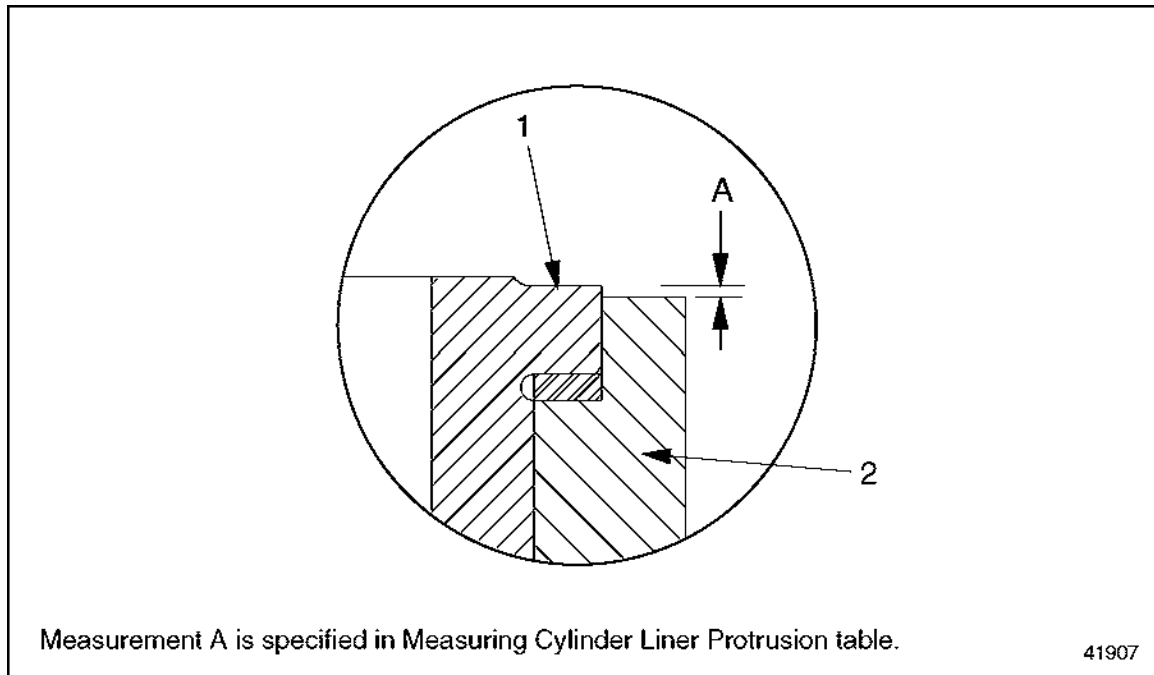

1 ENGINE

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6. Measure the cylinder liner protrusion from the block in four places, once at each slot in the measuring plate. See Figure 1-28. The acceptance/rejection criteria is listed in Table 1-11.



1. Cylinder Block

2. Cylinder Liner

Figure 1-28 Measuring Protrusion

Description	Value: mm (in.)
Cylinder Liner Protrusion From Block	0.230–0.330 (0.0090–0.0130)
Difference Between the Four Measuring Points	Max.: 0.02 (0.0007)

Table 1-11 Specifications for Measuring Cylinder Liner Protrusion

- [a] Set the scale on the dial gauge to zero.
 - [b] Move the dial gauge until the feeler touches the cylinder liner collar. Record the reading on the dial gauge.
 - [c] Move the dial gauge and support to the next slot, and repeat the measurement process, until four measurements have been made, one at each slot. Record each measurement.
 - [d] Check each measurement. If any one measurement records protrusion of less than 0.230 mm (0.0090 inch), or more than 0.330 mm (0.0130 inch), remove the cylinder liner and check it according to the procedures that refer to section 1.3.1.
 - [e] Compare the four measurements. If any measurement differs from any one of the others by more than 0.02 mm (0.0007 inch), replace the cylinder liner.
7. Remove the bolts, spacers and measuring plate (J 46071 or 402 589 00 21 00), as installed.
 8. Install the cylinder head. Refer to section 1.2.2.

1.3A EGR CYLINDER HEAD AND BLOCK

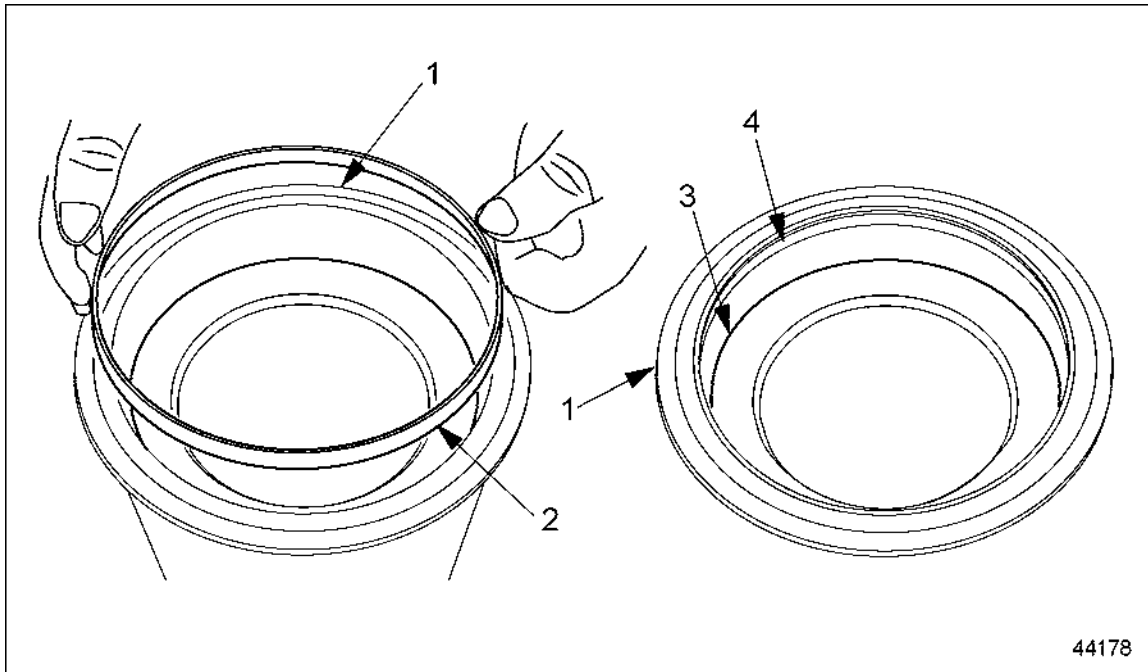
There are several minor changes in the cylinder liner, block and engine lifter brackets between the MBE 4000 EGR engine and the non-EGR engine.

1.3a.1 EGR Cylinder Head Installation

Be aware of the following notice when installing the cylinder head on an EGR engine:

NOTICE:

Be sure the carbon scraper ring is seated in the groove on the top part of the cylinder liner before installing a new cylinder head gasket and the cylinder head, otherwise component damage can result. See Figure 1-28a.



