# 7 EXHAUST SYSTEM

### 7.2.4 Exhaust Brake Assembly Installation

Install the exhaust brake assembly as follows:

1. Clean the mating surfaces on the brake valve housing and the turbocharger.
2. Install the brake valve housing on the turbocharger by slipping the housing over the turbocharger studs. Tighten the locknuts 50 N·m (37 lb·ft).

**CAUTION:**

**To avoid injury from the sudden release of a high-pressure hose connection, wear a face shield or goggles.**

3. Install the compressed-air line on the exhaust brake cylinder.
4. Clean the sealing surfaces on the exhaust pipe and brake valve housing.
5. Slide the exhaust pipe and clamp over the end of the housing. Tighten the clamp.
6. Install the air cleaner.
7. Connect the batteries, lower the hood, and remove the chocks from the rear tires.

## 7.3 EGR EXHAUST MANIFOLD

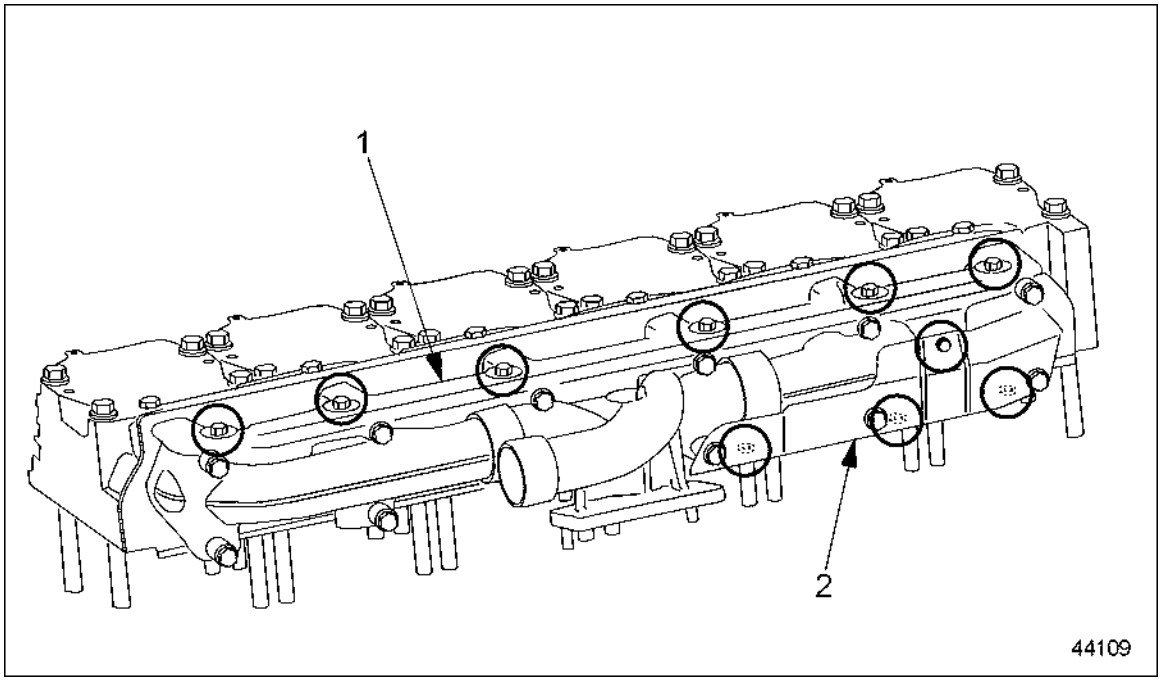
The EGR exhaust manifold is a three-piece manifold. The manifold assembly is assembled apart from the cylinder heads, then the entire assembly is installed to the heads.

### 7.3.1 EGR Exhaust Manifold Removal

Remove the EGR exhaust manifold as follows:

**NOTE:**
Although not shown in the below graphic, the heat exchanger and heat exchanger bracket are still installed on the engine before the exhaust manifold is removed.

1. Remove the bolt that attaches the smaller front heat shield to the main heat shield, then remove the three bolts attaching the shield to the bottom of the exhaust manifold. Now remove the heat shield. See Figure 7-6.

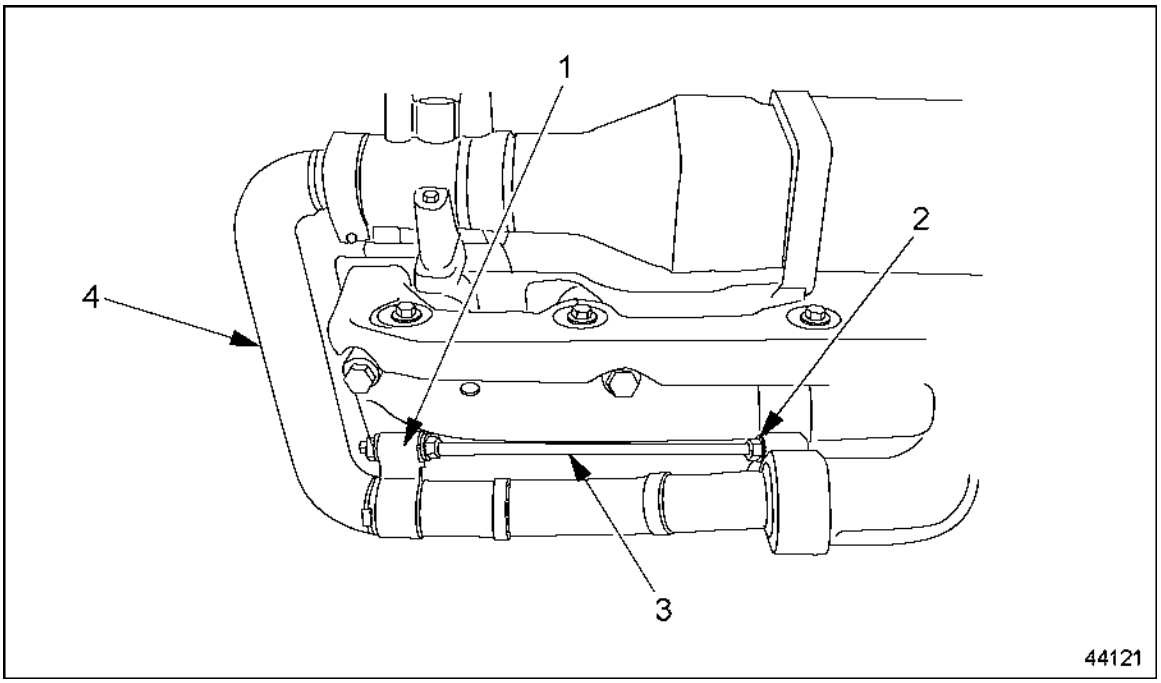



1. Upper or Main Heat Shield
2. Lower or Front Heat Shield

**Figure 7-6 Removal or Installation of the Exhaust Manifold Front Heat Shield**

**NOTE:**
Upper or main heat shield must remain on the exhaust manifold assembly until the assembly is removed due to inaccessibility of some of the heat shield mounting bolts.

2. Loosen and remove outside nut that is resting on outside face of stud bracket. See Figure 7-7.




1. Stud Bracket
2. Stud Nut
3. Stud
2. Exhaust Gas Inlet Pipe (Hot Pipe)

**Figure 7-7 Removing Stud from Exhaust Manifold and Inlet Pipe**

3. Loosen center nut on stud that is resting on the inside, against the intake manifold center piece.See Figure 7-7.

**NOTE:**
If the inside nut that rests against the stud bracket is NOT loosened or moved at this point, it is possible that the stud dimension adjustment will remain the same without needing further adjustment when reinstalled.

**NOTE:**
Stud and stud bracket should be loose enough to allow removal of the exhaust manifold inlet pipe.

4. Loosen and remove bolt from positioning clamp which holds the gas inlet pipe to the throttle valve. See Figure .

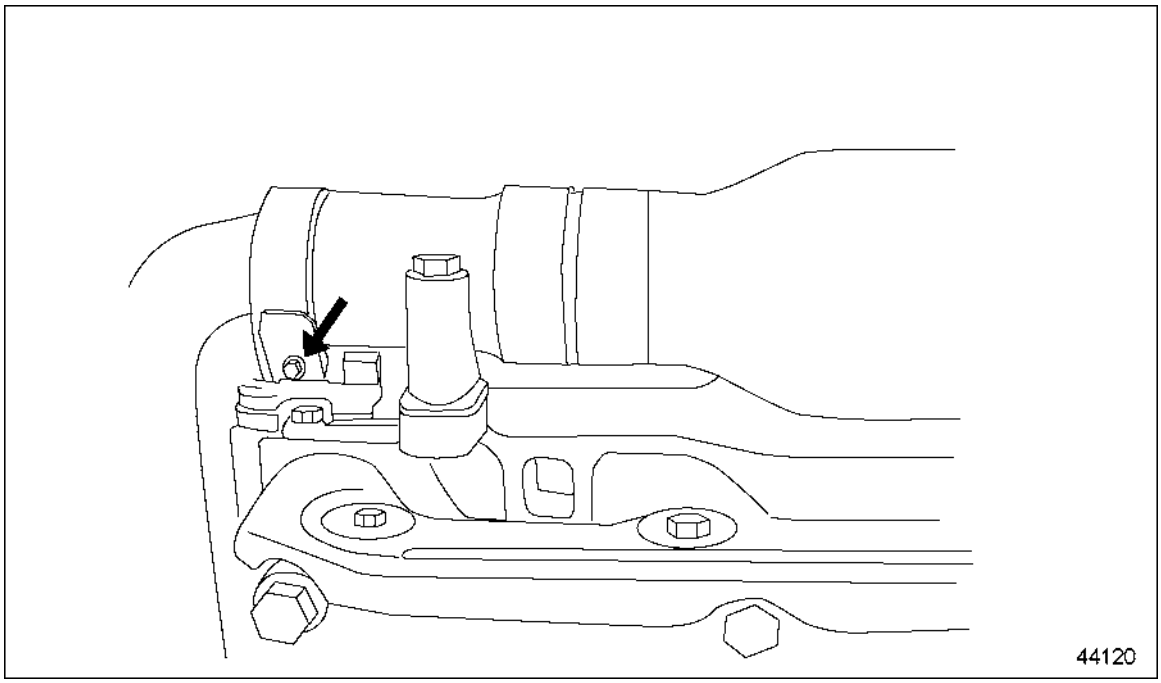



**Figure 7-8 Removing or Installing Positioning Clamp to Throttle Inlet Pipe**

5. Gently pull exhaust manifold gas inlet pipe from center piece of exhaust manifold and from throttle valve (see arrows in graphic). Remove the fey rings (four per groove) on the gas inlet pipe leading to the exhaust manifold center piece. See Figure 7-9.

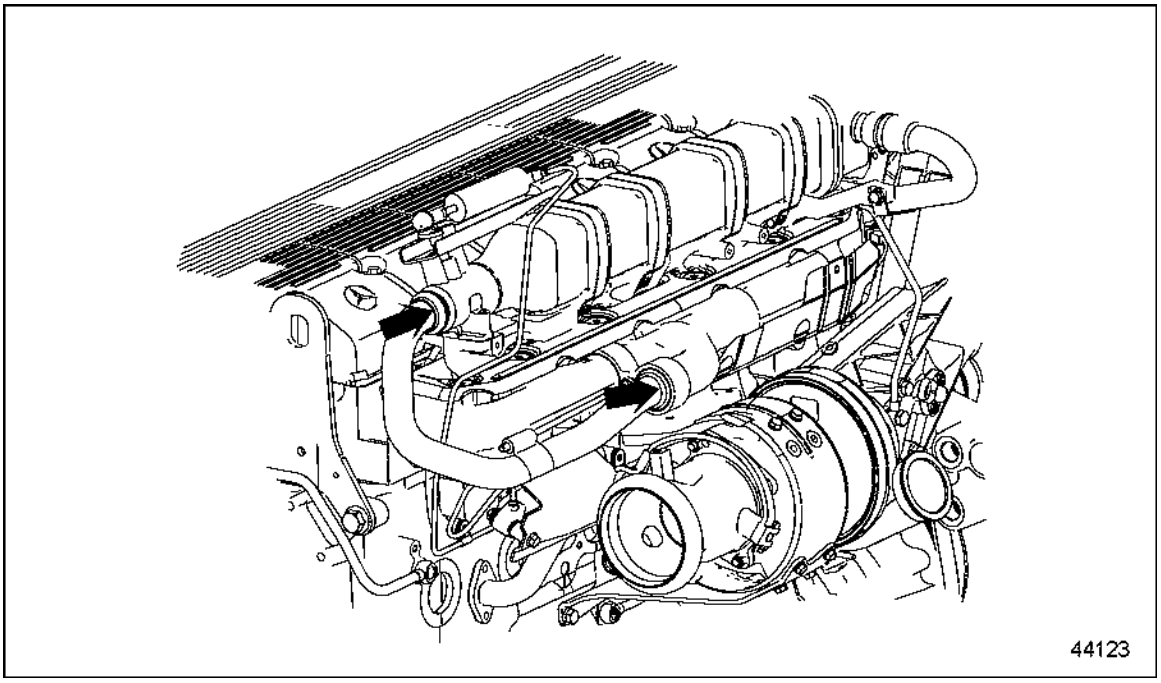



**Figure 7-9 Exhaust Manifold Gas Inlet Pipe Removal**

6. Remove the twelve bolts connecting the three-piece exhaust manifold to the block; remove the exhaust manifold assembly by first lowering the left side, then the right side out from under the heat exchanger bracket (not shown in graphic). See Figure 7-10.

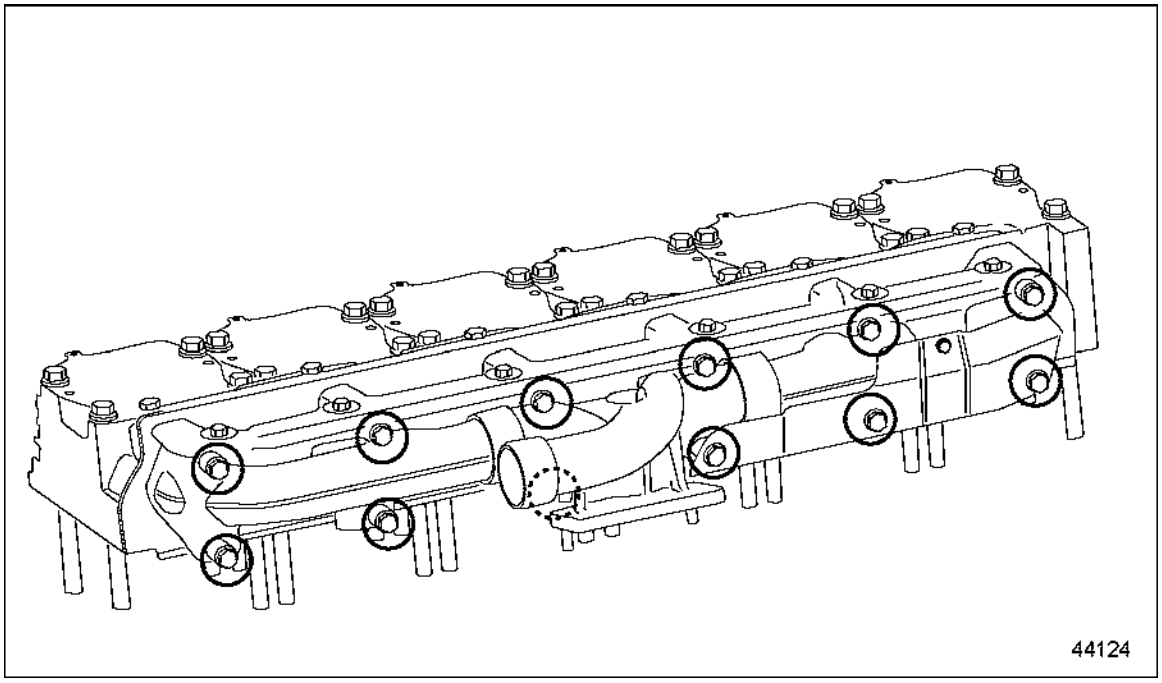
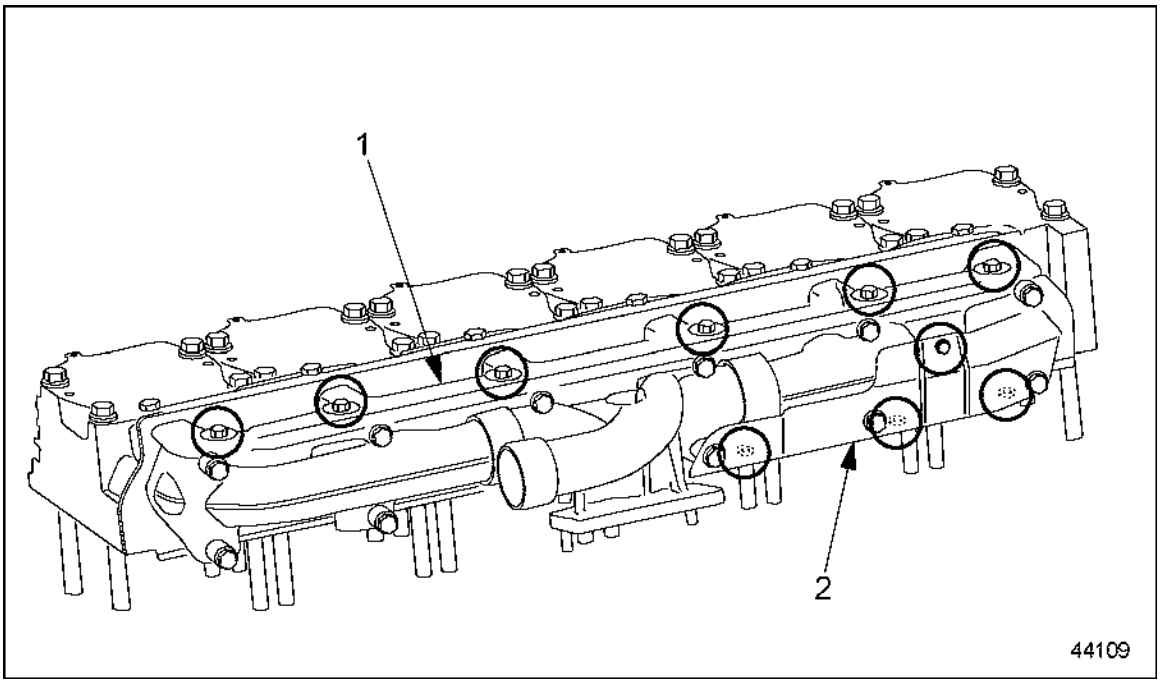



**Figure 7-10 Removing or Installing Three-piece Exhaust Manifold Assembly**

7. Remove the six mounting bolts from the main or upper heat shield at this point. Remove the heat shield. See Figure 7-11.




