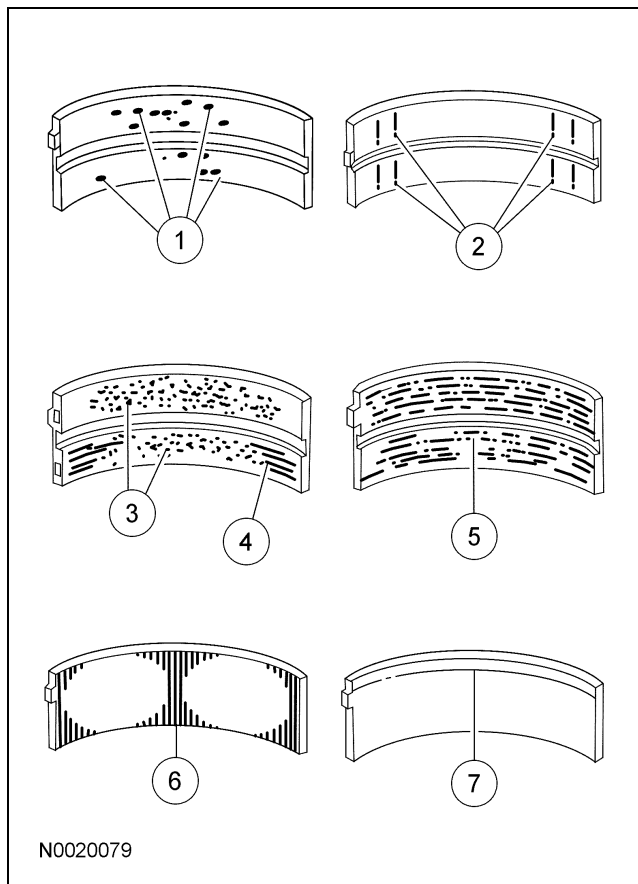


GENERAL PROCEDURES

Bearing Inspection

1. Inspect bearings for the following defects:

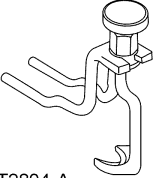
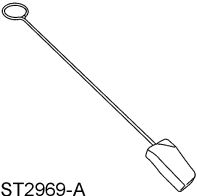
- 1 Cratering — fatigue failure
- 2 Spot polishing — incorrect seating
- 3 Imbedded dirty engine oil
- 4 Scratching — dirty engine oil
- 5 Base exposed — poor lubrication
- 6 Both edges worn — journal damaged
- 7 One edge worn — journal tapered or bearing not seated



IN-VEHICLE REPAIR

Camshaft — LH

Special Tool(s)

 <p>ST2804-A</p>	Compressor, Valve Spring 303-1039
 <p>ST2969-A</p>	Wedge, Timing Chain 303-1175

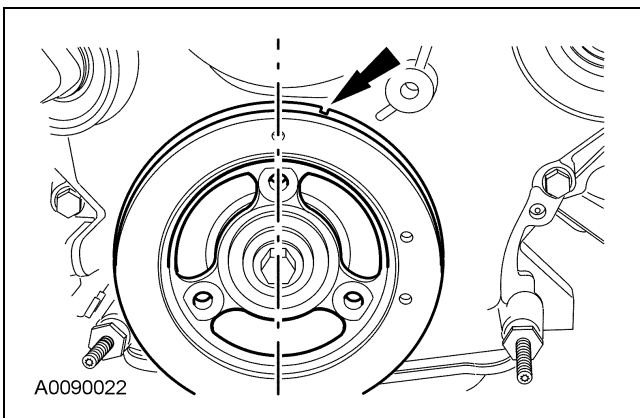
Material

Item	Specification
Motorcraft SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP (US); Motorcraft SAE 5W-20 Super Premium Motor Oil CXO-5W20-LSP12 (Canada); or equivalent	WSS-M2C930-A

Removal

⚠ CAUTION: The camshaft procedure must be followed exactly or damage to the valves and pistons will result.

1. Position the crankshaft damper spoke at the 12 o'clock position and the timing mark indentation at the 1 o'clock position.

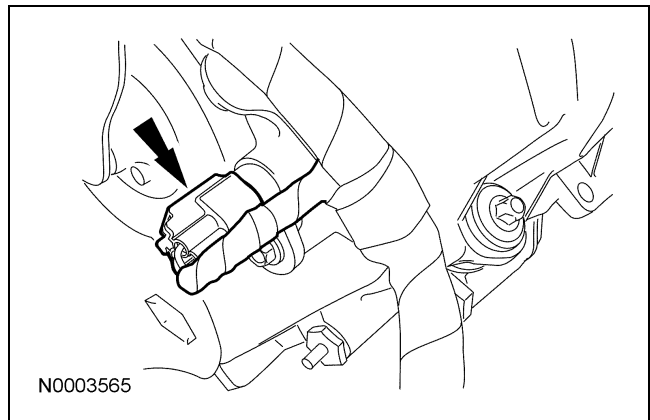


2. Remove the LH valve cover. For additional information, refer to Valve Cover — LH in this section.

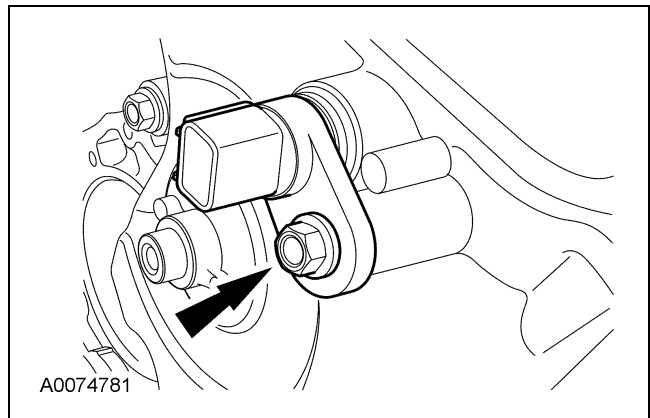
3. **⚠ CAUTION:** Damage to the camshaft phaser and sprocket assembly will occur if mishandled or used as a lifting or leveraging device.

Loosen and back off the LH camshaft phaser and sprocket bolt one full turn.

4. Disconnect the LH camshaft position (CMP) sensor electrical connector.



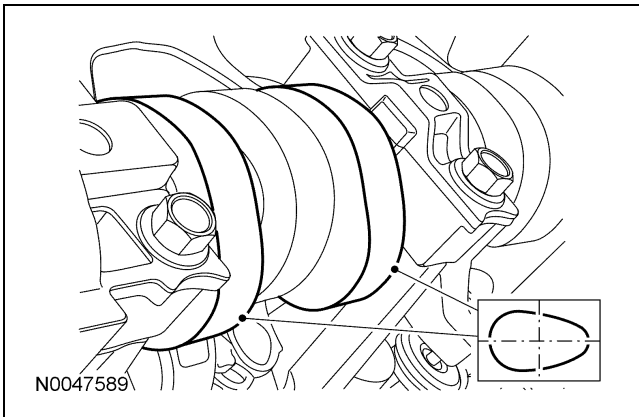
5. Remove the LH CMP sensor and the bolt.



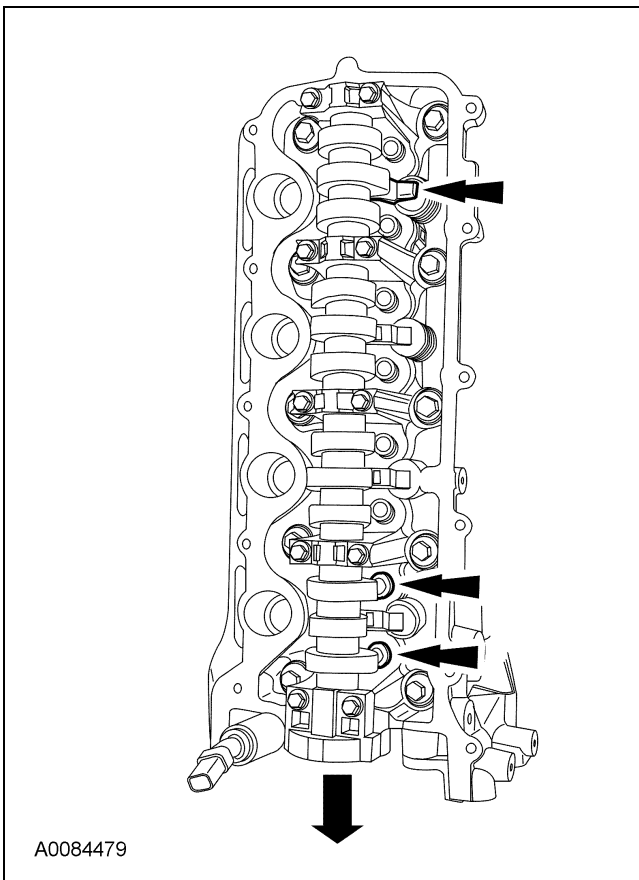
IN-VEHICLE REPAIR (Continued)

6. **NOTE:** If the camshaft lobes are not exactly positioned as shown, the crankshaft keyway will require one full additional rotation to 12 o'clock.

The No. 5 cylinder camshaft lobe must be coming up on the exhaust stroke. Verify by noting the position of the 2 intake camshaft lobes and the exhaust lobe on the No. 5 cylinder.



7. Remove only the 3 camshaft roller followers shown in the illustration.

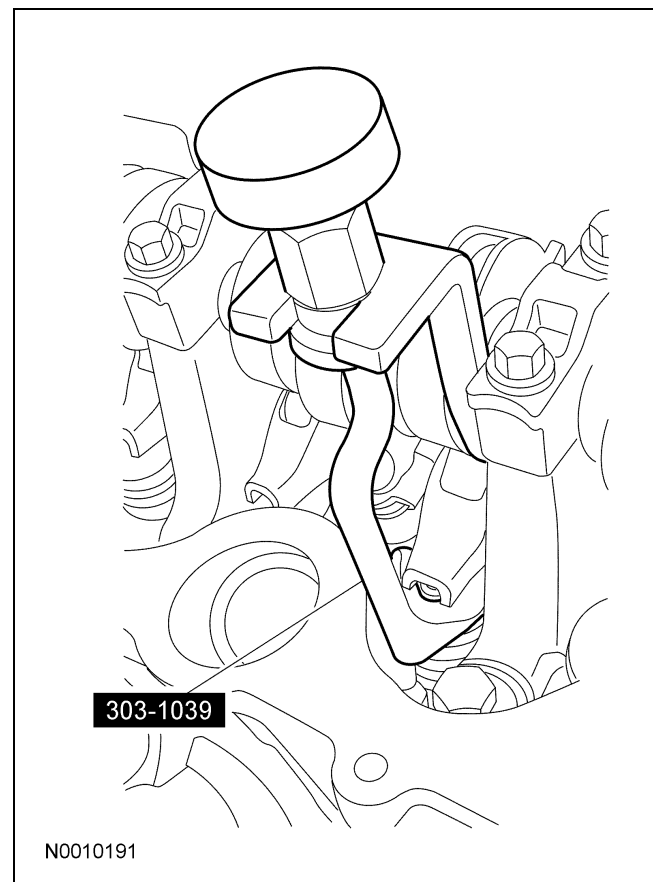


8. **⚠ CAUTION:** The camshaft roller followers must be installed in their original locations. Record camshaft roller follower locations. Failure to follow these instructions may result in engine damage.


NOTE: Do not allow the valve keepers to fall off of the valve or the valve may drop into the cylinder. If a valve drops into the cylinder, the cylinder head must be removed. For additional information, refer to Cylinder Head in this section.

NOTE: It may be necessary to push the valve down while compressing the spring.

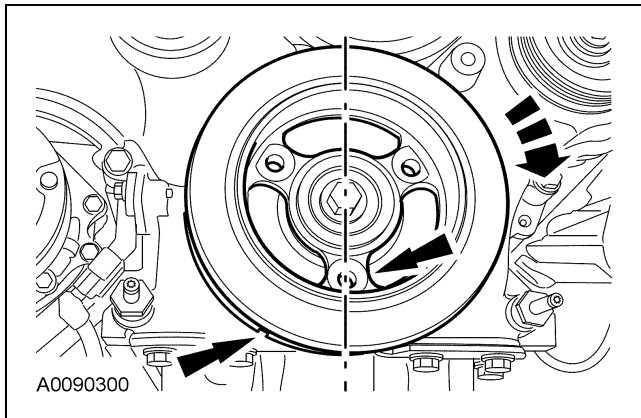
Using the special tool, remove only the 3 designated camshaft roller followers from the previous step.




IN-VEHICLE REPAIR (Continued)

9.  **CAUTION:** The crankshaft cannot be moved past the 6 o'clock position once set or engine damage may occur.

Rotate the crankshaft clockwise, as viewed from the front, positioning the crankshaft damper spoke at the 6 o'clock position and the timing mark indentation at the 7 o'clock position.

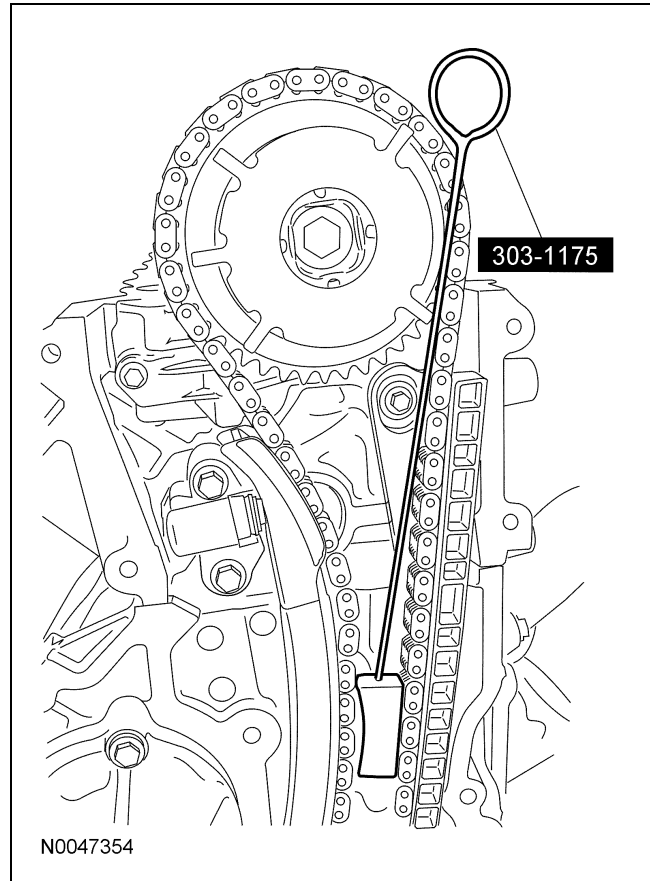


10.  **CAUTION:** Engine is not freewheeling. Camshaft procedure must be followed exactly or damage to valves and pistons will result.

NOTE: The Timing Chain Wedge tool must be installed square to the timing chain and the engine block.

NOTE: Engine front cover removed for clarity.

Install the special tool in the LH timing chain as shown.



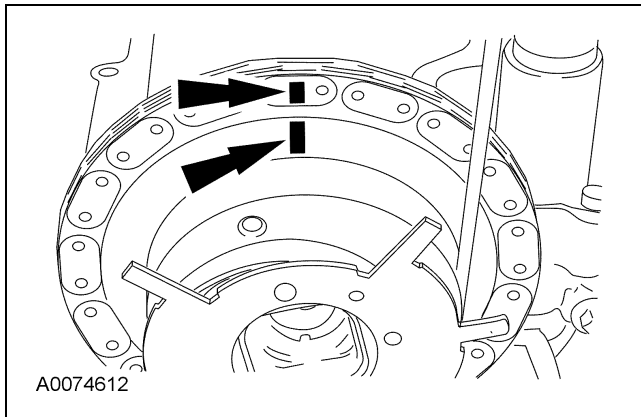
IN-VEHICLE REPAIR (Continued)

11. ⚠ **CAUTION:** Do not remove the Timing Chain Wedge tool at any time during assembly. If the special tool is removed or out of placement, the engine front cover must be removed and the engine must be retimed. For additional information, refer to Timing Drive Components in this section.

⚠ **CAUTION:** The timing chain must be installed in its original position onto the camshaft phaser and sprocket using the scribed marks, or damage to valves and pistons will result.

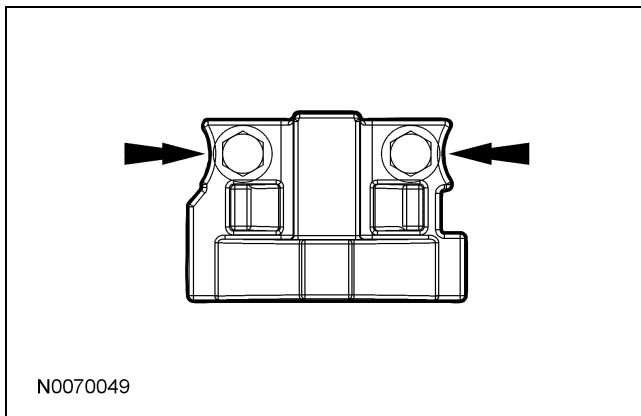
NOTE: RH shown, LH similar.

Scribe a location mark on the timing chain and the camshaft phaser and sprocket assembly.



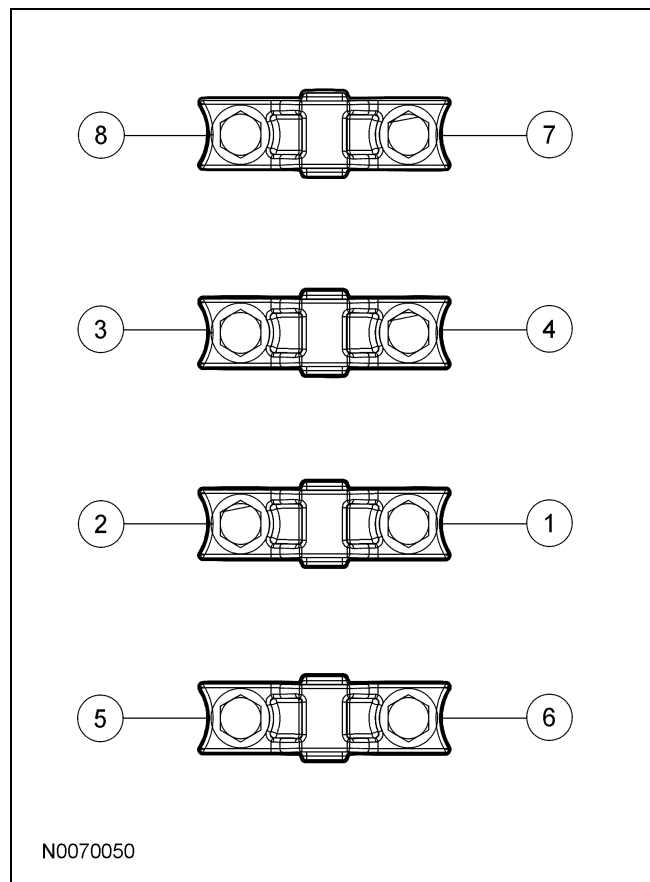
12. ⚠ **CAUTION:** When removing the front thrust camshaft bearing cap, use care as the cap may be damaged from side loading when removing the cam unequally in height from the bearing towers.

Remove the 2 bolts and the camshaft front bearing cap.



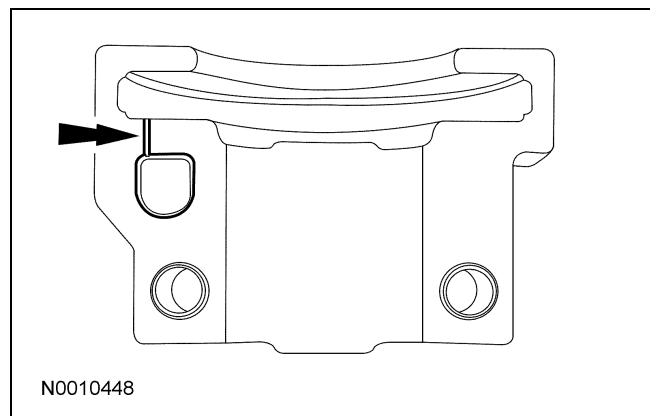
13. ⚠ **CAUTION:** The camshaft bearing caps must be installed in their original locations. Record camshaft bearing cap locations. Failure to follow these instructions may result in engine damage.

Remove the remaining bolts in the sequence shown and remove the camshaft bearing caps.





14. Clean and inspect the LH camshaft bearing caps.


- The camshaft front thrust bearing cap contains an oil metering groove. Make sure the groove is free of foreign material.



IN-VEHICLE REPAIR (Continued)

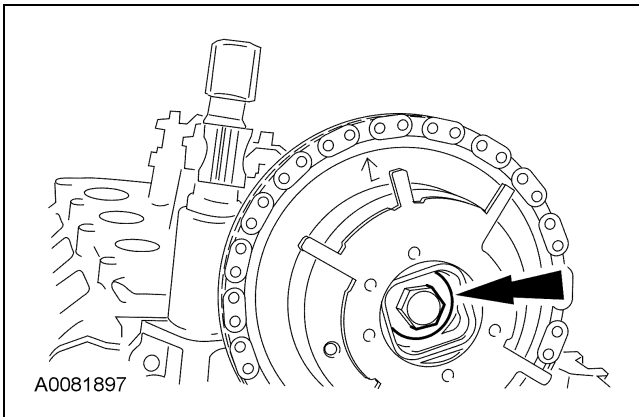
15.  **CAUTION:** Damage to the camshaft phaser and sprocket assembly will occur if mishandled or used as a lifting or leveraging device.

 **CAUTION:** Only use hand tools to remove the camshaft phaser and sprocket bolt or damage may occur to the camshaft or camshaft phaser and sprocket.

 **CAUTION:** Do not remove the Timing Chain Wedge tool at any time during assembly. If the special tool is removed or out of placement, the engine front cover must be removed and the engine must be retimed. For additional information, refer to Timing Drive Components in this section.


Remove the bolt and withdraw the camshaft from the camshaft phaser and sprocket assembly, leaving the camshaft phaser and sprocket assembly in place.


- Discard the bolt and washer.



16. Inspect the camshaft phaser and sprocket for damage. For additional information, refer to Camshaft Phaser and Sprocket in this section.

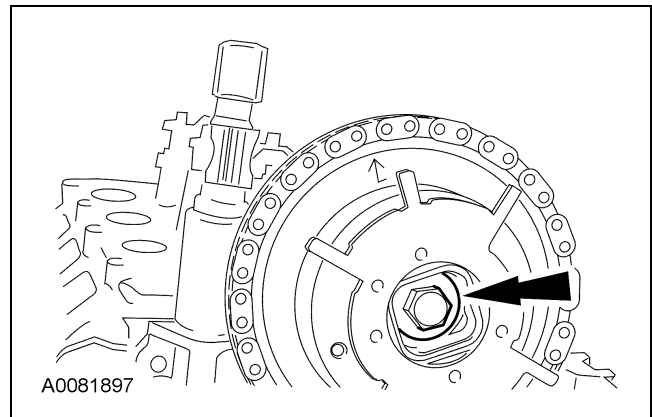
Installation

1. Lubricate the camshaft and camshaft journals with clean engine oil.
2.  **CAUTION:** Do not remove the Timing Chain Wedge tool at any time during assembly. If the special tool is removed or out of placement, the engine front cover must be removed and the engine must be retimed. For additional information, refer to Timing Drive Components in this section.


 **CAUTION:** Damage to the camshaft phaser and sprocket assembly will occur if mishandled or used as a lifting or leveraging device.


NOTE: Do not allow the camshaft roller followers to move out of position when installing the camshaft.

Install the camshaft into the camshaft phaser and sprocket assembly and onto the head. Install a new camshaft phaser and sprocket bolt finger tight.



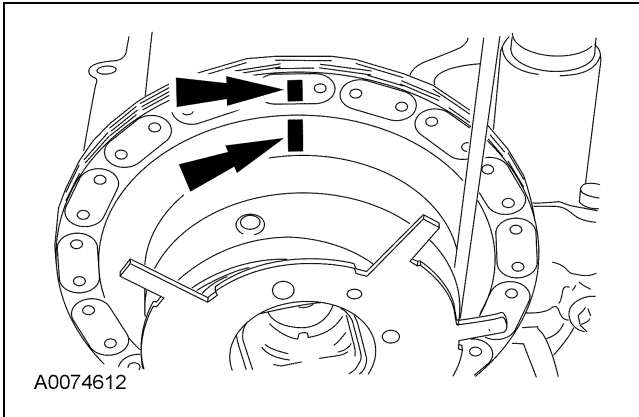
IN-VEHICLE REPAIR (Continued)

3.  **CAUTION:** Do not remove the Timing Chain Wedge tool at any time during assembly. If the special tool is removed or out of placement, the engine front cover must be removed and the engine must be retimed. For additional information, refer to Timing Drive Components in this section.

 **CAUTION:** The timing chain must be installed in its original position onto the camshaft phaser and sprocket using the scribed marks, or damage to valves and pistons will result.

NOTE: RH shown, LH similar.

Verify the camshaft phaser and sprocket and timing chain scribe marks are still in alignment.

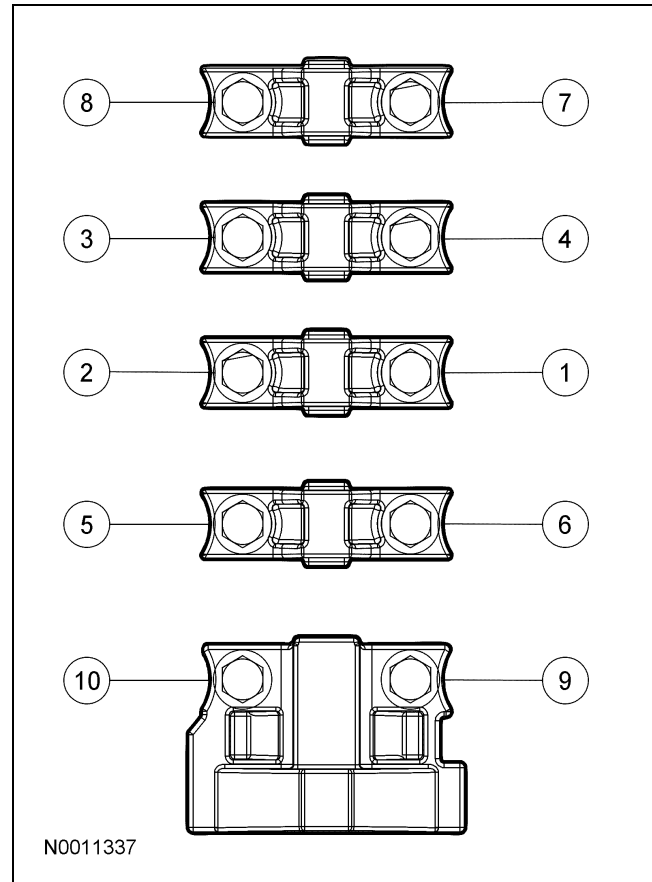


4. **NOTE:** Do not allow the camshaft roller followers to move out of position when installing the camshaft.

Install the camshaft bearing caps in their original locations.

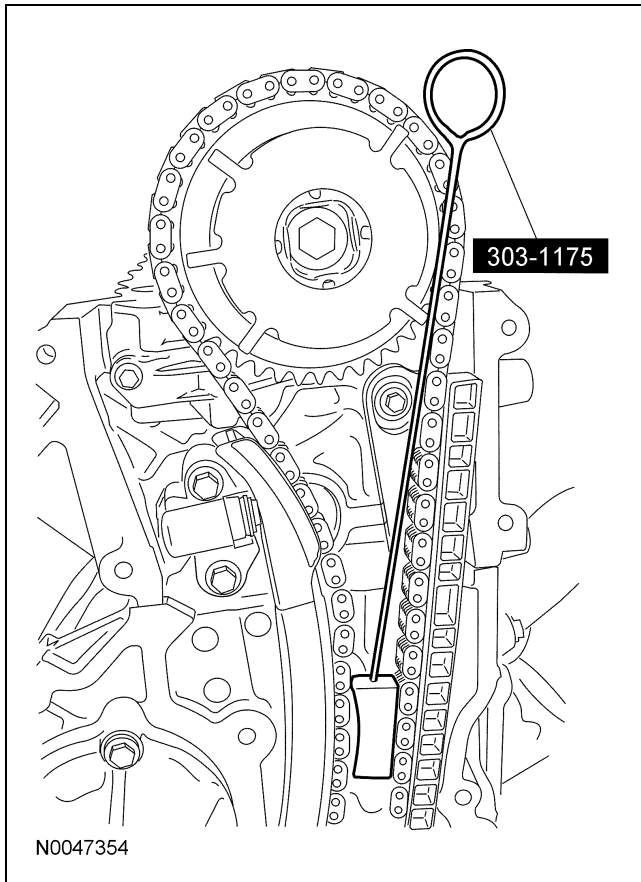
- Lubricate the camshaft bearing caps with clean engine oil.
- Position the front camshaft bearing cap.
- Position the remaining camshaft bearing caps.
- Install the bolts loosely.

5. Tighten the bolts in the sequence shown.
- Tighten to 10 Nm (89 lb-in).

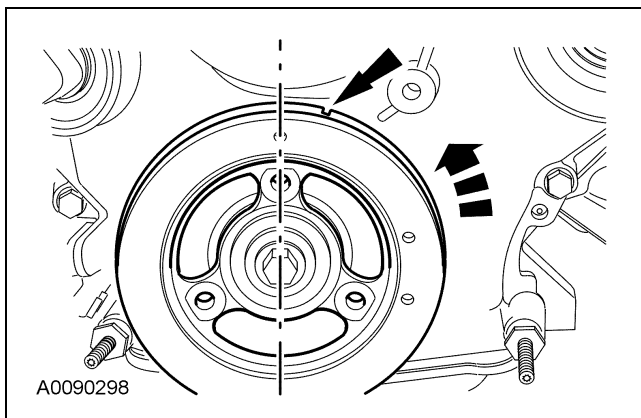


IN-VEHICLE REPAIR (Continued)

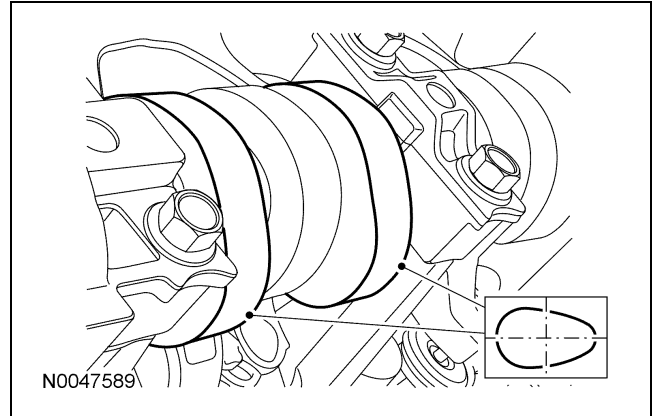
6. **NOTE:** Engine front cover removed for clarity.
Remove the special tools.



7. Rotate the crankshaft a half turn counterclockwise and position the crankshaft damper spoke at the 12 o'clock position and the timing mark indentation at the 1 o'clock position.



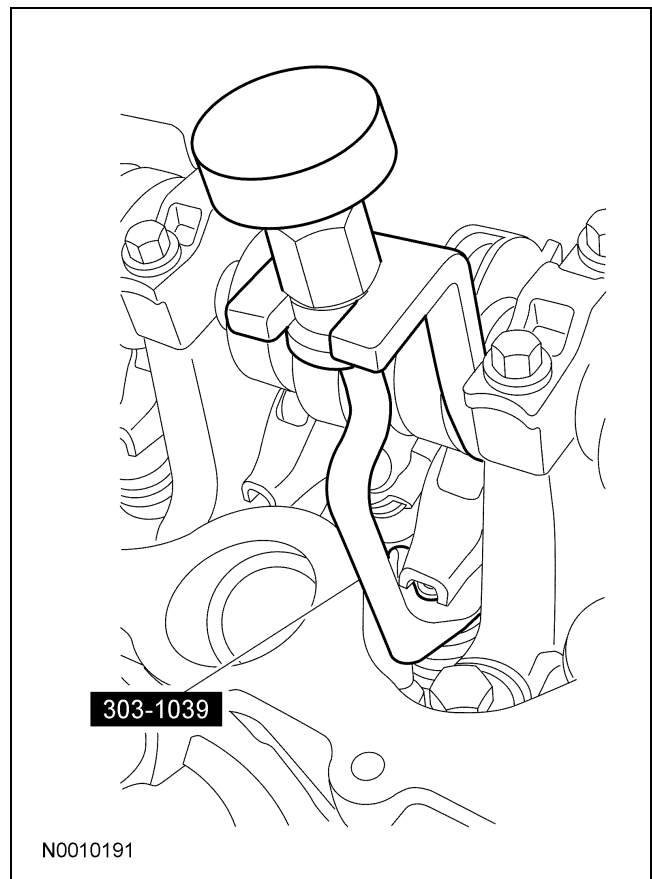
8. Verify correct camshaft position by noting the position of the No. 5 cylinder intake and exhaust camshaft lobes.



9. **NOTE:** Do not allow the valve keepers to fall off of the valve or the valve may drop into the cylinder. If a valve drops into the cylinder, the cylinder head must be removed. For additional information, refer to Cylinder Head in this section.

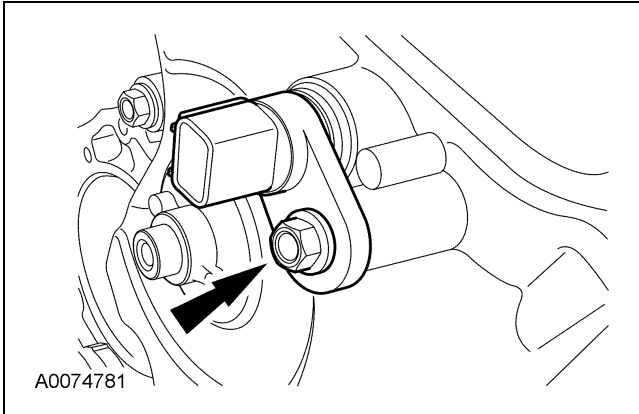
NOTE: It may be necessary to push the valve down while compressing the spring.

Using the special tool, install the 3 originally removed camshaft roller followers.

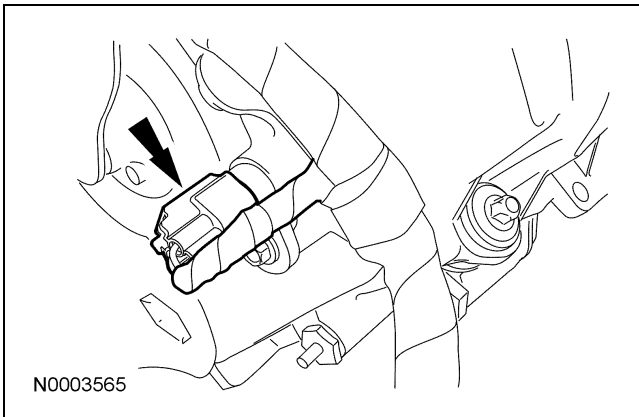


IN-VEHICLE REPAIR (Continued)

10. Install the CMP sensor and the bolt.



11. Connect the CMP electrical connector.

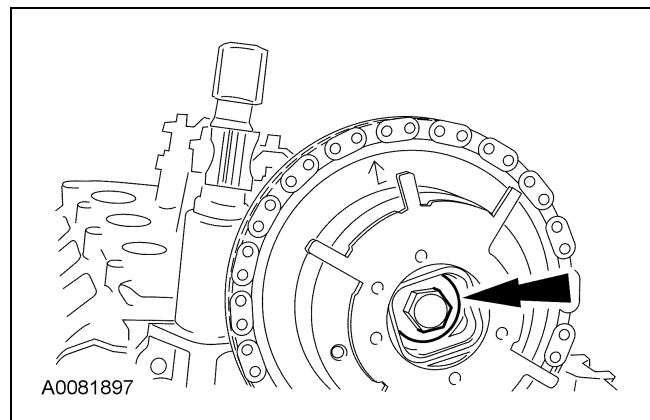


12. ⚠ **CAUTION:** Only use hand tools to install the camshaft phaser and sprocket assembly or damage may occur to the camshaft or camshaft phaser and sprocket.

⚠ **CAUTION:** Damage to the camshaft phaser and sprocket assembly will occur if mishandled or used as a lifting or leveraging device.

Tighten the camshaft phaser and sprocket bolt in 2 stages:

- Stage 1: Tighten to 40 Nm (30 lb-ft).
- Stage 2: Tighten an additional 90 degrees.

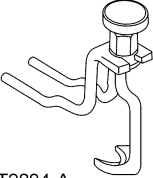
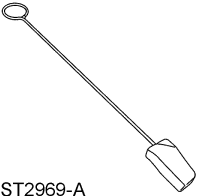


13. Install the LH valve cover. For additional information, refer to Valve Cover — LH in this section.

IN-VEHICLE REPAIR

Camshaft — RH

Special Tool(s)

 <p>ST2804-A</p>	Compressor, Valve Spring 303-1039
 <p>ST2969-A</p>	Wedge, Timing Chain 303-1175

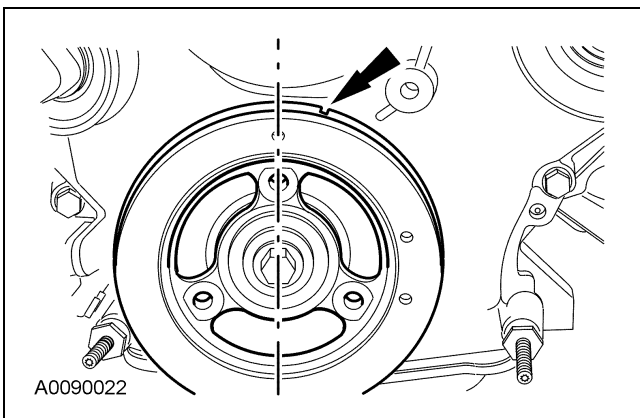
Material

Item	Specification
Motorcraft SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP (US); Motorcraft SAE 5W-20 Super Premium Motor Oil CXO-5W20-LSP12 (Canada); or equivalent	WSS-M2C930-A

Removal

⚠ CAUTION: The camshaft procedure must be followed exactly or damage to the valves and pistons will result.

1. Position the crankshaft damper spoke at the 12 o'clock position and the timing mark indentation at the 1 o'clock position.

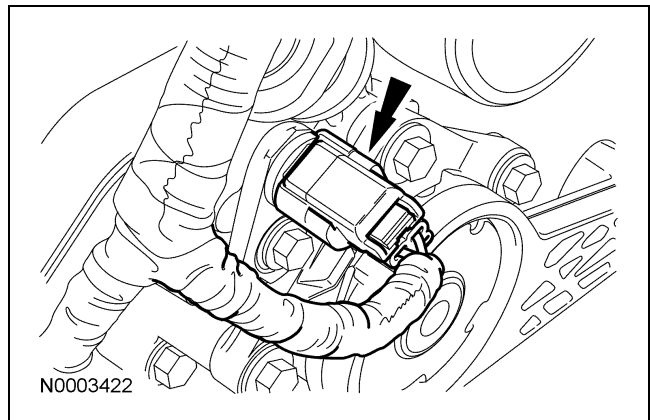


2. Remove the RH valve cover. For additional information, refer to Valve Cover — RH in this section.

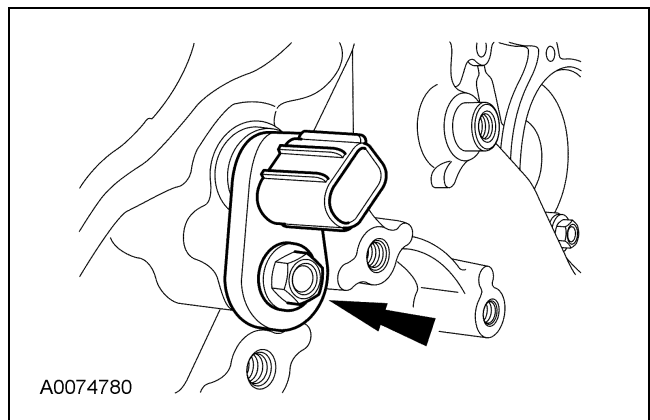
3. **⚠ CAUTION:** Damage to the camshaft phaser and sprocket assembly will occur if mishandled or used as a lifting or leveraging device.

Loosen and backoff the RH camshaft phaser and sprocket bolt one full turn.

4. Disconnect the RH camshaft position (CMP) sensor electrical connector.



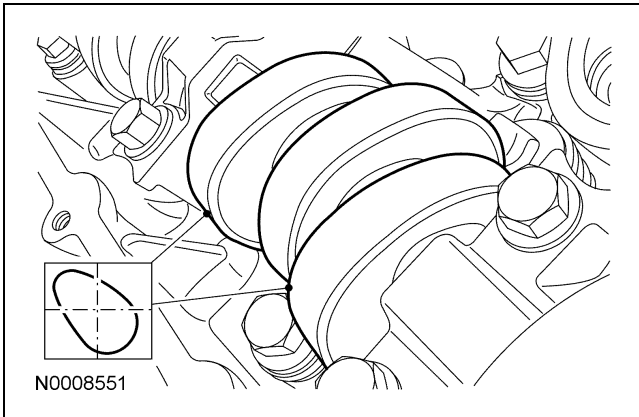
5. Remove the bolt and the RH CMP sensor.



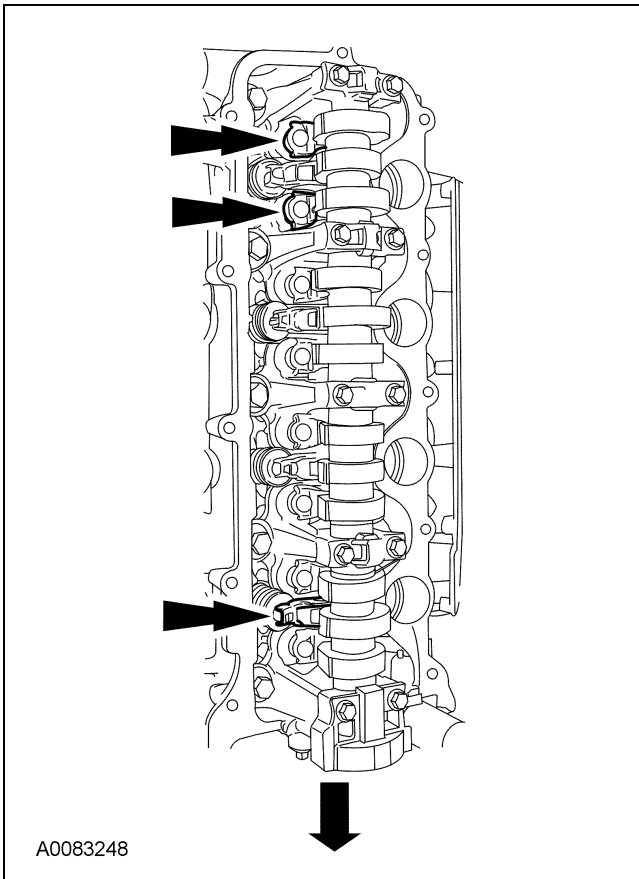
IN-VEHICLE REPAIR (Continued)

6. **NOTE:** If the camshaft lobes are not exactly positioned as shown, the crankshaft will require one full additional rotation to 12 o'clock.

The No. 1 cylinder camshaft exhaust lobe must be coming up on the exhaust stroke. Verify by noting the position of the 2 intake camshaft lobes and the exhaust lobe on the No. 1 cylinder.



7. Remove only the 3 camshaft roller followers shown in the illustration.

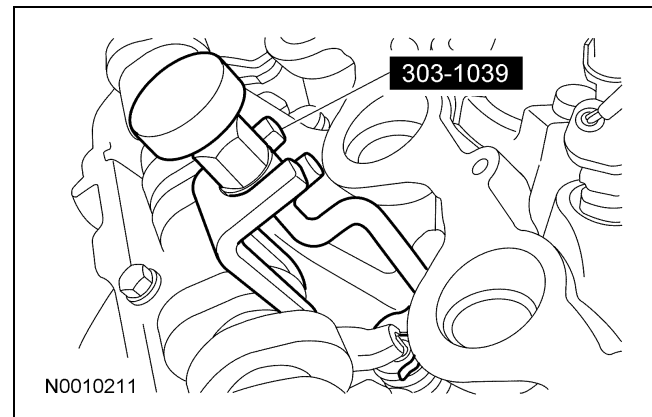


8. **⚠ CAUTION:** The camshaft roller followers must be installed in their original locations. Record camshaft roller follower locations. Failure to follow these instructions may result in engine damage.

NOTE: Do not allow the valve keepers to fall off of the valve or the valve may drop into the cylinder. If a valve drops into the cylinder, the cylinder head must be removed. For additional information, refer to Cylinder Head in this section.

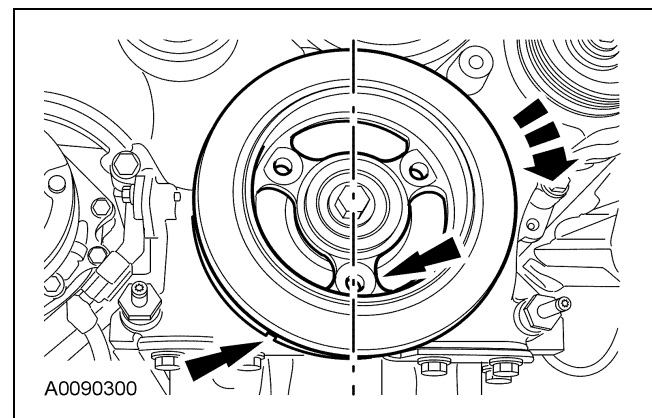
NOTE: It may be necessary to push the valve down while compressing the spring.

Using the special tool, remove only the 3 designated camshaft roller followers from the previous step.




9. **⚠ CAUTION:** The crankshaft cannot be moved past the 6 o'clock position once set or engine damage may occur.

Rotate the crankshaft clockwise, as viewed from the front, positioning the crankshaft damper spoke at the 6 o'clock position and the timing mark indentation at the 7 o'clock position.

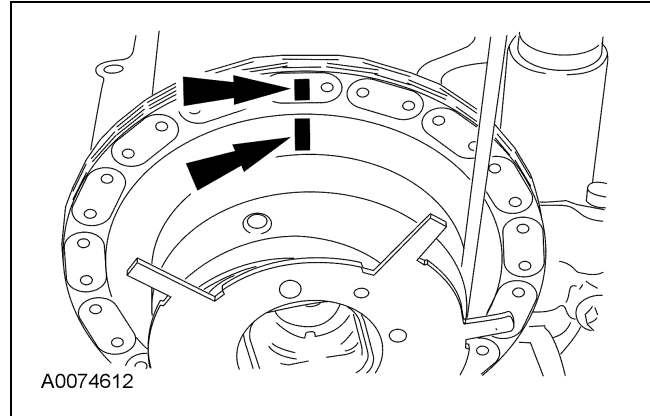
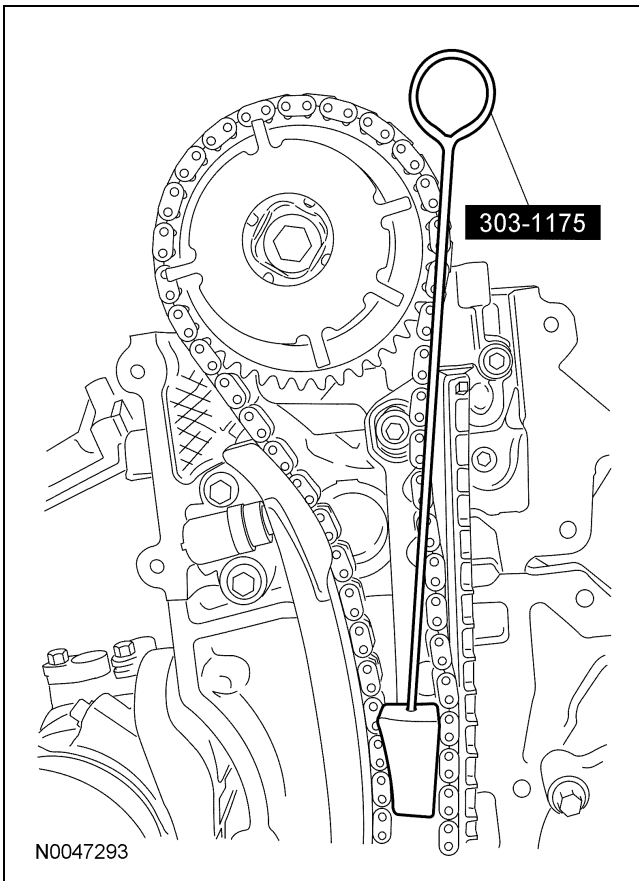



IN-VEHICLE REPAIR (Continued)

10.  **CAUTION:** Engine is not freewheeling. Camshaft procedure must be followed exactly or damage to valves and pistons will result.

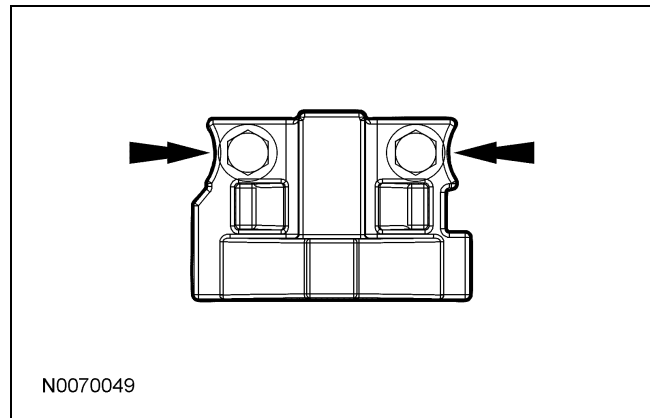
NOTE: The Timing Chain Wedge tool must be installed square to the timing chain and the engine block.


NOTE: Engine front cover removed for clarity. Install the special tool in the RH timing chain as shown.




12.  **CAUTION:** When removing the front thrust camshaft bearing cap, use care as the cap may be damaged from sideloading when removing the cam unequally in height from the bearing towers.

Remove the 2 bolts and the camshaft front bearing cap.




11.  **CAUTION:** Do not remove the Timing Chain Wedge tool at any time during assembly. If the special tool is removed or out of placement, the engine front cover must be removed and the engine must be retimed. For additional information, refer to Timing Drive Components in this section.

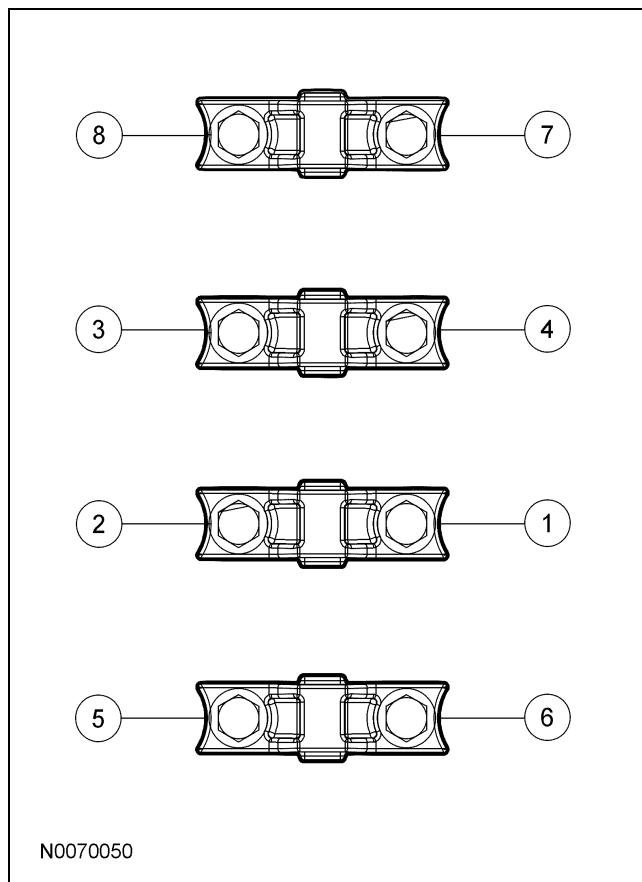
 **CAUTION:** The timing chain must be installed in its original position onto the camshaft phaser and sprocket using the scribed marks, or damage to valves and pistons will result.

Scribe a location mark on the timing chain and the camshaft phaser and sprocket assembly.

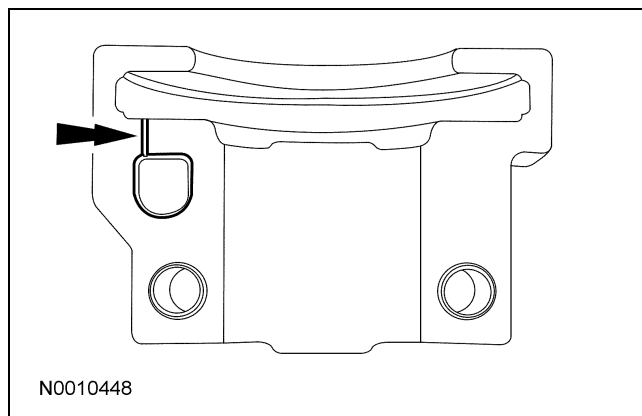
IN-VEHICLE REPAIR (Continued)


13.  **CAUTION:** The camshaft bearing caps must be installed in their original locations. Record camshaft bearing cap locations. Failure to follow these instructions may result in engine damage.


Remove the remaining bolts in the sequence shown and remove the camshaft bearing caps.




14. Clean and inspect the RH camshaft bearing caps.
- The camshaft front thrust bearing cap contains an oil metering groove. Make sure the groove is free of foreign material.



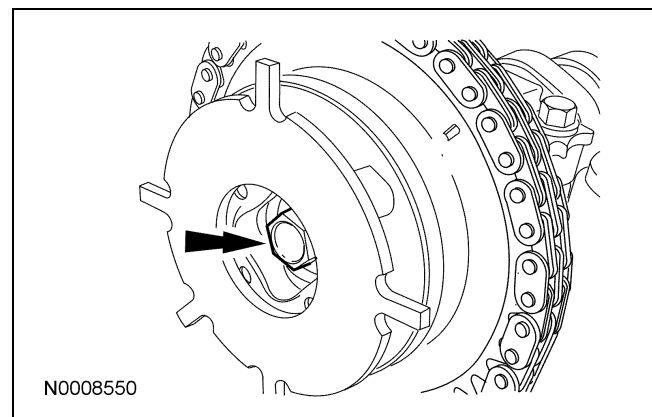
15.  **CAUTION:** Damage to the camshaft phaser and sprocket assembly will occur if mishandled or used as a lifting or leveraging device.

 **CAUTION:** Only use hand tools to remove the camshaft phaser and sprocket bolt or damage may occur to the camshaft or camshaft phaser and sprocket.

 **CAUTION:** Do not remove the Timing Chain Wedge tool at any time during assembly. If the special tool is removed or out of placement, the engine front cover must be removed and the engine must be retimed. For additional information, refer to Timing Drive Components in this section.

Remove the bolt and withdraw the camshaft from the camshaft phaser and sprocket assembly, leaving the camshaft phaser and sprocket assembly in place.

- Discard the bolt and washer.





16. Inspect the camshaft phaser and sprocket for damage. For additional information, refer to Camshaft Phaser and Sprocket in this section.

Installation

- Lubricate the camshaft and camshaft journals with clean engine oil.

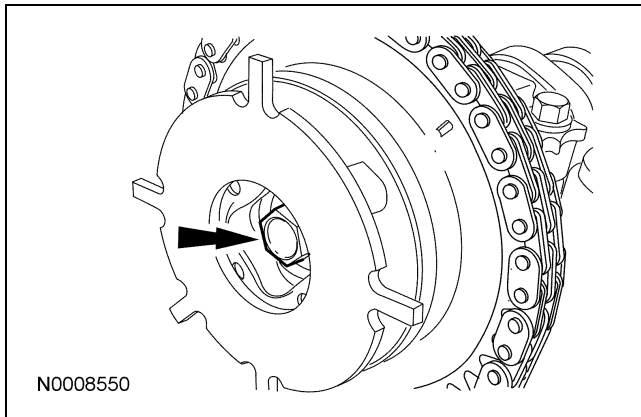
IN-VEHICLE REPAIR (Continued)


2.  **CAUTION:** Do not remove the Timing Chain Wedge tool at any time during assembly. If the special tool is removed or out of placement, the engine front cover must be removed and the engine must be retimed. For additional information, refer to Timing Drive Components in this section.


 **CAUTION:** Damage to the camshaft phaser and sprocket assembly will occur if mishandled or used as a lifting or leveraging device.

NOTE: Do not allow the camshaft roller followers to move out of position when installing the camshaft.

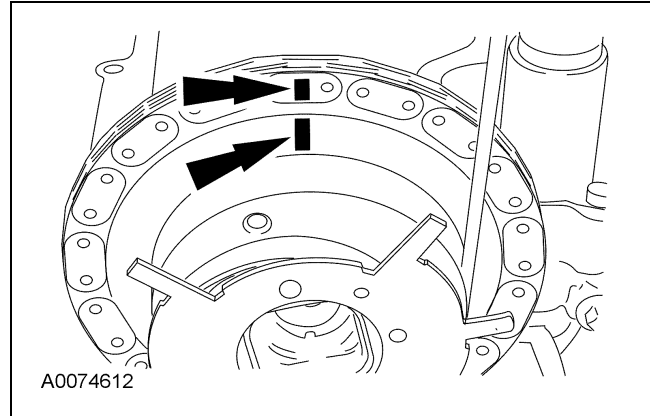
Install the camshaft into the camshaft phaser and sprocket assembly and onto the head. Install a new camshaft phaser and sprocket bolt finger tight.



3.  **CAUTION:** Do not remove the Timing Chain Wedge tool at any time during assembly. If the special tool is removed or out of placement, the engine front cover must be removed and the engine must be retimed. For additional information, refer to Timing Drive Components in this section.

 **CAUTION:** The timing chain must be installed in its original position onto the camshaft phaser and sprocket using the scribed marks, or damage to valves and pistons will result.

Verify the camshaft phaser and sprocket and timing chain scribe marks are still in alignment.



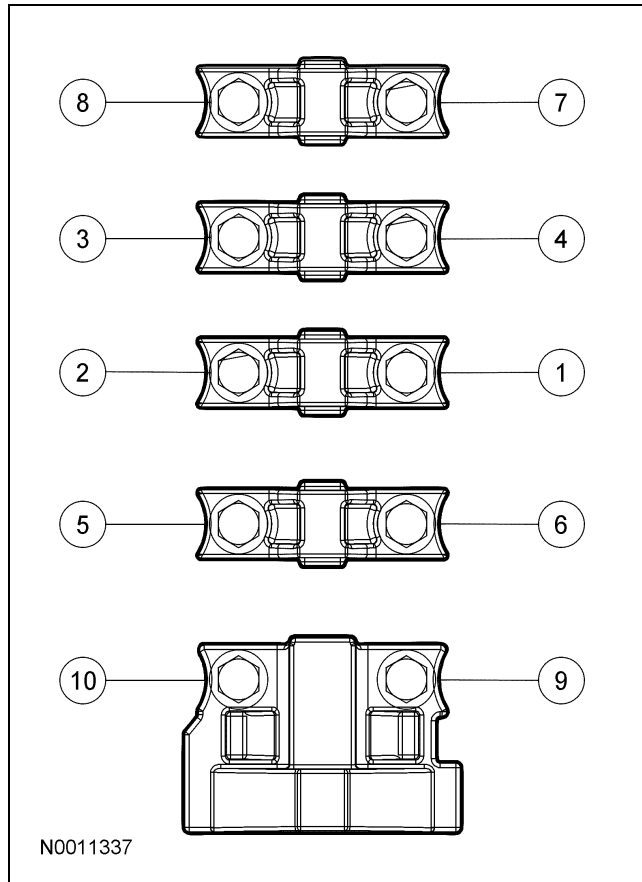
4. **NOTE:** Do not allow the camshaft roller followers to move out of position when installing the camshaft.

Install the camshaft bearing caps in their original locations.

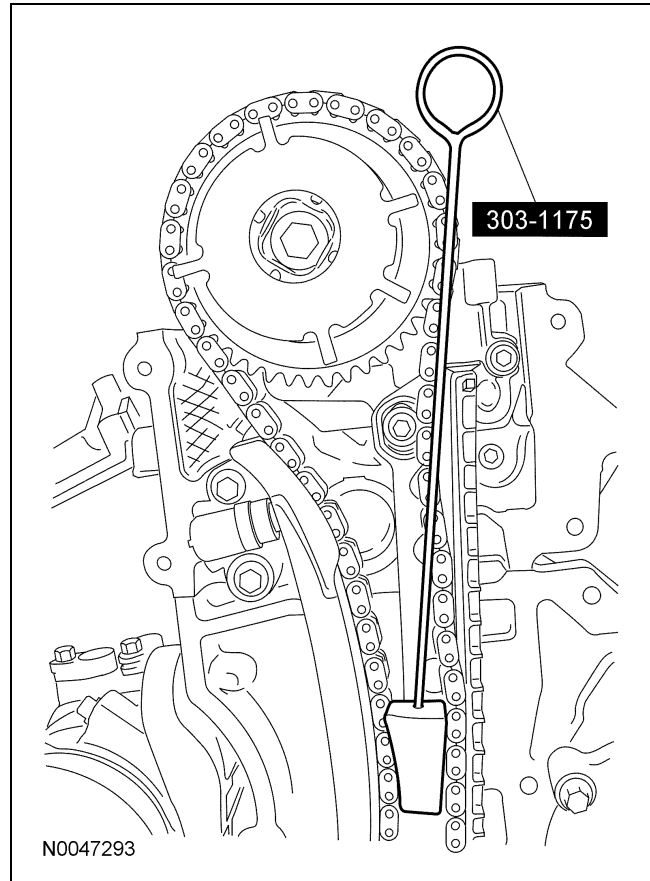
- Lubricate the camshaft bearing caps with clean engine oil.
- Position the front camshaft bearing cap.
- Position the remaining camshaft bearing caps.
- Install the bolts loosely.

IN-VEHICLE REPAIR (Continued)

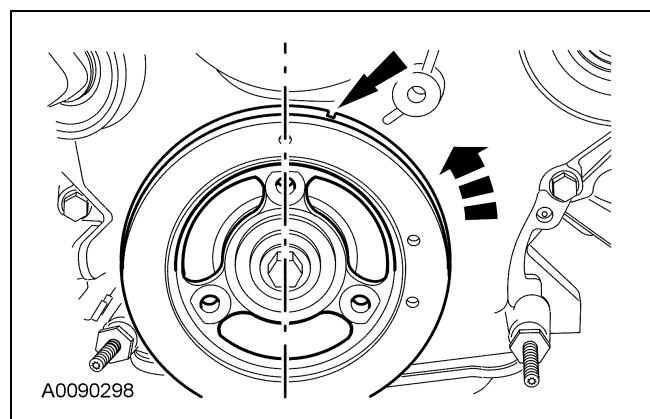
5. Tighten the bolts in the sequence shown.
- Tighten to 10 Nm (89 lb-in).



6. **NOTE:** Engine front cover removed for clarity. Remove the special tool.

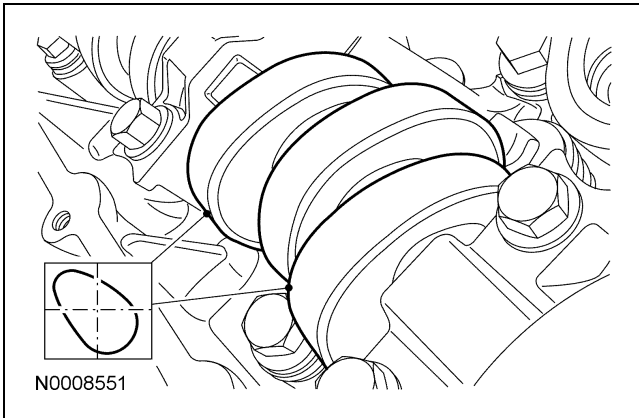


7. Rotate the crankshaft a half turn counterclockwise and position the crankshaft damper spoke at the 12 o'clock position and the timing mark indentation at the 1 o'clock position.



IN-VEHICLE REPAIR (Continued)

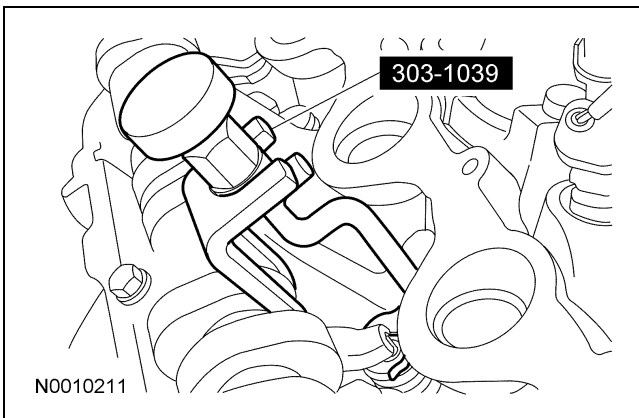
8. Verify correct camshaft position by noting the position of the No. 1 cylinder intake and exhaust camshaft lobes.



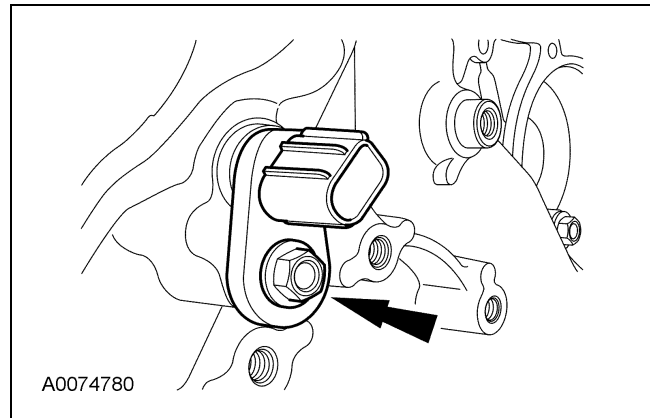
9. **NOTE:** Do not allow the valve keepers to fall off of the valve or the valve may drop into the cylinder. If a valve drops into the cylinder, the cylinder head must be removed. For additional information, refer to Cylinder Head in this section.

NOTE: It may be necessary to push the valve down while compressing the spring.

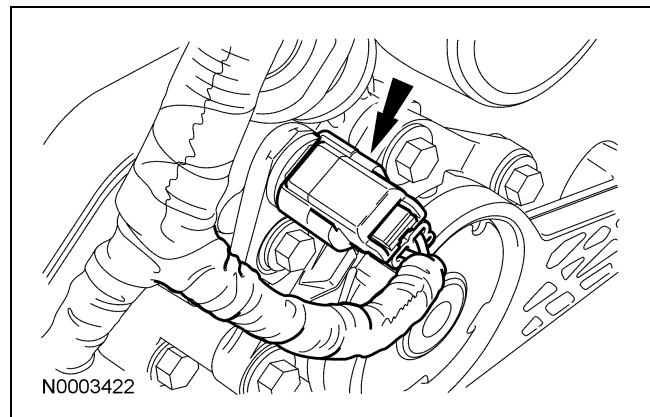
Using the special tool, install the 3 originally removed camshaft roller followers.




10. Install the CMP sensor and the bolt.
- Tighten to 10 Nm (89 lb-in).




11. Connect the CMP electrical connector.



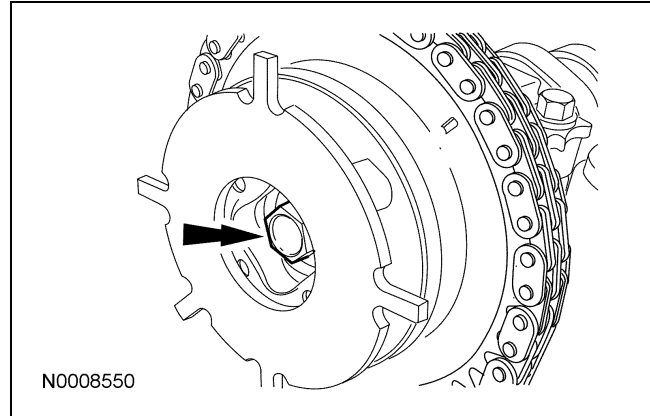
IN-VEHICLE REPAIR (Continued)

12.  **CAUTION:** Only use hand tools to install the camshaft phaser and sprocket assembly or damage may occur to the camshaft or camshaft phaser and sprocket.

 **CAUTION:** Damage to the camshaft phaser and sprocket assembly will occur if mishandled or used as a lifting or leveraging device.

Tighten the new camshaft phaser and sprocket bolt in 2 stages:

- Stage 1: Tighten to 40 Nm (30 lb-ft).
- Stage 2: Tighten an additional 90 degrees.



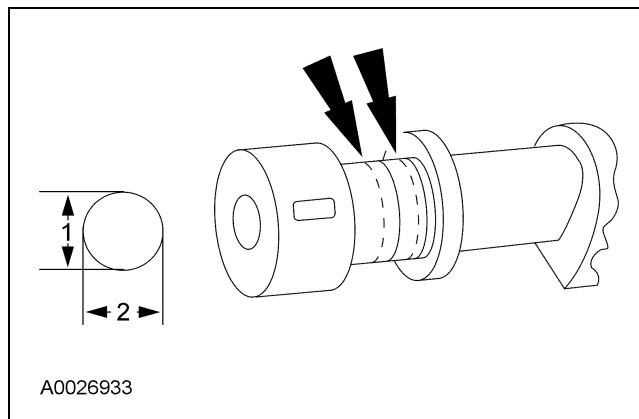
13. Install the RH valve cover. For additional information, refer to Valve Cover — RH in this section.

GENERAL PROCEDURES

Camshaft Bearing Journal Diameter

NOTE: Refer to the appropriate Section 303-01 for the specification.

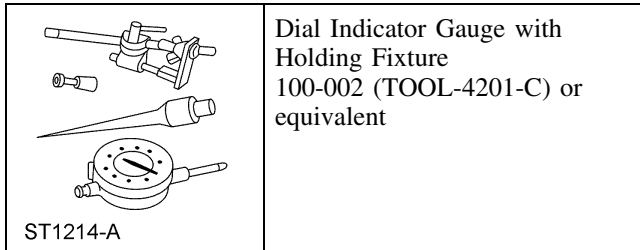
1. Measure each camshaft journal diameter in 2 directions.



GENERAL PROCEDURES

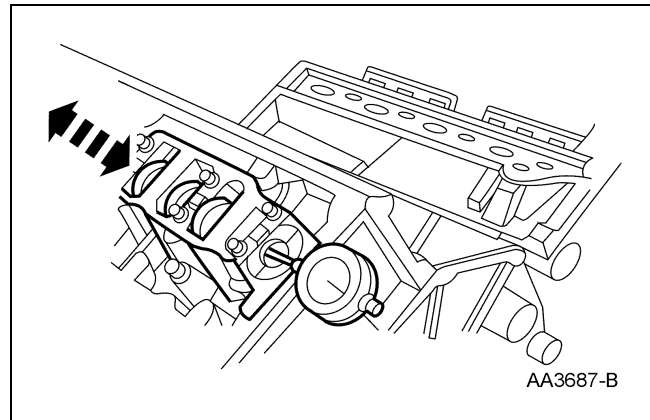
Camshaft End Play — OHC Engines

Special Tool(s)



NOTE: Refer to the appropriate Section 303-01 for the specification.

1. Using the special tool, measure the camshaft end play.
 2. Position the camshaft to the rear of the cylinder head.
 3. Zero the indicator.
4. Move the camshaft to the front of the cylinder head. Note and record the camshaft end play.
 - If camshaft end play exceeds specifications, install a new camshaft and recheck end play.
 - If camshaft end play exceeds specification after camshaft installation, install a new cylinder head.



GENERAL PROCEDURES

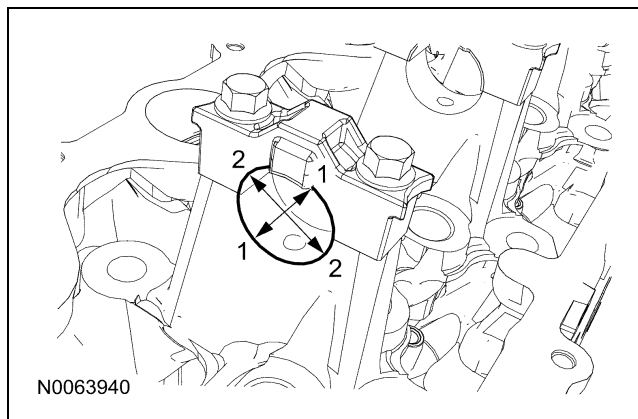
Camshaft Journal to Bearing Clearance — OHC Engines

NOTE: Refer to the appropriate Section 303-01 for the specification.

1. **NOTE:** The camshaft journals must meet specifications before checking camshaft journal clearance.

Measure each camshaft bearing in 2 directions.

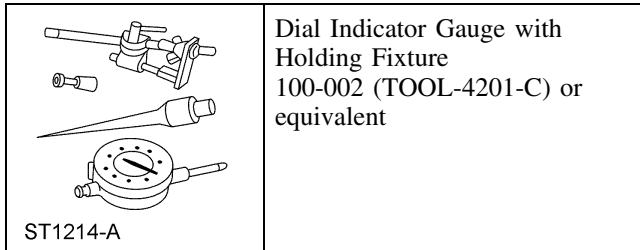
- Subtract the camshaft journal diameter from the camshaft bearing diameter.



GENERAL PROCEDURES

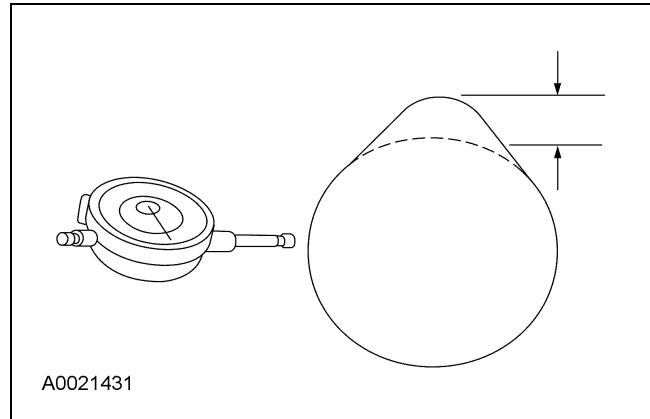
Camshaft Lobe Lift

Special Tool(s)



NOTE: Refer to the appropriate Section 303-01 for the specification.

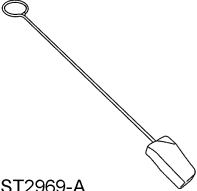
1. Use an indicator gauge to measure camshaft intake/exhaust lobe lift.
 - Rotate the camshaft and subtract the lowest indicator reading from the highest indicator reading to figure the camshaft lobe lift.



IN-VEHICLE REPAIR


Camshaft Phaser and Sprocket

Special Tool(s)

 <p>ST2969-A</p>	<p>Locking Tool, Timing Chain 303-1175</p>
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Removal

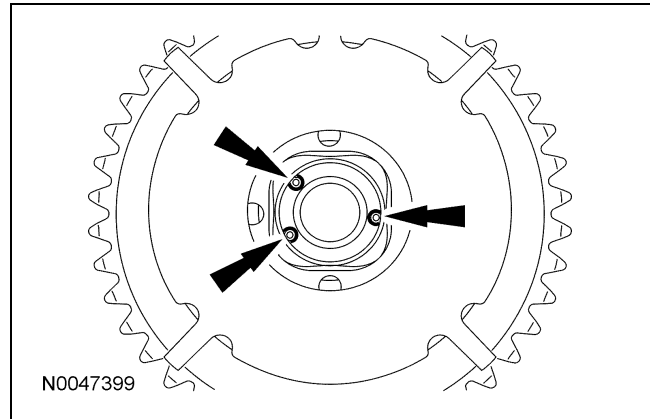
1. If servicing the RH camshaft phaser and sprocket, remove the RH camshaft. For additional information, refer to Camshaft — RH in this section.
2. If servicing the LH camshaft phaser and sprocket, remove the LH camshaft. For additional information, refer to Camshaft — LH in this section.

3.  **CAUTION: Damage to the camshaft phaser and sprocket assembly will occur if mishandled or used as a lifting or leveraging device.**

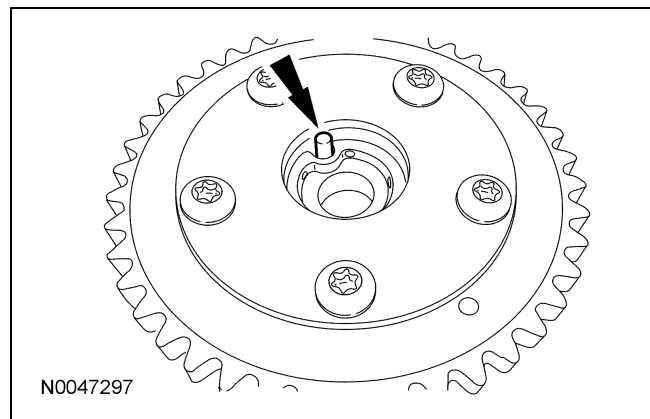
NOTE: Do not remove the Timing Chain Locking Tool at any time during assembly. If the special tool is removed or out of placement, the engine front cover must be removed and the engine must be retimed. For additional information, refer to Timing Drive Components in this section.

Remove the camshaft phaser and sprocket from the timing chain.

4. Inspect the front of the camshaft phaser and sprocket for missing or damaged roll pins.
 - If the roll pins are missing or damaged, a new camshaft phaser and sprocket must be installed.

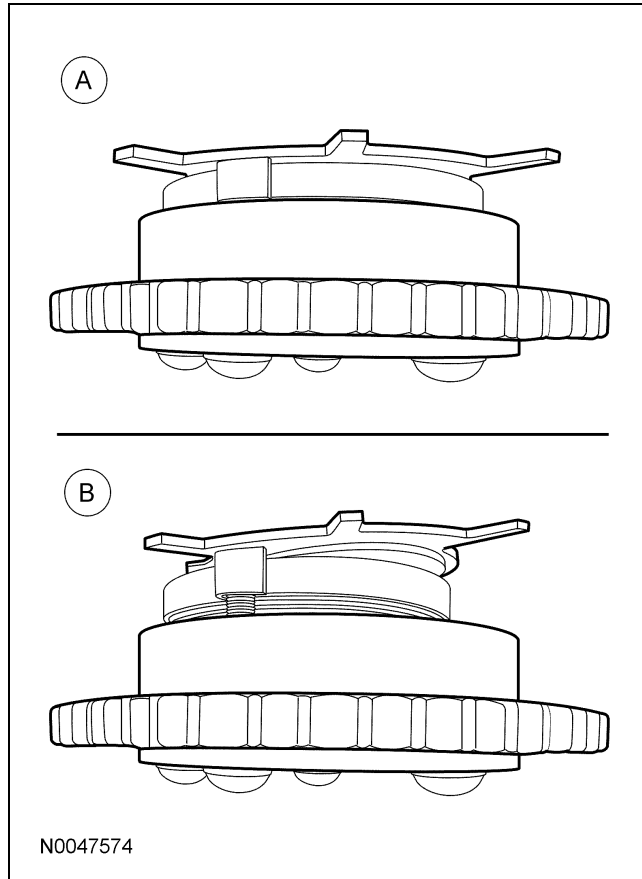


5. Inspect the rear of the camshaft phaser and sprocket for a deformed or damaged location pin.
 - If the location pin is deformed or damaged, a new camshaft phaser and sprocket must be installed.



IN-VEHICLE REPAIR (Continued)

6. Visually inspect the camshaft phaser and sprocket for squareness (A). If the trigger wheel or spring is deformed or damaged (B), install a new camshaft phaser and sprocket.

**Installation**

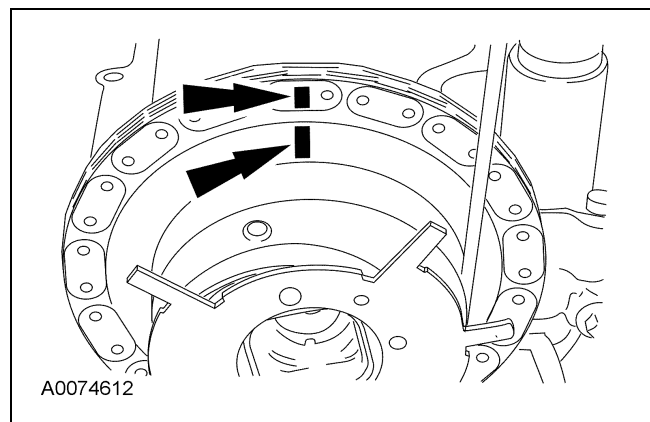
1. **CAUTION:** Damage to the camshaft phaser and sprocket assembly will occur if mishandled or used as a lifting or leveraging device.

If installing a new camshaft phaser and sprocket, transfer the original scribe mark to the new camshaft phaser and sprocket.

2. **CAUTION:** The timing chain must be installed in its original position onto the camshaft phaser and sprocket using the scribed marks, or damage to valves and pistons will result.

CAUTION: Damage to the camshaft phaser and sprocket assembly will occur if mishandled or used as a lifting or leveraging device.

Align the scribe marks and position the camshaft phaser and sprocket into the timing chain.

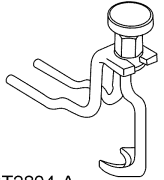


3. If servicing the RH camshaft phaser and sprocket, install the RH camshaft. For additional information, refer to Camshaft — RH in this section.
4. If servicing the LH camshaft phaser and sprocket, install the LH camshaft. For additional information, refer to Camshaft — LH in this section.

IN-VEHICLE REPAIR

Camshaft Roller Follower

Special Tool(s)

 <p>ST2804-A</p>	Compressor, Valve Spring 303-1039
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Material

Item	Specification
Motorcraft SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP (US); Motorcraft SAE 5W-20 Super Premium Motor Oil CXO-5W20-LSP12 (Canada); or equivalent	WSS-M2C930-A

Removal

LH cylinder head camshaft roller followers


1. Remove the LH valve cover. For additional information, refer to Valve Cover — LH in this section.

RH cylinder head camshaft roller followers

2. Remove the RH valve cover. For additional information, refer to Valve Cover — RH in this section.

All camshaft roller followers

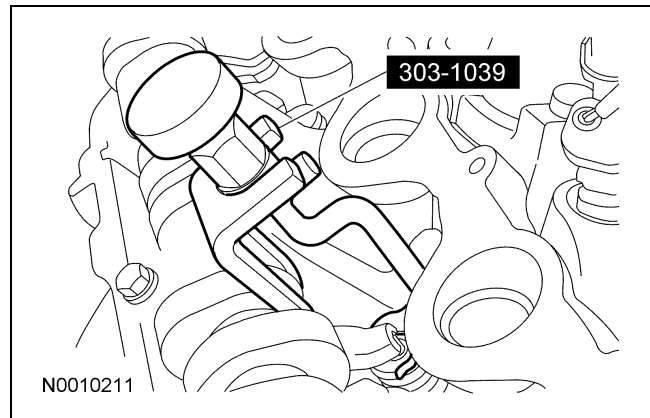
3. Rotate the crankshaft until the piston for the valve being serviced is at the top of its stroke with the intake valve and the exhaust valves closed.

4.  **CAUTION:** If the components are to be reinstalled, they must be installed in the same positions. Mark the components for installation into their original locations. Failure to follow these instructions may result in engine damage.

NOTE: Do not allow the valve keepers to fall off of the valve or the valve may drop into the cylinder. If a valve drops into the cylinder, the cylinder head must be removed. For additional information, refer to Cylinder Head in this section.


NOTE: It may be necessary to push the valve down while compressing the spring.

Using the special tool, compress the valve spring and remove the camshaft roller follower.



5. Repeat the previous 2 steps for each camshaft roller follower being serviced.
6. Inspect the camshaft roller follower. For additional information, refer to Section 303-00.

IN-VEHICLE REPAIR (Continued)**Installation****All camshaft roller followers**

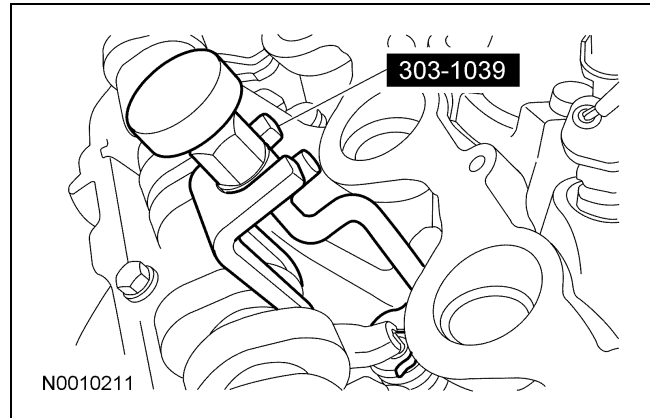
1.  **CAUTION:** If the components are to be reinstalled, they must be installed in the same positions. Failure to follow these instructions may result in engine damage.

NOTE: Do not allow the valve keepers to fall off of the valve or the valve may drop into the cylinder. If a valve drops into the cylinder, the cylinder head must be removed. For additional information, refer to Cylinder Head in this section.

NOTE: It may be necessary to push the valve down while compressing the spring.

NOTE: Lubricate the camshaft roller followers with clean engine oil prior to installation.

Using the special tool, compress the valve spring and install the camshaft roller follower.



2. Repeat the previous step for each camshaft roller follower being serviced.

LH cylinder head camshaft roller followers

3. Install the LH valve cover. For additional information, refer to Valve Cover — LH in this section.

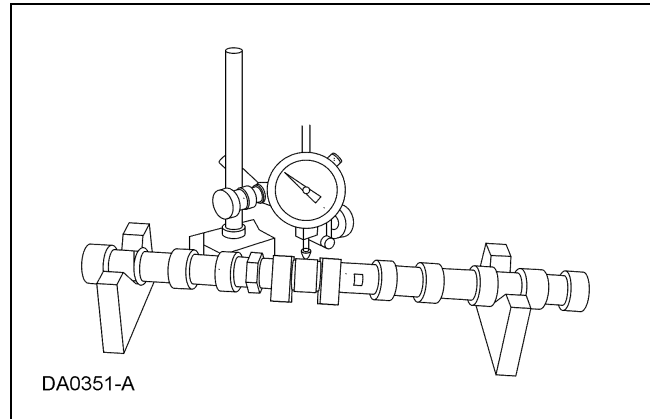
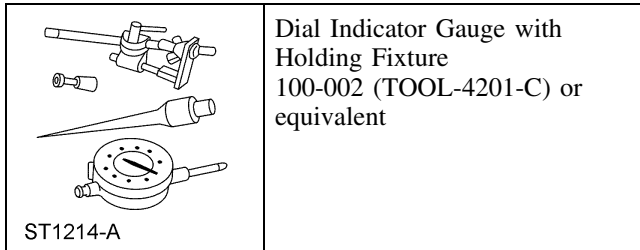
RH cylinder head camshaft roller followers

4. Install the RH valve cover. For additional information, refer to Valve Cover — RH.

GENERAL PROCEDURES

Camshaft Runout

Special Tool(s)



NOTE: Refer to the appropriate Section 303-01 for the specification.

1. **NOTE:** Camshaft journals must be within specifications before checking runout.

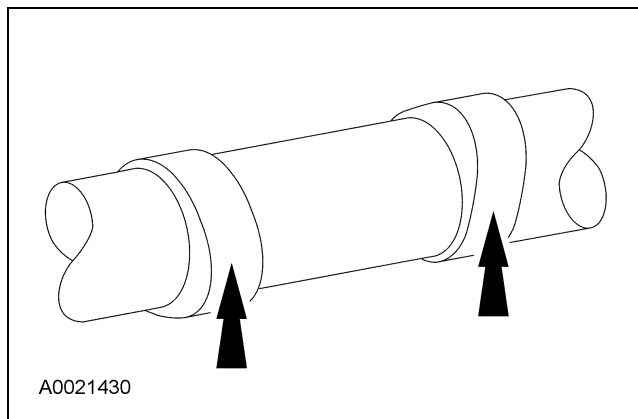
Using the special tool, measure the camshaft runout.

- Rotate the camshaft and subtract the lowest indicator reading from the highest indicator reading.

GENERAL PROCEDURES

Camshaft Surface Inspection

1. Inspect camshaft lobes for pitting or damage in the contact area. Minor pitting is acceptable outside the contact area.

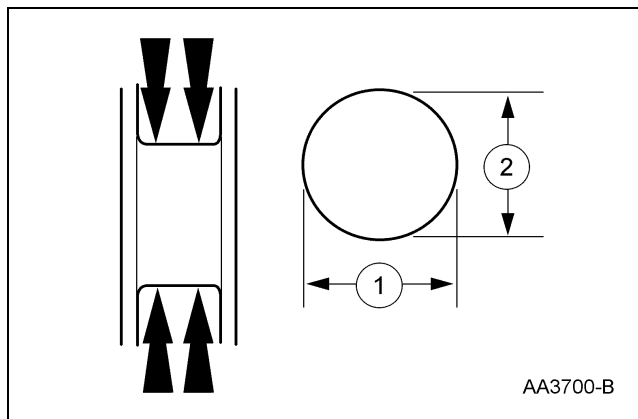


GENERAL PROCEDURES

Connecting Rod Bearing Journal Taper and Out-of-Round

NOTE: Refer to the appropriate Section 303-01 for the specification.

1. Measure the crankshaft connecting rod journal diameters in 2 directions perpendicular to one another at each end of the connecting rod journal. The difference in the measurements from one end to the other is the taper. Verify measurement is within the wear limit.



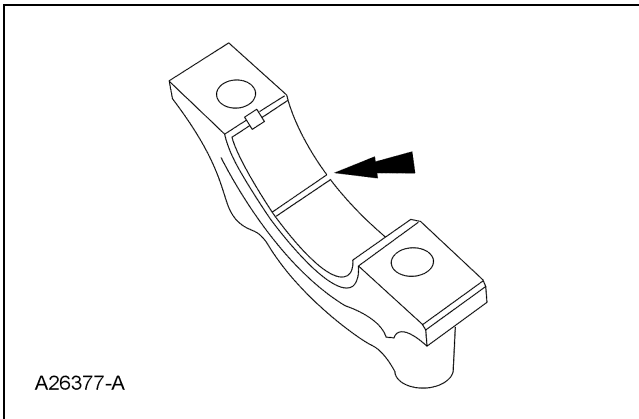
GENERAL PROCEDURES

Connecting Rod Bearing Journal-to-Bearing Clearance

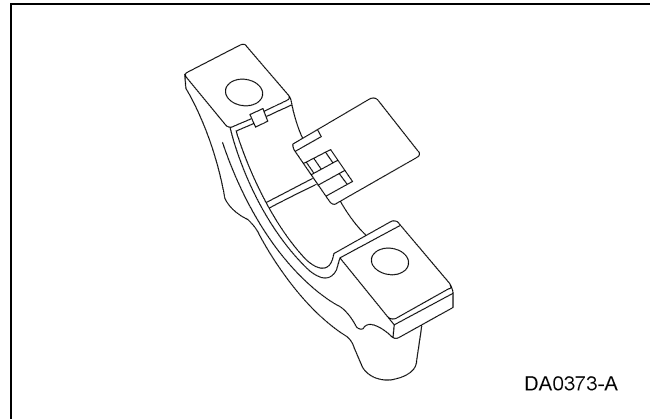
NOTE: Refer to the appropriate Section 303-01 for the specification.

NOTE: The crankshaft connecting rod journals must be within specifications to check the connecting rod bearing journal clearance.

1. Remove the connecting rod bearing cap.
2. Position a piece of Plastigage across the bearing surface.



4. Measure the Plastigage to get the connecting rod bearing journal clearance. The Plastigage should be smooth and flat. A changing width indicates a tapered or damaged connecting rod or connecting rod bearing.



3. **NOTE:** Do not turn the crankshaft during this step.

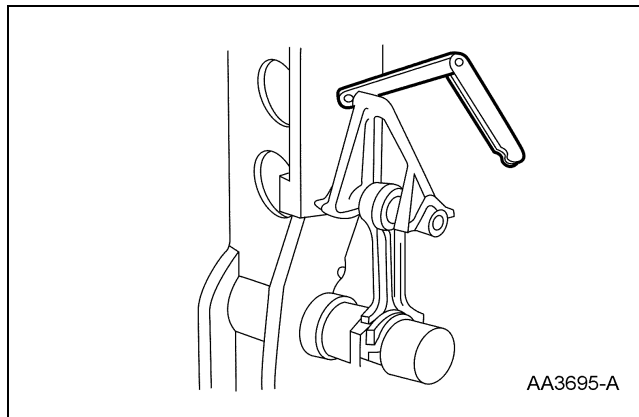
Install and tighten to specifications, then remove the connecting rod bearing cap.

GENERAL PROCEDURES

Connecting Rod Bend

NOTE: Refer to the appropriate Section 303-01 for the specification.

1. Measure the connecting rod bend on a suitable alignment fixture. Follow the instructions of the fixture manufacturer. Verify the bend measurement is within specification.

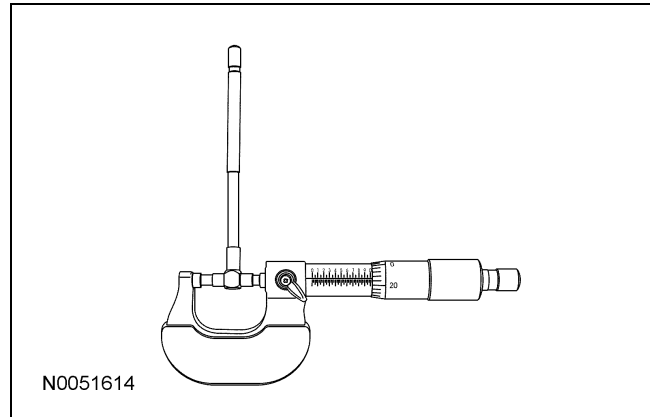
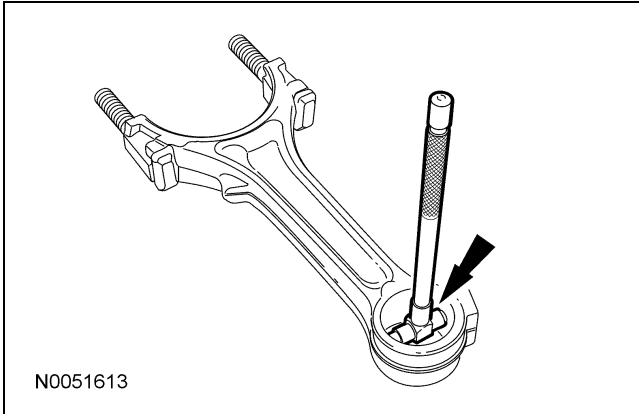


GENERAL PROCEDURES

Connecting Rod Bushing Diameter

NOTE: Refer to the appropriate Section 303-01 for the specification.


1. Use a telescoping gauge to determine the inner diameter of the connecting rod bushing, if equipped.



2. Measure the telescoping gauge with a micrometer. Verify the diameter is within specification.
-

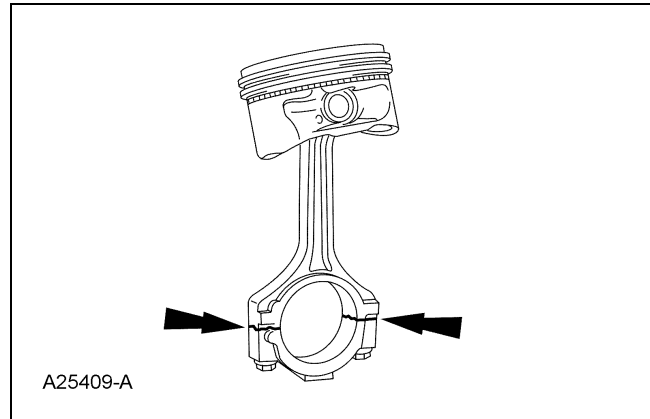
GENERAL PROCEDURES

Connecting Rod Cleaning

 **CAUTION:** Do not use a caustic cleaning solution or damage to connecting rods can occur.

1. **NOTE:** The connecting rod large end is a matched set. The connecting rod cap must be installed on the original connecting rod in the original position. Do not reverse the cap. Parts are not interchangeable.

Mark and separate the parts and clean with solvent. Clean the oil passages.

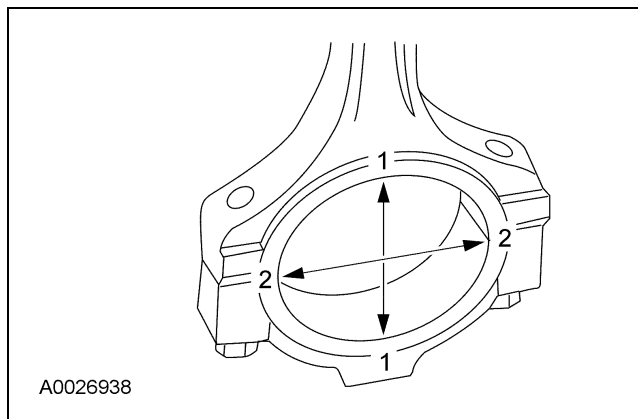


GENERAL PROCEDURES

Connecting Rod Large End Bore

NOTE: Refer to the appropriate Section 303-01 for the specification.

1. Tighten the bolts to specification, then measure the bore in 2 directions. The difference is the connecting rod bore out-of-round. Verify the out-of-round is within specification.

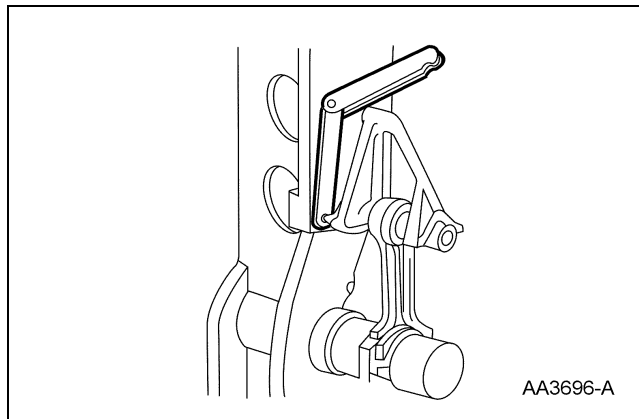


GENERAL PROCEDURES

Connecting Rod Twist

NOTE: Refer to the appropriate Section 303-01 for the specification.

1. Measure the connecting rod twist on a suitable alignment fixture. Follow the instructions of the fixture manufacturer. Verify the measurement is within specification.

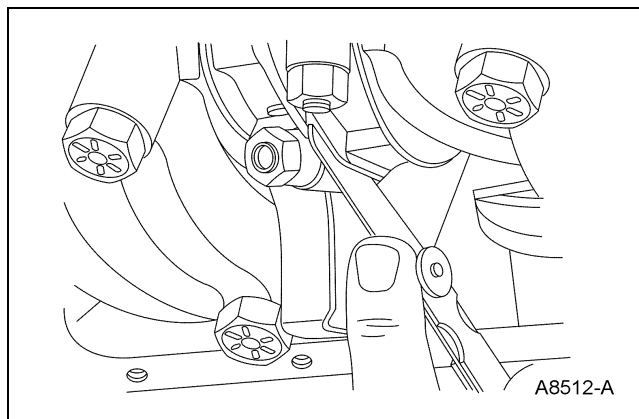


GENERAL PROCEDURES

Connecting Rod to Crankshaft Side Clearance

NOTE: Refer to the appropriate Section 303-01 for the specification.

1. Measure the clearance between the connecting rod and the crankshaft. Verify the measurement is within specification.

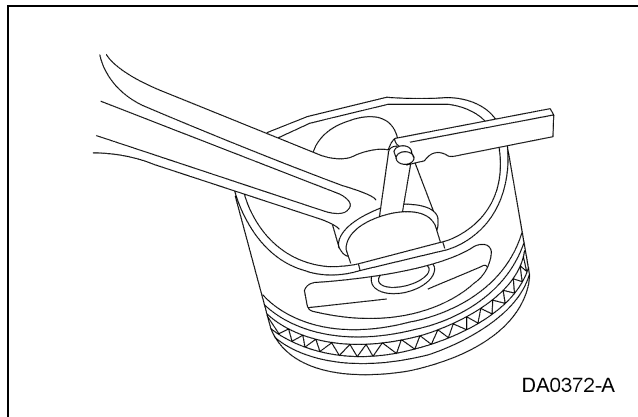


GENERAL PROCEDURES

Connecting Rod-to-Piston Clearance

NOTE: Refer to the appropriate Section 303-01 for the specification.

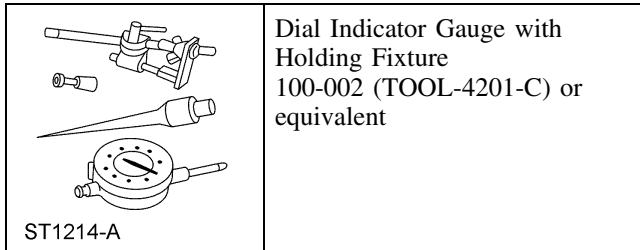
1. Measure the clearance between the connecting rod and the piston. Verify the measurement is within specification.



GENERAL PROCEDURES

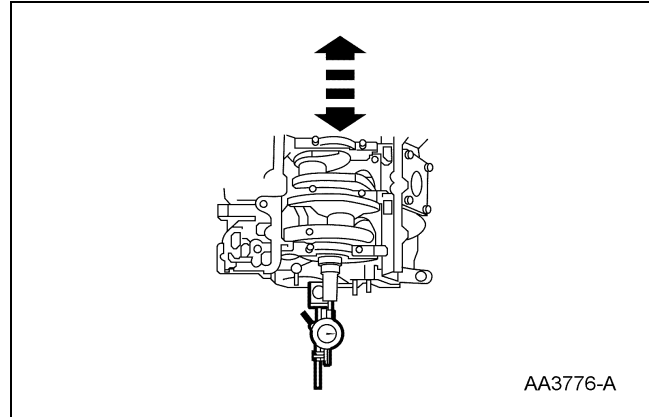
Crankshaft End Play

Special Tool(s)



NOTE: Refer to the appropriate Section 303-01 for the specification.

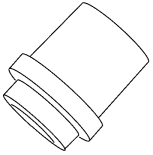
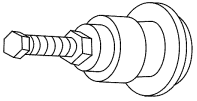
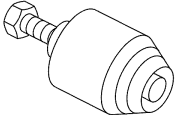
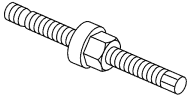
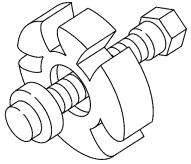
1. Using the Dial Indicator Gauge, measure the crankshaft end play.
 2. Position the crankshaft to the rear of the cylinder block.
 3. Zero the indicator.
 4. Move the crankshaft to the front of the cylinder block. Note and record the crankshaft end play.
-



IN-VEHICLE REPAIR

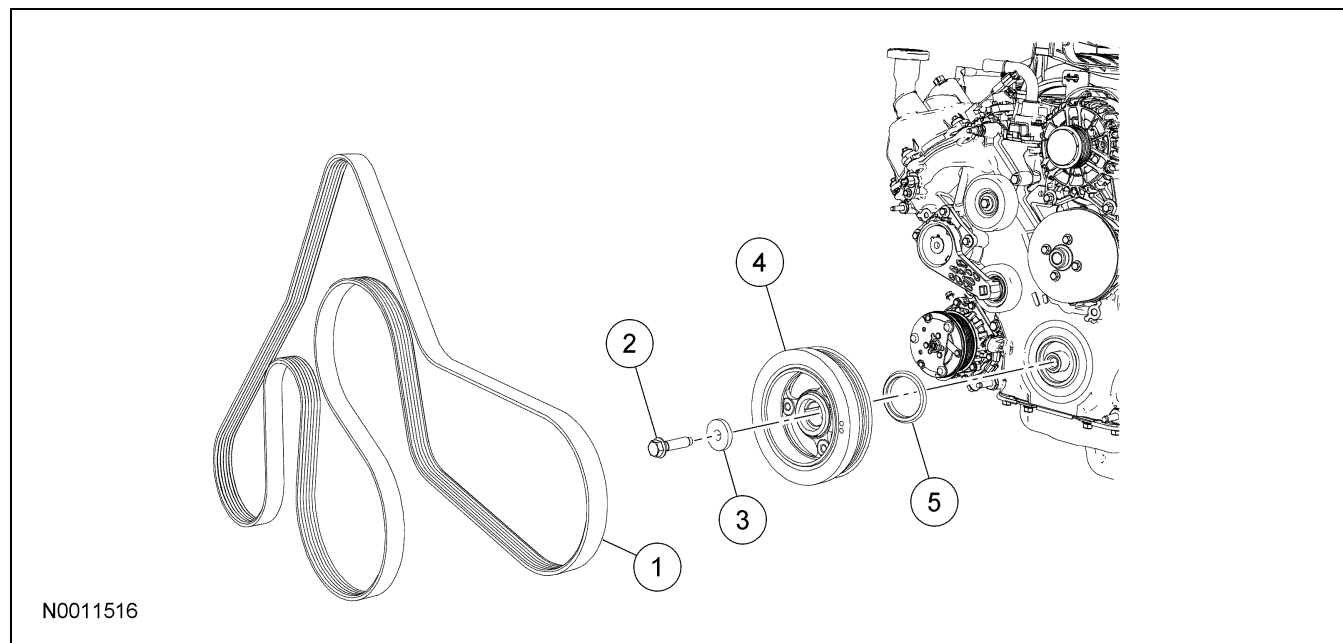
Crankshaft Front Seal

Special Tool(s)

 <p>ST2197-A</p>	<p>Installer, Crankshaft Front Seal 303-635</p>
 <p>ST1328-A</p>	<p>Installer, Front Cover Seal 303-335 (T88T-6701-A)</p>
 <p>ST1288-A</p>	<p>Remover, Crankshaft Front Seal 303-107 (T74P-6700-A)</p>
 <p>ST1287-A</p>	<p>Installer, Crankshaft Vibration Damper 303-102 (T74P-6316-B)</p>
 <p>ST1286-A</p>	<p>Remover, Crankshaft Vibration Damper 303-009 (T58P-6316-D)</p>

Material

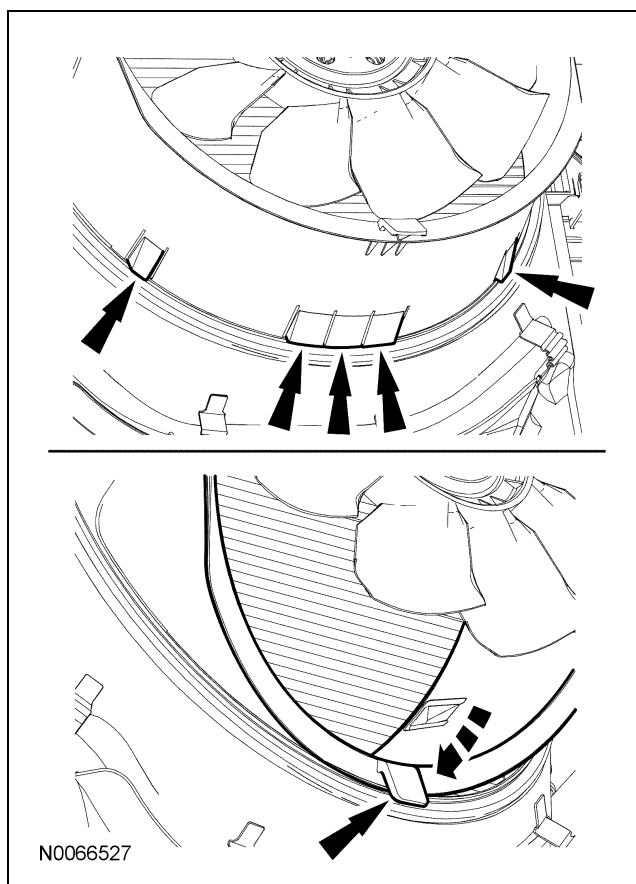
Item	Specification
Motorcraft Metal Surface Prep ZC-31	—
Motorcraft SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP (US); Motorcraft SAE 5W-20 Super Premium Motor Oil CXO-5W20-LSP12 (Canada); or equivalent	WSS-M2C930-A
Silicone Gasket and Sealant TA-30	WSE-M4G323-A4
Silicone Gasket Remover ZC-30	—

IN-VEHICLE REPAIR (Continued)

Item	Part Number	Description
1	8620	Accessory drive belt
2	W701512	Crankshaft pulley bolt
3	N806165	Crankshaft pulley bolt washer
4	6316	Crankshaft pulley
5	6700	Crankshaft front seal

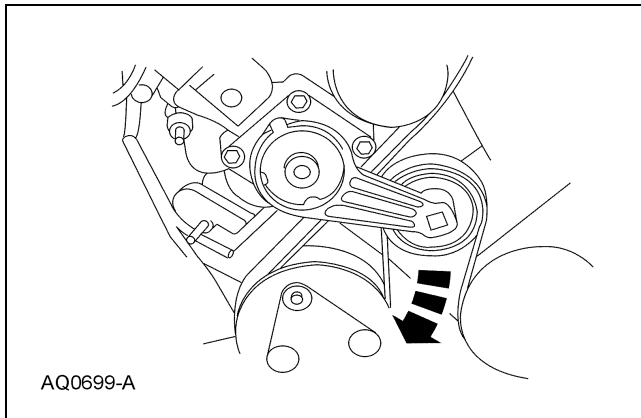
Removal

1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
2. Press the 5 position retaining tabs and rotate the lower cooling fan shroud upward until the position retainer tab locks into position.

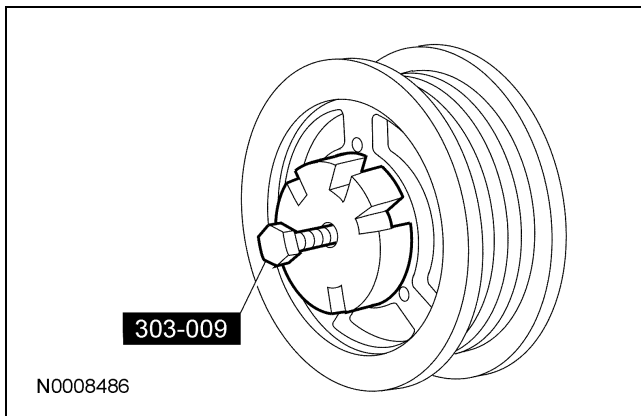


IN-VEHICLE REPAIR (Continued)

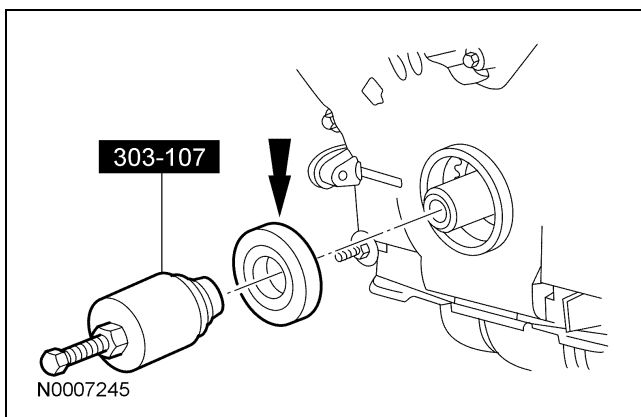
3. Rotate the tensioner clockwise and remove the accessory drive belt.



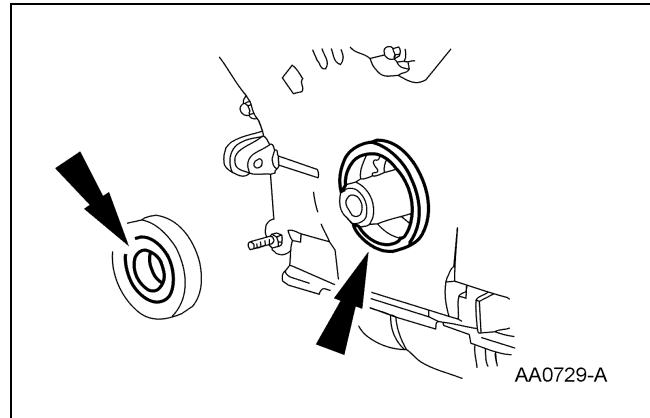
4. Remove the crankshaft pulley bolt and washer.
 - Discard the crankshaft pulley bolt.
5. Using the special tool, remove the crankshaft pulley.



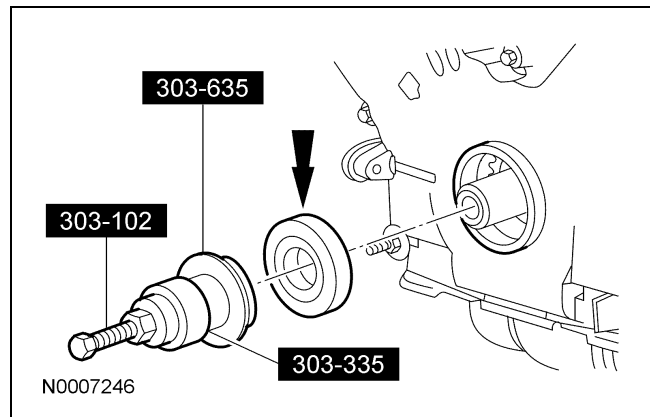
6. Using the special tool, remove and discard the crankshaft front seal.

**Installation**

1. Lubricate the engine front cover and the crankshaft front seal inner lip with clean engine oil.



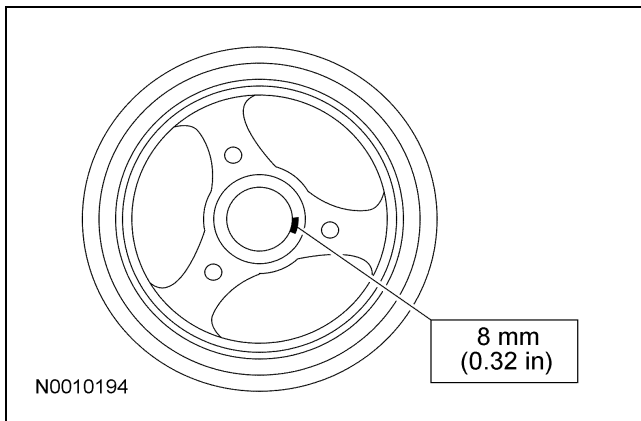
2. Using the special tools, install a new crankshaft front seal.



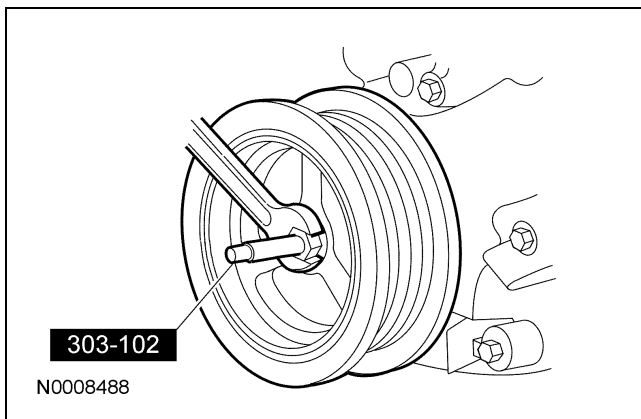
IN-VEHICLE REPAIR (Continued)

3. **NOTE:** If not secured within 4 minutes, the sealant must be removed and the sealing area cleaned with Motorcraft Metal Surface Prep and Silicone Gasket Remover. Follow the directions on the packaging. Allow to dry until there is no sign of wetness, or 4 minutes, whichever is longer. Failure to follow this procedure may cause future oil leakage.

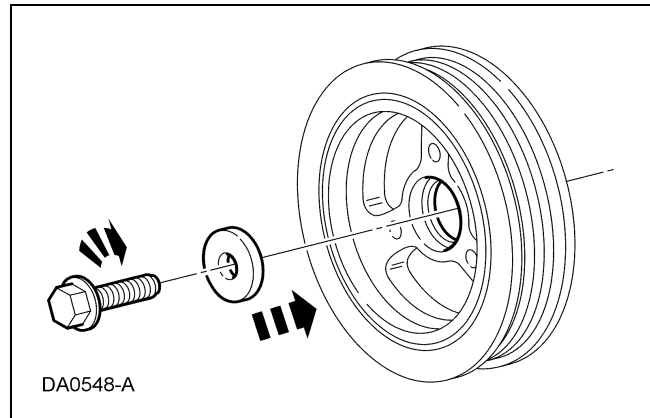
Apply Silicone Gasket and Sealant to the Woodruff key slot in the crankshaft pulley.



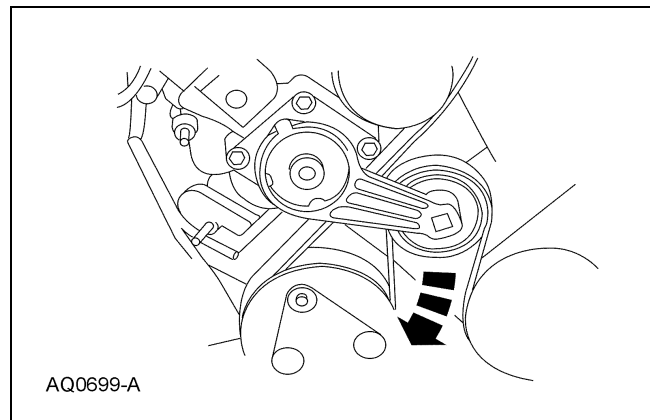
4. Using the special tool, install the crankshaft pulley.



5. Using a new crankshaft pulley bolt, install the bolt and washer and tighten the bolt in 4 stages.
- Stage 1: Tighten to 90 Nm (66 lb-ft).
 - Stage 2: Loosen 360 degrees.
 - Stage 3: Tighten to 50 Nm (37 lb-ft).
 - Stage 4: Tighten an additional 90 degrees.



6. Rotate the tensioner clockwise and install the accessory drive belt.



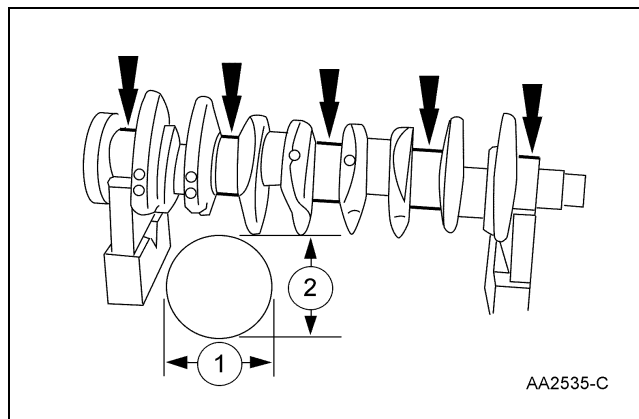
7. Press the position retaining tab and rotate the lower cooling fan shroud downward until the position retainer tab locks into position.

GENERAL PROCEDURES

Crankshaft Main Bearing Journal Diameter

NOTE: Refer to the appropriate Section 303-01 for the specification.

1. Measure each of the crankshaft main bearing journal diameters in at least 2 directions.

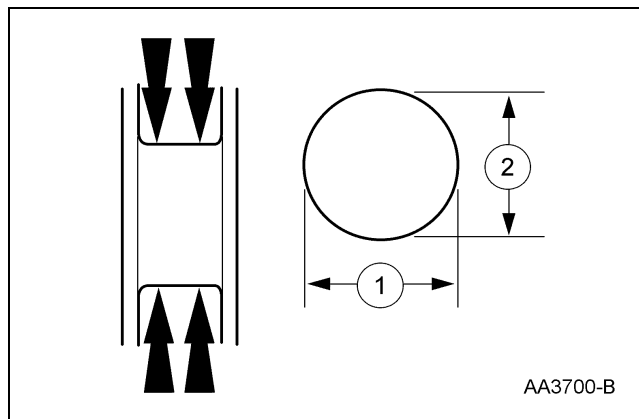


GENERAL PROCEDURES

Crankshaft Main Bearing Journal Taper and Out-of-Round

NOTE: Refer to the appropriate Section 303-01 for the specification.

1. Measure each of the crankshaft main bearing journal diameters in at least 2 directions at each end of the main bearing journal.



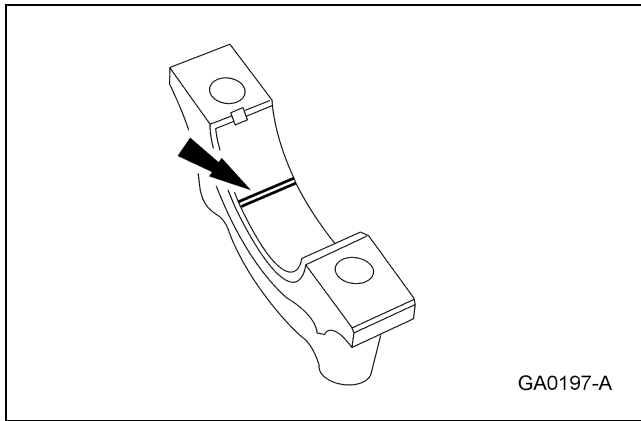
GENERAL PROCEDURES

Crankshaft Main Bearing Journal-to-Bearing Clearance

NOTE: Refer to the appropriate Section 303-01 for the specification.

NOTE: Crankshaft main bearing journals must be within specifications before checking journal clearance.

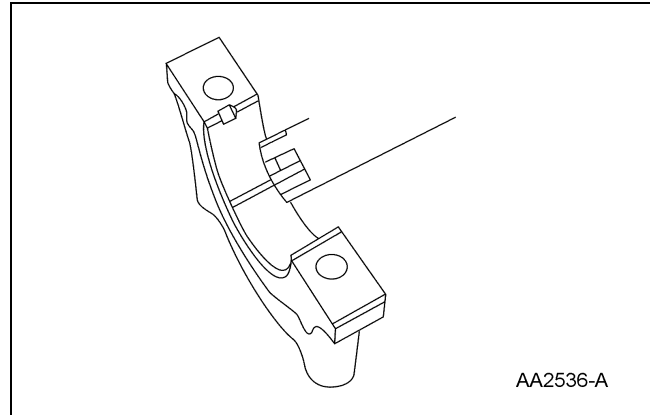
1. Remove the crankshaft main bearing caps and crankshaft main bearing.
2. Lay a piece of Plastigage across the face of each crankshaft main bearing surface.



3. **NOTE:** Do not turn the crankshaft while carrying out this procedure.

Install and remove the crankshaft main bearing cap.

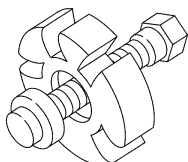
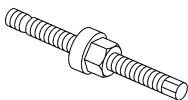
4. Verify the crankshaft journal clearance.



IN-VEHICLE REPAIR

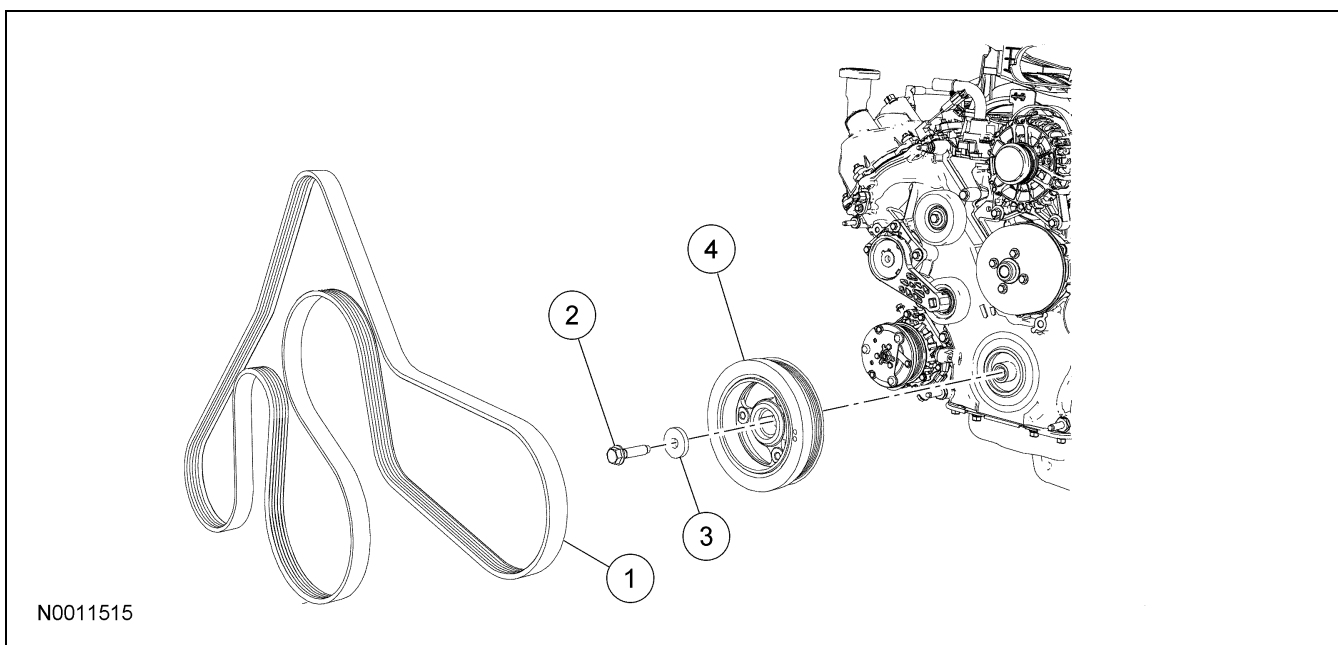
Crankshaft Pulley

Special Tool(s)

 <p>ST1286-A</p>	Remover, Crankshaft Vibration Damper 303-009 (T58P-6316-D)
 <p>ST1287-A</p>	Installer, Crankshaft Vibration Damper 303-102 (T74P-6316-B)

Material

Item	Specification
Motorcraft Metal Surface Prep ZC-31	—
Motorcraft SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP (US); Motorcraft SAE 5W-20 Super Premium Motor Oil CXO-5W20-LSP12 (Canada); or equivalent	WSS-M2C930-A
Silicone Gasket and Sealant TA-30	WSE-M4G323-A4
Silicone Gasket Remover ZC-30	—



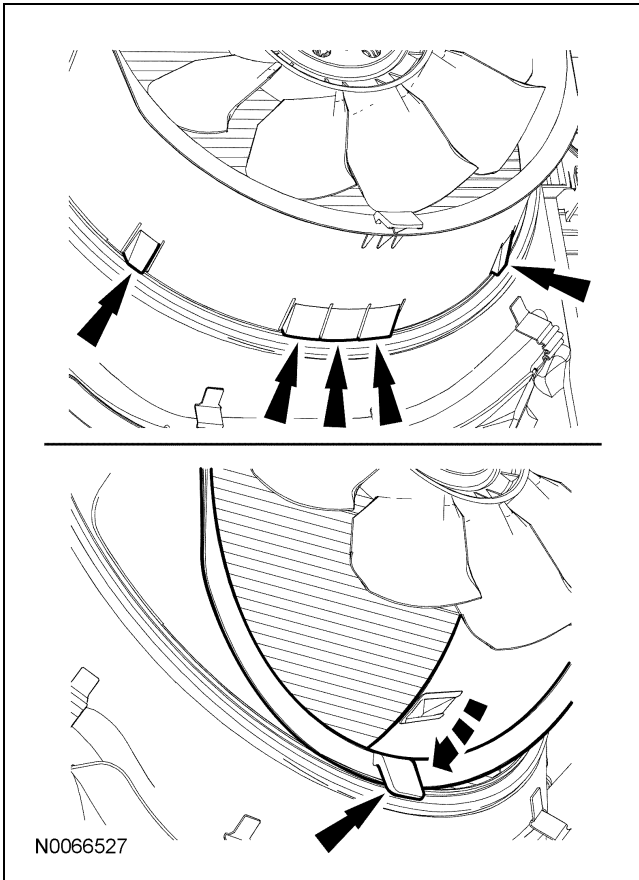
Item	Part Number	Description
1	8620	Accessory drive belt
2	W701512	Crankshaft pulley bolt
3	N806165	Crankshaft pulley bolt washer
4	6316	Crankshaft pulley

Removal

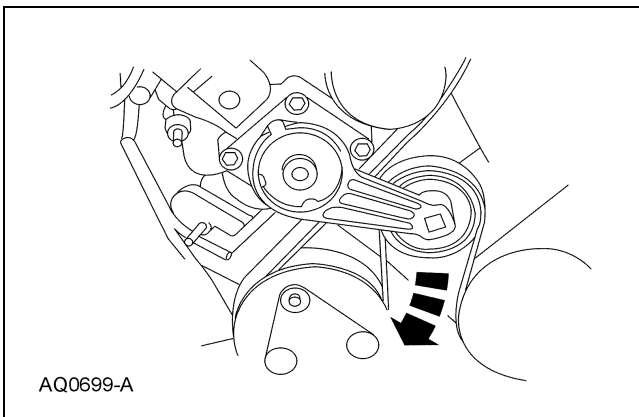
1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.

IN-VEHICLE REPAIR (Continued)

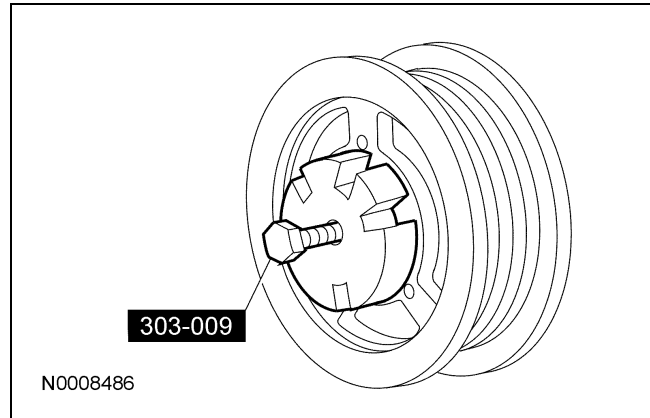
2. Press the 5 position retaining tabs and rotate the lower cooling fan shroud upward until the position retainer tab locks into position.



3. Rotate the tensioner clockwise and remove the accessory drive belt.

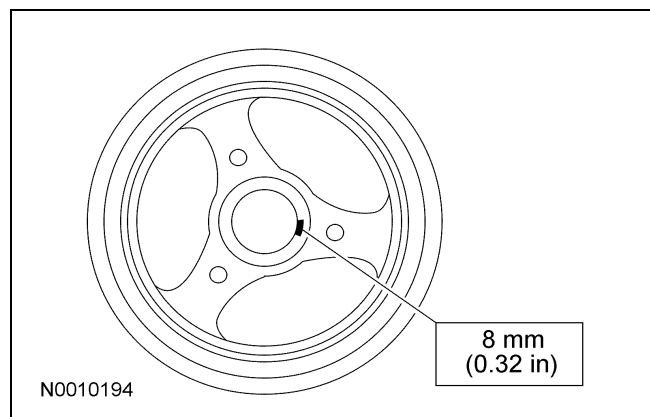


4. Remove the crankshaft pulley bolt and washer.
 - Discard the crankshaft pulley bolt.
5. Using the special tool, remove the crankshaft pulley.

**Installation**

1. **NOTE:** If not secured within 4 minutes, the sealant must be removed and the sealing area cleaned with Motorcraft Metal Surface Prep and Silicone Gasket Remover. Follow the directions on the packaging. Allow to dry until there is no sign of wetness, or 4 minutes, whichever is longer. Failure to follow this procedure may cause future oil leakage.

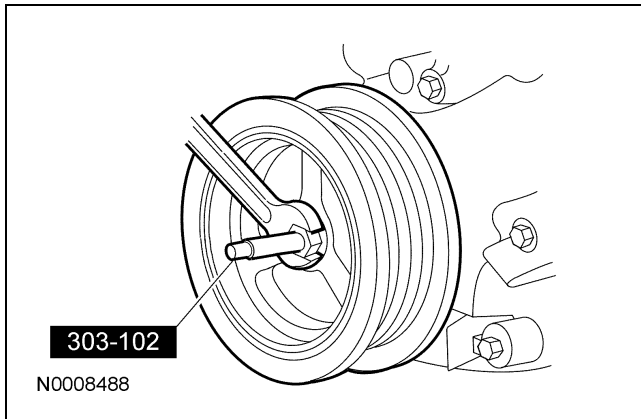
Apply Silicone Gasket and Sealant to the Woodruff key slot in the crankshaft pulley.



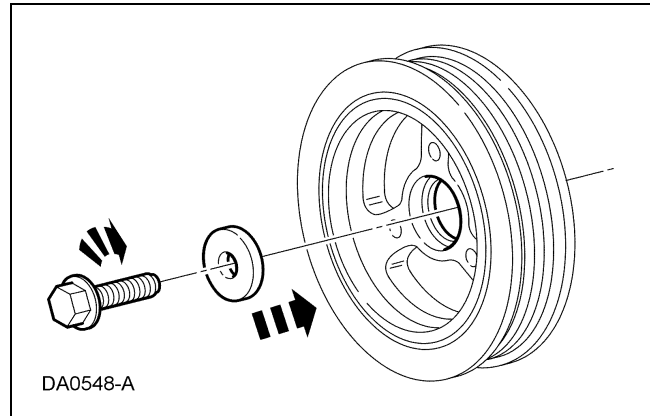
IN-VEHICLE REPAIR (Continued)

2. **NOTE:** Lubricate the crankshaft front seal inner lip with clean engine oil prior to installing the crankshaft pulley.

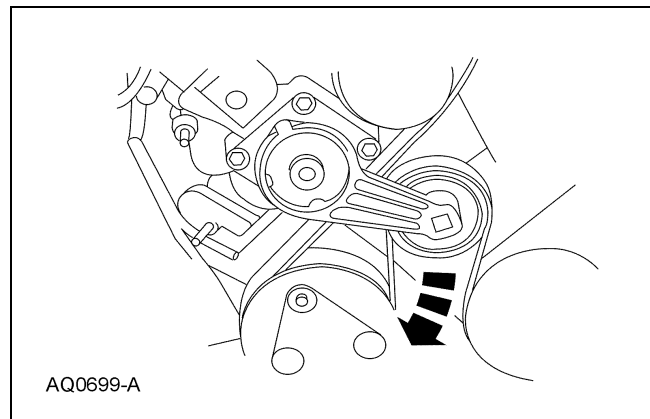
Using the special tool, install the crankshaft pulley.



3. Using a new crankshaft pulley bolt, install the bolt and washer and tighten the bolt in 4 stages.
- Stage 1: Tighten to 90 Nm (66 lb-ft).
 - Stage 2: Loosen 360 degrees.
 - Stage 3: Tighten to 50 Nm (37 lb-ft).
 - Stage 4: Tighten an additional 90 degrees.



4. Rotate the tensioner clockwise and install the accessory drive belt.

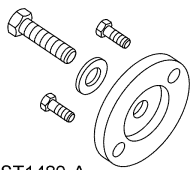
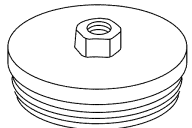

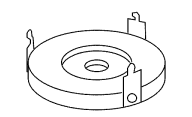
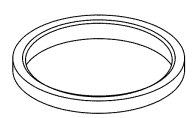
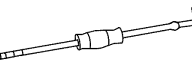


5. Press the position retaining tab and rotate the lower cooling fan shroud downward until the position retainer tab locks into position.

IN-VEHICLE REPAIR

Crankshaft Rear Seal

Special Tool(s)

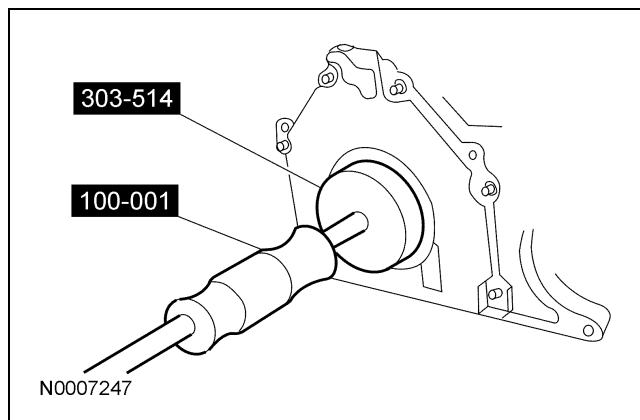
 <p>ST1480-A</p>	<p>Installer, Crankshaft Rear Oil Seal 303-518 (T95P-6701-DH)</p>
 <p>ST1382-A</p>	<p>Remover, Crankshaft Rear Oil Seal 303-519 (T95P-6701-EH)</p>
 <p>ST1479-A</p>	<p>Installer, Crankshaft Rear Oil Seal 303-516 (T95P-6701-BH)</p>
 <p>ST1481-A</p>	<p>Remover, Crankshaft Rear Oil Slinger 303-514 (T95P-6701-AH)</p>
 <p>ST1482-A</p>	<p>Installer, Crankshaft Rear Oil Slinger 303-517 (T95P-6701-CH)</p>
 <p>ST1185-A</p>	<p>Slide Hammer 100-001 (T50T-100-A)</p>

Material

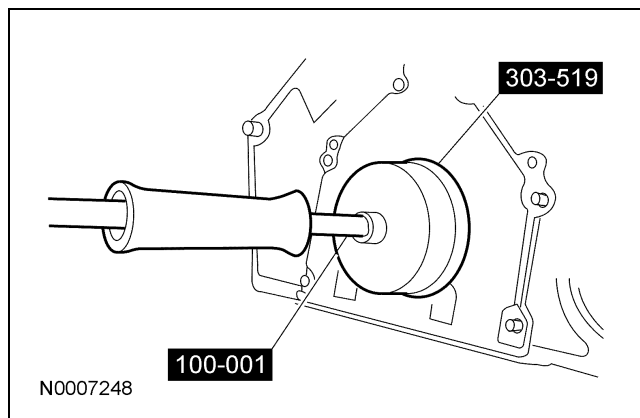
Item	Specification
<p>Motorcraft SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP (US); Motorcraft SAE 5W-20 Super Premium Motor Oil CXO-5W20-LSP12 (Canada); or equivalent</p>	<p>WSS-M2C930-A</p>

Removal

1. Remove the flexplate or flywheel. For additional information, refer to Flexplate or Flywheel in this section.
2. Remove the engine rear cover plate.
3. Using the special tools, remove and discard the crankshaft oil slinger.



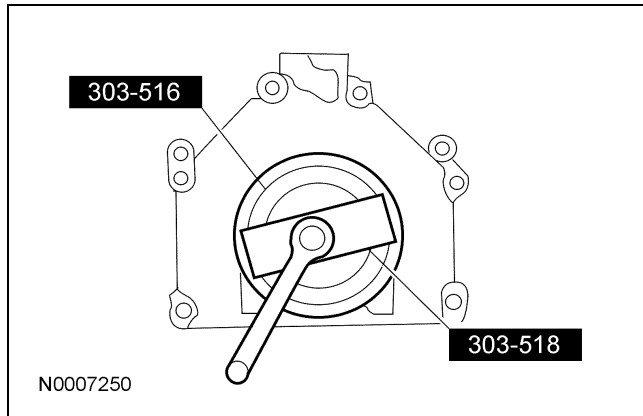
4. Using the special tools, remove and discard the crankshaft rear seal.



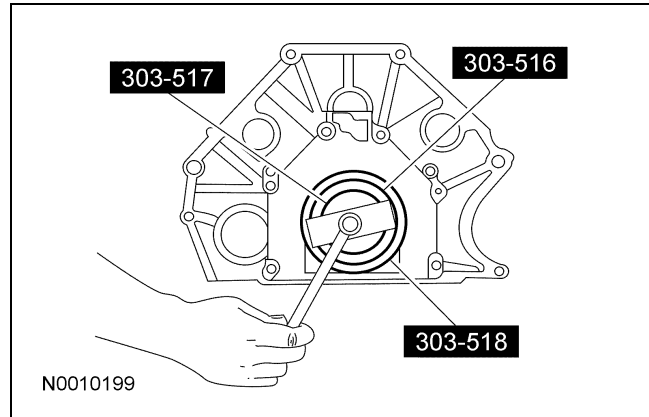
IN-VEHICLE REPAIR (Continued)**Installation**

1. **NOTE:** Lubricate the crankshaft rear seal with clean engine oil prior to installation.

Using the special tools, install a new crankshaft rear seal.



2. **NOTE:** Lubricate the crankshaft oil slinger with clean engine oil prior to installation.
Using the special tools, install a new crankshaft oil slinger.

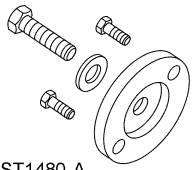
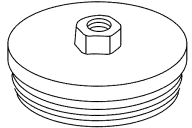

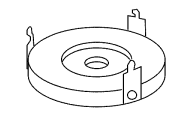
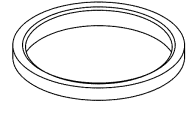
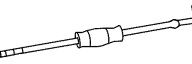


3. Install the engine rear cover plate.
4. Install the flexplate or flywheel. For additional information, refer to Flexplate or Flywheel in this section.

IN-VEHICLE REPAIR

Crankshaft Rear Seal with Retainer Plate

Special Tool(s)

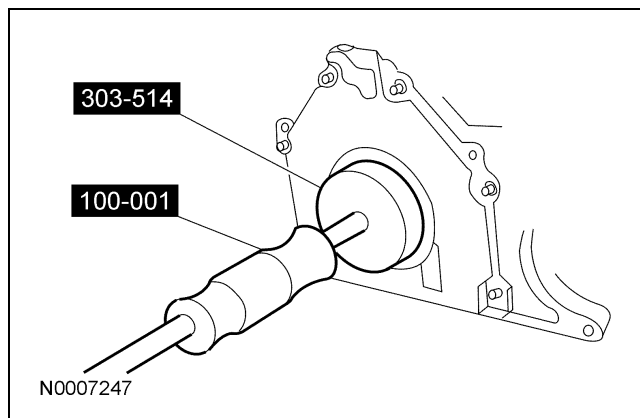
 <p>ST1480-A</p>	<p>Installer, Crankshaft Rear Seal 303-518 (T95P-6701-DH)</p>
 <p>ST1382-A</p>	<p>Remover, Crankshaft Rear Seal 303-519 (T95P-6701-EH)</p>
 <p>ST1479-A</p>	<p>Installer, Crankshaft Rear Seal 303-516 (T95P-6701-BH)</p>
 <p>ST1481-A</p>	<p>Remover, Crankshaft Rear Oil Slinger 303-514 (T95P-6701-AH)</p>
 <p>ST1482-A</p>	<p>Installer, Crankshaft Rear Oil Slinger 303-517 (T95P-6701-CH)</p>
 <p>ST1185-A</p>	<p>Impact Slide Hammer 100-001 (T50T-100-A)</p>

Material

Item	Specification
Motorcraft Metal Surface Prep ZC-31	—
Motorcraft SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP (US); Motorcraft SAE 5W-20 Super Premium Motor Oil CXO-5W20-LSP12 (Canada); or equivalent	WSS-M2C930-A
Silicone Gasket and Sealant TA-30	WSE-M4G323-A4
Silicone Gasket Remover ZC-30	—

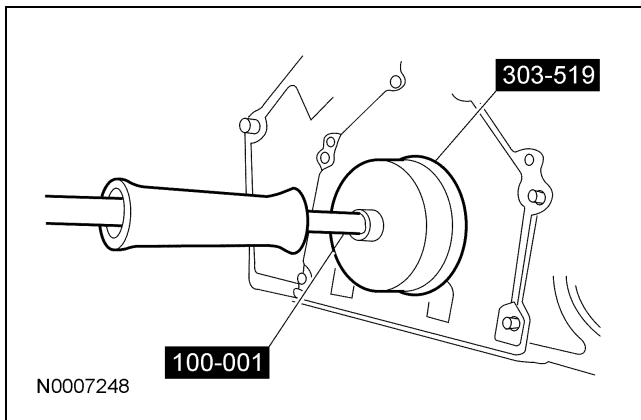
Removal

1. Remove the oil pan. For additional information, refer to Oil Pan in this section.
2. Using the special tools, remove the crankshaft oil slinger.
 - Discard the crankshaft oil slinger.



IN-VEHICLE REPAIR (Continued)

3. Using the special tools, remove the crankshaft rear seal.
 - Discard the crankshaft rear seal.



4. Remove the 6 bolts and the crankshaft rear seal retainer plate.

Installation

1. **CAUTION:** Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the sealing surfaces. These tools cause scratches and gouges which make leak paths. Use a plastic scraping tool to remove all traces of old sealant.

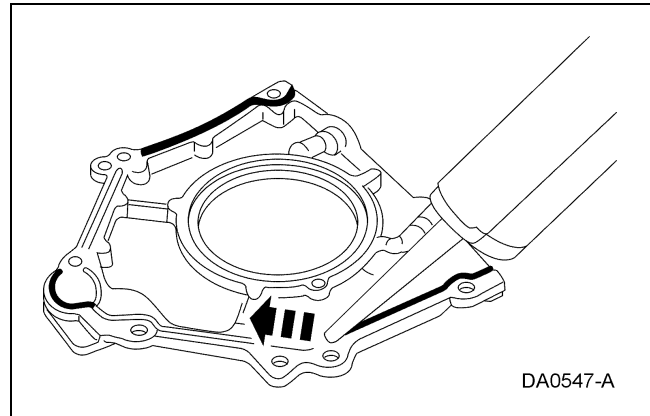
NOTE: Clean the sealing surfaces with Silicone Gasket Remover and Motorcraft Metal Surface Prep. Follow the directions on the packaging. Failure to follow this procedure can cause future oil leakage.

Clean and inspect the mating surface.

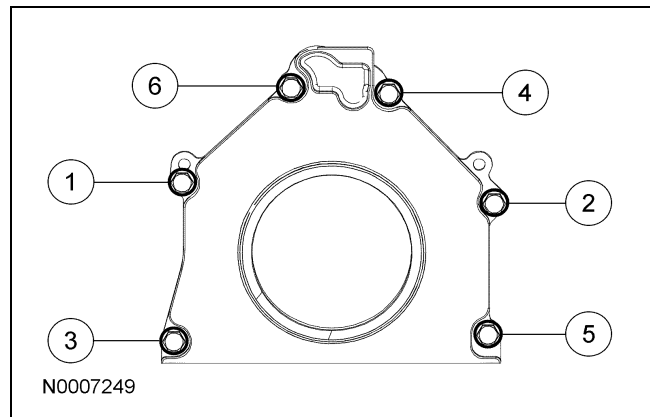
2. **NOTE:** If the rear crankshaft seal retaining plate is not secured within 4 minutes, the sealant must be removed and the sealing area cleaned with Silicone Gasket Remover and Motorcraft Metal Surface Prep. Follow the directions on the packaging. Allow to dry until there is no sign of wetness, or 4 minutes, whichever is longer. Failure to follow this procedure can cause future oil leaks.

NOTE: The silicone must be applied on the groove along the retainer plate.

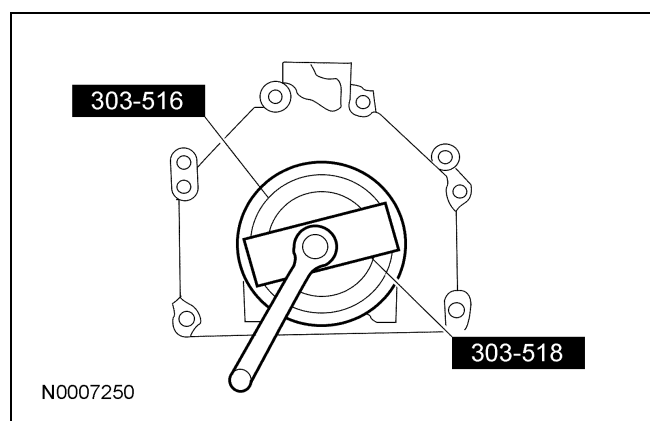
Apply a 4.06 mm (0.16 in) bead of Silicone Gasket and Sealant around the crankshaft rear seal retainer plate sealing surface.



3. Install the crankshaft rear seal retainer plate and the 6 bolts in the sequence shown in 2 stages:
 - Stage 1: Tighten to 10 Nm (89 lb-in).
 - Stage 2: Tighten an additional 60 degrees.

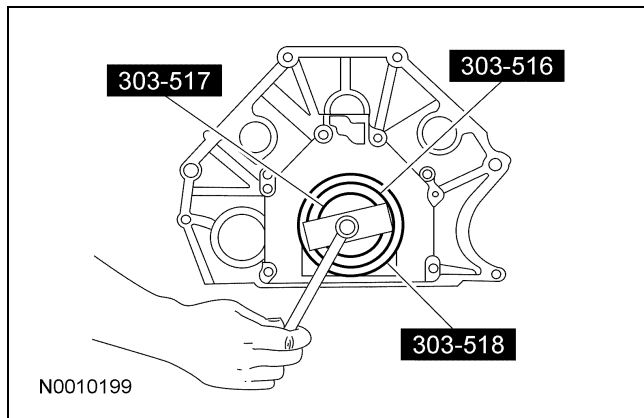


4. **NOTE:** Lubricate the inner lip of the crankshaft rear seal with clean engine oil.
Using the special tools, install the crankshaft rear seal.



IN-VEHICLE REPAIR (Continued)

5. Using the special tools, install the crankshaft rear oil slinger.

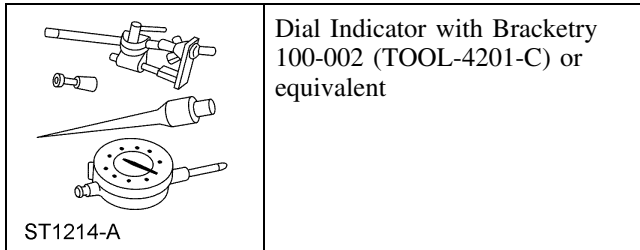


6. Install the oil pan. For additional information, refer to Oil Pan in this section.

GENERAL PROCEDURES

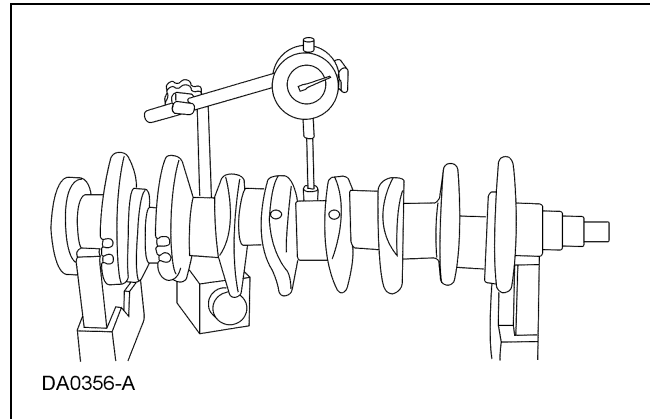
Crankshaft Runout

Special Tool(s)



Dial Indicator with Bracketry
100-002 (TOOL-4201-C) or
equivalent

ST1214-A



DA0356-A

NOTE: Refer to the appropriate Section 303-01 for the specification.

1. **NOTE:** Crankshaft main bearing journals must be within specifications before checking runout.

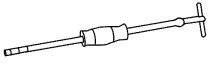
Use the Dial Indicator Gauge to measure the crankshaft runout.

- Rotate the crankshaft and subtract the lowest dial indicator reading from the highest dial indicator reading to figure the crankshaft runout.

GENERAL PROCEDURES

Cylinder Block Core Plug Replacement

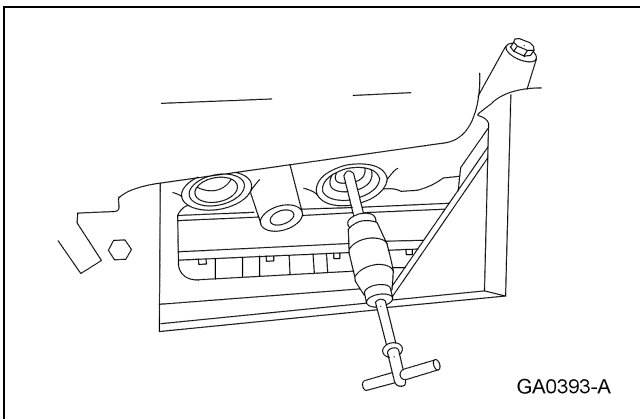
Special Tool(s)

 ST1185-A	Slide Hammer 100-001 (T50T-100-A)
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Material

Item	Specification
Threadlock 262 TA-26	WSK-M2G351-A6

1. Use a slide hammer or tools suitable to remove the cylinder block core plug.



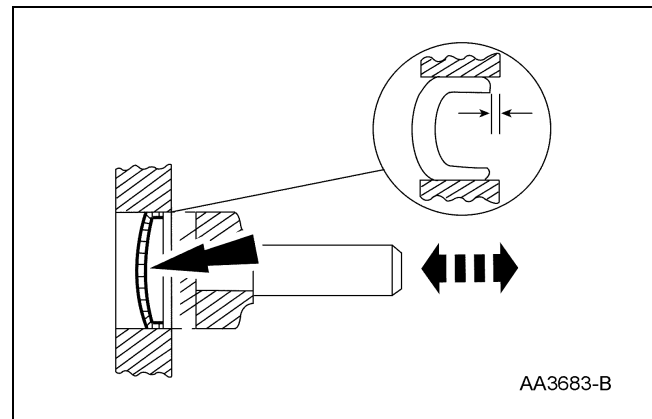
2. Inspect the cylinder block plug bore for any damage that would interfere with the correct sealing of the plug. If the cylinder block plug bore is damaged, bore for the next oversize plug.
3. **NOTE:** Oversize plugs are identified by the OS stamped in the flat located on the cup side of the plug.
Coat the cylinder block core plug and bore lightly with threadlock and install the cylinder block core plug.

Cup-Type

1. **CAUTION:** Use care during this procedure so as not to disturb or distort the cup sealing surface.

NOTE: When installed, the flanged edge must be below the chamfered edge of the bore to effectively seal the bore.

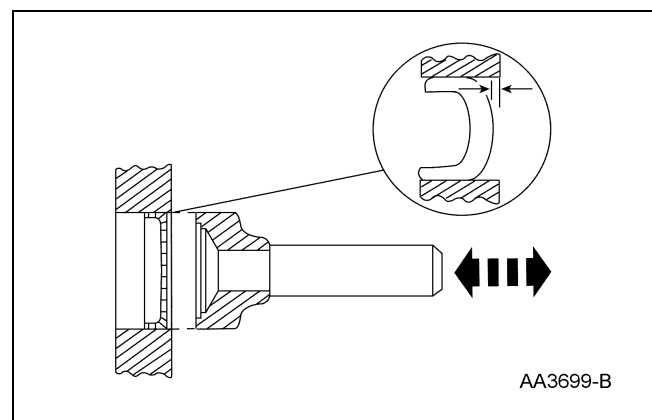
Use a tool suitable to seat the cup-type cylinder block core plug.



Expansion-Type

1. **CAUTION:** Do not contact the crown when installing an expansion-type cylinder block core plug. This could expand the plug before seating and result in leakage.

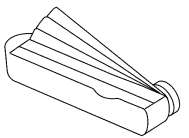
Use a tool suitable to seat the expansion-type cylinder block core plug.

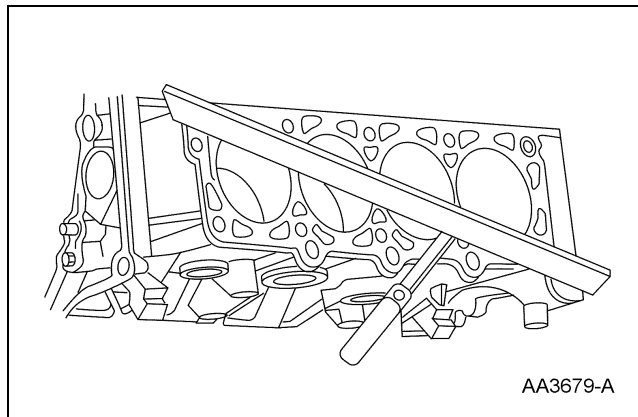


GENERAL PROCEDURES

Cylinder Block Distortion

Special Tool(s)

 ST1271-A	Feeler Gauge Set 303-D027 (D81L-4201-A) or equivalent
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NOTE: Refer to the appropriate Section 303-01 for the specification.

1. **NOTE:** Use a straightedge that is calibrated by the manufacturer to be flat within 0.005 mm (0.0002 in) per running foot of length, such as Snap-On® GA438A or equivalent. For example, if the straightedge is 61 cm (24 in) long, the machined edge must be flat within 0.010 mm (0.0004 in) from end to end.


Use a straightedge and a feeler gauge to inspect the cylinder block for flatness.

GENERAL PROCEDURES

Cylinder Bore Cleaning

Material

Item	Specification
Motorcraft SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP (US); Motorcraft SAE 5W-20 Super Premium Motor Oil CXO-5W20-LSP12 (Canada); or equivalent	WSS-M2C930-A

1.  **CAUTION:** If these procedures are not followed, rusting of the cylinder bores may occur.

Clean the cylinder bores with soap or detergent and water.

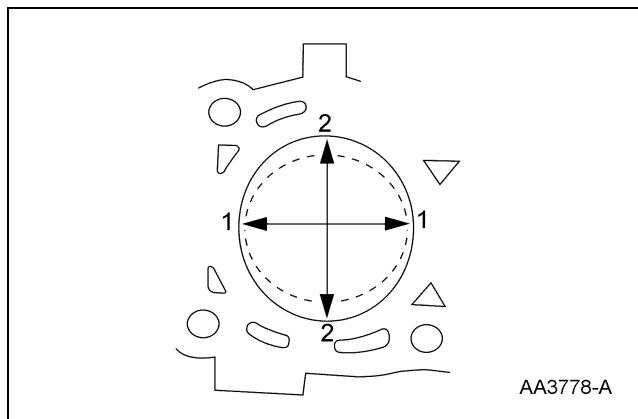
2. Thoroughly rinse with clean water and wipe dry with a clean, lint-free cloth.
3. Use a clean, lint-free cloth and lubricate the cylinder bores.
 - Use clean engine oil meeting Ford specification.

GENERAL PROCEDURES

Cylinder Bore Out-of-Round

NOTE: Refer to the appropriate Section 303-01 for the specification.

1. Measure the cylinder bore in 2 directions. The difference is the out-of-round.

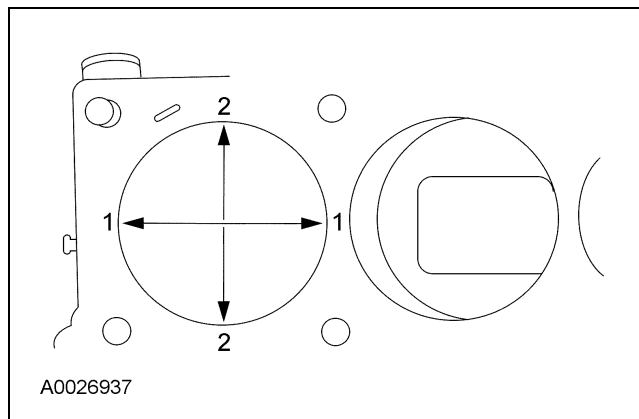


GENERAL PROCEDURES

Cylinder Bore Taper

NOTE: Refer to the appropriate Section 303-01 for the specification.

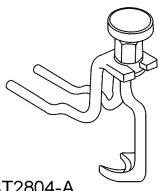
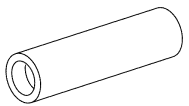
1. Measure the cylinder bore at the top, middle and bottom of piston ring travel in 2 directions as indicated. Verify the cylinder bore is within the wear limit. The difference indicates the cylinder bore taper. Bore the cylinder to the next oversize limit.



DISASSEMBLY AND ASSEMBLY OF SUBASSEMBLIES

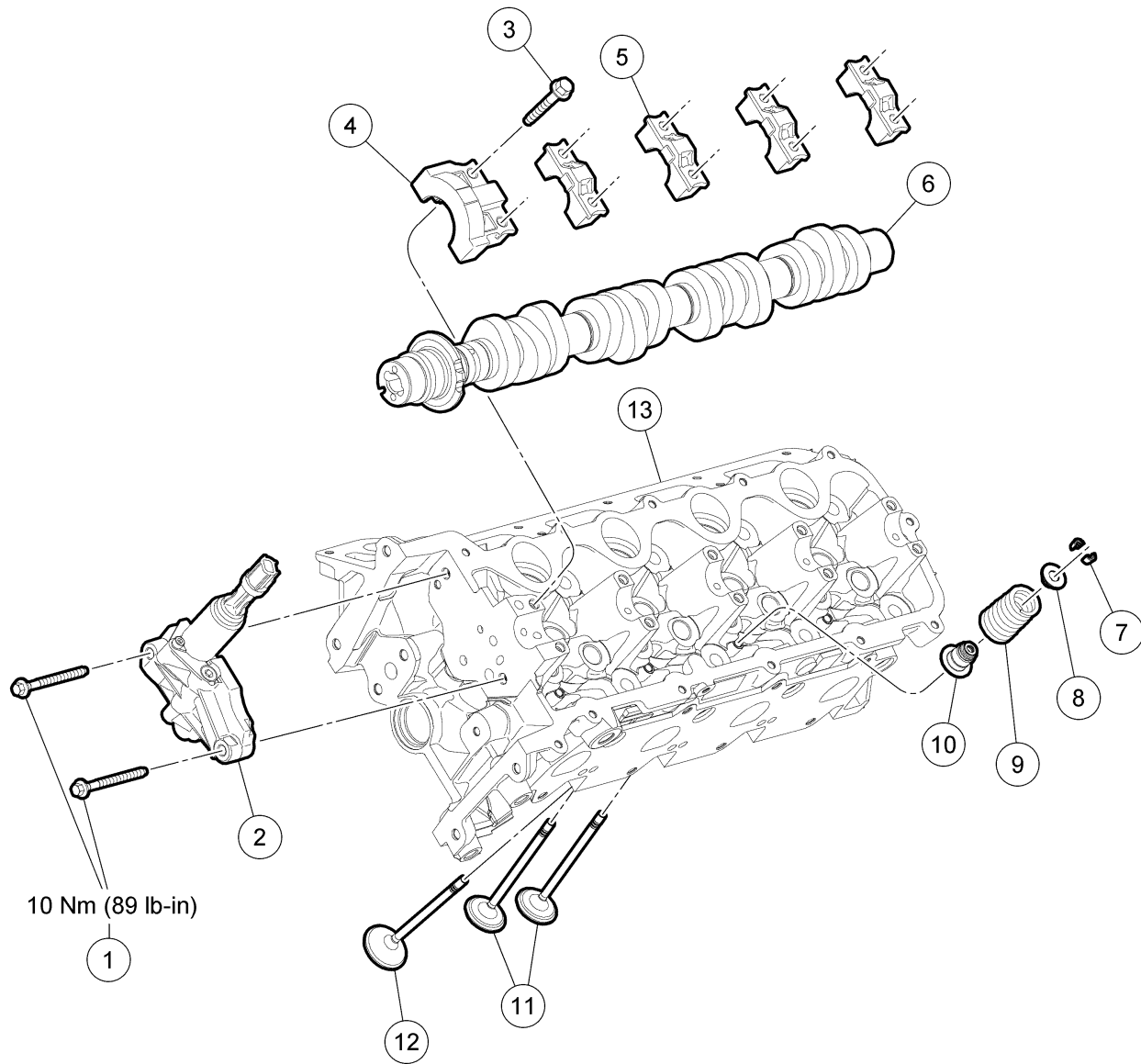
Cylinder Head

Special Tool(s)

 <p>ST2804-A</p>	Compressor, Valve Spring 303-1039
 <p>ST1332-A</p>	Installer, Valve Stem Oil Seal 303-383 (T91T-6571-A)

Material

Item	Specification
Motorcraft Metal Surface Prep ZC-31	—
Motorcraft SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP (US); Motorcraft SAE 5W-20 Super Premium Motor Oil CXO-5W20-LSP12 (Canada); or equivalent	WSS-M2C930-A
Silicone Gasket Remover ZC-30	—

DISASSEMBLY AND ASSEMBLY OF SUBASSEMBLIES (Continued)

N0010131

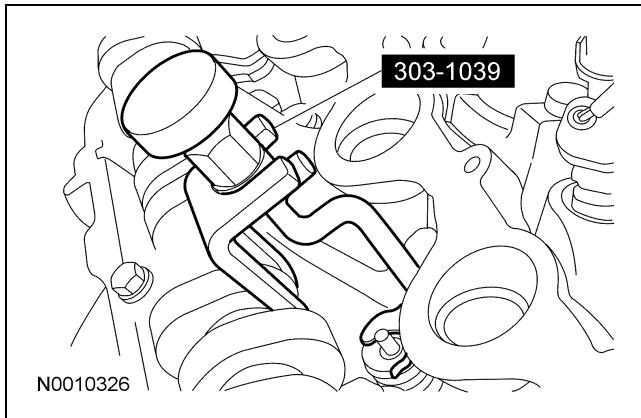
Item	Part Number	Description
1	W701520	Variable camshaft timing (VCT) housing assembly bolts (2 required)
2	6C261	VCT housing assembly
3	N807834	Camshaft bearing cap bolt (10 required)
4	6B284	Camshaft front bearing cap
5	6B280	Camshaft bearing cap (4 required)
6	6C255	Camshaft

Item	Part Number	Description
7	6518	Valve spring retainer key (24 required)
8	6514	Valve spring retainer (12 required)
9	6513	Valve spring (12 required)
10	6A517	Valve seal (12 required)
11	6507	Intake valves (8 required)
12	6505	Exhaust valve (4 required)
13	6050	Cylinder head


(Continued)

DISASSEMBLY AND ASSEMBLY OF SUBASSEMBLIES (Continued)**Disassembly**

1. Remove the bolts and the variable camshaft timing (VCT) housing.
 - Discard the gasket.
2. Lubricate the camshaft and camshaft journals with clean engine oil and install the camshaft.
3. Install the camshaft bearing caps in their original locations.
 - Lubricate the camshaft bearing caps with clean engine oil.
 - Position the front camshaft bearing cap.
 - Position the remaining camshaft bearing caps.
 - Install the bolts finger tight.
4. Using the special tool, compress the valve spring and remove the valve spring retainer keys.



5. Remove the valve spring retainer, the valve spring and the valve seal.
 - Discard the valve seal.
6. Remove the valve from the cylinder head.
7. Repeat the previous 3 steps for each valve.
8. Inspect the components. For additional information, refer to Section 303-00.

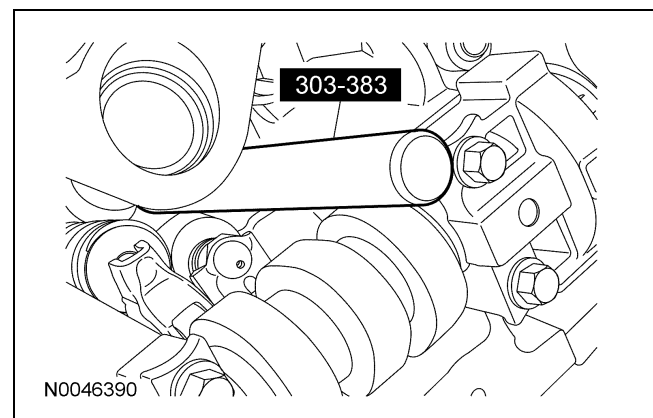
9.  **CAUTION:** Remove the front thrust camshaft bearing cap straight upward from the bearing towers, or the bearing cap may be damaged from sideloading.

Remove the bolts, the front camshaft bearing cap and then the remaining bearing caps.


10. Remove the camshaft.
11. Check the cylinder head for distortion. For additional information, refer to Section 303-00.

Assembly

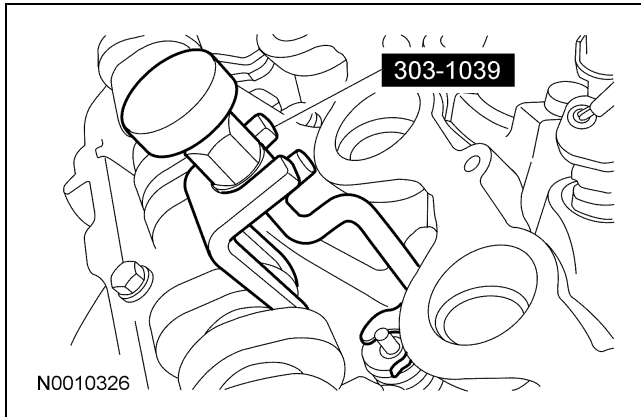
1. Lubricate the camshaft and camshaft journals with clean engine oil and install the camshaft.
2. Install the camshaft bearing caps in their original locations.
 - Lubricate the camshaft bearing caps with clean engine oil.
 - Position the front camshaft bearing cap.
 - Position the remaining camshaft bearing caps.
 - Install the bolts finger tight.
3. **NOTE:** Lubricate the valve stem with clean engine oil prior to installation. Install the valve into the cylinder head.
4. **NOTE:** Lubricate the valve seal and valve stem with clean engine oil prior to installation. Position a new valve seal onto the valve stem.
5. Using the special tool, install the new valve seal.



DISASSEMBLY AND ASSEMBLY OF SUBASSEMBLIES (Continued)

6.  **CAUTION:** If the components are to be reinstalled, they must be installed into their original locations.

Using the special tool, install the valve spring, the valve spring retainer and the valve spring retainer keys.

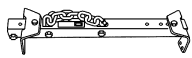
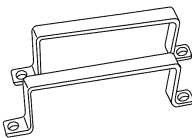
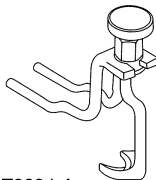
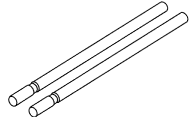
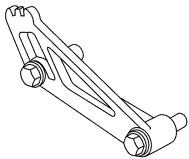
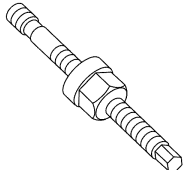


7. Repeat the previous 2 steps for each valve.
8. Remove the bolts the front camshaft bearing cap and then the remaining bearing caps.
9. Remove the camshaft.
10. Install a new gasket, the VCT housing and the bolts.
- Tighten to 10 Nm (89 lb-in).

INSTALLATION

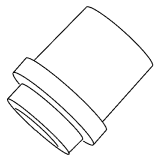
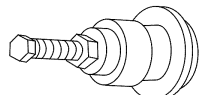
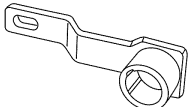

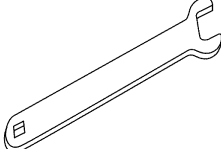
Cylinder Head

Special Tool(s)

 ST1377-A	Modular Engine Lift Bracket 303-F047 (014-00073) or equivalent
 ST1668-A	Remover/Installer, Cylinder Head 303-572 (T97T-6000-A)
 ST2804-A	Compressor, Valve Spring 303-1039
 ST2806-A	Alignment Pins, Cylinder Head 303-1040 (SR-015486)
 ST2807-A	Locking Tool, Camshaft Phaser Sprocket 303-1046
 ST2428-A	Installer, Crankshaft Vibration Damper 303-102 (T74P-6316-B)

(Continued)

Special Tool(s)

 ST2197-A	Installer, Crankshaft Front Seal 303-635
 ST1328-A	Installer, Front Cover Seal 303-335 (T88T-6701-A)
 ST1335-A	Holding Tool, Crankshaft 303-448 (T93P-6303-A)
 ST1499-A	Fan Pulley Holding Wrench 303-239 (T84T-6312-C)
 ST1500-A	Fan Clutch Nut Wrench 303-240 (T84T-6312-D)

Material

Item	Specification
Hydraulic Chain Tensioner Retaining Clip 1L3Z-6P250-AA	—
Motorcraft Metal Surface Prep ZC-31	—

(Continued)

INSTALLATION (Continued)**Material**

Item	Specification
Motorcraft Premium Gold Engine Coolant with Bittering Agent (US only) VC-7-B (US); CVC-7-A (Canada); or equivalent (yellow color)	WSS-M97B51-A1
Motorcraft SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP (US); Motorcraft SAE 5W-20 Super Premium Motor Oil CXO-5W20-LSP12 (Canada); or equivalent	WSS-M2C930-A
Silicone Brake Caliper Grease and Dielectric Compound XG-3-A	ESE-M1C171-A
Silicone Gasket and Sealant TA-30	WSE-M4G323-A4
Silicone Gasket Remover ZC-30	—

All cylinder heads

- CAUTION:** Make sure all coolant residue and foreign material are cleaned from the block surface and cylinder bore. Failure to follow these instructions may result in engine damage.

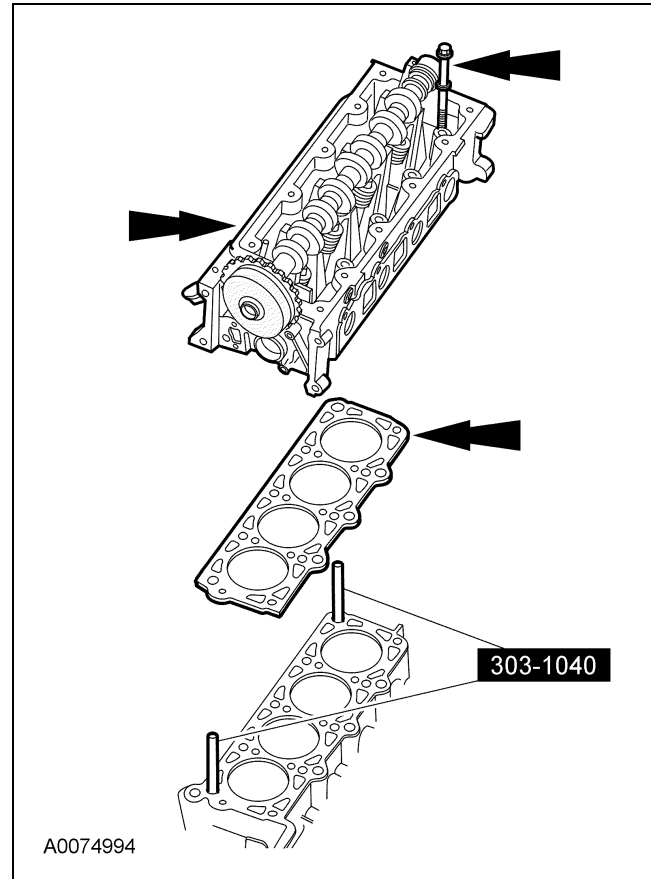
CAUTION: The use of sealing aids (aviation cement, copper spray and glue) is not permitted. The gasket must be installed dry. Failure to follow these instructions may result in future oil leakage.

CAUTION: The cylinder head bolts must be discarded and new bolts installed. They are a tighten-to-yield design and cannot be reused.

NOTE: Do not turn the crankshaft until instructed to do so.

NOTE: LH shown, RH similar.

Using the special tools, position the cylinder head gaskets and cylinder heads over the dowels and install the cylinder head bolts loosely.

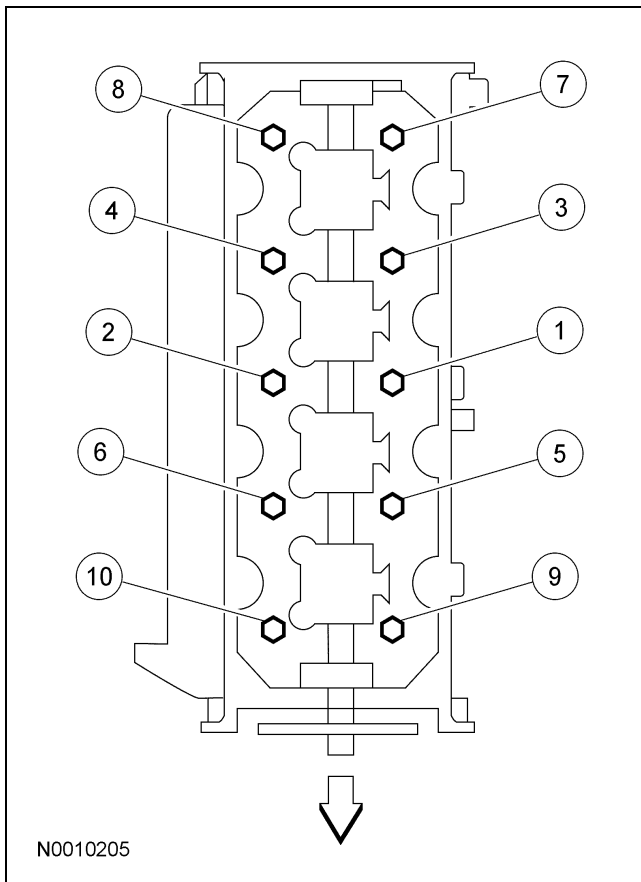


INSTALLATION (Continued)

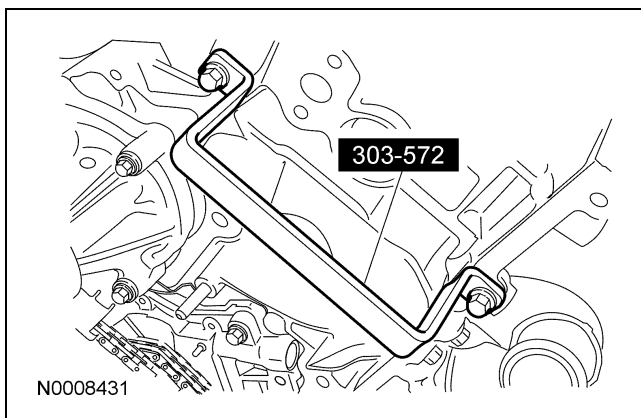
2. **NOTE:** Tighten the bolts in 3 stages, in the sequence shown.

NOTE: RH shown, LH similar.

- Stage 1: Tighten to 40 Nm (30 lb-ft).
- Stage 2: Tighten an additional 90 degrees.
- Stage 3: Tighten an additional 90 degrees.

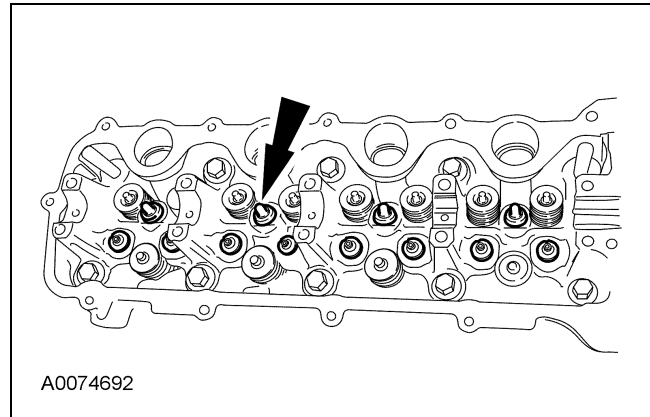
**LH cylinder head**

3. Remove the special tool from the LH cylinder head.



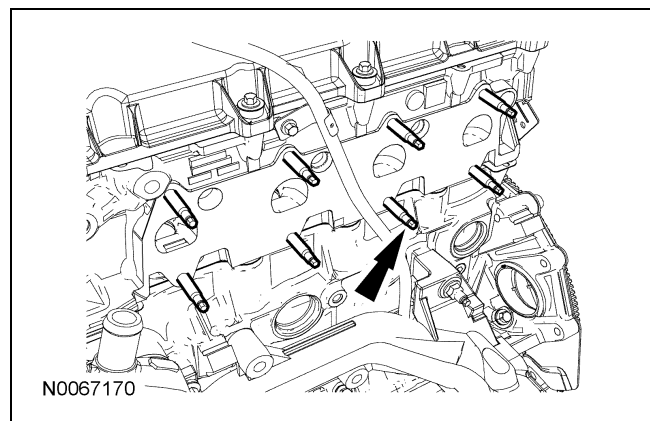
4. Install the hydraulic lash adjusters into the LH cylinder head.

- Lubricate the hydraulic lash adjusters with clean engine oil prior to installation.



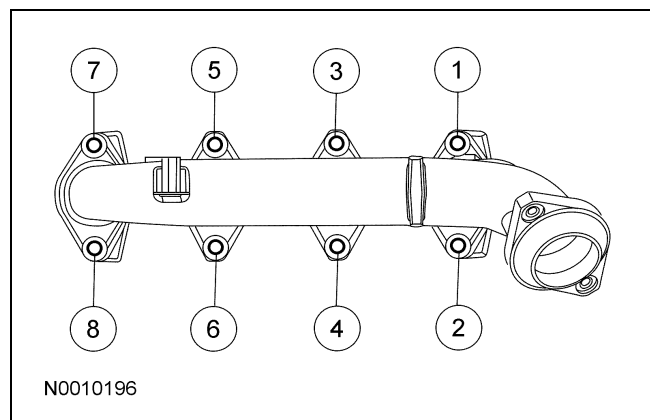
5. Install 8 new exhaust manifold studs.

- tighten to 12 Nm (9 lb-ft).



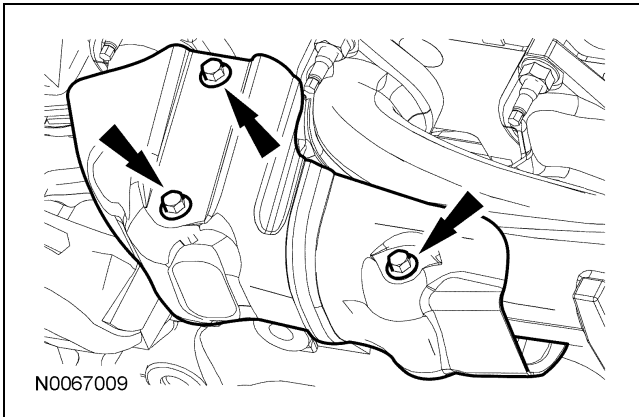
6. Position a new gasket and the LH exhaust manifold and tighten the 8 new nuts in the sequence shown.

- Tighten to 25 Nm (18 lb-ft).

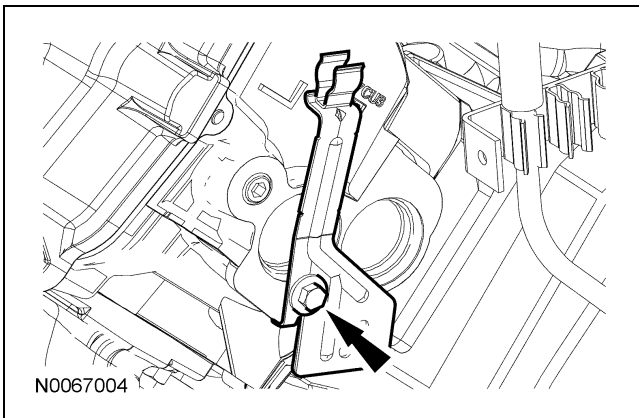


INSTALLATION (Continued)

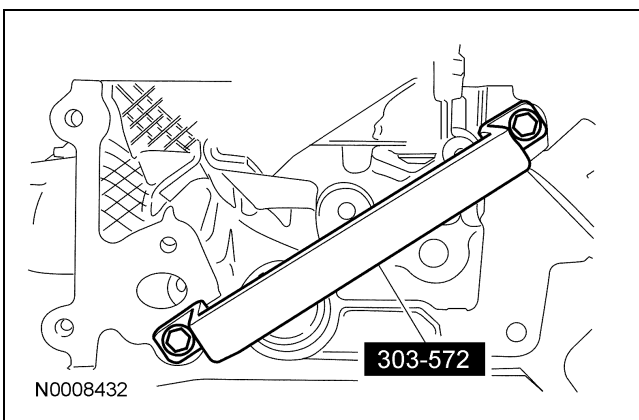
7. Position the LH exhaust manifold heat shield and install the 3 nuts.
- Tighten to 14 Nm (10 lb-ft).



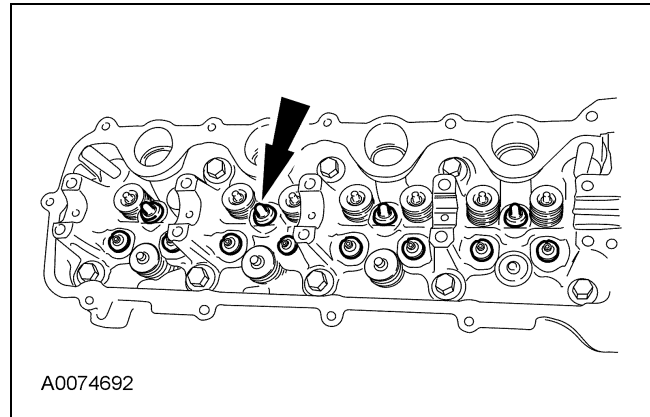
8. Position the intake manifold vacuum tube support bracket and install the bolt.
- Tighten to 10 Nm (89 lb-in).

**RH cylinder head**

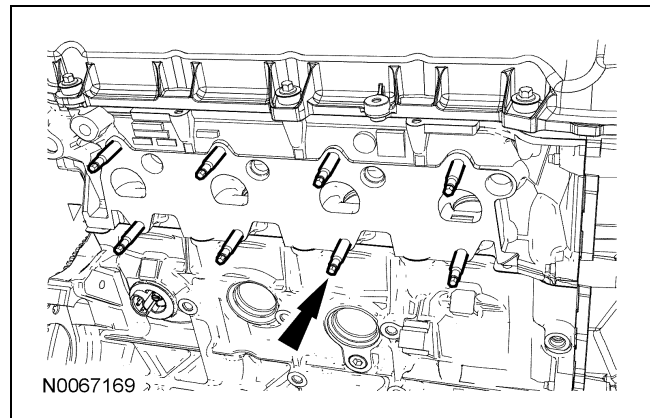
9. Remove the special tool from the RH cylinder head.



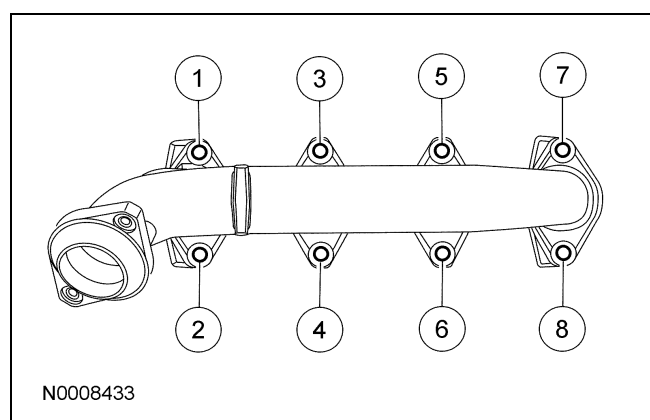
10. Install the hydraulic lash adjusters into the RH cylinder head.
- Lubricate the hydraulic lash adjusters with clean engine oil prior to installation.



11. Install 8 new exhaust manifold studs.
- Tighten to 12 Nm (9 lb-ft).



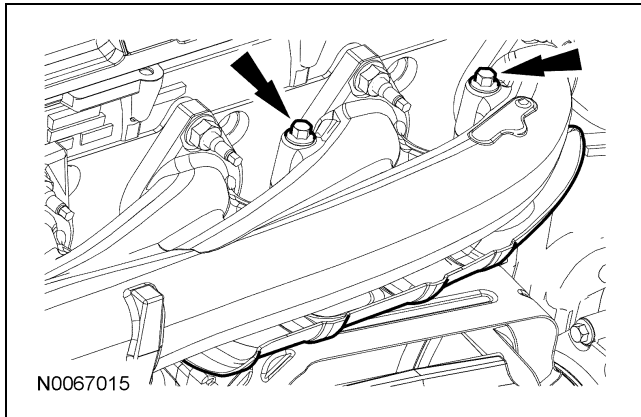
12. Position a new gasket and the RH exhaust manifold and tighten the 8 new nuts in the sequence shown.
- Tighten to 25 Nm (18 lb-ft).



INSTALLATION (Continued)

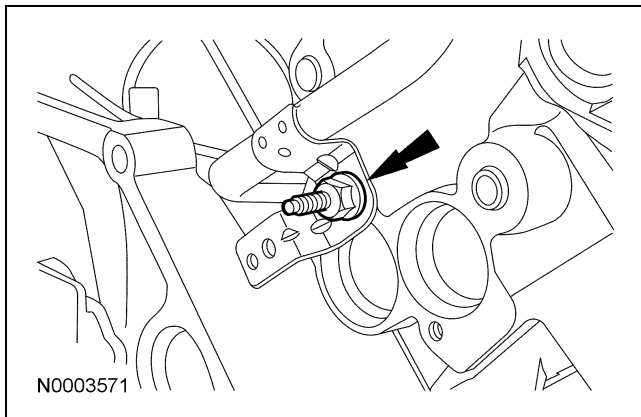
13. Position the RH exhaust manifold heat shield and install the 2 bolts.

- Tighten to 10 Nm (89 lb-in).

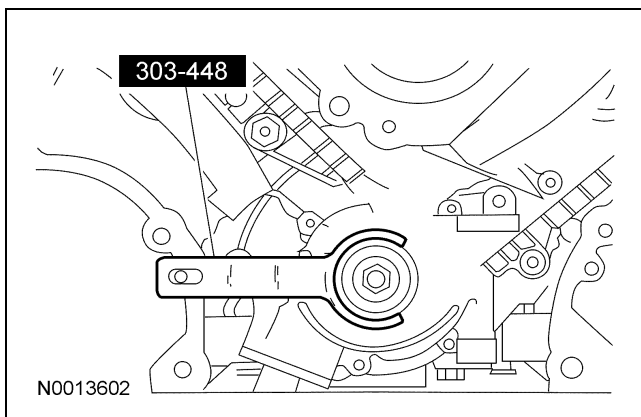


14. Install the coolant tube and the stud bolt.

- Tighten to 10 Nm (89 lb-in).

**All cylinder heads**

15. Position the crankshaft with the special tool, then remove the tool.



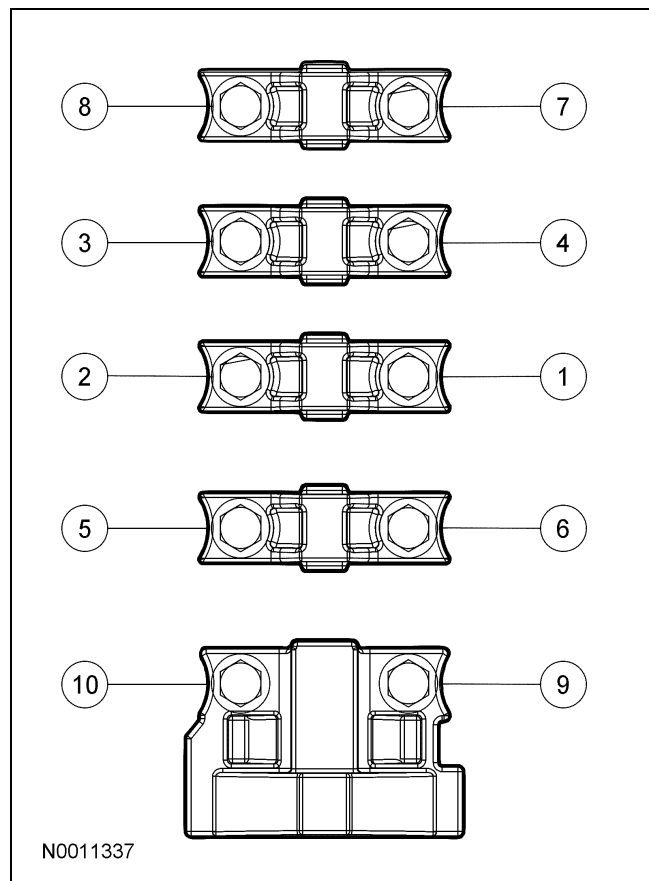
16. Install the LH and RH camshafts.

- Lubricate the camshaft and camshaft journals with clean engine oil prior to installation.


17. **NOTE:** LH shown, RH similar.

Install the LH and RH camshaft bearing caps in their original locations.

- Lubricate the camshaft bearing caps with clean engine oil.
- Position the front camshaft bearing cap.
- Position the remaining camshaft bearing caps.
- Install the bolts loosely.
- Tighten to 10 Nm (89 lb-in) in the sequence shown.

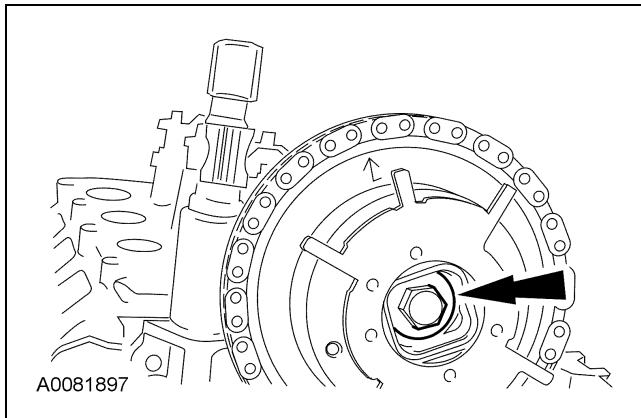



INSTALLATION (Continued)


18.  **CAUTION:** Damage to the variable camshaft timing (VCT) phaser sprocket assembly will occur if mishandled or used as a lifting or leveraging device.

NOTE: LH shown, RH similar.

Install the VCT phaser sprockets and new VCT phaser sprocket bolts finger tight.



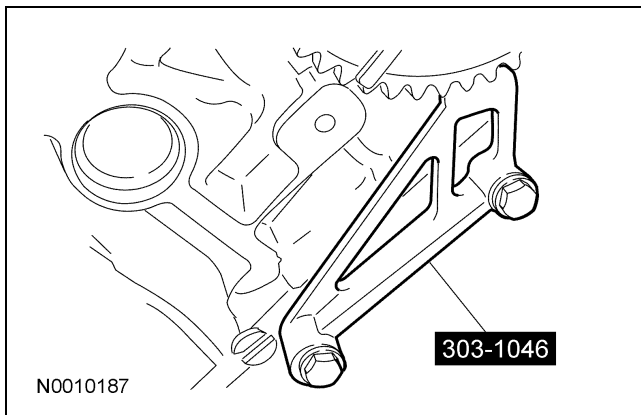
19.  **CAUTION:** Damage to the variable camshaft timing (VCT) phaser sprocket assembly will occur if mishandled or used as a lifting or leveraging device.


 **CAUTION:** Only use hand tools to remove the variable camshaft timing (VCT) phaser sprocket assembly or damage may occur to the camshaft or VCT phaser sprocket.


NOTE: LH shown, RH similar.

Using the special tool, tighten the LH and RH VCT phaser sprocket bolts in 2 stages.

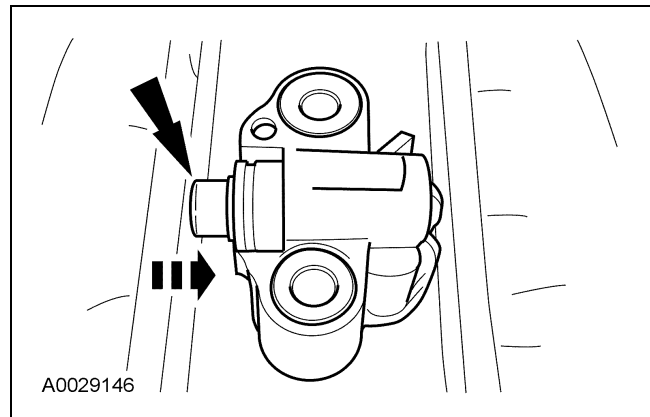
- Stage 1: Tighten to 40 Nm (30 lb-ft).
- Stage 2: Tighten an additional 90 degrees.



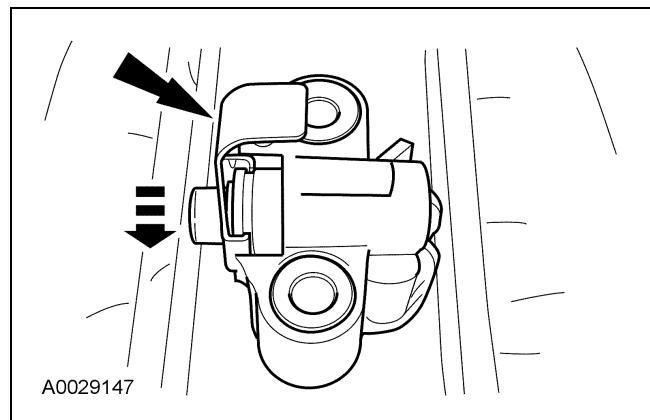
20.  **CAUTION:** Timing chain procedures must be followed exactly or damage to valves and pistons will result.

 **CAUTION:** Prior to installation, inspect the tensioner-sealing bead for seal integrity. If cracks, tears, separation from the tensioner body or permanent compression of the seal bead is observed, install a new tensioner or engine damage may occur.

Compress the tensioner plunger, using a vise.



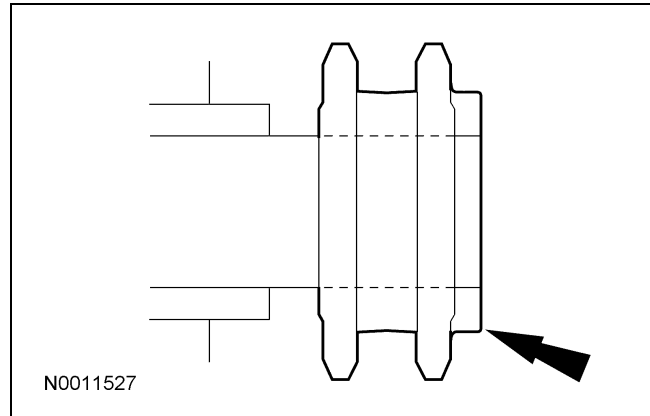
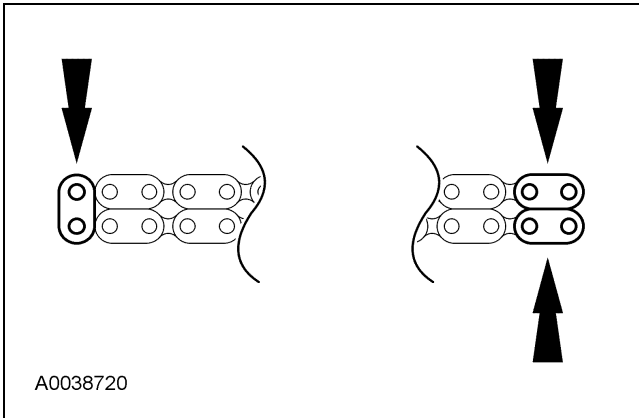
21. Install a retaining clip on the tensioner to hold the plunger in during installation.



22. Remove the tensioner from the vise.

INSTALLATION (Continued)

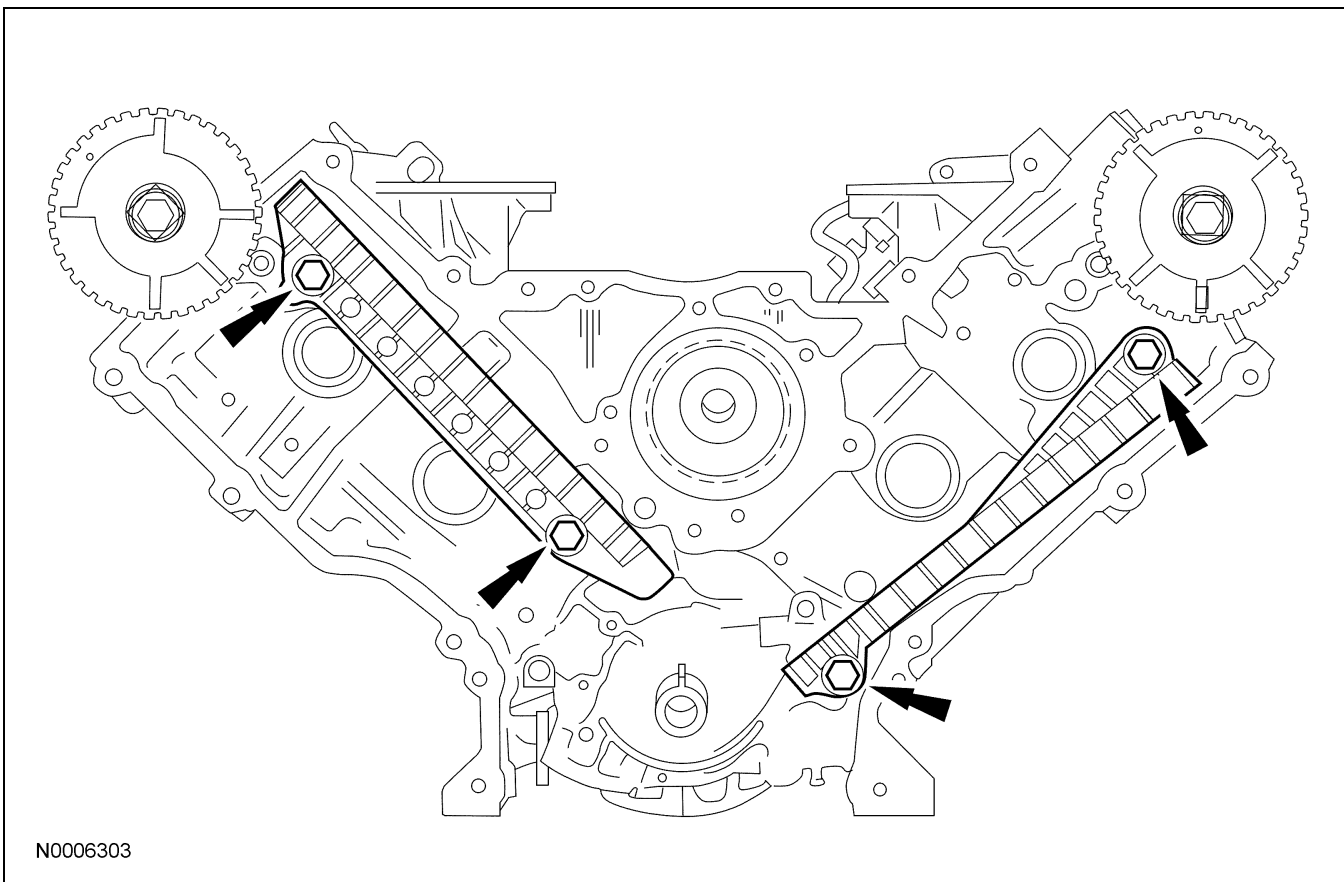
23. If the copper links are not visible, mark 2 links on one end and 1 link on the other end, and use as timing marks.



25. Install the 4 bolts and the LH and RH timing chain guides.

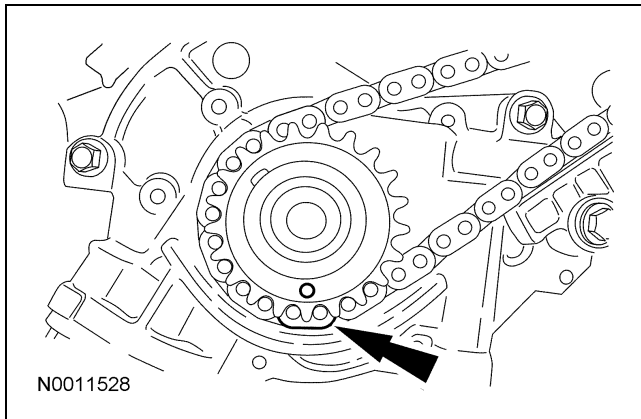
- Tighten to 10 Nm (89 lb-in).

24. Install the crankshaft sprocket, making sure the flange faces forward.



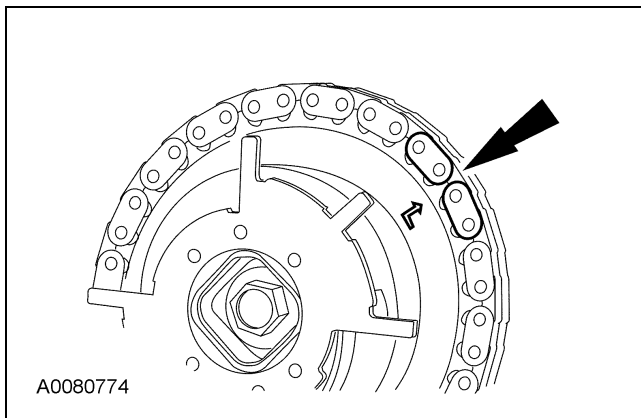
INSTALLATION (Continued)

26. Position the lower end of the LH (inner) timing chain on the crankshaft sprocket, aligning the timing mark on the outer flange of the crankshaft sprocket with the single copper (marked) link on the chain.



27. **NOTE:** Make sure the upper half of the timing chain is below the tensioner arm dowel.

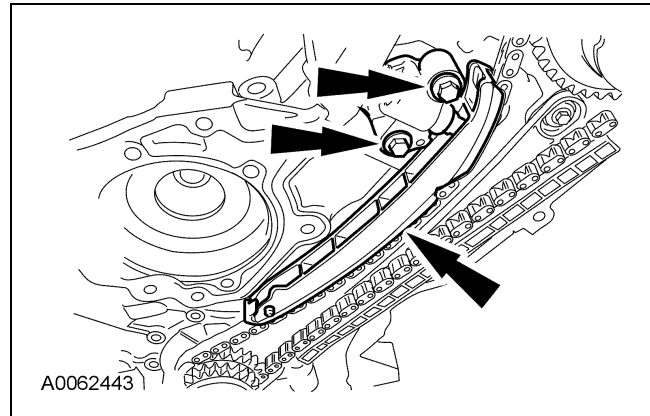
Position the timing chain on the VCT phaser sprocket with the timing mark positioned between the 2 copper (marked) chain links.



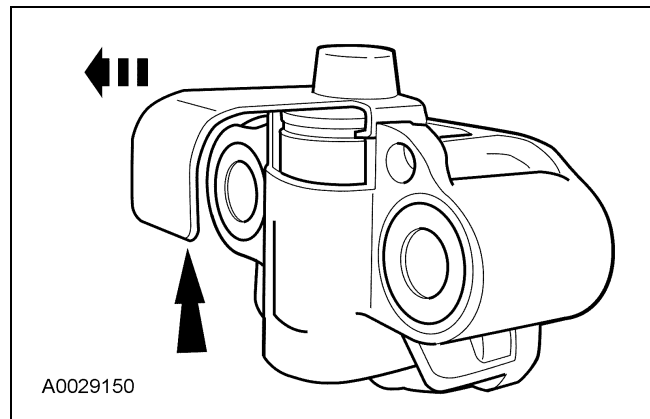
28. **NOTE:** The LH timing chain tensioner arm has a bump near the dowel hole for identification.

Position the LH timing chain tensioner arm on the dowel pin and install the LH timing chain tensioner and bolts.

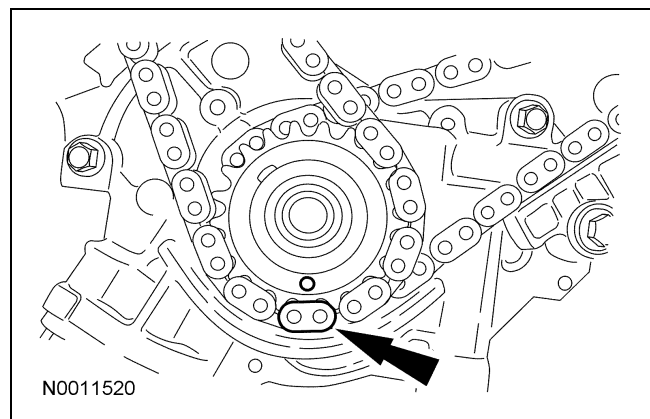
- Tighten to 25 Nm (18 lb-ft).



29. Remove the retaining clip from the LH timing chain tensioner.



30. Position the lower end of the RH (outer) timing chain on the crankshaft sprocket, aligning the timing mark on the sprocket with the single copper (marked) chain link.

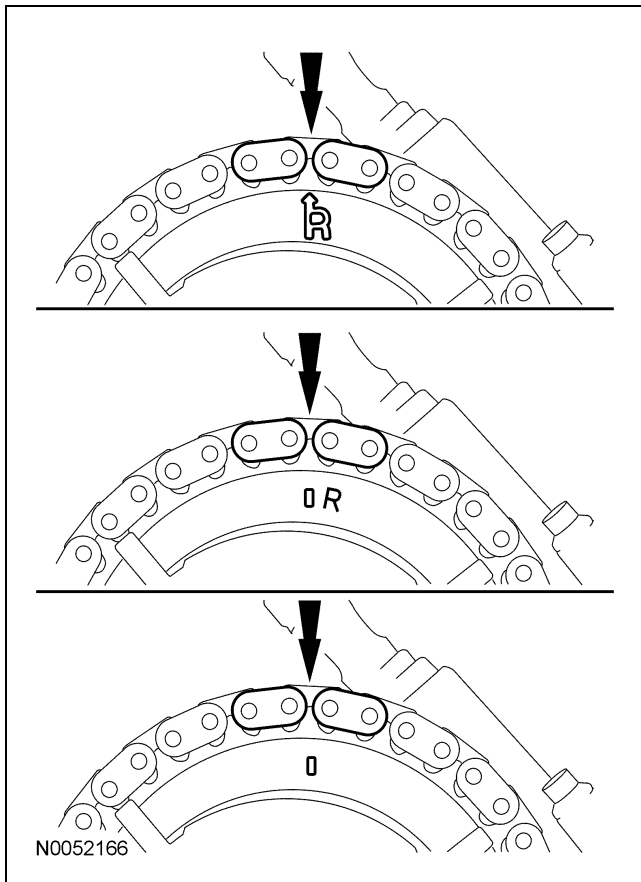


INSTALLATION (Continued)

31. **NOTE:** The lower half of the timing chain must be positioned above the tensioner arm dowel.

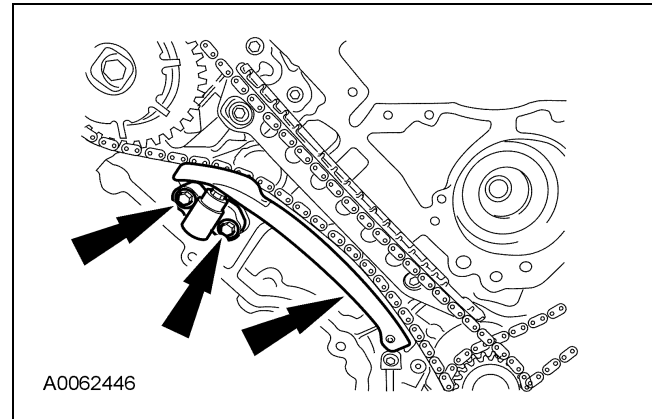
NOTE: The camshaft phaser and sprocket will be stamped with one of the illustrated timing marks for the RH camshaft.

Position the RH timing chain on the VCT phaser sprocket. Make sure the timing mark is positioned between the 2 copper (marked) chain links.

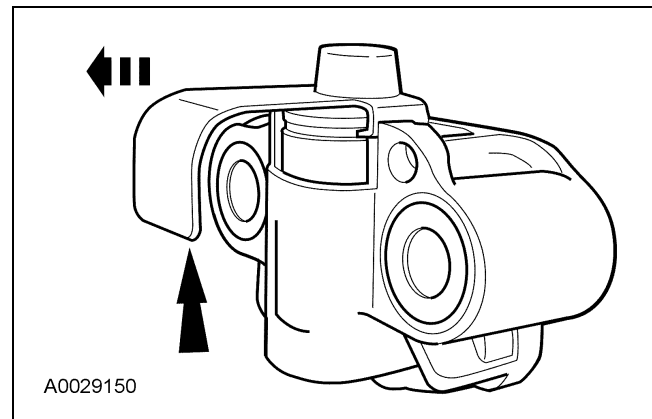


32. Position the RH timing chain tensioner arm on the dowel pin and install the RH timing chain tensioner and bolts.

- Tighten to 25 Nm (18 lb-ft).

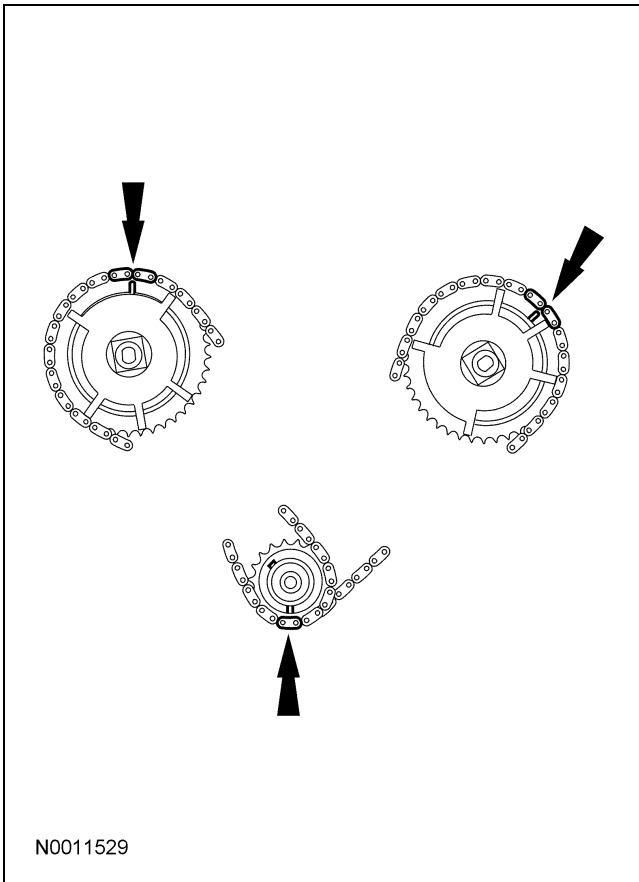


33. Remove the retaining clip from the RH timing chain tensioner.

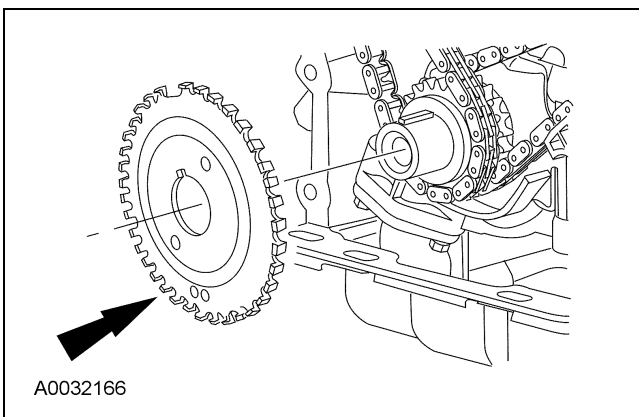


INSTALLATION (Continued)

34. As a post-check, verify correct alignment of all timing marks.



35. Install the crankshaft sensor ring on the crankshaft.

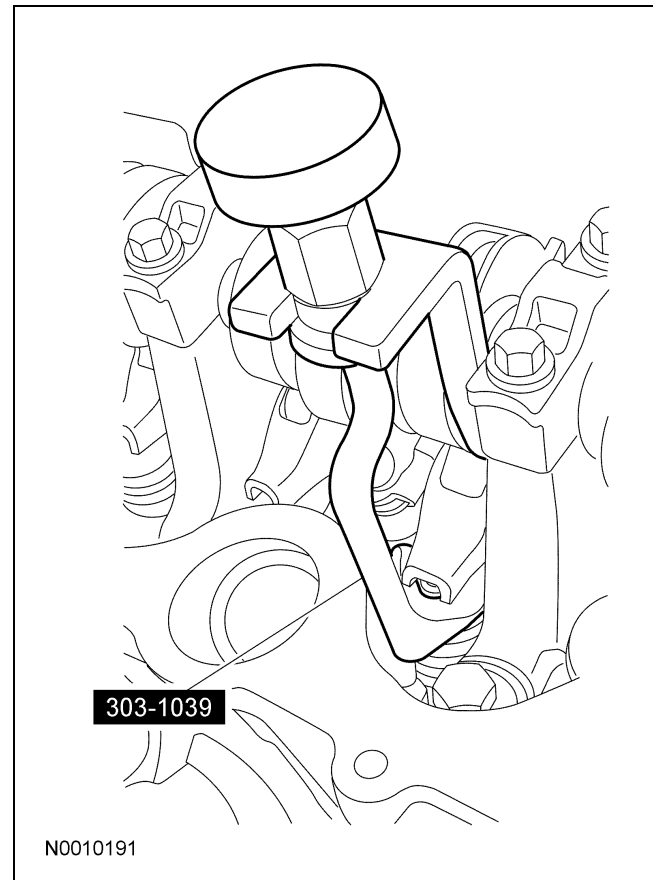


36. **NOTE:** Do not allow the valve keepers to fall off of the valve or the valve may drop into the cylinder. If a valve drops into the cylinder, the cylinder head must be removed.

NOTE: It may be necessary to push the valve down while compressing the spring.

Using the special tool, install all of the camshaft roller followers.

- Lubricate the camshaft roller followers with clean engine oil prior to installation.



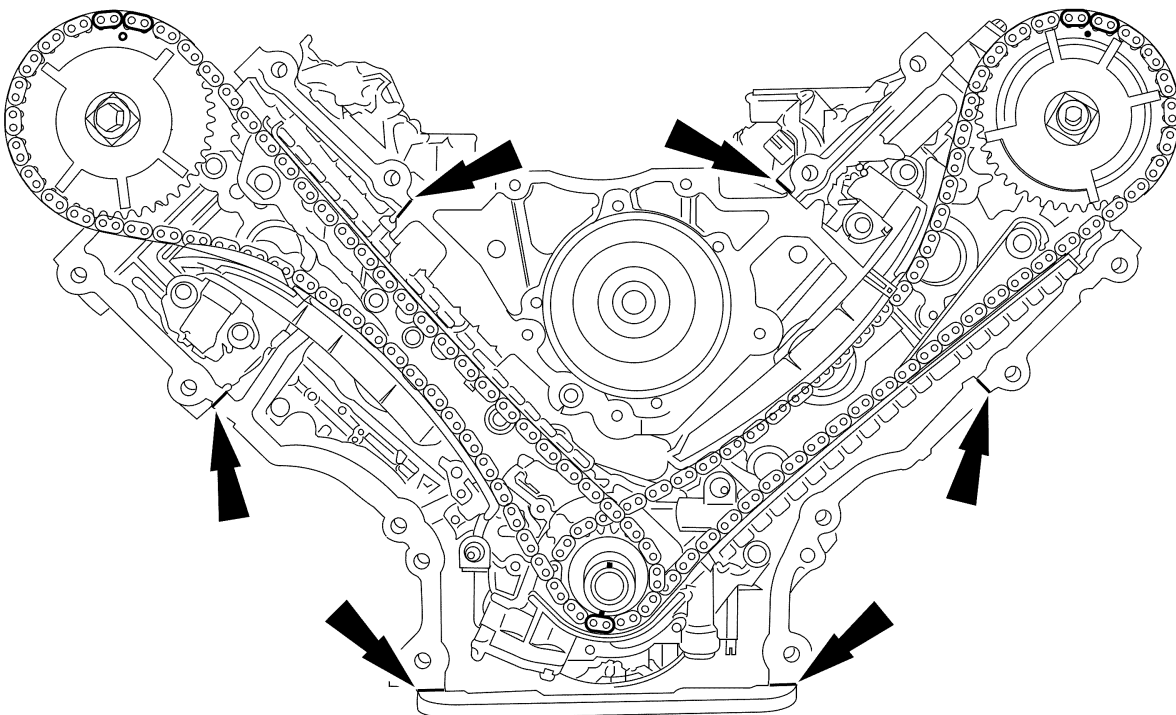
INSTALLATION (Continued)

37. ⚠ **CAUTION:** Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the sealing surfaces. These tools cause scratches and gouges which make leak paths. Use a plastic scraping tool to remove all traces of old sealant.

NOTE: If the engine front cover is not secured within 4 minutes, the sealant must be removed and the sealing area cleaned. To clean the sealing area, use Silicone Gasket Remover and Motorcraft Metal Surface Prep. Follow the directions on the packaging. Allow to dry until there is no sign of wetness, or 4 minutes, whichever is longer. Failure to follow this procedure may cause future oil leakage.

NOTE: Make sure that the engine front cover gasket is in place on the engine front cover before installation.

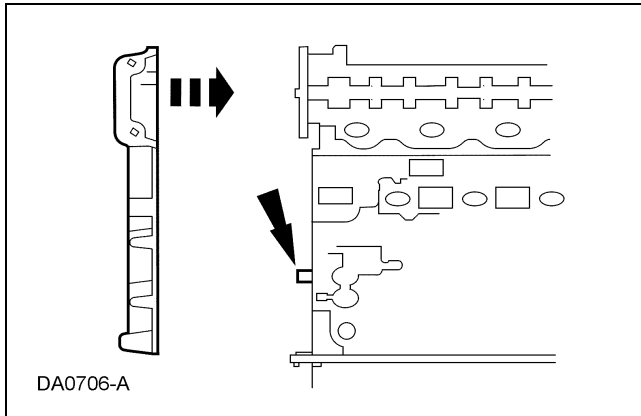
Apply a bead of Silicone Gasket and Sealant along the cylinder head-to-cylinder block surface and the oil pan-to-cylinder block surface, at the locations shown.



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INSTALLATION (Continued)

38. Install a new engine front cover gasket on the engine front cover. Position the engine front cover onto the dowels. Install the fasteners finger tight.



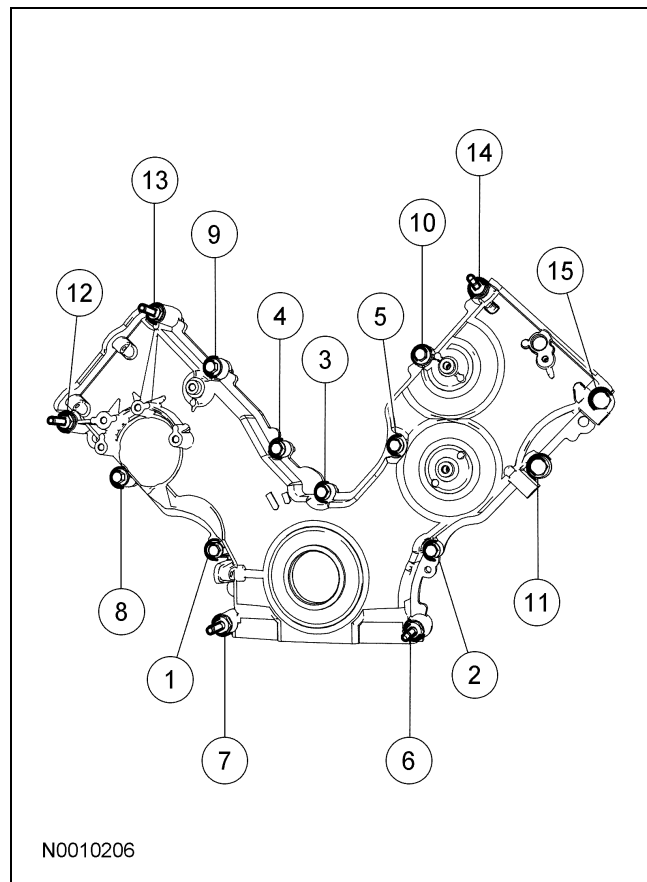
39. Tighten the engine front cover fasteners in sequence in 2 stages.

Stage 1: Tighten fasteners 1 through 15 to 25 Nm (18 lb-ft).

Stage 2: Tighten fasteners 6 and 7 to 48 Nm (35 lb-ft).

Item	Part Number	Description
1	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 50
2	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 50
3	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 50
4	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 50
5	N806177	Bolts, Hex Flange Head Pilot, M8 x 1.25 x 50
6	N808529	Stud, Hex Head Pilot, M10 x 1.5 x 1.5 x 103
7	N808529	Stud, Hex Head Pilot, M10 x 1.5 x 1.5 x 103
8	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 50

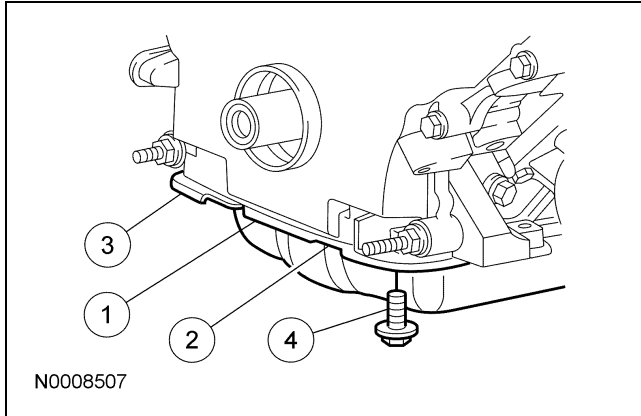
Item	Part Number	Description
9	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 50
10	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 50
11	W709573	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 50
12	W709573	Stud and Washer, Hex Head Pilot, M8 x 1.25 x 1.25 x 94
13	W709573	Stud and Washer, Hex Head Pilot, M8 x 1.25 x 1.25 x 94
14	W709573	Stud and Washer, Hex Head Pilot, M8 x 1.25 x 1.25 x 94
15	W709573	Bolt, Hex Head Pilot, M8 x 1.25 x 56



INSTALLATION (Continued)

40. Install the 4 front oil pan bolts in the sequence shown in 2 stages:

- Stage 1: Tighten to 20 Nm (15 lb-ft).
- Stage 2: Tighten an additional 60 degrees.

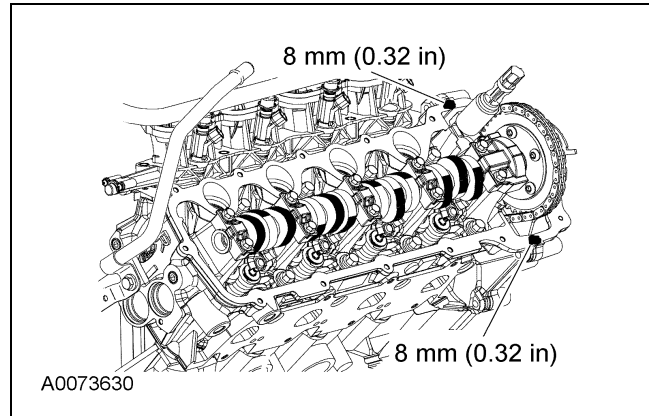


41. **CAUTION:** Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean sealing surfaces. These tools cause scratches and gouges which make leak paths. Use a plastic scraping tool to remove all traces of old sealant.

Clean the valve cover mating surface with Silicone Gasket Remover and Motorcraft Metal Surface Prep. Follow the directions on the packaging.

42. **NOTE:** If not secured within 4 minutes, the sealant must be removed and the sealing area cleaned. To clean the sealing area, use Silicone Gasket Remover and Motorcraft Metal Surface Prep. Follow the directions on the packaging. Allow to dry until there is no sign of wetness, or 4 minutes, whichever is longer. Failure to follow this procedure may cause future oil leakage.

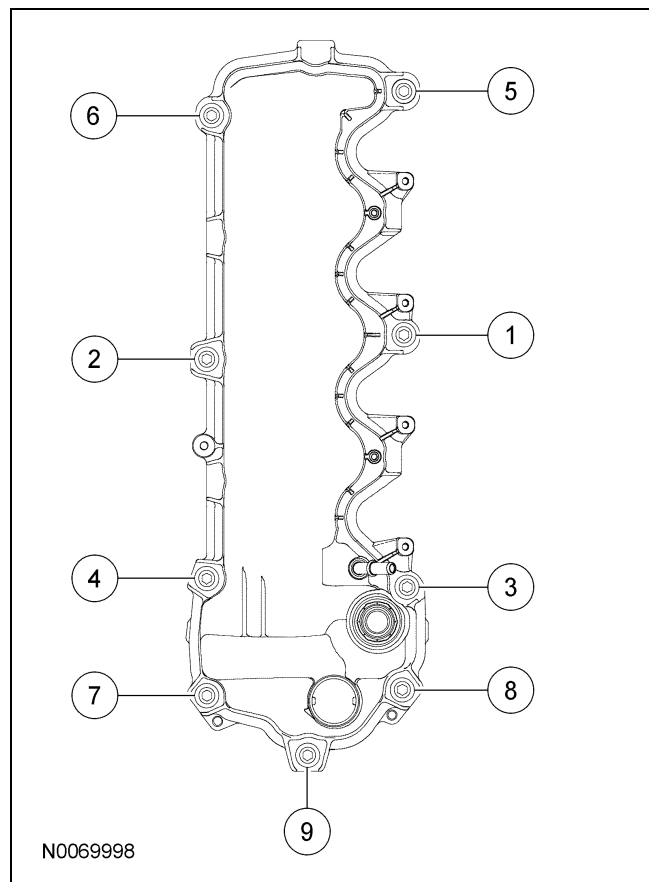
Apply Silicone Gasket and Sealant in 2 places where the engine front cover meets the cylinder head.




43. **CAUTION:** When installing the valve cover, make sure to avoid damaging the variable camshaft timing (VCT) solenoid.

Position the RH valve cover and gasket on the cylinder head and tighten the fasteners in the sequence shown.

- Tighten to 10 Nm (89 lb-in).



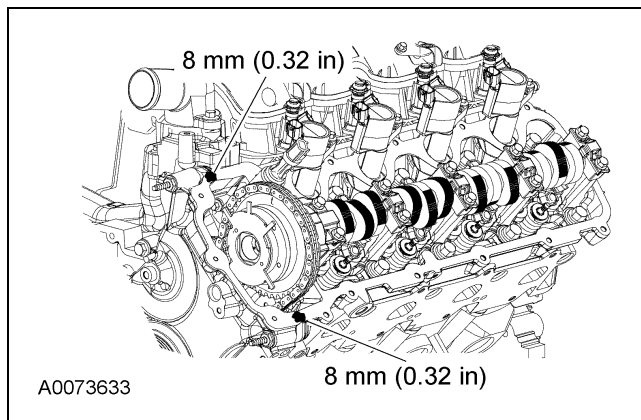
INSTALLATION (Continued)


44.  **CAUTION:** Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean sealing surfaces. These tools cause scratches and gouges which make leak paths. Use a plastic scraping tool to remove all traces of old sealant.

Clean the valve cover mating surface with Silicone Gasket Remover and Motorcraft Metal Surface Prep. Follow the directions on the packaging.

45. **NOTE:** If not secured within 4 minutes, the sealant must be removed and the sealing area cleaned. To clean the sealing area, use Silicone Gasket Remover and Motorcraft Metal Surface Prep. Follow the directions on the packaging. Allow to dry until there is no sign of wetness, or 4 minutes, whichever is longer. Failure to follow this procedure may cause future oil leakage.

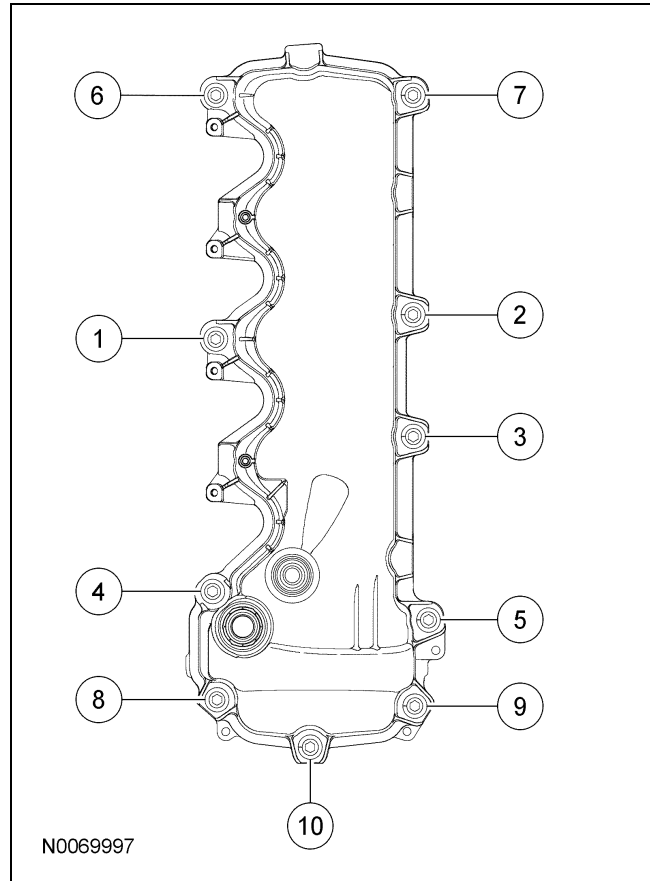
Apply Silicone Gasket and Sealant in 2 places where the engine front cover meets the cylinder head.



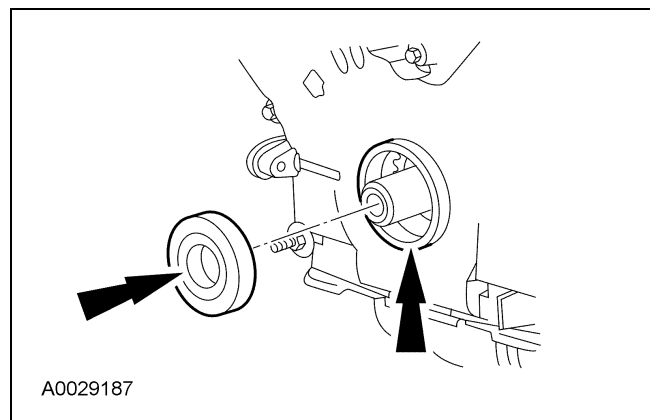
46.  **CAUTION:** When installing the valve cover, make sure to avoid damaging the variable camshaft timing (VCT) solenoid.

Position the LH valve cover and gasket on the cylinder head and tighten the fasteners in the sequence shown.

- Tighten to 10 Nm (89 lb-in).

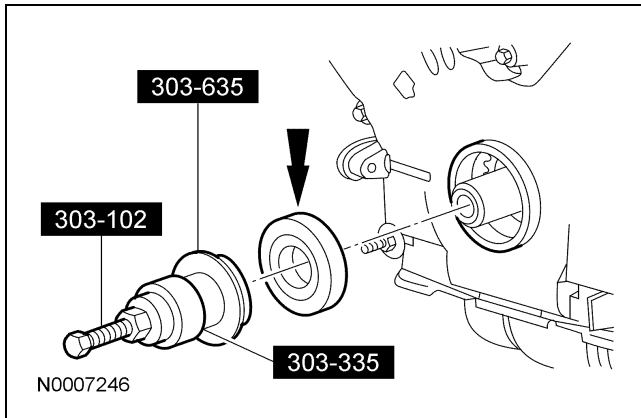


47. Lubricate the engine front cover and the crankshaft seal inner lip with clean engine oil.



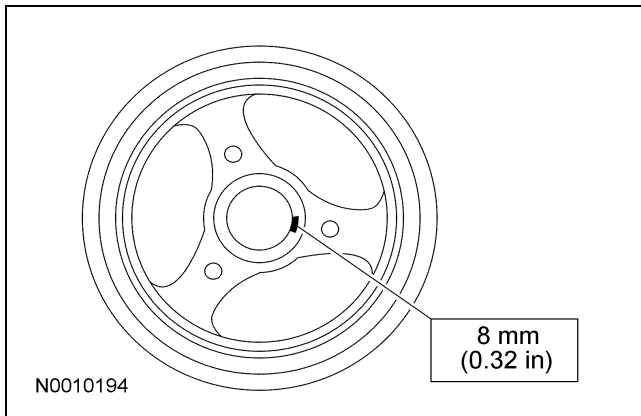
INSTALLATION (Continued)

48. Use the special tools to install a new crankshaft front seal into the engine front cover.

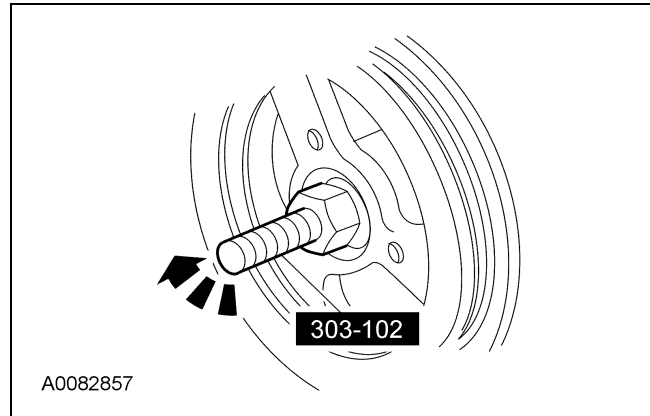


49. **NOTE:** If not secured within 4 minutes, the sealant must be removed and the sealing area cleaned. To clean the sealing area, use Silicone Gasket Remover and Motorcraft Metal Surface Prep. Follow the directions on the packaging. Allow to dry until there is no sign of wetness, or 4 minutes, whichever is longer. Failure to follow this procedure may cause future oil leakage.

Apply Silicone Gasket and Sealant to the Woodruff key slot on the crankshaft pulley.

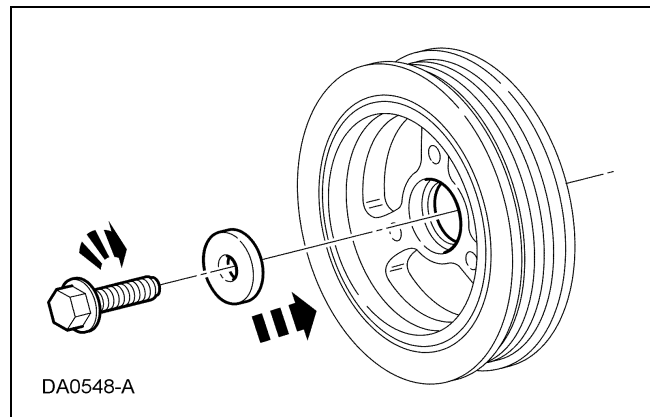


50. Use the special tool to install the crankshaft pulley.



51. Tighten the new crankshaft pulley bolt in 4 stages.

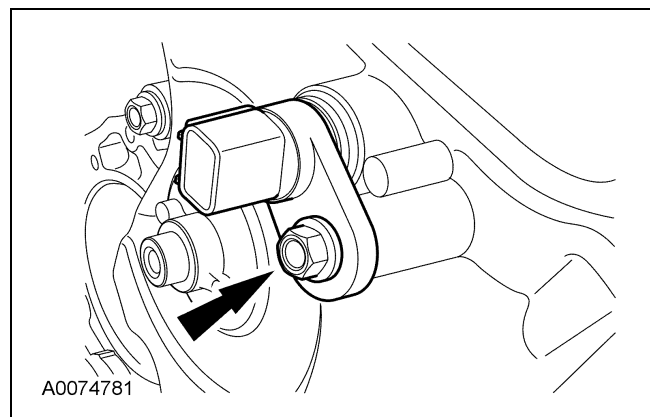
- Stage 1: Tighten to 90 Nm (66 lb-ft).
- Stage 2: Loosen 360 degrees.
- Stage 3: Tighten to 50 Nm (37 lb-ft).
- Stage 4: Tighten an additional 90 degrees.



52. **NOTE:** Lubricate the O-ring seal with clean engine oil prior to installation.

Install the LH camshaft position (CMP) sensor and the bolt.

- Tighten to 10 Nm (89 lb-in).

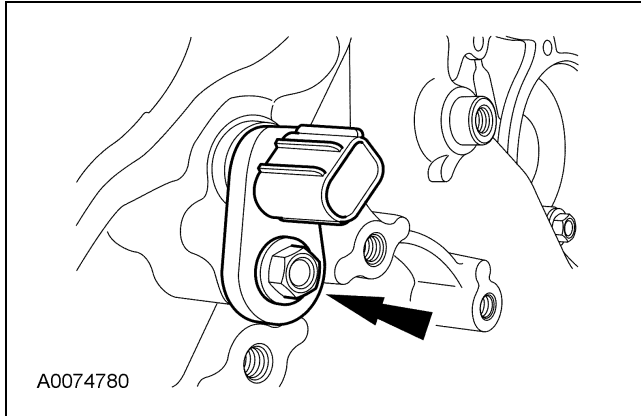


INSTALLATION (Continued)

53. **NOTE:** Lubricate the O-ring seal with clean engine oil prior to installation.

Install the RH CMP sensor and the bolt.

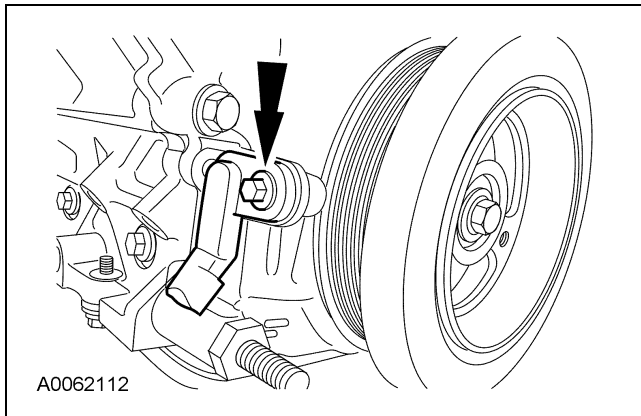
- Tighten to 10 Nm (89 lb-in).



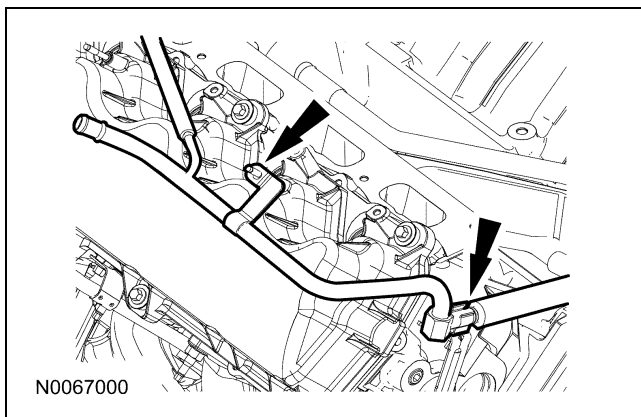
54. **NOTE:** Lubricate the O-ring seal with clean engine oil prior to installation.

Position the crankshaft position (CKP) sensor and the bolt.

- Tighten to 10 Nm (89 lb-in).

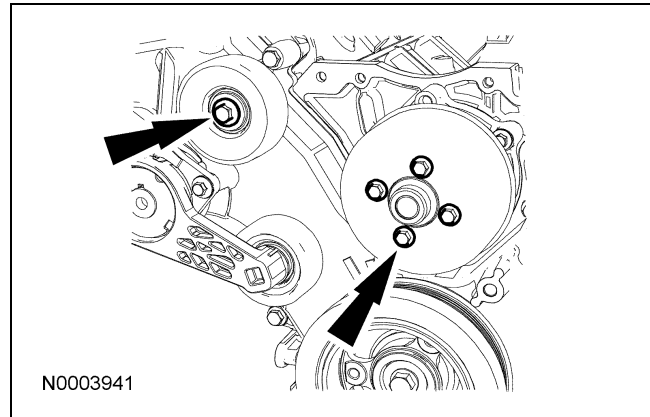


55. Connect the intake manifold vacuum tube to the valve cover stud and the support bracket.



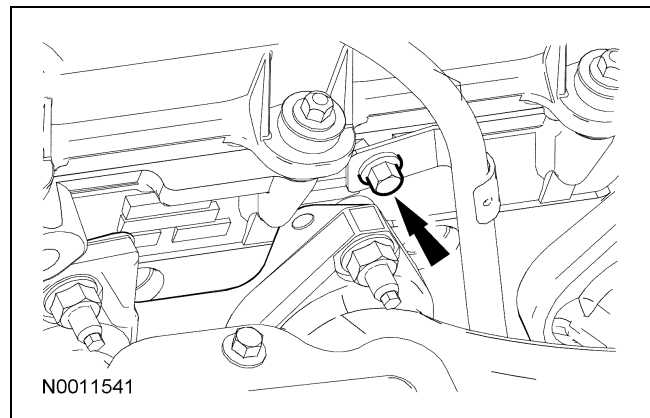
56. Install the accessory drive belt idler pulley, the coolant pump pulley and the 5 bolts.

- Tighten to 25 Nm (18 lb-ft).



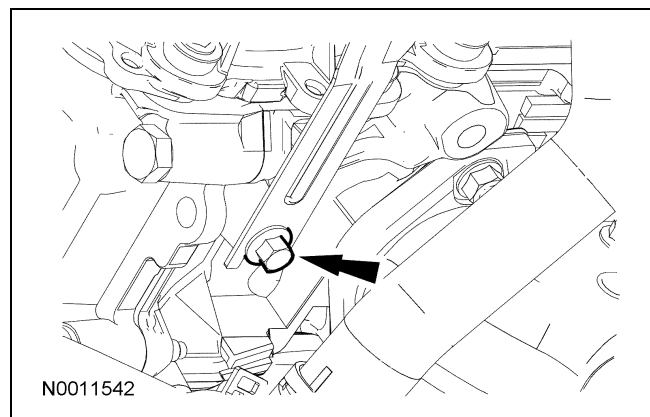
57. Position the oil level indicator and tube and install the bolt.

- Install a new O-ring seal and lubricate with clean engine oil prior to installation.
- Tighten to 10 Nm (89 lb-in).



58. Install the oil level indicator and tube front bolt.

- Tighten to 25 Nm (18 lb-ft).



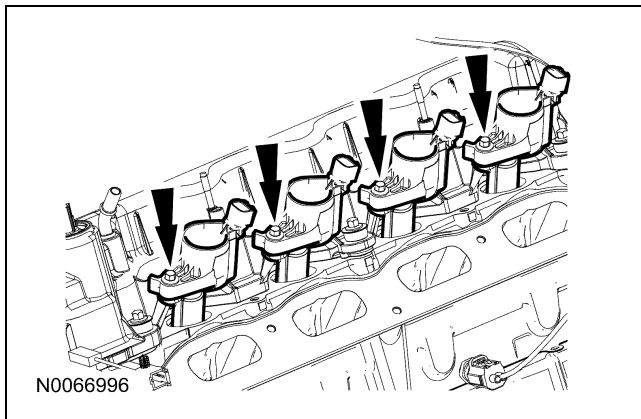
INSTALLATION (Continued)

59. **NOTE:** Verify that the ignition coil spring is correctly located inside the ignition coil boot and that there is no damage to the tip of the boot.

NOTE: LH shown, RH similar.

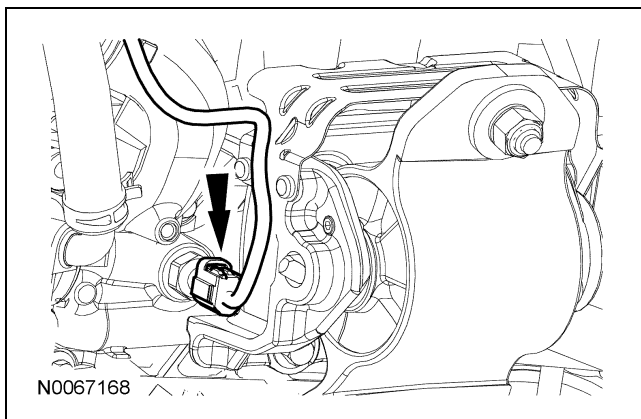
Install the 8 ignition coils and the 8 bolts.

- Apply a light coat of dielectric compound to the inside of the ignition coil boots prior to installation.
- Tighten to 6 Nm (53 lb-in).

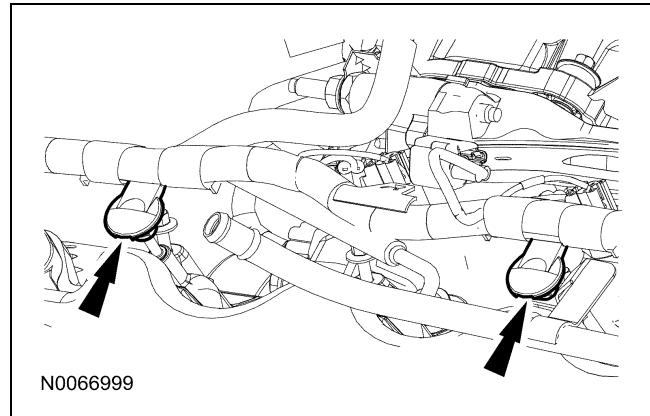


60. Position the electrical harness on the engine assembly.

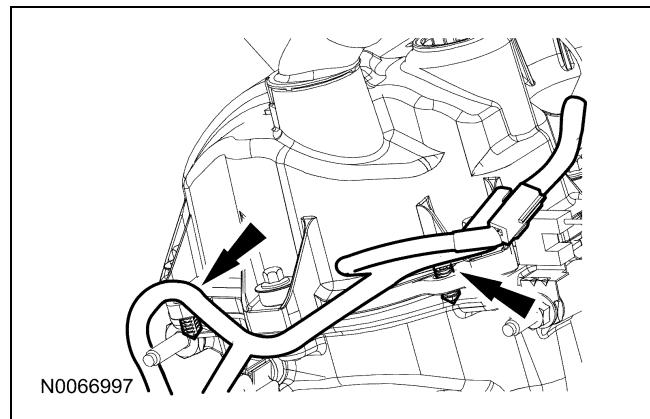
61. Connect the engine oil pressure (EOP) switch electrical connector.



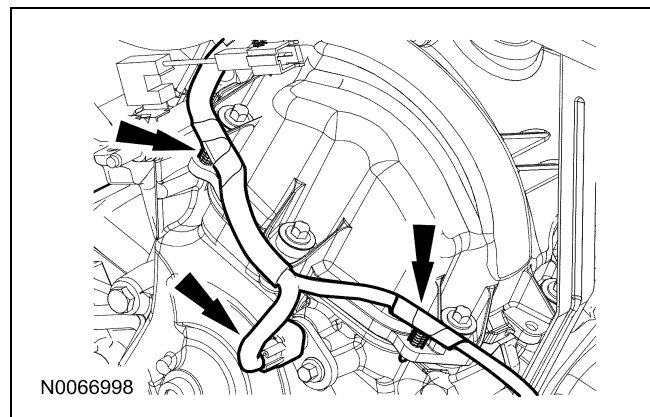
62. Connect the 2 engine wiring harness retainers to the LH valve cover studs.



63. Connect the engine wiring harness position retainers to the front of the RH valve cover.



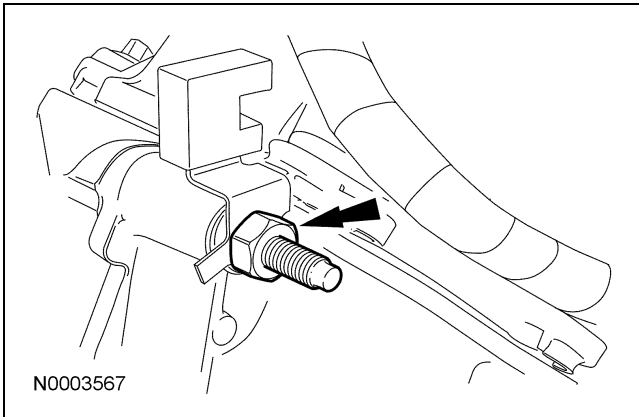
64. Connect the engine wiring harness position retainers to the front of the LH valve cover and the LH CMP sensor electrical connector.



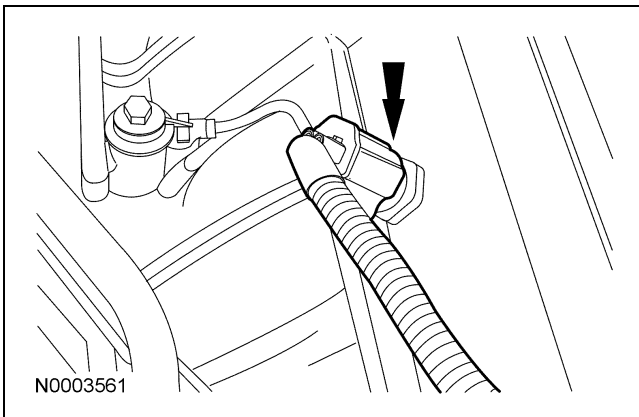
INSTALLATION (Continued)

65. Install the LH radio ignition interference capacitor and the stud bolt.

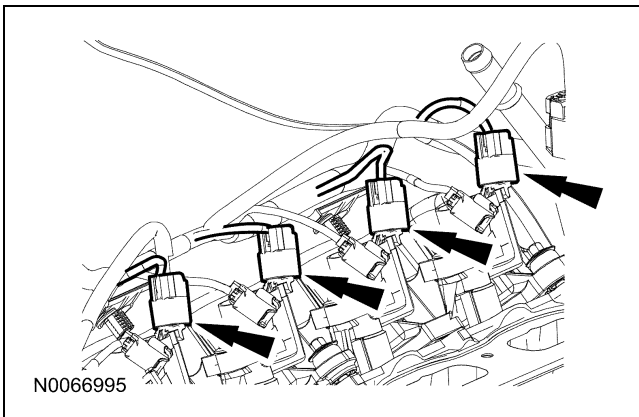
- Tighten to 25 Nm (18 lb-ft).



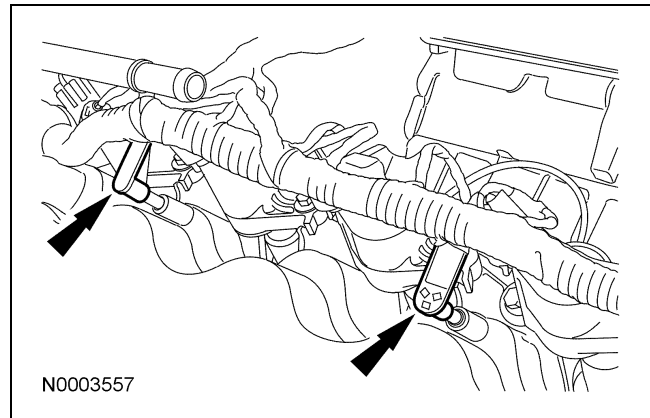
66. Connect the cylinder head temperature (CHT) sensor electrical connector.



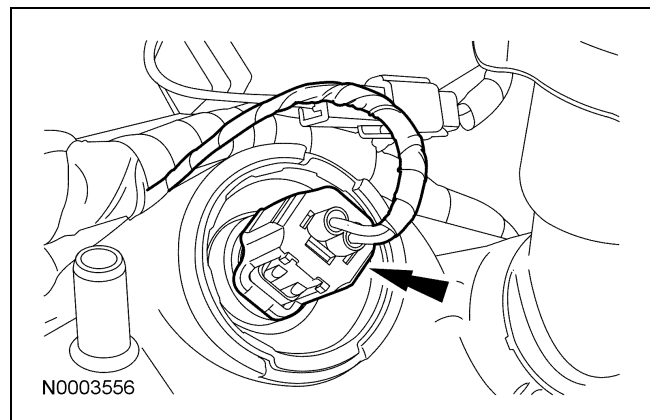
67. **NOTE:** RH shown, LH similar.
Connect the 8 ignition coil electrical connectors.



68. Connect the 2 engine wiring harness retainers from the RH valve cover studs.

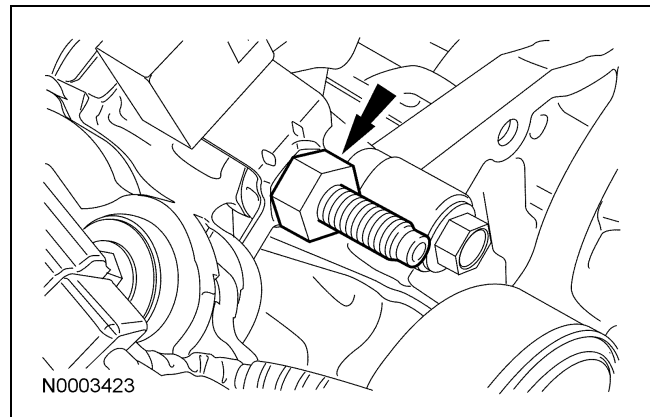


69. Connect the RH VCT solenoid electrical connector.



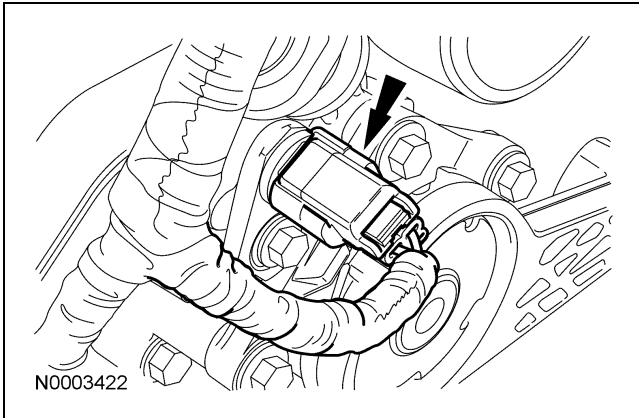
70. Install the RH radio ignition interference capacitor and the stud bolt.

- Tighten to 25 Nm (18 lb-ft).



INSTALLATION (Continued)

71. Connect the RH CMP sensor electrical connector.



72. **CAUTION:** The engine support insulator bracket bolts must be discarded and new bolts installed, or damage to the vehicle may occur. They are a tighten-to-yield design and cannot be reused.

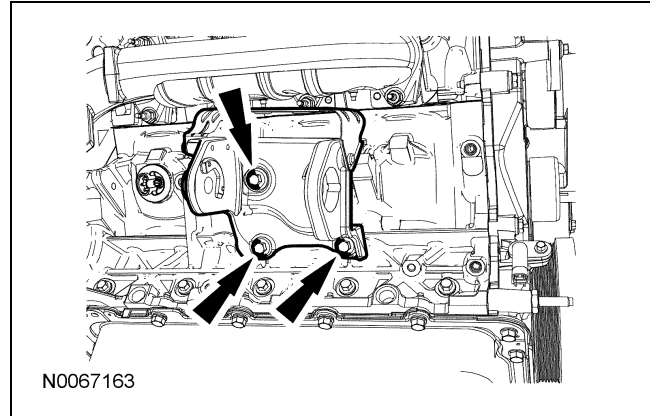
CAUTION: Clean the engine support insulator bracket mounting surfaces of any dirt or foreign material prior to installation. Failure to follow these instructions may result in engine support insulator damage.

NOTE: The engine support insulator bracket bolts must not be tightened more than 90 degrees after initial torque.

NOTE: Place a visible mark on the engine support insulator bracket and the bracket bolts. Turning the bolt 1 flat of the bolt head is equal to 60 degrees.

Position the RH engine support insulator bracket, position the engine support insulator bracket and install 3 new bolts in 2 stages.

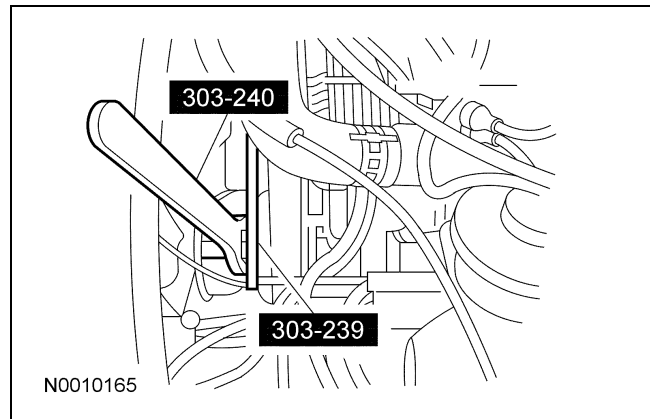
- Stage 1: Tighten to 30 Nm (22 lb-ft).
- Stage 2: Tighten an additional minimum of 60 degrees.



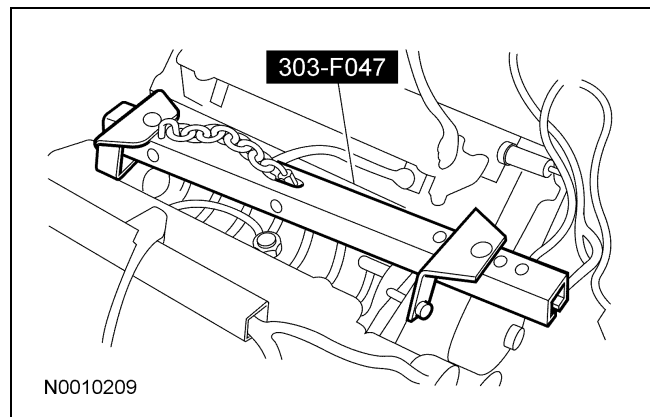
73. **NOTE:** The large clutch assembly nut has a RH thread and must be rotated clockwise to remove it.

Using the special tool, install the engine cooling fan onto the coolant pump pulley.

- Tighten to 55 Nm (41 lb-ft).



74. Install the special tool.



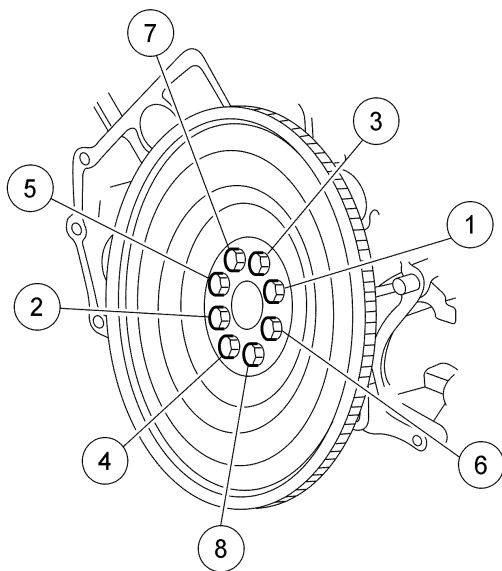
75. Using a suitable floor crane, remove the engine from the engine stand.

INSTALLATION (Continued)

76. Install the flexplate or flywheel and the 8 bolts in the sequence shown.

- Tighten to 80 Nm (59 lb-ft).

77. Install the engine. For additional information, refer to Engine in this section.

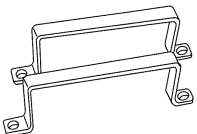
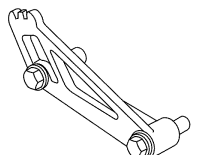
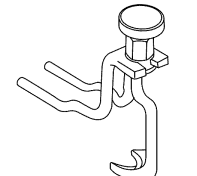
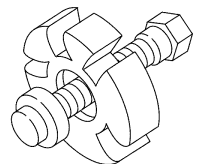
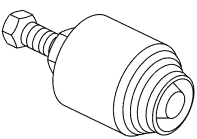
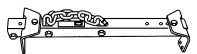


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REMOVAL


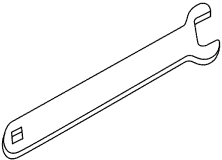
Cylinder Head

Special Tool(s)

 <p>ST1668-A</p>	Remover/Installer, Cylinder Head 303-572 (T97T-6000-A)
 <p>ST2807-A</p>	Locking Tool, Camshaft Phaser Sprocket 303-1046
 <p>ST2804-A</p>	Compressor, Valve Spring 303-1039
 <p>ST1286-A</p>	Remover, Crankshaft Vibration Damper 303-009 (T58P-6316-D)
 <p>ST1730-A</p>	Remover, Crankshaft Front Seal 303-107 (T74P-6700-A)
 <p>ST1377-A</p>	Modular Engine Lift Bracket 303-F047 (014-00073) or equivalent

(Continued)

Special Tool(s)

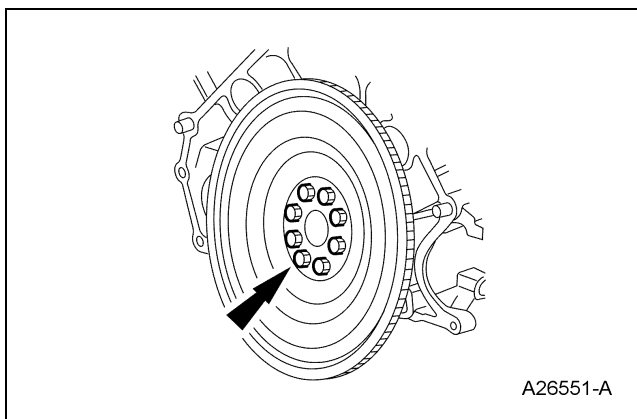
 <p>ST1499-A</p>	Fan Pulley Holding Wrench 303-239 (T84T-6312-C)
 <p>ST1500-A</p>	Fan Clutch Nut Wrench 303-240 (T84T-6312-D)

Material

Item	Specification
Metal Surface Prep ZC-31	—
Silicone Gasket Remover ZC-30	—

All cylinder heads

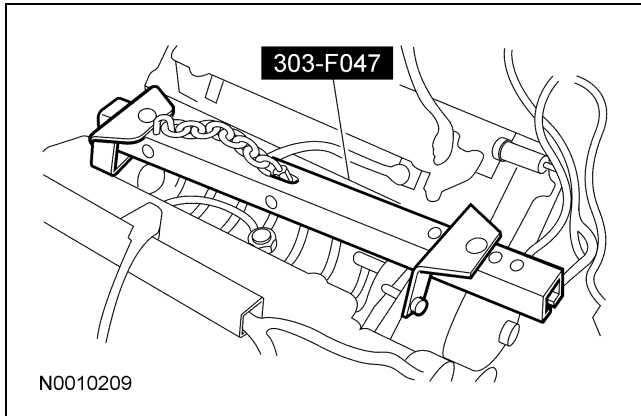
1. Remove the engine. For additional information, refer to Engine in this section.
2. **NOTE:** Flexplate shown, flywheel similar.
Remove the bolts and the flexplate or flywheel.



3. Install the engine onto a suitable engine stand.

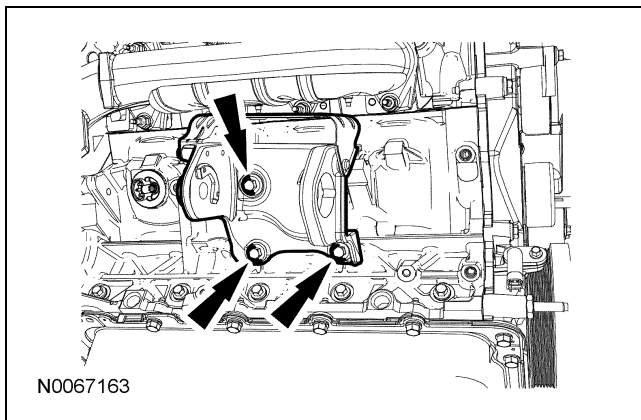
REMOVAL (Continued)

4. Remove the special tool.



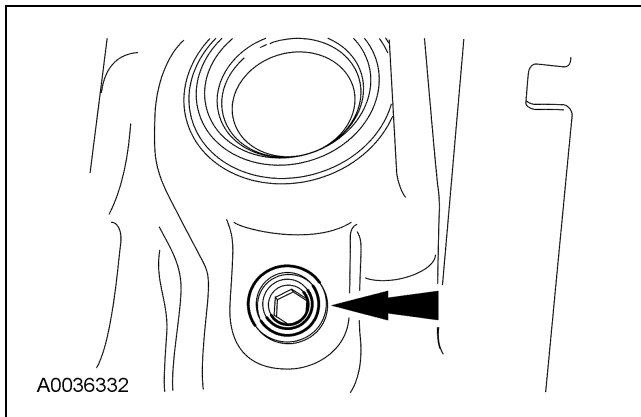
5. Remove the 3 bolts and the RH engine support insulator bracket.

- Discard the bolts.



6. **NOTE:** LH shown, RH similar.

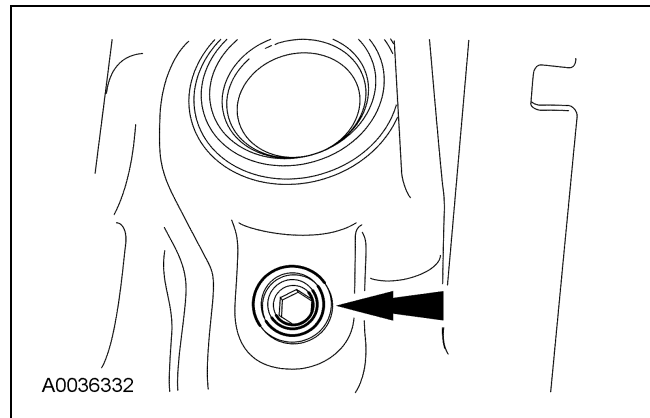
Remove the cylinder block drain plugs and drain the coolant into a suitable container.



7. **NOTE:** LH shown, RH similar.

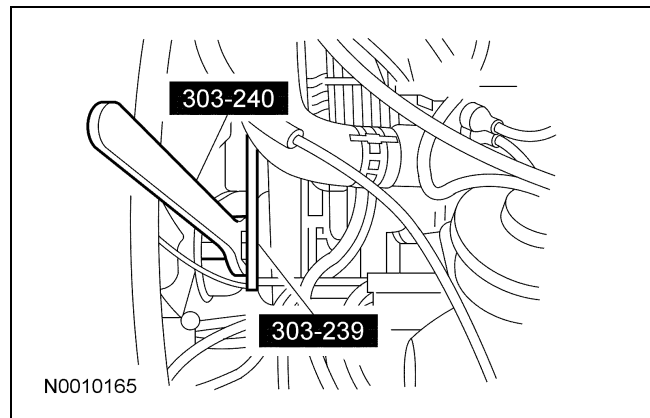
Install the cylinder block drain plugs.

- Tighten to 24 Nm (18 lb-ft).

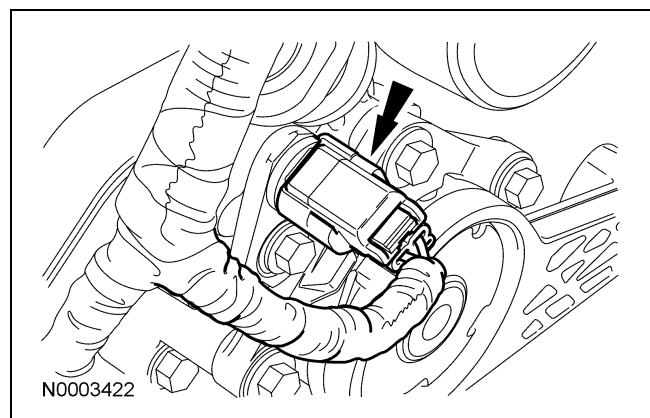


8. **NOTE:** The large clutch assembly nut has a RH thread and must be rotated counterclockwise to remove it.

Using the special tools, remove the engine cooling fan from the coolant pump pulley.

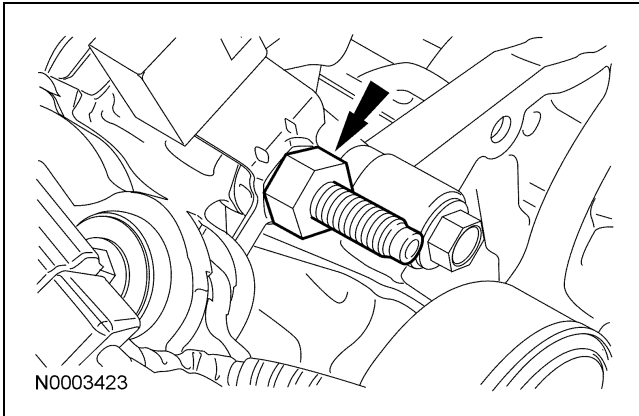


9. Disconnect the RH camshaft position (CMP) sensor electrical connector.

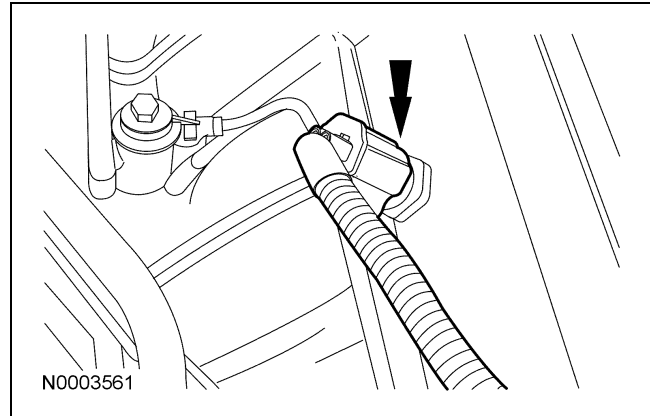


REMOVAL (Continued)

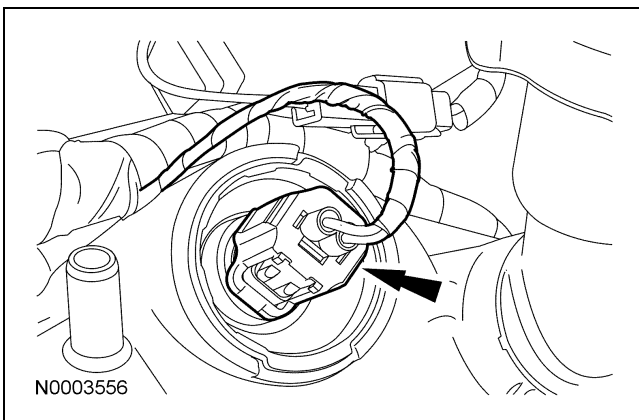
10. Remove the stud bolt and the RH radio ignition interference capacitor.



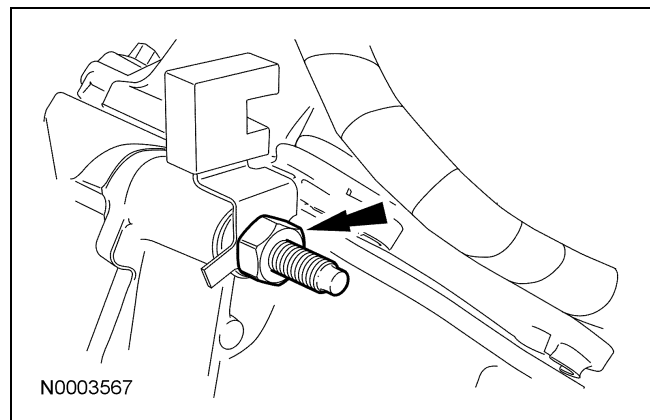
13. Disconnect the cylinder head temperature (CHT) sensor electrical connector.



11. Disconnect the RH variable camshaft timing (VCT) solenoid electrical connector.

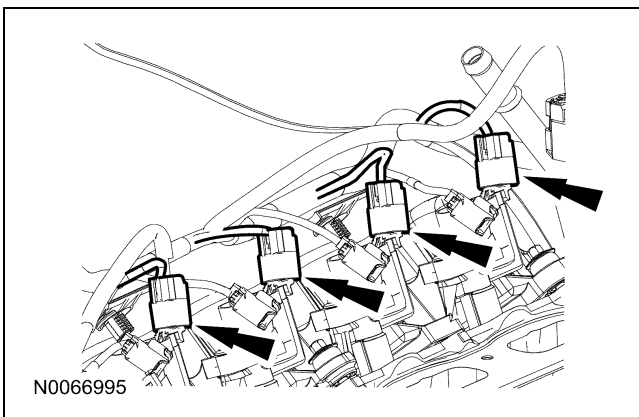


14. Remove the stud bolt and the LH radio ignition interference capacitor.

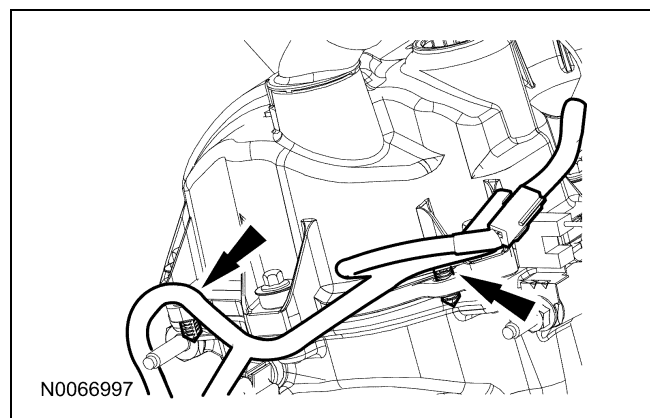


12. **NOTE:** RH shown, LH similar.

Disconnect the 8 ignition coil electrical connectors.

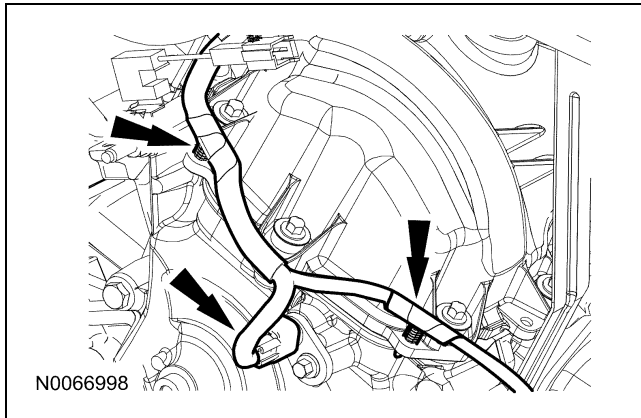


15. Disconnect the engine wiring harness position retainers from the front of the RH valve cover.

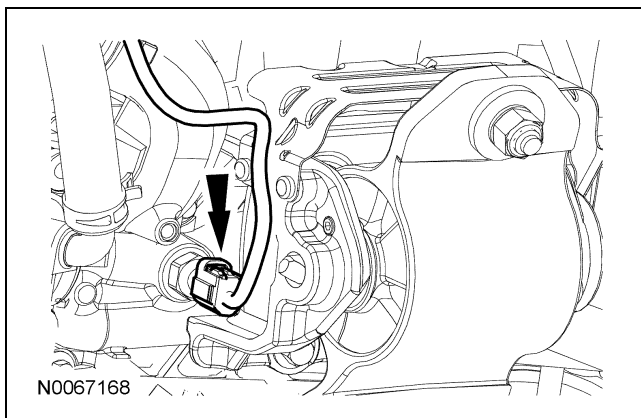


REMOVAL (Continued)

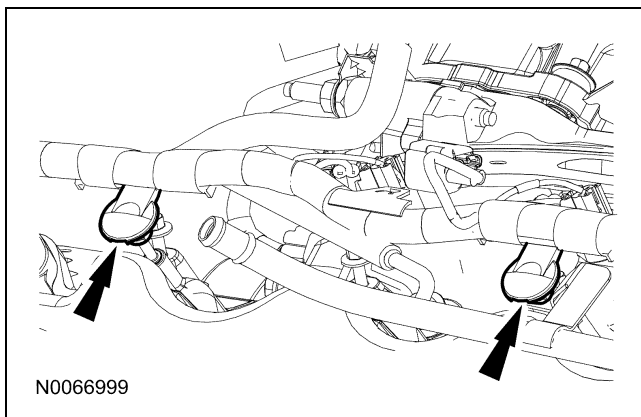
16. Disconnect the engine wiring harness position retainers from the front of the LH valve cover and the LH CMP sensor electrical connector.



