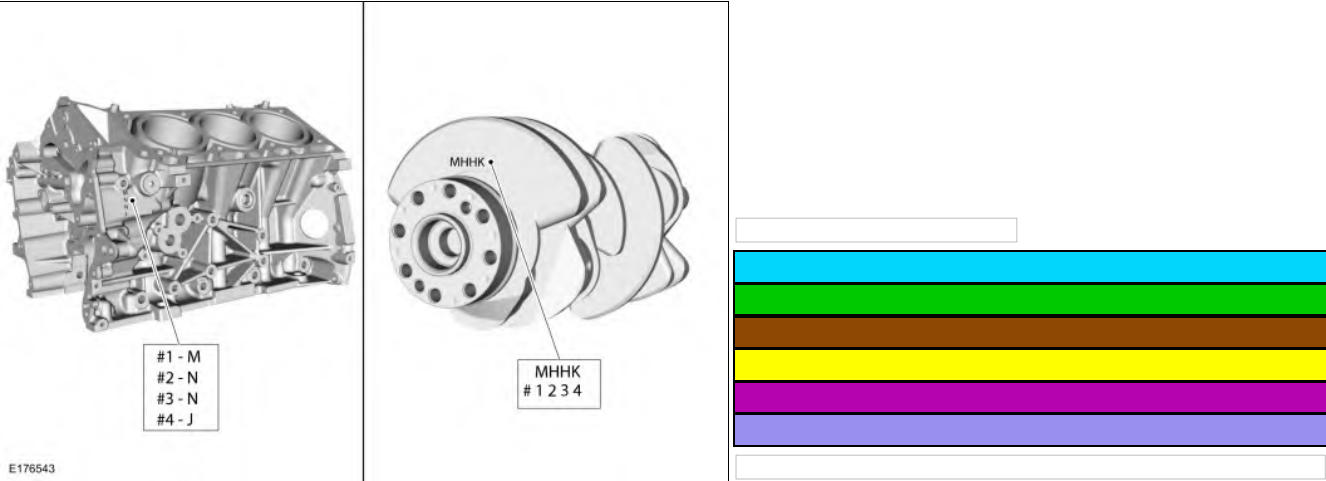




3. **NOTE:** This chart is continued in the next step.

NOTE: This chart is for selecting main bearings 1 and 4 only.

- Using the data recorded earlier and the Bearing Select Fit Chart, Standard Bearings, determine the required bearing grade for main bearings 1 and 4.
- 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(s) for the No. 1 crankshaft main bearing.
- As an example, if the engine block code letter is "M" and the crankshaft code letter is "M", the correct bearing grade for this main bearing is a "2" for the upper bearing and a "2" for the lower bearing.
- Repeat the above steps using the fourth letter of the block and crankshaft codes to select the No. 4 bearing

		MAIN HOUSING BORE DIAMETER														
		A	B	C	D	E	F	G	H	I	J	K	L	M		
		1	2	3	4	5	6	7	8	9	10	11	12	13		
CRANKSHAFT DIAMETER	U	72.400	72.401	72.402	72.403	72.404	72.405	72.406	72.407	72.408	72.409	72.410	72.411	72.412		
	T	67.503	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/2	1/2	1/2	1/2	1/2	1/2	1/2
	S	67.502	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/2	1/2	1/2	1/2	1/2	1/2	1/2
	R	67.501	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/2	1/2	1/2	1/2	1/2	1/2	1/2
	Q	67.500	1/1	1/1	1/1	1/1	1/1	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
	P	67.499	1/1	1/1	1/1	1/1	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
	O	67.498	1/1	1/1	1/1	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
	N	67.497	1/1	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
	M	67.496	1/1	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
	L	67.495	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
	K	67.494	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
	J	67.493	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
	I	67.492	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
	H	67.491	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
	G	67.490	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
	F	67.489	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
	E	67.488	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
	D	67.487	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
	C	67.486	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
	B	67.485	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
	A	67.484	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2
	67.483	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2	1/2

FOR MAINS #1 AND #4 ONLY
UPPER MAIN GRADE (BLOCK SIDE) / LOWER MAIN GRADE (CAP SIDE)

4. **NOTE:** This chart is for selecting main bearings 1 and 4 only.

CRANKSHAFT DIAMETER

FOR MAINS #2 AND #3 ONLY

6. **NOTE:** This chart is for selecting main bearings 2 and 3 only.



FOR MAINS #2 AND #3 ONLY

A	3	3	3
B	3	3	3
C	3	3	3
D	3	3	3
E	2	3	3
F	2	2	2
G	2	2	2
H	2	2	2
I	2	2	2
J	2	2	2
K	2	2	2
L	2	2	2
M	2	2	2

CRANKSHAFT DI



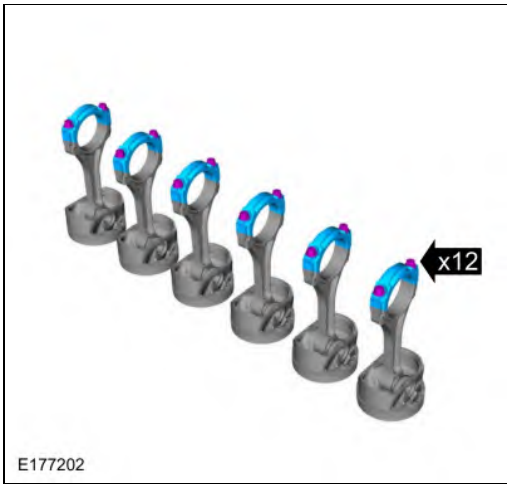
Using the original connecting rod cap bolts, install the connecting rod caps and bolts.

Torque:

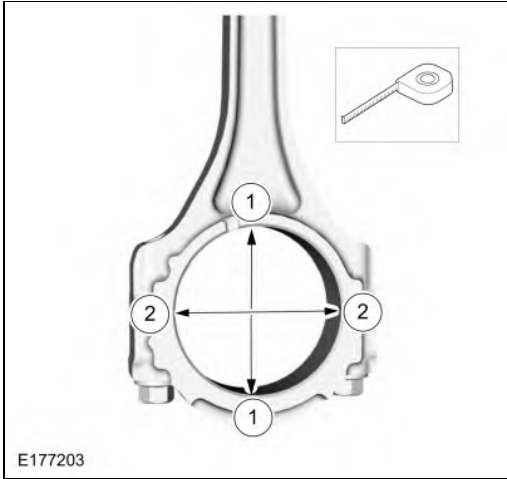
Stage 1: 17 lb.ft (23 Nm)

Stage 2: 32 lb.ft (43 Nm)

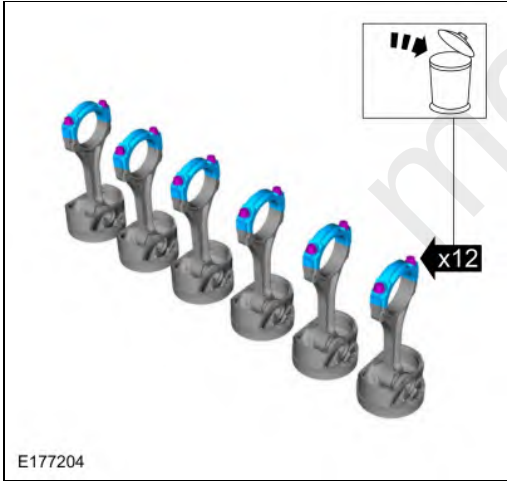
Stage 3: 105°



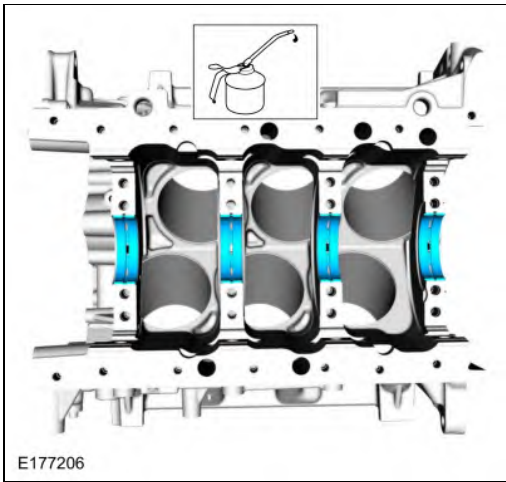
8. Measure the connecting rod large end bore in 2 directions.



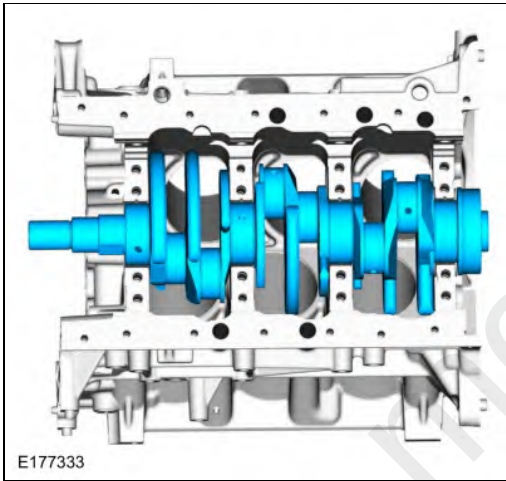
- 9.
- Remove the bolts and the rod cap.
 - Discard the bolts.



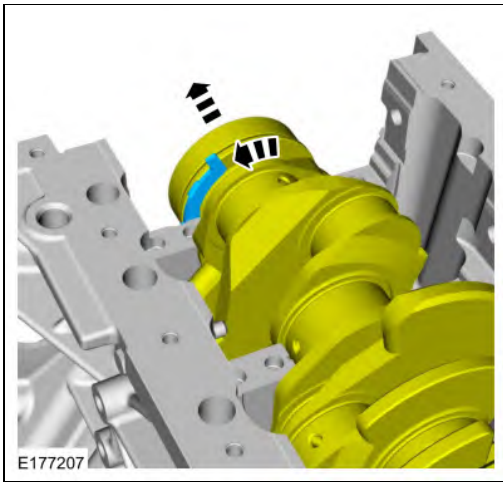
10. Measure each of the crankshaft connecting rod bearing journal diameters in at least 2 directions.



13. **NOTE:** Do not install the upper thrust bearings until the crankshaft is installed.
- NOTE:** Lubricate the thrust surfaces of the crankshaft with clean engine oil.
- Install the crankshaft.

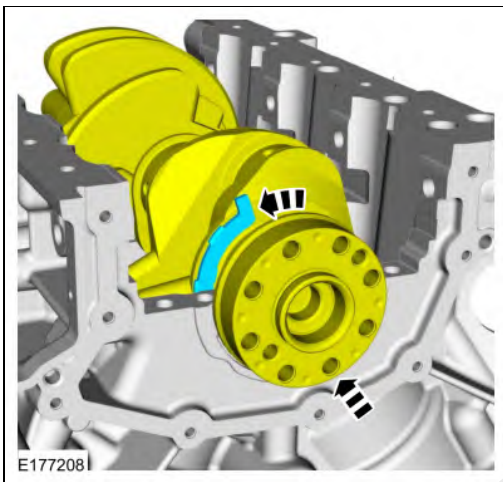


14. **NOTE:** Make sure the side of the thrust washer, with the wide oil grooves, faces the crankshaft thrust surface.
- Push the crankshaft rearward and install the rear crankshaft upper thrust washer at the back of the No. 4 rear bulkhead.

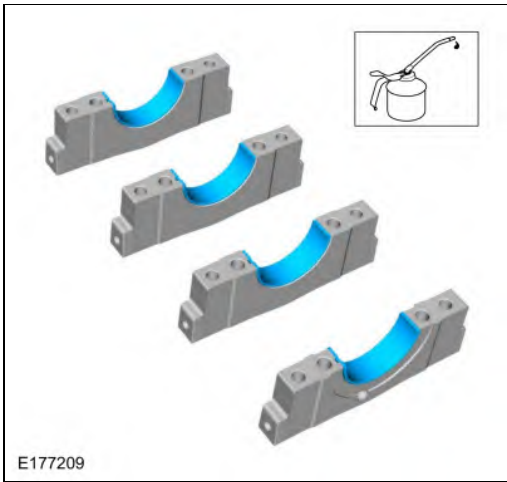


15. **NOTE:** Make sure the side of the thrust washer, with the wide oil grooves, faces the crankshaft thrust surface.

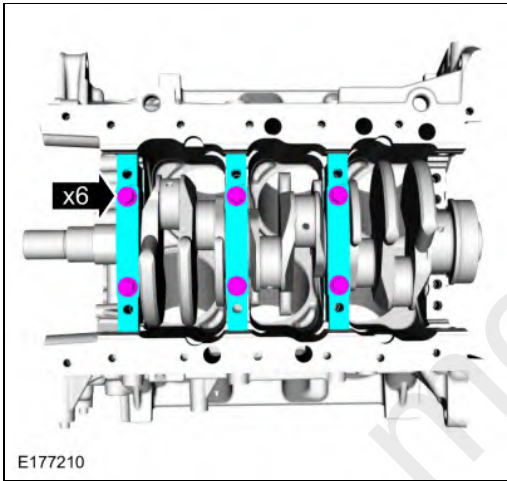
Push the crankshaft forward and install the front crankshaft upper thrust washer at the front of the No. 4 rear bulkhead.



16. Lubricate the crankshaft lower main bearings with clean engine oil and install them into the main bearing caps. Check seating and squareness of the bearings to make sure of proper seating in caps.



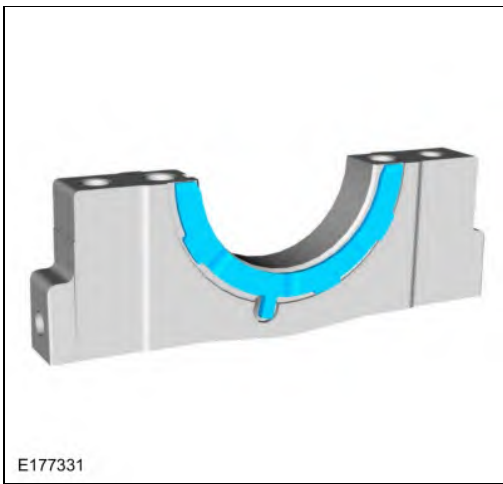
17. Position the No. 1, No. 2 and No. 3 main bearing caps on the cylinder block and, keeping the caps as square as possible, alternately draw the caps down evenly using the new bolts until the main bearing caps are seated.



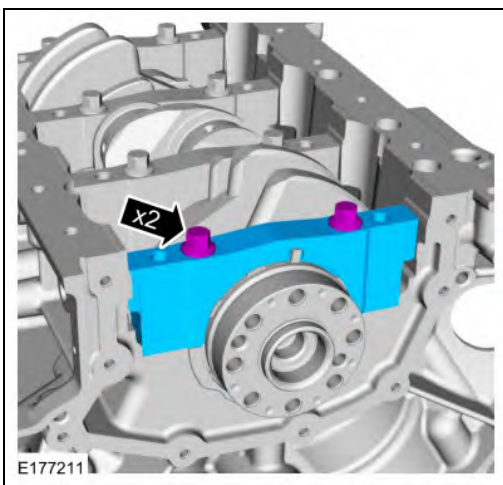
18. **NOTE:** Make sure the side of the thrust washer, with the wide oil grooves, faces the crankshaft thrust surface.

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

Install the lower crankshaft thrust washer to the back side of the No. 4 rear main bearing cap, with the tab aligned with the cutout in the main bearing cap.



19. Position main bearing cap No. 4 on the cylinder block and keeping the cap as square as possible, alternately draw the cap down evenly using the new bolts until the main bearing cap is seated.



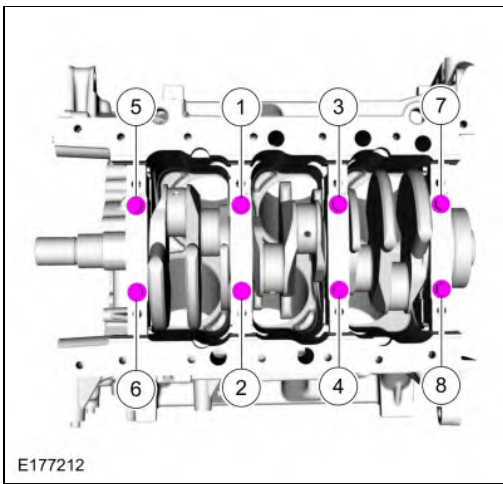
20. **NOTE:** While tightening the main bearing vertical bolts, push the crankshaft forward and the No. 4 main bearing cap rearward to seat the crankshaft thrust washers.

Tighten the main bearing bolts.

Torque:

Stage 1: 20 lb.ft (27 Nm)

Stage 2: 180°

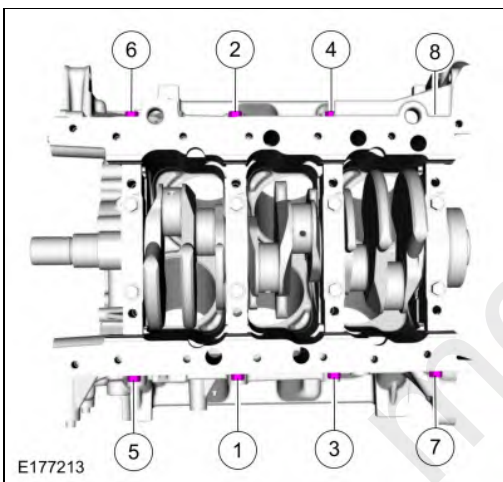


21. Install the new main bearing cap side bolts.

Torque:

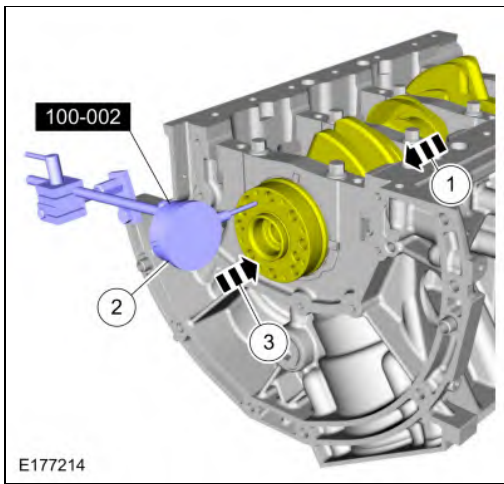
Stage 1: 33 lb.ft (45 Nm)

Stage 2: 90°



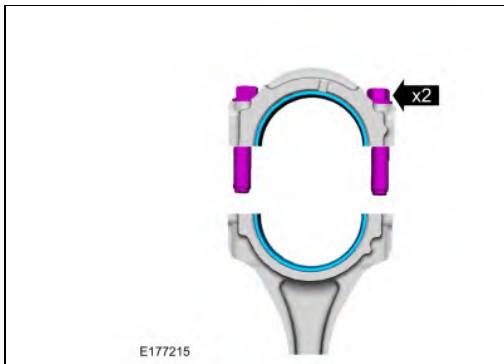
22.

1. Position the crankshaft to the rear of the cylinder block.
Use Special Service Tool: 100-002 (TOOL-4201-C) Holding Fixture with Dial Indicator Gauge.
2. Zero the Dial Indicator Gauge.
3. Move the crankshaft to the front of the cylinder block. Measure and record the crankshaft end play.



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

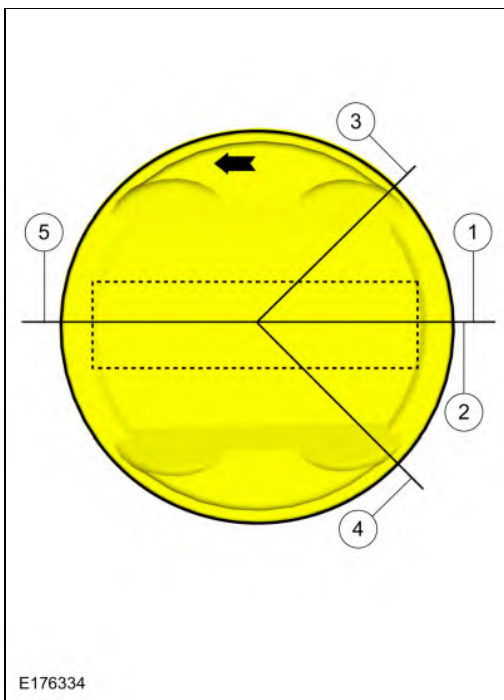
- Prepare the connecting rod and cap
- Insert the new bolts in the rod cap.
- Insert the upper and lower rod bearings into the rod and cap.



24. **NOTE:** The piston compression upper and lower ring should be installed with the "O" mark on the ring face pointing up toward the top of the piston.

NOTE: The arrow on the top of the piston indicates the front of the engine.

1. Center line of the piston parallel to the wrist pin bore.
2. Upper compression ring gap location.
3. Upper oil control segment ring gap location.
4. Lower oil control segment ring gap location.
5. Expander ring and lower compression ring gap location.



25. **NOTICE:** Be sure not to scratch the cylinder wall or crankshaft journal with the connecting rod. Push the piston down until the connecting rod bearing seats on the crankshaft journal.

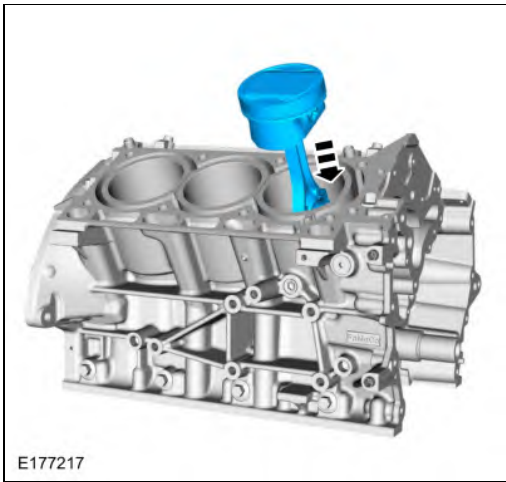
NOTE: Lubricate the pistons, piston rings, connecting rod bearings and the entire cylinder bores with clean engine oil.

NOTE: Make sure the piston rings are positioned to specifications for installation. Refer to Piston in this section.

NOTE: If the piston and or connecting rod are being installed new, the piston rod orientation marks and the arrow on the top of the dome of the piston should be facing toward the front of the engine block.

NOTE: If the piston and connecting rod are to be reinstalled, they must be installed in the same orientation as disassembled.

- Using the piston ring compressor, install the piston and connecting rod assemblies.
Use the General Equipment: Piston Ring Compressor
- Repeat until all 6 piston assemblies are installed.



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

NOTE: After installation of each piston, connecting rod, rod cap and bolts, rotate the crankshaft to verify smooth operation.

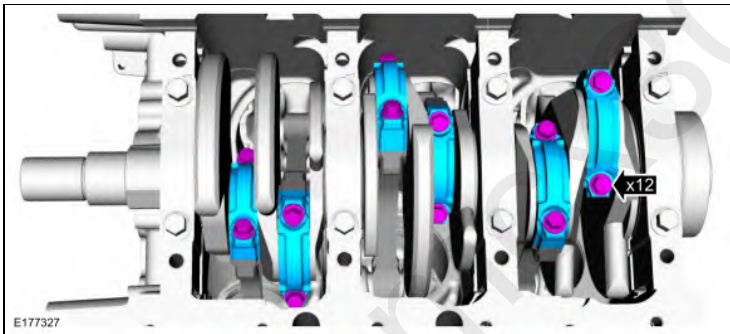
Install the connecting rod cap and the new bolts.

