INSTALLATION INSTRUCTIONS

SUBJECT: FREEDOM SERIES CYLINDER HEADS FOR 6.6L DURAMAX

FITMENT: 2001-2023 Chevrolet and GMC Silverado/Sierra 2500/3500 with 6.6L Duramax

PRODUCT P/N'S: FPE-61-10001-D-CL, FPE-61-10001-P-CL, FPE-61-10002-D, FPE-61-10002-P FPE-61-10003-D, FPE-61-10003-P, FPE-61-10004-D, FPE-61-10004-P, FPE-61-10014-D, FPE-61-10014-P

ESTIMATED INSTALLATION TIME: 40 hours

KIT CONTENTS:

Item	Description	Qty
1	Cylinder head	1

The instructions and guidelines contained in this document follow GM's standard procedures for the replacement of a cylinder head on the 6.6L LML (2011-2016) Duramax platform. Variations in the overall process may vary slightly in earlier and later model year applications. Reference the GM instructions particular to your VIN for additional details where required.

GUIDELINES AND CHECKLIST

1. Inspect the cylinder head deck for flatness before installing the new cylinder head. Reference the check procedure on page _ of this document.
2. A head gasket is not provided with this kit. A new head gasket will be required to complete this installation.
3. Fleece Performance recommends the use of ARP head bolts. Do not reuse the M12 bolts from the original cylinder head.

GENERAL OVERVIEW

Disassembly and removal:

1. Disconnect both batteries, drain oil and coolant system and remove air cleaner.
2. Remove intake air box, coolant surge tank bracket, and cold air charge tube.
3. Disconnect chassis fuel lines from rear of engine.
4. Remove cooling fan shroud bolts.
5. Loosen accessory drive belt.
6. Remove bolts retaining A/C condenser and move the condenser aside. Remove the alternator and set aside.
7. Remove the fuel filter assembly.
8. Remove intake manifold y-bridge.
9. Loosen oil dipstick tube bolts and remove intake air heater ground bracket.
10. Remove the turbocharger air inlet adapter.
11. Remove EGR bypass pipe, valve, and front cooler.
12. Disconnect and remove the exhaust adapter from the turbocharger.
13. Remove the cooling feed pipe and o-ring seal.
14. Remove both of the exhaust up-pipes.
15. Remove the driver and passenger side exhaust manifolds.
16. Remove the rear portion of the EGR cooler assembly.
17. Remove the turbocharger.
18. Remove the low and high-pressure fuel lines.
19. Remove the fuel injector return system.
20. Remove the fuel injector feed pipes.
21. Remove the high-pressure fuel rail assemblies.
22. Remove the lower intake manifolds.
23. Remove the fuel injectors.
24. Remove the upper and lower valve covers.
25. Remove rocker arms and push rods.
26. Remove the cylinder heads, gaskets, and dowel pins.

GENERAL OVERVIEW

Installation and reassembly:

1. Clean the head deck surface on the engine block and inspect for flatness.
2. Install new dowel pins.
3. Install the new cylinder head gaskets.
4. Install the new cylinder head using new M12 bolts.
5. Install the pushrods and rocker arm assemblies.
6. Check and set the valve lash.
7. Install the valve covers.
8. Install the fuel injectors.
9. Install the intake manifolds.
10. Install the high-pressure fuel rail.
11. Install the fuel injector feed lines.
12. Install the high and low-pressure fuel lines. Install the injector return system
13. Install the exhaust manifolds.
14. Install the turbocharger.
15. Install the rear portion of the EGR assembly.
16. Install the turbocharger up pipes.
17. Install the EGR cooling feed pipe.
18. Install the turbocharger exhaust adapter.
19. Install the intake manifold y-bridge.
20. Install EGR bypass pipe, valve, and front cooler.
21. Install intake manifold tube.
22. Install the fuel filter assembly.
23. Install the A/C compressor and the alternator. Install and tension the accessory drive belt.
24. Install the cooling fan shroud.
25. Connect the quick disconnect fuel fittings at the rear of the engine.
26. Install the charge air cooler tube and hot side charge tube. Install the surge tank brackets and airbox.
27. Add oil and coolant and install air cleaner. Connect the battery terminals.
28. Prime fuel system, then start the vehicle. Check for leaks.

DISASSEMBLY AND REMOVAL PROCEDURE:

NOTE: *All parts removed from the engine, apart from the stock cylinder head, are to be reinstalled unless otherwise stated.*

STEP 1: Disconnect both batteries, drain engine oil and coolant system. Remove the air cleaner.

a. Do not use impact tools on the battery terminals.
b. Coolant is best drained from the lower radiator hose. Place a large bucket underneath the vehicle to drain the coolant into.
c. Air cleaner can be removed by first loosening the hose clamps and then gently pulling off the duct. The box itself can be removed by lifting upward. Be careful not to damage the A/C line during removal.

STEP 2: Remove airbox and coolant surge tank bracket. Next, disconnect black plastic cold side charge air cooler (CAC) tube from throttle body.

a. With a screwdriver, push the lock ring counterclockwise. As the locking ring is rotated, the CAC pipe itself can be gently pulled out and off.
b. Remove CAC pipe from the turbocharger.

STEP 3: Disconnect chassis fuel lines from quick connect fittings at rear of engine using a quick connect removal collar tool. Use 3/8" and ½" fuel disconnect tools to perform this.

STEP 4: Remove the four (4) cooling fan shroud bolts.

a. For 2015 vehicles, it is not necessary to remove the fan shroud, gently adjust the shroud towards the radiator to provide access to the cooling fan center.
b. For 2014 and earlier vehicles, the fan shroud is two piece and can be more easily removed.
c. Unbolt cooling fan mount from front of engine by loosening three 15mm bolts and two stud nuts.
d. Remove the fan from the drive pulley using a fan removal tool. Perform this before removing the belt.

STEP 5: Release tension of the accessory drive belt by rotating tensioner using a ½" drive socket wrench. The intake manifold cover (embossed with 6.6L Turbo Diesel) can be removed by loosening the two 10mm bolts affixing it to the intake pipe. Remove the alternator bracket.

STEP 6: Unbolt and move aside A/C compressor. The refrigerant does not need to be evacuated. The alternator(s) can be removed and put aside.

STEP 7: Remove the fuel filter assembly.

a) Remove the upper intake manifold brace bolt, then remove the fuel filter bracket bolts. Remove the upper intake manifold brace.
b) Disconnect the fuel filter hoses and remove the fuel filter bracket bolts. Remove the fuel filter and bracket.

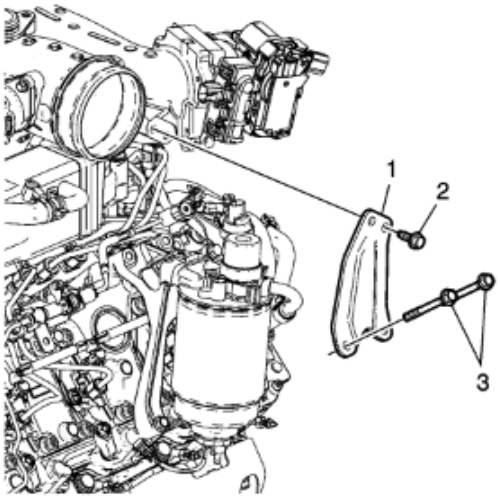


Fig. 1: Intake manifold brace

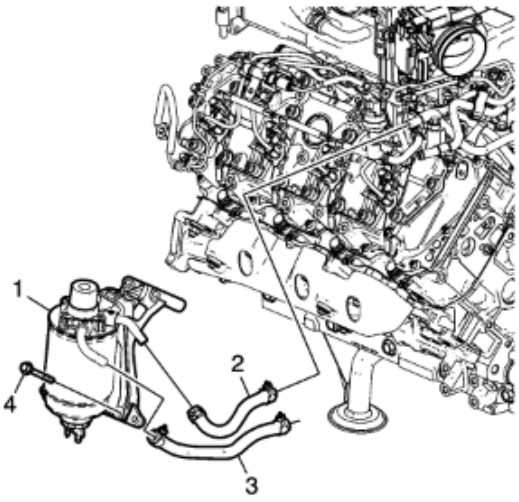


Fig. 2: Fuel filter removal

STEP 8: Remove intake manifold tube. First, disconnect the harness connector on the throttle body. Loosen the two 13mm bolts affixing the pipe to the intake manifold near the MAP sensor. (see figure 3)

STEP 9: Loosen the oil dipstick tube bracket bolts and the hidden 10mm bolt affixing the intake air heater ground bracket to the intake pipe. (see item 2 in figure 3)

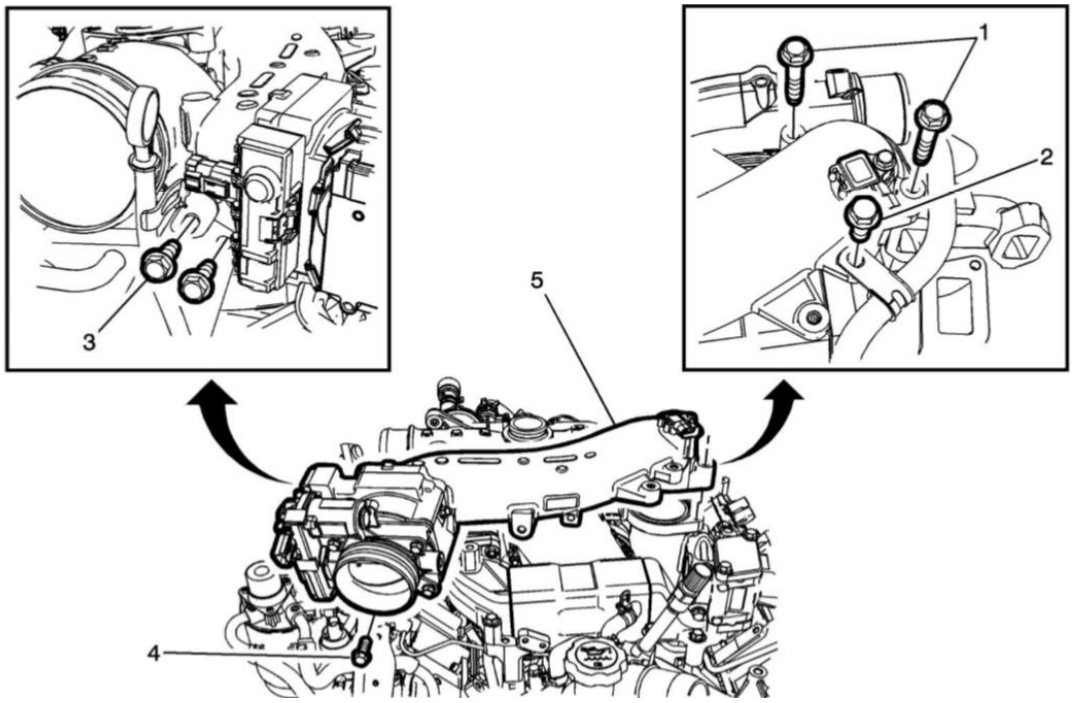


Fig. 3: Intake manifold tube

STEP 10: Remove the turbocharger air inlet adapter.

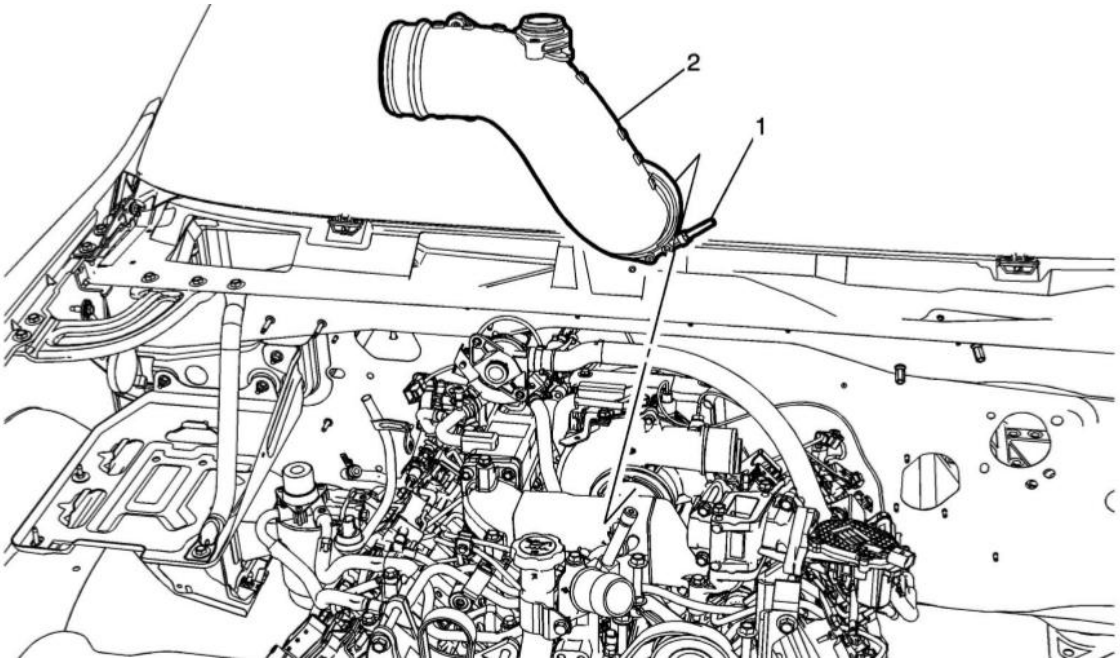


Fig. 4: Air inlet adapter removal

STEP 11: Remove EGR bypass pipe, valve, and front cooler.

a. Remove the EGR bypass pipe that connects the EGR bypass valve to the EGR valve.

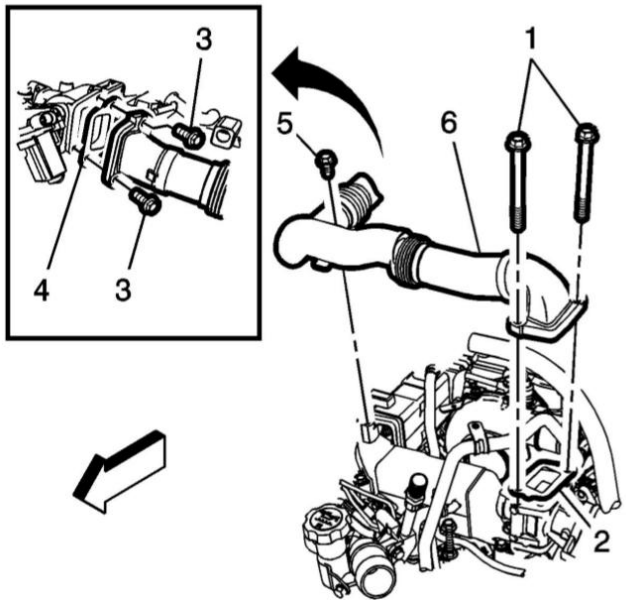


Fig. 5: EGR bypass pipe

b. The EGR valve can then be removed by loosening the four bolts that attach it to the intake manifold.

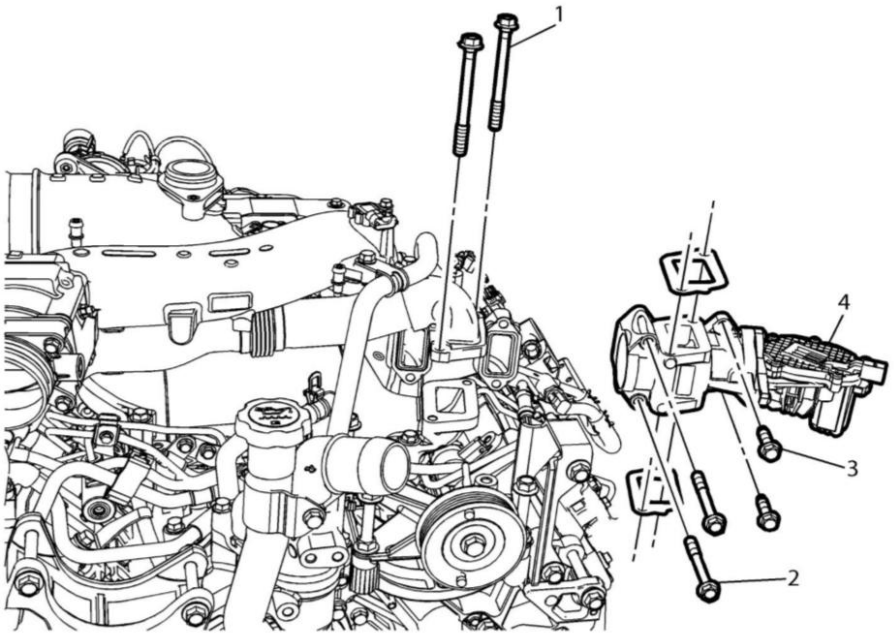


Fig. 6: EGR valve removal

c. The 4 front EGR cooler bolts can be accessed by carefully threading through a ¼" drive socket extension and a swivel socket.

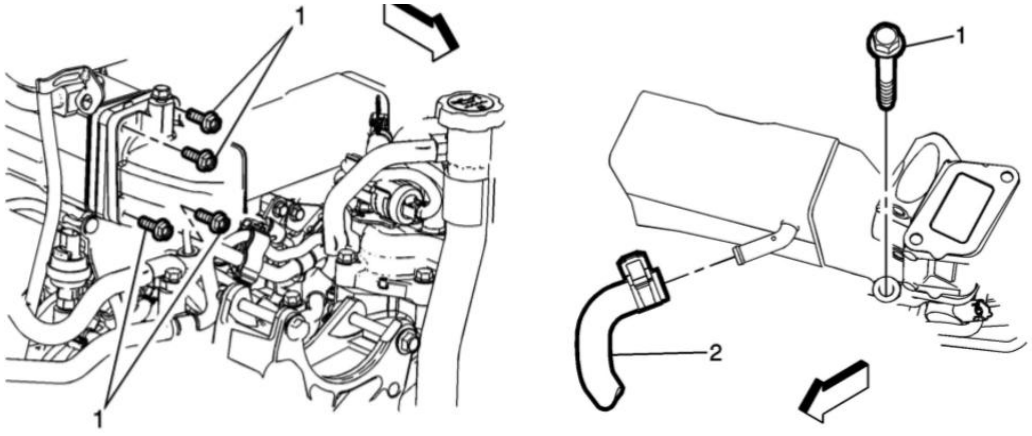


Fig. 7: EGR cooler removal

d. Remove the intake manifold y-bridge and gaskets.

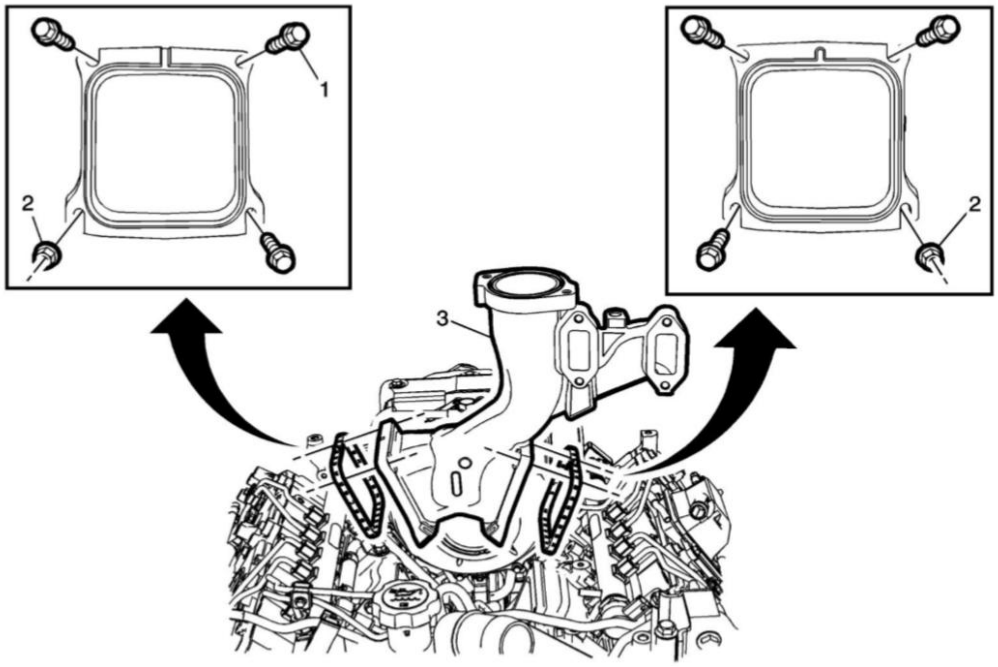


Fig. 8: Intake manifold y-bridge removal

STEP 12: Disconnect and remove the exhaust adapter from the turbocharger.

a. Remove the bolt retaining the exhaust adapter heat shield. Remove the heat shield. Reference figure 9.
b. Remove the bolt retaining the exhaust adapter to the passenger side exhaust up-pipe. Reference figure 10.

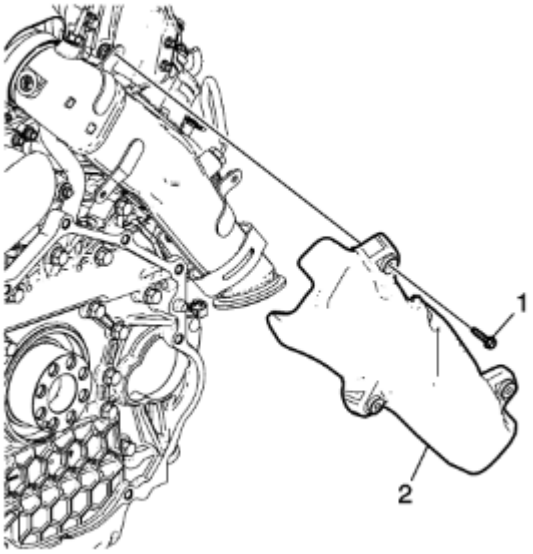


Fig. 10: Exhaust adapter heat shield removal

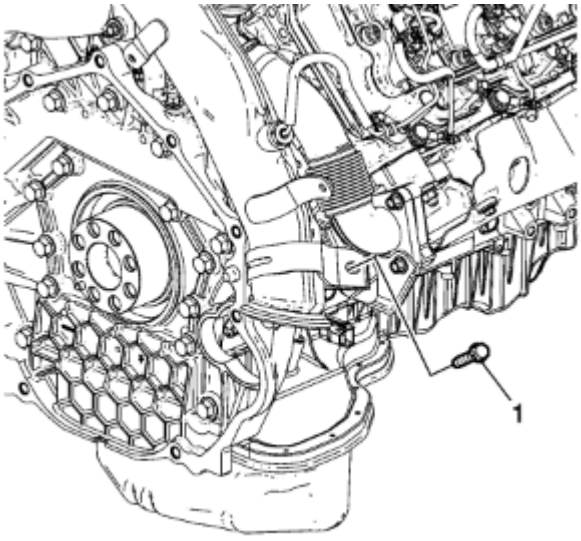


Fig. 11: Exhaust adapter bolt removal

c. Remove the NOx sensor (figure 11) and the exhaust temperature sensor (figure 13).

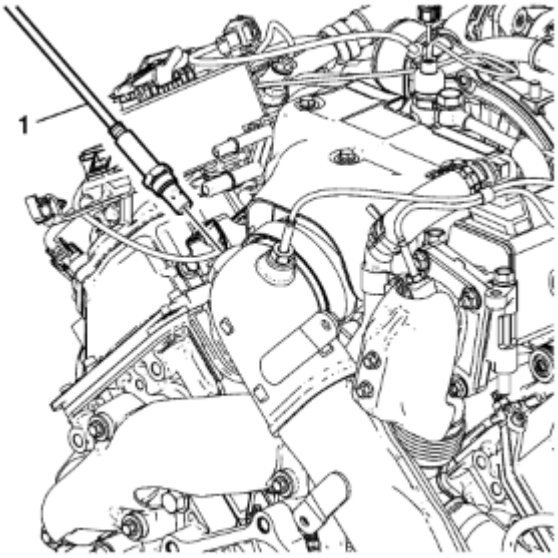


Fig. 11: NOx sensor removal

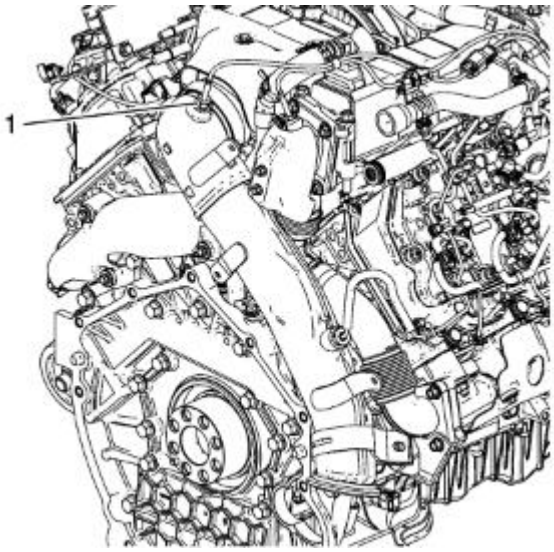


Fig. 12: Exhaust temperature sensor removal

d. Remove the bolts retaining the dosing injector and the fuel feed pipe clip (items labeled 1 and 2 in figure 13). Using a CH49736 QD removal tool, disconnect the dosing injector from the fitting and remove the dosing injector assembly as shown in figure 15.