- 1. Cylinder Liner
- 2. Carbon Scraper Ring

- 3. Installed Piston
- 4. Carbon Scraper Ring located in groove in cylinder liner

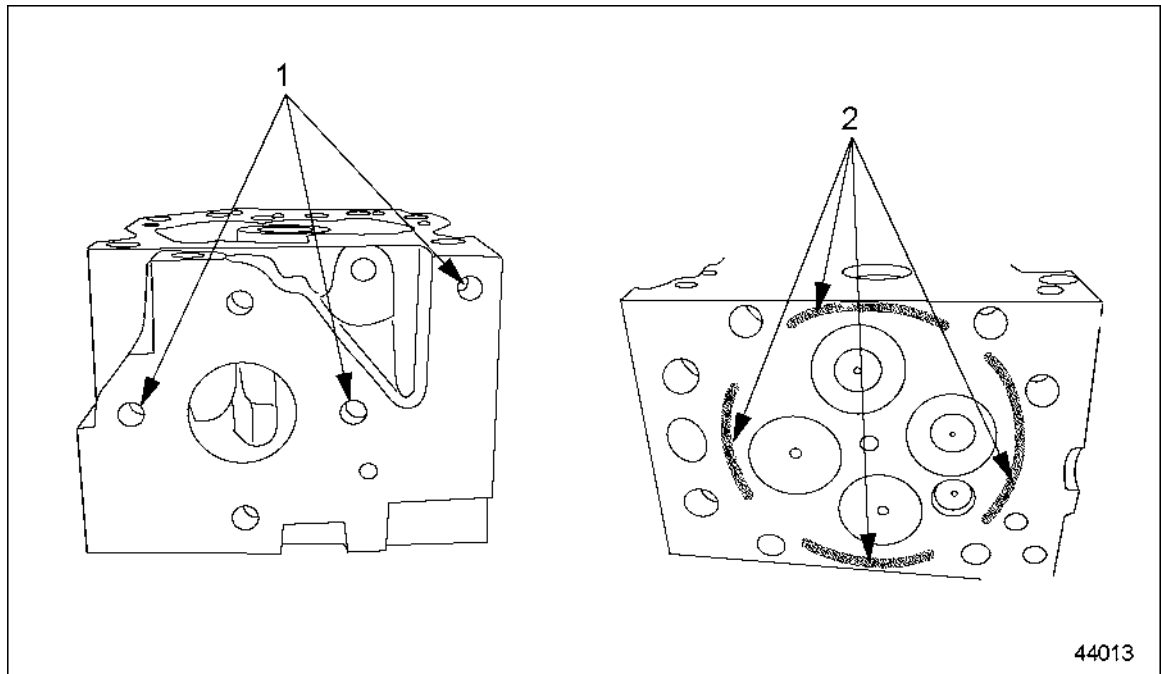
Figure 1-28a Installed Carbon Scraper Ring

NOTE:

All remaining installation procedures for the cylinder head are identical to a non-EGR engine.

1.3a.2 Cylinder Head Changes

There is also drilling in the head to attach the new EGR cooler support bracket. There is hardening at block division face of cylinder head also. See Figure 1-28b.



1. Drilling to attach the EGR Cooler Support Bracket 2. Hardening at Block Division Face

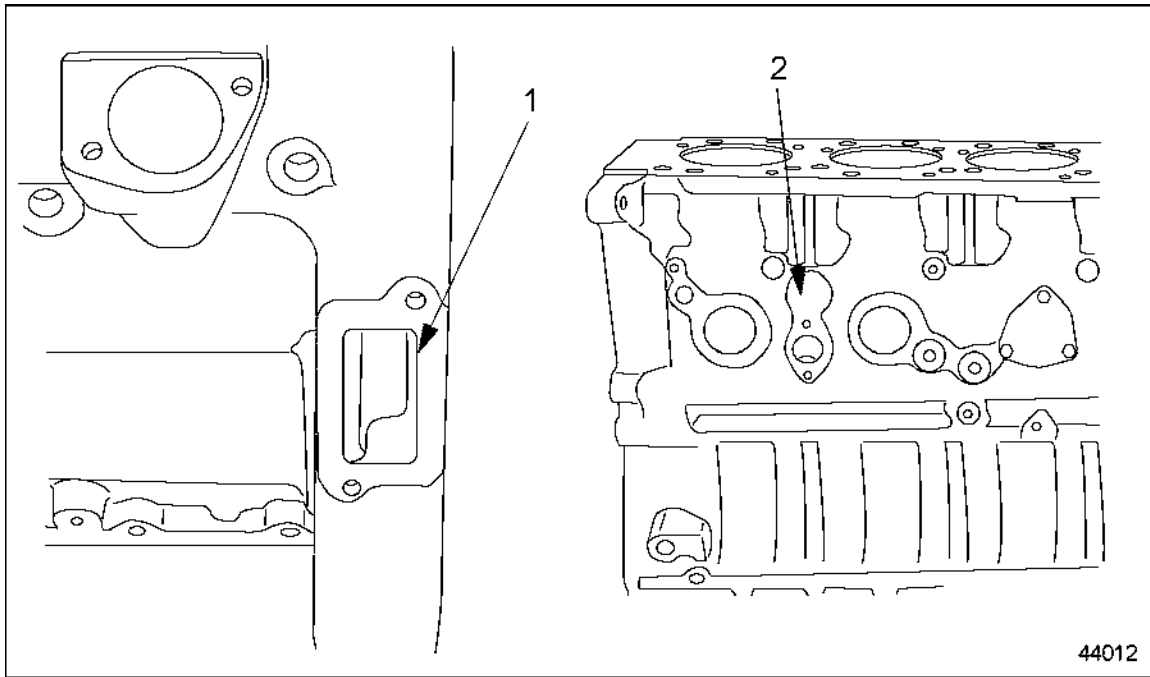
Figure 1-28b EGR Cylinder Head Changes

1.3a.3 Cylinder Liner Changes

One difference between the non-EGR cylinder liner to the EGR model is a groove on the top part of the cylinder liner, which houses the carbon scraper ring. See Figure 1-28a. The carbon scraper ring for the EGR engine is in the area previously hardened in the non-EGR cylinder liner. Its purpose is to inhibit coke formation.

1.3a.4 Cylinder Block Changes

The cylinder block has two additional openings machined in the block. There is now an opening near the air compressor housing and an opening flange for attaching the coolant inlet pipe going to the EGR cooler. See Figure 1-28c.



1. Opening near the air compressor housing

2. Flange for attaching coolant inlet pipe

Figure 1-28c EGR Cylinder Block Changes

1.3B EGR FRONT AND REAR LIFTER BRACKETS

The front lifter bracket on the non-EGR engine was moulded into the coolant pump. The EGR engine has separate front and rear lifter brackets.

