## 4 LUBRICATION SYSTEM

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</table>
4.1 ENGINE OIL CIRCUIT

The MBE 900 engines have a force-feed lubricating oil circuit supplied by a rotary oil pump.

4.1.1 Filling the Engine Oil Circuit

Fill the engine oil circuit as follows:

1. Remove the cylinder head cover. Refer to section 1.1.1.
2. Remove the screw plug from the oil-water heat exchanger. See Figure 4-1.
3. Pressurize the pre-oiler can (KM 352 589 11 63 00) to 303 kPa (44 psi), and then connect it to the heat exchanger. See Figure 4-1.
4. Open the shutoff valve and check the oil at the rocker arms. When the oil flowing out at the rocker arms is free of bubbles, close the valve.
5. Disconnect the pre-oiler can. Install the screw plug and a new seal at the oil-water heat exchanger. Tighten the plug 20 N-m (15 lb-ft). See Figure 4-1.
6. Install the cylinder head cover. Refer to section 1.1.2.
4.1 ENGINE OIL CIRCUIT

CAUTION:

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

☐ Always start and operate an engine in a well ventilated area.
☐ If operating an engine in an enclosed area, vent the exhaust to the outside.
☐ Do not modify or tamper with the exhaust system or emission control system.

7. Start the engine. Check the gauge for the correct oil pressure; check the lubrication system for leaks. Check the oil level and add if needed.
4.2 OIL SPRAY NOZZLE

If damaged, the oil spray nozzle must be replaced, not repaired. There are two types of oil spray nozzles that may be used: bolt-on oil spray nozzles and press-on oil spray nozzles.

4.2.1 Bolt-On Oil Spray Nozzle Removal

Remove the oil spray nozzle as follows:

**NOTE:**
This procedure refers to bolt-on oil spray nozzles only.

1. Remove the oil pan. Refer to section 4.7.1.

**NOTE:**
If necessary, use the engine cranking tool (KM 904 589 04 63 00) to rotate the crankshaft and gain access to the nozzles. See Figure 4-2. If damaged, replace the oil spray nozzle.

![Figure 4-2 Removing the Bolt-On Oil Spray Nozzle](image)

1. Oil Spray Nozzle
2. Hollow-Core Bolt

**Figure 4-2** Removing the Bolt-On Oil Spray Nozzle

2. Remove the hollow-core bolt that fastens each oil spray nozzle to the cylinder block.
4.2.2 Bolt-On Oil Spray Nozzle Installation

Install the oil spray nozzle as follows:

1. Install each nozzle in the block with the locator pin correctly installed. Tighten the screw 25 to 30 N·m (18 to 22 lb·ft). See Figure 4-2.

**NOTE:**
The locator pin must be inserted into the bore hole in the block until it engages.

2. Install the oil pan. Refer to section 4.7.2.

3. Fill the crankcase to the specified oil level as listed in Table 4-1. Do not overfill the crankcase.

<table>
<thead>
<tr>
<th>Description</th>
<th>4-Cylinder Engine</th>
<th>6-Cylinder Engine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil Pan Capacity*</td>
<td>16 L (17 qt)</td>
<td>25 L (26 qt)</td>
</tr>
</tbody>
</table>

* In standard pan, including oil filter

**Table 4-1 Lubricating Oil Capacity**

(Rev. 0304) All information subject to change without notice.
4.2.3 Press-On Oil Spray Nozzle Removal

Remove the press-on oil spray nozzle as follows:

1. Remove the engine.

NOTE:
This procedure refers to press-on oil spray nozzles only.

2. Remove the oil pan. Refer to section 4.7.1.
3. Remove the crankshaft. Refer to section 1.6.1.
4. Use the oil spray nozzle replacement kit (KM 906 589 00 43 00) to remove and replace the oil spray nozzle. It contains a remover tool, an installer tool, and two hex bolts for mounting the installer to the crankcase. See Figure 4-3.