Torque:

Stage 1: 17 lb.ft (23 Nm)

Stage 2: 32 lb.ft (43 Nm)

Stage 3: 105°

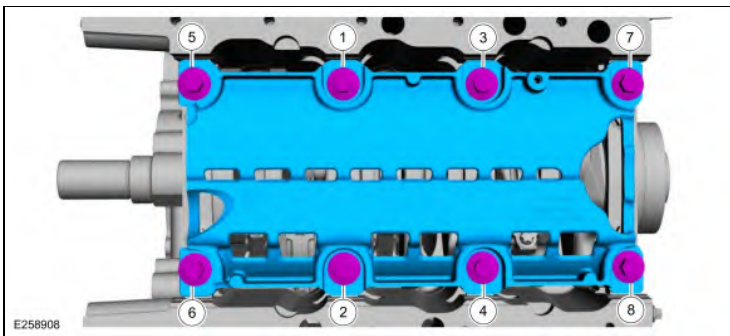


27. Install the main bearing cap support brace and the new bolts.

Torque:

Stage 1: 20 lb.ft (27 Nm)

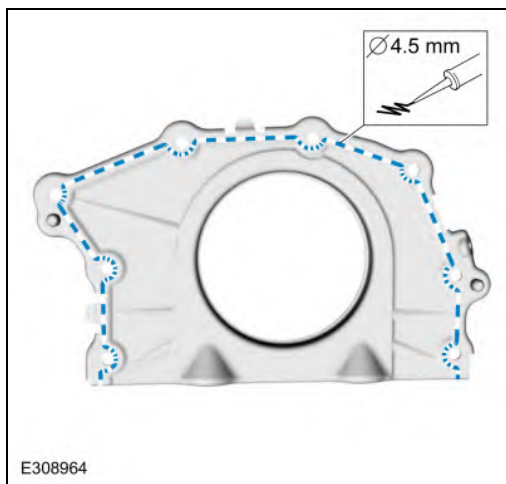
Stage 2: 225°



28. **NOTICE:** Failure to use Motorcraft® High Performance Engine RTV Silicone may cause the engine oil to foam excessively and result in serious engine damage.

NOTE: The crankshaft rear seal retainer must be installed and the bolts tightened within 10 minutes of sealant application.

Apply a 4.5 mm (0.177 in) bead of Motorcraft® High Performance Engine RTV Silicone to the sealing surface of the crankshaft rear seal retainer.

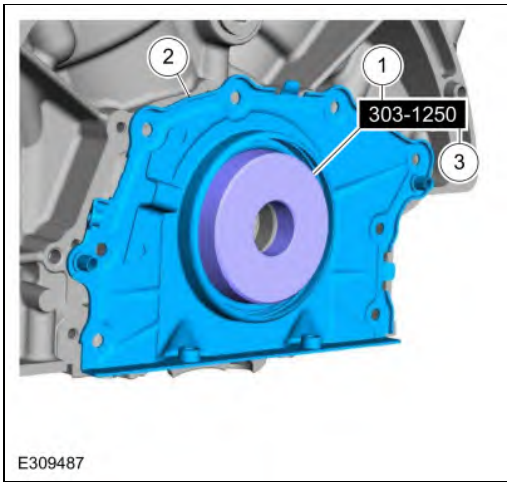


29. Lubricate the crankshaft rear seal with clean engine oil.



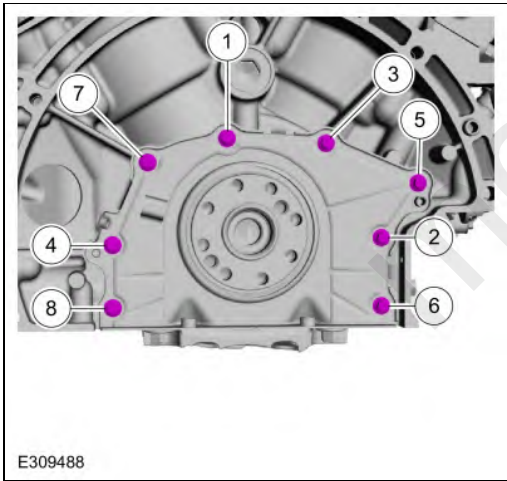
30.

1. Install the special tool.
Install Special Service Tool: 303-1250 Seal Installer, Rear Main.
2. **NOTE:** *Inspect and ensure that the crankshaft rear seal lip is not rolled before proceeding to step 31.*
Install the crankshaft rear seal.
3. Remove the special tool.
Remove Special Service Tool: 303-1250 Seal Installer, Rear Main.

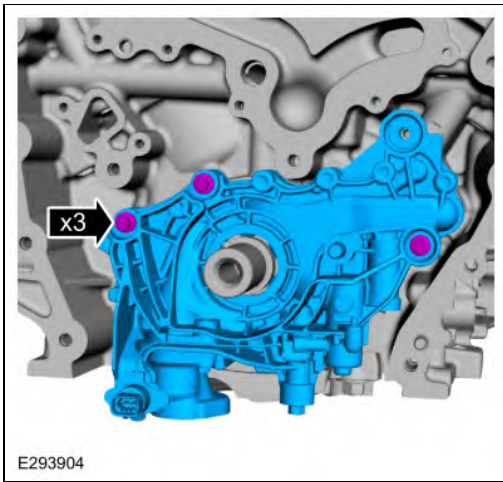


31. **NOTE:** The crankshaft rear seal retainer must be installed and the bolts tightened within 10 minutes of sealant application.

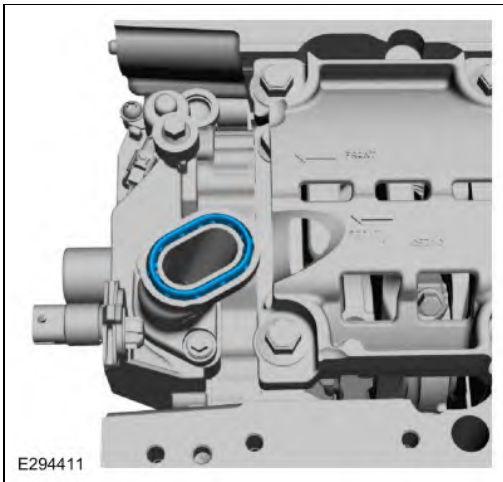
Install the crankshaft rear seal bolts and tighten in sequence shown.
Torque: 89 lb.in (10 Nm)



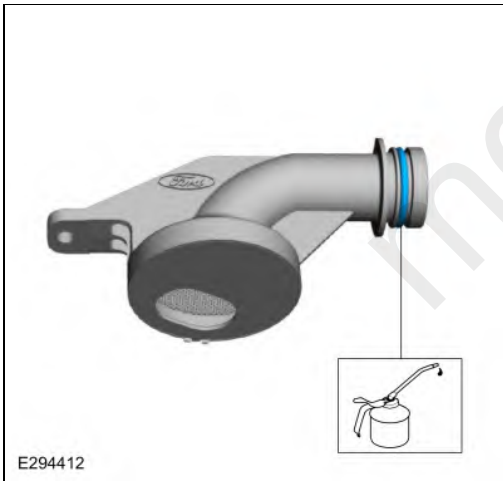
32. Prime the oil pump. Add 2 tablespoons of clean engine oil to the oil pump and rotate the oil pump by hand.
33. Install the oil pump and the bolts.
Torque: 89 lb.in (10 Nm)



34. Install a new oil pan-to-oil pump seal.

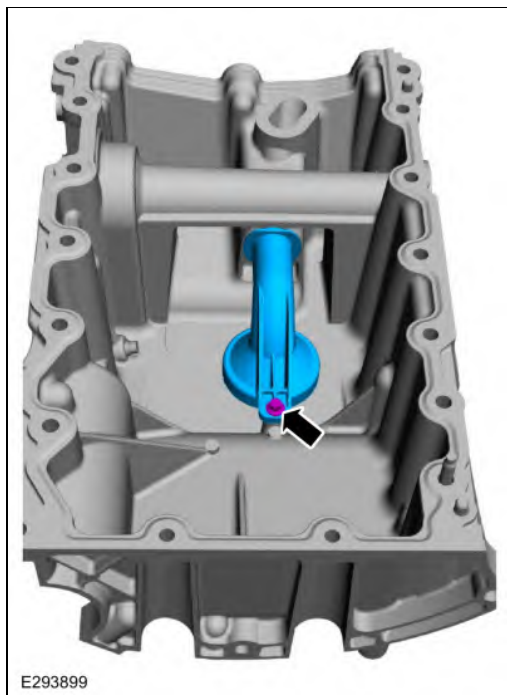


35. Install a new oil pump screen and pickup tube O-ring seal and lubricate with clean engine oil.



36. Install the oil pump screen and pickup tube and the bolt.

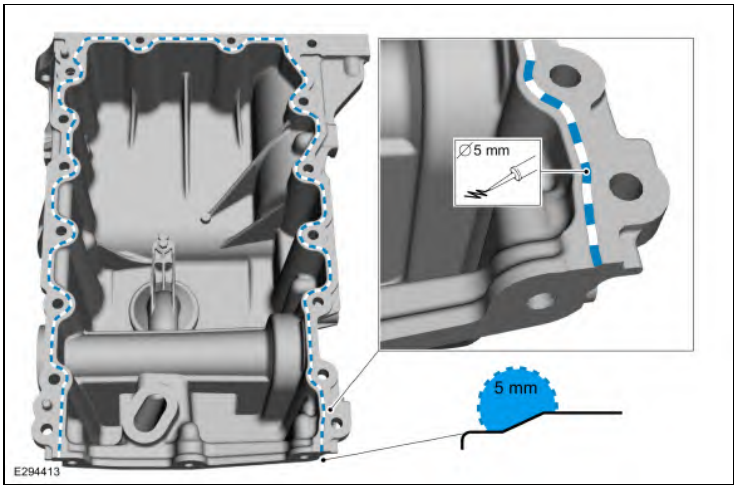
Torque: 89 lb.in (10 Nm)



37. **NOTICE:** Failure to use Motorcraft® High Performance Engine RTV Silicone may cause the engine oil to foam excessively and result in serious engine damage.

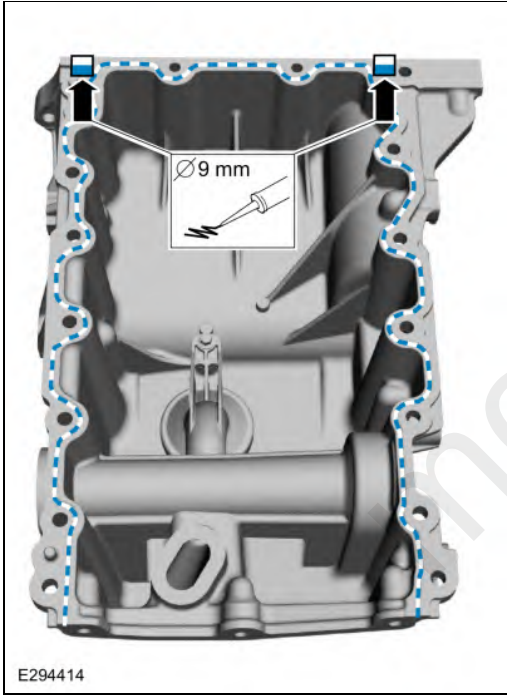
Apply a 5 mm (0.2 in) bead of Motorcraft® High Performance Engine RTV Silicone on the chamfer, as shown.

Material: Motorcraft® High Performance Engine RTV Silicone / TA-357 (WSE-M4G323-A6)

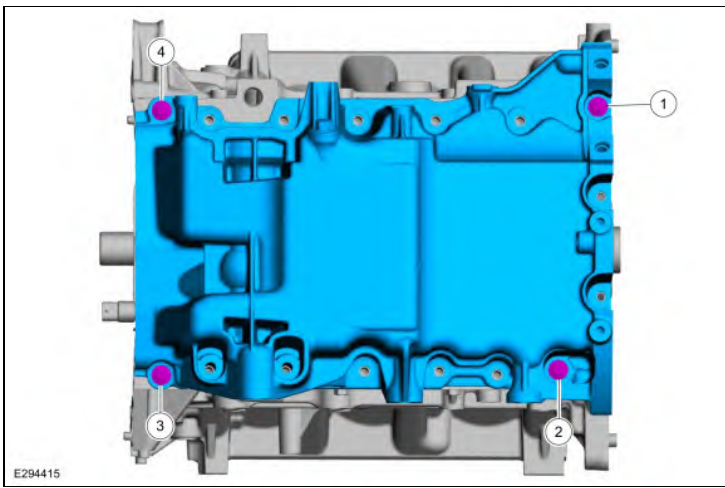


38. **NOTICE:** Failure to use Motorcraft® High Performance Engine RTV Silicone may cause the engine oil to foam excessively and result in serious engine damage.

Apply a 9 mm (0.35 in) bead of Motorcraft® High Performance Engine RTV Silicone to the 2 crankshaft seal retainer plate-to-cylinder block joint areas on the sealing surface of the oil pan.
Material: Motorcraft® High Performance Engine RTV Silicone / TA-357 (WSE-M4G323-A6)



39. Install the oil pan and bolts finger tight.



40. **NOTE:** The oil pan bolts must be installed and tightened within 10 minutes of the initial sealant application.

- Install the remaining oil pan bolts. Tighten in the sequence shown.

Torque:

Stage 1: Tighten bolts 1-9 and 11-14 to: 177 lb.in (20 Nm)

Stage 2: Tighten bolts 1-9 and 11-14 an additional: 45°

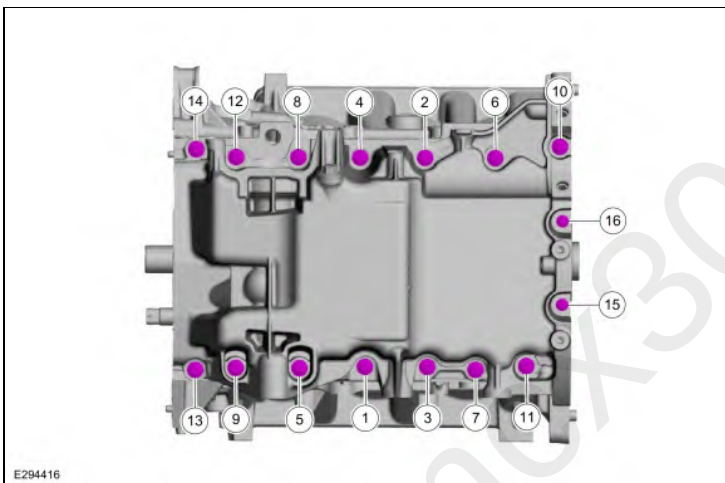
Stage 3: Tighten bolt 10 to: 177 lb.in (20 Nm)

Stage 4: Tighten bolt 10 an additional: 90°

Stage 5: Tighten bolts 15 and 16 to: 89 lb.in (10 Nm)

Stage 6: Tighten bolts 15 and 16 an additional: 45°

- Rotate the engine so the oil pan is facing downwards.

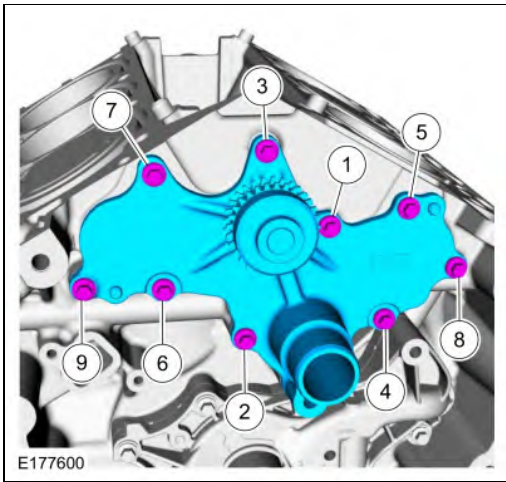


41. Install the channel cover plate and the bolts.

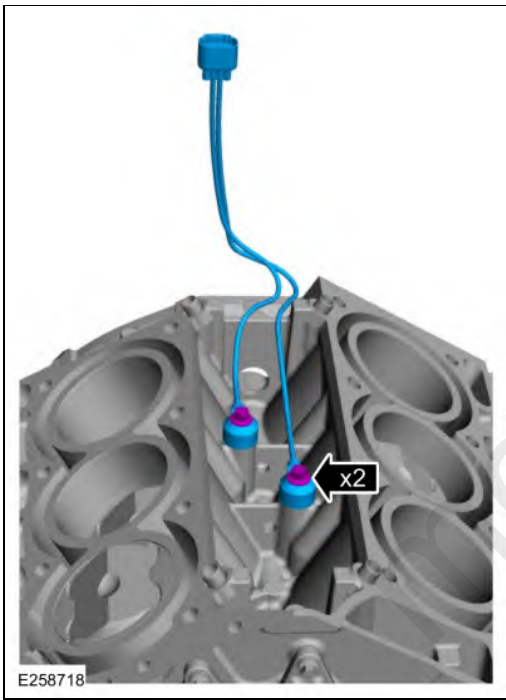
Torque:

Stage 1: 89 lb.in (10 Nm)

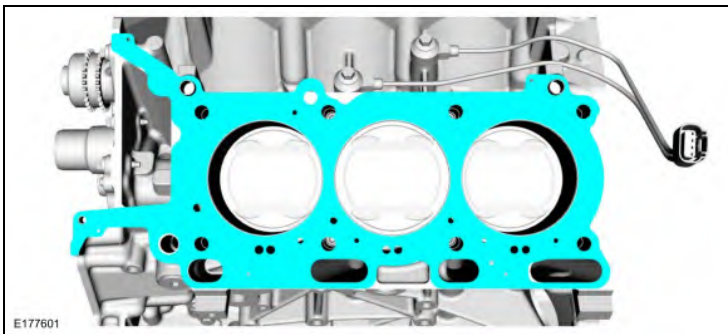
Stage 2: 45°



42. Install the KS and the bolts.
Torque: 177 lb.in (20 Nm)



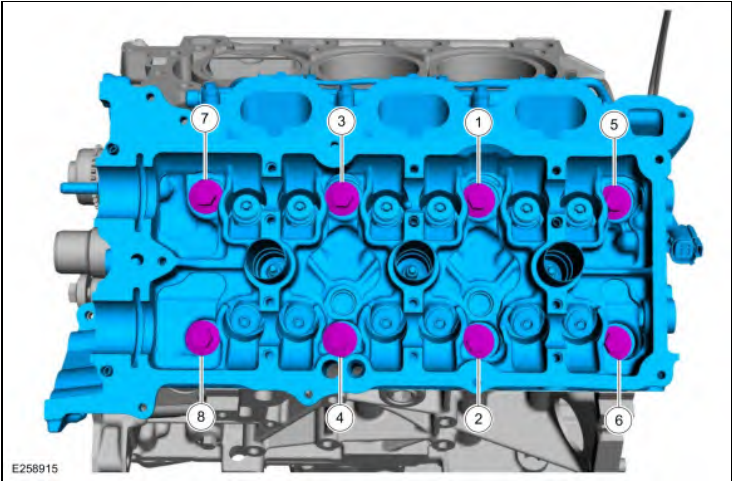
43. Install the LH cylinder head gasket.



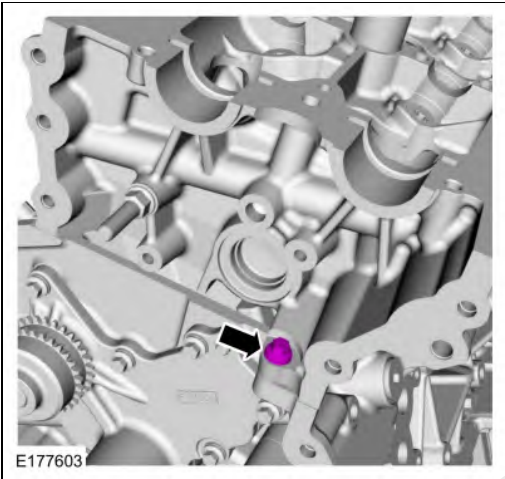
44. **NOTE:** If the cylinder head is replaced, a new secondary timing chain tensioner will need to be installed.

Install the cylinder head and the new bolts.
Torque:

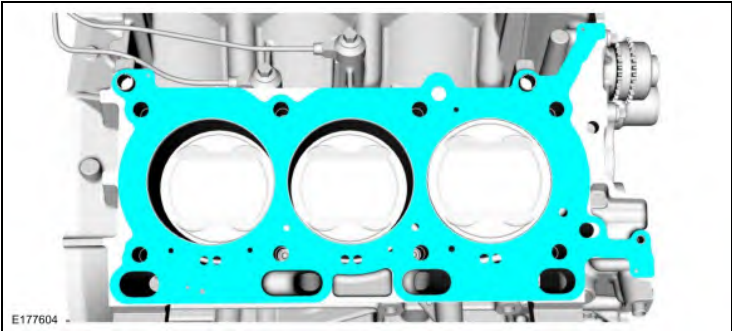
- Stage 1: 177 lb.in (20 Nm)
- Stage 2: 26 lb.ft (35 Nm)
- Stage 3: 90°
- Stage 4: 90°
- Stage 5: 45°



45. Install the M6 bolt.
Torque: 89 lb.in (10 Nm)

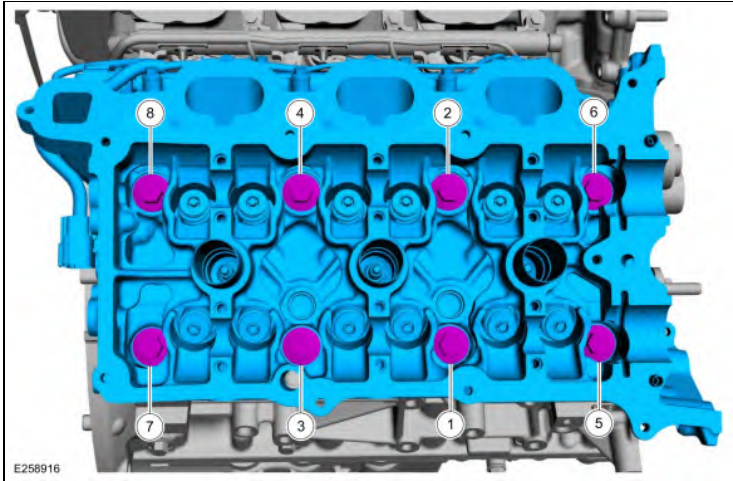


46. Install the RH cylinder head gasket.

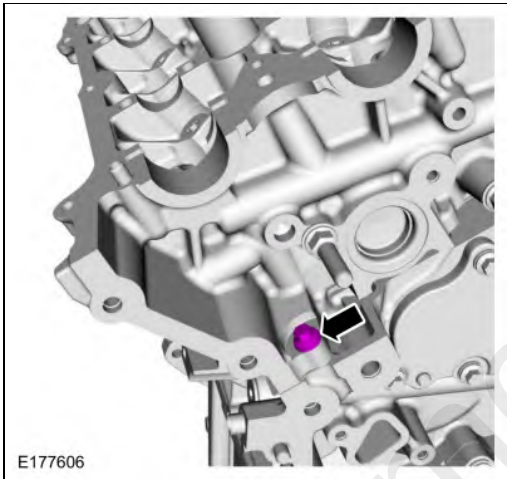


47. **NOTE:** If the cylinder head is replaced, a new secondary timing chain tensioner will need to be installed.
- Install the cylinder head and the new bolts.
Torque:

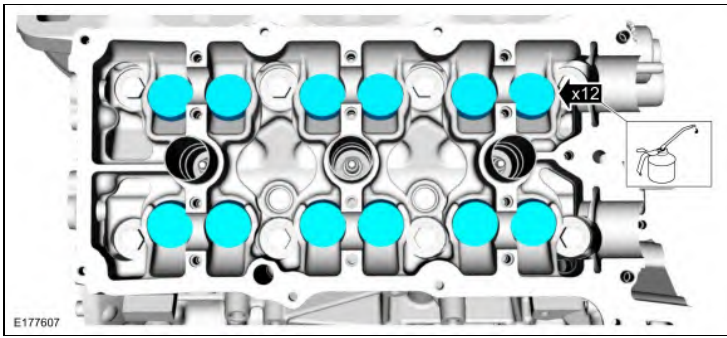
- Stage 1: 177 lb.in (20 Nm)
- Stage 2: 26 lb.ft (35 Nm)
- Stage 3: 90°
- Stage 4: 90°
- Stage 5: 45°



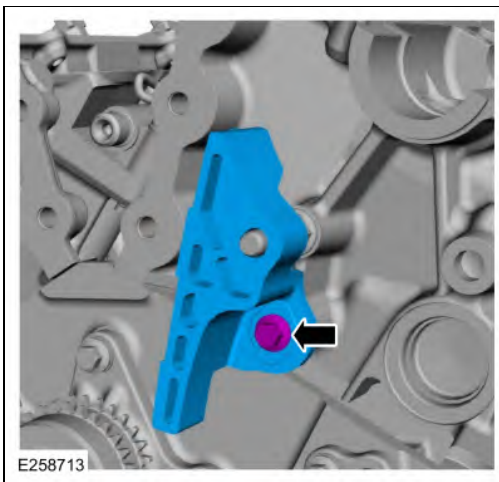
48. Install the M6 bolt.
Torque: 89 lb.in (10 Nm)



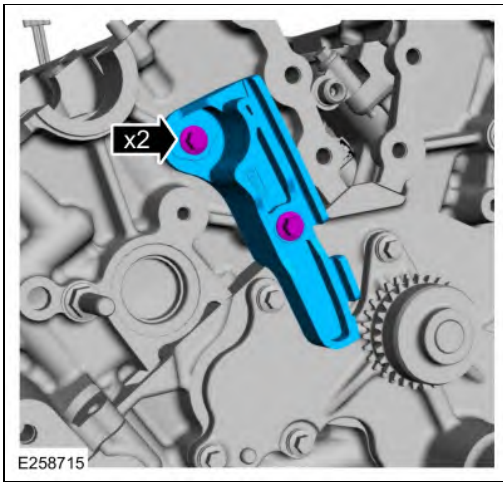
49. **NOTE:** Coat the valve tappets with clean engine oil prior to installation.
- NOTE:** The valve tappets must be installed in their original positions.
- NOTE:** RH shown, LH similar.
- Install the valve tappets.



