

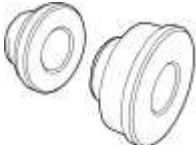







## Engine

### Special Tool(s) / General Equipment

 E234304	<a href="#">205-142</a> (T80T-4000-J) Installer, Differential Bearing Cone
 E133913	<a href="#">205-153</a> (T80T-4000-W) Handle
 E175042	<a href="#">303-1247</a> VCT Spark Plug Tube Seal Remover and Installer TKIT-2006UF-FLM TKIT-2006UF-ROW
 E274084	<a href="#">303-1250</a> Seal Installer, Rear Main TKIT-2006UFFLM
 E216458	<a href="#">303-1531</a> Installer, Front Crank Seal and Damper
 E222985	<a href="#">303-335</a> (T88T-6701-A) Installer, Front Cover Oil Seal TKIT-1988-FLM TKIT-1988-F
 E222985	<a href="#">303-448</a> (T93P-6303-A) Holding Tool, Crankshaft TKIT-1993-FLM TKIT-1993-LM
 E222985	<a href="#">303-F047</a> Lifting Bracket, Engine

Strap Wrench
Floor Crane
Mounting Stand
Clutch Alignment Tool
Piston Ring Compressor

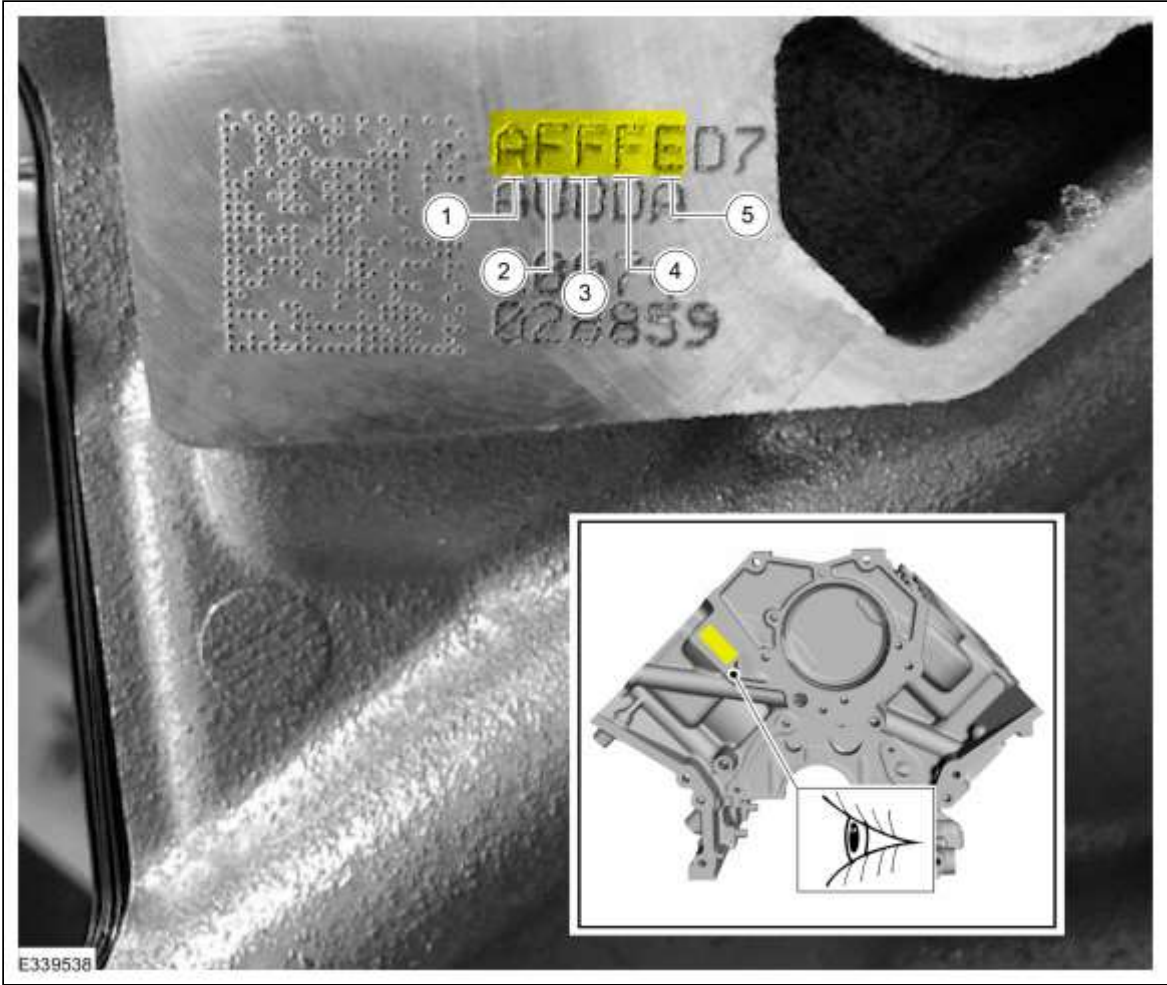
**Materials**

Name	Specification
Motorcraft® High Performance Engine RTV Silicone TA-357	WSE-M4G323-A6
Motorcraft® SAE 5W-50 Full Synthetic Motor Oil XO-5W50-QGT	WSS-M2C931-C
Motorcraft® Orange Concentrated Antifreeze/Coolant VC-3-B	WSS-M97B44-D

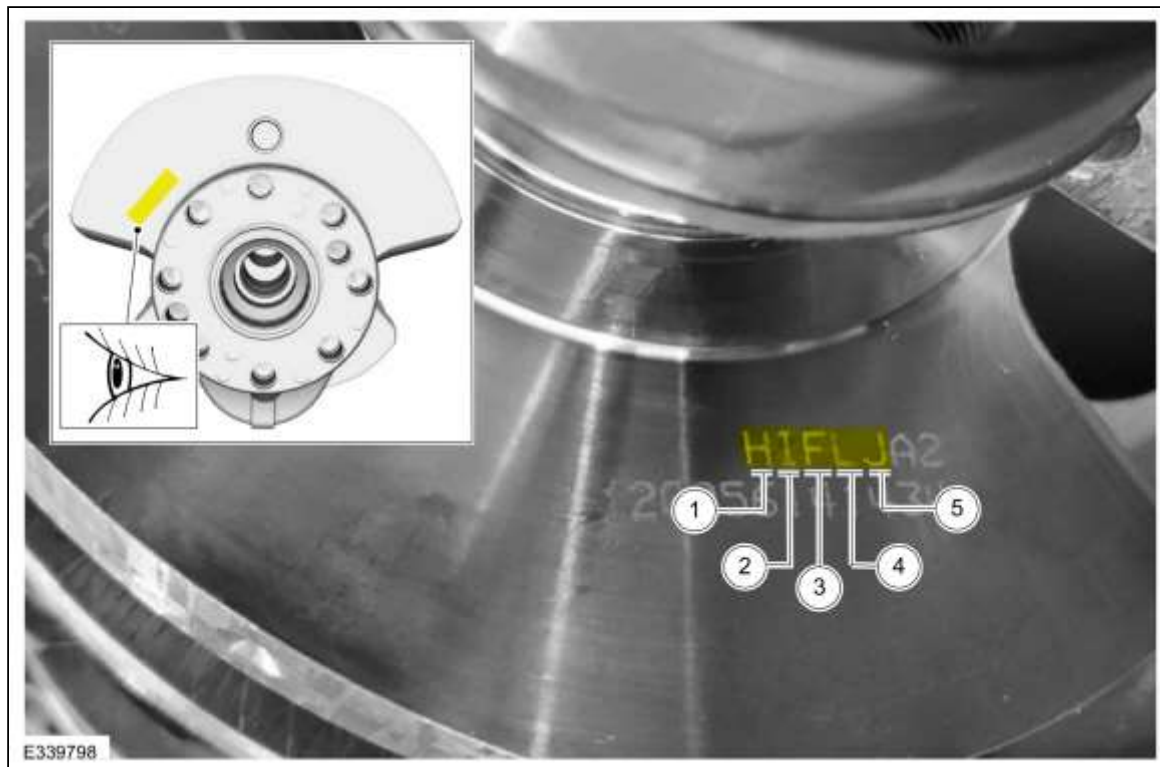
**NOTICE:** During engine repair procedures, cleanliness is extremely important. Any foreign material, including any material created while cleaning gasket surfaces, that enters the oil passages, coolant passages or the oil pan, can cause engine failure.

**NOTE:** During engine assembly it may become necessary to check bearing clearances and end play. Refer to Section 303-00.

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



- Record the main bearing code found on the rear of the crankshaft.






3. **NOTE:** This chart is for selecting main bearings 1 and 5 only, the remaining bearings will be selected using a different chart in the next step.

Using the data recorded earlier and the Bearing Select Fit Chart, Standard Bearings, determine the required bearing grade for main bearings 1 and 5.

- 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 "F" and the crankshaft code letter is "P", the correct bearing grade for this main bearing is a "1" for the upper bearing and a "2" for the lower bearing.
- Repeat the above steps using the fifth letter of the block and crankshaft codes to select the No. 5 bearing.






MAINS 1 & 5

UPPER/LOWER

# MINIMUM BLOCK DIA

MAXIMUM CRANKSHAFT DIA

		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	
		72.400	.401	.402	.403	.404	.405	.406	.407	.408	.409	.410	.411	.412	.413	.414	.415	.416	.417	.418	.419	.420	.421	.422	.423	.424
X	67.505	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	1/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2
W	67.504	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	1/2	1/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/3
V	67.503	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	1/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/3
U	67.502	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	1/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/3
T	67.501	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	1/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/3
S	67.500	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	1/2	1/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/3
R	67.499	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	1/2	1/2	1/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/3
Q	67.498	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	1/2	1/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/3
P	67.497	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	1/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/3
O	67.496	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	1/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/3
N	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	1/2	1/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/3
M	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	1/2	1/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/3
L	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	1/2	1/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/3
K	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	1/2	1/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/3
J	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	1/2	1/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/3
I	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	1/2	1/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/3
H	67.489	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/3
G	67.488	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/3
F	67.487	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/3
E	67.486	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/3
D	67.485	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/3
C	67.484	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/3
B	67.483	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/3
A	67.482	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/3
E189475	67.481	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/2	2/3

4. **NOTE:** This chart is for selecting main bearings 2, 3 and 4 only.

Using the data recorded earlier and the Bearing Select Fit Chart, Standard Bearings, determine the required bearing grade for main bearings 2, 3 and 4.

- Read the second letter of the engine block main bearing code and the second 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. 2 crankshaft main bearing
- As an example, if the engine block code letter is "F" and the crankshaft code letter is "P", the correct bearing grade for this main bearing is a "1" for the upper bearing and a "2" for the lower bearing
- Repeat the above steps using the third and fourth letters of the block and crankshaft codes to select the No. 3 and No. 4 bearings.

