

		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
		MAIN HOUSING BORE DIAMETER																				
CRANKSHAFT DIAMETER		72.402	72.403	72.404	72.405	72.406	72.407	72.408	72.409	72.410	72.411	72.412	72.413	72.414	72.415	72.416	72.417	72.418	72.419	72.420	72.421	72.422
		67.893	1/1	1/1	1/1	1/2	1/2	1/2	1/2	1/2	1/2	2/2	2/2	2/2	2/2	2/3	2/3	2/3	2/3	2/3	2/3	3/4
U		67.893	1/1	1/1	1/1	1/2	1/2	1/2	1/2	1/2	2/2	2/2	2/2	2/2	2/3	2/3	2/3	2/3	2/3	2/3	3/4	3/4
T		67.893	1/1	1/1	1/1	1/2	1/2	1/2	1/2	1/2	2/2	2/2	2/2	2/2	2/3	2/3	2/3	2/3	2/3	2/3	3/4	3/4
S		67.893	1/1	1/1	1/1	1/2	1/2	1/2	1/2	1/2	2/2	2/2	2/2	2/2	2/3	2/3	2/3	2/3	2/3	2/3	3/4	3/4
R		67.893	1/1	1/1	1/1	1/2	1/2	1/2	1/2	1/2	2/2	2/2	2/2	2/2	2/3	2/3	2/3	2/3	2/3	2/3	3/4	3/4
Q		67.893	1/1	1/1	1/1	1/2	1/2	1/2	1/2	1/2	2/2	2/2	2/2	2/2	2/3	2/3	2/3	2/3	2/3	2/3	3/4	3/4
P		67.893	1/1	1/1	1/1	1/2	1/2	1/2	1/2	1/2	2/2	2/2	2/2	2/2	2/3	2/3	2/3	2/3	2/3	2/3	3/4	3/4
O		67.893	1/1	1/1	1/1	1/2	1/2	1/2	1/2	1/2	2/2	2/2	2/2	2/2	2/3	2/3	2/3	2/3	2/3	2/3	3/4	3/4
N		67.893	1/1	1/1	1/1	1/2	1/2	1/2	1/2	1/2	2/2	2/2	2/2	2/2	2/3	2/3	2/3	2/3	2/3	2/3	3/4	3/4
M		67.893	1/1	1/1	1/1	1/2	1/2	1/2	1/2	1/2	2/2	2/2	2/2	2/2	2/3	2/3	2/3	2/3	2/3	2/3	3/4	3/4
L		67.893	1/1	1/1	1/1	1/2	1/2	1/2	1/2	1/2	2/2	2/2	2/2	2/2	2/3	2/3	2/3	2/3	2/3	2/3	3/4	3/4
K		67.893	1/1	1/1	1/1	1/2	1/2	1/2	1/2	1/2	2/2	2/2	2/2	2/2	2/3	2/3	2/3	2/3	2/3	2/3	3/4	3/4
J		67.893	1/1	1/1	1/1	1/2	1/2	1/2	1/2	1/2	2/2	2/2	2/2	2/2	2/3	2/3	2/3	2/3	2/3	2/3	3/4	3/4
I		67.893	1/1	1/1	1/1	1/2	1/2	1/2	1/2	1/2	2/2	2/2	2/2	2/2	2/3	2/3	2/3	2/3	2/3	2/3	3/4	3/4
H		67.893	1/1	1/1	1/1	1/2	1/2	1/2	1/2	1/2	2/2	2/2	2/2	2/2	2/3	2/3	2/3	2/3	2/3	2/3	3/4	3/4
G		67.893	1/1	1/1	1/1	1/2	1/2	1/2	1/2	1/2	2/2	2/2	2/2	2/2	2/3	2/3	2/3	2/3	2/3	2/3	3/4	3/4
F		67.893	1/1	1/1	1/1	1/2	1/2	1/2	1/2	1/2	2/2	2/2	2/2	2/2	2/3	2/3	2/3	2/3	2/3	2/3	3/4	3/4
E		67.893	1/1	1/1	1/1	1/2	1/2	1/2	1/2	1/2	2/2	2/2	2/2	2/2	2/3	2/3	2/3	2/3	2/3	2/3	3/4	3/4
D		67.893	1/1	1/1	1/1	1/2	1/2	1/2	1/2	1/2	2/2	2/2	2/2	2/2	2/3	2/3	2/3	2/3	2/3	2/3	3/4	3/4
C		67.893	1/1	1/1	1/1	1/2	1/2	1/2	1/2	1/2	2/2	2/2	2/2	2/2	2/3	2/3	2/3	2/3	2/3	2/3	3/4	3/4
B		67.893	1/1	1/1	1/1	1/2	1/2	1/2	1/2	1/2	2/2	2/2	2/2	2/2	2/3	2/3	2/3	2/3	2/3	2/3	3/4	3/4
A		67.893	1/1	1/1	1/1	1/2	1/2	1/2	1/2	1/2	2/2	2/2	2/2	2/2	2/3	2/3	2/3	2/3	2/3	2/3	3/4	3/4

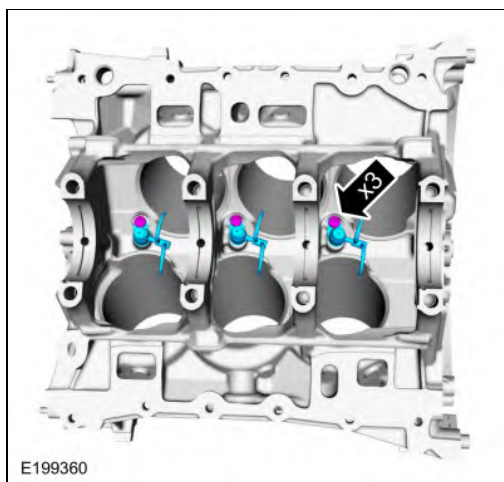
FOR ALL MAINS

UPPER MAIN GEAR (BLOCK SIDE) / LOWER MAIN GEAR (CAP SIDE)

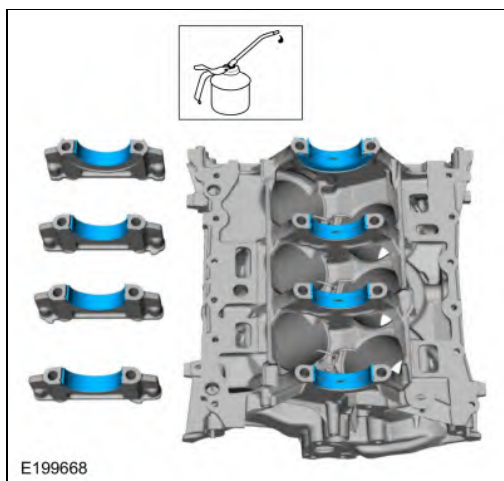
E199594



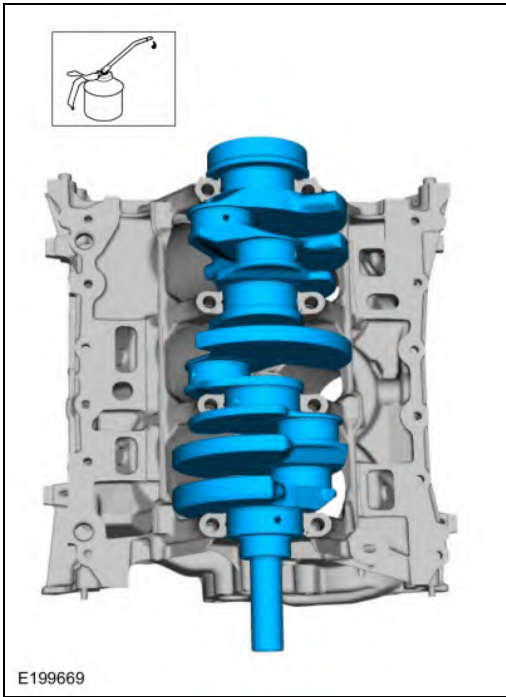
5. Install the piston cooling jets and bolts into the cylinder block.
Torque: 89 lb.in (10 Nm)



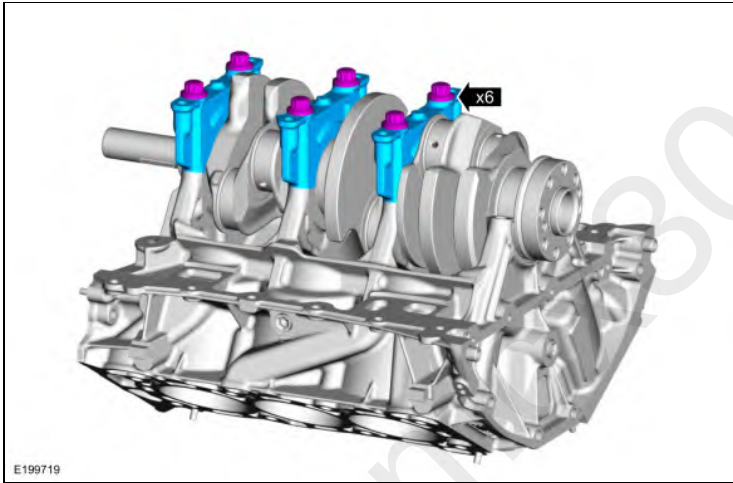
6. Install the crankshaft main bearings.
- Install the crankshaft upper main bearings and thrust bearing into the cylinder block.
 - Install the crankshaft lower main bearings into the bearing caps.
 - Make sure all oil passages are aligned.
 - Lubricate all main bearings with clean engine oil.



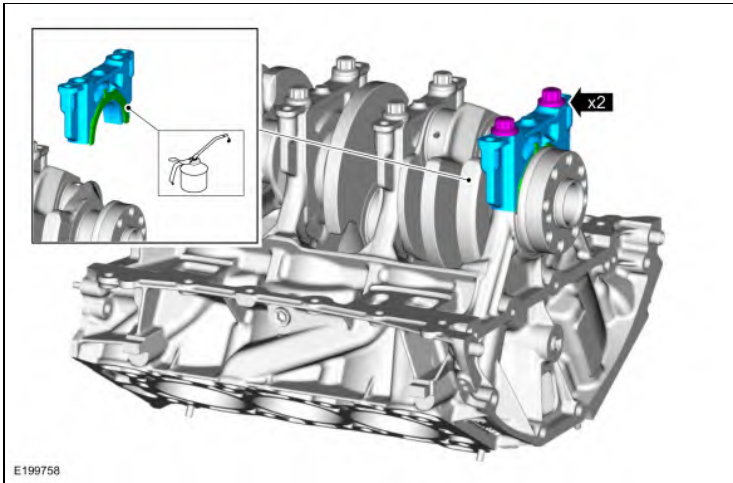
- 7.
1. Lubricate the crankshaft bearing journals with clean engine oil.
 2. Install the crankshaft into the cylinder block.



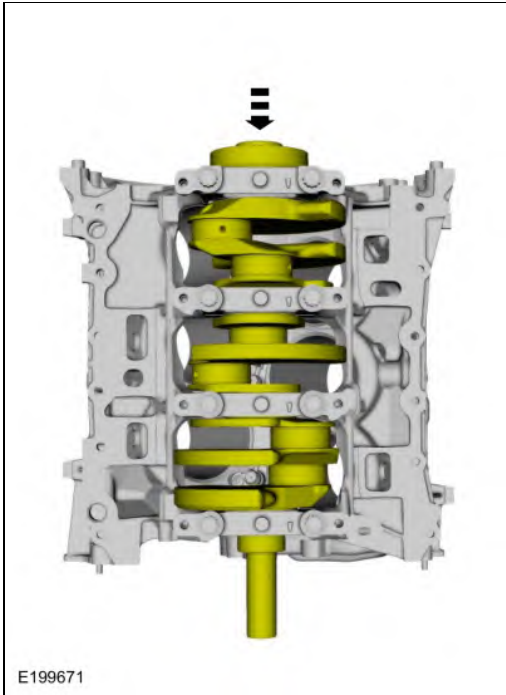
8. Install the No. 1, 2 and 3 main bearing caps and bolts on the cylinder block and, keeping the caps as square as possible, alternately draw the caps down evenly using the cap bolts.



- 9.
- Lubricate the lower thrust washer with clean engine oil.
 - Install the lower thrust washer and the No. 4 main bearing cap and, keeping the cap as square as possible, alternately draw the cap down evenly using the cap bolts.

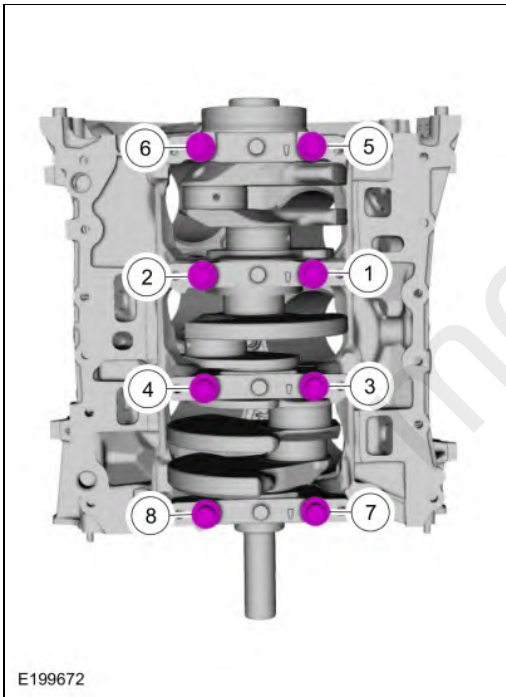


10. Push the crankshaft forward to seat the crankshaft thrust washer.

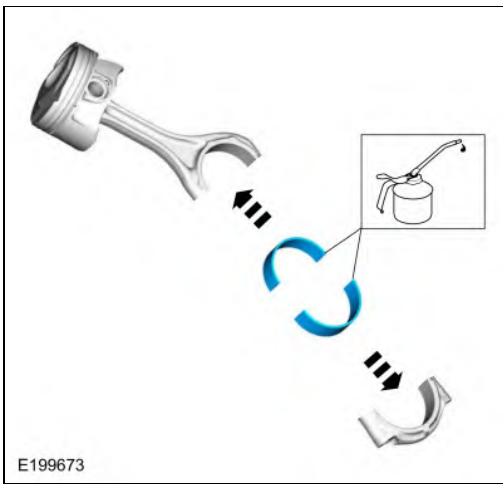


11. Tighten the main bearing cap bolts.

- Torque:*
- Stage 1: 30 lb.ft (40 Nm)
 - Stage 2: Loosen: 360°
 - Stage 3: 26 lb.ft (35 Nm)
 - Stage 4: 180°

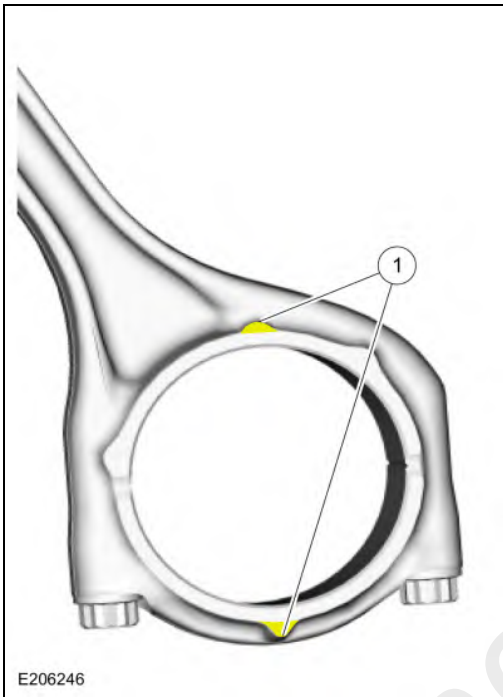


- 12.
- Check the crankshaft end play.
Refer to: Specifications (303-01B Engine - 3.0L EcoBoost, Specifications).
 - Check the piston-to-cylinder block and piston ring clearances.
Refer to: Specifications (303-01B Engine - 3.0L EcoBoost, Specifications).
 - Assemble the pistons and position the piston ring gaps.
Refer to: Piston (303-01B Engine - 3.0L EcoBoost, Disassembly and Assembly of Subassemblies).
13. Lubricate with clean engine oil and install the connecting rod bearings.



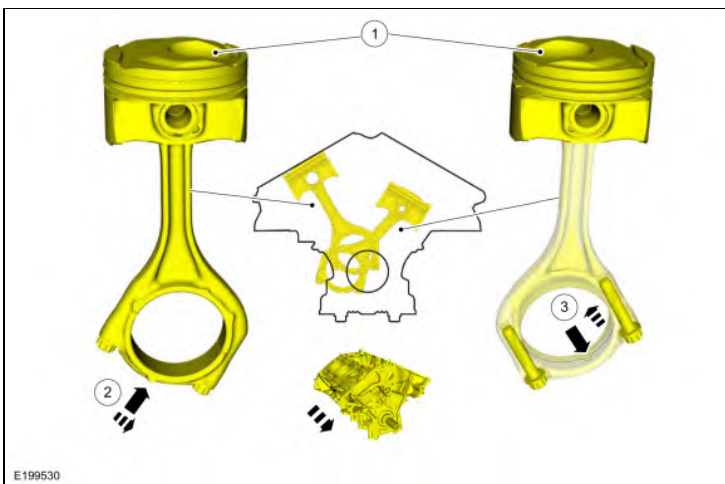
14.

- For assembly purposes the bump on the connecting rod will face the same way as the bump on the connecting rod cap.



15.

- For assembly purposes the bowl on the dome of the piston should be facing toward the intake of the engine.
- On the RH bank the bump on the connecting rod should face the front of the engine.
- On the LH bank the bump on the connecting rod should face the rear of the engine.



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

NOTICE: Do not allow the piston connecting rods to come in contact with the piston cooling jets or engine damage may occur.

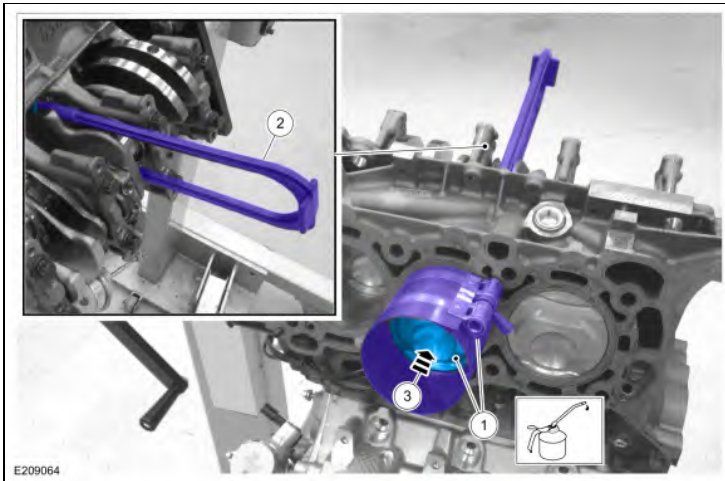
- Lubricate the piston with clean engine oil.
- Position the piston assembly and piston ring installer into the cylinder.

Use the General Equipment: Piston Ring Compressor

- **NOTE:** A commercially available piston rod installer must be used to prevent damage to the crankshaft journal.

Install a piston rod installer over the crankshaft journal and into the bolt holes of the connecting rod.

- Push the piston into the cylinder bore and guide the connecting rod onto the crankshaft journal.



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

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

1. Install the connecting rod cap and bearing.

Torque:

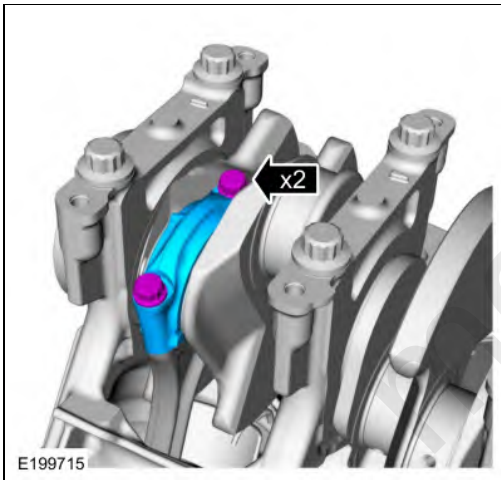
Stage 1: 24 lb.ft (32 Nm)

Stage 2: Loosen: 180°

Stage 3: 24 lb.ft (32 Nm)

Stage 4: 90°

2. Repeat the steps for each of the remaining pistons.



18. Install the main bearing cap support braces and the bolts.

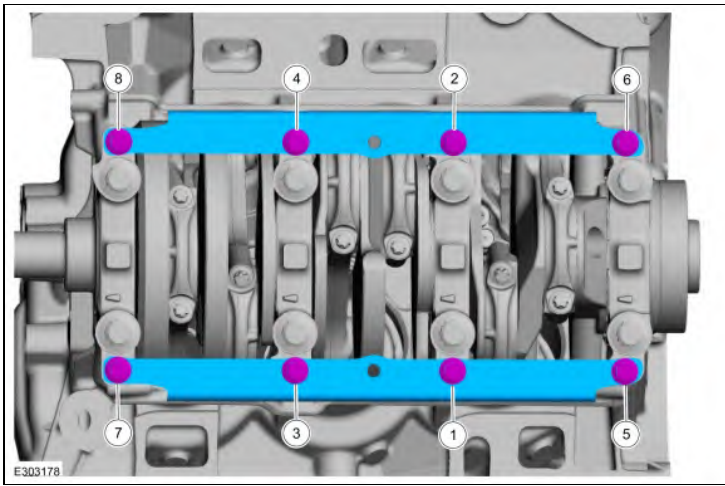
Torque:

Stage 1: 18 lb.ft (24 Nm)

Stage 2: Loosen: 360°

Stage 3: 22 lb.ft (30 Nm)

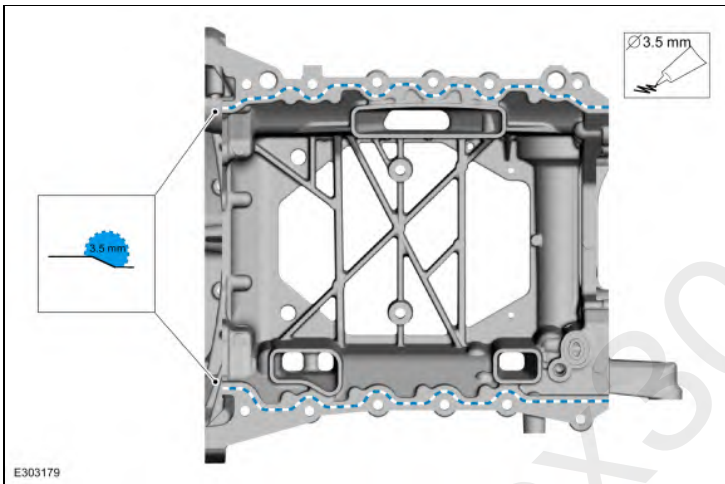
Stage 4: 40°



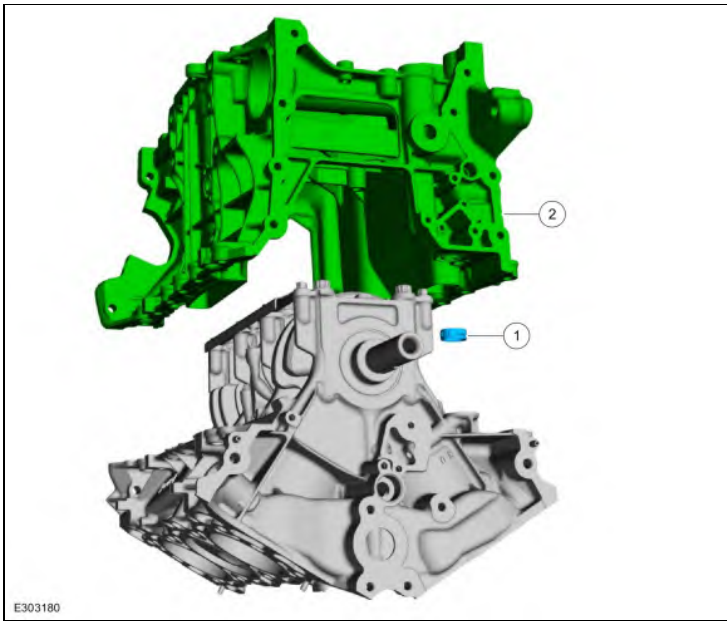
19. **NOTICE:** If the engine block skirt stiffener is not installed, aligned and the bolts tightened to minimum specification within 10 minutes, the sealant must be removed and the sealing area cleaned.

Apply a 3.5 mm (0.14 in) bead of Motorcraft® High Performance Engine RTV Silicone to the chamfer of the engine block skirt stiffener.

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



- 20.
1. Position the oil seal.
 2. Install the engine block skirt stiffener.



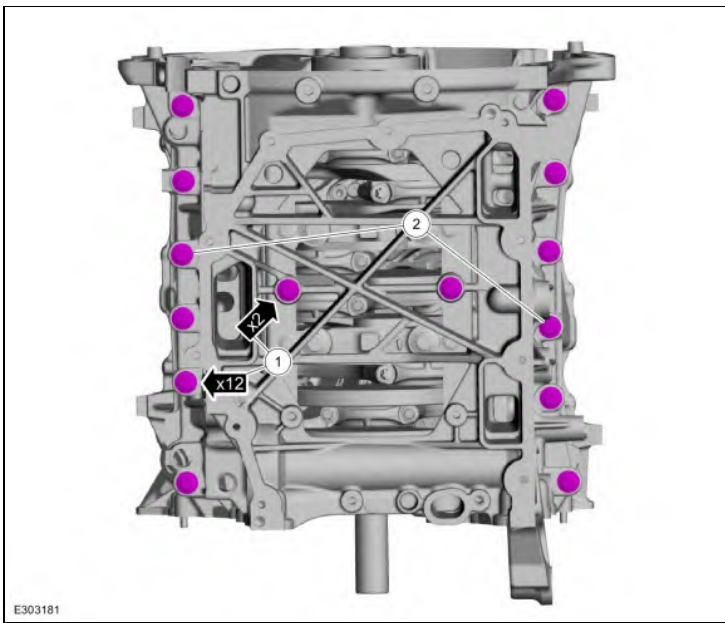
21.

