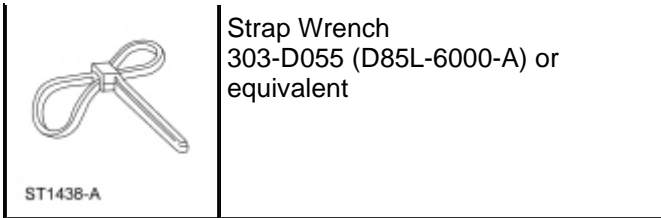


Cylinder Head

Special Tool(s)

 ST1718-A	Compressor, Valve Spring 303-452 (T93P-6565-AR)
 ST1341-A	Heavy Duty Floor Crane 014-00071 or equivalent
 ST1335-A	Holding Tool, Crankshaft 303-448 (T93P-6303-A)
 ST2197-A	Installer, Crankshaft Front Oil Seal 303-635
 ST1287-A	Installer, Crankshaft Vibration Damper 303-102 (T74P-6316-B)
 ST1326-A	Installer, Front Cover Oil Seal 303-335 (T88T-6701-A)
 ST1603-A	Lifting Bracket, Engine (2 required) 303-D087 (D93P-6001-A1) or equivalent
 ST1602-A	Lifting Bracket, Engine 303-D089 (D93P-6001-A3) or equivalent



Material

Item	Specification
Motorcraft® Metal Surface Prep ZC-31-A	—
Motorcraft® SAE 5W-50 Full Synthetic Motor Oil XO-5W50-QGT or equivalent	WSS-M2C931- B
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	—

Both cylinder heads

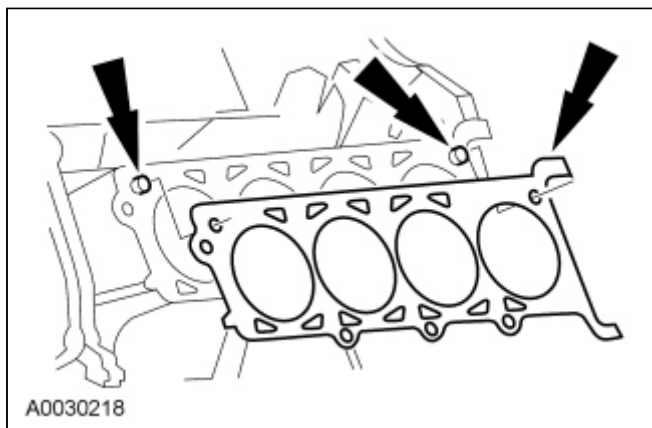
- NOTICE:** The gasket sealing surfaces on the cylinder head and the cylinder block must be clean. Failure to follow these instructions may result in engine damage. For additional information, refer to [Cylinder Head](#) in the Removal portion of this section.

NOTICE: 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 engine damage.

NOTICE: The new gasket has a film coating which is crucial to the ability of the gasket to seal correctly. Do not scratch the gasket.

NOTE: RH head gasket shown, LH head gasket similar.

Install the head gasket over the dowel pins.



- NOTICE:** Cylinder head machining or milling is not authorized by the Ford Motor Company. Cylinder head flatness must be within 0.0254 mm (0.001 in) across a 38.1 mm (1.5 in) square area. Failure to follow these instructions may result in engine damage.

NOTICE: The gasket sealing surfaces on the cylinder head and the cylinder block must be clean. 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.

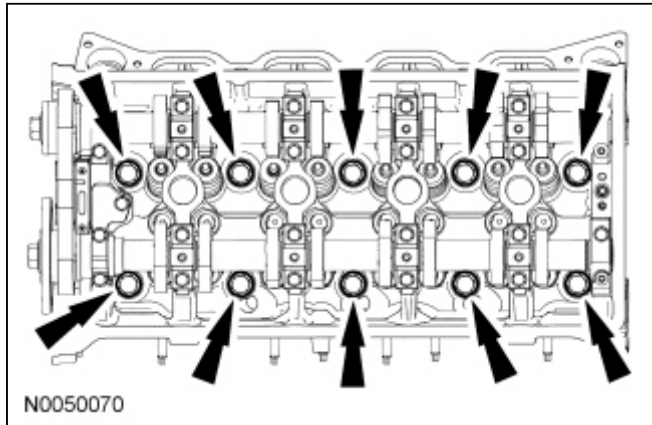
NOTICE: The use of sealing aids (aviation cement, copper spray and glue) is not permitted. The gasket must be installed dry. Failure to follow these instructions may result in engine damage.

NOTICE: Do not allow the dowels to scratch the sealing surface of the cylinder head during cylinder head installation. Failure to follow these instructions may result in engine damage.

NOTE: LH shown, RH similar.

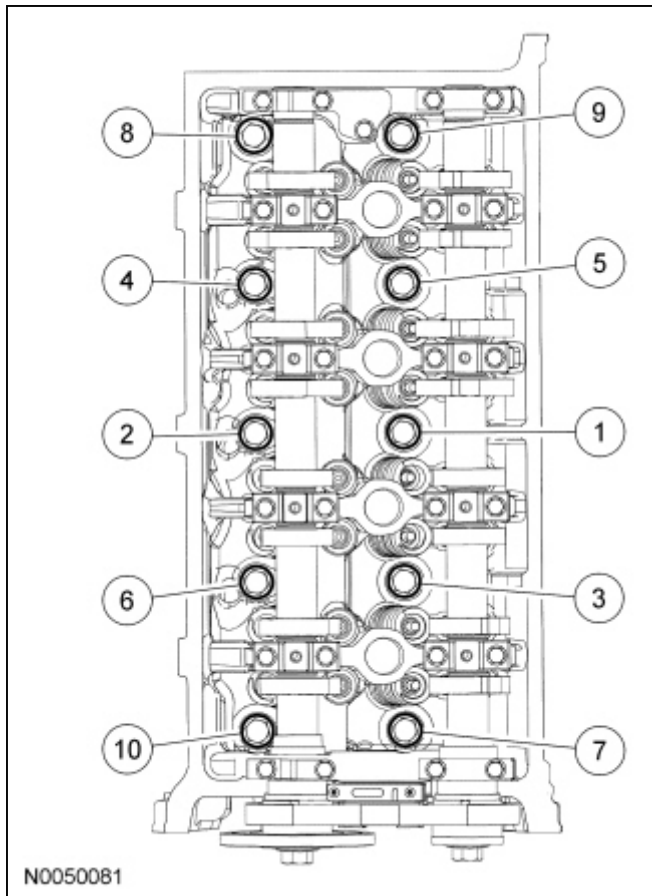
Install the cylinder head on the dowels and the head gasket.

- Loosely install the new bolts.

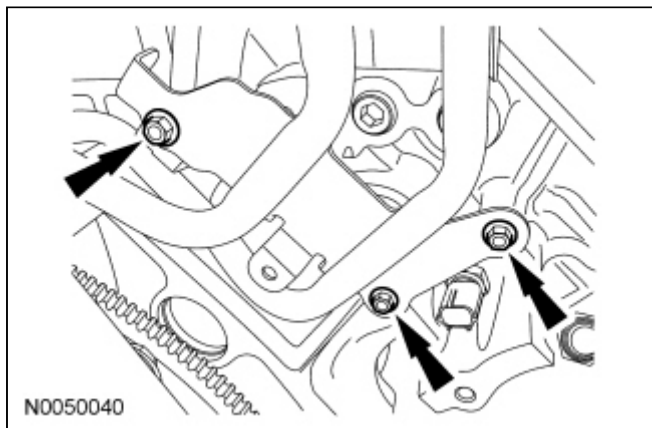


RH cylinder head

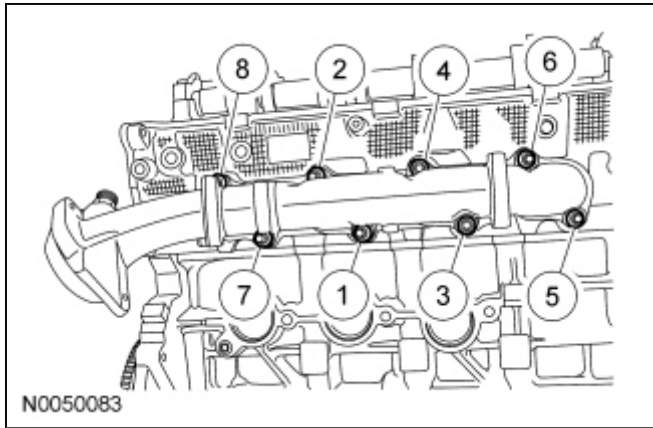
3. Tighten the new cylinder head bolts in 5 stages in the sequence shown.
 - Stage 1: Tighten to 20 Nm (177 lb-in).
 - Stage 2: Tighten to 50 Nm (37 lb-ft).
 - Stage 3: Tighten to 80 Nm (59 lb-ft).
 - Stage 4: Tighten an additional 90 degrees.
 - Stage 5: Tighten an additional 90 degrees.



4. Install the 3 coolant tube assembly bolts.
 - Tighten 10 Nm (89 lb-in).

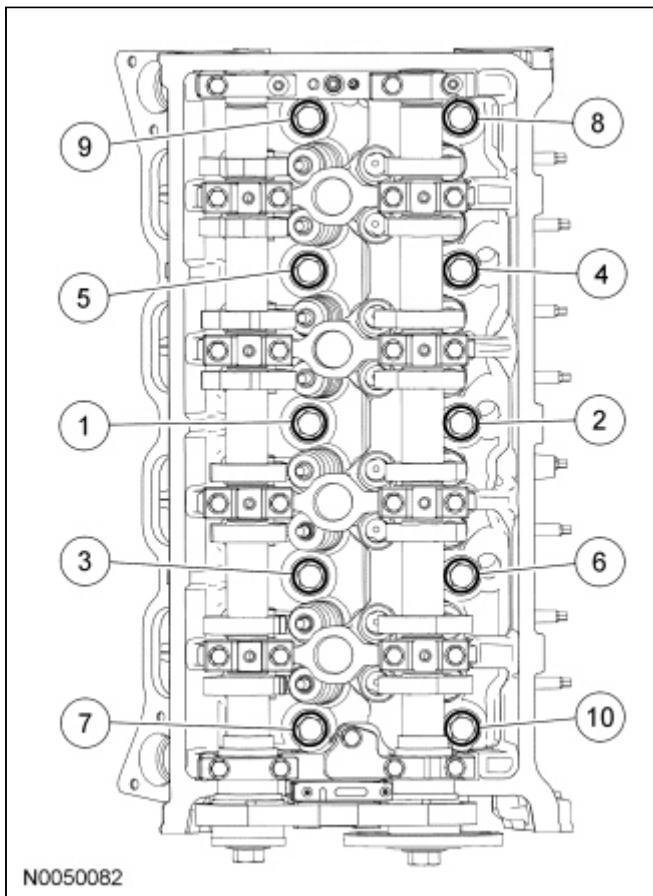


5. Install 8 new RH exhaust manifold studs.
 - Tighten to 12 Nm (106 lb-in).
6. Install new RH exhaust manifold gaskets, the RH exhaust manifold and 8 new nuts.
 - Tighten in the sequence shown to 20 Nm (177 lb-in).

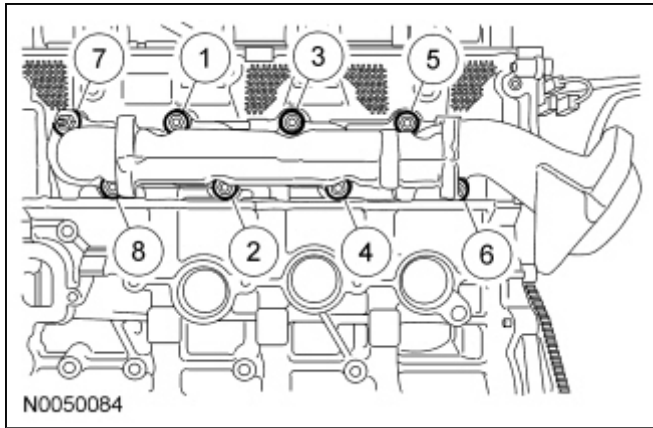


LH cylinder head

7. Tighten the new cylinder head bolts in 5 stages in the sequence shown.
 - Stage 1: Tighten to 20 Nm (177 lb-in).
 - Stage 2: Tighten to 50 Nm (37 lb-ft).
 - Stage 3: Tighten to 80 Nm (59 lb-ft).
 - Stage 4: Tighten an additional 90 degrees.
 - Stage 5: Tighten an additional 90 degrees.



8. Install 8 new LH exhaust manifold studs.
 - Tighten to 12 Nm (106 lb-in).
9. Install new LH exhaust manifold gaskets, the LH exhaust manifold and 8 new nuts.
 - Tighten in the sequence shown to 20 Nm (177 lb-in).

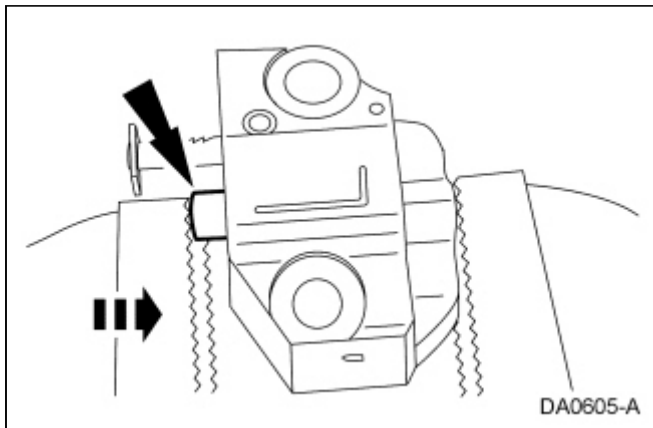


Both cylinder heads

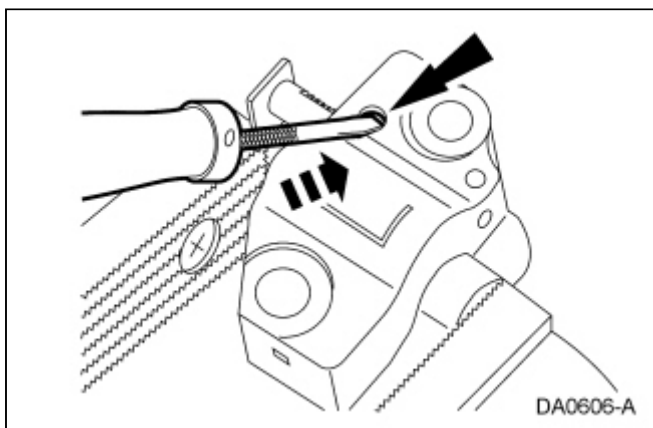
10. **NOTICE:** Do not compress the ratchet assembly. This will damage the ratchet assembly.

NOTE: LH shown, RH similar.

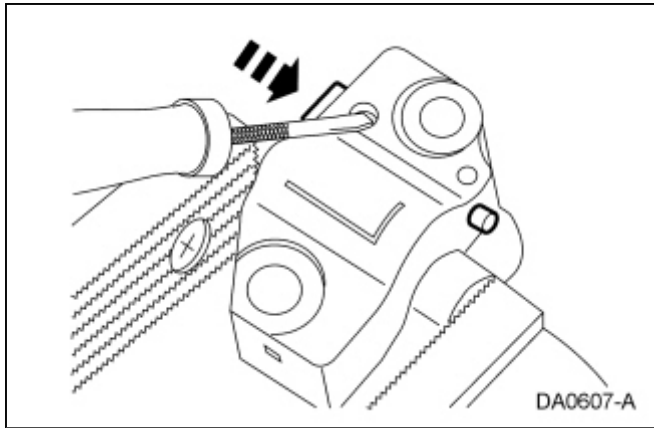
Compress each tensioner plunger, using an edge of a vise.