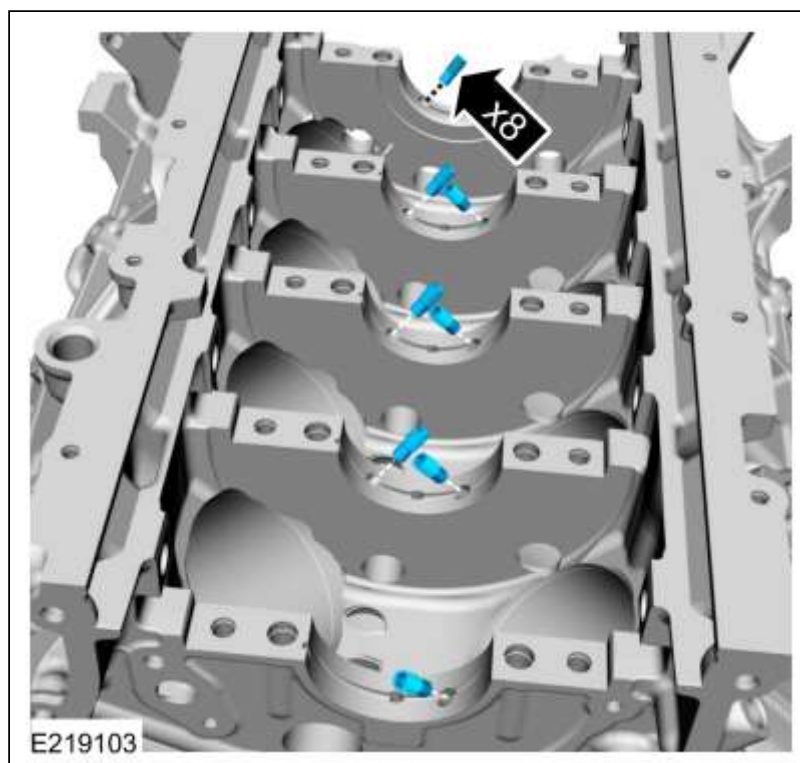




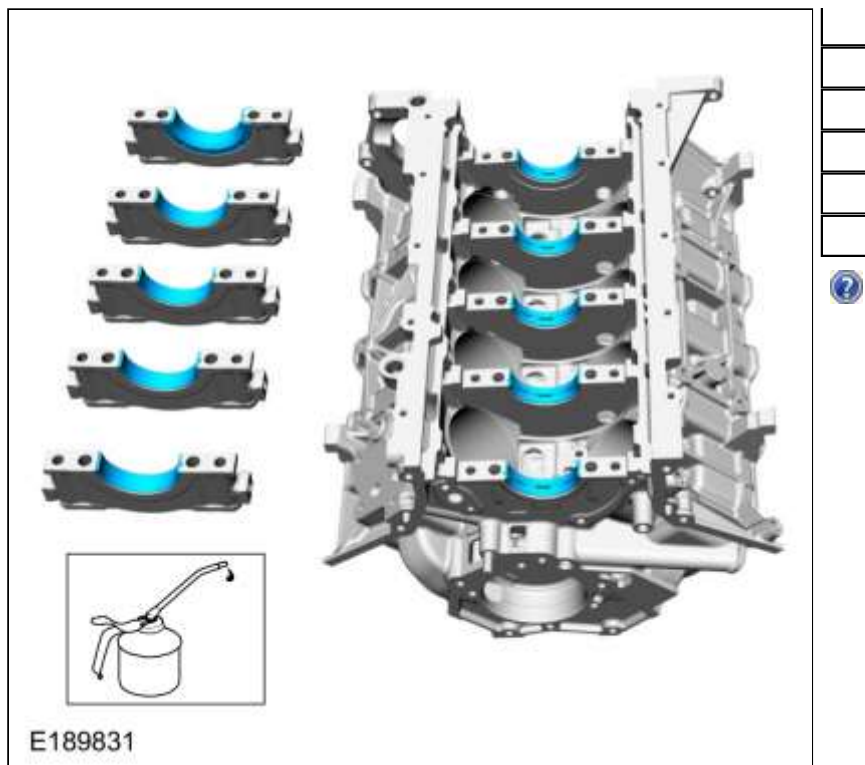



MAINS 2, 3 & 4			MINIMUM BLOCK DIA																								
UPPER/LOWER			A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	
			72.400	.401	.402	.403	.404	.405	.406	.407	.408	.409	.410	.411	.412	.413	.414	.415	.416	.417	.418	.419	.420	.421	.422	.423	.424
MAXIMUM CRANKSHAFT DIA	X	67.505	1/1	1/1	1/1	1/1	1/1	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	1/2	1/2	2/2	2/2	2/2	2/2
	W	67.504	1/1	1/1	1/1	1/1	1/1	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	1/2	1/2	2/2	2/2	2/2	2/2
	V	67.503	1/1	1/1	1/1	1/1	1/1	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	1/2	1/2	2/2	2/2	2/2	2/2
	U	67.502	1/1	1/1	1/1	1/1	1/1	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	1/2	2/2	2/2	2/2	2/2	2/2
	T	67.501	1/1	1/1	1/1	1/1	1/1	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	1/2	2/2	2/2	2/2	2/2	2/2
	S	67.500	1/1	1/1	1/1	1/1	1/1	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	1/2	2/2	2/2	2/2	2/2	2/2
	R	67.499	1/1	1/1	1/1	1/1	1/1	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	1/2	2/2	2/2	2/2	2/2	2/2
	Q	67.498	1/1	1/1	1/1	1/1	1/1	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	1/2	2/2	2/2	2/2	2/2	2/2
	P	67.497	1/1	1/1	1/1	1/1	1/1	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	1/2	2/2	2/2	2/2	2/2	2/2
	O	67.496	1/1	1/1	1/1	1/1	1/1	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	1/2	2/2	2/2	2/2	2/2	2/2
	N	67.495	1/1	1/1	1/1	1/1	1/1	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	1/2	2/2	2/2	2/2	2/2	2/2
	M	67.494	1/1	1/1	1/1	1/1	1/1	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	1/2	2/2	2/2	2/2	2/2	2/2
	L	67.493	1/1	1/1	1/1	1/1	1/1	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	1/2	2/2	2/2	2/2	2/2	2/2
	K	67.492	1/1	1/1	1/1	1/1	1/1	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	1/2	2/2	2/2	2/2	2/2	2/2
	J	67.491	1/1	1/1	1/1	1/1	1/1	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	1/2	2/2	2/2	2/2	2/2	2/2
	I	67.490	1/1	1/1	1/1	1/1	1/1	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	1/2	2/2	2/2	2/2	2/2	2/2
	H	67.489	1/1	1/1	1/1	1/1	1/1	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	1/2	2/2	2/2	2/2	2/2	2/2
	G	67.488	1/1	1/1	1/1	1/1	1/1	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	1/2	2/2	2/2	2/2	2/2	2/2
	F	67.487	1/1	1/1	1/1	1/1	1/1	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	1/2	2/2	2/2	2/2	2/2	2/2
	E	67.486	1/1	1/1	1/1	1/1	1/1	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	1/2	2/2	2/2	2/2	2/2	2/2
	D	67.485	1/1	1/1	1/1	1/1	1/1	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	1/2	2/2	2/2	2/2	2/2	2/2
	C	67.484	1/1	1/1	1/1	1/1	1/1	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	1/2	2/2	2/2	2/2	2/2	2/2
	B	67.483	1/1	1/1	1/1	1/1	1/1	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	1/2	2/2	2/2	2/2	2/2	2/2
	A	67.482	1/1	1/1	1/1	1/1	1/1	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	1/2	2/2	2/2	2/2	2/2	2/2
	E189476	67.481	1/1	1/1	1/1	1/1	1/1	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	1/2	2/2	2/2	2/2	2/2	2/2

5. Install the piston cooling jets and bolts.  
Torque: 18 lb.in (2 Nm)



6. Install the crankshaft main bearings.
- Install the crankshaft upper main bearings into the cylinder block.
  - Install the crankshaft lower main bearings and thrust bearing into the bearing caps.
  - Make sure all oil passages are aligned.
  - Lubricate all main bearings with clean engine oil.
- Material:* Motorcraft® SAE 5W-50 Full Synthetic Motor Oil / XO-5W50-QGT (WSS-M2C931-C)



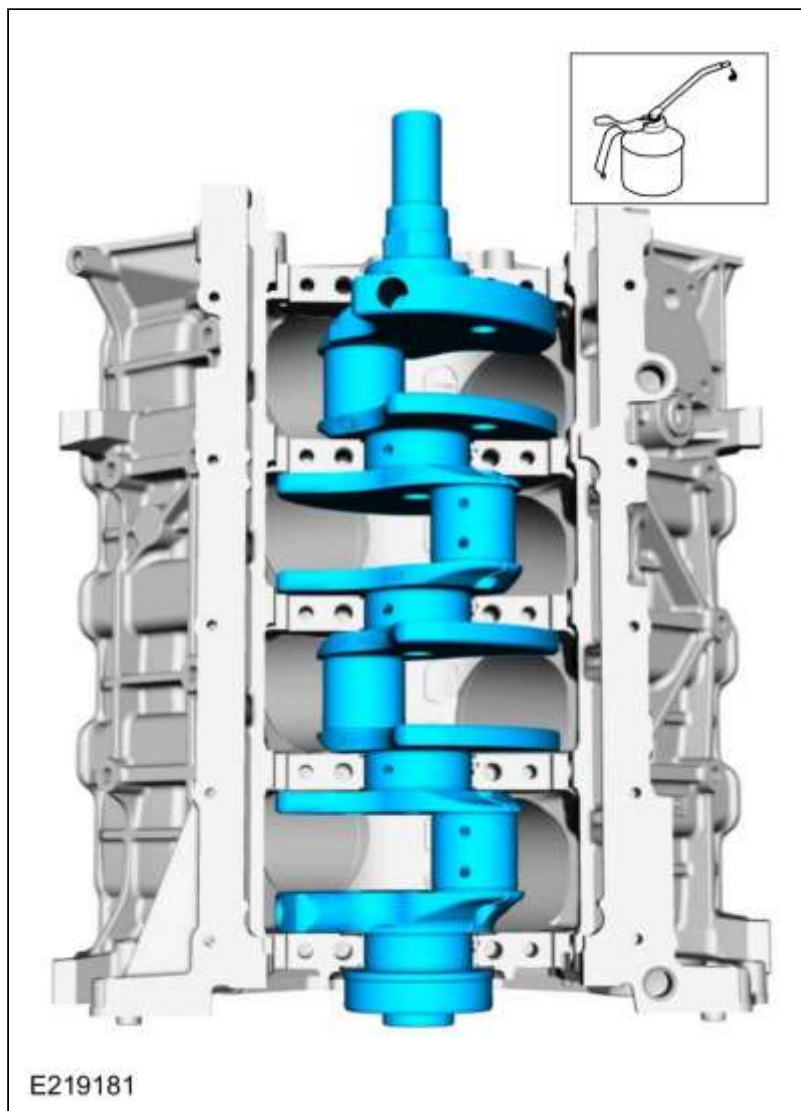
7. **NOTE:** Lubricate the crankshaft bearing journals with clean engine oil.

Install the crankshaft into the cylinder block.

*Material:* Motorcraft® SAE 5W-50 Full Synthetic Motor Oil / XO-5W50-QGT (WSS-M2C931-C)





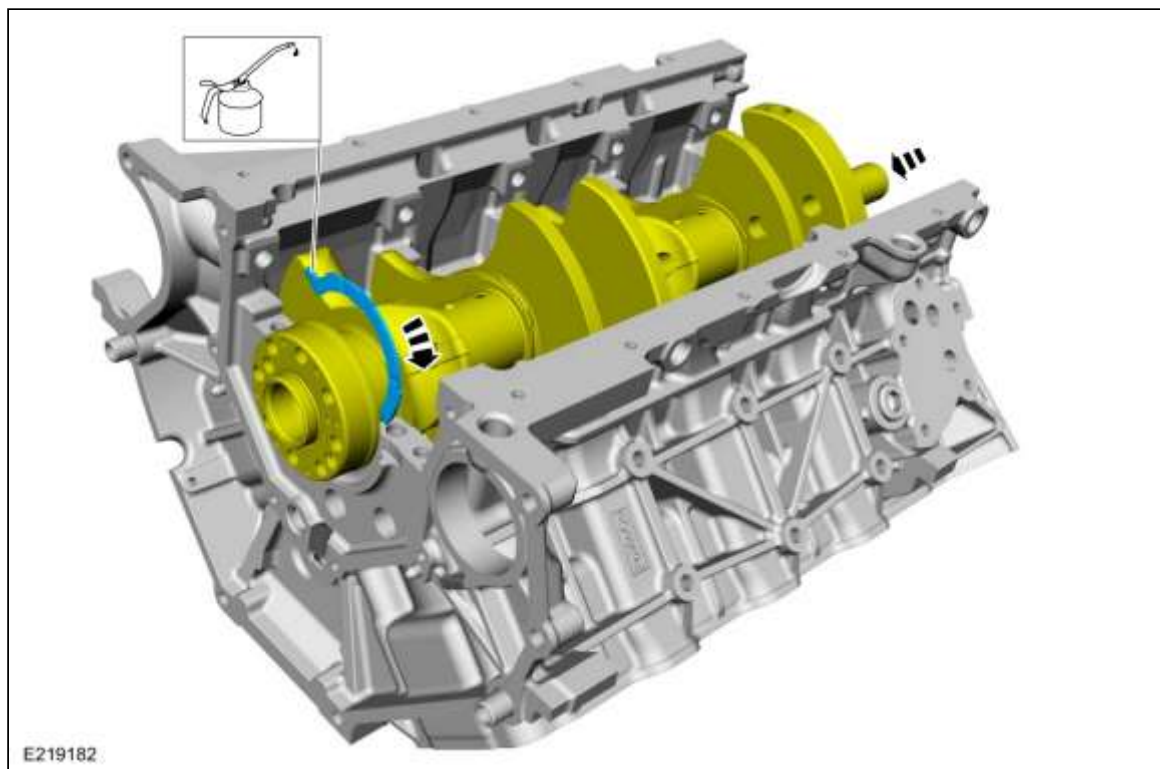



8. **NOTE:** The oil groove on the thrust washer must face toward the rear of the engine (against the crankshaft thrust surface).