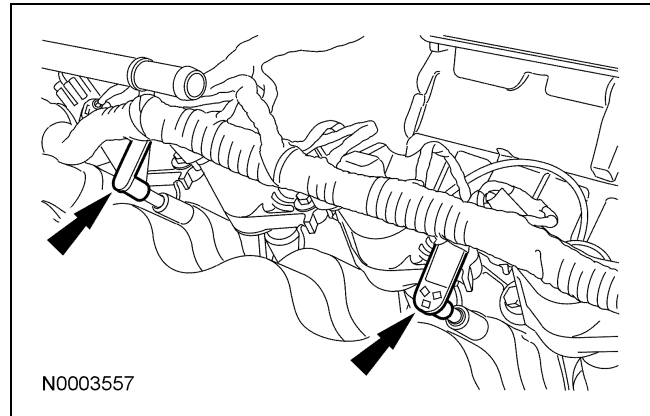
17. Disconnect the engine oil pressure (EOP) switch electrical connector.



18. Disconnect the 2 engine wiring harness retainers from the LH valve cover studs.



19. Disconnect the 2 engine wiring harness retainers from the RH valve cover studs.

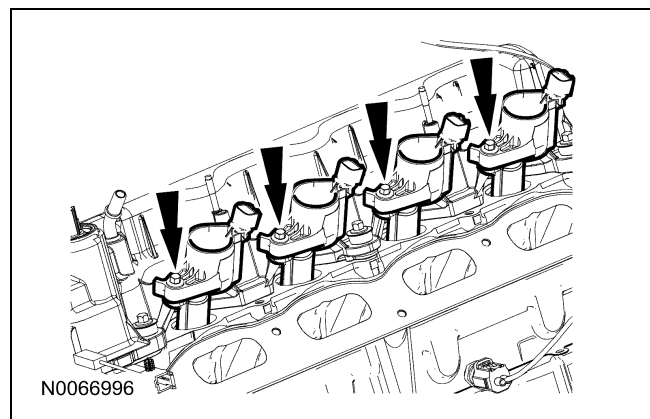


20. Remove the engine wiring harness from the engine assembly.

21. **NOTE:** RH shown, LH similar.

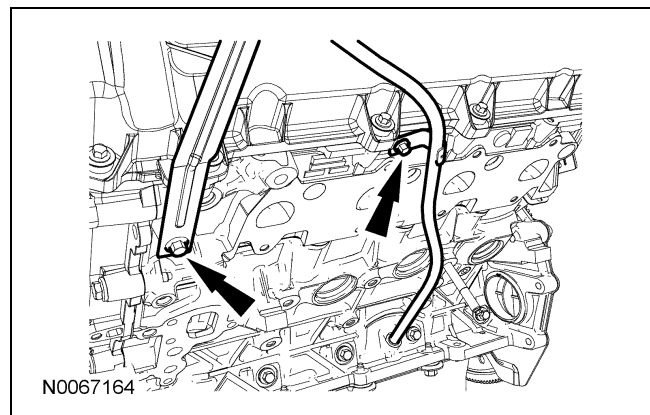
Remove the 8 bolts and the 8 ignition coils.

- Remove the ignition coil, using a twisting motion while pulling up on the ignition coil.



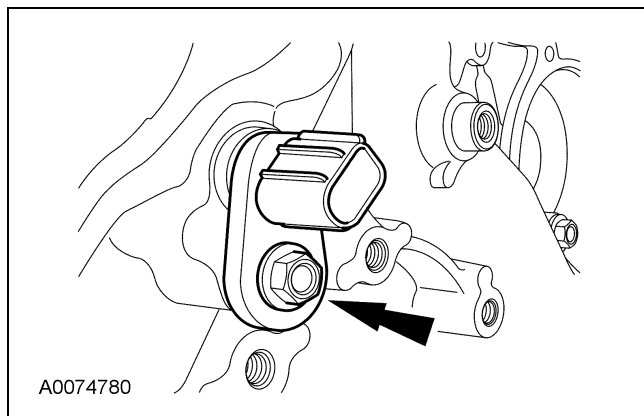
22. Remove the 2 bolts and the oil level indicator tube.

- Discard the O-ring seal.

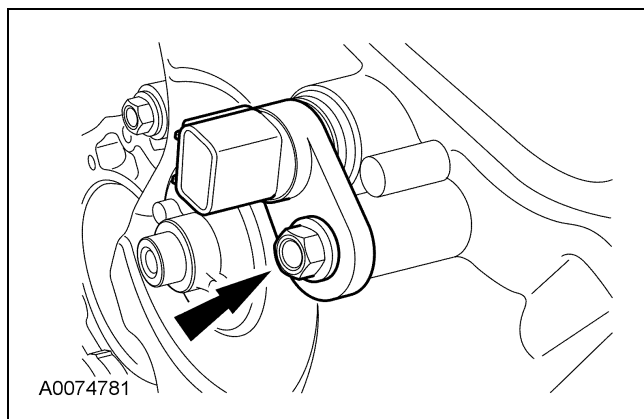


REMOVAL (Continued)

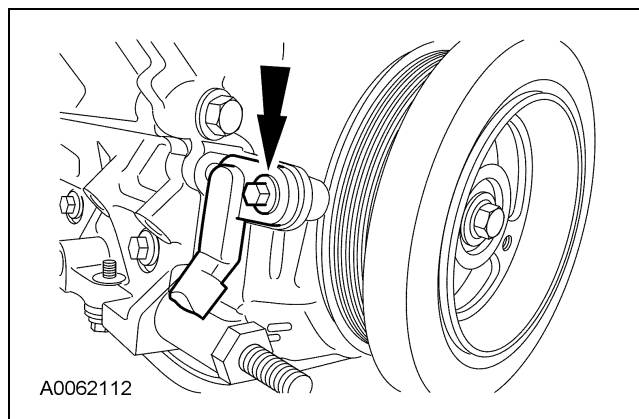
23. Remove the bolt and the RH CMP sensor.



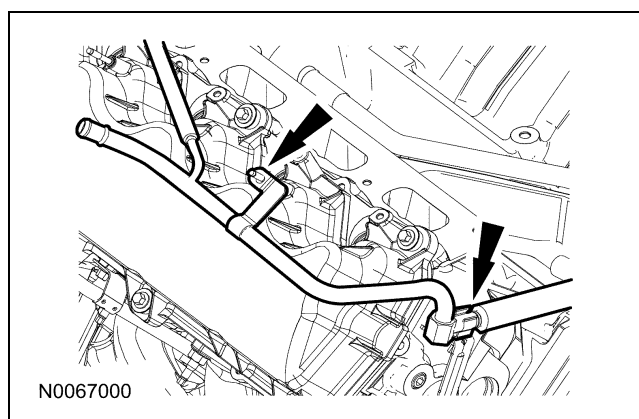
24. Remove the bolt and the LH CMP sensor.




25. Remove the bolt and the CKP sensor.




26. Disconnect the intake manifold vacuum tube from the valve cover stud and the support bracket.



REMOVAL (Continued)

27.  **CAUTION:** Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the sealing surfaces. These tools cause scratches and gouges, which make leak paths. Use a plastic scraping tool to remove all traces of old sealant. Failure to follow this procedure can cause future oil leakage.

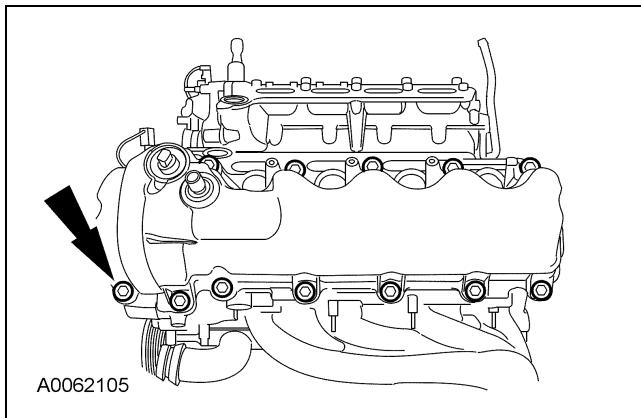
 **CAUTION:** When removing the valve cover, make sure to avoid damaging the variable camshaft timing (VCT) solenoid.

NOTE: The fasteners are part of the valve cover and should not be removed.

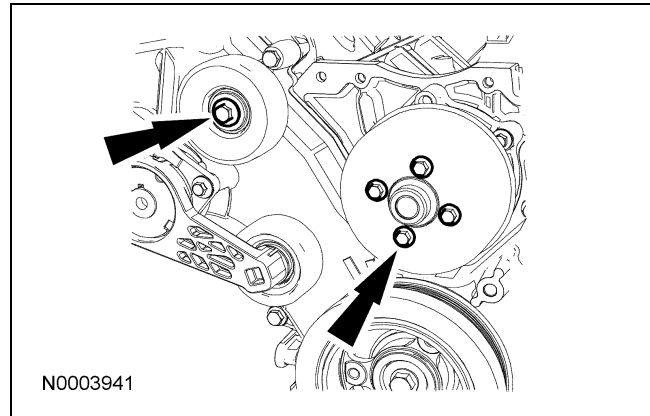
NOTE: LH shown, RH similar.

Remove the valve covers.

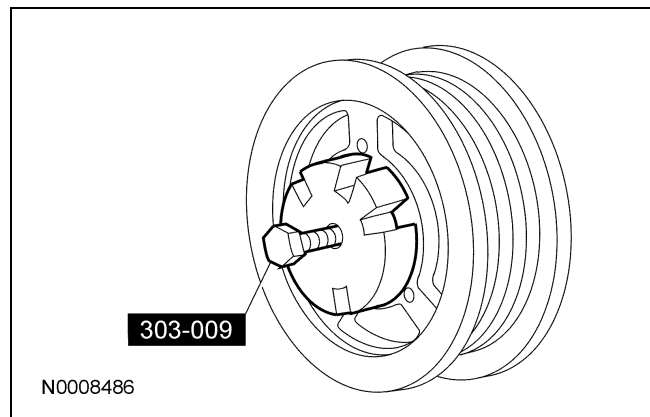
- Fully loosen the fasteners and remove the valve covers.
- Clean the valve cover mating surface of the cylinder head with Silicone Gasket Remover and Motorcraft Metal Surface Prep. Follow the directions on the packaging.
- Inspect the valve cover gasket. If the gasket is damaged, remove and discard the gasket. Clean the valve cover gasket groove with soap and water or a suitable solvent.



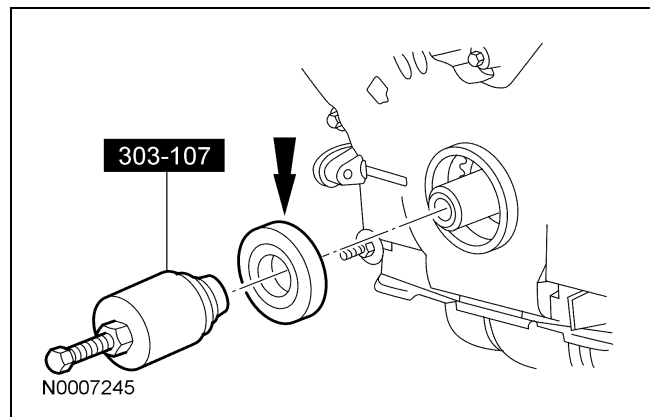
28. Remove the bolts, coolant pump pulley and accessory drive belt idler pulley.



29. Remove and discard the crankshaft pulley bolt. Using the special tool, remove the crankshaft pulley.

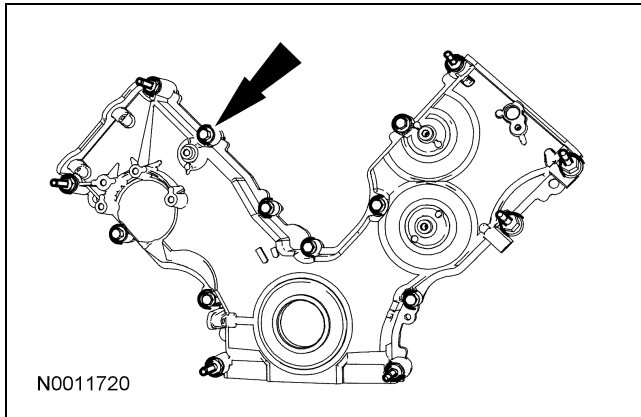


30. Using the special tool, remove and discard the crankshaft front seal.

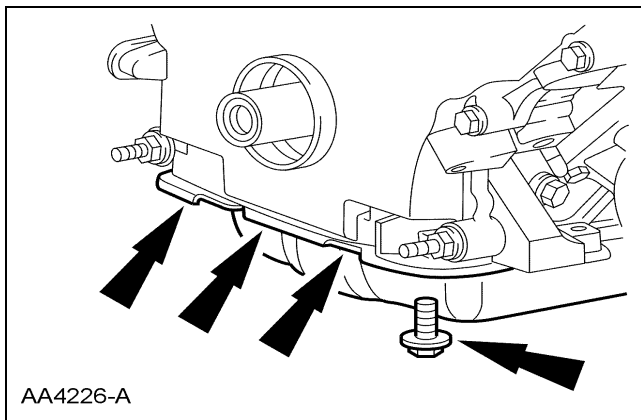


REMOVAL (Continued)

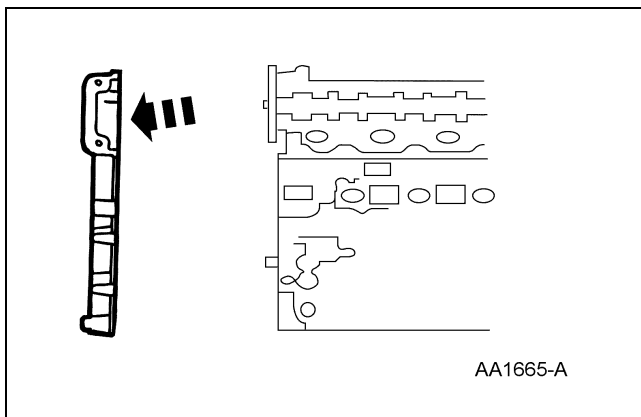
31. **NOTE:** Correct fastener location is essential for assembly procedure. Record fastener location.
Remove the fasteners.



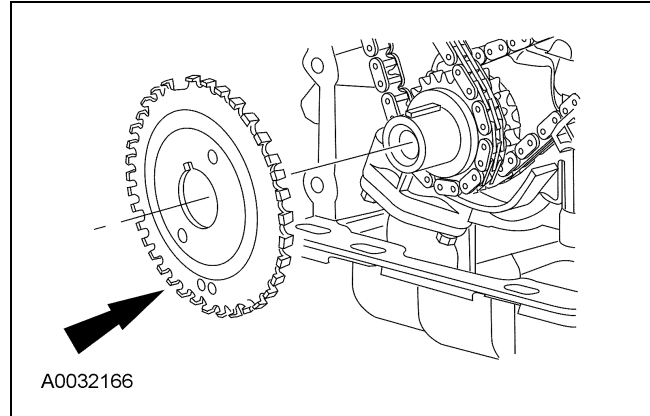
32. Remove the 4 front oil pan bolts.



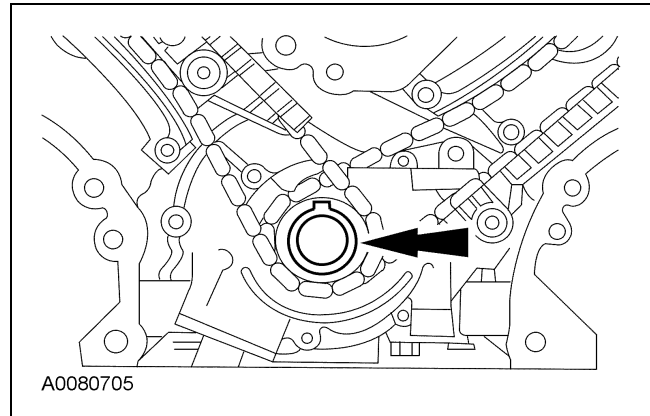
33. Remove the engine front cover from the cylinder block.



34. Remove the crankshaft sensor ring from the crankshaft.

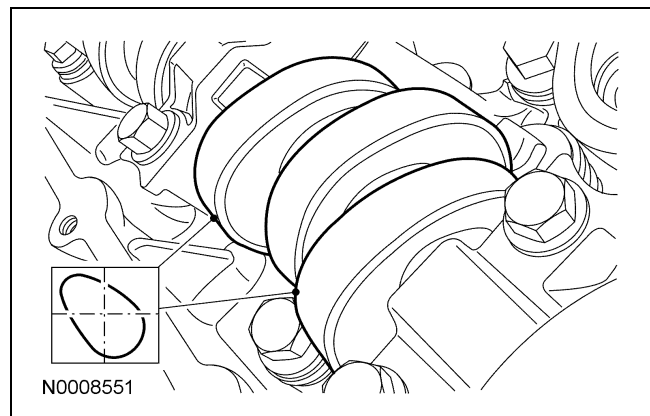


35. Position the crankshaft keyway at the 12 o'clock position.




36. **NOTE:** If the camshaft lobes are not exactly positioned as shown, the crankshaft will require one full additional rotation to 12 o'clock.

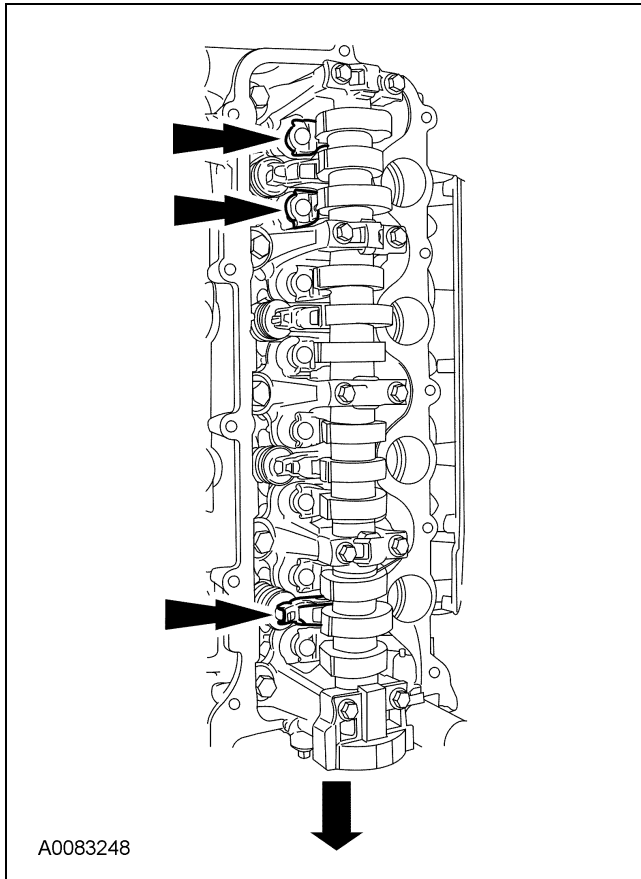
The No. 1 cylinder camshaft exhaust lobe must be coming up on the exhaust stroke. Verify by noting the position of the 2 intake camshaft lobes and the exhaust lobe on the No. 1 cylinder.



REMOVAL (Continued)

37.  **CAUTION:** If the components are to be reinstalled, they must be installed in the same positions. Mark the components for installation into the original locations. Failure to follow these instructions may result in engine damage.

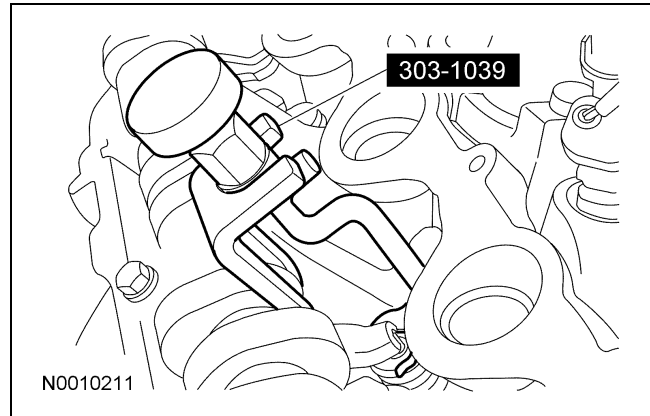
Remove only the 3 camshaft roller followers shown in the illustration from the RH cylinder head.




38. **NOTE:** Do not allow the valve keepers to fall off of the valve or the valve may drop into the cylinder. If a valve drops into the cylinder, the cylinder head must be removed.

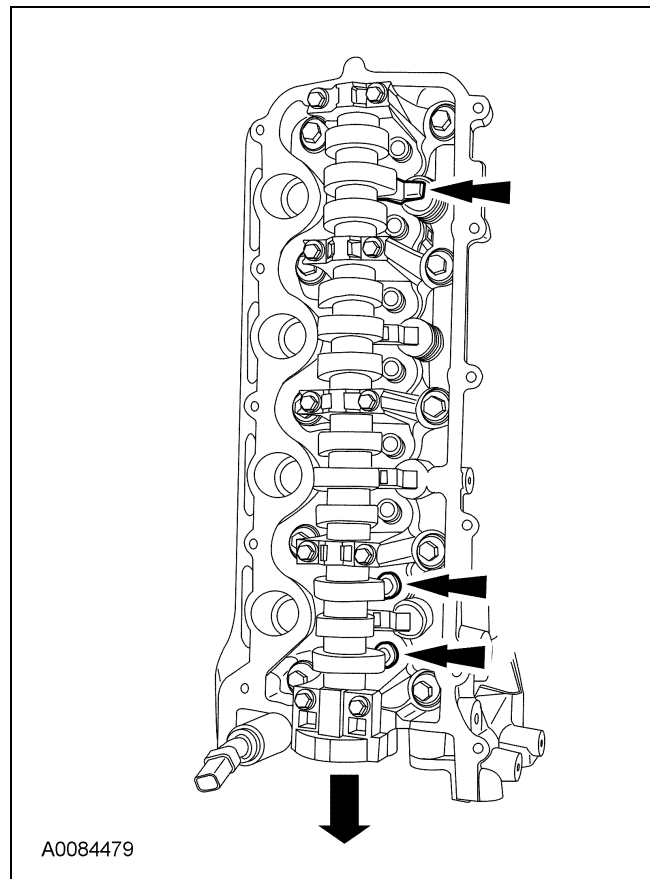
NOTE: It may be necessary to push the valve down while compressing the spring.

Using the special tool, remove the 3 camshaft roller followers designated in the previous step from the RH cylinder head.



39.  **CAUTION:** If the components are to be reinstalled, they must be installed in the same positions. Mark the components for installation into the original locations. Failure to follow these instructions may result in engine damage.

Remove only the 3 camshaft roller followers shown in the illustration from the LH cylinder head.

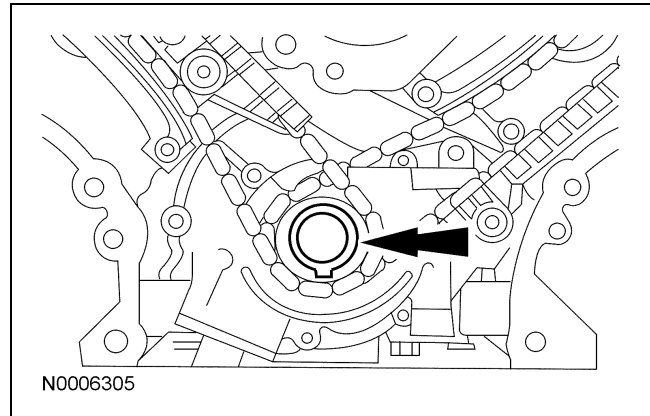
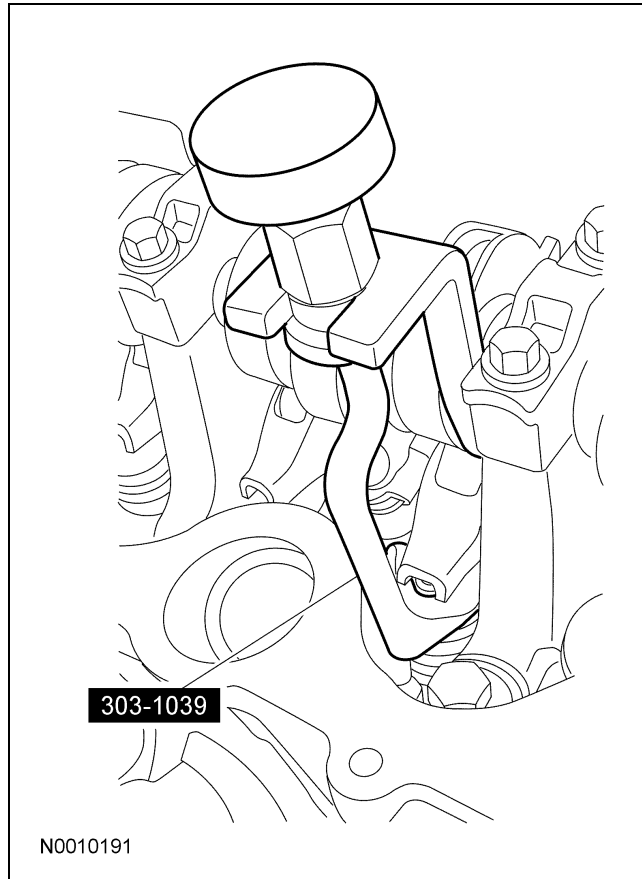


REMOVAL (Continued)

40. **NOTE:** Do not allow the valve keepers to fall off of the valve or the valve may drop into the cylinder. If a valve drops into the cylinder, the cylinder head must be removed.

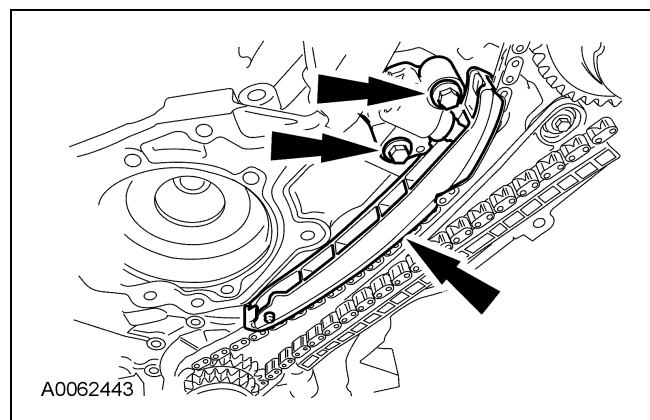
NOTE: It may be necessary to push the valve down while compressing the spring.

Using the special tool, remove the 3 camshaft roller followers designated in the previous step from the LH cylinder head.



42. **CAUTION:** If one or both of the tensioner mounting bolts are loosened or removed, the tensioner-sealing bead must be inspected for seal integrity. If cracks, tears, separation from the tensioner body or permanent compression of the seal bead is observed, install a new tensioner or engine damage may occur.


Remove the bolts, the LH timing chain tensioner and tensioner arm.



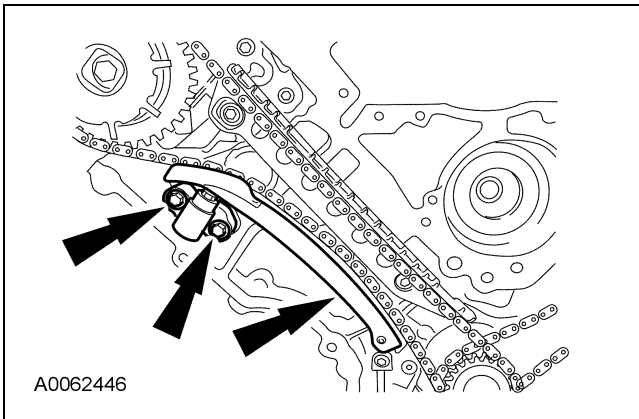
41. **CAUTION:** The crankshaft cannot be moved past the 6 o'clock position once set or engine damage may occur.

Rotate the crankshaft clockwise and position the crankshaft keyway at the 6 o'clock position.

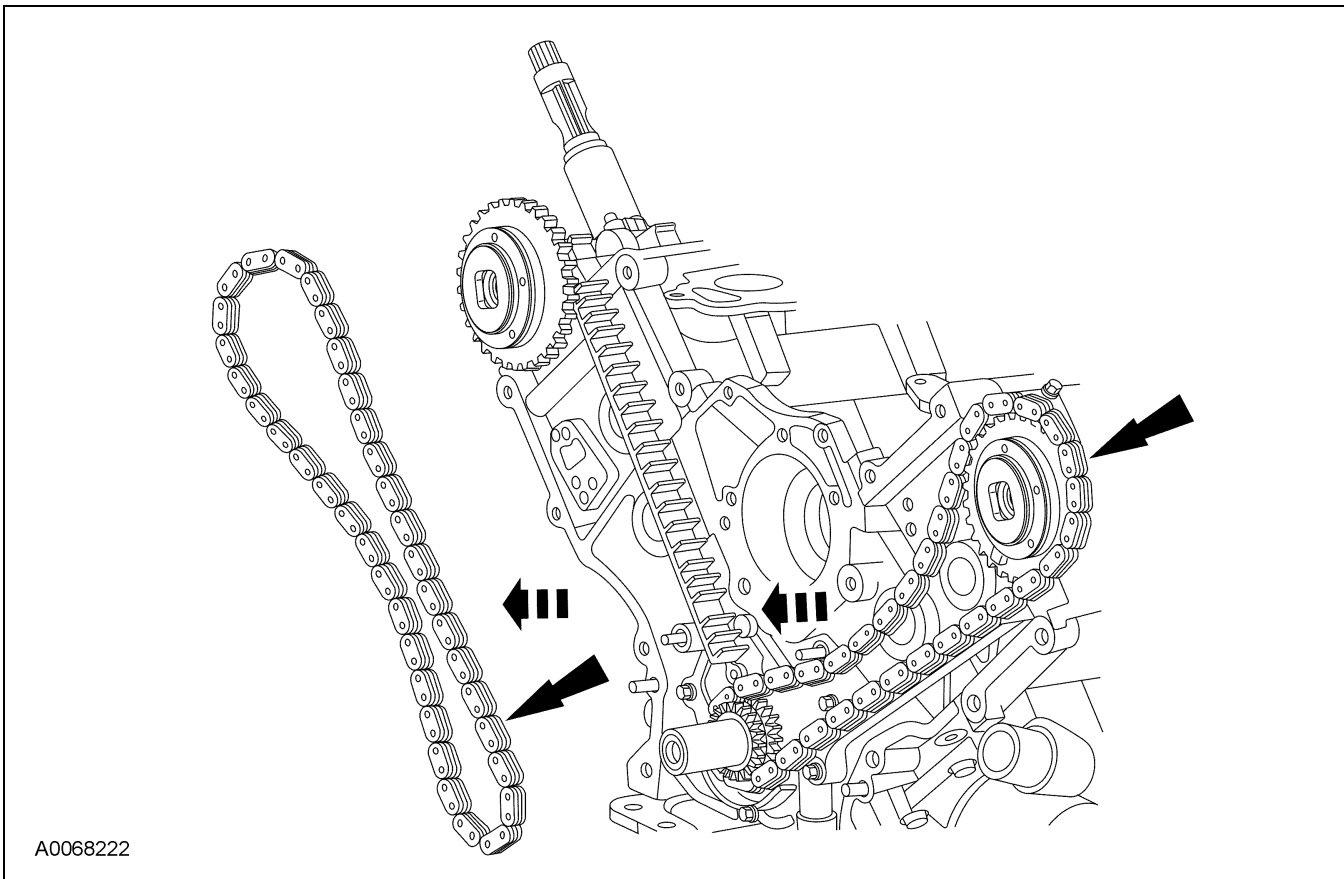
REMOVAL (Continued)

43.  **CAUTION:** If one or both of the tensioner mounting bolts are loosened or removed, the tensioner-sealing bead must be inspected for seal integrity. If cracks, tears, separation from the tensioner body or permanent compression of the seal bead is observed, install a new tensioner or engine damage may occur.

Remove the bolts, the RH timing chain tensioner and tensioner arm.



44. Remove the RH and LH timing chains and the crankshaft sprocket.
- Remove the RH timing chain from the camshaft sprocket.
 - Remove the RH timing chain from the crankshaft sprocket.
 - Remove the LH timing chain from the camshaft sprocket.
 - Remove the LH timing chain and crankshaft sprocket.

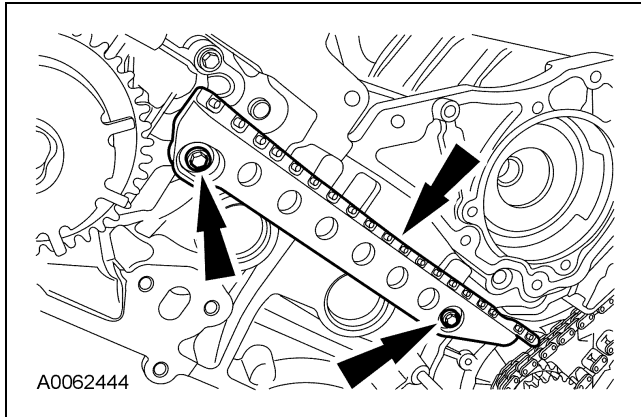


REMOVAL (Continued)

45. **NOTE:** RH shown, LH similar.

Remove the LH and RH timing chain guides.

- Remove the bolts.
- Remove both timing chain guides.

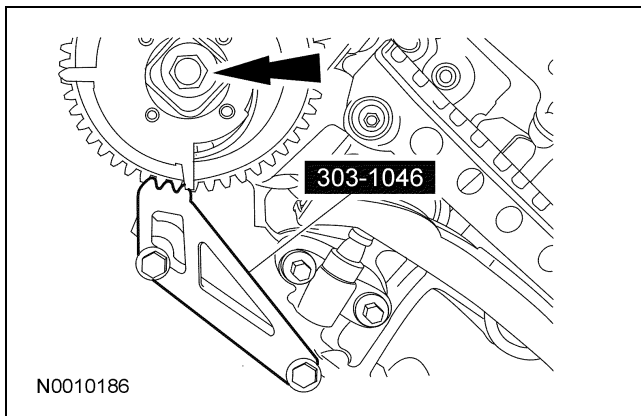


46. **CAUTION:** Damage to the variable camshaft timing (VCT) phaser sprocket assembly will occur if mishandled or used as a lifting or leveraging device.

CAUTION: Only use hand tools to remove the variable camshaft timing (VCT) phaser sprocket assembly or damage may occur to the camshaft or VCT phaser sprocket.

Using the special tool, remove the bolt and the RH VCT phaser sprocket assembly.

- Discard the VCT phaser sprocket bolt.

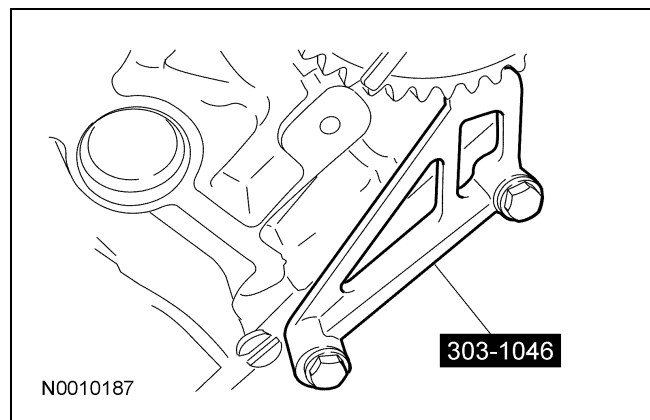


47. **CAUTION:** Damage to the variable camshaft timing (VCT) phaser sprocket assembly will occur if mishandled or used as a lifting or leveraging device.

CAUTION: Only use hand tools to remove the variable camshaft timing (VCT) phaser sprocket assembly or damage may occur to the camshaft or VCT phaser sprocket.

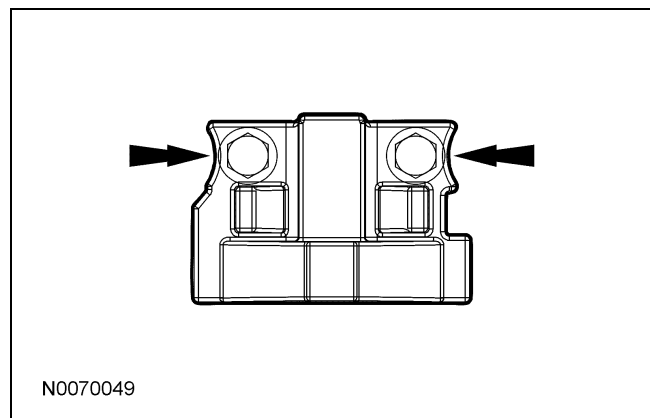
Using the special tool, remove the bolt and the LH VCT phaser sprocket assembly.

- Discard the VCT phaser sprocket bolt.




48. **CAUTION:** Remove the front thrust camshaft bearing cap straight upward from the bearing towers or the bearing cap may be damaged from sideloading.

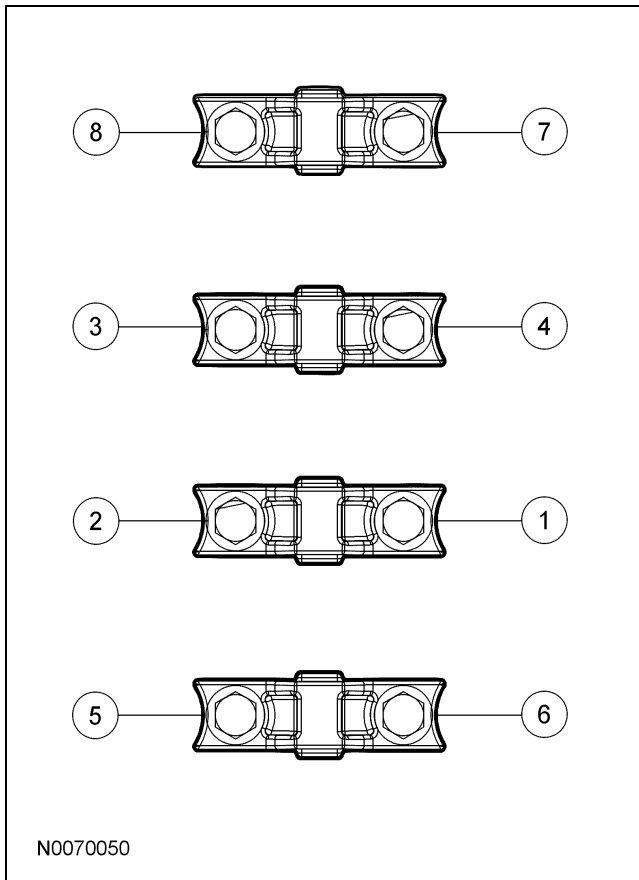
Remove the 2 bolts and the RH cylinder head camshaft front bearing cap.



REMOVAL (Continued)

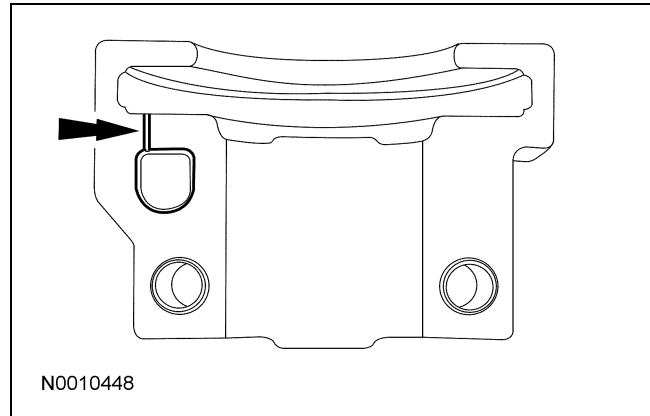
49.  **CAUTION:** The camshaft bearing caps must be installed in their original locations. Record camshaft bearing cap locations. Failure to follow these instructions may result in engine damage.

Remove the remaining bolts in the sequence shown and remove the RH cylinder head camshaft bearing caps.




50. Clean and inspect the RH camshaft bearing caps.

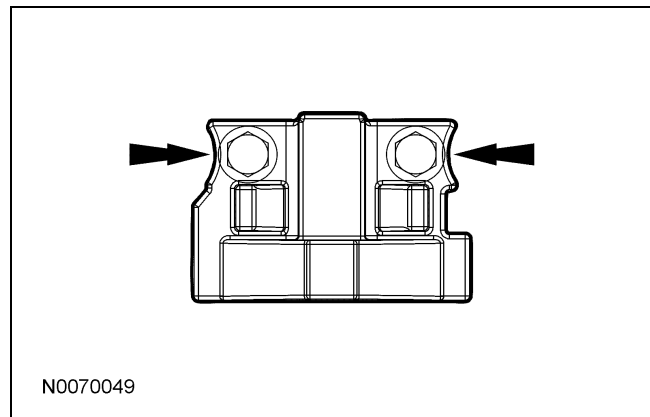
- The camshaft front thrust bearing cap contains an oil metering groove. Make sure the groove is free of foreign material.




51. Remove the RH camshaft.

52.  **CAUTION:** Remove the front thrust camshaft bearing cap straight upward from the bearing towers or the bearing cap may be damaged from sideloading.

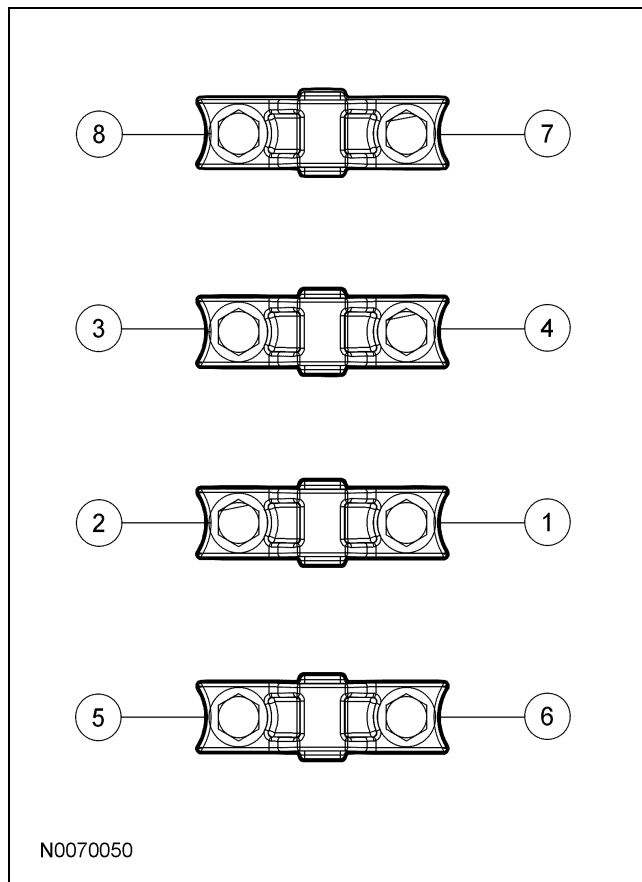
Remove the 2 bolts and the RH cylinder head camshaft front bearing cap.



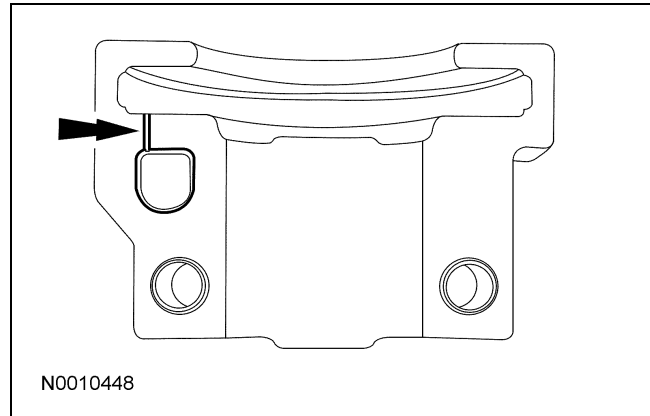
REMOVAL (Continued)

53.  **CAUTION:** The camshaft bearing caps must be installed in their original locations. Record camshaft bearing cap locations. Failure to follow these instructions may result in engine damage.


Remove the remaining bolts in the sequence shown and remove the LH cylinder head camshaft bearing caps.



54. Clean and inspect the LH camshaft bearing caps.
- The camshaft front thrust bearing cap contains an oil metering groove. Make sure the groove is free of foreign material.




55. Remove the LH camshaft.

56.  **CAUTION:** If the components are to be reinstalled, they must be installed in the same positions. Mark the components for installation into the original locations. Failure to follow these instructions may result in engine damage.

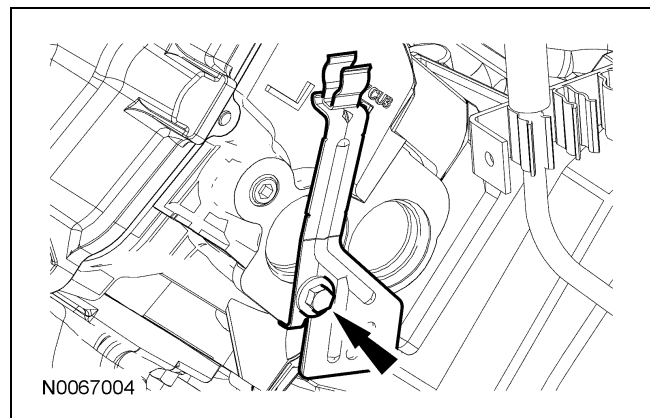
Remove the all of the remaining camshaft roller followers from the cylinder heads.

LH cylinder head

57.  **CAUTION:** If the components are to be reinstalled, they must be installed in the same positions. Mark the components for installation into the original locations. Failure to follow these instructions may result in engine damage.

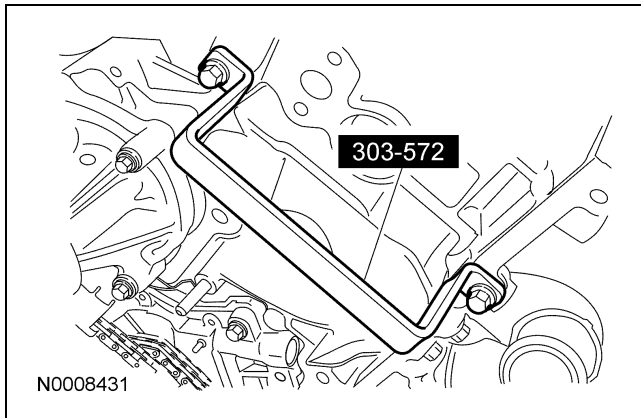
Remove the hydraulic lash adjusters from the LH cylinder head.

58. Remove the bolt and the intake manifold vacuum tube support bracket.

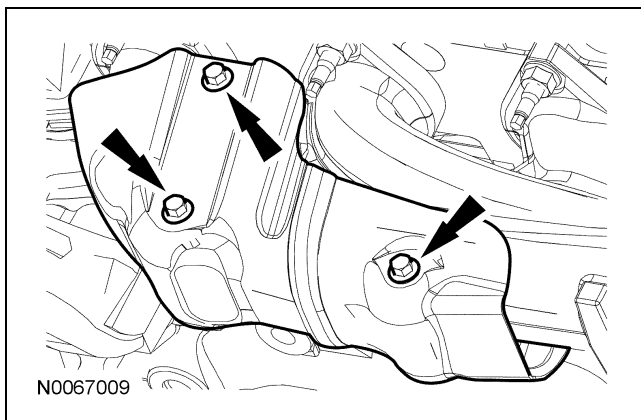


REMOVAL (Continued)

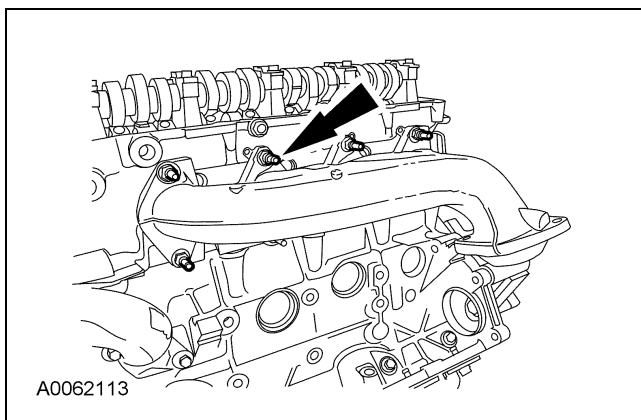
59. Install the special tool onto the LH cylinder head.




60. Remove the 3 bolts and the LH exhaust manifold shield.



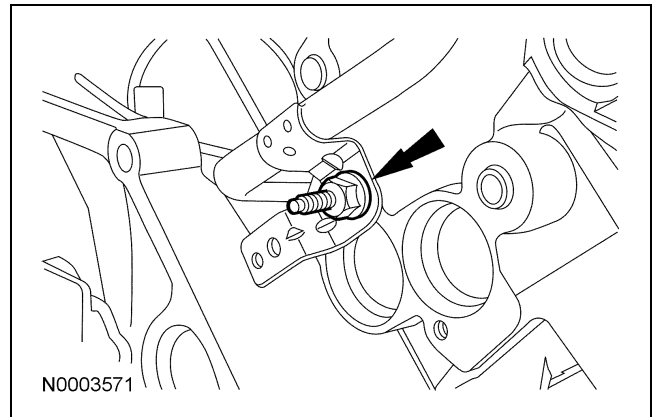
61. Remove the 8 nuts, the 8 studs and the LH exhaust manifold.
- Discard the gaskets, the 8 studs and the 8 nuts.
 - Inspect the exhaust manifold. For additional information, refer to Section 303-00.

**RH cylinder head**

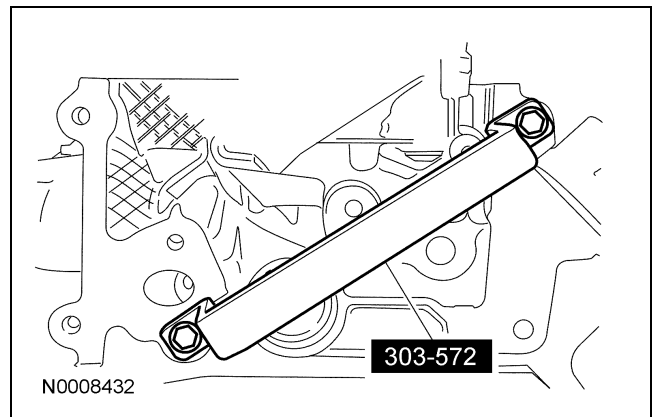
62.  **CAUTION:** If the components are to be reinstalled, they must be installed in the same positions. Mark the components for installation into the original locations. Failure to follow these instructions may result in engine damage.

Remove the hydraulic lash adjusters from the RH cylinder heads.

63. Remove the stud bolt and the coolant tube.
- Discard the O-ring seals.

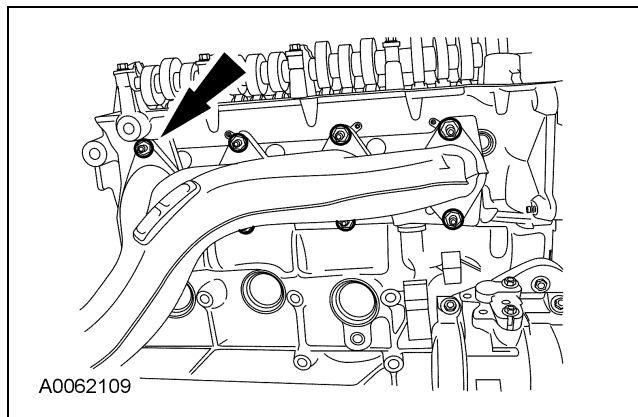
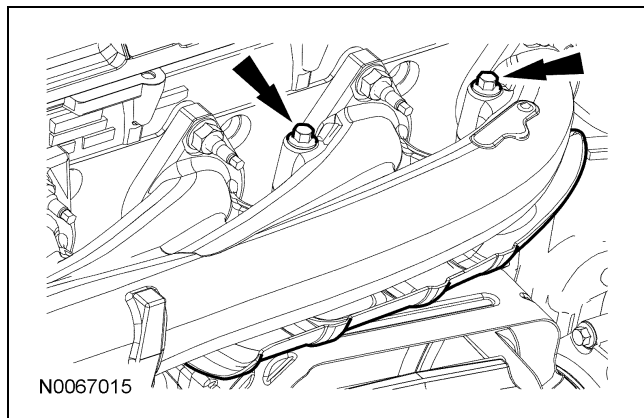


64. Install the special tool onto the RH cylinder head.



REMOVAL (Continued)

65. Remove the 2 bolts and the RH exhaust manifold heat shield.



66. Remove the 8 nuts, the 8 studs and the RH exhaust manifold.
- Discard the gaskets, the 8 studs and the 8 nuts.
 - Inspect the exhaust manifold. For additional information, refer to Section 303-00.

REMOVAL (Continued)**All cylinder heads**

67. ⚠ **CAUTION:** The cylinder head must be cool before removing it from the engine. Cylinder head warpage may result if a warm or hot cylinder head is removed.

⚠ **CAUTION:** Place clean shop towels over exposed engine cavities. Carefully remove the towels so foreign material is not dropped into the engine.

⚠ **CAUTION:** The cylinder head bolts must be discarded and new bolts must be installed. They are a tighten-to-yield design and cannot be reused.

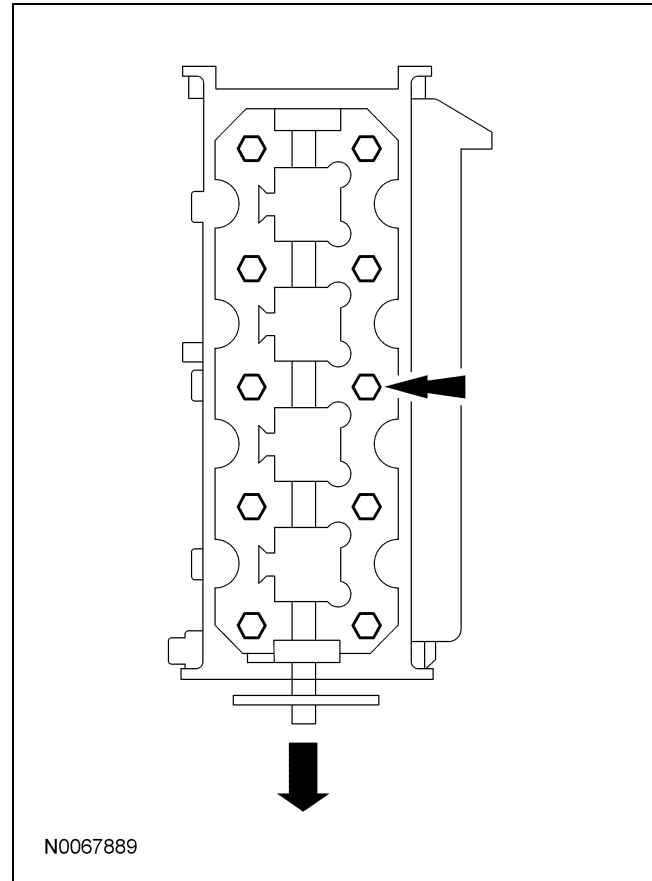
⚠ **CAUTION:** Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the sealing surfaces. These tools cause scratches and gouges, which make leak paths. Use a plastic scraping tool to remove all traces of old sealant. Failure to follow this procedure may cause future oil leakage.

⚠ **CAUTION:** Aluminum surfaces are soft and can be scratched easily. Never place the cylinder head gasket surface, unprotected, on a bench surface.


NOTE: RH shown, LH similar.


Remove the bolts and the cylinder head.

- Discard the cylinder head gasket.
- Discard the cylinder head bolts.



REMOVAL (Continued)

68.  **CAUTION:** Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the sealing surfaces. These tools cause scratches and gouges, which make leak paths. Use a plastic scraping tool to remove all traces of old sealant. Failure to follow this procedure may cause future oil leakage.

 **CAUTION:** Observe all warnings or cautions and follow all application directions contained on the packaging of the Silicone Gasket Remover and the Motorcraft Metal Surface Prep.

NOTE: If there is no residual gasket material present, Motorcraft Metal Surface Prep can be used to clean and prepare the surfaces.

Clean the cylinder head-to-cylinder block mating surfaces of both the cylinder head and the cylinder block.

- 1 Remove any large deposits of silicone or gasket material with a plastic scraper.
- 2 Apply Silicone Gasket Remover, following package directions, and allow to set for several minutes.
- 3 Remove the Silicone Gasket Remover with a plastic scraper. A second application of Silicone Gasket Remover may be required if residual traces of silicone or gasket material remain.
- 4 Apply Motorcraft Metal Surface Prep, following package directions, to remove any remaining traces of oil or coolant, and to prepare the surfaces to bond with the new gasket. Do not attempt to make the metal shiny. Some staining of the metal surfaces is normal.

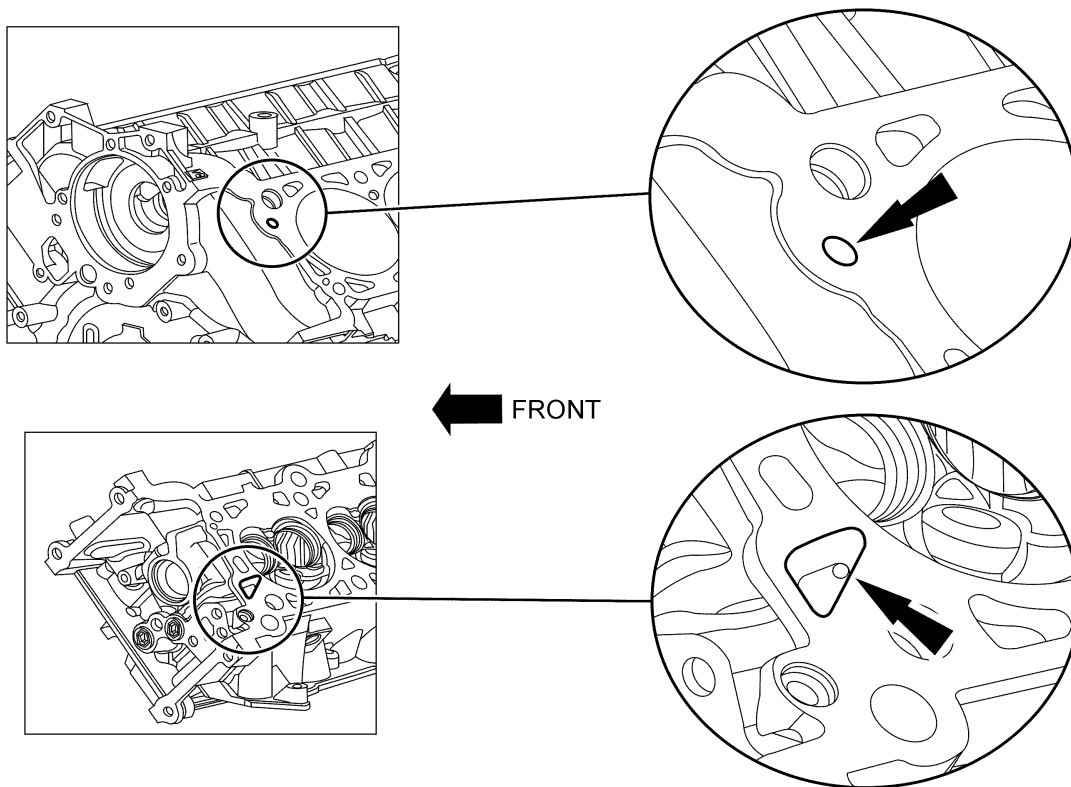
REMOVAL (Continued)

69. **NOTE:** Make sure all cylinder head surfaces are clear of any gasket material, RTV, oil and coolant. The cylinder head surface must be clean and dry before running a flatness check.

NOTE: Use a straightedge that is calibrated by the manufacturer to be flat within 0.005 mm (0.0002 in) per running foot length, such as Snap-On® GA438A or equivalent. For example, if the straightedge is 61 cm (24 in) long, the machined edge must be flat within 0.010 mm (0.0004 in) from end to end.

NOTE: LH shown, RH similar.

Support the cylinder head on a bench with the head gasket side up. Inspect all areas of the deck face with a straightedge, paying particular attention to the oil pressure feed area. The cylinder head must not have depressions deeper than 0.0254 mm (0.001 in) across a 38.1 mm (1.5 in) square area or scratches longer than 0.0254 mm (0.001 in).

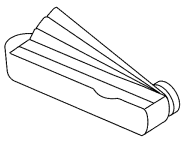


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GENERAL PROCEDURES

Cylinder Head Distortion

Special Tool(s)

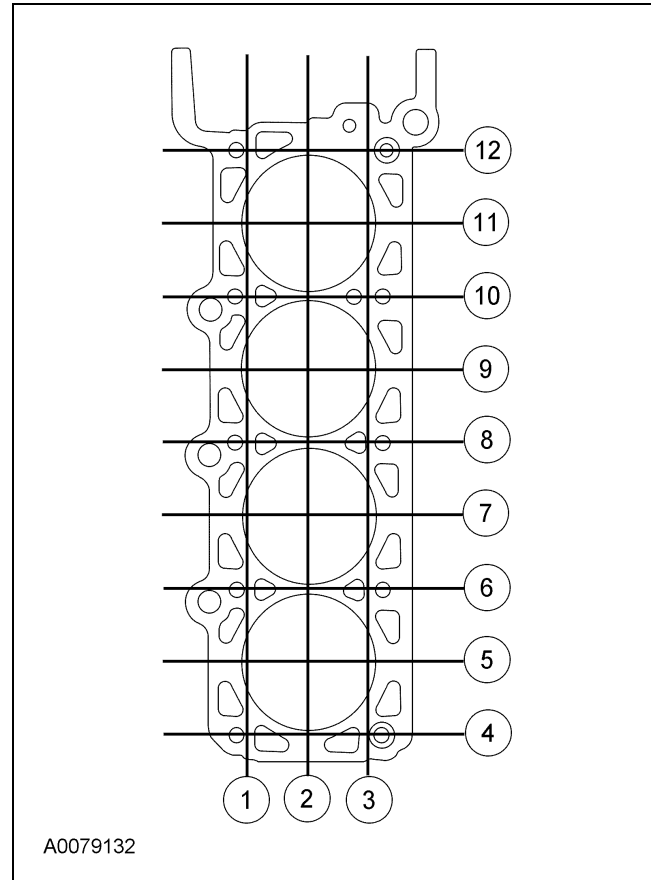
 <p>ST1271-A</p>	<p>Feeler Gauge Set 303-D027 (D81L-4201-A) or equivalent</p>
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NOTE: Refer to the appropriate Section 303-01 for the specification.

1. **NOTE:** Make sure all cylinder head surfaces are clear of any gasket material, RTV, oil and coolant. The cylinder head surface must be clean and dry before running a flatness check.

NOTE: Use a straightedge that is calibrated by the manufacturer to be flat within 0.005 mm (0.0002 in) per running foot of length, such as Snap-On® GA438A or equivalent. For example, if the straightedge is 61 cm (24 in) long, the machined edge must be flat within 0.010 mm (0.0004 in) from end to end.

Using a straightedge and a feeler gauge, inspect the cylinder head for flatness in the sequence shown.



DESCRIPTION AND OPERATION

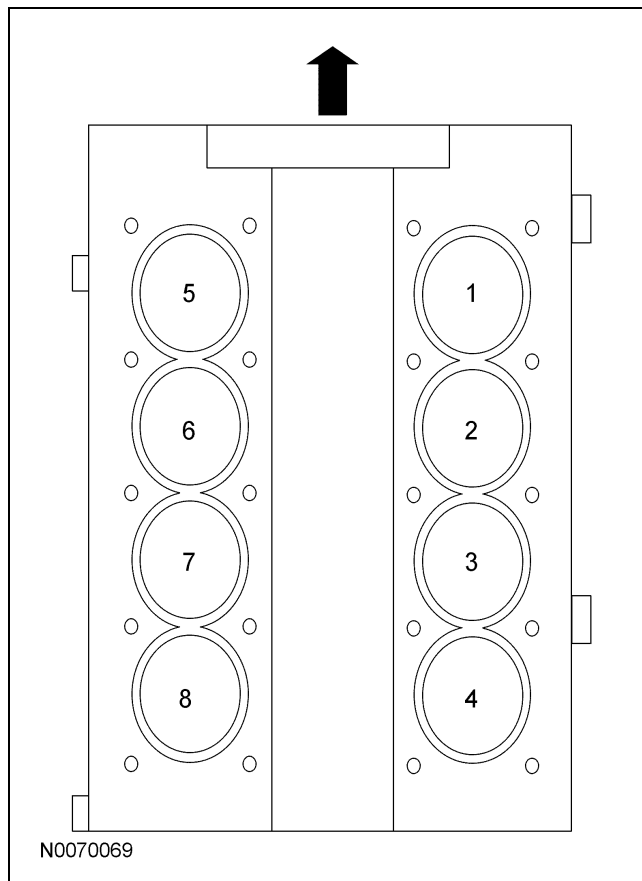
Engine

NOTE: For additional information, refer to the exploded view under the assembly procedure in this section.

The 5.4L (3V) is a V-8 engine with the following features:

- Single overhead camshafts
- Three valves per cylinder
- Sequential multiport fuel injection (SFI)
- Aluminum cylinder heads
- Cast iron, 90-degree V-cylinder block
- Variable camshaft timing (VCT)
- Individually chain-driven camshafts with a hydraulic timing chain tensioner on each timing chain
- Distributorless ignition system
- Electronic returnless fuel system

Engine Cylinder Identification



Identification

Always refer to these labels when installation of new parts is necessary or when checking engine calibrations. The engine parts often differ within a cubic inch displacement (CID) family. Verification of the identification codes will make sure that the correct parts are obtained. These codes contain all the pertinent information relating to the dates, optional equipment and revisions. The Ford Master Parts Catalog contains a complete listing of the codes and their applications.

Code Information

The engine code information label, located on the side of the valve cover and the front side of the valve cover, contains the following:

- Engine build date
- Engine plant code
- Engine code

Exhaust Emission Control System

Operation and necessary maintenance of the exhaust emission control devices used on this engine are covered in the [Powertrain Control/Emissions Diagnosis \(PC/ED\) manual](#).

Induction System

The sequential multiport fuel injection (SFI) provides the fuel/air mixture needed for combustion in the cylinders. The 8 solenoid-operated fuel injectors:

- are mounted in the intake manifold.
- meter fuel into the air intake stream in accordance with engine demand.
- are positioned so that their tips direct fuel just ahead of the engine intake valves.
- are connected in series with the fuel rail pressure and temperature sensor.
- supply fuel from the fuel tank with a fuel pump mounted in the fuel tank.

Valve Train

The valve train operates as follows:

- Ball-tip hydraulic lash adjusters provide automatic lash adjustment.

DESCRIPTION AND OPERATION (Continued)

- Roller followers ride on the camshaft lobe, transferring the up-and-down motion of the camshafts to the valves in the cylinder heads.

Positive Crankcase Ventilation System

All engines are equipped with a closed-type positive crankcase ventilation system recycling the crankcase vapors to the upper intake manifold.

Lubrication System

The engine lubrication system operates as follows:

- Oil is drawn into the oil pump through the oil pump screen cover and tube in the sump of the oil pan.
- Oil is pumped through the oil filter on the left front side of the cylinder block.
- Oil enters the main gallery where it is distributed to the crankshaft main journals and to both cylinder heads.
- From the main journals, the oil is routed through cross-drilled passages in the crankshaft to lubricate the connecting rod bearings. Controlled leakage through the crankshaft main bearings and connecting rod bearings is slung radially outward to cool and lubricate the cylinder walls as well as the entire connecting rod, piston and piston ring assembly.
- The left cylinder head is fed from a drilling into the supply passage feeding the main gallery at the front of the cylinder block. The right cylinder head is fed from a drilling into the rear of the main gallery. Main gallery pressure is reduced as it enters the cylinder head galleries through fixed serviceable orifices, located at the upper part of the feed passages. It is this reduced pressure in the cylinder head galleries which feeds the camshaft journals, the hydraulic lash adjusters and the primary and secondary timing chain tensioners.

- The camshaft lobe and roller followers are lubricated by splash created through valve train operation.


Oil Pump

The lubrication system of the 5.4L (3V) engine is designed to provide optimum oil flow to critical components of the engine through its entire operating range. The heart of the system is a positive displacement internal gear oil pump using top seal rotors. Generically this design is known as a gerotor pump, which operates as follows:

- The oil pump is mounted on the front face of the cylinder block.
 - The inner rotor is piloted on the crankshaft post and is driven through flats on the crankshaft.
 - System pressure is limited by an integral, internally-vented relief valve which directs the bypassed oil back to the inlet side of the oil pump.
 - Oil pump displacement has been selected to provide adequate volume to make sure of correct oil pressure, both at hot idle and maximum speed.
 - The relief valve calibration protects the system from excessive pressure during high viscosity conditions.
 - The relief valve is designed to provide adequate connecting rod bearing lubrication under high-temperature and high-speed conditions.
-

DESCRIPTION AND OPERATION

Engine

 **CAUTION:** When repairing engines, all parts must be contamination free. If contamination/foreign material is present when repairing an engine, premature engine failure may occur.

NOTE: Specifications show the expected minimum or maximum condition. Refer to the appropriate section in Group 303 for the procedure.

NOTE: If a component fails to meet the specifications, it is necessary to refinish it or install a new component. Wear limits are provided as an aid to determine if the component can be refinished. A new component must be installed when any component fails to meet specifications and cannot be refinished.

NOTE: This section contains information, steps and procedures that may not be specific to your engine.

This section covers general procedures and diagnosis and testing of the engine system, except for exhaust emission control devices, which are covered in the [Powertrain Control/Emissions Diagnosis \(PC/ED\) manual](#).

The engine incorporates the following features:
Refer to the appropriate section in Group 303 for the procedure.

- Crankcase ventilation or breather system
- Exhaust emission control system
- Evaporative emission control system

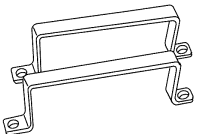
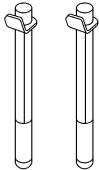
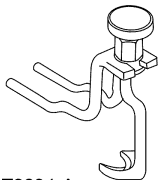
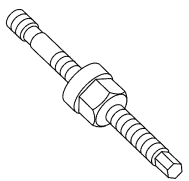
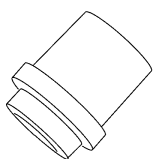
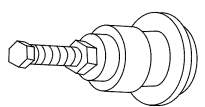
Some engines incorporate a fail-safe cooling system. Refer to the appropriate section in Group 303 for the procedure.

The engine, fuel system, ignition system, emissions system and exhaust system all affect exhaust emission levels and must be maintained according to the maintenance schedule. Refer to the scheduled Maintenance Guide.

Correct engine identification is required to order parts. Refer to the appropriate section in Group 303 for the procedure.

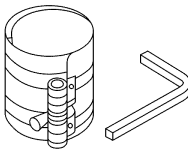
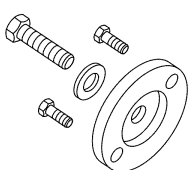
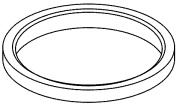
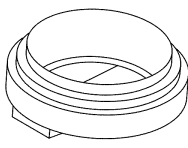
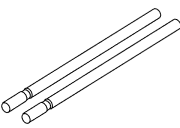
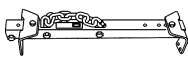
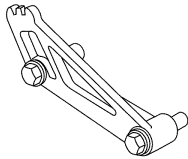
For complete vehicle and engine identification codes, refer to Section 100-01.

ASSEMBLY**Engine****Special Tool(s)**

 <p>ST1668-A</p>	Remover/Installer, Cylinder Head 303-572 (T97T-6000-A)
 <p>ST1337-A</p>	Installer, Connecting Rod 303-442 (T93P-6136-A)
 <p>ST2804-A</p>	Compressor, Valve Spring 303-1039
 <p>ST2428-A</p>	Installer, Crankshaft Vibration Damper 303-102 (T74P-6316-B)
 <p>ST2197-A</p>	Installer, Crankshaft Front Seal 303-635
 <p>ST1328-A</p>	Installer, Front Cover Seal 303-335 (T88T-6701-A)

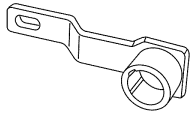

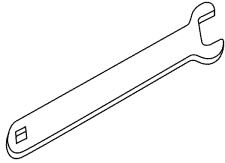
(Continued)

Special Tool(s)

 <p>ST1376-A</p>	Compressor, Piston Ring 303-D032 (D81L-6002-C) or equivalent
 <p>ST1480-A</p>	Installer, Crankshaft Rear Seal 303-518 (T95P-6701-DH)
 <p>ST1482-A</p>	Installer, Crankshaft Oil Slinger 303-517 (T95P-6701-CH)
 <p>ST1479-A</p>	Installer, Crankshaft Rear Seal 303-516 (T95P-6701-EH)
 <p>ST2806-A</p>	Alignment Pins, Cylinder Head 303-1040 (SR-015486)
 <p>ST1377-A</p>	Modular Engine Lift Bracket 303-F047 (014-00073) or equivalent
 <p>ST2807-A</p>	Locking Tool, Camshaft Phaser Sprocket 303-1046

(Continued)

ASSEMBLY (Continued)**Special Tool(s)**

 ST1335-A	Holding Tool, Crankshaft 303-448 (T93P-6303-A)
 ST1499-A	Fan Pulley Holding Wrench 303-239 (T84T-6312-C)
 ST1500-A	Fan Clutch Nut Wrench 303-240 (T84T-6312-D)

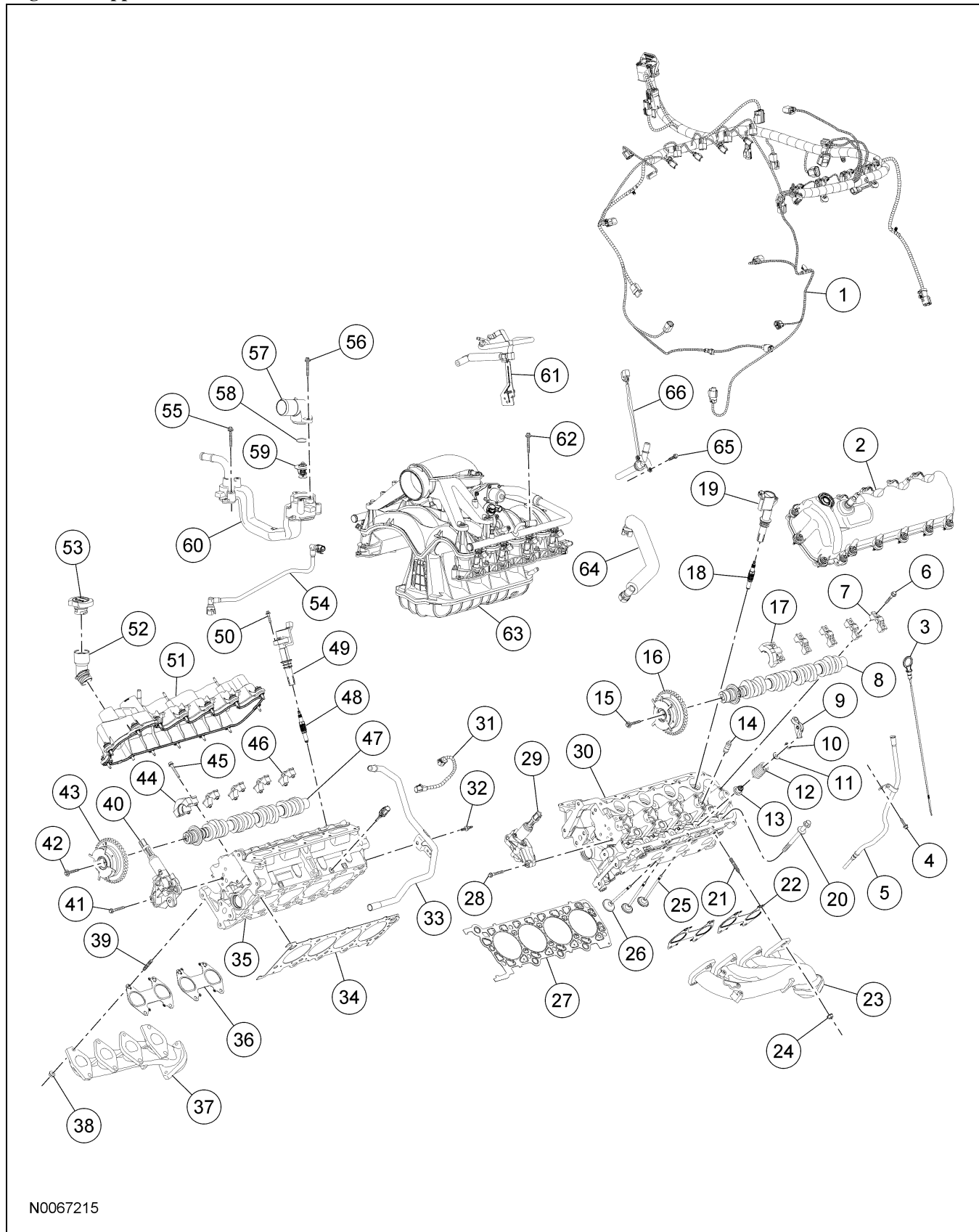
Material

Item	Specification
Hydraulic Chain Tensioner Retaining Clip 1L3Z-6P250-AA	—
Motorcraft Metal Surface Prep ZC-31	—

(Continued)

Material

Item	Specification
Motorcraft Premium Gold Engine Coolant with Bittering Agent (US only) VC-7-B (US); CVC-7-A (Canada); or equivalent (yellow color)	WSS-M97B51-A1
Motorcraft SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP (US); Motorcraft SAE 5W-20 Super Premium Motor Oil CXO-5W20-LSP12 (Canada); or equivalent	WSS-M2C930-A
Silicone Brake Caliper Grease and Dielectric Compound XG-3-A	ESE-M1C171-A
Silicone Gasket and Sealant TA-30	WSE-M4G323-A4
Silicone Gasket Remover ZC-30	—

ASSEMBLY (Continued)**Engine — Upper End**

N0067215

ASSEMBLY (Continued)

Item	Part Number	Description
1	12B637	Engine wiring harness
2	6A505	Valve cover — LH
3	6750	Oil level indicator
4	N605892	Oil level indicator tube bolt
5	6K873	Oil level indicator tube
6	N807834	Camshaft bearing cap bolt (10 required)
7	6B280	Camshaft bearing cap (4 required)
8	6C255	Camshaft — LH
9	6529	Roller follower (24 required)
10	6518	Valve spring retainer key (48 required)
11	6514	Valve spring retainer (24 required)
12	6513	Valve spring (24 required)
13	6A517	Valve stem seal (24 required)
14	6C501	Hydraulic lash adjuster (24 required)
15	6279	Camshaft phaser sprocket bolt — LH
16	6C524	Camshaft phaser sprocket — LH
17	6B284	Camshaft bearing cap
18	12405	Spark plug (4 required)
19	12A366	Ignition coil (4 required)
20	6065	Cylinder head bolt (20 required)
21	W707747	Exhaust manifold stud (8 required)
22	9Y431	Exhaust manifold gaskets (2 required)
23	9431	Exhaust manifold — LH
24	W701706	Exhaust manifold nut (8 required)
25	6507	Intake valve (16 required)
26	6505	Exhaust valve (8 required)
27	6083	Cylinder head gasket — LH
28	W701520	Variable camshaft timing (VCT) oil control solenoid assembly bolt (2 required)
29	6C261	VCT oil control solenoid assembly
30	6050	Cylinder head — LH
31	14B102	Cylinder head temperature (CHT) sensor jumper harness
32	W701571	Heater outlet tube stud bolt

(Continued)

Item	Part Number	Description
33	18663	Heater outlet tube
34	6051	Cylinder head gasket — RH
35	6049	Cylinder head — RH
36	9Y431	Exhaust manifold gaskets (2 required)
37	9430	Exhaust manifold — RH
38	W701706	Exhaust manifold nut (8 required)
39	W707747	Exhaust manifold stud (8 required)
40	6C260	VCT oil control solenoid assembly
41	W701520	VCT oil control solenoid assembly bolt (2 required)
42	6279	Camshaft phaser sprocket bolt — RH
43	6C524	Camshaft phaser sprocket — RH
44	6B284	Camshaft bearing cap
45	N807834	Camshaft bearing cap bolt (10 required)
46	6B280	Camshaft bearing cap (4 required)
47	6251	Camshaft — RH
48	12405	Spark plug (4 required)
49	12A366	Ignition coil (4 required)
50	W706175	Ignition coil bolt (8 required)
51	6582	Valve cover — RH
52	6765	Oil fill adapter
53	6766	Oil fill adapter cap
54	6758	Crankcase ventilation tube
55	W503282	Coolant crossover tube bolt (3 required)
56	W503279	Thermostat housing bolt (2 required)
57	8594	Thermostat housing
58	N806807	Thermostat O-ring seal
59	8575	Thermostat
60	8C369	Coolant crossover tube
61	9A474	Intake manifold vacuum harness and support bracket assembly
62	W709775	Intake manifold bolt (10 required)
63	9Y451	Intake manifold assembly
64	6K817	Positive crankcase ventilation (PCV) tube

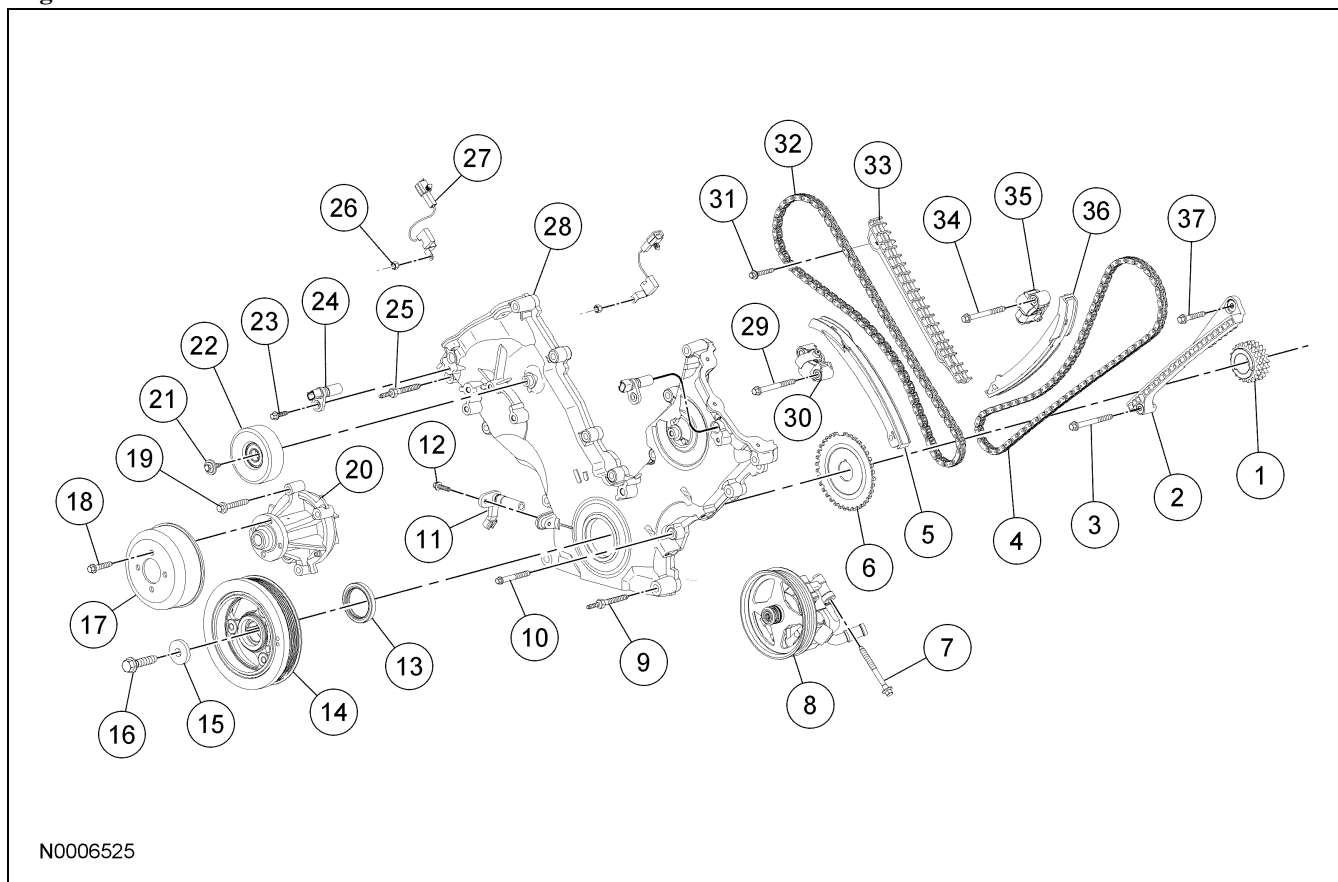
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ASSEMBLY (Continued)

Item	Part Number	Description
65	W500204	PCV heater element assembly bolt (2 required)

(Continued)

Item	Part Number	Description
66	9F624	PCV heater element assembly

Engine — Front End

Item	Part Number	Description
1	6306	Crankshaft sprocket
2	6B274	Timing chain guide — LH
3	N606527	Timing chain guide lower bolt — LH
4	6268	Timing chain — LH
5	6K255	Tensioner arm — RH
6	12A227	Ignition pulse wheel
7	W706447	Power steering pump bolt (2 required)
8	3A696	Power steering pump assembly
9	N808529	Engine front cover stud bolt (2 required)
10	N806177	Engine front cover bolt (10 required)
11	6C315	Crankshaft position (CKP) sensor

(Continued)

Item	Part Number	Description
12	N806155	CKP sensor bolt
13	6700	Crankshaft front seal
14	6316	Crankshaft pulley
15	N806165	Crankshaft pulley washer
16	W701512	Crankshaft pulley bolt
17	8A528	Coolant pump pulley
18	N806282	Coolant pump pulley bolt (4 required)
19	N806177	Coolant pump bolt (4 required)
20	8501	Coolant pump
21	N808102	Accessory drive belt idler pulley bolt
22	12A216	Accessory drive belt idler pulley
23	N806155	Camshaft position (CMP) sensor bolt (2 required)

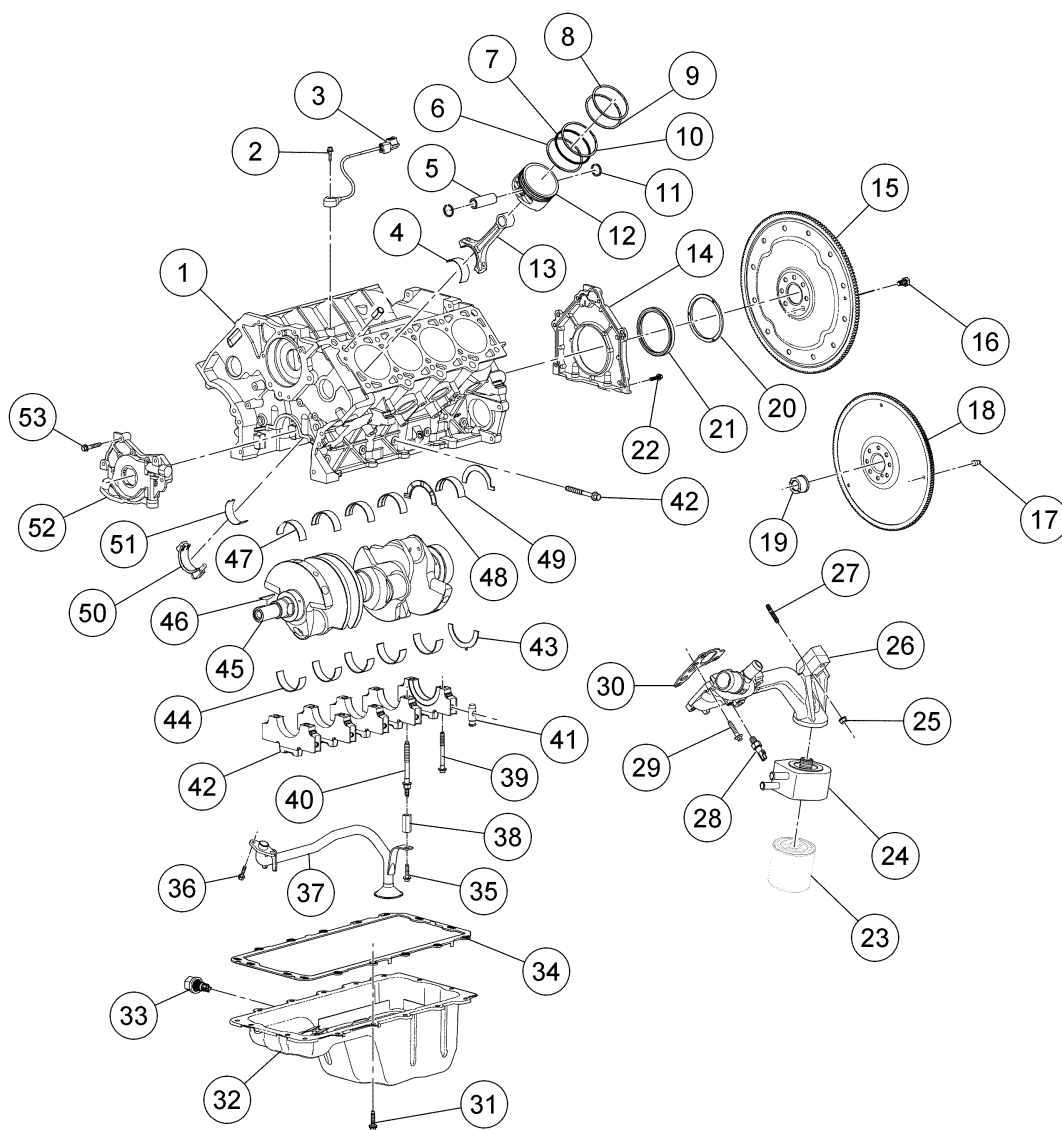
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ASSEMBLY (Continued)

Item	Part Number	Description
24	6B288	CMP sensor (2 required)
25	W709573	Engine front cover stud bolt (3 required)
26	N804758	Radio ignition interference capacitor nuts (2 required)
27	18801	Radio ignition interference capacitors (2 required)
28	6C086	Engine front cover
29	N606543	Timing chain tensioner bolt — RH (2 required)
30	6L266	Timing chain tensioner — RH

(Continued)

Item	Part Number	Description
31	W503282	Timing chain guide bolt — RH (2 required)
32	6268	Timing chain — RH
33	6M256	Timing chain guide — RH
34	N606543	Timing chain tensioner bolt — LH (2 required)
35	6M269	Timing chain tensioner — LH
36	6M274	Tensioner arm — LH
37	N605892	Timing chain guide upper bolt — LH

ASSEMBLY (Continued)**Engine — Lower End**

N0011594

Item	Part Number	Description
1	6010	Cylinder block
2	W500225	Knock sensor (KS) bolt (2 required)
3	12A699	KS (2 required)
4	6211	Upper connecting rod bearing (8 required)
5	6135	Piston pin (8 required)
6	6159	Outer oil control ring (8 required)

(Continued)

Item	Part Number	Description
7	6161	Inner oil control ring (8 required)
8	6150	Upper compression ring (8 required)
9	6152	Lower compression ring (8 required)
10	6159	Outer oil control ring (8 required)
11	6140	Piston pin retainer (16 required)

(Continued)

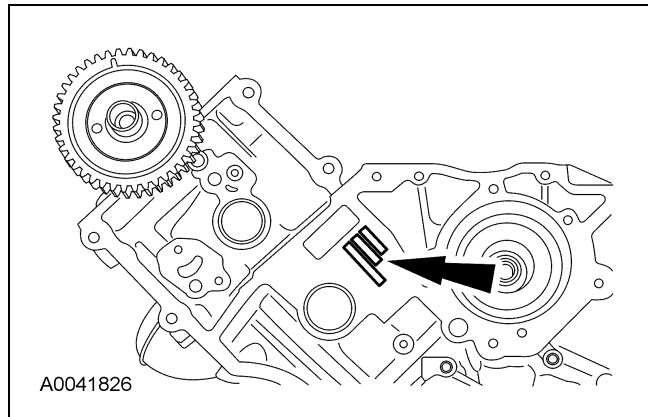
ASSEMBLY (Continued)

Item	Part Number	Description
12	6110	Piston (8 required)
13	6200	Connecting rod assembly (8 required)
14	6K318	Crankshaft rear seal retainer plate
15	6375	Flexplate
16	N806168	Flexplate bolt (8 required)
17	N806168	Flywheel bolt (8 required)
18	6375	Flywheel
19	N806168	Pilot bearing
20	6701	Crankshaft oil slinger
21	6310	Crankshaft rear seal
22	N806155	Crankshaft rear seal retainer plate bolt (6 required)
23	6714	Oil filter
24	6A642	Oil cooler
25	N620482	Oil filter adapter nut
26	6881	Oil filter adapter
27	W704787	Oil filter adapter stud
28	9278	Engine oil pressure (EOP) switch
29	N620482	Oil filter adapter bolt (4 required)
30	6A636	Oil filter adapter gasket
31	W701605	Oil pan bolt (16 required)
32	6675	Oil pan
33	12A648	Engine oil temperature (EOT) sensor
34	6710	Oil pan gasket
35	N605904	Oil pump screen and pickup tube bolt
36	N806155	Oil pump screen and pickup tube bolt (2 required)
37	6622	Oil pump screen and pickup tube
38	N806180	Oil pump screen and pickup tube spacer
39	6345	Crankshaft main bearing cap bolt (9 required)
40	6C357	Crankshaft main bearing cap stud
41	6A346	Crankshaft main bearing dowel (10 required)
42	6325	Crankshaft main bearing cap (5 required)
43	6K302	Crankshaft thrust washer — lower

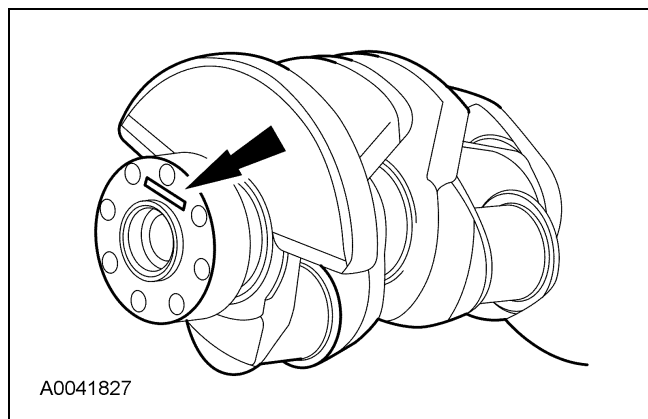
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Item	Part Number	Description
44	6A338	Crankshaft bearing — lower (5 required)
45	6303	Crankshaft
46	N806201	Crankshaft key
47	6333	Crankshaft bearing — upper (4 required)
48	6A341	Crankshaft thrust washer — upper (2 required)
49	6333	Crankshaft bearing — upper
50	6210	Connecting rod cap (8 required)
51	6211	Connecting rod bearing (8 required)
52	6621	Oil pump
53	N806183	Oil pump bolt (3 required)

1. Record the main bearing code found on the front of the engine block.



2. Record the main bearing code found on the back of the crankshaft.



ASSEMBLY (Continued)

3. Using the data recorded earlier and the Bearing Select Fit Chart, Standard Bearings, determine the required bearing grade for each main bearing.
- Read the first letter of the engine block main bearing code and the first letter of the crankshaft main bearing code.
 - Read down the column below the engine block main bearing code letter, and across the row next to the crankshaft main bearing code letter, until the 2 intersect. This is the required bearing grade for the No. 1 crankshaft main bearing.
 - As an example, if the engine block code letter is “F” and the crankshaft code letter is “D”, the correct bearing grade for this main bearing is a “2”.
 - Repeat this process for the remaining 4 main bearings.

		MINIMUM BLOCK DIA																							
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
72.400		.401	.402	.403	.404	.405	.406	.407	.408	.409	.410	.411	.412	.413	.414	.415	.416	.417	.418	.419	.420	.421	.422	.423	.424
MAXIMUM CRANKSHAFT DIA	X	67.504	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2
	W	67.503	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2
	V	67.502	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2
	U	67.501	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2
	T	67.500	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2
	S	67.499	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2
	R	67.498	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2
	Q	67.497	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2
	P	67.496	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2
	O	67.495	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2
	N	67.494	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2
	M	67.493	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2
	L	67.492	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2
	K	67.491	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2
	J	67.490	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2
	I	67.489	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2
	H	67.488	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2
	G	67.487	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	F	67.486	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	E	67.485	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	D	67.484	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	C	67.483	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	B	67.482	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
	A	67.481	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

A0031544

ASSEMBLY (Continued)

4. If oversize bearings are being used, use the procedure in the previous step and the Bearing Select Fit Chart, Oversize Bearings to determine the required bearing grade for each main bearing.

		MINIMUM BLOCK DIA																								
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	
		72.400	.401	.402	.403	.404	.405	.406	.407	.408	.409	.410	.411	.412	.413	.414	.415	.416	.417	.418	.419	.420	.421	.422	.423	.424
MAXIMUM CRANKSHAFT DIA	X	67.254	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2
	W	67.253	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2
	V	67.252	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2
	U	67.251	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2
	T	67.250	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2
	S	67.249	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2
	R	67.248	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2
	Q	67.247	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3
	P	67.246	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3
	O	67.245	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3
	N	67.244	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3
	M	67.243	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3
	L	67.242	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3
	K	67.241	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3
	J	67.240	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3
	I	67.239	2	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3
	H	67.238	2	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3
	G	67.237	2	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3
	F	67.236	2	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3
	E	67.235	2	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	D	67.234	2	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	C	67.233	2	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	B	67.232	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
	A	67.231	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

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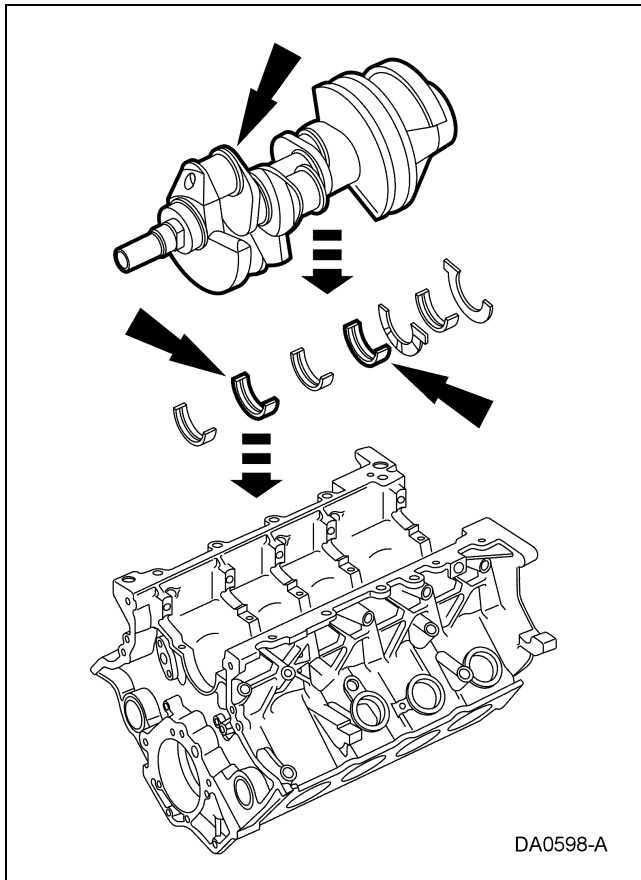
5. **NOTE:** Before assembling the cylinder block, all sealing surfaces must be free of chips, dirt, paint and foreign material. Also, make sure the coolant and oil passages are clear.

Install the crankshaft upper main bearings into the cylinder block and lubricate them with clean engine oil.

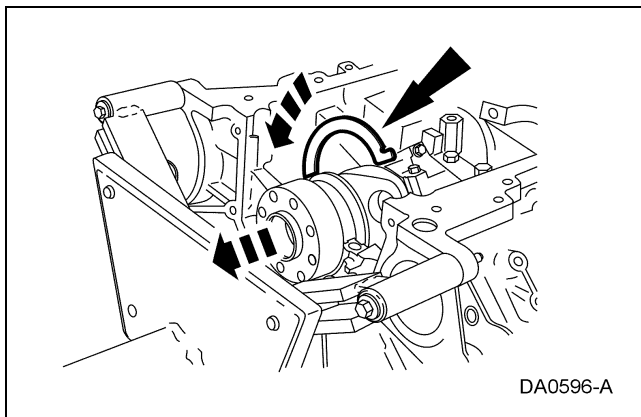
ASSEMBLY (Continued)

6. **NOTE:** The upper thrust washers are shown for location purposes only. Do not install the upper thrust washers until the crankshaft is installed. Refer to the following 2 steps.

Install the crankshaft onto the upper crankshaft main bearings.

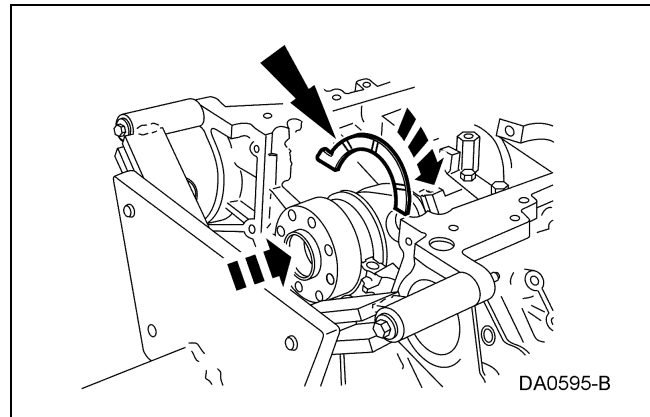


7. **NOTE:** The oil groove on the thrust washer must face toward the front of the engine (against the crankshaft thrust surface).
- Push the crankshaft rearward and install the rear crankshaft upper thrust washer at the back of the No. 5 main boss.



8. **NOTE:** The oil groove on the thrust washer must face toward the front of the engine (against the crankshaft surface).

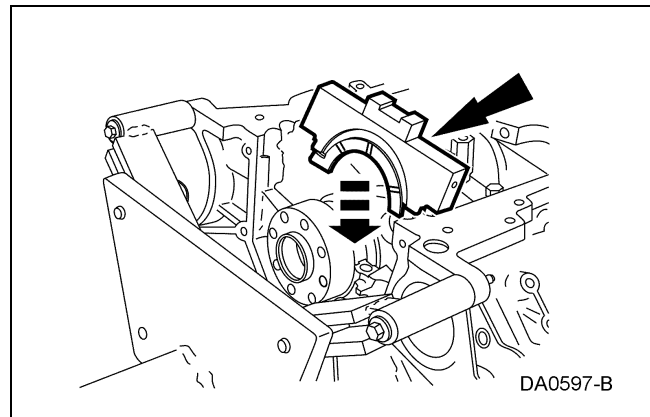
Push the crankshaft forward and install the front crankshaft upper thrust washer at the front of the No. 5 main boss.



9. **NOTE:** To aid in assembly, apply petroleum jelly to the back of the crankshaft thrust washer.

NOTE: The oil groove on the thrust washer must face toward the rear of the engine (crankshaft surface).

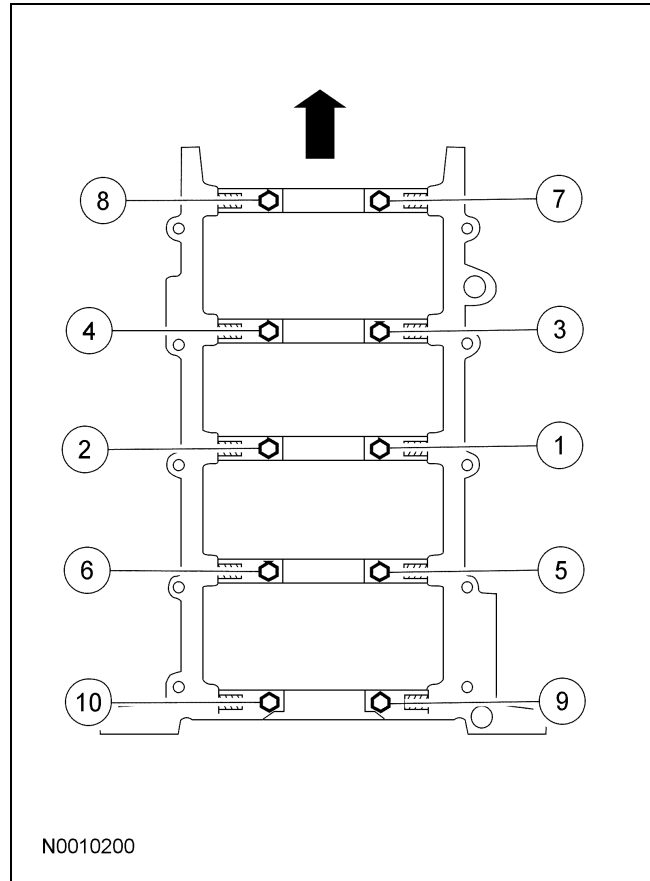
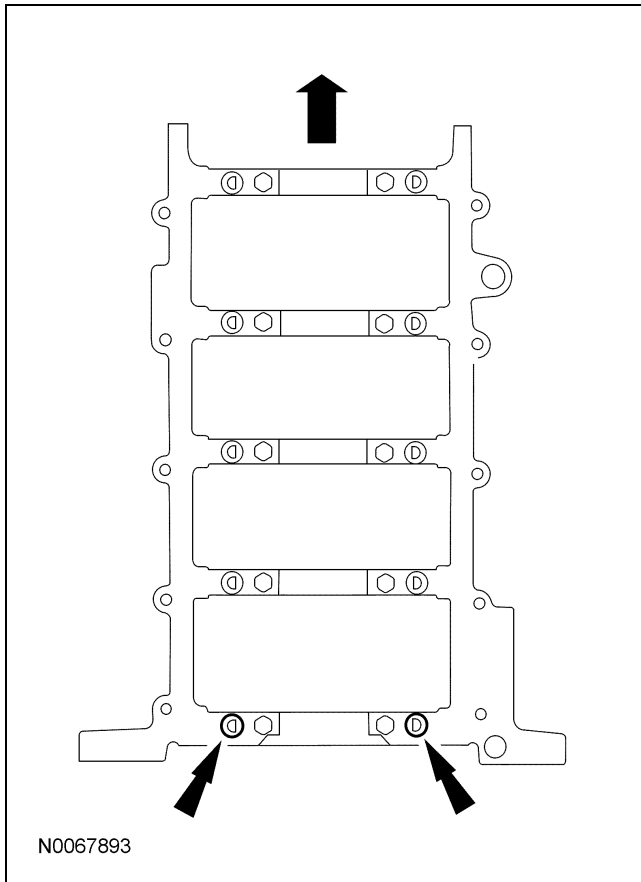
Install the lower crankshaft thrust washer to the back side of the No. 5 main bearing cap, with oil grooves facing the crankshaft surface.



10. Install the crankshaft lower main bearings into the main bearing caps and lubricate them with clean engine oil. Locate the main bearing cap on the cylinder block and, keeping the cap as square as possible, alternately draw the cap down evenly using the cap fasteners.

ASSEMBLY (Continued)

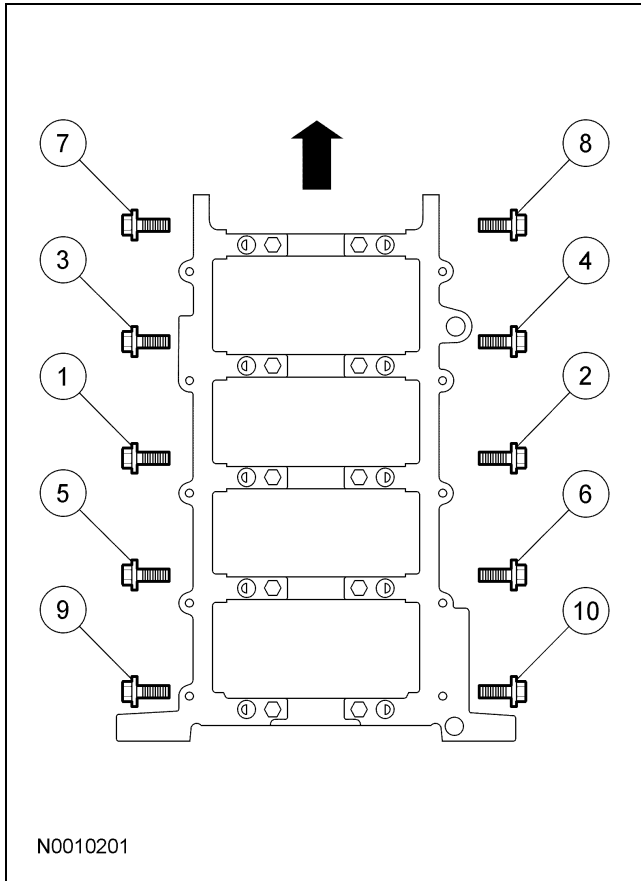
11. Install the dowel pins so the flat sides face the crankshaft.



12. Install the vertical main bearing cap fasteners and tighten in 2 stages, in the sequence shown.
- Stage 1: Tighten to 40 Nm (30 lb-ft).
 - Stage 2: Tighten an additional 90 degrees.

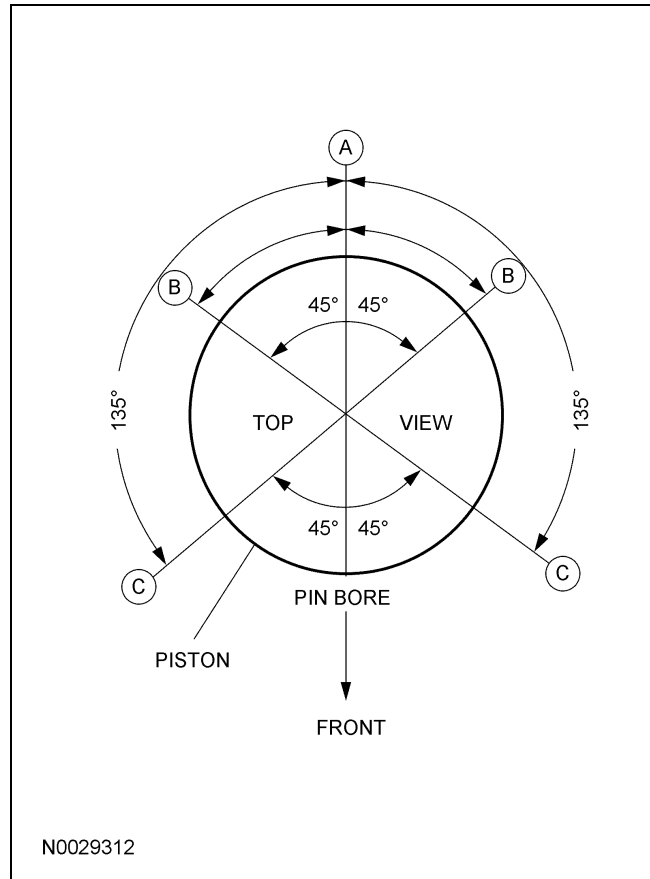
ASSEMBLY (Continued)

13. Install the side bolts and tighten them in 2 stages, in the sequence shown.
- Stage 1: Tighten to 30 Nm (22 lb-ft).
 - Stage 2: Tighten an additional 90 degrees.




14. Check the piston-to-cylinder block and piston ring clearances. For additional information, refer to Section 303-00.

15. Assemble the 8 pistons. For additional information, refer to Piston in this section.
16. Make sure the ring gaps (oil spacer — A, oil ring — B, compression ring — C) are correctly spaced around the circumference of the piston.



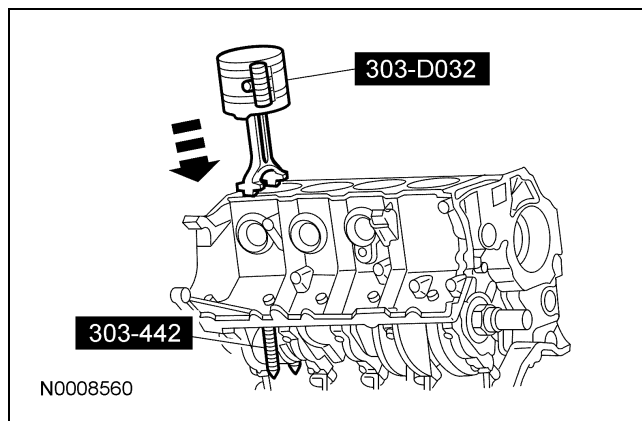
ASSEMBLY (Continued)


17.  **CAUTION:** Do not scratch the cylinder walls or crankshaft journals with the connecting rod or engine damage may occur.

NOTE: The following piston installation steps are for all 8 connecting rods, rod bearings and pistons. Only one connecting rod, rod bearing and piston is shown.

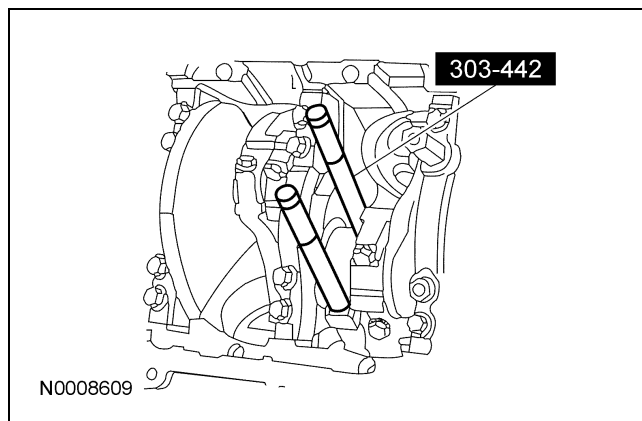
Use the special tools to install the connecting rod with the upper connecting rod bearing in place.


- Lubricate the piston and ring with clean engine oil.
- Lubricate the rod bearings with clean engine oil.



18.  **CAUTION:** Do not scratch the cylinder walls or crankshaft journals with the connecting rod or engine damage may occur.

Once the connecting rod is seated on the crankshaft journal, remove the special tool.



19.  **CAUTION:** The rod cap installation must keep the same orientation as marked during disassembly or engine damage may occur.

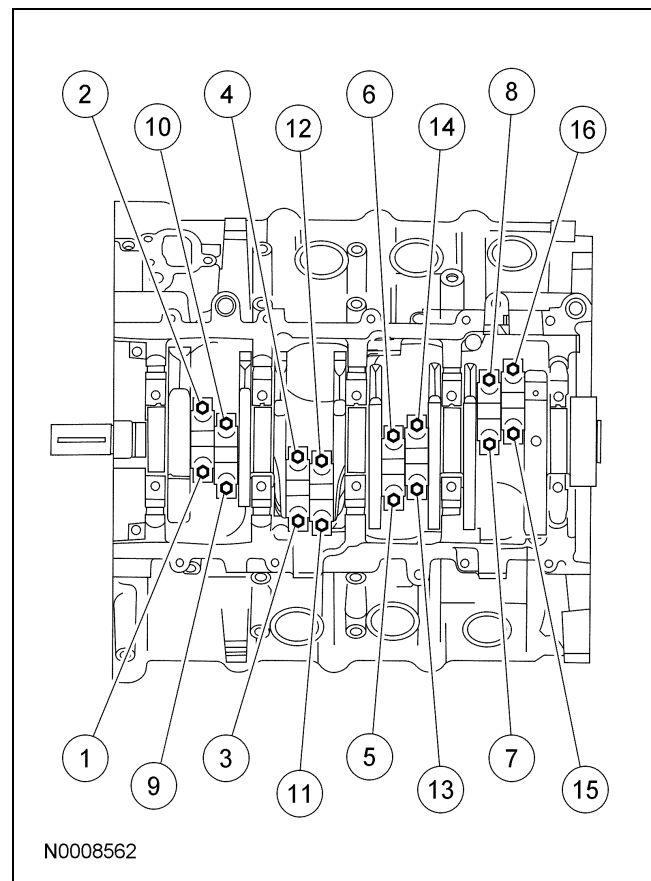
NOTE: The connecting rod caps are of the “cracked” design and must mate with the connecting rod ends. Excessive bearing clearance will result if not mated correctly.

Position the lower bearing and connecting rod, and install the new bolts loosely.

20. **NOTE:** Main bearing caps are removed for clarity.

Tighten the bolts in 2 stages, in the sequence shown.

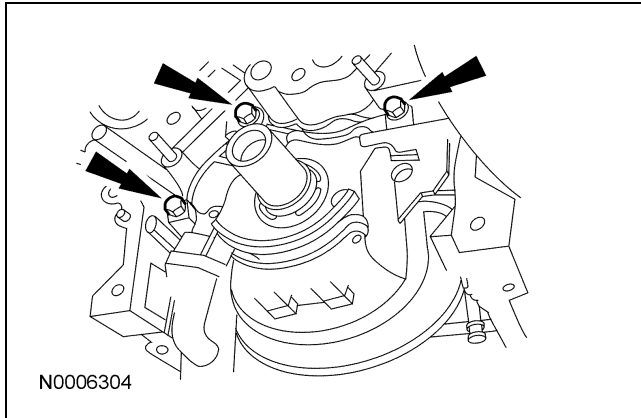
- Stage 1: Tighten to 43 Nm (32 lb-ft).
- Stage 2: Tighten an additional 105 degrees.



ASSEMBLY (Continued)

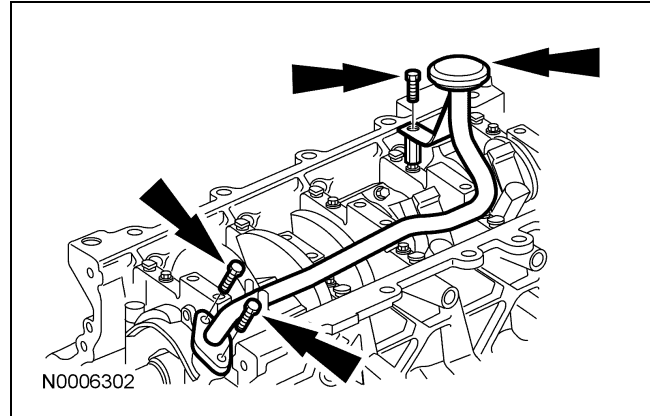
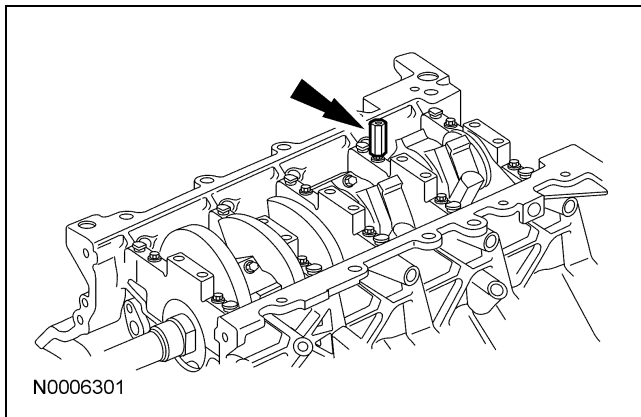
21. Position the oil pump and install the bolts.

- Tighten to 10 Nm (89 lb-in).

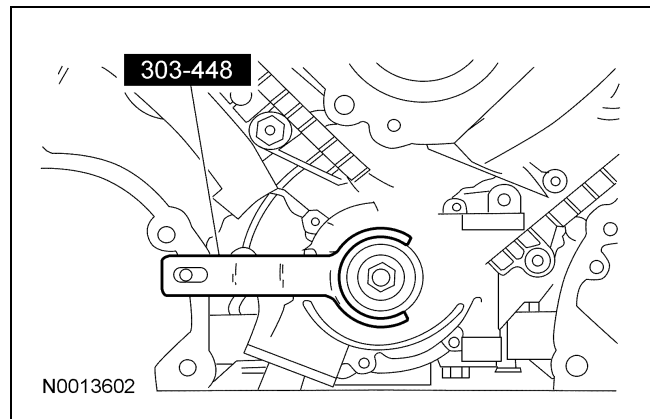


22. Install the oil pump screen and pickup tube spacer.

- Tighten to 25 Nm (18 lb-ft).



24. Position the crankshaft with the special tool, then remove the tool.



23. **⚠ CAUTION:** Make sure the O-ring is in place and not damaged. A missing or damaged O-ring can cause foam in the lubrication system, low oil pressure and severe engine damage.

NOTE: Clean and inspect the mating surfaces and install a new O-ring. Lubricate the O-ring with clean engine oil prior to installation.

Position the oil pump screen and pickup tube and install the bolts.

- Tighten the oil pump screen and pickup tube-to-oil pump bolts to 10 Nm (89 lb-in).
- Tighten the oil pump screen and pickup tube-to-spacer bolt to 25 Nm (18 lb-ft).

ASSEMBLY (Continued)

25. **CAUTION:** Make sure all coolant residue and foreign material are cleaned from the block surface and cylinder bore.

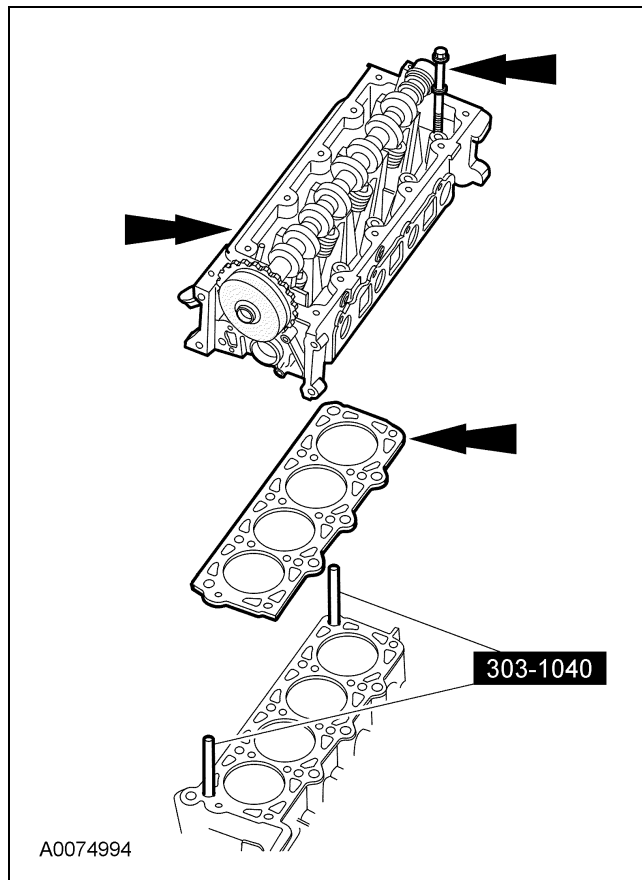
CAUTION: The use of sealing aids (aviation cement, copper spray and glue) is not permitted. The gasket must be installed dry or engine damage may occur.

CAUTION: The cylinder head bolts must be discarded and new bolts installed. They are a tighten-to-yield design and cannot be reused.

NOTE: Do not turn the crankshaft until instructed to do so.

NOTE: LH shown, RH similar.

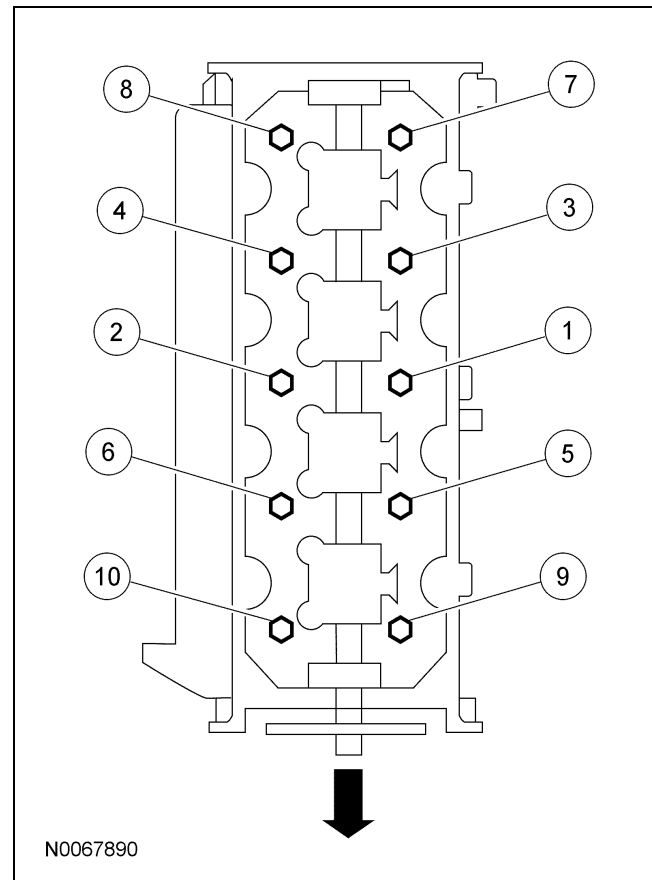
Using the special tools, position the cylinder head gaskets and cylinder heads over the dowels and install the cylinder head bolts loosely.



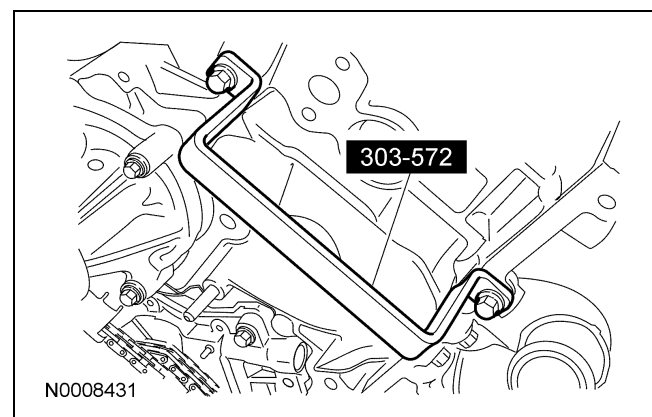
26. **NOTE:** Tighten the bolts in 3 stages, in the sequence shown.

NOTE: RH shown, LH similar.

- Stage 1: Tighten to 40 Nm (30 lb-ft).
- Stage 2: Tighten an additional 90 degrees.
- Stage 3: Tighten an additional 90 degrees.

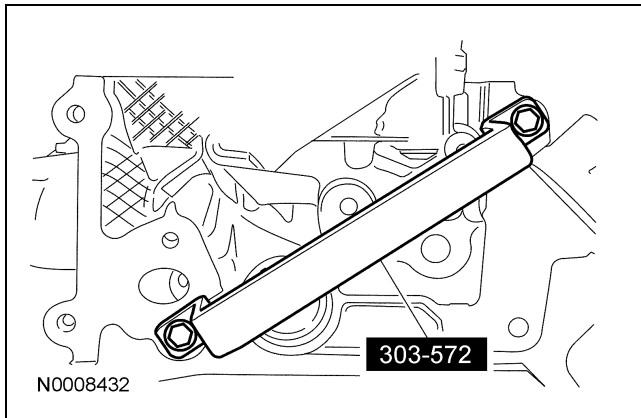


27. Remove the special tool from the LH cylinder head.



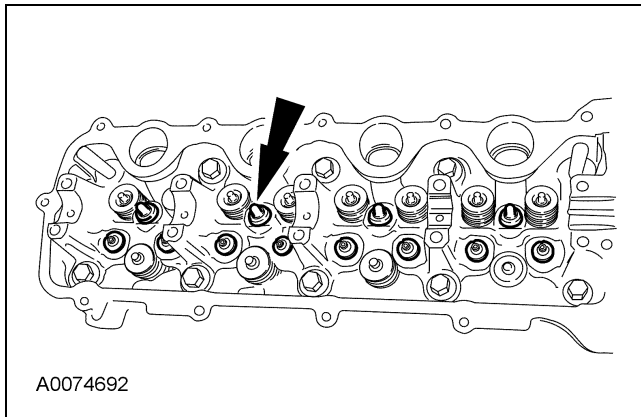
ASSEMBLY (Continued)

28. Remove the special tool from the RH cylinder head.



29. Install the hydraulic lash adjusters into the RH and LH cylinder heads.

- Lubricate the hydraulic lash adjusters with clean engine oil prior to installation.



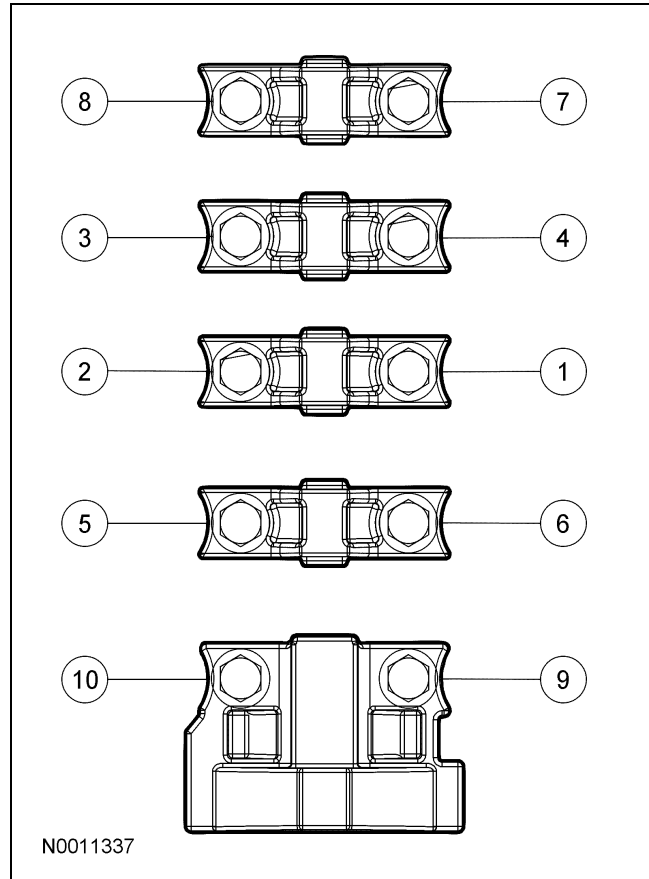
30. Install the LH and RH camshafts.

- Lubricate the camshaft and camshaft journals with clean engine oil prior to installation.

31. **NOTE:** LH shown, RH similar.

Install the LH and RH camshaft bearing caps in their original locations.

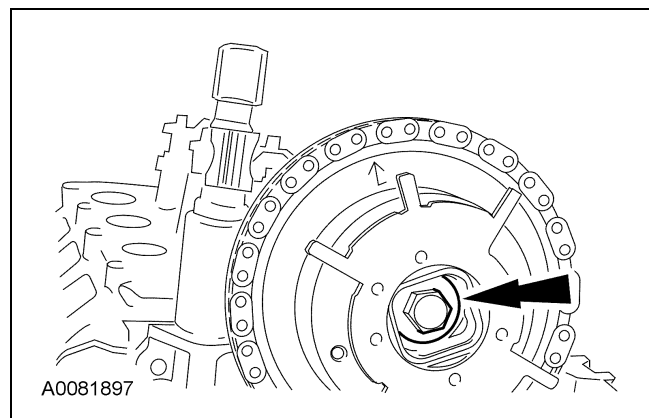
- Lubricate the camshaft bearing caps with clean engine oil.
- Position the front camshaft bearing cap.
- Position the remaining camshaft bearing caps.
- Install the bolts loosely.
- Tighten to 10 Nm (89 lb-in) in the sequence shown.




32. **⚠ CAUTION:** Damage to the variable camshaft timing (VCT) phaser sprocket assembly will occur if mishandled or used as a lifting or leveraging device.


NOTE: LH shown, RH similar.

Install the VCT phaser sprockets and new VCT phaser sprocket bolts finger tight.



ASSEMBLY (Continued)

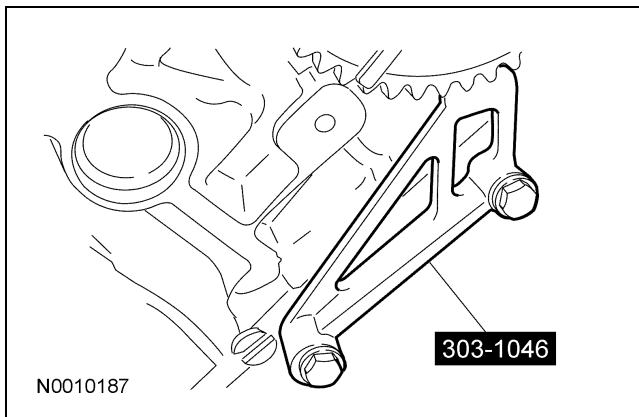
33.  **CAUTION:** Damage to the variable camshaft timing (VCT) phaser sprocket assembly will occur if mishandled or used as a lifting or leveraging device.


 **CAUTION:** Only use hand tools to remove the variable camshaft timing (VCT) phaser sprocket assembly or damage may occur to the camshaft or VCT phaser sprocket.


NOTE: LH shown, RH similar.

Using the special tool, tighten the LH and RH VCT phaser sprocket bolts in 2 stages.

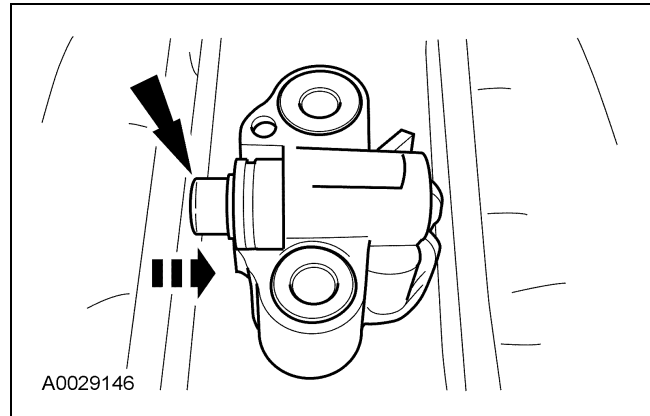
- Stage 1: Tighten to 40 Nm (30 lb-ft).
- Stage 2: Tighten an additional 90 degrees.



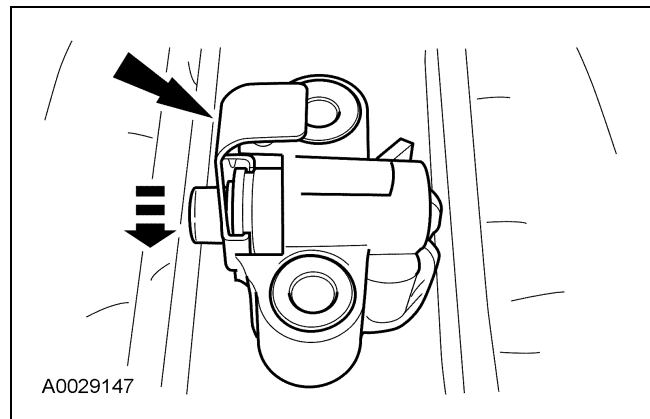
34.  **CAUTION:** Timing chain procedures must be followed exactly or damage to valves and pistons may result.

 **CAUTION:** Prior to installation, inspect the tensioner-sealing bead for seal integrity. If cracks, tears, separation from the tensioner body or permanent compression of the seal bead is observed, install a new tensioner or engine damage may occur.

Compress the tensioner plunger, using a vise.

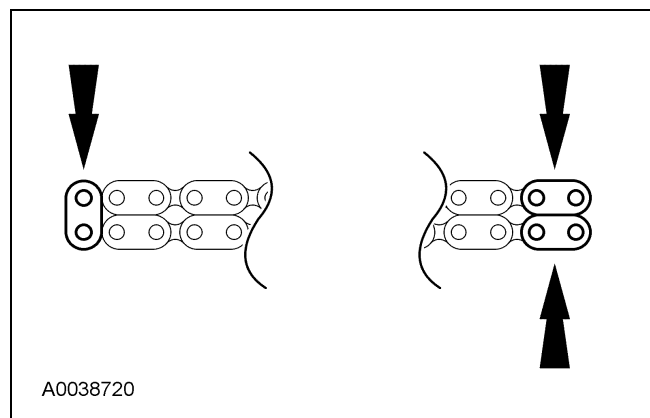


35. Install a retaining clip on the tensioner to hold the plunger in during installation.



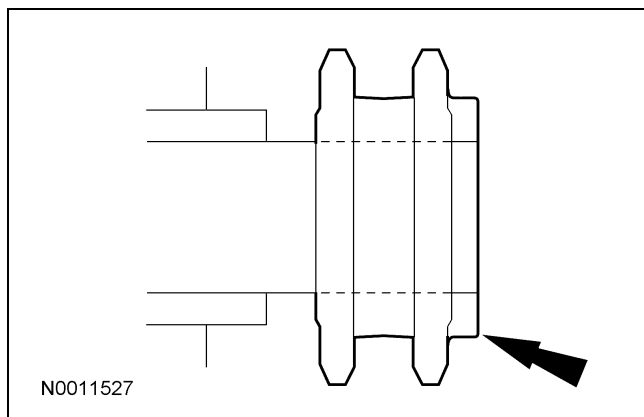
36. Remove the tensioner from the vise.

37. If the copper links are not visible, mark 2 links on one end and 1 link on the other end, and use as timing marks.



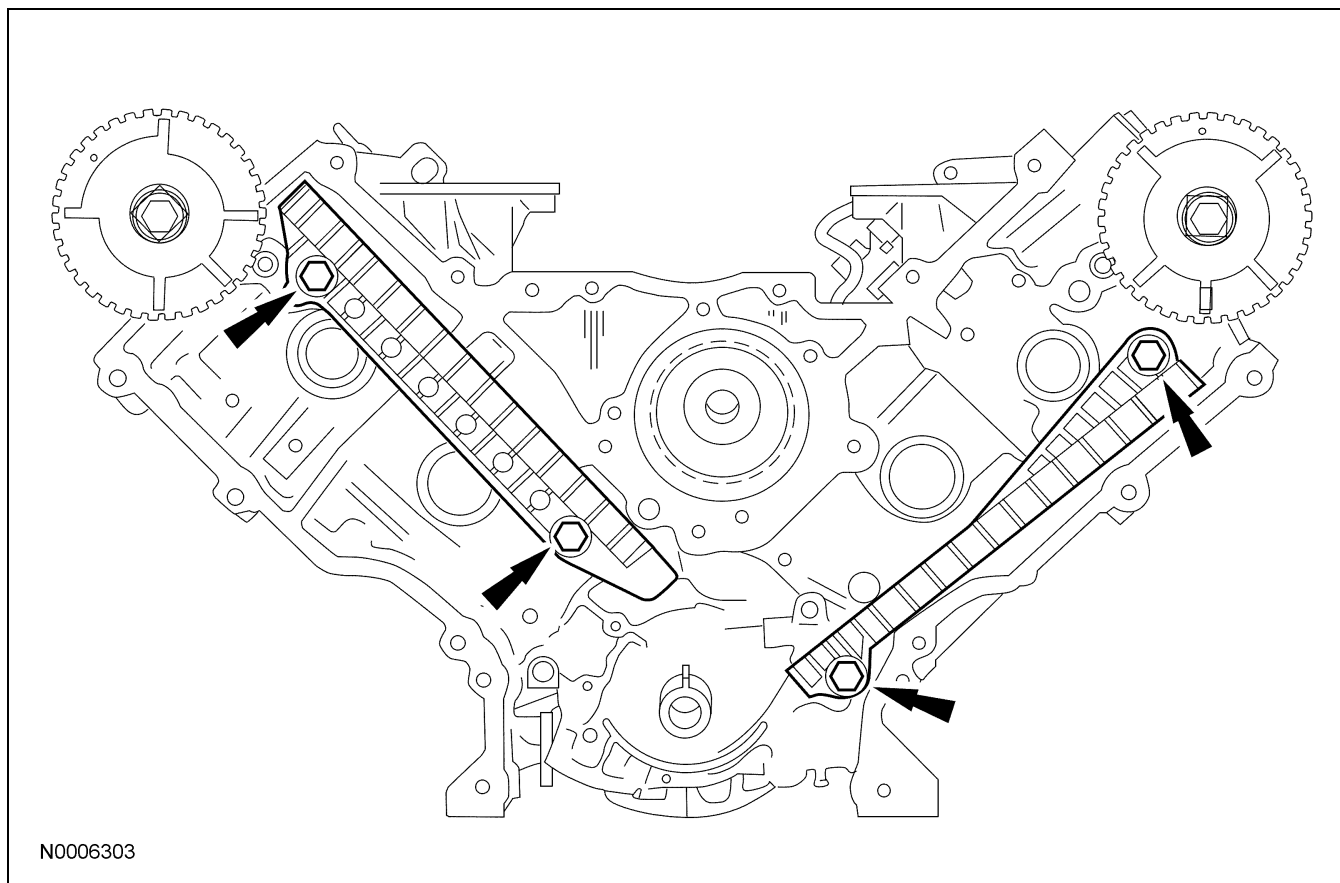
ASSEMBLY (Continued)

38. Install the crankshaft sprocket, making sure the flange faces forward.



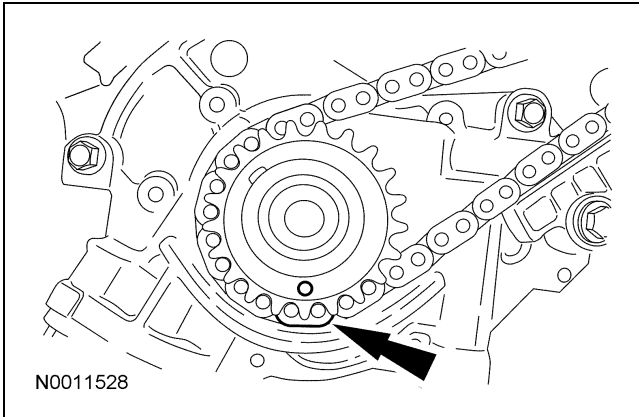
39. Install the 4 bolts and the LH and RH timing chain guides.

- Tighten to 10 Nm (89 lb-in).



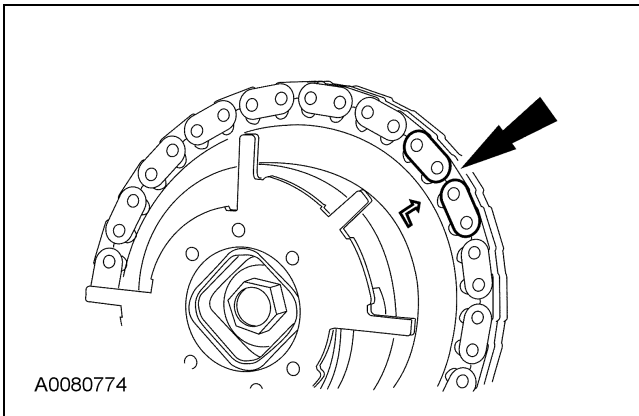
ASSEMBLY (Continued)

40. Position the lower end of the LH (inner) timing chain on the crankshaft sprocket, aligning the timing mark on the outer flange of the crankshaft sprocket with the single copper (marked) link on the chain.



41. **NOTE:** Make sure the upper half of the timing chain is below the tensioner arm dowel.

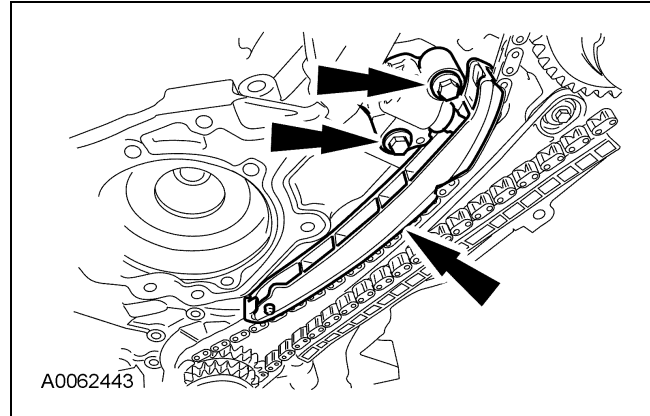
Position the timing chain on the VCT phaser sprocket with the timing mark positioned between the 2 copper (marked) chain links.



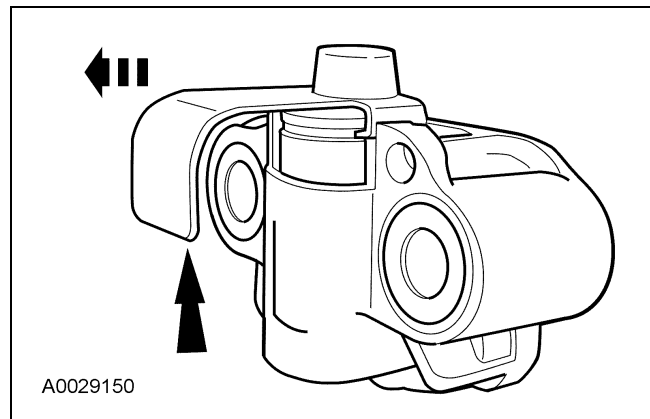
42. **NOTE:** The LH timing chain tensioner arm has a bump near the dowel hole for identification.

Position the LH timing chain tensioner arm on the dowel pin and install the LH timing chain tensioner and bolts.

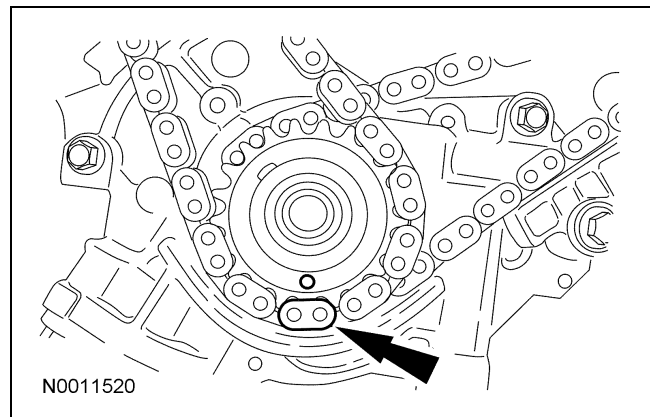
- Tighten to 25 Nm (18 lb-ft).



43. Remove the retaining clip from the LH timing chain tensioner.



44. Position the lower end of the RH (outer) timing chain on the crankshaft sprocket, aligning the timing mark on the sprocket with the single copper (marked) chain link.

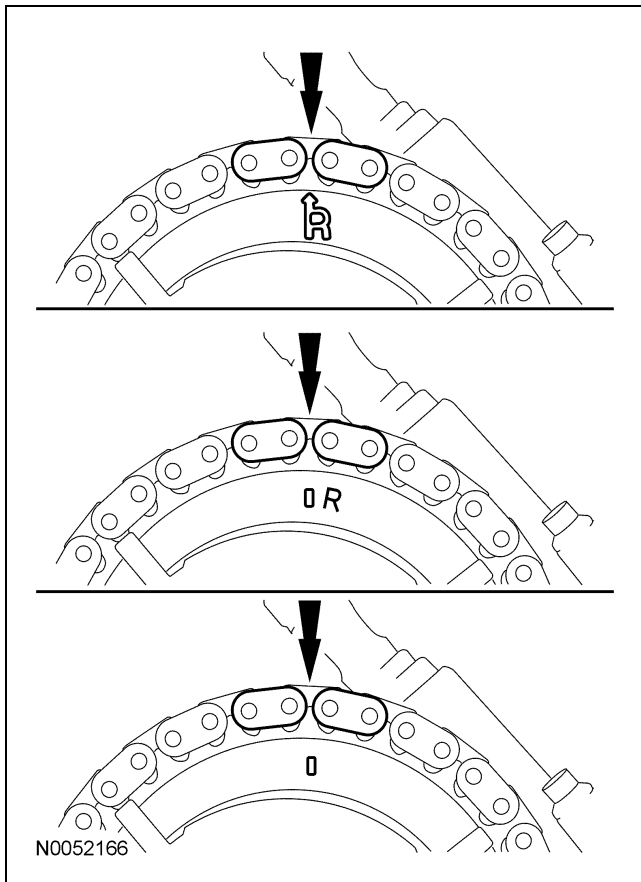


ASSEMBLY (Continued)

45. **NOTE:** The lower half of the timing chain must be positioned above the tensioner arm dowel.

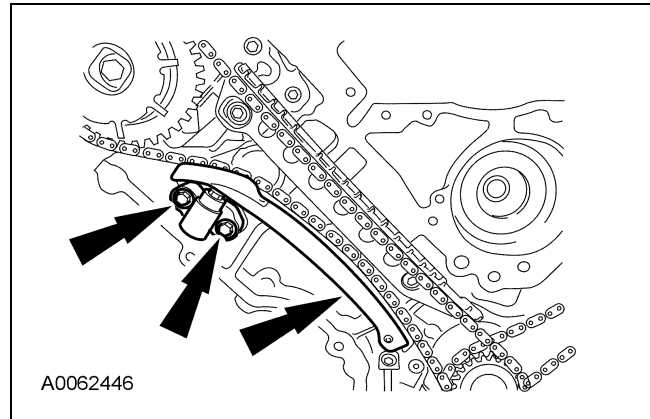
NOTE: The camshaft phaser and sprocket will be stamped with one of the illustrated timing marks for the RH camshaft.

Position the RH timing chain on the VCT phaser sprocket. Make sure the timing mark is positioned between the 2 copper (marked) chain links.

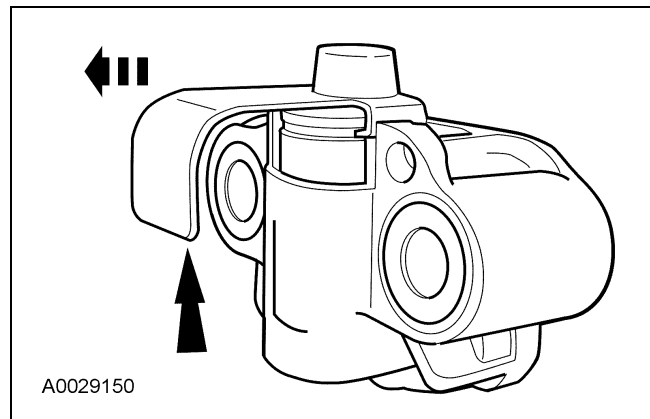


46. Position the RH timing chain tensioner arm on the dowel pin and install the RH timing chain tensioner and bolts.

- Tighten to 25 Nm (18 lb-ft).

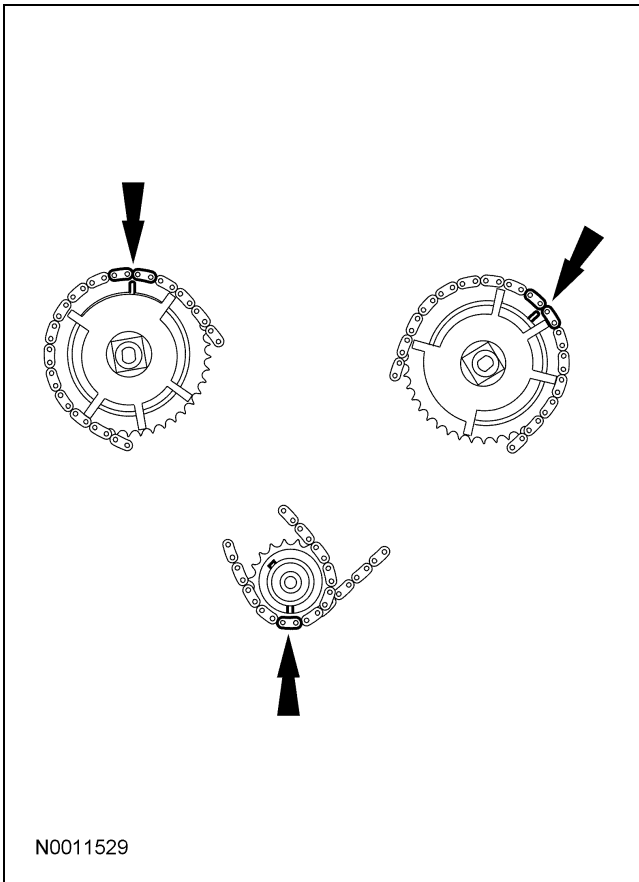


47. Remove the retaining clip from the RH timing chain tensioner.

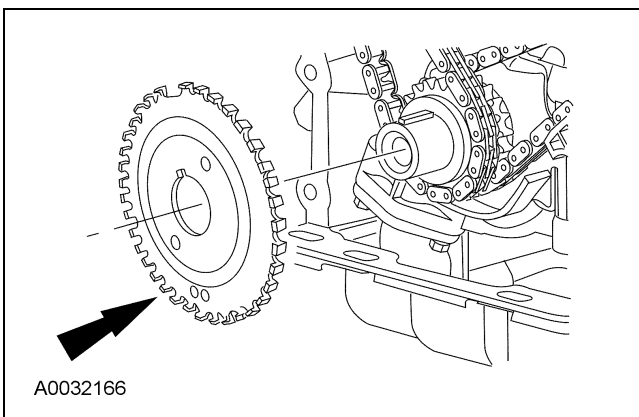


ASSEMBLY (Continued)

48. As a post-check, verify correct alignment of all timing marks.



49. Install the crankshaft sensor ring on the crankshaft.

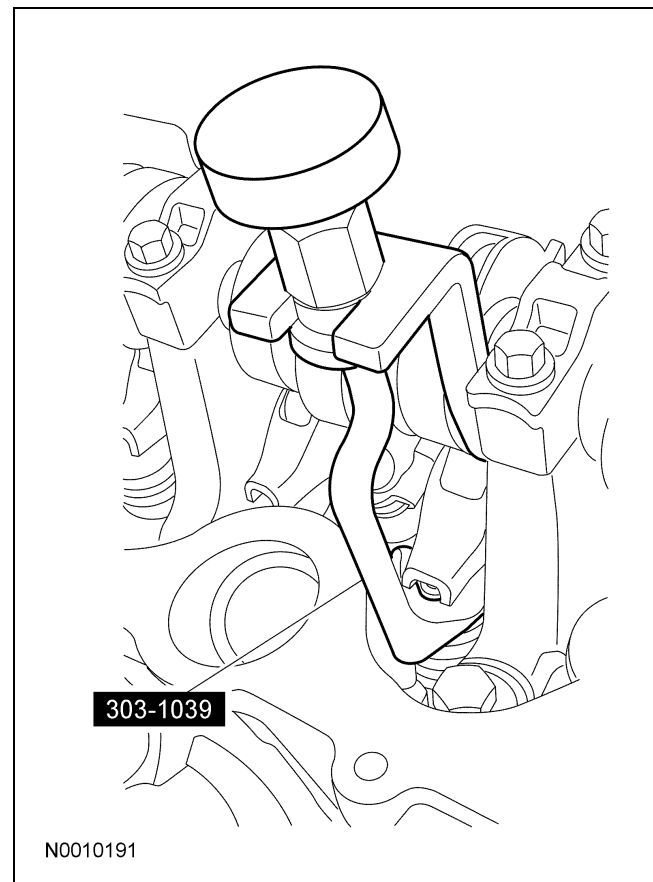


50. **NOTE:** Do not allow the valve keepers to fall off of the valve or the valve may drop into the cylinder. If a valve drops into the cylinder, the cylinder head must be removed.


NOTE: It may be necessary to push the valve down while compressing the spring.

Using the special tool, install all of the camshaft roller followers.

- Lubricate the camshaft roller followers with clean engine oil prior to installation.



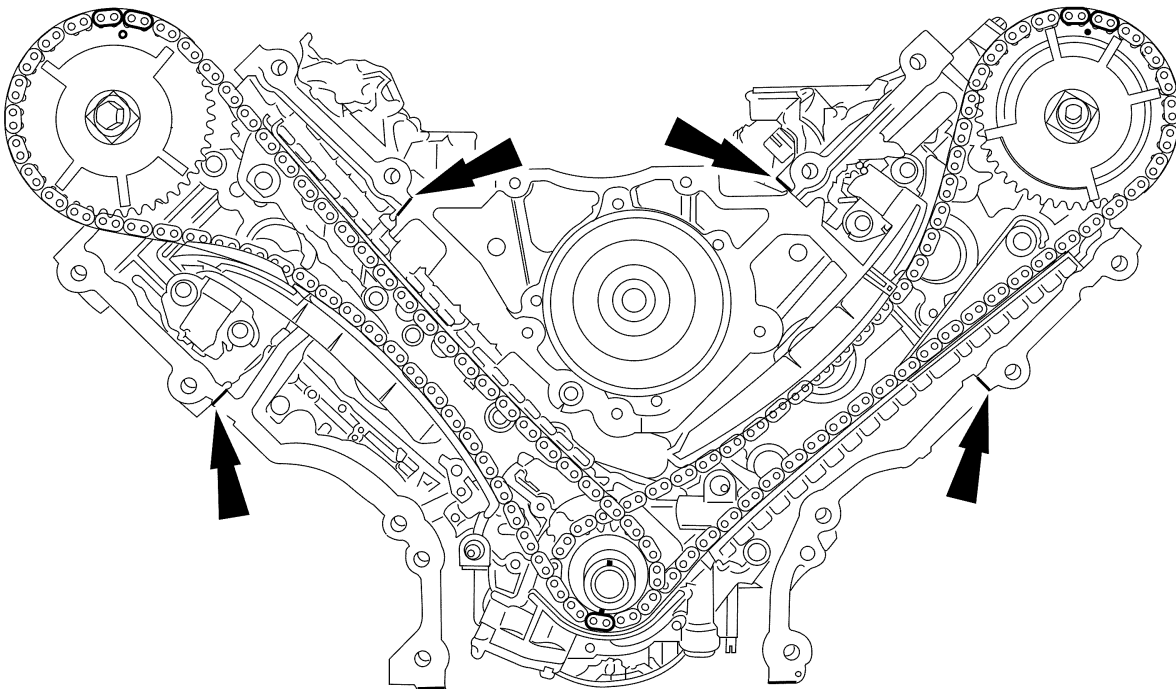
ASSEMBLY (Continued)

51.  **CAUTION:** Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the sealing surfaces. These tools cause scratches and gouges which make leak paths. Use a plastic scraping tool to remove all traces of old sealant.

NOTE: If the engine front cover is not secured within 4 minutes, the sealant must be removed and the sealing area cleaned. To clean the sealing area, use Silicone Gasket Remover and Motorcraft Metal Surface Prep. Follow the directions on the packaging. Allow to dry until there is no sign of wetness, or 4 minutes, whichever is longer. Failure to follow this procedure may cause future oil leakage.

NOTE: Make sure that the engine front cover gasket is in place on the engine front cover before installation.

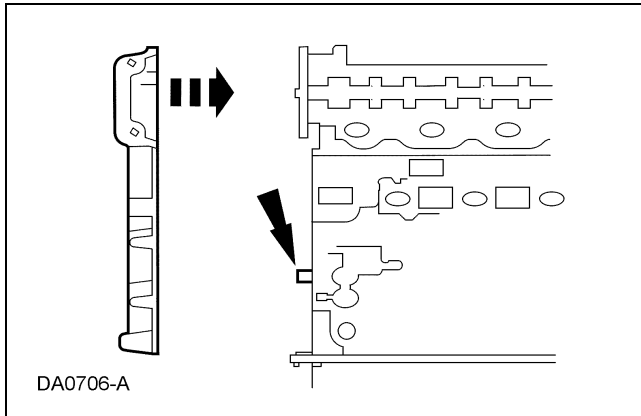
Apply a bead of Silicone Gasket and Sealant along the cylinder head-to-cylinder block surface at the locations shown.



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ASSEMBLY (Continued)

52. Install a new engine front cover gasket on the engine front cover. Position the engine front cover onto the dowels. Install the fasteners finger tight.



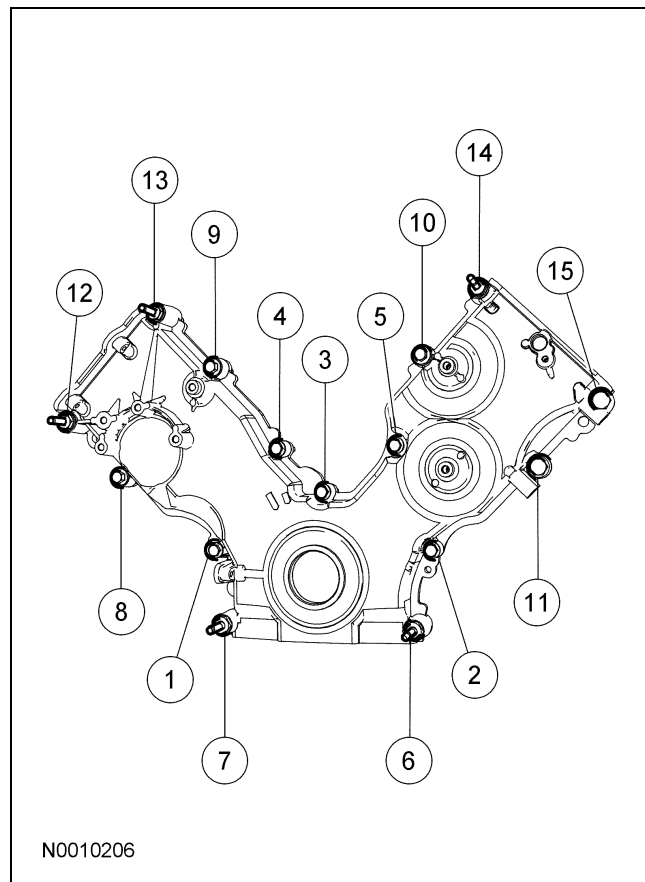
53. Tighten the engine front cover fasteners in sequence in 2 stages.

Stage 1: Tighten fasteners 1 through 15 to 25 Nm (18 lb-ft).

Stage 2: Tighten fasteners 6 and 7 to 48 Nm (35 lb-ft).

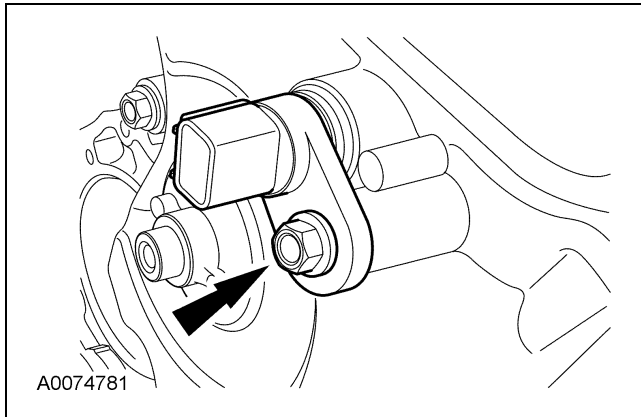
Item	Part Number	Description
1	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 50
2	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 50
3	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 50
4	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 50
5	N806177	Bolts, Hex Flange Head Pilot, M8 x 1.25 x 50
6	N808529	Stud, Hex Head Pilot, M10 x 1.5 x 1.5 x 103
7	N808529	Stud, Hex Head Pilot, M10 x 1.5 x 1.5 x 103
8	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 50

Item	Part Number	Description
9	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 50
10	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 50
11	W709573	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 50
12	W709573	Stud and Washer, Hex Head Pilot, M8 x 1.25 x 1.25 x 94
13	W709573	Stud and Washer, Hex Head Pilot, M8 x 1.25 x 1.25 x 94
14	W709573	Stud and Washer, Hex Head Pilot, M8 x 1.25 x 1.25 x 94
15	W709573	Bolt, Hex Head Pilot, M8 x 1.25 x 56

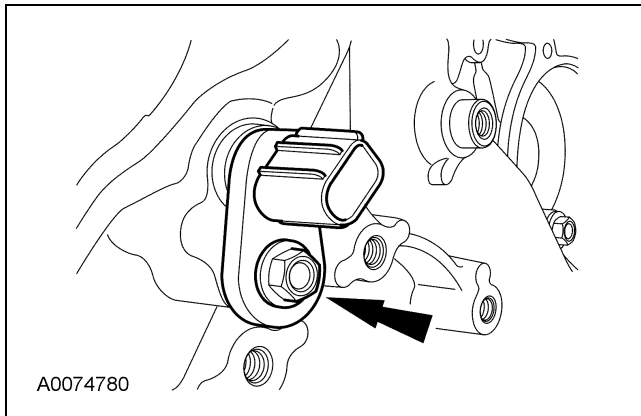


ASSEMBLY (Continued)

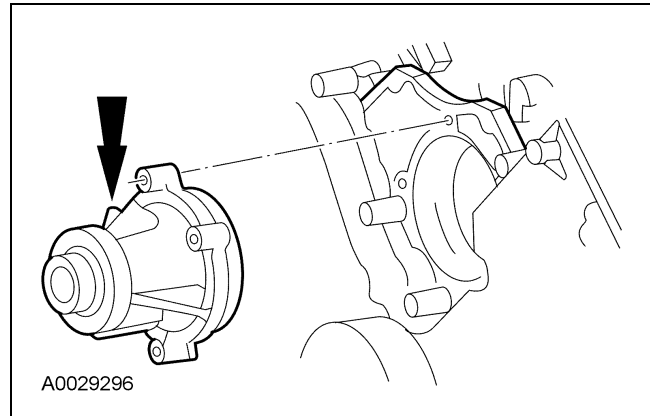
54. **NOTE:** Lubricate the O-ring seal with clean engine oil prior to installation.
Install the LH camshaft position (CMP) sensor and the bolt.
- Tighten to 10 Nm (89 lb-in).



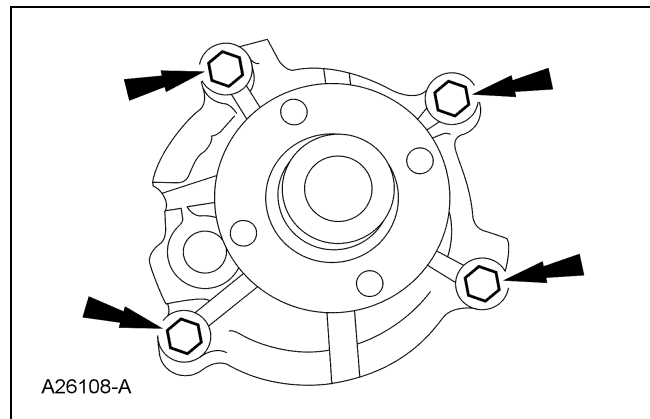
55. **NOTE:** Lubricate the O-ring seal with clean engine oil prior to installation.
Install the RH CMP sensor and the bolt.
- Tighten to 10 Nm (89 lb-in).



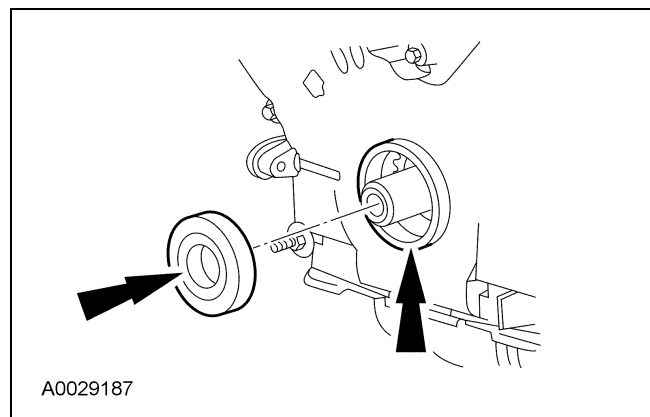
56. **⚠ CAUTION:** Do not rotate the coolant pump housing once the coolant pump has been positioned in the cylinder block. Damage to the O-ring seal will occur.
- Using a new O-ring seal, position the coolant pump and install the bolts loosely.
- Lubricate the new O-ring seal using clean engine coolant and install the O-ring seal onto the coolant pump.



57. Tighten the 4 coolant pump bolts.
- Tighten to 25 Nm (18 lb-ft).

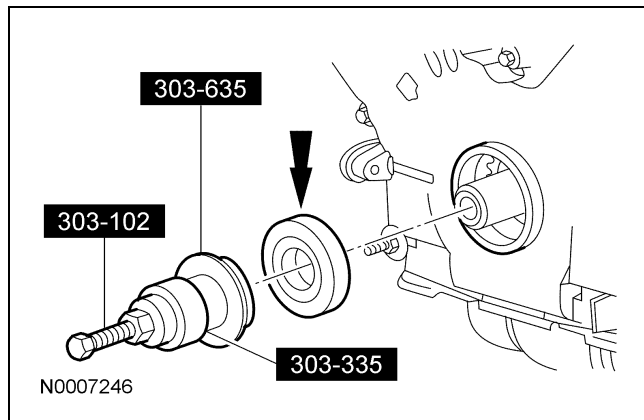


58. Lubricate the engine front cover and the crankshaft seal inner lip with clean engine oil.



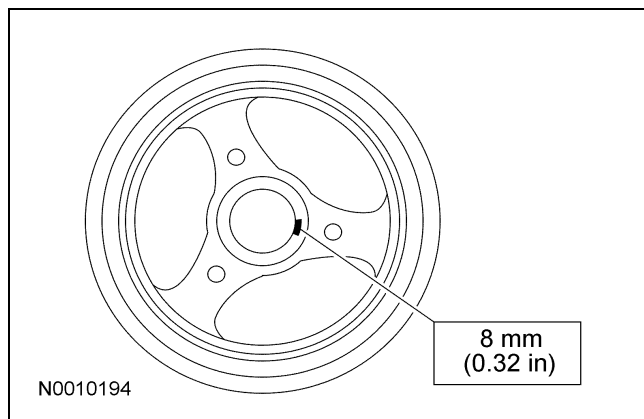
ASSEMBLY (Continued)

59. Using the special tools, install a new crankshaft front seal into the engine front cover.

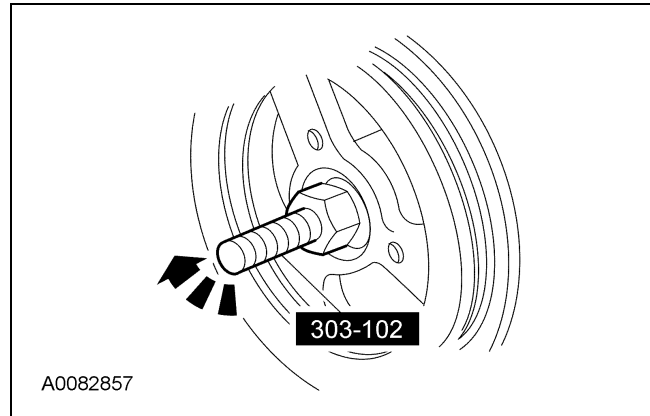


60. **NOTE:** If not secured within 4 minutes, the sealant must be removed and the sealing area cleaned. To clean the sealing area, use Silicone Gasket Remover and Motorcraft Metal Surface Prep. Follow the directions on the packaging. Allow to dry until there is no sign of wetness, or 4 minutes, whichever is longer. Failure to follow this procedure may cause future oil leakage.

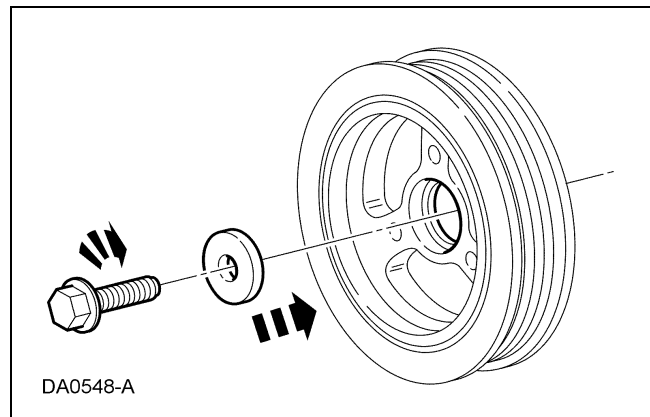
Apply Silicone Gasket and Sealant to the Woodruff key slot on the crankshaft pulley.



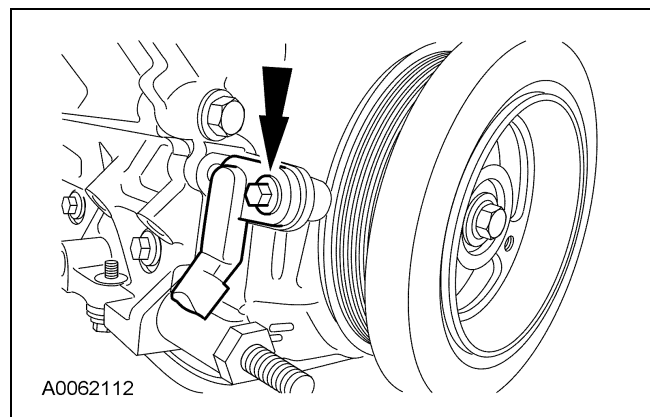
61. Use the special tool to install the crankshaft pulley.



62. Tighten the new crankshaft pulley bolt in 4 stages.
- Stage 1: Tighten to 90 Nm (66 lb-ft).
 - Stage 2: Loosen 360 degrees.
 - Stage 3: Tighten to 50 Nm (37 lb-ft).
 - Stage 4: Tighten an additional 90 degrees.



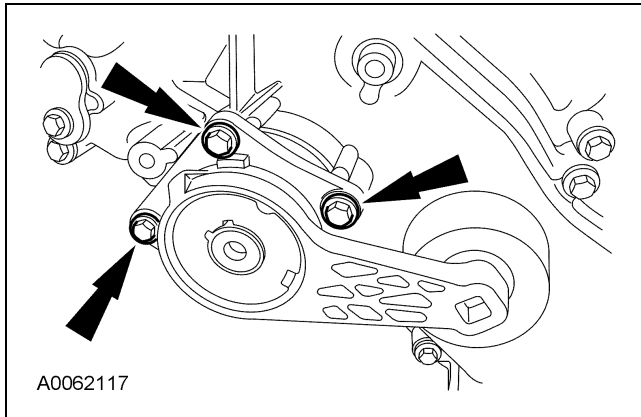
63. **NOTE:** Lubricate the O-ring seal with clean engine oil prior to installation. Position the crankshaft position (CKP) sensor and the bolt.
- Tighten to 10 Nm (89 lb-in).



ASSEMBLY (Continued)

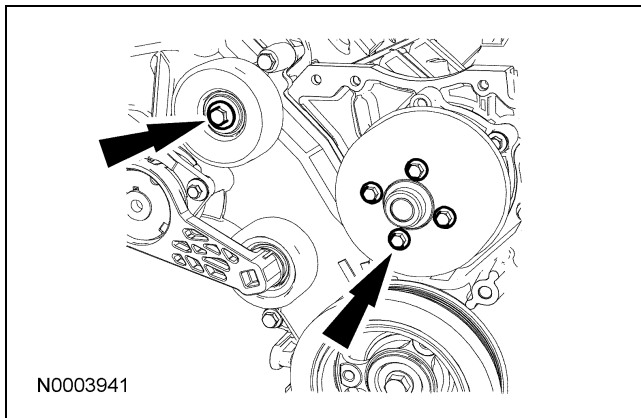
64. Position the accessory drive belt tensioner and install the 3 bolts.

- Tighten to 25 Nm (18 lb-ft).



65. Install the accessory drive belt idler pulley, the coolant pump pulley and the 5 bolts.

- Tighten to 25 Nm (18 lb-ft).

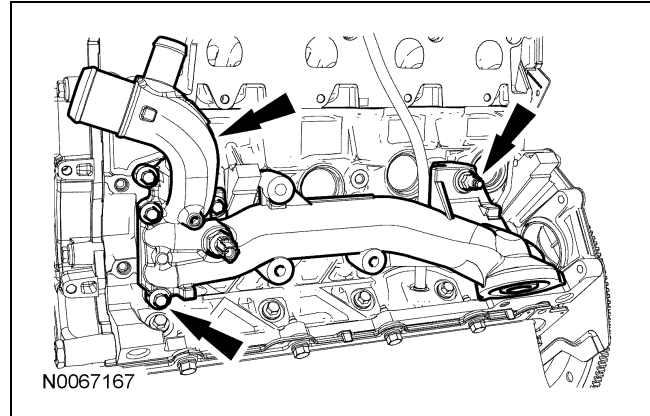


66. **⚠ CAUTION:** Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the sealing surfaces. These tools cause scratches and gouges which make leak paths. Use a plastic scraping tool to remove all traces of old sealant.

NOTE: Clean and inspect the mating surfaces, and install a new gasket.

Position the oil filter adapter and install the 4 bolts and the nut.

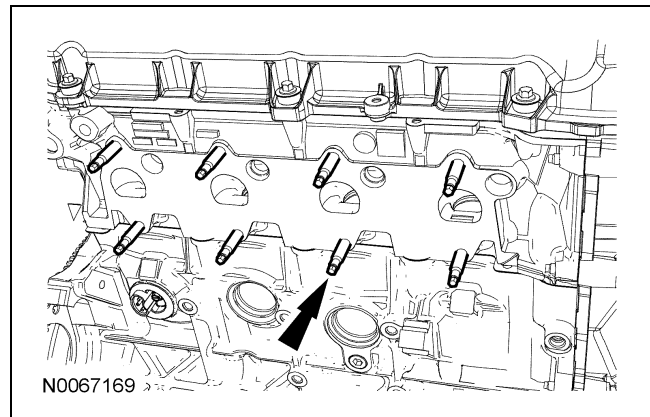
- Tighten the bolts to 25 Nm (18 lb-ft).
- Tighten the nut to 48 Nm (35 lb-ft).



67. **NOTE:** RH shown, LH similar.

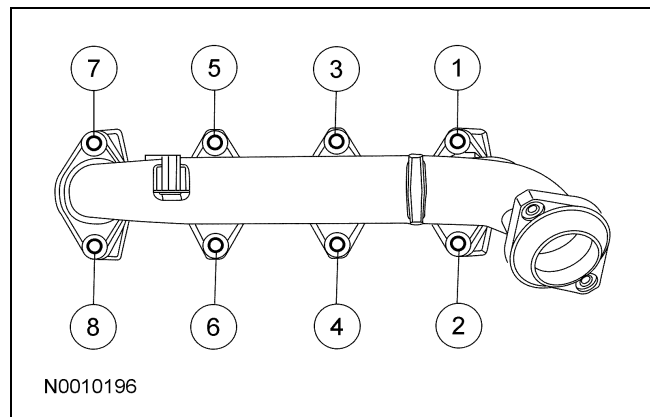
Install 16 new exhaust manifold studs.

- Tighten to 12 Nm (9 lb-ft).



68. Position a new gasket, the LH exhaust manifold and tighten the 8 new nuts in the sequence shown.

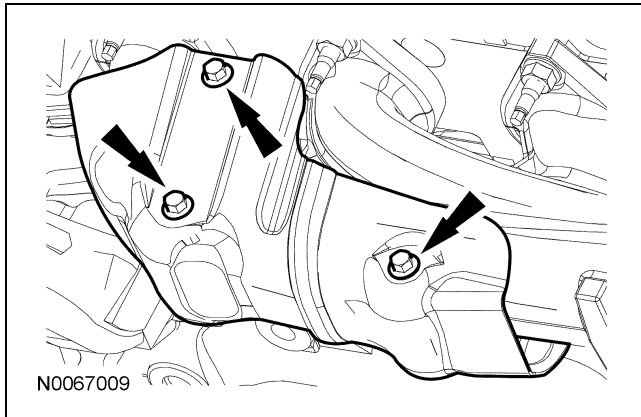
- Tighten to 25 Nm (18 lb-ft).



ASSEMBLY (Continued)

69. Position the LH exhaust manifold shield and install the 3 bolts.

- Tighten to 14 Nm (10 lb-ft).



70. **⚠ CAUTION:** The engine support insulator bracket bolts must be discarded and new bolts installed, or damage to the vehicle may occur. They are a tighten-to-yield design and cannot be reused.

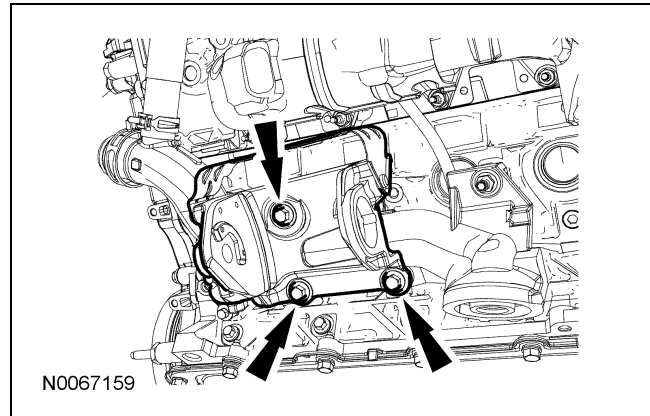
⚠ CAUTION: Clean the engine support insulator bracket mounting surfaces of any dirt or foreign material prior to installation. Failure to follow these instructions may result in engine support insulator damage.

NOTE: The engine support insulator bracket bolts must not be tightened more than 90 degrees after initial torque.

NOTE: Place a visible mark on the engine support insulator bracket and the bracket bolts. Turning the bolt 1 flat of the bolt head is equal to 60 degrees.

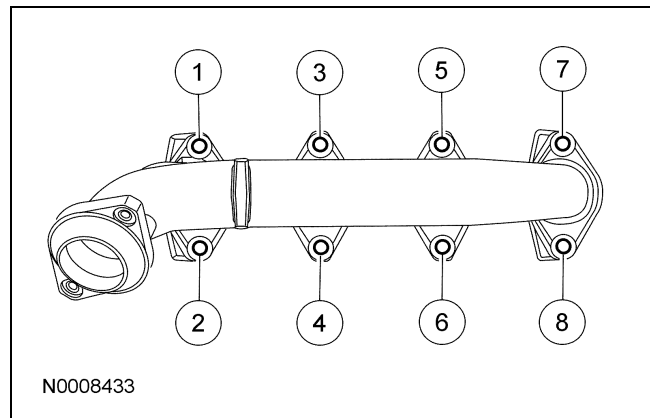
Position the LH engine support insulator bracket and install 3 new bolts in 2 stages.

- Stage 1: Tighten to 30 Nm (22 lb-ft).
- Stage 2: Tighten an additional minimum of 60 degrees.

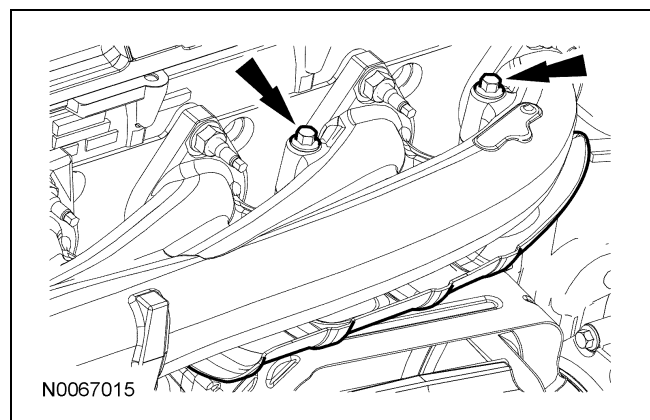


71. Position a new gasket, the RH exhaust manifold and tighten the 8 new nuts in the sequence shown.


- Tighten to 25 Nm (18 lb-ft).




72. Position the RH exhaust manifold heat shield and install the 2 bolts.



ASSEMBLY (Continued)

73.  **CAUTION:** The engine support insulator bracket bolts must be discarded and new bolts installed, or damage to the vehicle may occur. They are a tighten-to-yield design and cannot be reused.

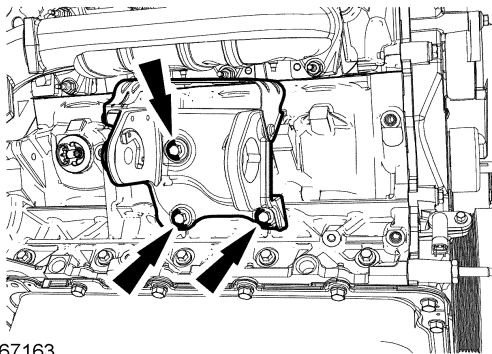
 **CAUTION:** Clean the engine support insulator bracket mounting surfaces of any dirt or foreign material prior to installation. Failure to follow these instructions may result in engine support insulator damage.

NOTE: The engine support insulator bracket bolts must not be tightened more than 90 degrees after initial torque.


NOTE: Place a visible mark on the engine support insulator bracket and the bracket bolts. Turning the bolt 1 flat of the bolt head is equal to 60 degrees.

Position the RH engine support insulator bracket, position the engine support insulator bracket and install 3 new bolts in 2 stages.

- Stage 1: Tighten to 30 Nm (22 lb-ft).
- Stage 2: Tighten an additional minimum of 60 degrees.



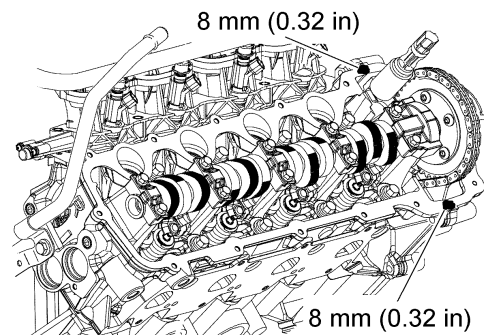
N0067163

74.  **CAUTION:** Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean sealing surfaces. These tools cause scratches and gouges which make leak paths. Use a plastic scraping tool to remove all traces of old sealant.

Clean the valve cover mating surface with Silicone Gasket Remover and Motorcraft Metal Surface Prep. Follow the directions on the packaging.


75. **NOTE:** If not secured within 4 minutes, the sealant must be removed and the sealing area cleaned. To clean the sealing area, use Silicone Gasket Remover and Motorcraft Metal Surface Prep. Follow the directions on the packaging. Allow to dry until there is no sign of wetness, or 4 minutes, whichever is longer. Failure to follow this procedure may cause future oil leakage.

Apply Silicone Gasket and Sealant in 2 places where the engine front cover meets the cylinder head.



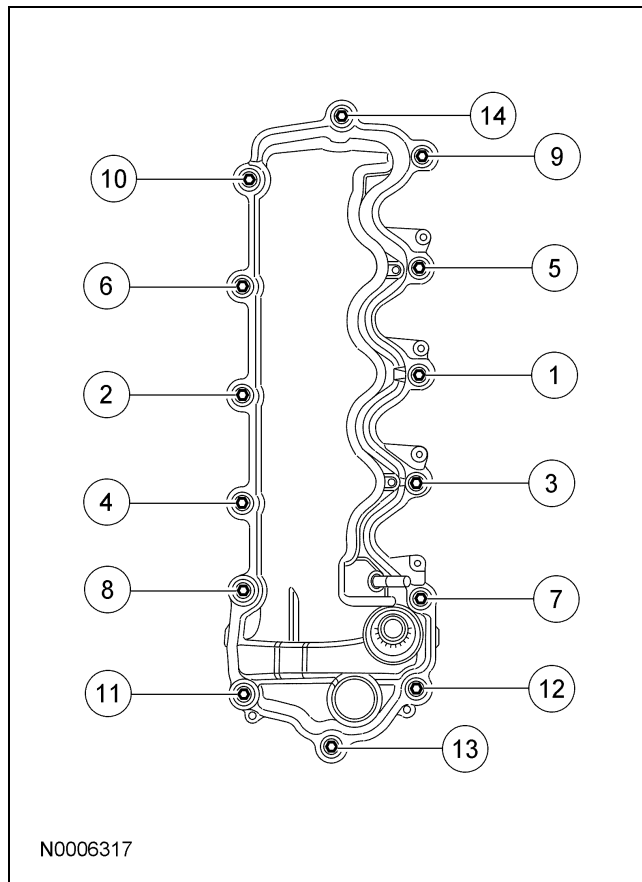
A0073630

ASSEMBLY (Continued)

76.  **CAUTION:** When installing the valve cover, make sure to avoid damaging the variable camshaft timing (VCT) solenoid.

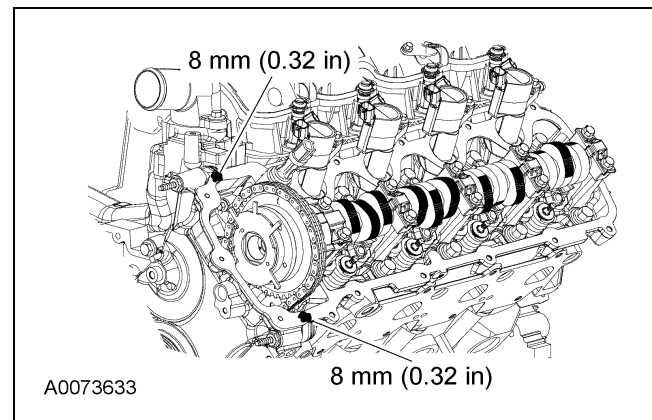
Position the RH valve cover and gasket on the cylinder head and tighten the fasteners in the sequence shown.


- Tighten to 10 Nm (89 lb-in).



78. **NOTE:** If not secured within 4 minutes, the sealant must be removed and the sealing area cleaned. To clean the sealing area, use Silicone Gasket Remover and Motorcraft Metal Surface Prep. Follow the directions on the packaging. Allow to dry until there is no sign of wetness, or 4 minutes, whichever is longer. Failure to follow this procedure may cause future oil leakage.


Apply Silicone Gasket and Sealant in 2 places where the engine front cover meets the cylinder head.



77.  **CAUTION:** Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean sealing surfaces. These tools cause scratches and gouges which make leak paths. Use a plastic scraping tool to remove all traces of old sealant.

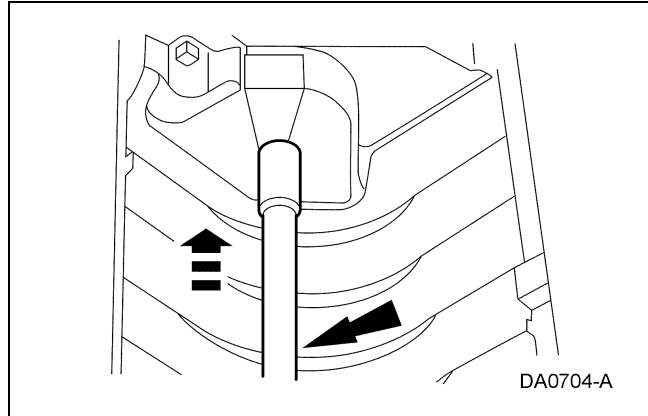
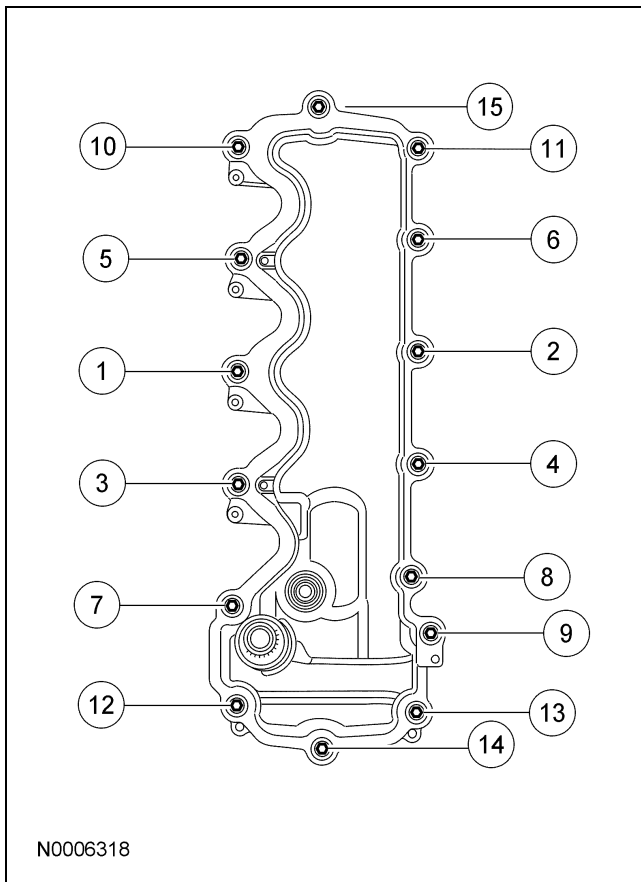
Clean the valve cover mating surface with Silicone Gasket Remover and Motorcraft Metal Surface Prep. Follow the directions on the packaging.

ASSEMBLY (Continued)

79.  **CAUTION:** When installing the valve cover, make sure to avoid damaging the variable camshaft timing (VCT) solenoid.

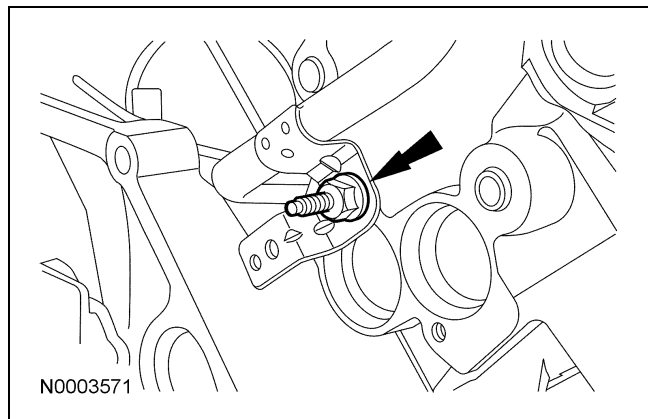
Position the LH valve cover and gasket on the cylinder head and tighten the fasteners in the sequence shown.

- Tighten to 10 Nm (89 lb-in).



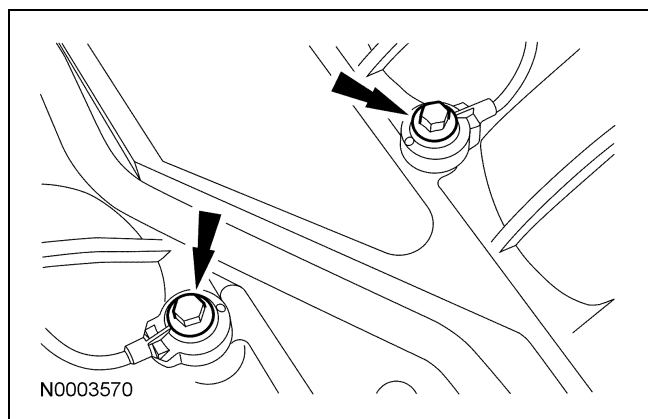
81. Install the coolant tube stud bolt.

- Tighten to 10 Nm (89 lb-in).



82. Install the 2 knock sensors (KS) and the bolts.

- Tighten to 20 Nm (15 lb-ft).



80. **NOTE:** Do not reuse the O-ring seals.

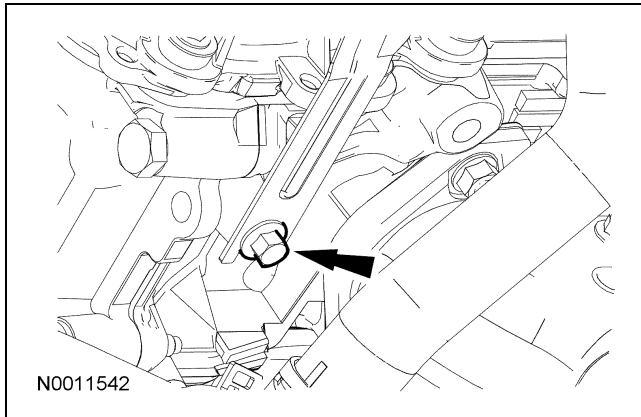
NOTE: Lubricate new O-ring seals with clean engine coolant prior to installation.

Slide the coolant tube forward with the new O-ring seals into the cylinder block.

ASSEMBLY (Continued)

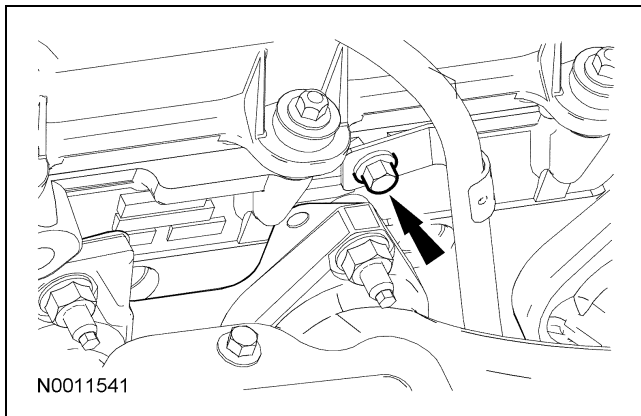
83. Install the oil level indicator tube and the front bolt.

- Tighten to 25 Nm (18 lb-ft).
- Install a new O-ring seal and lubricate with clean engine oil prior to installation.

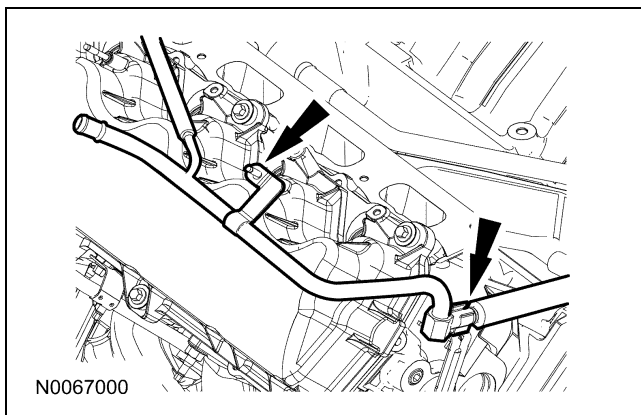


84. Install the rear oil level indicator tube bolt.

- Tighten to 10 Nm (89 lb-in).

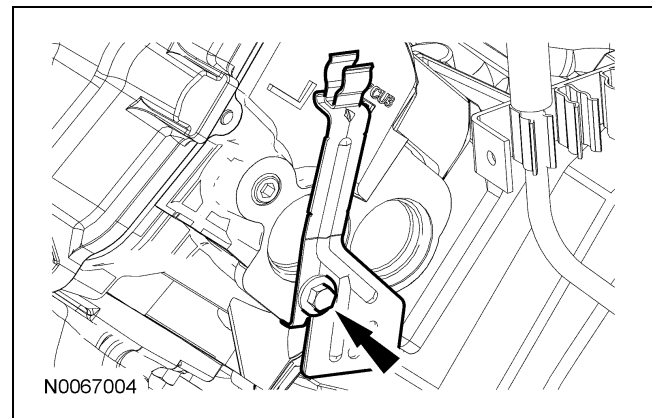


85. Connect the intake manifold vacuum tube to the valve cover stud and the support bracket.



86. Position the intake manifold vacuum tube support bracket and install the bolt.

- Tighten to 10 Nm (89 lb-in).

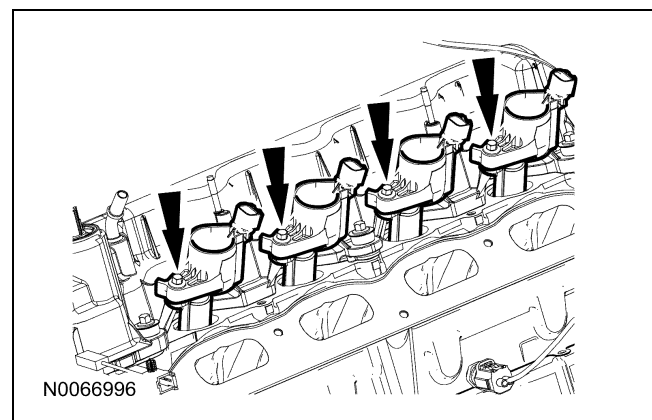


87. **NOTE:** Verify that the ignition coil spring is correctly located inside the ignition coil boot and that there is no damage to the tip of the boot.

NOTE: LH shown, RH similar.

Install the 8 ignition coils and the 8 bolts.

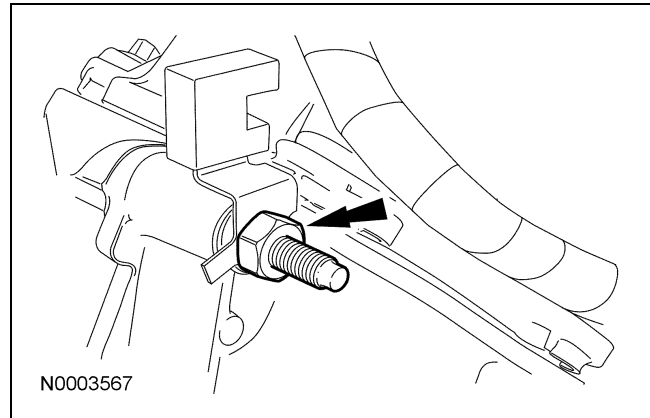
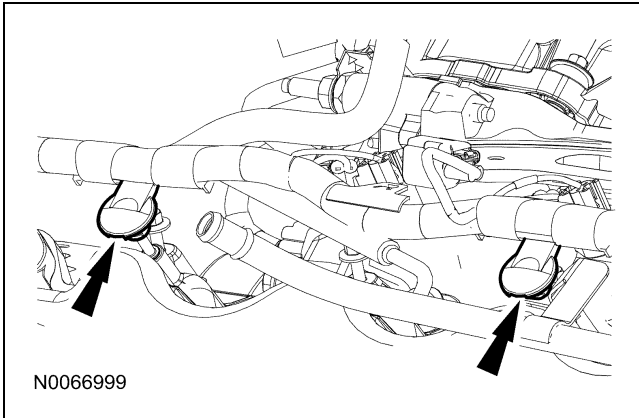
- Apply a light coat of dielectric compound to the inside of the ignition coil boots prior to installation.
- Tighten to 6 Nm (53 lb-in).



88. Position the engine wiring harness onto the engine assembly.

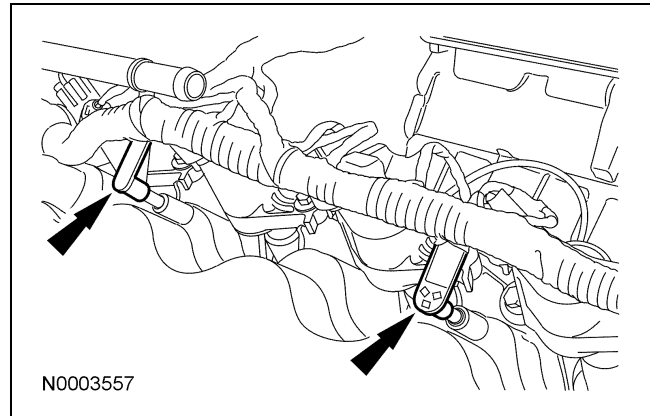
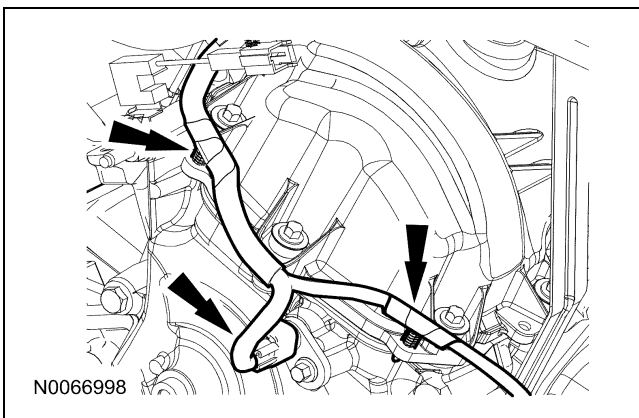
ASSEMBLY (Continued)

89. Connect the 2 engine wiring harness retainers to the LH valve cover studs.

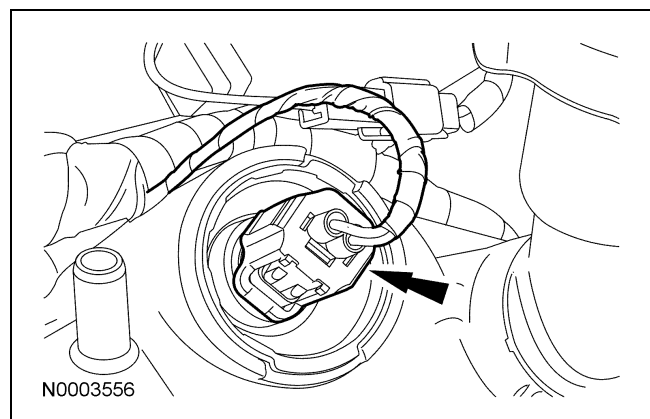
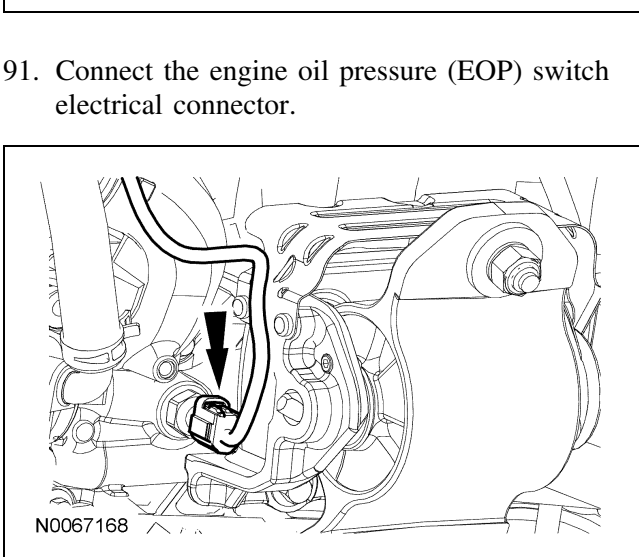


93. Connect the 2 engine wiring harness retainers from the RH valve cover studs.

90. Connect the engine wiring harness position retainers to the front of the LH valve cover and the LH CMP sensor electrical connector.



94. Connect the RH VCT solenoid electrical connector.



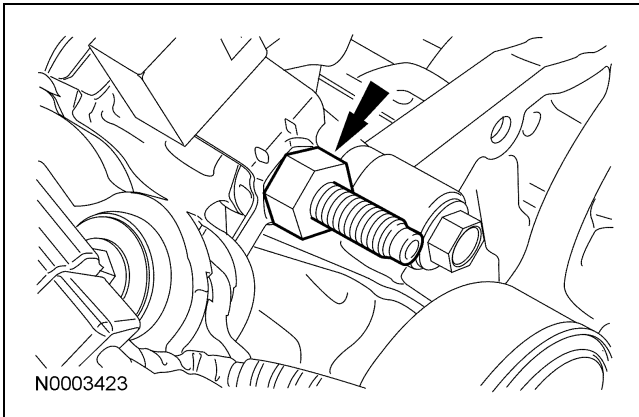
92. Install the LH radio ignition interference capacitor and the nut.

- Tighten to 10 Nm (89 lb-in).

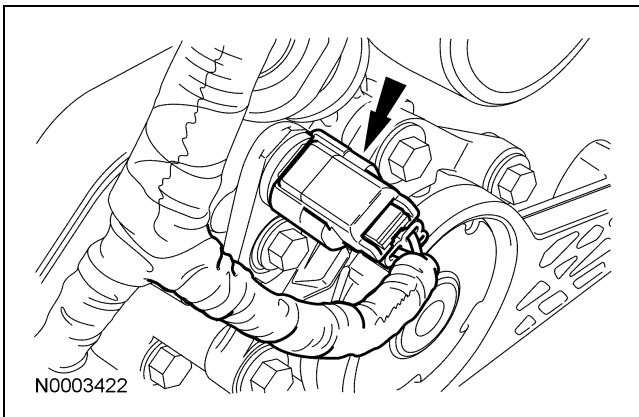
ASSEMBLY (Continued)

95. Install the RH radio ignition interference capacitor and the nut.

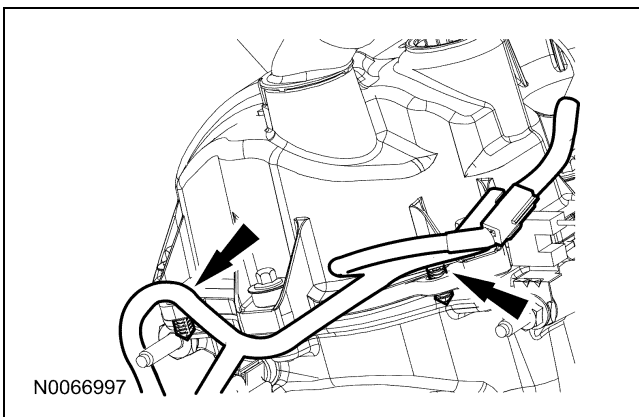
- Tighten to 10 Nm (89 lb-in).



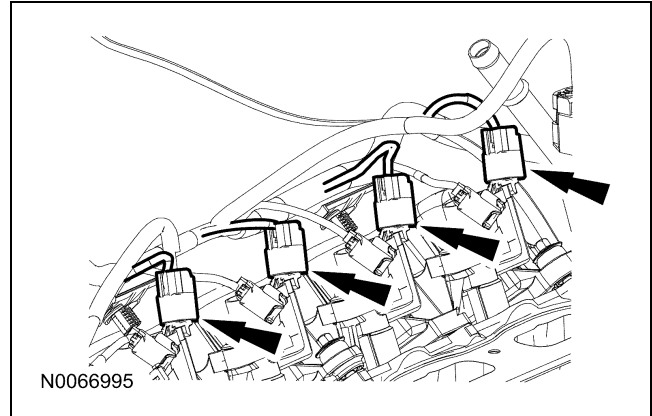
96. Connect the RH CMP sensor electrical connector.



97. Connect the engine wiring harness position retainers to the front of the RH valve cover.



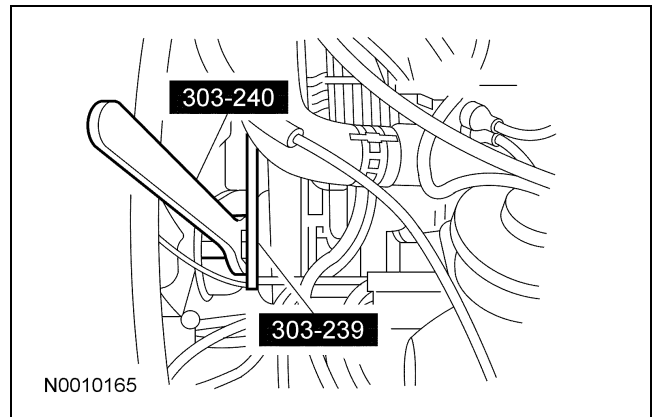
98. **NOTE:** LH shown, RH similar.
Connect the 8 ignition coil electrical connectors.



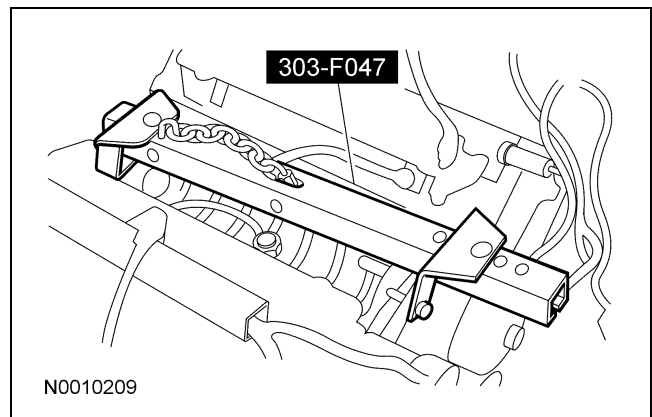
99. **NOTE:** The large clutch assembly nut has a RH thread and must be rotated clockwise to remove it.

Using the special tool, install the engine cooling fan onto the coolant pump pulley.

- Tighten to 55 Nm (41 lb-ft).




100. Install the special tool.



101. Using a suitable floor crane, remove the engine from the engine stand.

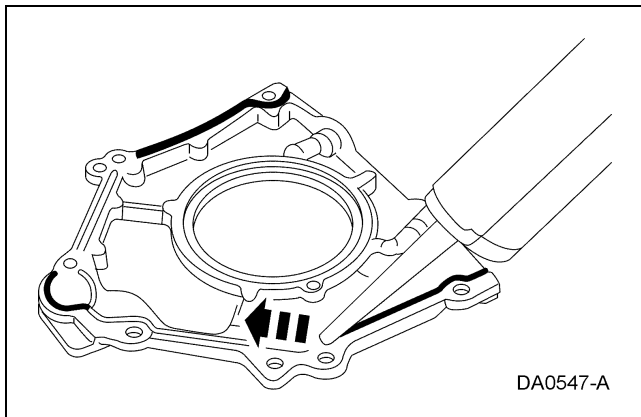
ASSEMBLY (Continued)

102.  **CAUTION:** Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the aluminum retainer plate. These tools cause scratches and gouges, which make leak paths. Use a plastic scraping tool to remove all traces of old sealant. Failure to follow this procedure can cause future oil leakage.

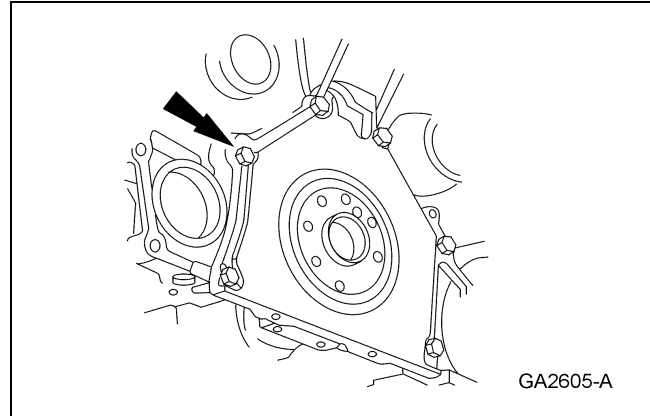
Inspect the crankshaft rear seal retainer plate. Clean the mating surface for the rear seal retainer plate with Silicone Gasket Remover and Motorcraft Metal Surface Prep. Follow the directions on the packaging.

103. **NOTE:** If not secured within 4 minutes, the sealant must be removed and the sealing area cleaned. To clean the sealing area, use Silicone Gasket Remover and Motorcraft Metal Surface Prep. Follow the directions on the packaging. Allow to dry until there is no sign of wetness, or 4 minutes, whichever is longer. Failure to follow this procedure may cause future oil leakage.

Apply a 4 mm (0.16 in) bead of Silicone Gasket and Sealant around the crankshaft rear seal retainer sealing surface.

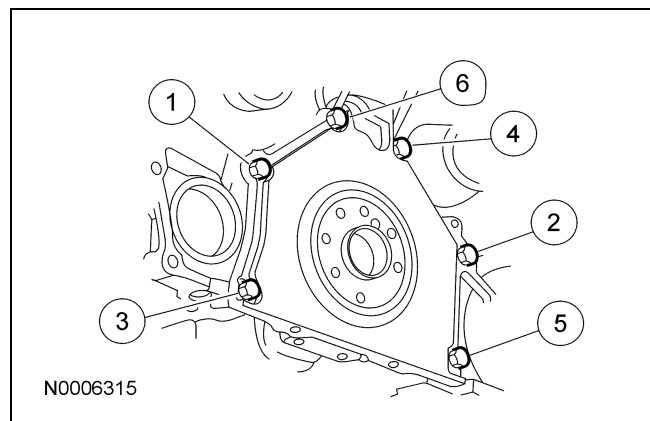



104. Install the crankshaft rear seal retainer plate and loosely install the 6 bolts.



105. Tighten the bolts in the sequence shown.

- Tighten to 10 Nm (89 lb-in).



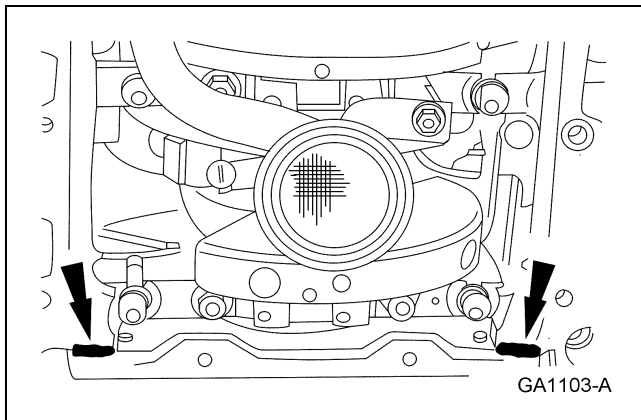
106.  **CAUTION:** Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the sealing surfaces. These tools cause scratches and gouges, which make leak paths. Use a plastic scraping tool to remove all traces of old sealant.

Inspect the oil pan. Clean the mating surface for the oil pan with Silicone Gasket Remover and Motorcraft Metal Surface Prep. Follow the directions on the packaging.

ASSEMBLY (Continued)

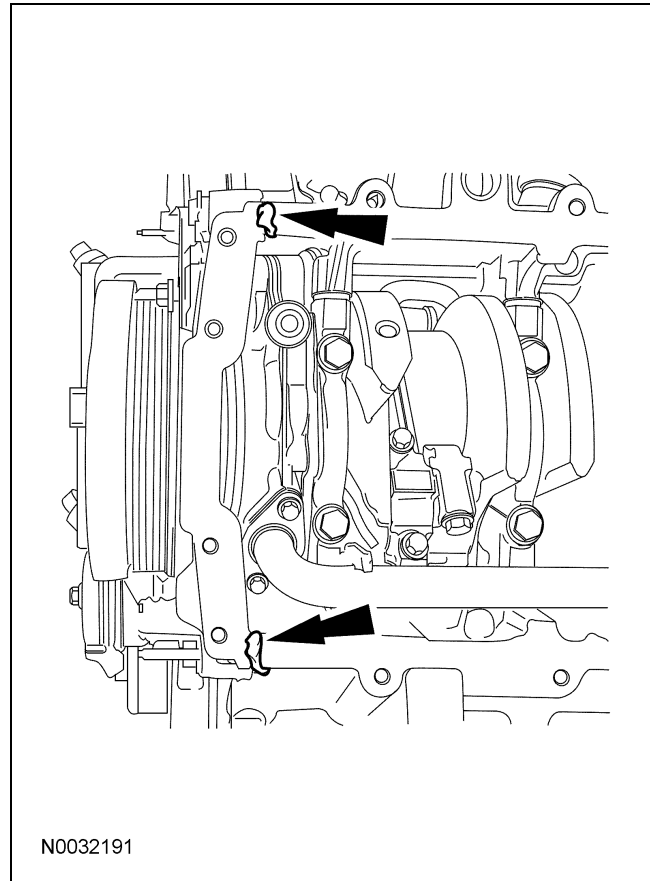
107. **NOTE:** If not secured within 4 minutes, the sealant must be removed and the sealing area cleaned. To clean the sealing area, use Silicone Gasket Remover and Motorcraft Metal Surface Prep. Follow the directions on the packaging. Allow to dry until there is no sign of wetness, or 4 minutes, whichever is longer. Failure to follow this procedure may cause future oil leakage.

Apply Silicone Gasket and Sealant at the crankshaft rear seal retainer plate-to-cylinder block sealing surface.

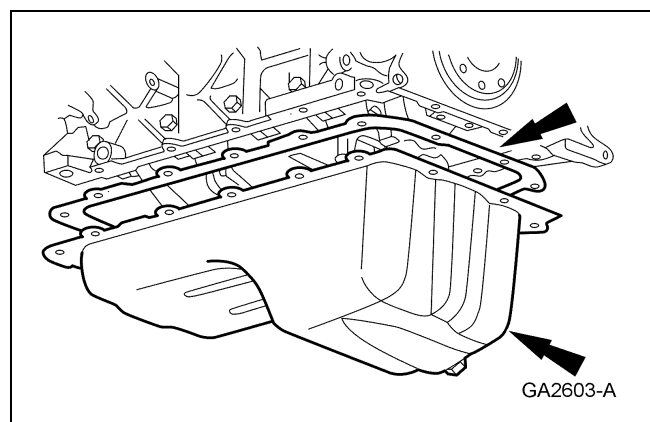


108. **NOTE:** If not secured within 4 minutes, the sealant must be removed and the sealing area cleaned. To clean the sealing area, use Silicone Gasket Remover and Motorcraft Metal Surface Prep. Follow the directions on the packaging. Allow to dry until there is no sign of wetness, or 4 minutes, whichever is longer. Failure to follow this procedure may cause future oil leakage.

Apply Silicone Gasket and Sealant at the engine front cover-to-cylinder block sealing surface.



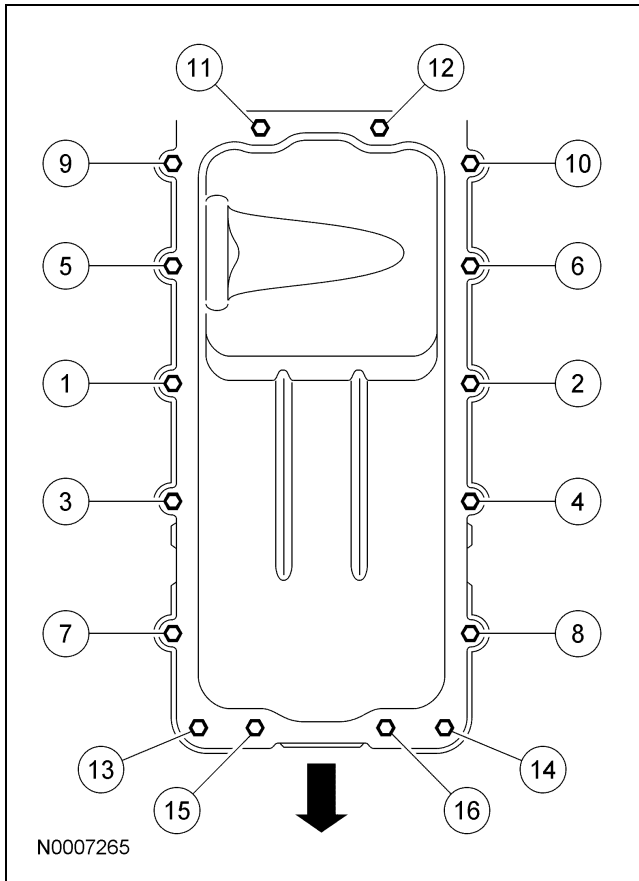
109. Install the oil pan gasket and the oil pan and loosely install the bolts.



ASSEMBLY (Continued)

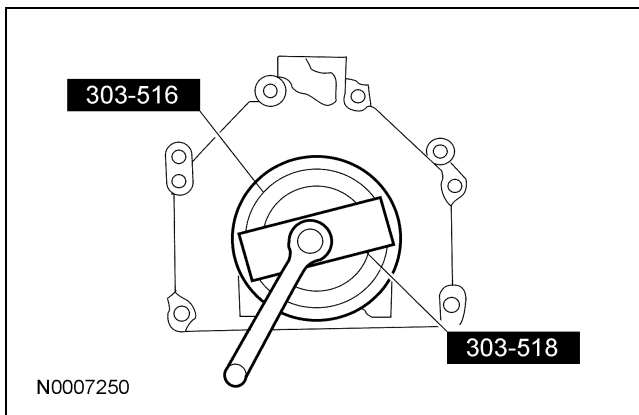
110. Tighten the bolts in 3 stages, in the sequence shown.

- Stage 1: Tighten to 2 Nm (18 lb-in).
- Stage 2: Tighten to 20 Nm (15 lb-ft).
- Stage 3: Tighten an additional 60 degrees.

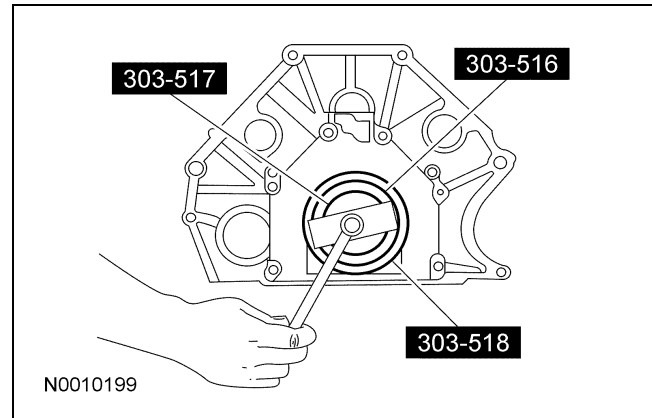


111. **NOTE:** Lubricate the inner lip of the crankshaft rear seal with clean engine oil.

Using the special tools, install a new crankshaft rear seal.

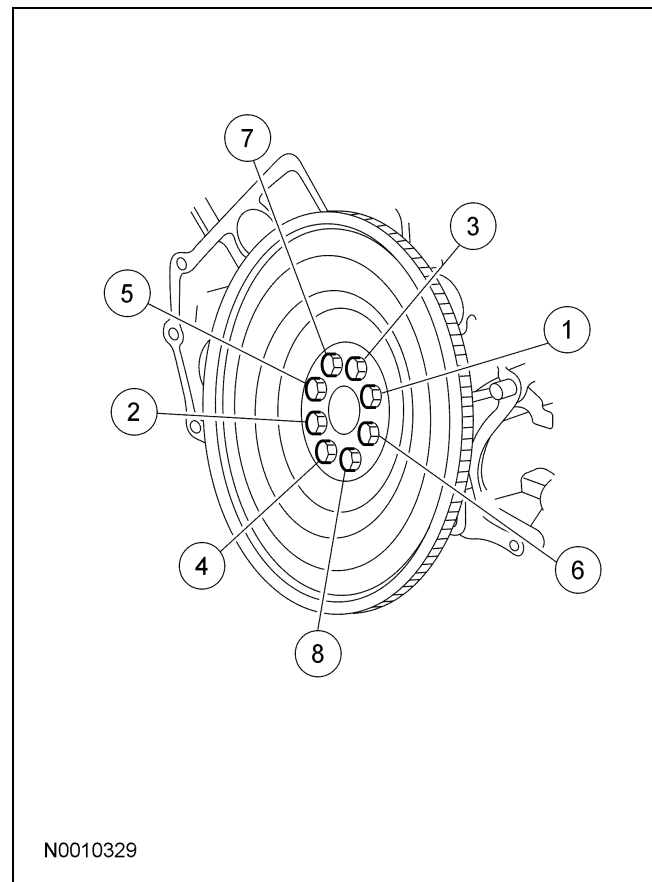


112. Using the special tools, install a new crankshaft rear oil slinger.



113. Install the flexplate or flywheel and the 8 bolts in the sequence shown.

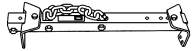
- Tighten to 80 Nm (59 lb-ft).



INSTALLATION

Engine

Special Tool(s)

 <p>ST1377-A</p>	Modular Engine Lift Bracket 303-F047 (014-00073) or equivalent
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Material

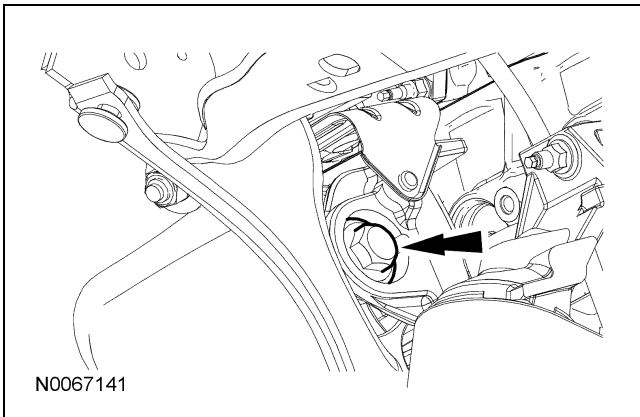
Item	Specification
Motorcraft SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP (US); Motorcraft SAE 5W-20 Super Premium Motor Oil CXO-5W20-LSP12 (Canada); or equivalent	WSS-M2C930-A

All vehicles

- Using a suitable floor crane, position the engine assembly into the vehicle.
- CAUTION:** Only use hand tools when installing the RH engine through bolt or damage to the engine support insulator may occur.

Install the LH engine support insulator through bolt.

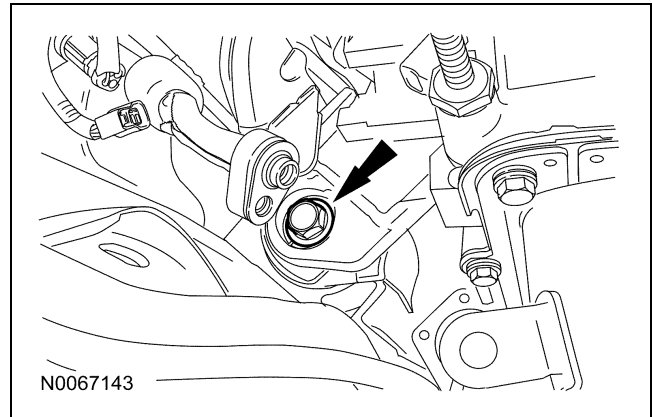
 - Tighten to 350 Nm (258 lb-ft).



- CAUTION:** Only use hand tools when installing the LH engine through bolt or damage to the engine support insulator may occur.

Install the RH engine support insulator through bolt.

 - Tighten to 350 Nm (258 lb-ft).



Manual transmission equipped vehicles

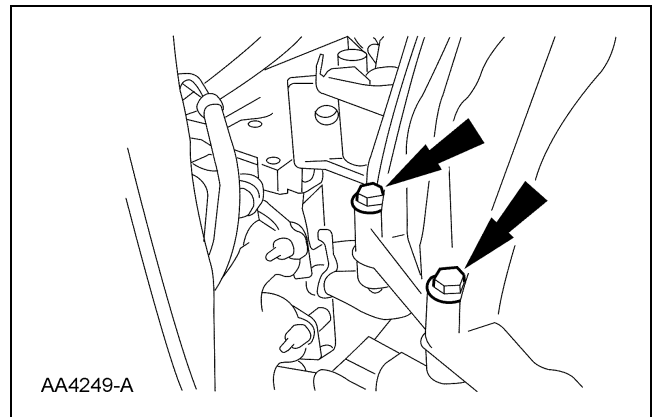
- Install the clutch and pressure plate. For additional information, refer to Section 308-01.

All automatic transmission equipped vehicles

- NOTE:** The upper 2 transmission-to-engine bolts will be installed later.

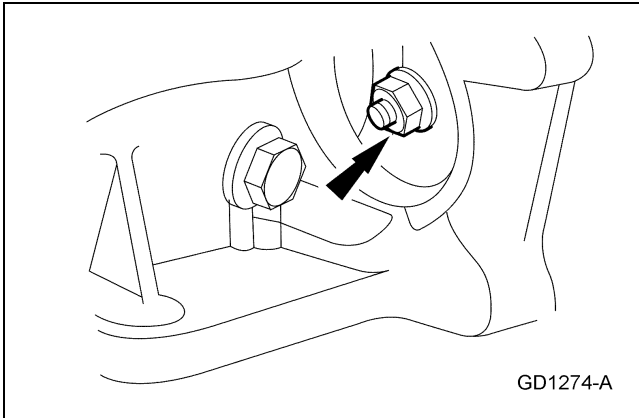
Install the lower 5 transmission-to-engine bolts.

 - Tighten to 48 Nm (35 lb-ft).

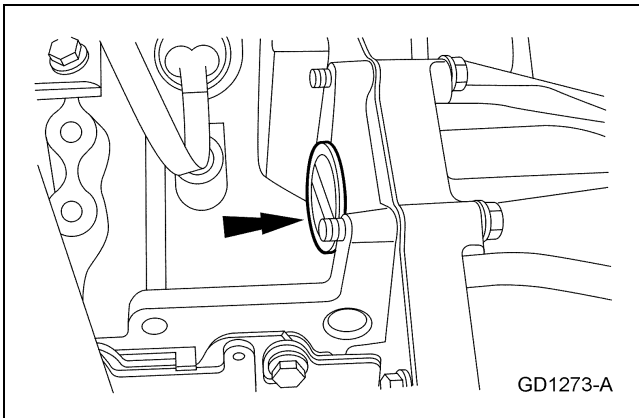


INSTALLATION (Continued)

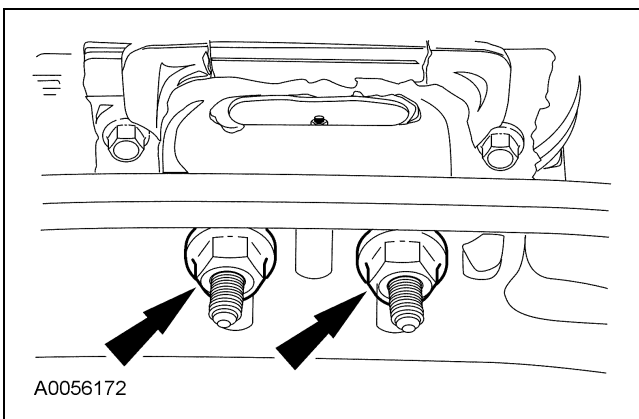
6. Install 4 new torque converter-to-flexplate nuts.
- Tighten to 35 Nm (26 lb-ft).



7. Install the cylinder block opening cover.



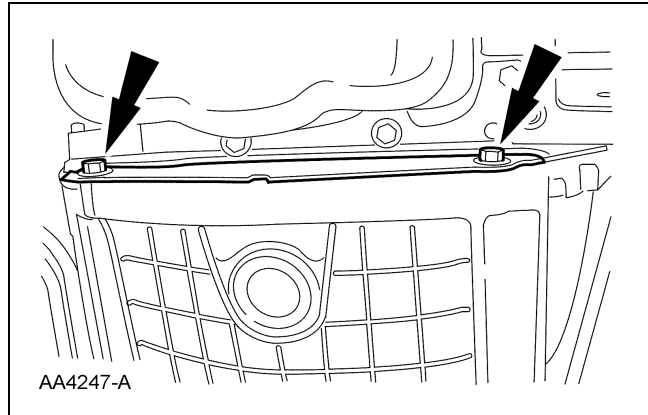
8. Install the 2 transmission rear mount nuts.
- Tighten to 103 Nm (76 lb-ft).



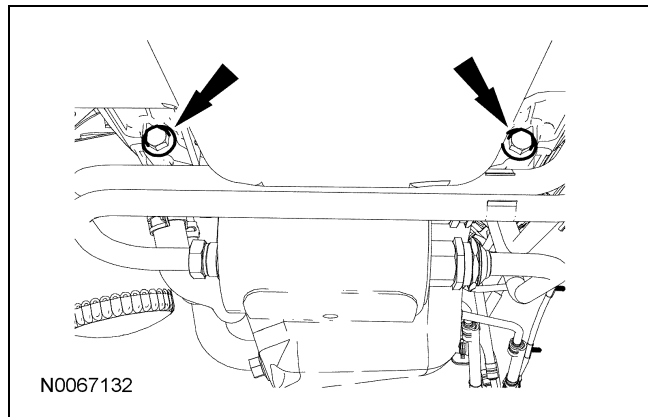
9. Install the starter. For additional information, refer to Section 303-06A.

Late build automatic transmission equipped vehicles

10. Install the flexplate inspection cover and the 2 bolts.
- Tighten to 34 Nm (25 lb-ft).

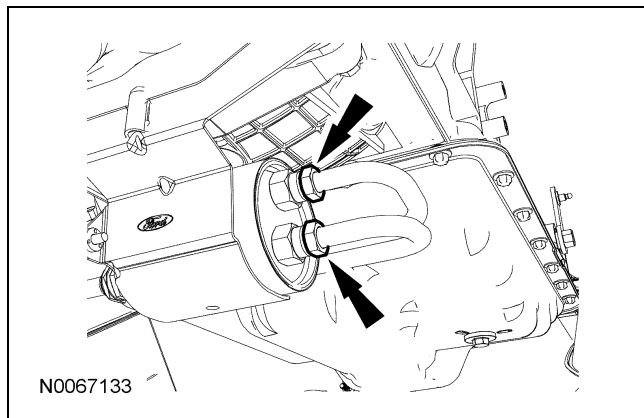
**Early build automatic transmission equipped vehicles**

11. Position the transmission auxiliary fluid cooler assembly and install the 2 bolts.
- Tighten to 35 Nm (26 lb-ft).

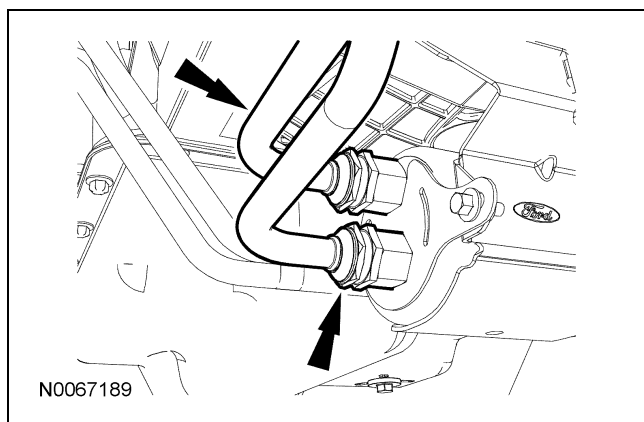


INSTALLATION (Continued)

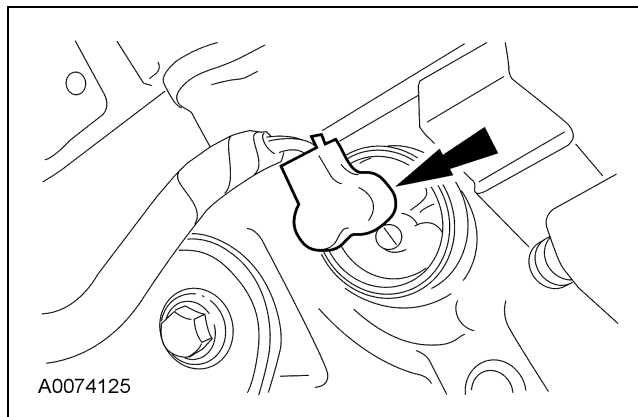
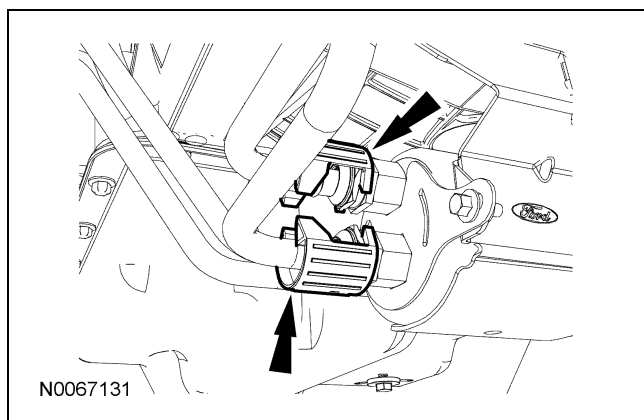
12. Connect the 2 transmission auxiliary fluid cooler outlet tubes.



13. Connect the 2 transmission auxiliary fluid cooler inlet tubes.

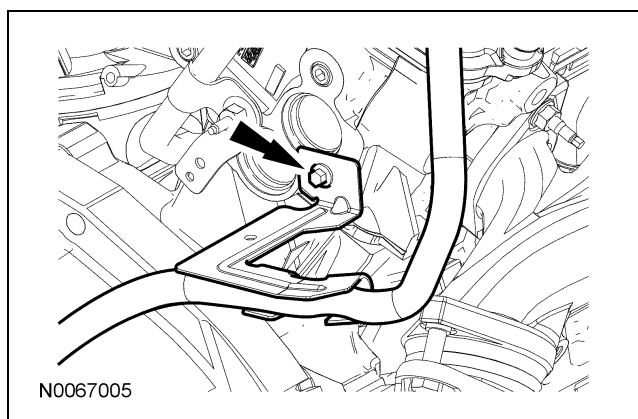


14. Install the 2 transmission auxiliary fluid cooler outlet tube secondary latches.



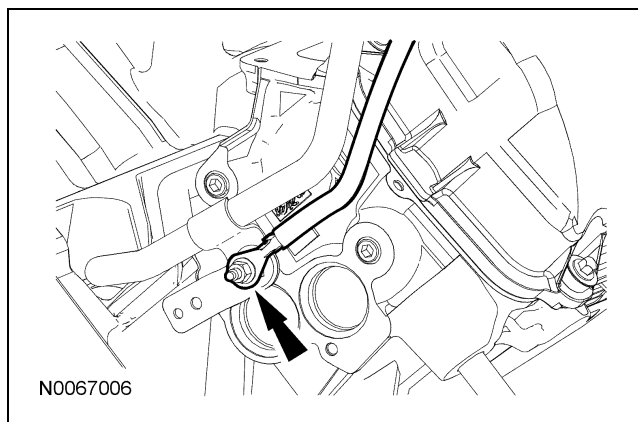
16. Position the transmission wiring harness support bracket and install the bolt.

- Tighten to 10 Nm (89 lb-in).



17. Connect the 2 engine wiring harness ground straps and install the nut.

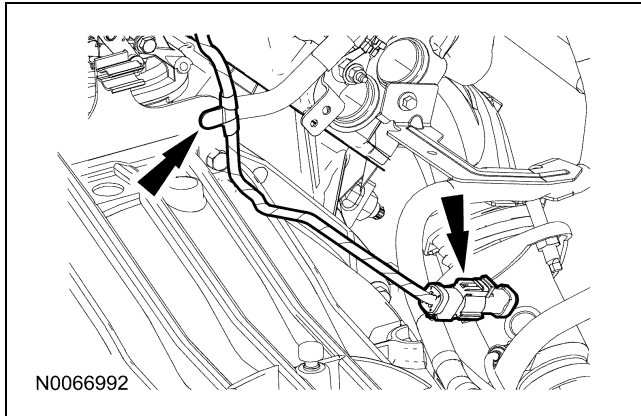
- Tighten to 10 Nm (89 lb-in).

**All vehicles**

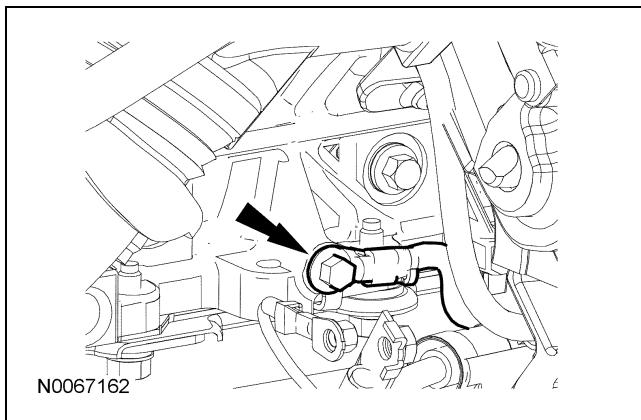
15. If equipped, connect the block heater electrical connector.

INSTALLATION (Continued)

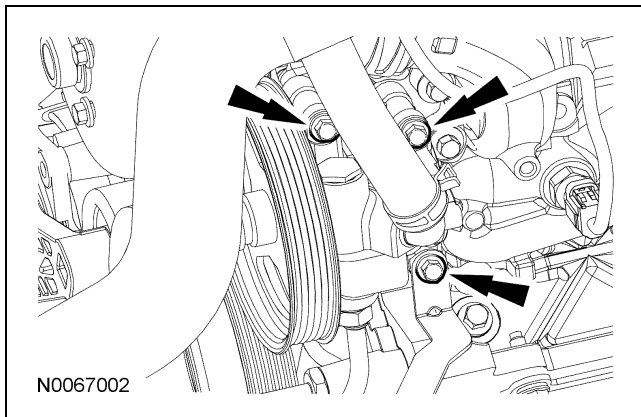
18. Connect the RH heated oxygen sensor (HO2S) wiring harness retainers.



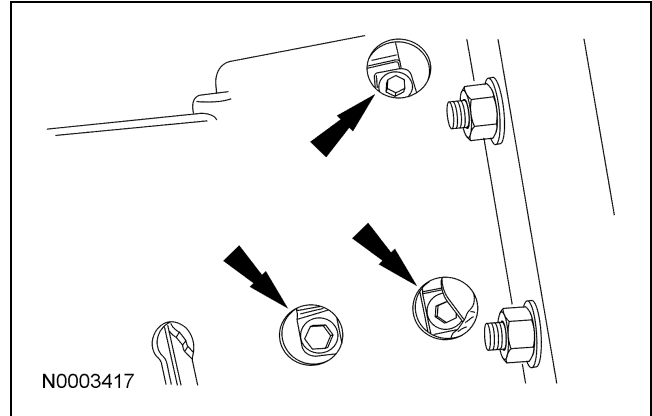
19. Position the ground strap and install the bolt.
- Tighten to 10 Nm (89 lb-in).



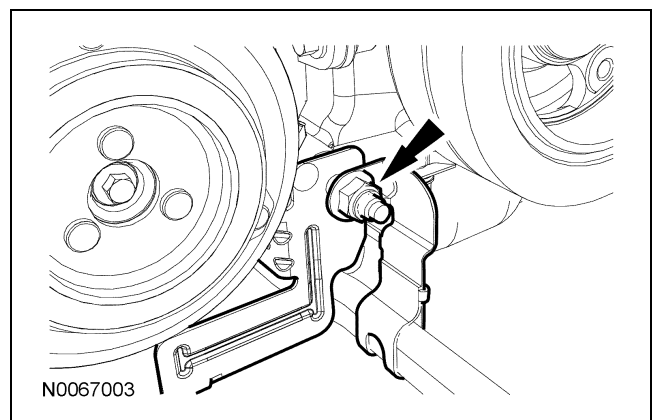
20. Position the power steering pump and install the 3 bolts.
- Tighten to 25 Nm (18 lb-ft).



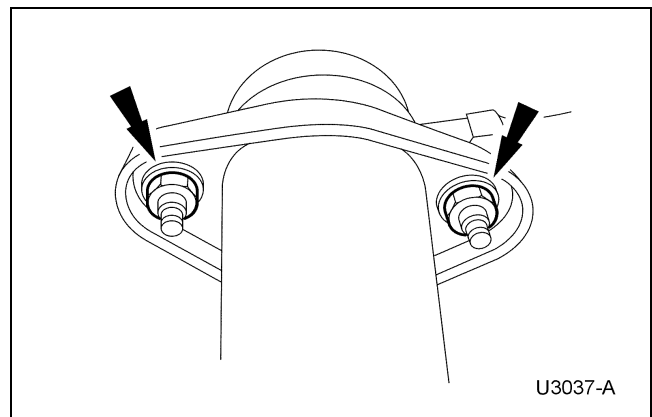
21. Position the A/C compressor and install the 3 bolts.
- Tighten to 25 Nm (18 lb-ft).



22. Position the transmission auxiliary fluid cooler tube support bracket and the starter wiring harness support bracket on the engine front cover stud bolt and install the nut.
- Tighten to 25 Nm (18 lb-ft).

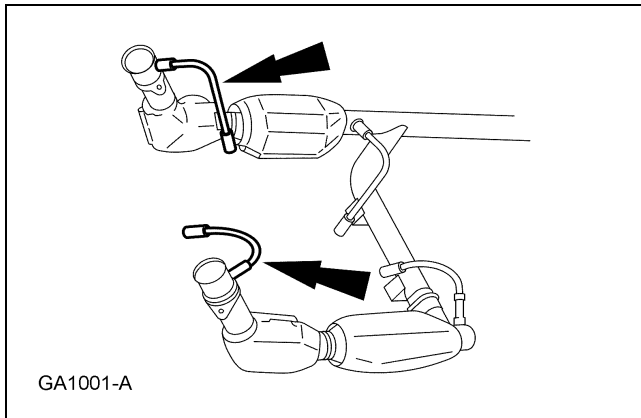


23. Install the 4 exhaust manifold flange nuts.
- Tighten to 40 Nm (30 lb-ft).



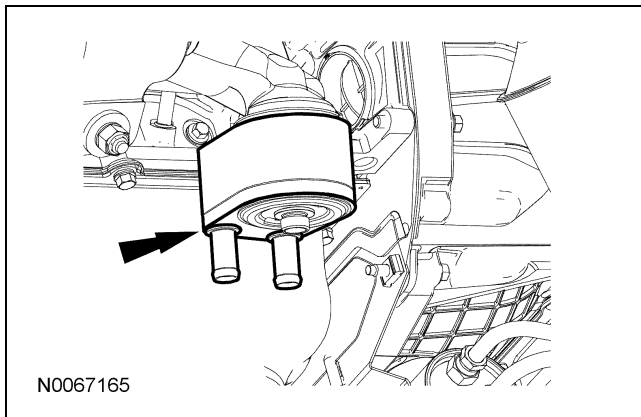
INSTALLATION (Continued)

24. Connect the 2 heated HO2S electrical connectors.

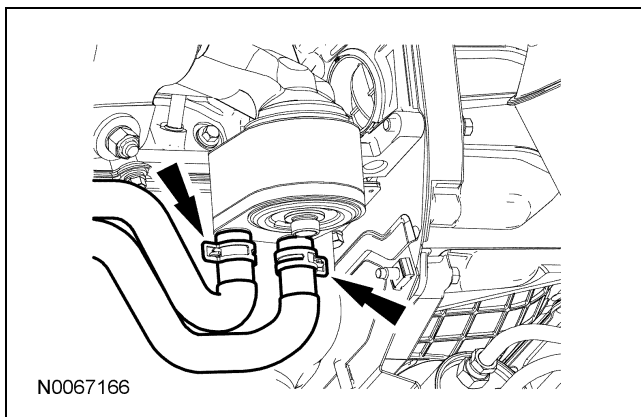


25. Position the oil cooler and install the threaded shaft.

- Tighten to 58 Nm (43 lb-ft).

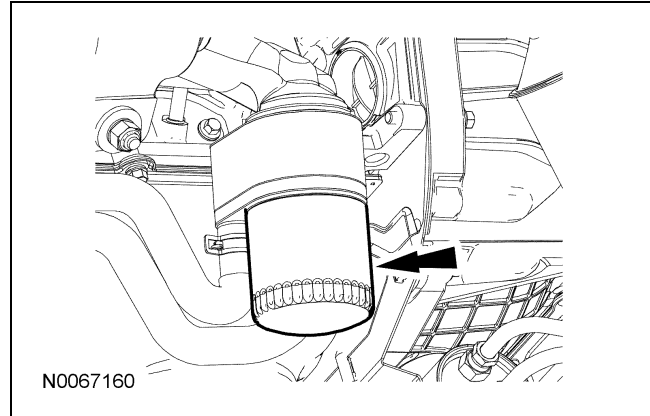


26. Connect the oil cooler coolant hoses.



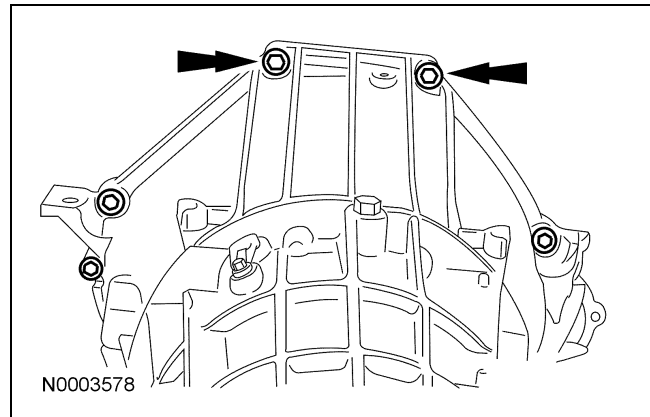
27. Install a new engine oil filter.

- Tighten to 16 Nm (12 lb-ft).

**Automatic transmission vehicles**

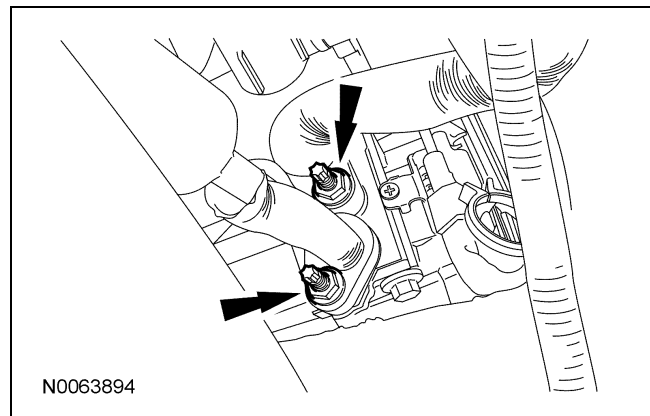
28. Install the upper 2 transmission-to-engine bolts.

- Tighten to 48 Nm (35 lb-ft).

**All vehicles**

29. Using new O-ring seals, connect the 2 A/C compressor manifold tube assemblies to the A/C compressor and install the 2 nuts.

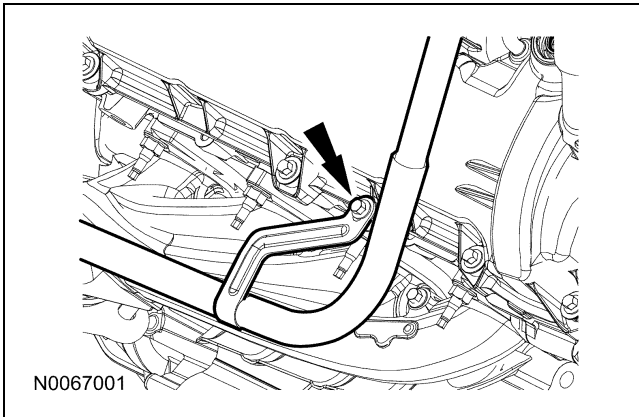
- Tighten to 20 Nm (15 lb-ft).



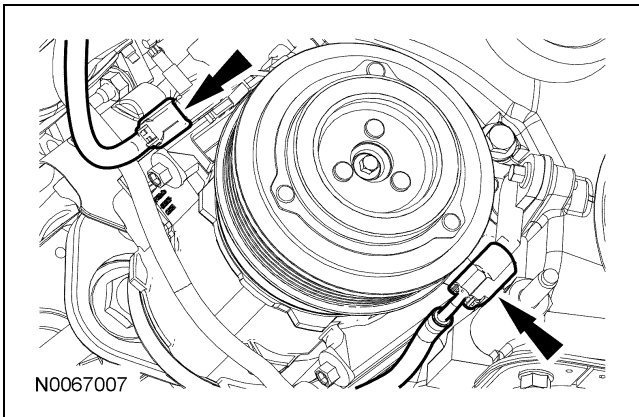
INSTALLATION (Continued)

30. Position the transmission fluid level indicator tube and install the bolt.

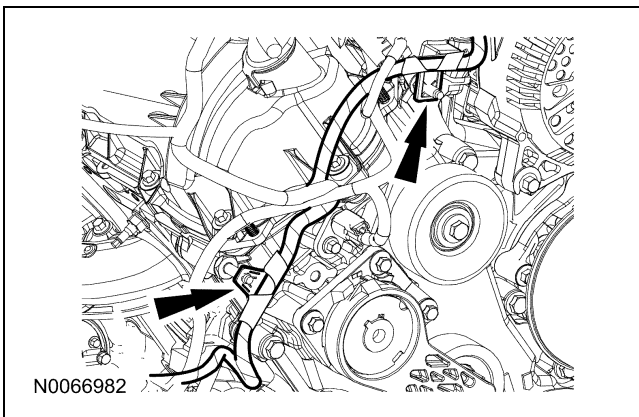
- Tighten to 10 Nm (89 lb-in).



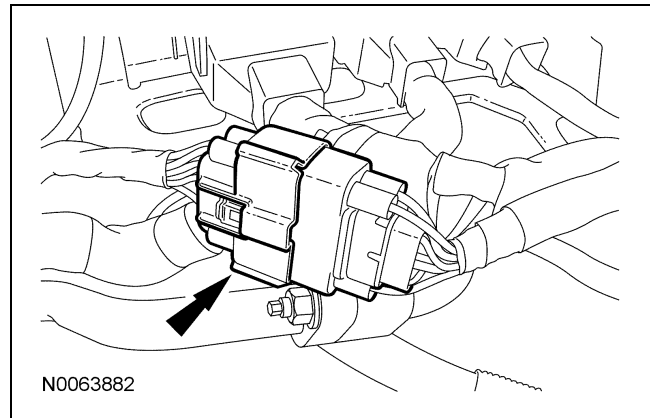
31. Position the generator wiring harness and connect the A/C compressor and crankshaft position (CKP) sensor electrical connectors.



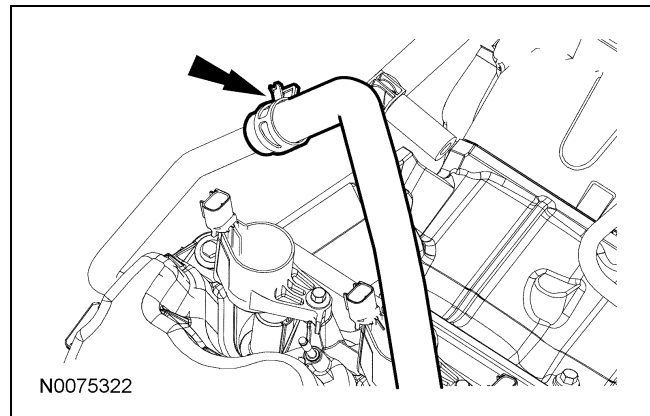
32. Connect the generator wiring harness position retainers to the engine front cover studs.



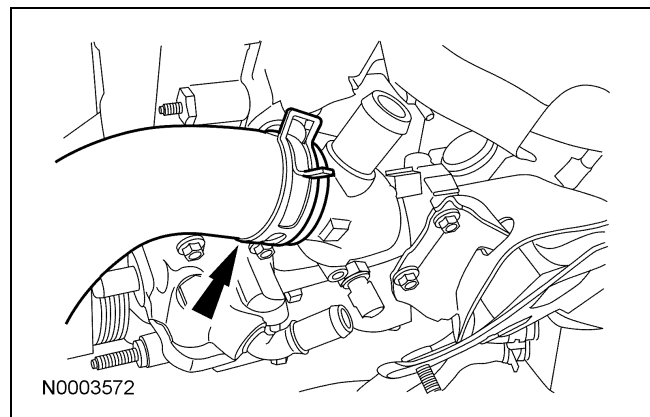
33. Connect the engine wiring harness electrical connector located below the PCM.



34. Connect the coolant hose to the coolant tube.

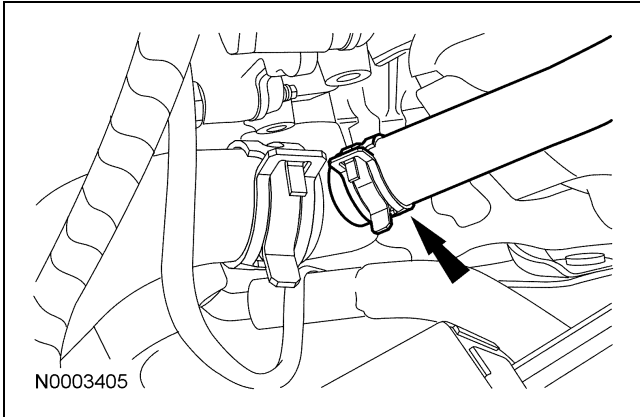


35. Connect the lower radiator hose to the oil filter adapter.



INSTALLATION (Continued)

36. Connect the degas bottle coolant hose.



37. Position the accessory drive belt onto the accessory drive pulleys.

38. Install the intake manifold. For additional information, refer to Intake Manifold in this section.

39. Install the PCM. For additional information, refer to Section 303-14A.

40. Install the degas bottle. For additional information, refer to Section 303-03.

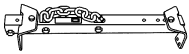
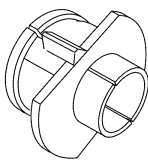
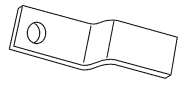
41. Fill the crankcase with clean engine oil.

42. Install the engine cooling module. For additional information, refer to Section 303-03.

REMOVAL

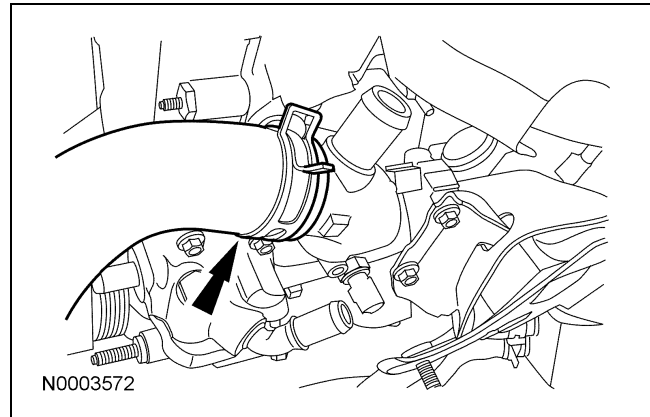
Engine

Special Tool(s)

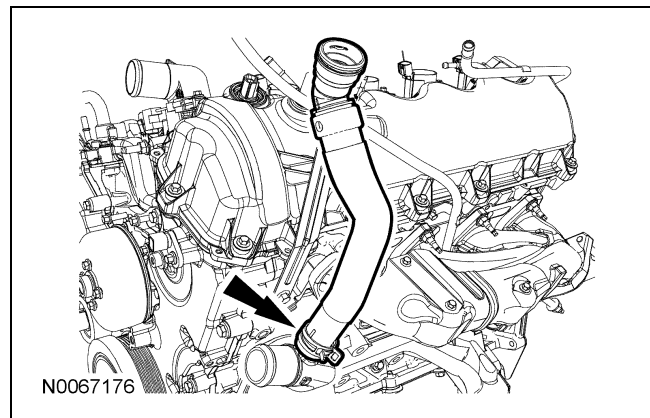
 ST1377-A	Modular Engine Lift Bracket 303-F047 (014-00073) or equivalent
 ST2921-A	Disconnect Tool, Transmission Cooler Line 303-F047 (014-00073) or equivalent
 ST1636-A	Retainer, Torque Converter 307-346 (T97T-7902-A) or equivalent

All vehicles

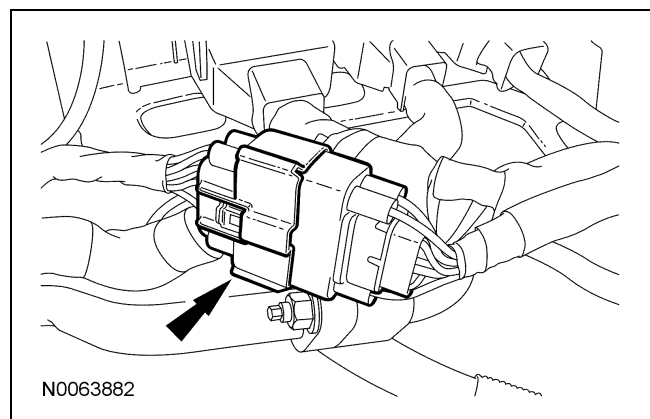
1. Release the fuel pressure. For additional information, refer to Section 310-00.
2. Remove the engine cooling module. For additional information, refer to Section 303-03.
3. Remove the intake manifold. For additional information, refer to Intake Manifold in this section.
4. Remove the degas bottle. For additional information, refer to Section 303-03.
5. Remove the PCM. For additional information, refer to Section 303-14A.
6. Remove the accessory drive belt.
7. Disconnect the lower radiator hose to the oil filter adapter.



8. Disconnect the degas bottle coolant hose.

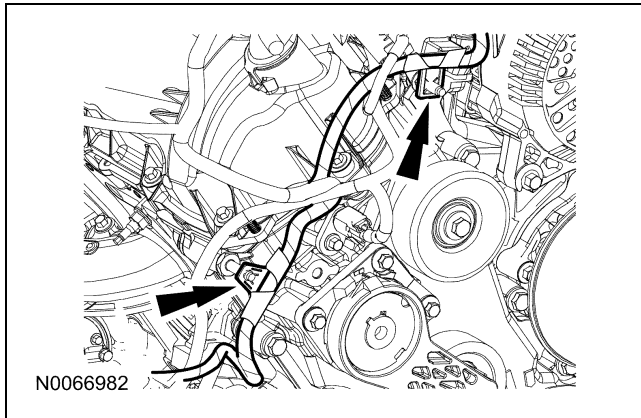


9. Disconnect the engine wiring harness electrical connector located below the PCM.

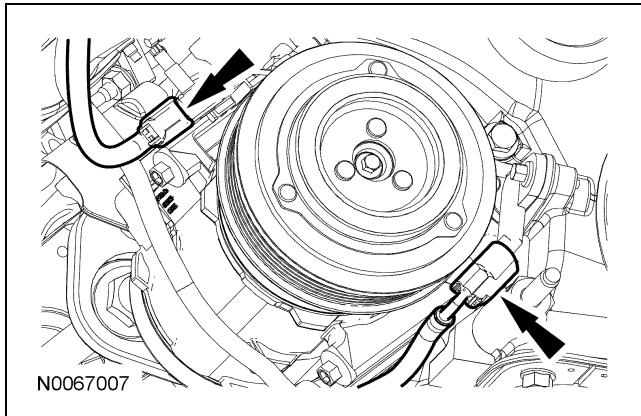


REMOVAL (Continued)

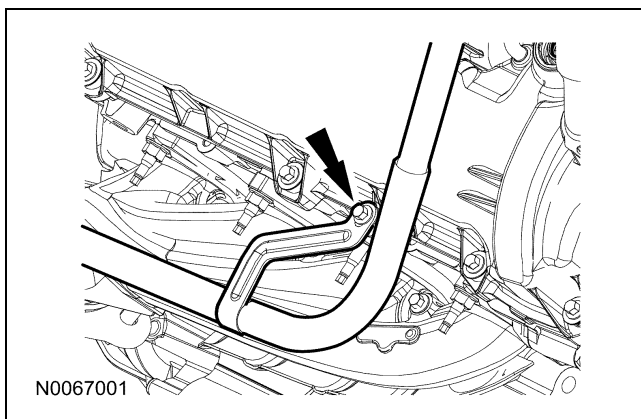
10. Disconnect the generator wiring harness position retainers from the engine front cover studs.



11. Disconnect the A/C compressor and crankshaft position (CKP) sensor electrical connectors and position the generator wiring harness aside.

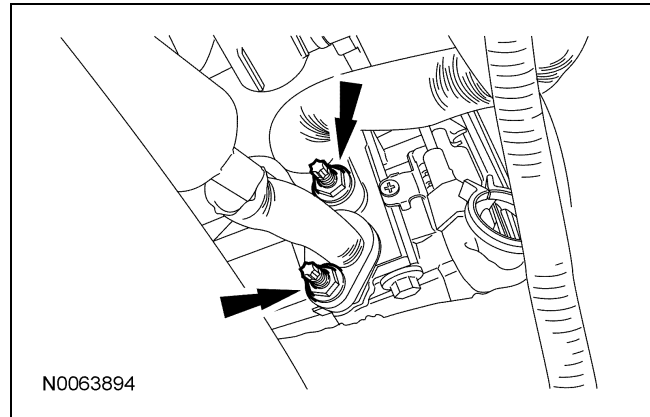


12. Remove the bolt and the transmission fluid level indicator tube.

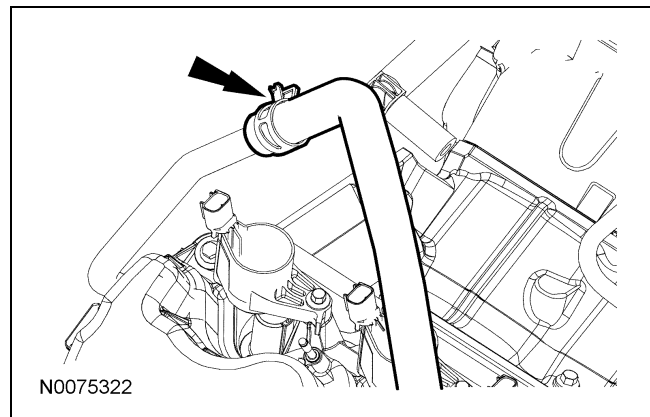


13. Remove the 2 nuts and disconnect the 2 A/C compressor manifold tube assemblies from the A/C compressor.

- Discard the O-rings seals.



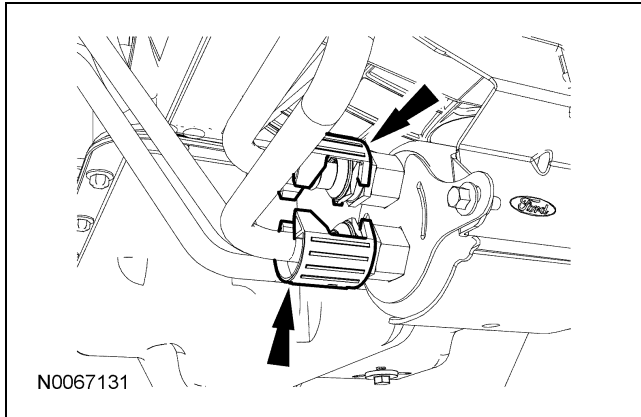
14. Disconnect the coolant hose from the coolant tube.

**Manual transmission equipped vehicles**

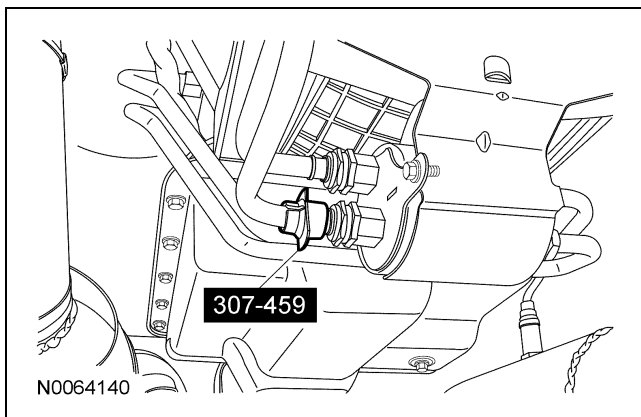
15. Remove the clutch and pressure plate. For additional information, refer to Section 308-01.

REMOVAL (Continued)**Early build automatic transmission equipped vehicles**

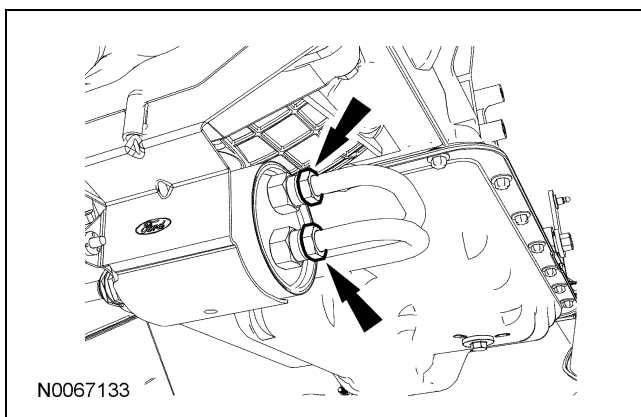
16. Remove the 2 transmission auxiliary fluid cooler outlet tube secondary latches.



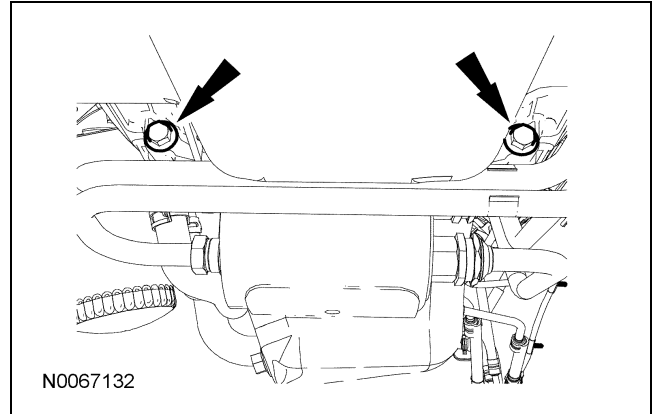
17. Using the special tool, disconnect the 2 transmission auxiliary fluid cooler inlet tubes.



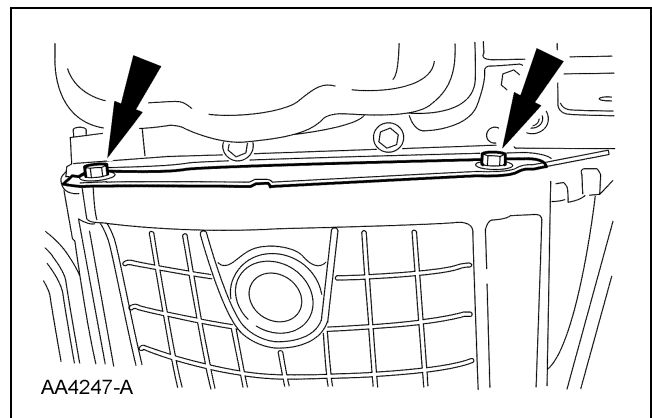
18. Disconnect the 2 transmission auxiliary fluid cooler outlet tubes.



19. Remove the 2 bolts and the transmission auxiliary fluid cooler assembly.

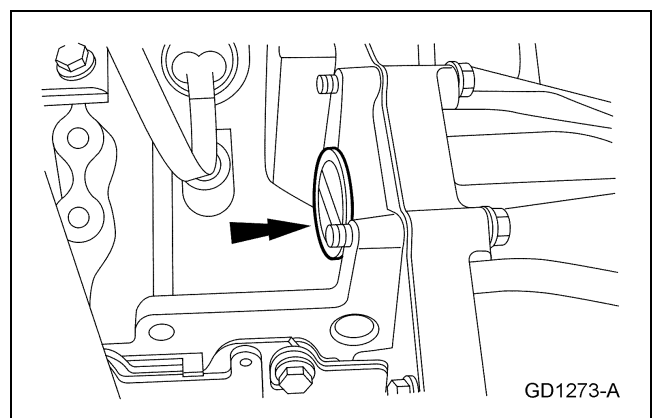
**Late build automatic transmission equipped vehicles**

20. Remove the 2 bolts and the flexplate inspection cover.

**All automatic transmission equipped vehicles**

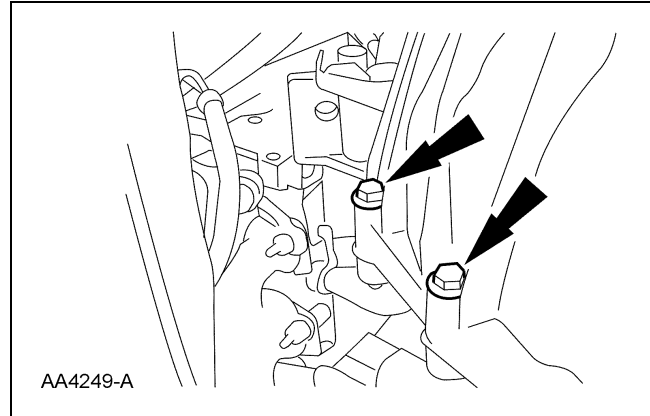
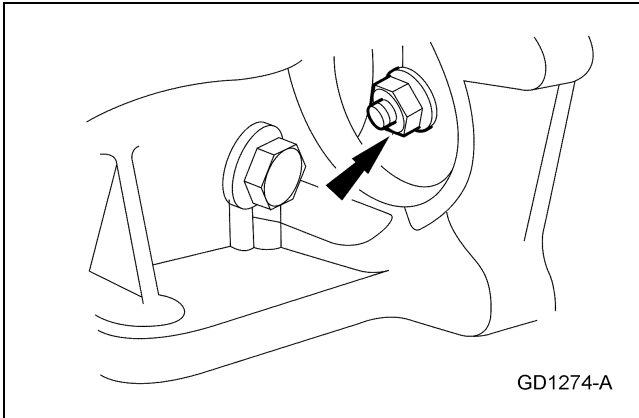
21. Remove the starter. For additional information, refer to Section 303-06A.

22. Remove the cylinder block opening cover.

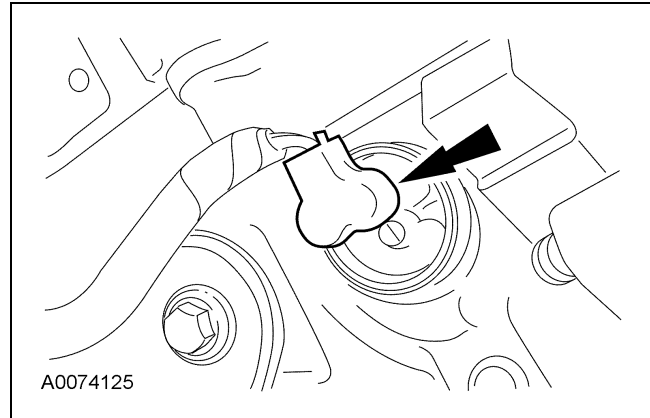
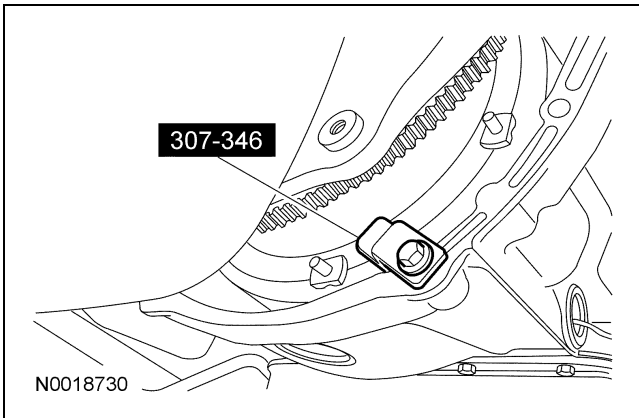


REMOVAL (Continued)

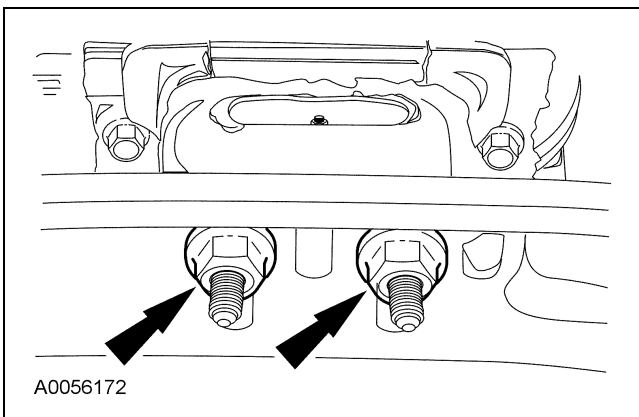
23. Remove the 4 torque converter-to-flexplate nuts.
- Discard the nuts.

**All vehicles**

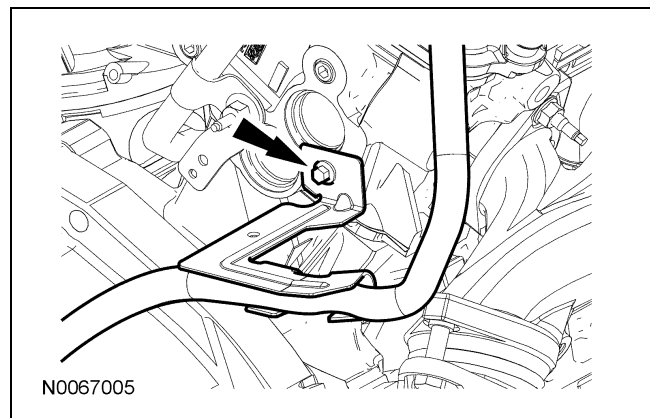
24. Install the special tool.