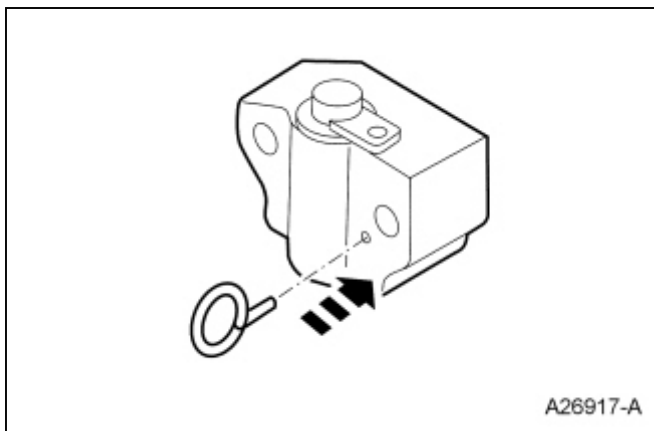
11. Using a small screwdriver or pick, push back and hold the ratchet mechanism.



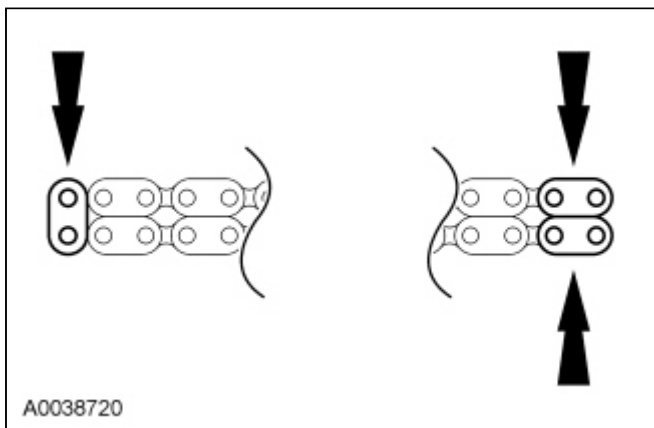
12. While holding the ratchet mechanism, push the ratchet arm back into the tensioner housing.



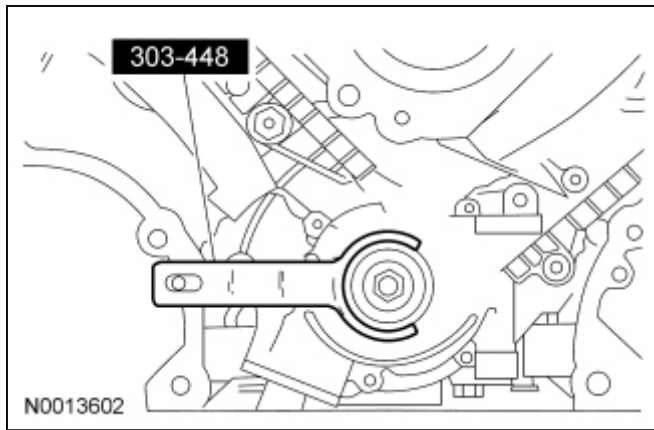
13. Install a suitable pin into the hole of each tensioner housing to hold the ratchet assembly and plunger in place during installation.
- Remove the tensioner from the vise.



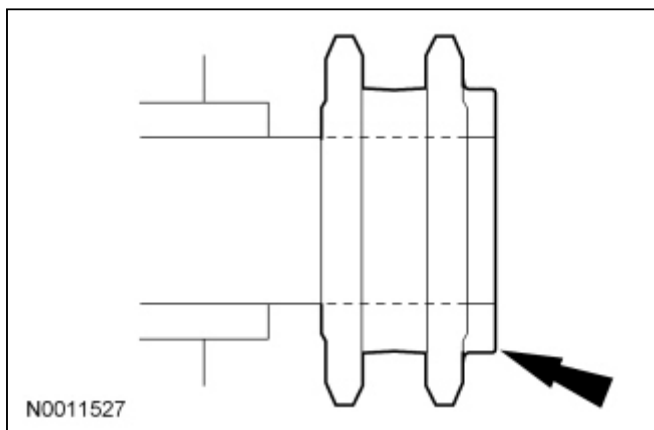
14. If the colored links are not visible, mark one link on one end and 2 links on the other end, and use as timing marks.



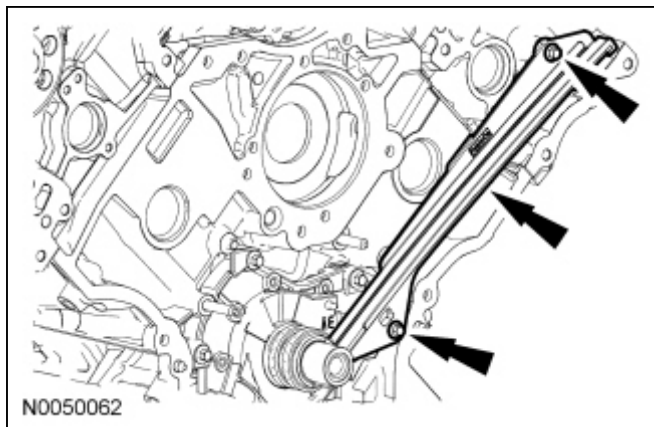
15. Using the Crankshaft Holding Tool, position the crankshaft.



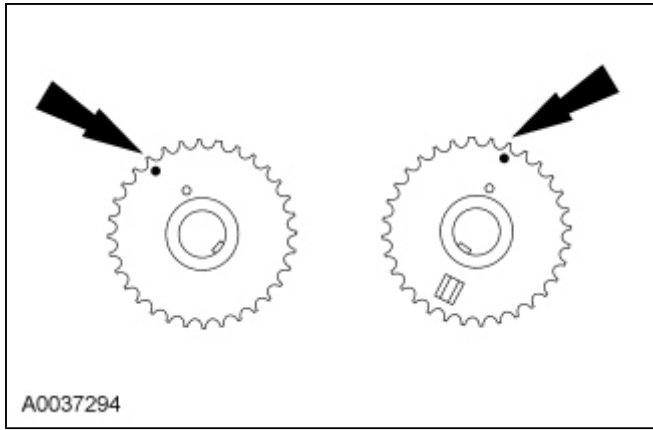
16. Install the crankshaft sprocket with the flange facing forward.



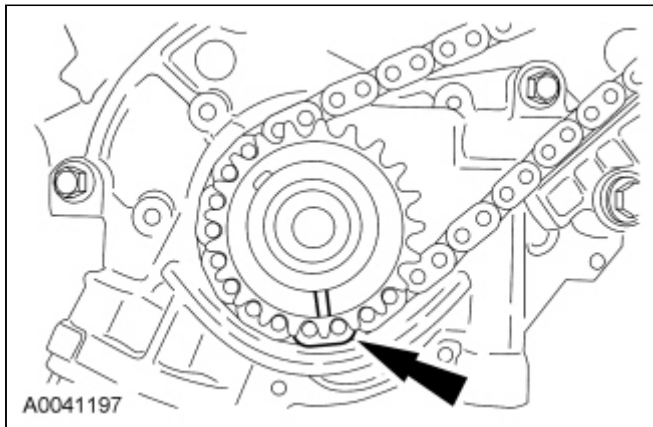
17. Install the LH primary timing chain guide and the 2 bolts.
• Tighten to 10 Nm (89 lb-in).



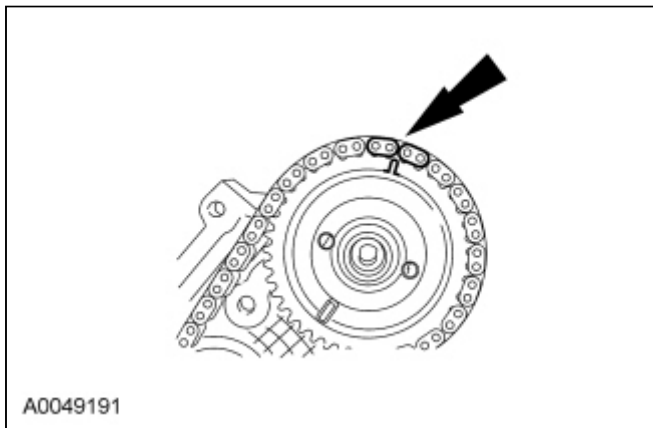
18. Position the camshaft sprocket timing marks as shown.



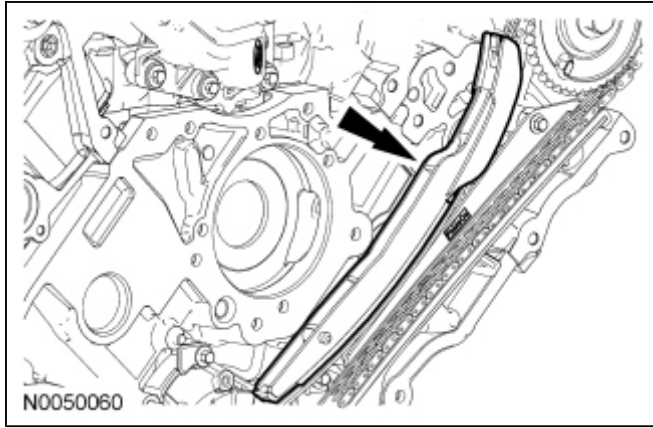
19. Position the LH (inner) timing chain onto the crankshaft sprocket, aligning the one colored link on the timing chain with the slot on the crankshaft sprocket.



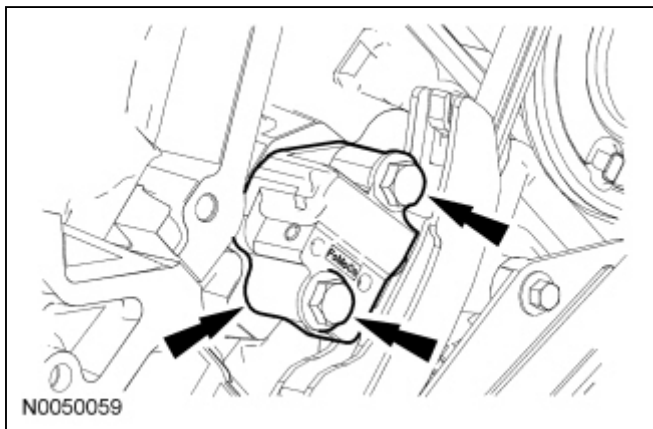
20. Install the LH timing chain on the camshaft sprocket, aligning the 2 colored links with the timing mark on the sprocket.



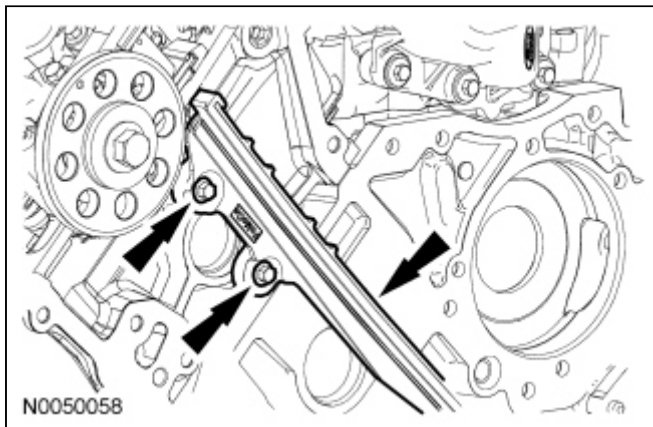
21. Install the LH primary timing chain tensioner arm.



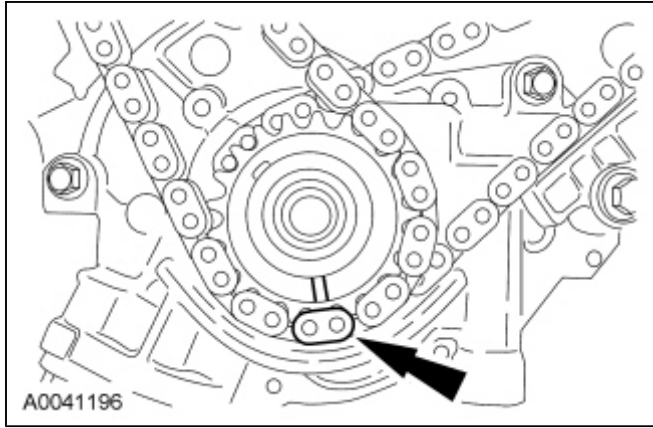
22. Install the LH primary timing chain tensioner and the 2 bolts.
- Tighten to 25 Nm (18 lb-ft).
 - Remove the pin from the tensioner.



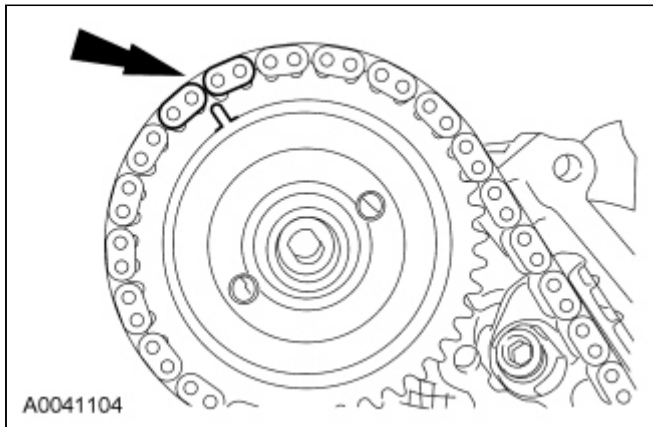
23. Install the RH primary timing chain guide and the 2 bolts.
- Tighten to 10 Nm (89 lb-in).



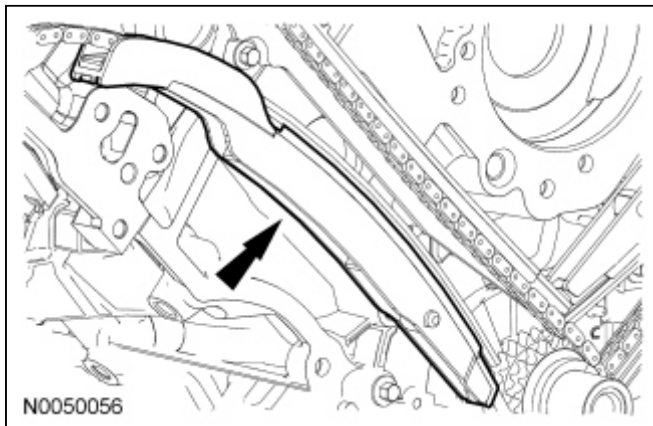
24. Position the RH (outer) timing chain on the crankshaft sprocket, aligning the colored link with the timing marks on the sprocket.



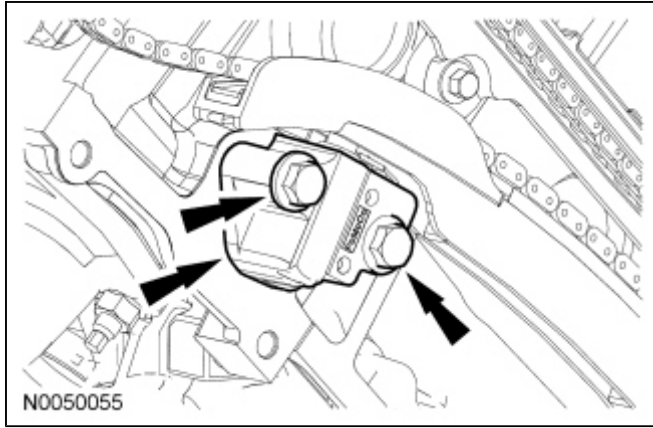
25. Install the RH timing chain on the camshaft sprocket, aligning the 2 colored links with the timing mark on the sprocket.