1. Upper or Main Heat Shield
2. Lower or Front Heat Shield

**Figure 7-11 Removing Upper Heat Shield**

8. Remove the stud and M8 nut and collar still attached to the center exhaust manifold piece.

9. Remove the two side pieces of the exhaust manifold from the center piece. See Figure 7-12.

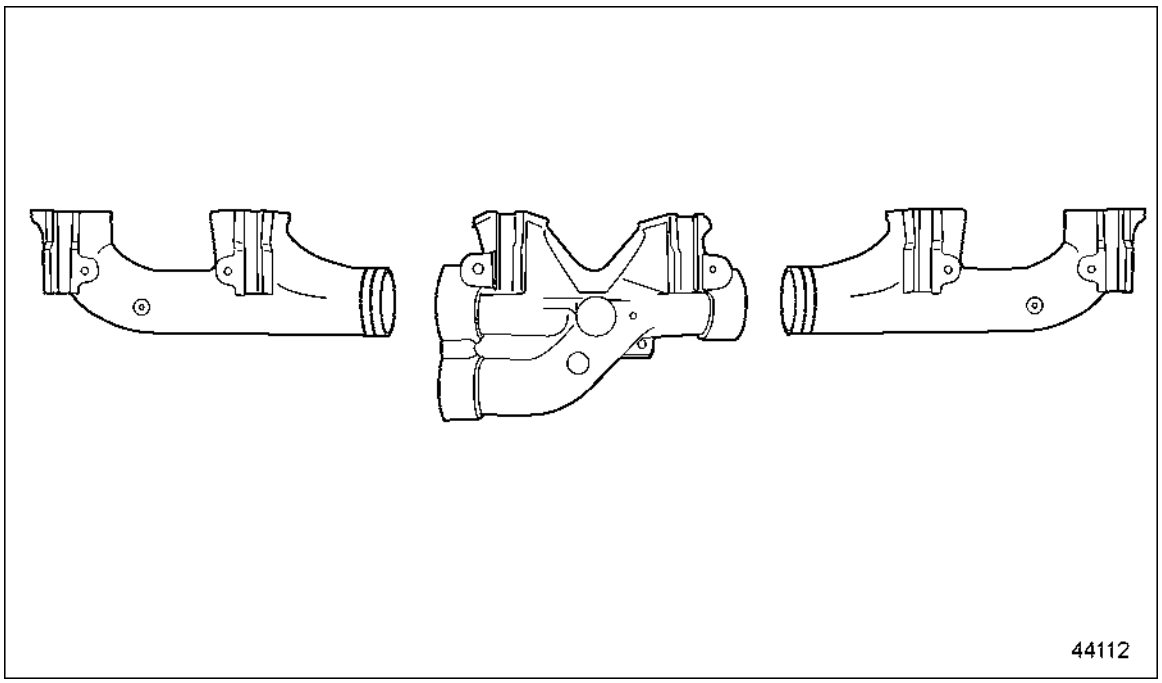
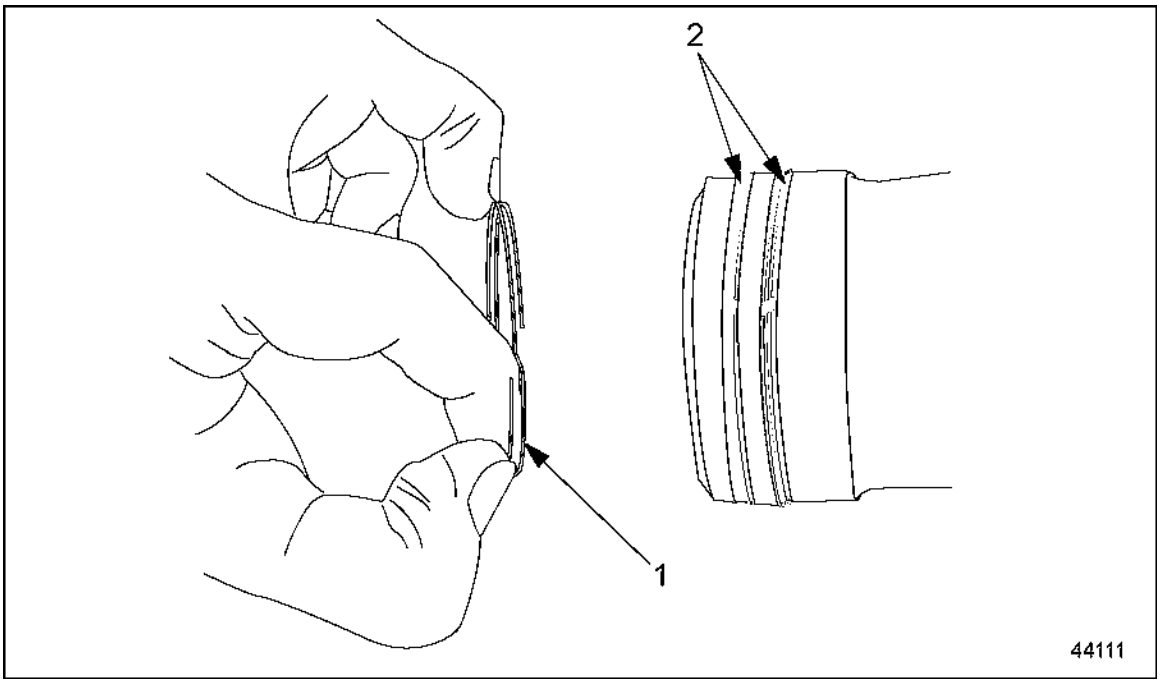



**Figure 7-12 Three Piece Exhaust Manifold Assembly**

10. Remove the fey rings (2 in each groove) from the two grooves of each exhaust manifold end piece. See Figure 7-13.

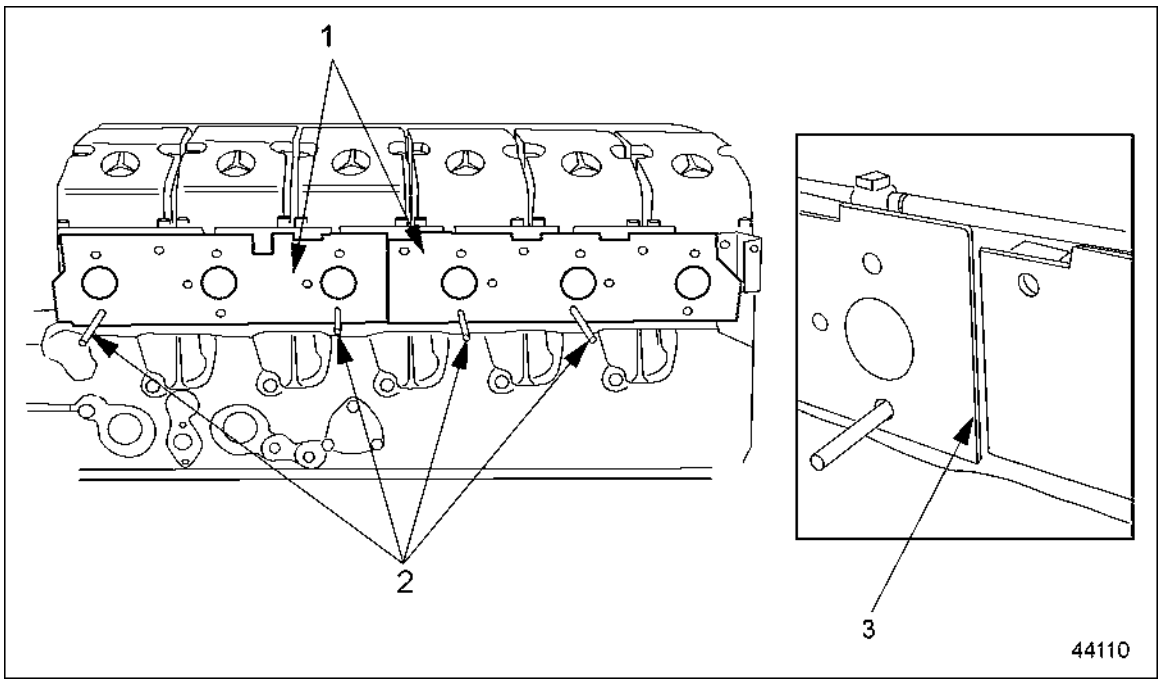



1. Fey Ring
2. Exhaust Manifold Grooves

**Figure 7-13 Installing or Removing Rings in Exhaust Manifold Grooves**

**NOTE:**
EGR cooler and cooler bracket will need to be removed before removing the exhaust manifold gaskets. Refer to section 7.4.1.

11. Remove exhaust manifold two-piece gasket from cylinder heads. See Figure 7-14.




1. Two-Piece Gasket
2. Guide Studs
3. Gasket Overlap (Rear overlaps the Front)

**Figure 7-14 Removal or Installation of Exhaust Manifold Gaskets**

## 7.3.2 EGR Exhaust Manifold Installation

Install the EGR exhaust manifold as follows:

**NOTE:**
The three-piece exhaust manifold and its related parts are first put together as an assembly; it is then mounted to the cylinder heads as one unit.

1. Install the exhaust manifold guide studs to the cylinder head and mount the two exhaust manifold gaskets. The rear gasket will overlap the front in the center of block. See Figure 7-14.

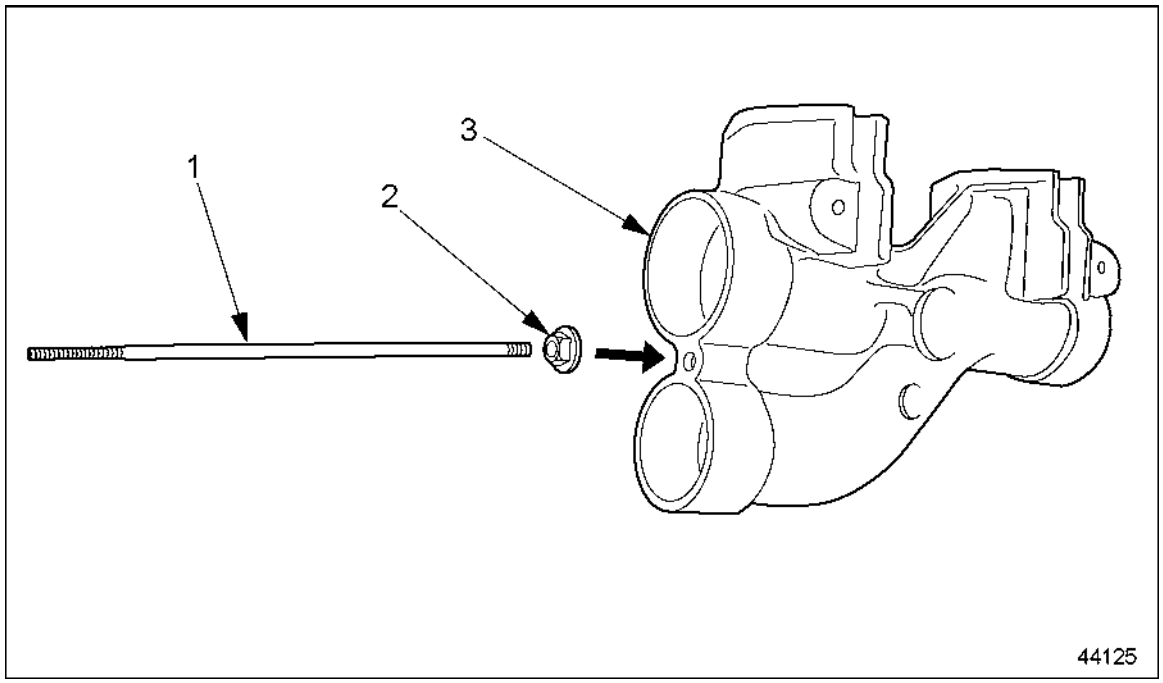
| NOTICE: |
| --- |
| There is a front and rear exhaust manifold gasket and the rear gasket is marked with a deep notch on top. The front gasket must be installed *before* the rear gasket can be installed. |

**NOTE:**
At this point, the heat exchanger and heat exchanger mounting bracket should be installed on the block, but the remaining exhaust manifold installation graphics will not show these two parts installed.

**NOTE:**
The exhaust manifold gasket studs are to be removed after installing the EGR cooler support bracket.

2. Install stud with M8 nut with collar onto exhaust manifold center piece. Do not tighten nut at this point.

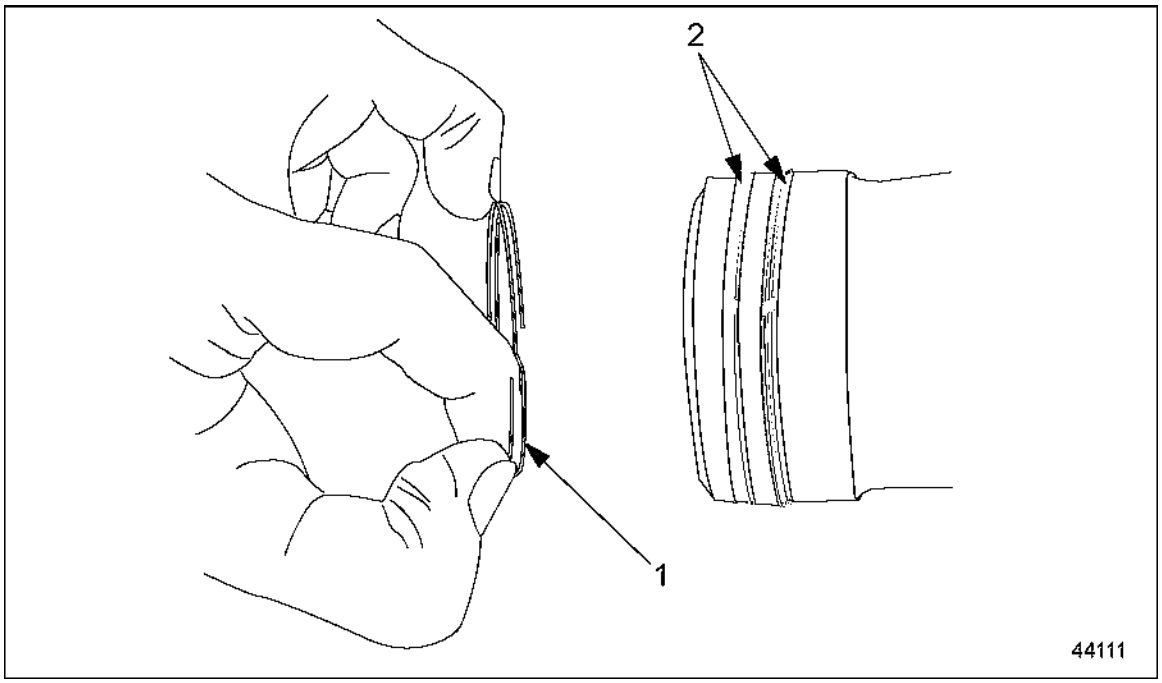
**NOTE:**
Stud must be installed on exhaust manifold center piece before fitting the two end pieces of manifold into center piece.




1. Stud
2. M8 Nut with Collar
3. Exhaust Manifold Center Piece

**Figure 7-15 Installing Stud in Exhaust Manifold Center Piece**

3. Install the fey rings (2 in each groove) in the two grooves of each exhaust manifold end piece. See Figure 7-16.




1. Fey Rings (2 per groove)
2. Exhaust Manifold Grooves

**Figure 7-16 Installing or Removing Rings in Exhaust Manifold Grooves**

4. Fit fey-ring ends of exhaust manifold pieces into center part of exhaust manifold. Do not use lubricant. See Figure 7-12.
5. Bolt upper heat shield to exhaust manifold using the six mounting bolts (M8 x 12mm). Finger-tighten all of the bolts, but torque the first bolt nearest the front part of the manifold to 25 N·m (19 lb·ft).

**NOTE:**
Upper heat shield bolt that is closest to front of engine is torqued before assembly is attached to engine due to impossible access after attachment to engine.