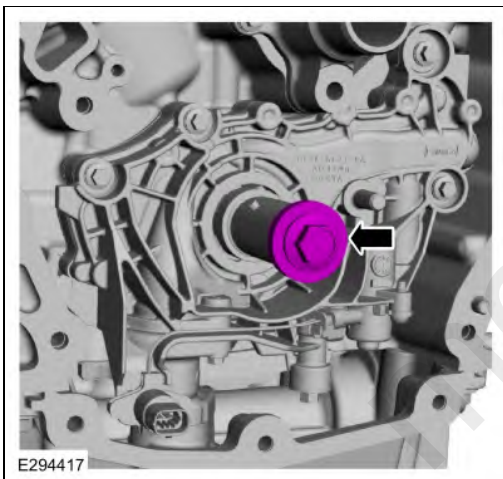
50. Install the LH upper primary timing chain guide and the bolt.
Torque: 89 lb.in (10 Nm)



51. Install the RH primary timing chain guide and the bolts.
Torque: 89 lb.in (10 Nm)

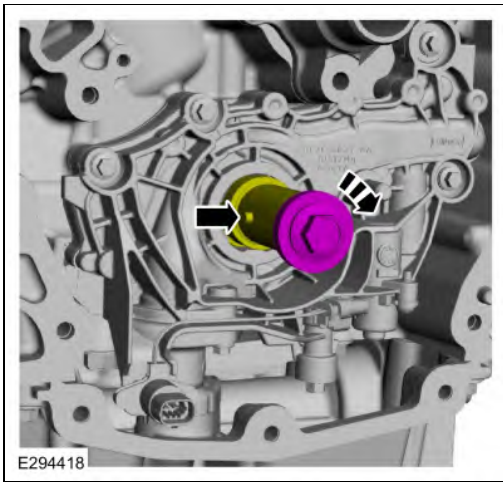


52. Install the original crankshaft bolt and washer.



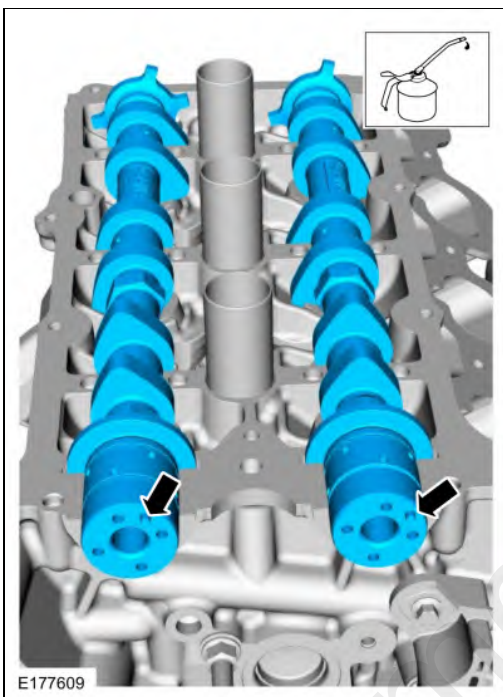
53. **NOTICE:** The crankshaft must remain in the freewheeling position (crankshaft dowel pin at 9 o'clock) until after the camshafts are installed and the valve clearance is checked/adjusted. Do not turn the crankshaft until instructed to do so. Failure to follow this process will result in severe engine damage.

Using the crankshaft bolt, position the crankshaft dowel pin in the 9 o'clock position.



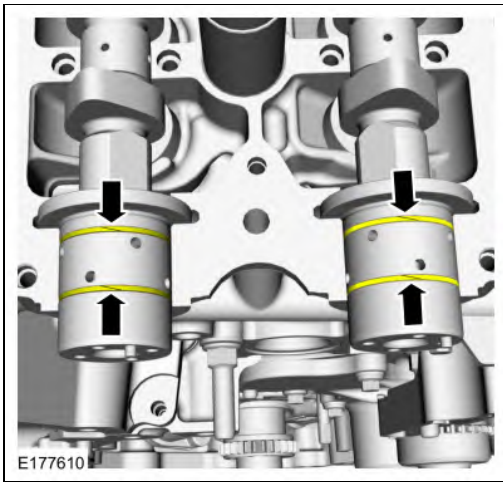
54. **NOTE:** Coat the camshafts with clean engine oil prior to installation.

Lubricate the camshafts with clean engine oil and position the camshafts onto the RH cylinder head in the neutral position as shown.



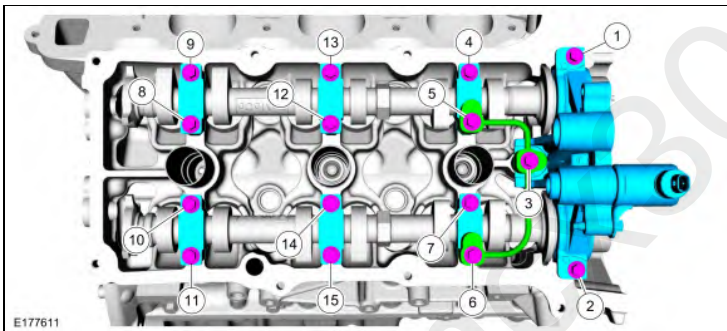
55. **NOTICE:** The camshaft seal gaps must be at the 12 o'clock position or damage to the engine may occur.

Position the RH camshaft seals gaps as shown.

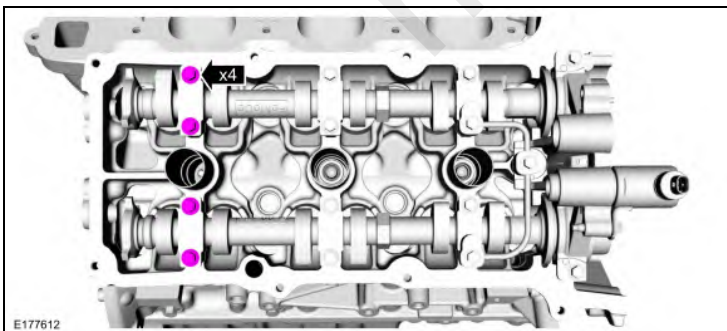


56. **NOTE:** Cylinder head camshaft bearing caps are numbered to verify that they are assembled in their original positions.

- Install the camshaft caps, oil tube and the bolts.
- Torque:*
- Stage 1: Tighten bolts 1, 2, 4, 5, 6 and 7 to: 71 lb.in (8 Nm)
 - Stage 2: Tighten bolts 1, 2, 4, 5, 6 and 7 an additional: 45°
 - Stage 3: Tighten bolts 8, 9, 10 and 11 to: 71 lb.in (8 Nm)
 - Stage 4: Tighten bolts 12, 13, 14 and 15 to: 71 lb.in (8 Nm)
 - Stage 5: Tighten bolts 12, 13, 14 and 15 an additional: 45°
- The camshaft torque sequence (bolt 3) will be finished after the timing chain is installed.

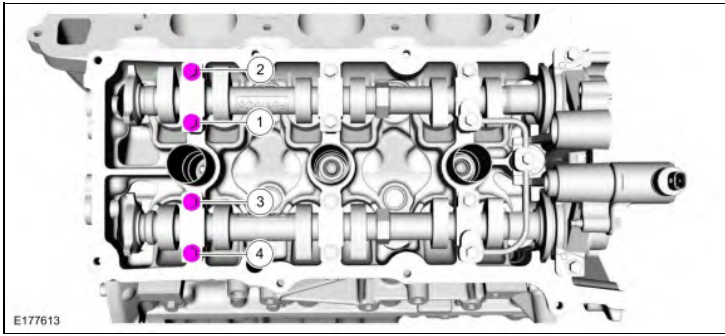


57. Loosen the camshaft cap bolts.



58. Tighten the camshaft cap bolts.

- Torque:*
- Stage 1: 71 lb.in (8 Nm)
 - Stage 2: 60°



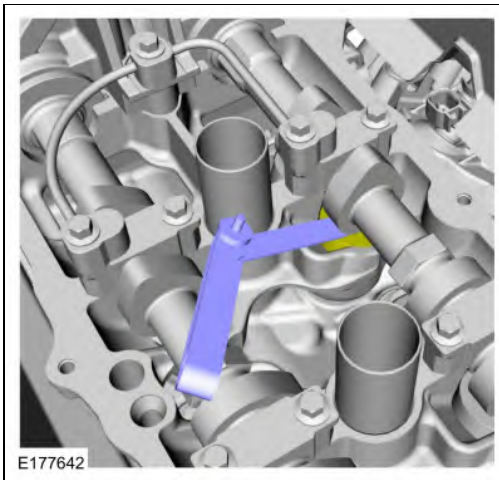
59. **NOTICE:** If any components are installed new, the engine valve clearance must be checked/adjusted or engine damage may occur.

NOTE: Use a camshaft sprocket bolt to turn the camshafts.

Confirm that the valve tappet clearances are within specification. If valve tappet clearances are not within specification, the clearance must be adjusted by installing new valve tappet(s) of the correct size.

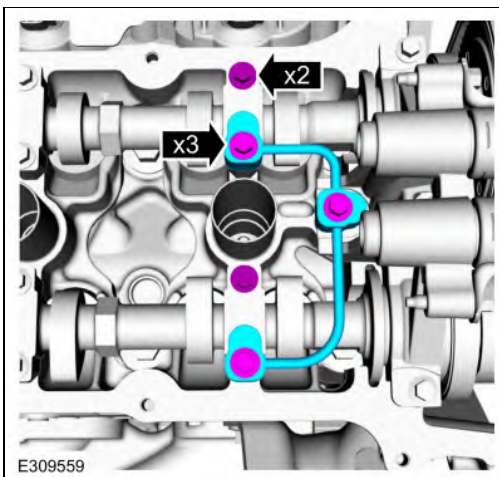
Refer to: Valve Clearance Adjustment (303-01C Engine - 3.3L Duratec-V6, General Procedures).

Use the General Equipment: Feeler Gauge

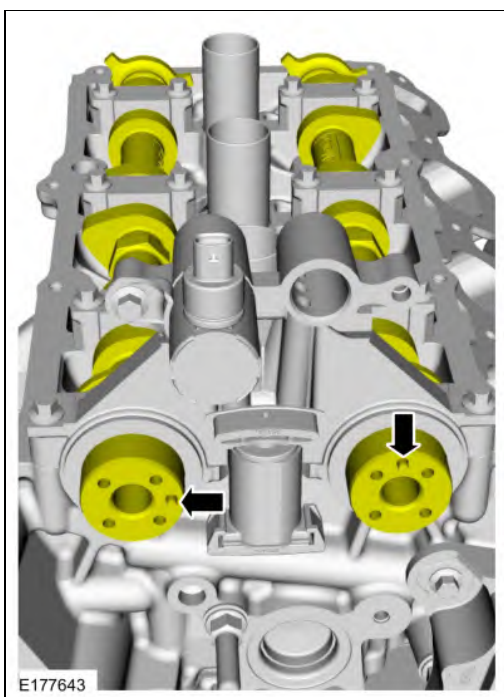


60.

- Remove the bolts and the RH oil tube.
- Loosen the 2 bolts.

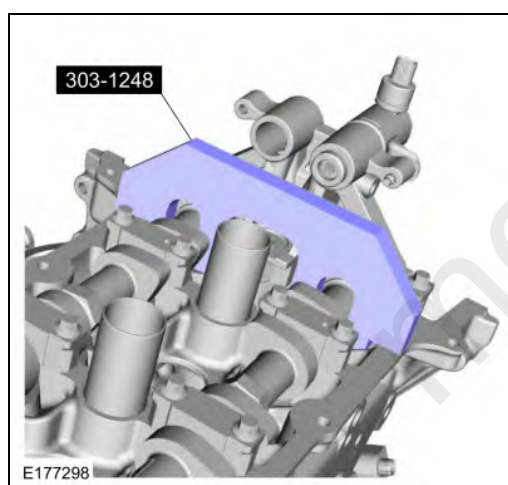


61. Rotate the RH camshafts to TDC.



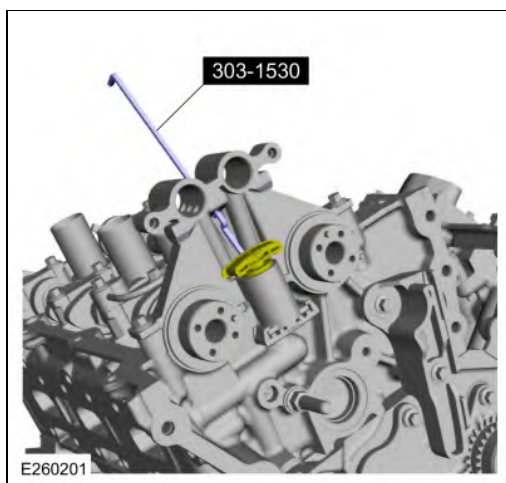
62. **NOTE:** *The Camshaft Holding Tool will hold the camshafts in the TDC position.*

Install Special Service Tool: 303-1248 Camshaft holding tools.

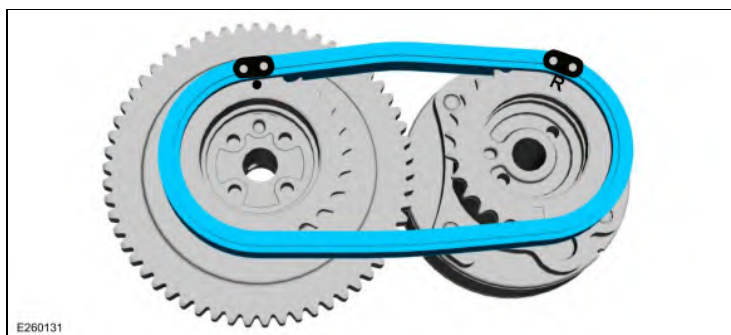


63. **NOTE:** The VCT oil control solenoids are removed for clarity.

Install Special Service Tool: 303-1530 Tool, Chain Tensioner Hold Down.

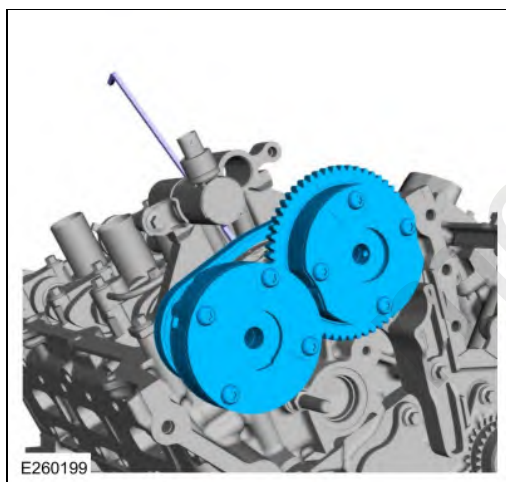


64. Align the colored links with the timing marks and assemble the RH VCT units.



65. **NOTE:** It may be necessary to rotate the camshafts slightly, to install the RH secondary timing assembly.

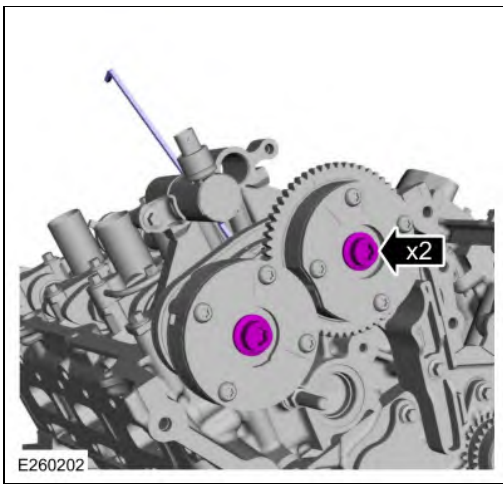
Position the RH VCT units and secondary timing chain onto the camshafts by aligning the holes in the VCT units with the dowel pins in the camshafts.



66. Install the new RH VCT unit bolts.

Torque:

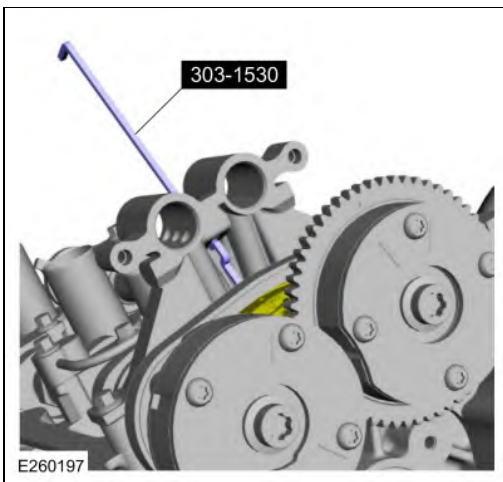
- Stage 1: 30 lb.ft (40 Nm)
- Stage 2: Loosen: 1 turn(s)
- Stage 3: 18 lb.ft (25 Nm)
- Stage 4: 180°



67. **NOTE:** Make sure the secondary timing chain is centered on the timing chain tensioner guides.

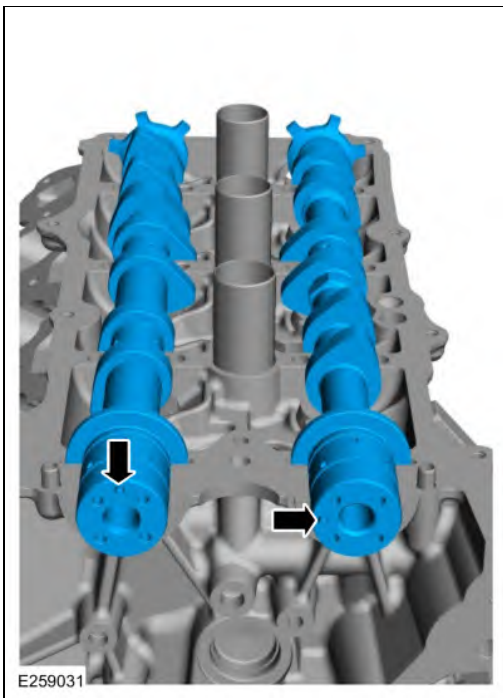
NOTE: The VCT oil control solenoids are removed for clarity.

Remove Special Service Tool: 303-1530 Tool, Chain Tensioner Hold Down.



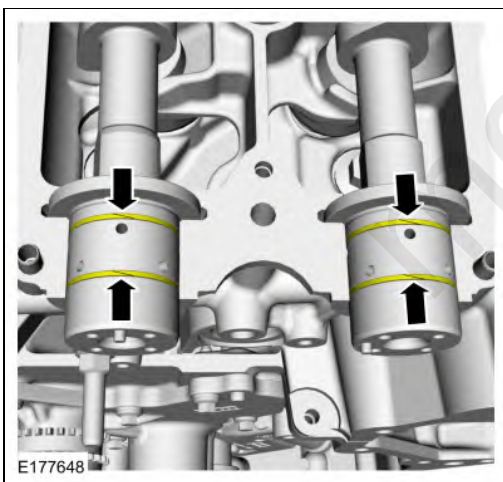
68. **NOTE:** Coat the camshafts with clean engine oil prior to installation.

Lubricate the camshafts with clean engine oil and position the camshafts onto the LH cylinder head in the neutral position as shown.



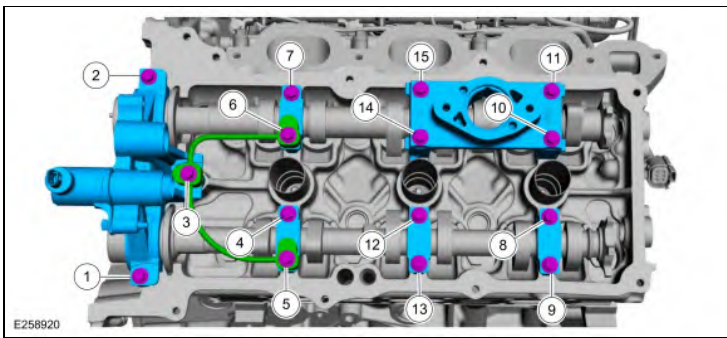
69. **NOTICE:** The camshaft seal gaps must be at the 12 o'clock position or damage to the engine may occur.

Position the LH camshaft seals as shown.

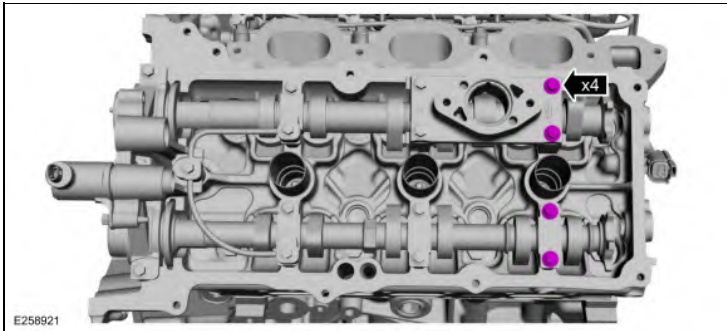


70. **NOTE:** Cylinder head camshaft bearing caps are numbered to verify that they are assembled in their original positions.

- Install the camshaft caps, oil tube and the bolts.
- Torque:*
- Stage 1: Tighten bolts 1, 2, 4, 5, 6 and 7 to: 71 lb.in (8 Nm)
 - Stage 2: Tighten bolts 1, 2, 4, 5, 6 and 7 an additional: 45°
 - Stage 3: Tighten bolts 8, 9, 10 and 11 to: 71 lb.in (8 Nm)
 - Stage 4: Tighten bolts 12, 13, 14 and 15 to: 71 lb.in (8 Nm)
 - Stage 5: Tighten bolts 12, 13, 14 and 15 an additional: 45°
- The camshaft torque sequence (bolt 3) will be finished after the timing chain is installed.