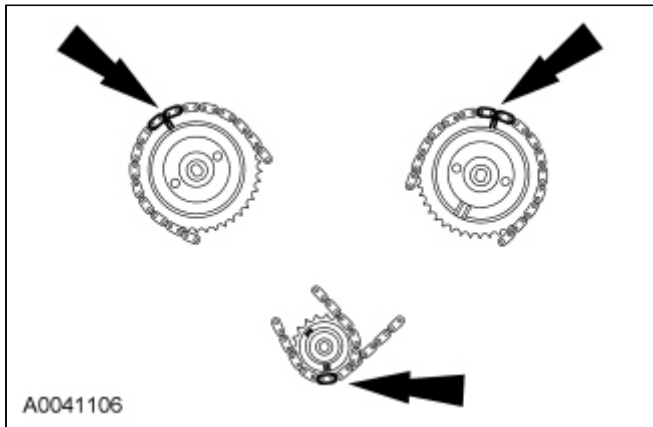
26. Install the RH primary timing chain tensioner arm.



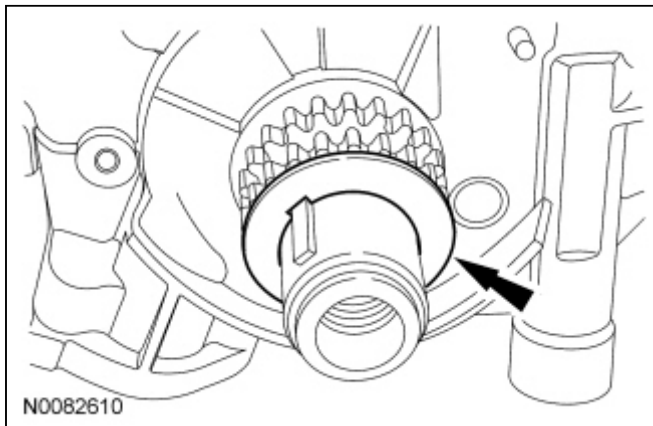
27. Install the RH primary timing chain tensioner and the 2 bolts.
- Tighten to 25 Nm (18 lb-ft).
 - Remove the pin from the tensioner.



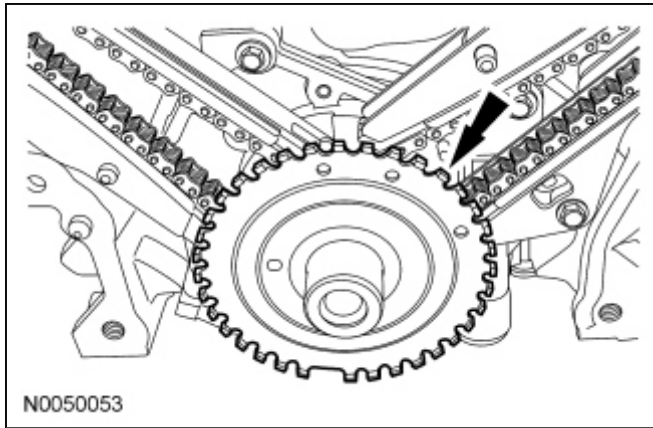
28. As a post-check, verify correct alignment of all timing marks. Make sure that the colored links are lined up with the marks on the crankshaft sprocket and the camshaft sprockets.



29. Install the crankshaft washer.

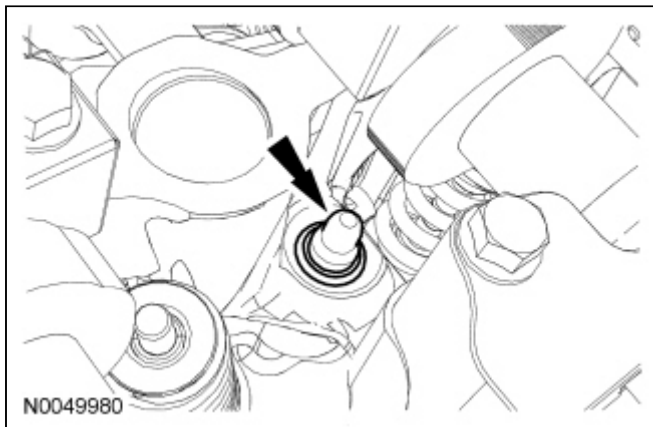


30. Install the crankshaft sensor ring.



31. **NOTICE:** If the components are to be reinstalled, they must be installed in their original positions or damage to the engine may occur.

Install the hydraulic lash adjusters.



32. Using the Valve Spring Compressor, compress the valve spring and install the roller follower.



33. Repeat the previous step to install all the roller followers.
34. **NOTICE:** Only use hand tools when removing or installing the spark plugs, or damage may occur to the cylinder head or spark plugs.

NOTE: RH shown, LH similar.

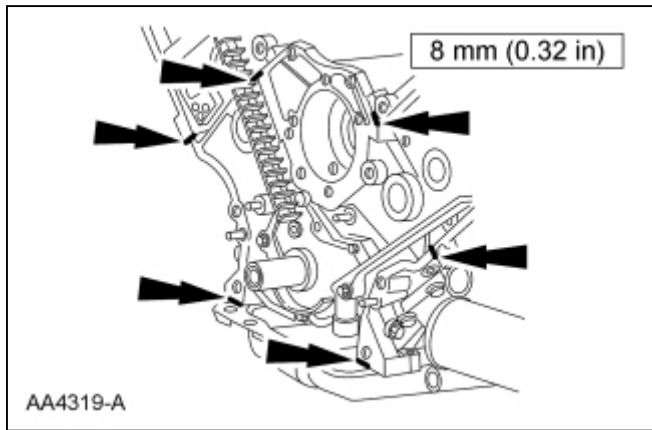
Install the 8 spark plugs.

- Tighten to 18 Nm (159 lb-in).

35. **NOTE:** If the engine front cover is not secured within 4 minutes, the sealant must be removed and the sealing area cleaned with metal surface prep. Allow to dry until there is no sign of wetness or 4 minutes,

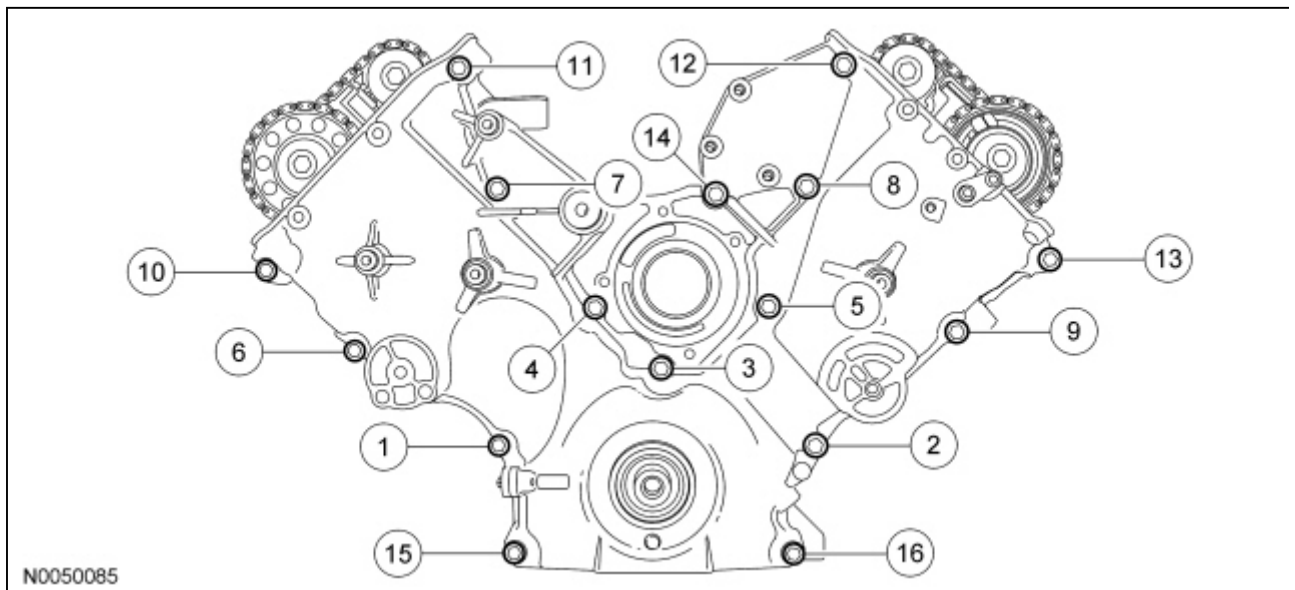
whichever is longer. Failure to follow this procedure can result in future oil leakage.

Apply silicone gasket and sealant in the locations shown.



36. Using new gaskets, install the engine front cover and the 16 bolts. Tighten the bolts in the sequence shown:

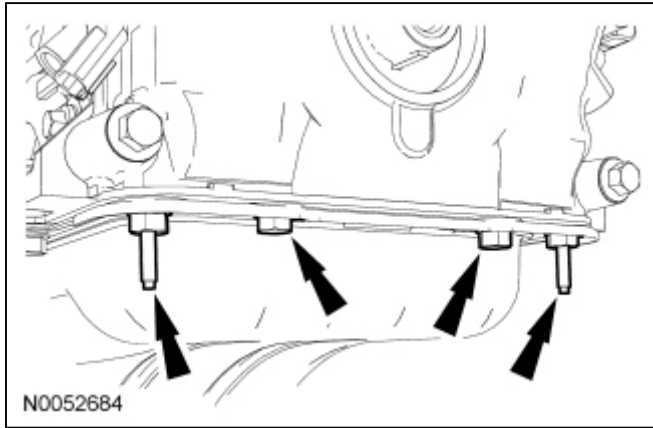
- Bolts 1 through 14 to 25 Nm (18 lb-ft).
- Bolts 15 and 16 to 50 Nm (37 lb-ft).



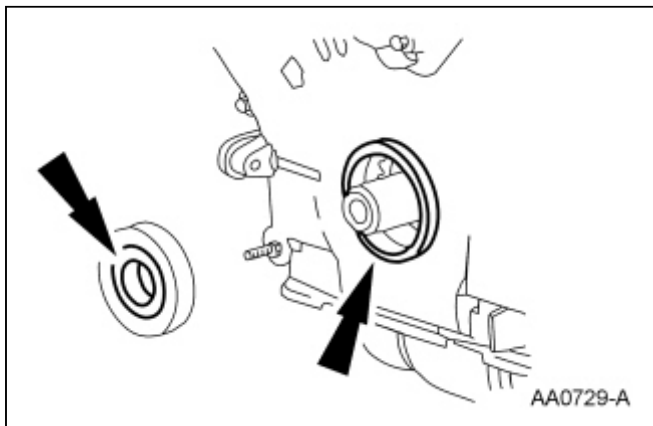
Item	Part Number	Description
1	N806177	Bolt, hex head pilot, M8 x 1.25 x 53
2	N806177	Bolt, hex head pilot, M8 x 1.25 x 53
3	N806177	Bolt, hex head pilot, M8 x 1.25 x 53
4	N806177	Bolt, hex head pilot, M8 x 1.25 x 53
5	N806177	Bolt, hex head pilot, M8 x 1.25 x 53
6	N806177	Bolt, hex head pilot, M8 x 1.25 x 53
7	N806177	Bolt, hex head pilot, M8 x 1.25 x 53
8	N806177	Bolt, hex head pilot, M8 x 1.25 x 53
9	N806177	Bolt, hex head pilot, M8 x 1.25 x 53
10	N806177	Bolt, hex head pilot, M8 x 1.25 x 53
11	N806177	Bolt, hex head pilot, M8 x 1.25 x 53
12	N806177	Bolt, hex head pilot, M8 x 1.25 x 53

13	N806177	Bolt, hex head pilot, M8 x 1.25 x 53
14	N806177	Bolt, hex head pilot, M8 x 1.25 x 53
15	N606063	Bolt, hex flange head pilot, M10 x 1.50 x 55
16	N606063	Bolt, hex flange head pilot, M10 x 1.50 x 55

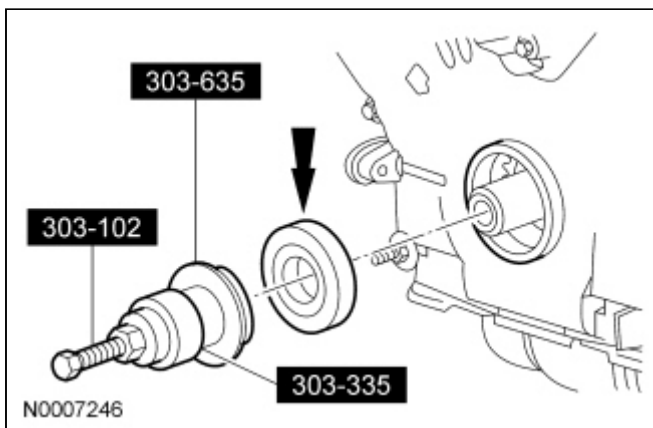
37. Install the 2 oil pan-to-engine front cover bolts and the 2 oil pan-to-engine front cover stud bolts.
- Tighten to 25 Nm (18 lb-ft).



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

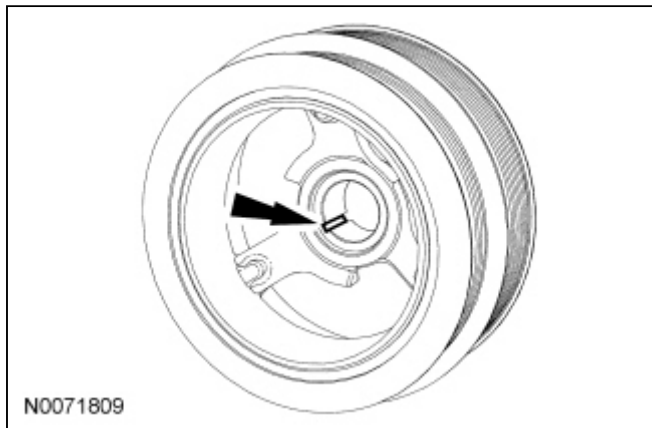


39. Using the Crankshaft Vibration Damper Installer, Front Cover Oil Seal Installer and the Crankshaft Front Oil Seal Installer, install the crankshaft front seal.

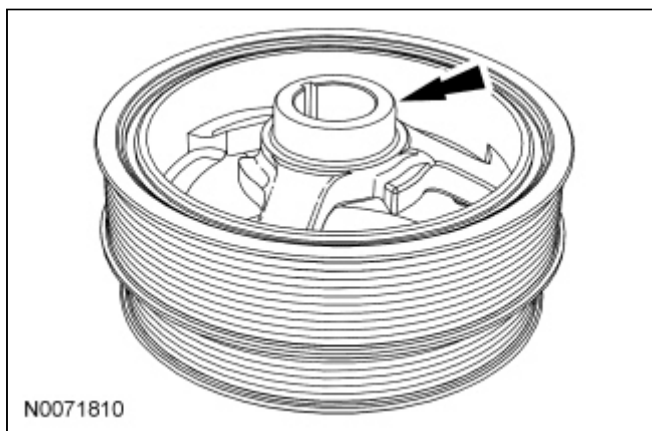


40. **NOTE:** If not secured within 4 minutes, the sealant must be removed and the sealing area cleaned. To clean the sealing area, use silicone gasket remover and metal surface prep. Follow the directions on the packaging. Failure to follow this procedure can cause future oil leakage.