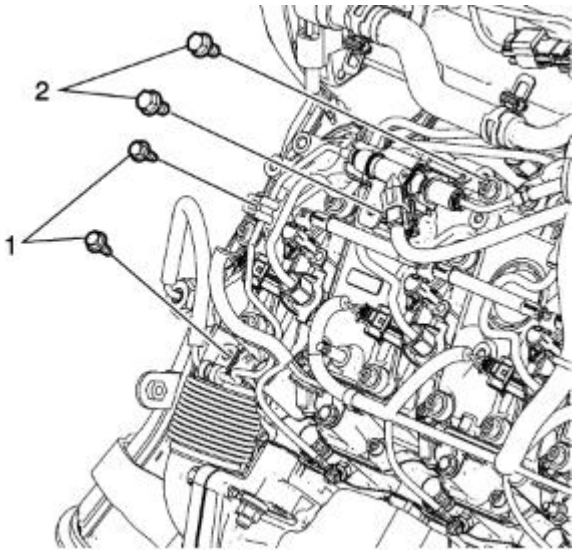


Fig. 13: Dosing injector bolt removal

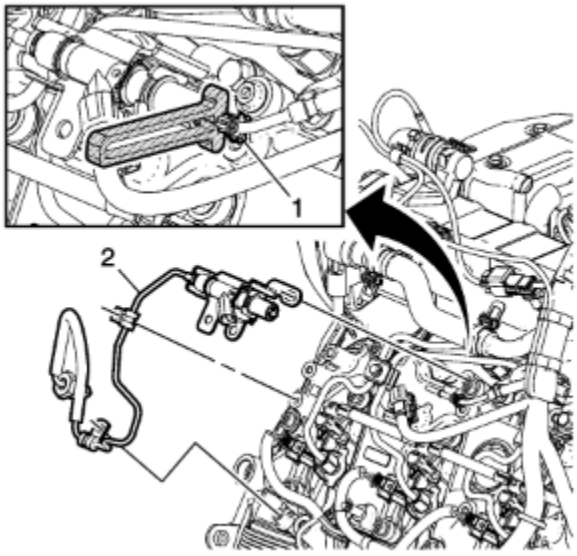


Fig. 14: Dosing injector removal

e) Loosen the clamp retaining the exhaust adapter to the turbocharger, then remove the adapter.

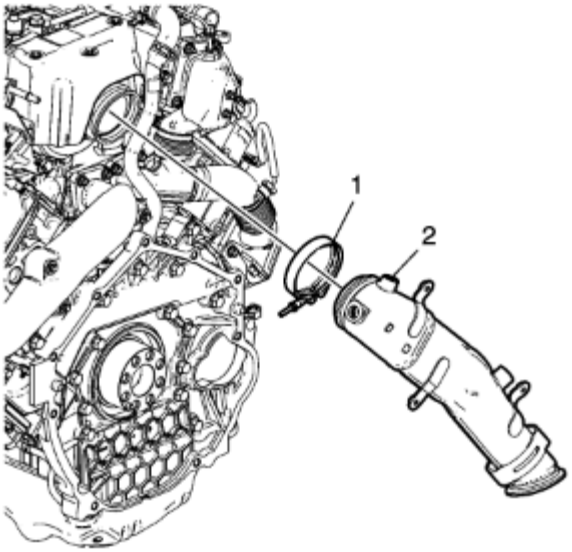


Fig. 15: Exhaust adapter removal

STEP 13: Remove the bolts retaining the EGR manifold cooling feed pipe to the engine block and EGR system. Loosen the clamps and remove the cooling feed pipe and o-ring seal. Discard of the o-ring.

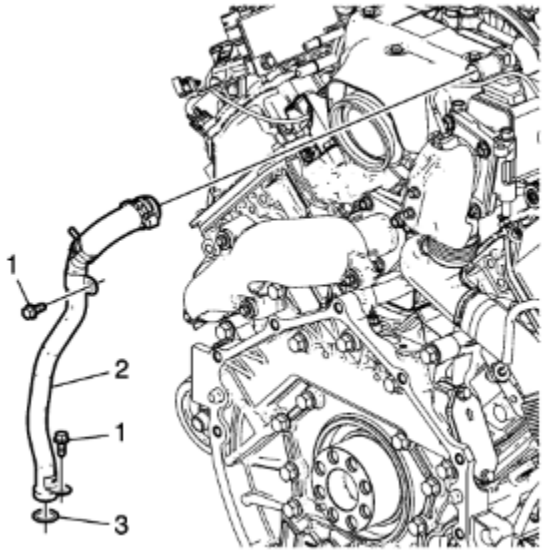


Fig. 16: EGR cooling feed pipe removal

STEP 14: Remove both of the exhaust up-pipes.

a) Remove the two bolts retaining the heat shield onto the top of the passenger-side up pipe. Remove the heat shield. Refer to figure 17 below.
b) Remove the EGR sensor as shown in figure 18.

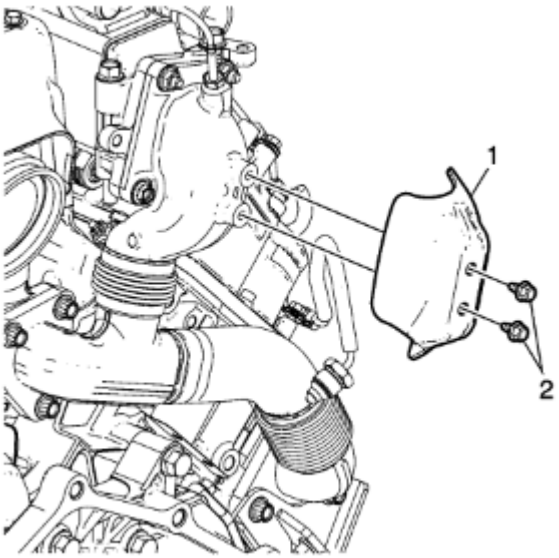


Fig. 17: Up-pipe heat shield removal

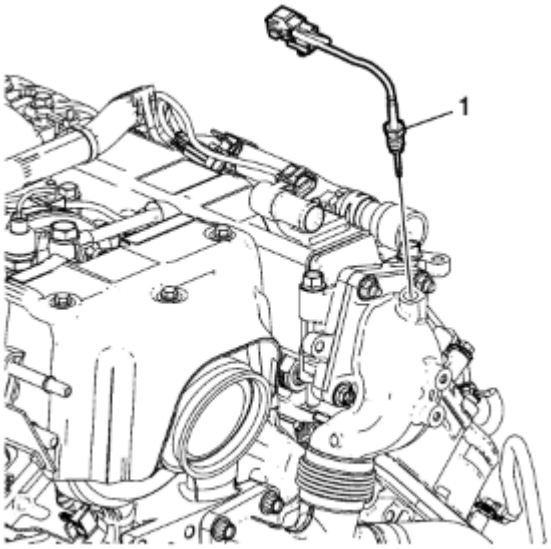


Fig. 18: EGR sensor removal

c) Remove the exhaust pipe nuts (1) and bolts (2 and 3) in the sequence shown in figure 19. Remove the passenger side exhaust up-pipe, bracket, and gaskets.

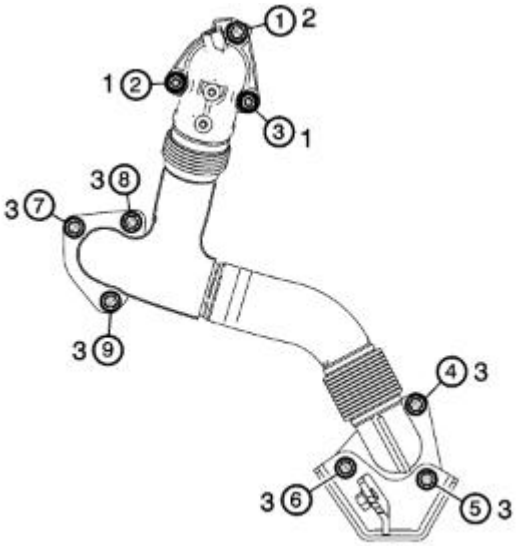


Fig. 19: Passenger side up-pipe fasteners

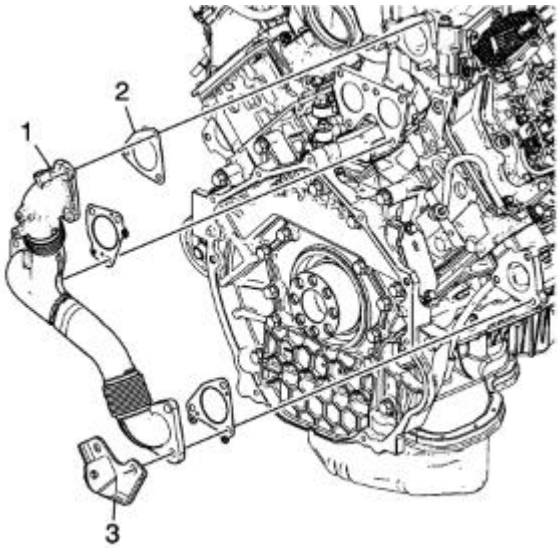


Fig. 20: Passenger side up-pipe removal

d) Remove the heat shield bolts on the driver's side up-pipe.
e) Remove the blots retaining the driver's side up-pipe to the turbocharger and exhaust manifold in the sequence shown in Fig 22. Remove the up-pipe and gaskets.

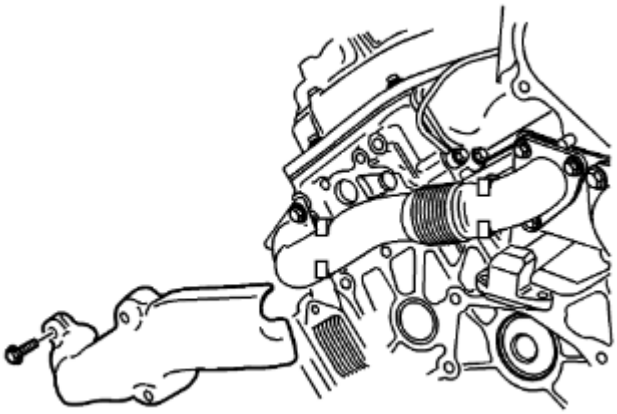


Fig. 21: Driver's side heat shield removal

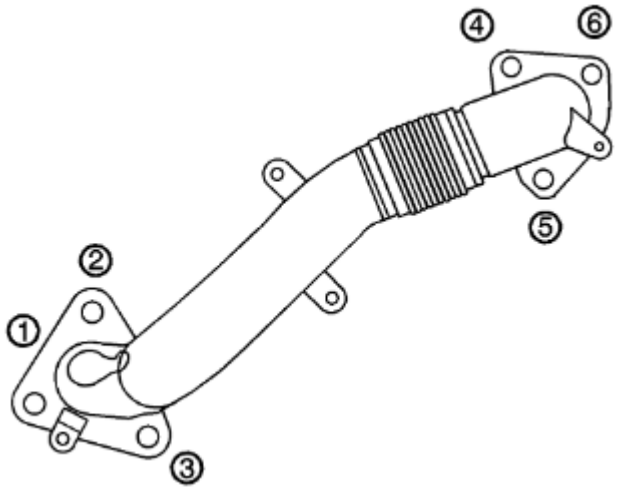


Fig. 22: Driver's side up-pipe fasteners

STEP 15: Remove the driver and passenger side exhaust manifolds.

a) Remove the bolts retaining the heat shield to the driver's side exhaust manifold. Remove the shield.

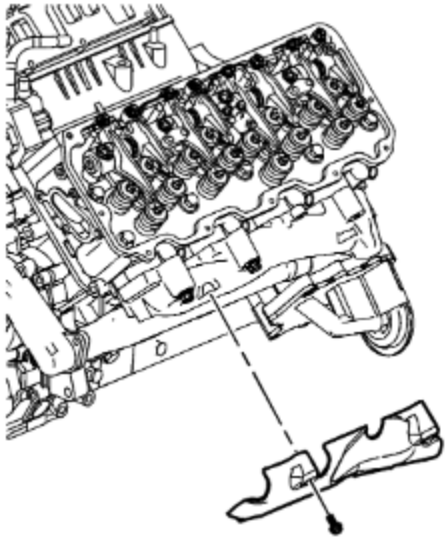


Fig. 23: Driver's side exhaust manifold heat shield removal

b) Remove the nut and bolts retaining the driver's side exhaust manifold to the cylinder head in the sequence shown in Fig. 24. Remove the exhaust manifold and gasket.

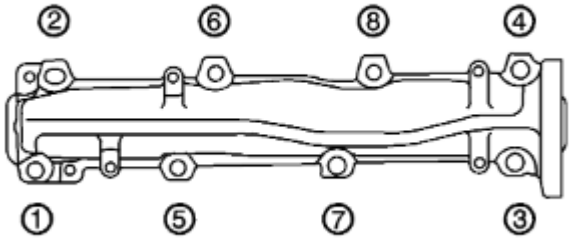


Fig. 24: Driver's side exhaust manifold fasteners

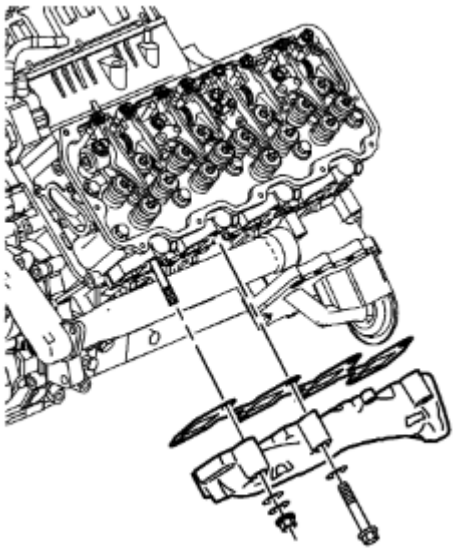


Fig. 25: Driver's side exhaust manifold removal

c) Repeat steps 16a and 16b for the passenger side exhaust manifold. Remove the nut and bolts in the sequence shown in Fig. 26.

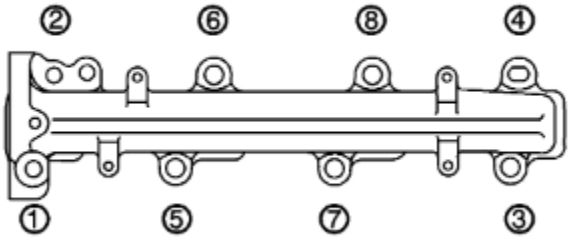


Fig. 26: Passenger side exhaust manifold fasteners

STEP 16: Remove the rear portion of the EGR cooler assembly.

a) Remove the cooling feed hoses (items 1 and 2), the heater water bypass hose (item 3), and the heater inlet hose (item 4).
b) Remove the two bolts retaining the rear EGR cooler bracket to the engine. These bolts are located on the rear passenger side of the engine.

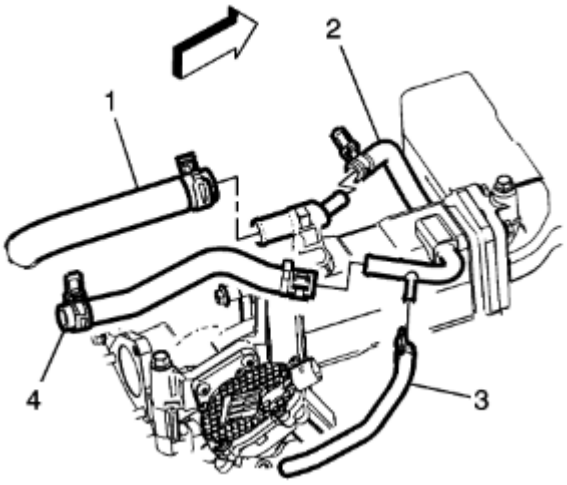


Fig. 27: Rear EGR hose removal

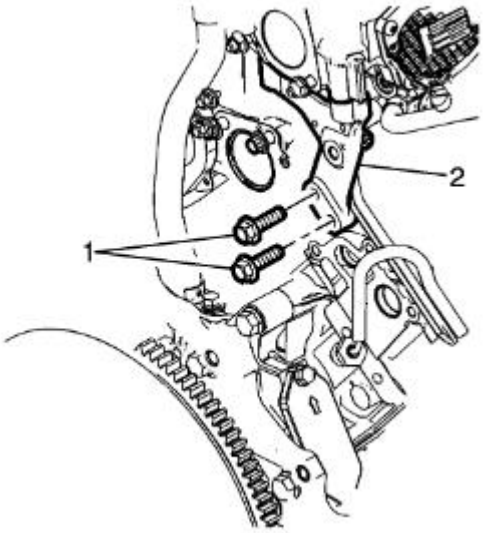


Fig. 28: Rear EGR bracket bolt removal

c) Remove the two bolts retaining the EGR cooler bracket to the EGR cooler. Disconnect the electrical harness connector from the EGR cooler.
d) Remove the rear EGR cooler assembly and discard the gasket.

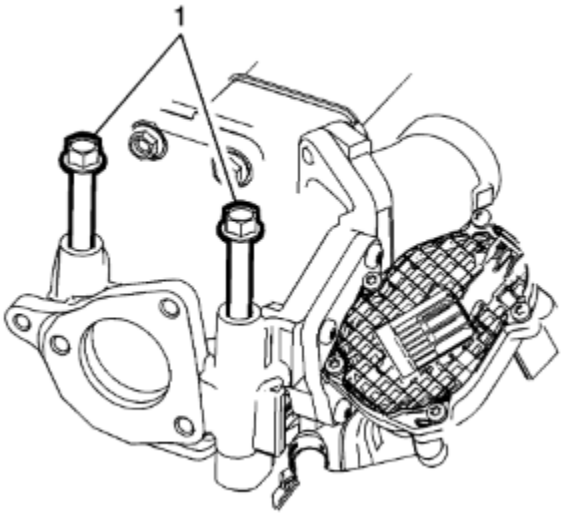


Fig. 29: Rear EGR Removal

STEP 17: Remove the turbocharger.

a) Remove the fuel feed and return pipe assembly bolts. Remove the fuel feed and return pipes.
b) Remove the bolts retaining the turbocharger upper heat shield. Remove the heat shield.

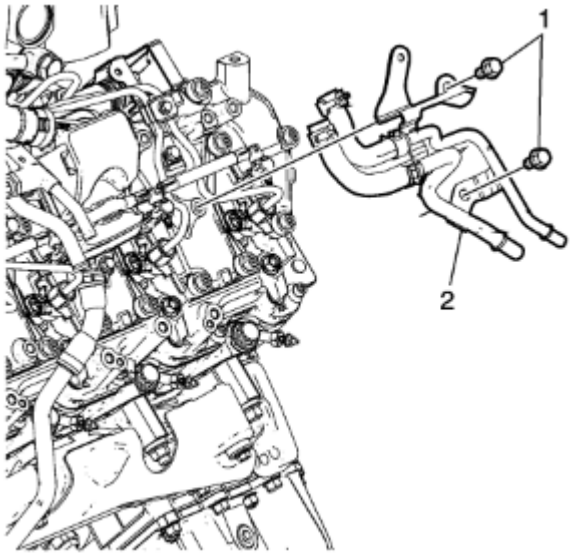


Fig. 30: Fuel Feed and return pipe

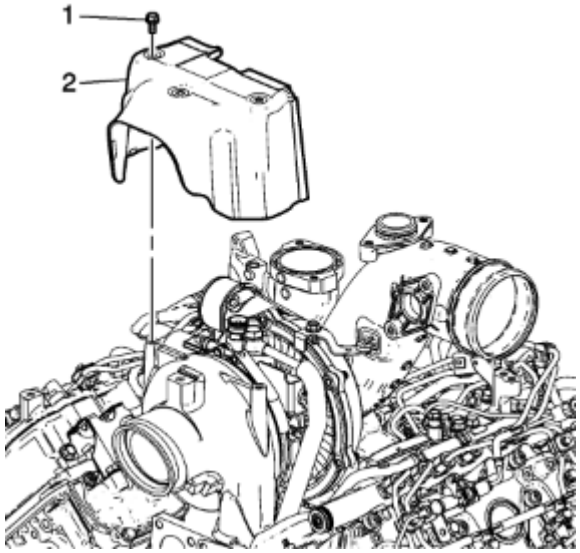


Fig. 31: Turbocharger upper heat shield removal

c) Remove the banjo bolt and washers retaining the turbocharger oil feed pipe.
d) Remove the turbocharger cooling return pipe bolts (items 3 and 4), then remove the turbocharger cooling return pipe and hose (items 1 and 2)

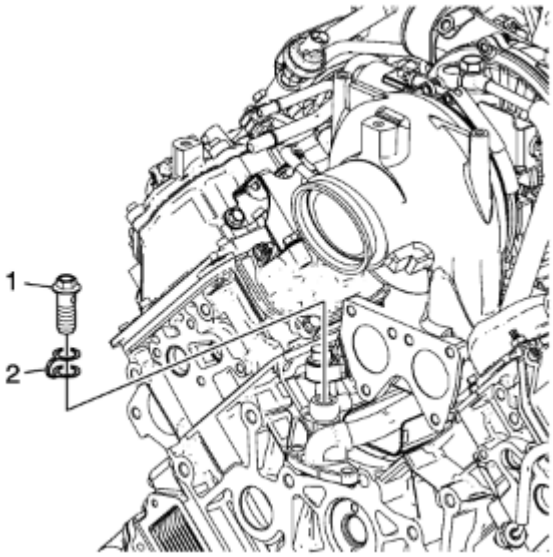


Fig. 32: Oil feed pipe banjo bolt and washer removal

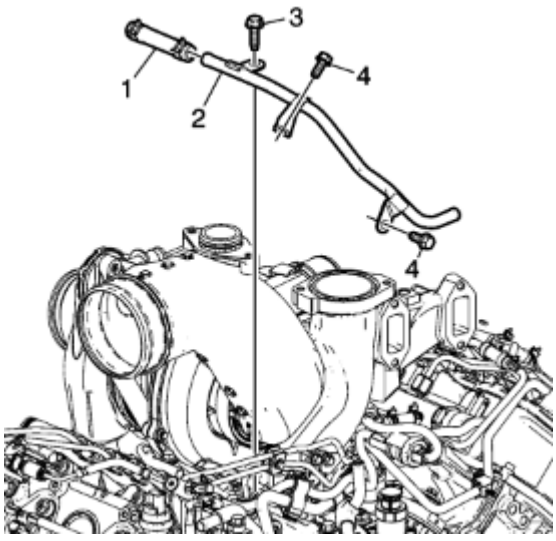


Fig. 33: Cooling return pipe removal

e) Remove the turbocharger mounting bolts (item 1) and the cooling return pipe bolt (item 3). Remove the turbocharger assembly from the engine.
f) Remove the turbocharger lower heat shield.