1. Install the bolts finger tight.
2. Tighten the 2 bolts.

Torque:

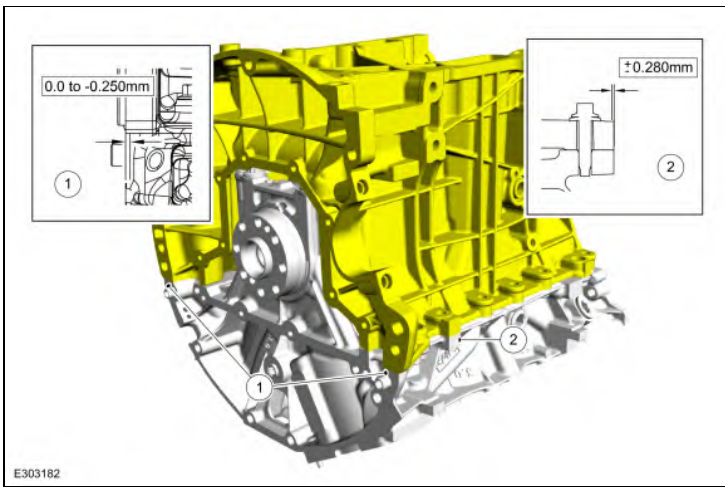
Stage 1: 35 lb.in (4 Nm)

Stage 2: Loosen: 360°



22.

1. Using a straight edge, align the rear face of the engine block skirt stiffener to the rear face of the engine block, flush or up to 0.250 mm (0.01 in) underflush.
2. Using a straight edge, align the machined boss on the left side of the engine block skirt stiffener to the machined boss on the left side of the engine block flush or within 0.280 mm (0.011 in) of flush.



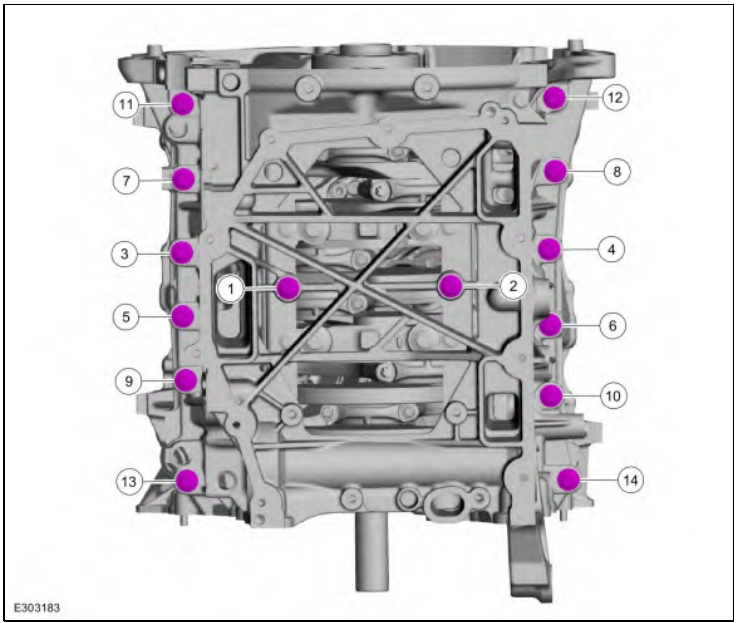
23. **NOTICE:** If the engine block skirt stiffener bolts minimal torque is not completed within 10 minutes of sealant application, or if final torque is not met within 60 minutes of sealant application the parts must be removed and the sealant must be removed and the sealing area cleaned.

Tighten the engine block skirt stiffener bolts.

Torque:

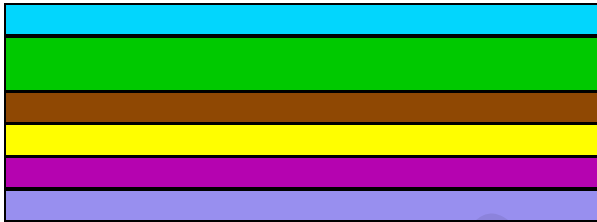
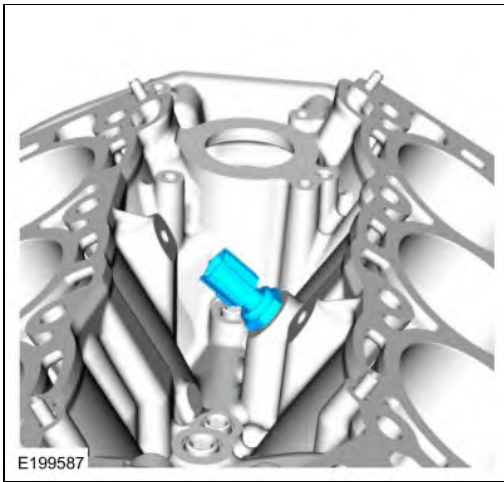
Stage 1: 35 lb.in (4 Nm)

Stage 2: 18 lb.ft (24 Nm)



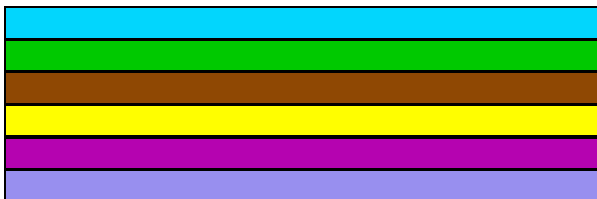
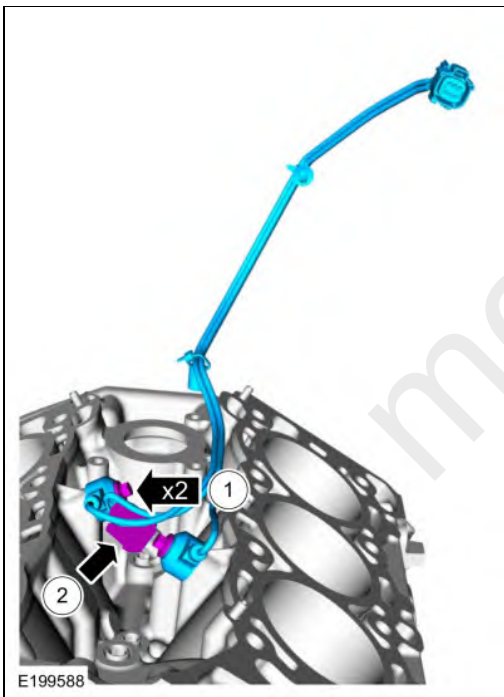
24. **NOTE:** Do not reuse the ECT sensor, install a new sensor.

Install a new ECT sensor.
Torque: 20 lb.ft (27 Nm)

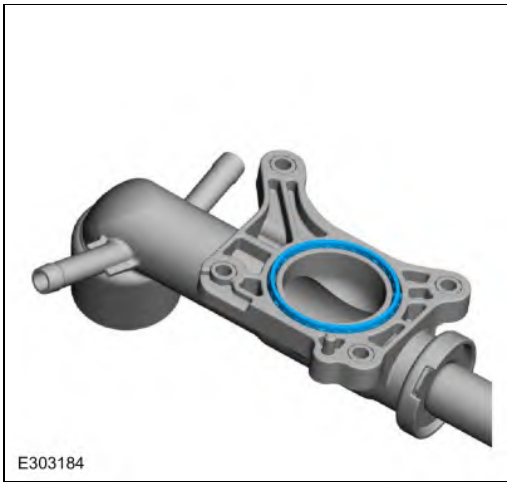


25.

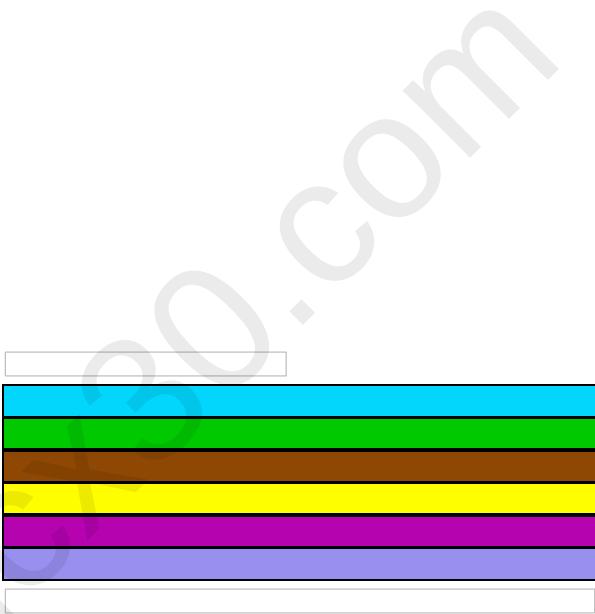
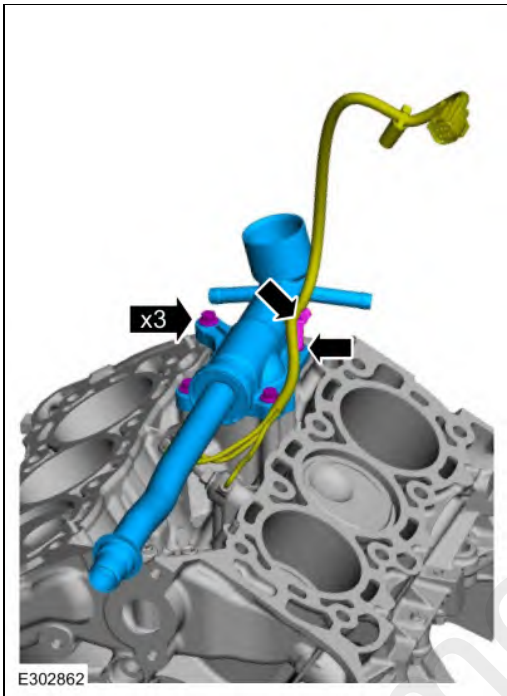
1. Install the KS assembly and the bolts.
Torque: 97 lb.in (11 Nm)
2. Connect the ECT sensor electrical connector.



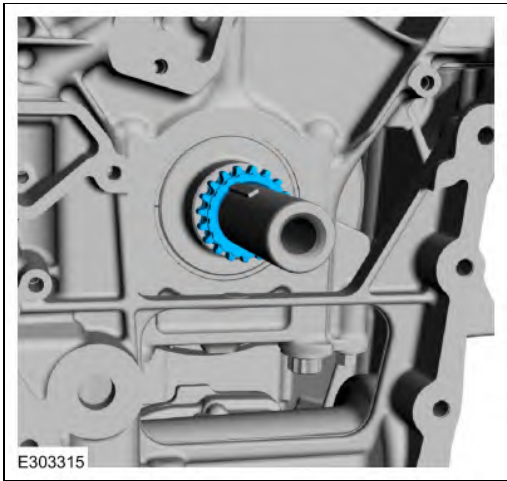
26. Install a new coolant outlet connector pipe gasket.



- 27.
1. Install the coolant outlet connector pipe, the bolts and the stud bolt.
Torque: 89 lb.in (10 Nm)
 2. Attach the wiring harness retainer to the stud bolt.



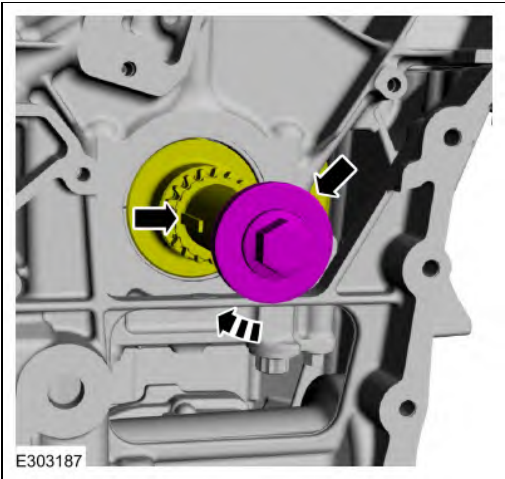
28. **NOTE:** A timing mark is stamped on both faces of the crankshaft sprocket. The sprocket can be installed with either of the faces positioned outward.
- Install the timing chain sprocket.



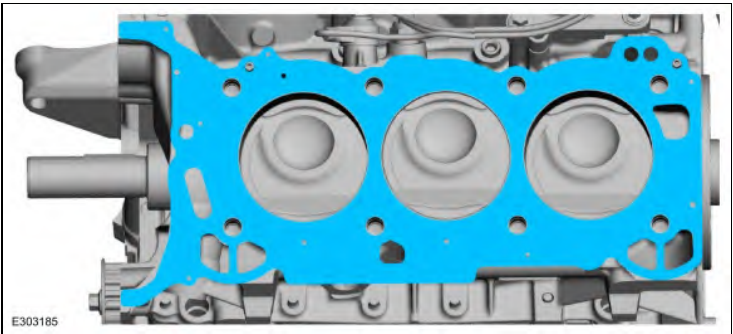
29. **NOTICE:** Rotate the crankshaft utilizing only the original crankshaft pulley bolt. Failure to follow this direction may cause damage to the crankshaft and result in

engine failure.

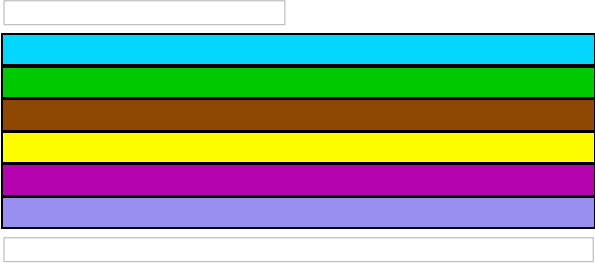
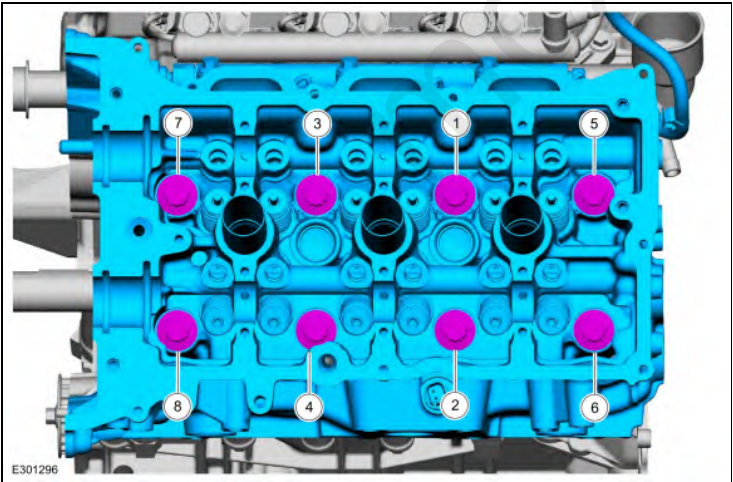
Install the original crankshaft pulley bolt and rotate the crankshaft clockwise until the keyway is at the 9 o'clock position.



30. Install a new LH cylinder head gasket.



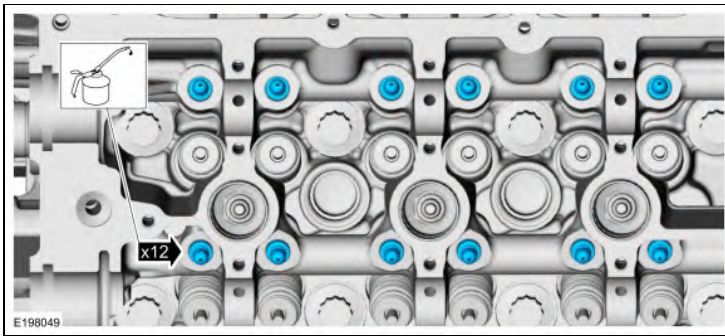
- 31.
- Install the cylinder head.
 - Install new cylinder head bolts.
- Torque:*
- Stage 1: 177 lb.in (20 Nm)
 - Stage 2: Loosen: 2 turn(s)
 - Stage 3: 37 lb.ft (50 Nm)
 - Stage 4: 180°



32. **NOTICE:** Do not install the camshaft roller followers at this time. The roller followers will be installed later in the procedure. If the roller followers are installed prior to the camshafts, the camshaft caps can become distorted during the camshaft tightening process and result in upper end engine noise or severe damage to the engine.

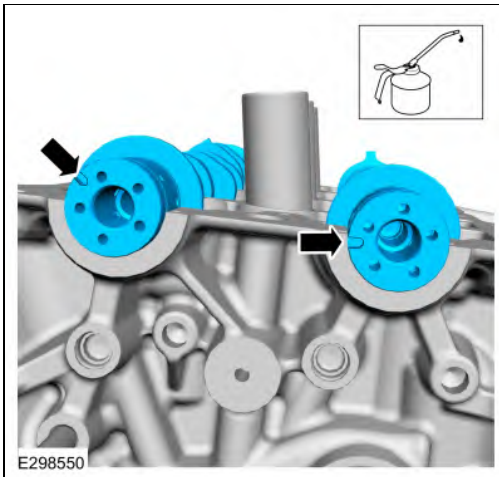
NOTE: If the original hydraulic lash adjusters are to be reinstalled, they must be installed in their original locations.

1. Lubricate the hydraulic lash adjusters with clean engine oil.
2. Install the hydraulic lash adjusters.

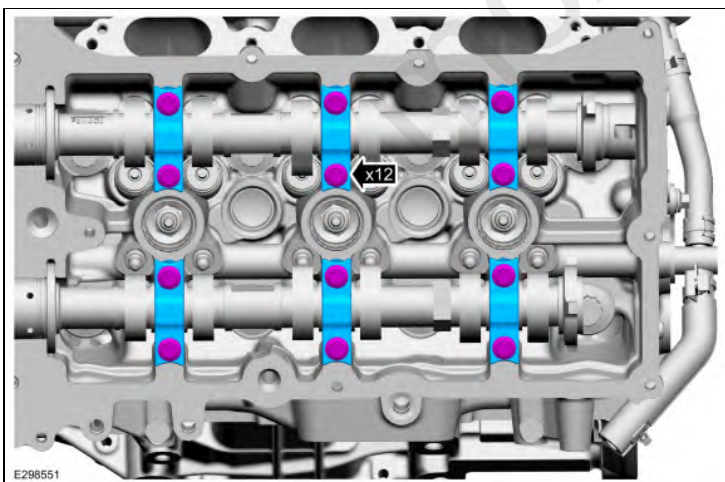


33.

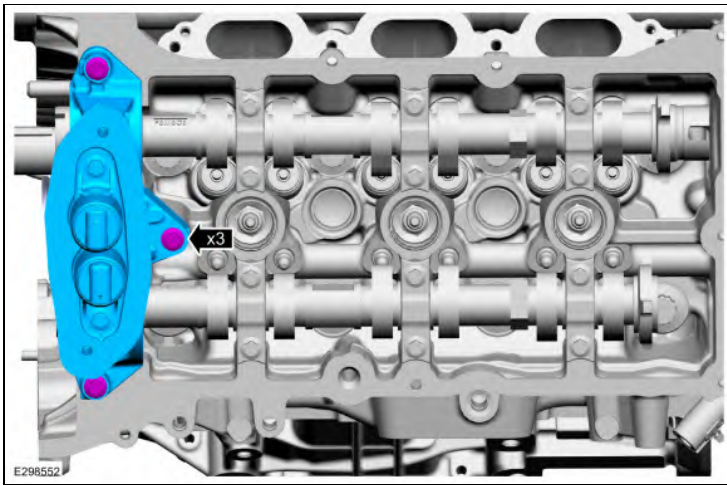
- Lubricate the camshafts with clean engine oil.
- Install the intake and exhaust camshafts in the neutral position. Align the D-slots as shown in the illustration.



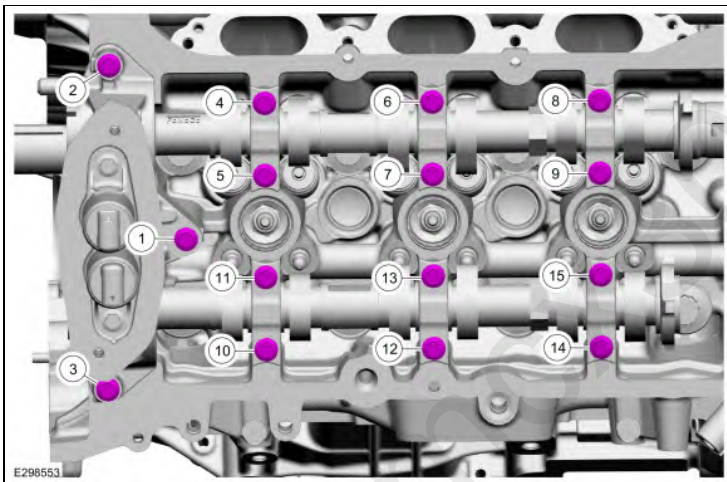
34. Install the camshaft bearing caps and the bolts. Do not tighten at this time.



35. Install the front camshaft bearing mega cap and the bolts. Do not tighten at this time.

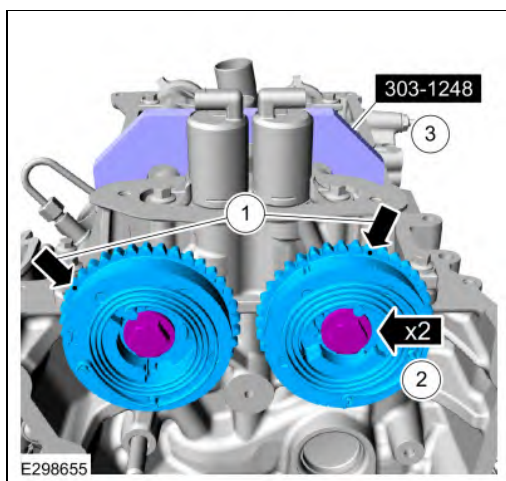


36. Tighten the bolts.
Torque: 89 lb.in (10 Nm)

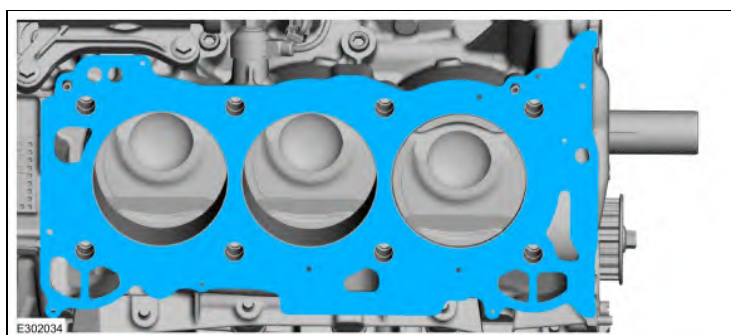


37. **NOTICE:** The VCT units have 2 timing marks on them, a triangle and a circle. For installation of the LH side the circle marks are used.

1. Install the VCT units. The **circle** timing marks on the VCT units will be at the 10 o'clock (intake) and 12:30 (exhaust) positions as shown in the illustration.
Install Special Service Tool: 303-1248 Camshaft holding tools.
2. Install the new VCT unit bolts.
Torque:
Stage 1: 30 lb.ft (40 Nm)
Stage 2: Loosen: 360°
Stage 3: 37 lb.ft (50 Nm)
Stage 4: 90°
3. Remove Special Service Tool: 303-1248 Camshaft holding tools.



38. Install a new RH cylinder head gasket.



- 39.
- Install the cylinder head.
 - Install new cylinder head bolts.

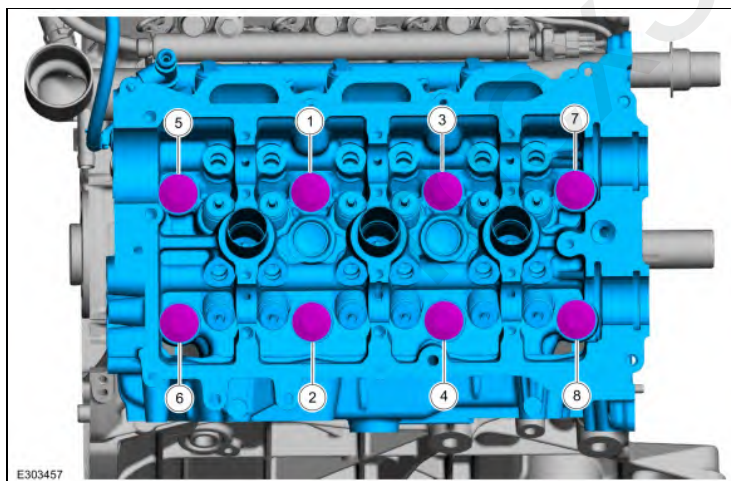
Torque:

Stage 1: 177 lb.in (20 Nm)

Stage 2: Loosen: 2 turn(s)

Stage 3: 37 lb.ft (50 Nm)

Stage 4: 180°

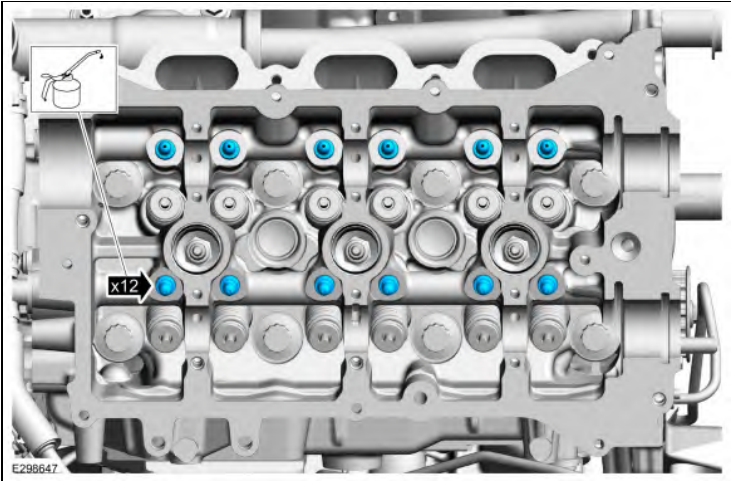


40. **NOTICE:** Do not install the camshaft roller followers at this time. The roller followers will be installed later in the procedure. If the roller followers are installed

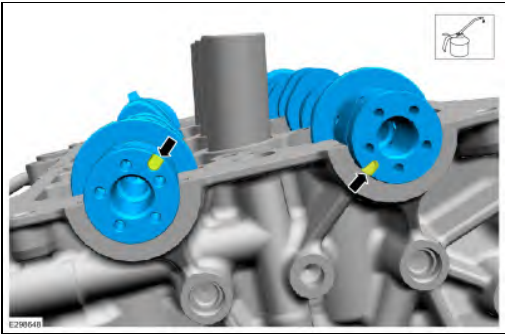
prior to the camshafts, the camshaft caps can become distorted during the camshaft tightening process and result in upper end engine noise or severe damage to the engine.

