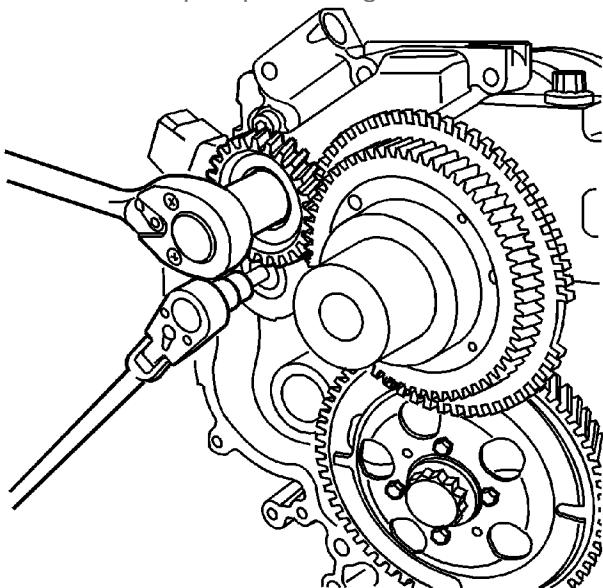




6. Install the oil pump drive gear and reluctor to the crankshaft.



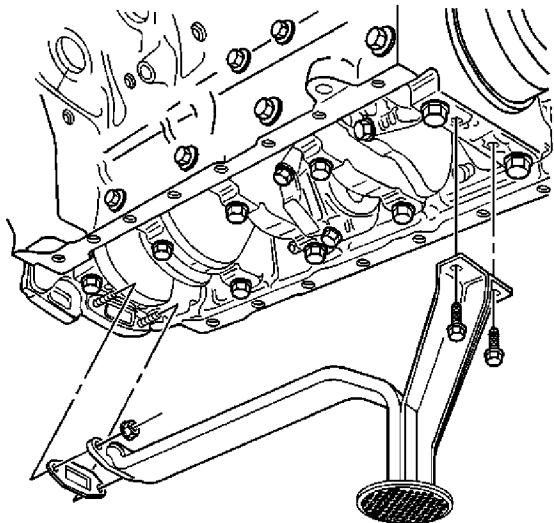
7. Install the oil pump driven gear.



8. While holding the secondary oil pump shaft with a hex driver, install the oil pump driven gear nut.

Tighten

Tighten the nut to 100 N·m (74 lb ft).



9. Install a NEW oil pump screen gasket to the oil pump.
10. Install the oil pump screen.
11. Install the oil pump screen bolts and nuts.

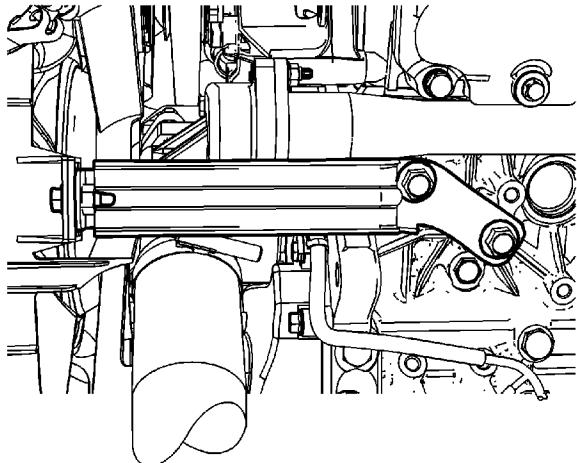
Tighten

Tighten the bolts/nuts to 25 N·m (18 lb ft).

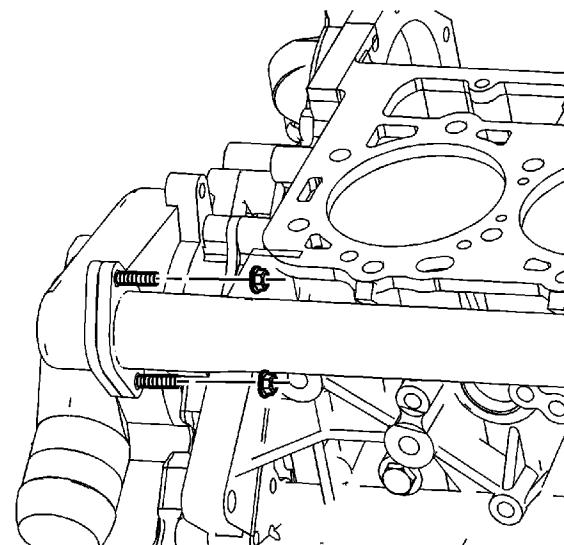
12. Install the engine front cover. Refer to [Engine Front Cover Replacement](#).
13. Install the upper oil pan. Refer to [Upper Oil Pan Replacement](#).

Oil Filter Adapter and Oil Cooler Assembly Replacement

Removal Procedure

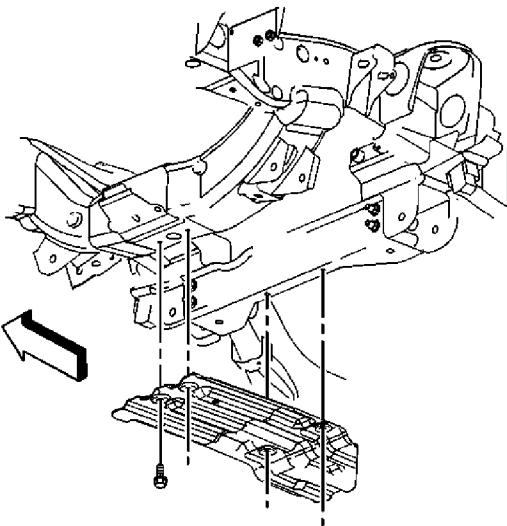


1. Drain the engine coolant and the engine block. Refer to [Cooling System Draining and Filling](#).
2. Remove the charge air inlet pipe. Refer to [Charge Air Cooler Inlet Pipe Replacement](#).
3. Remove the cooling fan shroud bracket bolts (1).
4. Remove the cooling fan shroud bracket (2).

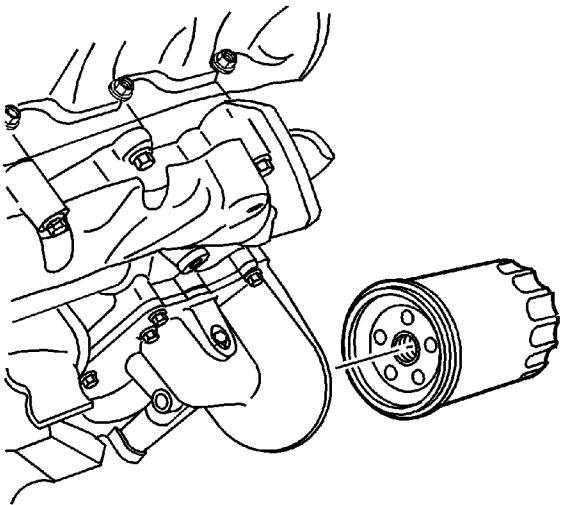


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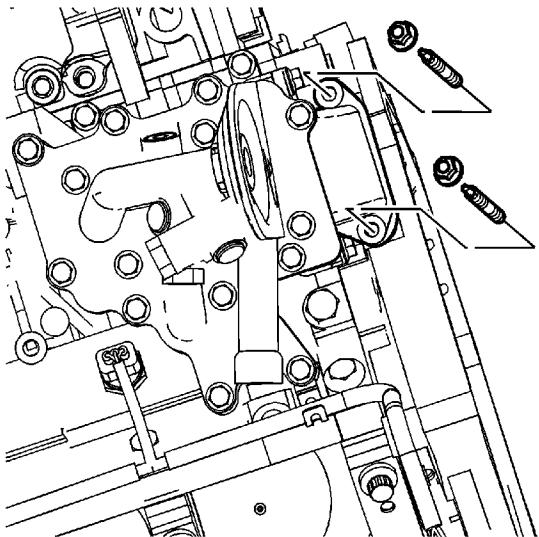
5. Loosen the water pump outlet pipe nuts at the coolant pipe.



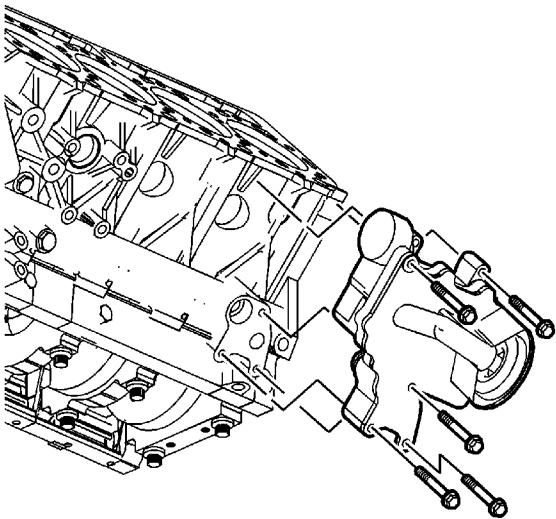
6. If equipped, remove the oil pan skid plate bolts and plate.



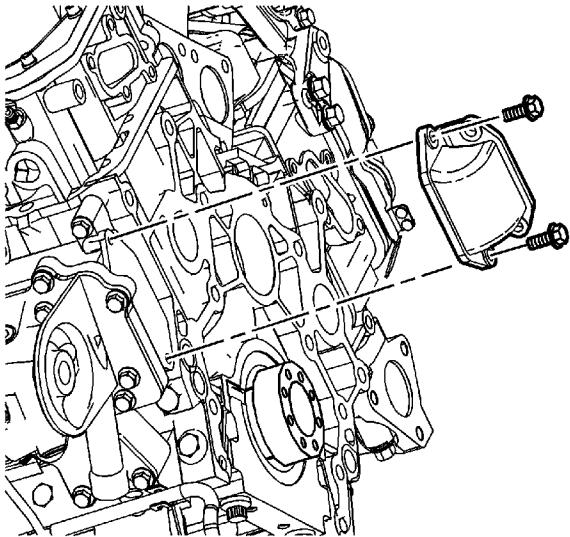
7. Remove the oil filter.



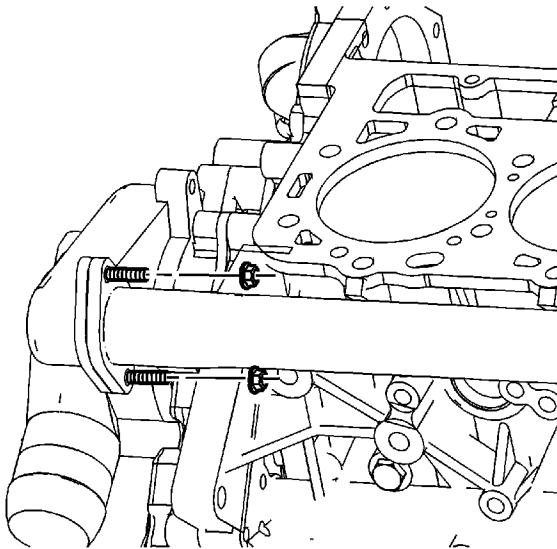
8. Remove the oil cooler adapter nuts and studs from the flywheel housing.



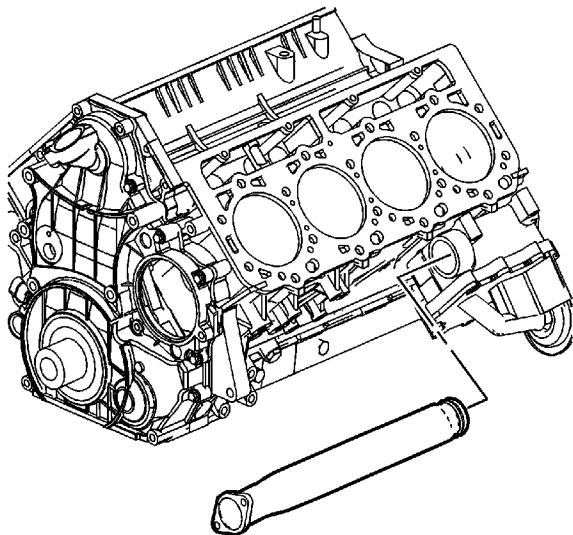
9. Remove the oil cooler assembly bolts.