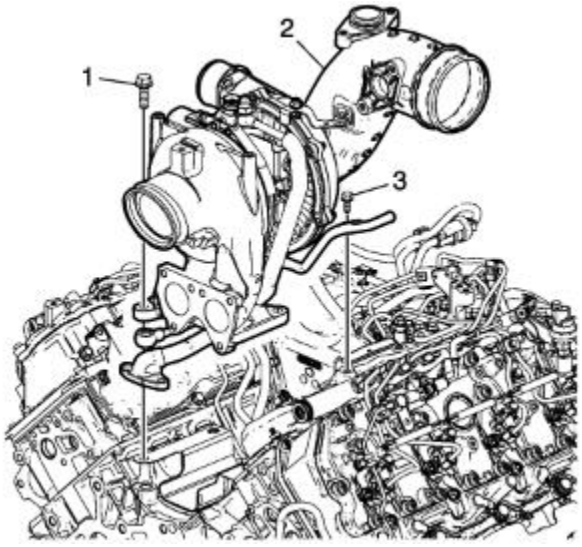


Fig. 34: Turbocharger removal

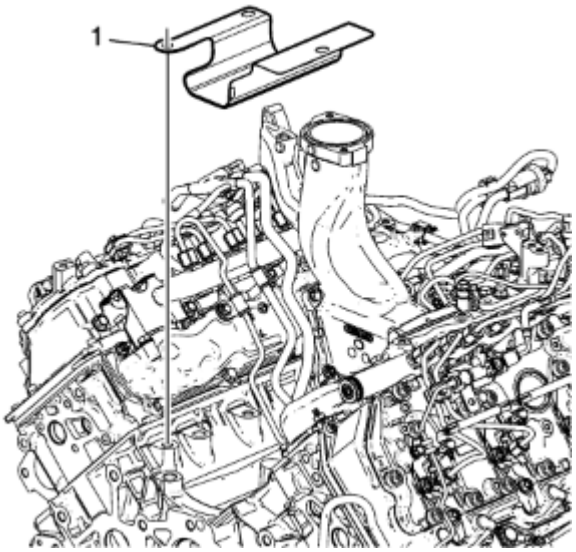


Fig. 35: Turbocharger lower heat shield removal

STEP 18: Remove the low and high-pressure fuel lines. Note: The following instructions are for a stock vehicle with the factory CP4 injection pump. For vehicles that have been converted for use with a CP3, refer to the installation instructions for your particular kit for component removal.

a) Remove the rail-to-rail high-pressure crossover lines.
b) Remove the high-pressure fuel feed line to the passenger side fuel rail.

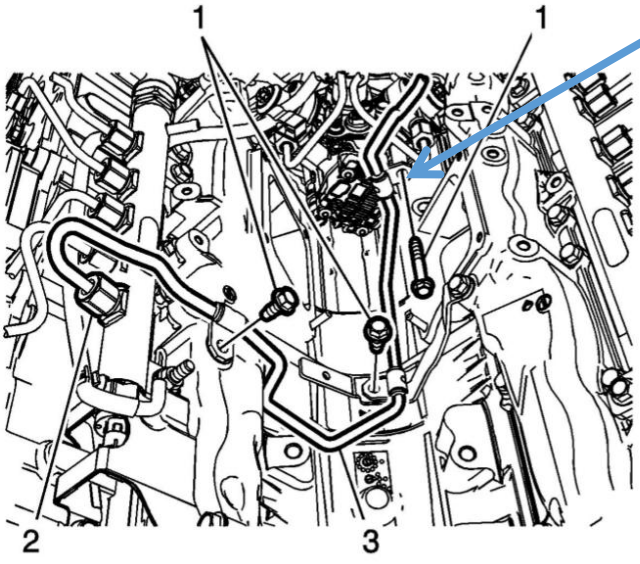


Fig. 36: Rail-to-rail crossover line removal

Rail to rail cross-over high-pressure line - Remove this line clamp/bracket from the high-pressure line.

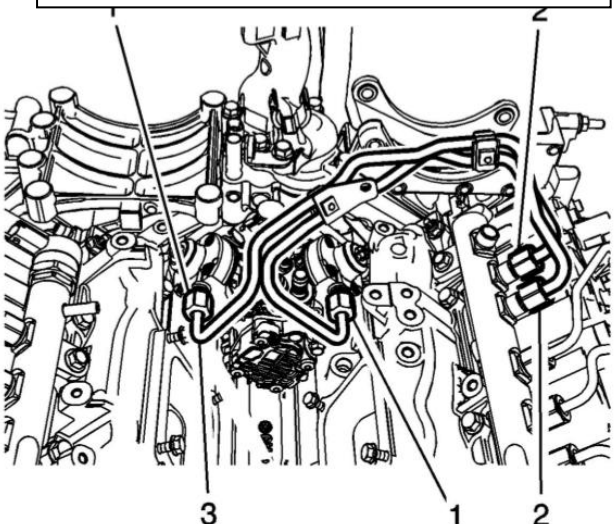


Fig. 37: High pressure fuel feed line removal

c) Remove the low-pressure fuel feed and return lines.

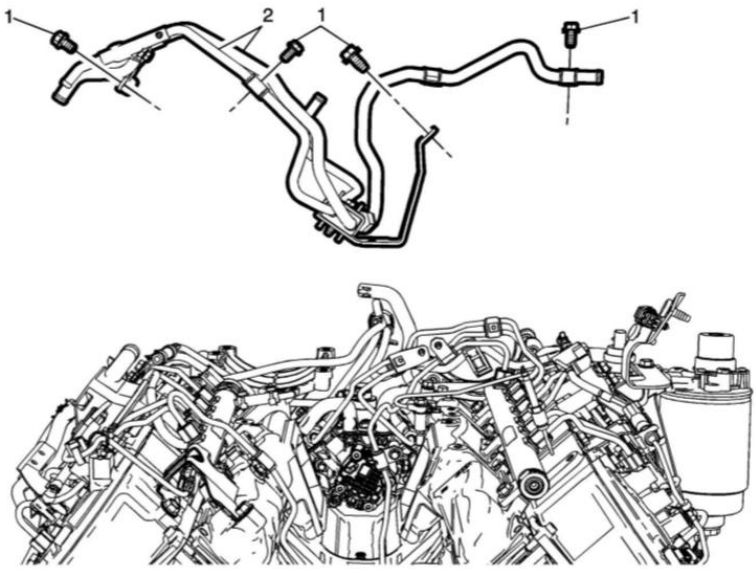


Fig. 38: Fuel feed and return line removal

STEP 19: Remove the fuel injector return system.

a) Remove the fuel return pipe by removing the bolt retaining it to the valve cover. Remove the hose.
b) Remove the engine vacuum switch, bracket bolt, bracket, and fuel pressure regulator vacuum hose.

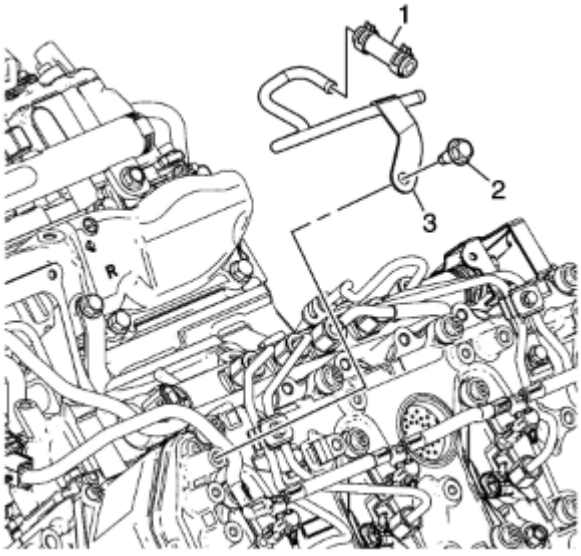


Fig. 39: Fuel return pipe removal

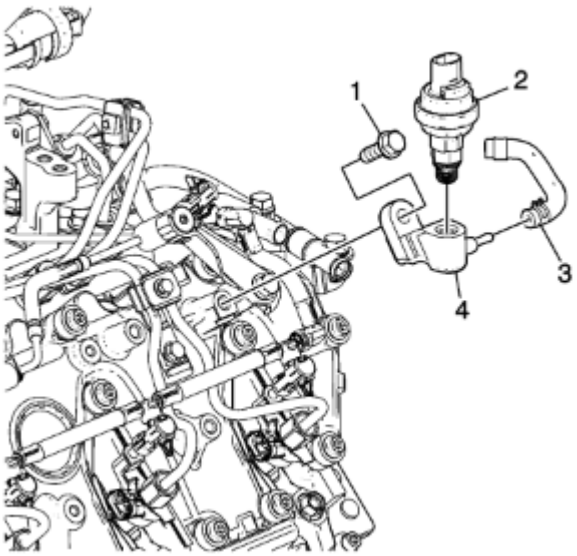


Fig. 40: Vacuum switch and bracket removal

c) Disconnect the fuel return line from the injector by pulling upwards on the locking sleeve. See figure 41.
d) Repeat step 19c for all 8 fuel injectors and remove the fuel injector return assembly.

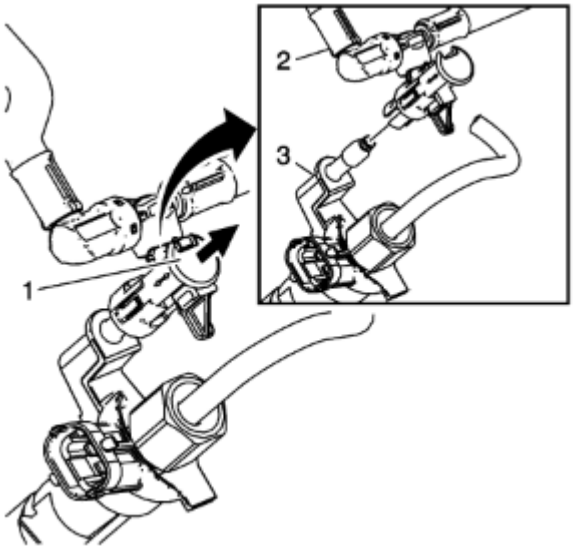


Fig. 41: Disconnecting the injector return line

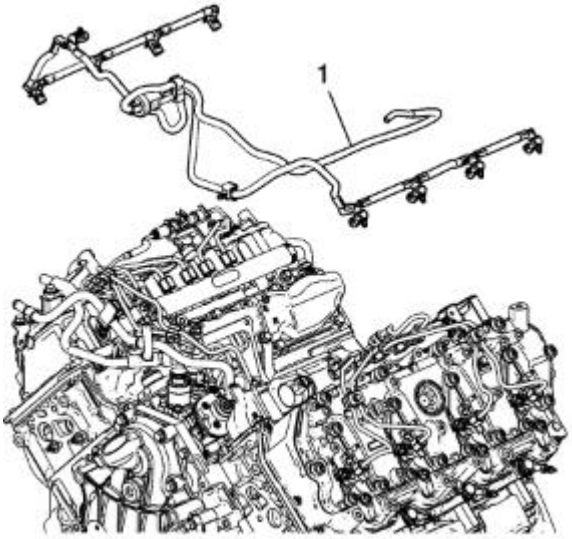


Fig. 42: Injector return assembly removal

STEP 20: Remove the fuel injector feed pipes.

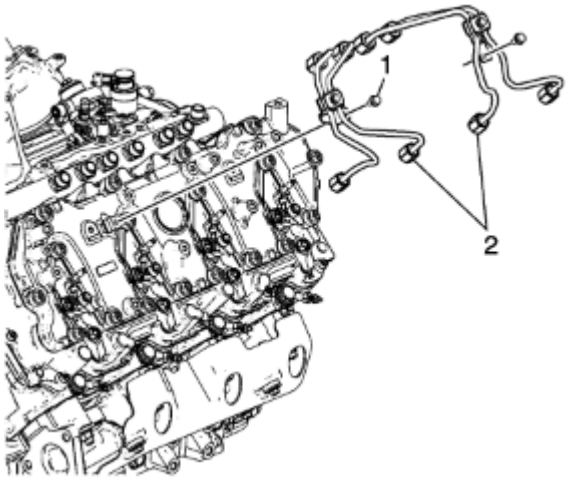


Fig. 43: Passenger side injector feed pipe removal

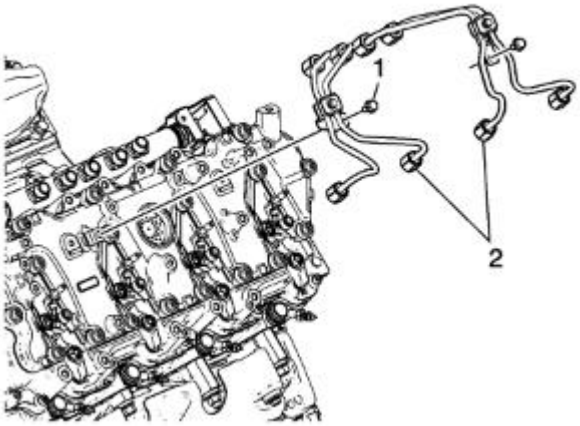


Fig. 44: Driver's side injector feed pipe removal

STEP 21: Remove the bolts retaining the high-pressure fuel rails and remove the fuel rail assemblies.

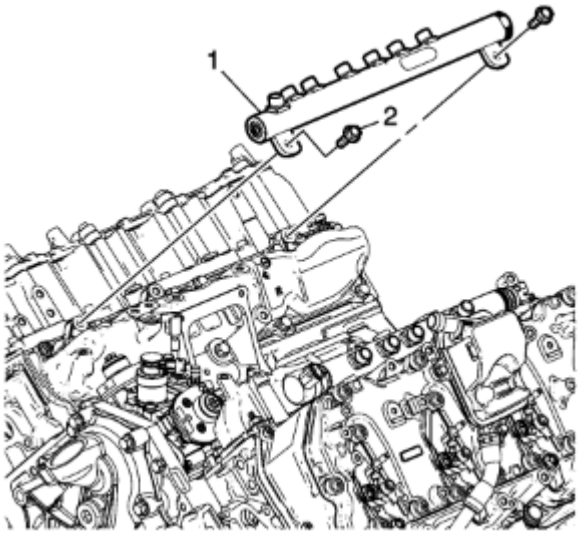


Fig. 45: Passenger side fuel rail removal

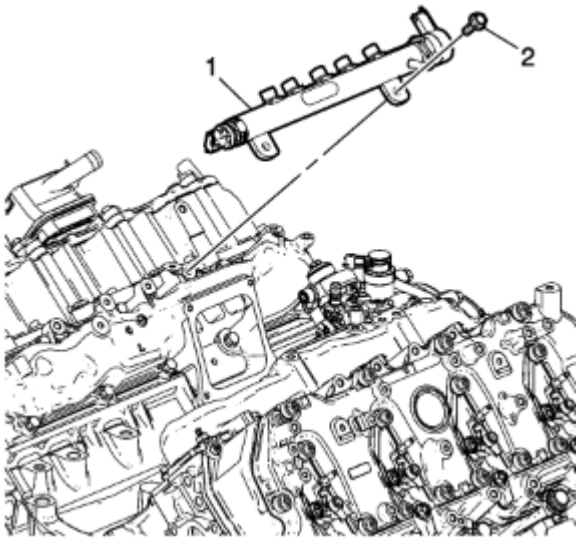


Fig. 46: Driver's side fuel rail removal

STEP 22: Remove the lower intake manifolds.

a) Remove the fuel feed pipe clip bracket bolt, then remove the fuel feed pipe clip bracket.

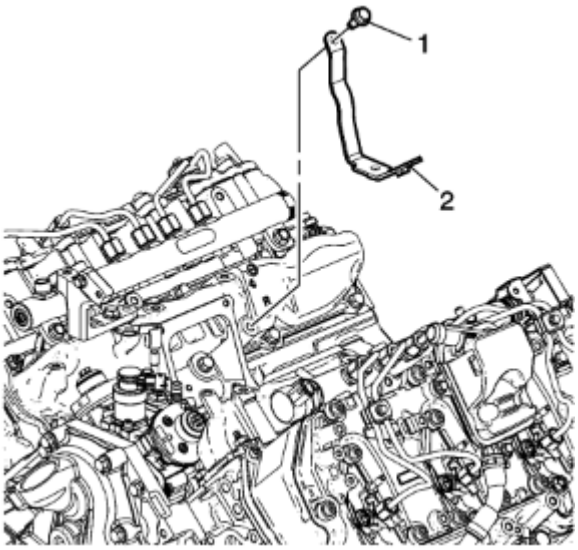


Fig. 47: Fuel feed pipe clip bracket removal

b) Remove the EGR valve bracket bolt and bracket. Remove the fuel feed hose bolt.

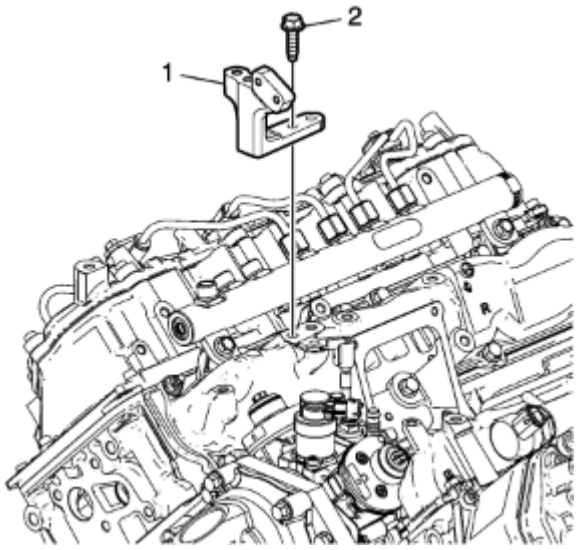


Fig. 48: EGR valve bracket removal

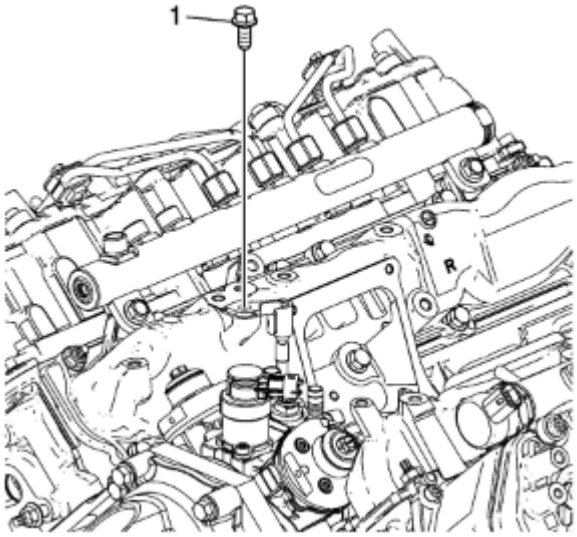


Fig. 49: Fuel feed hose bolt removal

c) Remove the bolts retaining the lower intake manifolds to the cylinder heads. A seal cutter may be required to remove the manifold from the cylinder head. Use a J37228 seal cutter if needed. Remove the lower intake manifolds from the cylinder heads. Clean and remove any sealant residue from the mating surface on the intake manifolds.

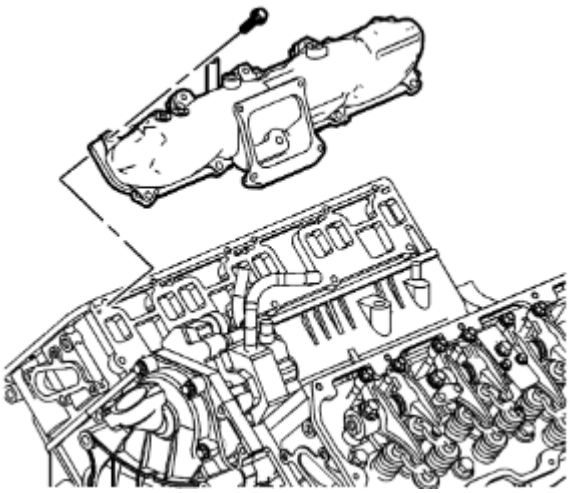


Fig. 50: Passenger side lower intake manifold removal

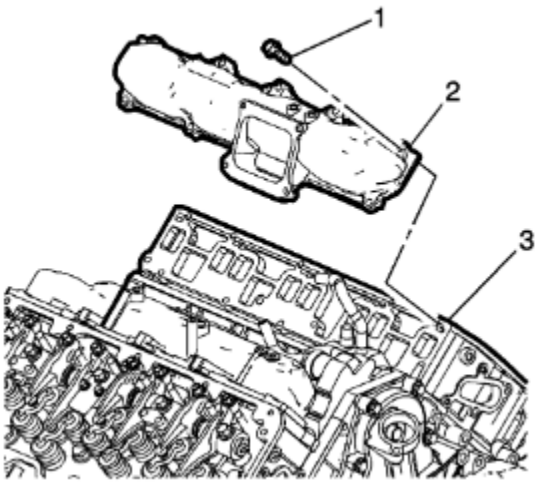


Fig. 51: Driver's side lower intake manifold removal

STEP 23: Remove the fuel injectors. Repeat the following steps for each injector.

a) Remove the fuel injector bracket bolts. Reference item 1 in figure 52.

b) Using a GM EN 49774 injector remover tool, install the tool onto the injector bracket. Pull upwards on the tool until the fuel injector breaks free from the seat, then remove from the engine. Remove the tool from the injector bracket.

NOTE: Mark each fuel injector with the cylinder number from which it was removed. The fuel injectors will need to go back into the same location upon installation. Failure to do so may result in poor performance and/or driveability.

c) Remove the fuel injector bracket pin (item 2 in figure 53). Remove the copper washer from the injector bore and discard. Remove the o-ring seal from the fuel injector (item 3 in figure 53) and discard.

NOTE: New copper washers and o-ring seals will be required for each injector upon installation.

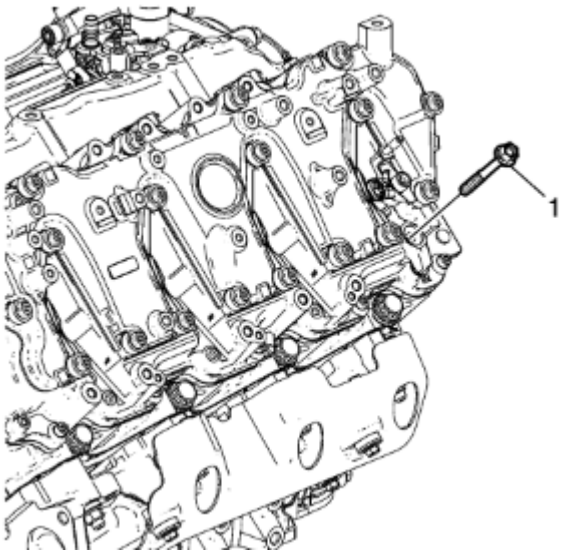


Fig. 52: Fuel injector bolt removal

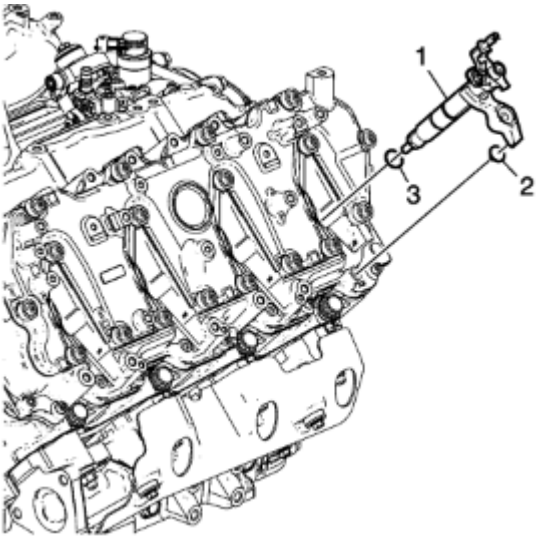


Fig. 53: Fuel injector removal

STEP 24: Remove the upper and lower valve covers.

a) Remove the bolts retaining the upper valve cover. Remove the upper valve cover and discard of the grommets (item 3) and the upper valve cover gasket (item 1).