NOTE: If the original components are to be reinstalled, they must be installed in their original locations.

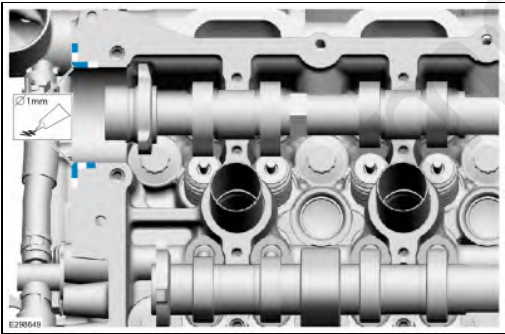
- 1. Lubricate the hydraulic lash adjusters with clean engine oil.
- 2. Install the hydraulic lash adjusters.



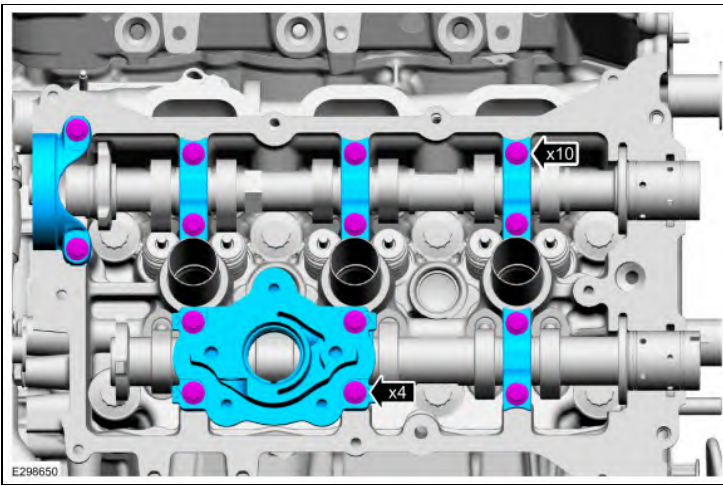
- 41.
- Lubricate the camshafts with clean engine oil.
 - Install the intake and exhaust camshafts in the neutral position. Align the D-slots as shown in the illustration.



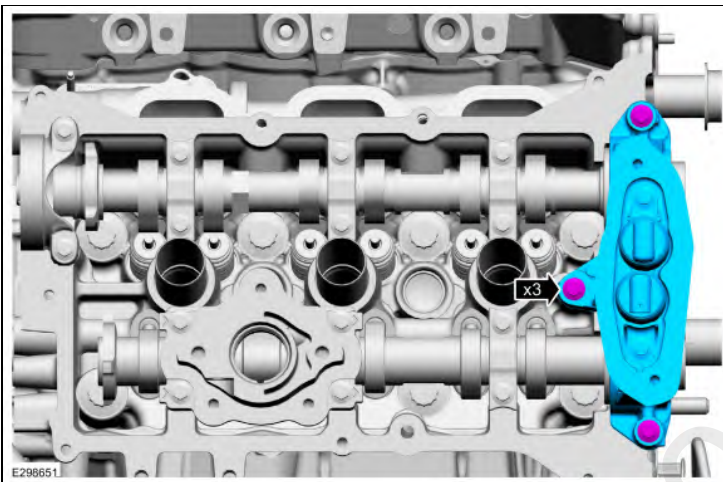
42. Apply a 1 mm bead of sealant to the rear camshaft cap mounting surface of the cylinder head.
Material: Flange Sealant / CU7Z-19B508-A (WSS-M2G348-A11)



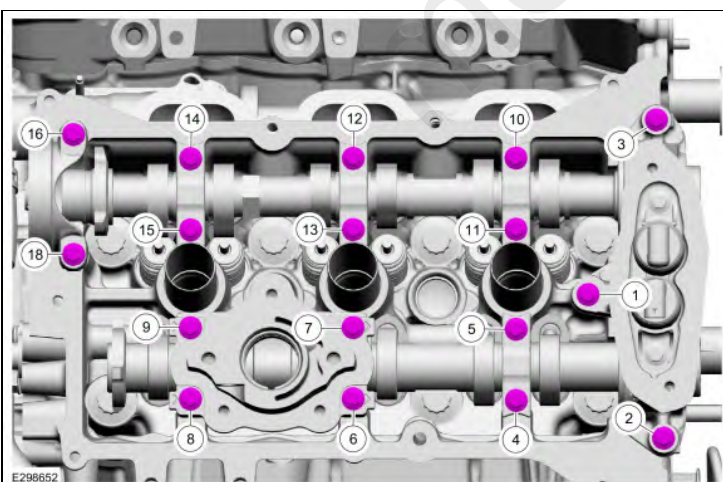
43. Install the camshaft bearing caps and the bolts. Do not tighten at this time.



44. Install the front camshaft bearing mega cap and the bolts. Do not tighten at this time.

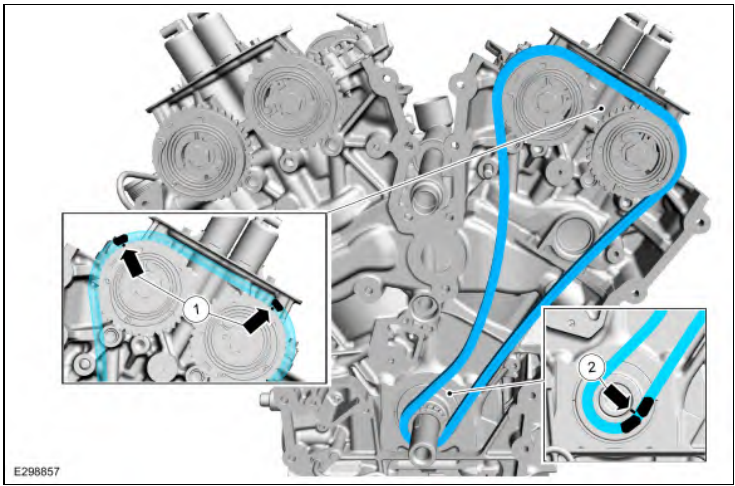


45. Tighten the bolts.
Torque: 89 lb.in (10 Nm)

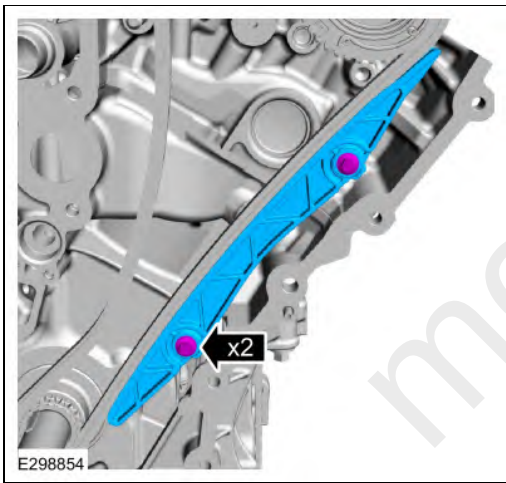


46. **NOTICE:** The VCT units have 2 timing marks on them, a triangle and a circle. For installation of the RH side the triangle marks are used.

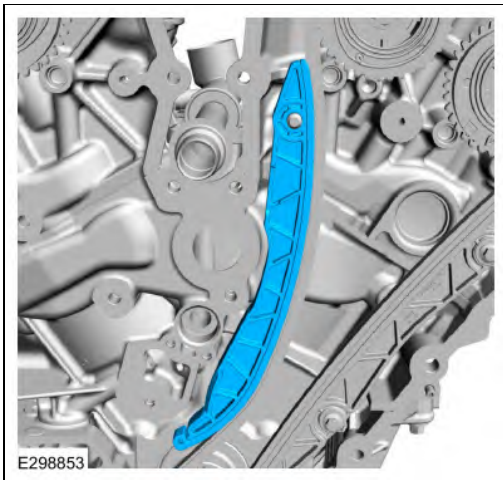
1. Install Special Service Tool: 303-1696 Cam Comb Tool Study.
2. Install the VCT units. The **triangle** timing marks on the VCT units will be at the 2 o'clock (intake) and 11 o'clock (exhaust) positions as shown in the illustration.
3. Install the new VCT unit bolts.
Torque:
 Stage 1: 30 lb.ft (40 Nm)
 Stage 2: Loosen: 360°
 Stage 3: 37 lb.ft (50 Nm)
 Stage 4: 90°
4. Remove Special Service Tool: 303-1696 Cam Comb Tool Study.



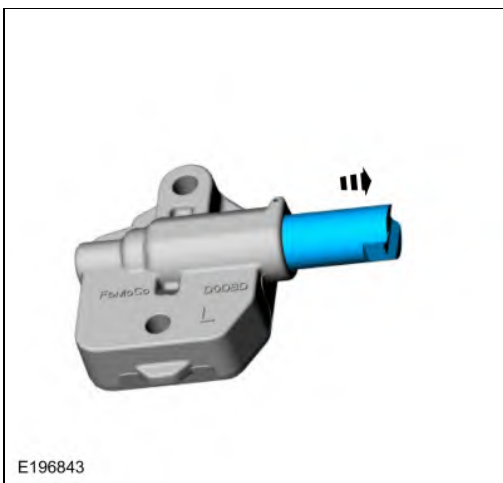
49. Install the LH timing chain guide and bolts.
Torque: 89 lb.in (10 Nm)



50. Install the LH timing chain tensioner arm.



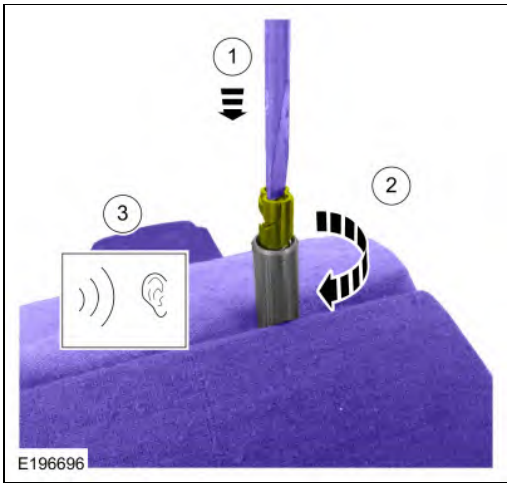
51. Slide the tensioner cylinder out of the LH timing chain tensioner housing.



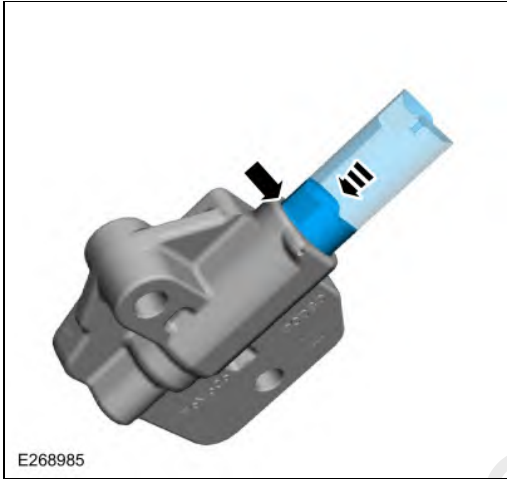
52. **NOTICE:** Use vise jaw protectors or cover the jaws of the vise with clean shop towels to prevent damage to the surface of the tensioner ratchet mechanism.

Mount the flat machined surfaces on the end of the tensioner cylinder into a vise.

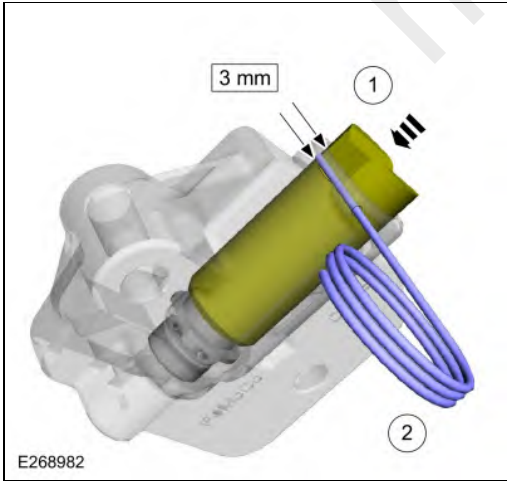
1. Using a flat-bladed screwdriver apply light downward pressure on the end of the tensioner ratchet mechanism.
Use the General Equipment: Vise
Use the General Equipment: Vise Jaw Protectors
Use the General Equipment: Flat-Bladed Screwdriver
2. Rotate the screwdriver clockwise approximately one turn.
3. An audible click will be heard when the tensioner ratchet mechanism locks into place.



53. Slide the tensiometer cylinder into the tensiometer housing until it contacts the bottom of the bore. The shoulder of the tensiometer cylinder will be flush with the top of the housing.

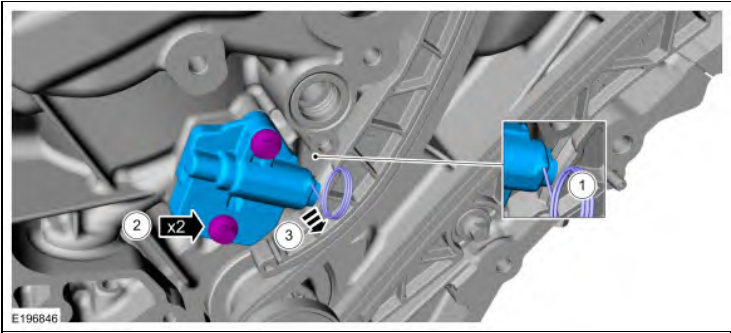


- 54.
1. Firmly press the tensiometer cylinder into the tensiometer housing until the shoulder of the tensiometer cylinder is approximately 3 mm (0.125 in) below the top of the housing.
 2. Install a retaining pin into the hole in the housing to lock the tensiometer cylinder in the retracted position.



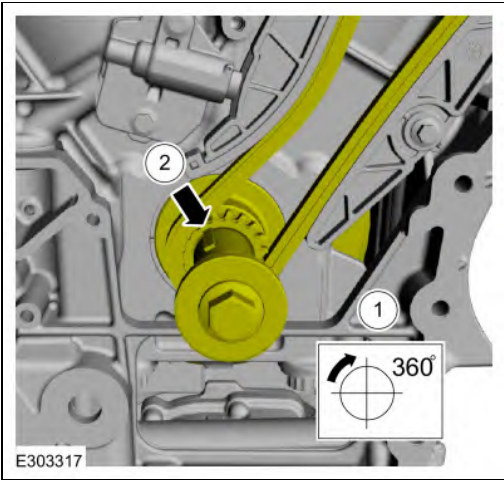
55.

- 1. Position the LH timing chain tensioner with the end of the tensioner correctly engaged to the tensioner arm.
- 2. Install the bolts.
- Torque: 89 lb.in (10 Nm)*
- 3. Remove the pin to allow the tensioner cylinder to extend and press against the timing chain tensioner arm.

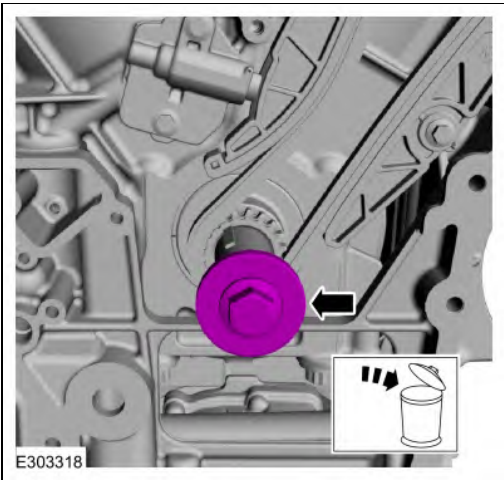


56. **NOTICE: The crankshaft must be rotated clockwise one revolution (360 degrees). Failure to do so will result in incorrect camshaft timing.**

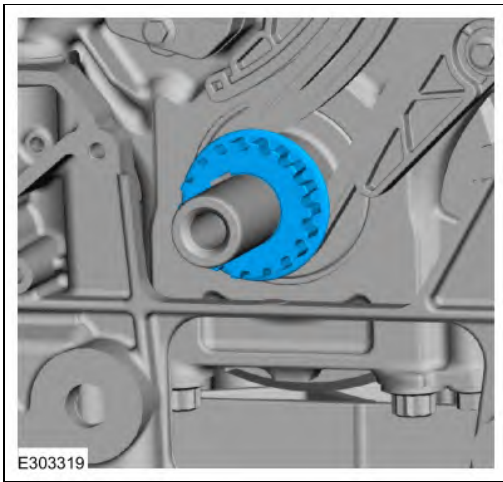
- 1. Rotate the crankshaft clockwise one revolution (360 degrees).
- 2. Position the crankshaft sprocket keyway at the 11 o'clock position.



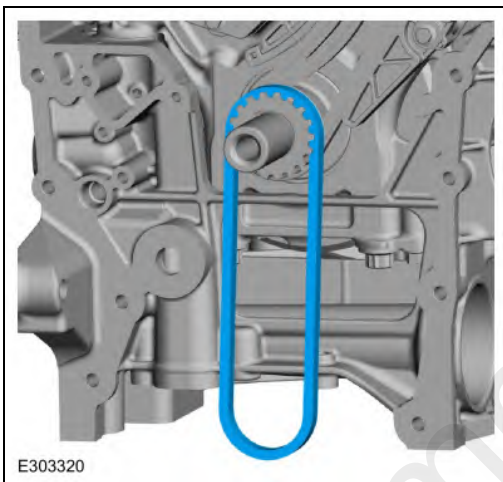
57. Remove and discard the original crankshaft pulley bolt.



58. Install the crankshaft sprocket.



59. Install the oil pump drive belt onto the crankshaft sprocket.



60. Prime the oil pump. Add 2 tablespoons of clean engine oil to the oil pump and rotate the oil pump by hand.

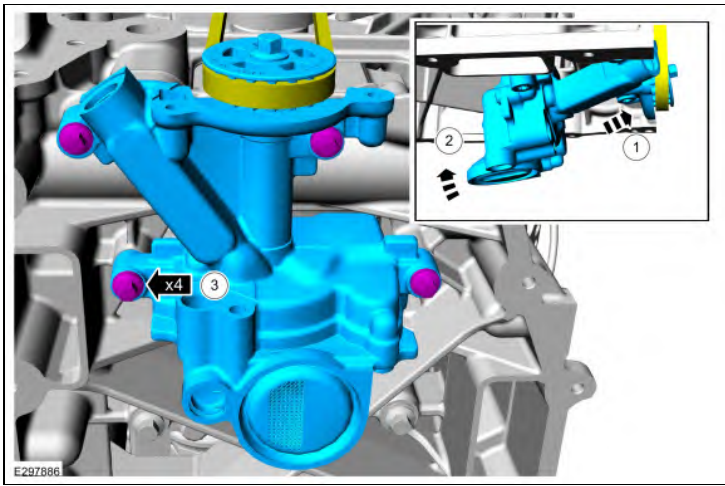
61. **NOTE:** Make sure the oil pump drive belt teeth are engaged in the crankshaft sprocket prior to installing the oil pump.

1. Install the oil pump sprocket into the oil pump drive belt.
2. Raise the rear of the oil pump assembly into the installed position.
3. Install the oil pump bolts.

Torque:

Stage 1: 89 lb.in (10 Nm)

Stage 2: 45Å°



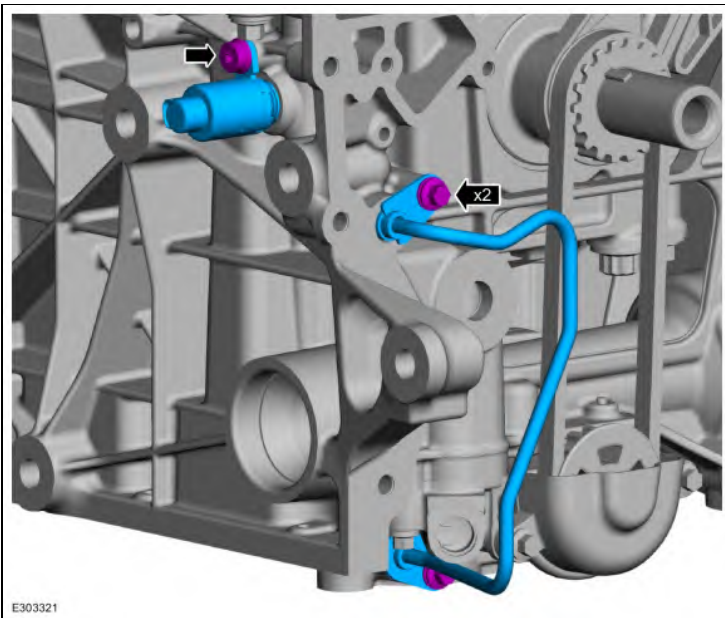
62.

1. Install new O-ring seals.
2. Lubricate the O-ring seals with clean engine oil.

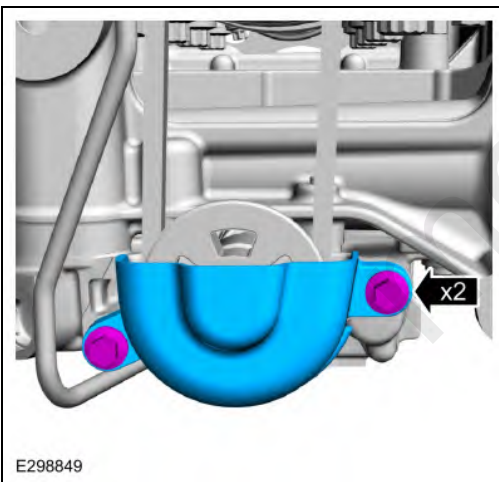


63.

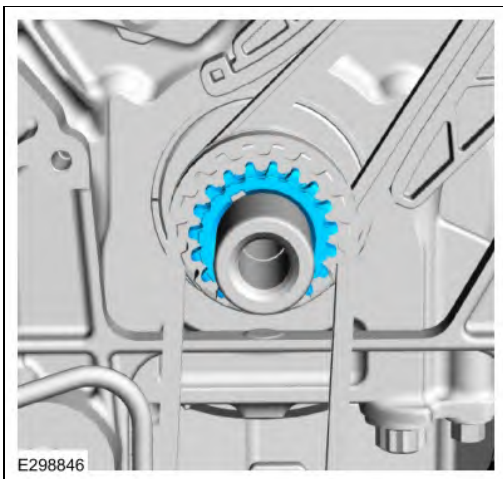
- Install the oil return tube and the bolts.
Torque: 89 lb.in (10 Nm)
- Install the oil control solenoid and the bolt.
Torque: 89 lb.in (10 Nm)



64. Install the splash shield and the bolts.
Torque: 89 lb.in (10 Nm)

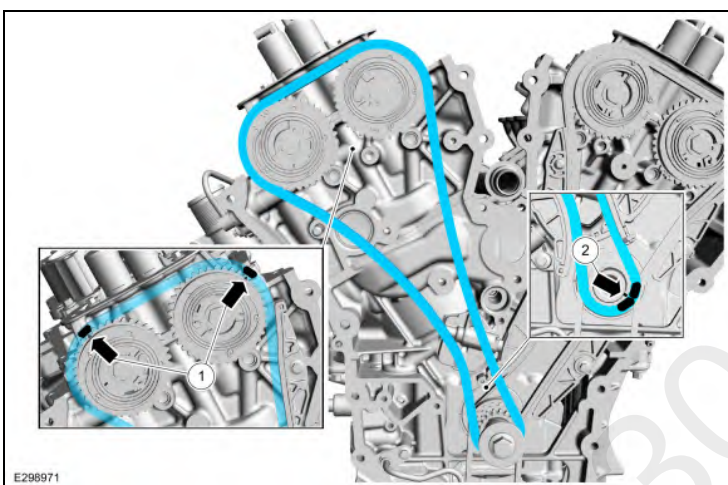


65. Install the timing chain sprocket.

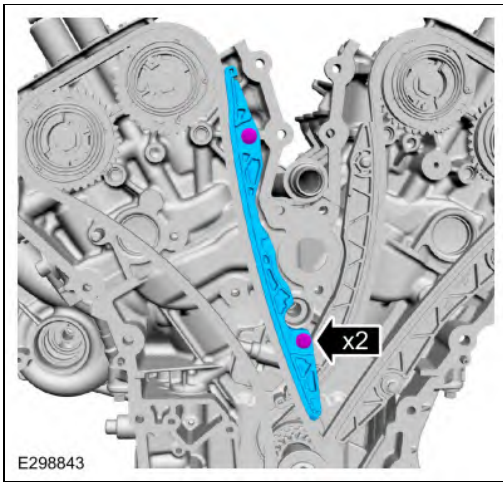


66. **NOTICE:** The VCT units have 2 timing marks on them, a triangle and a circle. For removal and installation of the RH side the triangle marks are used.