**NOTE:** Lubricate the thrust washer with clean engine oil.

Push the crankshaft rearward and install the rear crankshaft upper thrust washer at the back of the No. 5 main boss.  
**Material:** Motorcraft® SAE 5W-50 Full Synthetic Motor Oil / XO-5W50-QGT (WSS-M2C931-C)





9. **NOTE:** *Lubricate the fastener threads with clean engine oil.*

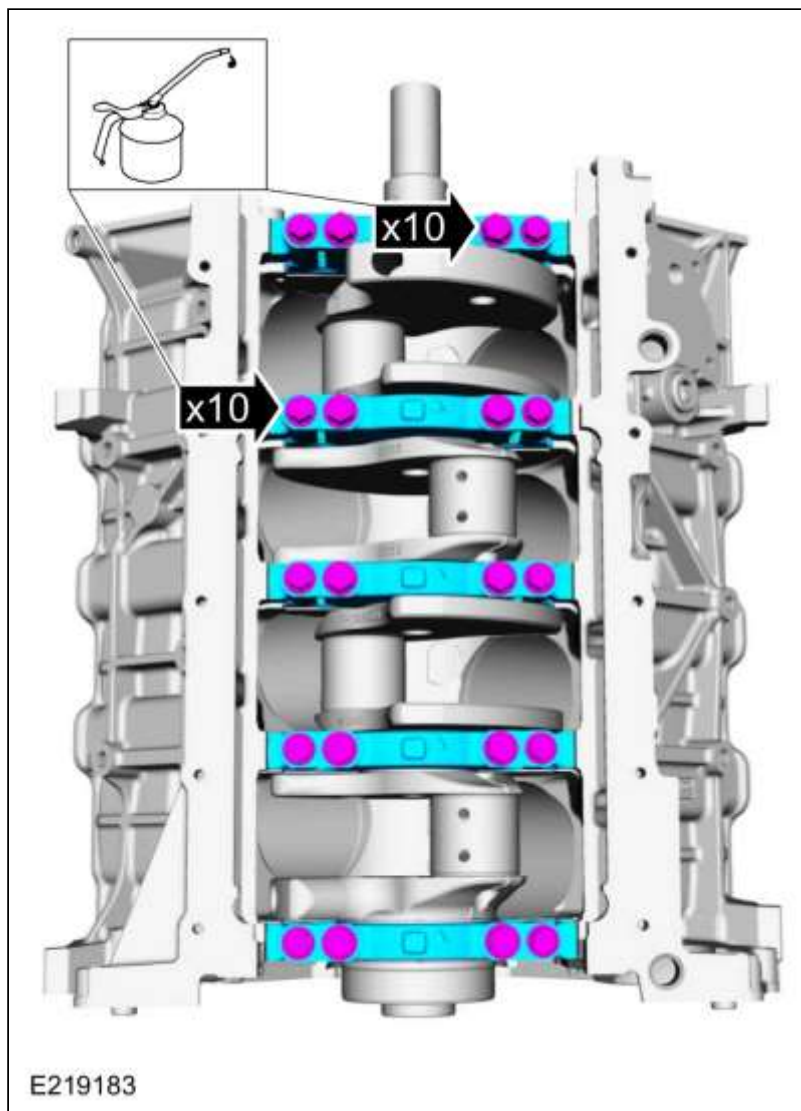
Install the main bearing caps and fasteners on the cylinder block and, keeping the caps as square as possible, alternately draw the caps down evenly using the cap fasteners.

*Material:* Motorcraft® SAE 5W-50 Full Synthetic Motor Oil / XO-5W50-QGT (WSS-M2C931-C)

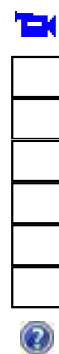


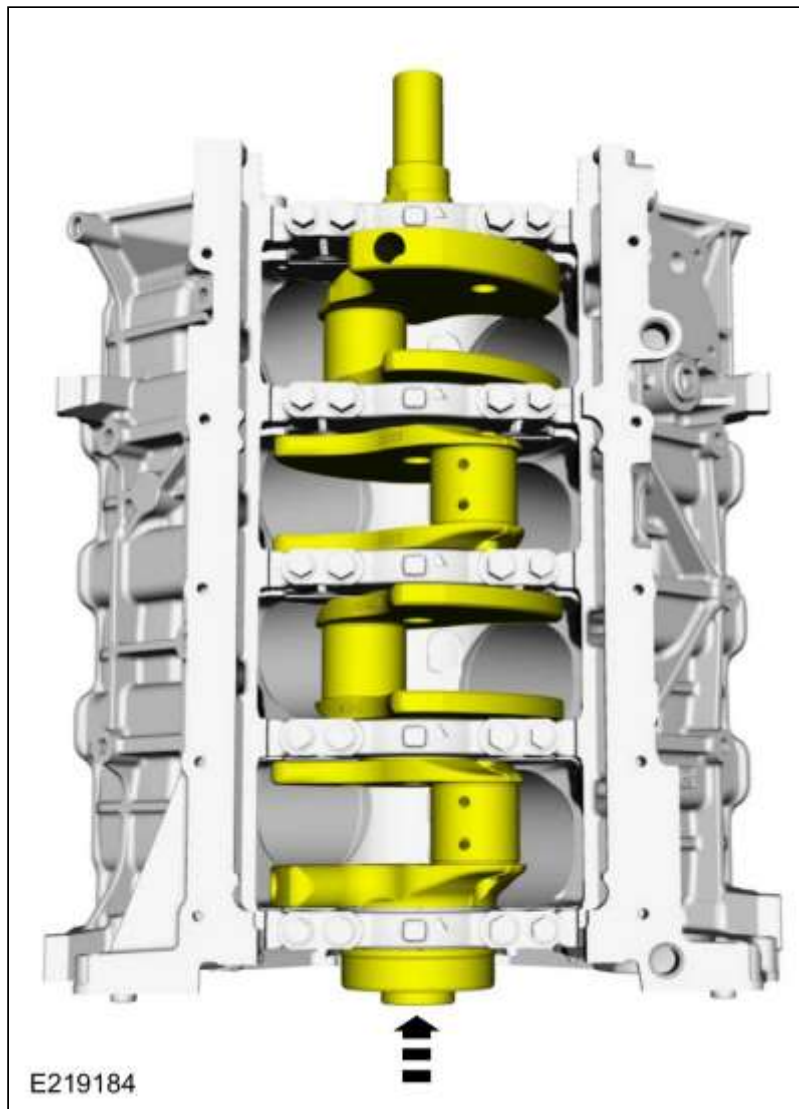




10. Push the crankshaft forward to seat the crankshaft thrust washer.





11. Tighten the vertical main bearing cap fasteners.

*Torque:*

Stage 1: 1 through 20: 177 lb.in (20 Nm)

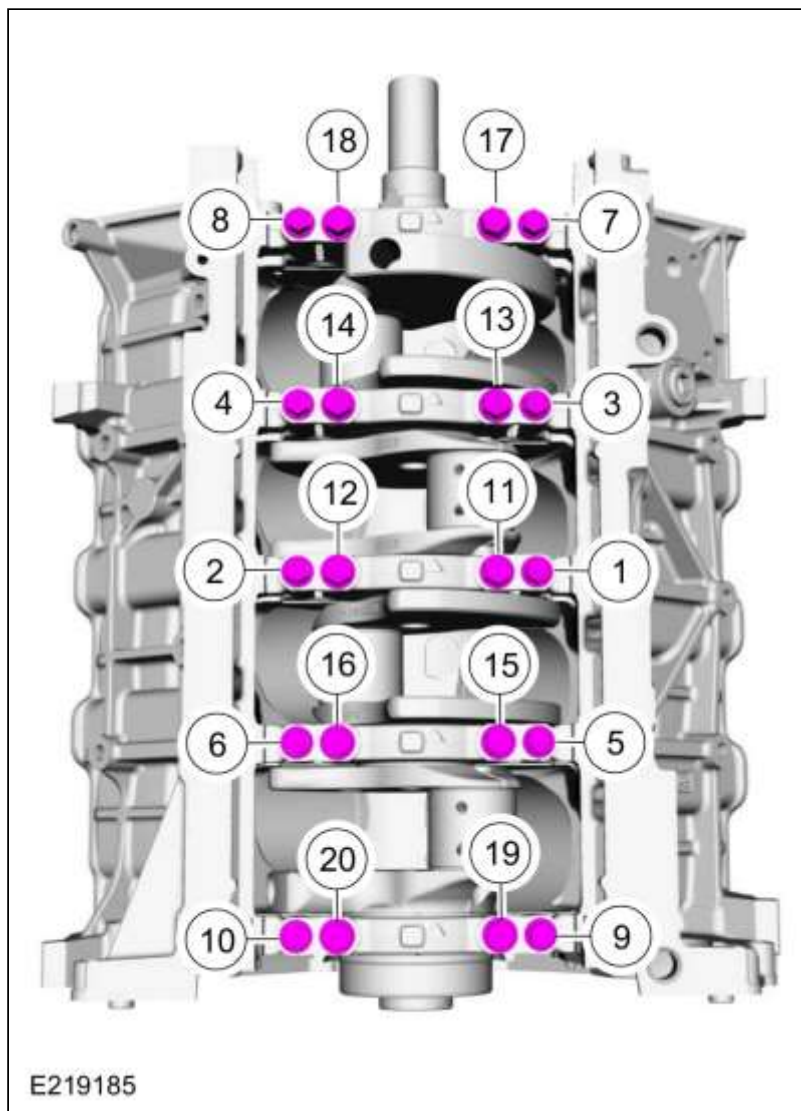
Stage 2: 1 through 10: 30 lb.ft (40 Nm)

Stage 3: 11 through 20 : 48 lb.ft (65 Nm)

Stage 4: 1 through 20: 90°





12. Install the cross-mounted main bearing cap fasteners.

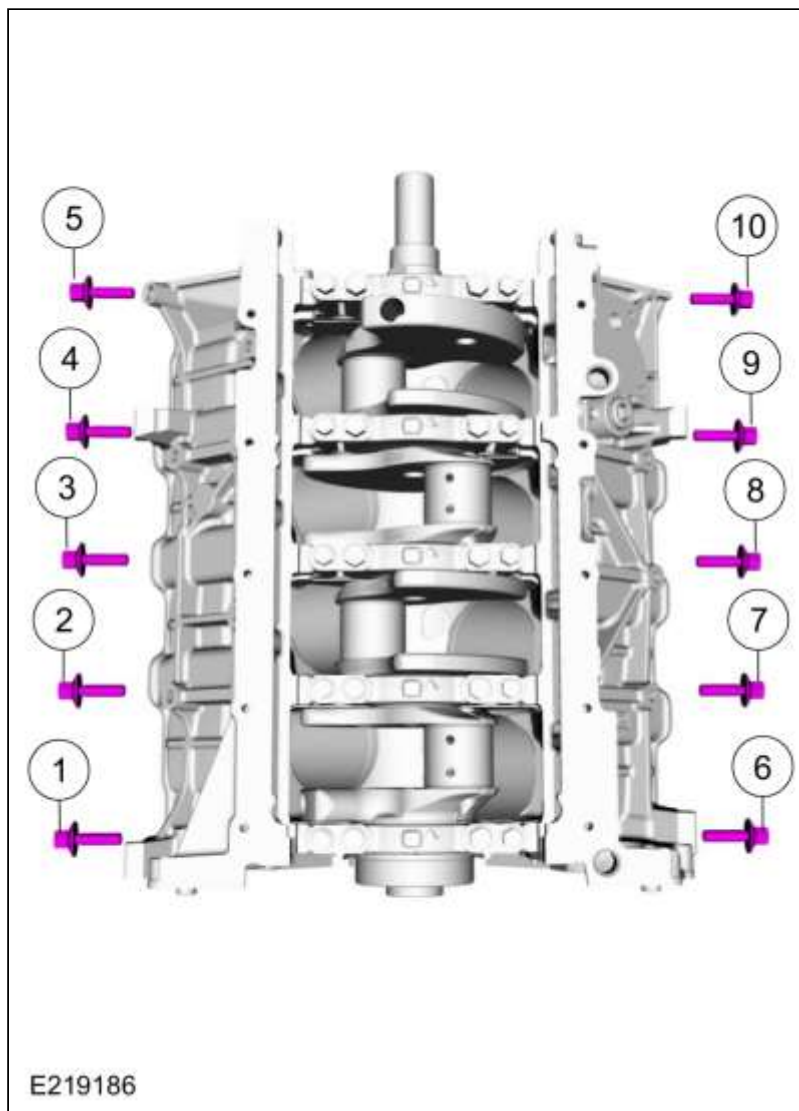
*Torque:*

Stage 1: 22 lb.ft (30 Nm)

Stage 2: 60°



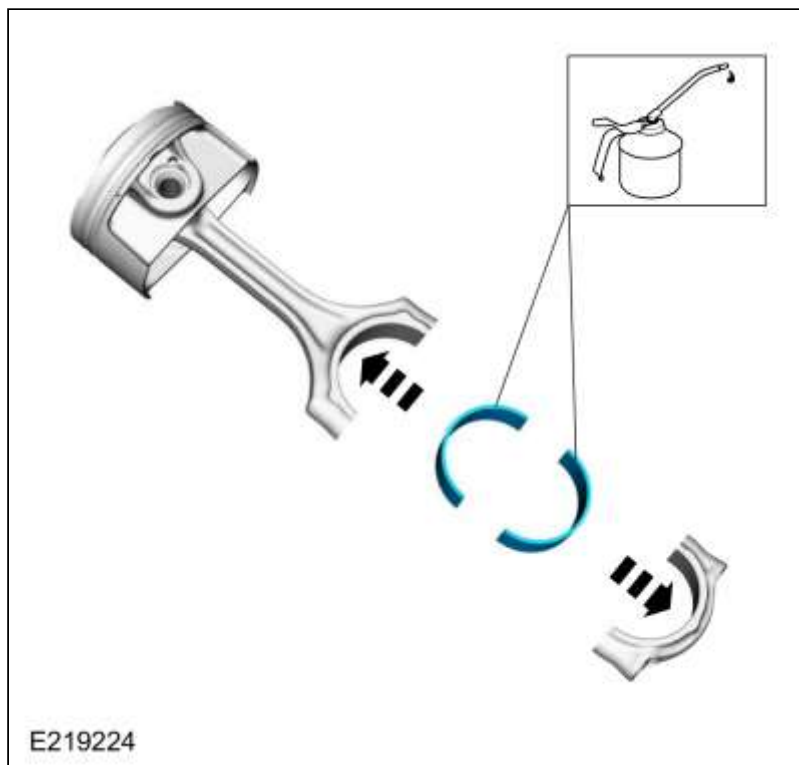


13.
  - Check the crankshaft end play.  
Refer to: [Specifications](#) (303-01D Engine - 5.2L 32V Ti-VCT, Specifications).
  - Check that crankshaft torque-to-turn does not exceed 6 Nm (53 lb-in).
  - Check the piston-to-cylinder block and piston ring clearances.  
Refer to: [Specifications](#) (303-01D Engine - 5.2L 32V Ti-VCT, Specifications).
  - Assemble the pistons and position the piston ring gaps.  
Refer to: [Piston](#) (303-01D Engine - 5.2L 32V Ti-VCT, Disassembly and Assembly of Subassemblies).
14. Lubricate with clean engine oil and install the connecting rod bearings.  
*Material:* Motorcraft® SAE 5W-50 Full Synthetic Motor Oil / XO-5W50-QGT (WSS-M2C931-C)