6. Bolt the lower heat shield to the upper heat shield with one captured bolt and washer (M8 x 12mm). Torque to 25 N·m (19 lb·ft).
7. Install the entire exhaust manifold assembly onto the cylinder heads by lifting the right side (or front) into place first, followed by the left (or rear). Install all exhaust manifold bolts, and then torque all 12 mounting bolts to 50 N·m (38 lb·ft), using a crisscross sequence.
8. Torque remaining three mounting bolts (captured bolt and washer type) of the lower heat shield to the exhaust manifold. Torque to 25 N·m (19 lb·ft).
9. Torque remaining five mounting bolts (captured bolt and washer type) of the upper heat shield to the exhaust manifold. Torque to 25 N·m (19 lb·ft).

10. Install the fey rings (4 per groove) on the gas inlet pipe leading to exhaust manifold center piece. Do not use lubricant.
11. Gently push gas inlet pipe into center exhaust manifold piece. Do not use lubricant.
12. Push gas inlet pipe of heat exchanger into throttle valve. Tighten screw at bottom of positioning clamp on throttle valve assembly. Clamp must be tightened to 10 N·m (7 lb·ft) *after* stud adjustment. Refer to step 14.
13. Screw the nut onto stud installed in exhaust manifold. Fit stud in the bracket that is attached to the gas inlet pipe. Attach a nut to the outer edge of bracket also.
14. Adjust 219 mm dimension on stud by doing the following:
    [a] Apply 25 N·m (19 lb·ft) tightening torque to the nut on exhaust manifold. Position stud to avoid any friction between the exhaust manifold and the gas inlet pipe. See Step One in see Figure 7-17.

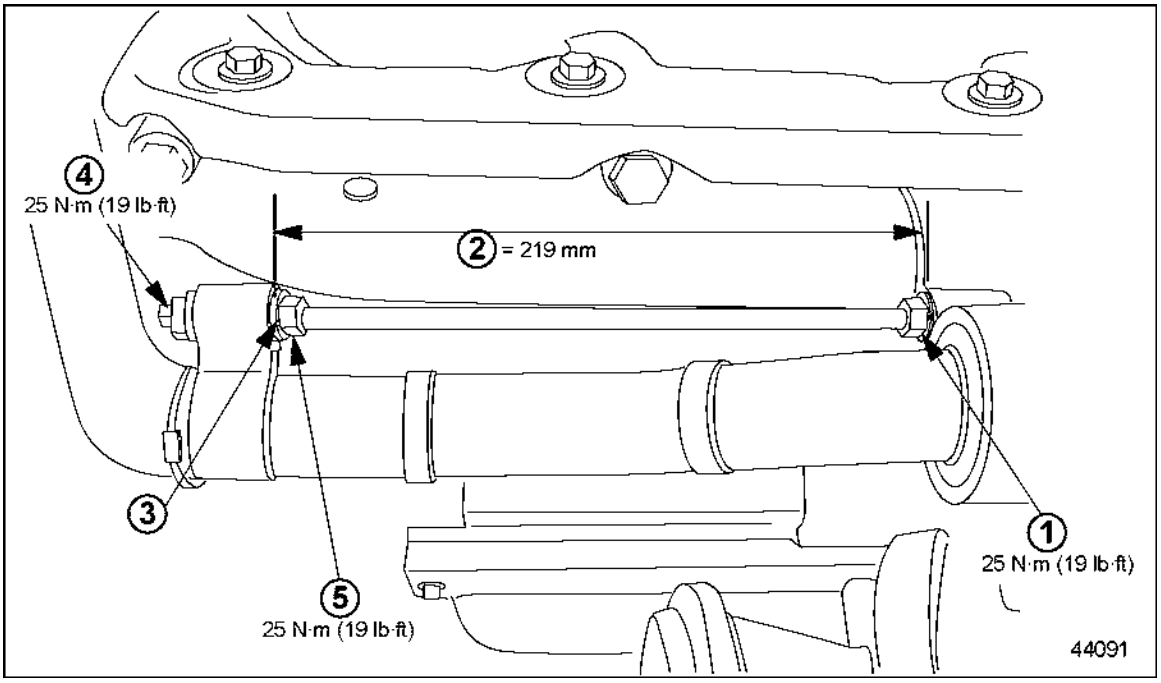



**Figure 7-17 Stud Adjustment**

    [b] Adjust dimension to 219 mm (8.62 in.). This measurement is from the machined face of manifold to the resting face on the pipe. See Step Two in see Figure 7-17.
    [c] Bring nut against the resting face on pipe (internal). See Step Three in see Figure 7-17.
    [d] Apply 25 N·m (19 lb·ft) tightening torque to nut on resting face on pipe (external). See Step Four in see Figure 7-17.
    [e] Apply 25 N·m (19 lb·ft) tightening torque to nut on resting face on pipe (internal). See Step Five in see Figure 7-17.

## 7.4 EGR COOLER AND COOLER SUPPORT BRACKET

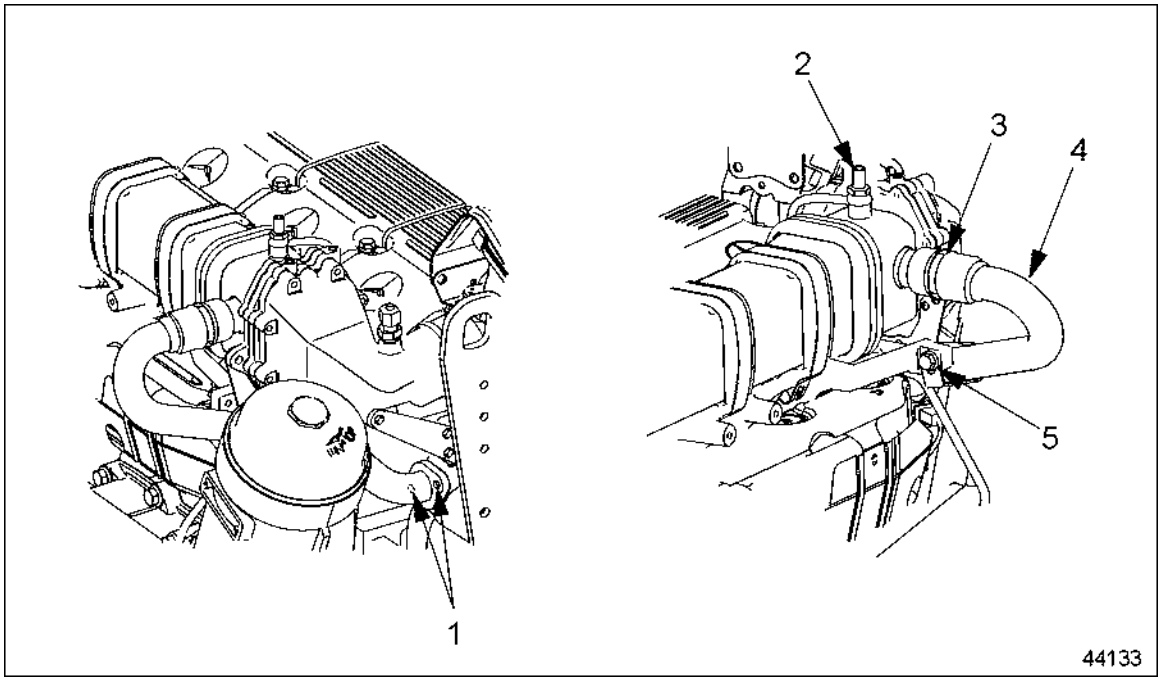
The EGR system is equipped with a single-pass cooler. Exhaust gasses coming from the first three cylinders are directed through the EGR shut off valve, through the cooler and reed valves, past the EGR control valve and the mixer, then back to the cylinder.

### 7.4.1 EGR Cooler and Support Bracket Removal

Remove the EGR cooler and its support bracket as follows:

**NOTE:**
The exhaust manifold and the gas inlet pipe have already been removed at this point. It is then possible to remove the cooler and support bracket without removing the throttle valve first.

1. Disconnect the coolant vent line located on top of the EGR cooler. See Figure 7-18.

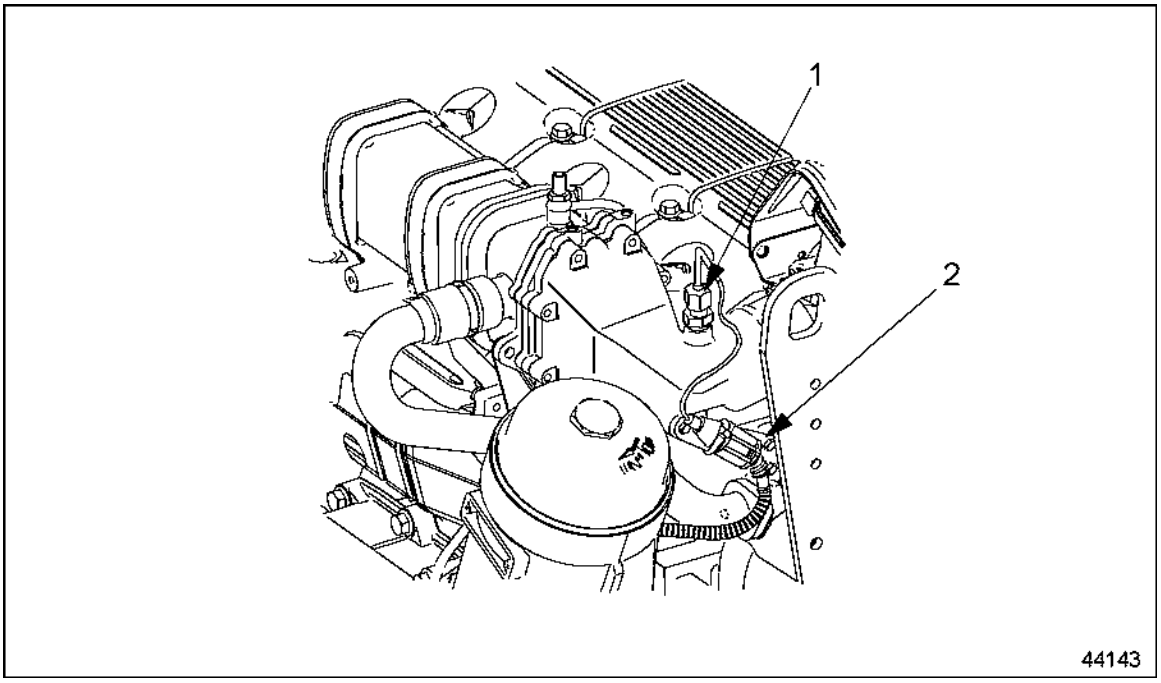



1. Coolant Outlet Pipe Bolts
2. Coolant Vent Line
3. Membrane
4. EGR Coolant Outlet Pipe
5. Coolant Outlet Pipe Bracket

**Figure 7-18 Removal of Coolant Vent Line and Coolant Outlet Pipe**

2. Remove the bolt attaching the coolant outlet pipe bracket to the pipe. Remove the bracket.
3. Remove the two bolts attaching the coolant outlet pipe flange to the coolant pump. Discard the gasket.

4. Pull the coolant outlet pipe away from the cooler, leaving the connecting membrane in the EGR cooler boss.
5. Remove the EGR temperature sensor from the reed valve housing and disconnect the sensor wiring harness where it is attached with cable ties to the reed valve housing mounting bracket. See Figure 7-19.

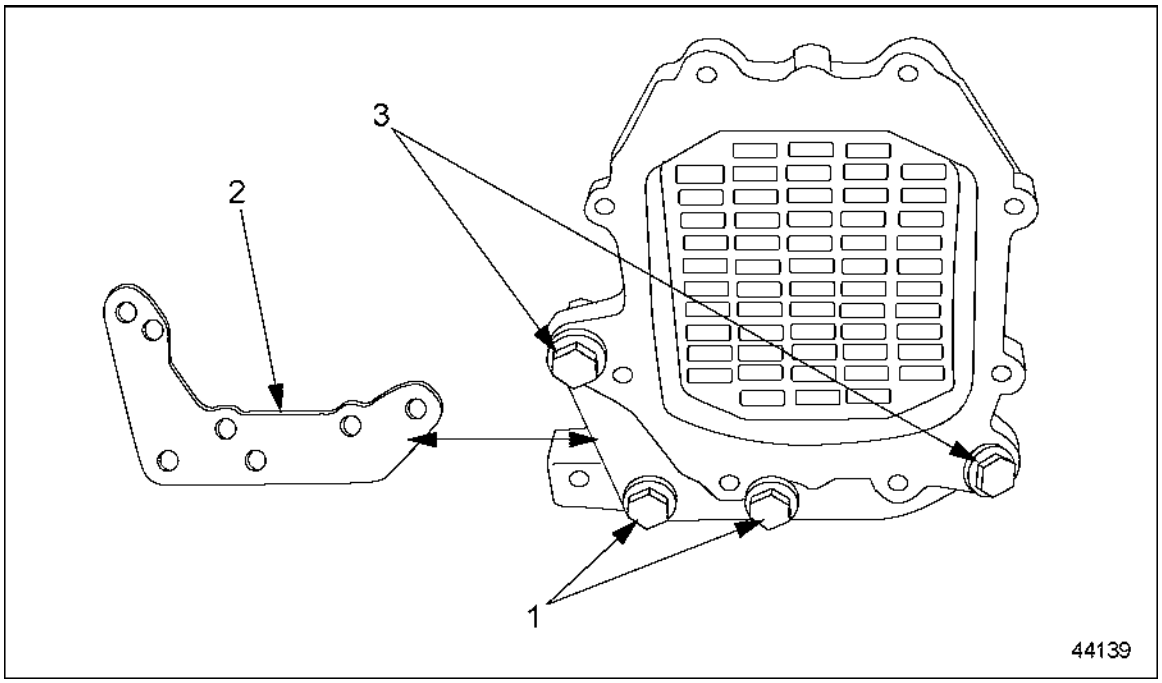



1. EGR Air Temperature Sensor
2. Reed Valve Housing Bracket

**Figure 7-19 Removing EGR Air Temperature Sensor**

6. Remove the three bolts from the front bracket that holds and stabilizes the reed valve housing to the thermostat housing. See Figure 7-19.

7. Remove the two front sheet metal support-to-cooler support bolts (See number 1 in graphic). See Figure 7-20.

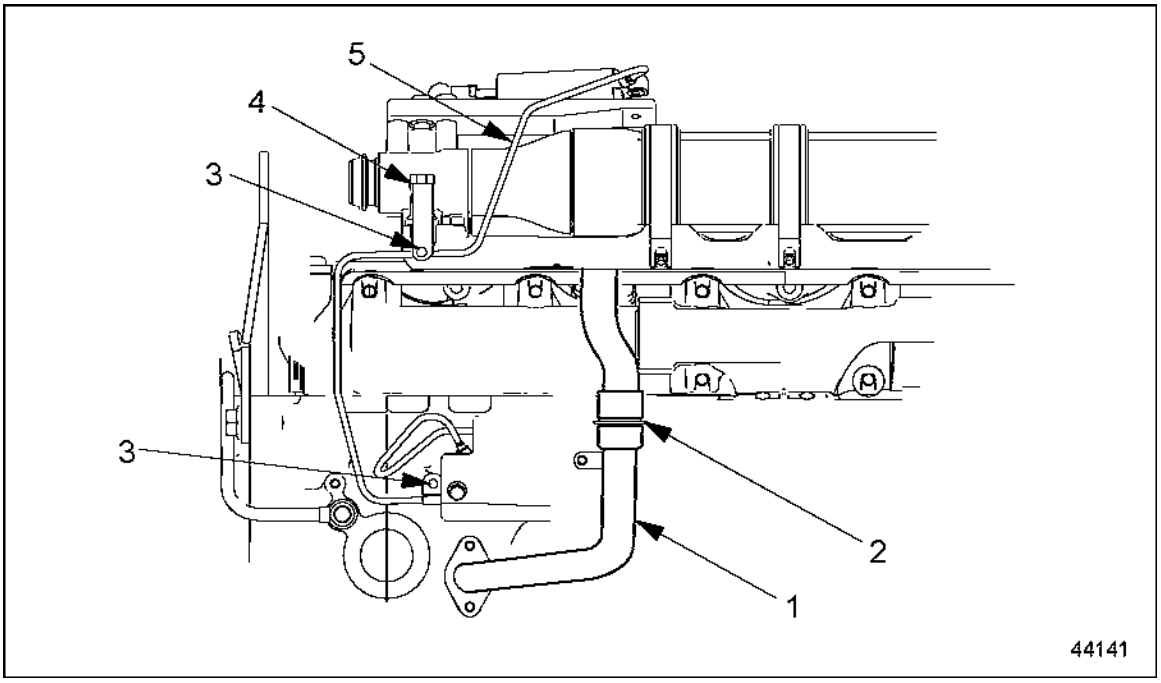



1. Front Sheet Metal Support-to-Cooler Support Bolts
2. Front Sheet Metal Support
3. EGR Cooler-to-Sheet Metal Support bolts

**Figure 7-20 Removing Front Sheet Metal Support**

**NOTE:**
Do not remove the eight mounting bolts attaching the reed valve housing to the cooler at this time. Also, do not remove the two EGR cooler-to-sheet metal support bolts at this time. They will all be removed once the EGR cooler as an assembly is taken off of the engine.

8. Remove the two bolts mounting the lower coolant inlet pipe to the block and remove the bracket bolt, just below the membrane, which attaches the lower coolant inlet pipe to the block. Remove gasket. See Figure 7-21.