25. Loosen the 2 transmission rear mount nuts.



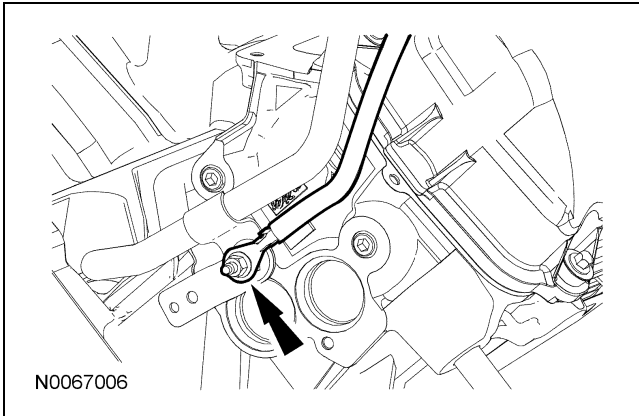
28. Remove the bolt and the transmission wiring harness support bracket.



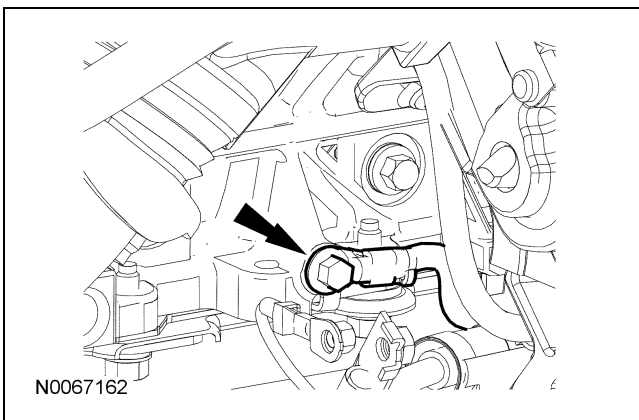
26. **NOTE:** The upper 2 transmission-to-engine bolts will be removed later.
- Remove the 5 transmission-to-engine bolts.

REMOVAL (Continued)

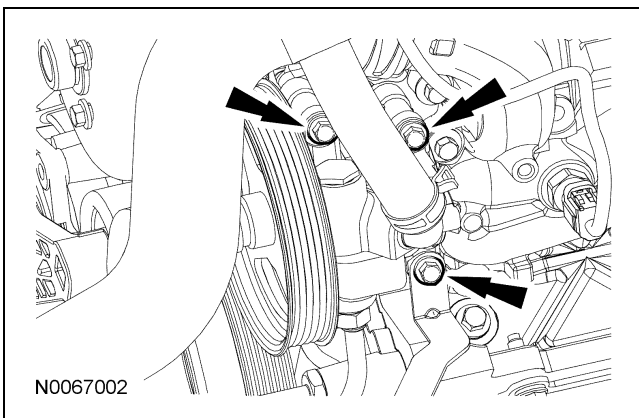
29. Remove the nut and the 2 engine wiring harness ground straps.



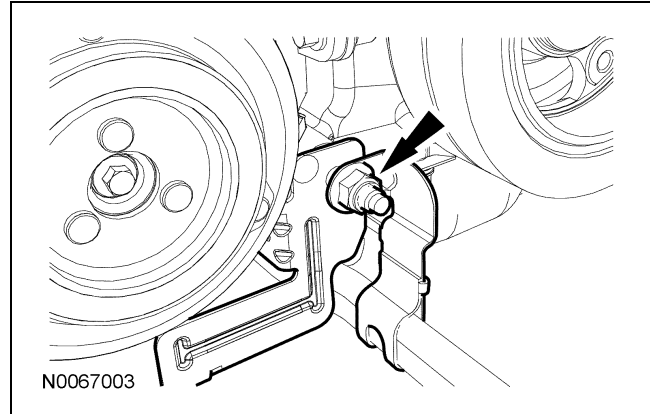
30. Remove the bolt and position the ground strap aside.



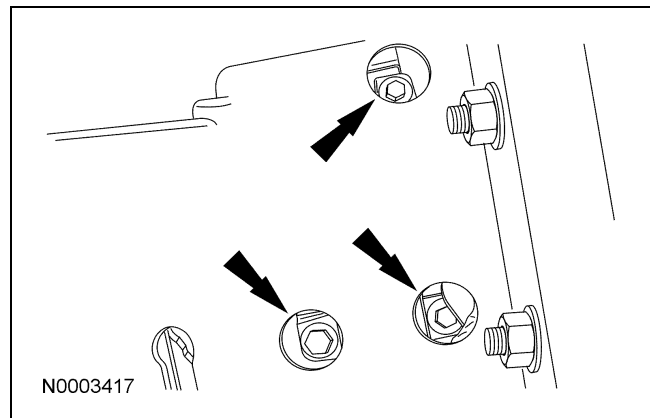
31. Remove the 3 bolts and position the power steering pump aside.



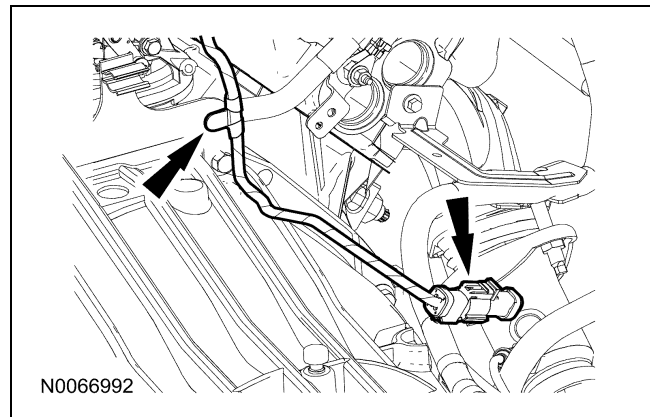
32. Remove the nut, the transmission auxiliary fluid cooler tube support bracket and the starter wiring harness support bracket from the engine front cover stud bolt.



33. Remove the 3 bolts and the A/C compressor.

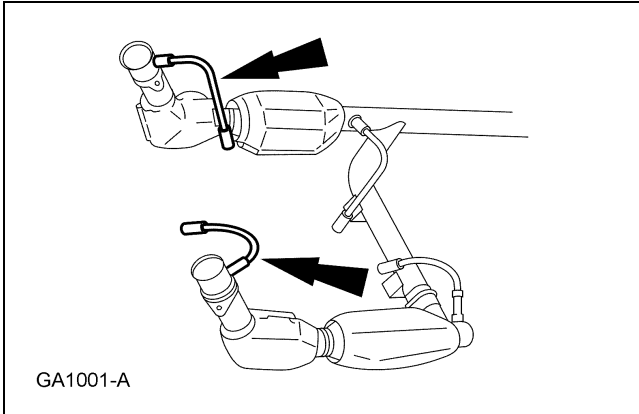


34. Disconnect the RH heated oxygen sensor (HO2S) wiring harness retainers.

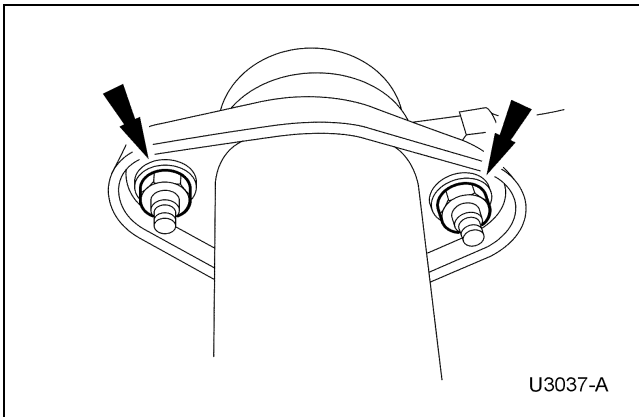


REMOVAL (Continued)

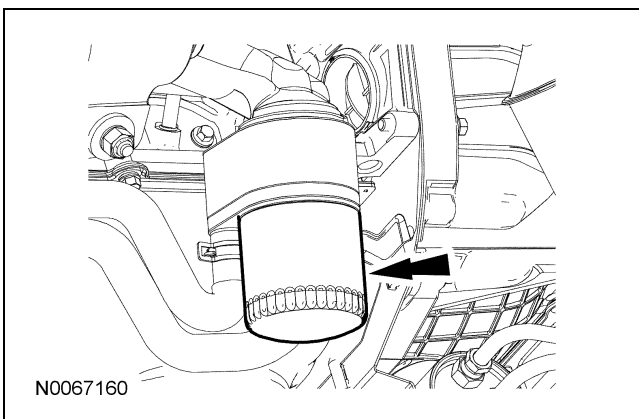
35. Disconnect the 2 HO2S electrical connectors.



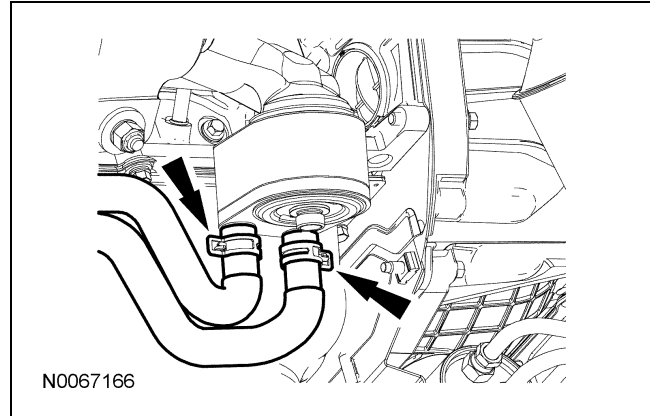
36. Remove the 4 exhaust manifold flange nuts.



37. Remove and discard the engine oil filter.

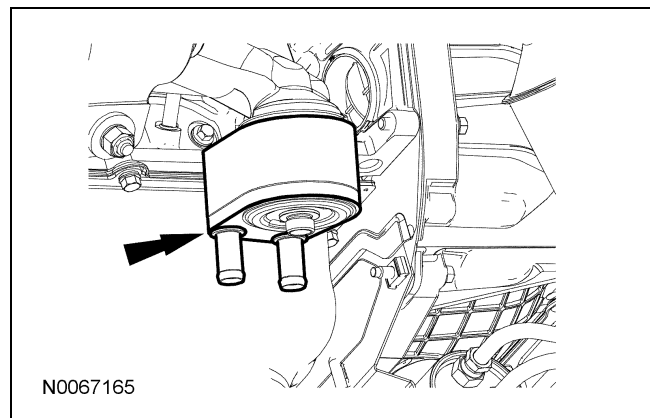


38. Disconnect the oil cooler coolant hoses.

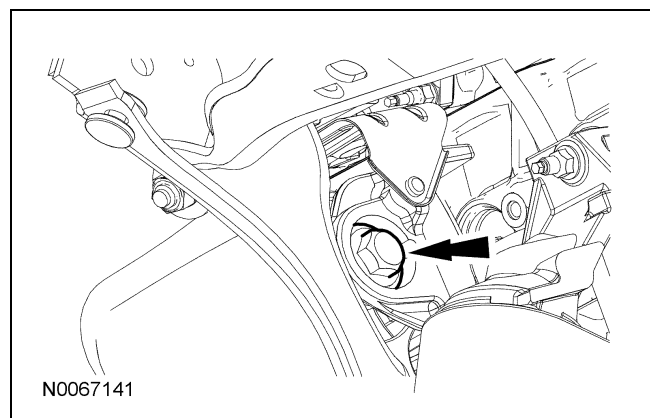


39. **⚠ CAUTION:** If metal foreign material is present in the oil cooler, mechanical concerns exist. To diagnose mechanical concerns, refer to Section 303-00.

Remove and inspect the engine oil cooler.

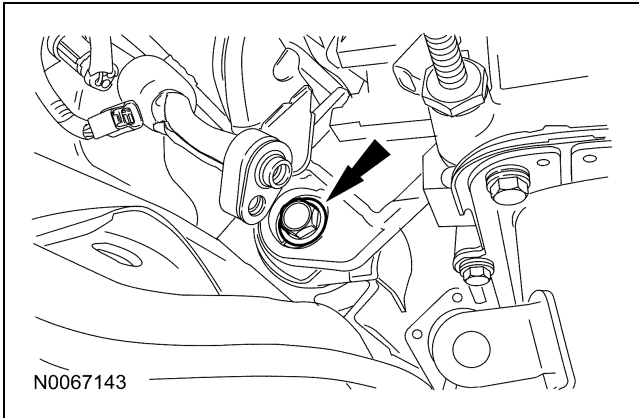


40. Remove the LH engine support insulator through bolt.

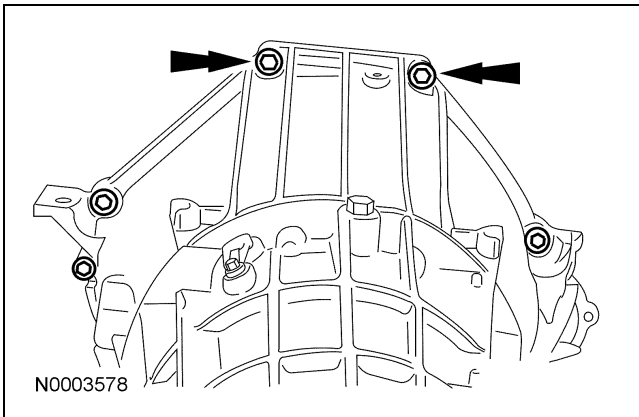


REMOVAL (Continued)

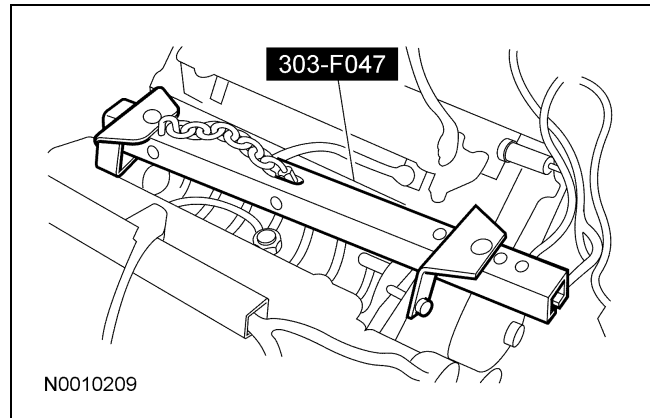
41. Remove the RH engine support insulator through bolt.

**Automatic transmission vehicles**

42. Remove the upper 2 transmission-to-engine bolts.

**All vehicles**

43. Install the special tool.

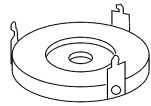
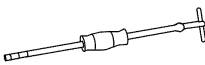
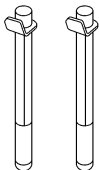
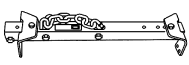
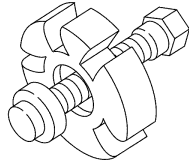
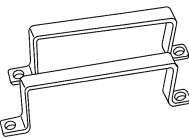


44. Using a suitable floor crane, remove the engine assembly from the vehicle.

DISASSEMBLY

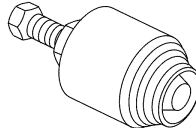
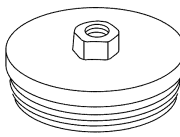
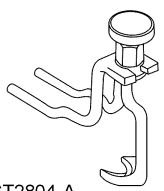
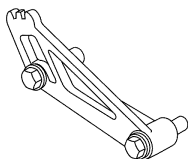

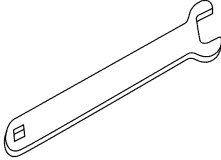
Engine

Special Tool(s)

 ST1481-A	Remover, Crankshaft Rear Oil Slinger 303-514 (T95P-6701-AH)
 ST1185-A	Slide Hammer 100-001 (T50T-100-A)
 ST1337-A	Installer, Connecting Rod 303-442 (T93P-6136-A)
 ST1377-A	Modular Engine Lift Bracket 303-F047 (014-00073) or equivalent
 ST1286-A	Remover, Crankshaft Vibration Damper 303-009 (T58P-6316-D)
 ST1668-A	Remover/Installer, Cylinder Head 303-572 (T97T-6000-A)

(Continued)

Special Tool(s)

 ST1730-A	Remover, Crankshaft Front Oil Seal 303-107 (T74P-6700-A)
 ST1382-A	Remover, Crankshaft Rear Seal 303-519 (T95P-6701-DH)
 ST2804-A	Compressor, Valve Spring 303-1039
 ST2807-A	Locking Tool, Camshaft Phaser Sprocket 303-1046
 ST1499-A	Fan Pulley Holding Wrench 303-239 (T84T-6312-C)
 ST1500-A	Fan Clutch Nut Wrench 303-240 (T84T-6312-D)

Material

Item	Specification
Motorcraft Metal Surface Prep ZC-31	—
Silicone Gasket Remover ZC-30	—

DISASSEMBLY (Continued)

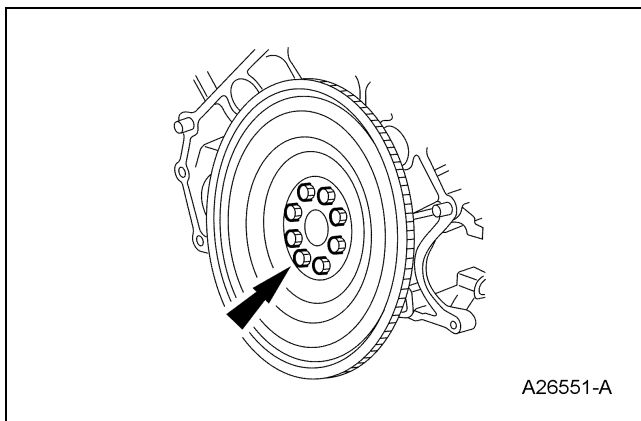
⚠ CAUTION: Remove the cylinder heads before removing the crankshaft. Failure to do so may result in engine damage.

⚠ CAUTION: During engine repair procedures, cleanliness is extremely important. Any foreign material, including any material created while cleaning gasket surfaces that enters the oil passages, coolant passages or the oil pan, may cause engine failure.

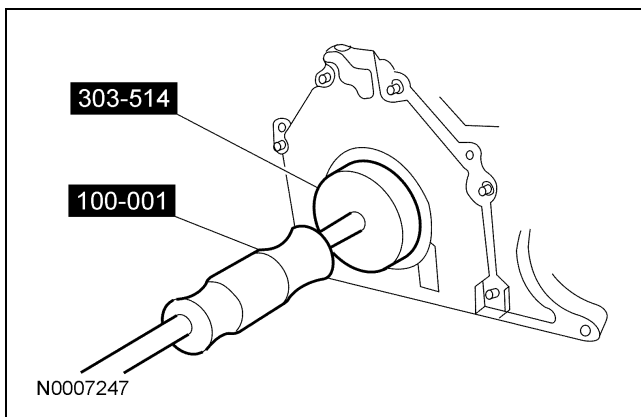
NOTE: The flexplate or flywheel, crankshaft rear seal and the crankshaft rear oil slinger must be removed before mounting the engine on the engine stand.

NOTE: For additional information, refer to the exploded view under the Assembly procedure in this section.

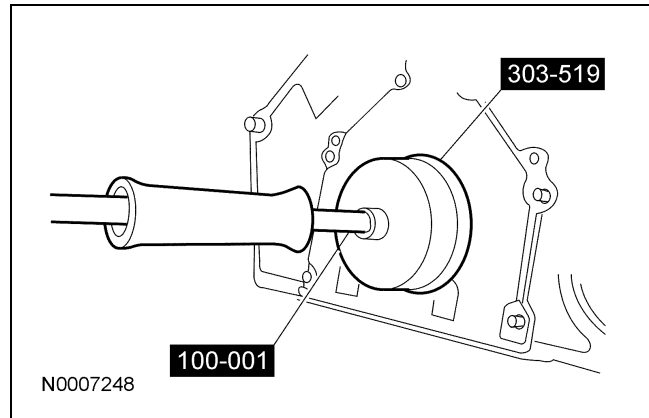
1. Remove the bolts and the flexplate or flywheel.



2. Using the special tools, remove and discard the crankshaft rear oil slinger.



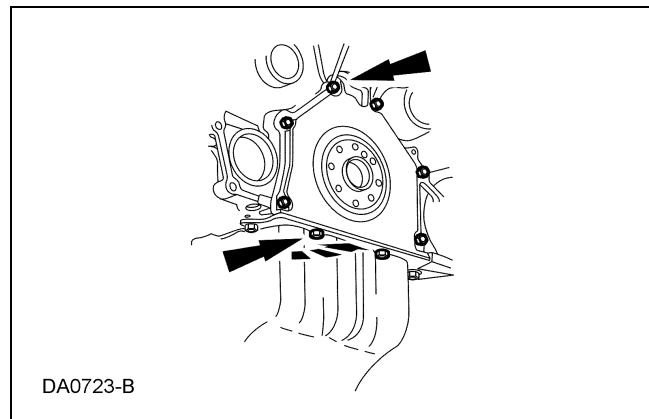
3. Using the special tools, remove and discard the crankshaft rear seal.



4. Remove the bolts and the crankshaft rear seal retainer plate.

- **⚠ CAUTION:** Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the sealing surfaces. These tools cause scratches and gouges, which make leak paths. Use a plastic scraping tool to remove all traces of old sealant.

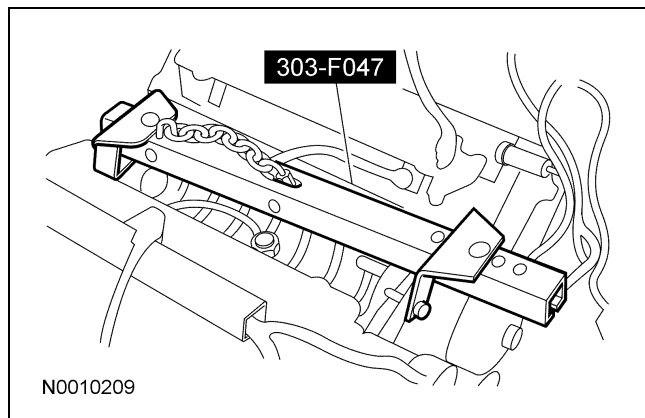
Clean and inspect the sealing surfaces.



5. Mount the engine on a suitable work stand.

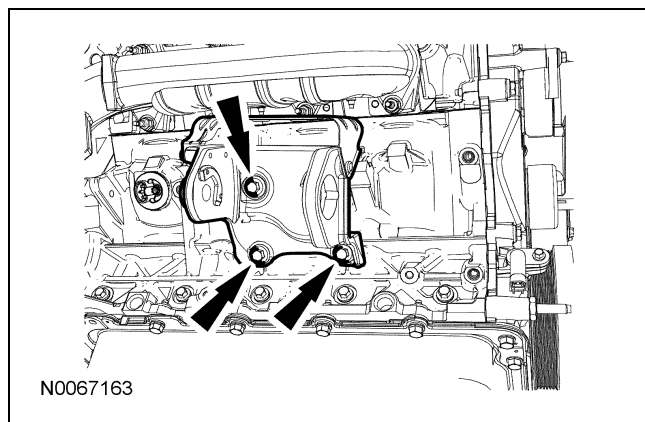
DISASSEMBLY (Continued)

6. Remove the special tool.



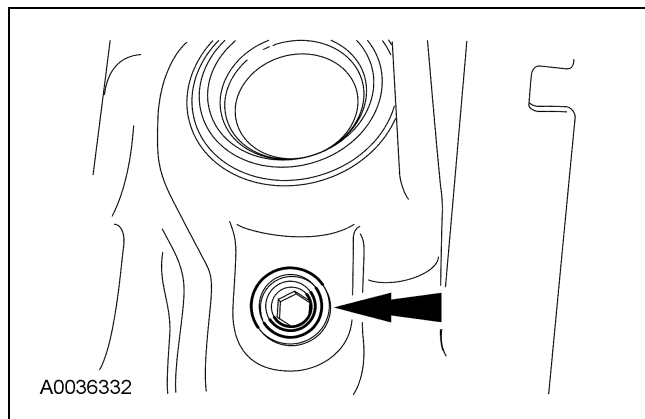
7. Remove the 3 bolts and the RH engine support insulator bracket.

- Discard the bolts.



8. **NOTE:** LH shown, RH similar.

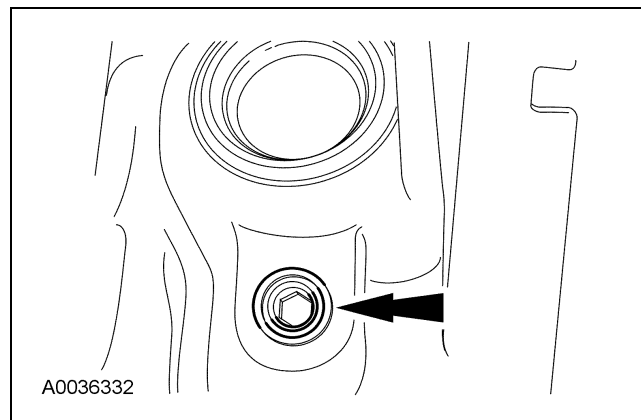
Remove the cylinder block drain plugs and drain the coolant into a suitable container.



9. **NOTE:** LH shown, RH similar.

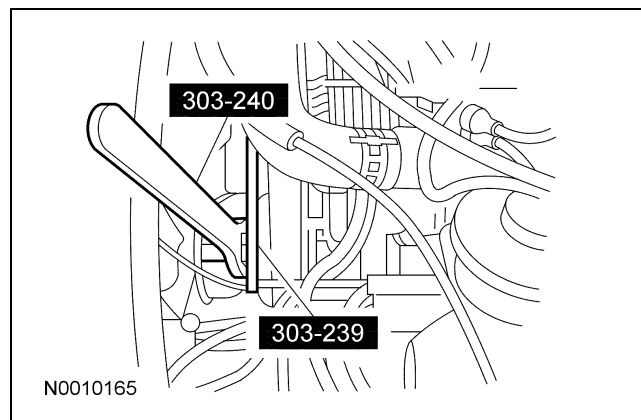
Install the cylinder block drain plugs.

- Tighten to 24 Nm (18 lb-ft).

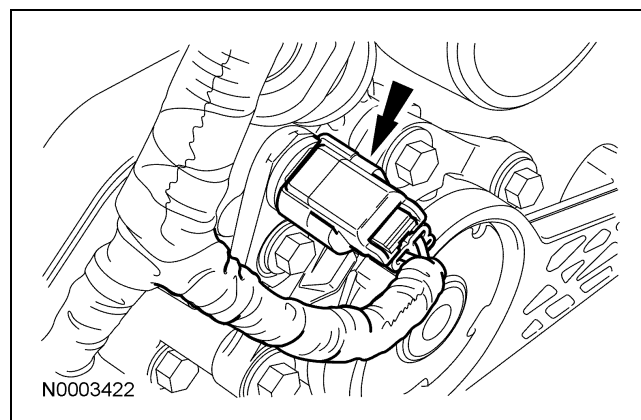


10. **NOTE:** The large clutch assembly nut has a RH thread and must be rotated counterclockwise to remove it.

Using the special tools, remove the engine cooling fan from the coolant pump pulley.

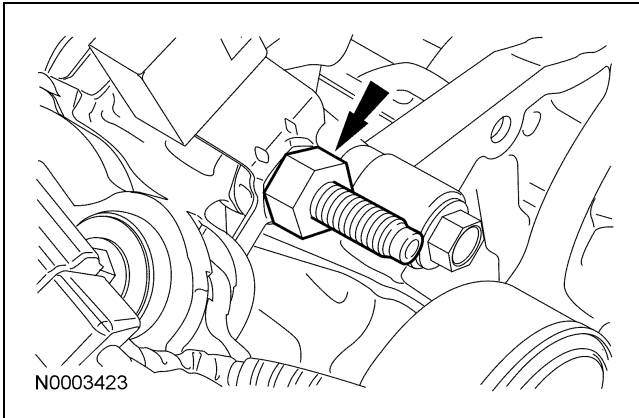


11. Disconnect the RH camshaft position (CMP) sensor electrical connector.

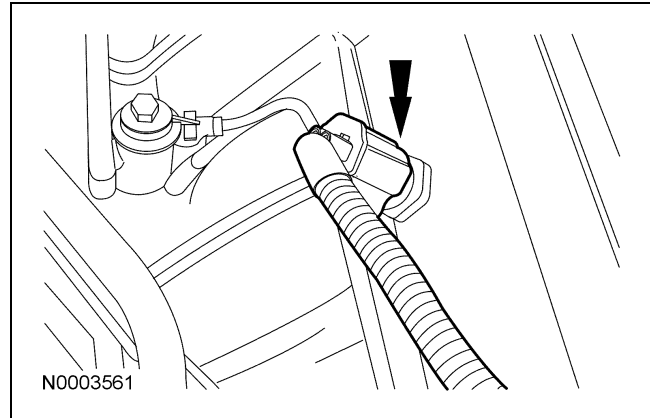


DISASSEMBLY (Continued)

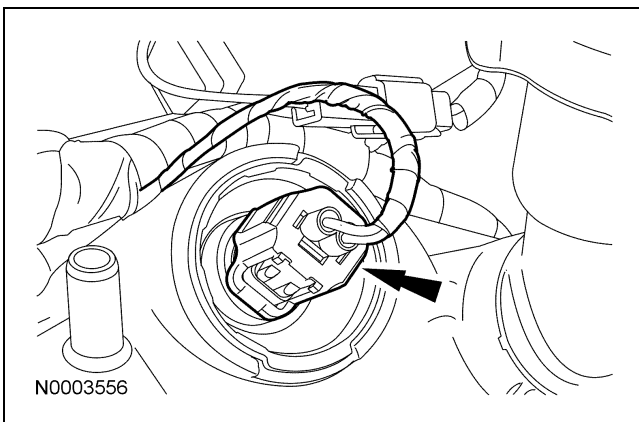
12. Remove the stud bolt and the RH radio ignition interference capacitor.



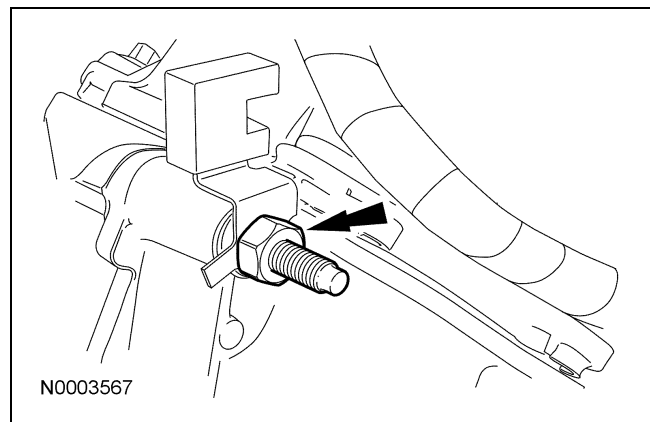
15. Disconnect the cylinder head temperature (CHT) sensor electrical connector.



13. Disconnect the RH variable camshaft timing (VCT) solenoid electrical connector.

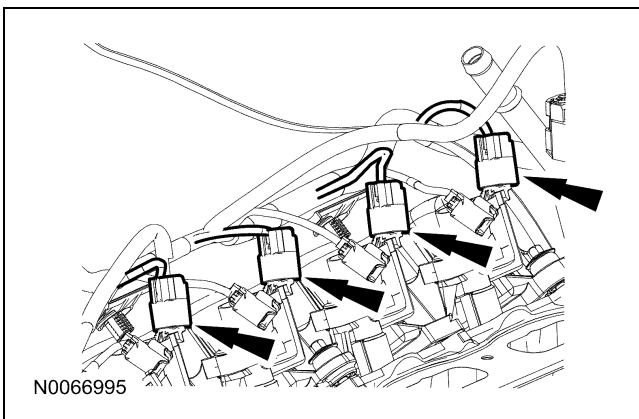


16. Remove the stud bolt and the LH radio ignition interference capacitor.

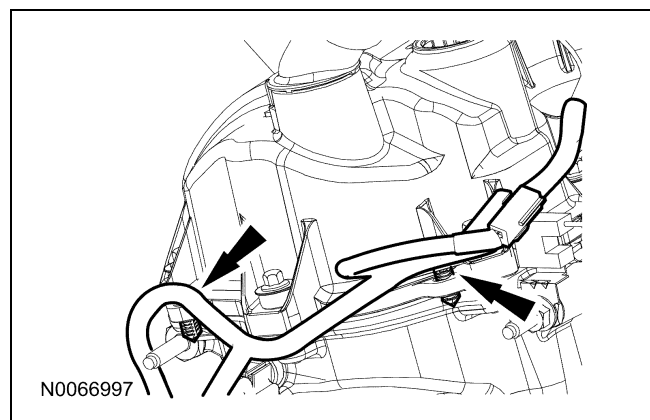


14. **NOTE:** RH shown, LH similar.

Disconnect the 8 ignition coil electrical connectors.

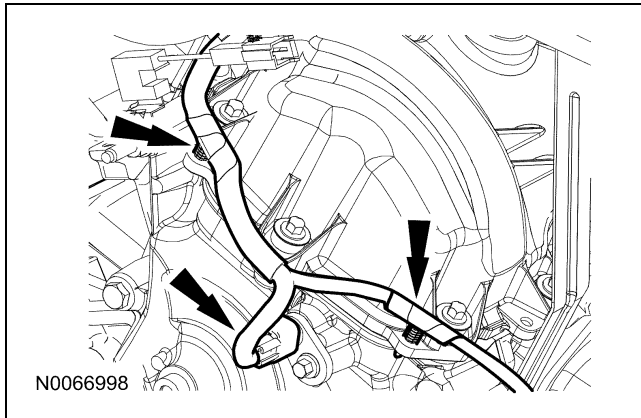


17. Disconnect the engine wiring harness position retainers from the front of the RH valve cover.

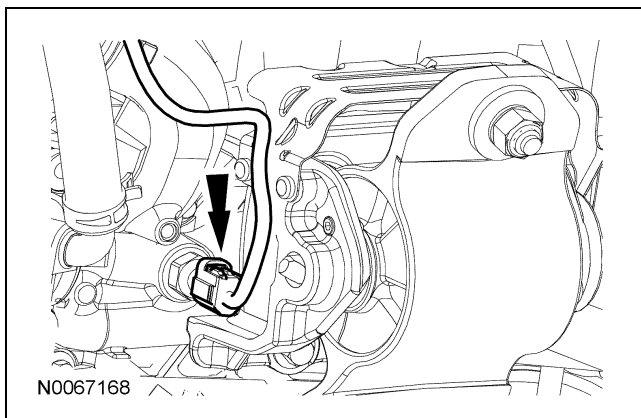


DISASSEMBLY (Continued)

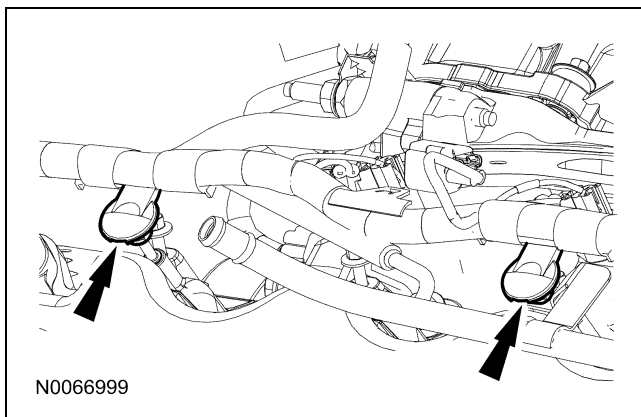
18. Disconnect the engine wiring harness position retainers from the front of the LH valve cover and the LH CMP sensor electrical connector.



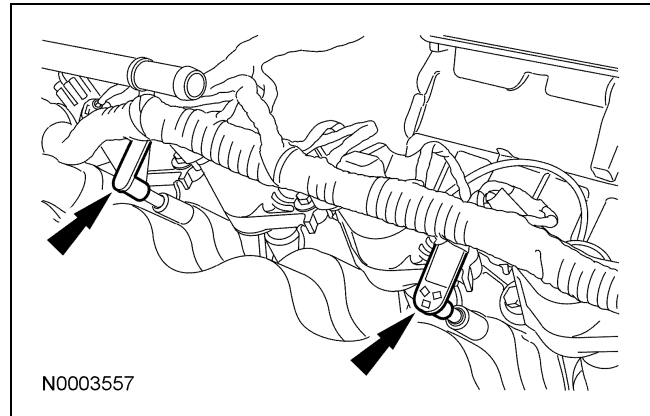
19. Disconnect the engine oil pressure (EOP) switch electrical connector.



20. Disconnect the 2 engine wiring harness retainers from the LH valve cover studs.



21. Disconnect the 2 engine wiring harness retainers from the RH valve cover studs.

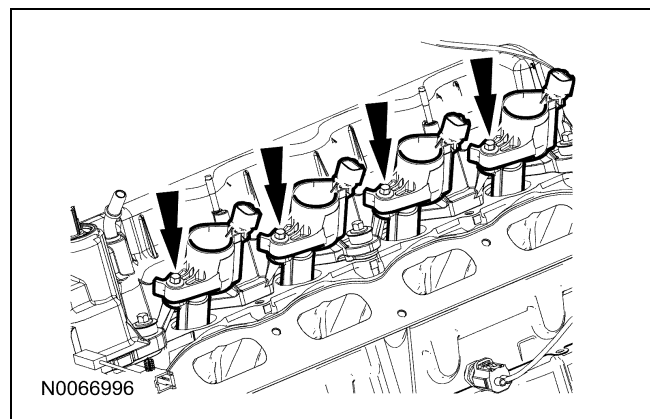


22. Remove the engine wiring harness from the engine assembly.

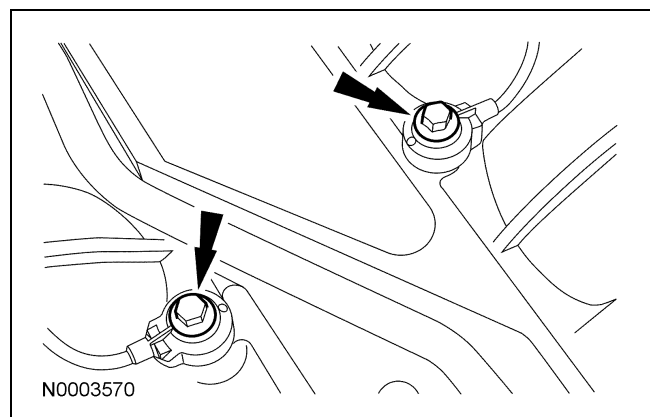
23. **NOTE:** RH shown, LH similar.

Remove the 8 bolts and the 8 ignition coils.

- Remove the ignition coil, using a twisting motion while pulling up on the ignition coil.



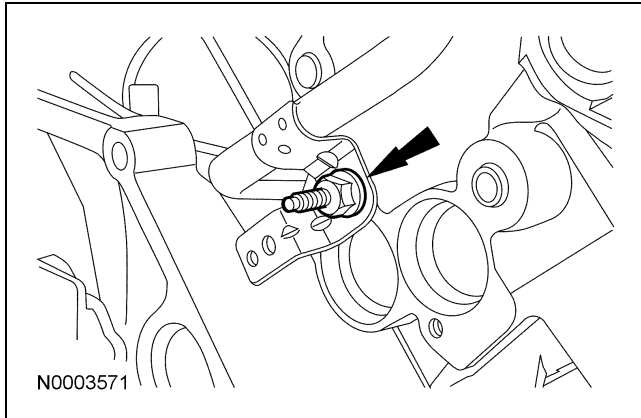
24. Remove the 2 bolts and the 2 knock sensors (KS).



DISASSEMBLY (Continued)

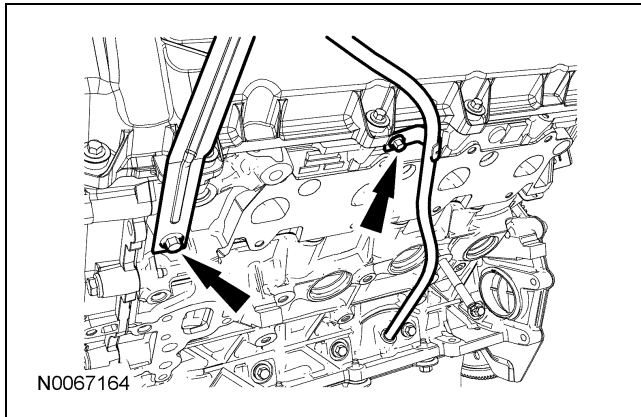
25. Remove the stud bolt and the coolant tube.

- Discard the O-ring seal.

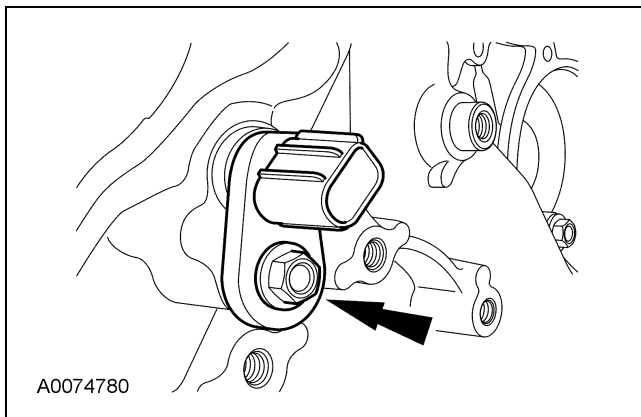


26. Remove the 2 bolts and the oil level indicator tube.

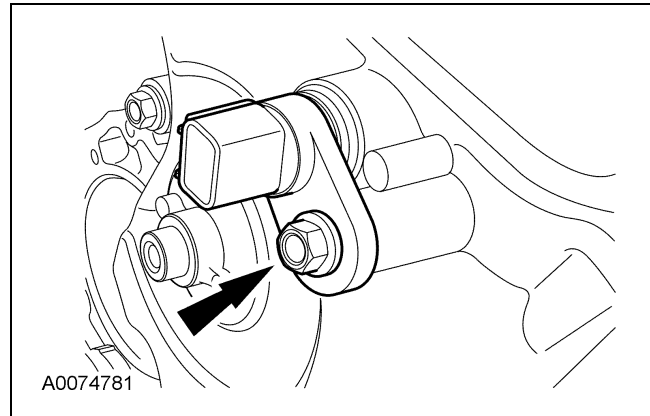
- Discard the O-ring seal.



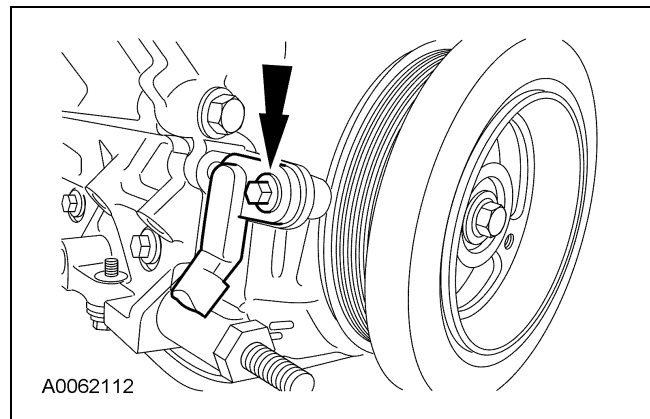
27. Remove the bolt and the RH CMP sensor.



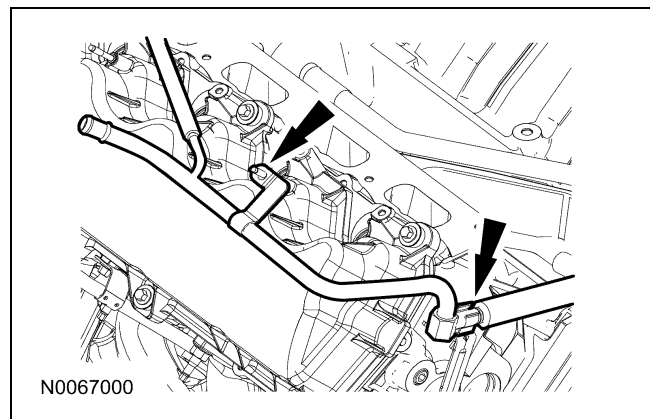
28. Remove the bolt and the LH CMP sensor.



29. Remove the bolt and the CKP sensor.

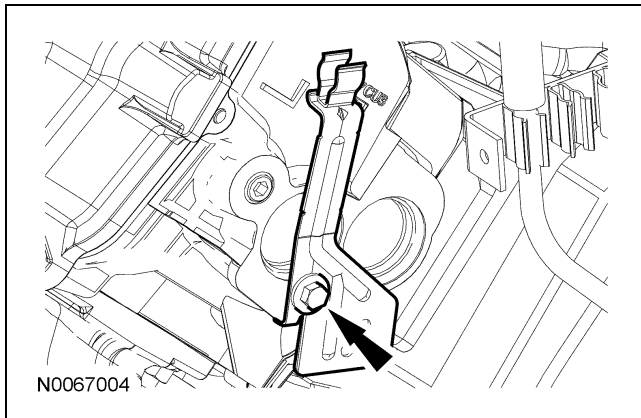


30. Disconnect the intake manifold vacuum tube from the valve cover stud and the support bracket.



DISASSEMBLY (Continued)

31. Remove the bolt and the intake manifold vacuum tube support bracket.



32. **⚠ CAUTION:** Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the sealing surfaces. These tools cause scratches and gouges, which make leak paths. Use a plastic scraping tool to remove all traces of old sealant.

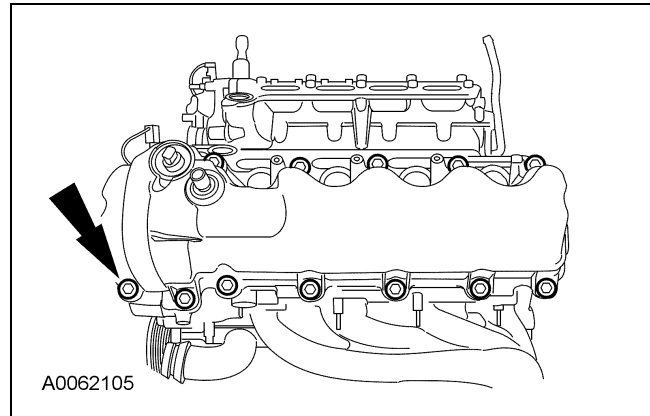
⚠ CAUTION: When removing the valve cover, make sure to avoid damaging the variable camshaft timing (VCT) solenoid.

NOTE: The fasteners are part of the valve cover and should not be removed.

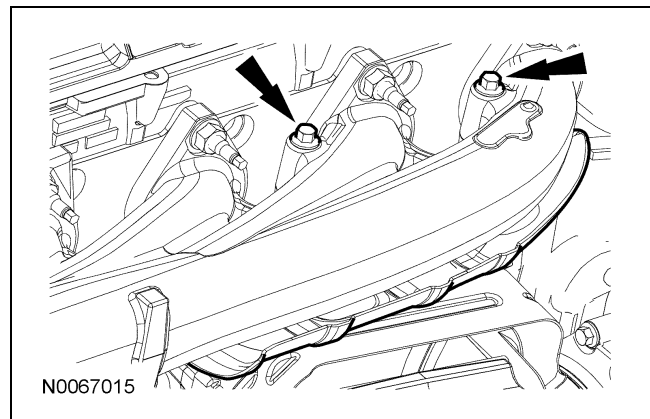
NOTE: LH shown, RH similar.

Remove the valve covers.

- Fully loosen the fasteners and remove the valve cover.
- Clean the valve cover mating surface of the cylinder head with Silicone Gasket Remover and Motorcraft Metal Surface Prep. Follow the directions on the packaging.
- Inspect the valve cover gasket. If the gasket is damaged, remove and discard the gasket. Clean the valve cover gasket groove with soap and water or a suitable solvent.

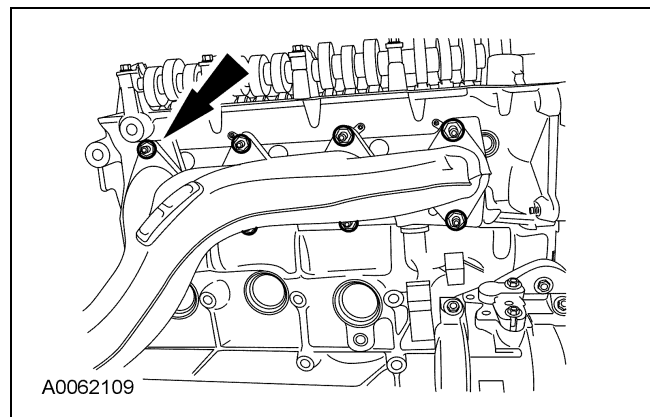


33. Remove the 2 bolts and the RH exhaust manifold heat shield.



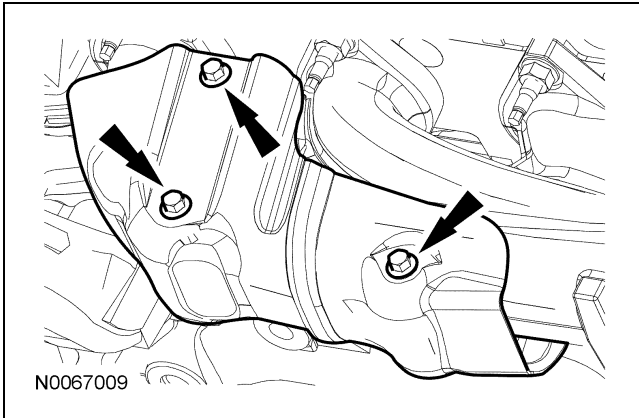
34. Remove the 8 nuts, the 8 studs and the RH exhaust manifold.

- Discard the gaskets, nuts and studs.
- Inspect the exhaust manifold. For additional information, refer to Section 303-00.

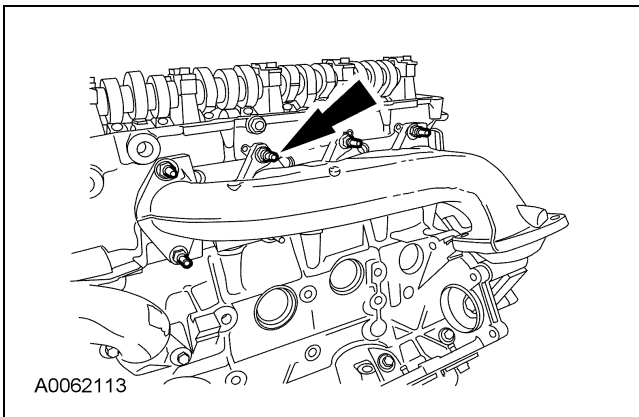


DISASSEMBLY (Continued)

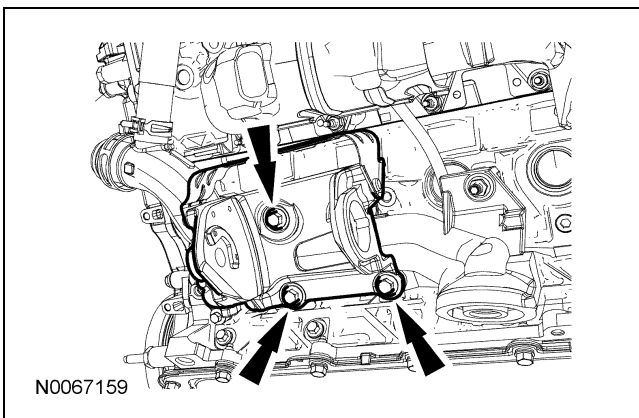
35. Remove the 3 bolts and the LH exhaust manifold shield.



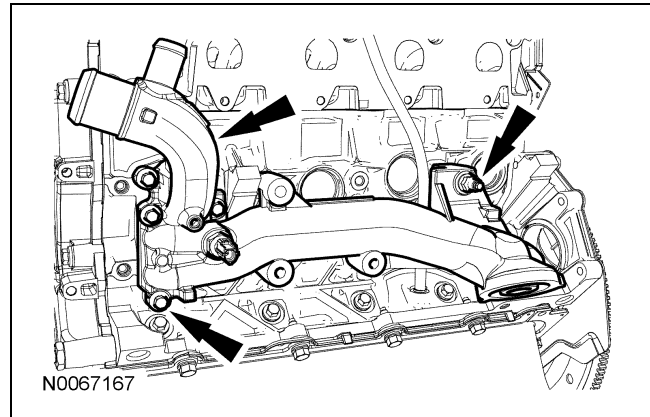
36. Remove the 8 nuts, the 8 studs and the LH exhaust manifold.
- Discard the gaskets, nuts and studs.
 - Inspect the exhaust manifold. For additional information, refer to Section 303-00.



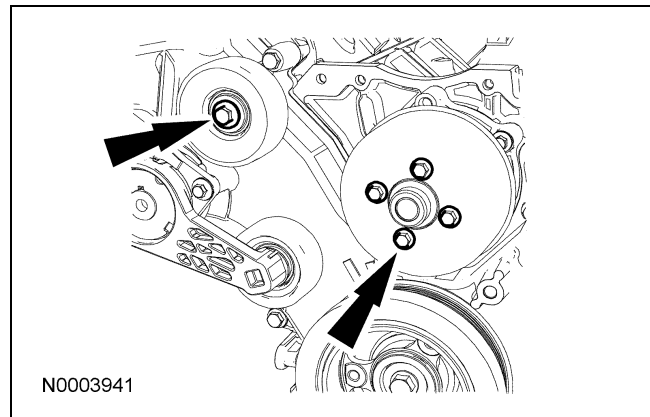
37. Remove the 3 bolts and the LH engine support insulator.
- Discard the bolts.



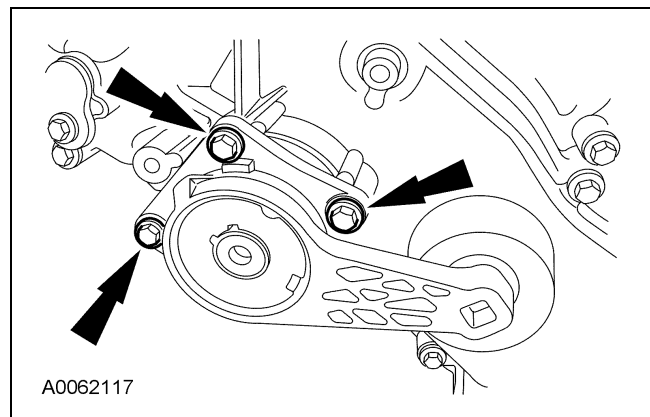
38. Remove the nut, the 4 bolts and the oil filter adapter and gasket.
- Discard the gasket.



39. Remove the bolts, coolant pump pulley and accessory drive belt idler pulley.

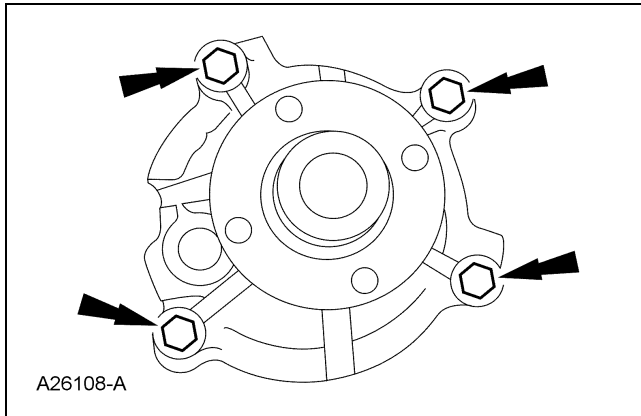


40. Remove the bolts and the accessory drive belt tensioner.



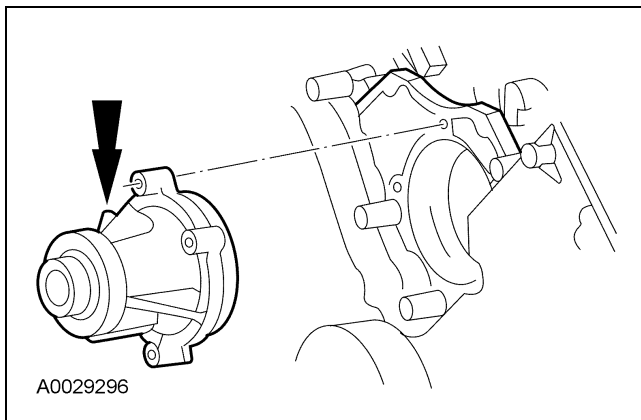
DISASSEMBLY (Continued)

41. Remove the bolts.

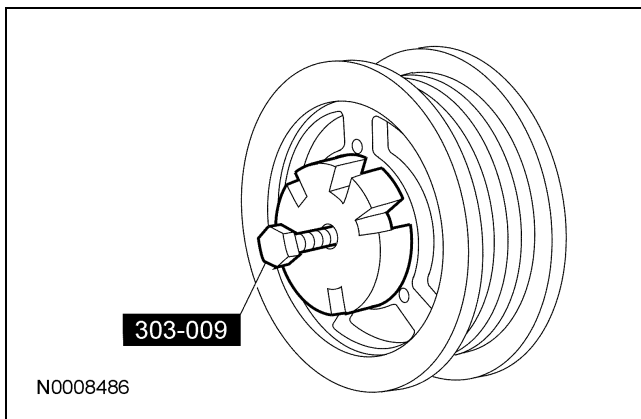


42. Remove the coolant pump from the cylinder block.

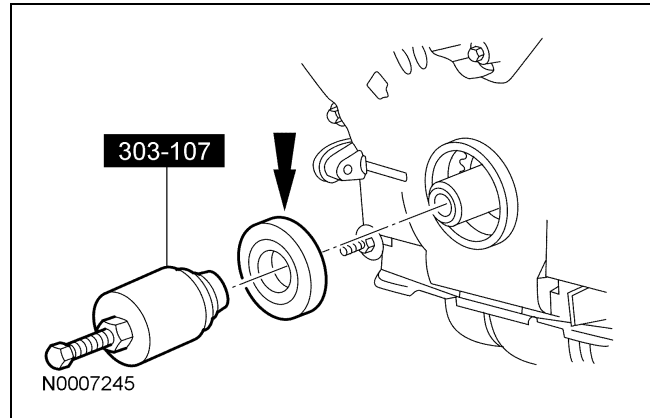
- Discard the O-ring seal.



43. Remove and discard the crankshaft pulley bolt. Using the special tool, remove the crankshaft pulley.



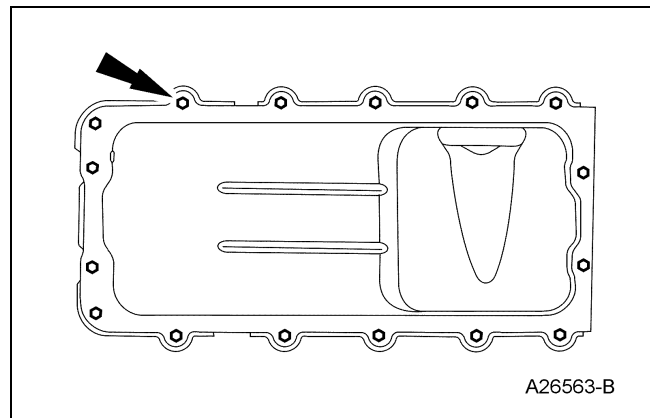
44. Using the special tool, remove and discard the crankshaft front seal.



45. Remove the bolts, oil pan and oil pan gasket.

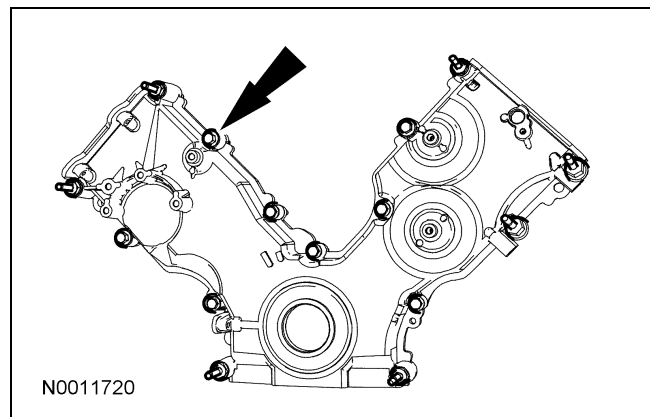
- **CAUTION:** Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the sealing surfaces. These tools cause scratches and gouges, which make leak paths. Use a plastic scraping tool to remove all traces of old sealant.

Clean and inspect the sealing surfaces.



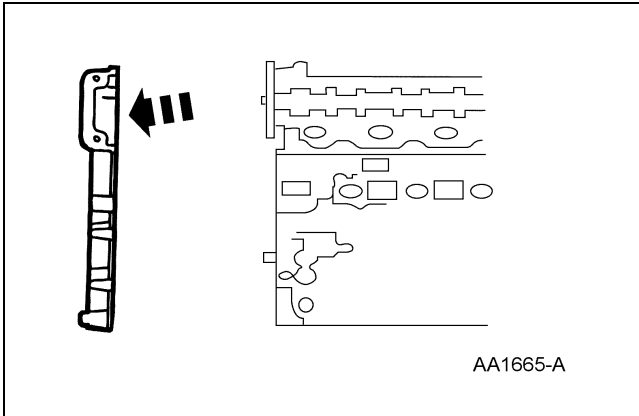
46. **NOTE:** Correct fastener location is essential for assembly procedure. Record fastener location.

Remove the fasteners.

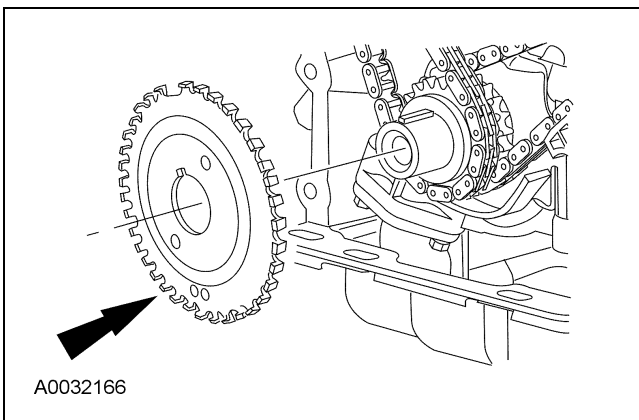


DISASSEMBLY (Continued)

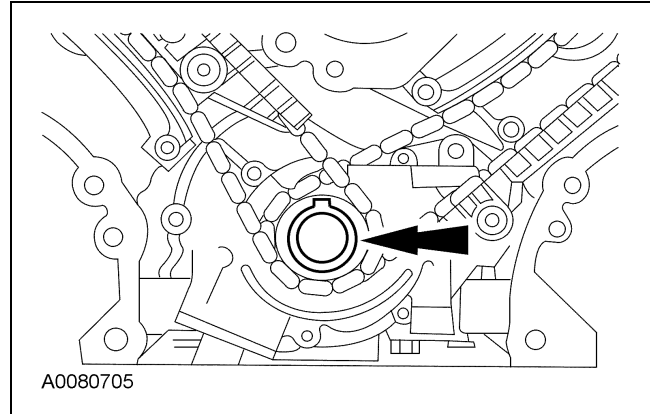
47. Remove the engine front cover from the cylinder block.



48. Remove the crankshaft sensor ring from the crankshaft.

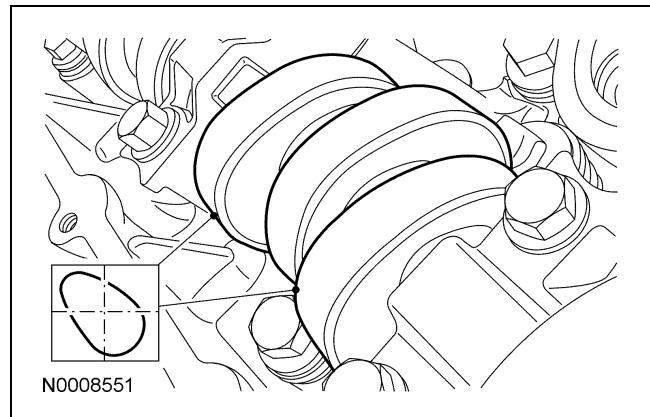


49. Position the crankshaft keyway at the 12 o'clock position.




50. **NOTE:** If the camshaft lobes are not exactly positioned as shown, the crankshaft will require one full additional rotation to 12 o'clock.

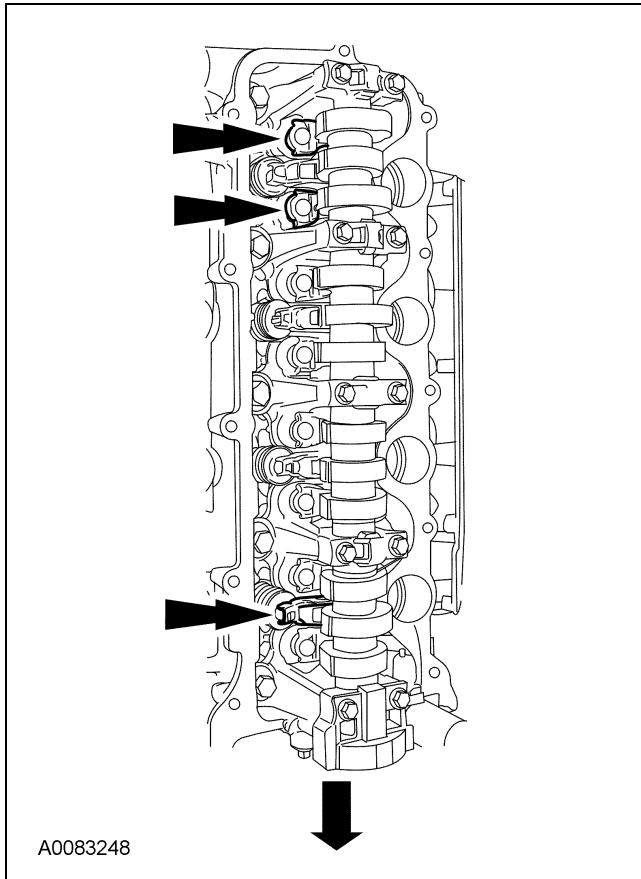
The No. 1 cylinder camshaft exhaust lobe must be coming up on the exhaust stroke. Verify by noting the position of the 2 intake camshaft lobes and the exhaust lobe on the No. 1 cylinder.



DISASSEMBLY (Continued)

51.  **CAUTION:** If the components are to be reinstalled, they must be installed in the same positions. Mark the components for installation into their original locations. Failure to follow these instructions may result in engine damage.

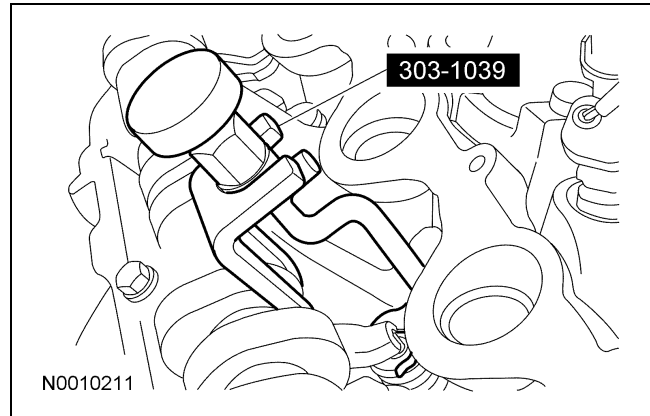
Remove only the 3 camshaft roller followers shown in the illustration from the RH cylinder head.




52. **NOTE:** Do not allow the valve keepers to fall off of the valve or the valve may drop into the cylinder. If a valve drops into the cylinder, the cylinder head must be removed.

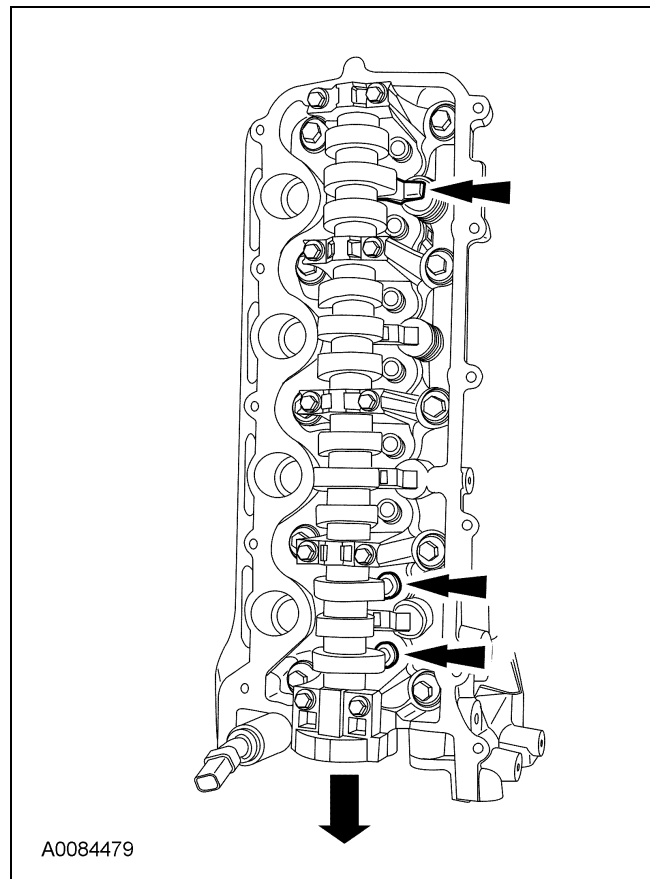
NOTE: It may be necessary to push the valve down while compressing the spring.

Using the special tool, remove the 3 camshaft roller followers designated in the previous step from the RH cylinder head.



53.  **CAUTION:** If the components are to be reinstalled, they must be installed in the same positions. Mark the components for installation into their original locations. Failure to follow these instructions may result in engine damage.

Remove only the 3 camshaft roller followers shown in the illustration from the LH cylinder head.

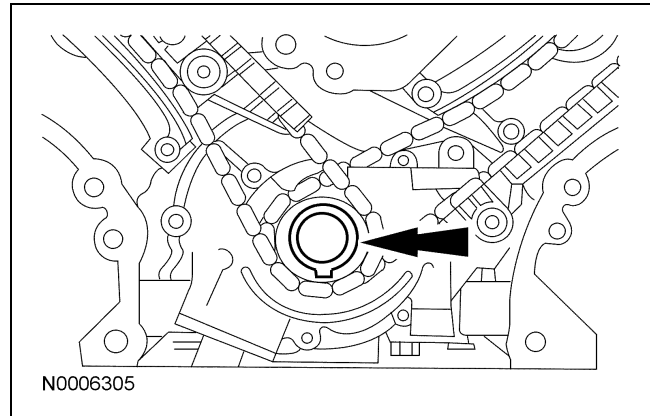
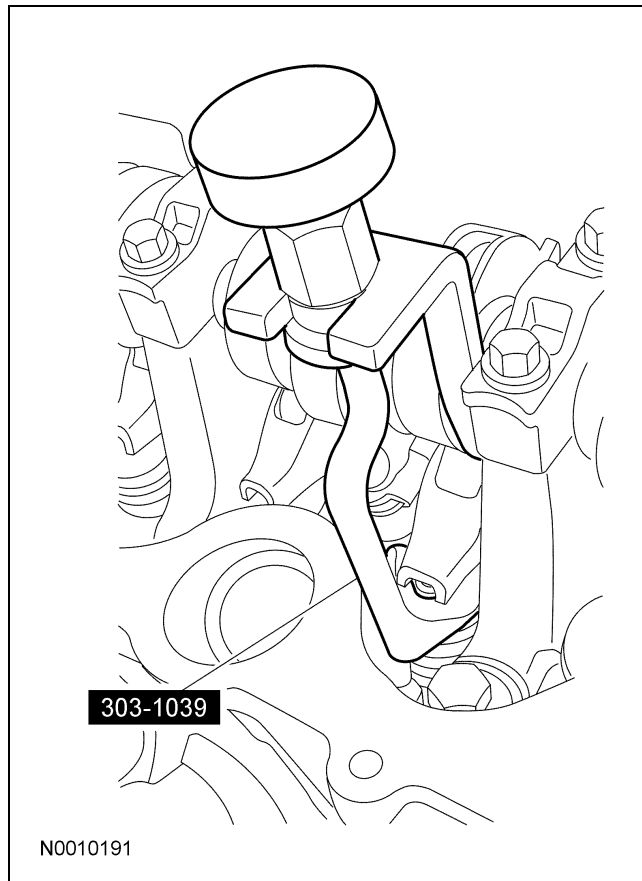


DISASSEMBLY (Continued)

54. **NOTE:** Do not allow the valve keepers to fall off of the valve or the valve may drop into the cylinder. If a valve drops into the cylinder, the cylinder head must be removed.

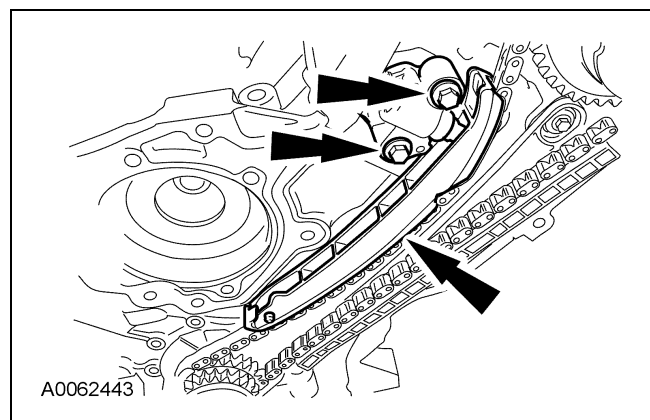
NOTE: It may be necessary to push the valve down while compressing the spring.

Using the special tool, remove the 3 camshaft roller followers designated in the previous step from the LH cylinder head.



56. **CAUTION:** If one or both of the tensioner mounting bolts are loosened or removed, the tensioner-sealing bead must be inspected for seal integrity. If cracks, tears, separation from the tensioner body or permanent compression of the seal bead is observed, install a new tensioner or engine damage may occur.


Remove the bolts, the LH timing chain tensioner and tensioner arm.



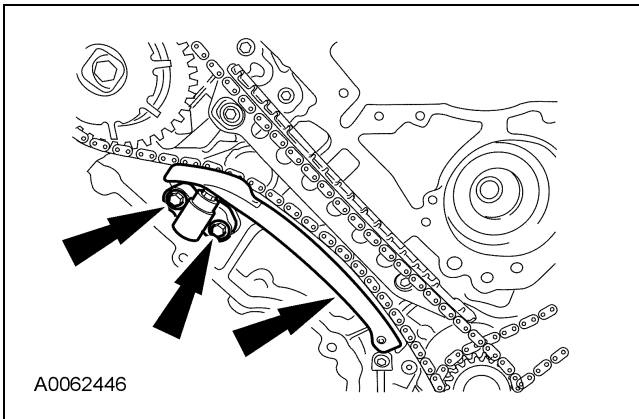
55. **CAUTION:** The crankshaft cannot be moved past the 6 o'clock position once set or engine damage may occur.

Rotate the crankshaft clockwise and position the crankshaft keyway at the 6 o'clock position.

DISASSEMBLY (Continued)

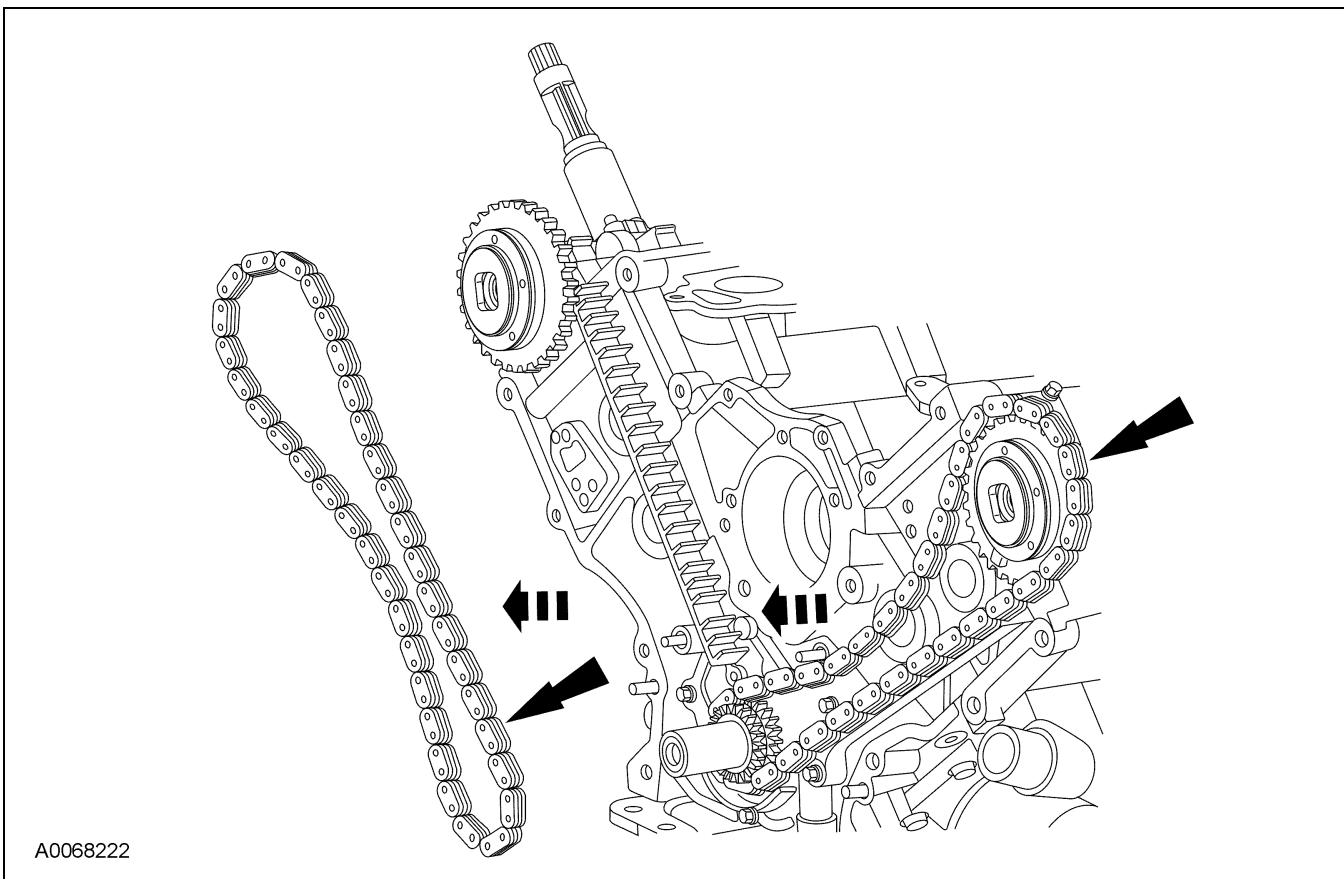
57.  **CAUTION:** If one or both of the tensioner mounting bolts are loosened or removed, the tensioner-sealing bead must be inspected for seal integrity. If cracks, tears, separation from the tensioner body or permanent compression of the seal bead is observed, install a new tensioner or engine damage may occur.

Remove the bolts, the RH timing chain tensioner and tensioner arm.



58. Remove the RH and LH timing chains and the crankshaft sprocket.

- Remove the RH timing chain from the camshaft sprocket.
- Remove the RH timing chain from the crankshaft sprocket.
- Remove the LH timing chain from the camshaft sprocket.
- Remove the LH timing chain and crankshaft sprocket.

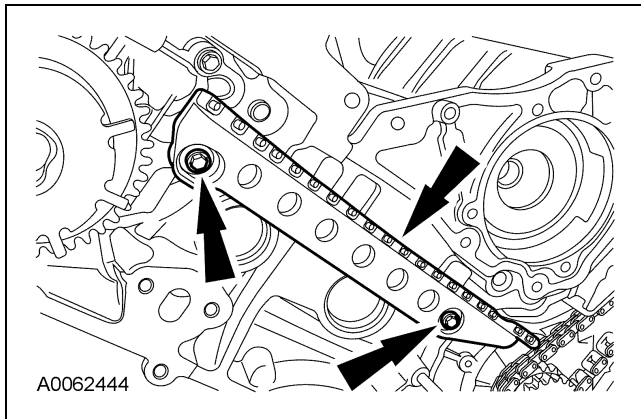


DISASSEMBLY (Continued)

59. **NOTE:** RH shown, LH similar.

Remove the LH and RH timing chain guides.

- Remove the bolts.
- Remove both timing chain guides.

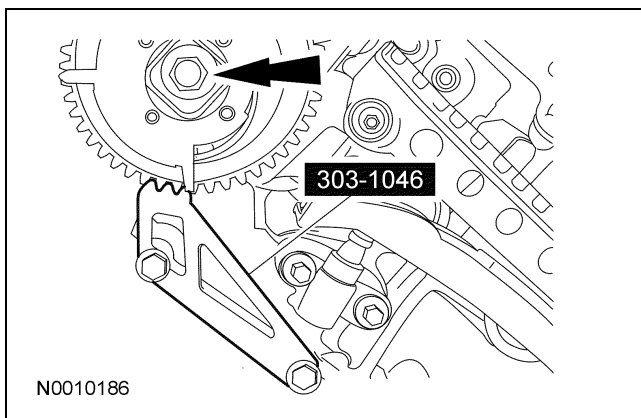


60. **⚠ CAUTION:** Damage to the variable camshaft timing (VCT) phaser sprocket assembly will occur if mishandled or used as a lifting or leveraging device.

⚠ CAUTION: Only use hand tools to remove the variable camshaft timing (VCT) phaser sprocket assembly or damage may occur to the camshaft or VCT phaser sprocket.

Using the special tool, remove the bolt and the RH VCT phaser sprocket assembly.

- Discard the VCT phaser sprocket bolt.

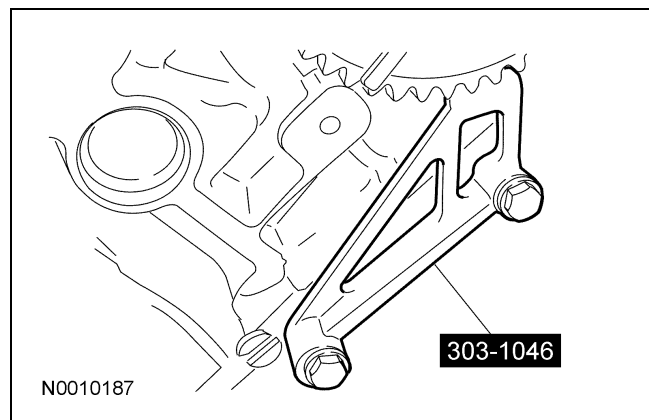


61. **⚠ CAUTION:** Damage to the variable camshaft timing (VCT) phaser sprocket assembly will occur if mishandled or used as a lifting or leveraging device.

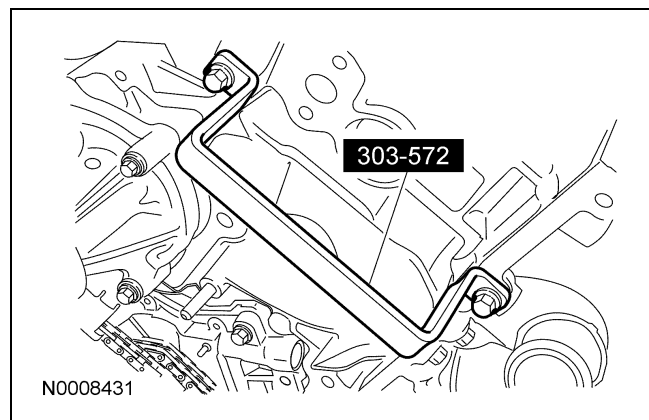
⚠ CAUTION: Only use hand tools to remove the variable camshaft timing (VCT) phaser sprocket assembly or damage may occur to the camshaft or VCT phaser sprocket.

Using the special tool, remove the bolt and the LH VCT phaser sprocket assembly.

- Discard the VCT phaser sprocket bolt.

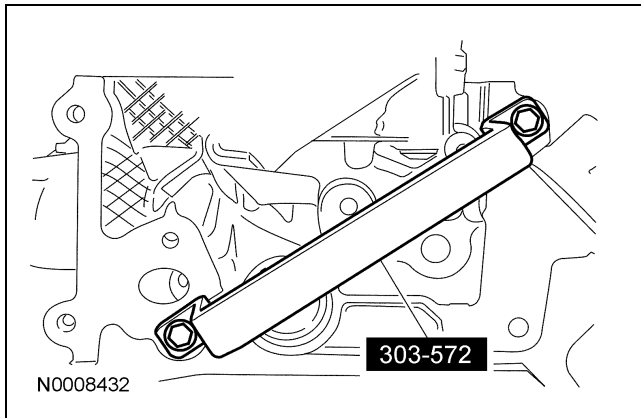


62. Install the special tool onto the LH cylinder head.



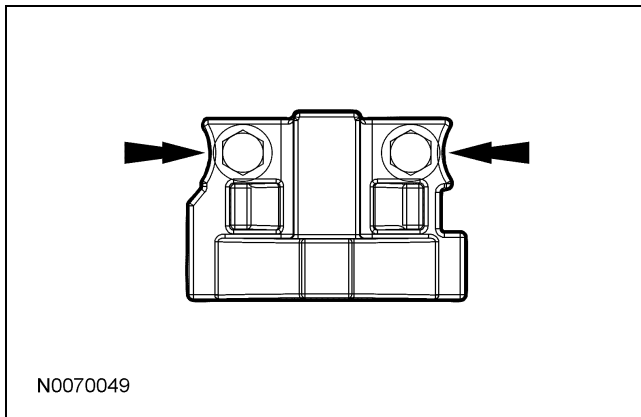
DISASSEMBLY (Continued)

63. Install the special tool onto the RH cylinder head.



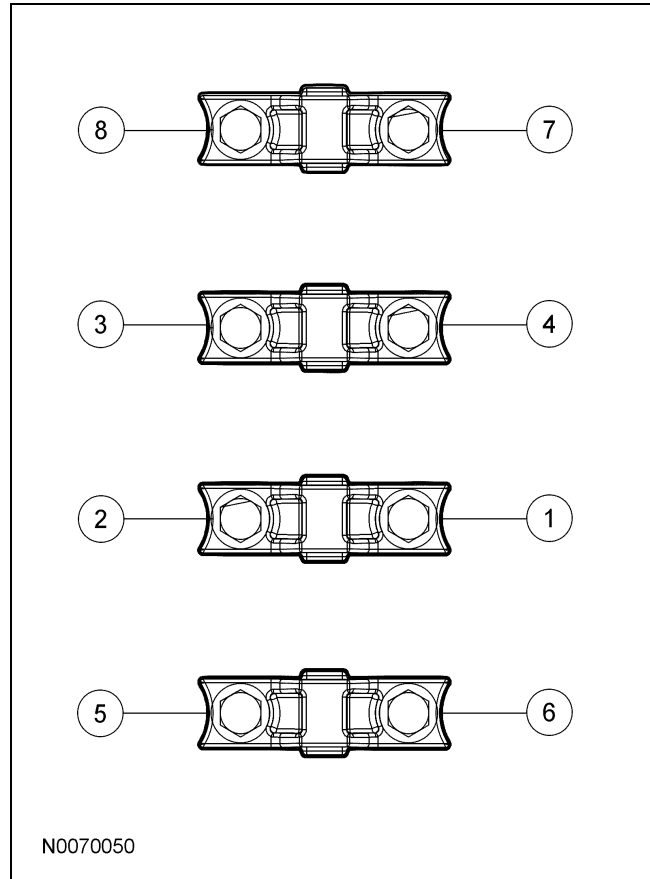
64. **CAUTION:** Remove the front thrust camshaft bearing cap straight upward from the bearing towers or the bearing cap may be damaged from sideloading.

Remove the 2 bolts and the RH cylinder head camshaft front bearing cap.



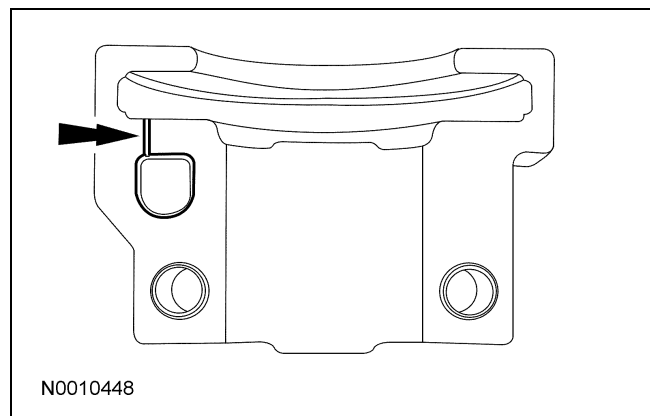
65. **CAUTION:** The camshaft bearing caps must be installed in their original locations. Record camshaft bearing cap locations. Failure to follow these instructions may result in engine damage.

Remove the remaining bolts in the sequence shown and remove the RH cylinder head camshaft bearing caps.




66. Clean and inspect the RH camshaft bearing caps.

- The camshaft front thrust bearing cap contains an oil metering groove. Make sure the groove is free of foreign material.




67. Remove the RH camshaft.


DISASSEMBLY (Continued)

68.  **CAUTION:** If the components are to be reinstalled, they must be installed in the same positions. Mark the components for installation into their original locations. Failure to follow these instructions may result in engine damage.

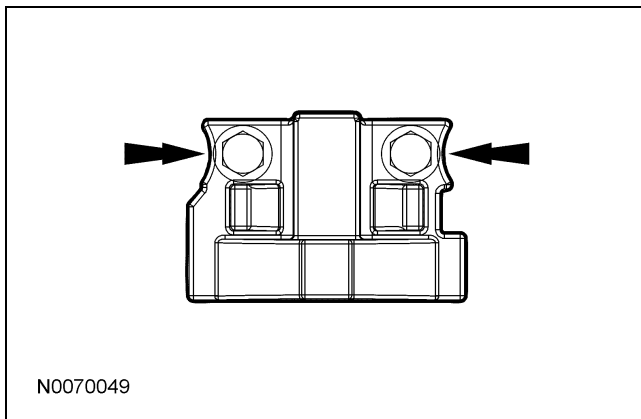
Remove the remaining camshaft roller followers from the RH cylinder head.


69.  **CAUTION:** If the components are to be reinstalled, they must be installed in the same positions. Mark the components for installation into their original locations. Failure to follow these instructions may result in engine damage.

Remove the hydraulic lash adjusters from the RH cylinder head.

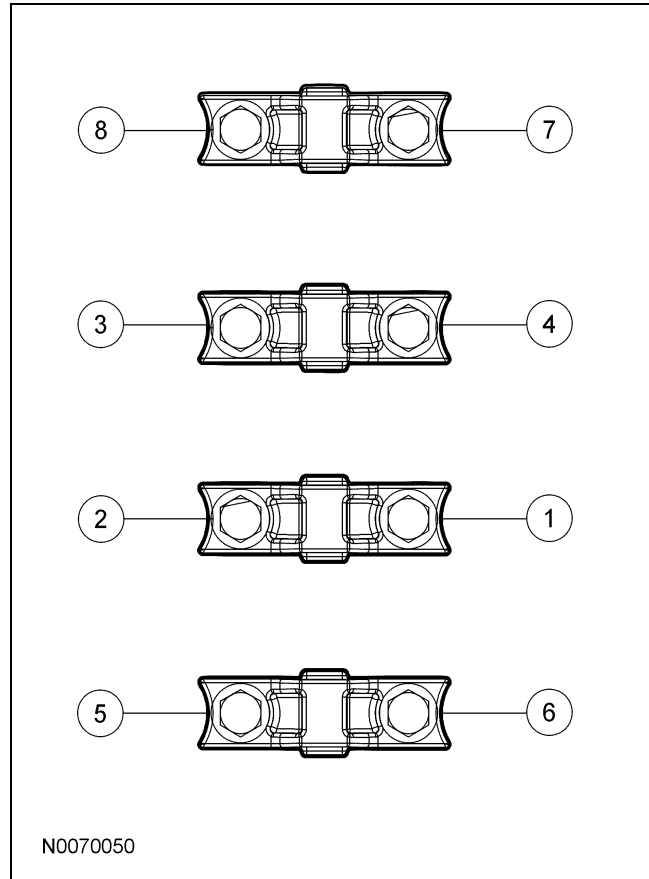
70.  **CAUTION:** Remove the front thrust camshaft bearing cap straight upward from the bearing towers or the bearing cap may be damaged from sideloading.

Remove the 2 bolts and the LH cylinder head camshaft bearing cap.



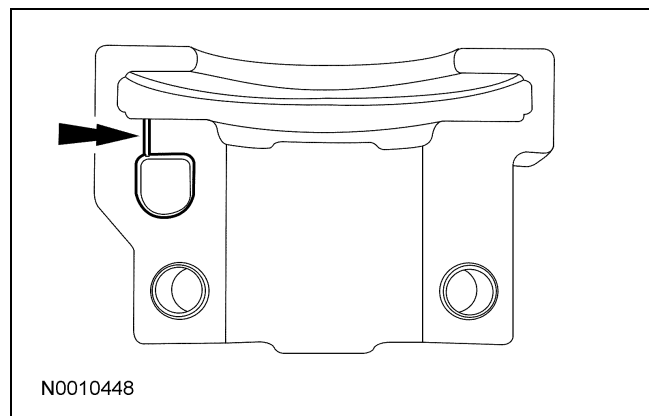
71.  **CAUTION:** The camshaft bearing caps must be installed in their original locations. Record camshaft bearing cap locations. Failure to follow these instructions may result in engine damage.

Remove the remaining bolts in the sequence shown and remove the LH cylinder head camshaft bearing caps.



72. Clean and inspect the LH camshaft bearing caps.

- The camshaft front thrust bearing cap contains an oil metering groove. Make sure the groove is free of foreign material.



73. Remove the LH camshaft.

DISASSEMBLY (Continued)

74. ⚠ **CAUTION:** If the components are to be reinstalled, they must be installed in the same positions. Mark the components for installation into the original locations. Failure to follow these instructions may result in engine damage.

Remove the remaining camshaft roller followers from the LH cylinder head.

75. ⚠ **CAUTION:** If the components are to be reinstalled, they must be installed in the same positions. Mark the components for installation into their original locations. Failure to follow these instructions may result in engine damage.

Remove the hydraulic lash adjusters from the LH cylinder head.

76. ⚠ **CAUTION:** The cylinder head must be cool before removing it from the engine. Cylinder head warpage may result if a warm or hot cylinder head is removed.

⚠ **CAUTION:** Place clean shop towels over exposed engine cavities. Carefully remove the towels so foreign material is not dropped into the engine. Failure to follow this procedure may cause engine damage.

⚠ **CAUTION:** The cylinder head bolts must be discarded and new bolts must be installed. They are a tighten-to-yield design and cannot be reused.

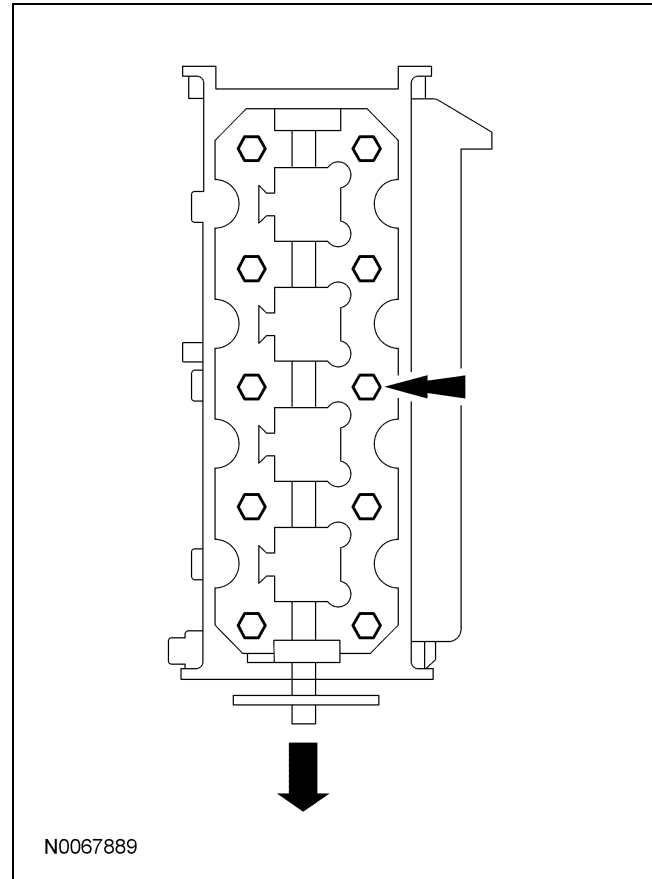
⚠ **CAUTION:** Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the sealing surfaces. These tools cause scratches and gouges, which make leak paths. Use a plastic scraping tool to remove all traces of old sealant.

⚠ **CAUTION:** Aluminum surfaces are soft and can be scratched easily. Never place the cylinder head gasket surface, unprotected, on a bench surface. Failure to follow this procedure may cause engine damage.


NOTE: RH shown, LH similar.


Remove the bolts and the cylinder head.

- Discard the cylinder head gasket.
- Discard the cylinder head bolts.



DISASSEMBLY (Continued)

77.  **CAUTION:** Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the sealing surfaces. These tools cause scratches and gouges, which make leak paths. Use a plastic scraping tool to remove all traces of old sealant.

 **CAUTION:** Observe all warnings or cautions and follow all application directions contained on the packaging of the Silicone Gasket Remover and the Motorcraft Metal Surface Prep. Failure to follow this procedure may cause engine damage.

NOTE: If there is no residual gasket material present, Motorcraft Metal Surface Prep can be used to clean and prepare the surfaces.

Clean the cylinder head-to-cylinder block mating surfaces of both the cylinder head and the cylinder block.

- 1 Remove any large deposits of silicone or gasket material with a plastic scraper.
- 2 Apply Silicone Gasket Remover, following package directions, and allow to set for several minutes.
- 3 Remove the Silicone Gasket Remover with a plastic scraper. A second application of Silicone Gasket Remover may be required if residual traces of silicone or gasket material remain.
- 4 Apply Motorcraft Metal Surface Prep, following package directions, to remove any remaining traces of oil or coolant, and to prepare the surfaces to bond with the new gasket. Do not attempt to make the metal shiny. Some staining of the metal surfaces is normal.

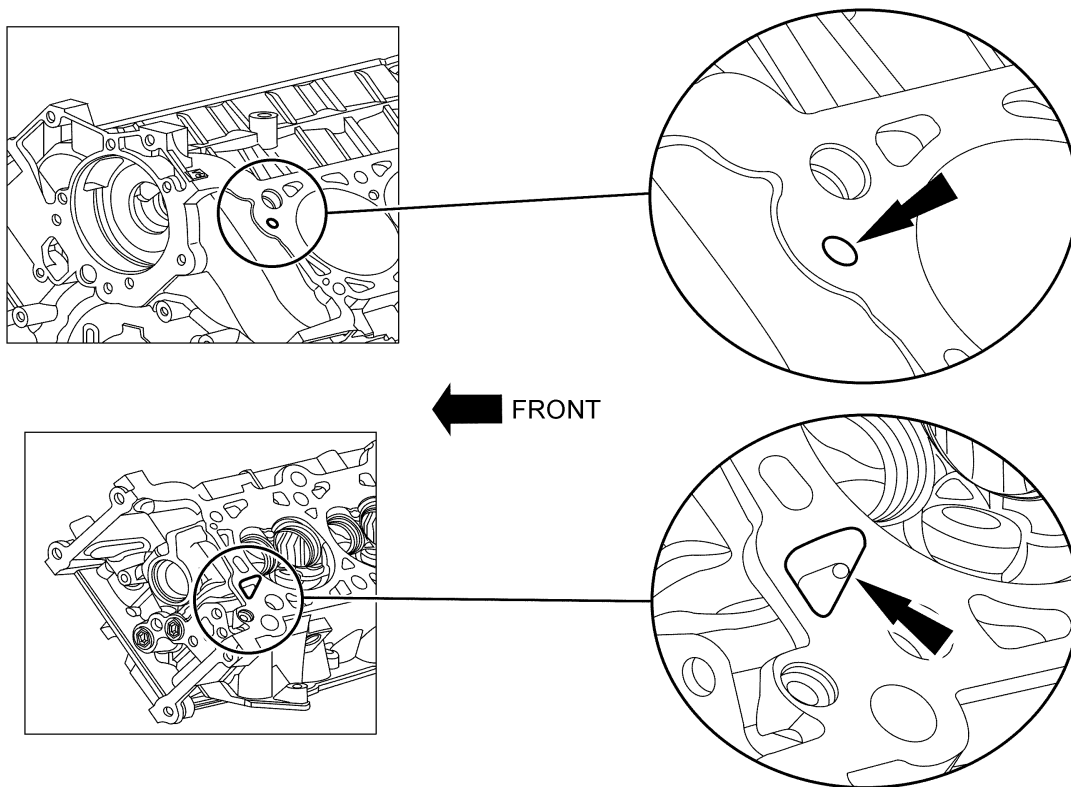
DISASSEMBLY (Continued)

78. **NOTE:** Make sure all cylinder head surfaces are clear of any gasket material, RTV, oil and coolant. The cylinder head surface must be clean and dry before running a flatness check.

NOTE: Use a straightedge that is calibrated by the manufacturer to be flat within 0.005 mm (0.0002 in) per running foot length, such as Snap-On® GA438A or equivalent. For example, if the straightedge is 61 cm (24 in) long, the machined edge must be flat within 0.010 mm (0.0004 in) from end to end.

NOTE: LH shown, RH similar.

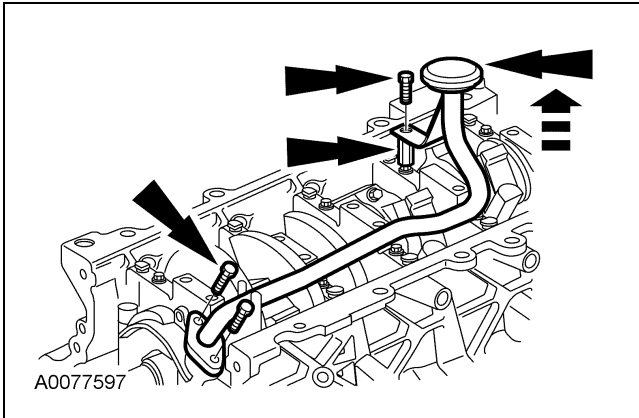
Support the cylinder head on a bench with the head gasket side up. Inspect all areas of the deck face with a straightedge, paying particular attention to the oil pressure feed area. The cylinder head must not have depressions deeper than 0.0254 mm (0.001 in) across a 38.1 mm (1.5 in) square area or scratches longer than 0.0254 mm (0.001 in).



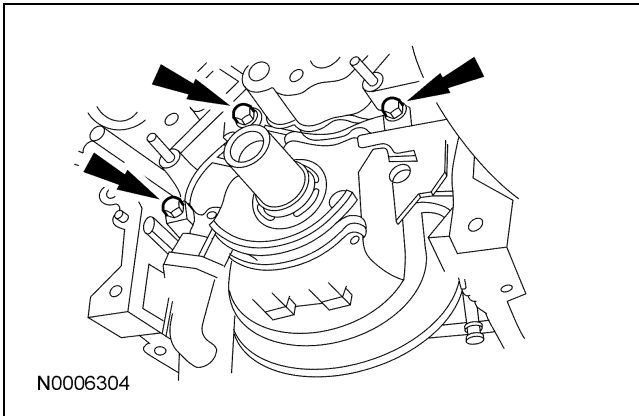
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DISASSEMBLY (Continued)


79. Remove the bolts, the oil pump screen and pickup tube and the spacer.



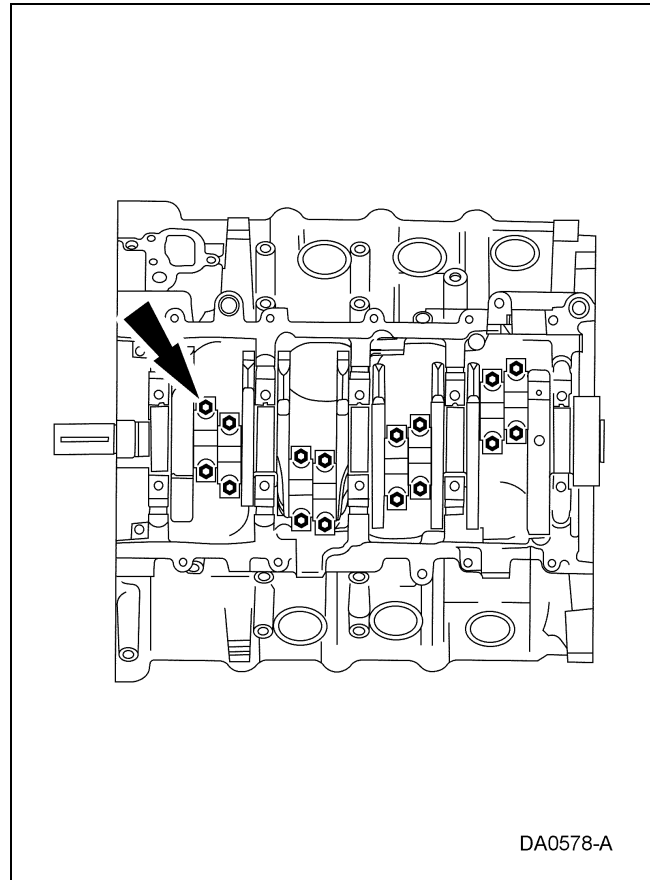
80. Remove the 3 bolts and the oil pump.




81. Before removing the pistons, inspect the top of the cylinder bores. If necessary, remove the ridge or carbon deposits from each cylinder using an abrasive pad or equivalent, following the manufacturer instructions.

82.  **CAUTION:** Verify that the connecting rods and rod caps have orientation numbers cast into them. If not, number the connecting rods and rod caps for correct orientation. Failure to follow these instructions may result in engine damage.

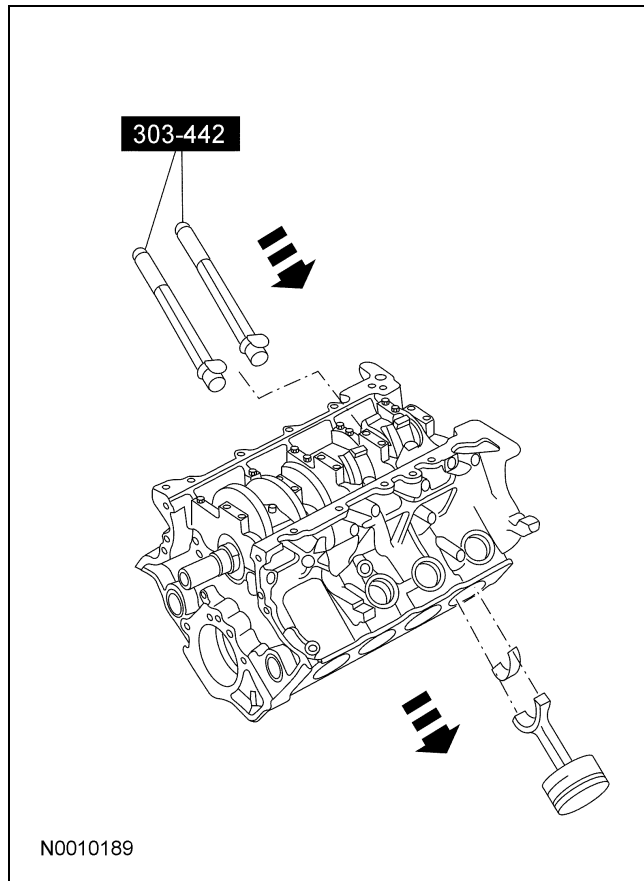
Remove the bolts and the connecting rod caps. Discard the bolts.



DISASSEMBLY (Continued)

83.  **CAUTION:** Do not scratch the cylinder walls or crankshaft journals with the connecting rod. Failure to follow these instructions may result in engine damage.

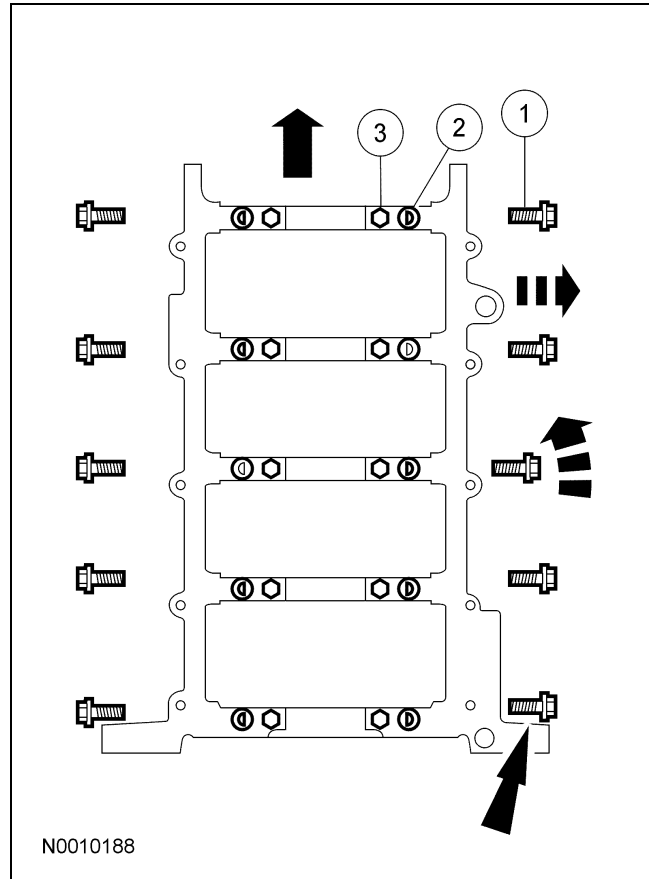
Use the special tool to push the piston through the top of the cylinder block.



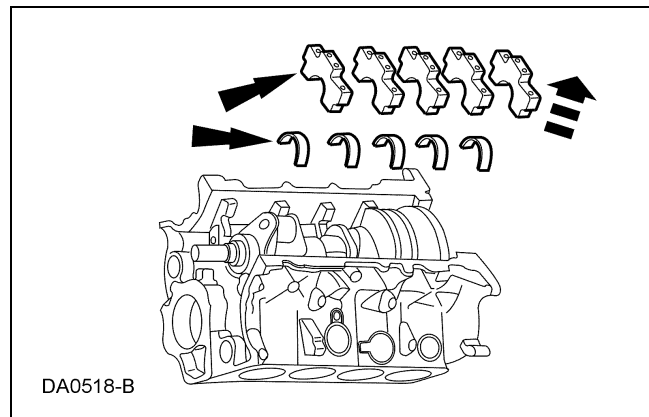
84. Disassemble the 8 pistons. For additional information, refer to Piston in this section.

85. Remove the fasteners.

- 1 Remove and discard the cross-mounted main cap bolts.
- 2 Remove the dowels.
- 3 Remove and discard the main bearing cap bolts.

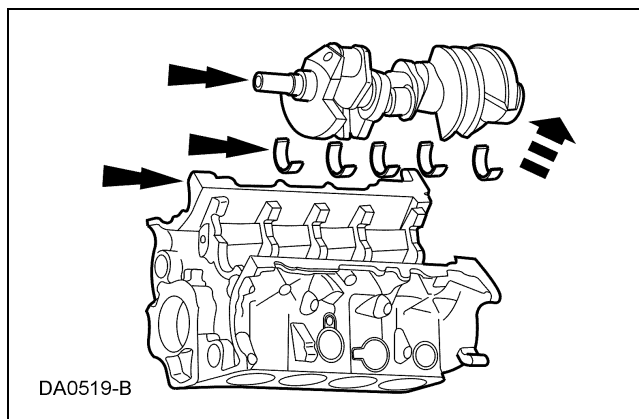


86. Remove the 5 main bearing caps, the lower crankshaft main bearings and the lower thrust washer.



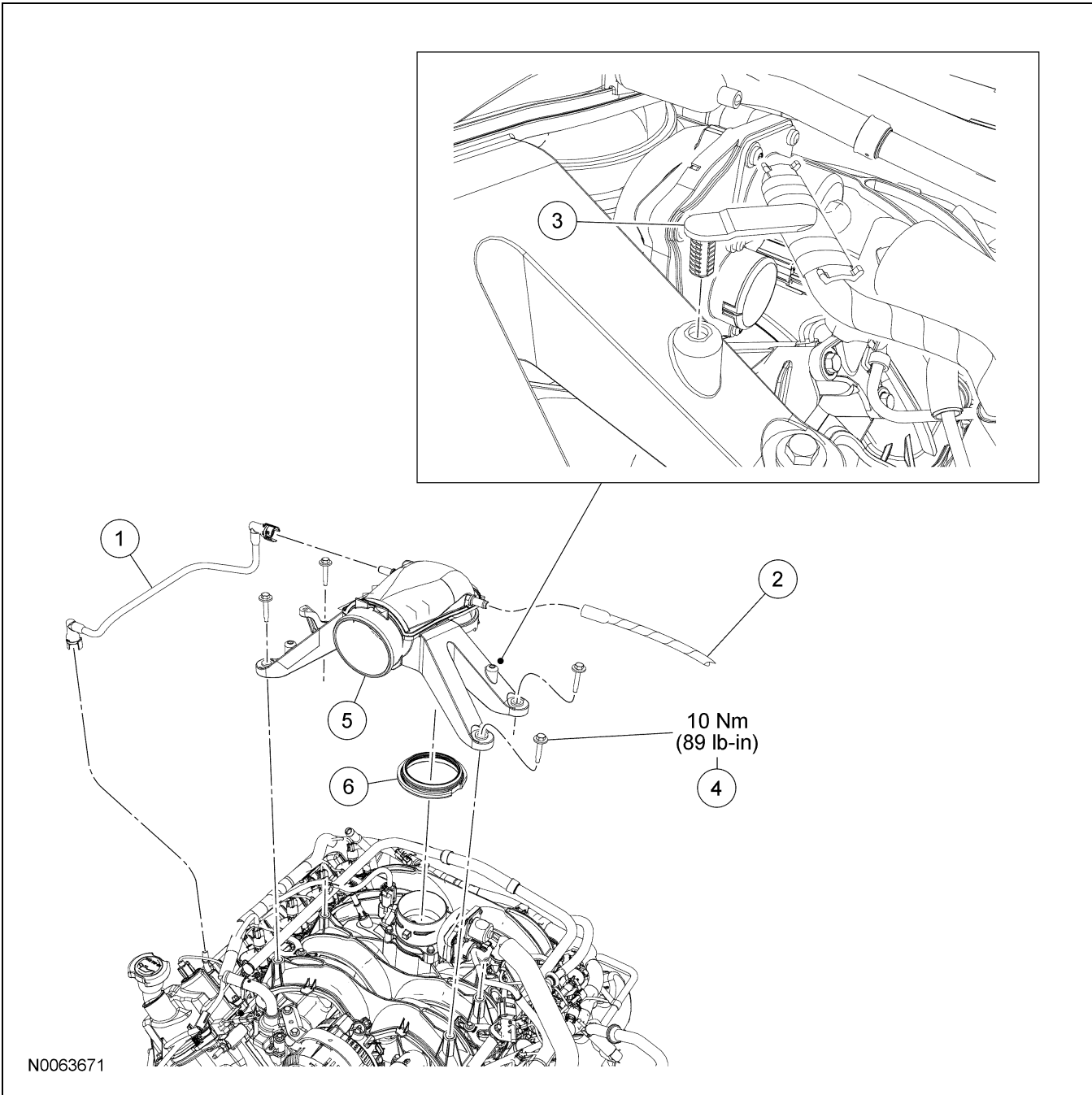
DISASSEMBLY (Continued)

87. Remove the crankshaft, the upper crankshaft main bearings and the upper thrust washers from the cylinder block.



IN-VEHICLE REPAIR

Engine Lubrication Components —
Exploded View

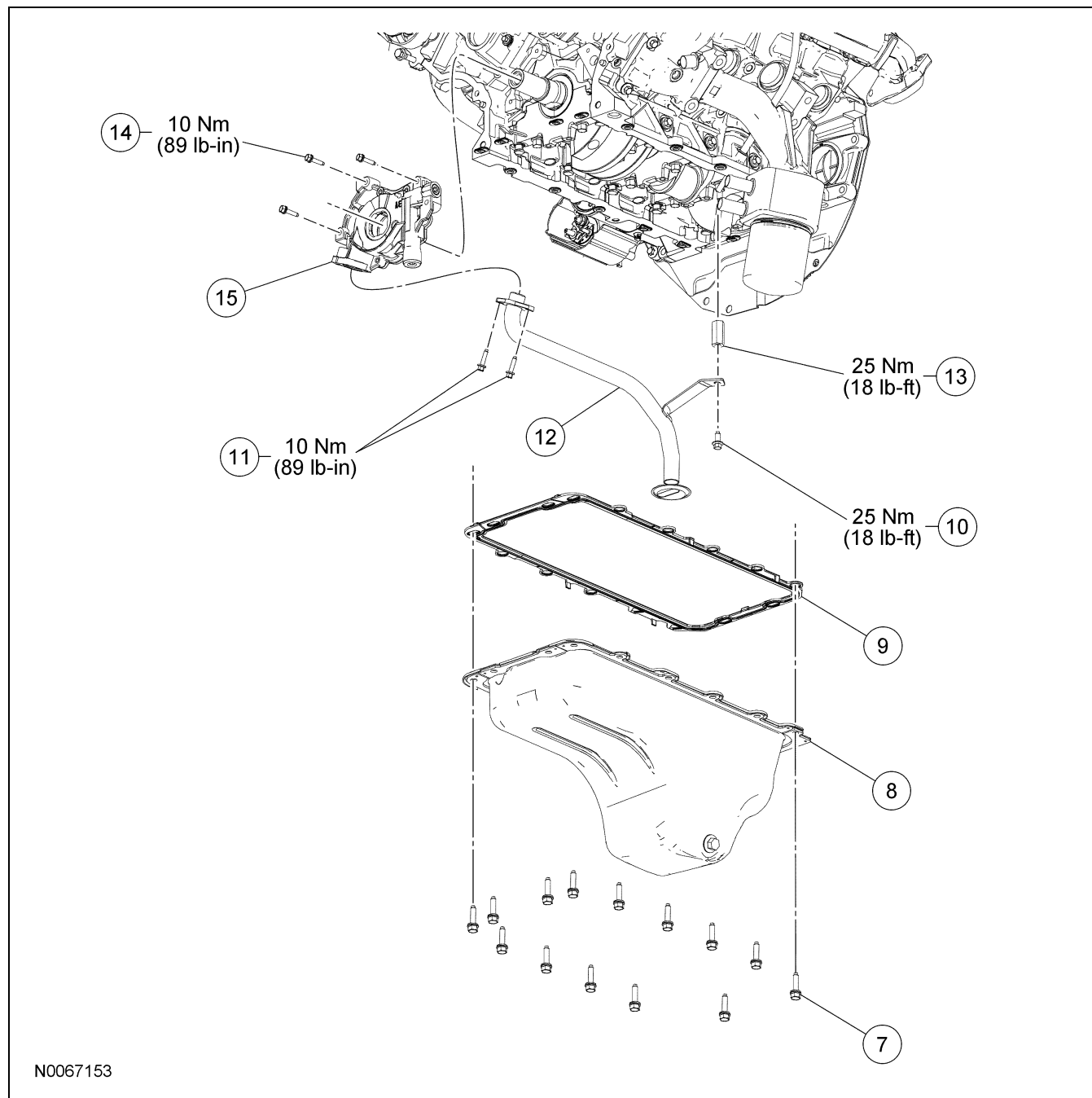


Item	Part Number	Description
1	6758	Crankcase ventilation tube
2	—	Vacuum hose (part of 9D446)
3	—	Engine wiring harness retainer (part of 12B637)

(Continued)

Item	Part Number	Description
4	9F991	Air cleaner outlet pipe-to-throttle body (TB) adapter bolt (4 required)
5	9A589	Air cleaner outlet pipe-to-TB adapter
6	—	Air cleaner outlet pipe-to-TB adapter seal (part of 9A589)

IN-VEHICLE REPAIR (Continued)



Item	Part Number	Description
7	W701605	Oil pan bolt (16 required)
8	6675	Oil pan
9	6710	Oil pan gasket
10	N605904	Oil pump screen and pickup tube-to-spacer bolt
11	N806155	Oil pump screen and pickup tube-to-oil pump bolts (2 required)

Item	Part Number	Description
12	6622	Oil pump screen and pickup tube
13	N806180	Oil pump screen and pickup tube spacer
14	N806183	Oil pump bolt (3 required)
15	6621	Oil pump

(Continued)

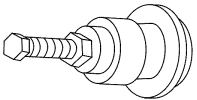
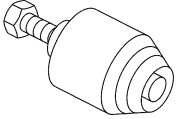
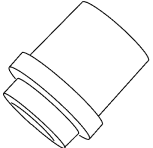
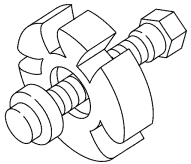
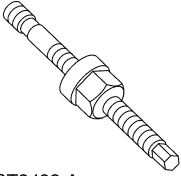
IN-VEHICLE REPAIR (Continued)

1. For additional information, refer to the procedures in this section.
-

IN-VEHICLE REPAIR

Engine Front Cover

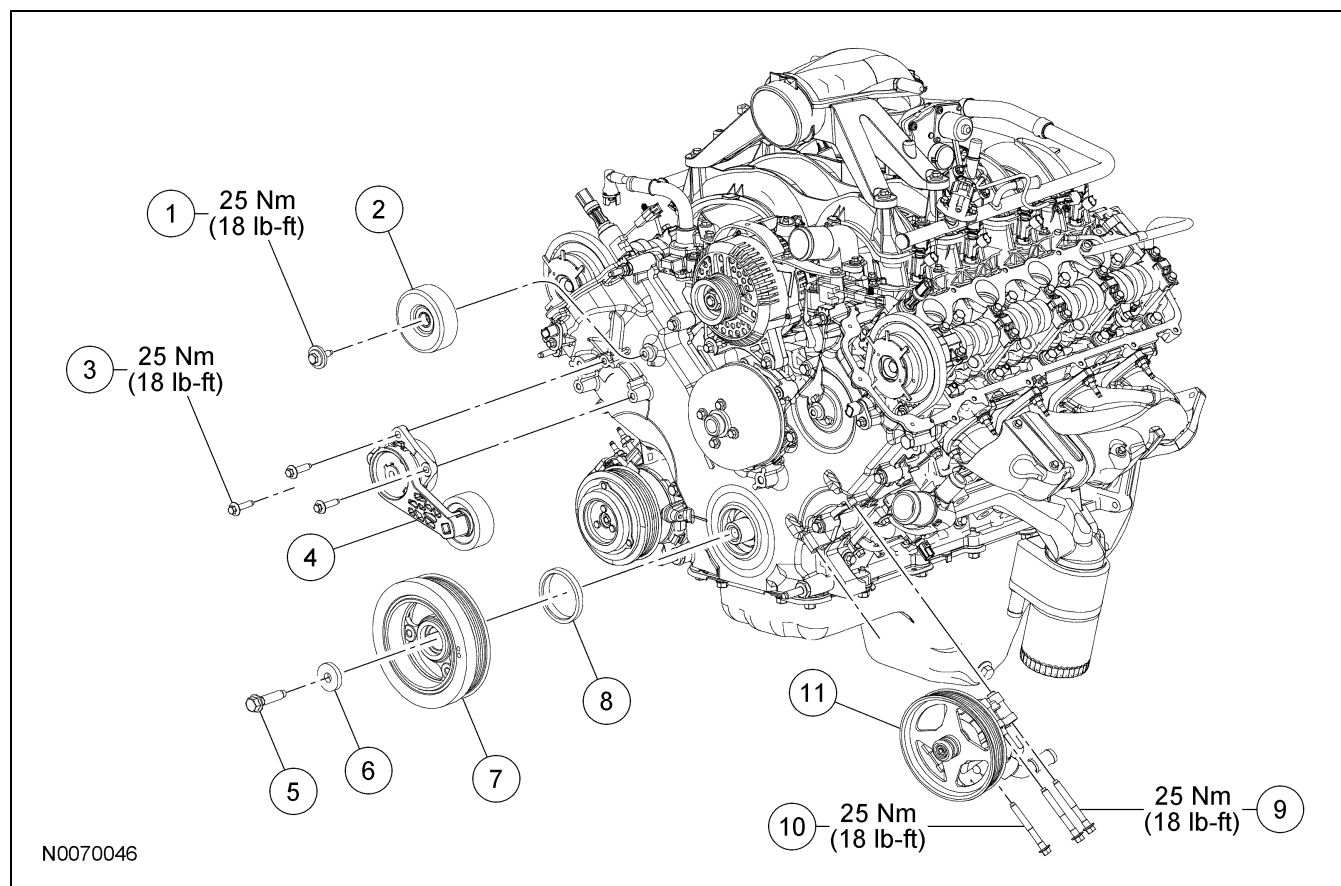
Special Tool(s)

 <p>ST1328-A</p>	<p>Installer, Crankshaft Front Seal 303-335 (T88T-6701-A)</p>
 <p>ST1288-A</p>	<p>Remover, Crankshaft Front Seal 303-107 (T74P-6700-A)</p>
 <p>ST2197-A</p>	<p>Installer, Crankshaft Front Seal 303-635</p>
 <p>ST1286-A</p>	<p>Remover, Crankshaft Vibration Damper 303-009 (T58P-6316-D)</p>
 <p>ST2428-A</p>	<p>Installer, Crankshaft Vibration Damper 303-102 (T74P-6316-B)</p>

Material

Item	Specification
Motorcraft Metal Surface Prep ZC-31	—
Motorcraft SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP (US); Motorcraft SAE 5W-20 Super Premium Motor Oil CXO-5W20-LSP12 (Canada); or equivalent	WSS-M2C930-A
Silicone Gasket Remover ZC-30	—
Silicone Gasket and Sealant TA-30	WSE-M4G323-A4

IN-VEHICLE REPAIR (Continued)

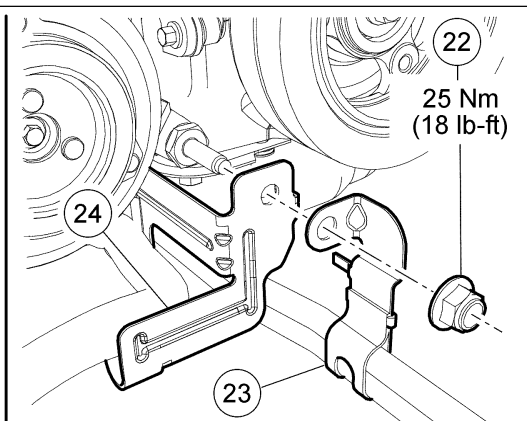
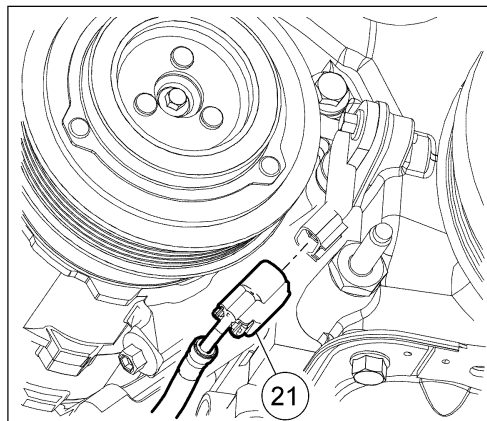
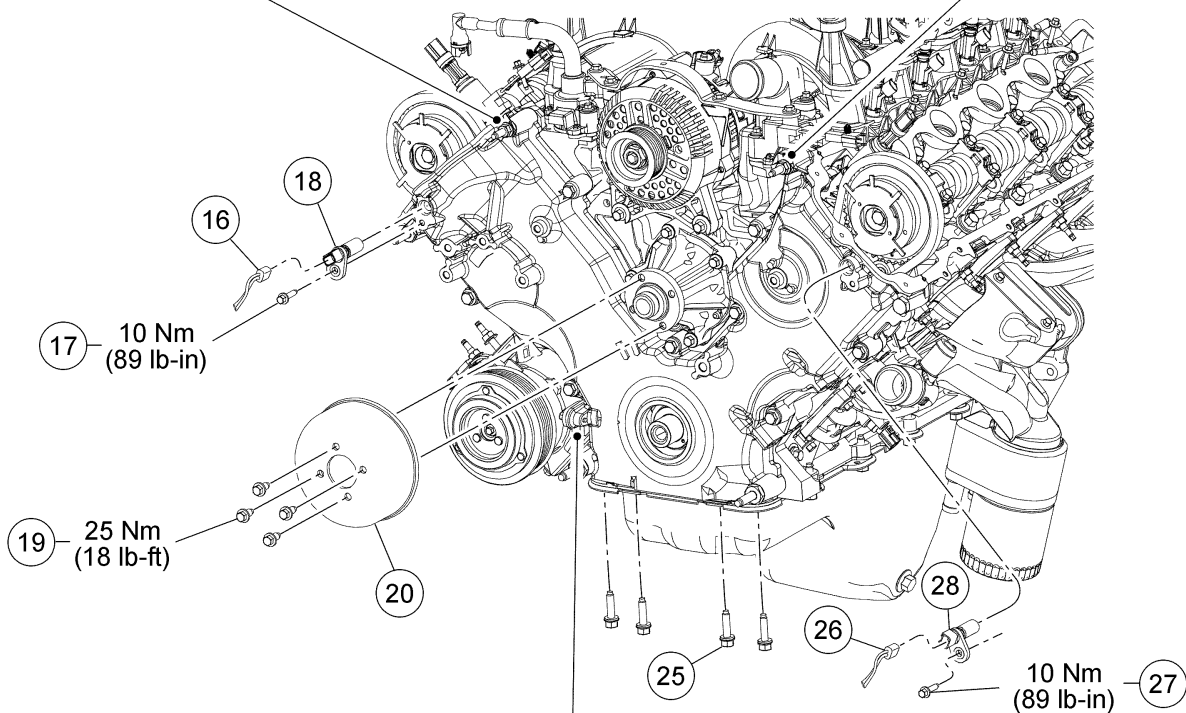
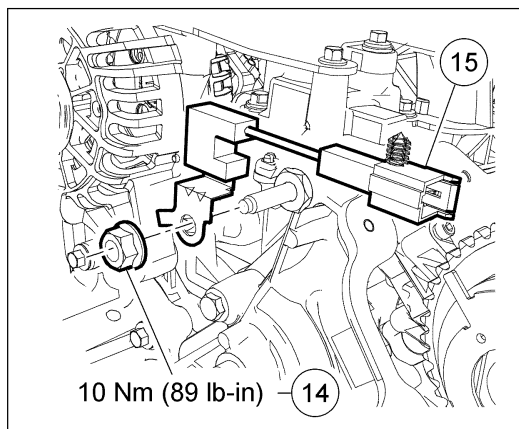
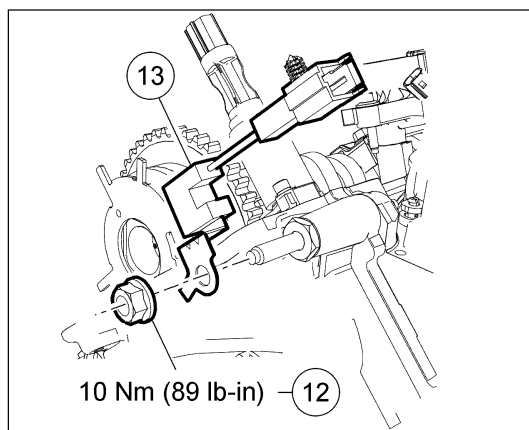


Item	Part Number	Description
1	N808102	Accessory drive belt idler pulley bolt
2	19A216	Accessory drive belt idler pulley
3	N808920	Accessory drive belt tensioner bolt (3 required)
4	6B209	Accessory drive belt tensioner
5	W701512	Crankshaft pulley bolt

(Continued)

Item	Part Number	Description
6	N806165	Crankshaft pulley bolt washer
7	6316	Crankshaft pulley
8	6700	Crankshaft front seal
9	W500315	Power steering pump bolt (2 required)
10	W701526	Power steering pump bolt
11	3A696	Power steering pump

IN-VEHICLE REPAIR (Continued)



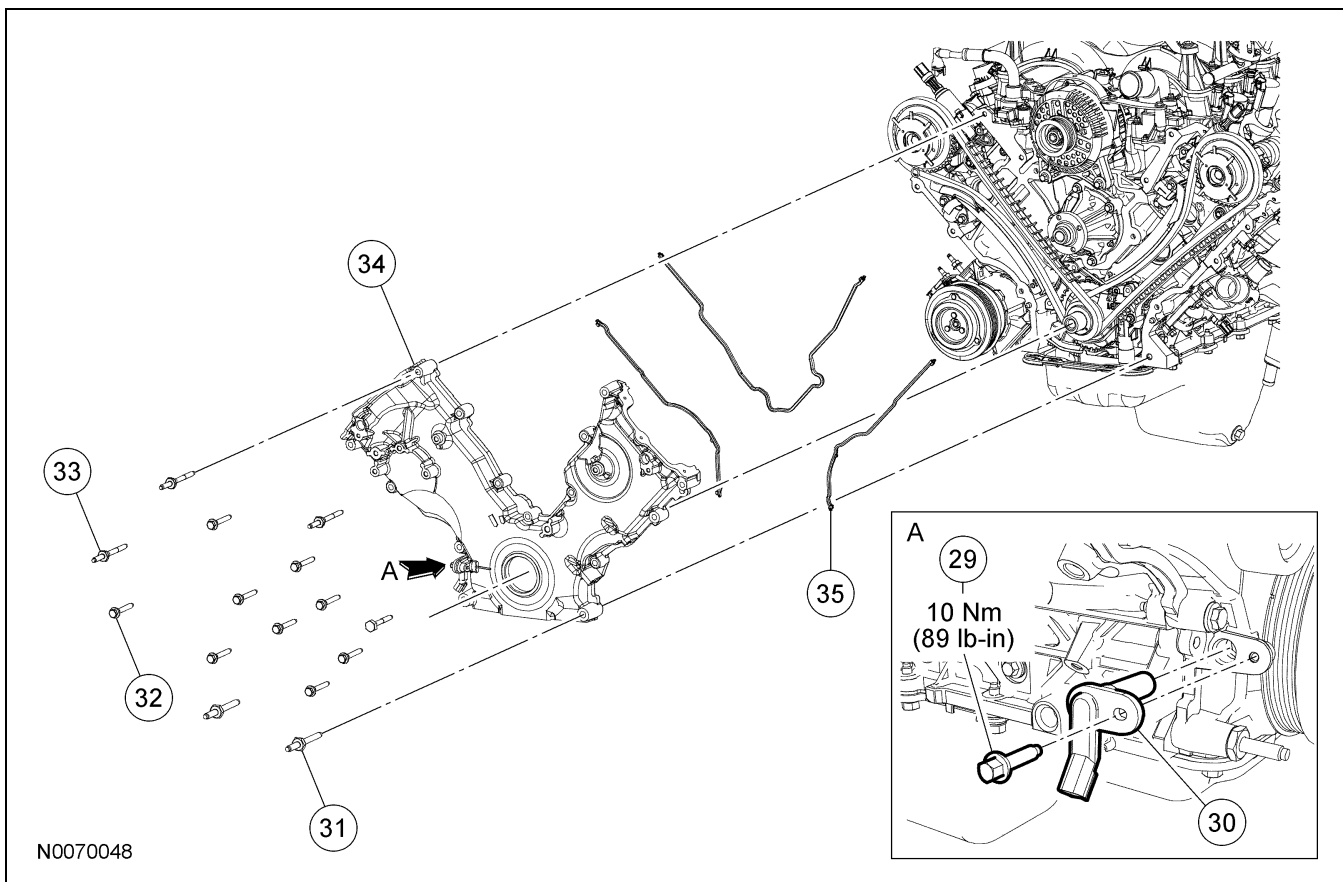
N0070047

IN-VEHICLE REPAIR (Continued)

Item	Part Number	Description
12	N804758	RH radio ignition interference capacitor nut
13	18801	RH radio ignition interference capacitor
14	N804758	LH radio ignition interference capacitor nut
15	18801	LH radio ignition interference capacitor
16	—	RH camshaft position (CMP) sensor electrical connector (part of 12B637)
17	N806155	RH CMP sensor bolt
18	6B288	RH CMP sensor
19	N806282	Coolant pump pulley bolt (4 required)
20	8A528	Coolant pump pulley

(Continued)

Item	Part Number	Description
21	—	Crankshaft position (CKP) sensor electrical connector (part of 12B637)
22	W605289	Transmission fluid cooler tube and battery wiring harness support brackets nut
23	—	Transmission fluid cooler tube support bracket
24	—	Starter wiring harness support bracket
25	W701605	Oil pan bolt (4 required)
26	—	LH CMP sensor electrical connector (part of 12B637)
27	N806155	LH CMP sensor bolt
28	6B288	LH CMP sensor



Item	Part Number	Description
29	N806155	CKP sensor bolt
30	6C315	CKP sensor
31	N808529	Engine front cover stud (2 required)

(Continued)

Item	Part Number	Description
32	N806177	Engine front cover bolt (8 required)
33	N709573	Engine front cover stud (5 required)
34	6C086	Engine front cover

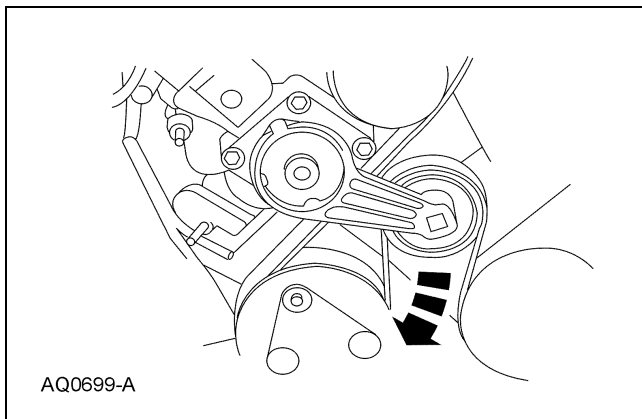
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IN-VEHICLE REPAIR (Continued)

Item	Part Number	Description
35	6D081	Engine front cover gasket (3 required)

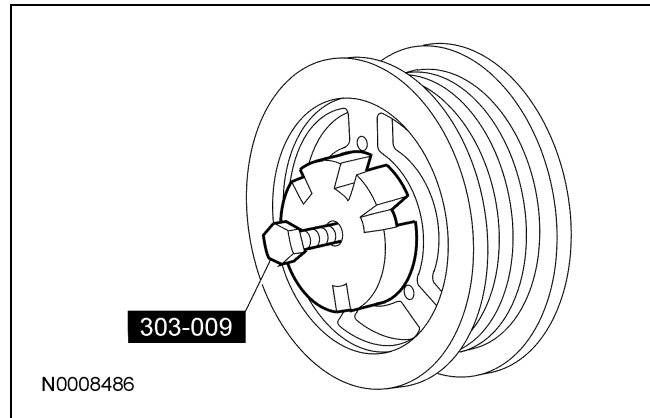
Removal

1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
2. Drain the engine oil.
3. Remove the engine cooling fan shroud. For additional information, refer to Section 303-03
4. Remove the engine cooling fan. For additional information, refer to Section 303-03.
5. Remove the RH valve cover. For additional information, refer to Valve Cover — RH in this section.
6. Remove the LH valve cover. For additional information, refer to Valve Cover — LH in this section.
7. Loosen the 4 coolant pump pulley bolts.
8. Rotate the tensioner clockwise and remove the accessory drive belt.

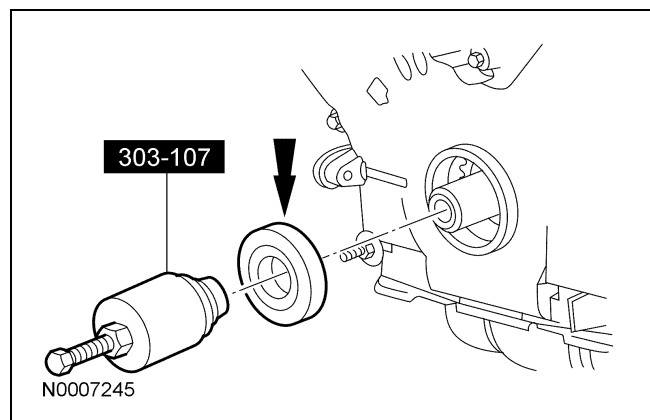


9. Remove the bolt and the accessory drive idler pulley.
10. Remove the 3 bolts and the accessory drive belt tensioner.
11. Remove the crankshaft pulley bolt and washer.
 - Discard the crankshaft pulley bolt.

12. Using the special tool, remove the crankshaft pulley.



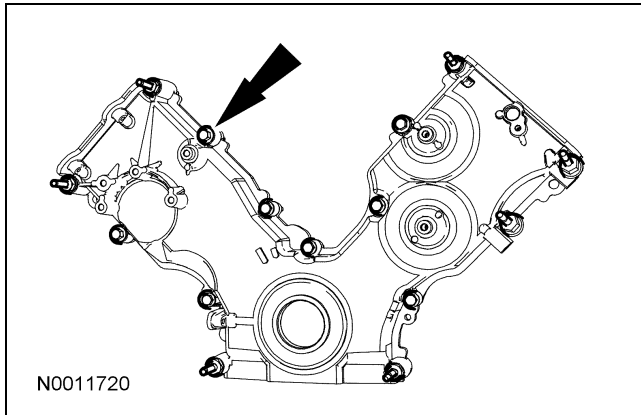
13. Using the special tool, remove and discard the crankshaft front seal.



14. Remove the 3 bolts and position the power steering pump assembly aside.
15. Remove the 2 nuts and the RH and LH radio ignition interference capacitors.
16. Disconnect the RH camshaft position (CMP) sensor electrical connector.
17. Remove the bolt and the RH CMP sensor.
18. Disconnect the LH CMP sensor electrical connector.
19. Remove the bolt and the LH CMP sensor.
20. Remove the 4 bolts and the coolant pump pulley.
21. Disconnect the crankshaft position (CKP) sensor electrical connector.

IN-VEHICLE REPAIR (Continued)

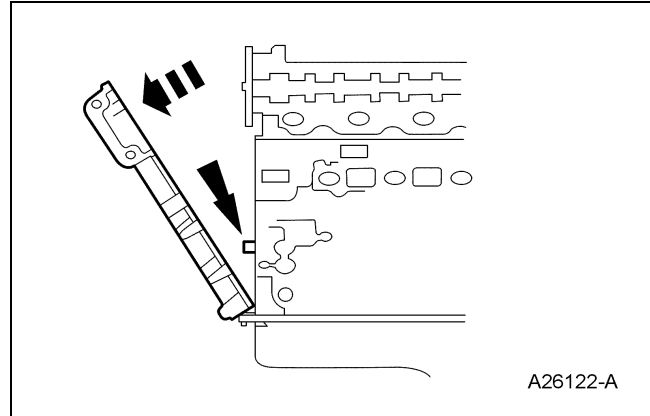
22. Remove the nut and the starter wiring harness and transmission cooler tube support brackets from the stud bolt.
23. Remove the 4 front oil pan bolts.
24. Remove the bolts and the studs.



25. **⚠ CAUTION:** Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the sealing surfaces. These tools cause scratches and gouges which make leak paths. Use a plastic scraping tool to remove all traces of old sealant. Failure to follow this procedure may cause future oil leakage.

Remove the engine front cover from the front cover to cylinder block dowel.

- Remove the engine front cover gaskets.
- Clean the mating surfaces with Silicone Gasket Remover and Motorcraft Metal Surface Prep. Follow the directions on the packaging.
- Inspect the mating surfaces.




26. Remove the bolt and the CKP sensor.

Installation

1. **NOTE:** Lubricate the O-ring seal with clean engine oil prior to installation. Install the CKP sensor and the bolt.
 - Tighten to 10 Nm (89 lb-in).

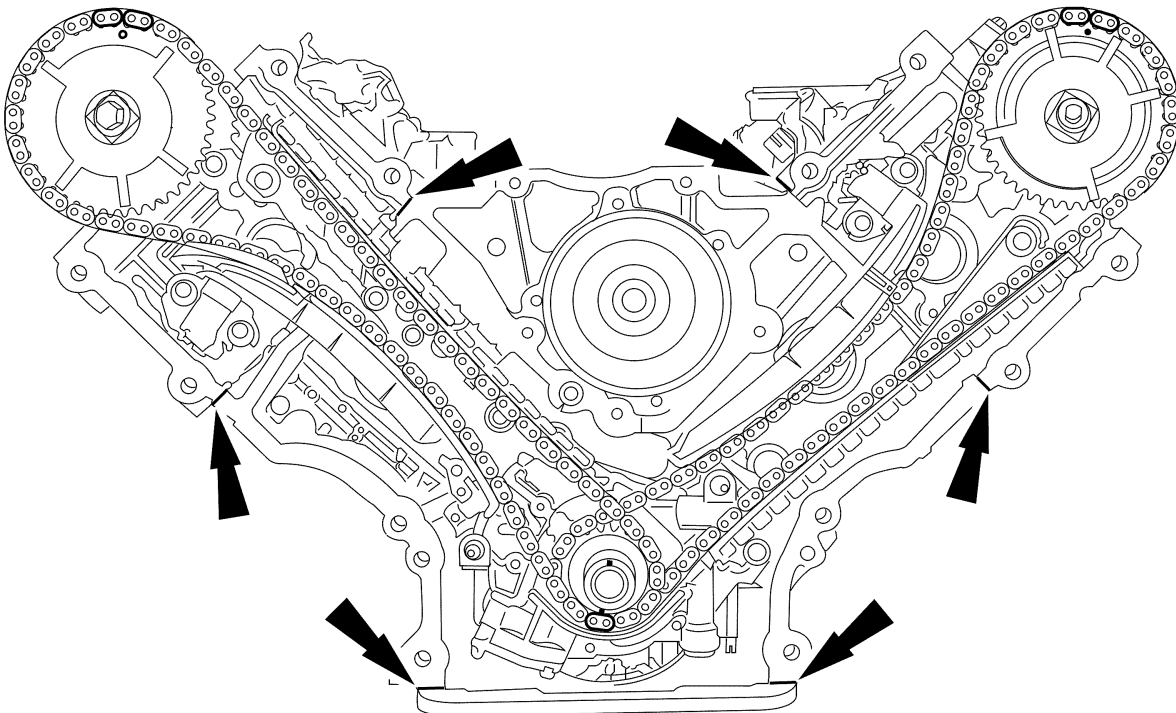
IN-VEHICLE REPAIR (Continued)

2.  **CAUTION:** Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the sealing surfaces. These tools cause scratches and gouges which make leak paths. Use a plastic scraping tool to remove all traces of old sealant.

NOTE: If the engine front cover is not secured within 4 minutes, the sealant must be removed and the sealing area cleaned. To clean the sealing area, use Silicone Gasket Remover and Motorcraft Metal Surface Prep. Follow the directions on the packaging. Allow to dry until there is no sign of wetness, or 4 minutes, whichever is longer. Failure to follow this procedure may cause future oil leakage.

NOTE: Make sure that the engine front cover gasket is in place on the engine front cover before installation.

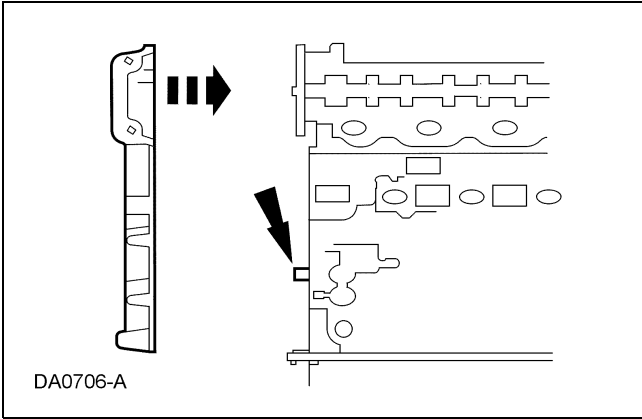
Apply a bead of Silicone Gasket and Sealant along the cylinder head-to-cylinder block surface and the oil pan-to-cylinder block surface, at the locations shown.



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IN-VEHICLE REPAIR (Continued)

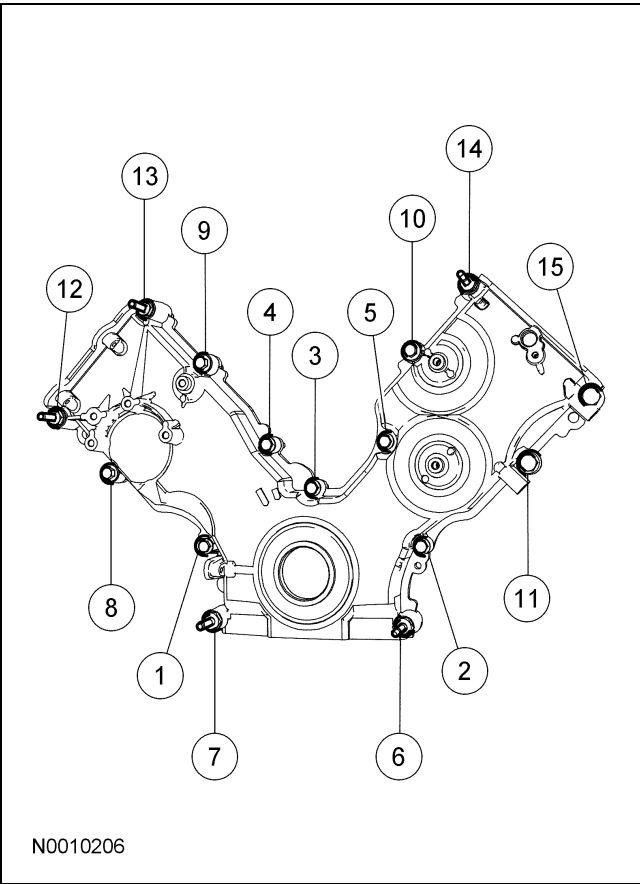
3. Install a new engine front cover gasket on the engine front cover. Position the engine front cover onto the dowels. Install the fasteners finger tight.



4. Tighten the engine front cover fasteners in sequence in 2 stages.
- Stage 1: Tighten fasteners 1 through 15 to 25 Nm (18 lb-ft).
- Stage 2: Tighten fasteners 6 and 7 to 48 Nm (35 lb-ft).

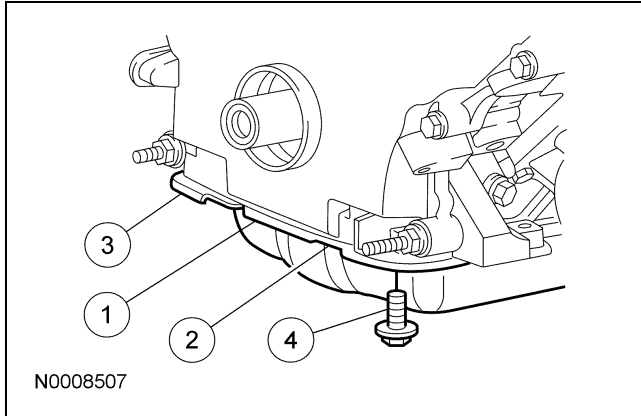
Item	Part Number	Description
1	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 50
2	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 50
3	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 50
4	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 50
5	N806177	Bolts, Hex Flange Head Pilot, M8 x 1.25 x 50
6	N808529	Stud, Hex Head Pilot, M10 x 1.5 x 1.5 x 103
7	N808529	Stud, Hex Head Pilot, M10 x 1.5 x 1.5 x 103
8	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 50

Item	Part Number	Description
9	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 50
10	N806177	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 50
11	W709573	Bolt, Hex Flange Head Pilot, M8 x 1.25 x 50
12	W709573	Stud and Washer, Hex Head Pilot, M8 x 1.25 x 1.25 x 94
13	W709573	Stud and Washer, Hex Head Pilot, M8 x 1.25 x 1.25 x 94
14	W709573	Stud and Washer, Hex Head Pilot, M8 x 1.25 x 1.25 x 94
15	W709573	Bolt, Hex Head Pilot, M8 x 1.25 x 56



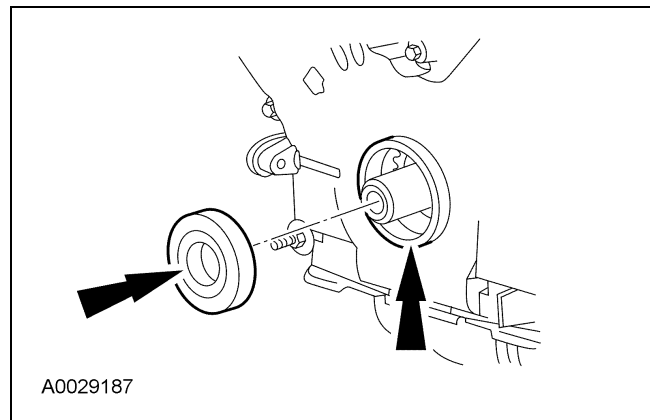
IN-VEHICLE REPAIR (Continued)

5. Loosely install the bolts, then tighten the bolts in 2 stages, in the sequence shown.
 - Stage 1: Tighten to 20 Nm (15 lb-ft).
 - Stage 2: Tighten an additional 60 degrees.

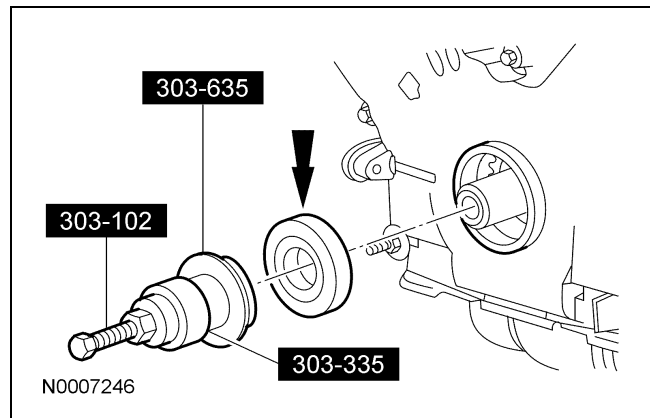


6. Connect the CKP sensor electrical connector.
7. Position the starter wiring harness and transmission fluid cooler tubes support brackets and install the nut.
 - Tighten to 25 Nm (18 lb-ft).
8. Position the power steering pump assembly and install the 3 bolts.
 - Tighten to 25 Nm (18 lb-ft).
9. **NOTE:** Lubricate the O-ring seal with clean engine oil prior to installation. Install the RH CMP sensor and the bolt.
 - Tighten to 10 Nm (89 lb-in).
10. Connect the RH CMP sensor electrical connector.
11. **NOTE:** Lubricate the O-ring seal with clean engine oil prior to installation. Install the LH CMP sensor and the bolt.
 - Tighten to 10 Nm (89 lb-in).
12. Connect the LH CMP sensor electrical connector.
13. Install the RH and LH radio ignition interference capacitors and the 2 nuts.
 - Tighten to 10 Nm (89 lb-in).

14. Install the accessory drive belt tensioner and the 3 bolts.
 - Tighten to 25 Nm (18 lb-ft).
15. Install the coolant pump pulley and the 4 bolts finger tight.
16. Install the accessory drive idler pulley and the bolt.
 - Tighten to 25 Nm (18 lb-ft).
17. Lubricate the engine front cover and the crankshaft front seal inner lip with clean engine oil.



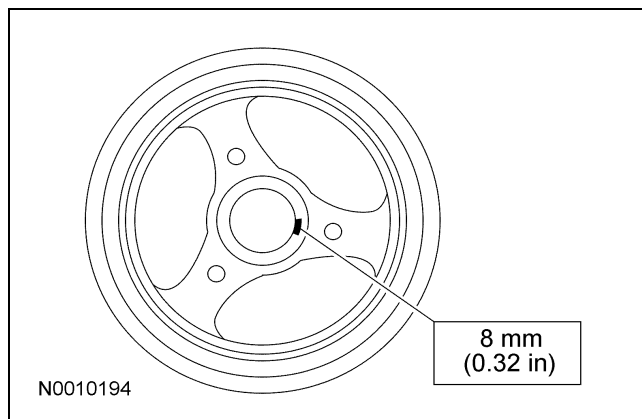
18. Using the special tools, install a new crankshaft front seal into the engine front cover.



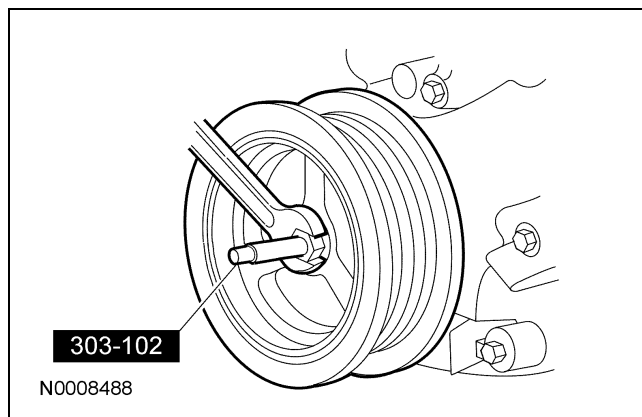
IN-VEHICLE REPAIR (Continued)

19. **NOTE:** If not secured within 4 minutes, the sealant must be removed and the sealing area cleaned. To clean the sealing area, use Silicone Gasket Remover and Motorcraft Metal Surface Prep. Follow the directions on the packaging. Allow to dry until there is no sign of wetness, or 4 minutes, whichever is longer. Failure to follow this procedure may cause future oil leakage.

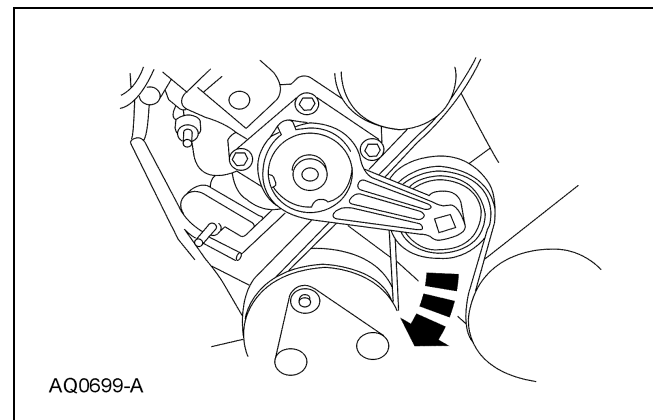
Apply Silicone Gasket and Sealant to the Woodruff key slot on the crankshaft pulley.



20. Use the special tool to install the crankshaft pulley.



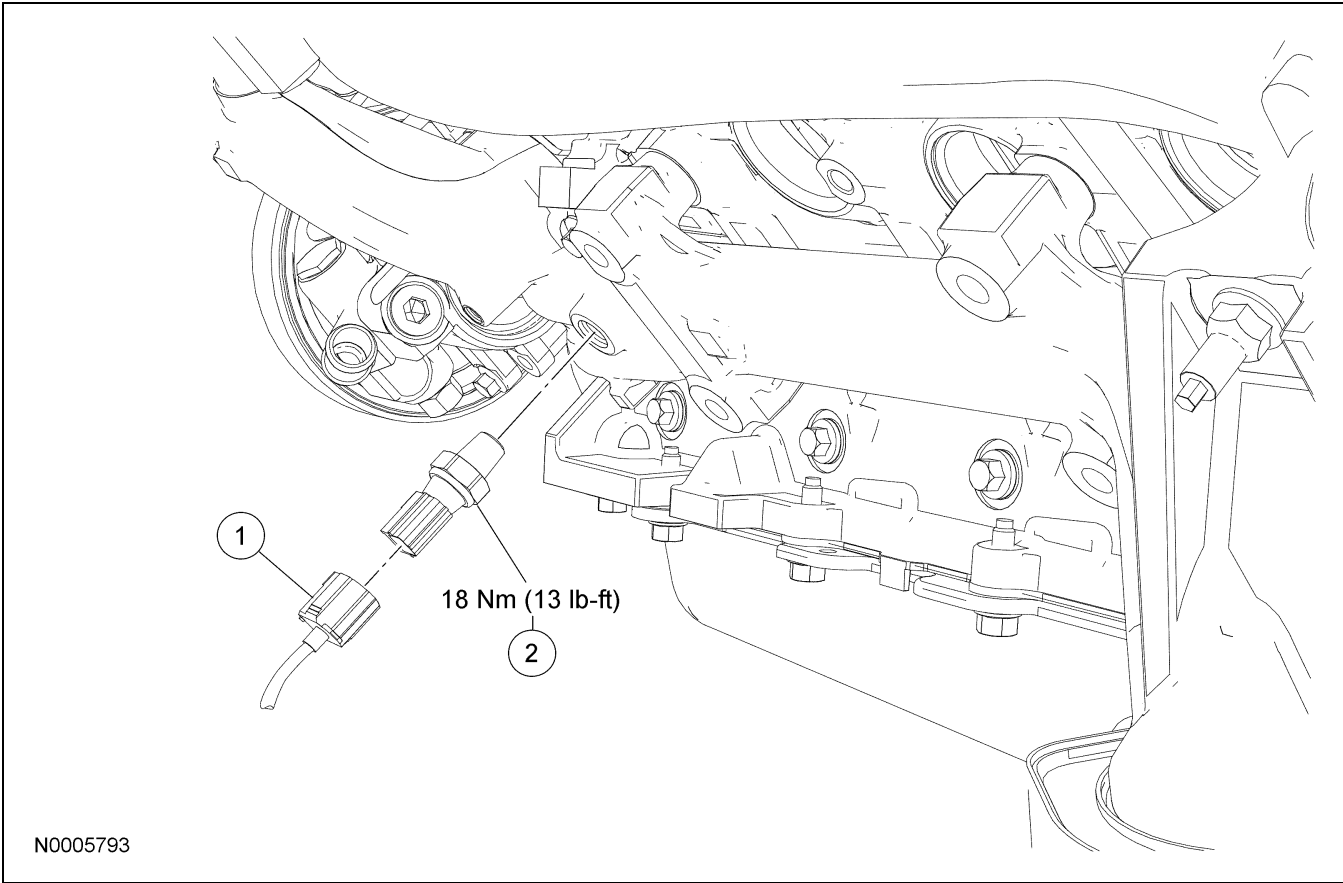
21. Tighten the new crankshaft pulley bolt in 4 stages.
- Stage 1: Tighten to 90 Nm (66 lb-ft).
 - Stage 2: Loosen 360 degrees.
 - Stage 3: Tighten to 50 Nm (37 lb-ft).
 - Stage 4: Tighten an additional 90 degrees.
22. Rotate the tensioner clockwise and install the accessory drive belt.



23. Tighten the 4 coolant pump pulley bolts.
- Tighten to 25 Nm (18 lb-ft).
24. Install the RH valve cover. For additional information, refer to Valve Cover — RH in this section.
25. Install the LH valve cover. For additional information, refer to Valve Cover — LH in this section.
26. Install the engine cooling fan. For additional information, refer to Section 303-03.
27. Install the engine cooling fan shroud. For additional information, refer to Section 303-03.
28. Fill the crankcase with clean engine oil.

IN-VEHICLE REPAIR

Engine Oil Pressure (EOP) Switch



Item	Part Number	Description
1	—	Engine oil pressure (EOP) switch electrical connector (part of 12B637)
2	9278	EOP switch

2. Disconnect the engine oil pressure (EOP) switch electrical connector.
3. Remove the EOP switch.
 - To install, tighten to 18 Nm (13 lb-ft).
4. To install, reverse the removal procedure.

Removal and Installation

1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.

IN-VEHICLE REPAIR

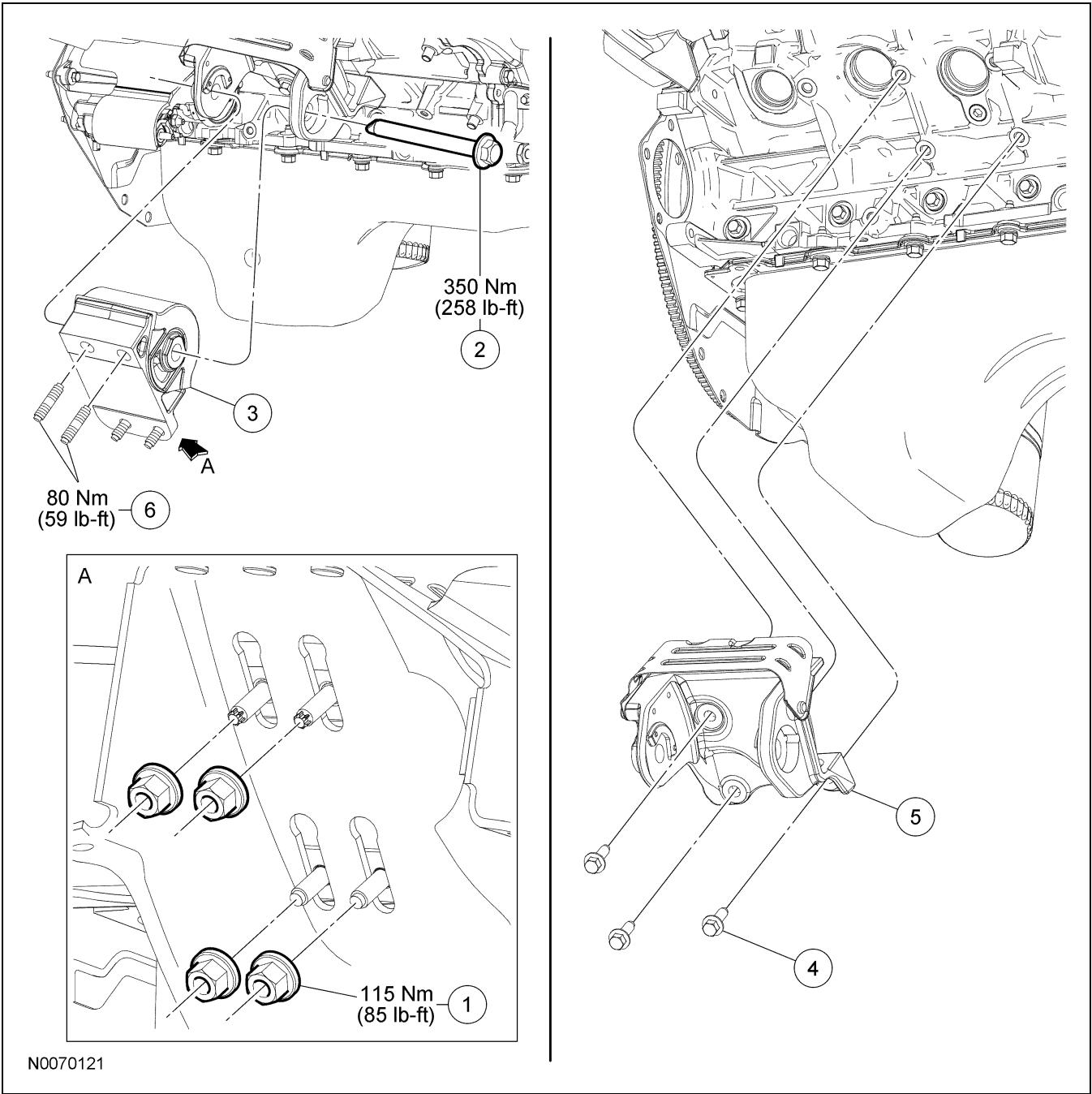
Engine Support Insulators

Special Tool(s)

 ST2176-B	Engine Support Bar, Heavy Duty 303-F070
 ST2970-A	Support Hook 303-F071
 ST2592-A	Engine Support Bracket 303-639

IN-VEHICLE REPAIR (Continued)

RH Engine Support Insulator



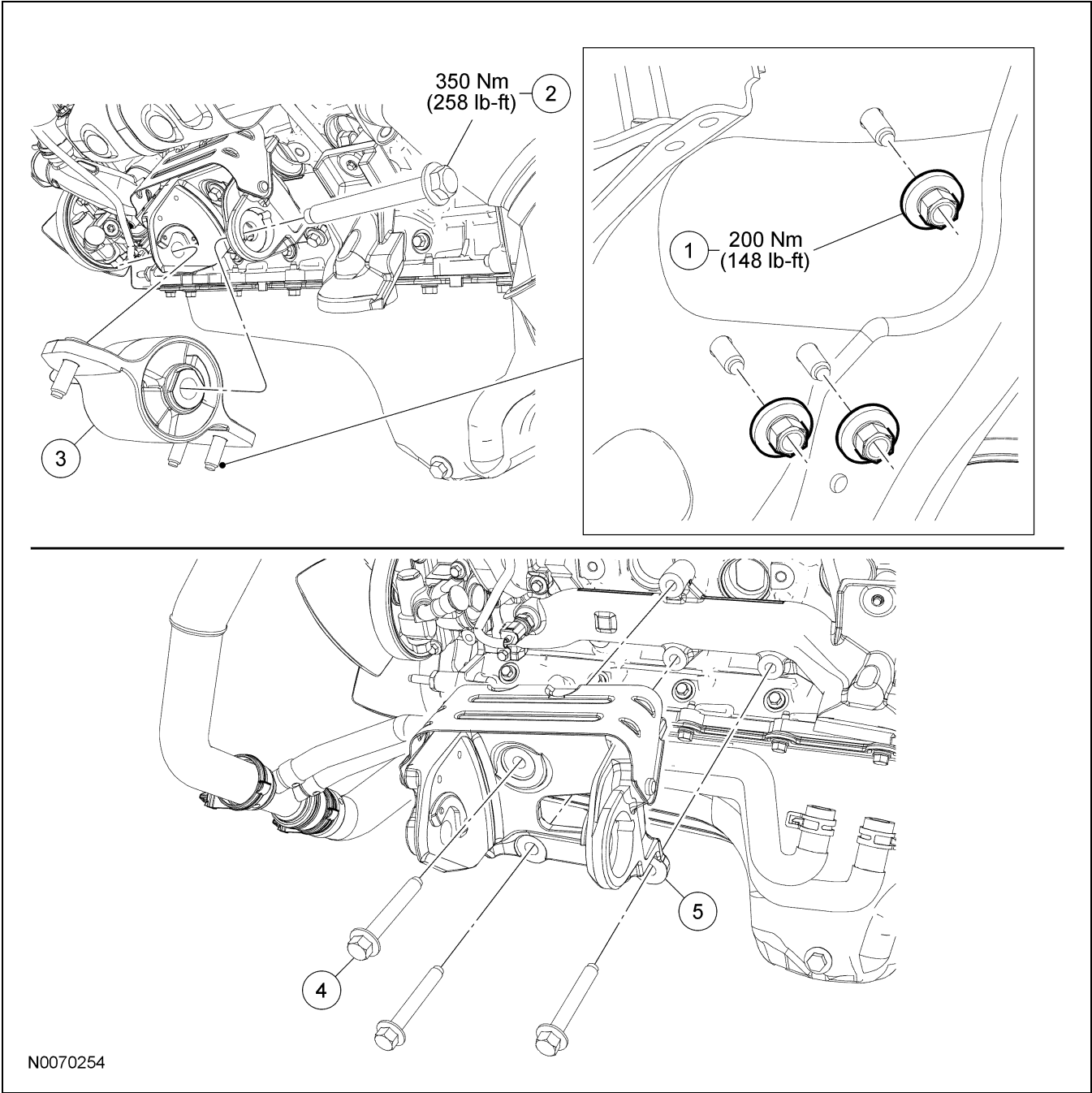
Item	Part Number	Description
1	W709771	RH engine support insulator nut (4 required)
2	W711959	RH engine support insulator through bolt
3	6038	RH engine support
4	W712861	RH engine support insulator bracket bolt (3 required)

(Continued)

Item	Part Number	Description
5	6046	RH engine support insulator bracket
6	W790018	RH engine support insulator stud (2 required)

IN-VEHICLE REPAIR (Continued)

LH Engine Support Insulator



Item	Part Number	Description
1	W711336	LH engine support insulator nut (3 required)
2	W711959	LH engine support insulator through bolt
3	6B032	LH engine support
4	W712860	LH engine support insulator bracket bolt (3 required)
5	6B033	LH engine support insulator bracket

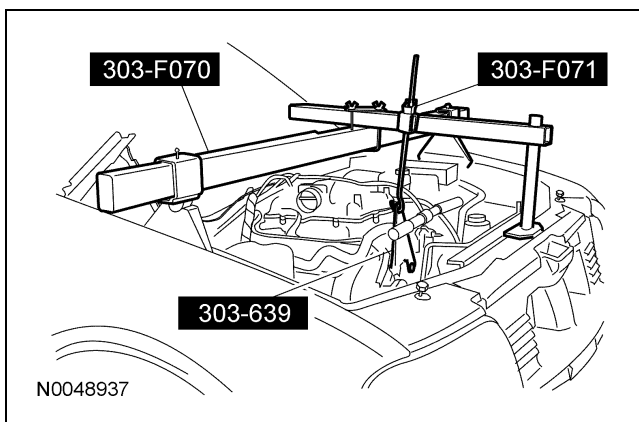
Removal

All vehicles

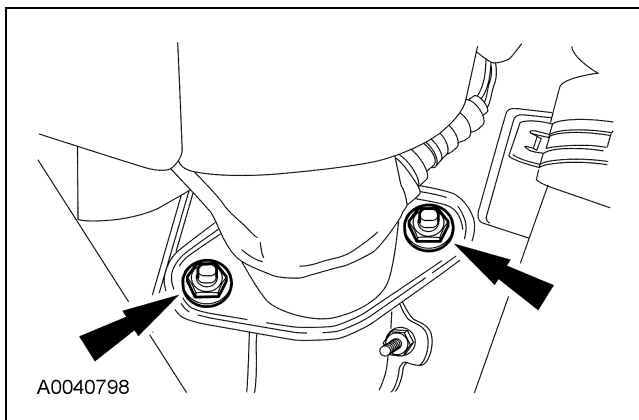
1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
2. Disconnect the battery ground cable. For additional information, refer to Section 414-01.

IN-VEHICLE REPAIR (Continued)

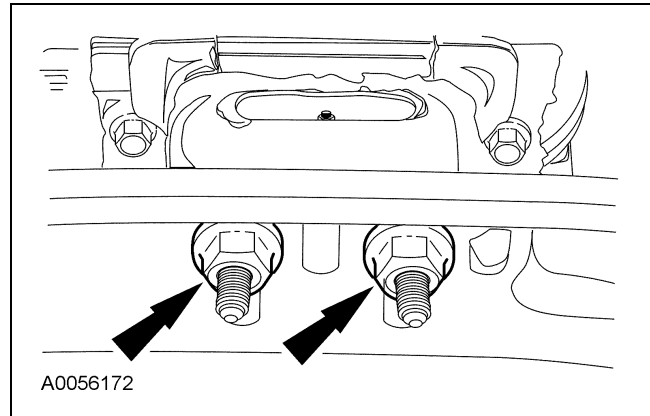
3. Remove the air cleaner outlet pipe. For additional information, refer to Section 303-12.
4. Remove the throttle body (TB). For additional information, refer to Section 303-04A.
5. Remove the generator. For additional information, refer to Section 414-02.
6. Remove the engine cooling fan. For additional information, refer to Section 303-03.
7. Install the special tools.



8. Remove the 4 exhaust Y-pipe nuts.



9. Remove and discard the transmission mount-to-crossmember nuts.

**RH engine support insulator**

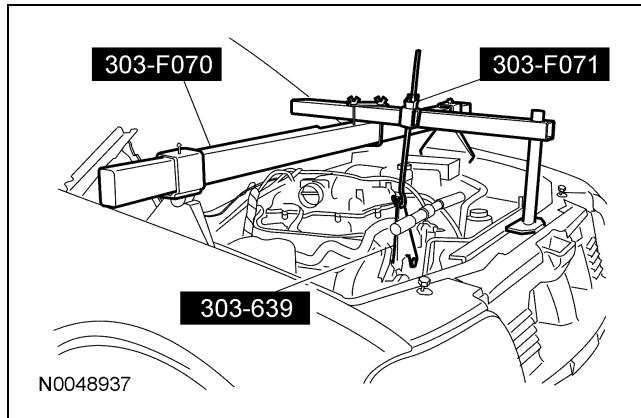
10. Remove the A/C compressor. For additional information, refer to Section 412-01.
11. Remove the starter. For additional information, refer to Section 303-06A.
12. Remove and discard the RH engine support insulator through bolt.
13. Loosen the LH engine support insulator through bolt.
14. Loosen the 3 LH engine support insulator nuts.
15. Remove and discard the 4 RH engine support insulator nuts.

LH engine support insulator

16. Remove the oil cooler. For additional information, refer to Oil Cooler in this section.
17. Loosen the RH engine support insulator through bolt.
18. Remove and discard the LH engine support insulator through bolt.
19. Loosen the 4 RH engine support insulator nuts.
20. Remove and discard the 3 LH engine support insulator nuts.

IN-VEHICLE REPAIR (Continued)**All engine support insulators**

21. Using the special tools, raise the engine.

**RH engine support insulator**

22. Remove the RH engine support insulator.
23. **CAUTION:** The engine support insulator bracket bolts must be discarded and new bolts installed, or damage to the vehicle may occur. They are a tighten-to-yield design and cannot be reused.

If servicing the RH engine support insulator bracket, remove the 3 bolts and the RH engine mount bracket.

- Discard the 3 engine support insulator bracket bolts.

LH engine support insulator

24. Remove the LH engine support insulator.
25. **CAUTION:** The engine support insulator bracket bolts must be discarded and new bolts installed, or damage to the vehicle may occur. They are a tighten-to-yield design and cannot be reused.
- If servicing the LH engine support insulator bracket, remove the 3 bolts and the LH engine mount bracket.
- Discard the 3 engine support insulator bracket bolts.

Installation**All engine support insulators**

1. Clean the engine support insulator-to-cylinder block and engine support insulator-to-frame mating surfaces of any dirt or foreign material prior to installation.

LH engine support insulator

2. **CAUTION:** The engine support insulator bracket bolts must be discarded and new bolts installed, or damage to the vehicle may occur. They are a tighten-to-yield design and cannot be reused.

CAUTION: The engine support insulator bracket bolts must not be tightened more than 90 degrees after initial torque, or damage to the bolts may occur.


NOTE: Place a visible mark on the engine support insulator bracket and the bracket bolts. Turning the bolt 1 flat of the bolt head is equal to 60 degrees.


If servicing the LH engine support insulator bracket, position the engine support insulator bracket and install 3 new bolts in 2 stages.

- Stage 1: Tighten to 30 Nm (22 lb-ft).
- Stage 2: Tighten an additional minimum of 60 degrees.

3. Position the LH engine support insulator into the vehicle.

IN-VEHICLE REPAIR (Continued)**RH engine support insulator**

4.  **CAUTION:** The engine support insulator bracket bolts must be discarded and new bolts installed. They are a tighten-to-yield design and cannot be reused.

 **CAUTION:** The engine support insulator bracket bolts must not be tightened more than 90 degrees after initial torque, or damage to the bolts may occur.

NOTE: Place a visible mark on the engine support insulator bracket and the bracket bolts. Turning the bolt 1 flat of the bolt head is equal to 60 degrees.

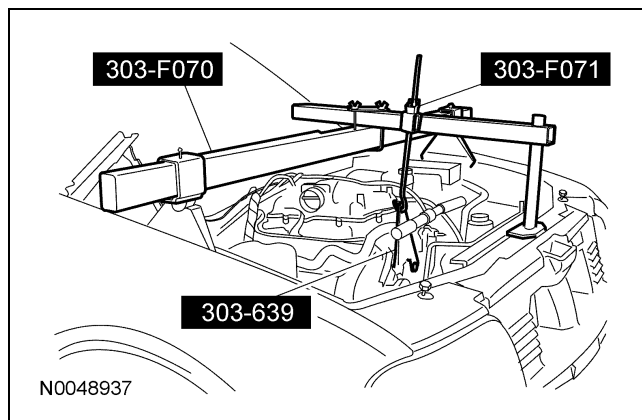
If servicing the RH engine support insulator bracket, position the engine support insulator bracket and install 3 new bolts in 2 stages.


- Stage 1: Tighten to 30 Nm (22 lb-ft).
- Stage 2: Tighten an additional minimum of 60 degrees.

5. Position the RH engine support insulator into the vehicle.

All engine support insulators


6. Using the special tools, lower the engine.

**LH engine support insulator**

7.  **CAUTION:** Only use hand tools when installing the engine support insulator nuts or damage to the engine support insulator may occur.


Install 3 new LH engine support insulator nuts.

- Tighten to 200 Nm (148 lb-ft).

8.  **CAUTION:** Only use hand tools when installing the engine support insulator nuts or damage to the engine support insulator may occur.


Install 4 new RH engine support insulator nuts.

- Tighten to 115 Nm (85 lb-ft).

9.  **CAUTION:** Only use hand tools when installing the engine support through bolt or damage to the engine support insulator may occur.

Install a new LH engine support insulator through bolt.

- Tighten to 350 Nm (258 lb-ft).


10.  **CAUTION:** Only use hand tools when installing the engine support through bolt or damage to the engine support insulator may occur.

Install a new RH engine support insulator through bolt.

- Tighten to 350 Nm (258 lb-ft).


11. Install the oil cooler. For additional information, refer to Oil Cooler in this section.

RH engine support insulator

12.  **CAUTION:** Only use hand tools when installing the engine support insulator nuts or damage to the engine support insulator may occur.

Install 4 new RH engine support insulator nuts.


- Tighten to 115 Nm (85 lb-ft).

13.  **CAUTION:** Only use hand tools when installing the engine support insulator nuts or damage to the engine support insulator may occur.

Install 3 new LH engine support insulator nuts.


- Tighten to 200 Nm (148 lb-ft).

IN-VEHICLE REPAIR (Continued)

14.  **CAUTION:** Only use hand tools when installing the engine support through bolt or damage to the engine support insulator may occur.

Install a new LH engine support insulator through bolt.

- Tighten to 350 Nm (258 lb-ft).

15.  **CAUTION:** Only use hand tools when installing the engine support through bolt or damage to the engine support insulator may occur.


Install a new RH engine support insulator through bolt.

- Tighten to 350 Nm (258 lb-ft).

16. Install the starter. For additional information, refer to Section 303-06A.

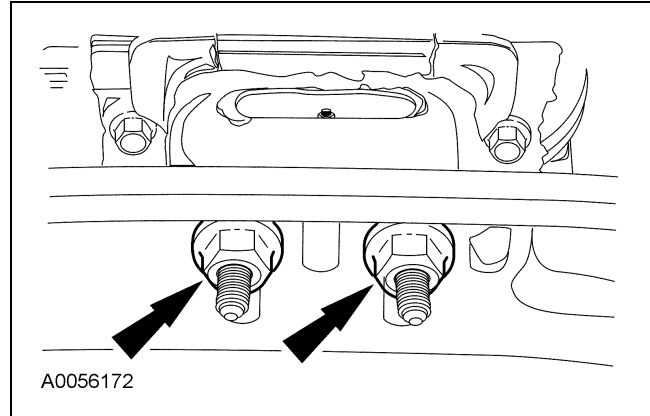
17. Install the A/C compressor. For additional information, refer to Section 412-01.

All vehicles

18.  **CAUTION:** Only use hand tools when installing the transmission mount-to-crossmember nuts or damage to the transmission mount may occur.

Install 2 new transmission mount-to-crossmember nuts.

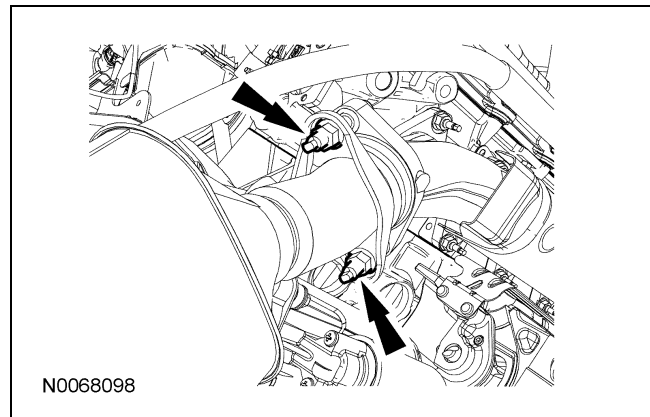
- Tighten to 115 Nm (85 lb-ft).



19. **NOTE:** RH shown, LH similar.

Install the 4 exhaust Y-pipe flange nuts.

- Tighten to 40 Nm (30 lb-ft).



20. Install the engine cooling fan. For additional information, refer to Section 303-03.

21. Install the generator. For additional information, refer to Section 414-02.

22. Install the TB. For additional information, refer to Section 303-04A.

23. Install the air cleaner outlet pipe. For additional information, refer to Section 303-12.

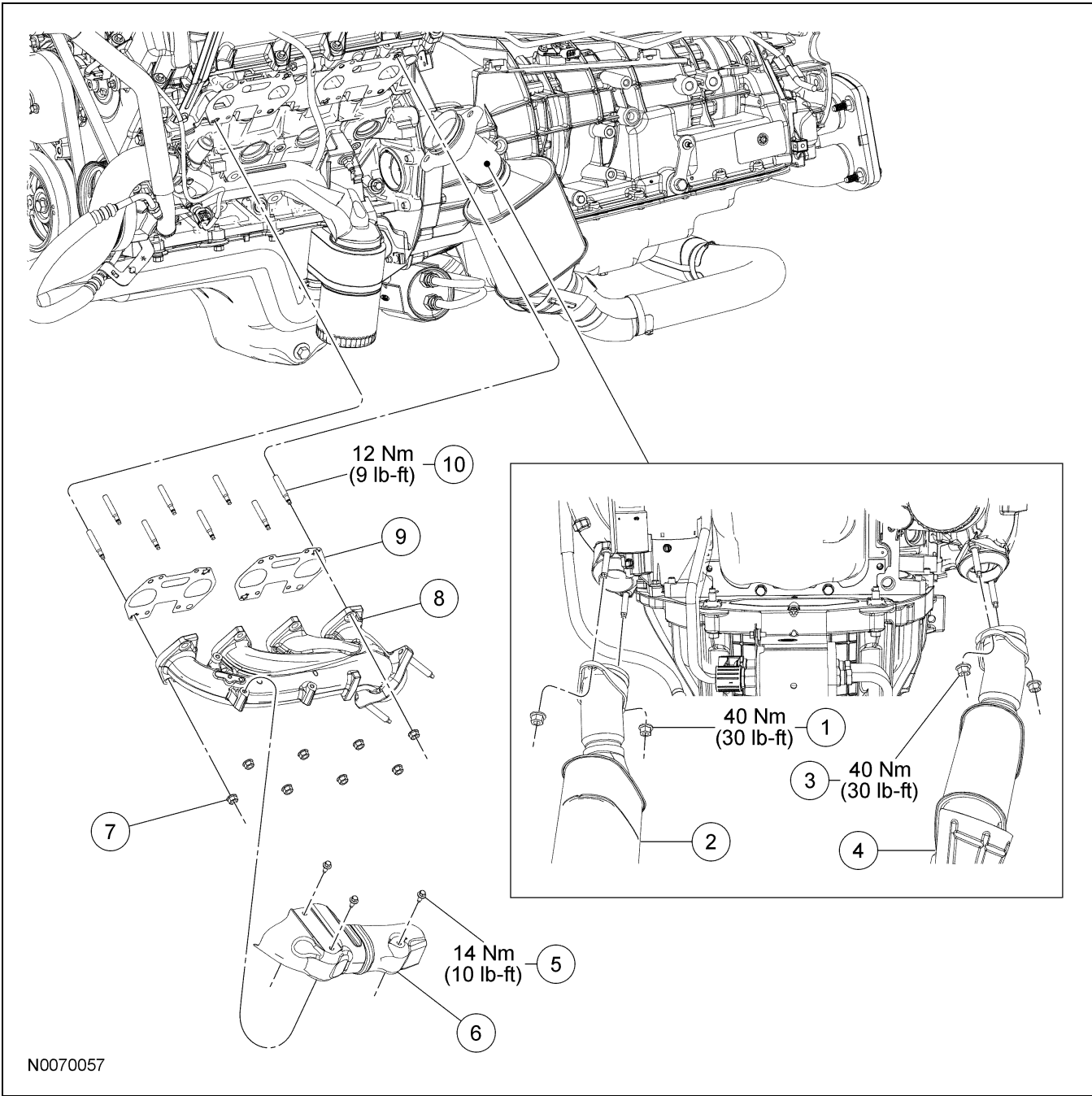
24. Connect the battery ground cable. For additional information, refer to Section 414-01.

IN-VEHICLE REPAIR

Exhaust Manifold — LH

Material

Item	Specification
Motorcraft Metal Surface Prep ZC-31	—

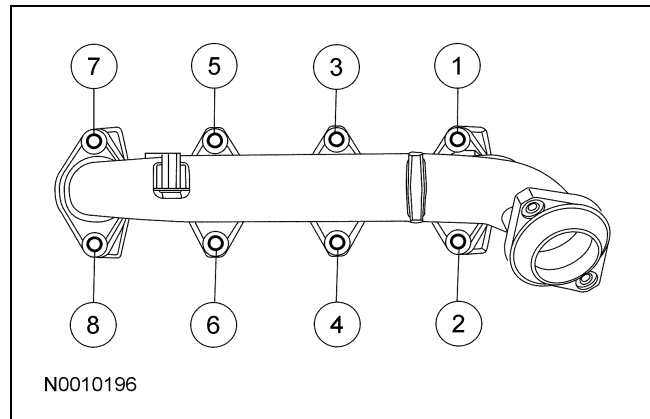


IN-VEHICLE REPAIR (Continued)

Item	Part Number	Description
1	W705443	RH exhaust Y-pipe flange nut (2 required)
2	5F250	RH exhaust Y-pipe flange
3	W705443	LH exhaust Y-pipe flange nut (2 required)
4	5F250	LH exhaust Y-pipe flange
5	W711460	Exhaust manifold heat shield bolt (3 required)
6	9Y427	Exhaust manifold heat shield
7	W701706	Exhaust manifold nut (8 required)
8	9431	Exhaust manifold
9	9Y431	Exhaust manifold gasket (2 required)
10	W707747	Exhaust manifold-to-cylinder head stud (8 required)

Removal and Installation

- Remove the LH fender splash shield. For additional information, refer to Section 501-02.
- Remove the degas bottle assembly. For additional information, refer to Section 303-03.
- Remove the 4 exhaust manifold-to-catalytic converter nuts.
 - To install, tighten to 40 Nm (30 lb-ft).
- Remove the 3 bolts and the exhaust manifold heat shield.
 - To install, tighten to 14 Nm (10 lb-ft).
- Remove the 8 nuts, 8 exhaust manifold-to-cylinder head studs and the exhaust manifold.
 - Discard the 8 nuts and the 8 exhaust manifold-to-cylinder head studs.
 - To install, tighten the new exhaust manifold-to-cylinder head studs to 12 Nm (9 lb-ft).
 - To install, tighten the new nuts to 25 Nm (18 lb-ft) in the sequence shown.



- ⚠ CAUTION: Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the sealing surfaces. These may cause scratches and gouges resulting in leak paths. Use a plastic scraper to clean the sealing surfaces.**

Remove and discard the exhaust manifold gaskets.

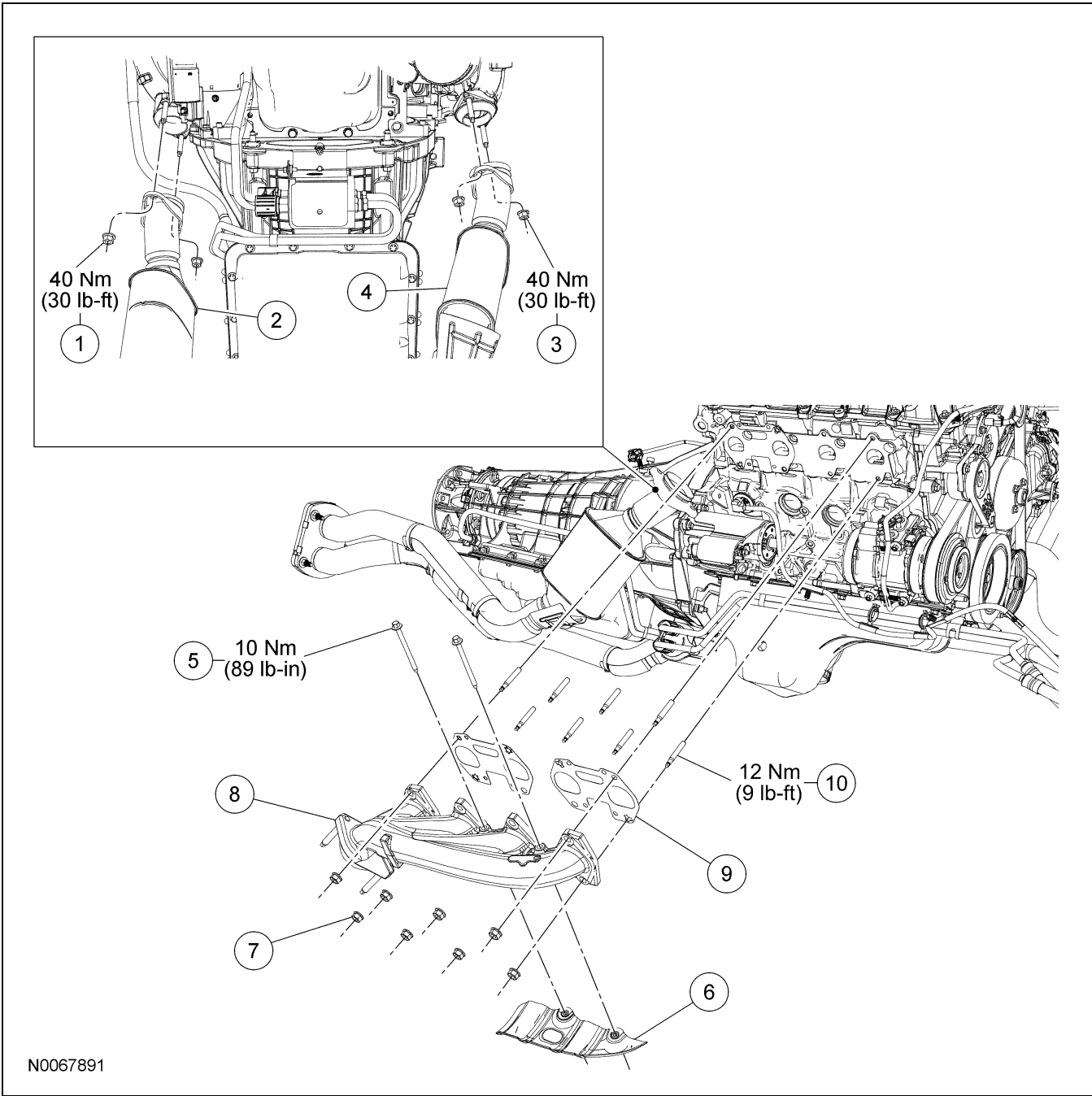
 - Clean the sealing surfaces with Motorcraft Metal Surface Prep. Follow the directions on the packaging.
- Inspect the exhaust manifold. For additional information, refer to Section 303-00.
- To install, reverse the removal procedure.

IN-VEHICLE REPAIR

Exhaust Manifold — RH

Material

Item	Specification
Motorcraft Metal Surface Prep ZC-31	—

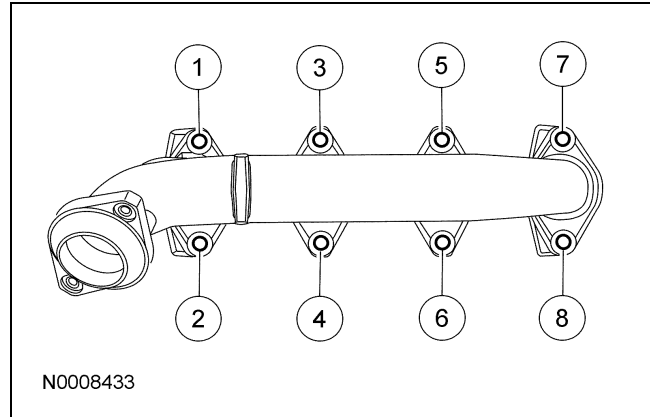


IN-VEHICLE REPAIR (Continued)

Item	Part Number	Description
1	W705443	RH exhaust Y-pipe flange nut (2 required)
2	5F250	RH exhaust Y-pipe flange
3	W705443	LH exhaust Y-pipe flange nut (2 required)
4	5F250	LH exhaust Y-pipe flange
5	N806543	Exhaust manifold heat shield bolt (2 required)
6	4569	Exhaust manifold heat shield
7	W701706	Exhaust manifold nut (8 required)
8	9431	Exhaust manifold
9	9Y431	Exhaust manifold gasket (2 required)
10	W701706	Exhaust manifold-to-cylinder head stud (8 required)

Removal and Installation

- With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
- Remove the starter. For additional information, refer to Section 303-06A.
- Remove the RH inner fenderwell. For additional information, refer to Section 501-02.
- Remove the 4 exhaust manifold-to-catalytic converter nuts.
 - To install, tighten to 40 Nm (30 lb-ft).
- Remove the 2 bolts and the exhaust manifold heat shield.
 - To install, tighten to 10 Nm (89 lb-in).
- Remove the 8 nuts, 8 exhaust manifold-to-cylinder head studs and the exhaust manifold.
 - Discard the 8 nuts and studs.
 - To install, tighten the new exhaust manifold-to-cylinder head studs to 12 Nm (9 lb-ft).
 - To install, tighten the new nuts to 25 Nm (18 lb-ft) in the sequence shown.



- ⚠ CAUTION: Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the sealing surfaces. These may cause scratches and gouges resulting in leak paths. Use a plastic scraper to clean the sealing surfaces.**

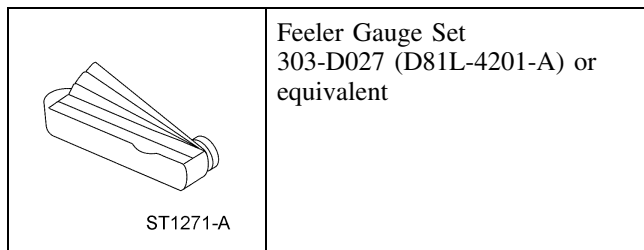
Remove and discard the exhaust manifold gaskets.

 - Clean the sealing surfaces with Motorcraft Metal Surface Prep. Follow the directions on the packaging.
- Inspect the exhaust manifold. For additional information, refer to Section 303-00.
- To install, reverse the removal procedure.

GENERAL PROCEDURES

Exhaust Manifold Cleaning and Inspection

Special Tool(s)

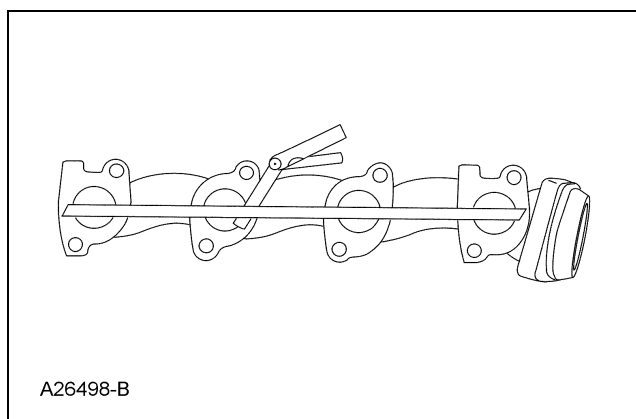


1. Clean the exhaust manifold using a suitable solvent. Use a plastic scraping tool to clean the gasket sealing surfaces.

2. **NOTE:** New exhaust manifold gaskets, studs, nuts and/or bolts must be installed when an exhaust manifold is serviced.

NOTE: Use a straightedge that is calibrated by the manufacturer to be flat within 0.005 mm (0.0002 in) per running foot of length, such as Snap-On® GA438A or equivalent. For example, if the straightedge is 61 cm (24 in) long, the machined edge must be flat within 0.010 mm (0.0004 in) from end to end.

Using the precision straight edge and a feeler gauge, check the exhaust manifold sealing surface for warpage. If the warpage is greater than 0.76 mm (0.0299 in), install a new exhaust manifold.

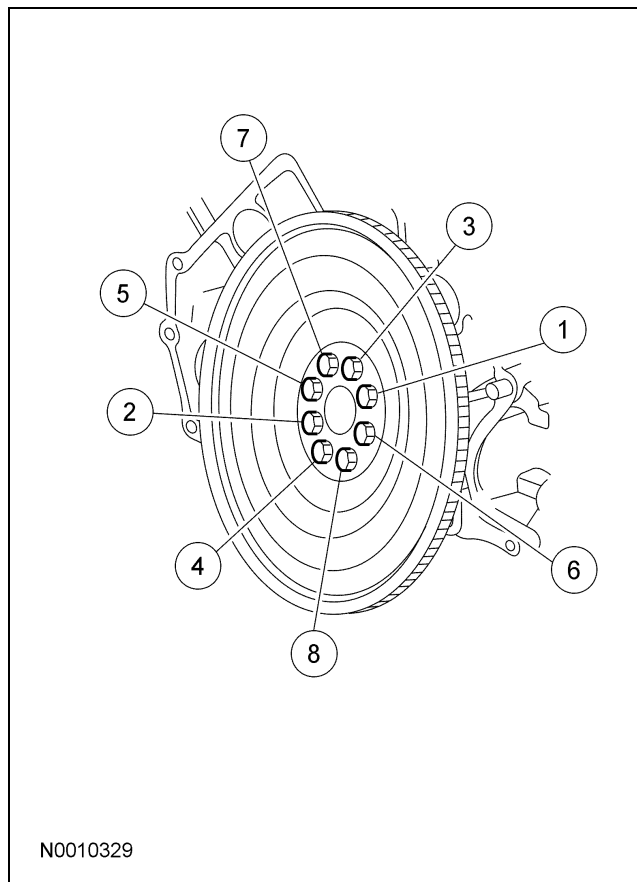


IN-VEHICLE REPAIR

Flexplate

Removal and Installation

1. Remove the transmission. For additional information, refer to Section 307-01.
2. Remove the 8 bolts and the flexplate.
 - To install, tighten to 80 Nm (59 lb-ft) in the sequence shown.

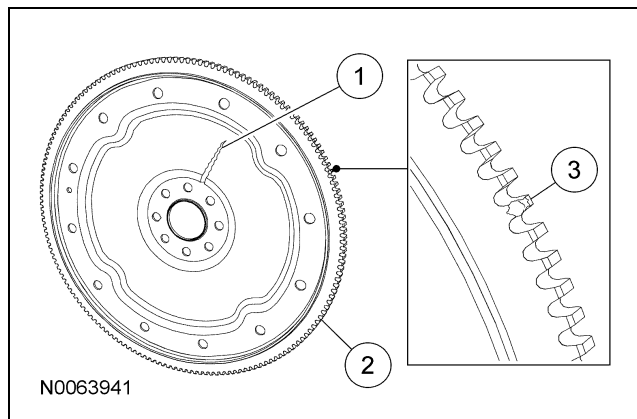


3. To install, reverse the removal procedure.

GENERAL PROCEDURES

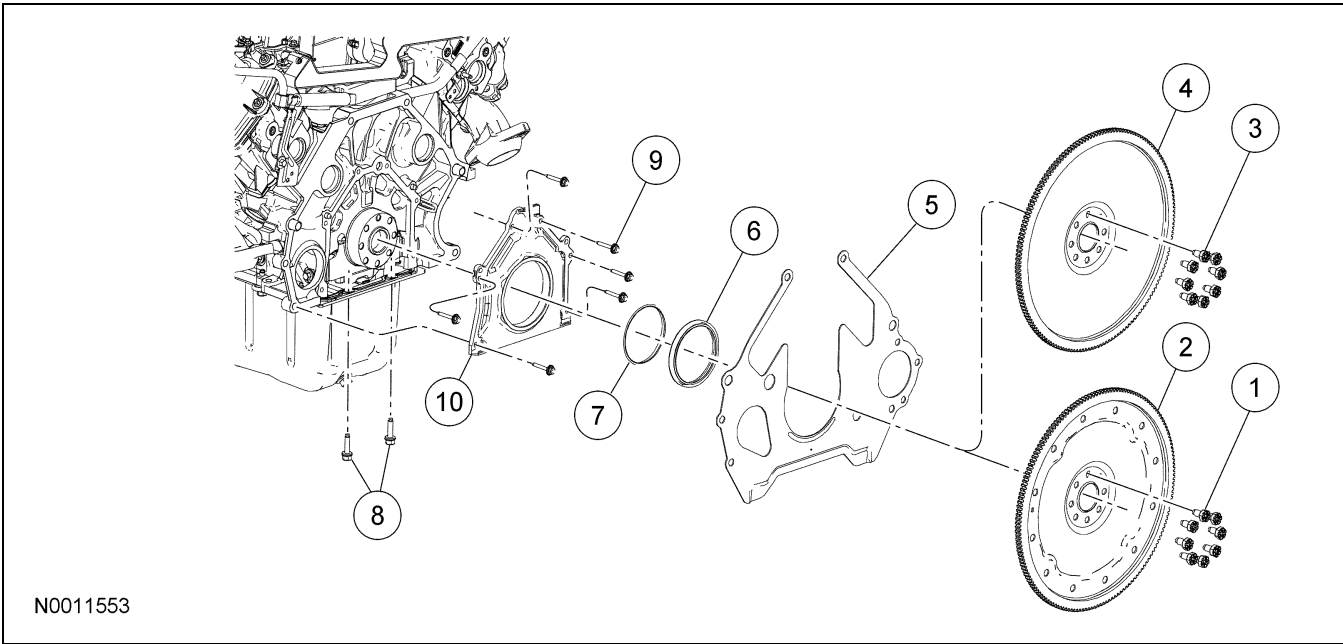
Flexplate Inspection

1. Inspect the flexplate for:
 - 1 Any cracks.
 - 2 Worn ring gear teeth.
 - 3 Chipped or cracked ring gear teeth.



IN-VEHICLE REPAIR

Flexplate or Flywheel and Crankshaft
Rear Seal — Exploded View



Item	Part Number	Description
1	N806168	Flexplate bolt (8 required)
2	6375	Flexplate
3	N808139	Flywheel bolt (8 required)
4	6375	Flywheel
5	6A373	Rear cover plate
6	6310	Crankshaft oil slinger
7	6701	Crankshaft rear seal

(Continued)

Item	Part Number	Description
8	W701605	Oil pan bolts (2 required)
9	N806155	Crankshaft rear seal retainer plate bolt (6 required)
10	6K318	Crankshaft rear seal retainer plate

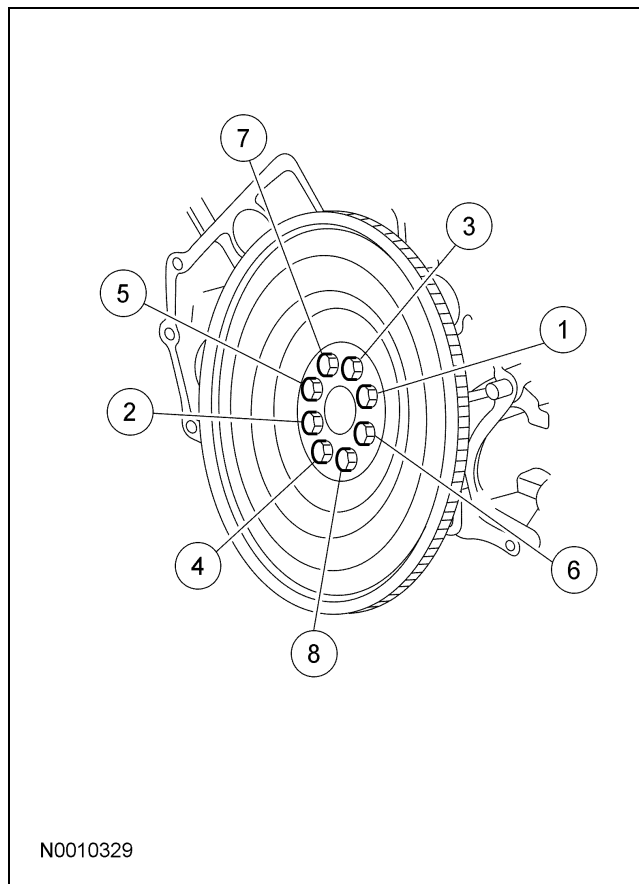
1. For additional information, refer to the procedures in this section.

IN-VEHICLE REPAIR

Flywheel

Removal and Installation

1. Remove the clutch and pressure plate. For additional information, refer to Section 308-01.
2. Remove the 8 bolts and the flywheel.
 - To install, tighten to 80 Nm (59 lb-ft) in the sequence shown.



3. To install, reverse the removal procedure.

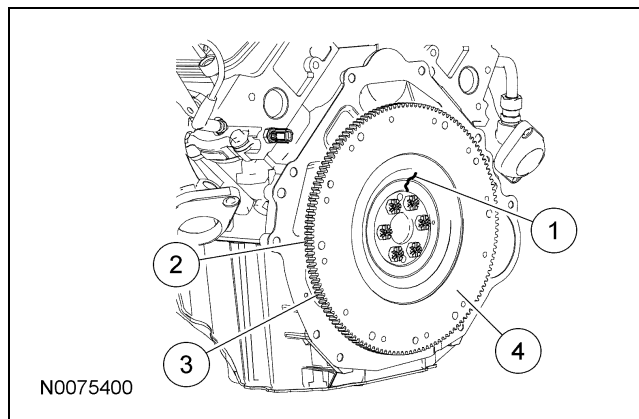
GENERAL PROCEDURES

Flywheel Inspection

1. **NOTE:** The flywheel cannot be resurfaced, it must be replaced.

Inspect the flywheel for:

- 1 Any cracks.
- 2 Worn ring gear teeth.
- 3 Chipped or cracked ring gear teeth.
- 4 Scratches, nicks and discoloration.



2008 Ford F-350 SUPER DUTY

Submodel: XLT | Engine Type: V8 | Liters: 5.4
Fuel Delivery: FI | Fuel: GAS

GROUP 03: Engine

- SECTION 303-00: Engine System — General Information
- SECTION 303-01A: Engine — 5.4L (3V)
- SECTION 303-01B: Engine — 6.8L (3V)
- SECTION 303-01C: Engine — 6.4L Diesel
- SECTION 303-03: Engine Cooling
- SECTION 303-04A: Fuel Charging and Controls — 5.4L (3V)
- SECTION 303-04B: Fuel Charging and Controls — 6.8L (3V)
- SECTION 303-04C: Fuel Charging and Controls — 6.4L Diesel
- SECTION 303-04D: Fuel Charging and Controls — Turbocharger
- SECTION 303-04E: Fuel Charging and Controls — Fuel and Turbocharger Cooling System
- SECTION 303-05: Accessory Drive
- SECTION 303-06A: Starting System — Gasoline Engines
- SECTION 303-06B: Starting System — Diesel Engine
- SECTION 303-07A: Engine Ignition — 5.4L and 6.8L (3V)
- SECTION 303-07B: Glow Plug System
- SECTION 303-08: Engine Emission Control
- SECTION 303-12: Intake Air Distribution and Filtering
- SECTION 303-13: Evaporative Emissions
- SECTION 303-14A: Electronic Engine Controls — Gasoline Engines
- SECTION 303-14B: Electronic Engine Controls — Diesel Engine


IN-VEHICLE REPAIR

Hydraulic Lash Adjuster

Material

Item	Specification
Motorcraft SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP (US); Motorcraft SAE 5W-20 Super Premium Motor Oil CXO-5W20-LSP12 (Canada); or equivalent	WSS-M2C930-A

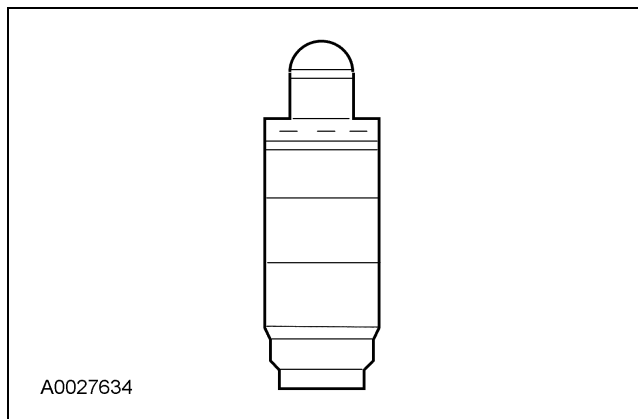
Removal and Installation

1. Remove the camshafts. For additional information, refer to Camshaft — LH or Camshaft — RH in this section.
2. Remove the remaining roller followers from the cylinder head being serviced.
3.  **CAUTION:** If the components are to be reinstalled, they must be installed in the same positions. Mark the components for installation into their original locations. Failure to follow these instructions may result in engine damage.
Remove the hydraulic lash adjusters that are being serviced.
4. Inspect the hydraulic lash adjusters. For additional information, refer to Section 303-00.
5. **NOTE:** Lubricate each of the hydraulic lash adjusters with clean engine oil prior to installation.
To install, reverse the removal procedure.

GENERAL PROCEDURES

Hydraulic Lash Adjuster Inspection

1. Inspect the hydraulic lash adjuster and roller follower for damage. If any damage is found, inspect the camshaft lobes and valves for damage.

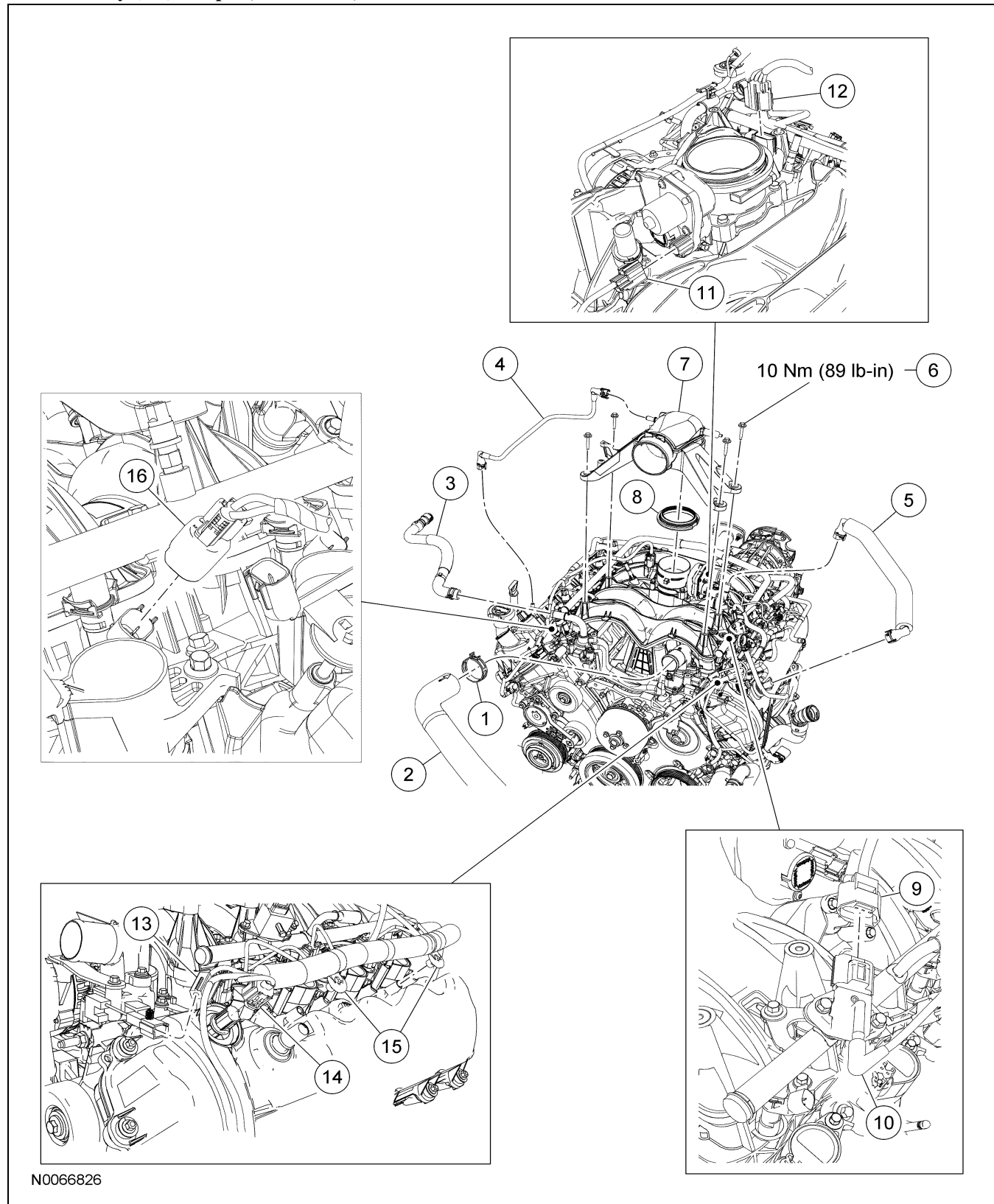


IN-VEHICLE REPAIR

Intake Manifold

Material

Item	Specification
Motorcraft Metal Surface Prep ZC-31	—
Silicone Gasket Remover ZC-30	—

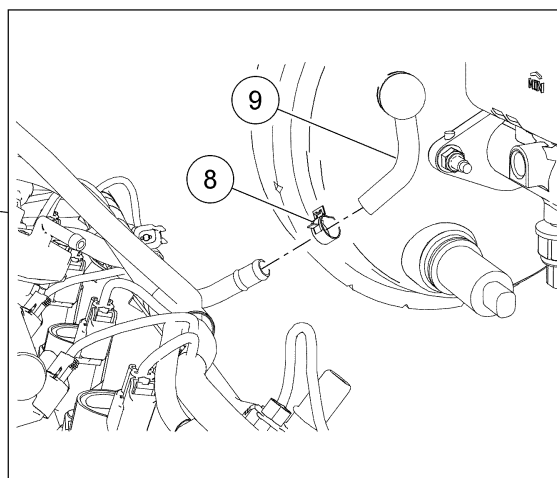
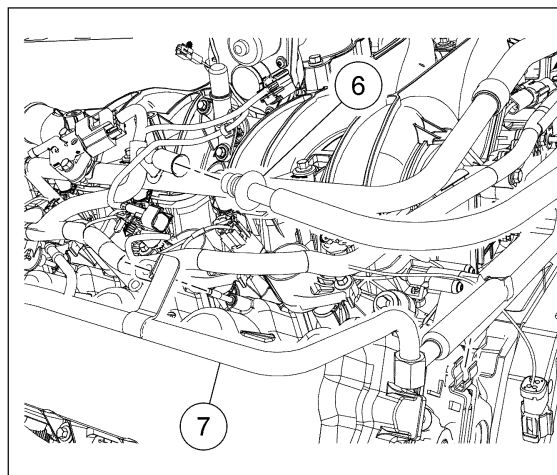
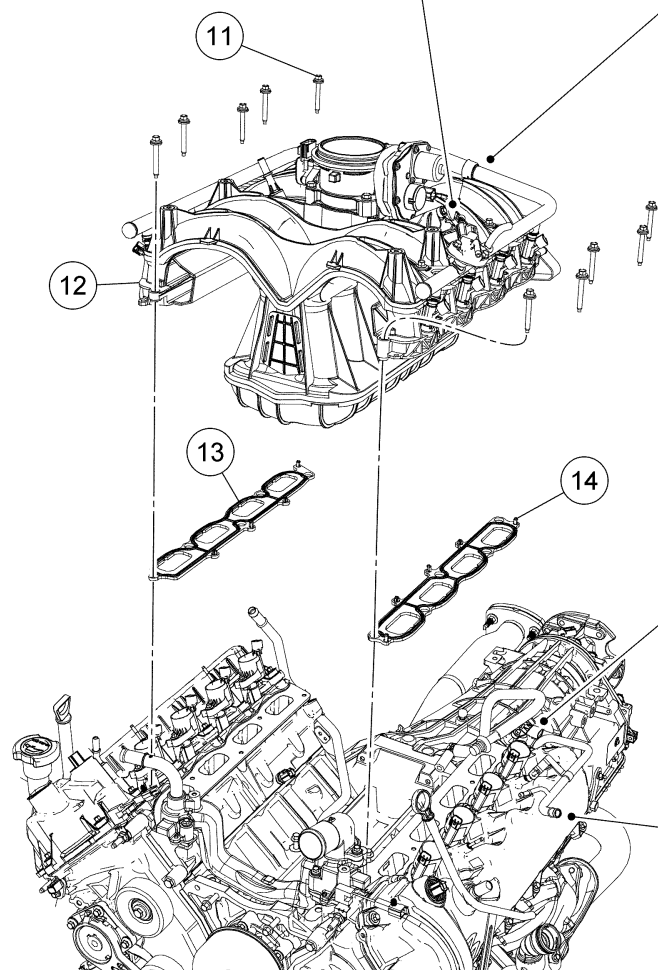
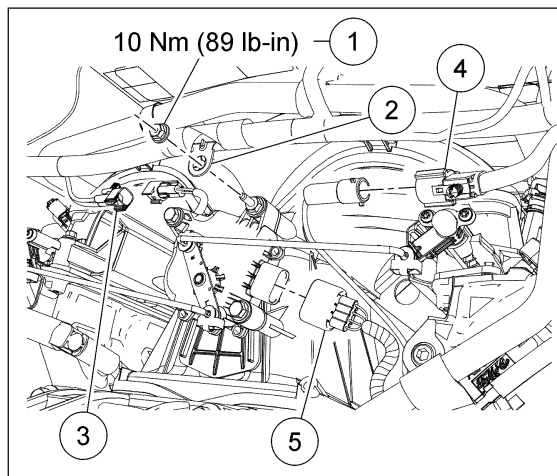
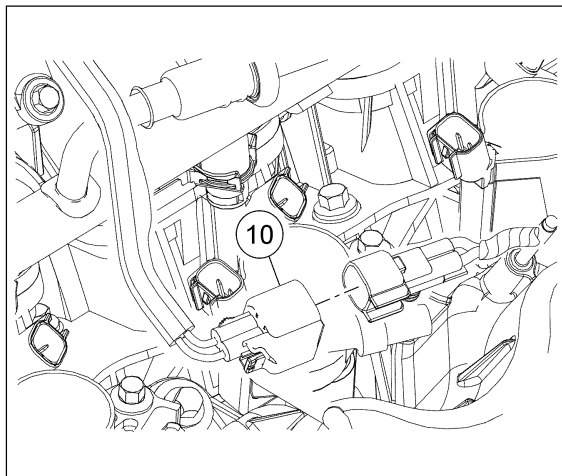
IN-VEHICLE REPAIR (Continued)**Throttle Body (TB) Adapter, PCV Tube, Crankcase Vent Tube and Electrical Connectors**

IN-VEHICLE REPAIR (Continued)

Item	Part Number	Description
1	W705800	Radiator hose clamp
2	9F792	Radiator hose
3	9229	Heater coolant hose
4	6K824	Crankcase ventilation tube
5	6K817	PCV tube
6	W505426	Air cleaner outlet pipe-to-throttle body (TB) adapter bolt (4 required)
7	9G651	Air cleaner outlet pipe-to-TB adapter
8	9B694	Air cleaner outlet pipe-to-TB adapter seal
9	—	Fuel rail pressure and temperature sensor electrical connector (part of 12B637)
10	—	Fuel rail pressure and temperature sensor vacuum hose (part of 9D446)

(Continued)

Item	Part Number	Description
11	—	Electronic acceleration control electrical connector (part of 12B637)
12	—	Throttle position (TP) sensor electrical connector (part of 12B637)
13	—	Radio ignition interference capacitor electrical connector (part of 12B637)
14	—	Variable camshaft timing (VCT) oil control solenoid electrical connector (part of 12B637)
15	—	Engine wiring harness retainers (part of 12B637)
16	—	Fuel injector electrical connector (8 required) (part of 12B637)

IN-VEHICLE REPAIR (Continued)**Intake Manifold and Gaskets**

N0076893

IN-VEHICLE REPAIR (Continued)

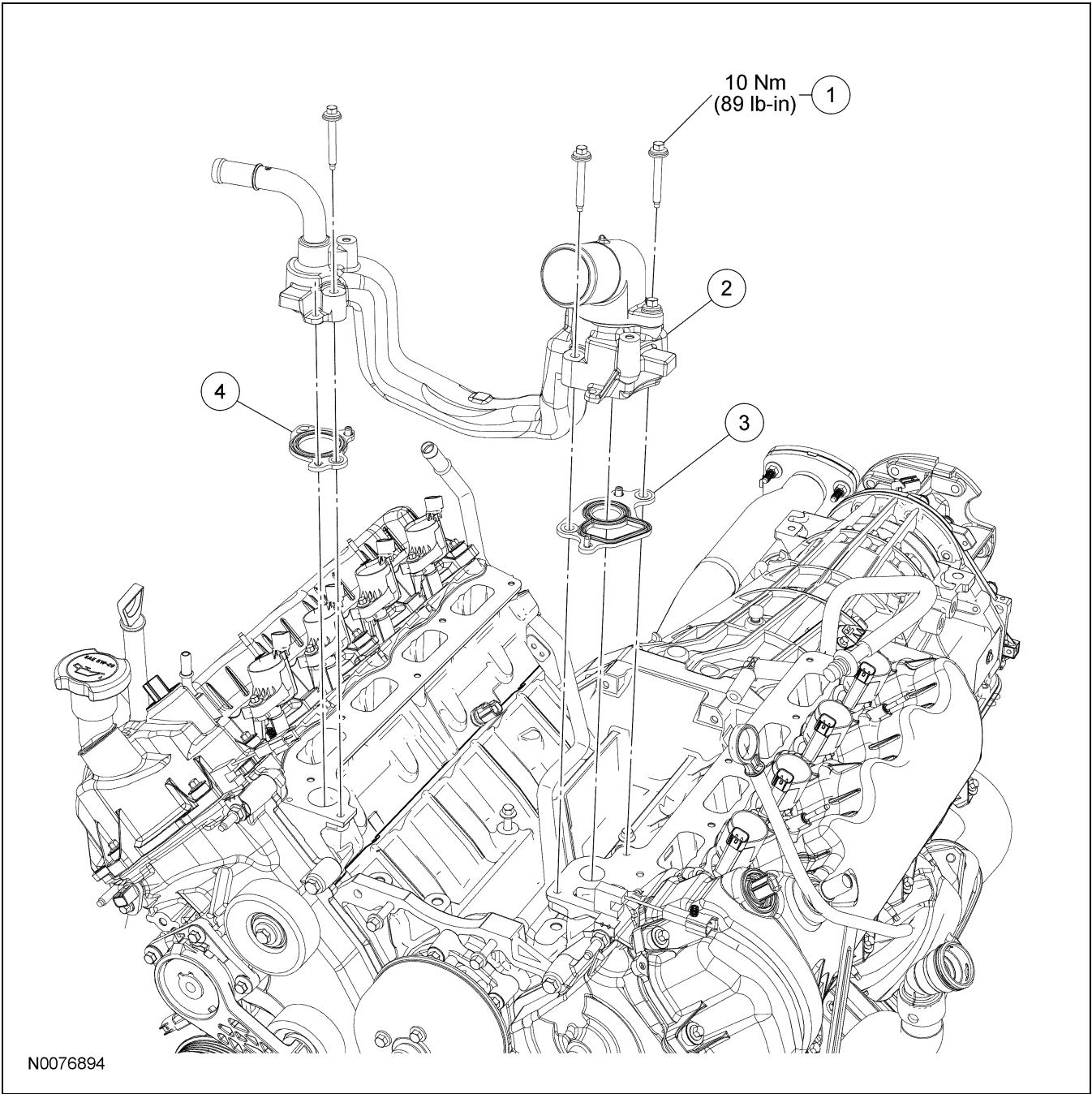
Item	Part Number	Description
1	N621903	Engine wiring harness retainer nut
2	—	Engine wiring harness retainer (part of 12B637)
3	—	Knock sensor (KS) electrical connector (2 required) (part of 12B637)
4	—	Cylinder head temperature (CHT) sensor electrical connector (part of 12B637)
5	—	Charge motion control valve (CMCV) electrical connector (part of 12B637)
6	9J338	Fuel supply tube spring lock coupling

(Continued)

Item	Part Number	Description
7	9A474	Vacuum tube
8	—	Intake manifold vacuum tube-to-brake booster hose clamp (part of 9A474)
9	—	Intake manifold vacuum tube-to-brake booster hose (part of 9A474)
10	—	PCV intake fitting electrical connector (part of 12B637)
11	W709775	Intake manifold bolt (10 required)
12	9Y451	Intake manifold
13	9439	RH intake manifold gasket
14	9441	LH intake manifold gasket

IN-VEHICLE REPAIR (Continued)

Engine Coolant Crossover Manifold Assembly and Gaskets





Item	Part Number	Description
1	W503297	Engine coolant crossover manifold assembly bolt (3 required)
2	8C369	Engine coolant crossover manifold assembly


Item	Part Number	Description
3	8C387	RH engine coolant crossover manifold assembly gasket
4	8C389	LH engine coolant crossover manifold assembly gasket

(Continued)

IN-VEHICLE REPAIR (Continued)**Removal**

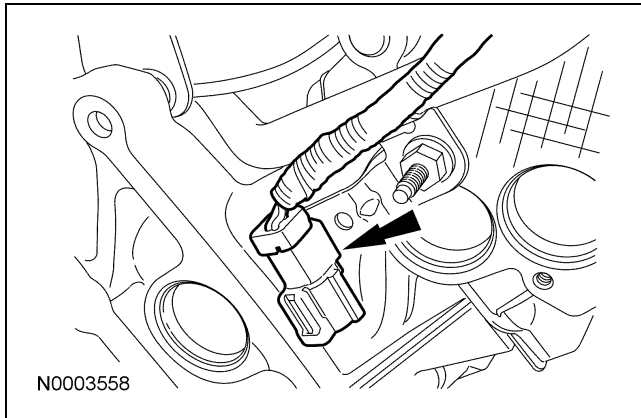
 **WARNING:** Do not smoke, carry lighted tobacco or have an open flame of any type when working on or near any fuel-related component. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in serious personal injury.


 **WARNING:** Before working on or disconnecting any of the fuel tubes or fuel system components, relieve the fuel system pressure to prevent accidental spraying of fuel. Fuel in the fuel system remains under high pressure, even when the engine is not running. Failure to follow this instruction may result in serious personal injury.

1. Disconnect the fuel supply spring lock coupling from the fuel rail. For additional information, refer to Section 310-00.
2. Drain the cooling system. For additional information, refer to Section 303-03.
3. Remove the generator. For additional information, refer to Section 414-02.
4. Remove the air cleaner outlet pipe. For additional information, refer to Section 303-12.
5. Disconnect the upper radiator hose from the thermostat housing.
6. Disconnect the heater coolant hose from the engine coolant crossover manifold assembly.
7. Disconnect the evaporative emissions (EVAP) system tube from the intake manifold and position aside. For additional information, refer to Section 310-00.
8. Disconnect the quick connect couplings and remove the PCV tube. For additional information, refer to Section 310-00.
9. Remove the 4 bolts and the air cleaner outlet pipe-to-throttle body (TB) adapter.
10. Disconnect the fuel rail pressure and temperature sensor electrical connector and vacuum connector.
11. Disconnect the 8 fuel injector electrical connectors.
12. Disconnect the throttle position (TP) sensor and electronic acceleration control electrical connectors.
13. Disconnect the heated PCV intake fitting electrical connector.
14. Disconnect the LH variable camshaft timing (VCT) solenoid electrical connector.
15. Disconnect the LH radio ignition interference capacitor electrical connector.
16. Disconnect the wiring harness retainers from the LH valve cover studs and position the harness aside.
17. Disconnect the brake booster vacuum hose from the intake manifold vacuum tube.
18. Remove the 10 intake manifold bolts.
19.  **CAUTION:** Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the sealing surfaces. These tools cause scratches and gouges which make leak paths. Use a plastic scraping tool to remove all traces of old sealant.
Remove the 3 bolts, the engine coolant crossover manifold assembly and discard the gaskets.
 - Clean and inspect the sealing surfaces with Silicone Gasket Remover and Motorcraft Metal Surface Prep. Follow the directions on the packaging.
20. Disconnect the charge motion control valve (CMCV) electrical connector.

IN-VEHICLE REPAIR (Continued)

21. Disconnect the RH heated exhaust gas oxygen sensor (HO2S) electrical connector and detach the electrical connector retainers.



22. Disconnect the intake manifold vacuum tube from the valve cover stud and the support bracket.
23. Position the intake manifold assembly forward and disconnect the cylinder head temperature (CHT) sensor jumper harness electrical connector.
24. Disconnect the LH and RH knock sensor (KS) electrical connectors.
25. Remove the nut and disconnect the engine wiring harness retainer from the CMCV stud.
26.  **CAUTION: Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the sealing surfaces. These tools cause scratches and gouges which make leak paths. Use a plastic scraping tool to remove all traces of old sealant.**

Remove the intake manifold and discard the gaskets.

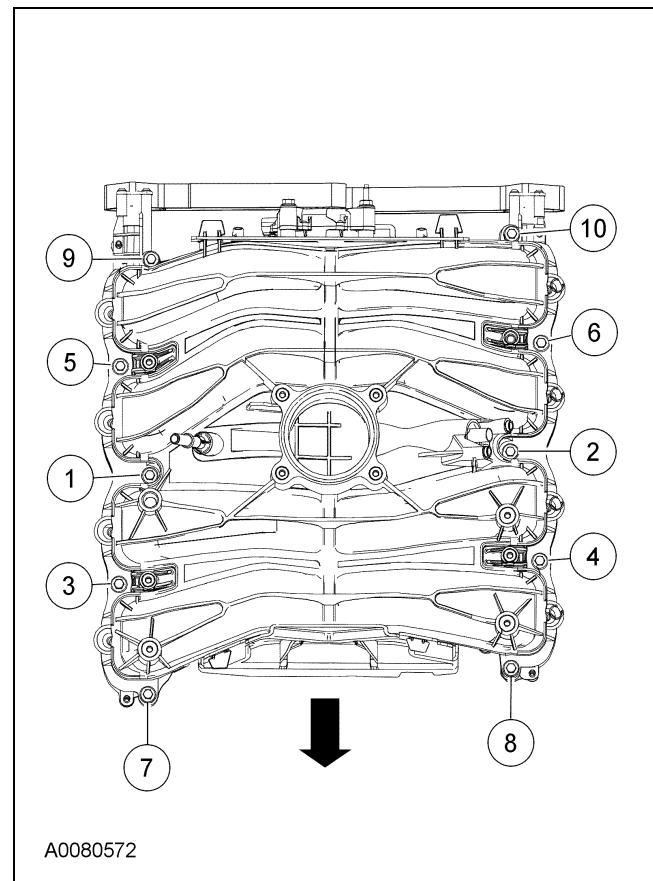
- Clean and inspect the sealing surfaces with Motorcraft Metal Surface Prep and Silicone Gasket Remover. Follow the directions on the packaging.

Installation

1. **NOTE:** Electrical and vacuum harnesses must not restrict movement of the CMCV control rods at the rear of the intake manifold. Use extreme care on installation of the intake manifold to prevent any pinching of electrical and vacuum harnesses.

Using new intake manifold gaskets, position the intake manifold.

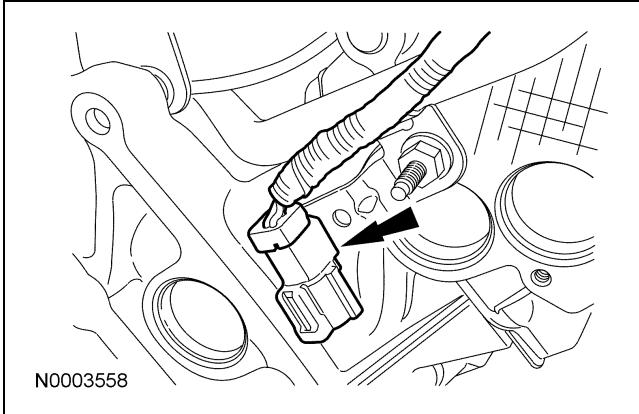
2. Using new gaskets, position the engine coolant crossover manifold assembly and install the 3 bolts
- Tighten to 10 Nm (89 lb-in).
3. Install the intake manifold bolts and tighten in 2 stages in the sequence shown.
- Stage 1: Tighten to 2 Nm (18 lb-in).
 - Stage 2: Tighten to 10 Nm (89 lb-in).



4. Connect the engine wiring harness retainer to the CMCV stud and install the nut.
- Tighten to 10 Nm (89 lb-in).

IN-VEHICLE REPAIR (Continued)

5. Connect the CMCV electrical connector.
6. Connect the HO2S electrical connector and attach the electrical connector retainer.



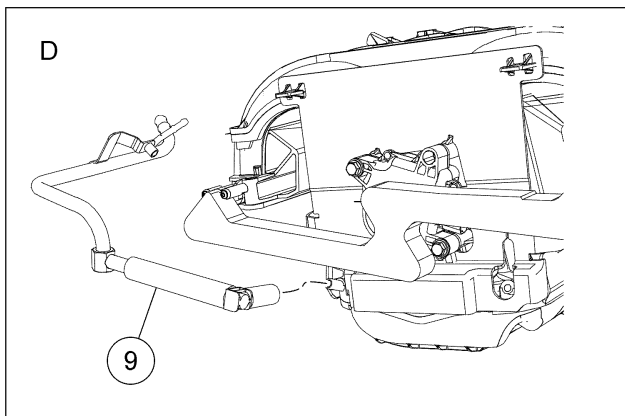
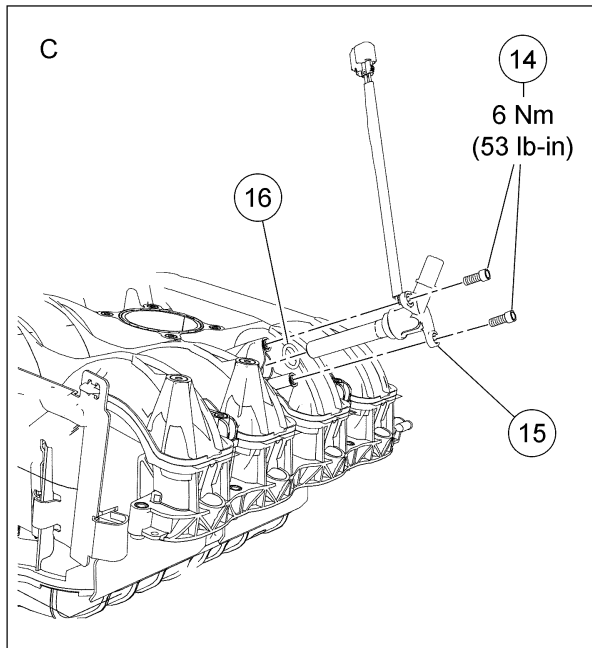
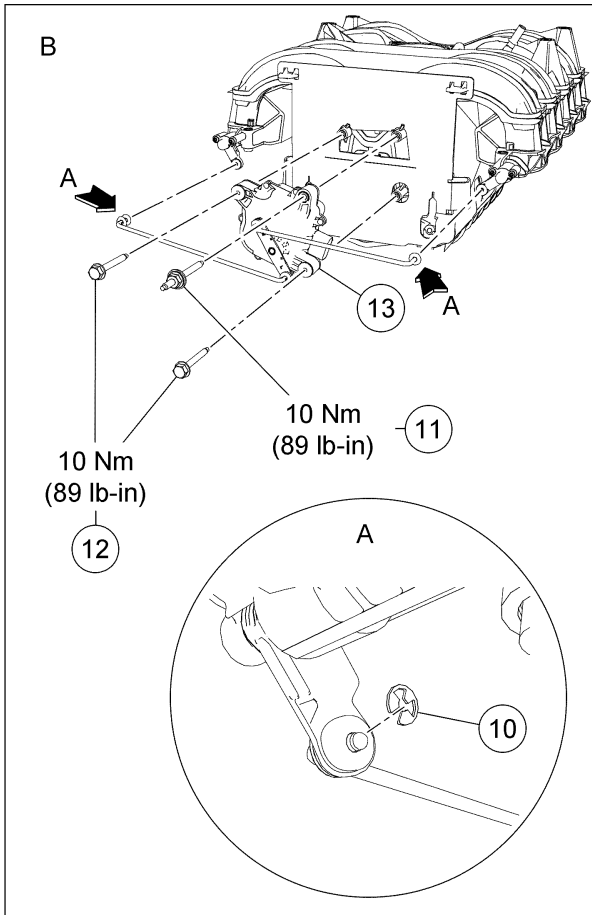
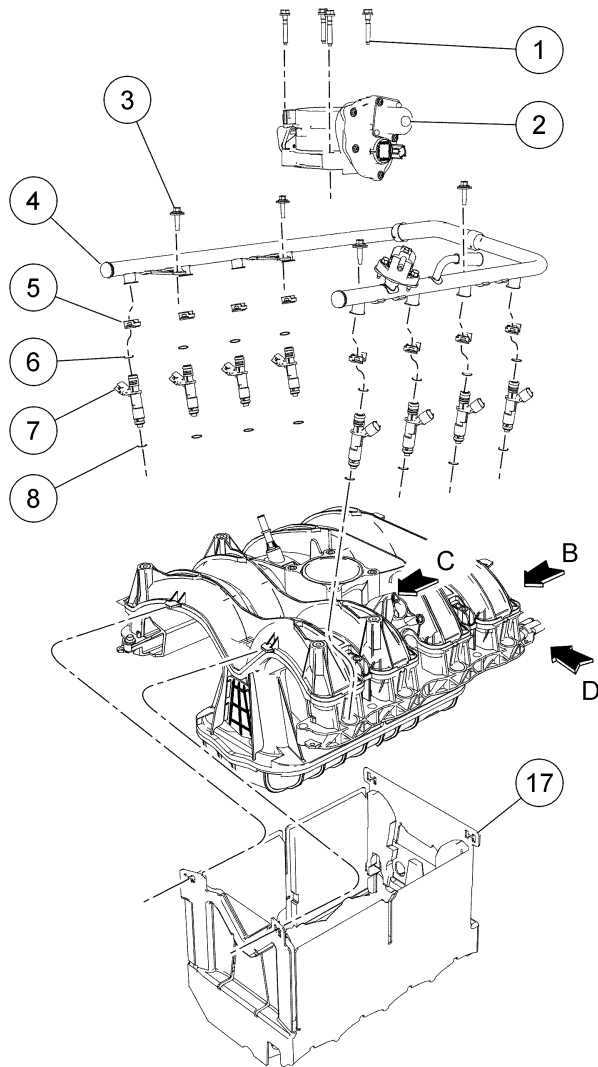
7. Connect the CHT sensor jumper harness electrical connector.
8. Connect the LH and RH KS electrical connectors.
9. Connect the intake manifold vacuum tube to the support bracket and the valve cover stud.
10. Connect the brake booster vacuum hose to the intake manifold vacuum tube.
11. Position the engine wiring harness and connect the wiring harness retainers to the LH valve cover stud bolts.
12. Connect the LH radio ignition interference capacitor electrical connector.
13. Connect the LH VCT solenoid electrical connector.
14. Connect the heated PCV intake fitting electrical connector.
15. Connect the TP sensor and electronic acceleration control electrical connectors.
16. Connect the 8 fuel injector electrical connectors.
17. Connect the fuel rail pressure and temperature sensor electrical connector and vacuum connector.
18. Position the air cleaner outlet pipe-to-throttle body (TB) adapter and install the 4 bolts.
 - Tighten to 10 Nm (89 lb-in).
19. Connect the fuel supply spring lock coupling to the fuel rail. For additional information, refer to Section 310-00.
20. Position the PCV tube and connect the quick connect couplings. For additional information, refer to Section 310-00.
21. Connect the EVAP tube quick connect coupling to the intake manifold. For additional information, refer to Section 310-00.
22. Connect the heater coolant hose to the engine coolant crossover manifold assembly.
23. Connect the upper radiator hose to the thermostat housing.
24. Install the generator. For additional information, refer to Section 414-02.
25. Install the air cleaner outlet pipe. For additional information, refer to Section 303-12.
26. Fill and bleed the engine cooling system. For additional information, refer to Section 303-03.

DISASSEMBLY AND ASSEMBLY OF SUBASSEMBLIES

Intake Manifold Assembly

Material

Item	Specification
Motorcraft SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP (US); Motorcraft SAE 5W-20 Super Premium Motor Oil CXO-5W20-LSP12 (Canada); or equivalent	WSS-M2C930-A

DISASSEMBLY AND ASSEMBLY OF SUBASSEMBLIES (Continued)

N0010498

DISASSEMBLY AND ASSEMBLY OF SUBASSEMBLIES (Continued)

Item	Part Number	Description
1	N705438	Throttle body (TB) bolt (4 required)
2	9F991	TB assembly
3	N705800	Fuel rail bolt (4 required)
4	9F792	Fuel rail
5	9F907	Fuel injector-to-fuel rail locking clip (8 required)
6	—	Fuel injector-to-fuel rail O-ring seal (8 required)
7	9F593	Fuel injector (8 required)
8	—	Fuel injector-to-intake manifold O-ring seal (8 required)
9	9D446	Intake manifold vacuum tube assembly
10	—	Charge motion control valve (CMCV) rod locking clip (2 required)
11	W708165	CMCV stud bolt
12	W709184	CMCV bolts (2 required)
13	9L490	CMCV
14	W500204	Positive crankcase ventilation (PCV) heater element bolts (2 required)
15	9F624	PCV heater element
16	—	PCV heater element O-ring seal
17	6N041	Engine noise shield insulator

Disassembly

- Remove the 4 bolts and the throttle body (TB).
- Remove the 4 bolts and the fuel rail.
- Remove the fuel injector-to-fuel rail locking clips and separate the fuel injectors from the fuel rail.
 - Discard the 2 O-ring seals from each fuel injector.
- Remove the vacuum tube assembly from the intake manifold.
- Remove the charge motion control valve (CMCV) rod locking clips.
- Remove the stud bolt, the 2 bolts and the CMCV.
- Remove the 2 bolts and the PCV heater element.
 - Discard the O-ring seal.
- Remove the engine noise shield insulator from the intake manifold.

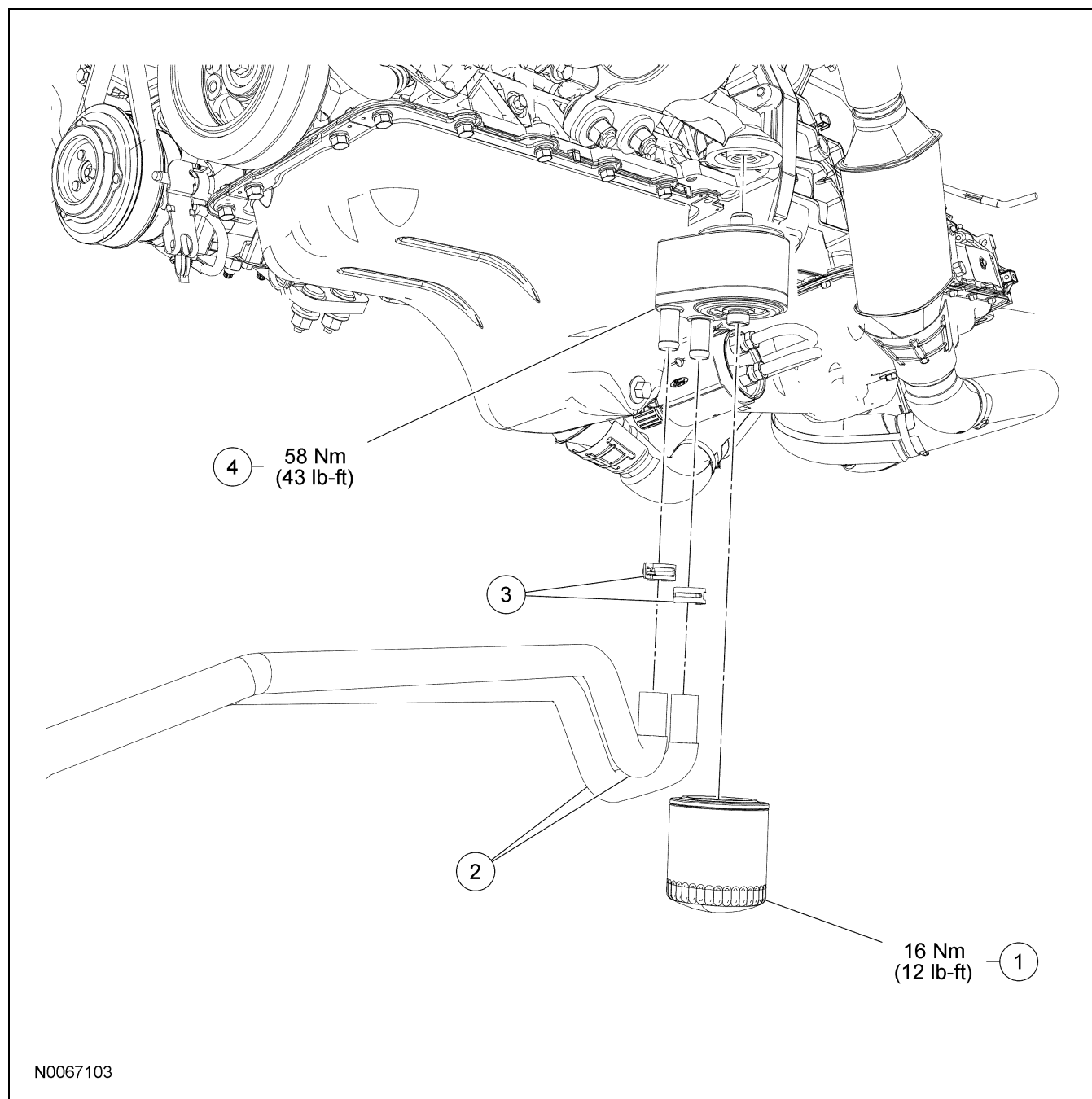
Assembly

- Install the engine noise shield insulator onto the intake manifold.
- NOTE:** Lubricate the new O-ring seal with clean engine oil prior to installation.
Using a new O-ring seal, install the PCV heater element and the 2 bolts.
 - Tighten to 6 Nm (53 lb-in).
- Position the CMCV and install the stud bolt and the 2 bolts.
 - Tighten to 10 Nm (89 lb-in).
- Install the CMCV rod locking clips.
- Install the vacuum tube assembly onto the intake manifold.
- NOTE:** Lubricate the new O-ring seals with clean engine oil prior to installation.
Install new O-ring seals on each of the fuel injectors.
- Assemble the fuel injectors onto the fuel rail and install the locking clips.
- Install the fuel rail and fuel injector assembly onto the intake manifold.
- Install the 4 fuel rail bolts.
 - Tighten to 10 Nm (89 lb-in).
- Install the TB and tighten the bolts in 2 stages.
 - Stage 1: Tighten to 9 Nm (80 lb-in).
 - Stage 2: Tighten an additional 90 degrees.

IN-VEHICLE REPAIR**Oil Cooler****Material**

Item	Specification
Motorcraft SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP (US); Motorcraft SAE 5W-20 Super Premium Motor Oil CXO-5W20-LSP12 (Canada); or equivalent	WSS-M2C930-A

IN-VEHICLE REPAIR (Continued)




Item	Part Number	Description
1	6714	Oil filter
2	—	Oil cooler coolant hoses
3	—	Oil cooler coolant hose clamps
4	6A642	Oil cooler

Removal and Installation

1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.

2. Drain the engine cooling system. For additional information, refer to Section 303-03.
3. Remove and discard the oil filter.
 - To install, tighten to 16 Nm (12 lb-ft).
4. Disconnect the oil cooler coolant hoses and position aside.

IN-VEHICLE REPAIR (Continued)

5.  **CAUTION:** If metal foreign material is present in the oil cooler, mechanical concerns exist. To diagnose mechanical concerns, refer to Section 303-00.

Remove and inspect the engine oil cooler.

- To install, tighten to 58 Nm (43 lb-ft).
-

6. To install, reverse the removal procedure.

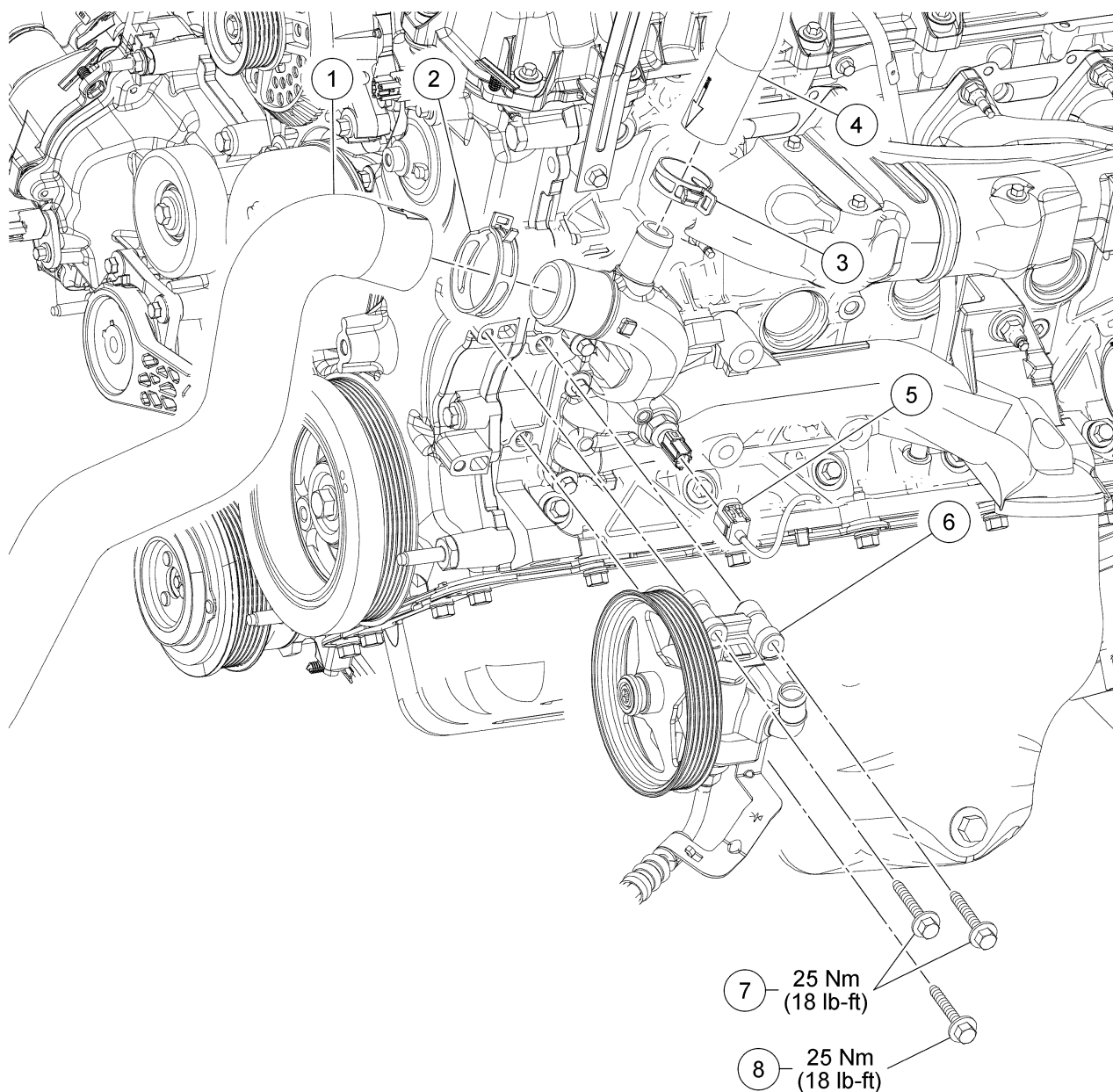
IN-VEHICLE REPAIR

Oil Filter Adapter

Material

Item	Specification
Motorcraft Metal Surface Prep ZC-31	—
Motorcraft SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP (US); Motorcraft SAE 5W-20 Super Premium Motor Oil CXO-5W20-LSP12 (Canada); or equivalent	WSS-M2C930-A
Silicone Gasket Remover ZC-30	—

IN-VEHICLE REPAIR (Continued)



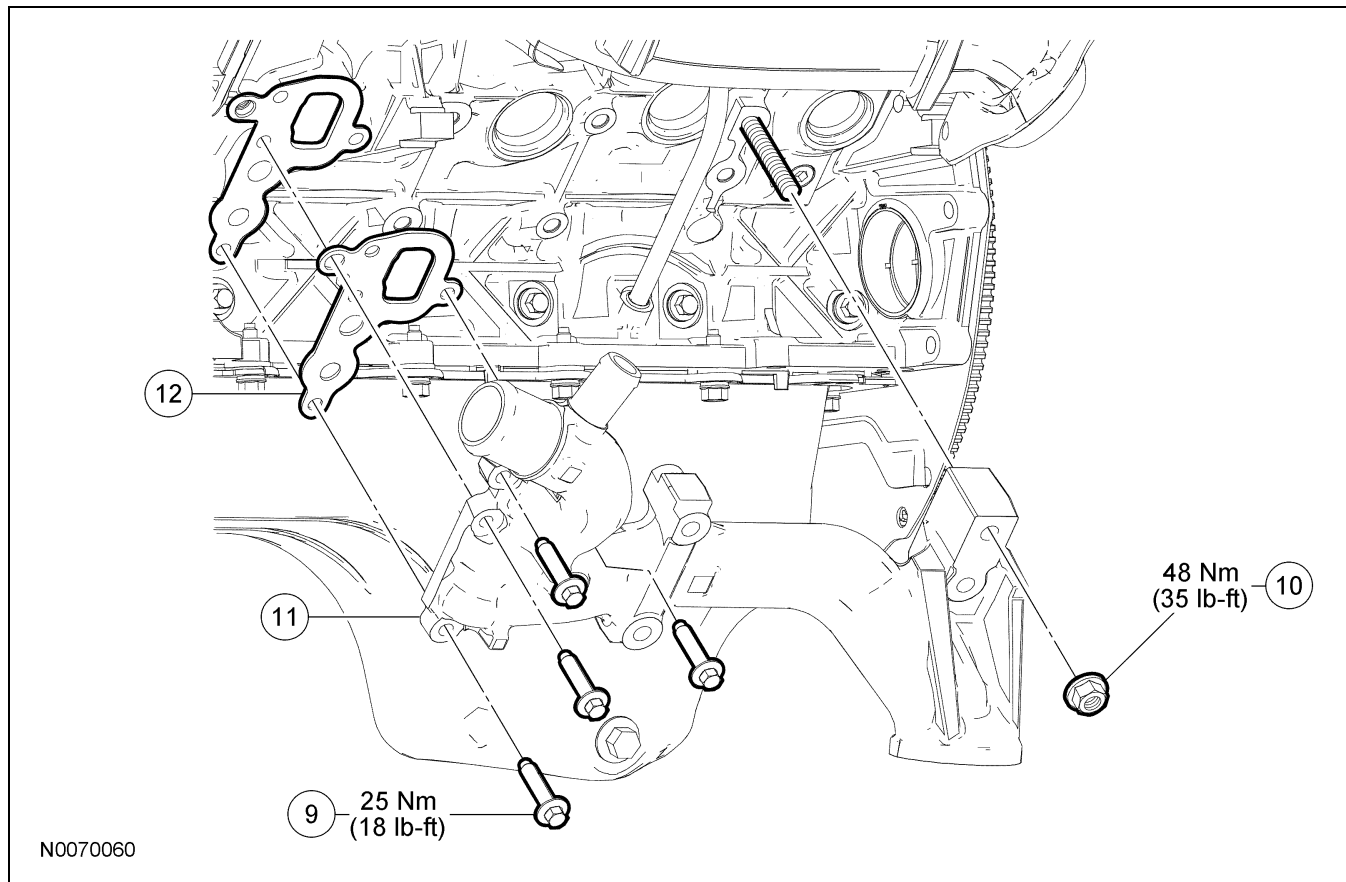
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Item	Part Number	Description
1	8B273	Lower radiator hose
2	15161	Lower radiator hose clamp
3	12B637	Degas bottle coolant hose clamp
4	8B273	Degas bottle coolant hose
5	—	Engine oil pressure (EOP) switch electrical connector (part of 12B637)

Item	Part Number	Description
6	3A696	Power steering pump
7	W500315	Power steering pump bolt (2 required)
8	W701526	Power steering pump bolt

(Continued)

IN-VEHICLE REPAIR (Continued)

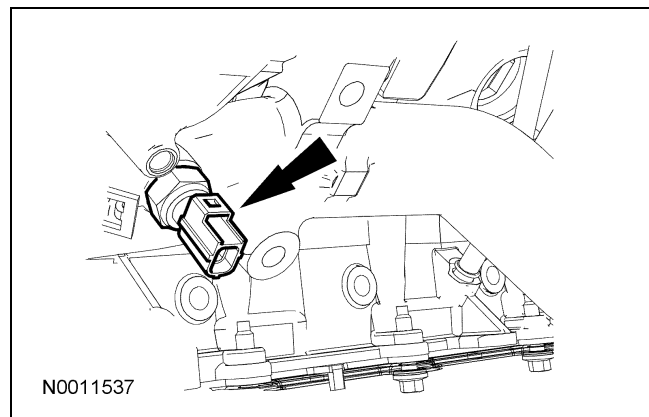


Item	Part Number	Description
9	N806156	Oil filter adapter bolt (4 required)
10	N620482	Oil filter adapter nut
11	6884	Oil filter adapter
12	6A636	Oil filter adapter gasket

Removal and Installation

1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
2. Remove the LH engine mount. For additional information, refer to Engine Support Insulators in this section.
3. Remove the 3 bolts and position the power steering pump assembly aside.
 - To install, tighten to 25 Nm (18 lb-ft).
4. Disconnect the lower radiator hose from the oil filter adapter and position it aside.


5. Disconnect the degas bottle hose from the oil filter adapter and position it aside.
6. Disconnect the engine oil pressure (EOP) switch electrical connector.
7. Remove the EOP switch.
 - To install, tighten to 18 Nm (13 lb-ft).



8. Remove the oil filter adapter nut.
 - To install, tighten to 48 Nm (35 lb-ft).

IN-VEHICLE REPAIR (Continued)

9. Remove the 4 bolts and the oil filter adapter.
- To install, tighten to 25 Nm (18 lb-ft).
11. To install, reverse the removal procedure.

10.  **CAUTION: Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the sealing surfaces. These tools cause scratches and gouges, which make leak paths. Use a plastic scraping tool to remove all traces of old sealant. Failure to follow this procedure may cause future oil leakage.**

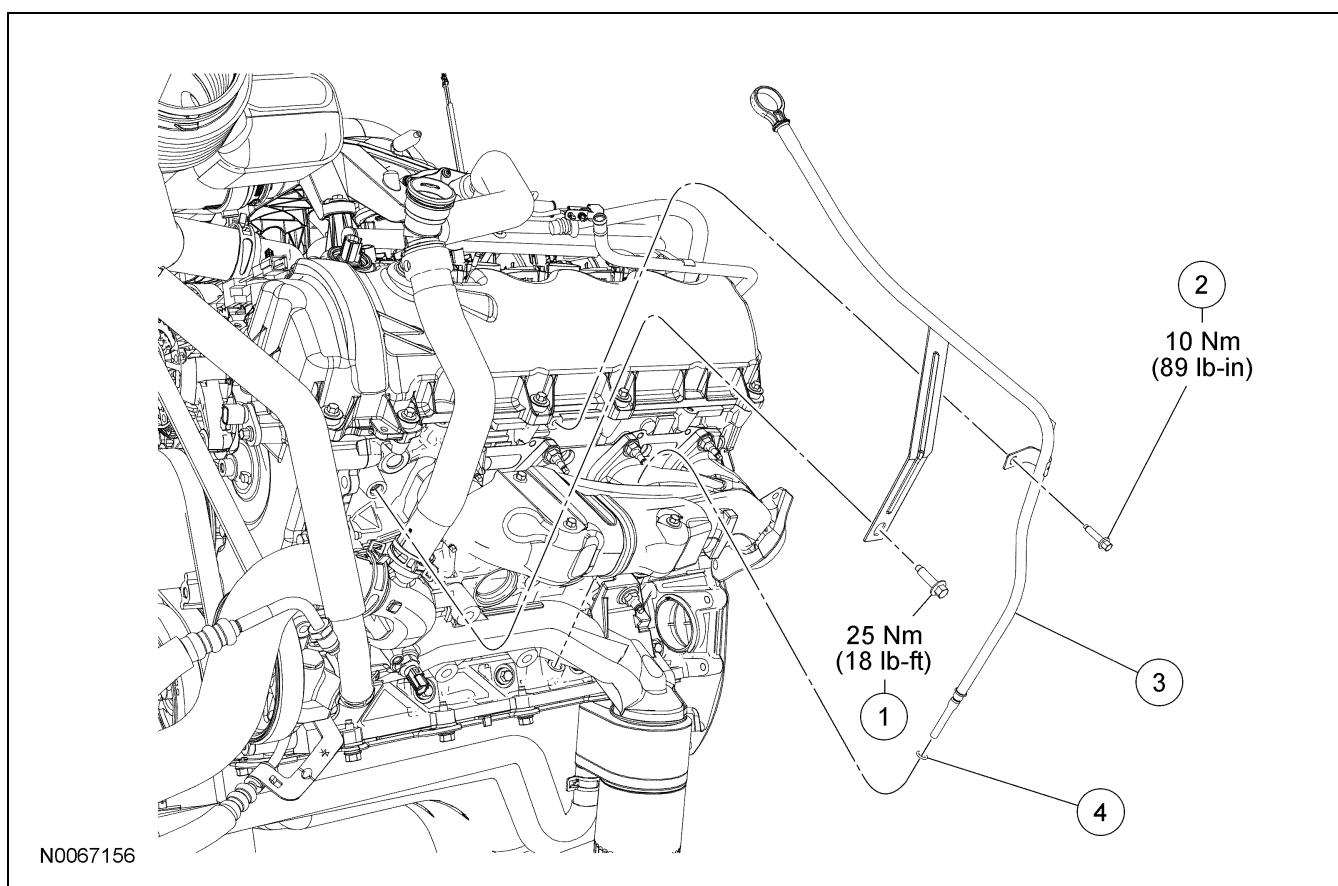
Remove and discard the oil filter adapter gasket. Clean the sealing surfaces with Silicone Gasket Remover and Motorcraft Metal Surface Prep. Follow the directions on the packaging. Inspect the mating surfaces.

IN-VEHICLE REPAIR

Oil Level Indicator and Tube

Material

Item	Specification
Motorcraft SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP (US); Motorcraft SAE 5W-20 Super Premium Motor Oil CXO-5W20-LSP12 (Canada); or equivalent	WSS-M2C930-A



Item	Part Number	Description
1	W500224	Oil level indicator and tube bolt
2	N605892	Rear oil level indicator and tube bolt
3	6K873	Oil level indicator and tube
4	—	Oil level indicator tube O-ring seal

Removal and Installation

1. Remove the front oil level indicator and tube bolt.
 - To install, tighten to 25 Nm (18 lb-ft).
2. Remove the rear oil level indicator and tube bolt.
 - To install, tighten to 10 Nm (89 lb-in).

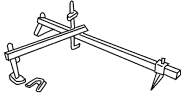
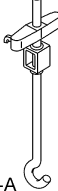
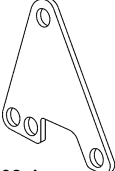
IN-VEHICLE REPAIR (Continued)

3. Remove the oil level indicator and tube from the cylinder block.
 - Discard the O-ring seal.
 4. **NOTE:** Lubricate the new oil level indicator tube O-ring seal with clean engine oil prior to installation.
To install, reverse the removal procedure.
-

IN-VEHICLE REPAIR

Oil Pan

Special Tool(s)

 <p>ST2176-B</p>	<p>Engine Support Bar, Heavy Duty 303-F070</p>
 <p>ST2970-A</p>	<p>Support Hook 303-F071</p>
 <p>ST2592-A</p>	<p>Engine Support Bracket 303-639</p>

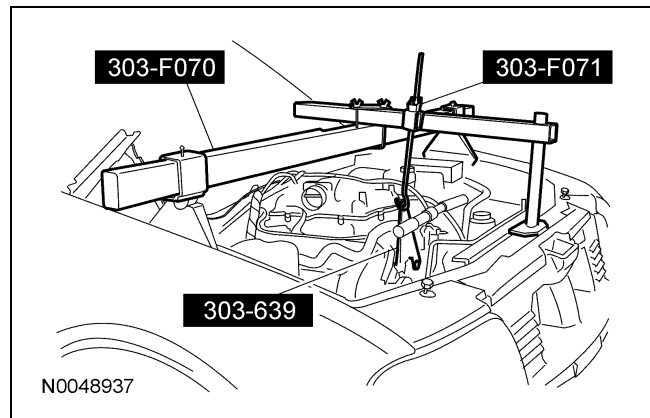
Material

Item	Specification
Motorcraft Metal Surface Prep ZC-31	—
Motorcraft SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP (US); Motorcraft SAE 5W-20 Super Premium Motor Oil CXO-5W20-LSP12 (Canada); or equivalent	WSS-M2C930-A
Silicone Gasket and Sealant TA-30	WSE-M4G323-A4
Silicone Gasket Remover ZC-30	—

Removal

All vehicles

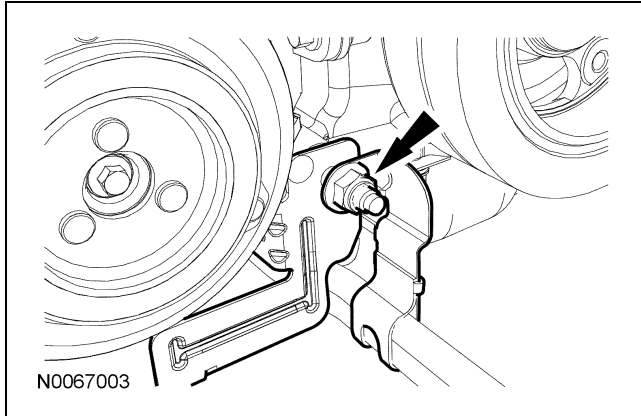
- With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
- Remove the generator. For additional information, refer to Section 414-02.
- Remove the engine cooling fan. For additional information, refer to Section 303-03.
- Disconnect the crankcase vent tube quick connect coupling from the air cleaner outlet pipe-to-throttle body (TB) adapter. For additional information, refer to Section 310-00.
- Disconnect the vacuum hose from the air cleaner outlet pipe-to-TB adapter.
- Disconnect the wiring harness retainer from the air cleaner outlet pipe-to-TB adapter.
- Remove the 4 air cleaner outlet pipe-to-TB adapter bolts.
- Remove the air cleaner outlet pipe-to-TB adapter.
- Install the special tools.



- If equipped, remove the engine oil cooler. For additional information, refer to Oil Cooler in this section.

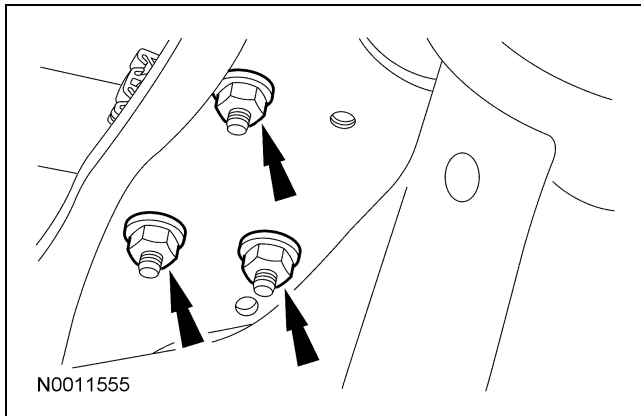
IN-VEHICLE REPAIR (Continued)

11. Remove the nut, the transmission auxiliary fluid cooler tube support bracket and the starter wiring harness support bracket from the engine front cover stud bolt.

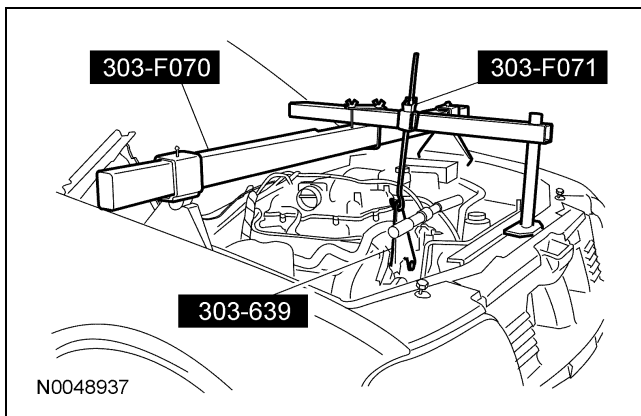


12. **NOTE:** LH shown, RH similar.

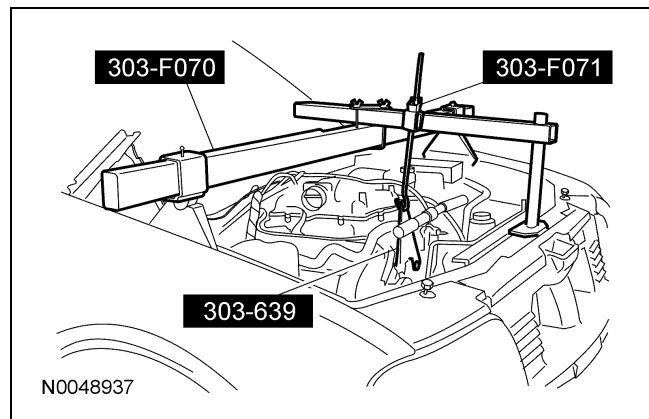
Remove and discard the 7 engine support insulator-to-crossmember nuts.



13. Using the special tools, raise the engine assembly.



14. Remove 16 oil pan bolts and position the oil pan onto the crossmember.
15. Remove the 3 bolts and position the oil pump screen and pickup tube into the oil pan.
16. Position the oil pan onto the engine and install one bolt at the front and one bolt at the rear of the oil pan to hold it in position.
17. Using the special tools, align the engine support insulator studs and lower the engine.

**Manual transmission equipped vehicles**

18. Remove the flywheel. For additional information, refer to Flywheel in this section.

Automatic transmission equipped vehicles

19. Remove the flexplate. For additional information, refer to Flexplate in this section.

All vehicles

20. Remove the rear engine cover.
21. Remove the 2 bolts, the oil pan and the oil pump screen and pickup tube.
- Inspect the oil pan gasket for damage.
 - Discard the oil pan gasket.
 - Discard the oil pump screen and pickup tube O-ring seal.

IN-VEHICLE REPAIR (Continued)**Installation****All vehicles**

1. **⚠ CAUTION:** Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the sealing surfaces. These tools cause scratches and gouges, which make leak paths. Use a plastic scraping tool to remove all traces of old sealant. Failure to follow this procedure may cause future oil leakage.

Inspect the oil pan. Clean the mating surface for the oil pan with Silicone Gasket Remover and Motorcraft Metal Surface Prep. Follow the directions on the packaging.

2. Install a new O-ring seal onto the oil pump screen and pickup tube.
3. Position the oil pump screen and pickup tube in the oil pan and position the oil pan and new gasket into the vehicle.
4. Install the rear engine cover.

Manual transmission equipped vehicles

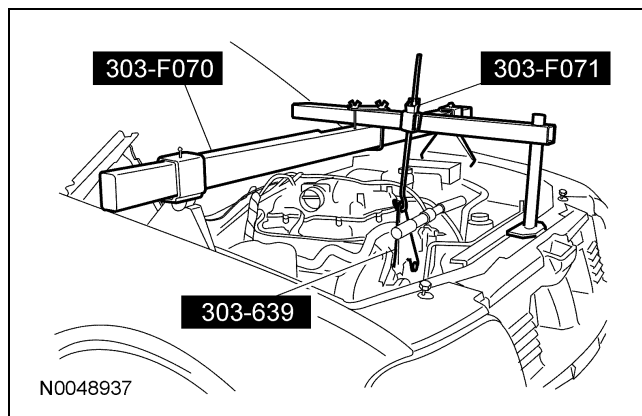
5. Install the flywheel. For additional information, refer to Flywheel in this section.

Automatic transmission equipped vehicles

6. Install the flexplate. For additional information, refer to Flexplate in this section.

All vehicles

7. Using the special tools, raise the engine.



8. **⚠ CAUTION:** Make sure to install a new O-ring seal. A missing or damaged O-ring seal can cause foam in the lubrication system and low oil pressure. Failure to follow this instruction may result in engine damage.

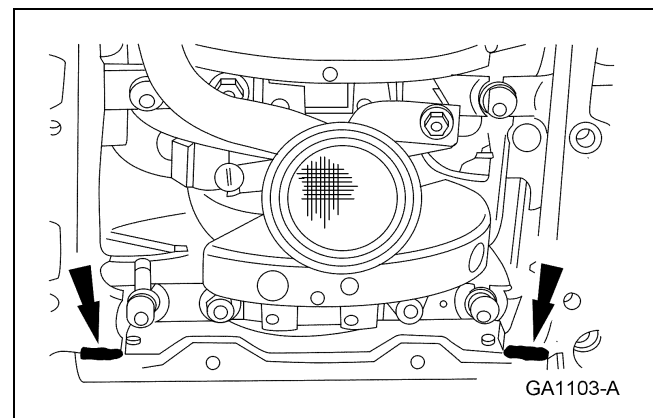
NOTE: Clean and inspect the mating surfaces and install a new O-ring seal. Lubricate the O-ring seal with clean engine oil prior to installation.

Position the oil pump screen and pickup tube and install the bolts.

- Tighten the oil pump screen and pickup tube-to-oil pump bolts to 10 Nm (89 lb-in).
- Tighten the oil pump screen and pickup tube-to-spacer bolt to 25 Nm (18 lb-ft).

9. **NOTE:** If not secured within 4 minutes, the sealant must be removed and the sealing area cleaned. To clean the sealing area, use Silicone Gasket Remover and Motorcraft Metal Surface Prep. Follow the directions on the packaging. Allow to dry until there is no sign of wetness, or 4 minutes, whichever is longer. Failure to follow this procedure may cause future oil leakage.

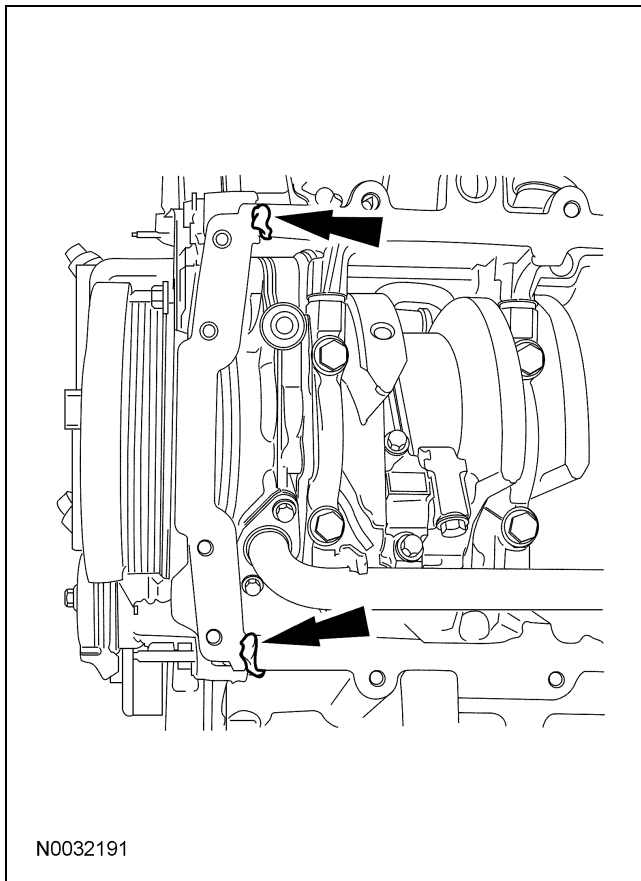
Apply Silicone Gasket and Sealant at the crankshaft rear seal retainer plate-to-cylinder block sealing surface.