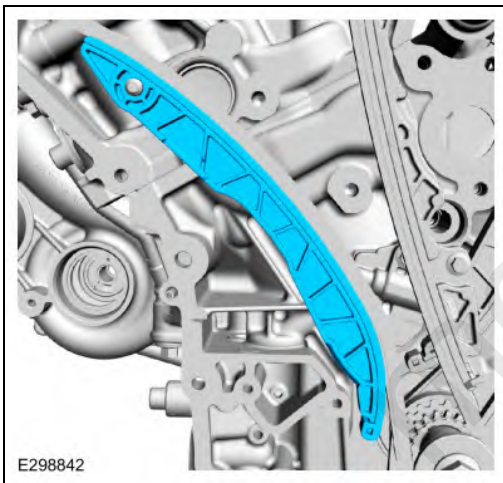
1. Install the RH timing chain with the single colored links aligned with the **triangle** timing marks on the VCT units.
2. Install the double colored links so they straddle the timing mark on the crankshaft sprocket.



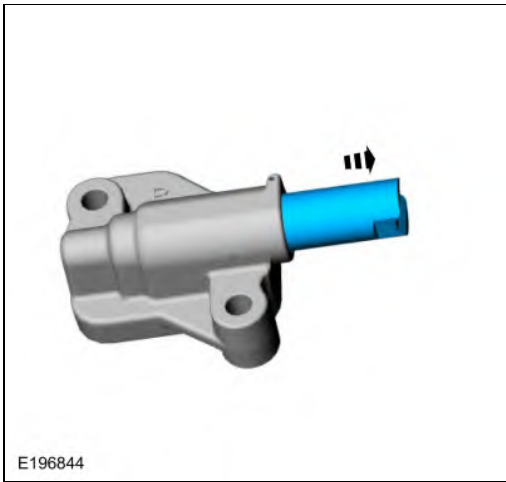
67. Install the RH timing chain guide and bolts.
Torque: 89 lb.in (10 Nm)



68. Install the RH timing chain tensioner arm.



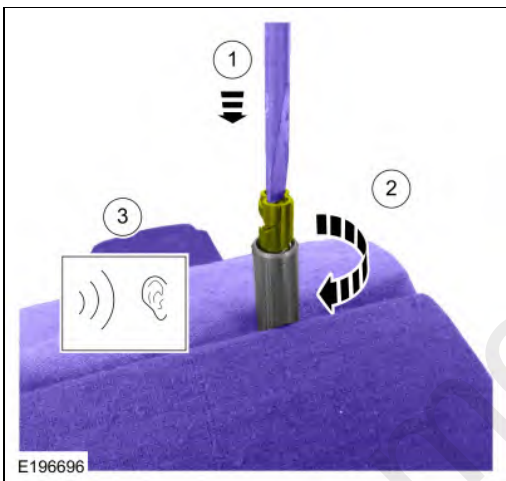
69. Slide the tensioner cylinder out of the RH timing chain tensioner housing.



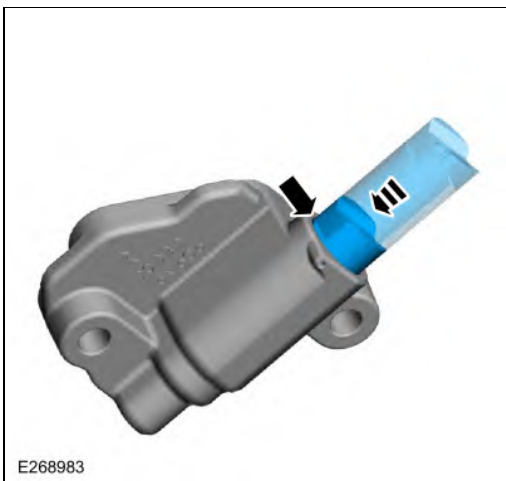
70. **NOTICE:** Use vise jaw protectors or cover the jaws of the vise with clean shop towels to prevent damage to the surface of the tensioner ratchet mechanism.

Mount the flat machined surfaces on the end of the tensioner cylinder into a vise.

1. Using a flat-bladed screwdriver apply light downward pressure on the end of the tensioner ratchet mechanism.
Use the General Equipment: Vise
Use the General Equipment: Vise Jaw Protectors
Use the General Equipment: Flat-Bladed Screwdriver
2. Rotate the screwdriver clockwise approximately one turn.
3. An audible click will be heard when the tensioner ratchet mechanism locks into place.

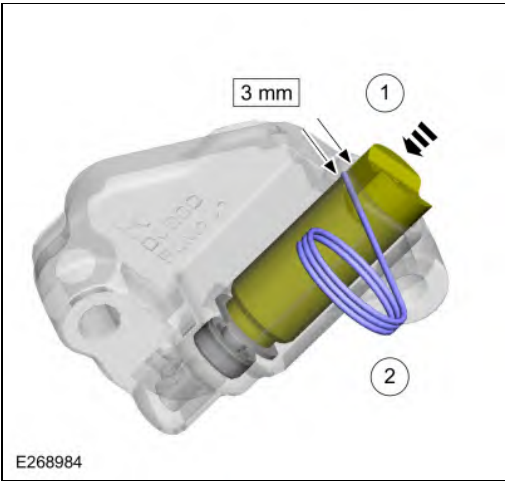


71. Slide the tensioner cylinder into the tensioner housing until it contacts the bottom of the bore. The shoulder of the tensioner cylinder will be flush with the top of the housing.



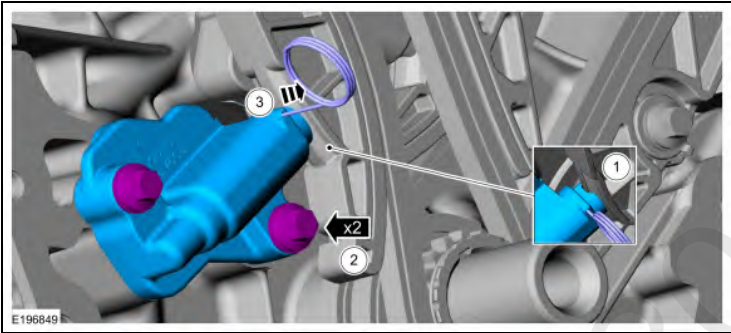
72.

1. Firmly press the tensioner cylinder into the tensioner housing until the shoulder of the tensioner cylinder is approximately 3 mm (0.125 in) below the top of the housing.
2. Install a retaining pin into the hole in the housing to lock the tensioner cylinder in the retracted position.

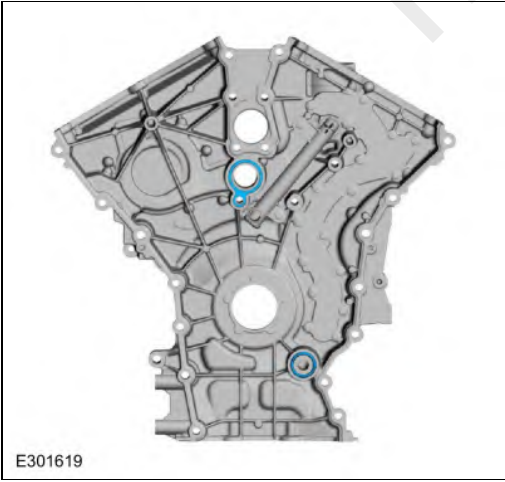


73.

1. Position the RH timing chain tensioner with the end of the tensioner correctly engaged to the tensioner arm.
2. Install the bolts.
Torque: 89 lb.in (10 Nm)
3. Remove the pin to allow the tensioner cylinder to extend and press against the timing chain tensioner arm.

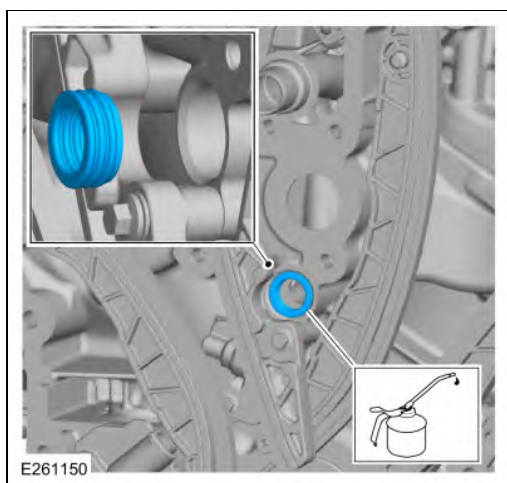


74. Install new engine front cover gaskets.



75.

1. Lubricate a new oil gallery seal (6G068) with clean engine oil.
2. Install the new oil gallery seal (6G068).

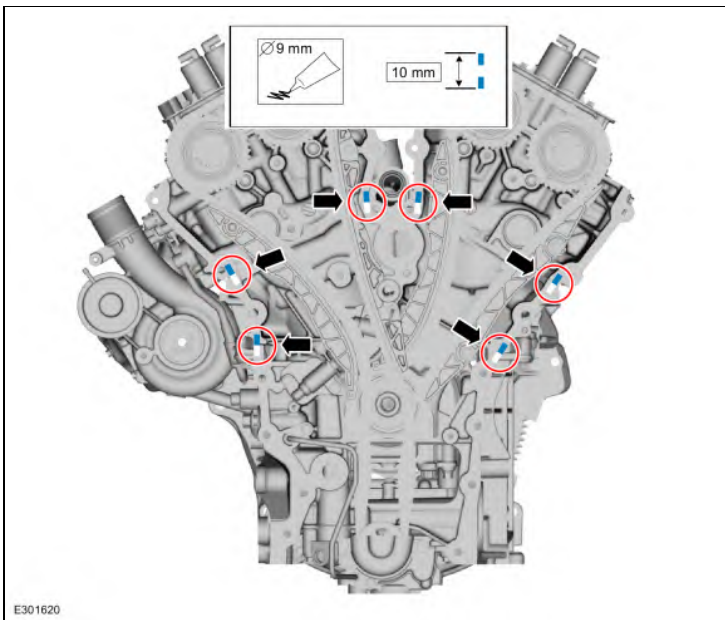


76. **NOTICE:** Failure to use Motorcraft® High Performance Engine RTV Silicone may cause the engine oil to foam excessively and result in serious engine damage.

NOTE: The engine front cover must be installed within 10 minutes of applying the sealer and the bolts must be installed and tightened to 2-5 Nm (18-44 lb-in) within 15 of applying the sealer. Final tightening of the bolts must be completed within 60 minutes of applying the sealer. Failure to follow this procedure can cause future oil leakage.

Apply 9 mm (0.35 in) beads of Motorcraft® High Performance Engine RTV Silicone 10 mm (0.40 in) in length to the cylinder block skirt-to-cylinder block joints and the cylinder head-to-cylinder block joints as indicated.

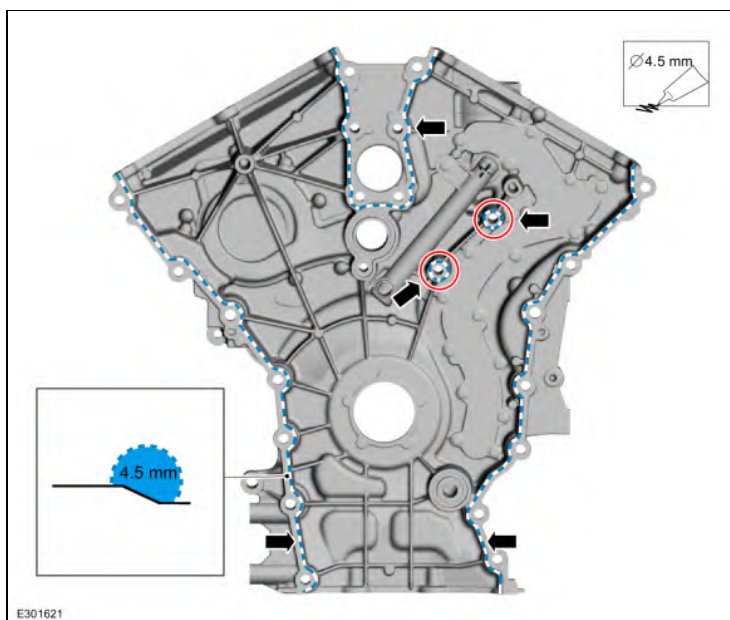
Material: Motorcraft® High Performance Engine RTV Silicone / TA-357 (WSE-M4G323-A6)



77. **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 must be installed within 10 minutes of applying the sealer and the bolts must be installed and tightened to 2-5 Nm (18-44 lb-in) within 15 of applying the sealer. Final tightening of the bolts must be completed within 60 minutes of applying the sealer. Failure to follow this procedure can cause future oil leakage.

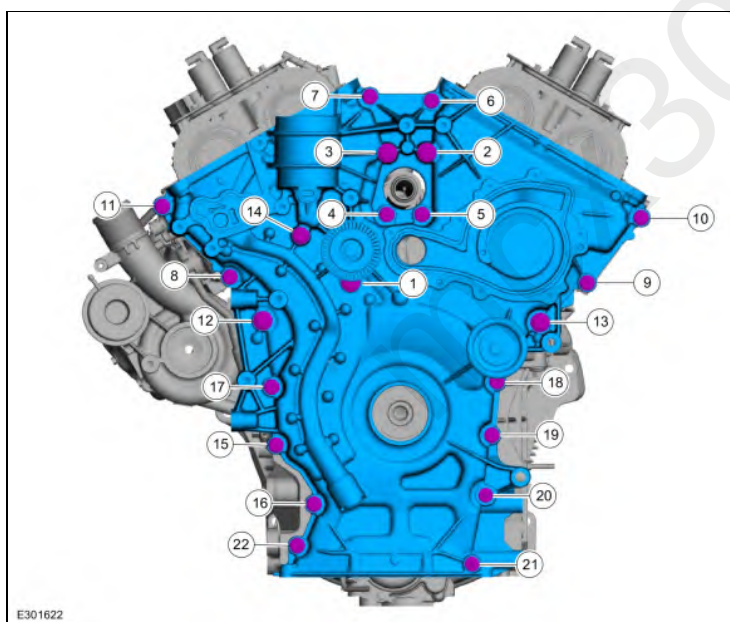
1. Apply a 4.5 mm (0.18 in) bead of Motorcraft® High Performance Engine RTV Silicone to the engine front cover sealing surfaces of the inner bolt bosses.
Material: Motorcraft® High Performance Engine RTV Silicone / TA-357 (WSE-M4G323-A6)
2. Apply a 4.5 mm (0.18 in) bead of Motorcraft® High Performance Engine RTV Silicone to the chamfer of the engine front cover sealing surfaces.
Material: Motorcraft® High Performance Engine RTV Silicone / TA-357 (WSE-M4G323-A6)



78. Install the engine front cover and the fasteners.

Torque:

- Stage 1: Tighten bolts 1 through 11 to: 18 lb.ft (24 Nm)
- Stage 2: Tighten bolts 12 through 13 to: 35 lb.ft (48 Nm)
- Stage 3: Tighten bolts 14 through 20 to: 18 lb.ft (24 Nm)

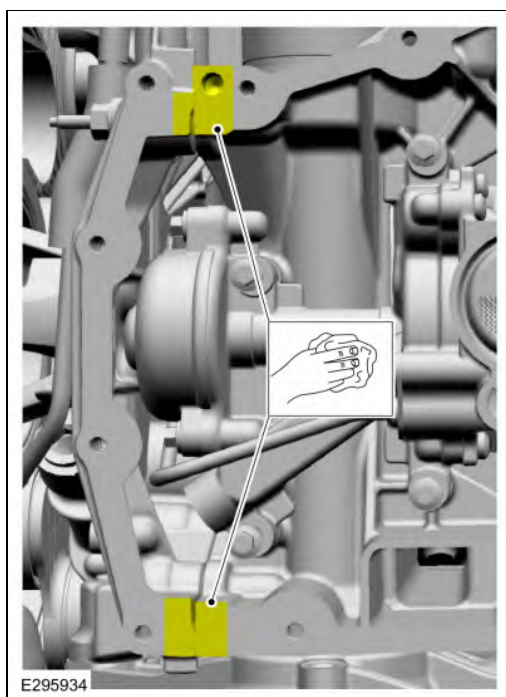


79. Refer to: RTV Sealing Surface Cleaning and Preparation (303-00 Engine System - General Information, General Procedures).

Material: Motorcraft® Silicone Gasket Remover / ZC-30-A

Material: Motorcraft® Metal Surface Prep Wipes / ZC-31-B

Material: Motorcraft® Metal Brake Parts Cleaner / PM-4-A, PM-4-B

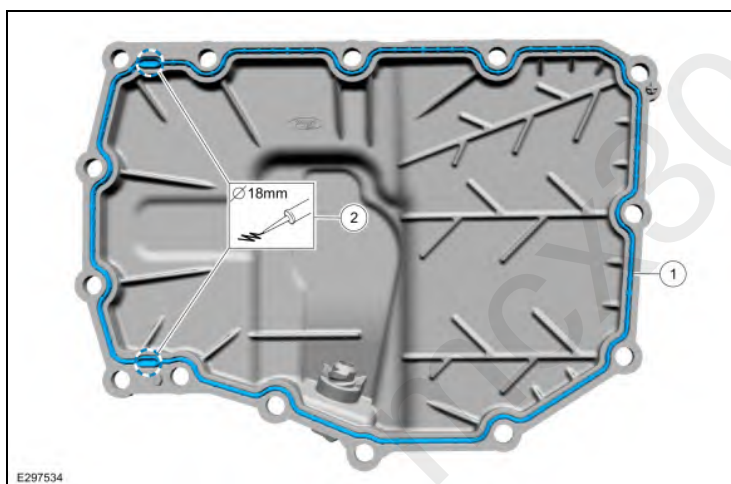


80. **NOTICE:** Failure to use Motorcraft® High Performance Engine RTV Silicone may cause the engine oil to foam excessively and result in serious engine damage.

NOTE: The oil pan must be installed within 10 minutes of applying the sealer and the bolts must be installed and tightened to 2-5 Nm (18-44 lb-in) within 15 of applying the sealer. Final tightening of the bolts must be completed within 60 minutes of applying the sealer. Failure to follow this procedure can cause future oil leakage.

1. Install a new gasket.
2. Apply 18 mm (0.7 in) drops of sealant.

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

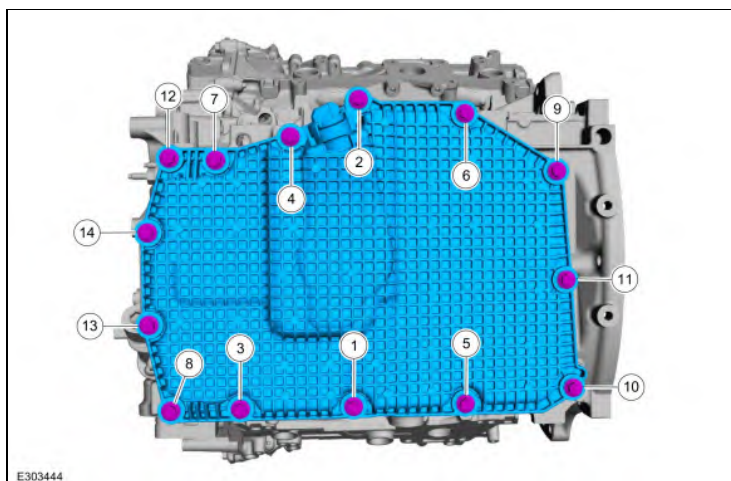


81. Tighten the bolts in 2 stages.

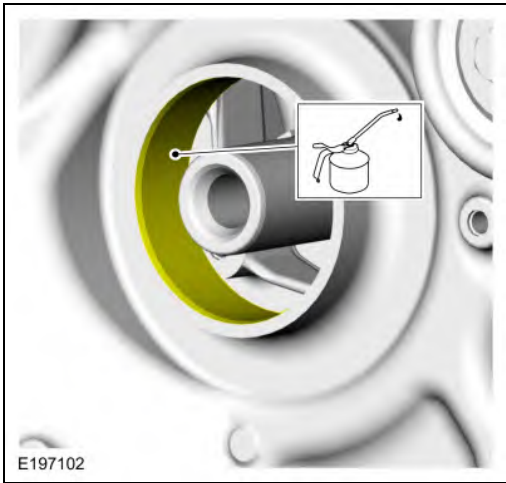
Torque:

Stage 1: 89 lb.in (10 Nm)

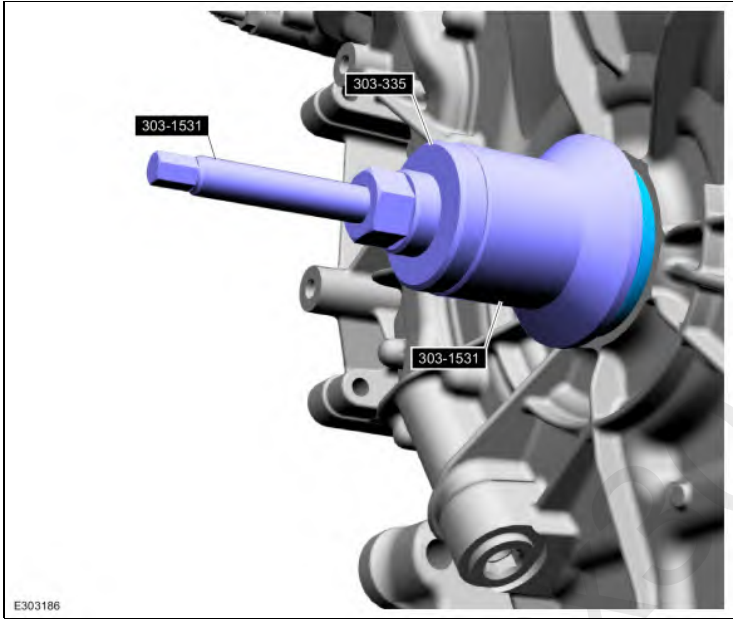
Stage 2: 45°



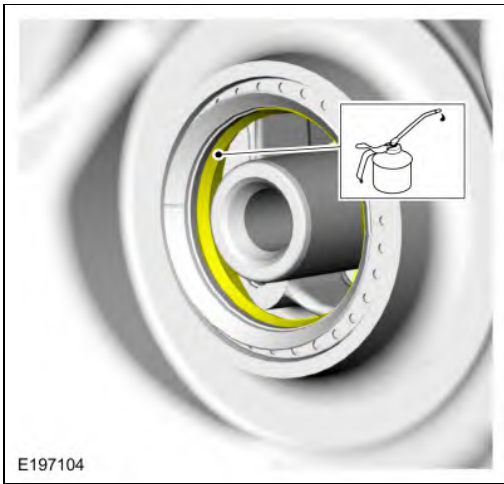
82. Lubricate the engine front cover bore with clean engine oil.



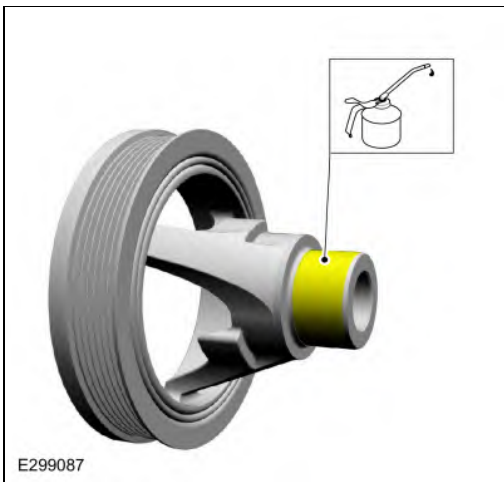
83. Using the special tools, install the new crankshaft front oil seal.
Use Special Service Tool: 303-335 (T88T-6701-A) Installer, Front Cover Oil Seal. , 303-1531 Installer, Front Crank Seal and Damper.



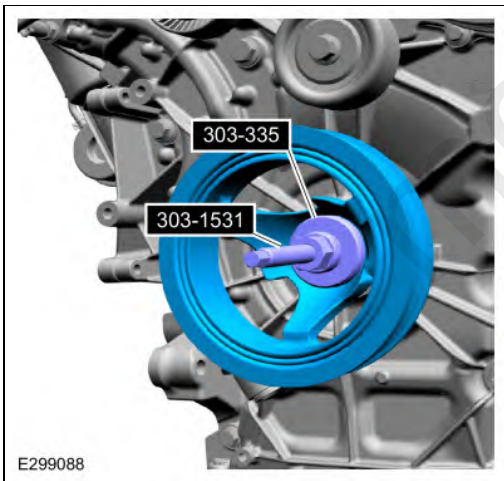
84. Lubricate the crankshaft front seal inner lip with clean engine oil.



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



86. Using the special tools, install the crankshaft pulley.
Use Special Service Tool: 303-335 (T88T-6701-A) Installer, Front Cover Oil Seal , 303-1531 Installer, Front Crank Seal and Damper.



87. **NOTE:** Use a universal pulley holder (such as an OTC 4754, or equivalent).

Using a universal pulley holder, install and tighten a new crankshaft pulley bolt.