1. Lower Coolant Inlet Pipe
2. Membrane
3. Air Line Mounting Bolts
4. Shut off Valve Housing Bolt (2 qty.)
4. Air Supply Line

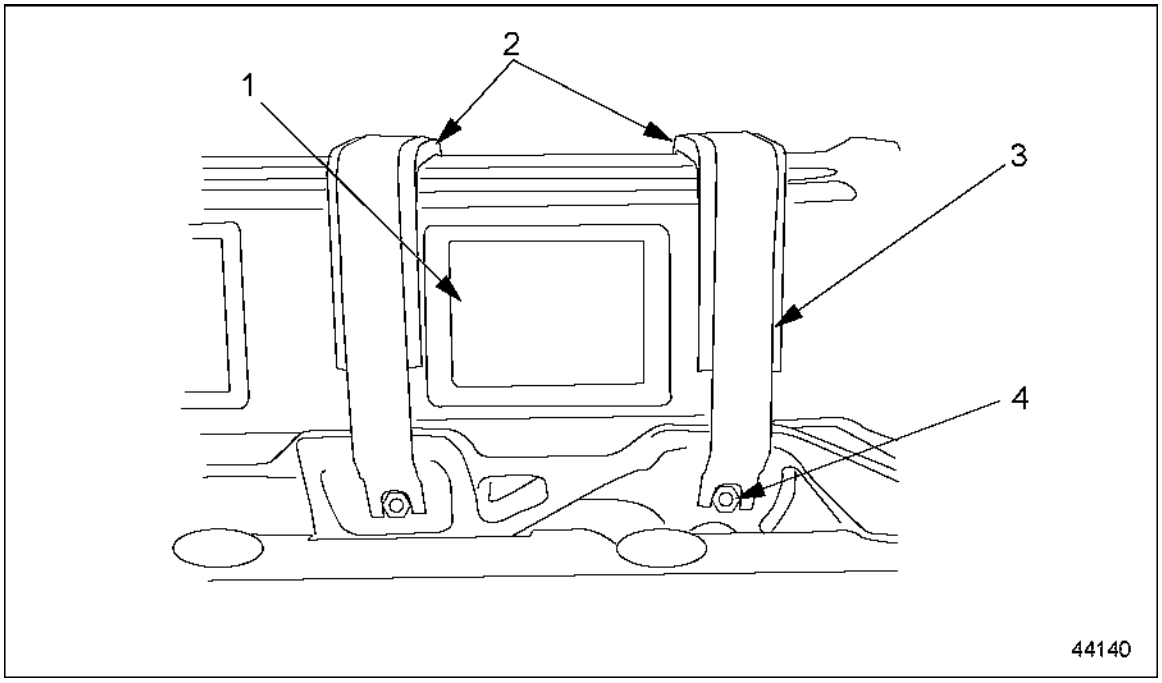
**Figure 7-21 Removing Coolant Inlet Pipe**

9. Pull down on the lower coolant inlet pipe to loosen it from the upper pipe. Remove the membrane also.

**NOTE:**
Have a container nearby to drain any unused coolant from the inlet pipes.

10. Remove the two shut off valve housing bolts that hold the valve housing to the EGR cooler support. See Figure 7-21.
11. Remove the air line mounting bolts. Loosen and remove the air supply line from the EGR shut off valve. See Figure 7-21.

12. Loosen and remove the four bolts from the four tightening clamps that are holding the EGR cooler to the cooler support bracket. Remove the four tightening tools for clamps also. See Figure 7-22.

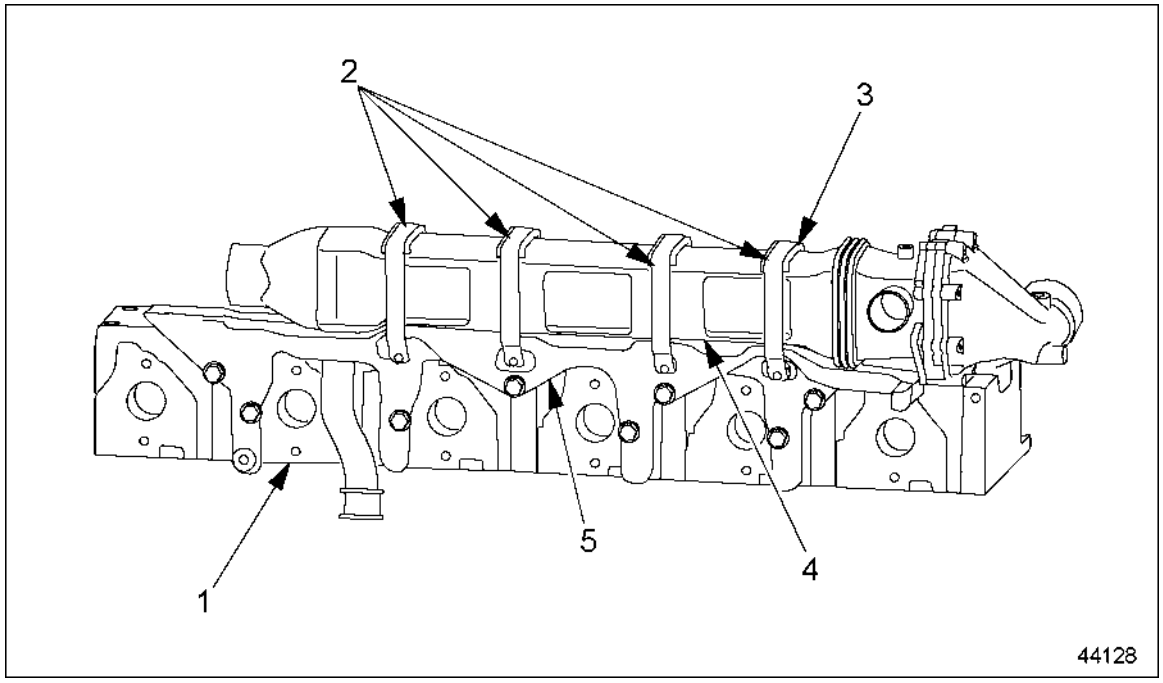



1. EGR Cooler
2. Tightening Tool for Clamps
3. Clamps (4 Qty.)
4. Clamp Bolts

**Figure 7-22 Removing Tightening Clamps on the Cooler**

**NOTE:**
The oil filter and oil filter cover should be removed for good clearance when removing and installing the EGR cooler assembly.

13. With the cooler completely loosened at this point, pull the cooler housing flange away from the EGR control valve. As the cooler is lifted, slide the cooler inlet pipe up through the opening in the cooler support bracket. See Figure 7-23.

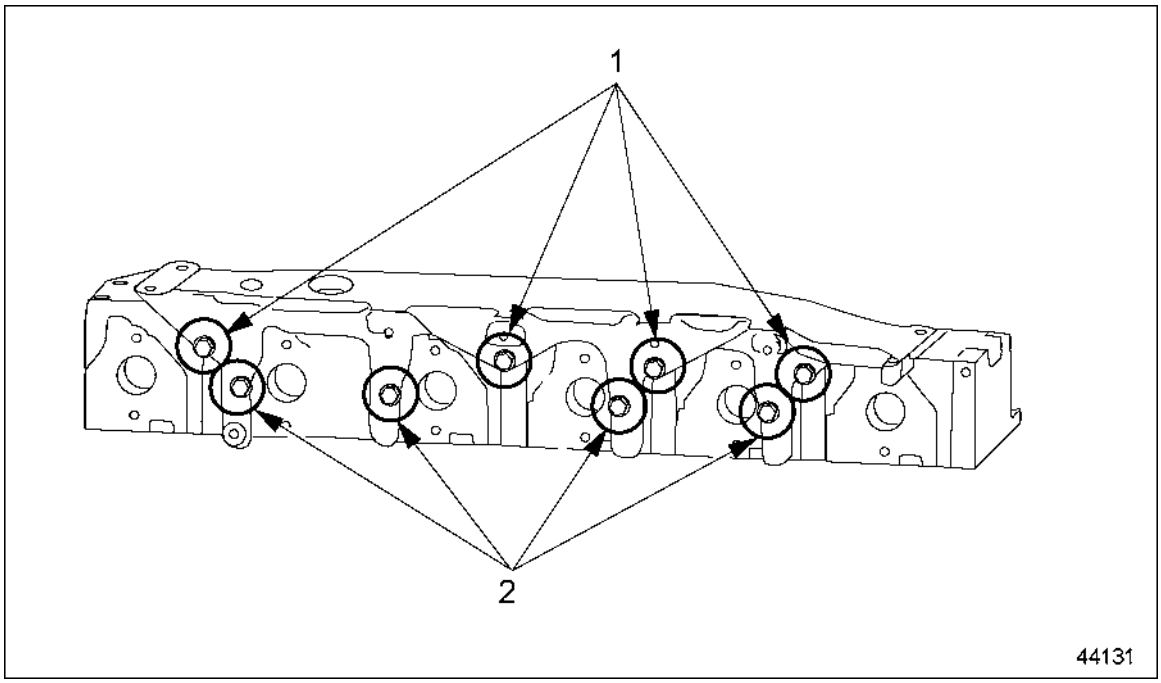



1. Cylinder Heads
2. EGR CoolerTightening Clamps
3. Tightening Tool for Clamps
4. EGR Cooler
5. EGR Cooler Support

**Figure 7-23 Removing EGR Cooler**

**NOTE:**
Before removing the eight bolts from the EGR cooler support, insert the four guide studs into the exhaust manifold gasket holes to support the gaskets once the cooler support is removed.

14. Remove the eight mounting bolts from the EGR cooler support and remove the support from cylinder heads.See Figure 7-24.

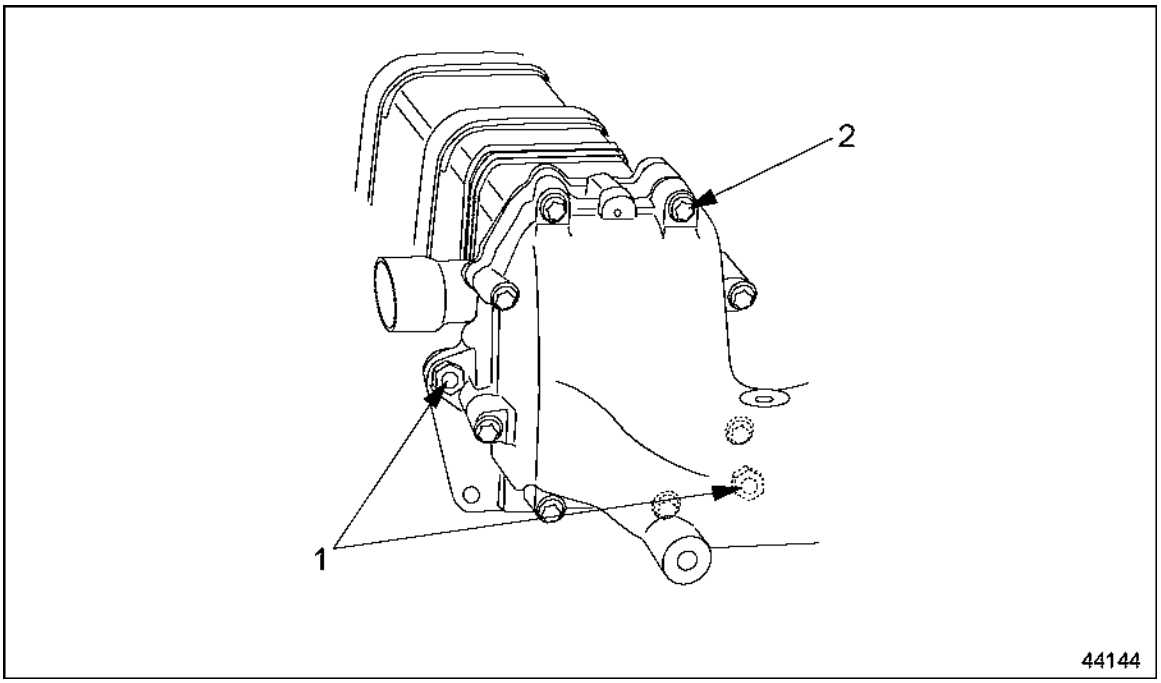



1. M10 x 65 mm bolts
2. M10 x 45 mm bolts

**Figure 7-24 Removing the EGR Cooler Support**

15. Remove the eight mounting bolts from the EGR cooler flange, which houses the reed valves.See Figure 7-25.

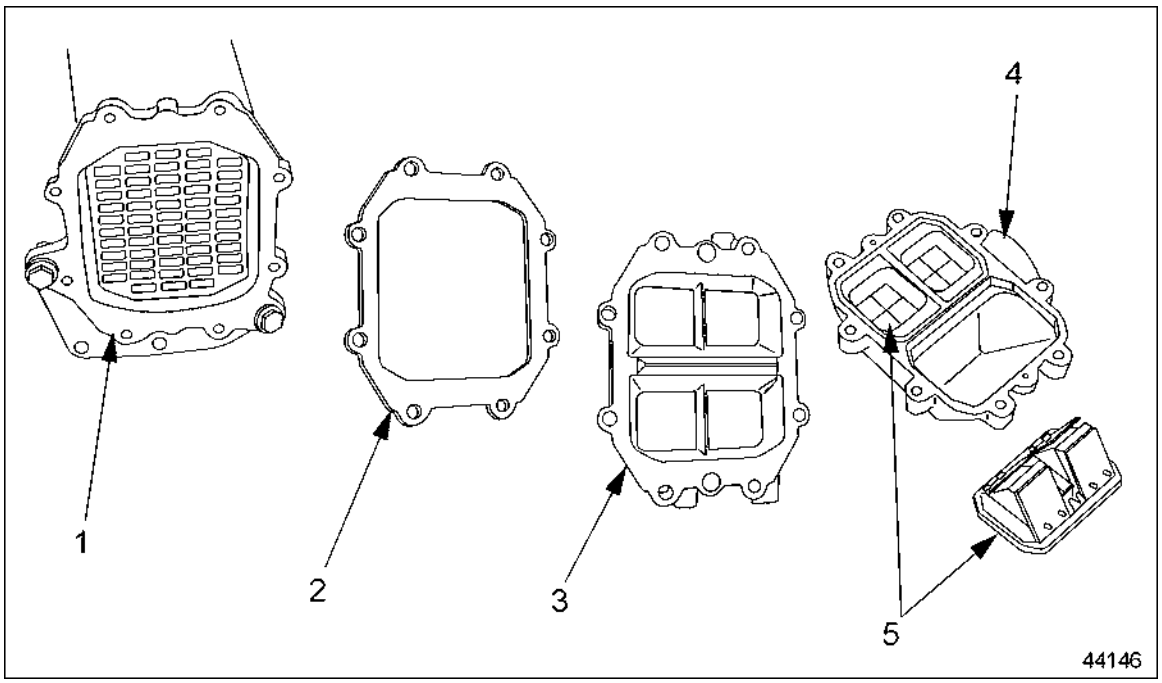



1. EGR Cooler-to- Sheet Metal Support Bolts
2. EGR Cooler Flange Bolts

**Figure 7-25 Removing the EGR Cooler Flange**

16. Remove the two EGR cooler-to-sheet metal support bolts. See Figure 7-25.

17. Remove the reed valves from housing. See Figure 7-26.




1. EGR Cooler Housing
2. EGR Cooler Gasket
3. EGR Cooler Intermediate Flange
4. EGR Reed Valve Flange
5. Reed Valves

**Figure 7-26 Removing the EGR Cooler Flange and Components**

18. Remove the intermediate flange and gasket from cooler flange assembly. See Figure 7-26.

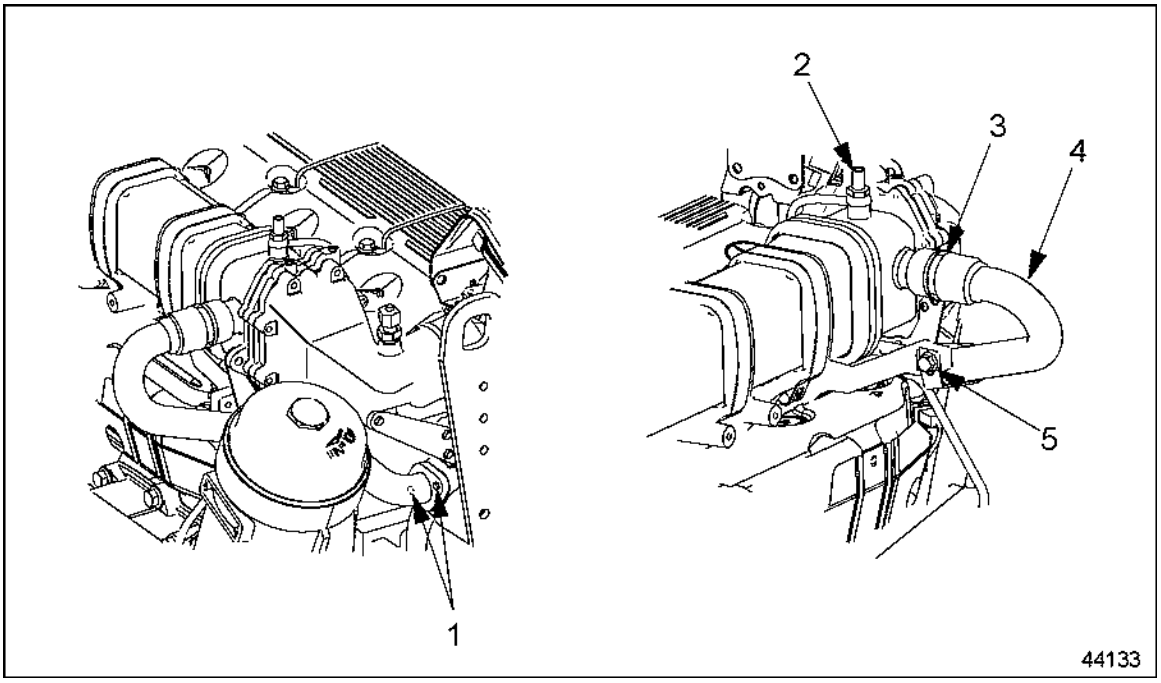
## 7.4.2 EGR Cooler and Support Bracket Installation

Install the EGR cooler and the EGR cooler support bracket as follows:

**NOTE:**
Exhaust manifold gaskets will have to be installed before EGR cooler support or cooler can be installed. Refer to section 7.3.2.