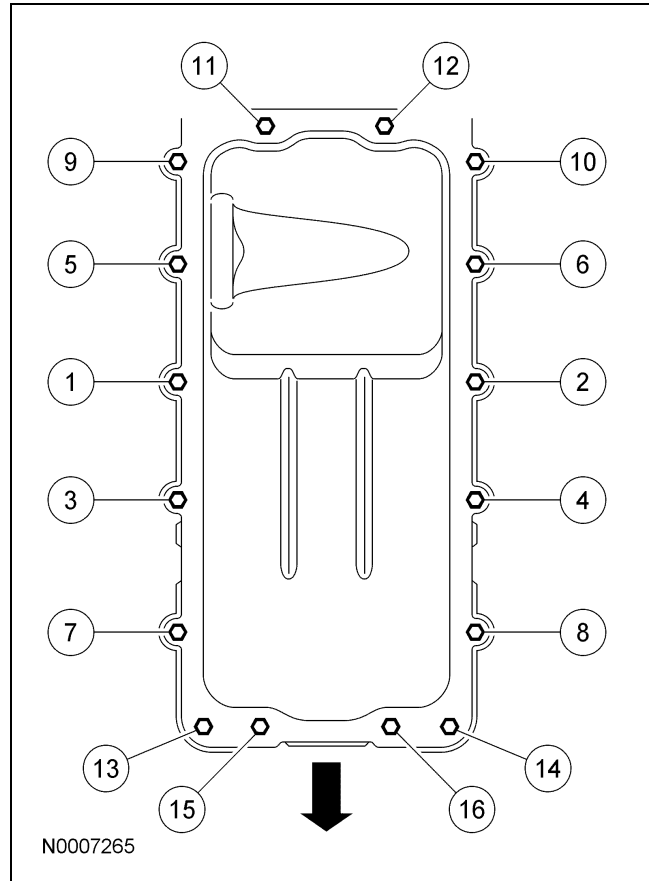
IN-VEHICLE REPAIR (Continued)

10. **NOTE:** If not secured within 4 minutes, the sealant must be removed and the sealing area cleaned. To clean the sealing area, use Silicone Gasket Remover and Motorcraft Metal Surface Prep. Follow the directions on the packaging. Allow to dry until there is no sign of wetness, or 4 minutes, whichever is longer. Failure to follow this procedure may cause future oil leakage.

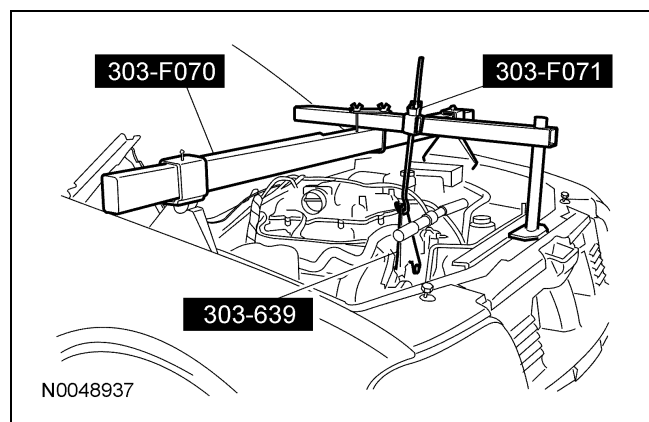
Apply Silicone Gasket and Sealant at the engine front cover-to-cylinder block sealing surface.




11. Position the oil pan gasket and the oil pan and loosely install the 16 bolts.
12. Tighten the bolts in 3 stages, in the sequence shown.
- Stage 1: Tighten to 2 Nm (18 lb-in).
 - Stage 2: Tighten to 20 Nm (15 lb-ft).
 - Stage 3: Tighten an additional 60 degrees.



13. Using the special tools, align the engine support insulator studs and lower the engine.

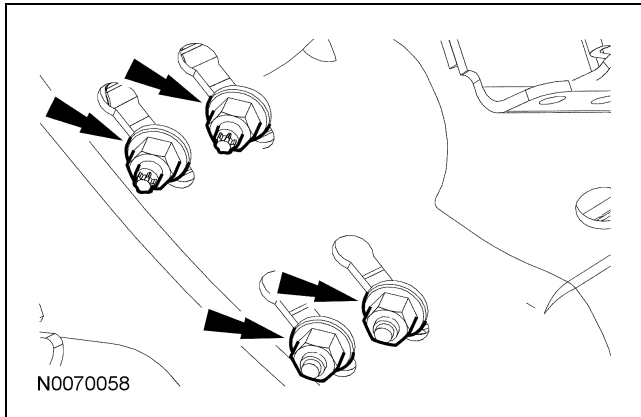



IN-VEHICLE REPAIR (Continued)

14.  **CAUTION:** Only use hand tools when installing the engine support insulator nuts or damage to the engine support insulator may occur.

Install 4 new RH engine support insulator nuts.

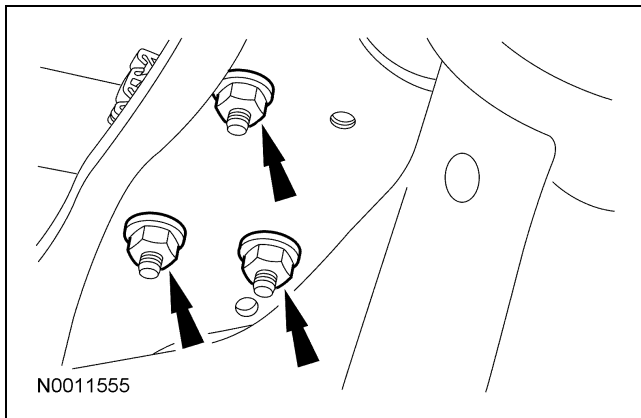
- Tighten to 115 Nm (85 lb-ft).



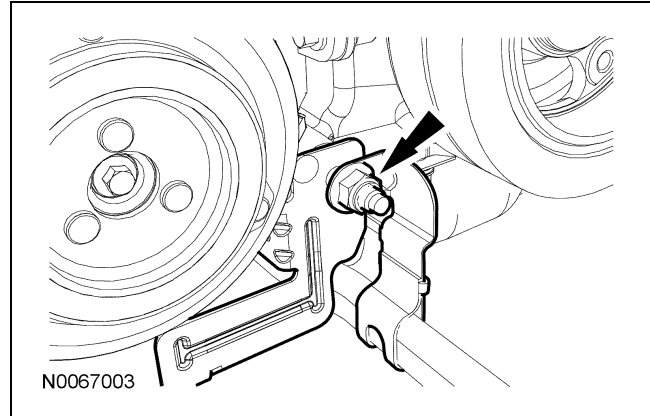
15.  **CAUTION:** Only use hand tools when installing the engine support insulator nuts or damage to the engine support insulator may occur.

Install 3 new LH engine support insulator nuts.

- Tighten to 200 Nm (148 lb-ft).



16. Position the transmission auxiliary fluid cooler tube support bracket and the starter wiring harness support bracket onto the engine front cover stud bolt and install the nut.
- Tighten to 25 Nm (18 lb-ft).



17. If equipped, install the engine oil cooler. For additional information, refer to Oil Cooler in this section.
18. Install the air cleaner outlet pipe-to-TB adapter.
19. Install the 4 air cleaner outlet pipe-to-TB adapter bolts.
- Tighten to 10 Nm (89 lb-in).
20. Connect the wiring harness retainer to the air cleaner outlet pipe-to-TB adapter.
21. Connect the vacuum hose to the air cleaner outlet pipe-to-TB adapter.
22. Connect the crankcase vent tube quick connect coupling to the air cleaner outlet pipe-to-TB adapter. For additional information, refer to Section 310-00.
23. Install the engine cooling fan. For additional information, refer to Section 303-03.
24. Install the generator. For additional information, refer to Section 414-02.
25. Fill the crankcase with clean engine oil.

IN-VEHICLE REPAIR

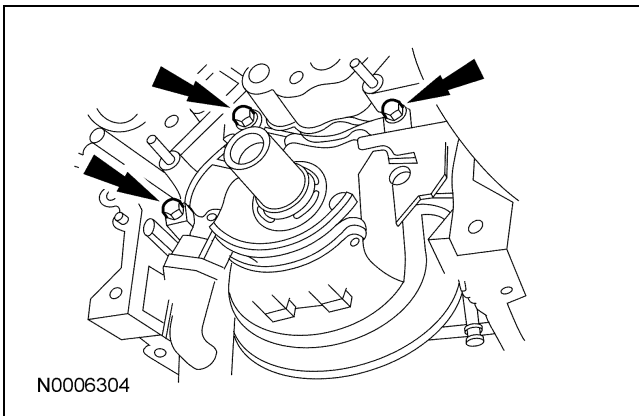
Oil Pump

Material

Item	Specification
Motorcraft Metal Surface Prep ZC-31	—
Motorcraft SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP (US); Motorcraft SAE 5W-20 Super Premium Motor Oil CXO-5W20-LSP12 (Canada); or equivalent	WSS-M2C930-A

Removal

1. Remove the timing drive components. For additional information, refer to Timing Drive Components in this section.
2. Remove the oil pan. For additional information, refer to Oil Pan in this section.
3. Remove the 3 bolts and the oil pump.

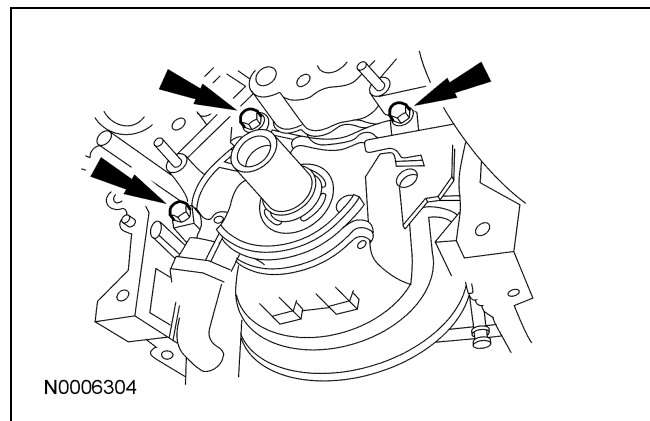


Installation

1. **CAUTION:** Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the sealing surfaces. These tools cause scratches and gouges which make leak paths. Use a plastic scraping tool to remove all traces of old sealant.

Clean the sealing surfaces with Motorcraft Metal Surface Prep. Follow the directions on the packaging. Inspect the mating surfaces.

2. Position the oil pump and install the bolts.
 - Tighten to 10 Nm (89 lb-in).



3. Install the oil pan. For additional information, refer to Oil Pan in this section.
4. Install the timing drive components. For additional information, refer to Timing Drive Components in this section.

IN-VEHICLE REPAIR

Oil Pump Screen and Pickup Tube

Removal and Installation

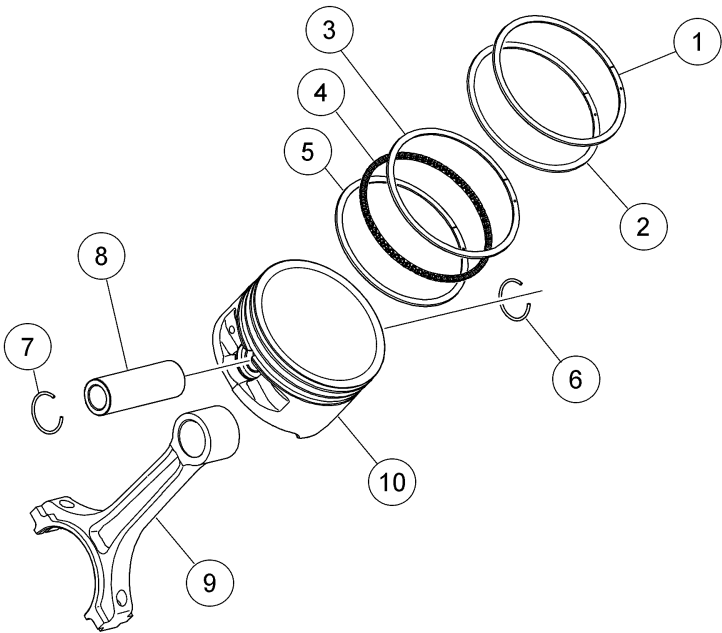
1. Remove the oil pan. For additional information, refer to Oil Pan in this section.
-

DISASSEMBLY AND ASSEMBLY
OF SUBASSEMBLIES

Piston

Material

Item	Specification
Motorcraft SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP (US); Motorcraft SAE 5W-20 Super Premium Motor Oil CXO-5W20-LSP12 (Canada); or equivalent	WSS-M2C930-A



N0010114

Item	Part Number	Description
1	6150	Piston compression upper ring
2	6152	Piston compression lower ring
3	6159	Piston oil control upper segment ring
4	6161	Piston oil control spacer
5	6159	Piston oil control lower segment ring

Item	Part Number	Description
6	6140	Piston pin retainer
7	6140	Piston pin retainer
8	6135	Piston pin
9	6200	Connecting rod
10	6110	Piston

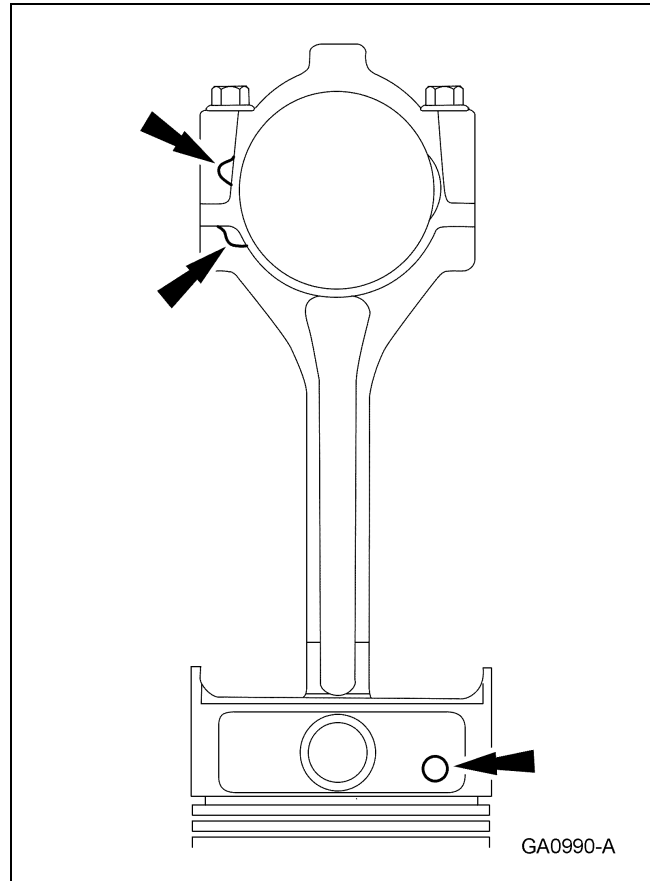
(Continued)

DISASSEMBLY AND ASSEMBLY OF SUBASSEMBLIES (Continued)**Disassembly**

1. Remove the piston rings from the piston.
 - Discard the piston rings.
2. Remove the piston pin retainers and the piston pin.
3. Separate the piston from the connecting rod.
4. Clean and inspect the piston and connecting rod. For additional information, refer to Section 303-00.

Assembly

1. **NOTE:** The connecting rod must be installed into the piston with identification markings toward the front.
Position the connecting rod in the piston.



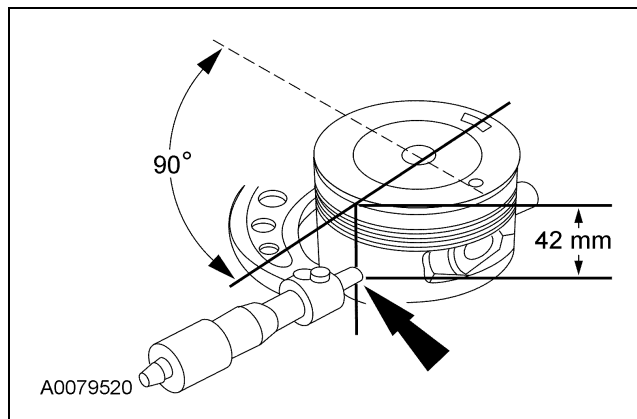
2. Lubricate the piston pin and pin bore with clean engine oil.
3. Install the piston pin in the piston and connecting rod assembly.
4. Install the piston pin retaining clips in the piston.
5. Lubricate the piston and the new piston rings with clean engine oil.
6. Install the piston rings onto the piston.

GENERAL PROCEDURES

Piston Diameter

NOTE: Refer to the appropriate Section 303-01 for the specification.

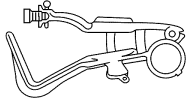
1. Measure the piston diameter 90 degrees from the piston pin and 42 mm (1.65 in) down from the top of the piston at the point indicated.



GENERAL PROCEDURES

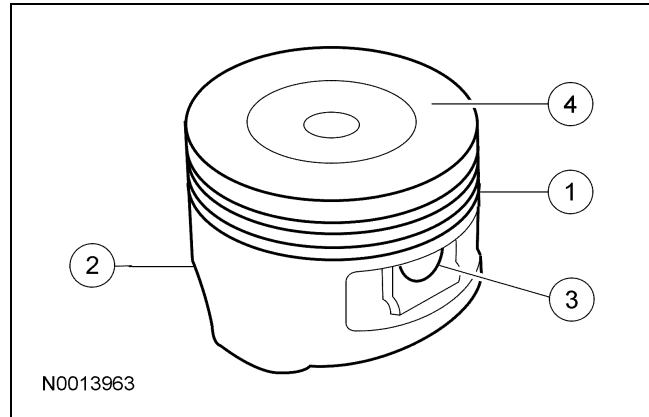
Piston Inspection

Special Tool(s)

	Scraper, Piston Ring Groove 303-D033 (D81L-6002-D) or equivalent
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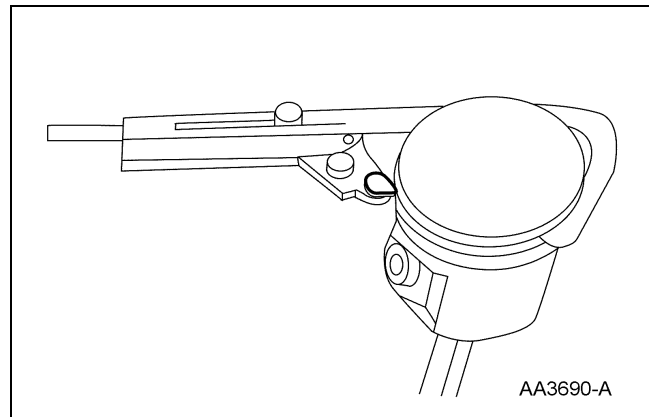
⚠ CAUTION: Do not use a caustic cleaning solution or a wire brush to clean the pistons or damage can occur.

1. Clean and inspect the (1) ring lands, (2) skirts, (3) pin bosses and the (4) tops of the pistons. If wear marks, scores or glazing is found on the piston skirt, check for a bent or twisted connecting rod.



2. Use the Piston Ring Groove Scraper to clean the piston ring grooves.


- Make sure the oil ring holes are clean.



GENERAL PROCEDURES

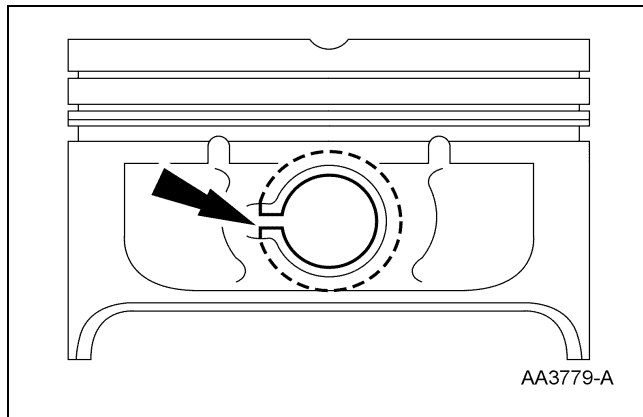
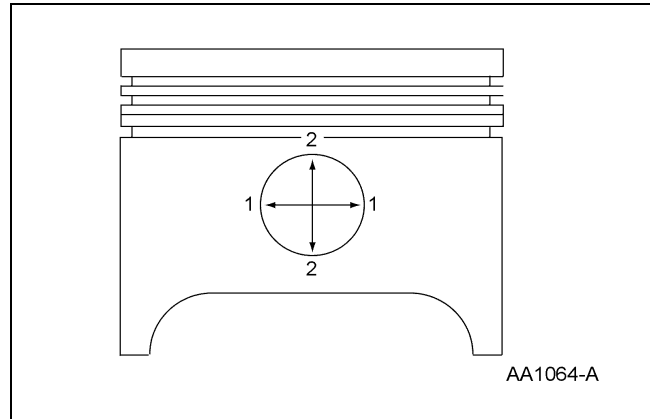
Piston Pin Bore Diameter

NOTE: Refer to the appropriate Section 303-01 for the specification.

1.  **WARNING:** Since the retainer ring has a tendency to spring out, cover the end of the pin bore with a hand or shop rag when removing the ring. Wear eye protection. Failure to follow these instructions may result in serious personal injury.

NOTE: Piston and piston pins are a matched set and should not be interchanged.

Measure the piston pin bore diameter in 2 directions on each side. Verify the diameter is within specification.

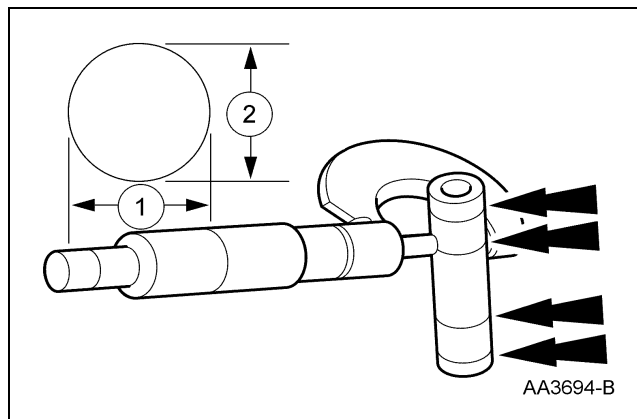


GENERAL PROCEDURES

Piston Pin Diameter


NOTE: Refer to the appropriate Section 303-01 for the specification.

1. Measure the piston pin diameter in 2 directions at the points shown. Verify the diameter is within specification.



GENERAL PROCEDURES

Piston Ring End Gap

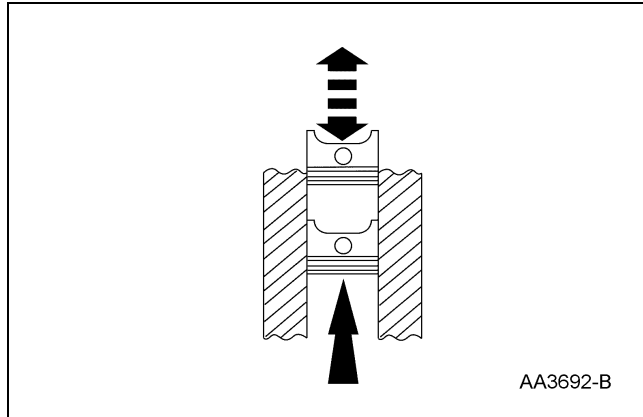
 **CAUTION:** Use care when fitting piston rings to avoid possible damage to the piston ring or the cylinder bore.

NOTE: Piston rings should not be transferred from one piston to another.

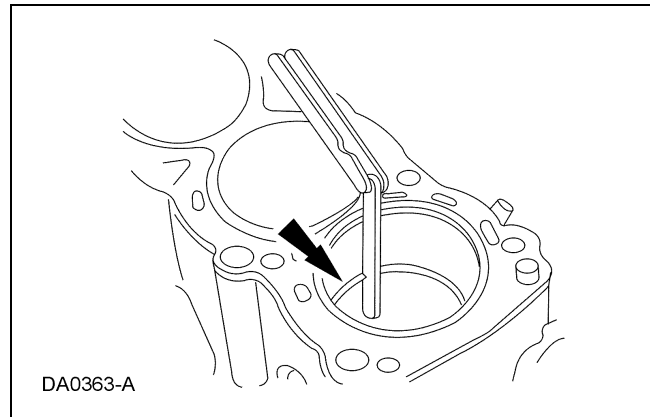
NOTE: Refer to the appropriate Section 303-01 for the specification.

NOTE: The cylinder bore must be within specification for taper and out-of-round.

1. Use a piston without rings to push a piston ring in a cylinder to the bottom of ring travel.



2. Use a feeler gauge to measure the top piston ring end gap and the second piston ring end gap.

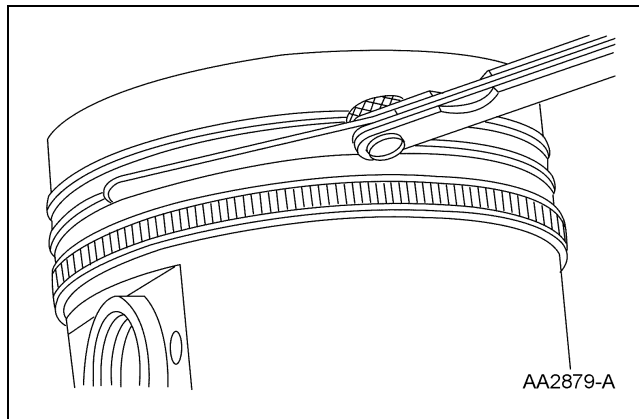
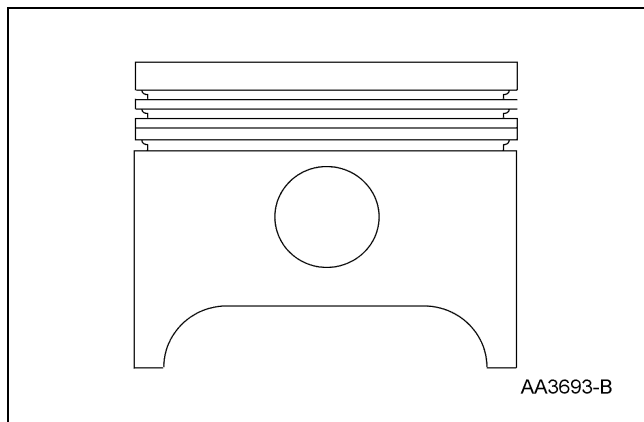


GENERAL PROCEDURES

Piston Ring-to-Groove Clearance

NOTE: Refer to the appropriate Section 303-01 for the specification.

1. Inspect the piston for ring land damage or accelerated wear.



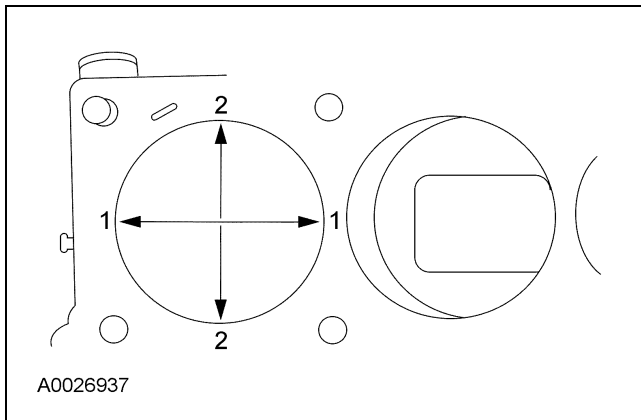
2. Measure the piston ring-to-groove clearance.
-

GENERAL PROCEDURES

Piston Selection

NOTE: The cylinder bore must be within the specifications for taper and out-of-round before fitting a piston.

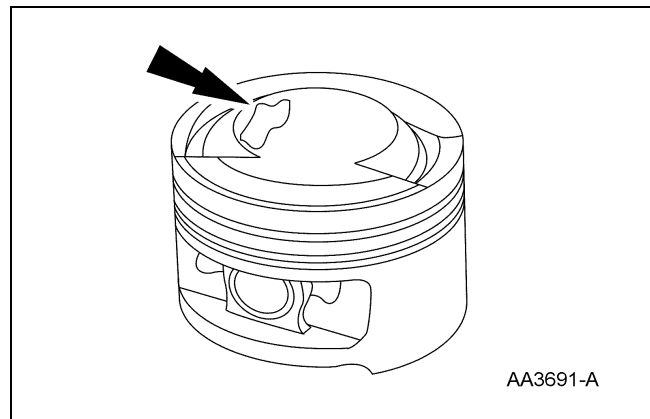
1. Select a piston size based on the cylinder bore.



2. **NOTE:** For precision fit, new pistons are divided into 3 categories within each size range based on their relative position within the range. A paint spot or specific size grade on a new piston indicates the position within the size range.

Choose the piston with the correct paint color or specific size grade.

- Refer to the appropriate section in Group 303 for the procedure.



GENERAL PROCEDURES

Piston To Cylinder Bore Clearance


NOTE: Refer to the appropriate Section 303-01 for the specification.

1. Subtract the piston diameter from the cylinder bore diameter to find the piston-to-cylinder bore clearance.
-

GENERAL PROCEDURES

Powertrain/Drivetrain Mount Neutralizing

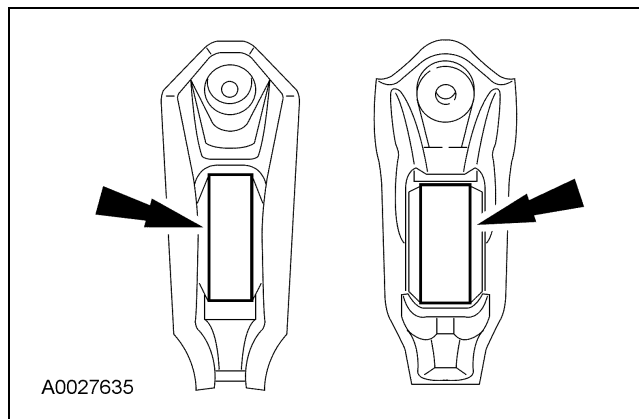
NOTE: Refer to the appropriate section and procedure for special instructions on loosening and tightening mount fasteners.

1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
 2. Loosen, but do not remove, the powertrain/drivetrain mount fasteners.
 3. Lower the vehicle.
 4.  **CAUTION:** Do not twist or strain the powertrain/drivetrain mounts or damage to the mounts may occur.
Move the vehicle in forward and reverse 0.6-1.2 m (2-4 ft).
 5. Raise and support the vehicle.
 6. Tighten the powertrain/drivetrain mount fasteners.
 7. Lower the vehicle.
 8. Test the system for normal operation.
-

GENERAL PROCEDURES

Roller Follower Inspection

1. Inspect the roller follower for flat spots or scoring. If any damage is found, inspect the camshaft lobes and hydraulic lash adjuster for damage.



2008 Ford F-350 SUPER DUTY

Submodel: XLT | Engine Type: V8 | Liters: 5.4
Fuel Delivery: FI | Fuel: GAS

SECTION 303-00:
Engine System — General Information

SPECIFICATIONS
DESCRIPTION AND OPERATION
Engine
DIAGNOSIS AND TESTING
Engine
Inspection and Verification — Engine Performance
Inspection and Verification — Noise, Vibration and Harshness (NVH)
Symptom Chart — Engine Performance
Symptom Chart — Noise, Vibration and Harshness (NVH)
Component Tests
Engine Oil Leaks
Compression Test — Compression Gauge Check
Cylinder Leakage Detection
Excessive Engine Oil Consumption
Intake Manifold Vacuum Test
Oil Pressure Test
Valve Train Analysis
GENERAL PROCEDURES
Sprockets
Camshaft Bearing Journal Diameter
Camshaft Journal to Bearing Clearance — OHC Engines
Camshaft End Play — OHC Engines
Camshaft Surface Inspection
Camshaft Lobe Lift
Camshaft Runout
Crankshaft Main Bearing Journal Diameter
Crankshaft Main Bearing Journal Taper and Out-of-Round
Crankshaft Main Bearing Journal-to-Bearing Clearance
Crankshaft End Play
Crankshaft Runout
Cylinder Bore Taper
Cylinder Bore Out-of-Round
Piston Inspection
Piston Pin Bore Diameter
Piston Diameter
Piston To Cylinder Bore Clearance
Piston Selection
Piston Ring End Gap
Piston Ring-to-Groove Clearance
Piston Pin Diameter
Connecting Rod Cleaning
Connecting Rod Large End Bore
Connecting Rod Bushing Diameter
Connecting Rod Bend
Connecting Rod Twist
Connecting Rod to Crankshaft Side Clearance
Connecting Rod-to-Piston Clearance
Connecting Rod Bearing Journal-to-Bearing Clearance
Connecting Rod Bearing Journal Taper and Out-of-Round
Roller Follower Inspection
Hydraulic Lash Adjuster Inspection
Valve Stem Diameter
Valve Stem to Valve Guide Clearance
Valve Inspection
Valve Guide Inner Diameter
Valve Spring Installed Length

Valve Spring Free Length
Valve Spring Squareness
Valve Spring Strength
Valve Seat Inspection
Valve Seat Width
Valve Seat Runout
Flexplate Inspection
Flywheel Inspection
Cylinder Head Distortion
Cylinder Block Distortion
Cylinder Bore Cleaning
Cylinder Block Core Plug Replacement
Spark Plug Inspection
Exhaust Manifold Cleaning and Inspection
Bearing Inspection
Powertrain/Drivetrain Mount Neutralizing

2008 Ford F-350 SUPER DUTY

Submodel: XLT | Engine Type: V8 | Liters: 5.4
Fuel Delivery: FI | Fuel: GAS

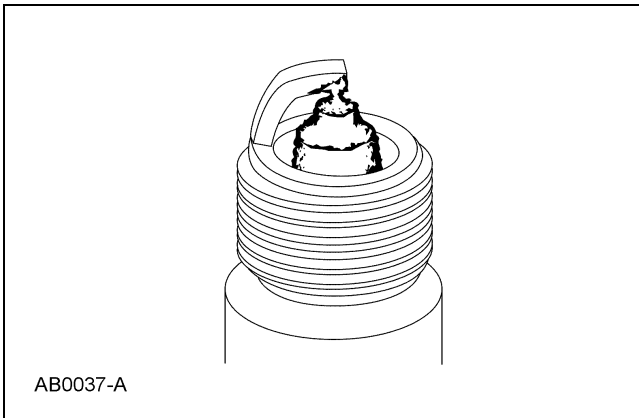
SECTION 303-01A:
Engine — 5.4L (3V)

SPECIFICATIONS
DESCRIPTION AND OPERATION
Engine
DIAGNOSIS AND TESTING
Engine
IN-VEHICLE REPAIR
Intake Manifold
Valve Cover — RH
Valve Cover — LH
Crankshaft Pulley
Crankshaft Front Seal
Engine Front Cover
Timing Drive Components
Valve Train Components — Exploded View
Camshaft — LH
Camshaft — RH
Camshaft Phaser and Sprocket
Camshaft Roller Follower
Valve Springs
Valve Seals
Hydraulic Lash Adjuster
Exhaust Manifold — LH
Exhaust Manifold — RH
Engine Lubrication Components — Exploded View
Oil Pan
Oil Pump
Oil Pump Screen and Pickup Tube
Oil Cooler
Oil Filter Adapter
Engine Oil Pressure (EOP) Switch
Oil Level Indicator and Tube
Flexplate or Flywheel and Crankshaft Rear Seal — Exploded View
Flexplate
Flywheel
Crankshaft Rear Seal
Crankshaft Rear Seal with Retainer Plate
Engine Support Insulators
REMOVAL
Engine
Cylinder Head
DISASSEMBLY
Engine
DISASSEMBLY AND ASSEMBLY OF SUBASSEMBLIES
Cylinder Head
Piston
Intake Manifold Assembly
ASSEMBLY
Engine
INSTALLATION
Engine
Cylinder Head

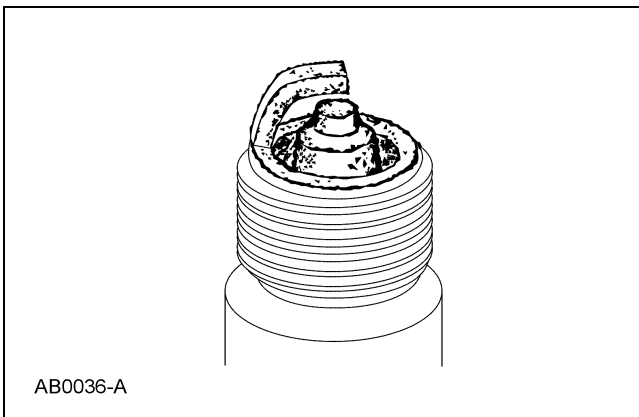
GENERAL PROCEDURES

Spark Plug Inspection

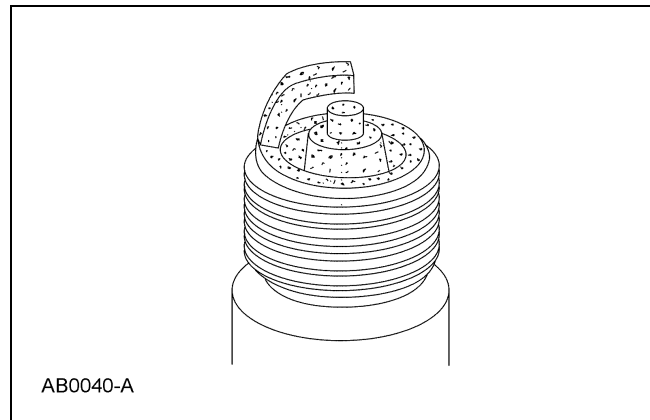
1. Inspect the spark plug for a bridged gap.
 - Check for deposit build-up closing the gap between the electrodes. Deposits are caused by oil or carbon fouling.
 - Clean the spark plug.



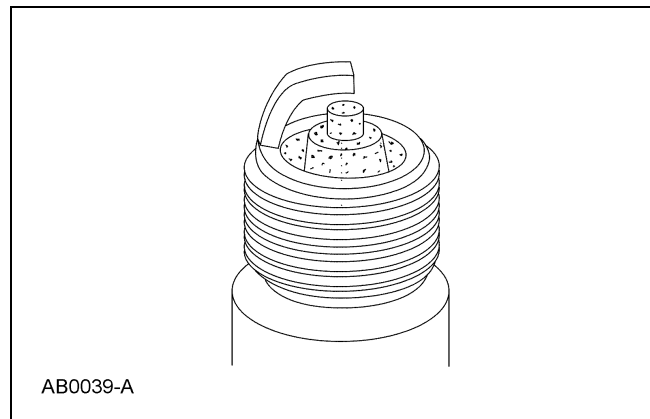
2. Check for oil fouling.
 - Check for wet, black deposits on the insulator shell bore electrodes, caused by excessive oil entering the combustion chamber through worn rings and pistons, excessive valve-to-guide clearance or worn or loose bearings.
 - Correct the oil leak concern.
 - Install a new spark plug.



3. Inspect for carbon fouling. Look for black, dry, fluffy carbon deposits on the insulator tips, exposed shell surfaces and electrodes, caused by a spark plug with an incorrect heat range, dirty air cleaner, too rich a fuel mixture or excessive idling.
 - Install new spark plugs.

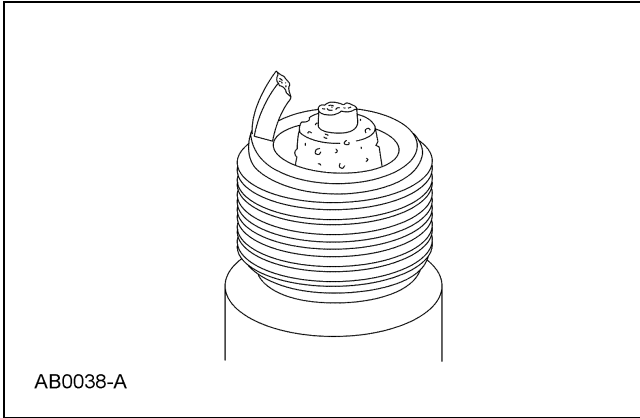


4. Inspect for normal burning.
 - Check for light tan or gray deposits on the firing tip.

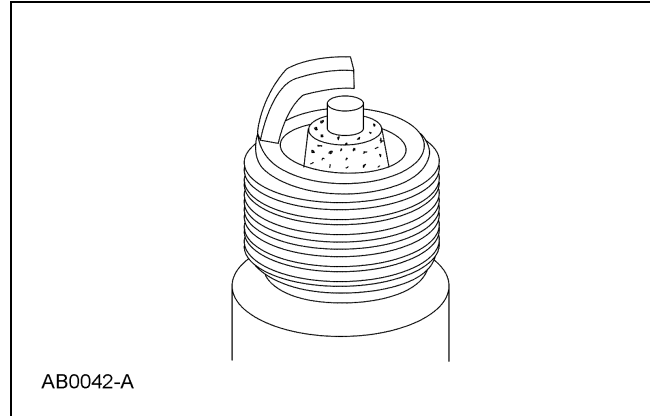


GENERAL PROCEDURES (Continued)

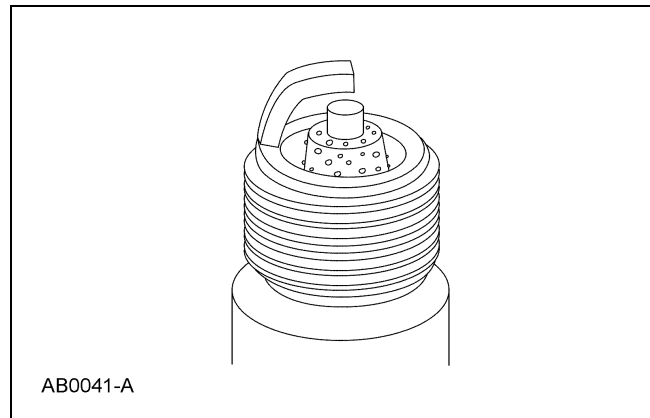
5. Inspect for pre-ignition, identified by melted electrodes and a possibly damaged insulator. Metallic deposits on the insulator indicate engine damage. This may be caused by incorrect ignition timing, wrong type of fuel or the unauthorized installation of a heli-coil insert in place of the spark plug threads.
- Install a new spark plug.



6. Inspect for overheating, identified by white or light gray spots and with a bluish-burnt appearance of electrodes. This is caused by engine overheating, wrong type of fuel, loose spark plugs, spark plugs with an incorrect heat range, low fuel pump pressure or incorrect ignition timing.
- Install a new spark plug.



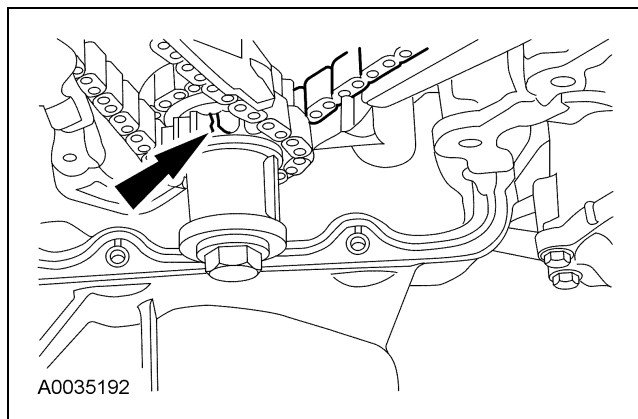
7. Inspect for fused deposits, identified by melted or spotty deposits resembling bubbles or blisters. These are caused by sudden acceleration.
- Install new spark plugs.



GENERAL PROCEDURES

Sprockets

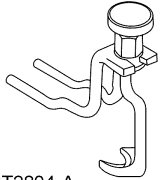
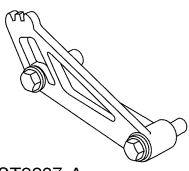
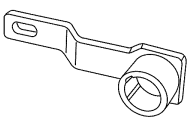
1. Inspect the sprockets for cracks and worn or chipped teeth.



IN-VEHICLE REPAIR

Timing Drive Components

Special Tool(s)

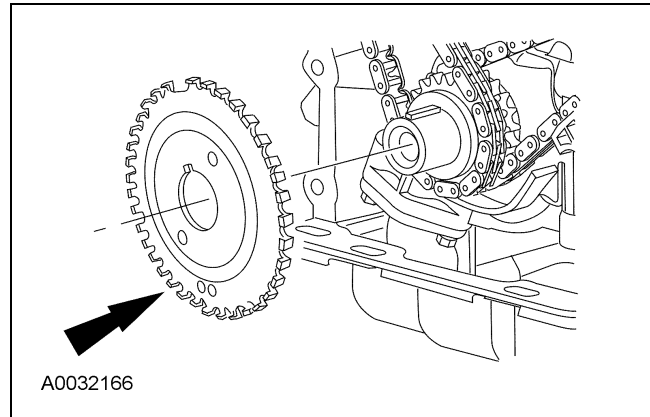
 <p>ST2804-A</p>	Compressor, Valve Spring 303-1039
 <p>ST2807-A</p>	Locking Tool, Camshaft Phaser Sprocket 303-1046
 <p>ST1335-A</p>	Holding Tool, Crankshaft 303-448 (T93P-6303-A)

Material

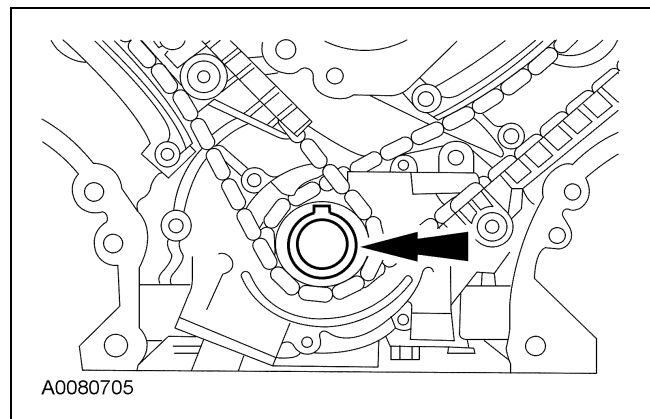
Item	Specification
Hydraulic Chain Tensioner Retaining Clip 1L3Z-6P250-AA	—
Motorcraft SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP (US); Motorcraft SAE 5W-20 Super Premium Motor Oil CXO-5W20-LSP12 (Canada); or equivalent	WSS-M2C930-A

Removal

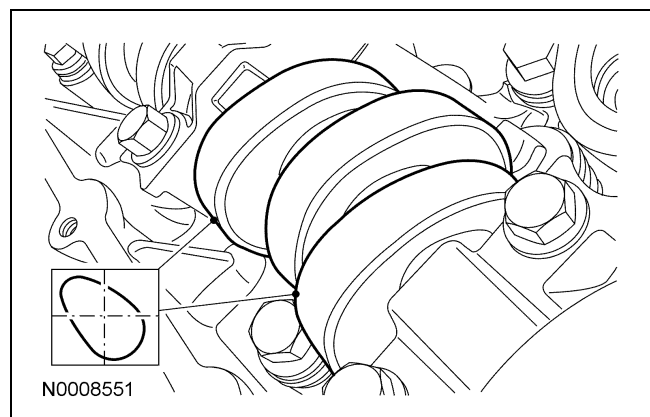
1. Remove the engine front cover. For additional information, refer to Engine Front Cover in this section.
2. Remove the crankshaft sensor ring from the crankshaft.




3. Position the crankshaft keyway at the 12 o'clock position.



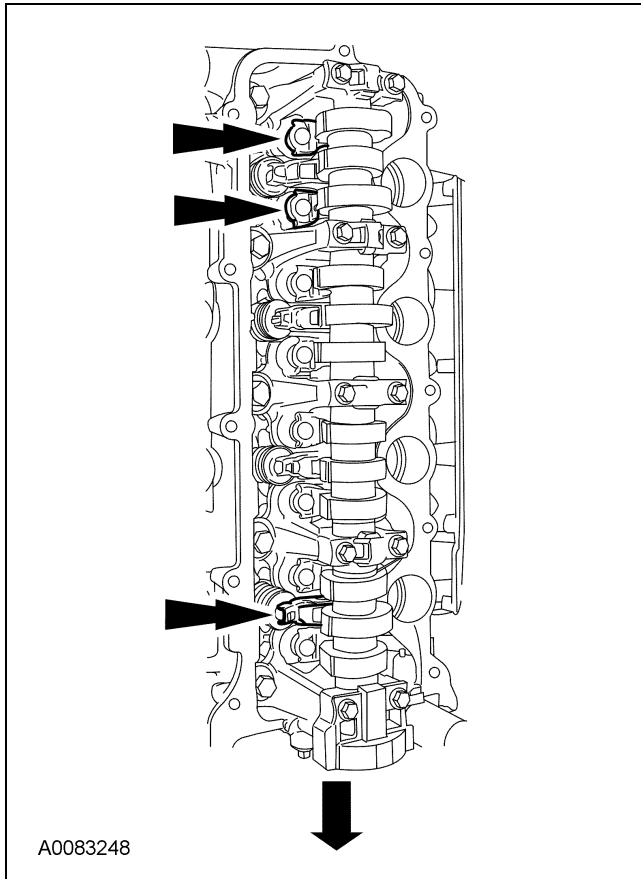
4. **NOTE:** If the camshaft lobes are not exactly positioned as shown, the crankshaft will require one full additional rotation to 12 o'clock.
The No. 1 cylinder camshaft exhaust lobe must be coming up on the exhaust stroke. Verify by noting the position of the 2 intake camshaft lobes and the exhaust lobe on the No. 1 cylinder.



IN-VEHICLE REPAIR (Continued)

5.  **CAUTION:** If the components are to be reinstalled, they must be installed in the same positions. Mark the components for installation into the original locations. Failure to follow these instructions may result in engine damage.

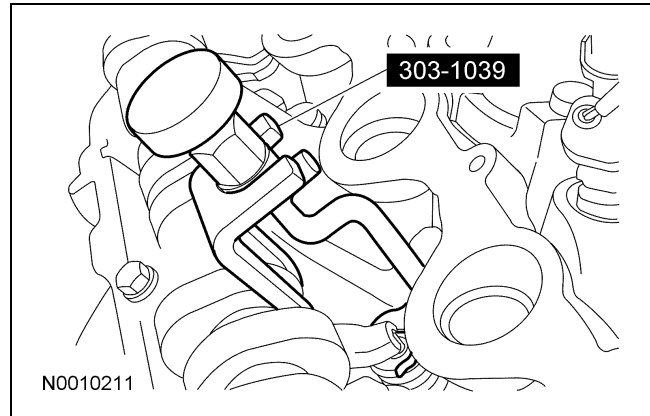
Remove only the 3 camshaft roller followers shown in the illustration from the RH cylinder head.




6. **NOTE:** Do not allow the valve keepers to fall off of the valve or the valve may drop into the cylinder. If a valve drops into the cylinder, the cylinder head must be removed. For additional information, refer to **Cylinder Head** in this section.

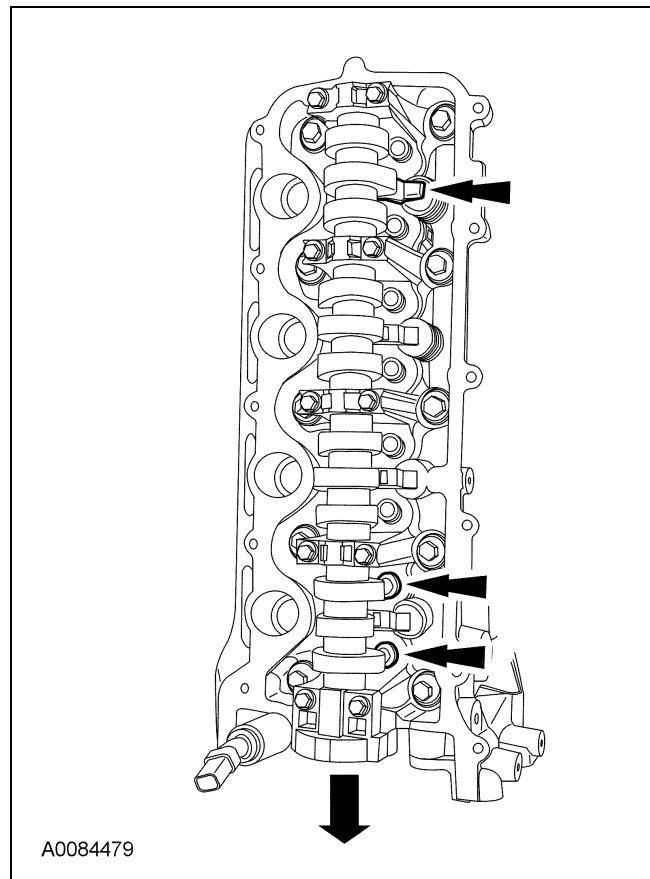
NOTE: It may be necessary to push the valve down while compressing the spring.

Using the special tool, remove the 3 designated camshaft roller followers in the previous step from the RH cylinder head.



7.  **CAUTION:** If the components are to be reinstalled, they must be installed in the same positions. Mark the components for installation into the original locations. Failure to follow these instructions may result in engine damage.

Remove only the 3 camshaft roller followers shown in the illustration from the LH cylinder head.

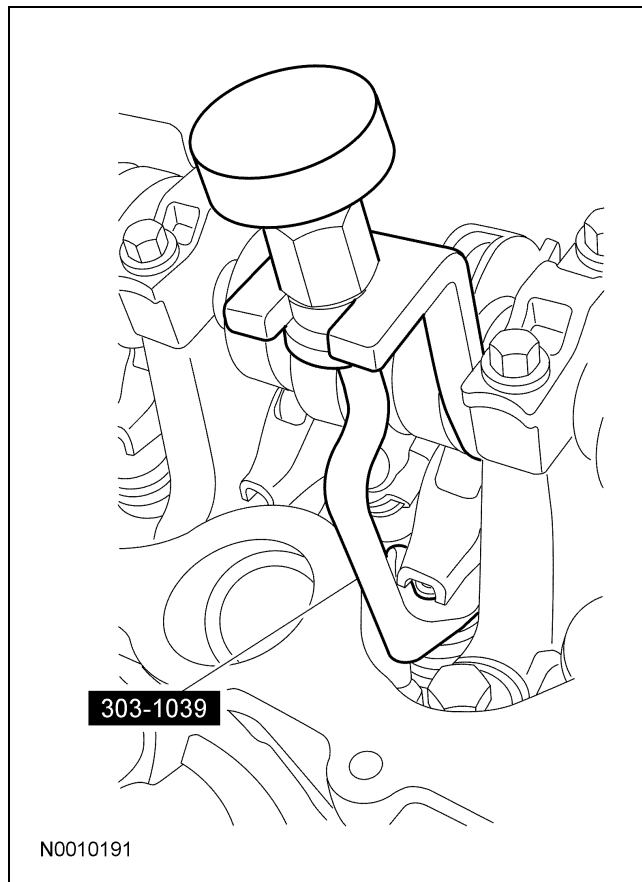
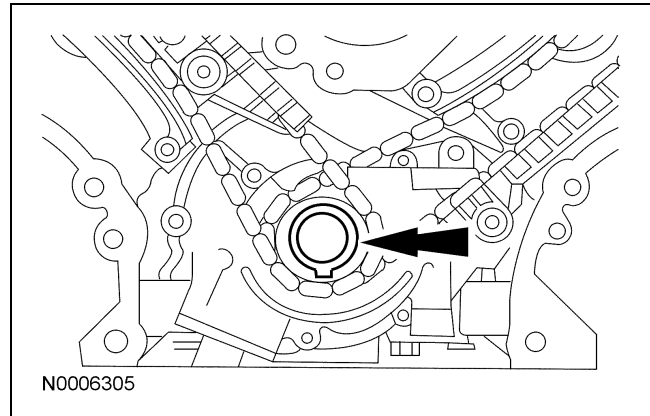


IN-VEHICLE REPAIR (Continued)

8. **NOTE:** Do not allow the valve keepers to fall off of the valve or the valve may drop into the cylinder. If a valve drops into the cylinder, the cylinder head must be removed. For additional information, refer to **Cylinder Head** in this section.

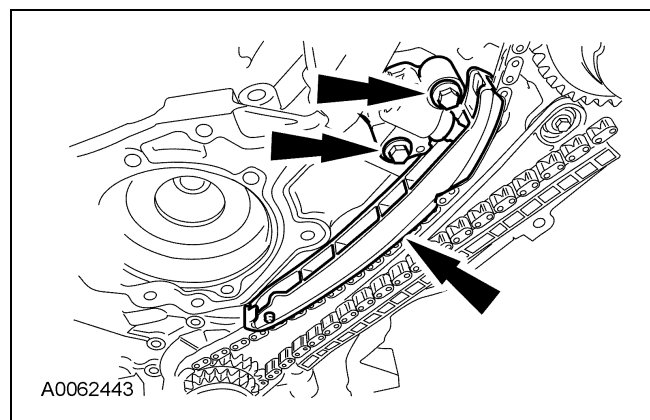
NOTE: It may be necessary to push the valve down while compressing the spring.

Using the special tool, remove the 3 designated camshaft roller followers in the previous step from the LH cylinder head.



10. **⚠ CAUTION:** If one or both of the tensioner mounting bolts are loosened or removed, the tensioner-sealing bead must be inspected for seal integrity. If cracks, tears, separation from the tensioner body or permanent compression of the seal bead is observed. Install a new tensioner or engine damage may occur.


Remove the bolts, the LH timing chain tensioner and tensioner arm.



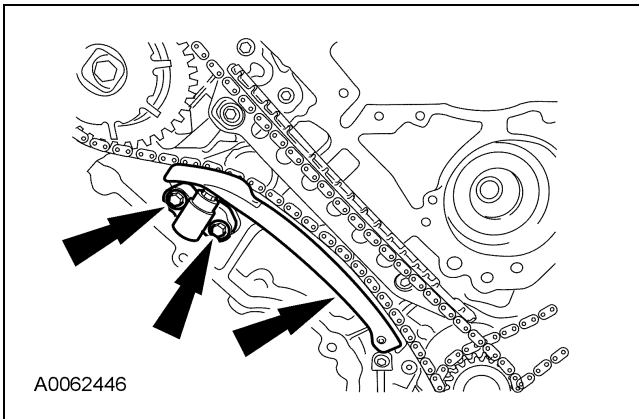
9. **⚠ CAUTION:** The crankshaft cannot be moved past the 6 o'clock position once set or engine damage may occur.

Rotate the crankshaft clockwise and position the crankshaft keyway at the 6 o'clock position.

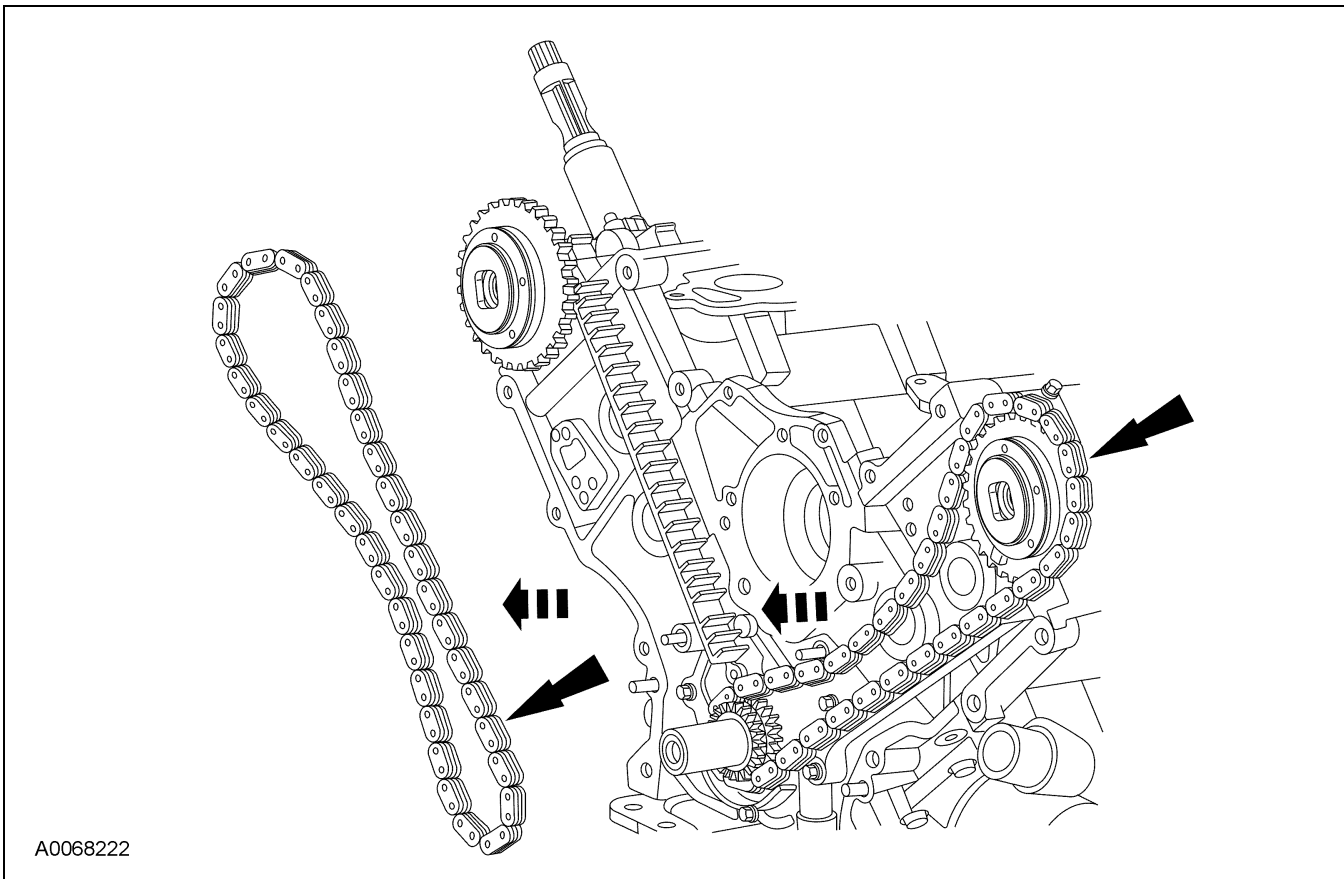
IN-VEHICLE REPAIR (Continued)

11.  **CAUTION:** If one or both of the tensioner mounting bolts are loosened or removed, the tensioner-sealing bead must be inspected for seal integrity. If cracks, tears, separation from the tensioner body or permanent compression of the seal bead is observed. Install a new tensioner or engine damage may occur.

Remove the bolts, the RH timing chain tensioner and tensioner arm.



12. Remove the RH and LH timing chains and the crankshaft sprocket.
- Remove the RH timing chain from the camshaft sprocket.
 - Remove the RH timing chain from the crankshaft sprocket.
 - Remove the LH timing chain from the camshaft sprocket.
 - Remove the LH timing chain and crankshaft sprocket.

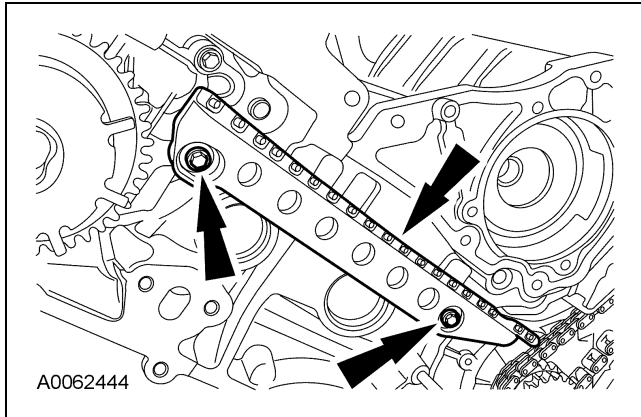


IN-VEHICLE REPAIR (Continued)

13. **NOTE:** RH shown, LH similar.

Remove the LH and RH timing chain guides.

- Remove the bolts.
- Remove both timing chain guides.

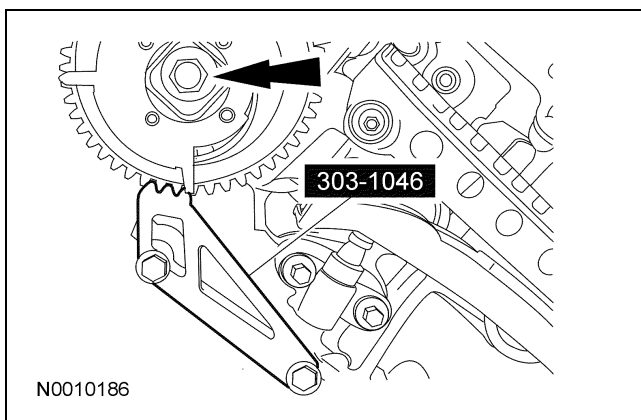


14. **⚠ CAUTION:** Damage to the variable camshaft timing (VCT) phaser sprocket assembly will occur if mishandled or used as a lifting or leveraging device.

⚠ CAUTION: Only use hand tools to remove the variable camshaft timing (VCT) phaser sprocket assembly or damage may occur to the camshaft or VCT phaser sprocket.

Using the special tool, remove the bolt and the RH variable camshaft timing (VCT) phaser sprocket assembly.

- Discard the VCT phaser sprocket bolt.

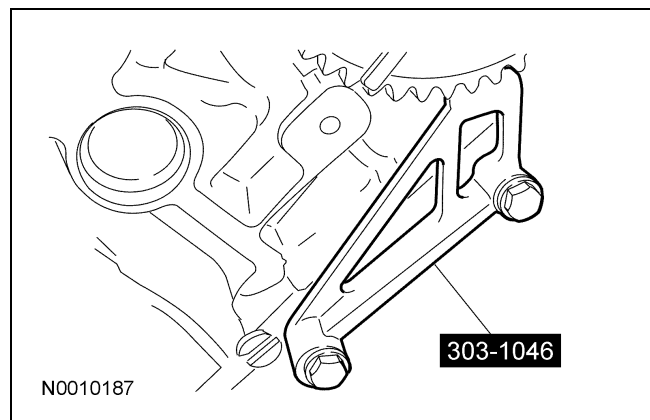


15. **⚠ CAUTION:** Damage to the variable camshaft timing (VCT) phaser sprocket assembly will occur if mishandled or used as a lifting or leveraging device.

⚠ CAUTION: Only use hand tools to remove the variable camshaft timing (VCT) phaser sprocket assembly or damage may occur to the camshaft or VCT phaser sprocket.

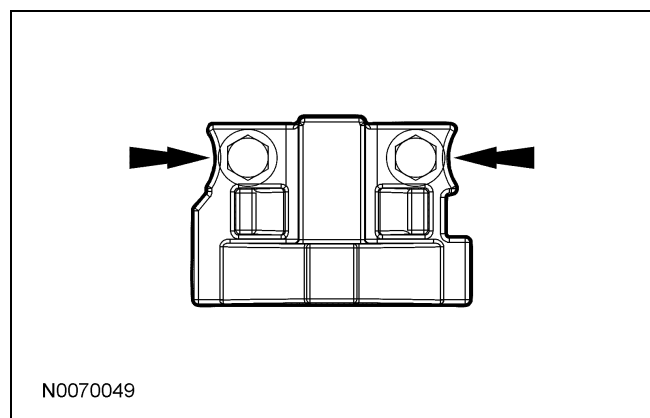
Using the special tool, remove the bolt and the LH VCT phaser sprocket assembly.

- Discard the VCT phaser sprocket bolt.




16. **⚠ CAUTION:** Remove the front thrust camshaft bearing cap straight upward from the bearing towers or the bearing cap may be damaged from sideloading.

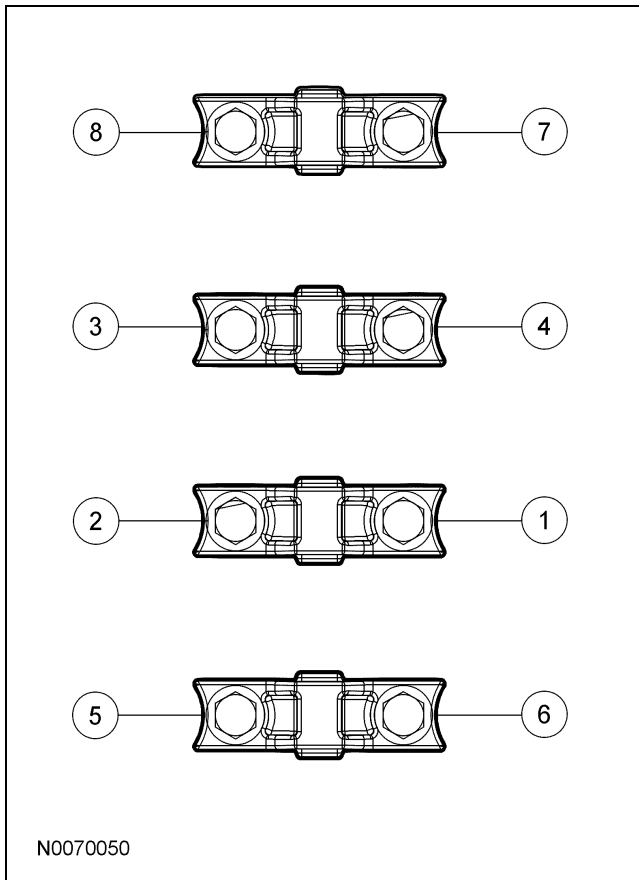
Remove the 2 bolts and the RH cylinder head camshaft front bearing cap.



IN-VEHICLE REPAIR (Continued)

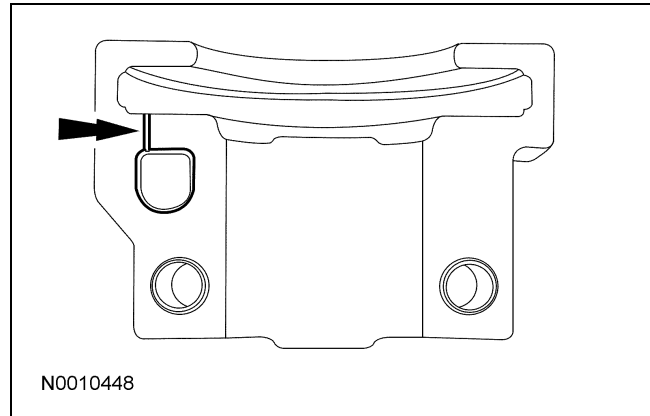
17.  **CAUTION:** The camshaft bearing caps must be installed in their original locations. Record camshaft bearing cap locations. Failure to follow these instructions may result in engine damage.

Remove the remaining bolts in the sequence shown and remove the RH cylinder head camshaft bearing caps.




18. Clean and inspect the RH camshaft bearing caps.

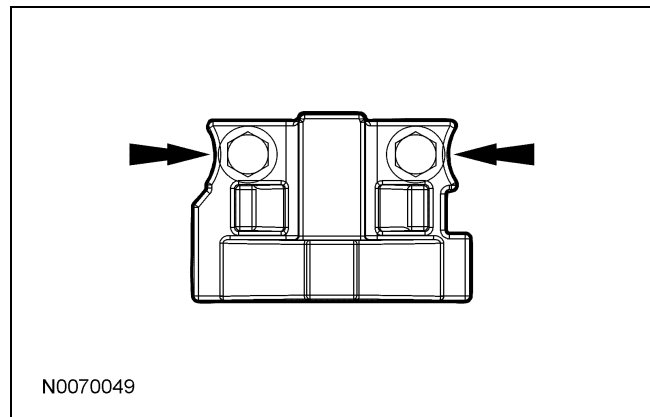
- The camshaft front thrust bearing cap contains an oil metering groove. Make sure the groove is free of foreign material.




19. Remove the RH camshaft.

20.  **CAUTION:** Remove the front thrust camshaft bearing cap straight upward from the bearing towers or the bearing cap may be damaged from sideloading.

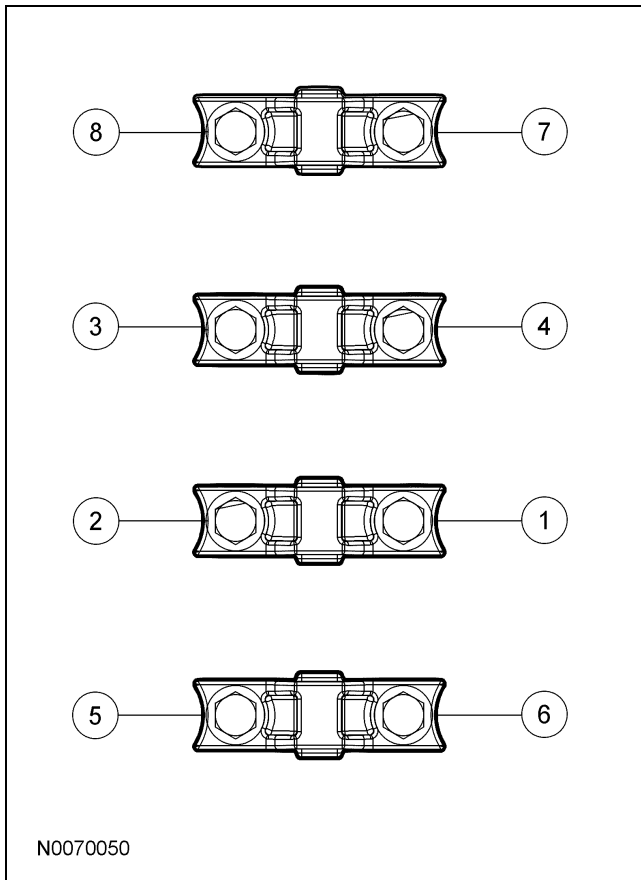
Remove the 2 bolts and the RH cylinder camshaft front bearing cap.



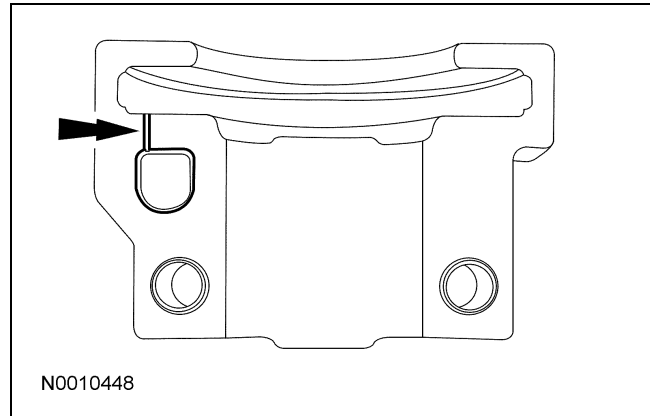
IN-VEHICLE REPAIR (Continued)

21.  **CAUTION:** The camshaft bearing caps must be installed in their original locations. Record camshaft bearing cap locations. Failure to follow these instructions may result in engine damage.


Remove the remaining bolts in the sequence shown and remove the LH cylinder head camshaft bearing caps.



22. Clean and inspect the LH camshaft bearing caps.
- The camshaft front thrust bearing cap contains an oil metering groove. Make sure the groove is free of foreign material.



23. Remove the LH camshaft.

24.  **CAUTION:** If the components are to be reinstalled, they must be installed in the same positions. Mark the components for installation into their original locations. Failure to follow these instructions may result in engine damage.

Remove all of the remaining camshaft roller followers from the cylinder heads.

Installation

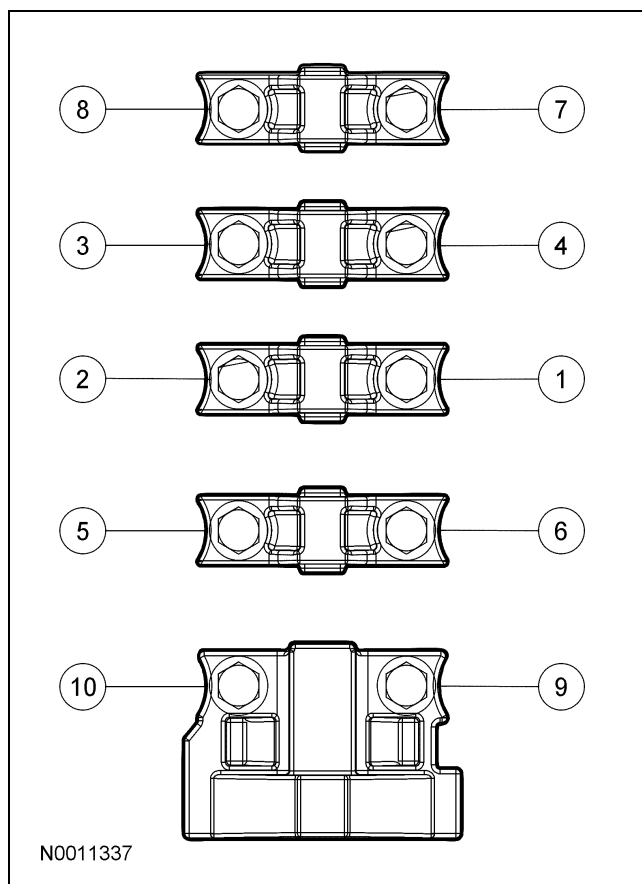
- Install the LH and RH camshafts.
 - Lubricate the camshaft and camshaft journals with clean engine oil prior to installation.

IN-VEHICLE REPAIR (Continued)

2. **NOTE:** LH shown, RH similar.

Install the LH and RH camshaft bearing caps in their original locations.

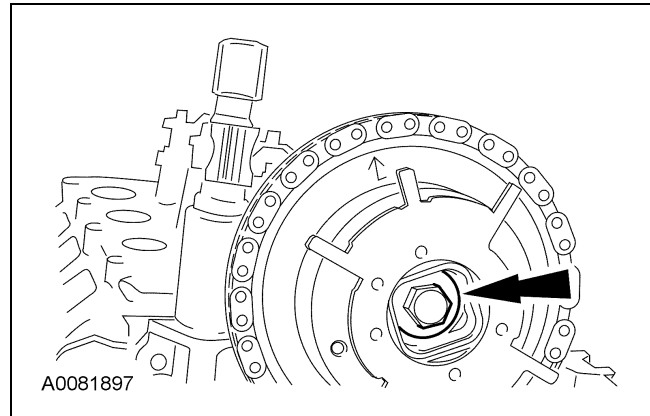
- Lubricate the camshaft bearing caps with clean engine oil.
- Position the front camshaft bearing cap.
- Position the remaining camshaft bearing caps.
- Install the bolts loosely.
- Tighten to 10 Nm (89 lb-in) in the sequence shown.



3. **⚠ CAUTION:** Damage to the variable camshaft timing (VCT) phaser sprocket assembly will occur if mishandled or used as a lifting or leveraging device.

NOTE: LH shown, RH similar.

Install the VCT phaser sprockets and new VCT phaser sprocket bolts finger tight.



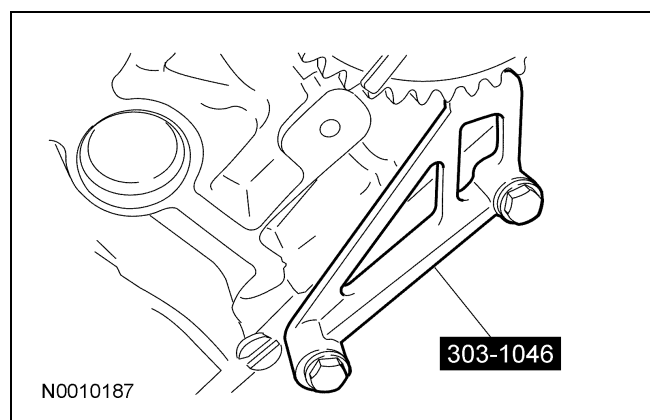
4. **⚠ CAUTION:** Damage to the variable camshaft timing (VCT) phaser sprocket assembly will occur if mishandled or used as a lifting or leveraging device.

⚠ CAUTION: Only use hand tools to remove the variable camshaft timing (VCT) phaser sprocket assembly or damage may occur to the camshaft or VCT phaser sprocket.

NOTE: LH shown, RH similar.

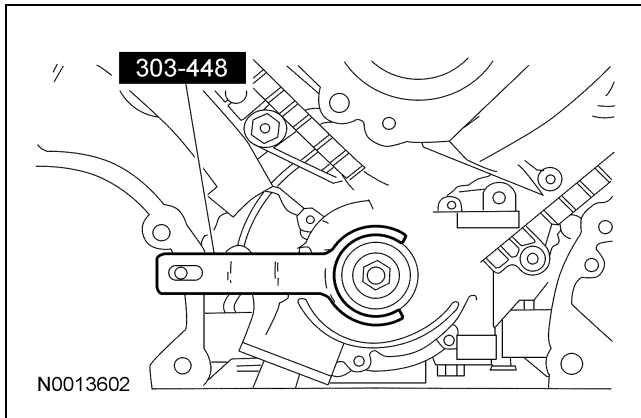
Using the special tool, tighten the LH and RH VCT phaser sprocket bolts in 2 stages.

- Stage 1: Tighten to 40 Nm (30 lb-ft).
- Stage 2: Tighten an additional 90 degrees.



IN-VEHICLE REPAIR (Continued)

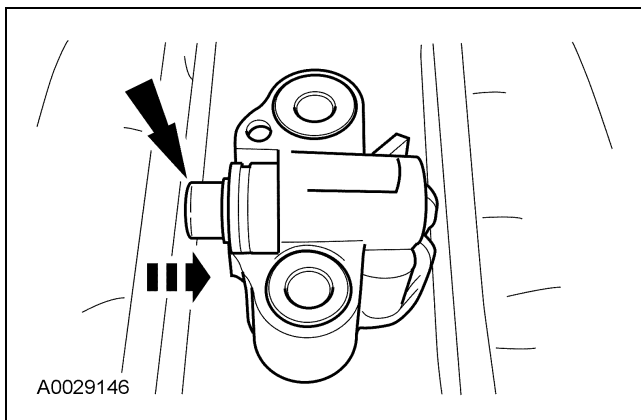
5. Position the crankshaft with the special tool, then remove the tool.



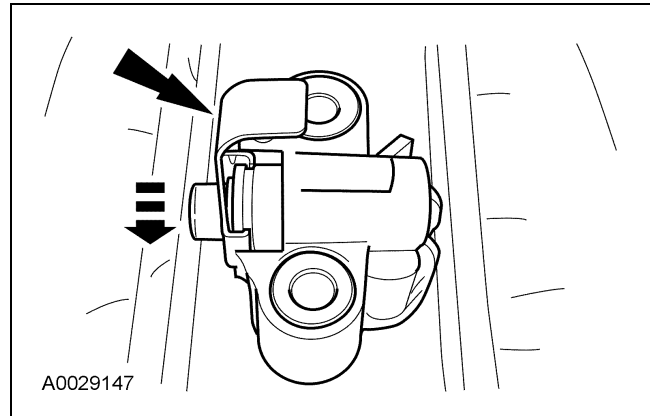
6. **⚠ CAUTION: Timing chain procedures must be followed exactly or damage to valves and pistons will result.**

⚠ CAUTION: Prior to installation, inspect the tensioner-sealing bead for seal integrity. If cracks, tears, separation from the tensioner body or permanent compression of the seal bead is observed. Install a new tensioner or engine damage may occur.

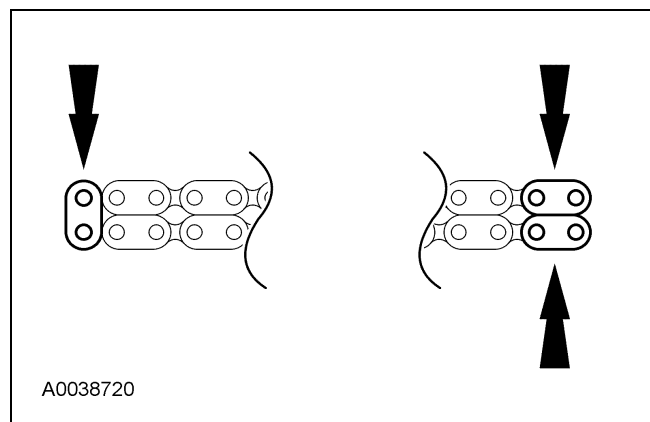
Compress the tensioner plunger, using a vise.



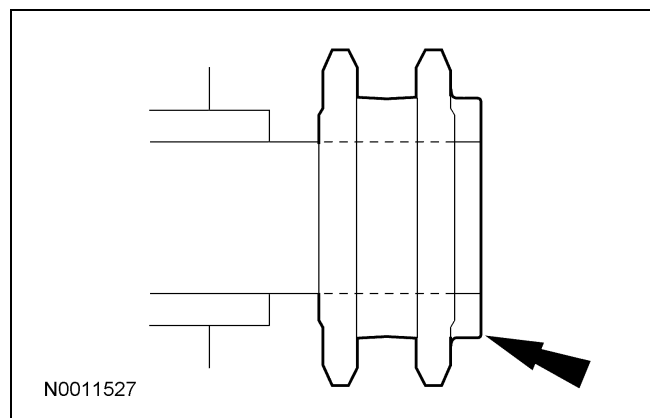
7. Install a retaining clip on the tensioner to hold the plunger in during installation.



8. Remove the tensioner from the vise.
9. If the copper links are not visible, mark 2 links on one end and 1 link on the other end, and use as timing marks.



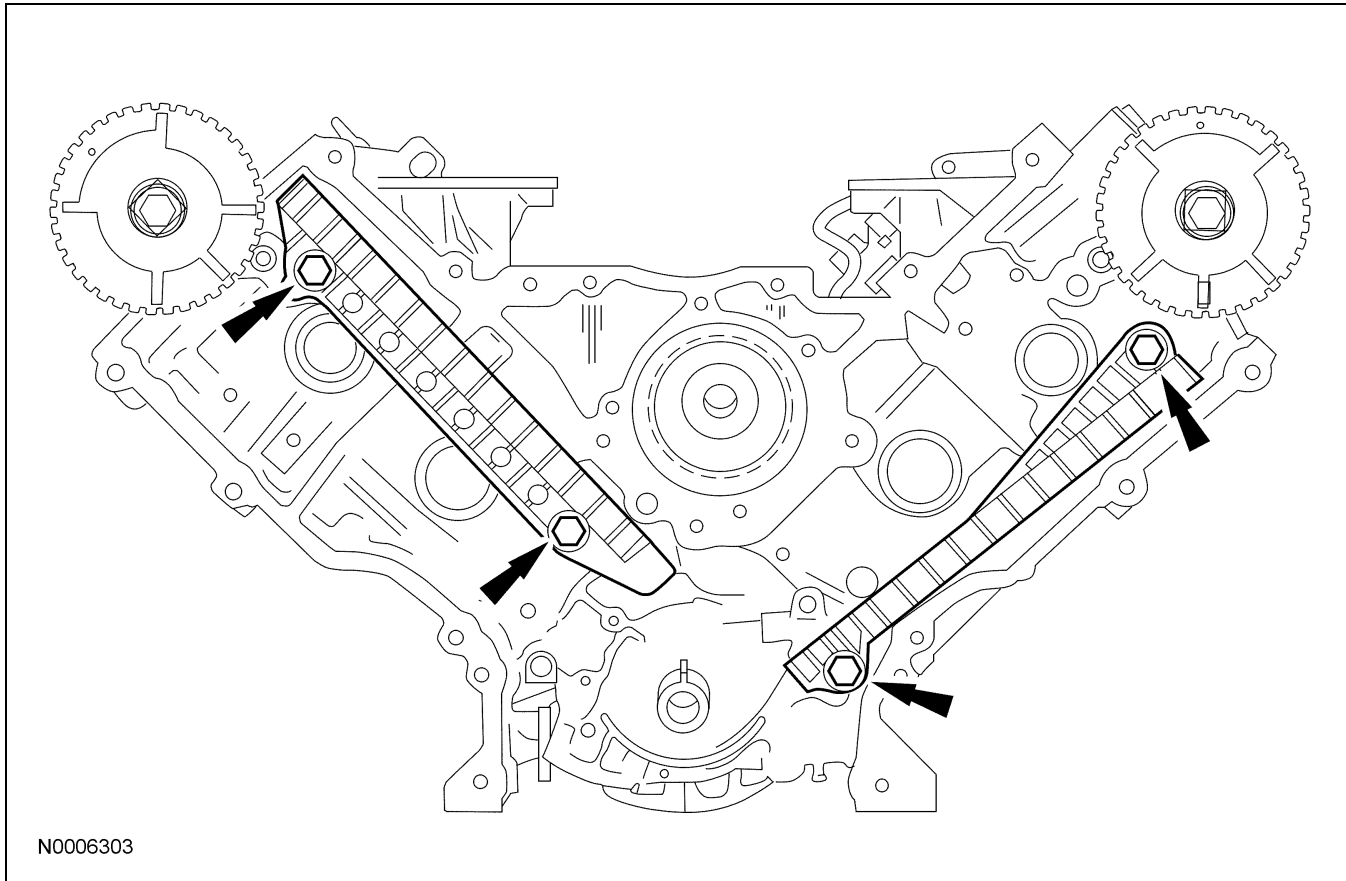
10. Install the crankshaft sprocket, making sure the flange faces forward.



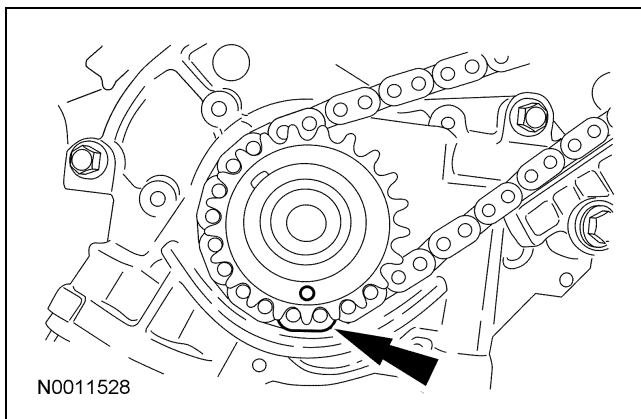
IN-VEHICLE REPAIR (Continued)

11. Install the 4 bolts and the LH and RH timing chain guides.

- Tighten to 10 Nm (89 lb-in).

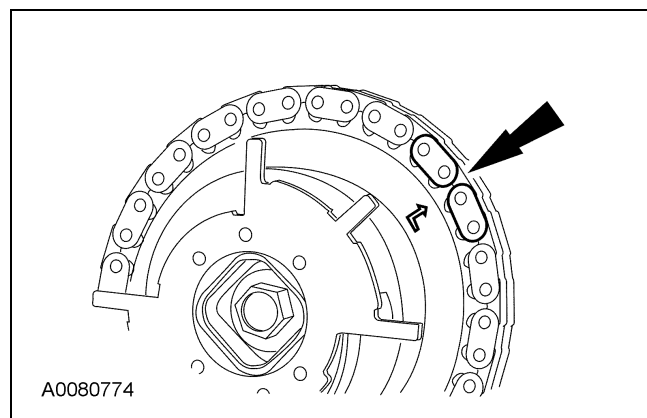


12. Position the lower end of the LH (inner) timing chain on the crankshaft sprocket, aligning the timing mark on the outer flange of the crankshaft sprocket with the single copper (marked) link on the chain.



13. **NOTE:** Make sure the upper half of the timing chain is below the tensioner arm dowel.

Position the timing chain on the VCT phaser sprocket with the timing mark positioned between the 2 copper (marked) chain links.

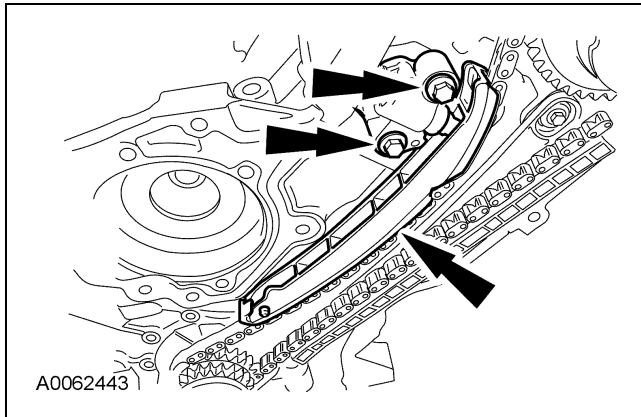


IN-VEHICLE REPAIR (Continued)

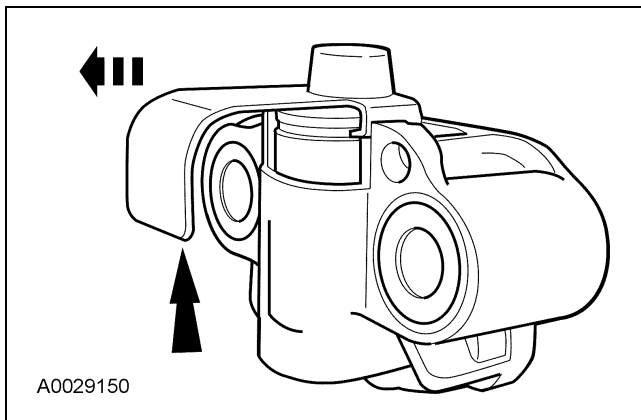
14. **NOTE:** The LH timing chain tensioner arm has a bump near the dowel hole for identification.

Position the LH timing chain tensioner arm on the dowel pin and install the LH timing chain tensioner and bolts.

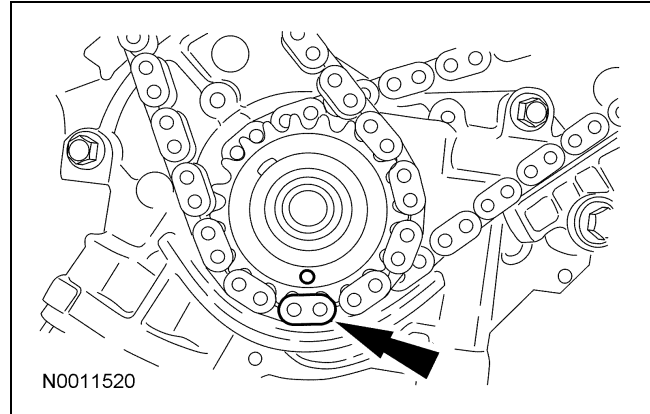
- Tighten to 25 Nm (18 lb-ft).



15. Remove the retaining clip from the LH timing chain tensioner.



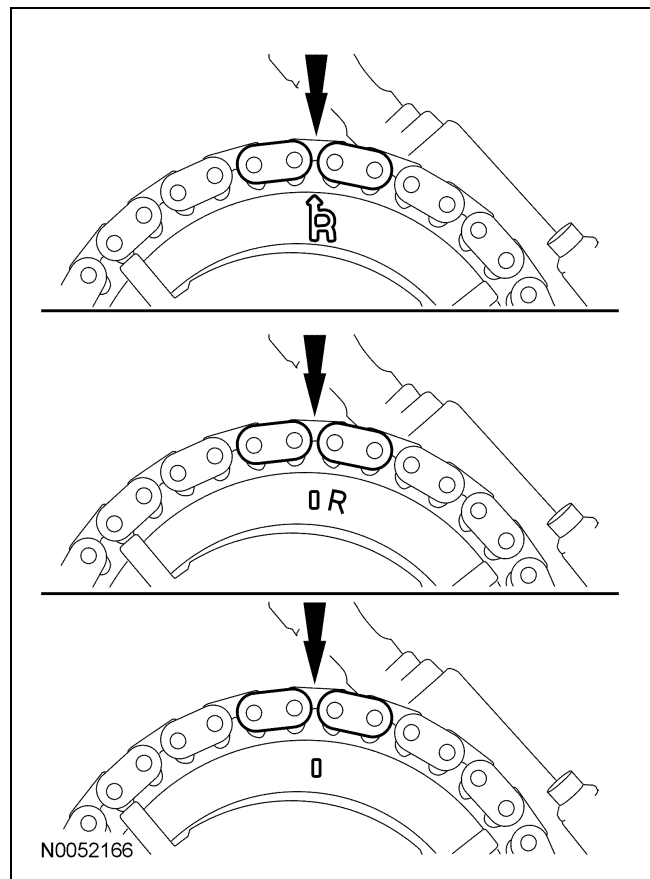
16. Position the lower end of the RH (outer) timing chain on the crankshaft sprocket, aligning the timing mark on the sprocket with the single copper (marked) chain link.



17. **NOTE:** The lower half of the timing chain must be positioned above the tensioner arm dowel.

NOTE: The camshaft phaser and sprocket will be stamped with one of the illustrated timing marks for the RH camshaft.

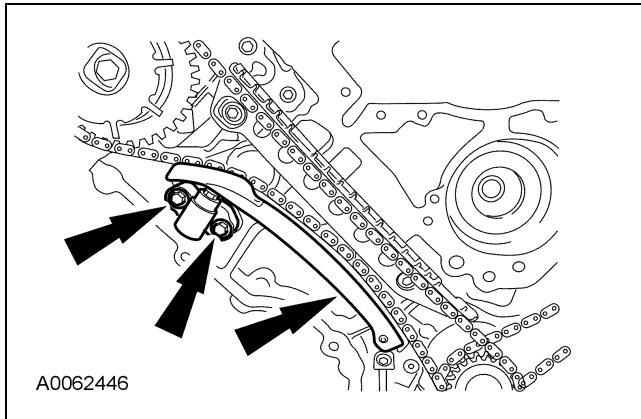
Position the RH timing chain on the VCT phaser sprocket. Make sure the timing mark is positioned between the 2 copper (marked) chain links.



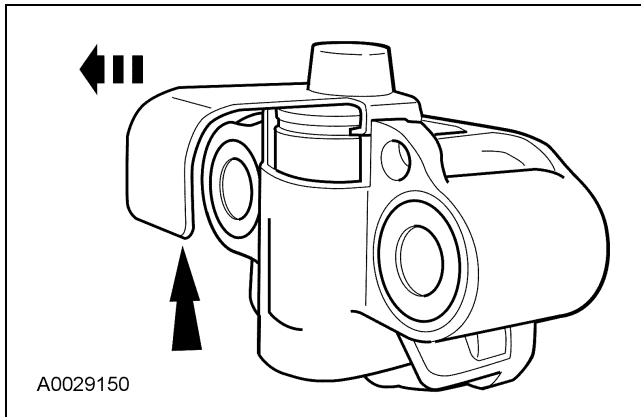
IN-VEHICLE REPAIR (Continued)

18. Position the RH timing chain tensioner arm on the dowel pin and install the RH timing chain tensioner and bolts.

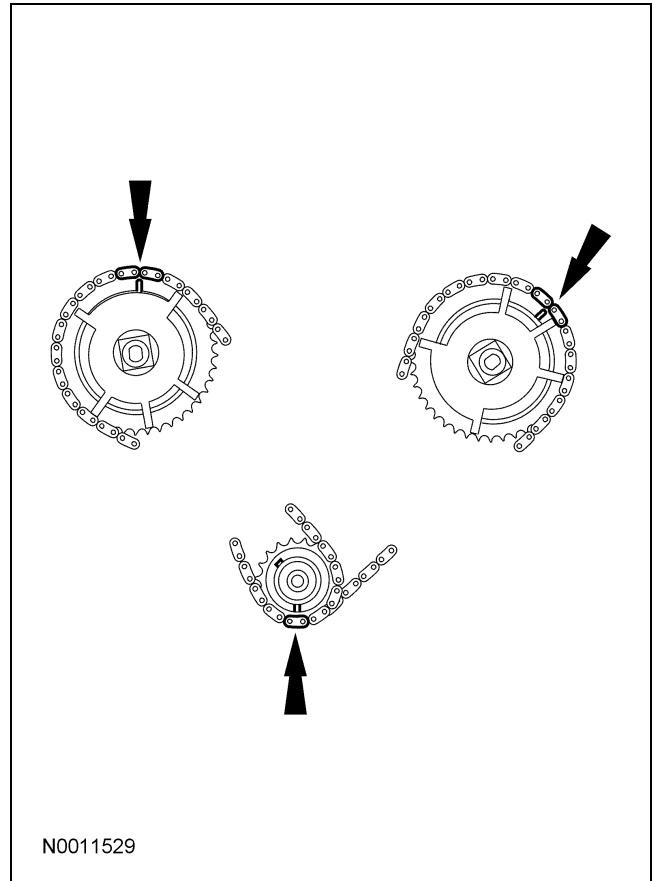
- Tighten to 25 Nm (18 lb-ft).



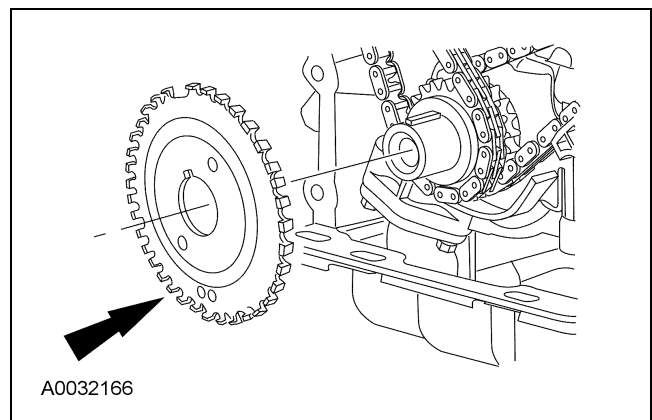
19. Remove the retaining clip from the RH timing chain tensioner.




20. As a post-check, verify correct alignment of all timing marks.



21. Install the crankshaft sensor ring on the crankshaft.



IN-VEHICLE REPAIR (Continued)

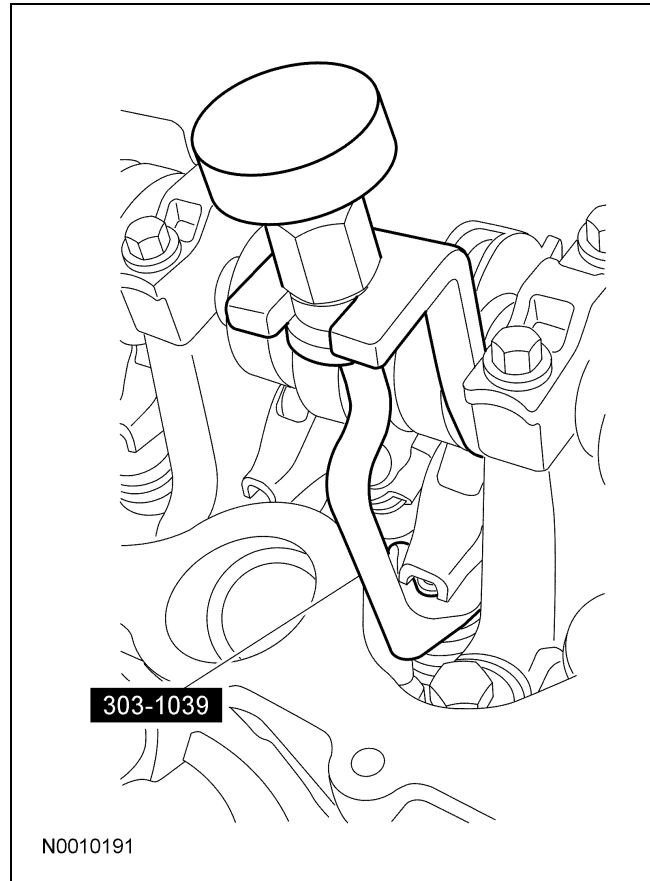
22.  **CAUTION:** If the components are to be reinstalled, they must be installed into their original locations. Failure to follow these instructions may result in engine damage.

NOTE: Do not allow the valve keepers to fall off of the valve or the valve may drop into the cylinder. If a valve drops into the cylinder, the cylinder head must be removed. For additional information, refer to Cylinder Head in this section.

NOTE: It may be necessary to push the valve down while compressing the spring.

Using the special tool, install all of the camshaft roller followers.

- Lubricate the camshaft roller followers with clean engine oil prior to installation.



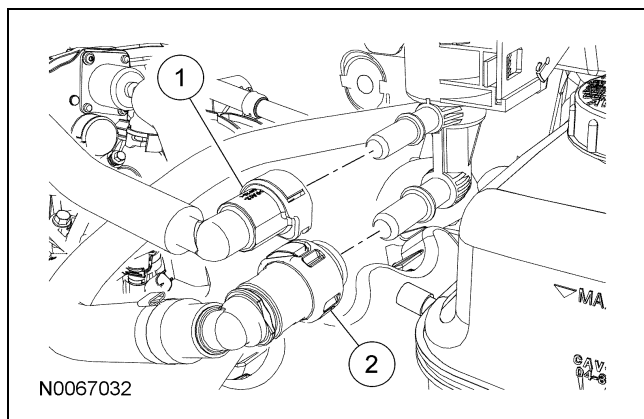
23. Install the engine front cover. For additional information, refer to Engine Front Cover in this section.

IN-VEHICLE REPAIR

Valve Cover — LH

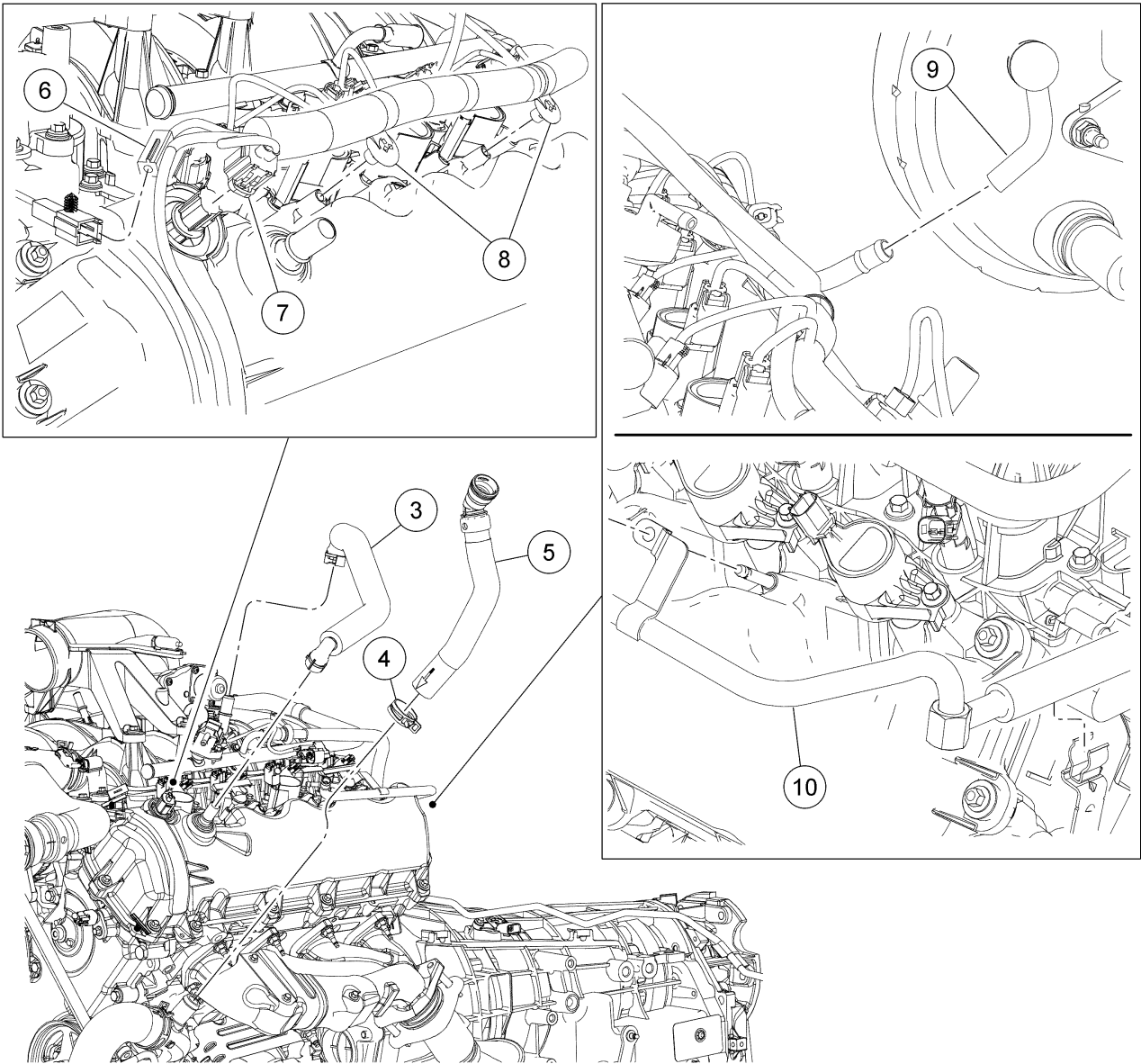
Material

Item	Specification
Motorcraft Metal Surface Prep ZC-31	—
Silicone Brake Caliper Grease and Dielectric Compound XG-3-A	ESE-M1C171-A
Silicone Gasket and Sealant TA-30	WSE-M4G323-A4
Silicone Gasket Remover ZC-30	—



Item	Part Number	Description
1	—	Evaporative emissions (EVAP) fuel vapor tube quick connect fitting
2	—	EVAP fuel vapor tube quick connect fitting

IN-VEHICLE REPAIR (Continued)



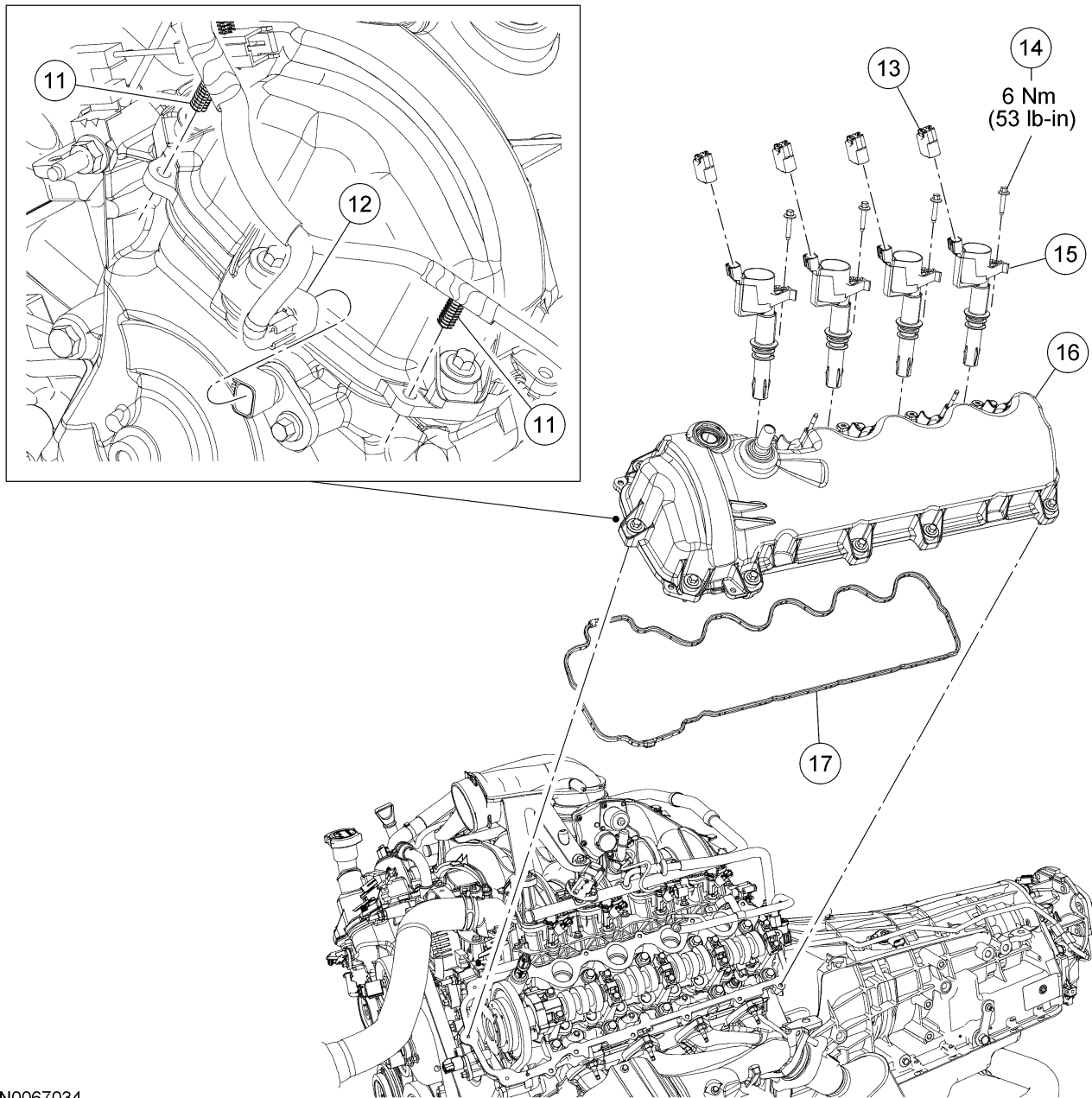
N0067033

Item	Part Number	Description
3	6K817	Positive crankcase ventilation (PCV) tube
4	—	Degas bottle coolant outlet hose clamp
5	—	Degas bottle coolant outlet hose
6	—	LH radio ignition interference capacitor electrical connector (part of 12B637)

(Continued)

Item	Part Number	Description
7	—	LH variable camshaft timing (VCT) solenoid electrical connector (part of 12B637)
8	—	Engine wiring harness retainers (part of 12B637)
9	—	Intake manifold vacuum tube-to-brake booster hose
10	9D446	Intake manifold vacuum tube

IN-VEHICLE REPAIR (Continued)



N0067034

Item	Part Number	Description
11	—	Engine wiring harness retainers (part of 12B637)
12	—	Camshaft position (CMP) sensor electrical connector (part of 12B637)
13	—	LH ignition coil electrical connector (4 required) (part of 12B637)
14	W706175	LH ignition coil bolt (4 required)
15	12A366	LH ignition coil (4 required)

(Continued)


Item	Part Number	Description
16	6A505	LH valve cover
17	6A559	LH valve cover gasket


Removal

1. Remove the air cleaner outlet pipe. For additional information, refer to Section 303-12.
2. Remove the degas bottle assembly. For additional information, refer to Section 303-03.

IN-VEHICLE REPAIR (Continued)

3. Remove the oil level indicator and tube. For additional information, refer to Oil Level Indicator and Tube in this section.
4. Disconnect the degas bottle coolant outlet hose.
5. Disconnect the 2 evaporative emissions (EVAP) system tube quick connect couplings and position the tubes aside. For additional information, refer to Section 310-00.
6. Disconnect the quick connect couplings and remove the PCV tube. For additional information, refer to Section 310-00.
7. Disconnect the 4 LH ignition coil electrical connectors.
8. Remove the 4 bolts and the 4 LH ignition coils.
 - Remove the ignition coil, using a twisting motion while pulling up on the ignition coil.
9. Disconnect the intake manifold vacuum tube hose from the brake booster.
10. Disconnect the radio ignition interference capacitor electrical connector.
11. Disconnect the variable camshaft timing (VCT) solenoid electrical connector and the wiring harness retainers.
12. Disconnect the intake manifold vacuum tube from the support bracket and the valve cover stud.

13.  **CAUTION:** Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the sealing surfaces. These tools cause scratches and gouges which make leak paths. Use a plastic scraping tool to remove all traces of old sealant. Failure to follow this procedure may cause future oil leakage.

 **CAUTION:** When removing the valve cover, make sure to avoid damaging the variable camshaft timing (VCT) solenoid.

NOTE: The fasteners are part of the valve cover and should not be removed.

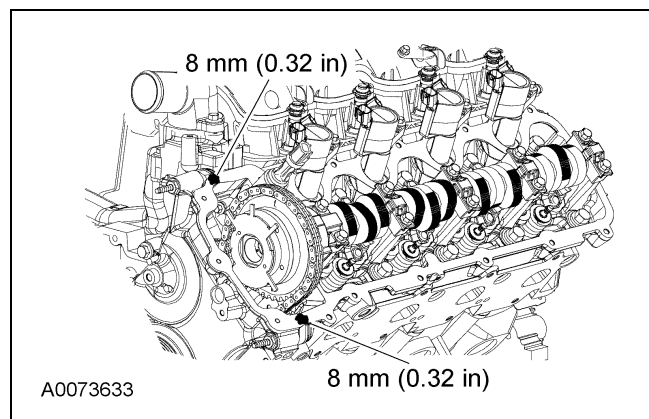
Fully loosen the 15 fasteners and remove the LH valve cover and gasket.

- Clean the valve cover mating surface of the cylinder head with Silicone Gasket Remover and Motorcraft Metal Surface Prep. Follow the directions on the packaging.
- Discard the valve cover gasket. Clean the valve cover gasket groove with soap and water or a suitable solvent.

Installation

1. **NOTE:** If the valve cover is not secured within 4 minutes, the sealant must be removed and the sealing area cleaned with Silicone Gasket Remover and Motorcraft Metal Surface Prep. Follow the directions on the packaging. Allow to dry until there is no sign of wetness, or 4 minutes, whichever is longer. Failure to follow this procedure may cause future oil leakage.

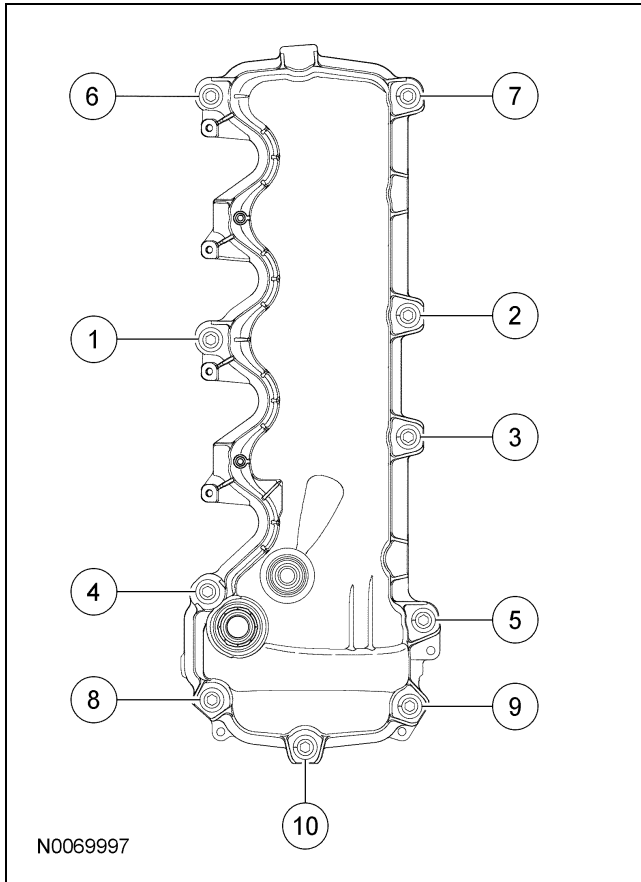
Apply a bead of Silicone Gasket and Sealant in 2 places where the engine front cover meets the cylinder head.



IN-VEHICLE REPAIR (Continued)

2. Position the LH valve cover and a new gasket on the cylinder head and tighten the bolts in the sequence shown.

- Tighten to 10 Nm (89 lb-in).



3. Position the intake manifold vacuum tube assembly onto the support bracket and the valve cover stud.
4. Connect the VCT solenoid electrical connector and the wiring harness retainers.

5. Connect the radio ignition interference capacitor electrical connector.

6. Connect the intake manifold vacuum tube hose to the brake booster.

7. **NOTE:** Verify that the ignition coil spring is correctly located inside the ignition coil boot and that there is no damage to the tip of the boot.

Install the 4 LH ignition coils and the 4 bolts.

- Apply a light coat of dielectric compound to the inside of the ignition coil boots prior to installation.
- Tighten to 6 Nm (53 lb-in).

8. Connect the 4 LH ignition coil electrical connectors.

9. Position the 2 EVAP system tubes and connect the quick connect couplings. For additional information, refer to Section 310-00.

10. Install the oil level indicator and tube. For additional information, refer to Oil Level Indicator and Tube in this section.

11. Position the PCV tube and connect the quick connect couplings. For additional information, refer to Section 310-00.

12. Connect the degas bottle coolant outlet hose.

13. Install the degas bottle assembly. For additional information, refer to Section 303-03.

14. Install the air cleaner outlet pipe. For additional information, refer to Section 303-12.

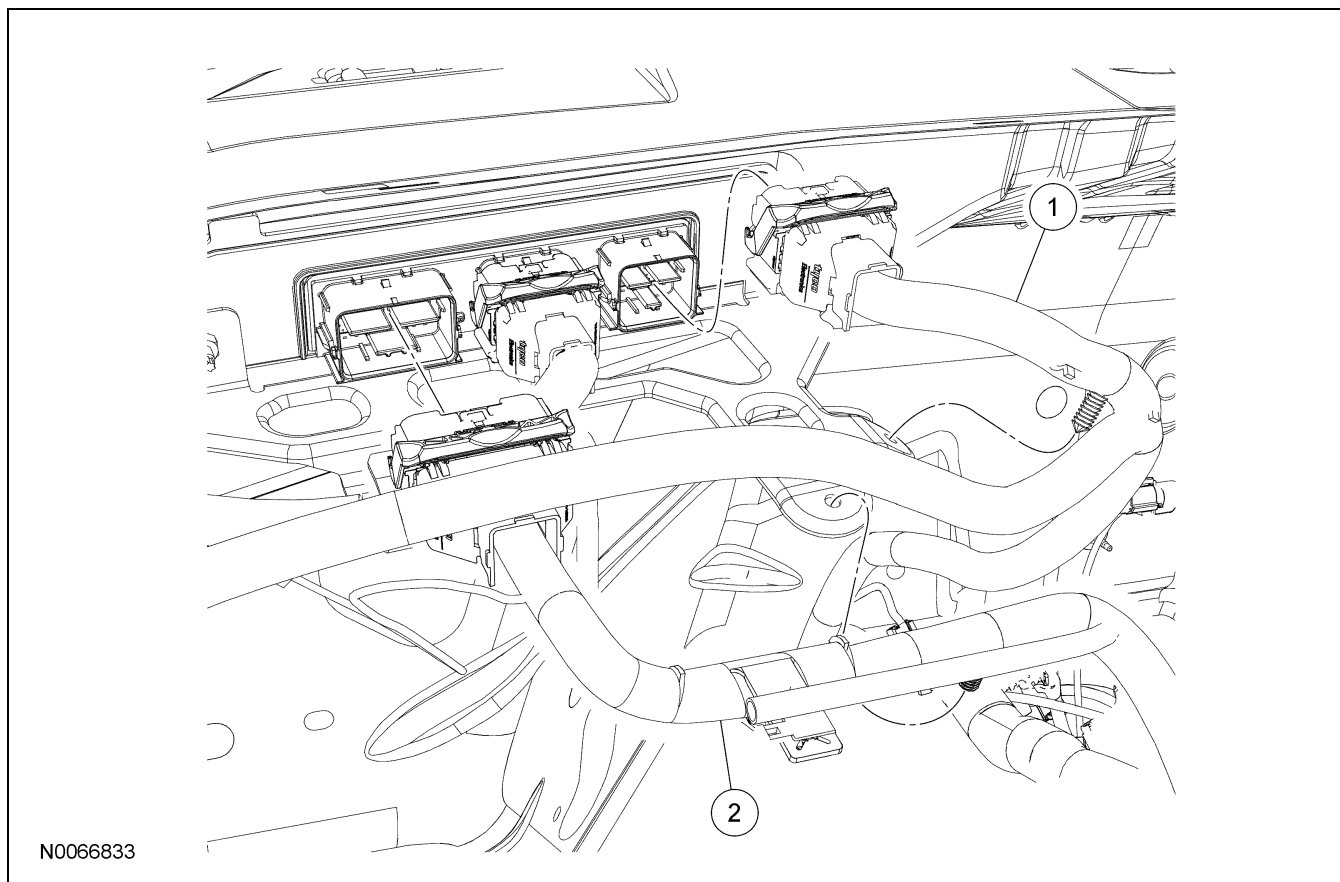
IN-VEHICLE REPAIR

Valve Cover — RH

Material

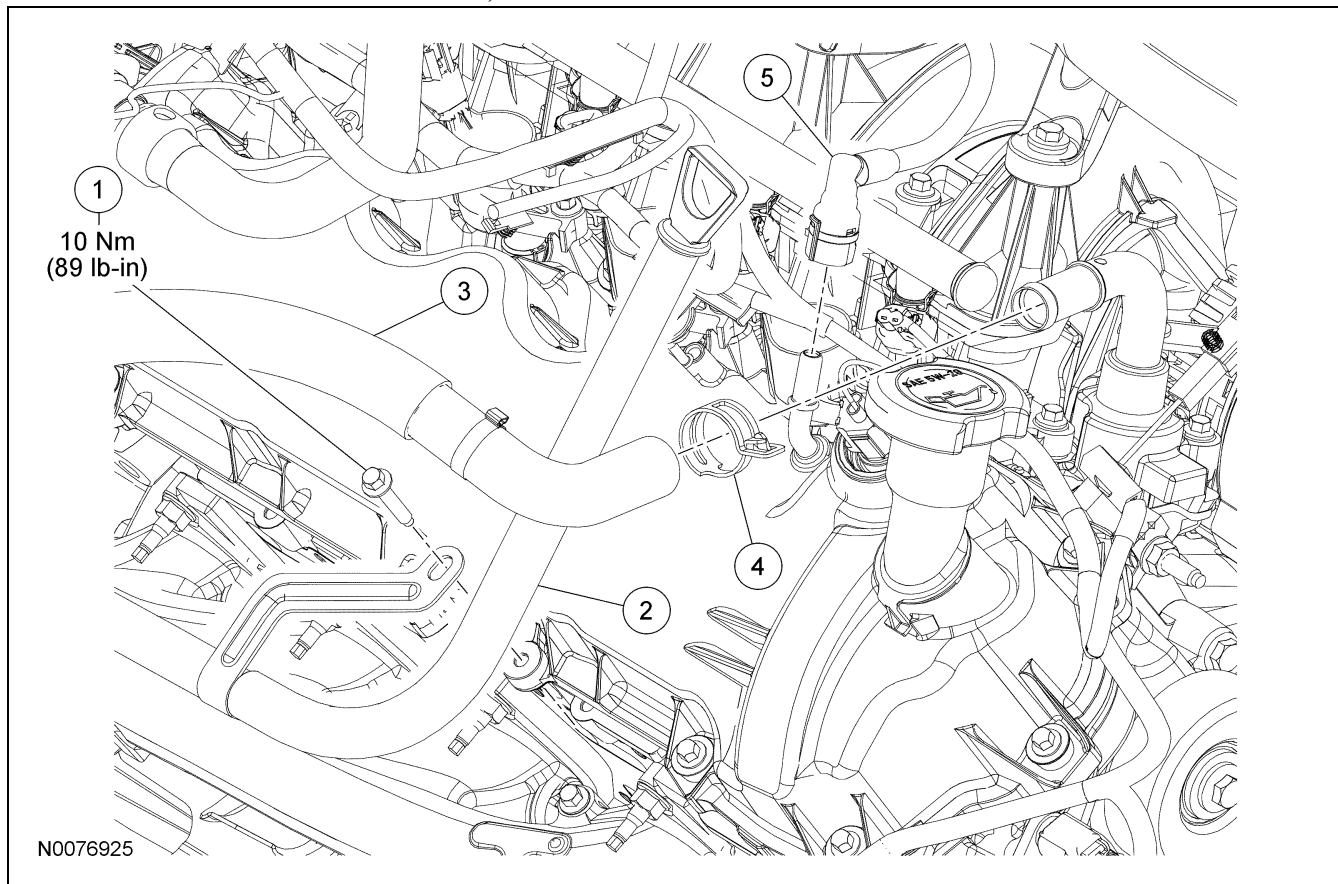
Item	Specification
Motorcraft Metal Surface Prep ZC-31	—
Silicone Brake Caliper Grease and Dielectric Compound XG-3-A	ESE-M1C171-A
Silicone Gasket and Sealant TA-30	WSE-M4G323-A4
Silicone Gasket Remover ZC-30	—

PCM Electrical Connections



IN-VEHICLE REPAIR (Continued)

Item	Part Number	Description
1	—	Transmission wiring harness electrical connector and wiring harness retainer (part of 15525)
2	—	Engine wiring harness electrical connector and wiring harness retainer (part of 12B637)

Transmission Fluid Level Indicator Tube, Crankcase Vent Tube and Coolant Hose

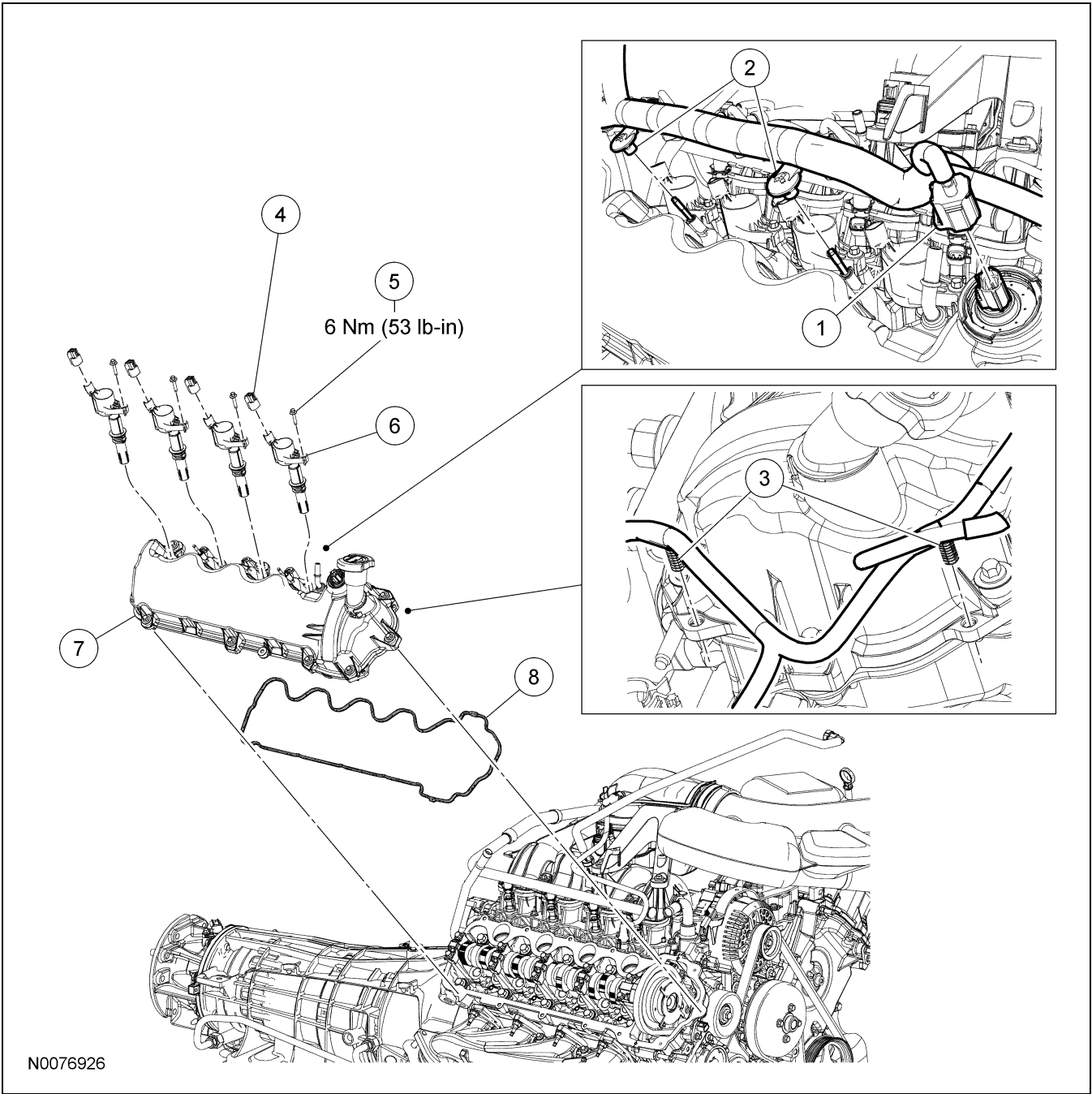
Item	Part Number	Description
1	N859356	Transmission fluid level indicator tube support bracket bolt
2	7A228	Transmission fluid level indicator tube

(Continued)

Item	Part Number	Description
3	9929	Heater coolant hose
4	—	Heater coolant hose clamp
5	6758	Crankcase ventilation tube quick connect coupling

IN-VEHICLE REPAIR (Continued)

Ignition Coils, RH Valve Cover and Gasket



Item	Part Number	Description
1	—	Variable camshaft timing (VCT) solenoid electrical connector (part of 12B637)
2	—	Engine wiring harness retainers (part of 12B637)
3	—	Engine wiring harness retainers (part of 12B637)
4	—	RH ignition coil electrical connector (4 required) (part of 12B637)

(Continued)


Item	Part Number	Description
5	W706175	RH ignition coil bolt (4 required)
6	12A366	RH ignition coil (4 required)
7	6582	RH valve cover
8	6584	RH valve cover gasket


Removal

1. Drain the engine cooling system. For additional information, refer to Section 303-03.

IN-VEHICLE REPAIR (Continued)

2. Remove the bolt and position the transmission filler tube aside.
3. Disconnect the quick connect coupling and position the crankcase vent tube aside. For additional information, refer to Section 310-00.
4. Disconnect the heater coolant hose from the coolant crossover assembly.
5. Disconnect the 2 PCM electrical connectors and the wiring harness retainers from the support bracket and position aside.
6. Disconnect the 4 RH ignition coil electrical connectors.
7. Remove the 4 RH bolts and the 4 RH ignition coils.
 - Remove the ignition coil, using a twisting motion while pulling up on the ignition coil.
8. Disconnect the variable camshaft timing (VCT) solenoid electrical connector.
9. Disconnect the 4 wiring harness retainers from the valve cover and position the wiring harness aside.

10.  **CAUTION:** Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the sealing surfaces. These tools cause scratches and gouges which make leak paths. Use a plastic scraping tool to remove all traces of old sealant. Failure to follow this procedure may cause future oil leakage.

 **CAUTION:** When removing the valve cover, make sure to avoid damaging the variable camshaft timing (VCT) solenoid.

NOTE: The fasteners are part of the valve cover and should not be removed.

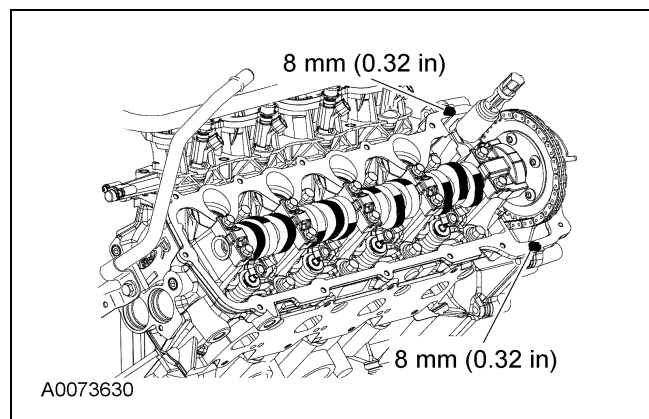
Fully loosen the 15 fasteners and remove the RH valve cover and gasket.

- Clean the valve cover mating surface of the cylinder head with Silicone Gasket Remover and Motorcraft Metal Surface Prep. Follow the directions on the packaging.
- Discard the valve cover gasket. Clean the valve cover gasket groove with soap and water or a suitable solvent.

Installation

1. **NOTE:** If the valve cover is not secured within 4 minutes, the sealant must be removed and the sealing area cleaned with Silicone Gasket Remover and Motorcraft Metal Surface Prep. Follow the directions on the packaging. Allow to dry until there is no sign of wetness, or 4 minutes, whichever is longer. Failure to follow this procedure may cause future oil leakage.

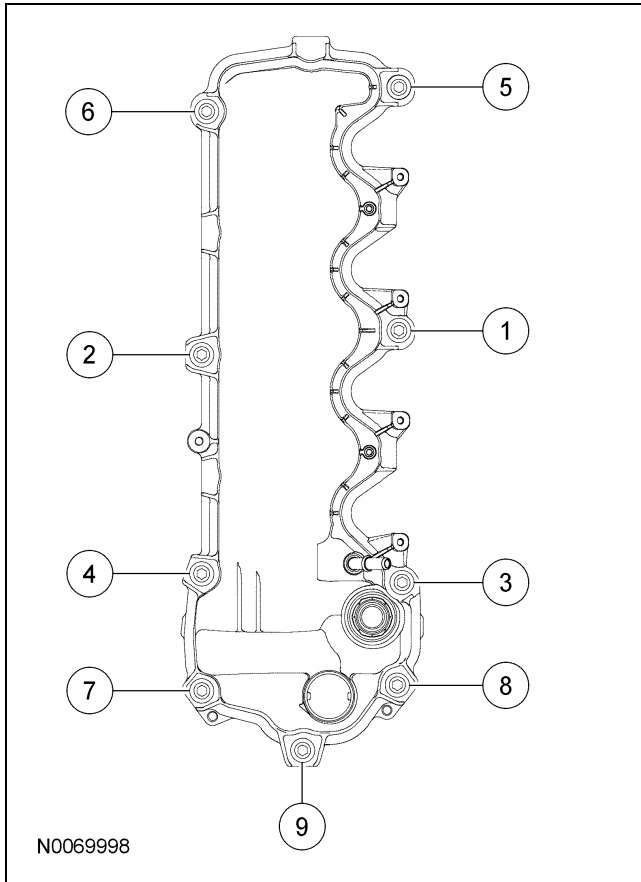
Apply a bead of Silicone Gasket and Sealant in 2 places where the engine front cover meets the cylinder head.



IN-VEHICLE REPAIR (Continued)

2. Position the RH valve cover and new gasket on the cylinder head and tighten the bolts in the sequence shown.

- Tighten to 10 Nm (89 lb-in).



3. Connect the wiring harness retainers to the valve cover.

4. Connect the VCT solenoid electrical connector.

5. **NOTE:** Verify that the ignition coil spring is correctly located inside the ignition coil boot and that there is no damage to the tip of the boot.

Install the 4 RH ignition coils and the 4 bolts.

- Apply a light coat of dielectric compound to the inside of the ignition coil boots prior to installation.
- Tighten to 6 Nm (53 lb-in).

6. Connect the 4 RH ignition coil electrical connectors.

7. Connect the 2 PCM electrical connectors and the wiring harness retainers to the support bracket.

8. Position the crankcase vent tube and connect the quick connect couplings. For additional information, refer to Section 310-00.

9. Connect the heater coolant hose to the engine coolant crossover manifold assembly.

10. Position the transmission filler tube and install the bolt.

- Tighten to 10 Nm (89 lb-in).

11. Fill and bleed the engine cooling system. For additional information, refer to Section 303-03.

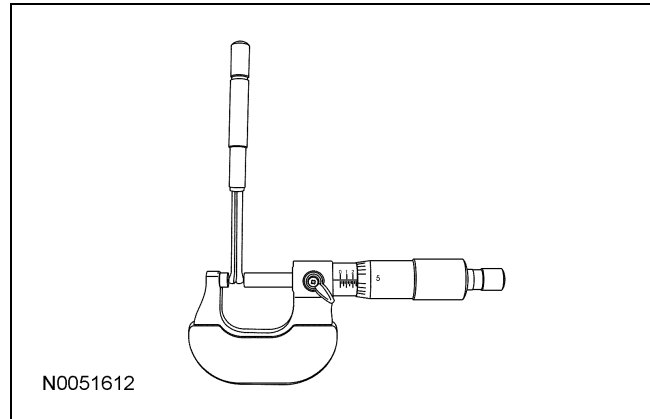
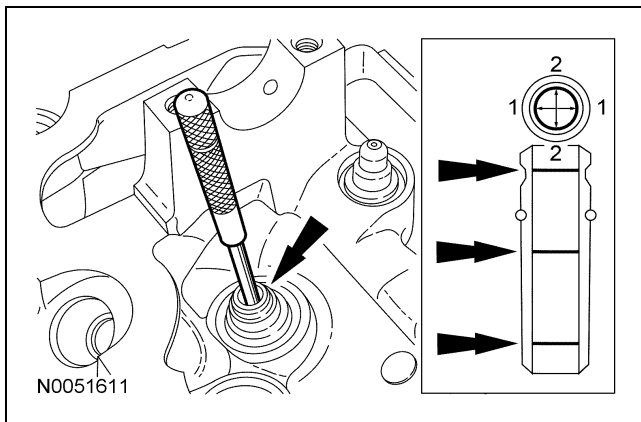
GENERAL PROCEDURES

Valve Guide Inner Diameter

NOTE: Refer to the appropriate Section 303-01 for the specification.

1. **NOTE:** Valve guides tend to wear in an hourglass pattern. The ball gauge can be inserted into the combustion chamber side of the valve guide if necessary.

Use a ball gauge to determine the inner diameter of the valve guides in 2 directions at the top, middle and bottom of the valve guide.



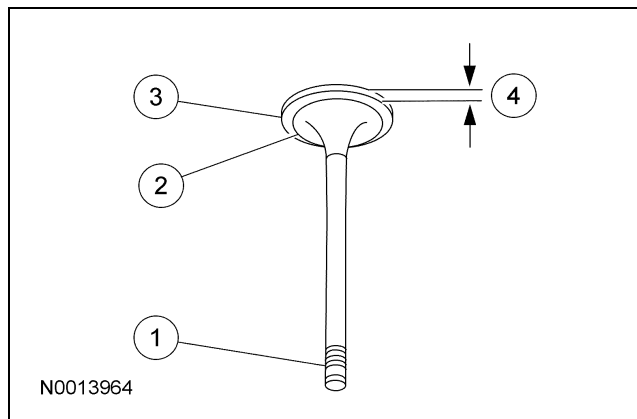
3. If the valve guide is not within specifications, install a new cylinder head assembly.

2. Measure the ball gauge with a micrometer.
-

GENERAL PROCEDURES

Valve Inspection

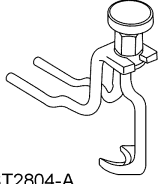
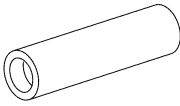
1. Inspect the following valve areas:
 - 1 The end of the stem for grooves or scoring.
 - 2 The valve face and the edge for pits, grooves or scores.
 - 3 The valve head for signs of burning, erosion, warpage and cracking.
 - 4 The valve margin for wear.



IN-VEHICLE REPAIR

Valve Seals

Special Tool(s)

 <p>ST2804-A</p>	Compressor, Valve Spring 303-1039
 <p>ST1332-A</p>	Installer, Valve Stem Oil Seal 303-383 (T91P-6571-A)

Material

Item	Specification
Motorcraft SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP (US); Motorcraft SAE 5W-20 Super Premium Motor Oil CXO-5W20-LSP12 (Canada); or equivalent	WSS-M2C930-A

Removal

RH cylinder head valve seals

1. Remove the RH valve cover. For additional information, refer to Valve Cover — RH in this section.


LH cylinder head valve seals

2. Depending on the valve being serviced, remove the LH or RH valve cover. For additional information, refer to Valve Cover — LH or Valve Cover — RH in this section.

All valve seals

3. Remove the spark plug for the cylinder being serviced. For additional information, refer to Section 303-07A.

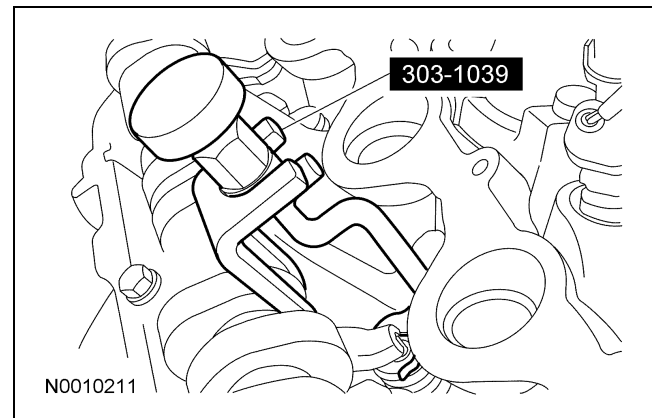
4. Rotate the crankshaft until the piston for the valve being serviced is at the top of its stroke with the intake valve and the exhaust valves closed.

5.  **CAUTION:** If the components are to be reinstalled, they must be installed in the same positions. Mark the components for installation into their original locations. Failure to follow these instructions may result in engine damage.

NOTE: Do not allow the valve keepers to fall off of the valve or the valve may drop into the cylinder. If a valve drops into the cylinder, the cylinder head must be removed. For additional information, refer to Cylinder Head in this section.


NOTE: It may be necessary to push the valve down while compressing the spring.

Using the special tool, compress the valve spring and remove the camshaft roller follower.



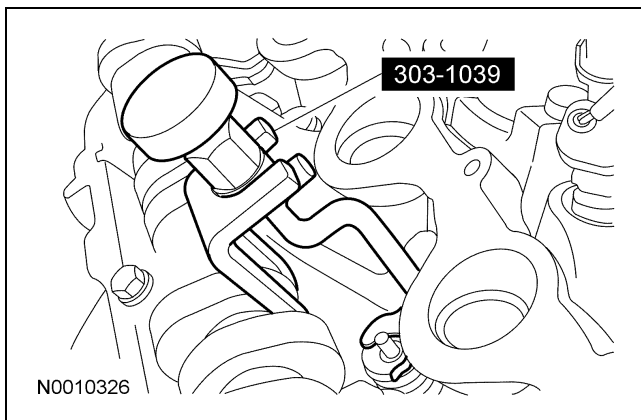
6. Use compressed air in the cylinder being serviced to hold the valves in position.
 - Apply a minimum of 965 kPa (140 psi) of compressed air into the cylinder.

IN-VEHICLE REPAIR (Continued)

7.  **CAUTION:** If the components are to be reinstalled, they must be installed in the same positions. Mark the components for installation into their original locations. Failure to follow these instructions may result in engine damage.

NOTE: If air pressure has forced the piston to the bottom of the cylinder, any loss of air pressure will allow the valve to fall into the cylinder. If air pressure must be removed, support the valve prior to removal. If a valve drops into the cylinder, remove the cylinder head. For additional information, refer to Cylinder Head in this section.

Using the special tool, compress the valve spring and remove the valve spring retainer keys.

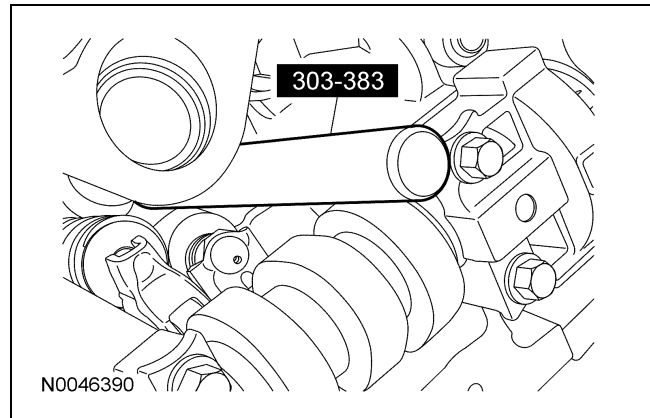



8. Remove the valve spring retainer, the valve spring and the valve seal.
- Discard the valve seal.
9. Inspect the components. For additional information, refer to Section 303-00.

Installation**All valve seals**

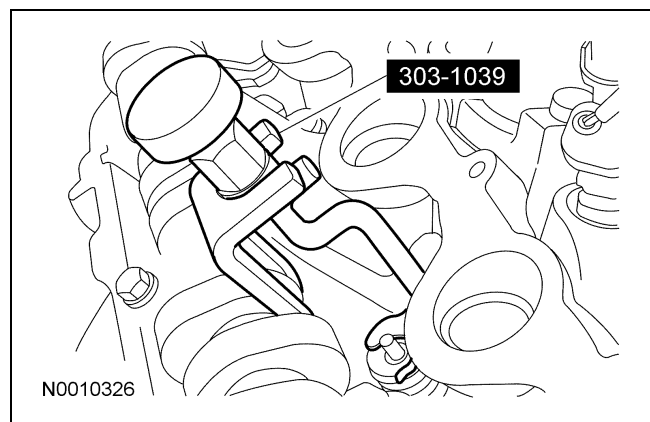
1. **NOTE:** Lubricate the valve seal and valve stem with clean engine oil prior to installation. Position a new valve seal onto the valve stem.

2. Using the special tool, install the new valve seal.




3.  **CAUTION:** If the components are to be reinstalled, they must be installed in the same positions. Failure to follow these instructions may result in engine damage.

Using the special tool, install the valve spring, the valve spring retainer and the valve spring retainer keys.



4. Relieve the air pressure from the cylinder.

IN-VEHICLE REPAIR (Continued)

5.  **CAUTION:** If the components are to be reinstalled, they must be installed in the same positions. Failure to follow these instructions may result in engine damage.

NOTE: Do not allow the valve keepers to fall off of the valve or the valve may drop into the cylinder. If a valve drops into the cylinder, the cylinder head must be removed. For additional information, refer to Cylinder Head in this section.

NOTE: It may be necessary to push the valve down while compressing the spring.

NOTE: Lubricate the camshaft roller followers with clean engine oil prior to installation.

Using the special tool, compress the valve spring and install the camshaft roller follower.

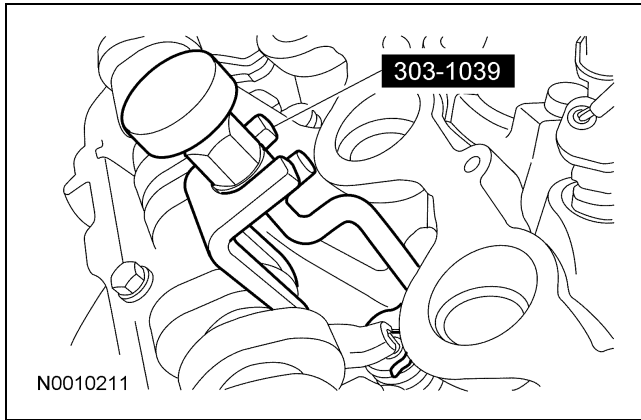
6. Install the spark plug. For additional information, refer to Section 303-07A.

LH cylinder head valve seals

7. Install the LH valve cover. For additional information, refer to Valve Cover — LH in this section.

RH cylinder head valve seals

8. Install the RH valve cover. For additional information, refer to Valve Cover — RH in this section.



GENERAL PROCEDURES

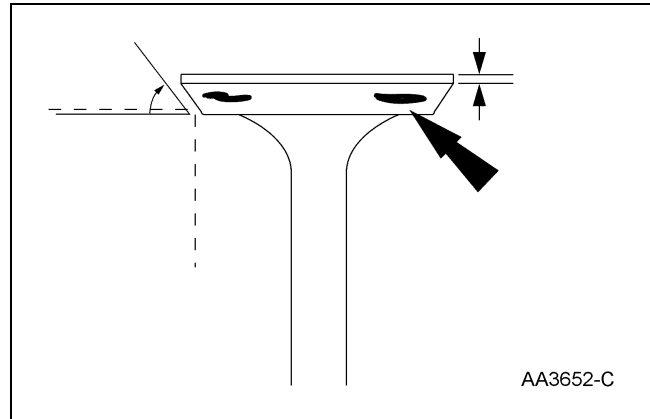
Valve Seat Inspection

Valve and Seat Refacing Measurements

NOTE: Refer to the appropriate Section 303-01 for the specification.

NOTE: After grinding valves or valve seats, check valve clearance.

1. Check the valve head and seat.
 - Check valve angles.
 - Check margin width.
 - Be sure margin width is within specification.
2. Inspect for abnormalities on the valve face and seat. Install a new cylinder head assembly if abnormalities are found.

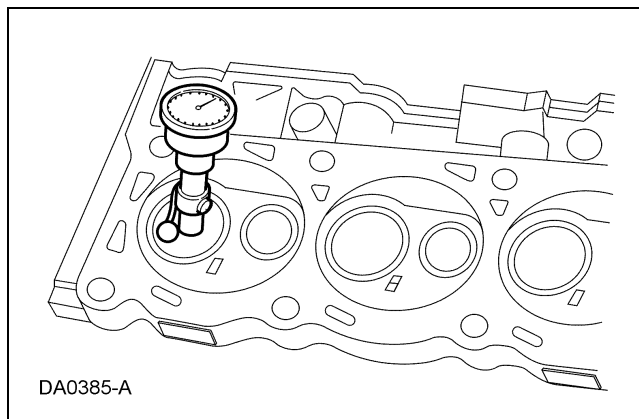


GENERAL PROCEDURES

Valve Seat Runout

NOTE: Refer to the appropriate Section 303-01 for the specification.

1. Use a valve seat runout gauge to check valve seat runout.

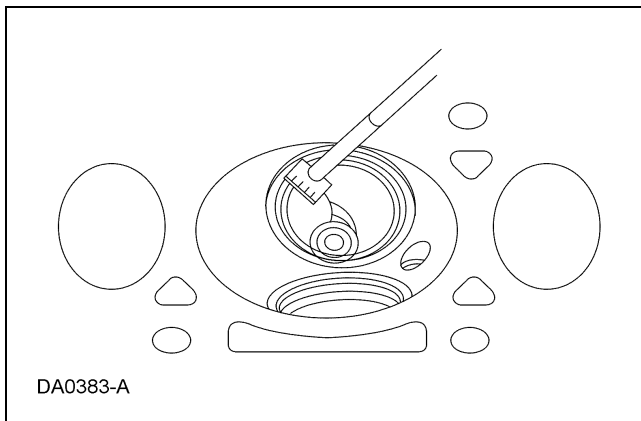


GENERAL PROCEDURES

Valve Seat Width

NOTE: Refer to the appropriate Section 303-01 for the specification.

1. Measure the valve seat width. If necessary, grind the valve seat to specification.
 - Measure the intake valve seat width.
 - Measure the exhaust valve seat width.
 - Recheck the valve spring installed length after the seats have been ground, and shim the valve springs as necessary to achieve the correct installed spring length.

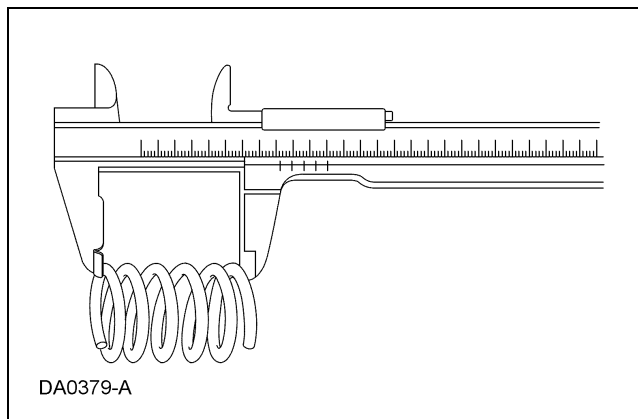


GENERAL PROCEDURES

Valve Spring Free Length

NOTE: Refer to the appropriate Section 303-01 for the specification.

1. Measure the free length of each valve spring.

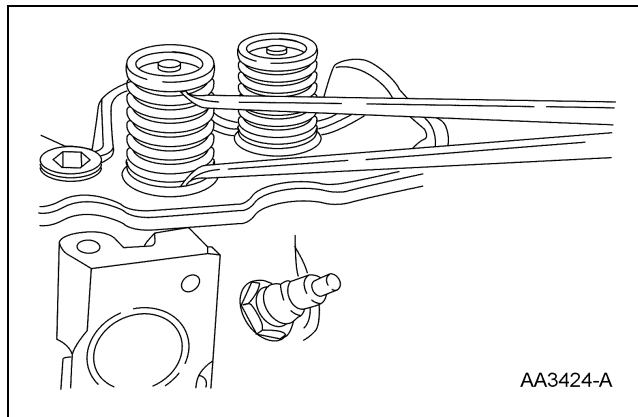


GENERAL PROCEDURES

Valve Spring Installed Length

NOTE: Refer to the appropriate Section 303-01 for the specification.

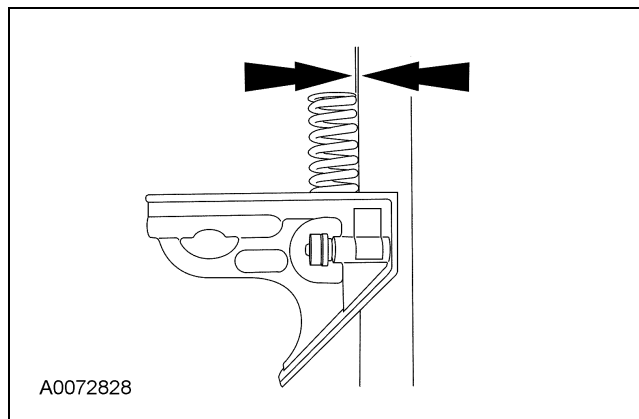
1. Measure the installed length of each valve spring.



GENERAL PROCEDURES

Valve Spring Squareness

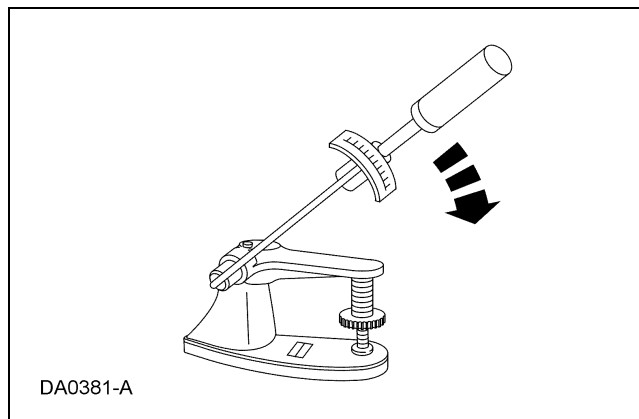
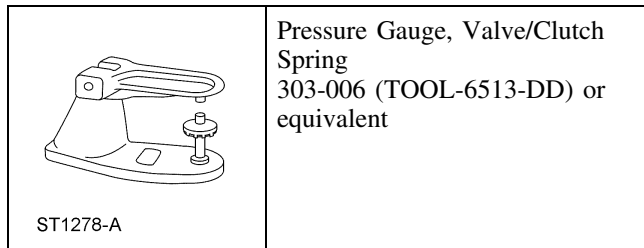
1. Measure the out-of-square on each valve spring.
 - Turn the valve spring and observe the space between the top of the valve spring and the square.



GENERAL PROCEDURES

Valve Spring Strength

Special Tool(s)



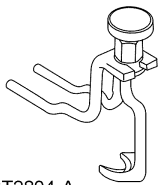
NOTE: Refer to the appropriate Section 303-01 for the specification.

1. Use the special tool to check the valve spring for correct strength at the specified valve spring length.
-

IN-VEHICLE REPAIR

Valve Springs

Special Tool(s)

 <p>ST2804-A</p>	<p>Compressor, Valve Spring 303-1039</p>
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Material

Item	Specification
<p>Motorcraft SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP (US); Motorcraft SAE 5W-20 Super Premium Motor Oil CXO-5W20-LSP12 (Canada); or equivalent</p>	<p>WSS-M2C930-A</p>

Removal

RH cylinder head valve springs


1. Remove the RH valve cover. For additional information, refer to Valve Cover — RH in this section.

LH cylinder head valve springs

2. Remove the LH valve cover. For additional information, refer to Valve Cover — LH in this section.

All valve springs

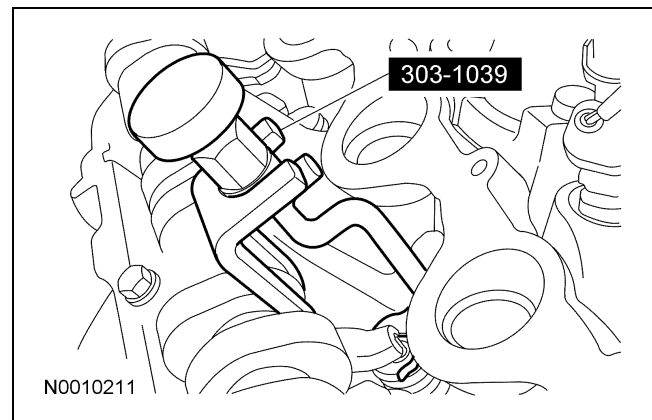
3. Remove the spark plug for the cylinder being serviced. For additional information, refer to Section 303-07A.
4. Rotate the crankshaft until the piston for the valve being serviced is at the top of its stroke with the intake valve and the exhaust valves closed.

5.  **CAUTION:** If the components are to be reinstalled, they must be installed in the same positions. Mark the components for installation into their original locations. Failure to follow these instructions may result in engine damage.

NOTE: Do not allow the valve keepers to fall off of the valve or the valve may drop into the cylinder. If a valve drops into the cylinder, the cylinder head must be removed. For additional information, refer to Cylinder Head in this section.


NOTE: It may be necessary to push the valve down while compressing the spring.

Using the special tool, compress the valve spring and remove the camshaft roller follower.



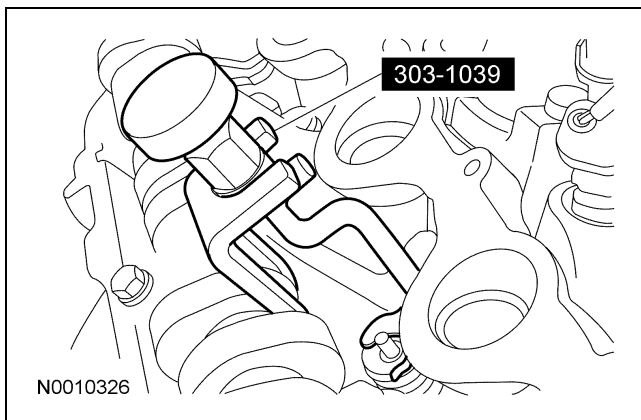
6. Use compressed air in the cylinder being serviced to hold both valves in position.
 - Apply a minimum of 965 kPa (140 psi) of compressed air into the cylinder.

IN-VEHICLE REPAIR (Continued)

7.  **CAUTION:** If the components are to be reinstalled, they must be installed in the same positions. Mark the components for installation into their original locations. Failure to follow these instructions may result in engine damage.


NOTE: If air pressure has forced the piston to the bottom of the cylinder, any loss of air pressure will allow the valve to fall into the cylinder. If air pressure must be removed, support the valve prior to removal. If a valve drops into the cylinder, remove the cylinder head. For additional information, refer to Cylinder Head in this section.

Using the special tool, compress the valve spring and remove the valve spring retainer keys.

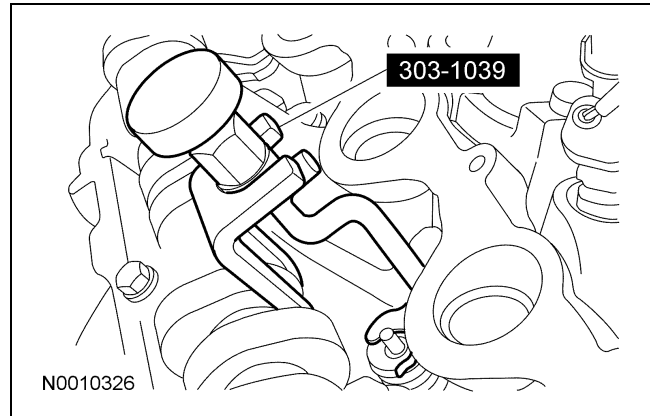



8. Remove the valve spring retainer and the valve spring.
9. Inspect the valve spring. For additional information, refer to Section 303-00.

Installation**All valve springs**

1.  **CAUTION:** If the components are to be reinstalled, they must be installed in the same positions. Failure to follow these instructions may result in engine damage.

Using the special tool, install the valve spring, the valve spring retainer and the valve spring retainer keys.



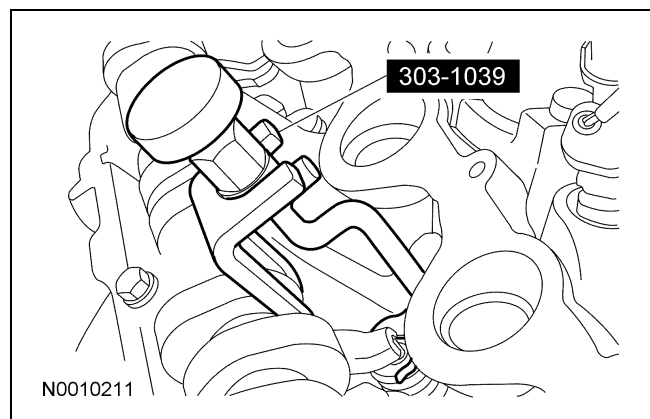
2. Relieve the air pressure from the cylinder.
3.  **CAUTION:** If the components are to be reinstalled, they must be installed in the same positions. Failure to follow these instructions may result in engine damage.

NOTE: Do not allow the valve keepers to fall off of the valve or the valve may drop into the cylinder. If a valve drops into the cylinder, the cylinder head must be removed. For additional information, refer to Cylinder Head in this section.

NOTE: It may be necessary to push the valve down while compressing the spring.

NOTE: Lubricate the camshaft roller followers with clean engine oil prior to installation.

Using the special tool, compress the valve spring and install the camshaft roller follower.



4. Install the spark plug. For additional information, refer to Section 303-07A.

IN-VEHICLE REPAIR (Continued)**LH cylinder head valve springs**

5. Install the LH valve cover. For additional information, refer to Valve Cover — LH in this section.

RH cylinder head valve springs

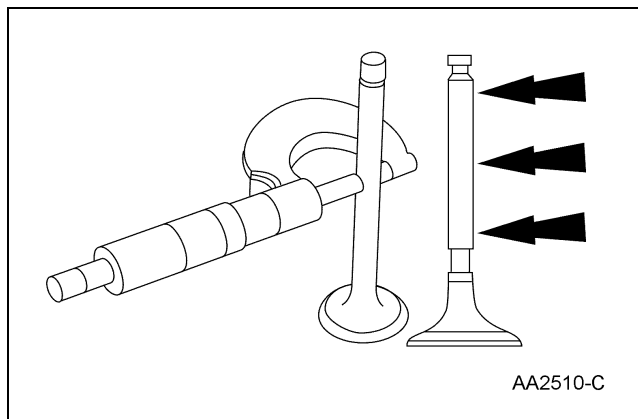
6. Install the RH valve cover. For additional information, refer to Valve Cover — RH in this section.
-

GENERAL PROCEDURES

Valve Stem Diameter

NOTE: Refer to the appropriate Section 303-01 for the specification.

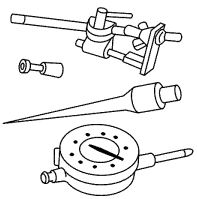
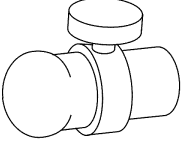
1. Measure the diameter of each intake and exhaust valve stem at the points shown. Verify the diameter is within specification.



GENERAL PROCEDURES

Valve Stem to Valve Guide Clearance

Special Tool(s)

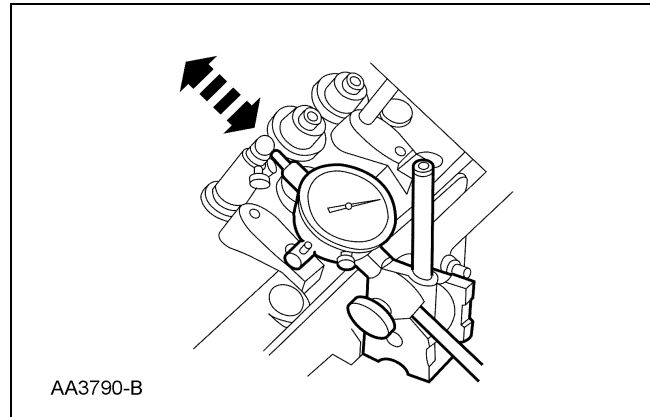
 <p>ST1214-A</p>	<p>Dial Indicator Gauge with Holding Fixture 100-002 (TOOL-4201-C) or equivalent</p>
 <p>ST1251-A</p>	<p>Clearance Gauge, Valve Guide 303-004 (TOOL-6505-E) or equivalent</p>

NOTE: Refer to the appropriate Section 303-01 for the specification.

NOTE: The valve stem diameter must be within specifications before checking valve stem-to-valve guide clearance.

1. **NOTE:** If necessary, use a magnetic base.

Install a Valve Guide Clearance Gauge on the valve stem and install a Dial Indicator Gauge with Holding Fixture. Lower the valve until the clearance gauge contacts the upper surface of the valve guide.

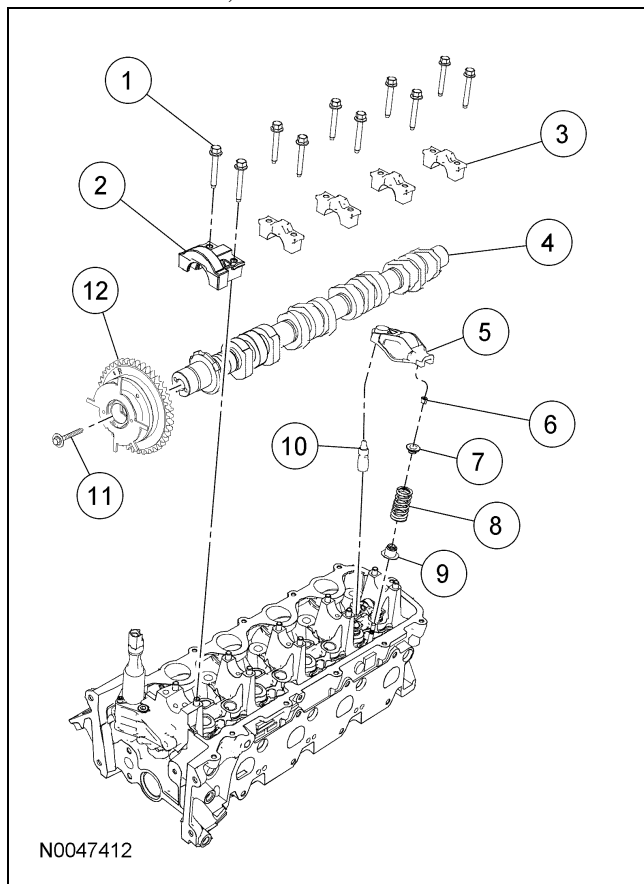


2. Move the clearance gauge toward the indicator and zero the indicator. Move the clearance gauge away from the indicator and note the reading. The reading will be **DOUBLE** the valve stem-to-valve guide clearance.

IN-VEHICLE REPAIR

Valve Train Components — Exploded View

NOTE: LH shown, RH similar.



Item	Part Number	Description
1	N807834	Camshaft bearing cap bolt (10 required)
2	6B284	Camshaft front bearing cap
3	6B280	Camshaft bearing cap (4 required)
4	6C255	Camshaft
5	6529	Camshaft roller follower (12 required)
6	6518	Valve spring retainer key (24 required)
7	6514	Valve spring retainer (12 required)
8	6513	Valve spring (12 required)
9	6A517	Valve seal (12 required)
10	6C501	Hydraulic lash adjuster (12 required)
11	6279	Camshaft phaser and sprocket bolt
12	6C524	Camshaft phaser and sprocket

IN-VEHICLE REPAIR (Continued)

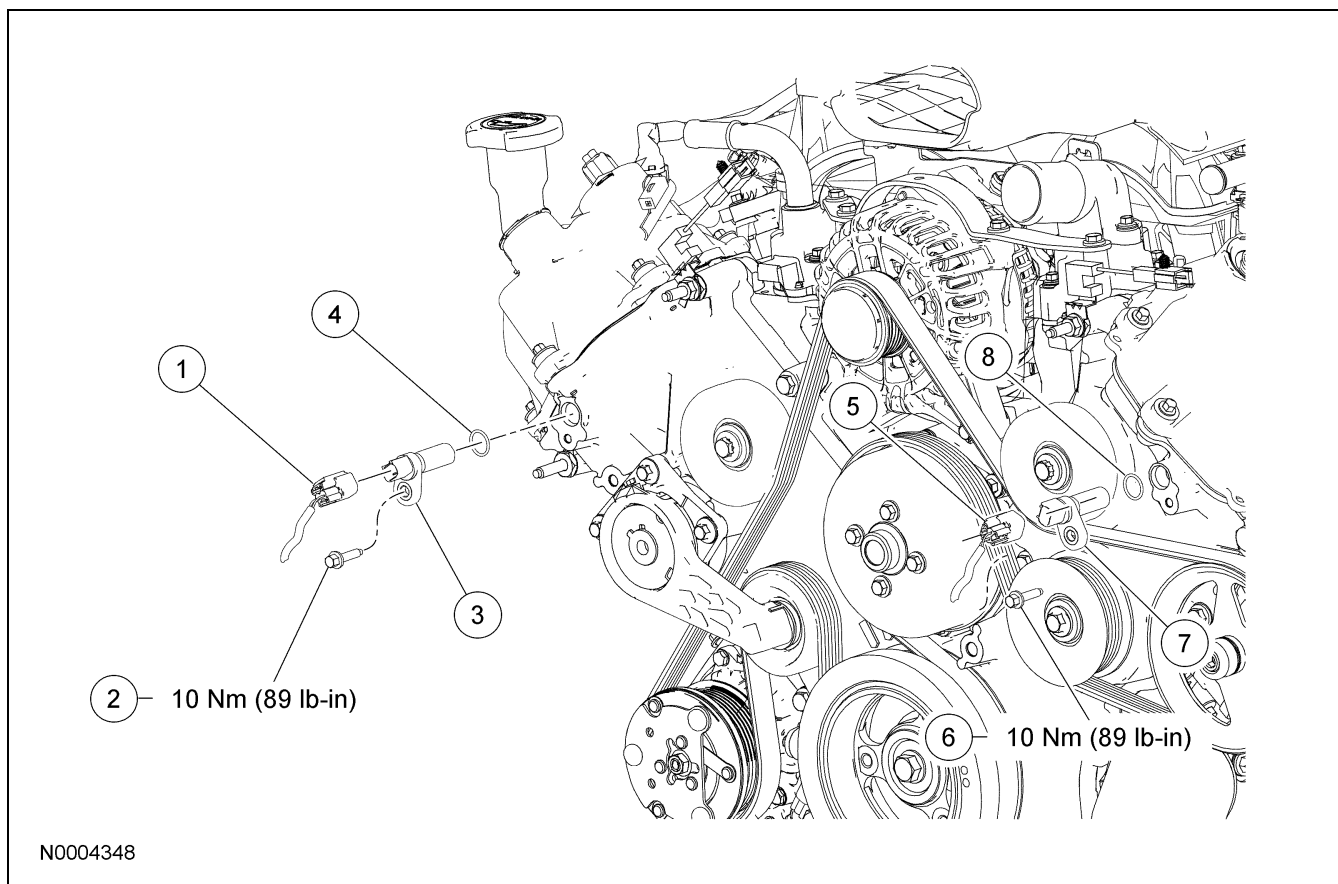
1. For additional information, refer to the procedures in this section.
-

REMOVAL AND INSTALLATION

Camshaft Position (CMP) Sensor — 5.4L

Material

Item	Specification
Motorcraft SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP (US); Motorcraft SAE 5W-20 Super Premium Motor Oil CXO-5W20-LSP12 (Canada); or equivalent	WSS-M2C930-A



Item	Part Number	Description
1	—	RH camshaft position (CMP) sensor electrical connector (part of 12B637)
2	N806155-S	RH CMP sensor bolt
3	6B288	RH CMP sensor
4	6758	RH CMP sensor O-ring seal
5	—	LH CMP sensor electrical connector (part of 12B637)

(Continued)

Item	Part Number	Description
6	N806155-S	LH CMP sensor bolt
7	6B288	LH CMP sensor
8	6758	LH CMP sensor O-ring seal

Removal and Installation

1. Disconnect the camshaft position (CMP) sensor electrical connector.

REMOVAL AND INSTALLATION (Continued)

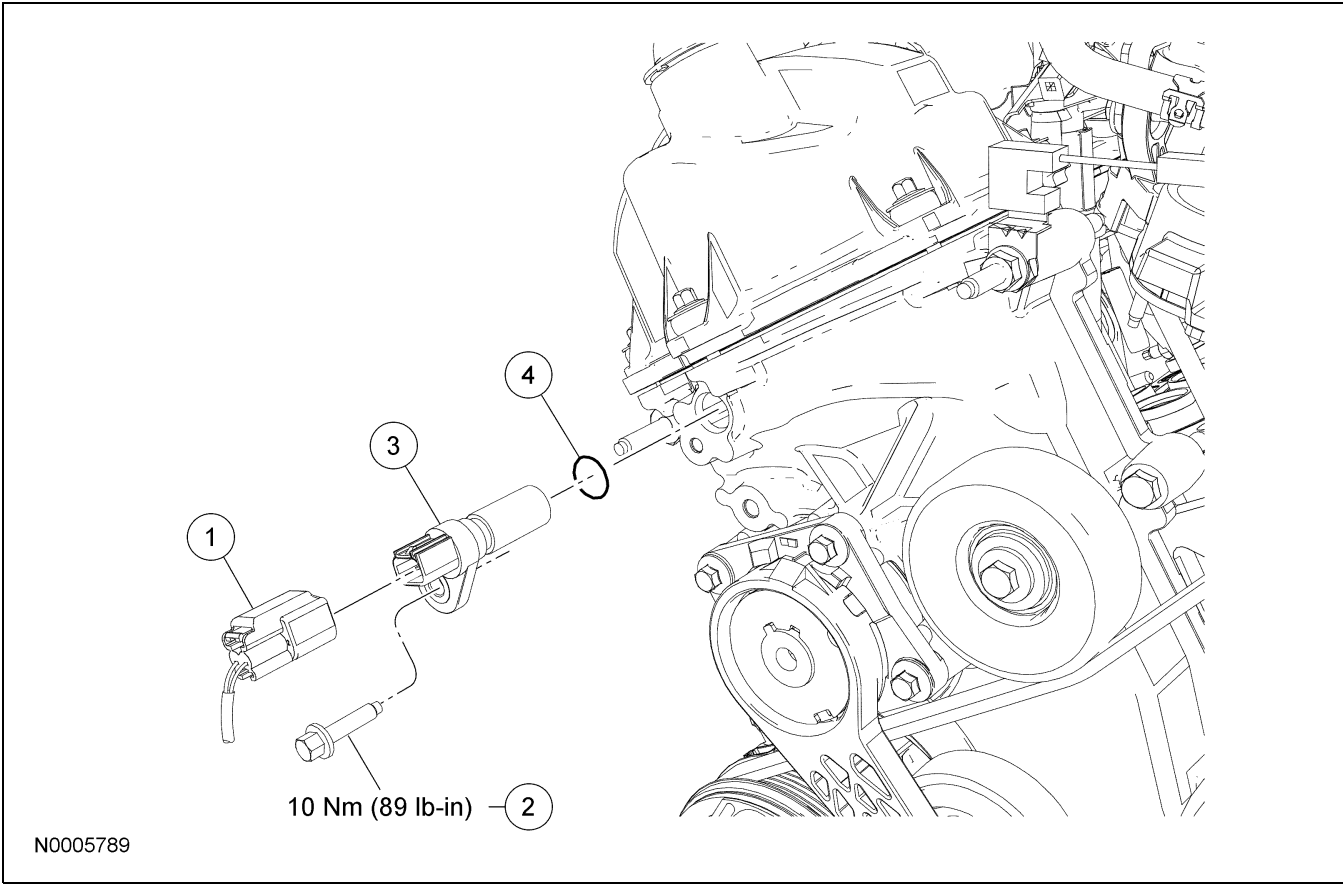
2. Remove the bolt and the CMP sensor.
 - To install, tighten to 10 Nm (89 lb-in).
 - Lubricate the O-ring seal with clean engine oil prior to installation.
 3. To install, reverse the removal procedure.
-

REMOVAL AND INSTALLATION

Camshaft Position (CMP) Sensor —
6.8L

Material

Item	Specification
Motorcraft SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP (US); Motorcraft SAE 5W-20 Super Premium Motor Oil CXO-5W20-LSP12 (Canada); or equivalent	WSS-M2C930-A



Item	Part Number	Description
1	—	Camshaft position (CMP) sensor electrical connector (part of 12B637)
2	N806155-S	CMP sensor bolt
3	6B288	CMP sensor
4	6758	CMP sensor O-ring seal

Removal and Installation

1. Disconnect the camshaft position (CMP) sensor electrical connector.

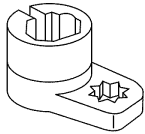
REMOVAL AND INSTALLATION (Continued)

2. Remove the bolt and the CMP sensor.
 - To install, tighten to 10 Nm (89 lb-in).
 - Lubricate the O-ring seal with clean engine oil prior to installation.
 3. To install, reverse the removal procedure.
-

REMOVAL AND INSTALLATION

Catalyst Monitor Sensor

Special Tool(s)

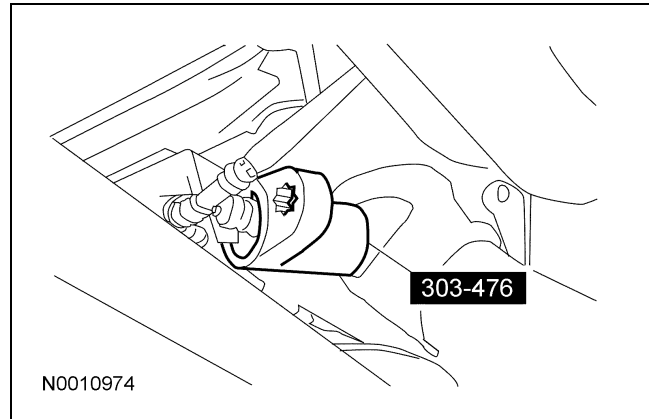
 <p>ST1447-A</p>	<p>Socket, Exhaust Gas Oxygen Sensor 303-476 (T94P-9472-A)</p>
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Material

Item	Specification
High Temperature Nickel Anti-Seize Lubricant XL-2 (US); CXG-2-B (Canada)	ESE-M12A4-A
Penetrating and Lock Lubricant XL-1 (US); CXC-51-A (Canada)	—

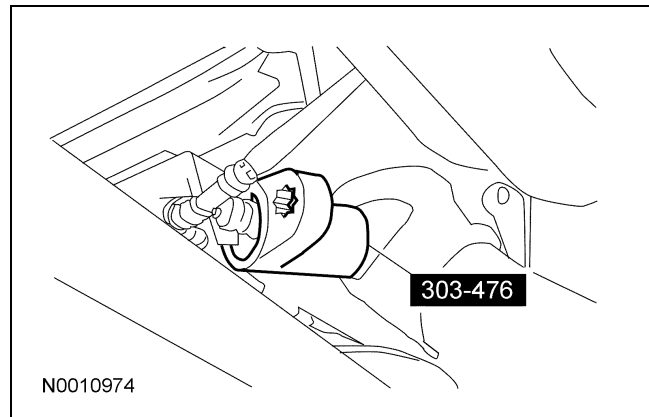
Removal

1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
2. Disconnect the catalyst monitor sensor electrical connector.
3. Using the special tool, remove the catalyst monitor sensor.
 - Apply penetrating lubricant to the catalyst monitor sensor to assist in removal.



Installation

1. Using the special tool, install the catalyst monitor sensor.
 - To install, tighten to 46 Nm (34 lb-ft).
 - Apply a light coat of high temperature nickel anti-seize lubricant to the catalyst monitor sensor threads prior to installation.



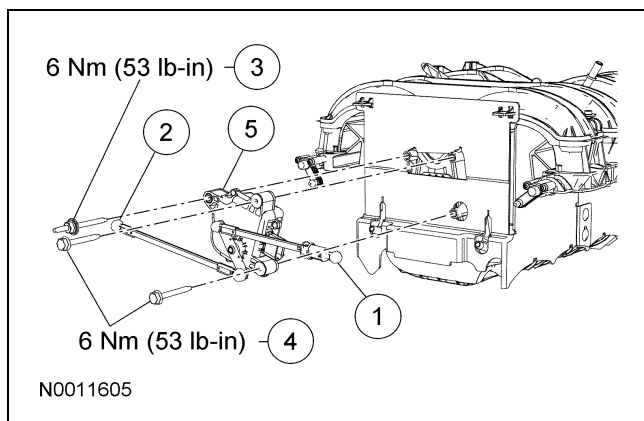
2. Connect the catalyst monitor sensor electrical connector.

REMOVAL AND INSTALLATION

Charge Motion Control Valve (CMCV) — 5.4L

Material

Item	Specification
Motorcraft SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP (US); Motorcraft SAE 5W-20 Super Premium Motor Oil CXO-5W20-LSP12 (Canada); or equivalent	WSS-M2C930-A



Item	Part Number	Description
1	9B841	Charge motion control valve (CMCV) RH rod
2	9B842	CMCV LH rod

(Continued)

Item	Part Number	Description
3	W709084	CMCV stud bolt
4	W708165	CMCV bolts (2 required)
5	9L490	CMCV

Removal and Installation

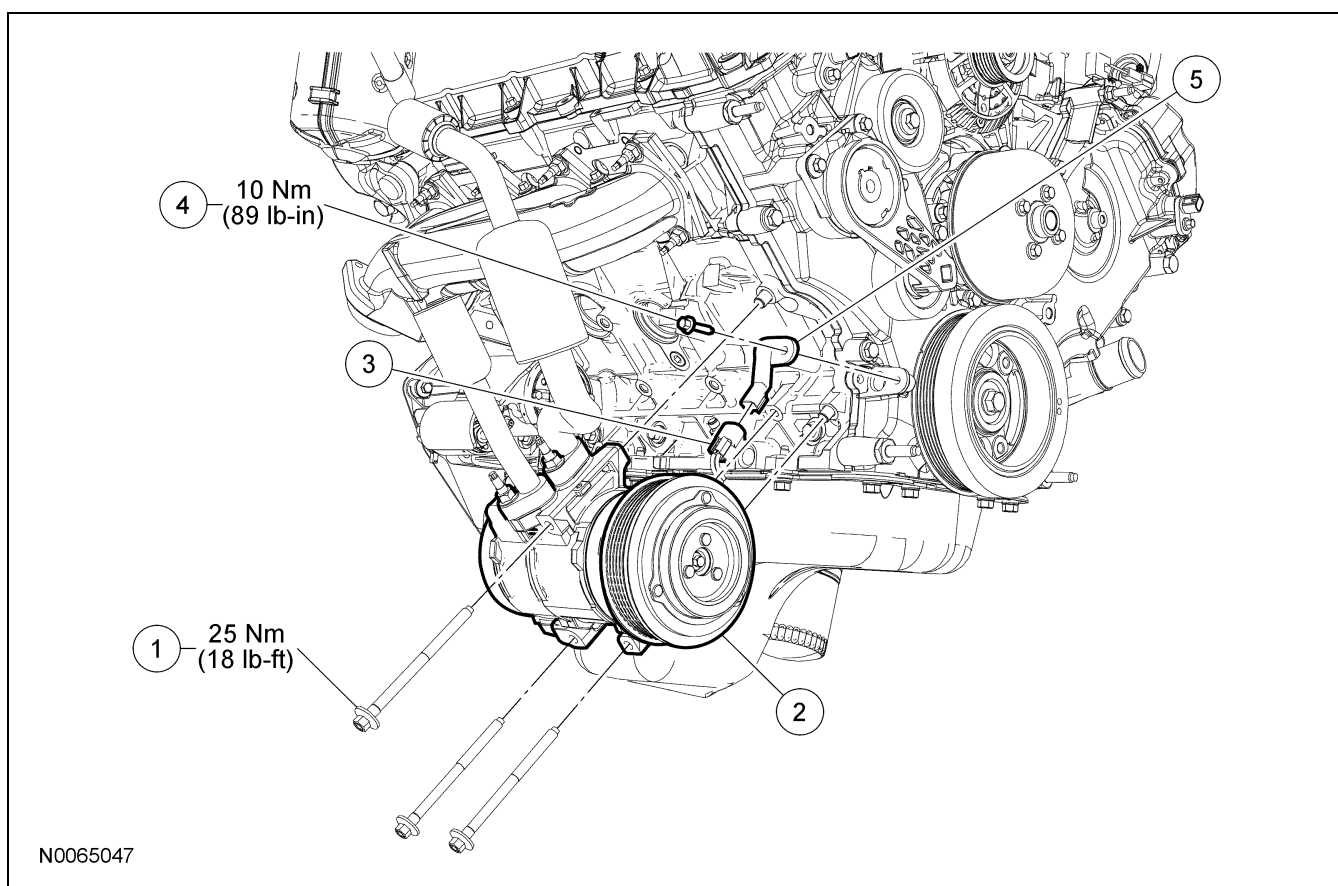
1. Remove the intake manifold. For additional information, refer to Section 303-01A.
2. Disconnect the charge motion control valve (CMCV) RH and LH rods from the intake manifold.
 - Lubricate the CMCV RH and LH rod ends with clean engine oil prior to installation.
3. Remove the stud bolt, the 2 bolts and the CMCV.
 - To install, tighten to 6 Nm (53 lb-in).
4. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Crankshaft Position (CKP) Sensor

Material

Item	Specification
Motorcraft SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP (US); Motorcraft SAE 5W-20 Super Premium Motor Oil CXO-5W20-LSP12 (Canada); or equivalent	WSS-M2C930-A



Item	Part Number	Description
1	N806184	A/C compressor bolt (3 required)
2	19703	A/C compressor
3	—	Crankshaft position (CKP) sensor electrical connector (part of 12B637)
4	N806155	CKP sensor bolt
5	6C315	CKP sensor
6	—	CKP sensor O-ring seal (part of 6C315)

Removal and Installation

1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
2. Remove the accessory drive belt. For additional information, refer to Section 303-05.

REMOVAL AND INSTALLATION (Continued)

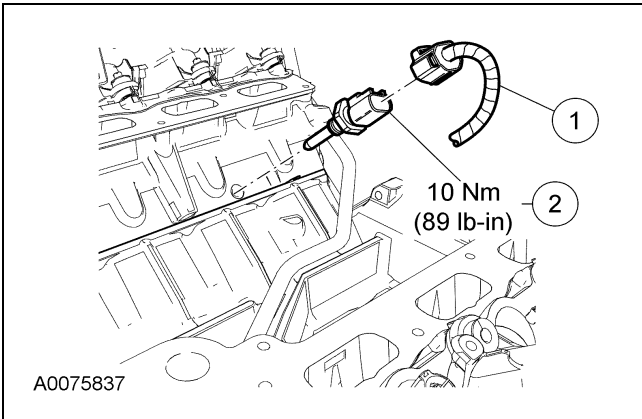
3. Remove the 3 bolts and position the A/C compressor aside.
 - To install, tighten to 25 Nm (18 lb-ft).
 4. Disconnect the crankshaft position (CKP) sensor electrical connector.
 5. Remove the bolt and the CKP sensor.
 - To install, tighten to 10 Nm (89 lb-in).
 - Lubricate the O-ring seal with clean engine oil prior to installation.
 6. To install, reverse the removal procedure.
-

REMOVAL AND INSTALLATION

Cylinder Head Temperature (CHT) Sensor

Material

Item	Specification
High Temperature Nickel Anti-Seize Lubricant XL-2 (US); CXG-2-B (Canada)	ESE-M12A4-A



Item	Part Number	Description
1	—	Cylinder head temperature (CHT) sensor electrical connector (part of 12B637)
2	6G004	CHT sensor

Removal and Installation

1. Remove the intake manifold. For additional information, refer to Section 303-01A (5.4L) or Section 303-01B (6.8L).
2. Disconnect the cylinder head temperature (CHT) sensor electrical connector.
3. Remove the CHT sensor and discard.
 - To install, tighten to 10 Nm (89 lb-in).
 - Coat the new CHT sensor threads with high temperature nickel anti-seize lubricant prior to installation.
4. To install, reverse the removal procedure.

DESCRIPTION AND OPERATION

Electronic Engine Controls

The electronic engine controls consist of the:

- powertrain control module (PCM).
- camshaft position (CMP) sensor.
- crankshaft position (CKP) sensor.
- throttle position (TP) sensor.
- mass air flow (MAF) sensor.
- heated oxygen sensor (HO2S).
- catalyst monitor sensor (CMS).
- charge motion control valve (CMCV) (5.4L).
- intake manifold runner control (IMRC) actuator (6.8L).
- knock sensor (KS).
- cylinder head temperature (CHT) sensor.
- engine oil temperature (EOT) sensor.
- variable camshaft timing (VCT) oil control solenoid (5.4L).
- clutch pedal position (CPP) switch.
- fuel rail pressure and temperature sensor.

The PCM needs the following inputs to control the engine correctly:

- Camshaft position
- Crankshaft position
- Engine rpm
- Engine cylinder head temperature
- Amount of engine detonation
- Fuel rail pressure and temperature

The CMP sensor:

- sends the PCM a signal indicating camshaft position used for fuel synchronization and coil firing.

The CKP sensor:

- sends the PCM a signal indicating crankshaft position.
- is essential for calculating spark timing.

The TP sensor:

- sends the PCM a signal indicating the throttle plate angle.
- is the main input to the PCM from the driver.

The MAF sensor:

- sends the PCM a signal indicating mass airflow rate of air entering the engine.
- incorporates the intake air temperature (IAT) sensor.

The HO2S and CMS:

- have the ability to create a voltage signal dependent on exhaust oxygen content.
- provide feedback information to the PCM used to calculate fuel delivery.

The KS sensor:

- is located top forward of the block under the intake manifold.
- sends a signal to the PCM indicating engine detonation.

The CHT sensor:

- is mounted into the wall of the cylinder head and is not connected to any coolant passages.
- sends a signal to the PCM indicating the cylinder head temperature.
 - If the temperature exceeds 126°C (258°F), the PCM disables 4 fuel injectors at a time. The PCM will alternate which 4 injectors are disabled every 32 engine cycles. The 4 cylinders that are not being fuel injected act as air pumps to aid in cooling the engine.
 - If the temperature exceeds 154 °C (310°F), the PCM disables all of the fuel injectors until the engine temperature drops below 154°C (310°F).

The fuel rail pressure and temperature sensor:

- measures the fuel pressure and temperature and sends these signals to the PCM.
- uses intake manifold vacuum as a pressure reference.

DESCRIPTION AND OPERATION (Continued)

The VCT oil control solenoid (5.4L):

- is an electrically controlled hydraulic valve that directs engine oil to the variable camshaft. Once the PCM transmits a signal, the solenoid moves a valve spool, directing oil into the camshaft phaser cavity. This action changes valve timing by either inducing an advance or retard condition. The camshaft is, thereby repositioned in relation to crankshaft timing and allows for optimum engine performance and lower emissions.

The CPP switch (manual transmission only):

- sends a signal to the PCM indicating clutch pedal position.

The 5.4L air induction system improves engine performance by using the CMCV assemblies as follows:

- The intake manifold has 2 runners per cylinder, feeding each of the intake ports in the cylinder heads.
- The CMCV assemblies are located between the intake manifold and cylinder heads, providing 2 air passages for each cylinder.
- One air passage is always open and the other passage switches from closed to open by means of a valve plate.

- The valve plates are opened and closed by the CMCV electric actuator, which is controlled by the PCM.


The 6.8L air induction system improves engine performance by using the IMRC as follows:

- The intake manifold has 2 runners per cylinder, feeding each of the intake ports in the cylinder heads.
- The IMRC assemblies are located between the upper intake manifold and cylinder heads, providing 2 air passages for each cylinder.
- The valve plates are opened and closed by the IMRC electric actuator, which is controlled by PCM.
- One air passage is always open and the other passage switches from closed to open by means of a valve plate.
 - Below 1,500 rpm, this valve plate is closed to improve fuel economy and emissions.
 - Above 1,500 rpm, this valve plate opens to improve high speed engine performance.

DESCRIPTION AND OPERATION

Fuel Charging and Controls

Sequential Multi-port Fuel Injection (SFI)

 **WARNING:** Do not smoke, carry lighted tobacco or have an open flame of any type when working on or near any fuel-related component. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in serious personal injury.

The fuel charging and controls system consists of the:

- throttle body.
- fuel injectors.
- fuel rail.

The fuel charging and controls system is:


- a sequential multi-port fuel injection (SFI) system.
- pulse width modulated (PWM).
- mass air flow (MAF) controlled.

Fuel is metered into each intake port in a sequential firing order. Fuel injectors pulse to follow engine firing order, in accordance with engine demand, on a tuned intake manifold.

The basic fuel requirement of the engine is determined from the data supplied to the powertrain control module (PCM) by the MAF sensor, which measures the amount of air being drawn into the engine.

The various sensors detect any changes in the operating conditions and send signals to the PCM. This permits the PCM to control the opening duration (pulse width) of the fuel injectors and maintain optimum exhaust emission control and engine performance for all operating conditions.

Throttle Body

 **CAUTION:** Do not hold the throttle plate open with any object that could scratch the bore or plate while servicing or cleaning the throttle body.

The throttle body:

- controls air supply to the intake manifold by electronically positioning the throttle plate.
- is not adjustable.
- must be removed from the vehicle to be cleaned.

Refer to Throttle Body in this section.


Fuel Injectors

The fuel injectors:

- are electronically operated by the PCM.
- atomize the fuel as the fuel is delivered.
- each have an internal solenoid that opens a needle valve, which injects fuel into the intake port in the cylinder head.
- are deposit resistant.

For removal and installation, refer to Fuel Rail and Fuel Injector — Exploded View and Fuel Rail in this section.

Fuel Rail

 **CAUTION:** The fuel injectors and the fuel rail must be handled with extreme care to prevent damage to sealing areas and sensitive fuel-metering orifices.

The fuel rail:

- receives fuel from the fuel supply tube.
- delivers fuel to the fuel injectors.

For removal and installation, refer to Fuel Rail and Fuel Injector — Exploded View and Fuel Rail in this section.


REMOVAL AND INSTALLATION


Fuel Injectors


Material


Item	Specification
Motorcraft SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP (US); Motorcraft SAE 5W-20 Super Premium Motor Oil CXO-5W20-LSP12 (Canada); or equivalent	WSS-M2C930-A

Removal and Installation

 **WARNING:** Do not smoke, carry lighted tobacco or have an open flame of any type when working on or near any fuel-related component. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in serious personal injury.

 **WARNING:** Before working on or disconnecting any of the fuel tubes or fuel system components, relieve the fuel system pressure to prevent accidental spraying of fuel. Fuel in the fuel system remains under high pressure, even when the engine is not running. Failure to follow this instruction may result in serious personal injury.

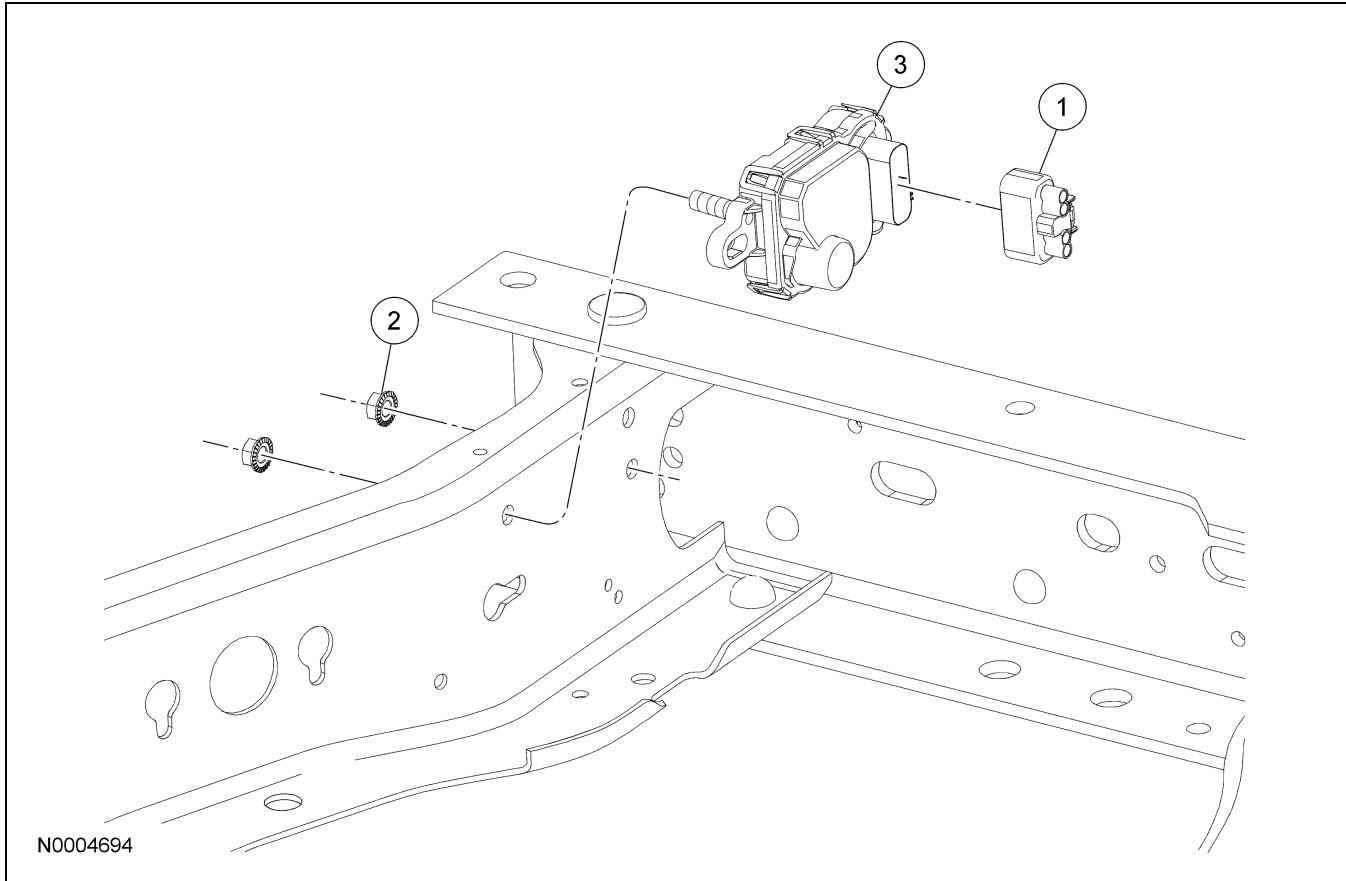
 **CAUTION:** Fuel injection equipment is manufactured to very precise tolerances and fine clearances. It is therefore essential that absolute cleanliness is observed when working with these components. Always install blanking plugs to any open orifices or tubes.

1. Remove the fuel rail. For additional information, refer to Fuel Rail in this section.
2.  **CAUTION:** Use O-ring seals that are made of special fuel-resistant material. Use of ordinary O-rings can cause the fuel system to leak.
NOTE: Lubricate the new O-ring seals with clean engine oil prior to installation.
Remove the fuel injectors from the intake manifold and discard the upper and lower fuel injector O-ring seals.
3. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Fuel Pump Driver Module (FPDM)

Removal and Installation



Item	Part Number	Description
1	14A464	Fuel pump driver module (FPDM) electrical connector (part of 14405)
2	W705448-S	FPDM nut
3	9D370	FPDM

1. **NOTE:** The fuel pump driver module (FPDM) is located on the LH rear of the vehicle above the spare tire.

NOTE: Vehicle may be equipped with a spare tire lock. If so, the key is located in the glove compartment.

Insert the drive end of the jack handle, with the spare tire carrier key attached, through the opening left of the license plate. Lower and remove the spare tire assembly.

2. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
3. Disconnect the fuel pump driver module (FPDM) electrical connector.
4. Remove the FPDM nuts.
 - To install, tighten to 10 Nm (89 lb-in).
5. Remove the FPDM.
6. To install, reverse the removal procedure.


REMOVAL AND INSTALLATION


Fuel Rail


Material


Item	Specification
Motorcraft SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP (US); Motorcraft SAE 5W-20 Super Premium Motor Oil CXO-5W20-LSP12 (Canada); or equivalent	WSS-M2C930-A

Removal and Installation

 **WARNING:** Do not smoke, carry lighted tobacco or have an open flame of any type when working on or near any fuel-related component. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in serious personal injury.

 **WARNING:** Before working on or disconnecting any of the fuel tubes or fuel system components, relieve the fuel system pressure to prevent accidental spraying of fuel. Fuel in the fuel system remains under high pressure, even when the engine is not running. Failure to follow this instruction may result in serious personal injury.

 **CAUTION:** Fuel injection equipment is manufactured to very precise tolerances and fine clearances. It is therefore essential that absolute cleanliness is observed when working with these components. Always install blanking plugs to any open orifices or tubes.

 **CAUTION:** When reusing liquid or vapor tube connectors, make sure to use compressed air to remove any foreign material from the connector retaining clip area before separating from the tube.

- Release the fuel system pressure. For additional information, refer to Section 310-00.
- Disconnect the battery ground cable. For additional information, refer to Section 414-01.
- Remove the air cleaner outlet tube. For additional information, refer to Section 303-12.
- Disconnect the quick connect couplings and remove the crankcase vent tube. For additional information, refer to Section 310-00.
- Disconnect the vacuum hose from the air cleaner outlet pipe-to-throttle body (TB) adapter and position aside.
- Disconnect the wiring harness retainer from the air cleaner outlet pipe-to-TB adapter.
- Remove the 4 air cleaner outlet pipe-to-TB adapter bolts.
 - To install, tighten to 10 Nm (89 lb-in).
- Remove the air cleaner outlet pipe-to-TB adapter.
- Disconnect the quick connect couplings and remove the positive crankcase ventilation (PCV) tube. For additional information, refer to Section 310-00.
- Disconnect the evaporative emissions (EVAP) tube quick connect coupling from the intake manifold and position aside. For additional information, refer to Section 310-00.
- Disconnect the fuel rail pressure and temperature sensor electrical and vacuum connectors.
- Disconnect the 8 fuel injector electrical connectors.
- Disconnect the electronic throttle control electrical connector.
- Disconnect the throttle position (TP) sensor electrical connector.
- Disconnect the heated PCV intake fitting electrical connector.
- Disconnect the fuel supply tube spring lock coupling. For additional information, refer to Section 310-00.

REMOVAL AND INSTALLATION (Continued)

17. **NOTE:** When removing the fuel rail, leave the fuel injectors in the intake manifold. This will make removal of the fuel rail easier.

Remove the 4 fuel rail bolts and the fuel rail.

- To install, tighten to 10 Nm (89 lb-in).

18. **NOTE:** Lubricate the new O-ring seal with clean engine oil prior to installation.

If servicing the fuel rail, remove the 2 bolts and the fuel rail pressure and temperature sensor.

- Discard the O-ring seal.
- To install, tighten to 4 Nm (35 lb-in).

19. Remove the fuel injectors from the intake manifold. For additional information, refer to Fuel Injectors in this section.

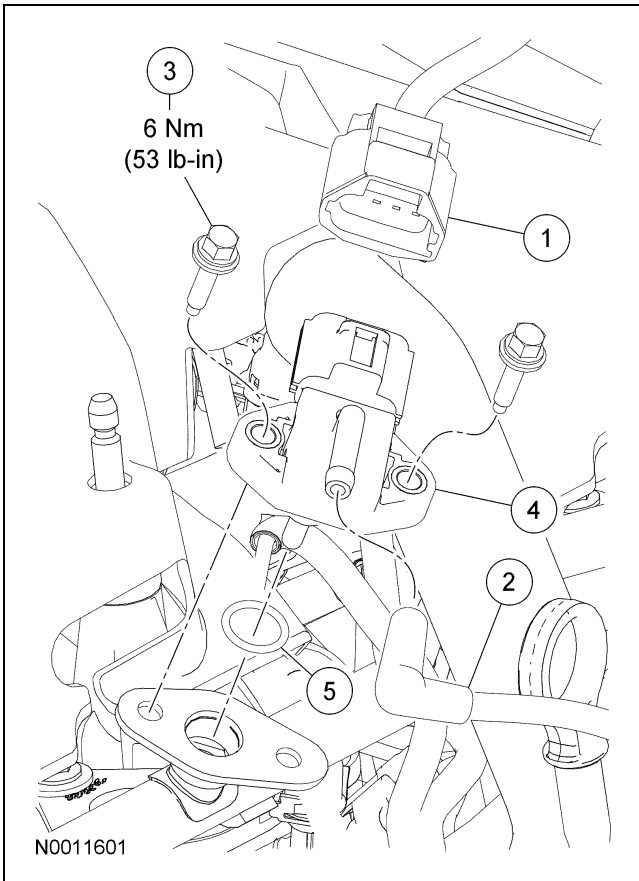
20. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Fuel Rail Pressure and Temperature Sensor — 5.4L

Material

Item	Specification
Motorcraft SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP (US); Motorcraft SAE 5W-20 Super Premium Motor Oil CXO-5W20-LSP12 (Canada); or equivalent	WSS-M2C930-A



Item	Part Number	Description
1	—	Fuel rail pressure and temperature sensor electrical connector (part of 12B637)
2	9E498	Fuel rail pressure and temperature sensor vacuum connector
3	N808874	Fuel rail pressure and temperature sensor bolt (2 required)

(Continued)

Item	Part Number	Description
4	9F972	Fuel rail pressure and temperature sensor
5	—	Fuel rail pressure and temperature sensor O-ring seal

Removal and Installation

⚠ WARNING: Do not smoke, carry lighted tobacco or have an open flame of any type when working on or near any fuel-related component. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in serious personal injury.

⚠ WARNING: Before working on or disconnecting any of the fuel tubes or fuel system components, relieve the fuel system pressure to prevent accidental spraying of fuel. Fuel in the fuel system remains under high pressure, even when the engine is not running. Failure to follow this instruction may result in serious personal injury.

1. Release the fuel system pressure. For additional information, refer to Section 310-00.
2. Disconnect the battery ground cable. For additional information, refer to Section 414-01.
3. Disconnect the fuel rail pressure and temperature sensor electrical and vacuum connectors.

REMOVAL AND INSTALLATION (Continued)

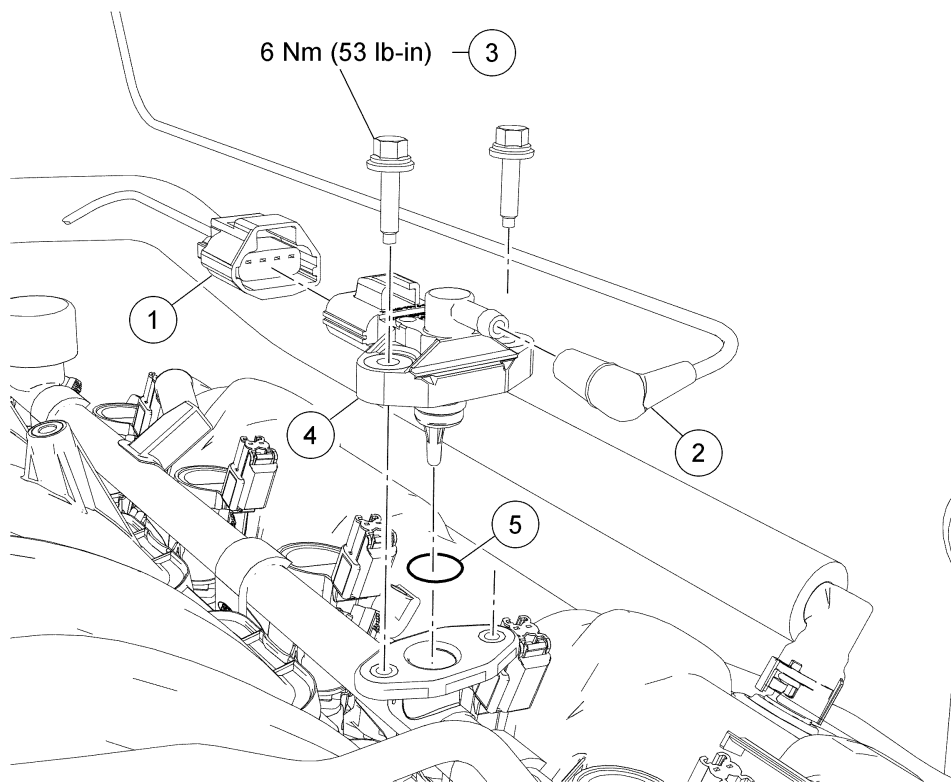
4. Remove the 2 bolts and the fuel rail pressure and temperature sensor and discard the O-ring seal.
 - To install, tighten to 6 Nm (53 lb-in).
 - Install a new O-ring seal.
 - Lubricate the new O-ring seal with clean engine oil prior to installation.
 5. To install, reverse the removal procedure.
-

REMOVAL AND INSTALLATION

Fuel Rail Pressure and Temperature Sensor — 6.8L

Material

Item	Specification
Motorcraft SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP (US); Motorcraft SAE 5W-20 Super Premium Motor Oil CXO-5W20-LSP12 (Canada); or equivalent	WSS-M2C930-A




N0011602


Item	Part Number	Description
1	—	Fuel rail pressure and temperature sensor electrical connector (part of 12B637)
2	9E498	Fuel rail pressure and temperature sensor vacuum connector
3	W705870	Fuel rail pressure and temperature sensor bolt (2 required)

(Continued)

Item	Part Number	Description
4	9F972	Fuel rail pressure and temperature sensor
5	—	Fuel rail pressure and temperature sensor O-ring seal

REMOVAL AND INSTALLATION (Continued)**Removal and Installation**

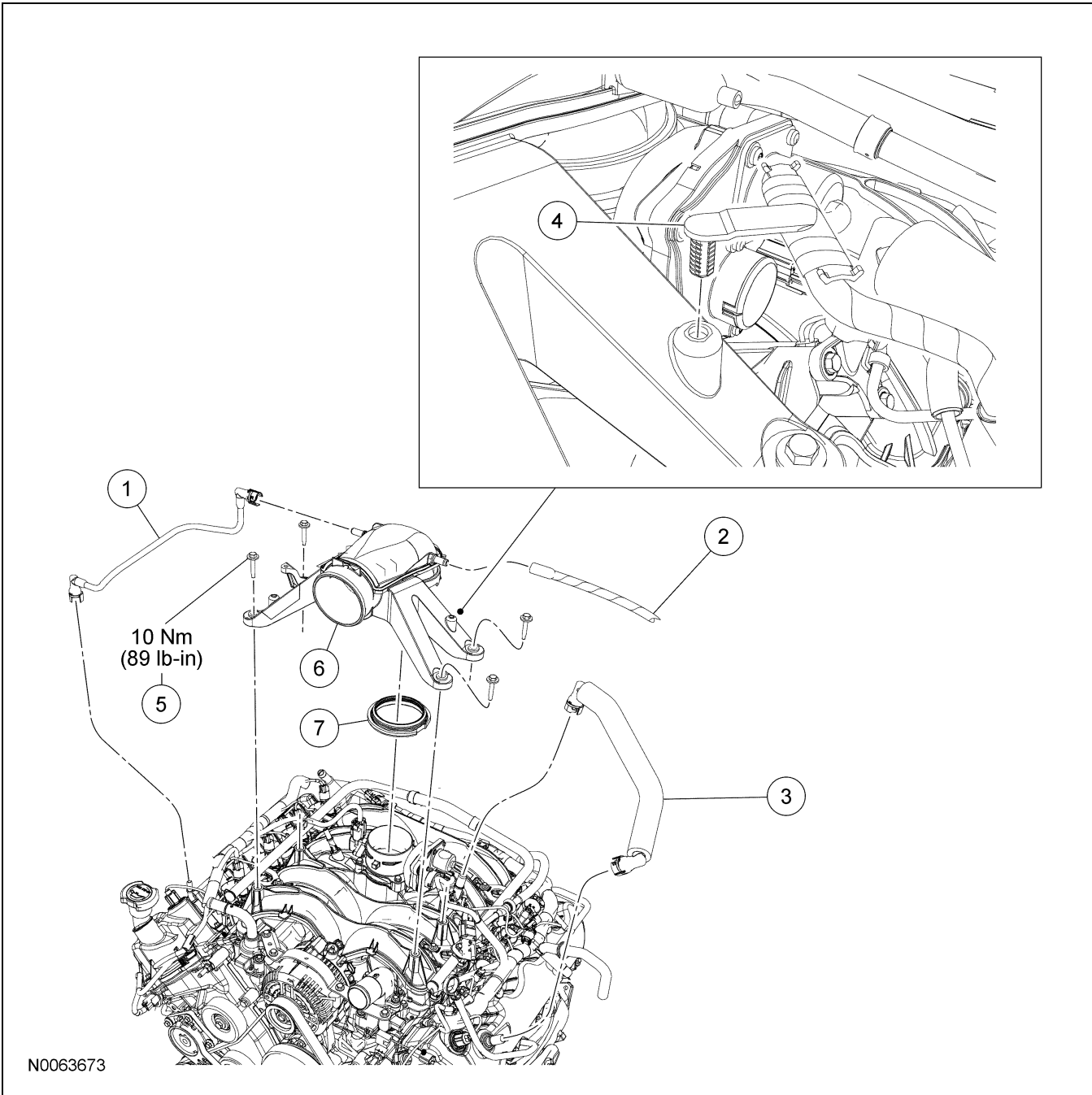
 **WARNING:** Do not smoke, carry lighted tobacco or have an open flame of any type when working on or near any fuel-related component. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in serious personal injury.

 **WARNING:** Before working on or disconnecting any of the fuel tubes or fuel system components, relieve the fuel system pressure to prevent accidental spraying of fuel. Fuel in the fuel system remains under high pressure, even when the engine is not running. Failure to follow this instruction may result in serious personal injury.

1. Release the fuel system pressure. For additional information, refer to Section 310-00.
 2. Disconnect the battery ground cable. For additional information, refer to Section 414-01.
 3. Disconnect the fuel rail pressure and temperature sensor electrical and vacuum connectors.
 4. Remove the 2 bolts and the fuel rail pressure and temperature sensor and discard the O-ring seal.
 - To install, tighten to 6 Nm (53 lb-in).
 - Install a new O-ring seal.
 - Lubricate the new O-ring seal with clean engine oil prior to installation.
 5. To install, reverse the removal procedure.
-

REMOVAL AND INSTALLATION

Fuel Rail and Fuel Injector —
Exploded View

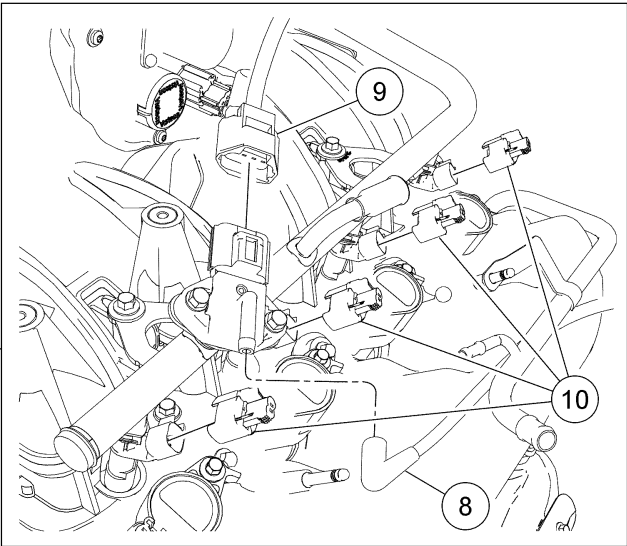
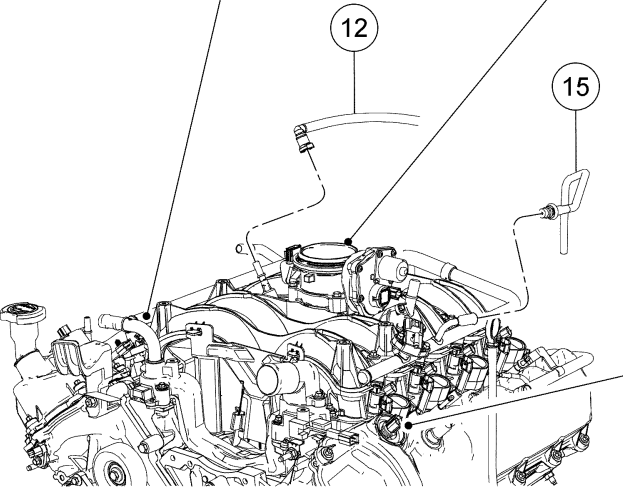
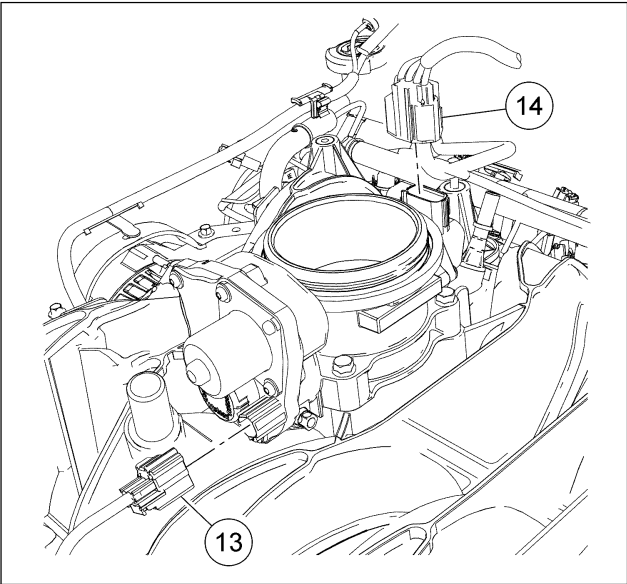
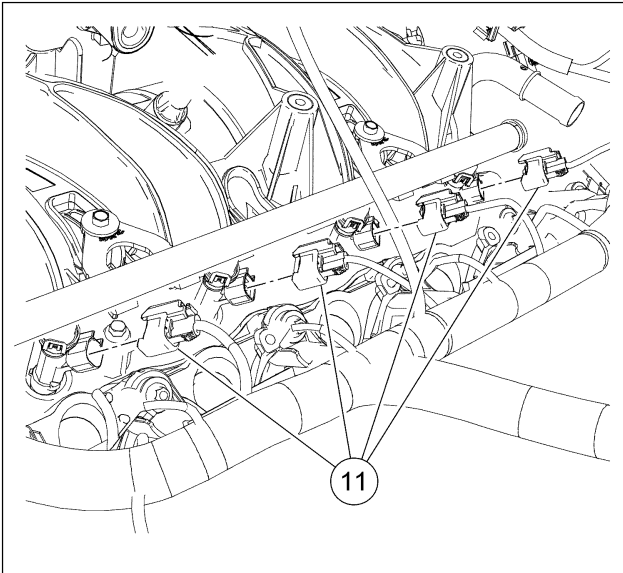


Item	Part Number	Description
1	6758	Crankcase ventilation tube
2	—	Vacuum hose (part of 9D446)
3	6K817	Positive crankcase ventilation (PCV) tube
4	—	Engine wiring harness retainer (part of 12B637)

(Continued)

Item	Part Number	Description
5	9F991	Air cleaner outlet pipe-to-throttle body (TB) adapter bolt (4 required)
6	9A589	Air cleaner outlet pipe-to-TB adapter
7	—	Air cleaner outlet pipe-to-TB adapter seal (part of 9A589)

REMOVAL AND INSTALLATION (Continued)



N0063674

Item	Part Number	Description
8	—	Fuel rail pressure and temperature sensor vacuum hose (part of 9D446)
9	—	Fuel rail pressure and temperature sensor electrical connector (part of 12B637)
10	—	LH fuel injector electrical connectors (4 required) (part of 12B637)

(Continued)

Item	Part Number	Description
11	—	RH fuel injector electrical connectors (4 required) (part of 12B637)
12	6K824	Evaporative emissions system (EVAP) tube
13	—	Electronic acceleration control electrical connector (part of 12B637)

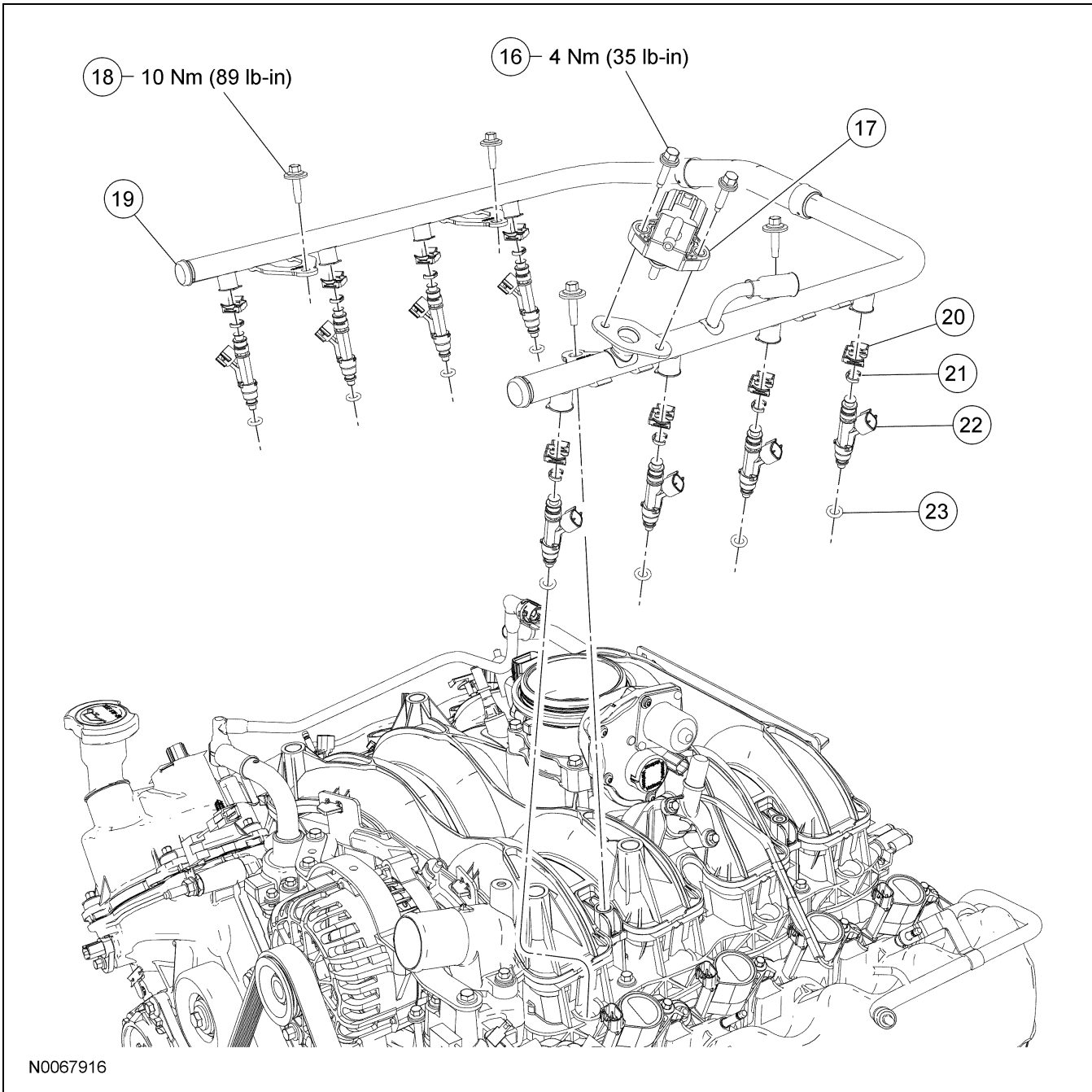
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REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
14	—	Throttle position (TP) sensor electrical connector (part of 12B637)

(Continued)

Item	Part Number	Description
15	9J274	Fuel tube spring lock coupling



Item	Part Number	Description
16	N808874	Fuel rail pressure and temperature sensor bolt (2 required)
17	9F972	Fuel rail pressure and temperature sensor

(Continued)

Item	Part Number	Description
18	N804394	Fuel rail bolt (4 required)
19	9F792	Fuel rail
20	9C995	Fuel injector-to-fuel rail locking clip (8 required)

(Continued)

REMOVAL AND INSTALLATION (Continued)

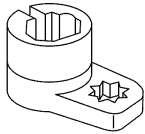
Item	Part Number	Description
21	—	Fuel injector-to-fuel rail O-ring seal (8 required)
22	9F593	Fuel injector (8 required)
23	—	Fuel injector-to-intake manifold O-ring seal (8 required)

1. For additional information, refer to the procedures in this section.

REMOVAL AND INSTALLATION

Heated Oxygen Sensor (HO2S)

Special Tool(s)

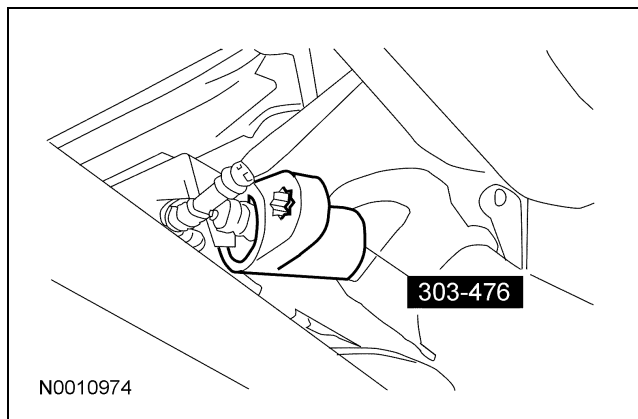
	Socket, Exhaust Gas Oxygen Sensor 303-476 (T94P-9472-A)
ST1447-A	

Material

Item	Specification
High Temperature Nickel Anti-Seize Lubricant XL-2 (US); CXG-2-B (Canada)	ESE-M12A4-A
Penetrating and Lock Lubricant XL-1 (US); CXC-51-A (Canada)	—

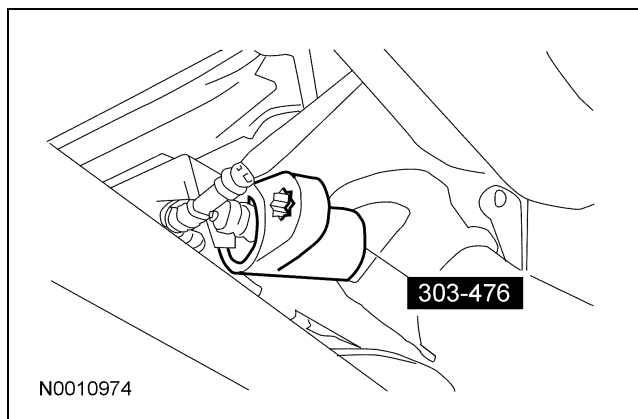
Removal

1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
2. Disconnect the heated oxygen sensor (HO2S) electrical connector.
3. Using the special tool, remove the HO2S.
 - Apply penetrating lubricant to the HO2S to assist in removal.



Installation

1. Using the special tool, install the HO2S.
 - To install, tighten to 46 Nm (34 lb-ft).
 - Apply a light coat of high temperature nickel anti-seize lubricant to the HO2S threads prior to installation.

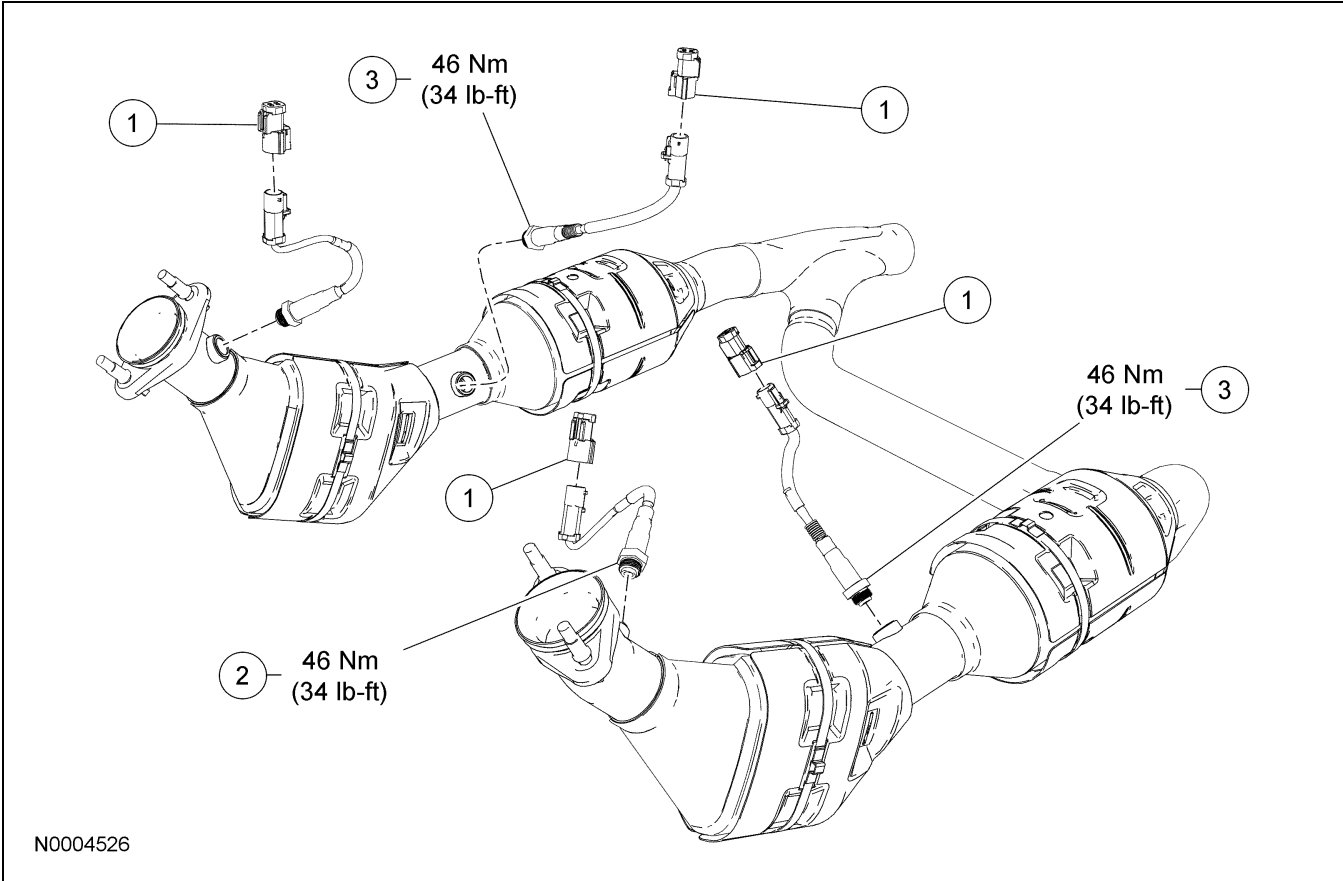


2. Connect the HO2S electrical connector.

REMOVAL AND INSTALLATION

Heated Oxygen Sensor (HO2S) and
Catalyst Monitor Sensor — Exploded
View

NOTE: 5.4L shown, 6.8L similar.



Item	Part Number	Description
1	—	Sensor electrical connectors (part of 14A464)
2	9F472	Heated oxygen sensor (HO2S) (2 required)
3	9G444	Catalyst monitor sensors (2 required)

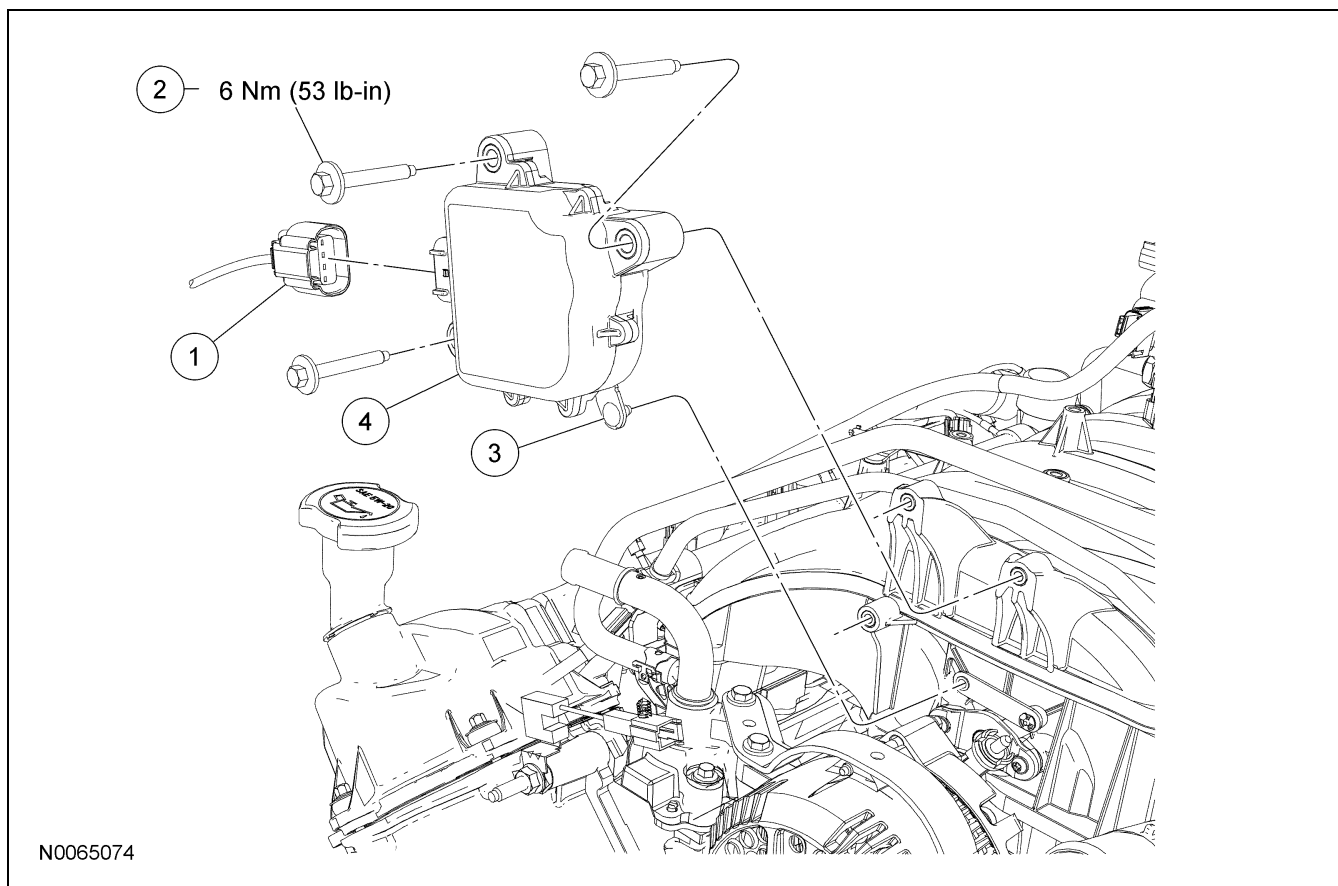
1. For additional information, refer to the procedures in this section.

REMOVAL AND INSTALLATION

Intake Manifold Runner Control (IMRC) Actuator — 6.8L

Material

Item	Specification
Motorcraft SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP (US); Motorcraft SAE 5W-20 Super Premium Motor Oil CXO-5W20-LSP12 (Canada); or equivalent	WSS-M2C930-A



Item	Part Number	Description
1	—	Intake manifold runner control (IMRC) actuator electrical connector (part of 12B637)
2	W503917-S	IMRC bolt (3 required)
3	—	IMRC rod pivot pin
4	9J559	IMRC

Removal and Installation

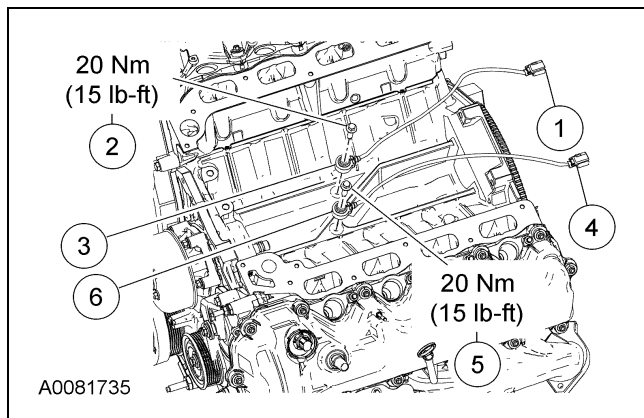
1. Remove the air cleaner outlet pipe. For additional information, refer to Section 303-12.
2. Disconnect the intake manifold runner control (IMRC) actuator electrical connector.
3. Remove the 3 bolts.
 - To install, tighten to 6 Nm (53 lb-in).

REMOVAL AND INSTALLATION (Continued)

4. Disconnect the IMRC rod pivot pin from the intake manifold rod and remove the IMRC.
 - Lubricate the IMRC rod pivot pin with clean engine oil prior to installation.
 5. To install, reverse the removal procedure.
-

REMOVAL AND INSTALLATION

Knock Sensor (KS) — 5.4L



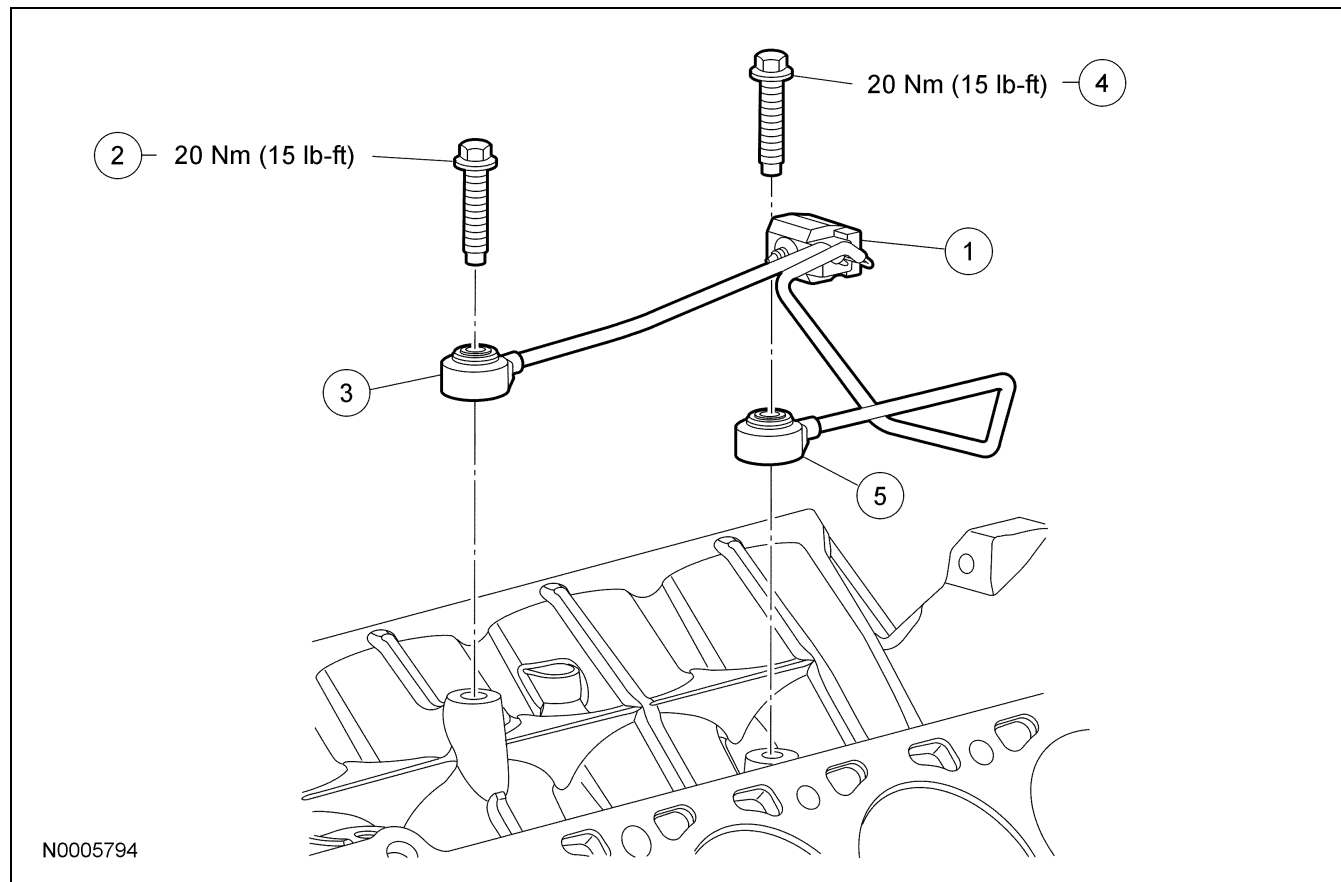
Item	Part Number	Description
1	—	RH knock sensor (KS) electrical connector (part of 12B637)
2	W500225	RH KS bolt
3	12A699	RH KS
4	14A464	LH KS electrical connector
5	W500225	LH KS bolt
6	12A699	LH KS

Removal and Installation

1. Remove the intake manifold. For additional information, refer to Section 303-01A.
2. Disconnect the knock sensor (KS) electrical connectors.
3. Remove the 2 bolts and the 2 KS.
 - To install, tighten to 20 Nm (15 lb-ft).
4. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Knock Sensor (KS) — 6.8L



Item	Part Number	Description
1	—	Knock sensor (KS) electrical connector (part of 12B637)
2	W500225	RH KS bolt
3	12A699	RH KS
4	W500225	LH KS bolt
5	12A699	LH KS

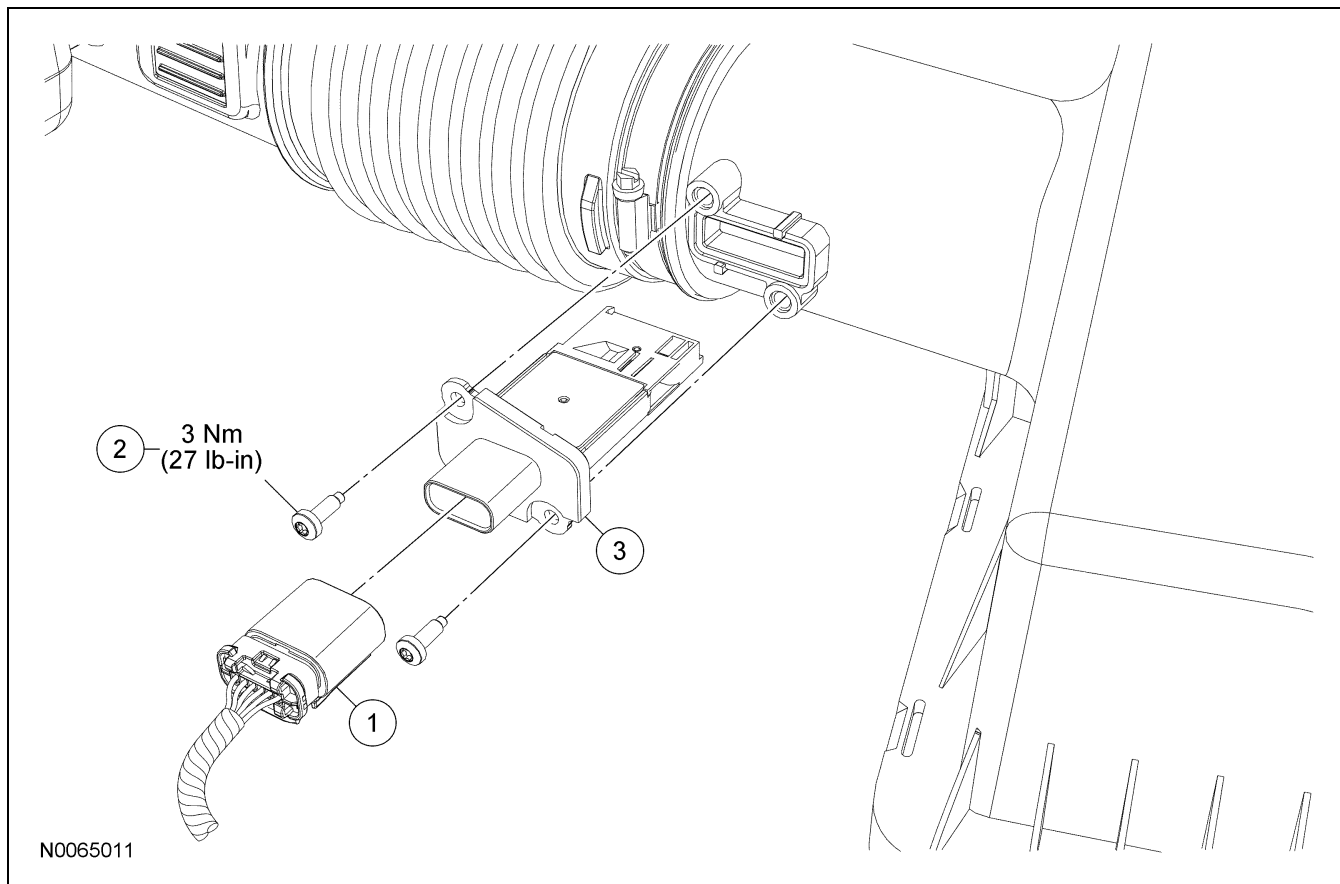
2. Disconnect the knock sensor (KS) electrical connector.
3. Remove the 2 bolts and the 2 KS.
 - To install, tighten to 20 Nm (15 lb-ft).
4. To install, reverse the removal procedure.

Removal and Installation

1. Remove the intake manifold. For additional information, refer to Section 303-01B.

REMOVAL AND INSTALLATION

Mass Air Flow (MAF) Sensor



Item	Part Number	Description
1	—	Mass air flow (MAF) sensor electrical connector (part of 12B637)
2	W505562	MAF sensor bolt (2 required)
3	12B579	MAF sensor

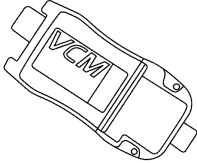
Removal and Installation

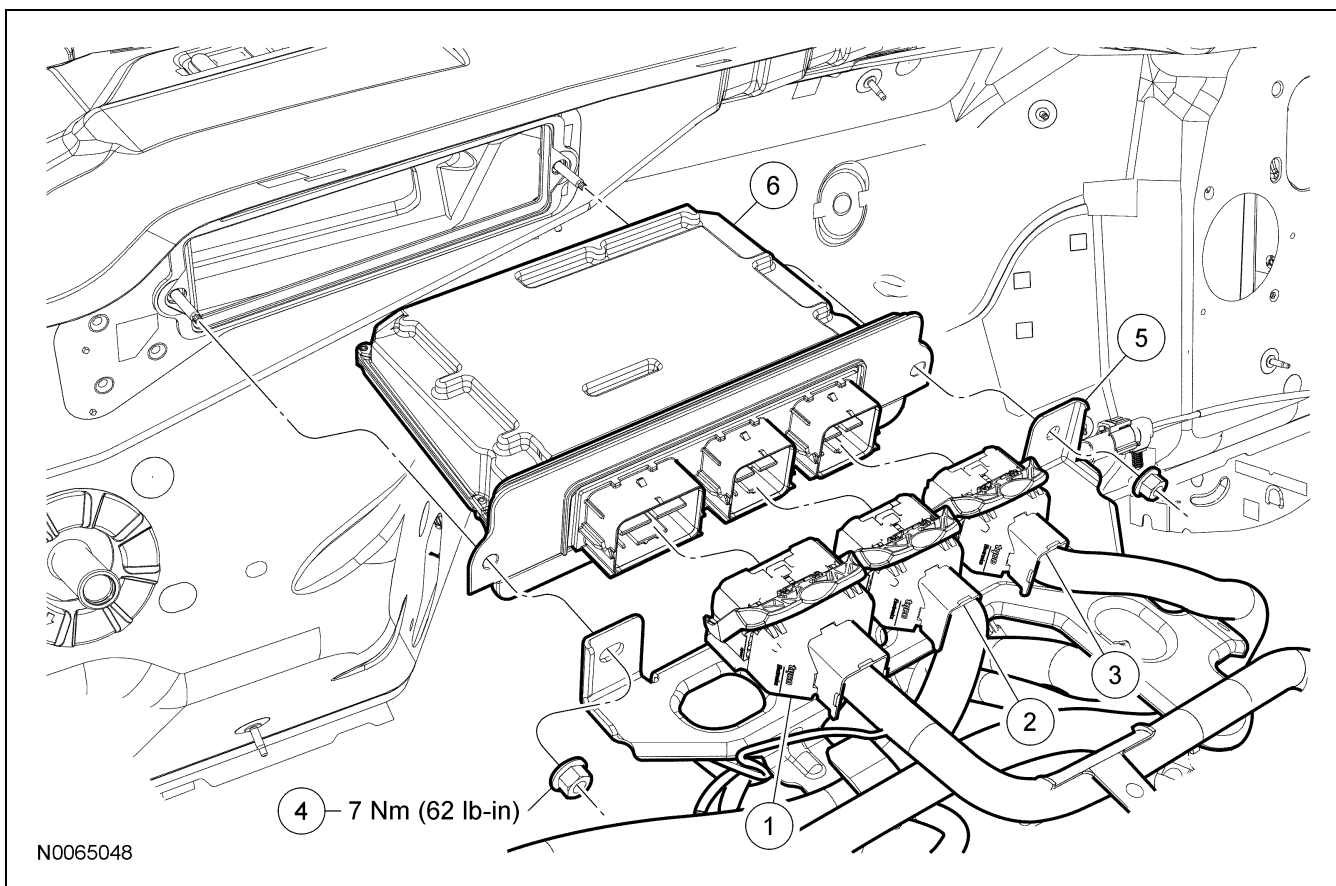
1. Disconnect the mass air flow (MAF) sensor electrical connector.
2. Remove the 2 bolts and the MAF sensor.
 - To install, tighten to 3 Nm (27 lb-in).
3. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Powertrain Control Module (PCM)

Special Tool(s)

	Vehicle Communication Module (VCM) and Integrated Diagnostic System (IDS) software with appropriate hardware, or equivalent scan tool
ST2834-A	



Item	Part Number	Description
1	—	Powertrain control module (PCM) electrical connector (part of 12B637)
2	—	PCM electrical connector (part of 12A581)
3	—	PCM electrical connector (part of 15525)

(Continued)

Item	Part Number	Description
4	N621905	PCM wiring harness support bracket nut (2 required)
5	14A206	PCM wiring harness support bracket
6	12A650	PCM

REMOVAL AND INSTALLATION (Continued)**Removal and Installation**

1. **NOTE:** Refer to the [Powertrain Control/Emissions Diagnosis \(PC/ED\) manual](#) for correct vehicle communication module (VCM) hook-up procedure.

If servicing the powertrain control module (PCM), connect the scan tool to the vehicle. Allow the scan tool to identify the vehicle and obtain configuration data.

- All programmable module information will automatically be retrieved by the VCM.
-

2. Disconnect the 3 powertrain control module (PCM) electrical connectors.
3. Remove the 2 nuts and position the PCM wiring harness support bracket aside.
 - To install, tighten to 7 Nm (62 lb-in).
4. Remove the PCM.
5. To install, reverse the removal procedure.

2008 Ford F-350 SUPER DUTY

Submodel: XLT | Engine Type: V8 | Liters: 5.4
Fuel Delivery: FI | Fuel: GAS

SECTION 303-04A:
Fuel Charging and Controls — 5.4L (3V)

- SPECIFICATIONS
- DESCRIPTION AND OPERATION
 - Fuel Charging and Controls
- DIAGNOSIS AND TESTING
 - Fuel Charging and Controls
- REMOVAL AND INSTALLATION
 - Throttle Body
 - Fuel Rail and Fuel Injector — Exploded View
 - Fuel Rail
 - Fuel Injectors
 - Fuel Pump Driver Module (FPDM)

2008 Ford F-350 SUPER DUTY

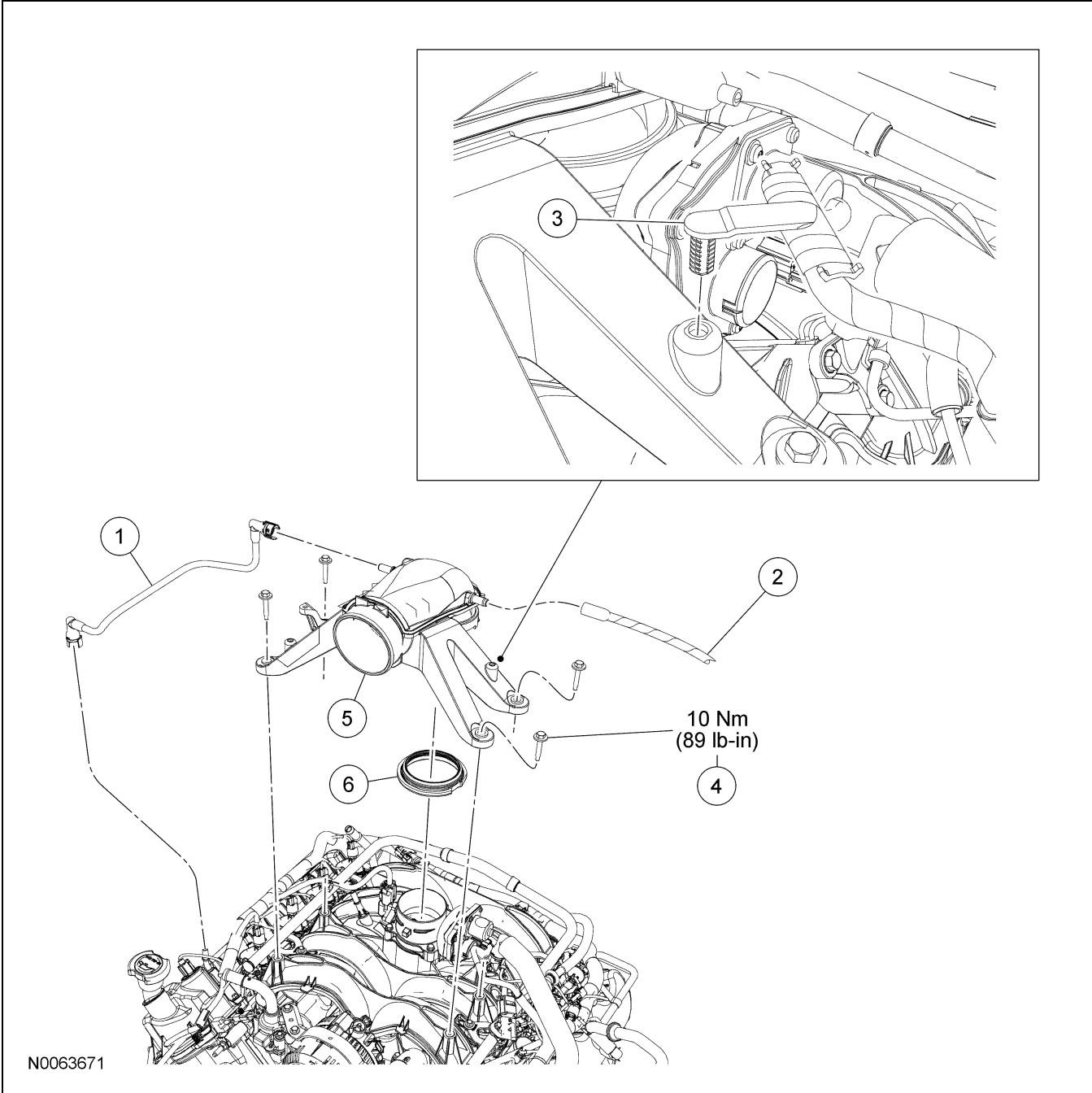
Submodel: XLT | Engine Type: V8 | Liters: 5.4
Fuel Delivery: FI | Fuel: GAS

SECTION 303-14A:
Electronic Engine Controls — Gasoline Engines

SPECIFICATIONS
DESCRIPTION AND OPERATION
Electronic Engine Controls
DIAGNOSIS AND TESTING
Electronic Engine Controls
REMOVAL AND INSTALLATION
Camshaft Position (CMP) Sensor — 5.4L
Camshaft Position (CMP) Sensor — 6.8L
Crankshaft Position (CKP) Sensor
Powertrain Control Module (PCM)
Throttle Position (TP) Sensor — 5.4L
Throttle Position (TP) Sensor — 6.8L
Fuel Rail Pressure and Temperature Sensor — 5.4L
Fuel Rail Pressure and Temperature Sensor — 6.8L
Variable Camshaft Timing (VCT) Oil Control Solenoid — 5.4L
Mass Air Flow (MAF) Sensor
Heated Oxygen Sensor (HO2S) and Catalyst Monitor Sensor — Exploded View
Heated Oxygen Sensor (HO2S)
Catalyst Monitor Sensor
Knock Sensor (KS) — 5.4L
Knock Sensor (KS) — 6.8L
Cylinder Head Temperature (CHT) Sensor
Charge Motion Control Valve (CMCV) — 5.4L
Intake Manifold Runner Control (IMRC) Actuator — 6.8L

REMOVAL AND INSTALLATION

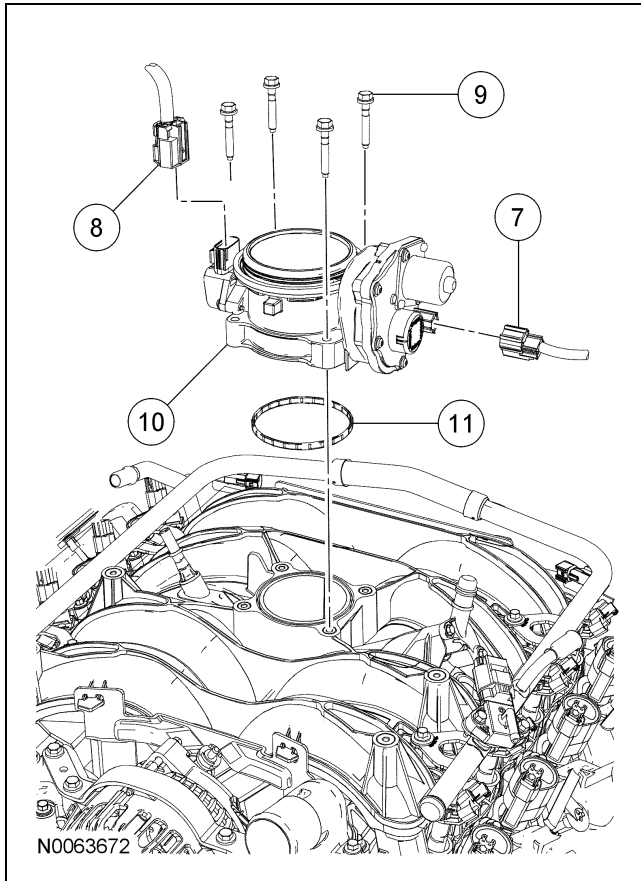
Throttle Body



Item	Part Number	Description
1	6758	Crankcase ventilation tube
2	—	Vacuum hose (part of 9D446)
3	—	Engine wiring harness retainer (part of 12B637)
4	9F991	Air cleaner outlet pipe-to-throttle body (TB) adapter bolt (4 required)

Item	Part Number	Description
5	9A589	Air cleaner outlet pipe-to-TB adapter
6	—	Air cleaner outlet pipe-to-TB adapter seal (part of 9A589)

(Continued)

REMOVAL AND INSTALLATION (Continued)**Removal**

⚠ WARNING: Do not smoke, carry lighted tobacco or have an open flame of any type when working on or near any fuel-related component. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in serious personal injury.

⚠ CAUTION: The throttle body (TB) must be removed from the vehicle to be cleaned. Do not hold the throttle plate open, with any object that could scratch the bore or plate, while servicing or cleaning the throttle body.

1. Remove the air cleaner outlet tube. For additional information, refer to Section 303-12.
2. Disconnect the crankcase vent tube quick connect coupling from the air cleaner outlet pipe-to-throttle body (TB) adapter. For additional information, refer to Section 310-00.
3. Disconnect the vacuum hose from the air cleaner outlet pipe-to-TB adapter.
4. Disconnect the wiring harness retainer from the air cleaner outlet pipe-to-TB adapter.
5. Remove the 4 air cleaner outlet pipe-to-TB adapter bolts.
6. Remove the air cleaner outlet pipe-to-TB adapter.
7. Disconnect the electronic throttle control electrical connector.
8. Disconnect the throttle position (TP) sensor electrical connector.
9. Remove the 4 bolts and the TB assembly.
 - Discard the TB O-ring seal.

Installation

1. Using a new O-ring seal, install the TB and tighten the 4 bolts in 2 stages.
 - Stage 1: Tighten to 9 Nm (80 lb-in).
 - Stage 2: Tighten an additional 90 degrees (1/4 turn).

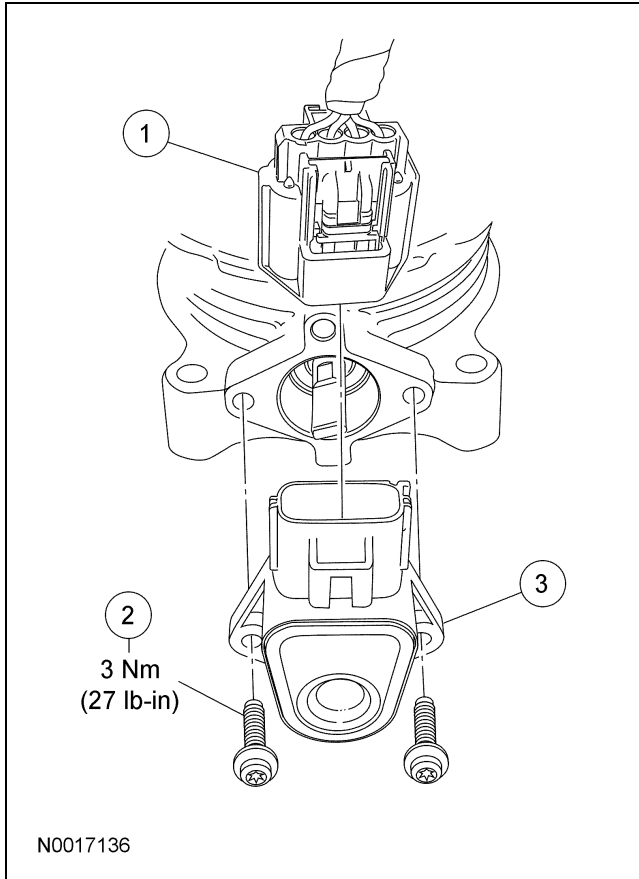
Item	Part Number	Description
7	—	Electronic throttle control electrical connector (part of 12B637)
8	—	Throttle position (TP) sensor electrical connector (part of 12B637)
9	N705438	Throttle body (TB) bolt (4 required)
10	9F991	TB
11	9E936	TB O-ring seal

REMOVAL AND INSTALLATION (Continued)

2. Connect the TP sensor electrical connector.
 3. Connect the electronic throttle control electrical connector.
 4. Install the air cleaner outlet pipe-to-TB adapter.
 5. Install the 4 air cleaner outlet pipe-to-TB adapter bolts.
 - Tighten to 10 Nm (89 lb-in).
 6. Connect the wiring harness retainer to the air cleaner outlet pipe-to-TB adapter.
 7. Connect the vacuum hose to the air cleaner outlet pipe-to-TB adapter.
 8. Connect the crankcase vent tube quick connect coupling to the air cleaner outlet pipe-to-TB adapter. For additional information, refer to Section 310-00.
 9. Install the air cleaner outlet tube. For additional information, refer to Section 303-12.
-

REMOVAL AND INSTALLATION

Throttle Position (TP) Sensor — 5.4L



Item	Part Number	Description
1	14A464	Throttle position (TP) sensor electrical connector
2	W707535	TP screw (2 required)
3	9E928	TP sensor

Removal

1. Disconnect the throttle position (TP) sensor electrical connector.
2. **CAUTION:** Failure to remove the throttle position (TP) sensor screws in the following manner will result in damage to the screws. First loosen the screws 1-2 full turns using a hand tool and then use a suitable high speed driver to complete the removal.

Remove and discard the 2 screws and the TP sensor.

Installation

1. **CAUTION:** Do not reuse the throttle position (TP) sensor and screws. A new TP sensor and screws must be installed.
 CAUTION: Do not use a high speed driver to install the new screws or damage to the throttle position (TP) sensor can occur.

NOTE: When installing the new TP sensor, make sure that the radial locator tab on the TP sensor is aligned with the radial locator hole on the throttle body.

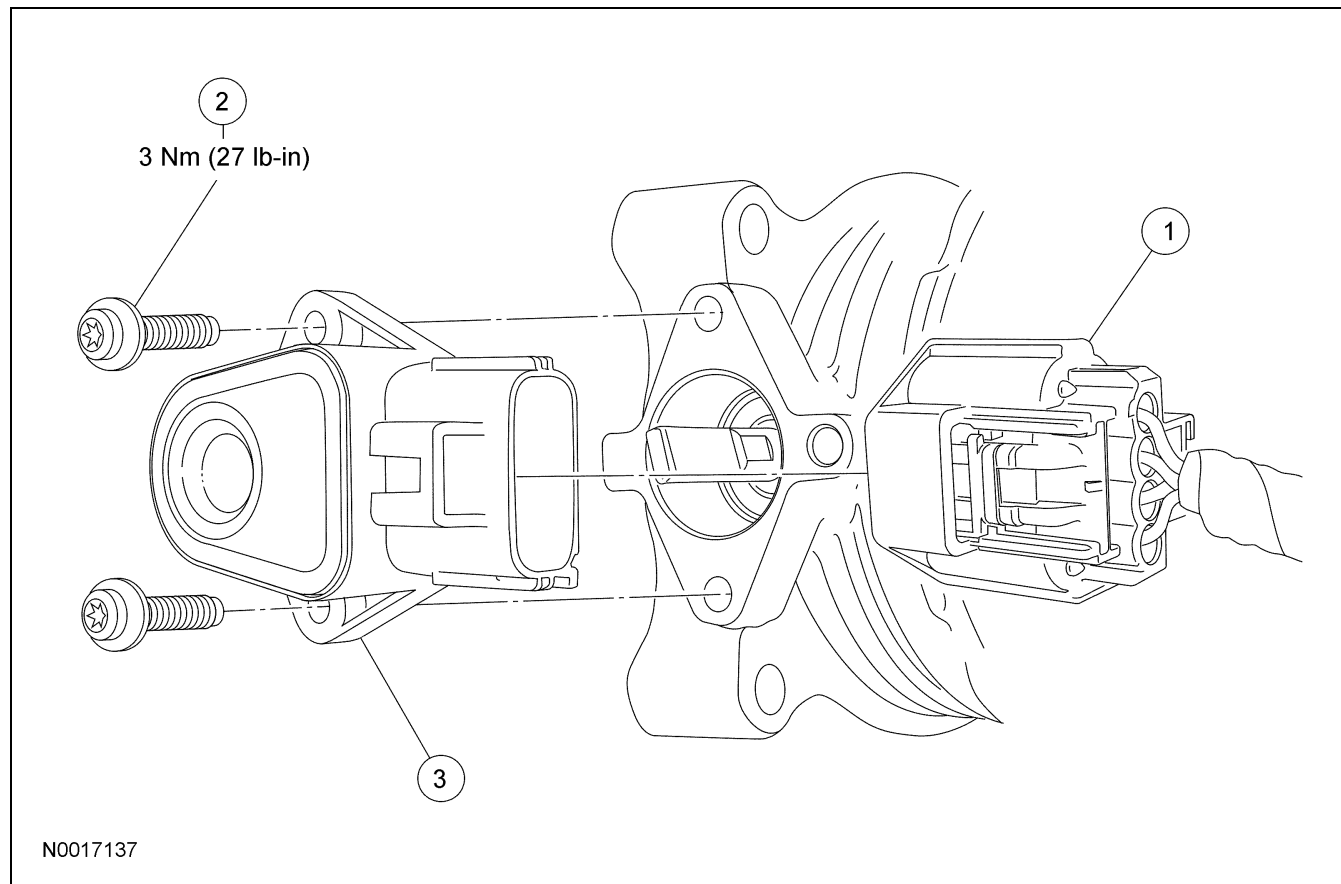
Position the new TP sensor and install the 2 new screws.

- Tighten to 3 Nm (27 lb-in).

2. Connect the TP sensor electrical connector.

REMOVAL AND INSTALLATION

Throttle Position (TP) Sensor — 6.8L



Item	Part Number	Description
1	14A464	Throttle position (TP) sensor electrical connector
2	W707535	TP screw (2 required)
3	9E928	TP sensor

Removal


1. Disconnect the throttle position (TP) sensor electrical connector.


2. **⚠ CAUTION:** Failure to remove the throttle position (TP) sensor screws in the following manner will result in damage to the screws. First loosen the screws 1-2 full turns using a hand tool and then use a suitable high speed driver to complete the removal.

Remove and discard the 2 screws and the TP sensor.

REMOVAL AND INSTALLATION (Continued)**Installation**

2. Connect the TP sensor electrical connector.

1.  **CAUTION:** Do not reuse the throttle position (TP) sensor and screws. A new TP sensor and screws must be installed.

 **CAUTION:** Do not use a high speed driver to install the new screws or damage to the throttle position (TP) sensor can occur.

NOTE: When installing the new TP sensor, make sure that the radial locator tab on the TP sensor is aligned with the radial locator hole on the throttle body.

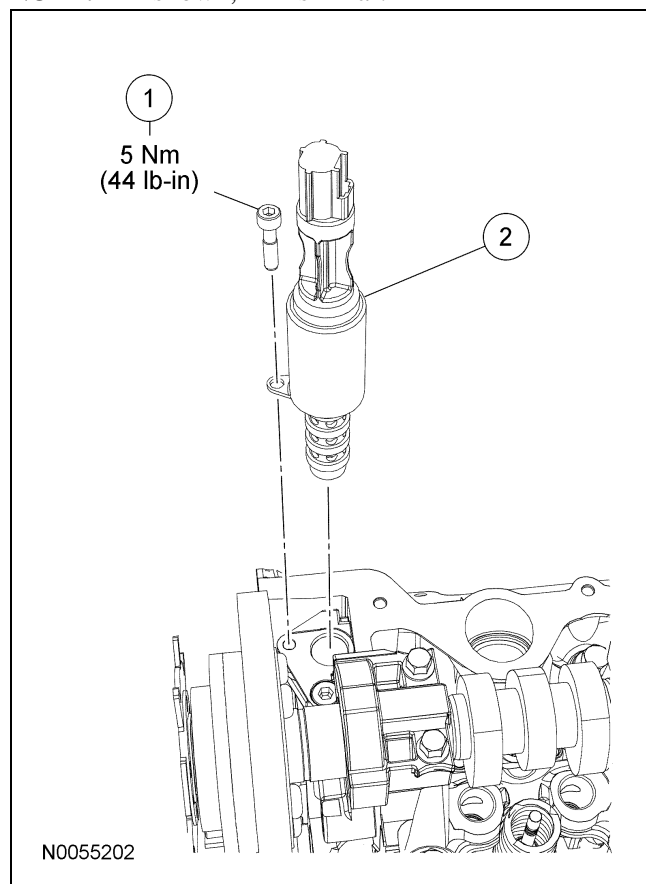
Position the new TP sensor and install the 2 new screws.

- Tighten to 3 Nm (27 lb-in).
-

REMOVAL AND INSTALLATION

Variable Camshaft Timing (VCT) Oil Control Solenoid — 5.4L

NOTE: LH shown, RH similar.



Item	Part Number	Description
1	6C260	Variable camshaft timing (VCT) oil control solenoid bolt
2	6C297	VCT oil control solenoid

Removal and Installation

1. Remove the valve cover. For additional information, refer to Section 303-01A.
2. Remove the bolt and the variable camshaft timing (VCT) oil control solenoid.
 - To install, tighten to 5 Nm (44 lb-in).
3. To install, reverse the removal procedure.

DESCRIPTION AND OPERATION

Acceleration Control

The acceleration control consists of one of the following:

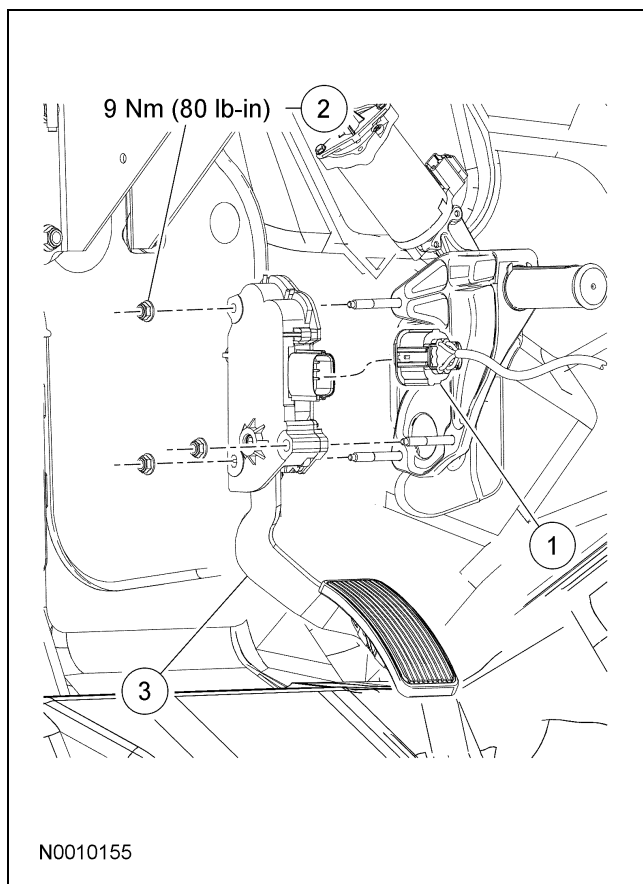
- a fixed accelerator pedal and position sensor assembly.
- or an adjustable accelerator pedal and position sensor assembly.

The throttle is controlled by an accelerator pedal position sensor on the accelerator pedal assembly. The accelerator pedal position sensor sends a signal to the PCM in response to throttle pedal movements initiated by the driver. The PCM sends a signal to the electronic throttle control which increases and decreases throttle position.

