Exhaust Manifold - Remove and Install

SMCS Code: 1059-010

Removal Procedure

1. Disconnect tube assembly (3) and tube assembly (5).

2. Attach a suitable lifting device to exhaust manifold (2) and the turbocharger. The weight of exhaust manifold (2) and the turbocharger is approximately 40 kg (88 lb).

3. Remove bolts (1) and locks (4).

4. Remove exhaust manifold (2), the turbocharger, and the gaskets from the cylinder head assembly.

Installation Procedure

Table 10

<table>
<thead>
<tr>
<th>Required Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tool</strong></td>
</tr>
<tr>
<td>A</td>
</tr>
<tr>
<td>B</td>
</tr>
</tbody>
</table>

NOTICE

Excessive use of sealant can cause damage to components.

To avoid component damage use only the amount of sealant necessary for the application.

1. Apply Tooling (A) to the outside diameter of the male ends of exhaust manifold (2). Assemble exhaust manifold (2) and remove the excess sealer from the joints.

2. Apply Tooling (B) to the threads of bolts (1). Attach a suitable lifting device to exhaust manifold (2) and the turbocharger. The weight of exhaust manifold (2) and the turbocharger is approximately 40 kg (88 lb). Position the gaskets, exhaust manifold (2), and the turbocharger on the cylinder head assembly. Install locks (4) and bolts (1).

3. Connect tube assembly (3) and tube assembly (5).

4. Tighten Bolt (1) through Bolt (12) in a numerical sequence.

   Tighten bolts to the following torque. .... 4 ± 1 N·m (35 ± 9 lb in)

5. Tighten Bolt (1) through Bolt (12) in a numerical sequence.
Tighten bolts to the following torque. \( \pm 45 \pm 5 \text{ N·m} \) or \( (33 \pm 4 \text{ lb ft}) \)

6. Bend the locking tab over the flat of each bolt head.

**Note:** Prior to starting or running the engine, allow the sealant in the exhaust manifold joints to air dry for 24 hours.

### Air Inlet Heater Solenoid - Remove and Install

**SMCS Code:** 1090-010-OD

**Removal Procedure**

![Illustration 27](image1)

1. Disconnect the battery. Refer to Operation and Maintenance Manual, "Battery or Battery Cable - Disconnect".

2. Disconnect harness assemblies (2) and harness assemblies (3).

3. Remove solenoid (1).

**Installation Procedure**

![Illustration 28](image2)

1. Position solenoid (1) on the engine.

2. Connect harness assemblies (2) and harness assemblies (3).

3. Connect the battery. Refer to Operation and Maintenance Manual, "Battery or Battery Cable - Disconnect".

### Inlet and Exhaust Valves - Remove and Install

**SMCS Code:** 1105-010

**Removal Procedure**

<table>
<thead>
<tr>
<th>Required Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tool</strong></td>
</tr>
<tr>
<td>A</td>
</tr>
</tbody>
</table>

**Start By:**

a. Remove the cylinder head assembly. Refer to Disassembly and Assembly, "Cylinder Head - Remove".

**NOTICE**

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.
The valve spring keepers can be thrown from the valve when the valve spring compressor is released. Ensure that the valve spring keepers are properly installed on the valve stem. To help prevent personal injury, keep away from the front of the valve spring keepers and valve springs during the installation of the valves.

**Note:** The following components of the exhaust valves are different from the components of the inlet valves: spring retainer (5), valve spring (4), and valve (2).

1. Use Tooling (A) to compress valve spring (4). Remove retainer locks (6).
2. Remove Tooling (A). Remove spring retainer (5), valve spring (4), and washer (3).
3. Remove valve seal (1) and valve (2).

### Installation Procedure

**Table 12**

<table>
<thead>
<tr>
<th>Tool</th>
<th>Part Number</th>
<th>Part Description</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>5S-1330</td>
<td>Valve Spring Compressor</td>
<td>1</td>
</tr>
</tbody>
</table>

---

**NOTICE**

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.
Inlet and Exhaust Valve Guides - Remove and Install

SMCS Code: 1104-010

Removal Procedure

Table 13

<table>
<thead>
<tr>
<th>Tool</th>
<th>Part Number</th>
<th>Part Description</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1U-7793</td>
<td>Valve Guide Driver</td>
<td>1</td>
</tr>
<tr>
<td>B</td>
<td>9U-6895</td>
<td>Valve Guide Driver</td>
<td>1</td>
</tr>
</tbody>
</table>

Start By:

a. Remove the inlet and exhaust valves. Refer to Disassembly and Assembly, "Inlet and Exhaust Valves - Remove and Install".

NOTICE
Keep all parts clean from contaminants. Contaminants may cause rapid wear and shortened component life.