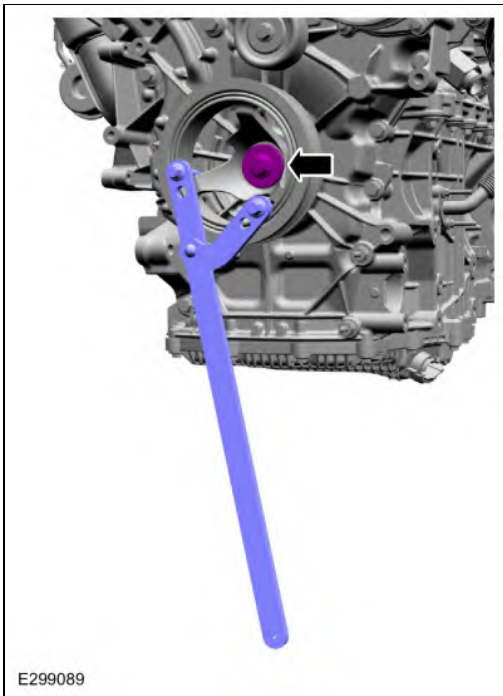
Torque:

Stage 1: 166 lb.ft (225 Nm)

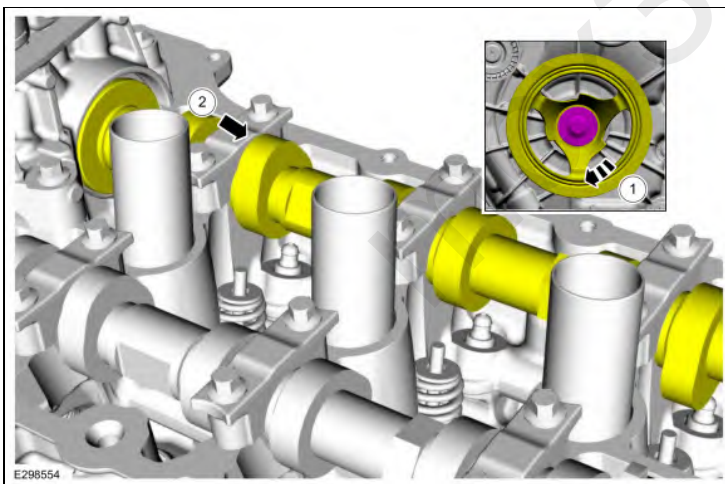
Stage 2: Loosen: 360°

Stage 3: 26 lb.ft (35 Nm)

Stage 4: 270°



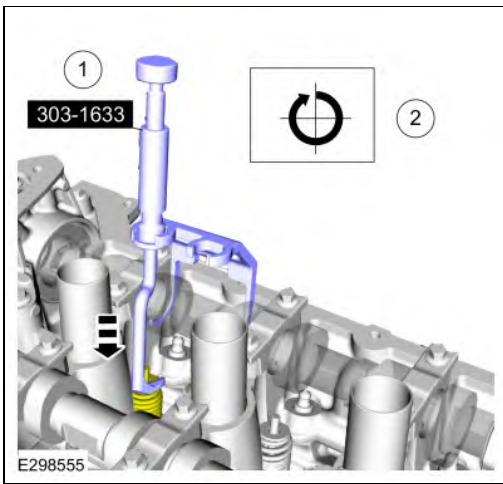
88. Rotate the crankshaft pulley bolt clockwise to position the camshaft lobe upward for the camshaft roller follower to be installed.



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

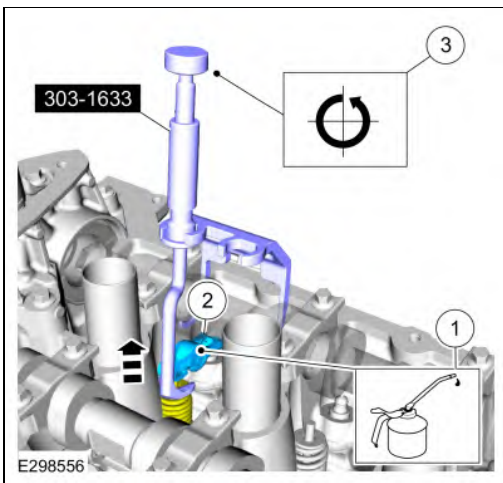
NOTE: It may be necessary to push the valve down while compressing the spring.

1. Install Special Service Tool: 303-1633 Remover, Roller Rocker Follower.
2. Turn the knob on the special tool clockwise to depress the valve and spring.



90.

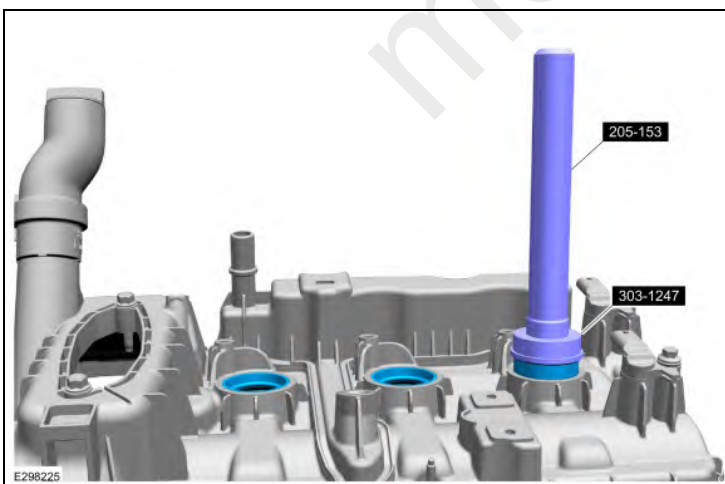
1. Lubricate the camshaft roller follower with clean engine oil.
 2. Install the camshaft roller follower.
 3. Turn the knob on the special tool counterclockwise to raise the valve and spring.
- Remove Special Service Tool: 303-1633 Remover, Roller Rocker Follower.
- Repeat steps for the remaining camshaft roller followers.



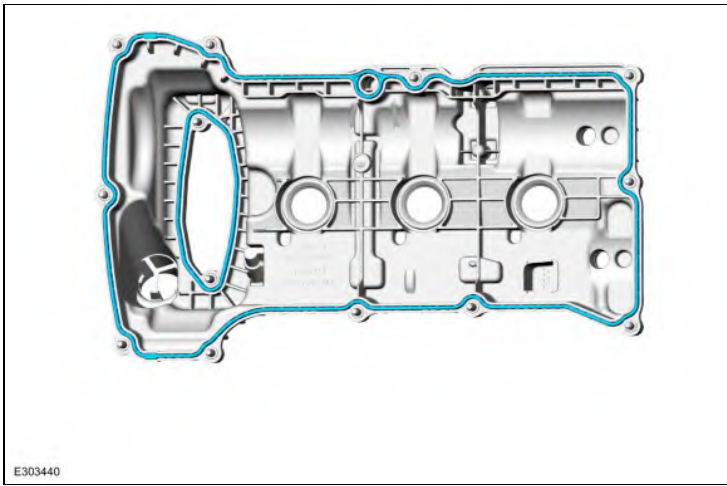
91. **NOTE:** Installation of new seals is only required if damaged seals were removed.

Using the special tools, install new spark plug tube seals.

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



92. Install new gaskets.



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

Clean the valve cover mating surface of the cylinder head and engine front cover.

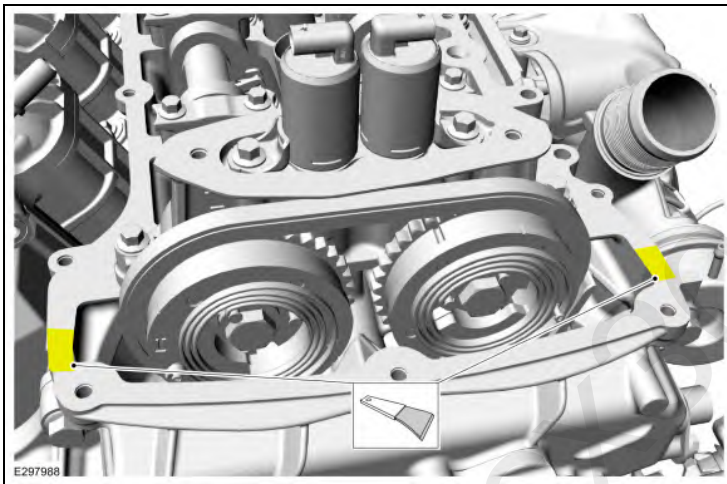
Refer to: RTV Sealing Surface Cleaning and Preparation (303-00 Engine System - General Information, General Procedures).

Use the General Equipment: Plastic Scraper

Material: Motorcraft® Silicone Gasket Remover / ZC-30-A

Material: Motorcraft® Metal Surface Prep Wipes / ZC-31-B

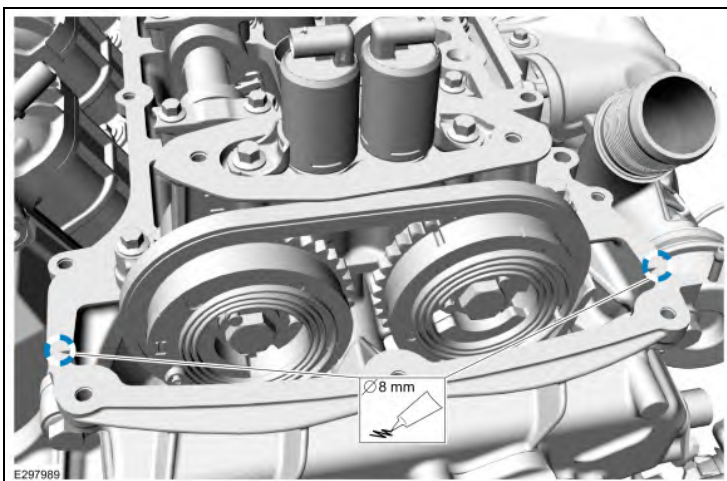
Material: Motorcraft® Metal Brake Parts Cleaner / PM-4-A, PM-4-B



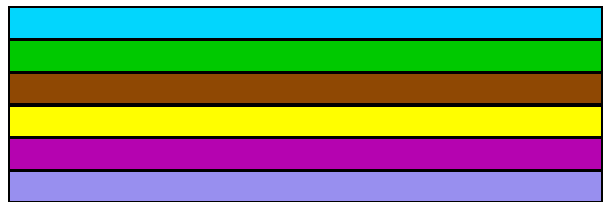
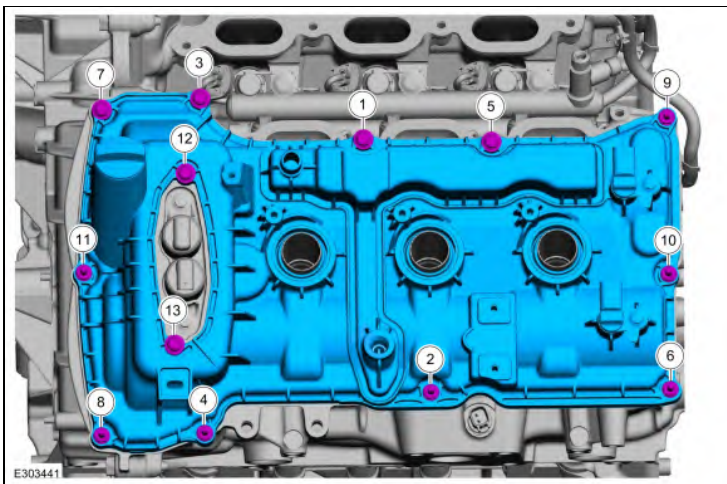
94. **NOTICE:** If the valve cover is not installed and the fasteners tightened within 10 minutes, the sealant must be removed and the sealing area cleaned.

Apply an 8 mm (0.31 in) diameter drop 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)



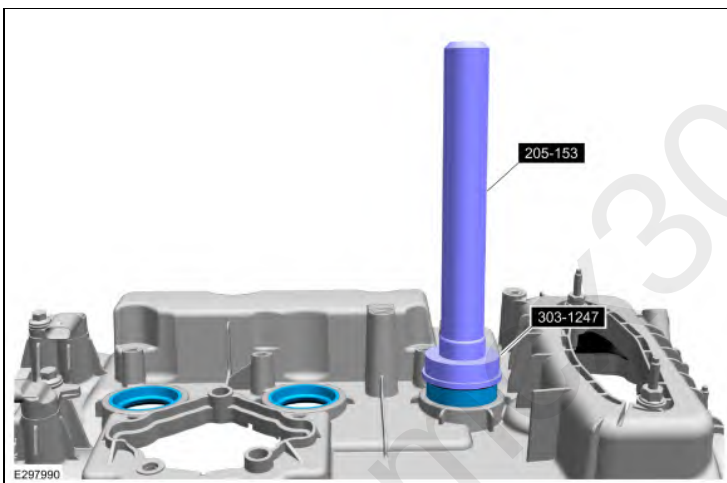
95. Install the valve cover and tighten the bolts in sequence.
Torque: 89 lb.in (10 Nm)



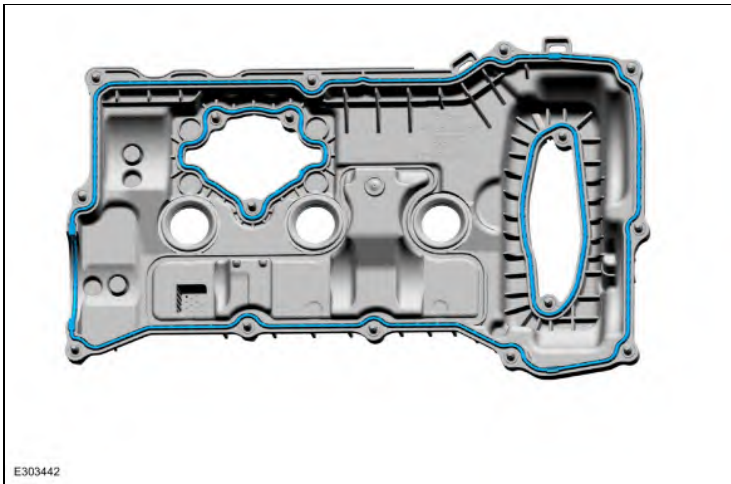
96. **NOTE:** Installation of new seals is only required if damaged seals were removed.

Using the special tools, install new spark plug tube seals.

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

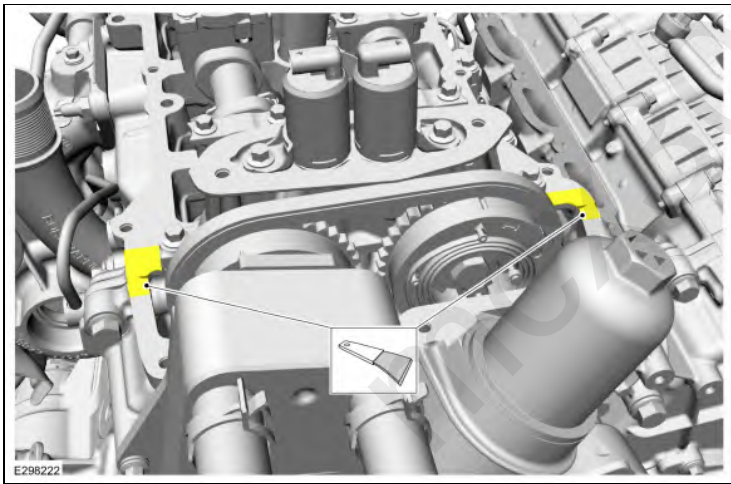


97. Install new gaskets



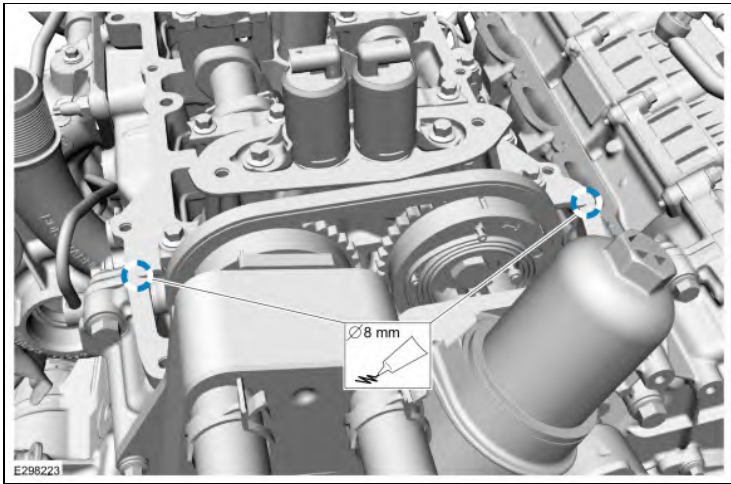
98. **NOTICE:** Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the sealing surfaces. These tools cause scratches and gouges which make leak paths. Use a plastic scraping tool to remove all traces of old sealant.

Clean the valve cover mating surface of the cylinder head and engine front cover.
Refer to: RTV Sealing Surface Cleaning and Preparation (303-00 Engine System - General Information, General Procedures).
Use the General Equipment: Plastic Scraper
Material: Motorcraft® Silicone Gasket Remover / ZC-30-A
Material: Motorcraft® Metal Surface Prep Wipes / ZC-31-B
Material: Motorcraft® Metal Brake Parts Cleaner / PM-4-A, PM-4-B



99. **NOTICE:** If the valve cover is not installed and the fasteners tightened within 10 minutes, the sealant must be removed and the sealing area cleaned.

Apply an 8 mm (0.31 in) diameter drop 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)



- Torque:* 89 lb.in (10 Nm)

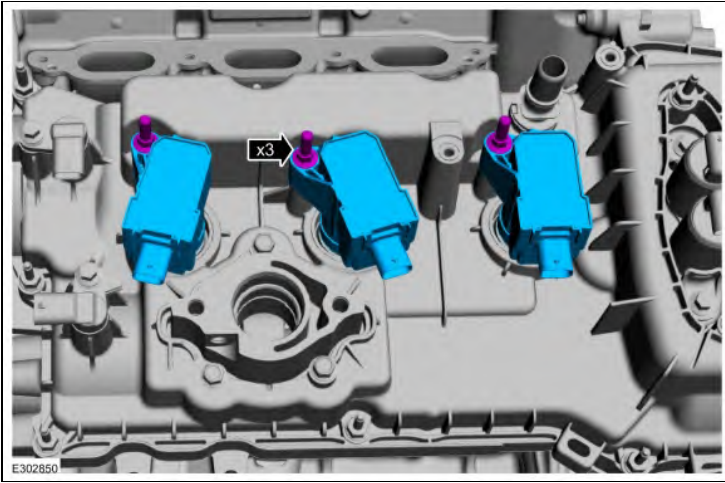


- Torque: 53 lb.in (6 Nm)*

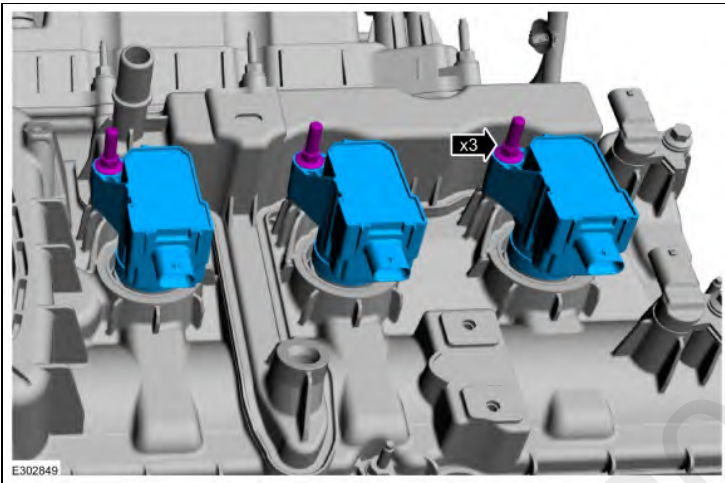


-

- Torque: 53 lb.in (6 Nm)*

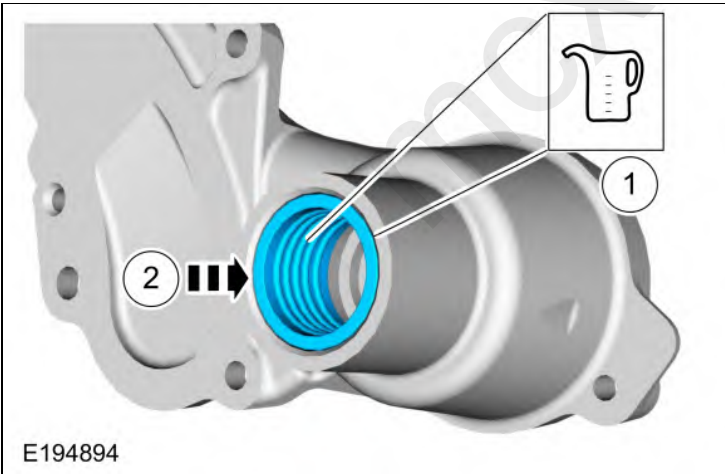


104. Install the LH ignition coil-on-plugs and stud bolts.
Torque: 53 lb.in (6 Nm)

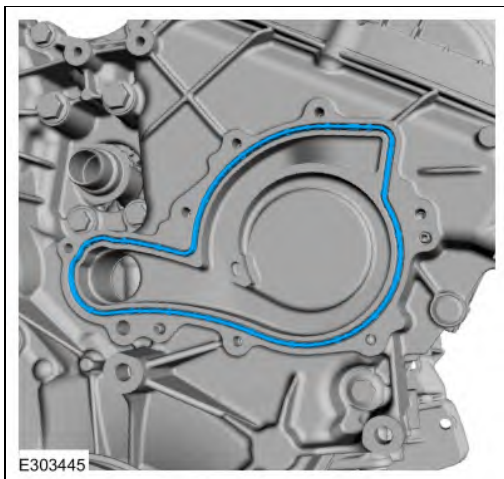


105.

- Lubricate the inside and the outside diameter of the grommet with clean engine coolant.
- Install the grommet so it is flush with the rear of the coolant pump housing.



106. Install a new coolant pump gasket.



107. **NOTE:** Verify the front cover dowel pins are aligned to the coolant pump and that the coolant pump is fully seated prior to installing the fasteners.

- Install the coolant pump and the fasteners.

Torque:

Fasteners 1-6:

Stage 1: 89 lb.in (10 Nm)

Stage 2: 45°

- *Torque:*

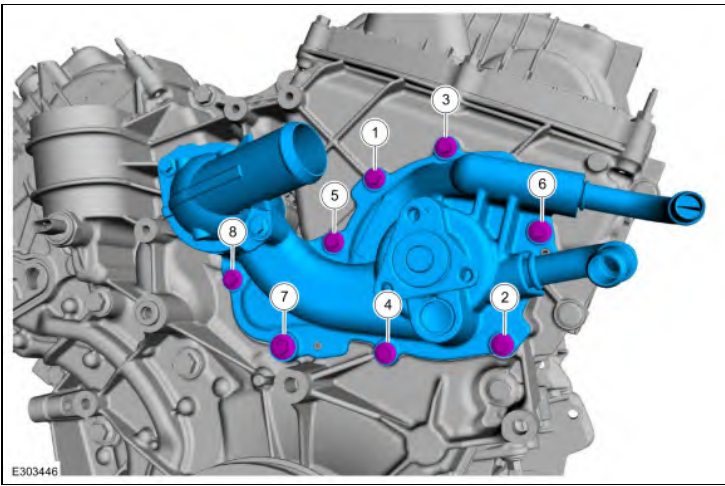
Fastener 7: 18 lb.ft (24 Nm)

- *Torque:*

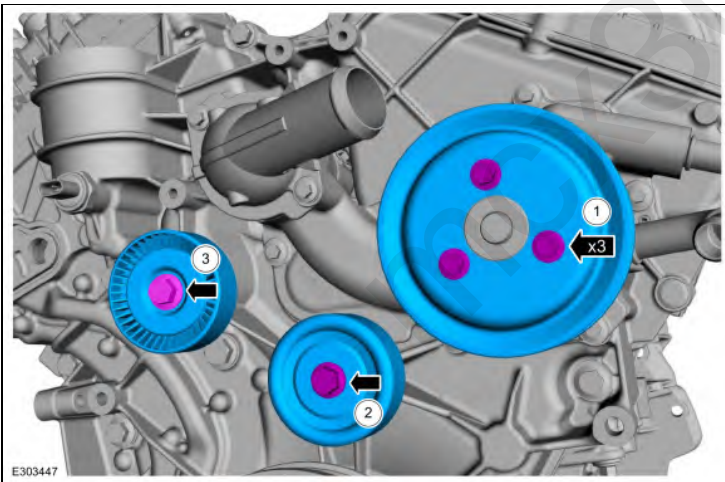
Fasteners 8:

Stage 1: 89 lb.in (10 Nm)

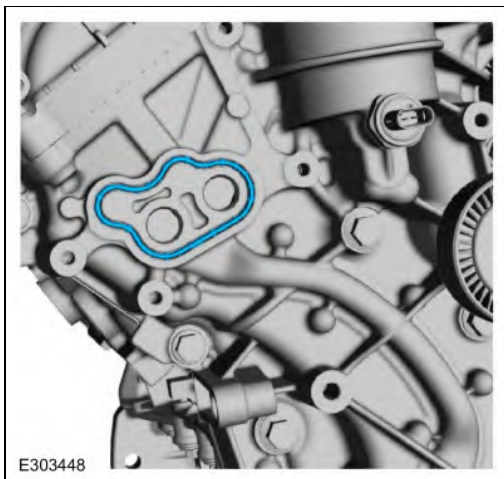
Stage 2: 45°



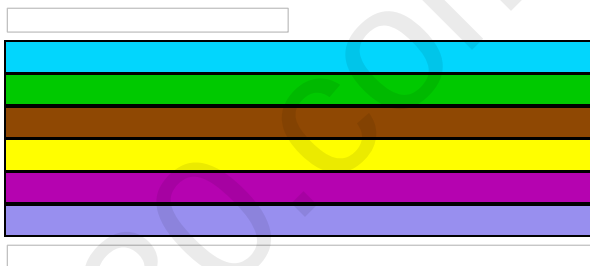
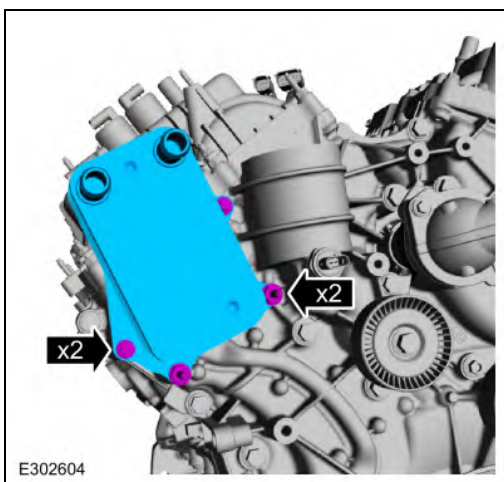
- 108.
1. Install the coolant pump pulley and the bolts.
Torque: 18 lb.ft (24 Nm)
 2. Install the idler pulley and the bolt.
Torque: 35 lb.ft (48 Nm)
 3. Install the idler pulley and the bolt.
Torque: 18 lb.ft (24 Nm)



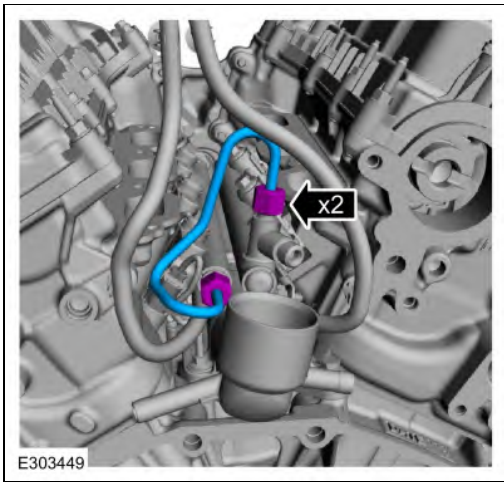
109. Install a new oil cooler gasket.