1. Install coolant outlet pipe. Install the two M8 x 25 mm bolts through the coolant pipe flange, metal gasket and into the coolant pump. Leave loose until the cooler assemly is installed, then torque bolts to 35 N·m (26 lb·ft). See Figure 7-27.

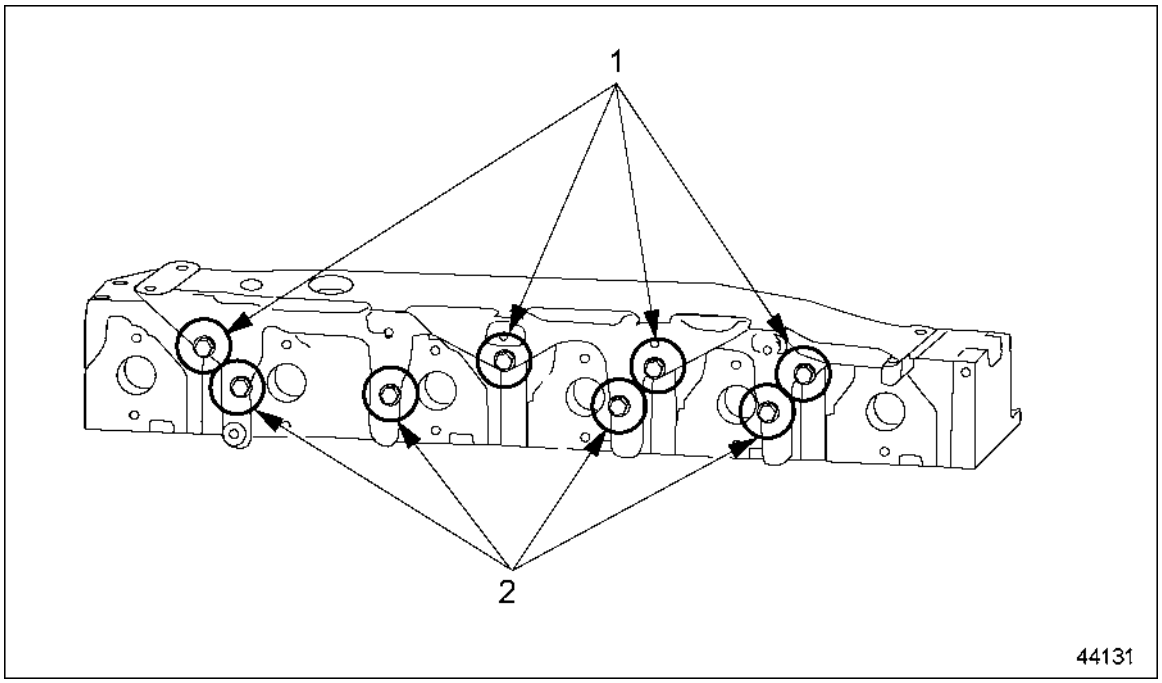



1. Coolant Outlet Pipe Bolts
2. Coolant Vent Line
3. Membrane
4. EGR Coolant Outlet Pipe
5. Coolant Outlet Pipe Bracket

**Figure 7-27 Installation of Coolant Outlet Pipe**

**NOTE:**
Coolant outlet pipe *must* be installed to coolant pump *before* the EGR cooler support and cooler are installed.

2. Install the cooler support to the cylinder heads using the eight mounting bolts. Torque all bolts to 25 N·m (19 lb·ft). See Figure 7-28.




1. M10 x 65 mm bolts
2. M10 x 45 mm bolts

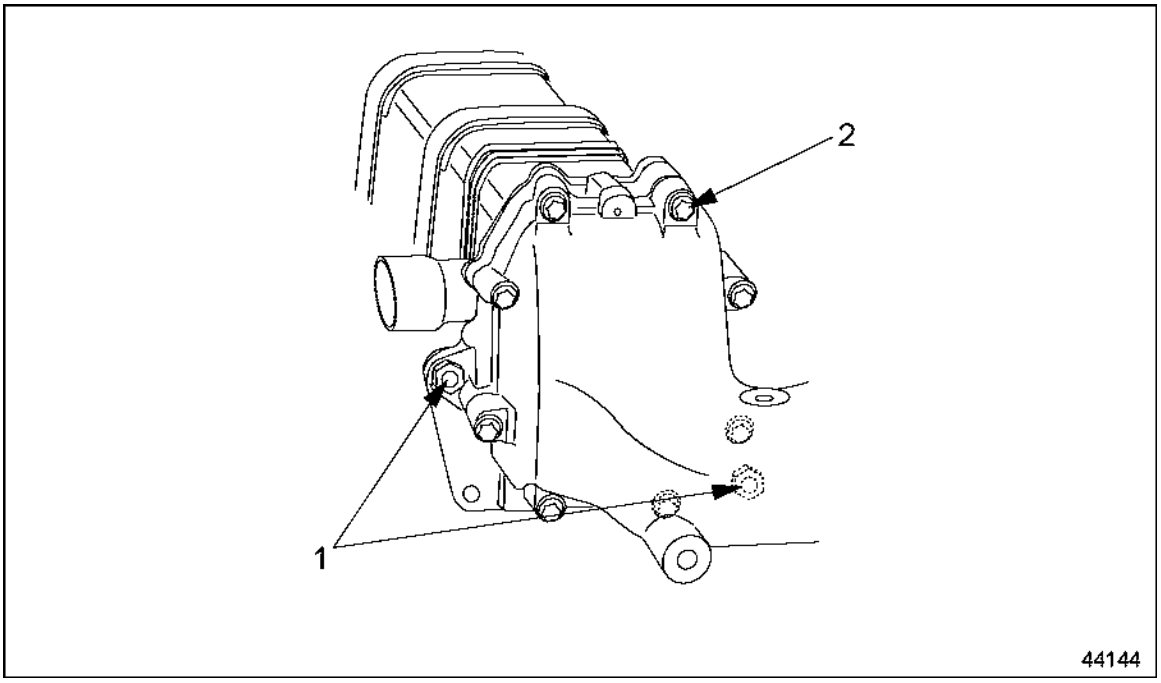
**Figure 7-28 Installing EGR Cooler Support**

**NOTE:**
If at this point the exhaust manifold gasket studs are still in place, they will need to be removed.

**NOTE:**
Assemble and attach the EGR reed valve housing to the cooler before mounting the cooler to the cooler support.

3. Insert the reed valves into the EGR reed valve housing flange.

4. Assemble the EGR reed valve housing flange, cooler intermediate flange, gasket and front sheet metal support together. Attach all to the cooler housing using the eight mounting bolts. Torque the bolts to 10 N·m (8 lb·ft). See Figure 7-29.

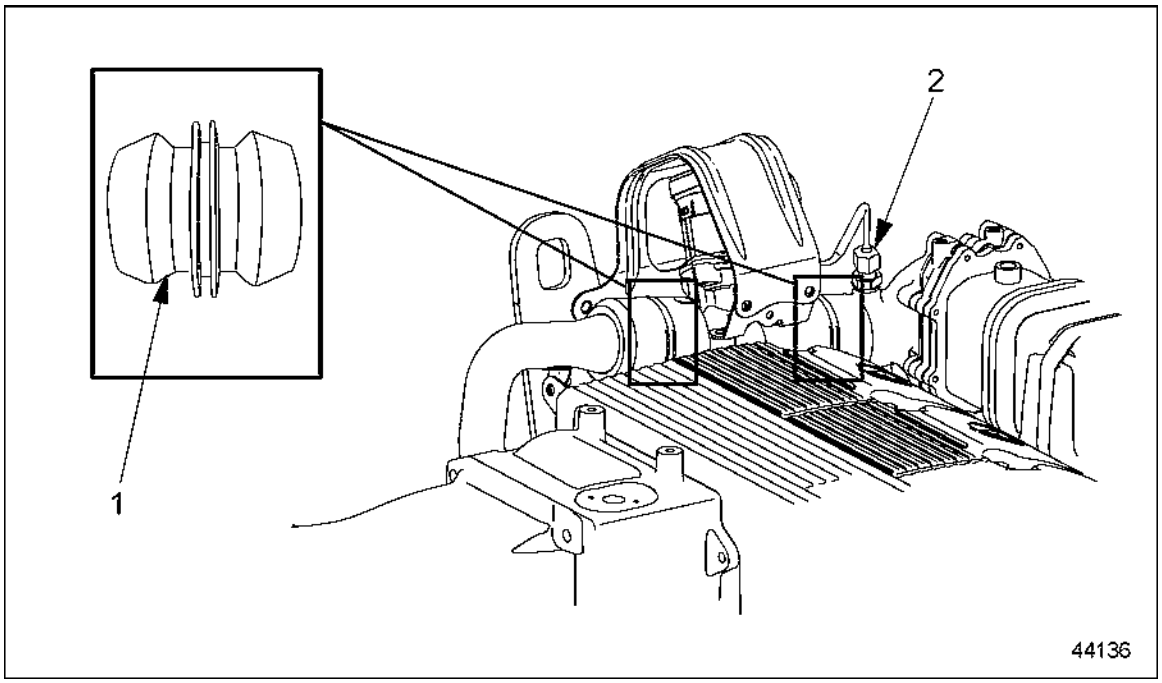



1. EGR Cooler-to- Sheet Metal Support Bolts
2. EGR Cooler Flange Bolts

**Figure 7-29 Installing the EGR Cooler Flange**

5. Attach the EGR cooler to the front sheet metal support with two bolts. Torque to 25 N·m (19 lb·ft). See Figure 7-29.

6. Using industrial petroleum grease, insert a membrane into the side of the EGR control valve that is closest to the EGR cooler. See Figure 7-30.



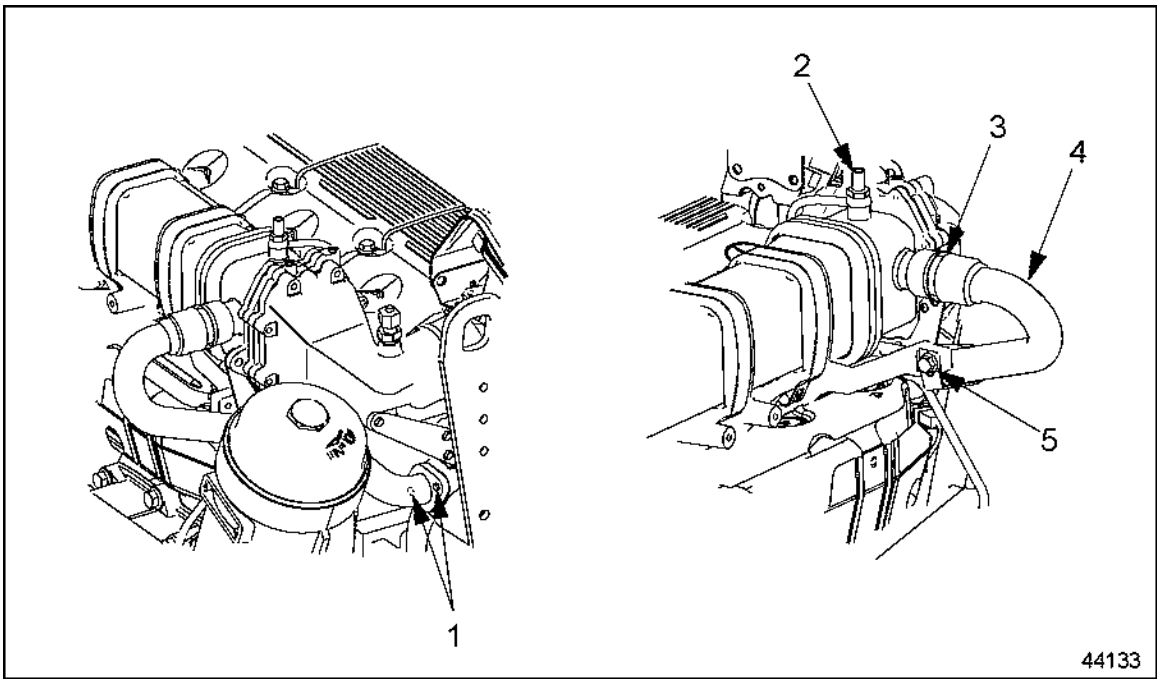

1. Symmetric membrane
2. EGR Temperature Sensor

**Figure 7-30 Installing Symmetric Membrane into EGR Valve**

7. Lift entire EGR cooler with attached cooler flange and sit this on top of cooler support, taking care to insert the upper half of the coolant inlet pipe down through the appropriate hole in the cooler support. At the same time, push the cooler flange into the membrane. See Figure 7-30.

**NOTE:**
The oil filter and oil filter cover should be removed for good clearance when removing and installing the EGR cooler assembly.

8. Insert the connecting membrane in the EGR cooler boss using industrial petroleum grease and push the EGR coolant outlet pipe onto the cooler. See Figure 7-31.



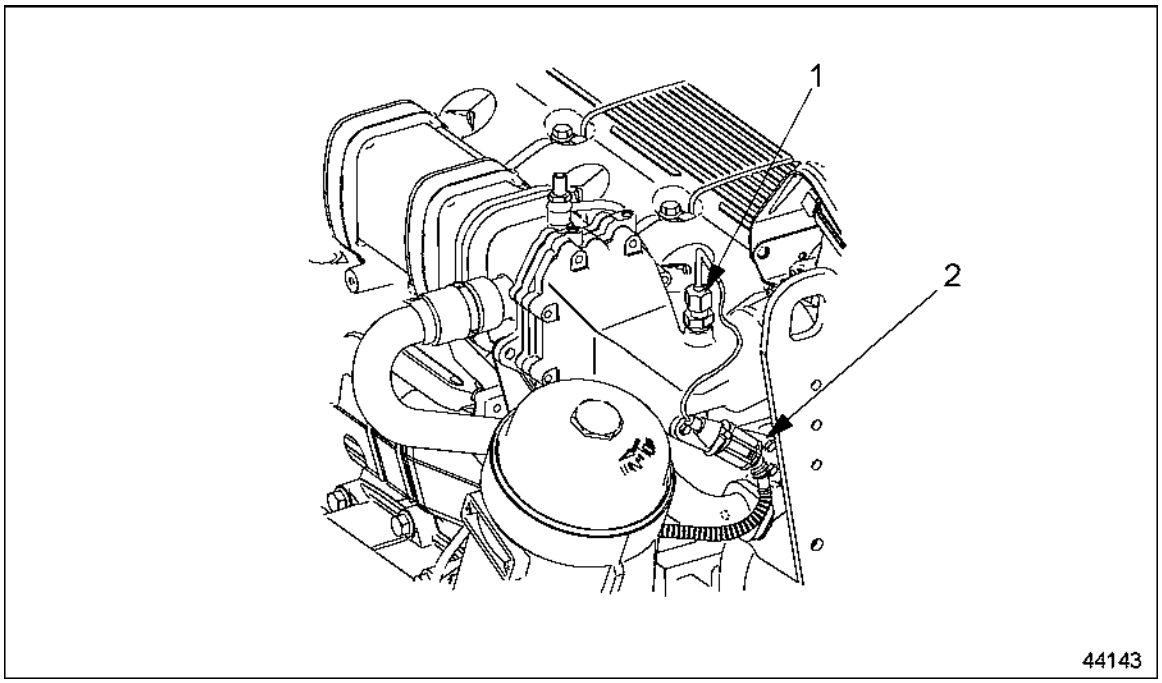

1. Coolant Outlet Pipe Bolts
2. Coolant Vent Line
3. Membrane
4. EGR Coolant Outlet Pipe
5. Coolant Outlet Pipe Bracket

**Figure 7-31 Installation of Coolant Vent Line and Coolant Outlet Pipe**

9. Attach front sheet metal support-to-cooler support using two M8 x 12 mm bolts. Torque to 25 N·m (19 lb·ft).
10. Install the bolt to the coolant outlet pipe bracket. Torque to 35 N·m (26 lb·ft). See Figure 7-31.
11. Install coolant vent line. Torque to 25 N·m (19 lb·ft).
12. Install the reed valve-housing bracket to the thermostat housing with the three mounting bolts. Torque to 25 N·m (19 lb·ft). See Figure 7-32.
13. Install the EGR air temperature sensor into reed valve housing flange. Torque to 25 N·m (19 lb·ft). Using plastic ties, attach remainder of sensor to reed valve-housing bracket.See Figure 7-32.

