7. Secure the TMF turbine housing with four 5/8 in. hex-head bolts.
8. Tighten the bolts to 34 N·m (300 lb· in.) torque.

6.6.7 Installation of Turbocharger

To install the turbocharger:

1. Attach a chain hoist and a suitable lifting sling to the turbocharger assembly.
2. Remove any covers that were placed over the openings of the air inlet and exhaust outlet openings on the engine and turbocharger when the turbocharger was removed.
3. Remove any covers on the oil inlet and drain lines, and the oil inlet and drain openings on the turbocharger.
4. Place the turbocharger assembly into position on the exhaust manifold. Use a new gasket between the exhaust manifold and the turbine housing flange.
5. Secure the turbocharger to the exhaust flange. Tighten the nuts just enough to hold the turbocharger in place.
6. Slide the charge air cooler air inlet tube hose over the compressor housing outlet opening and secure it in place with the hose clamps.
CAUTION:

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

NOTE:
Do not use any type of lubricant on the inside of any air inlet hose or on the hose contact surfaces of the turbocharger compressor housing, CAC ducting or the intake manifold.

7. Tighten the turbocharger to exhaust manifold locknuts to 58-73 N·m (43-54 lb·ft) torque.

8. Install the oil drain line, using a new gasket, between the opening in the bottom side of the turbocharger center housing and the drain hose that runs to the cylinder block. Tighten the bolts to 30-38 N·m (22-28 lb·ft) torque.

9. If turbocharger is water cooled, install the coolant supply and return hoses.

10. Refer to section for verification of proper turbocharger installation.

For Series 60 engines with Exhaust Gas Recirculation (EGR) systems install the VNT turbocharger as follows:

1. Place base gasket over studs on exhaust manifold.

2. Place turbocharger over studs.

3. Install four M10 nuts and washers and torque to 49 N·m (36 lb·ft).

4. Connect air line to VNT actuator and torque to 20 N·m (14 lb·ft).

5. Install turbocharger compressor outlet temperature sensor.

6. Install turbocharger speed sensor.

7. Connect air line from variable pressure output device (VPOD) to actuator on VNT.
6.6.8 EGR Cooler Removal

For Series 60 engines equipped with EGR systems remove EGR Cooler as follows:

| CAUTION: |
| To avoid injury from hot surfaces, allow engine to cool before removing any component. Wear protective gloves. |

1. Remove two bolts and seal ring from water pump outlet elbow. Discard seal ring.
2. Remove water pump outlet elbow from hose on EGR water inlet.
3. Remove hose and clamps from EGR Cooler water inlet.
4. Slide clamp onto hose of oil cooler water inlet.
5. Remove turnbuckle clamp, S-Pipe and EGR Valve assembly from EGR Cooler inlet. See Figure 6-29.

Figure 6-29 EGR Cooler and Related Parts

1. EGR Valve Assembly
2. S-Pipe
3. Turnbuckle Clamp
4. Clevis Pin
5. Cotter Pin
6. EGR Cooler
6. Remove Delivery Pipe clamp from EGR Cooler outlet. See Figure 6-30.

Figure 6-30  EGR Cooler and Delivery Pipe

<p>| | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>1. Clamp</td>
<td>3. EGR Cooler</td>
</tr>
<tr>
<td>2. Delivery Pipe</td>
<td></td>
</tr>
</tbody>
</table>

**CAUTION:**

To avoid injury when removing or installing a heavy engine component, ensure the component is properly supported and securely attached to an adequate lifting device to prevent the component from falling.

7. Remove four bolts attaching EGR Cooler backplate to engine block.
8. Remove hose and clamp from oil cooler water inlet.

6.6.9  EGR Cooler Installation

Series 60 engines equipped with EGR systems have a EGR Cooler which cools the exhaust gas prior to introduction in the Intake Manifold.