Figure 4-3 Press-On Oil Spray Nozzle Replacement Kit
5. Attach the impact extractor (KM 355 589 01 63 00) to the threaded end of the remover tool (KM 906 589 00 43 00). See Figure 4-4.

![Remover Assembly](image)

Figure 4-4 Remover Assembly

6. Using the remover assembly, remove the oil spray nozzle.
   [a] Insert the slot in the end of the remover tool around the spray tube and turn it so the spray tube is locked in place.
   [b] Operate the slide hammer on the impact extractor and remove the oil spray nozzle from the crankcase.
   [c] Discard the old oil spray nozzle.
4.2.4 Press-On Oil Spray Nozzle Installation

Install the press-on oil spray nozzle as follows:

1. Insert a new oil spray nozzle into the slot in the end of the installer tool (KM 906 589 00 43 00) until the spray tube is locked in place.

2. Using the hex bolts provided in the kit, attach the hanger arm of the installer tool to the bolt holes in the crankcase where the bearing caps were installed. Tighten the hex bolts to 34 N·m (25 lb-ft). See Figure 4-5.

NOTE:
The oil spray nozzle must be vertical with respect to the crankcase when it is installed.

![Press-On Oil Spray Nozzle Installation Diagram](image)
3. Install the oil spray nozzle in the crankcase, taking care to note the location of the parallel pin on the installer. See Figure 4-6.

**Figure 4-6 Parallel Pin Location**

[a] Make sure the oil spray nozzle is correctly positioned in its hole in the crankcase.

[b] Check the location of the parallel pin to make sure the oil spray nozzle is vertical with respect to the crankcase.

[c] Using a hammer, hit the top of the installer until the oil spray nozzle is fully seated. The spray nozzle should be firmly in place.

[d] Remove the installer tool from the crankcase.

4. Do this procedure for each oil spray nozzle to be replaced.

5. Clean the oil passage holes in the crankcase main bearing race.

6. Install the crankshaft. Refer to section 1.6.2.
NOTICE:

If the oil spray nozzle is not correctly positioned with respect to the piston, serious engine damage could result.

7. Turn the crankshaft and check, at each cylinder, the clearance between the piston and the oil spray nozzle.
8. Install the oil pan. Refer to section 4.7.2.
9. Install the engine.
10. Fill the crankcase to the specified oil level. Do not overfill the crankcase.
4.3 OIL PUMP

The rotary oil pump that supplies the force-feed lubricating oil circuit is positioned at the front of the cylinder block and driven by the crankshaft drive gear.

4.3.1 Oil Pump Removal

Remove the oil pump as follows:

1. Remove the vibration damper. Refer to section 1.9.1.
2. Remove the oil pan from the crankcase. Refer to section 4.7.1.
3. Remove the dipstick guide tube and bracket at the suction pipe. See Figure 4-7.

4. Remove the suction pipe.
5. Remove the oil pump using care not to damage the sealing surface.
6. Remove the radial seal and the O-ring at the connection fitting.

Figure 4-7  Oil Pump Removal

1. Oil Pump  7. Bracket (Suction Pipe)
2. O-ring  8. Suction Pipe
3. Dowel Pin  9. Radial Seal
4. Connection Fitting  10. Oil Pump to Cylinder Block Bolt
5. Drive Gear  11. Suction Pipe to Oil Pump Bolt
7. Thoroughly clean the contact surfaces of the oil pump.

### 4.3.2 Oil Pump Installation

Install the oil pump as follows:

1. Install a new O-ring at the connection fitting.

2. Using the front seal installer (KM 904 589 02 15 00), press in the radial seal. Make sure the seal is evenly installed around the entire circumference of the oil pump. Check the setback of the seal. See Figure 4-8.