**NOTICE:**

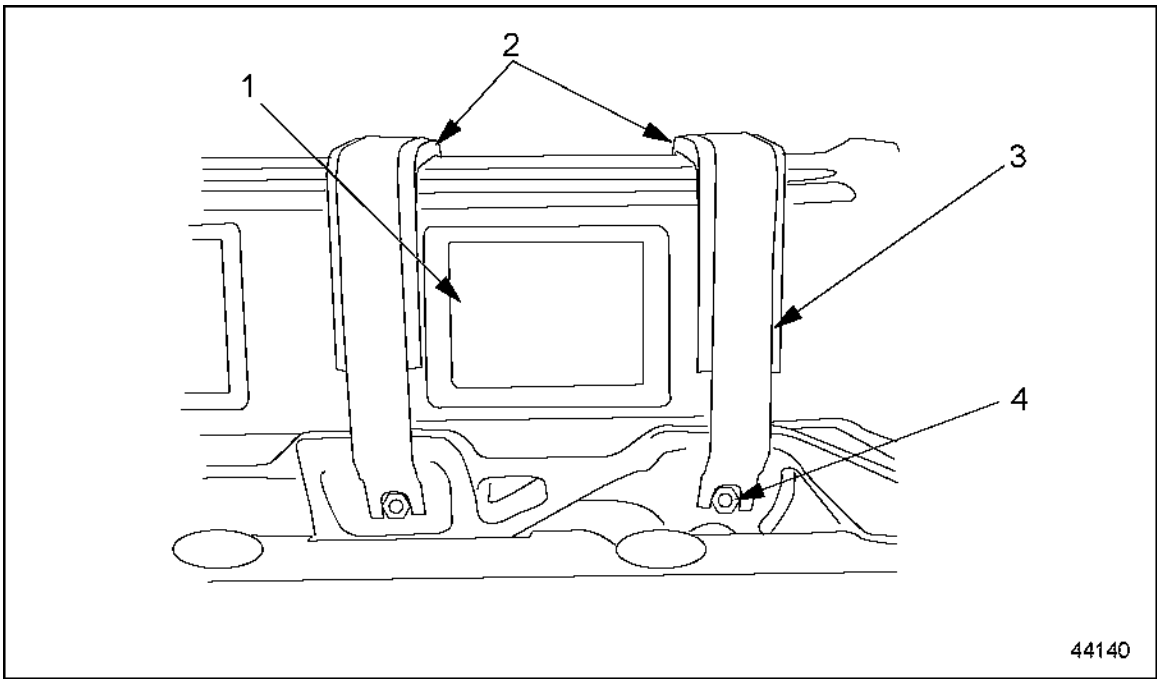
There is a possibility of installing the air temperature sensor wrong-sided. Take care to install it properly.




1. EGR Air Temperature Sensor
2. Reed Valve Housing Bracket

**Figure 7-32 Installing the EGR Air Temperature Sensor and Housing Bracket**

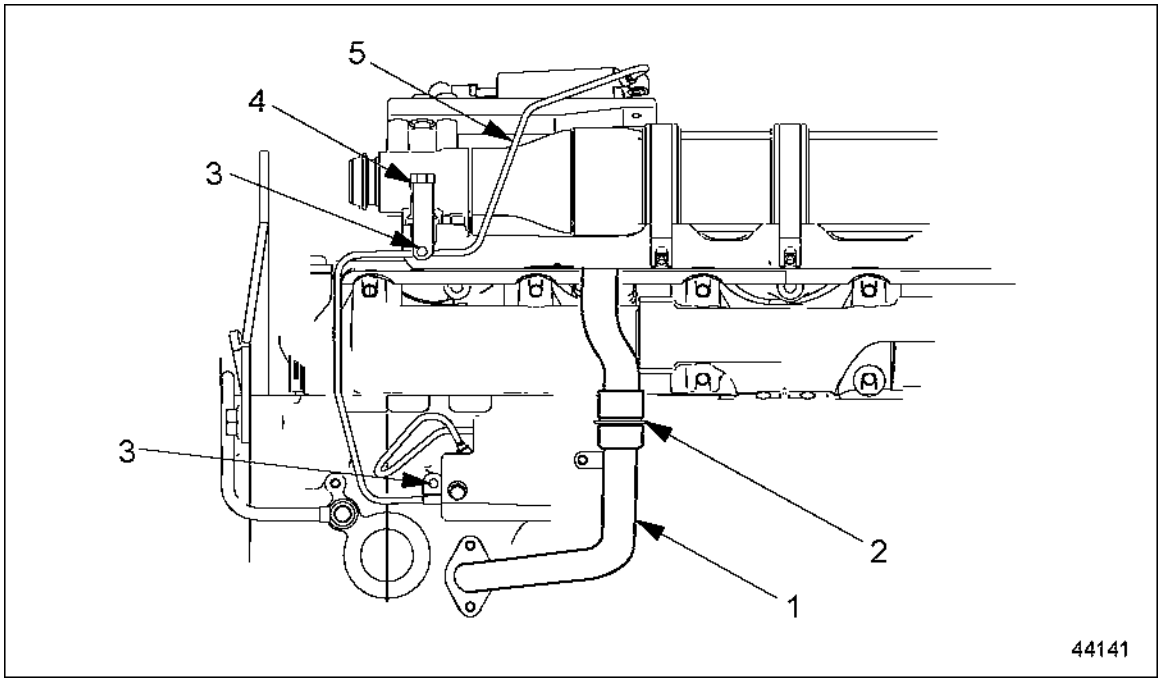
14. Install the four tightening tools with four tightening clamps that hold the EGR cooler to the cooler support bracket. Apply 10 N·m (8 lb·ft) clamping force to clamps. See Figure 7-33.




1. EGR Cooler
2. Tightening Tool for Clamps
3. Clamps (4 Qty.)
4. Clamp Bolts

**Figure 7-33 Installing Tightening Clamps on the Cooler**

15. Fit lower coolant inlet pipe into the symmetric membrane. Install the two bolts in the metal gasket and engine block. Also install bolt in pipe support bracket. Torque both bolts to 35 N·m (26 lb·ft).




1. Lower Coolant Inlet Pipe
2. Membrane
3. Air Line Mounting Bolts
4. Shut off Valve Housing Bolt (2 qty.)
4. Air Supply Line

**Figure 7-34 Installing Coolant Inlet Pipe**

16. Tighten EGR shutoff valve using two bolts. Torque to 35 N·m (26 lb·ft).
17. Install and attach air supply line using two mounting bolts. Torque to ?

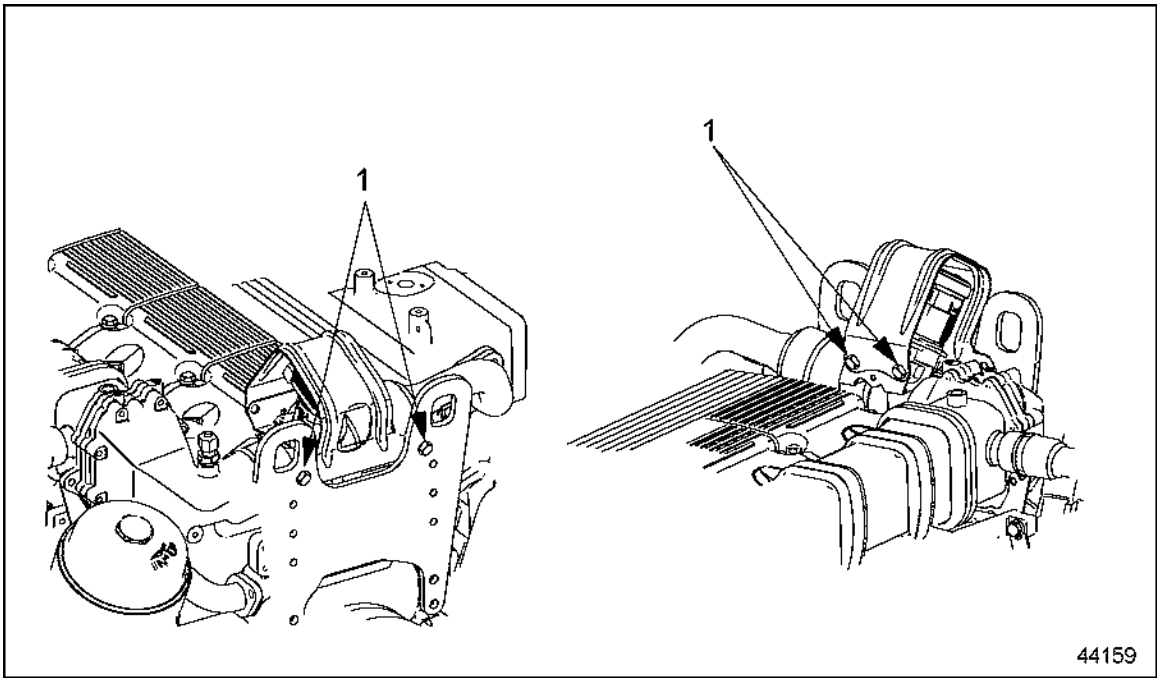
## 7.5 EGR CONTROL VALVE, GAS OUTLET PIPE, AND GAS MIXER

The EGR control valve controls the quantity of exhaust gas returning back to the intake manifold.

### 7.5.1 Removal of EGR Control Valve, Gas Outlet Pipe, and Gas Mixer

Remove the EGR control valve, gas outlet pipe, and gas mixer as follows:

1. Remove the EGR control valve cover mounting bolts attached to the front lifter bracket and to the rear of the EGR valve. See Figure 7-35.

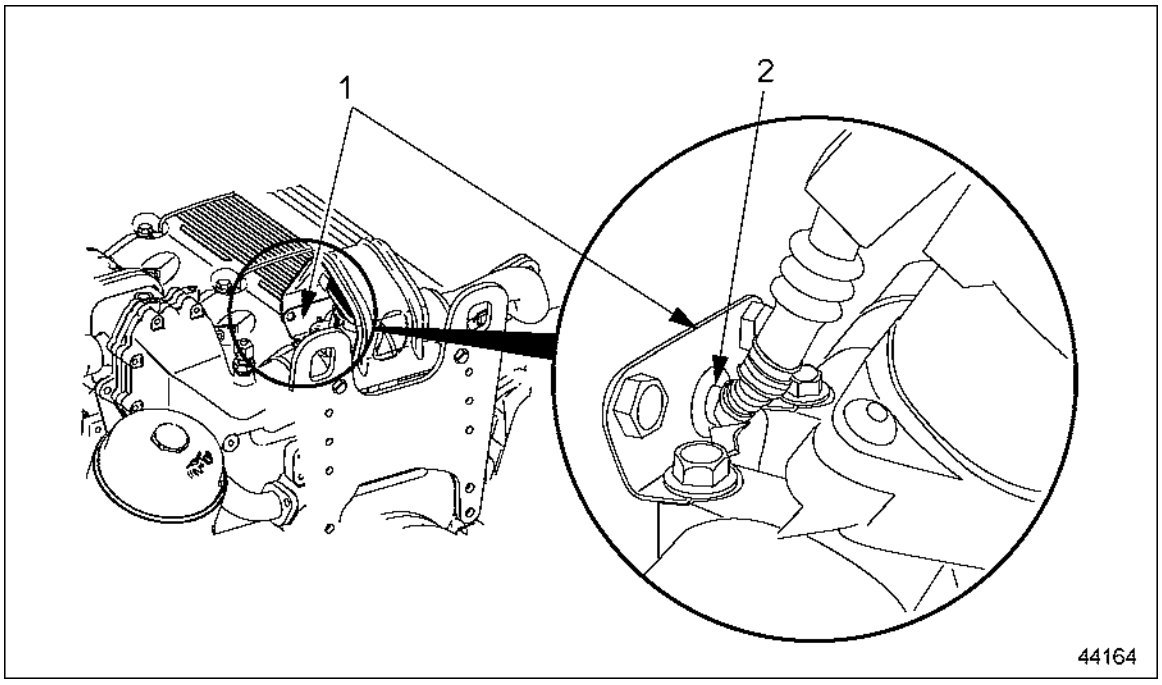



1. EGR Control Valve Cover Mounting Bolts

**Figure 7-35 Removal of EGR Control Valve Cover**

2. Loosen the wiring harness terminal from the back cover mounting bracket by punching the push-mount cable tie out of the drilled hole in the mounting bracket. Remove the two

mounting bolts attaching the back cover bracket to the control valve. See Figure 7-36. Remove back bracket.

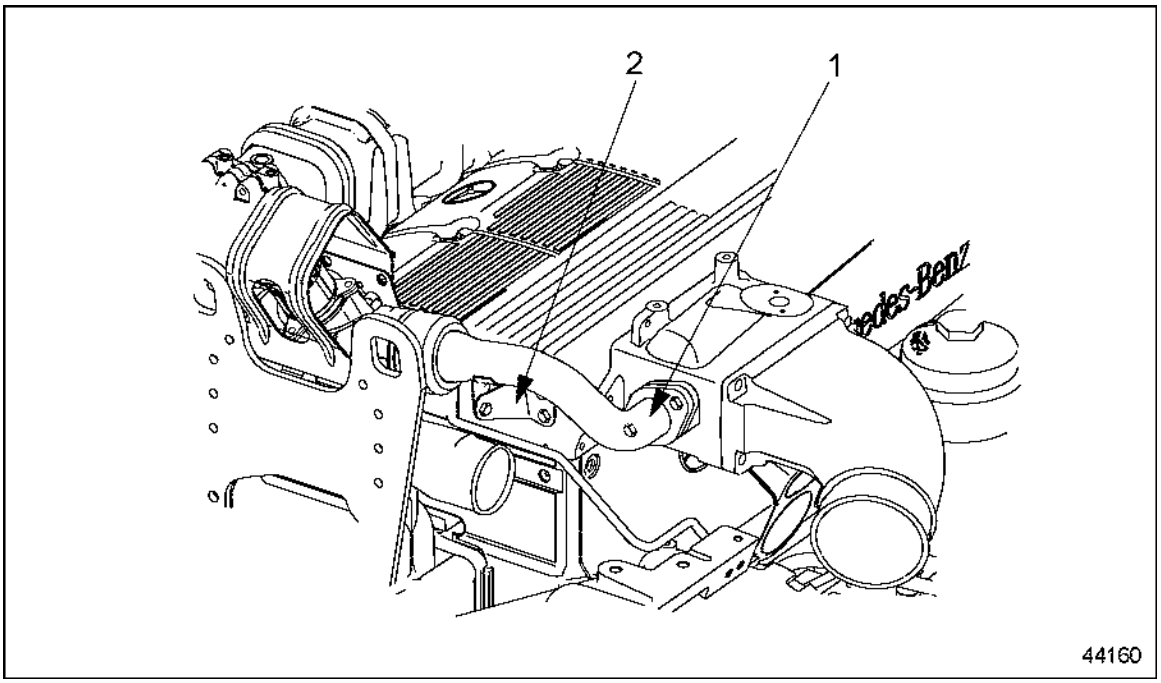



1. EGR Control Valve Back Mounting Bracket
2. Push-Mount Cable Tie

**Figure 7-36 Removing the Back Control Valve Cover Bracket**

3. Remove the two bolts from gas outlet pipe attaching the pipe to the gas mixer. See Figure 7-37.

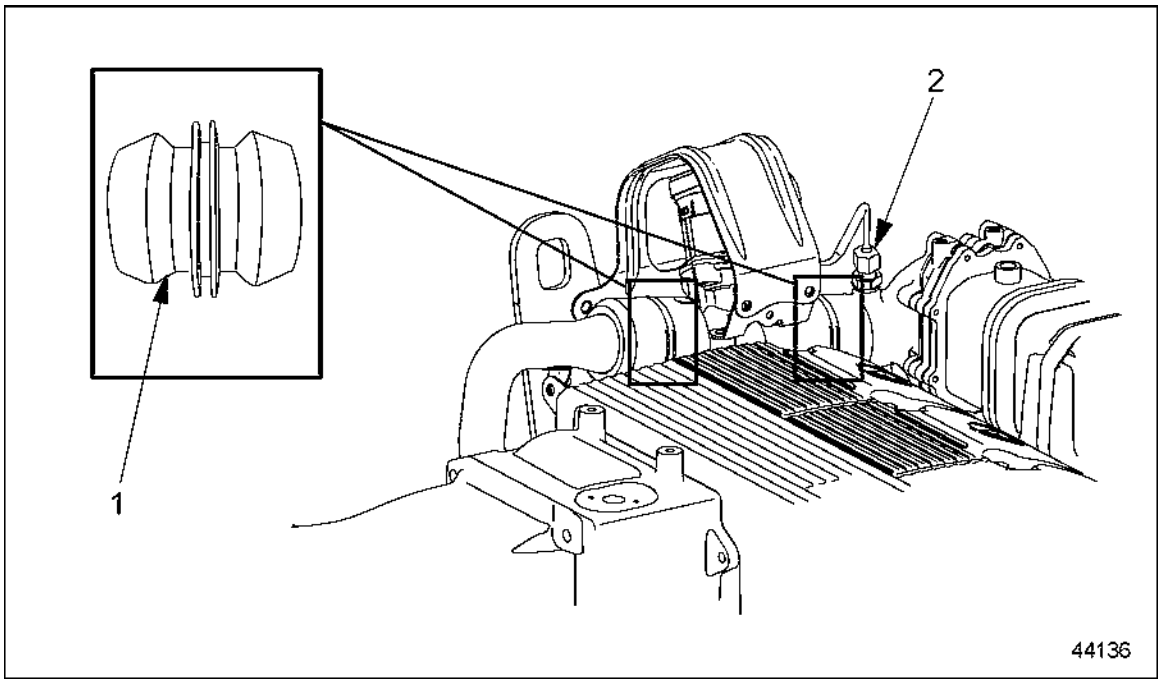



1. Gas Outlet Pipe Flange
2. Gas Outlet Pipe Mounting Bracket

**Figure 7-37 Removal of EGR Gas Outlet Pipe**

4. Remove the metal gasket.
5. Remove the three bolts that attach the gas outlet pipe mounting bracket to the intake manifold and to the outlet pipe. See Figure 7-37.