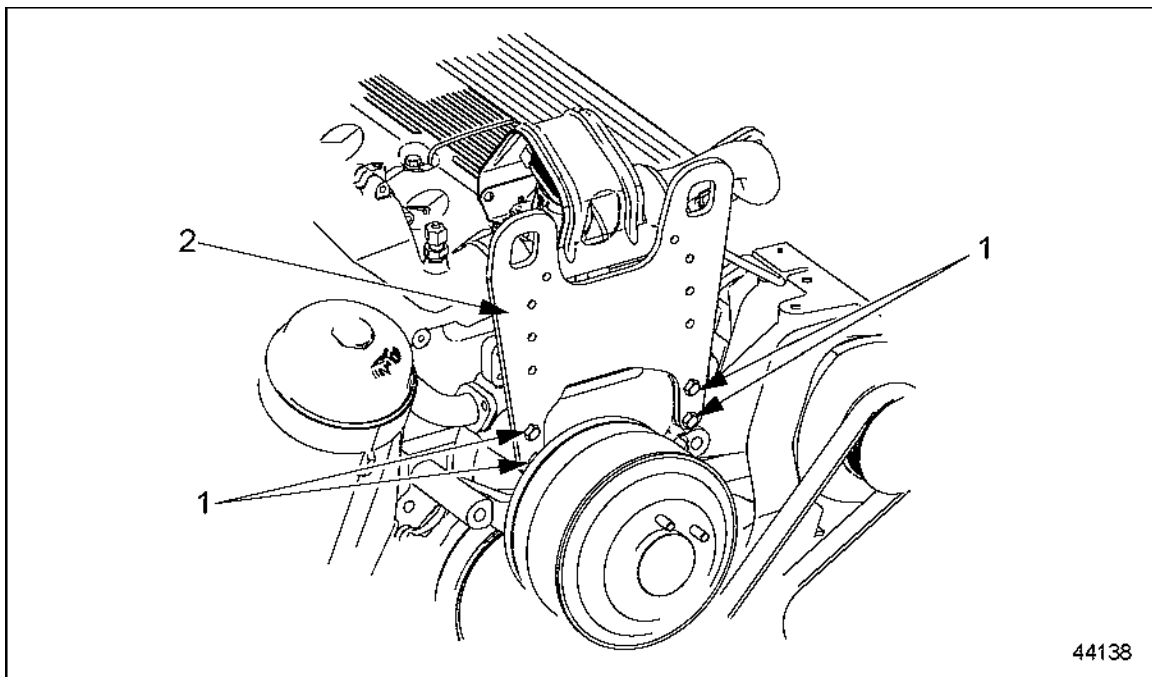
NOTICE:

A spreader bar *must* be used at all times in conjunction with the front and rear lifter brackets to lift the EGR engine to ensure that no engine damage will result. The brackets are designed to lift vertically.

1.3b.1 Removal of Front and Rear Lifter Brackets

Perform the following steps to remove the front and rear lifter brackets:

1. Remove the four M10 x 25 mm mounting bolts from the front lifter bracket and remove the bracket. See Figure 1-28d.

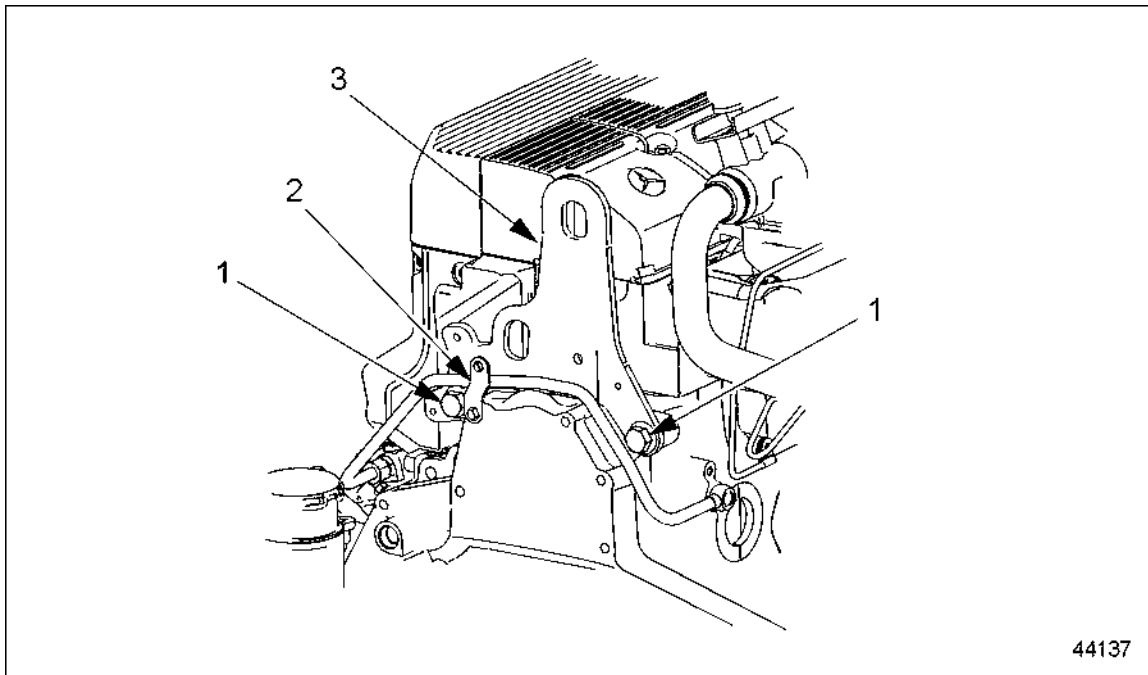


1. Front Lifter Bracket Mounting Bolts

2. Front Lifter Bracket

Figure 1-28d Removal / Installation of Front Lifter Bracket

2. Remove the two bolts from the rear lifter bracket. See Figure 1-28e.



1. Rear Lifter Bracket Mounting Bolts

3. Rear Lifter Bracket

2. Vent Line Bracket

Figure 1-28e Removal / Installation of Rear Lifter Bracket

3. Remove the vent line bracket.
4. Remove the rear lifter bracket.

1.3b.2 Installation of Front and Rear Lifter Brackets

Perform the following steps to install the front and rear lifter brackets:

1. Install the front lifter bracket using the four M10 x 25 mm mounting bolts. See Figure 1-28d.
2. Torque the four bolts to 60 N·m (44 lb·ft).
3. Install the rear lifter bracket using two mounting bolts. See Figure 1-28e.
4. Torque the two bolts to 200 N·m (147.5 lb·ft).

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1.4 ENGINE BRAKE

Engine braking is controlled by a pneumatically-operated exhaust brake on the turbocharger in conjunction with constant-throttle valves on the cylinder head. The exhaust back-pressure is used by the exhaust brake to increase braking performance. The constant-throttle valves use the air that escapes through them on the compression stroke to provide braking force.

The constant throttles are small valves which are built into the cylinder heads and positioned opposite the exhaust valves. When open, a link is created between the combustion chamber and the exhaust port. When the engine brake is switched on, the constant-throttle valves are opened by pneumatic pressure.