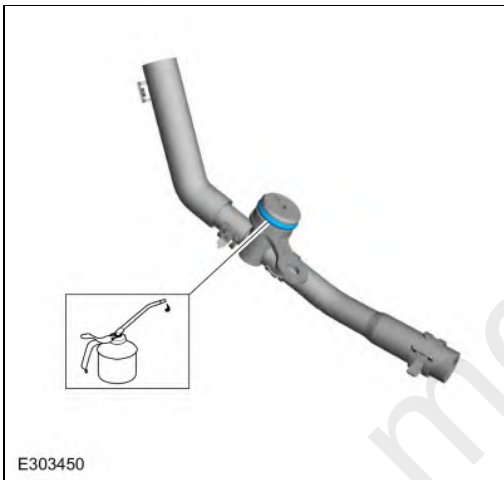
110. Install the oil cooler and the fasteners.
Torque: 89 lb.in (10 Nm)



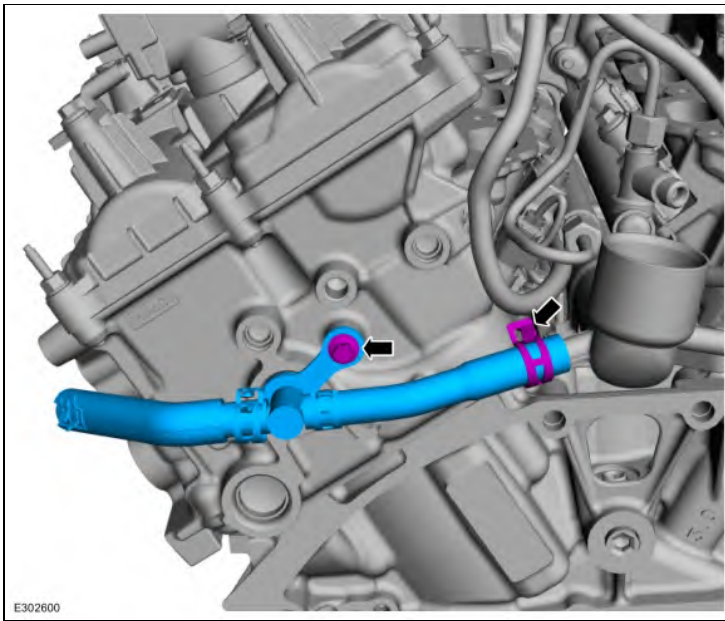
111. Install a new fuel rail-to-fuel rail high-pressure fuel tube and finger tighten the flare nuts.
- Final tighten the flare nuts.
Torque:
 Stage 1: 62 lb.in (7 Nm)
 Stage 2: 89 lb.in (10 Nm)
 Stage 3: 25Å°



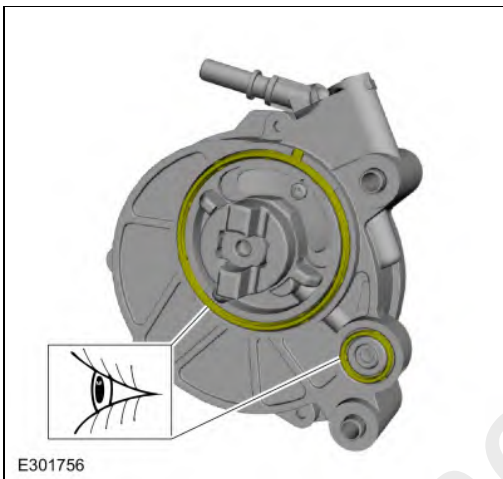
112. Install a new O-ring seal and lubricate with clean engine coolant.



- 113.
- Install the TC coolant return tube and clamp.
 - Install the bolt.
- Torque: 89 lb.in (10 Nm)*



114. Inspect the gaskets and install new gaskets as necessary.



115. **NOTICE:** Do not use wire brushes, power abrasive discs or 3M[®] Roloc[®] Bristle Disk (2-in white part number 07528) to clean the sealing surfaces. These tools cause scratches and gouges that make leak paths. They also cause contamination that will cause premature engine failure. Remove all traces of the sealant.

Make sure that the mating faces of the engine are clean and free of foreign material.

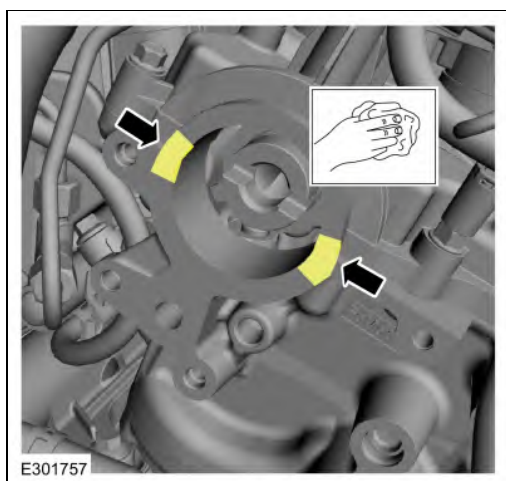
Refer to: RTV Sealing Surface Cleaning and Preparation (303-00 Engine System - General Information, General Procedures).

Use the General Equipment: Plastic Scraper

Material: Motorcraft[®] Silicone Gasket Remover / ZC-30-A

Material: Motorcraft[®] Metal Brake Parts Cleaner / PM-4-A, PM-4-B

Material: Motorcraft[®] Metal Surface Prep Wipes / ZC-31-B

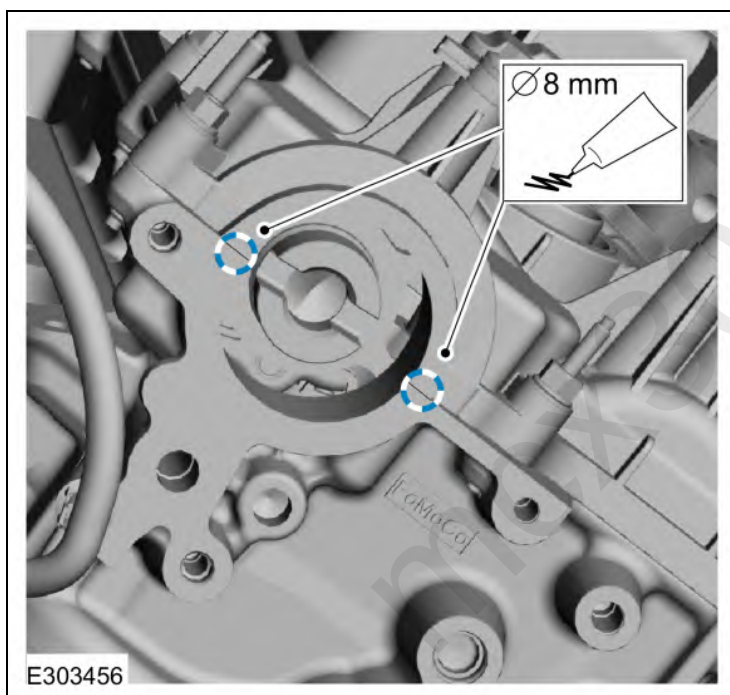


116. **NOTICE:** Failure to use Motorcraft® High Performance Engine RTV Silicone may cause the engine oil to foam excessively and result in serious engine damage.

NOTE: If the brake vacuum pump is not secured within 10 minutes of sealant application, the sealant must be removed and the sealing area cleaned. Failure to follow this procedure can cause future oil leakage.

Apply 8 mm (0.31 in) beads of Motorcraft® High Performance Engine RTV Silicone in the locations shown.

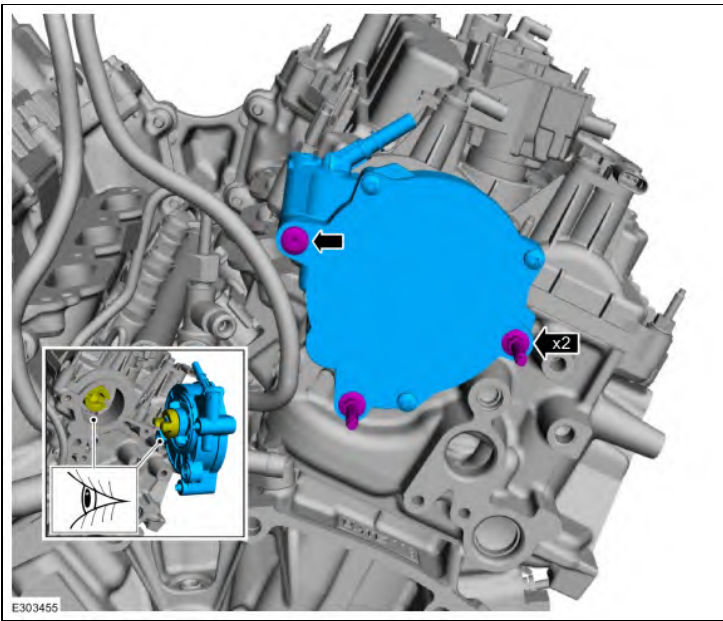
Material: Motorcraft® High Performance Engine RTV Silicone / TA-357 (WSE-M4G323-A6)



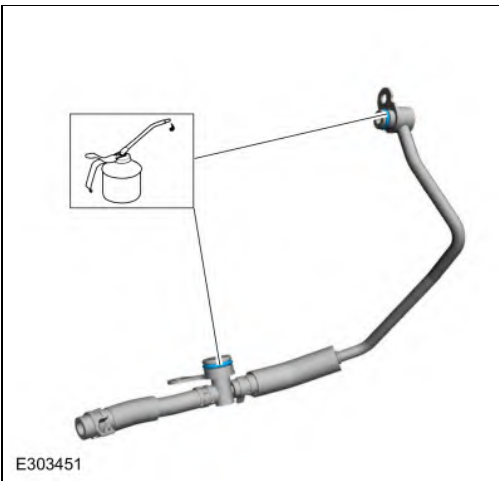
117. **NOTE:** Manually align the brake vacuum pump drive key with the camshaft slot before installation.

Position the vacuum pump and install the fasteners.

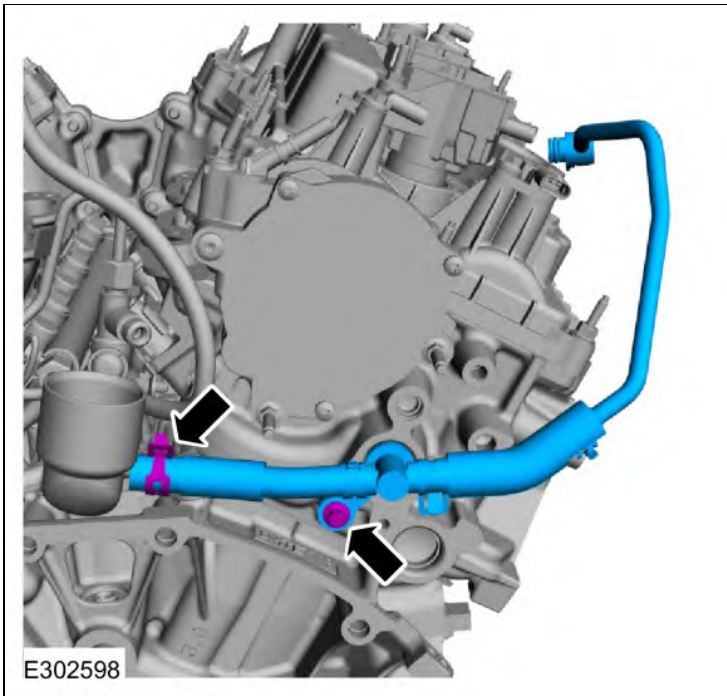
Torque: 89 lb.in (10 Nm)



118. Install new O-ring seals and lubricate with clean engine coolant.

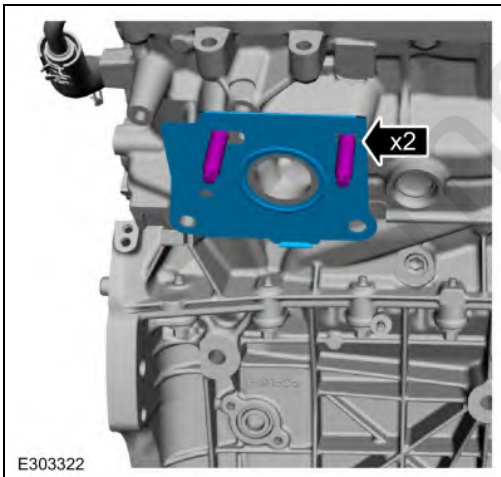


- 119.
- Install the TC coolant return tube and clamp.
 - Install the bolt.
- Torque: 89 lb.in (10 Nm)*



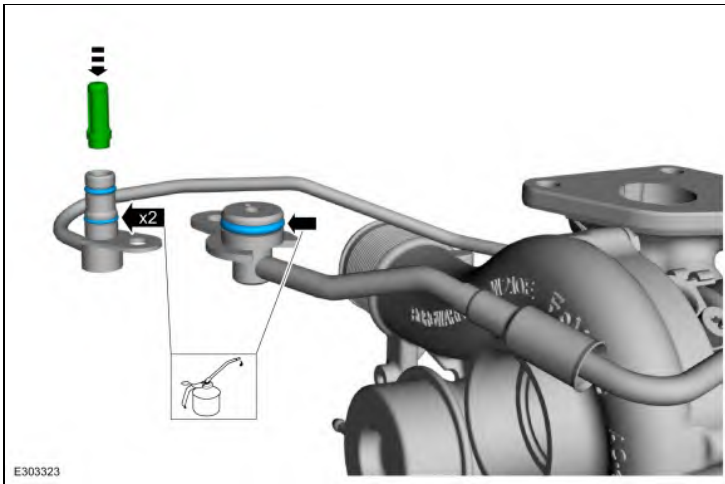
120.

- If removed, install new TC mounting studs.
Torque: 102 lb.in (11.5 Nm)
- Install a new TC gasket.



121.

1. Install new TC oil supply tube O-ring seals and a new TC oil supply tube oil filter. Lubricate the new TC oil supply tube O-ring seals with clean engine oil.
2. Install a new TC coolant supply tube O-ring seal. Lubricate the new TC coolant supply tube O-ring seal with clean engine coolant.



122.

1. **NOTE:** Install the coolant supply tube and the oil supply tube to the engine block while installing the TC.

Install the TC and loosely install the new fasteners.

2. Tighten the fasteners in sequence.

Torque:

Fastener 1: 44 lb.ft (60 Nm)

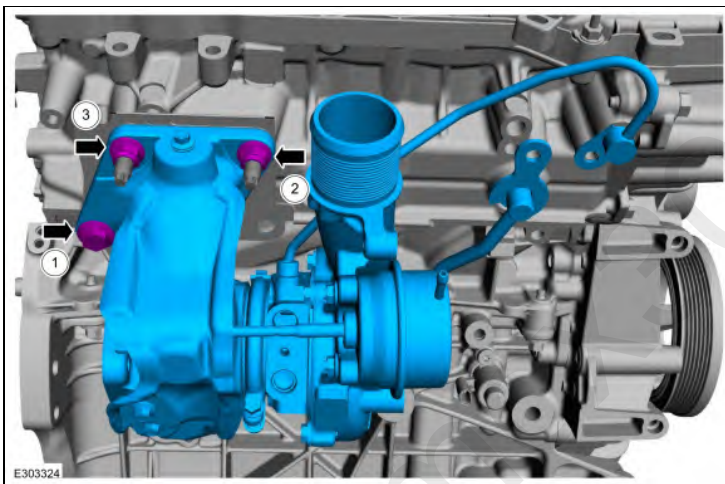
Fastener 2: 44 lb.ft (60 Nm)

Fastener 3: 27 lb.ft (37 Nm)

Re-tighten fastener 1: 44 lb.ft (60 Nm)

Re-tighten fastener 2: 44 lb.ft (60 Nm)

Re-tighten fastener 3: 27 lb.ft (37 Nm)



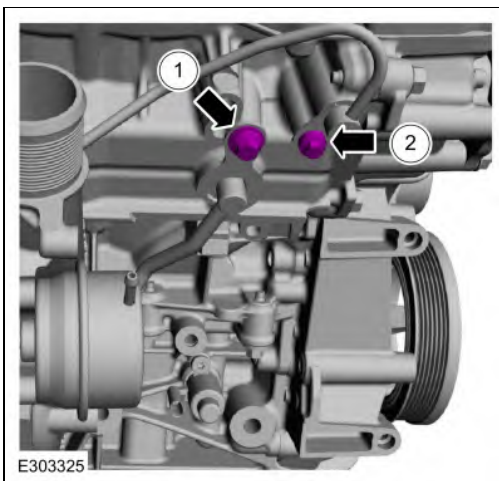
123.

1. Install the TC oil supply tube bolt.

Torque: 18 lb.ft (24 Nm)

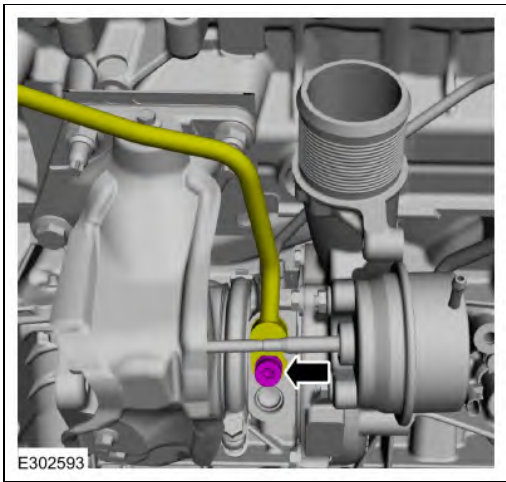
2. Install the TC coolant supply tube bolt.

Torque: 89 lb.in (10 Nm)

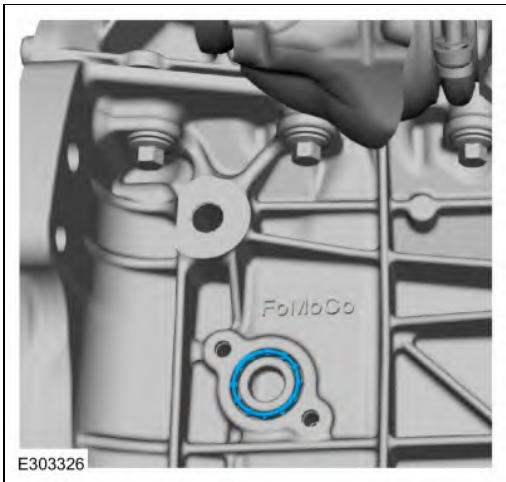


124. Install the TC coolant return tube and the bolt.

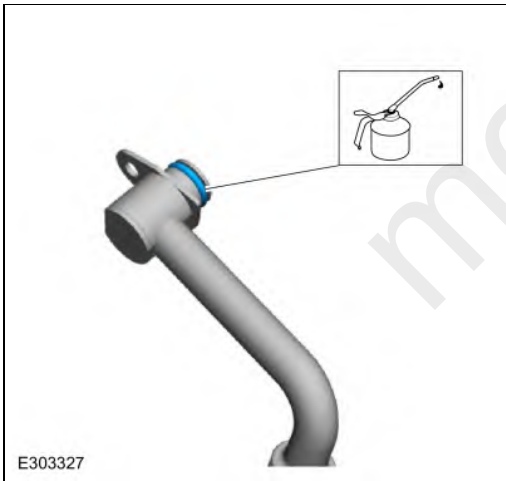
Torque: 89 lb.in (10 Nm)



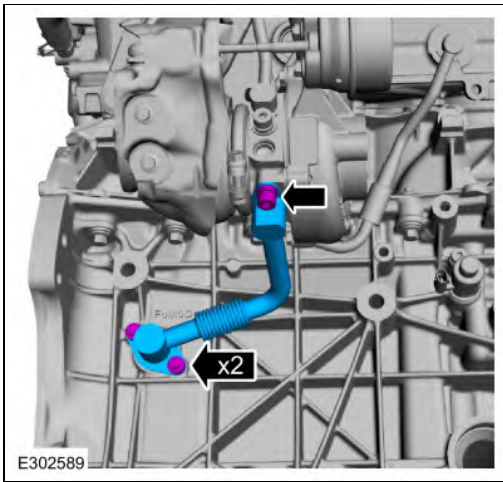
125. Install a new TC oil return tube-to-engine block gasket.



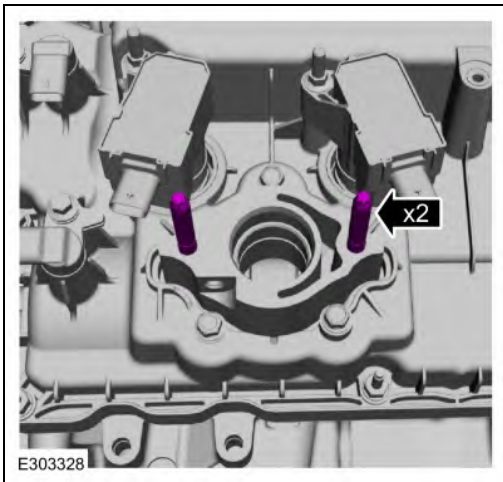
126. Install a new TC oil return tube O-ring seal and lubricate with clean engine oil.



127. Install the TC oil return tube and the fasteners.
Torque: 89 lb.in (10 Nm)



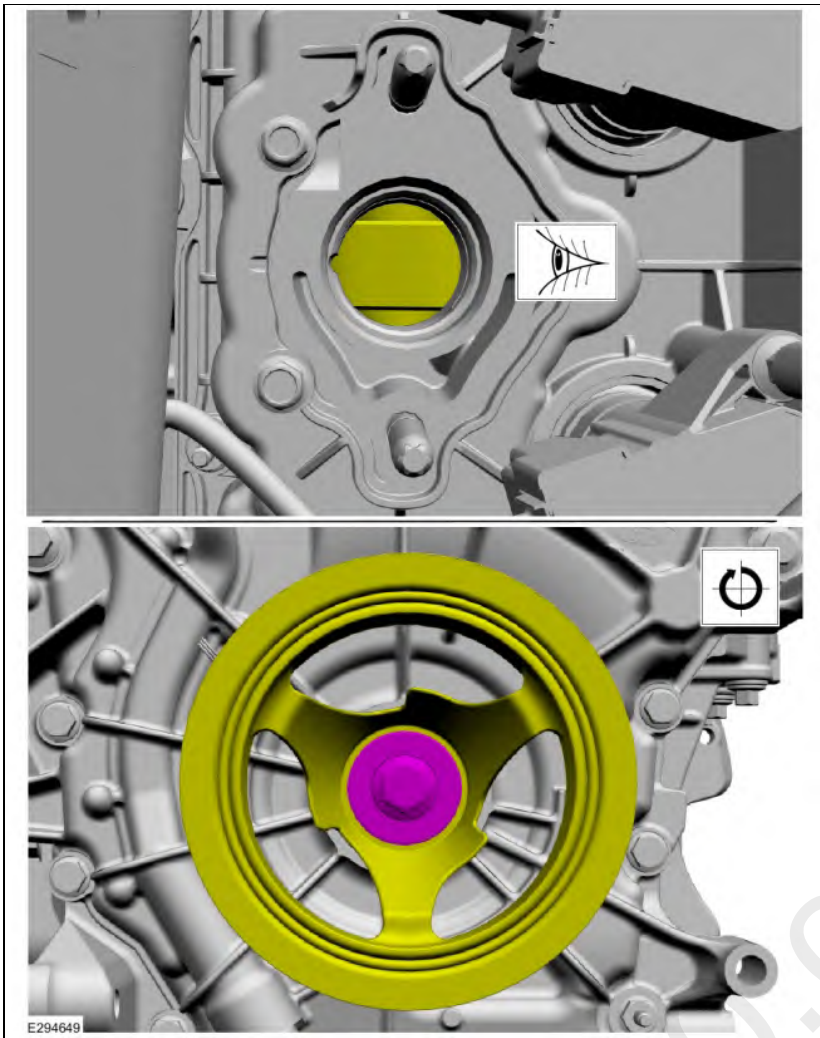
128. If removed, install and tighten the high-pressure fuel pump mounting studs.
Torque: 106 lb.in (12 Nm)



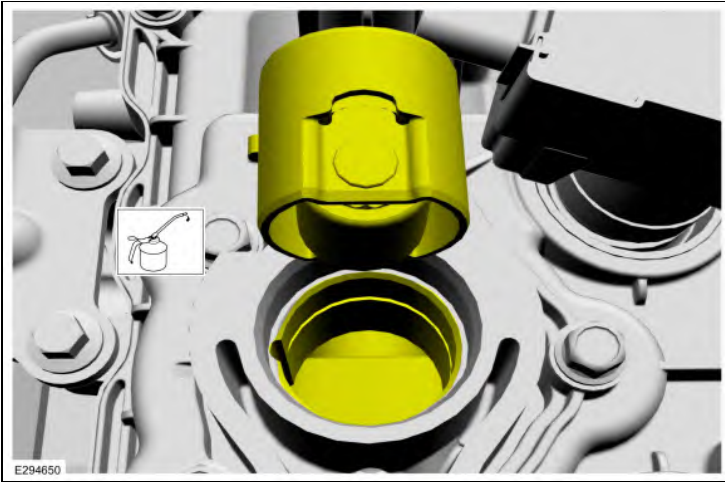
129. **NOTICE: Only rotate the crankshaft Clockwise (CW) or damage to the engine may occur.**

NOTICE: The drive lobe for the high-pressure fuel pump must be at BDC (bottom dead center) for the high-pressure fuel pump installation.