Install the EGR Cooler as follows:

1. Install hose and clamps over oil cooler water inlet.
2. Insert EGR Cooler water outlet into hose on oil cooler inlet.
3. Align EGR Cooler back plate holes with four bosses on cylinder block.
4. Thread four M10 bolts through back plate and into cylinder block.
5. Tighten bolts to 46-52 N·m (34-38 lb·ft).
6. Install hose and clamps onto EGR Cooler water inlet see Figure 6-31.

7. Insert water pump outlet elbow into hose on EGR cooler water inlet.
8. Install new seal ring and water pump elbow on water pump with two M10 bolts torque bolts to 58-73 N·m (43-54 lb·ft).

**6.6.10 S-Pipe and EGR Valve Removal**

For Series 60 Engines equipped EGR systems remove S-Pipe and EGR Valve as follows:
6.6 TURBOCHARGER (DIESEL)

CAUTION:

To avoid injury from hot surfaces, allow engine to cool before removing any component. Wear protective gloves.

1. Remove nut, spherical washer and crab from M8 stud securing S-pipe to exhaust manifold.
2. Loosen turnbuckles.
3. Remove clevis and clip pins securing turnbuckle clamp to EGR Cooler, remove turnbuckle clamp and S-Pipe.
4. Remove oil inlet and outlet fittings from actuator assembly, remove EGR Valve and actuator assembly. See Figure 6-32.

![Diagram of EGR Valve and Actuator Assembly]

- 1. EGR Valve and Actuator Assembly
- 2. Oil Outlet Hose and Fitting
- 3. Oil Inlet Hose and Fitting

**Figure 6-32 EGR Valve and Actuator Assembly**

6.6.11 Disassembly of the EGR Valve and Actuator Assembly

Disassemble the EGR Valve and Actuator assemblies as follows:
NOTICE:
The actuator assembly can be separated from the EGR Valve assembly, however there should not be any further disassembly.
DO NOT disassemble the actuator or EGR valve assemblies.

1. Remove two bolts securing actuator assembly, heat and insulator shields to EGR Valve assembly.
2. Disassemble the EGR valve assembly from the actuator assembly.

6.6.11.1 Cleaning of the EGR Valve and Actuator Assembly

Clean the internal spline drive on the actuator assembly and external spline on the valve shaft as follows:

1. Brush splines to loosen debris.
2. Remove any loose debris with compressed air.

CAUTION:
To avoid injury from flying debris when using compressed air, wear adequate eye protection (face shield or safety goggles) and do not exceed 40 psi (276 kPa) air pressure.

6.6.11.2 Inspection of the EGR Valve and Actuator Assembly

Inspect the EGR Valve and Actuator Assembly as follows:

1. Visually inspect actuator and valve assemblies for excessive wear.
2. If the EGR valve or actuator assemblies are defective replace with a new assembly.
3. If the EGR valve or actuator assemblies are not defective reuse the assembly.

6.6.12 Assembly of the EGR Valve and Actuator Assemblies

Assemble the EGR valve and actuator as follows:

NOTE:
The insulator shield must be replaced whenever the actuator assembly is disassembled from the EGR valve assembly. The heat shield can be reused.

NOTE:
The spline drive for the actuator assembly is keyed to ensure proper alignment with the shaft on the valve assembly.
1. Install the actuator assembly, heat and insulation shields onto the splined shaft of the EGR valve assembly. **DO NOT FORCE.** See Figure 6-33.

![Figure 6-33](image)

**Figure 6-33 Actuator and EGR Valve and Related Parts**

1. Valve and Insert Assembly  
2. Insulator Shield  
3. Splined Internal Drive  
4. Actuator Assembly  
5. Bolts  
6. Heat Shield  
7. Splined External Shaft

2. Install two bolts into the actuator and EGR valve.

3. Torque bolts evenly to ensure EGR valve and actuator assemblies are not misaligned. Misalignment will cause the assemblies to bind.

4. Torque bolts to 24-28 N·m (18-21 lb·ft).

### 6.6.13 S-Pipe and EGR Valve Installation

Exhaust gas flows from the exhaust manifold through the S-pipe and EGR valve to the cooler. This system includes three spherical slip joints to allow motion between the exhaust manifold and cooler due to assembly variation, vibration and thermal growth. The three joints are coated with a special material that allows for relative movement between parts while still maintaining a seal and minimizing wear.