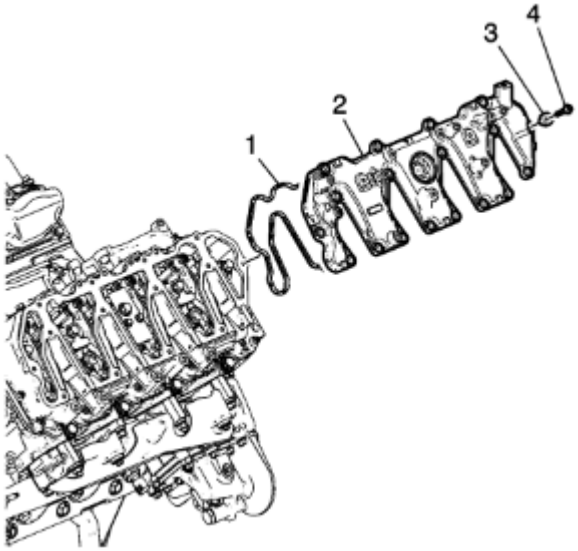


Fig. 54: Driver's side upper valve cover removal

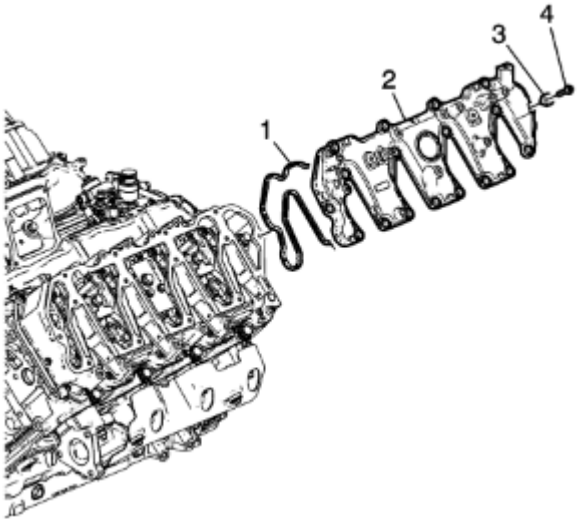


Fig. 55: Passenger side upper valve cover removal

b) Remove the bolts retaining the lower valve cover to the cylinder head. Remove the lower valve cover. The gasket may be reused if it is not torn, cracked, stretched, or swollen.

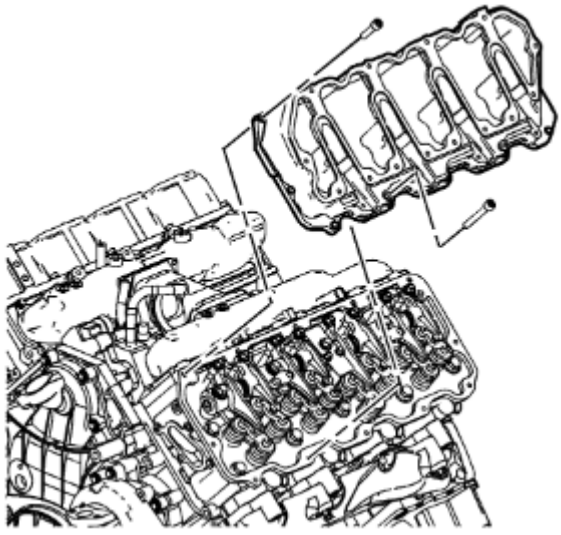


Fig. 56: Driver's side lower valve cover removal

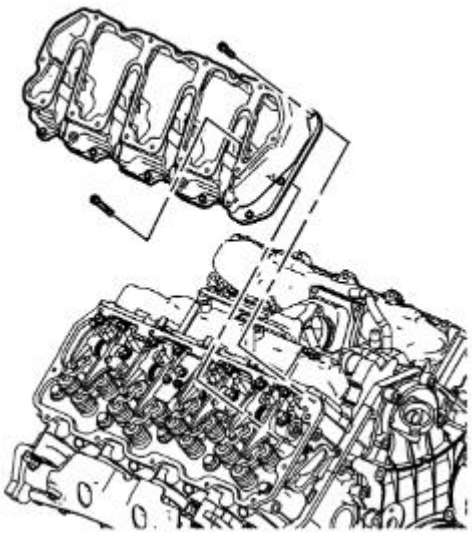


Fig. 57: Passenger side lower valve cover removal

STEP 25: Remove rocker arms and push rods.

NOTE: The below steps apply to both the passenger and driver's-side cylinder heads

a) Remove the rocker arm shaft oil deflector bolts, then remove the oil deflector.
b) Loosen the valve clearance lock nuts on each rocker arm, then loosen the adjusting screws.

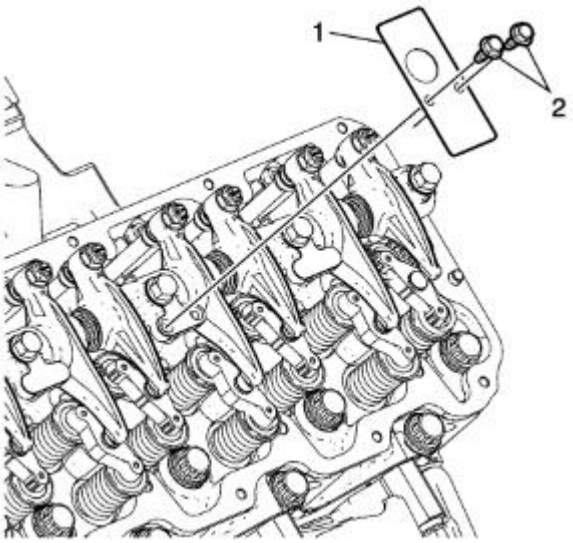


Fig. 58: Oil deflector removal

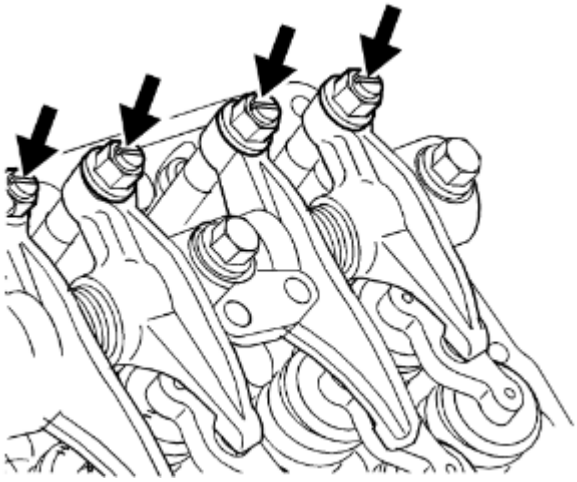


Fig. 59: Loosening of lock nuts and adjusting screws

c) Remove the rocker arm shaft bolts in the sequence shown in figure 60. Remove the rocker arm shaft assembly.
d) Remove the valve bridge pins, valve bridges, and pushrods.

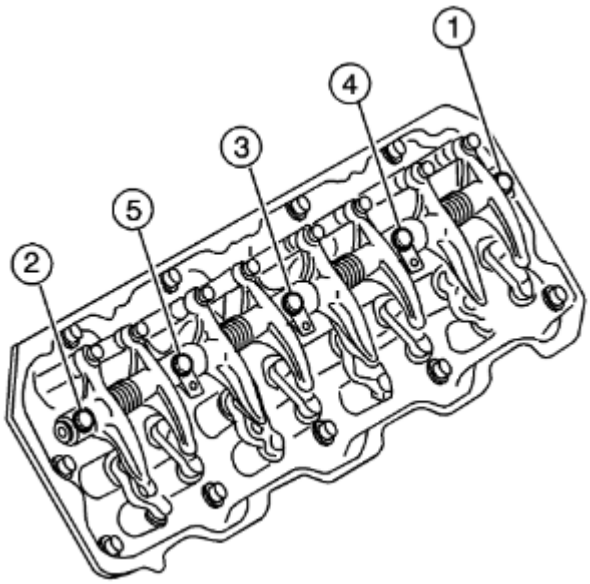


Fig. 60: Rocker shaft bolt removal sequence

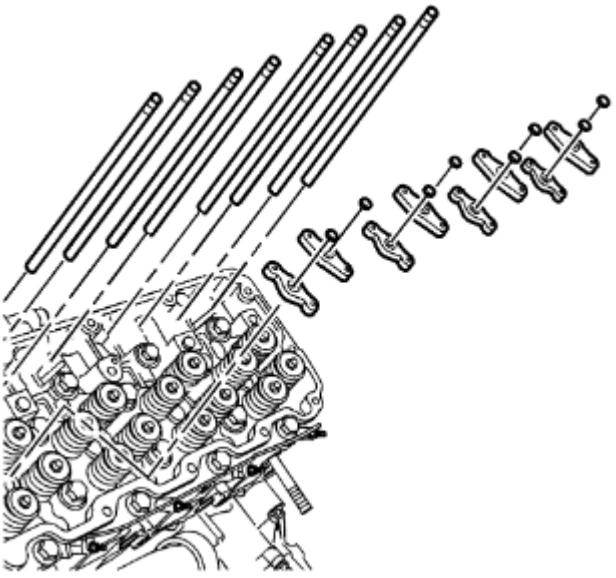


Fig. 61: Pushrod and valve component removal

STEP 26: Remove the cylinder heads.

a) Remove the cylinder head bolts in the sequence shown below. Bolts 1-4 (size M8) can be retained and bolts 5-22 (size M12) should be discarded once removed.

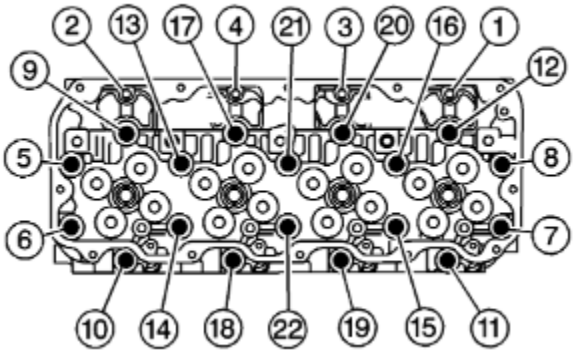


Fig. 62: Driver and passenger side cylinder head bolt removal sequence

b) Remove the cylinder head assembly and gasket from the engine block. Discard of the cylinder head gasket. Remove and discard of the four OE cylinder head dowels (two per side). The dowel locations are called out using arrows in figures 63 and 64.

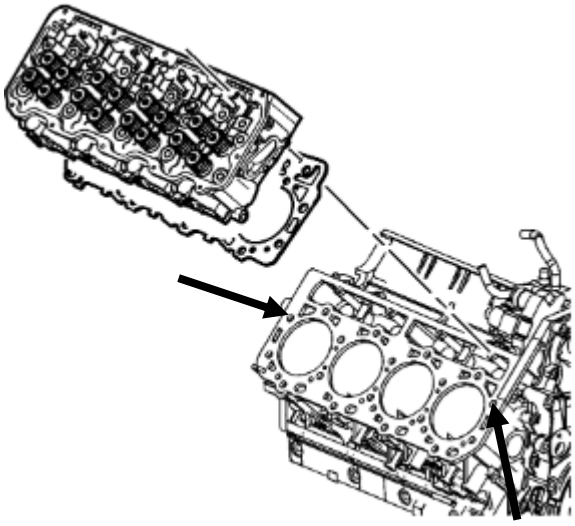


Fig. 63: Passenger side cylinder head removal

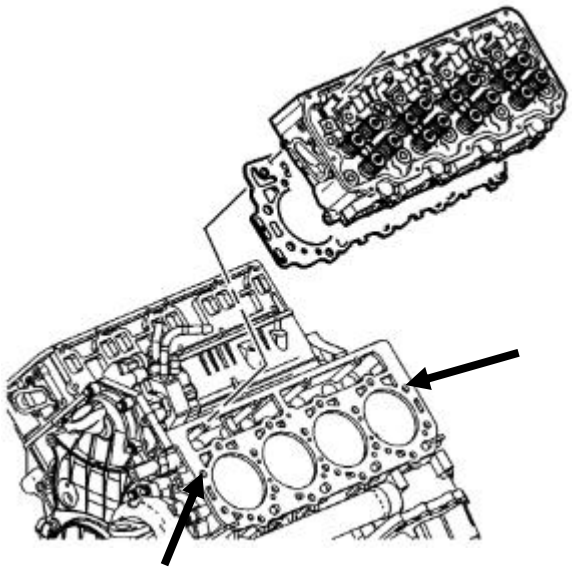


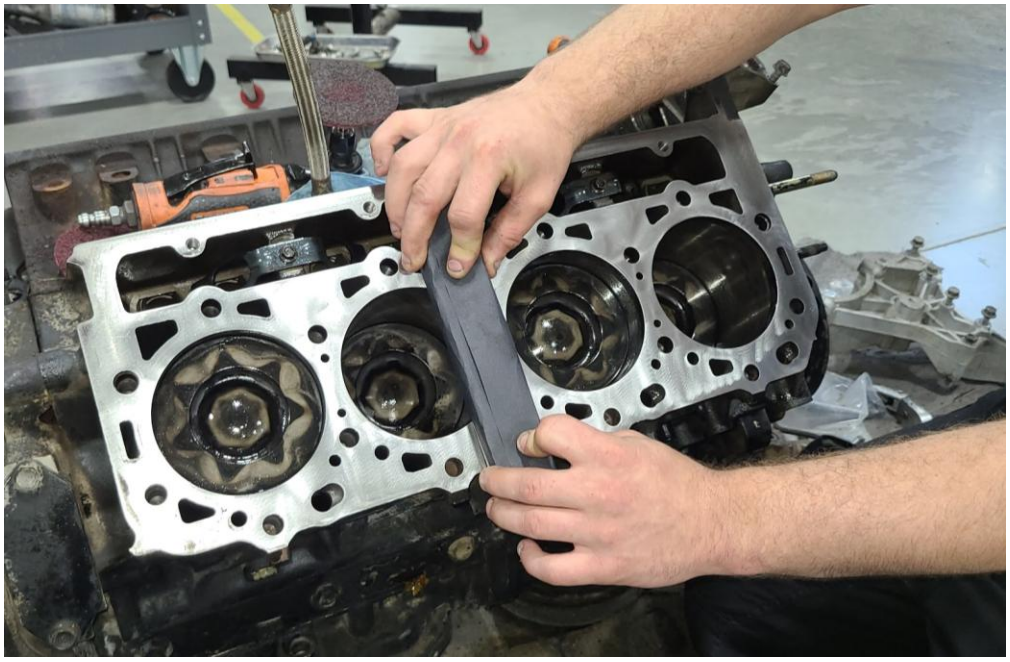
Fig. 64: Driver's side cylinder head removal

INSTALLATION AND REASSEMBLY

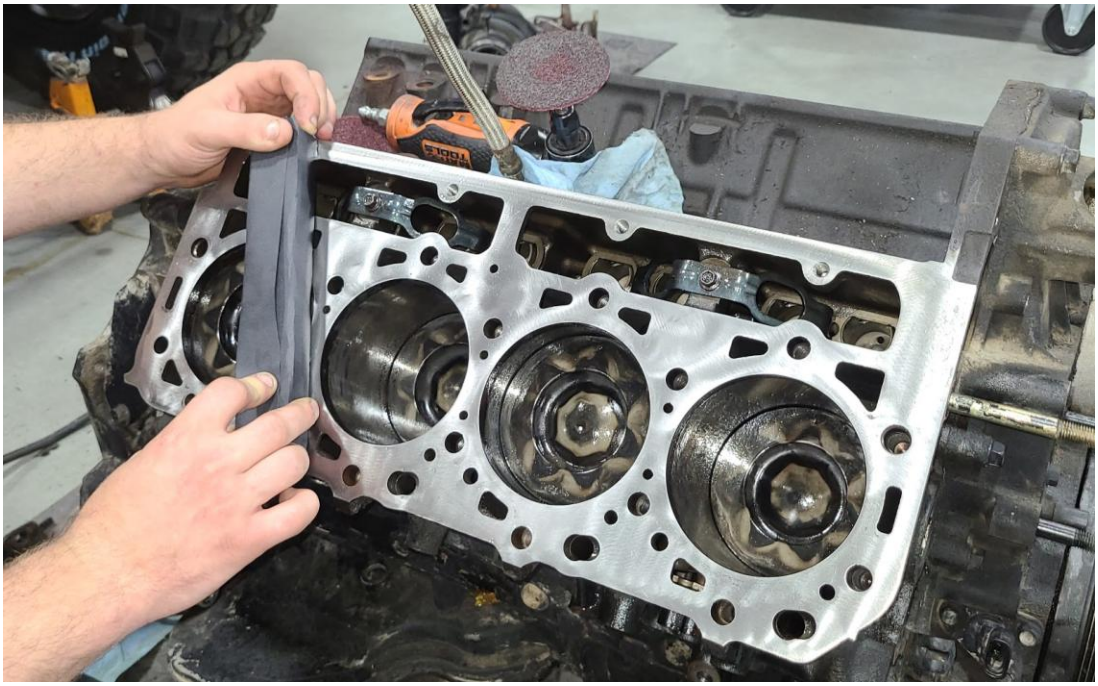
NOTE: Always reference the appropriate factory manual for your specific engine and vehicle. Variances exist among different models of engine configurations. The instructions below should only be considered as guidelines for the installation.

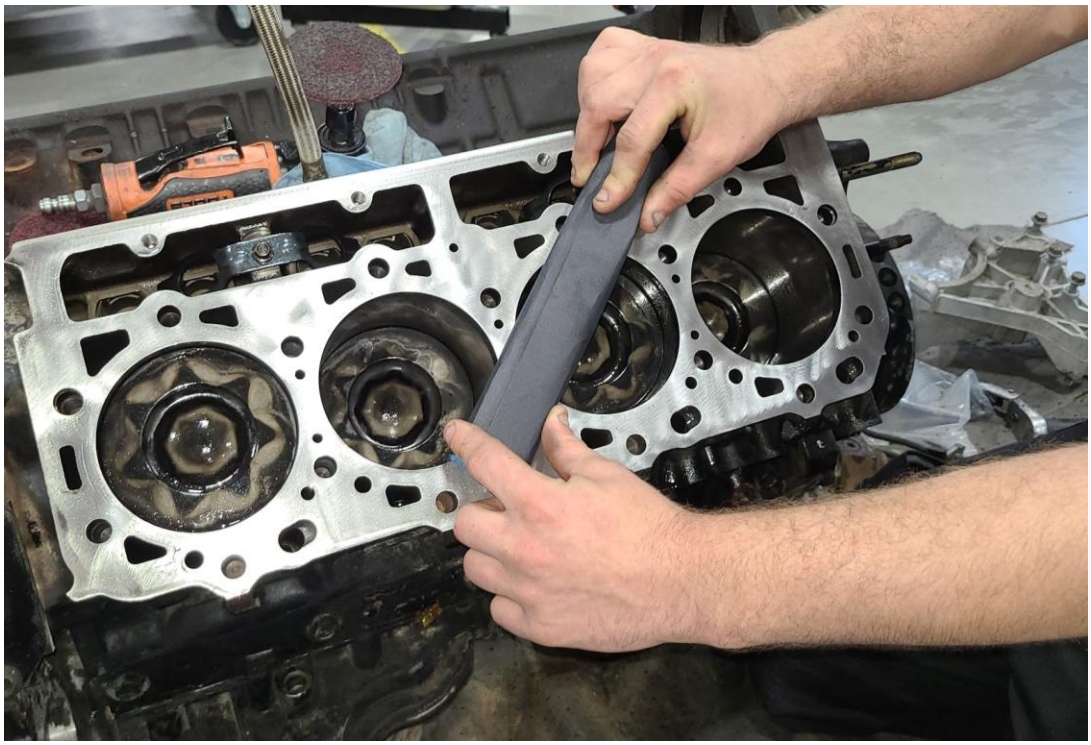
STEP 1: Clean the cylinder head gasket sealing surface and inspect for flatness.

a) Using a flat steel bar with 400 or 600 grit sandpaper; and a spray lubricant (WD-40) work front to back keeping the bar flat with even pressure.

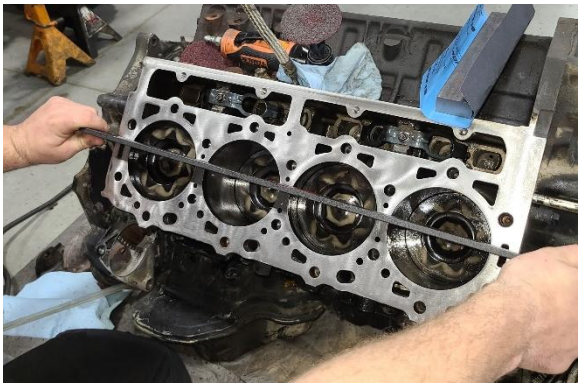


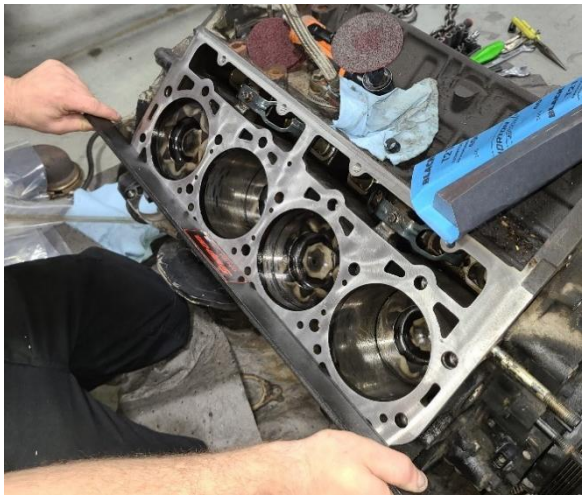
b) Then work at a diagonal to the left and then to the right corners.





c) Using a precision ground straight edge such as Snap-On GA438A or Matco SE6431A (a ruler or metal bar IS NOT a precision ground straight edge) Check the deck of the block for flatness using a 0.006" (0.15mm) feeler, ensure that the gauge will not slide under the tool with the tool in 5 positions; straight across the center of the block, corner to corner of the block in both directions, across the top of the block, and across the bottom of the block. After verifying the deck is within flatness specifications, clean the deck, head bolt holes, and cylinders out with brake wash and compressed air.





STEP 2: Install new block-to-cylinder head dowel pins into the decks at the locations noted by the arrows in figures 63 and 64 on page 25.

STEP 3: Install the new head gaskets onto the cylinder decks. The head gaskets are specific to one side of the engine. Reference the stamped letters on the gaskets (R for passenger and L for driver). Improper placement of the gaskets will block oil and coolant passages and will cause severe engine damage. Fleece Performance recommends using head gasket GM part number 12637788 (grade c passenger) and 12637785 (grade c driver).

STEP 4: Install the new cylinder heads.

a. Place the new cylinder head on top of the cylinder head gasket and ensure that the dowel pins are aligned before fully seating the head.

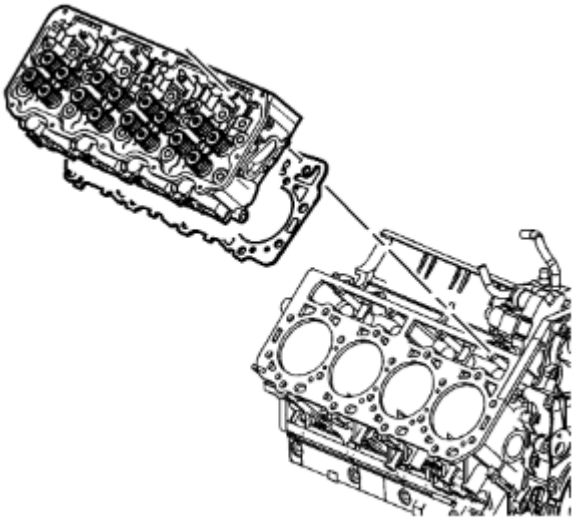


Fig. 65: Passenger side cylinder head installation

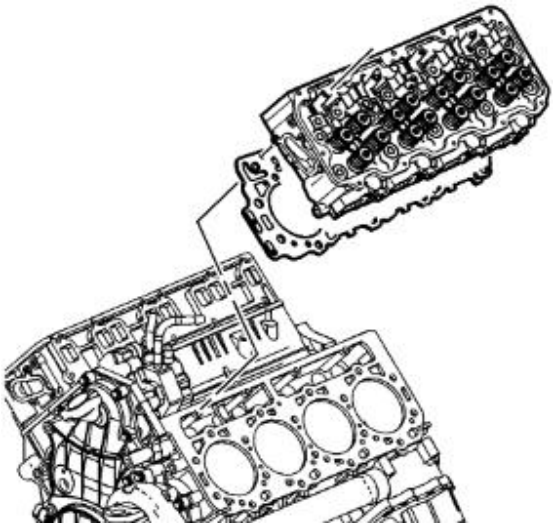


Fig. 66: Driver's side cylinder head installation

b. Install new M12 cylinder head bolts (fasteners 1-18 in figure 68) and torque them in sequence in the four following stages.