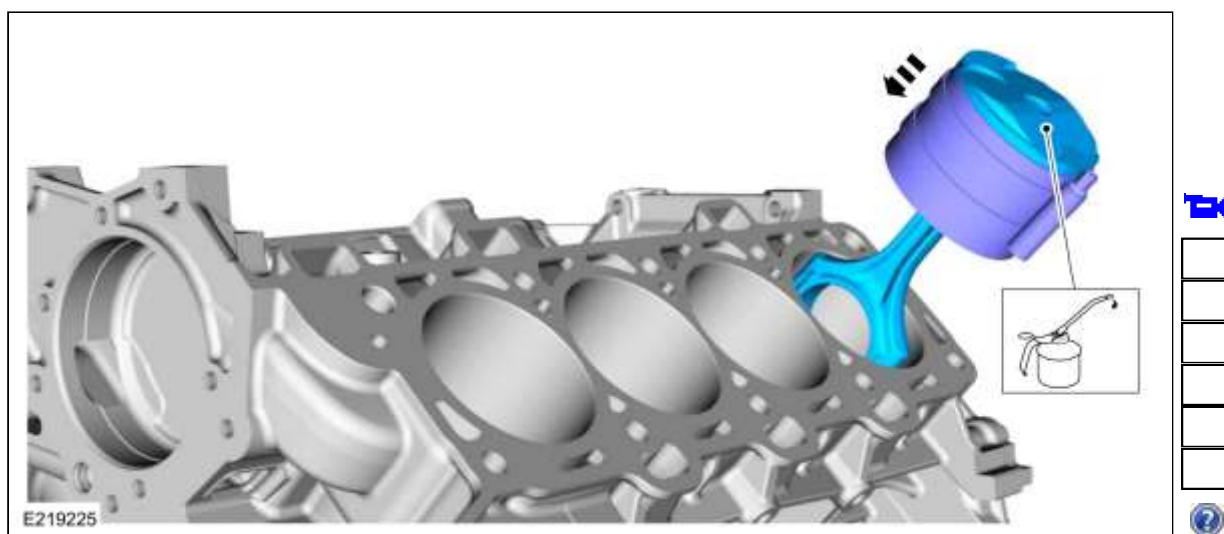



15. **NOTICE:** Be sure not to scratch the cylinder wall or crankshaft journal with the connecting rod. Push the piston down until the connecting rod bearing seats on the crankshaft journal.

**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 piston with clean engine oil.

- Using a piston ring compressor, install the piston.  
Use the General Equipment: Piston Ring Compressor  
Material: Motorcraft® SAE 5W-50 Full Synthetic Motor Oil / XO-5W50-QGT (WSS-M2C931-C)



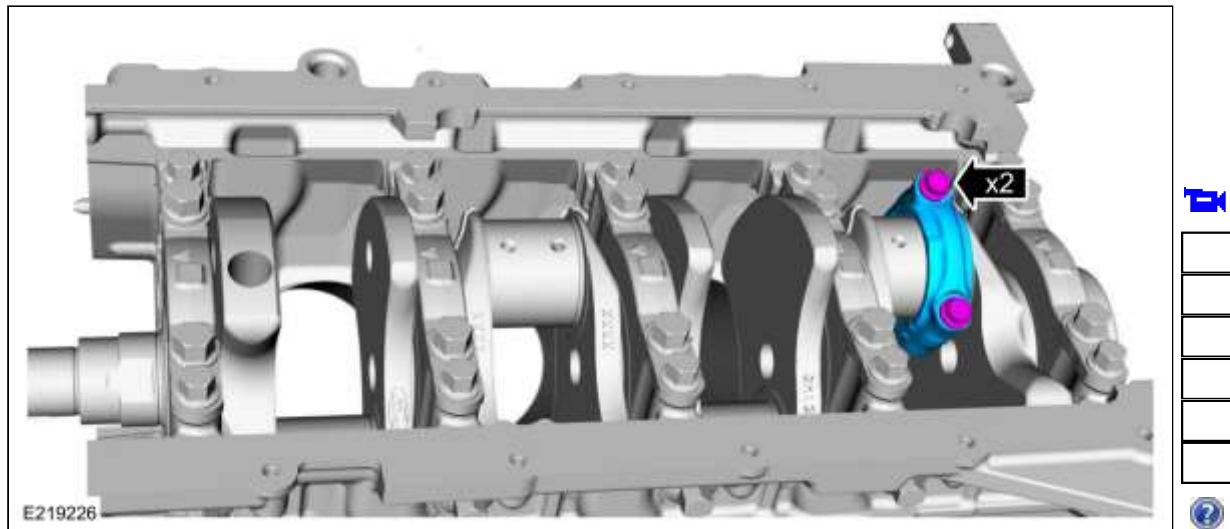
16. **NOTICE:** The rod cap installation must keep the same orientation as marked during disassembly or engine damage may occur.

**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.

Install the connecting rod cap and bearing.



- Install the new bolts hand tight.



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

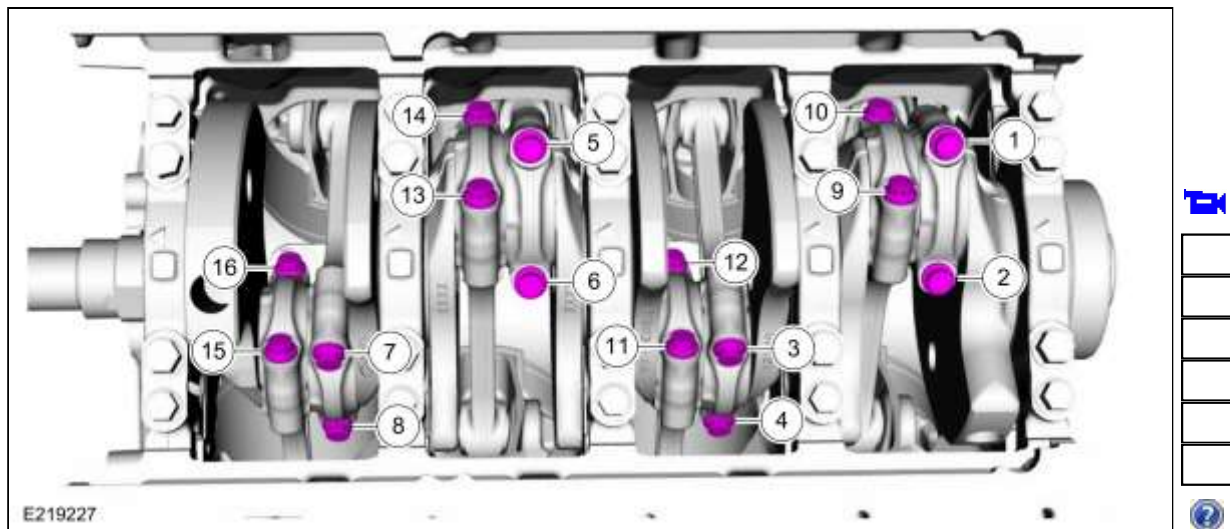
18. Tighten the connecting rod bolts.

*Torque:*

Stage 1: 18 lb.ft (25 Nm)

Stage 2: 24 lb.ft (33 Nm)

Stage 3: 90°



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

20. **NOTE:** Oil pump must be held against the cylinder block until all bolts are tightened.

- Rotate the inner rotor of the oil pump assembly to align the flats on the crankshaft and slip the oil pump over the crankshaft until seated against the block.
- Rotate the oil pump until the bolt holes are aligned to the block and install the fasteners hand tight.

*Torque:*

Stage 1: A: 89 lb.in (10 Nm)

Stage 2: B: 18 lb.ft (25 Nm)

Stage 3: C: 89 lb.in (10 Nm)

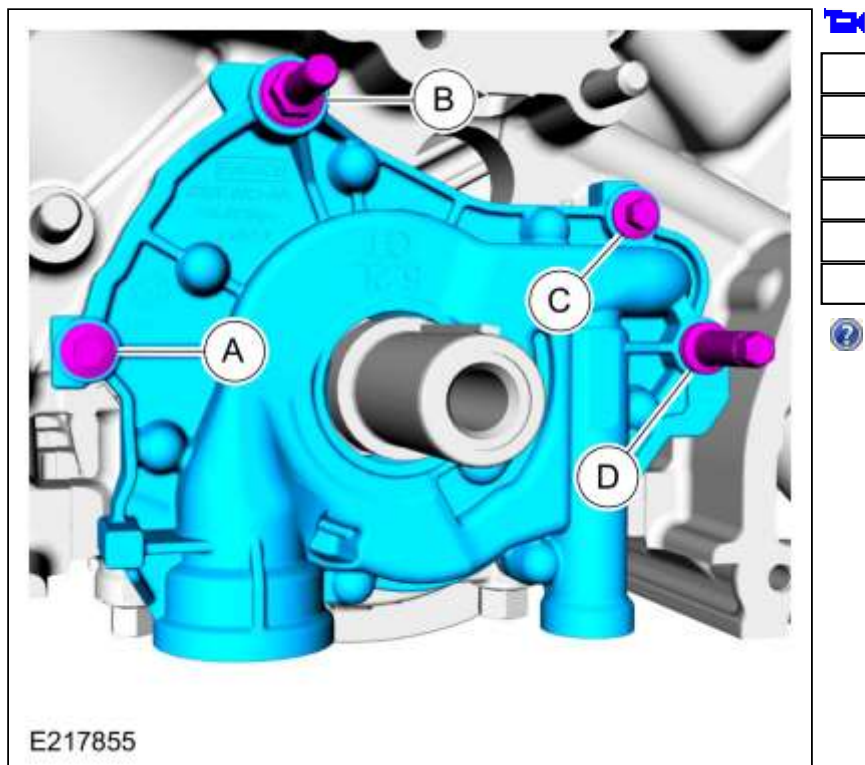
Stage 4: D: 177 lb.in (20 Nm)