Installation Procedure

Table 14

<table>
<thead>
<tr>
<th>Tool</th>
<th>Part Number</th>
<th>Part Description</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1U-7793</td>
<td>Valve Guide Driver</td>
<td>1</td>
</tr>
<tr>
<td>B</td>
<td>9U-6895</td>
<td>Valve Guide Driver</td>
<td>1</td>
</tr>
<tr>
<td>C</td>
<td>1U-7792</td>
<td>Guide Collar</td>
<td>1</td>
</tr>
<tr>
<td>D</td>
<td>149-4008</td>
<td>Guide Collar</td>
<td>1</td>
</tr>
</tbody>
</table>

NOTICE
Keep all parts clean from contaminants. Contaminants may cause rapid wear and shortened component life.

Illustration 32

Note: Position the valve guides and tap on the top of the valve guides. This is done in order to start the valve guides into the cylinder head assembly.

1. Use Tooling (A) and Tooling (C) to install inlet valve guides (1). Install inlet valve guides (1) until the protrusion is $23.0 \pm 0.50$ mm ($0.90 \pm 0.020$ inch) above the cylinder head assembly.

2. Use Tooling (B) and Tooling (D) to install the exhaust valve guides. Install the exhaust valve guides until the protrusion is $17.8 \pm 0.50$ mm ($0.70 \pm 0.020$ inch) above the cylinder head assembly.

End By:

a. Install the inlet and exhaust valves. Refer to Disassembly and Assembly, "Inlet and Exhaust Valves - Remove and Install".
Inlet and Exhaust Valve Seat Inserts - Remove and Install

SMCS Code: 1103-010

Removal Procedure

Table 15

<table>
<thead>
<tr>
<th>Tool</th>
<th>Part Number</th>
<th>Part Description</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>6V-4194</td>
<td>Valve Seat Extractor(2)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>165-5647</td>
<td>Valve Seat Extractor(3)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>6V-4804</td>
<td>Handle</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>6V-4192</td>
<td>Shaft</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>6V-4199</td>
<td>Lifting Bracket</td>
<td>1</td>
</tr>
</tbody>
</table>

(1) Part of the 166-7441 Valve Seat Extractor Tool Group
(2) Use for removal of the exhaust valve seats
(3) Use for removal of the inlet valve seats

Start By:

a. Remove the inlet and exhaust valves. Refer to Disassembly and Assembly, “Inlet and Exhaust Valves - Remove and Install”.

NOTICE

Keep all parts clean from contaminants.
Contaminants may cause rapid wear and shortened component life.

Installation Procedure

Table 16

<table>
<thead>
<tr>
<th>Tool</th>
<th>Part Number</th>
<th>Part Description</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>149-6115</td>
<td>Installer</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>133-9306</td>
<td>Valve Guide</td>
<td>1</td>
</tr>
</tbody>
</table>

NOTICE

Keep all parts clean from contaminants.
Contaminants may cause rapid wear and shortened component life.

1. Lower the temperature of new valve seat inserts (1).

2. Use Tooling (B) and a suitable press to install the new valve seat inserts in the cylinder head.

Note: Do not machine the prefinished valve seat inserts in order to correct the valve stem projection. An excessive valve stem projection indicates that the valve seat insert is not seated or material was not cleaned from the bottom of the counterbore.

End By:

a. Install the inlet valves and exhaust valves. Refer to Disassembly and Assembly, “Inlet and Exhaust Valves - Remove and Install”.

1. Use Tooling (A) to remove valve seat inserts (1).
**Engine Oil Filter Base and Oil Cooler - Remove**

**SMCS Code:** 1306-011; 1378-012

### Removal Procedure

#### Table 17

<table>
<thead>
<tr>
<th>Tool</th>
<th>Part Number</th>
<th>Part Description</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>185-3630</td>
<td>Strap Wrench Assembly</td>
<td>1</td>
</tr>
</tbody>
</table>

**NOTICE**

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting and repair of the product. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Refer to Special Publication, NENG2500, “Caterpillar Tools and Shop Products Guide” for tools and supplies suitable to collect and contain fluids on Caterpillar products.

Dispose of all fluids according to local regulations and mandates.

1. Drain the coolant system. Refer to Operation and Maintenance Manual, “Refill Capacities and Recommendations”.

2. Remove nuts (1). Remove bracket (2) and the hose assembly. Use Tooling (A) and remove oil filter (3).

3. Remove bolts (4). Remove engine oil filter base (5) and the gasket.

4. Remove oil cooler (6) and the gasket. Remove O-ring seals (7).

---

**Engine Oil Filter Base - Disassemble**

**SMCS Code:** 1306-015

### Disassembly Procedure

**Start By:**

a. Remove the engine oil filter base and the oil cooler. Refer to Disassembly and Assembly, “Engine Oil Filter Base and Oil Cooler - Remove”.

**NOTICE**

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.
Personal injury can result from being struck by parts propelled by a released spring force. Make sure to wear all necessary protective equipment.

Follow the recommended procedure and use all recommended tooling to release the spring force.