71. Loosen the camshaft cap bolts.

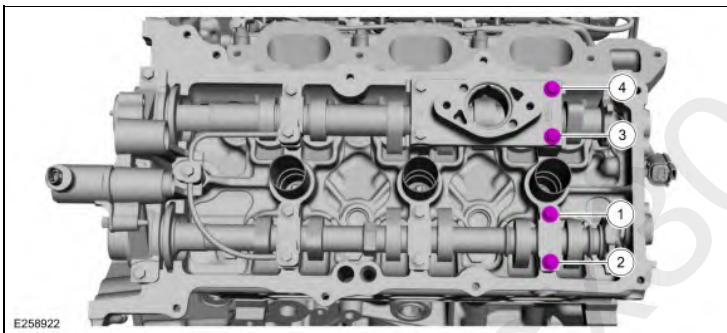


72. Tighten the camshaft cap bolts in sequence shown.

Torque:

Stage 1: 71 lb.in (8 Nm)

Stage 2: 60Å°

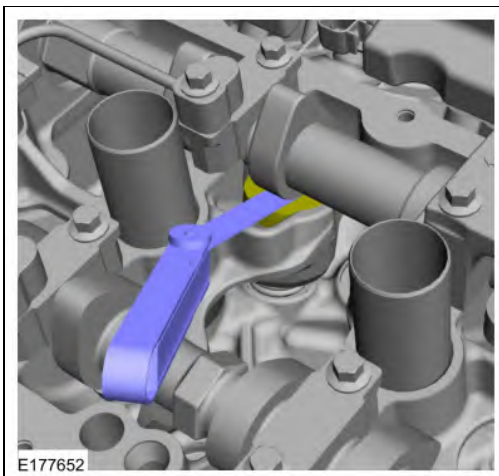


73. **NOTICE:** If any components are installed new, the engine valve clearance must be checked/adjusted or engine damage may occur.

NOTE: Use a camshaft sprocket bolt to turn the camshafts.

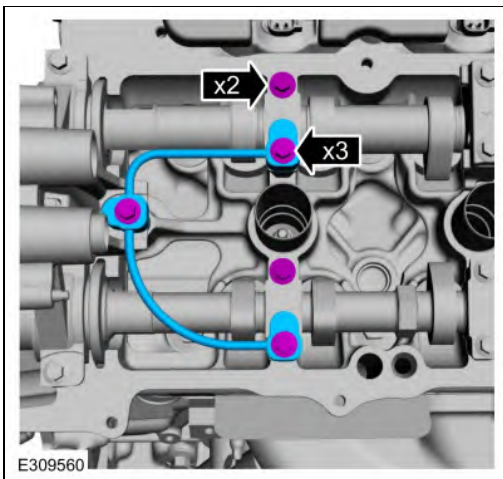
Confirm that the valve tappet clearances are within specification. If valve tappet clearances are not within specification, the clearance must be adjusted by installing new valve tappet(s) of the correct size.

Refer to: Valve Clearance Adjustment (303-01C Engine - 3.3L Duratec-V6, General Procedures).

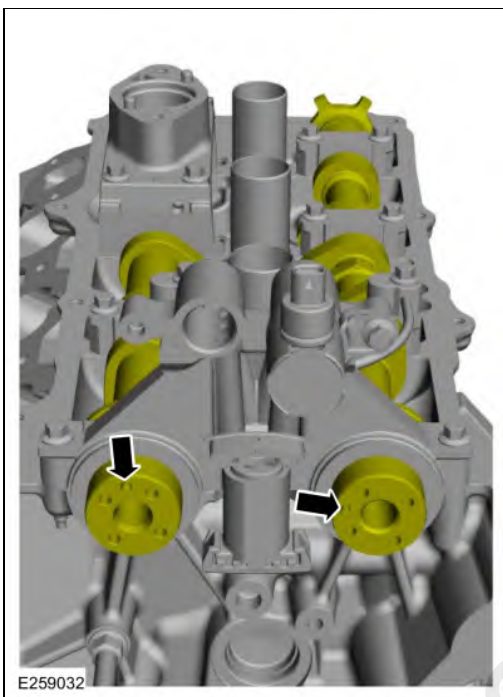


74.

- Remove bolts and the LH oil tube.
- Loosen the 2 bolts.

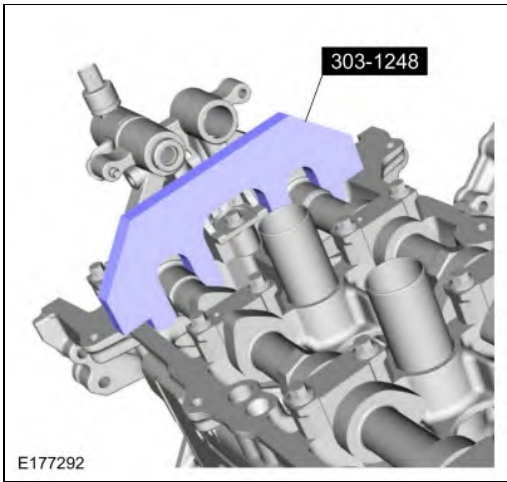


75. Rotate the LH camshafts to TDC.



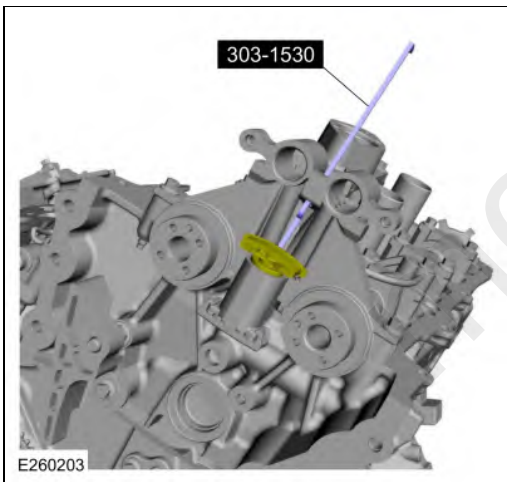
76. **NOTE:** The Camshaft Holding Tool will hold the camshafts in the TDC position.

Install Special Service Tool: 303-1248 Camshaft holding tools.

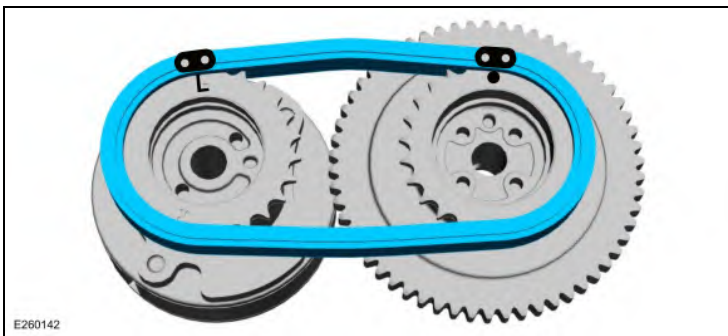


77. **NOTE:** The VCT oil control solenoids are removed for clarity.

Install Special Service Tool: 303-1530 Tool, Chain Tensioner Hold Down.

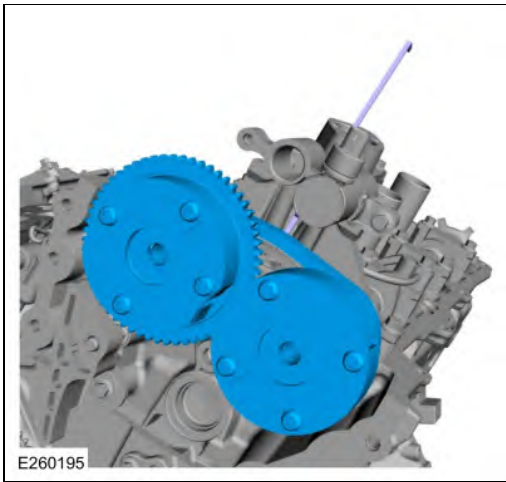


78. Align the colored links with the timing marks and assemble the LH VCT units.



79. **NOTE:** It may be necessary to rotate the camshafts slightly, to install the LH secondary timing assembly.

Position the LH VCT units and secondary timing chain onto the camshafts by aligning the holes in the VCT units with the dowel pins in the camshafts.



80. Install the new LH VCT unit bolts.

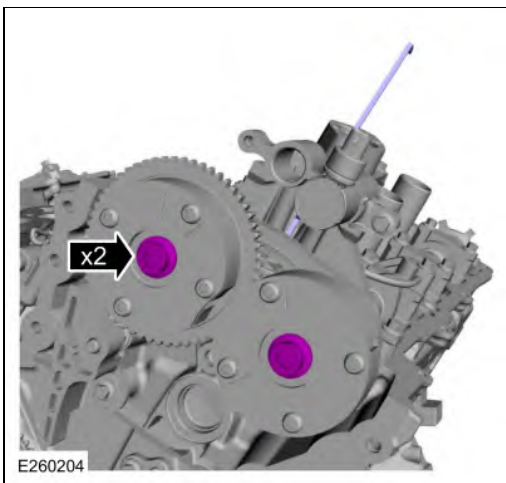
Torque:

Stage 1: 30 lb.ft (40 Nm)

Stage 2: Loosen: 1 turn(s)

Stage 3: 18 lb.ft (25 Nm)

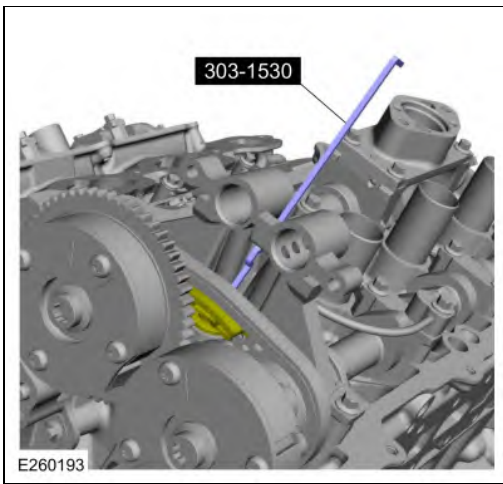
Stage 4: 180°



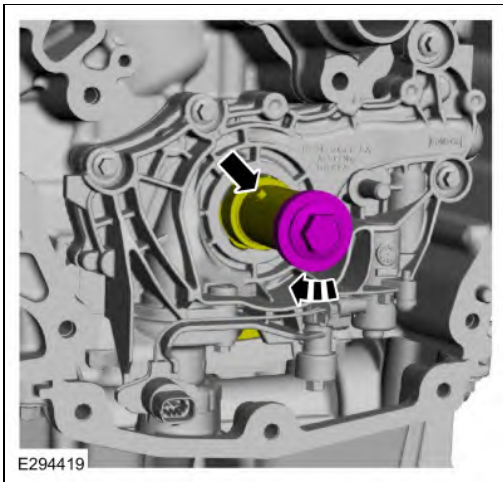
81. **NOTE:** Make sure the secondary timing chain is centered on the timing chain tensioner guides.

NOTE: The VCT oil control solenoids are removed for clarity.

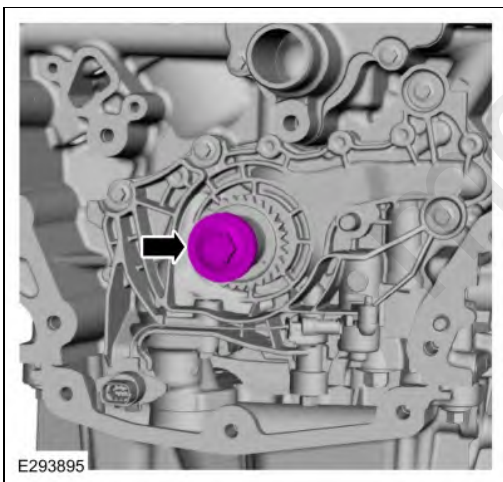
Remove Special Service Tool: 303-1530 Tool, Chain Tensioner Hold Down.



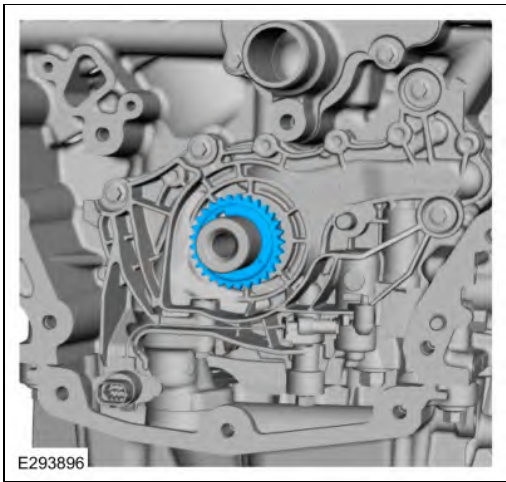
82. Using the crankshaft bolt, rotate the crankshaft clockwise 60 degrees to the TDC position (crankshaft dowel pin at 11 o'clock).



83. Remove the crankshaft pulley bolt.

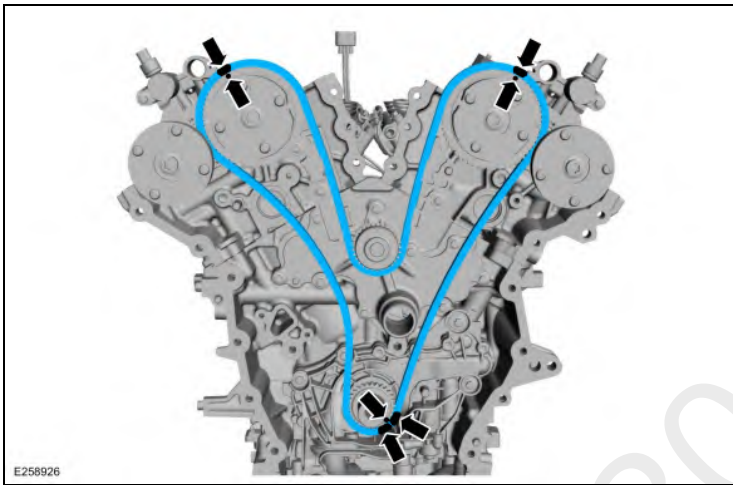


84. Install the crankshaft sprocket.



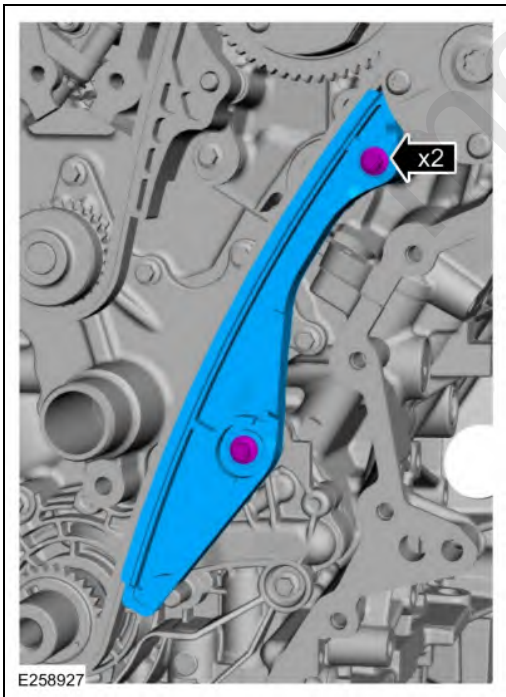
85. **NOTE:** It may be necessary to rotate the camshafts slightly, to align the timing marks.

Install the timing chain with the colored links aligned with the timing marks on the VCT units and the crankshaft sprocket.

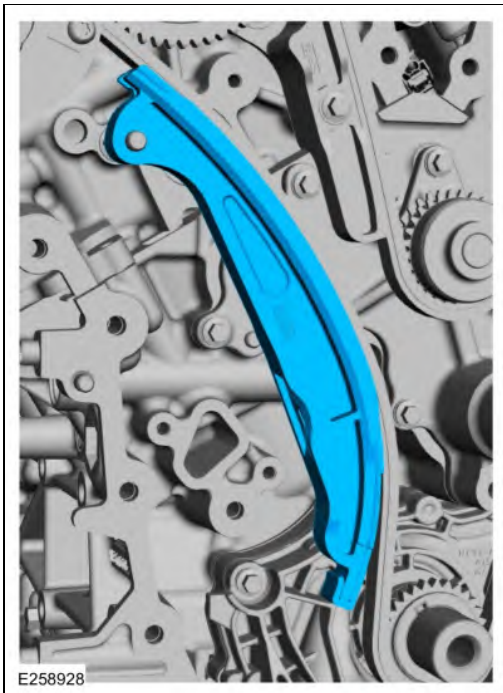


86. Install the lower LH timing chain guide and the bolts.

Torque: 89 lb.in (10 Nm)



87. Install the timing chain tensioner arm.

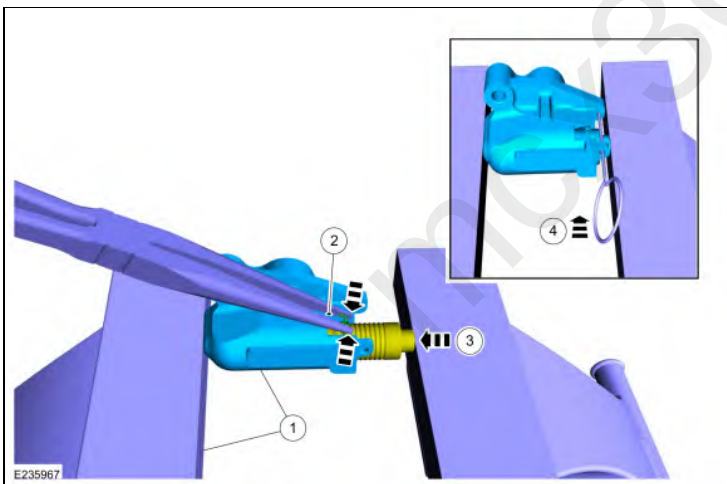


E258928



88.

1. Position the tensioner in a soft-jawed vise.
2. Using pliers, squeeze the ends of the ratchet wire clip together.
3. Using the soft-jawed vise, compress the plunger to the reset position.
4. Install a locking pin in the 2 holes of the tensioner body to hold the plunger in place.

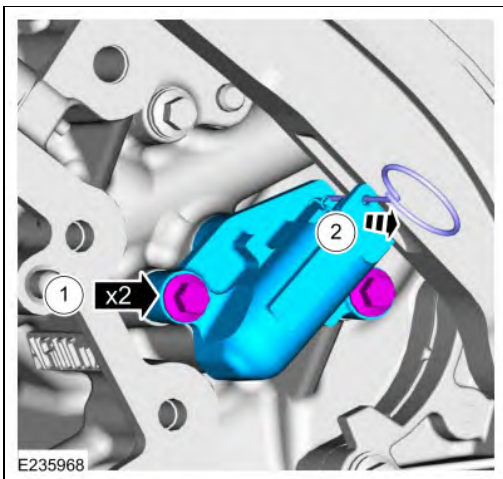


E235967



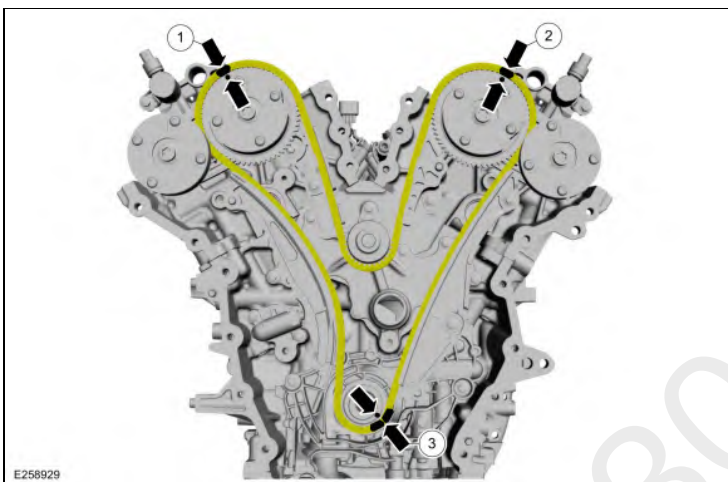
89. **NOTE:** It may be necessary to rotate the camshafts slightly to remove slack from the timing chain to install the tensioner.

1. Install the timing chain tensioner and the bolts.
Torque: 89 lb.in (10 Nm)
2. Remove the lockpin.



90.

- As a post-check, verify correct alignment of all timing marks.
- There are 48 links in between the RH intake VCT unit colored link (1) and the LH intake VCT unit colored link (2).
- There are 35 links in between LH intake VCT unit colored link (2) and the 2 crankshaft sprocket links (3).



91. **NOTICE:** Do not use excessive force when installing the VCT oil control solenoid. Damage to the mega cap could cause the cylinder head to be inoperable. If difficult to install the VCT oil control solenoid, inspect the bore and VCT oil control solenoid to ensure there are no burrs, sharp edges or contaminants present on the mating surface. Only clean the external surfaces as necessary.

Install the VCT oil control solenoids and the bolts.

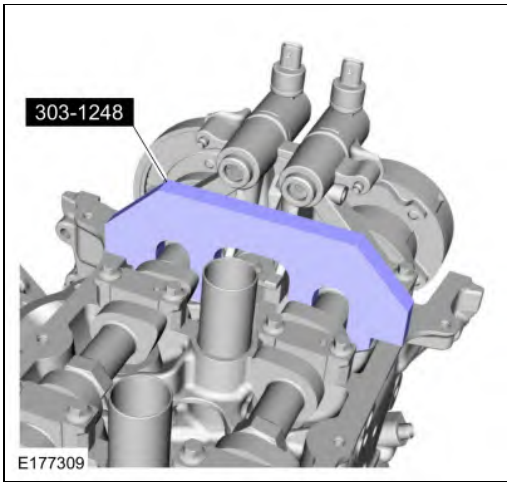
Torque:

Stage 1: 71 lb.in (8 Nm)

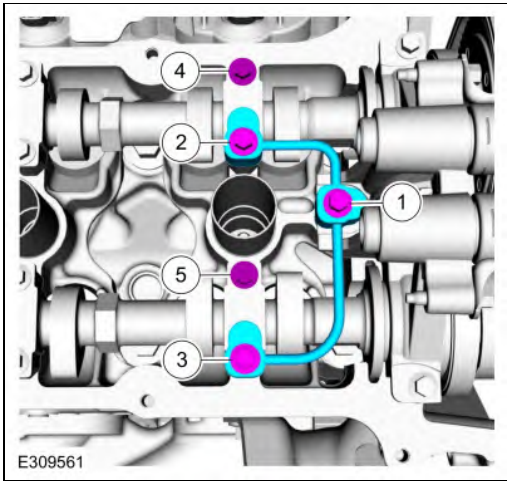
Stage 2: 20Å°



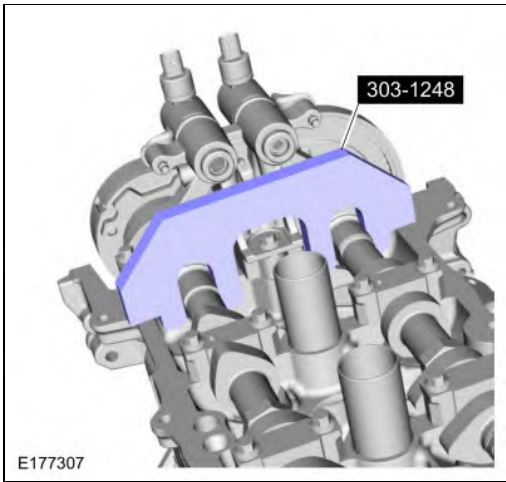
92. Remove Special Service Tool: 303-1248 Camshaft holding tools.