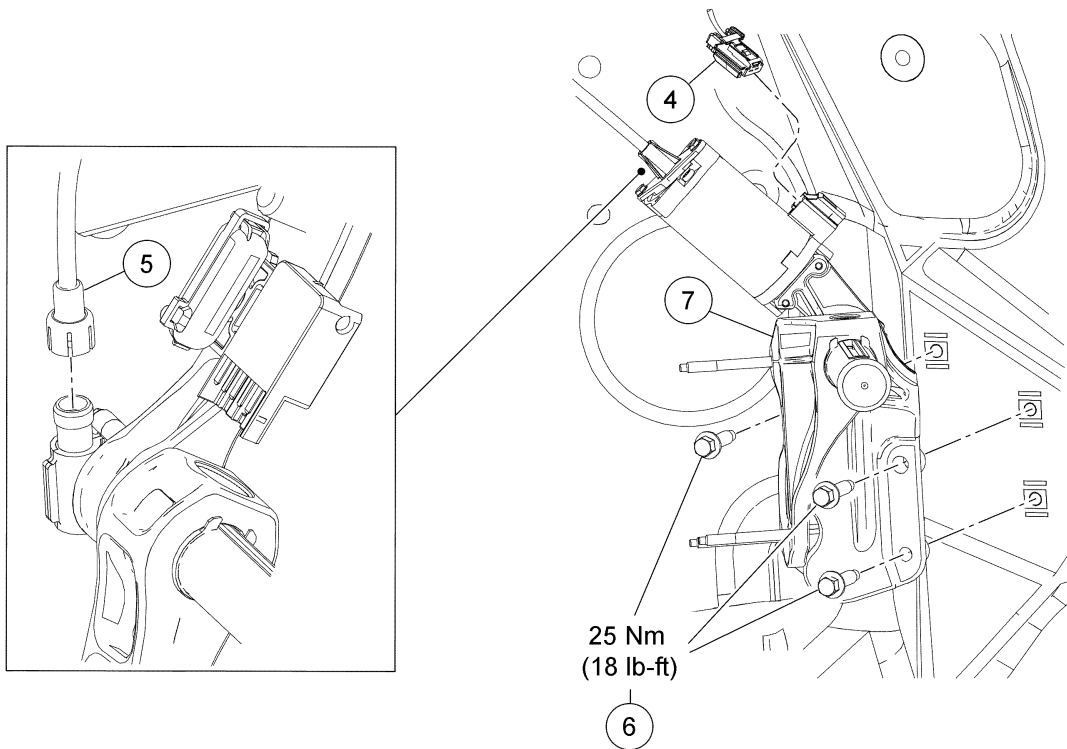
Some vehicles are equipped with adjustable pedals. This allows both the accelerator and brake pedals to be adjusted simultaneously forward or rearward. A rocker switch on the instrument panel provides adjustment on the pedal assembly when it is activated. On vehicles with the memory seat option, the pedal position can be controlled by the memory selection, as well as the rocker switch. The adjustable accelerator pedal can be serviced separately from the adjuster. The components in the acceleration control system are not adjustable and new components must be installed if damaged or worn.

REMOVAL AND INSTALLATION

Accelerator Pedal — Adjustable



Item	Part Number	Description
1	—	Accelerator pedal and position sensor assembly electrical connector (part of 14A005)
2	W520101	Accelerator pedal and position sensor assembly nut (3 required)
3	9F836	Accelerator pedal and position sensor assembly

REMOVAL AND INSTALLATION (Continued)

N0045261

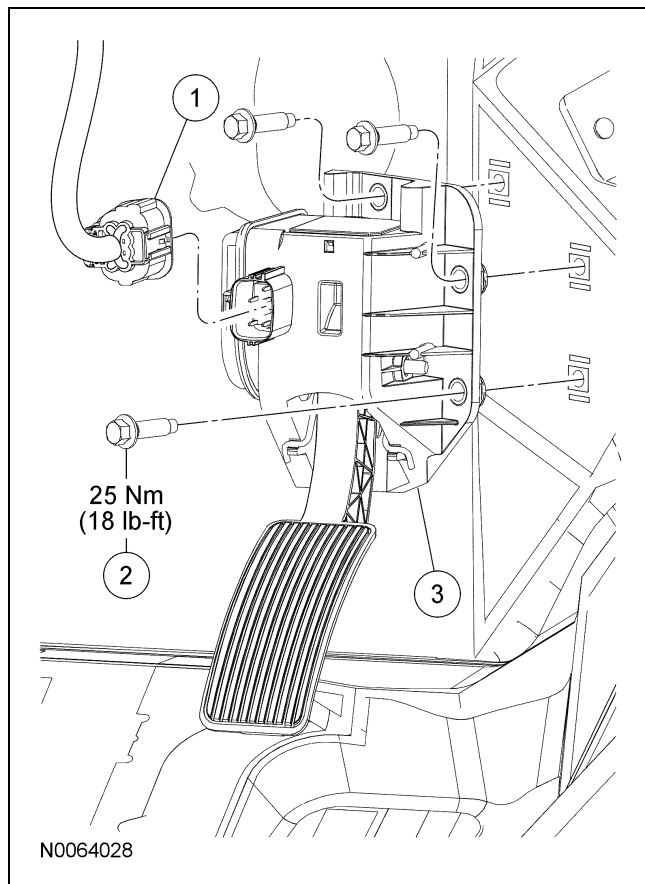
Item	Part Number	Description
4	—	Adjustable pedal motor electrical connector (part of 14A005)
5	—	Adjustable pedal motor-to-brake pedal drive cable (part of 9D823)
6	W611636	Adjustable pedal motor and bracket assembly bolts (3 required)
7	9D823	Adjustable pedal motor and bracket assembly

Removal and Installation

1. Disconnect the accelerator pedal and position sensor assembly electrical connector.
2. Disconnect the adjustable pedal motor electrical connector.
3. Disconnect the adjustable pedal motor drive cable from the brake pedal assembly.
4. Remove the 3 nuts and the accelerator pedal and position sensor assembly.
 - To install, tighten to 9 Nm (80 lb-in).
5. Remove the 3 bolts and the adjustable pedal motor and bracket assembly.
 - To install, tighten to 25 Nm (18 lb-ft).
6. To install, reverse the removal procedure.
 - The brake pedal and the accelerator pedal must be indexed when installing a new cable or a new adjustable pedal motor assembly. Index the adjustable pedal assemblies. For additional information, refer to Section 206-06.

REMOVAL AND INSTALLATION

Accelerator Pedal — Fixed



Item	Part Number	Description
1	—	Accelerator pedal and position sensor assembly electrical connector (part of 14A005)
2	W611636	Accelerator pedal and position sensor assembly bolt (3 required)
3	9F836	Accelerator pedal and position sensor assembly

Removal and Installation

1. Disconnect the accelerator pedal and position sensor assembly electrical connector.

REMOVAL AND INSTALLATION (Continued)

2. Remove the 3 bolts and the accelerator pedal and position sensor assembly.
 - To install, tighten to 25 Nm (18 lb-ft).
 3. To install, reverse the removal procedure.
-

2008 Ford F-350 SUPER DUTY

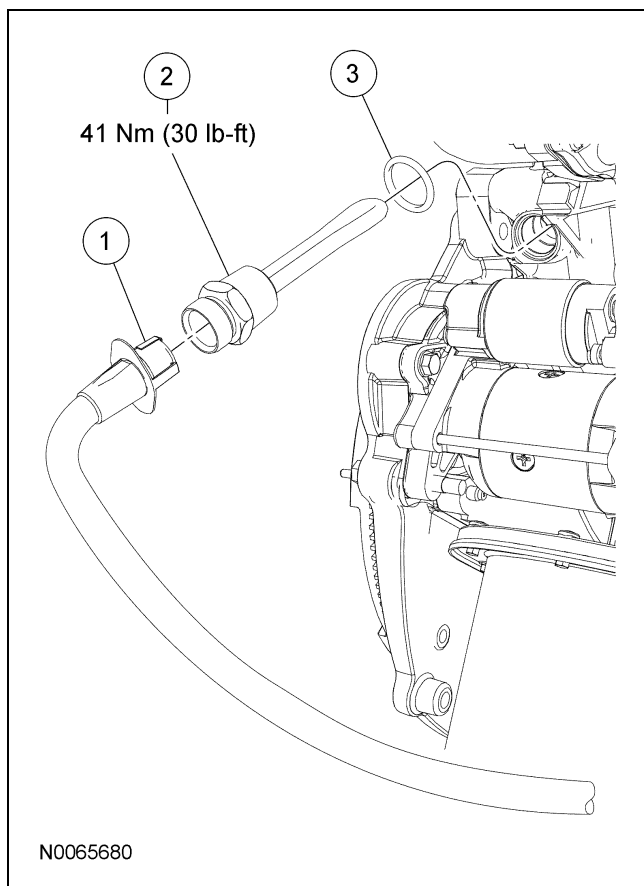
Submodel: XLT | Engine Type: V8 | Liters: 5.4
Fuel Delivery: FI | Fuel: GAS

SECTION 310-02:
Acceleration Control

- SPECIFICATIONS
- DESCRIPTION AND OPERATION
 - Acceleration Control
- DIAGNOSIS AND TESTING
 - Acceleration Control
- REMOVAL AND INSTALLATION
 - Accelerator Pedal — Fixed
 - Accelerator Pedal — Adjustable

REMOVAL AND INSTALLATION

Block Heater — 6.4L Diesel



Item	Part Number	Description
1	17446	Block heater electrical connector (part of 6B018)
2	6A051	Block heater
3	—	Block heater O-ring seal (part of 6A051)

Removal and Installation

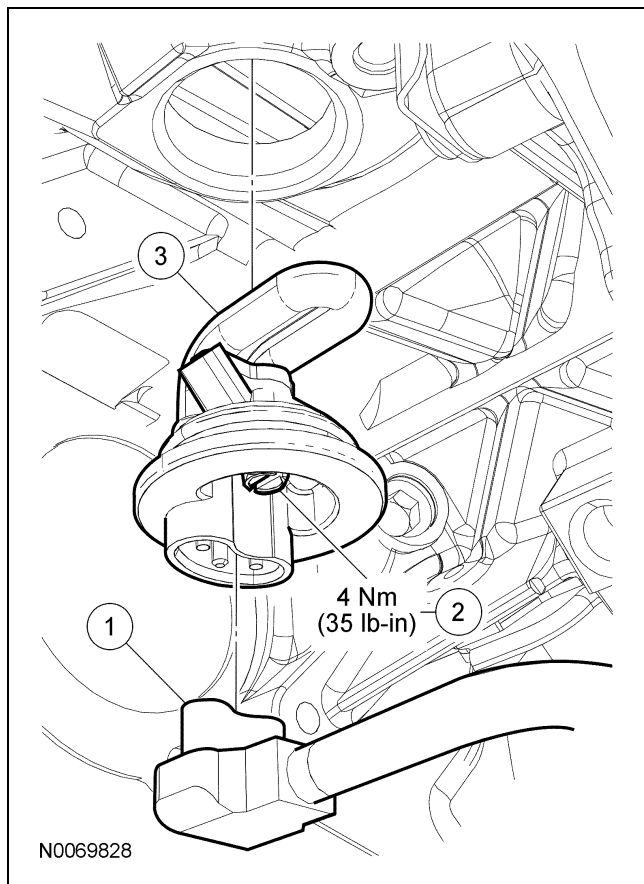
1. With vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
2. Drain the cooling system. For additional information, refer to Cooling System Draining, Filling and Bleeding in this section.
3. Disconnect the block heater electrical connector.

REMOVAL AND INSTALLATION (Continued)

4. Remove the block heater and discard the O-ring seal.
 - To install, tighten to 41 Nm (30 lb-ft).
 - Install a new O-ring seal.
 5. To install, reverse the removal procedure.
-

REMOVAL AND INSTALLATION


Block Heater — Gasoline Engines



Item	Part Number	Description
1	14A199	Block heater electrical connector
2	—	Block heater retaining screw (part of 6A051)
3	6A051	Block heater

Removal and Installation


1. Drain the engine cooling system. For additional information, refer to Cooling System Draining, Filling and Bleeding in this section.

2.  **CAUTION: Do not loosen the block heater retaining screw more than necessary for removal. The nut can fall off inside the engine and damage the cooling system.**

Loosen the block heater retaining screw and remove the block heater.

- To install, tighten to 4 Nm (35 lb-in).

REMOVAL AND INSTALLATION (Continued)

3.  **CAUTION:** Route the block heater power cable away from hot or rotating components, or damage to the cable can occur.

To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

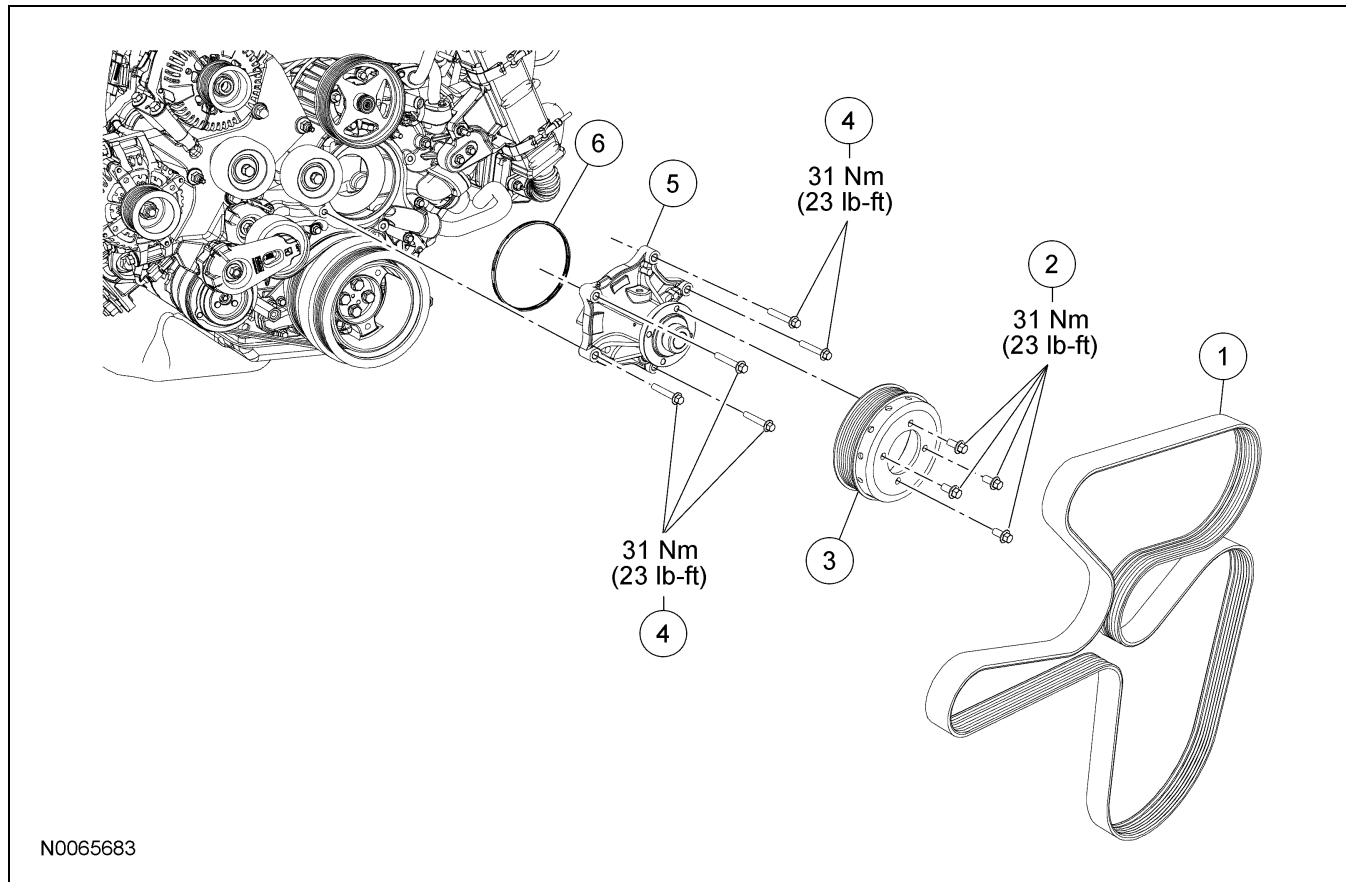
Coolant Crossover Manifold Assembly — Gasoline Engines

Removal and Installation

1. The coolant crossover manifold assembly is serviced with the intake manifold. For additional information, refer to Section 303-01A for 5.4L 3V engines or Section 303-01B for 6.8L 3V engines.
-

REMOVAL AND INSTALLATION

Coolant Pump — 6.4L Diesel

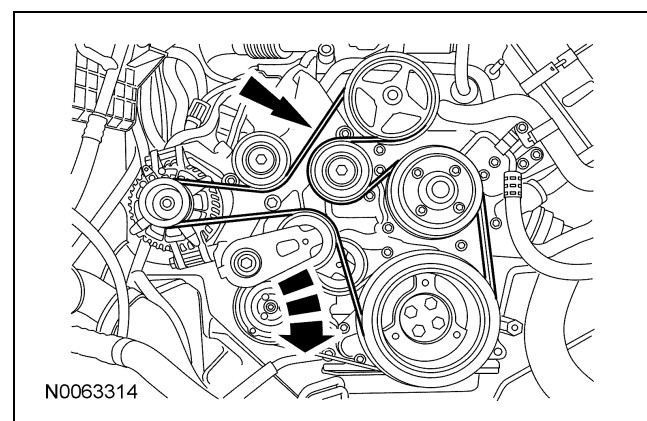


Item	Part Number	Description
1	8620	Accessory drive belt
2	W300001	Coolant pump pulley bolts (4 required)
3	8509	Coolant pump pulley
4	W301752	Coolant pump bolts (5 required)
5	8501	Coolant pump
6	8507	Coolant pump O-ring seal

Removal and Installation

1. Drain the cooling system. For additional information, refer to Cooling System Draining, Filling and Bleeding in this section.
2. Remove the engine cooling fan. For additional information, refer to Cooling Fan — 6.4L Diesel in this section.
3. Loosen the coolant pump pulley bolts.

4. Rotate the accessory drive belt tensioner clockwise and position the drive belt aside.



5. Remove the bolts and the coolant pump pulley.
 - To install, tighten to 31 Nm (23 lb-ft).
6. Remove the bolts and the coolant pump. Remove and discard the O-ring seal.
 - To install, tighten to 31 Nm (23 lb-ft).

REMOVAL AND INSTALLATION (Continued)

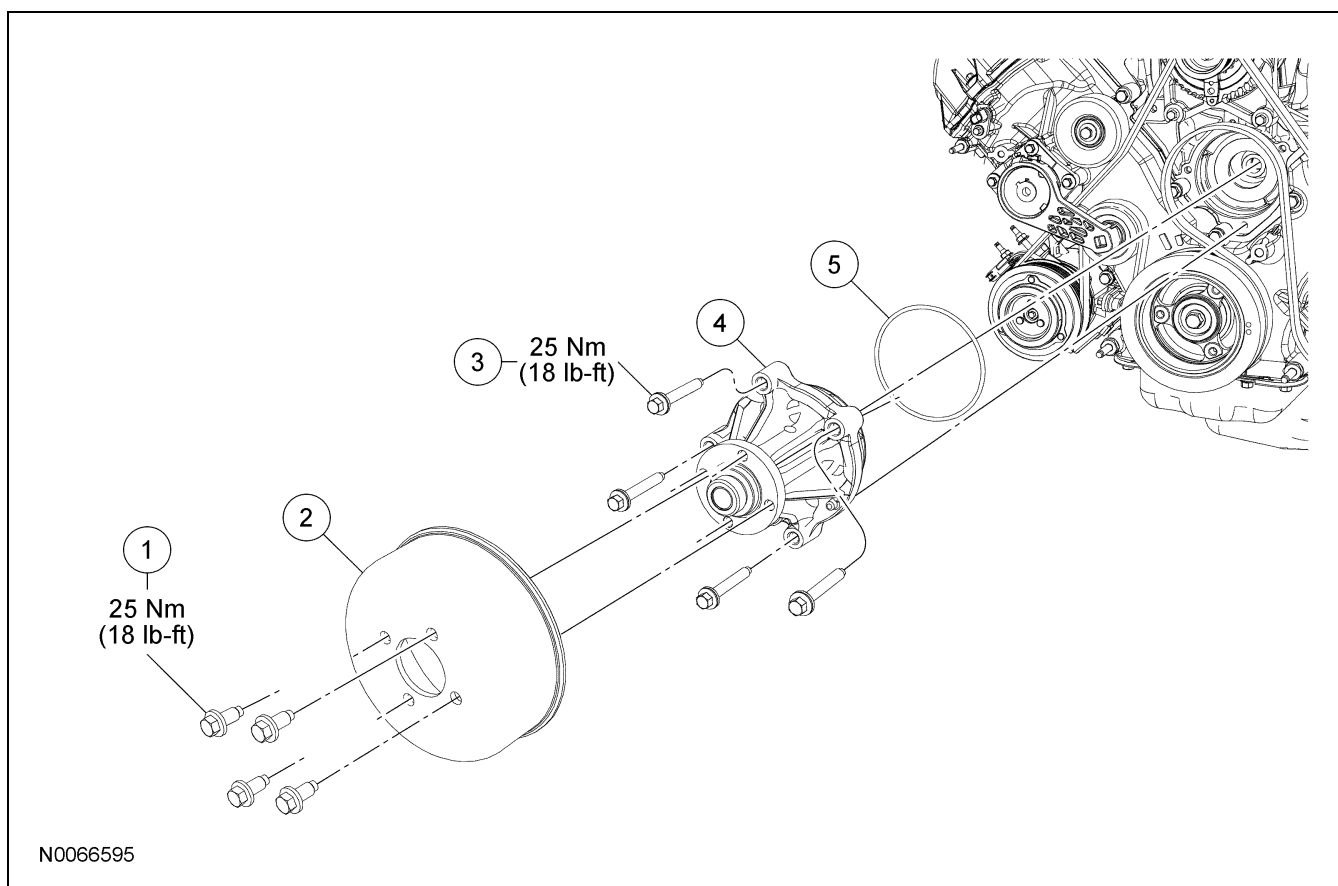
7. To install, reverse the removal procedure.
 - Install a new O-ring seal.
-

REMOVAL AND INSTALLATION

Coolant Pump — Gasoline Engines

Material

Item	Specification
Motorcraft Premium Gold Engine Coolant with Bittering Agent (US only) VC-7-B (US); CVC-7-A (Canada); or equivalent (yellow color)	WSS-M97B51-A1
Motorcraft Metal Surface Prep ZC-31	—



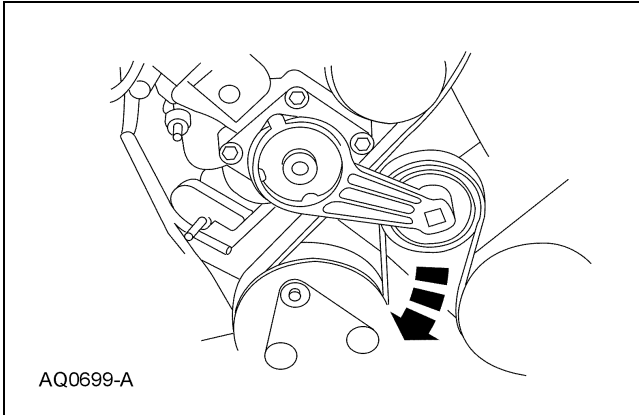
Item	Part Number	Description
1	N806282	Coolant pump pulley bolt (4 required)
2	8A528	Coolant pump pulley
3	N808794	Coolant pump bolt (4 required)
4	8501	Coolant pump
5	391108	Coolant pump O-ring seal

Removal and Installation

1. Drain the engine cooling system. For additional information, refer to Cooling System Draining, Filling and Bleeding in this section.
2. Remove the cooling fan. For additional information, refer to Cooling Fan — Gasoline Engines in this section.

REMOVAL AND INSTALLATION (Continued)

3. Loosen the 4 coolant pump pulley bolts.
 - To install, tighten to 25 Nm (18 lb-ft).
4. Rotate the tensioner clockwise and remove the accessory drive belt from the coolant pump pulley.

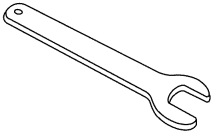
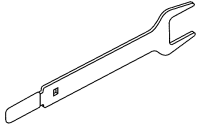


5. Remove the 4 bolts and the coolant pump pulley.
6. Remove the 4 bolts and the coolant pump. Discard the O-ring seal.
 - To install, tighten to 25 Nm (18 lb-ft).
7. Clean and inspect the sealing surfaces with metal surface prep. Follow the directions on the packaging.
8. To install, reverse the removal procedure.
 - Install a new coolant pump O-ring seal. Lubricate the O-ring seal with clean engine coolant prior to installation.

REMOVAL AND INSTALLATION

Cooling Fan — 6.4L Diesel

Special Tool(s)

 ST2175-A	Wrench, Fan Clutch Nut 303-214 (T83T-6312-B)
 ST2736-A	Wrench, Fan Hub Nut 303-774

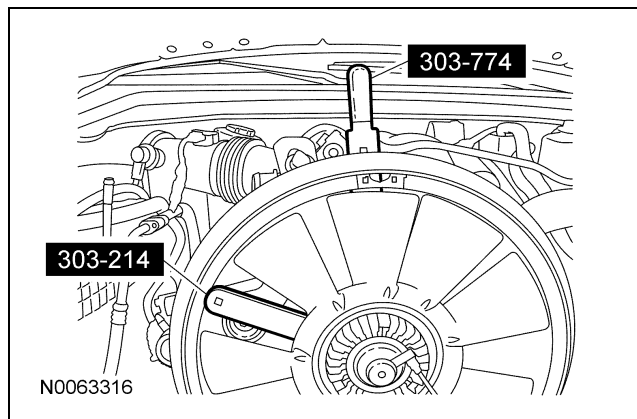
Removal and Installation

1. Remove the upper cooling fan shroud. For additional information, refer to Cooling Fan Shroud — 6.4L Diesel, Upper in this section.
2. Disconnect the cooling fan clutch electrical connector. Unclip and position the fan wiring aside.

3. **NOTE:** The fan hub has a LH thread.

Using the special tools, remove the cooling fan and clutch.

- To install, tighten to 150 Nm (111 lb-ft).

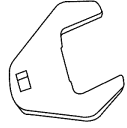
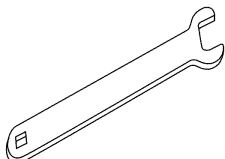

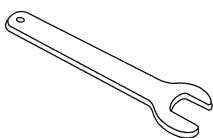


4. If necessary, remove the bolts and separate the cooling fan and the clutch.
 - To install, tighten to 7 Nm (62 lb-in).
5. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION


Cooling Fan — Gasoline Engines

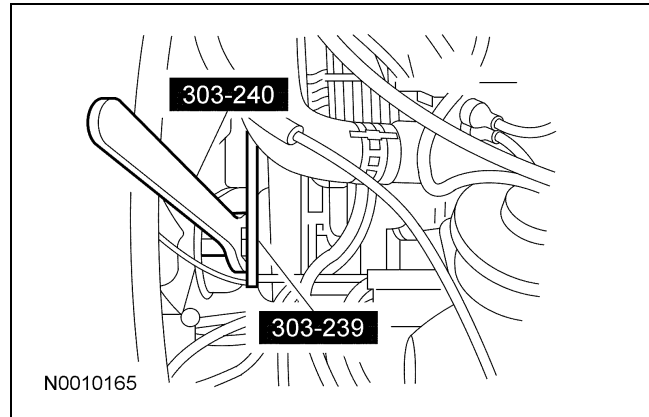
Special Tool(s)

 ST1499-A	Fan Pulley Holding Wrench (5.4L) 303-239 (T84T-6312-C)
 ST1500-A	Fan Clutch Nut Wrench (5.4L) 303-240 (T84T-6312-D)
 ST2542-A	Fan Pulley Holding Wrench (6.8L) 303-478 (T94T-6312-AH)
 ST2175-A	Fan Clutch Nut Wrench (6.8L) 303-214 (T83T-6312-B)

Removal and Installation

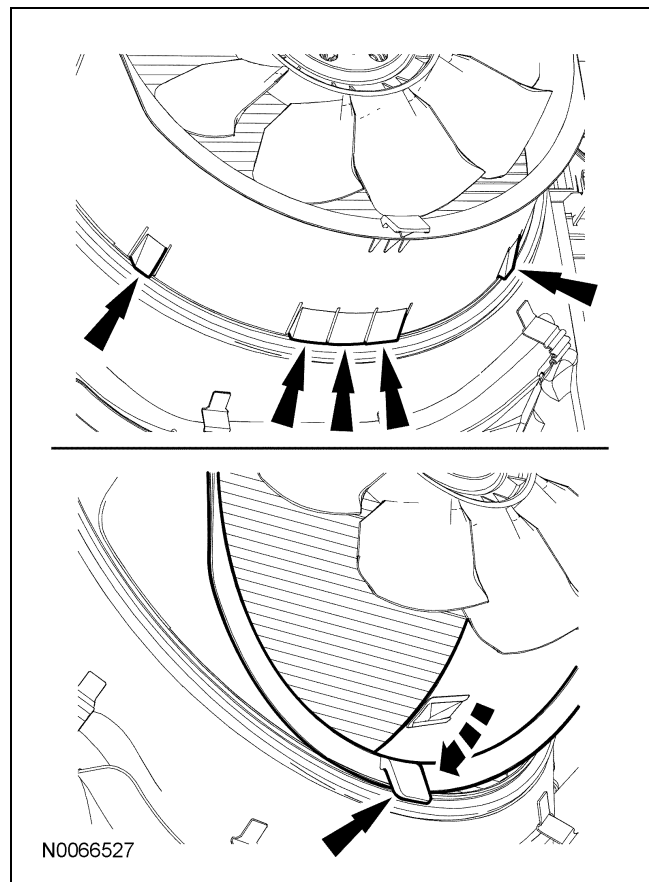
5.4L engines

1. Remove the air cleaner outlet pipe. For additional information, refer to Section 303-12.
2.  **CAUTION:** The large clutch assembly nut has a right-hand thread and must be rotated counterclockwise to remove it.
Using the special tool, remove the fan and fan clutch from the coolant pump pulley.
 - To install, tighten to 55 Nm (41 lb-ft).




6.8L engines

3. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
4. Press the 4 position retaining tabs and rotate the lower cooling fan shroud upward until the position retainer tab locks into position.

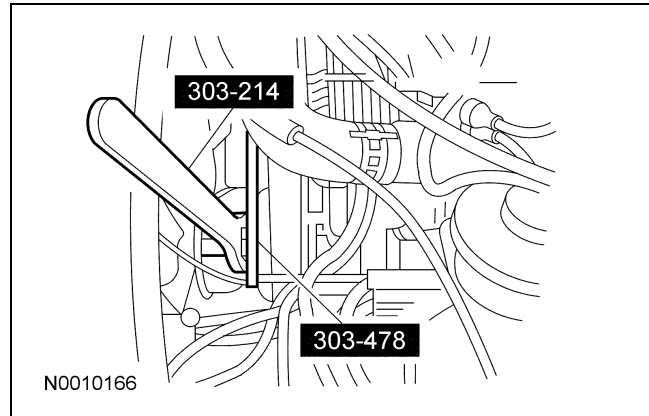


REMOVAL AND INSTALLATION (Continued)

5. Disconnect the 2 lower radiator hose assembly position retainers and position the radiator hose assembly aside.
6. Remove the 4 nuts and position the stabilizer bar downward.
 - To install, tighten to 48 Nm (35 lb-ft).
7.  **CAUTION: The large clutch assembly nut has a RH thread and must be rotated counterclockwise to remove it.**

Using the special tool, remove the fan and fan clutch from the coolant pump pulley.

- To install, tighten to 133 Nm (98 lb-ft).

**All engines**

8. If servicing the cooling fan or clutch, remove the 4 bolts and separate the cooling fan and cooling fan clutch.
 - To install, tighten to 7 Nm (62 lb-in).
9. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Cooling Fan Shroud — 6.4L Diesel, Lower

Removal and Installation

1. Remove the radiator. For additional information, refer to Radiator — 6.4L Diesel in this section.
 2. Detach the lower radiator hose retainers.
 3. Remove the bolts and position the fuel cooling system coolant pump aside.
 - Detach the turbocharger actuator cooler-to-fuel cooling system radiator hose from the retainer.
 4. Disconnect the wiring harness retaining straps and the wiring harness retainers from the lower fan shroud and position the wiring harness aside.
 5. Remove the lower fan shroud.
 6. To install, reverse the removal procedure.
-

REMOVAL AND INSTALLATION

Cooling Fan Shroud — 6.4L Diesel, Upper

Removal and Installation

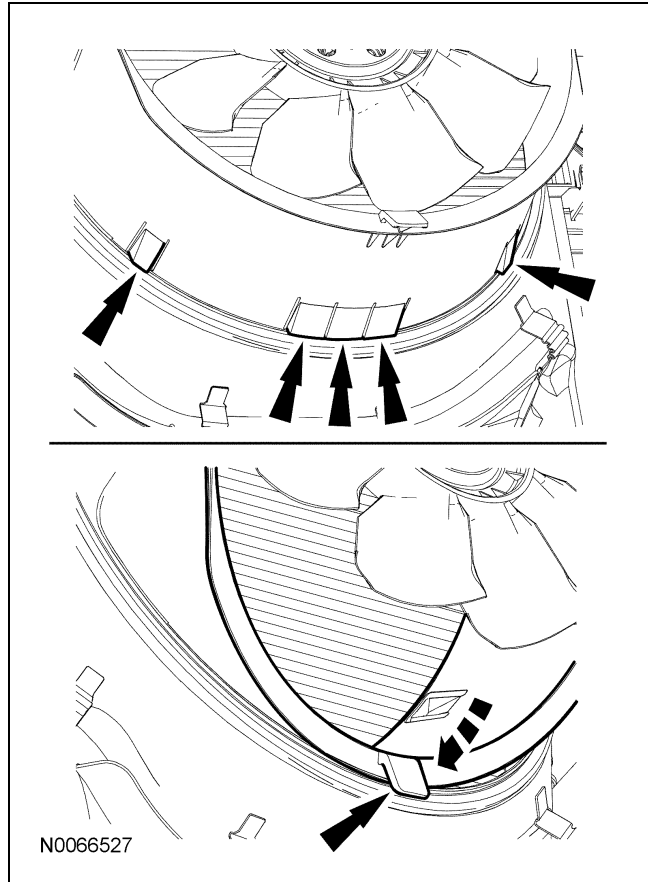
1. Drain the cooling system. For additional information, refer to Cooling System Draining, Filling and Bleeding in this section.
2. Remove the RH charge air cooler (CAC) tube. For additional information, refer to Section 303-12.
3. Disconnect the vacuum solenoid electrical connector from the vacuum solenoid, if equipped, or the retainer on the upper fan shroud.
4. Detach the vacuum solenoid wiring harness retainers from the upper cooling fan shroud.
5. Disconnect the radiator-to-degas bottle hose from the degas bottle. If equipped, disconnect the vacuum hose connector.
6. Loosen the clamp and disconnect the LH CAC tube from the turbocharger.
 - To install, tighten to 12 Nm (9 lb-ft).
7. Remove the spring clip, disconnect the upper radiator hose from the radiator, and position the upper radiator hose aside.
 - To install, make sure the spring clip is seated correctly.
8. Disconnect the coolant pump-to-fuel cooler hose from the power steering reservoir.
9. Remove the bolts and disconnect the power steering reservoir from the upper fan shroud.
 - To install, tighten to 8 Nm (71 lb-in).
10. Disconnect the radiator-to-degas bottle hose at the radiator.
11. Remove the bolts and the upper fan shroud.
 - When removing the upper fan shroud, raise the RH side first to remove it from the vehicle.
 - To install, tighten to 7 Nm (62 lb-in).
12. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Cooling Fan Shroud — Gasoline Engines

Removal and Installation

1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
2. Drain the engine cooling system. For additional information, refer to Cooling System Draining, Filling and Bleeding in this section.
3. Remove the air cleaner outlet pipe. For additional information, refer to Section 303-12.
4. Remove the clip and disconnect the upper radiator coolant hose quick connect coupling.
5. Remove the 2 bolts and position the power steering reservoir aside.
 - To install, tighten to 7 Nm (62 lb-in).
6. Disconnect the degas bottle coolant inlet hose from the radiator.
7. Disconnect the degas bottle coolant inlet hose position retainer from the cooling fan shroud and position aside.
8. If equipped with four wheel drive (4WD), remove the bolt and position the 4WD differential vacuum valve aside.
 - To install, tighten to 8 Nm (71 lb-in).
9. Disconnect the 4 position retainers and position the engine compartment wiring harness aside.
10. Press the 4 position retaining tabs and rotate the lower cooling fan shroud upward until the position retainer tab locks into position.
11. Remove the 4 bolts and the engine cooling fan shroud assembly.
 - To install, tighten to 7 Nm (62 lb-in).
12. To install, reverse the removal procedure.



REMOVAL AND INSTALLATION

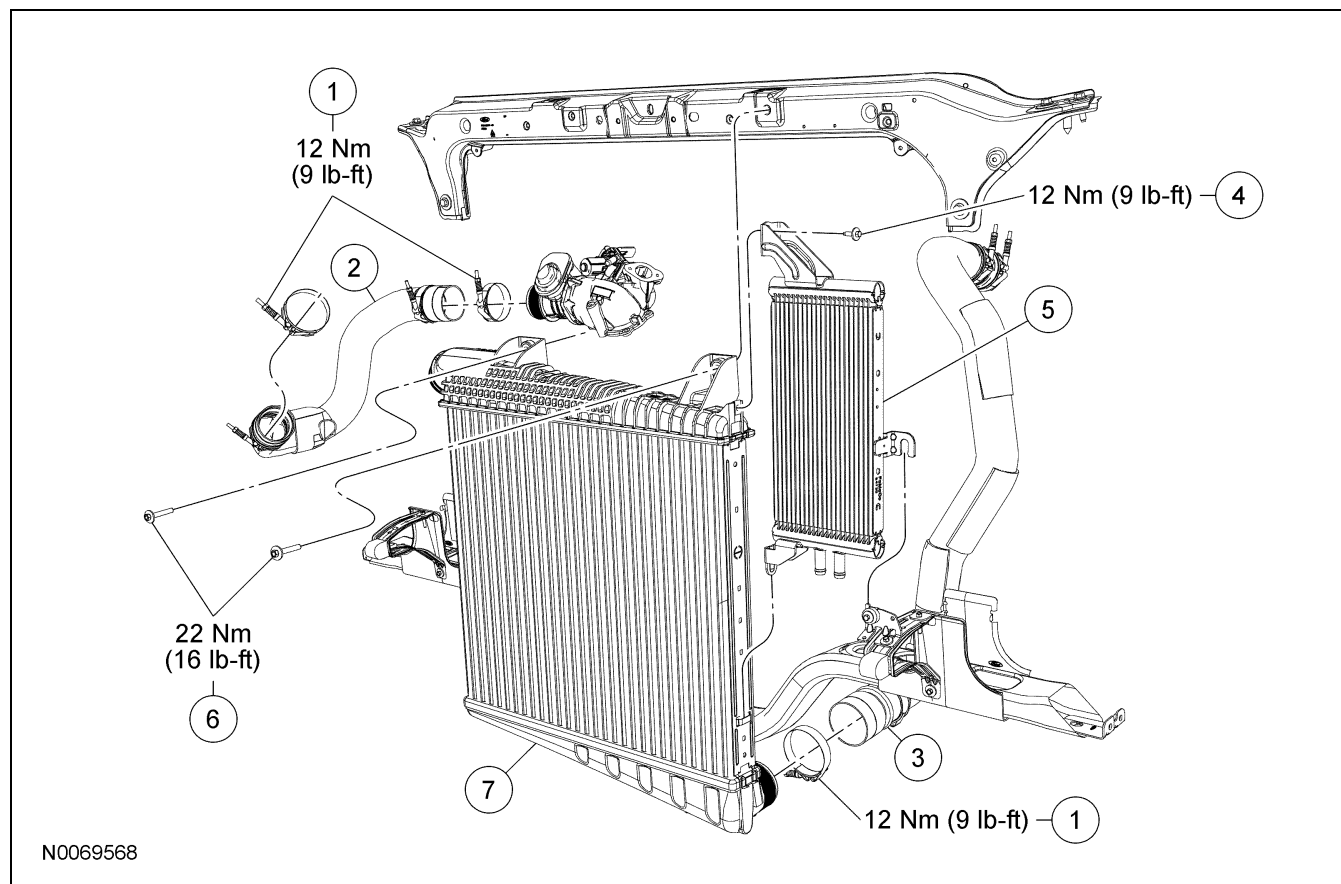
Cooling Fan Stator — 6.4L Diesel

Removal and Installation

1. Remove the cooling fan. For additional information, refer to Cooling Fan — 6.4L Diesel in this section.
 2. Remove the 2 bolts, 2 nuts and the cooling fan stator.
 - To install, tighten to 25 Nm (18 lb-ft).
 3. To install, reverse the removal procedure.
-

REMOVAL AND INSTALLATION

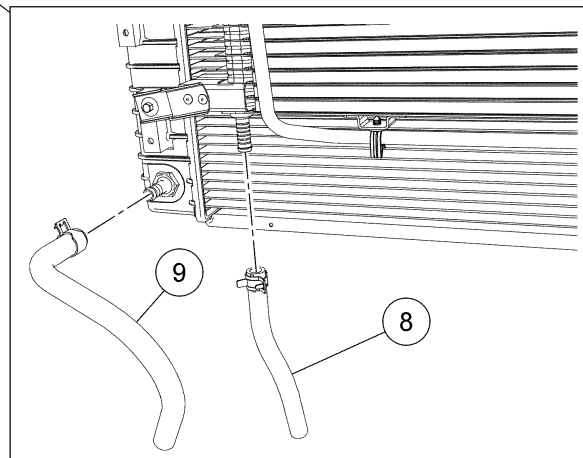
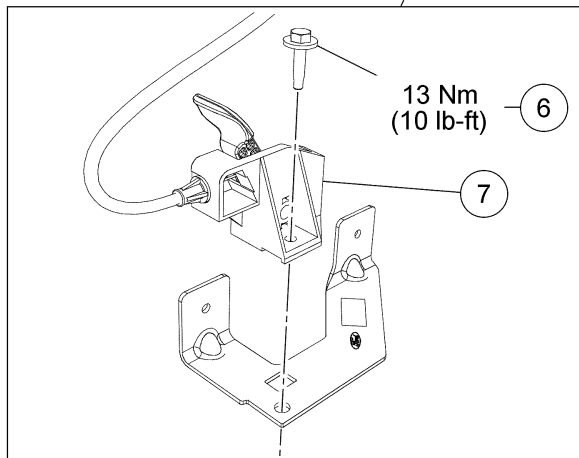
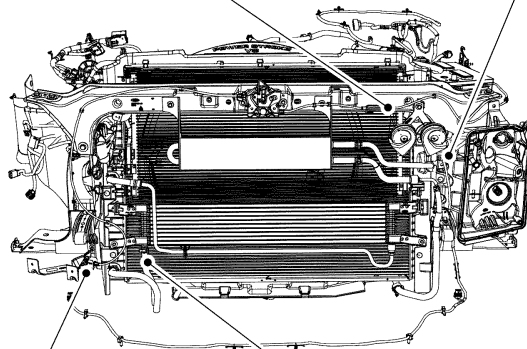
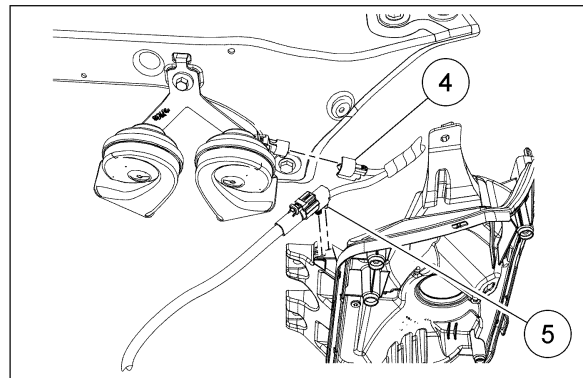
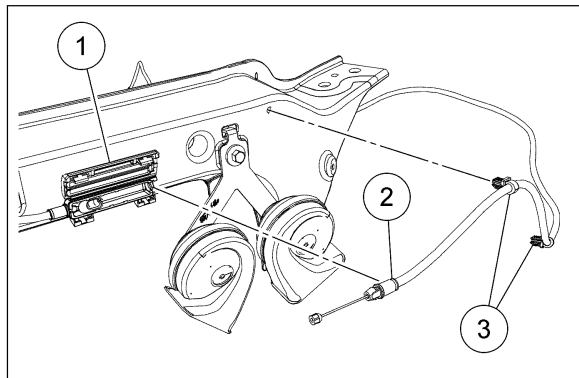
Cooling Module — 6.4L Diesel



Item	Part Number	Description
1	6K786	Charge air cooler (CAC) tube clamps
2	6F073	RH CAC tube
3	6C646	LH CAC tube
4	1325346	Fuel cooling system radiator bolt

(Continued)

Item	Part Number	Description
5	8D010	Fuel cooling system radiator
6	W711849	CAC bolts (2 required)
7	6K775	CAC

REMOVAL AND INSTALLATION (Continued)

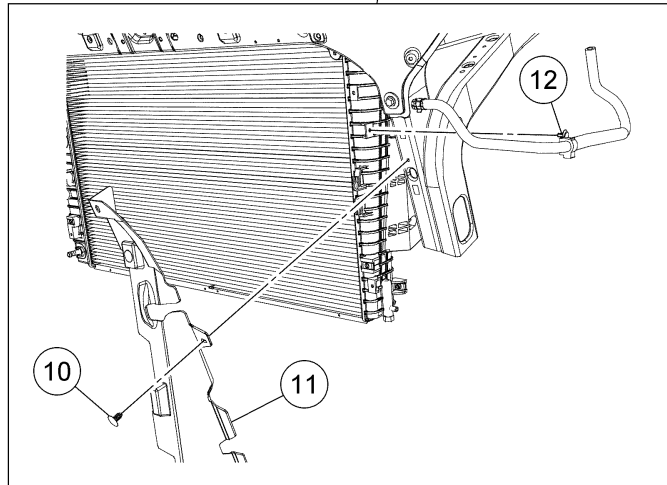
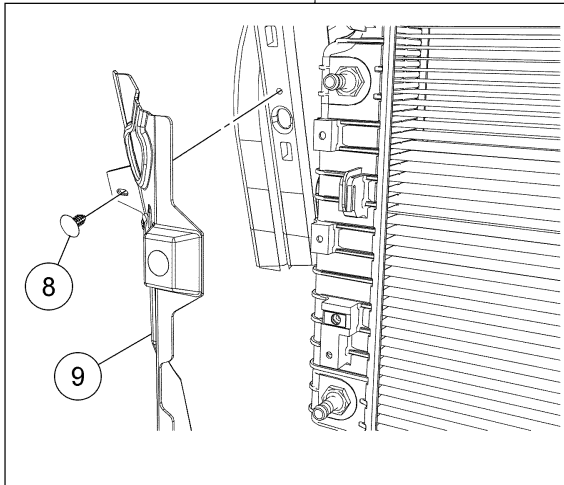
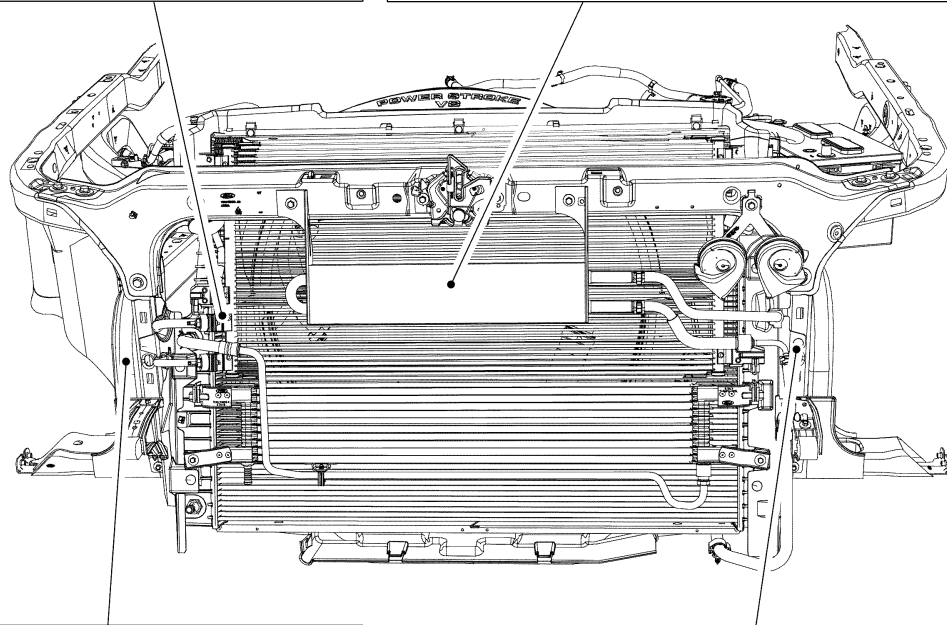
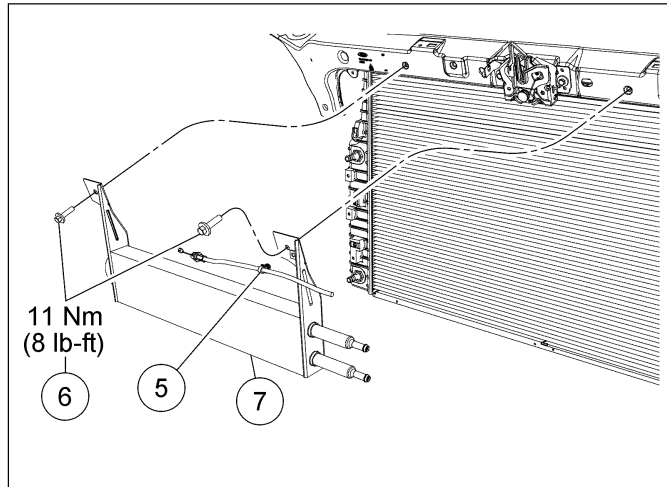
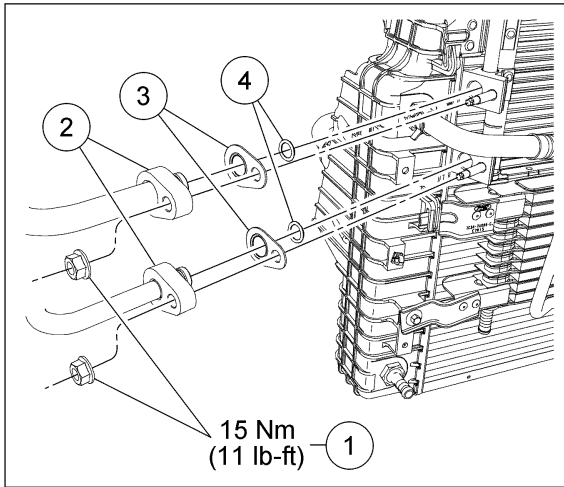
N0066556

Item	Part Number	Description
1	—	Hood latch cable connector housing (part of 16C656)
2	16C656	Hood latch cable
3	W712867	Hood latch cable retainers (part of 16C656)
4	14A464	Horn electrical connector (part of 12A581)
5	14A163	Fog light electrical connector retainer (part of 12A581)

Item	Part Number	Description
6	W505424	Hood latch lever bolt
7	16B975	Hood latch lever
8	7B028	Transmission fluid cooler hose
9	7F112	Transmission fluid cooler hose

(Continued)

REMOVAL AND INSTALLATION (Continued)



N0065685

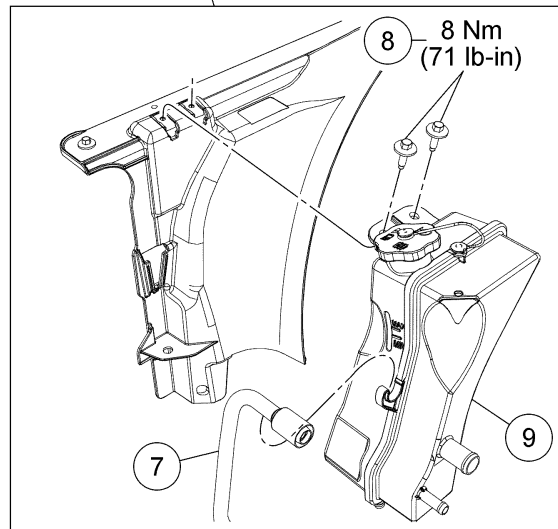
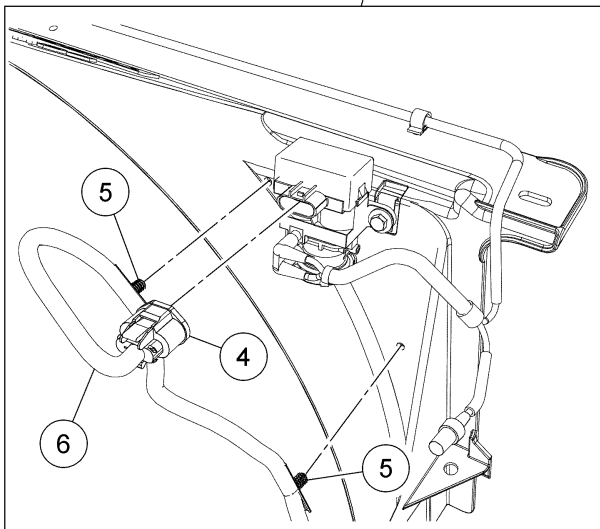
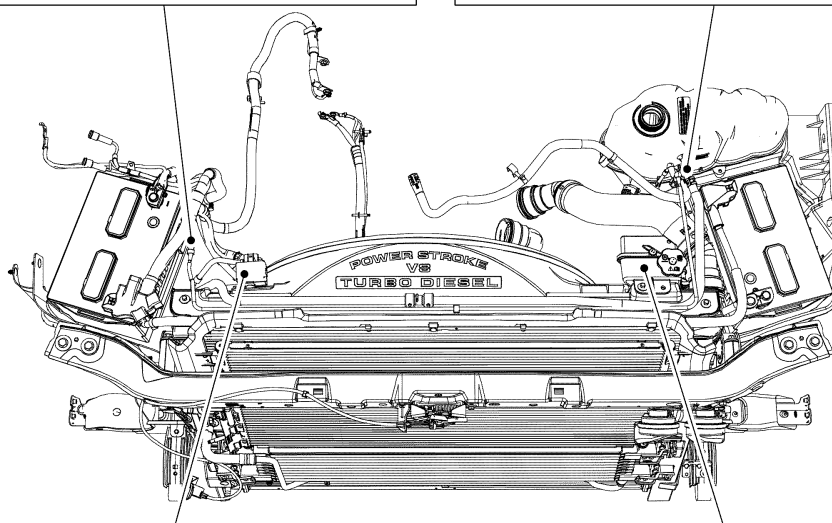
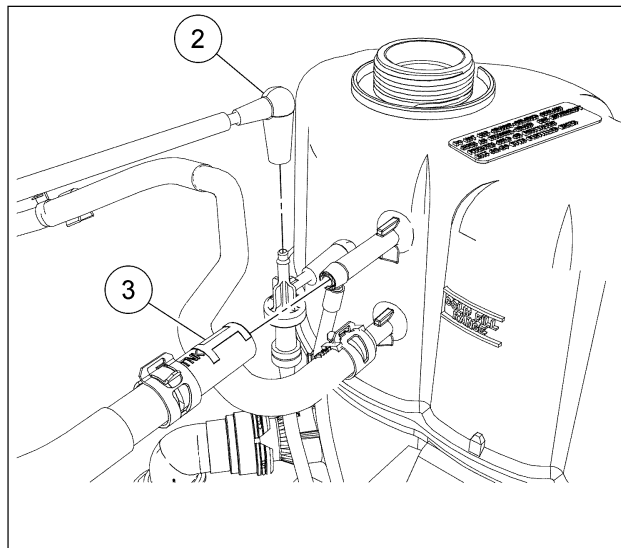
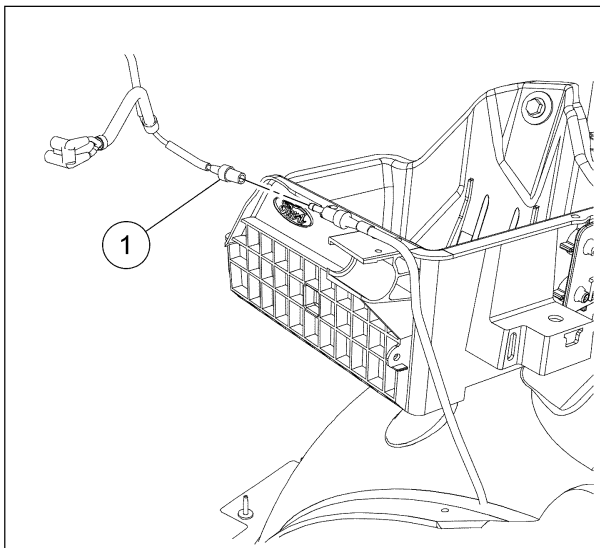
REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	W520413	A/C tubes-to-condenser nuts (2 required)
2	19C700	A/C tube fittings (2 required)
3	—	A/C tube fitting gaskets (2 required) (part of 19C700)
4	—	A/C tube fitting O-ring seals (2 required) (part of 19C700)
5	W712867	Hood latch cable retainer (part of 011403)
6	W711851	Power steering fluid cooler bolts (2 required)

(Continued)

Item	Part Number	Description
7	3D746	Power steering fluid cooler
8	R00696	RH air deflector retainer (part of 8A261)
9	8A261	RH air deflector
10	R00696	LH air deflector retainer (part of 8A261)
11	8A261	LH air deflector
12	84043	Power steering fluid hose retainer (part of 3B748)

REMOVAL AND INSTALLATION (Continued)



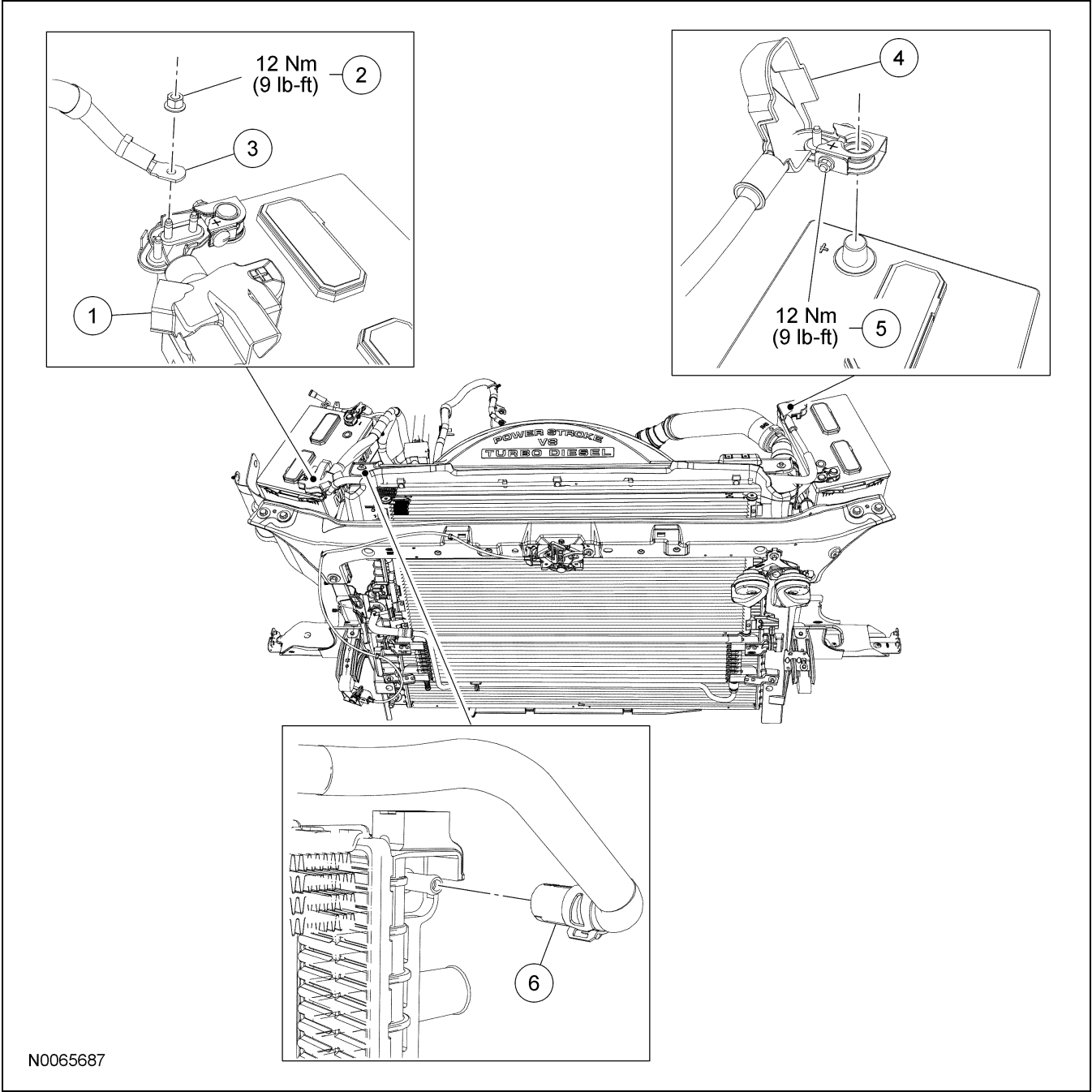
N0065686

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	9E499	Vacuum hose connector
2	9E499	Vacuum hose connector
3	8W005	Radiator-to-degas bottle hose
4	14A464	Vacuum solenoid electrical connector (part of 12A581)
5	13A506	Wiring harness retainers (part of 12A581)

Item	Part Number	Description
6	12A581	Wiring harness
7	8D012	Coolant pump-to-fuel cooler hose
8	W503924	Power steering fluid reservoir bolts
9	3R700	Power steering fluid reservoir

(Continued)



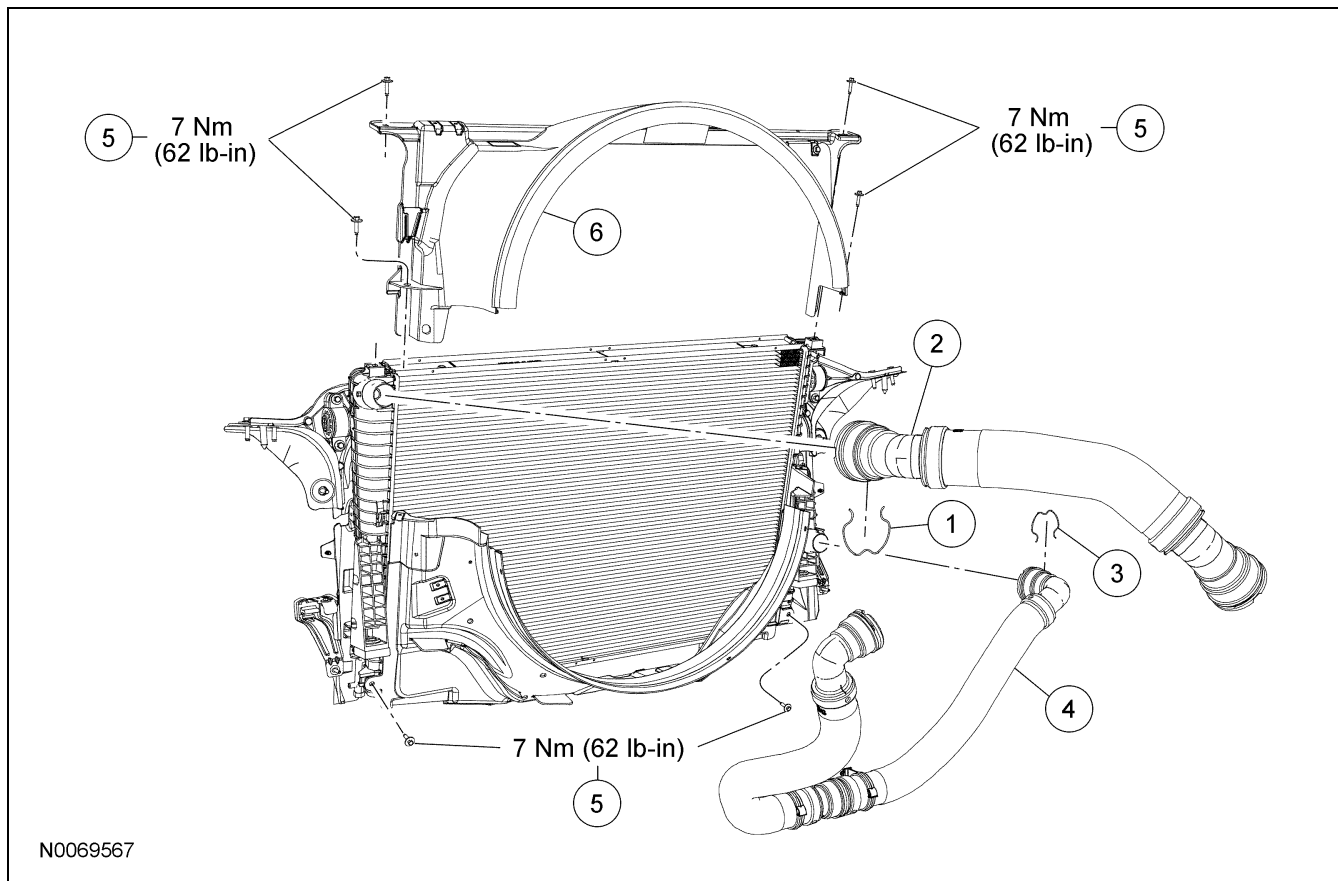
N0065687

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	14277	RH battery positive terminal cover
2	W705790	Battery cable nut
3	14300	Battery cable

(Continued)

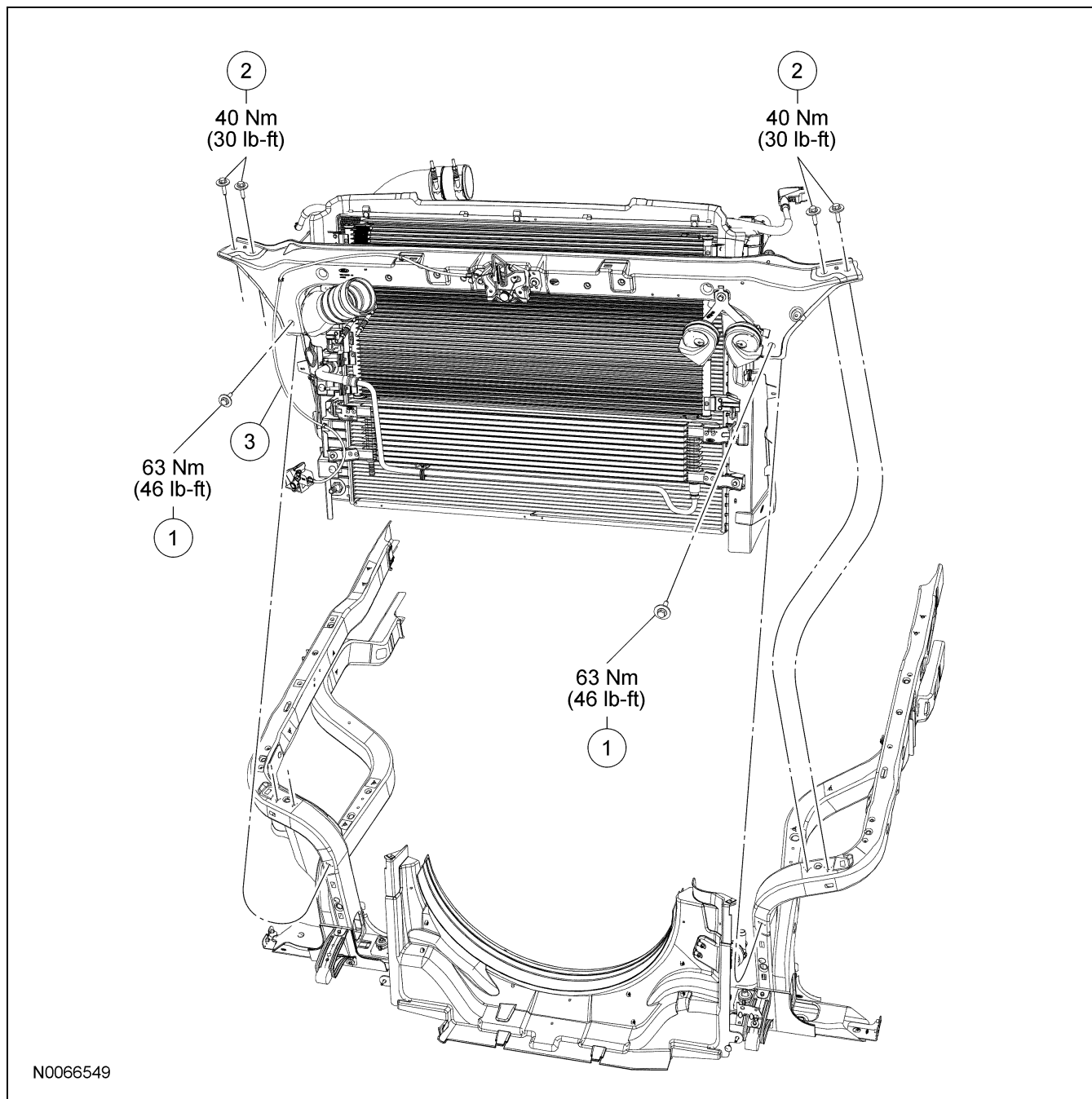
Item	Part Number	Description
4	14277	LH battery positive terminal cover
5	14450	LH battery positive terminal
6	8W005	Radiator-to-degas bottle hose



Item	Part Number	Description
1	—	Upper radiator hose spring clip (part of 8B274)
2	8B274	Upper radiator hose
3	—	Lower radiator hose spring clip (part of 8286)

(Continued)

Item	Part Number	Description
4	8286	Lower radiator hose
5	W503924	Cooling fan shroud bolts (6 required)
6	8L604	Upper cooling fan shroud

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	W712810	Upper radiator support front bolts (2 required)
2	W701835	Upper radiator support top bolts (4 required)
3	—	Cooling module assembly

Removal and Installation

1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
2. Disconnect the battery ground cable. For additional information, refer to Section 414-01.
3. Drain the engine cooling system. For additional information, refer to Cooling System Draining, Filling and Bleeding in this section.
4. Recover the A/C system. For additional information, refer to Section 412-00.
5. Loosen the clamp and disconnect the LH charge air cooler (CAC) tube from the CAC.
 - To install, tighten to 12 Nm (9 lb-ft).

REMOVAL AND INSTALLATION (Continued)

6. Remove the bolt and position the hood latch lever in front of the cooling module.
 - To install, tighten to 13 Nm (10 lb-ft).
7. Disconnect the horn electrical connector.
8. If equipped, detach the fog light electrical connector retainer from the headlamp housing.
9. Loosen the clamps and disconnect the RH CAC tube from the CAC and the turbocharger.
 - To install, tighten to 12 Nm (9 lb-ft).
10. **NOTE:** The fuel cooler radiator side bolt does not have to be removed to remove the fuel cooler radiator.
Remove the fuel cooler radiator top bolt. Lift the fuel cooler radiator off the retainers and position it aside.
 - To install, tighten to 12 Nm (9 lb-ft).
11. Remove the bolts and the CAC.
 - To install, tighten to 22 Nm (16 lb-ft).
12. Loosen the clamp and disconnect the radiator-to-degas bottle hose from the degas bottle. If equipped, disconnect the vacuum hose near the degas bottle.
13. Remove the spring clip and disconnect the upper radiator hose from the radiator.
 - To install, make sure the spring clip is installed correctly.
14. Detach the coolant pump-to-fuel cooler hose from the power steering fluid reservoir.
15. Remove the bolts and position the power steering fluid reservoir aside.
 - To install, tighten to 8 Nm (71 lb-in).
16. Detach the radiator-to-degas bottle hose from the radiator.
17. If equipped, disconnect the vacuum hose at the RH battery tray.
18. Disconnect the electrical connector from the vacuum solenoid, if equipped, or the retainer on the upper fan shroud.
19. Detach the wiring harness retainers from the upper fan shroud and position the wiring harness aside.
20. Remove the bolts and the upper fan shroud.
 - To install, tighten to 7 Nm (62 lb-in).
21. Position the RH battery positive terminal cover aside, remove the nut and disconnect the battery cable from the RH battery positive terminal.
 - To install, tighten to 12 Nm (9 lb-ft).
22. Position the LH battery positive terminal cover aside and disconnect the LH battery positive terminal from the battery.
 - To install, tighten to 12 Nm (9 lb-ft).
23. Open the hood latch cable connector housing and disconnect the cable and cable retainers.
24. Remove the LH air deflector pushpin.
25. Detach the power steering hose retainer from the radiator.
26. Disconnect the hood cable retainer from the power steering fluid cooler. Remove the bolts and position the power steering cooler aside.
 - To install, tighten to 11 Nm (8 lb-ft).
27. Loosen the clamps and disconnect the transmission cooler hoses.
28. Remove the nuts and disconnect the A/C tubes from the condenser. Remove and discard the O-rings and gaskets.
 - To install, use new O-rings and gaskets.
 - To install, tighten to 15 Nm (11 lb-ft).
29. Remove the RH air deflector pushpin.
30. Remove the spring clip and disconnect the lower radiator hose.
 - To install, make sure the spring clip is installed correctly.
31. Remove the lower cooling fan shroud bolts.
 - To install, tighten to 7 Nm (62 lb-in).

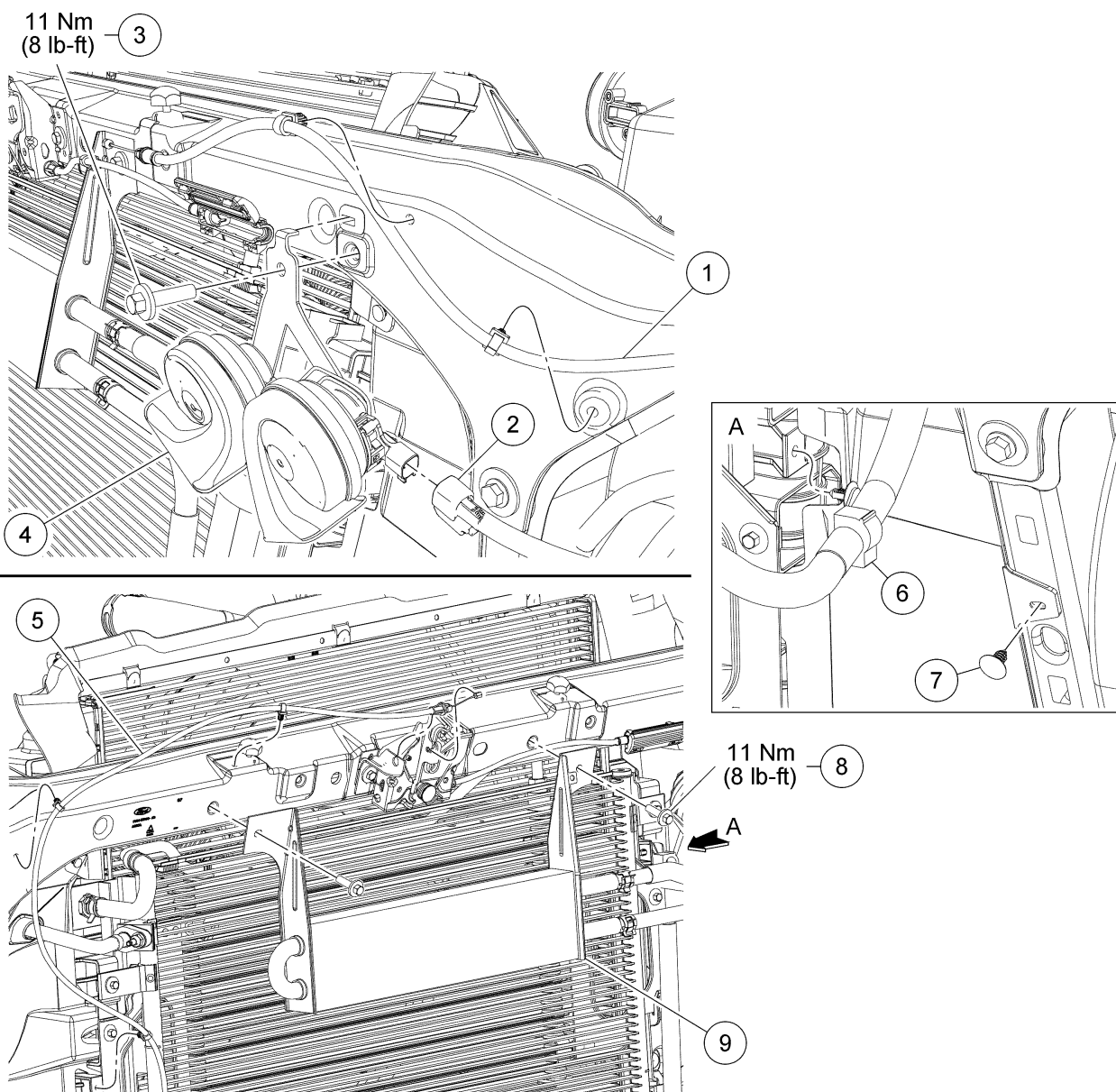
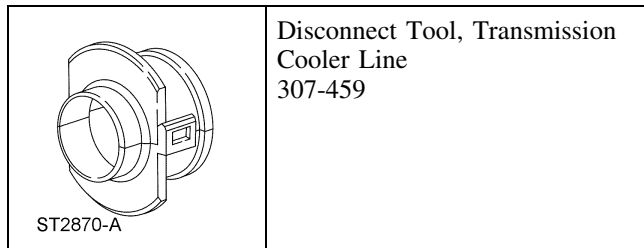
REMOVAL AND INSTALLATION (Continued)

32. Remove the 6 upper radiator support bolts.
With the help of an assistant, remove the cooling module assembly and the RH CAC tube.
- To install, tighten the upper radiator support top bolts to 40 Nm (30 lb-ft).
 - To install, tighten the upper radiator support front bolts to 63 Nm (46 lb-ft).
33. To install, reverse the removal procedure.
-

REMOVAL AND INSTALLATION

Cooling Module — Gasoline Engines

Special Tool(s)



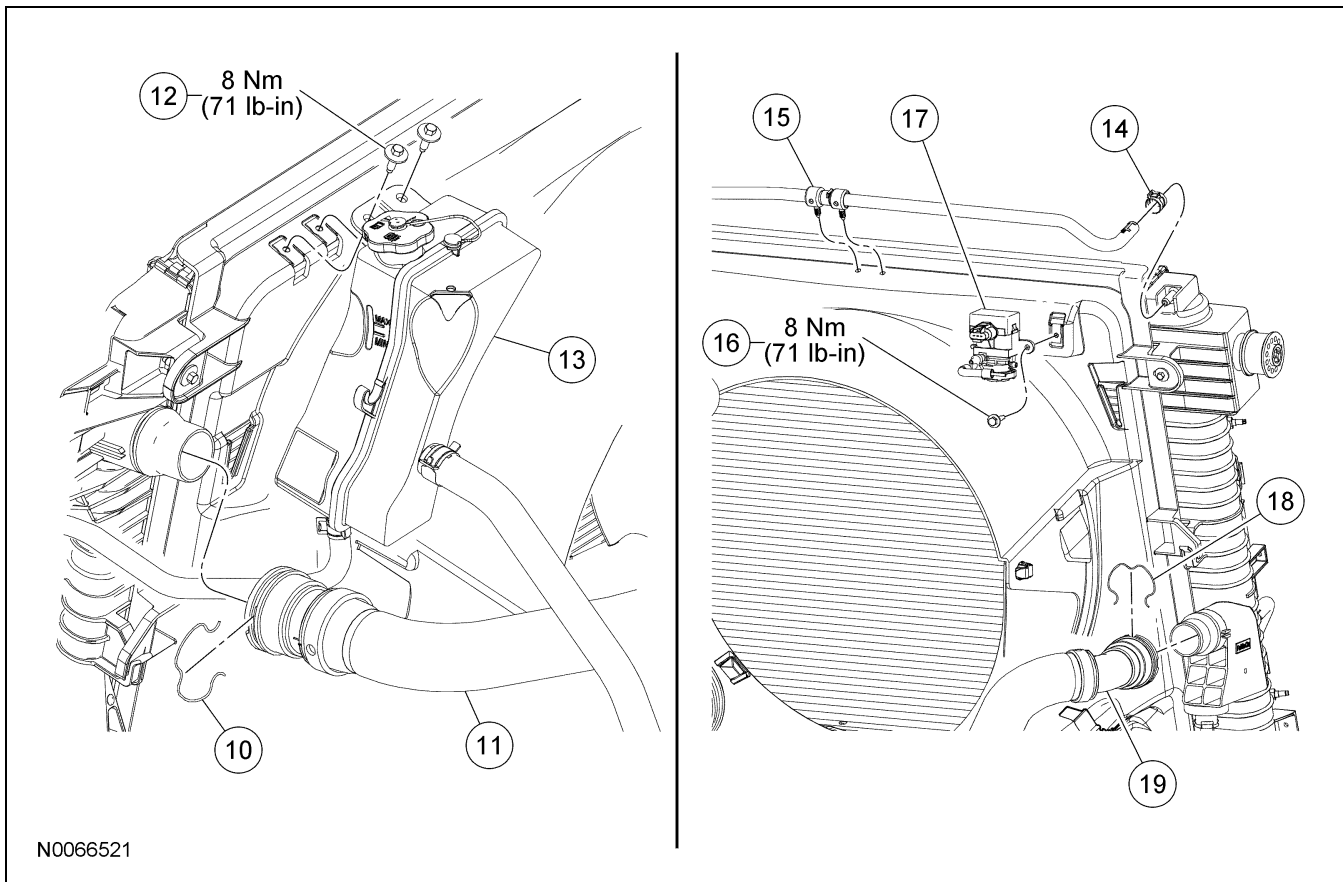
N0066520

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	16C656	Hood latch cable assembly
2	—	Horn assembly electrical connector (part of 12A581)
3	W711851	Horn assembly support bracket bolt
4	13A803	Horn assembly
5	16B975	Hood latch safety release cable

(Continued)

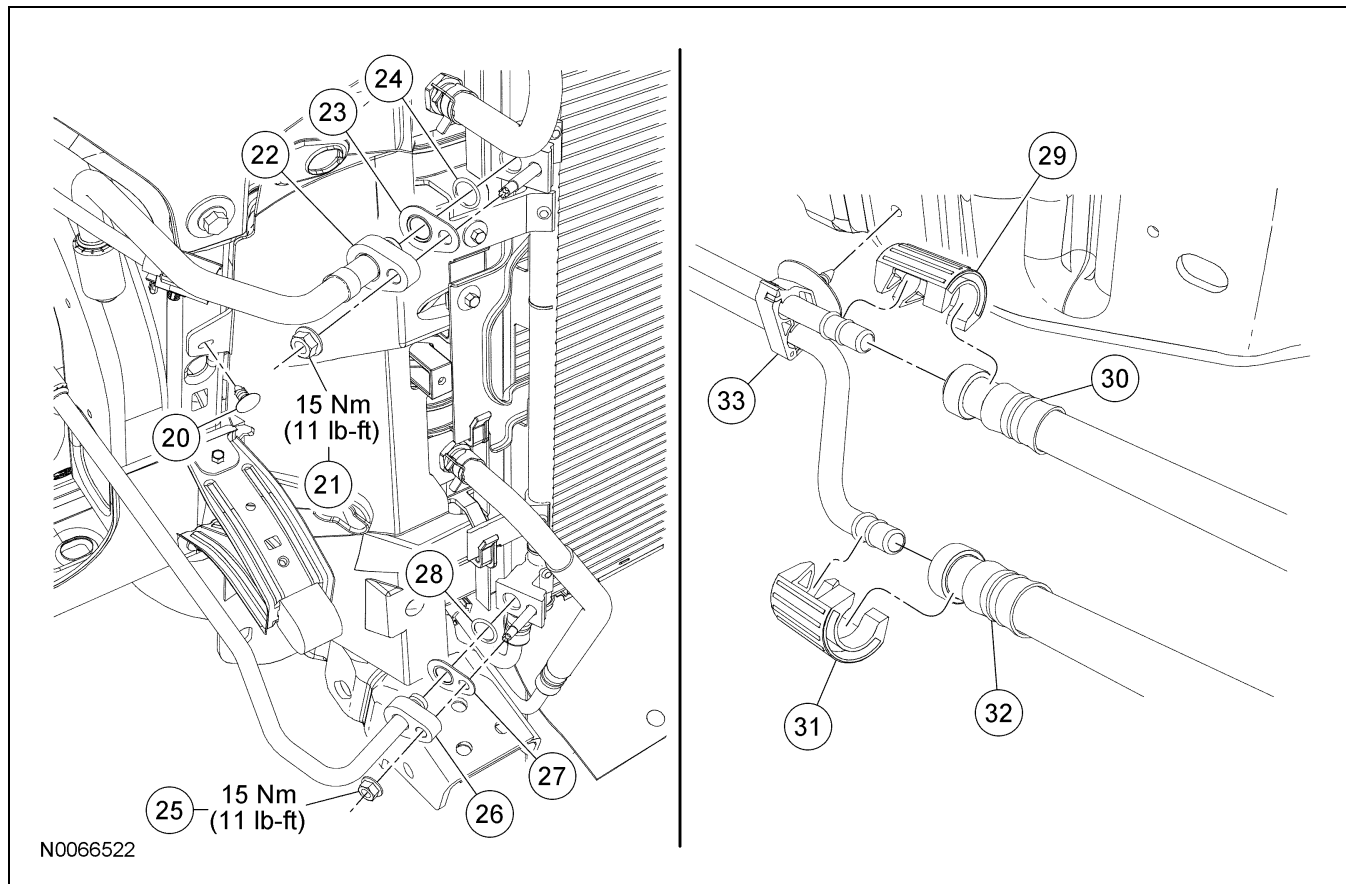
Item	Part Number	Description
6	—	Power steering fluid cooler hose position retainer (part of 3B748)
7	8A261	Air deflector retainer
8	W711851	Power steering fluid cooler bolt (2 required)
9	3D746	Power steering fluid cooler



Item	Part Number	Description
10	—	Upper radiator coolant hose quick connect coupling clip
11	8B274	Upper radiator coolant hose quick connect coupling
12	W503924	Power steering reservoir bolt (2 required)
13	3R700	Power steering reservoir
14	15161	Degas bottle coolant inlet hose clamp
15	8W005	Degas bottle coolant inlet hose

(Continued)

Item	Part Number	Description
16	W505425	Four wheel drive (4WD) differential vacuum valve bolt
17	9H465	4WD differential vacuum valve
18	—	Lower radiator coolant hose quick connect coupling clip
19	8286	Lower radiator coolant hose quick connect coupling

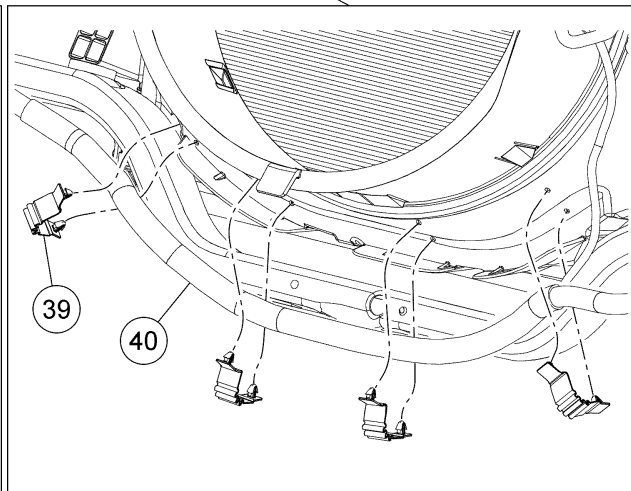
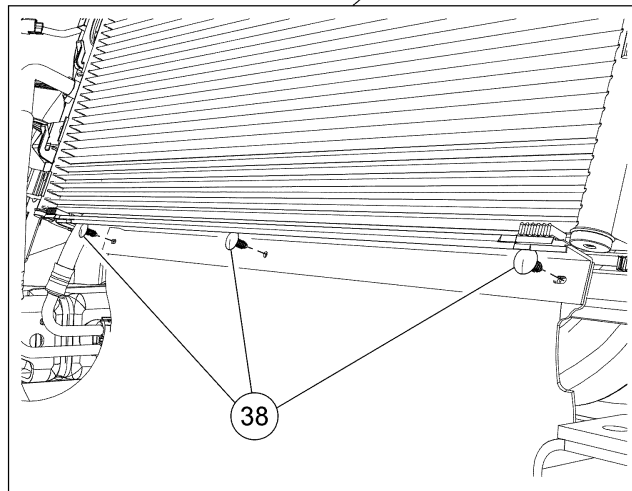
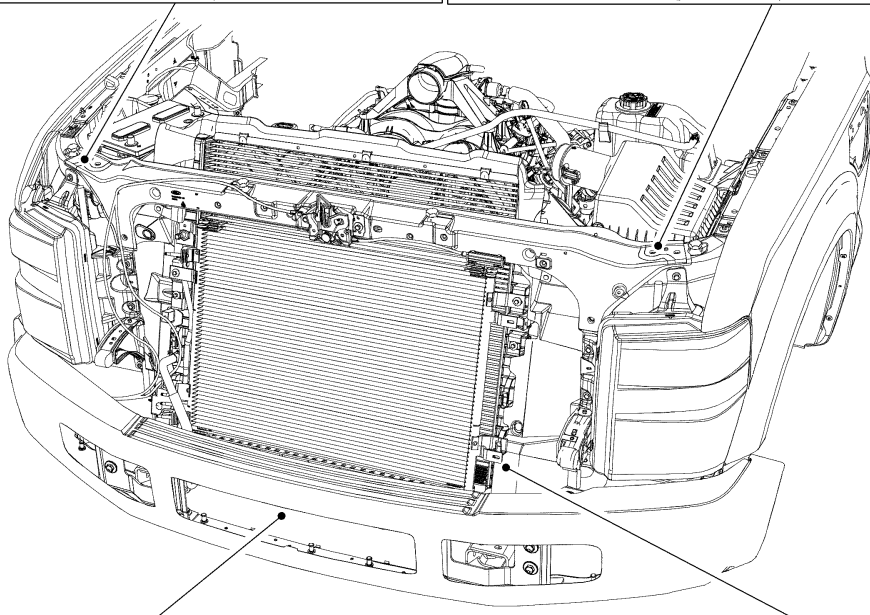
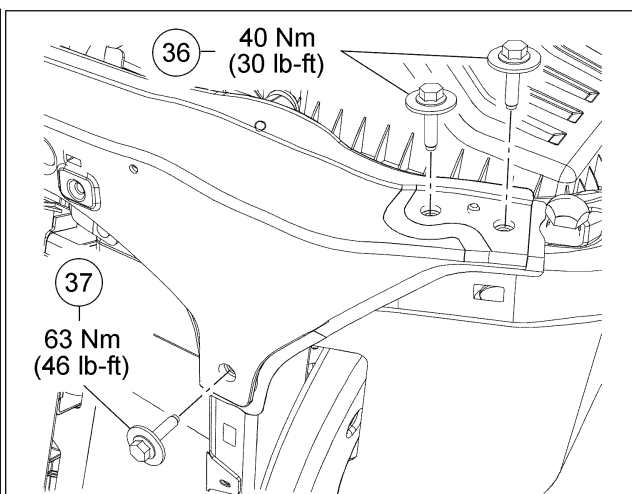
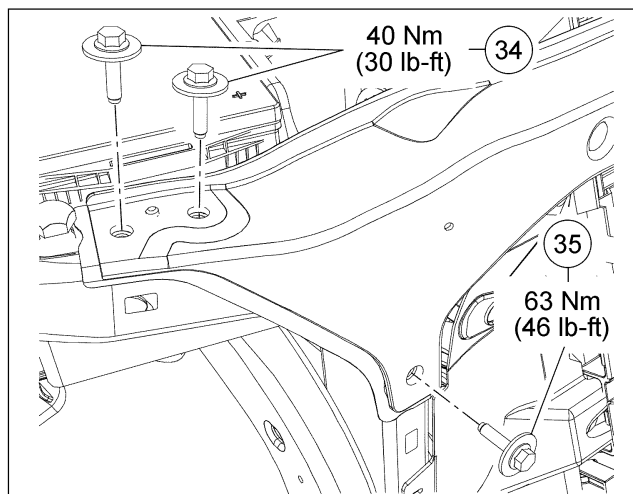
REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
20	8A261	Air deflector retainer
21	W520413	A/C compressor-to-condenser tube nut
22	19972	A/C compressor-to-condenser tube
23	—	A/C compressor-to-condenser tube gasket
24	19E889	A/C condenser outlet tube O-ring seal
25	W520413	A/C condenser outlet tube nut
26	19N651	A/C condenser outlet tube
27	19B588	A/C condenser outlet tube gasket
28	19E889	A/C condenser outlet tube O-ring seal

(Continued)

Item	Part Number	Description
29	7J081	Transmission auxiliary fluid cooler tube quick connect coupling secondary latch
30	7A030	Transmission auxiliary fluid cooler inlet tube
31	7J081	Transmission auxiliary fluid cooler tube quick connect coupling secondary latch
32	7A031	Transmission auxiliary fluid cooler outlet tube
33	—	Transmission auxiliary fluid cooler tube position retainer (part of 7H420)

REMOVAL AND INSTALLATION (Continued)



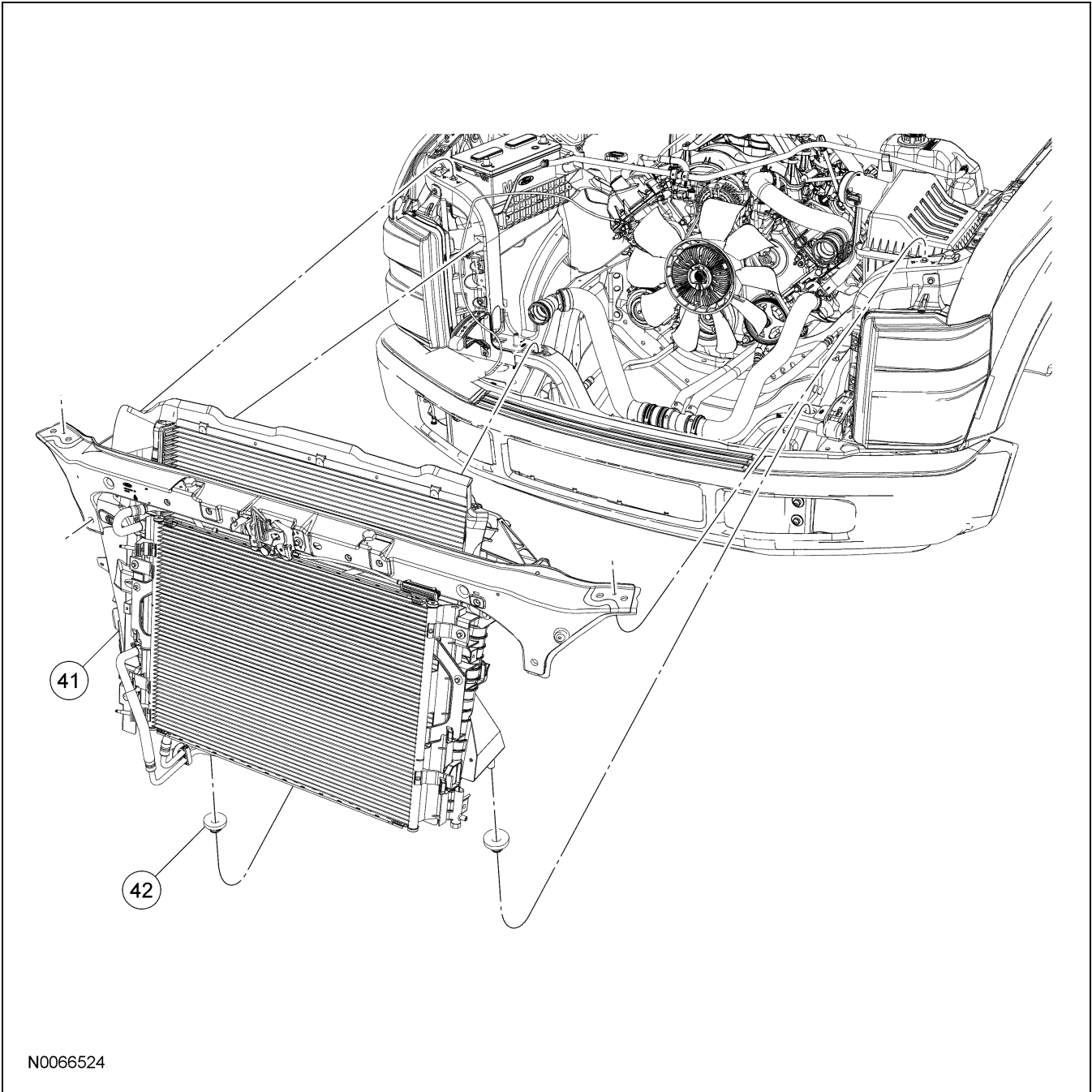
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REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
34	8A261	Radiator support RH top bolts (2 required)
35	W520413	Radiator support RH front bolt
36	19972	Radiator support LH top bolts (2 required)
37	—	Radiator support LH front bolt

Item	Part Number	Description
38	8A211	Air deflector retainers (3 required)
39	14A282	Wiring harness position retainer (4 required)
40	12A581	Engine compartment wiring harness

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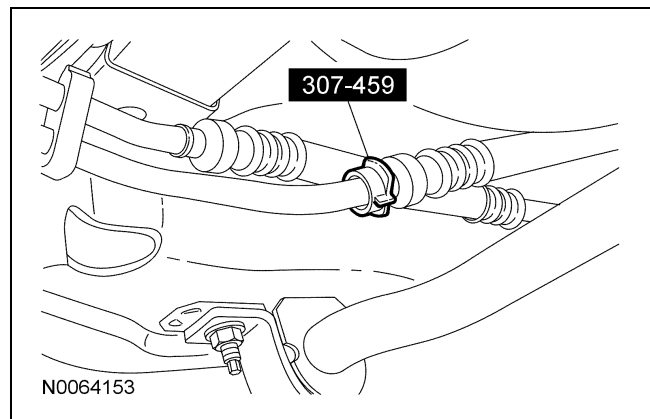
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REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
41	—	Engine cooling module assembly
42	8B204	Lower radiator support insulator (2 required)

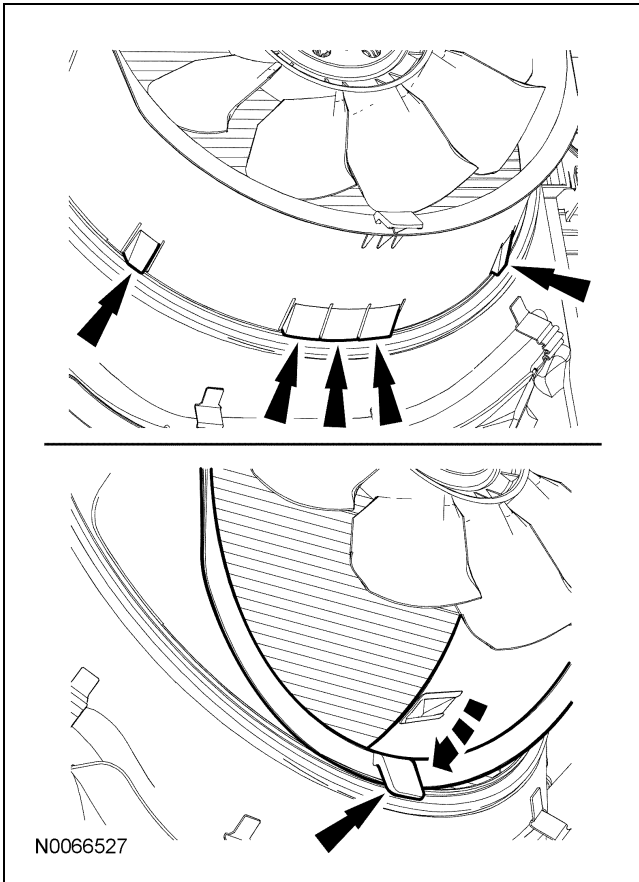
Removal

1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
2. Recover the refrigerant. For additional information, refer to Section 412-00.
3. Drain the engine cooling system. For additional information, refer to Cooling System Draining, Filling and Bleeding in this section.
4. Remove the air cleaner outlet pipe. For additional information, refer to Section 303-12.
5. Disconnect the horn assembly electrical connector.
6. Disconnect the LH hood latch cable and the position retainers and position the cable aside.
7. Remove the bolt and the horn assembly.
8. Disconnect the RH hood safety latch cable and the position retainers and position the cable aside.
9. Disconnect the power steering fluid cooler hose position retainer from the radiator.
10. Disconnect the LH air deflector retainer.
11. Remove the 2 bolts and position the power steering fluid cooler aside.
12. Remove the clip and disconnect the upper radiator coolant hose quick connect coupling.
13. Remove the 2 bolts and position the power steering reservoir aside.
14. Disconnect the degas bottle coolant inlet hose from the radiator.
15. Disconnect the degas bottle coolant inlet hose position retainer from the cooling fan shroud and position aside.
16. If equipped with four wheel drive (4WD), remove the bolt and position the 4WD differential vacuum valve aside.
 - To install, tighten to 8 Nm (71 lb-in).
17. Remove the clip and disconnect the lower radiator coolant hose quick connect coupling.
18. Remove the nut and disconnect the A/C compressor-to-condenser tube.
 - Discard the gasket seal and the O-ring seals.
19. Remove the nut and disconnect the A/C condenser outlet tube.
 - Discard the gasket seal and the O-ring seals.
20. Disconnect the RH air deflector retainer.
21. Remove the 2 secondary latches and using the special tool, disconnect the transmission auxiliary fluid cooler tube quick connect couplings and position retainers.
22. Disconnect the 4 position retainers and position the engine compartment wiring harness aside.
23. Remove the 3 lower air deflector retainers.



REMOVAL AND INSTALLATION (Continued)

24. Press the 5 position retaining tabs and rotate the lower cooling fan shroud upward until the position retainer tab locks into position.



25. Remove the 6 radiator upper support bolts and the engine cooling module.

Installation

1. Position the engine cooling module into the vehicle and install the 6 upper radiator support bolts finger tight.
2. Tighten the 4 radiator support top bolts.
 - Tighten to 40 Nm (30 lb-ft).
3. Tighten the 2 radiator support front bolts.
 - Tighten to 63 Nm (46 lb-ft).
4. Position the lower air deflector and install the 3 pushpin retainers.
5. Connect the position retainer and transmission auxiliary cooler tube quick connect couplings and install the secondary latches.
6. Using a new gasket seal and new O-ring seals, connect the A/C compressor-to-condenser tube to the condenser and install the nut.
 - Tighten to 15 Nm (11 lb-ft).
7. Using a new gasket seal and new O-ring seals, connect the condenser outlet tube to the condenser and install the nut.
 - Tighten to 15 Nm (11 lb-ft).
8. Install the RH air deflector pushpin retainer.
9. If equipped with 4WD, position the 4WD differential vacuum valve and install the bolt.
 - To install, tighten to 8 Nm (71 lb-in).
10. Position the engine compartment wiring harness and connect the 4 wiring harness position retainers to the cooling fan shroud.
11. Connect the lower radiator coolant hose quick connect coupling and install the locking clip.
12. Press the engine cooling fan lower shroud position retainer and rotate the lower fan shroud down until the 4 position retaining tabs lock into position.
13. Connect the degas bottle coolant inlet hose position retainer to the cooling fan shroud.
14. Connect the degas bottle coolant inlet hose to the radiator.
15. Position the power steering reservoir and install the 2 bolts.
 - To install, tighten to 8 Nm (71 lb-in).
16. Connect the upper radiator coolant hose quick connect coupling and install the locking clip.
17. Position the power steering fluid cooler and install the 2 bolts.
 - Tighten to 11 Nm (8 lb-ft).
18. Install the power steering fluid cooler hose retainer onto the radiator.
19. Install the LH air deflector pushpin retainer.
20. Connect the RH hood safety latch cable and position retainers.

REMOVAL AND INSTALLATION (Continued)

- | | |
|--|---|
| 21. Position the horn assembly bracket and install the bolt. <ul style="list-style-type: none">• Tighten to 11 Nm (8 lb-ft). | 24. Install the air cleaner outlet pipe. For additional information, refer to Section 303-12. |
| 22. Connect the horn assembly electrical connector. | 25. Fill and bleed the cooling system. For additional information, refer to Section 303-03. |
| 23. Connect the LH hood latch cable and position retainers. | 26. Evacuate, leak test and charge the refrigerant system. For additional information, refer to Section 412-00. |
-

GENERAL PROCEDURES

Cooling System Draining, Filling and Bleeding

Special Tool(s)



Material

Item	Specification
Motorcraft Premium Gold Engine Coolant with Bittering Agent (US only) VC-7-B (US); CVC-7-A (Canada); or equivalent (yellow color)	WSS-M97B51-A1

Draining

⚠ WARNING: Always allow the engine to cool before opening the cooling system. Do not unscrew the coolant pressure relief cap when the engine is operating or the cooling system is hot. The cooling system is under pressure; steam and hot liquid can come out forcefully when the cap is loosened slightly. Failure to follow these instructions may result in serious personal injury.

⚠ CAUTION: Always fill the cooling system with the same type of coolant that was drained from the system. Do not mix coolant types. Failure to follow these instructions may result in damage to the cooling system.

⚠ CAUTION: The coolant must be recovered in a suitable, clean container for reuse. If the coolant is contaminated, it must be recycled or disposed of correctly and the system filled with new coolant. Failure to follow these instructions may result in damage to the cooling system.

NOTE: Less than 80% of coolant capacity can be recovered with the engine in the vehicle. Dirty, rusty or contaminated coolant requires replacement.

1. Place a suitable container below the radiator draincock. If equipped, disconnect the coolant return hose at the fluid cooler.
2. Remove the pressure relief cap from the degas bottle.
3. Open the radiator draincock and drain the coolant into a suitable container.
4. Close the radiator draincock when finished.

Filling and Bleeding with RADKITPLUS

1. **⚠ CAUTION:** With the engine cold, fill vehicles to within the cold fill range shown on the degas bottle. This fill level will allow for coolant expansion. Overfilling the degas bottle may result in damage to the pressure cap, which can cause the engine to overheat.

Using the special tool, install the RADKITPLUS and follow the RADKITPLUS manufacturer's instructions to fill and bleed the cooling system.

Filling and Bleeding without RADKITPLUS

⚠ CAUTION: Engine coolant provides freeze protection, boil protection, cooling efficiency and corrosion protection to the engine and cooling components. In order to obtain these protections, the engine coolant must be maintained at the correct concentration and fluid level in the degas bottle. Failure to follow these instructions may result in damage to the cooling system.


When adding engine coolant, use a 50/50 mixture of engine coolant and distilled water.

To maintain the integrity of the coolant and the cooling system:

- add Motorcraft Premium Gold Engine Coolant with Bittering Agent. Always fill the cooling system with the same type of coolant that was drained from the system. Do not mix coolant types.
- do not add orange-colored Motorcraft Specialty Orange Engine Coolant with Bittering Agent (US). Mixing coolants may degrade the coolant's corrosion protection.

GENERAL PROCEDURES (Continued)

- **do not add alcohol, methanol, brine or any engine coolants mixed with alcohol or methanol antifreeze. These can cause engine damage from overheating or freezing.**

1.  **CAUTION:** With the engine cold, fill vehicles to within the cold fill range shown on the degas bottle. This fill level will allow for coolant expansion. Overfilling the degas bottle may result in damage to the pressure cap, which can cause the engine to overheat.

Fill the engine cooling system via the degas bottle until coolant level is between the coolant fill level marks.

2. Run the engine at 2,000 rpm for 5 minutes, until it reaches operating temperature.
 3. Turn off the engine and allow the cooling system to cool.
 4. Add the correct engine coolant mixture to the degas bottle until the coolant level is between the COOLANT FILL LEVEL marks.
 5. **NOTE:** If the air discharge remains cool and the engine coolant temperature gauge does not move, the engine coolant level is low in the engine and must be filled. Stop the engine, allow to cool and fill the cooling system as described.


Start the engine and allow it to idle until normal operating temperature is reached. Hot air should discharge from the A/C vents with the climate control setting to full heat. The engine coolant temperature gauge should maintain a stabilized reading in the middle of the NORMAL range and the upper radiator hose should feel hot to the touch.
 6. Repeat Steps 3 through 5 until the degas bottle is at the correct level.
-

GENERAL PROCEDURES

Cooling System Flushing

Material

Item	Specification
Premium Cooling System Flush VC-1	ESR-M14P7-A

1.  **WARNING:** Always allow the engine to cool before opening the cooling system. Do not unscrew the coolant pressure relief cap when the engine is operating or the cooling system is hot. The cooling system is under pressure; steam and hot liquid can come out forcefully when the cap is loosened slightly. Failure to follow these instructions may result in serious personal injury.

Once pressure is released, remove the pressure relief cap.

Drain the cooling system. For additional information, refer to Cooling System Draining, Filling and Bleeding in this section.

2. Remove the coolant thermostat.

3. Install the coolant hose connection without the coolant thermostat.

4. **NOTE:** Refer to the cooling system flusher manufacturer's operating instructions for specific vehicle hook-up.

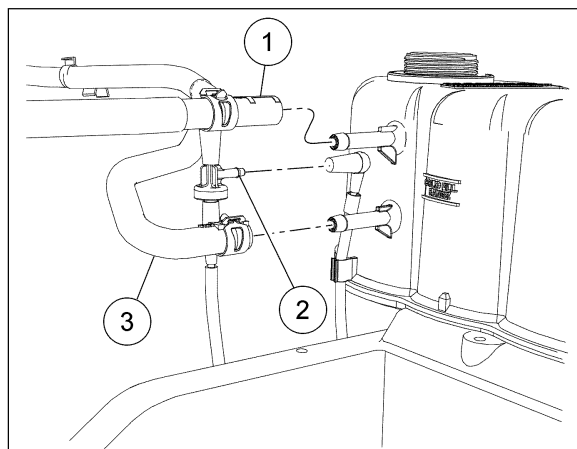
Use an appropriate cooling system flusher to flush the engine and radiator.

Use Premium Cooling System Flush or equivalent.

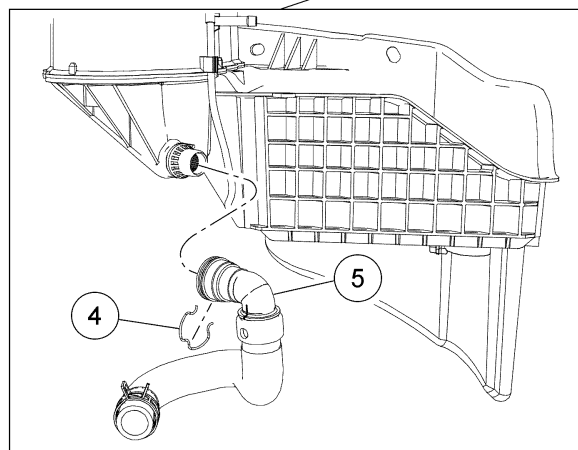
5. Install the coolant thermostat. For additional information, refer to Thermostat — Gasoline Engines or Thermostat — 6.4L Diesel in this section.
6. Backflush the heater core if necessary. For additional information, refer to Heater Core Backflushing in this section.
7. Fill the cooling system. For additional information, refer to Cooling System Draining, Filling and Bleeding in this section.

REMOVAL AND INSTALLATION

Degas Bottle — 6.4L Diesel



6
19 Nm
(14 lb-ft)



N0066557

Item	Part Number	Description
1	8W005	Radiator-to-degas bottle hose
2	P4160	Vacuum hose connector
3	9Y439	EGR-to-degas bottle hose
4	—	Degas bottle-to-engine hose spring clip (part of 8C351)

Item	Part Number	Description
5	8C351	Degas bottle-to-engine hose
6	W701835	Degas bottle bolts (2 required)
7	6A987	Degas bottle

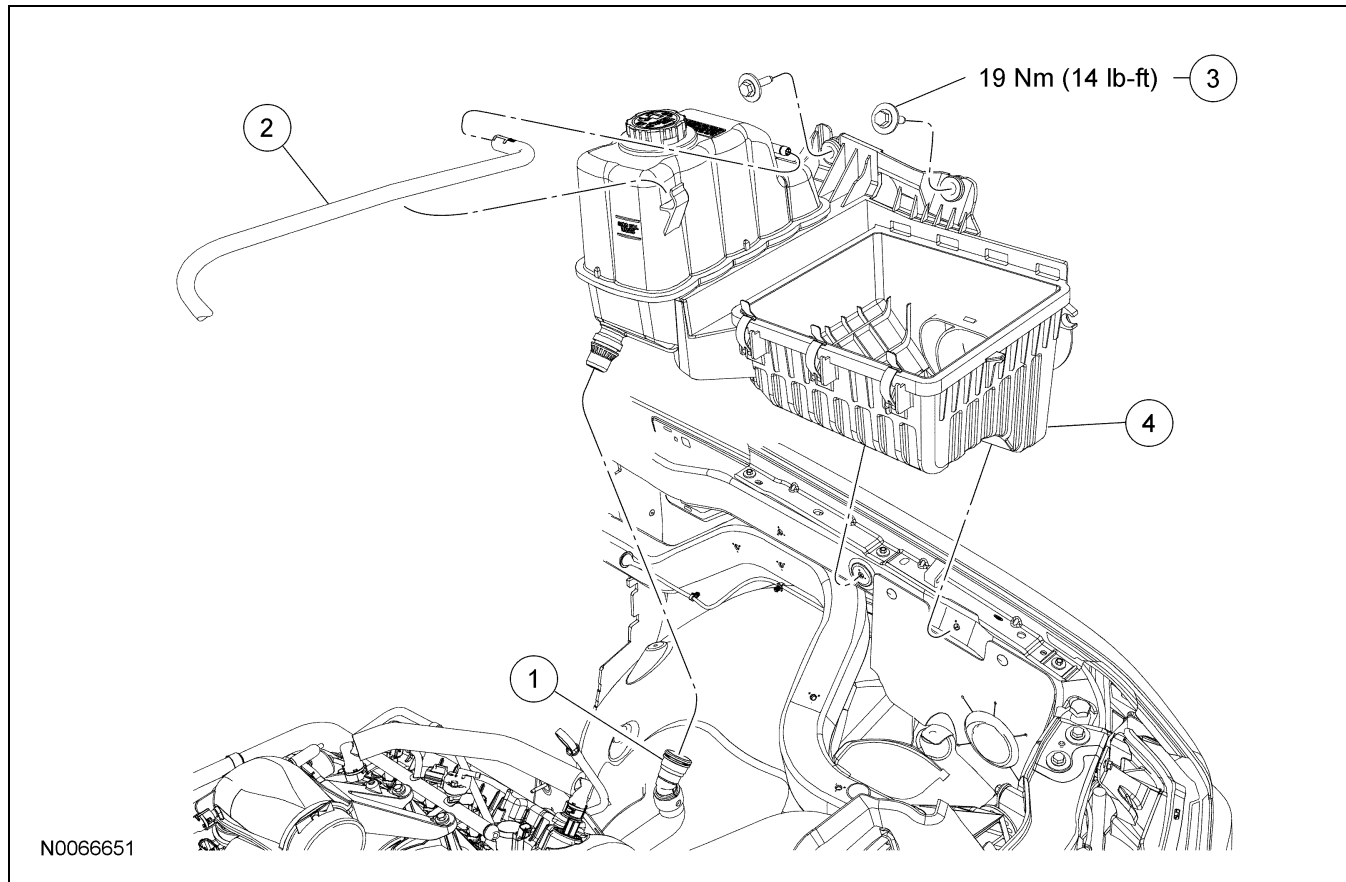
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REMOVAL AND INSTALLATION (Continued)**Removal and Installation**

1. Drain the engine cooling system. For additional information, refer to Cooling System Draining, Filling and Bleeding in this section.
 2. Remove the LH battery. For additional information, refer to Section 414-01.
 3. Loosen the clamp and disconnect the radiator-to-degas bottle hose from the degas bottle.
 4. Loosen the clamp and disconnect the EGR cooler-to-degas bottle hose from the degas bottle.
 5. If equipped, disconnect the vacuum hose connector.
 6. Remove the bolts and lift up the degas bottle in order to access the engine-to-degas bottle hose.
 - To install, tighten to 19 Nm (14 lb-ft).
 7. Remove the spring clip and disconnect the engine-to-degas bottle hose from the degas bottle. Remove the degas bottle from the vehicle.
 - To install, make sure the spring clip is correctly installed.
 8. To install, reverse the removal procedure.
-

REMOVAL AND INSTALLATION

Degas Bottle — Gasoline Engines



Item	Part Number	Description
1	8C351	Degas bottle coolant outlet hose quick connect coupling
2	8W005	Degas bottle coolant inlet hose
3	W701835	Degas bottle assembly bolts (2 required)
4	6A987	Degas bottle assembly


Removal and Installation

1. Drain the engine cooling system. For additional information, refer to Cooling System Draining, Filling and Bleeding in this section.

2. Remove the air cleaner element. For additional information, refer to Section 303-12.
3. Disconnect the degas bottle coolant outlet hose quick connect coupling.
4. Disconnect the degas bottle coolant inlet hose.
5. Remove the 2 bolts and the degas bottle assembly.
 - To install, tighten to 19 Nm (14 lb-ft).
6. To install, reverse the removal procedure.

DESCRIPTION AND OPERATION

Engine Cooling

 **CAUTION:** Always fill the cooling system with the same type of coolant that is present in the system. Do not mix coolant types. Mixing coolant types can result in cooling system damage.


The cooling system components include the following:

- Block heater
- Fan blade
- Fan clutch
- Fan shroud
- Radiator
- Degas bottle
- Pressure relief cap
- Radiator draincock
- Coolant pump
- Coolant thermostat
- Oil filter adapter
- Upper radiator hose
- Lower radiator hose
- Degas bottle supply hose
- Fan stator — 6.4L
- Exhaust gas recirculation (EGR) coolers — 6.4L
- Engine oil cooler — 6.4L
- Heater core
- Heater hoses

Engine coolant provides freeze protection, boil protection, cooling efficiency and corrosion protection to the engine and cooling components. In order to obtain these protections, the engine coolant must be maintained at the correct concentration and fluid level in the degas bottle.

When adding engine coolant, use a 50/50 mixture of engine coolant and distilled water.

To maintain the integrity of the coolant and the cooling system:

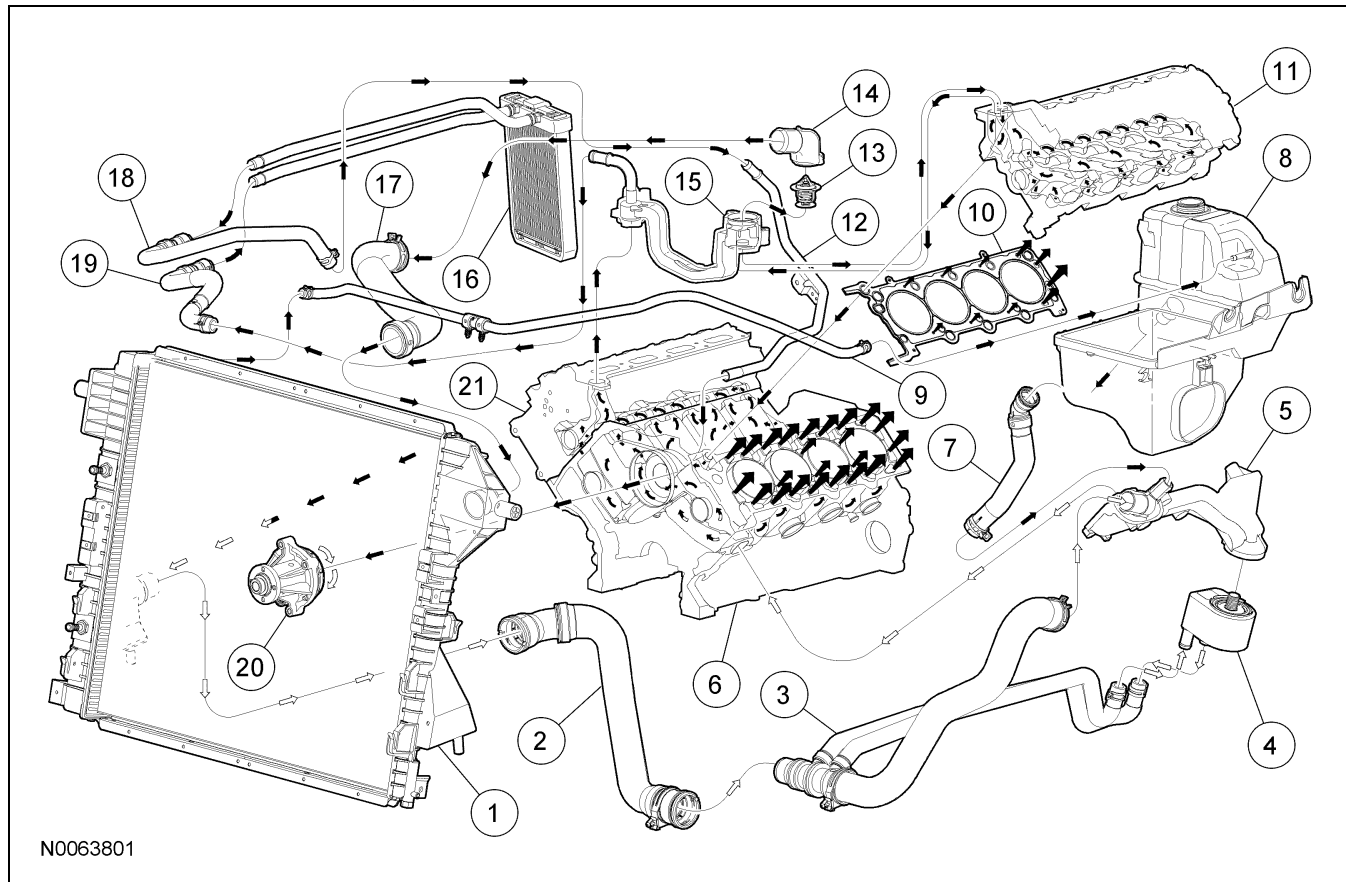
-  **CAUTION:** With the engine cold, fill vehicles to within the cold fill range shown on the degas bottle. This fill level will allow for coolant expansion. Overfilling the degas bottle may result in damage to the pressure cap, which can cause the engine to overheat.

Add Motorcraft Premium Gold Engine Coolant with Bittering Agent or equivalent (yellow color). Do not mix coolant types.

- Do not add/mix orange-colored Motorcraft Specialty Orange Engine Coolant with Bittering Agent (US) Motorcraft Extended Life Engine Coolant (Canada); or equivalent. Mixing coolants may degrade the coolant's corrosion protection.
- Do not add alcohol, methanol, brine or any engine coolants mixed with alcohol or methanol antifreeze. These can cause engine damage from overheating or freezing.
- Do not mix with recycled coolant. Use of such coolants may harm the engine and cooling system components. Do not mix coolant types.

DESCRIPTION AND OPERATION (Continued)**Coolant Flow Diagram, 5.4L 3V**

NOTE: Black arrows indicate hot, white arrows indicate cold.



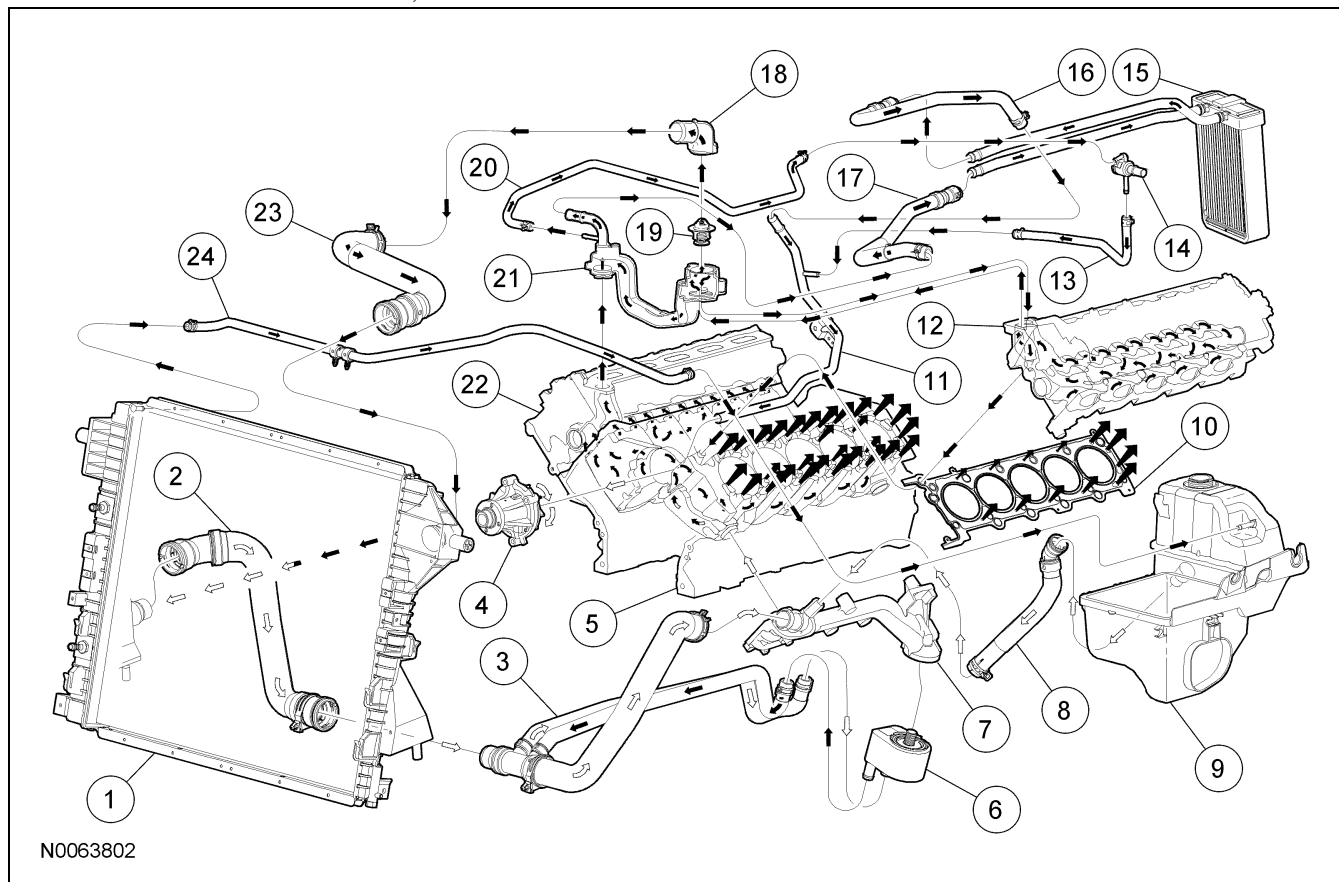
Item	Part Number	Description
1	8005	Radiator assembly
2	8286	Lower radiator hose assembly
3	8D033	Lower radiator hose assembly
4	6A642	Oil cooler assembly
5	6884	Oil filter adapter
6	6010	Cylinder block
7	8C351	Degas bottle coolant return hose
8	6A987	Degas bottle assembly
9	8W005	Degas bottle coolant inlet hose
10	6083	LH cylinder head gasket

(Continued)

Item	Part Number	Description
11	6050	LH cylinder head
12	18663	Heater coolant outlet tube
13	8575	Thermostat
14	8594	Thermostat housing
15	8C369	Coolant crossover assembly
16	19B555	Heater assembly
17	8B274	Upper radiator hose assembly
18	18K580	Heater outlet hose assembly
19	18K579	Heater inlet hose assembly
20	8501	Coolant pump
21	6049	RH cylinder head

DESCRIPTION AND OPERATION (Continued)**Coolant Flow Diagram, 6.8L 3V**

NOTE: Black arrows indicate hot, white arrows indicate cold.



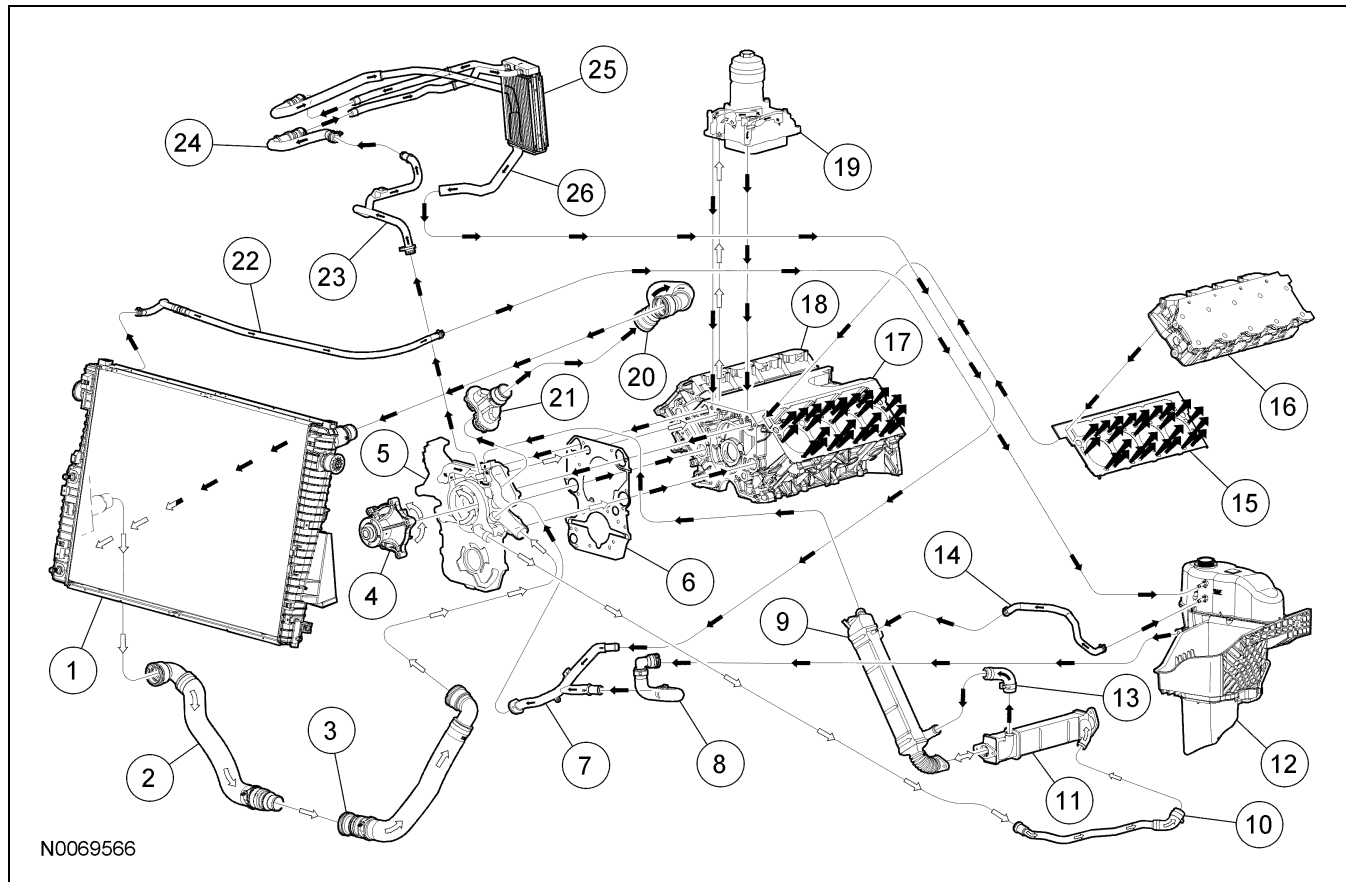
Item	Part Number	Description
1	8005	Radiator assembly
2	8286	Lower radiator hose assembly
3	8D033	Lower radiator hose assembly
4	8501	Coolant pump
5	6010	Cylinder block
6	6A642	Oil cooler assembly
7	6884	Oil filter adapter
8	8C351	Degas bottle coolant return hose
9	6A987	Degas bottle assembly
10	6083	LH cylinder head gasket
11	18663	Heater coolant outlet tube
12	6050	LH cylinder head
13	18465	Heated positive crankcase ventilation (PCV) fitting coolant outlet hose

Item	Part Number	Description
14	9A474	Heated PCV fitting
15	19B555	Heater core
16	18K580	Heater outlet hose assembly
17	18K579	Heater inlet hose assembly
18	8594	Thermostat housing
19	8575	Thermostat
20	18465	Heated PCV fitting coolant inlet hose
21	8C369	Coolant crossover assembly
22	6049	RH cylinder head
23	8B274	Upper radiator hose assembly
24	8W005	Degas bottle coolant inlet hose

(Continued)

DESCRIPTION AND OPERATION (Continued)**Coolant Flow Diagram, 6.4L Diesel**

NOTE: Black arrows indicate hot, white arrows indicate cold.



Item	Part Number	Description
1	8005	Radiator assembly
2	8286	RH lower radiator hose assembly
3	8D033	LH lower radiator hose assembly
4	8501	Coolant pump
5	6019	Engine front cover assembly
6	6020	Engine front cover gasket
7	8592	Heater return tube
8	8C351	Degas bottle coolant return hose
9	9P456	Exhaust gas recirculation (EGR) cooler (vertical)
10	9F468	EGR cooler inlet tube
11	9F464	EGR cooler assembly (horizontal)
12	6A987	Degas bottle assembly

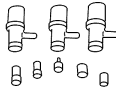
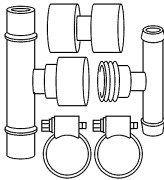
(Continued)

Item	Part Number	Description
13	19F466	EGR cooler outlet tube
14	9F466	EGR coolant return tube
15	6051	LH cylinder head gasket
16	6049	LH cylinder head
17	6010	Upper crankcase assembly
18	6049	RH cylinder head
19	8594	Oil cooler and filter module assembly
20	8B274	Upper radiator hose assembly
21	8575	Thermostat housing
22	8W005	Degas bottle coolant inlet hose
23	8592	Heater coolant supply tube
24	18K579	Heater coolant supply hose
25	18476	Heater core assembly
26	18K580	Heater coolant outlet hose

GENERAL PROCEDURES


Heater Core Backflushing

Special Tool(s)

 ST1167-A	Drain Kit 164-R3662 or equivalent
 ST1168-A	Flush Kit Hardware Package 164-R3658 or equivalent

Material

Item	Specification
Premium Cooling System Flush VC-1	ESR-M14P7-A

-  **WARNING:** Always allow the engine to cool before opening the cooling system. Do not unscrew the coolant pressure relief cap when the engine is operating or the cooling system is hot. The cooling system is under pressure; steam and hot liquid can come out forcefully when the cap is loosened slightly. Failure to follow these instructions may result in serious personal injury.

Once pressure is released, remove the pressure relief cap.
- Clamp off the heater hoses.
- NOTE:** Refer to the cooling system Flush-All Operating Instructions for particular vehicle hook-up.

Use cooling system Flush-All, Flush Kit Hardware Package and Drain Kit to backflush the heater core. Use Premium Cooling System Flush or equivalent.
- Remove the clamps from the heater hoses.

REMOVAL AND INSTALLATION

Radiator — 6.4L Diesel

Removal and Installation

1. Remove the upper fan shroud. For additional information, refer to Cooling Fan Shroud — 6.4L Diesel, Upper in this section.
 2. Remove the pushpins and the top air deflector.
 3. Detach the battery cable from the radiator. Position the battery cable aside.
 4. Remove the spring clip and disconnect the lower radiator hose from the radiator.
 5. Detach the hood latch release cable retainer from the radiator.
 6. Disconnect the transmission fluid cooler hoses and drain the fluid into a suitable container.
 7. Remove the RH air deflector pushpins from the radiator.
 8. Remove the bolt and position the fuel cooling system radiator aside.
 - To install, tighten to 12 Nm (9 lb-ft).
 9. Remove the LH air deflector pushpins from the radiator.
 10. Detach the power steering fluid hose retainer from the radiator.
 11. Remove the bolts and position the transmission fluid cooler aside.
 - Secure the transmission fluid cooler as needed.
 - To install, tighten to 11 Nm (8 lb-ft).
 12. Detach the A/C fitting from the RH battery tray.
 13. Detach the A/C hose retainer from the RH inner fender splash shield.
 14. Remove the bolts and detach the A/C condenser from the radiator.
 - Secure the A/C condenser as needed.
 - To install, tighten to 8 Nm (71 lb-in).
 15. Remove the lower fan shroud bolts.
 - To install, tighten to 7 Nm (62 lb-in).
 16. With the help of an assistant, remove the radiator.
 17. To install, reverse the removal procedure.
 - Check the transmission fluid level and fill as necessary.
-

REMOVAL AND INSTALLATION

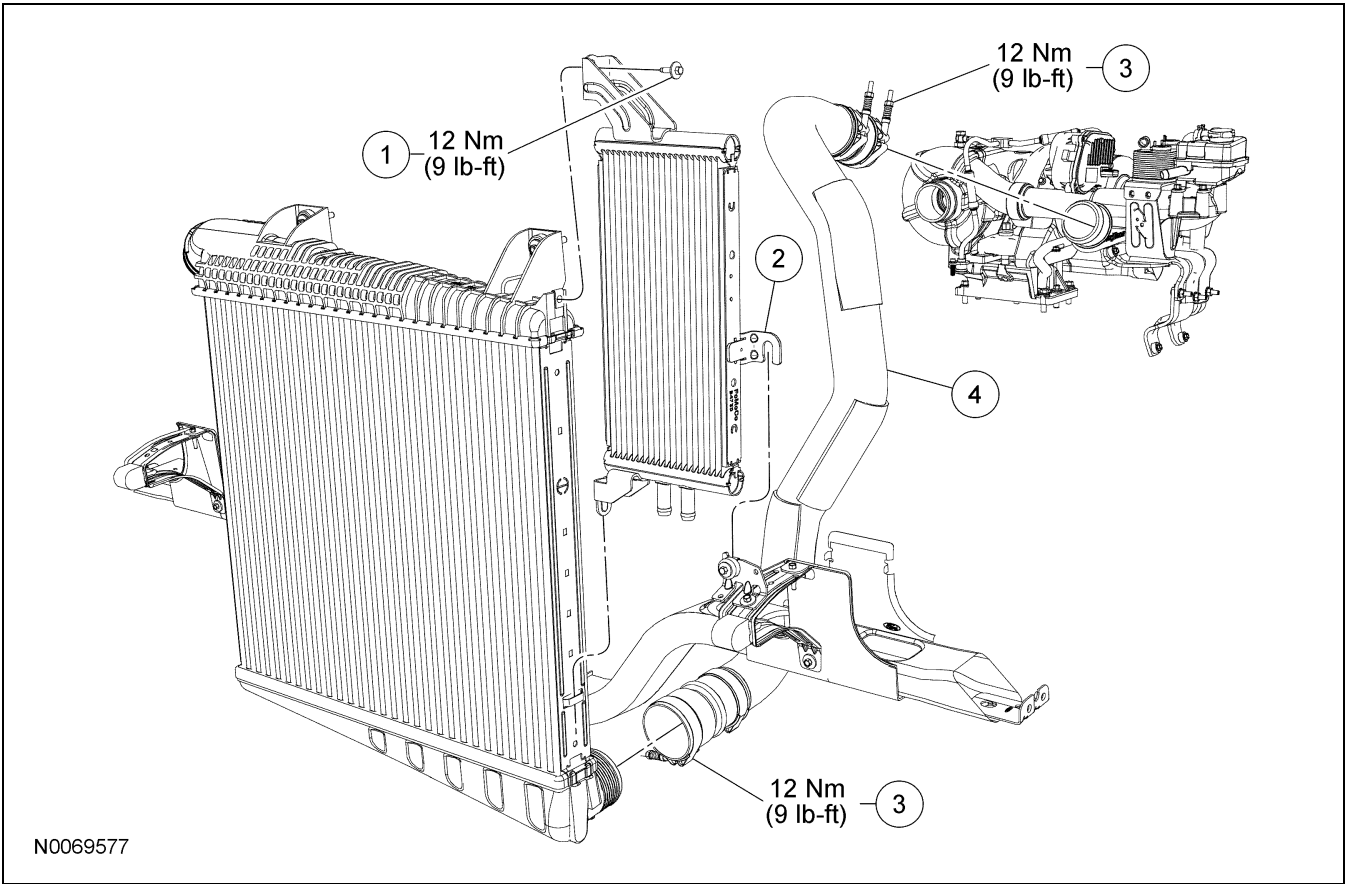
Radiator — Gasoline Engines

Removal and Installation

1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
2. Drain the engine cooling system. For additional information, refer to Cooling System Draining, Filling and Bleeding in this section.
3. Remove the cooling fan. For additional information, refer to Cooling Fan — Gasoline Engines in this section.
4. Remove the cooling fan shroud. For additional information, refer to Cooling Fan Shroud — Gasoline Engines in this section.
5. Remove the 2 bolts and position the power steering fluid cooler aside.
 - To install, tighten to 11 Nm (8 lb-ft).
6. Remove the 2 bolts and disconnect the A/C condenser from the radiator.
 - To install, tighten to 8 Nm (71 lb-in).
7. Remove the 2 bolts and disconnect the 2 hoses and the transmission auxiliary fluid cooler from the radiator.
 - To install, tighten to 11 Nm (8 lb-ft).
8. Disconnect the 2 radiator air deflector retainers.
9. Remove the clip and disconnect the lower radiator hose quick connect coupling.
10. Remove the 4 radiator-to-radiator support bolts, the 2 radiator-to-radiator support clamps and the radiator.
 - To install, tighten to 10 Nm (89 lb-in).
11. If servicing the radiator, remove the radiator support insulators.
12. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Radiator and Cooling Fan —
Exploded View, 6.4L Diesel

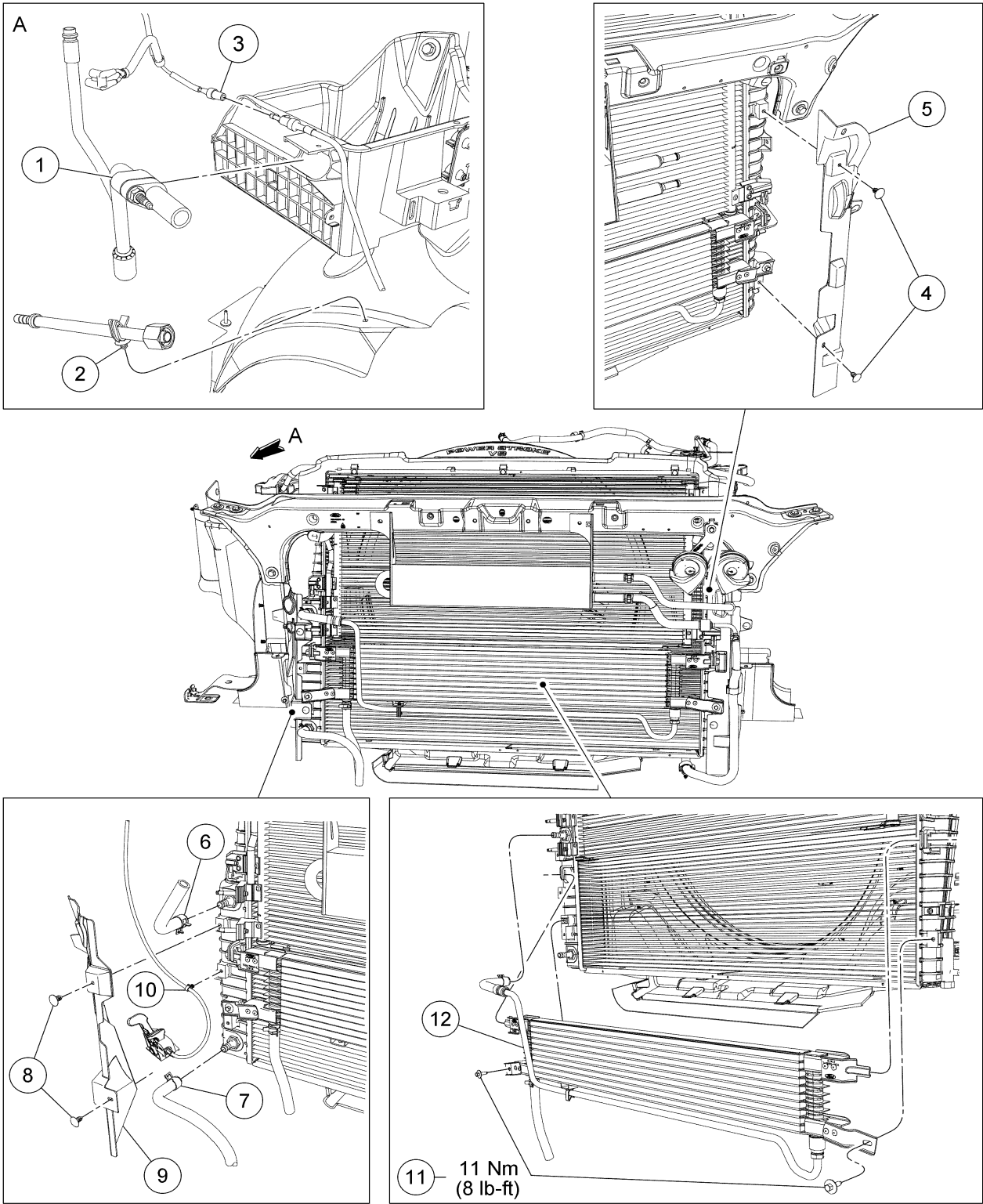


Item	Part Number	Description
1	1325346	Fuel cooling system radiator top bolt
2	8D010	Fuel cooling system radiator

(Continued)

Item	Part Number	Description
3	6K786	LH charge air cooler (CAC) tube clamp
4	6C646	LH CAC tube

REMOVAL AND INSTALLATION (Continued)



N0069578

Item	Part Number	Description
1	—	A/C tube in-line fitting
2	W711947	A/C tube retainer (part of 19N651)

(Continued)

Item	Part Number	Description
3	9E499	Vacuum hose connector
4	R00696	LH air deflector pushpins (part of 8A261) (2 required)

(Continued)

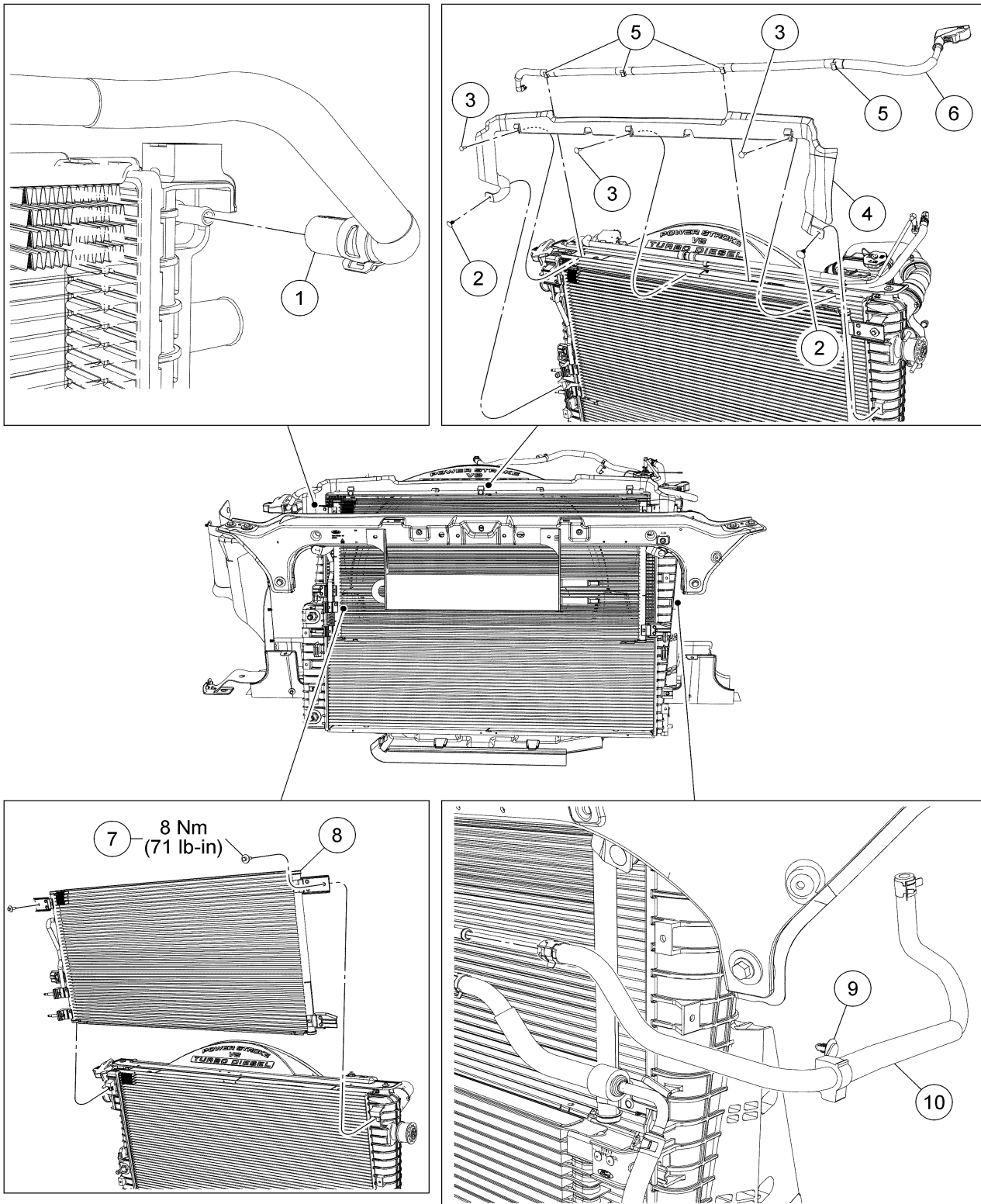
REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
5	8A261	LH air deflector
6	7C410	Transmission fluid cooler hose
7	7F112	Transmission fluid cooler hose
8	R00696	RH air deflector pushpins (part of 8A211) (2 required)

(Continued)

Item	Part Number	Description
9	8A211	RH air deflector
10	W712867	Hood latch release cable retainer (part of 16B975)
11	W503924	Transmission fluid cooler bolts (2 required)
12	7H189	Transmission fluid cooler

REMOVAL AND INSTALLATION (Continued)



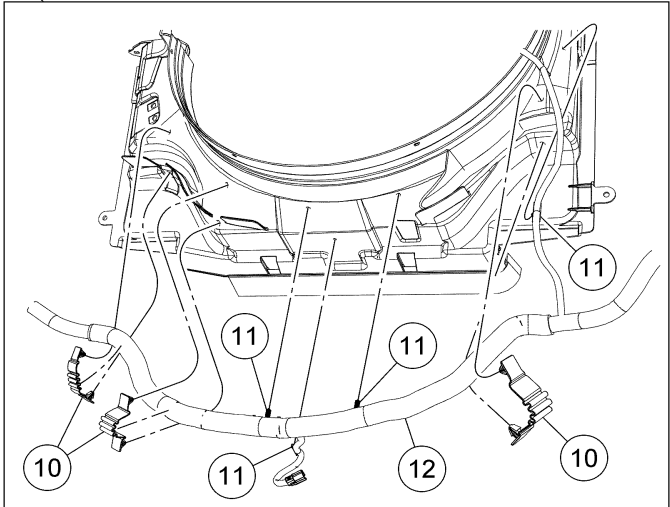
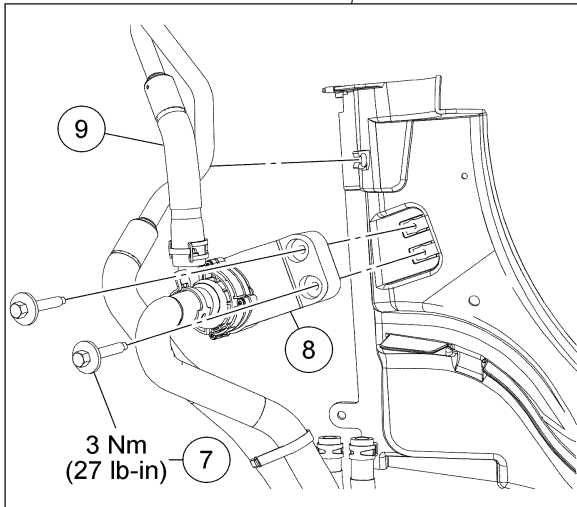
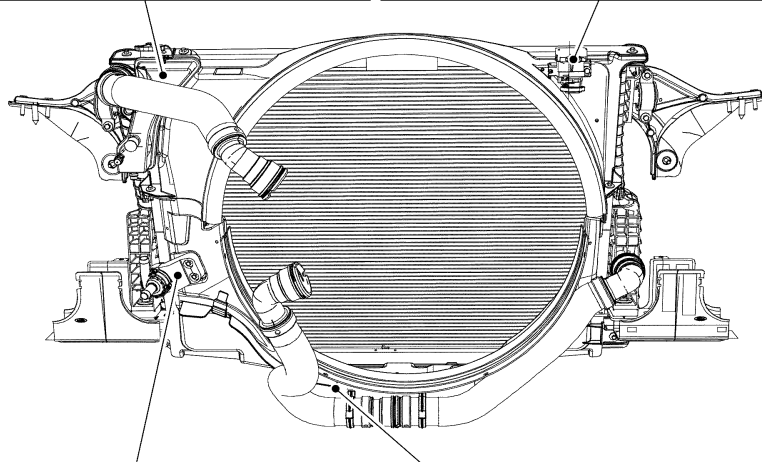
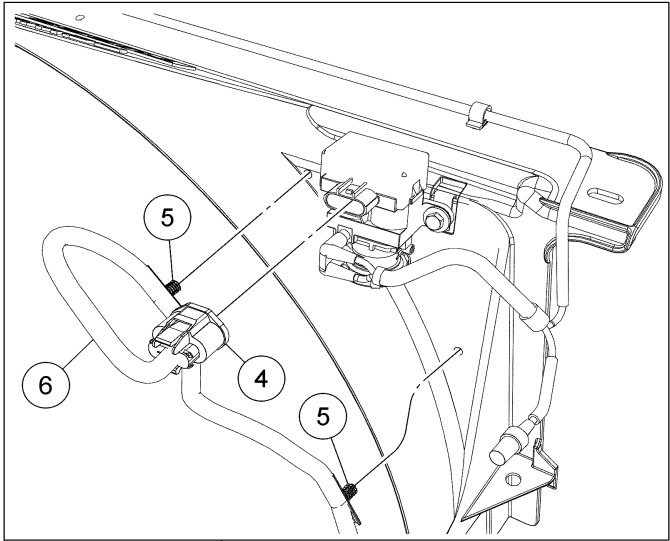
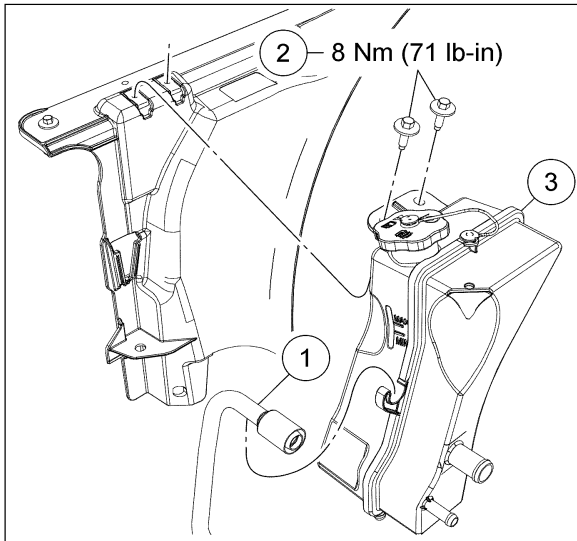
N0066552

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	8W005	Radiator-to-degas bottle hose
2	R00696	Top air deflector side pushpins (part of 16C824) (2 required)
3	R00840	Top air deflector top pushpins (part of 16C824) (3 required)
4	16C824	Top air deflector
5	13A506	Battery cable retainers (part of 14300) (4 required)

(Continued)

Item	Part Number	Description
6	14300	Battery cable
7	W503924	A/C condenser bolt (2 required)
8	120302	A/C condenser
9	84043	Power steering fluid hose retainer (part of 3B748)
10	3B748	Power steering fluid hose

REMOVAL AND INSTALLATION (Continued)

N0069579

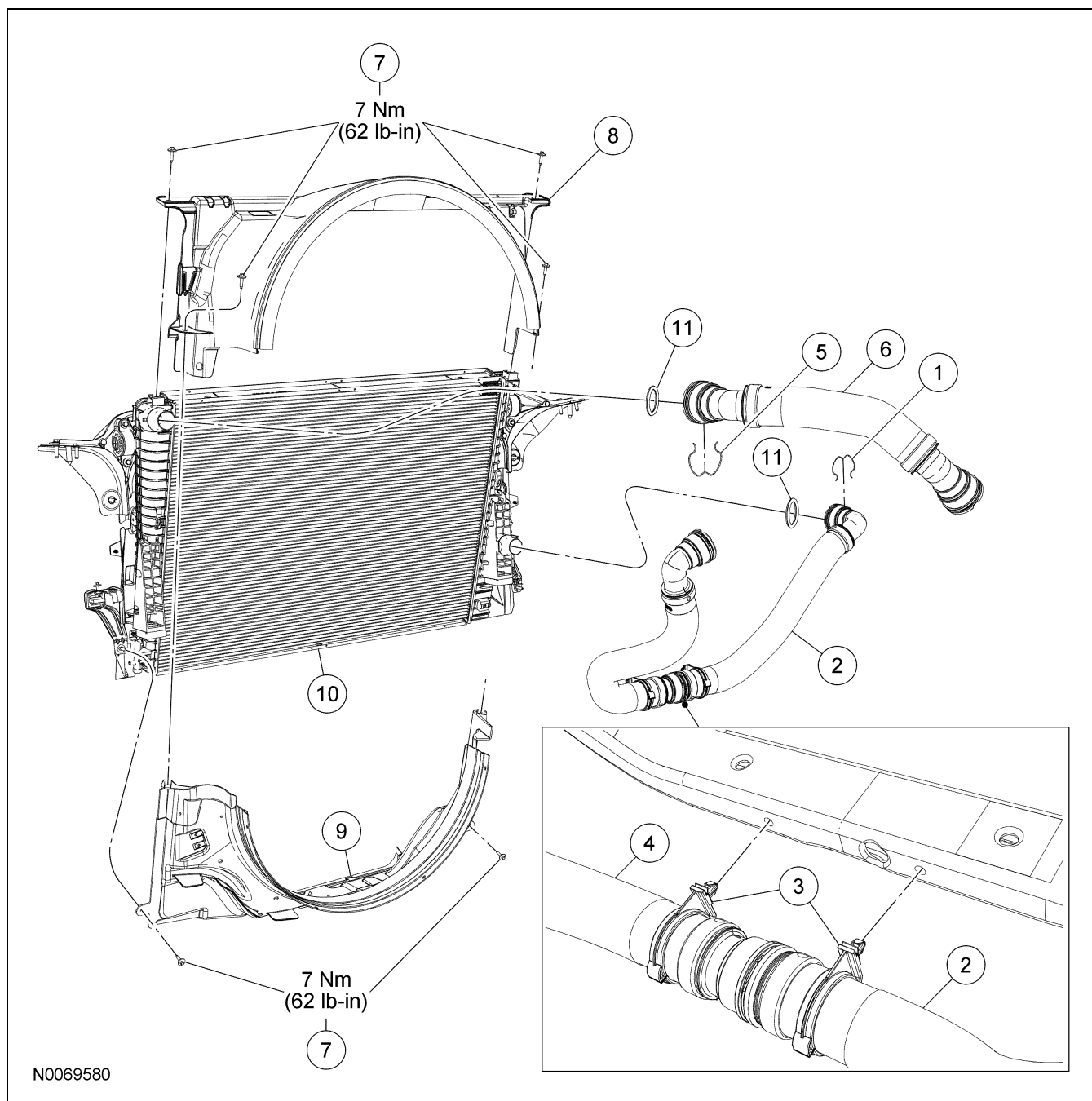
REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	8D012	Coolant pump-to-fuel cooler hose
2	W503924	Power steering fluid reservoir bolts (2 required)
3	3R700	Power steering fluid reservoir
4	14A464	Vacuum solenoid electrical connector (part of 12A581)
5	13A506	Wiring harness retainers (part of 12A581) (2 required)
6	12A581	Wiring harness
7	W503926	Fuel cooling system coolant pump bolt (2 Required)

(Continued)

Item	Part Number	Description
8	8B552	Fuel cooling system coolant pump
9	8D011	Turbocharger actuator cooler-to-fuel cooling system radiator hose
10	14A282	Wiring harness retaining straps (3 required)
11	13A506	Wiring harness retainers (part of 12A581) (4 required)
12	15A581	Wiring harness

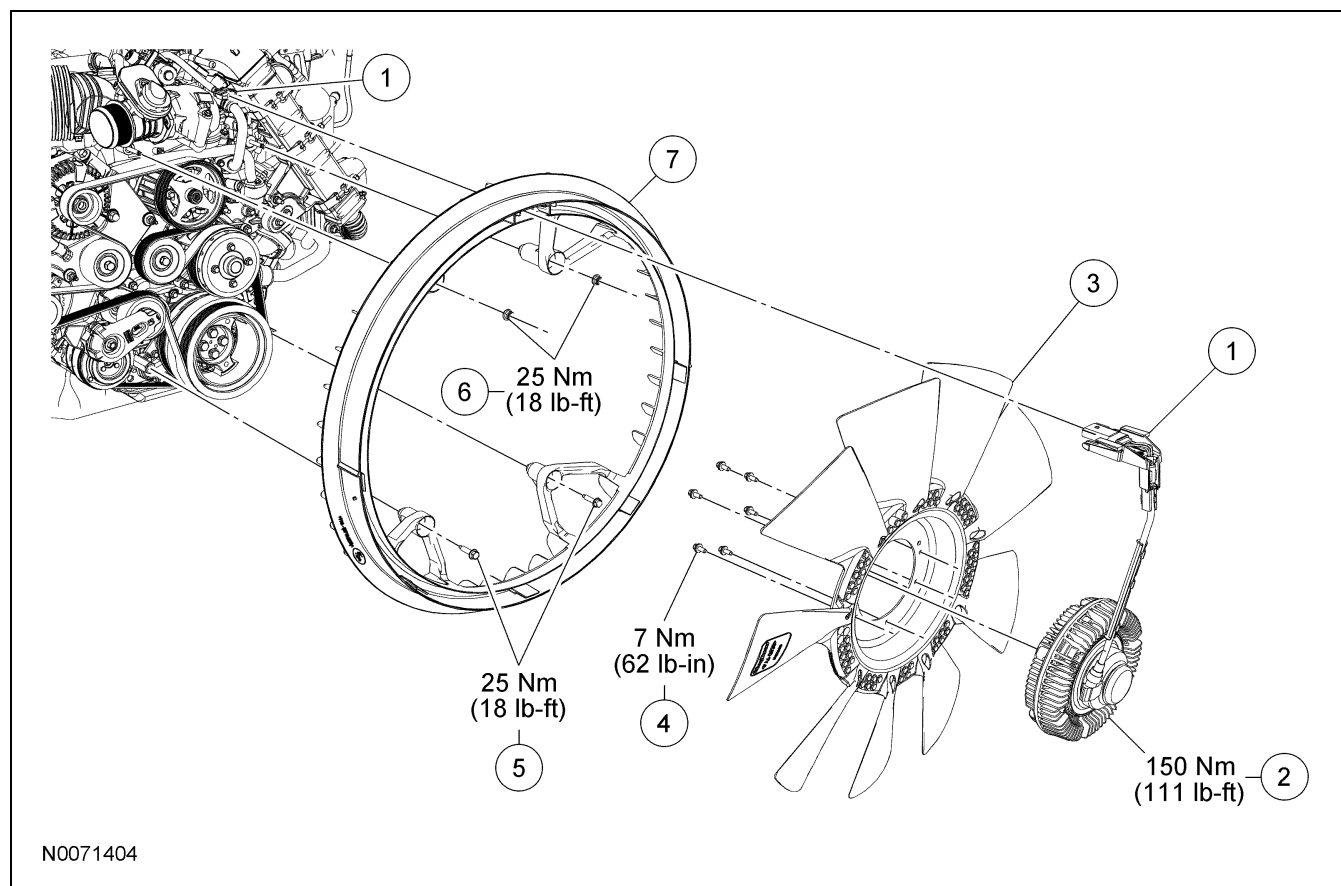
REMOVAL AND INSTALLATION (Continued)



Item	Part Number	Description
1	—	Lower radiator hose spring clip (part of 8286)
2	8286	Lower radiator hose
3	8W237	Lower radiator hose retainers (2 required)
4	8D033	Lower radiator hose-to-engine block hose
5	8D037	Upper radiator hose spring clip (part of 8B274)

(Continued)

Item	Part Number	Description
6	8B274	Upper radiator hose
7	W503924	Cooling fan shroud bolts (6 required)
8	8L604	Upper cooling fan shroud
9	8K619	Lower cooling fan shroud
10	8005	Radiator
11	8D058	Coolant hose quick connect coupling O-ring seal

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	14A464	Cooling fan clutch electrical connector
2	8A616	Cooling fan clutch
3	8600	Cooling fan
4	N602527	Cooling fan-to-cooling fan clutch bolt (6 required)
5	010020535	Cooling fan stator bolts (2 required)

(Continued)

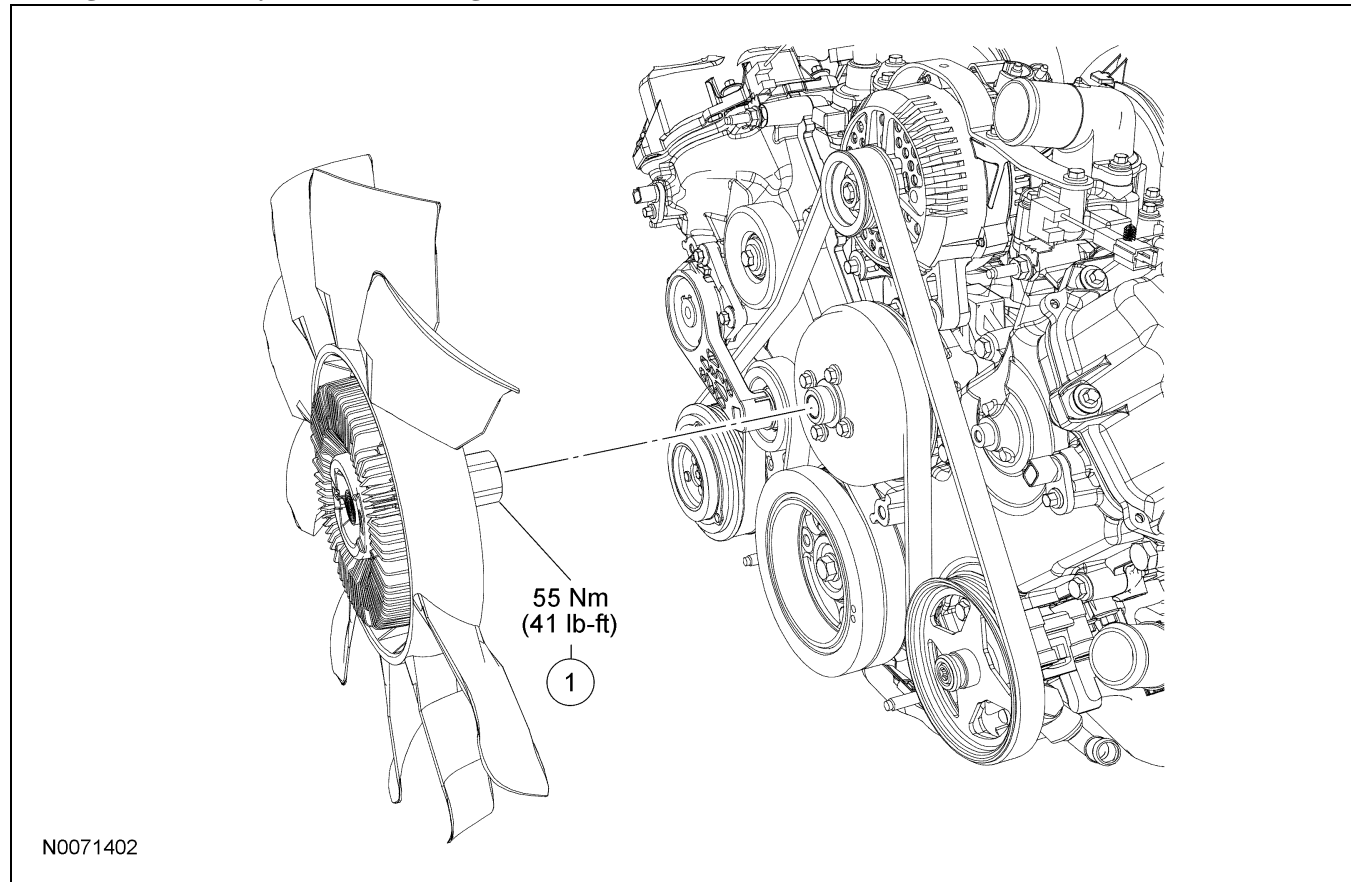
Item	Part Number	Description
6	W520102	Cooling fan stator nuts (2 required)
7	8B614	Cooling fan stator

1. For additional information, refer to the procedures in this section.

REMOVAL AND INSTALLATION

Radiator and Cooling Fan — Exploded View, Gasoline Engines

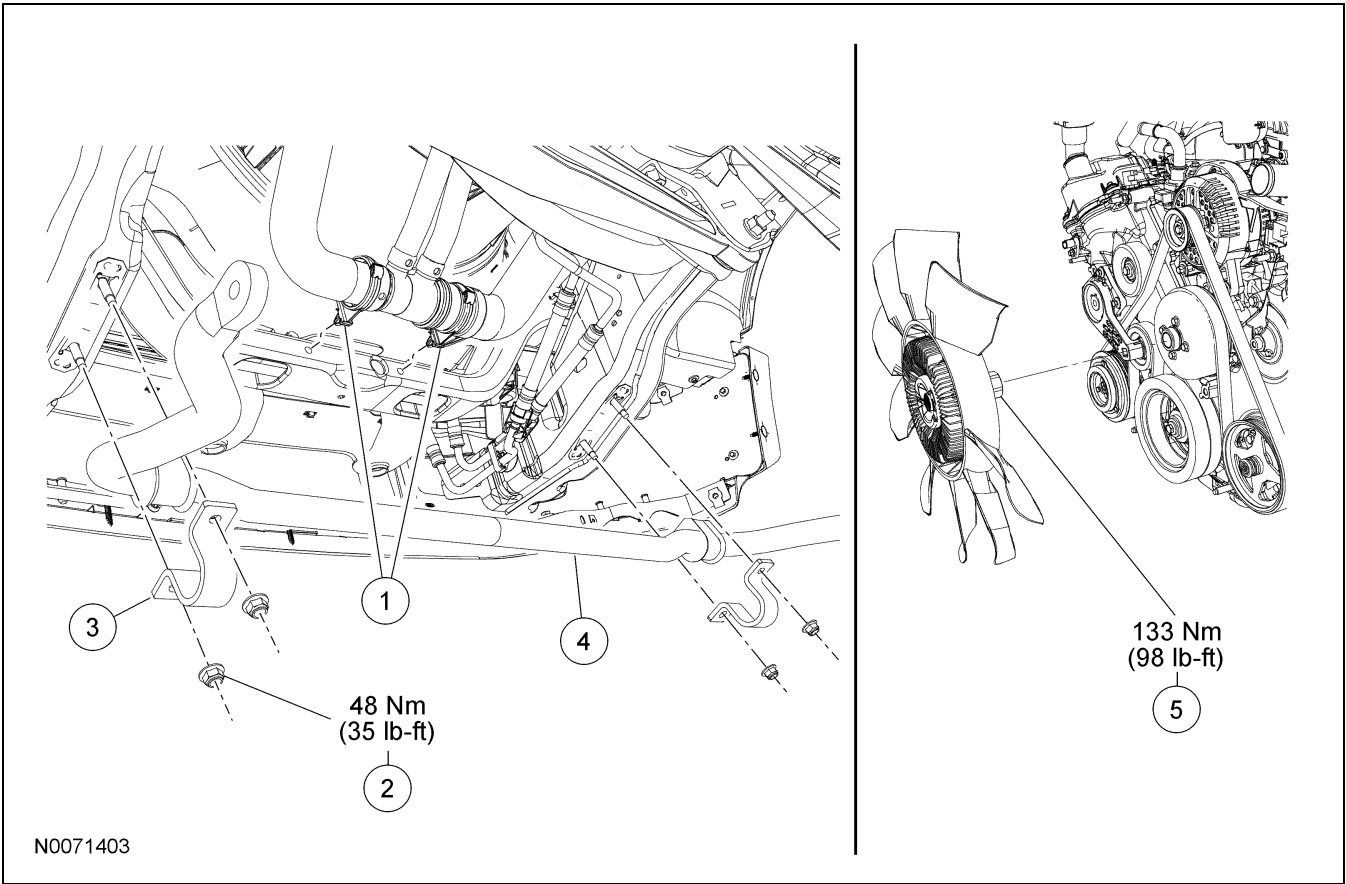
Cooling Fan Assembly — 5.4L (3V) Engine



Item	Part Number	Description
1	—	Cooling fan and clutch assembly

REMOVAL AND INSTALLATION (Continued)

Cooling Fan Assembly — 6.8L (3V) Engine



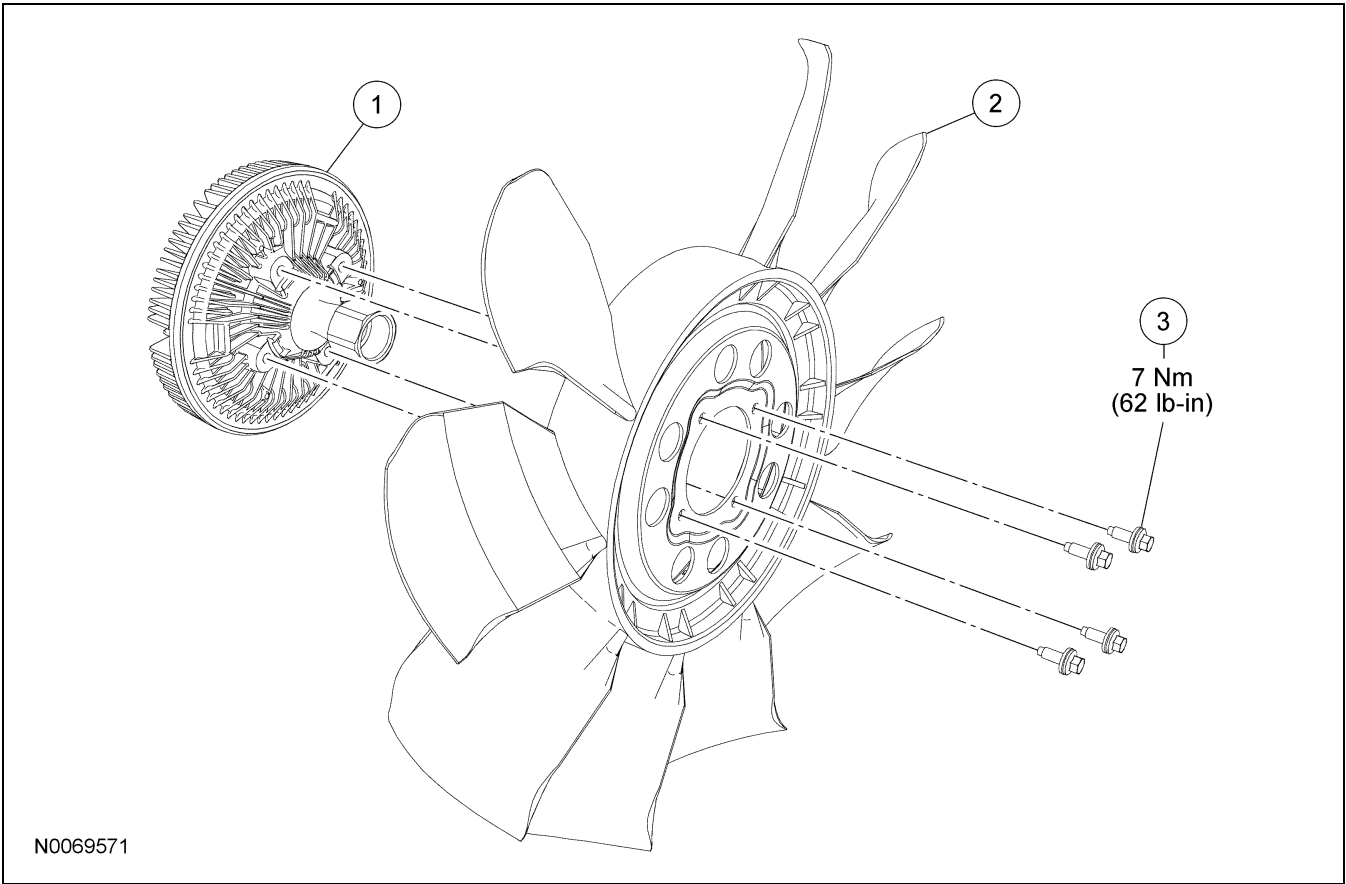
Item	Part Number	Description
1	8W287	Lower radiator hose position retainers (part of 8286)
2	W712045	Front stabilizer bar nut (4 required)
3	3B353	Front stabilizer bar bracket (2 required)

(Continued)

Item	Part Number	Description
4	5494	Front stabilizer bar
5	—	Cooling fan and clutch assembly

REMOVAL AND INSTALLATION (Continued)

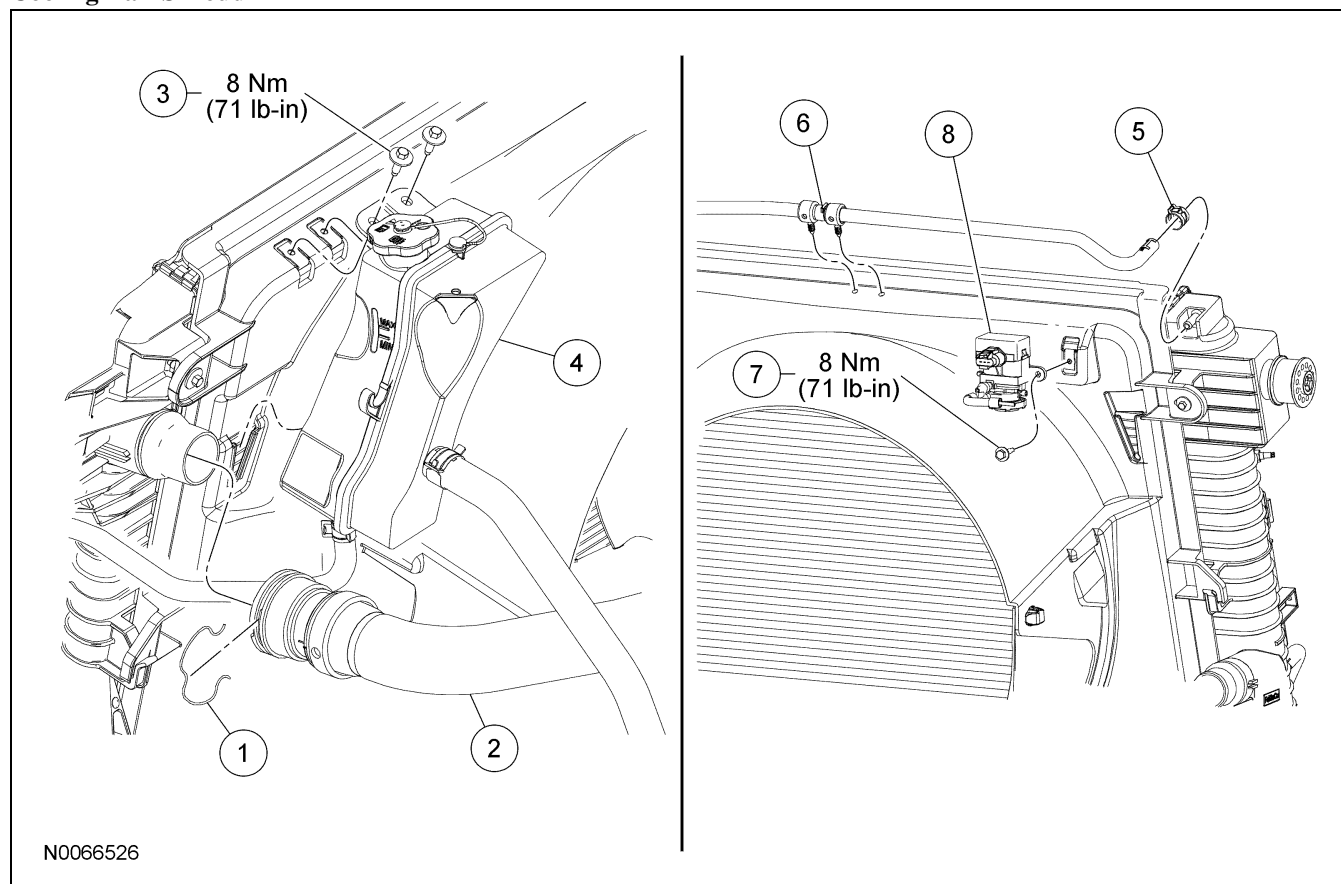
Cooling Fan and Clutch



Item	Part Number	Description
1	8A616	Cooling fan clutch
2	8600	Cooling fan

(Continued)

Item	Part Number	Description
3	N602527	Cooling fan clutch bolt (4 required)

REMOVAL AND INSTALLATION (Continued)**Cooling Fan Shroud**

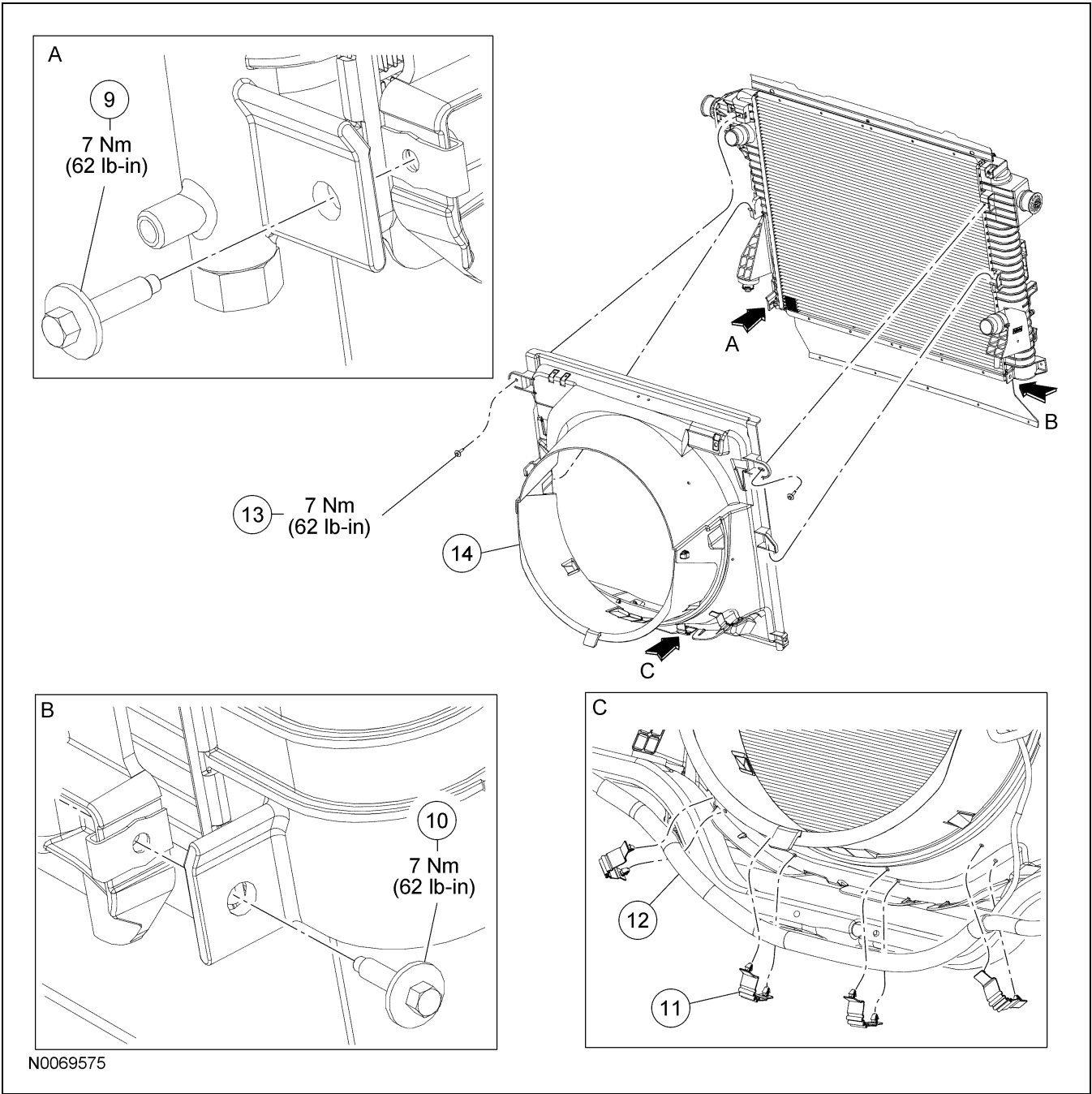
Item	Part Number	Description
1	—	Upper radiator coolant hose quick connect coupling clip
2	8B274	Upper radiator coolant hose quick connect coupling
3	W503924	Power steering reservoir bolt (2 required)
4	3R700	Power steering reservoir
5	15161	Degas bottle coolant inlet hose clamp

(Continued)

Item	Part Number	Description
6	8W005	Degas bottle coolant inlet hose
7	W505425	Four wheel drive (4WD) differential vacuum valve bolt
8	9H465	4WD differential vacuum valve

REMOVAL AND INSTALLATION (Continued)

Cooling Fan Shroud Continued



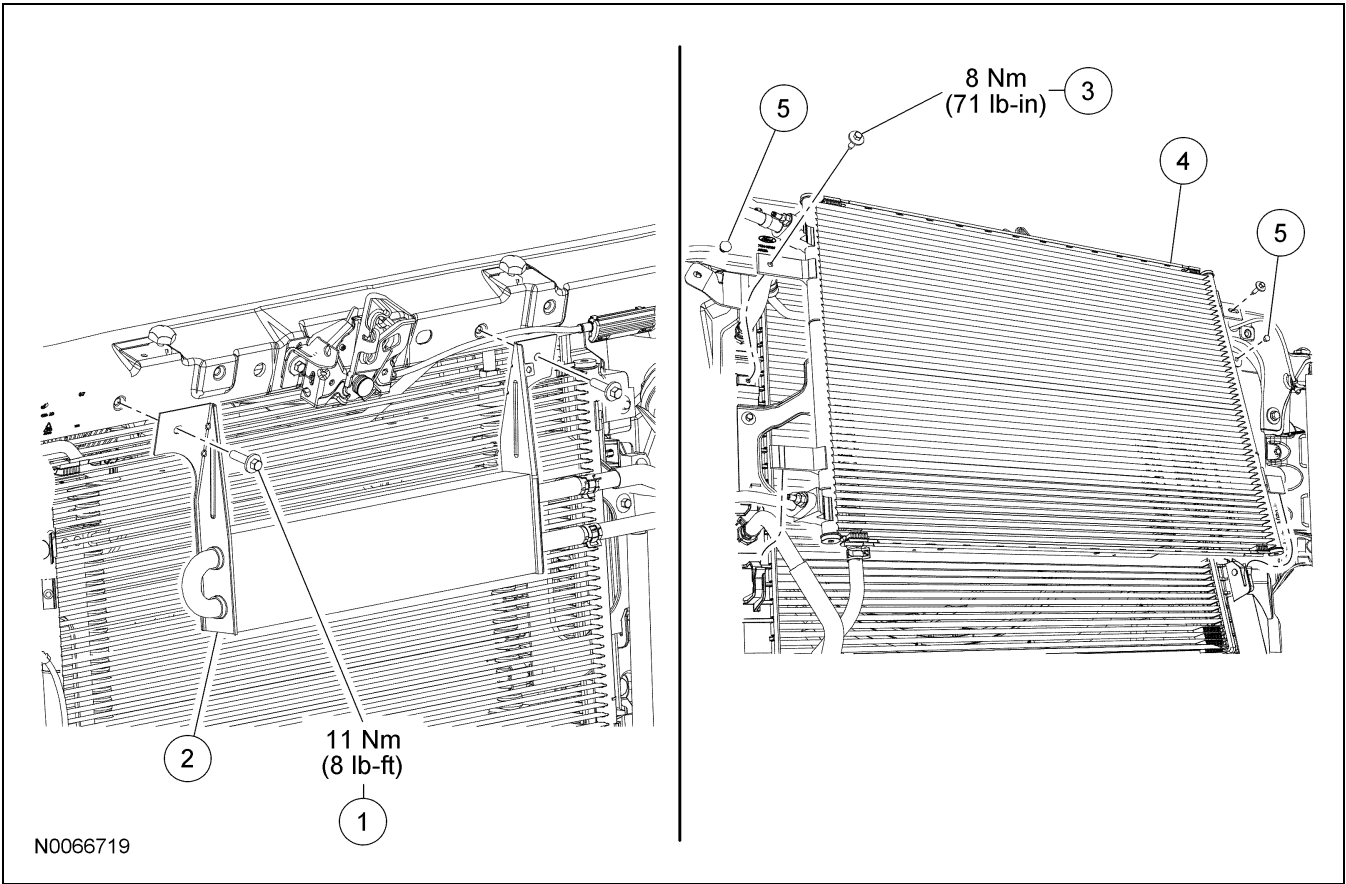
Item	Part Number	Description
9	W503925	Engine cooling fan shroud LH lower bolt
10	W503924	Engine cooling fan shroud RH lower bolt
11	14A282	Wiring harness position retainer (4 required)

(Continued)

Item	Part Number	Description
12	12A581	Engine compartment wiring harness
13	W503924	Engine cooling fan shroud upper bolt (2 required)
14	8L604	Engine cooling fan shroud

REMOVAL AND INSTALLATION (Continued)

Radiator



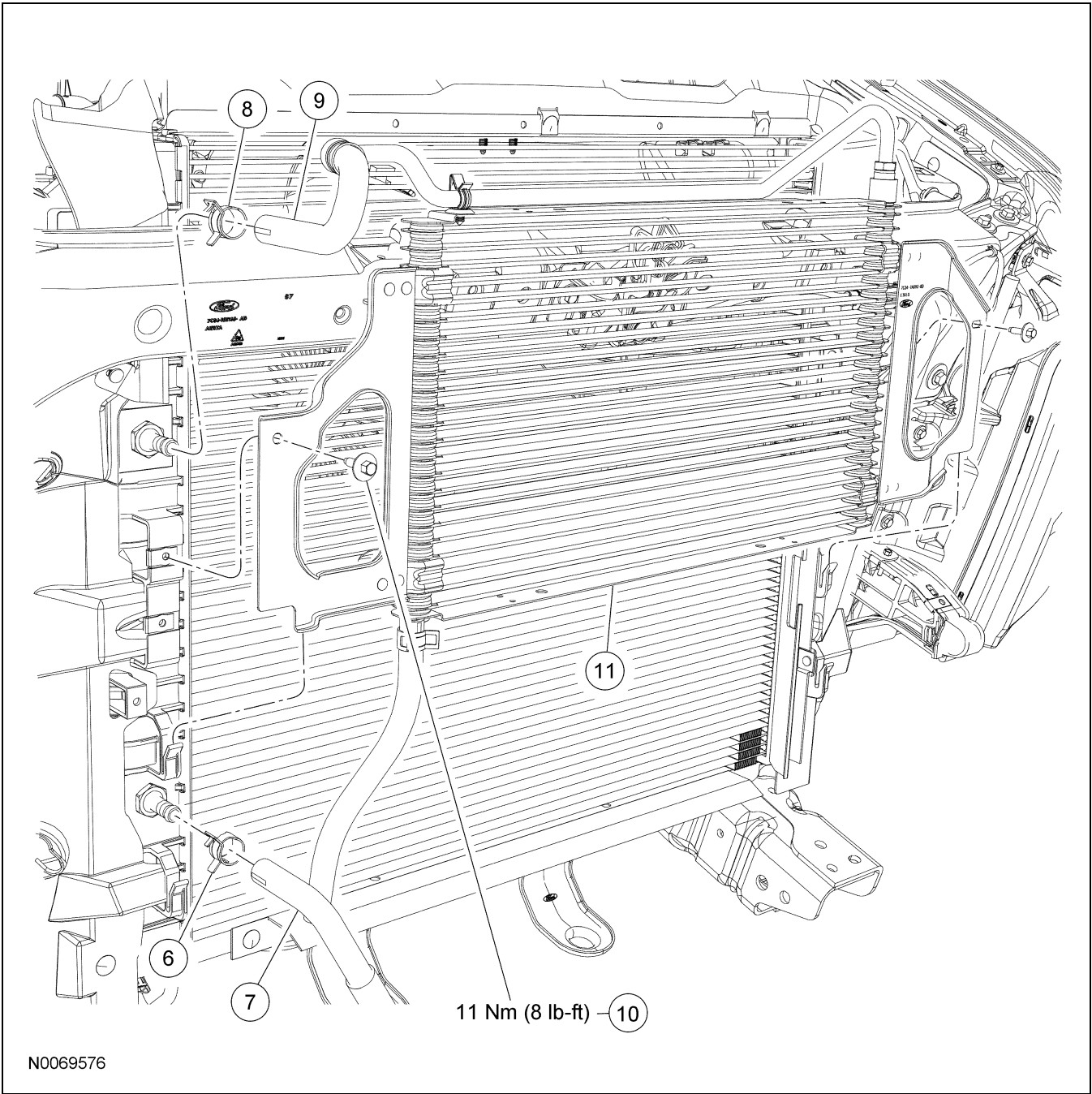
Item	Part Number	Description
1	W711851	Power steering fluid cooler bolt (2 required)
2	3D746	Power steering fluid cooler
3	W711851	A/C condenser bolt (2 bolts)

(Continued)

Item	Part Number	Description
4	3D746	A/C condenser
5	—	Radiator air deflector retainers (2 required)

REMOVAL AND INSTALLATION (Continued)

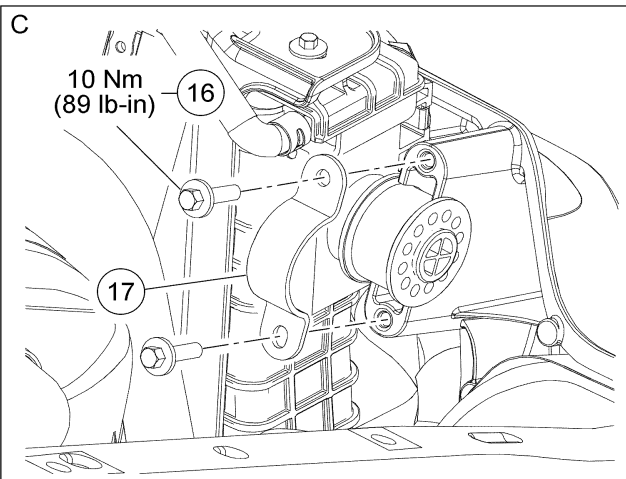
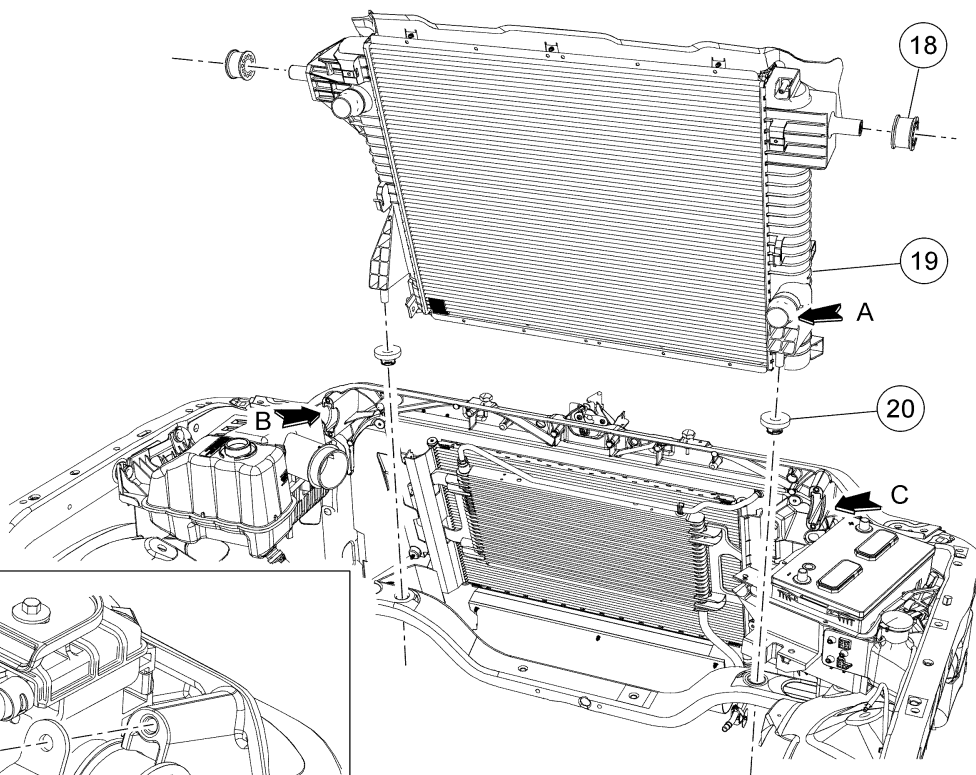
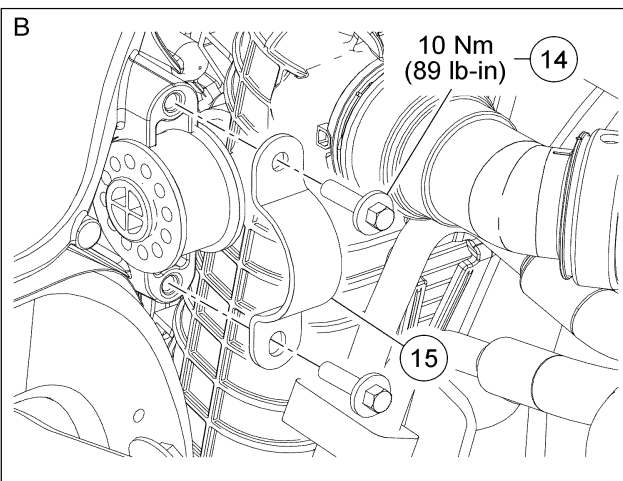
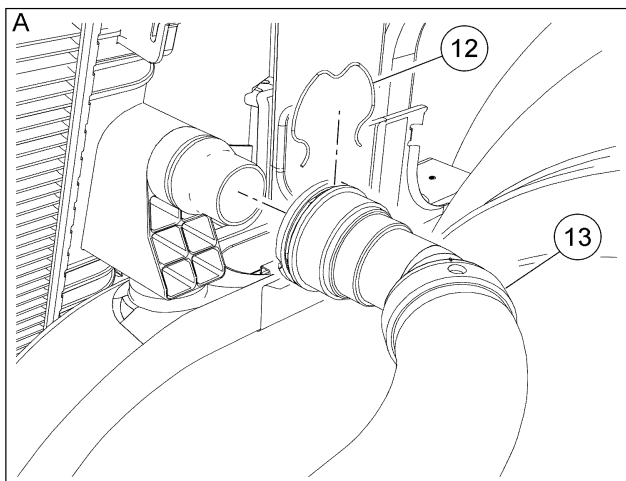
Radiator Continued



Item	Part Number	Description
6	—	Transmission fluid cooler outlet hose clamp
7	—	Transmission fluid cooler outlet hose
8	—	Transmission auxiliary fluid cooler-to-radiator inlet hose clamp

Item	Part Number	Description
9	—	Transmission auxiliary fluid cooler-to-radiator inlet hose
10	—	Transmission auxiliary fluid cooler bolt (2 required)
11	7H189	Transmission auxiliary fluid cooler

(Continued)

REMOVAL AND INSTALLATION (Continued)**Radiator Continued**

N0066721

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
12	—	Lower radiator hose spring clip (part of 8286)
13	8286	Lower radiator hose
14	N808979	Radiator-to-radiator support LH bolt (2 required)
15	—	Radiator-to-radiator support LH bracket
16	N808979	Radiator-to-radiator support RH bolt (2 required)

(Continued)

Item	Part Number	Description
17	—	Radiator-to-radiator support RH bracket
18	—	Radiator upper insulator (2 required)
19	8005	Radiator
20	8B204	Radiator lower insulator (2 required)

1. For additional information, refer to the procedures in this section.

2008 Ford F-350 SUPER DUTY

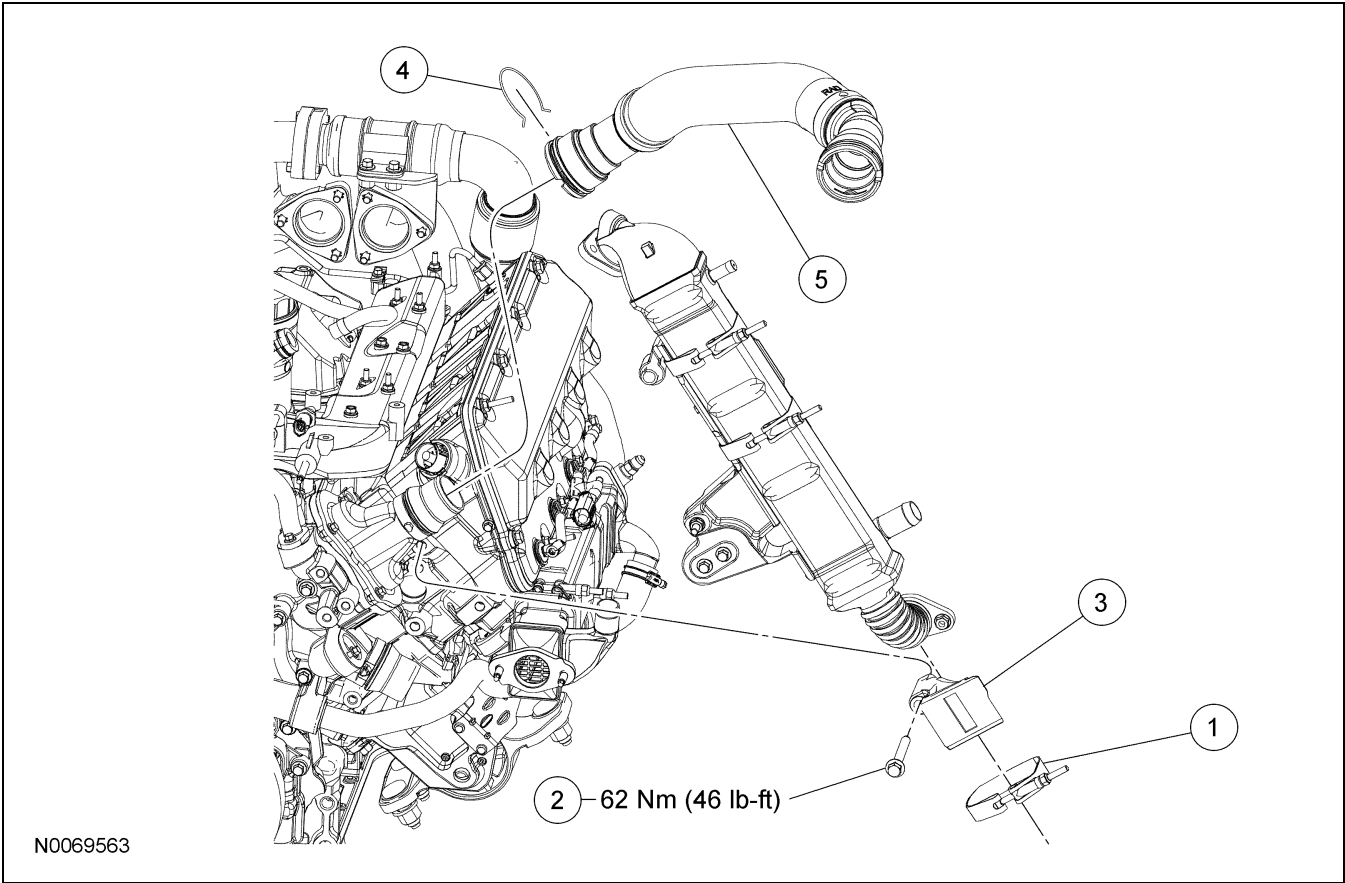
Submodel: XLT | Engine Type: V8 | Liters: 5.4
Fuel Delivery: FI | Fuel: GAS

SECTION 303-03:
Engine Cooling

SPECIFICATIONS
DESCRIPTION AND OPERATION
Engine Cooling
DIAGNOSIS AND TESTING
Engine Cooling
Principles of Operation
Inspection and Verification
PCM DTC Chart
Symptom Chart
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Pinpoint Test A: Loss of Coolant
Pinpoint Test B: The Engine Overheats
Pinpoint Test C: The Engine Does Not Reach Normal Operating Temperature
Component Tests
Pressure Test — Degas Bottle Systems
Pressure Test — Coolant Expansion Tank Systems
Cap
Thermostat
Radiator Leak Test, Removed From Vehicle
Fan Clutch Test
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Cooling System Draining, Filling and Bleeding
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Filling and Bleeding with RADKITPLUS
Filling and Bleeding without RADKITPLUS
Cooling System Flushing
Heater Core Backflushing
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Block Heater — 6.4L Diesel
Coolant Crossover Manifold Assembly — Gasoline Engines
Thermostat — Gasoline Engines
Thermostat — 6.4L Diesel
Coolant Pump — Gasoline Engines
Coolant Pump — 6.4L Diesel
Cooling Module — Gasoline Engines
Cooling Module — 6.4L Diesel
Radiator and Cooling Fan — Exploded View, Gasoline Engines
Cooling Fan — Gasoline Engines
Cooling Fan Shroud — Gasoline Engines
Radiator — Gasoline Engines
Radiator and Cooling Fan — Exploded View, 6.4L Diesel
Cooling Fan Shroud — 6.4L Diesel, Lower
Cooling Fan Shroud — 6.4L Diesel, Upper
Cooling Fan — 6.4L Diesel
Cooling Fan Stator — 6.4L Diesel
Radiator — 6.4L Diesel
Degas Bottle — Gasoline Engines
Degas Bottle — 6.4L Diesel

REMOVAL AND INSTALLATION

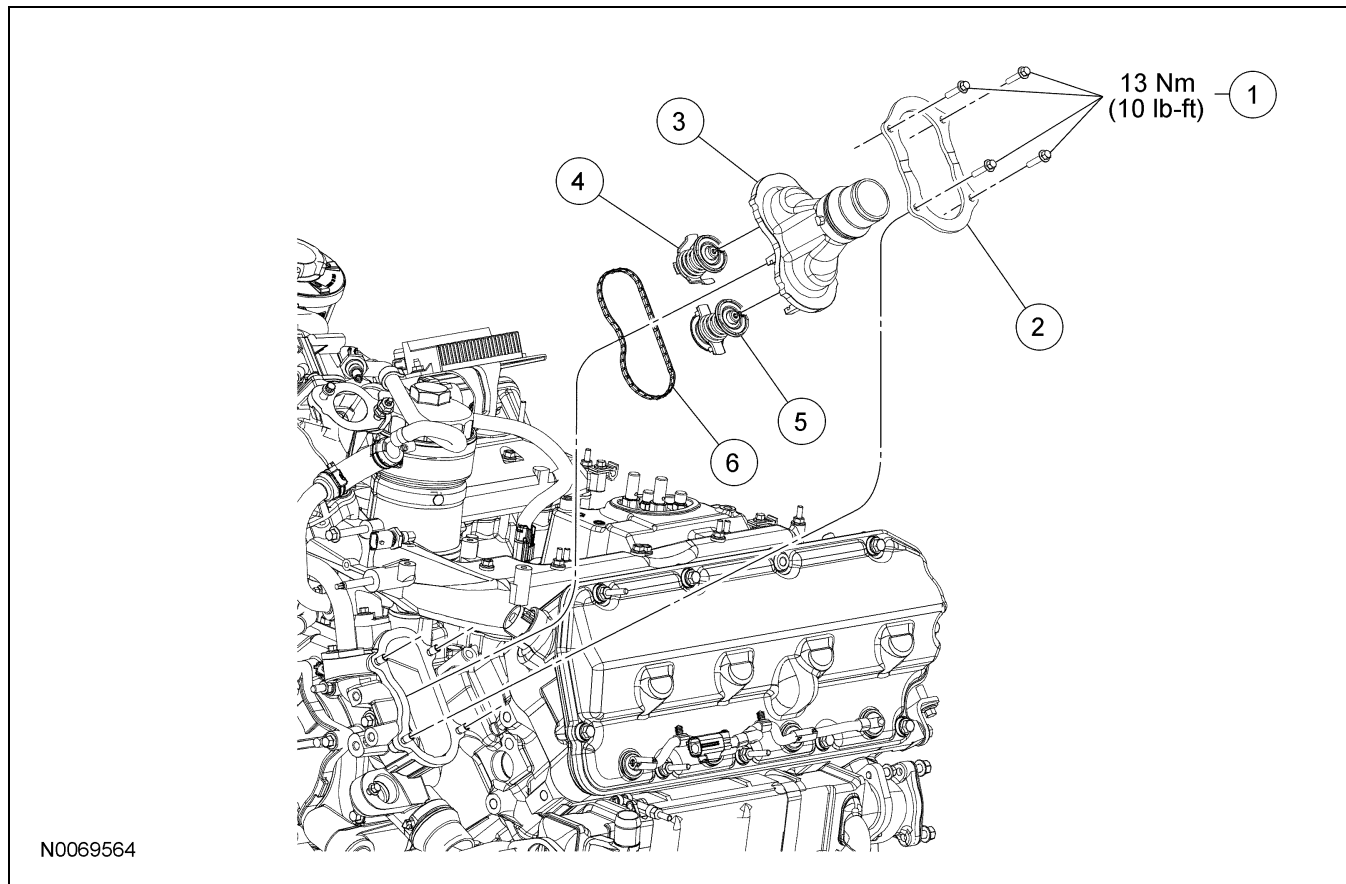
Thermostat — 6.4L Diesel



Item	Part Number	Description
1	8287	Vertical EGR cooler clamp
2	W302547	Vertical EGR cooler bracket bolt
3	9F465	Vertical EGR cooler bracket

(Continued)

Item	Part Number	Description
4	—	Upper radiator hose spring clip
5	8B274	Upper radiator hose

REMOVAL AND INSTALLATION (Continued)


Item	Part Number	Description
1	W300014	Thermostat housing bolts
2	8575	Thermostat housing collar
3	8575	Thermostat housing
4	8575	Thermostat without bypass
5	8575	Thermostat with bypass
6	8255	Thermostat housing gasket

Removal

NOTE: Removal of the vertical EGR cooler is not required to service the thermostats.

1. Remove the upper cooling fan shroud. For additional information, refer to Cooling Fan Shroud — 6.4L Diesel, Upper in this section.
2. Remove the degas bottle. For additional information, refer to Degas Bottle — 6.4L Diesel in this section.
3. Using a mirror, find the end of the upper radiator hose spring clip. Remove the spring clip, disconnect the upper radiator hose from the thermostat housing and position the upper radiator hose aside.
4. Remove and discard the nut and the vertical EGR cooler lower clamp.
5. Remove the bolt and the vertical EGR cooler lower bracket.
6. **NOTE:** The 6.4L diesel engine uses 2 thermostats.
Remove the bolts, the collar and the thermostat housing.
 - Lift the bottom of the collar up and rotate toward the engine to remove.

REMOVAL AND INSTALLATION (Continued)

7.  **CAUTION: If the thermostats are contaminated with engine oil, new thermostats must be installed. Reusing a thermostat that has been exposed to engine oil may result in engine overheating.**

Remove the thermostats and the gasket from the thermostat housing.

- Discard the gasket.

Installation

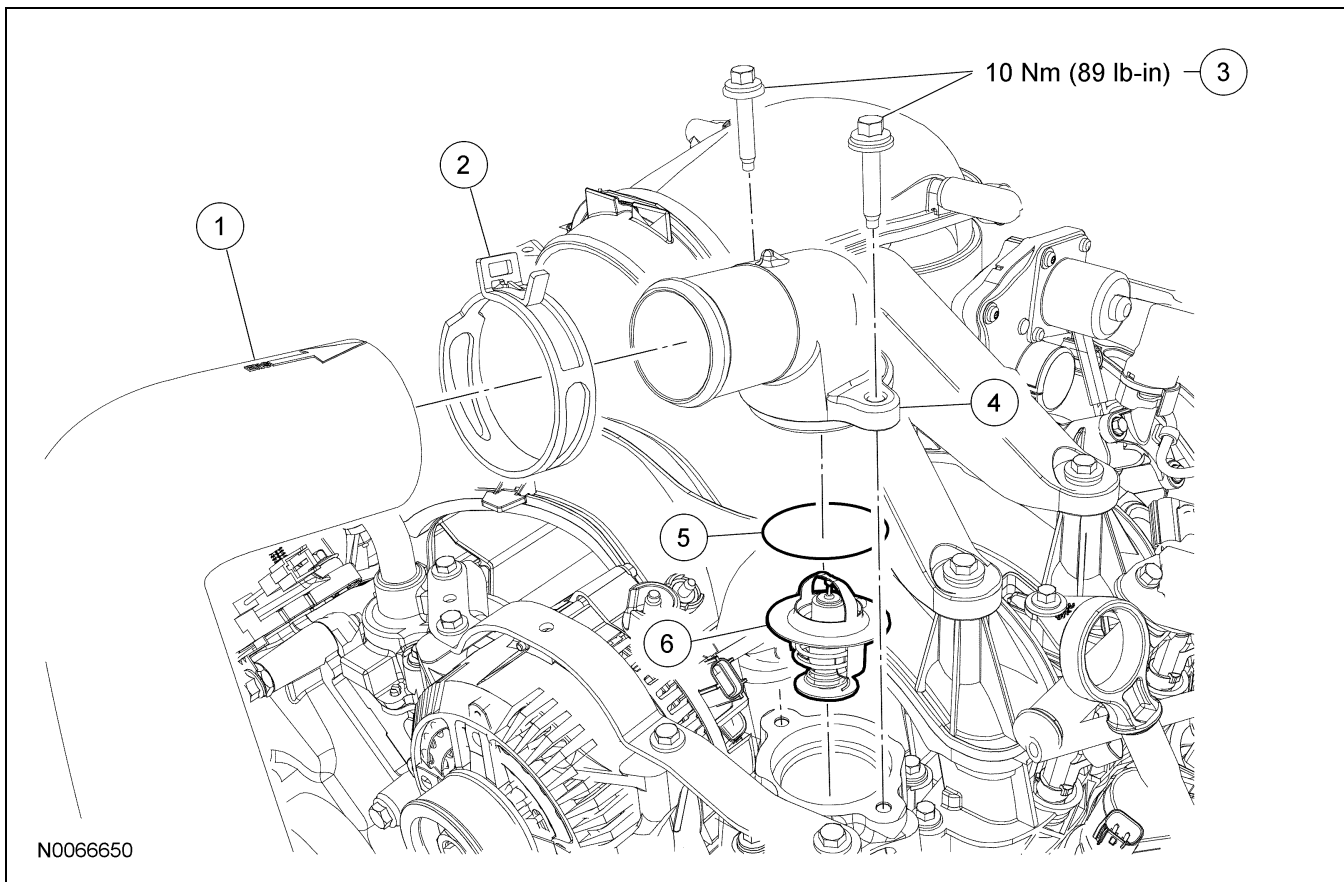
1. Install a new gasket and the thermostats into the thermostat housing.
2. Install the thermostat housing, the collar and the bolts.
 - Tighten to 13 Nm (10 lb-ft).
3. Position the lower vertical EGR cooler bracket and loosely install the bolt.
4. Install a new vertical EGR cooler lower clamp. Tighten the clamp nut in 3 stages.
 - Stage 1: Tighten the nut to 10 Nm (89 lb-in).
 - Stage 2: Loosen the nut 720 degrees (2 complete turns).
 - Stage 3: Tighten the nut to 8 Nm (71 lb-in).
5. Tighten the lower EGR cooler bracket bolt.
 - Tighten to 62 Nm (46 lb-ft).
6. Connect the upper radiator hose to the thermostat housing. Install the spring clip.
 - Verify the spring clip is correctly seated.
7. Install the degas bottle. For additional information, refer to Degas Bottle — 6.4L Diesel in this section.
8. Install the upper cooling fan shroud. For additional information, refer to Cooling Fan Shroud — 6.4L Diesel, Upper in this section.

REMOVAL AND INSTALLATION

Thermostat — Gasoline Engines

Material

Item	Specification
Motorcraft Metal Surface Prep ZC-31	—
Silicone Gasket Remover ZC-30	—



Item	Part Number	Description
1	8B274	Upper radiator hose
2	15161	Upper radiator hose clamp
3	W503279	Thermostat housing bolts (2 required)
4	8594	Thermostat housing
5	N806807	Thermostat O-ring seal
6	8575	Thermostat

Removal and Installation


1. Drain the engine cooling system. For additional information, refer to Cooling System Draining, Filling and Bleeding in this section.
2. Remove the air cleaner outlet pipe. For additional information, refer to Section 303-12.
3. If servicing the thermostat housing, disconnect the upper radiator hose from the thermostat housing.


REMOVAL AND INSTALLATION (Continued)

4. Remove the 2 bolts, position the thermostat housing aside and remove the thermostat. Discard the O-ring seal.
 - Inspect the mating surfaces and clean the sealing surfaces with metal surface prep and silicone gasket remover. Follow the directions on the packaging.
 - Install a new O-ring seal.
 - To install, tighten to 10 Nm (89 lb-in).
 5. To install, reverse the removal procedure.
-

REMOVAL AND INSTALLATION

Battery — Diesel


 **WARNING:** Batteries contain sulfuric acid and produce explosive gases. Work in a well-ventilated area. Do not allow the battery to come in contact with flames, sparks or burning substances. Avoid contact with skin, eyes or clothing. Shield eyes when working near the battery to protect against possible splashing of acid solution. In case of acid contact with skin or eyes, flush immediately with water for a minimum of 15 minutes, then get prompt medical attention. If acid is swallowed, call a physician immediately. Failure to follow these instructions may result in serious personal injury.


 **WARNING:** Always deplete the backup power supply before repairing or installing any new front or side air bag supplemental restraint system (SRS) component and before servicing, removing, installing, adjusting or striking components near the front or side impact sensors or the restraints control module (RCM). Nearby components include doors, instrument panel, console, door latches, strikers, seats and hood latches.


Refer to the Description and Operation portion of Section 501-20B for location of the RCM and impact sensor(s).

To deplete the backup power supply energy, disconnect the battery ground cable and wait at least 1 minute. Be sure to disconnect auxiliary batteries and power supplies (if equipped).

Failure to follow these instructions may result in serious personal injury or death in the event of an accidental deployment.

 **WARNING:** Always lift a plastic-cased battery with a battery carrier or with hands on opposite corners. Excessive pressure on the battery end walls may cause acid to flow through the vent caps, resulting in personal injury and/or damage to the vehicle or battery.

 **WARNING:** Do not get underneath the frame-mounted battery when disconnecting or connecting the auxiliary battery safety straps. The battery is heavy and could fall. Failure to follow this instruction may result in serious personal injury.


1. Disconnect the battery. For additional information, refer to Battery Disconnect — Dual in this section.
2.  **CAUTION:** Be sure the battery cover is reinstalled to avoid premature battery failure.
If equipped, remove the battery cover.
 - Release the cable from the battery cover.
3. Remove the battery hold-down clamp bolt.
 - To install, tighten to 9 Nm (80 lb-in).


REMOVAL AND INSTALLATION (Continued)

4. Remove the battery.
5. To install, reverse the removal procedure.
-

REMOVAL AND INSTALLATION

Battery — Gasoline


 **WARNING:** Batteries contain sulfuric acid and produce explosive gases. Work in a well-ventilated area. Do not allow the battery to come in contact with flames, sparks or burning substances. Avoid contact with skin, eyes or clothing. Shield eyes when working near the battery to protect against possible splashing of acid solution. In case of acid contact with skin or eyes, flush immediately with water for a minimum of 15 minutes, then get prompt medical attention. If acid is swallowed, call a physician immediately. Failure to follow these instructions may result in serious personal injury.

 **WARNING:** Always deplete the backup power supply before repairing or installing any new front or side air bag supplemental restraint system (SRS) component and before servicing, removing, installing, adjusting or striking components near the front or side impact sensors or the restraints control module (RCM). Nearby components include doors, instrument panel, console, door latches, strikers, seats and hood latches.

Refer to the Description and Operation portion of Section 501-20B for location of the RCM and impact sensor(s).

To deplete the backup power supply energy, disconnect the battery ground cable and wait at least 1 minute. Be sure to disconnect auxiliary batteries and power supplies (if equipped).

Failure to follow these instructions may result in serious personal injury or death in the event of an accidental deployment.

 **WARNING:** Always lift a plastic-cased battery with a battery carrier or with hands on opposite corners. Excessive pressure on the battery end walls may cause acid to flow through the vent caps, resulting in personal injury and/or damage to the vehicle or battery.

1. Disconnect the battery. For additional information, refer to Battery Disconnect in this section.

2. Remove the battery hold-down clamp bolt.
 - To install, tighten to 9 Nm (80 lb-in).
3. Remove the battery.

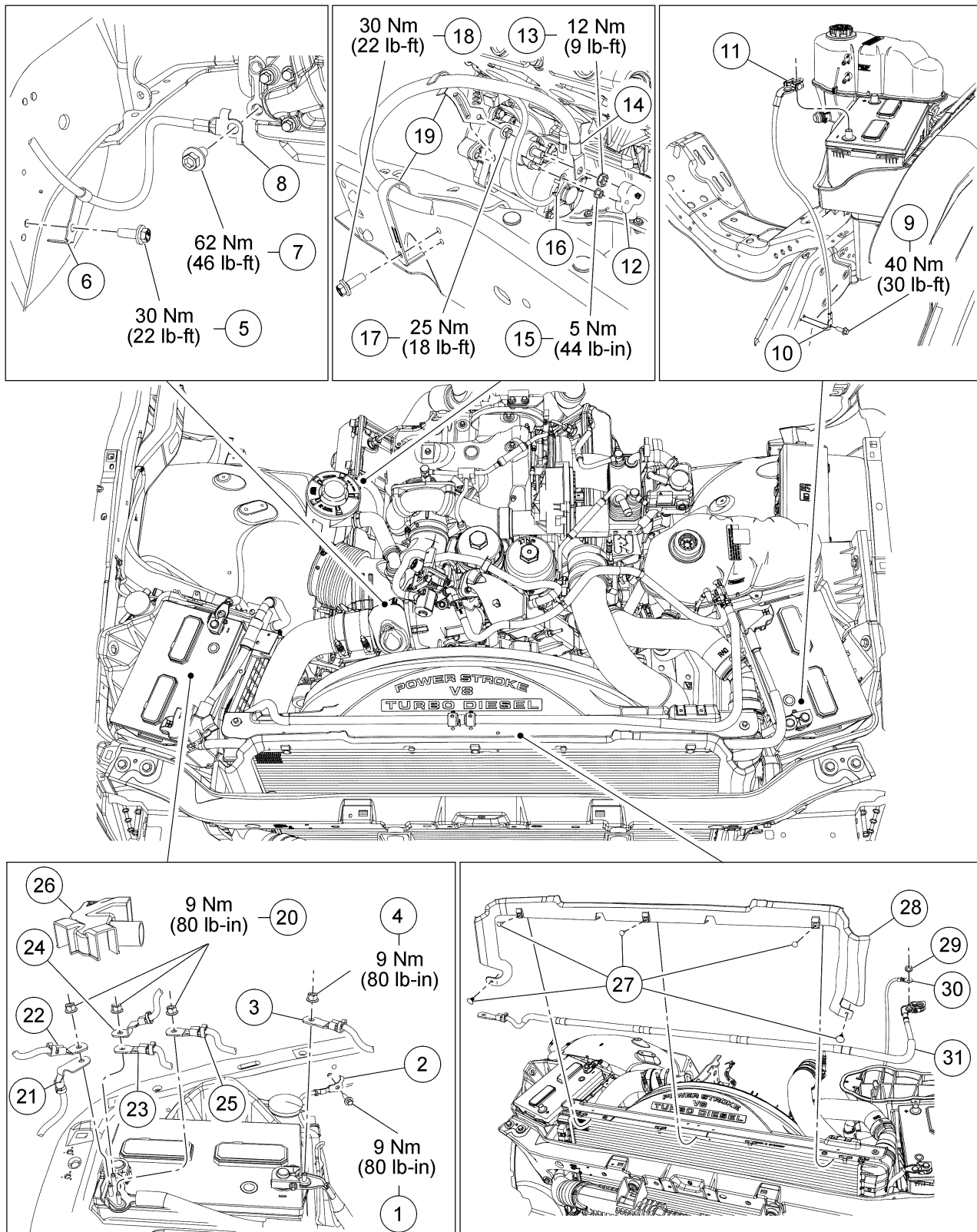
REMOVAL AND INSTALLATION (Continued)

4.  **CAUTION:** Be sure the battery cover is reinstalled to avoid premature battery failure.
5. To install, reverse the removal procedure.

If equipped, remove the battery cover.

REMOVAL AND INSTALLATION

Battery Cables — Diesel



N0069477

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	W706287-S900	Battery ground cable terminal screw
2	—	Battery ground cable terminal
3	—	Blower motor ground cable terminal
4	S705790-S901	Battery ground cable nut
5	N605812-S437M	Battery ground cable-to-frame bracket bolt
6	—	Battery ground cable-to-frame bracket
7	N605812-S437	Battery ground cable terminal bolt
8	—	Battery ground cable terminal
9	W505274-S437M	Auxiliary battery ground cable-to-frame terminal bolt
10	—	Auxiliary battery ground cable-to-frame terminal
11	14301	Auxiliary negative battery cable
12	11N087	Starter solenoid terminal cover
13	W710959-S413	Starter solenoid positive cable terminal nut
14	—	Starter solenoid positive cable terminal (part of 14300)
15	W705790-S901	Starter solenoid wire terminal nut
16	—	Starter solenoid wire terminal (part of 14300)
17	N805024-S901	Positive battery cable bracket nut
18	—	Positive battery cable bracket bolt
19	—	Positive battery cable brackets
20	W705790-S901	Positive battery cable nut
21	12A581	Engine control cable terminal
22	14300	Positive battery cable terminal
23	—	Blower motor cable terminal
24	—	Generator B+ cable terminal
25	—	Cable terminal
26	—	Battery positive protective cover
27	—	Pin-type retainers (5 required) (part of 8327)
28	8327	Upper radiator air deflector
29	W705790-S901	Power distribution box (PDB) cable terminal nut
30	12A581	PDB cable terminal
31	14300	Battery positive cable

Removal and Installation**All battery cables**

1. Disconnect the battery. For additional information, refer to Battery Disconnect — Dual in this section.

Negative battery cable

2. Remove the screw and position the battery ground cable terminal aside.
 - To install, tighten to 30 Nm (22 lb-ft).
3. Remove the bolt and position the battery ground cable terminal aside.
 - To install, tighten to 62 Nm (46 lb-ft).
4. **NOTE:** Position the RH splash shield aside to access the battery ground cable bolt. Remove the bolt and position the battery ground cable-to-frame terminal aside.
 - To install, tighten to 30 Nm (22 lb-ft).

Auxiliary negative battery cable

5. **NOTE:** Position the LH splash shield aside to access the battery ground cable bolt. Remove the bolt and position the auxiliary battery ground cable-to-frame terminal aside.
 - To install, tighten to 40 Nm (30 lb-ft).

Positive battery cable

6. Remove the starter solenoid terminal cover.
7. Remove the nut and position the starter solenoid positive cable terminal aside.
 - To install, tighten to 12 Nm (9 lb-ft).
8. Remove the nut and position the starter solenoid wire terminal aside.
 - To install, tighten to 5 Nm (44 lb-in).
9. Remove the nut from the stud and remove the positive battery cable bracket from the stud.
 - To install, tighten to 25 Nm (18 lb-ft).

REMOVAL AND INSTALLATION (Continued)

10. Remove the bolt and position the positive battery cable-to-frame bracket aside.
 - To install, tighten to 30 Nm (22 lb-ft).
11. Remove the nut(s) and position the attaching cable terminal(s) aside.
 - To install, tighten to 9 Nm (80 lb-in).
12. Disconnect the starter relay electrical connector.

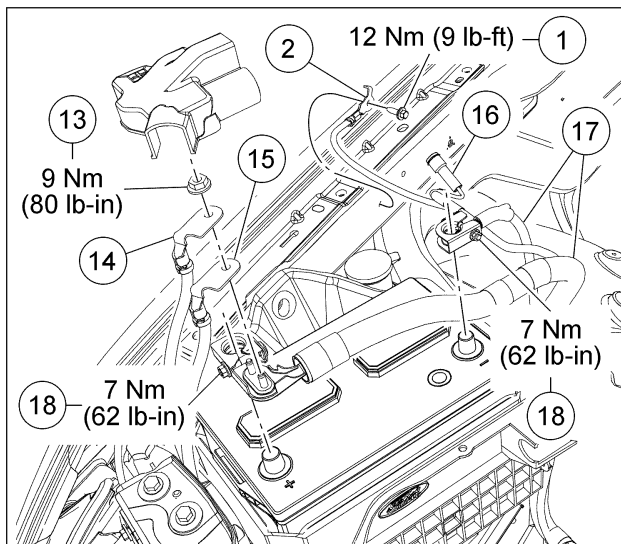
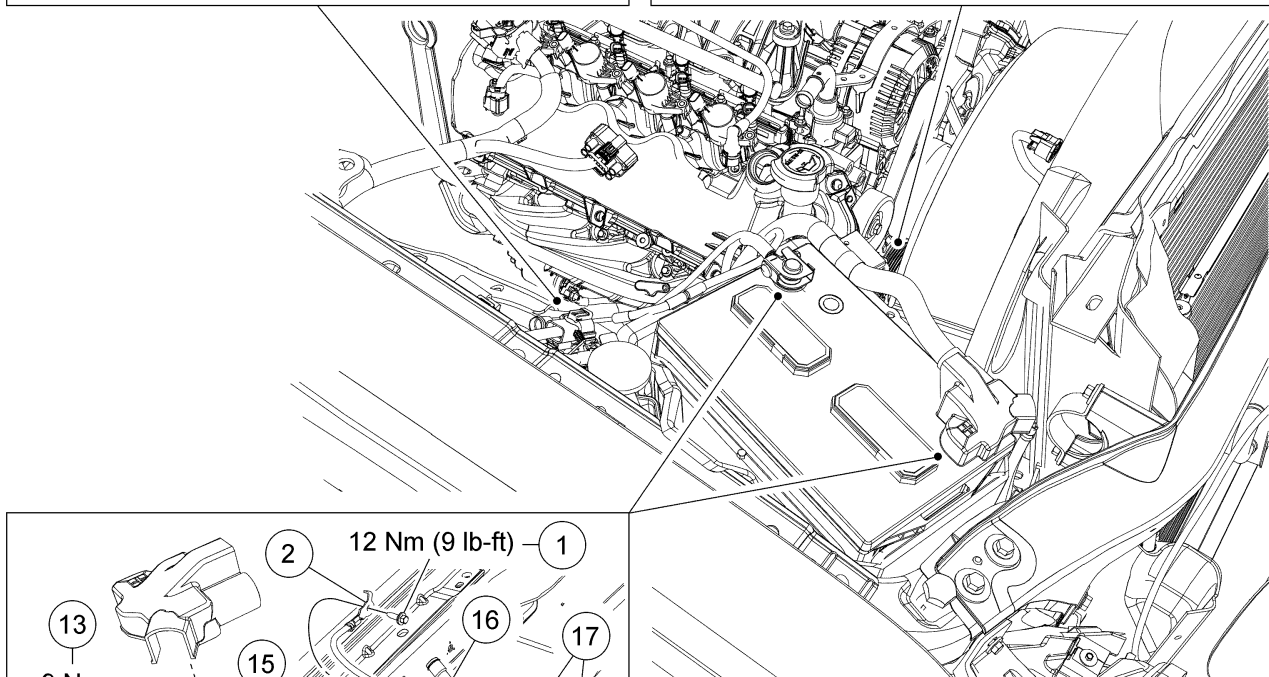
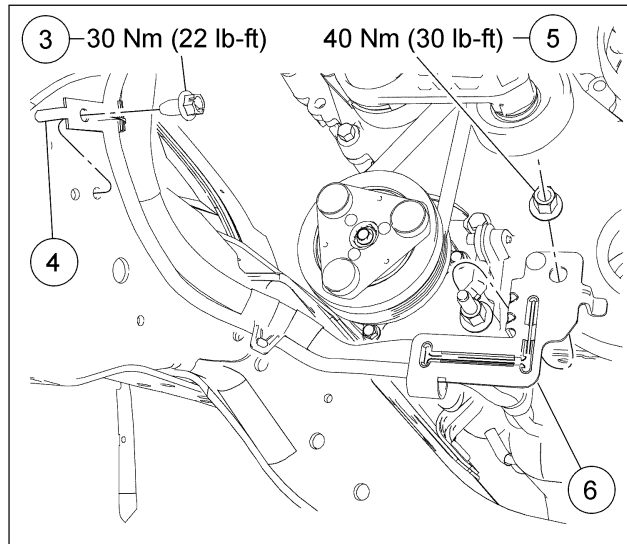
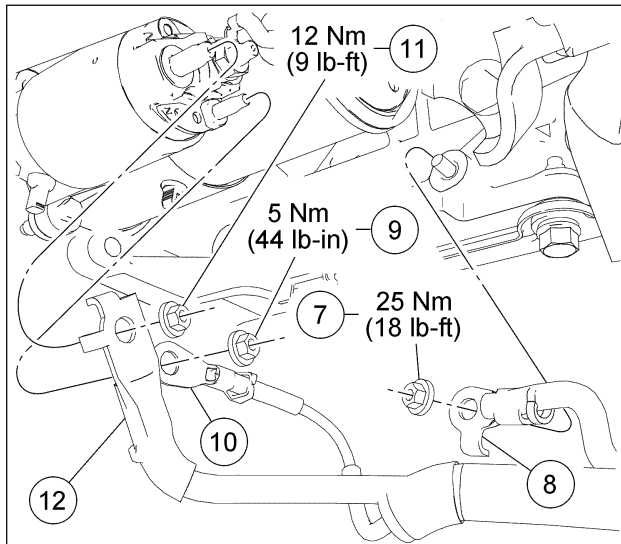
Auxiliary positive battery cable

13. Remove the 5 pin-type retainers and the upper radiator air deflector.
 14. Remove the nut and position the power distribution box (PDB) cable terminal aside.
 - To install, tighten to 9 Nm (80 lb-in).
-

15. Release the positive battery cable locators and remove the cable.
16. To install, reverse the removal procedure.
 - A clearance of at least 15 mm (0.59 in) must be kept between the positive battery cable and the splash shield bolt. To verify there is sufficient clearance, place your hand between the positive battery cable and splash shield bolt. If you are unable to fit your hand between the splash shield bolt and positive battery cable, bend the P-clip over the frame and recheck clearance.

REMOVAL AND INSTALLATION

Battery Cables — Gasoline



N0069588

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	W706287	Battery ground cable terminal screw
2	—	Battery ground cable terminal (part of 14301)
3	W505247	Battery cable harness bracket bolt
4	—	Battery cable harness bracket
5	W520113	Front engine cover battery ground cable bracket nut
6	—	Front engine cover battery ground cable bracket (part of 14301)
7	W506022	Battery ground cable eyelet bolt
8	—	Battery ground cable eyelet (part of 14301)
9	W705790	Starter solenoid wire terminal nut
10	—	Starter solenoid wire terminal (part of 14300)
11	W706414	Starter solenoid positive cable terminal nut
12	—	Starter solenoid positive cable terminal (part of 14300)
13	W705790	Generator B+ cable terminal nut/power distribution box (PDB) cable terminal nut
14	14305	Generator B+ cable terminal
15	12A581	PDB cable terminal
16	—	Starter relay electrical connector (part of 14300)
17	14300	Battery cables
18	14B060	Battery cable terminal


2. Remove the screw and position the battery ground cable terminal aside.
 - To install, tighten to 12 Nm (9 lb-ft).
3. Remove the bolt and position the battery cable harness bracket aside.
 - To install, tighten to 30 Nm (22 lb-ft).
4. Remove the nut and position the battery ground cable terminal aside.
 - To install, tighten to 40 Nm (30 lb-ft).
5. Remove the bolt and position the battery ground cable eyelet aside.
 - To install, tighten to 25 Nm (18 lb-ft).
6. Remove the nut and position the starter solenoid wire terminal aside.
 - To install, tighten to 5 Nm (44 lb-in).
7. Remove the nut and position the starter solenoid positive cable terminal aside.
 - To install, tighten to 12 Nm (9 lb-ft).
8. Remove the nut and position the generator B+ cable terminal and the power distribution box (PDB) cable terminal aside.
 - To install, tighten to 9 Nm (80 lb-in).
9. Disconnect the starter relay electrical connector.
10. Remove the battery cable assembly.
11. To install, reverse the removal procedure.


Removal and Installation

1. Disconnect the battery. For additional information, refer to Battery Disconnect in this section.

GENERAL PROCEDURES

Battery Disconnect — Dual


 **WARNING:** Batteries contain sulfuric acid and produce explosive gases. Work in a well-ventilated area. Do not allow the battery to come in contact with flames, sparks or burning substances. Avoid contact with skin, eyes or clothing. Shield eyes when working near the battery to protect against possible splashing of acid solution. In case of acid contact with skin or eyes, flush immediately with water for a minimum of 15 minutes, then get prompt medical attention. If acid is swallowed, call a physician immediately. Failure to follow these instructions may result in serious personal injury.

 **WARNING:** Always deplete the backup power supply before repairing or installing any new front or side air bag supplemental restraint system (SRS) component and before servicing, removing, installing, adjusting or striking components near the front or side impact sensors or the restraints control module (RCM). Nearby components include doors, instrument panel, console, door latches, strikers, seats and hood latches.

Refer to the Description and Operation portion of Section 501-20B for location of the RCM and impact sensor(s).

To deplete the backup power supply energy, disconnect the battery ground cable and wait at least 1 minute. Be sure to disconnect auxiliary batteries and power supplies (if equipped).

Failure to follow these instructions may result in serious personal injury or death in the event of an accidental deployment.

 **WARNING:** Always lift a plastic-cased battery with a battery carrier or with hands on opposite corners. Excessive pressure on the battery end walls may cause acid to flow through the vent caps, resulting in personal injury and/or damage to the vehicle or battery.

NOTE: When the battery is disconnected and connected, some abnormal drive symptoms may occur while the vehicle relearns its adaptive strategy. The vehicle may need to be driven to relearn its strategy.


1. Disconnect the auxiliary negative battery cable (LH side of the engine compartment).
 - To connect, tighten to 7 Nm (62 lb-in).
2. Disconnect the negative battery cable (RH side of the engine compartment).
 - To connect, tighten to 7 Nm (62 lb-in).
3. Disconnect the positive battery cable (RH side of the engine compartment).
 - To connect, tighten to 7 Nm (62 lb-in).


GENERAL PROCEDURES (Continued)

4. Disconnect the auxiliary positive battery cable (LH side of the engine compartment).
 - To connect, tighten to 7 Nm (62 lb-in).
 5. To connect, reverse the disconnect procedure.
-

GENERAL PROCEDURES

Battery Disconnect


 **WARNING:** Batteries contain sulfuric acid and produce explosive gases. Work in a well-ventilated area. Do not allow the battery to come in contact with flames, sparks or burning substances. Avoid contact with skin, eyes or clothing. Shield eyes when working near the battery to protect against possible splashing of acid solution. In case of acid contact with skin or eyes, flush immediately with water for a minimum of 15 minutes, then get prompt medical attention. If acid is swallowed, call a physician immediately. Failure to follow these instructions may result in serious personal injury.

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Refer to the Description and Operation portion of Section 501-20B for location of the RCM and impact sensor(s).

To deplete the backup power supply energy, disconnect the battery ground cable and wait at least 1 minute. Be sure to disconnect auxiliary batteries and power supplies (if equipped).

Failure to follow these instructions may result in serious personal injury or death in the event of an accidental deployment.

 **WARNING:** Always lift a plastic-cased battery with a battery carrier or with hands on opposite corners. Excessive pressure on the battery end walls may cause acid to flow through the vent caps, resulting in personal injury and/or damage to the vehicle or battery.

NOTE: When the battery is disconnected and connected, some abnormal drive symptoms may occur while the vehicle relearns its adaptive strategy. The vehicle may need to be driven to relearn its strategy.

NOTE: When the battery is disconnected and connected, the illumination display needs to be calibrated. After the battery is connected, rotate the dimmer switch from the lowest dim position to the full bright, dome ON position.

1. Disconnect the negative battery cable.
 - To connect, tighten to 7 Nm (62 lb-in).

GENERAL PROCEDURES (Continued)

2. Disconnect the positive battery cable.
 - To connect, tighten to 7 Nm (62 lb-in).
 3. To connect, reverse the disconnect procedure.
-

REMOVAL AND INSTALLATION

Battery Tray — Auxiliary

All vehicles

1. Remove the auxiliary battery. For additional information, refer to Battery — Diesel in this section.
2. Using a suitable suction device, siphon the coolant from the degas bottle.
3. Disconnect the 2 radiator overflow hoses from the degas bottle.

4x4 vehicles with electronic shift on the fly

4. Disconnect the vacuum hose from the vacuum reservoir.

All vehicles

5. Remove the 4 bolts and position the battery tray/degas bottle assembly to gain access to the coolant return hose.
 - To install, tighten to 19 Nm (14 lb-ft).
 6. Disconnect the coolant return hose and remove the battery tray/degas bottle assembly.
 7. To install, reverse the removal procedure.
-

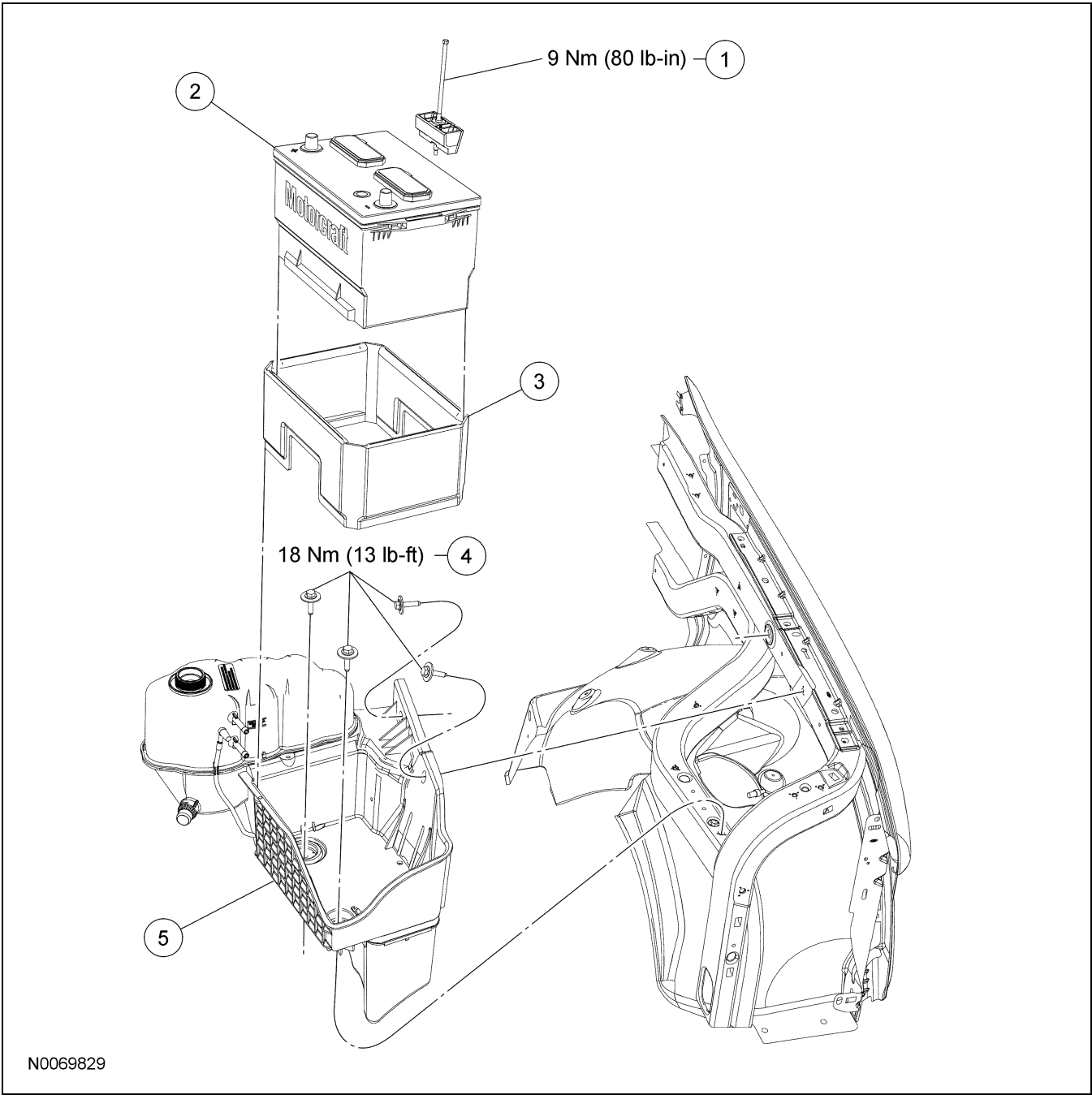
REMOVAL AND INSTALLATION

Battery Tray — Gasoline

1. Remove the battery. For additional information, refer to Battery — Gasoline in this section.
 2. Disconnect the A/C tube from the battery tray and position the A/C tube aside.
 3. Disconnect the wire harness retainers from the battery tray and position the wire harness aside.
 4. Remove the 3 bolts and the battery tray/washer bottle assembly.
 - To install, tighten to 18 Nm (13 lb-ft).
 5. To install, reverse the removal procedure.
-

REMOVAL AND INSTALLATION

Battery and Battery Tray — Exploded View, Diesel



Item	Part Number	Description
1	N808480	Battery hold-down clamp and bolt
2	10655	Battery

(Continued)

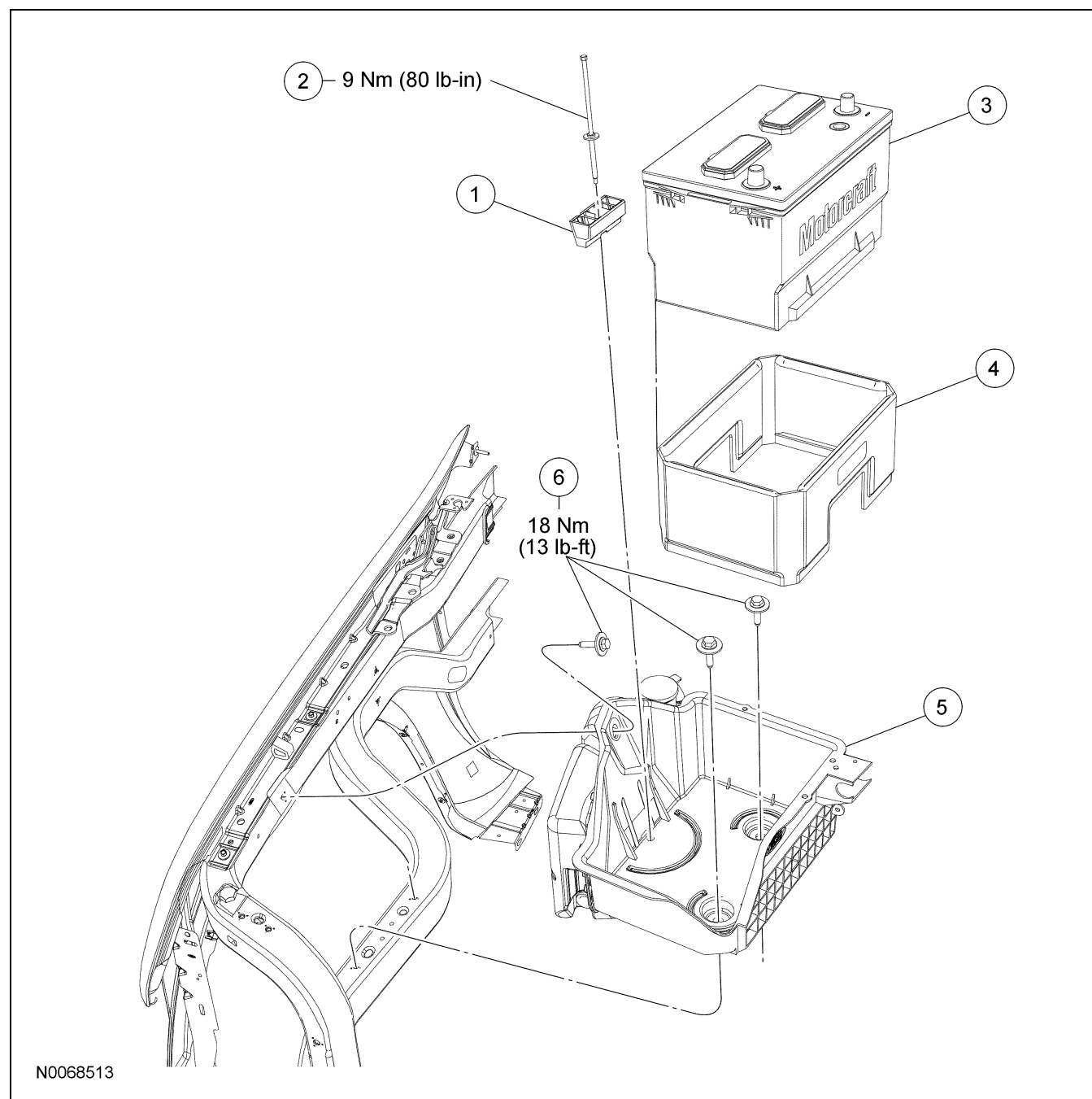
Item	Part Number	Description
3	10A687	Battery cover
4	N811479	Battery tray bolts (4 required)
5	10732	Battery tray

REMOVAL AND INSTALLATION (Continued)

1. For additional information, refer to the procedures in this section.
-

REMOVAL AND INSTALLATION

Battery and Battery Tray — Exploded View, Gasoline



Item	Part Number	Description
1	—	Battery hold-down clamp
2	N808480	Battery hold-down clamp bolt
3	10655	Battery

(Continued)

Item	Part Number	Description
4	10A687	Battery cover
5	10732	Battery tray
6	N811479	Battery tray bolts (3 required)

REMOVAL AND INSTALLATION (Continued)

1. For additional information, refer to the procedures in this section.
-

DESCRIPTION AND OPERATION

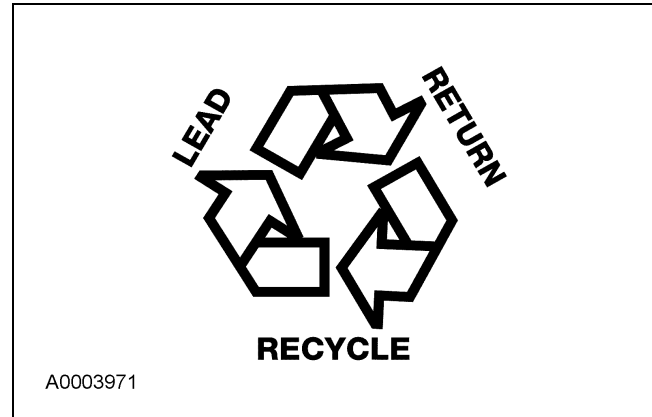
Battery and Cables

Vehicles are equipped with a 12-volt maintenance-free battery.

The battery and cable system consists of the following components:

- Battery
- Battery cable assembly
- Battery tray

Ford Motor Company strongly recommends that lead-acid batteries be returned to an authorized recycling facility for disposal.



DESCRIPTION AND OPERATION

Charging System

The charging system is a negative ground system. The generator is belt-driven by the engine accessory drive system. When the engine is started, the generator begins to generate AC, which is internally converted to DC. This current is then supplied to the vehicle electrical system through the output (B+) terminal of the generator.

On the dual generator system, the PCM controls the charging system warning indicator and commands the lamp on if the PCM detects a concern on the monitored circuits.

The set voltage varies with temperature and is typically higher in cold temperatures than in warm temperatures. This allows for better battery recharge in the winter and reduces the chance of overcharging in the summer.

The charging system consists of the following:

- Generator(s)
- Internal voltage regulator
- Charging system warning indicator
- Battery
- Circuitry and cables

Battery

The battery is a 12-volt DC source connected in a negative ground system. The battery case is sealed and includes 2 vent holes to release gases. The battery has 3 major functions:

- Engine cranking power source
- Voltage stabilizer for the electrical system
- Temporary power source when electrical loads exceed the generator output current

Generator

The single generator system consists of the generator mounted on the bottom right of the engine (diesel) or top center of the engine (gas). The gas engines use a 3G 115-amp generator with a 2.71:1 pulley ratio. The 6.4L diesel engine uses a SC1 135-amp generator with a 2.79:1 pulley ratio.

The dual generator package consists of an upper/lower dual generator system. The 6.4L upper generator is a 4G 120-amp generator with a 3.00:1 pulley ratio. The 6.4L lower generator is a SC5 200-amp generator with a 2.79:1 pulley ratio. The upper and lower generators are not interchangeable.

A option is available (6.4L diesel only) that includes a SC5 200-amp generator with a 2.79:1 pulley ratio. The SC1 and the SC5 are similar in appearance and use the same connectors, making them interchangeable. Identification between the different generators can be carried out by referring to the generator engineering number, 2 letter code on the label and the parts catalog.

2008 Ford F-350 SUPER DUTY

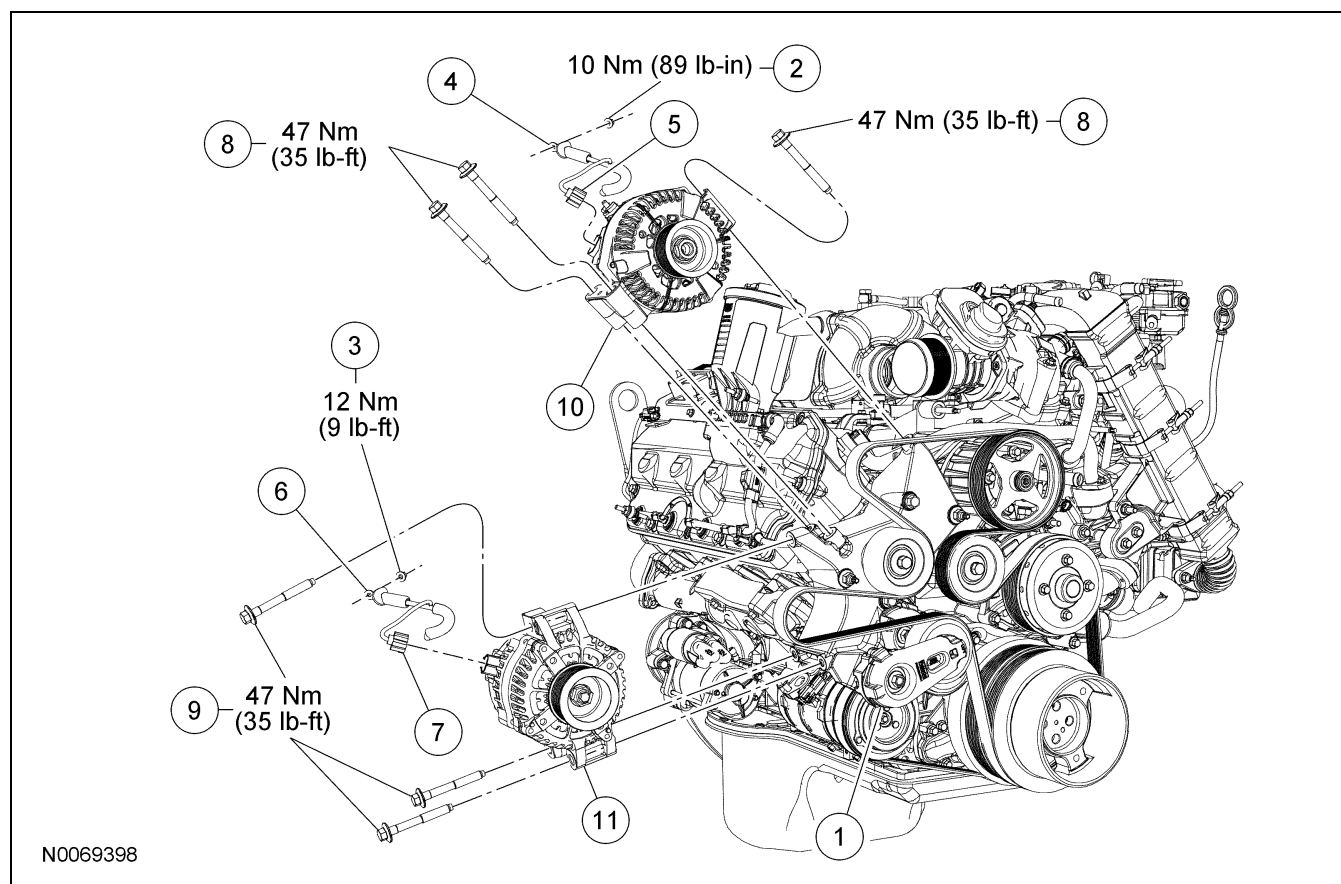
Submodel: XLT | Engine Type: V8 | Liters: 5.4
Fuel Delivery: FI | Fuel: GAS

GROUP 14: Battery and Charging System

- SECTION 414-00: Charging System — General Information
- SECTION 414-01: Battery, Mounting and Cables
- SECTION 414-02: Generator and Regulator

REMOVAL AND INSTALLATION

Generator — 6.4L Diesel, Dual Generator



Item	Part Number	Description
1	6B209	Accessory drive belt tensioner
2	W705790-S901	Generator B+ terminal nut — upper generator
3	W711953-S437	Generator B+ terminal nut — lower generator
4	—	Generator B+ terminal (part of 14305) — upper generator
5	—	Generator electrical connector (part of 14305) — upper generator
6	—	Generator B+ terminal (part of 14305) — lower generator
7	—	Generator electrical connector (part of 14305) — upper generator
8	N805424	Generator bolts (3 required) — upper generator
9	N805424	Generator bolts (3 required) — lower generator

(Continued)

Item	Part Number	Description
10	10300	Generator — upper
11	10300	Generator — lower

Removal and Installation

NOTE: This procedure applies to the primary (lower) and/or secondary (upper) generator of the dual generator system.

Both generators

1. Disconnect the batteries. For additional information, refer to Section 414-01.
2. Remove the air cleaner assembly. For additional information, refer to Section 303-12.

REMOVAL AND INSTALLATION (Continued)**Primary generator**

3. Remove the fender splash shield. For additional information, refer to Section 501-02.

Secondary generator

4. Loosen the RH charge air cooler (CAC) tube clamp at the intake throttle adapter and position the CAC tube aside.
 - To install, tighten to 8 Nm (71 lb-in).

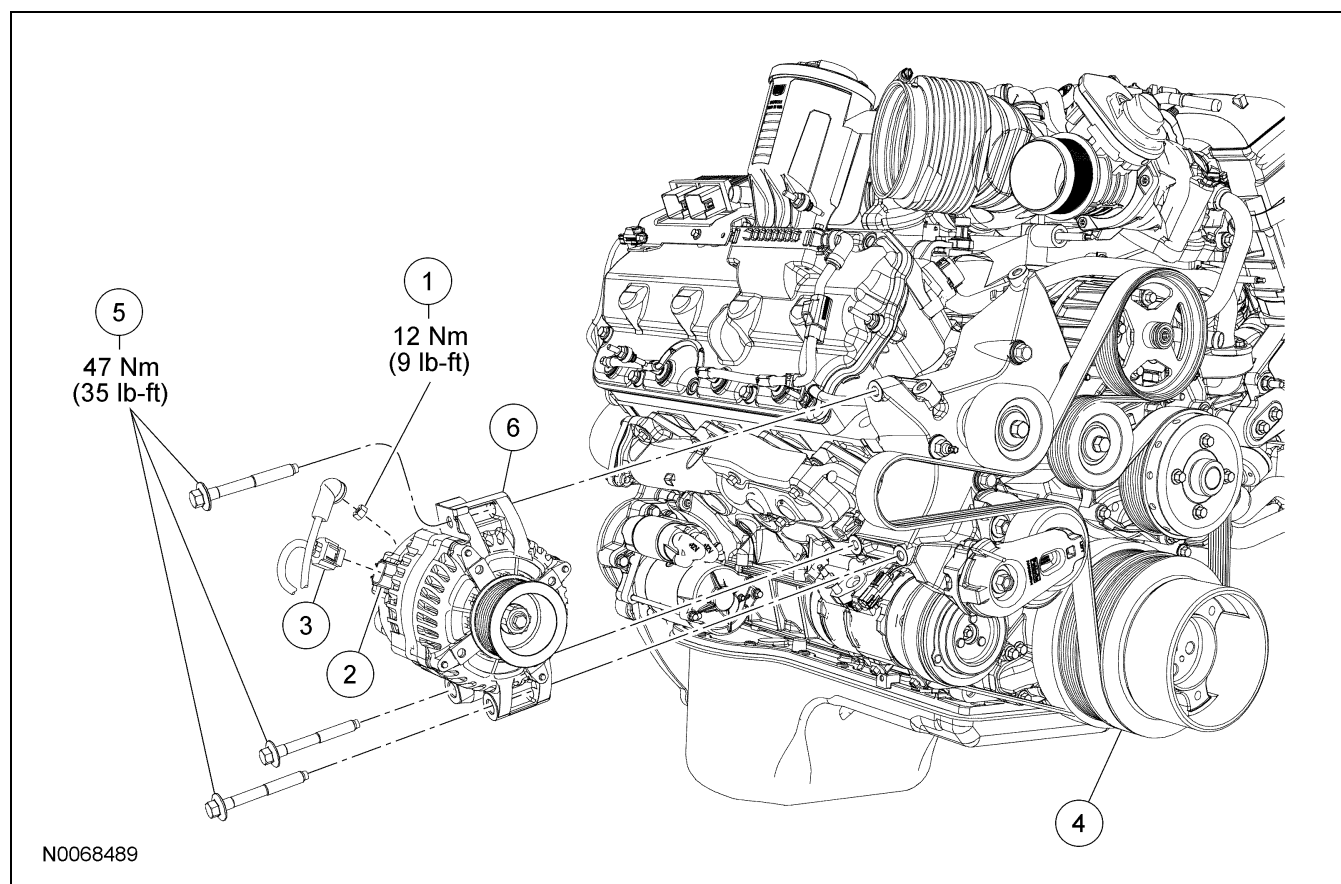
Both generators

5. Rotate the accessory drive belt tensioner clockwise and remove the drive belt from the generator pulley.

6. Remove the nut(s) and position the generator B+ terminal(s) aside.
 - To install, tighten primary (lower) generator nut to 12 Nm (9 lb-ft).
 - To install, tighten secondary (upper) generator nut to 10 Nm (89 lb-in).
7. Disconnect the generator electrical connector.
8. Remove the 2 lower bolts to the generator.
 - To install, tighten to 47 Nm (35 lb-ft).
9. Remove the upper bolt and the generator.
 - To install, tighten to 47 Nm (35 lb-ft).
10. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Generator — 6.4L Diesel, Single Generator



Item	Part Number	Description
1	W711953-S437	Generator B+ terminal nut
2	—	Generator connector (part of 10300)
3	—	Generator electrical connector (part of 12B637)
4	8620	Accessory drive belt
5	N805424	Generator bolts (3 required)
6	10300	Generator

Removal and Installation

1. Disconnect the batteries. For additional information, refer to Section 414-01.
2. Remove the air cleaner assembly. For additional information, refer to Section 303-12.

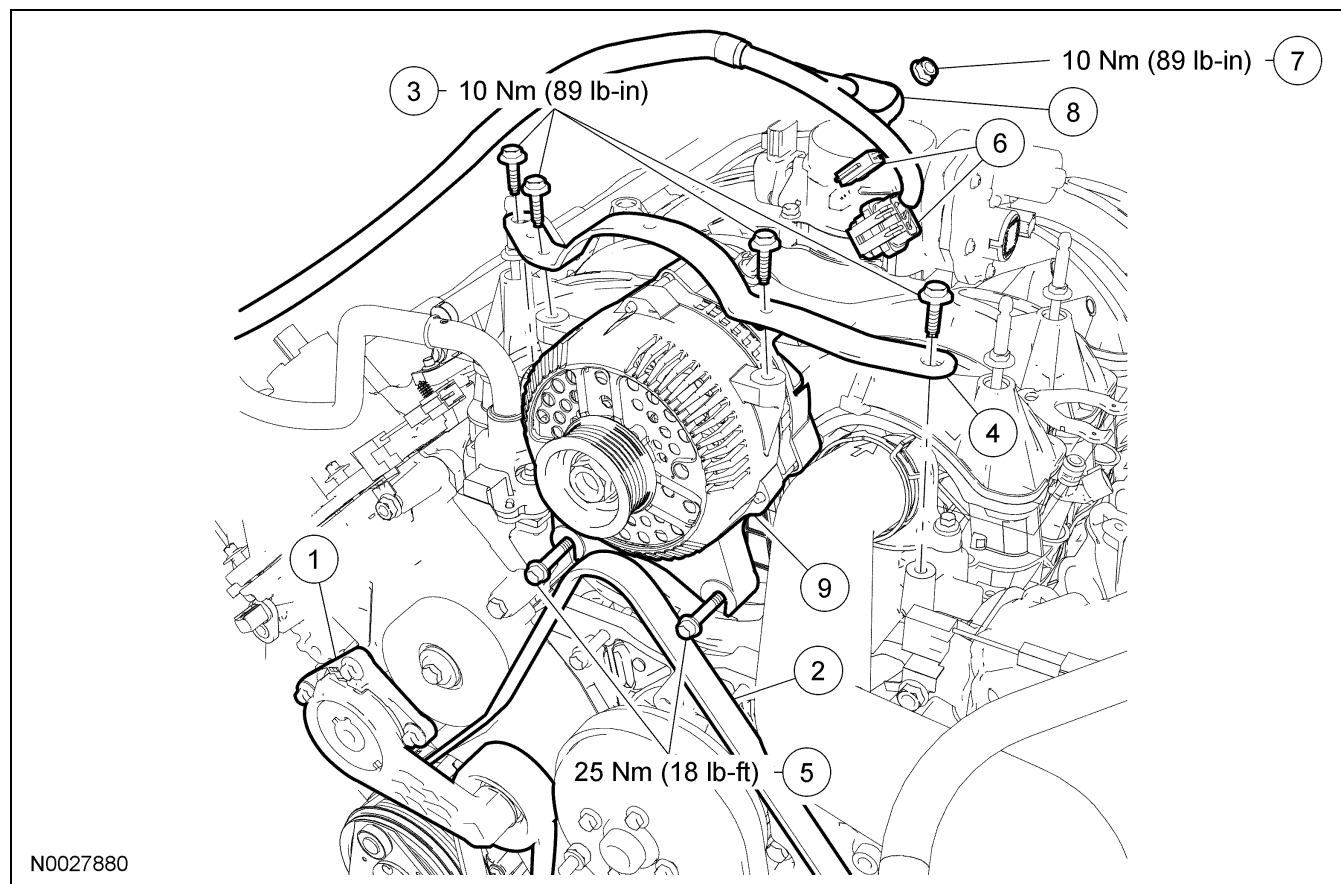
3. Remove the fender splash shield. For additional information, refer to Section 501-02.
4. Rotate the accessory drive belt tensioner clockwise and remove the drive belt from the generator pulley.
5. Remove the nut and position the generator B+ terminal aside.
 - To install, tighten to 12 Nm (9 lb-ft).
6. Disconnect the generator electrical connector.
7. Remove the 2 lower bolts to the generator.
 - To install, tighten to 47 Nm (35 lb-ft).

REMOVAL AND INSTALLATION (Continued)

8. Remove the upper bolt and the generator.
 - To install, tighten to 47 Nm (35 lb-ft).
 9. To install, reverse the removal procedure.
-

REMOVAL AND INSTALLATION

Generator — Gasoline Engines




Item	Part Number	Description
1	6B209	Accessory drive belt tensioner
2	8620	Accessory drive belt
3	N807309	Generator bracket bolts (4 required)
4	10153	Generator bracket
5	N811334	Generator bolts (2 required)
6	—	Generator electrical connectors (part of 14305)
7	W705790-S901	Generator B+ terminal nut
8	—	Generator B+ terminal (part of 14305)
9	10300	Generator

Removal and Installation

1. Disconnect the battery. For additional information, refer to Section 414-01.

2. If equipped with 5.4L engine, remove the air cleaner intake pipe. For additional information, refer to Section 303-12.
3. Release the accessory drive belt tension and remove the drive belt from the generator pulley.
4. Remove the 4 bolts and the generator bracket.
 - Release the harness locator.
 - To install, tighten to 10 Nm (89 lb-in).
5. Remove the 2 bolts and position the generator aside.
 - To install, tighten to 25 Nm (18 lb-ft).
6. Disconnect the 2 generator electrical connectors.

REMOVAL AND INSTALLATION (Continued)

7.  **CAUTION:** When installing the generator, make sure to hand-start the generator B+ terminal nut to prevent cross-threading.

Remove the nut and position the generator B+ terminal aside.

- To install, tighten to 10 Nm (89 lb-in).
-

8. Remove the generator.
9. To install, reverse the removal procedure.

DESCRIPTION AND OPERATION

Generator

Single Generator

The single generator system consists of the generator mounted on the bottom right of the engine (diesel) or top center of the engine (gasoline). The gasoline engines use a 115-amp generator with a 2.71:1 pulley ratio. The diesel engine uses a 135-amp generator with a 2.79:1 pulley ratio.

An option is available (diesel only) that includes a 200-amp generator with a 2.79:1 pulley ratio. The 2 generators are similar in appearance and use the same connectors, making them interchangeable. Identification between the different generators can be carried out by referring to the generator engineering part number and the master parts catalog.

Dual Generator

The dual generator package consists of an upper/lower generator system (diesel only). The 6.4L upper generator is a 120-amp generator with a 3.00:1 pulley ratio. The 6.4L lower generator is a 200-amp generator with a 2.79:1 pulley ratio. The upper and lower generators are not interchangeable.

2008 Ford F-350 SUPER DUTY

Submodel: XLT | Engine Type: V8 | Liters: 5.4
Fuel Delivery: FI | Fuel: GAS

SECTION 303-06A:
Starting System — Gasoline Engines

SPECIFICATIONS
DESCRIPTION AND OPERATION
Starting System
DIAGNOSIS AND TESTING
Starting System
Principles of Operation
Starting System — Anti-Theft Intervention
Inspection and Verification
Symptom Chart
Pinpoint Tests
Component Tests
Starter Motor — Ground Circuit
GENERAL PROCEDURES
Starter Motor Drive Gear and Flywheel Ring Gear Inspection
REMOVAL AND INSTALLATION
Starter Motor

2008 Ford F-350 SUPER DUTY

Submodel: XLT | Engine Type: V8 | Liters: 5.4
Fuel Delivery: FI | Fuel: GAS

SECTION 414-00:
Charging System — General Information

SPECIFICATIONS
DESCRIPTION AND OPERATION
Charging System
DIAGNOSIS AND TESTING
Charging System — Single Generator, Gas
Principles of Operation
Inspection and Verification
Symptom Chart
Pinpoint Tests
Component Tests
Charging System — Single Generator, Diesel
Principles of Operation
Inspection and Verification
Symptom Chart
Pinpoint Tests
Component Tests
Charging System — Dual Generators
Principles of Operation
Inspection and Verification
Symptom Chart
Pinpoint Tests
Component Tests

2008 Ford F-350 SUPER DUTY

Submodel: XLT | Engine Type: V8 | Liters: 5.4
Fuel Delivery: FI | Fuel: GAS

SECTION 414-01:
Battery, Mounting and Cables

SPECIFICATIONS
DESCRIPTION AND OPERATION
Battery and Cables
DIAGNOSIS AND TESTING
Battery
Principles of Operation
Inspection and Verification
Pinpoint Tests
GENERAL PROCEDURES
Battery Disconnect
Battery Disconnect — Dual
REMOVAL AND INSTALLATION
Battery and Battery Tray — Exploded View, Gasoline
Battery — Gasoline
Battery Tray — Gasoline
Battery and Battery Tray — Exploded View, Diesel
Battery — Diesel
Battery Tray — Auxiliary
Battery Cables — Gasoline
Battery Cables — Diesel

2008 Ford F-350 SUPER DUTY

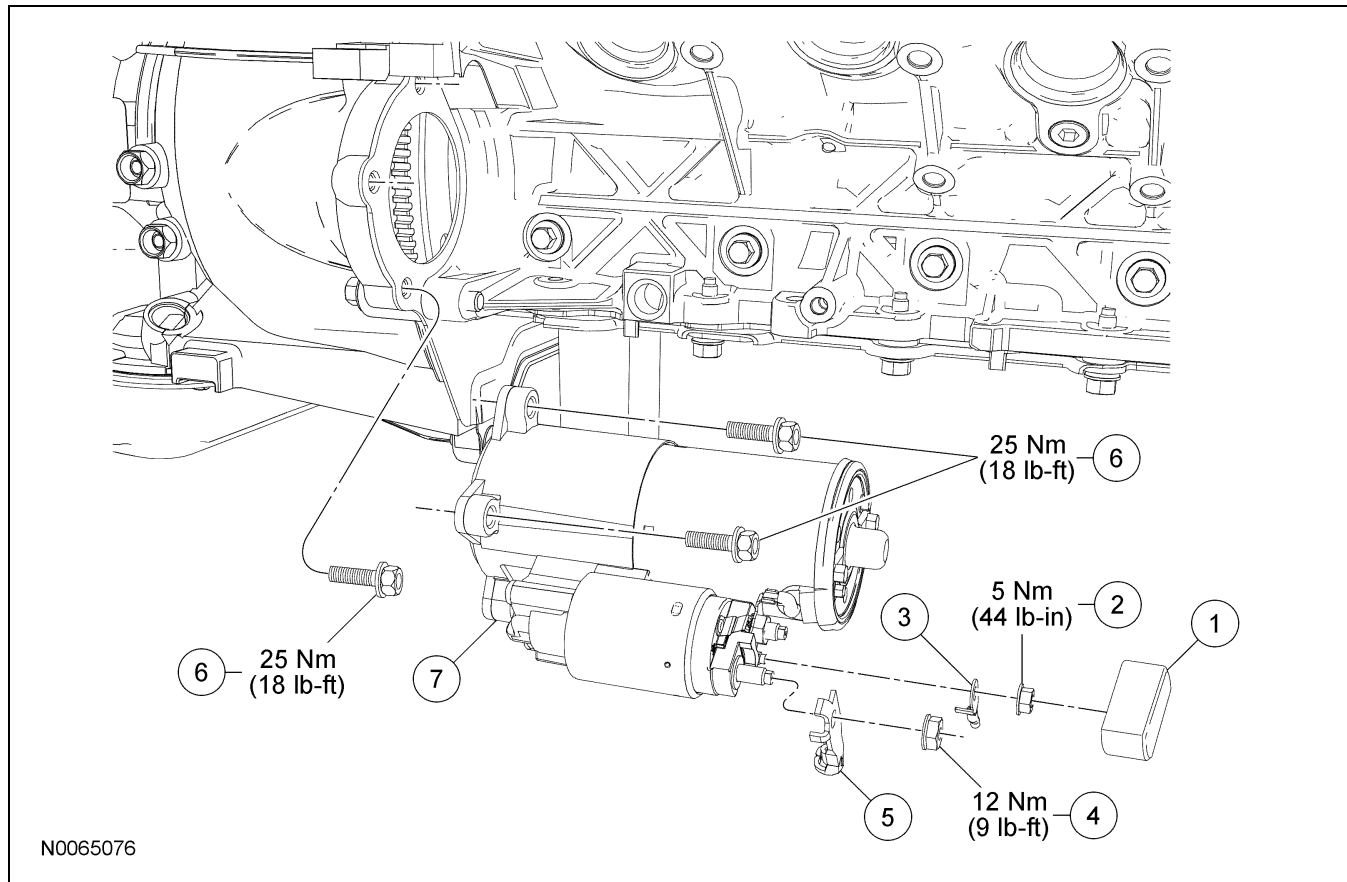
Submodel: XLT | Engine Type: V8 | Liters: 5.4
Fuel Delivery: FI | Fuel: GAS

SECTION 414-02:
Generator and Regulator

- SPECIFICATIONS
- DESCRIPTION AND OPERATION
 - Generator
- DIAGNOSIS AND TESTING
 - Generator
- REMOVAL AND INSTALLATION
 - Generator — Gasoline Engines
 - Generator — 6.4L Diesel, Single Generator
 - Generator — 6.4L Diesel, Dual Generator
 - Voltage Regulator

REMOVAL AND INSTALLATION

Starter Motor



Item	Part Number	Description
1	11N087	Terminal cover
2	W705790	Starter solenoid S-terminal nut
3	14463	Starter solenoid S-terminal eyelet
4	W706414	Starter solenoid B-terminal nut
5	14463	Starter solenoid B-terminal eyelet
6	W704942	Starter motor mounting bolts (3 required)
7	11000	Starter motor

Removal and Installation

⚠ WARNING: Always disconnect the battery ground cable at the battery before disconnecting the starter motor battery terminal lead. If a tool is shorted at the starter motor battery terminal, the tool can quickly heat enough to cause a skin burn. Failure to follow this instruction may result in serious personal injury.

1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
2. Disconnect the battery ground cable. For additional information, refer to Section 414-01.
3. Remove the starter terminal cover and remove the nut and the solenoid S-terminal electrical connection.
 - To install, tighten to 5 Nm (44 lb-in).