3. Coat the contact surface between the block and the oil pump with Loctite® 574.

4. Position the front seal installer (KM 904 589 02 15 00) guide sleeve on the crankshaft flange and install the oil pump. Pay special attention to the dowel pin and the position of the drive gear. Tighten the oil pump to crankcase bolts 25 N·m (18 lb·ft). Remove the guide sleeve.

**NOTE:**
It may be necessary to rock the pump counterclockwise so the teeth of the gear can properly align with the crankshaft drive gear.
5. Install the suction pipe and tighten the fasteners 25 N·m (18 lb·ft).
6. Install the bracket and the dipstick guide tube on the suction pipe. Tighten the suction pipe bracket bolt 50 N·m (37 lb·ft).
7. Install the oil pan with a new gasket.
8. Install the vibration damper. Refer to section 1.9.2.
9. Fill the engine with the correct amount and appropriate type of clean engine oil. Do not overfill.

### CAUTION:

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

- Always start and operate an engine in a well ventilated area.
- If operating an engine in an enclosed area, vent the exhaust to the outside.
- Do not modify or tamper with the exhaust system or emission control system.

10. Start the engine and check for leaks.
11. Check the engine oil level and add oil if necessary.
4.4 OIL FILTER HOUSING

4.4.1 Oil Filter Housing Removal

Remove the oil filter housing as follows:

1. Remove the poly-V belt.
2. Remove the belt tensioner. Refer to section 9.2.3.
3. Unscrew the oil filter cap. See Figure 4-9.

4. Disconnect the wiring harness from the oil pressure/temperature sensor.
5. Remove the alternator mounting strap from the oil filter housing.
6. Disconnect the oil supply line from the oil filter housing.
7. Remove the filter element and inspect it and the O-ring for damage. Replace only if necessary.
8. Remove the oil filter housing from the crankcase. Be prepared to collect any oil which runs out of the housing, and dispose of it properly.
9. Remove the filter housing gasket and discard.

4.4.2 Oil Filter Housing Installation

Install the oil filter housing as follows:

1. Using a new gasket, install the oil filter housing on the crankcase. Tighten the fasteners 25 N·m (18 lb·ft).
2. Install the filter element.
3. Connect the oil supply line to the oil filter housing.
4. Install the alternator mounting strap on the oil filter housing. Tighten the strap mounting bolts 40 N·m (30 lb·ft).
5. Connect the wiring harness to the oil pressure/temperature sensor.
6. Install the oil filter cap. Using a 36-mm socket, tighten the cap 25 N·m (18 lb·ft).
7. Install the belt tensioner. Refer to section 9.2.4.
8. Install the poly-V belt. Refer to section 9.2.2.

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☐ If operating an engine in an enclosed area, vent the exhaust to the outside.
☐ Do not modify or tamper with the exhaust system or emission control system.

9. Start the engine and check for leaks.
10. Check the engine oil level and add oil if necessary.
4.5 OIL FILTER ELEMENT

Replace the oil filter element.

4.5.1 Oil Filter Element Replacement

Replace the oil filter element as follows:

1. Clean the outside of the oil filter housing, then unscrew the oil filter cap from the housing. See Figure 4-10.

2. Unscrew the cap and filter and allow the oil to drain into the housing. After draining, remove the assembly from the housing.

NOTE:
Use care to prevent foreign objects from entering the filter housing.

3. Remove the element by pressing and twisting the side and detaching it from the cap.

4. Remove the oil filter O-ring and discard it. Lightly coat a new O-ring with engine oil and install it.

5. Insert a new filter element into the cap.
6. Install the element and cap assembly on the filter housing. Tighten the cap 25 N·m (18 lb-ft).