NOTE:

When in emergency running mode (constant rpm), the engine brake can be activated only when the engine is in overrun. When constant rpm has been attained, the engine brake is automatically turned off.

For greater braking power, an optional turbo brake is available.

1.4.1 Constant-Throttle Valve Removal

Remove the constant-throttle valve as follows:

1. Remove the cylinder head. Refer to section 1.2.1.
2. Remove the injector nozzle. Refer to section 2.3.1.

1.15A EGR PISTON, PISTON RING, AND CONNECTING ROD

The difference from the non-EGR engine cylinder liner to the EGR engine, is a groove on the top part of the cylinder liner, which houses the carbon scraper ring. The EGR engine uses a new tool for piston installation; however, all other procedures are the same for the EGR and non-EGR engine.

1.15a.1 Piston Removal for EGR Engine

Perform the following steps to remove the piston from an EGR engine:

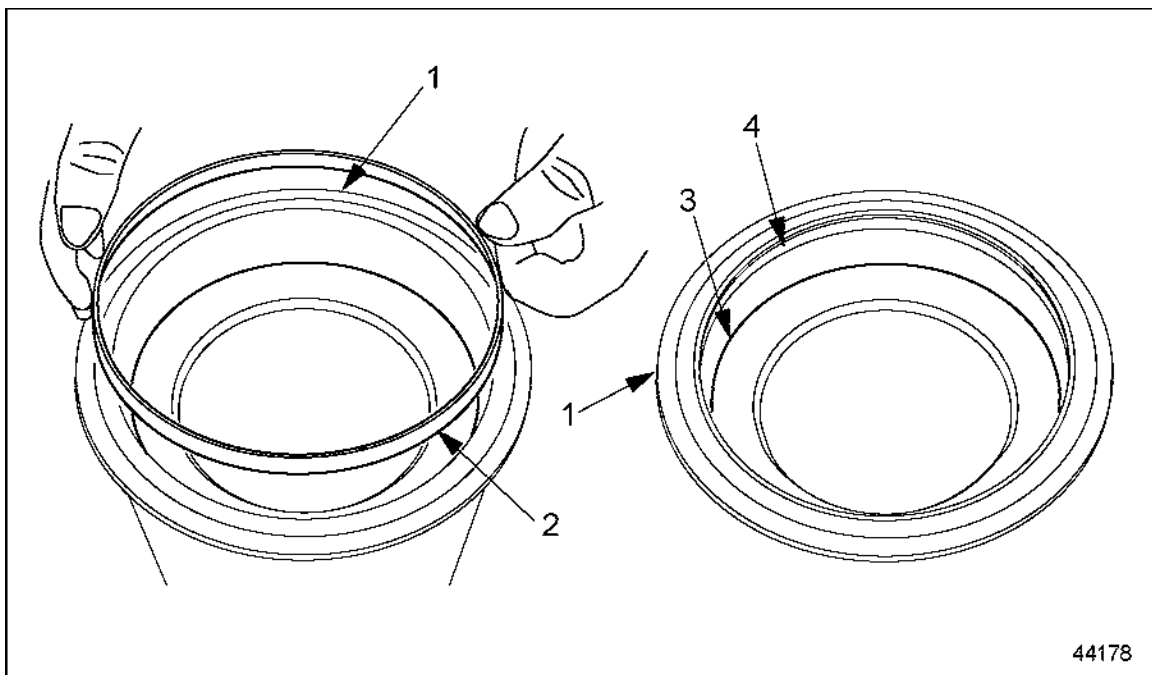
NOTICE:

The carbon scraper ring has a smaller internal diameter than the piston skirt diameter; therefore, the piston installation and removal must be carried out with the carbon scraper ring *removed*.

NOTE:

Piston removal in the EGR engine is performed with the engine facing upright – not turned on it's side.

1. Remove the carbon scraper ring from the cylinder liner groove. See Figure 1-98a.



1. Cylinder Liner

2. Carbon Scraper Ring

3. Installed Piston

4. Installed Carbon Scraper Ring

Figure 1-98a Removing Carbon Scraper Ring

2. Push the piston and connecting rod assembly out of the cylinder liner.
3. Follow remaining steps for non-EGR engine piston removal. Refer to section 1.15.1.

1.15a.2 Piston Installation for EGR Engine

Perform the following steps to install the piston in an EGR engine:

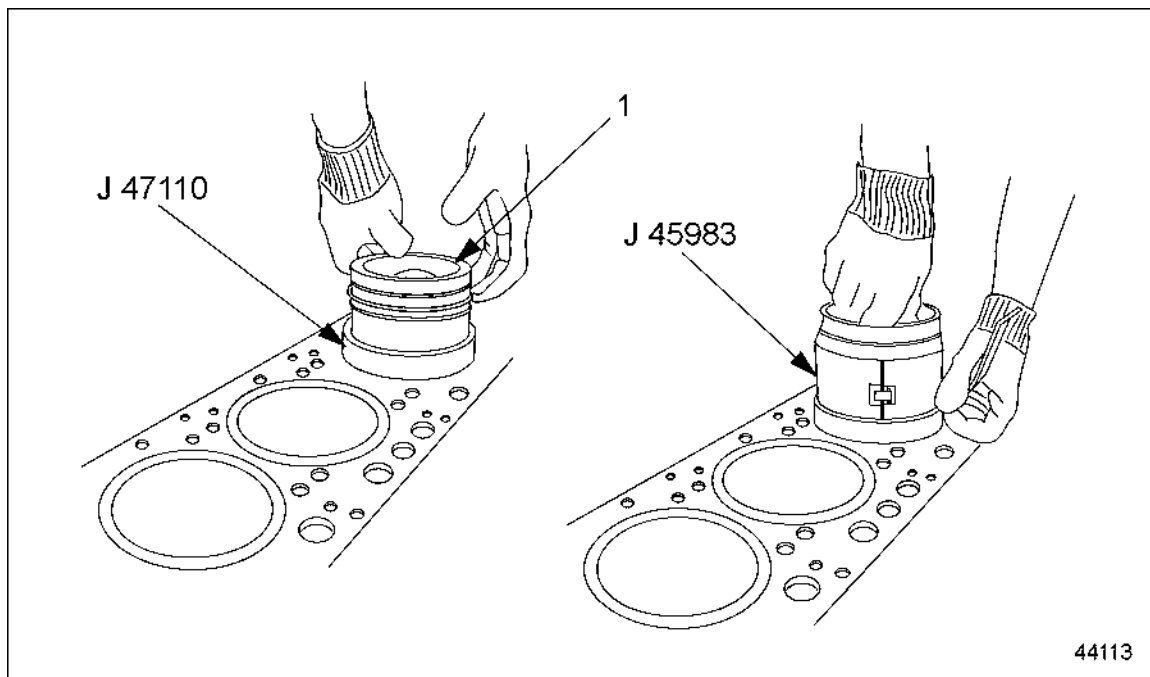
NOTICE:

The carbon scraper ring has a smaller internal diameter than the piston skirt diameter; therefore, the piston installation and removal must be carried out with the carbon scraper ring *uninstalled or removed*.