10. Remove the oil cooler adapter bolts from the oil filter adapter/oil cooler.
11. Remove the oil cooler and adapter.

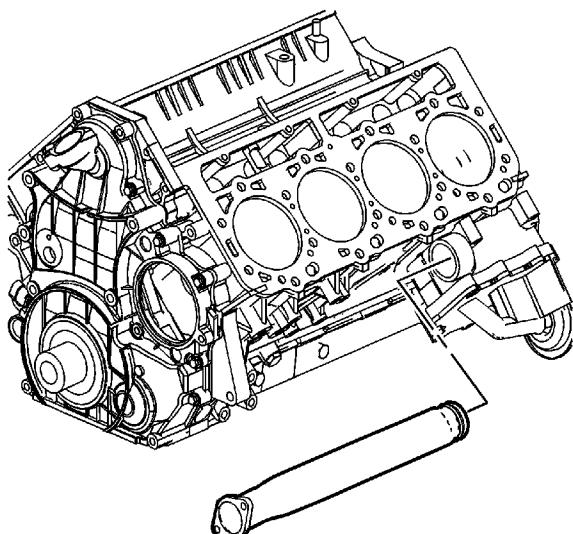


12. Remove the coolant pipe nuts.



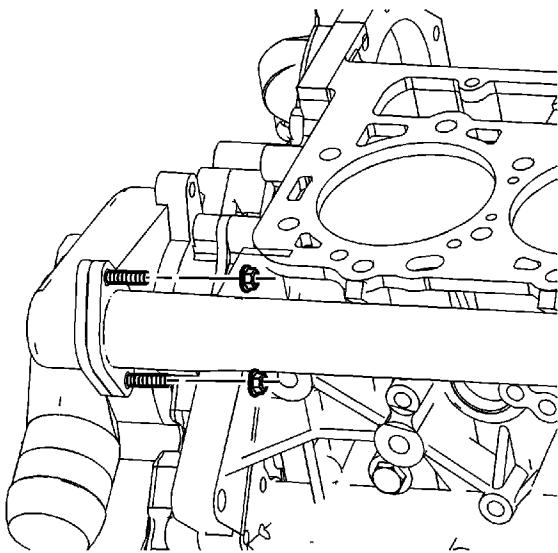
13. Remove the coolant pipe.
14. Remove and discard the oil filter adapter/oil cooler O-ring seals.
15. Remove and discard the coolant pipe O-ring and gasket.
16. If required, clean and inspect the oil filter adapter/oil cooler. Refer to [Oil Filter Adapter and Oil Cooler Assembly Cleaning and Inspection](#).

Installation Procedure



1. Install new coolant pipe O-ring and gasket.
2. Install new oil filter adapter/oil cooler O-ring seals.
3. Install the coolant pipe.

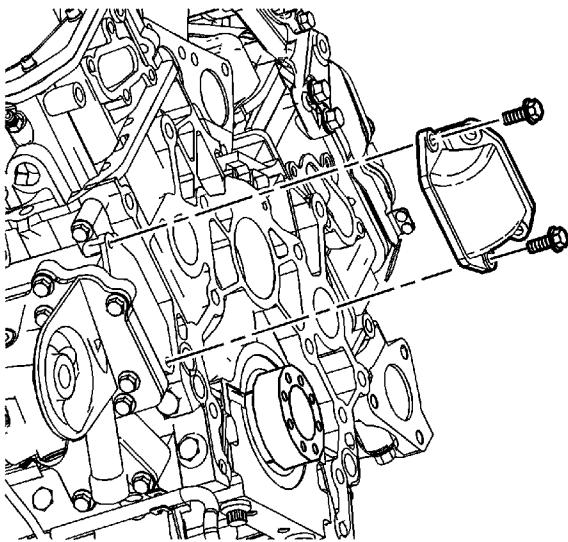
Caution: Refer to [Fastener Caution](#) in the Preface section.



4. Install the coolant pipe nuts.

Tighten

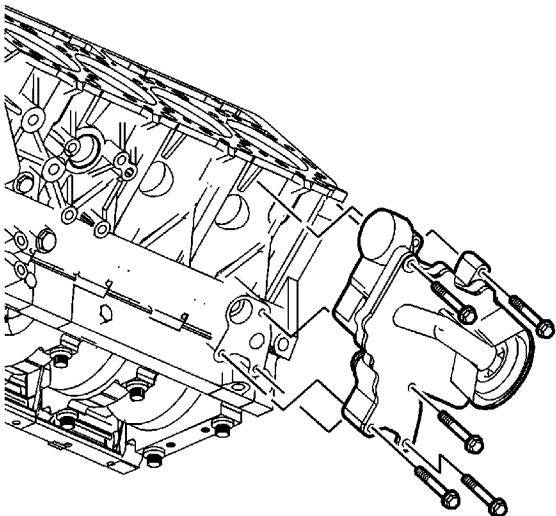
Tighten the coolant pipe nuts to 25 N·m (18 lb ft).



5. Install the oil cooler and adapter.
6. Install the oil cooler adapter bolts to the oil filter adapter/oil cooler.

Tighten

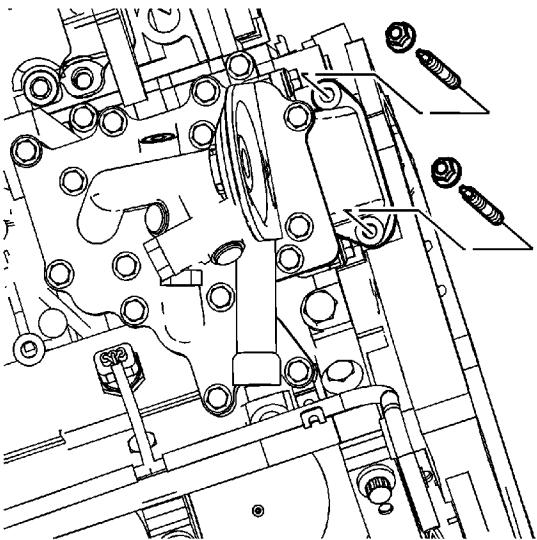
Tighten the oil cooler adapter bolts to 25 N·m (18 lb ft).



7. Install the oil cooler assembly bolts.

Tighten

Tighten the oil cooler assembly bolts to 25 N·m (18 lb ft).

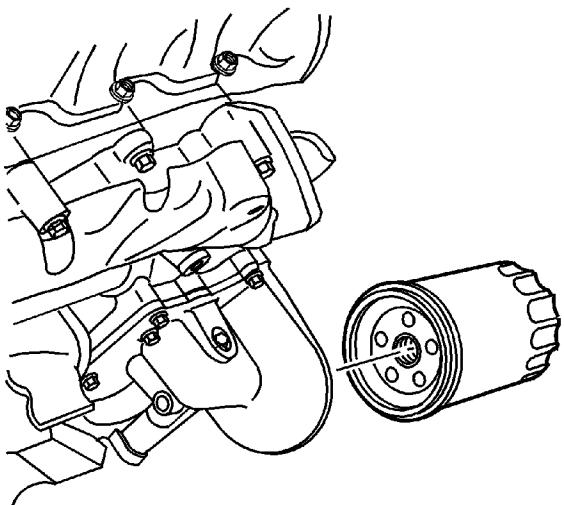


8. Install the oil cooler adapter nuts and studs to the flywheel housing.

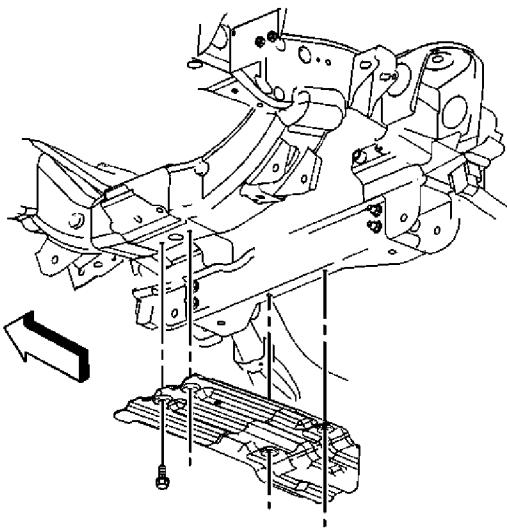
Tighten

- Tighten the oil cooler adapter nuts to 25 N·m (18 lb ft).

- Tighten the oil cooler adapter studs to 10 N·m (89 lb in).



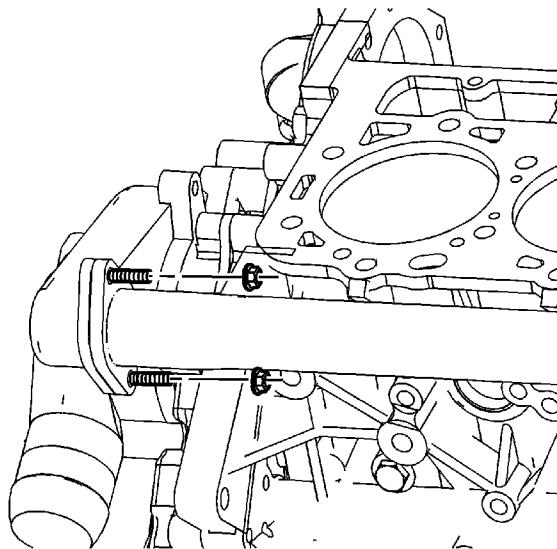
9. Install the oil filter.



10. If removed, install the oil pan skid plate bolts and plate.

Tighten

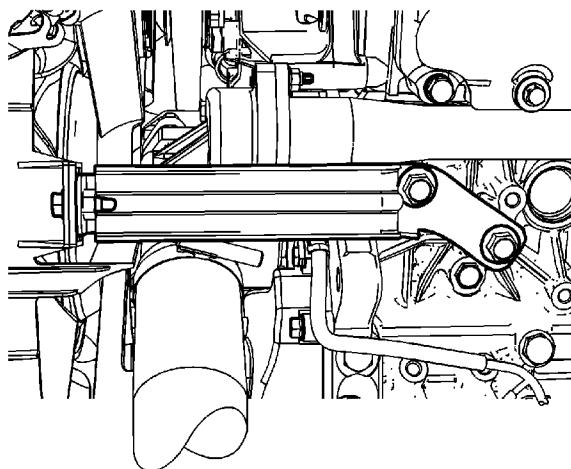
Tighten the bolts to 20 N·m (15 lb ft).



11. Install the water pump outlet pipe nuts at the coolant pipe.

Tighten

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



12. Position the cooling fan shroud bracket (2).
13. Install the cooling fan shroud bracket bolts (1).

Tighten

Tighten the fan shroud bolt to 8 N·m (71 lb in).

Tighten

Tighten the fan shroud bracket to engine block bolts to 58N·m (63 lb ft).

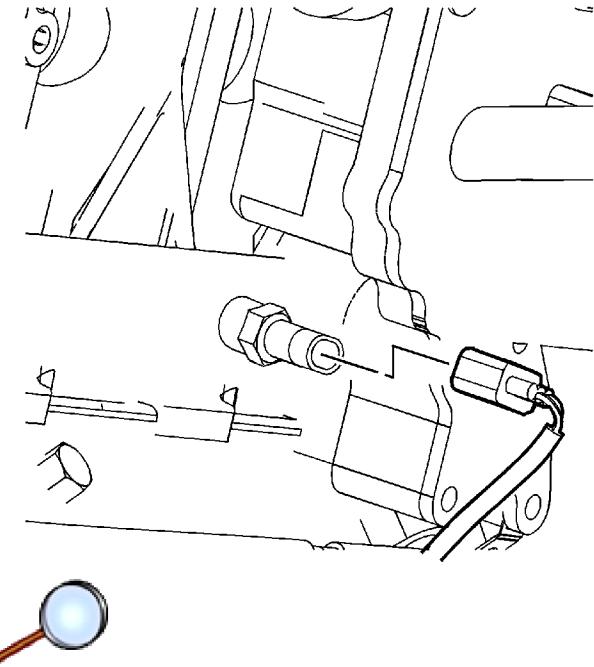
14. Install the charge air inlet pipe. Refer to [Charge Air Cooler Inlet Pipe Replacement](#).
15. Fill the cooling system. Refer to [Cooling System Draining and Filling](#).