6. Pull outlet pipe away from mixer and from the EGR control valve, exposing the membrane in the control valve. See Figure 7-38.

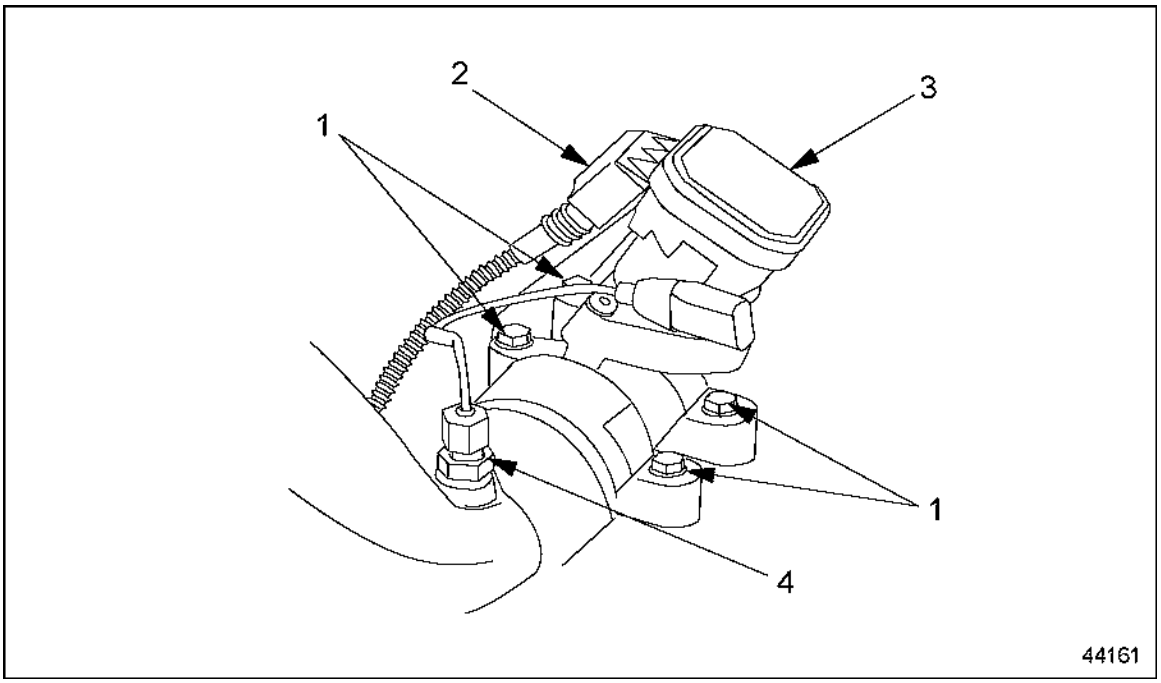



1. Membrane
2. EGR Temperature Sensor

**Figure 7-38 Removing the Symmetric Membrane on Gas Outlet Pipe Side**

7. Remove membrane from the EGR control valve.
8. Disconnect wiring harness terminal from valve connector. See Figure 7-39.

9. Remove the four bolts attaching the EGR control valve to the thermostat housing. See Figure 7-39.

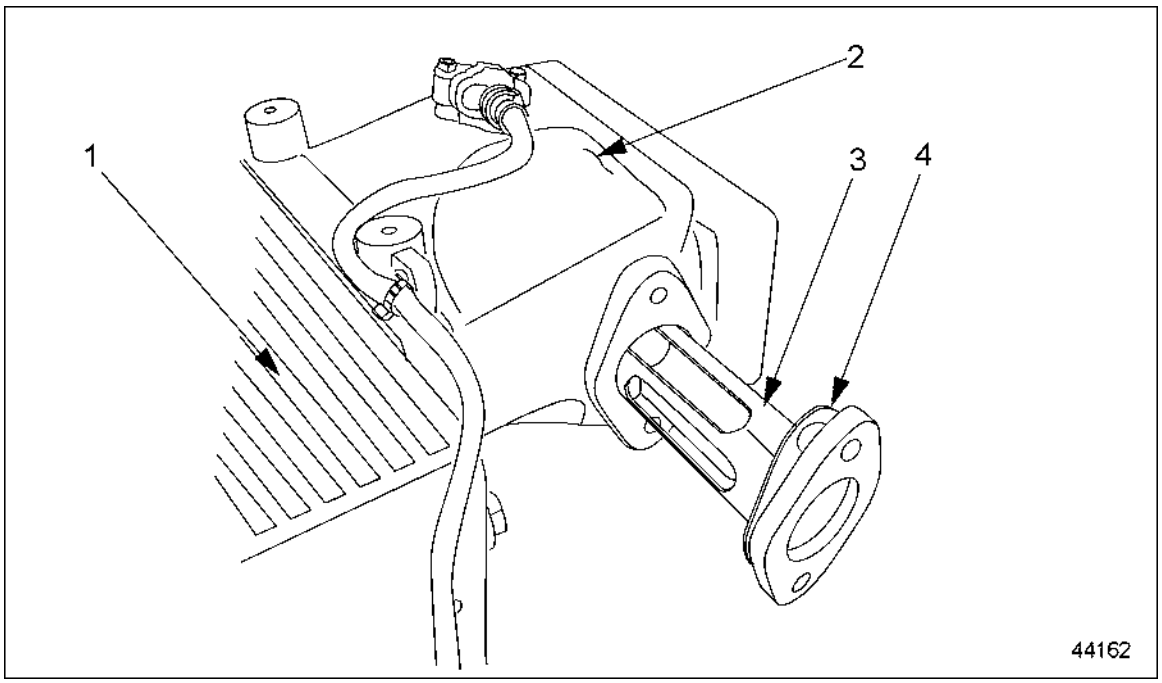



1. EGR Control Valve Mounting Bolts
2. Wiring Harness Terminal
3. EGR Control Valve
4. EGR Temperature Sensor

**Figure 7-39 Removal or Installation of EGR Control Valve**

10. Pull the EGR control valve out of the reed valve housing flange.
11. Remove symmetric membrane from the housing flange. See Figure 7-38.

12. Pull the gas mixing pipe and metal gasket out of the air inlet pipe of mixer. See Figure 7-40.

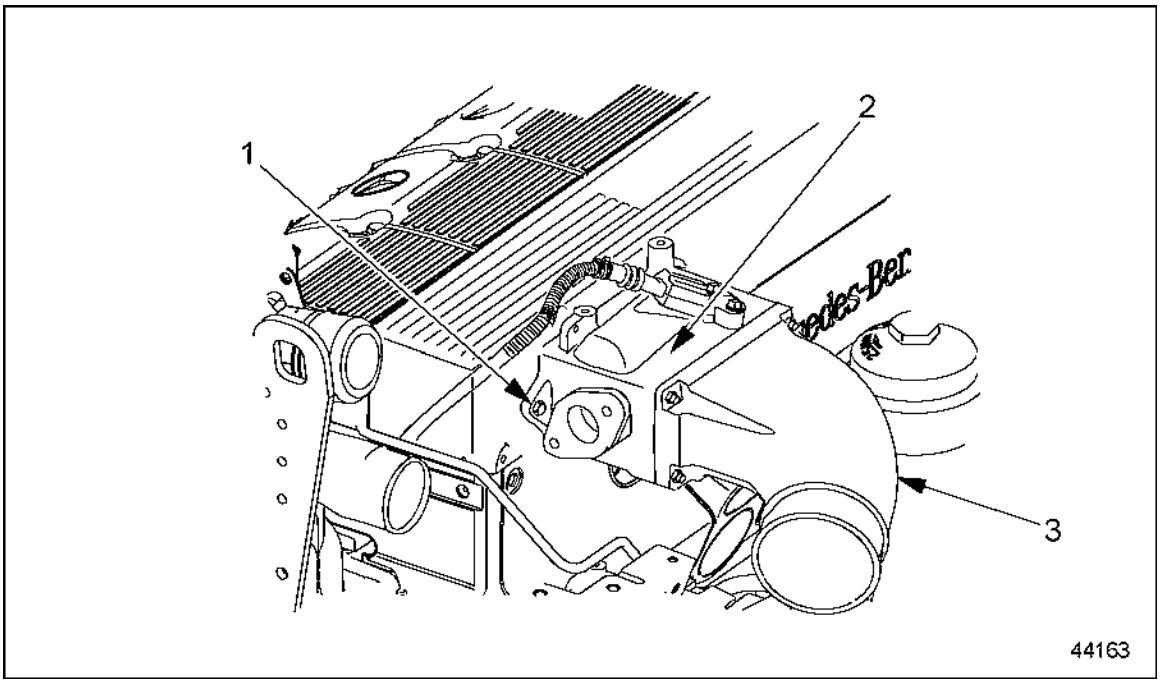



1. Intake Manifold
2. AIr Inlet Mixer
3. Gas Mixing Pipe
4. Metal Gasket

**Figure 7-40 Removal of Gas Mixing Pipe**

13. Remove the turbo boost/air temperature sensor attached to the gas mixer.

14. Remove the four bolts that attach the air intake pipe to the gas mixer. Remove the metal gasket as well. See Figure 7-41.




1. Air Inlet Mixer Mounting Bolts (2 qty.)
2. EGR Gas Mixer
3. Air Inlet Pipe

**Figure 7-41 Removal of EGR Gas Mixer**

15. Remove the two bolts that attach the EGR gas mixer to the intake manifold. See Figure 7-41. Pull gas mixer off of four long studs away from intake manifold.
16. Unscrew the four studs from intake manifold.
17. Remove the metal gasket.

## 7.5.2 Installation of EGR Control Valve, Gas Outlet Pipe, and Gas Mixer

Install the EGR control valve and gas outlet pipe as follows:

1. Insert a symmetric membrane into the reed valve housing flange using industrial petroleum jelly. See Figure 7-38.
2. Insert the EGR control valve onto this membrane using petroleum jelly.
3. Install the back two bolts of the EGR control valve (M8 x 90 mm). Install the front two bolts (those closest to the front lifter bracket) of the EGR control valve (M8 x 40 mm). Torque all bolts to 25 N·m (19 lb·ft).
4. Using two bolts, install the back control valve bracket that holds the wiring harness terminal in place. Torque to 25 N·m (19 lb·ft).

5. Connect wiring harness terminal to valve connector.
6. Insert a second membrane into the right side of the EGR control valve housing using industrial petroleum jelly.
7. Taking the EGR gas outlet pipe in hand, fit component manually onto symmetric membrane, using petroleum jelly.
8. Install the four gas mixer mounting studs into the intake manifold.
9. Install metal gasket over studs.
10. Fit gas mixer over mounting studs and push on as far as possible.
11. Install the gas mixing pipe into the air inlet pipe of mixer using a new metal gasket. See Figure 7-40.

| **NOTICE:** |
| --- |
| To avoid any engine damage, ensure that the gas passage of the mixing pipe is turned towards the intake manifold. |

**NOTE:**
Due to its ackward shape, gas outlet pipe must be mounted to gas mixer before the gas mixer can be firmly attached to intake manifold.

12. Mount gas outlet pipe to gas mixer using a new metal gasket and two M8 x 16 mm bolts. Adjust gas mixer if necessary to accommodate the gas outlet pipe. Torque to 25 N·m (19 lb·ft).
13. Position support bracket in place for gas outlet pipe. Install bracket using three M8 x 16 mm bolts. Torque to 25 N·m (19 lb·ft).
14. Install the air inlet pipe to the gas mixer using four nuts. Torque to 50 N·m (37 lb·ft). See Figure 7-41.
15. Install the turbo boost/air intake temperature sensor to the gas mixer.

## 7.6 EPV (ELECTRONIC PROPORTIONAL VALVE) AND WABCO® AIR SOLENOID VALVE

Listed in Table 7-4 is each proportional valve listed and the component it activates.

| Proportional Valve | Component |
|---|---|
| PV1 | Exhaust flap enable + EGR shutoff valve or boost control = wastegate valve (Turbobrake) |
| PV2 | EGR control valve |
| PV3 | Fan |
| PV4 | Fan |
| PV5 | CTV (Constant Throttle Valve) |
| PV6 | Turbobrake sliding sleeve + EGR shutoff valve |

**Table 7-4 Proportional Valve Chart**

### 7.6.1 Removal of EPV Valve and Wabco Air Solenoid Valve

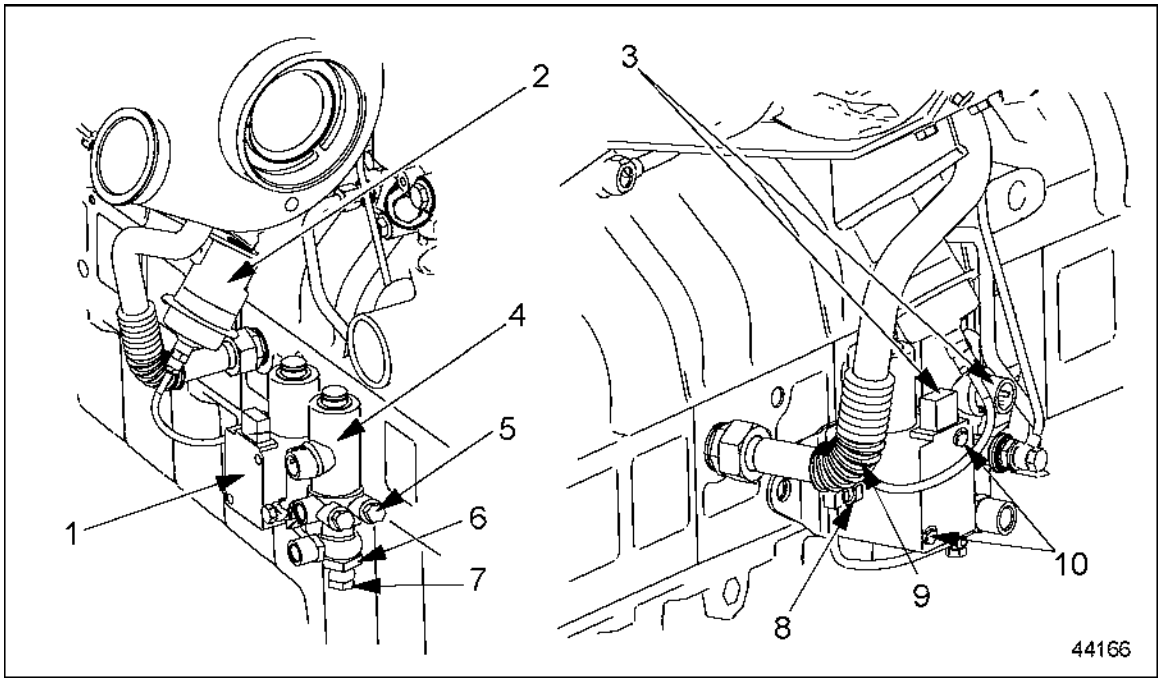
Perform the following steps to remove the EPV valve, Wabco air solenoid valve and all the corresponding connections:

1. Disconnect wiring harness from the EPV valve and the Wabco solenoid valve.

**⚠ CAUTION:**

**To avoid injury from the sudden release of a high-pressure hose connection, wear a face shield or goggles.**

2. Disconnect the compressed air pipe between inlet connection installed at EPV valve and turbo brake actuator. See Figure 7-42.




1. EPV (Electronic Proportional Valve)
2. Wastegate
3. Electric Wiring Harness Terminals
4. Wabco Valve
5. Solenoid Valve Mounting Bolts
6. Large Hollow Screw
7. Small Hollow Screw
8. EPV Valve Inlet
9. EPV Valve Outlet (hidden)
10. EPV Valve Mounting Bolts

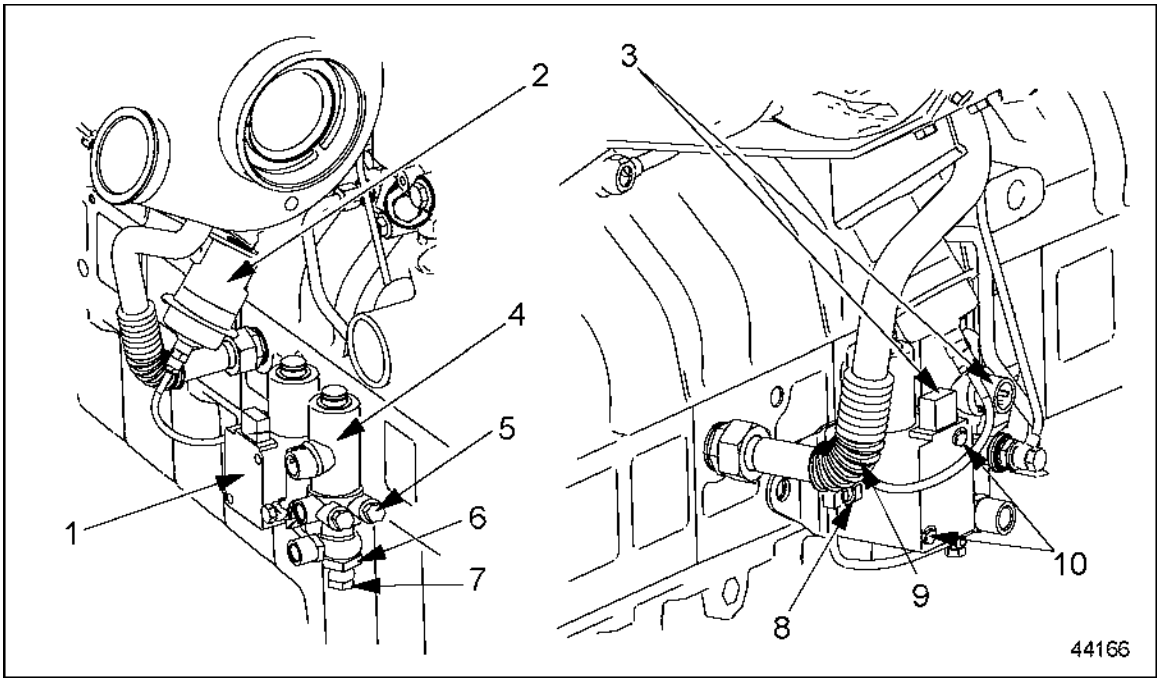
**Figure 7-42 Installing the EPV Valve / Wabco Solenoid Valve**

3. Remove the smaller hollow screw below the larger hollow screw.
4. Disconnect the inlet and outlet connections at EPV pressure regulating valve.
5. Remove the large hollow screw in threaded connection.
6. Remove the two M8 x 50 mm bolts that hold the EPV valve on the left side of bracket.
7. Remove the two M8 x 50 mm bolts that hold the Wabco solenoid valve on the right side of bracket.
8. Remove the two M14 x 25 mm bolts that hold the EPV/solenoid valve bracket to the block.