NOTE:

Piston installation in the EGR engine is performed with the engine facing upright – not turned on it's side.

1. Install J tool (J 47110) to the cylinder block. See Figure 1-98b.








1. Piston

Figure 1-98b Installation of Piston

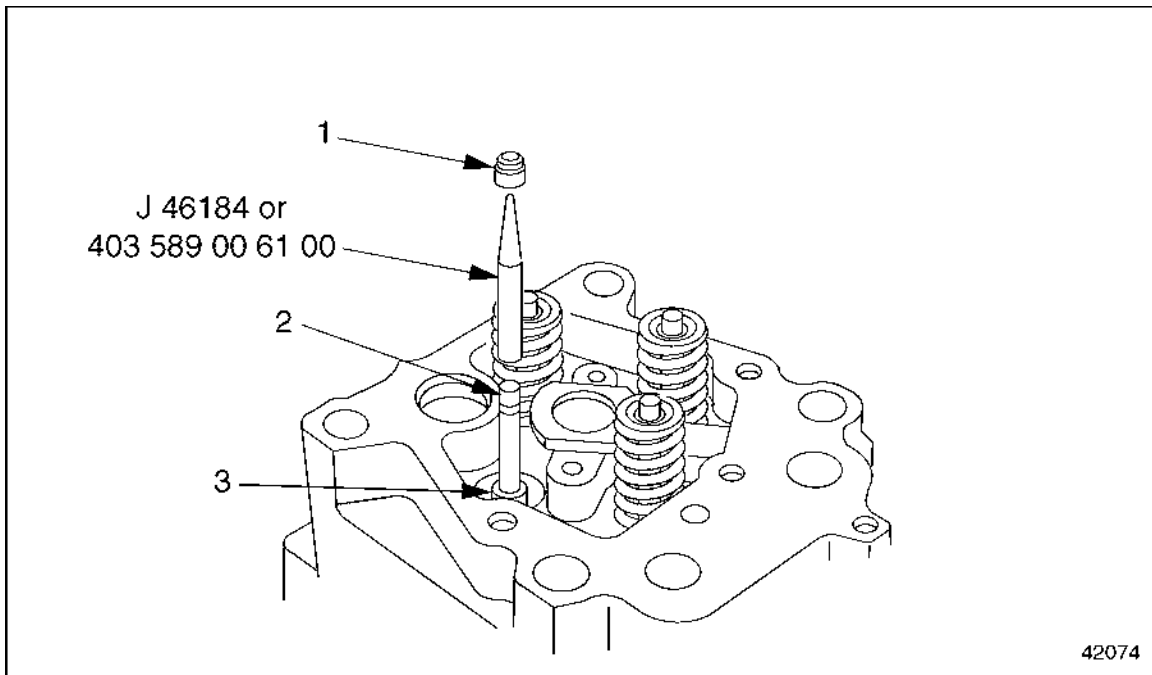
NOTE:

There are NO arrows on the top of the EGR piston to direct the installation. The piston can be installed in any direction and it will be correct.

2. Push the piston into cylinder liner, using ring compressor J tool (J 45983) to compress the piston rings. 
3. Clean the carbon scraper ring seat in the cylinder liner. 
4. After piston is installed, install carbon scraper ring in the cylinder liner groove. See Figure 1-98a. 
5. Check carbon scraper ring for correct fit after installation. 
6. Follow remaining steps for piston installation in a non-EGR engine. Refer to section 1.15.2. 

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- Remove the collets, spring retainer, valve spring, and spring base. See Figure 1-116.



- | | |
|--------------------|----------------|
| 1. Valve Stem Seal | 3. Valve Guide |
| 2. Valve Stem | |

Figure 1-116 Valve Stem Seal Replacement

- Remove the valve stem seal. Do not remove the valve.
- Lubricate the valve stem and valve stem seal installer (J 46184 or 403 589 00 61 00) with a light coating of clean engine oil.

NOTE:

The installer prevents the groove on the valve stem from damaging the seal.

- Push the valve stem seal installer (J 46184 or 403 589 00 61 00) over the valve stem until it makes contact with the valve.
- Slide the seal over the installer and the valve stem. Using fingers, press the seal into place until the seal seats on the valve guide.

NOTE:

Check the seal to make sure it is correctly seated on the valve guide.

- Remove the installer from the valve stem seal and the valve.
- Install the collets, spring retainer, valve spring and spring base, as removed.
- Repeat the procedure for the other valves.
- Install the cylinder head. Refer to section 1.2.2.

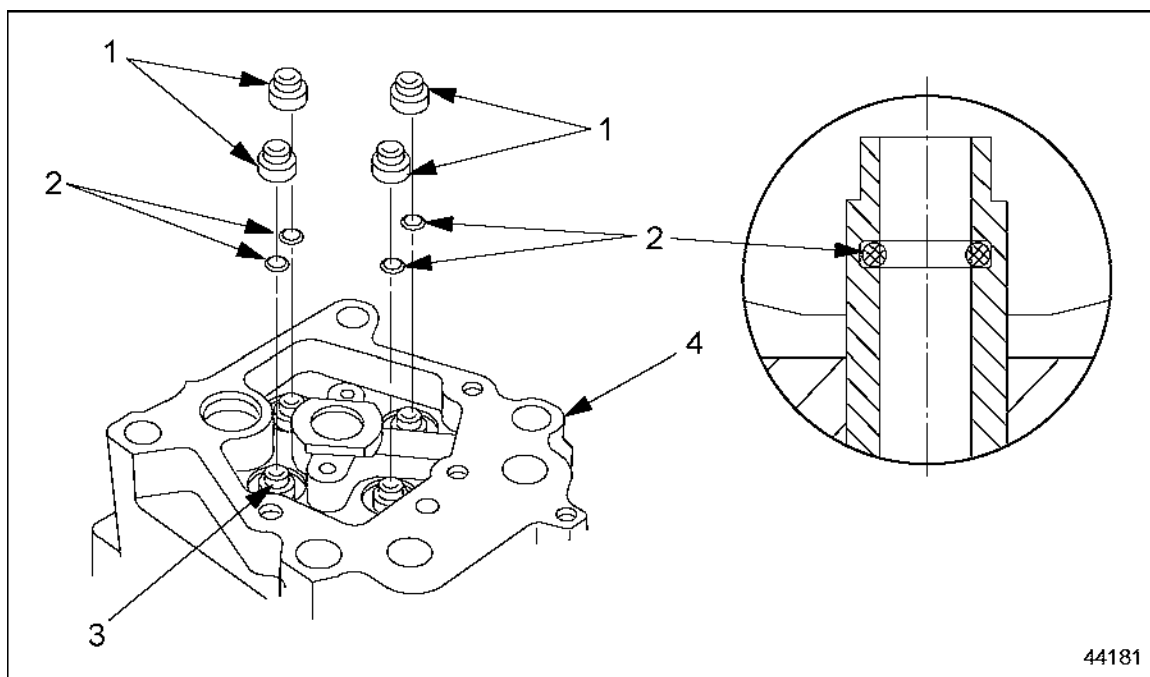
1.16A EGR VALVES

The exhaust valves and valve specifications in the EGR engine have changed due to the addition of valve stem sealing rings under the valve stem seals in the engine.