Stage 5: A: 45°

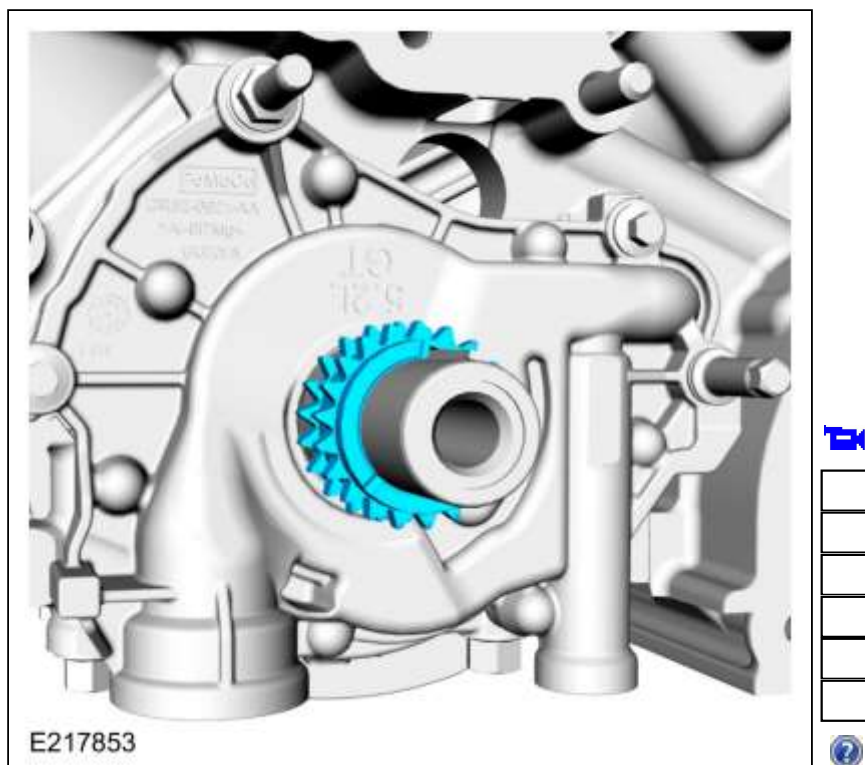
Stage 6: B: 75°

Stage 7: C: 45°

Stage 8: D: 60°

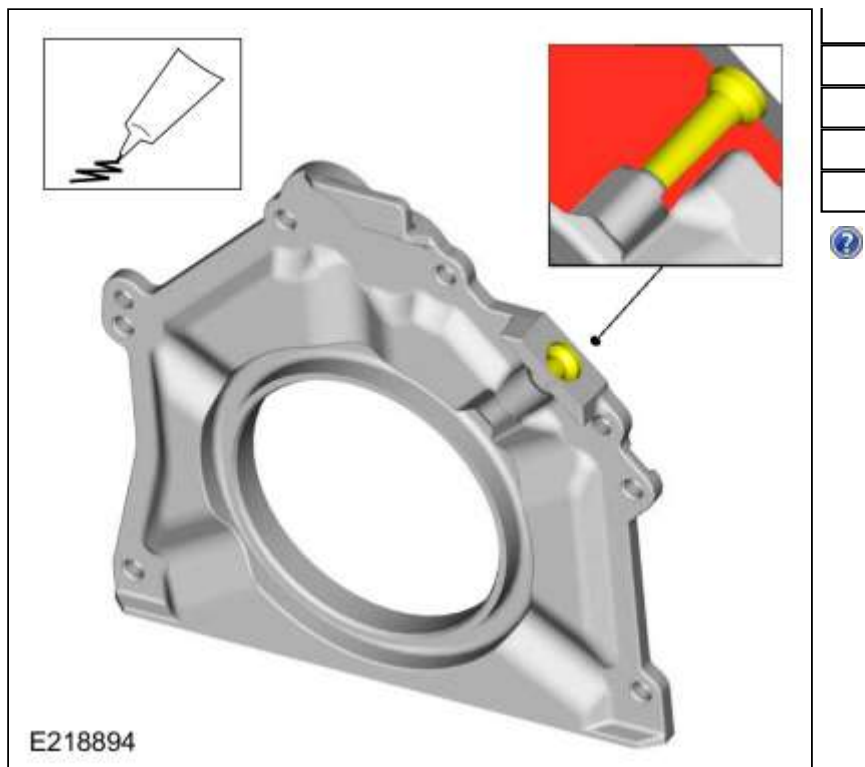


21. Install the crankshaft sprocket.



22. **NOTE:** The primer is good for up to 30 days after it has been applied.

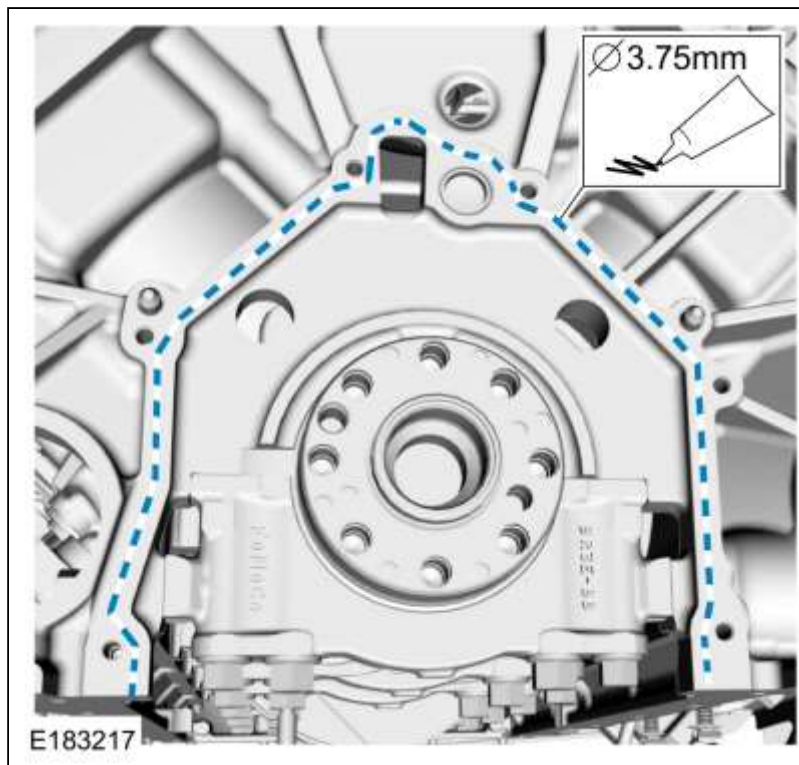
- Apply Loctite® 7649 Primer to the CKP sensor bore of the rear seal retainer plate.
- Allow the primer to dry for 2 minutes, making sure no other substance comes in contact with the primed surface.



23. **NOTE:** If the rear crankshaft seal retaining plate is not secured within 4 minutes, the sealant must be removed and the sealing area cleaned. Failure to follow this procedure may cause future oil leaks.

Apply a 3.75 mm (0.147 in) bead of silicone gasket and sealant to the rear crankshaft seal retainer mating surface on the engine block.

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

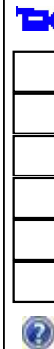
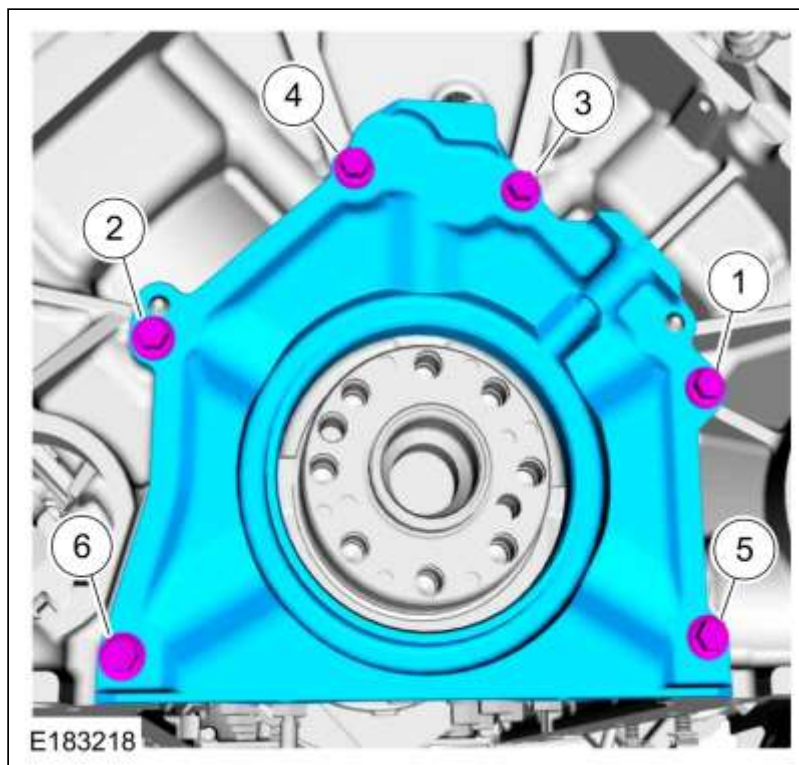


24. Install the crankshaft rear seal retainer plate and the bolts.

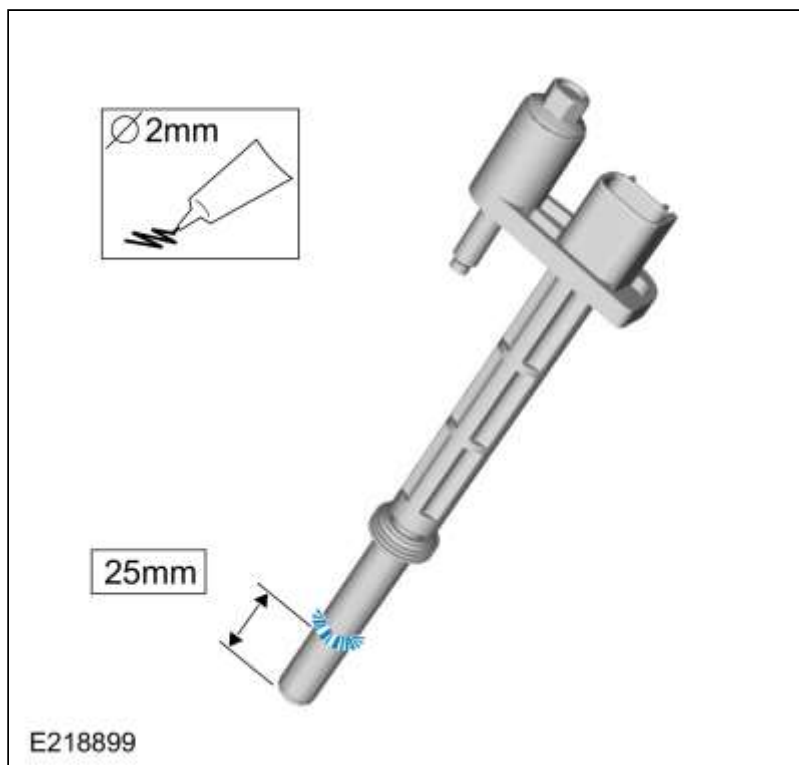
Torque:

Stage 1: 89 lb.in (10 Nm)

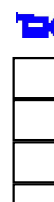
Stage 2: 45°



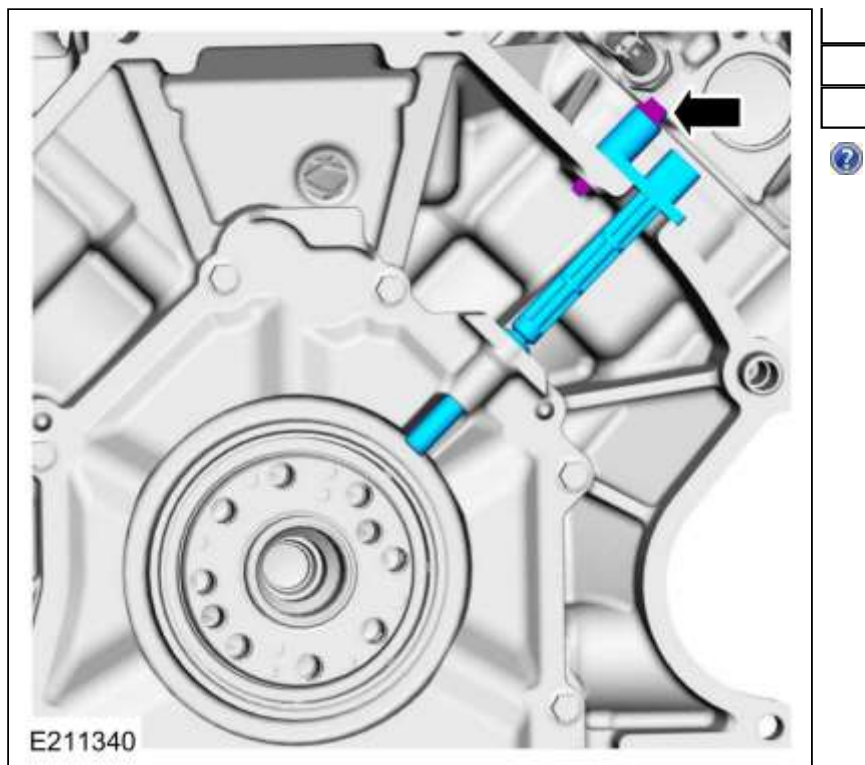
25. Apply a 2 mm bead of Loctite® 638 Sealer around the barrel of the CKP sensor 25mm (1 in) from the bottom end.



26. Install the CKP sensor and bolt.  
Torque: 89 lb.in (10 Nm)

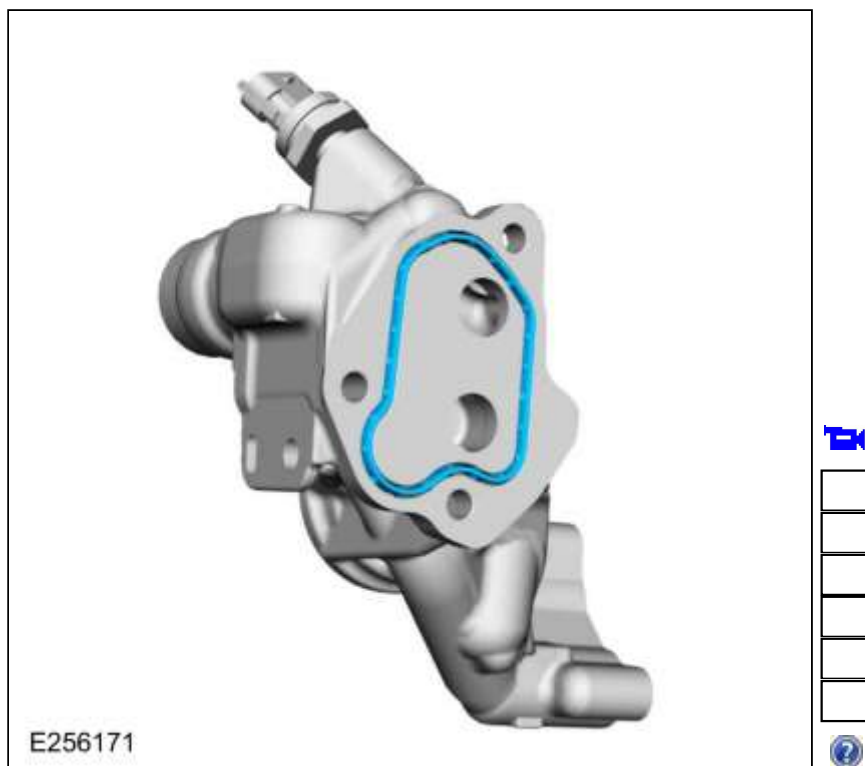






27. **NOTE:** *Early build engine shown, late build engine similar.*

Install a new gasket.