<table>
<thead>
<tr>
<th>CAUTION:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.</td>
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</tr>
<tr>
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</tr>
</tbody>
</table>

7. Start the engine and check for leaks.

8. Check the engine oil level and add oil if necessary.
4.6 HEAT EXCHANGER

4.6.1 Heat Exchanger Removal

Remove the heat exchanger as follows:

<table>
<thead>
<tr>
<th>CAUTION:</th>
</tr>
</thead>
<tbody>
<tr>
<td>To avoid injury from the expulsion of hot coolant, never remove the cooling system pressure cap while the engine is at operating temperature. Remove the cap slowly to relieve pressure. Wear adequate protective clothing (face shield or safety goggles, rubber gloves, apron, and boots).</td>
</tr>
</tbody>
</table>

1. When the engine is cool, drain the coolant from the radiator.

NOTE:
If the cooling system is rusty, it should be flushed.
2. Remove the oil filter cap. See Figure 4-11. Inspect the seal for damage and replace if necessary.

3. Remove the air cleaner hose.

4. Cut the wiring tie strap at the vent line.
To avoid injury from the sudden release of a high-pressure hose connection, wear a face shield or goggles.

5. Remove the vent line from the connection at the coolant pump to cylinder head, and from the oil separator.

6. Disconnect the wiring connector from the oil temperature sensor.

7. Disconnect the oil pressure line from the oil filter housing and the turbocharger.

8. Remove the seal plug and seal from the heat exchanger. Discard the seal. Drain the oil into a suitable container.

9. Remove the heat exchanger from the cylinder block. Discard the gasket.

10. Remove the housing cover and discard the gasket.

### 4.6.2 Heat Exchanger Installation

Install the heat exchanger as follows:

1. Install the housing cover and a new housing cover gasket on the heat exchanger. Do not tighten the housing cover bolt at this time.

2. Install the heat exchanger and a new gasket on the cylinder block. Tighten the mounting bolts 25 N·m (18 lb-ft).

3. Tighten the housing cover bolt 25 N·m (18 lb-ft).

4. Install the screw plug with a new seal. Tighten the plug 20 N·m (15 lb-ft).

5. Attach the oil pressure line to the oil filter and the turbocharger.

6. Connect the wiring harness to the oil temperature sensor.

7. Attach the vent line to the connection at the coolant pump to cylinder head, and to the oil separator.

8. Using a new tie strap, attach the wiring harness to the vent line.

9. Install the air cleaner hose.

10. Install the oil filter cap. Replace the O-ring. Tighten the cap 25 N·m (18 lb-ft).

11. Fill the cooling system.

12. Fill the engine oil circuit.
4.6 HEAT EXCHANGER

<table>
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<tr>
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</tr>
<tr>
<td>□ Do not modify or tamper with the exhaust system or emission control system.</td>
</tr>
</tbody>
</table>

13. Start the engine. Check the gauge for the correct oil pressure; check the lubrication system for leaks.
4.7 **OIL PAN**

### 4.7.1 Oil Pan Removal

Remove the oil pan as follows:

1. Drain the engine oil.
2. Remove the oil pan from the block and discard the gasket. See Figure 4-12.

![Figure 4-12 Oil Pan Removal](image)

1. Oil Pan
2. Gasket
3. Oil Pan Bolts
4. Oil Pan Drain Plug
5. Drain Plug Seal
6. Oil Level Sensor

### 4.7.2 Oil Pan Installation

Install the oil pan as follows:

1. Position a new gasket on the block.
2. Install the pan on the block and tighten the bolts 25 N·m (18 lb·ft).
3. Install the oil drain plug. Tighten the plug 65 N·m (48 lb·ft).
4. Fill the engine with engine oil.
4.7 OIL PAN

CAUTION:

Diesel engine exhaust and some of its constituents are known to the State of California to cause cancer, birth defects, and other reproductive harm.

☐ Always start and operate an engine in a well ventilated area.
☐ If operating an engine in an enclosed area, vent the exhaust to the outside.
☐ Do not modify or tamper with the exhaust system or emission control system.

5. Start the engine and check for leaks.

6. Shut down the engine. Check the oil level and add oil if necessary.

NOTE:
Do not fill beyond the maximum fill level on the dipstick, since overfilling may result in high oil consumption. See Figure 4-13.