1.16a.1 Valve Removal in the EGR Engine

Perform the following steps in removing the valves from the EGR engine:

1. Follow the procedures for valve removal in a non-EGR engine until reaching the valve stem seals removal step. Refer to section 1.16.5.
2. With the cylinder head in an upright position, remove and discard the valve stem seals and valve stem sealing rings. See Figure 1-116a.



- | | |
|----------------------------|------------------|
| 1. Valve Stem Seal | 3. Valve Guide |
| 2. Valve Stem Sealing Ring | 4. Cylinder Head |

Figure 1-116a Removing Valve Stem Seals and Valve Stem Sealing Rings

NOTE:

The valve guide with valve stem sealing ring are used *only* in the EGR engines.

3. Check the following critical valve dimensions, and repair as necessary. See Figure 1-116b to determine the dimensions. Listed in Table 1-43a are the dimensions for the intake valve and the differences between the exhaust non-EGR and exhaust EGR valves.

- Valve stem diameter (A)
- Valve seat diameter at the contact surface of the cylinder head (B)
- Valve head diameter (C)

- Valve seat height (D)
- Valve seat width at the valve head (E)
- Valve seat angle (F)
- Valve length (G)

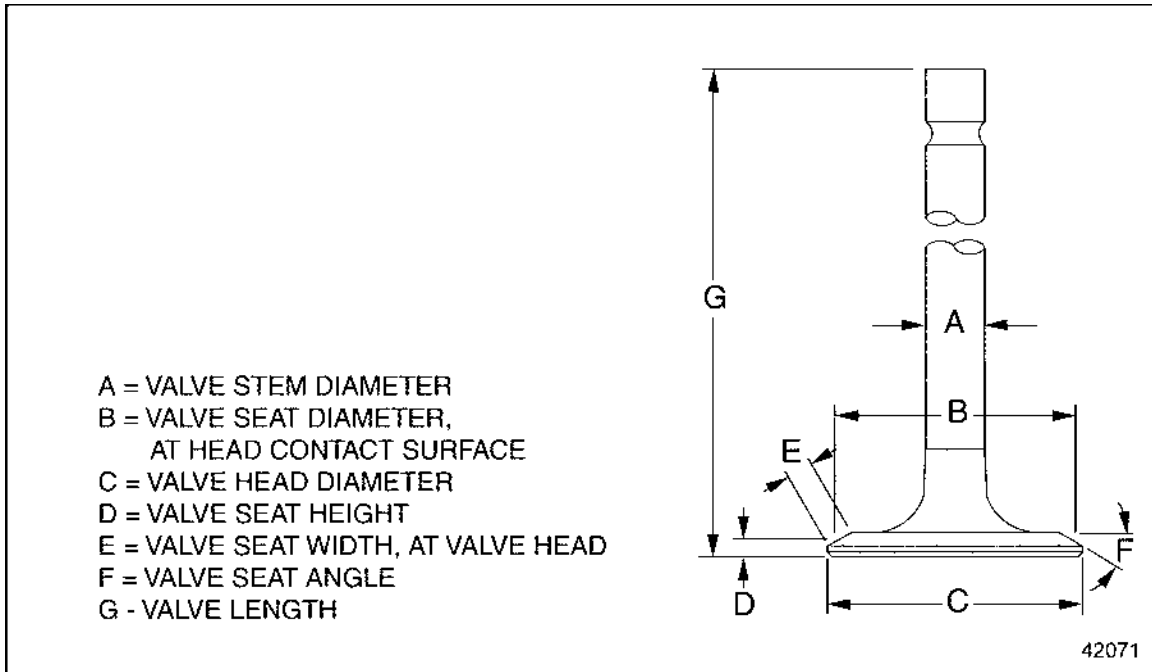


Figure 1-116b Critical Dimensions, Valve Stem and Head for EGR Engines

Description	Intake, mm (in.)	Exhaust-EPA 98, mm (in.)	Exhaust-EPA 04, mm (in.)
Valve stem diameter (A)	8.935-8.950 (0.3518-0.3524)	8.925-8.940 (0.3514-0.3520)	8.925-8.940 (0.3514-0.3520)
Valve seat diameter at head contact surface (B)	42.0 (1.65)	39.0 (1.54)	39.0 (1.54)
Valve head diameter (C)	45.4-45.6 (1.79-1.80)	40.9-41.3 (1.61-1.63)	41.9-42.3 (1.65-1.67)
Valve seat height-new (D)	3.1-3.3 (0.12-0.13)	2.8-3.1 (0.11-0.12)	3.0-3.3 (0.12-0.13)
Minimum valve seat height-after grinding (D)	2.9 (0.11)	2.3 (0.09)	2.9 (0.11)
Valve seat width at valve head (E)	3.5-4.5 (0.14-0.18)	3.5-4.5 (0.14-0.18)	min. 3.5 (0.14)
Valve seat angle (F)	30 degrees	45 degrees	36 degrees
Valve length (G)	145.0 (5.71)	145.0 (5.71)	145.0 (5.71)

Table 1-43a Valve Removal/Installation Specifications in mm (in.)

1.16a.2 Valve Installation in the EGR Engine

Perform the following steps in installing the valves in the EGR engine:

1. Install the valve stem sealing ring in the valve guide in the cylinder head.
2. Lubricate each valve with a light coating of engine oil.
3. Install the valves in order, as marked on removal.

NOTE:

In the EGR engine, always replace the valve stem seal and valve stem sealing ring if the valve has been removed. Check the valve stem seal to make sure it is correctly seated on the valve guide.

4. Using tool J 46174, install new valve stem seals and seat the valve stem seal with J tool, J 46184. Refer to section 1.16a.3.
5. Using the adaptor (J 46173), install the spring seats, springs, spring retainers, and collets (keepers). Check the keepers to be sure they are locked in place.
6. Remove the adaptor (J 46173), from the cylinder head.
7. Install the cylinder head.

1.16a.3 Valve Stem Seal and Valve Stem Sealing Ring Replacement in the EGR Engine

Replace the valve stem seal and valve stem sealing ring as follows:

NOTE:

In the EGR engine, always replace the valve stem seal and valve stem sealing ring if the valve has been removed.