1. 37 ft-lb
2. 59 ft-lb
3. Tighten 60 degrees
4. Tighten 60 degrees

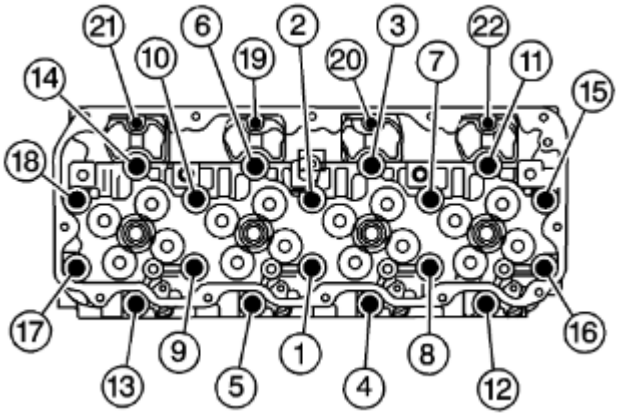


Fig. 67: Cylinder head torque sequence

c. Install the four M8 bolts retained in step 27 of disassembly and removal into locations 19-22 in figure 67 onto both cylinder heads. Torque the bolts in ascending order to 18 ft-lb.

STEP 5: Install pushrods and rocker arms. Installation is the same for both driver and passenger side cylinder heads.

a. Install the valve bridges, valve bridge pins, and pushrods. Reference figure 69 for the orientation of the valve bridges.

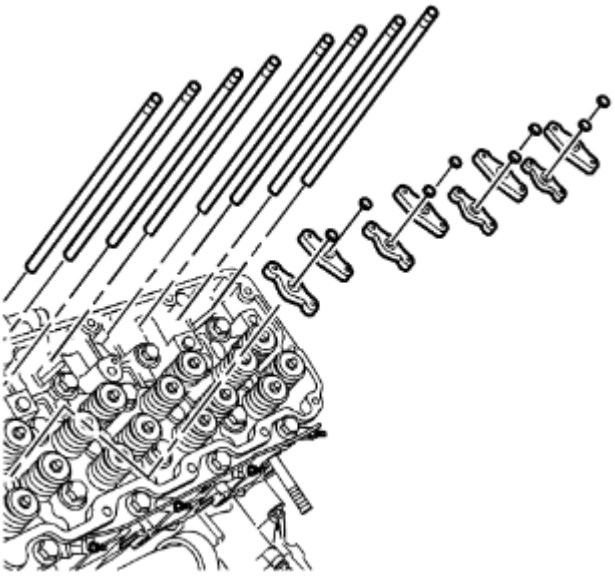


Fig. 68: Installation of valve bridges, pins, and pushrods

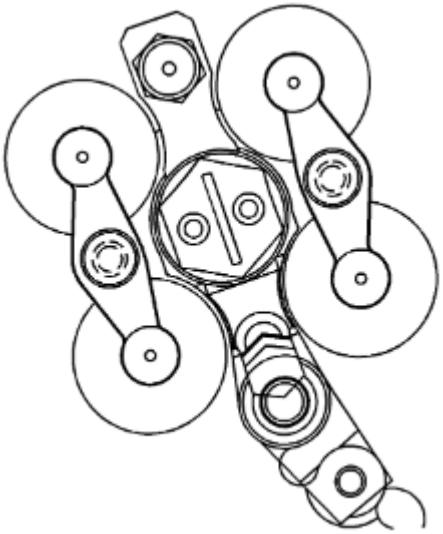


Fig. 69: Valve bridge orientation

b. Install the rocker arm shaft assembly. Before torquing the bolts, ensure that all pushrods are correctly seated into the valve lifters and rocker arms. Torque the rocker arm assembly bolts to 30 ft-lb in the order shown in figure 71.

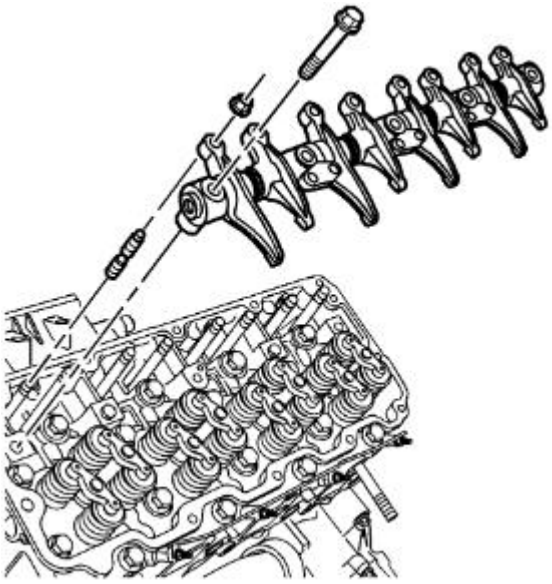


Fig. 70: Rocker arm shaft installation

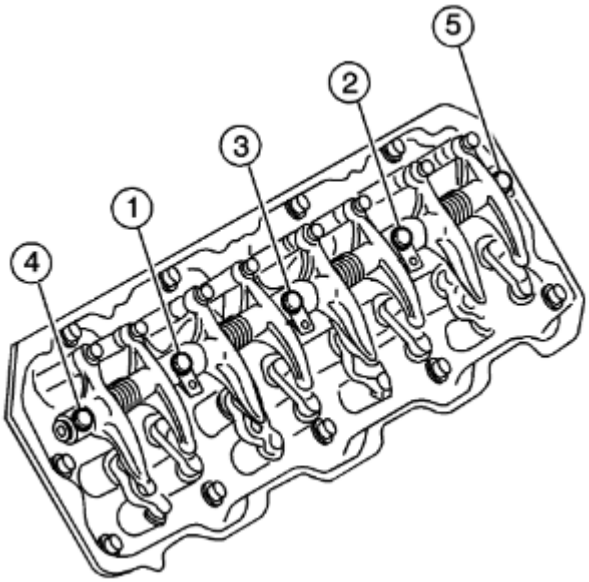


Fig. 71: Rocker shaft torque sequence

c. Install the rocker arm shaft oil deflector and torque the bolts to 89 in-lb.

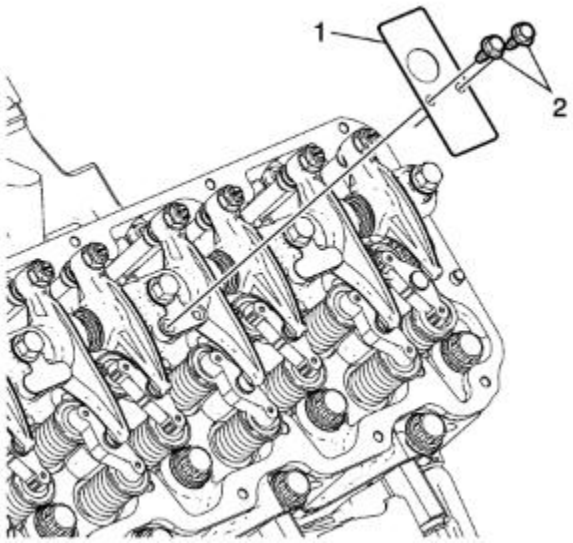


Fig. 72: Rocker arm shaft oil deflector installation

STEP 6: Check and set the valve lash.

a. Rotate the crankshaft to bring the number 1 cylinder (front cylinder on passenger side bank) to top dead center of the compression stroke.
b. Insert a feeler gauge between the tip of the rocker arm and the valve bridge as shown in figure 73. The gap should be 0.012 in (0.3mm). If the gap is not to spec, loosen the valve lash lock nut and adjust the valve adjusting screws. Once within spec, tighten the valve lash lock nut to 16 ft-lb.

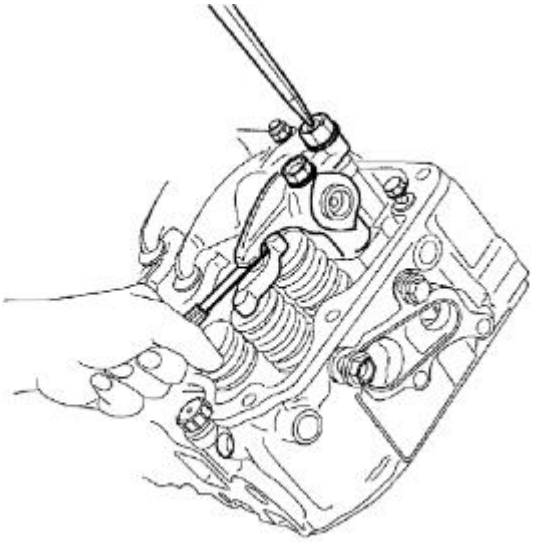


Fig. 73: Valve lash check and adjustment

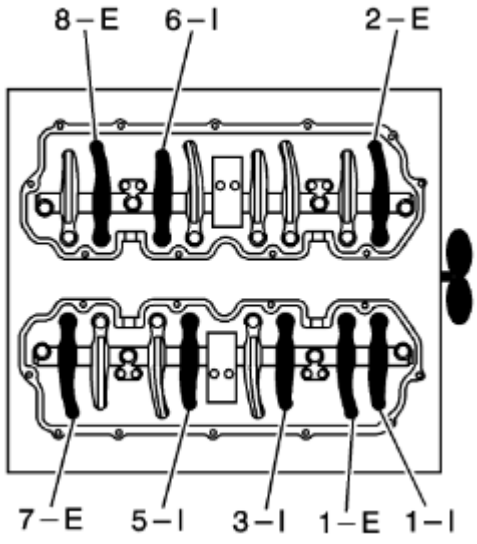


Fig. 74: Valves adjusted with cylinder one at compression stroke TDC

c. Rotate the crankshaft to bring cylinder 1 to top dead center on its exhaust stroke. Repeat step 6b on the valves shown in figure 75.

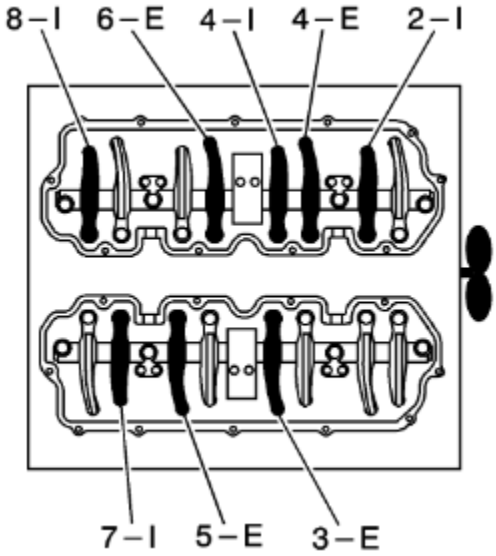


Fig. 75: Valves adjusted with cylinder one at exhaust stroke TDC

STEP 7: Install the lower and upper valve covers.

a. Install new rocker arm cover grommets and rocker arm cover bolts if they are serviced with the grommet. Inspect the sealing gasket on the lower valve cover for damage such as tears, cracks, stretching or swelling. If damaged, discard of the gasket and replace it with a new one.
b. Install the lower valve cover onto the driver's side cylinder head. Torque the bolts to 89 in-lb in the sequence shown in figure 77. Once all bolts have been torqued, re-tighten them to 89 in-lb in the same sequence.

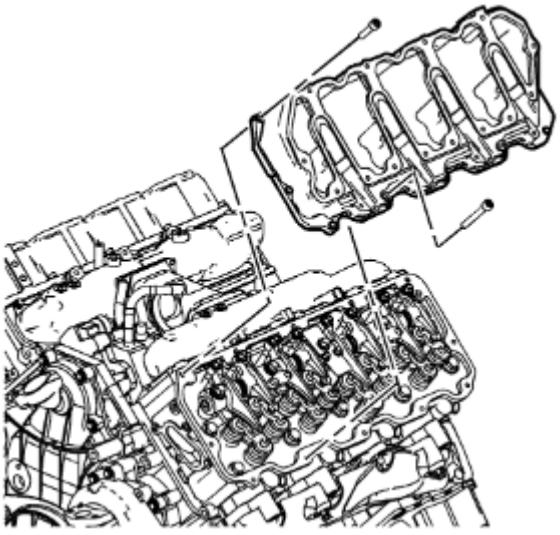


Fig. 76: Lower valve cover installation (driver's side)

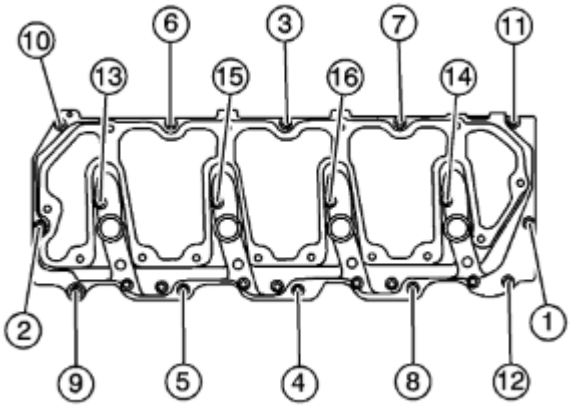


Fig. 77: Lower valve cover tightening sequence (both sides)

c. Repeat steps 7a and 7b for the passenger side lower valve cover. Reference figure 77 for the tightening sequence.

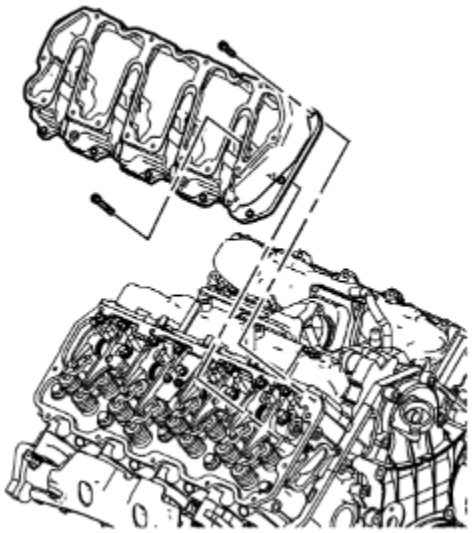


Fig. 78: Lower valve cover installation (passenger side)

d. Install the new upper valve cover gasket (item 1) onto the driver's side upper valve cover. Install the new upper valve cover grommets (item 3) and bolts (item 4). Install the upper valve cover (item 2) onto the lower valve cover and torque the bolts to 89 in-lb in the sequence shown in figure 80.

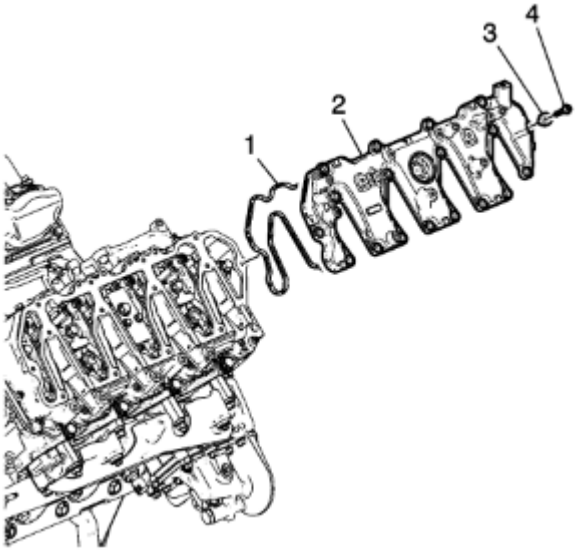


Fig. 79: Upper valve cover installation (driver's side)

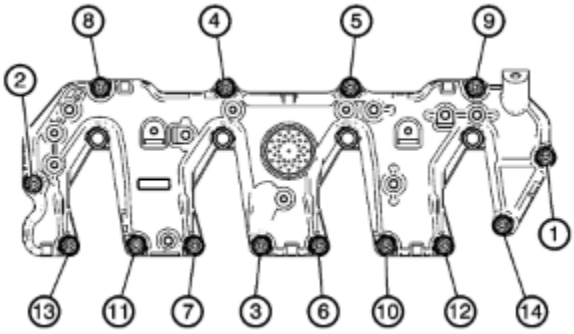


Fig. 80: Upper valve cover tightening sequence (both sides)

e. Repeat step 7d for the passenger side upper valve cover. Reference the tightening sequence shown in figure 80.

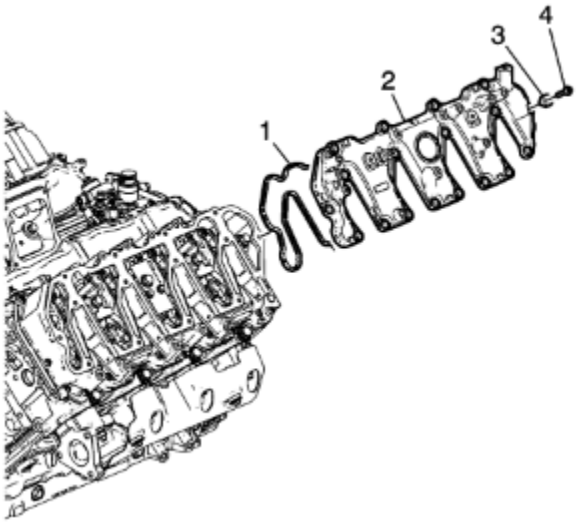


Fig. 81: Upper valve cover installation (passenger side)

STEP 8: Install the fuel injectors.

a. Install new o-ring seals (item 3) onto the fuel injectors and lubricate them with engine oil. Install new copper washers onto the fuel injectors. Install the fuel injector bracket pins.
b. Install the fuel injectors into the same cylinder locations that they were removed from. Install the fuel injector bracket bolts and torque them to 22 ft-lb.

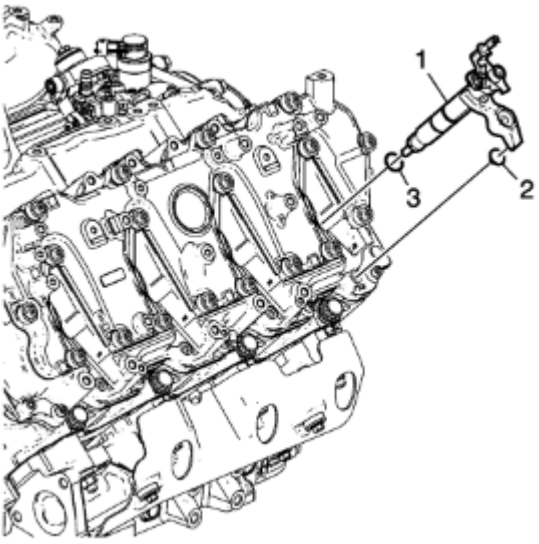


Fig. 82: Fuel injector reassembly and installation

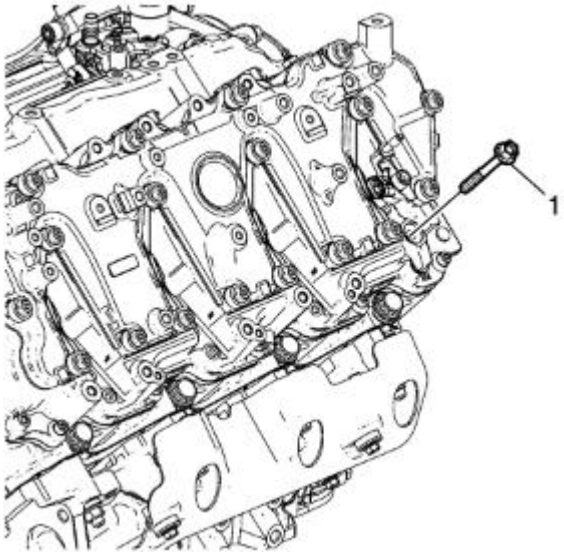


Fig. 83: Fuel injector bracket bolt installation

STEP 9: Install the intake manifolds.

a. Ensure that the mating surfaces on the intake manifolds are clean and free of old sealant.
b. Place a 1/8 in wide by 1/16 in tall bead of sealant on the intake manifold mating surface.
c. Install the intake manifolds onto the cylinder heads and torque the bolts to 18 ft-lb in the sequences shown in figure 86 (driver's side) and figure 87 (passenger side).

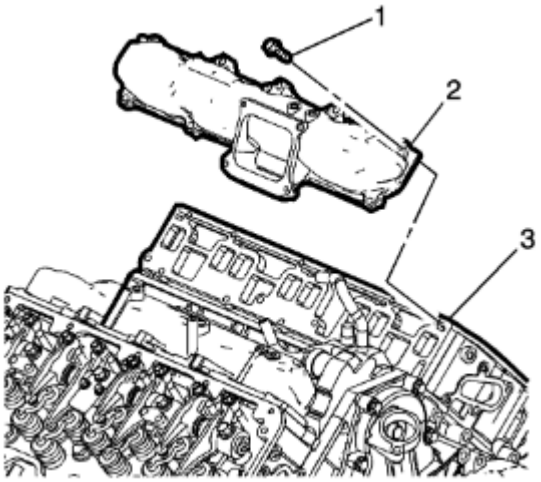


Fig. 84: Driver's side intake manifold installation

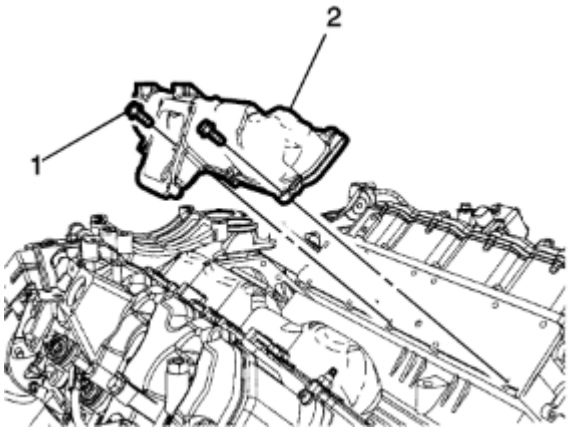


Fig. 85: Passenger side intake manifold installation

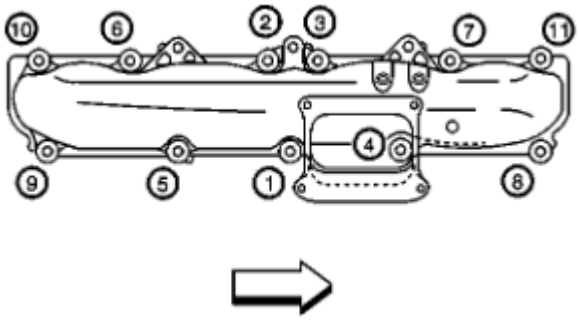


Fig. 86: Driver's side intake manifold tightening sequence

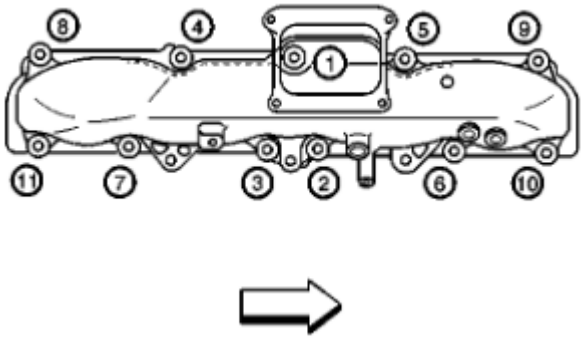


Fig. 87: Passenger side intake manifold tightening sequence

STEP 10: Install the high-pressure fuel rails.

a. Install the driver and passenger side high-pressure fuel rails. Torque the mounting bolts to 18 ft-lb.