Engine Oil Pressure Sensor and/or Switch Replacement

Special Tools

[DT-48827](#) Skip Shift Socket

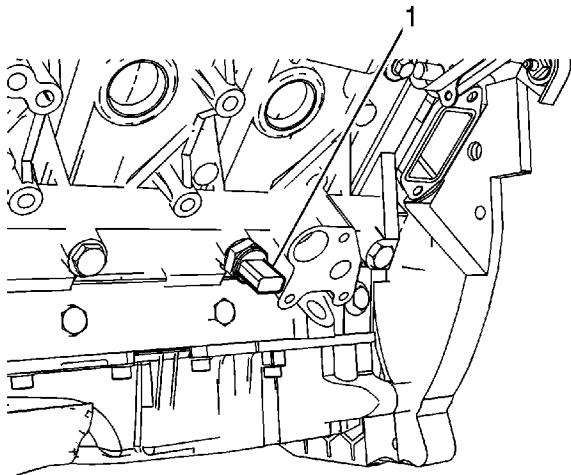
Removal Procedure



1. Remove the left wheelhouse inner panel. Refer to [Front Wheelhouse Liner Replacement - Left Side](#).

Note: Clean the area around the sensor. Do not allow debris to enter the engine.

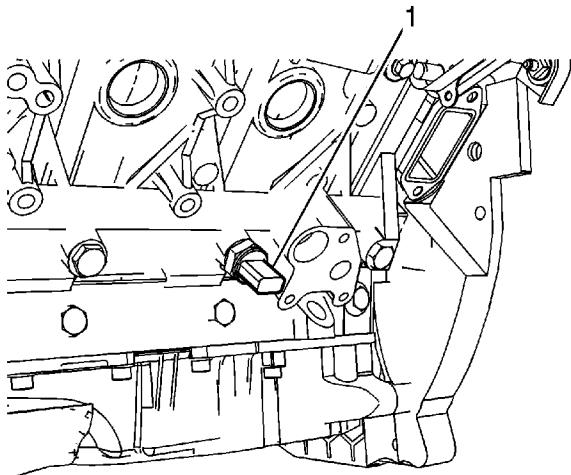
2. Disconnect the oil pressure sensor electrical connector.



3. Using [DT-48827](#), remove the oil pressure sensor (1).

Installation Procedure

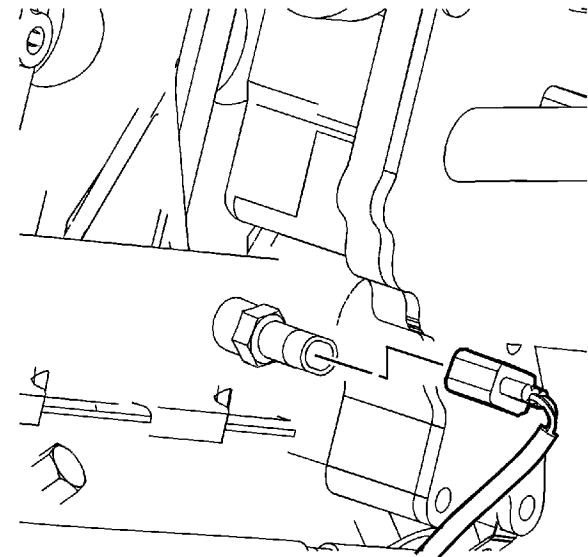
Caution: Refer to [Fastener Caution](#) in the Preface section.



1. Apply sealant to the threads of the oil pressure sensor. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for the correct part number.
2. Using [DT-48827](#), install the oil pressure sensor (1).

Tighten

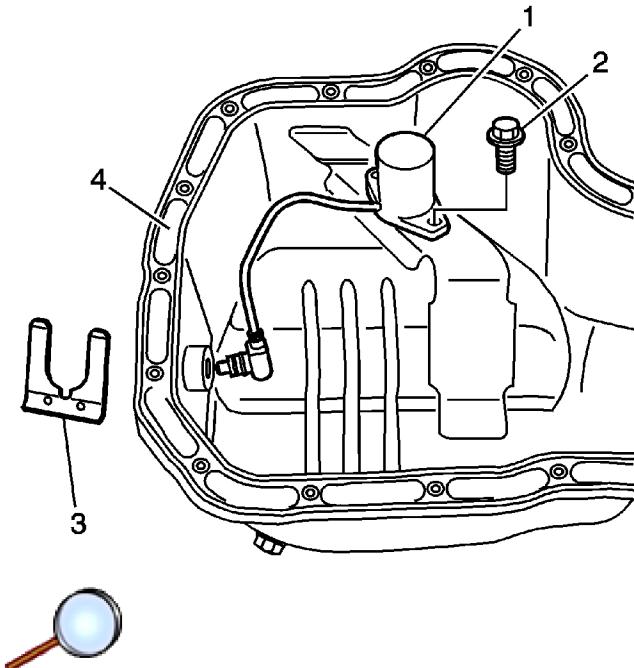
Tighten the sensor to 49 N·m (36 lb ft).



3. Connect the oil pressure sensor electrical connector.
4. Install the left wheelhouse inner panel. Refer to [Front Wheelhouse Liner Replacement - Left Side](#).
5. Check and add engine oil if necessary.

Engine Oil Level Sensor and/or Switch Replacement

Removal Procedure

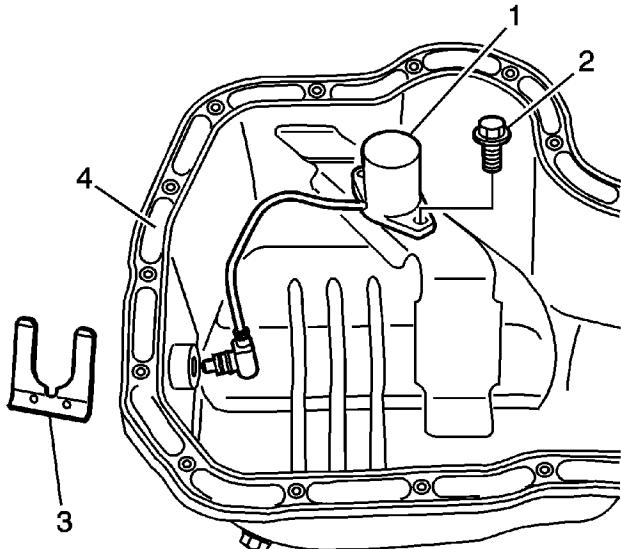


1. Remove the lower oil pan. Refer to [Lower Oil Pan Replacement](#).
2. Remove the oil level sensor clip (3).
3. Remove the oil level sensor bolt (2) and sensor (1).

Installation Procedure

Note: When routing the oil level sensor wire, ensure that the wire is routed along the side of the oil pan.

Caution: Refer to [Fastener Caution](#) in the Preface section.



1. Install the oil level sensor (1) and bolt (2) and tighten to **9 N·m (80 lb in)**.
2. Install the oil level sensor clip (3).
3. Install the lower oil pan. Refer to [Lower Oil Pan Replacement](#).

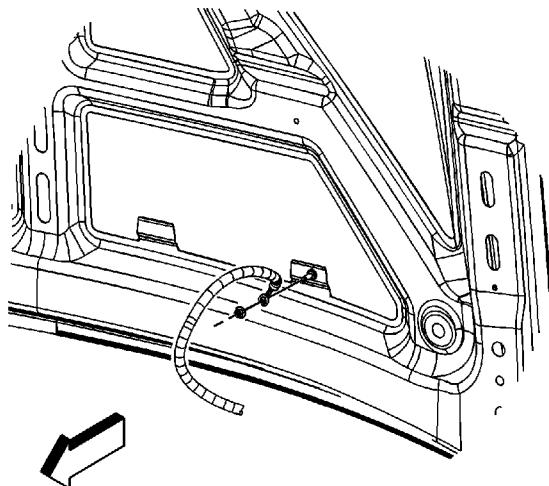
Engine Replacement

Special Tools

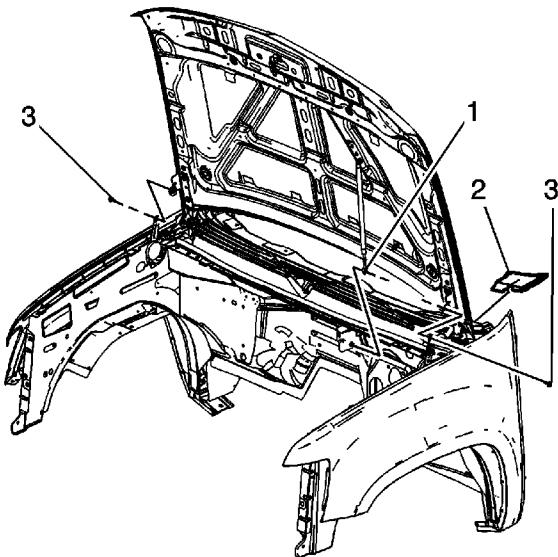
- [J 36857](#) Engine Lift Brackets
- [J 41769](#) Fuel Line Quick Disconnect Tool
- [J 44581](#) Fuel Line Disconnect Tool

Removal Procedure

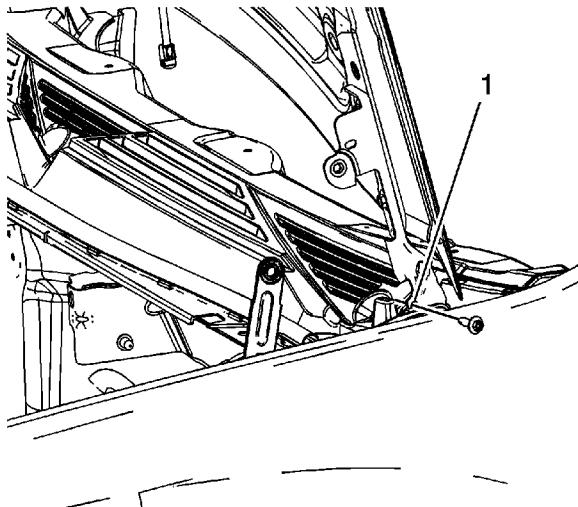
Note: In order to remove the engine the vehicle needs to be on a hoist. The front wheels and tires will also require removal. The vehicle will have to be supported by the frame when the tires are removed.



1. Open the hood.
2. Remove the ground strap from the stud.



3. Assemble 2 sets of the following: an M6 bolt, 2 each 19.05 mm (0.75 in) flat washers and an M6 nut.
4. Release the retainer securing the hood strut rod to the hood strut bracket stud.
5. Remove the air inlet grille end caps (1), lift the end cap up in order to disengage the retainers. (left side shown, right side similar).
6. Have an assistant support the hood.
7. Remove the hood hinge bolts (2) and set aside.



Note: There is a positive stop which limits the hood from being opened too far.

8. Raise the hood until the service position notch (1) in the upper hinge is reached.
9. Install the 2 sets of the M6 bolts to both the left and right side service notches and tighten finger tight.