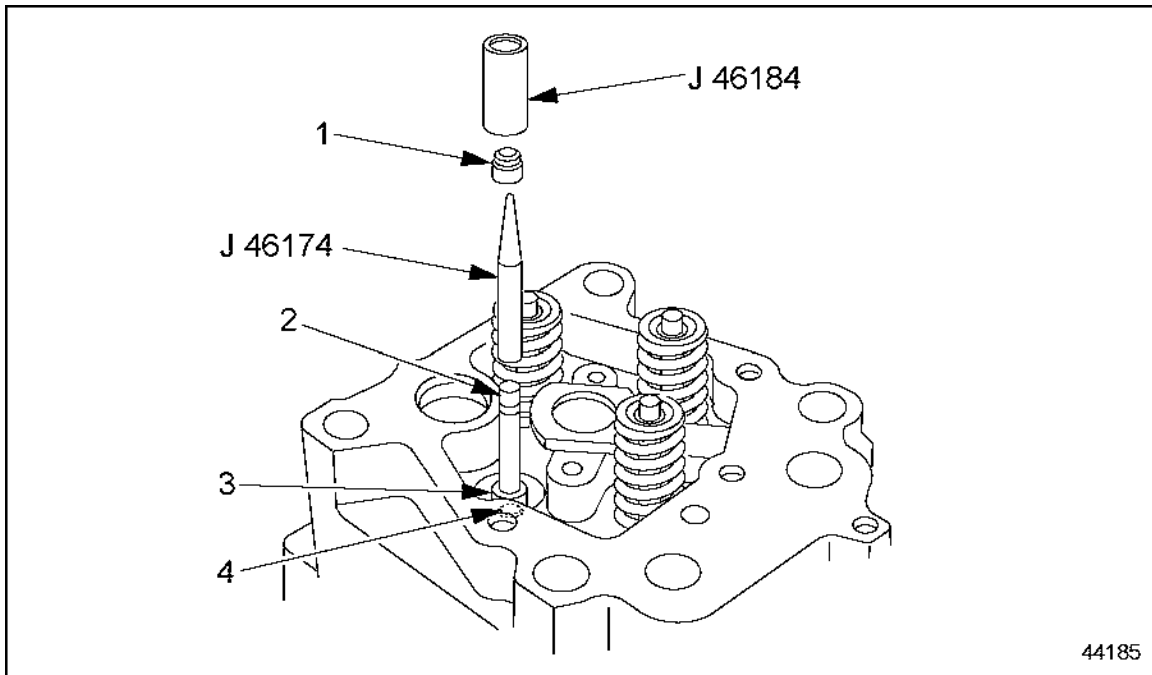
1. Remove the cylinder head from the engine.

NOTE:

Use care during removal to not damage the valve guides and valve stems.

2. Remove the keeper, spring retainer, valve spring, and spring seat.
3. Remove the valve stem seal and discard.
4. Remove the valve.
5. Remove the valve stem sealing ring and discard. Repeat procedure for all remaining valves.
6. Clean all parts before reinstalling components.
7. Install the valve stem sealing ring in the valve guide and then install the valve in the head. Repeat procedure for all remaining valves.

8. Lubricate the valve stem and valve stem seal installer/protector (J 46174) with a light coating of clean engine oil.



- | | |
|--------------------|--|
| 1. Valve Stem Seal | 3. Valve Guide |
| 2. Valve Stem | 4. Valve Stem Sealing Ring (installed) |

Figure 1-116c Valve Stem Seal and Sealing Ring Replacement

NOTE:

The installer/protector prevents the groove on the valve stem from damaging the valve stem seal.

9. Push the valve stem seal installer/protector (J 46174) over the valve stem until it makes contact with the valve.
10. Slide the valve stem seal over the installer/protector and the valve stem. Using fingers, press valve stem seal into place until the seal seats on the valve guide.
11. Remove J tool, J 46174.
12. Using valve guide seal installer (J 46184) and the appropriate hammer, drive the valve stem seal on the guide.

NOTE:

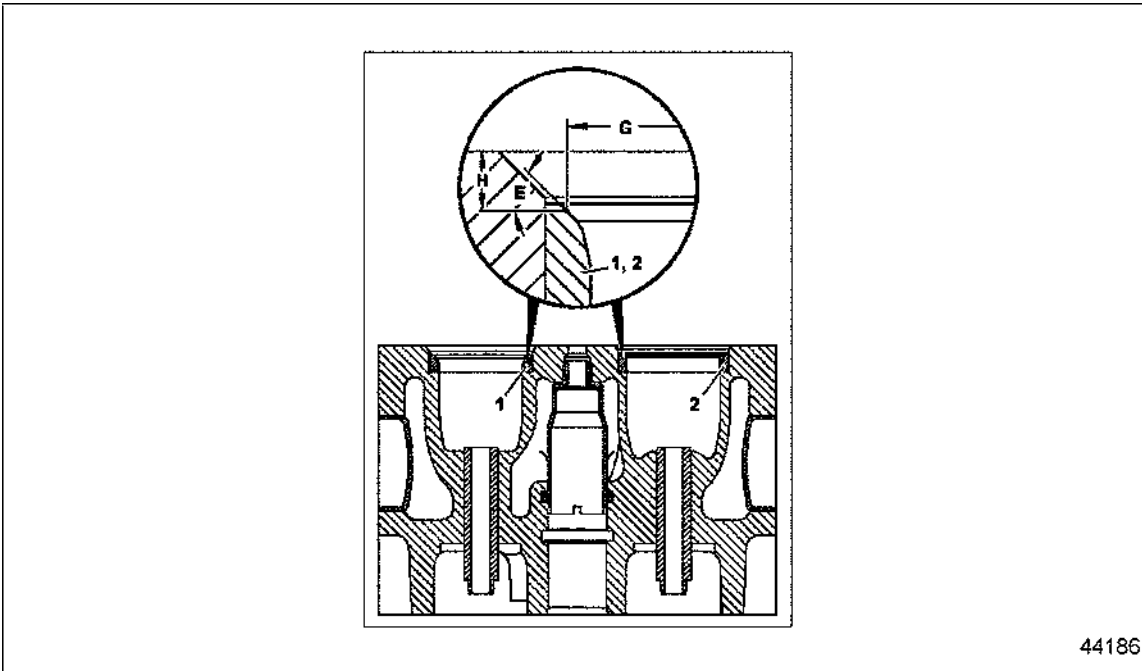
Check the seal to make sure it is correctly seated on the valve guide.

13. Remove the installer from the valve stem seal and the valve.
14. Install the keeper, spring retainer, valve spring and spring seat, as removed.
15. Repeat the procedure for the other valves.

16. Install the cylinder head on the EGR engine. Refer to section 1.3a.1.

1.16a.4 Valve Seats

See Figure 1-116d and listed in Table 1-43b are the specifications for valve seats.