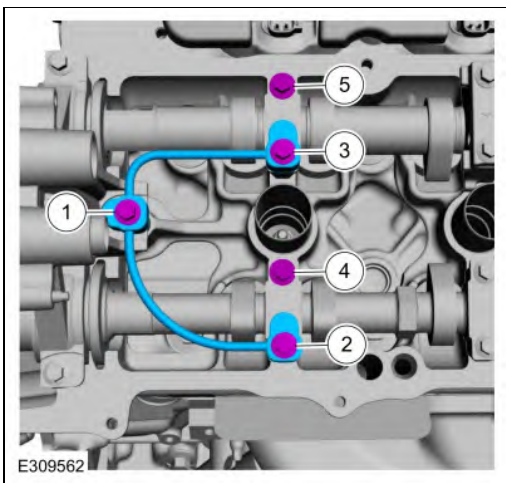
93. Install the RH oil tube and the bolts finger tight.
- Torque:*
- Stage 1: Tighten bolts 1, 2 and 3 to: 71 lb.in (8 Nm)
 - Stage 2: Tighten bolts 1, 2 and 3 an additional: 60°
 - Stage 3: Tighten bolts 4 and 5 to: 71 lb.in (8 Nm)
 - Stage 4: Tighten bolts 4 and 5 an additional: 45°



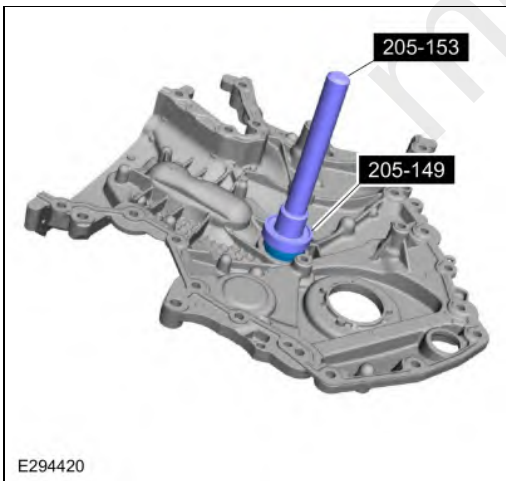
94. Remove Special Service Tool: 303-1248 Camshaft holding tools.



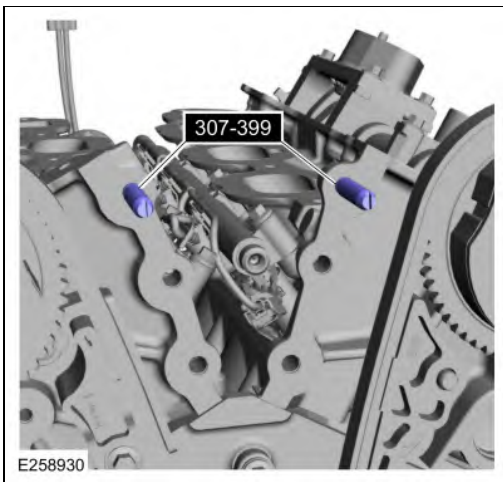
95. Install the LH oil tube and the bolts finger tight.
- Torque:*
- Stage 1: Tighten bolts 1, 2 and 3 to: 71 lb.in (8 Nm)
 - Stage 2: Tighten bolts 1, 2 and 3 an additional: 60°
 - Stage 3: Tighten bolts 4 and 5 to: 71 lb.in (8 Nm)
 - Stage 4: Tighten bolts 4 and 5 an additional: 45°



96. Using the special tools, install the front cover to coolant pipe seal.
- Use Special Service Tool: 205-149 (T80T-4000-R) Installer, Spindle Bearing , 205-153 (T80T-4000-W) Handle.



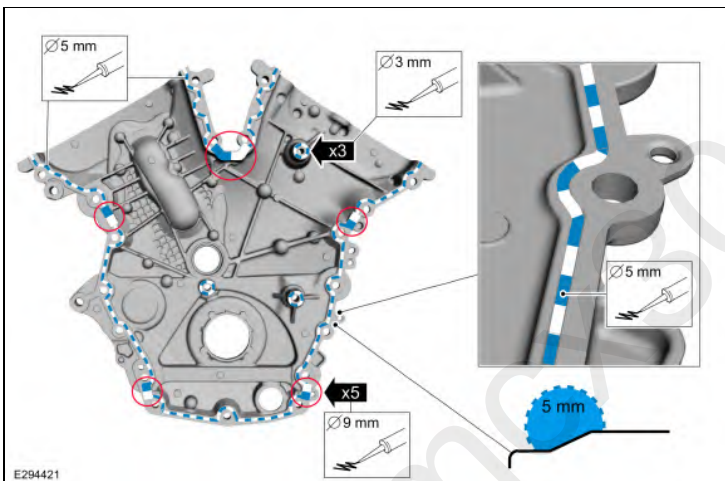
97. Install Special Service Tool: 307-399 Alignment Pins, Transmission Fluid Pump.



98. **NOTICE:** Failure to use Motorcraft® High Performance Engine RTV Silicone may cause the engine oil to foam excessively and result in serious engine damage.

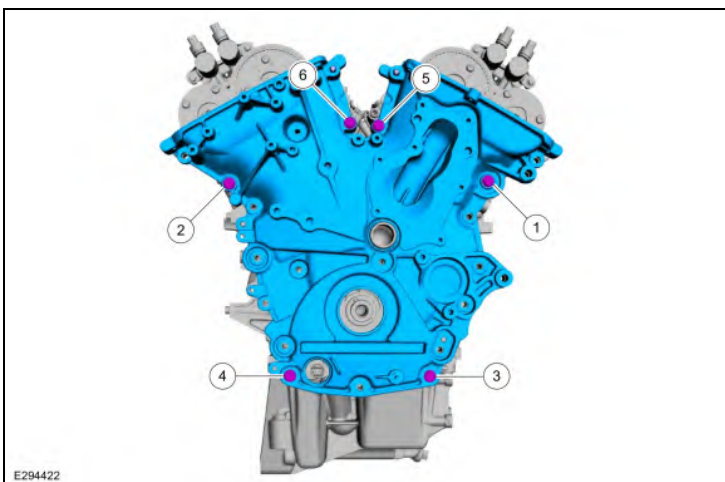
NOTE: The engine front cover and the 6 bolts must be installed within 4 minutes of the initial sealant application. The remainder of the engine front cover bolts must be installed and tightened within 10 minutes of the initial sealant application. If the time limits are exceeded, the sealant must be removed, the sealing area cleaned and sealant reapplied. Failure to follow this procedure can cause future oil leakage.

- Apply a 3 mm (0.12 in) bead of Motorcraft® High Performance Engine RTV Silicone to the engine front cover inner bolt bosses.
Material: Motorcraft® High Performance Engine RTV Silicone / TA-357 (WSE-M4G323-A6)
- Apply a 5 mm (0.19 in) bead of Motorcraft® High Performance Engine RTV Silicone on the chamfer, as shown.
Material: Motorcraft® High Performance Engine RTV Silicone / TA-357 (WSE-M4G323-A6)
- Apply a 9 mm (0.35 in) bead of Motorcraft® High Performance Engine RTV Silicone to the oil pan-to-cylinder block joint and the cylinder head-to-cylinder block joint areas of the engine front cover in places as indicated.
Material: Motorcraft® High Performance Engine RTV Silicone / TA-357 (WSE-M4G323-A6)

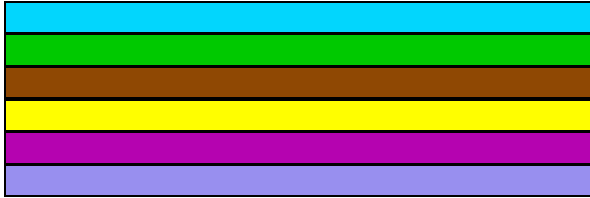
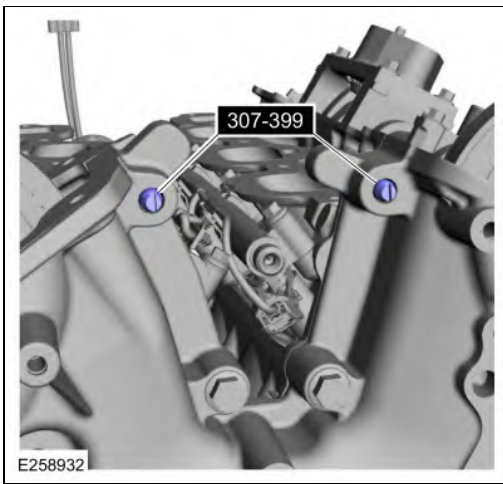


99. **NOTE:** Make sure the locating dowel pins are seated correctly in the cylinder block.

Install the engine front cover and the bolts.
Torque: 27 lb.in (3 Nm)



100. Remove Special Service Tool: 307-399 Alignment Pins, Transmission Fluid Pump.



101. **NOTE:** The engine front cover bolts must be installed and tightened within 10 minutes of the initial sealant application.

Install the remaining engine front cover bolts.

Torque:

Stage 1: Tighten bolts 1 through 20 to: 89 lb.in (10 Nm)

Stage 2: Tighten bolts 1 through 19 and 22 to: 177 lb.in (20 Nm)

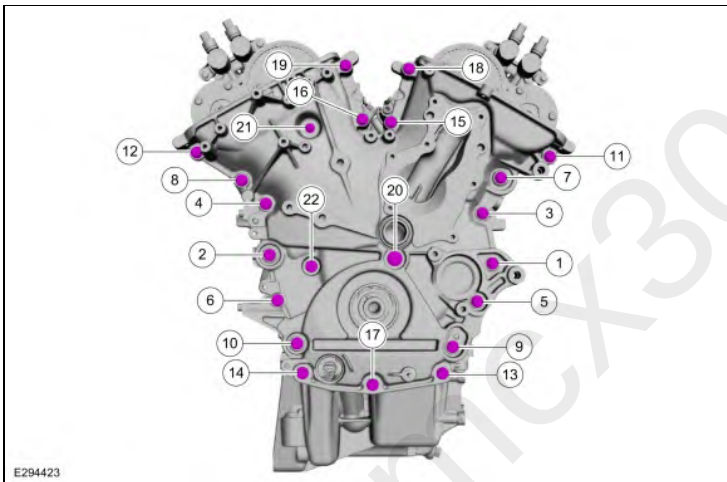
Stage 3: Tighten bolts 1 through 19 and 22 an additional: 45°

Stage 4: Tighten bolt 20 to: 177 lb.in (20 Nm)

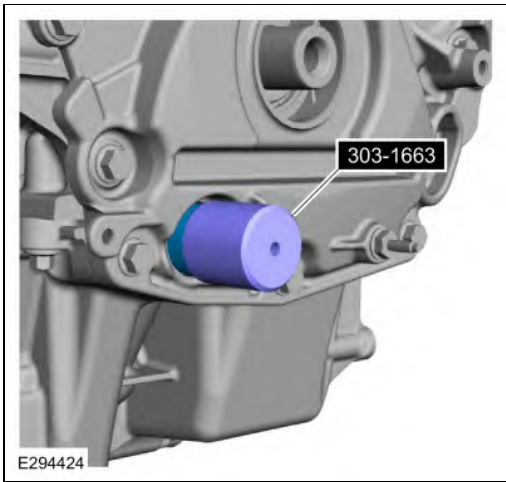
Stage 5: Tighten bolt 20 an additional: 90°

Stage 6: Tighten bolt 21 to: 89 lb.in (10 Nm)

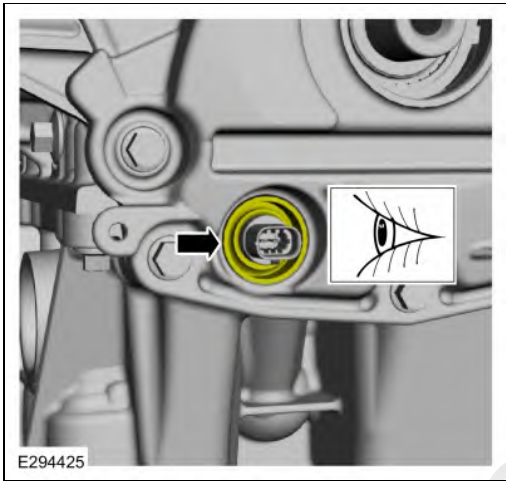
Stage 7: Tighten bolt 21 an additional: 45°



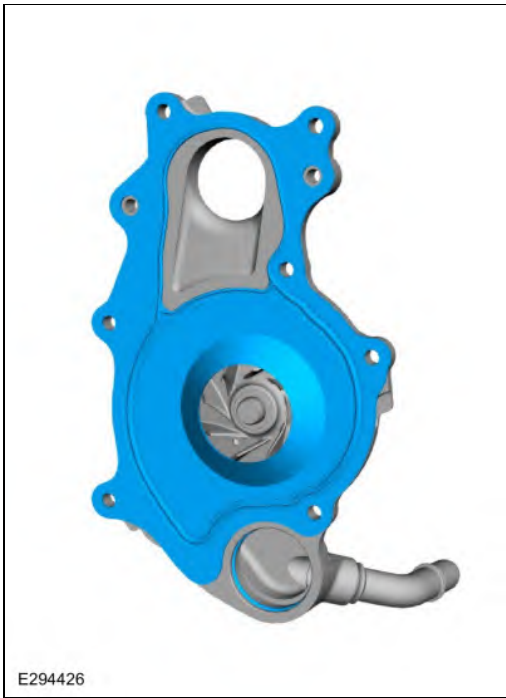
102. Using the special tool and a hammer, install the oil pump electrical connector seal.
Use Special Service Tool: 303-1663 Installer, VDOP Seal.



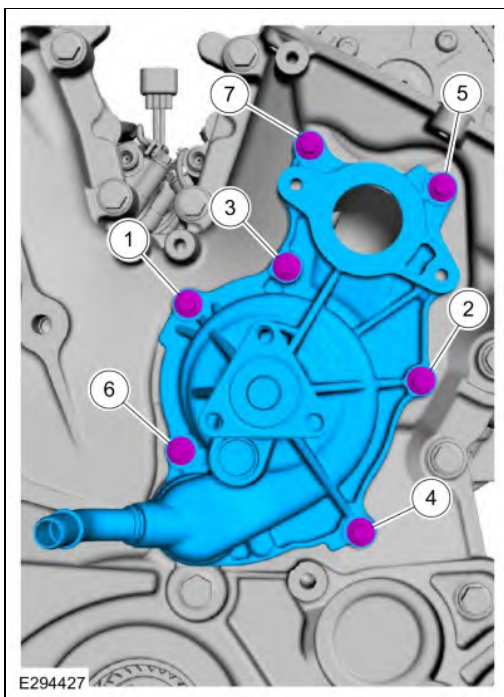
103. Make sure the oil pump electrical connector seal is below the top of the oil pump electrical connector or the oil pump electrical connector seal may leak oil.



104. Install a new coolant pump gasket and O-ring seal.



105. Install the coolant pump and the bolts.
Torque:
Stage 1: 89 lb.in (10 Nm)
Stage 2: 45°



E294427



106. **NOTE:** Make sure that a new fuel rail to fuel rail high-pressure fuel tube is installed.

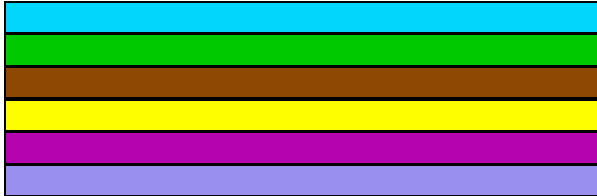
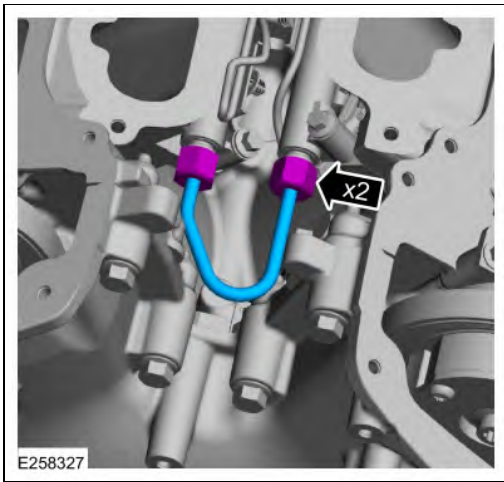
- Install the fuel rail to fuel rail high-pressure fuel tube and finger tight the flare nuts.
- Tighten the flare nuts in the following 3 stages.

Torque:

Stage 1: 62 lb.in (7 Nm)

Stage 2: 89 lb.in (10 Nm)

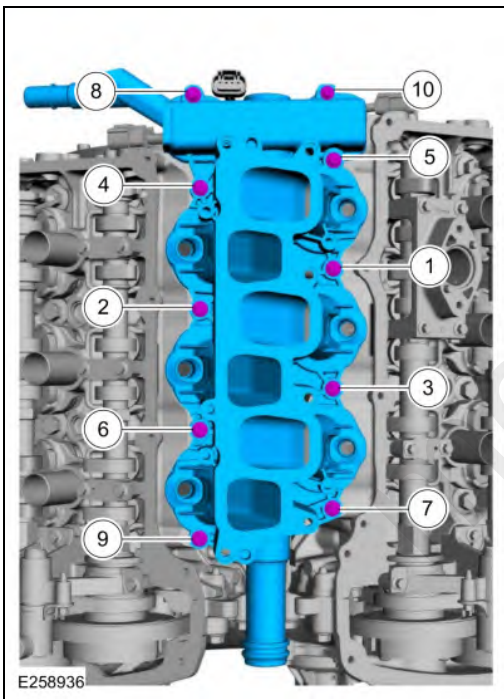
Stage 3: If the torque required to tighten any flare nut on the new high-pressure fuel tube reaches or exceeds 75 Nm (55 lb-ft), the high pressure fuel tube must be discarded and replaced with another new high-pressure fuel tube.: 30°



107. **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.

Install the lower intake manifold and the bolts.

Torque: 89 lb.in (10 Nm)

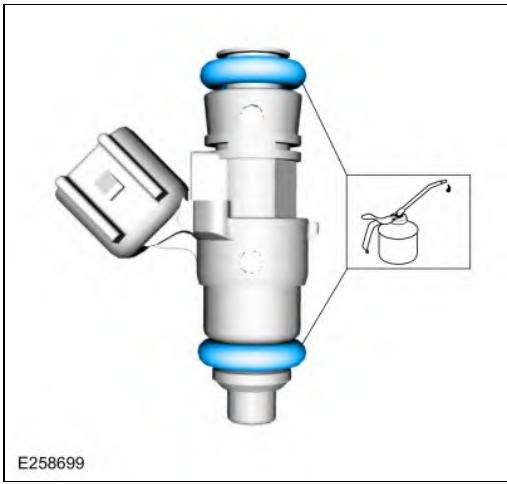


108. **NOTICE:** Use O-ring seals that are made of special fuel-resistant material. Use of ordinary O-rings can cause the fuel system to leak. Do not reuse the O-ring seals.

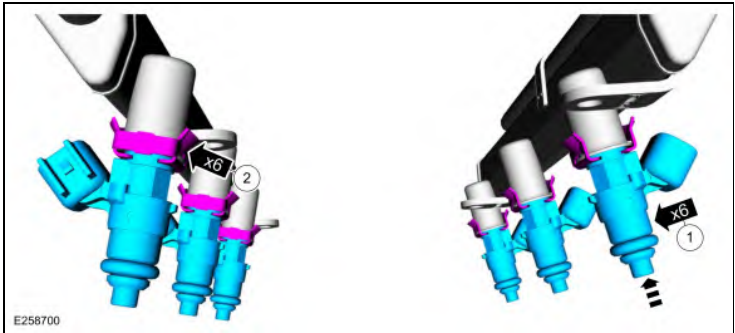
NOTICE: The upper and lower fuel injector O-ring seals are similar in appearance, but are not interchangeable.

NOTE: Make sure that new fuel injector O-ring seals are installed.

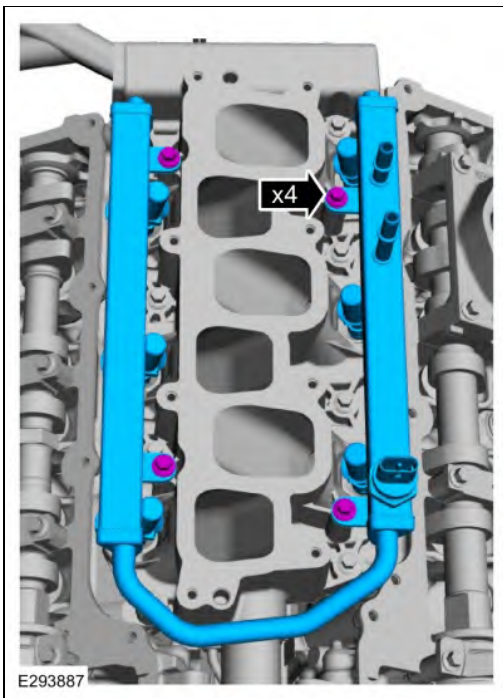
- Install the new fuel injector O-ring seals onto the fuel injectors.
- Lubricate the new fuel injector O-ring seals with clean engine oil.



- 109.
1. Install the fuel injectors into the fuel rail.
 2. Install the fuel injectors retaining clips.



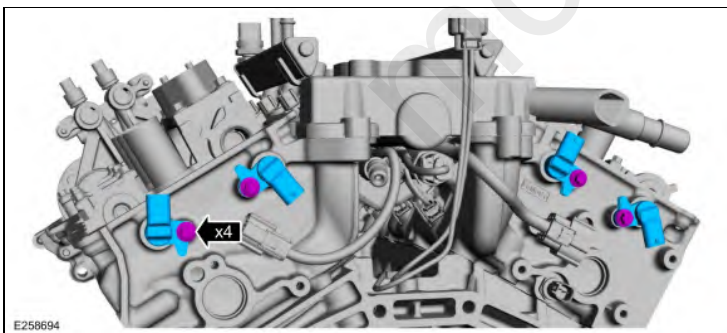
110. Install the port injection fuel rail and the bolts.
Torque: 89 lb.in (10 Nm)



111. **NOTE:** Apply clean engine oil to the CMP sensor O-ring seals.

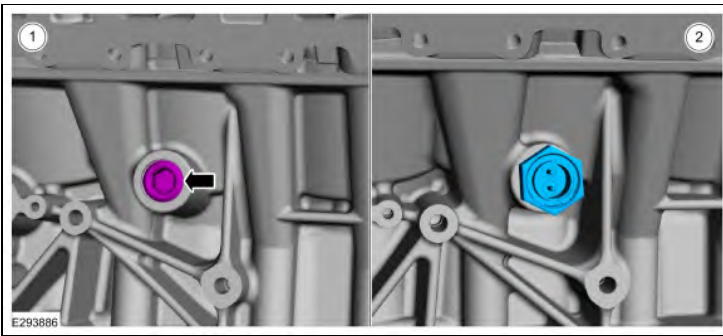
Install the CMP sensors and the bolts.

Torque: 89 lb.in (10 Nm)



112.

1. Install the LH block coolant drain plug.
Torque: 30 lb.ft (40 Nm)
2. If equipped, install the block heater.
Torque: 30 lb.ft (40 Nm)

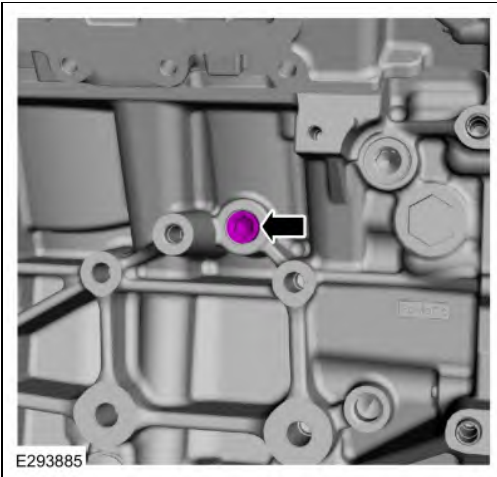


113. Install the RH block coolant drain plug.

Torque:

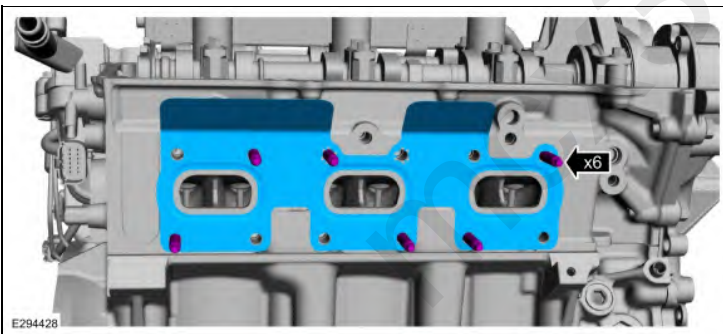
Stage 1: 142 lb.in (16 Nm)

Stage 2: 180°



114.