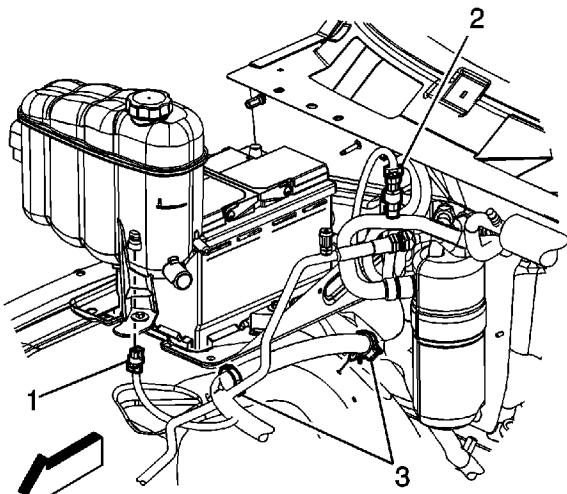
Caution: Refer to [Fastener Caution](#) in the Preface section.

10. Lower the hood until the bolts rest against the lower hinge, tighten the bolts to secure the hood.

Tighten

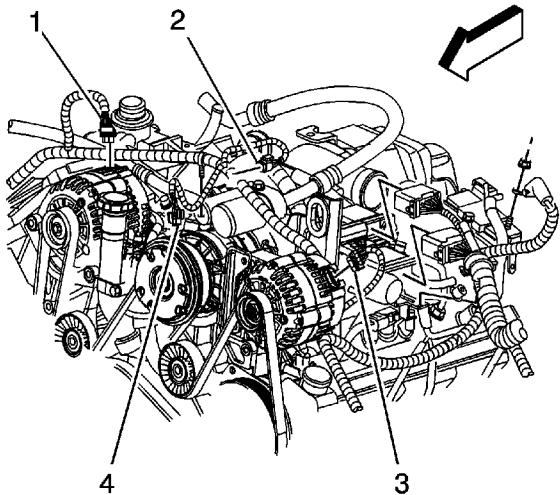
Tighten the bolts to 20 N·m (15 lb ft).

11. The hood is now set in the service position.
12. Recover the air conditioning (A/C) system. Refer to [Refrigerant Recovery and Recharging](#).
13. Disconnect the negative battery cables. Refer to [Battery Negative Cable Disconnection and Connection](#).
14. Drain the cooling system. Refer to [Cooling System Draining and Filling](#).



15. Disconnect the following engine wire harness connectors:
 - Surge tank switch (1)
 - A/C pressure cycling switch (2)
 - Remove the engine wire harness clips from the wheelhouse inner panel (3).
16. Remove the air cleaner. Refer to [Air Cleaner Assembly Replacement](#).
17. Remove the surge tank. Refer to [Radiator Surge Tank Replacement](#).
18. Raise and suitably support the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
19. Remove both front tires and wheels. Refer to [Tire and Wheel Removal and Installation](#).
20. Remove both fender wheelhouse inner panels. Refer to [Front Wheelhouse Liner Replacement - Right Side](#) and [Front Wheelhouse Liner Replacement - Left Side](#).
21. Lower the vehicle.
22. Remove the charged air cooler pipes. Refer to [Charge Air Cooler Inlet Pipe Replacement](#) and [Charge Air Cooler Outlet Pipe Replacement](#).
23. Remove the radiator inlet hose. Refer to [Radiator Inlet Hose Replacement](#).
24. Remove the upper fan shroud. Refer to [Engine Coolant Fan Upper Shroud Replacement](#).
25. Remove the lower fan shroud. Refer to [Engine Coolant Fan Lower Shroud Replacement](#).
26. Remove the radiator outlet hose. Refer to [Radiator Outlet Hose Replacement](#).
27. Remove the outlet heater hose pipe bolt from the bracket.
28. Remove the outlet heater hose pipe nut.
29. Move the heater hose and secure aside.

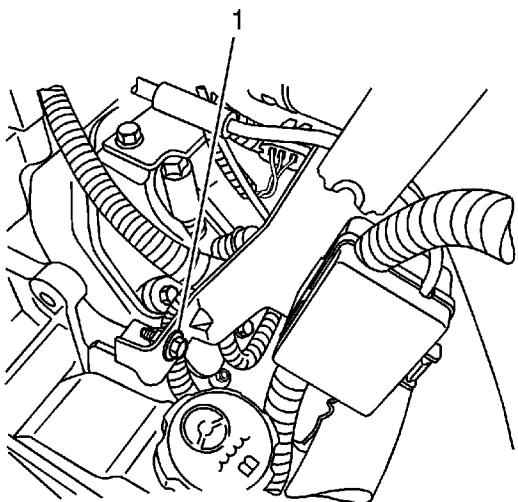
30. Remove the radiator support. Refer to [Radiator Support Replacement](#).



31. Disconnect the following electrical connectors:

- Generator connector (1)
- A/C refrigerant switch (2)
- Dual generator harness connector (3), if equipped
- A/C compressor clutch (4)

32. Remove the harness clip from the oil fill pipe.



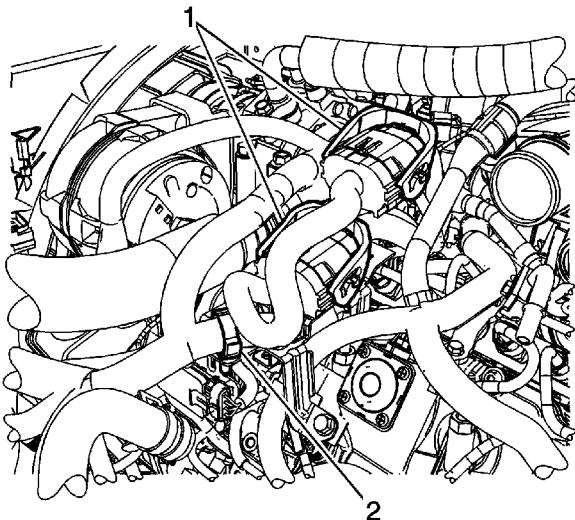
33. Remove the battery cable to the generator.

34. If equipped, remove the battery cable to the auxiliary generator.

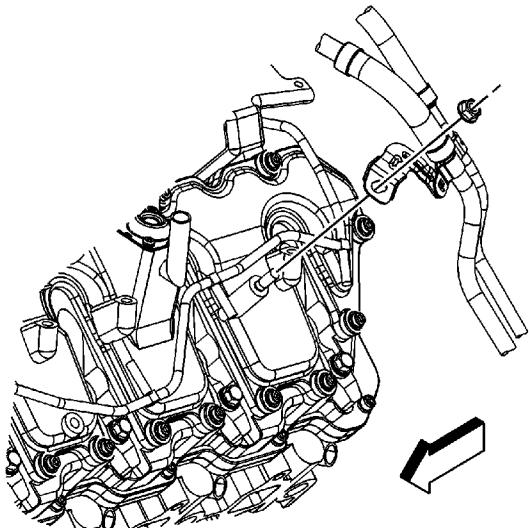
35. Remove the battery cable harness clip from the upper air intake tube.

36. Remove the battery cable junction block bolt (1) from the power steering pump.

37. Move and secure the battery cables out of the way.



38. Disconnect the main engine electrical harness connectors. Lift up on the latches (1) in order to disconnect the connectors.
39. Open the harness clip (2).
40. Remove the main engine electrical harness connectors.

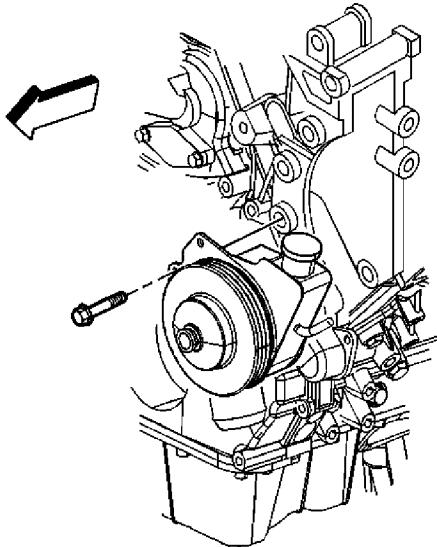


41. Using [J 41769](#), disconnect the fuel lines at the engine.
42. Remove the nut and the fuel line bracket from the upper valve rocker arm cover stud.
43. Secure the fuel lines out of the way.
44. Remove the drive belt. Refer to [Drive Belt Replacement](#).
45. Disconnect the suction hose from the accumulator.

The compressor end can remain on the compressor.

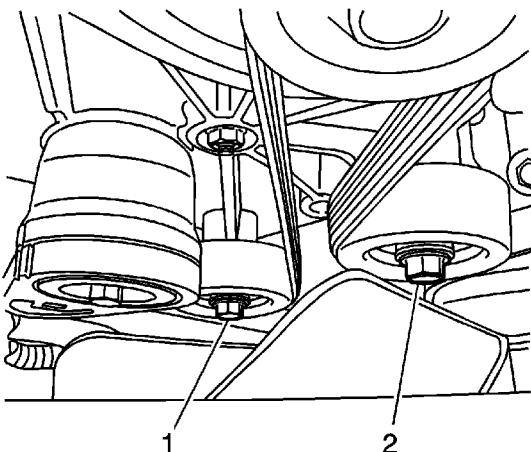
46. Remove the A/C compressor. Refer to [Air Conditioning Compressor Replacement](#).

47. Move the wiring harness to the left side of the vehicle and secure out of the way.

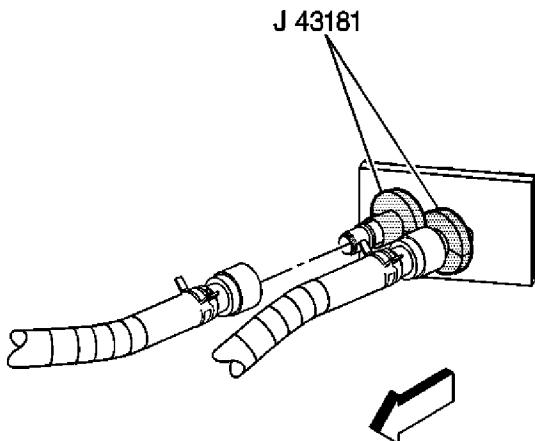


48. Remove the bolts retaining the power steering pump front bracket to the power steering pump and the air conditioner compressor mounting bracket. Position the power steering pump aside.
49. Remove the air conditioning and power steering pump mounting bracket. Refer to [Air Conditioning \(A/C\) Compressor and Power Steering Pump Bracket Replacement](#).

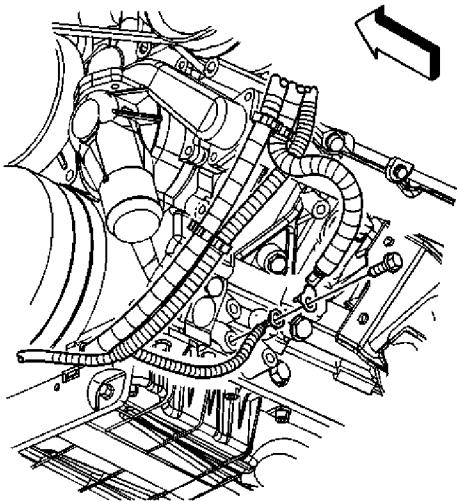
When the battery cables are removed from the engine the power steering pump can be removed further out of the way.



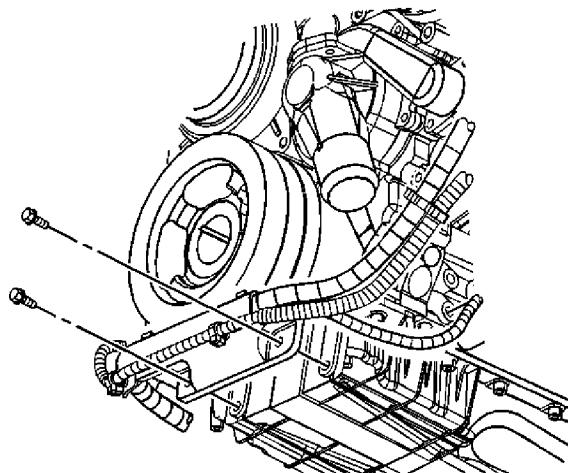
50. Remove the right idler pulley bolt (1) and pulley.
51. Remove the generator bracket. Refer to [Generator Bracket Replacement](#).