28. **NOTE:** *Early build engine with oil filter adapter (1) designed for a spin-on oil filter.*

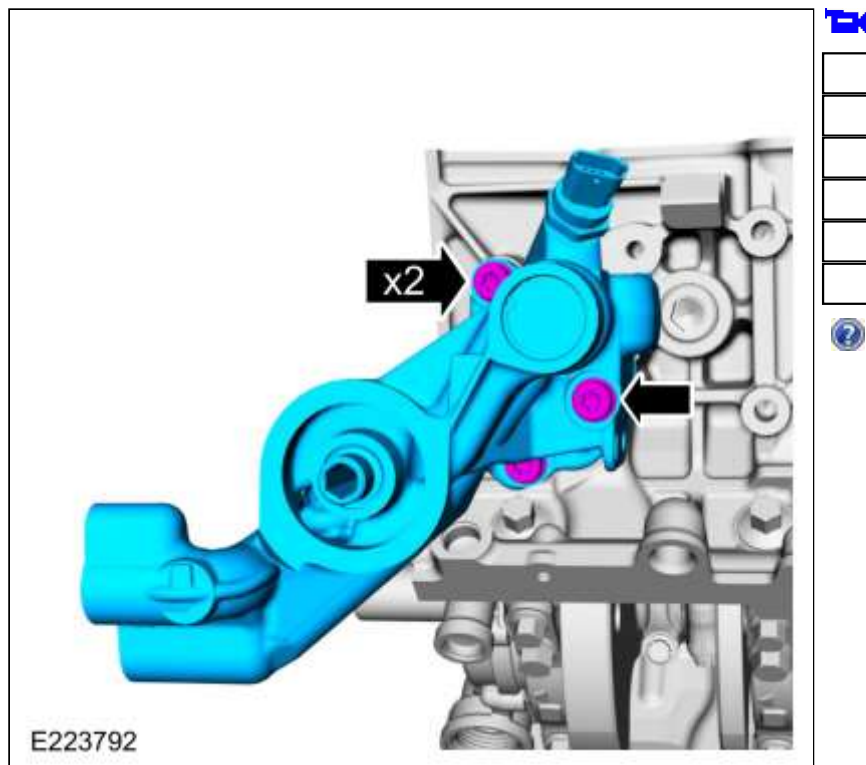
Install the oil filter adapter and the bolts.

*Torque:*

Stage 1: 177 lb.in (20 Nm)

Stage 2: 60°

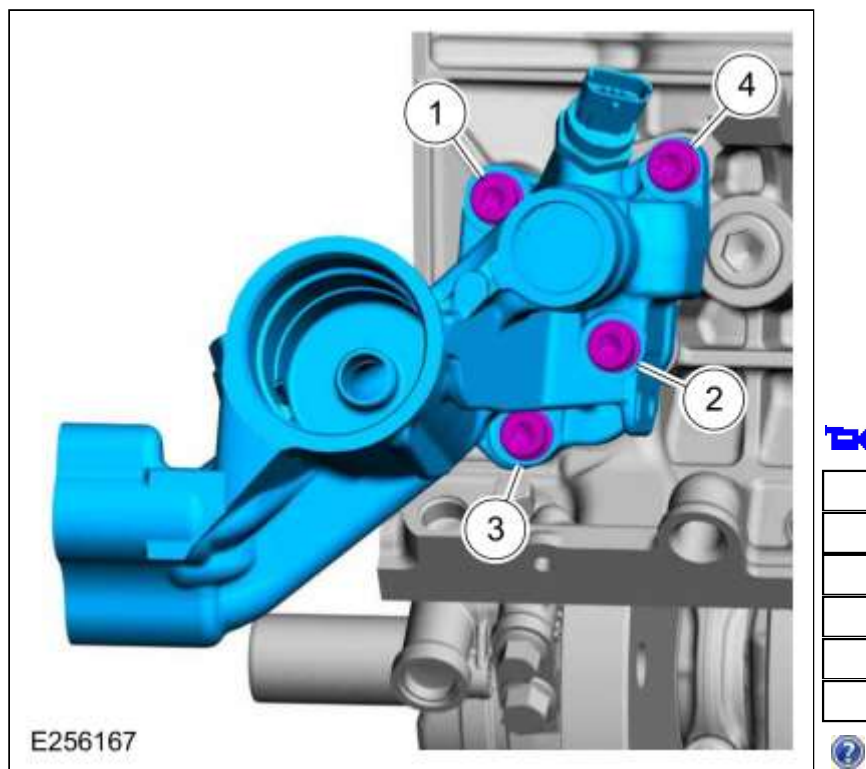




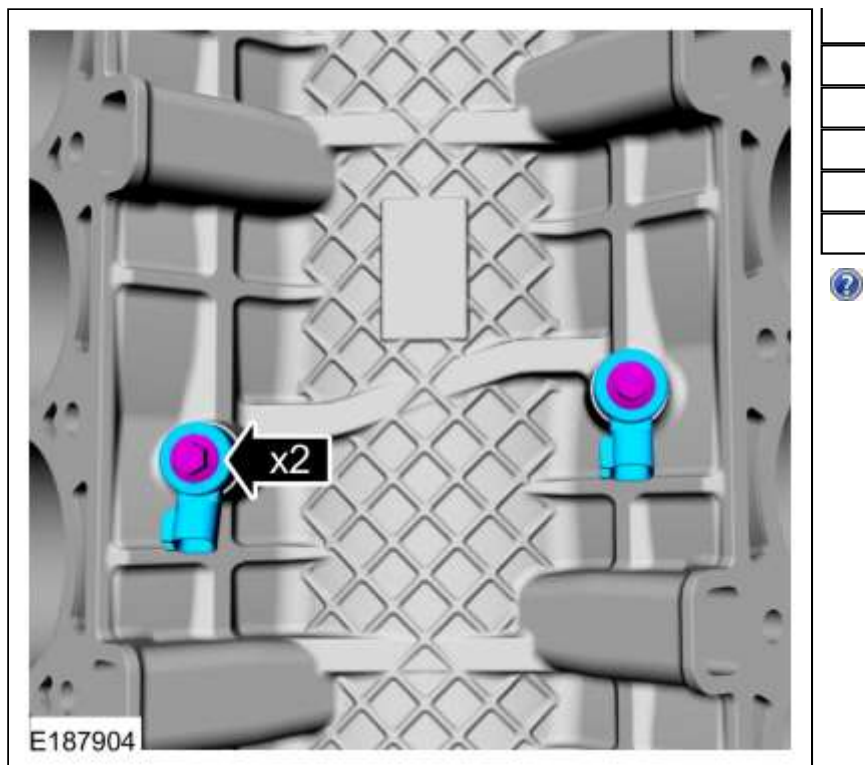
29. **NOTE:** *Late build engine with oil filter adapter (2) designed for a cartridge oil filter.*

Install the oil filter adapter and the bolts.

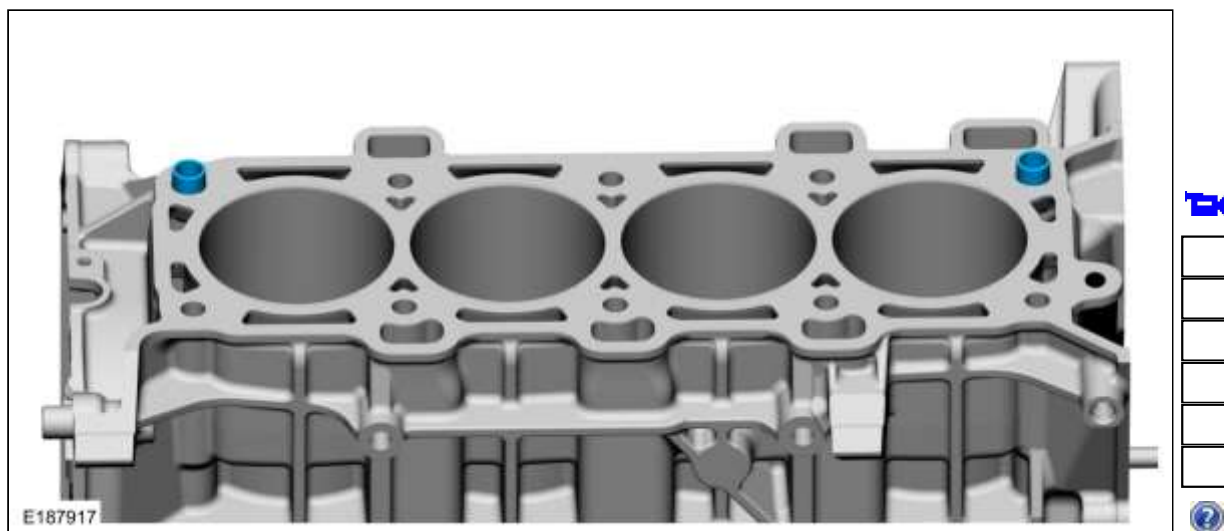
- Tighten in sequence.  
Torque: 18 lb.ft (24 Nm)



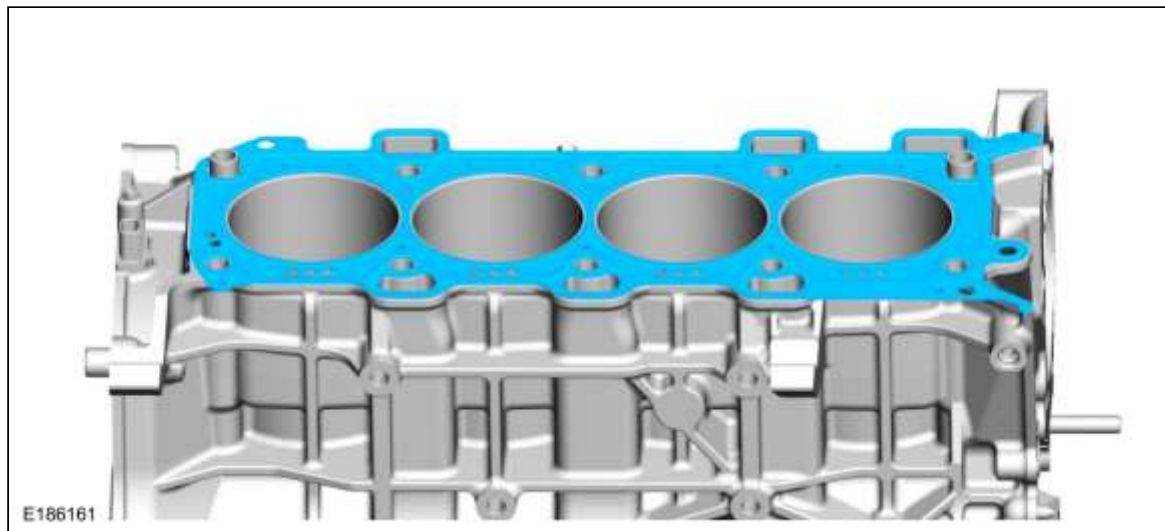
30. Install the KSs and the bolts.  
Torque: 177 lb.in (20 Nm)



31. Install the dowels on the RH bank of the cylinder block.



32. Install a new RH cylinder head gasket.



33. **NOTE:** The cylinder head bolts are torque-to-yield and must not be reused. New cylinder head bolts must be installed.

Install the cylinder head and the new bolts.