## 7.6.2 Installation of EPV Valve and Wabco Air Solenoid Valve

Perform the following steps to install the EPV valve, Wabco air solenoid valve and all corresponding connections:

1. Install the EPV/solenoid valve bracket to the block with two M14 x 25 mm bolts. Torque to 100 N·m (74 lb·ft).
2. Mount the Wabco solenoid valve on right side of bracket using two M8 x 50 mm bolts. Apply 25 N·m (19 lb·ft) tightening torque. See Figure 7-43.




1. EPV (Electronic Proportional Valve)
2. Turbo Brake Actuator
3. Electric Wiring Harness Terminals
4. Wabco Valve
5. Solenoid Valve Mounting Bolts
6. Hollow Screw
7. Small Hollow Screw
8. EPV Valve Inlet
9. EPV Valve Outlet (hidden)
10. EPV Valve Mounting Bolts

**Figure 7-43 Installing the EPV Valve / Wabco Solenoid Valve**

3. Mount the EPV valve on left side of bracket using two M8 x 50 mm bolts. Torque to 25 N·m (19 lb·ft) tightening torque.
4. Install large hollow screw in threaded connection. Torque to 50 N·m (37 lb·ft). See Figure 7-43.

**⚠ CAUTION:**

**To avoid injury from the sudden release of a high-pressure hose connection, wear a face shield or goggles.**

5. Install inlet and outlet connections at EPV pressure regulating valve. Torque to 15 N·m (11 lb·ft).

**NOTICE:**

Avoid friction on compressed air pipe traveling under the EPV valve or potential damage to engine could result.

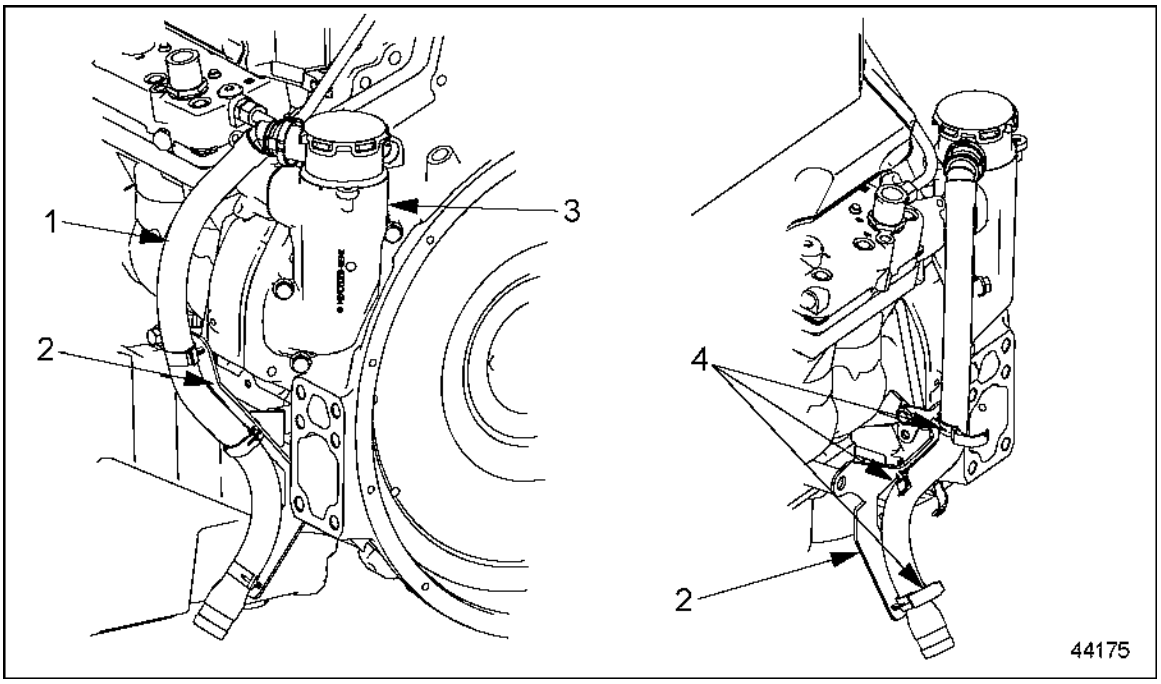
6. Install smaller hollow screw below larger hollow screw, securing connection. Torque to 15 N·m (11 lb·ft).
7. Fit the pipe between inlet connection installed at EPV valve and turbo brake actuator.
8. Connect wiring harness to EPV valve and Wabco valve.

## 7.7 HENGST® BREATHER FILTER

### 7.7.1 Removal of Hengst Filter and Bracket

Perform the following steps to remove the Hengst filter:

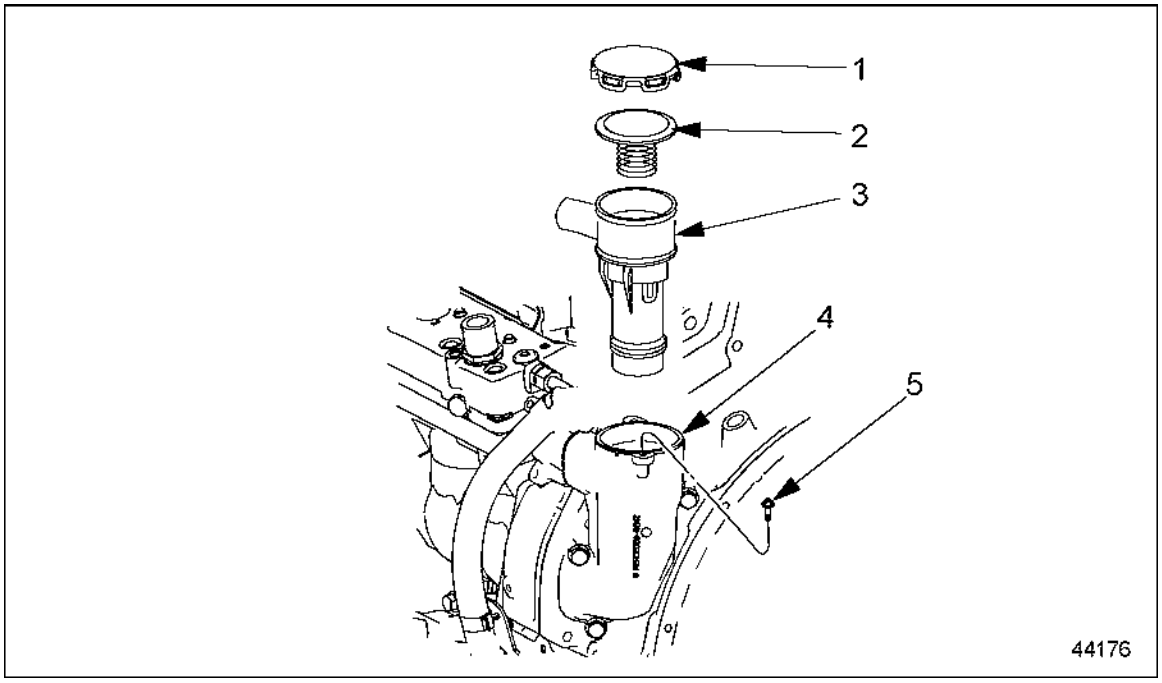
1. Disconnect the breather piping from the Hengst filter. See Figure 7-44.




1. Filter Piping
2. Filter Piping Bracket
3. Hengst Filter
4. Plastic Clamps

**Figure 7-44 Removal of Hengst Filter and Related Parts**

2. Unsnap the filter cap and remove the spring and diaphragm insert from centrifugal filter. Remove the two assembly bolts from the breather filter assembly, and pull the breather assembly out. See Figure 7-45.




1. Filter Cap
2. Spring and Diaphragm
3. Centrifugal Filter
4. Breather
5. Assembly Bolt

**Figure 7-45 Hengst Filter Assembly**

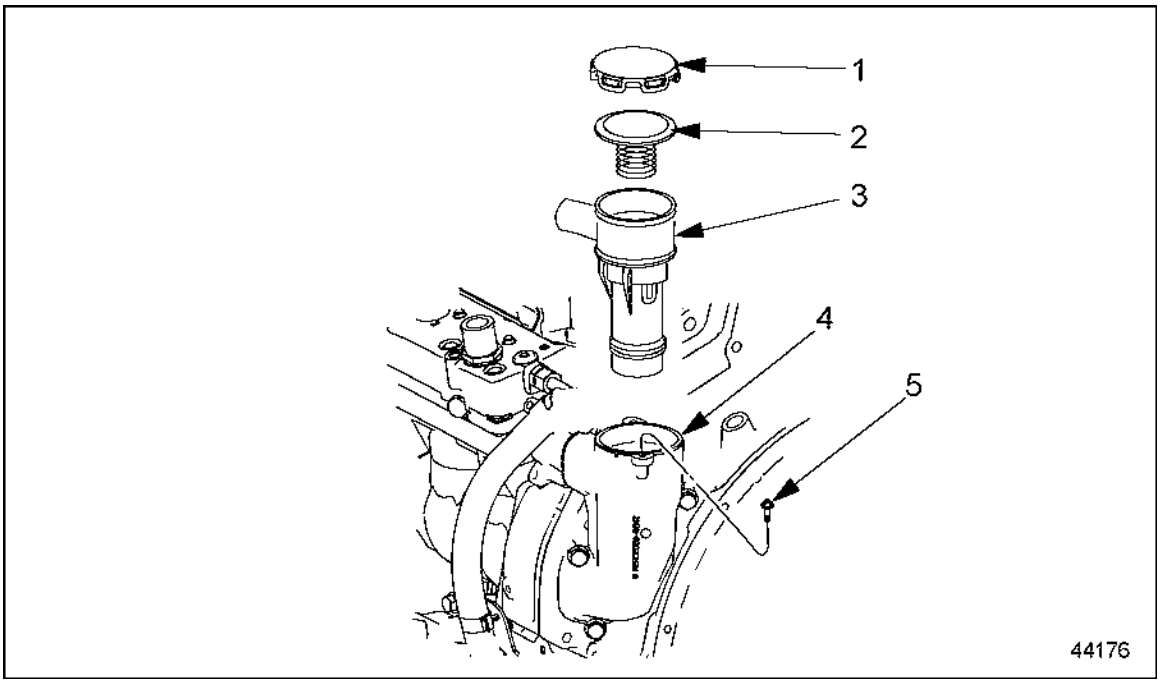
3. Remove the three plastic clamps holding the breather piping to the bracket. Remove the piping. See Figure 7-44.
4. Remove the two bolts from the air compressor and the block that are holding the piping bracket on. Remove the piping bracket.
5. Remove the three M8 x 35 mm bolts holding the breather filter to the timing case.
6. Remove the two M8 x 25 mm bolts holding the breather filter to the block.
7. Remove the breather filter.

## 7.7.2 Installation of Hengst Filter

Perform the following steps to install the Hengst filter:

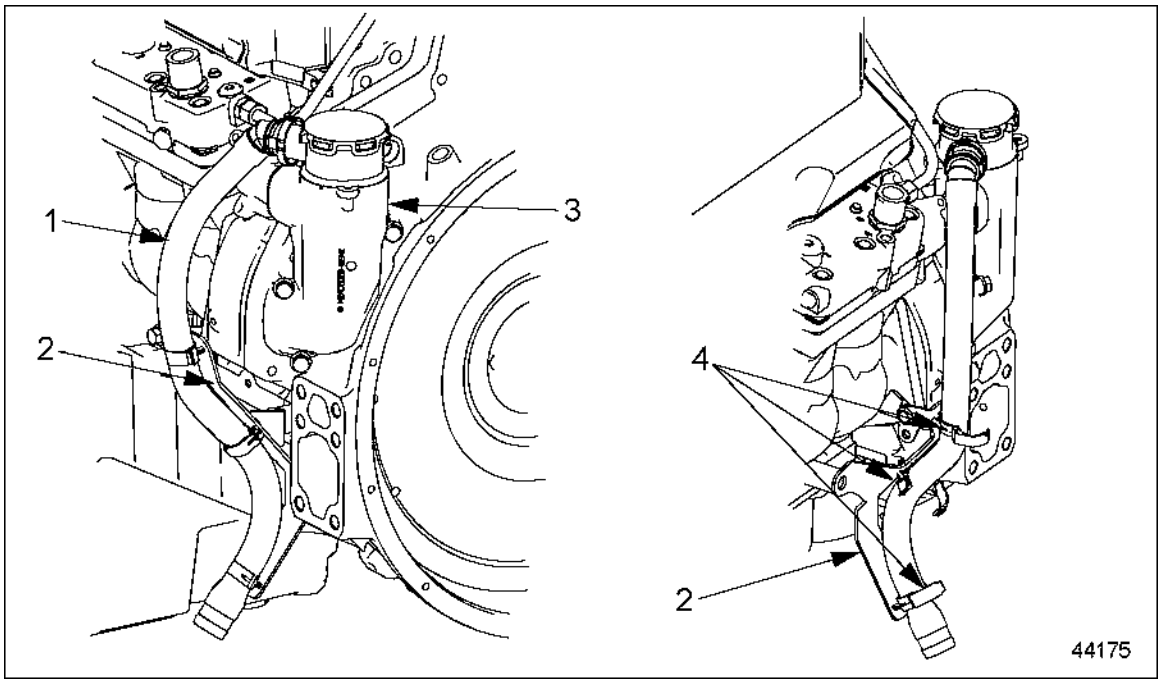
1. Assemble the centrifugal filter, spring and diaphragm insert and the cap into the breather housing. Bolt down with two hex head bolts. See Figure 7-46.




1. Filter Cap
2. Spring and Diaphragm
3. Centrifugal Filter
4. Breather
5. Assembly Bolt

**Figure 7-46 Hengst Filter Assembly**

2. Install the filter assembly onto the timing case using three M8 x 35 mm bolts. Torque to 25 N·m (19 lb·ft).




1. FIlter Piping
2. FIlter Piping Bracket
3. Hengst Filter
4. Plastic Clamps

**Figure 7-47 Installation of Hengst Filter and Related Parts**

3. Install the assembly to the block using two M8 x 25 mm bolts. Torque to 25 N·m (19 lb·ft).
4. Attach the temporary filter piping bracket to the air compressor and block as follows:
   [a] Install a M14 x 60 mm bolt with a spacer at the engine block.
   [b] Install a M10 x 35 mm bolt at the air compressor.
   [c] Torque to 60 N·m (44 lb·ft) at the air compressor and 100 N·m (74 lb·ft) torque at the block.
5. Install pipe, connecting it at the Hengst filter mouth.
6. Install three plastic clamps at pipe bracket. See Figure 7-47.

# 7.A ADDITIONAL INFORMATION

## SPECIFICATIONS

This section contains the specifications for servicing the engine.

## Exhaust Manifold

The torque values for the turbocharger and the exhaust manifold are listed in Table 7-5.

| Description | N·m (lb·ft) |
|---|---|
| Turbocharger to Exhaust Manifold Nuts | 50 (37) |
| Exhaust Manifold Mounting Bolts | 50 (37) |

**Table 7-5 Turbocharger and Exhaust Manifold Torque Values**

## Exhaust Brake Assembly

The exhaust brake assembly specifications are listed in Table 7-6. Listed in Table 7-7 are the exhaust brake assembly torque values.

| Description | Value in mm (in.) |
|---|---|
| End Play (axial play) of Exhaust Brake Shaft | 0.4 - 0.7 (0.016 - 0.028) |
| Radial Play of Exhaust Brake Shaft | 0.200 - 0.263 (0.00787 - 0.01035) |
| Distance between the two Projecting Bushings, | 84.2 (3.31) |
| Projection of the Rear Bushing into the Brake Valve Housing | 2.6 (0.10) |

**Table 7-6 Exhaust Brake Assembly Specifications**

| Description | N·m (lb·ft) |
|---|---|
| Adjusting Lever Bolt | 15 (11) |
| Bracket Mounting Bolt | 35 (25) |
| Exhaust Brake Cylinder Locknut | 25 (18) |
| Valve Mounting Bolts | 30 (22) |

**Table 7-7 Exhaust Brake Assembly Torque Values**