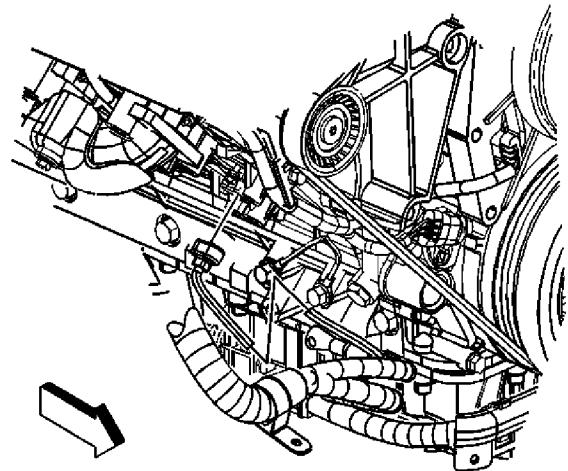
52. Use the [J 43181](#) in order to disconnect the inlet heater hose from the heater core inlet.
53. Remove the bolt and the ground wires at the rear of the left cylinder head.
54. Raise the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
55. Remove the oil pan skid plate. Refer to [Oil Pan Skid Plate Replacement](#).
56. Remove the engine shield from the vehicle, if equipped. Refer to [Engine Shield Replacement](#).



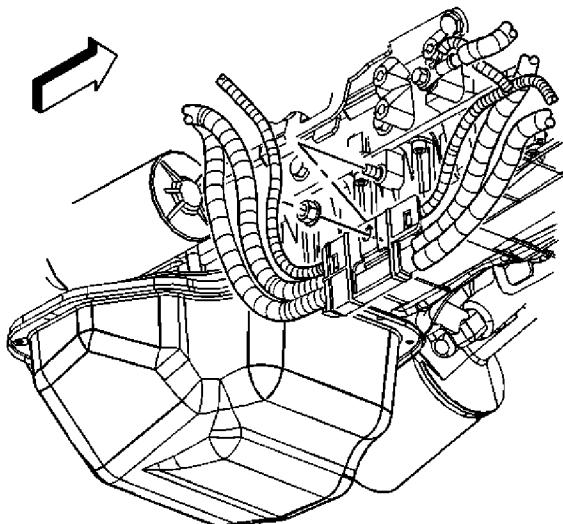
57. Remove the bolt for the battery negative cable and the engine wiring harness ground wire from the left side of the engine.



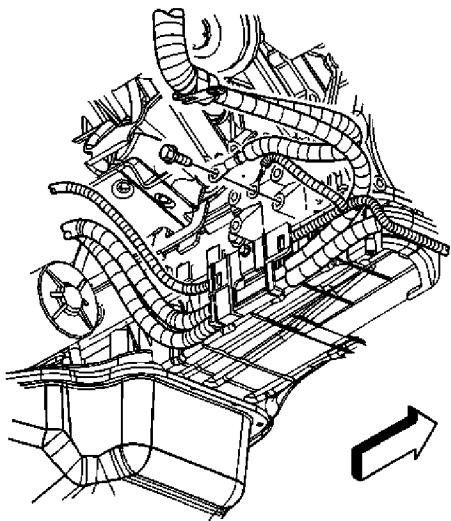
58. Remove the bolts holding the battery cable channel retainer to the lower crankcase.



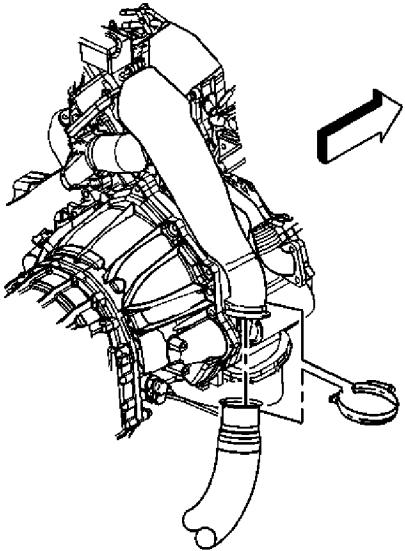
59. Disconnect the cord for the engine coolant heater.
60. Remove the starter. Refer to [Starter Replacement](#).



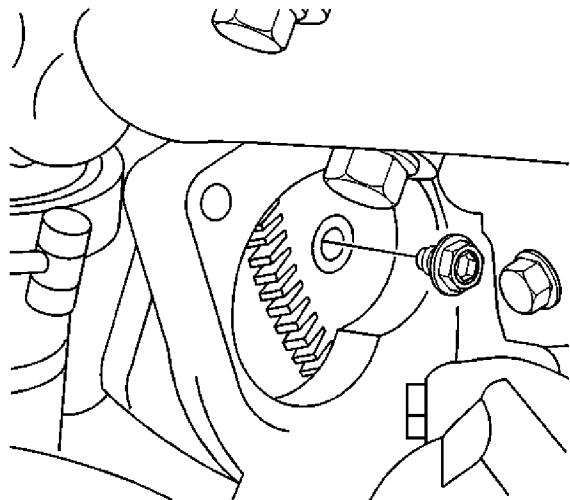
61. Remove the nut holding the battery cable bracket to the right side of the lower crankcase.



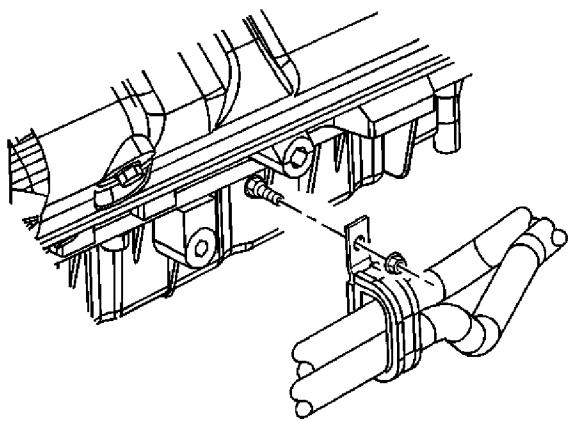
62. Remove the bolt holding the auxiliary battery negative cable and the engine wiring harness ground wires to the right side of the engine.
63. Move and secure the battery cables out of the way.



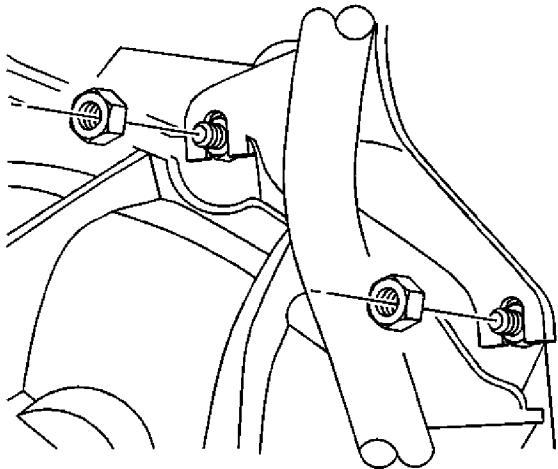
64. Raise the vehicle. Refer to [Lifting and Jacking the Vehicle](#).
65. Drain the engine oil. Refer to [Engine Oil and Oil Filter Replacement](#).
66. Remove the exhaust pipe to the exhaust outlet clamp. Move the clamp onto the exhaust pipe.
67. If vehicle is 4-wheel drive (4WD) equipped, remove the front differential carrier assembly. Refer to [Differential Carrier Assembly Replacement](#).



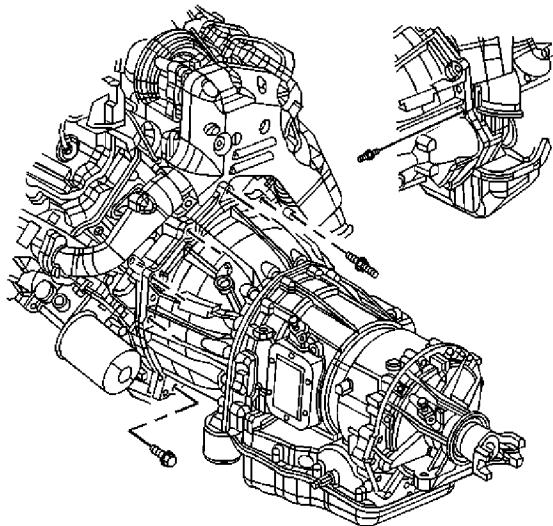
68. If equipped with an automatic transmission, mark the flywheel and torque converter relationship for assembly purposes.
69. Remove the torque convertor bolts through the starter opening.



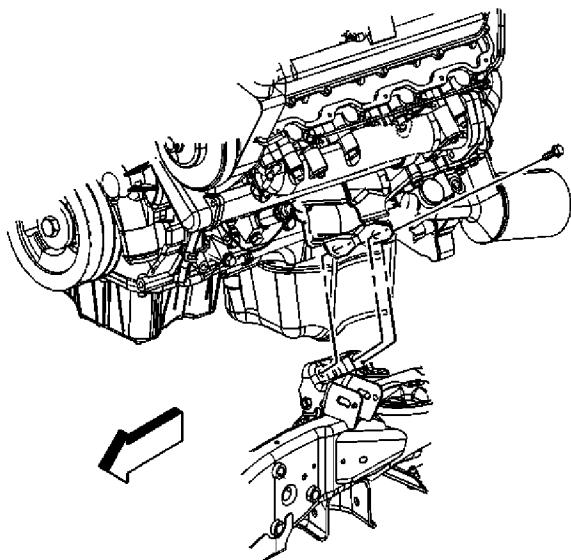
70. If equipped with an automatic transmission, remove the transmission oil line clip nut.



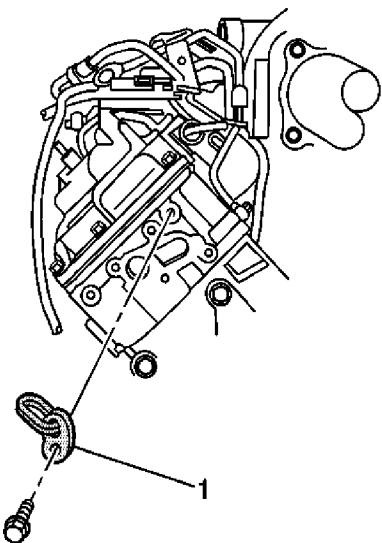
71. If equipped with an automatic transmission, remove the nuts retaining transmission fluid fill tube bracket.



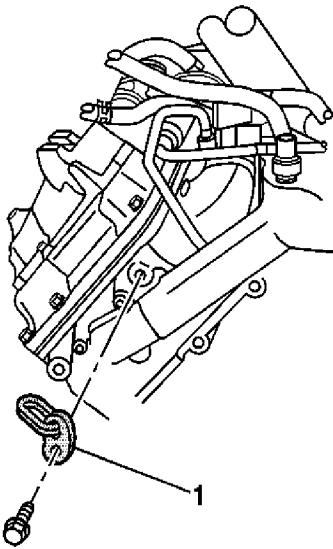
72. Remove the transmission to engine stud and bolts (automatic transmission shown). Note the location of the studs and any brackets attached to the studs.



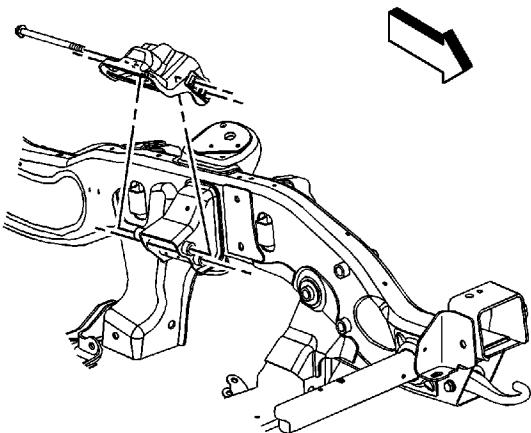
73. Lower the vehicle to work through the wheelhouse opening.
74. Remove the engine mount to frame bracket bolts (left side shown).
75. Lower the vehicle.
76. Remove the upper exhaust gas recirculation cooling pipe. Refer to [Exhaust Gas Recirculation Cooling Pipe Replacement - Upper](#).