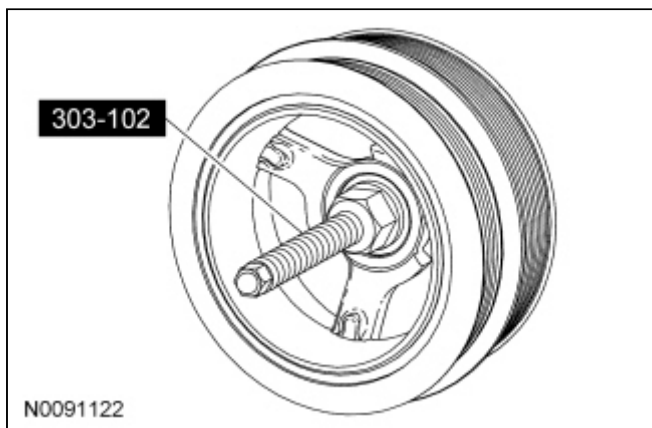
Apply silicone gasket and sealant to the Woodruff key slot on the crankshaft pulley.



41. Lubricate the crankshaft pulley sealing surface with clean engine oil prior to installation.

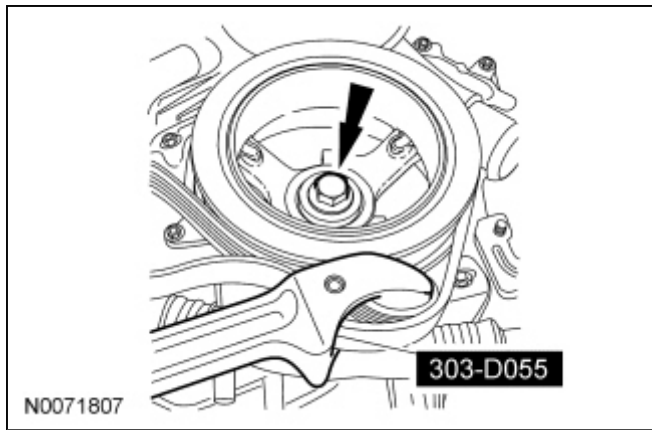


42. Using the Crankshaft Vibration Damper Installer, install the crankshaft pulley.

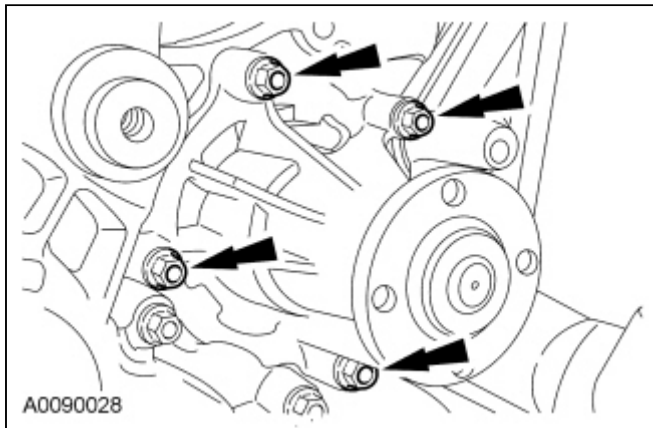


43. Using the Strap Wrench, install a new crankshaft pulley bolt and the original washer, tighten the bolt in 4 stages:

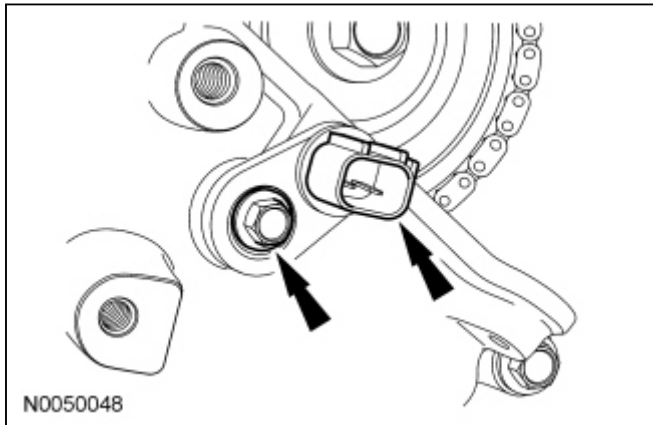
- Stage 1: Tighten to 90 Nm (66 lb-ft).
- Stage 2: Loosen one full turn.
- Stage 3: Tighten to 50 Nm (37 lb-ft).
- Stage 4: Tighten an additional 90 degrees.



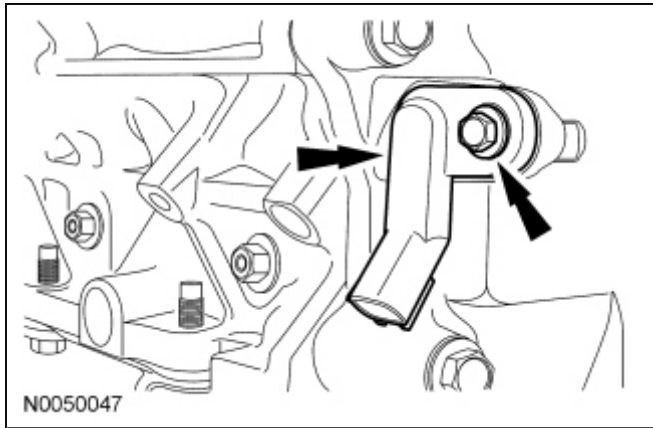
44. Install the coolant pump and the 4 bolts.
- Tighten to 25 Nm (18 lb-ft).



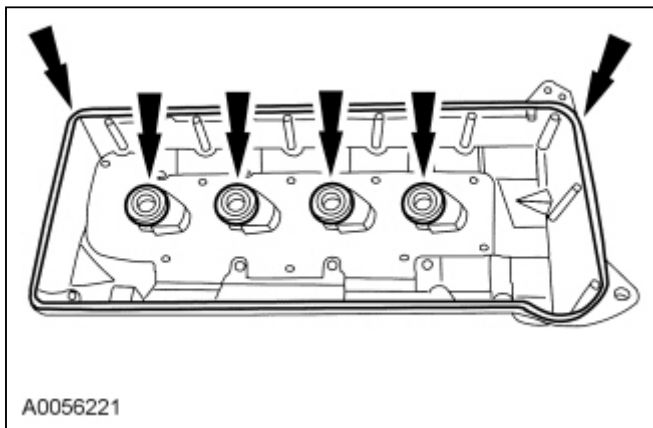
45. Install the Camshaft Position (CMP) sensor and the bolt.
- Tighten to 10 Nm (89 lb-in).



46. Install the Crankshaft Position (CKP) sensor and the bolt.
- Tighten to 10 Nm (89 lb-in).



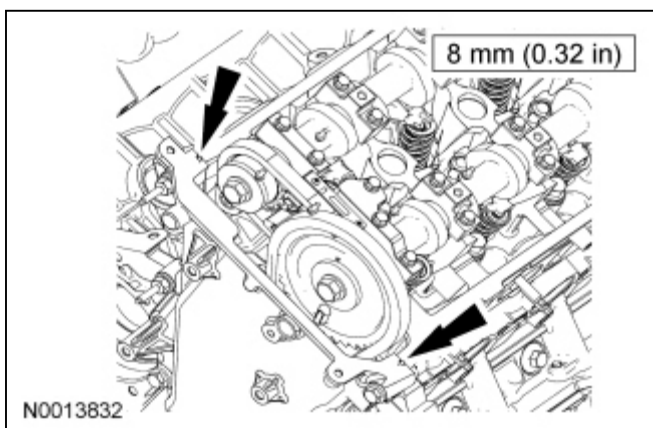
47. Install new gaskets. Make sure the gaskets are correctly seated on the valve cover.



48. **NOTE:** If the valve covers are not secured within 4 minutes, the sealant must be removed and the sealing area cleaned with metal surface prep. 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 leakage.

NOTE: LH shown, RH similar.

Apply silicone gasket sealant in the locations shown.

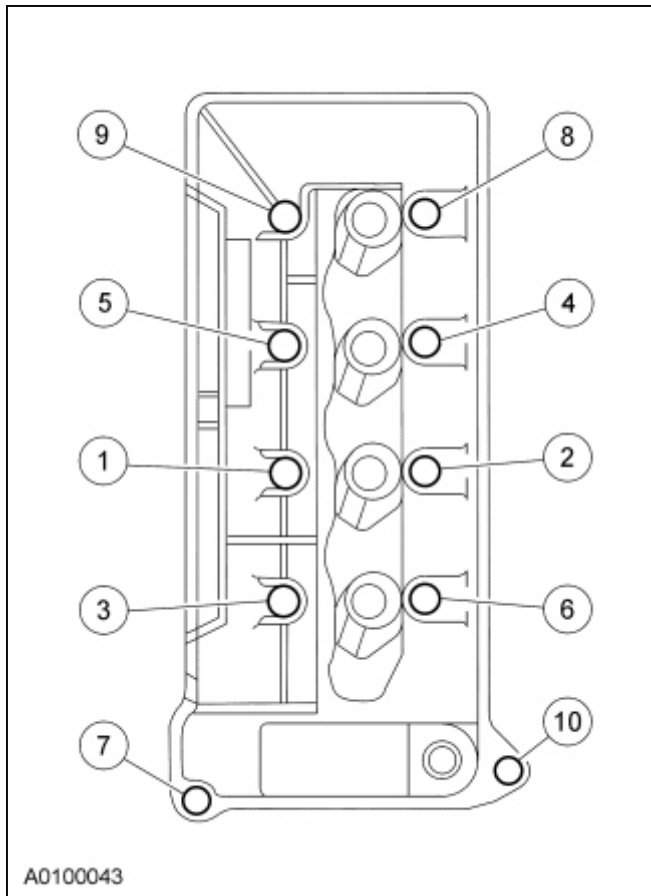


49. **NOTE:** If the valve covers are not secured within 4 minutes, the sealant must be removed and the sealing area cleaned with metal surface prep. Allow to dry until there is no sign of wetness or 4 minutes, whichever is longer. Failure to follow this procedure can cause future oil leakage.

NOTE: LH shown, RH similar.

Install the valve covers and the bolts.

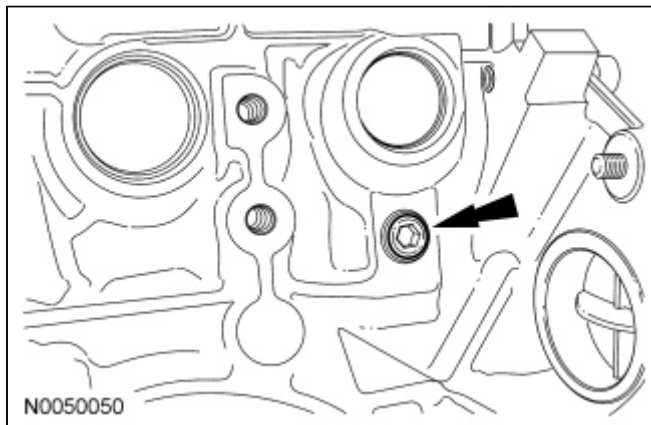
- Tighten in the sequence shown to 10 Nm (89 lb-in).



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

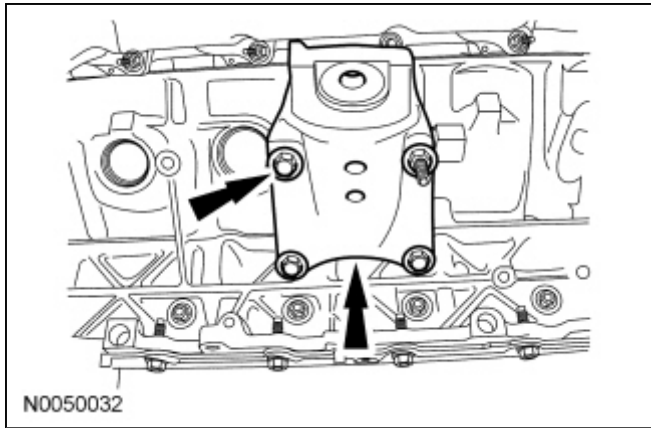
If equipped, install the LH and RH block drain plugs.

- Tighten to 14 Nm (124 lb-in).



51. Install the RH engine insulator bracket, the stud bolt, and the 3 bolts.

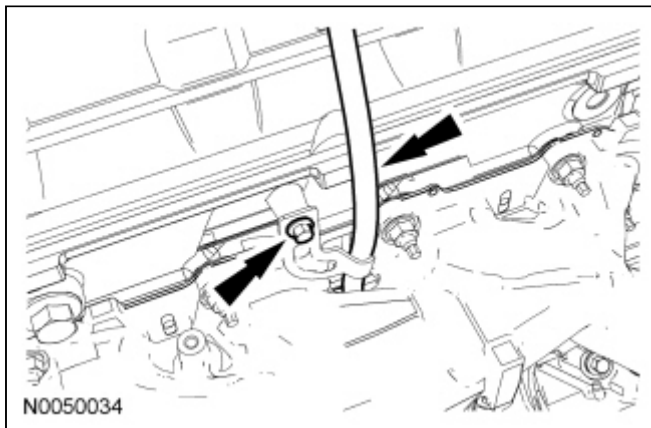
- Tighten to 80 Nm (59 lb-ft).



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

Using a new O-ring seal, install the oil level indicator tube, bolt and oil level indicator.

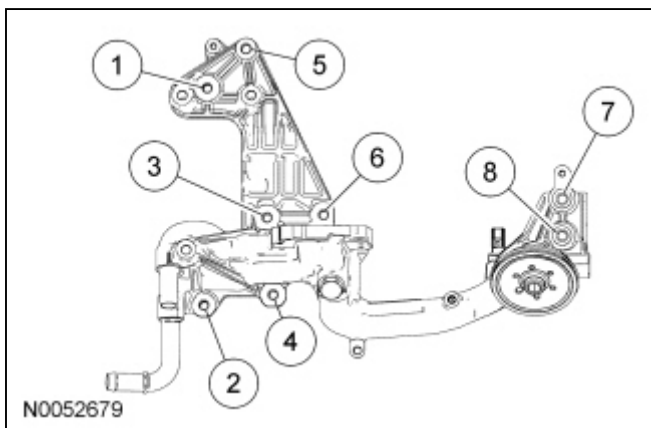
- Tighten to 10 Nm (89 lb-in).



53. **NOTE:** Clean and inspect the sealing surfaces with metal surface prep. Follow the directions on the packaging.

Using a new gasket, install the oil filter adapter and the 8 bolts.

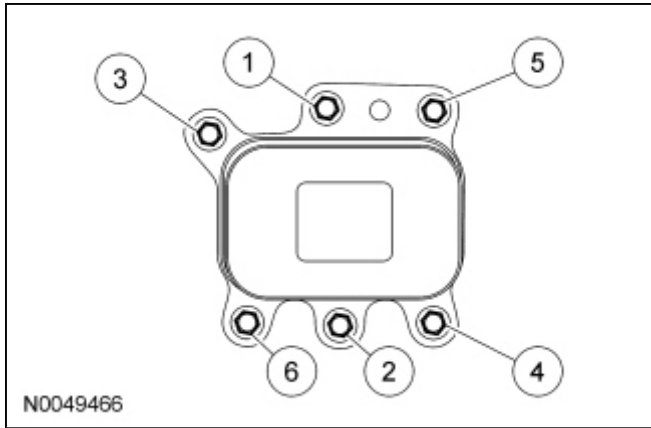
- Tighten in the sequence shown:
 - Bolts 1 through 6 to 25 Nm (18 lb-ft).
 - Bolts 7 and 8 to 50 Nm (37 lb-ft).