- Install the exhaust manifold studs.
- *Torque:* 106 lb.in (12 Nm)
- Install the exhaust manifold gasket.

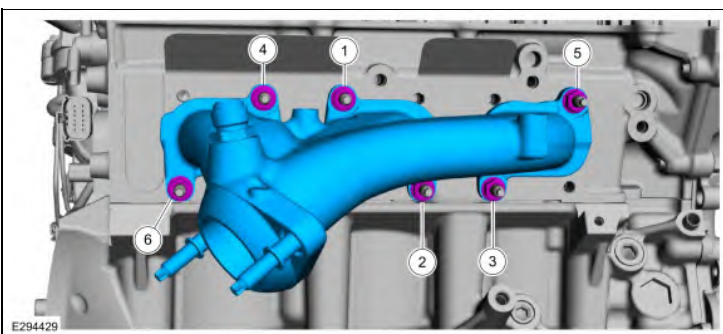


115. Install the exhaust manifold and the new nuts.

Torque:

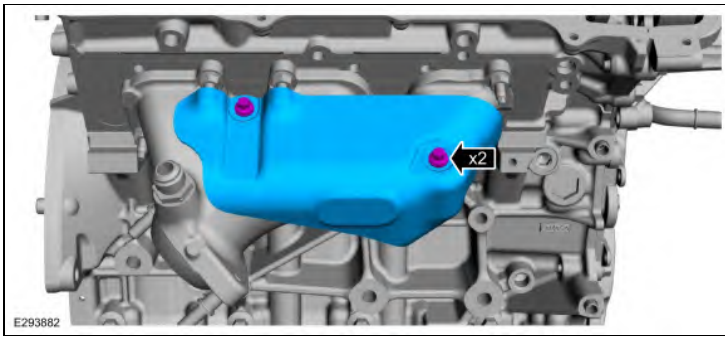
Stage 1: 168 lb.in (19 Nm)

Stage 2: 18 lb.ft (25 Nm)



116. Install the RH exhaust manifold heat shield and the bolts.

Torque: 106 lb.in (12 Nm)

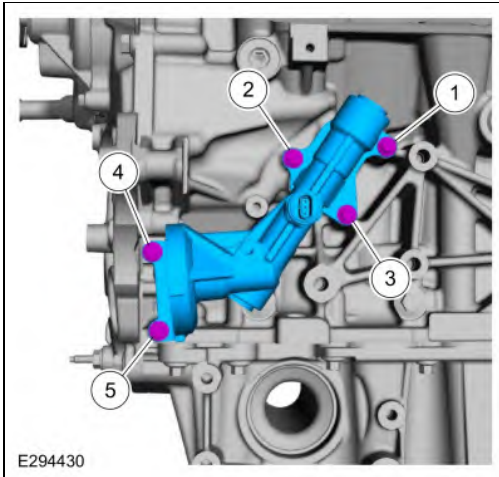


117. Install the oil filter adapter and the bolts.

Torque:

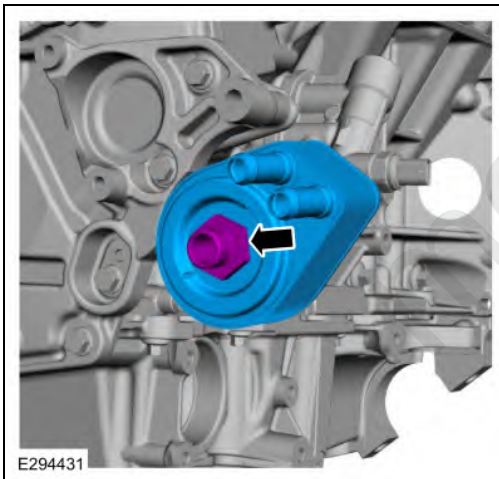
Stage 1: 89 lb.in (10 Nm)

Stage 2: 45°



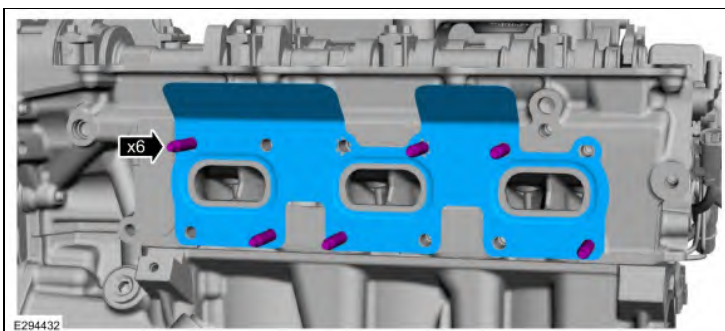
118. Install the oil cooler and the bolt.

Torque: 43 lb.ft (58 Nm)



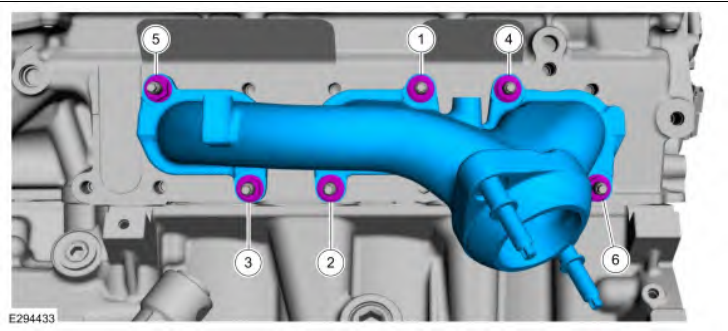
119.

- Install the exhaust manifold studs.
- Torque:* 106 lb.in (12 Nm)
- Install the exhaust manifold gasket.



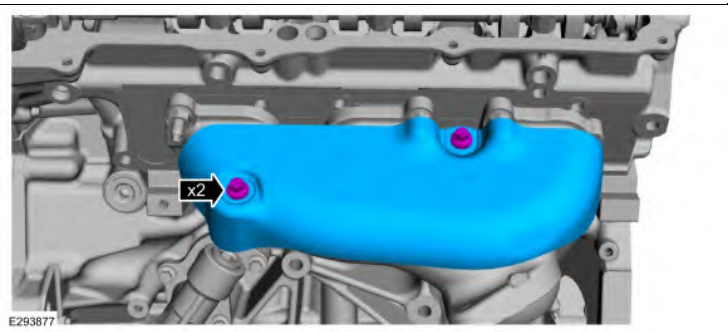
120. Install the exhaust manifold and the new nuts.

Torque:
Stage 1: 168 lb.in (19 Nm)
Stage 2: 18 lb.ft (25 Nm)



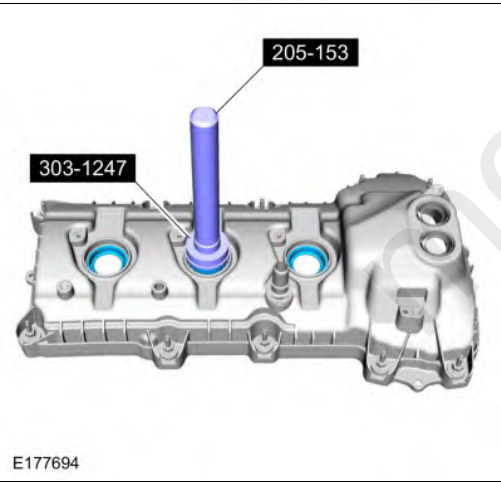
121. Install the LH exhaust manifold heat shield and the bolts.

Torque: 106 lb.in (12 Nm)



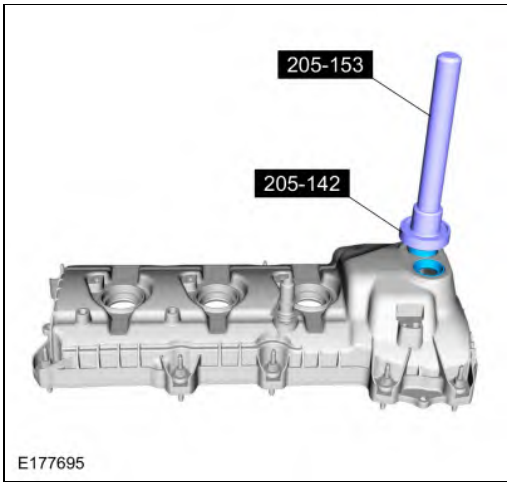
122. **NOTE:** Installation of new seals is only required if damaged seals were removed.

If removed, using the special tools, install the spark plug tube seals.
Use Special Service Tool: 303-1247 VCT Spark Plug Tube Seal Remover and Installer. , 205-153 (T80T-4000-W) Handle.



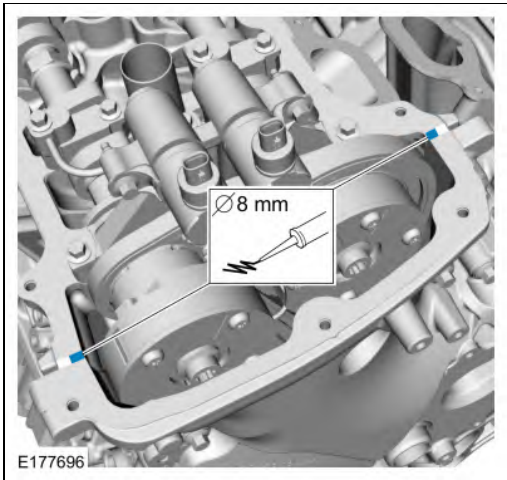
123. **NOTE:** Installation of new seals is only required if damaged seals were removed.

If removed, using the special tools, install the VCToil control solenoid seals.
Use Special Service Tool: 205-142 (T80T-4000-J) Installer, Differential Bearing Cone. , 205-153 (T80T-4000-W) Handle.

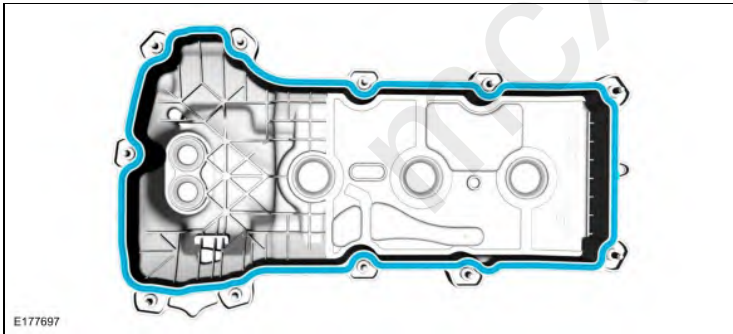


124. **NOTE:** If the valve cover is not installed and the fasteners tightened within 4 minutes, the sealant must be removed and the sealing area cleaned. To clean the sealing area, use silicone gasket remover and metal surface prep. Failure to follow this procedure can cause future oil leakage.

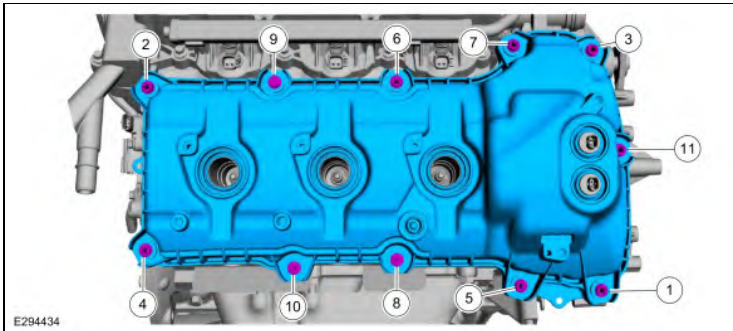
Apply an 8 mm (0.31 in) bead of Motorcraft® High Performance Engine RTV Silicone to the engine front cover-to-cylinder head joints.
 Material: Motorcraft® High Performance Engine RTV Silicone / TA-357 (WSE-M4G323-A6)



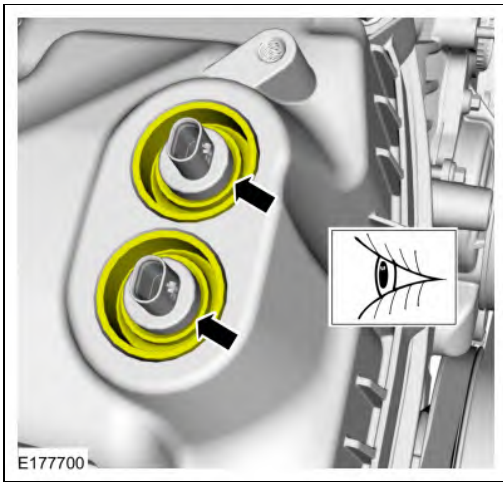
125. Install a new valve cover gasket.



126. Install the valve cover and tighten the bolts.
 Torque: 89 lb.in (10 Nm)



127. Make sure the VCT seals in the valve cover are below the top of the VCT oil control solenoid electrical connector or the VCT seal may leak oil.

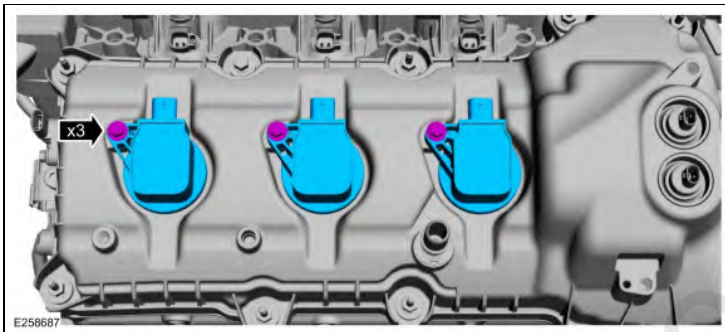


128. Install the RH coil-on-plugs and the bolts.

Torque:

Stage 1: 62 lb.in (7 Nm)

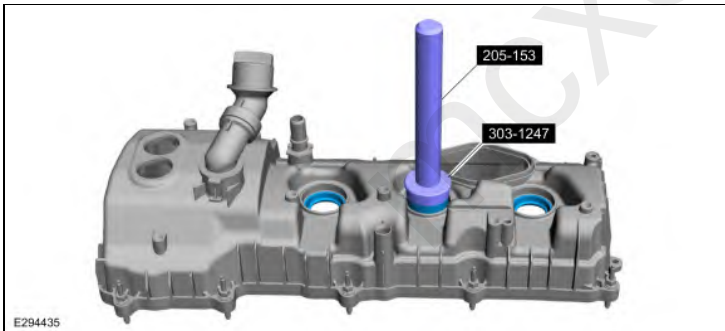
Stage 2: 50°



129. **NOTE:** Installation of new seals is only required if damaged seals were removed.

If removed, using the special tools, install the spark plug tube seals.

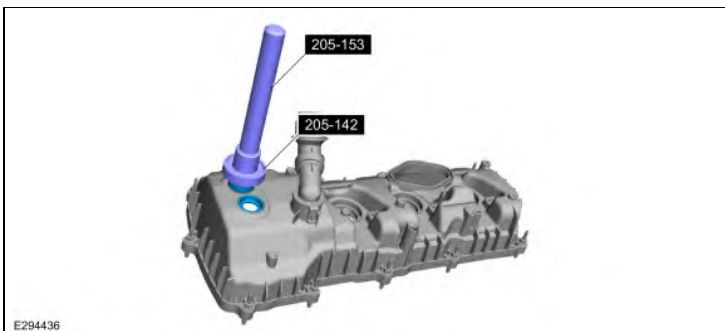
Use Special Service Tool: 303-1247 VCT Spark Plug Tube Seal Remover and Installer. , 205-153 (T80T-4000-W) Handle.



130. **NOTE:** Installation of new seals is only required if damaged seals were removed.

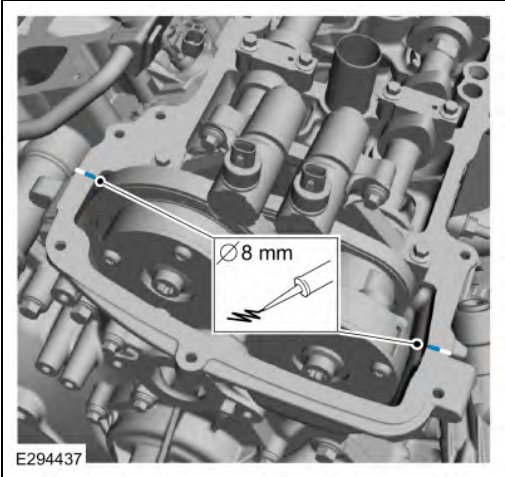
If removed, using the special tools, install the VCToil control solenoid seals.

Use Special Service Tool: 205-142 (T80T-4000-J) Installer, Differential Bearing Cone. , 205-153 (T80T-4000-W) Handle.

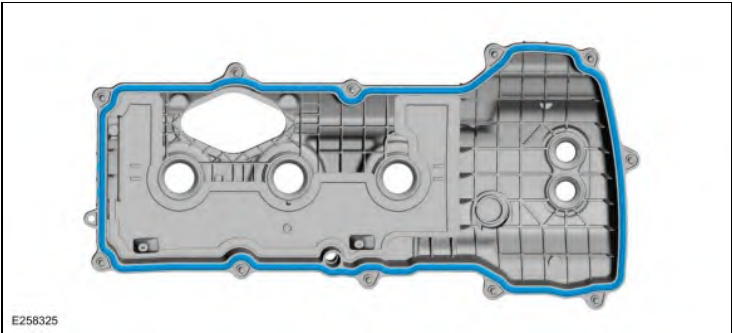


131. **NOTE:** If the valve cover is not installed and the fasteners tightened within 4 minutes, the sealant must be removed and the sealing area cleaned. To clean the sealing area, use silicone gasket remover and metal surface prep. Failure to follow this procedure can cause future oil leakage.

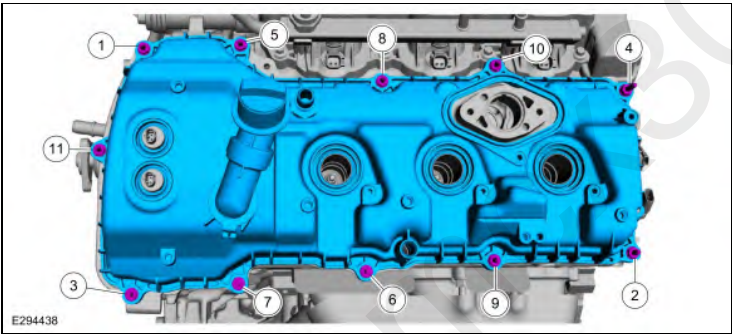
Apply an 8 mm (0.31 in) bead of Motorcraft® High Performance Engine RTV Silicone to the engine front cover-to-cylinder head joints.



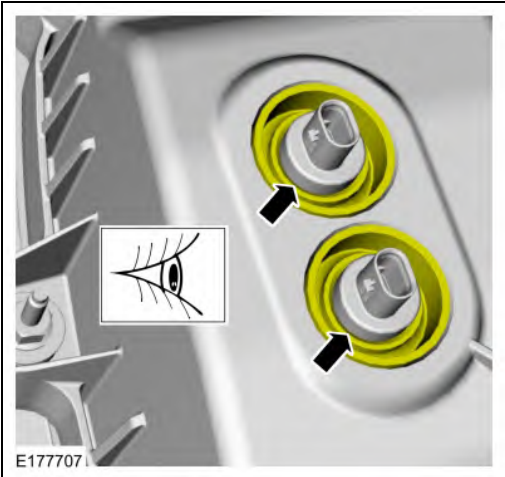
132. Install a new valve cover gasket.



133. Install the valve cover and tighten the bolts.
Torque: 89 lb.in (10 Nm)

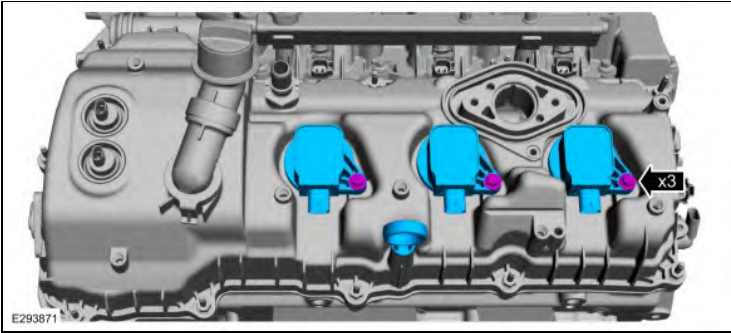


134. Make sure the VCT seals in the valve cover are below the top of the VCT oil control solenoid electrical connector or the VCT seal may leak oil.

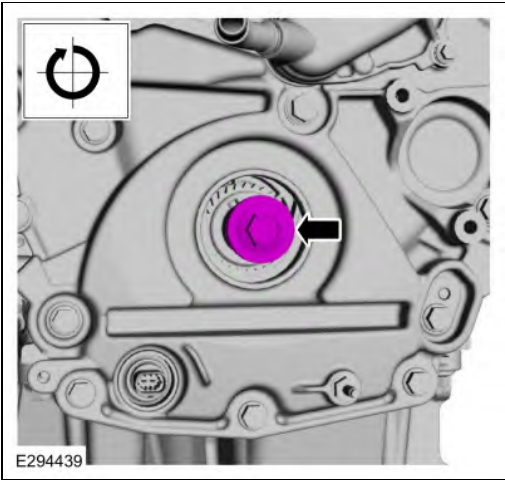


135.

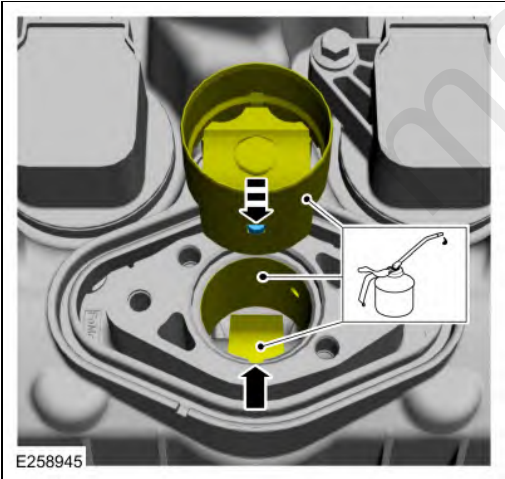
- Install the LH coil-on-plugs and the bolts.
Torque:
Stage 1: 62 lb.in (7 Nm)
Stage 2: 50Â°
- Install the oil level indicator.



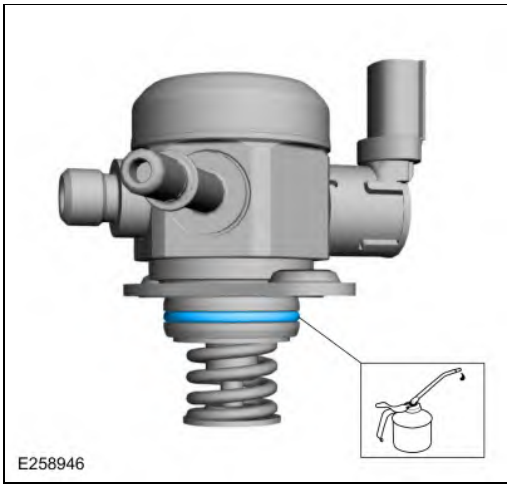
136. **NOTICE:** Only rotate the crankshaft clockwise or damage to the engine may occur.
- NOTICE:** The drive lobe for the high-pressure fuel pump must be at BDC for the high-pressure fuel pump installation.
- Using the crankshaft pulley bolt, turn the crankshaft until the high-pressure fuel pump drive lobe is at BDC.