(1) Oil cooler bypass valve
(2) Oil filter bypass valve

**Engine Oil Filter Base - Assemble**

**SMCS Code:** 1306-016

**Assembly Procedure**

*NOTICE*

Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

---

**WARNING**

Improper assembly of parts that are spring loaded can cause bodily injury.

To prevent possible injury, follow the established assembly procedure and wear protective equipment.

(1) Oil cooler bypass valve
(2) Oil filter bypass valve

**End By:**

a. Install the engine oil filter base and the oil cooler. Refer to Disassembly and Assembly, “Engine Oil Filter Base and Oil Cooler - Install”.

**Engine Oil Filter Base and Oil Cooler - Install**

**SMCS Code:** 1306-012; 1378-012

**Installation Procedure**

<table>
<thead>
<tr>
<th>Tool</th>
<th>Part Number</th>
<th>Part Description</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>185-3630</td>
<td>Strap Wrench Assembly</td>
<td>1</td>
</tr>
</tbody>
</table>
**Note:** Check O-ring seals for wear or for damage. If necessary, replace the O-ring seals.

1. Install O-ring seals (7). Install oil cooler (6) and the gasket.

2. Install the gasket and engine oil filter base (5). Install bolts (4).

3. Tighten bolts (4) in a numerical sequence to a torque of 15 N·m (11 lb ft). Tighten bolts (4) in a numerical sequence to a torque of 28 N·m (21 lb ft).

4. Install oil filter (3) with Tooling (A). Install the hose assembly and bracket (2). Install nuts (1).

5. Fill the coolant system. Refer to Operation and Maintenance Manual, “Refill Capacities and Recommendations”.
Engine Oil Pump - Remove

SMCS Code: 1304-011

Removal Procedure

Start By:

a. Remove the engine oil pan. Refer to Disassembly and Assembly, “Engine Oil Pan - Remove and Install”.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Remove bolts (1) and bolt (2).
2. Remove engine oil pump (3).
3. Remove the O-ring seals.

Engine Oil Pump - Disassemble

SMCS Code: 1304-015

Disassembly Procedure

Table 19

<table>
<thead>
<tr>
<th>Required Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tool</strong></td>
</tr>
<tr>
<td>A</td>
</tr>
<tr>
<td>B</td>
</tr>
</tbody>
</table>

Start By:

a. Remove the engine oil pump. Refer to Disassembly and Assembly, “Engine Oil Pump - Remove”.

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Remove bolts (1), oil pickup tube (2), and the gasket from the engine oil pump. Remove bolt (3) and outlet elbow (4) from the engine oil pump.
2. Remove bolt (5).

3. Remove idler gear (7) from shaft (8).

4. Use Tooling (B) and remove bearing (6) from idler gear (7).

5. Use Tooling (A) to remove drive gear (9) from engine oil pump (10).

**Engine Oil Pump - Assemble**

**SMCS Code:** 1304-016

**Assembly Procedure**

**Table 20**

<table>
<thead>
<tr>
<th>Tool</th>
<th>Part Number</th>
<th>Part Description</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>1P-0510</td>
<td>Driver Gp</td>
<td>1</td>
</tr>
</tbody>
</table>

NOTICE
Keep all parts clean from contaminants.

Contaminants may cause rapid wear and shortened component life.

1. Use Tooling (B) and press drive gear (9) on the shaft assembly until drive gear (9) is flush with the end of the shaft assembly.

2. Install bearing (6) in idler gear (7). Install bearing (6) so the distance between the hub bolt face of idler gear and bearing (6) is 0.75 ± 0.25 mm (0.030 ± 0.010 inch).

3. Install idler gear (7) on shaft (8). Install bolt (5). Tighten bolt (5) to a torque of 70 ± 15 N·m (52 ± 11 lb ft).

4. Position the gasket and oil pickup tube (2) onto engine oil pump (10). Install bolts (1).

5. Position the O-ring seal and outlet elbow (4) onto engine oil pump (10). Install bolt (3).

**End By:**

a. Install the engine oil pump. Refer to Disassembly and Assembly, “Engine Oil Pump - Install”.

---

Illustration 46  
Illustration 47  
Illustration 48
Engine Oil Pump - Install

SMCS Code: 1304-012

Installation Procedure

NOTICE
Keep all parts clean from contaminants. Contaminants may cause rapid wear and shortened component life.

1. Install the O-ring seals. Position engine oil pump (3) on the cylinder block.

2. Install bolts (1) and bolt (2).

End By:

a. Install the engine oil pan. Refer to Disassembly and Assembly, “Engine Oil Pan - Remove and Install”.

Water Pump - Remove

SMCS Code: 1361-011

Removal Procedure

Start By:

a. Remove the alternator. Refer to Disassembly and Assembly, “Alternator - Remove and Install”.

1. Drain the coolant system. Refer to Operation and Maintenance Manual, "Refill Capacities and Recommendations".

2. Remove bolts (1). Remove support bracket (2).

3. Disconnect hose (3).

4. Remove bolts (4). Remove water pump (5).