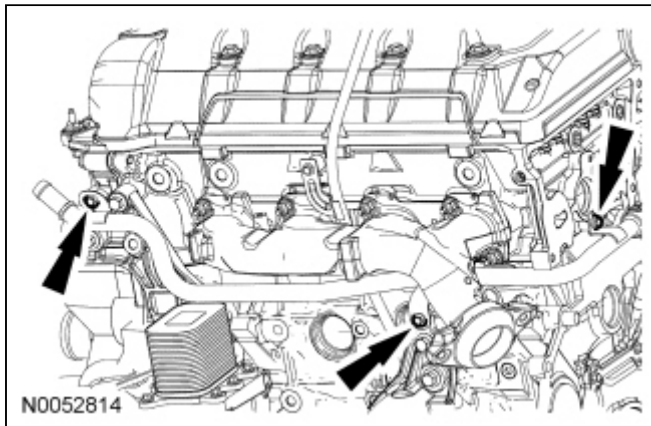
54. **NOTE:** Clean and inspect the sealing surfaces with metal surface prep. Follow the directions on the packaging.

Using a new gasket, install the oil cooler and the 6 bolts.

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



55. Install the 3 coolant tube assembly bolts.
- Tighten to 10 Nm (89 lb-in).

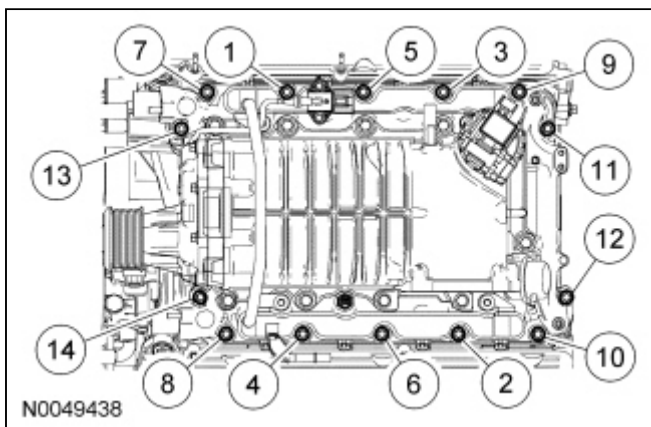


56. **NOTICE:** If the engine is repaired or replaced because of upper engine failure, typically including valve or piston damage, check the intake manifold for metal debris. If metal debris is found, install a new intake manifold. Failure to follow these instructions can result in engine damage.

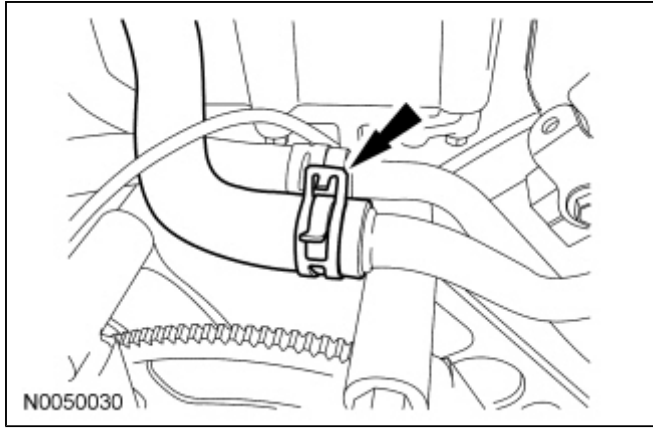
NOTE: Clean and inspect the sealing surfaces with metal surface prep. Follow the directions on the packaging.

Using new intake manifold gaskets, install the intake manifold and the 14 bolts.

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



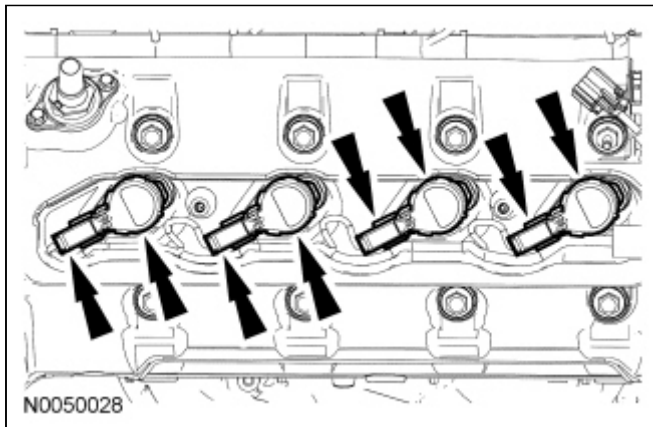
57. Connect the intake manifold-to-coolant tube assembly hose.



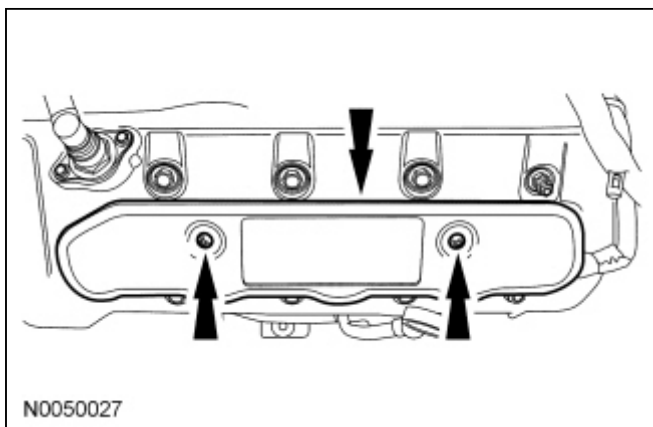
58. Position the wiring harness assembly onto the engine.
59. **NOTE:** Apply a light film of brake dielectric grease to the inside of the coil boots before installation.

Install the 4 LH coil-on-plugs.

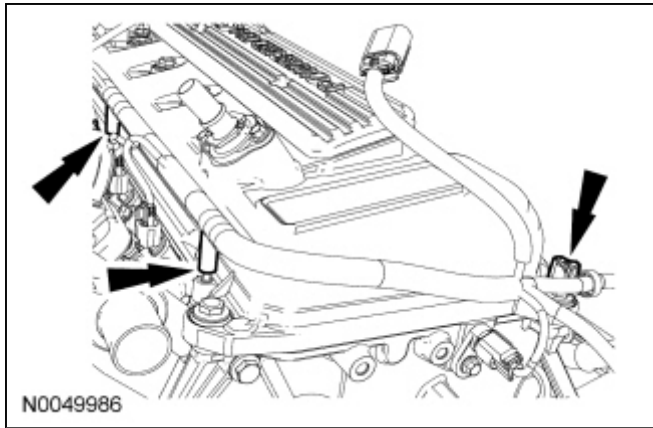
- Connect the 4 LH coil-on-plug electrical connectors.



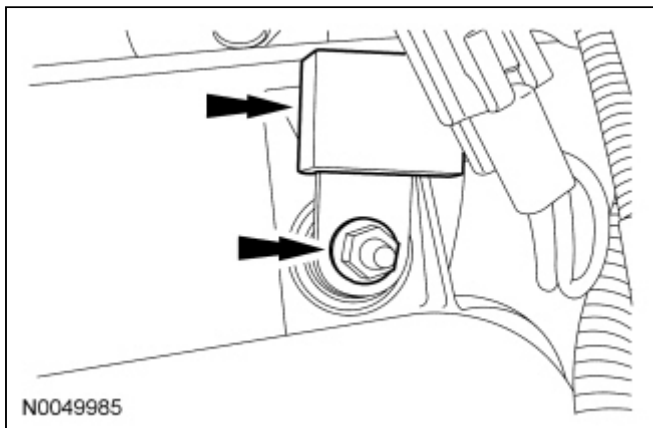
60. Install the LH coil-on-plug cover and the 2 bolts.
- Tighten to 10 Nm (89 lb-in).



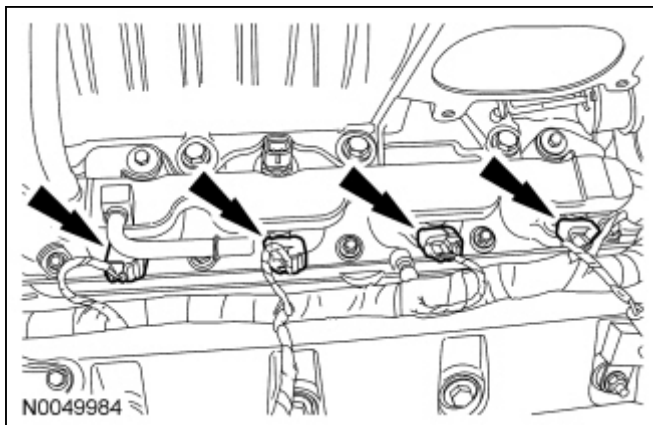
61. Attach the wiring harness retainers to the LH valve cover stud bolts.



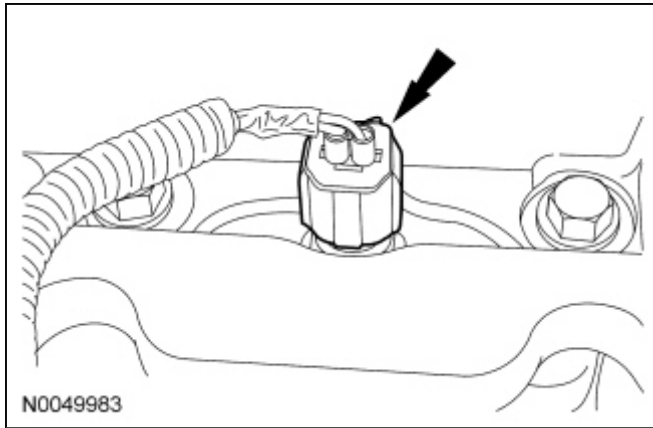
62. Install the LH radio interference capacitor and the nut.
- Tighten to 10 Nm (89 lb-in).



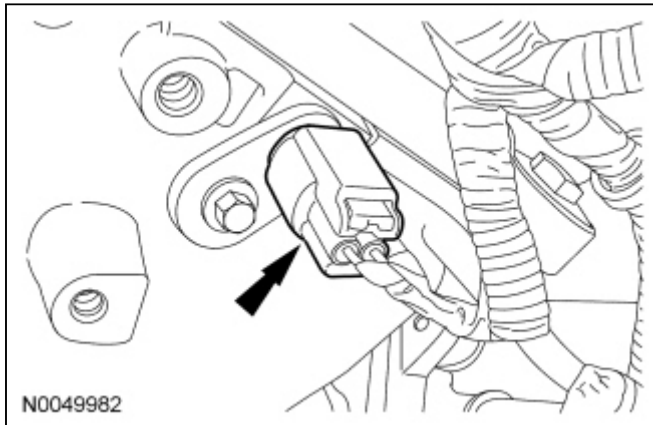
63. Connect the 4 LH fuel injector electrical connectors.



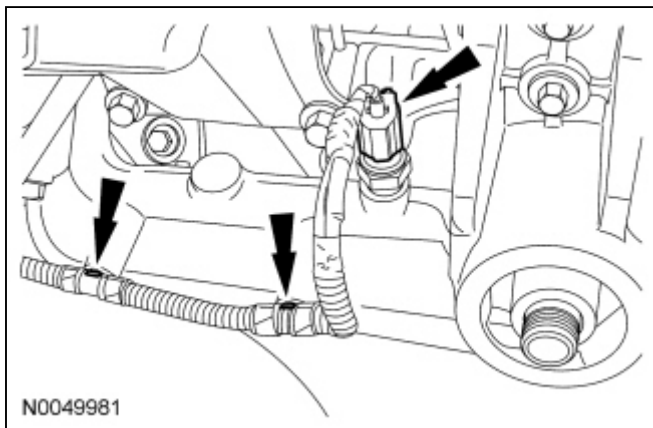
64. Connect the Intake Air Temperature 2 (IAT2) sensor electrical connector.



65. Connect the CMP sensor electrical connector.



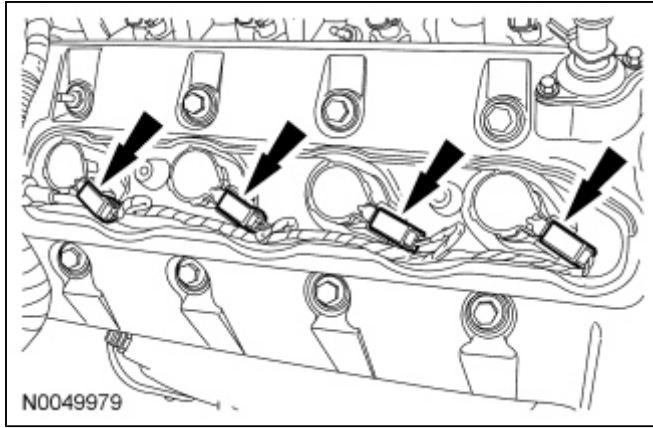
66. Connect the Engine Oil Pressure (EOP) switch electrical connector.



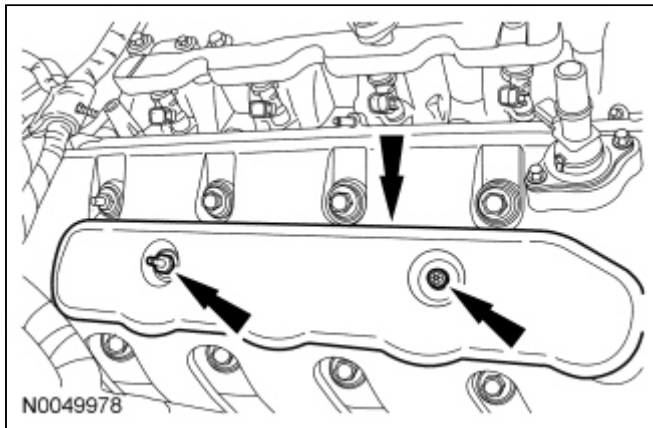
67. **NOTE:** Apply a light film of brake dielectric grease to the inside of the coil boots before installation.

Install the 4 RH coil-on-plugs.

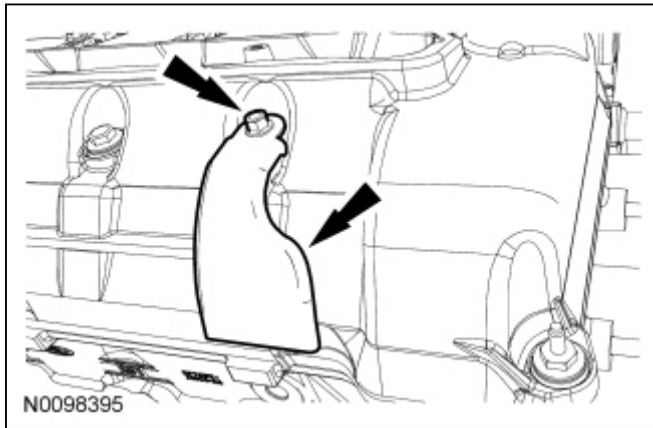
- Connect the 4 RH coil-on-plug electrical connectors.



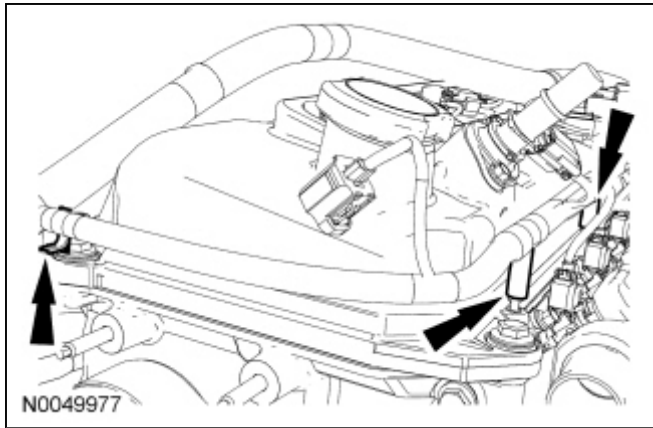
68. Install the RH coil-on-plug cover, bolt and stud bolt.
- Tighten to 10 Nm (89 lb-in).