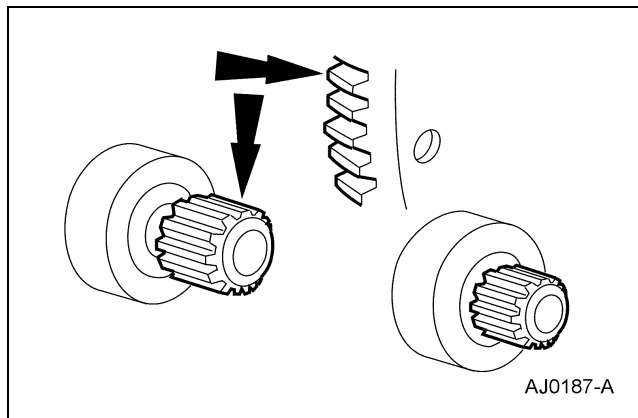
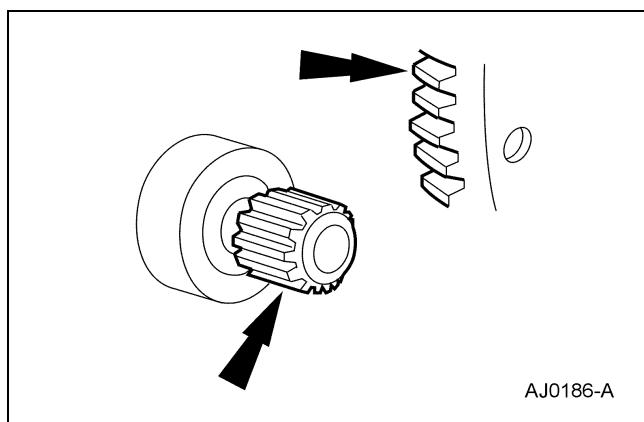
REMOVAL AND INSTALLATION (Continued)

4. Remove the nut and the solenoid B-terminal electrical connection.
 - To install, tighten to 12 Nm (9 lb-ft).
 5. Remove the 3 bolts and the starter motor.
 - To install, tighten to 25 Nm (18 lb-ft).
 6. To install, reverse the removal procedure.
 - Loosely install the 3 bolts.
 - Tighten the upper bolt.
 - Tighten the lower bolts.
-

GENERAL PROCEDURES

Starter Motor Drive Gear and Flywheel Ring Gear Inspection

1. Remove the starter motor. For additional information, refer to Starter Motor in this section.
2. Check the wear patterns on the starter drive and the flywheel ring gear. If the wear pattern is normal, install the starter motor. For additional information, refer to Starter Motor in this section.
3. If the starter drive gear and the flywheel ring gear are not fully meshing or the gears are milled or damaged, install a new flexplate and a new starter motor. For additional information, refer to Section 303-01A or Section 303-01B and Starter Motor in this section.



DESCRIPTION AND OPERATION

Starting System

The starting system consists of the following:

- Starter motor
- Starter motor relay
- Starter drive
- Battery
- Transmission range (TR) sensor
- Clutch pedal position (CPP) switch
- Ignition switch
- PCM
- One-touch integrated start (OTIS) diode (Late build vehicles)

The function of the starting system is to crank the engine at a speed fast enough to permit the engine to start. When the starter solenoid is energized, a magnetic field is created in the starter solenoid windings. The iron plunger core is drawn into the starter solenoid coil, and a drive lever and pin connected to the starter drive engages the drive pinion gear to the flexplate ring gear. When the plunger is pulled all the way in, its' contact disc closes the circuit between the battery and the motor feed terminals. This sends current to the motor and the drive pinion gear cranks the flexplate to start the engine. When current flows to the starter motor, the starter solenoid pull-in coil is bypassed, and the hold-in coil keeps the drive pinion gear engaged with the flexplate.

Automatic transmissions have a TR sensor in the transmission. The TR sensor prevents operation of the starter motor unless NEUTRAL or PARK is selected.

Manual transmission equipped vehicles have a CPP switch. The CPP switch prevents operation of the starter motor unless the clutch pedal is fully depressed.

One-Touch Integrated Start (OTIS)

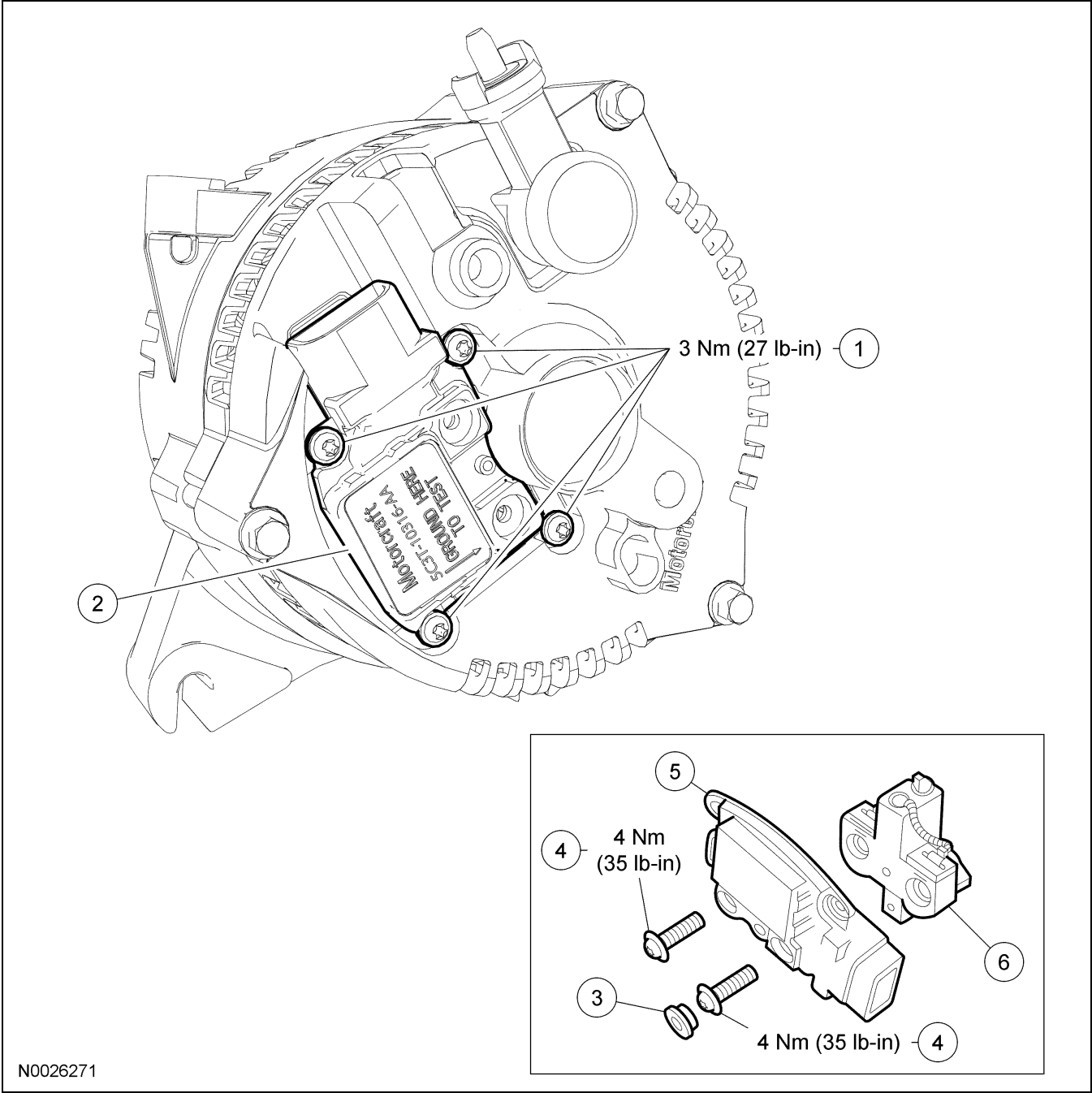
This vehicle has one-touch integrated start (OTIS), a computer-assisted cranking system. This feature assists in starting the engine. If the ignition key is turned to the START position and released when the engine begins cranking, the engine may continue cranking for up to 10 seconds or until the vehicle starts.

Once the ignition is turned to the START position, the PCM reads starter motor request (SMR) from the ignition switch and gains control of the starter engagement. The customer is no longer in the loop after the initial crank request, the customer may release the key to the RUN/START position. The PCM will disengage the starter motor based on the following events:

- The engine is started (rpm threshold)
- A set time has been exceeded
- The ignition key has been turned to the OFF position

REMOVAL AND INSTALLATION

Voltage Regulator



N0026271

Item	Part Number	Description
1	—	Generator brush and terminal holder — voltage regulator screws (4 required) (part of 10316)
2	10316	Generator brush and terminal holder — voltage regulator


(Continued)

Item	Part Number	Description
3	—	Test terminal A screw cap (part of 10316)
4	—	Generator brush and terminal holder screws (2 required) (part of 10316)
5	10316	Generator voltage regulator
6	—	Generator brush and terminal holder (part of 10316)

REMOVAL AND INSTALLATION (Continued)**Removal**

1. Remove the generator. For additional information, refer to Generator — Gasoline Engines in this section.
2. Remove the 4 generator brush and terminal holder — voltage regulator screws and position the generator brush and terminal holder — voltage regulator aside.
3. Remove the test terminal A screw cap, the 2 generator brush and terminal holder screws and separate the generator brush and terminal holder from the generator voltage regulator.

Installation

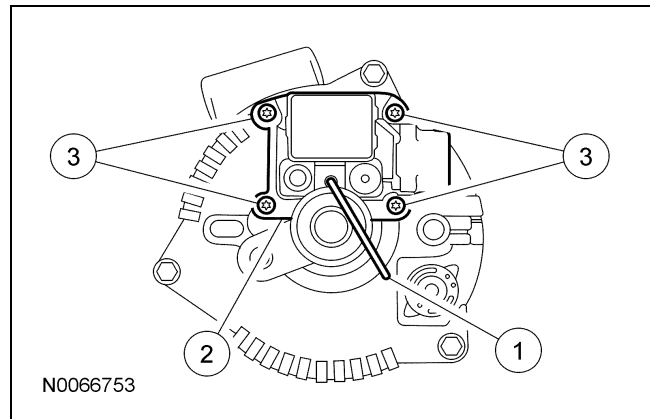
1.  **CAUTION: Make sure the screw cap is installed over test terminal A to prevent accidental shorting to ground.**

Install the 2 screws and the brush and terminal holder on the generator voltage regulator.

- Tighten to 4 Nm (35 lb-in).

2. Install the generator brush and terminal holder — voltage regulator on the generator.

- 1 Press the brushes in and insert a wire to hold the brushes during installation.
- 2 Position the generator brush and terminal holder — voltage regulator.
- 3 Install the 4 generator brush and terminal holder — voltage regulator screws.
 - Tighten to 3 Nm (27 lb-in).
- Remove the wire.

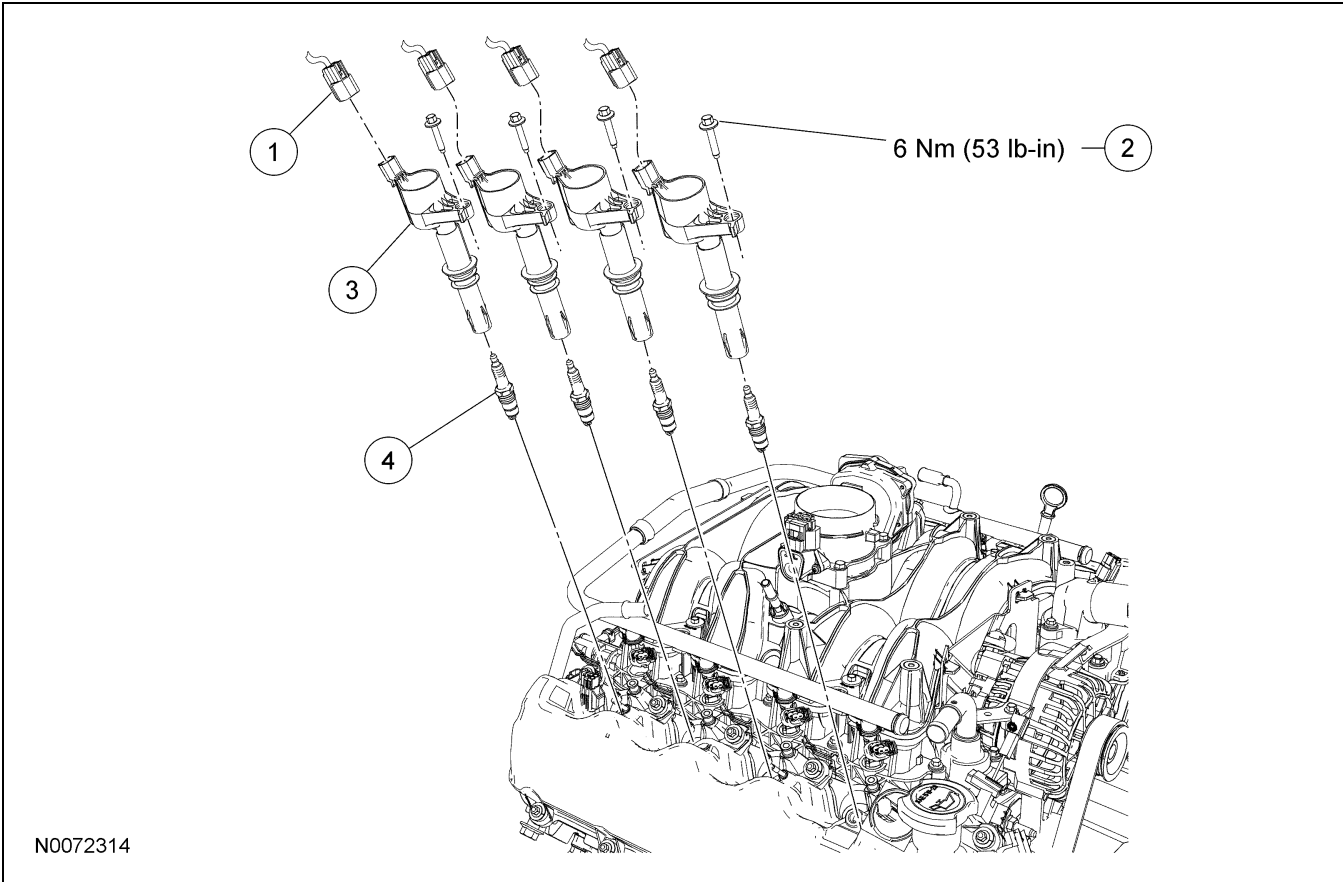


3. Install the generator. For additional information, refer to Generator — Gasoline Engines in this section.

REMOVAL AND INSTALLATION

Engine Ignition Components —
Exploded View

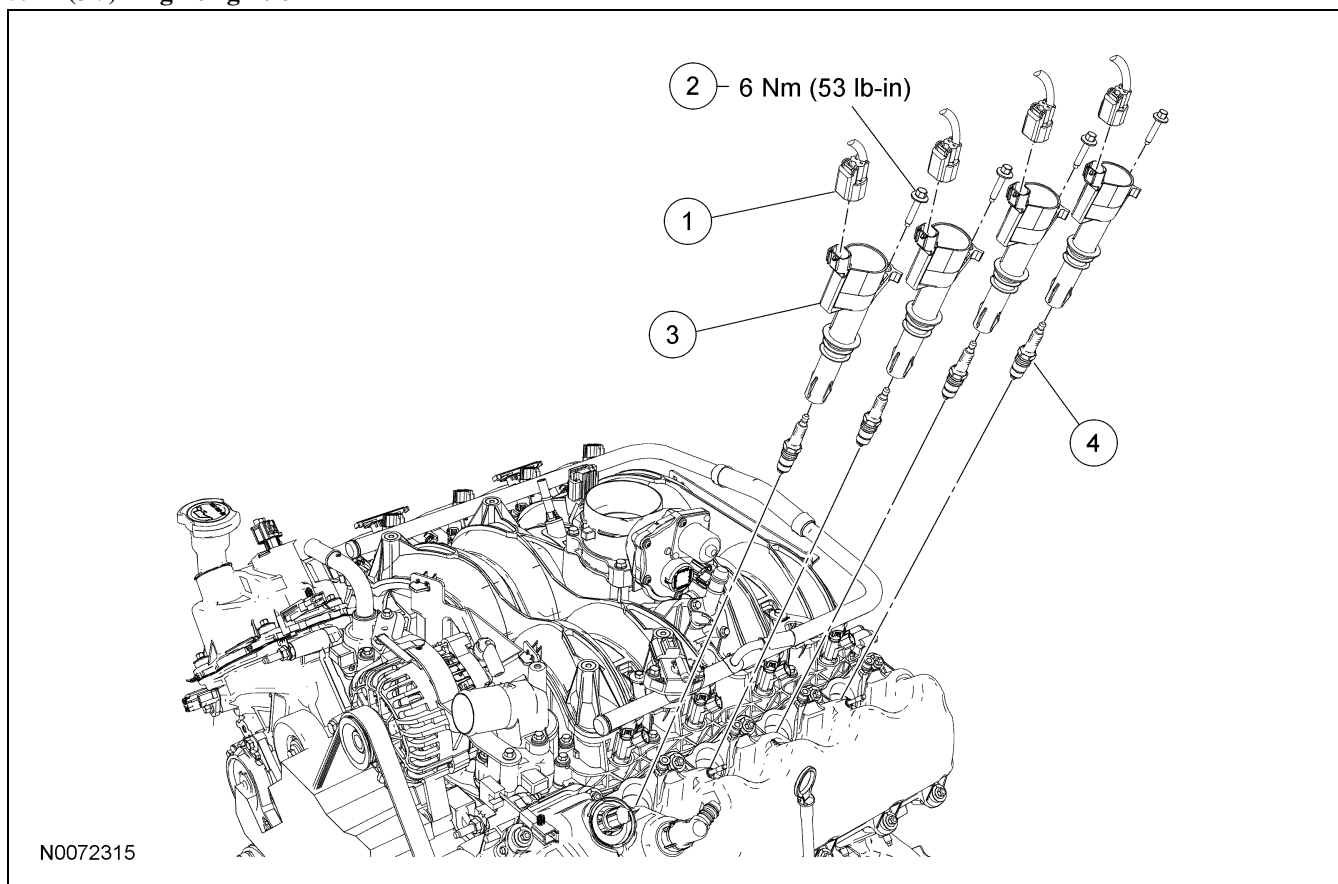
5.4L (3V) Engine Ignition — RH



Item	Part Number	Description
1	—	RH ignition coil electrical connector (4 required) (part of 12B637)
2	W706175	RH ignition coil retaining bolt (4 required)

Item	Part Number	Description
3	12A366	RH ignition coil (4 required)
4	12405	RH spark plug (4 required)

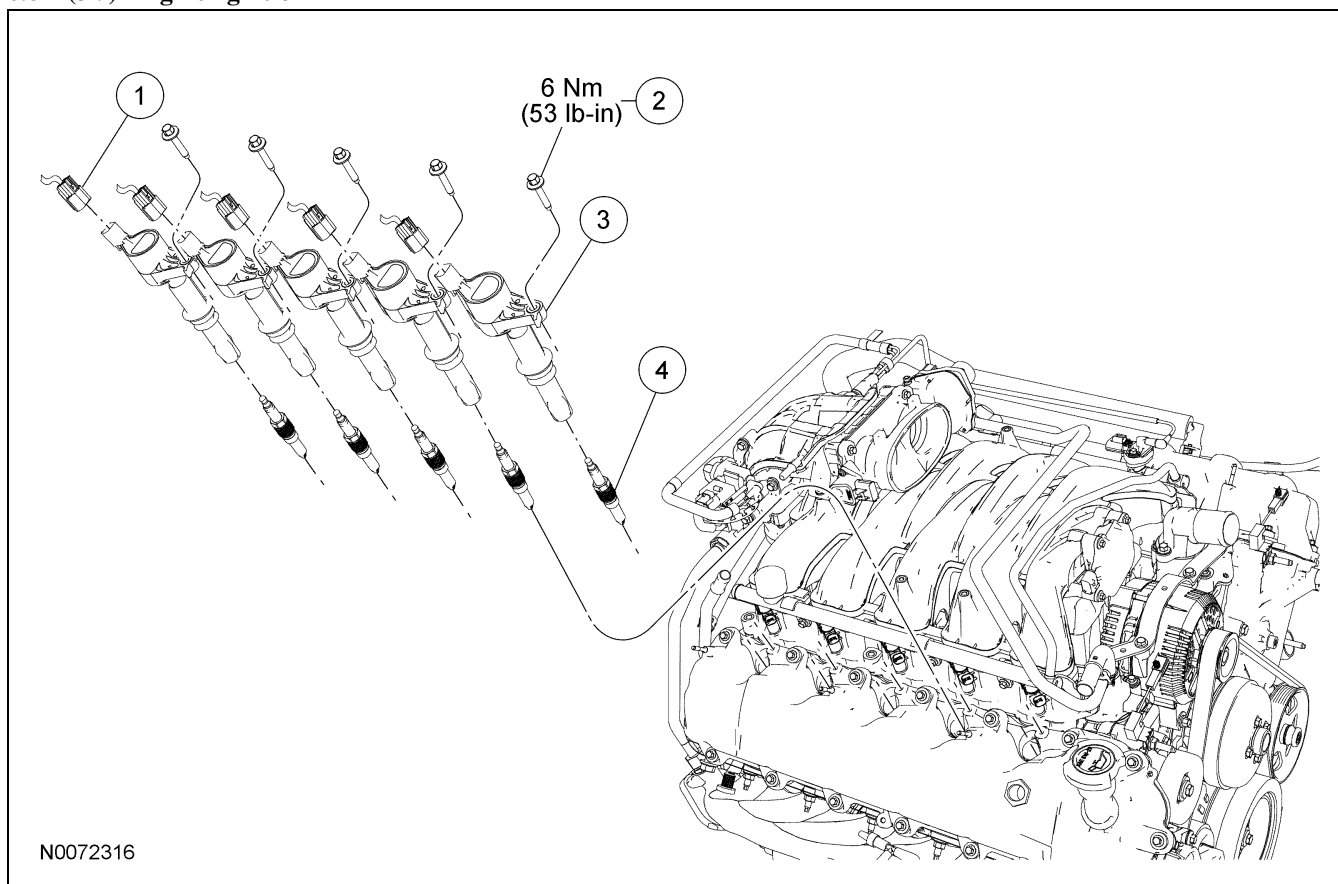
(Continued)

REMOVAL AND INSTALLATION (Continued)**5.4L (3V) Engine Ignition — LH**

Item	Part Number	Description
1	—	LH ignition coil electrical connector (4 required) (part of 12B637)
2	W706175	LH ignition coil retaining bolt (4 required)

(Continued)

Item	Part Number	Description
3	12A366	LH ignition coil (4 required)
4	12405	LH spark plug (4 required)

REMOVAL AND INSTALLATION (Continued)**6.8L (3V) Engine Ignition — RH**

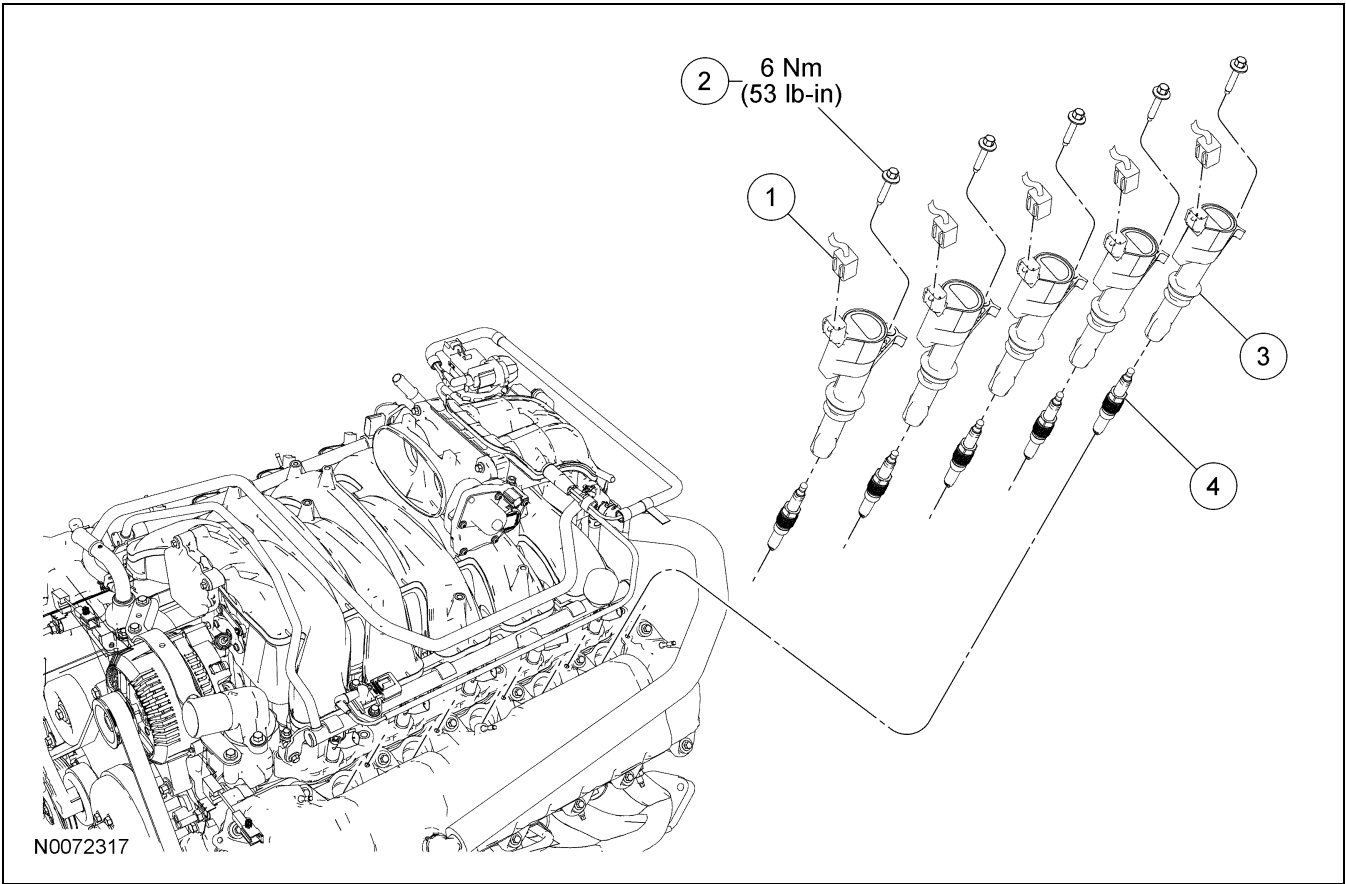
Item	Part Number	Description
1	—	RH ignition coil electrical connector (5 required) (part of 12B637)
2	W706175	RH ignition coil retaining bolt (5 required)

(Continued)

Item	Part Number	Description
3	12A366	RH ignition coil (5 required)
4	12405	RH spark plug (5 required)

REMOVAL AND INSTALLATION (Continued)

6.8L (3V) Engine Ignition — LH



Item	Part Number	Description
1	—	LH ignition coil electrical connector (5 required) (part of 12B637)
2	W706175	LH ignition coil retaining bolt (5 required)

(Continued)

Item	Part Number	Description
3	12A366	LH ignition coil (5 required)
4	12405	LH spark plug (5 required)

1. For additional information, refer to the procedures in this section.

REMOVAL AND INSTALLATION

Ignition Coil-On-Plug

Material

Item	Specification
Silicone Brake Caliper Grease and Dielectric Compound XG-3-A	ESE-M1C171-A

Removal and Installation

1. Disconnect the ignition coil electrical connector.
 2. Remove the bolt and the ignition coil.
 - Remove the ignition coil, using a twisting motion while pulling up on the ignition coil.
 - To install, tighten to 6 Nm (53 lb-in).
-

3. **NOTE:** Verify that the ignition coil spring is correctly located inside the ignition coil boot and that there is no damage to the tip of the boot.

To install, reverse the removal procedure.

- Apply a light coat of dielectric compound to the inside of the ignition coil boots.

DESCRIPTION AND OPERATION

Ignition System

The electronic ignition system is a coil-on-plug ignition system. The coil-on-plug ignition system consists of the following components:

- Crankshaft position (CKP) sensor
- Ignition coils
- Spark plugs

The CKP sensor:

- is a variable reluctance sensor.
 - is triggered by a sensor ring mounted on the crankshaft.
 - provides base timing and crankshaft speed (rpm) to the powertrain control module (PCM).
-

The separate ignition coils:

- change low voltage signals from the PCM to high voltage pulses.
- supply the high voltage pulses to the spark plugs.
- are connected directly to each spark plug.

The spark plugs:

- change high voltage pulses into a spark which ignites the fuel and air mixture.
- originally equipped on the vehicle have a platinum-enhanced active electrode for long life.

2008 Ford F-350 SUPER DUTY

Submodel: XLT | Engine Type: V8 | Liters: 5.4
Fuel Delivery: FI | Fuel: GAS

SECTION 303-07A:
Engine Ignition — 5.4L and 6.8L (3V)

SPECIFICATIONS
DESCRIPTION AND OPERATION
Ignition System
DIAGNOSIS AND TESTING
Ignition System
REMOVAL AND INSTALLATION
Engine Ignition Components — Exploded View
Ignition Coil-On-Plug
Spark Plugs

REMOVAL AND INSTALLATION


Spark Plugs


Removal and Installation

All vehicles

1. Remove the ignition coil-on-plug. For additional information, refer to Ignition Coil-On-Plug in this section.

Early build vehicles

2.  **CAUTION:** Do not remove the spark plugs when the engine is hot or cold soaked. Spark plug thread or cylinder head damage can occur. Make sure the engine is warm (hand touch after cooling down) prior to spark plug removal

 **CAUTION:** Only use hand tools when removing or installing the spark plugs or damage can occur to the cylinder head or spark plug.

NOTE: Use compressed air to remove any foreign material from the spark plug well before removing the spark plugs.


NOTE: If an original spark plug is used, make sure it is installed in the same cylinder from which it was taken. New spark plugs can be used in any cylinder.


NOTE: Refer to the specifications in this section for correct spark plug identification.

Remove the spark plugs.

- To install, tighten to 34 Nm (25 lb-ft).

Late build vehicles

3.  **CAUTION:** Do not remove the spark plugs when the engine is hot or cold soaked. Spark plug thread or cylinder head damage can occur. Make sure the engine is warm (hand touch after cooling down) prior to spark plug removal

 **CAUTION:** Only use hand tools when removing or installing the spark plugs or damage can occur to the cylinder head or spark plug.

NOTE: Use compressed air to remove any foreign material from the spark plug well before removing the spark plugs.


NOTE: If an original spark plug is used, make sure it is installed in the same cylinder from which it was taken. New spark plugs can be used in any cylinder.

NOTE: Refer to the specifications in this section for correct spark plug identification.

Remove the spark plugs.

- To install, tighten to 12 Nm (9 lb-ft).

All vehicles

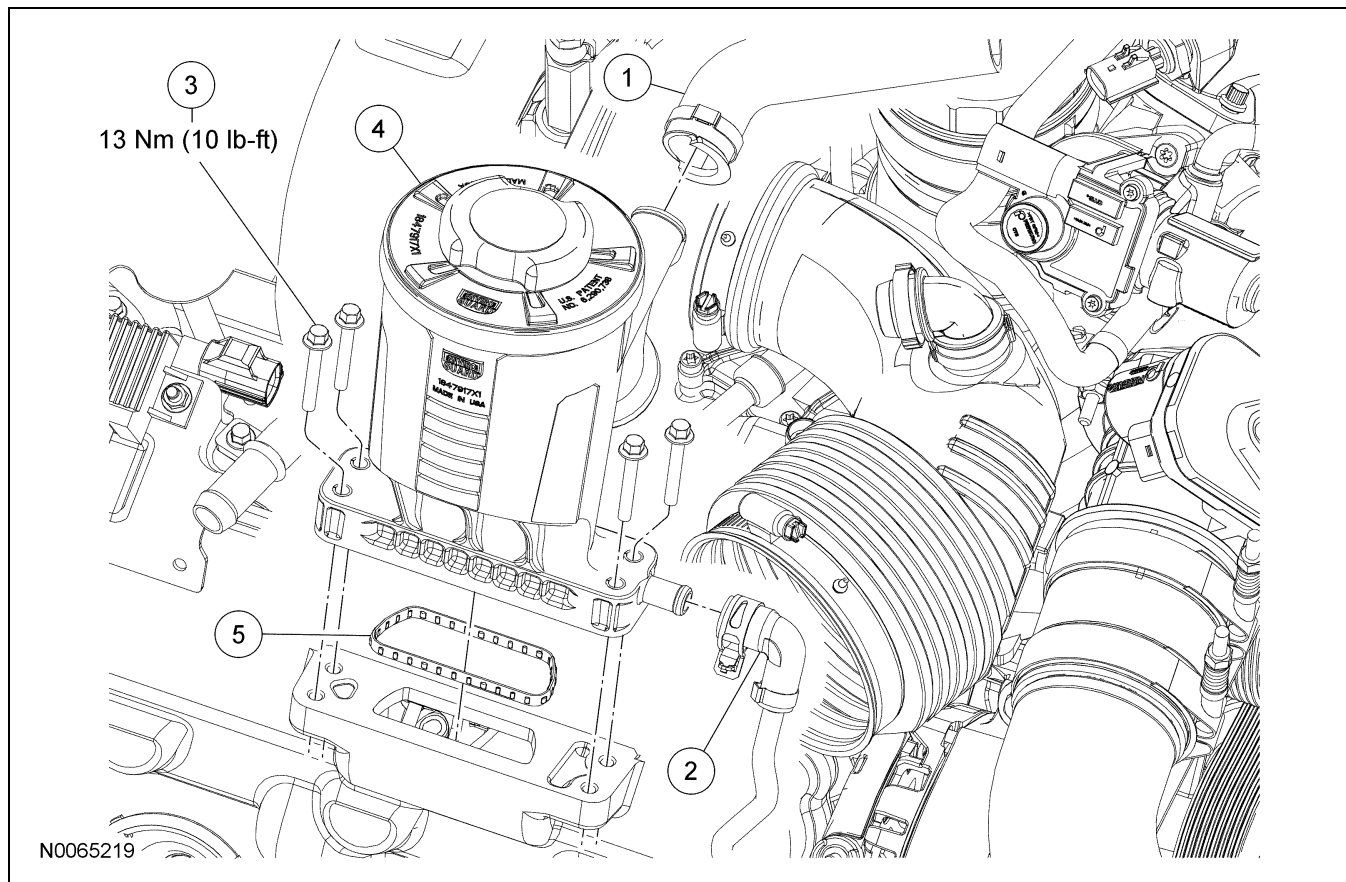
4.  **CAUTION:** The spark plug gap is NOT adjustable. Damage can occur to the ceramic if the gap is adjusted. Install a new spark plug if the gap is out of specification.

Inspect the spark plugs. Install new spark plugs as necessary. For additional information, refer to Section 303-00.

5. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Crankcase Vent Oil Separator — 6.4L Diesel



Item	Part Number	Description
1	6N664	Crankcase vent oil separator-to-air cleaner outlet tube hose.
2	6A664	Oil return tube
3	W302520	Crankcase vent oil separator bolt (4 required)
4	6A665	Crankcase vent oil separator
5	6721	Crankcase vent oil separator seal

Removal and Installation

1. Disconnect the crankcase vent oil separator-to-air cleaner outlet tube hose.
 - Discard the clamp.

2. Disconnect the oil return tube from the crankcase vent oil separator.
3. Remove the 4 bolts and the crankcase vent oil separator.
 - To install, tighten to 13 Nm (10 lb-ft).
4. Remove and discard the crankcase vent oil separator seal.
5. To install, reverse the removal procedure.
 - Install a new crankcase vent oil separator seal.
 - Install a new crankcase vent oil separator-to-air cleaner outlet tube hose clamp.

DESCRIPTION AND OPERATION

Engine Emission Control — 5.4L (3V), 6.8L (3V)

NOTE: Do not permanently remove or render inoperative any part of the Vehicle Emission Control System including related hardware. Failure to comply may violate applicable state and federal law.

The gasoline engine emission control system consists of the:

- PCV system.

Positive Crankcase Ventilation (PCV) System

The PCV system:

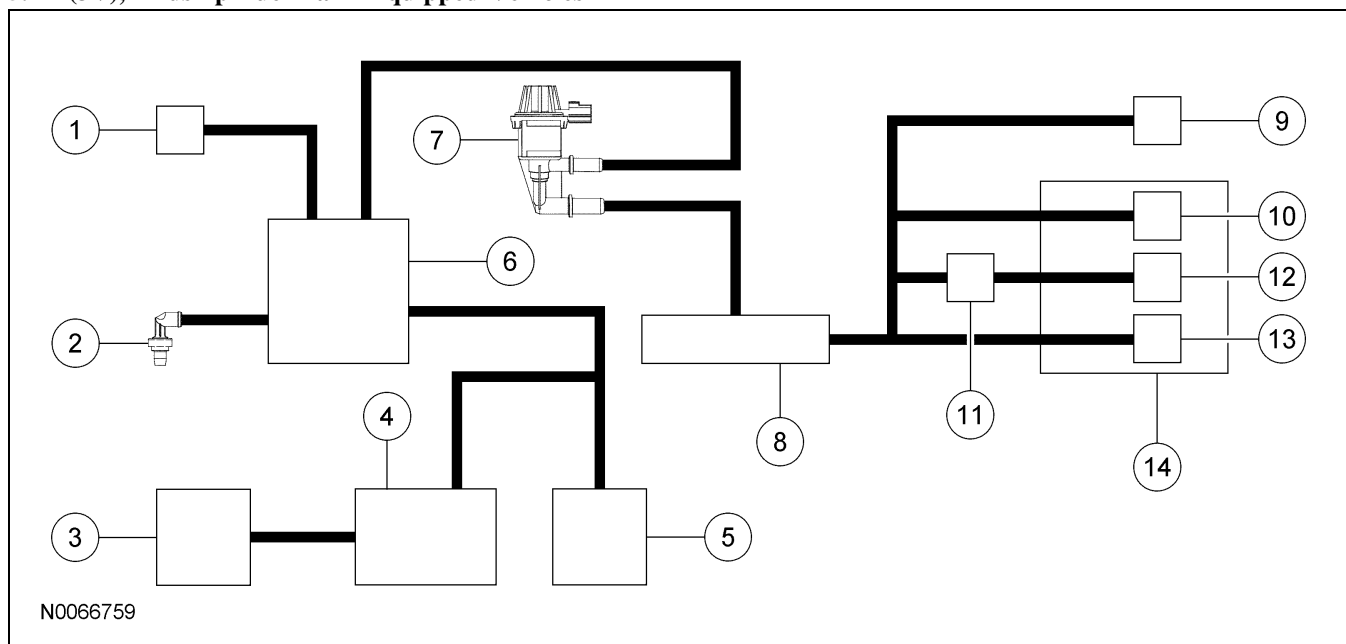
- uses intake manifold vacuum to ventilate blow-by fumes from the crankcase.
- returns the fumes to the intake manifold for combustion.

The PCV valve:

- varies the amount of blow-by gases returned to the intake manifold based on available engine vacuum.
- prevents the entry of combustion gases backfiring into the crankcase.
- is integral to the LH valve cover.
- is heated to prevent freezing.

Evaporative Emission (EVAP) Control System Vacuum Routing

5.4L (3V), Midship Fuel Tank Equipped Vehicles



Item	Part Number	Description
1	9G756	Fuel rail pressure and temperature sensor
2	6A505	LH valve cover
3	6582	RH valve cover
4	9A589	Air cleaner outlet pipe-to-throttle body (TB) adapter
5	—	Brake booster

(Continued)

Item	Part Number	Description
6	9Y451	Intake manifold
7	9C915	Evaporative emissions (EVAP) canister purge valve
8	9E633	EVAP canister assembly
9	9034	Fuel filler pipe
10	—	Fuel vent valve
11	9C052	Fuel pressure sensor
12	9H307	Fuel pump (FP) module

(Continued)

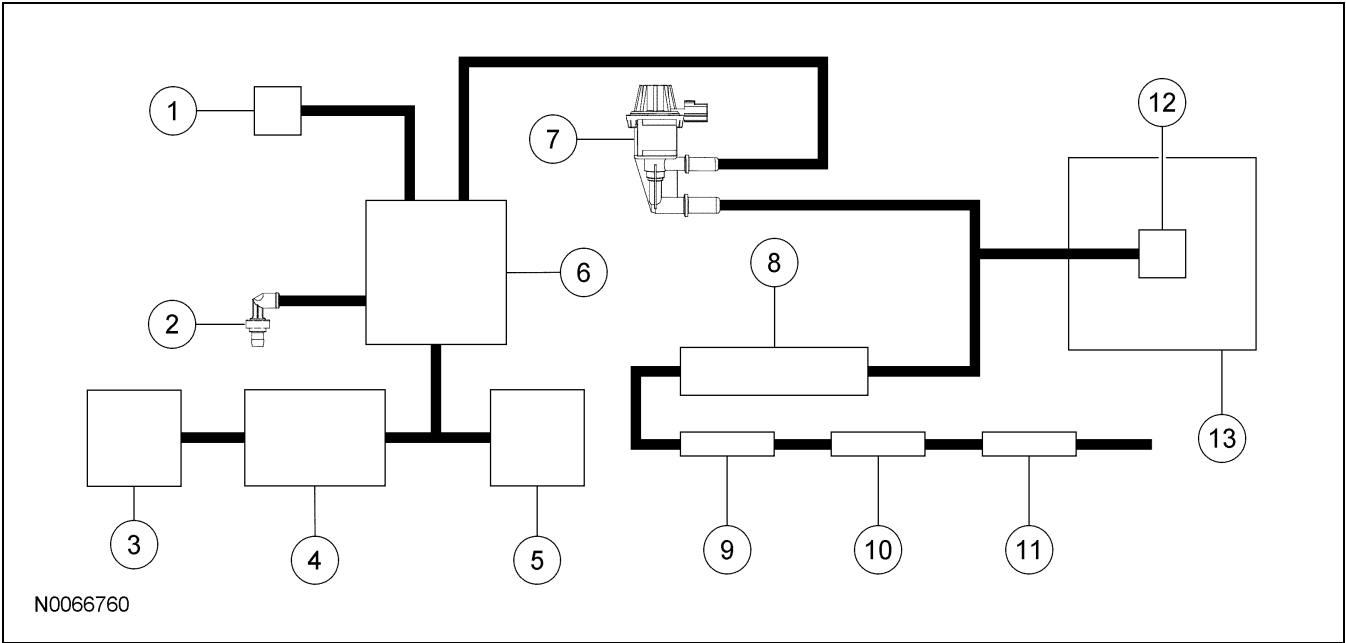
DESCRIPTION AND OPERATION (Continued)

Item	Part Number	Description
13	—	Fuel vent valve

(Continued)

Item	Part Number	Description
14	9K007	Midship fuel tank

5.4L (3V), Aft-of-Axle Fuel Tank Equipped Vehicles



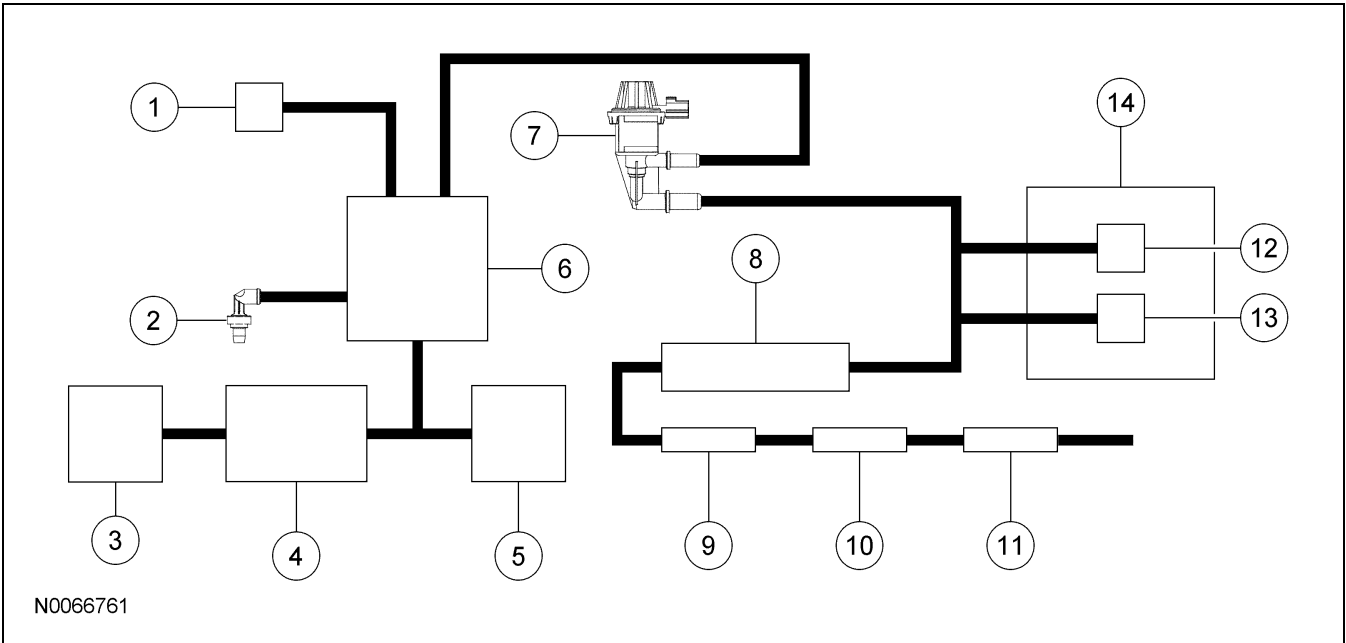
Item	Part Number	Description
1	9G756	Fuel rail pressure and temperature sensor
2	6A505	LH valve cover
3	6582	RH valve cover
4	9A589	Air cleaner outlet pipe-to-throttle body (TB) adapter
5	—	Brake booster
6	9Y451	Intake manifold

(Continued)

Item	Part Number	Description
7	9C915	Evaporative emissions (EVAP) canister purge valve
8	9D653	EVAP canister assembly
9	9F675	EVAP filter assembly
10	9F945	EVAP canister vent solenoid
11	9B328	EVAP dust separator
12	—	Fuel vent valve
13	9K007	Aft-of-axle fuel tank

DESCRIPTION AND OPERATION (Continued)

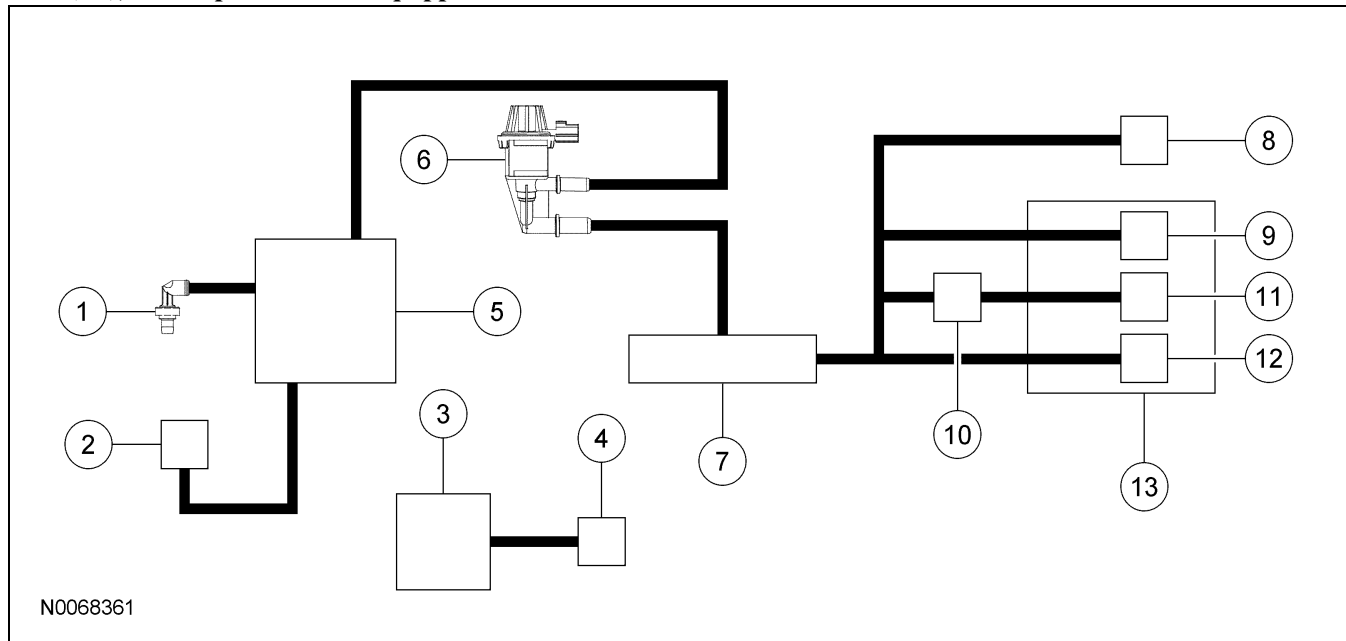
5.4L (3V), Auxiliary Fuel Tank Equipped Vehicles



Item	Part Number	Description
1	9G756	Fuel rail pressure and temperature sensor
2	6A505	LH valve cover
3	6582	RH valve cover
4	9A589	Air cleaner outlet pipe-to-throttle body (TB) adapter
5	—	Brake booster
6	9Y451	Intake manifold
7	9C915	Evaporative emissions (EVAP) canister purge valve

Item	Part Number	Description
8	9D653	EVAP canister assembly
9	9F675	EVAP filter assembly
10	9F945	EVAP canister vent solenoid
11	9B328	EVAP dust separator
12	—	Fuel vent valve
13	—	Fuel vent valve
14	9K007	Auxiliary fuel tank

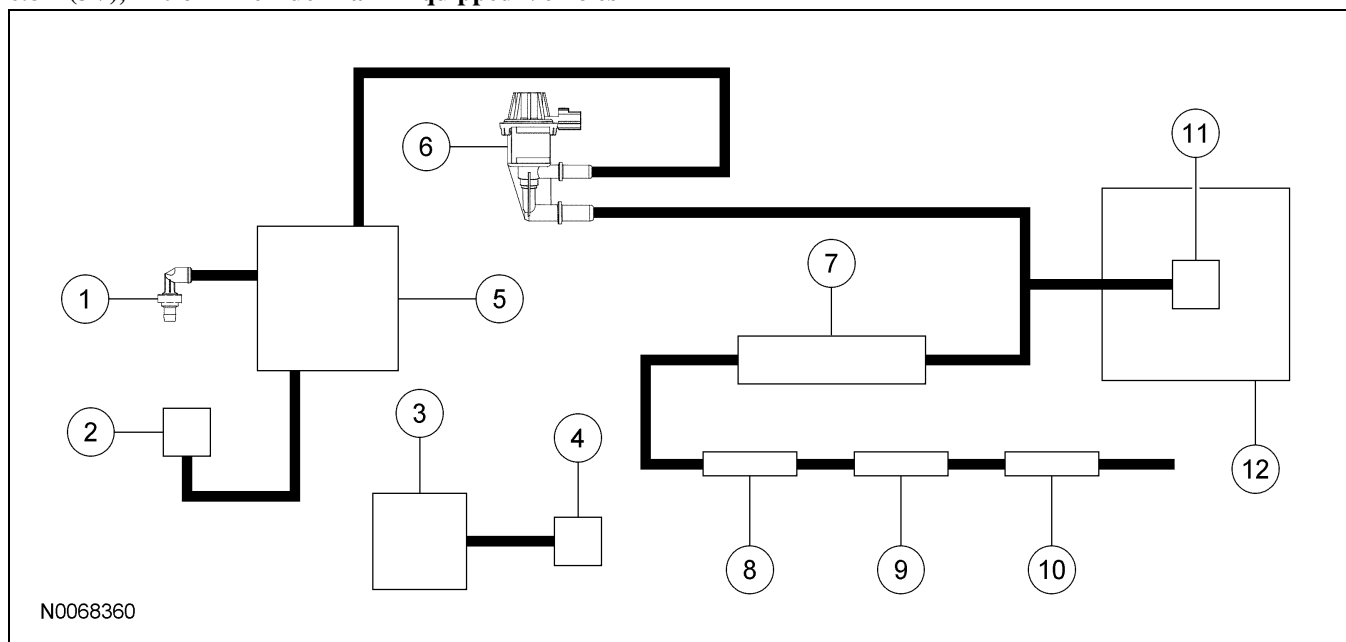
(Continued)

DESCRIPTION AND OPERATION (Continued)**6.8L (3V), Midship Fuel Tank Equipped Vehicles**

Item	Part Number	Description
1	6A505	LH valve cover
2	9G756	Fuel rail pressure and temperature sensor
3	6582	RH valve cover
4	9A589	Air cleaner outlet pipe
5	9Y451	Intake manifold
6	9C915	Evaporative emissions (EVAP) canister purge valve

Item	Part Number	Description
7	9E633	EVAP canister assembly
8	9034	Fuel filler pipe
9	—	Fuel vent valve
10	9C052	Fuel pressure sensor
11	9H307	Fuel pump (FP) module
12	—	Fuel vent valve
13	9K007	Midship fuel tank

(Continued)

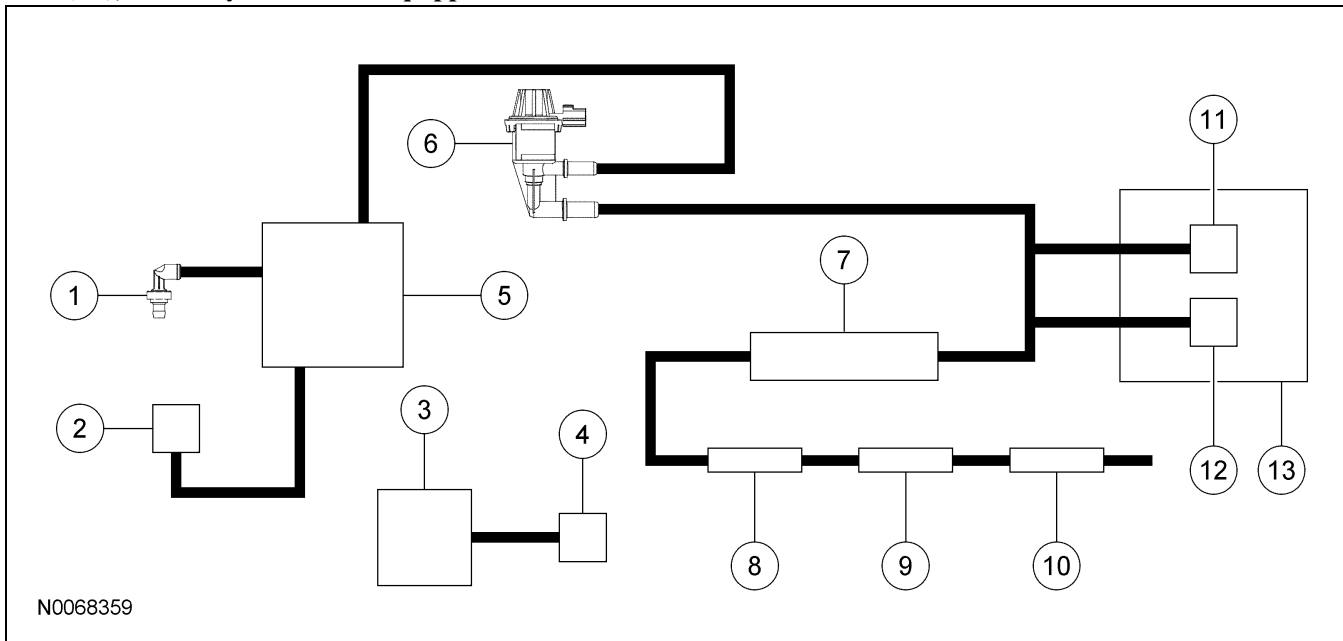
6.8L (3V), Aft-of-Axle Fuel Tank Equipped Vehicles

DESCRIPTION AND OPERATION (Continued)

Item	Part Number	Description
1	6A505	LH valve cover
2	9G756	Fuel rail pressure and temperature sensor
3	6582	RH valve cover
4	9A589	Air cleaner outlet pipe
5	9Y451	Intake manifold
6	9C915	Evaporative emissions (EVAP) canister purge valve

(Continued)

Item	Part Number	Description
7	9E633	EVAP canister assembly
8	9F675	EVAP filter assembly
9	9F945	EVAP canister vent solenoid
10	9B328	EVAP dust separator
11	—	Fuel vent valve
12	9K007	Aft-of-axle fuel tank

6.8L (3V), Auxiliary Fuel Tank Equipped Vehicles

Item	Part Number	Description
1	6A505	LH valve cover
2	9G756	Fuel rail pressure and temperature sensor
3	6582	RH valve cover
4	9A589	Air cleaner outlet pipe
5	9Y451	Intake manifold
6	9C915	Evaporative emissions (EVAP) canister purge valve

(Continued)

Item	Part Number	Description
7	9E633	EVAP canister assembly
8	9F675	EVAP filter assembly
9	9F945	EVAP canister vent solenoid
10	9B328	EVAP dust separator
11	—	Fuel vent valve
12	—	Fuel vent valve
13	9K007	Auxiliary fuel tank

DESCRIPTION AND OPERATION

Engine Emission Control — 6.4L Diesel

The EGR system includes:

- EGR valve and EGR housing
- Horizontal EGR cooler assembly
- Vertical EGR cooler assembly
- EGR oxidation catalytic converter (OC)

The EGR system reduces the peak combustion temperatures and oxides of Nitrogen (NOx). Due to emissions requirements the EGR is used in over 80% of engine operation modes.

The exhaust gas is fed from the turbo up pipes through the EGR OC. This EGR OC helps to reduce the formation of lacquer in the EGR system by converting the heavy hydrocarbons into dry soot. This helps to improve the effectiveness of the EGR coolers. Refer to Section 309-00.

The exhaust gas then enters the EGR coolers. The 6.4L has 2 coolers in series, in order to meet the exhaust gas cooling requirements. The EGR coolers are a shell-and tube-style heat exchanger.

The cooler EGR gas is then routed to the EGR valve that is mounted in the EGR housing. The EGR valve is used to control the amount of cooled exhaust gases that are introduced into the clean air stream.

REMOVAL AND INSTALLATION

Exhaust Gas Recirculation (EGR) Cooler — 6.4L Diesel, Horizontal Cooler

Removal and Installation

1. **NOTE:** The horizontal EGR cooler mounting clamps are one time use only, new clamps must be installed each time the clamp nuts are loosened or removed. The LH exhaust manifold bolts and gaskets are also one time use only. Since it is necessary to remove 4 of the LH exhaust manifold bolts to remove the horizontal EGR cooler mounting bracket, the LH exhaust manifold must also be removed to install new gaskets and bolts. For that reason, the EGR cooler removal steps are included in the LH exhaust manifold procedure.

Remove the LH exhaust manifold. For additional information, refer to Section 303-01C.

2. To install, reverse the removal procedure.
-

REMOVAL AND INSTALLATION

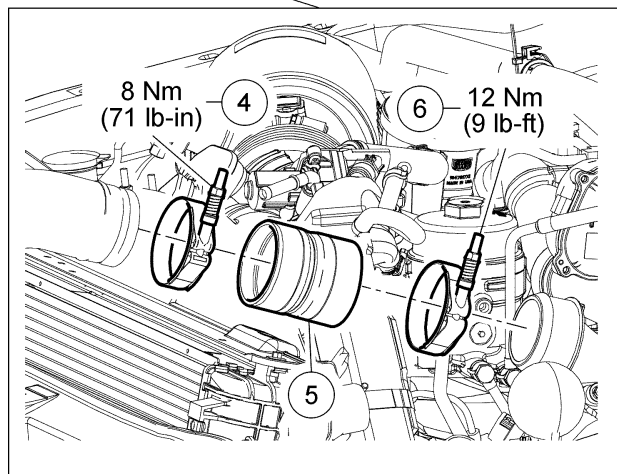
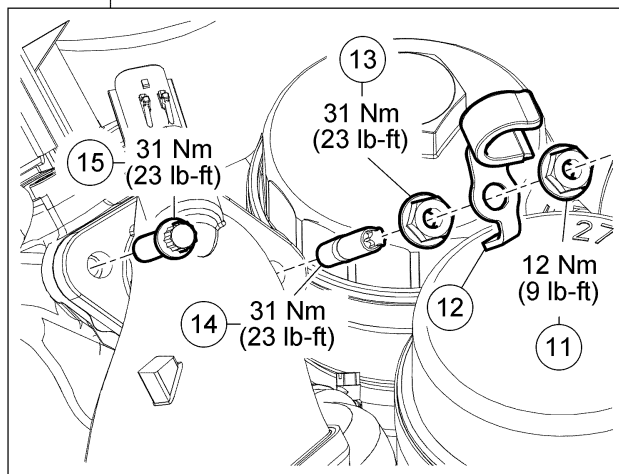
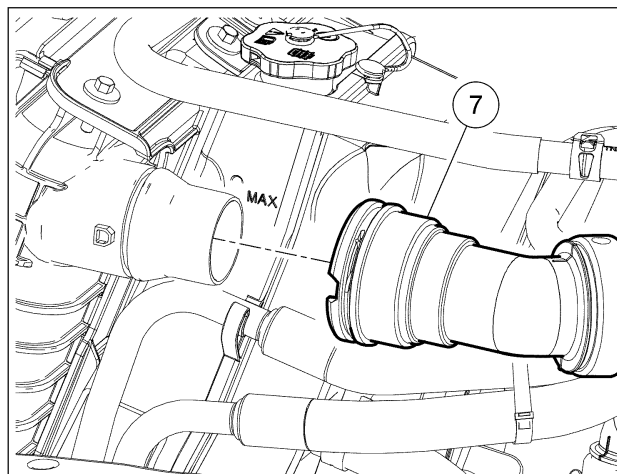
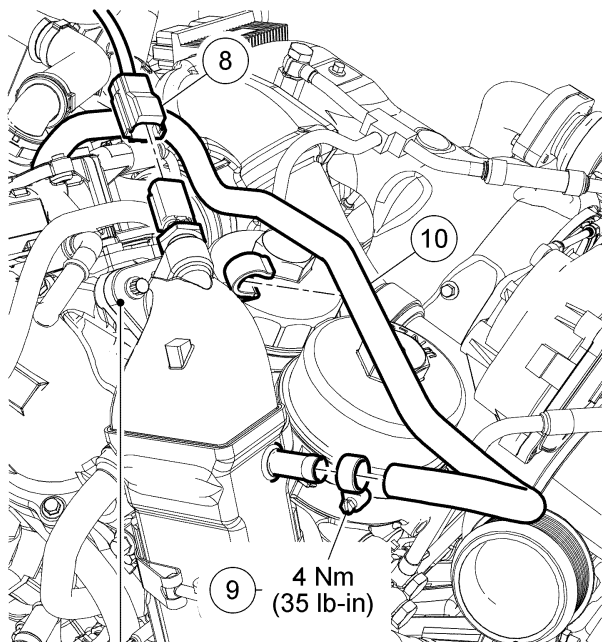
Exhaust Gas Recirculation (EGR) Cooler — 6.4L Diesel, Vertical Cooler



N0065197

Item	Part Number	Description
1	—	Fuel cooler tube
2	W701317	Power steering reservoir bolts (2 required)
3	3R700	Power steering reservoir

REMOVAL AND INSTALLATION (Continued)



N0069584

Item	Part Number	Description
4	—	LH charge air cooler (CAC) tube-to-CAC tube flex joint clamp
5	—	LH CAC tube flex joint
6	—	LH CAC tube flex joint-to-turbocharger clamp
7	—	Upper radiator hose quick connect coupling

(Continued)

Item	Part Number	Description
8	—	Exhaust gas recirculation temperature (EGRT) sensor outlet electrical connector (part of 12B637)
9	8287	EGR valve coolant supply hose clamp
10	9F466	EGR valve coolant supply hose
11	W302551	EGR cooler coolant hose position retainer nut

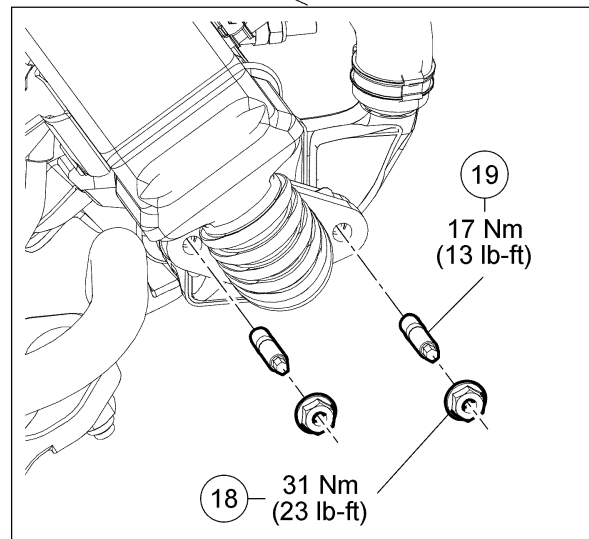
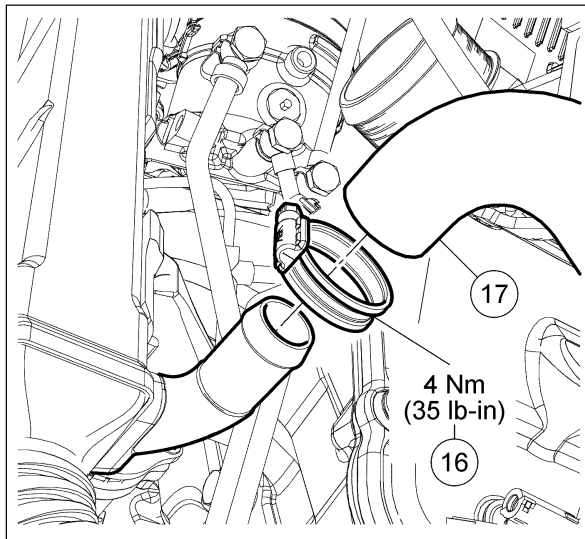
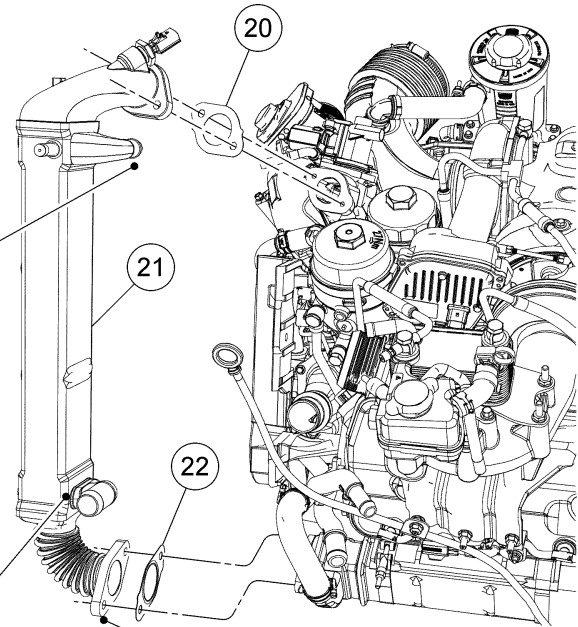
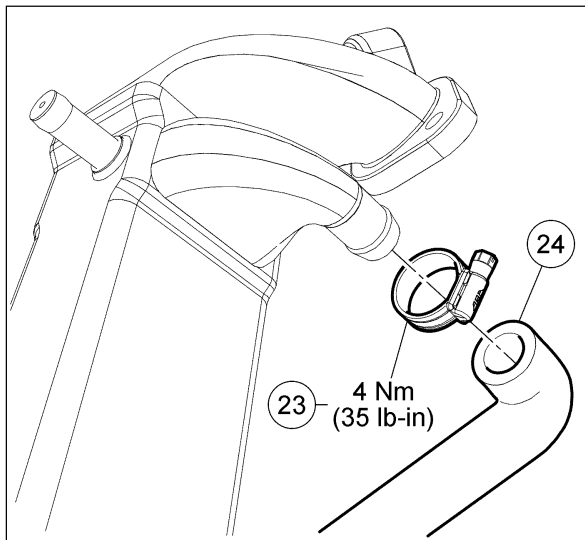
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REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
12	9L456	EGR cooler coolant hose position retainer
13	W302551	EGR cooler upper nut

(Continued)

Item	Part Number	Description
14	W302054	EGR cooler upper stud
15	W302651	EGR cooler upper bolt



N0069585

Item	Part Number	Description
16	8287	EGR cooler coolant inlet hose clamp
17	9F466	EGR cooler coolant inlet hose

(Continued)

Item	Part Number	Description
18	W300050	EGR cooler lower nut (2 required)
19	W302633	EGR cooler lower stud (2 required)

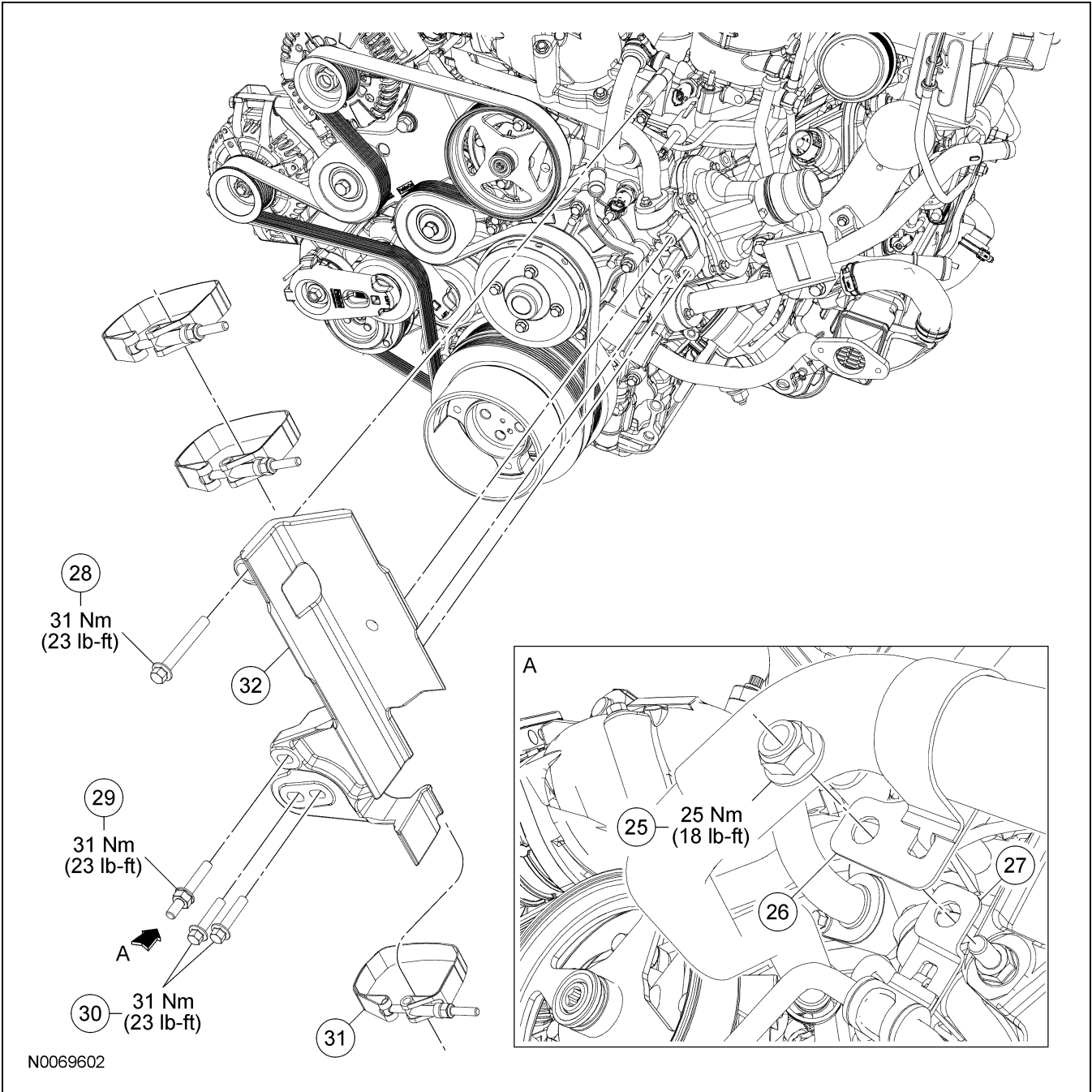
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REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
20	9E933	EGR cooler outlet gasket
21	9P456	EGR cooler (vertical)
22	9H454	EGR cooler inlet gasket
23	8287	EGR cooler coolant outlet hose clamp

Item	Part Number	Description
24	—	EGR cooler coolant outlet hose

(Continued)



REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
25	N601307	Power steering tube position retainer nut
26	—	Power steering tube position retainer
27	—	Power steering tube position retainer
28	W300006	EGR cooler support bracket upper bolt
29	W302054	EGR cooler support bracket stud
30	W300014	EGR cooler support bracket lower bolt (2 required)
31	9F488	EGR cooler support clamps (3 required)
32	9F465	EGR cooler support bracket

Removal

- Remove the degas bottle assembly. For additional information, refer to Section 303-03.
- Remove the spring clip and disconnect the upper radiator hose quick connect coupling.
- Disconnect the fuel cooler tube from the retainer on the power steering reservoir.
- Remove the 2 bolts and position the power steering reservoir aside.
- Loosen the charge air cooler (CAC) tube flex joint-to-turbocharger clamp and position the CAC tube aside.
- Remove the cooling fan stator. For additional information, refer to Section 303-03.
- Disconnect the exhaust gas recirculation temperature (EGRT) sensor outlet electrical connector.
- Disconnect the EGR valve coolant supply hose from the retainer and the EGR cooler.
- Remove the EGR cooler coolant hose position retainer nut and the coolant hose position retainer.
- Remove the EGR cooler upper nut and bolt.
- Remove the EGR cooler upper stud.
- Remove the EGR cooler lower 2 nuts, the 2 studs and the EGR cooler inlet gasket.
 - Discard the 2 studs and the EGR cooler inlet gasket.
- Remove the 3 nuts and separate the EGR cooler support clamps.
 - Before removing the nuts, mark the location of the clamps on the support bracket.
- Disconnect the EGR cooler coolant inlet hose and discard the clamp.
- Position aside the EGR cooler and disconnect the EGR cooler coolant outlet hose.
 - Discard the coolant outlet hose clamp.
- Remove the EGR cooler and discard the outlet gasket.
- Remove the power steering tube position retainers nut and position the power steering tubes aside.
- Remove the 2 EGR cooler support bracket lower bolts and the stud bolt.
- Remove the EGR cooler support bracket upper bolt and the EGR cooler support bracket.
 - Remove and discard the 3 EGR cooler support clamps.

Installation

- Position 3 new EGR cooler support clamps on the EGR cooler bracket.
- Position the EGR cooler bracket and install the 3 bolts and the stud bolt finger-tight.
- NOTE:** Do not tighten the clamps for the EGR cooler at this time.
Position the EGR cooler and using a new clamp, connect the EGR cooler coolant outlet hose and loosely install the EGR cooler clamp nuts.
- Using a new clamp, connect the EGR cooler coolant inlet hose and tighten the inlet and outlet hose clamps.
 - Tighten to 4 Nm (35 lb-in).

REMOVAL AND INSTALLATION (Continued)

5. Using a new EGR cooler outlet gasket, position the gasket and install the EGR cooler upper stud.
 - Tighten to 31 Nm (23 lb-ft).
 6. Install the EGR cooler upper nut and bolt finger-tight.
 7. Using a new EGR cooler inlet gasket, install the lower gasket and the EGR cooler lower 2 studs.
 - Tighten to 17 Nm (13 lb-ft).
 8. Install the EGR cooler lower retaining nuts finger-tight.
 9. **NOTE:** Make sure to locate the EGR cooler clamps at the marked locations on the support bracket.

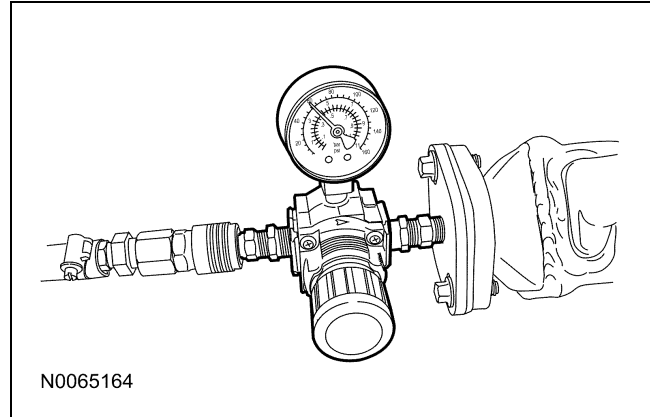
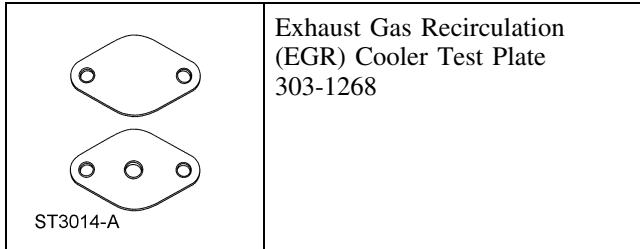
Position the EGR cooler clamps and tighten the 3 clamp nuts.

 - Tighten to 9 Nm (80 lb-in).
 - Loosen the clamps 720 degrees.
 - Tighten to 7 Nm (62 lb-in).
 10. Tighten the EGR cooler support bracket lower 2 bolts.
 - Tighten to 31 Nm (23 lb-ft).
 11. Tighten the EGR cooler support bracket upper bolt and the lower stud bolt.
 - Tighten to 31 Nm (23 lb-ft).
 12. Position back the 2 power steering tube position retainers and install the nut.
 - Tighten to 25 Nm (18 lb-ft).
 13. Tighten the EGR cooler upper nut and bolt.
 - Tighten to 31 Nm (23 lb-ft).
 14. Tighten the 2 EGR cooler lower nuts.
 - Tighten to 31 Nm (23 lb-ft).
 15. Install the EGR valve coolant supply hose position retainer and the nut.
 - Tighten to 12 Nm (9 lb-ft).
 16. Using a new clamp, connect the EGR valve coolant supply hose.
 - Tighten to 4 Nm (35 lb-in).
 17. Connect the EGRT sensor electrical connector.
 18. Install the cooling fan stator. For additional information, refer to Section 303-03.
 19. Position back the CAC tube and tighten the clamp.
 - Tighten to 8 Nm (71 lb-in).
 20. Position back the power steering reservoir and install the 2 bolts.
 - Tighten to 8 Nm (71 lb-in).
 21. Connect the fuel cooler tube to the retainer on the power steering reservoir.
 22. Install the spring clip and connect the upper radiator hose quick connect coupling.
 23. Install the degas bottle assembly. For additional information, refer to Section 303-03.
-

GENERAL PROCEDURES

Exhaust Gas Recirculation (EGR) Cooler Leak Test

Special Tool(s)

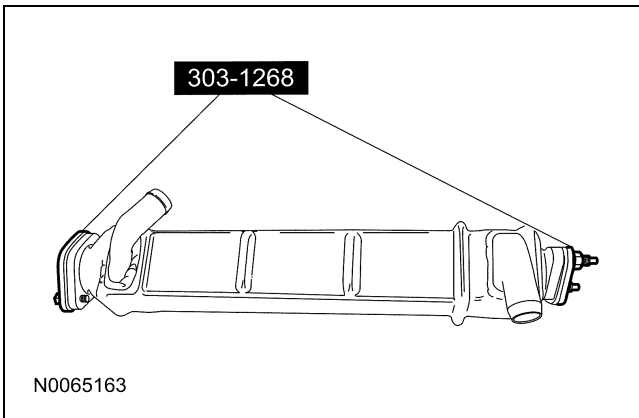


1. **NOTE:** The original cooler mounting fasteners can be used, or M8 fasteners may be procured locally.

Using 4 M8 bolts and nuts, install the special tools to each end of the EGR cooler.

- Tighten the 4 nuts to 31 Nm (23 lb-ft).

3. Completely submerge the EGR cooler in water. Inspect for air bubbles coming from the coolant passages.
4. Return the EGR cooler assembly to service if no leaks are detected. If leaks are detected, install a new EGR cooler assembly.



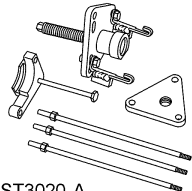

2. **⚠ CAUTION: Do not exceed 207 kPa (30 psi) at any time, excessive pressure can damage the exhaust gas recirculation (EGR) cooler.**

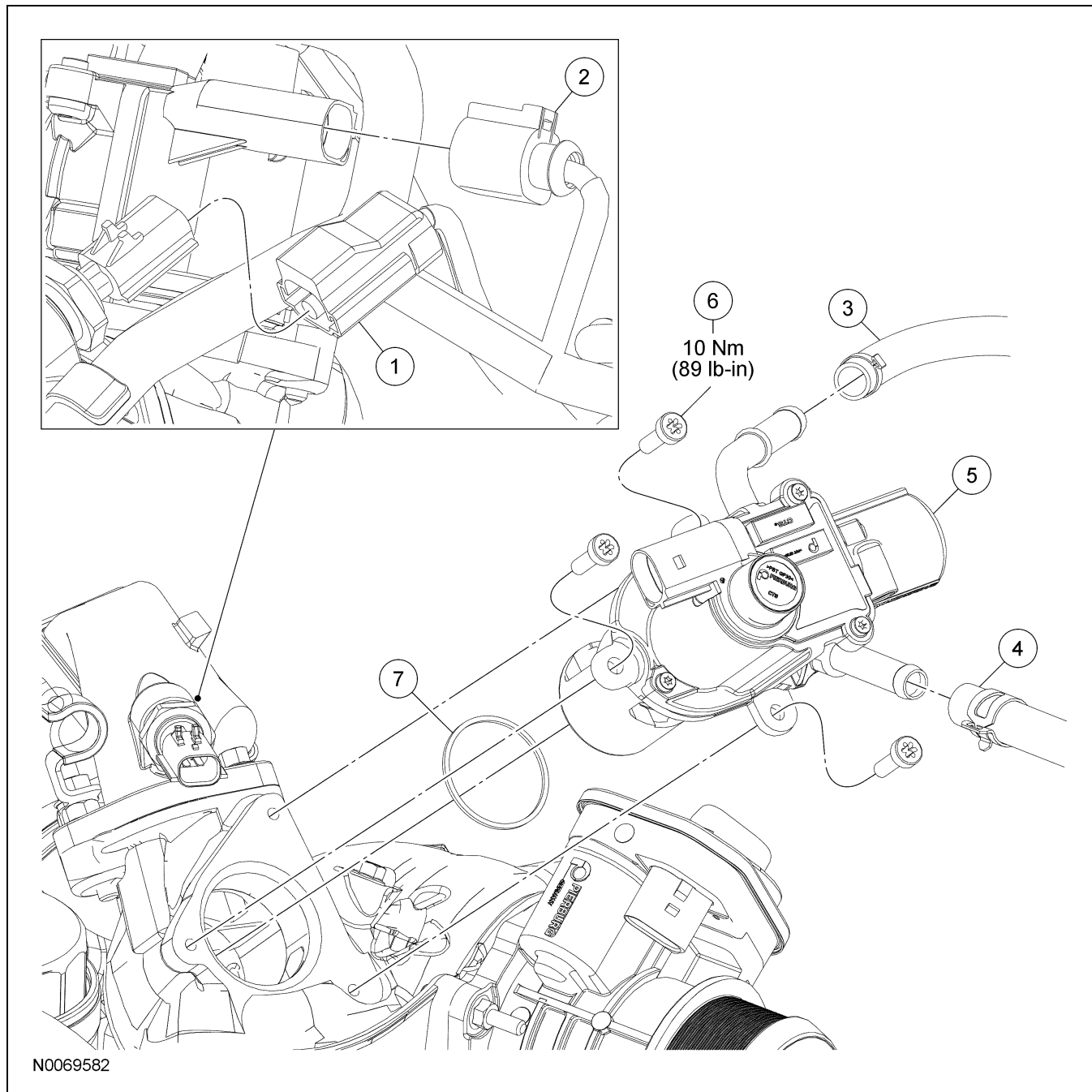
Connect a regulated air supply and slowly adjust the air pressure until 207 kPa (30 psi) is reached, then shut off the air supply.

REMOVAL AND INSTALLATION

Exhaust Gas Recirculation (EGR) Valve — 6.4L Diesel

Special Tool(s)

 <p>ST3020-A</p>	Exhaust Gas Recirculation (EGR) Valve Puller 303-1267
 <p>ST3018-A</p>	Exhaust Gas Recirculation (EGR) Brush 303-1258


REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	—	Exhaust gas recirculation temperature (EGRT) sensor outlet electrical connector (part of 12B637)
2	—	EGR valve electrical connector (part of 12B637)
3	—	Coolant outlet hose
4	9F466	Coolant inlet hose
5	9D475	EGR valve
6	W302552	EGR valve bolt (3 required)
7	9F949	EGR valve O-ring seal

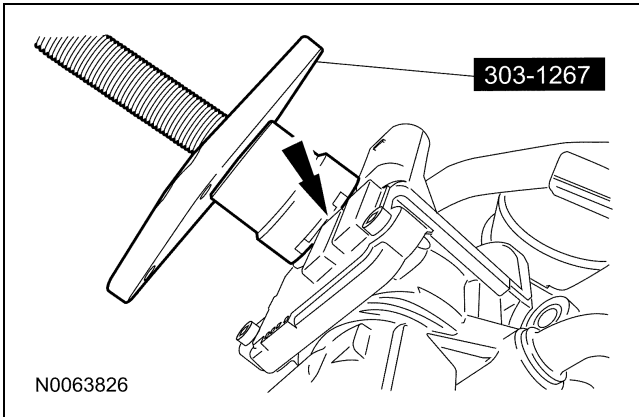
Removal


1. Drain the engine cooling system. For additional information, refer to Section 303-03.
2. Disconnect the exhaust gas recirculation temperature (EGRT) sensor outlet and the EGR valve electrical connectors.
3. Disconnect the coolant inlet and outlet hoses and position aside.
4. Remove the bolts for the EGR valve.

REMOVAL AND INSTALLATION (Continued)

5.  **CAUTION:** Position the notch in the tool over the raised area on the top of the exhaust gas recirculation (EGR) valve, or damage to the EGR valve can occur.

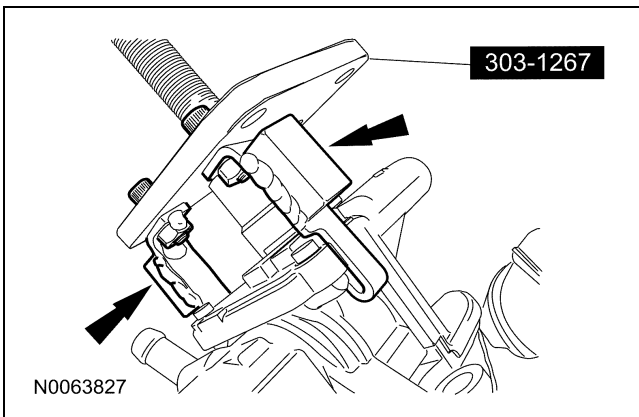
Position the special tool on top of the EGR valve.



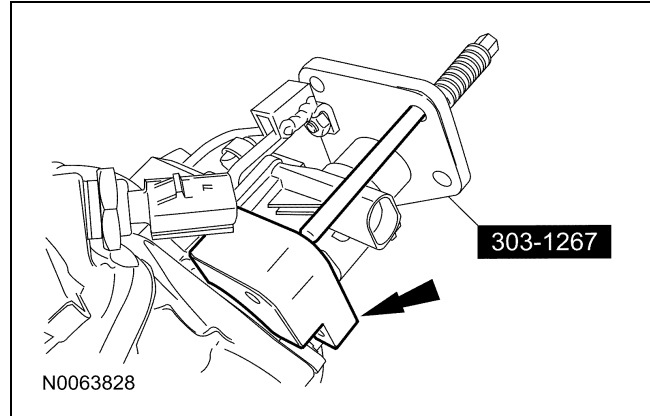
6.  **CAUTION:** Make sure that the special tool hooks are positioned on the exhaust gas recirculation (EGR) valve body as shown, or damage to the EGR valve can occur.

NOTE: The hooks are labeled RH and LH for correct placement. Make sure they are installed in correct location.

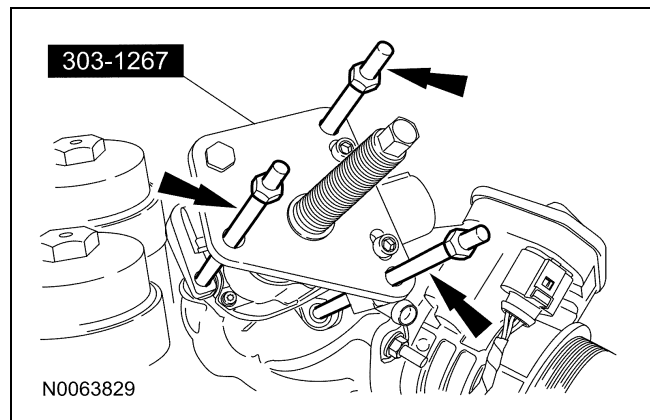
Using the Allen-head bolts supplied with the special tool, install the hooks on the middle plate of the special tool and position the hooks on the EGR valve body as shown.



7. Position the special tool lower plate below the flange on the valve body and install the bolt to attach it to the middle plate of the special tool.



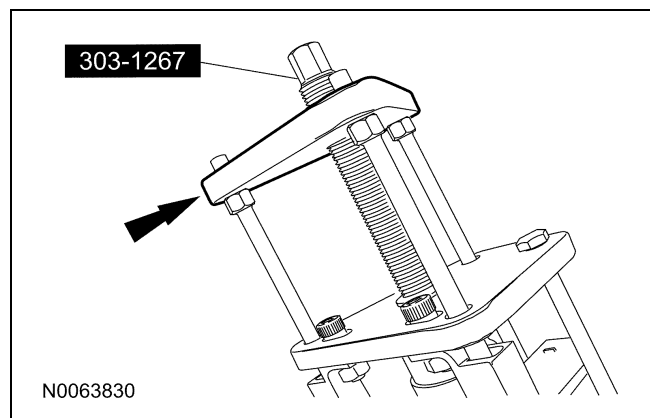
8. Insert the 3 rods through the middle plate of the special tool. The front 2 rods will pass through the hooks, the rear rod also passes through the special tool lower plate. Thread the rods into the EGR valve bolt holes.



9. **NOTE:** The special tool has LH thread.

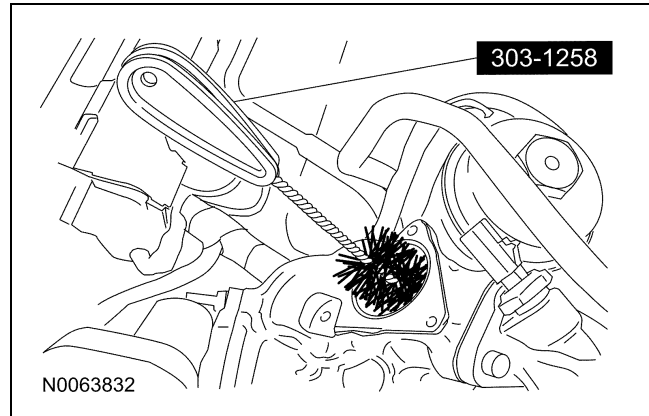
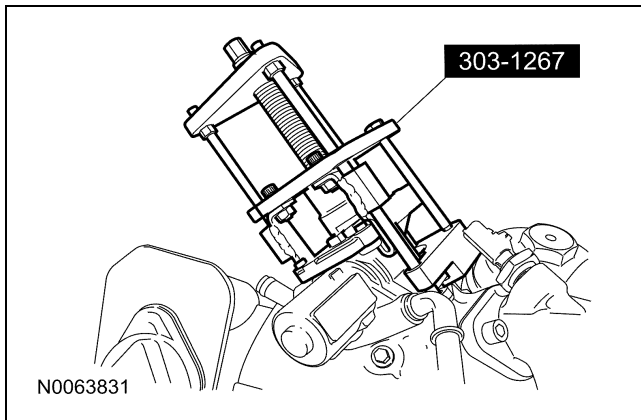
Install the special tool top plate and run the top plate down until it sits on the support rod nuts.

- It may be necessary to adjust the support rods so that the plate sits squarely on top of the nuts.



REMOVAL AND INSTALLATION (Continued)

10. **NOTE:** The special tool has LH thread.
- Using the special tool, remove the EGR valve.
- Discard the O-ring seal.

**Installation**

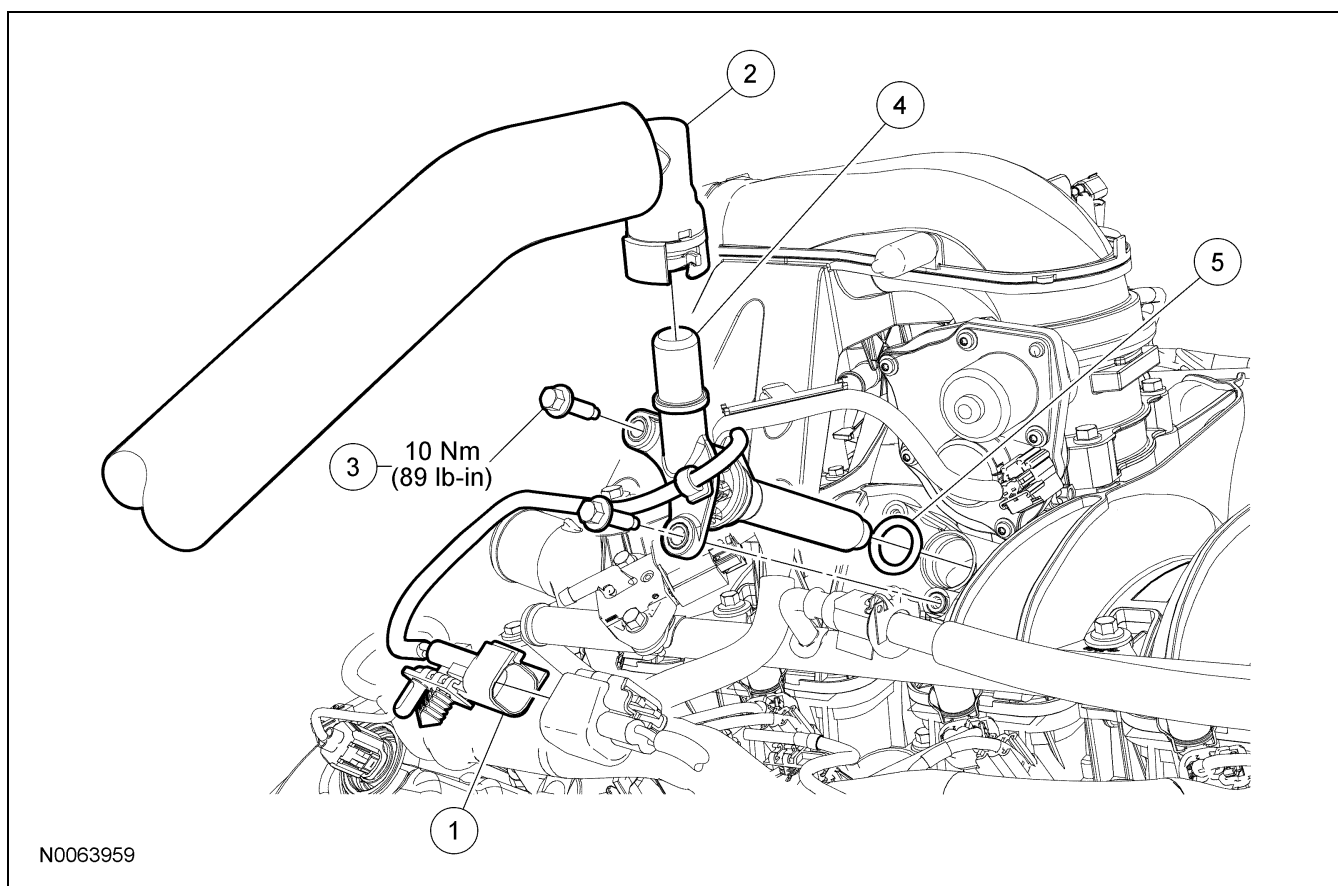
1. Using a new O-ring seal, install the EGR valve and the 3 bolts.
 - Tighten to 10 Nm (89 lb-in).
2. Connect the coolant inlet and outlet hoses.
3. Connect the EGRT sensor outlet and the EGR valve electrical connectors.
4. Fill and bleed the engine cooling system. For additional information, refer to Section 303-03.

REMOVAL AND INSTALLATION

Positive Crankcase Ventilation (PCV) Heater Element — 5.4L

Material

Item	Specification
Motorcraft SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP (US); Motorcraft SAE 5W-20 Super Premium Motor Oil CXO-5W20-LSP12 (Canada); or equivalent	WSS-M2C930-A



Item	Part Number	Description
1	—	PCV heater element electrical connector (part of 12B637)
2	6K817	PCV tube
3	W701724	PCV heater element bolt (2 required)
4	9F695	PCV heater element
5	9K540	PCV heater element O-ring seal

Removal

1. Disconnect the PCV heater element electrical connector.
2. Disconnect the quick connect couplings and remove the PCV tube. For additional information, refer to Section 310-00.

REMOVAL AND INSTALLATION (Continued)

3. Remove the 2 bolts and the PCV heater element.
 - Discard the O-ring seal.
2. Position the PCV tube and connect the quick connect couplings. For additional information, refer to Section 310-00.

Installation

1. **NOTE:** Lubricate the O-ring seal with clean engine oil prior to installation.
Using a new O-ring seal, install the PCV heater element and the bolt.
 - Tighten to 10 Nm (89 lb-in).
-

3. Connect the PCV heater element electrical connector.

2008 Ford F-350 SUPER DUTY

Submodel: XLT | Engine Type: V8 | Liters: 5.4
Fuel Delivery: FI | Fuel: GAS


SECTION 303-08:
Engine Emission Control


SPECIFICATIONS
DESCRIPTION AND OPERATION
Engine Emission Control — 5.4L (3V), 6.8L (3V)
Engine Emission Control — 6.4L Diesel
DIAGNOSIS AND TESTING
Engine Emission Control
GENERAL PROCEDURES
Exhaust Gas Recirculation (EGR) Cooler Leak Test
REMOVAL AND INSTALLATION
Positive Crankcase Ventilation (PCV) Heater Element — 5.4L
Exhaust Gas Recirculation (EGR) Valve — 6.4L Diesel
Exhaust Gas Recirculation (EGR) Cooler — 6.4L Diesel, Vertical Cooler
Exhaust Gas Recirculation (EGR) Cooler — 6.4L Diesel, Horizontal Cooler
Crankcase Vent Oil Separator — 6.4L Diesel

REMOVAL AND INSTALLATION

Dust Separator

Removal and Installation

 **WARNING:** When working on or near the evaporative emission (EVAP) system, disconnect the battery ground cable from the battery. The EVAP system contains fuel vapor and condensed fuel vapor, so an electrical spark may cause a fire or explosion. Failure to follow this instruction may result in serious personal injury.

 **WARNING:** Do not smoke, carry lighted tobacco or have an open flame of any type when working on or near any fuel-related component. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in serious personal injury.

NOTE: Some vehicles come equipped with a steel fuel tank that is mounted midship. This fuel tank is referred to as an auxiliary fuel tank.

Midship fuel tank equipped vehicles

1. **NOTE:** The evaporative emission (EVAP) canister vent solenoid and dust separator are an assembly. This assembly is removed with the EVAP canister vent solenoid.

Refer to Evaporative Emission Canister Vent Solenoid in this section.

Aft-of-axle and auxiliary fuel tank equipped vehicles

2. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
3. Disconnect the battery ground cable. For additional information, refer to Section 414-01.
4. Disconnect the EVAP canister vent solenoid electrical connector.
5. Disconnect the fuel tank vapor tube-to-EVAP canister assembly quick connect coupling. For additional information, refer to Section 310-00.

6. Disconnect the fuel vapor vent hose from the dust separator.

Aft-of-axle fuel tank equipped vehicles

7. Disconnect the fuel pump driver module (FPDM) electrical connector from the fuel pump driver module.

Aft-of-axle and auxiliary fuel tank equipped vehicles

8. Remove the 4 bolts and the EVAP canister and bracket assembly.
 - To install, tighten to 17 Nm (13 lb-ft).
9. Place the EVAP canister and bracket assembly on a clean work surface.

Aft-of-axle fuel tank equipped vehicles

10. Disconnect the dust separator hose.
11. Remove the dust separator from the EVAP canister bracket assembly.

Auxiliary fuel tank equipped vehicles

12. Disconnect the EVAP filter assembly-to-EVAP canister assembly tube quick connect coupling at the EVAP canister assembly. For additional information, refer to Section 310-00.
13. Remove the EVAP canister assembly.
14. Disconnect the dust separator hoses.
15. Remove the dust separator from the EVAP canister bracket assembly.

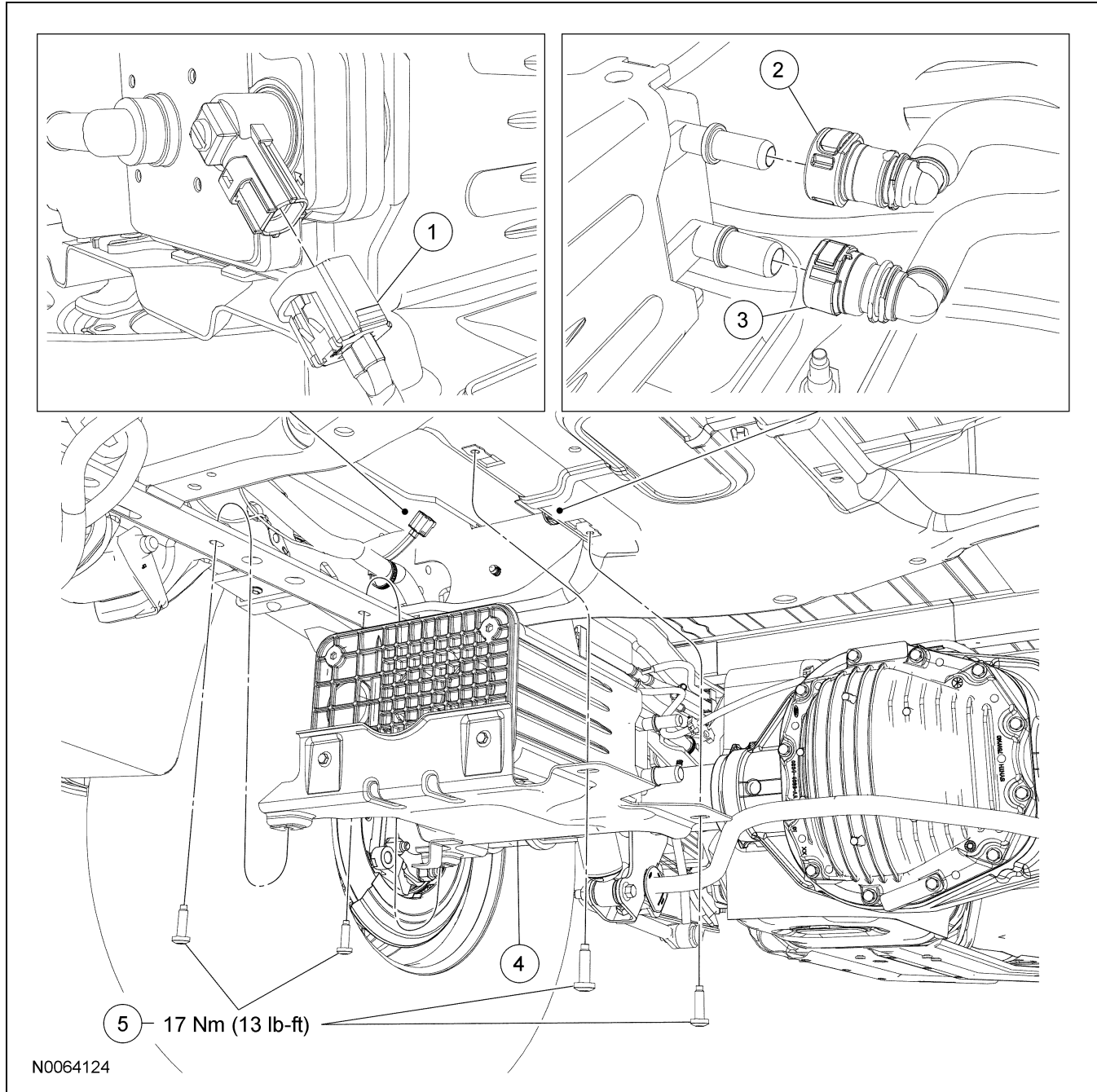
REMOVAL AND INSTALLATION (Continued)**Aft-of-axle and auxiliary fuel tank equipped vehicles**

16. To install, reverse the removal procedure.
- Carry out the EVAP system leak test. For additional information, refer to Evaporative Emission System Leak Test in this section.
 - Carry out the EVAP repair verification drive cycle. For additional information, refer to Evaporative Emission Repair Verification Drive Cycle in this section.
-

REMOVAL AND INSTALLATION

Evaporative Emission (EVAP) System Components — Exploded View

Midship Fuel Tank Equipped Vehicles

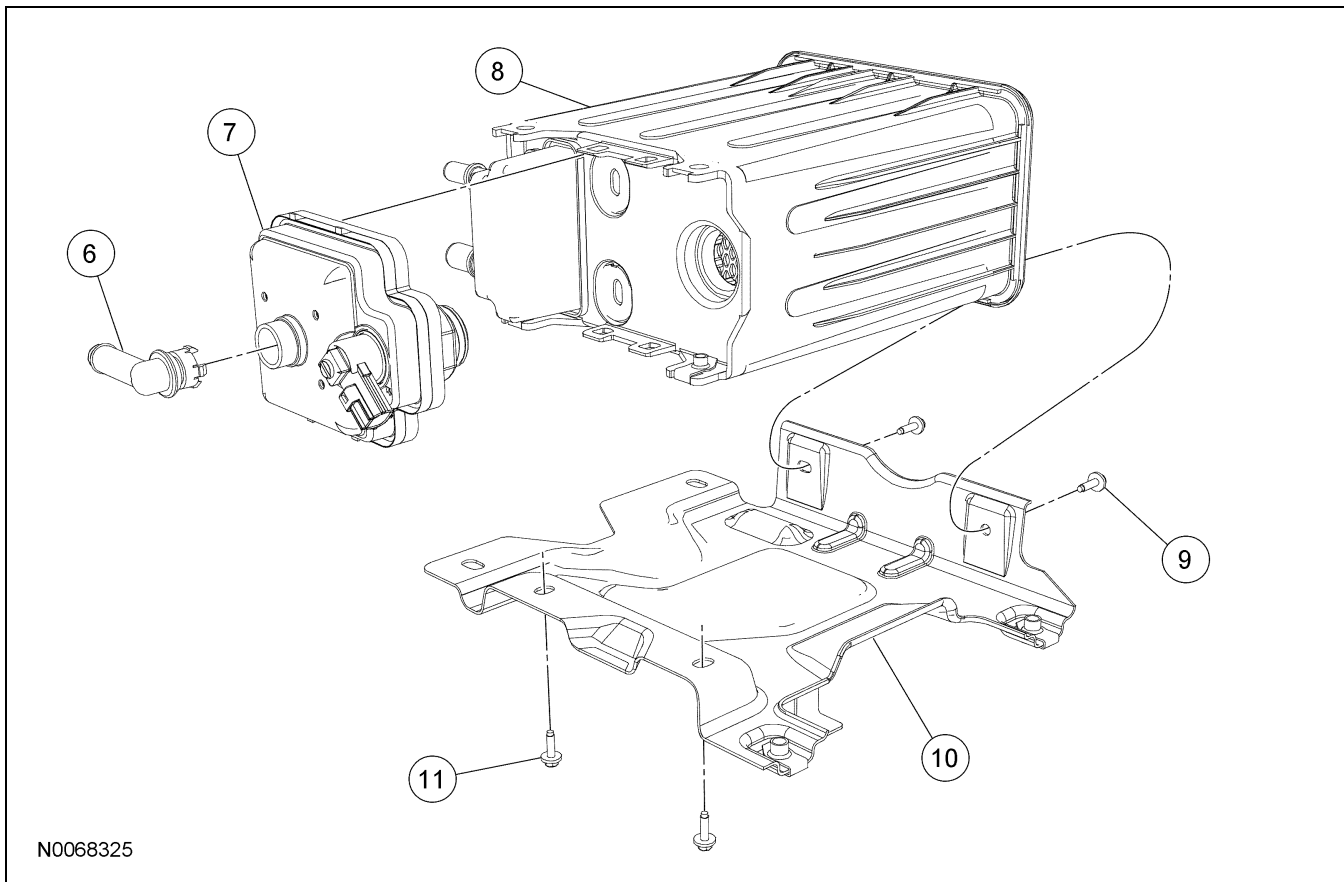


REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	—	Evaporative emissions (EVAP) canister vent solenoid electrical connector (part of 14405)
2	—	EVAP canister purge valve vapor tube-to-evaporative emissions (EVAP) canister assembly quick connect coupling (part of 9S278)

Item	Part Number	Description
3	—	Fuel tank vapor tube-to-EVAP canister assembly quick connect coupling (part of 9S278)
4	9E857	EVAP canister and bracket assembly
5	W505594	EVAP canister assembly bracket bolts (4 required)

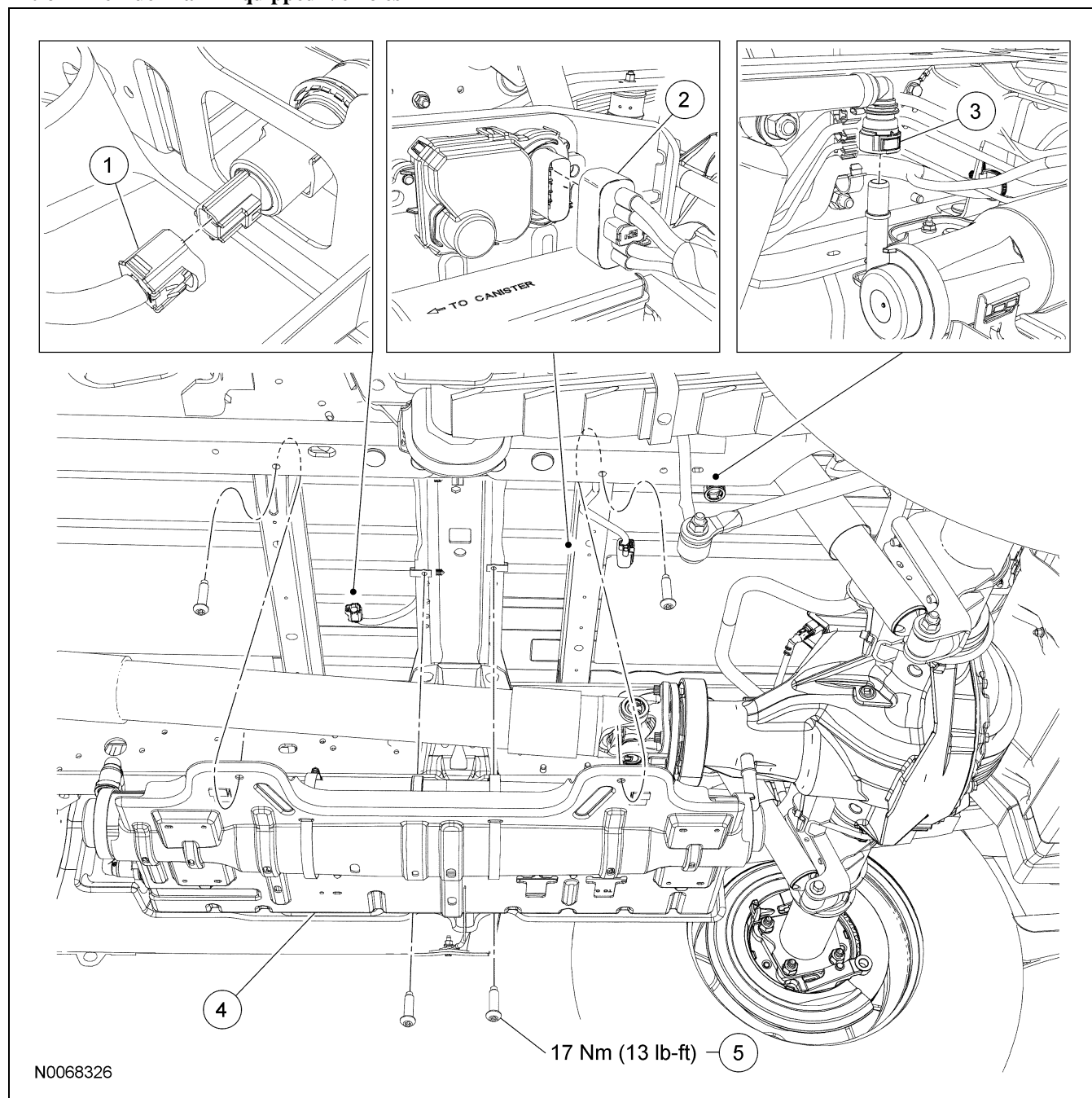
(Continued)



Item	Part Number	Description
6	9E629	EVAP canister vent solenoid and dust separator assembly tube
7	9B328	EVAP canister vent solenoid and dust separator assembly
8	9D653	EVAP canister assembly
9	9R543	EVAP canister assembly-to-bracket screw (2 required)

(Continued)

Item	Part Number	Description
10	9E817	EVAP canister assembly bracket
11	W500213	EVAP canister assembly-to-bracket bolt (2 required)

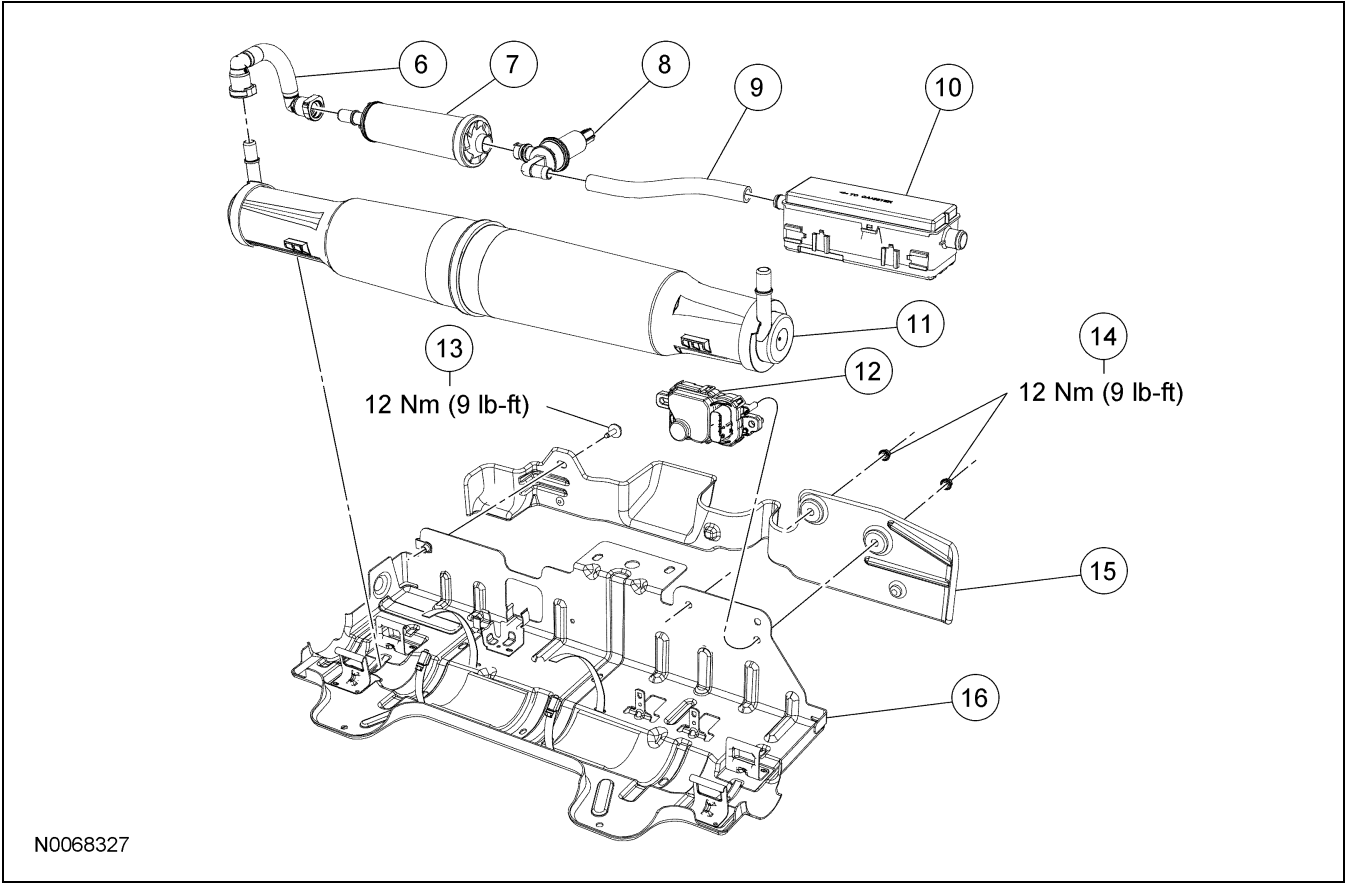
REMOVAL AND INSTALLATION (Continued)**Aft-of-Axle Fuel Tank Equipped Vehicles**

Item	Part Number	Description
1	—	Evaporative emission (EVAP) canister vent solenoid electrical connector (part of 14405)
2	—	Fuel pump driver module (FPDM) electrical connector (part of 14405)

(Continued)

Item	Part Number	Description
3	—	Fuel tank vapor tube-to-EVAP canister assembly quick connect coupling (part of 9S278)
4	9E857	EVAP canister and bracket assembly
5	W505594	EVAP canister assembly bracket bolt (4 required)

REMOVAL AND INSTALLATION (Continued)



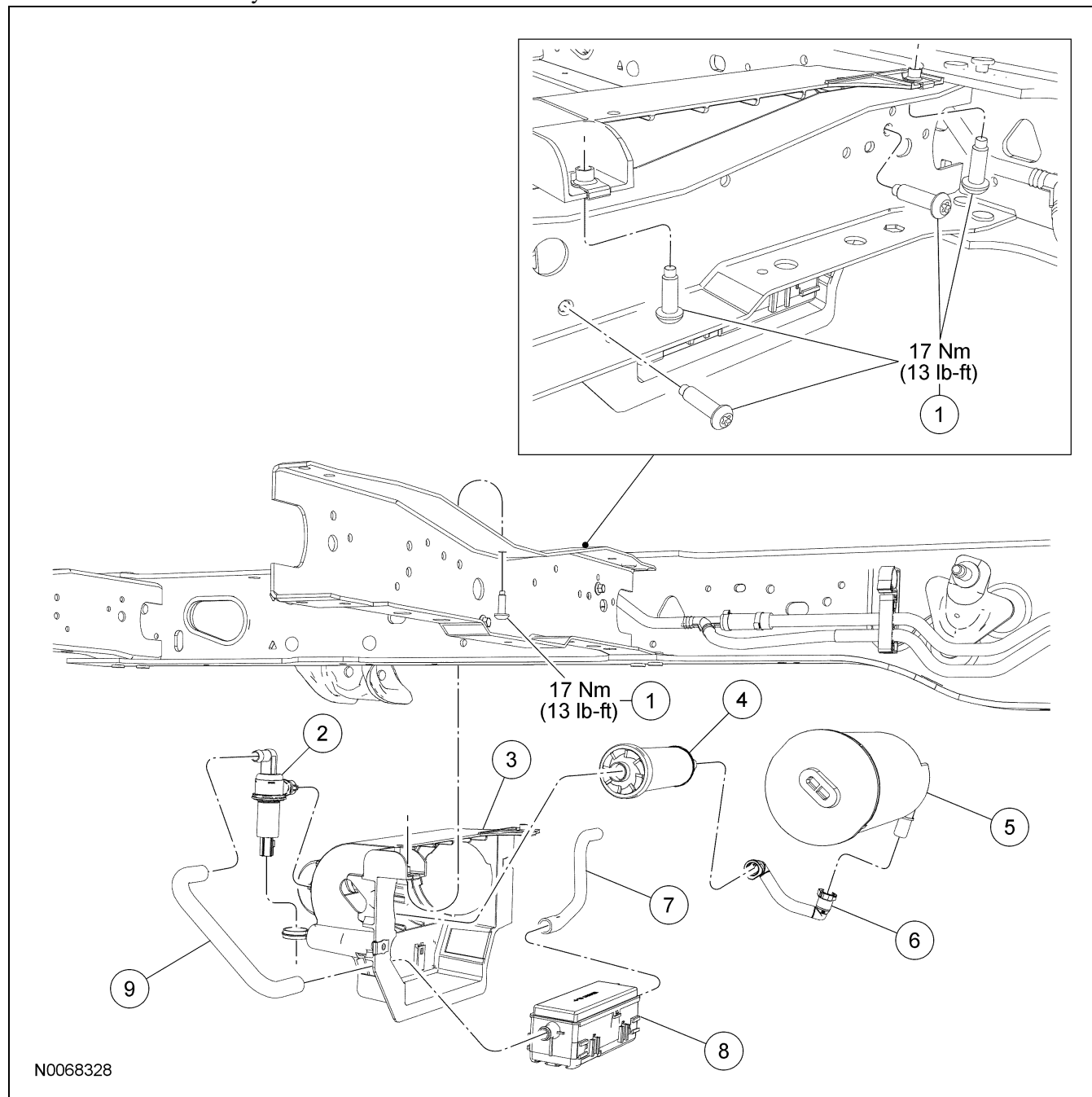
Item	Part Number	Description
6	9K318	EVAP filter assembly-to-EVAP canister tube
7	9F675	EVAP filter assembly
8	9F945	EVAP canister vent solenoid
9	9K324	EVAP dust separator-to-EVAP canister vent solenoid hose
10	9B328	EVAP dust separator
11	9D653	EVAP canister assembly (primary and bleed)

(Continued)

Item	Part Number	Description
12	9D372	FPDM
13	N811155	EVAP canister and bracket assembly heat shield bolt
14	W709361	FPDM nuts (2 required)
15	9G752	EVAP canister and bracket assembly heat shield
16	9D665	EVAP canister assembly bracket

REMOVAL AND INSTALLATION (Continued)**Auxiliary Fuel Tank Equipped Vehicles**

NOTE: Some vehicles come equipped with a steel fuel tank that is mounted midship. This fuel tank is referred to as an auxiliary fuel tank.



Item	Part Number	Description
1	W505594	Evaporative emission (EVAP) canister assembly bracket bolts (4 required)
2	9F945	EVAP canister vent solenoid
3	9D665	EVAP canister assembly bracket
4	9F675	EVAP filter assembly

(Continued)

Item	Part Number	Description
5	9C985	EVAP canister assembly
6	9K318	EVAP filter assembly-to-EVAP canister tube
7	9K324	EVAP dust separator hose
8	9B328	EVAP dust separator

(Continued)

REMOVAL AND INSTALLATION (Continued)


Item	Part Number	Description
9	9K324	EVAP dust separator-to-EVAP canister vent solenoid hose


1. For additional information, refer to the procedures in this section.

REMOVAL AND INSTALLATION

Evaporative Emission Canister

Removal

 **WARNING:** When working on or near the evaporative emission (EVAP) system, disconnect the battery ground cable from the battery. The EVAP system contains fuel vapor and condensed fuel vapor, so an electrical spark may cause a fire or explosion. Failure to follow this instruction may result in serious personal injury.

 **WARNING:** Do not smoke, carry lighted tobacco or have an open flame of any type when working on or near any fuel-related component. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in serious personal injury.

NOTE: Some vehicles come equipped with a steel fuel tank that is mounted midship. This fuel tank is referred to as an auxiliary fuel tank.

All vehicles

1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
2. Disconnect the battery ground cable. For additional information, refer to Section 414-01.

Midship fuel tank equipped vehicles

3. **NOTE:** The midship fuel tank evaporative emissions (EVAP) canister and bracket assembly is located above the spare tire. Removal of the spare tire is required to remove the midship fuel tank EVAP canister and bracket assembly.

Disconnect the EVAP canister purge valve vapor tube-to-EVAP canister assembly quick connect coupling and fuel tank vapor tube-to-EVAP canister assembly quick connect coupling. For additional information, refer to Section 310-00.

All vehicles

4. Disconnect the EVAP canister vent solenoid electrical connector.

Aft-of-axle and auxiliary fuel tank equipped vehicles

5. Disconnect the fuel tank vapor tube-to-EVAP canister assembly quick connect coupling. For additional information, refer to Section 310-00.
6. Disconnect the fuel vapor vent hose from the dust separator.
7. If necessary, disconnect the fuel pump driver module (FPDM) electrical connector from the fuel pump driver module.

All vehicles

8. Remove the 4 bolts and the EVAP canister and bracket assembly.
9. Place the EVAP canister and bracket assembly on a clean work surface.

Midship fuel tank equipped vehicles

10. Remove the canister vent solenoid and dust separator assembly from the EVAP canister assembly.
11. Remove the 2 EVAP canister assembly-to-EVAP canister assembly bracket bolts.
12. Remove the 2 EVAP canister assembly-to-EVAP canister assembly bracket screws.

Aft-of-axle and auxiliary fuel tank equipped vehicles

13. If necessary, remove the clamps from the EVAP canister assembly.
14. Disconnect the EVAP filter assembly-to-EVAP canister assembly tube quick connect coupling. For additional information, refer to Section 310-00.


REMOVAL AND INSTALLATION (Continued)

15. Remove the EVAP canister assembly from the EVAP canister assembly bracket.

Installation**Aft-of-axle and auxiliary fuel tank equipped vehicles**

1. Position the EVAP canister into the EVAP canister bracket.
2. Connect the EVAP filter assembly-to-EVAP canister assembly tube quick connect coupling. For additional information, refer to Section 310-00.
3. If necessary, install the clamp around the EVAP canister.

Midship fuel tank equipped vehicles

 **CAUTION: Install the evaporative emission (EVAP) canister-to-EVAP canister assembly bracket screws before installing the EVAP canister-to-EVAP canister assembly bracket bolts or damage to the EVAP canister will occur.**

4. Install the 2 EVAP canister assembly-to-EVAP canister assembly bracket screws.
 - Tighten to 6 Nm (53 lb-in).
5. Install the 2 EVAP canister assembly-to-EVAP canister assembly bracket bolts.
 - Tighten to 6 Nm (53 lb-in).
6. Install the EVAP canister vent solenoid and dust separator assembly to the EVAP canister assembly.

All vehicles

7. Install the EVAP canister and bracket assembly into the vehicle and install the 4 bolts.
 - Tighten to 17 Nm (13 lb-ft).

Aft-of-axle and auxiliary fuel tank equipped vehicles

8. If disconnected, connect the FPDM electrical connector to the FPDM.
9. Connect the fuel vapor vent hose to the dust separator.
10. Connect the fuel tank vapor tube-to-EVAP canister assembly quick connect coupling. For additional information, refer to Section 310-00.

All vehicles

11. Connect the EVAP canister vent solenoid electrical connector.

Midship fuel tank equipped vehicles

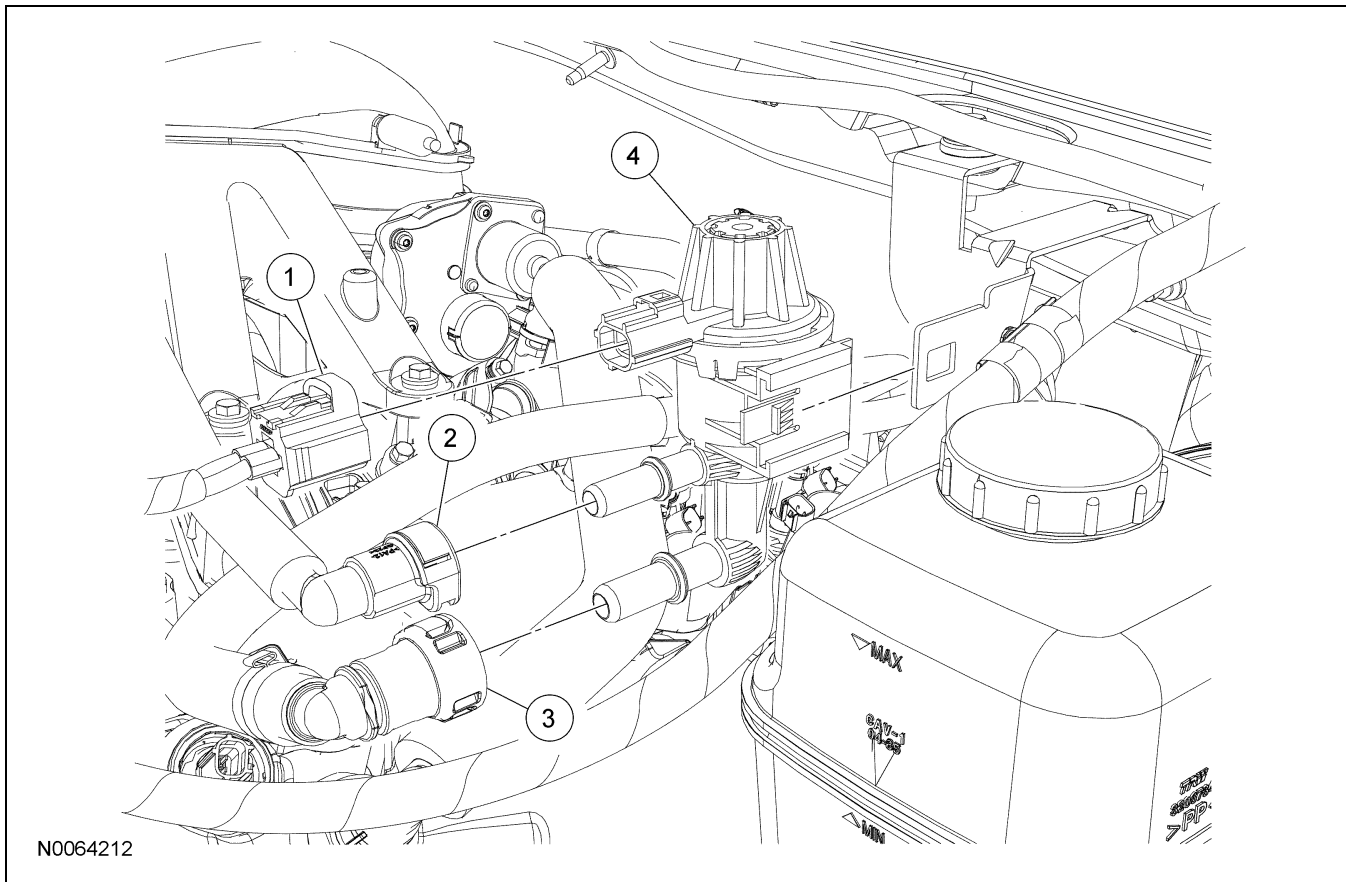
12. Connect the EVAP canister purge valve vapor tube-to-EVAP canister assembly quick connect coupling and fuel tank vapor tube-to-EVAP canister assembly quick connect coupling. For additional information, refer to Section 310-00.
13. Connect the battery ground. For additional information, refer to Section 414-01.

All vehicles

14. Carry out the EVAP system leak test. For additional information, refer to Evaporative Emission System Leak Test in this section.
15. Carry out the EVAP repair verification drive cycle. For additional information, refer to Evaporative Emission Repair Verification Drive Cycle in this section.

REMOVAL AND INSTALLATION

Evaporative Emission Canister Purge Valve



Item	Part Number	Description
1	—	Evaporative emission (EVAP) canister purge valve electrical connector (part of 12A581)
2	—	Intake manifold-to-EVAP canister purge valve fuel vapor tube quick connect coupling (part of 9D289)
3	—	EVAP canister assembly-to-EVAP canister purge valve fuel vapor tube quick connect coupling (part of 9J338)
4	9C915	EVAP canister purge valve

Removal and Installation

⚠ WARNING: When working on or near the evaporative emission (EVAP) system, disconnect the battery ground cable from the battery. The EVAP system contains fuel vapor and condensed fuel vapor, so an electrical spark may cause a fire or explosion. Failure to follow this instruction may result in serious personal injury.

⚠ WARNING: Do not smoke, carry lighted tobacco or have an open flame of any type when working on or near any fuel-related component. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in serious personal injury.

1. Disconnect the battery ground cable. For additional information, refer to Section 414-01.


REMOVAL AND INSTALLATION (Continued)


2. Disconnect the evaporative emissions (EVAP) canister purge solenoid electrical connector.
 3. Disconnect the intake manifold-to-EVAP canister purge valve vapor tube quick connect coupling. For additional information, refer to Section 310-00.
 4. Disconnect the EVAP canister assembly-to-EVAP canister purge valve vapor tube quick connect coupling. For additional information, refer to Section 310-00.
 5. Remove the EVAP canister purge valve from the bracket.
 6. To install, reverse the removal procedure.
 - Carry out the EVAP system leak test. For additional information, refer to Evaporative Emission System Leak Test in this section.
 - Carry out the EVAP repair verification drive cycle. For additional information, refer to Evaporative Emission Repair Verification Drive Cycle in this section.
-

REMOVAL AND INSTALLATION

Evaporative Emission Canister Vent Solenoid

Removal and Installation

 **WARNING:** When working on or near the evaporative emission (EVAP) system, disconnect the battery ground cable from the battery. The EVAP system contains fuel vapor and condensed fuel vapor, so an electrical spark may cause a fire or explosion. Failure to follow this instruction may result in serious personal injury.

 **WARNING:** Do not smoke, carry lighted tobacco or have an open flame of any type when working on or near any fuel-related component. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in serious personal injury.

NOTE: Some vehicles come equipped with a steel fuel tank that is mounted midship. This fuel tank is referred to as an auxiliary fuel tank.

All vehicles

1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
2. Disconnect the battery ground cable. For additional information, refer to Section 414-01.

Midship fuel tank equipped vehicles

3. **NOTE:** The midship fuel tank evaporative emissions (EVAP) canister and bracket assembly is located above the spare tire. Removal of the spare tire is required to remove the midship fuel tank EVAP canister and bracket assembly.

Disconnect the EVAP canister purge valve vapor tube-to-EVAP canister quick connect coupling and fuel tank vapor tube-to-EVAP canister assembly quick connect coupling. For additional information, refer to Section 310-00.

All vehicles

4. Disconnect the EVAP canister vent solenoid electrical connector.

Aft-of-axle and auxiliary fuel tank equipped vehicles

5. Disconnect the fuel tank vapor tube-to-EVAP canister assembly quick connect coupling. For additional information, refer to Section 310-00.
6. Disconnect the fuel vapor vent hose from the dust separator.
7. If necessary, disconnect the fuel pump driver module (FPDM) electrical connector from the fuel pump driver module.

All vehicles

8. Remove the 4 bolts and the EVAP canister and bracket assembly.
 - To install, tighten to 17 Nm (13 lb-ft).
9. Place the EVAP canister and bracket assembly on a clean work surface.

Midship fuel tank equipped vehicles

10. Remove the canister vent solenoid and dust separator assembly from the EVAP canister assembly.

Aft-of-axle and auxiliary fuel tank equipped vehicles

11. Disconnect the dust separator hose from the EVAP canister vent solenoid.
12. Disconnect the EVAP canister vent solenoid from the EVAP filter assembly and remove the EVAP canister vent solenoid.

REMOVAL AND INSTALLATION (Continued)**All vehicles**

13. To install, reverse the removal procedure.

- Carry out the EVAP system leak test. For additional information, refer to Evaporative Emission System Leak Test in this section.
 - Carry out the EVAP repair verification drive cycle. For additional information, refer to Evaporative Emission Repair Verification Drive Cycle in this section.
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GENERAL PROCEDURES

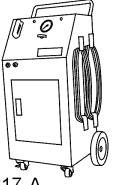
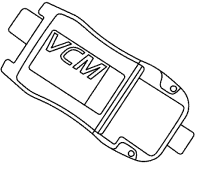
Evaporative Emission Repair Verification Drive Cycle

1. Refer to the [Powertrain Control/Emissions
Diagnosis \(PC/ED\) manual](#).
-

GENERAL PROCEDURES

Evaporative Emission System Leak Test

Special Tool(s)

 ST2817-A	VACUTEC Smoke Machine Fuel EVAP Emissions System Tester 218-0002 or equivalent
 ST2834-A	Vehicle Communication Module (VCM) and Integrated Diagnostic System (IDS) software with appropriate hardware, or equivalent scan tool


Phase 1 — Leak Verification

1. Using the scan tool, run the evaporative emissions (EVAP) system test.
2. **NOTE:** Some small leaks may not be detected using the EVAP system test. If the system has passed the test but a leak is still suspected, then proceed to Phase 2.
If the EVAP system failed the EVAP system test, then proceed to Phase 2.

Phase 2 — System Leak Check

1. Disconnect the upper fuel vapor tube quick connect coupling from the EVAP canister purge valve. For additional information, refer to Section 310-00.

2. Connect the smoke machine emissions tester to the upper EVAP canister purge valve fitting. For additional information, refer to the manufacturer's instruction.
3. **NOTE:** In the scan tool, the EVAP canister purge valve is referred to as the EVMV. Using the scan tool, energize the EVAP canister purge valve to the open position.

4.  **CAUTION:** The canister vent solenoid must not be energized for more than 9 minutes at one time. Once the canister vent solenoid is energized and de-energized, adequate time must be allowed for the component to cool adequately. Failure to allow the component to cool may create a false failure in the diagnostics, causing unnecessary repairs.

Using the scan tool, close the canister vent solenoid.

5. Introduce smoke from the smoke machine emissions tester into the EVAP system. For additional information, refer to the manufacturer's instructions.
6. Use the halogen light provided with the smoke machine emissions tester to look for smoke coming from the EVAP system. This will indicate a leak point.
7. Repair any leaks as necessary.
8. Repeat the leak test until the system passes.

DESCRIPTION AND OPERATION

Evaporative Emissions

NOTE: The vehicle vacuum routing diagrams are contained in the Description and Operation subsection of the Engine Emission Control section. Refer to Section 303-08.

The evaporative emission (EVAP) system consists of:

- dust separator (aft-of-axle and auxiliary fuel tanks).
- EVAP canister assembly.
- EVAP canister bracket.
- EVAP canister purge valve.
- EVAP canister vent solenoid and dust separator assembly (midship fuel tank).
- EVAP canister vent solenoid (aft-of-axle and auxiliary fuel tanks).
- EVAP filter assembly (aft-of-axle and auxiliary fuel tanks).
- fuel tank pressure sensor.
- vapor tubes.

The EVAP system:

- prevents hydrocarbon emissions from reaching the atmosphere.
- stores fuel vapors in the EVAP canister that are generated during vehicle operation and fuel filling (on-board refueling vapor recovery [ORVR] only) or hot soak, until they can be consumed by the engine during normal engine operation.
- routes the stored fuel vapors to the engine during engine operation.
- is controlled by the PCM which uses various sensor inputs to calculate the desired amount of purge flow. The PCM regulates the purge flow, induced by the application of intake manifold vacuum, by varying the duty cycle applied to the canister purge valve.

The fuel vapors are routed:

- from the fuel tank through the fuel vapor vent valves.
- to the EVAP canister(s) through a vapor tube.
- to the engine when the EVAP canister purge valve is opened by the PCM.

The fuel tank pressure (FTP) sensor (OBD II only):

- monitors the pressure levels in the fuel tank.
- communicates the pressure reading to the PCM during the OBD II leak test.

The EVAP canister assembly:

- is mounted above the spare tire on midship fuel tank equipped vehicle.
- is mounted on the LH frame rail on aft-of-axle fuel tank equipped vehicles.
- is mounted mid frame on auxiliary fuel tank equipped vehicles.
- contains activated carbon.
- stores fuel vapors.

The fuel tank filler cap:

- relieves system vacuum below 3.8 kPa (15.26 in H₂O).

The canister vent solenoid (OBD II only):

- is an assembly with dust separator on midship fuel tank.
- is located on the EVAP canister assembly.
- is normally open.
- seals the EVAP system for the OBD II leak and pressure tests.
- is mounted to the EVAP canister.
- is repaired as a separate item.

The EVAP canister purge valve:

- is located in the engine compartment.
- is normally closed.
- regulates the purging of the EVAP canister.
- is controlled by the PCM.

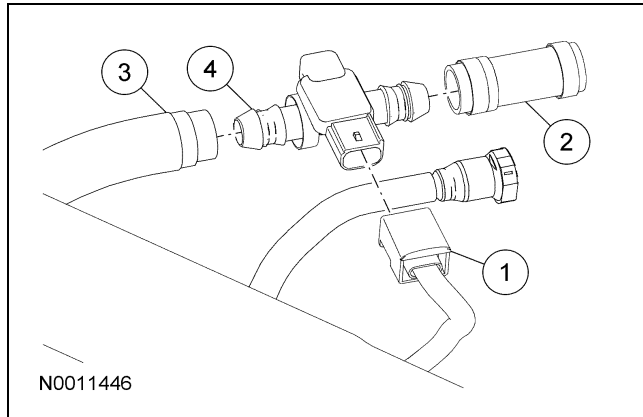
The EVAP system monitor (OBD II only):

- is a self-test strategy within the PCM which tests the integrity of the EVAP system.
- monitors the EVAP system for leaks.
- monitors electronic EVAP components for irrationally high or low voltages.
- monitors for correct EVAP system operation.
- uses negative and positive leak test methods to test and activate the EVAP system.

REMOVAL AND INSTALLATION

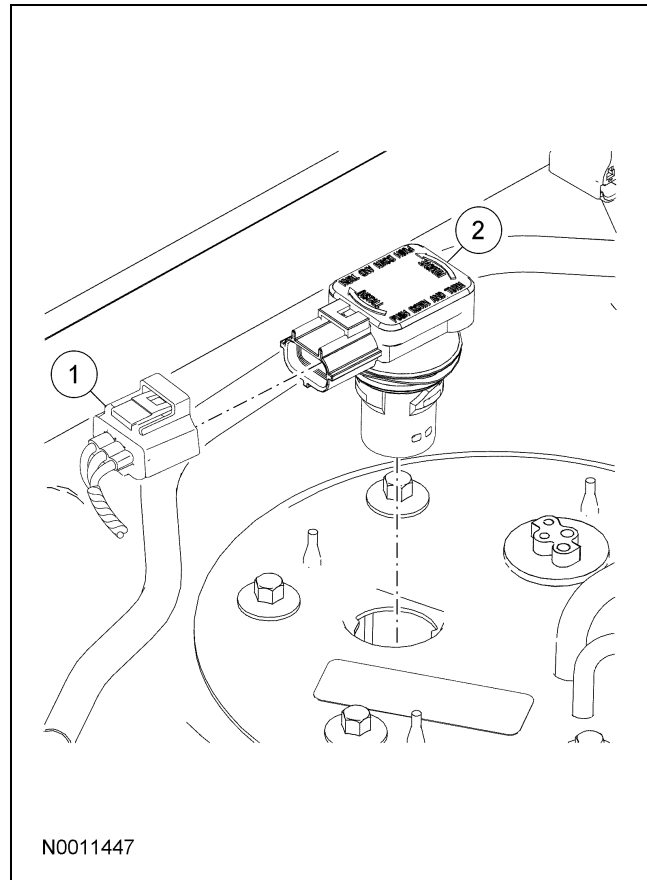
Fuel Tank Pressure Sensor

Midship Fuel Tank Equipped Vehicles



Item	Part Number	Description
1	—	Fuel tank pressure sensor electrical connector (part of 14C585)
2	—	Fuel vapor tube
3	—	Fuel vapor tube
4	9C052	Fuel tank pressure sensor

Aft-of-Axle and Auxiliary Fuel Tank Equipped Vehicles



Item	Part Number	Description
1	—	Fuel tank pressure sensor electrical connector (part of 14C585)
2	9C052	Fuel tank pressure sensor

REMOVAL AND INSTALLATION (Continued)**Removal and Installation**

⚠ WARNING: When working on or near the evaporative emission (EVAP) system, disconnect the battery ground cable from the battery. The EVAP system contains fuel vapor and condensed fuel vapor, so an electrical spark may cause a fire or explosion. Failure to follow this instruction may result in serious personal injury.

⚠ WARNING: Do not smoke, carry lighted tobacco or have an open flame of any type when working on or near any fuel-related component. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in serious personal injury.

All vehicles

1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
2. Remove the fuel tank. For additional information, refer to Section 310-01.

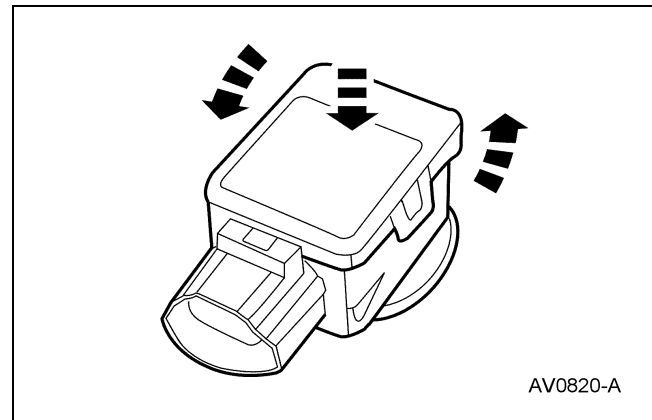
Midship fuel tank equipped vehicles

3. Disconnect the fuel tank pressure sensor electrical connector.
4. Disconnect the fuel vapor tubes from the fuel pressure sensor.
5. Remove the fuel pressure sensor.

Aft-of-axle and auxiliary fuel tank equipped vehicles

6. **⚠ CAUTION:** The fuel tank pressure sensor must be disengaged from the fuel tank before it can be removed. Push down while rotating the sensor counterclockwise to disengage it from the fuel tank. Failure to do so can cause damage to the fuel tank pressure sensor or the fuel tank.

Press down and rotate the fuel tank pressure sensor counterclockwise and remove it from the fuel tank.

**All vehicles**

7. To install, reverse the removal procedure.
 - Carry out the evaporative emission system leak test. For additional information, refer to Evaporative Emission System Leak Test in this section.
 - Carry out the evaporative emissions repair verification drive cycle. For additional information, refer to Evaporative Emission Repair Verification Drive Cycle in this section.

2008 Ford F-350 SUPER DUTY

Submodel: XLT | Engine Type: V8 | Liters: 5.4
Fuel Delivery: FI | Fuel: GAS

SECTION 303-13:
Evaporative Emissions

SPECIFICATIONS
DESCRIPTION AND OPERATION
Evaporative Emissions
DIAGNOSIS AND TESTING
Evaporative Emissions
GENERAL PROCEDURES
Evaporative Emission System Leak Test
Evaporative Emission Repair Verification Drive Cycle
REMOVAL AND INSTALLATION
Evaporative Emission (EVAP) System Components — Exploded View
Evaporative Emission Canister Vent Solenoid
Evaporative Emission Canister
Evaporative Emission Canister Purge Valve
Dust Separator
Fuel Tank Pressure Sensor

REMOVAL AND INSTALLATION

Catalytic Converter — Gasoline Engines

Removal

NOTE: Some applications are equipped with a catalytic converter delete pipe in place of the underbody catalytic converter. The catalytic converter delete pipe mounts in the exhaust system the same way as the underbody catalytic converter. The catalytic converter delete pipe does not have a catalytic monitor sensor.

1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
2. If equipped, remove the skid plate.
3. Remove the 2 exhaust Y-pipe flange bolts.
4. Loosen the catalytic converter-to-muffler Torca® clamp or, if equipped, the catalytic converter-to-exhaust intermediate pipe Torca® clamp.
5. If equipped, disconnect the exhaust intermediate pipe isolator and the front muffler isolator.
6. Disconnect the catalytic converter from the isolator.
7. Remove the catalytic converter.

Installation

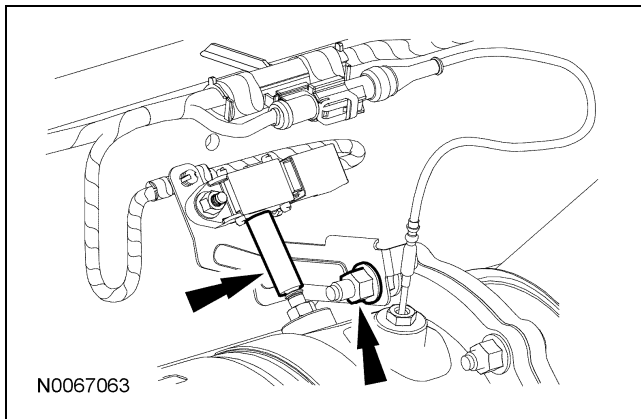
1. Position the catalytic converter into the muffler or, if equipped, the exhaust intermediate pipe.
2. If equipped, connect the exhaust intermediate pipe isolator, the front muffler isolator and the catalytic converter isolator.
3. Install the exhaust Y-pipe flange bolts.
 - Tighten to 40 Nm (30 lb-ft).
4. Make sure the button on the catalytic converter is fully inserted into the button slot on the muffler or, if equipped, the exhaust intermediate pipe and tighten the catalytic converter-to-muffler Torca® clamp or, if equipped, the exhaust intermediate pipe Torca® clamp.
 - Tighten to 55 Nm (41 lb-ft).
5. **NOTE:** The exhaust system alignment procedure only needs to be carried out if the exhaust system isolators are not at zero load. Check to see if the exhaust system isolators are at zero load. If the exhaust system isolators are not at zero load, carry out the exhaust system alignment procedure. For additional information, refer to Exhaust System Alignment — Gasoline Engines in this section.
6. If equipped, install the skid plate.

REMOVAL AND INSTALLATION

Diesel Particulate Filter — 6.4L Diesel

Removal

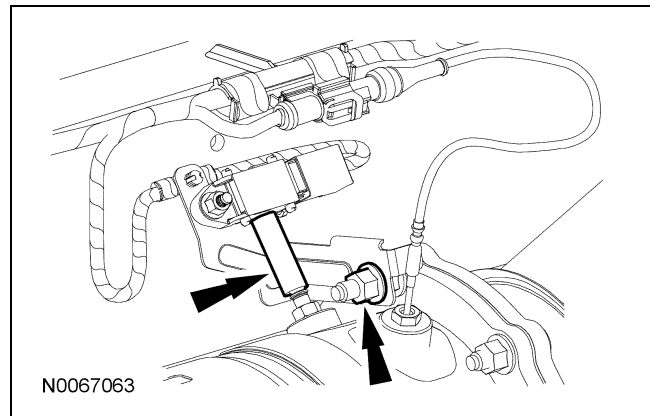
1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
2. Remove the tailpipe. For additional information, refer to Tailpipe — 6.4L Diesel in this section.
3. If equipped, remove the exhaust intermediate pipe. For additional information, refer to Exhaust Intermediate Pipe — 6.4L Diesel in this section.
4. Disconnect the exhaust gas temperature (EGT) sensor electrical connector.
5. Using a suitable lifting device support the diesel particulate filter.
6. Remove the back pressure sensor bracket and nut and disconnect the back pressure sensor tube.



7. Remove the 7 diesel particulate filter-to-oxidation catalytic converter (OC) nuts.
 - Discard the nuts.
8. Disconnect the isolators and lower the diesel particulate filter from the vehicle.
 - Discard the diesel particulate filter-to-OC gasket.

Installation

1. **NOTE:** Make sure the diesel particulate filter-to-OC gasket surface is clean.
Install a new diesel particulate filter-to-OC gasket.
2. Using a suitable lifting device, position the diesel particulate filter in the vehicle and connect the isolator.
3. Install the 7 new diesel particulate filter-to-OC nuts.
 - Tighten to 40 Nm (30 lb-ft).
4. Connect the back pressure sensor to the tube and install the back pressure sensor and nut.
 - Tighten to 40 Nm (30 lb-ft).



5. If equipped, install the exhaust intermediate pipe. For additional information, refer to Exhaust Intermediate Pipe — 6.4L Diesel in this section.
6. Install the tailpipe. For additional information, refer to Tailpipe — 6.4L Diesel in this section.
7. Connect the EGT sensor electrical connector.

REMOVAL AND INSTALLATION (Continued)

8. **NOTE:** The exhaust system alignment procedure only needs to be carried out if the exhaust system isolators are not at zero load.

Check to see if the exhaust system isolators are at zero load. If the exhaust system isolators are not at zero load, carry out the exhaust system alignment procedure. For additional information, refer to Exhaust System Alignment — 6.4L Diesel in this section.

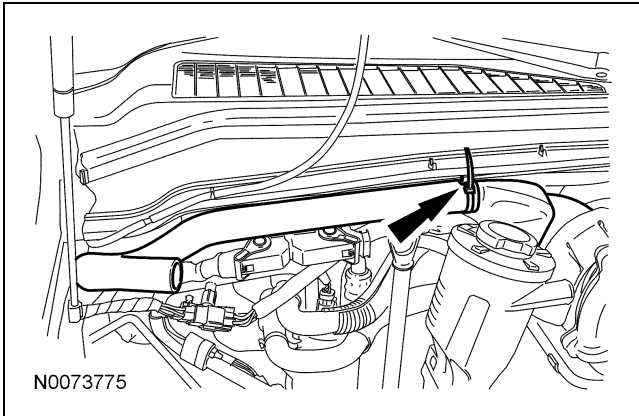
REMOVAL AND INSTALLATION

Exhaust Downpipe — 6.4L Diesel

Removal

NOTE: Exhaust fasteners are of a torque prevailing design. Use only new fasteners with the same part number as the original. Torque values must be used as specified during reassembly to make sure of correct retention of exhaust components.

1. Remove the transmission. For additional information, refer to Section 307-01 or Section 308-03.
2. If necessary, remove the auxiliary air intake from the cowl.

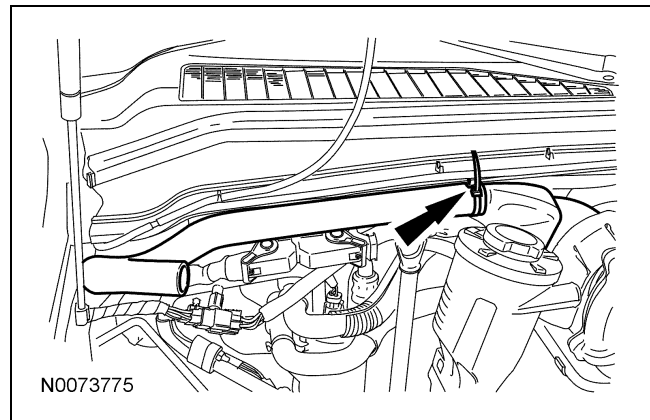


3. Loosen the exhaust downpipe-to-turbocharger clamp.
 - Discard the exhaust downpipe-to-turbocharger clamp and gasket.
4. Remove the exhaust downpipe-to-oxidation catalytic converter (OC) bolts and remove the exhaust downpipe from the vehicle.

Installation

1. Position the exhaust downpipe into the vehicle and loosely install exhaust downpipe-to-OC bolts.
2. Install a new exhaust downpipe-to-turbocharger gasket.

3. Install the exhaust downpipe to the turbocharger and a new exhaust downpipe-to-turbocharger clamp.
 - Make sure the exhaust downpipe clip is over the lip on the turbocharger.
 - Align the new exhaust downpipe-to-turbocharger clamp so that the exhaust downpipe clip and the opening in the exhaust downpipe-to-turbocharger clamp are aligned and tightened to maintain position.
 - Align the downpipe so that the area just above the flat in the pipe is approximately 20 mm (0.787 in) from the frame.
 - Tighten to 10 Nm (89 lb-in).
4. Tighten the exhaust downpipe-to-OC bolts
 - Tighten to 40 Nm (30 lb-ft).
5. Tighten the exhaust downpipe-to-turbocharger clamp.
 - Tighten to 15 Nm (11 lb-ft).
6. If removed, install the auxiliary air intake onto the cowl.



7. Install the transmission. For additional information, refer to Section 307-01 or Section 308-03.

REMOVAL AND INSTALLATION (Continued)

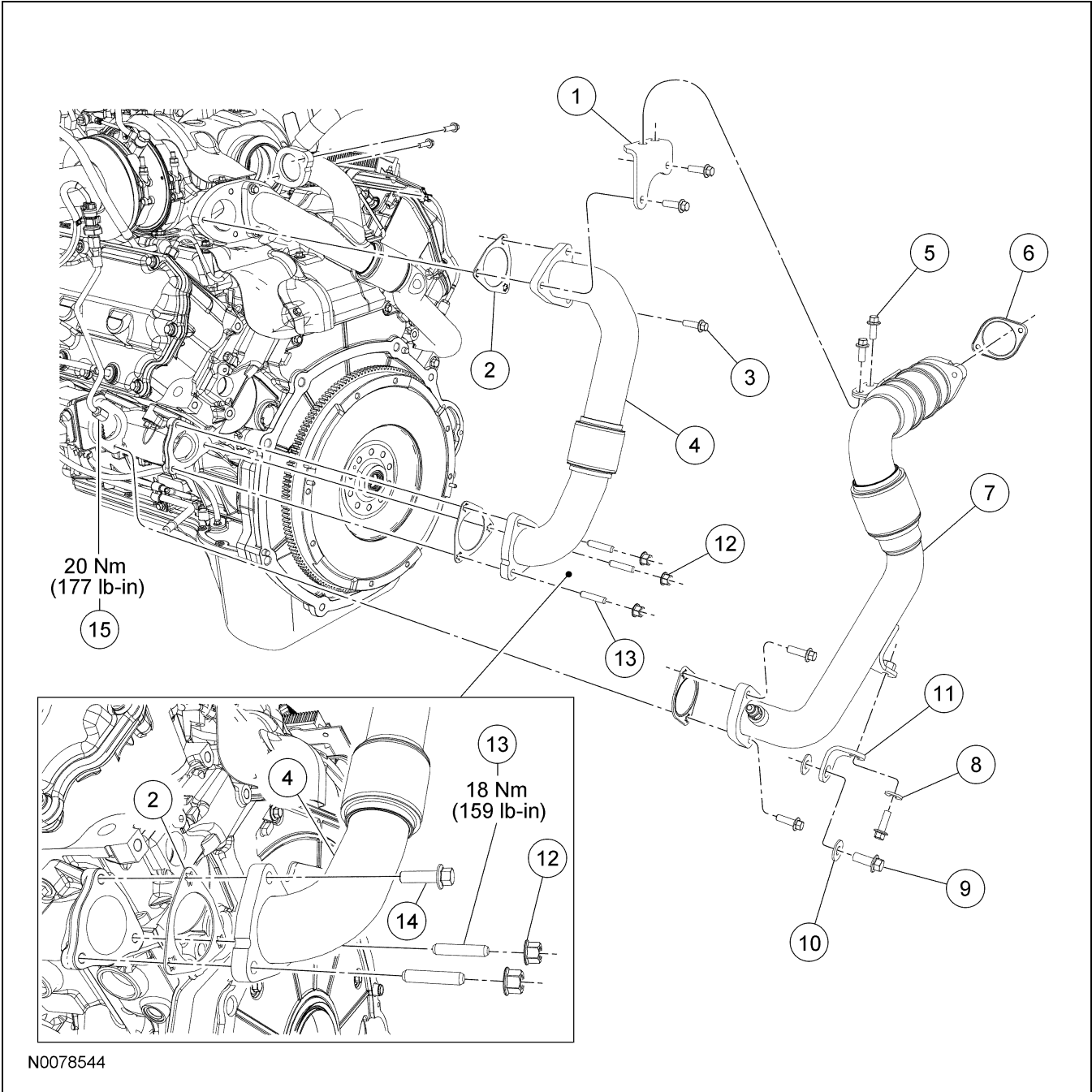
8. **NOTE:** The exhaust system alignment procedure only needs to be carried out if the exhaust system isolators are not at zero load.

Check to see if the exhaust system isolators are at zero load. If the exhaust system isolators are not at zero load, carry out the exhaust system alignment procedure. For additional information, refer to Exhaust System Alignment — 6.4L Diesel in this section.

REMOVAL AND INSTALLATION

Exhaust Gas Recirculation (EGR)
Oxidation Catalytic Converter (OC) —
6.4L Diesel

NOTE: Vehicle body removed from art for clarity.



Item	Part Number	Description
1	5D261	EGR-oxidation catalytic converter (OC) pipe bracket
2	6N640	Turbocharger inlet pipe gasket (2 required)

(Continued)

Item	Part Number	Description
3	W302649	Turbocharger inlet pipe and EGR-OC pipe bolt (8 required)
4	6K854	LH turbocharger inlet pipe

(Continued)

REMOVAL AND INSTALLATION (Continued)

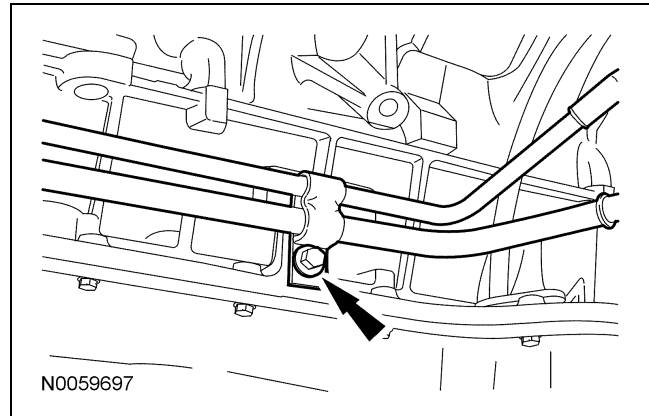
Item	Part Number	Description
5	W300003	EGR-OC pipe-to-EGR-OC pipe bracket bolt (2 required)
6	6N640	EGR-OC pipe gasket (2 required)
7	5H267	EGR-OC pipe
8	W302142	EGR-OC pipe bracket-to-cylinder head bracket washer
9	W301402	Cylinder head bracket-to-cylinder head bolt
10	W302624	Cylinder head bracket-to-cylinder head washer (2 required)
11	5D261	EGR-OC pipe bracket-to-cylinder head bracket
12	W302494	Turbocharger inlet pipe-to-exhaust manifold nut (3 required)
13	W302495	Turbocharger inlet pipe-to-exhaust manifold stud
14	W302649	LH turbocharger inlet pipe-to-exhaust manifold bolt (service only)
15	—	Exhaust pressure (EP) sensor tube fitting (part of NJ460)

Removal

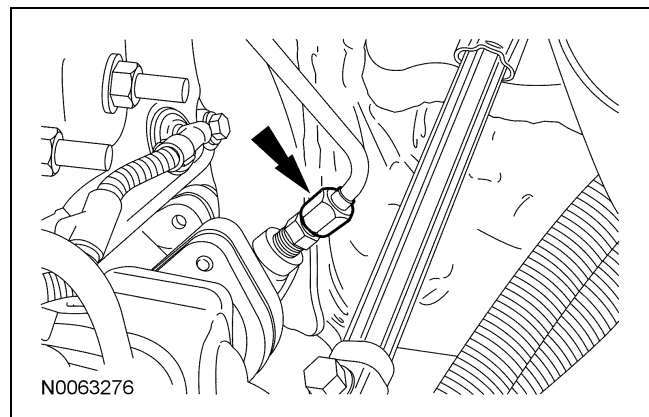
⚠ CAUTION: Do not bend or twist the exhaust gas recirculation (EGR)-oxidation catalytic converter (OC) pipe or damage to the bellow on the EGR-OC pipe may occur.

⚠ CAUTION: Do not bend or twist the turbocharger inlet pipe or damage to the bellow on the turbocharger inlet pipe may occur.

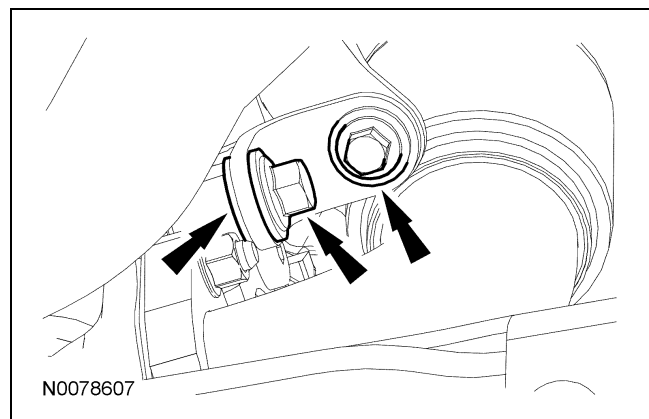
1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
2. Remove the fuel tubes retention bracket and bolt at the lower left corner of the engine.



3. Disconnect the exhaust pressure (EP) sensor tube fitting from the EGR-oxidation catalytic converter (OC) pipe.

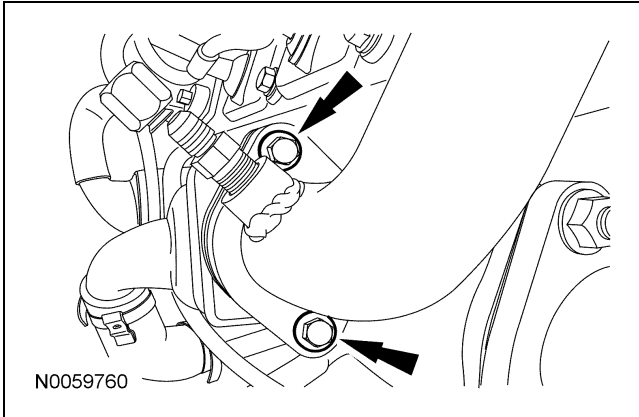


4. Remove the EGR-OC pipe bracket-to-cylinder head bracket bolt and washer. Remove the EGR-OC pipe bracket-to-LH cylinder head bolt, washers and the bracket.
 - Discard the bolts.




REMOVAL AND INSTALLATION (Continued)

5. Remove the RH turbocharger inlet pipe-to-EGR-OC pipe bolts and the EGR-OC-to-turbocharger bracket bolts.
 - Discard the bolts.
6. Remove the EGR-OC-to-EGR cooler bolts and position the EGR-OC pipe to the left side of the vehicle and aside.
 - Discard the bolts.



7. Remove the LH turbocharger inlet pipe-to-turbocharger bolts and remove the EGR-OC bracket.
 - Discard the bolts.
8. **NOTE:** On vehicles that have had previous service to the LH turbocharger inlet pipe, a service bolt will be in place of the upper exhaust manifold nut and stud.
Remove the LH turbocharger inlet pipe-to-exhaust manifold nuts and, if equipped, service bolt.
 - Discard the nuts and, if equipped, service bolt.
9. **NOTE:** On vehicles that have had previous service to the LH turbocharger inlet pipe, a service bolt will be in place of the upper exhaust manifold nut and stud.
Remove the LH turbocharger inlet pipe-to-exhaust manifold studs.

10.  **CAUTION:** Do not allow the exhaust gas recirculation (EGR)-oxidation catalytic converter (OC) pipe to contact the cowl insulation blanket or damage to the insulation blanket may occur.


NOTE: To aid in removal of the EGR-OC pipe, guide the flat part of the EGR-OC-to-turbocharger bracket that is welded onto the EGR-OC pipe, to the rear lower left corner of the rear engine heat shield. Gently press the fuel tubes at the lower left corner of the engine slightly forward and slowly guide the pipe down.


Remove the LH turbocharger inlet pipe, and then remove the EGR-OC pipe from the vehicle.


- Discard the gaskets.

11. Inspect the EGR-OC pipe for clogging.

Installation

1.  **CAUTION:** Do not allow the exhaust gas recirculation (EGR)-oxidation catalytic converter (OC) pipe to contact the cowl insulation blanket or damage to the insulation blanket may occur.

 **CAUTION:** Do not bend or twist the exhaust gas recirculation (EGR)-oxidation catalytic converter (OC) pipe or damage to the bellow on the EGR-OC pipe may occur.

 **CAUTION:** Do not bend or twist the turbocharger inlet pipe or damage to the bellow on the turbocharger inlet pipe may occur.

NOTE: To aid in installation of the EGR-OC pipe, gently press the fuel tubes at the lower left corner of the engine forward and guide the flat of the part of the EGR-OC-to-turbocharger bracket that is welded onto the EGR-OC pipe up to the rear lower left corner of the rear engine heat shield and then slowly guide the EGR-OC pipe past the heat shield and into position.

Position the EGR-OC pipe into the vehicle and to the LH side out of the way.

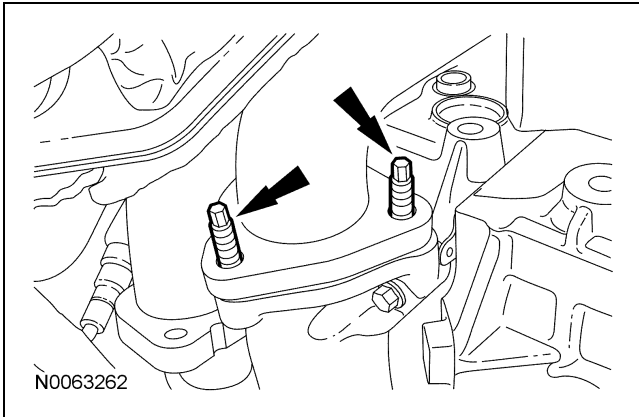
2. Position the LH turbocharger inlet pipe into the vehicle.

REMOVAL AND INSTALLATION (Continued)

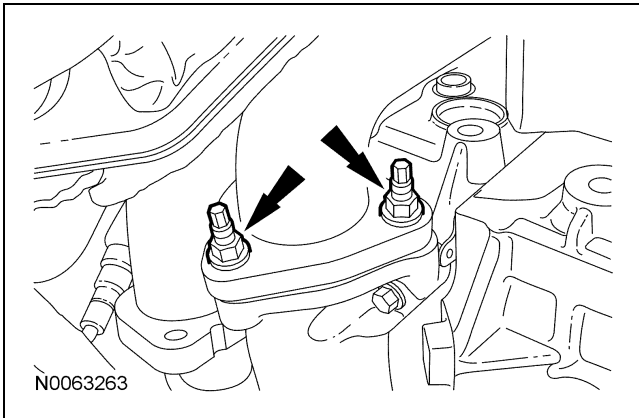
3. **NOTE:** To aid in installation, the upper LH turbocharge inlet pipe-to-exhaust manifold stud is replaced with a bolt.

Install the new LH turbocharger inlet pipe-to-exhaust manifold gasket and the 2 lower studs.

- Tighten to 18 Nm (159 lb-in).

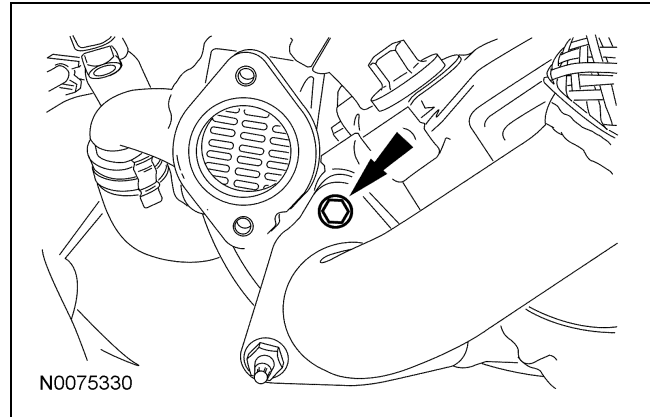


4. Position the new LH turbocharger inlet pipe-to-turbocharger gasket and loosely install the EGR-OC bracket and new bolts.
5. Loosely install new LH turbocharger inlet pipe-to-exhaust manifold nuts.

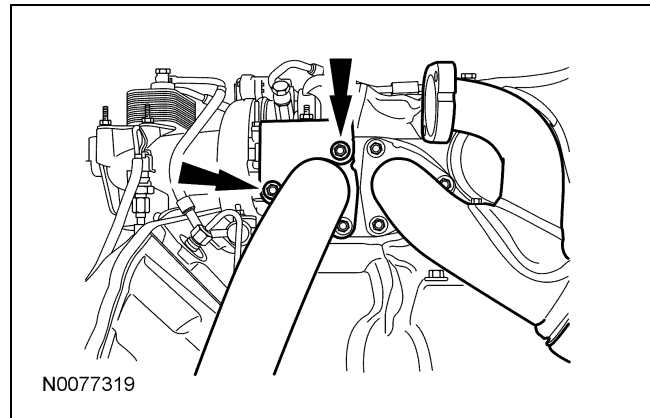


6. **NOTE:** To aid in installation, the upper LH turbocharger inlet pipe-to-exhaust manifold stud is replaced with bolt part number W302649.


Loosely install a new LH turbocharger inlet pipe-to-exhaust manifold bolt.



7. Tighten the 2 LH turbocharger inlet pipe-to-turbocharger upper bolts.
- Tighten to 25 Nm (18 lb-ft).



REMOVAL AND INSTALLATION (Continued)

8.  **CAUTION:** Due to limited access, one of the specific Half-moon wrenches and other tools described must be used to correctly tighten the fasteners in this step. Failure to follow this instruction may result in engine failure.

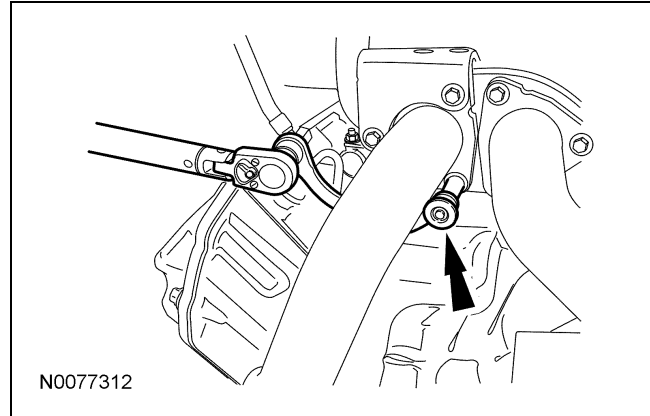
NOTE: To complete this step, it will be necessary to use the following tools:

- A 3/8-in drive torque wrench that is 241.3 mm (9.5 in) or 368.3 mm (14.5 in) from center of the handle to the center of the square drive.
- One of the 10-mm/12-mm Half-moon wrenches listed in the following chart.
- A 12-mm Allen socket (to drive the Half-moon wrench).

NOTE: To obtain the required torque value of 25 Nm (18 lb-ft), it will be crucial to orient the Half-moon wrench in the direction shown and 180 degrees (straight out) from the torque wrench. The torque wrench must be set to the value specified in the following chart, for the Half-moon wrench and torque wrench length being used.

Tighten the LH turbocharger inlet pipes-to-turbocharger bottom bolt.

- Refer to the following chart for torque wrench setting, based on the specific Half-moon wrench and torque wrench length being used.



REMOVAL AND INSTALLATION (Continued)**Torque Chart — Turbocharger Inlet Pipes-to-Turbocharger, Bottom 2 Bolts**

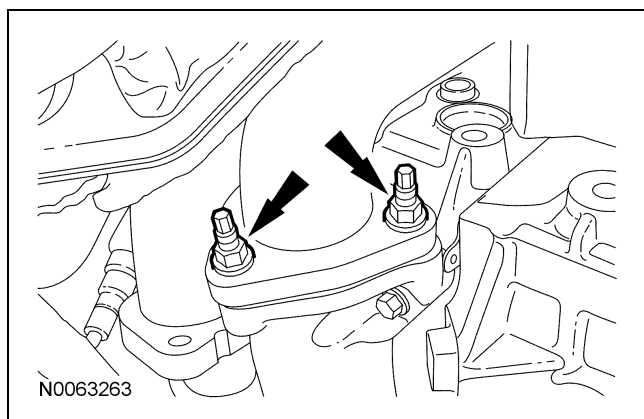
Half-Moon Wrench Brand	Wrench Part Number	Wrench Size	Torque Wrench Length	Torque Wrench Setting	
				Nm	lb-ft
Cornwell®	BWM-1012MM	10/12 mm	9.5 in	20	15
Gear Wrench®	9851	10/12 mm	9.5 in	18	13
Matco®	MHM1012	10/12 mm	9.5 in	18	13
Mac®	HMM1012R	10/12 mm	9.5 in	15	11
Snap-On®	CXM1012	10/12 mm	9.5 in	18	13
Cornwell®	BWM-1012MM	10/12 mm	14.5 in	19	14
Gear Wrench®	9851	10/12 mm	14.5 in	18	13
Matco®	MHM1012	10/12 mm	14.5 in	18	13
Mac®	HMM1012R	10/12 mm	14.5 in	16	12
Snap-On®	CXM1012	10/12 mm	14.5 in	18	13

NOTE: To achieve the required torque of 25 Nm (18 lb-ft), the torque wrench must be set to the appropriate Torque Wrench Setting listed in this chart.

N0076310

9. Tighten the 2 LH turbocharger inlet pipe-to-exhaust manifold nuts.

- Tighten to 31 Nm (23 lb-ft).



N0063263

REMOVAL AND INSTALLATION (Continued)

10. ⚠ **CAUTION:** Due to limited access, one of the specific Half-moon wrenches and other tools described must be used to correctly tighten the fasteners in this step. Failure to follow this instruction may result in engine failure.

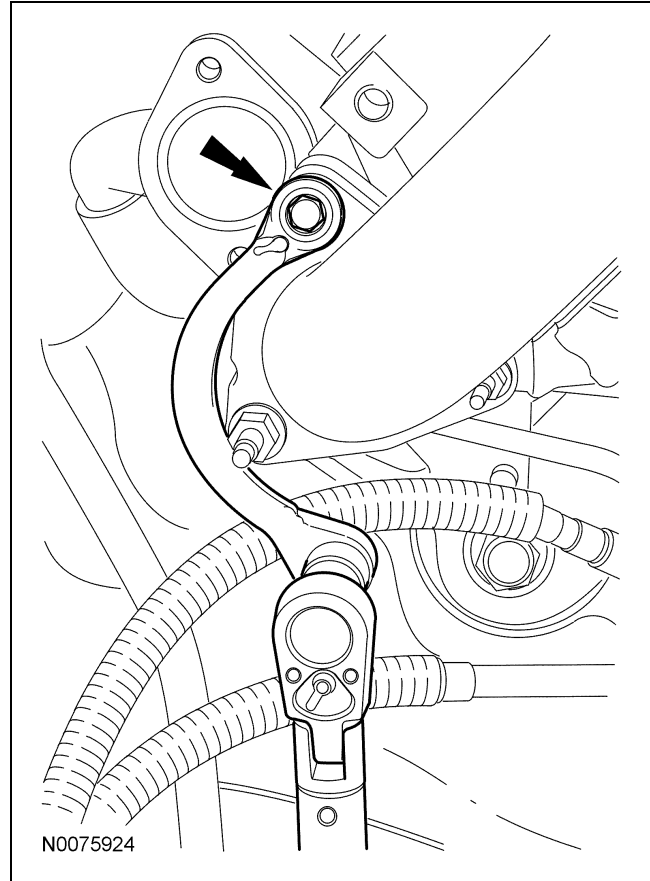
NOTE: To complete this step, it will be necessary to use the following tools:

- A 3/8-in drive torque wrench that is 368.3 mm (14.5 in) or 381.0 mm (15.0 in) from the center of the handle to the center of the square drive.
- One of the 10-mm/12-mm Half-moon wrenches listed in the following chart.
- A 12-mm Allen socket (to drive the Half-moon wrench).

NOTE: To obtain the specified torque value of 31 Nm (23 lb-ft), it will be crucial to orient the Half-moon wrench in the direction shown and 180 degrees (straight out) from the torque wrench. The torque wrench must be set to the value specified in the following chart, for the Half-moon wrench and torque wrench length being used.

Tighten the LH turbocharger inlet pipe-to-LH exhaust manifold bolt.

- Refer to the following chart for torque wrench setting, based on the specific Half-moon wrench and torque wrench length being used.




REMOVAL AND INSTALLATION (Continued)**Torque Chart — LH Turbocharger Inlet Pipe-to-LH Exhaust Manifold Upper Bolt**

Half-Moon Wrench Brand	Wrench Part Number	Wrench Size	Torque Wrench Length	Torque Wrench Setting	
				Nm	lb-ft
Cornwell®	BWM-1012MM	10/12 mm	14.5 in	26	19
Gear Wrench®	9851	10/12 mm	14.5 in	23	17
Matco®	MHM1012	10/12 mm	14.5 in	22	16
Mac®	HMM1012R	10/12 mm	14.5 in	22	16
Snap-On®	CXM1012	10/12 mm	14.5 in	22	16
Cornwell®	BWM-1012MM	10/12 mm	15.0 in	27	20
Gear Wrench®	9851	10/12 mm	15.0 in	23	17
Matco®	MHM1012	10/12 mm	15.0 in	23	17
Mac®	HMM1012R	10/12 mm	15.0 in	23	17
Snap-On®	CXM1012	10/12 mm	15.0 in	23	17

NOTE: To achieve the required torque of 31 Nm (23 lb-ft), the torque wrench must be set to the appropriate Torque Wrench Setting listed in this chart.

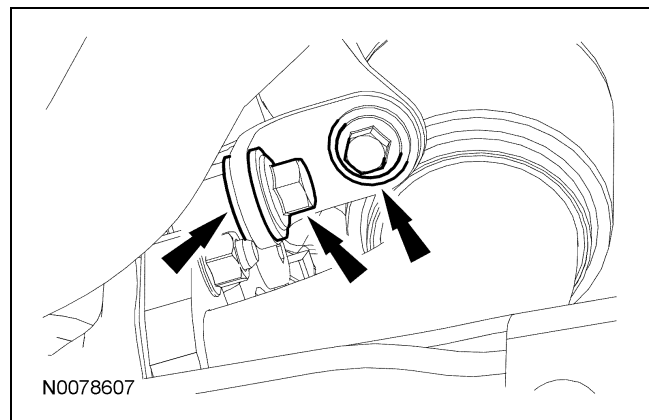
N0076309

11. Position the EGR-OC pipe and install a new EGR-OC pipe-to-horizontal EGR cooler gasket and loosely install the new bolts.

12.  **CAUTION:** Make sure the correct bolts are installed in the bracket or damage to the exhaust gas recirculation (EGR)-oxidation catalytic converter (OC) pipe may occur.

Install a new EGR-OC pipe-to-RH turbocharger inlet pipe gasket and loosely install new bolts. Loosely install the new EGR-OC-to-turbocharger bracket bolts.

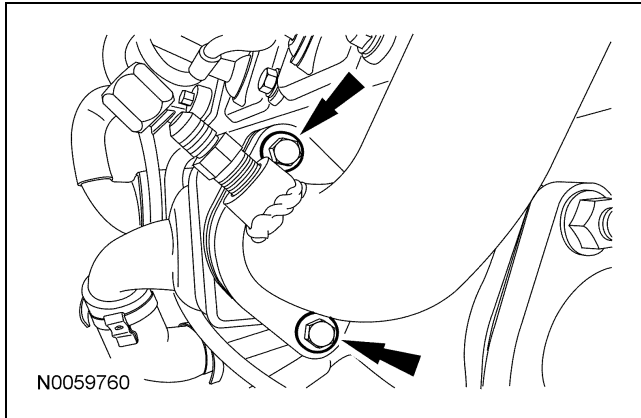
13. Position the cylinder head bracket and install the EGR-OC bracket-to-cylinder head bracket washer and a new bolt. Loosely install the cylinder head bracket-to-cylinder head washers and a new bolt. Finger tighten both bolts.



REMOVAL AND INSTALLATION (Continued)

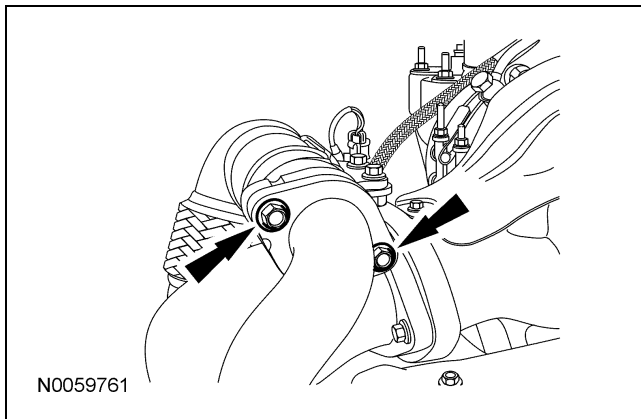
14. Tighten the EGR-OC-to-EGR cooler bolts.

- Tighten to 31 Nm (23 lb-ft).



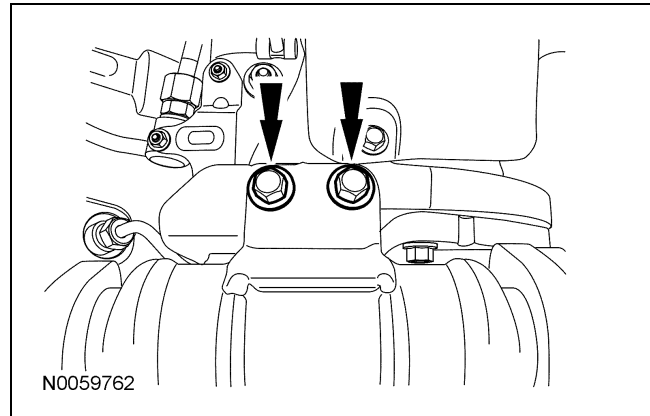
15. Tighten the RH turbocharger inlet pipe-to-EGR-OC bolts.


- Tighten to 31 Nm (23 lb-ft).



16. Tighten the EGR-OC-to-turbocharger bracket bolts.

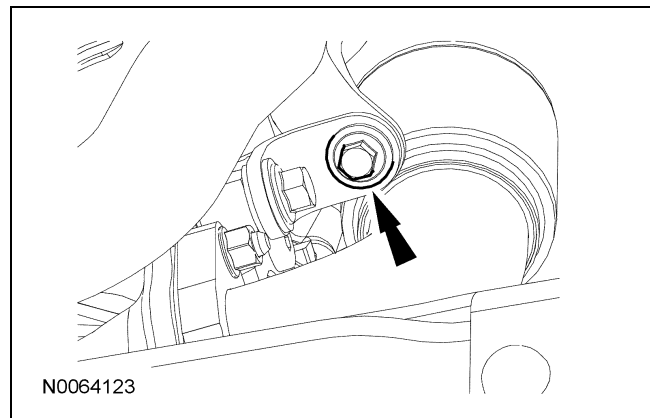
- Tighten to 31 Nm (23 lb-ft).



17.  **CAUTION:** Failure to install and correctly tighten the exhaust gas recirculation (EGR)-oxidation catalytic converter (OC) pipe bracket bolt will result in damage to the horizontal EGR cooler and possible engine damage.

Tighten the EGR-OC bracket-to-cylinder head bracket bolt.

- Tighten to 31 Nm (23 lb-ft).



REMOVAL AND INSTALLATION (Continued)

18. ⚠ **CAUTION:** Failure to install and correctly tighten the exhaust gas recirculation (EGR)-oxidation catalytic converter (OC) pipe support bolt will result in damage to the horizontal EGR cooler and possible engine damage.

⚠ **CAUTION:** Due to limited access, one of the specific Half-moon wrenches and other tools described must be used to correctly tighten the fasteners in this step. Failure to follow this instruction may result in engine failure.

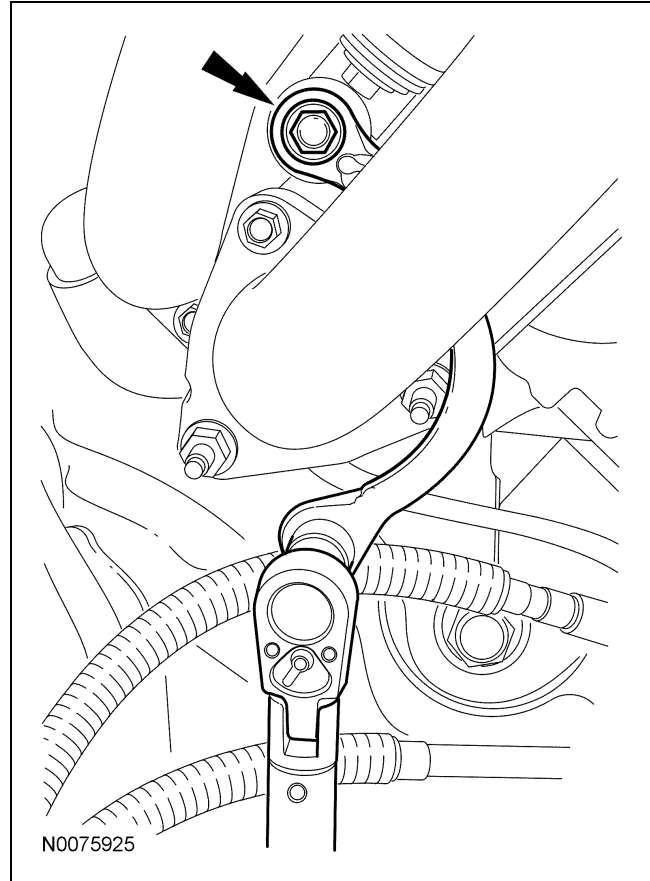
NOTE: To complete this step, it will be necessary to use the following tools:

- A 3/8-in drive torque wrench that is 368.3 mm (14.5 in) or 381.0 mm (15.0 in) from the center of the handle to the center of the square drive.
- One of the 11-mm/13-mm Half-moon wrenches listed in the following chart.
- An 11-mm Allen socket (to drive the Half-moon wrench).

NOTE: To obtain the specified torque value of 63 Nm (46 lb-ft), it will be crucial to orient the Half-moon wrench in the direction shown and 180 degrees (straight out) from the torque wrench. The torque wrench must be set to the value specified in the following chart, for the Half-moon wrench and torque wrench length being used.

Tighten the EGR-OC pipe bracket-to-LH cylinder head bolt.

- Refer to the following chart for torque wrench setting, based on the specific Half-moon wrench and torque wrench length being used.



REMOVAL AND INSTALLATION (Continued)**Torque Chart— EGR-OC Pipe Bracket-to-LH Cylinder Head Bolt**

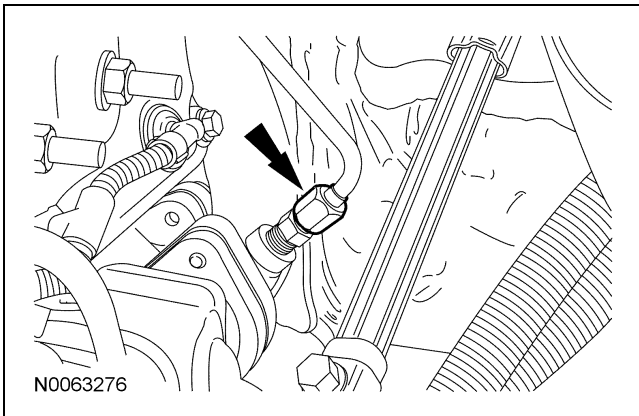
Half-Moon Wrench Brand	Wrench Part Number	Wrench Size	Torque Wrench Length	Torque Wrench Setting	
				Nm	lb-ft
Cornwell®	BWM-1113MM	11/13 mm	14.5 in	47	35
Gear Wrench®	9852	11/13 mm	14.5 in	46	34
Matco®	MHM1113	11/13 mm	14.5 in	46	34
Mac®	HMM1113R	11/13 mm	14.5 in	46	34
Snap-On®	CXM1113	11/13 mm	14.5 in	46	34
Cornwell®	BWM-1113MM	11/13 mm	15.0 in	49	36
Gear Wrench®	9852	11/13 mm	15.0 in	47	35
Matco®	MHM1113	11/13 mm	15.0 in	47	35
Mac®	HMM1113R	11/13 mm	15.0 in	47	35
Snap-On®	CXM1113	11/13 mm	15.0 in	47	35

NOTE: To achieve the required torque of 62 Nm (46 lb-ft), the torque wrench must be set to the appropriate Torque Wrench Setting listed in this chart.

N0078499

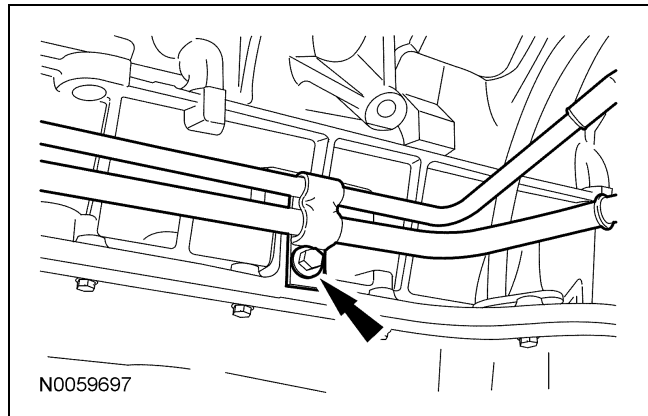
19. Connect the EP sensor tube fitting onto the EGR-OC pipe.

- Tighten to 20 Nm (177 lb-in).



20. Install the fuel tubes retention bracket and bolt at the lower left corner of the engine.

- Tighten to 31 Nm (23 lb-ft).



REMOVAL AND INSTALLATION

Exhaust Gas Recirculation (EGR) Oxidation Catalytic Converter (OC) and Turbocharger Inlet Pipes — 6.4L Diesel, Body Off

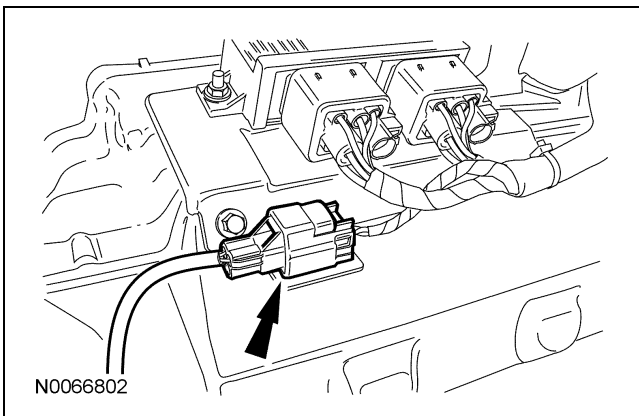
Removal

⚠ CAUTION: Do not bend or twist the exhaust gas recirculation (EGR)-oxidation catalytic converter (OC) pipe or damage to the bellow on the EGR-OC pipe may occur.

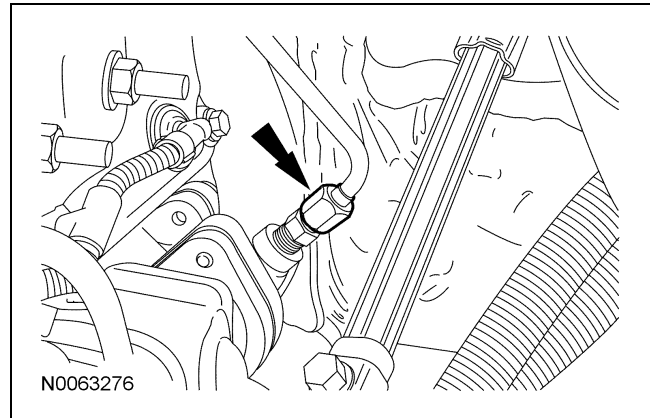
⚠ CAUTION: Do not bend or twist the turbocharger inlet pipe or damage to the bellow on the turbocharger inlet pipe may occur.

NOTE: This procedure is provided for use with other procedures that require the removal of the vehicle body. If the vehicle body is not being removed, refer to the “Body On” version of this procedure.

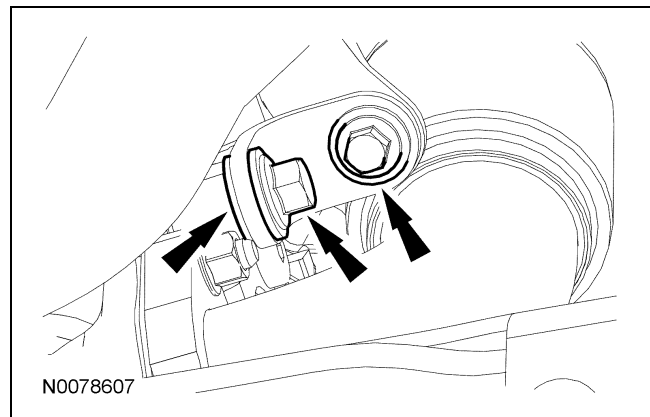
1. Remove the vehicle body. For additional information, refer to Section 502-02.
2. Loosen the exhaust downpipe-to-turbocharger clamp.
3. Remove the exhaust downpipe-to-oxidation catalytic converter (OC) bolts and remove the exhaust downpipe from the vehicle.
 - Discard the clamp and gasket.
4. Disconnect the exhaust gas recirculation temperature (EGRT) sensor electrical connector.



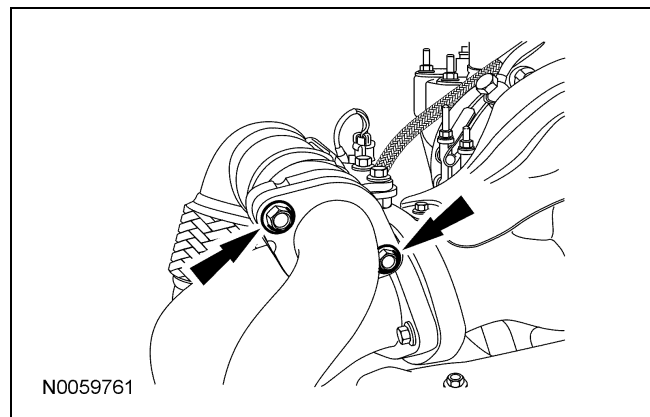
5. Disconnect the exhaust pressure (EP) sensor tube fitting.



6. Remove the EGR-OC pipe bracket-to-cylinder head bracket bolt and washer. Remove the cylinder head bracket-to-cylinder head bolt, washers and the bracket.
 - Discard the bolts.



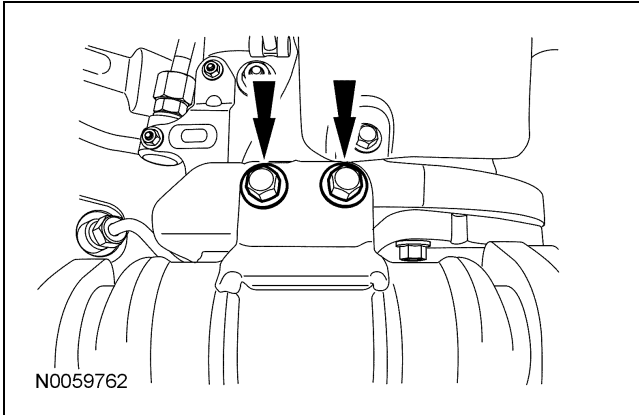
7. Remove the RH turbocharger inlet pipe-to-EGR-OC pipe bolts.
 - Discard the bolts.



REMOVAL AND INSTALLATION (Continued)

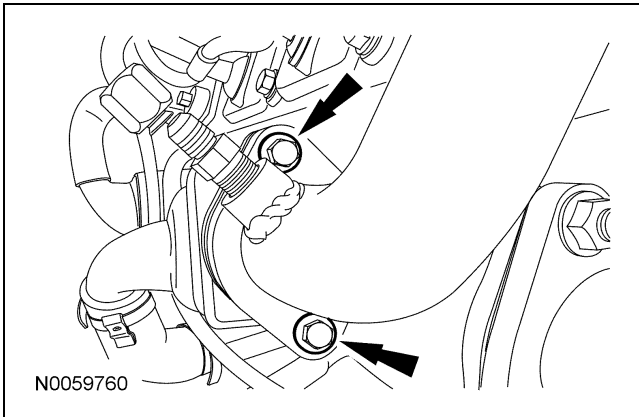
8. Remove the EGR-OC-to-turbocharger bracket bolts.

- Discard the bolts.



9. Remove the EGR-OC-to-EGR cooler bolts.

- Discard the bolts.



10. Remove EGR-OC pipe from the vehicle.

- Discard the gaskets.

11. Remove the RH turbocharger inlet pipe-to-turbocharger bolts.

- Discard the bolts.

12. Remove the RH turbocharger inlet pipe-to-exhaust manifold nuts.

- Discard the nuts.

13. Remove the RH turbocharger inlet pipe from the vehicle.

- Discard the gaskets.

14. Remove the LH turbocharger inlet pipe-to-turbocharger bolts and remove the EGR-OC bracket.

- Discard the bolts.

15. **NOTE:** On vehicles that have had previous service to the LH turbocharger inlet pipe, a service bolt will be in place of the upper exhaust manifold nut and stud.

Remove the LH turbocharger inlet pipe-to-exhaust manifold nuts and, if equipped, service bolt.

- Discard the nuts and, if equipped, service bolt.

16. Remove the LH turbocharger inlet pipe from the vehicle.

- Discard the gaskets.

17. Inspect the EGR-OC pipe for damage, obstructions or plugging of the filter. If the filter cannot be cleaned or the obstruction removed, install a new EGR-OC pipe.

Installation

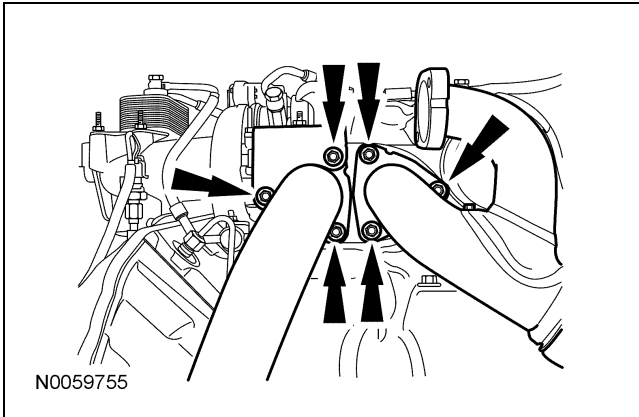
⚠ CAUTION: Do not bend or twist the exhaust gas recirculation (EGR)-oxidation catalytic converter (OC) pipe or damage to the bellow on the EGR-OC pipe may occur.

⚠ CAUTION: Do not bend or twist the turbocharger inlet pipe or damage to the bellow on the turbocharger inlet pipe may occur.

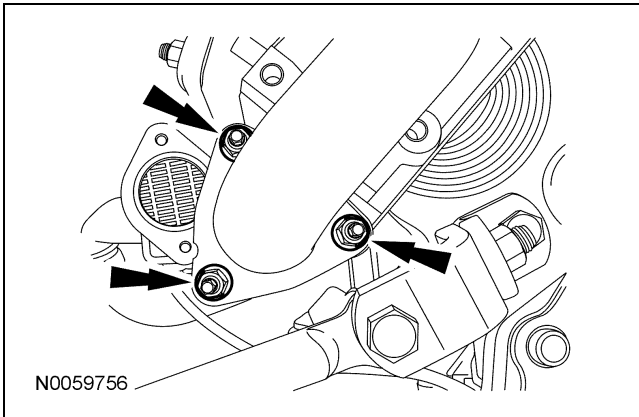
1. Install new gaskets on the exhaust manifolds-to-turbocharger inlet pipe joints.

REMOVAL AND INSTALLATION (Continued)

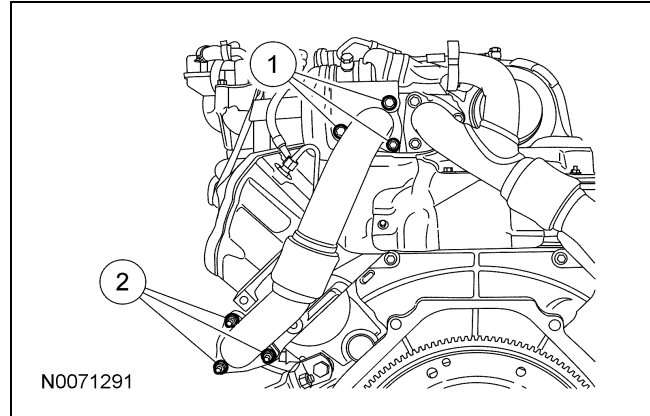
2. Position the turbocharger inlet pipes, new turbocharger inlet pipe-to-turbocharger gaskets and the EGR-OC bracket, and loosely install new turbocharger inlet pipe-to-turbocharger bolts.



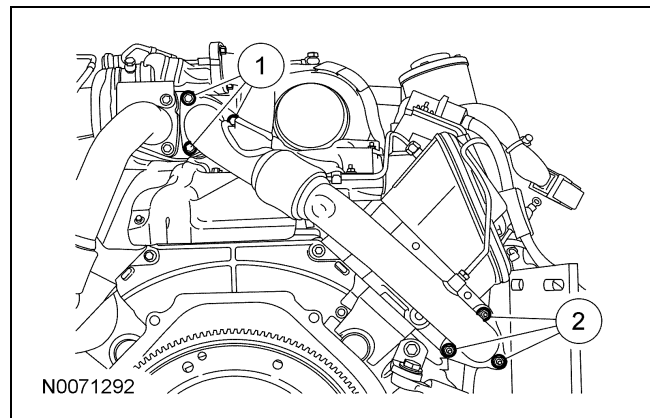
3. **NOTE:** LH side shown, RH side similar.
NOTE: A new service bolt may be installed at the upper location at the LH exhaust manifold.
 Loosely install the new turbocharger inlet pipe-to-exhaust manifold nuts.




4. Tighten the LH turbocharger inlet pipe-to-turbocharger bolts and LH turbocharger inlet pipe-to-exhaust manifold nuts (and service bolt).
 - 1 Tighten the bolts to 24 Nm (18 lb-ft).
 - 2 Tighten the nuts (and service bolt) to 31 Nm (23 lb-ft).



5. Tighten the RH turbocharger inlet pipe-to-turbocharger bolts and RH turbocharger inlet pipe-to-exhaust manifold nuts.
 - 1 Tighten the bolts to 24 Nm (18 lb-ft).
 - 2 Tighten the nuts to 31 Nm (23 lb-ft).

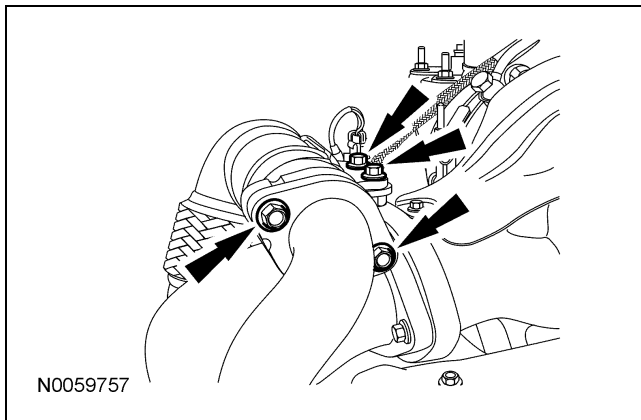


REMOVAL AND INSTALLATION (Continued)

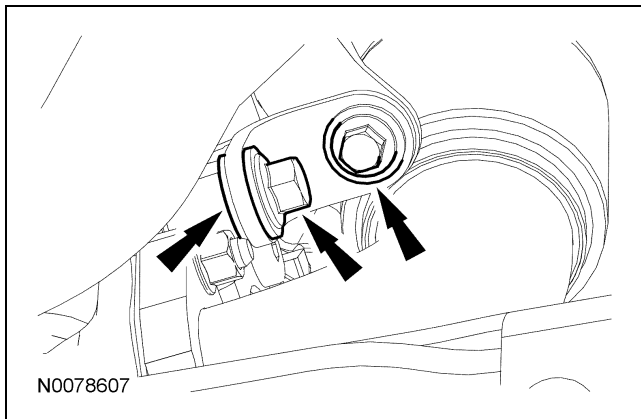
6.  **CAUTION:** Make sure the correct bolts are installed in the bracket or damage to the exhaust gas recirculation (EGR)-oxidation catalytic converter (OC) pipe may occur.

NOTE: EGR-OC pipe-to-RH turbocharger inlet pipe joint shown, EGR-OC pipe-to-horizontal EGR cooler joint similar.

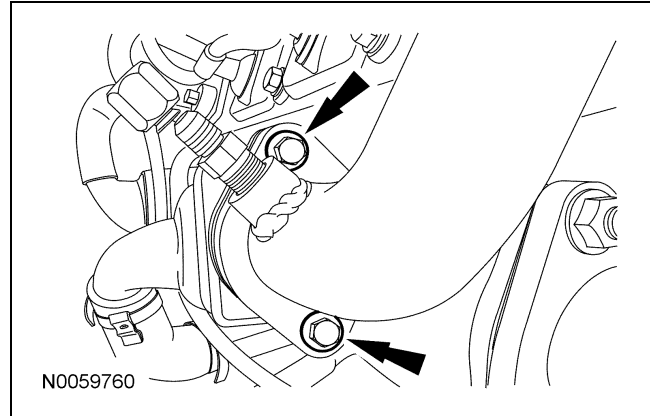
Position the EGR-OC pipe and loosely install new EGR-OC-to-bracket bolts. Install new gaskets and loosely install the new RH inlet pipe-to-EGR-OC pipe bolts and the new EGR-OC-to-horizontal EGR cooler bolts.



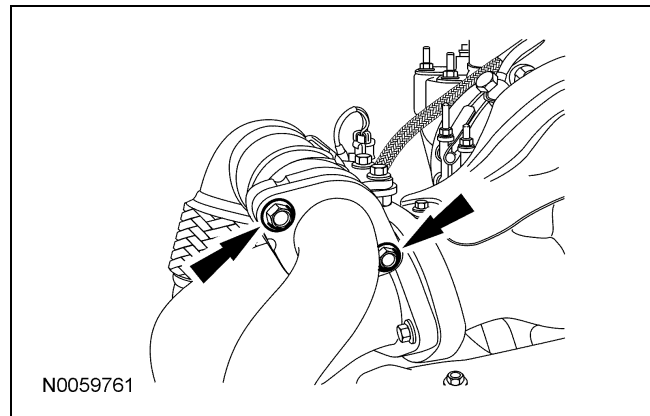
7. Position the cylinder head bracket and install the EGR-OC bracket-to-cylinder head bracket washer and a new bolt. Loosely install the cylinder head bracket-to-cylinder head washers and a new bolt. Finger tighten both bolts.



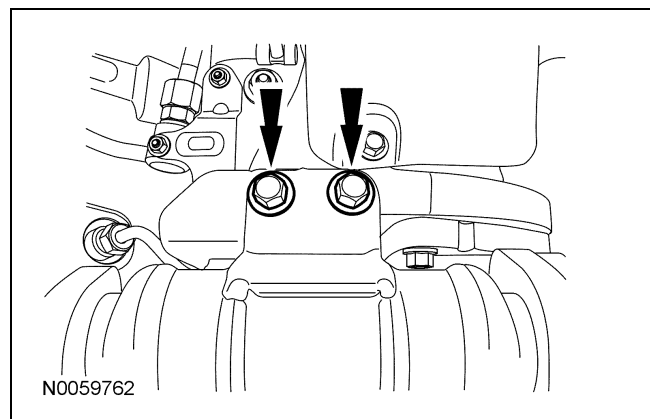
8. Tighten the EGR-OC-to-EGR cooler bolts.
- Tighten to 31 Nm (23 lb-ft).




9. Tighten the RH turbocharger inlet pipe-to-EGR-OC bolts.
- Tighten to 31 Nm (23 lb-ft).



10. Tighten the EGR-OC-to-turbocharger bracket bolts.
- Tighten to 31 Nm (23 lb-ft).

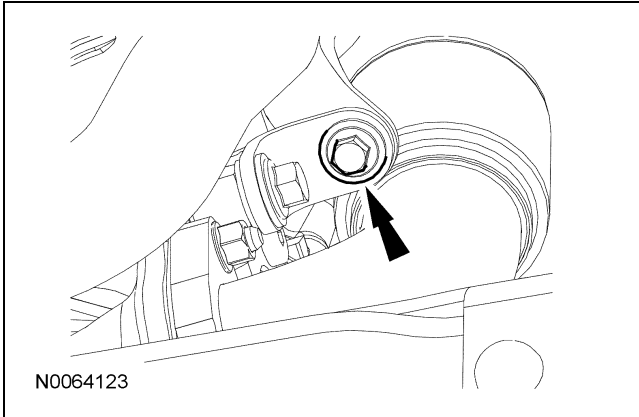



REMOVAL AND INSTALLATION (Continued)

11.  **CAUTION:** Failure to install and correctly tighten the exhaust gas recirculation (EGR)-oxidation catalytic converter (OC) pipe bracket bolt will result in damage to the horizontal EGR cooler and possible engine damage.

Tighten the EGR-OC bracket-to-cylinder head bracket bolt.

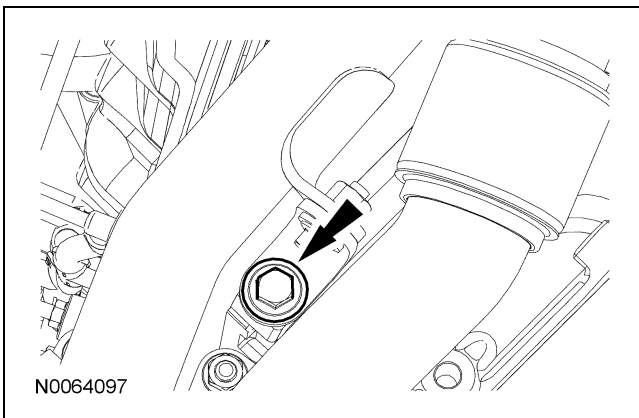
- Tighten to 31 Nm (23 lb-ft).



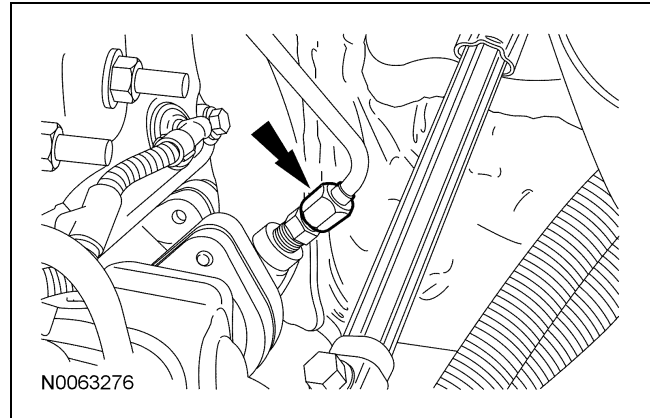
12.  **CAUTION:** Failure to install and correctly tighten the exhaust gas recirculation (EGR)-oxidation catalytic converter (OC) pipe bracket bolt will result in damage to the horizontal EGR cooler and possible engine damage.

Tighten the cylinder head bracket-to-cylinder head bolt.

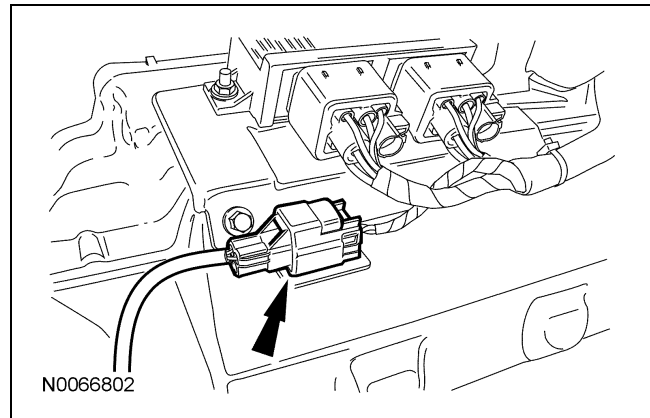
- Tighten to 62 Nm (46 lb-ft).



13. Install the EP sensor tube fitting.
- Tighten to 20 Nm (177 lb-in).



14. Connect the EGRT sensor electrical connector.



15. **NOTE:** Do not install the exhaust downpipe until both turbocharger inlet pipes and the EGR-OC pipe are installed and all fasteners are tightened.

Position the exhaust downpipe into the vehicle and loosely install exhaust downpipe-to-OC bolts.

16. Install a new exhaust downpipe-to-turbocharger gasket.

REMOVAL AND INSTALLATION (Continued)

17. Position the exhaust downpipe to the turbocharger and install and pre-tighten a new exhaust downpipe-to-turbocharger clamp.
 - Make sure the exhaust downpipe clip is over the lip on the turbocharger.
 - Align the new exhaust downpipe-to-turbocharger clamp so that the exhaust downpipe clip and the opening in the exhaust downpipe-to-turbocharger clamp are aligned and tightened to maintain position.
 - Align the downpipe so that the area just above the flat in the pipe is approximately 20 mm (0.787 in) from the frame.
 - Pre-tighten to 10 Nm (89 lb-in) to stiffen the joint.
 18. Tighten the exhaust downpipe-to-OC bolts.
 - Tighten to 40 Nm (30 lb-ft).
 19. Tighten the exhaust downpipe-to-turbocharger clamp.
 - Tighten to 15 Nm (133 lb-in).
-

REMOVAL AND INSTALLATION

Exhaust Gas Recirculation (EGR) Oxidation Catalytic Converter (OC) and Turbocharger Inlet Pipes — 6.4L Diesel, Body On

Removal

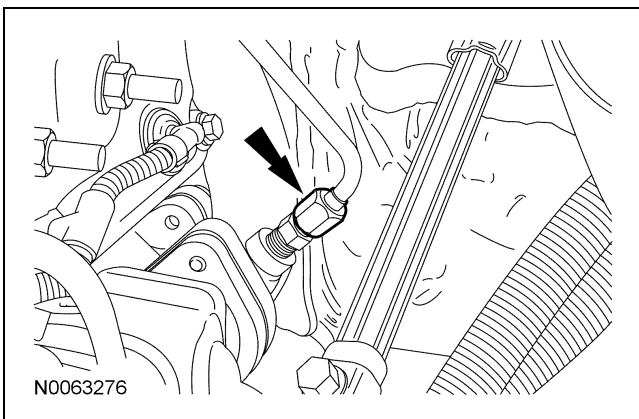
CAUTION: Do not bend or twist the exhaust gas recirculation (EGR)-oxidation catalytic converter (OC) pipe or damage to the bellow on the EGR-OC pipe may occur.

CAUTION: Do not bend or twist the turbocharger inlet pipe or damage to the bellow on the turbocharger inlet pipe may occur.

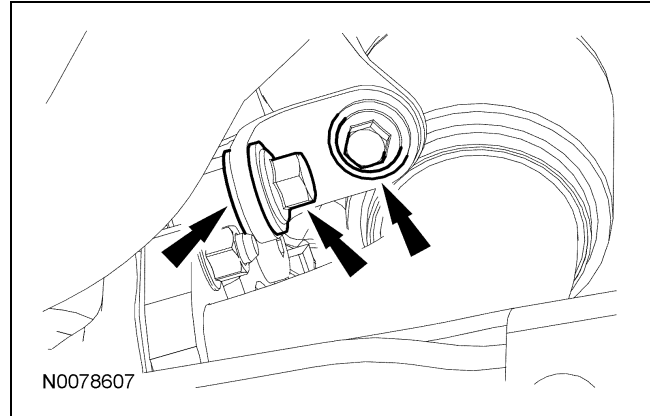
NOTE: This procedure is provided for use when both turbocharger inlet pipes and the EGR-oxidation catalytic converter (OC) pipe must all be removed, and the vehicle body is not being removed. If the vehicle body is being removed, refer to the “Body Off” version of this procedure.

NOTE: This procedure is provided for use when it is necessary to remove both turbocharger inlet pipes and EGR-OC pipe. If service is only being performed on one pipe, refer to the appropriate pipe procedure.

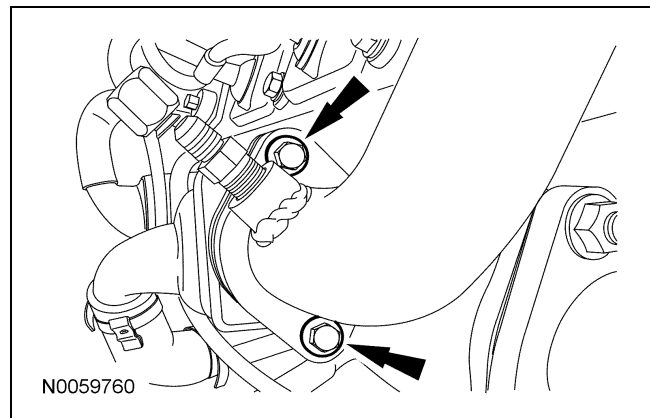
1. Remove the exhaust downpipe. For additional information, refer to Exhaust Downpipe — 6.4L Diesel in this section.
2. Disconnect the exhaust pressure (EP) sensor tube fitting.



3. Remove the EGR-OC pipe bracket-to-cylinder head bracket bolt and washer. Remove the EGR-OC pipe bracket-to-LH cylinder head bolt, washers and the bracket.
 - Discard the bolts.

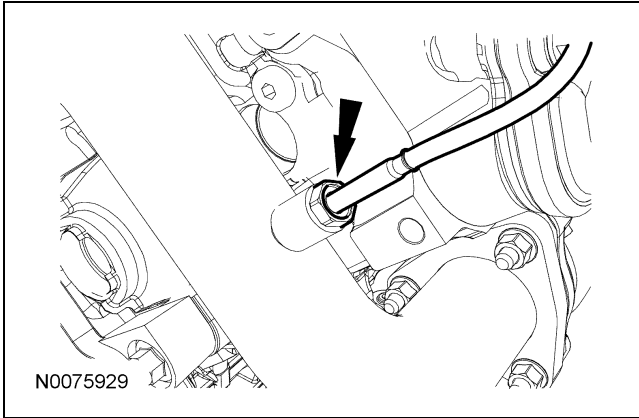


4. Remove the RH turbocharger inlet pipe-to-EGR-OC pipe bolts and the EGR-OC-to-turbocharger bracket bolts.
 - Discard the bolts.
5. Remove the EGR-OC-to-EGR cooler bolts and position the EGR-OC pipe to the left side of the vehicle and aside.
 - Discard the bolts.



REMOVAL AND INSTALLATION (Continued)

6. Remove the exhaust gas temperature (EGT) sensor from the RH turbocharger inlet pipe and position aside.



7. Remove the RH turbocharger inlet pipe-to-exhaust manifold nuts.
- Discard the nuts.
8. Remove the RH turbocharger inlet pipe-to-turbocharger bolts.
- Discard the bolts.
9. Remove the RH turbocharger inlet pipe from the vehicle.
- Discard the gaskets.
10. Remove the LH turbocharger inlet pipe-to-turbocharger bolts and remove the EGR-OC bracket.
- Discard the bolts.
11. **NOTE:** On vehicles that have had previous service to the LH turbocharger inlet pipe, a service bolt will be in place of the upper exhaust manifold nut and stud.
- Remove the LH turbocharger inlet pipe-to-exhaust manifold nuts and, if equipped, service bolt.
- Discard the nuts and, if equipped, service bolt.

12. **NOTE:** On vehicles that have had previous service to the LH turbocharger inlet pipe, a service bolt will be in place of the upper exhaust manifold nut and stud.

Remove the LH turbocharger inlet pipe-to-exhaust manifold studs.


13. **NOTE:** To aid in removal of the EGR-OC pipe, lower the pipe down slightly, rotate the EGR-OC-to-RH turbocharger inlet pipe flange to the LH side of the vehicle and then lower the EGR-OC pipe completely out of the vehicle.


Remove the LH turbocharger inlet pipe and then remove the EGR-OC pipe from the vehicle.

- Discard the gaskets.

14. Inspect the EGR-OC pipe for clogging.

Installation

 **CAUTION:** Do not bend or twist the exhaust gas recirculation (EGR)-oxidation catalytic converter (OC) pipe or damage to the bellow on the EGR-OC pipe may occur.

 **CAUTION:** Do not bend or twist the turbocharger inlet pipe or damage to the bellow on the turbocharger inlet pipe may occur.

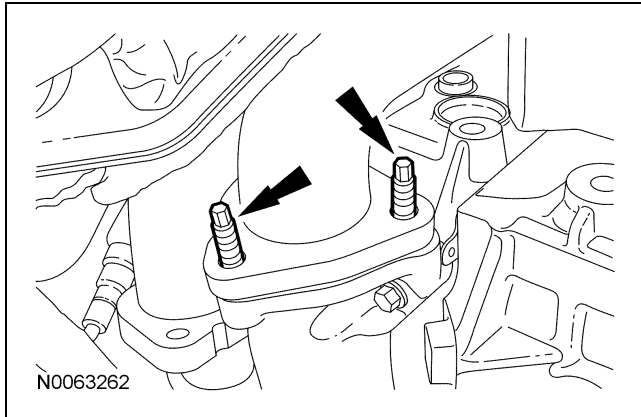
1. **NOTE:** To aid in installation of the EGR-OC pipe, install the pipe with the EGR-OC pipe-to-RH turbocharger inlet pipe flange facing the LH side of the vehicle. Raise the EGR-OC pipe until it passes the transmission bellhousing or transmission bellhousing mating surface, then rotate the pipe back into position.
- Position the EGR-OC pipe into the vehicle and to the LH side out of the way.
2. Position the LH turbocharger inlet pipe into position.

REMOVAL AND INSTALLATION (Continued)

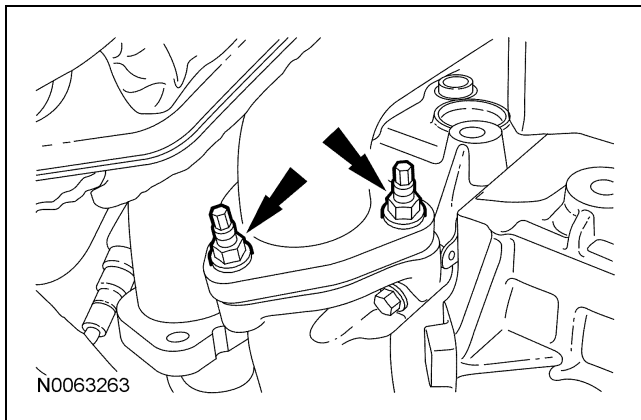
3. **NOTE:** To aid in installation, the upper LH turbocharge inlet pipe-to-exhaust manifold stud is replaced with a bolt.

Install the new LH turbocharger inlet pipe-to-exhaust manifold gasket and the 2 lower studs.

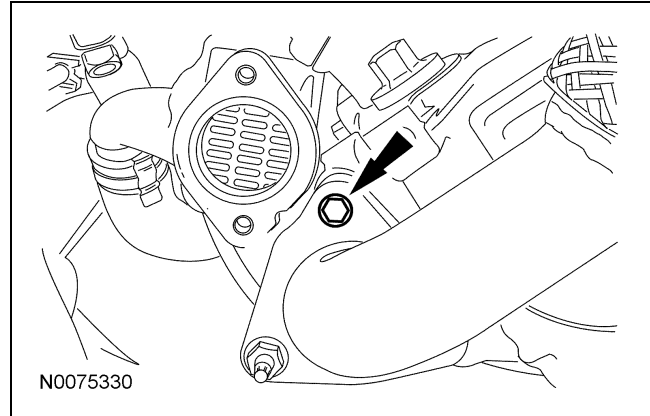
- Tighten to 18 Nm (159 lb-in).



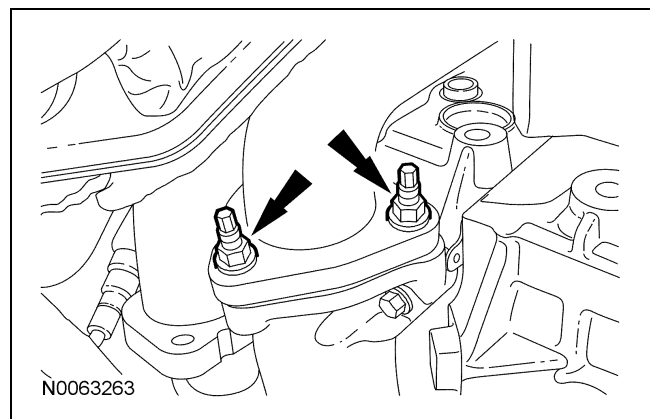
4. Position the new LH turbocharger inlet pipe-to-turbocharger gasket and loosely install the EGR-OC bracket and new bolts.
5. Loosely install new LH turbocharger inlet pipe-to-exhaust manifold nuts.




6. **NOTE:** To aid in installation, the upper LH turbocharger inlet pipe-to-exhaust manifold stud is replaced with bolt part number W302649.
- Loosely install a new LH turbocharger inlet pipe-to-exhaust manifold bolt.



7. Install the RH turbocharger inlet pipe-to-exhaust manifold gasket and position the RH turbocharger inlet pipe into the vehicle.
8. Position a new RH turbocharger inlet pipe-to-turbocharger gasket and install new bolts.
9. Loosely install new RH turbocharger inlet pipe-to-exhaust manifold nuts.
10. Tighten the LH turbocharger inlet pipe-to-turbocharger bolts.
- Tighten to 25 Nm (18 lb-ft).
11. Tighten the 2 LH turbocharger inlet pipe-to-exhaust manifold nuts.
- Tighten to 31 Nm (23 lb-ft).



REMOVAL AND INSTALLATION (Continued)

12.  **CAUTION:** Due to limited access, one of the specific Half-moon wrenches and other tools described must be used to correctly tighten the fasteners in this step. Failure to follow this instruction may result in engine failure.

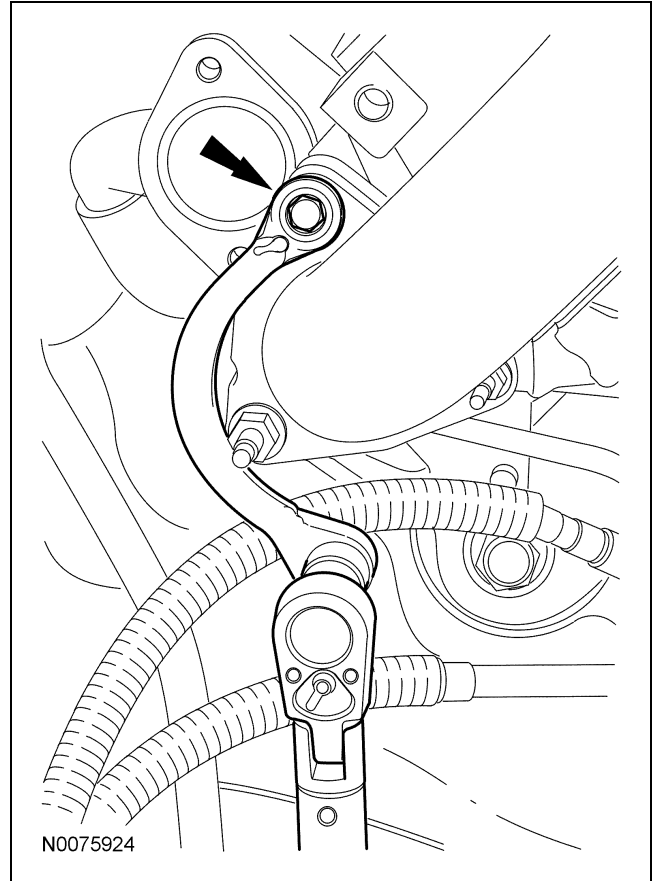
NOTE: To complete this step, it will be necessary to use the following tools:

- A 3/8-in drive torque wrench that is 368.3 mm (14.5 in) or 381.0 mm (15.0 in) from the center of the handle to the center of the square drive.
- One of the 10-mm/12-mm Half-moon wrenches listed in the following chart.
- A 12-mm Allen socket (to drive the Half-moon wrench).

NOTE: To obtain the specified torque value of 31 Nm (23 lb-ft), it will be crucial to orient the Half-moon wrench in the direction shown and 180 degrees (straight out) from the torque wrench. The torque wrench must be set to the value specified in the following chart, for the Half-moon wrench and torque wrench length being used.

Tighten the LH turbocharger inlet pipe-to-LH exhaust manifold bolt.

- Refer to the following chart for torque wrench setting, based on the specific Half-moon wrench and torque wrench length being used.



REMOVAL AND INSTALLATION (Continued)**Torque Chart — LH Turbocharger Inlet Pipe-to-LH Exhaust Manifold Upper Bolt**

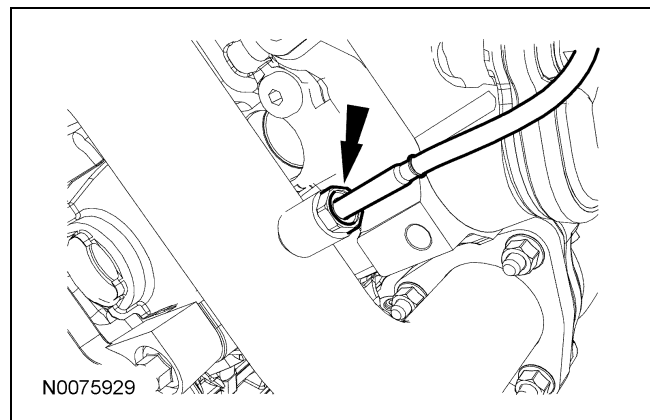
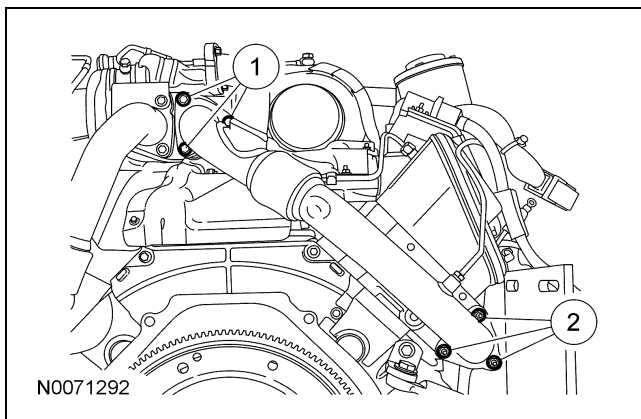
Half-Moon Wrench Brand	Wrench Part Number	Wrench Size	Torque Wrench Length	Torque Wrench Setting	
				Nm	lb-ft
Cornwell®	BWM-1012MM	10/12 mm	14.5 in	26	19
Gear Wrench®	9851	10/12 mm	14.5 in	23	17
Matco®	MHM1012	10/12 mm	14.5 in	22	16
Mac®	HMM1012R	10/12 mm	14.5 in	22	16
Snap-On®	CXM1012	10/12 mm	14.5 in	22	16
Cornwell®	BWM-1012MM	10/12 mm	15.0 in	27	20
Gear Wrench®	9851	10/12 mm	15.0 in	23	17
Matco®	MHM1012	10/12 mm	15.0 in	23	17
Mac®	HMM1012R	10/12 mm	15.0 in	23	17
Snap-On®	CXM1012	10/12 mm	15.0 in	23	17

NOTE: To achieve the required torque of 31 Nm (23 lb-ft), the torque wrench must be set to the appropriate Torque Wrench Setting listed in this chart.

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13. Tighten the RH turbocharger inlet pipe-to-turbocharger bolts and RH turbocharger inlet pipe-to-exhaust manifold nuts.

- 1 Tighten the bolts to 25 Nm (18 lb-ft).
- 2 Tighten the nuts to 31 Nm (23 lb-ft).




15. Position the EGR-OC pipe and install a new EGR-OC pipe-to-horizontal EGR cooler gasket and loosely install the new bolts.

14. Install the EGT sensor into the RH turbocharger inlet pipe.

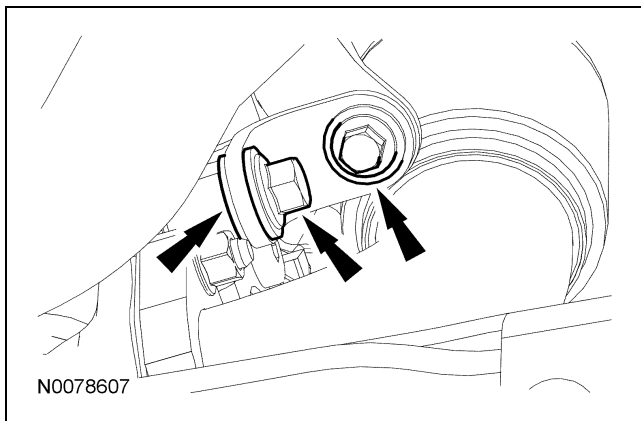
- Tighten to 44 Nm (32 lb-ft).

REMOVAL AND INSTALLATION (Continued)

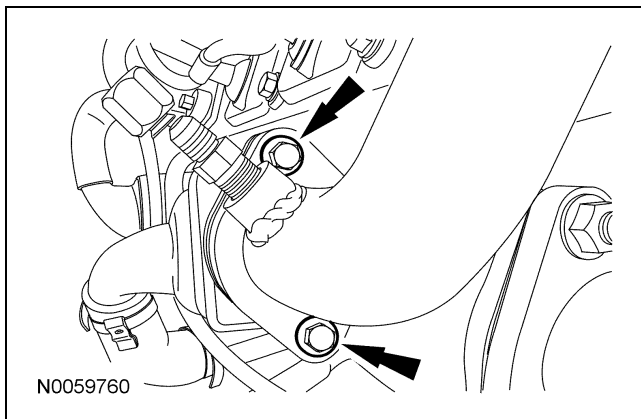
16.  **CAUTION:** Make sure the correct bolts are installed in the bracket or damage to the exhaust gas recirculation (EGR)-oxidation catalytic converter (OC) pipe may occur.

Install a new EGR-OC pipe-to-RH turbocharger inlet pipe gasket and loosely install new bolts. Loosely install new EGR-OC-to-turbocharger bracket bolts.

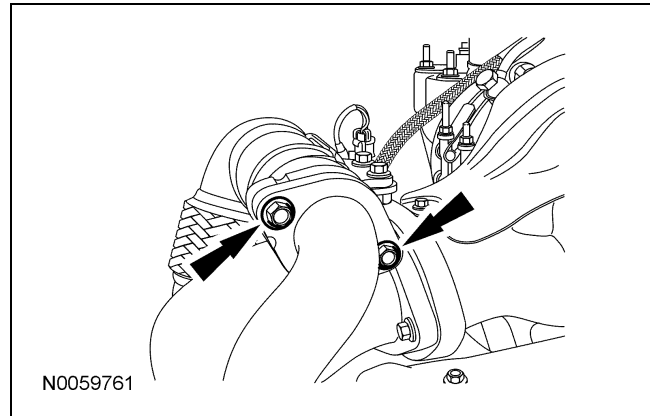
17. Position the cylinder head bracket and install the EGR-OC bracket-to-cylinder head bracket washer and a new bolt. Loosely install the cylinder head bracket-to-cylinder head washers and a new bolt. Finger tighten both bolts.



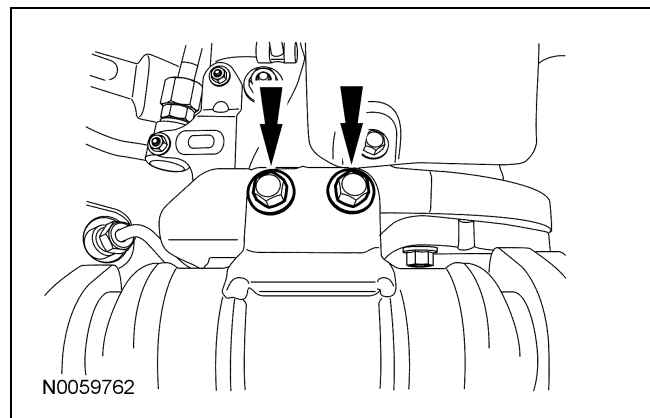
18. Tighten the EGR-OC-to-EGR cooler bolts.
- Tighten to 31 Nm (23 lb-ft).




19. Tighten the RH turbocharger inlet pipe-to-EGR-OC bolts.
- Tighten to 31 Nm (23 lb-ft).



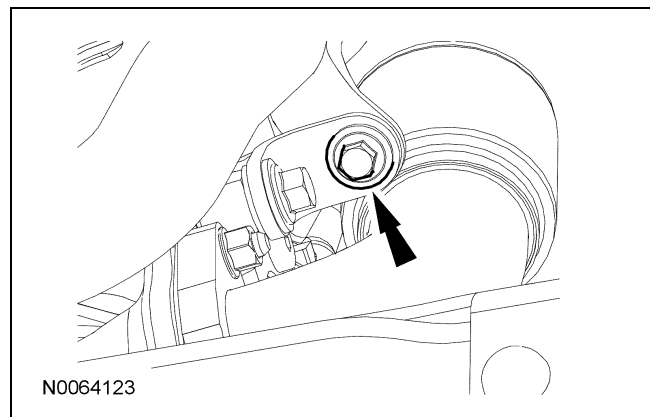
20. Tighten the EGR-OC-to-turbocharger bracket bolts.
- Tighten to 31 Nm (23 lb-ft).



21.  **CAUTION:** Failure to install and correctly tighten the exhaust gas recirculation (EGR)-oxidation catalytic converter (OC) pipe bracket bolt will result in damage to the horizontal EGR cooler and possible engine damage.

Tighten the EGR-OC bracket-to-cylinder head bracket bolt.

- Tighten to 31 Nm (23 lb-ft).



REMOVAL AND INSTALLATION (Continued)

22. ⚠ **CAUTION:** Failure to install and correctly tighten the exhaust gas recirculation (EGR)-oxidation catalytic converter (OC) pipe support bolt will result in damage to the horizontal EGR cooler and possible engine damage.

⚠ **CAUTION:** Due to limited access, one of the specific Half-moon wrenches and other tools described must be used to correctly tighten the fasteners in this step. Failure to follow this instruction may result in engine failure.

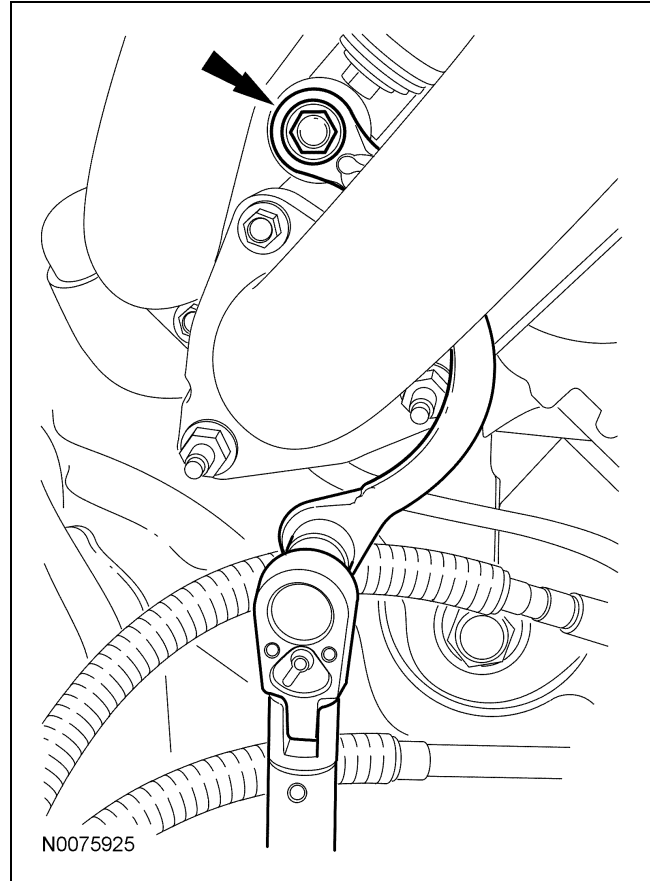
NOTE: To complete this step, it will be necessary to use the following tools:

- A 3/8-in drive torque wrench that is 368.3 mm (14.5 in) or 381.0 mm (15.0 in) from the center of the handle to the center of the square drive.
- One of the 11-mm/13-mm Half-moon wrenches listed in the following chart.
- An 11-mm Allen socket (to drive the Half-moon wrench).

NOTE: To obtain the specified torque value of 63 Nm (46 lb-ft), it will be crucial to orient the Half-moon wrench in the direction shown and 180 degrees (straight out) from the torque wrench. The torque wrench must be set to the value specified in the following chart, for the Half-moon wrench and torque wrench length being used.

Tighten the EGR-OC pipe bracket-to-LH cylinder head bolt.

- Refer to the following chart for torque wrench setting, based on the specific Half-moon wrench and torque wrench length being used.



REMOVAL AND INSTALLATION (Continued)

Torque Chart— EGR-OC Pipe Bracket-to-LH Cylinder Head Bolt

Half-Moon Wrench Brand	Wrench Part Number	Wrench Size	Torque Wrench Length	Torque Wrench Setting	
				Nm	lb-ft
Cornwell®	BWM-1113MM	11/13 mm	14.5 in	47	35
Gear Wrench®	9852	11/13 mm	14.5 in	46	34
Matco®	MHM1113	11/13 mm	14.5 in	46	34
Mac®	HMM1113R	11/13 mm	14.5 in	46	34
Snap-On®	CXM1113	11/13 mm	14.5 in	46	34
Cornwell®	BWM-1113MM	11/13 mm	15.0 in	49	36
Gear Wrench®	9852	11/13 mm	15.0 in	47	35
Matco®	MHM1113	11/13 mm	15.0 in	47	35
Mac®	HMM1113R	11/13 mm	15.0 in	47	35
Snap-On®	CXM1113	11/13 mm	15.0 in	47	35

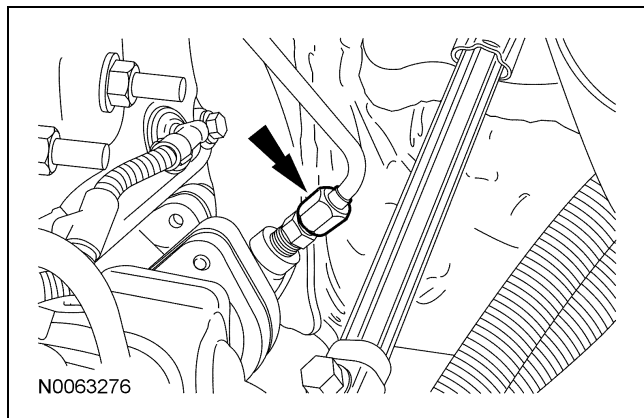
NOTE: To achieve the required torque of 62 Nm (46 lb-ft), the torque wrench must be set to the appropriate Torque Wrench Setting listed in this chart.

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23. Install the EP sensor tube fitting into the EGR-OC pipe.

- Tighten to 20 Nm (177 lb-in).

24. Install the exhaust downpipe. For additional information, refer to Exhaust Downpipe — 6.4L Diesel in this section.



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REMOVAL AND INSTALLATION

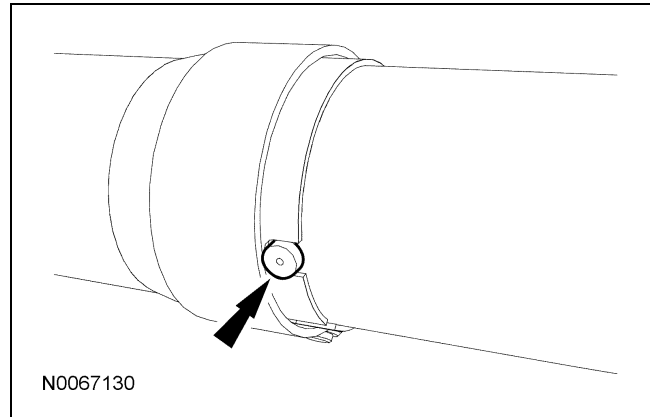
Exhaust Intermediate Pipe — 6.4L Diesel

Removal

1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
2. Remove the tailpipe. For additional information, refer to Tailpipe — 6.4L Diesel.
3. Loosen the exhaust intermediate pipe-to-diesel particulate filter Torca® clamp.
4. Remove the intermediate pipe from the vehicle.

Installation

1. Install the intermediate pipe into the vehicle and slide onto the diesel particulate filter.
2. Make sure the diesel particulate filter button is fully inserted into the button slot on the exhaust intermediate pipe and tighten the exhaust intermediate pipe-to-diesel particulate filter Torca® clamp.
 - Tighten to 55 Nm (41 lb-ft).



3. Install the tailpipe. For additional information, refer to Tailpipe — 6.4L Diesel.

4. **NOTE:** The exhaust system alignment procedure only needs to be carried out if the exhaust system isolators are not at zero load.

Check to see if the exhaust system isolators are at zero load. If the exhaust system isolators are not at zero load, then carry out the exhaust system alignment procedure. For additional information, refer to Exhaust System Alignment — 6.4L Diesel in this section.

REMOVAL AND INSTALLATION

Exhaust Intermediate Pipe — Gasoline Engines

Removal

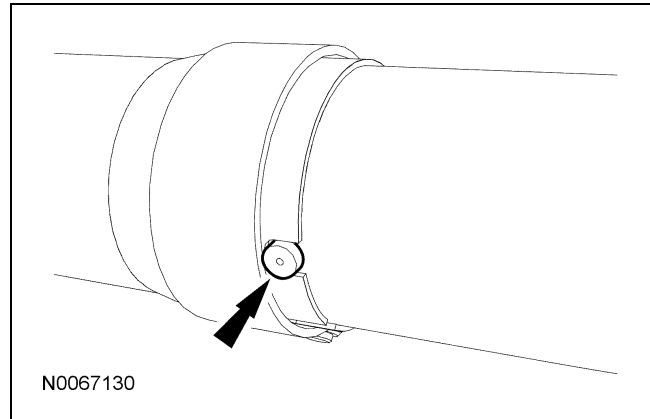
NOTE: Exhaust fasteners are of a torque prevailing design. Use only new fasteners with the same part number as the original. Torque values must be used as specified during reassembly to make sure of correct retention of exhaust components.

NOTE: Some vehicle applications are not equipped with an exhaust intermediate pipe.

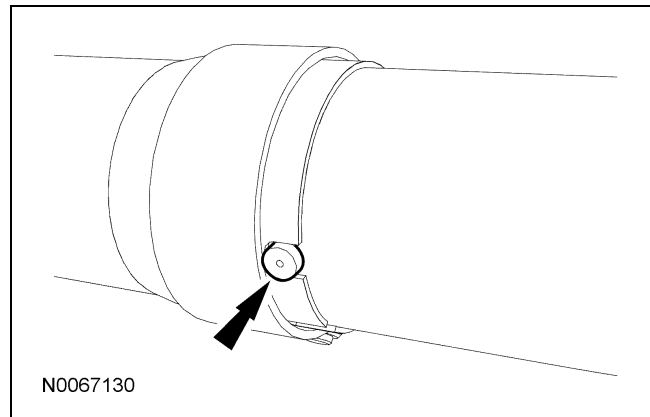
1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
2. Loosen the exhaust intermediate pipe-to-catalytic converter or catalytic converter delete pipe Torca® clamp.
3. Loosen the exhaust intermediate pipe-to-muffler Torca® clamp.
4. If equipped, disconnect the intermediate pipe from the isolator.
5. Disconnect the front muffler isolator.
6. Remove the exhaust intermediate pipe.

Installation

1. Position the exhaust intermediate pipe into the muffler and then onto the catalytic converter or delete pipe.
2. If equipped, connect the exhaust intermediate pipe isolator.
3. Connect the front muffler isolator.
4. Make sure the button on the catalytic converter or catalytic converter delete pipe is fully inserted into the button slot on the exhaust intermediate pipe and tighten the exhaust intermediate pipe-to-catalytic converter or catalytic converter delete pipe Torca® clamp.
 - Tighten to 55 Nm (41 lb-ft).



5. Make sure the button on the exhaust intermediate pipe is fully inserted into the button slot on the muffler and tailpipe and tighten the exhaust intermediate pipe-to-muffler and tailpipe Torca® clamp.
 - Tighten to 55 Nm (41 lb-ft).



REMOVAL AND INSTALLATION (Continued)

6. **NOTE:** The exhaust system alignment procedure only needs to be carried out if the exhaust system isolators are not at zero load.

Check to see if the exhaust system isolators are at zero load. If the exhaust system isolators are not at zero load, carry out the exhaust system alignment procedure. For additional information, refer to Exhaust System Alignment — Gasoline Engines in this section.

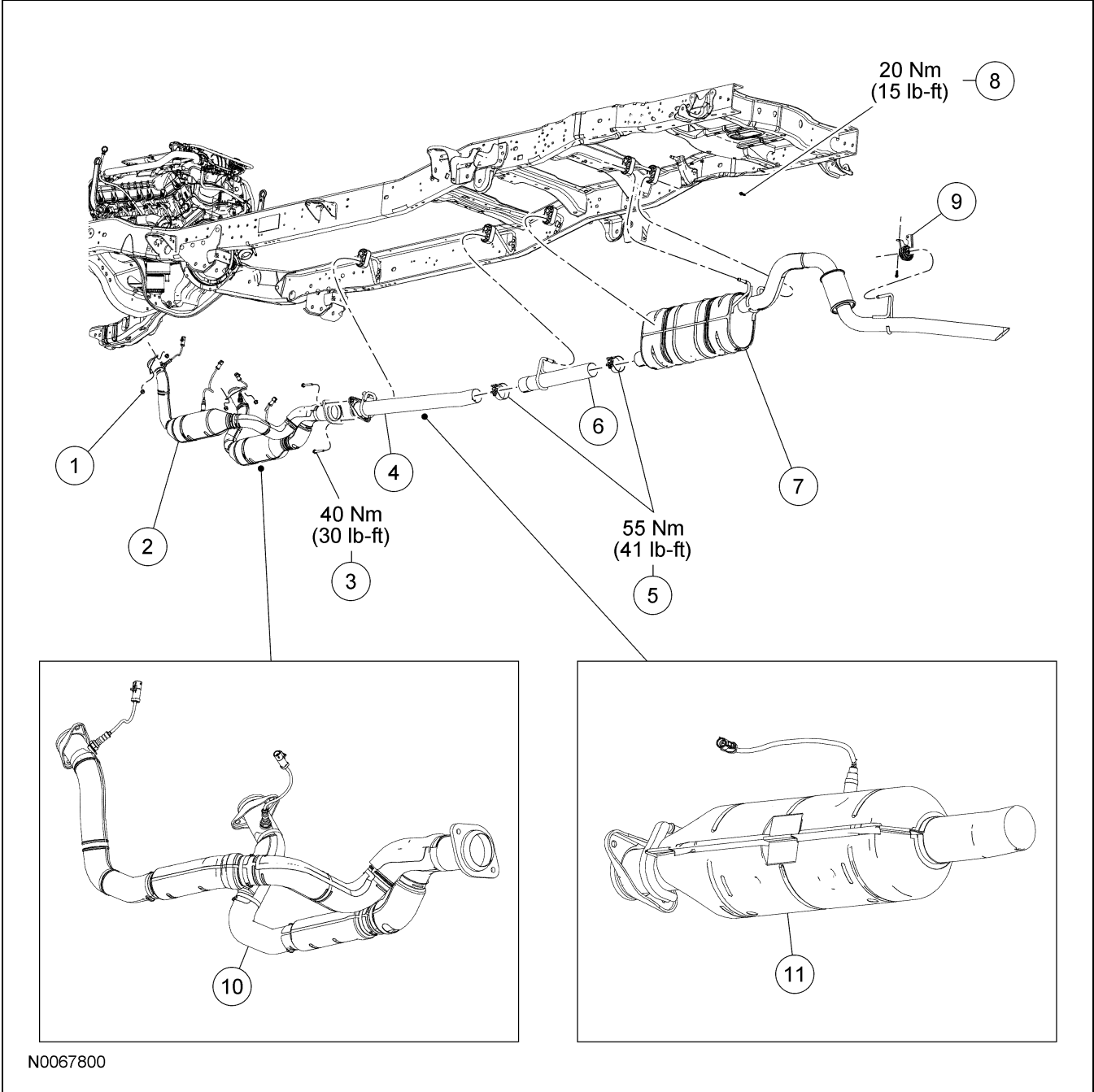
REMOVAL AND INSTALLATION

Exhaust System — Exploded View

Exhaust System — Gasoline Engine

NOTE: Exhaust systems will vary by wheelbase, frames will vary by width and length.

NOTE: Vehicle body removed from art for clarity.



Item	Part Number	Description
1	W705443	Exhaust Y-pipe-to-exhaust manifold nut (4 required)
2	5F250	Exhaust Y-pipe with dual catalytic converter

(Continued)

Item	Part Number	Description
3	W711365	Exhaust Y-pipe-to-catalytic converter delete pipe bolt (2 required)

(Continued)

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
4	5246	Catalytic converter delete pipe
5	5A281	Torca® clamps
6	5A212	Exhaust intermediate pipe
7	5230	Muffler and tailpipe assembly
8	W709736	Tailpipe hanger bolt (2 required)

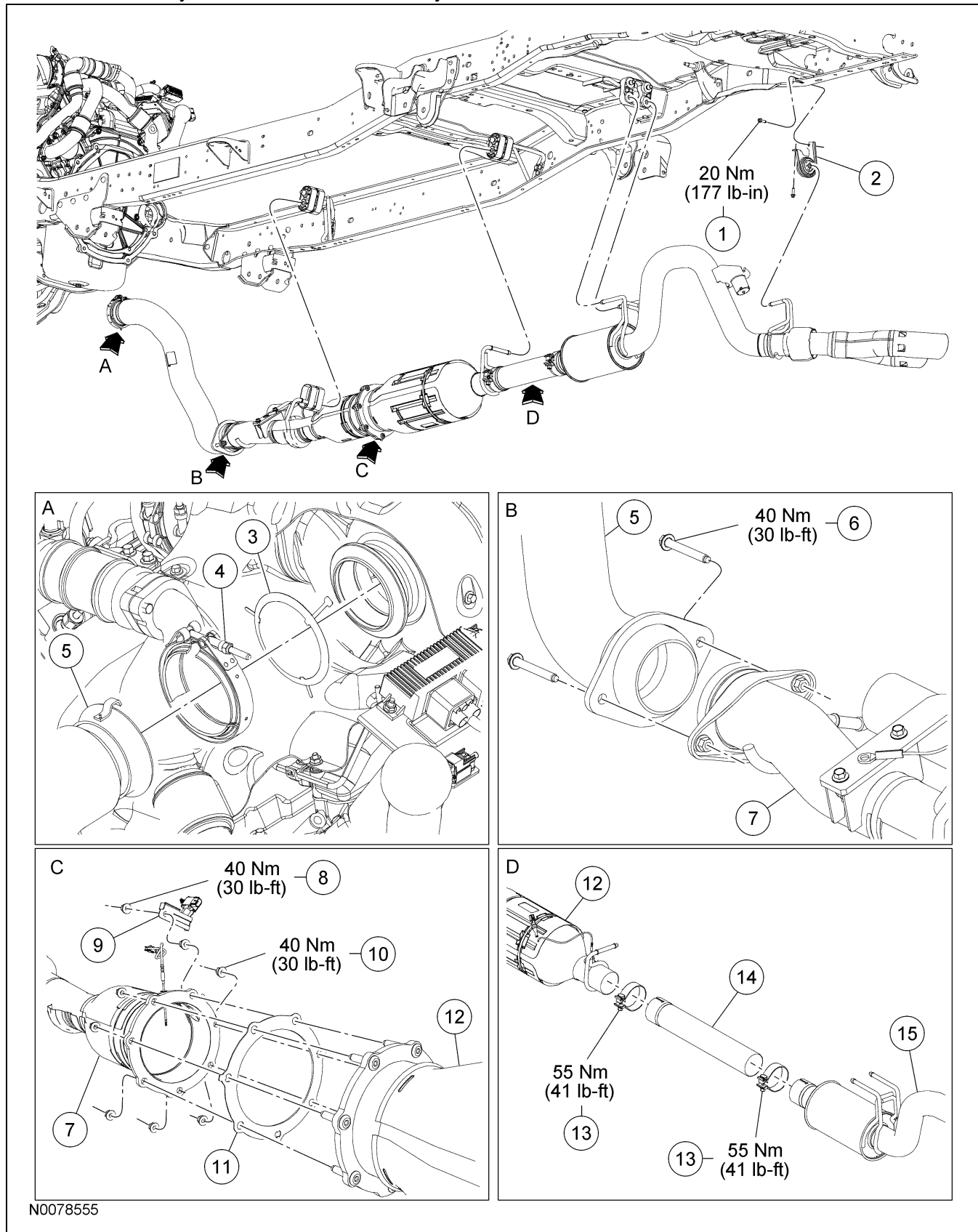
(Continued)

Item	Part Number	Description
9	5260	Tailpipe hanger
10	5246	Exhaust Y-pipe without dual catalytic converters
11	5E212	Catalytic converter

REMOVAL AND INSTALLATION (Continued)**Exhaust System — 6.4L Diesel Engine**

NOTE: Exhaust systems will vary by wheelbase, frames will vary by width and length.

NOTE: Vehicle body removed from art for clarity.



REMOVAL AND INSTALLATION (Continued)

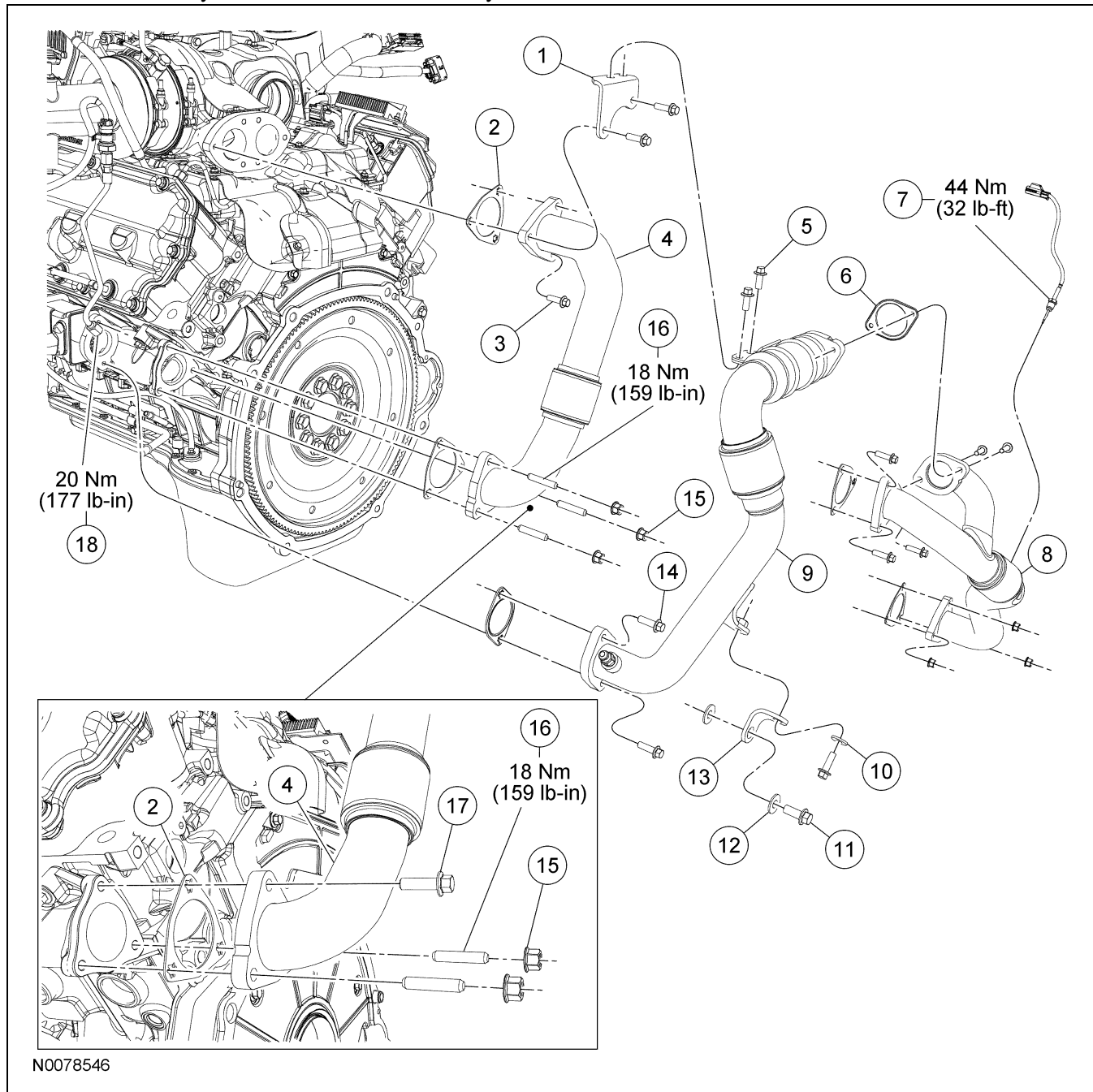
Item	Part Number	Description
1	5261	Tailpipe hanger bolt (2 required)
2	W709736	Tailpipe hanger
3	6L612	Downpipe-to-turbocharger gasket
4	5A281	Downpipe-to-turbocharger clamp
5	6N646	Exhaust downpipe
6	W711407	Exhaust downpipe-to-oxidation catalytic converter (OC) bolt (2 required)
7	5H267	OC

(Continued)

Item	Part Number	Description
8	—	Back pressure sensor bracket nut
9	—	Back pressure sensor and bracket
10	W705443	OC-to-diesel particulate filter nut (7 required)
11	5E241	OC-to-diesel particulate filter gasket
12	5H221	Diesel particulate filter
13	5A281	Torca® clamps
14	5A212	Exhaust intermediate pipe
15	5230	Tailpipe

REMOVAL AND INSTALLATION (Continued)**Turbocharger Inlet Pipes and EGR-Oxidation Catalytic Converter (OC) Pipe — 6.4L Diesel**

NOTE: Vehicle body removed from art for clarity.



Item	Part Number	Description
1	5D261	EGR-oxidation catalytic converter (OC) pipe bracket
2	6N640	Turbocharger inlet pipe gasket (4 required)
3	W302649	Turbocharger inlet pipe and EGR-OC bolt (8 required)
4	6K854	LH turbocharger inlet pipe

(Continued)

Item	Part Number	Description
5	W300003	EGR-OC pipe-to-EGR-OC pipe bracket bolt (2 required)
6	6N640	EGR-OC pipe gasket (2 required)
7	12B591	Exhaust gas temperature (EGT) sensor
8	6K854	RH turbocharger inlet pipe
9	5H267	EGR-OC pipe

(Continued)

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
10	W302142	EGR-OC pipe bracket-to-cylinder head bracket washer
11	W301402	Cylinder head bracket-to-cylinder head bolt
12	W302624	Cylinder head bracket-to-cylinder head washer (2 required)
13	5D261	EGR-OC pipe bracket-to-cylinder head bracket
14	W302649	EGR-OC pipe-to-EGR cooler bolt (2 required)

(Continued)

Item	Part Number	Description
15	W302494	Turbocharger inlet pipe-to-exhaust manifold nut (6 required)
16	W302495	Turbocharger inlet pipe-to-exhaust manifold stud
17	W302649	LH turbocharger inlet pipe-to-exhaust manifold bolt (service only)
18	—	Exhaust pressure (EP) sensor tube fitting (part of 9J460)

1. For additional information, refer to the procedures in this section.

DESCRIPTION AND OPERATION

Exhaust System

The 6.4L diesel exhaust system consists of the following:

- Turbocharger inlet pipes
- EGR-oxidation catalytic converter (OC) pipe
- Downpipe
- OC
- Diesel particulate filter
- Intermediate pipe (if equipped)
- Tailpipe with a built-in resonator

The gasoline exhaust system consists of the following:

- Exhaust Y-pipe
- Catalytic converter (if equipped)
- Catalytic converter delete pipe (if equipped)
- Intermediate pipe (if equipped)
- Muffler and tailpipe assembly

Exhaust System

The exhaust system provides an exit for exhaust gases and reduces engine noise by passing exhaust gases through the catalytic converter and a muffler assembly. Rubber exhaust hanger isolators attach the exhaust system to the mounting hooks.

Turbocharger Inlet Pipe — 6.4L Diesel

The turbocharger inlet pipes transport the exhaust gas from the exhaust manifolds to the turbocharger. The expansion joint in the turbocharger inlet pipes is to accommodate thermal growth in the turbocharger inlet pipes and is not an assembly aid. The turbocharger inlet pipes should not be bent or twisted at the expansion joint.

EGR-Oxidation Catalytic Converter (OC) — 6.4L Diesel

The EGR-OC pipe transports exhaust gases to the EGR coolers. The EGR-OC pipe contains a honeycomb filter with a catalyst. The catalyst keeps the EGR coolers clean by removing heavy chain hydrocarbons or soluble organic fraction from the exhaust gas stream.

The bracket from the EGR-OC pipe to the cylinder head is critical for durability of the horizontal EGR cooler. This bracket must be correctly assembled with bolts to prevent damage to the EGR cooler.

Catalytic Converter — Gasoline Engines

The catalytic converter plays a major role in the emission control system. The catalytic converter operates as a gas reactor. Its catalytic function is to speed the heat-producing chemical reaction of components in the exhaust gases in order to reduce air pollutants. The catalyst material inside the catalytic converter consists of a ceramic substrate.

The catalytic converter is designed to provide a long life. No maintenance is necessary for the catalytic converter.

Oxidation Catalytic Converter (OC) and Diesel Particulate Filter — 6.4L Diesel

The OC is coupled to a diesel particulate filter which reduces the amount of air pollutants in the exhaust emitted from the tailpipe. The OC is a ceramic catalytic converter which oxidizes hydrocarbons in the exhaust and generates heat for diesel particulate filter regeneration. The diesel particulate filter is a highly engineered silicon carbide wall-flow catalyst that traps particulates. As soot gathers in the system it begins to restrict the filter and the filter needs to be periodically cleaned. The soot can be cleaned in 2 different ways: Passive regeneration and active regeneration. Both methods occur automatically and require no action from the driver/operator.

Over time a slight amount of ash will build up in the diesel particulate filter which is not removed during the regeneration process. The diesel particulate filter will need to be removed for ash cleaning at approximately 193,000 km (120,000 mi) or greater (actual mileage can vary greatly depending upon engine/vehicle operating conditions) and replaced with a new or remanufactured (ash cleaned) part. A new diesel particulate filter will need to be installed at approximately 400,000 km (250,000 mi) or greater depending on engine/vehicle operating conditions. In both cases the PCM will set a check engine light to inform the customer to bring the vehicle to the dealer for service. If there are any issues with the oxidation catalytic converter/diesel particulate filter system, a check engine light will be set by the PCM.

DESCRIPTION AND OPERATION (Continued)

Passive Regeneration — 6.4L Diesel

Passive regeneration occurs naturally as a result of normal engine operating conditions. During passive regeneration, the exhaust constituents/temperature are at an appropriate level where some soot can be reduced or oxidized (burned) thus cleaning the filter.


Active Regeneration — 6.4L Diesel


Active regeneration, which is initiated by the PCM, will occur when there is not enough passive regeneration occurring due to vehicle drive patterns. In an active regeneration, the diesel particulate filter is cleaned by raising the exhaust temperature to a point where the soot is burned away. After the soot is burned off, the exhaust temperature and back pressure (restriction) fall back to normal levels.


Sound Insulators and Shields


Sound insulators and shields attached to the underbody protect the vehicle from exhaust system heat and should be inspected at regular intervals to make sure they are not dented or out of position. If a sound insulator and shield is damaged or shows evidence of deterioration, a new sound insulator and shield should be installed. The sound insulators and shields for the muffler, exhaust downpipe, inlet pipe and catalytic converter pipe are installed separately.


Precautions


 **WARNING:** Keep the holes and tabs in the tailpipe free of foreign material or blockage. Do not modify or permanently remove the tailpipe section that contains the holes. Operating the vehicle with plugged or blocked holes or with modifications to the system may result in elevated exhaust gas temperatures, which may burn persons contacted by the exhaust gas. Failure to follow these instructions may result in serious personal injury to the technician or vehicle occupant(s).


 **WARNING:** Initiate a manual regeneration of the diesel particulate filter (DPF) only when the vehicle is on the ground with the area around the tailpipe free of people, obstructions, foreign material or other items. Manual regeneration causes the exhaust gas to quickly get **VERY HOT**. Failure to follow these instructions may result in serious personal injury.

 **CAUTION:** Do not use leaded fuel in a vehicle equipped with a catalytic converter. In a vehicle that is continually misfueled, the lead in the fuel will be deposited in the catalytic converter and completely blanket the catalyst. Lead reacts with platinum to “poison” the catalyst. Continuous use of leaded fuel can destroy the catalyst and render the catalytic converter useless.

 **CAUTION:** The addition of lead to the catalytic converter can also solidify the catalyst, causing excessive back pressure in the exhaust system and possibly causing engine damage.

 **CAUTION:** For areas where ultra low sulfur diesel fuel (15 ppm sulfur maximum) is required, use only ultra low sulfur diesel fuel in diesel vehicles equipped with an oxidation catalytic converter (OC) and diesel particulate filter. In a diesel vehicle that is continually misfueled by using low sulfur (16-500 ppm) or high sulfur (500 ppm or greater) diesel fuel, the sulfur can effectively poison the catalyst. Continuous use of low sulfur or high sulfur can destroy the catalyst and render the catalyst useless.

 **CAUTION:** Extremely high temperatures (1,100°C [2,012°F] or above) due to misfiring or over-rich fuel/air mixture will cause the ceramic substrate or diesel particulate filter substrate to sinter or burn, destroying the catalytic converter, oxidation catalytic converter (OC) and/or diesel particulate filter. Do not continue to operate the vehicle if the engine is misfiring, there is a power loss or other unusual operating conditions, such as engine overheating and backfiring.

 **CAUTION:** Do not use oil or grease-based lubricants on the isolators. These lubricants may cause deterioration of the isolator. This can lead to separation of the isolator from the exhaust hanger bracket during vehicle operation.

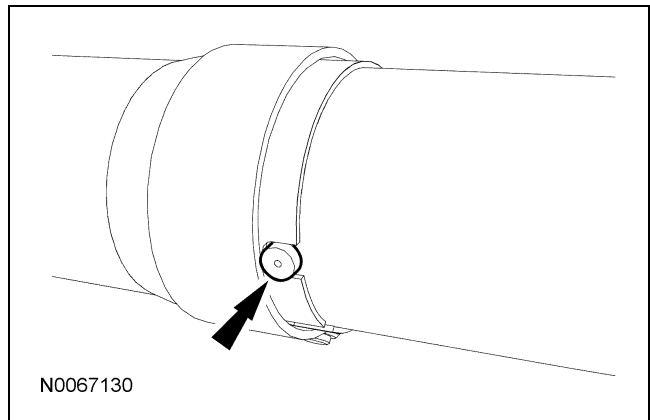
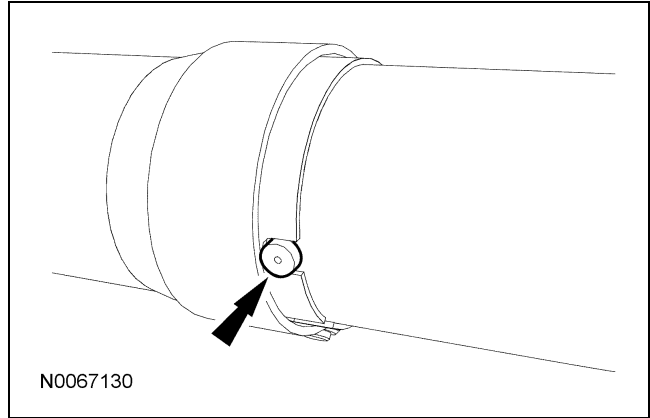
NOTE: Exhaust fasteners are of a prevailing torque design. Use only new fasteners with the same part number as the original. Torque values must be used as specified during reassembly to make sure of correct retention of exhaust components.

Make sure to follow these precautions when carrying out the procedures in this section.

GENERAL PROCEDURES

Exhaust System Alignment — 6.4L Diesel

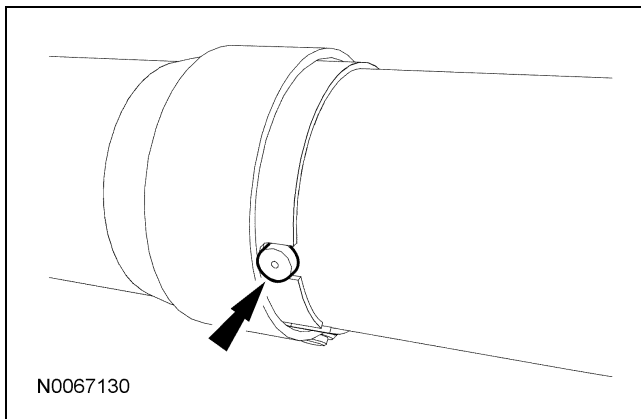
1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
2. **NOTE:** Do not loosen the oxidation catalytic converter (OC)-to-diesel particulate filter nuts. Loosen all fasteners joining the exhaust system components.
 - Discard all fasteners and the turbocharger-to-downpipe gasket.
3. Loosely install new exhaust downpipe-to-OC bolts.
4. Install a new exhaust downpipe-to-turbocharger gasket.
5. Install the exhaust downpipe to the turbocharger and a new exhaust downpipe-to-turbocharger clamp.
 - Make sure the exhaust downpipe clip is over the lip on the turbocharger.
 - Align the new exhaust downpipe-to-turbocharger clamp so that the exhaust downpipe clip and the opening in the exhaust downpipe-to-turbocharger clamp are aligned and tightened to maintain position.
 - Align the downpipe so that the area just above the flat in the pipe is approximately 20 mm (0.787 in) from the frame.
 - Tighten to 10 Nm (89 lb-in).
6. Tighten the exhaust downpipe-to-OC bolts.
 - Tighten to 40 Nm (30 lb-ft).
7. Tighten the exhaust downpipe-to-turbocharger clamp.
 - Tighten to 15 Nm (133 lb-in).
8. Make sure the diesel particulate filter button is fully inserted into the button slot on the tailpipe or, if equipped, the exhaust intermediate pipe; then tighten the diesel particulate filter-to-muffler Torca® clamp or, if equipped, the exhaust intermediate pipe Torca® clamp.
 - Tighten to 55 Nm (41 lb-ft).
9. If equipped, make sure the button on the exhaust intermediate pipe is fully inserted into the button slot on the tailpipe and tighten the muffler and tailpipe-to-exhaust intermediate pipe Torca® clamp.
 - Tighten to 55 Nm (41 lb-ft).
10. Start the engine and check the exhaust system for leaks.