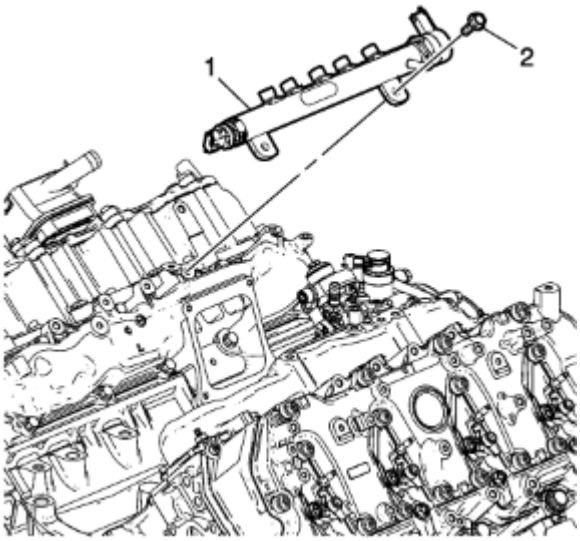


Fig. 88: Driver's side high-pressure fuel rail installation

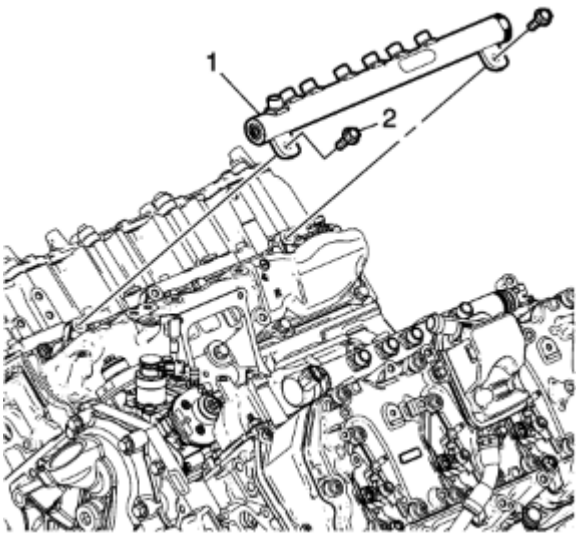


Fig. 89: Passenger side high-pressure fuel rail installation

b. Install the intake manifold heat shield onto the rear of the driver's side intake manifold. Torque the bolts to 18 ft-lb.
c. Install the fuel feed pipe clip bracket. Torque the bolt to 18 ft-lb.

Fig. 90: Intake manifold heat shield installation

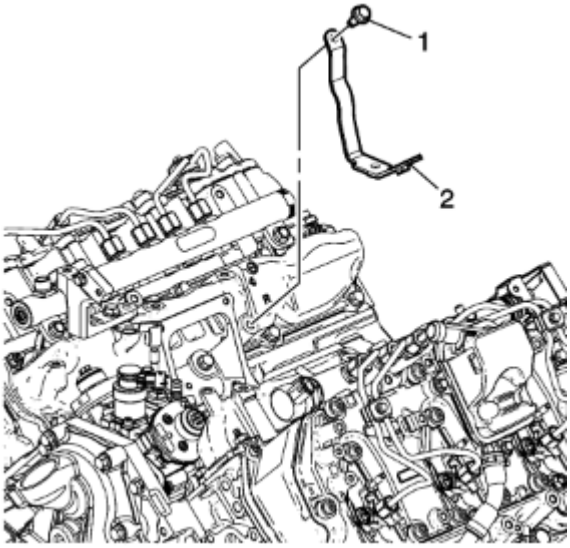


Fig. 91: Fuel feed pipe clip bracket installation

d. Install the exhaust gas recirculation (EGR) bracket and torque the bolt to 18 ft-lb.
e. Install the fuel feed hose bolt and torque the bolt to 18 ft-lb.

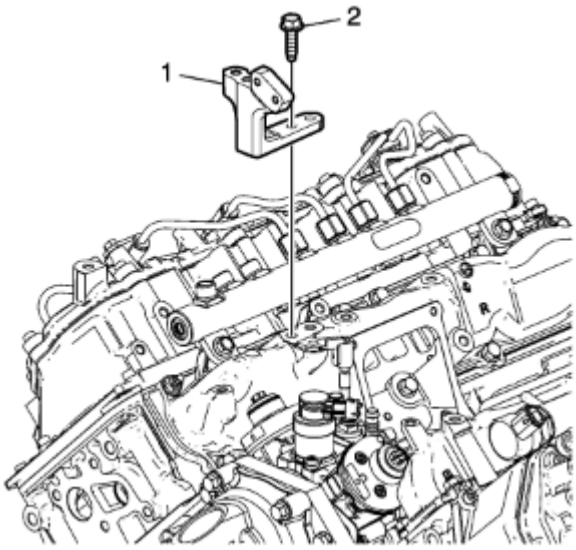


Fig. 92: EGR bracket installation

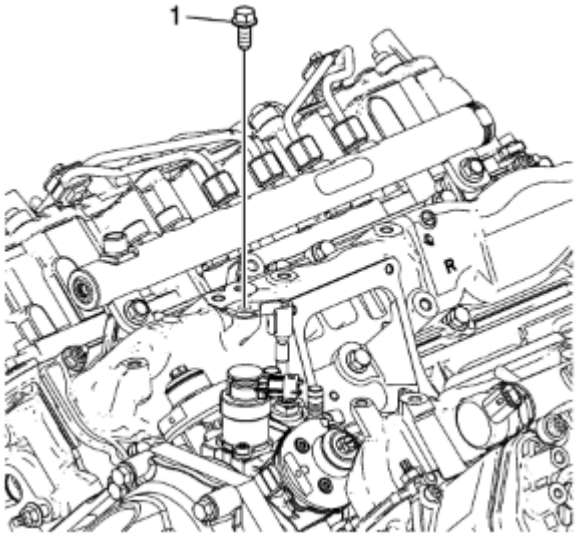


Fig. 93: Fuel feed hose bolt installation

STEP 11: Install the fuel injector feed pipes as shown in figures 94 and 95. Install the nuts onto the high-pressure fuel rail ports and the injectors and torque the nuts (item 2) to 22 ft-lb. Install the mounting bolts (item 1) and torque the bolts to 89 in-lb.

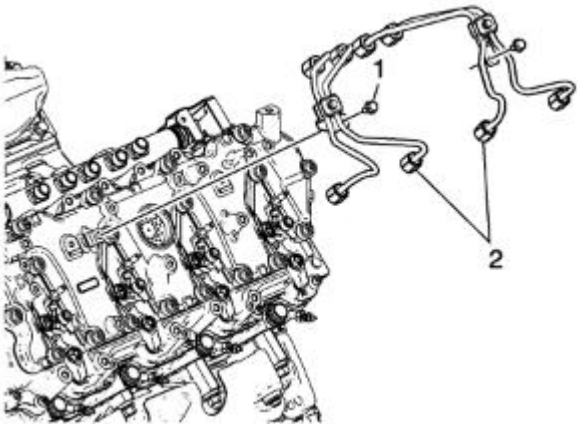


Fig. 94: Fuel injector feed pipe installation (driver's side)

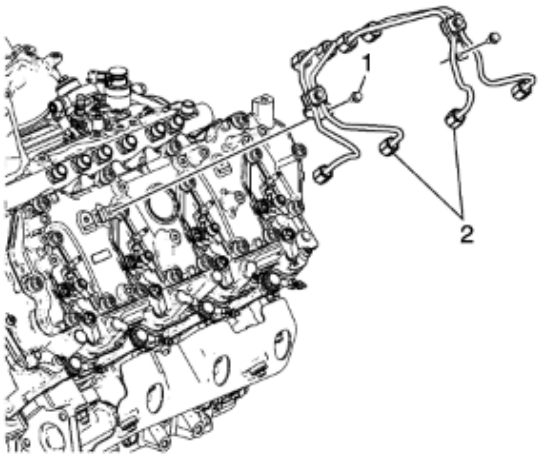


Fig. 95: Fuel injector feed pipe installation (passenger side)

STEP 12: Install the high and low-pressure fuel lines and the injector return system.

a. Install the fuel feed hose (item 3) and fuel feed pipe (item 2). Install the fuel feed pipe bolts and torque the bolts to 18 ft-lb. Reference figure 96 for this step.
b. Install the fuel return pipe. Torque the mounting bolt to 18 ft-lb. Reference figure 97 for this step.

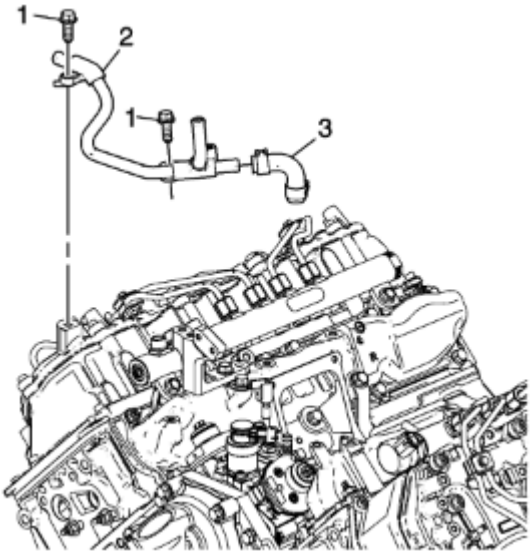


Fig. 96: Fuel feed hose and pipe installation

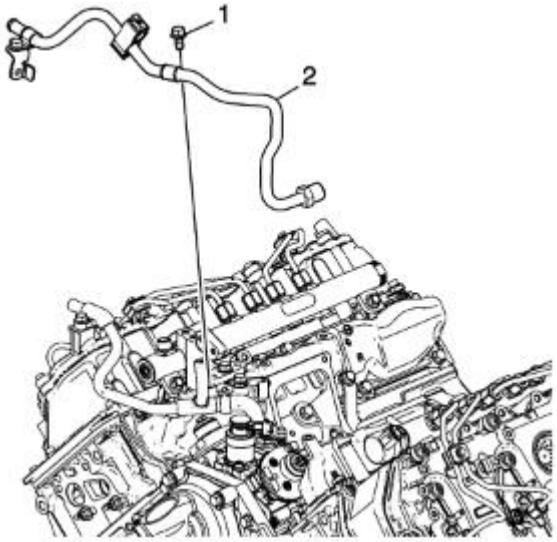


Fig. 97: Fuel return pipe installation

c. Install the high-pressure fuel rail crossover pipe (item 4) and tighten the nuts on both ends to 22 ft-lb. Install the mounting bolts (items 1 and 3) and torque the bolts to 89 in-lb. Install the isolator bracket mounting bolt (item 2) and torque the bolt to 18 ft-lb.

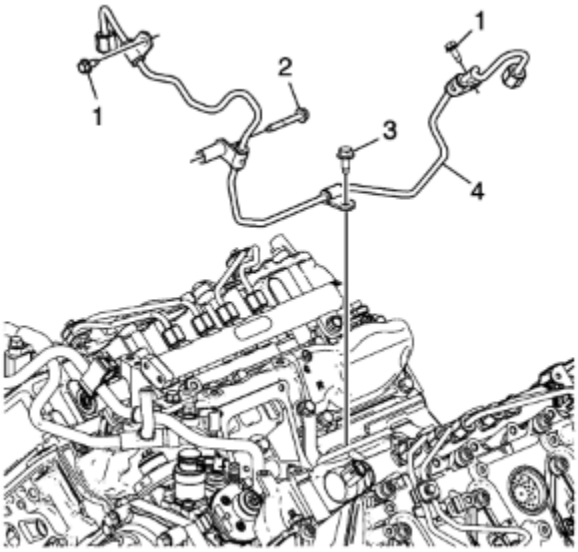


Fig. 98: High-pressure fuel rail crossover pipe installation

d. Install the high-pressure fuel rail feed pipe. Torque the fittings connecting to the fuel rail to 22 ft-lb. Torque the fittings connecting to the injection pump to 28 ft-lb. Install the mounting bolt and torque the bolt to 89 in-lb.

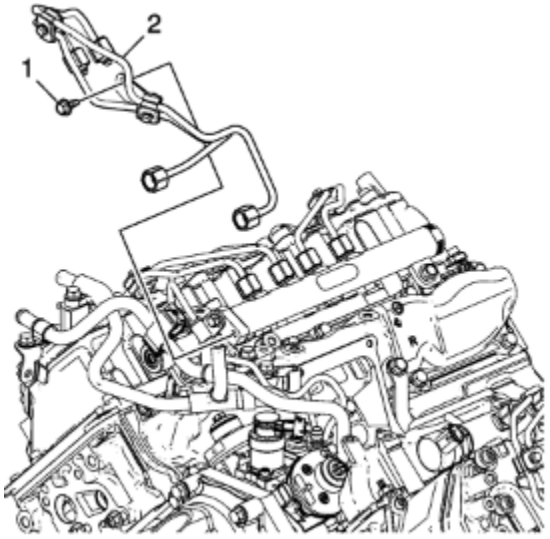


Fig. 99: High-pressure fuel rail feed pipe installation

e. Install the indirect injector assembly (item 5) and dosing injector feed pipe assembly (item 2). Torque the indirect injector feed pipe bracket bolts (item 3) to 18 ft-lb. Torque the indirect injector feed pipe clip bolts (item 4) to 89 in-lb. Install the fuel pipe bracket bolt (item 1) and torque it to 18 ft-lb. Install the indirect injector feed pipe banjo bolt (item 6) and washers (item 7) and torque the bolt to 89 in-lb.

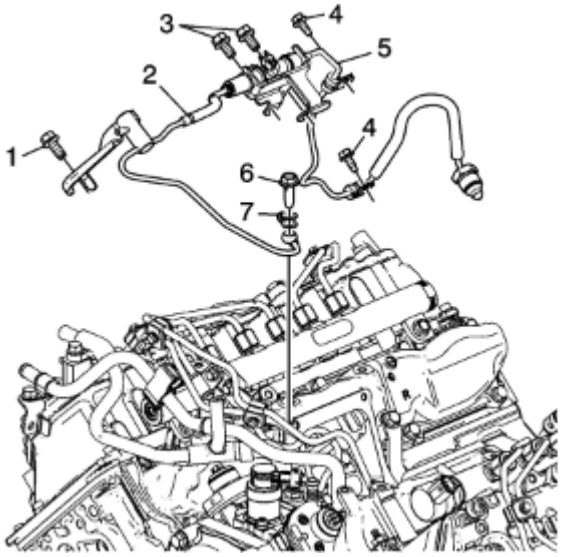


Fig. 100: Indirect injector installation

f. Inspect the o-rings (item 1 in figure 102) on the injector return ports for damage and replace if necessary. If the locking tabs (item 2 in figure 102) are damaged, replace the fuel injector return assembly.

g. To install the return line assembly, ensure that the cylindrical locking sleeve (item 3 in figure 102) is in the upward position, then push the fitting onto the injector return port on the injector assembly. Press down on the locking sleeve until it locks in place. Repeat for all eight injectors.

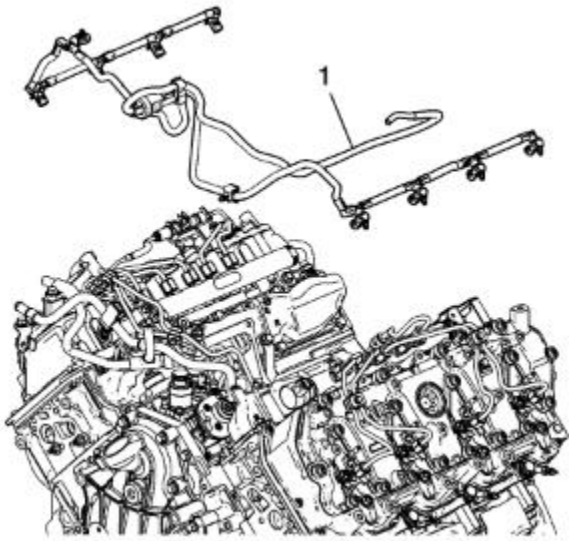


Fig. 101: Fuel injector return assembly

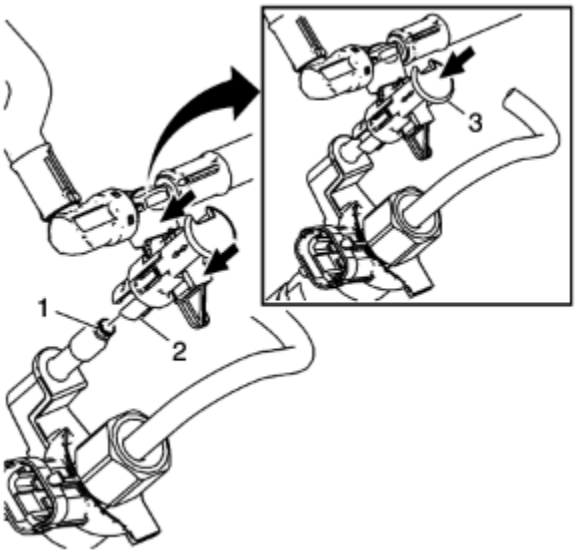


Fig. 102: Injector return fitting installation

h. Install the engine fuel vacuum switch bracket (item 4) and torque the vacuum switch bracket bolt (item 1) to 18 ft-lb. Install the engine fuel vacuum switch (item 2) onto the bracket and torque it to 18 ft-lb. Connect the fuel pressure regulator vacuum hose (item 3).

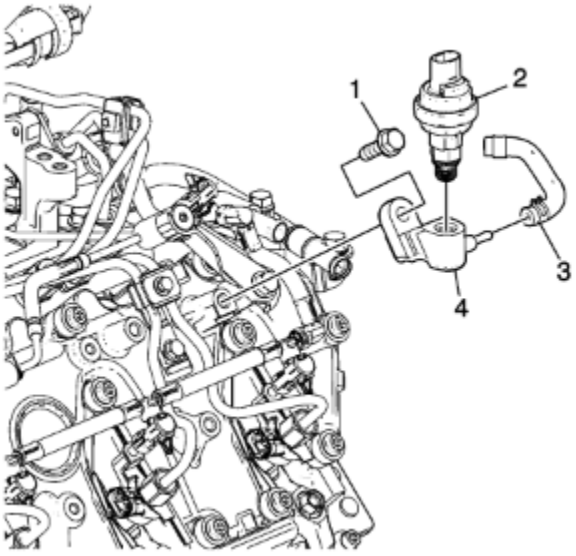


Fig. 103: Engine fuel vacuum switch installation

i. Install the fuel return hose (item 1 in figure 104) and the fuel return pipe (item 3 in figure 104). Install the mounting bolt and torque the bolt to 18 ft-lb.

j. Install the fuel return hose (item 2 in figure 105) and the fuel filter return pipe (item 3 in figure 105). Tighten the fuel filter return pipe fitting (item 1 in figure 105) onto the fuel return pipe installed in step 12b and shown in figure 96 and torque the fitting to 18 ft-lb. Install the mounting bolt (item 4 in figure 105) and torque the bolt to 89 in-lb.

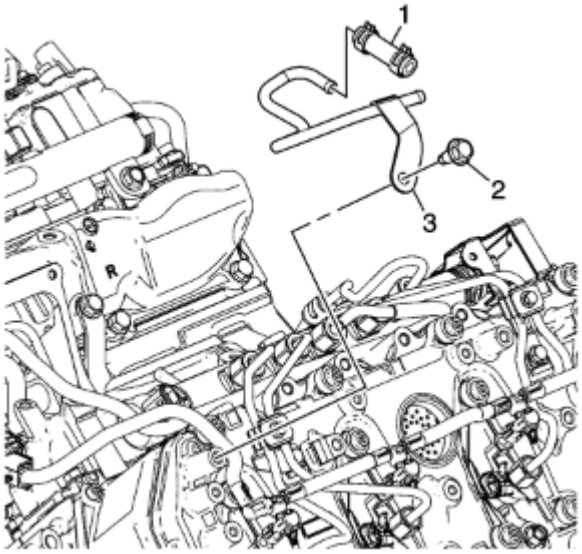


Fig. 104: Fuel return pipe installation

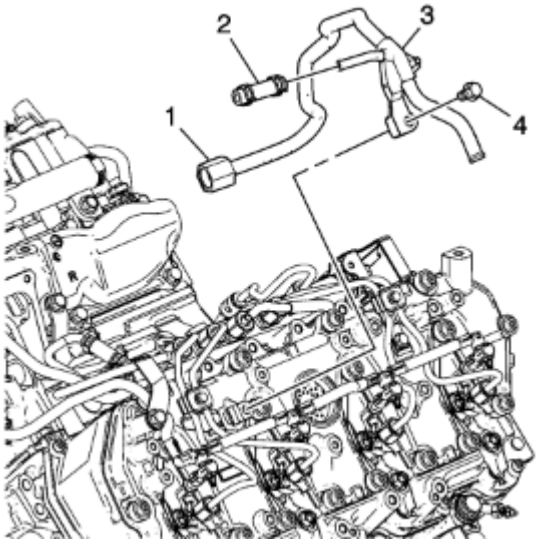


Fig. 105: Fuel filter return pipe installation

k. Install the fuel feed hose (item 1) and the fuel feed pipe (item 5). Install the upper fuel pipe bracket clip (item 3) and the upper fuel pipe bracket clip bolt (item 2). Torque the bolt to 18 ft-lb. Install the fuel feed pipe bolt (item 4) and torque the bolt to 89 in-lb. Install the fuel temperature sensor (item 6) and torque it to 16 ft-lb.

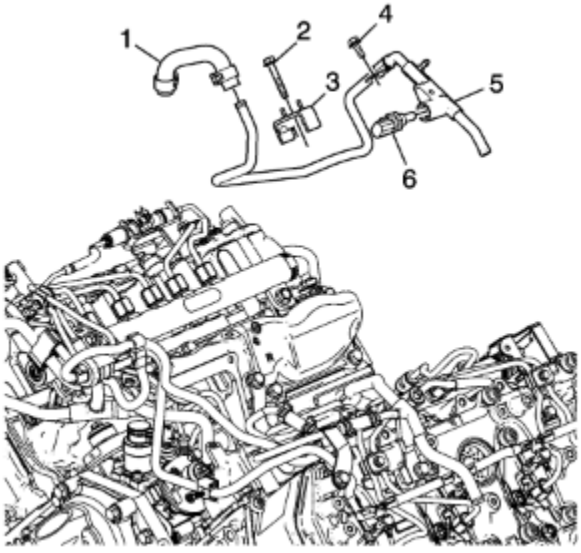


Fig. 106: Fuel feed hose and pipe installation

STEP 13: Install the exhaust manifolds.

a. Install new exhaust manifold gaskets onto the heads, then install the manifolds. Torque the bolts in the sequences shown in figures 108 and 110. Torque all bolts to 42 ft-lb. Once all bolts are torqued in sequence, torque the center four bolts again to 42 ft-lb.

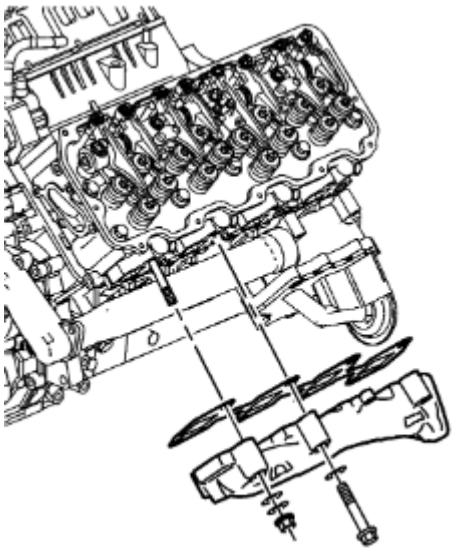


Fig. 107: Driver's side exhaust manifold installation

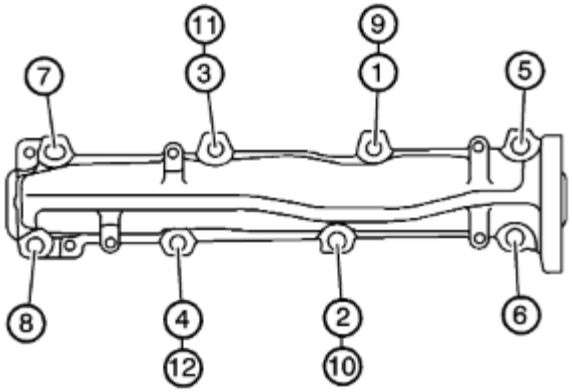


Fig. 108: Driver's side exhaust manifold tightening sequence

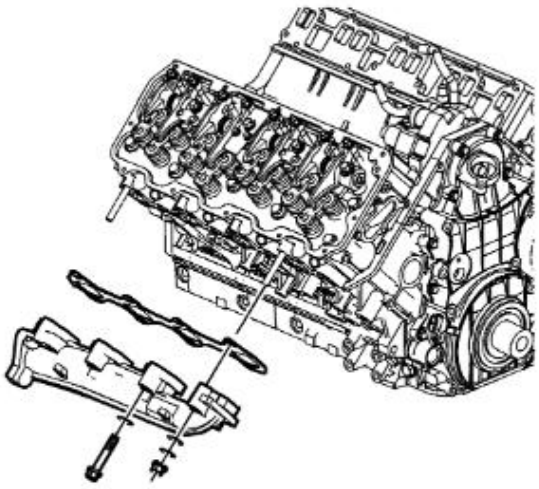


Fig. 109: Passenger side exhaust manifold installation

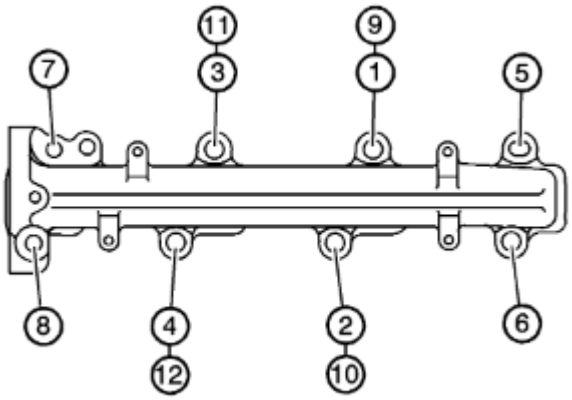


Fig. 110: Passenger side exhaust manifold tightening sequence

b. Install the exhaust manifold heat shields and torque the mounting bolts to 89 in-lb.