77. Install the [J 36857](#) (1) to the rear of the left cylinder head with a suitable bolt.

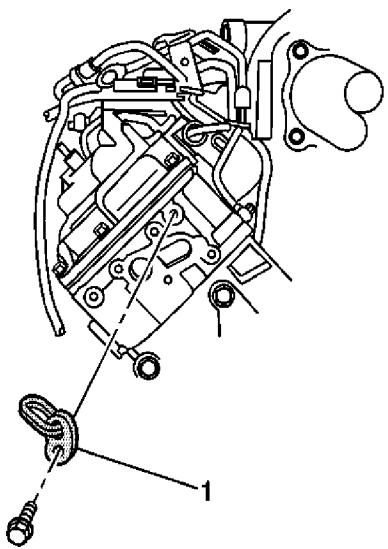


78. Install the [J 36857](#) (1) to the front of the right cylinder head with a suitable bolt.
79. Install a suitable lifting device. The engine will have to be angled in order to remove. Use a load positioning sling to assist in angling the engine.



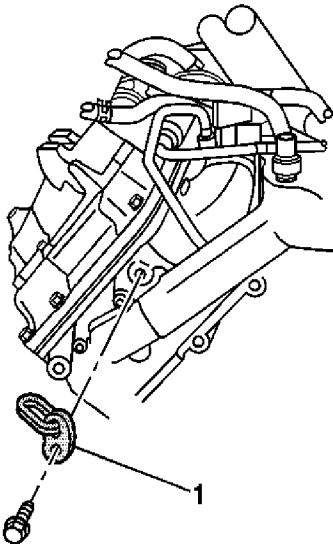
80. Raise the vehicle off of the engine mounts.
81. Remove the left and right engine mount frame brackets, if equipped.
82. Remove the engine from the vehicle.
83. In order to secure the engine to an engine stand remove the following and follow the special procedures:
 - Refer to [Engine Flywheel Removal](#).
 - Refer to [Exhaust Outlet Removal](#).
 - Refer to [Upper Oil Pan Removal](#).
 - Refer to [Engine Flywheel Housing Removal](#).
 - Refer to [Engine Mounting to Stand](#).

Installation Procedure





1. Install the [J 36857](#) (1) to the rear of the left cylinder head with a suitable bolt.

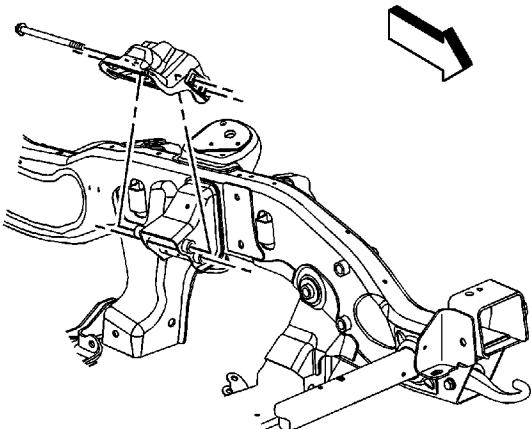


2. Install the [J 36857](#) (1) to the front of the right cylinder head with a suitable bolt.
3. Install a suitable lifting device. The engine will have to be angled in order to install. Use a load positioning sling to assist in angling the engine.
4. Remove the engine from the stand. Refer to [Engine Removal from Stand](#).
5. Install the following:
 - Refer to [Engine Flywheel Installation](#).
 - Refer to [Exhaust Outlet Installation](#).
 - Refer to [Upper Oil Pan Installation](#).
 - Refer to [Engine Flywheel Housing Installation](#).
6. Install the engine in the vehicle.

Note: Do not draw the engine to the transmission using the transmission bolts. If everything is aligned properly the engine and transmission will come together easily.

7. Loosely install 2 transmission to engine bolts.

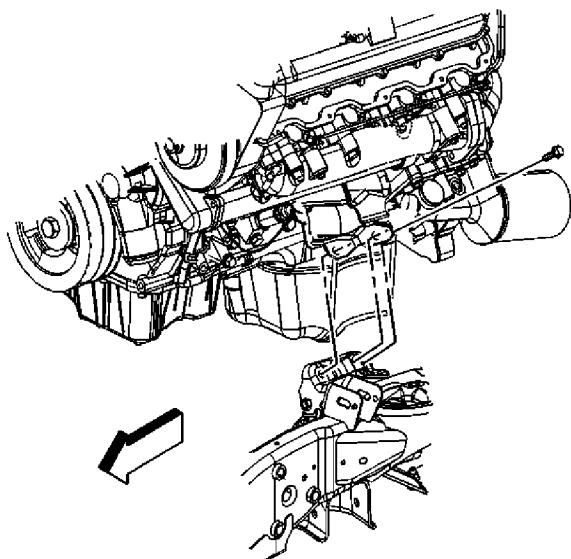
Caution: Refer to [Fastener Caution](#) in the Preface section.



8. Install the left and right side engine mount frame brackets, if equipped.

Tighten

Tighten the through-bolts to 75 N·m (55 lb ft).

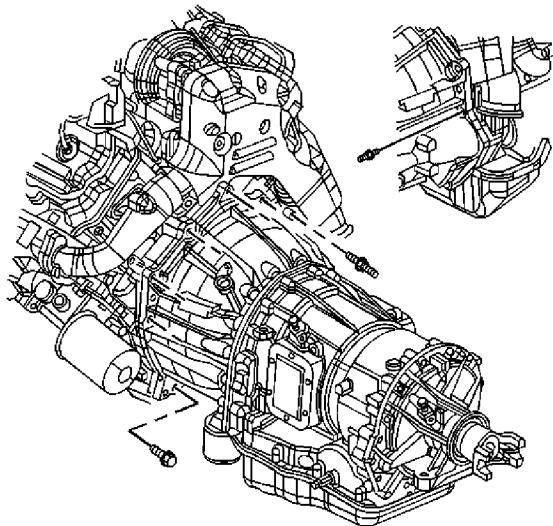


9. Install the engine mount to frame bracket bolts (left side shown).

Tighten

Tighten the bolts to 65 N·m (50 lb ft).

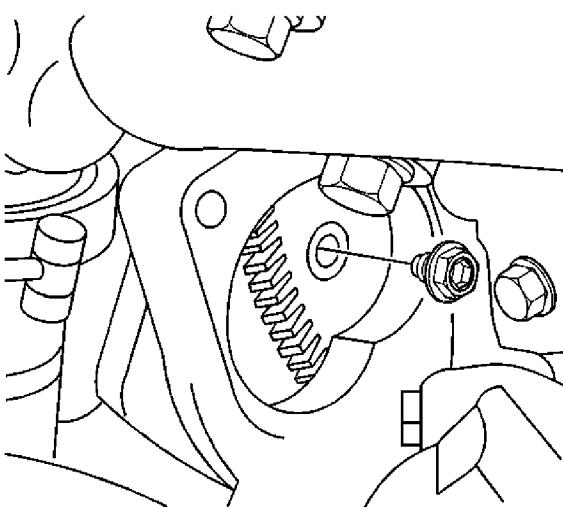
10. Remove the [J 36857](#) from the cylinder heads.
11. Raise the vehicle.



12. Install the transmission to engine bolts (automatic transmission shown).

Tighten

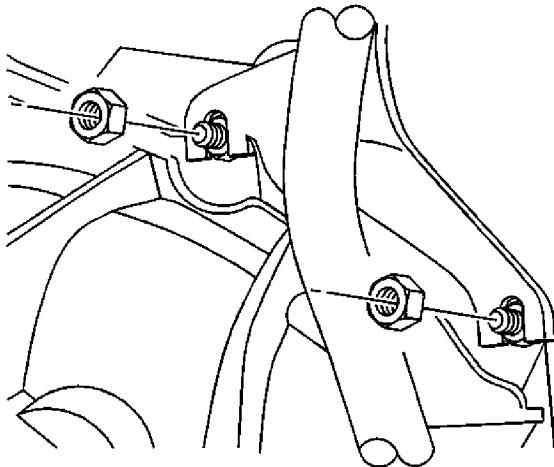
Tighten the studs and bolts to 50 N·m (37 lb ft).



13. If equipped with an automatic transmission install the torque convertor bolts.

Tighten

Tighten the bolts to 60 N·m (44 lb ft).

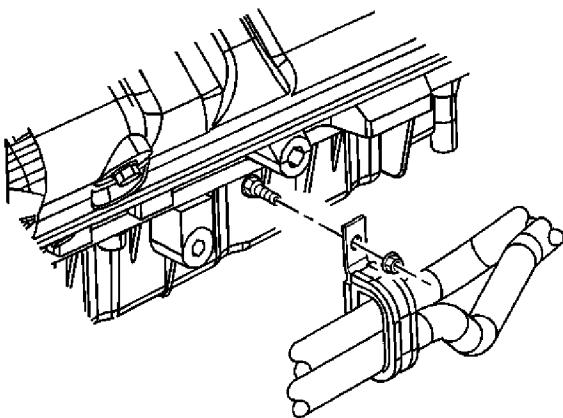


14. If equipped with an automatic transmission, install the nuts retaining the transmission fluid fill tube bracket.

Tighten

Tighten the nuts to 18 N·m (13 lb ft).

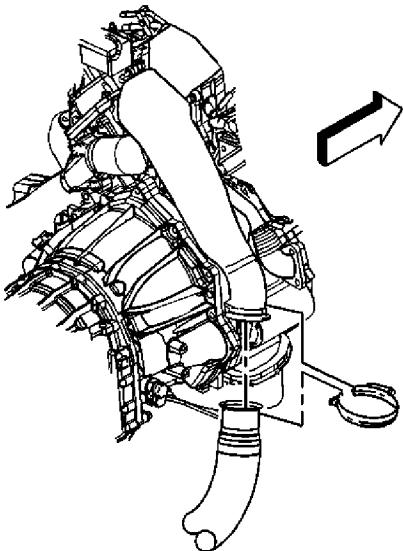
15. If the vehicle is 4WD equipped, install the front differential carrier assembly. Refer to [Differential Carrier Assembly Replacement](#).



16. If equipped with an automatic transmission, install the nut retaining the transmission oil cooler line clip.

Tighten

Tighten the nut to 9 N·m (80 lb in).

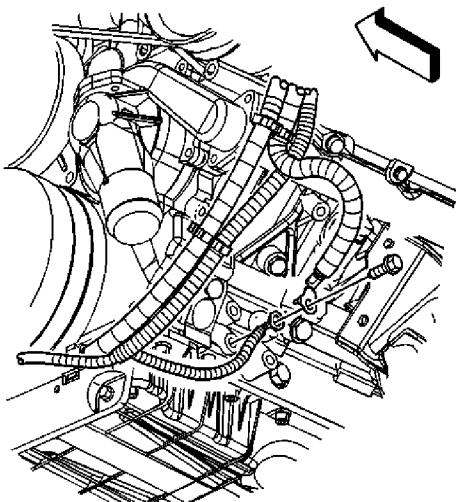


17. Install the exhaust pipe to the exhaust outlet.
18. Install the exhaust manifold pipe to the exhaust outlet clamp.

Tighten

Tighten the clamp to 40 N·m (30 lb ft).