![Figure 4-13 Oil Dipstick](image-url)

1. Maximum Fill Level
2. Minimum Fill Level

Figure 4-13 Oil Dipstick
4.8 OIL CENTRIFUGE

4.8.1 Oil Centrifuge Removal

Remove the oil centrifuge as follows: (See Figure 4-13a for component locations)

1. Oil Centrifuge
2. CTV Control Valve
3. CTV Control Valve Oil Line
4. Banjo bolt and Washers
5. Bolts
6. Centrifuge Bolts
7. Engine Trim Cover

Figure 4-14 Oil Centrifuge and Related Components

1. Disconnect the CTV control valve (2) electrical plug connector.
2. Remove banjo bolt and washers (4) from oil line (3) at CTV control valve (2). Discard washers.
3. Remove two bolts (5) and gasket from CTV control valve (2) and remove valve. Discard gasket.
4. Remove three bolts (6) securing centrifuge (1) to cylinder block and remove. Remove and discard seal ring on centrifuge.

### 4.8.2 Oil Centrifuge Disassembly

Disassemble the Oil Centrifuge as follows:

1. Remove centrifuge top and seal ring. Discard seal ring.
2. Remove spinner from centrifuge.

### 4.8.3 Oil Centrifuge Assembly

1. Install spinner in oil centrifuge
2. Install oil centrifuge cover and new seal ring. Tighten cover to 40 N·m (30 lb-ft).

### 4.8.4 Oil Centrifuge Installation

Install the oil centrifuge as follows: (See Figure 4-13a for component locations)

1. Install new seal ring on oil centrifuge (1) housing and secure to cylinder block with four bolts (6). Tighten bolts to 60-66 N·m (44-49 lb-ft).
2. Install CTV control valve (2) to the centrifuge (1) housing with two bolts (5). Tighten bolts to 31-35 N·m (23-26 lb-ft).
3. Install banjo bolt and two new washers (4) and secure CTV oil line (3) to CTV control valve (2). Tighten banjo bolt to 40-50 N·m (30-37 lb-ft).
4. Connect CTV control valve (2) connector plug.

### 4.8.5 CTV Oil Line Removal

Remove the CTV oil line as follows: (See Figure 4-13a for component locations).

1. Remove banjo bolt and washers (4) from CTV oil line (3) at CTV control valve (2). See Figure 4-14.
2. Remove the engine trim panel (7).
3. Remove banjo bolt and two washers securing CTV oil line (3) to cylinder block. Discard washers.

### 4.8.6 CTV Oil Line Installation

Install the CTV oil line as follows: (See Figure 4-13a for component locations).
1. Install banjo bolt and two new washers (4) on the CTV oil line (3) at the CTV control valve (2). See Figure 4-13a. Tighten banjo bolt to 40-50 N·m (30-37 lb-ft).

2. Install the banjo bolt and two new washers and attach the oil line (3) to the cylinder head fitting. Tighten banjo bolt to 40-50 N·m (30-37 lb-ft).

3. Install the engine trim panel (7).

4.8.7 Centrifuge Oil Supply Tube Removal

Remove the Centrifuge Oil Supply tube as follows: (See Figure 4-13b for component locations).

Figure 4-15 Centrifuge Oil Supply Tube and Related Components

1. Remove oil pan. Refer to section 4.7.1.

2. Remove two bolts (3) at clips, attaching oil supply line (4) to bottom of cylinder block (2).

3. Remove two banjo bolts and four washers (1) securing oil supply line (4) to cylinder block (2). Remove line and discard washers.