STEP 14: Install the turbocharger.

a. Install the turbocharger air inlet adapter bracket (item 3 in figure 111) and torque the bracket nut (item 3 in figure 111) to 89 in-lb. Install the turbocharger air inlet adapter (item 1 in figure 111) and loosely tighten the holding clamp.
b. Install the turbocharger oil feed pipe (item 3 in figure 112). Install the oil feed banjo bolt (item 1 in figure 112) and washers. Torque the banjo bolt to 26 ft-lb.

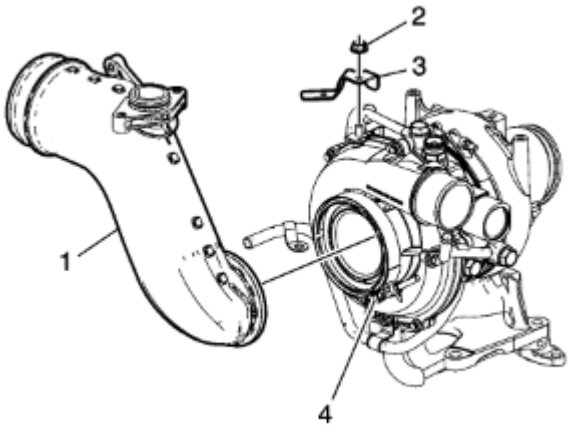


Fig. 111: Turbocharger air inlet adapter installation

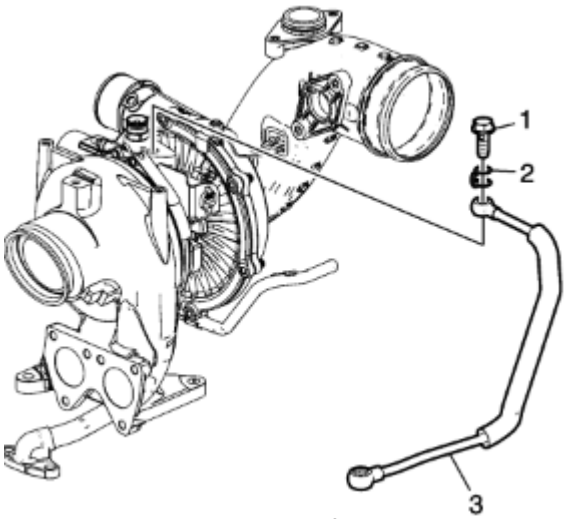


Fig. 112: Turbocharger oil feed pipe installation

c. Install the turbocharger lower heat shield.
d. Install the turbocharger assembly with the oil feed pipe, oil return pipe, and cooling return pipe. Torque the turbocharger mounting bolts (item 1 in figure 114) to 58 ft-lb. Torque the turbocharger cooling return pipe bolt (item 3 in figure 114) to 18 ft-lb.

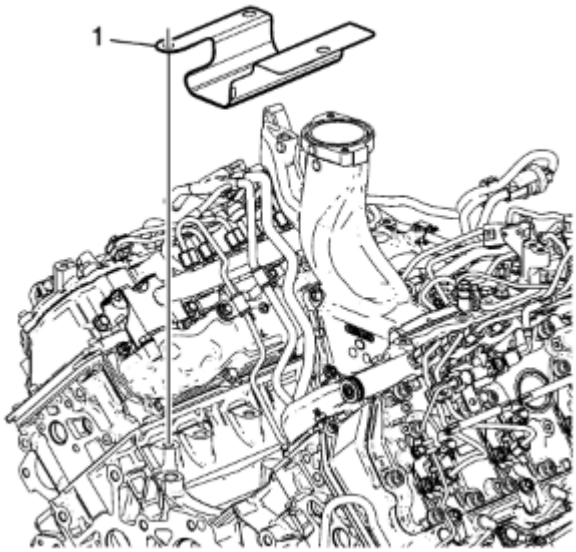


Fig. 113: Turbocharger lower heat shield installation

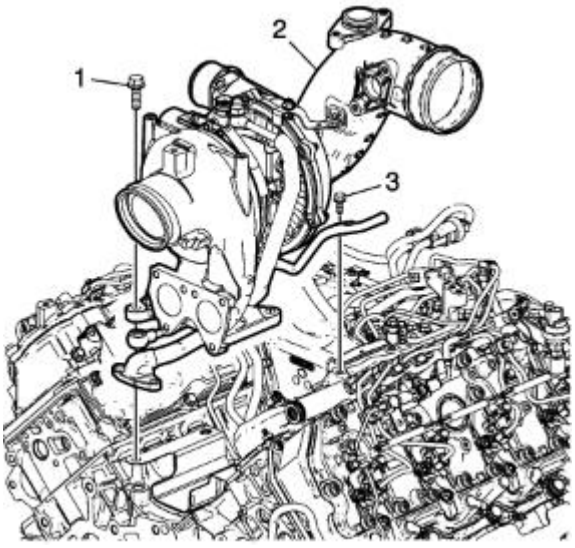


Fig. 114: Turbocharger assembly installation

e. Rotate the air inlet adapter until the tab (item 2 in figure 115) contacts the air inlet adapter tube bracket (item 1 in figure 115). Tighten the air inlet adapter holding clamp to 89 in-lb.
f. Install the turbocharger cooling return pipe (item 2 in figure 116) and the turbocharger cooling return hose (item 1 in figure 116). Install the three mounting bolts and torque them to 18 ft-lb.

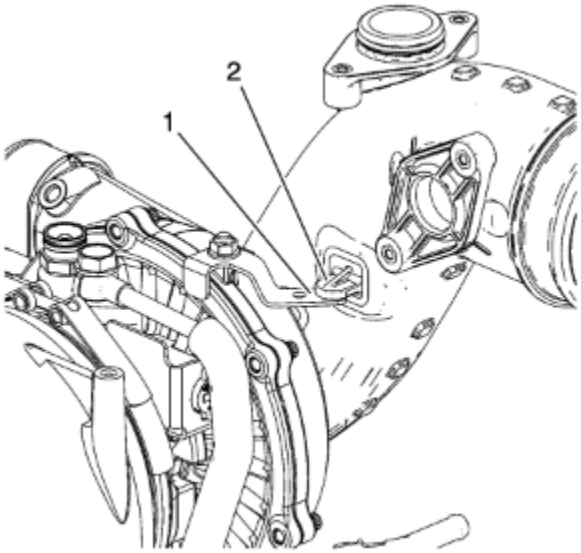


Fig. 115: Turbocharger air inlet adapter clocking

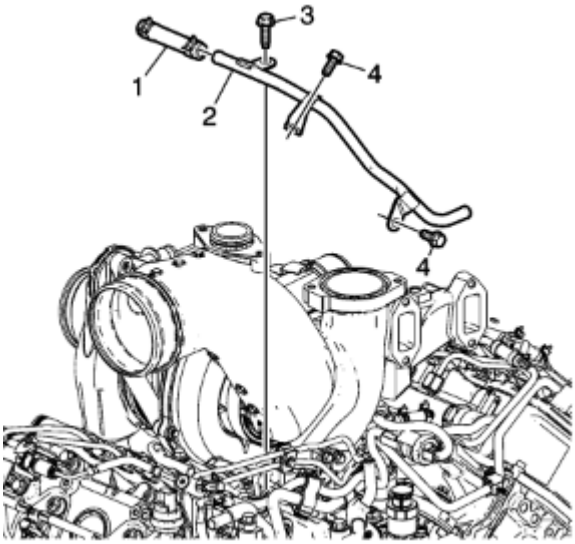


Fig. 116: Turbocharger cooling return hose and pipe installation

g. Install the oil supply line banjo bolt and washers as shown in figure 117. Torque the banjo bolt to 37 ft-lb.
h. Install the turbocharger upper heat shield as shown in figure 118. Torque the bolts to 89 in-lb.

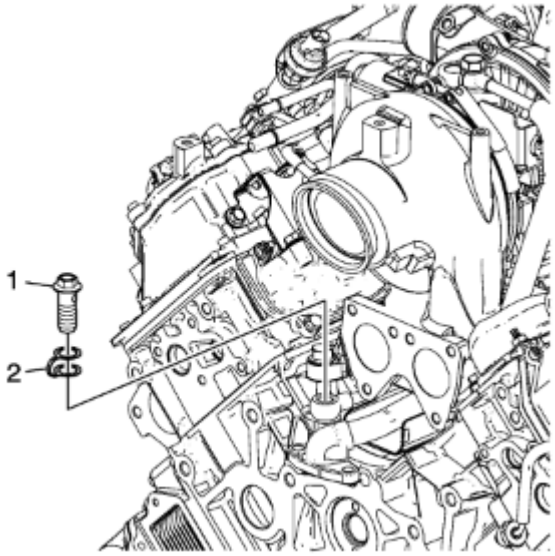


Fig. 117: Turbocharger oil supply banjo bolt installation

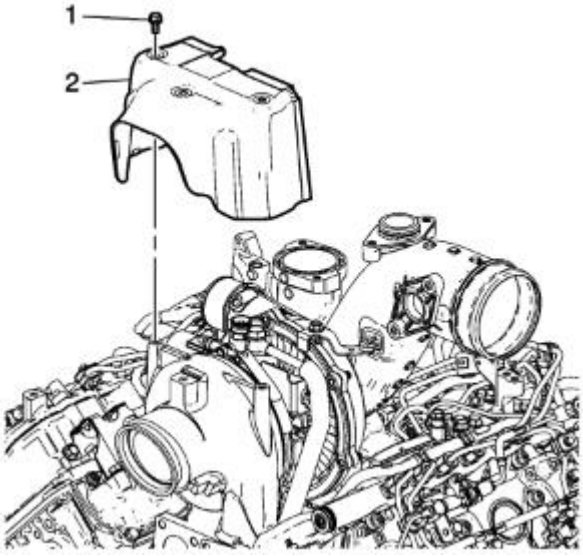


Fig. 118: Turbocharger upper heat shield installation

i. Install the fuel feed and return pipes assembly onto the driver's side valve cover. Torque the bolts to 18 ft-lb.

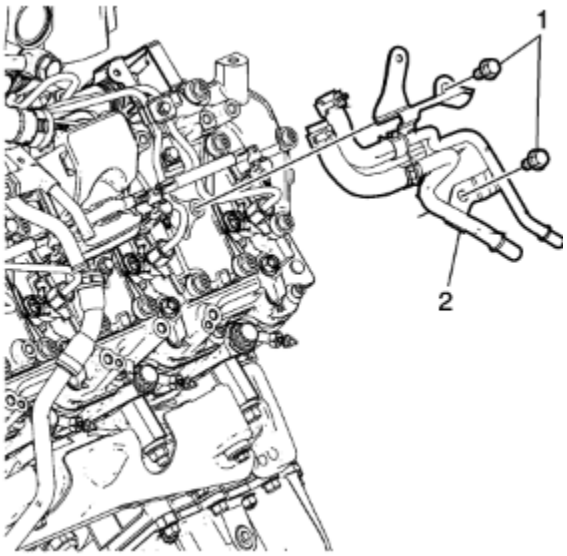


Fig. 119: Fuel feed and return pipe assembly installation

STEP 15: Install the rear portion of the EGR assembly.

a. Install the rear EGR bracket bolts as shown in figure 120 and torque them to 18 ft-lb.
b. Install the EGR mounting bolts as shown in figure 121 and torque them to 39 ft-lb.

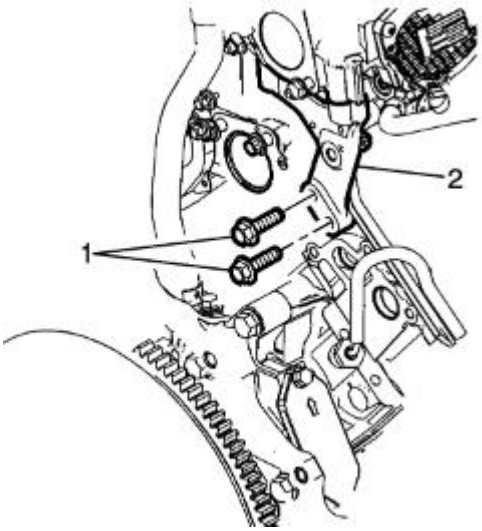


Fig. 120: EGR bracket mounting

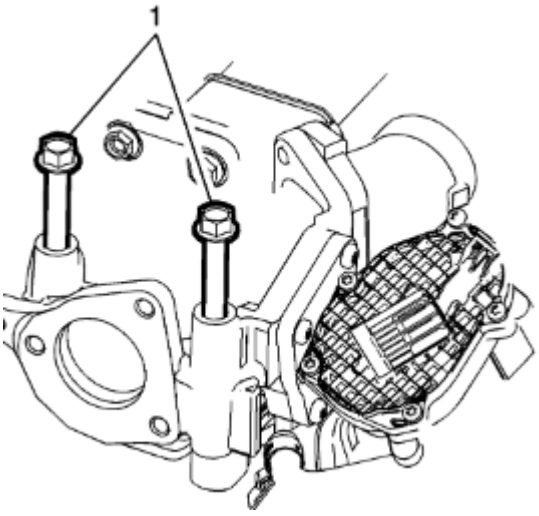


Fig. 121: EGR mounting bolt installation

c. Connect the EGR cooling feed hoses (items 1 and 2 in figure 122), the heater water bypass hose (item 3 in figure 122), and the heater inlet hose (item 4 in figure 122).

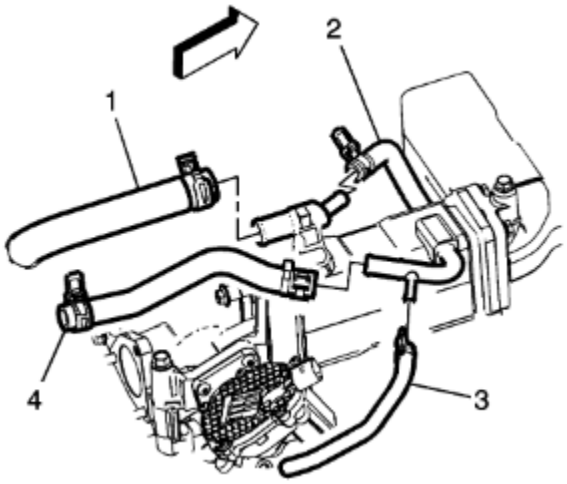


Fig. 122: EGR hose installations

STEP 16: Install the exhaust up-pipes.

a. Install the driver's side exhaust up-pipe. Install new gaskets and ensure that the tabs on the gaskets match the orientations shown in figure 123. Install the bolts in the sequence shown in figure 124 and torque them to 39 ft-lb. Install the driver's side exhaust pipe heat shield and torque the bolts to 89 in-lb.

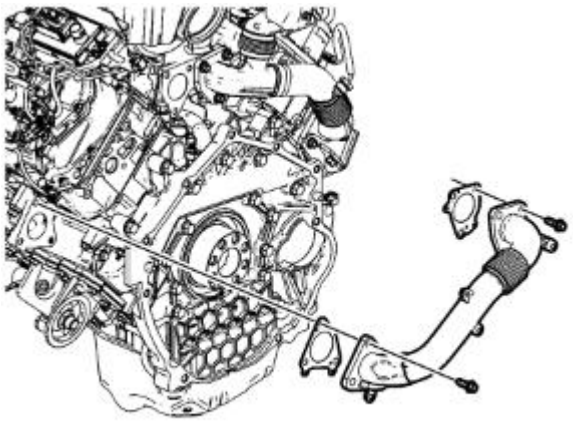


Fig. 123: Driver's side exhaust up-pipe installation

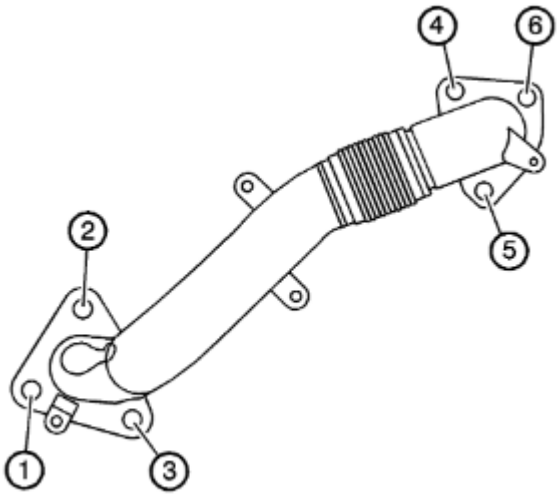


Fig. 124: Driver's side exhaust up-pipe tightening sequence

b. Install the passenger side exhaust up-pipe. Install new gaskets and ensure that the tabs on the gaskets match the orientations shown in figure 125. On the connection to the passenger side exhaust manifold, the bolts will install through the exhaust pipe bracket (item 3 in figure 125). Torque the two bolts and one nut connecting the up-pipe to the EGR cooler to 18 ft-lb. Torque the remaining six bolts to 39 ft-lb. Reference the tightening sequence in figure 126.

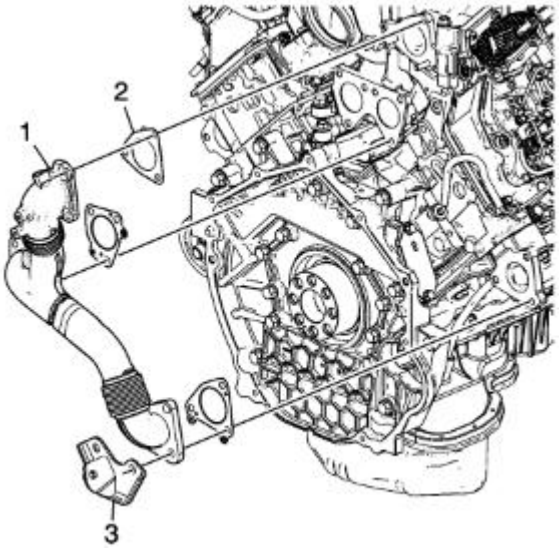


Fig. 125: Passenger side exhaust up-pipe installation

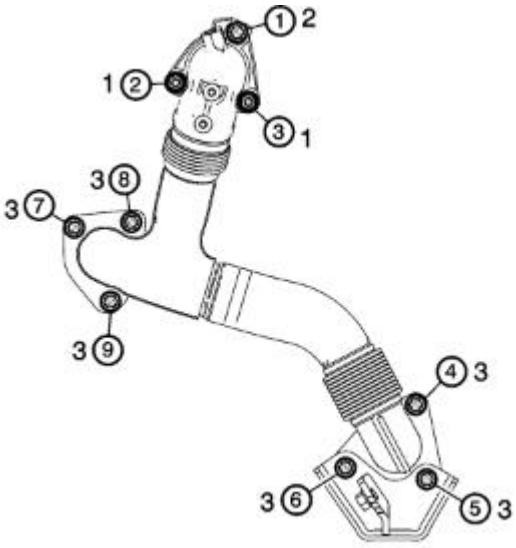


Fig. 126: Passenger side exhaust up-pipe tightening sequence

c. Install and reconnect the exhaust gas recirculation (EGR) sensor as shown in figure 127. Torque the sensor to 32 ft-lb.
d. Install the exhaust pipe heat shield as shown in figure 128. Torque the bolts to 53 in-lb.

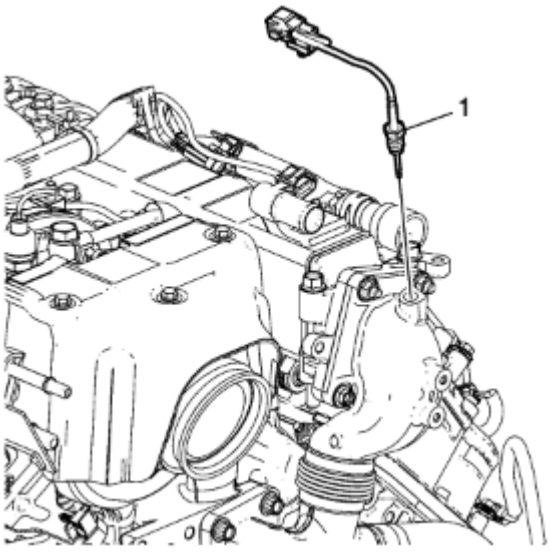


Fig. 127: EGR sensor installation

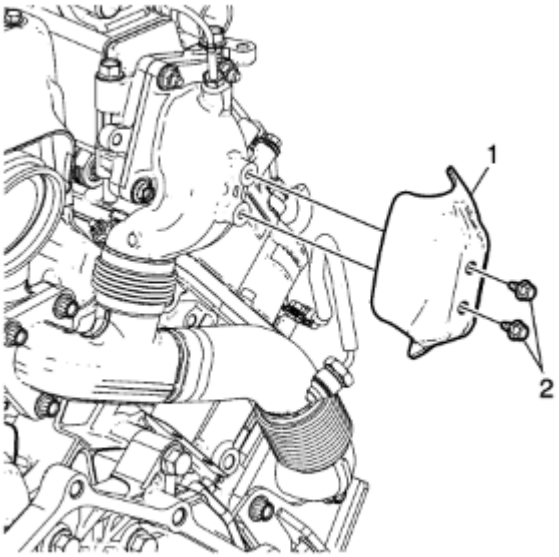


Fig. 128: Exhaust pipe heat shield installation

STEP 17: Install the exhaust gas recirculation manifold cooling feed pipe o-ring seal using a new o-ring. Install the EGR manifold cooling feed pipe and torque the bolts to 18 ft-lb.

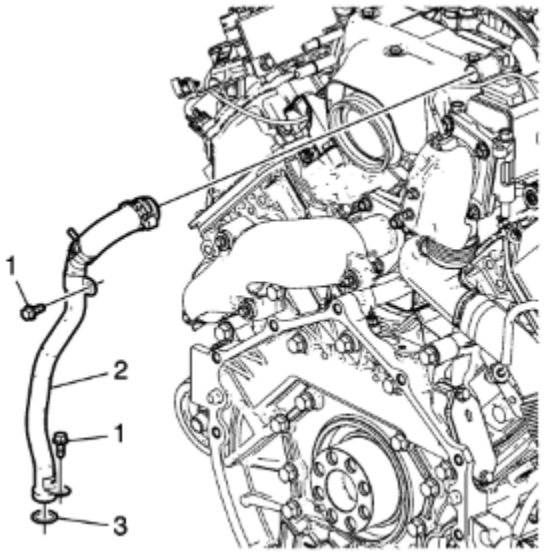


Fig. 129: EGR manifold cooling feed pipe installation

STEP 18: Install the turbocharger exhaust adapter.

a. Install the turbocharger exhaust adapter and exhaust adapter clamp as shown in figure 130. Tighten the clamp to 89 in-lb. Connect the dosing injector fitting and torque the fitting to 33 ft-lb.
b. Install the exhaust temperature sensor as shown in figure 131. Torque the sensor to 14 ft-lb.