GENERAL PROCEDURES

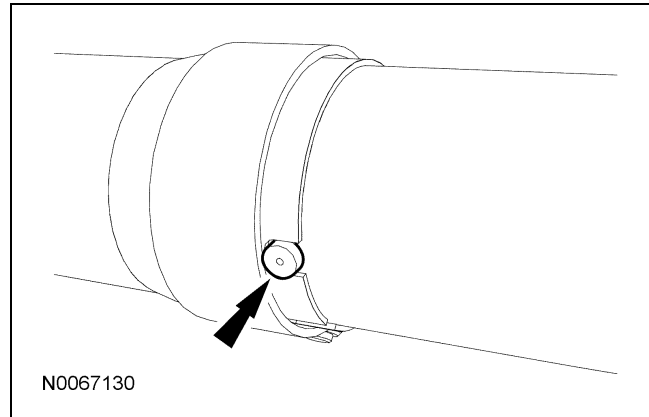
Exhaust System Alignment — Gasoline Engines

1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
2. Loosen all fasteners joining the exhaust system components.
3. Beginning at the front of the vehicle, align the exhaust system to establish the maximum clearance. Make sure all fit pipes are pushed all the way into the preceding pipe and the notches are correctly lined up with the tabs.

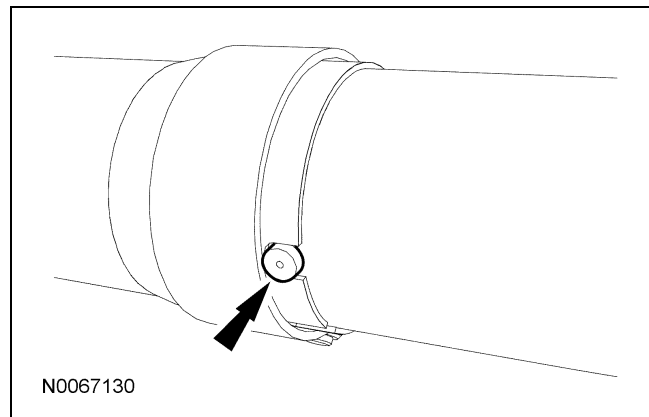


4. Align the Y-pipe outlet and tighten the catalytic converter-to-exhaust manifold nuts to specification as follows:
 - Tighten the RH leg of the Y-pipe. Tighten the outboard exhaust manifold stud-to-Y-pipe nut to 20 Nm (15 lb-ft). Tighten the inboard exhaust manifold stud-to-Y-pipe nut to 40 Nm (30 lb-ft), then tighten the outboard exhaust manifold stud-to-Y-pipe nut to 40 Nm (30 lb-ft).
 - Tighten the LH leg of the Y-pipe. Tighten the outboard exhaust manifold stud-to-Y-pipe nut to 20 Nm (15 lb-ft). Tighten the inboard exhaust manifold stud-to-Y-pipe nut to 40 Nm (30 lb-ft), then tighten the outboard exhaust manifold stud-to-Y-pipe nut to 40 Nm (30 lb-ft).
5. Align the Y-pipe flange to catalytic converter or catalytic converter delete pipe flare.
 - Tighten to 40 Nm (30 lb-ft).

6. Make sure the catalytic converter or catalytic converter delete pipe button is fully inserted into the button slot on the muffler and tailpipe or, if equipped, the exhaust intermediate pipe; then tighten the catalytic converter or catalytic converter delete pipe-to-muffler Torca® clamp or, if equipped, the exhaust intermediate pipe Torca® clamp.
 - Tighten to 55 Nm (41 lb-ft).



7. If equipped, make sure the button on the exhaust intermediate pipe is fully inserted into the button slot on the muffler and tailpipe, and tighten the muffler and tailpipe-to-exhaust intermediate pipe Torca® clamp.
 - Tighten to 55 Nm (41 lb-ft).



GENERAL PROCEDURES (Continued)

8. Start the engine and check the exhaust system for leaks.
-

REMOVAL AND INSTALLATION

Exhaust Y-Pipe — Gasoline Engines

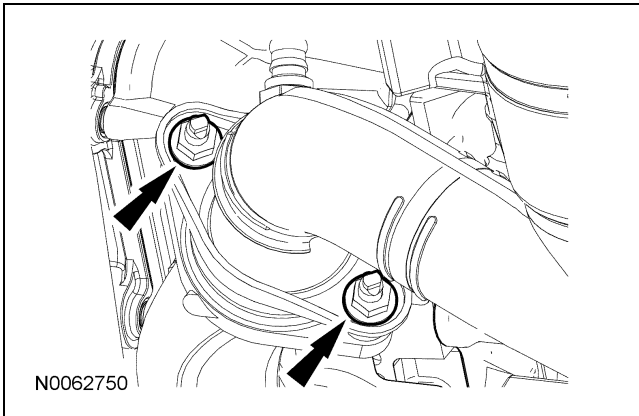
Removal

NOTE: Exhaust fasteners are of a torque prevailing design. Use only new fasteners with the same part number as the original. Torque values must be used as specified during reassembly to make sure of correct retention of exhaust components.

1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
2. Disconnect the 2 heated oxygen sensors (HO2S) and the 2 catalyst monitor sensor electrical connectors.
3. Remove the 2 exhaust Y-pipe flange bolts.
4. **NOTE:** LH exhaust manifold-to-exhaust Y-pipe shown, RH similar.

With the help of an assistant, remove the 4 exhaust manifold-to-exhaust Y-pipe nuts and the exhaust Y-pipe assembly from the vehicle.

- Discard the nuts.

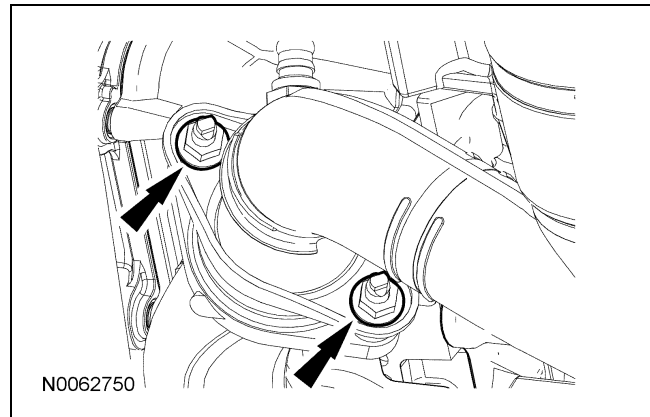


Installation

NOTE: Do not tighten any fasteners until all components are aligned.

1. **NOTE:** LH exhaust manifold-to-exhaust Y-pipe shown, RH similar.

With the help of an assistant, position the exhaust Y-pipe into the vehicle and loosely install 4 new exhaust Y-pipe-to-exhaust manifold nuts.



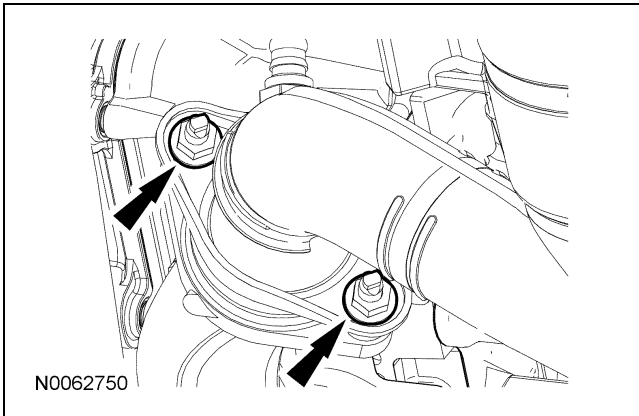
2. Loosely install the 2 exhaust Y-pipe flange bolts.

REMOVAL AND INSTALLATION (Continued)

3. **NOTE:** Make sure the exhaust Y-pipe is aligned to provide maximum clearance to adjacent parts.

To seat the LH exhaust manifold-to-exhaust Y-pipe nuts, tighten the nuts in the following sequence.

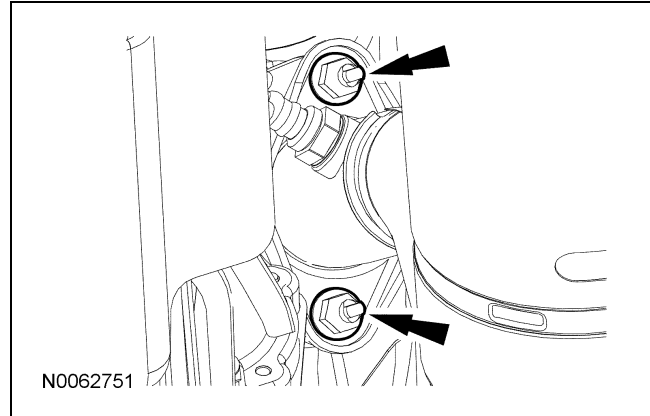
- Tighten the lower LH exhaust manifold-to-exhaust Y-pipe nut to 20 Nm (177 lb-in).
- Tighten the upper LH exhaust manifold-to-exhaust Y-pipe nut to 40 Nm (30 lb-ft).
- Tighten the lower LH exhaust manifold-to-exhaust Y-pipe nut to 40 Nm (30 lb-ft).



4. **NOTE:** Make sure the exhaust Y-pipe is aligned to provide maximum clearance to adjacent parts.

To seat the RH exhaust manifold-to-Y-pipe nuts, tighten the nuts in the following sequence.

- Tighten the lower RH exhaust manifold-to-exhaust Y-pipe nut to 20 Nm (177 lb-in).
- Tighten the upper RH exhaust manifold-to-exhaust Y-pipe nut to 40 Nm (30 lb-ft).
- Tighten the lower RH exhaust manifold-to-exhaust Y-pipe nut to 40 Nm (30 lb-ft).



5. Tighten the 2 exhaust Y-pipe flange bolts.
- Tighten to 40 Nm (30 lb-ft).
6. Connect the HO2S and the 2 catalyst monitor sensor electrical connectors.
7. **NOTE:** The exhaust system alignment procedure only needs to be carried out if the exhaust system isolators are not at zero load. Check to see if the exhaust system isolators are at zero load. If the exhaust system isolators are not at zero load, carry out the exhaust system alignment procedure. For additional information, refer to Exhaust System Alignment — Gasoline Engines in this section.

2008 Ford F-350 SUPER DUTY

Submodel: XLT | Engine Type: V8 | Liters: 5.4
Fuel Delivery: FI | Fuel: GAS

GROUP 09: Exhaust System

SECTION 309-00: Exhaust System

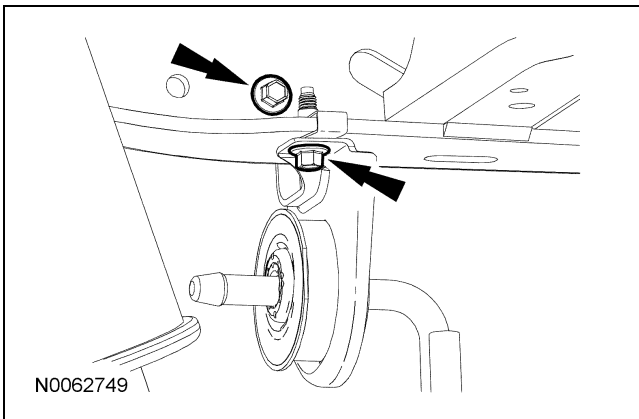
REMOVAL AND INSTALLATION

Muffler and Tailpipe — Gasoline Engines

Removal

NOTE: Exhaust fasteners are of a torque prevailing design. Use only new fasteners with the same part number as the original. Torque values must be used as specified during reassembly to make sure of correct retention of exhaust components.

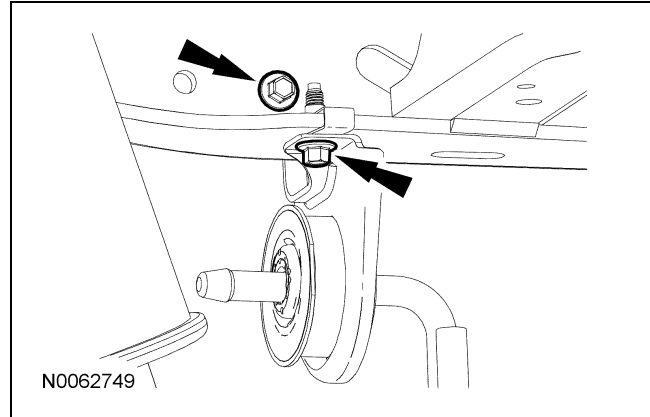
1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
2. Loosen the catalytic converter-to-muffler coupling or, if equipped, the exhaust intermediate pipe-to-muffler coupling.
3. Support the muffler and tailpipe assembly.
4. Disconnect the muffler isolators.
5. Remove the 2 tailpipe isolator and bracket bolts from the frame and remove from the tailpipe.



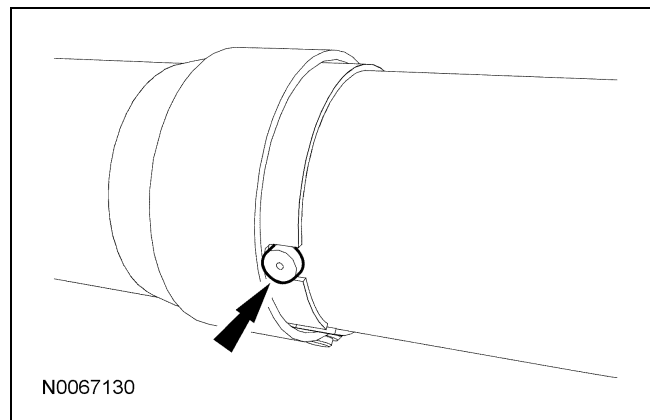
6. Remove the muffler and tailpipe from the vehicle.

Installation

1. Position the muffler and tailpipe into the vehicle and support.
2. Install the tailpipe isolator and bracket onto the tailpipe and install the 2 tailpipe isolator and bracket bolts to the frame.
 - Tighten to 20 Nm (177 lb-in).



3. Connect the muffler isolators.
4. Install the catalytic converter or catalytic converter delete pipe or, if equipped, the intermediate pipe into the muffler and tailpipe.
5. Make sure the button on the catalytic converter or catalytic converter delete pipe or, if equipped, the exhaust intermediate pipe is fully inserted into the button slot on the muffler and tailpipe. Tighten the muffler and tailpipe-to-catalytic converter or catalytic converter delete pipe or, if equipped, the exhaust intermediate pipe Torca® clamp.
 - Tighten to 55 Nm (41 lb-ft).



REMOVAL AND INSTALLATION (Continued)

6. **NOTE:** The exhaust system alignment procedure only needs to be carried out if the exhaust system isolators are not at zero load.

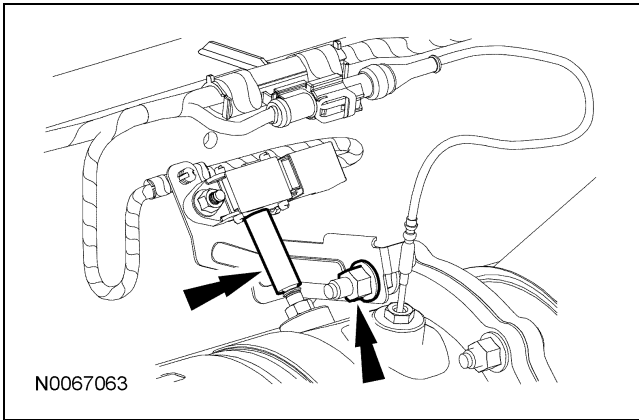
Check to see if the exhaust system isolators are at zero load. If the exhaust system isolators are not at zero load, carry out the exhaust system alignment procedure. For additional information, refer to Exhaust System Alignment — Gasoline Engines in this section.

REMOVAL AND INSTALLATION

Oxidation Catalytic Converter (OC) — 6.4L Diesel

Removal

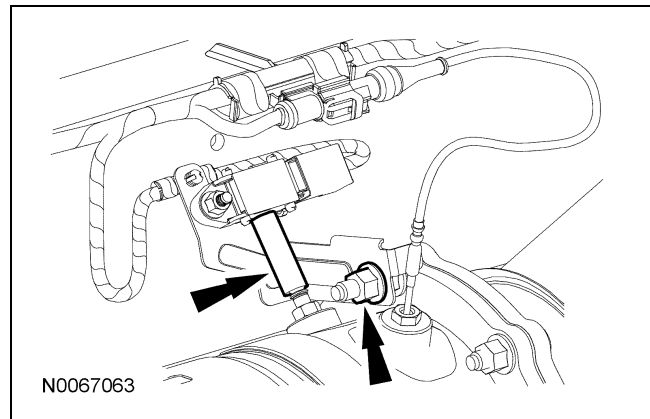
1. With the vehicle in NEUTRAL, position it on a hoist. For additional, refer to Section 100-02.
2. Remove the back pressure sensor bracket and nut and disconnect the back pressure sensor tube.



3. Disconnect the exhaust gas temperature (EGT) sensor electrical connectors.
4. Remove the resonator and tailpipe assembly. For additional information, refer to Tailpipe — 6.4L Diesel.
5. Remove the 7 diesel particulate filter-to-oxidation catalytic converter (OC) nuts.
 - Discard the nuts.
6. Disconnect the isolators and remove the diesel particulate filter and, if equipped, the intermediate pipe as an assembly.
 - Discard the diesel particulate filter-to-OC gasket.
7. Support the OC.
8. Remove the OC-to-downpipe bolts.
9. Disconnect the OC isolators and remove the OC from the vehicle.

Installation

1. Position the OC in the vehicle and connect the isolators.
2. Install OC-to-downpipe bolts.
 - Tighten to 40 Nm (30 lb-ft).
3. **NOTE:** Make sure the diesel particulate filter-to-OC gasket surface is clean. Install a new diesel particulate filter-to-OC gasket.
4. Position the diesel particulate filter and, if equipped, the intermediate pipe as an assembly into the vehicle and connect the isolators.
5. Install the 7 new OC-to-diesel particulate filter nuts.
 - Tighten to 40 Nm (30 lb-ft).
6. Install the resonator and tailpipe assembly into the vehicle. For additional information, refer to Tailpipe — 6.4L Diesel.
7. Connect the back pressure sensor to the tube and install the back pressure sensor and nut.
 - Tighten to 40 Nm (30 lb-ft).



8. Connect the EGT sensor electrical connectors.

REMOVAL AND INSTALLATION (Continued)

9. **NOTE:** The exhaust system alignment procedure only needs to be carried out if the exhaust system isolators are not at zero load.

Check to see if the exhaust system isolators are at zero load. If the exhaust system isolators are not at zero load, carry out the exhaust system alignment procedure. For additional information, refer to Exhaust System Alignment — 6.4L Diesel in this section.

2008 Ford F-350 SUPER DUTY

Submodel: XLT | Engine Type: V8 | Liters: 5.4
Fuel Delivery: FI | Fuel: GAS

SECTION 309-00:
Exhaust System

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DESCRIPTION AND OPERATION
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Symptom Chart — Noise, Vibration and Harshness (NVH)
Pinpoint Test
Pinpoint Test
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Exhaust System Alignment — Gasoline Engines
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REMOVAL AND INSTALLATION
Exhaust System — Exploded View
Exhaust Gas Recirculation (EGR) Oxidation Catalytic Converter (OC) and Turbocharger Inlet Pipes — 6.4L Diesel, Body Off
Exhaust Gas Recirculation (EGR) Oxidation Catalytic Converter (OC) and Turbocharger Inlet Pipes — 6.4L Diesel, Body On
Exhaust Gas Recirculation (EGR) Oxidation Catalytic Converter (OC) — 6.4L Diesel
Turbocharger Inlet Pipe — LH, 6.4L Diesel
Turbocharger Inlet Pipe — RH, 6.4L Diesel
Exhaust Y-Pipe — Gasoline Engines
Exhaust Downpipe — 6.4L Diesel
Catalytic Converter — Gasoline Engines
Oxidation Catalytic Converter (OC) — 6.4L Diesel
Diesel Particulate Filter — 6.4L Diesel
Exhaust Intermediate Pipe — Gasoline Engines
Exhaust Intermediate Pipe — 6.4L Diesel
Muffler and Tailpipe — Gasoline Engines
Tailpipe — 6.4L Diesel

REMOVAL AND INSTALLATION

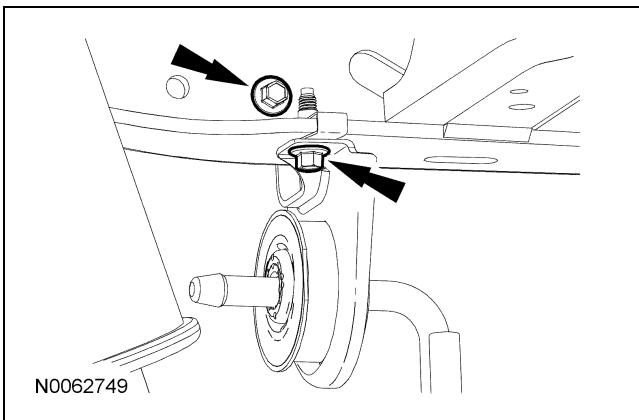
Tailpipe — 6.4L Diesel

Removal

⚠ WARNING: Keep the holes and tabs in the tailpipe free of foreign material or blockage. Do not modify or permanently remove the tailpipe section that contains the holes. Operating the vehicle with plugged or blocked holes or with modifications to the system may result in elevated exhaust gas temperatures, which may burn persons contacted by the exhaust gas. Failure to follow these instructions may result in serious personal injury to the technician or vehicle occupant(s).

NOTE: Do not modify, install an aftermarket part, or permanently remove the tailpipe.

1. With the vehicle in NEUTRAL, position it on a hoist. For additional, refer to Section 100-02.
2. Loosen the diesel particulate filter or, if equipped, the intermediate pipe-to-resonator and tailpipe assembly Torca® clamp.
3. Remove the 2 tailpipe isolator and bracket bolts from the frame.

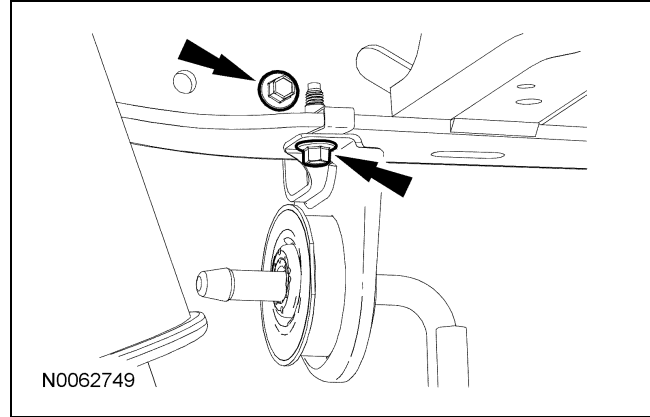


4. Disconnect the isolators and remove the tailpipe from the vehicle.

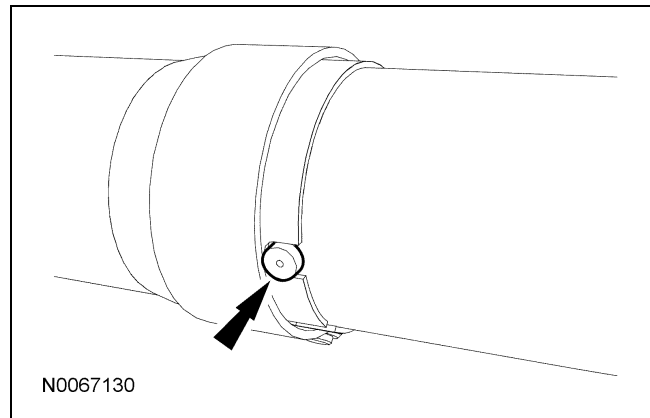
Installation

1. Install the tailpipe into the vehicle and connect the isolators while sliding the assembly onto the diesel particulate filter or, if equipped, the exhaust intermediate pipe.

2. Install the tailpipe isolator and bracket onto the tailpipe and install the 2 tailpipe isolator and bracket bolts to the frame.
 - Tighten to 20 Nm (177 lb-in).



3. Make sure the diesel particulate filter or, if equipped, the intermediate pipe button is fully inserted into the button slot on the tailpipe and tighten the tailpipe-to-diesel particulate filter or, if equipped, the intermediate pipe Torca® clamp.
 - Tighten to 55 Nm (41 lb-ft).



REMOVAL AND INSTALLATION (Continued)

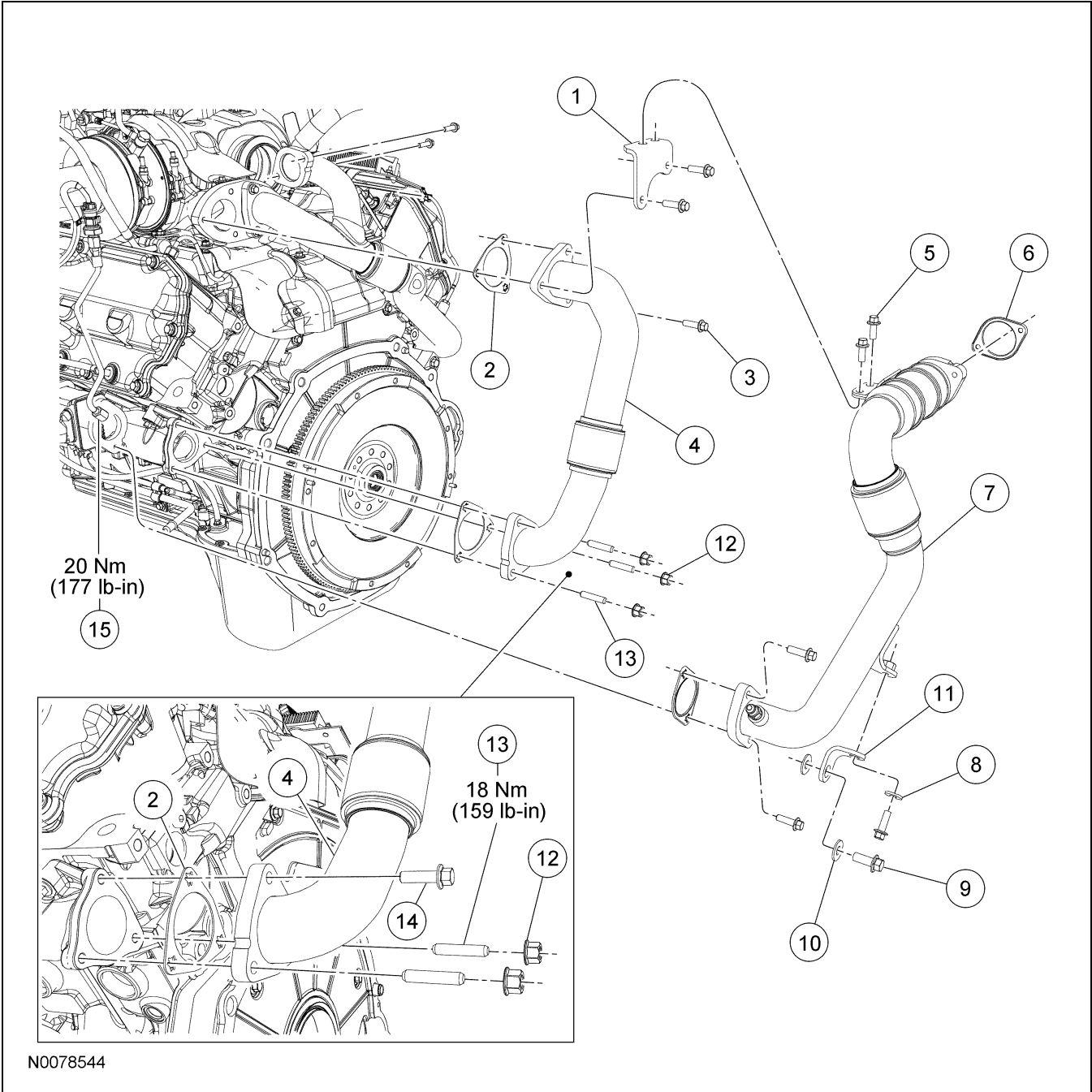
4. **NOTE:** The exhaust system alignment procedure only needs to be carried out if the exhaust system isolators are not at zero load.

Check to see if the exhaust system isolators are at zero load. If the exhaust system isolators are not at zero load, carry out the exhaust system alignment procedure. For additional information, refer to Exhaust System Alignment — 6.4L Diesel in this section.

REMOVAL AND INSTALLATION

Turbocharger Inlet Pipe — LH, 6.4L Diesel

NOTE: Vehicle body removed from art for clarity.



Item	Part Number	Description
1	5D261	EGR-oxidation catalytic converter (OC) pipe bracket
2	6N640	Turbocharger inlet pipe gasket (2 required)

(Continued)

Item	Part Number	Description
3	W302649	Turbocharger inlet pipe and EGR-OC pipe bolt (8 required)
4	6K854	LH turbocharger inlet pipe

(Continued)

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
5	W300003	EGR-OC pipe-to-EGR-OC pipe bracket bolt (2 required)
6	6N640	EGR-OC pipe gasket (2 required)
7	5H267	EGR-OC pipe
8	W302142	EGR-OC pipe bracket-to-cylinder head bracket washer
9	W301402	Cylinder head bracket-to-cylinder head bolt
10	W302624	Cylinder head bracket-to-cylinder head washer (2 required)
11	5D261	EGR-OC pipe bracket-to-cylinder head bracket
12	W302494	Turbocharger inlet pipe-to-exhaust manifold nut (3 required)
13	W302495	Turbocharger inlet pipe-to-exhaust manifold stud
14	W302649	LH turbocharger inlet pipe-to-exhaust manifold bolt (service only)
15	—	Exhaust pressure (EP) sensor tube fitting (part of 9J460)

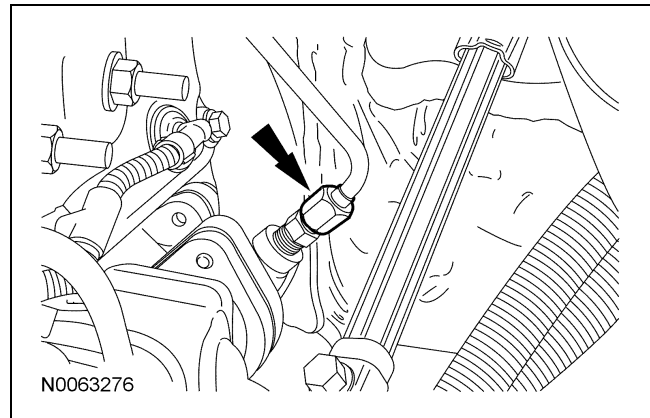
Removal

⚠ CAUTION: Do not bend or twist the exhaust gas recirculation (EGR)-oxidation catalytic converter (OC) pipe or damage to the bellow on the EGR-OC pipe may occur.

⚠ CAUTION: Do not bend or twist the turbocharger inlet pipe or damage to the bellow on the turbocharger inlet pipe may occur.

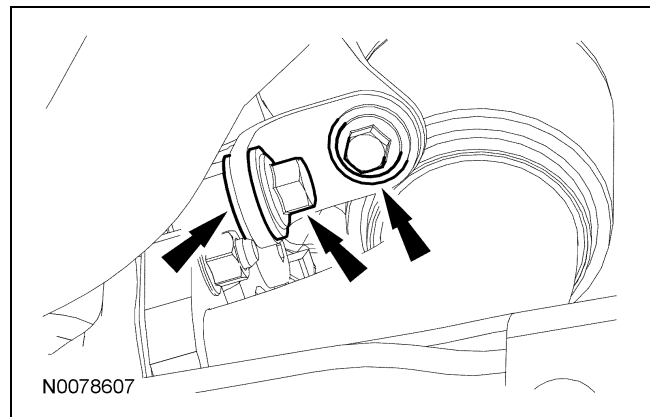
1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.

2. Disconnect the exhaust pressure (EP) sensor tube fitting.



3. Remove the EGR-oxidation catalytic converter (OC) pipe bracket-to-cylinder head bracket bolt and washer. Remove the EGR-OC pipe bracket-to-LH cylinder head bolt, washers and the bracket.

- Discard the bolts.



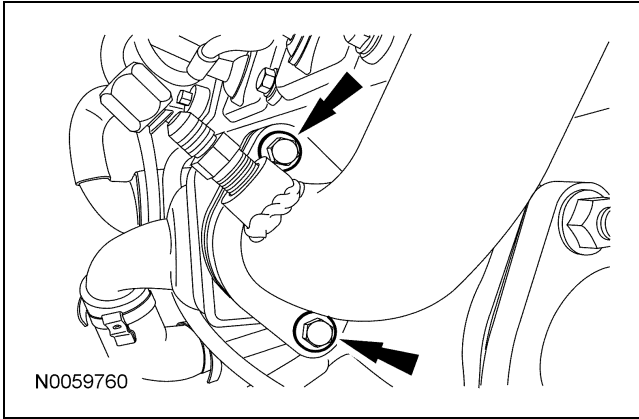
4. Remove the RH turbocharger inlet pipe-to-EGR-OC pipe bolts and the EGR-OC-to-turbocharger bracket bolts.

- Discard the bolts.

REMOVAL AND INSTALLATION (Continued)

5. Remove the EGR-OC-to-EGR cooler bolts and position the EGR-OC pipe to the left side of the vehicle and aside.

- Discard the bolts and gaskets.



6. Remove the LH turbocharger inlet pipe-to-turbocharger bolts and remove the EGR-OC bracket.
 - Discard the bolts.
7. **NOTE:** On vehicles that have had previous service to the LH turbocharger inlet pipe, a service bolt will be in place of the upper exhaust manifold nut and stud. Remove the LH turbocharger inlet pipe-to-exhaust manifold nuts and, if equipped, service bolt.
 - Discard the nuts and, if equipped, service bolt.
8. **NOTE:** On vehicles that have had previous service to the LH turbocharger inlet pipe, a service bolt will be in place of the upper exhaust manifold nut and stud. Remove the LH turbocharger inlet pipe-to-exhaust manifold studs.
9. Remove the LH turbocharger inlet pipe from the vehicle.
 - Discard the gaskets.

Installation

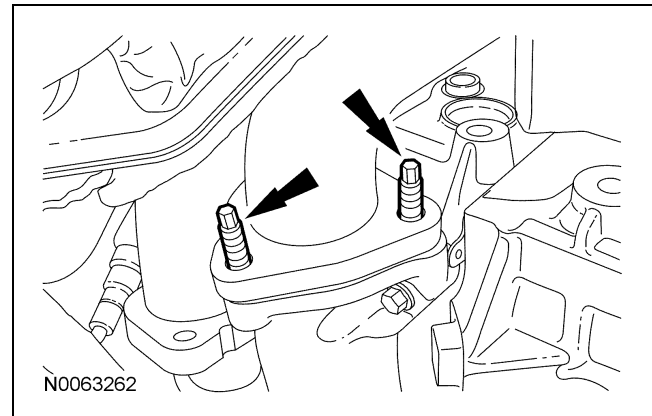
⚠ CAUTION: Do not bend or twist the exhaust gas recirculation (EGR)-oxidation catalytic converter (OC) pipe or damage to the bellow on the EGR-OC pipe may occur.

⚠ CAUTION: Do not bend or twist the turbocharger inlet pipe or damage to the bellow on the turbocharger inlet pipe may occur.

1. Position the LH turbocharger inlet pipe into the vehicle.
2. **NOTE:** To aid in installation, the upper LH turbocharger inlet pipe-to-exhaust manifold stud is replaced with a bolt.

Install the new LH turbocharger inlet pipe-to-exhaust manifold gasket and the 2 lower studs.

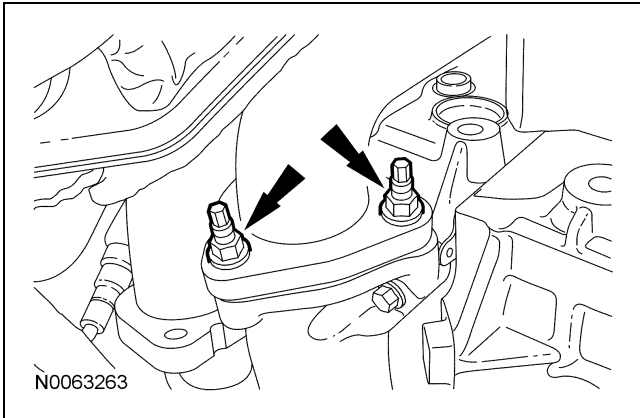
- Tighten to 18 Nm (159 lb-in).



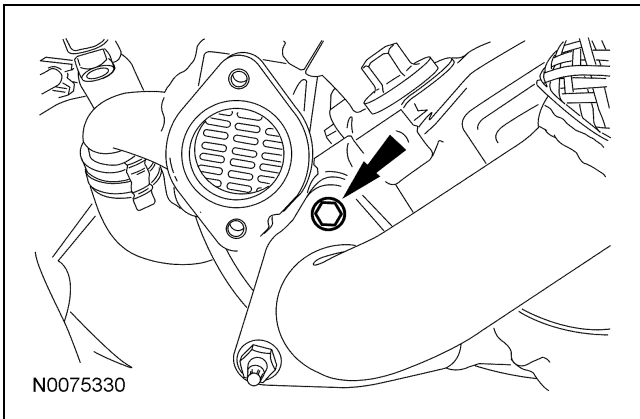
3. Position the new LH turbocharger inlet pipe-to-turbocharger gasket and loosely install the EGR-OC bracket and new bolts.

REMOVAL AND INSTALLATION (Continued)

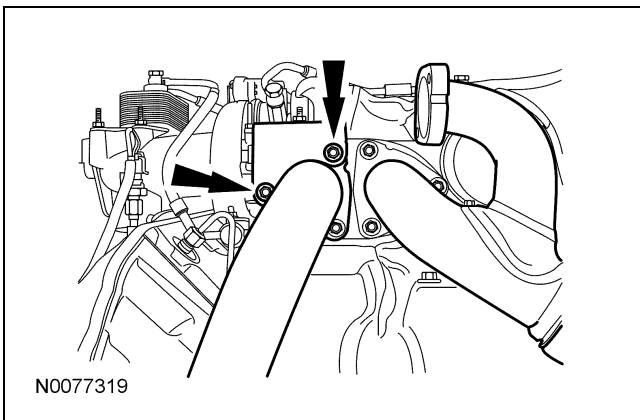
4. Loosely install new LH turbocharger inlet pipe-to-exhaust manifold nuts.



5. **NOTE:** To aid in installation, the upper LH turbocharger inlet pipe-to-exhaust manifold stud is replaced with bolt part number W302649. Loosely install a new LH turbocharger inlet pipe-to-exhaust manifold bolt.



6. Tighten the LH turbocharger inlet pipe-to-turbocharger upper 2 bolts.
- Tighten to 25 Nm (18 lb-ft).



7. **⚠ CAUTION:** Due to limited access, one of the specific Half-moon wrenches and other tools described must be used to correctly tighten the fasteners in this step. Failure to follow this instruction may result in engine failure.

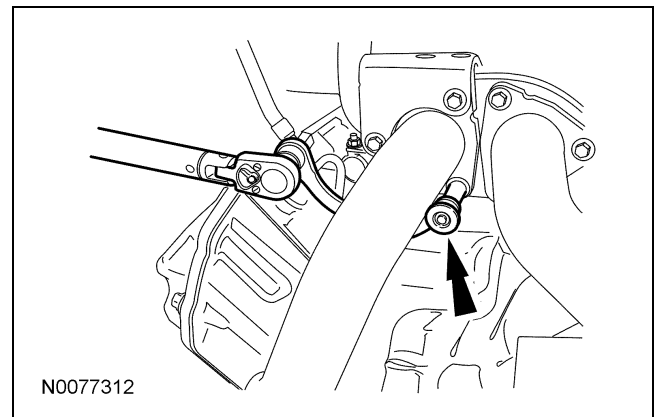
NOTE: To complete this step, it will be necessary to use the following tools:

- A 3/8-in drive torque wrench that is 241.3 mm (9.5 in) or 368.3 mm (14.5 in) from center of the handle to the center of the square drive.
- One of the 10-mm/12-mm Half-moon wrenches listed in the following chart.
- A 12-mm Allen socket (to drive the Half-moon wrench).

NOTE: To obtain the required torque value of 25 Nm (18 lb-ft), it will be crucial to orient the Half-moon wrench in the direction shown and 180 degrees (straight out) from the torque wrench. The torque wrench must be set to the value specified in the following chart, for the Half-moon wrench and torque wrench length being used.

Tighten the LH turbocharger inlet pipes-to-turbocharger bottom bolt.

- Refer to the following chart for torque wrench setting, based on the specific Half-moon wrench and torque wrench length being used.



REMOVAL AND INSTALLATION (Continued)**Torque Chart — Turbocharger Inlet Pipes-to-Turbocharger, Bottom 2 Bolts**

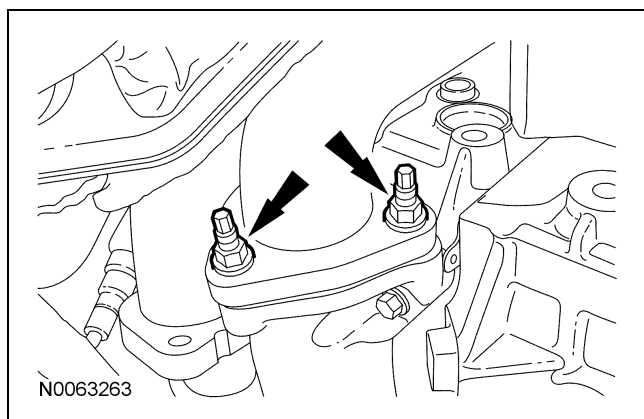
Half-Moon Wrench Brand	Wrench Part Number	Wrench Size	Torque Wrench Length	Torque Wrench Setting	
				Nm	lb-ft
Cornwell®	BWM-1012MM	10/12 mm	9.5 in	20	15
Gear Wrench®	9851	10/12 mm	9.5 in	18	13
Matco®	MHM1012	10/12 mm	9.5 in	18	13
Mac®	HMM1012R	10/12 mm	9.5 in	15	11
Snap-On®	CXM1012	10/12 mm	9.5 in	18	13
Cornwell®	BWM-1012MM	10/12 mm	14.5 in	19	14
Gear Wrench®	9851	10/12 mm	14.5 in	18	13
Matco®	MHM1012	10/12 mm	14.5 in	18	13
Mac®	HMM1012R	10/12 mm	14.5 in	16	12
Snap-On®	CXM1012	10/12 mm	14.5 in	18	13

NOTE: To achieve the required torque of 25 Nm (18 lb-ft), the torque wrench must be set to the appropriate Torque Wrench Setting listed in this chart.

N0076310


8. Tighten the 2 LH turbocharger inlet pipe-to-exhaust manifold nuts.

- Tighten to 31 Nm (23 lb-ft).



N0063263

REMOVAL AND INSTALLATION (Continued)

9.  **CAUTION:** Due to limited access, one of the specific Half-moon wrenches and other tools described must be used to correctly tighten the fasteners in this step. Failure to follow this instruction may result in engine failure.

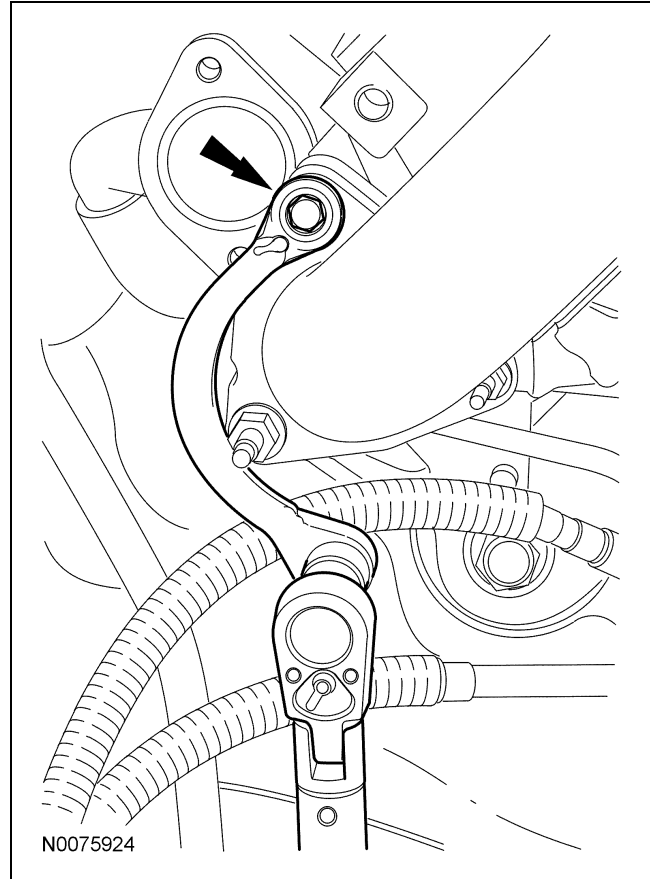
NOTE: To complete this step, it will be necessary to use the following tools:

- A 3/8-in drive torque wrench that is 368.3 mm (14.5 in) or 381.0 mm (15.0 in) from the center of the handle to the center of the square drive.
- One of the 10-mm/12-mm Half-moon wrenches listed in the following chart.
- A 12-mm Allen socket (to drive the Half-moon wrench).

NOTE: To obtain the specified torque value of 31 Nm (23 lb-ft), it will be crucial to orient the Half-moon wrench in the direction shown and 180 degrees (straight out) from the torque wrench. The torque wrench must be set to the value specified in the following chart, for the Half-moon wrench and torque wrench length being used.

Tighten the LH turbocharger inlet pipe-to-LH exhaust manifold bolt.

- Refer to the following chart for torque wrench setting, based on the specific Half-moon wrench and torque wrench length being used.




REMOVAL AND INSTALLATION (Continued)**Torque Chart — LH Turbocharger Inlet Pipe-to-LH Exhaust Manifold Upper Bolt**

Half-Moon Wrench Brand	Wrench Part Number	Wrench Size	Torque Wrench Length	Torque Wrench Setting	
				Nm	lb-ft
Cornwell®	BWM-1012MM	10/12 mm	14.5 in	26	19
Gear Wrench®	9851	10/12 mm	14.5 in	23	17
Matco®	MHM1012	10/12 mm	14.5 in	22	16
Mac®	HMM1012R	10/12 mm	14.5 in	22	16
Snap-On®	CXM1012	10/12 mm	14.5 in	22	16
Cornwell®	BWM-1012MM	10/12 mm	15.0 in	27	20
Gear Wrench®	9851	10/12 mm	15.0 in	23	17
Matco®	MHM1012	10/12 mm	15.0 in	23	17
Mac®	HMM1012R	10/12 mm	15.0 in	23	17
Snap-On®	CXM1012	10/12 mm	15.0 in	23	17

NOTE: To achieve the required torque of 31 Nm (23 lb-ft), the torque wrench must be set to the appropriate Torque Wrench Setting listed in this chart.

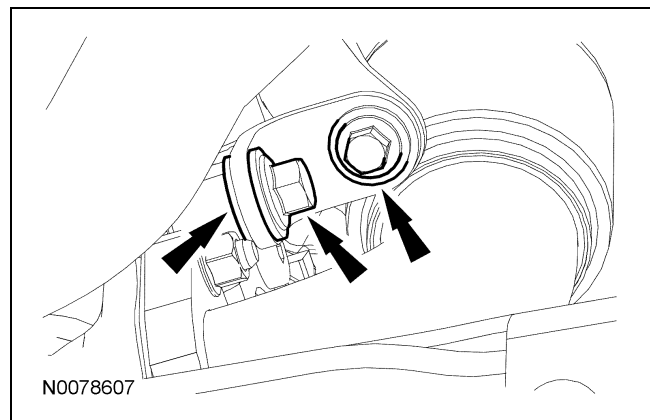
N0076309

10. Position the EGR-OC pipe and install a new EGR-OC pipe-to-horizontal EGR cooler gasket and loosely install the new bolts.

11.  **CAUTION:** Make sure the correct bolts are installed in the bracket or damage to the exhaust gas recirculation (EGR)-oxidation catalytic converter (OC) pipe may occur.

Install a new EGR-OC pipe-to-RH turbocharger inlet pipe gasket and loosely install new bolts. Loosely install new EGR-OC-to-turbocharger bracket bolts.

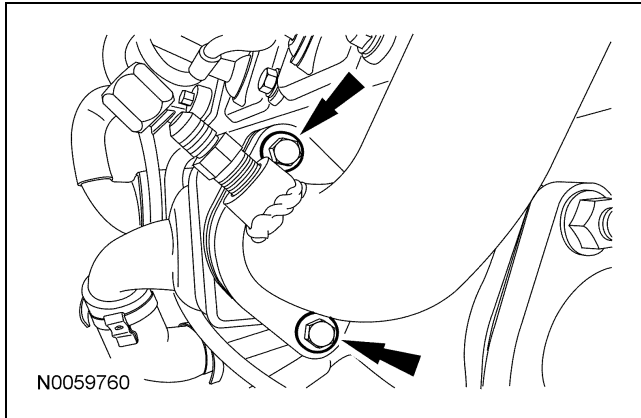
12. Position the cylinder head bracket and install the EGR-OC bracket-to-cylinder head bracket washer and a new bolt. Loosely install the cylinder head bracket-to-cylinder head washers and a new bolt. Finger tighten both bolts.



REMOVAL AND INSTALLATION (Continued)

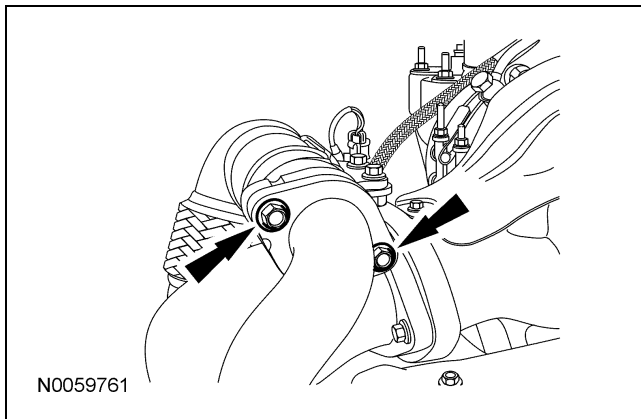
13. Tighten the EGR-OC-to-EGR cooler bolts.

- Tighten to 31 Nm (23 lb-ft).



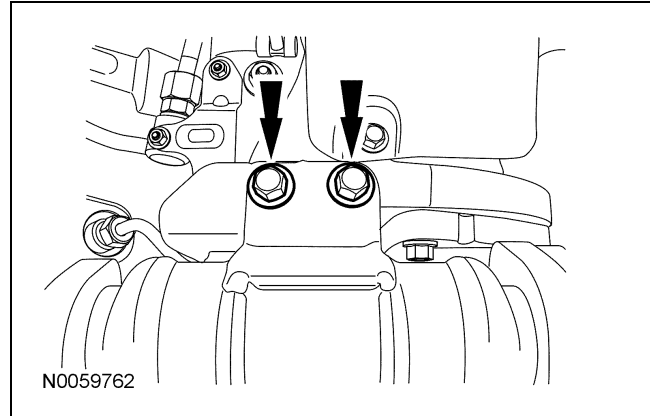
14. Tighten the RH turbocharger inlet pipe-to-EGR-OC bolts.

- Tighten to 31 Nm (23 lb-ft).



15. Tighten the EGR-OC-to-turbocharger bracket bolts.

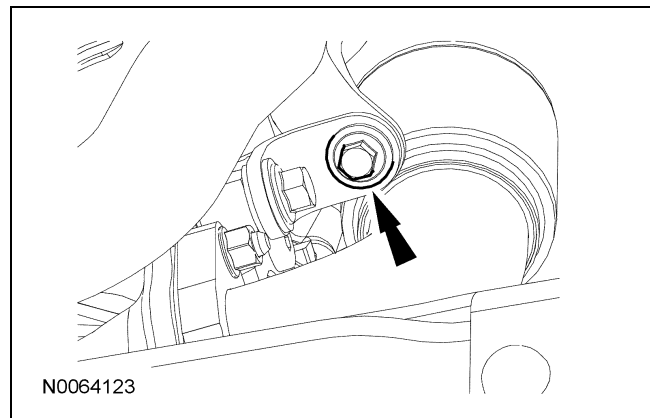
- Tighten to 31 Nm (23 lb-ft).



16. **⚠ CAUTION:** Failure to install and correctly tighten the exhaust gas recirculation (EGR)-oxidation catalytic converter (OC) pipe bracket bolt will result in damage to the horizontal EGR cooler and possible engine damage.

Tighten the EGR-OC bracket-to-cylinder head bracket bolt.

- Tighten to 31 Nm (23 lb-ft).



REMOVAL AND INSTALLATION (Continued)

17. ⚠ **CAUTION:** Failure to install and correctly tighten the exhaust gas recirculation (EGR)-oxidation catalytic converter (OC) pipe support bolt will result in damage to the horizontal EGR cooler and possible engine damage.

⚠ **CAUTION:** Due to limited access, one of the specific Half-moon wrenches and other tools described must be used to correctly tighten the fasteners in this step. Failure to follow this instruction may result in engine failure.

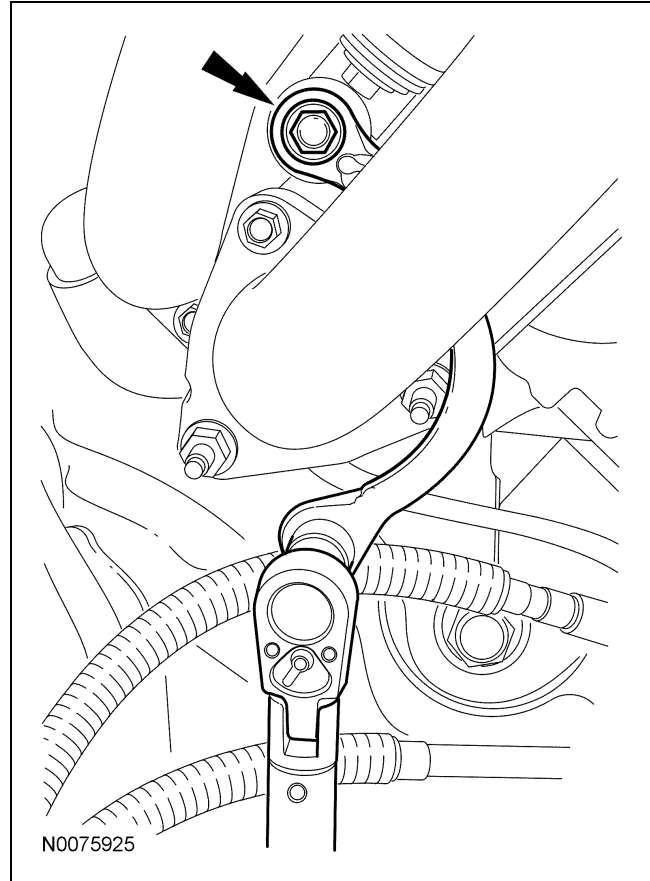
NOTE: To complete this step, it will be necessary to use the following tools:

- A 3/8-in drive torque wrench that is 368.3 mm (14.5 in) or 381.0 mm (15.0 in) from the center of the handle to the center of the square drive.
- One of the 11-mm/13-mm Half-moon wrenches listed in the following chart.
- An 11-mm Allen socket (to drive the Half-moon wrench).

NOTE: To obtain the specified torque value of 63 Nm (46 lb-ft), it will be crucial to orient the Half-moon wrench in the direction shown and 180 degrees (straight out) from the torque wrench. The torque wrench must be set to the value specified in the following chart, for the Half-moon wrench and torque wrench length being used.

Tighten the EGR-OC pipe bracket-to-LH cylinder head bolt.

- Refer to the following chart for torque wrench setting, based on the specific Half-moon wrench and torque wrench length being used.



REMOVAL AND INSTALLATION (Continued)**Torque Chart— EGR-OC Pipe Bracket-to-LH Cylinder Head Bolt**

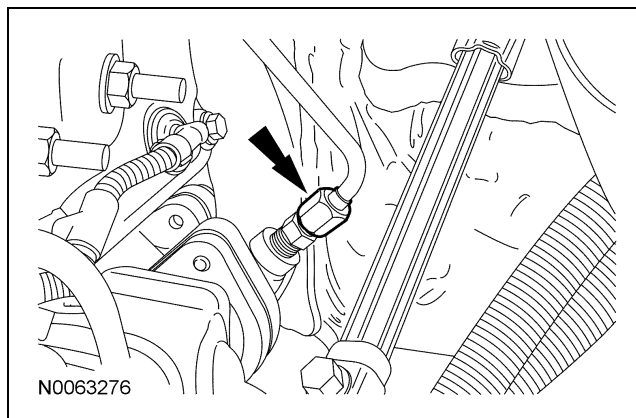
Half-Moon Wrench Brand	Wrench Part Number	Wrench Size	Torque Wrench Length	Torque Wrench Setting	
				Nm	lb-ft
Cornwell®	BWM-1113MM	11/13 mm	14.5 in	47	35
Gear Wrench®	9852	11/13 mm	14.5 in	46	34
Matco®	MHM1113	11/13 mm	14.5 in	46	34
Mac®	HMM1113R	11/13 mm	14.5 in	46	34
Snap-On®	CXM1113	11/13 mm	14.5 in	46	34
Cornwell®	BWM-1113MM	11/13 mm	15.0 in	49	36
Gear Wrench®	9852	11/13 mm	15.0 in	47	35
Matco®	MHM1113	11/13 mm	15.0 in	47	35
Mac®	HMM1113R	11/13 mm	15.0 in	47	35
Snap-On®	CXM1113	11/13 mm	15.0 in	47	35

NOTE: To achieve the required torque of 62 Nm (46 lb-ft), the torque wrench must be set to the appropriate Torque Wrench Setting listed in this chart.

N0078499

18. Install the EP sensor tube fitting into the EGR-OC pipe.

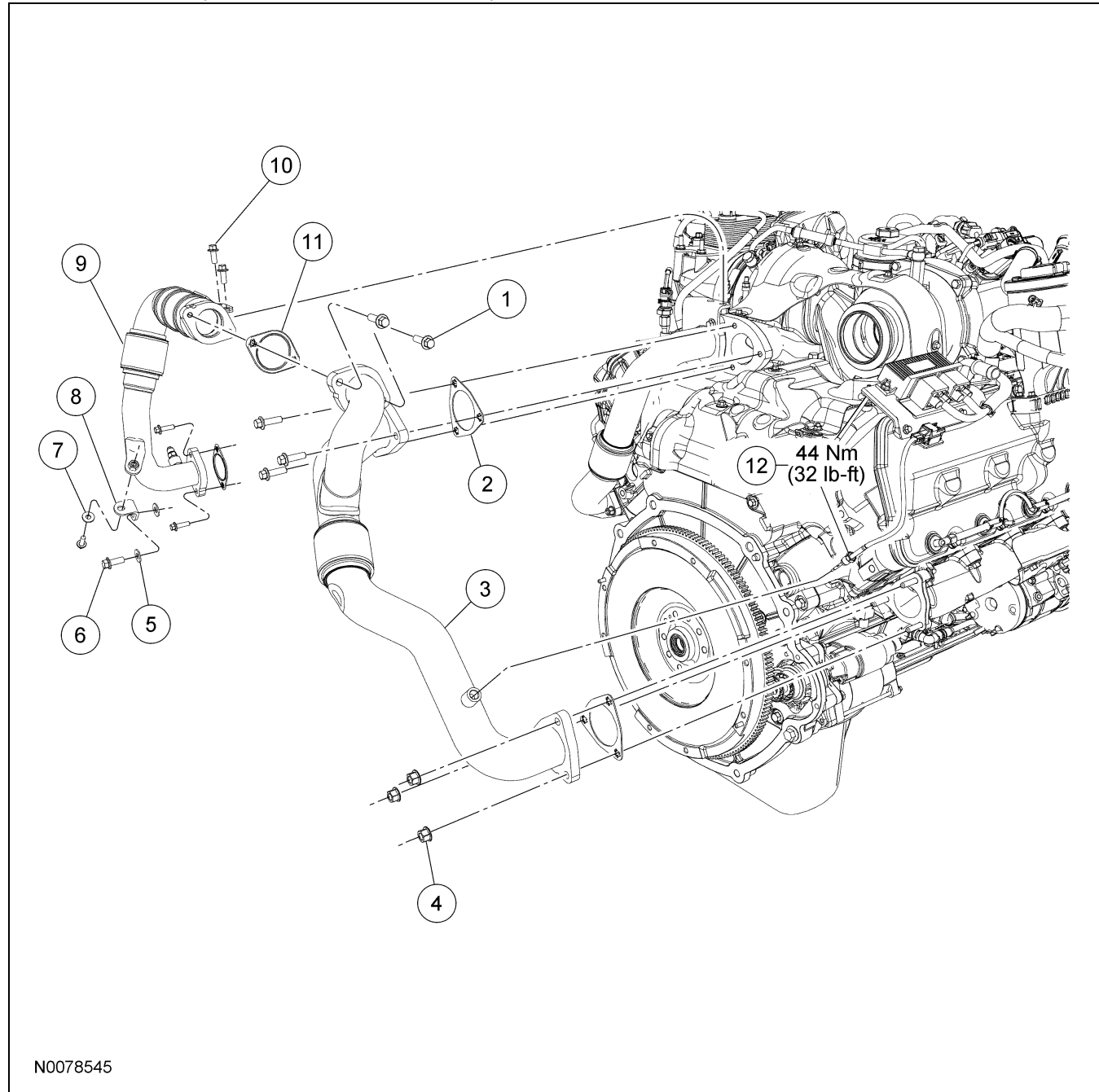
- Tighten to 20 Nm (177 lb-in).



REMOVAL AND INSTALLATION

Turbocharger Inlet Pipe — RH, 6.4L Diesel

NOTE: Vehicle body removed from art for clarity.



REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	W302649	Turbocharger inlet pipe and EGR-oxidation catalytic converter (OC) pipe bolt (8 required)
2	6N640	Turbocharger inlet pipe gasket (2 required)
3	6K854	RH turbocharger inlet pipe
4	W302494	Turbocharger inlet pipe-to-exhaust manifold nut (3 required)
5	W302624	Cylinder head bracket-to-cylinder head washer (2 required)
6	W301402	Cylinder head bracket-to-cylinder head bolt
7	W302142	EGR-OC pipe bracket-to-cylinder head bracket washer
8	5D261	EGR-OC pipe bracket-to-cylinder head bracket
9	5H267	EGR-OC pipe
10	W300003	EGR-OC pipe-to-EGR-OC pipe bracket bolt (2 required)
11	6N640	EGR-OC pipe gasket (2 required)
12	12B591	Exhaust gas temperature (EGT) sensor

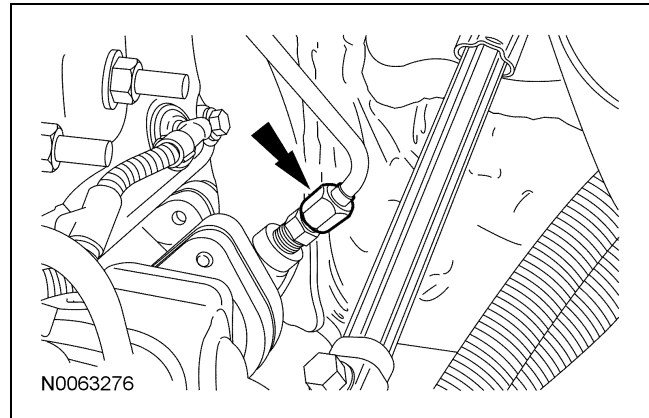
Removal

⚠ CAUTION: Do not bend or twist the exhaust gas recirculation (EGR)-oxidation catalytic converter (OC) pipe or damage to the bellow on the EGR-OC pipe may occur.

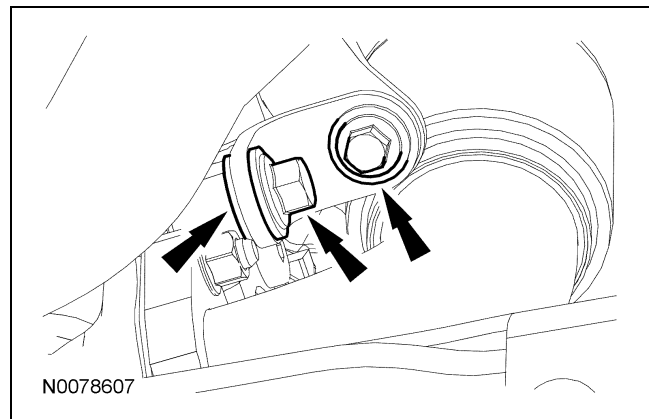
⚠ CAUTION: Do not bend or twist the turbocharger inlet pipe or damage to the bellow on the turbocharger inlet pipe may occur.

1. Remove the exhaust downpipe. For additional information, refer to Exhaust Downpipe — 6.4L Diesel in this section.

2. Disconnect the exhaust pressure (EP) sensor tube fitting from the EGR-oxidation catalytic converter (OC) pipe.



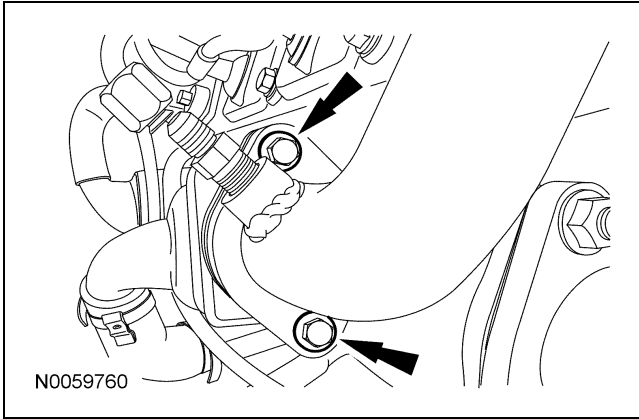
3. Remove the EGR-OC pipe bracket-to-cylinder head bracket bolt and washer. Remove the EGR-OC pipe bracket-to-LH cylinder head bolt, washers and the bracket.
 - Discard the bolts.



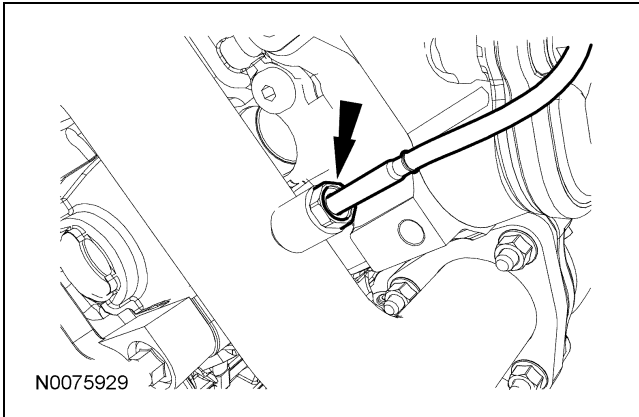
4. Remove the RH turbocharger inlet pipe-to-EGR-OC pipe bolts and the EGR-OC-to-turbocharger bracket bolts.
 - Discard the bolts.

REMOVAL AND INSTALLATION (Continued)

5. Remove the EGR-OC-to-EGR cooler bolts and position the EGR-OC pipe to the left side of the vehicle and aside.
 - Discard the bolts and gaskets.



6. Remove exhaust gas temperature (EGT) sensor from the RH turbocharger inlet pipe and position aside.



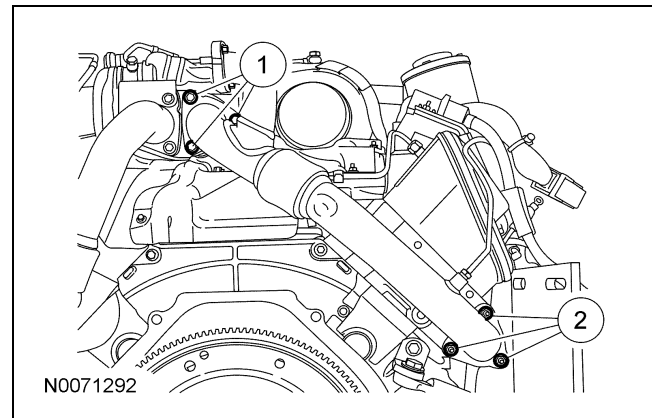
7. Remove the RH turbocharger inlet pipe-to-exhaust manifold nuts.
 - Discard the nuts.
8. Remove the RH turbocharger inlet pipe-to-turbocharger bolts.
 - Discard the bolts.
9. Remove the RH turbocharger inlet pipe from the vehicle.
 - Discard the gaskets.

Installation

CAUTION: Do not bend or twist the exhaust gas recirculation (EGR)-oxidation catalytic converter (OC) pipe or damage to the bellow on the EGR-OC pipe may occur.

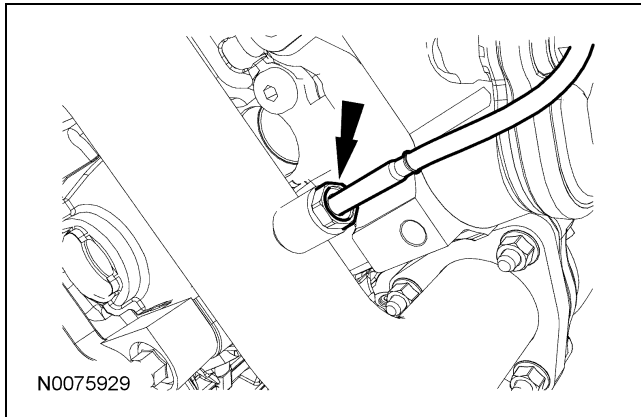
CAUTION: Do not bend or twist the turbocharger inlet pipe or damage to the bellow on the turbocharger inlet pipe may occur.

1. Install the RH turbocharger inlet pipe-to-exhaust manifold gasket and position the RH turbocharger inlet pipe.
2. Position a new RH turbocharger inlet pipe-to-turbocharger gasket and loosely install new bolts.
3. Loosely install new RH turbocharger inlet pipe-to-exhaust manifold nuts.
4. Tighten the RH turbocharger inlet pipe-to-turbocharger bolts and RH turbocharger inlet pipe-to-exhaust manifold nuts.
 - 1 Tighten the bolts to 25 Nm (18 lb-ft).
 - 2 Tighten the nuts to 31 Nm (23 lb-ft).



REMOVAL AND INSTALLATION (Continued)

5. Install the EGT sensor into the RH turbocharger inlet pipe.
 - Tighten to 44 Nm (32 lb-ft).

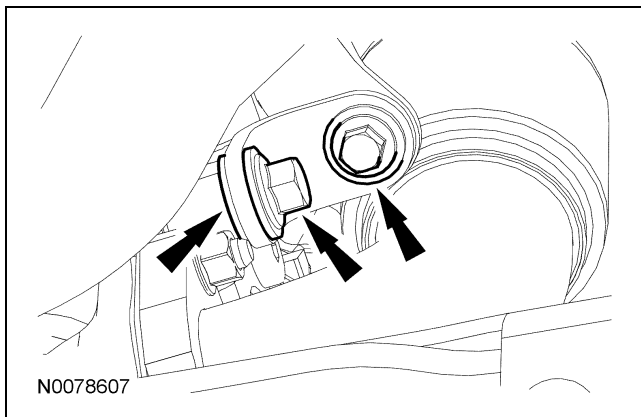


6. Position the EGR-OC pipe and install a new EGR-OC pipe-to-horizontal EGR cooler gasket and loosely install the new bolts.

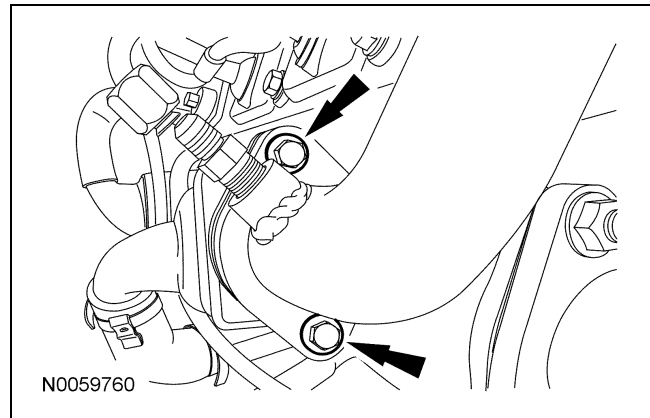
7. **⚠ CAUTION: Make sure the correct bolts are installed in the bracket or damage to the exhaust gas recirculation (EGR)-oxidation catalytic converter (OC) pipe may occur.**

Install a new EGR-OC pipe-to-RH turbocharger inlet pipe gasket and loosely install new bolts. Loosely install new EGR-OC-to-turbocharger bracket bolts.

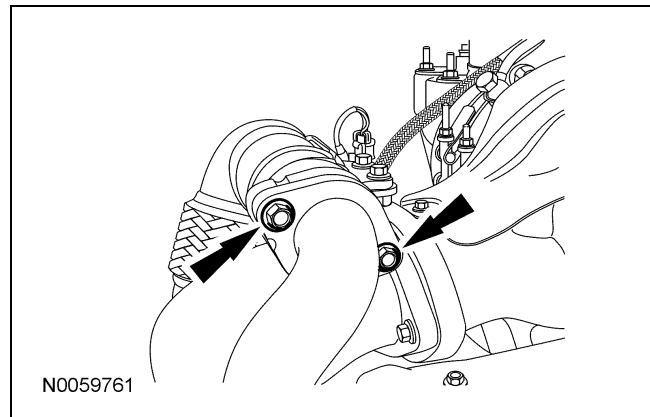
8. Position the cylinder head bracket and install the EGR-OC bracket-to-cylinder head bracket washer and a new bolt. Loosely install the cylinder head bracket-to-cylinder head washers and a new bolt. Finger tighten both bolts.



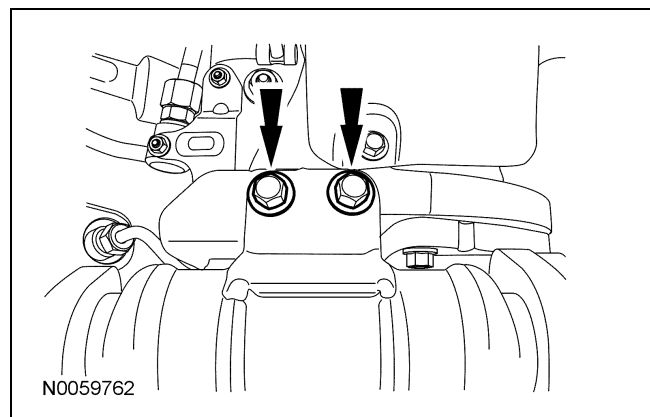
9. Tighten the EGR-OC-to-EGR cooler bolts.
 - Tighten to 31 Nm (23 lb-ft).




10. Tighten the RH turbocharger inlet pipe-to-EGR-OC bolts.
 - Tighten to 31 Nm (23 lb-ft).



11. Tighten the EGR-OC-to-turbocharger bracket bolts.
 - Tighten to 31 Nm (23 lb-ft).

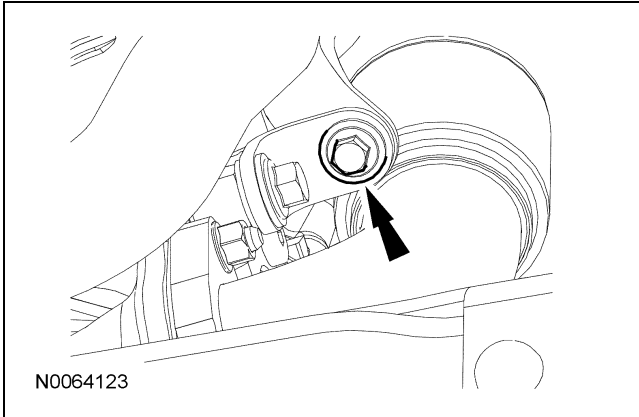


REMOVAL AND INSTALLATION (Continued)

12.  **CAUTION:** Failure to install and correctly tighten the exhaust gas recirculation (EGR)-oxidation catalytic converter (OC) pipe bracket bolt will result in damage to the horizontal EGR cooler and possible engine damage.

Tighten the EGR-OC bracket-to-cylinder head bracket bolt.

- Tighten to 31 Nm (23 lb-ft).



REMOVAL AND INSTALLATION (Continued)

13. ⚠ **CAUTION:** Failure to install and correctly tighten the exhaust gas recirculation (EGR)-oxidation catalytic converter (OC) pipe support bolt will result in damage to the horizontal EGR cooler and possible engine damage.

⚠ **CAUTION:** Due to limited access, one of the specific Half-moon wrenches and other tools described must be used to correctly tighten the fasteners in this step. Failure to follow this instruction may result in engine failure.

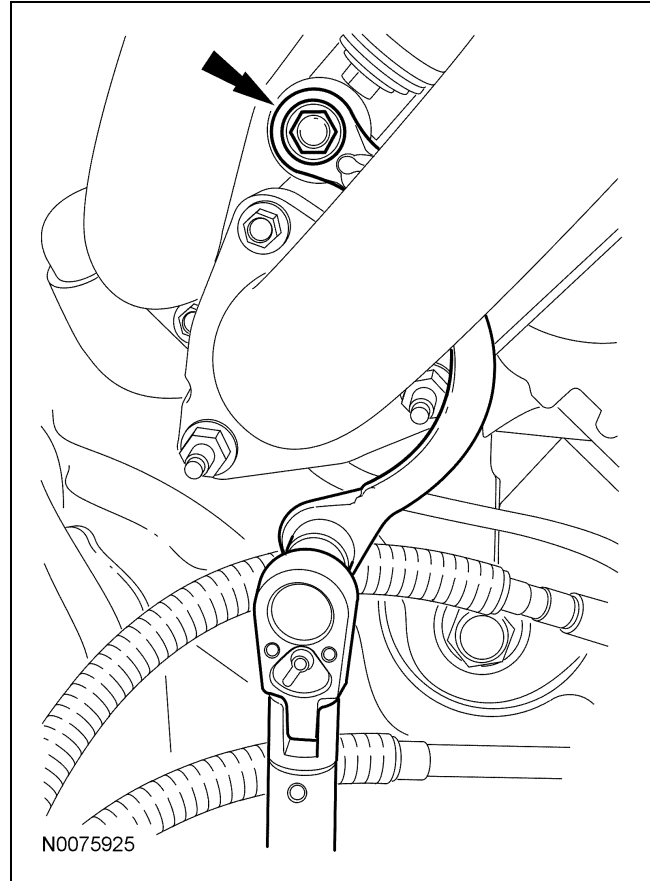
NOTE: To complete this step, it will be necessary to use the following tools:

- A 3/8-in drive torque wrench that is 368.3 mm (14.5 in) or 381.0 mm (15.0 in) from the center of the handle to the center of the square drive.
- One of the 11-mm/13-mm Half-moon wrenches listed in the following chart.
- An 11-mm Allen socket (to drive the Half-moon wrench).

NOTE: To obtain the specified torque value of 63 Nm (46 lb-ft), it will be crucial to orient the Half-moon wrench in the direction shown and 180 degrees (straight out) from the torque wrench. The torque wrench must be set to the value specified in the following chart, for the Half-moon wrench and torque wrench length being used.

Tighten the EGR-OC pipe bracket-to-LH cylinder head bolt.

- Refer to the following chart for torque wrench setting, based on the specific Half-moon wrench and torque wrench length being used.



REMOVAL AND INSTALLATION (Continued)**Torque Chart— EGR-OC Pipe Bracket-to-LH Cylinder Head Bolt**

Half-Moon Wrench Brand	Wrench Part Number	Wrench Size	Torque Wrench Length	Torque Wrench Setting	
				Nm	lb-ft
Cornwell®	BWM-1113MM	11/13 mm	14.5 in	47	35
Gear Wrench®	9852	11/13 mm	14.5 in	46	34
Matco®	MHM1113	11/13 mm	14.5 in	46	34
Mac®	HMM1113R	11/13 mm	14.5 in	46	34
Snap-On®	CXM1113	11/13 mm	14.5 in	46	34
Cornwell®	BWM-1113MM	11/13 mm	15.0 in	49	36
Gear Wrench®	9852	11/13 mm	15.0 in	47	35
Matco®	MHM1113	11/13 mm	15.0 in	47	35
Mac®	HMM1113R	11/13 mm	15.0 in	47	35
Snap-On®	CXM1113	11/13 mm	15.0 in	47	35

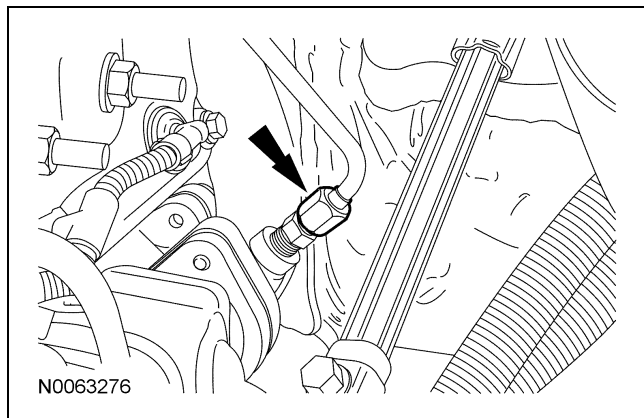
NOTE: To achieve the required torque of 62 Nm (46 lb-ft), the torque wrench must be set to the appropriate Torque Wrench Setting listed in this chart.

N0078499

14. Connect the EP sensor tube fitting onto the EGR-OC pipe.

- Tighten to 20 Nm (177 lb-in).

15. Install the exhaust downpipe. For additional information, refer to Exhaust Downpipe — 6.4L Diesel in this section.



N0063276

2008 Ford F-350 SUPER DUTY

Submodel: XLT | Engine Type: V8 | Liters: 5.4
Fuel Delivery: FI | Fuel: GAS

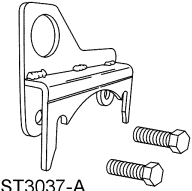
SECTION 303-04D:
Fuel Charging and Controls — Turbocharger

SPECIFICATIONS
DESCRIPTION AND OPERATION
Turbocharger
DIAGNOSIS AND TESTING
Turbocharger
Principles of Operation
Inspection and Verification
Symptom Chart
Component Tests
Turbocharger Internal Oil Leak Test
REMOVAL AND INSTALLATION
Turbocharger — Body Off
Turbocharger — Body On
Turbocharger Pedestal
DISASSEMBLY AND ASSEMBLY
Turbocharger

REMOVAL AND INSTALLATION

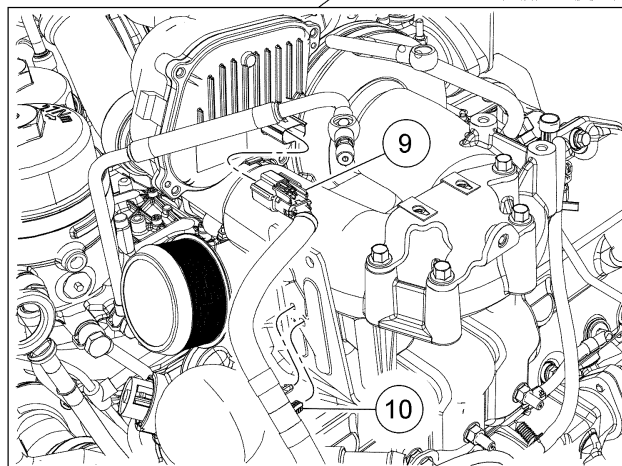
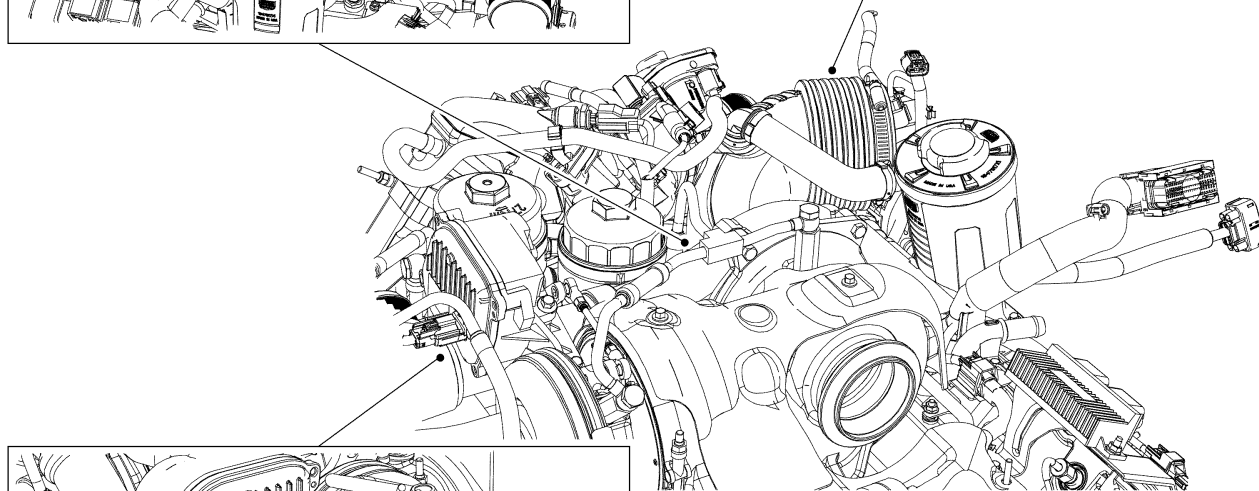
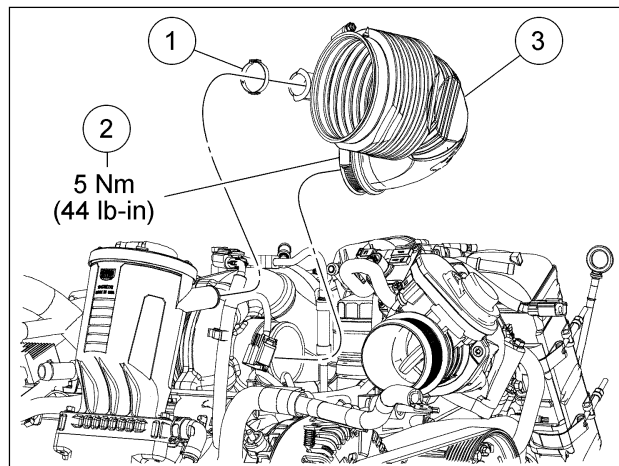
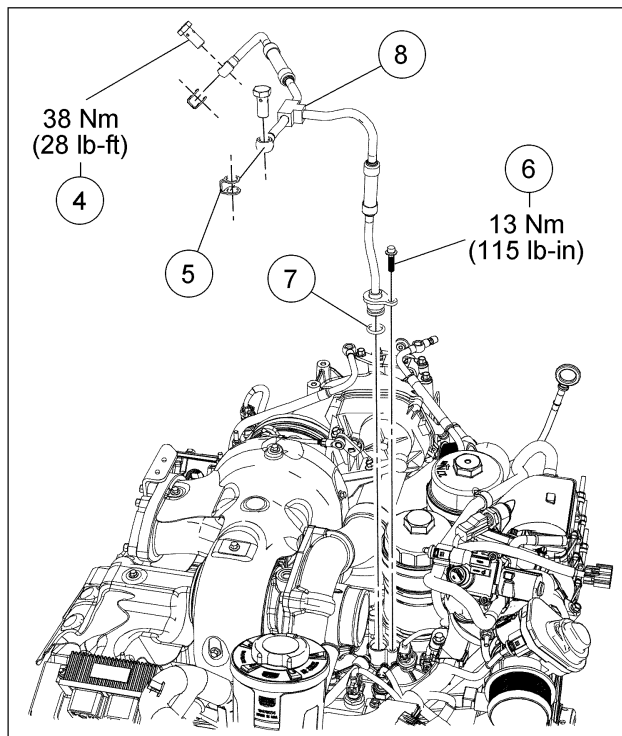
Turbocharger — Body Off

Special Tool(s)

 ST3037-A	Turbocharger Lifting Bracket 303-1266
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Material

Item	Specification
SAE 15W-40 Super Duty Diesel Motor Oil XO-15W40-QSD (US); CXO-15W40-LSD12 (Canada); or equivalent	WSS-M2C171-E

REMOVAL AND INSTALLATION (Continued)**Turbocharger Oil, Air and Electrical Connections**

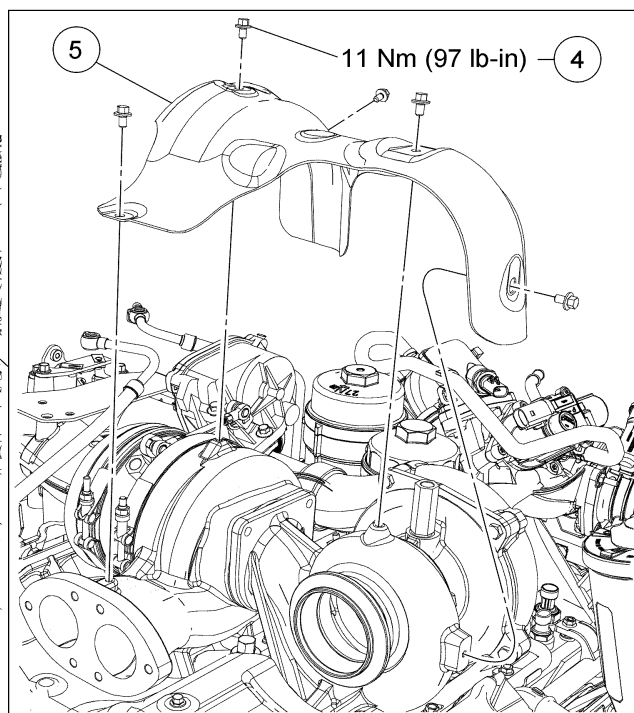
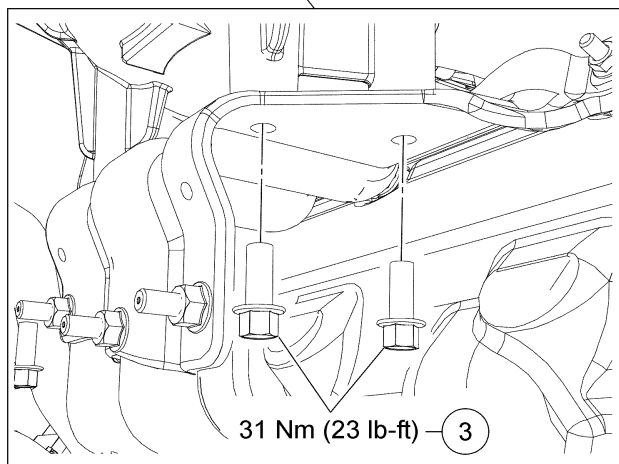
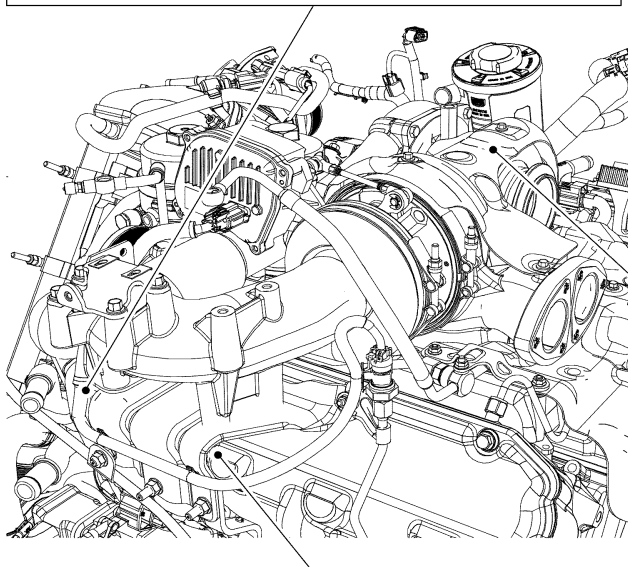
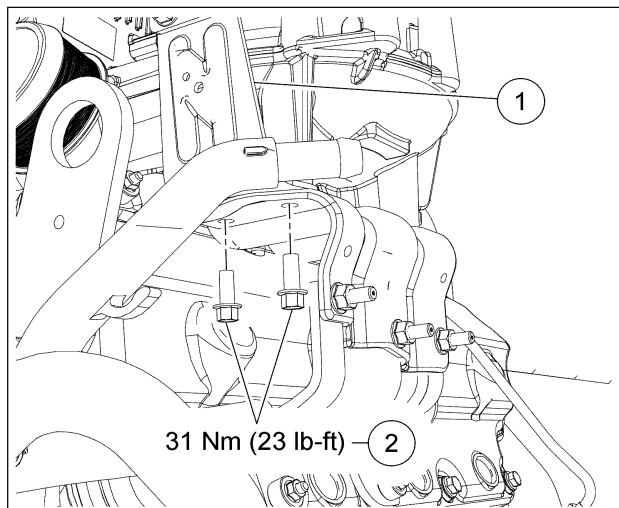
N0077108

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	6K786	Air cleaner outlet tube-to-crankcase vent oil separator hose clamp
2	6K789	Air cleaner outlet tube clamp
3	6C646	Air cleaner outlet tube
4	W302472	Turbocharger oil supply tube banjo fitting bolt (2 required)
5	W302474	Copper sealing washer (2 required)

(Continued)

Item	Part Number	Description
6	W300005	Turbocharger oil supply tube bolt
7	W302203	O-ring seal
8	9T516	Turbocharger oil supply tube
9	—	Turbocharger actuator electrical connector (part of 12B637)
10	—	Pin-type retainer (part of 12B637)

REMOVAL AND INSTALLATION (Continued)**Turbocharger Crossover Tube and Heat Shield**

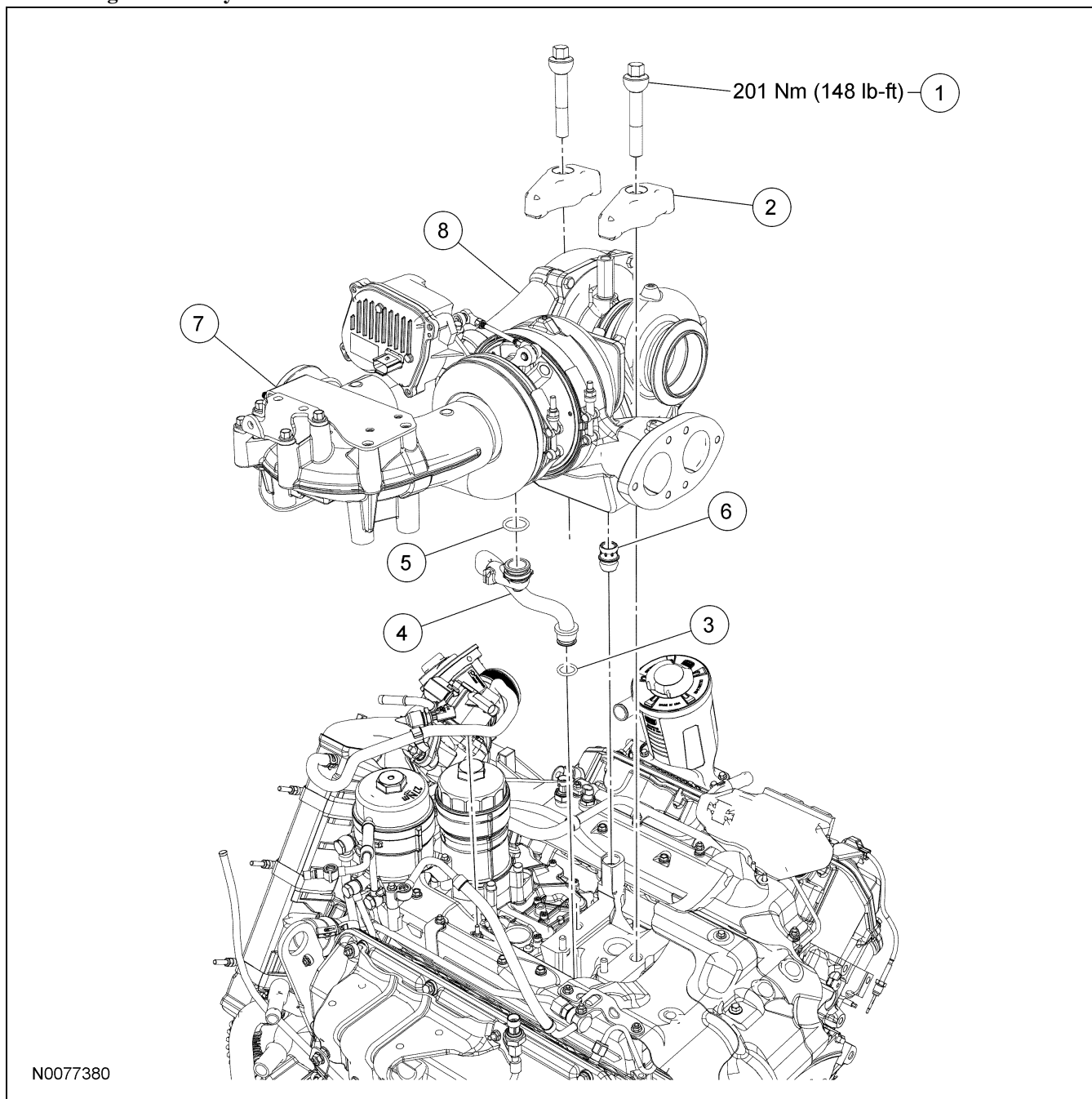
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REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	9C131	Front fuel cooler bracket
2	W302649	Turbocharger crossover tube front bolts (2 required)
3	W302649	Turbocharger crossover tube rear bolts (2 required)

Item	Part Number	Description
4	W301643	Turbocharger heat shield bolt (5 required)
5	9F460	Turbocharger heat shield

(Continued)

Turbocharger Assembly

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	W302501	Turbocharger hold-down bolt (2 required)
2	9P462	Turbocharger hold down (2 required)
3	W302511	O-ring seal
4	9T516	High-pressure drain tube
5	W302512	O-ring seal
6	9T514	Low-pressure drain tube
7	9346	Fuel cooler bracket
8	6K682	Turbocharger assembly

Removal

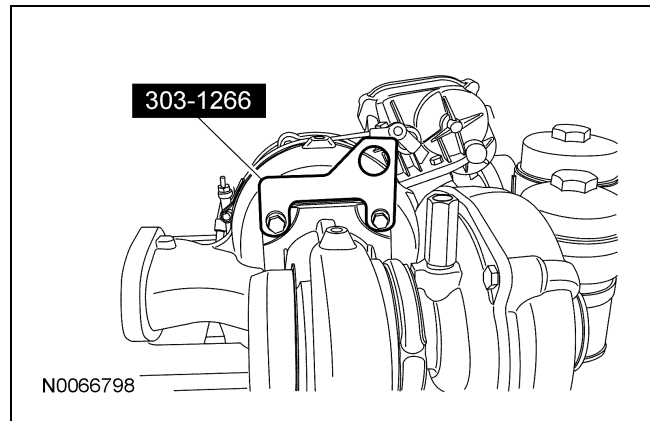
NOTE: It is recommended that this component be serviced with the vehicle body removed. If the body cannot be removed, refer to the Turbocharger — Body On version of the procedure in this section.

- Remove the body. For additional information, refer to Section 502-02.
- Remove the turbocharger inlet pipes. Carry out the Exhaust Gas Recirculation (EGR) Oxidation Catalytic Converter (OC) and Turbocharger Inlet Pipes — 6.4L Diesel, Body Off procedure. For additional information, refer to Section 309-00.
- Remove the clamp and disconnect the air cleaner outlet tube-to-crankcase vent oil separator hose at the vent oil separator.
- Loosen the clamp and remove the air cleaner outlet tube.
- ⚠ CAUTION: Do not lean on, pull on or use the turbocharger oil supply tube as a handle or damage to the turbocharger oil supply tube may occur.**

NOTE: Use a back-up wrench to prevent the fittings from turning.

Remove the turbocharger oil supply tube banjo fitting bolts and copper sealing washers.

 - Discard the copper sealing washers.
- Remove the bolt and the turbocharger oil supply tube.
 - Remove and discard the O-ring seal.
- Disconnect the turbocharger actuator electrical connector and pin-type retainer.
- Remove the 4 bolts for the turbocharger crossover tube and the front fuel cooler bracket.
- Remove the 5 bolts and the turbocharger heat shield.
- Remove the 2 bolts and hold downs for the turbocharger.
- Install the special tool.
 - Tighten to 20 Nm (177 lb-in).



- ⚠ CAUTION: Failure to use the turbocharger lifting bracket during removal, handling or installation of the turbocharger could result in a low-pressure to high-pressure turbocharger seal failure.**

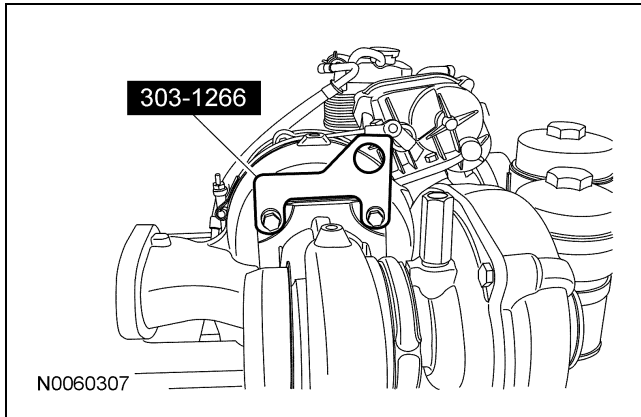
⚠ CAUTION: Make sure the turbocharger assembly is kept level to the engine during removal or installation. Failure to follow these instructions may result in damage to the high-pressure oil drain tube.

NOTE: Use care when removing the turbocharger. The crossover tube should not be removed. The seals in the crossover tube are one-time-use seals and must be installed new.

Using the special tool, remove the turbocharger assembly.
- Remove the turbocharger oil drain tubes.
 - Remove and discard the low-pressure drain tube.
 - Remove the high-pressure oil drain tube.
 - Remove and discard the 2 O-ring seals.

REMOVAL AND INSTALLATION (Continued)**Installation**

1. If removed, install the special tool.
 - Tighten to 20 Nm (177 lb-in).



2. **NOTE:** Lubricate the low-pressure oil drain tube with clean engine oil prior to installing.
NOTE: Install the low-pressure drain tube with the taper side down.

Install the low-pressure turbocharger oil drain tube in the turbocharger.

3. **NOTE:** Install 2 new O-ring seals and lubricate with clean engine oil prior to installing the tube.

Install the turbocharger high-pressure oil drain tube.

4. **⚠ CAUTION:** Failure to use the turbocharger lifting bracket during removal, handling or installation of the turbocharger could result in a low-pressure to high-pressure turbocharger seal failure.

⚠ CAUTION: Make sure the turbocharger assembly is kept level to the engine during removal or installation. Failure to follow these instructions may result in damage to the high-pressure oil drain tube.

Using the special tool, install the turbocharger assembly.

5. **NOTE:** After removing the special tool, the top bolt holes remain open on the turbocharger.
Remove the special tool.

6. Install the 2 turbocharger hold downs and the bolts.
 - Tighten to 201 Nm (148 lb-ft).
7. Position the turbocharger heat shield and install the 5 bolts.
 - Tighten to 11 Nm (97 lb-in).
8. Position the front fuel cooler bracket. Install the 4 bolts for the turbocharger crossover tube.
 - Tighten to 31 Nm (23 lb-ft).
9. Connect the turbocharger actuator electrical connector and pin-type retainer.
10. **NOTE:** Install a new O-ring seal and apply clean engine oil.
Position the turbocharger oil supply tube and install the bolt.
 - Tighten to 13 Nm (115 lb-in).
11. Prelubricate the oil inlet holes of the turbocharger assembly with clean oil and spin the compressor wheel several times to coat the bearings with oil.
12. **⚠ CAUTION:** Only use banjo bolts with a green hex head. The green-headed bolts do not contain a check valve. When viewed from the inner end, the correct bolt will appear open. Failure to install the correct banjo bolt may result in damage to the turbochargers.
NOTE: Use a back-up wrench to prevent the fittings from turning.
Install 2 new copper sealing washers and the oil supply tube banjo fittings on the turbocharger oil supply fittings.
 - Tighten to 38 Nm (28 lb-ft).
 - Verify that the turbocharger oil supply tube does not contact the turbocharger actuator linkage.
13. Install the air cleaner outlet tube and tighten the clamp.
 - Tighten to 5 Nm (44 lb-in).

REMOVAL AND INSTALLATION (Continued)

14. **NOTE:** Install a new clamp prior to connecting the hose.

Connect the air cleaner outlet tube-to-crankcase vent oil separator hose to the vent oil separator and tighten the clamp.

15. Install the turbocharger inlet pipes. Carry out the Exhaust Gas Recirculation (EGR) Oxidation Catalytic Converter (OC) and Turbocharger Inlet Pipes — 6.4L Diesel, Body Off procedure. For additional information, refer to Section 309-00.

16. Install the body. For additional information, refer to Section 502-02.
-

DESCRIPTION AND OPERATION

Turbocharger

The 2-stage turbocharger assembly consists of the following components:

- Low-pressure turbocharger
- High-pressure turbocharger
- Turbocharger actuator

The 2-stage turbocharger assembly is an exhaust-driven centrifugal compressor. Its purpose is to increase power output by supplying compressed air to the engine. The internal components are oil and air cooled. Engine oil is circulated through the housings, which acts as a heat barrier between the hot turbine and the cold compressor. Sleeve-type bearings are lubricated by engine oil. Oil is pumped directly from the oil filter module, then circulated to each turbocharger housing and returned to the sump through the oil drains in the turbocharger pedestal. The 2-stage turbocharger assembly consists of a low-pressure and high-pressure turbocharger mounted in series.

The variable geometry turbocharger is electronically controlled by the turbocharger actuator, via the PCM through the controller area network (CAN). The turbocharger actuator controls intake manifold pressure. The high-pressure turbocharger uses a set of moveable vanes in the turbine housing to change the flow of the exhaust gases throughout the turbocharger. These vanes can be positioned to change the angle or direction and the velocity of flow to the turbine wheel, depending upon the conditions in which the engine is operating. As power demand increases, exhaust gas velocity increases in direct relation, as does intake manifold boost pressure. Conversely, as the flow of exhaust gas diminishes, intake manifold boost pressure also reduce at the same rate.

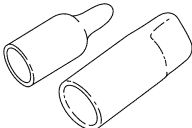
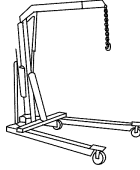
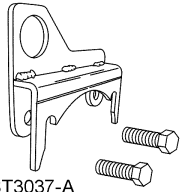
Vaness mounted around the internal circumference of the high-pressure turbine housing are connected to a unison ring. The unison ring links all the vanes together and when the unison ring moves, all the vanes move. The unison ring is moved by the turbocharger actuator and linkage. Turbocharger control is a closed-loop system using the exhaust pressure (EP) sensor to provide feedback to the PCM. In response to engine speed, engine load, manifold pressure and barometric pressure, the PCM controls the turbocharger actuator position to match manifold boost to the requirements of the engine.

Expanding exhaust gases drive the turbine shaft assembly to speeds over 100,000 rpm. Filtered air entering the low-pressure turbocharger compressor side of the turbocharger is compressed and delivered to the high-pressure turbocharger. The air entering the high-pressure turbocharger compressor side of the turbocharger is compressed and delivered to a charge air cooler (CAC). The very hot compressed air is cooled by the CAC, and then continues on to fill the intake manifold at a pressure higher than atmospheric pressure. Because considerably more air is forced into the intake manifold, the results are increased power, fuel efficiency and the ability to maintain power at higher altitudes.

REMOVAL AND INSTALLATION

Turbocharger — Body On

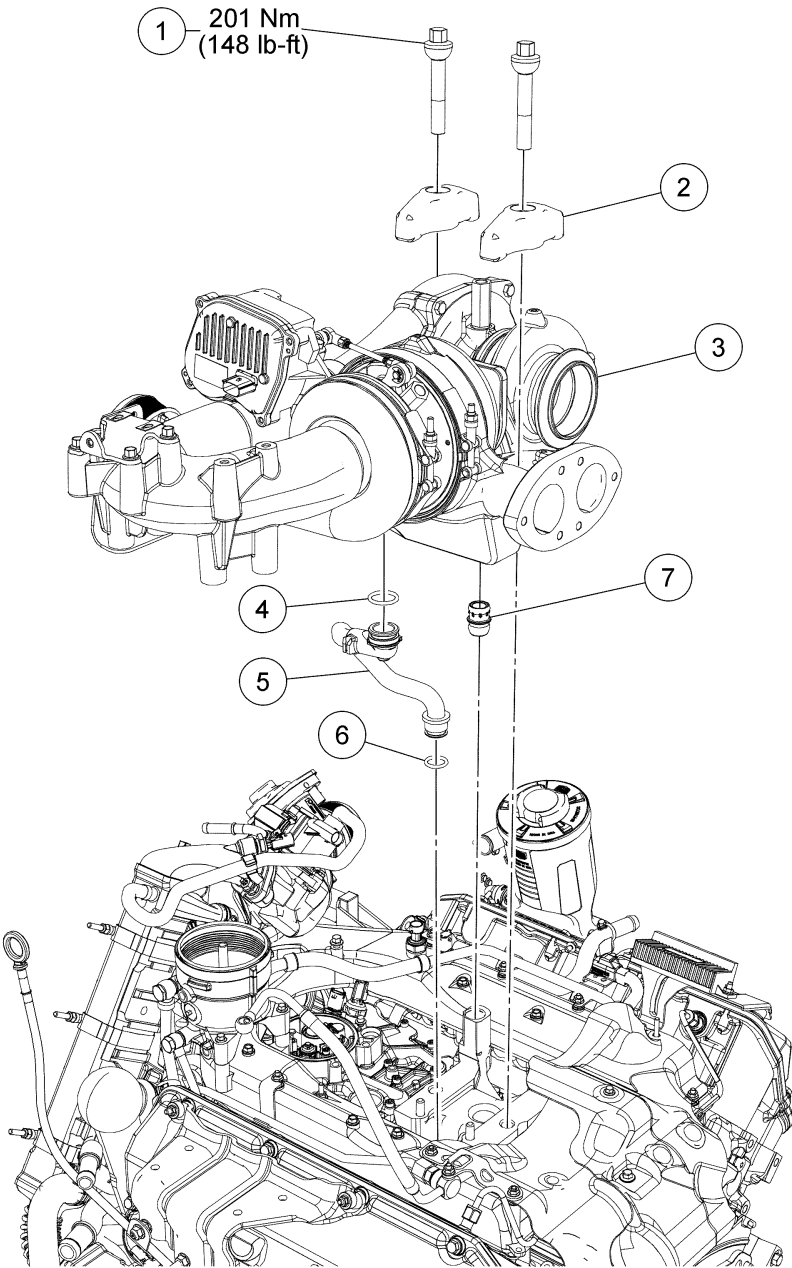
Special Tool(s)

 ST3023A	Fuel System Caps 310-158
 ST1341-A	Heavy Duty Floor Crane 014-00072 or equivalent
 ST3037-A	Turbocharger Lifting Bracket 303-1266

Material

Item	Specification
SAE 15W-40 Super Duty Diesel Motor Oil XO-15W40-QSD (US); CXO-15W40-LSD12 (Canada); or equivalent	WSS-M2C171-E

REMOVAL AND INSTALLATION (Continued)



N0075800

Item	Part Number	Description
1	W302501	Turbocharger hold-down bolt (2 required)
2	9P462	Turbocharger hold down (2 required)
3	6K682	Turbocharger assembly

(Continued)

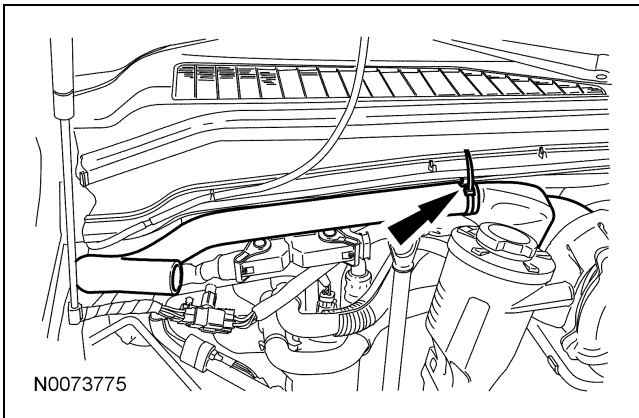
Item	Part Number	Description
4	W302512	O-ring seal
5	9T516	High-pressure drain tube
6	W302511	O-ring seal
7	9T514	Low-pressure drain tube

REMOVAL AND INSTALLATION (Continued)**Removal**

⚠ CAUTION: Position a suitable material in front of the charge air cooler (CAC) or damage to the CAC may occur.

NOTE: It is recommended that this component be serviced with the vehicle body removed. If the body can be removed, refer to the Turbocharger — Body Off version of the procedure in this section.

1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
2. Remove the degas bottle. For additional information, refer to Section 303-03.
3. Remove the air cleaner assembly and air cleaner outlet pipe. For additional information, refer to Section 303-12.
4. Remove the auxiliary air intake hose.

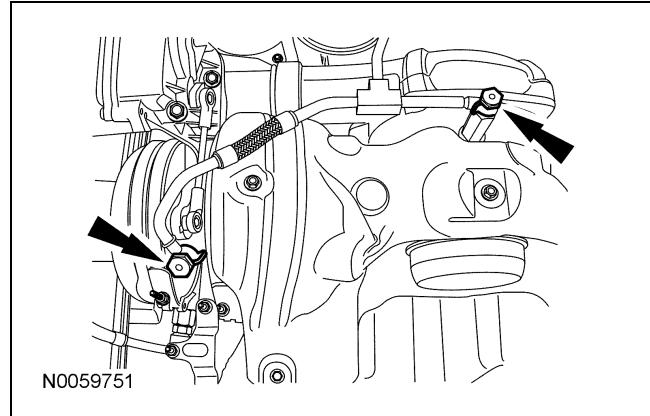


5. **⚠ CAUTION:** Do not lean on, pull on or use the turbocharger oil supply tube as a handle or damage to the turbocharger oil supply tube may occur.

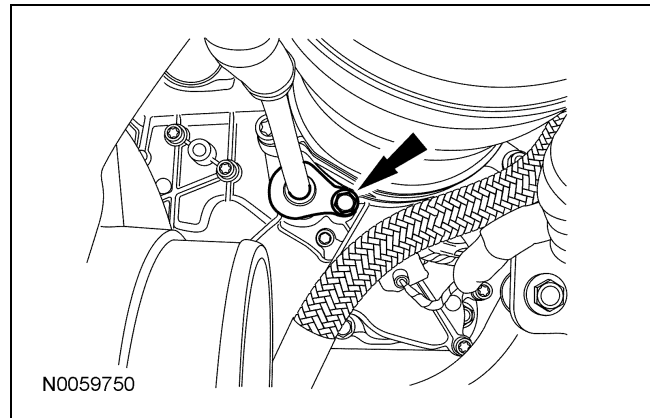
NOTE: Use a back-up wrench to prevent the fittings from turning.

Remove the turbocharger oil supply tube banjo bolts and copper sealing washers.

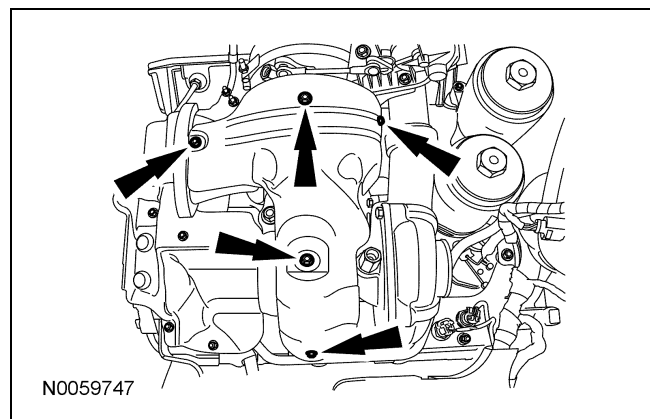
- Discard the copper sealing washers.




6. Remove the bolt and the turbocharger oil supply tube.
 - Remove and discard the O-ring seal.
 - Plug or cap the openings as needed.



7. **NOTE:** Roll the heat shield towards the cowl, then lift up in the front and remove forward. Remove the bolts and the turbocharger heat shield.

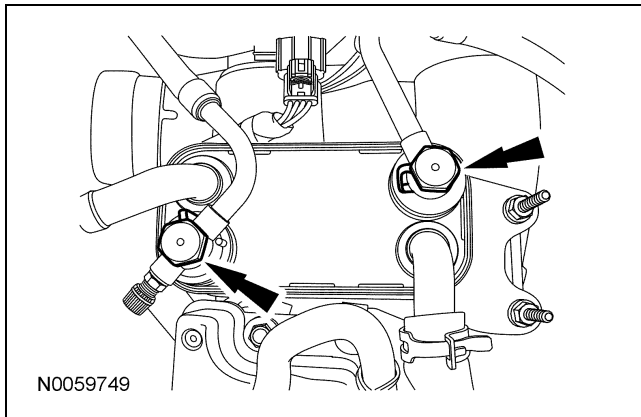


REMOVAL AND INSTALLATION (Continued)

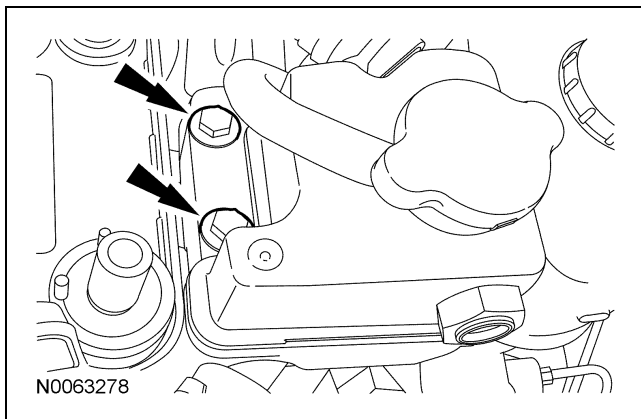
8.  **CAUTION:** Fuel injection equipment is manufactured to very precise tolerances and fine clearances. To prevent fuel system damage, it is essential that absolute cleanliness is observed when working with these components. Always install Fuel System Caps to any open orifices or tubes.

Remove the banjo bolts and the sealing washers at the fuel cooler.

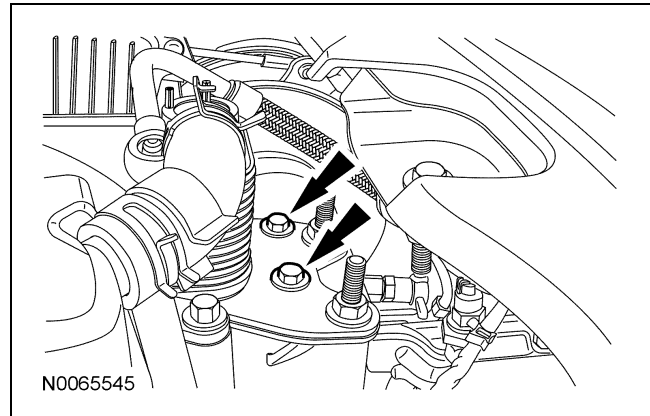
- Discard the sealing washers.



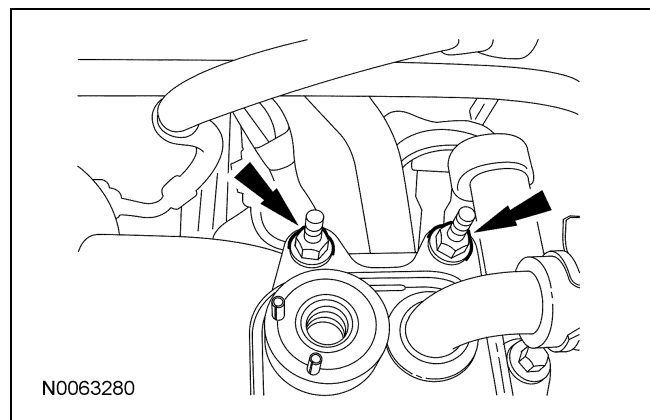
9. Remove the 3 bolts for the fuel cooling system expansion tank.



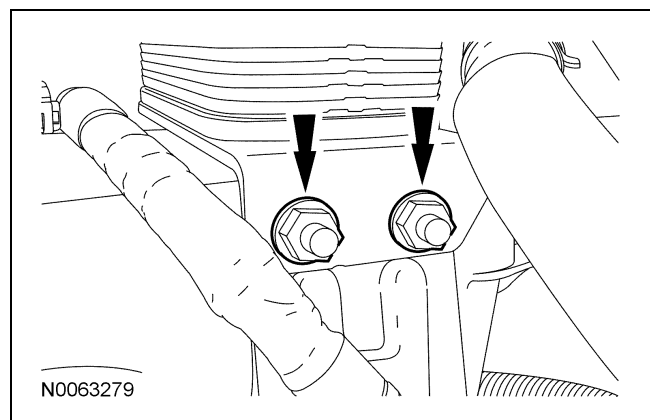
10. Remove the bolts for the fuel cooler.



11. Remove the stud bolts for the fuel cooler.

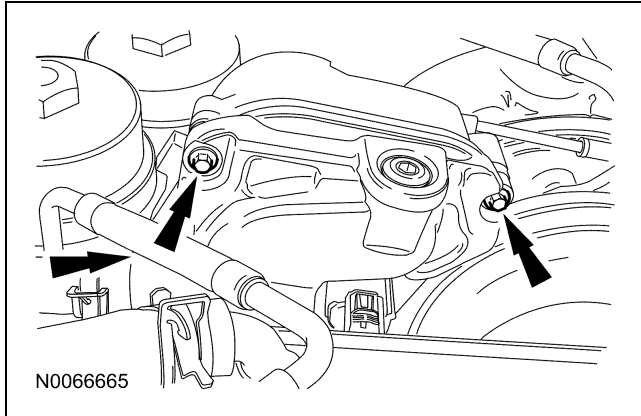


12. Remove the 2 nuts for the fuel cooler.

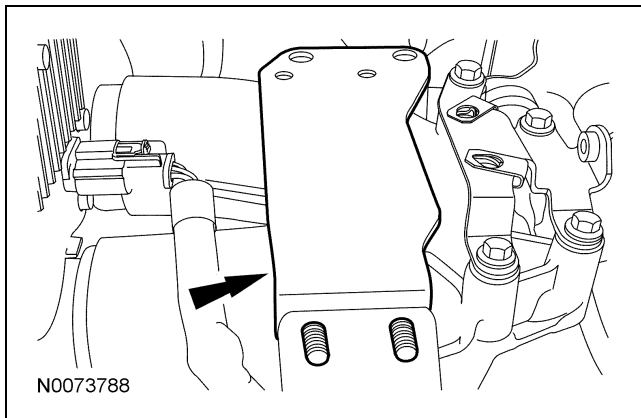


REMOVAL AND INSTALLATION (Continued)

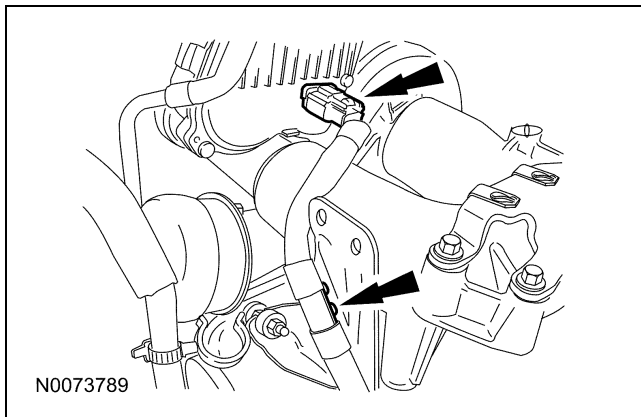
13. Remove the 3 bolts for the turbocharger actuator cooler. Position the fuel cooler, fuel cooling system expansion tank and turbocharger actuator cooler aside.



14. Remove the fuel cooler bracket.



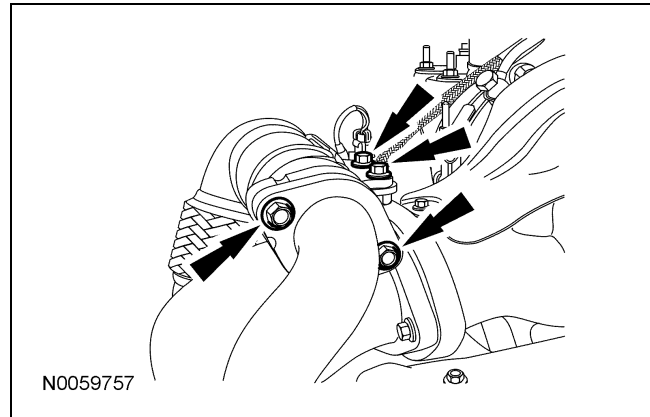
15. Disconnect the turbocharger actuator electrical connector and pin-type retainer.



16. **NOTE:** Engine removed from art for clarity.

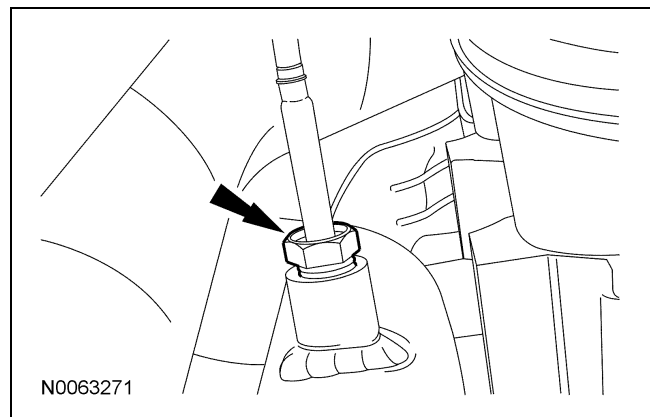
Remove the RH turbocharger inlet pipe-to-EGR-oxidation catalytic converter (OC) pipe bolts and the EGR-OC-to-turbocharger bracket bolts.

- Discard the bolts.



17. Remove the RH splash shield. For additional information, refer to Section 501-02.

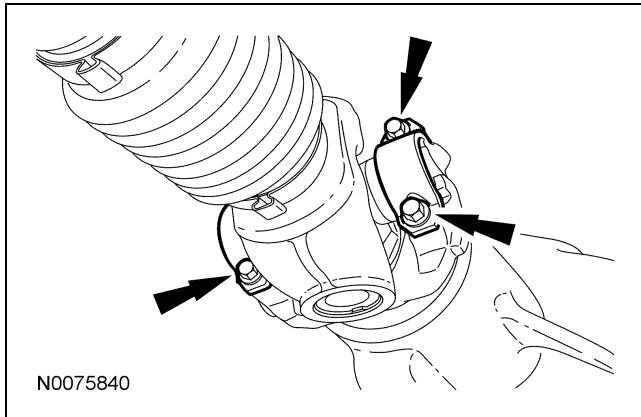
18. Remove the exhaust gas recirculation temperature (EGRT) sensor from the RH turbocharger inlet pipe.



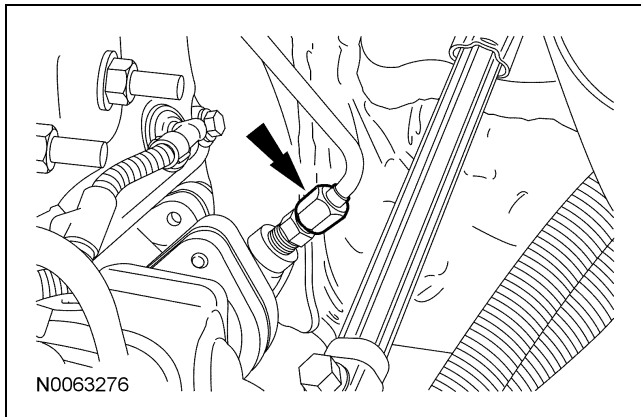
REMOVAL AND INSTALLATION (Continued)

19. **NOTE:** Index-mark the drive shaft prior to disconnecting from the axle.

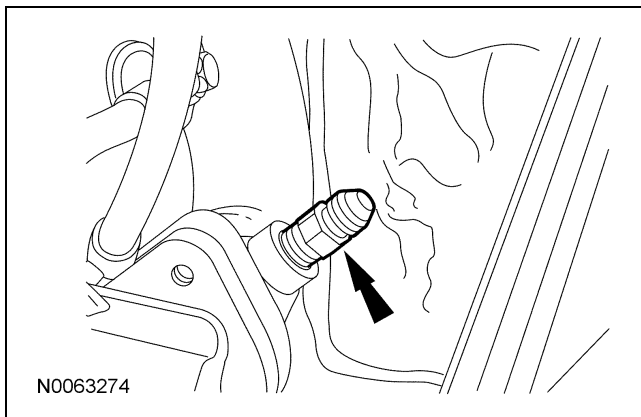
If equipped, remove the 4 bolts, straps and position aside the front drive shaft aside.



20. Disconnect the exhaust pressure (EP) sensor tube from the EGR-OC pipe.

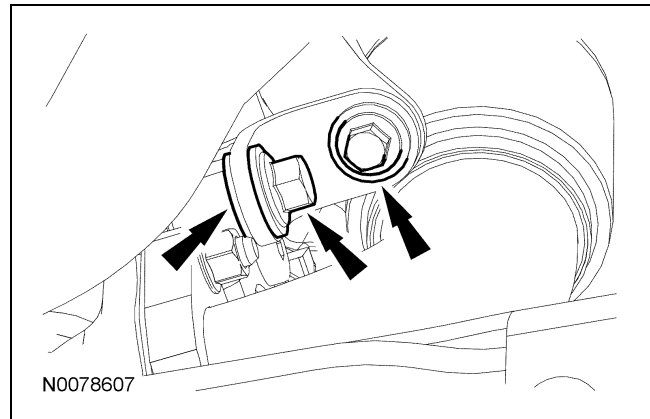


21. Remove the EP sensor tube fitting from the EGR-OC pipe.



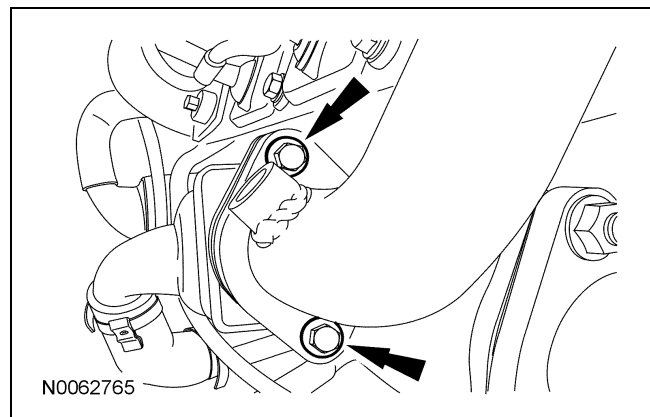
22. Remove the EGR-OC pipe bracket-to-bracket bolt and washer. Remove the cylinder head bracket-to-cylinder head bolt, washers and the bracket.

- Discard the bolts.

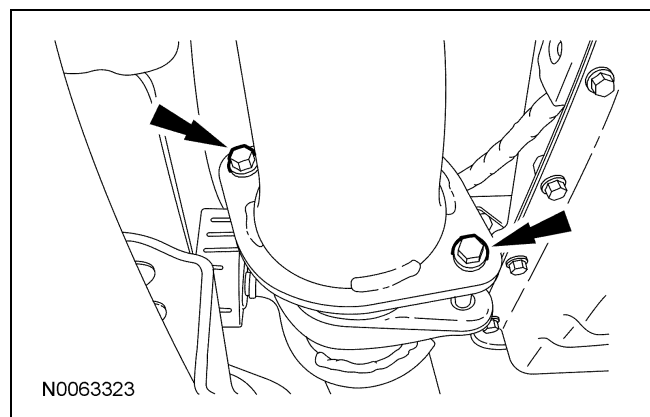


23. Remove the EGR-OC-to-EGR cooler bolts.

- Discard the bolts and gasket.



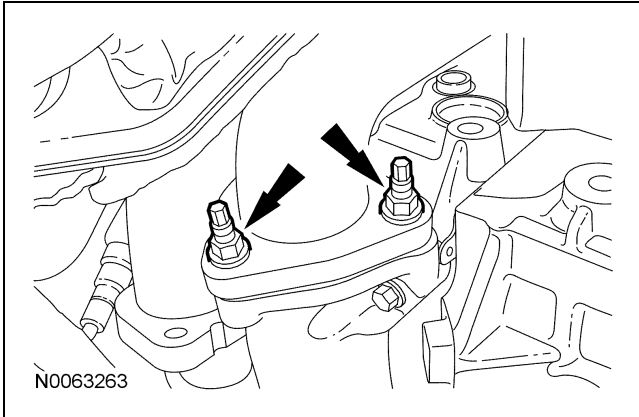
24. Loosen the exhaust downpipe-to-OC pipe bolts.



REMOVAL AND INSTALLATION (Continued)

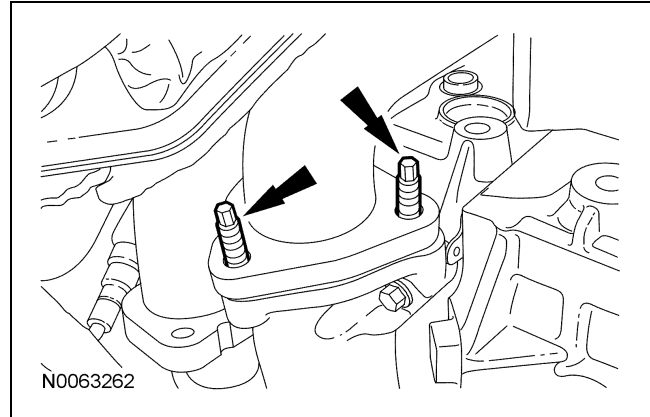
25. **NOTE:** LH shown, RH similar.

Remove and discard the 6 LH and RH turbocharger inlet pipes-to-exhaust manifold nuts.



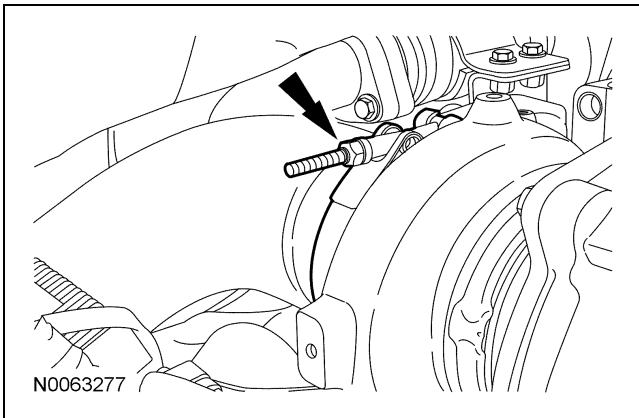
28. Remove the 3 LH turbocharger inlet pipes-to-exhaust manifold studs and gasket. Remove the LH turbocharger inlet pipe.

- Discard the studs and gasket.



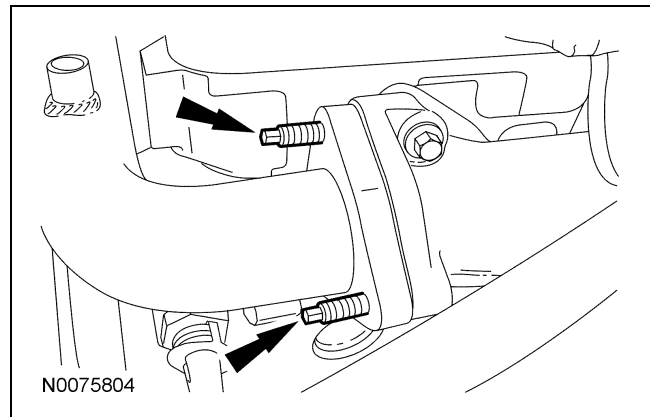
26. Remove and discard the exhaust downpipe clamp. Position aside the exhaust downpipe.

- Remove and discard the exhaust downpipe gasket.



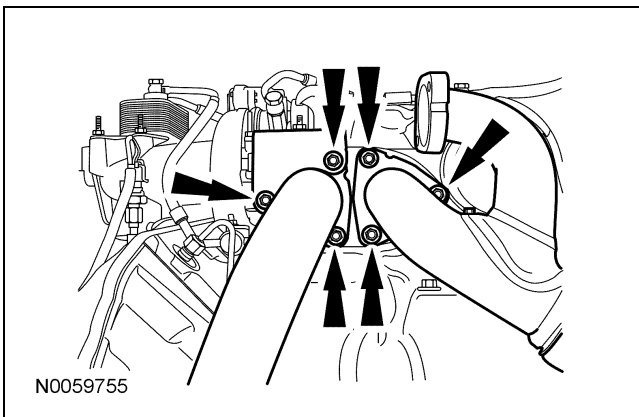
29. Remove the 2 outer RH turbocharger inlet pipes-to-exhaust manifold studs.

- Discard the studs.

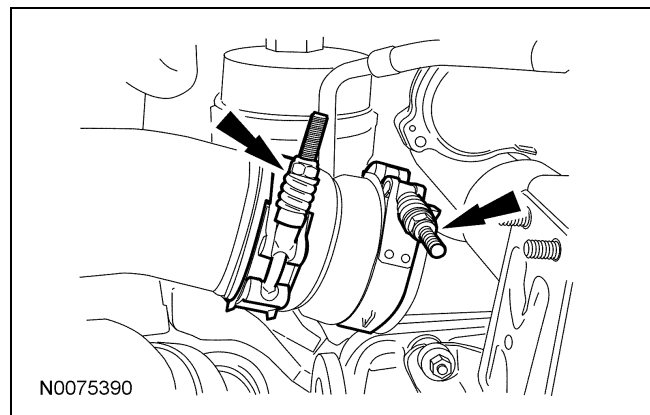


27. Remove the 6 turbocharger inlet pipe bolts and EGR-OC-to-turbocharger bracket.


- Discard the bolts and gaskets.



30. Loosen the clamps and remove the charge air cooler (CAC) tube flex coupling.

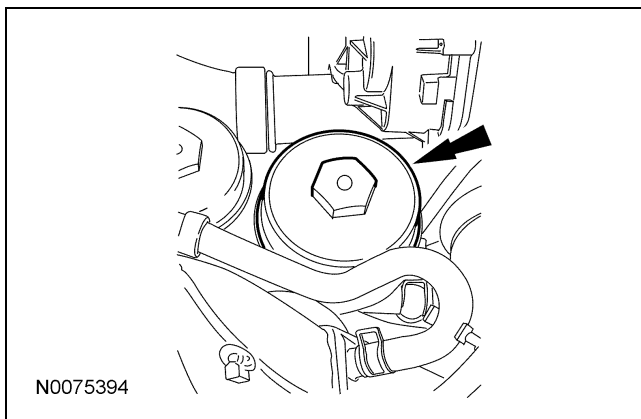



REMOVAL AND INSTALLATION (Continued)

31.  **CAUTION:** Fuel injection equipment is manufactured to very precise tolerances and fine clearances. To prevent fuel system damage, it is essential that absolute cleanliness is observed when working with these components. Always install fuel system caps to any open orifices or tubes.

Remove the fuel filter module cover, fuel filter and, using a suitable suction device, remove the fuel from the fuel filter module.

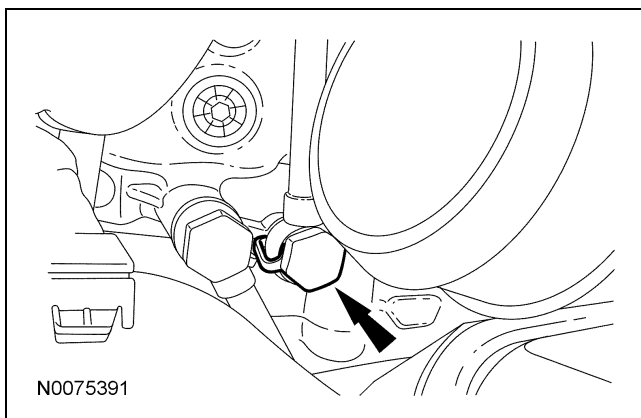
- Cover the fuel filter housing with a covering to prevent foreign material from entering the fuel system.



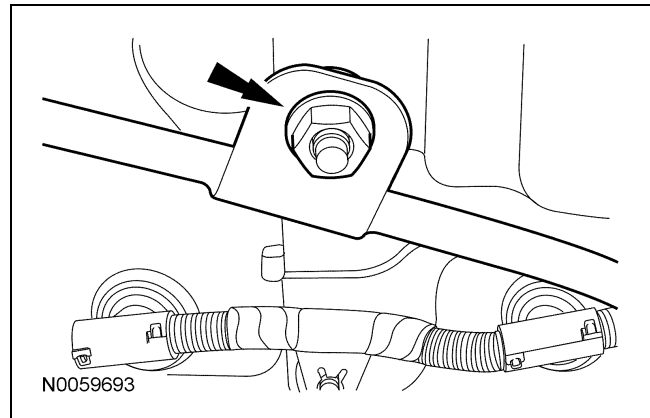
32.  **CAUTION:** Fuel injection equipment is manufactured to very precise tolerances and fine clearances. To prevent fuel system damage, it is essential that absolute cleanliness is observed when working with these components. Always install Fuel System Caps to any open orifices or tubes.

Remove the banjo bolt, copper sealing washer and fuel cooler to fuel filter module tube.

- Discard the copper sealing washer.

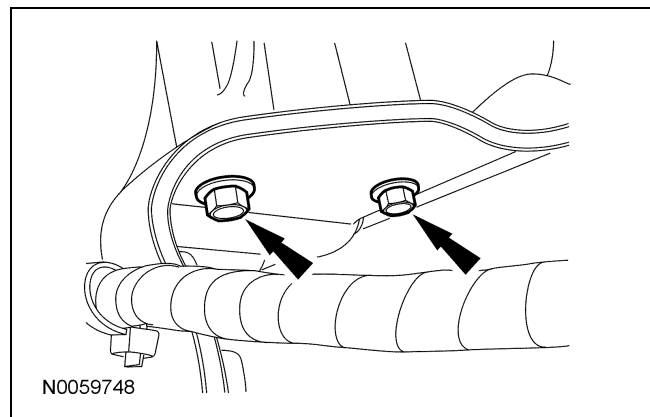


33. Remove the nut and position the oil level indicator and tube aside.

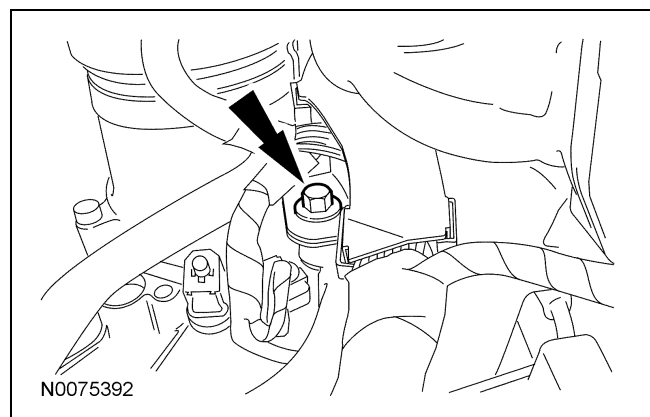


34. Remove the bolts for the turbocharger crossover tube.


- Remove the front fuel cooler bracket.



35. Remove the bolt for the engine wiring harness.

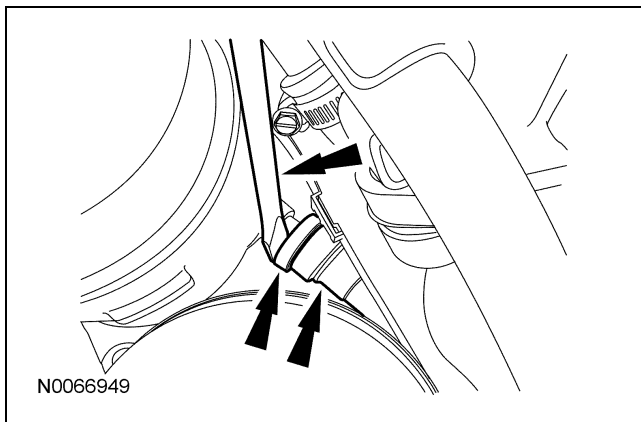


REMOVAL AND INSTALLATION (Continued)

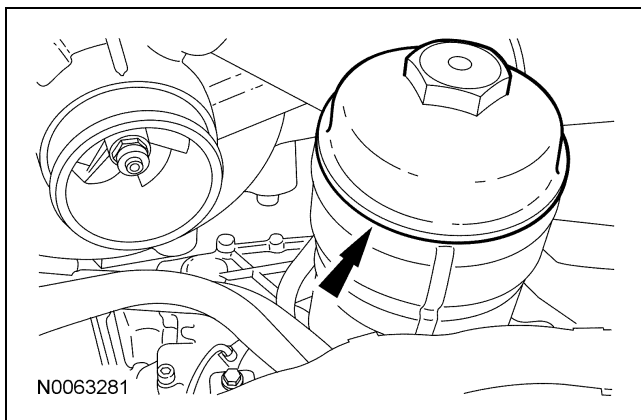
36.  **CAUTION:** Fuel injection equipment is manufactured to very precise tolerances and fine clearances. To prevent fuel system damage, it is essential that absolute cleanliness is observed when working with these components. Always install Fuel System Caps to any open orifices or tubes.

NOTE: Use a commercially available disconnect tool and a screwdriver to release the fuel tube.

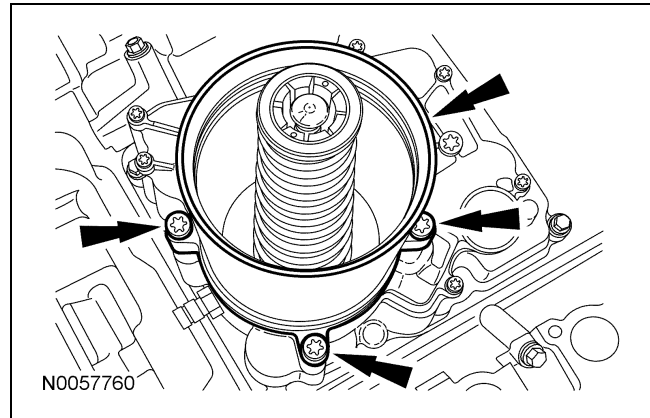
Disconnect the fuel injection pump supply tube at the fuel filter module.



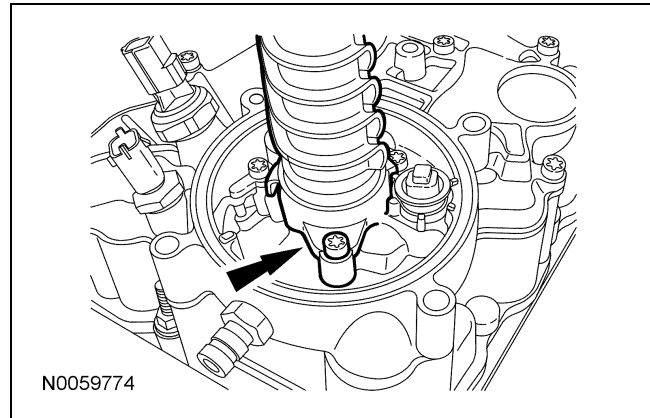
37. Remove and discard the oil filter element and O-ring seal.



38. Remove the 4 Torx bolts and the oil filter housing.

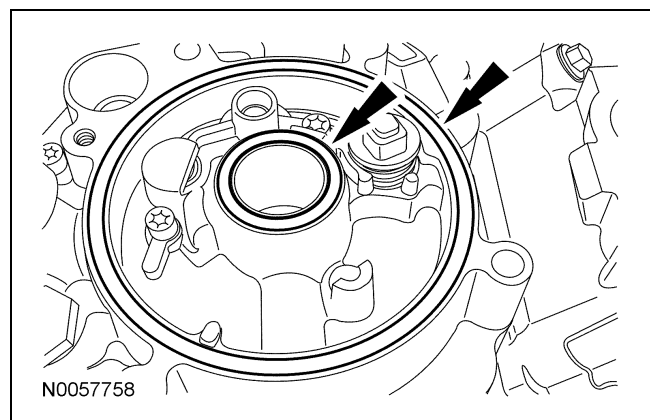


39. Remove the screw and the oil filter return tube assembly.



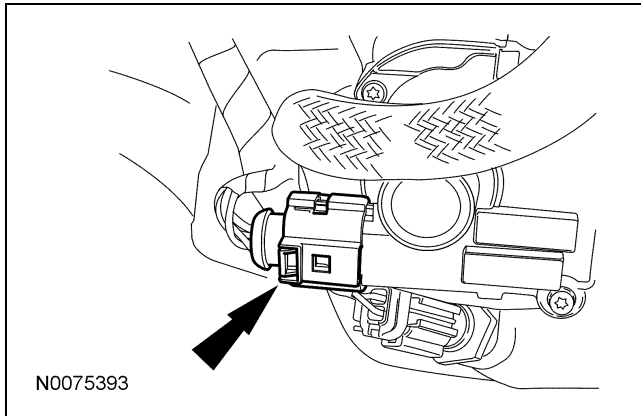
40. Remove and discard the oil filter base gasket and seal.

- Cover the oil cooler to prevent foreign material from entering.



REMOVAL AND INSTALLATION (Continued)

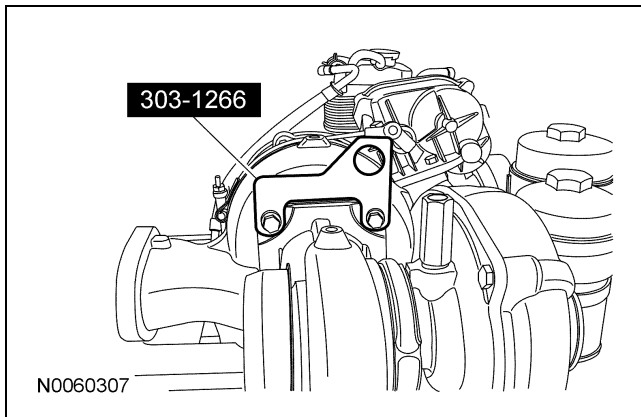
41. Disconnect the EGR valve electrical connector.





42. Remove the bolts and the hold downs for the turbocharger.

43. Install the special tool.

- Tighten to 20 Nm (177 lb-in).



44.  **CAUTION:** Failure to use the turbocharger lifting bracket during removal, handling or installation of the turbocharger could result in a low-pressure to high-pressure turbocharger seal failure.

 **CAUTION:** Make sure the turbocharger assembly is kept level to the engine during removal or installation. Failure to follow these instructions may result in damage to the high-pressure oil drain tube.

NOTE: Use care when removing the turbocharger. The crossover tube should not be removed. The seals in the crossover tube are one-time-use seals and must be installed new.

With the help of an assistant, using the heavy duty lifting crane, remove the turbocharger assembly.

- Remove and discard the RH turbocharger inlet pipe gasket at the RH exhaust manifold.

45. Remove the turbocharger oil drain tubes.

- Remove and discard the low-pressure drain tube.
- Remove the high pressure oil drain tube.
- Remove and discard the 2 O-ring seals.

Installation

1. **NOTE:** Lubricate the low-pressure turbocharger oil drain tube with clean engine oil prior to installing.

NOTE: Install the low-pressure turbocharger drain tube with the taper side down.

Install the low-pressure turbocharger drain tube in the turbocharger.

2. **NOTE:** Install 2 new O-rings seals and lubricate with clean engine oil prior to installing.

Install the turbocharger high-pressure oil drain tube.

REMOVAL AND INSTALLATION (Continued)

3. **CAUTION:** Failure to use the turbocharger lifting bracket during removal, handling or installation of the turbocharger could result in a low-pressure to high-pressure seal failure.

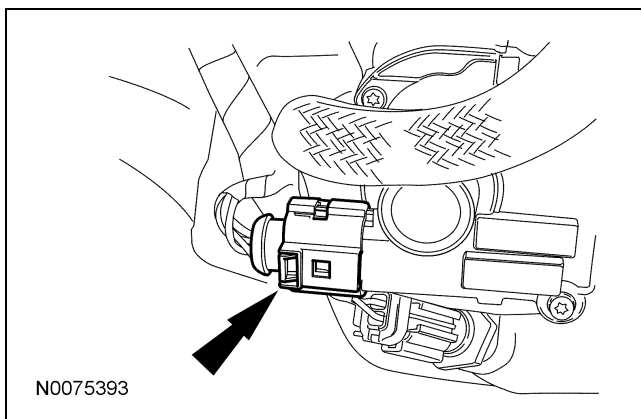
CAUTION: Make sure the turbocharger assembly is kept level to the engine during removal or installation. Failure to follow these instructions may result in damage to the high-pressure oil drain tube.

NOTE: Make sure the turbocharger is positioned under the high-pressure fuel pump heat shield on the right side.

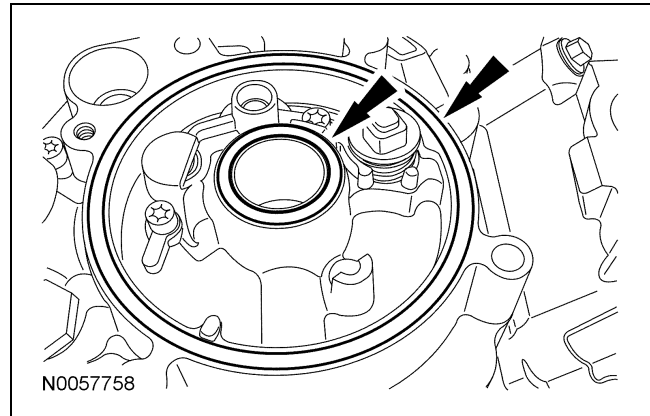
NOTE: Install a new gasket for the RH turbocharger inlet pipe at the RH exhaust manifold prior to installing the turbocharger assembly.

With the help of an assistant, using the heavy duty lifting crane, install the turbocharger assembly.

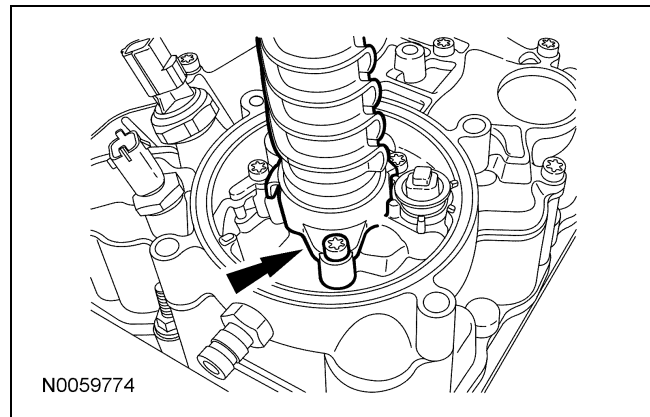
4. **NOTE:** After removing the special tool, the top bolt holes remain open on the turbocharger. Remove the special tool.
5. Install the 2 turbocharger hold downs and bolts.
- Tighten to 201 Nm (148 lb-ft).
6. Connect the EGR valve electrical connector.



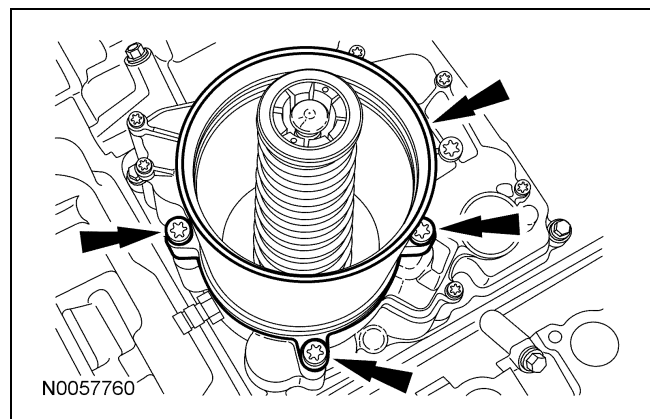
7. Install the oil filter base gasket and O-ring seal.
- Apply clean engine oil to the oil filter base gasket and O-ring seal.



8. Install the oil filter return tube assembly and screw.
- On new oil return tubes, tighten to 7 Nm (62 lb-in).
 - On used oil return tubes, tighten to 5 Nm (44 lb-in).

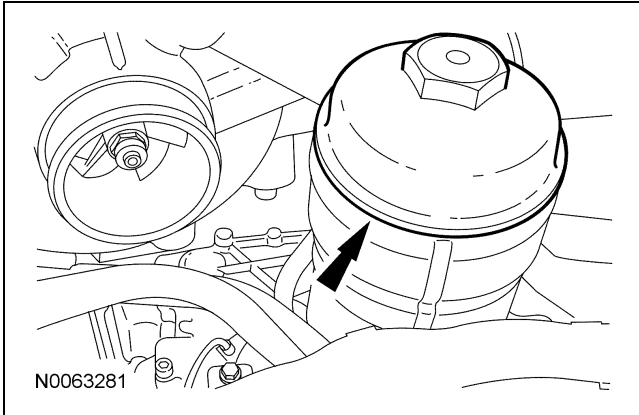


9. Install the oil filter housing and 4 Torx bolts.
- Tighten to 22 Nm (16 lb-ft).

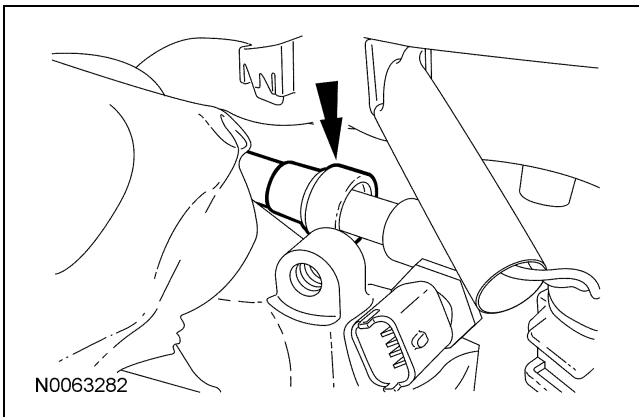


REMOVAL AND INSTALLATION (Continued)

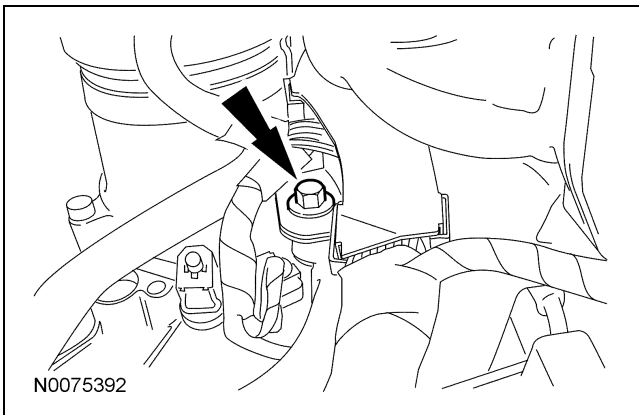
10. **NOTE:** Install a new O-ring seal on the oil filter cap and apply clean engine oil.
Install a new oil filter element and the oil filter cap.
- Tighten to 25 Nm (18 lb-ft).



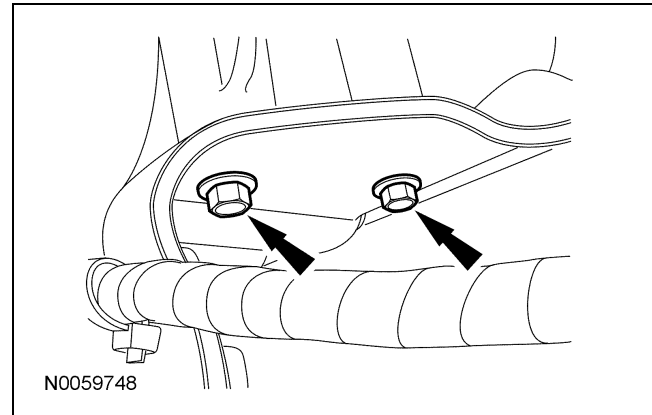
11. Connect the fuel injection pump supply tube at the fuel filter module.



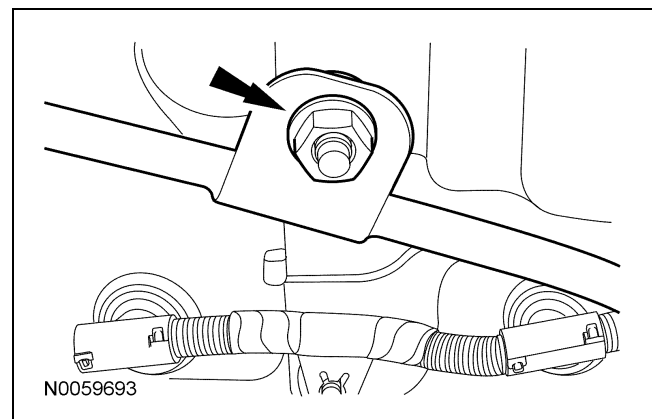
12. Install the bolt for the engine wiring harness.
- Tighten to 8 Nm (71 lb-in).




13. Position the front fuel cooler bracket. Install the bolts for the turbocharger crossover tube.
- Tighten to 31 Nm (23 lb-ft).



14. Position back the oil level indicator and tube and install the nut.
- Tighten to 31 Nm (23 lb-ft).

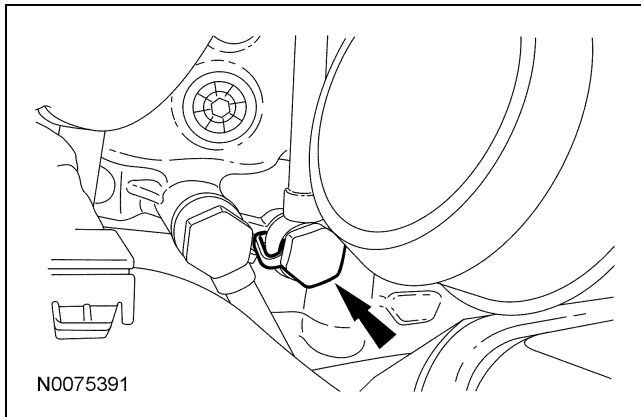


REMOVAL AND INSTALLATION (Continued)

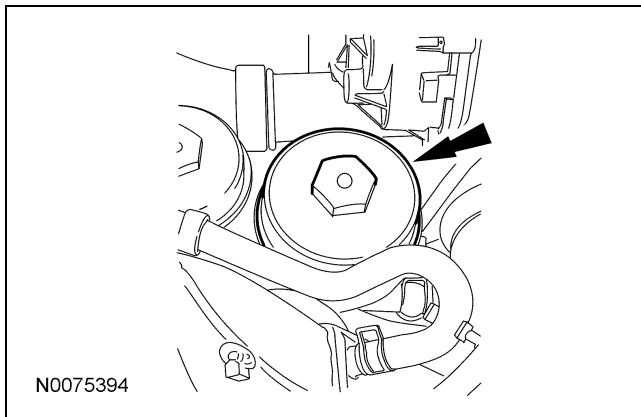
15.  **CAUTION:** Use only banjo bolts with a green hex head. The green-headed bolts do not contain a check valve. When viewed from the inner end, the correct bolt will appear open. Failure to install the correct banjo bolt may result in damage to the fuel system.

Install fuel cooler-to-fuel filter module tube, new copper sealing washer and the banjo bolt.

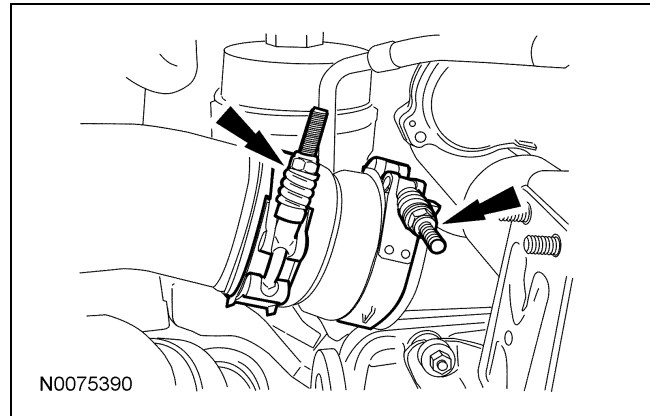
- Tighten to 38 Nm (28 lb-ft).



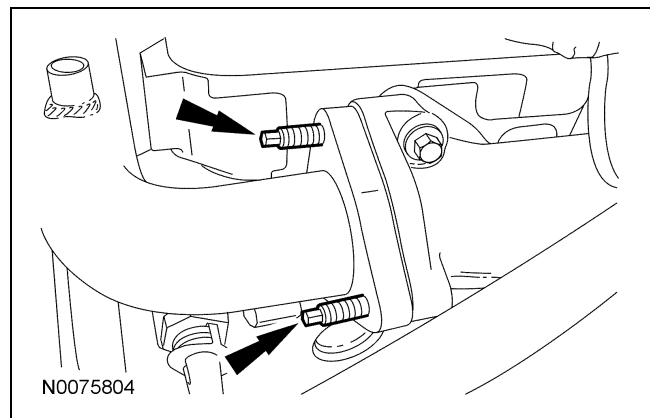
16. Install the fuel filter element and cover.
- Tighten to 27 Nm (20 lb-ft).




17. Install the CAC tube flex coupling and clamps.
- Tighten the engine clamp to 12 Nm (106 lb-in).
 - Tighten the tube clamp to 8 Nm (71 lb-in).



18. Install the 2 studs for the RH turbocharger inlet pipe.
- Tighten to 18 Nm (159 lb-in).



REMOVAL AND INSTALLATION (Continued)

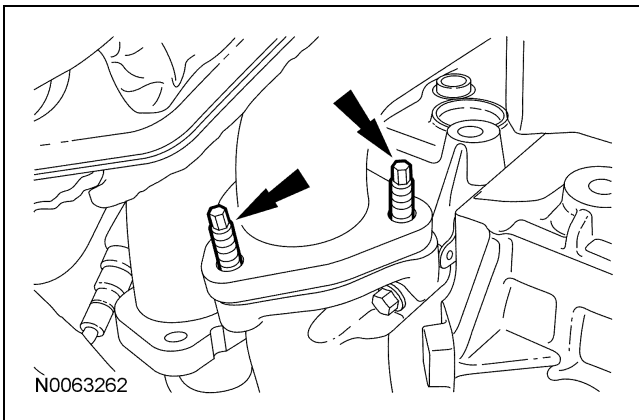
19.  **CAUTION:** Do not bend or twist the turbocharger inlet pipe or damage to the turbocharger inlet pipe may occur.

NOTE: To aid in installation, replace the top stud with bolt part number W302649.

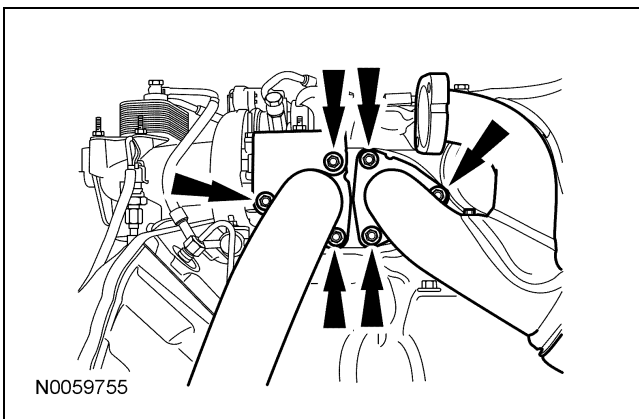
NOTE: It will be necessary to position the OC-EGR pipe as needed.


Position the LH turbocharger inlet pipe in the vehicle. Install the gasket and 2 studs for the LH turbocharger inlet pipe. Loosely install the bolt.

- Tighten the studs to 18 Nm (159 lb-in).



20. Install the turbocharger inlet pipe gaskets, bracket and loosely install the 6 new bolts.
- Tighten the top 4 bolts to 25 Nm (18 lb-ft).



21.  **CAUTION:** Due to limited access, one of the specific Half-moon wrenches and other tools described must be used to correctly tighten the fasteners in this step. Failure to follow this instruction may result in engine failure.

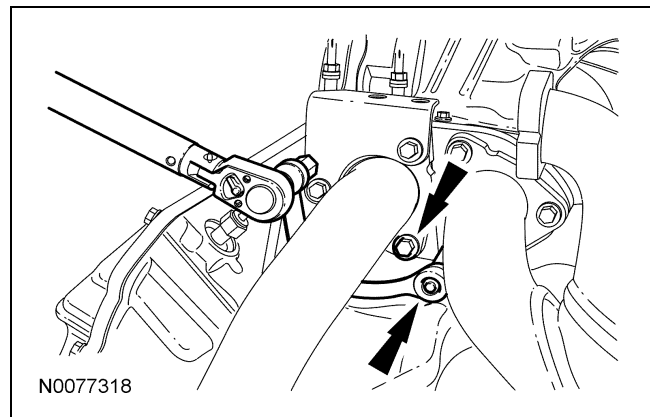
NOTE: To complete this step, it will be necessary to use the following tools:

- A 3/8-in drive torque wrench that is 241.3 mm (9.5 in) or 368.3 mm (14.5 in) from center of the handle to the center of the square drive.
- One of the 10-mm/12-mm Half-moon wrenches listed in the following chart.
- A 12-mm Allen socket (to drive the Half-moon wrench).

NOTE: To obtain the required torque value of 25 Nm (18 lb-ft), it will be crucial to orient the Half-moon wrench in the direction shown and 180 degrees (straight out) from the torque wrench. The torque wrench must be set to the value specified in the following chart for the Half-moon wrench and torque wrench length being used.

Tighten the turbocharger inlet pipes-to-turbocharger bottom 2 bolts.

- Refer to the following chart for torque wrench setting, based on the specific Half-moon wrench and torque wrench length being used.



REMOVAL AND INSTALLATION (Continued)**Torque Chart — Turbocharger Inlet Pipes-to-Turbocharger, Bottom 2 Bolts**

Half-Moon Wrench Brand	Wrench Part Number	Wrench Size	Torque Wrench Length	Torque Wrench Setting	
				Nm	lb-ft
Cornwell®	BWM-1012MM	10/12 mm	9.5 in	20	15
Gear Wrench®	9851	10/12 mm	9.5 in	18	13
Matco®	MHM1012	10/12 mm	9.5 in	18	13
Mac®	HMM1012R	10/12 mm	9.5 in	15	11
Snap-On®	CXM1012	10/12 mm	9.5 in	18	13
Cornwell®	BWM-1012MM	10/12 mm	14.5 in	19	14
Gear Wrench®	9851	10/12 mm	14.5 in	18	13
Matco®	MHM1012	10/12 mm	14.5 in	18	13
Mac®	HMM1012R	10/12 mm	14.5 in	16	12
Snap-On®	CXM1012	10/12 mm	14.5 in	18	13

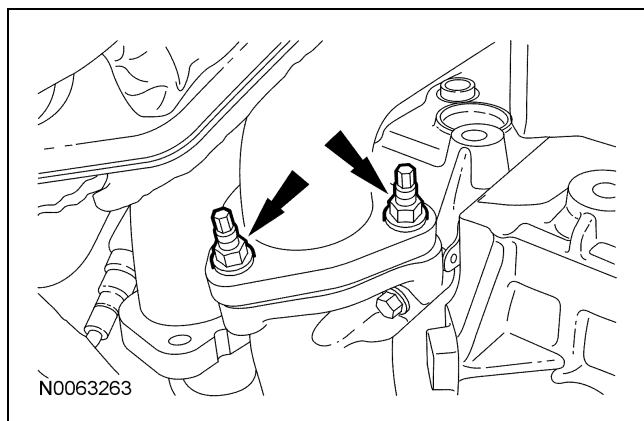
NOTE: To achieve the required torque of 25 Nm (18 lb-ft), the torque wrench must be set to the appropriate Torque Wrench Setting listed in this chart.

N0076310

22. **NOTE:** LH shown, RH similar.


Install the 5 lower turbocharger inlet pipe nuts.

- Tighten to 31 Nm (23 lb-ft).



N0063263

REMOVAL AND INSTALLATION (Continued)

23.  **CAUTION:** Due to limited access, one of the specific Half-moon wrenches and other tools described must be used to correctly tighten the fasteners in this step. Failure to follow this instruction may result in engine failure.

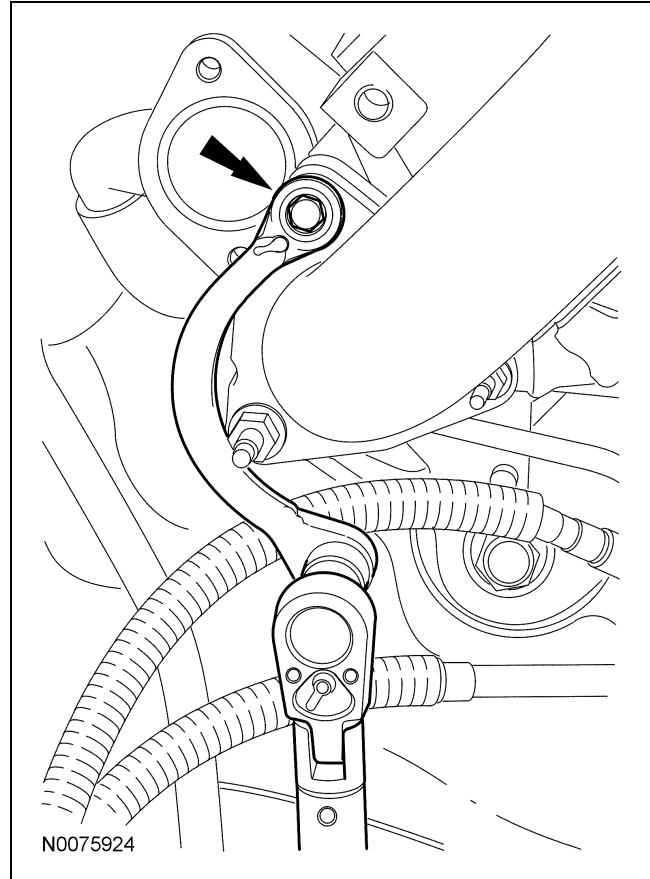
NOTE: To complete this step, it will be necessary to use the following tools:

- A 3/8-in drive torque wrench that is 368.3 mm (14.5 in) or 381.0 mm (15.0 in) from the center of the handle to the center of the square drive.
- One of the 10-mm/12-mm Half-moon wrenches listed in the following chart.
- A 12-mm Allen socket (to drive the Half-moon wrench).

NOTE: To obtain the required torque value of 31 Nm (23 lb-ft), it will be crucial to orient the Half-moon wrench in the direction shown and 180 degrees (straight out) from the torque wrench. The torque wrench must be set to the value specified in the following chart for the Half-moon wrench and torque wrench length being used.

Tighten the LH turbocharger inlet pipe-to-LH exhaust manifold bolt.

- Refer to the following chart for torque wrench setting, based on the specific Half-moon wrench and torque wrench length being used.



REMOVAL AND INSTALLATION (Continued)**Torque Chart — LH Turbocharger Inlet Pipe-to-LH Exhaust Manifold Upper Bolt**

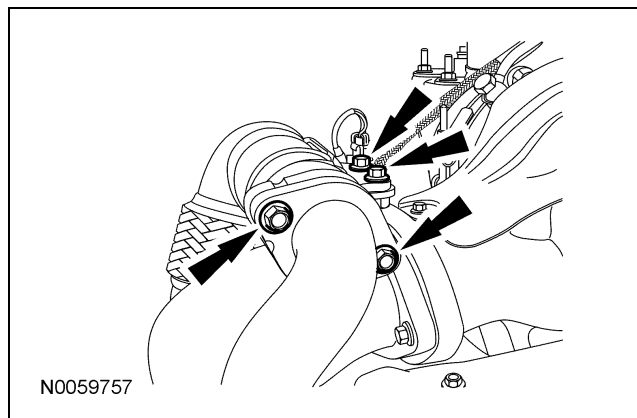
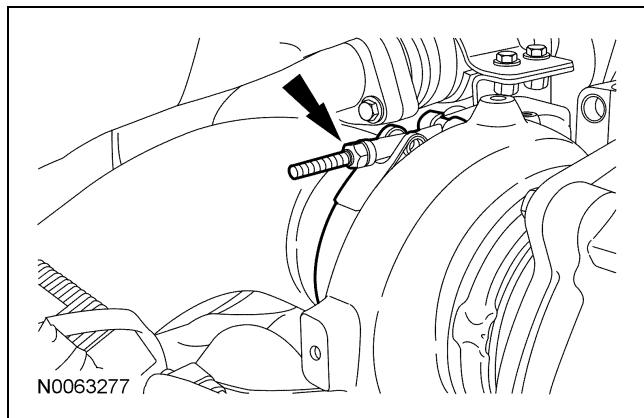
Half-Moon Wrench Brand	Wrench Part Number	Wrench Size	Torque Wrench Length	Torque Wrench Setting	
				Nm	lb-ft
Cornwell®	BWM-1012MM	10/12 mm	14.5 in	26	19
Gear Wrench®	9851	10/12 mm	14.5 in	23	17
Matco®	MHM1012	10/12 mm	14.5 in	22	16
Mac®	HMM1012R	10/12 mm	14.5 in	22	16
Snap-On®	CXM1012	10/12 mm	14.5 in	22	16
Cornwell®	BWM-1012MM	10/12 mm	15.0 in	27	20
Gear Wrench®	9851	10/12 mm	15.0 in	23	17
Matco®	MHM1012	10/12 mm	15.0 in	23	17
Mac®	HMM1012R	10/12 mm	15.0 in	23	17
Snap-On®	CXM1012	10/12 mm	15.0 in	23	17

NOTE: To achieve the required torque of 31 Nm (23 lb-ft), the torque wrench must be set to the appropriate Torque Wrench Setting listed in this chart.

N0076309

24. Install the new gasket and clamp for the exhaust downpipe.

- Tighten to 15 Nm (133 lb-in).



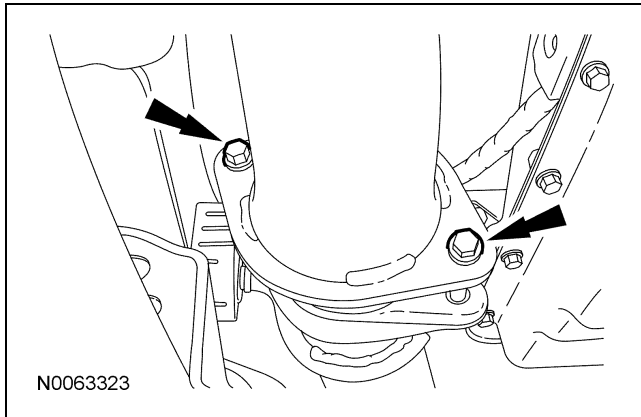
25. **⚠ CAUTION:** Make sure the correct bolts are installed in the bracket or damage to the bracket can occur.

Position the EGR-OC pipe and loosely install the new bracket bolts. Install a gasket and loosely install the new bolts.

REMOVAL AND INSTALLATION (Continued)

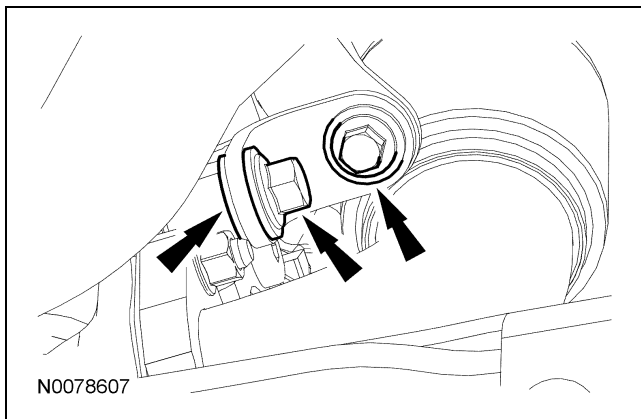
26. Tighten the bolts for the exhaust downpipe at the OC.

- Tighten to 40 Nm (30 lb-ft).



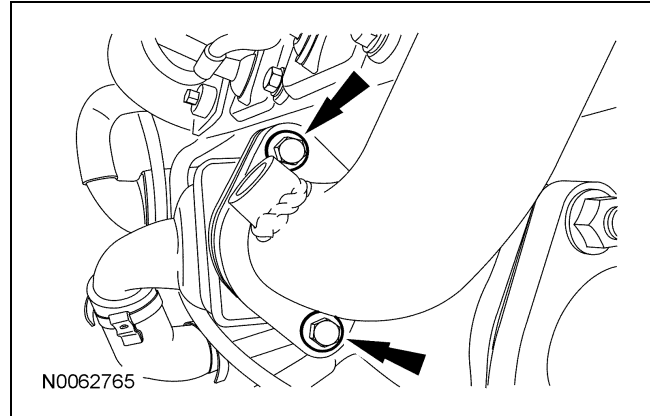
27. **⚠ CAUTION:** Failure to install and correctly tighten the exhaust gas recirculation (EGR)-oxidation catalytic converter (OC) pipe support bolts will result in damage to the horizontal EGR cooler and possible engine damage.

Install the bracket, washers and loosely install the new bolts for the EGR-OC pipe bracket.



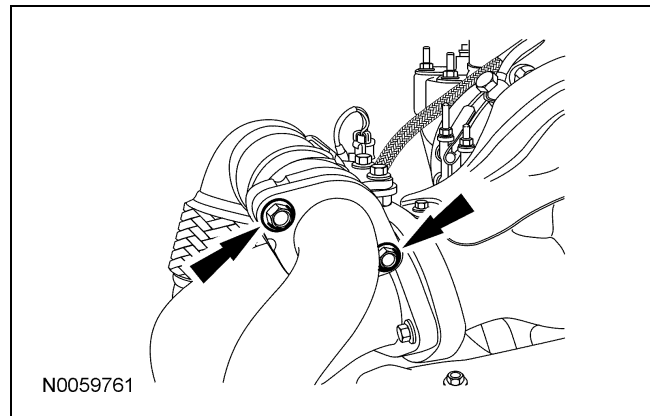
28. Install the gasket and the new bolts for the EGR-OC pipe at the EGR cooler.

- Tighten to 31 Nm (23 lb-ft).



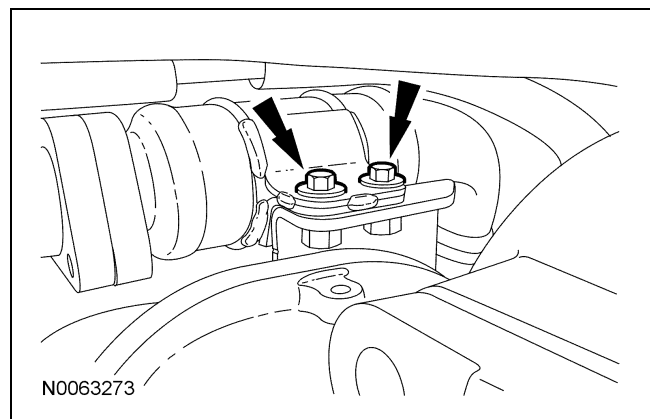
29. Tighten the EGR-OC pipe bolts at the RH turbocharger inlet pipe.

- Tighten to 31 Nm (23 lb-ft).




30. Tighten the bolts for the EGR-OC pipe bracket at the turbocharger.

- Tighten to 31 Nm (23 lb-ft).

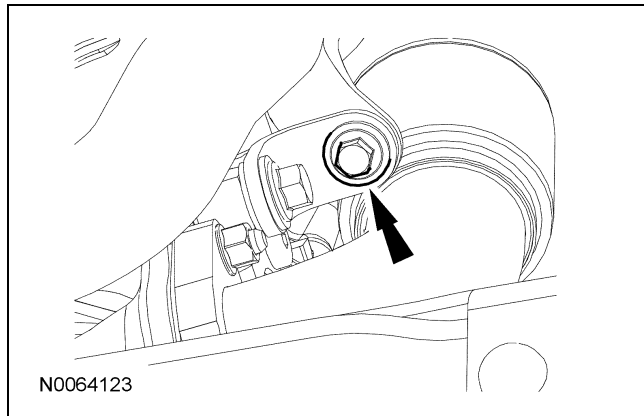


REMOVAL AND INSTALLATION (Continued)

31.  **CAUTION:** Failure to install and correctly tighten the exhaust gas recirculation (EGR)-oxidation catalytic converter (OC) pipe support bolt will result in damage to the horizontal EGR cooler and possible engine damage.

Tighten the bolt for the EGR-OC pipe bracket.

- Tighten to 31 Nm (23 lb-ft).



REMOVAL AND INSTALLATION (Continued)

32. ⚠ **CAUTION:** Failure to install and correctly tighten the exhaust gas recirculation (EGR)-oxidation catalytic converter (OC) pipe support bolt will result in damage to the horizontal EGR cooler and possible engine damage.

⚠ **CAUTION:** Due to limited access, one of the specific Half-moon wrenches and other tools described must be used to correctly tighten the fasteners in this step. Failure to follow this instruction may result in engine failure.

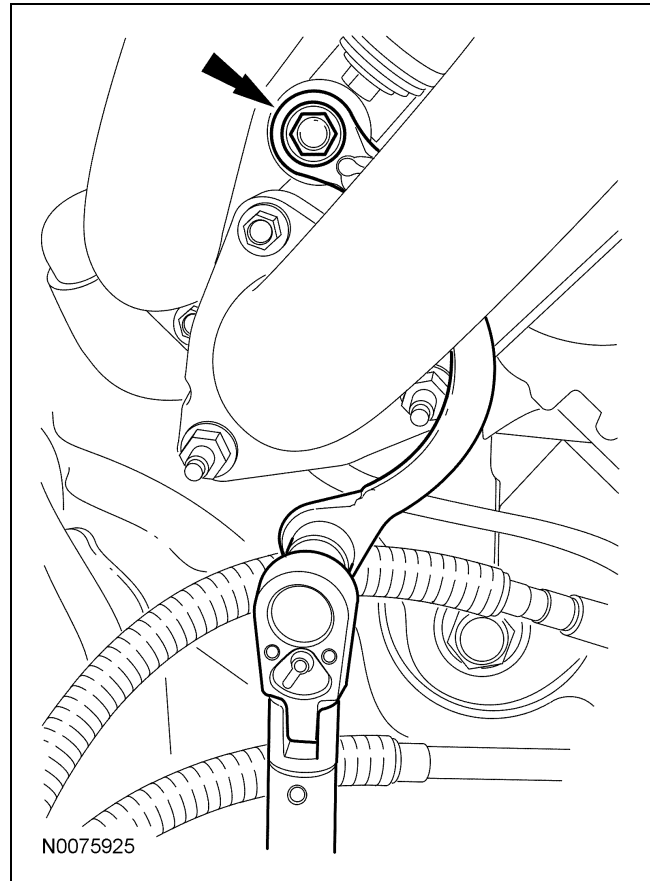
NOTE: To complete this step, it will be necessary to use the following tools:

- A 3/8-in drive torque wrench that is 368.3 mm (14.5 in) or 381.0 mm (15.0 in) from the center of the handle to the center of the square drive.
- One of the 11-mm/13-mm Half-moon wrenches listed in the following chart.
- A 11-mm Allen socket (to drive the Half-moon wrench).

NOTE: To obtain the required torque value of 63 Nm (46 lb-ft), it will be crucial to orient the Half-moon wrench in the direction shown and 180 degrees (straight out) from the torque wrench. The torque wrench must be set to the value specified in the following chart for the Half-moon wrench and torque wrench length being used.

Tighten the EGR-OC pipe bracket-to-LH cylinder head bolt.

- Refer to the following chart for torque wrench setting, based on the specific Half-moon wrench and torque wrench length being used.



REMOVAL AND INSTALLATION (Continued)**Torque Chart— EGR-OC Pipe Bracket-to-LH Cylinder Head Bolt**

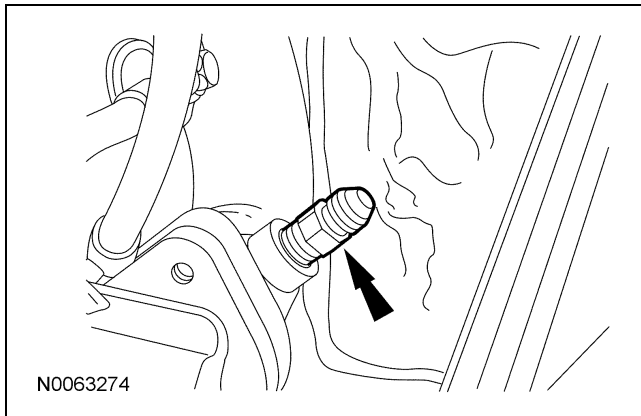
Half-Moon Wrench Brand	Wrench Part Number	Wrench Size	Torque Wrench Length	Torque Wrench Setting	
				Nm	lb-ft
Cornwell®	BWM-1113MM	11/13 mm	14.5 in	47	35
Gear Wrench®	9852	11/13 mm	14.5 in	46	34
Matco®	MHM1113	11/13 mm	14.5 in	46	34
Mac®	HMM1113R	11/13 mm	14.5 in	46	34
Snap-On®	CXM1113	11/13 mm	14.5 in	46	34
Cornwell®	BWM-1113MM	11/13 mm	15.0 in	49	36
Gear Wrench®	9852	11/13 mm	15.0 in	47	35
Matco®	MHM1113	11/13 mm	15.0 in	47	35
Mac®	HMM1113R	11/13 mm	15.0 in	47	35
Snap-On®	CXM1113	11/13 mm	15.0 in	47	35

NOTE: To achieve the required torque of 62 Nm (46 lb-ft), the torque wrench must be set to the appropriate Torque Wrench Setting listed in this chart.

N0078499

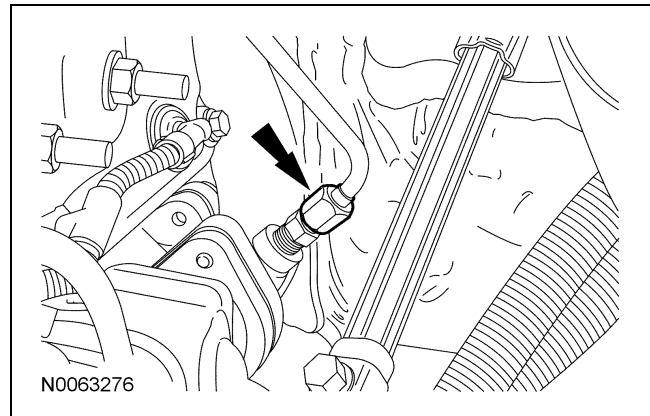
33. Install the EP sensor tube fitting into the EGR-OC pipe.

- Tighten to 27 Nm (20 lb-ft).



34. Connect the EP sensor tube to the EGR-OC pipe.

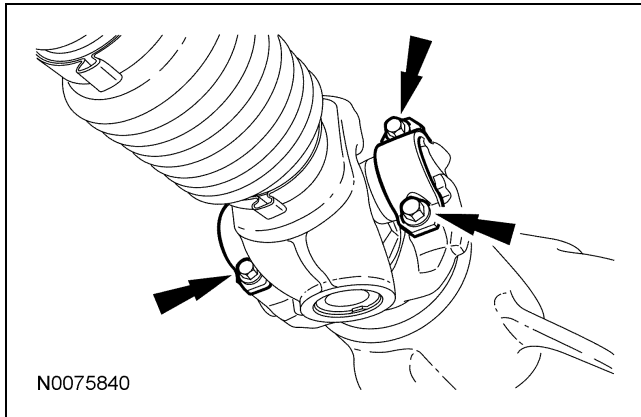
- Tighten to 20 Nm (177 lb-in).



REMOVAL AND INSTALLATION (Continued)

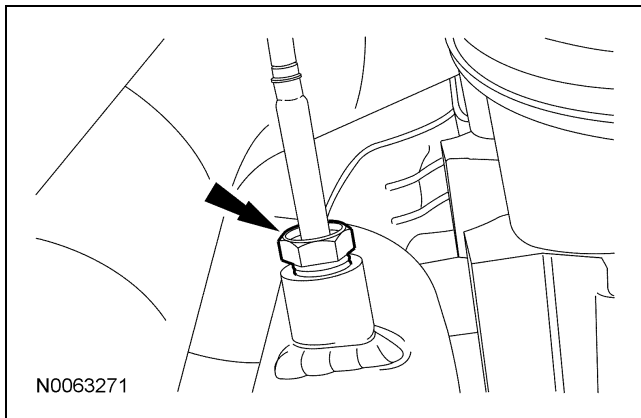
35. If equipped, position back the front drive shaft and install the straps and bolts.

- Tighten to 35 Nm (26 lb-ft).



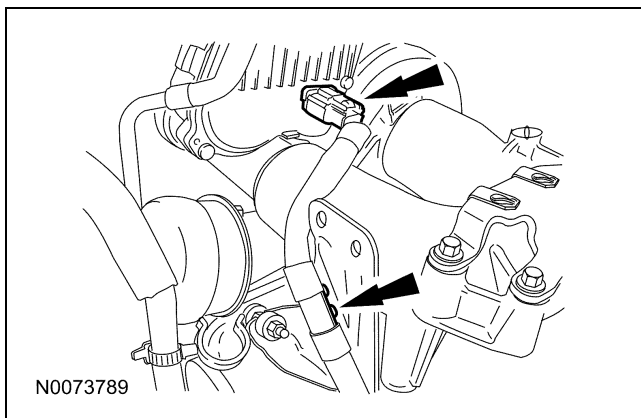
36. Install the EGRT sensor into the RH turbocharger inlet pipe.

- Tighten to 44 Nm (32 lb-ft).

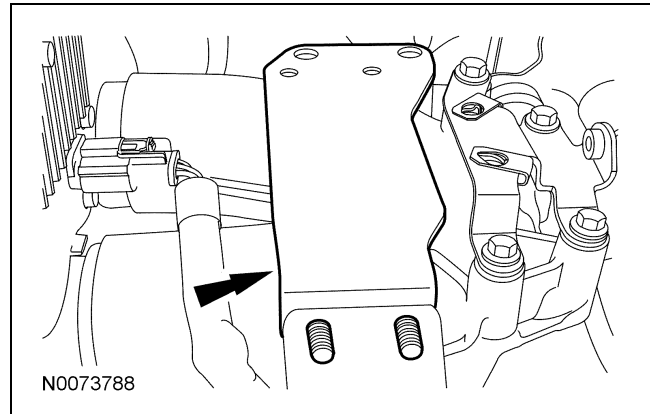


37. Install the RH splash shield. For additional information, refer to Section 501-02.

38. Connect the turbocharger actuator electrical connector and pin-type retainer.

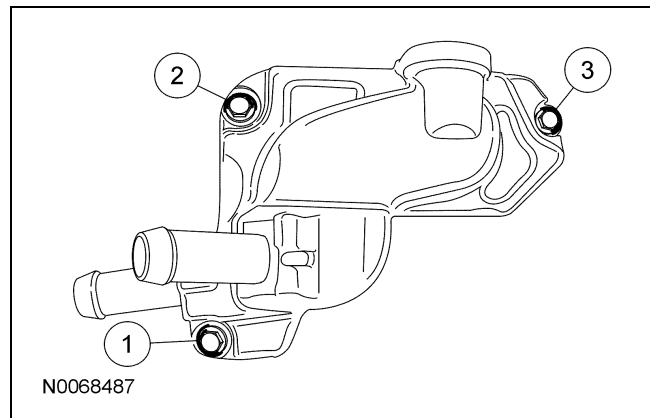


39. Position the fuel cooler bracket.



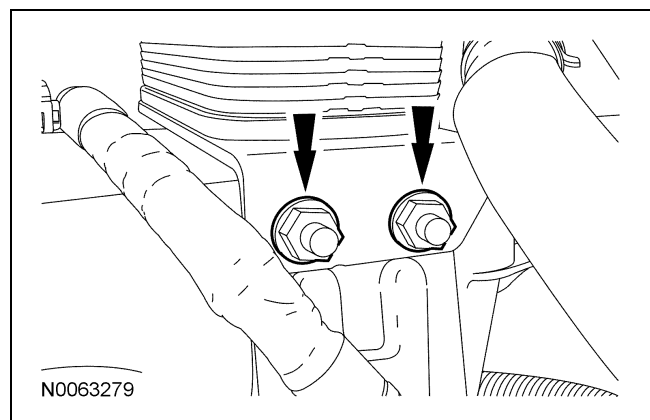
40. Position back the fuel cooler, fuel cooling system expansion tank and turbocharger actuator cooler. Install the bolts for the turbocharger actuator cooler. Tighten the bolts in the sequence shown in 2 stages.

- Stage 1: Finger tighten the bolts.
- Stage 2: Tighten to 7 Nm (62 lb-in).



41. Install the 2 nuts for the fuel cooler.

- Tighten to 19 Nm (168 lb-in).

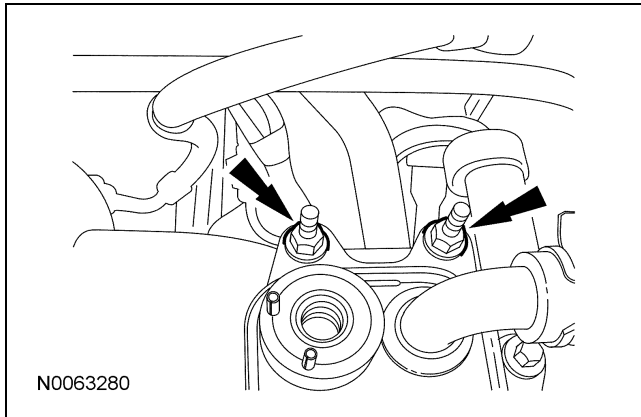


REMOVAL AND INSTALLATION (Continued)

42. **NOTE:** It may be necessary to loosen the front bolts of the turbocharger crossover in order to get correct alignment of the holes for the fuel cooler.

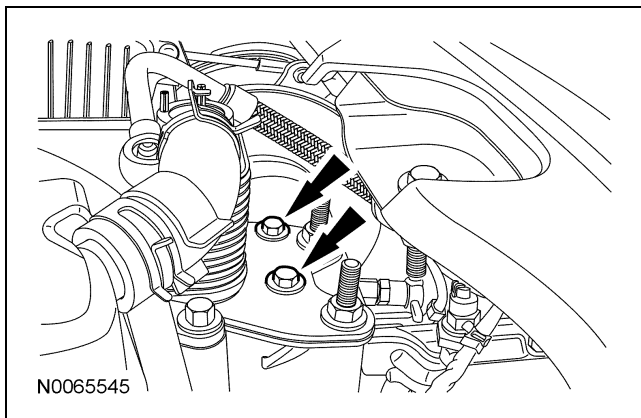
Install the 2 stud bolts for the fuel cooler.

- Tighten to 25 Nm (18 lb-ft).



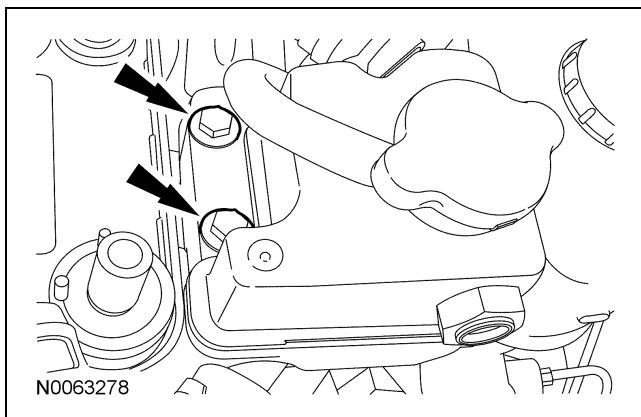
43. Install the 2 bolts for the fuel cooler.

- Tighten to 9 Nm (80 lb-in).



44. Install the 3 bolts for the fuel cooling system expansion tank.

- Tighten to 9 Nm (80 lb-in).

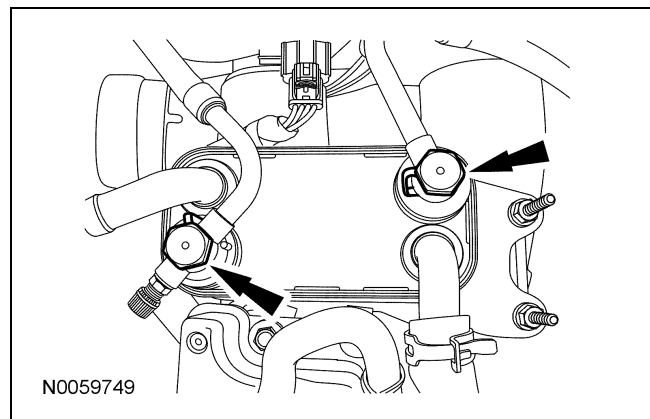


45. **CAUTION:** Use only banjo bolts with a green hex head. The green-headed bolts do not contain a check valve. When viewed from the inner end, the correct bolt will appear open. Failure to install the correct banjo bolt may result in damage to the fuel system.

CAUTION: Make sure that the fuel tubes are not rubbing against the turbocharger actuator cooler or damage to the fuel tubes may occur.

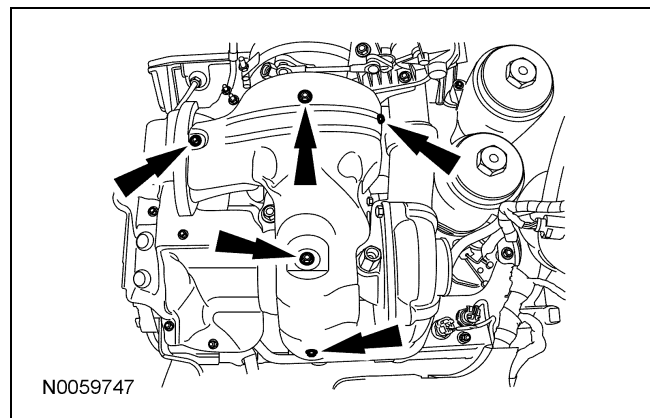
Install the new sealing washers and banjo bolts at the fuel cooler.

- Tighten to 25 Nm (18 lb-ft).



46. Position the turbocharger heat shield and install the bolt.

- Tighten to 11 Nm (97 lb-in).

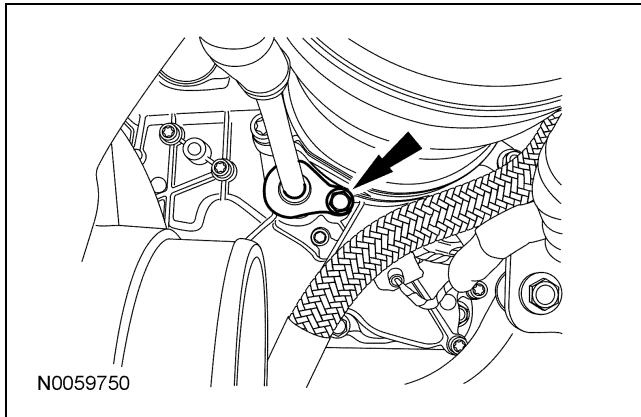


REMOVAL AND INSTALLATION (Continued)

47. **NOTE:** Install a new O-ring seal and apply clean engine oil.

Position the turbocharger oil supply tube and install the bolt.

- Tighten to 13 Nm (115 lb-in).



48. Prelubricate the oil inlet holes of the turbocharger assembly with clean engine oil and spin the compressor wheel several times to coat the bearings with oil.

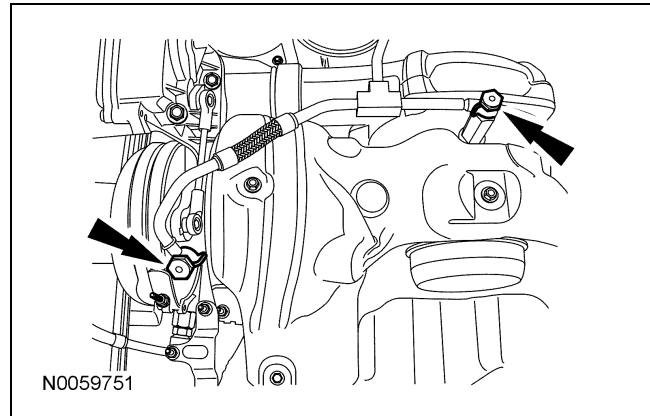
49. **CAUTION:** Use only banjo bolts with a green hex head. The green-headed bolts do not contain a check valve. When viewed from the inner end, the correct bolt will appear open. Failure to install the correct banjo bolt may result in damage to the turbochargers.

CAUTION: Do not lean on, pull on or use the turbocharger oil supply tube as a handle or damage to the turbocharger oil supply tube may occur.

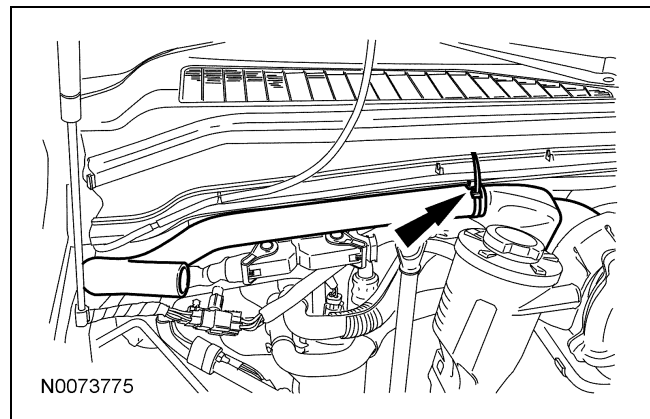
NOTE: Use a back-up wrench to prevent the fittings from turning.

Install 2 new copper sealing washers and the turbocharger oil supply tube banjo bolts.

- Tighten to 38 Nm (28 lb-ft).
- Verify that the turbocharger oil supply tube does not contact the turbocharger actuator linkage.



50. Position the auxiliary air intake hose in the vehicle.

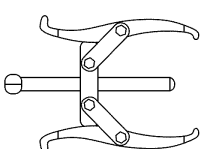
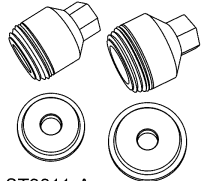
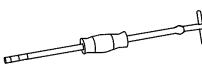
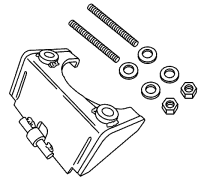
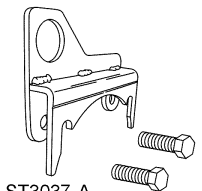
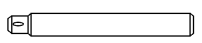


51. Install the air cleaner assembly and air cleaner outlet pipe. For additional information, refer to Section 303-12.
52. Install the degas bottle. For additional information, refer to Section 303-03.
53. Bleed the low pressure fuel system. For additional information, refer to Section 310-00.

DISASSEMBLY AND ASSEMBLY

Turbocharger

Special Tool(s)

 ST1321-A	2-Jaw Puller 205-D035 (D81L-1002-A) or equivalent
 ST3011-A	Air Crossover Seal Installers 303-1264
 ST1185-A	Impact Slide Hammer 100-001 (T50T-100-A)
 ST3019-A	Low-Pressure Turbocharger to High-Pressure Turbocharger Press 303-1269
 ST3037-A	Turbocharger Lifting Bracket 303-1266
 ST1255-A	Universal Handle 205-153 (T80T-4000-W)

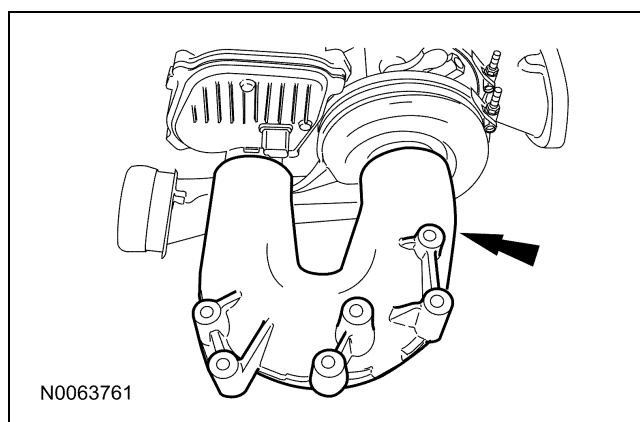
Material

Item	Specification
SAE 15W-40 Super Duty Diesel Motor Oil XO-15W40-QSD (US); CXO-15W40-LSD12 (Canada); or equivalent	WSS-M2C171-E

Disassembly

All turbochargers

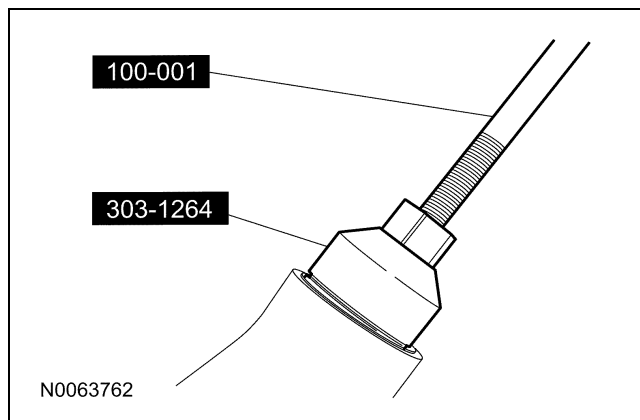
1. Remove the turbocharger crossover tube.



2. **NOTE:** The seals in the turbocharger crossover tube are one-time-use seals and must be installed new every time the connection is disassembled.

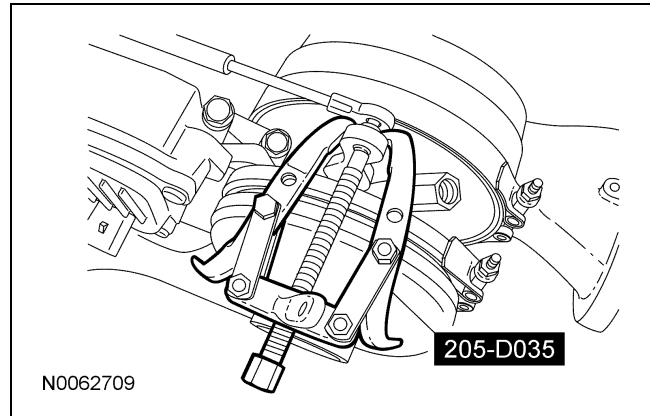
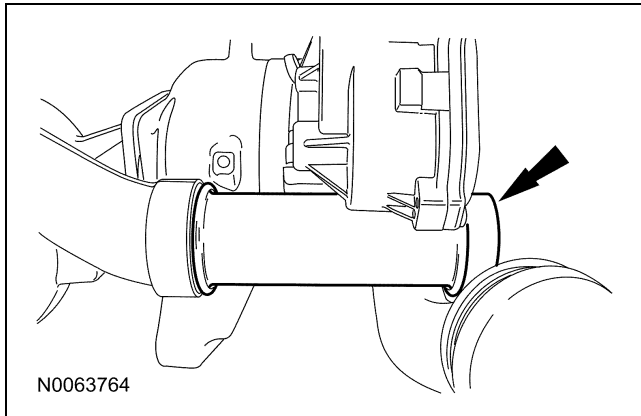
NOTE: Large remover shown, small remover similar.

Position the crossover tube in a soft-jawed vise. Using the special tool, remove the turbocharger crossover seal from each end of the crossover tube.



DISASSEMBLY AND ASSEMBLY (Continued)

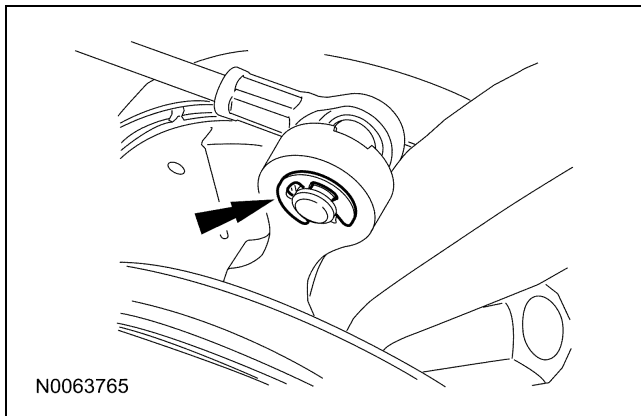
3. Remove the turbocharger tube.

**Turbocharger with slip-fit linkage****Turbocharger with press-fit linkage**

4. **NOTE:** Remove the turbocharger actuator only if the high-pressure turbocharger is being serviced.

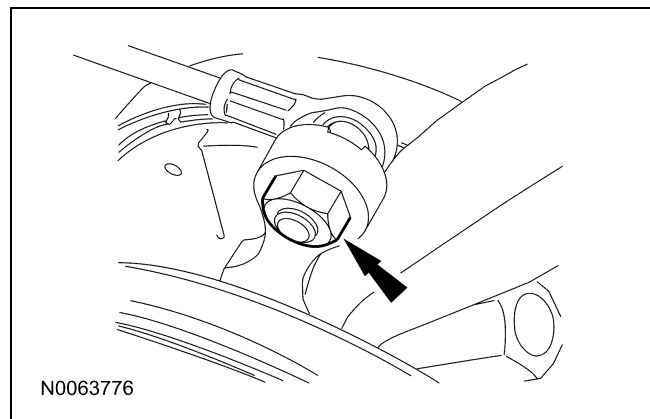
NOTE: It will be necessary to position the linkage to gain access to the clip. A section of rubber hose can be used to hold the linkage in position while removing the clip.

Remove the clip for the turbocharger actuator linkage.



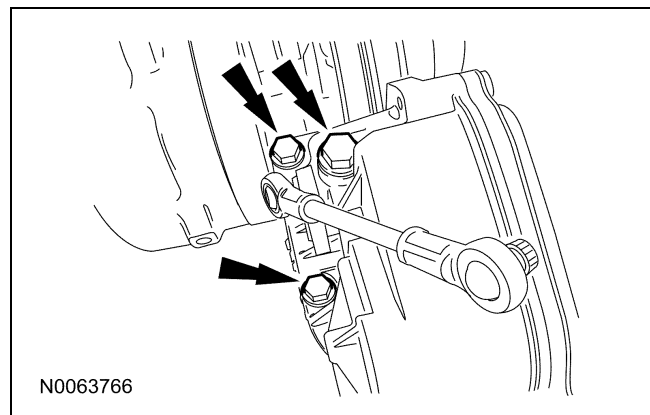
6. **NOTE:** Remove the turbocharger actuator only if the high-pressure turbocharger is being serviced.

Remove the nut and disconnect the turbocharger actuator linkage.

**All turbochargers**

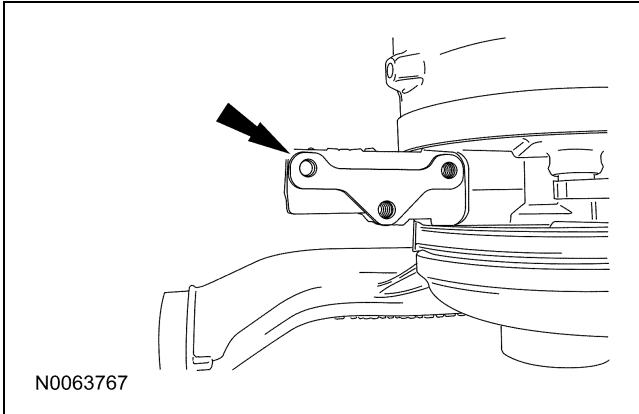
5. Using the special tool, disconnect the turbocharger actuator linkage.

7. Remove the bolts and the turbocharger actuator.

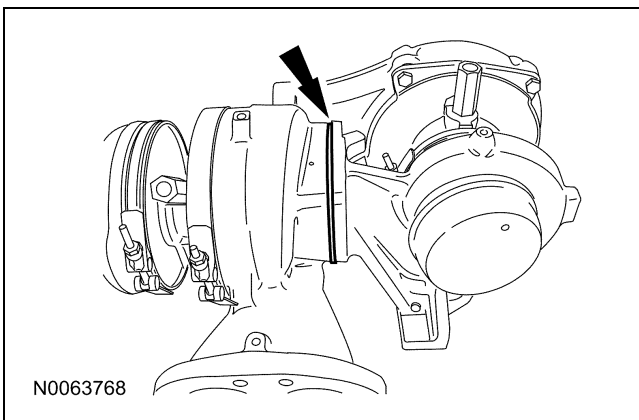


DISASSEMBLY AND ASSEMBLY (Continued)

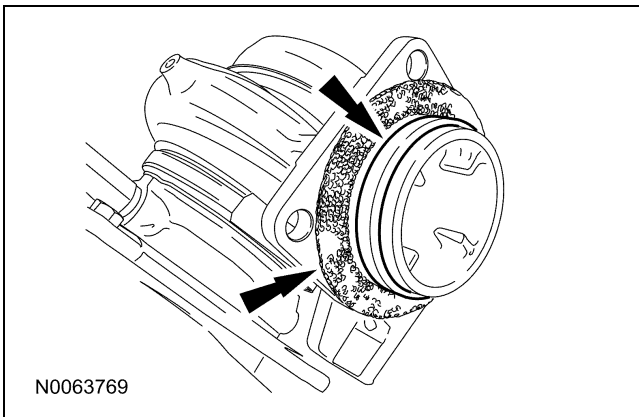
8. Remove the turbocharger actuator insulator.



9. Measure the gap between the 2 turbochargers prior to separating them and record the gap. Using an appropriate tool, carefully separate the 2 turbochargers.

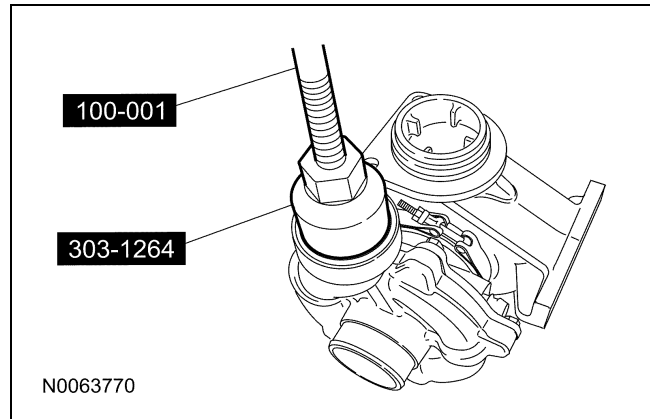


10. Remove and discard the low-pressure to high-pressure turbocharger seal and gasket.



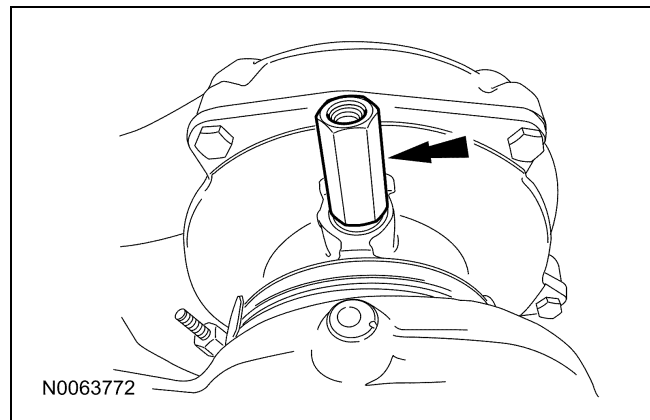
11. **NOTE:** The seal in the turbocharger is a one-time-use seal and must be installed new every time the connection is disassembled.

Using the special tool, remove the low-pressure turbocharger tube seal from the turbocharger.



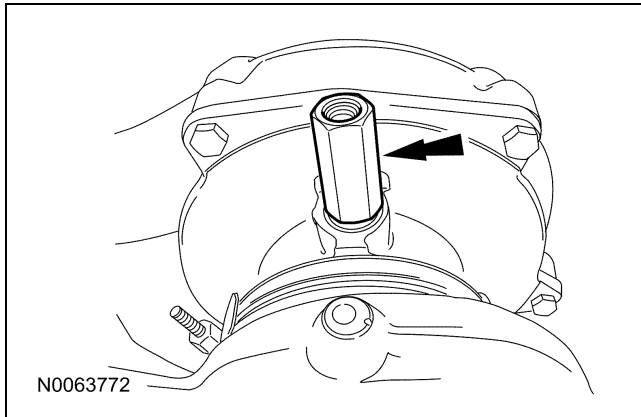
12. If necessary, remove the turbocharger oil supply standoffs.

- Remove and discard the O-ring seal.

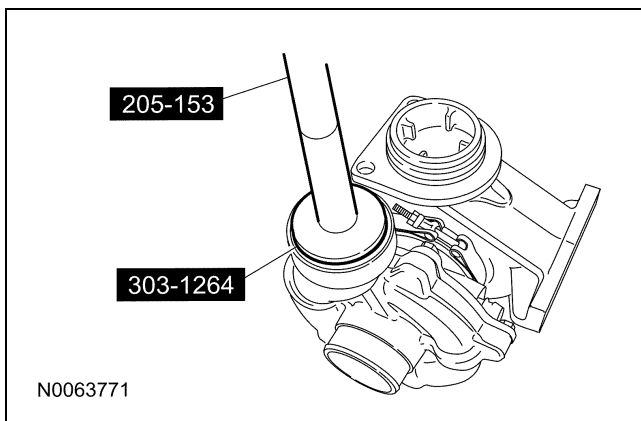


DISASSEMBLY AND ASSEMBLY (Continued)**Assembly****All turbochargers**

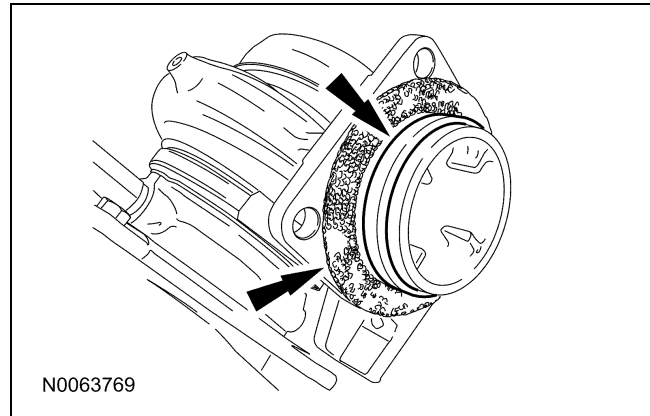
1. **NOTE:** Install a new O-ring seal on the turbocharger oil supply standoffs.
If necessary, install the turbocharger oil supply standoffs.
 - Tighten to 47 Nm (35 lb-ft).



2. Using the special tools, install the low-pressure turbocharger tube seal in the turbocharger.



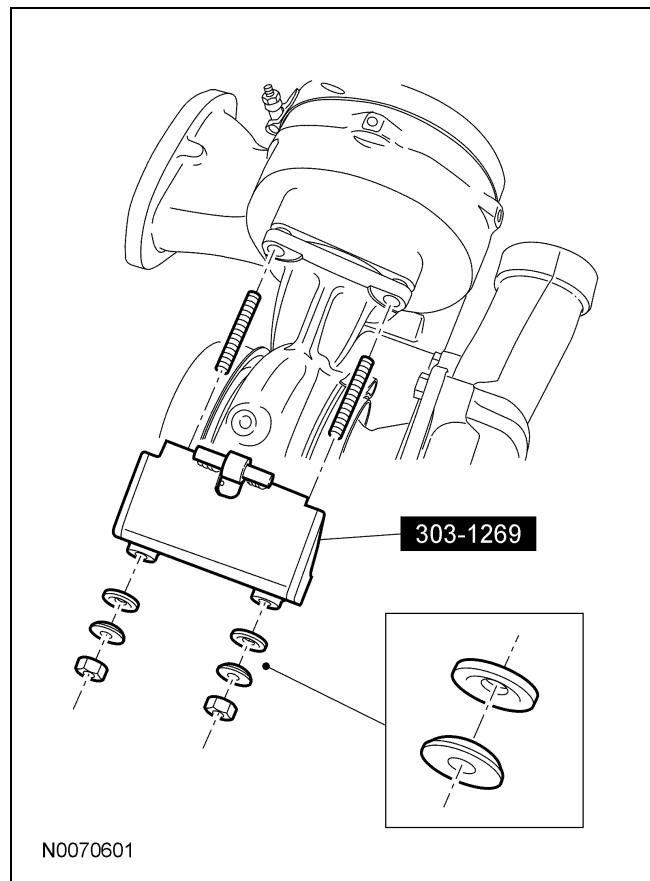
3. Install a new low-pressure to high-pressure turbocharger seal and gasket.




4. **⚠ CAUTION:** The washers must be installed with the convex and concave surfaces facing towards each other. Failure to install the washers correctly may result in damage to the tool.

NOTE: Prior to installing the special tool, assemble the turbochargers by hand. Verify that the turbocharger assembly goes back together evenly.

Install the special tool and loosely install the nuts.



DISASSEMBLY AND ASSEMBLY (Continued)

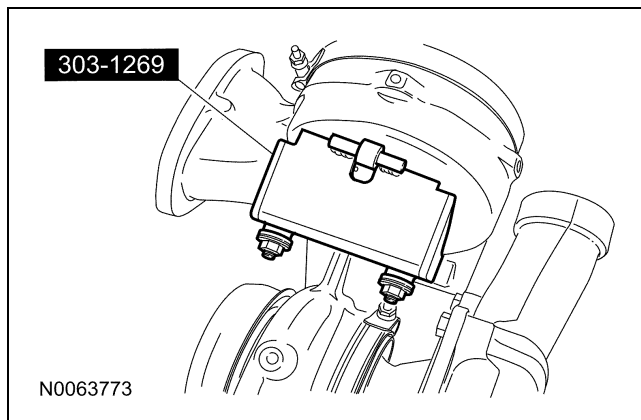
5.  **CAUTION:** Do not over-tighten the nuts or damage to the special tool may occur.


NOTE: A block of wood may be used to level the turbocharger during assembly of the turbochargers.

NOTE: The turbochargers do not go flush together. Remove the tool when the gap equals the measurement taken during the disassembly.

Using the special tool, assemble the turbocharger assembly.

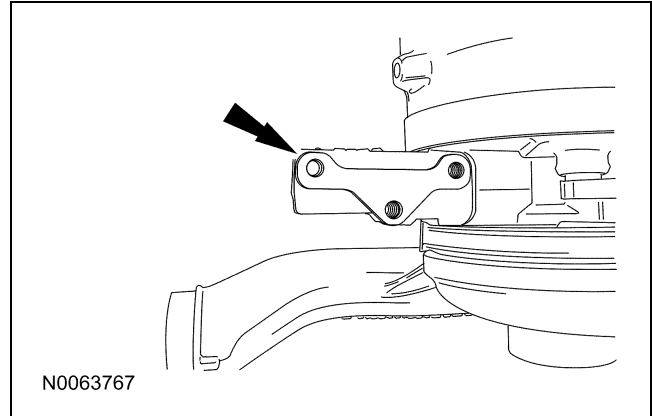
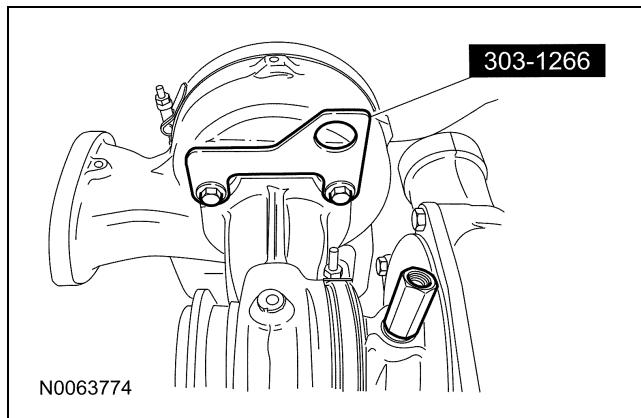
- Tighten to 17 Nm (150 lb-in).



6.  **CAUTION:** Failure to use the turbocharger lifting bracket during removal, handling or installation of the turbocharger could result in a low-pressure to high-pressure turbocharger seal failure.

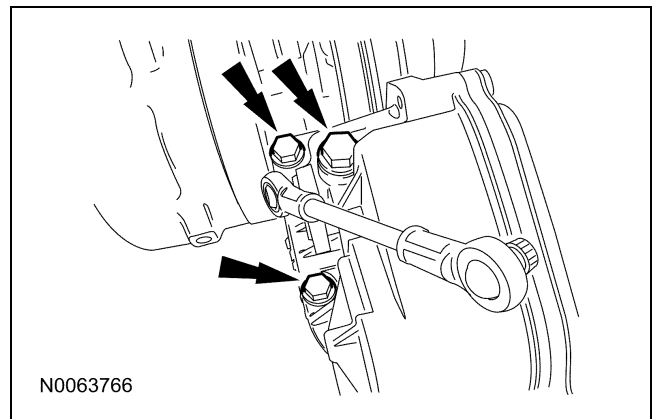
Install the special tool and bolts.

- Tighten to 20 Nm (177 lb-in).



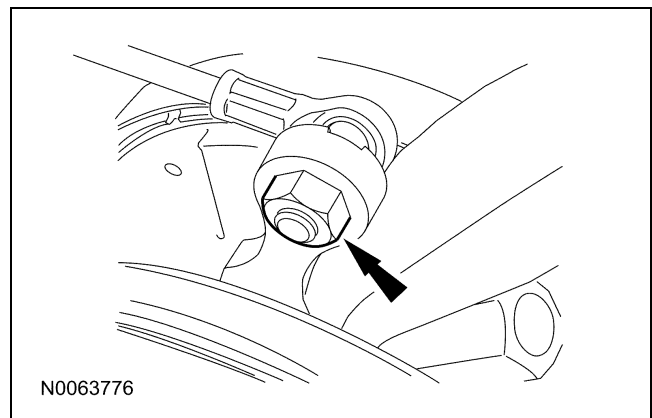
8. Install the turbocharger actuator and bolts.

- Tighten to 19 Nm (168 lb-in).

**Turbocharger with slip-fit linkage**

9. Position the turbocharger actuator linkage and install the nut.

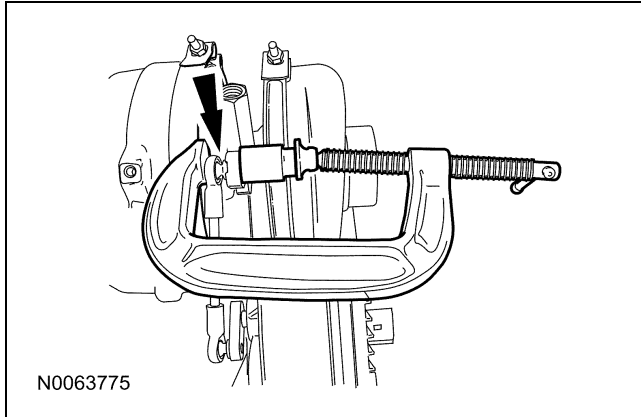
- Tighten to 8 Nm (71 lb-in).



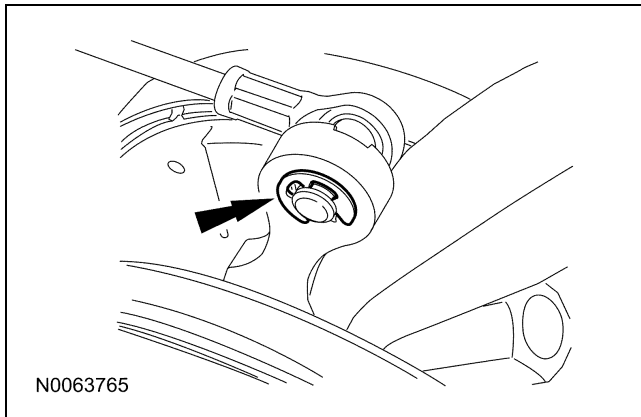
7. Position the turbocharger actuator insulator.

DISASSEMBLY AND ASSEMBLY (Continued)**Turbocharger with press-fit linkage**

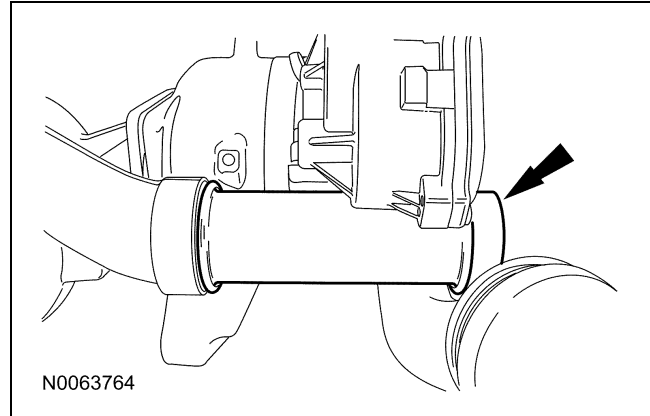
10. Using a C-clamp and a socket, install the turbocharger actuator linkage.



11. Install the clip for the turbocharger actuator linkage.

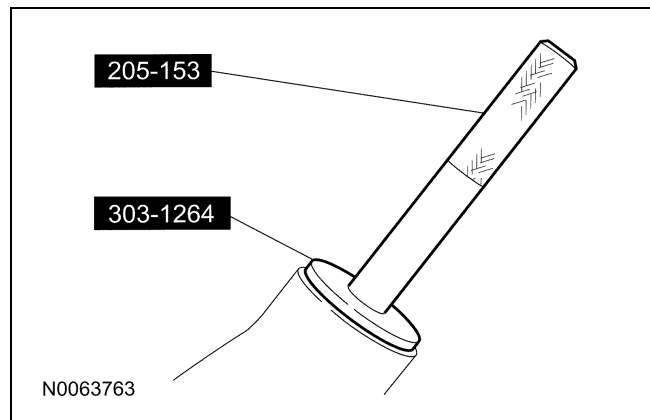
**All turbochargers**

12. **NOTE:** Lubricate the seal with clean engine oil prior to assembly.
Install the turbocharger tube.

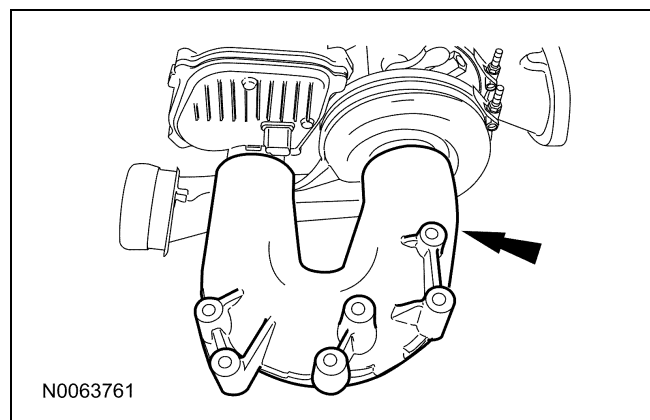


13. **NOTE:** Large installer shown, small installer similar.

Position the crossover tube in a soft-jawed vise. Using the special tool, install a new seal in each end of the turbocharger crossover tube.

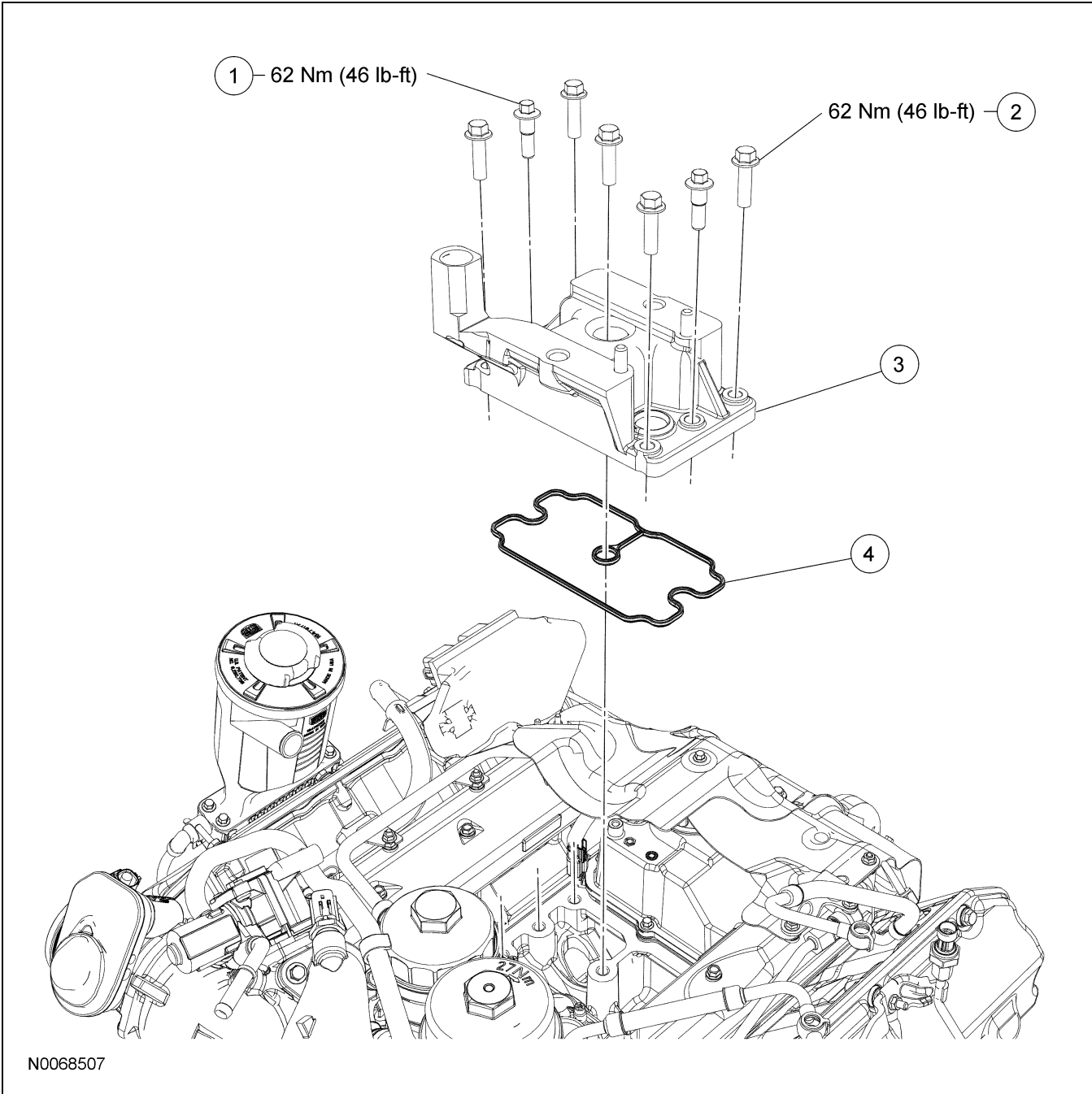


14. Install the turbocharger crossover tube.



REMOVAL AND INSTALLATION

Turbocharger Pedestal



N0068507

Item	Part Number	Description
1	W302514	Turbocharger pedestal bolt (2 required)
2	W302214	Bolt (5 required)
3	9P462	Turbocharger pedestal
4	W302508	Turbocharger pedestal gasket

Removal and Installation

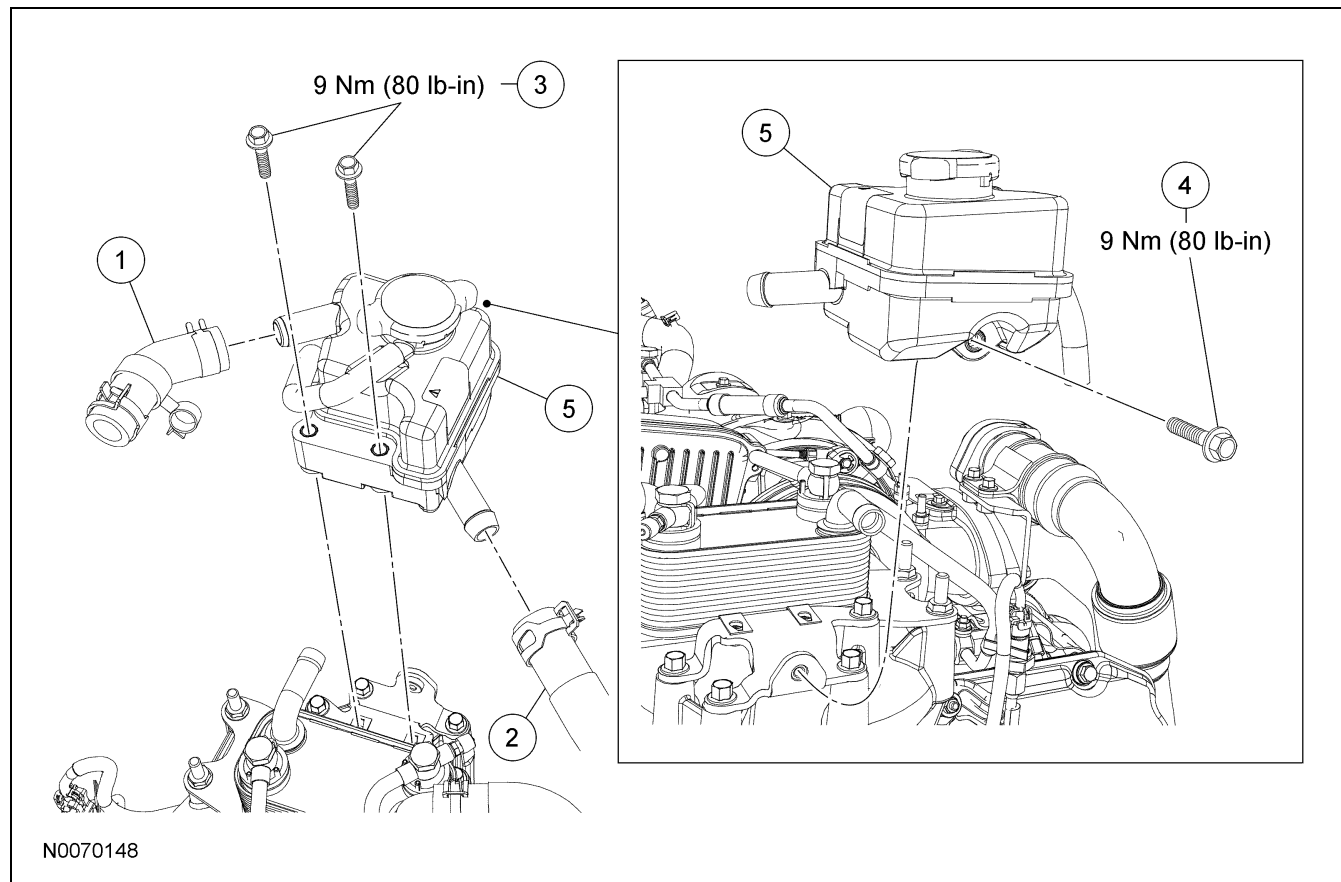
1. Remove the turbocharger. For additional information, refer to Turbocharger — Body Off or Turbocharger — Body On in this section.

REMOVAL AND INSTALLATION (Continued)

2. **NOTE:** Mark the 2 side center bolts so they can be installed in their original position.
Remove the bolts and the turbocharger pedestal.
 - To install, tighten to 62 Nm (46 lb-ft).
 3. To install, reverse the removal procedure.
 - Install a new press-in-place gasket.
-

REMOVAL AND INSTALLATION

Coolant Expansion Tank



Item	Part Number	Description
1	R836	Fuel cooler-to-coolant expansion tank hose
2	8D011	Coolant expansion tank-to-turbocharger actuator cooler hose
3	W302517	Coolant expansion tank bolts (2 required)
4	W302516	Coolant expansion tank bolt
5	9C248	Coolant expansion tank

Removal and Installation

1. Drain the fuel and turbocharger cooling system. For additional information, refer to Fuel and Turbocharger Cooling System Draining, Filling and Bleeding in this section.
2. Disconnect the fuel cooler-to-coolant expansion tank hose from the coolant expansion tank.
3. Disconnect the coolant expansion tank-to-turbocharger actuator cooler hose from the coolant expansion tank.
4. Remove the bolts and the coolant expansion tank.
 - To install, tighten to 9 Nm (80 lb-in).
5. To install, reverse the removal procedure.
 - Fill and bleed the fuel and turbocharger cooling system. For additional information, refer to Fuel and Turbocharger Cooling System Draining, Filling and Bleeding in this section.

REMOVAL AND INSTALLATION (Continued)

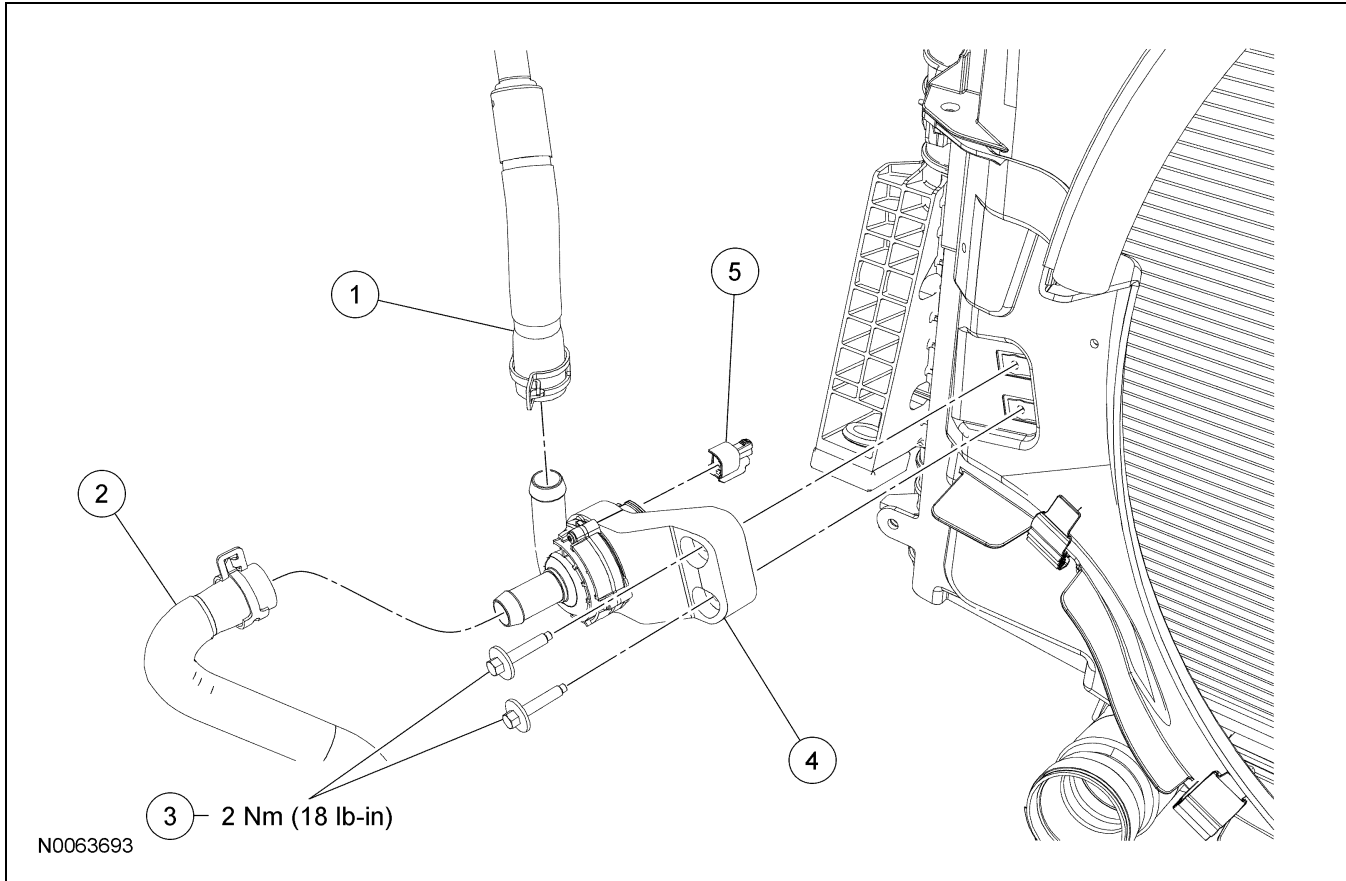
Item	Part Number	Description
11	—	Turbocharger actuator cooler
12	8D011	Turbocharger actuator cooler-to-radiator hose
13	8D011	Radiator-to-coolant pump hose

Removal and Installation

1. Drain the fuel and turbocharger cooling system. For additional information, refer to Fuel and Turbocharger Cooling System Draining, Filling and Bleeding in this section.
 2. If necessary, remove and discard the tie straps.
 3. If necessary, position aside the coolant hose clip.
 4. Disconnect the coolant hose being serviced from the components on each end of the coolant hose and remove the coolant hose.
 5. To install, reverse the removal procedure.
 - If necessary, install new tie straps.
 - Fill and bleed the fuel and turbocharger cooling system. For additional information, refer to Fuel and Turbocharger Cooling System Draining, Filling and Bleeding in this section.
-

REMOVAL AND INSTALLATION

Coolant Pump



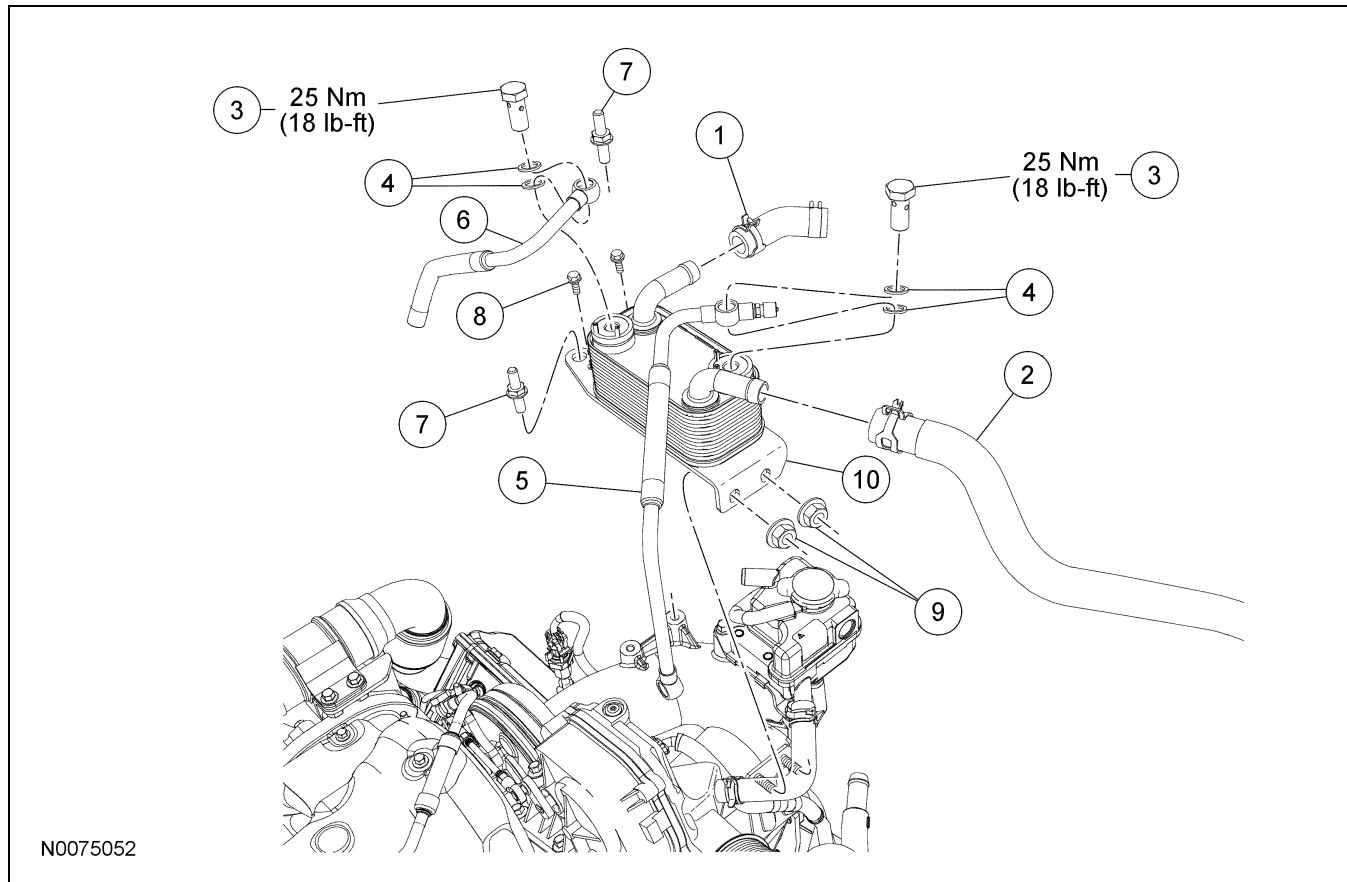
Item	Part Number	Description
1	8D011	Coolant pump-to-fuel cooler hose
2	8D011	Radiator-to-coolant pump hose
3	W503926	Coolant pump bolts
4	8B552	Coolant pump
5	14A464	Coolant pump electrical connector (part of 12A581)

Removal and Installation

1. Drain the fuel and turbocharger cooling system. For additional information, refer to Fuel and Turbocharger Cooling System Draining, Filling and Bleeding in this section.
2. Remove the LH fender splash shield. For additional information, refer to Section 501-02.
3. Disconnect the radiator-to-coolant pump hose at the coolant pump.
4. Disconnect the coolant pump-to-fuel cooler hose at the coolant pump.
5. Remove the bolts and detach the coolant pump from the cooling module.
 - To install, tighten to 2 Nm (18 lb-in).
6. Disconnect the coolant pump electrical connector and remove the coolant pump.
7. To install, reverse the removal procedure.
 - Fill and bleed the fuel and turbocharger cooling system. For additional information, refer to Fuel and Turbocharger Cooling System Draining, Filling and Bleeding in this section.

REMOVAL AND INSTALLATION

Fuel Cooler



Item	Part Number	Description
1	9G842	Fuel cooler-to-coolant expansion tank hose
2	8D011	Coolant pump-to-fuel cooler hose
3	W302472	Fuel tube banjo bolts (2 required)
4	—	Fuel tube banjo bolt washers (4 required)
5	9D309	Fuel cooler-to-fuel filter fuel tube
6	9D309	Fuel pump-to-fuel cooler fuel tube
7	W307472	Fuel cooler stud bolts (2 required)
8	W301401	Fuel cooler bolts (2 required)
9	W302628	Fuel cooler nuts (2 required)
10	9N103	Fuel cooler

Removal


1. Drain the fuel and turbocharger cooling system. For additional information, refer to Fuel and Turbocharger Cooling System Draining, Filling and Bleeding in this section.
2. Release the low-pressure fuel system pressure. For additional information, refer to Section 310-00.
3. Disconnect the fuel cooler-to-coolant expansion tank hose at the fuel cooler.
4. Disconnect the coolant pump-to-fuel cooler hose at the fuel cooler.
5. Remove the banjo bolt and disconnect the fuel cooler-to-fuel filter fuel tube.
 - Remove and discard the sealing washers.

REMOVAL AND INSTALLATION (Continued)

6. Remove the banjo bolt and disconnect the fuel pump-to-fuel cooler fuel tube.
 - Remove and discard the sealing washers.
7. Remove the bolts, the stud bolts, the nuts and the fuel cooler.


Installation


1. Position the fuel cooler and install the bolts, the stud bolts and the nuts.
 - Tighten the bolts, stud bolts and the nuts in 3 stages.
 - Stage 1: Tighten the nuts to 19 Nm (14 lb-ft).
 - Stage 2: Tighten the stud bolts to 24 Nm (18 lb-ft).
 - Stage 3: Tighten the bolts to 9 Nm (80 lb-in).

2.  **CAUTION: Use only banjo bolts with a green hex head. The green headed bolts do not contain a check valve. When viewed from the inner end, the correct bolt will appear opened. Failure to install the correct banjo bolt may result in damage to the fuel system.**

Install new sealing washers for the fuel pump-to-fuel cooler fuel tube, position the fuel tube and install the banjo bolt.

- Tighten to 25 Nm (18 lb-ft).

3.  **CAUTION: Use only banjo bolts with a green hex head. The green headed bolts do not contain a check valve. When viewed from the inner end, the correct bolt will appear opened. Failure to install the correct banjo bolt may result in damage to the fuel system.**

 **CAUTION: Make sure that the fuel tubes are not rubbing against the turbocharger actuator cooler or damage to the fuel tubes may occur.**

Install new sealing washers for the fuel cooler-to-fuel filter fuel tube, position the fuel tube and install the banjo bolt.

- Tighten to 25 Nm (18 lb-ft).
4. Connect the coolant pump-to-fuel cooler hose to the fuel cooler.
 5. Connect the fuel cooler-to-coolant expansion tank hose to the fuel cooler.
 6. Fill and bleed the fuel and turbocharger cooling system. For additional information, refer to Fuel and Turbocharger Cooling System Draining, Filling and Bleeding in this section.
 7. Pressurize the low-pressure fuel system. For additional information, refer to Section 310-00.

DESCRIPTION AND OPERATION

Fuel and Turbocharger Cooling System

The fuel and turbocharger cooling system consists of the following components:

- Coolant expansion tank
- Radiator
- Coolant pump
- Fuel cooler
- Turbocharger actuator cooler
- Coolant hoses

The fuel and turbocharger cooling system is a self-contained cooling system. It is designed to remove some of the heat added by the high-pressure common rail fuel-injection system and the turbocharger actuator. The high-pressure common rail fuel-injection system uses fuel for lubrication and cooling, as well as being the working medium to create the high pressure. This adds a significant amount of heat to the fuel. The fuel cooling system is designed to keep the high-pressure pump inlet and fuel tank return below 70°C (158°F).

The coolant expansion tank is located on top of the turbocharger crossover tube. The coolant expansion tank allows for coolant expansion, system pressurization and de-aeration and serves as the location for service fill.

The radiator is located on the driver side of the cooling module.

The electric coolant pump is located on the driver side of the cooling fan lower shroud.

The fuel cooler is located on top of the turbocharger crossover tube.

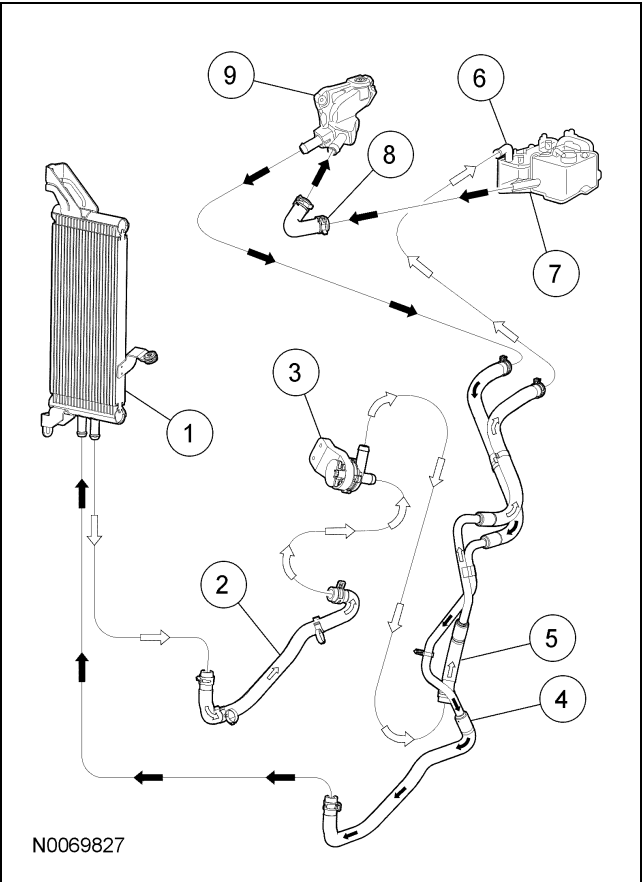
The turbocharger actuator cooler is attached to the turbocharger actuator.

Coolant hoses connect the various components.

It is important to make sure the fuel cooling system is bled correctly and the coolant level maintained for optimum performance.

Coolant Flow Diagram

NOTE: Black arrows indicate hot, white arrows indicate cold.



Item	Part Number	Description
1	8D010	Fuel cooling system radiator
2	8D011	Fuel cooling system radiator-to-coolant pump coolant hose
3	8D552	Coolant pump
4	8D011	Coolant expansion tank-to-fuel cooling system radiator coolant hose
5	8D011	Coolant pump-to-fuel cooler hose
6	—	Fuel cooler
7	9C248	Coolant expansion tank
8	—	Turbocharger actuator cooler hose
9	—	Turbocharger actuator cooler

GENERAL PROCEDURES

Fuel and Turbocharger Cooling System Draining, Filling and Bleeding

Special Tool(s)

 <p>ST2818-A</p>	<p>RADKITPLUS 078-00497</p>
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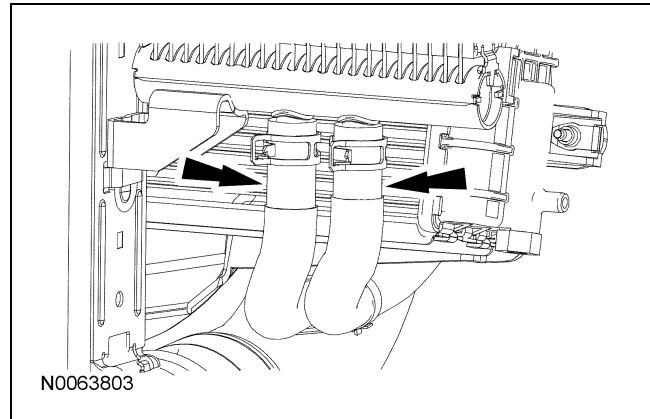
Material

Item	Specification
Motorcraft Premium Gold Engine Coolant with Bittering Agent (US only) VC-7-B (US); CVC-7-A (Canada); or equivalent (yellow color)	WSS-M97B51-A1

Draining

⚠ WARNING: Always allow the engine to cool before opening the cooling system. Do not unscrew the coolant pressure relief cap when the engine is operating or the cooling system is hot. The cooling system is under pressure; steam and hot liquid can come out forcefully when the cap is loosened slightly. Failure to follow these instructions may result in serious personal injury.

1. Allow the fuel cooling system to cool and remove the pressure relief cap.
2. Disconnect the coolant hoses at the fuel cooling system radiator and drain the coolant into an appropriate container.



Filling and bleeding with RADKITPLUS

1. **⚠ CAUTION:** With the system cold, fill vehicles to within the sight glass on the coolant expansion tank. This fill level will allow for coolant expansion. Overfilling the coolant expansion tank may result in damage to the pressure cap, which can cause the fuel and turbocharger cooling system to overheat.

Install the RADKITPLUS and follow the RADKITPLUS manufacturer's instructions to fill and bleed the cooling system.

2. **NOTE:** An operating coolant pump that squeals indicates either:
 - the system is not completely filled or bled.
 - the coolant pump is bad and must be replaced.

If the coolant pump squeals, drain the cooling system, fill and bleed the cooling system again.

- If the coolant pump still squeals, replace the coolant pump. For additional information, refer to Coolant Pump in this section.

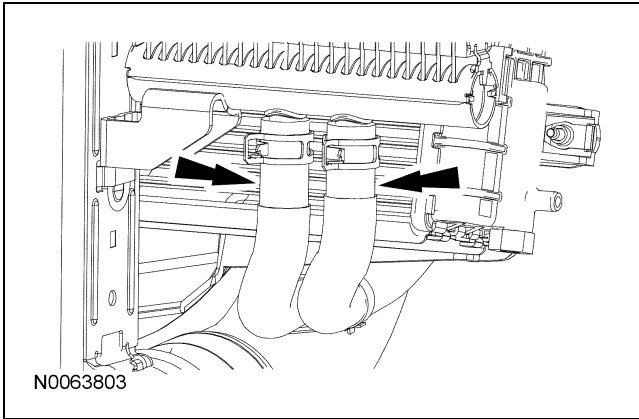
Filling and bleeding without RADKITPLUS

1. Remove the front bumper. For additional information, refer to Section 501-19.

GENERAL PROCEDURES (Continued)

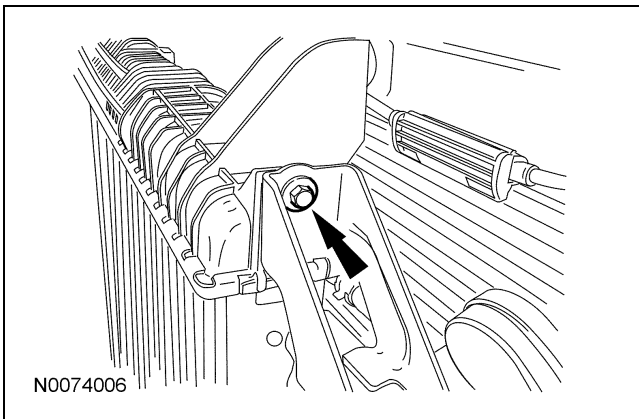
2. **NOTE:** Make sure the system was completely drained before attempting to fill and bleed the system.

Connect the coolant hoses at the fuel cooling system radiator.

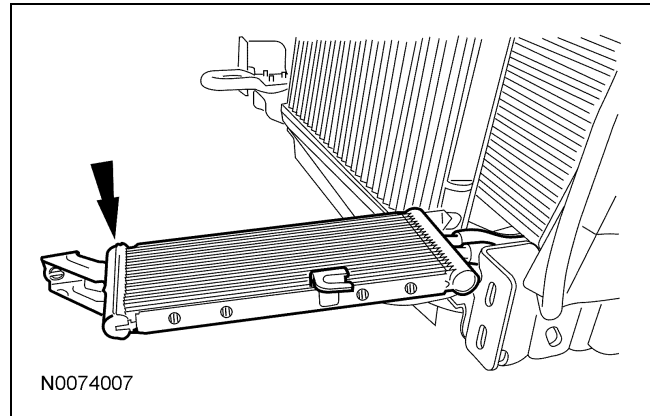


3. **NOTE:** The side bolt does not have to be removed to remove the fuel cooling system radiator.

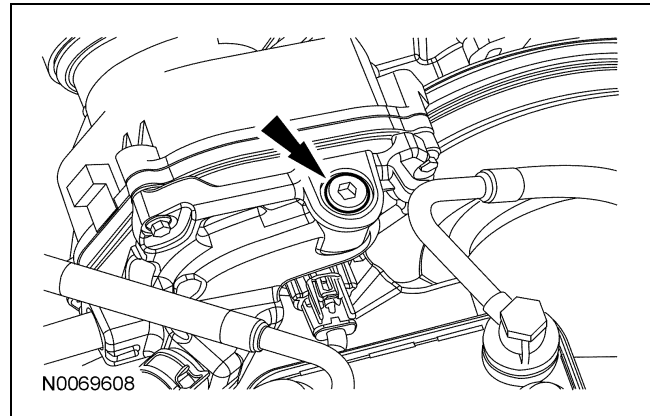
Remove the fuel cooling system radiator top bolt.



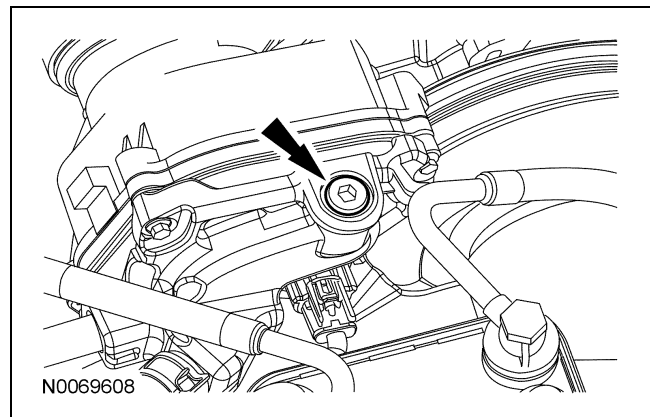
4. Slide the fuel and turbocharger cooling system radiator up off the side bolt and position the radiator horizontally.



5. Remove the plug from the turbocharger actuator cooler.

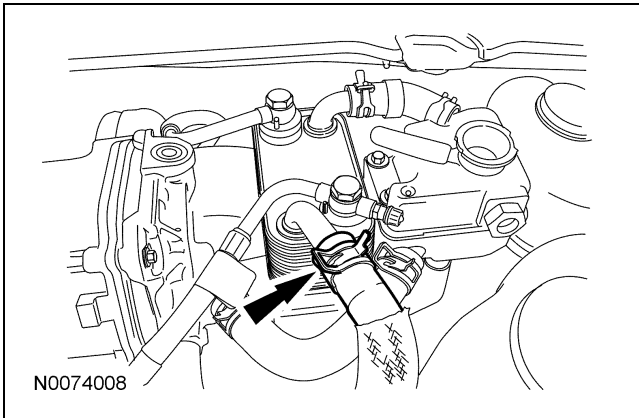


6. Fill the fuel and turbocharger cooling system through the expansion tank until the coolant reaches the top of the turbocharger actuator plug hole.
7. Install the turbocharger cooler plug.
- Tighten to 33 Nm (24 lb-ft).



GENERAL PROCEDURES (Continued)

8. Disconnect the coolant pump-to-fuel cooler hose from the cooler and place the hose in a clear container.

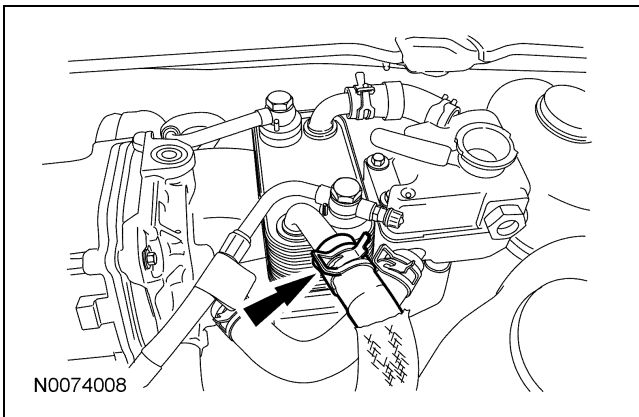


9. **NOTE:** The engine has to be running and the fuel temperature has to be above 35°C (95°F) before the fuel cooling pump will be turned on by the PCM.

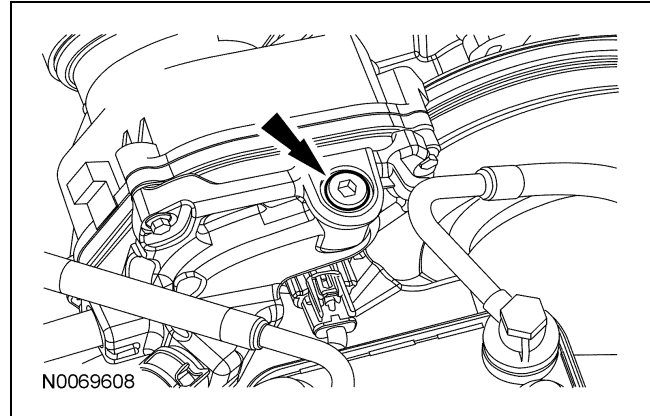
NOTE: Top off the coolant expansion tank as needed.

Start the engine and run the engine until the coolant pump turns on and the coolant starts to fill the container (approximately 15 minutes from when the pump turns on).

10. Turn the ignition switch to the OFF position.
11. Connect the coolant pump-to-fuel cooler hose to the fuel cooler.

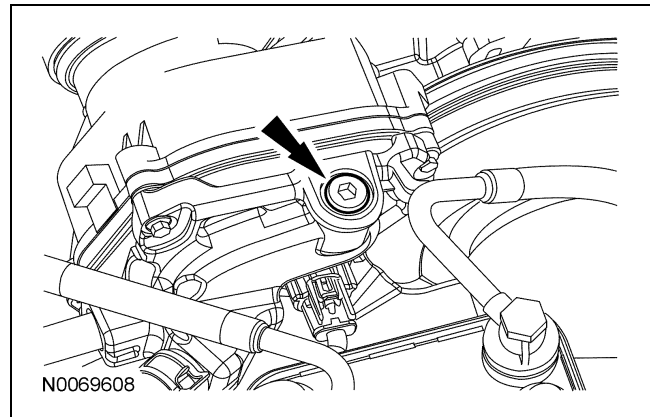


12. Remove the plug from the turbocharger actuator cooler.



13. Fill the fuel and turbocharger cooling system through the expansion tank until the coolant reaches the top of the turbocharger actuator plug hole.

14. Install the turbocharger actuator cooler plug.
- Tighten to 33 Nm (24 lb-ft).



15. Start the engine and continue to fill the coolant expansion tank until the coolant in the coolant expansion tank is visible through the site glass.

16. **NOTE:** An operating coolant pump that squeals indicates either:

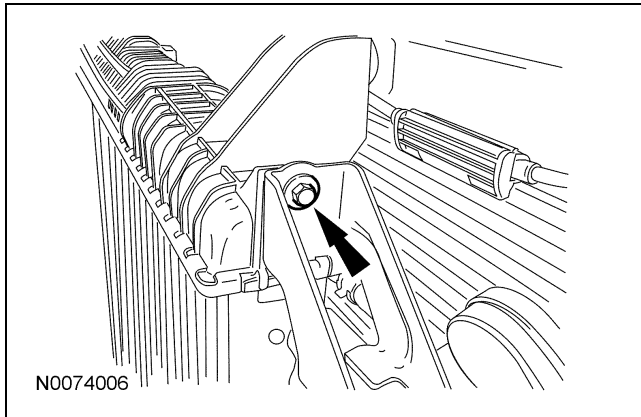
- the system is not completely filled or bled.
- the coolant pump is bad and must be replaced.

If the coolant pump squeals, drain the cooling system, fill and bleed the cooling system again.

- If the coolant pump still squeals, replace the coolant pump. For additional information, refer to Coolant Pump in this section.

GENERAL PROCEDURES (Continued)

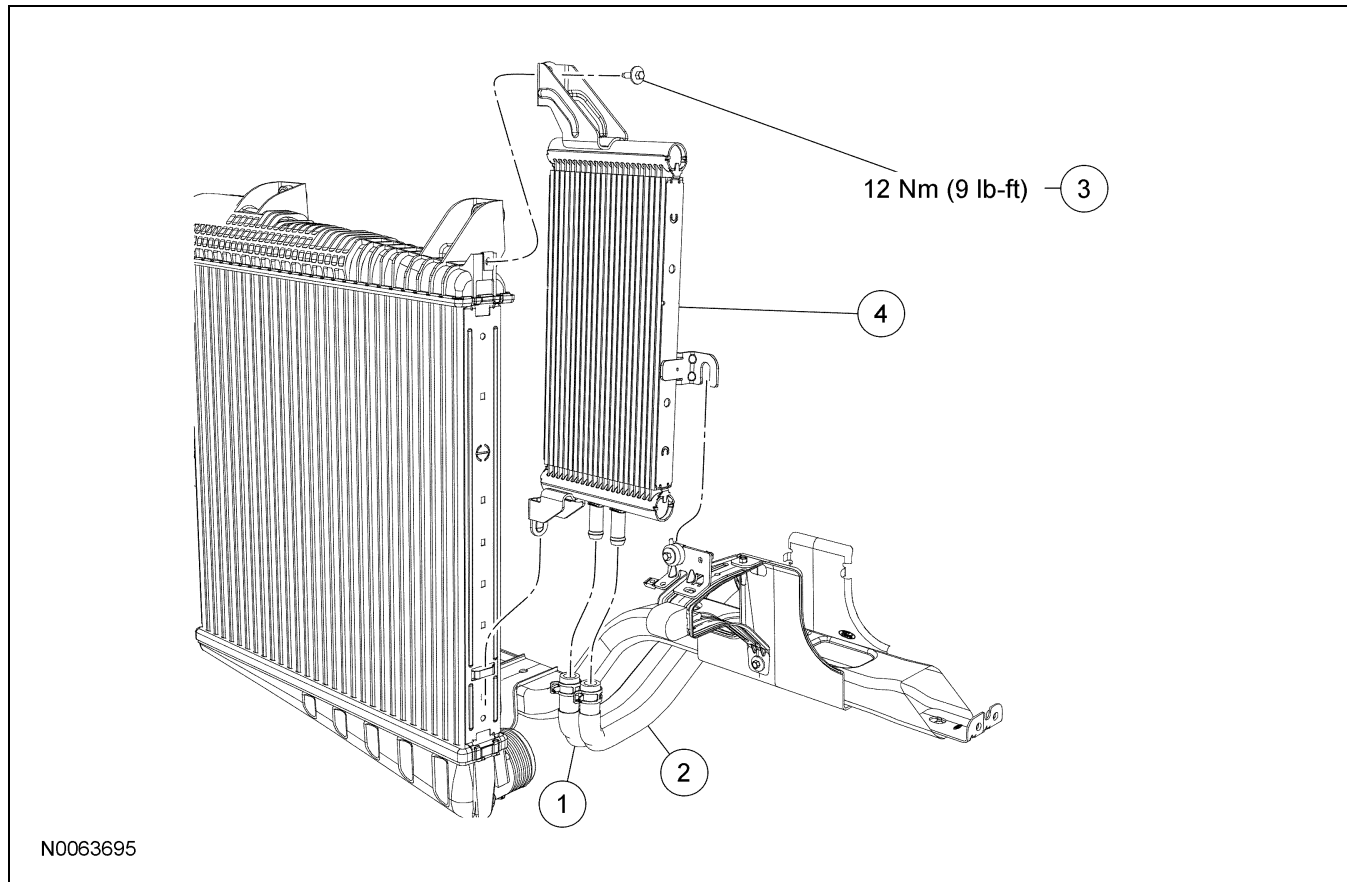
17. Position the fuel and turbocharger cooling system radiator and install the bolt.
- Tighten to 12 Nm (9 lb-ft).



18. Top off the coolant expansion tank, if necessary and until coolant is visible throughout the sight glass.
19. Install the pressure relief cap.
20. Clean any coolant that may have spilled on the engine components.
21. Install the front bumper. For additional information, refer to Section 501-19.

REMOVAL AND INSTALLATION

Radiator



Item	Part Number	Description
1	8D011	Fuel cooling system radiator-to-coolant pump hose
2	8D011	Coolant expansion tank-to-radiator hose
3	—	Fuel cooling system radiator bolt
4	8D010	Fuel cooling system radiator

Installation

- NOTE:** Do not tighten the fuel cooling system radiator bolt at this time. The fuel cooling system radiator must be removed and positioned horizontally to bleed the fuel cooling system. Only install the bolt tight enough to ease connection of the coolant hoses to the fuel cooling system radiator.

Position the fuel cooling system radiator and install the bolt finger tight.

Removal

- Drain the fuel and turbocharger cooling system. For additional information, refer to Fuel and Turbocharger Cooling System Draining, Filling and Bleeding in this section.
- NOTE:** The side bolt does not have to be removed to remove the fuel cooling system radiator.
Remove the cooling system radiator bolt.
Remove the fuel cooling system radiator by sliding it up off the retainers.