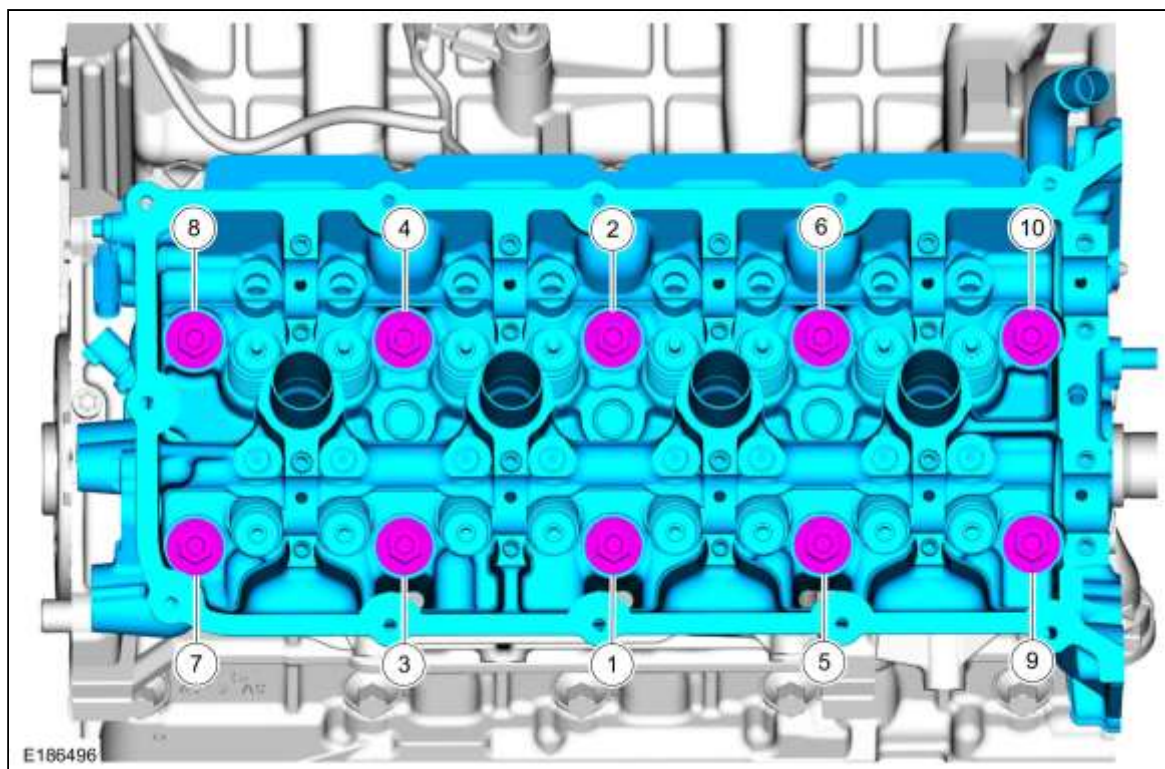
*Torque:*

Stage 1: 22 lb.ft (30 Nm)

Stage 2: 37 lb.ft (50 Nm)

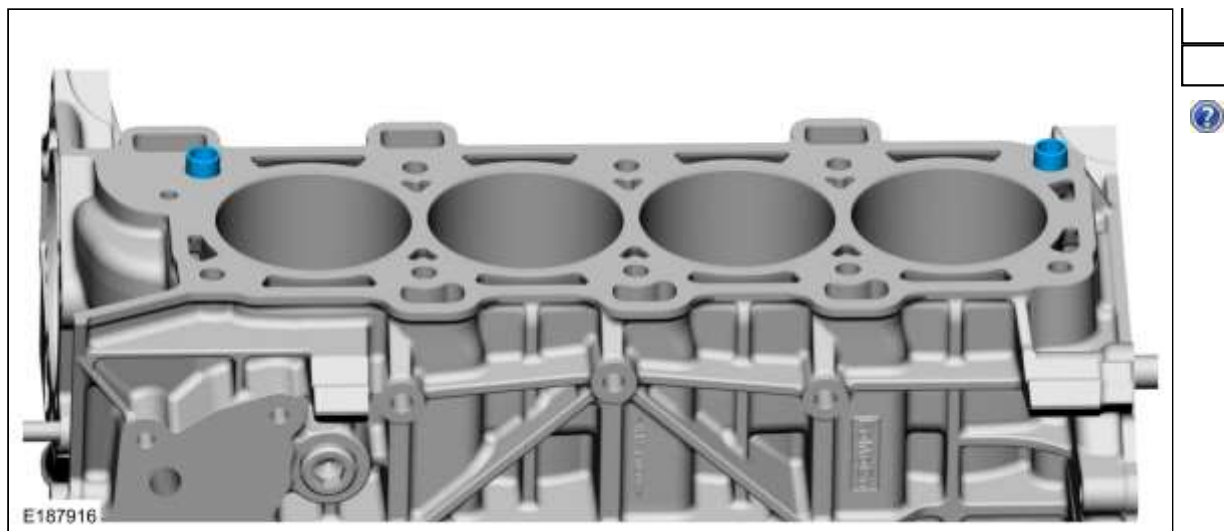
Stage 3: Tighten an additional : 90°

Stage 4: Tighten an additional : 90°

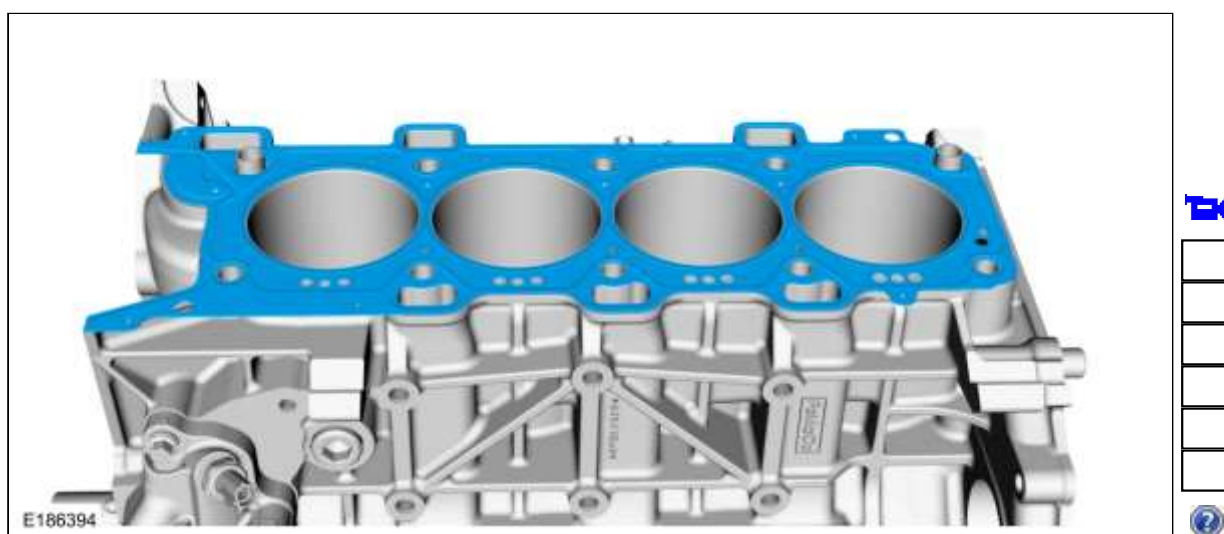


34. Install the dowels on the LH bank of the cylinder block.





35. Install a new LH cylinder head gasket.



36. **NOTE:** The cylinder head bolts are torque-to-yield and must not be reused. New cylinder head bolts must be installed.

Install the cylinder head and the new bolts.

*Torque:*

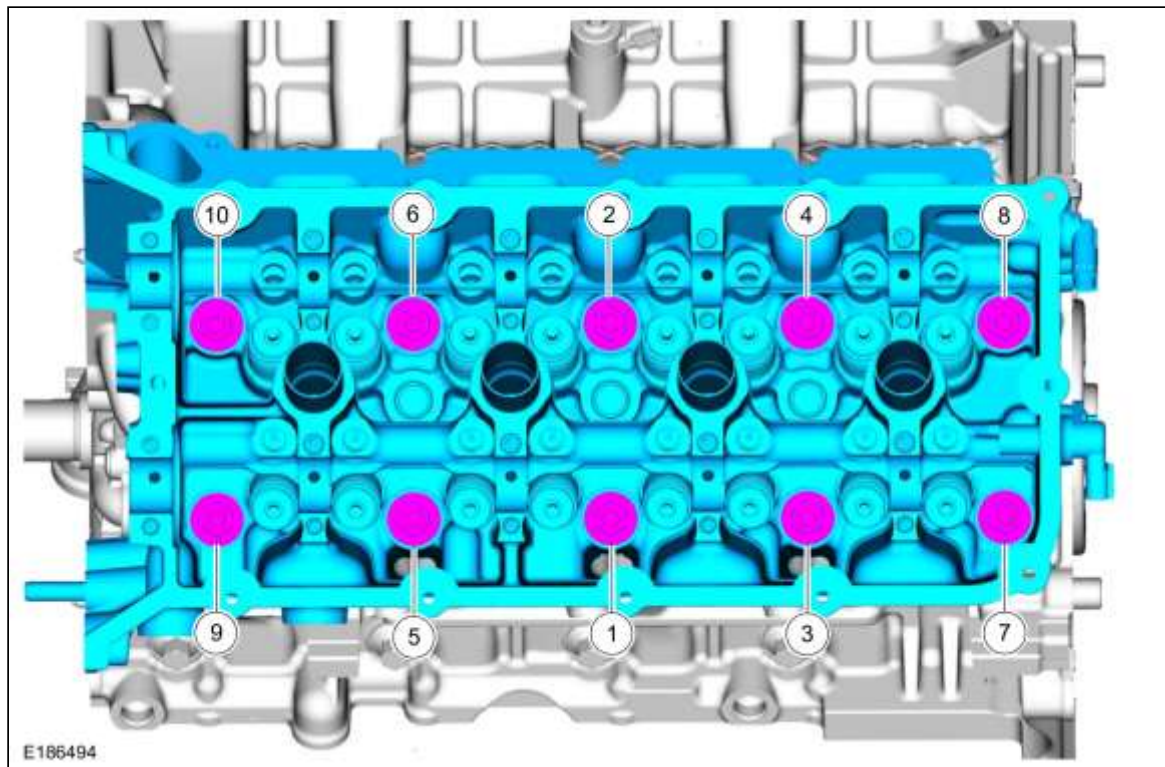
Stage 1: 22 lb.ft (30 Nm)

Stage 2: 37 lb.ft (50 Nm)

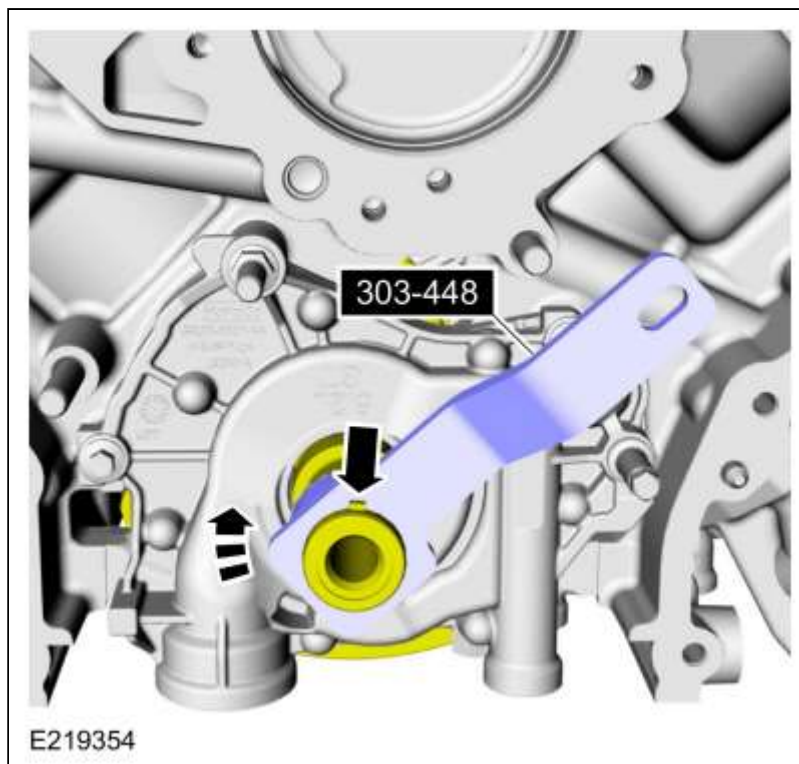
Stage 3: Tighten an additional : 90°

Stage 4: Tighten an additional : 90°





37. Using the special tool, rotate the crankshaft clockwise until the keyway is at the 12:30 position.  
Use Special Service Tool: [303-448 \(T93P-6303-A\) Holding Tool, Crankshaft](#).



**NOTICE:** The LH camshafts, VCT units and timing chains must be installed first. Only turn the crankshaft as instructed. Failure to do so may result in the camshafts installed out of phase and serious damage to the engine will result.