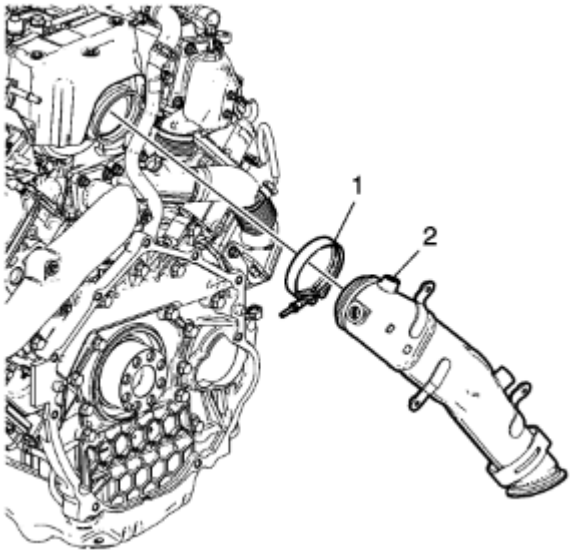


Fig. 130: Turbocharger exhaust adapter installation

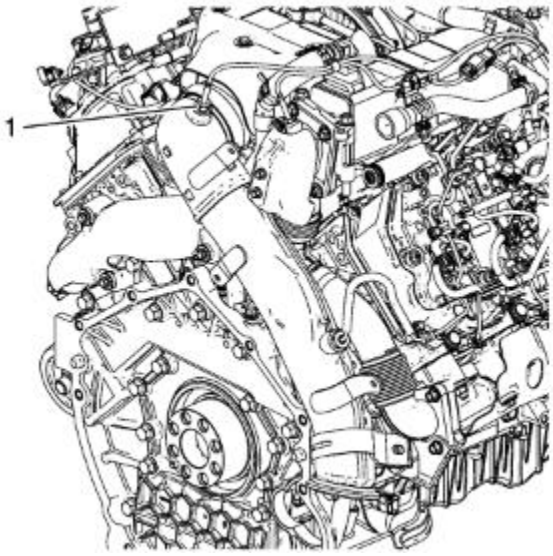


Fig. 131: Exhaust temperature sensor installation

c. Install the NOx sensor into the exhaust adapter as shown in figure 132 and torque the sensor to 33 lb-ft.
d. Install the exhaust adapter to passenger side exhaust bracket bolt and torque the bolt to 25 ft-lb. Install the heat shield onto the exhaust adapter and tighten the bolts to 89 in-lb.

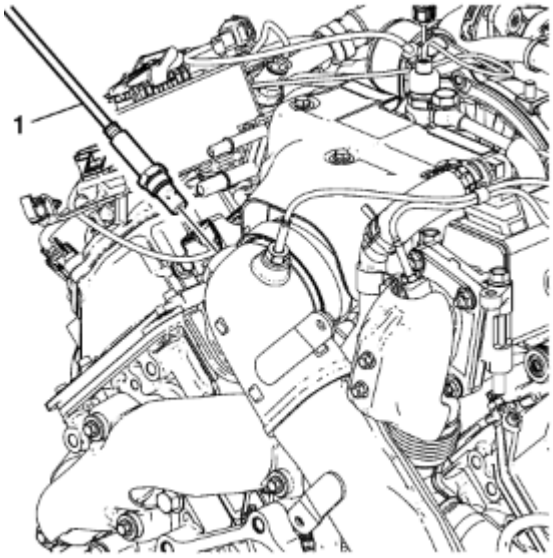


Fig. 132: NOx sensor installation

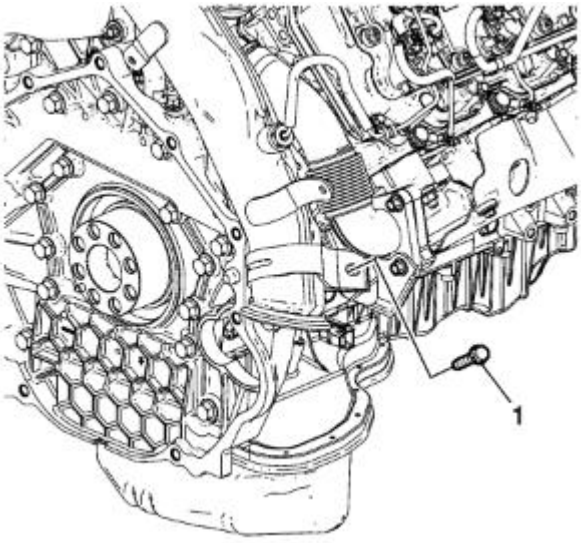


Fig. 133: Exhaust adapter to passenger side exhaust bracket bolt installation

STEP 19: Install the intake manifold y-bridge and gaskets. Install the two nuts first. Torque the nuts to 89 in-lb. Install the six bolts and torque them to 89 in-lb.

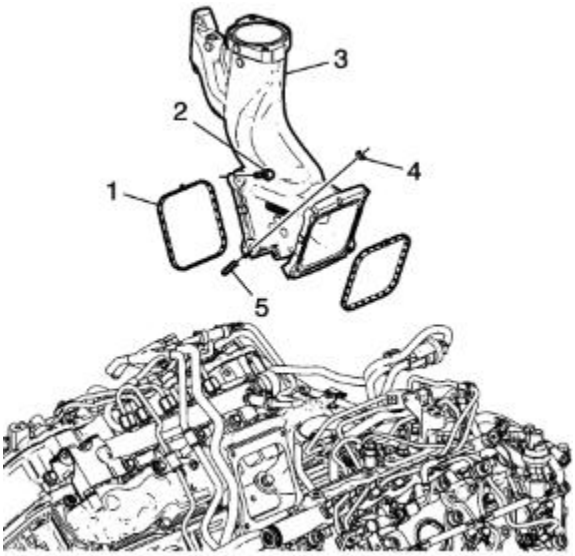


Fig. 134: Intake manifold y-bridge installation

STEP 20: Install the front EGR cooler, valve, and bypass pipe.

a. Install the front EGR cooler (item 2 in figure 135) with a new gasket (item 1 in figure 135). Install the four bolts connecting the front EGR cooler to the rear EGR cooler installed in step 15. Torque the bolts to 18 ft-lb.

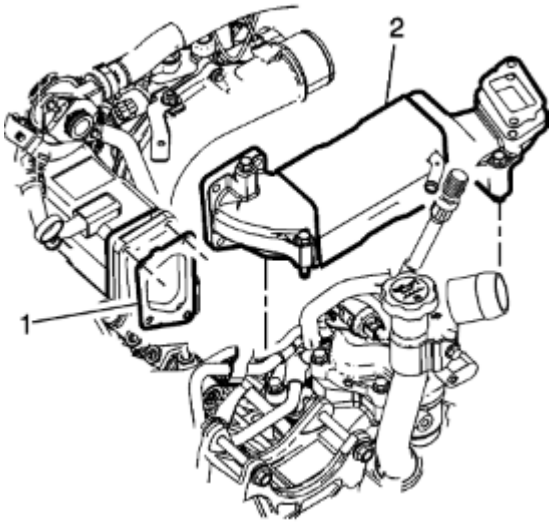


Fig. 135: Front EGR cooler installation

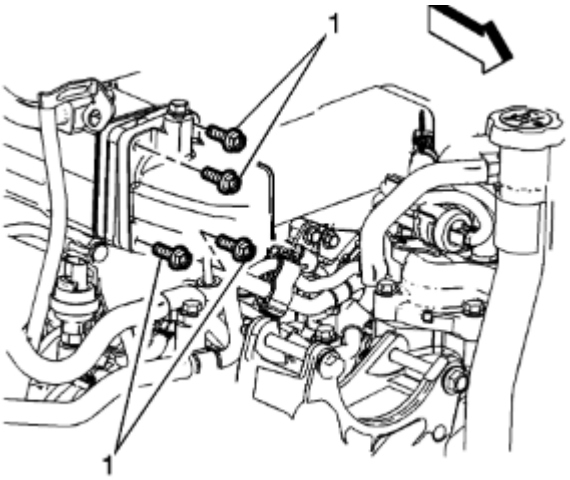


Fig. 136: Front EGR cooler bolts installed

b. Install the front EGR cooler mounting bolts as shown in figure 137. Torque the bolts to 18 ft-lb.
c. Install the EGR manifold cooling return hose (item 2 in figure 138) and the mounting bolt (item 1 in figure 138). Torque the mounting bolt to 18 ft-lb.

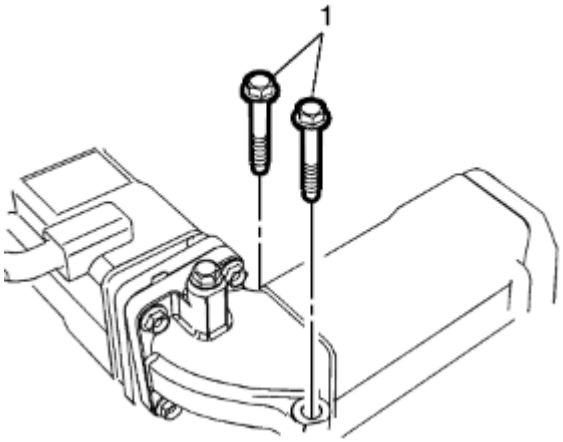


Fig. 137: Front EGR cooler mounting bolts installed

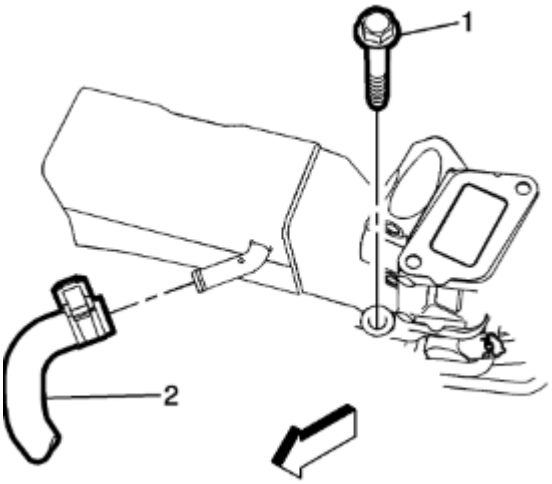


Fig. 138: EGR manifold cooling return hose and mounting bolt installation

d. Install new gaskets between the EGR valve, the EGR cooler, and the intake manifold y-bridge. Install the bolts connecting the EGR valve to the intake manifold y-bridge. Torque the bolts to 18 ft-lb. Reconnect the EGR valve electrical harness connector.

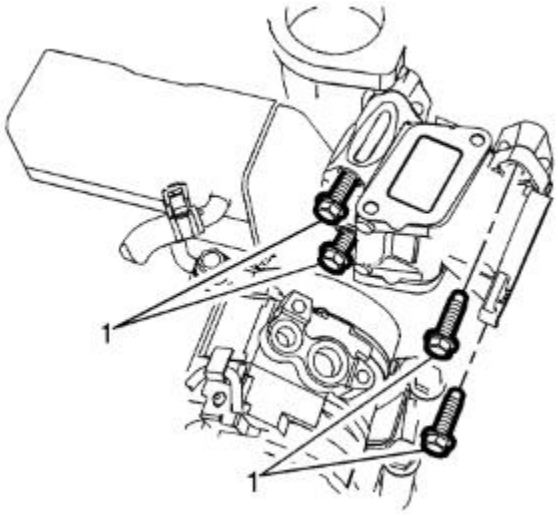


Fig. 139: EGR valve installation

e. Install the EGR bypass pipe using new gaskets (items 2 and 4) on the front and rear connections. Connect the rear section of the bypass pipe first to the rear EGR cooler assembly and torque the bolts (item 3) to 18 ft-lb. Connect the front of the bypass pipe to the EGR valve. Torque the bolts (item 1) to 18 ft-lb. Install the center mounting bolt (item 5) and torque the bolt to 18 ft-lb.

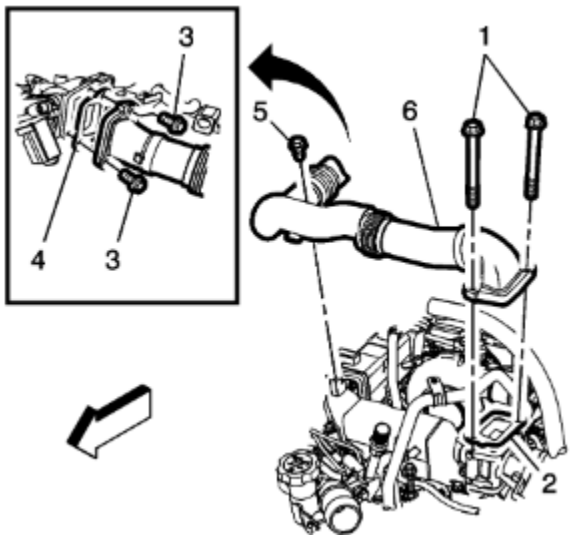


Fig. 140: EGR bypass pipe installation

STEP 21: Install the intake manifold tube assembly as shown in figure 142. Torque items 1-3 to 18 ft-lb. Torque item 4 to 53 in-lb. Reconnect the electrical harness connection to the throttle body.

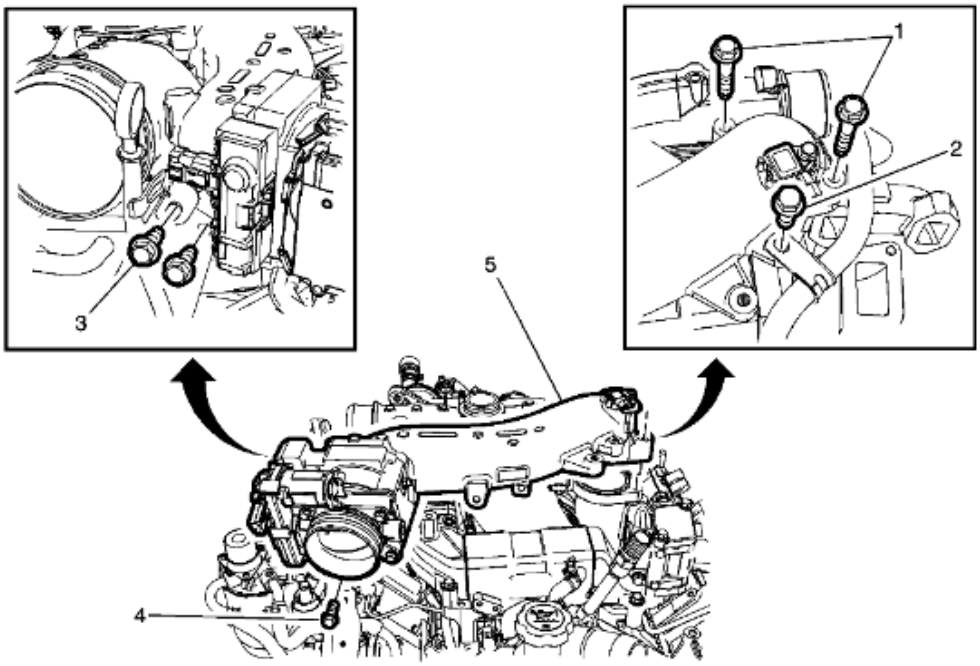


Fig. 141: Intake manifold tube installation

STEP 22: Install the fuel filter assembly.

a. Install the fuel filter and bracket assembly as shown in figure 142. Torque the mounting bolts to 18 ft-lb. Connect the fuel filter hoses (items 2 and 3 in figure 142) as shown.
b. Install the upper intake manifold brace. Torque the mounting bolts to 18 ft-lb.

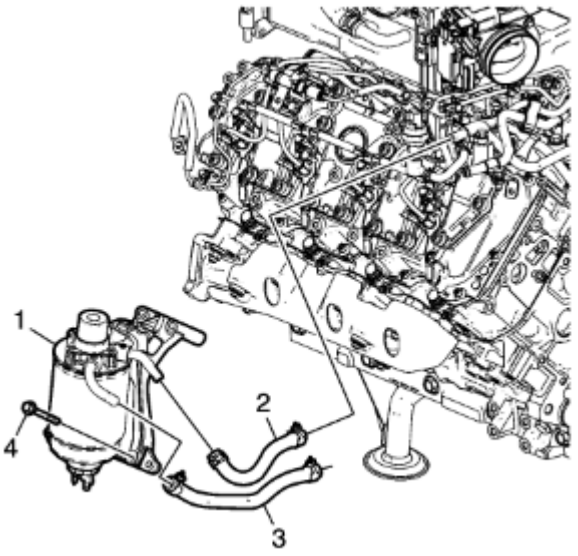


Fig. 142: Fuel filter assembly installation

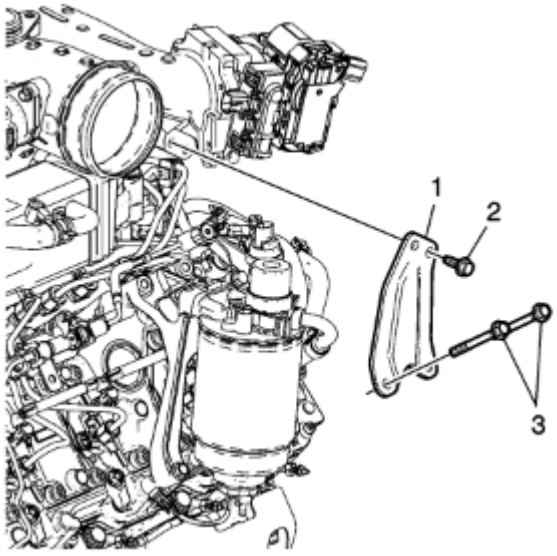


Fig. 143: Upper intake manifold brace installation

STEP 23: Install the alternator and torque the mounting bolts to 37 ft-lb. Install the A/C compressor and torque the mounting bolts to 37 ft-lb. Install the accessory drive belt.

STEP 24: Install the cooling fan shroud and tighten the mounting bolts and nuts to 80 in-lb. Install the intake manifold cover.

STEP 25: Connect the chassis fuel lines at the rear of the engine. The 3/8" line will connect to the fuel return and the ½" line will connect to the fuel feed.

STEP 26: Install the charge air cooler tube onto the turbocharger air intake adapter and connect the other end to the intercooler boot. Install the surge tank bracket and torque the fasteners to 18 ft-lb. Install the airbox.

STEP 27: Refill the cooling system, add engine oil, and install the air cleaner. Connect the battery terminals.

STEP 28: Prime the fuel system. Start the vehicle and inspect for leaks. Add fluids as necessary.

TORQUE SPEC REFERENCE TABLE

Part/Description	Torque Spec	Step Number
M12 cylinder head bolts	See step 4b	4b
M8 cylinder head bolts	18 ft-lb	4c
Rocker arm assembly bolts	30 ft-lb	5b
Oil deflector bolts	89 in-lb	5c
Valve lash lock nuts	16 ft-lb	6b
Lower valve cover bolts	89 in-lb	7b
Upper valve cover bolts	89 in-lb	7d
Fuel injector bracket bolts	22 ft-lb	8b
Intake manifold bolts	18 ft-lb	9c
High-pressure fuel rail bolts	18 ft-lb	10a
Intake manifold heat shield bolts	18 ft-lb	10b
Fuel feed pipe clip bracket bolt	18 ft-lb	10c
EGR bracket bolt	18 ft-lb	10d
Fuel feed hose bolt	18 ft-lb	10e
Injector feed pipe nuts	22 ft-lb	11
Injector feed pipe mounting bolts	89 in-lb	11
Fuel feed pipe bolts	18 ft-lb	12a
Fuel return pipe bolt	18 ft-lb	12b
Fuel rail crossover pipe nuts	22 ft-lb	12c
Crossover pipe mounting bolts	89 in-lb	12c
Crossover pipe isolator bracket bolt	18 ft-lb	12c
High-pressure fuel rail feed pipe to fuel rail nuts	22 ft-lb	12d
High-pressure fuel rail feed pipe to injection pump nuts	28 ft-lb	12d
High-pressure fuel rail feed pipe mounting bolts	89 in-lb	12d
Indirect injector feed pipe bracket bolts	18 ft-lb	12e
Indirect injector feed pipe clip bolts	89 in-lb	12e
Indirect injector fuel pipe bracket bolt	18 ft-lb	12e
Indirect injector banjo bolt	89 in-lb	12e
Vacuum switch bracket bolt	18 ft-lb	12h
Engine fuel vacuum switch	18 ft-lb	12h
Fuel return pipe mounting bolt	18 ft-lb	12i
Filter return pipe nut	18 ft-lb	12j
Filter return pipe mounting bolt	89 in-lb	12j
Upper fuel pipe bracket clip bolt	18 ft-lb	12k
Fuel feed pipe bolt	89 in-lb	12k
Fuel temperature sensor	16 ft-lb	12k
Exhaust manifold bolts	42 ft-lb	13a
Exhaust manifold heat shield bolts	89 in-lb	13b
Turbocharger air inlet adapter bracket bolt	89 in-lb	14a
Turbocharger oil feed banjo bolt	26 ft-lb	14b
Turbocharger mounting bolts	58 ft-lb	14d
Turbocharger cooling return pipe bolt	18 ft-lb	14d
Turbocharger air inlet adapter holding clamp nut	89 in-lb	14e

TORQUE SPEC REFERENCE TABLE CONTINUED

Part/Description	Torque Spec	Step Number
Turbocharger cooling return pipe mounting bolts	18 ft-lb	14f
Turbocharger oil supply line banjo bolt	37 ft-lb	14g
Turbocharger upper heat shield bolts	89 in-lb	14h
Fuel feed and return pipe assembly bolts	18 ft-lb	14i
Rear EGR bracket bolts	18 ft-lb	15a
EGR mounting bolts	39 ft-lb	15b
Exhaust up-pipe bolts to manifolds and turbocharger	39 ft-lb	16a/16b
Driver's side exhaust up-pipe heat shield bolts	89 in-lb	16a
Passenger side exhaust up pipe to EGR cooler bolts and nut	18 ft-lb	16b
EGR sensor	32 ft-lb	16c
Exhaust heat shield	53 in-lb	16d
EGR manifold cooling feed pipe bolts	18 ft-lb	17
Turbocharger exhaust adapter clamp nut	89 in-lb	18a
Dosing injector nut	33 ft-lb	18a
Exhaust temperature sensor	14 ft-lb	18b
NOx sensor	33 ft-lb	18c
Exhaust bracket bolt	25 ft-lb	18d
Exhaust adapter heat shield bolts	89 in-lb	18d
Intake manifold y-bridge bolts and nuts	89 in-lb	19
EGR cooler to rear EGR cooler bolts	18 ft-lb	20a
Front EGR cooler mounting bolts	18 ft-lb	20b
EGR manifold mounting bolt	18 ft-lb	20c
EGR valve to y-bridge bolts	18 ft-lb	20d
EGR bypass pipe bolts	18 ft-lb	20e
Intake manifold tube mounting bolts	18 ft-lb	21
Throttle body to intake manifold tube support bolt	53 in-lb	21
Fuel filter bracket bolts	18 ft-lb	22a
Upper intake manifold brace bolts	18 ft-lb	22b
Alternator and A/C compressor mounting bolts	37 ft-lb	23
Cooling fan shroud bolts	80 in-lb	24
Surge tank bracket bolts	18 ft-lb	26

RECOMMENDED REPLACED COMPONENT REFERENCE TABLE

Component	RECOMMENDED PN	Step Number
Driver's side head gasket	GM 12637788	4a
Passenger side head gasket	GM 12637785	4a
Upper valve cover gaskets	GM 12628569	7d/7e
Fuel injector o-ring seal	GM 94013303	8a
Fuel injector washer	GM 97327722	8a
Exhaust manifold gasket	GM 98002804	13a
Exhaust manifold up-pipe gasket	GM 97188685	16a/16b
Turbocharger to up-pipe gasket	GM 97192618	16a/16b
Up-pipe to EGR gasket	GM 98065519	16b
Rear EGR to front EGR gasket	GM 98065521	20a
EGR valve gasket	GM 98062923	20d/20e
EGR valve to y-bridge gasket	GM 12635466	20d
Rear EGR to bypass pipe gasket	GM 98065523	20e