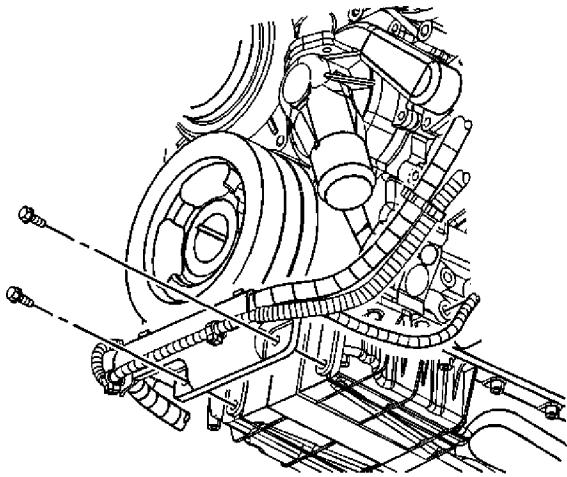
19. Lower the vehicle to work through the front fender wheelhouse openings.



20. Install the bolt retaining the battery negative cable and the engine wiring harness ground wire to the left side of the engine.

Tighten

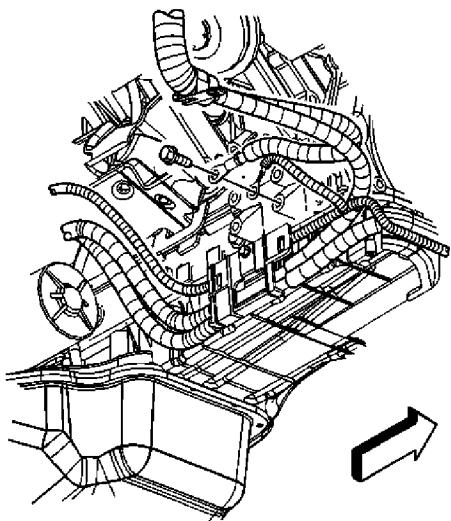
Tighten the bolt to 34 N·m (25 lb ft).



21. Install the bolts holding the battery cable channel retainer to the lower crankcase.

Tighten

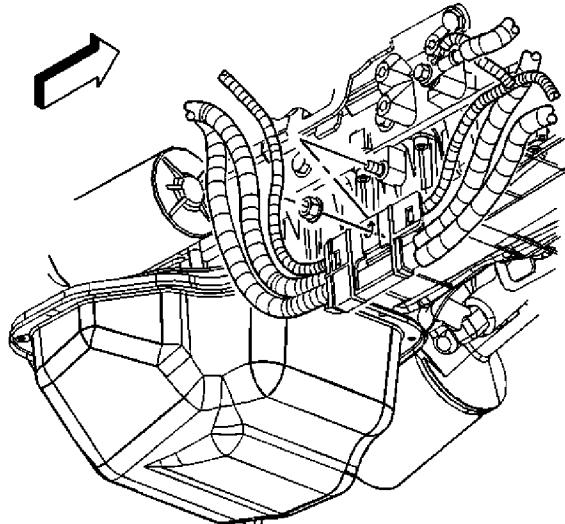
Tighten the bolts to 12 N·m (106 lb ft).



22. Install the bolts holding the auxiliary battery negative cable and the engine wiring harness ground wires to the right side of the engine.

Tighten

Tighten the bolts to 34 N·m (25 lb ft).

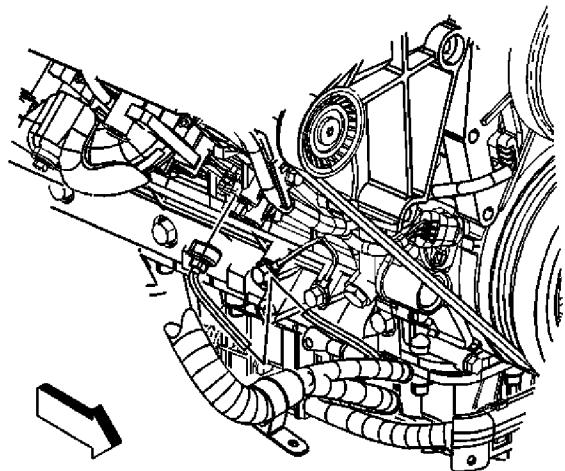


23. Install the nut holding the battery cable bracket to the right side of the lower crankcase.

Tighten

Tighten the nut to 8 N·m (71 lb in).

24. Install the starter. Refer to [Starter Replacement](#).

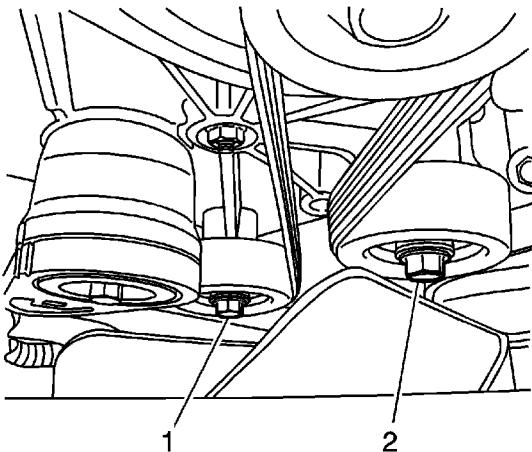


25. Connect the cord for the engine coolant heater.
26. Install the engine oil pan skid plate. Refer to [Oil Pan Skid Plate Replacement](#).
27. Install the engine shield. Refer to [Engine Shield Replacement](#).
28. Lower the vehicle.
29. Install the bolt and the ground wires at the rear of the left cylinder head.

Tighten

Tighten the bolt to 34 N·m (25 lb ft).

30. Install the upper exhaust gas recirculation cooling pipe. Refer to [Exhaust Gas Recirculation Cooling Pipe Replacement - Upper](#).
31. Install the generator bracket. Refer to [Generator Bracket Replacement](#).

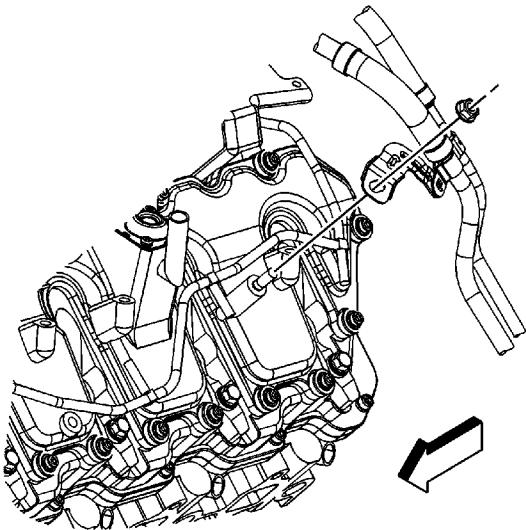


32. Install the right idler pulley and bolt (1).

Tighten

Tighten the bolt to 43 N·m (32 lb ft).

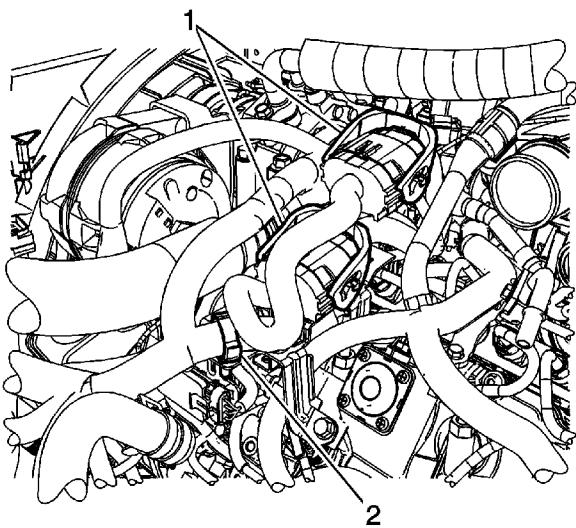
33. Install the air conditioning compressor and the power steering pump mounting bracket. Refer to [Air Conditioning \(A/C\) Compressor and Power Steering Pump Bracket Replacement](#).
34. Install the A/C compressor. Refer to [Air Conditioning Compressor Replacement](#).
35. Position the engine wiring harness on the engine.
36. Install the A/C suction hose to the accumulator.
37. Install the drive belt. Refer to [Drive Belt Replacement](#).



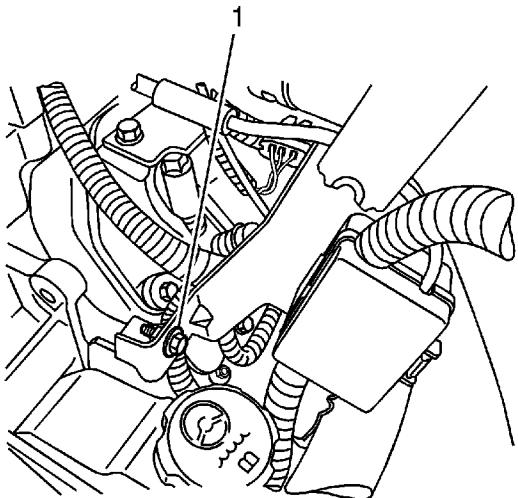
38. Connect the fuel hoses at the engine.
39. Install the nut and the fuel hose bracket to the valve rocker arm cover stud.

Tighten

Tighten the nut to 21 N·m (15 lb ft).



40. Connect the main engine electrical harness connectors.
41. Push down on the latches (1) in order to connect the connectors.
42. Close the harness clip (2).



43. Install the cable junction block and bolt (1) to the power steering pump.

Tighten

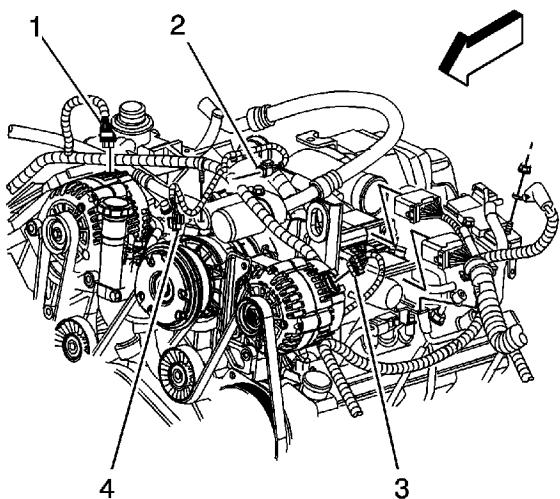
Tighten the bolt to 9 N·m (80 lb in).

44. If equipped, install the battery cable to the auxiliary generator.
45. Install the battery cable to the generator.

Tighten

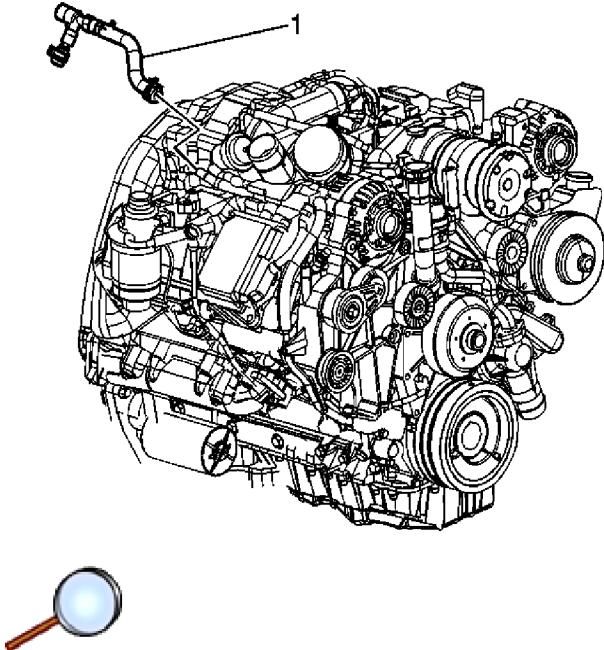
Tighten the nut to 9 N·m (80 lb in).

46. Install the battery cable harness clip to the upper air intake tube.



47. Connect the following electrical connectors:

- Generator connector (1)
 - A/C refrigerant switch (2)
 - Dual generator harness connector (3), if equipped
 - A/C compressor clutch (4)
48. Install the harness clip to the oil fill pipe.
49. Install the radiator support. Refer to [Radiator Support Replacement](#).
50. Install the radiator outlet hose. Refer to [Radiator Outlet Hose Replacement](#).
51. Install the lower fan shroud. Refer to [Engine Coolant Fan Lower Shroud Replacement](#).
52. Install the upper fan shroud. Refer to [Engine Coolant Fan Upper Shroud Replacement](#).