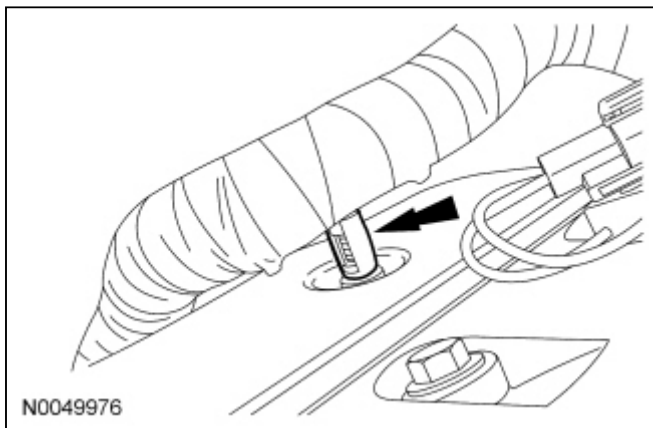
69. Install the A/C tube support bracket and nut.
- Tighten to 9 Nm (80 lb-in).



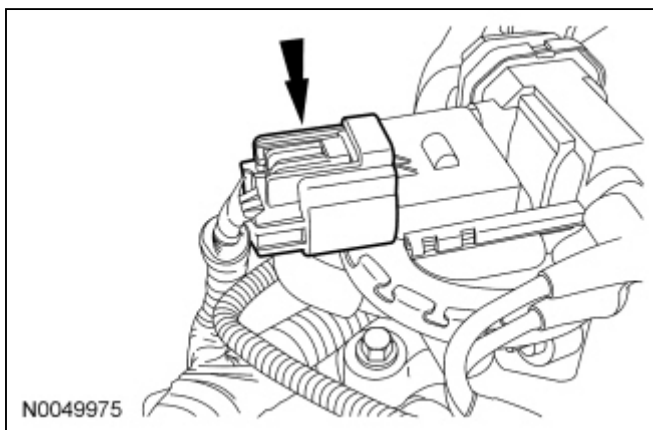
70. Attach the wiring harness retainers to the RH valve cover stud bolts.



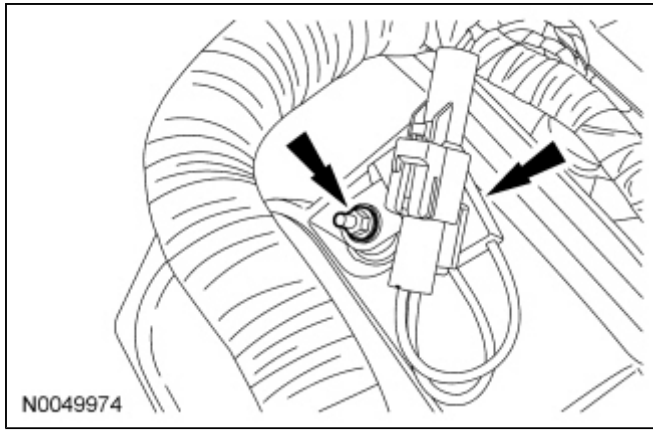
71. Attach the wiring harness to the RH coil-on-plug cover stud bolt.



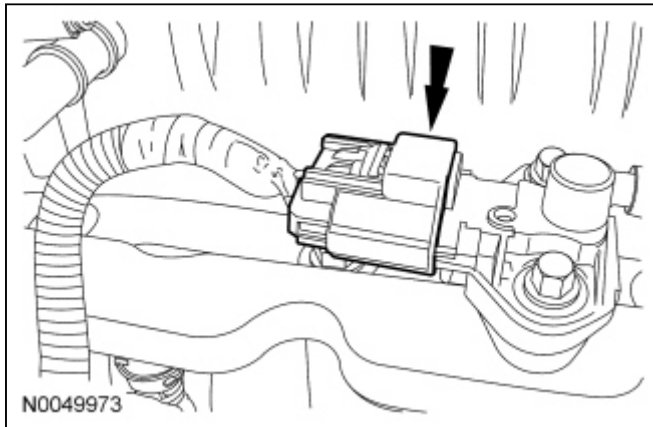
72. Connect the EGR valve electrical connector.



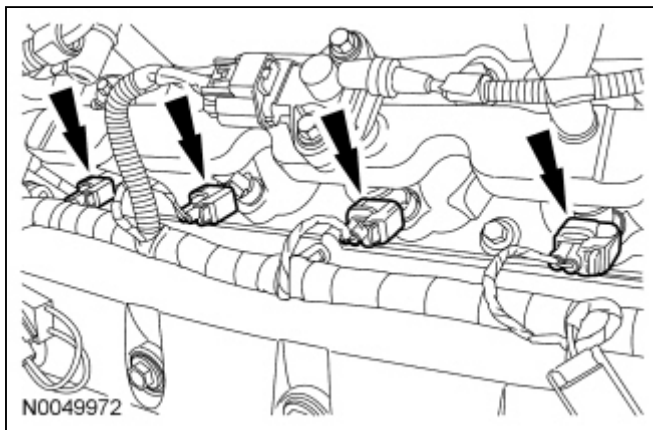
73. Install the RH radio interference capacitor and the nut.
• Tighten to 10 Nm (89 lb-in).



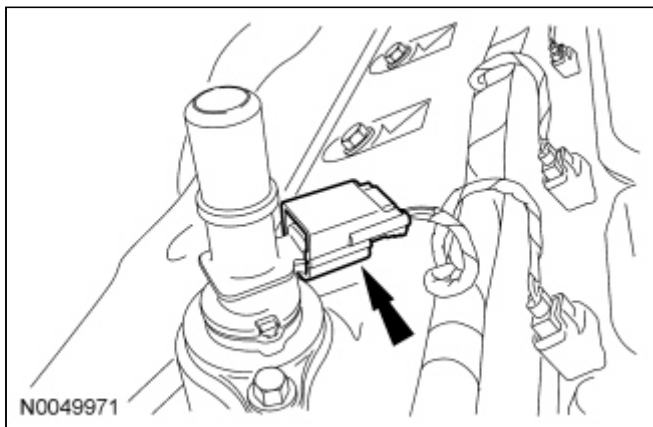
74. Connect the fuel rail pressure and temperature sensor electrical connector.



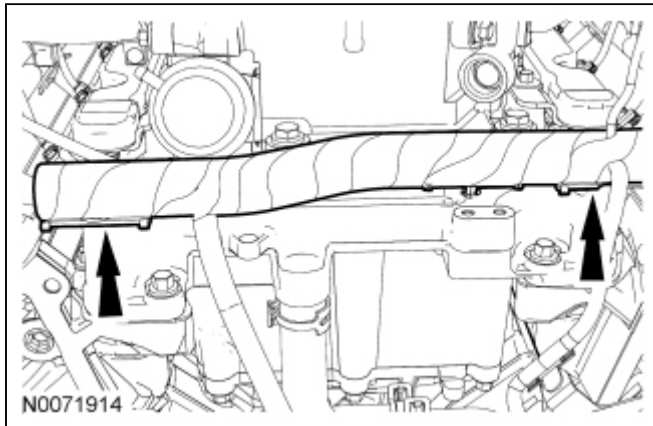
75. Connect the 4 RH fuel injector electrical connectors.



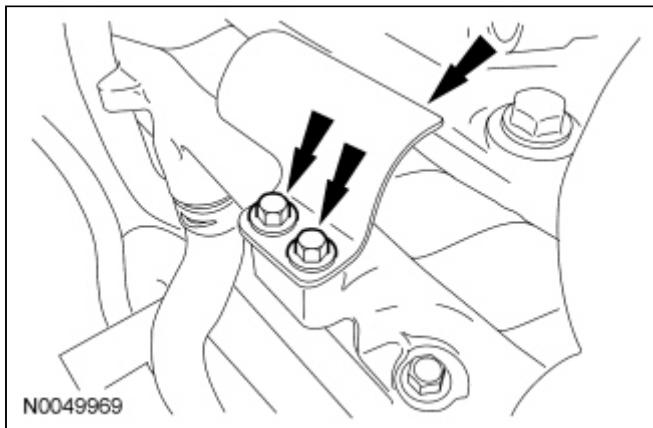
76. Connect the PCV valve electrical connector.



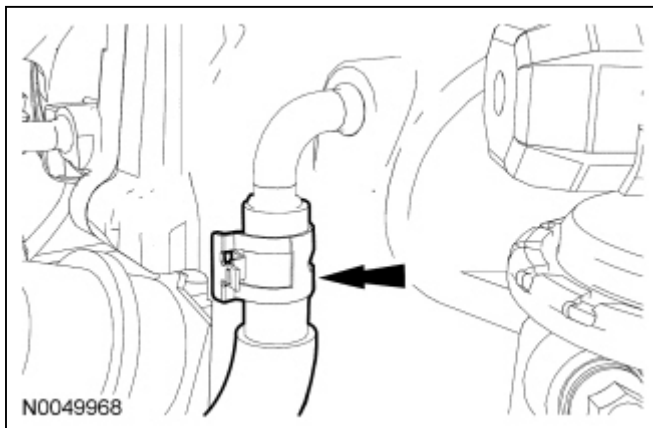
77. Attach the 2 wiring harness pin-type retainers.



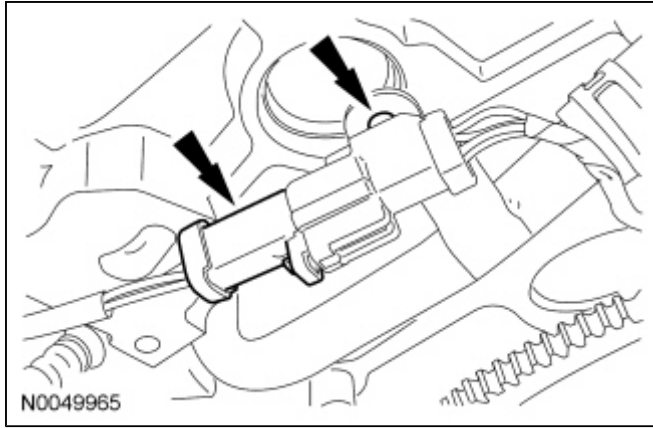
78. Install the wiring harness retaining bracket and the 2 bolts.
• Tighten to 10 Nm (89 lb-in).



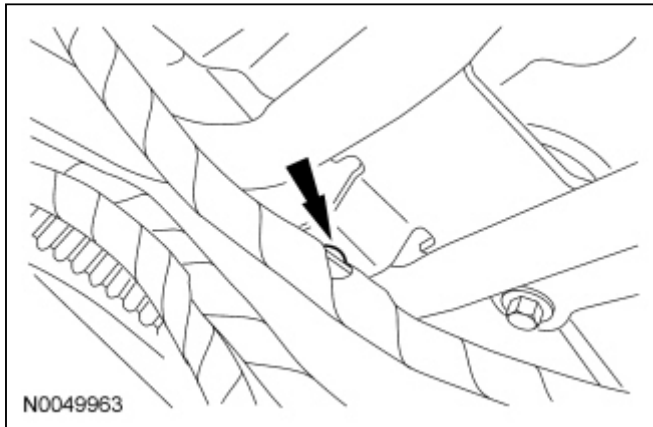
79. Connect the bubbler tube from the Supercharger (SC).



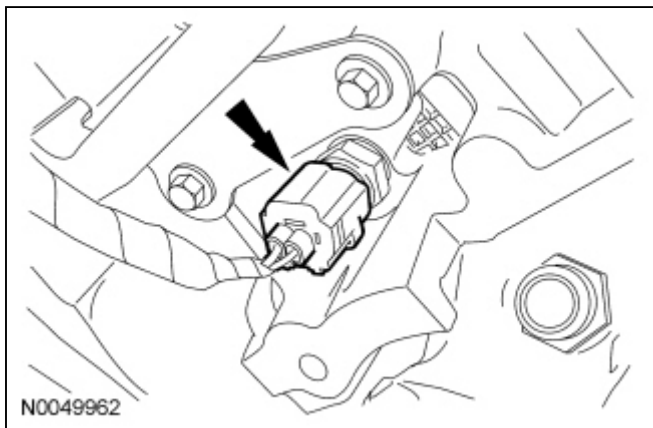
80. Connect the LH Heated Oxygen Sensor (HO2S) electrical connector and pin-type retainer.



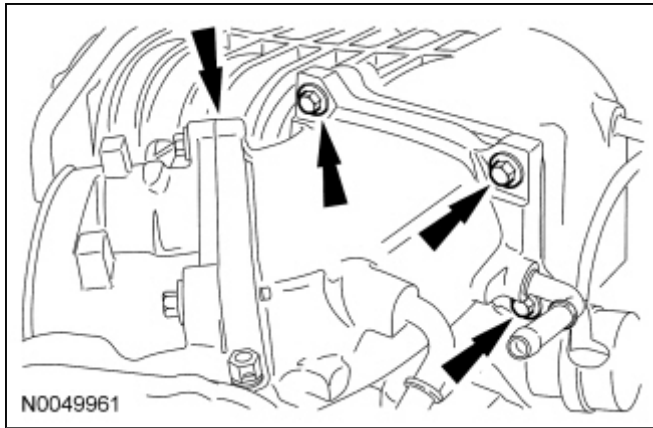
81. Attach the 2 wiring harness pin-type retainers (1 shown) to the coolant tube assembly bracket.



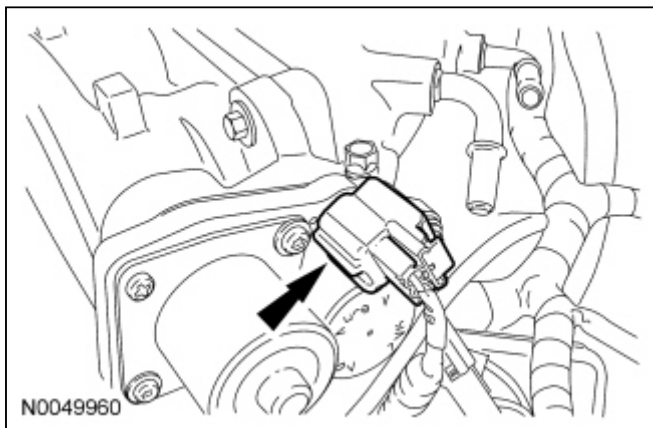
82. Connect the Cylinder Head Temperature (CHT) sensor electrical connector.



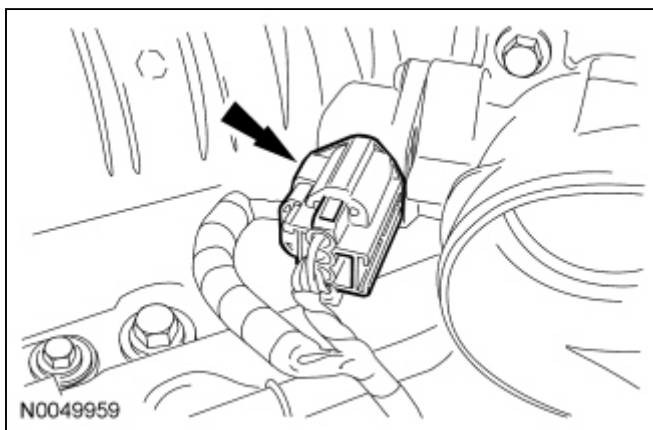
83. Install a new gasket, the Throttle Body (TB) and spacer assembly and the 4 bolts.
- Tighten to 10 Nm (89 lb-in).