REMOVAL AND INSTALLATION (Continued)

2. Fill and bleed the fuel and turbocharger cooling system. For additional information, refer to Fuel and Turbocharger Cooling System Draining, Filling and Bleeding in this section.
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2008 Ford F-350 SUPER DUTY

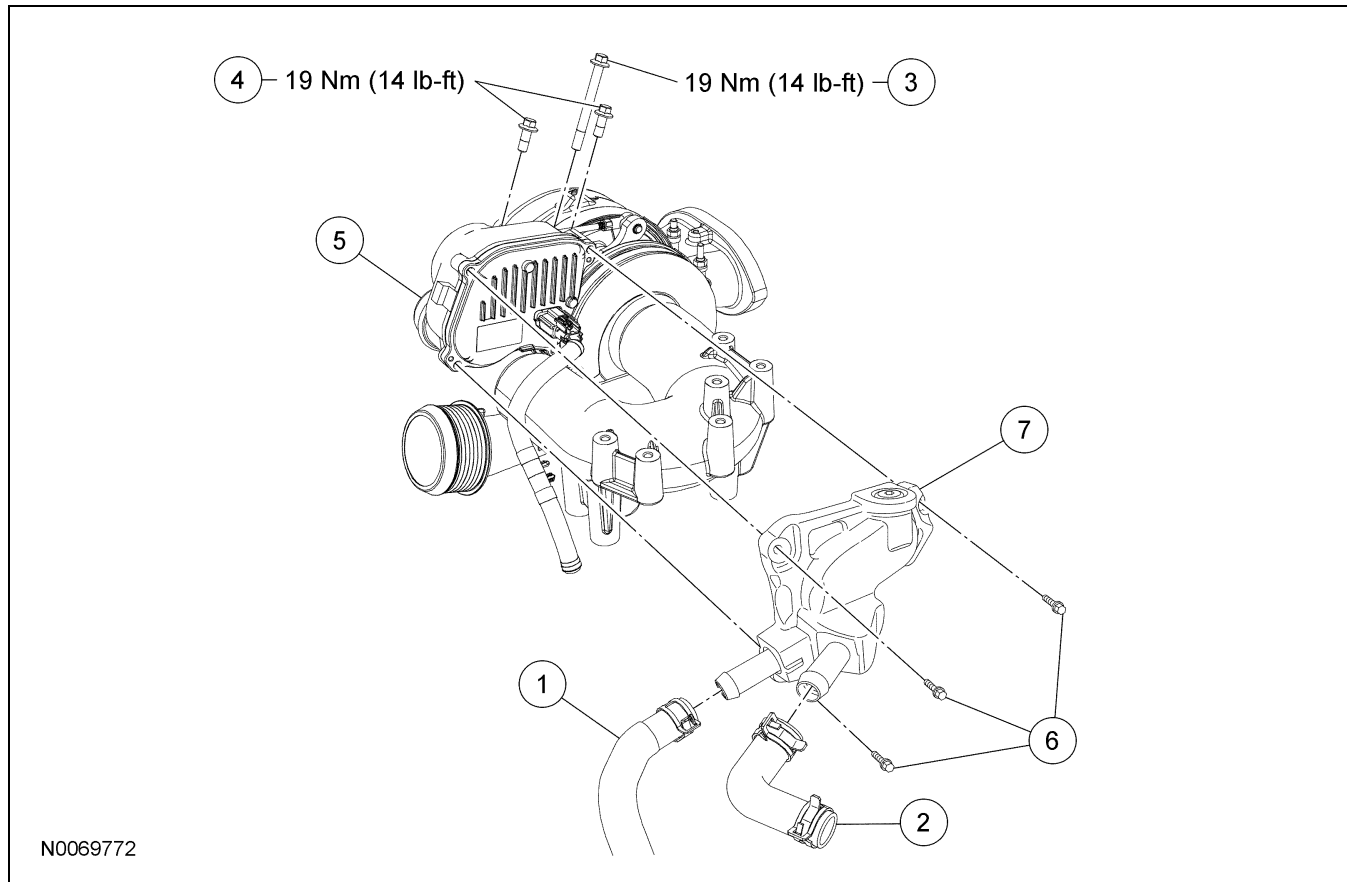
Submodel: XLT | Engine Type: V8 | Liters: 5.4
Fuel Delivery: FI | Fuel: GAS

SECTION 303-04E:
Fuel Charging and Controls — Fuel and Turbocharger Cooling System

SPECIFICATIONS
DESCRIPTION AND OPERATION
Fuel and Turbocharger Cooling System
DIAGNOSIS AND TESTING
Fuel and Turbocharger Cooling System
Principles of Operation
Inspection and Verification
Component Tests
Fuel and Turbocharger Cooling System Pressure Test
Cap
GENERAL PROCEDURES
Fuel and Turbocharger Cooling System Draining, Filling and Bleeding
REMOVAL AND INSTALLATION
Coolant Expansion Tank
Coolant Hose
Coolant Pump
Fuel Cooler
Radiator
Turbocharger Actuator Cooler

REMOVAL AND INSTALLATION

Turbocharger Actuator Cooler



Item	Part Number	Description
1	8D011	Turbocharger actuator cooler-to-radiator hose
2	—	Coolant expansion tank-to-turbocharger actuator cooler hose
3	W302504	Turbocharger actuator long bolt
4	W302503	Turbocharger actuator short bolts (2 required)
5	9F089	Turbocharger actuator
6	—	Turbocharger actuator cooler bolts (3 required)
7	—	Turbocharger actuator cooler

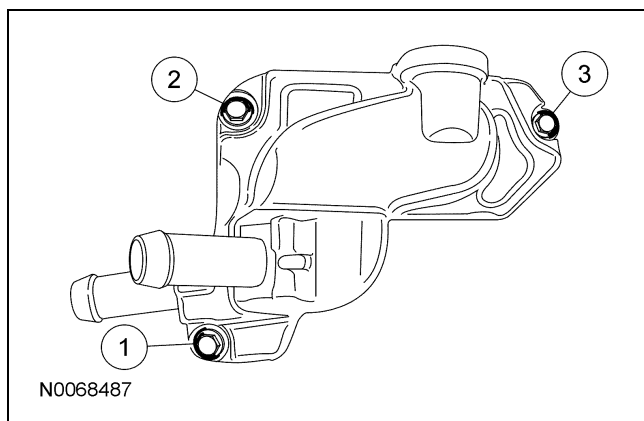
2. Disconnect the turbocharger actuator cooler-to-radiator hose from the cooler.
3. Disconnect the expansion tank-to-turbocharger actuator cooler hose from the cooler.
4. **NOTE:** To allow access to the upper rear cooler bolt, it is necessary to loosen the turbocharger actuator bolts in order to lift the turbocharger actuator and cooler.
Loosen the 3 turbocharger actuator bolts.
5. Remove the bolts and the turbocharger actuator cooler.

Removal

1. Drain the fuel and turbocharger cooling system.
For additional information, refer to Fuel and Turbocharger Cooling System Draining, Filling and Bleeding in this section.

REMOVAL AND INSTALLATION (Continued)**Installation**

1. Position the turbocharger actuator cooler and install the bolts. Tighten the bolts in the sequence shown in 2 stages.
 - Stage 1: Finger-tighten the bolts.
 - Stage 2: Tighten to 7 Nm (62 lb-in).



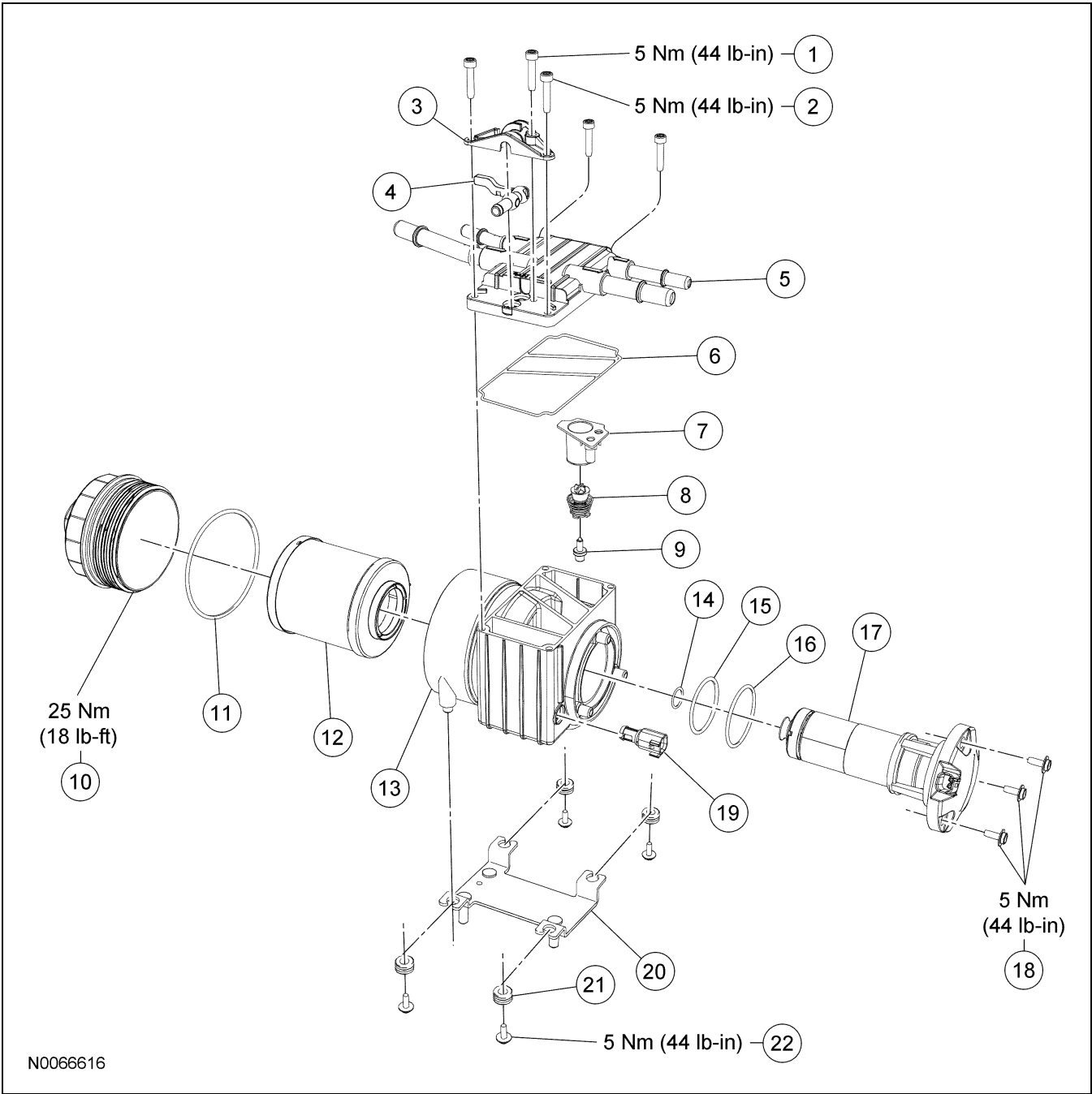
2. Tighten the turbocharger actuator bolts.
 - Tighten to 19 Nm (14 lb-ft).
3. Connect the expansion tank-to-turbocharger actuator cooler hose to the actuator.
4. Connect the turbocharger actuator cooler-to-radiator hose to the cooler.
5. Fill and bleed the fuel and turbocharger cooling system. For additional information, refer to Fuel and Turbocharger Cooling System Draining, Filling and Bleeding in this section.

DISASSEMBLY AND ASSEMBLY

Fuel Conditioning Module — 6.4L Diesel

Material


Item	Specification
SAE 15W-40 Super Duty Diesel Motor Oil XO-15W40-QSD (US); CXO-15W40-LSD12 (Canada); or equivalent	WSS-M2C171-D



DISASSEMBLY AND ASSEMBLY (Continued)

Item	Part Number	Description
1	—	Drain valve cover bolt (part of 9G282)
2	—	Manifold cover bolt (4 required) (part of 9G282)
3	—	Drain valve cover (part of 9G282)
4	—	Drain valve (part of 9G282)
5	—	Manifold cover (part of 9G282)
6	—	Manifold cover gasket (part of 9G282)
7	—	Return valve retainer (part of 9G282)
8	—	Return valve (part of 9G282)
9	—	Return valve plunger (part of 9G282)
10	—	Fuel filter cover (part of 9G282)
11	—	Fuel filter cover O-ring seal (part of 9G282)
12	—	Fuel filter (part of 9G282)
13	—	Fuel conditioning module body (part of 9G282)
14	—	Fuel pump (FP) O-ring seal (part of 9G282)
15	—	FP O-ring seal (part of 9G282)
16	—	FP O-ring seal (part of 9G282)
17	—	FP (part of 9G282)
18	—	FP bolts (3 required) (part of 9G282)
19	—	Water in fuel sensor (part of 9G282)
20	—	Fuel conditioning module mounting bracket (part of 9G282)
21	—	Fuel conditioning module mounting bracket rubber grommet (part of 9G282)
22	—	Fuel conditioning module mounting bracket bolts (4 required) (part of 9G282)

Disassembly

1.  **CAUTION:** The fuel conditioning module that is used with the 6.4L diesel engine has a brown cover. Installing a fuel conditioning module with a black cover may result in damage to the high-pressure fuel system.

Remove the fuel filter cover and drain the fuel from the housing.


- Remove and discard the O-ring seal.
2. Remove the fuel filter and discard.
 3. If necessary, remove the bolt and the drain valve cover.
 4. Remove the bolts and the manifold cover.
 - Remove and discard the press-in-place gasket.
 5. Remove the return valve assembly.
 6. Remove the bolts and the fuel pump (FP).
 - Remove and discard the O-ring seals.
 7. Remove the screws and the fuel conditioning module mounting bracket.
 - Inspect the fuel conditioning module mounting bracket rubber grommets for damage. If any fuel conditioning module mounting bracket rubber grommets are damaged, install a new grommet(s).

Assembly

1. Install the fuel conditioning mounting bracket and bolts.
 - Tighten to 5 Nm (44 lb-in).
2. Install new O-ring seals on the FP and lubricate with clean engine oil.
3. Install the FP and bolts.
 - Tighten to 5 Nm (44 lb-in).
4. Install the return valve assembly.
5. Install a new press-in-place gasket in the fuel manifold.

DISASSEMBLY AND ASSEMBLY (Continued)

6. If removed, install the drain valve cover and bolt.
 - Tighten to 5 Nm (44 lb-in).
 7. Install the manifold cover and bolts.
 - Tighten to 5 Nm (44 lb-in).
 8. Lubricate the O-ring seal with clean engine oil and install the fuel filter.
 9. Install a new O-ring seal on the fuel filter cover and lubricate with clean engine oil.
-

10.  **CAUTION:** The fuel conditioning module that is used with the 6.4L diesel engine has a brown cover. Installing a fuel conditioning module with a black cover may result in damage to the high-pressure fuel system.

Install the fuel filter cover.

- Tighten to 25 Nm (18 lb-ft).

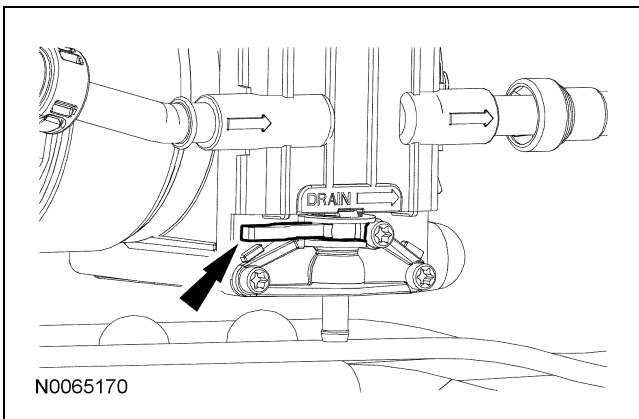
REMOVAL AND INSTALLATION

Fuel Conditioning Module — 6.4L Diesel

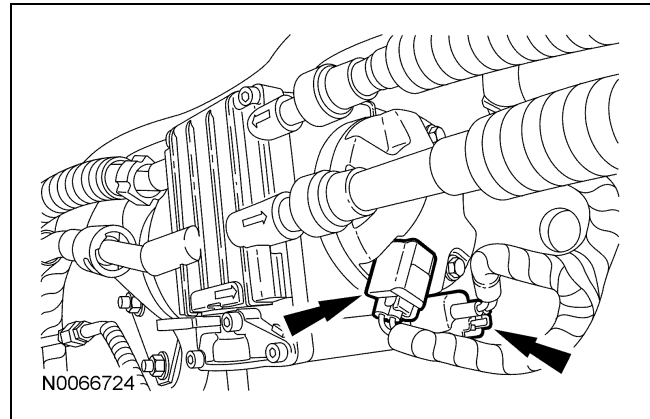
Removal and Installation

⚠ WARNING: When handling fuel, always observe fuel handling precautions and be prepared in the event of fuel spillage. Spilled fuel may be ignited by hot vehicle components or other ignition sources. Failure to follow these instructions may result in serious personal injury.

1. Release the fuel system pressure. For additional information, refer to Section 310-00.
2. Open the fuel/water separator drain valve and drain the fuel into a suitable container.



3. Disconnect the fuel pump and the water in fuel sensor electrical connectors.



4. Disconnect the fuel tank-to-fuel conditioning module fuel supply tube and fuel conditioning module-to-fuel tank fuel return tube quick connect coupling. For additional information, refer to Section 310-00.
5. Disconnect the fuel tank-to-fuel conditioning module-to-engine fuel supply tube and engine-to-fuel conditioning module fuel return tube spring lock coupling. For additional information, refer to Section 310-00.
6. Remove the mounting nuts and the fuel conditioning module.
 - To install, tighten to 20 Nm (15 lb-ft).
7. **⚠ CAUTION:** The fuel conditioning module that is used with the 6.4L diesel engine has a brown cover. Installing a fuel conditioning module with a black cover may result in damage to the high-pressure fuel system.
To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Fuel Filter — Gasoline Engines

Removal and Installation

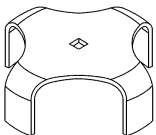
NOTE: Some residual fuel may remain in the fuel filter after releasing the fuel system pressure. Upon disconnecting or removing the fuel filter, carefully drain any residual fuel into a suitable container.

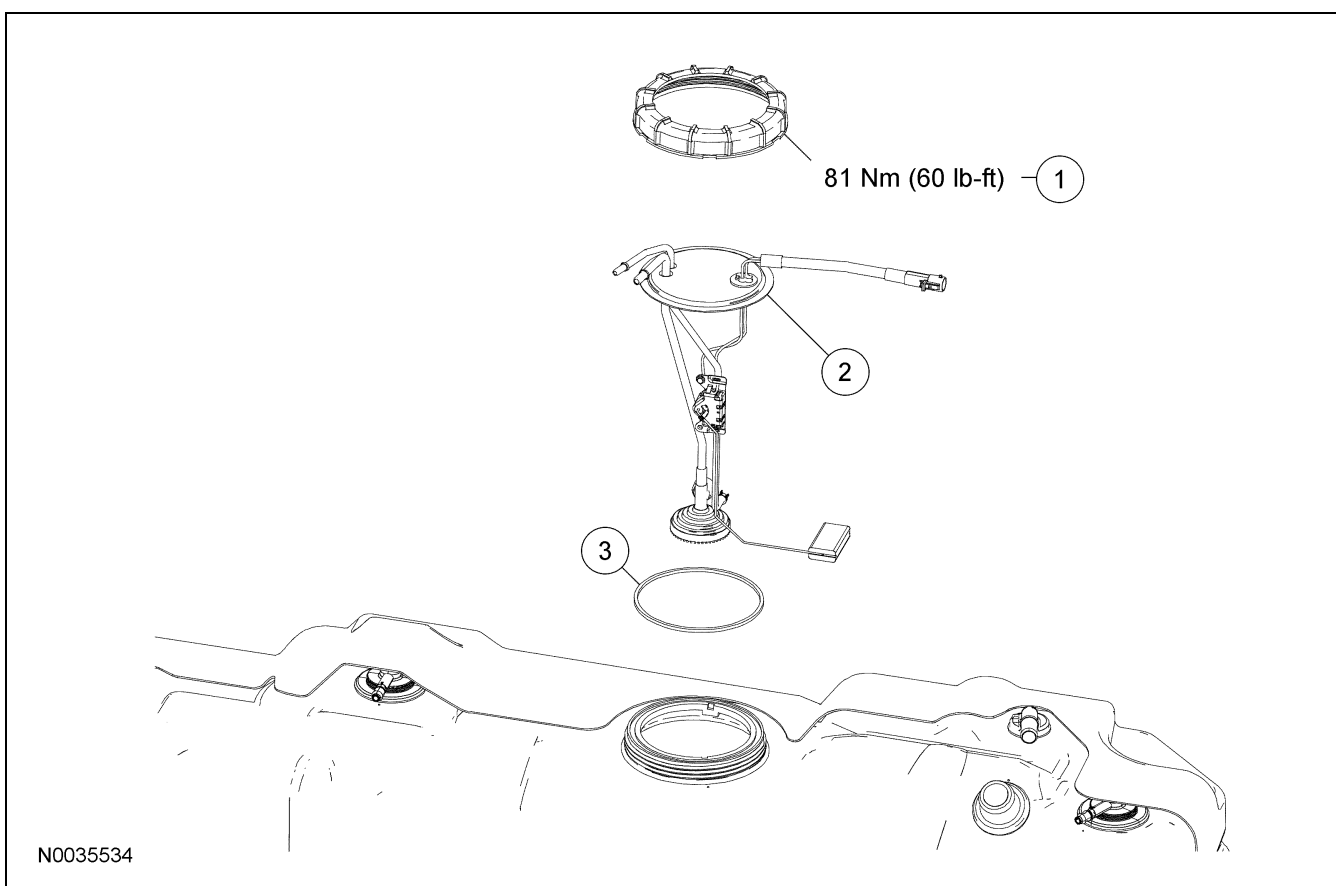
1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
 2. Disconnect the fuel supply tube-to-fuel filter inlet quick connect coupling. For additional information, refer to Section 310-00.
 3. Disconnect the fuel supply tube-to-fuel filter outlet quick connect coupling. For additional information, refer to Section 310-00.
 4. Remove and discard the fuel filter.
 5. To install, reverse the removal procedure.
 - Install a new fuel filter.
-

REMOVAL AND INSTALLATION

Fuel Level Sensor — Plastic Fuel Tank

Special Tool(s)

	Fuel Tank Sender Unit Socket 310-059 (T97T-9275-A)
ST2376-A	



Item	Part Number	Description
1	9A307	Fuel level sensor lock ring
2	9275	Fuel level sensor
3	9417	Fuel level sensor gasket

REMOVAL AND INSTALLATION (Continued)**Removal and Installation**

⚠ WARNING: Do not smoke, carry lighted tobacco or have an open flame of any type when working on or near any fuel-related component. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in serious personal injury.

⚠ WARNING: When handling fuel, always observe fuel handling precautions and be prepared in the event of fuel spillage. Spilled fuel may be ignited by hot vehicle components or other ignition sources. Failure to follow these instructions may result in serious personal injury.

NOTE: This procedure is for diesel applications only.

1. **NOTE:** The fuel tank must be drained completely. Upon removal of the fuel level sensor, the tank must be inspected for contamination.

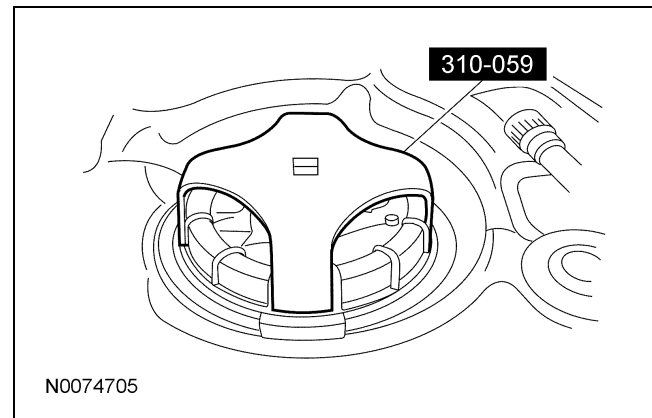
Remove the fuel tank. For additional information, refer to Fuel Tank — Midship.

2. **⚠ CAUTION:** Clean the fuel tank of any dirt or foreign material before servicing the fuel level sensor. In extreme dirt or dusty conditions it may be necessary to wash the fuel tank using a water hose. Before removing the fuel level sensor, make sure that there is no residual dirt or foreign material around the fuel level sensor flange. If dirt or foreign material enter the fuel tank, damage to the fuel level sensor or other fuel system components may occur.

Clean the area around the fuel level sensor lock ring.

3. Using the special tool, remove the fuel level sensor lock ring.

- To install, tighten to 81 Nm (60 lb-ft).



4. **⚠ CAUTION:** The fuel level sensor must be handled carefully to avoid damage to the float arm.

Completely remove the fuel level sensor from the fuel tank.

5. **NOTE:** Make sure to install a new fuel level sensor gasket or fuel leakage could occur causing vehicle damage.

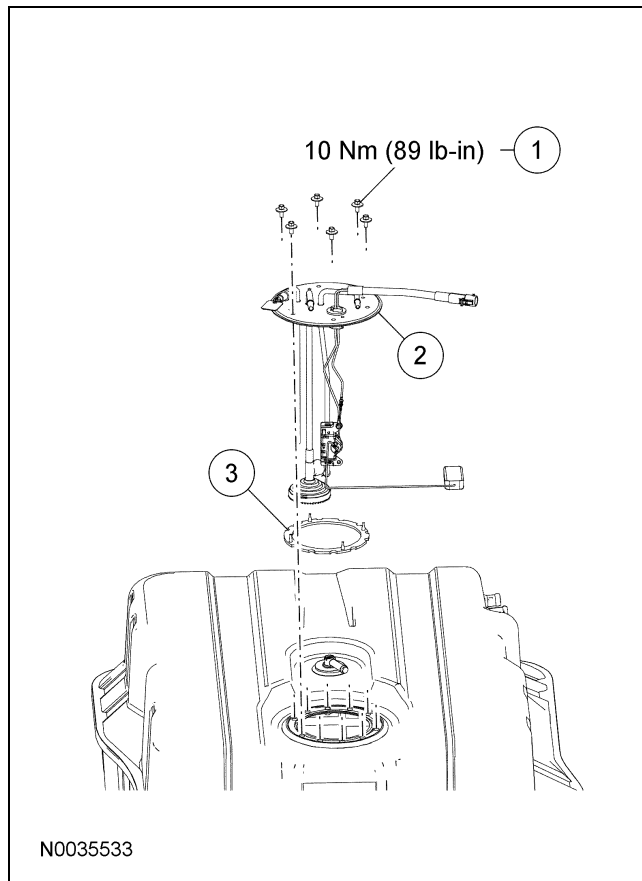
Remove and discard the fuel level sensor gasket.

6. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Fuel Level Sensor — Steel Fuel Tank

NOTE: Aft-of-axle fuel tank shown, auxiliary fuel tank similar.



Item	Part Number	Description
1	N602725	Fuel level sensor bolt (6 required)
2	9275	Fuel level sensor
3	9276	Fuel level sensor gasket

Removal and Installation

NOTE: This procedure is for diesel applications only.

- NOTE:** The fuel tank must be drained completely. Upon removal of the fuel level sensor, the tank must be inspected for contamination.

Remove the fuel tank. For additional information, refer to Fuel Tank — Aft-of-Axle or Fuel Tank — Auxiliary.

- CAUTION:** Clean the fuel tank of any dirt or foreign material before servicing the fuel level sensor. In extreme dirt or dusty conditions it may be necessary to wash the fuel tank using a water hose. Before removing the fuel level sensor, make sure that there is no residual dirt or foreign material around the fuel level sensor flange. If dirt or foreign material enter the fuel tank, damage to the fuel level sensor or other fuel system components may occur.

Clean the area around the fuel level sensor mounting flange.

- Remove the 6 bolts from the fuel level sensor.
 - To install, tighten to 10 Nm (89 lb-in).
- CAUTION:** The fuel level sensor must be handled carefully to avoid damage to the float arm.

Completely remove the fuel level sensor from the fuel tank.

- NOTE:** Inspect the surfaces of the fuel level sensor flange and fuel tank gasket contact surfaces. Do not polish or adjust the gasket contact area of the fuel tank flange or the fuel tank. Install a new fuel level sensor or fuel tank if the gasket contact area is bent, scratched or corroded or fuel leakage could occur causing vehicle damage.

NOTE: Make sure to install a new fuel level sensor gasket or fuel leakage could occur causing vehicle damage.

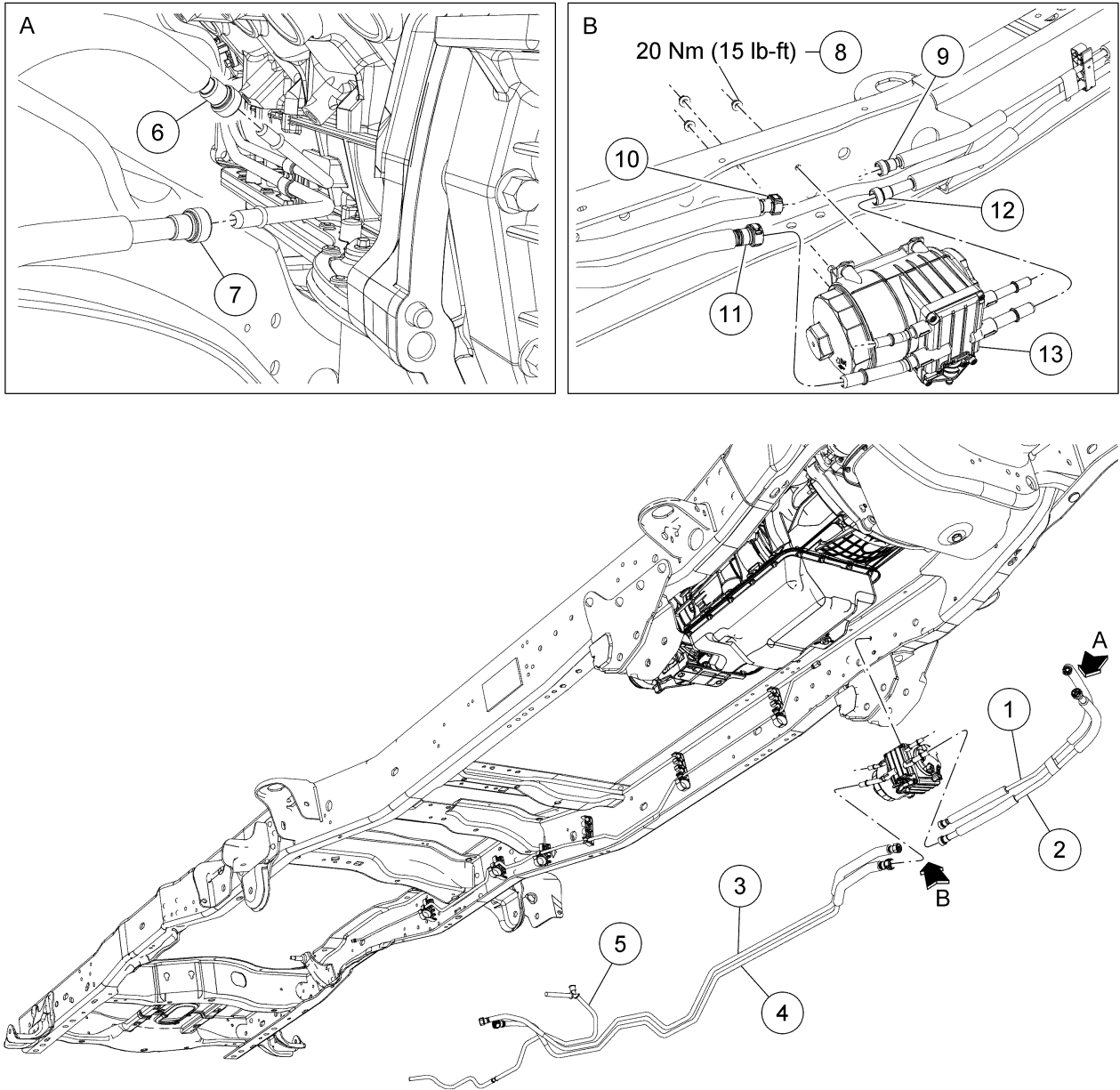
Remove and discard the fuel level sensor gasket.

- To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Fuel Lines — 6.4L Diesel

Midship Fuel Tank



N0066830

Item	Part Number	Description
1	9J338	Fuel return tube
2	9J338	Fuel supply tube
3	9S278	Fuel return tube
4	9S278	Fuel supply tube
5	9S278	Fuel tank vapor tube

(Continued)

Item	Part Number	Description
6	—	Fuel return tube-to-engine fuel return tube spring lock coupling (part of 9J338)
7	—	Fuel supply tube-to-engine fuel supply tube spring lock coupling (part of 9J338)

(Continued)

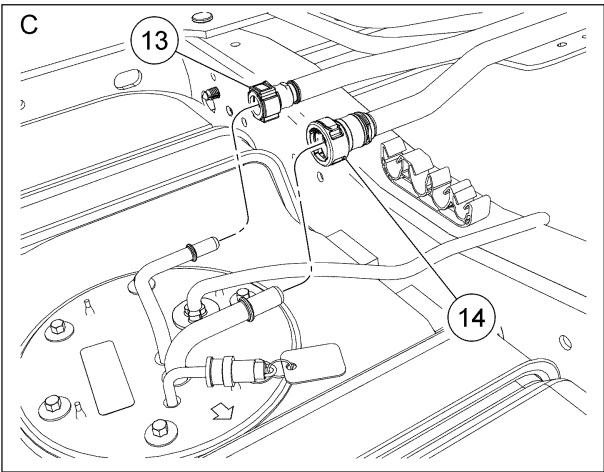
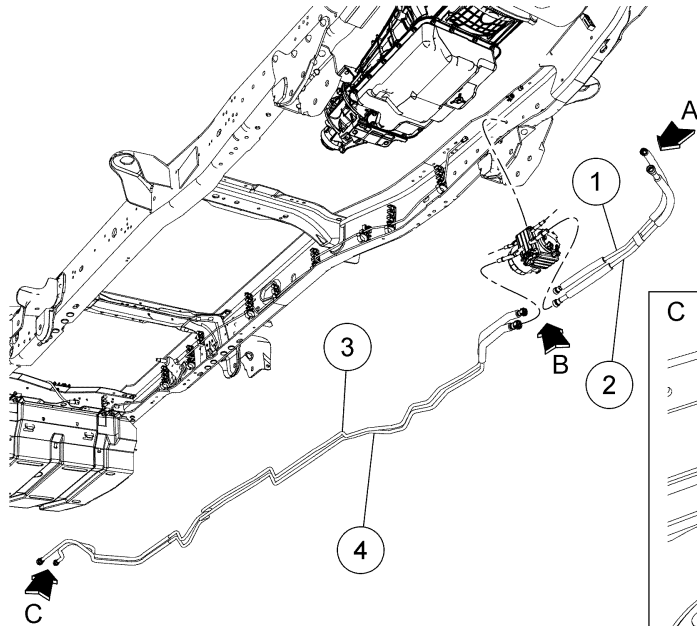
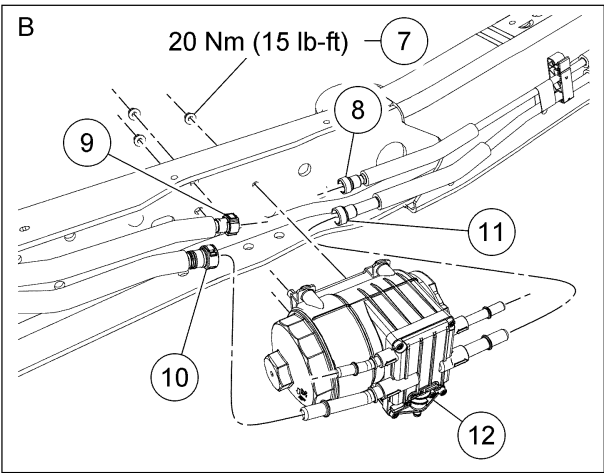
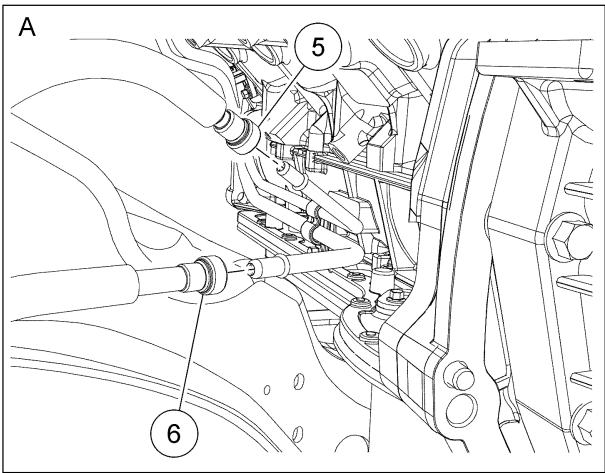
REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
8	W520102	Fuel conditioning module mounting nut (3 required)
9	—	Fuel return tube-to-fuel conditioning module spring lock coupling (part of 9J338)
10	—	Fuel return tube-to-fuel conditioning module quick connect coupling (part of 9J338)

(Continued)

Item	Part Number	Description
11	—	Fuel supply tube-to-fuel conditioning module quick connect coupling (part of 9J338)
12	—	Fuel supply tube-to-fuel conditioning module spring lock coupling (part of 9J338)
13	9G282	Fuel conditioning module

Aft-of-Axle Fuel Tank



N0066831

REMOVAL AND INSTALLATION (Continued)

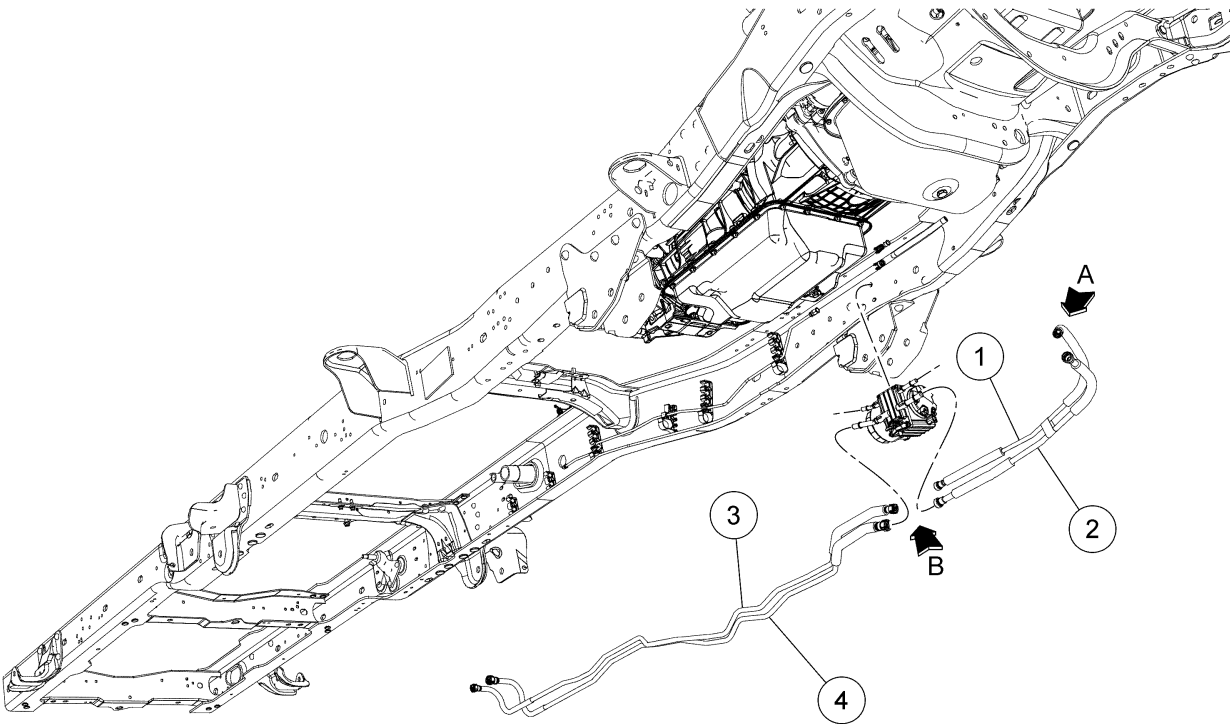
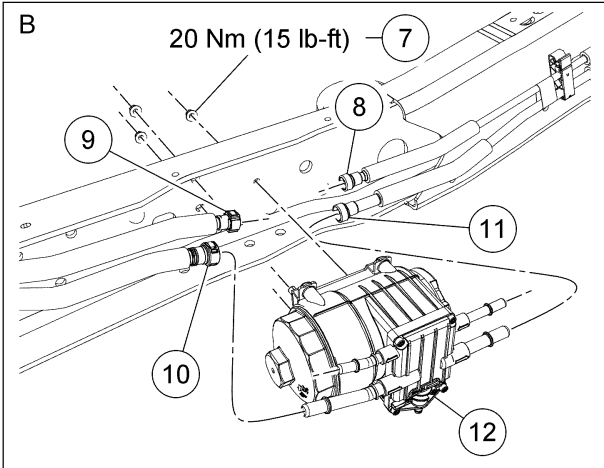
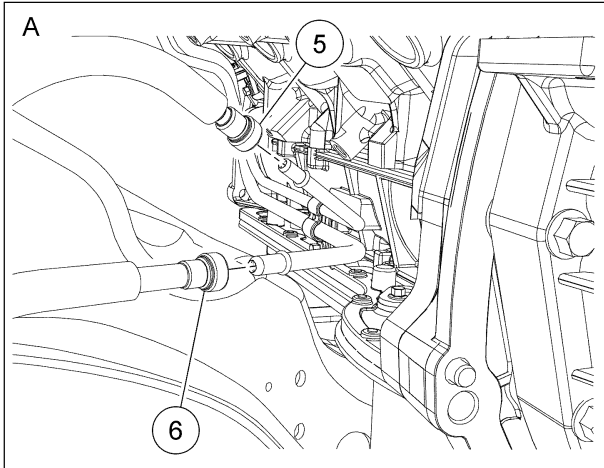
Item	Part Number	Description
1	9J338	Fuel return tube
2	9J338	Fuel supply tube
3	9S278	Fuel return tube
4	9S278	Fuel supply tube
5	—	Fuel return tube-to-engine fuel return tube spring lock coupling (part of 9J338)
6	—	Fuel supply tube-to-engine fuel supply tube spring lock coupling (part of 9J338)
7	W520102	Fuel conditioning module mounting nut (3 required)
8	—	Fuel return tube-to-fuel conditioning module spring lock coupling (part of 9J338)
9	—	Fuel return tube-to-fuel conditioning module quick connect coupling (part of 9J338)

(Continued)

Item	Part Number	Description
10	—	Fuel supply tube-to-fuel conditioning module quick connect coupling (part of 9J338)
11	—	Fuel supply tube-to-fuel conditioning module spring lock coupling (part of 9J338)
12	9G282	Fuel conditioning module
13	—	Fuel return tube-to-fuel level sensor quick connect coupling (part of 9S278)
14	—	Fuel supply tube-to-fuel level sensor quick connect coupling (part of 9S278)

REMOVAL AND INSTALLATION (Continued)

Auxiliary Fuel Tank



N0066832

Item	Part Number	Description
1	9J338	Fuel return tube
2	9J338	Fuel supply tube
3	9S278	Fuel return tube
4	9S278	Fuel supply tube
5	—	Fuel return tube-to-engine fuel return tube spring lock coupling (part of 9J338)

(Continued)


Item	Part Number	Description
6	—	Fuel supply tube-to-engine fuel supply tube spring lock coupling (part of 9J338)
7	W520102	Fuel conditioning module mounting nut (3 required)
8	—	Fuel return tube-to-fuel conditioning module spring lock coupling (part of 9J338)

(Continued)

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
9	—	Fuel return tube-to-fuel conditioning module quick connect coupling (part of 9J338)
10	—	Fuel supply tube-to-fuel conditioning module quick connect coupling (part of 9J338)
11	—	Fuel supply tube-to-fuel conditioning module spring lock coupling (part of 9J338)
12	9G282	Fuel conditioning module

Removal and Installation

 **WARNING:** When handling fuel, always observe fuel handling precautions and be prepared in the event of fuel spillage. Spilled fuel may be ignited by hot vehicle components or other ignition sources. Failure to follow these instructions may result in serious personal injury.

NOTE: Some residual fuel may remain in the fuel tubes after releasing the fuel system pressure. Upon disconnecting or removing any fuel tubes, carefully drain any residual fuel into a suitable container.

All vehicles

1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
2. Release the fuel system pressure. For additional information, refer to Section 310-00.

Midship and auxiliary fuel tank equipped vehicles

3. Remove the fuel tank. For additional information, refer to Fuel Tank — Midship or Fuel Tank — Auxiliary in this section.

Aft-of-axle fuel tank equipped vehicles

4. Disconnect the fuel supply tube-to-fuel level sensor quick connect coupling and the fuel return tube-to-fuel level sensor quick connect coupling. For additional information, refer to Section 310-00.


All vehicles

5. Disconnect the fuel supply tube-to-engine fuel supply tube spring lock coupling and the fuel return tube-to-engine fuel return tube spring lock coupling. For additional information, refer to Section 310-00.
6. Disconnect the fuel supply tube-to-fuel conditioning module spring lock coupling and the fuel return tube-to-fuel conditioning module spring lock coupling. For additional information, refer to Section 310-00.
7. Disconnect the fuel supply tube-to-fuel conditioning module quick connect coupling and the fuel return tube-to-fuel conditioning module quick connect coupling. For additional information, refer to Section 310-00.
8. Disconnect the fuel supply tubes and fuel return tubes from the position retainers and remove from the vehicle.
9. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Fuel Lines — Aft of Axle Tank, Gasoline Engines

Removal and Installation

 **WARNING:** When handling fuel, always observe fuel handling precautions and be prepared in the event of fuel spillage. Spilled fuel may be ignited by hot vehicle components or other ignition sources. Failure to follow these instructions may result in serious personal injury.

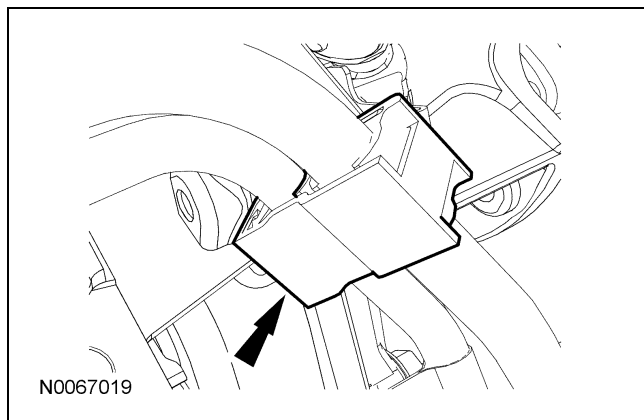
NOTE: Some residual fuel may remain in the fuel tubes after releasing the fuel system pressure. Upon disconnecting or removing any fuel tubes, carefully drain any residual fuel into a suitable container.

NOTE: On some aft-of-axle applications, it may be necessary to remove a bed mounting bracket(s) in order to remove the fuel tubes or vapor tubes.

1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
2. Release the fuel system pressure. For additional information, refer to Section 310-00.
3. Disconnect the battery ground cable. For additional information, refer to Section 414-01.
4. Disconnect the fuel supply tube-to-fuel rail spring lock coupling. For additional information, refer to Section 310-00.
5. Disconnect the fuel vapor tube-to evaporative emissions (EVAP) canister purge valve quick connect coupling. For additional information, refer to Section 310-00.
6. Disconnect the fuel supply tube-to-fuel pump (FP) module quick connect coupling. For additional information, refer to Section 310-00.
7. Disconnect the fuel vapor tube-to-fuel tank grade vent valve quick connect coupling. For additional information, refer to Section 310-00.
8. Disconnect the fuel tank vapor tube-to-EVAP canister assembly quick connect coupling. For additional information, refer to Section 310-00.
9. Disconnect the fuel vapor vent hose from the dust separator.
10. Disconnect the fuel pump driver module (FPDM) electrical connector from the fuel pump driver module.
11. Remove the 4 bolts and the EVAP canister and bracket assembly.
 - To install, tighten to 17 Nm (13 lb-ft).
12. Disconnect the fuel supply tube-to-fuel filter inlet quick connect coupling. For additional information, refer to Section 310-00.
13. Disconnect the fuel supply tube-to-fuel filter outlet quick connect coupling. For additional information, refer to Section 310-00.
14. Remove the fuel filter, fuel filter retainer and nut.
 - To install, tighten to 20 Nm (15 lb-ft).
15. Disconnect the center fuel supply tube-to-front fuel supply tube quick connect coupling. For additional information, refer to Section 310-00.
16. Disconnect the rear fuel supply tube from the position retainers and remove from the vehicle.
17. Disconnect the center fuel supply tube from the position retainers and remove from the vehicle.
18. Disconnect the center vapor tube-to-front vapor tube quick connect coupling. For additional information, refer to Section 310-00.
19. Disconnect the center fuel vapor tube-to-rear vapor tube quick connect coupling. For additional information, refer to Section 310-00.
20. Disconnect the center fuel vapor tube from the position retainers and remove from the vehicle.
21. Disconnect the rear fuel vapor tube from the position retainers and remove from the vehicle.

REMOVAL AND INSTALLATION (Continued)

22. Disconnect the front fuel vapor tube and front fuel supply tube from the position retainer at the back of the transmission.




23. Disconnect the fuel supply tube and the fuel vapor tube from the position retainer at the rear of the engine and remove from the vehicle.

24. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Fuel Lines — Auxiliary, Gasoline

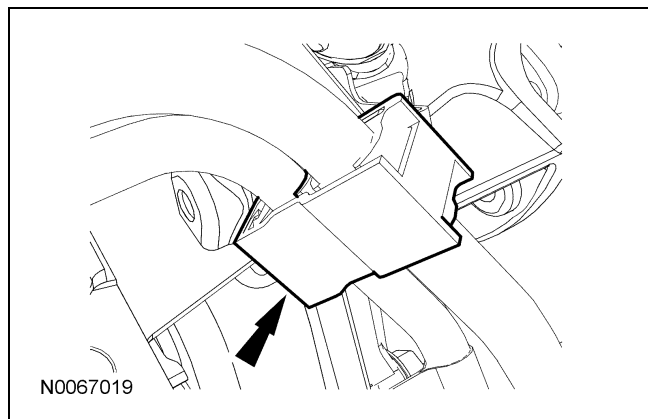
Removal and Installation

 **WARNING:** When handling fuel, always observe fuel handling precautions and be prepared in the event of fuel spillage. Spilled fuel may be ignited by hot vehicle components or other ignition sources. Failure to follow these instructions may result in serious personal injury.

NOTE: Some residual fuel may remain in the fuel tubes after releasing the fuel system pressure. Upon disconnecting or removing any fuel tubes, carefully drain any residual fuel into a suitable container.

NOTE: On some aft-of-axle applications, it may be necessary to remove a bed mounting bracket(s) in order to remove the fuel tubes or vapor tubes.

1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
2. Release the fuel system pressure. For additional information, refer to Section 310-00.
3. Disconnect the battery ground cable. For additional information, refer to Section 414-01.
4. Disconnect the fuel supply tube-to-fuel rail spring lock coupling. For additional information, refer to Section 310-00.
5. Disconnect the fuel vapor tube-to evaporative emissions (EVAP) canister purge valve quick connect coupling. For additional information, refer to Section 310-00.
6. Remove the fuel tank. For additional information, refer to Fuel Tank — Midship or Fuel Tank — Auxiliary in this section.
7. Disconnect the fuel supply tube-to-fuel filter inlet quick connect coupling. For additional information, refer to Section 310-00.
8. Disconnect the fuel supply tube-to-fuel filter outlet quick connect coupling. For additional information, refer to Section 310-00.
9. Remove the fuel filter, fuel filter retainer and nut.
 - To install, tighten to 20 Nm (15 lb-ft).
10. Disconnect the center fuel supply tube-to-front fuel supply tube quick connect coupling. For additional information, refer to Section 310-00.
11. Disconnect the rear fuel supply tube from the position retainers and remove from the vehicle.
12. Disconnect the center fuel supply tube from the position retainers and remove from the vehicle.
13. Disconnect the center vapor tube-to-front vapor tube quick connect coupling. For additional information, refer to Section 310-00.
14. Disconnect the center fuel vapor tube-to-rear vapor tube quick connect coupling. For additional information, refer to Section 310-00.
15. Disconnect the center fuel vapor tube from the position retainers and remove from the vehicle.
16. Disconnect the rear fuel vapor tube from the position retainers and remove from the vehicle.
17. Disconnect the front fuel vapor tube and front fuel supply tube from the position retainer at the back of the transmission.
18. Disconnect the fuel supply tube and the fuel vapor tube from the position retainer at the rear of the engine and remove from the vehicle.




REMOVAL AND INSTALLATION (Continued)

19. Remove the fuel tank fuel vapor tube from the position retainers and remove from the vehicle.
20. To install, reverse the removal procedure.
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REMOVAL AND INSTALLATION

Fuel Lines — Midship Tank, Gasoline Engines

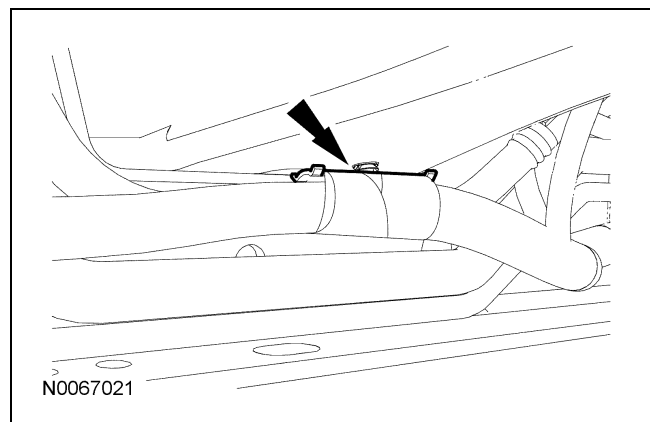
Removal and Installation

 **WARNING:** When handling fuel, always observe fuel handling precautions and be prepared in the event of fuel spillage. Spilled fuel may be ignited by hot vehicle components or other ignition sources. Failure to follow these instructions may result in serious personal injury.

NOTE: Some residual fuel may remain in the fuel tubes after releasing the fuel system pressure. Upon disconnecting or removing any fuel tubes, carefully drain any residual fuel into a suitable container.

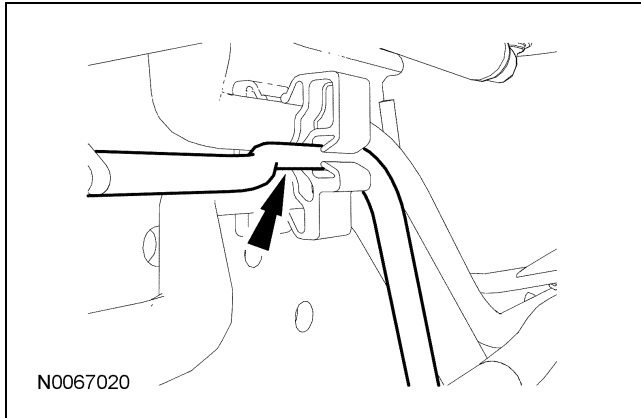
NOTE: On some aft-of-axle applications, it may be necessary to remove a bed mounting bracket(s) in order to remove the fuel tubes or vapor tubes.

1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
2. Release the fuel system pressure. For additional information, refer to Section 310-00.
3. Disconnect the battery ground cable. For additional information, refer to Section 414-01.
4. Disconnect the fuel supply tube-to-fuel rail spring lock coupling. For additional information, refer to Section 310-00.
5. Disconnect the fuel vapor tube-to evaporative emissions (EVAP) canister purge valve quick connect coupling. For additional information, refer to Section 310-00.
6. Remove the fuel tank. For additional information, refer to Fuel Tank — Midship or Fuel Tank — Auxiliary in this section.
7. Disconnect the fuel supply tube-to-fuel filter inlet quick connect coupling. For additional information, refer to Section 310-00.
8. Disconnect the fuel supply tube-to-fuel filter outlet quick connect coupling. For additional information, refer to Section 310-00.
9. Remove the fuel filter, fuel filter retainer and nut.
 - To install, tighten to 20 Nm (15 lb-ft).
10. Disconnect the center fuel supply tube-to-front fuel supply tube quick connect coupling. For additional information, refer to Section 310-00.
11. Disconnect the rear fuel supply tube from the position retainers and remove from the vehicle.
12. Disconnect the center fuel supply tube from the position retainers and remove from the vehicle.
13. Disconnect the rear vapor tube-to-front vapor tube quick connect coupling. For additional information, refer to Section 310-00.
14. Disconnect the rear vapor tube-to-EVAP canister quick connect coupling. For additional information, refer to Section 310-00.
15. Disconnect the wiring harness pushpin connector from the No. 5 crossmember.

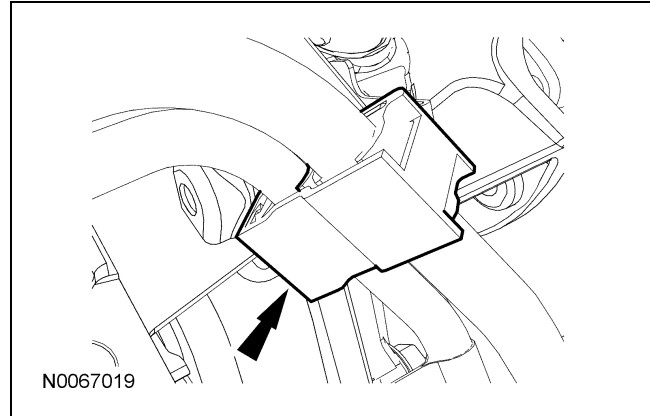


REMOVAL AND INSTALLATION (Continued)

16. Disconnect the brake line from the position retainer behind the No. 5 crossmember.



17. Disconnect the rear fuel vapor tube from the position retainers and remove from the vehicle.
18. Disconnect the front fuel vapor tube and front fuel supply tube from the position retainer at the back of the transmission.

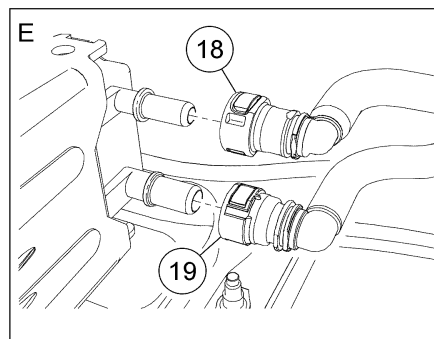
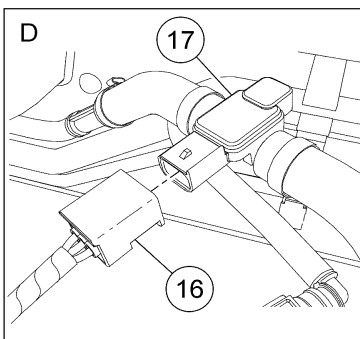
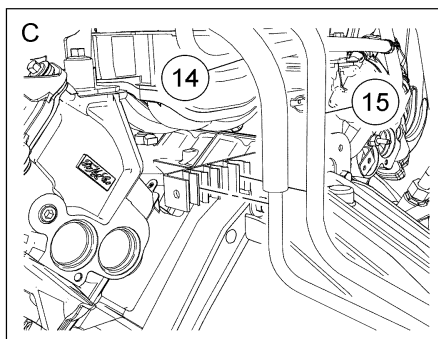
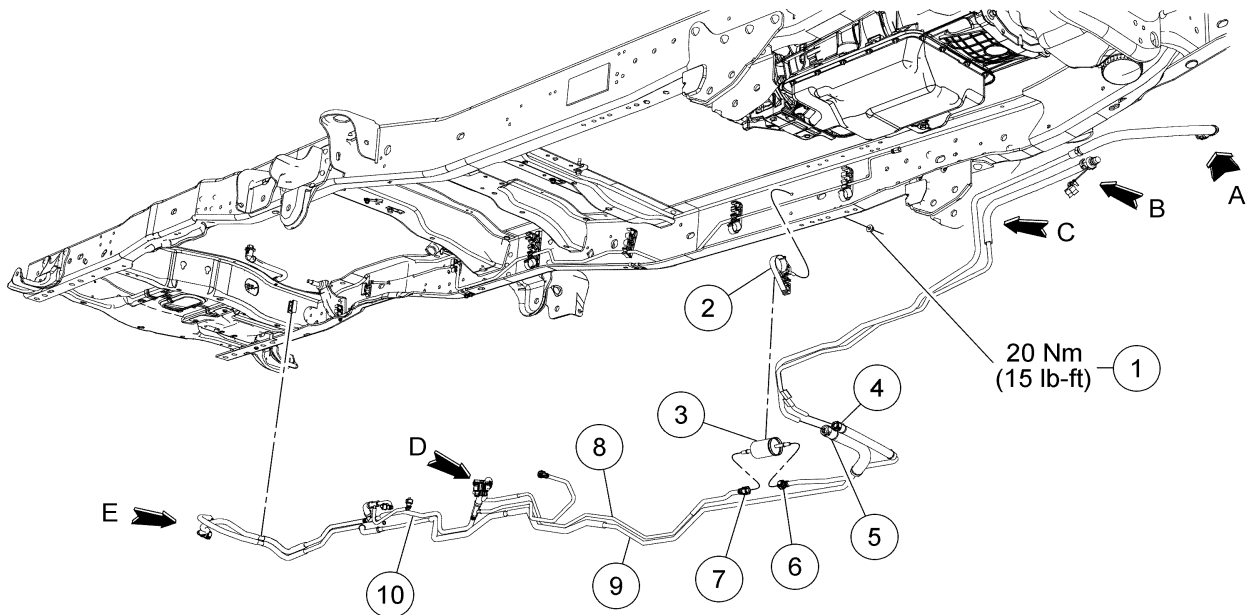
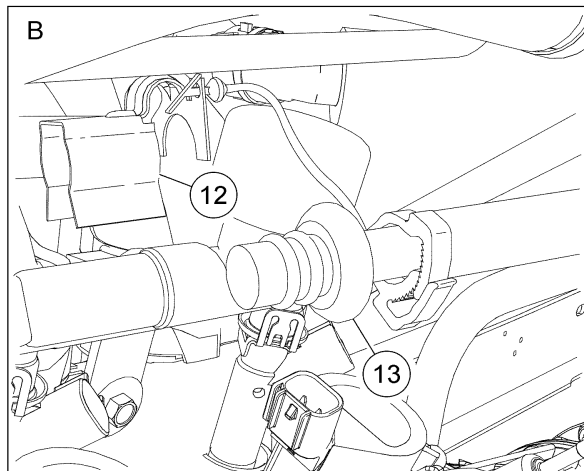
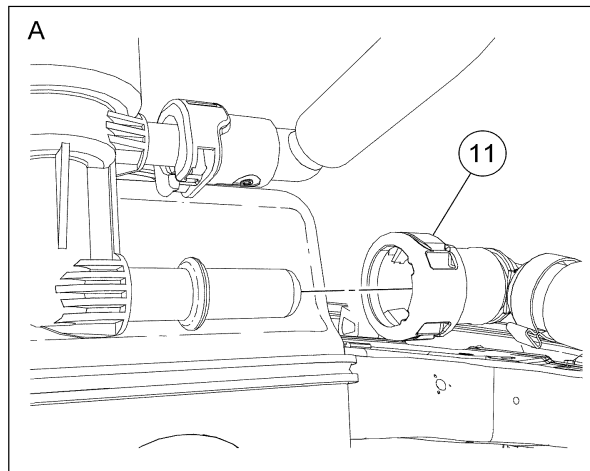


19. Disconnect the fuel supply tube and the fuel vapor tube from the position retainer at the rear of the engine and remove from the vehicle.
20. Disconnect the fuel tank filler pipe vent tube-to-fuel tank pressure sensor and vapor tube assembly quick connect coupling.
21. Disconnect the fuel tank pressure sensor electrical connector.
22. Disconnect the fuel tank pressure sensor and vapor tube assembly-to-EVAP canister quick connect coupling. For additional information, refer to Section 310-00.
23. Disconnect the fuel tank pressure sensor and vapor tube assembly from the position retainers and remove from the vehicle.
24. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Fuel Lines and Fuel Filter — Exploded View, Gasoline Engines

Midship Fuel Tank



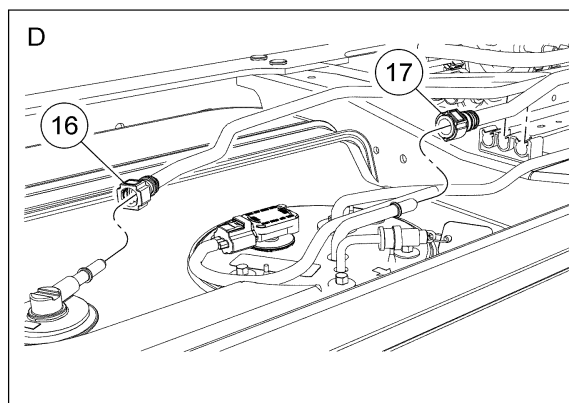
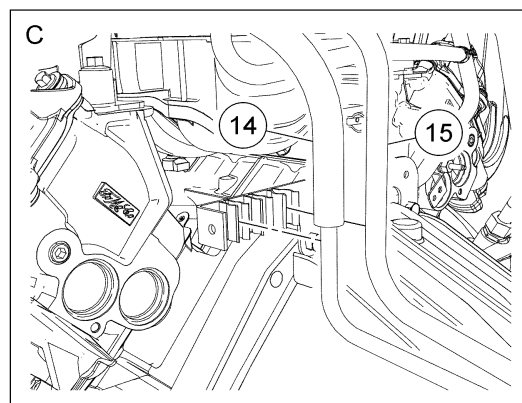
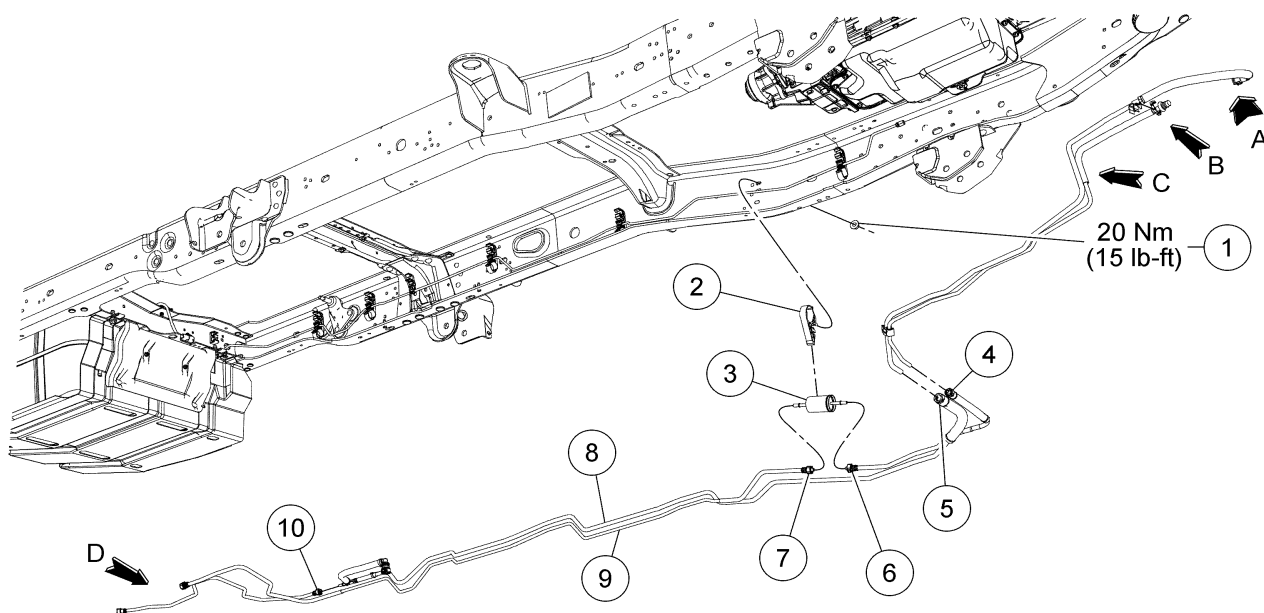
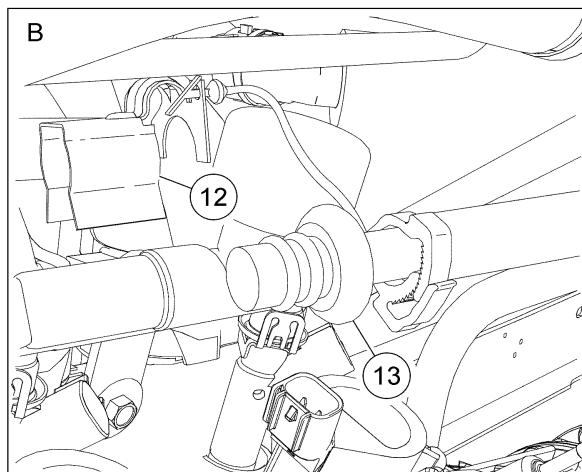
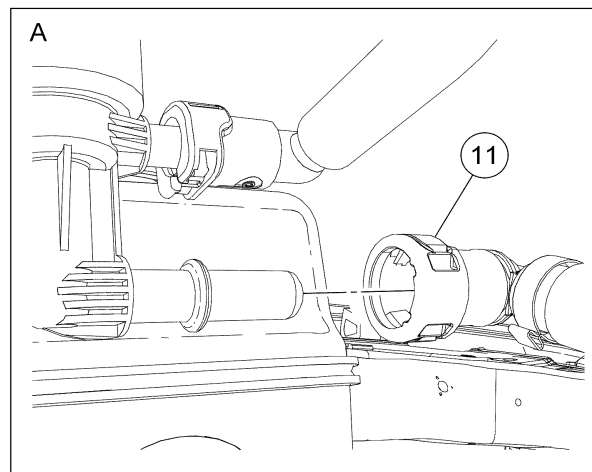
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REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	W520102	Fuel filter retainer nut
2	—	Fuel filter retainer
3	9155	Fuel filter
4	—	Center fuel supply tube-to-front fuel supply tube quick connect coupling (part of 9S278)
5	—	Center fuel vapor tube-to-front fuel vapor tube quick connect coupling (part of 9S278)
6	—	Fuel supply tube-to-fuel filter outlet quick connect coupling (part of 9S278)
7	—	Fuel supply tube-to-fuel filter inlet quick connect coupling (part of 9S278)
8	9S278	Fuel supply tube
9	9S278	Fuel vapor tube
10	9S278	Fuel tank pressure sensor and vapor tube assembly
11	—	Fuel vapor tube-to-evaporative emissions (EVAP) canister purge valve quick connect coupling (part of 9J338)

(Continued)

Item	Part Number	Description
12	—	Spring lock coupling safety clip
13	—	Fuel supply tube-to-fuel rail spring lock coupling (part of 9J338)
14	9J338	Fuel vapor tube
15	9J338	Fuel supply tube
16	—	Fuel tank pressure sensor electrical connector (part of 14405)
17	9C052	Fuel tank pressure sensor
18	—	Fuel vapor tube-to-EVAP canister quick connect coupling (part of 9S278)
19	—	Fuel tank pressure sensor and vapor tube assembly-to-EVAP canister quick connect coupling (part of 9S278)

REMOVAL AND INSTALLATION (Continued)**Aft-of-Axle Fuel Tank**

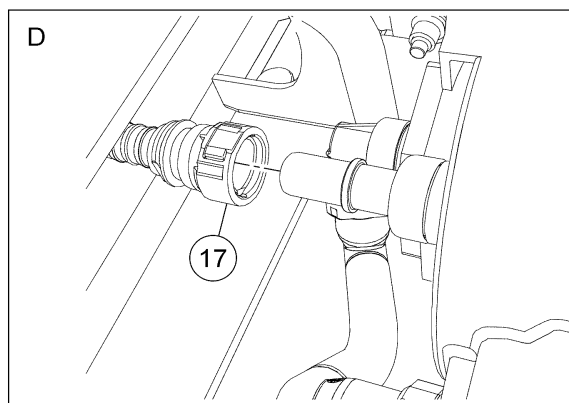
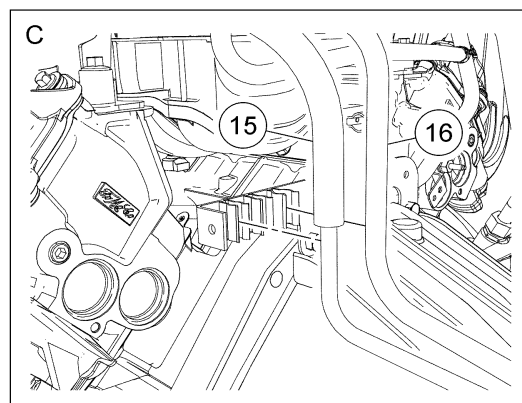
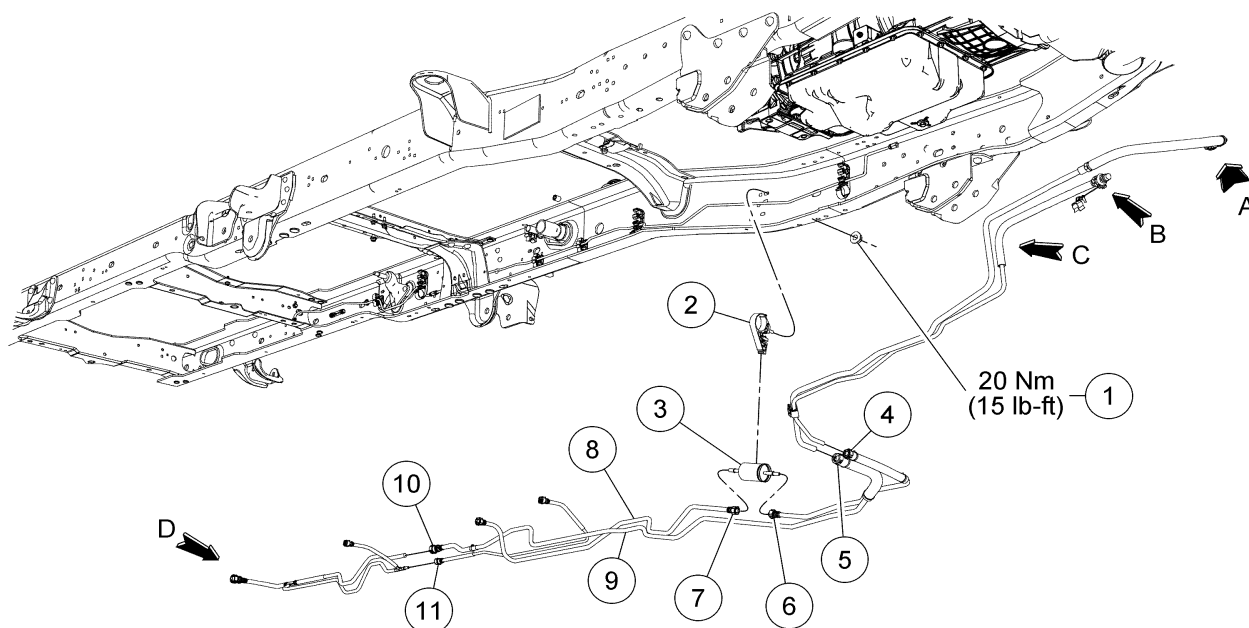
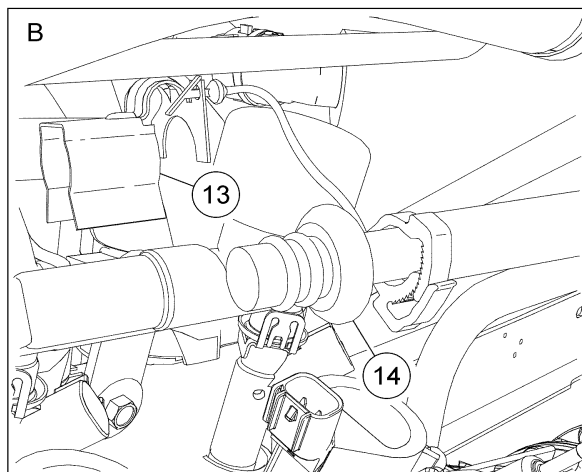
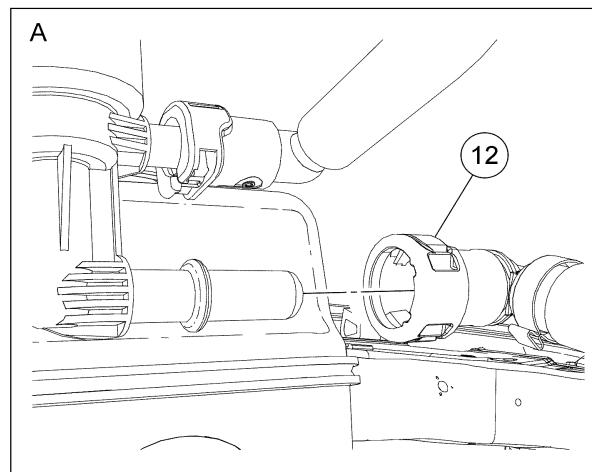
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REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	W520102	Fuel filter retainer nut
2	—	Fuel filter retainer
3	9155	Fuel filter
4	—	Center fuel supply tube-to-front fuel supply tube quick connect coupling (part of 9S278)
5	—	Center fuel vapor tube-to-front fuel vapor tube quick connect coupling (part of 9S278)
6	—	Fuel supply tube-to-fuel filter outlet quick connect coupling (part of 9S278)
7	—	Fuel supply tube-to-fuel filter inlet quick connect coupling (part of 9S278)
8	9S278	Fuel supply tube
9	9S278	Fuel vapor tube
10	—	Center fuel vapor tube-to-rear fuel vapor tube quick connect coupling (part of 9S278)

(Continued)

Item	Part Number	Description
11	—	Fuel vapor tube-to-EVAP canister purge valve quick connect coupling (part of 9J338)
12	—	Spring lock coupling safety clip
13	—	Fuel supply tube-to-fuel rail spring lock coupling (part of 9J338)
14	9J338	Fuel vapor tube
15	9J338	Fuel supply tube
16	—	Fuel vapor tube-to-fuel tank grade vent valve quick connect coupling (part of 9S278)
17	—	Fuel supply tube-to-fuel pump (FP) module quick connect coupling (part of 9S278)

REMOVAL AND INSTALLATION (Continued)**Auxiliary Fuel Tank**

N0066823

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	W520102	Fuel filter retainer nut
2	—	Fuel filter retainer
3	9155	Fuel filter
4	—	Center fuel supply tube-to-front fuel supply tube quick connect coupling (part of 9S278)
5	—	Center fuel vapor tube-to-front fuel vapor tube quick connect coupling (part of 9S278)
6	—	Fuel supply tube-to-fuel filter outlet quick connect coupling (part of 9S278)
7	—	Fuel supply tube-to-fuel filter inlet quick connect coupling (part of 9S278)
8	9S278	Fuel supply tube
9	9S278	Fuel vapor tube
10	—	Center fuel vapor tube-to-rear fuel vapor tube quick connect coupling (part of 9S278)

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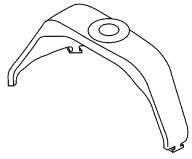
Item	Part Number	Description
11	—	Fuel tank vapor tube-to-rear fuel vapor tube quick connect coupling (part of 9S278)
12	—	Fuel vapor tube-to-EVAP canister purge valve quick connect coupling (part of 9J338)
13	—	Spring lock coupling safety clip
14	—	Fuel supply tube-to-fuel rail spring lock coupling (part of 9J338)
15	9J338	Fuel vapor tube
16	9J338	Fuel supply tube
17	—	Fuel vapor tube-to-EVAP canister quick connect coupling (part of 9A334)

1. For additional information, refer to the procedures in this section.

REMOVAL AND INSTALLATION

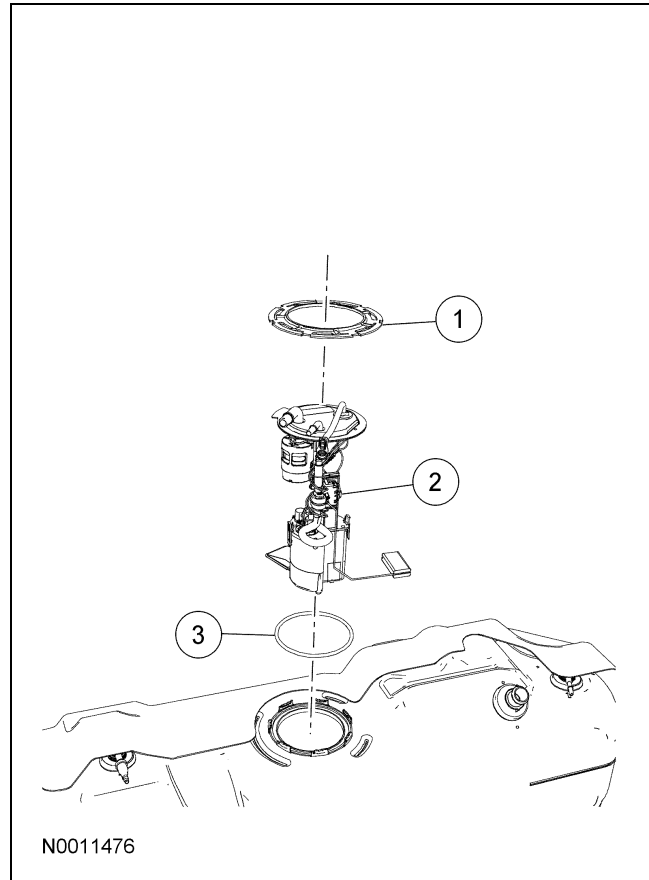
Fuel Pump Module — Plastic Fuel Tank

Special Tool(s)

 <p>ST2803-A</p>	<p>Lock Ring Wrench 310-123</p>
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Material

Item	Specification
<p>Motorcraft SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP (US); Motorcraft SAE 5W-20 Super Premium Motor Oil CXO-5W20-LSP12 (Canada); or equivalent</p>	<p>WSS-M2C930-A</p>



Item	Part Number	Description
1	9C385	Fuel pump (FP) module lock ring
2	9H307	FP module
3	9276	FP module O-ring seal


Removal and Installation

NOTE: This procedure is for gasoline applications only.

1. **NOTE:** The fuel tank must be drained completely. Upon removal of the fuel pump (FP) module, the tank must be inspected for contamination.

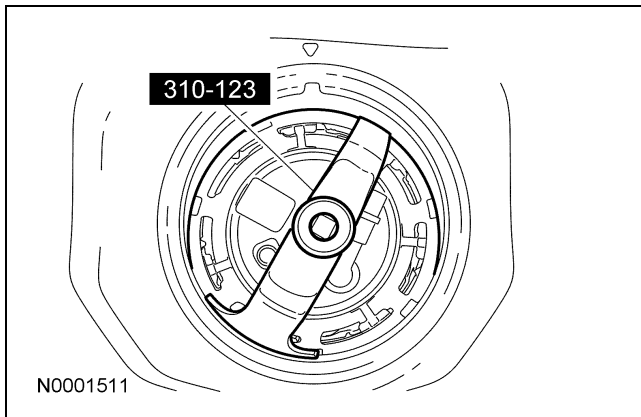
Remove the fuel tank. For additional information, refer to Fuel Tank — Midship in this section.


REMOVAL AND INSTALLATION (Continued)

2.  **CAUTION:** Clean the fuel tank of any dirt or foreign material before servicing the fuel pump (FP) module. In extreme dirt or dusty conditions it may be necessary to wash the fuel tank using a water hose. Before removing the FP module, make sure that there is no residual dirt or foreign material around the FP module flange. If dirt or foreign material enter the fuel tank, damage to the FP module or other fuel system components may occur.

Clean the area around the FP module mounting flange.

3. Using the special tool, remove the FP module lock ring.



4.  **CAUTION:** The fuel pump (FP) module must be handled carefully to avoid damage to the float arm.

Completely remove the FP module from the fuel tank.

5. **NOTE:** Inspect the surfaces of the FP module flange and fuel tank O-ring seal contact surfaces. Do not polish or adjust the O-ring seal contact area of the fuel tank flange or the fuel tank. Install a new FP module or fuel tank if the O-ring seal contact area is bent, scratched or corroded or fuel leakage could occur.

NOTE: Make sure to install a new FP module O-ring seal and lock ring or fuel leakage could occur.

NOTE: Apply clean engine oil to the O-ring seal prior to installation.

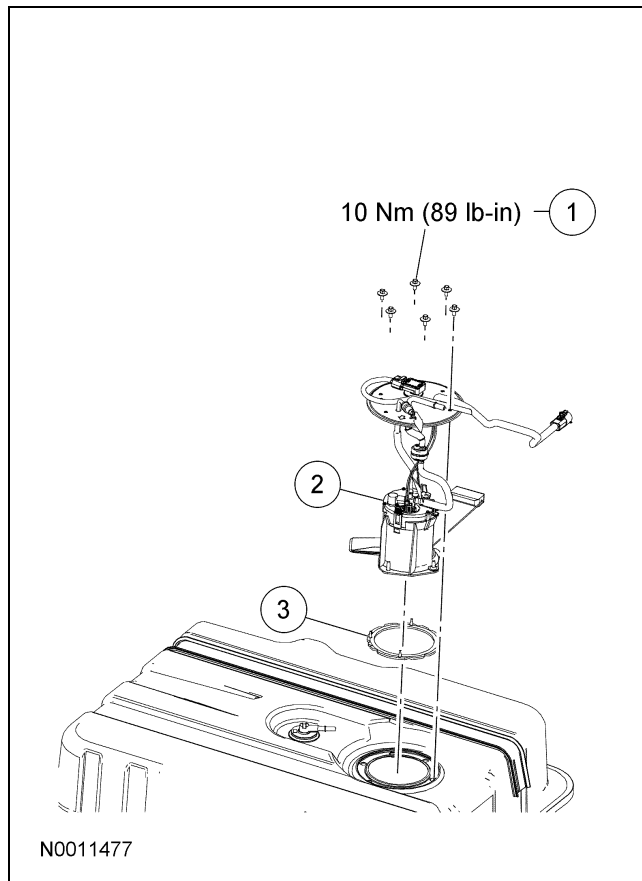
Remove and discard the FP module O-ring seal.

6. To install, reverse the removal procedure.
- Make sure the alignment arrows on the FP module and the fuel tank meet before tightening the FP module lock ring.

REMOVAL AND INSTALLATION

Fuel Pump Module — Steel Fuel Tank

NOTE: Aft-of-axle fuel tank shown, auxiliary fuel tank similar.



Item	Part Number	Description
1	N602725	Fuel pump (FP) module bolt (6 required)
2	9B785	FP module
3	—	FP module gasket

Removal and Installation

NOTE: This procedure is for gasoline applications only.

1. **NOTE:** The fuel tank must be drained completely. Upon removal of the fuel pump (FP) module, the tank must be inspected for contamination.

Remove the fuel tank. For additional information, refer to Fuel Tank — Aft-of-Axle or Fuel Tank — Auxiliary in this section.

2. **CAUTION:** Clean the fuel tank of any dirt or foreign material before servicing the fuel pump (FP) module. In extreme dirt or dusty conditions it may be necessary to wash the fuel tank using a water hose. Before removing the FP module, make sure that there is no residual dirt or foreign material around the FP module flange. If dirt or foreign material enter the fuel tank, damage to the FP module or other fuel system components may occur.

Clean the area around the FP mounting flange.

3. Remove the 6 bolts from the FP module.
 - To install, tighten to 10 Nm (89 lb-in).

4. **CAUTION:** The fuel pump (FP) module must be handled carefully to avoid damage to the float arm.

Completely remove the FP module from the fuel tank.

5. **NOTE:** Inspect the surfaces of the FP module flange and fuel tank gasket contact surfaces. Do not polish or adjust the gasket contact area of the fuel tank flange or the fuel tank. Install a new FP module or fuel tank if the gasket contact area is bent, scratched or corroded or fuel leakage could occur.

NOTE: Make sure to install a new FP module gasket or fuel leakage could occur.

Remove and discard the FP module gasket.

6. To install, reverse the removal procedure.

DESCRIPTION AND OPERATION

Fuel System — Diesel Engine

The diesel fuel system consists of:

- fuel tubes.
- vapor tube (midship fuel tank).
- fuel filter.
- fuel level sensor.
- fuel tank filler pipe assembly.
- fuel tank.
- high pressure fuel system.
- horizontal fuel conditioning module (HFCM).
- inertia fuel shutoff (IFS) switch.
- low pressure fuel system.

The fuel system for the high pressure common rail direct injection turbocharged (DIT) diesel engine:

- is controlled by the PCM.
- utilizes an HFCM, which contains an electric fuel pump and incorporates a fuel filter and water separator assembly.

The electric fuel pump:

- draws fuel from the fuel tank.
- circulates fuel at low pressure through the 10 micron HFCM fuel filter and water separator to the engine fuel filter module, where the pressure is regulated. The fuel is filtered through the 4 micron engine fuel filter, then supplied to the high pressure fuel injection pump. Fuel is returned from the injectors through the cylinder head fuel galleries and joins fuel return from the high pressure fuel injection pump. The combined return fuel goes through the engine fuel cooler and back to the engine fuel filter module. The return fuel is re-circulated in the engine fuel filter module or returned back to the tank through the chassis lines and hoses based on engine demand.

Fuel Filter/Water Separator

The diesel engine is equipped with a fuel filter and water separator HFCM assembly. Drain the water from the HFCM at the recommended maintenance intervals. Refer to the Owner's Literature for the maintenance intervals.

A water in fuel indicator on the instrument panel will alert the operator. When the indicator glows continuously while the engine is running, drain the water from the fuel filter and water separator bowl as soon as possible to prevent damage to the fuel injection system.

DESCRIPTION AND OPERATION

Fuel System — Gasoline Engines

The gasoline fuel system consist of:

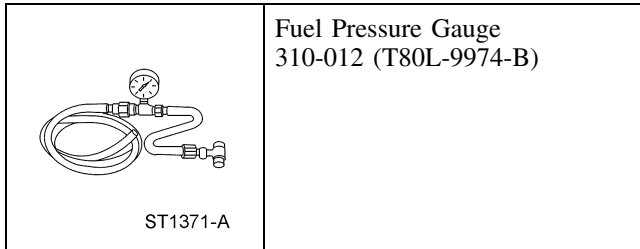
- fuel and vapor tubes.
- fuel filter.
- fuel pump (FP) module.
- fuel tank filler pipe assembly.
- fuel tank.
- inertia fuel shutoff (IFS) switch.

The vehicle is equipped with electronic multiport fuel injection that is supplied by an electronic returnless fuel system. The PCM receives pressure information from a fuel pressure sensor mounted on the fuel rail. The PCM is able to maintain constant fuel pressure by varying the FP module output. This is accomplished by increasing or decreasing voltage supplied to the FP module. The returnless fuel system offers improved economy, lower fuel temperatures and decreased fuel vapor in the fuel tank.

GENERAL PROCEDURES

Fuel System Bleeding — High Pressure, Diesel Engine

Special Tool(s)

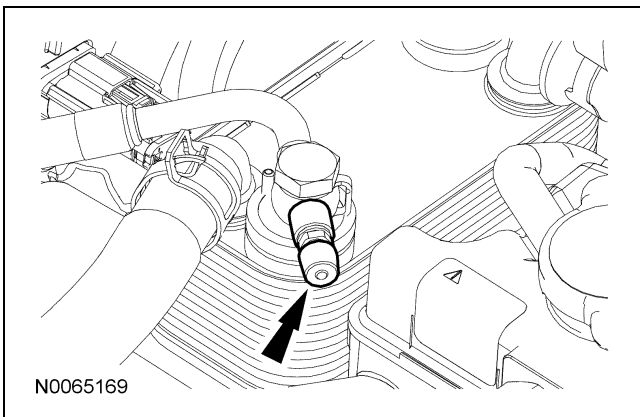


⚠ WARNING: Do not smoke, carry lighted tobacco or have an open flame of any type when working on or near any fuel-related component. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in serious personal injury.

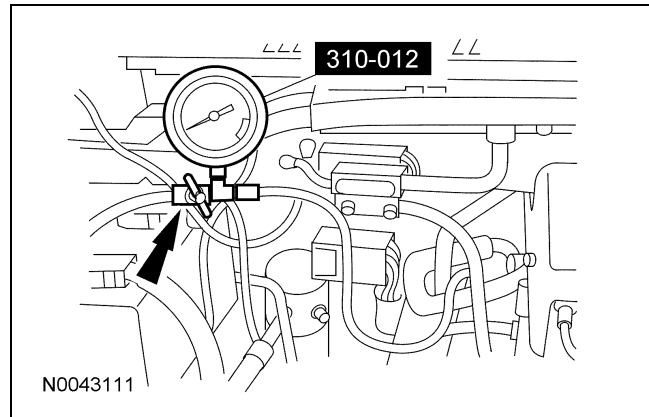
⚠ WARNING: Do not carry personal electronic devices such as cell phones, pagers or audio equipment of any type when working on or near any fuel-related component. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in serious personal injury.

⚠ WARNING: When handling fuel, always observe fuel handling precautions and be prepared in the event of fuel spillage. Spilled fuel may be ignited by hot vehicle components or other ignition sources. Failure to follow these instructions may result in serious personal injury.

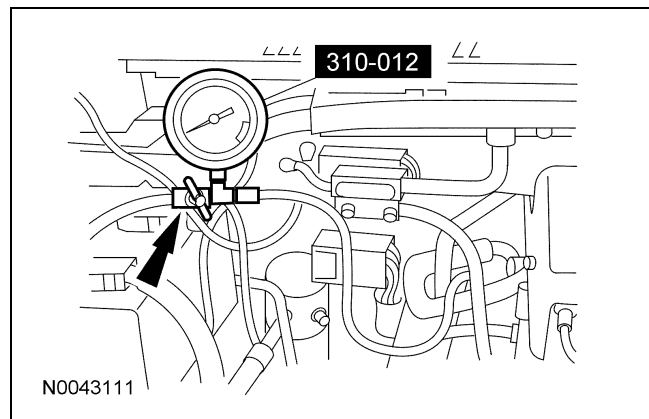
1. Remove the Schrader valve cap and attach the special tool.



2. Place the special tool discharge hose into a suitable fuel container.
3. **NOTE:** Open manual valve slowly. This may drain fuel from the fuel system.
Open the manual valve on the special tool.



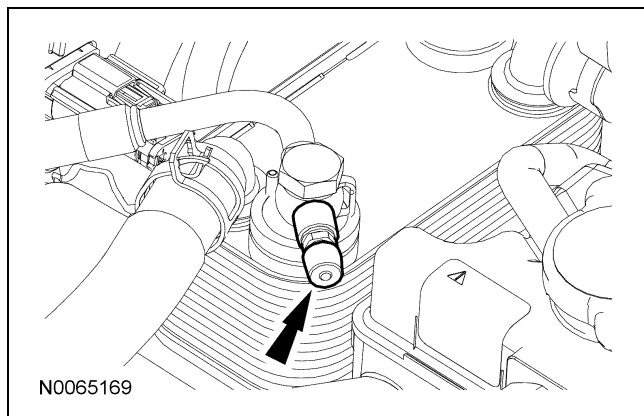
4. Crank the engine until there is no air present in the discharge hose.
5. Close the manual valve on the special tool.



6. Perform the high pressure fuel system test. For additional information, refer to the [Powertrain Control/Emissions Diagnosis \(PC/ED\) manual](#).

GENERAL PROCEDURES (Continued)

7. Install the Schrader valve cap.



GENERAL PROCEDURES

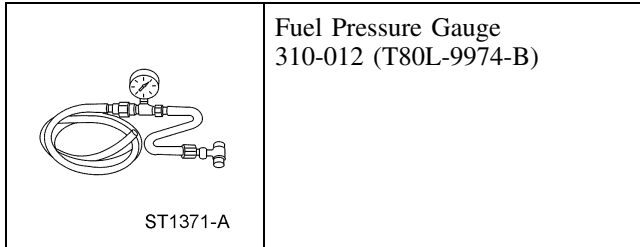
Fuel System Bleeding — Low Pressure, Diesel Engine

1. Turn the ignition key ON without starting the engine.
 2. Wait 30 seconds for the fuel conditioning module to run.
 3. Turn the ignition key OFF.
 4. Repeat this procedure 6 times before starting the engine.
 5. Perform the low pressure fuel system test. For additional information, refer to Fuel System Pressure Test — Diesel Engine in this section.
-

GENERAL PROCEDURES

Fuel System Pressure Release — Diesel Engine

Special Tool(s)



⚠ WARNING: Do not smoke, carry lighted tobacco or have an open flame of any type when working on or near any fuel-related component. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in serious personal injury.

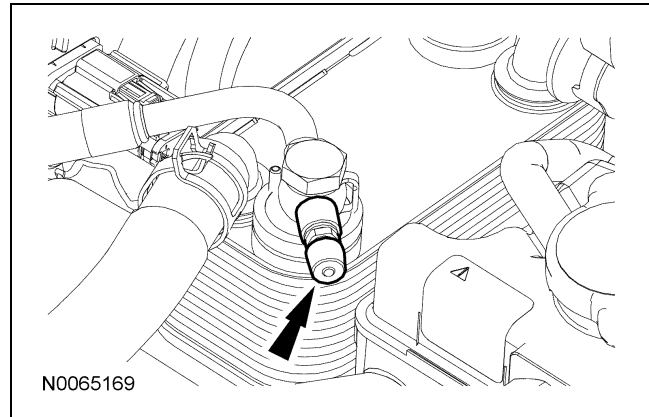
⚠ WARNING: Before working on or disconnecting any of the fuel tubes or fuel system components, relieve the fuel system pressure to prevent accidental spraying of fuel. Fuel in the fuel system remains under high pressure, even when the engine is not running. Failure to follow this instruction may result in serious personal injury.

⚠ WARNING: Do not work on the fuel system until the pressure has been released and the engine has cooled. Fuel in the high-pressure fuel system is hot and under very high pressure. High-pressure fuel may cause cuts and contact with hot fuel may cause burns. Failure to follow these instructions may result in serious personal injury.

NOTE: This procedure is for releasing the low pressure fuel system pressure. The high pressure fuel system cannot be relieved of pressure manually. The high pressure fuel system will lose pressure as the engine cools down. The pressure will bleed off after approximately 30 seconds with the key in the OFF position. Wait for the engine to be cool before servicing the high pressure fuel system.

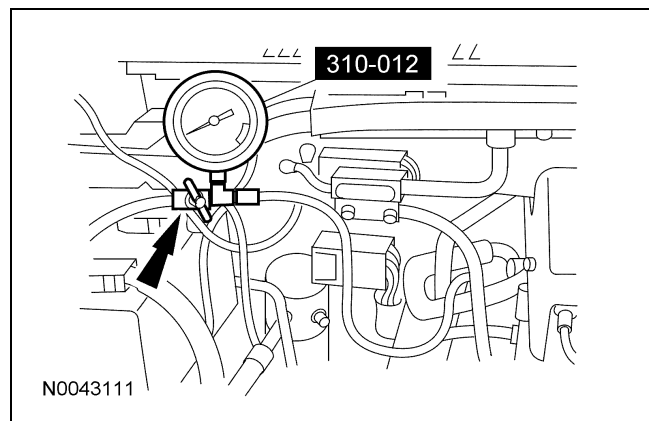
1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.

2. Disconnect both battery ground cables. For additional information, refer to Section 414-01.
3. Remove the Schrader valve cap and attach the special tool.



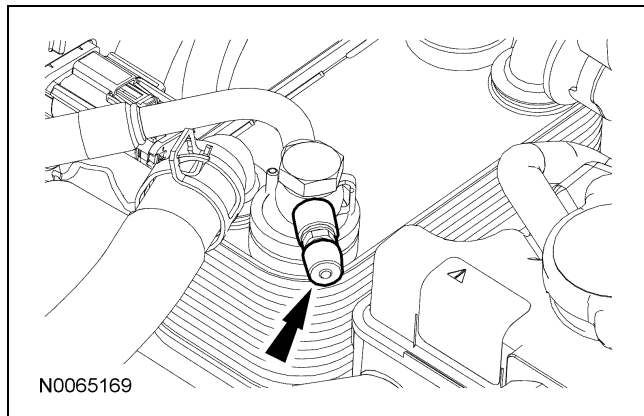
4. **NOTE:** Open manual valve slowly to relieve the system pressure. This may drain fuel from the fuel system. Place the fuel in a suitable container.

Open the manual valve on the special tool and relieve the fuel pressure.



GENERAL PROCEDURES (Continued)

5. Install the Schrader valve cap.

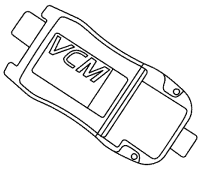


6. Connect both battery ground cables. For additional information, refer to Section 414-01.
7. To repressurize and bleed the fuel system, refer to Fuel System Bleeding — Low Pressure, Diesel Engine or Fuel System Bleeding — High Pressure, Diesel Engine in this section.

GENERAL PROCEDURES

Fuel System Pressure Release — Gasoline Engines

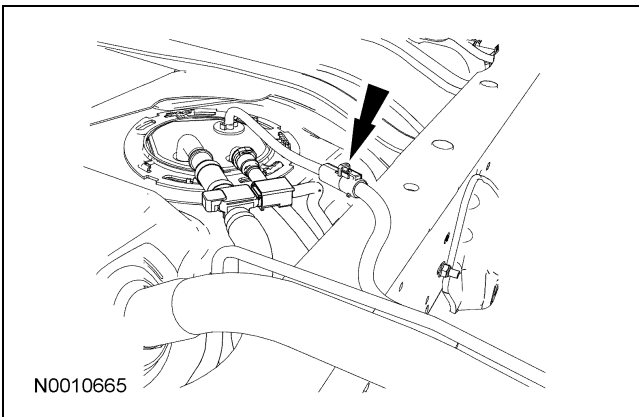
Special Tool(s)

	Vehicle Communication Module (VCM) and Integrated Diagnostic System (IDS) software with appropriate hardware, or equivalent scan tool
ST2834-A	

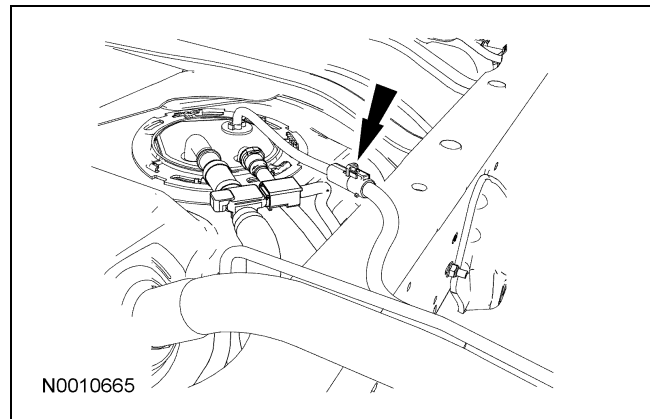
⚠ WARNING: Do not smoke, carry lighted tobacco or have an open flame of any type when working on or near any fuel-related component. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in serious personal injury.

⚠ WARNING: Before working on or disconnecting any of the fuel tubes or fuel system components, relieve the fuel system pressure to prevent accidental spraying of fuel. Fuel in the fuel system remains under high pressure, even when the engine is not running. Failure to follow this instruction may result in serious personal injury.

1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
2. Disconnect the fuel pump (FP) module electrical connector.



3. Start the engine and allow it to idle until it stalls.
4. After the engine stalls, crank the engine for approximately 5 seconds to make sure the fuel rail pressure has been released.
5. Turn the ignition switch to the OFF position.
6. When fuel system service is complete, connect the FP module electrical connector.

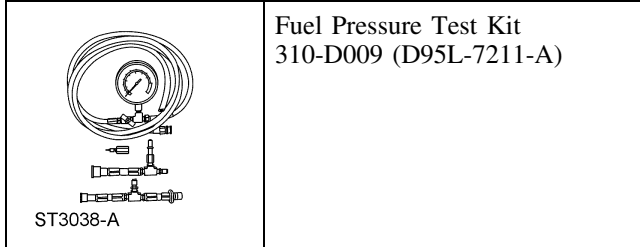


7. **NOTE:** It may take more than one key cycle to pressurize the fuel system. Cycle the ignition key and wait 3 seconds to pressurize the fuel system. Check for leaks before starting the engine.
8. Install the scan tool. Turn the key ON with the engine OFF. Cycle the key OFF, then ON. Select the appropriate vehicle and engine qualifier. Clear all DTCs and carry out a PCM reset.
9. Start the vehicle and check the fuel system for leaks.

GENERAL PROCEDURES

Fuel System Pressure Test — Diesel Engine

Special Tool(s)

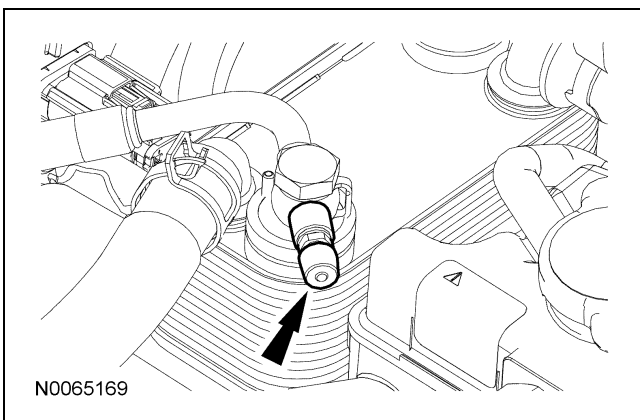


⚠ WARNING: Do not smoke, carry lighted tobacco or have an open flame of any type when working on or near any fuel-related component. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in serious personal injury.

⚠ WARNING: When handling fuel, always observe fuel handling precautions and be prepared in the event of fuel spillage. Spilled fuel may be ignited by hot vehicle components or other ignition sources. Failure to follow these instructions may result in serious personal injury.

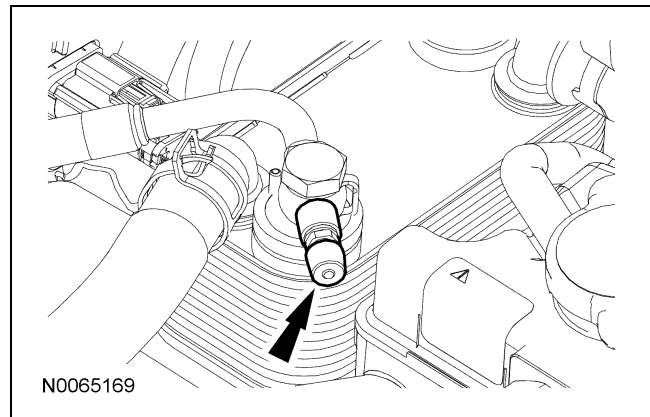
NOTE: This procedure will only test the low pressure fuel system.

1. Remove the schrader valve cap.



2. Connect the special tool to the schrader valve.
3. Test the fuel system pressure to make sure it is within the specified range. For additional information, refer to Specifications in this section.
4. **NOTE:** Open the drain valve slowly to relieve the fuel system pressure. This may drain fuel from the system. Place the fuel in a suitable container.

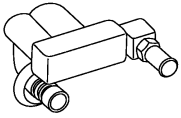
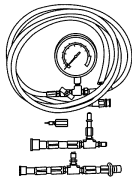
Upon completion of the fuel system pressure test, open the drain valve on the special tool and relieve the fuel system pressure.
5. Install the schrader valve cap.



GENERAL PROCEDURES

Fuel System Pressure Test — Gasoline Engines

Special Tool(s)

 <p>ST2805-A</p>	<p>Fuel pressure test connector 310-122</p>
 <p>ST3038-A</p>	<p>Fuel Pressure Test Kit 310-D009 (D95L-7211-A)</p>

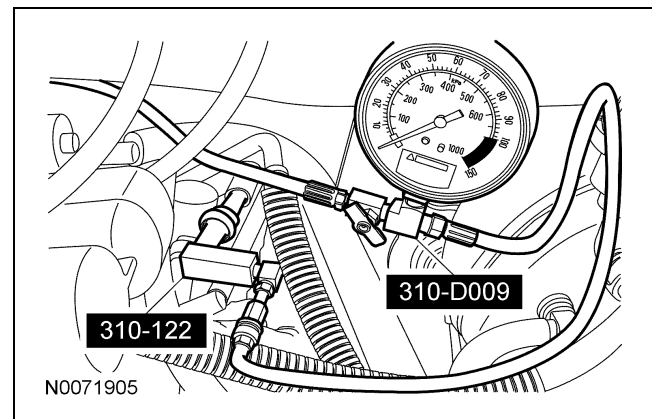
⚠ WARNING: Do not smoke, carry lighted tobacco or have an open flame of any type when working on or near any fuel-related component. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in serious personal injury.

⚠ WARNING: Before working on or disconnecting any of the fuel tubes or fuel system components, relieve the fuel system pressure to prevent accidental spraying of fuel. Fuel in the fuel system remains under high pressure, even when the engine is not running. Failure to follow this instruction may result in serious personal injury.

⚠ WARNING: Do not carry personal electronic devices such as cell phones, pagers or audio equipment of any type when working on or near any fuel-related component. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in serious personal injury.

⚠ WARNING: When handling fuel, always observe fuel handling precautions and be prepared in the event of fuel spillage. Spilled fuel may be ignited by hot vehicle components or other ignition sources. Failure to follow these instructions may result in serious personal injury.

1. Disconnect the fuel supply line-to-fuel rail spring lock coupling. For additional information, refer to Spring Lock Couplings in this section.
2. Install the special tools in line between the fuel supply line and fuel rail.

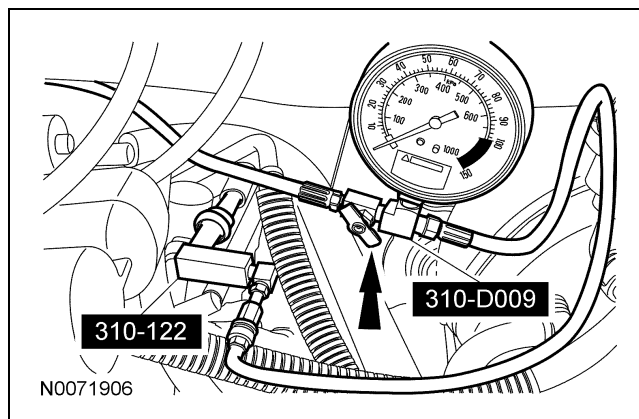


3. **NOTE:** The fuel pump (FP) module electrical connector was disconnected during the fuel system pressure release.
Connect the FP module electrical connector.
4. **NOTE:** It may take more than one key cycle to pressurize the fuel system.
Cycle the ignition key and wait 3 seconds to pressurize the fuel system. Check for leaks before starting the engine.
5. Test the fuel system pressure to make sure it is within the specified range. For additional information, refer to Specifications in this section.

GENERAL PROCEDURES (Continued)

6. **NOTE:** Open the drain valve slowly to relieve the fuel system pressure. This may drain fuel from the system. Place the fuel in a suitable container.

Upon completion of the fuel system pressure test, open the drain valve on the special tool and relieve the fuel system pressure.



REMOVAL AND INSTALLATION

Fuel Tank — Aft-of-Axle

Removal and Installation

All vehicles

1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
2. Release the fuel system pressure. For additional information, refer to Section 310-00.
3. Disconnect the battery ground cable. For additional information, refer to Section 414-01.
4. Drain the fuel from the fuel tank. For additional information, refer to Section 310-00.
5. Loosen the hose clamps and disconnect the fuel tank filler pipe and fuel tank filler pipe vent hose from the fuel tank.

Gasoline engines

6. Disconnect the fuel supply tube-to-fuel pump (FP) module quick connect coupling. For additional information, refer to Section 310-00.
 7. Disconnect the fuel vapor tube-to-fuel tank grade vent valve quick connect coupling. For additional information, refer to Section 310-00.
-

Diesel engine

8. Disconnect the fuel supply tube-to-fuel level sensor quick connect coupling. For additional information, refer to Section 310-00.
9. Disconnect the fuel return tube-to-fuel level sensor quick connect coupling. For additional information, refer to Section 310-00.

All vehicles

10. Place a suitable lifting device under the fuel tank shield.
11. Remove the 4 bolts from the fuel tank shield.
 - To install, tighten to 90 Nm (66 lb-ft).
12. Lower the fuel tank.
13. Remove the 2 nuts from the fuel tank straps and remove the fuel tank straps.
 - To install, tighten to 80 Nm (59 lb-ft).
14. Remove the fuel tank from the fuel tank shield.
15. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Fuel Tank — Auxiliary

Removal and Installation

NOTE: Some auxiliary tanks are stand alone applications and some are dual tank applications.

All vehicles

1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
2. Release the fuel system pressure. For additional information, refer to Section 310-00.
3. Disconnect the battery ground cable. For additional information, refer to Section 414-01.
4. Drain the fuel from the fuel tank. For additional information, refer to Section 310-00.
5. Loosen the hose clamps and disconnect the fuel tank filler pipe and the fuel tank filler pipe vent hose from the fuel tank.

Gasoline engines

6. Disconnect the fuel vapor tube-to-fuel pump (FP) module quick connect coupling and the fuel supply tube-to-FP module quick connect coupling. For additional information, refer to Section 310-00.

7. Disconnect the fuel vapor tube-to-fuel tank grade vent valve quick connect couplings. For additional information, refer to Section 310-00.

Diesel engine

8. Disconnect the fuel return tube-to-fuel level sensor quick connect coupling and fuel supply tube-to-fuel level sensor quick connect coupling. For additional information, refer to Section 310-00.

All vehicles

9. Remove the fuel tank heat shield and bolts
 - To install, tighten to 22 Nm (16 lb-ft).
10. Place a suitable lifting device under the fuel tank.
11. Remove fuel tank strap nut and bolt and carefully position the 2 fuel tank straps aside.
 - To install, tighten to 40 Nm (30 lb-ft).
12. Lower the fuel tank.
13. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Fuel Tank — Midship

Removal and Installation

All vehicles

1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
2. Release the fuel system pressure. For additional information, refer to Section 310-00.
3. Disconnect the battery ground cable. For additional information, refer to Section 414-01.
4. Drain the fuel from the fuel tank. For additional information, refer to Section 310-00.
5. If equipped, remove the 6 bolts and the fuel tank shield.
 - To install, tighten to 22 Nm (16 lb-ft).

Gasoline engines

6. Loosen the hose clamp and disconnect the fuel tank filler pipe from the fuel tank.
7. Disconnect the fuel tank filler pipe vent tube quick connect coupling. For additional information, refer to Section 310-00.

Diesel engine

8. Loosen the hose clamps and disconnect the fuel tank filler pipe and fuel tank filler pipe vent tube from the fuel tank.

All vehicles

9. Place a suitable lifting device under the fuel tank.
10. Remove the 4 fuel tank strap bolts and remove the 2 fuel tank straps.
 - To install, tighten to 40 Nm (30 lb-ft).
11. Slightly lower the fuel tank.

Gasoline engines

12. Disconnect the fuel vapor tube-to-fuel pump (FP) module quick connect coupling and the fuel supply tube-to-FP module quick connect coupling. For additional information, refer to Section 310-00.
13. Disconnect the fuel vapor tube-to-fuel tank grade vent valve quick connect couplings. For additional information, refer to Section 310-00.

Diesel engine

14. Disconnect the fuel return tube-to-fuel level sensor quick connect coupling and the fuel supply tube-to-fuel level sensor quick connect coupling. For additional information, refer to Section 310-00.
15. Remove the fuel vapor hose from the fuel tank grade vent valves.
16. Disconnect the fuel level sensor electrical connector.

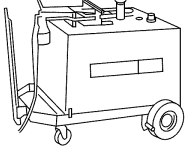

All vehicles

17. Lower the fuel tank.
18. To install, reverse the removal procedure.

GENERAL PROCEDURES

Fuel Tank Draining

Special Tool(s)

 <p>ST1134A</p>	<p>100 Gallon Gasoline Hand Pump Storage Tanker 034-00007 or equivalent</p>
 <p>ST1134A</p>	<p>100 Gallon Diesel Fuel Hand Pump Storage Tanker 034-00005 or equivalent</p>

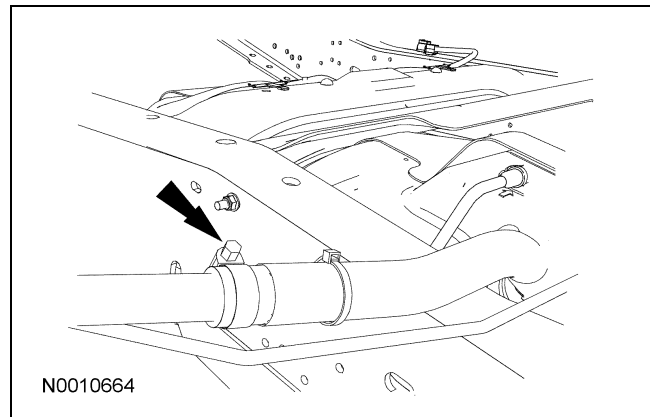
⚠ WARNING: Do not smoke, carry lighted tobacco or have an open flame of any type when working on or near any fuel-related component. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in serious personal injury.

⚠ WARNING: Do not carry personal electronic devices such as cell phones, pagers or audio equipment of any type when working on or near any fuel-related component. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in serious personal injury.

⚠ WARNING: When handling fuel, always observe fuel handling precautions and be prepared in the event of fuel spillage. Spilled fuel may be ignited by hot vehicle components or other ignition sources. Failure to follow these instructions may result in serious personal injury.

⚠ WARNING: Remove the fuel filler cap slowly. The fuel system may be under pressure. If the fuel filler cap is venting vapor or if you hear a hissing sound, wait until it stops before completely removing the fuel filler cap. Otherwise, fuel may spray out. Failure to follow these instructions may result in serious personal injury.

1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
2. Disconnect the battery ground cable. For additional information, refer to Section 414-01.
3. Remove the filler pipe hose at the filler pipe hose connection. Loosen the clamp and disconnect the hose.




4. **NOTE:** Follow the operating instructions supplied by the equipment manufacturer. Insert the hose from the storage tanker and siphon the fuel through the fuel filler hose opening.

REMOVAL AND INSTALLATION

Fuel Tank Filler Pipe — Aft-of-Axle

Removal and Installation


 **WARNING:** Remove the fuel filler cap slowly. The fuel system may be under pressure. If the fuel filler cap is venting vapor or if you hear a hissing sound, wait until it stops before completely removing the fuel filler cap. Otherwise, fuel may spray out. Failure to follow these instructions may result in serious personal injury.

1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
 2. Disconnect the battery ground cable. For additional information, refer to Section 414-01.
 3. Drain the fuel tank until the fuel level is at or below half. For additional information, refer to Section 310-00.
 4. If equipped, remove the fuel tank filler pipe assembly ground strap clip from the frame.
 5. Loosen the hose clamps and disconnect the fuel tank filler pipe and fuel tank filler pipe vent hose from the fuel tank.
 6. Remove the fuel tank filler cap.
 7. Remove the 3 fuel tank filler pipe upper retaining screws.
 - On early build vehicles, install new fuel tank filler pipe retaining screw plastic inserts, if required.
 8. Remove the fuel tank filler pipe assembly.
 9. To install, reverse the removal procedure.
-

REMOVAL AND INSTALLATION

Fuel Tank Filler Pipe — Auxiliary

Removal and Installation


 **WARNING:** Remove the fuel filler cap slowly. The fuel system may be under pressure. If the fuel filler cap is venting vapor or if you hear a hissing sound, wait until it stops before completely removing the fuel filler cap. Otherwise, fuel may spray out. Failure to follow these instructions may result in serious personal injury.

1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
 2. Disconnect the battery ground cable. For additional information, refer to Section 414-01.
 3. Drain the fuel tank until the fuel level is at or below half. For additional information, refer to Section 310-00.
 4. Loosen the hose clamps and disconnect the fuel tank filler pipe and fuel tank filler pipe vent hose from the fuel tank.
 5. Remove the fuel tank filler cap.
 6. Remove the 3 fuel tank filler pipe upper retaining screws.
 - On early build vehicles, install new fuel tank filler pipe retaining screw plastic inserts, if required.
 7. Remove the fuel filler pipe assembly.
 8. To install, reverse the removal procedure.
-

REMOVAL AND INSTALLATION

Fuel Tank Filler Pipe — Midship

Removal and Installation

 **WARNING:** Remove the fuel filler cap slowly. The fuel system may be under pressure. If the fuel filler cap is venting vapor or if you hear a hissing sound, wait until it stops before completely removing the fuel filler cap. Otherwise, fuel may spray out. Failure to follow these instructions may result in serious personal injury.

All vehicles

1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
2. Disconnect the battery ground cable. For additional information, refer to Section 414-01.

Gasoline engines

3. Loosen the hose clamp and disconnect the fuel tank filler pipe from the fuel tank.

4. Disconnect the fuel tank filler pipe vent tube quick connect coupling. For additional information, refer to Section 310-00.

Diesel engine

5. Loosen the hose clamps and disconnect the fuel tank filler pipe and fuel tank filler pipe vent tube from the fuel tank.

All vehicles

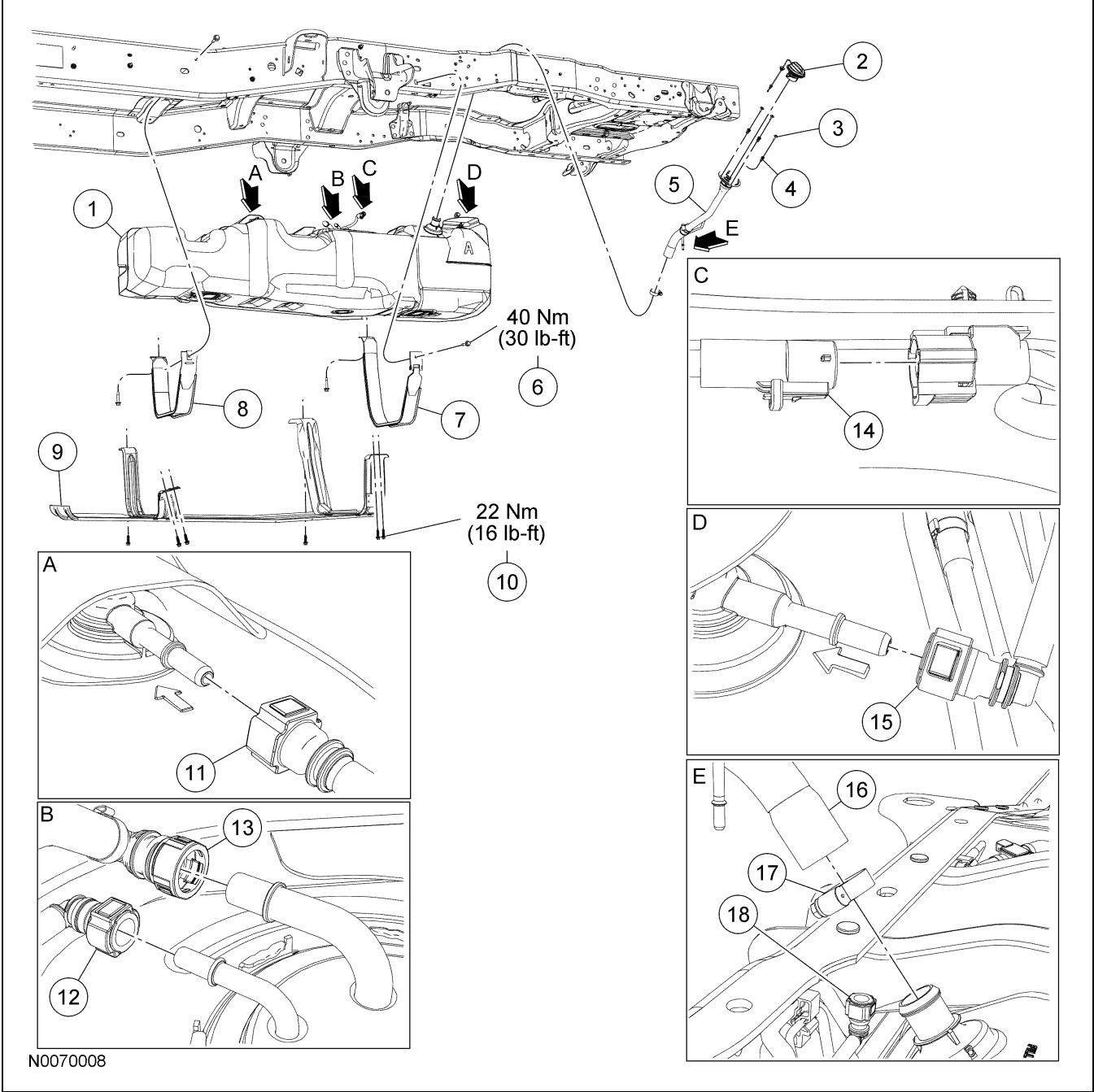
6. Remove the fuel tank filler cap.
7. Remove the 3 fuel tank filler pipe retaining screws.
 - On early build vehicles, install new fuel tank filler pipe retaining screw plastic inserts, if required.
8. Remove the fuel filler tank filler pipe assembly.
9. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Fuel Tank and Filler Pipe — Exploded View

Midship Fuel Tank — 114L (30 Gal)

NOTE: Gasoline shown, diesel similar.



Item	Part Number	Description
1	9002	Midship fuel tank
2	9030	Fuel tank filler cap
3	W711103	Fuel tank filler pipe retaining screw (3 required)

(Continued)

Item	Part Number	Description
4	558324	Fuel tank filler pipe retaining screw plastic insert (early build) (3 required)
5	9034	Fuel tank filler pipe assembly

(Continued)

REMOVAL AND INSTALLATION (Continued)

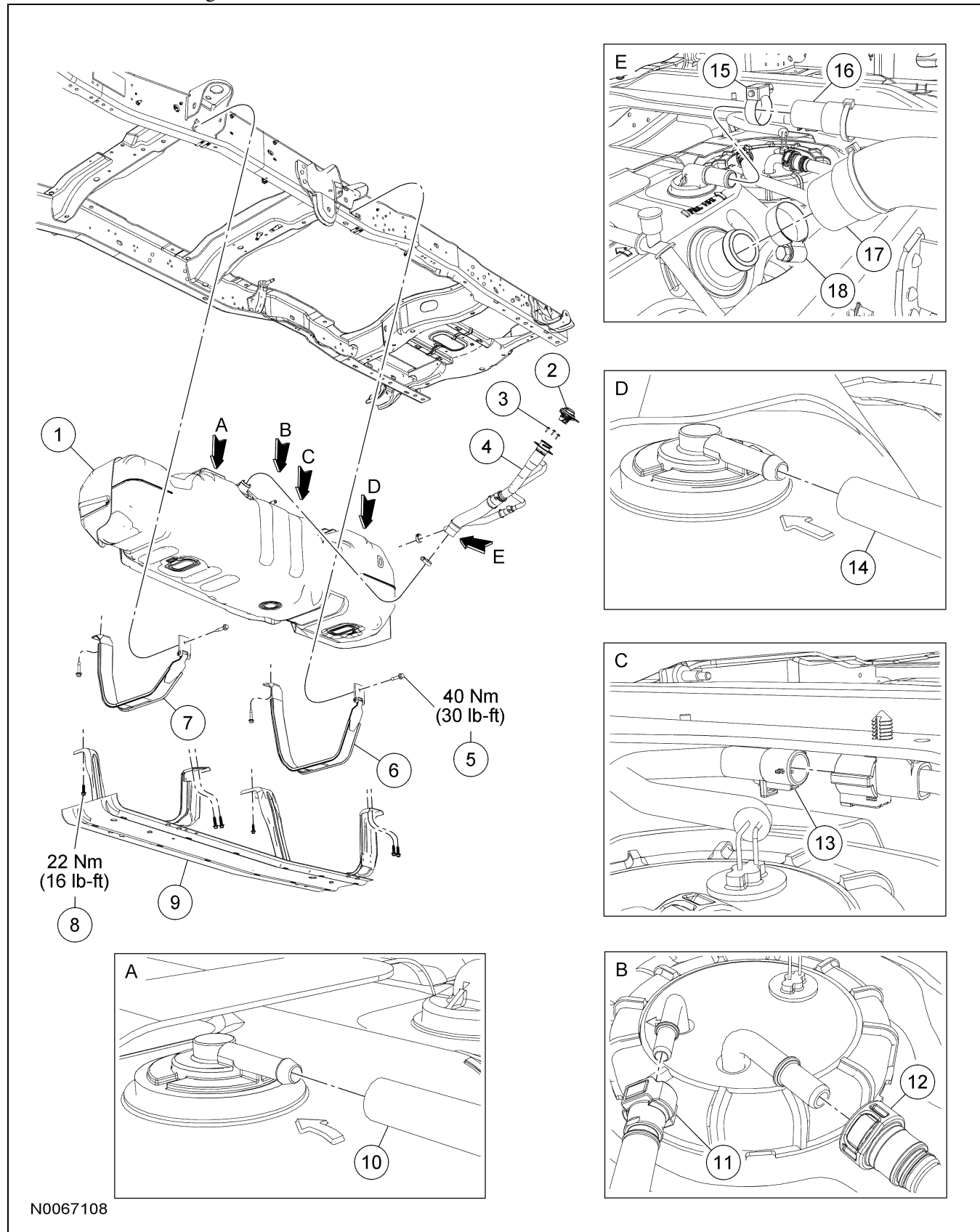
Item	Part Number	Description
6	W506435	Fuel tank strap bolt (4 required)
7	9057	Rear fuel tank strap
8	9054	Front fuel tank strap
9	9K036	Fuel tank shield
10	W709736	Fuel tank shield bolts (6 required)
11	—	Fuel vapor tube-to-fuel tank grade vent valve quick connect coupling (part of 9S278)
12	—	Fuel supply tube-to-fuel pump (FP) module quick connect coupling (part of 9S278)
13	—	Fuel vapor tube-to-FP module quick connect coupling (part of 9S278)

(Continued)

Item	Part Number	Description
14	—	FP module electrical connector (part of 9H307)
15	—	Fuel vapor tube-to-fuel tank grade vent valve quick connect coupling (part of 9S278)
16	—	Fuel tank filler pipe (part of 9034)
17	W711088	Fuel tank filler pipe-to-fuel tank hose clamp
18	—	Fuel vapor tube-to-fuel tank filler pipe vent tube quick connect coupling (part of 9S278)

REMOVAL AND INSTALLATION (Continued)

Midship Fuel Tank — 148L (38 Gal)

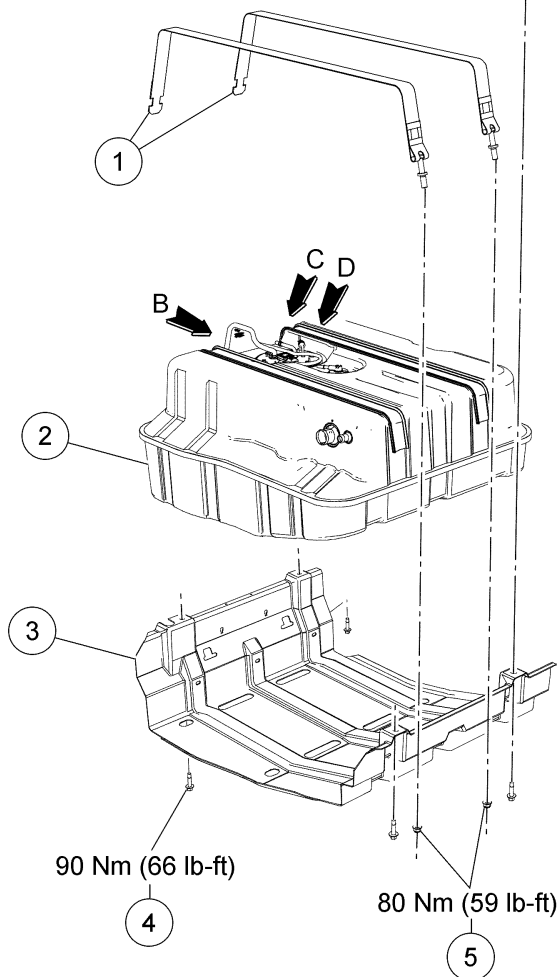
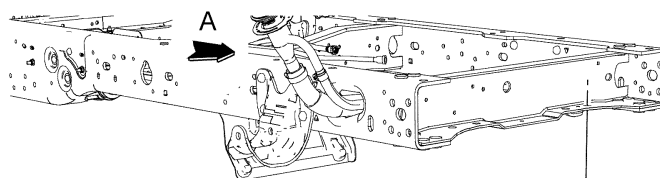
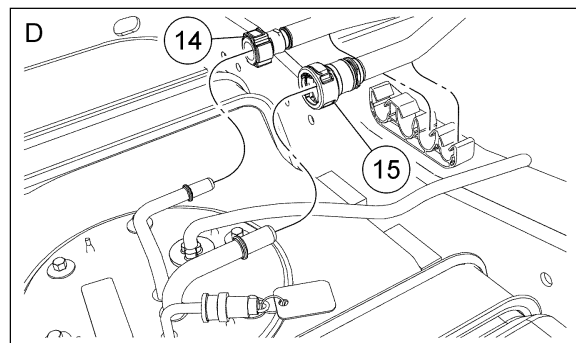
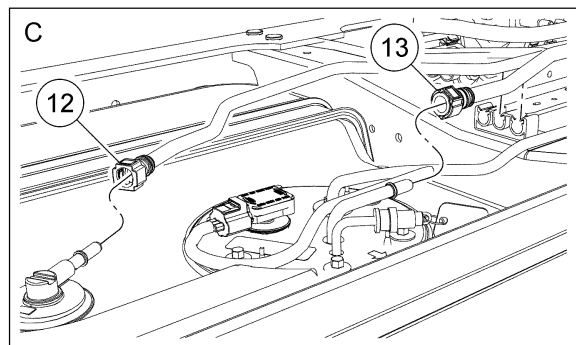
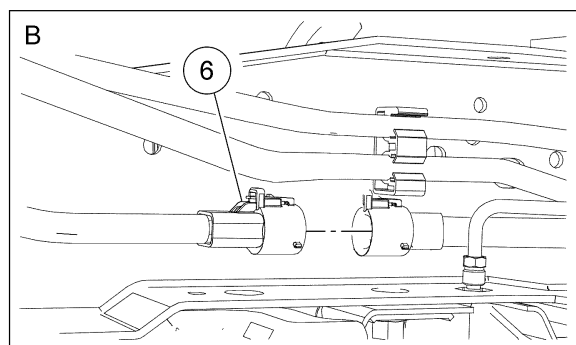
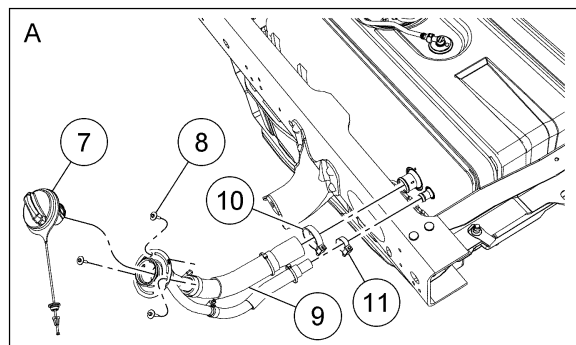
NOTE: Diesel shown, gasoline similar.

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	9002	Midship fuel tank
2	9030	Fuel tank filler cap
3	W711103	Fuel tank filler pipe retaining screw (3 required)
4	9034	Fuel tank filler pipe assembly
5	W506435	Fuel tank strap bolt (4 required)
6	9057	Rear fuel tank strap
7	9054	Front fuel tank strap
8	W709736	Fuel tank shield bolt (6 required)
9	9K036	Fuel tank shield
10	—	Fuel vapor hose-to-fuel tank grade vent valve (part of 9S278)
11	—	Fuel return tube-to-fuel level sensor quick connect coupling (part of 9S278)

(Continued)

Item	Part Number	Description
12	—	Fuel supply tube-to-fuel level sensor quick connect coupling (part of 9S278)
13	—	Fuel level sensor electrical connector (part of 9275)
14	—	Fuel vapor hose-to-fuel tank grade vent valve (part of 9S278)
15	W711089	Fuel tank filler pipe vent hose-to-fuel tank hose clamp
16	—	Fuel tank filler pipe vent hose (part of 9034)
17	—	Fuel tank filler pipe (part of 9034)
18	W711088	Fuel tank filler pipe-to-fuel tank hose clamp

REMOVAL AND INSTALLATION (Continued)**Aft-of-Axle Fuel Tank — 151L (40 Gal)**

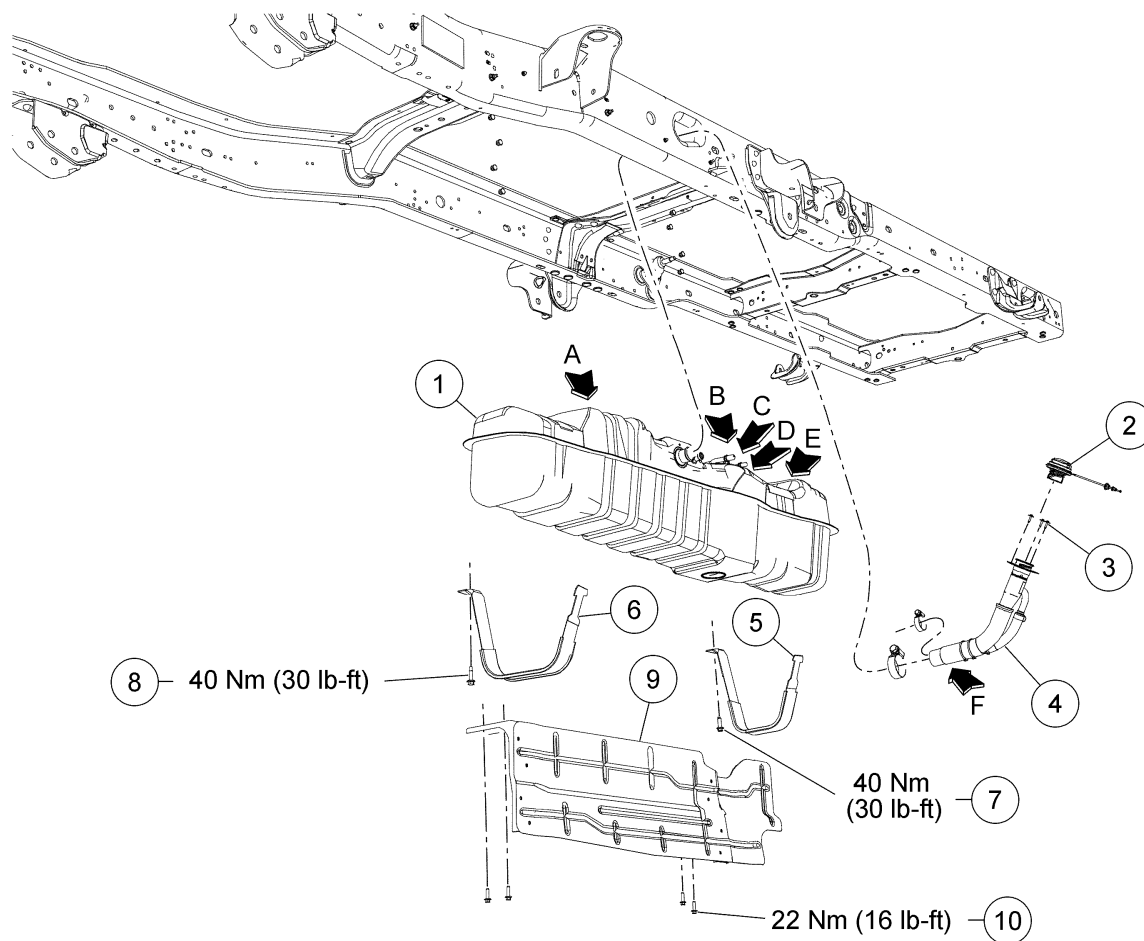
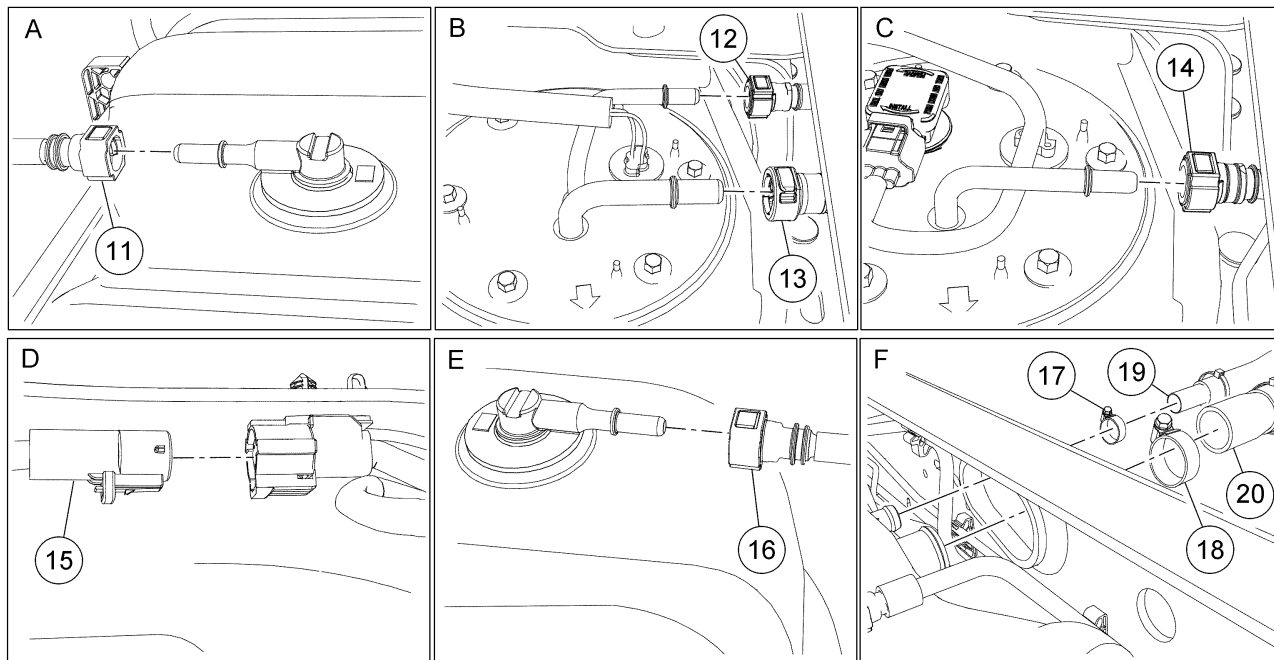
N0066771

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	9092	Fuel tank straps
2	9002	Aft-of-axle fuel tank
3	9A147	Fuel tank shield
4	N803892-S102	Fuel tank shield bolt (4 required)
5	W520104-S439	Fuel tank strap nut (2 required)
6	—	Fuel pump (FP) module (gasoline engine)/fuel level sensor (diesel engine) electrical connector (part of 9B785 gasoline engine/9275 diesel engine)
7	9030	Fuel tank filler cap
8	W711103	Fuel tank filler pipe retaining screw (3 required)
9	9034	Fuel tank filler pipe assembly
10	W711088	Fuel tank filler pipe hose clamp

(Continued)

Item	Part Number	Description
11	W711089	Fuel tank filler pipe vent hose clamp
12	—	Fuel vapor tube-to-fuel tank grade vent valve quick connect coupling (gasoline engine) (part of 9S278)
13	—	Fuel supply tube-to-FP module quick connect coupling (gasoline engine) (part of 9S278)
14	—	Fuel return tube-to-fuel level sensor quick connect coupling (diesel engine) (part of 9S278)
15	—	Fuel supply tube-to-fuel level sensor quick connect coupling (diesel engine) (part of 9S278)

REMOVAL AND INSTALLATION (Continued)**Auxiliary Fuel Tank — 72L (19 Gal)**

N0067109

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	9002	Auxiliary fuel tank
2	9030	Fuel tank filler cap
3	W711103	Fuel tank filler pipe retaining screw (3 required)
4	9034	Fuel tank filler pipe assembly
5	9054	Rear fuel tank strap
6	9057	Front fuel tank strap
7	W506435	Rear fuel tank strap bolt
8	W506435	Front fuel tank strap bolt
9	9K014	Fuel tank shield
10	W506424	Fuel tank shield bolt (4 required)
11	—	Fuel vapor tube-to-fuel tank grade vent valve quick connect coupling (gasoline engine) (part of 9S278)
12	—	Fuel return tube-to-fuel level sensor quick connect coupling (diesel engine) (part of 9S278)
13	—	Fuel supply tube-to-fuel level sensor quick connect coupling (diesel engine) (part of 9S278)

(Continued)

Item	Part Number	Description
14	—	Fuel supply tube-to-fuel pump (FP) module quick connect coupling (gasoline engines) (part of 9S278)
15	—	FP module (gasoline engine)/fuel level sensor (diesel engine) electrical connector (part of 9B785 gasoline engine/9275 diesel engine)
16	—	Fuel vapor tube-to-fuel tank grade vent valve quick connect coupling (gasoline engines) (part of 9S278)
17	W711089	Fuel tank filler pipe vent hose clamp
18	W711088	Fuel tank filler pipe hose clamp
19	—	Fuel tank filler pipe vent hose (part of 9034)
20	—	Fuel tank filler pipe (part of 9034)

1. For additional information, refer to the procedures in this section.

DESCRIPTION AND OPERATION

Fuel Tank and Lines

Gasoline Engines

The gasoline fuel system consists of:

- the fuel tank, there are 3 available fuel tanks.
 - The midship fuel tank is mounted to the LH frame side rail.
 - The auxiliary fuel tank is mounted to the LH frame side rail.
 - The aft-of-axle fuel tank is mounted between the side rails.
- a fuel tank filler pipe which contains a restrictor plate to permit only unleaded fuel to be pumped into the fuel tank.
- a 1/4 turn fuel tank filler cap.
- a fuel filter providing filtration to protect the fuel injectors.
- fuel and vapor tubes.
- a fuel rail-mounted fuel pressure and temperature sensor.
- a fuel pump (FP) which provides pressurized fuel to the engine and contains:
 - a serviceable fuel sender.
 - an inlet filter.
 - a check valve which maintains system pressure after the FP is shut off.
 - a pressure relief valve for overpressure protection in the event of restricted flow.
- an inertia fuel shutoff (IFS) switch
- a fuel pump driver module (FPDM)

The fuel tank stores the liquid fuel. Electrical power to the FP is provided through the IFS switch. The fuel pump module is controlled by the FPDM. The fuel pump provides fuel to the fuel rail through the fuel supply tube. Vapor tubes route fuel vapor to the EVAP canister and the intake manifold through the EVAP canister purge valve.

Diesel Engines

The diesel fuel system consists of:

- the fuel tank, there are 3 available fuel tanks.
 - The midship fuel tank is mounted to the LH frame side rail.
 - The auxiliary fuel tank is mounted to the LH frame side rail.
 - The aft-of-axle fuel tank is mounted at the rear of the frame between the side rails.
- a fuel tank filler pipe without a restrictor plate.
- fuel tubes.
- a threaded fuel tank filler cap.
- the fuel conditioning module.
 - contains a fuel filter and water separator to protect the fuel injectors.
 - contains an in-line FP which provides pressurized fuel to the engine and contains a pressure relief valve for overpressure protection in the event of restricted flow.
 - is frame mounted.
- an IFS switch
- a vapor tube (midship fuel tank)

The fuel tank stores the liquid fuel. The FP is controlled by the FP PCM relay. Electrical power to the FP is provided through the IFS switch. The fuel supply tubes route fuel from the fuel tank to the engine and the fuel return tubes route unused fuel from the engine back to the fuel tank.

2008 Ford F-350 SUPER DUTY

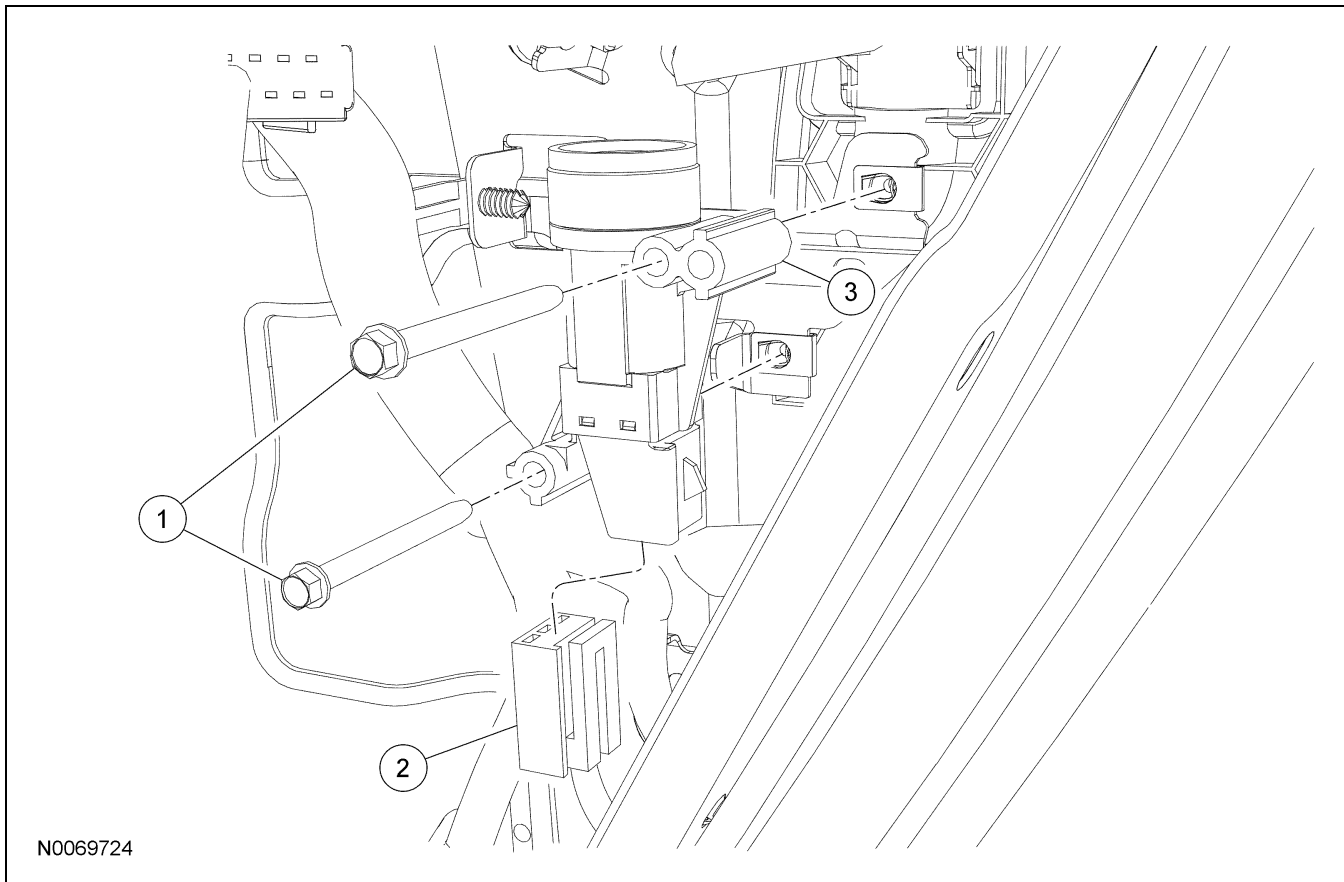
Submodel: XLT | Engine Type: V8 | Liters: 5.4
Fuel Delivery: FI | Fuel: GAS

GROUP 10: Fuel System

- SECTION 310-00: Fuel System — General Information — Gasoline and Diesel
- SECTION 310-01: Fuel Tank and Lines — Gasoline and Diesel
- SECTION 310-02: Acceleration Control
- SECTION 310-03: Speed Control

REMOVAL AND INSTALLATION

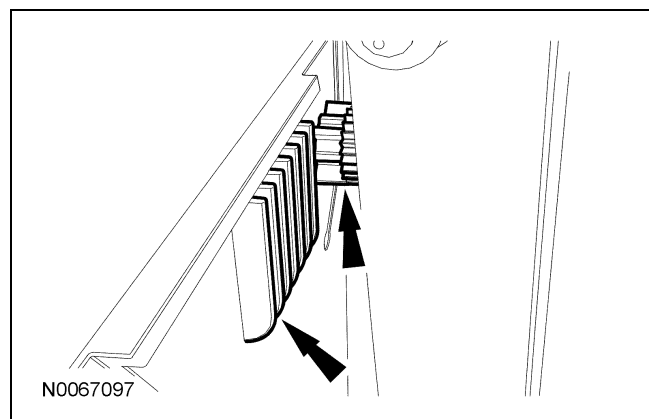
Inertia Fuel Shutoff (IFS) Switch



Item	Part Number	Description
1	W504149	Inertia fuel shutoff (IFS) switch bolts (2 required)
2	14A464	IFS switch electrical connector
3	9341A	IFS switch

Removal and Installation

1. Open the glove compartment.
2. Release the glove compartment stop and lower the glove compartment.



3. Remove the inertia fuel shutoff (IFS) switch retaining bolts (2 required).
4. Disconnect the IFS switch electrical connector and remove the IFS switch from the vehicle.
5. To install, reverse the removal procedure.

GENERAL PROCEDURES

Quick Connect Coupling

Material

Item	Specification
Motorcraft SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP (US); Motorcraft SAE 5W-20 Super Premium Motor Oil CXO-5W20-LSP12 (Canada); or equivalent	WSS-M2C930-A

Disconnect — Type I

⚠ WARNING: When working on or near the evaporative emission (EVAP) system, disconnect the battery ground cable from the battery. The EVAP system contains fuel vapor and condensed fuel vapor, so an electrical spark may cause a fire or explosion. Failure to follow this instruction may result in serious personal injury.

⚠ WARNING: Do not smoke, carry lighted tobacco or have an open flame of any type when working on or near any fuel-related component. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in serious personal injury.

⚠ WARNING: Do not carry personal electronic devices such as cell phones, pagers or audio equipment of any type when working on or near any fuel-related component. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in serious personal injury.

⚠ WARNING: When handling fuel, always observe fuel handling precautions and be prepared in the event of fuel spillage. Spilled fuel may be ignited by hot vehicle components or other ignition sources. Failure to follow these instructions may result in serious personal injury.

⚠ WARNING: Before working on or disconnecting any of the fuel tubes or fuel system components, relieve the fuel system pressure to prevent accidental spraying of fuel. Fuel in the fuel system remains under high pressure, even when the engine is not running. Failure to follow this instruction may result in serious personal injury.

⚠ CAUTION: When reusing liquid or vapor tube connectors, make sure to use compressed air to remove any foreign material from the connector retaining clip area before separating from the tube or damage to the tube or connector retaining clip can occur. Apply clean engine oil to the end of the tube before inserting the tube into the connector.

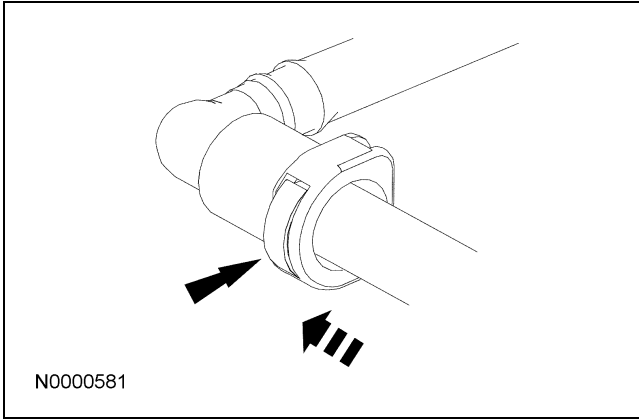
⚠ CAUTION: Fuel injection equipment is manufactured to very precise tolerances and fine clearances. It is essential that absolute cleanliness is observed when working with these components or component damage can occur. Always install blanking plugs to any open orifices or tubes.

⚠ CAUTION: Do not use any tools. The use of tools may cause a deformity in the clip components which may cause fuel leaks.

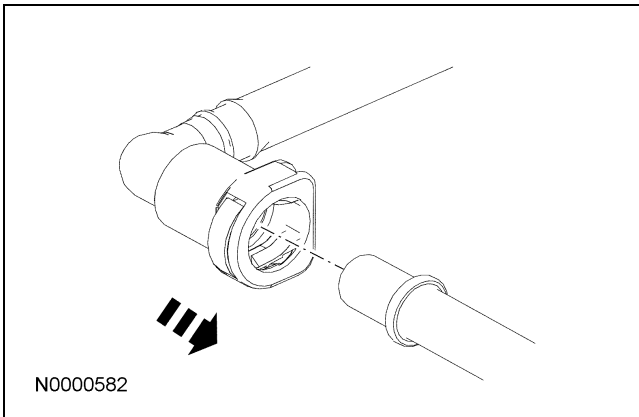
1. If servicing a liquid fuel tube, release the fuel system pressure. For additional information, refer to Fuel System Pressure Release — Gasoline Engines or Fuel System Pressure Release — Diesel Engine in this section.
2. Disconnect the battery ground cable. For additional information, refer to Section 414-01.

GENERAL PROCEDURES (Continued)

3. Disconnect the fuel tube quick connect coupling.
 - Press the fuel tube quick connect coupling button and pull the fuel tube to disconnect.

**Connect — Type I**

1. **NOTE:** Make sure the fuel tube clicks into place when installing the tube. To make sure that the fuel tube is fully seated, pull on the tube.
- NOTE:** Apply clean engine oil to O-ring seals. Install the quick connect coupling onto the tube until it is fully seated.

**Disconnect — Type II**

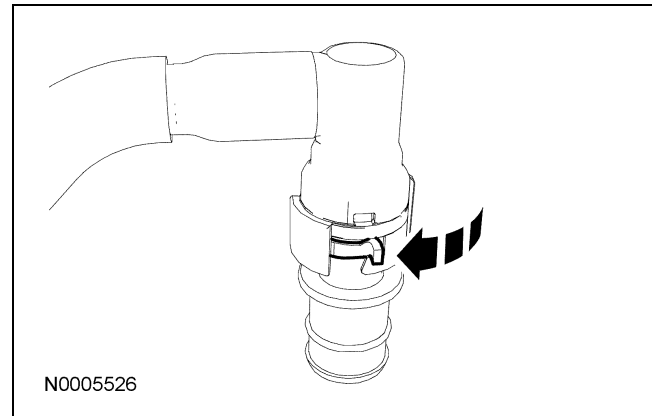
⚠ WARNING: Do not smoke, carry lighted tobacco or have an open flame of any type when working on or near any fuel-related component. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in serious personal injury.

⚠ WARNING: Do not carry personal electronic devices such as cell phones, pagers or audio equipment of any type when working on or near any fuel-related component. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in serious personal injury.

⚠ CAUTION: When reusing liquid or vapor tube connectors, make sure to use compressed air to remove any foreign material from the connector retaining clip area before separating from the tube or damage to the tube or connector retaining clip can occur. Apply clean engine oil to the end of the tube before inserting the tube into the connector.

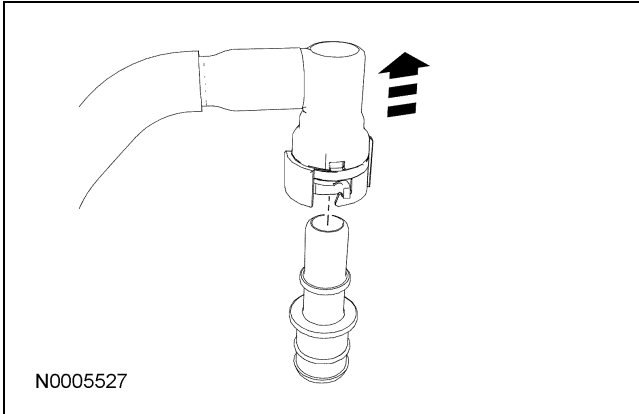
⚠ CAUTION: Fuel injection equipment is manufactured to very precise tolerances and fine clearances. It is essential that absolute cleanliness is observed when working with these components or component damage can occur. Always install blanking plugs to any open orifices or tubes.

1. Release the locking tab on the coupling.



GENERAL PROCEDURES (Continued)

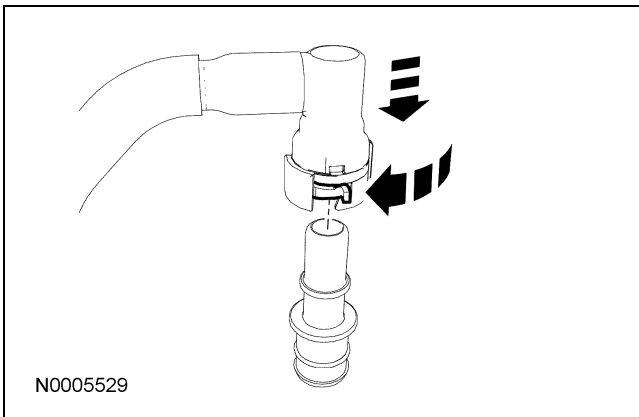
2. Separate the coupling from the fitting.

**Connect — Type II**

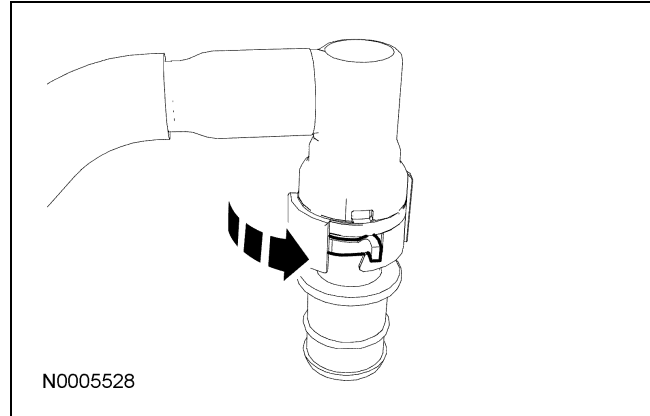
1. **NOTE:** Make sure the fuel tube clicks into place when installing the tube. To make sure that the fuel tube is fully seated, pull on the tube.

NOTE: Apply clean engine oil to O-ring seals.

Release the locking tab and install the coupling onto the fitting.



2. Position the locking tab into the latched position.

**Disconnect — Type III**

⚠ WARNING: When working on or near the evaporative emission (EVAP) system, disconnect the battery ground cable from the battery. The EVAP system contains fuel vapor and condensed fuel vapor, so an electrical spark may cause a fire or explosion. Failure to follow this instruction may result in serious personal injury.

⚠ WARNING: Do not smoke, carry lighted tobacco or have an open flame of any type when working on or near any fuel-related component. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in serious personal injury.

⚠ WARNING: Do not carry personal electronic devices such as cell phones, pagers or audio equipment of any type when working on or near any fuel-related component. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in serious personal injury.

⚠ WARNING: When handling fuel, always observe fuel handling precautions and be prepared in the event of fuel spillage. Spilled fuel may be ignited by hot vehicle components or other ignition sources. Failure to follow these instructions may result in serious personal injury.

GENERAL PROCEDURES (Continued)

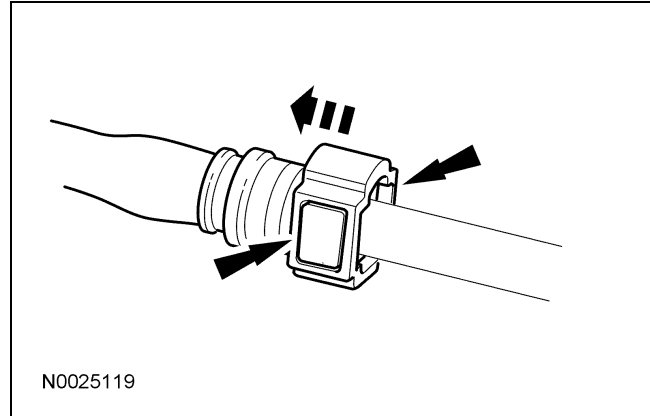
⚠ WARNING: Before working on or disconnecting any of the fuel tubes or fuel system components, relieve the fuel system pressure to prevent accidental spraying of fuel. Fuel in the fuel system remains under high pressure, even when the engine is not running. Failure to follow this instruction may result in serious personal injury.

⚠ CAUTION: When reusing liquid or vapor tube connectors, make sure to use compressed air to remove any foreign material from the connector retaining clip area before separating from the tube or damage to the tube or connector retaining clip can occur. Apply clean engine oil to the end of the tube before inserting the tube into the connector.

⚠ CAUTION: Fuel injection equipment is manufactured to very precise tolerances and fine clearances. It is essential that absolute cleanliness is observed when working with these components or component damage can occur. Always install blanking plugs to any open orifices or tubes.

⚠ CAUTION: Do not use any tools. The use of tools may cause a deformity in the clip components which may cause fuel leaks.

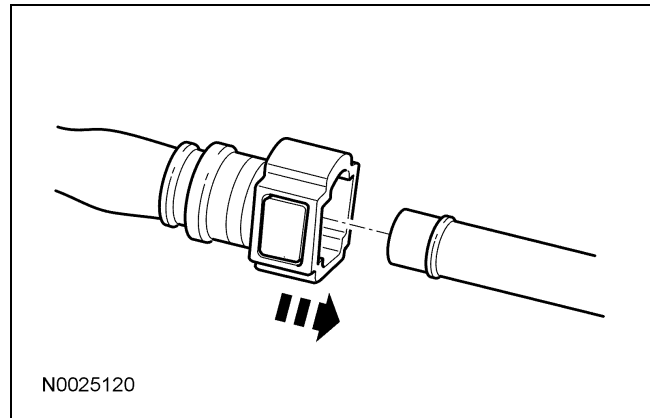
1. If servicing a liquid fuel tube, release the fuel system pressure. For additional information, refer to Fuel System Pressure Release — Gasoline Engines or Fuel System Pressure Release — Diesel Engine in this section.
2. Disconnect the battery ground cable. For additional information, refer to Section 414-01.
3. Disconnect the fuel tube quick connect coupling.
 - Press the 2 fuel tube quick connect coupling buttons and pull the fuel tube to disconnect.



Connect — Type III

1. **NOTE:** Make sure the fuel tube clicks into place when installing the tube. To make sure that the fuel tube is fully seated, pull on the tube.

NOTE: Apply clean engine oil to O-ring seals. Install the quick connect coupling onto the tube until it is fully seated.



2008 Ford F-350 SUPER DUTY

Submodel: XLT | Engine Type: V8 | Liters: 5.4
Fuel Delivery: FI | Fuel: GAS

SECTION 310-00:
Fuel System — General Information — Gasoline and Diesel

SPECIFICATIONS

DESCRIPTION AND OPERATION

Fuel System — Gasoline Engines

Fuel System — Diesel Engine

DIAGNOSIS AND TESTING

Fuel System

Principles of Operation

Inspection and Verification

Symptom Chart

Pinpoint Test

GENERAL PROCEDURES

Fuel System Pressure Release — Gasoline Engines

Fuel System Pressure Release — Diesel Engine

Fuel System Bleeding — Low Pressure, Diesel Engine

Fuel System Bleeding — High Pressure, Diesel Engine

Fuel System Pressure Test — Gasoline Engines

Fuel System Pressure Test — Diesel Engine

Fuel Tank Draining

Spring Lock Couplings

Quick Connect Coupling

2008 Ford F-350 SUPER DUTY

Submodel: XLT | Engine Type: V8 | Liters: 5.4
Fuel Delivery: FI | Fuel: GAS

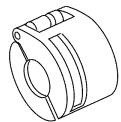
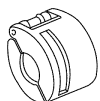
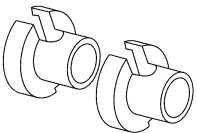
SECTION 310-01:
Fuel Tank and Lines — Gasoline and Diesel

SPECIFICATIONS
DESCRIPTION AND OPERATION
Fuel Tank and Lines
DIAGNOSIS AND TESTING
Fuel Tank and Lines
REMOVAL AND INSTALLATION
Fuel Tank and Filler Pipe — Exploded View
Fuel Tank — Midship
Fuel Tank Filler Pipe — Midship
Fuel Tank — Aft-of-Axle
Fuel Tank Filler Pipe — Aft-of-Axle
Fuel Tank — Auxiliary
Fuel Tank Filler Pipe — Auxiliary
Fuel Pump Module — Steel Fuel Tank
Fuel Pump Module — Plastic Fuel Tank
Fuel Level Sensor — Steel Fuel Tank
Fuel Level Sensor — Plastic Fuel Tank
Fuel Lines and Fuel Filter — Exploded View, Gasdine Engines
Fuel Lines — Midship Tank, Gasdine Engines
Fuel Lines — Aft of Axle Tank, Gasdine Engines
Fuel Lines — Auxiliary, Gasdine
Fuel Filter — Gasdine Engines
Fuel Lines — 6.4L Diesel
Water-In-Fuel Sensor — 6.4L Diesel
Fuel Conditioning Module — 6.4L Diesel
Inertia Fuel Shutoff (IFS) Switch
DISASSEMBLY AND ASSEMBLY
Fuel Conditioning Module — 6.4L Diesel

GENERAL PROCEDURES

Spring Lock Couplings

Special Tool(s)

 ST1146-A	Disconnect Tool, Spring Lock Coupling (3/8-inch yellow) 310-D004 (D87L-9280-A) or equivalent
 ST1147-A	Disconnect Tool, Spring Lock Coupling (1/2-inch green) 310-D005 (D87L-9280-B) or equivalent
 ST1399-A	Disconnect Tool, Spring Lock Coupling 310-S039 (T90T-9550-A) or equivalent

Material

Item	Specification
Motorcraft SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP (US); Motorcraft SAE 5W-20 Super Premium Motor Oil CXO-5W20-LSP12 (Canada); or equivalent	WSS-M2C930-A

Disconnect — Type I

⚠ WARNING: Do not smoke, carry lighted tobacco or have an open flame of any type when working on or near any fuel-related component. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in serious personal injury.

⚠ WARNING: Before working on or disconnecting any of the fuel tubes or fuel system components, relieve the fuel system pressure to prevent accidental spraying of fuel. Fuel in the fuel system remains under high pressure, even when the engine is not running. Failure to follow this instruction may result in serious personal injury.

⚠ WARNING: Do not carry personal electronic devices such as cell phones, pagers or audio equipment of any type when working on or near any fuel-related component. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in serious personal injury.

⚠ WARNING: When handling fuel, always observe fuel handling precautions and be prepared in the event of fuel spillage. Spilled fuel may be ignited by hot vehicle components or other ignition sources. Failure to follow these instructions may result in serious personal injury.

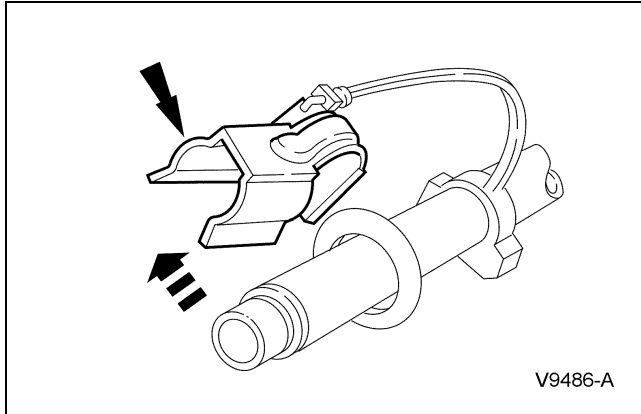
⚠ CAUTION: When reusing liquid or vapor tube connectors, make sure to use compressed air to remove any foreign material from the connector retaining clip area before separating from the tube or damage to the tube or connector retaining clip can occur. Apply clean engine oil to the end of the tube before inserting the tube into the connector.

⚠ CAUTION: Fuel injection equipment is manufactured to very precise tolerances and fine clearances. It is essential that absolute cleanliness is observed when working with these components or component damage can occur. Always install blanking plugs to any open orifices or tubes.

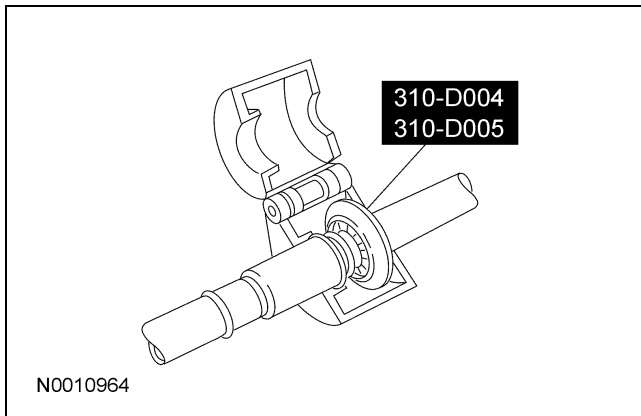
GENERAL PROCEDURES (Continued)

1. Relieve the fuel pressure. For additional information, refer to Fuel System Pressure Release — Gasoline Engines or Fuel System Pressure Release — Diesel Engine in this section.

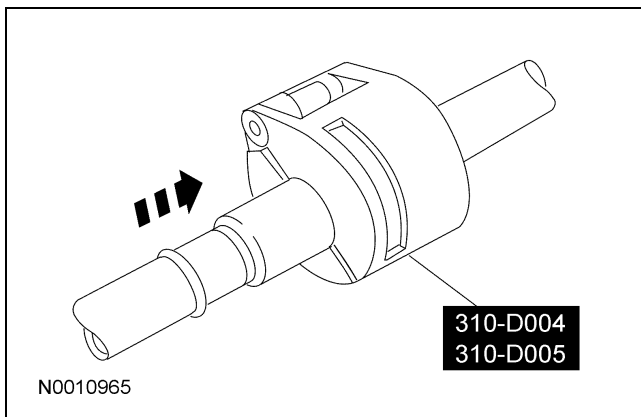
2. Remove the fuel tube safety clip.



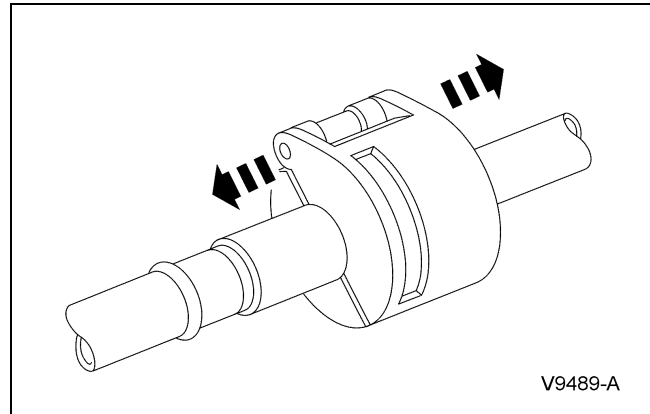
3. Install the special tool.



4. Close and push the special tool into the open side of the cage.

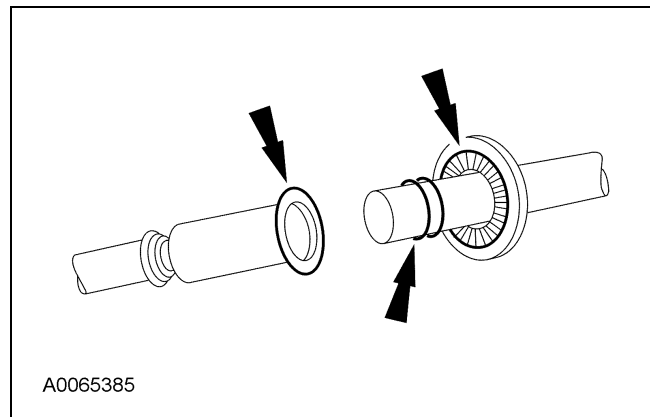


5. Separate the spring lock coupling.

**Connect — Type I**

1. **NOTE:** Apply clean engine oil to the O-ring seals.

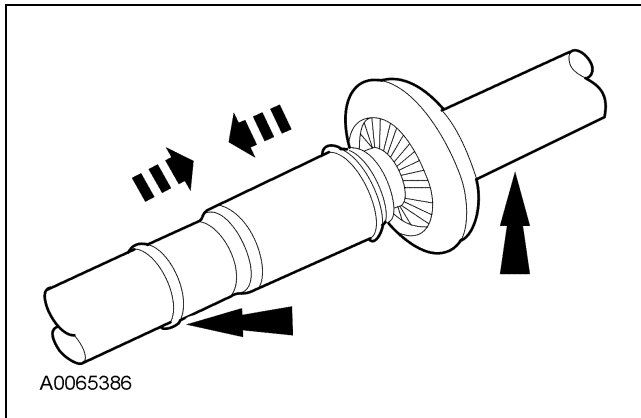
Inspect and clean both spring lock coupling ends. Install new O-ring seals and garter springs if necessary.



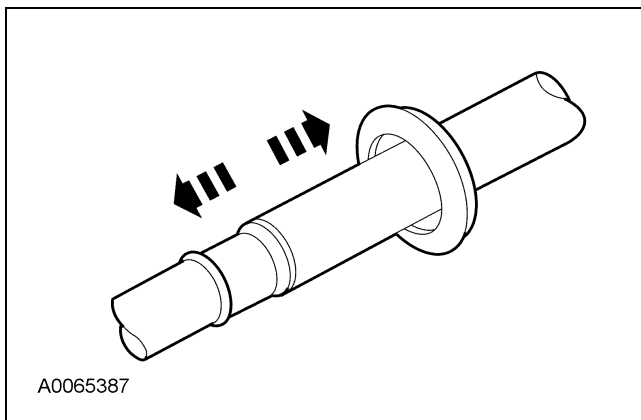
GENERAL PROCEDURES (Continued)

2. **NOTE:** Make sure the fuel tube clicks into place when installing the tube. To make sure that the fuel tube is fully seated, pull on the tube.

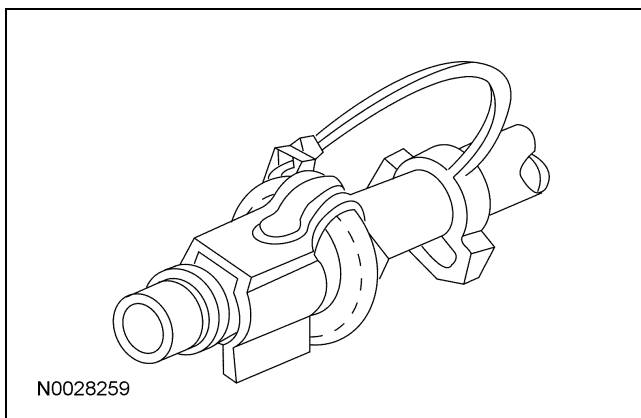
Fit the male end into the female end and push until the garter spring snaps over the flared end of the female end.



3. Make sure the spring lock coupling is engaged by pulling on the tubes.



4. Install the fuel tube safety clip.

**Disconnect — Type II**

⚠ WARNING: Do not smoke, carry lighted tobacco or have an open flame of any type when working on or near any fuel-related component. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in serious personal injury.

⚠ WARNING: Do not carry personal electronic devices such as cell phones, pagers or audio equipment of any type when working on or near any fuel-related component. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in serious personal injury.

⚠ WARNING: When handling fuel, always observe fuel handling precautions and be prepared in the event of fuel spillage. Spilled fuel may be ignited by hot vehicle components or other ignition sources. Failure to follow these instructions may result in serious personal injury.

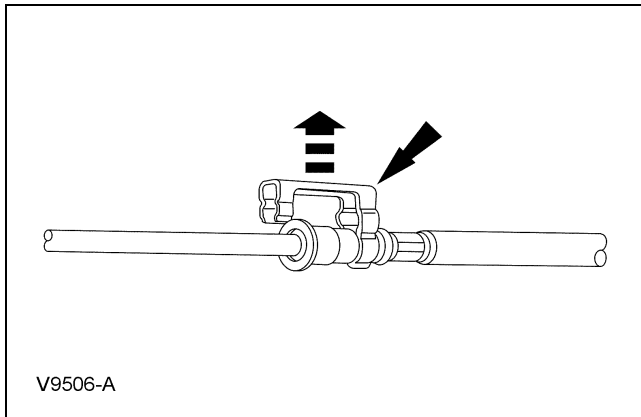
⚠ WARNING: Before working on or disconnecting any of the fuel tubes or fuel system components, relieve the fuel system pressure to prevent accidental spraying of fuel. Fuel in the fuel system remains under high pressure, even when the engine is not running. Failure to follow this instruction may result in serious personal injury.

⚠ CAUTION: When reusing liquid or vapor tube connectors, make sure to use compressed air to remove any foreign material from the connector retaining clip area before separating from the tube or damage to the tube or connector retaining clip can occur. Apply clean engine oil to the end of the tube before inserting the tube into the connector.

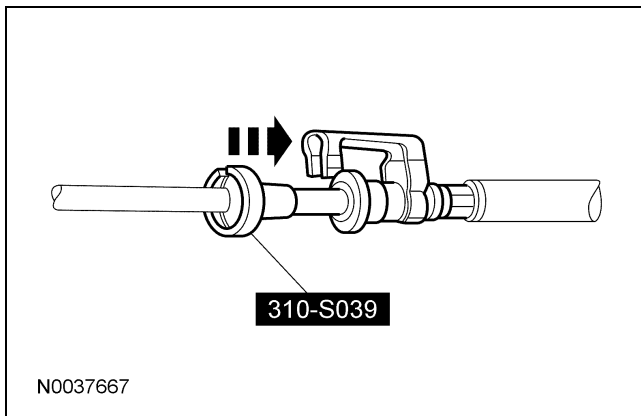
⚠ CAUTION: Fuel injection equipment is manufactured to very precise tolerances and fine clearances. It is essential that absolute cleanliness is observed when working with these components or component damage can occur. Always install blanking plugs to any open orifices or tubes.

GENERAL PROCEDURES (Continued)

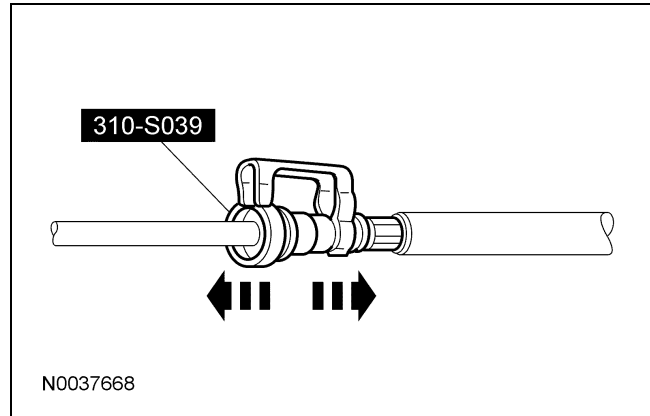
1. Relieve the fuel pressure. For additional information, refer to Fuel System Pressure Release — Gasoline Engines or Fuel System Pressure Release — Diesel Engine in this section.
2. Disconnect the battery ground cable. For additional information, refer to Section 414-01.
3. If equipped, disconnect the safety clip from the fuel tube.



4. Install the special tool and push into the spring lock coupling.



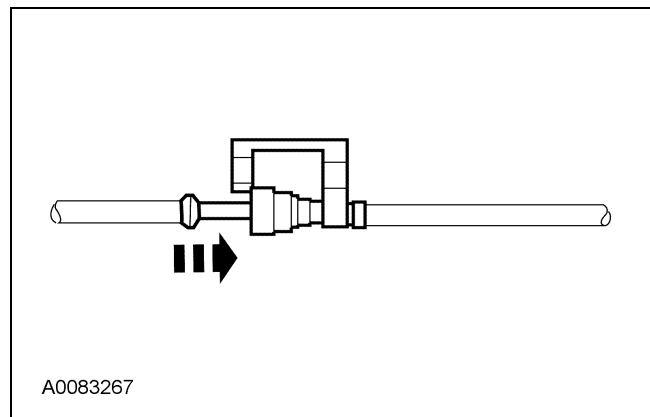
5. Separate the spring lock coupling ends.

**Connect — Type II**

1. Inspect and clean both spring lock coupling ends.
2. **NOTE:** Make sure the fuel tube clicks into place when installing the tube. To make sure that the fuel tube is fully seated, pull on the tube.

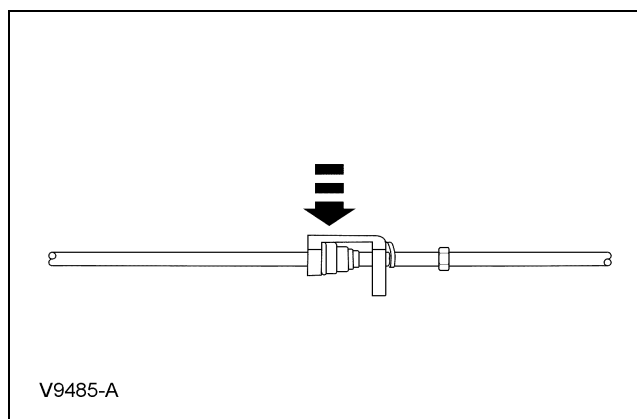
NOTE: Lubricate the spring lock coupling with clean engine oil to ease assembly.

Align and push the fuel tube spring lock coupling until a click is heard.



GENERAL PROCEDURES (Continued)

3. Pull on the spring lock coupling to make sure it is fully seated. If equipped, install the safety clip.



REMOVAL AND INSTALLATION

Water-In-Fuel Sensor — 6.4L Diesel

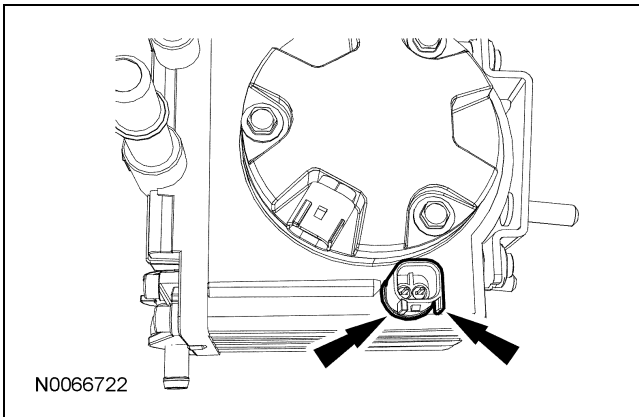
Material

Item	Specification
SAE 15W-40 Super Duty Diesel Motor Oil XO-15W40-QSD (US); CXO-15W40-LSD12 (Canada); or equivalent	WSS-M2C171-D

Removal

All vehicles

1. Remove the fuel conditioning module. For additional information, refer to Fuel Conditioning Module — 6.4L Diesel in this section.
2. Note the orientation of the water-in-fuel sensor locating guides.



3. **NOTE:** Use care when removing the water-in-fuel sensor. If the sensor is damaged during removal, the fuel conditioning module cover must be removed and the module cleaned to remove any pieces of the damaged sensor. Using an appropriate tool, turn the water-in-fuel sensor at least 45 degrees counterclockwise.
4. Pull the water-in-fuel sensor straight out of the fuel conditioning module.
5. Inspect the water-in-fuel sensor for damage. Make sure that there are no pieces broken off of the sensor.

Vehicles with a damaged sensor

6. Remove the screws and manifold cover.
7. Clean the inside of the fuel conditioning module, making sure that any loose pieces of the water-in-fuel sensor are removed.

Installation

Vehicles with a damaged sensor

1. Install a new manifold cover seal and clean the seal mating surface.
2. Install the manifold cover and screws.
 - Lubricate the manifold cover seal with clean motor oil just before installing the cover.
 - Tighten to 5 Nm (44 lb-in).

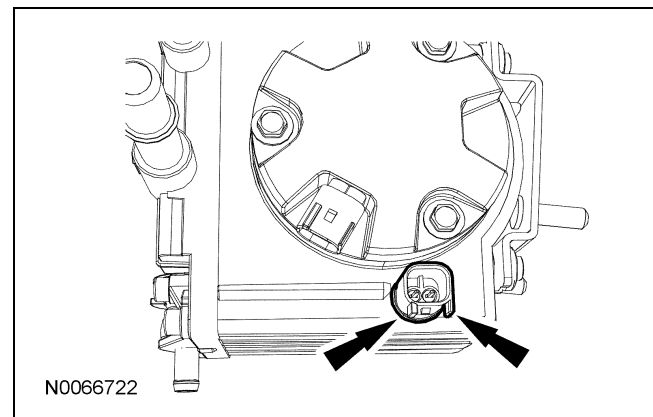
All vehicles

3. **NOTE:** Make sure the water-in-fuel sensor hole is clean.

Lubricate the water-in-fuel sensor hole and water-in-fuel sensor seal with clean motor oil.

4. **NOTE:** The guides on the water-in-fuel sensor should be pointing downward.

Align the water-in-fuel sensor to the water-in-fuel sensor hole and insert the sensor until a click is heard or felt.



5. If required, using a rubber mallet, gently tap the water-in-fuel sensor into place. Pull on the water-in-fuel sensor to verify that it is securely in place.

REMOVAL AND INSTALLATION (Continued)

6. Install the fuel conditioning module. For additional information, refer to Fuel Conditioning Module — 6.4L Diesel in this section.
 7. Start the vehicle and idle for one minute while noting engine performance.
 8. If engine is running rough, check for air leaks.
 9. Shut the vehicle off and inspect for fuel leaks.
-

REMOVAL AND INSTALLATION

Air Cleaner — 6.4L Diesel

Removal and Installation

1. Disconnect the restriction gauge and mass air flow (MAF) sensor electrical connectors.
 2. Loosen the clamp and disconnect the air cleaner outlet pipe from the air cleaner.
 - To install, tighten to 5 Nm (44 lb-in).
 3. Disconnect the secondary air intake hose from the air cleaner outlet housing.
 4. Pull up on the air cleaner to remove it from the air cleaner support bracket.
 5. To install, reverse the removal procedure.
-

REMOVAL AND INSTALLATION

Air Cleaner — Gasoline Engines


Removal and Installation

1. The air cleaner housing is an integral part of the degas bottle and cannot be serviced separately. For additional information, refer to Section 303-03.
-

REMOVAL AND INSTALLATION

Air Cleaner Element — 6.4L Diesel

Removal

1. Release the toggle clamps and raise the air cleaner outlet housing.
 2. Disconnect the secondary air intake hose from the air cleaner outlet housing and set the housing aside.
 3.  **CAUTION: Do not use a tool to pry the element from the air cleaner housing. Failure to follow this instruction may result in air cleaner and engine damage.**
Pull outboard on the top edge of the air cleaner element and remove the element.
 - Discard the air cleaner element.
-


Installation

1. **NOTE:** Make sure the element is positioned inboard of the stop feature in the air cleaner housing.
Position a new air cleaner element into the air cleaner housing.
2. Push the element down and inboard to compress the seal into the air cleaner housing.
3. Connect the secondary air intake hose to the air cleaner outlet housing and position the cover on the air cleaner housing.
4. Secure the 2 toggle clamps.

REMOVAL AND INSTALLATION

Air Cleaner Element — Gasoline Engines

Removal and Installation

1. Disconnect the air cleaner outlet pipe from the air cleaner cover.
 - To install, tighten to 4 Nm (35 lb-in).
 2. Disconnect the mass air flow (MAF) sensor electrical connector.
 3. Release the retaining clips and position the air cleaner cover aside.
 4. If servicing the air cleaner cover, remove the 2 bolts and the MAF sensor.
 - To install, tighten to 3 Nm (27 lb-in).
 5. Remove the air cleaner element.
 6.  **CAUTION: The air cleaner element must be fully seated into the air cleaner housing. Failure to do so will result in unusual engine noise.**
To install, reverse the removal procedure.
-

REMOVAL AND INSTALLATION

Air Cleaner Intake Pipe — 6.4L Diesel

Removal and Installation

1. Remove the RH splash shield. For additional information, refer to Section 501-02.
 2. Remove the RH battery. For additional information, refer to Section 414-01.
 3. Remove the air cleaner. For additional information, refer to Air Cleaner — 6.4L Diesel in this section.
 4. Disconnect the windshield washer solvent hose and the position retainers.
 5. Disconnect the wiring harness, vacuum hose, battery positive cable and battery negative cable position retainers from the battery tray.
 6. Disconnect the A/C condenser inlet tube from the battery tray.
 7. Remove the 2 bolts and the air cleaner support bracket.
 - To install, tighten to 15 Nm (11 lb-ft).
 8. Remove the 3 bolts and position the battery tray aside for access to the windshield washer solvent pump electrical connector.
 - To install, tighten to 15 Nm (11 lb-ft).
 9. Disconnect the windshield washer solvent pump electrical connector and remove the battery tray.
 10. Remove the 4 pushpin retainers and the air cleaner intake pipe.
 11. To install, reverse the removal procedure.
-

REMOVAL AND INSTALLATION

Air Cleaner Outlet Pipe — 6.4L Diesel

Removal and Installation

1. Disconnect the crankcase vent oil separator hose and discard the clamp.
 2. Loosen the clamp and disconnect the air cleaner outlet pipe from the turbo charger.
 - To install, tighten to 5 Nm (44 lb-in).
 3. Loosen the clamp and disconnect the air cleaner outlet pipe from the air cleaner.
 - To install, tighten to 5 Nm (44 lb-in).
 4. To install, reverse the removal procedure.
 - Use a new clamp when connecting the crankcase vent oil separator.
-

REMOVAL AND INSTALLATION

Air Cleaner Outlet Pipe — Gasoline Engines

Removal and Installation

All engines

1. Disconnect the degas bottle coolant hose from the air cleaner outlet pipe.

6.8L (3V) engine

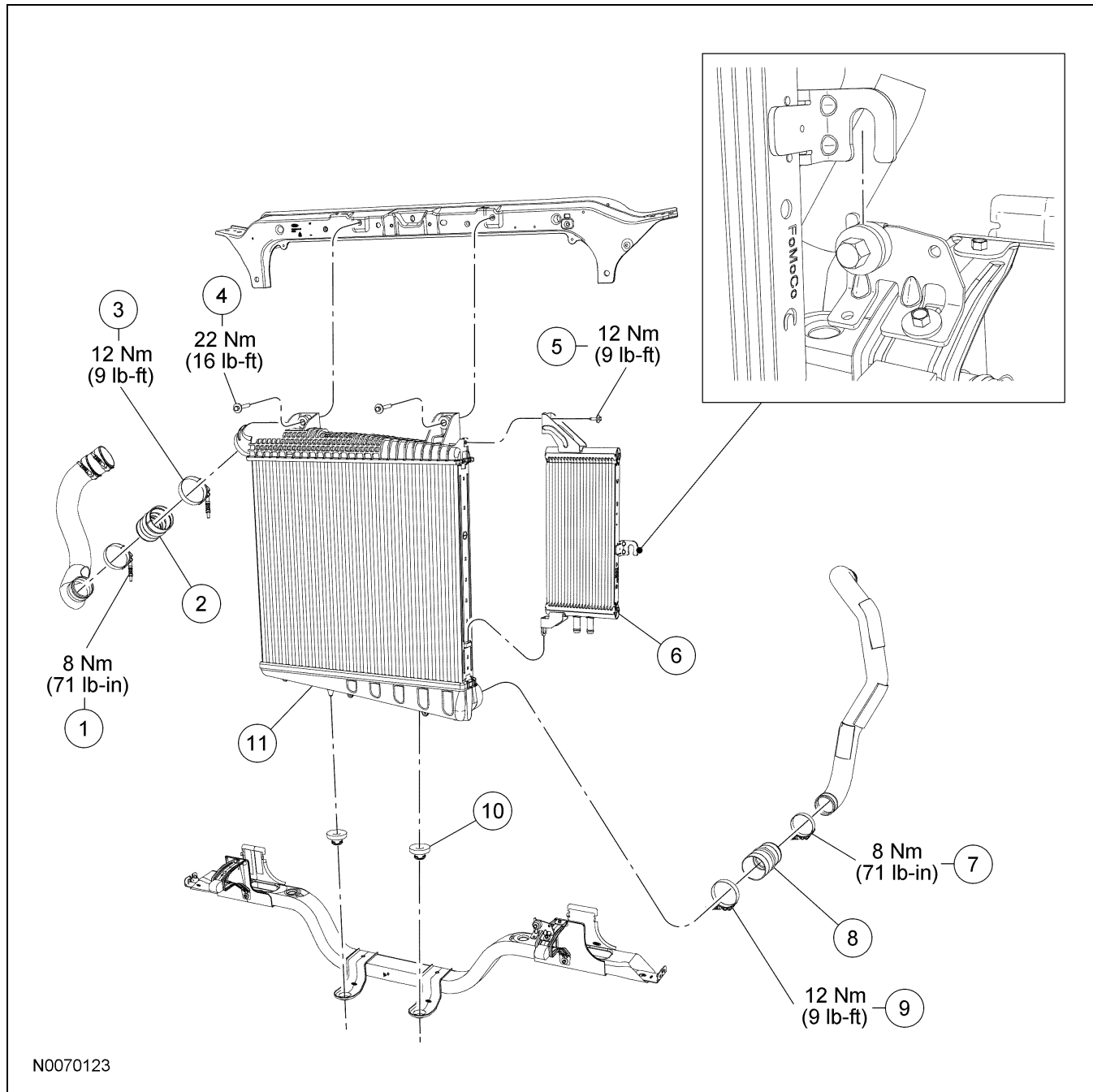
2. Disconnect the crankcase ventilation tube quick connect coupling from the air cleaner outlet pipe. For additional information, refer to Section 310-00.

All engines

3. Loosen the 2 clamps and remove the air cleaner outlet pipe.
 - To install, tighten to 4 Nm (35 lb-in).
 4. To install, reverse the removal procedure.
-

REMOVAL AND INSTALLATION

Charge Air Cooler — 6.4L Diesel



Item	Part Number	Description
1	—	Upper charge air cooler (CAC) tube-to-CAC tube flex joint clamp
2	—	CAC tube flex joint
3	—	CAC tube flex joint-to-CAC clamp
4	W711849	CAC mount bolt (2 required)

(Continued)

Item	Part Number	Description
5	W325346	Fuel cooler radiator bolt
6	8D010	Fuel cooler radiator
7	—	Lower CAC tube-to-CAC tube flex joint clamp
8	—	CAC tube flex joint
9	—	CAC tube flex joint-to-CAC clamp

(Continued)

REMOVAL AND INSTALLATION (Continued)

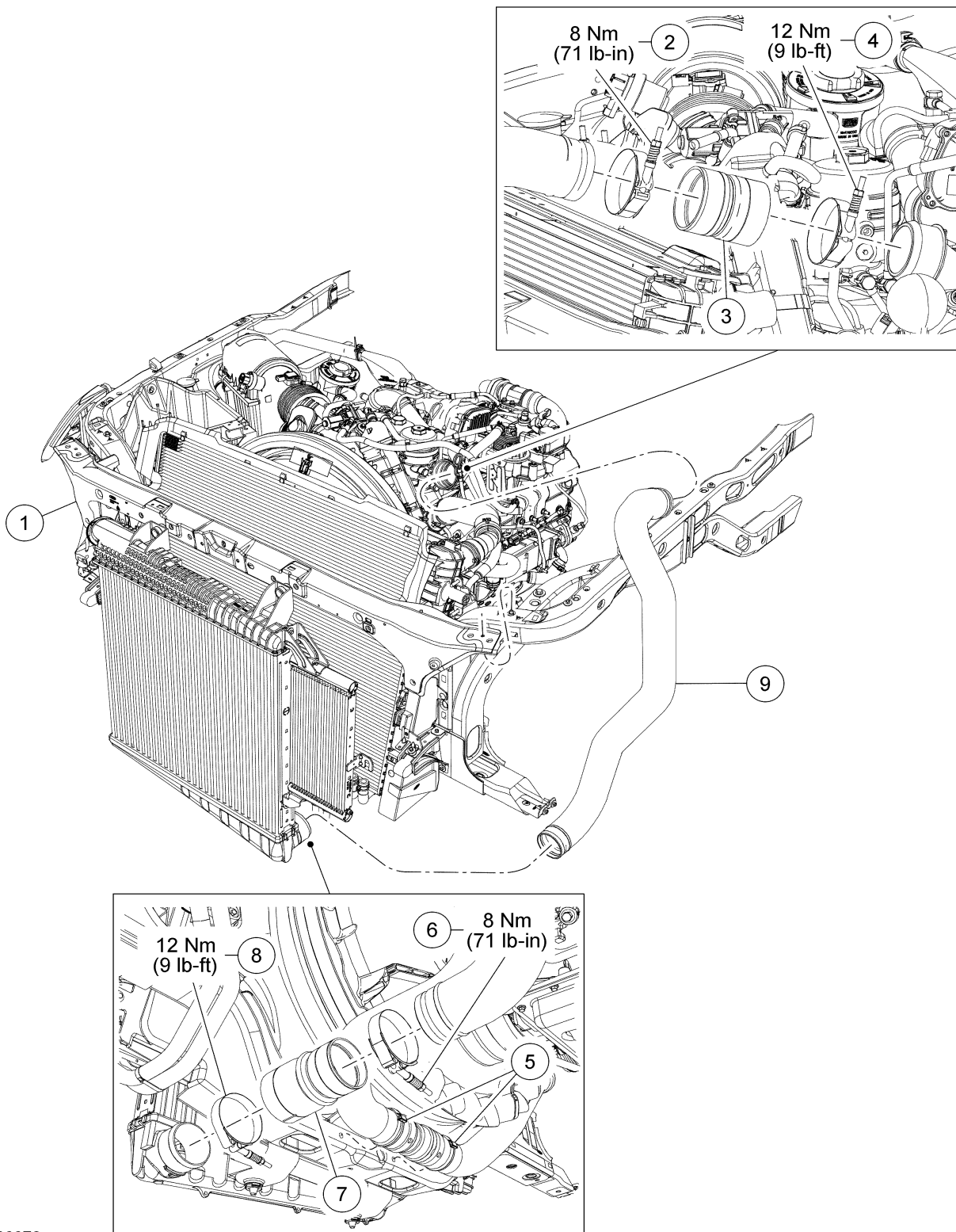
Item	Part Number	Description
10	8B204	CAC mount insulators
11	6K775	CAC

Removal and Installation

1. With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
 2. **NOTE:** If there is any oil residue, clean both connecting ports and the inside surface of the charge air cooler (CAC) tube to prevent the tube from blowing off.
Loosen the clamp and disconnect the lower CAC tube flex joint from the CAC.
 - To install, tighten to 12 Nm (9 lb-ft).
 3. Remove the bolt for the fuel cooler radiator. Separate the fuel cooler radiator from the CAC and position aside.
 - To install, tighten to 12 Nm (9 lb-ft).
 4. Loosen the clamp and disconnect the upper CAC tube flex joint from the CAC.
 - To install, tighten to 12 Nm (9 lb-ft).
 5. Remove the 2 bolts and the CAC.
 - To install, tighten to 22 Nm (16 lb-ft).
 6. To install, reverse the removal procedure.
 - Verify that the rubber insulators are in the brackets before installing the CAC.
-

REMOVAL AND INSTALLATION

Charge Air Cooler (CAC) Tube — LH, 6.4L Diesel



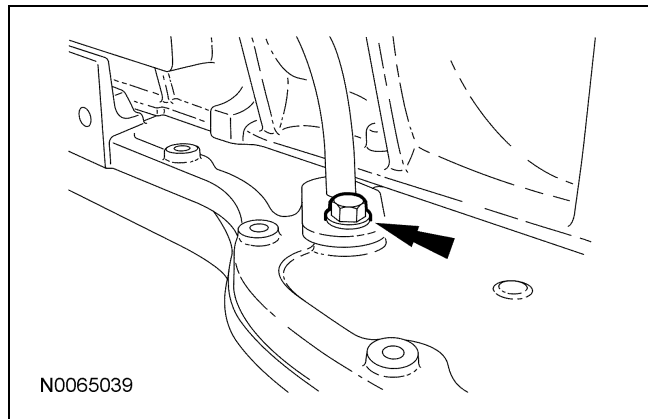
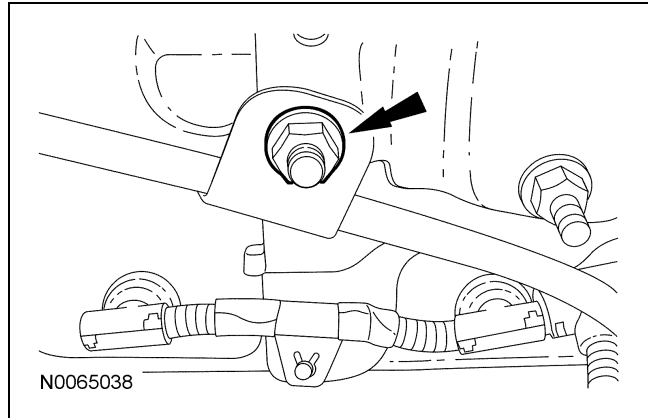
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REMOVAL AND INSTALLATION (Continued)


Item	Part Number	Description
1	16E166	Radiator support
2	—	LH charge air cooler (CAC) tube-to-CAC tube flex joint clamp
3	—	LH CAC tube flex joint
4	—	LH CAC tube flex joint-to-turbo clamp
5	—	Lower radiator hose assembly position retainers (2 required)
6	—	LH CAC tube-to-CAC tube flex joint clamp
7	—	LH CAC tube flex joint
8	—	LH CAC tube flex joint-to-CAC clamp
9	—	LH CAC tube

Removal and Installation

- With the vehicle in NEUTRAL, position it on a hoist. For additional information, refer to Section 100-02.
- Remove the coolant degas module. For additional information, refer to Section 303-03.
- Remove the upper cooling fan shroud. For additional information, refer to Section 303-03.
- Position the front wheels to the right.
- Loosen the LH charge air cooler (CAC) tube clamp and disconnect the tube from the lower flex joint.
 - To install, tighten to 8 Nm (71 lb-in).
- Disconnect the lower radiator hose position retainers.
- Remove the nut for the oil level indicator tube.
 - To install, tighten to 31 Nm (23 lb-ft).
- Remove the bolt and position the oil level indicator tube aside.
 - To install, tighten to 13 Nm (10 lb-ft).
- Loosen the LH CAC tube clamp and remove the upper flex joint.
 - To install, tighten to 8 Nm (71 lb-in).



REMOVAL AND INSTALLATION (Continued)

10.  **CAUTION:** There is a brake tube mounted to the vehicle frame near the lower end of the charge air cooler (CAC) tube. When removing the CAC tube, use care not to hook the CAC tube lip on the brake tube. The brake tube can be damaged if this occurs.

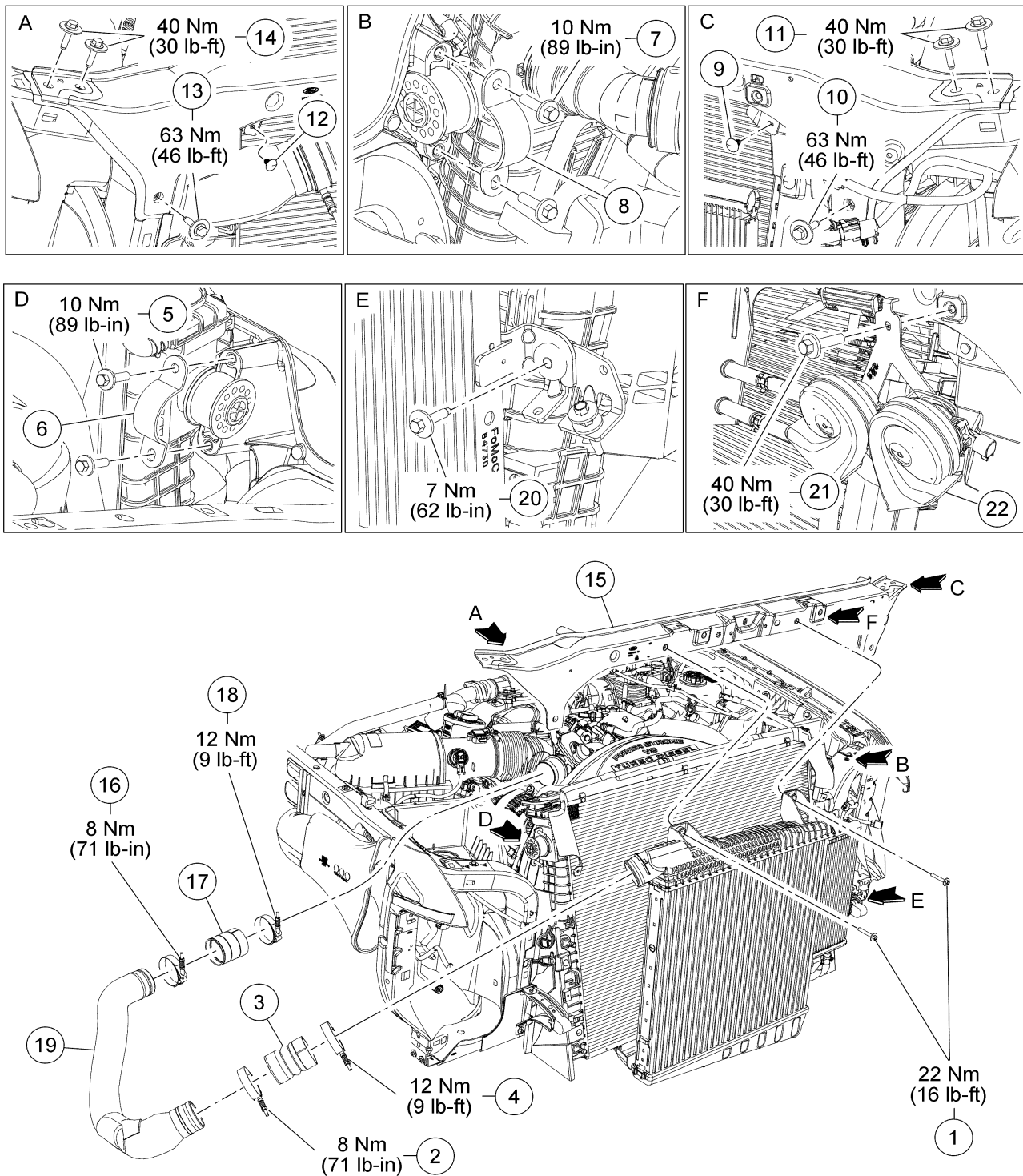
Remove the LH CAC tube.

- Rotate the CAC tube to the left until it stops at the brace. Start to raise the CAC tube and continue to turn it to the left until the tube can be removed.
-

11. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Charge Air Cooler (CAC) Tube — RH, 6.4L Diesel




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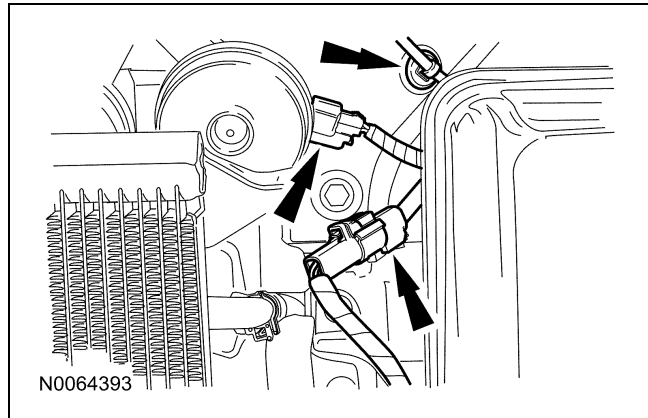
REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	W711849	Charge air cooler (CAC) mount bolts (2 required)
2	—	RH CAC tube-to-CAC tube flex joint clamp
3	—	RH CAC tube flex joint
4	—	RH CAC tube flex joint-to-CAC clamp
5	—	RH radiator support clamp bolt (2 required)
6	—	RH radiator support clamp
7	—	LH radiator support clamp bolt (2 required)
8	—	LH radiator support clamp
9	—	LH radiator air deflector pushpin retainer
10	W712810	LH radiator support front bolt
11	W701835	LH radiator support top bolts (2 required)
12	—	RH radiator air deflector pushpin retainer
13	W712810	RH radiator support front bolt
14	W701835	RH radiator support top bolts (2 required)
15	16E166	Radiator support
16	—	RH CAC tube-to-CAC tube flex joint clamp
17	—	RH CAC tube flex joint
18	—	RH CAC tube flex joint-to-throttle body (TB) clamp
19	6F073	RH CAC tube
20	W503925	Fuel cooler bolt
21	W711851	Horn and bracket assembly bolt
22	13A803	Horn and bracket assembly

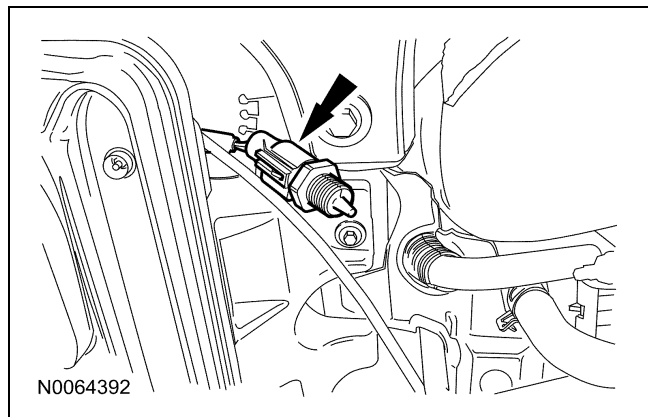
Removal and Installation

 **CAUTION:** Position a suitable protective material in front of the charge air cooler (CAC) or damage to the CAC can occur.

- Loosen the RH charge air cooler (CAC) tube clamps and disconnect the CAC tube from the flex hoses.
 - To install, tighten to 8 Nm (71 lb-in).
- Remove the side bolt for the fuel cooler radiator.
 - To install, tighten to 7 Nm (62 lb-in).
- Remove the bolts for the CAC.
 - To install, tighten to 15 Nm (11 lb-ft).
- Remove the 4 radiator support clamp bolts and the 2 radiator support clamps.
 - To install, tighten to 10 Nm (89 lb-in).
- Remove the 2 radiator isolators.
- Disconnect the horn assembly electrical connector, the hood latch release cable position retainer and if equipped, disconnect the fog light electrical connector position retainer.



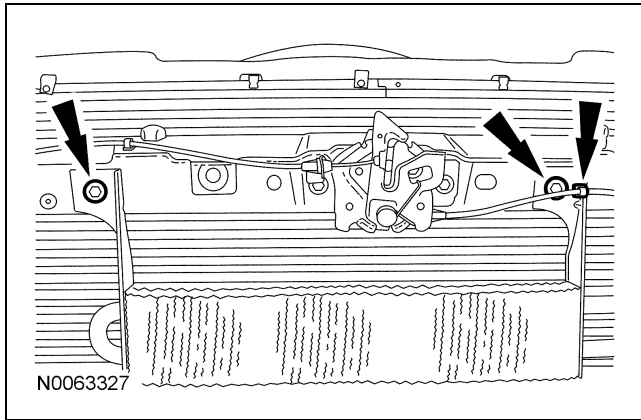
- Remove the bolt and the horns.
- If equipped, disconnect the temperature sensor pushpin and position aside.



- Remove the 2 air deflector pushpin retainers.

REMOVAL AND INSTALLATION (Continued)

10. Disconnect the hood cable retainer. Remove the 2 power steering cooler bolts and position the power steering cooler aside.



11. **NOTE:** Mark the front bolts to aid in installation.

NOTE: Use care when removing the radiator core support to not damage the alignment pins. Remove the 2 front bolts for the radiator core support.

- To install, tighten to 63 Nm (46 lb-ft).
12. Remove the 4 top bolts for the radiator core support. Position the radiator core support forward to remove the CAC tube.
- To install, tighten to 40 Nm (30 lb-ft).
13. Remove the CAC tube from the vehicle.
14. To install, reverse the removal procedure.

DESCRIPTION AND OPERATION

Intake Air Distribution and Filtering

The gasoline engine intake air system consists of the following:

- Air cleaner
- Air cleaner element
- Air cleaner cover
- Mass air flow (MAF) sensor
- Air cleaner outlet pipe

The diesel engine intake air system adds the following:

- Engine charge air cooler (CAC)
 - CAC tubes (inlet and outlet)
 - CAC clamps
 - Engine air cleaner bracket
 - Primary fresh air inlet
 - Secondary fresh air inlet
 - Restriction gauge
-

The engine intake air system:

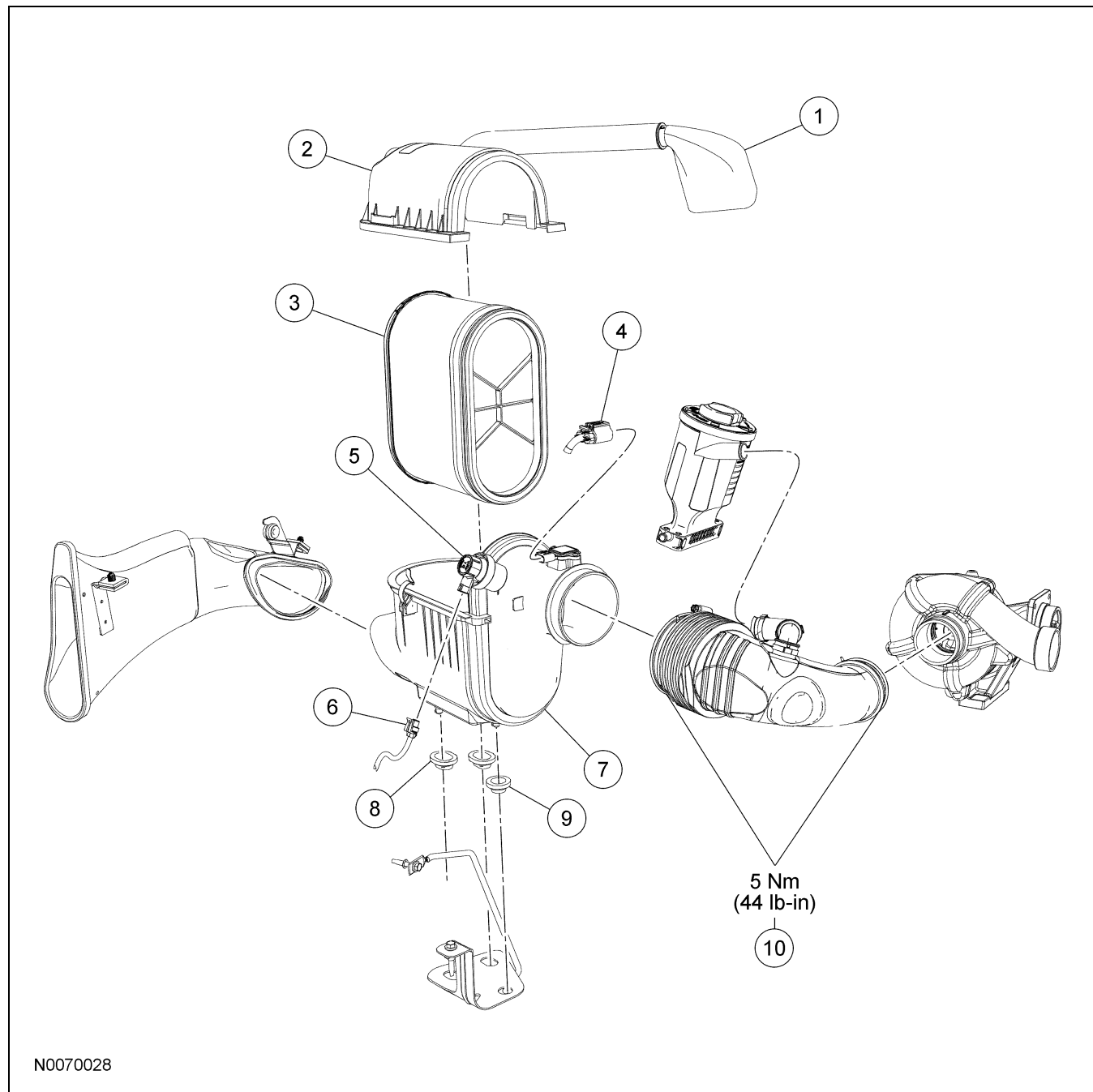
- cleans intake air with a replaceable air cleaner element.
- measures airflow and intake air temperature with a MAF sensor. Refer to Section 303-14A or Section 303-14B.

The engine air cleaner contains an air cleaner element made of treated, pleated paper. A new air cleaner element must be installed periodically as scheduled or indicated (6.4L diesel). Engine performance and fuel economy are adversely affected when maximum restriction of the air cleaner element is reached.

On diesel applications, the charge air cooler subsystem cools and increases the density of the compressed turbocharger air.

REMOVAL AND INSTALLATION

Intake Air System Components — Exploded View, 6.4L Diesel



Item	Part Number	Description
1	9B613	Secondary air intake
2	9643	Air cleaner outlet housing
3	9601	Air cleaner element
4	—	Mass air flow (MAF) sensor electrical connector (part of 14A464)

(Continued)

Item	Part Number	Description
5	9N622	Restriction gauge
6	—	Restriction gauge electrical connector (part of 14A464)
7	9A600	Air cleaner housing
8	9P686	Air cleaner housing isolator, oval (2 required)

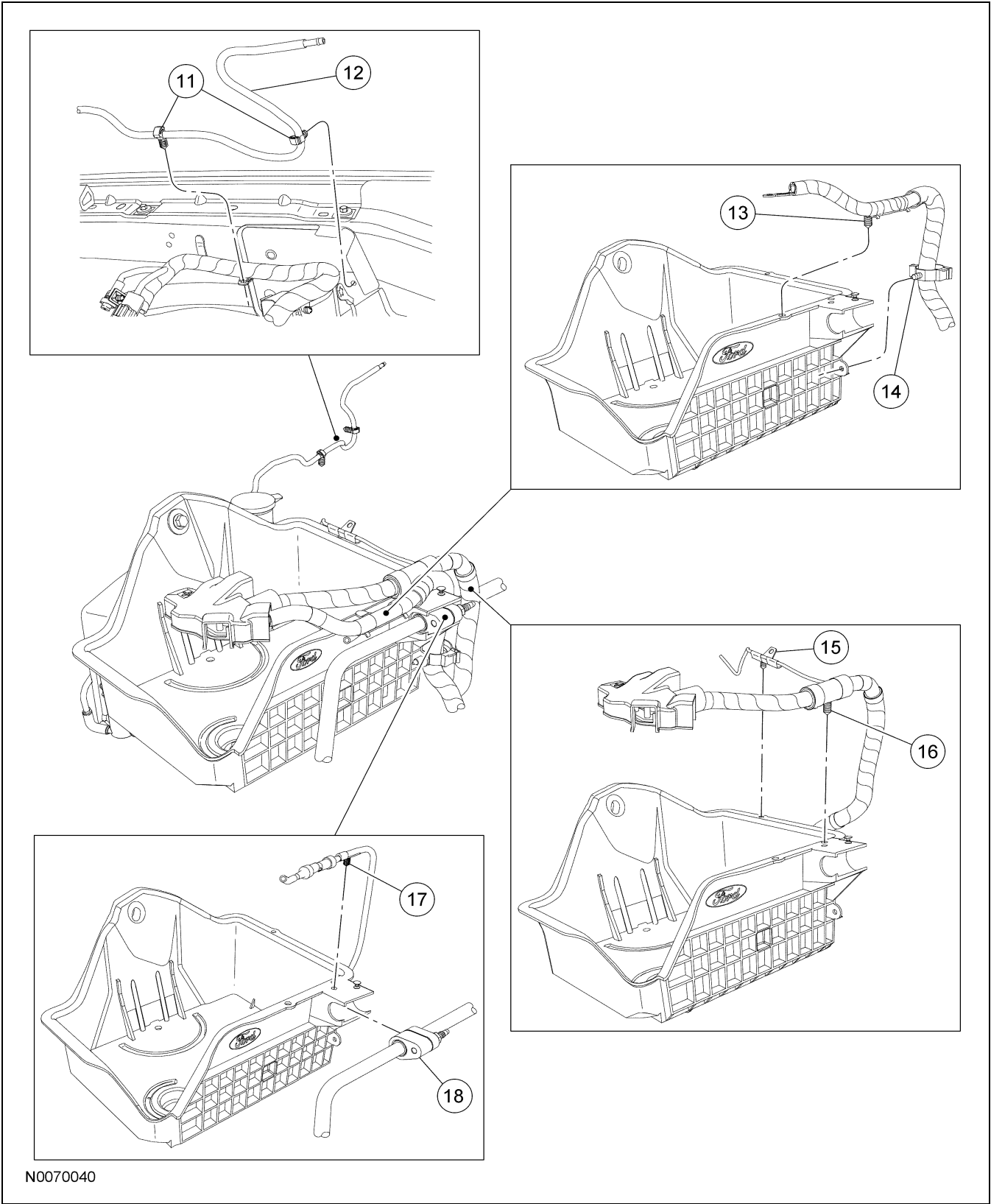
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REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
9	9P686	Air cleaner housing isolator, round

(Continued)

Item	Part Number	Description
10	9B659	Air cleaner outlet pipe



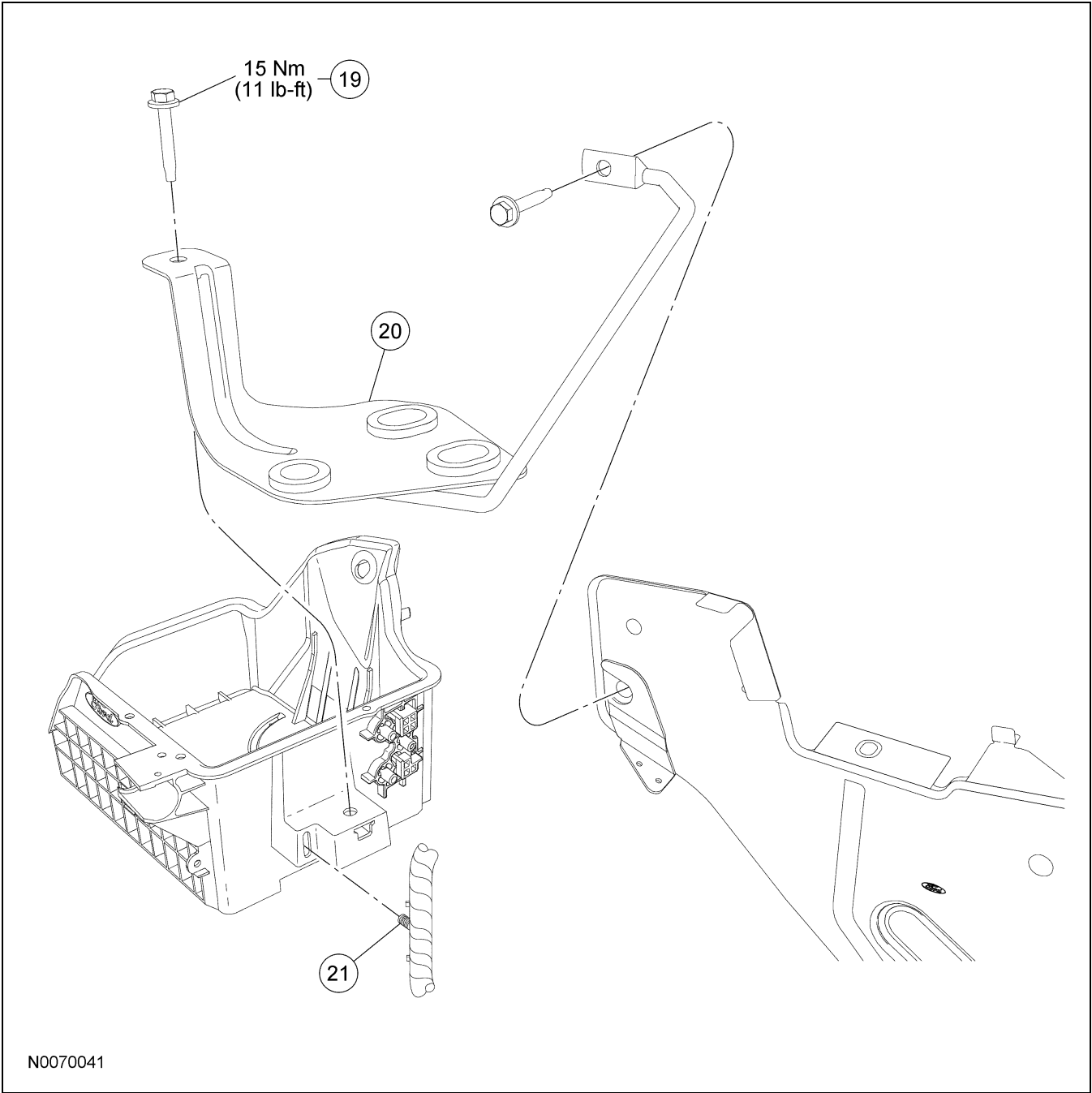
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REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
11	—	Windshield washer solvent hose position retainers (part of 17K605)
12	17K605	Windshield washer solvent hose
13	—	Battery cable position retainer (part of 12A581)
14	—	Battery cable position retainer (part of 12A581)

Item	Part Number	Description
15	—	Vacuum hose position retainer (part of 9A600)
16	—	Battery cable position retainer (part of 14B060)
17	—	Vacuum hose position retainer (part of 3C124)
18	19C700	A/C condenser inlet tube

(Continued)

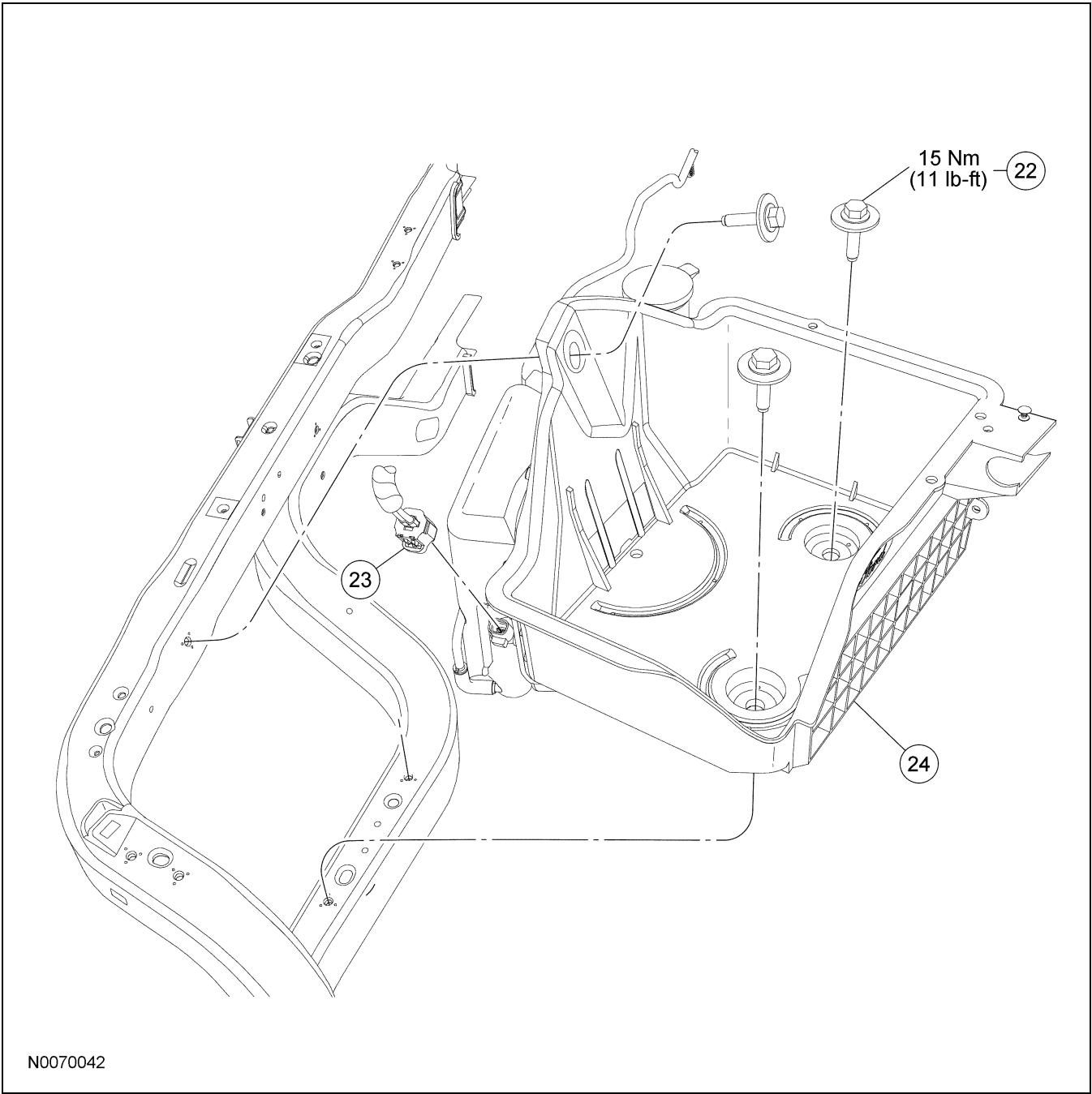


REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
19	W711320	Air cleaner housing support bracket bolt (2 required)
20	9647	Air cleaner housing support bracket

Item	Part Number	Description
21	—	Battery ground cable harness retainer (part of 14301)

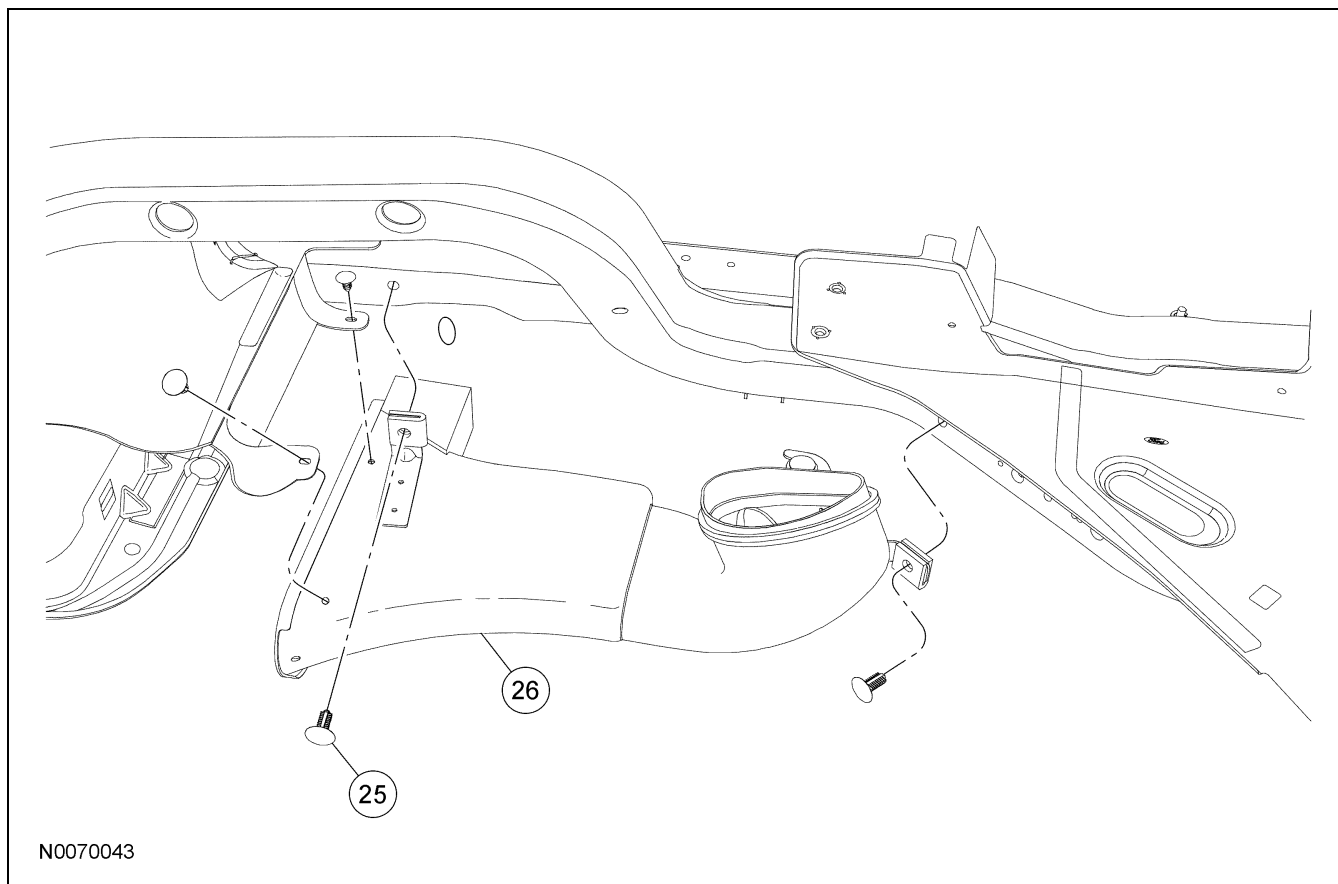
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N0070042

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
22	W701835	Battery tray bolt (3 required)
23	—	Windshield washer solvent pump electrical connector (part of 12A581)
24	10723	Battery tray assembly



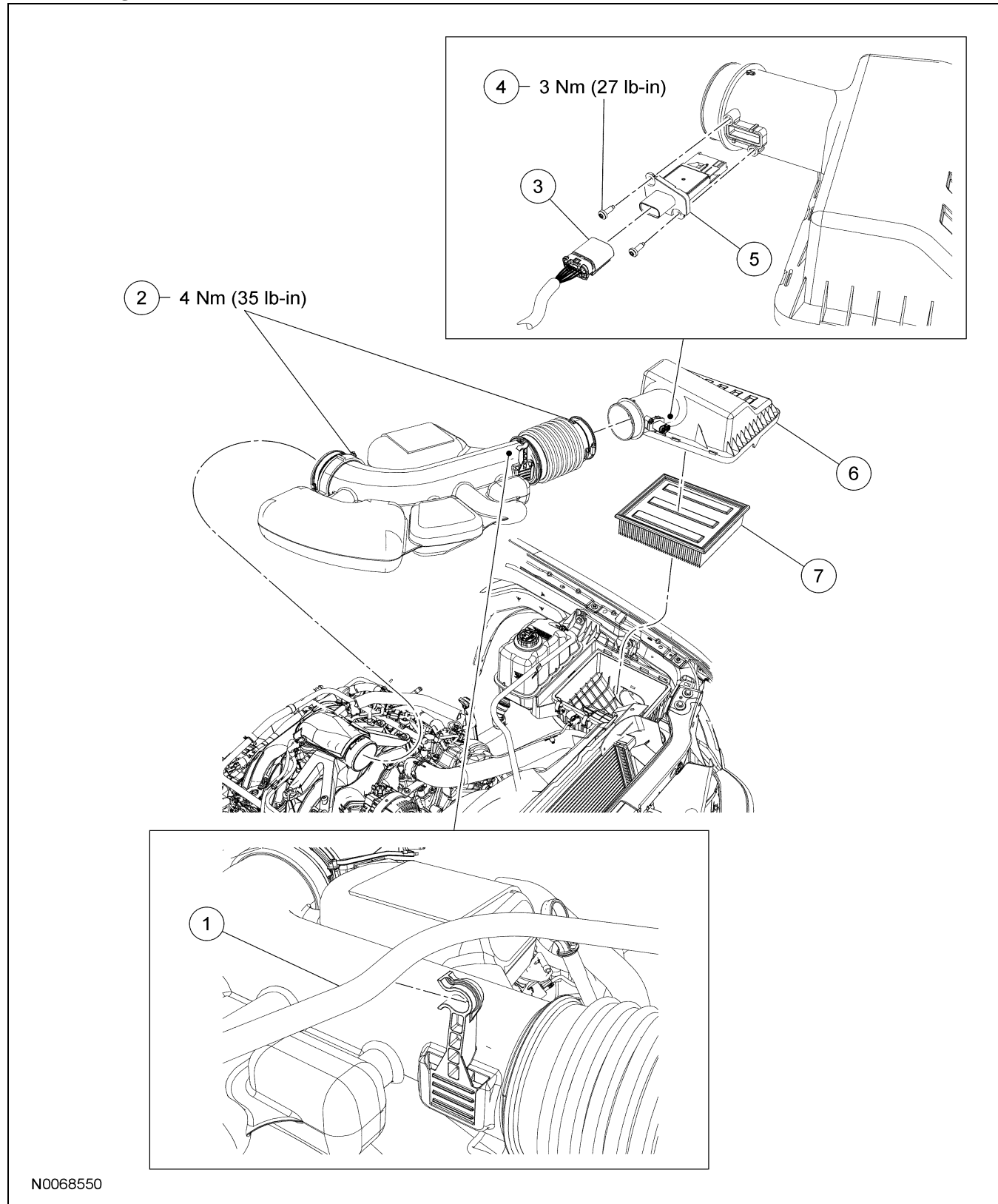
Item	Part Number	Description
25	W709453	Pushpin retainer (4 required)
26	9G788	Air cleaner intake pipe

1. For additional information, refer to the procedures in this section.

REMOVAL AND INSTALLATION

Intake Air System Components — Exploded View, Gasoline Engines

5.4L (3V) Engine



REMOVAL AND INSTALLATION (Continued)

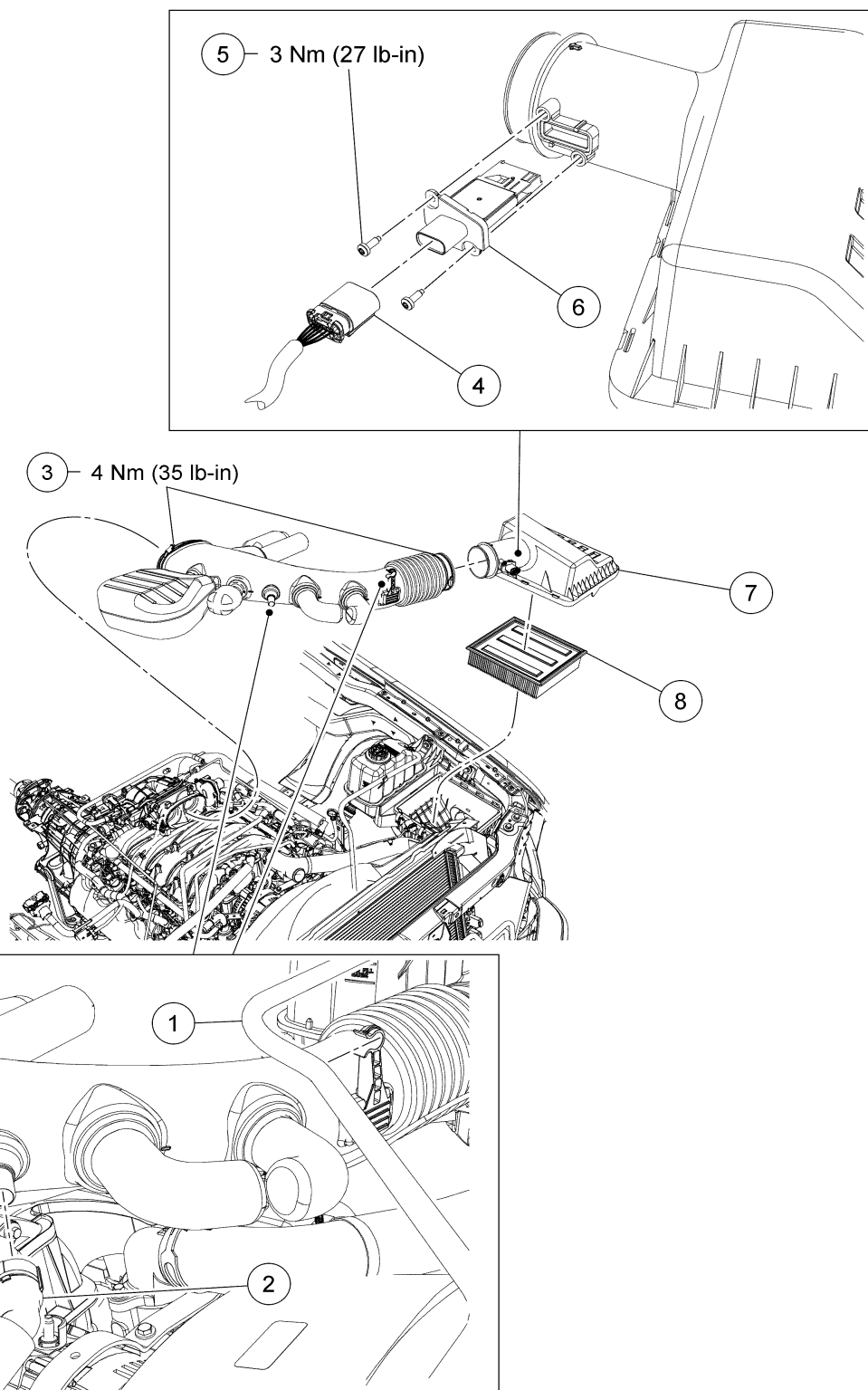
Item	Part Number	Description
1	8W005	Degas bottle coolant hose
2	9F805	Air cleaner outlet pipe clamps
3	14A464	Mass air flow (MAF) sensor electrical connector
4	W709287	MAF sensor bolt (2 required)

(Continued)

Item	Part Number	Description
5	12B579	MAF sensor
6	—	Air cleaner cover (part of 6A987)
7	9601	Air cleaner element

REMOVAL AND INSTALLATION (Continued)

6.8L (3V) Engine



N0068551

REMOVAL AND INSTALLATION (Continued)

Item	Part Number	Description
1	8W005	Degas bottle coolant hose
2	6K817	Crankcase ventilation tube
3	9F805	Air cleaner outlet pipe clamps
4	14A464	Mass air flow (MAF) sensor electrical connector
5	W709287	MAF sensor bolt (2 required)

(Continued)

Item	Part Number	Description
6	12B579	MAF sensor
7	—	Air cleaner cover (part of 6A987)
8	9601	Air cleaner element

1. For additional information, refer to the procedures in this section.

2008 Ford F-350 SUPER DUTY

Submodel: XLT | Engine Type: V8 | Liters: 5.4
Fuel Delivery: FI | Fuel: GAS

SECTION 303-12:
Intake Air Distribution and Filtering

SPECIFICATIONS
DESCRIPTION AND OPERATION
Intake Air Distribution and Filtering
DIAGNOSIS AND TESTING
Intake Air Distribution and Filtering
REMOVAL AND INSTALLATION
Intake Air System Components — Exploded View, Gasoline Engines
Air Cleaner Element — Gasoline Engines
Air Cleaner Outlet Pipe — Gasoline Engines
Air Cleaner — Gasoline Engines
Intake Air System Components — Exploded View, 6.4L Diesel
Air Cleaner Element — 6.4L Diesel
Air Cleaner — 6.4L Diesel
Air Cleaner Intake Pipe — 6.4L Diesel
Air Cleaner Outlet Pipe — 6.4L Diesel
Charge Air Cooler — 6.4L Diesel
Charge Air Cooler (CAC) Tube — LH, 6.4L Diesel
Charge Air Cooler (CAC) Tube — RH, 6.4L Diesel

DESCRIPTION AND OPERATION

Accessory Drive

The gasoline engine accessory drive system:

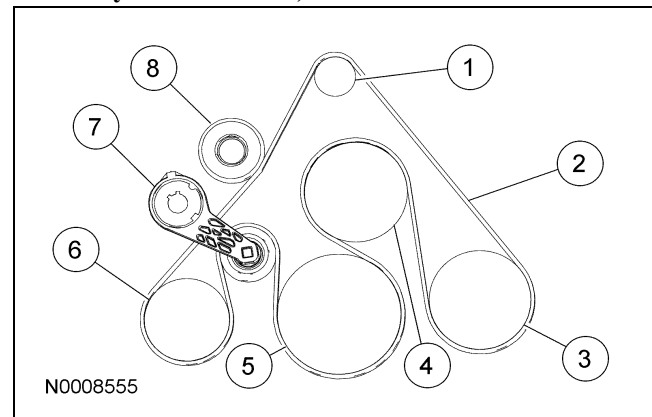
- has a single serpentine drive belt (6 ribs).
- has one idler pulley.
- has an automatic belt tensioner.
- is not adjustable.

The diesel engine accessory drive system:

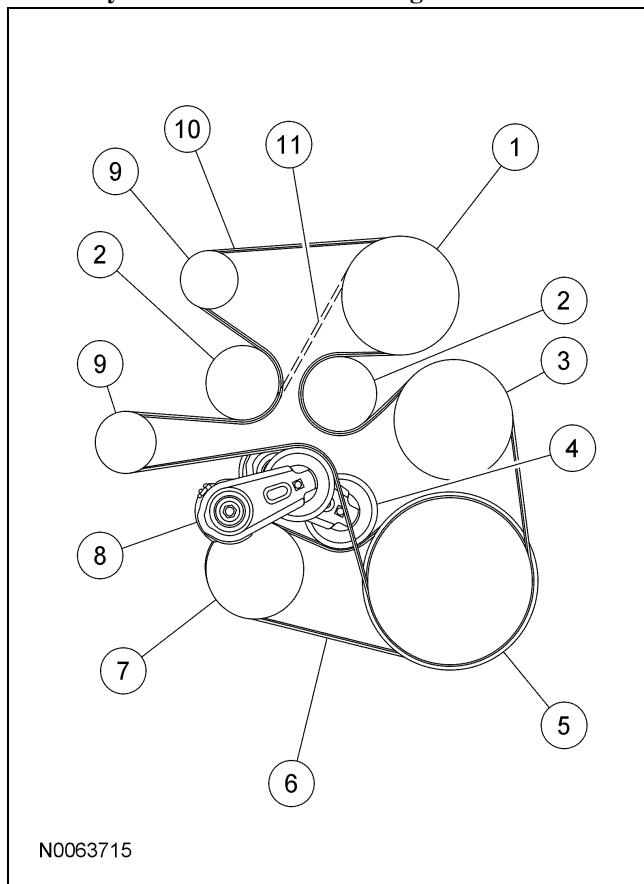
- has a single serpentine drive belt (without A/C) (8 ribs).
- has 2 serpentine drive belts (with A/C) (8 ribs).
- has 2 idler pulleys.
- has an automatic belt tensioner.
- is not adjustable.

The accessory drive system provides power to operate components which power other systems. These could include components such as the generator, power steering pump and A/C compressor. Each of these components is equipped with a pulley which is driven by the accessory drive belt. The accessory drive belt is driven by the engine crankshaft pulley. One or more idler pulleys may be provided to facilitate belt routing and alignment. The automatic belt tensioner maintains correct belt tension and compensates for component wear and changes in system load. System load changes can be caused by the A/C compressor clutch engaging or disengaging, or demand changes on other systems powered by the accessory drive belt. To maintain correct operation of this system, it is critical that the correct length drive belt be installed. The pulleys must also be correctly aligned and kept clean.

Accessory Drive — 5.4L, 6.8L With A/C



Item	Part Number	Description
1	10344	Generator pulley
2	8620	Accessory drive belt
3	3D673	Power steering pump pulley
4	8A528	Water pump pulley
5	6316	Crankshaft pulley
6	19D784	A/C clutch pulley
7	6B209	Accessory drive belt tensioner pulley
8	19A216	Accessory drive belt idler pulley

DESCRIPTION AND OPERATION (Continued)**Accessory Drive — 6.4L Diesel Engine**

Item	Part Number	Description
3	8A528	Water pump pulley
4	6B209	Accessory drive belt tensioner (A/C compressor drive belt)
5	6312	Crankshaft pulley
6	8620	Accessory drive belt (A/C compressor)
7	19D784	A/C clutch pulley
8	6B209	Accessory drive belt tensioner
9	10344	Generator pulleys
10	8620	Accessory drive belt (dual generator)
11	8620	Accessory drive belt (single generator)

Item	Part Number	Description
1	3D673	Power steering pump pulley
2	19A216	Accessory drive belt idler pulleys

(Continued)

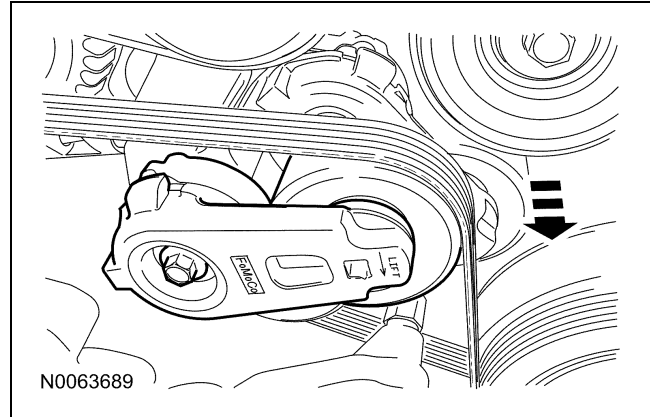
REMOVAL AND INSTALLATION

Accessory Drive Belt — 6.4L Diesel

Removal and Installation

1. Remove the cooling fan upper shroud. For additional information, refer to Section 303-03.
2. **NOTE:** The engine cooling fan has unevenly spaced blades. Position the fan to access the accessory drive belt tensioner.

Rotate the accessory drive belt tensioner clockwise and remove the accessory drive belt.



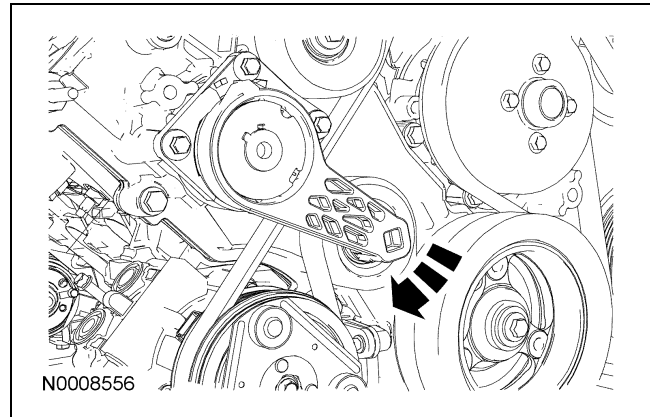
3. **NOTE:** Refer to Accessory Drive in the Description and Operation portion of this section for correct drive belt routing. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Accessory Drive Belt — Gasoline Engines

Removal and Installation

1. Rotate the drive belt tensioner clockwise and remove the accessory drive belt.



2. **NOTE:** Refer to Accessory Drive for correct drive belt routing.

To install, reverse the removal procedure.

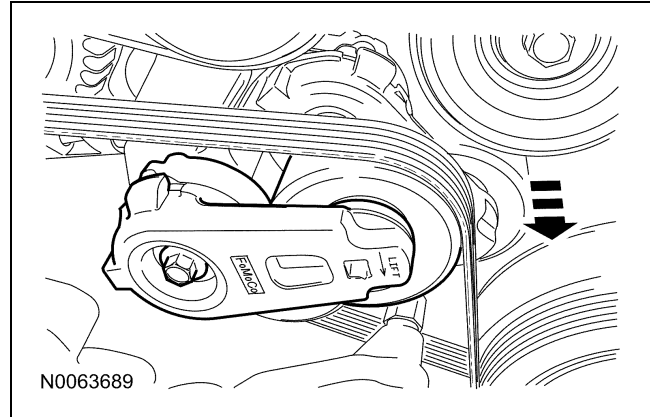
REMOVAL AND INSTALLATION

Accessory Drive Belt Idler Pulley — 6.4L Diesel

Removal and Installation

1. Remove the cooling fan upper shroud. For additional information, refer to Section 303-03.
2. **NOTE:** The engine cooling fan has unevenly spaced blades. Position the fan to access the accessory drive belt tensioner.

Rotate the accessory drive belt tensioner clockwise and remove the accessory drive belt.



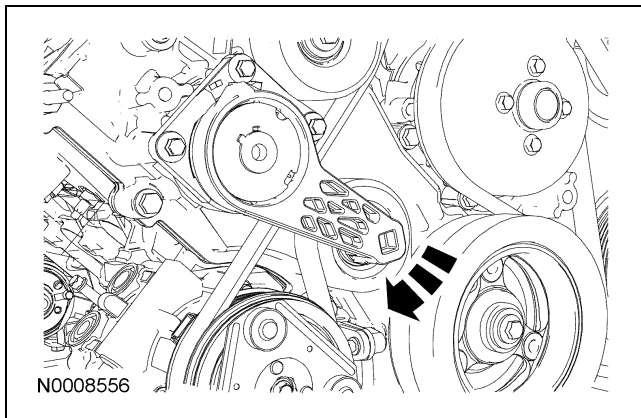
3. Remove the bolt and the accessory drive belt idler pulley.
 - To install, tighten to 47 Nm (35 lb-ft).
4. Repeat the previous step for each accessory drive belt idler pulley being serviced.
5. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Accessory Drive Belt Idler Pulley — Gasoline Engines

Removal and Installation

1. Rotate the accessory drive belt tensioner clockwise and remove the accessory drive belt.
2. Remove the bolt and the accessory drive belt idler pulley.
 - To install, tighten to 25 Nm (18 lb-ft).
3. Repeat the previous step for each accessory drive belt idler pulley being serviced.
4. To install, reverse the removal procedure.



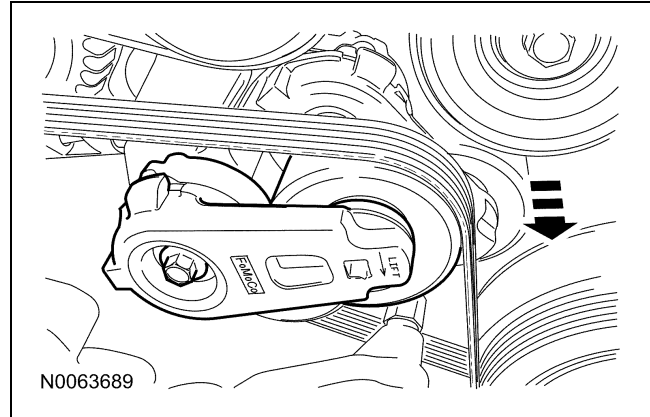
REMOVAL AND INSTALLATION

Accessory Drive Belt Tensioner — 6.4L Diesel

Removal and Installation

1. Remove the cooling fan upper shroud. For additional information, refer to Section 303-03.
2. **NOTE:** The engine cooling fan has unevenly spaced blades. Position the fan to access the accessory drive belt tensioner.

Rotate the accessory drive belt tensioner clockwise and remove the accessory drive belt.



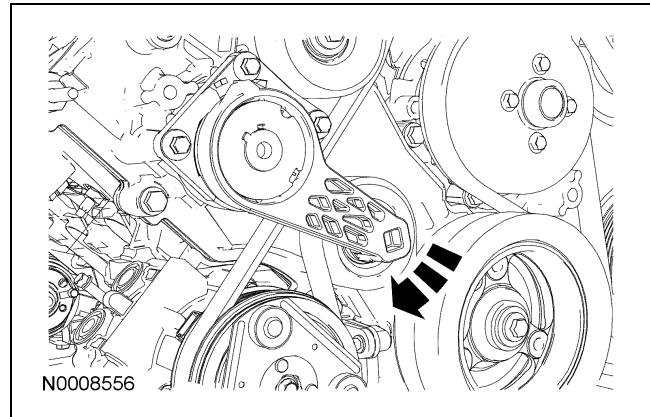
3. Remove the bolt and the accessory drive belt tensioner.
 - To install, tighten to 47 Nm (35 lb-ft).
4. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Accessory Drive Belt Tensioner — Gasoline Engines

Removal and Installation

1. Rotate the accessory drive belt tensioner clockwise and remove the accessory drive belt.



2. Remove the 3 bolts and the accessory drive belt tensioner.
 - To install, tighten to 25 Nm (18 lb-ft).
 3. To install, reverse the removal procedure.
-

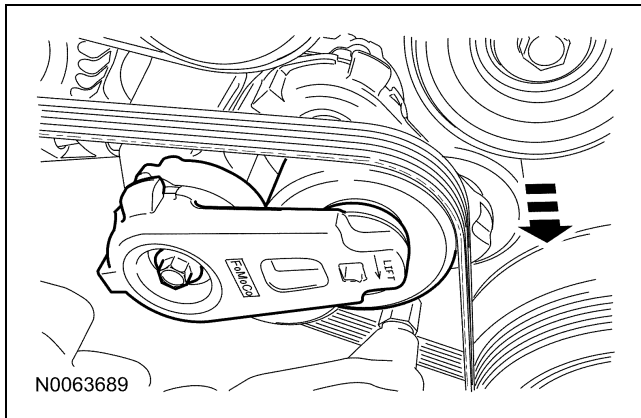
REMOVAL AND INSTALLATION

Air Conditioning (A/C) Compressor Belt — 6.4L Diesel

Removal and Installation

1. Remove the cooling fan stator. For additional information, refer to Section 303-03.
2. **NOTE:** The engine cooling fan has unevenly spaced blades. Position the fan to access the accessory drive belt tensioner.

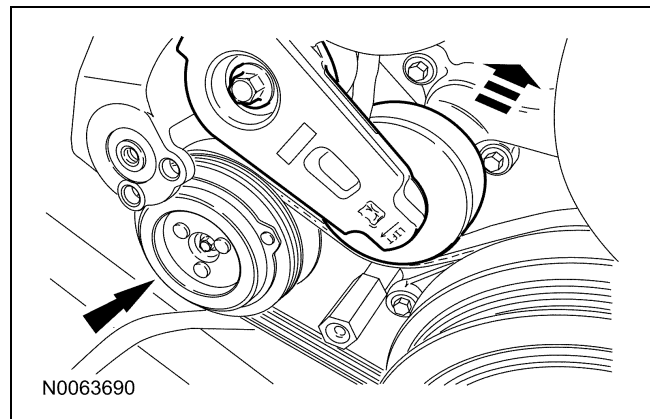
Rotate the accessory drive belt tensioner clockwise and remove the accessory drive belt.



3. **NOTE:** Accessory drive belt tensioner shown removed for clarity.

Rotate the A/C compressor belt tensioner counterclockwise and remove the A/C compressor belt.

- First detach the drive belt from the bottom of the A/C compressor pulley, then remove it from the crankshaft pulley, and finally slide the belt out from between the tensioner bracket and the A/C compressor pulley.



4. To install, reverse the removal procedure.

REMOVAL AND INSTALLATION

Air Conditioning (A/C) Compressor Belt Tensioner — 6.4L Diesel

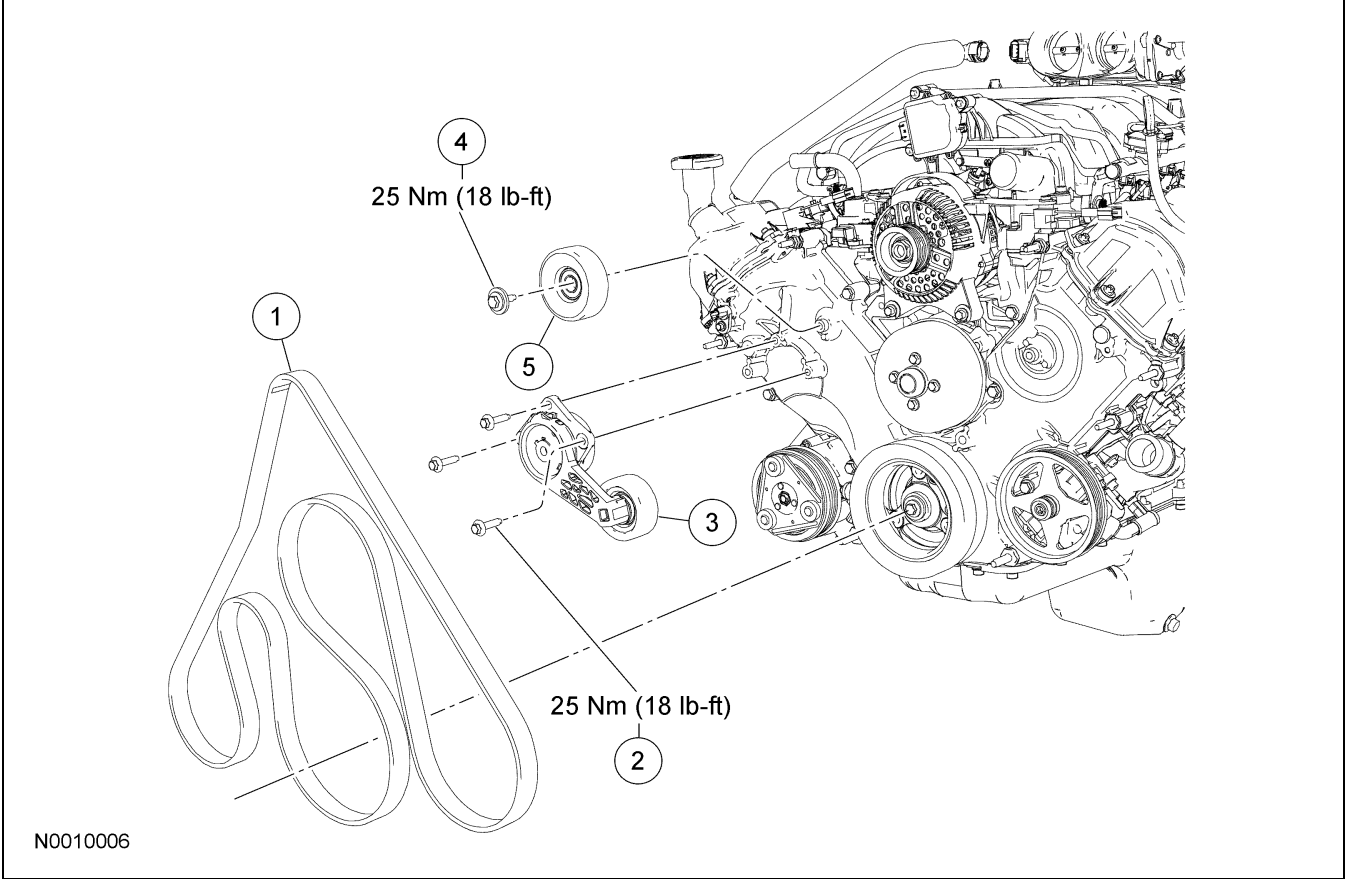
1. Remove the A/C compressor belt. For additional information, refer to Air Conditioning (A/C) Compressor Belt — 6.4L Diesel in this section.
 2. Remove the bolt and the A/C compressor belt tensioner.
 - To install, tighten to 47 Nm (35 lb-ft).
 3. To install, reverse the removal procedure.
-

REMOVAL AND INSTALLATION

Front End Accessory Drive (FEAD) —
Exploded View

Front End Accessory Drive (FEAD) Exploded View — 5.4L (3V), 6.8L (3V)

NOTE: 6.8L (3V) shown, 5.4L (3V) similar



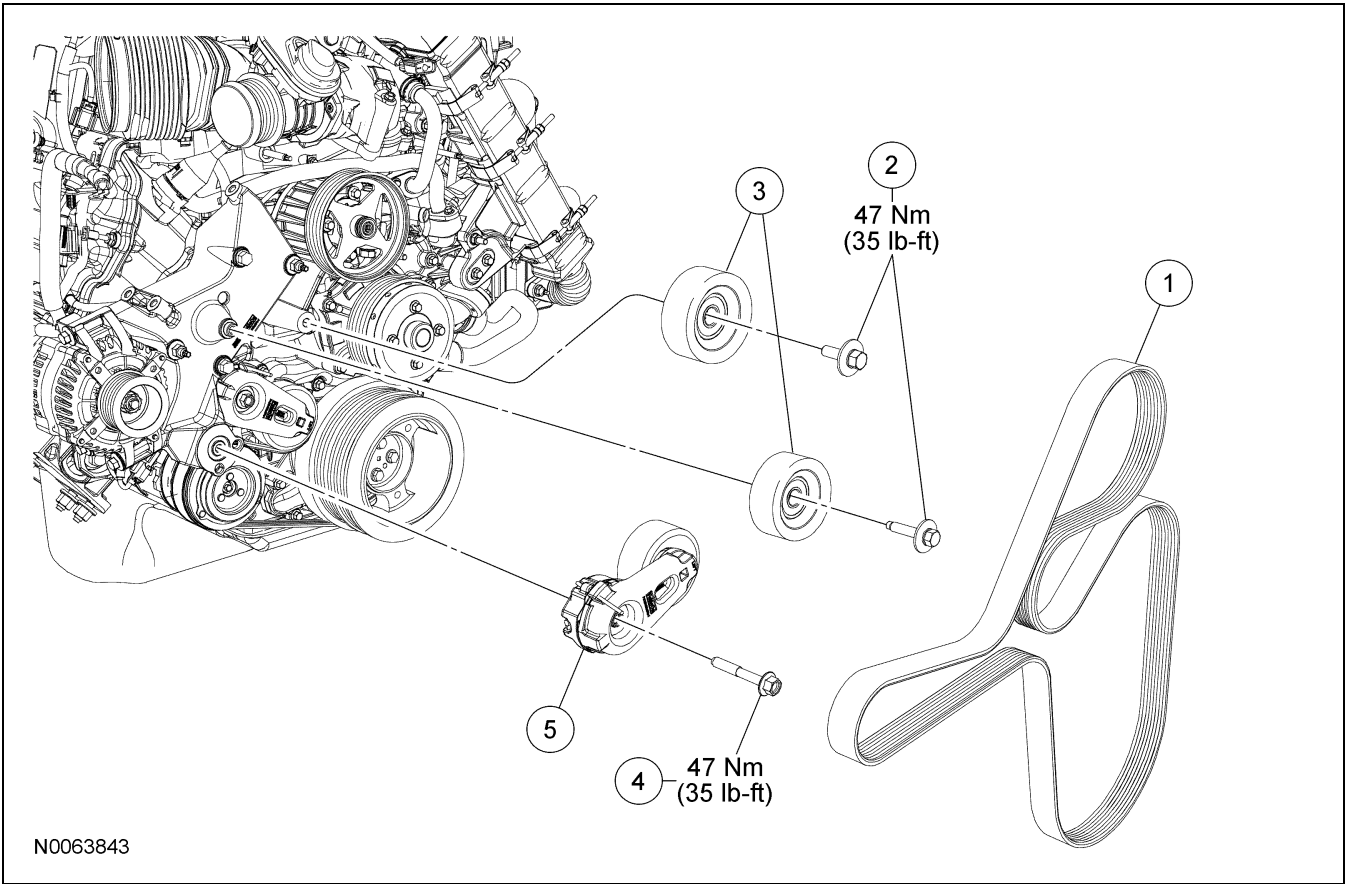
Item	Part Number	Description
1	8620	Accessory drive belt
2	N808920	Belt tensioner bolt (3 required)
3	6B209	Belt tensioner

(Continued)

Item	Part Number	Description
4	N808102	Idler pulley bolt
5	19A216	Idler pulley

REMOVAL AND INSTALLATION (Continued)

Front End Accessory Drive (FEAD) Exploded View — 6.4L Diesel With Single Generator



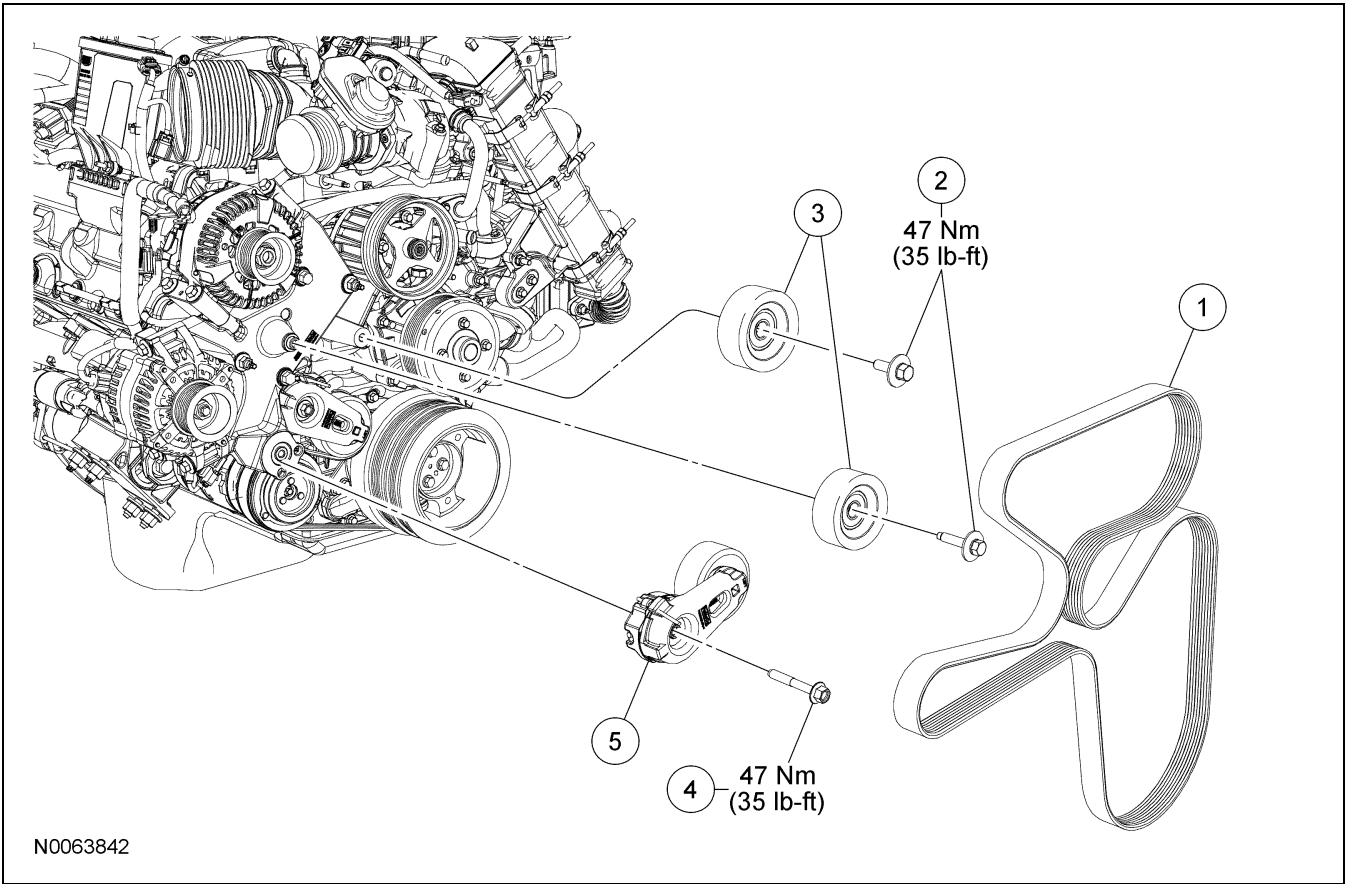
Item	Part Number	Description
1	8620	Accessory drive belt
2	—	Accessory drive belt idler pulley bolt (part of 19A216)
3	19A216	Accessory drive belt idler pulley

Item	Part Number	Description
4	—	Accessory drive belt tensioner bolt (part of 6B209)
5	6B209	Accessory drive belt tensioner assembly

(Continued)

REMOVAL AND INSTALLATION (Continued)

Front End Accessory Drive (FEAD) Exploded View — 6.4L Diesel With Dual Generators



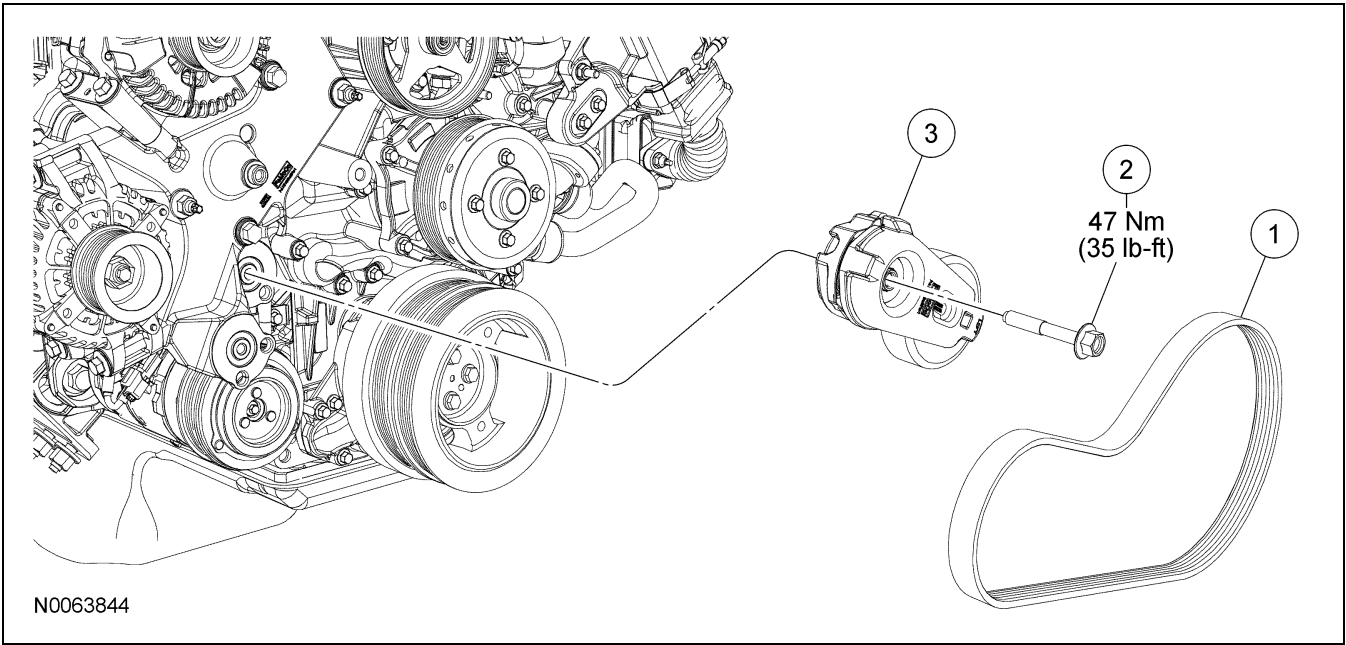
Item	Part Number	Description
1	8620	Accessory drive belt
2	—	Accessory drive belt idler pulley bolt (part of 19A216)
3	19A216	Accessory drive belt idler pulley

Item	Part Number	Description
4	—	Accessory drive belt tensioner bolt (part of 6B209)
5	6B209	Accessory drive belt tensioner assembly

(Continued)

REMOVAL AND INSTALLATION (Continued)

A/C Compressor Drive Components — 6.4L Diesel



Item	Part Number	Description
1	8620	A/C compressor drive belt
2	—	A/C drive belt tensioner bolt (part of 6B209)
3	6B209	A/C drive belt tensioner

1. For additional information, refer to the procedures in this section.

2008 Ford F-350 SUPER DUTY

Submodel: XLT | Engine Type: V8 | Liters: 5.4
Fuel Delivery: FI | Fuel: GAS

SECTION 303-05:
Accessory Drive

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DESCRIPTION AND OPERATION
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DIAGNOSIS AND TESTING
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Inspection and Verification
Symptom Chart
Component Tests
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Accessory Drive Belt Tensioner — Gasoline Engines
Accessory Drive Belt Idler Pulley — Gasoline Engines
Accessory Drive Belt — 6.4L Diesel
Accessory Drive Belt Tensioner — 6.4L Diesel
Accessory Drive Belt Idler Pulley — 6.4L Diesel
Air Conditioning (A/C) Compressor Belt — 6.4L Diesel
Air Conditioning (A/C) Compressor Belt Tensioner — 6.4L Diesel