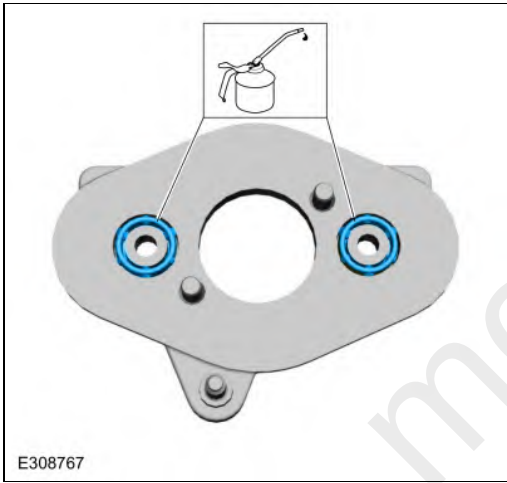
137. Apply clean engine oil to the high-pressure fuel pump mounting pedestal bore, the drive lobe and the roller tappet and install the high-pressure fuel pump roller tappet.



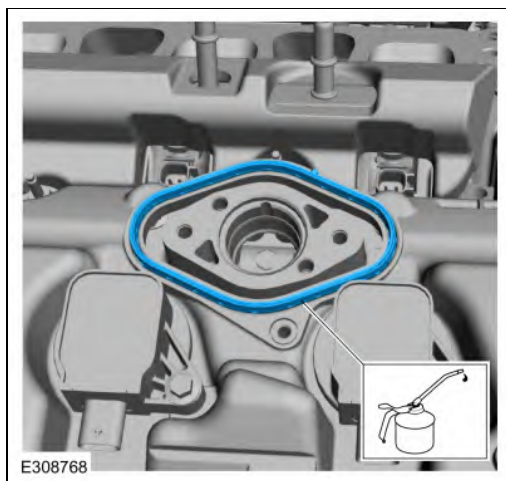
- 138.
- Install a new high-pressure fuel pump O-ring seal.
 - Lubricate with clean engine oil.



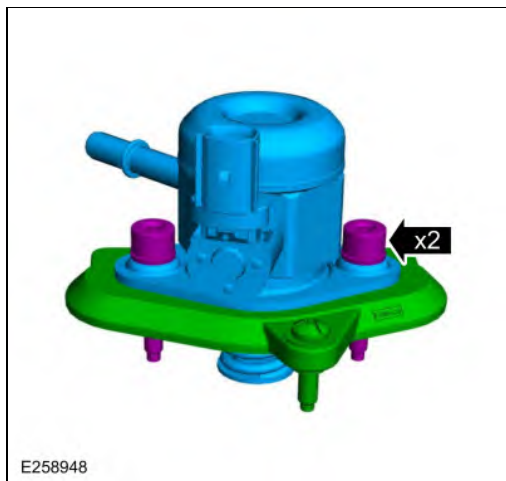
139. Lubricate the high-pressure fuel pump mounting plate O-ring seals with clean engine oil and install.



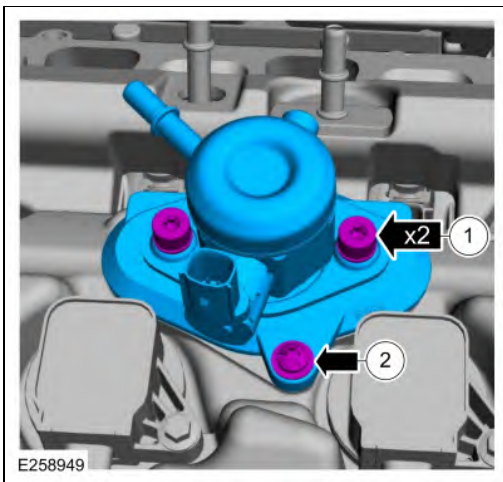
140. Lubricate the high-pressure fuel pump mounting plate seal with clean engine oil and install.



141. Install the high-pressure fuel pump mounting plate on to the high-pressure fuel pump and install the high-pressure fuel pump bolts.

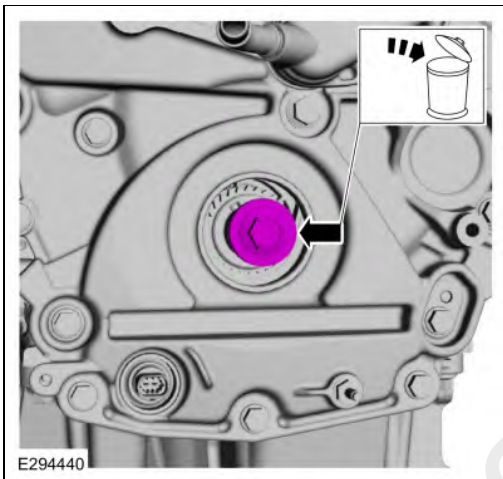


- 142.
1. Install the high-pressure fuel pump with the mounting plate, and finger tighten the high-pressure fuel pump bolts. Finger tighten the mounting plate bolt. Alternately tighten each high-pressure fuel pump bolt one complete revolution until seated. Tighten the fuel high-pressure fuel pump bolts in the following 2 stages.
Torque:
 Stage 1: 89 lb.in (10 Nm)
 Stage 2: 45°
 2. Tighten the high-pressure fuel pump mounting plate bolt.
Torque: 89 lb.in (10 Nm)



143.

- Remove the crankshaft pulley bolt and washer.
- Discard the bolt.



144.

- Install the new fuel rail high-pressure fuel tube and finger tight the flare nuts.
- Install the new high-pressure fuel pump to direct injection fuel rail tube nut finger tight.
- Tighten the fuel rail high-pressure fuel tube flare nuts.

Torque:

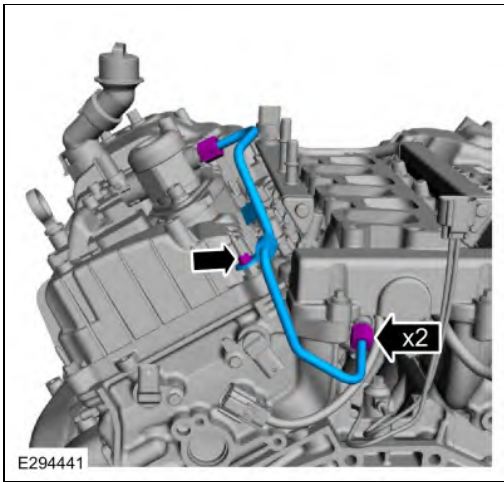
Stage 1: 71 lb.in (8 Nm)

Stage 2: 89 lb.in (10 Nm)

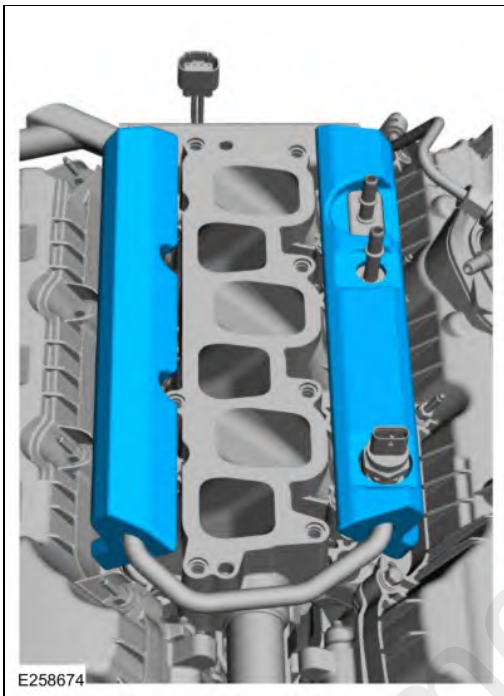
Stage 3: If the torque required to tighten any flare nut on the new high-pressure fuel tube reaches or exceeds 75 Nm (55 lb-ft), then that high pressure fuel tube must be discarded and replaced with another new high-pressure fuel tube.: 30°

- Tighten the high-pressure fuel pump to direct injection fuel rail tube nut.

Torque: 62 lb.in (7 Nm)

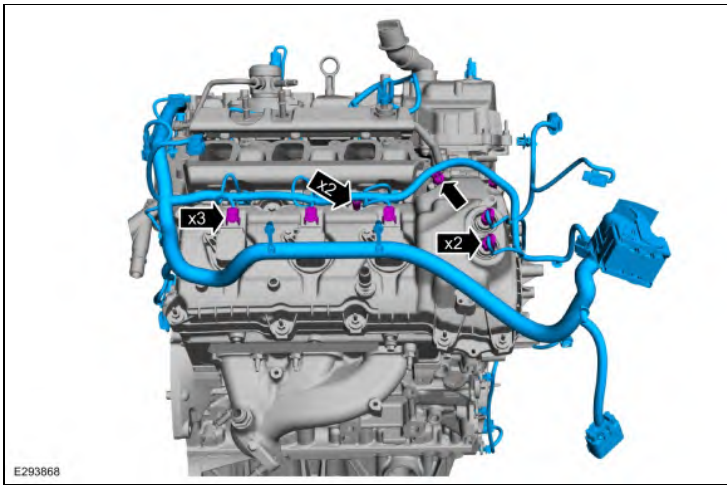


145. Install the fuel rail insulators.

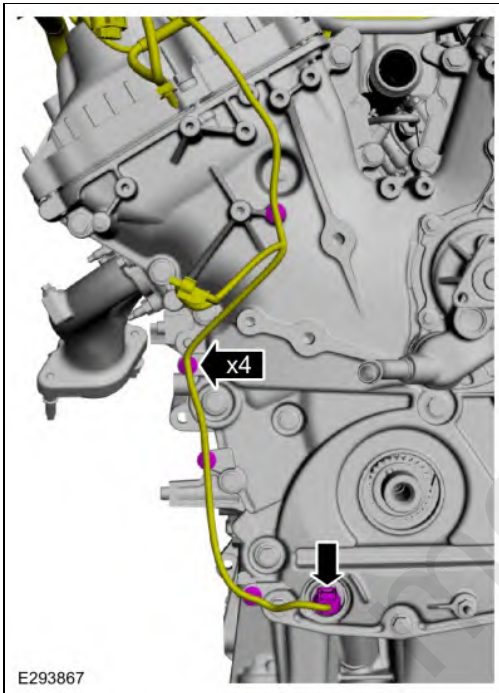


146.

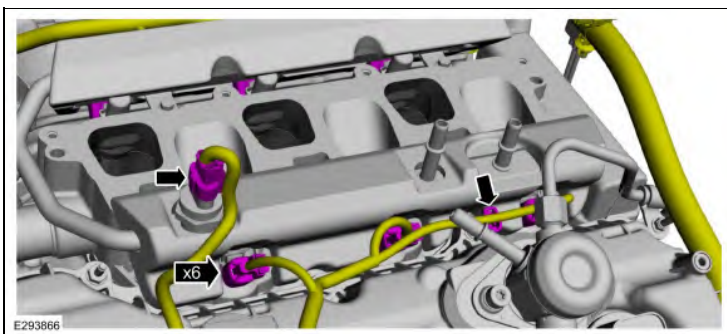
- Install the engine wiring harness and attach the wiring harness retainers.
- Connect the ignition coil-on-plug electrical connectors.
- Connect the VCT oil control solenoids electrical connectors.



147. Connect the oil pressure control solenoid, EGR valve electrical connectors and attach the wiring harness retainers.

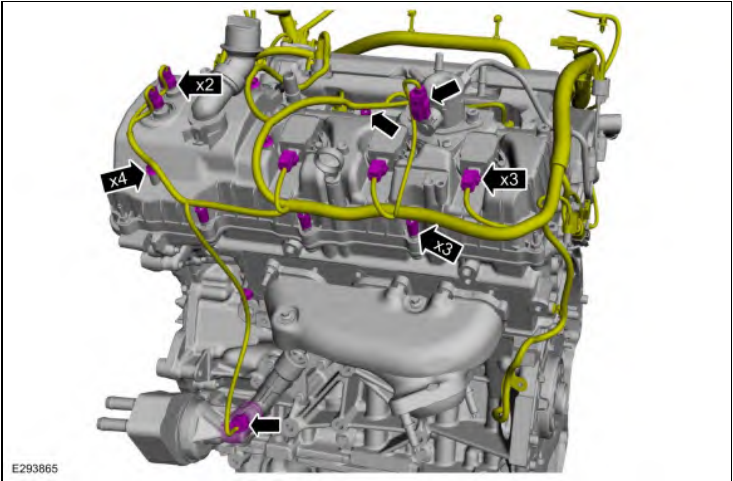


- 148.
- Connect the port injector fuel rail electrical connectors.
 - Attach the wiring harness retainer.
 - Connect the FRP temperature sensor electrical connector.

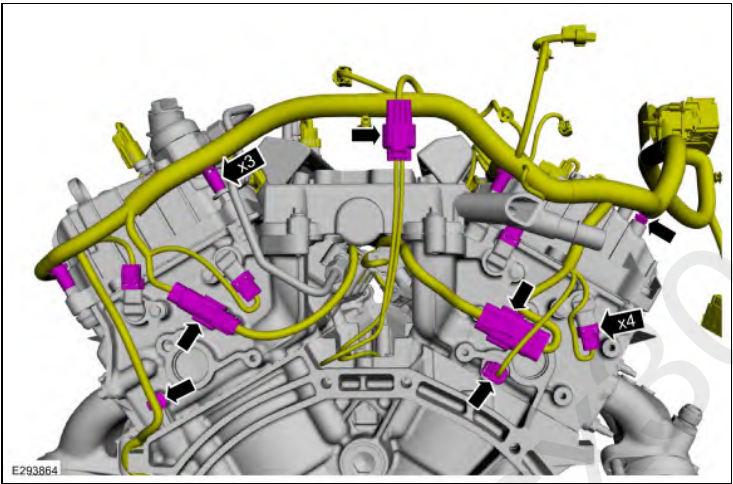


- 149.
- Attach the wiring harness retainers.
 - Connect the oil pressure switch electrical connector.
 - Connect the ignition coil-on-plug electrical connectors.

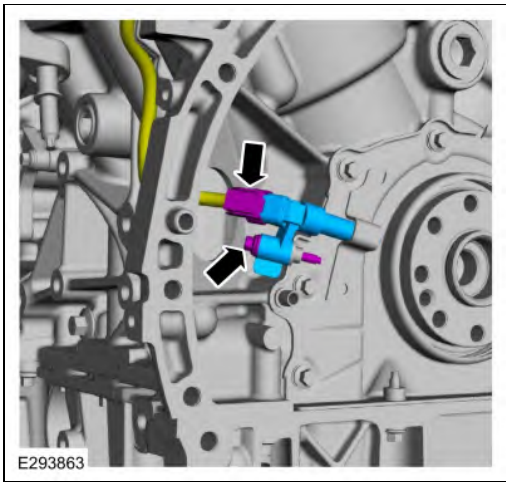
- Connect the VCT oil control solenoids electrical connectors.
- Connect the high-pressure fuel pump electrical connector.



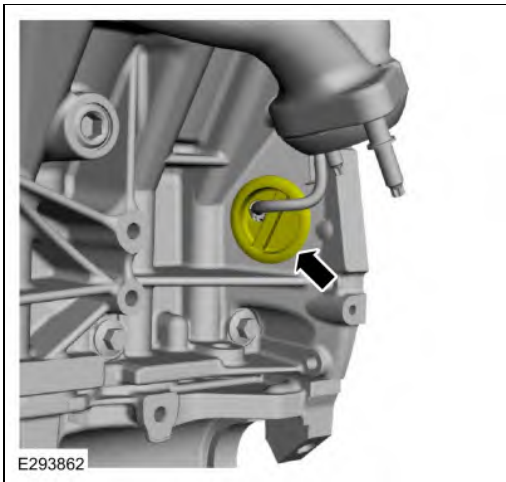
- 150.
- Attach the wiring harness retainers.
 - Connect the direct injection fuel rail electrical connectors.
 - Connect the CMP sensor electrical connectors.
 - Connect the KS and CHT sensor electrical connectors.



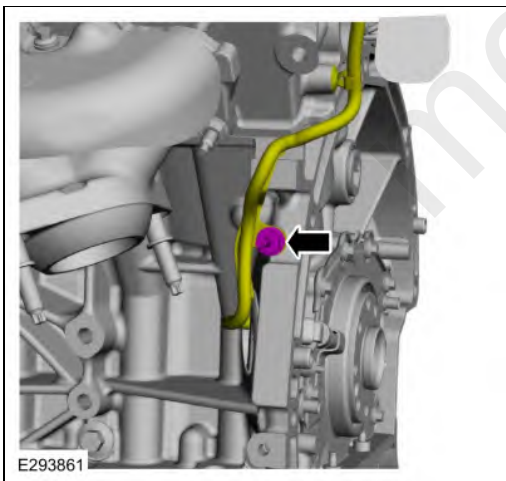
- 151.
- Install the CKP sensor and the bolt.
Torque: 53 lb.in (6 Nm)
 - Connect the CKP sensor electrical connector.



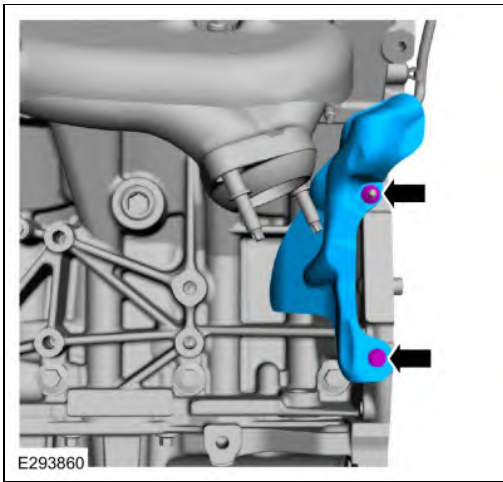
152. Install the wiring harness grommet.



153. Install the wiring harness retainer stud bolt.
Torque: 89 lb.in (10 Nm)

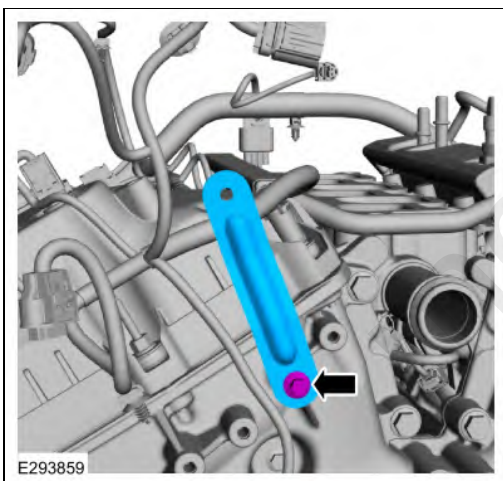


154. Install the heat shield, nut and bolt.
Torque: 89 lb.in (10 Nm)



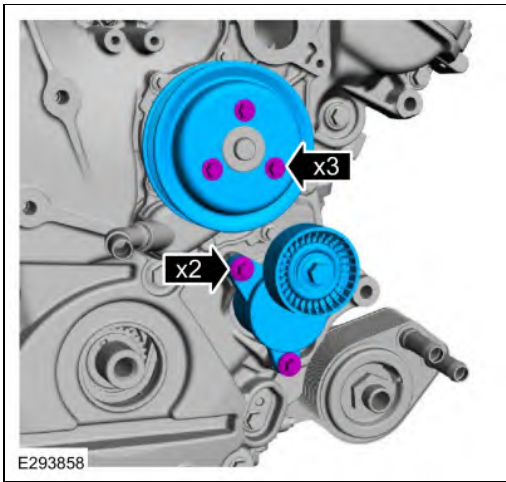
155. **NOTE:** The bolt will be tighten after the installation of the upper intake manifold.

Install the upper intake manifold support bracket and bolt finger tight.

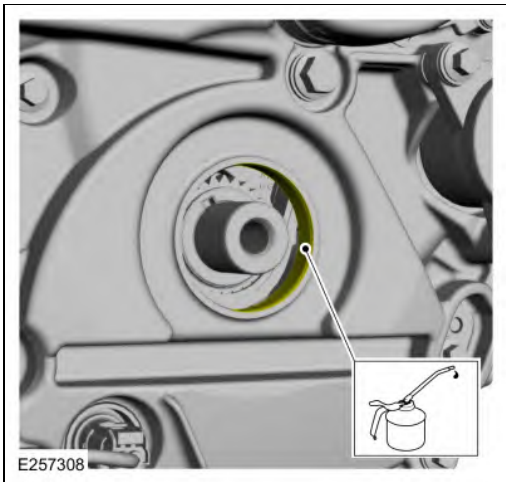


156.

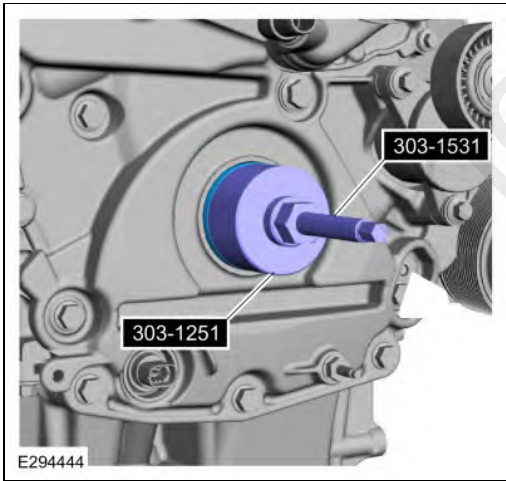
- Install the coolant pump pulley and the bolts.
Torque: 18 lb.ft (24 Nm)
- Install the accessory drive belt tensioner and the bolts.
Torque: 18 lb.ft (25 Nm)



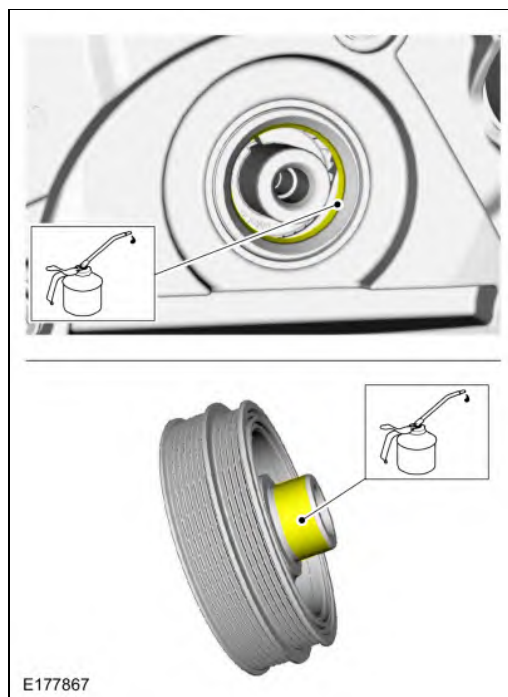
157. Lubricate the crankshaft front seal bore with clean engine oil.



158. Using the special tools, install the crankshaft front seal.
Use Special Service Tool: 303-102 Installer, Crankshaft Pulley. , 303-1251 Installer, Front Seal.



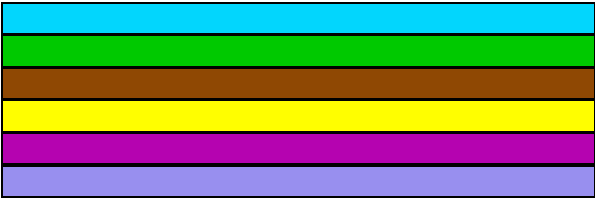
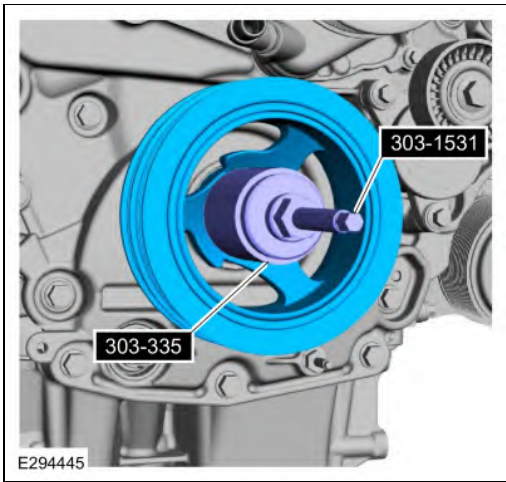
159. Lubricate the crankshaft front seal and the crankshaft pulley with clean engine oil.