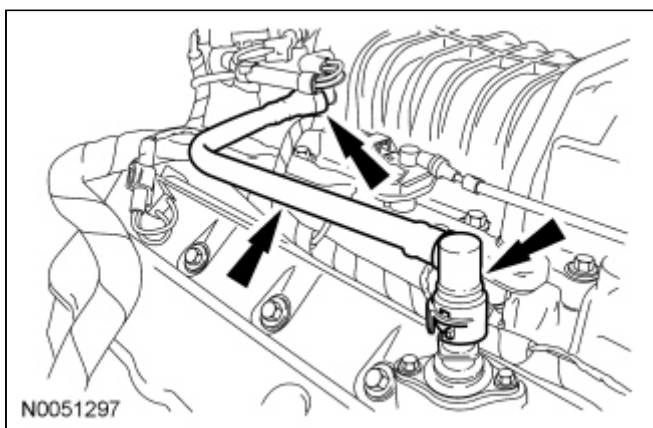
84. Connect the **TB** control electrical connector.



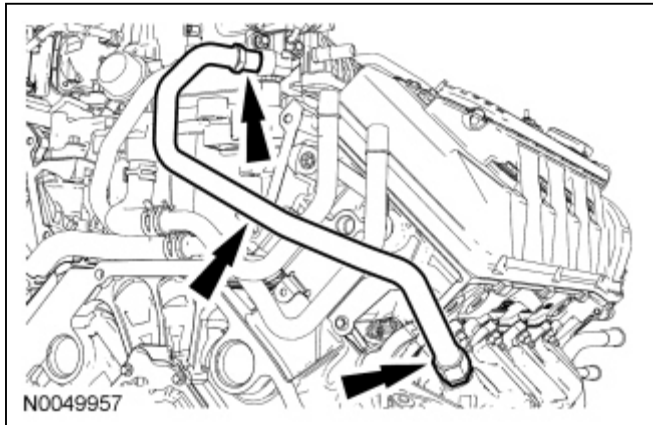
85. Connect the **TP** sensor electrical connector.



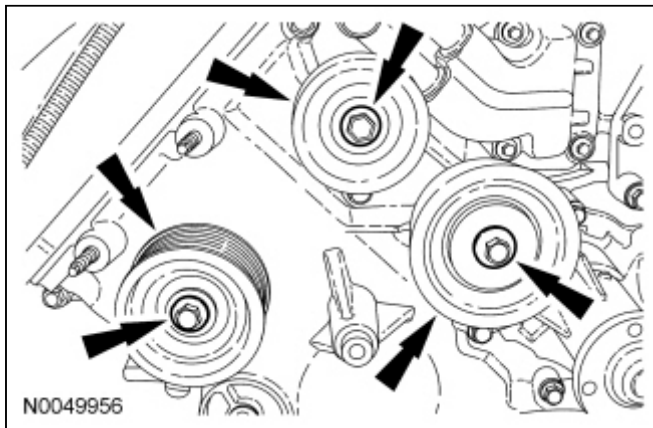
86. Install and connect the crankcase ventilation tube.



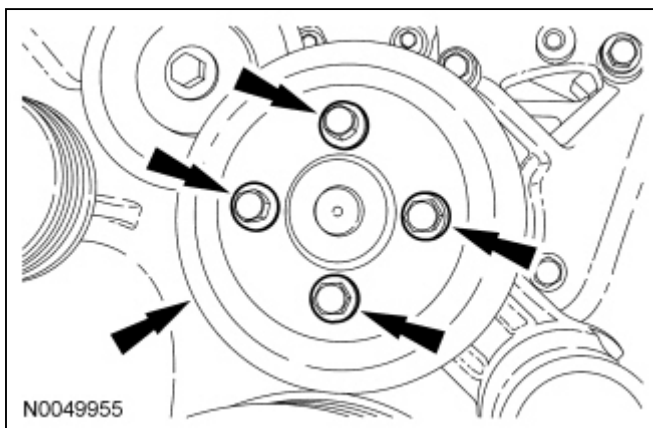
87. Install the EGR tube.
- Tighten to 40 Nm (30 lb-ft).



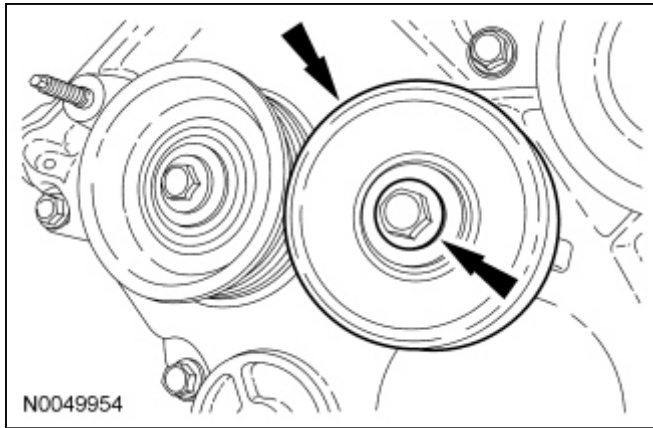
88. Install the 3 **SC** drive belt idler pulleys and the 3 bolts.
- Tighten the heavy load idler pulley (closest to centerline of engine) to 48 Nm (35 lb-ft).
 - Tighten the smooth idler pulley and the grooved idler pulley to 25 Nm (18 lb-ft).



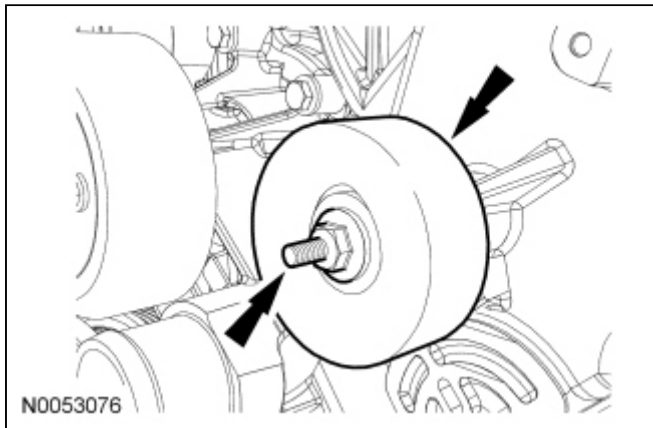
89. Install the coolant pump pulley and the 4 bolts.
- Do not tighten the bolts at this time.



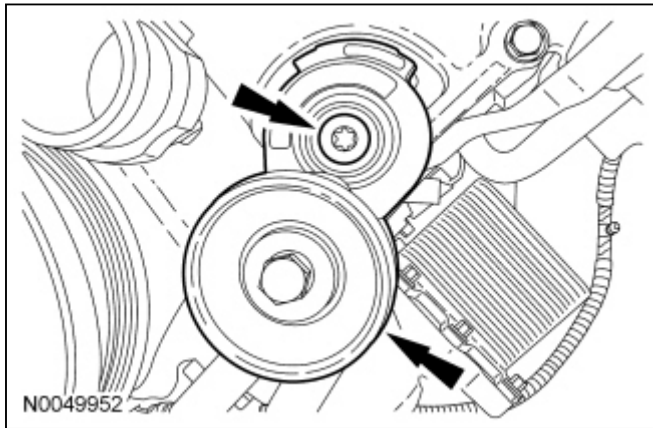
90. Install the accessory drive belt idler pulley (grooved) and the bolt.
- Tighten to 25 Nm (18 lb-ft).



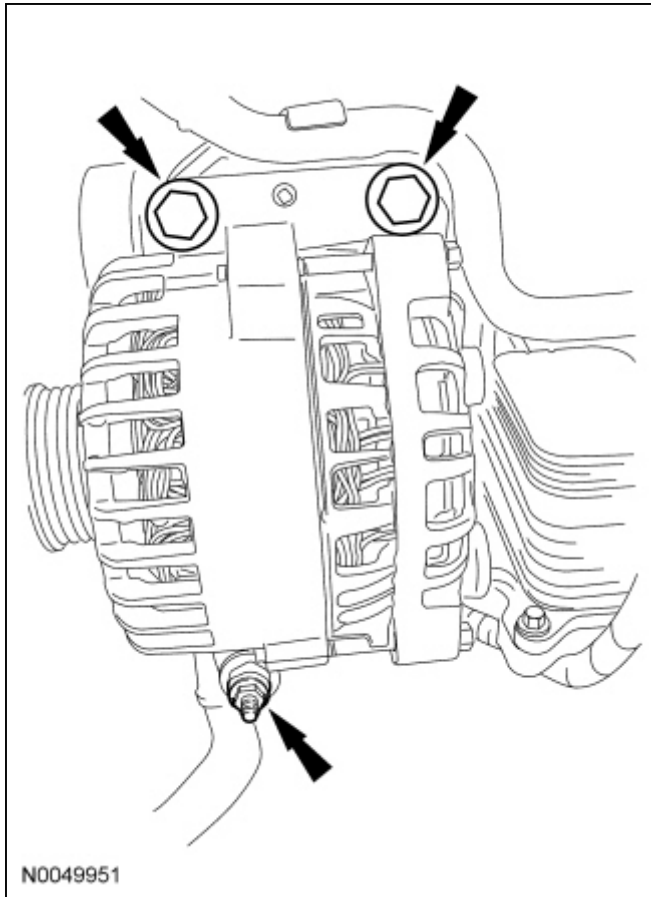
91. Install the accessory drive belt idler pulley (smooth) and the stud bolt.
- Tighten to 25 Nm (18 lb-ft).



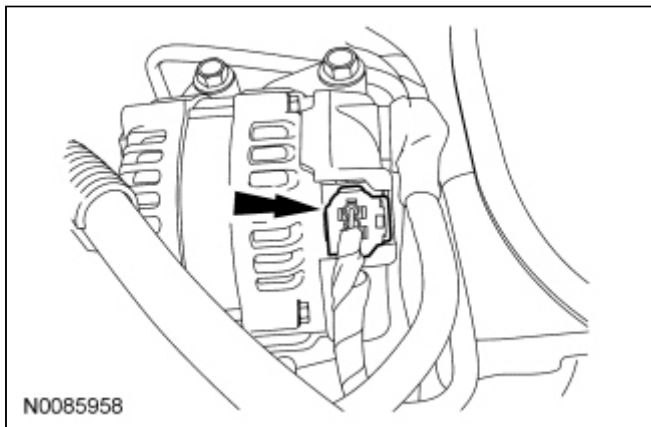
92. Install the accessory drive belt tensioner and the bolt.
- Tighten to 25 Nm (18 lb-ft).



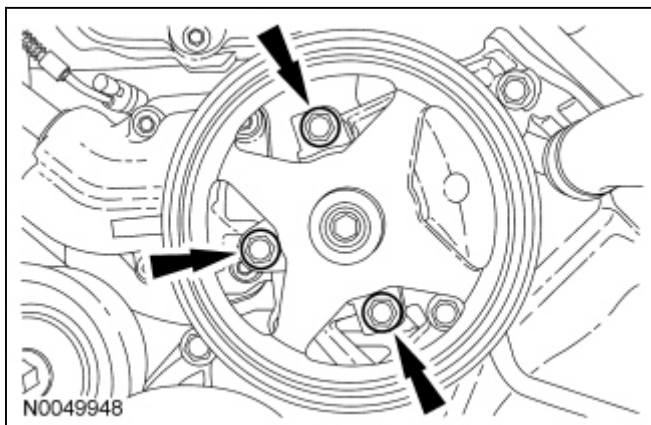
93. Install the alternator, 2 bolts and the stud bolt.
- Tighten to 50 Nm (37 lb-ft).



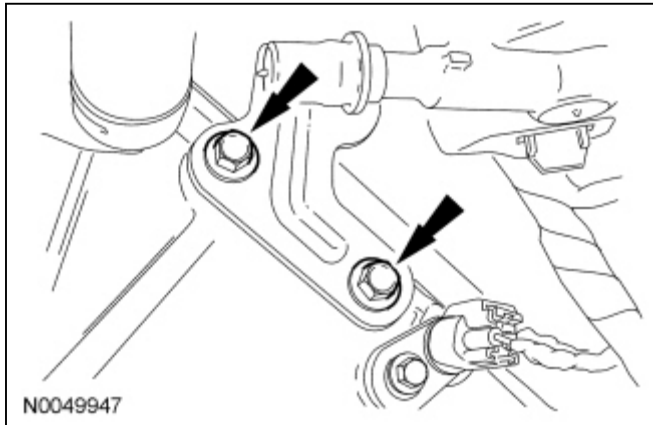
94. Connect the generator electrical connector.



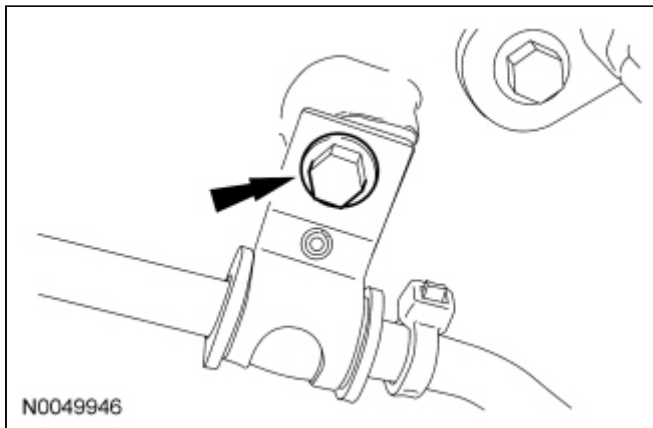
95. Install the power steering pump and reservoir assembly and the 3 bolts.
• Tighten to 25 Nm (18 lb-ft).



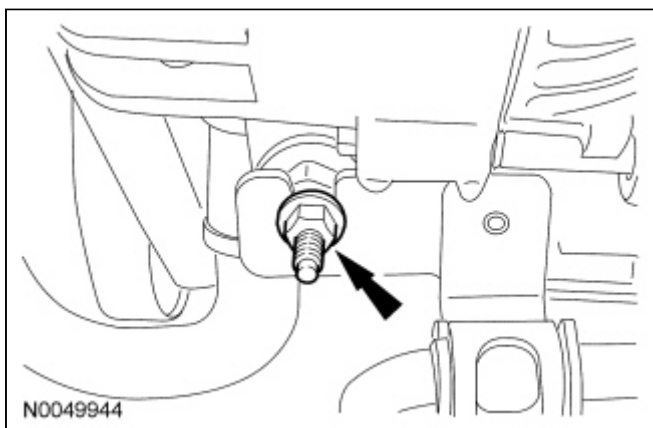
96. Install the power steering reservoir bracket bolts.
- Tighten to 25 Nm (18 lb-ft).



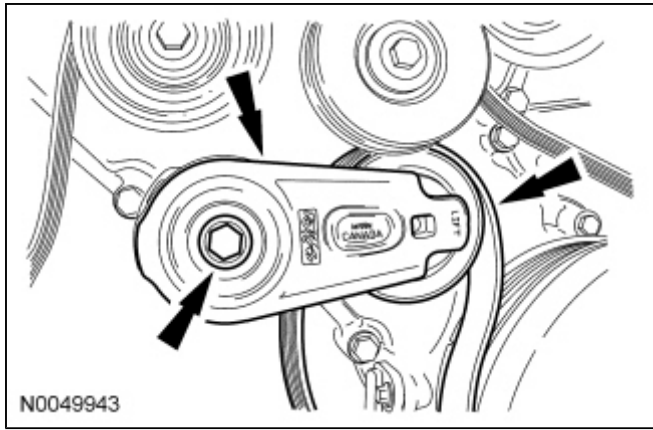
97. Install the power steering tube bracket bolt.
- Tighten to 10 Nm (89 lb-in).