Install the S-Pipe as follows:

1. If the exhaust manifold stud has not been installed use the following procedure:
[a] Apply antiseize to threads on the M8 stud and install in the threaded hole near the EGR port on the bottom of the exhaust manifold.

[b] Torque to 25-30 N·m (18-22 lb·ft).

2. If removed install exhaust manifold on the engine. Refer to Section 7.2.

3. Loosely install crab, spherical washer and nut on the M8 stud.

4. Install the turnbuckle clamp on the cooler using clevis and clip pins. The turnbuckles on either side of the clamp should be extended; each turnbuckle nut should be engaged by a few threads. See Figure 6-34.

![Figure 6-34 Turn Buckle Clamp Assembly](image)

1. Clip Pin
2. Turnbuckle
3. Clevis Pin
4. Exhaust Manifold
5. S-Pipe
6. EGR Valve and Actuator Assembly
7. Turnbuckle Clamp
8. EGR Cooler
5. Slide and rotate the S-pipe into position with hold down tabs under the crab. See Figure 6-37.

### NOTICE:

| Inspect spherical sealing surfaces for scratches. Replace hardware if deeply scratched or galled. |

### NOTE:

The valve **TOP** is indicated on the casting. See Figure 6-35.

---

**Figure 6-35**  
EGR Valve and Actuator Assembly
6. Slide and rotate the EGR valve into position between the S-pipe and cooler. See Figure 6-36.
7. Rotate the turnbuckle clamp up and over the S-pipe so that the clamp's saddle rests in the bowl on top of the S-pipe.

8. Tighten the nuts on the turnbuckle by hand, making sure that both turnbuckle nuts are tightened equally. If one side is tightened more than the other, the EGR valve will be pulled out of alignment, and the exhaust gas path will not be sealed. Leave the nuts finger tight.

9. Finger tighten the nut on the crab at the other end of the S-Pipe.

10. Shift the S-pipe back and forth to ensure that the spherical joints are properly seated and the parts are aligned. When the manifold, S-pipe, EGR valve and EGR cooler are in alignment, the crab nut and turnbuckle clamp can be tightened.

11. Torque the crab nut to 25-30 N·m (18-22 lb·ft).

12. Tighten the turnbuckle clamp, turning each nut equally. Stop tightening the clamp when the torque on the outer nut reaches 25-30 N·m (18-22 lb·ft). See Figure 6-37.

---

**Figure 6-37**  
**EGR Assembly and Related Parts**
NOTICE:
Particle debris in the lubrication inlet and outlet ports of the actuator assembly can cause performance problems. Use care to keep any debris out of the actuator and oil lines when servicing. See Figure 6-38.

**Figure 6-38**  EGR Valve and Actuator Oil Inlet and Outlet Locations
13. Install oil inlet and outlet fittings on actuator assembly and torque to 24-28 N·m (18-21 lb·ft). See Figure 6-39.

**Figure 6-39**  EGR Valve Assembly with Oil Lines
6.6.14 EGR Delivery Pipe Removal

For Series 60 engines equipped with EGR systems remove Delivery Pipe as follows:

**CAUTION:**

To avoid injury from hot surfaces, allow engine to cool before removing any component. Wear protective gloves.

1. Remove bolts from L-brackets on top of camshaft gear cover. Remove the bolt and nut from the two P-clips. See Figure 6-40.

![Delivery Pipe and Related Parts](image)

1. Bolt
2. L-Bracket
3. Hose
4. P-Clip
5. Nut
6. Delivery Pipe
7. EGR Temperature Sensor

**Figure 6-40** Delivery Pipe and Related Parts

2. Remove EGR temperature sensor from delivery pipe. See Figure 6-40.
3. Remove bolt securing P-Clip and S-bracket to heat shield on exhaust manifold. See Figure 6-41.