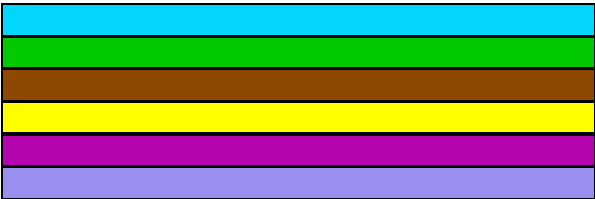
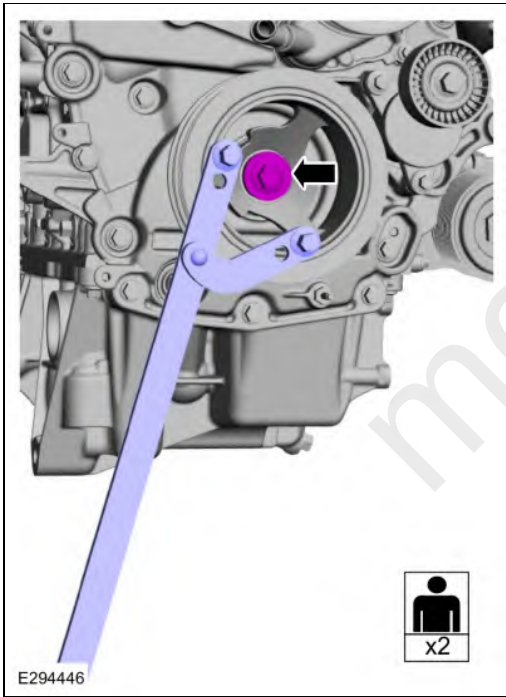
160. Using the special tools, install the crankshaft pulley.

Use Special Service Tool: 303-102 Installer, Crankshaft Pulley. , 303-335 (T88T-6701-A) Installer, Front Cover Oil Seal.

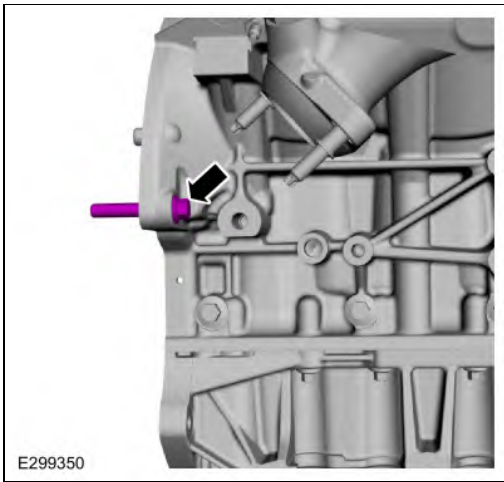




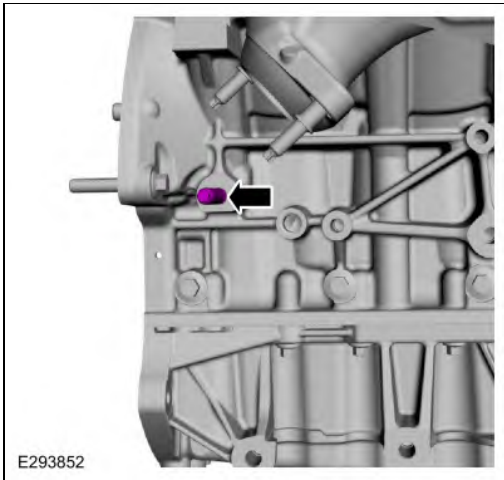
161. **NOTE:** Use a universal pulley holder (such as an OTC 4754, or equivalent).
- With the aid of an assistant, using a universal pulley holder, install and tighten a new crankshaft pulley bolt and the washer and tighten in 3 stages.
- Torque:*
- Stage 1: 37 lb.ft (50 Nm)
 - Stage 2: 90°
 - Stage 3: 60°



162. Install the transmission bolt.



163. Install the new RH engine mount stud.
Torque: 35 lb.ft (48 Nm)



164. Install a new front axle assembly seal and lubricate.



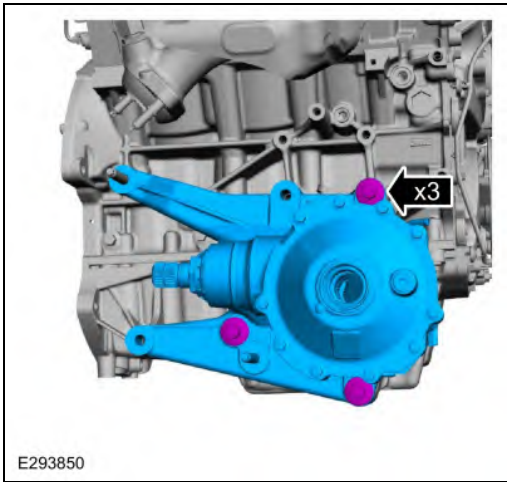
165.

- Clean the front axle assembly-to-cylinder block mating surfaces of any dirt or foreign material prior to installation.
- Install the front axle assembly and the bolts.

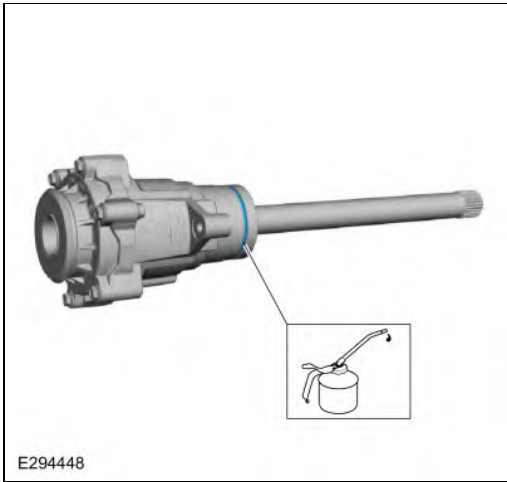
Torque:

Stage 1: 66 lb.ft (90 Nm)

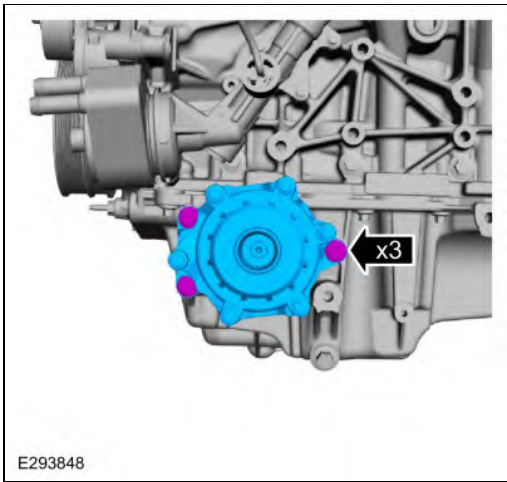
Stage 2: 90°



166. Install a new axle connector seal and lubricate.

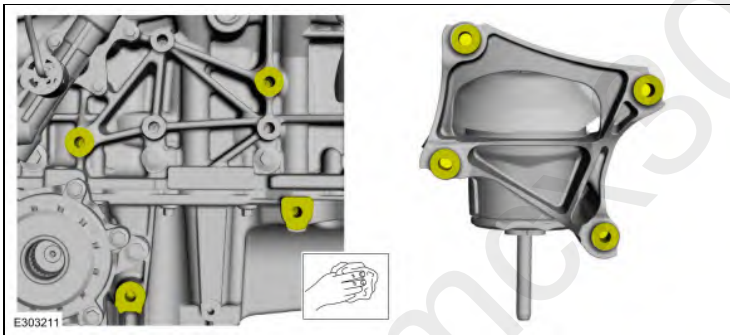


167. Install the LH axle connector and the bolts.
Torque: 26 lb.ft (35 Nm)

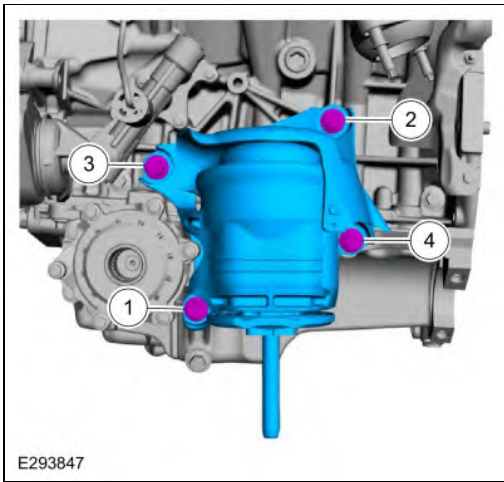


168. **NOTE:**

Clean the LH engine mount-to-cylinder block mating surfaces of any dirt or foreign material prior to installation.

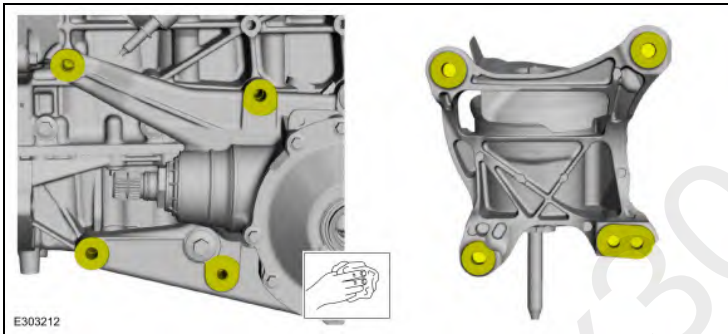


169. Install the LH engine mount and the new bolts.
Torque: 46 lb.ft (63 Nm)



170. **NOTE:**

Clean the RH engine mount-to-cylinder block mating surfaces of any dirt or foreign material prior to installation.

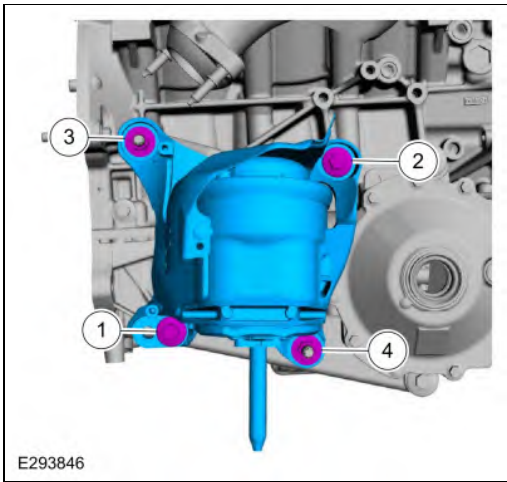


171. Install the RH engine mount and the new nuts and bolts.

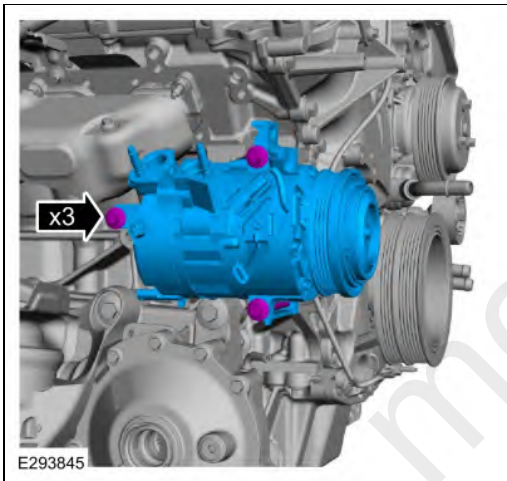
Torque:

Stage 1: 66 lb.ft (90 Nm)

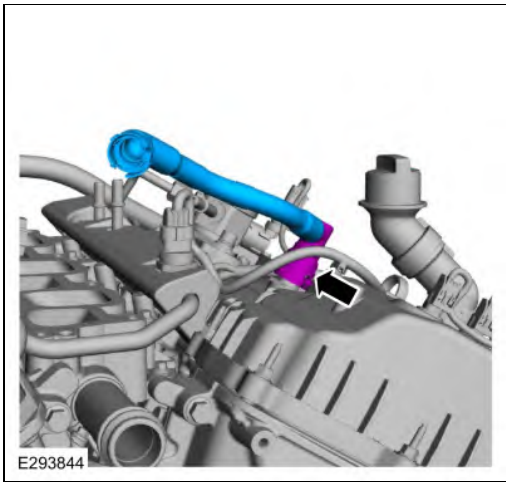
Stage 2: 90°



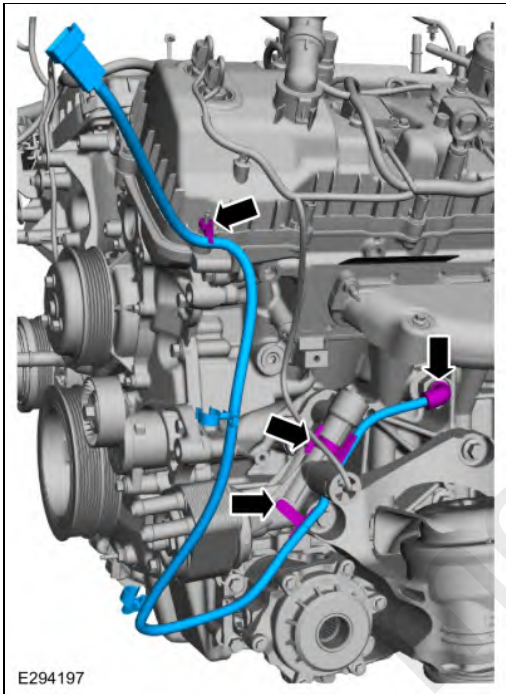
172. Install the A/C compressor and the bolts.
Torque: 18 lb.ft (25 Nm)



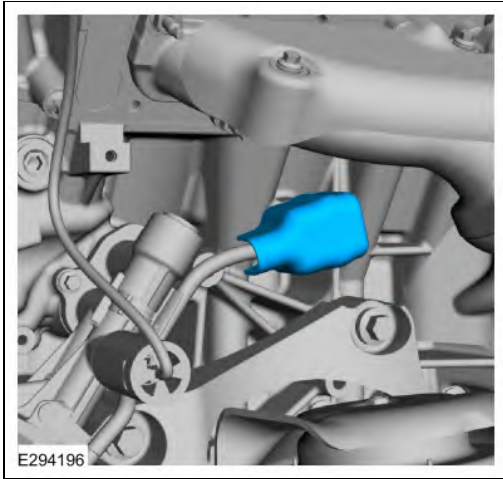
173. Install the crankcase vent tube.



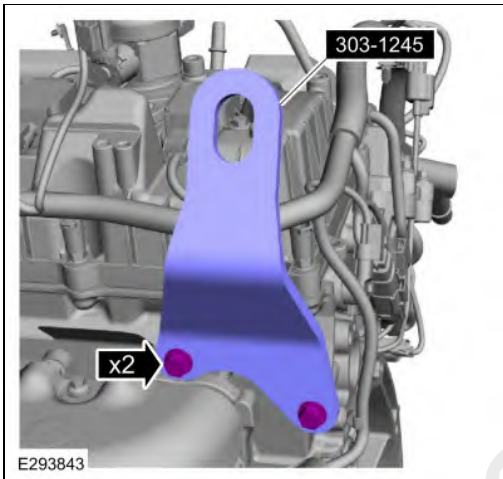
174. If equipped with block heater, connect the block heater electrical connector and wiring harness retainers.



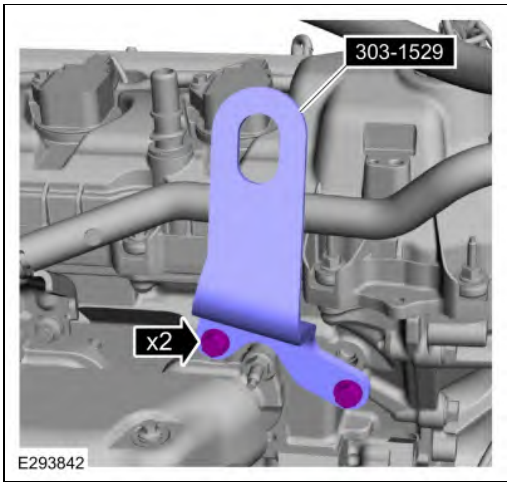
175. If equipped with block heater, install the block heater electrical connector heat shield.



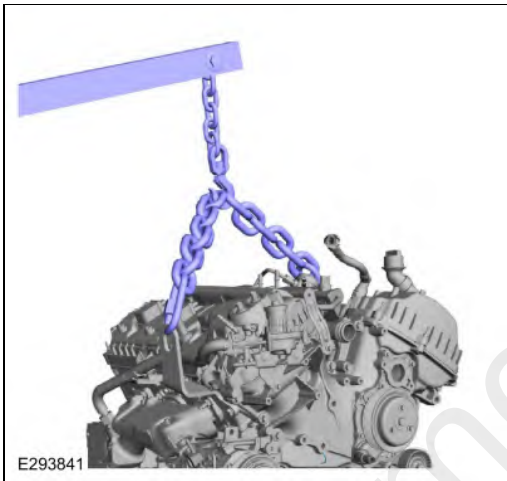
176. Install the LH lift eye and the bolts.
 Use Special Service Tool: 303-1245 Engine Lift Eye.
 Torque: 18 lb.ft (24 Nm)



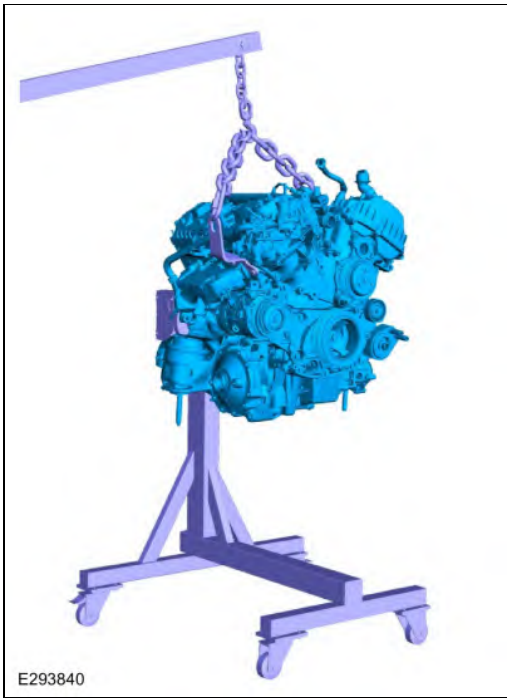
177. Install the RH lift eye and the bolts.
 Use Special Service Tool: 303-1529 Lift Eye, Engine.
 Torque: 18 lb.ft (24 Nm)



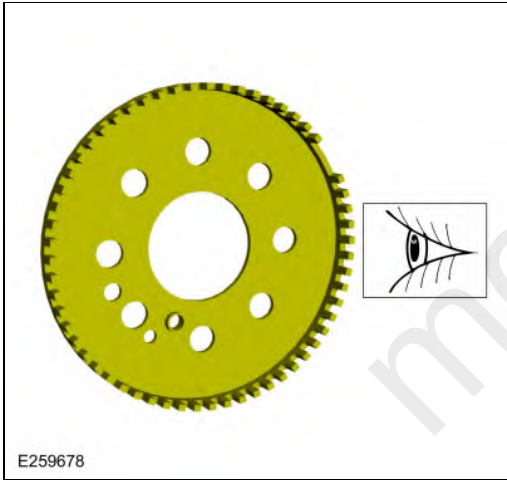
178. Install the floor crane and chains.
 Use the General Equipment: Floor Crane



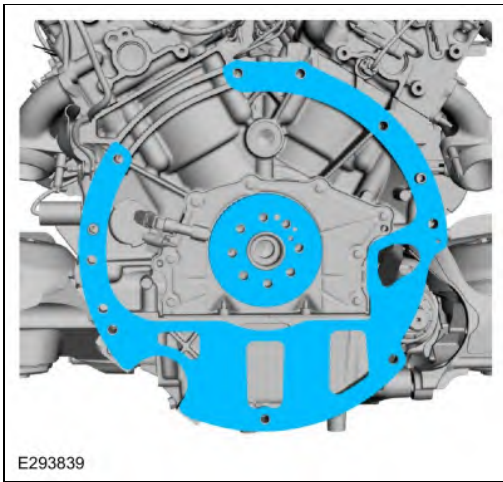
179. Remove the engine from the mounting stand.
 Use the General Equipment: Mounting Stand



180. Inspect the ignition pulse ring for damage. If the ignition pulse ring has been dropped or has any visual damage, it must be replaced.

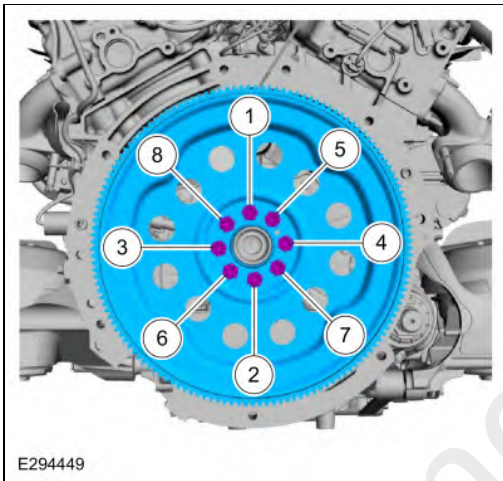


181. **NOTE:** Make sure the crankshaft ignition pulse ring is aligned with the inset hole on the crankshaft flange.
Install the crankshaft sensor ring and the engine-to-transmission spacer plate.



182. **NOTE:** One of the 8 flexplate holes are offset so the flexplate can only be installed in one position.

- Install the flexplate aligning it with the offset hole and hand start bolts 5, 6, 7 and 8.
- Tighten the bolts 5, 6, 7 and 8 in sequence one turn at a time until the flexplate is snug against the rear face of the crankshaft.
- Torque the bolts 5, 6, 7 and 8 in sequence.
Torque: 59 lb.ft (80 Nm)
- Install the bolts 1, 2, 3 and 4 finger tight.
- Torque the bolts 1, 2, 3 and 4 in sequence.
Torque: 59 lb.ft (80 Nm)



Installation

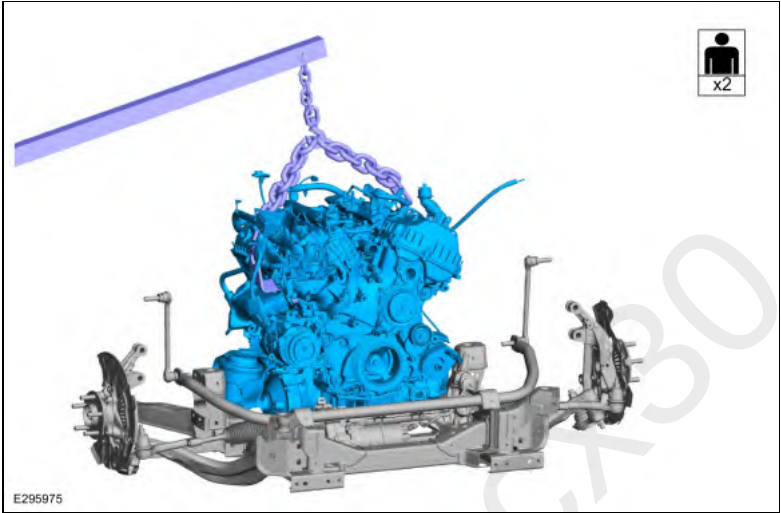
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Engine

Special Tool(s) / General Equipment

	303-1245 Engine Lift Eye TKIT-2006UF-FLM TKIT-2006UF-ROW
	303-1529 Lift Eye, Engine TKIT-2010A-F TKIT-2010A-LM TKIT-2010A-ROW
Adjustable Mounting Arm	
Hose Clamp Remover/Installer	
Wooden Block	

1. With the aid of an assistant and using the floor crane and chain, install the engine on the subframe.



2. Install and adjust and tighten the adjustable mounting arm bolts.
Use the General Equipment: Adjustable Mounting Arm