4.8.8 Centrifuge Oil Supply Tube Installation

Install the Centrifuge oil supply tube as follows: (See Figure 4-13b for component locations)

1. Install two banjo bolts and four new washers (1) and attach centrifuge oil line (4) to bottom of cylinder block (2). Tighten banjo bolts to 40-50 N·m (30-37 lb-ft).
2. Secure the centrifuge oil supply line (4) to bottom of cylinder block (2) with two bolts (3). Tighten bolts to 60-66 Nm (44-49 lb-ft).
3. Install oil pan. Refer to section 4.7.2.

**4.8.9 CTV Control Valve Removal**

Remove the CTV Control Valve as follows: See Figure 4-13a.

1. Disconnect the CTV control valve (2) electrical plug connector.
2. Remove banjo bolt and washers (4) from oil tube (3) at CTV control valve (2). Discard washers.
3. Remove two bolts (5) and gasket from CTV control valve (2) and remove valve. Discard gasket.

**4.8.10 CTV Control Valve Installation**

Install the CTV Control Valve as follows: (See Figure 4-13a for component locations)

1. Install CTV control valve (2) and new gasket to the centrifuge (1) housing and secure with two bolts. Tighten bolts to 31-35 N·m (23-26 lb-ft).
2. Install banjo bolt and two new washers (4) and secure CTV oil line (3) to CTV control valve (2). Tighten banjo bolt to 40-50 N·m (30-37 lb-ft).
3. Connect CTV control valve (2) connector plug.
### 4.A Additional Information

<table>
<thead>
<tr>
<th>Description</th>
<th>Page</th>
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<tbody>
<tr>
<td>SPECIFICATIONS</td>
<td>4-30</td>
</tr>
</tbody>
</table>
SPECIFICATIONS

The lubricating oil capacity is listed in Table 4-2.

<table>
<thead>
<tr>
<th>Description</th>
<th>4-Cylinder Engines</th>
<th>6-Cylinder Engines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil Pan Capacity</td>
<td>16 L (17 qt.)</td>
<td>25 L (26 qt.)</td>
</tr>
</tbody>
</table>

Table 4-2  Lubricating Oil Capacity

The torque values are listed in Table 4-3.

<table>
<thead>
<tr>
<th>Description</th>
<th>N·m (lb·ft)</th>
<th>kg·cm (lb·in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternator Strap Mounting Bolt</td>
<td>40 (30)</td>
<td>—</td>
</tr>
<tr>
<td>Housing Cover Bolt to Oil-Water Heat Exchanger</td>
<td>25 (18)</td>
<td>—</td>
</tr>
<tr>
<td>Oil Filter Cap</td>
<td>25 (18)</td>
<td>—</td>
</tr>
<tr>
<td>Oil Pump to Crankcase Bolt</td>
<td>25 (18)</td>
<td>—</td>
</tr>
<tr>
<td>Oil Pressure/Temperature Sensor Mounting</td>
<td>—</td>
<td>81 (72)</td>
</tr>
<tr>
<td>Oil Filter Housing to Crankcase</td>
<td>25 (18)</td>
<td>—</td>
</tr>
<tr>
<td>Oil Spray Nozzle Bolt</td>
<td>25 to 30 (18 to 22)</td>
<td>—</td>
</tr>
<tr>
<td>Oil-Water Heat Exchanger to Crankcase</td>
<td>25 (18)</td>
<td>—</td>
</tr>
<tr>
<td>Screw Plug to Oil-Water Heat Exchanger</td>
<td>20 (15)</td>
<td>—</td>
</tr>
<tr>
<td>Suction Pipe Bracket Bolt</td>
<td>50 (37)</td>
<td>—</td>
</tr>
<tr>
<td>Suction Pipe to Oil Pump Bolt</td>
<td>25 (18)</td>
<td>—</td>
</tr>
<tr>
<td>Oil Pan Drain Plug</td>
<td>65 (48)</td>
<td>—</td>
</tr>
<tr>
<td>Oil Pan M8 Bolts</td>
<td>25 (18)</td>
<td>—</td>
</tr>
</tbody>
</table>

Table 4-3  Torque Values