Figure 6-41 Delivery Pipe and Related Parts

4. Remove clamp at delivery tube (small end) to cooler outlet flange.

5. Disconnect Delta-P tubes at delivery pipe.
6. Remove clamp at mixer end (large end) of delivery pipe to intake manifold. See Figure 6-42.

Figure 6-42 Delivery Pipe and Related Parts

6.6.15 Removal of Delivery Pipe Hose

The Series 60 2004 Exhaust Gas Recirculation (EGR) engine utilizes a three piece delivery pipe. The delivery pipe uses a mixer-section, mid-section, venturi-section and two hose connections with attaching clamps. In the event the hose connections need replacement use the following procedure.

To replace hose connections proceed as follows:

1. Remove EGR delivery pipe from engine refer to section 6.6.14.
2. Open clamps and remove hose from mixer-section and mid-section, remove hose from mid-section and venturi-section.

### 6.6.16 Installation of Delivery Pipe Hose

To install hose connections proceed as follows:

**NOTICE:**
If hose clamps have been removed from delivery pipe, they must be reinstalled prior to hose installation.

**NOTICE:**
Ensure when installed on the hose, clamps are seated against the beads on the delivery pipe mixer section, mid-section and venturi-section. Do Not over stretch clamp, open enough to clear hose. See figure 6-42a and see Figure 6-42b.

![Figure 6-42a](rev_12/03)

1. Delivery Tube
2. Hose Clamp
3. Pipe Bead

**Figure 6-42a**
EGR Delivery Pipe
1. Hose Clamp  
2. Hose

**Figure 6-42b  Delivery Pipe and Related Parts**

<table>
<thead>
<tr>
<th>NOTICE:</th>
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<tr>
<td>Before hose is installed on delivery pipe ensure there are not any sharp edges present that can cut the hose liner (BLACK I.D.).</td>
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</table>

1. Install mixer-section of delivery pipe to intake manifold with band clamp. Refer to section 6.6.17 for torque specifications.
2. Install hose on delivery pipe mixer-section, secure hose with clamp. Ensure top of delivery pipe is horizontal. See Figure 6-42c.
3. Install venturi-section on EGR cooler with clamp and connect Delta-P tubes refer to section 6.6.17 and refer to section 6.6.19. See Figure 6-42d.

Figure 6-42d  EGR Cooler and Delivery Pipe
4. Install hose on venturi-section and secure hose with clamp. See Figure 6-42e.

**Figure 6-42e** Venturi-Section and Related parts

1. P-Clip
2. S-Bracket
3. Mid-Section
4. Hose
5. Venturi-Section
6. Clamp
7. Exhaust Manifold Heat Shield
5. Align delivery pipe mid-section with the venturi-section and mixer-section, push the ends of the delivery pipe mid-section onto the hose connections and secure with clamps. See Figure 6-42f.

![Diagram of the delivery pipe and related parts](44083)

1. Venturi-Section  
2. Hose  
3. Mid-Section  
4. Mixer-Section

Figure 6-42f Delivery Pipe and Related Parts

6. Ensure installed hose connections are properly aligned.

7. Install any brackets or hardware that were removed for the hose replacement procedure. Refer to section 6.6.17 and refer to section 6.6.19.

### 6.6.17 EGR Delivery Pipe Installation

The EGR Delivery Pipe provides a flow path from the cooler to the Intake Manifold.

For Series 60 Engines equipped with EGR systems install the delivery pipe as follows:

1. Loosely install the mixer end of the pipe (large diameter tube) to the intake manifold with band clamp. See Figure 6-42.

2. Loosely install the flow meter end of the pipe (small end) to the cooler outlet flange with band clamp. See Figure 6-30.

3. Loosely install two gusseted L-brackets to the top of the camshaft gear cover.

4. Loosely attach the delivery pipe to the gusseted L-brackets with two P-clips. See Figure 6-40.
5. Loosely attach the delivery pipe to the forward exhaust manifold heat shield with a P-clip and S-bracket. See Figure 6-41.