44186

1. Exhaust Valve Seat

2. Intake Valve Seat

Figure 1-116d Valve Seats on EGR Engine

Description	Intake Valve, mm (in.)	Exhaust Valve-EPA 98, mm (in.)	Exhaust Valve-EPA 04, mm (in.)
Valve seat angle (E)	30 Degree	45 Degree	36 Degree
Valve seat surface diameter (G)	41.99-42.01(1.65-1.654)	38.99-39.0 (1.535-1.535)	38.99-39.01(1.535-1.536)
Relative position (H) to diameter G	4.00-4.15 (0.157-0.163)	3.80-3.95 (0.15-0.16)	4.00-4.15 (0.157-0.163)

Table 1-43b Valve Seat Specifications for EGR Engine

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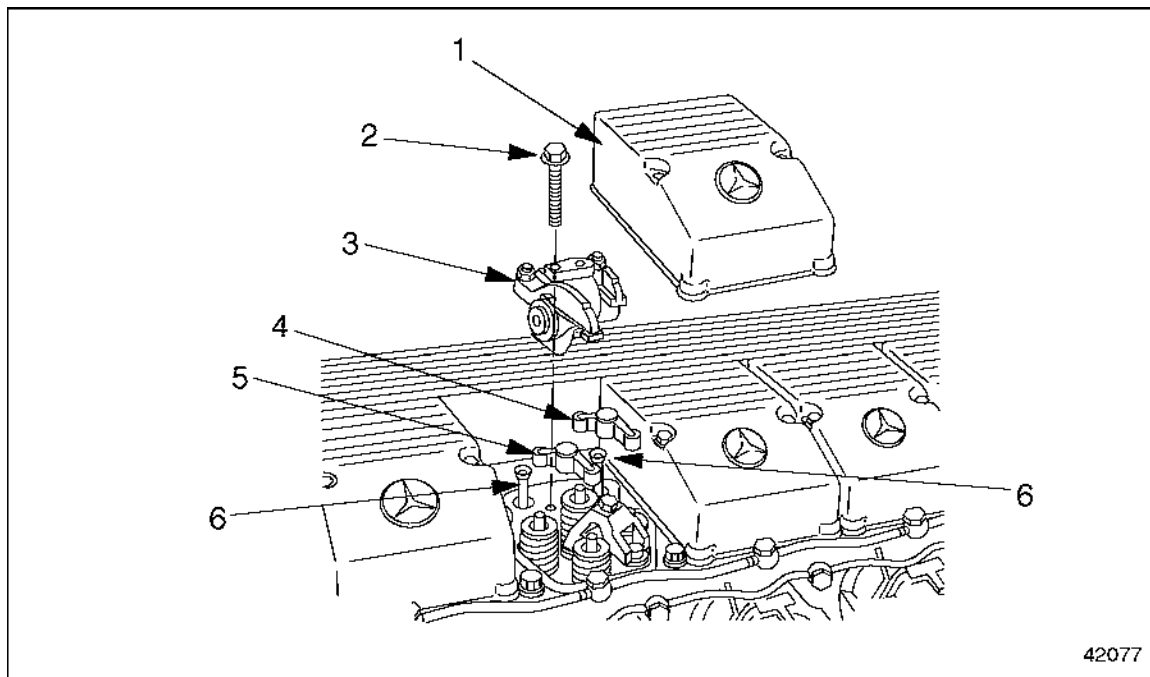
1.17 ROCKER ARM

Perform the following procedures for removal and installation of the rocker arm:

1.17.1 Rocker Arm Removal

Remove the rocker arm assembly as follows:

1. Remove the cylinder head cover on each cylinder head. Refer to section 1.1.1.
2. Remove the rocker arm assembly. See Figure 1-117.



- | | |
|-----------------------------|-------------------------|
| 1. Cylinder Head Cover | 4. Intake Valve Bridge |
| 2. Rocker Arm Mounting Bolt | 5. Exhaust Valve Bridge |
| 3. Rocker Arm Assembly | 6. Pushrod |

Figure 1-117 Rocker Assembly

- [a] Loosen the each valve lash adjusting screw.
 - [b] Remove each rocker arm mounting bolt.
 - [c] If removing more than one rocker arm assembly, mark the assembly with a paint pen to identify it on installation.
 - [d] Remove the rocker arm assembly from the cylinder head.
3. Inspect the rocker arm assembly for wear. If necessary, disassemble the rocker arm assembly and replace any worn parts. Refer to section 1.17.2.

1.18A EGR CAMSHAFT

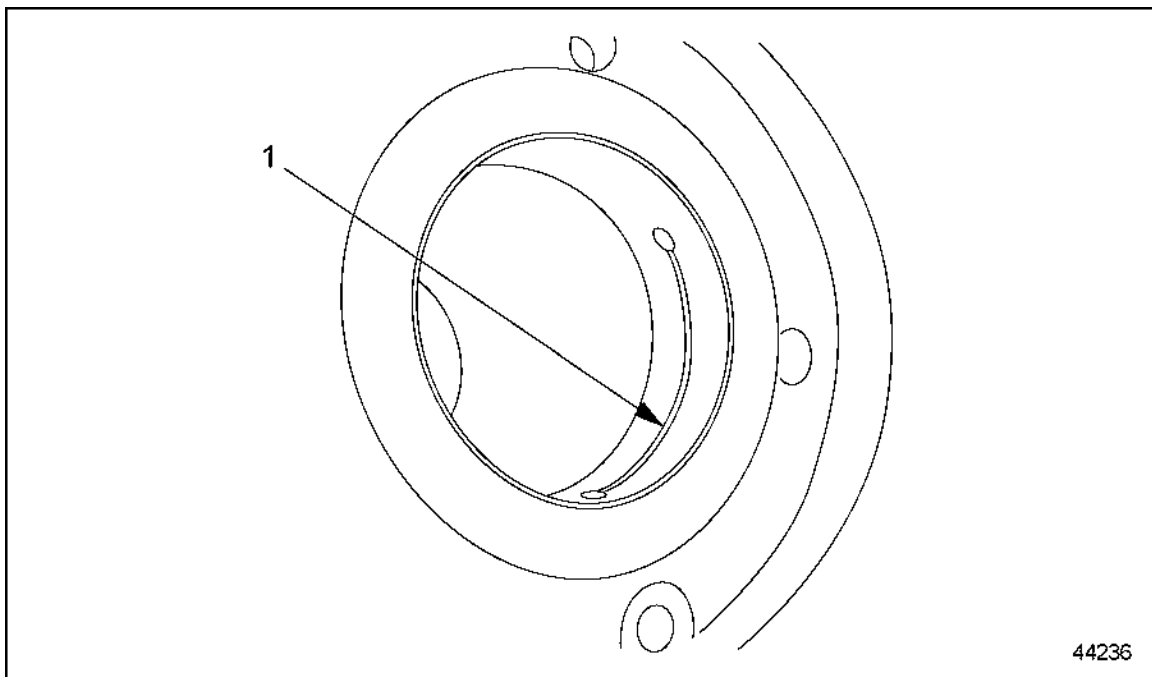
The removal, installation, and inspection of the EGR camshaft is the same as in the non-EGR engine, except for the following minor changes.

1.18a.1 EGR Camshaft Changes

In the EGR engine, there is a possibility of installing the camshaft bushings in an inverted (wrong) position.

NOTICE:

If the EGR camshaft bushings are installed in an inverted (wrong) channel position, there is potential for engine damage due to lack of lubrication. The holes in the camshaft journal *must* be lined up with the holes in the camshaft bushing.



1. Bushing Groove

Figure 1-127 Camshaft Bushing Installation

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