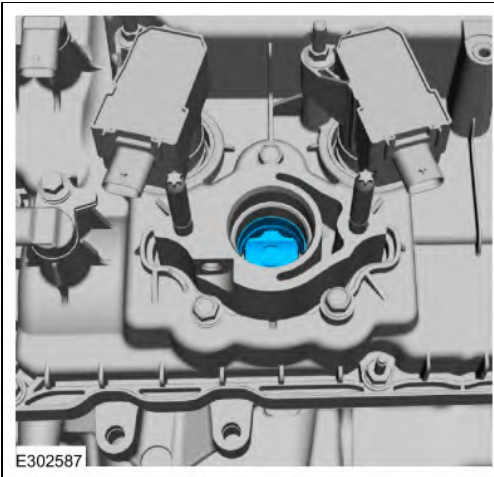
Using the crankshaft pulley bolt, turn the crankshaft until the high-pressure fuel pump drive lobe is at BDC (bottom dead center).



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

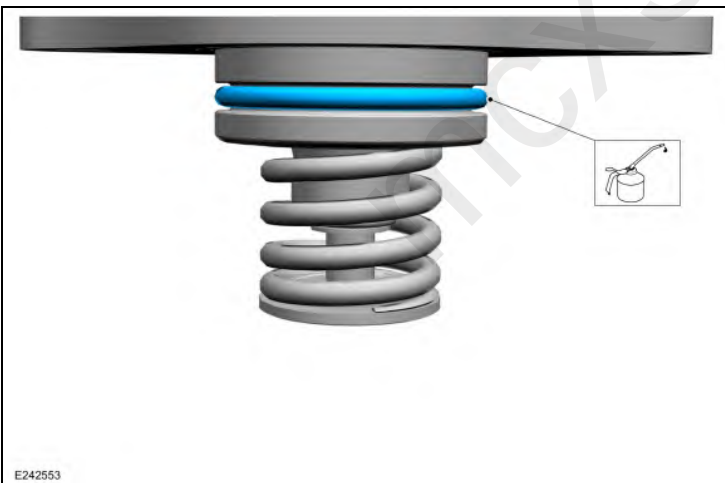


131. Install the high-pressure fuel pump roller tappet.



132. **NOTE:** Apply clean engine oil to the high-pressure fuel pump O-ring seals.

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

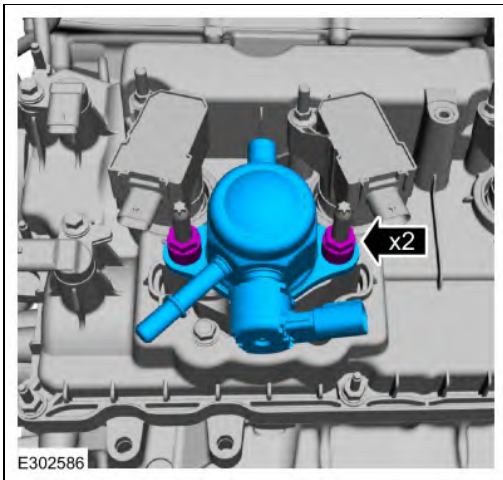


133. Install the high-pressure fuel pump, then install the mounting nuts finger tight. Alternately tighten each high-pressure fuel pump nut one complete revolution until seated. Tighten the fuel high-pressure fuel pump nuts in the following 2 stages.

Torque:

Stage 1: 177 lb.in (20 Nm)

Stage 2: 45Å°



134. **NOTICE:** In stage 4, if the torque required to tighten any flare nut on the new high-pressure fuel tube reaches or exceeds 37 lb ft (50 Nm), then that high pressure fuel tube must be discarded and replaced with another new high-pressure fuel tube.

NOTE: Calculate the correct torque wrench setting for the following torque using the Torque Wrench Adapter Formulas.

NOTE: Make sure that a new high-pressure fuel tube is installed.

Install the high-pressure fuel tube and bracket nuts, tighten the high-pressure fuel tube flare nuts and bracket nuts finger tight.

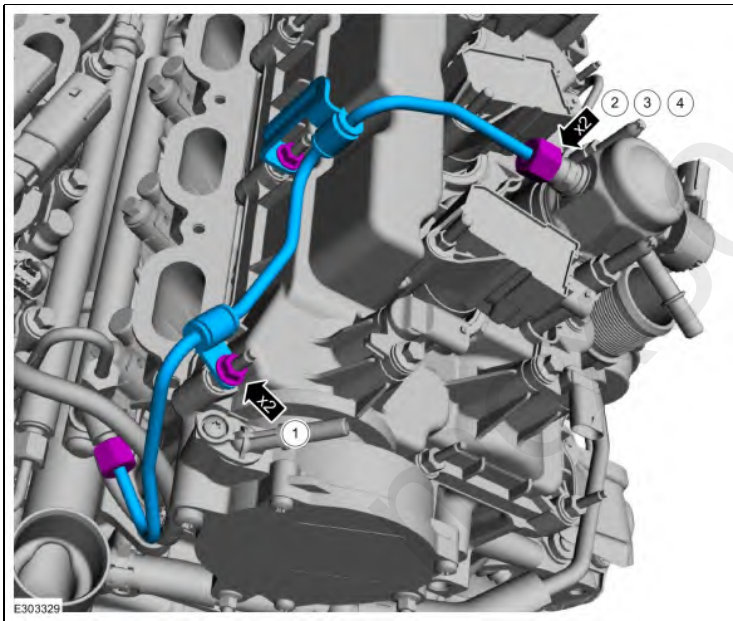
Torque:

Stage 1: Tighten the high-pressure fuel tube bracket nuts to : 89 lb.in (10 Nm)

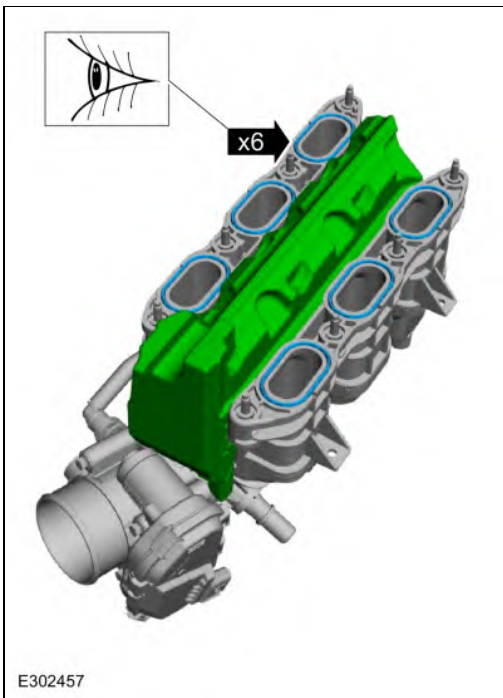
Stage 2: Tighten the high-pressure fuel tube flare nuts to : 62 lb.in (7 Nm)

Stage 3: Tighten the high-pressure fuel tube flare nuts to : 89 lb.in (10 Nm)

Stage 4: Tighten the high-pressure fuel tube flare nuts an additional : 25Å°

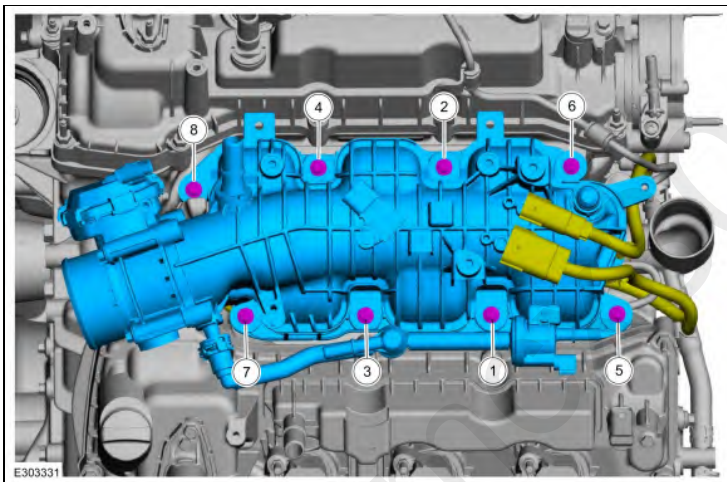


- 135.
- Install the gaskets.
 - Install the insulator.

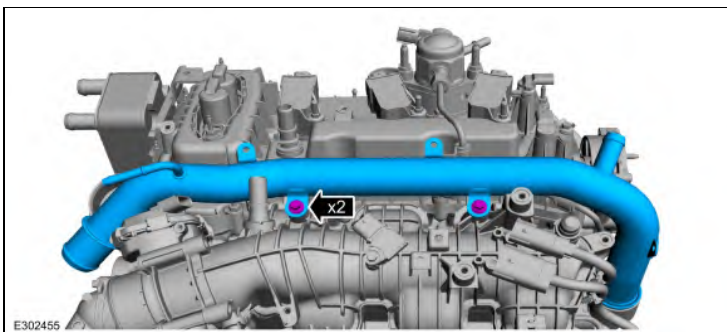


136. **NOTICE:** If the engine is repaired or replaced because of upper engine failure, typically including valve or piston damage, check the intake manifold for metal debris. If metal debris is found, install a new intake manifold. Failure to follow these instructions can result in engine damage.

Install the intake manifold and tighten the bolts.
Torque: 89 lb.in (10 Nm)



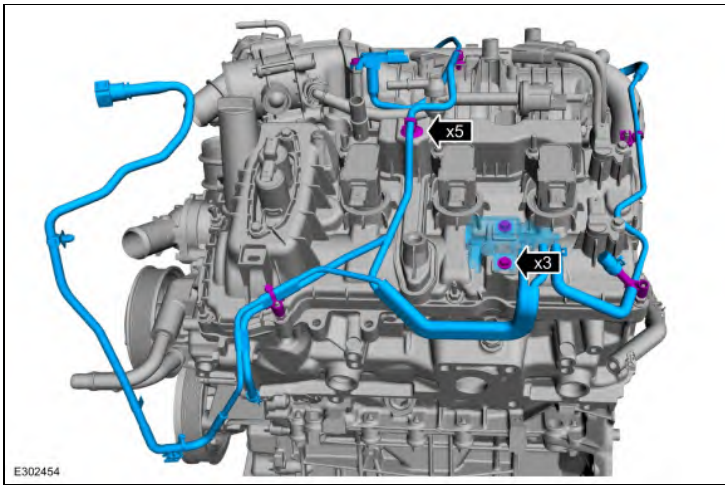
137. Install the coolant pipe and the bolts.
Torque: 97 lb.in (11 Nm)



138.

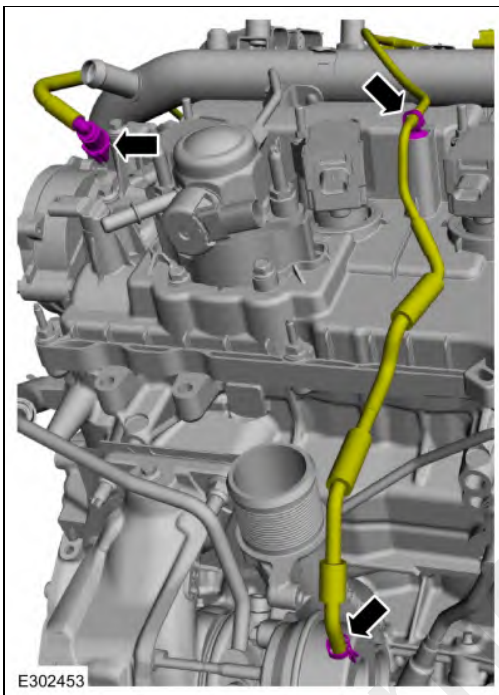
- Install the vacuum harness onto the engine.
- Attach the vacuum harness retainers.
- Install the bolts.

Torque: 62 lb.in (7 Nm)



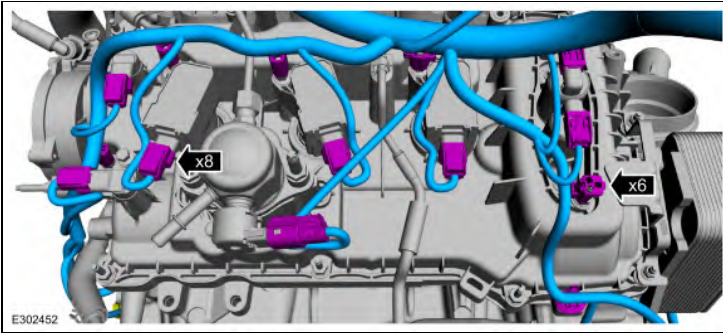
139.

- Connect the vacuum harness quick release coupling.
Refer to: Quick Release Coupling (310-00 Fuel System - General Information - 3.0L EcoBoost) .
- Attach the vacuum harness retainer.
- Install the vacuum hose and clamp.

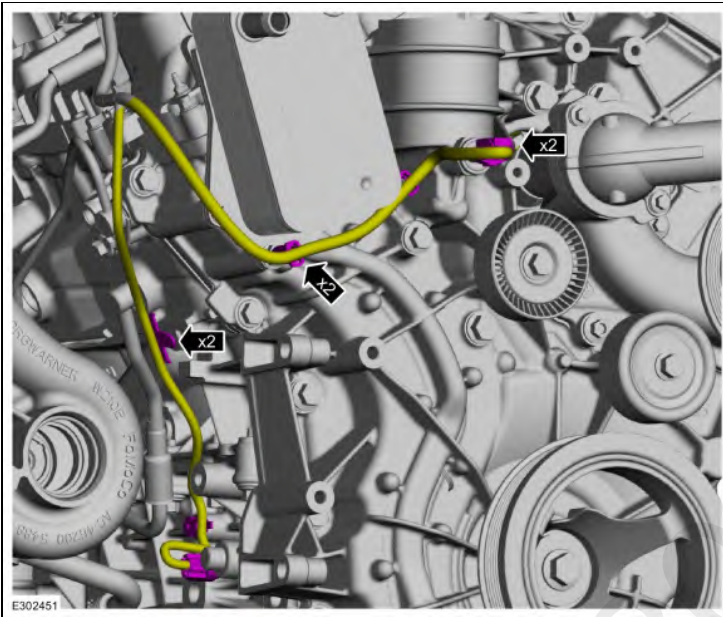


140.

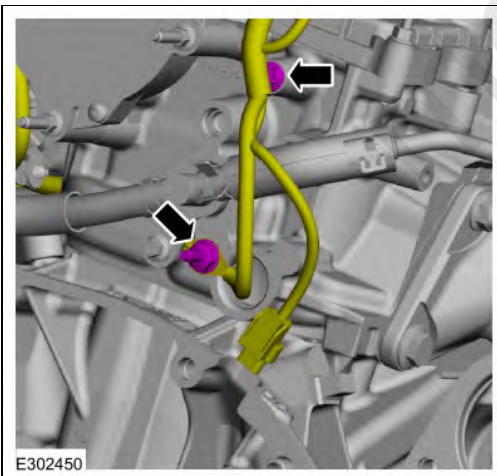
- Install the wiring harness onto the engine.
- Connect the wiring harness electrical connectors.
- Attach the wiring harness retainers.



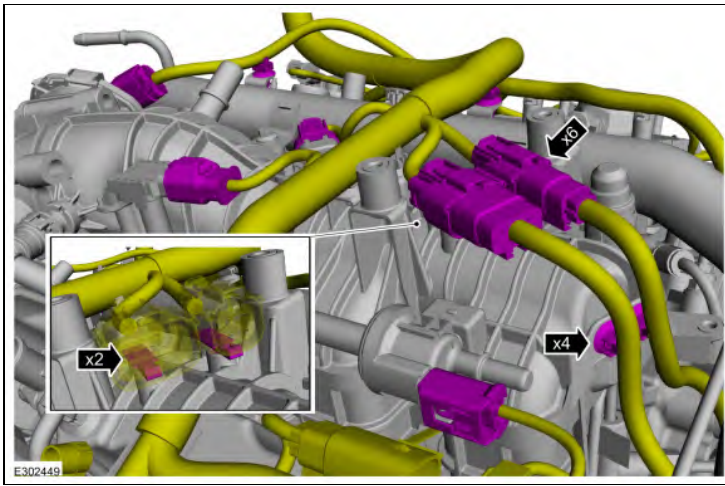
- 141.
- Attach the wiring harness retainers.
 - Connect the wiring harness electrical connectors.



- 142.
- Attach the wiring harness retainer.
 - Install the ground wire and stud bolt to the rear of the RH cylinder head.
Torque: 89 lb.in (10 Nm)

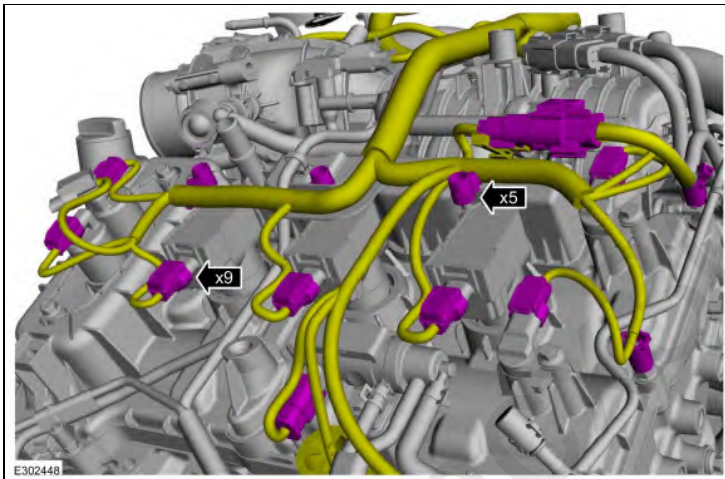


- 143.
- Attach the wiring harness retainers.
 - Connect the wiring harness electrical connectors.



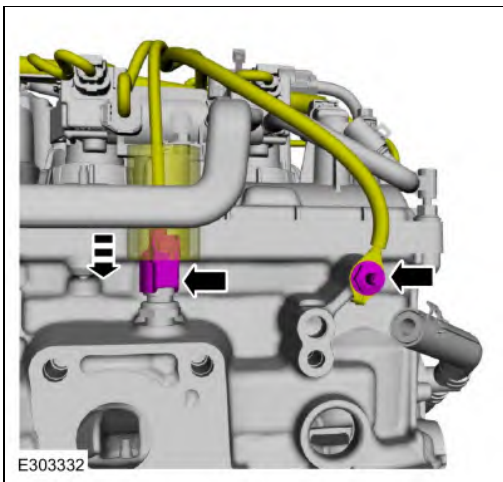
144.

- Attach the wiring harness retainers.
- Connect the wiring harness electrical connectors.

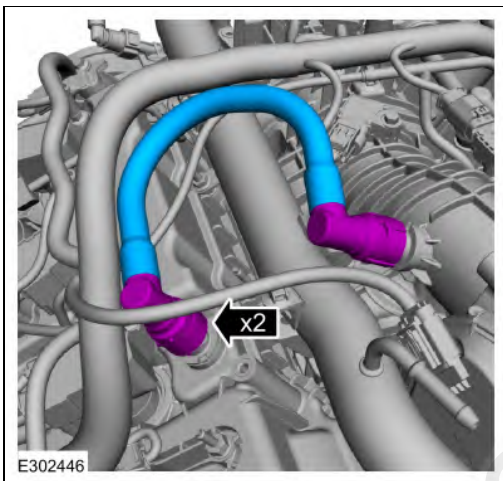


145.

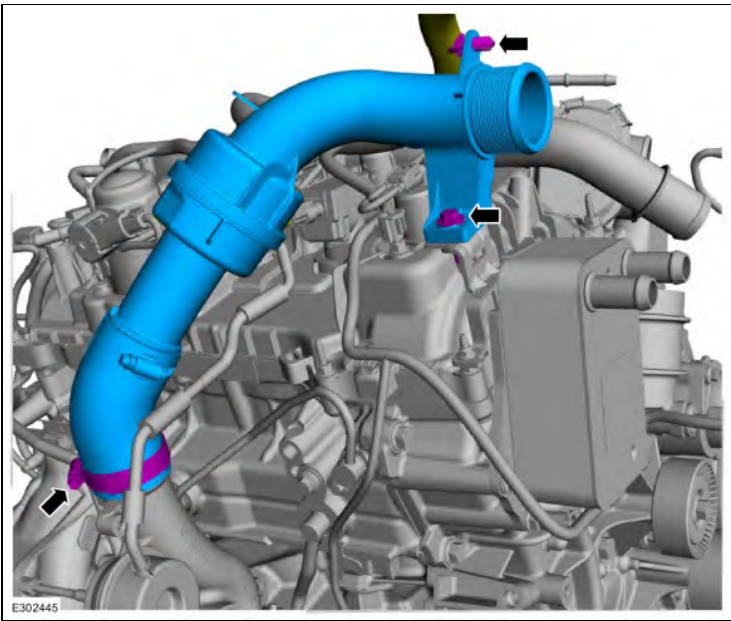
- Connect the CHT electrical connector.
- Slide the wiring harness insulator down.
- Install the ground wire and the stud bolt.
Torque: 89 lb.in (10 Nm)



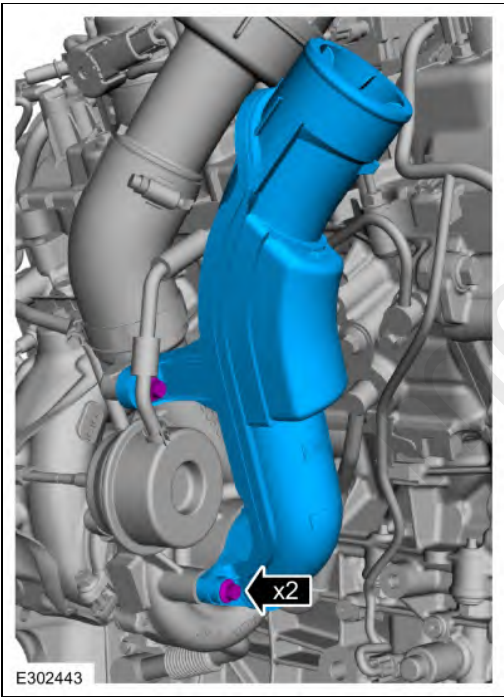
146. Install the crankcase vent tube and connect the quick release couplings.
Refer to: Quick Release Coupling (310-00 Fuel System - General Information - 3.0L EcoBoost) .



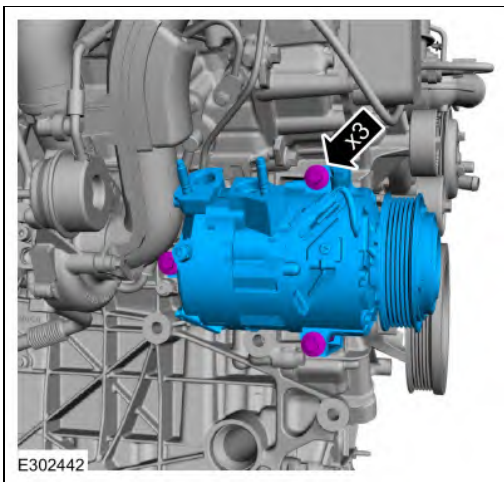
- 147.
- Install the CAC inlet pipe and tighten the clamp.
Torque: 42 lb.in (4.8 Nm)
 - Install the bolt.
Torque: 93 lb.in (10.5 Nm)
 - Attach the wiring harness retainer.



148. Install the air cleaner outlet pipe and the bolts.
Torque: 93 lb.in (10.5 Nm)

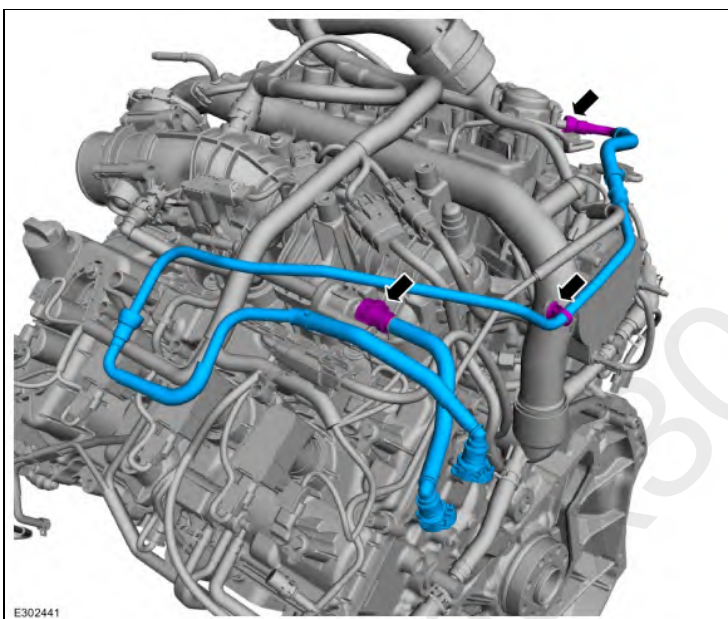


149. Install the A/C compressor and the bolts.
Torque: 18 lb.ft (25 Nm)

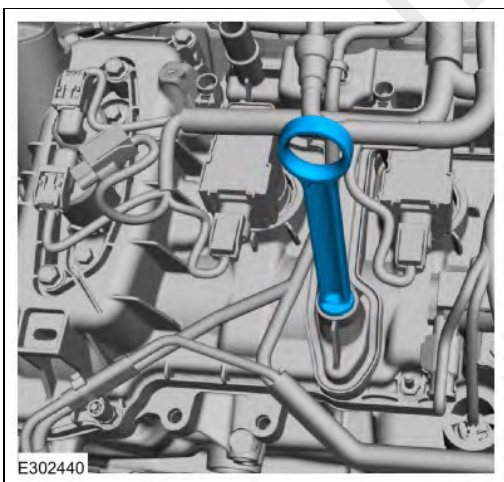


150.