**NOTICE:**

| Make sure that the P-clip is mounted behind the S-bracket. |

**Notice:**

| On some models the delivery tube is clipped to a bracket on the alternator. Ensure correct alignment before torquing. |

6. Tighten the delivery tube to intake mixer clamp to 12 N·m (106 lb·in.).

7. Tighten the clamp at the delivery tube to cooler to 12 N·m (106 lb·in).

8. Tighten the L-Bracket bolts in the camshaft gear cover to 58-73 N·m (43-54 lb·ft).

**Notice:**

| The camshaft gear cover is aluminum. Over tightening the bolt can strip threads in the camshaft gear cover. |

9. Tighten the bolt and nut connecting the two P-clips to the gusseted L-brackets to 30-38 N·m (22-28 lb·ft).

10. Tighten the bolt into the heat shield to 30-38 N·m (22-28 lb·ft).

### 6.6.18 EGR Rate Measurement System Removal

For Series 60 engines equipped with EGR systems remove Delta-P Sensor Rate Measurement System as follows:

**CAUTION:**

| To avoid injury from hot surfaces, allow engine to cool before removing any component. Wear protective gloves. |

1. Remove four hose clamps at Delta-P sensor. See Figure 6-42g.

2. Remove bolt and P-clips securing Delta-P tubes.

3. Remove Delta-P tubes from ports on Delta-P Sensor and Delivery tube.

4. Remove two bolts securing Delta-P Sensor to bracket.

5. Remove three nuts and six isolators securing Delta-P sensor mount to thermostat housing. See Figure 6-42g.
6.6.19 EGR Rate Measurement System Installation

EGR Rate Measurement system provides DDEC with measurements resulting in EGR flow rate prediction. The Rate Measurement system consists of a Venturi with pressure differential sensor and exhaust gas temperature sensor. Pressure differential between Venturi inlet and throat, along with exhaust gas temperature are converted to mass flow rate in DDEC. The Venturi is a component of the delivery pipe.

Install the EGR Rate Measurement System as follows:

1. Install the Delta-P sensor mount over the thermostat housing. Rubber isolators should be installed on both sides of the mount in each of the three mounting holes. Tighten nuts over the mounting studs until the nuts come to a hard stop. Torque the nuts to 23-27 N·m (17-20 lb·ft).

2. Install the Delta-P sensor to the bracket with two bolts torque to 30-38 N·m (22-28 lb·ft).

3. Install a hose connector with a clamp on each end to both ports on the sensor bracket.

4. Loosely install two Delta-P tubes to the delivery pipe. The tube ends should line up with the hose connections on the Delta-P sensor bracket.

5. Loosely clip the Delta-P tubes to the exhaust manifold assembly using clips.

6. Tighten the Delta-P tube nuts to 24-30 N·m (18-22 lb·ft).

7. Tighten the clip bolt to 30-38 N·m (22-28 lb·ft).

8. Tighten the four hose clamps until snug.
6.6.20 Variable Pressure Output Device (VPOD) Removal

The Variable Pressure Output Device (VPOD) modulates air pressure to the VNT. Remove the VPOD as follows:
To avoid injury from hot surfaces, allow engine to cool before removing any component. Wear protective gloves.

1. Remove airline from VPOD.
2. Unplug harness connection.
3. Remove two bolts and one stud holding VPOD assembly and bracket to engine block.

6.6.21 Variable Pressure Output Device (VPOD) Installation

Install Variable Pressure Output Device (VPOD) as follows:

1. Align VPOD assembly and bracket to threaded holes in engine block, install two bolts and one stud. Torque the M10 bolt and M10 stud to 58-73 N·m (43-54 lb-ft). Torque the M8 bolt to 30-38 N·m (22-28 lb-ft).
2. Connect airline to VPOD and tighten. See Figure 6-42h.

**Figure 6-42h**  VPOD and Related Parts

1. VPOD Assembly  
2. Clip  
3. Bolt  
4. Air Line Connection
3. Plug harness connection into VPOD assembly. See Figure 6-42i.

**Figure 6-42i**

**NOTE:**
The VPOD assembly is not serviced remove and replace only.
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