53. Connect the inlet heater hose (1) to the heater core inlet.

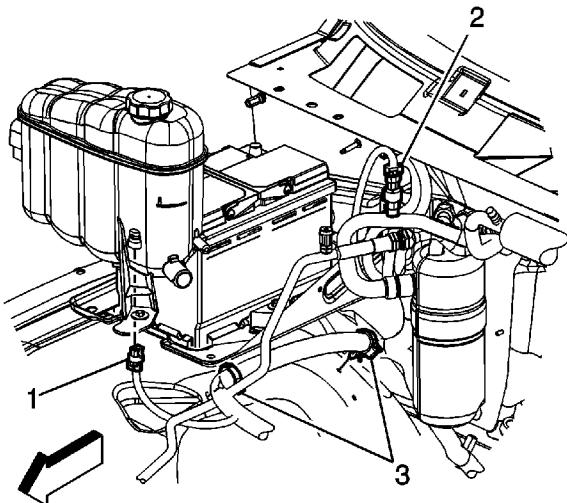
Firmly push to quick connector onto the heater core pipe until you hear an audible click.

54. Install the outlet heater hose to the outlet radiator hose.
55. Install the bolt retaining the heater hose pipe to the bracket.

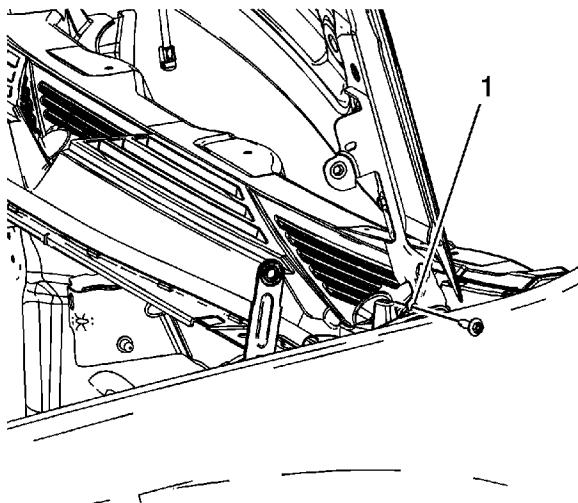
Tighten

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

56. Install the radiator inlet hose. Refer to [Radiator Inlet Hose Replacement](#).
57. Install the charged air cooler pipes and hoses to the turbocharger and the charged air cooler. Refer to [Charge Air Cooler Inlet Pipe Replacement](#) and [Charge Air Cooler Outlet Pipe Replacement](#).
58. Install both fender wheelhouse inner panels (1). Refer to [Front Wheelhouse Liner Replacement - Right Side](#) and [Front Wheelhouse Liner Replacement - Left Side](#).
59. Install both front tires and wheels. Refer to [Tire and Wheel Removal and Installation](#).
60. Install the surge tank. Refer to [Radiator Surge Tank Replacement](#).
61. Install the air cleaner. Refer to [Air Cleaner Assembly Replacement](#).

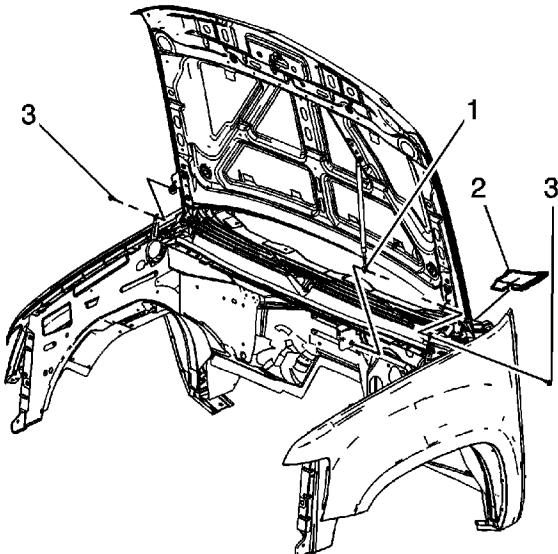


62. Connect the following engine wire harness connectors:
 - Install the engine wire harness clips to the wheelhouse inner panel (3).
 - A/C pressure cycling switch (2)
 - Surge tank switch (1)
63. Connect the batteries negative cables. Refer to [Battery Negative Cable Disconnection and Connection](#).
64. Fill the engine coolant. Refer to [Cooling System Draining and Filling](#).
65. Prelube the engine. Refer to [Engine Prelubing](#).
66. Operate the engine, inspect for coolant, oil, fuel, and exhaust leaks.
67. Inspect for proper oil pressure.
68. Inspect for proper engine operation.



Note: There is a positive stop which limits the hood from being opened too far.

69. With the aid of the assistant raise the hood slightly until the hood hinge bolts can be removed from the service position notch (1).

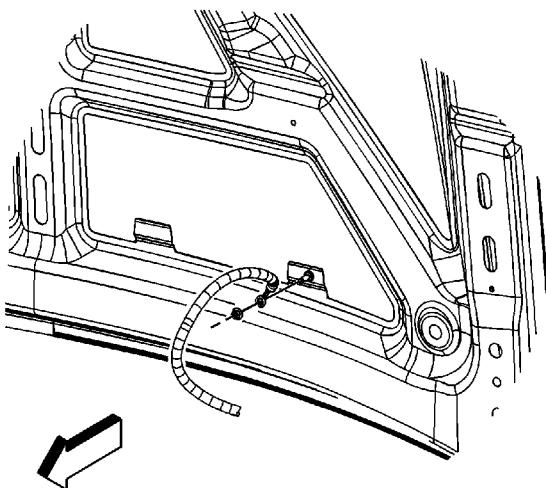


70. With the aid of an assistant lower the hood and install the hood hinge bolts (2) to the hood hinges.

Tighten

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

71. Install the air inlet grille end caps (1), push down the end cap in order to engage the retainers. (left side shown, right side similar).



72. Install the ground strap to the hood stud.

73. Install the ground strap nut at the hood stud.

Tighten

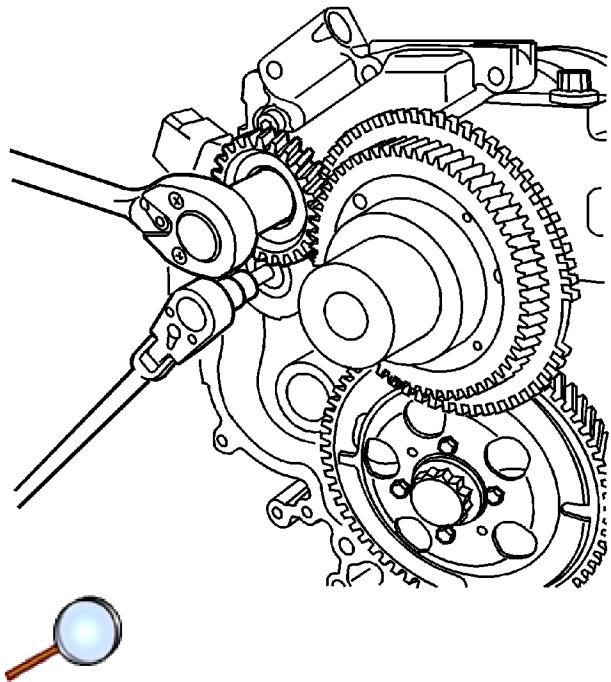
Tighten the nut to 9 N·m (80 lb in).

74. Close the hood.

75. Road test the vehicle for normal operation.

76. Inspect for coolant, oil, or exhaust leaks.

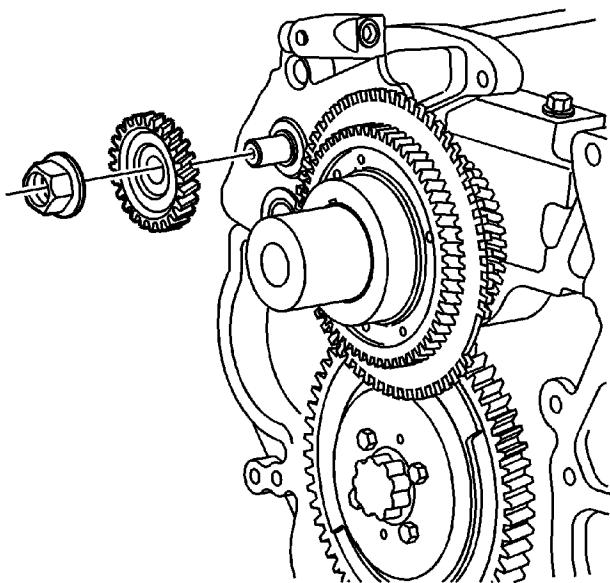
Oil Pump Removal



Caution: Do not use an impact driver to remove or install the oil pump driven gear nut. Use of an impact driver may shear the oil pump drive gear pin in the crankshaft.

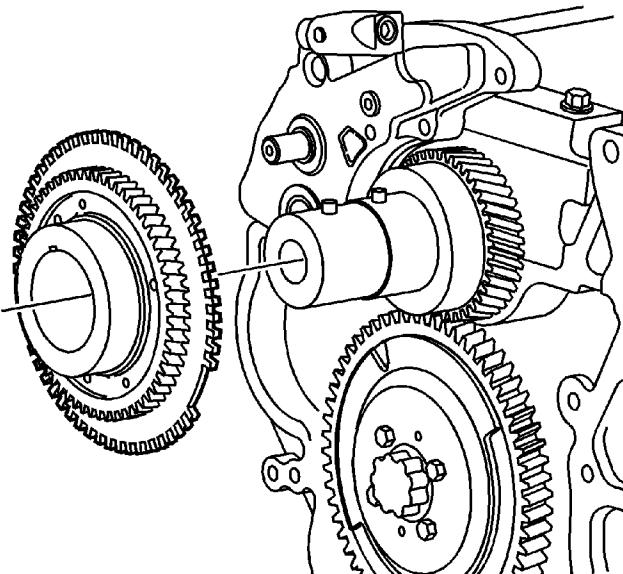
Note: Look for an "L" on the end of the oil pump shaft. If there is an "L" present, the nut and shaft have left hand threads. Service the nut accordingly.

1. While holding the secondary oil pump shaft with a hex driver, remove the oil pump driven gear nut.



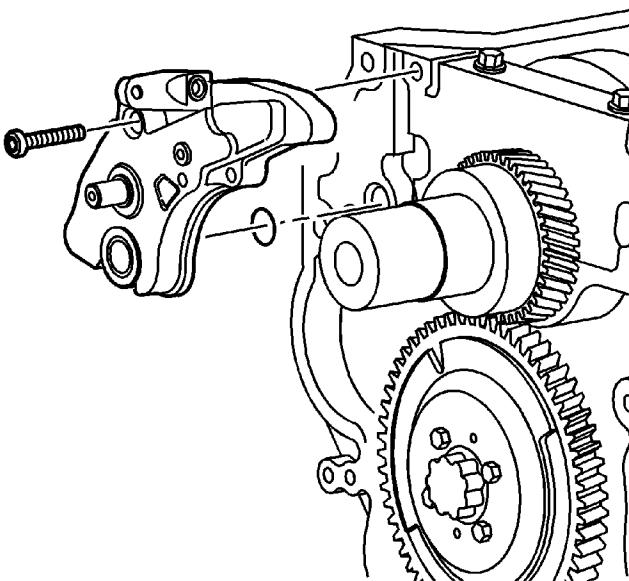


2. Remove the oil pump driven gear.



Note: Do not damage the crankshaft sensor reluctor teeth.

3. Remove the oil pump drive gear and crank sensor reluctor assembly.



4. Remove the oil pump bolts.
5. Remove the oil pump.
6. Remove the O-ring and discard.