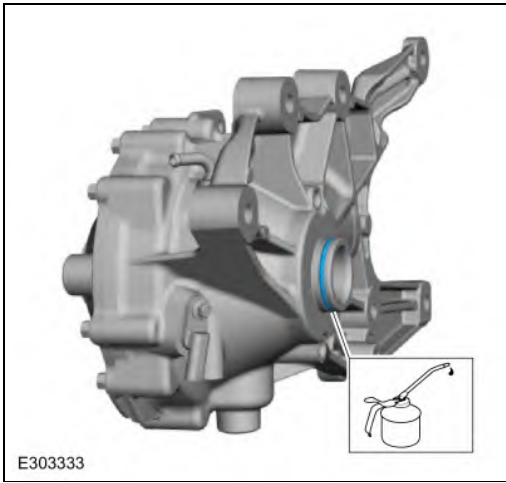
- Install the EVAP tube and connect the quick release coupling.
Refer to: Quick Release Coupling (310-00 Fuel System - General Information - 3.0L EcoBoost) .
- Install the fuel tube assembly and connect the quick release coupling.
Refer to: Quick Release Coupling (310-00 Fuel System - General Information - 3.0L EcoBoost) .
- Attach the fuel tube retainer.



151. Install the oil level indicator.

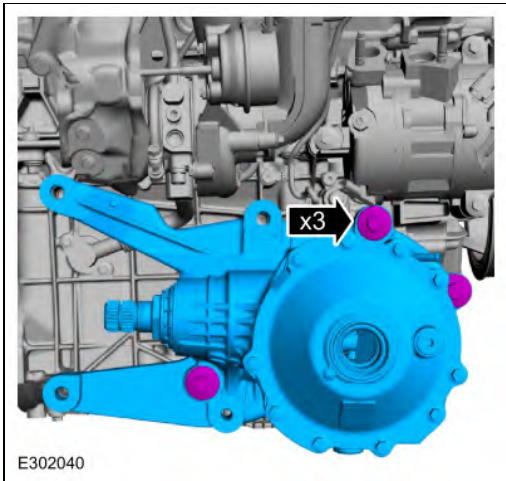


152. Install a new front axle assembly seal and lubricate with clean engine oil.

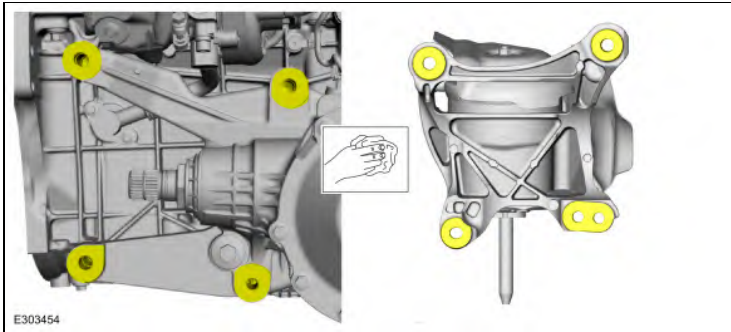


153.

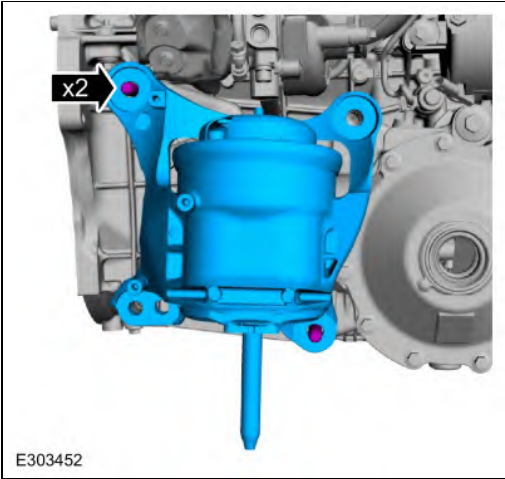
1. Clean the front axle assembly-to-cylinder block mating surfaces of any dirt or foreign material prior to installation.
 2. Install the front axle assembly and the bolts.
- Torque:*
 Stage 1: 66 lb.ft (90 Nm)
 Stage 2: 90Å°



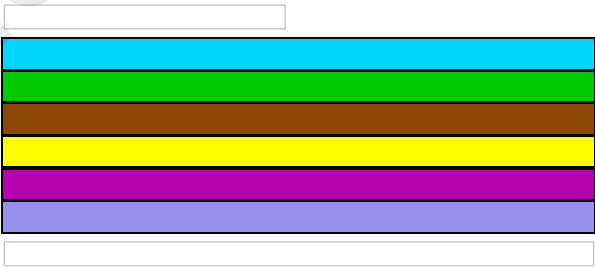
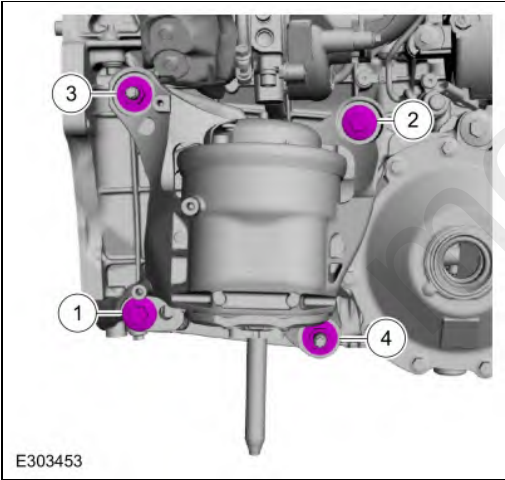
154. Clean the engine mount mating surfaces of any dirt or foreign material prior to installation.



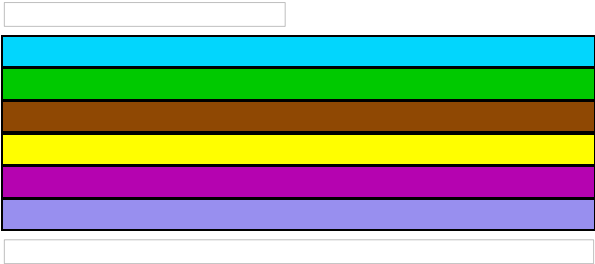
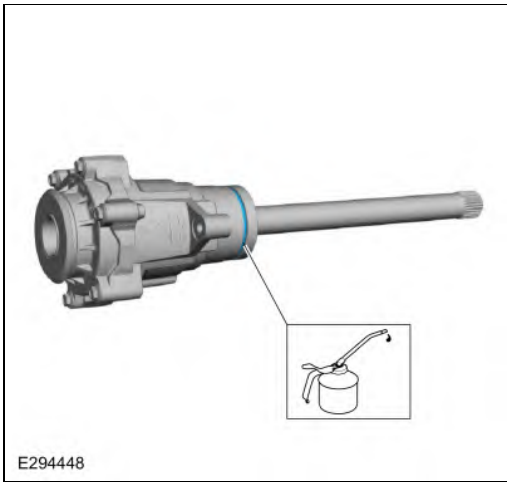
155. Position the RH engine mount and install the new studs.
Torque: 35 lb.ft (48 Nm)



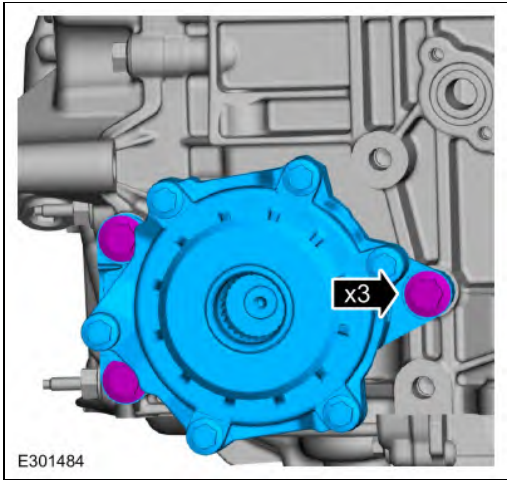
156. Install the new bolts and nuts finger-tight and then tighten in sequence.
Torque:
Stage 1: 66 lb.ft (90 Nm)
Stage 2: 90°



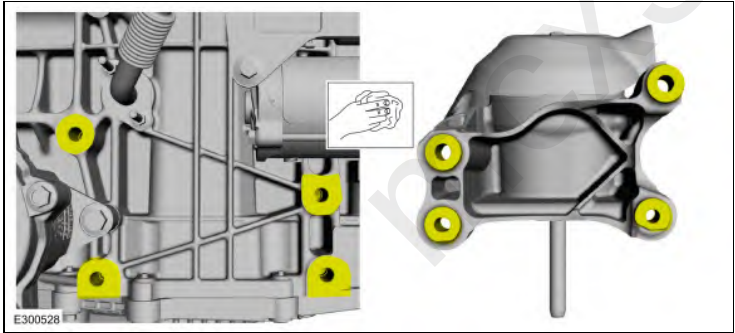
157. Install a new axle connector seal and lubricate with clean engine oil.



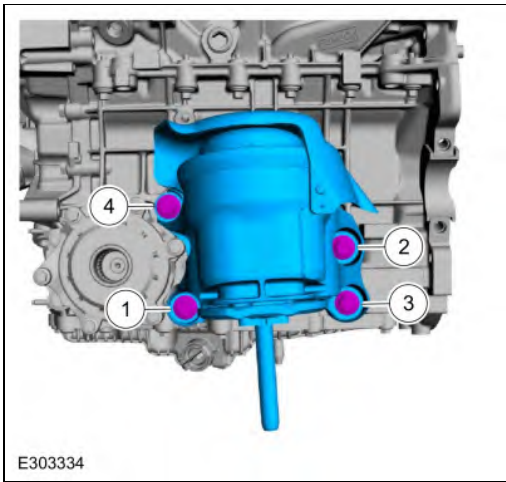
158. Install the front axle disconnect actuator and the bolts.
Torque: 26 lb.ft (35 Nm)



159. Clean the engine mount mating surfaces of any dirt or foreign material prior to installation.

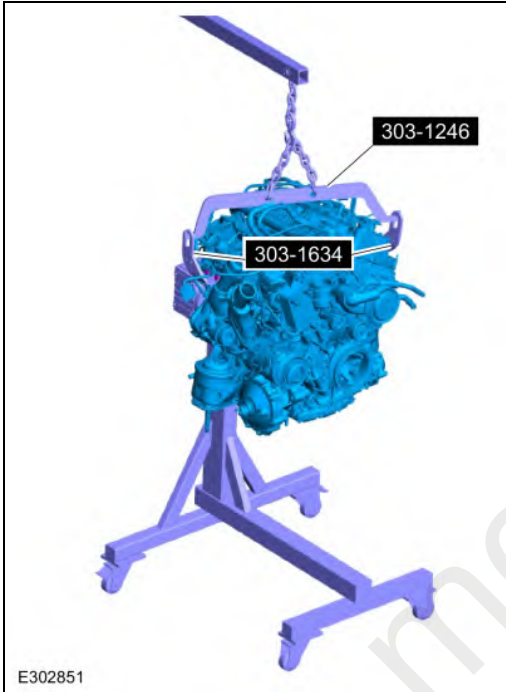


160. Install the LH engine mount, the new bolts finger-tight and then tighten in sequence.
Torque: 46 lb.ft (63 Nm)



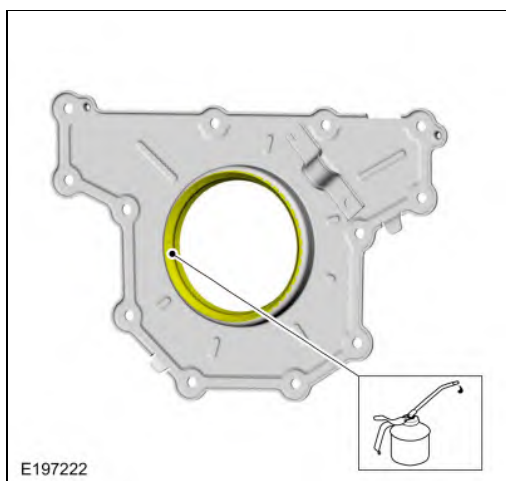
E303334

161. Using a floor crane, remove the engine from the mounting stand.
Install Special Service Tool: 303-1634 Lift Eyes (2). , 303-1246 Engine Spreader Bar.
Use the General Equipment: Floor Crane
Use the General Equipment: Mounting Stand



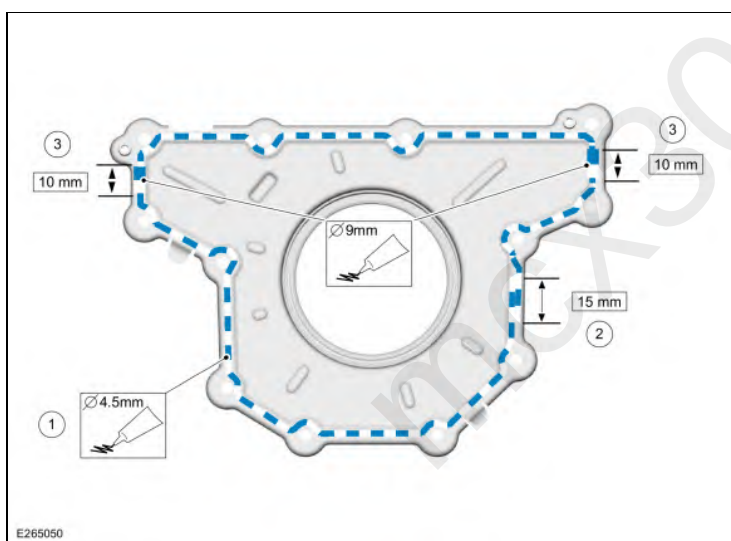
E302851

162. Lubricate the crankshaft rear seal lips with clean engine oil.



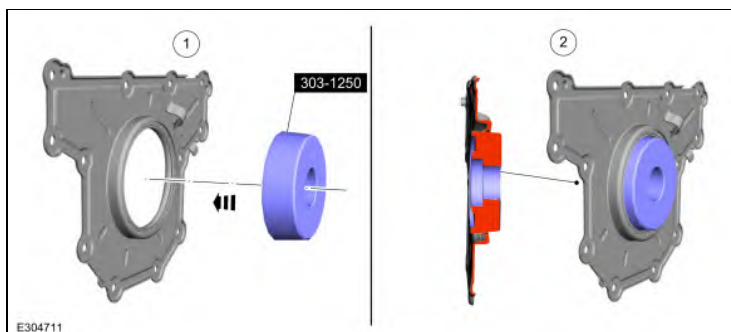
163. **NOTE:** The crankshaft rear seal and retainer plate must be installed within 10 minutes of applying the sealer and the bolts must be installed and tightened to 2-5 Nm (18-44 lb-in) within 15 of applying the sealer. Final tightening of the bolts must be completed within 60 minutes of applying the sealer. Failure to follow this procedure can cause future oil leakage.

1. Apply a 4.5 mm (0.18 in) bead of Motorcraft® High Performance Engine RTV Silicone to the crankshaft rear seal and retainer plate.
Material: Motorcraft® High Performance Engine RTV Silicone / TA-357 (WSE-M4G323-A6)
2. Overlap the beginning and ending of the sealant bead 15 mm (0.59 in).
Material: Motorcraft® High Performance Engine RTV Silicone / TA-357 (WSE-M4G323-A6)
3. Apply 9 mm (0.35 in) beads of Motorcraft® High Performance Engine RTV Silicone that are 10 mm (0.40 in) in length as indicated in the graphic.
Material: Motorcraft® High Performance Engine RTV Silicone / TA-357 (WSE-M4G323-A6)



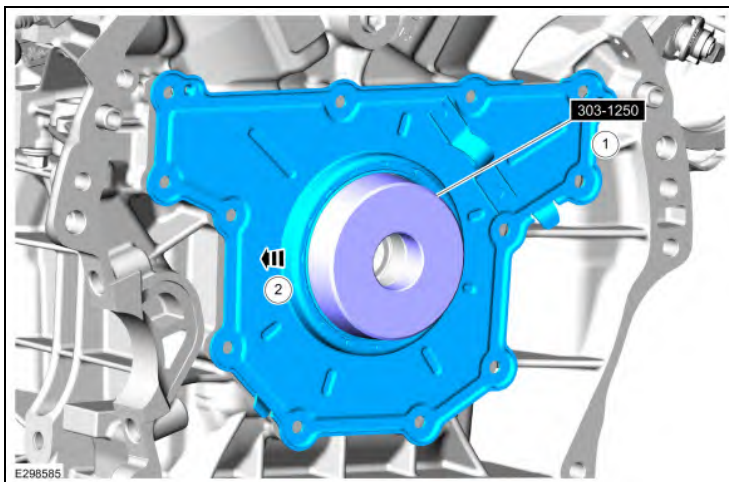
164. **NOTICE:** The special tool must be inserted into the rear of the crankshaft seal to prevent the seal lip from rolling backwards.

1. Insert the magnetic base of the special tool into the rear opening of the crankshaft seal.
Install Special Service Tool: 303-1250 Seal Installer, Rear Main.
2. The magnetic base of the special tool should protrude slightly from the front of the seal plate

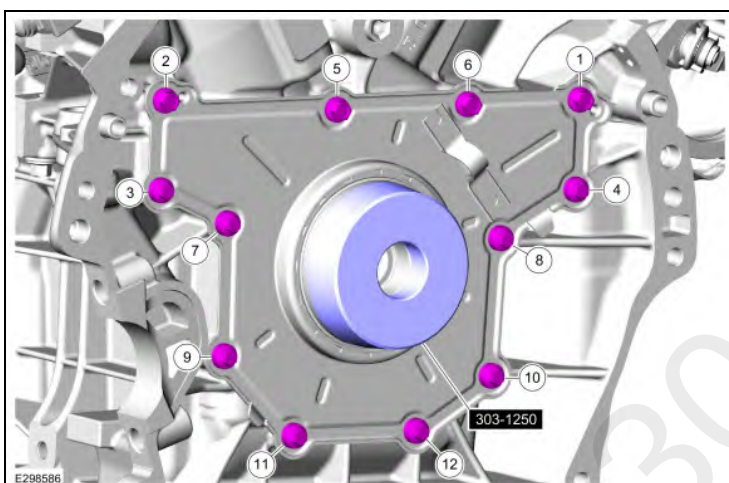


- 165.
- Position the special tool and seal plate onto the end of the crankshaft.
Use Special Service Tool: 303-1250 Seal Installer, Rear Main.

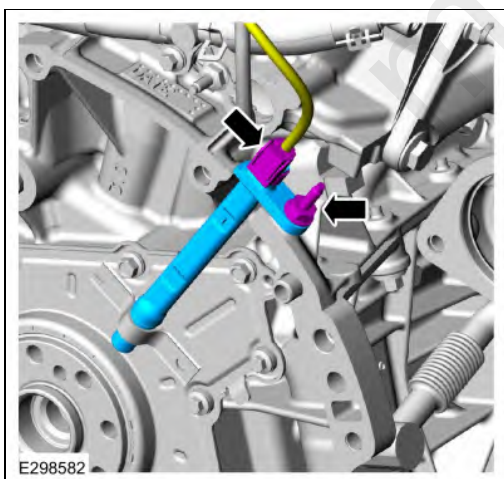
- Slide the new crankshaft rear seal and retainer plate onto the crankshaft and into the installed position.



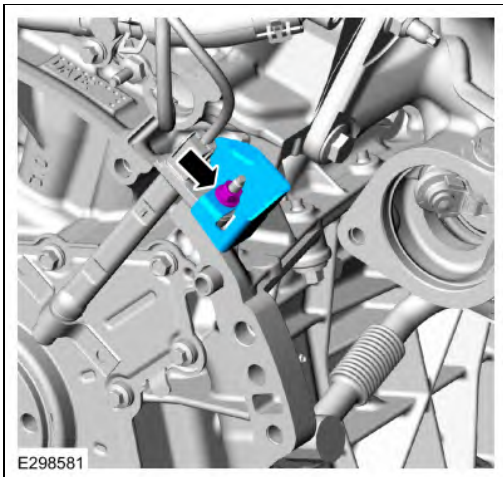
166. Install the crankshaft rear seal retainer plate bolts.
Remove Special Service Tool: 303-1250 Seal Installer, Rear Main.
Torque: 89 lb.in (10 Nm)



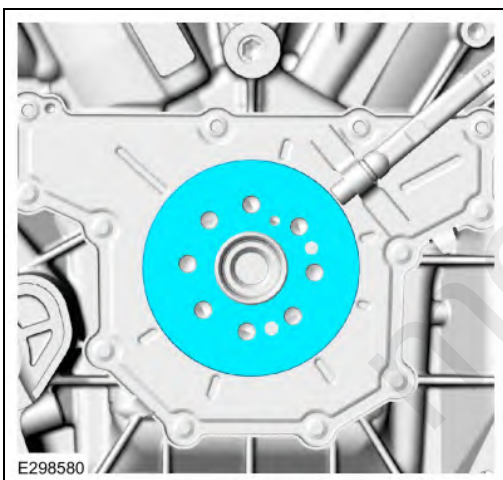
- 167.
1. Install the CKP sensor and the stud bolt.
Torque: 89 lb.in (10 Nm)
 2. Connect the CKP sensor electrical connector.



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

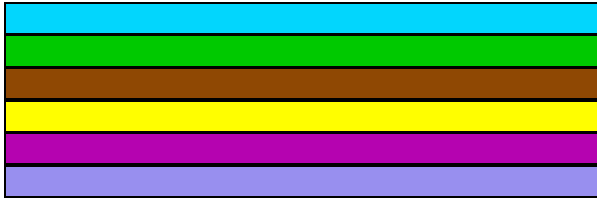
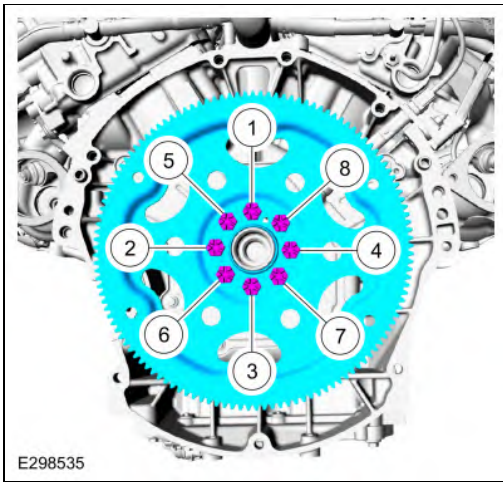


169. Install the crankshaft sensor ring.



170.

1. Position the flexplate on the crankshaft.
2. Install the bolts then rundown the bolts one turn at a time in sequence shown until the flexplate is snug against the rear face of the crankshaft.
3. Final tighten the bolts in sequence shown.
Torque: 59 lb.ft (80 Nm)



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Installation

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Engine

Special Tool(s) / General Equipment

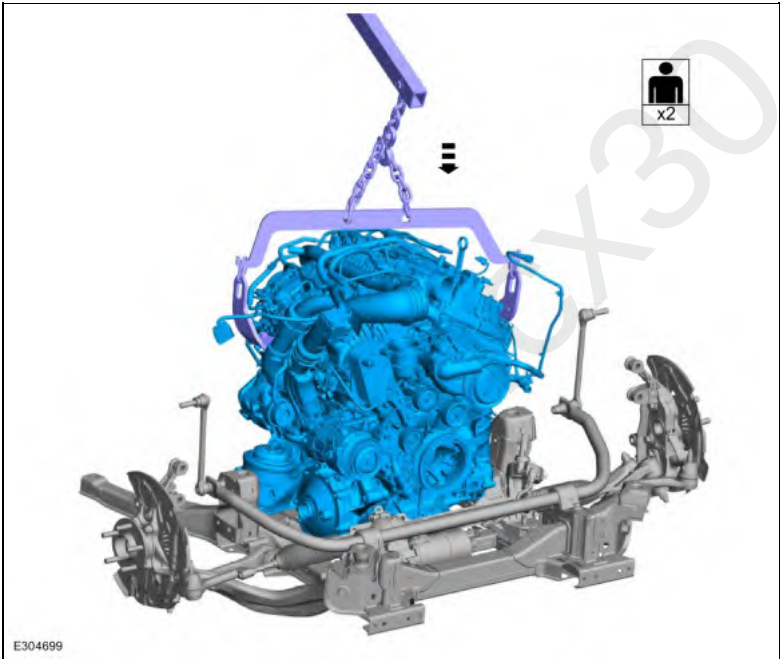
	303-1246 Engine Spreader Bar TKIT-2006UF-FLM TKIT-2006UF-ROW
	303-1634 Lift Eyes (2) TKIT-2014D-ROW3 TKIT-2014D-FL_ROW
Adjustable Mounting Arm	
Wooden Block	

Materials

Name	Specification
Motorcraft® Premium Long-Life Grease XG-1-E1	ESA-M1C75-B

NOTICE: The turbocharger compressor vanes can be damaged by even the smallest particles. When removing any turbocharger or engine air intake system component, ensure that no debris enters the system. Failure to do so may result in damage to the turbocharger.

1. Inspect the turbocharger or engine air intake system components and clean, if necessary.
2. With the aid of an assistant and using the floor crane and chain, install the engine on the subframe.



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