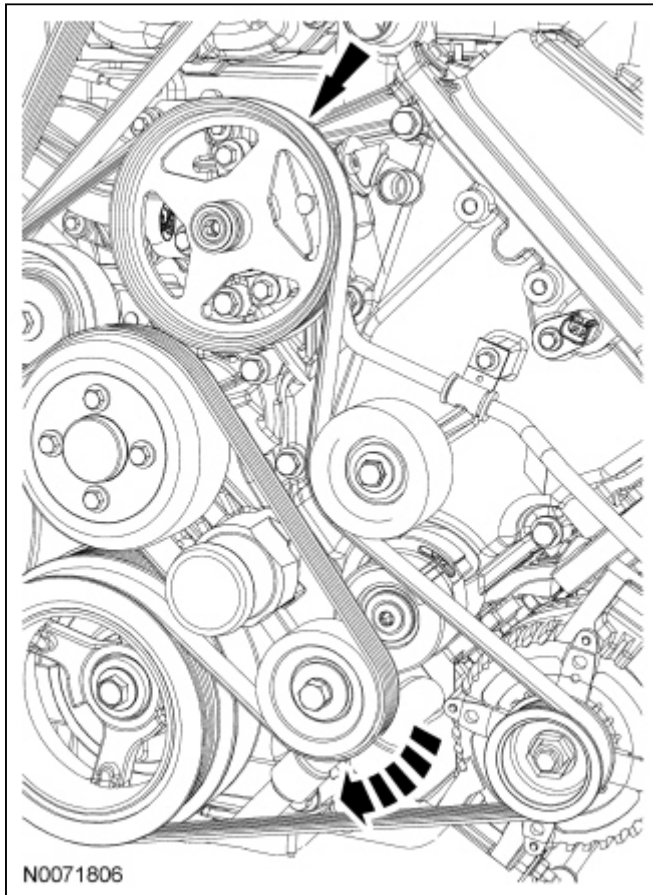
98. Install the power steering tube bracket nut.
- Tighten to 10 Nm (89 lb-in).



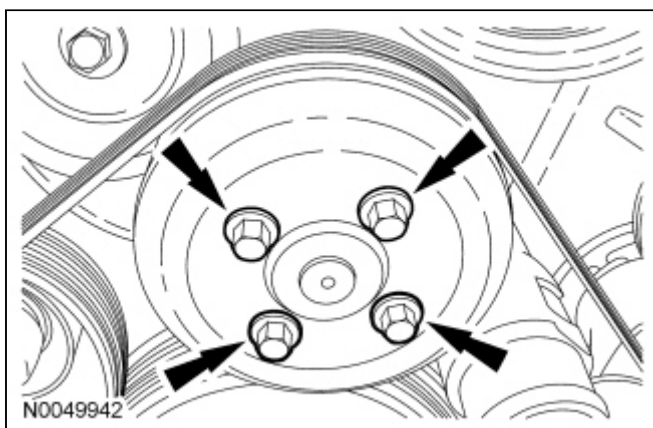
99. Position the SC drive belt and install the SC drive belt tensioner and bolt.
- Tighten to 48 Nm (35 lb-ft).



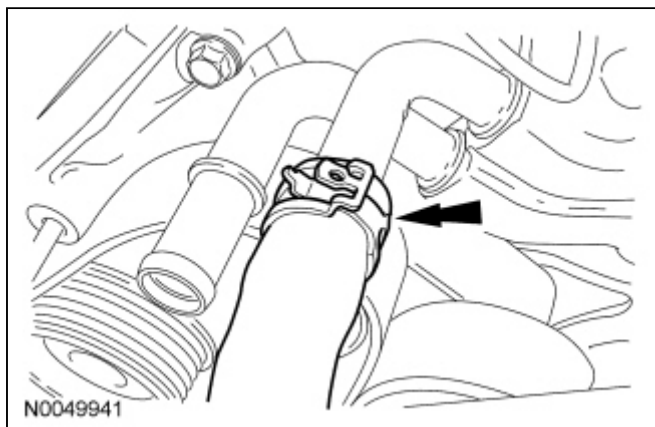
100. Rotate the accessory drive belt tensioner clockwise and install the accessory drive belt.



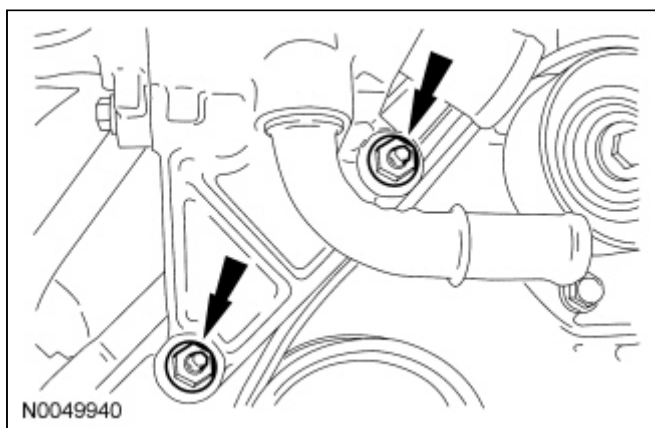
101. Tighten the 4 coolant pump pulley bolts to 25 Nm (18 lb-ft).



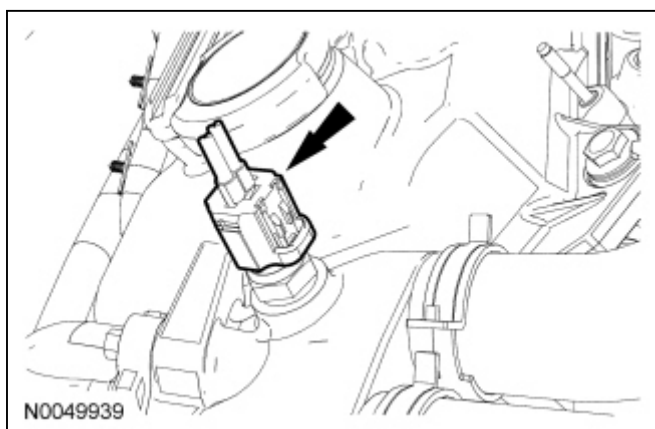
102. Connect the coolant hose from the Charge Air Cooler (CAC).



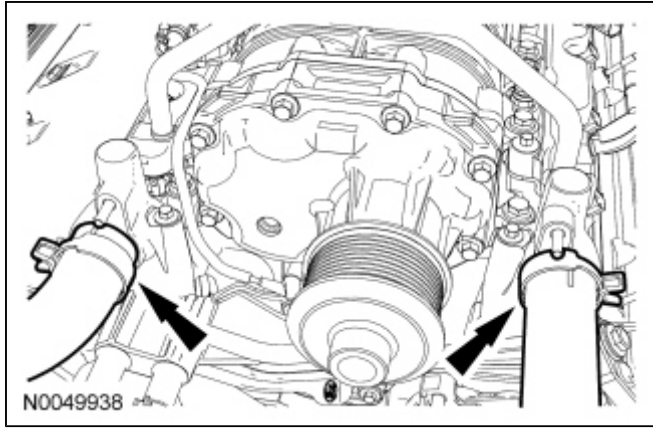
103. Install the thermostat housing assembly and the 2 nuts.
• Tighten to 25 Nm (18 lb-ft).



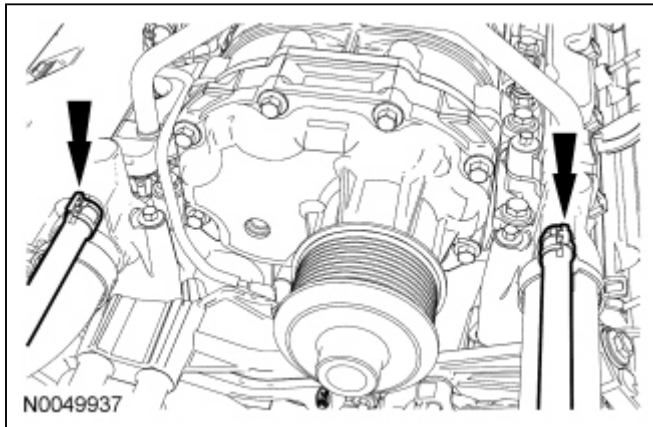
104. Connect the Engine Coolant Temperature (ECT) sensor electrical connector.



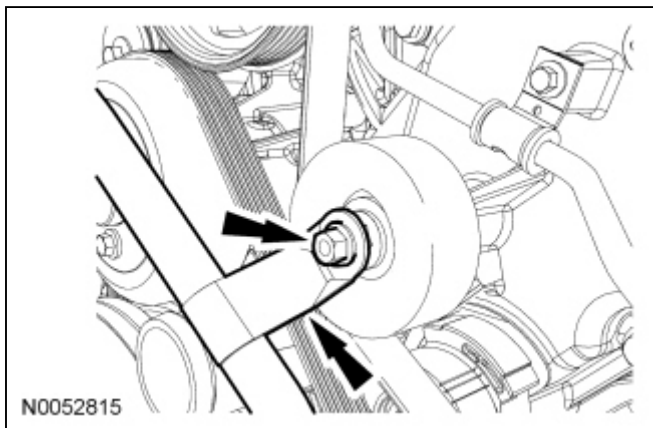
105. Connect the 2 upper radiator hoses to the intake manifold.



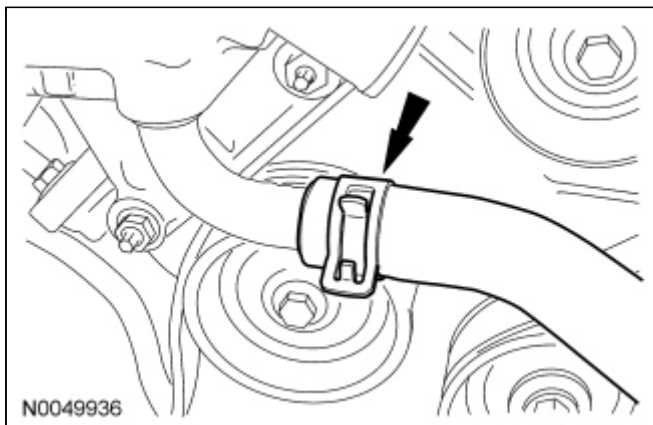
106. Connect the 2 coolant vent hoses to the intake manifold.



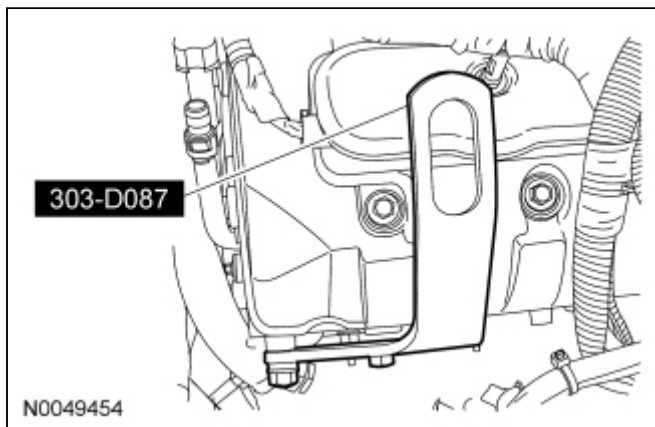
107. Install the coolant tube bracket nut.



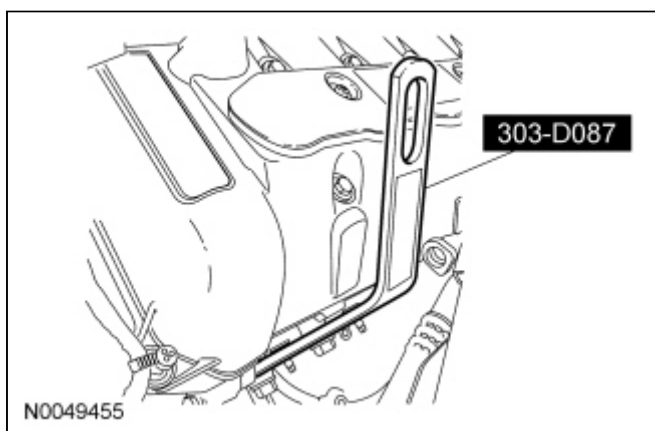
108. Connect the coolant hose to the thermostat housing.



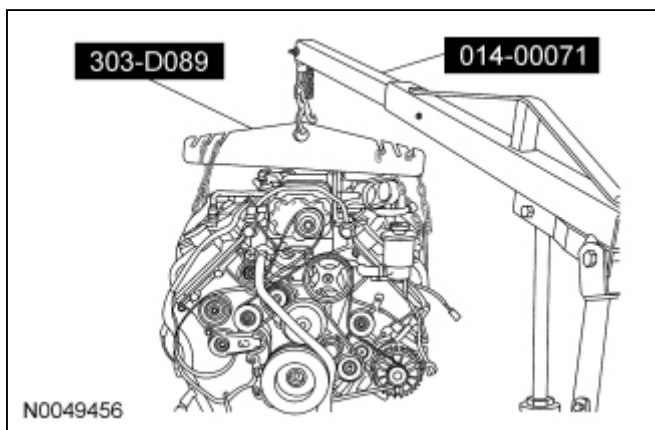
109. Install the Engine Lifting Bracket.



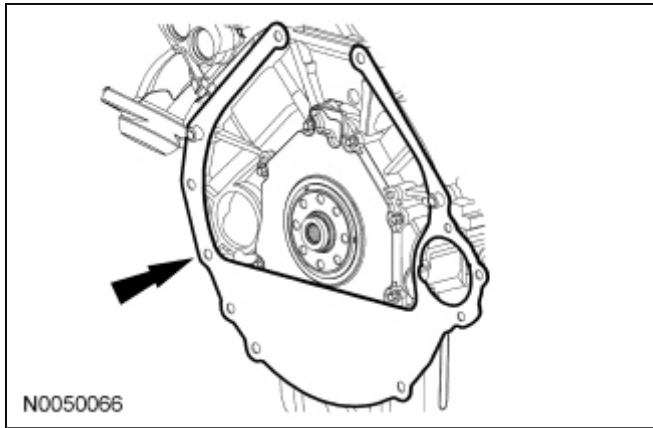
110. Install the Engine Lifting Bracket.



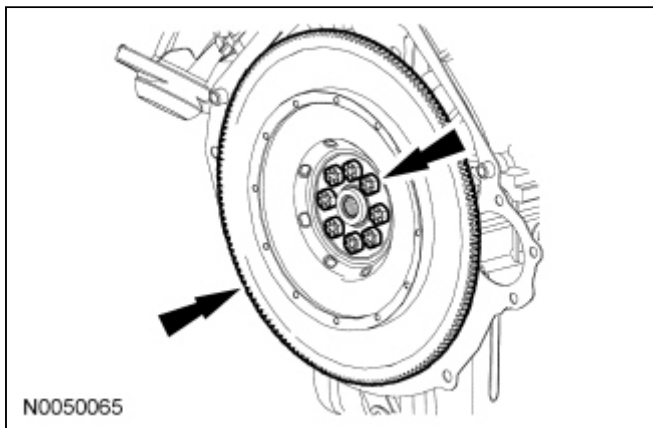
111. Using the Heavy Duty Floor Crane and the Engine Lifting Bracket, remove the engine from the work stand.



112. Install the engine/transmission spacer plate.



113. Install the flywheel and the 8 bolts.
- Tighten to 80 Nm (59 lb-ft).



114. Install the engine into the vehicle. For additional information, refer to [Engine](#) in this section.
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