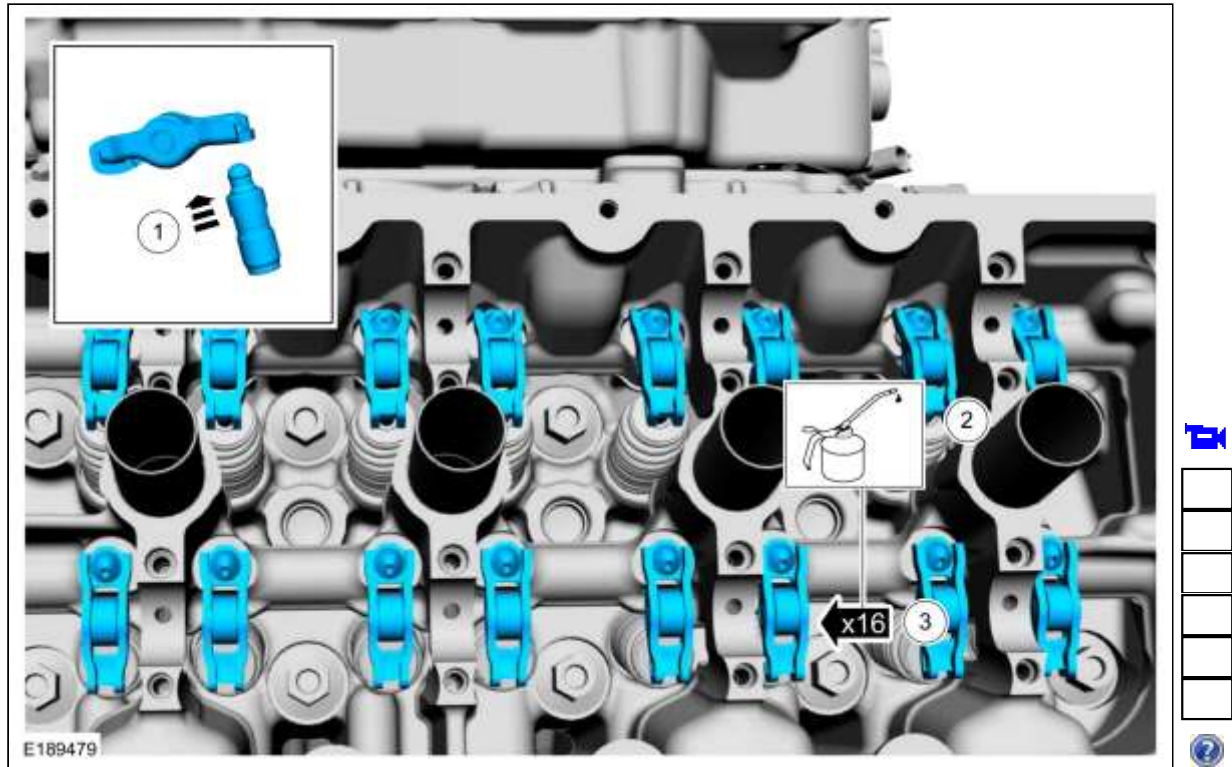
38. **NOTE:** If the components are to be reinstalled, they must be installed in their original locations.

1. **NOTE:** Early build date engines are not equipped with spring clips on the camshaft roller followers.

Assemble the hydraulic lash adjusters onto the spring clips on the camshaft roller followers.

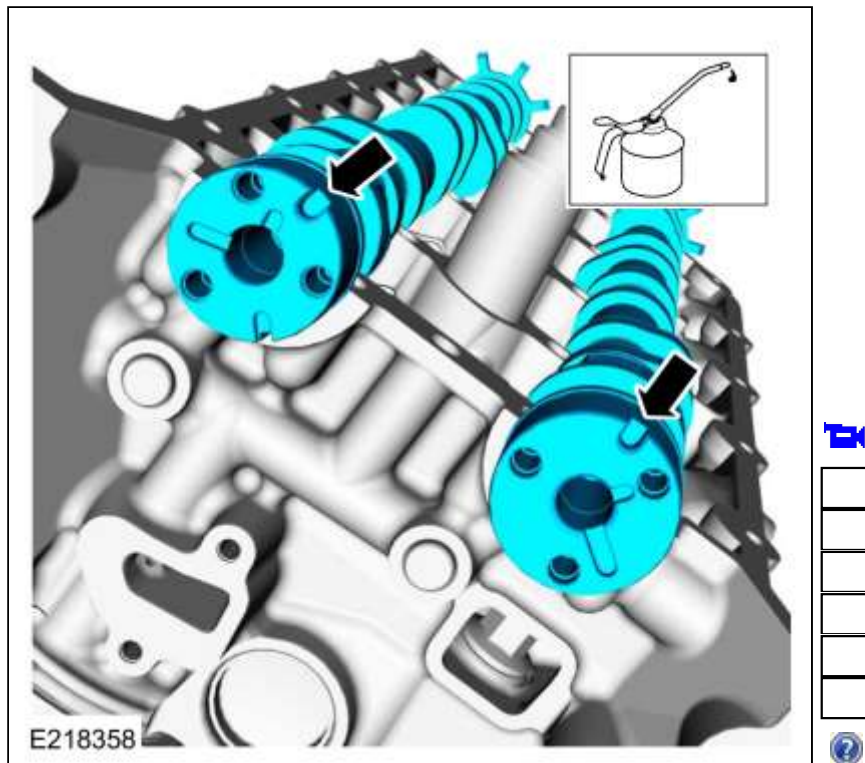


2. Lubricate the camshaft roller followers and hydraulic lash adjusters with clean engine oil.  
*Material: Motorcraft® SAE 5W-50 Full Synthetic Motor Oil / XO-5W50-QGT (WSS-M2C931-C)*
3. Install the camshaft roller followers and hydraulic lash adjusters.



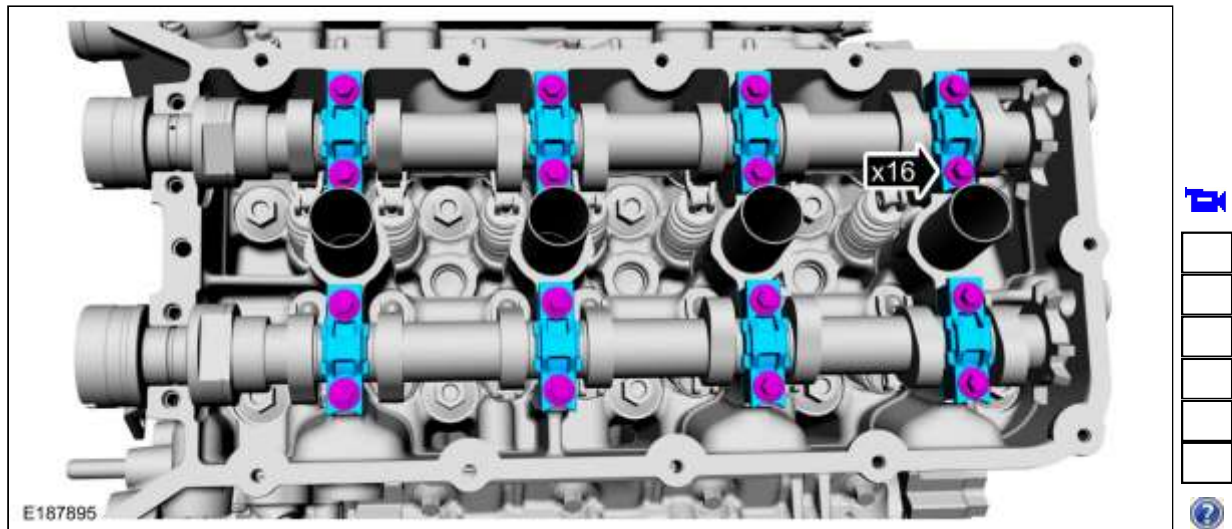
39. **NOTE:** Lubricate the camshaft journals and lobes with clean engine oil prior to installation.

Install the intake and exhaust camshafts in the neutral position. Align the D-slots as shown in the illustration.  
*Material: Motorcraft® SAE 5W-50 Full Synthetic Motor Oil / XO-5W50-QGT (WSS-M2C931-C)*



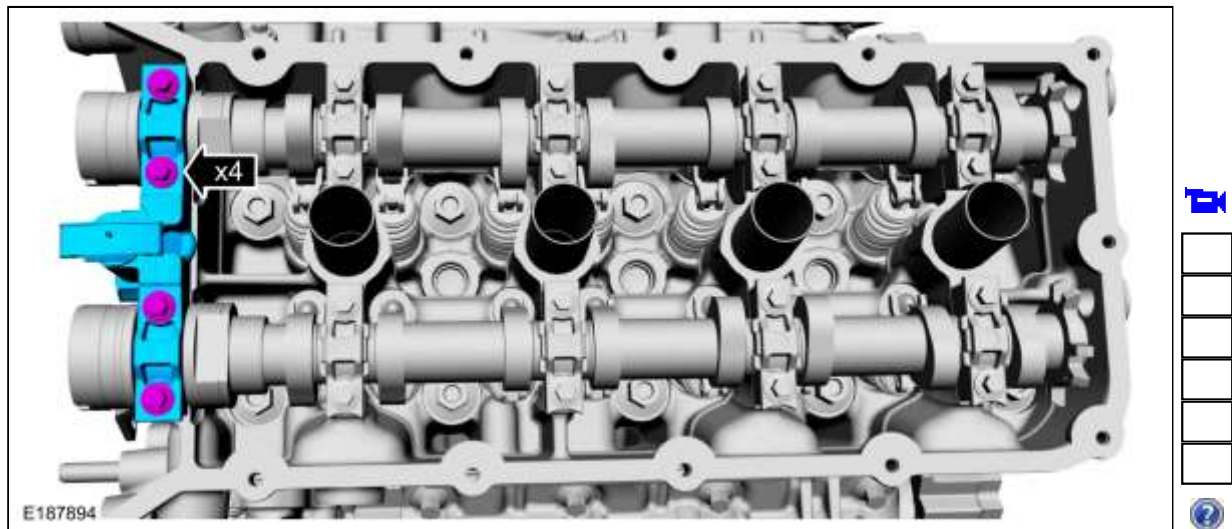
40. **NOTE:** Do not tighten at this time.

Install the camshaft bearing caps and the bolts.



41. **NOTE:** Do not tighten at this time.

Install the front camshaft bearing mega cap and the bolts.

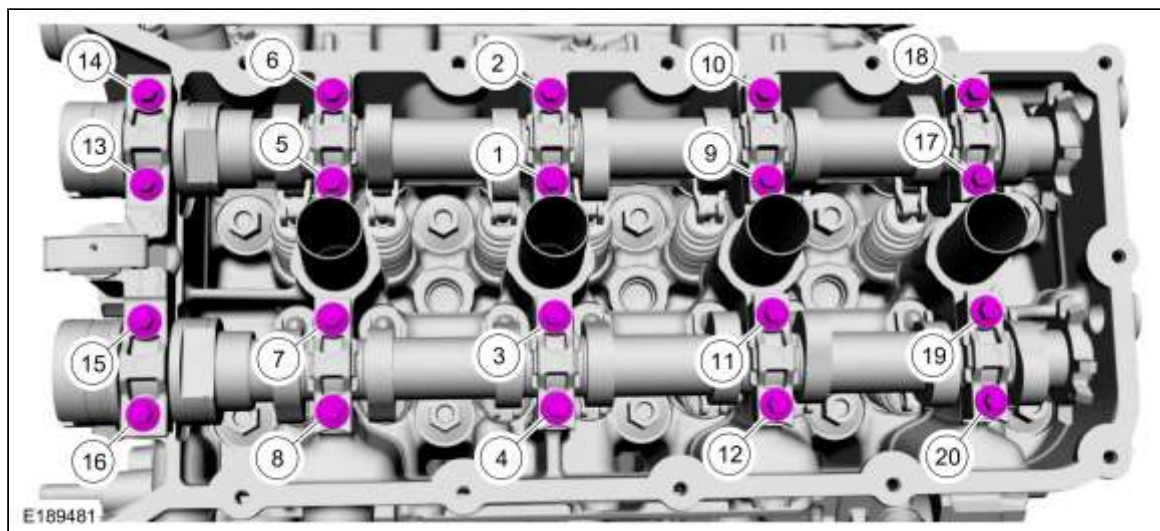


42. Tighten the bolts.

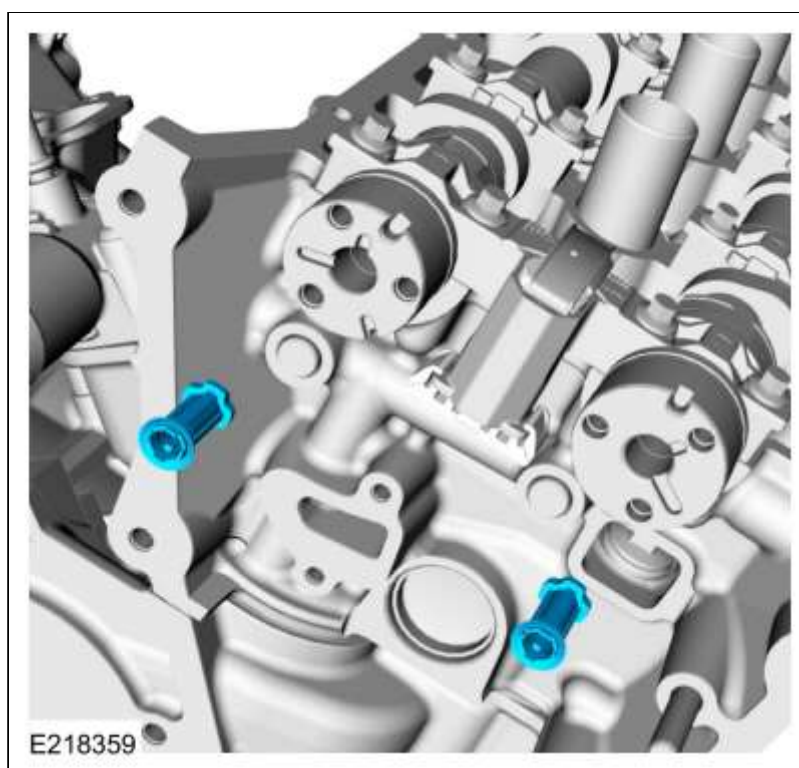
*Torque:*

Stage 1: 53 lb.in (6 Nm)

Stage 2: 53 lb. in (6 Nm) plus an additional : 45°

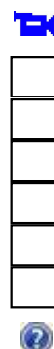


43. Install new VCT system oil filters into the camshafts.

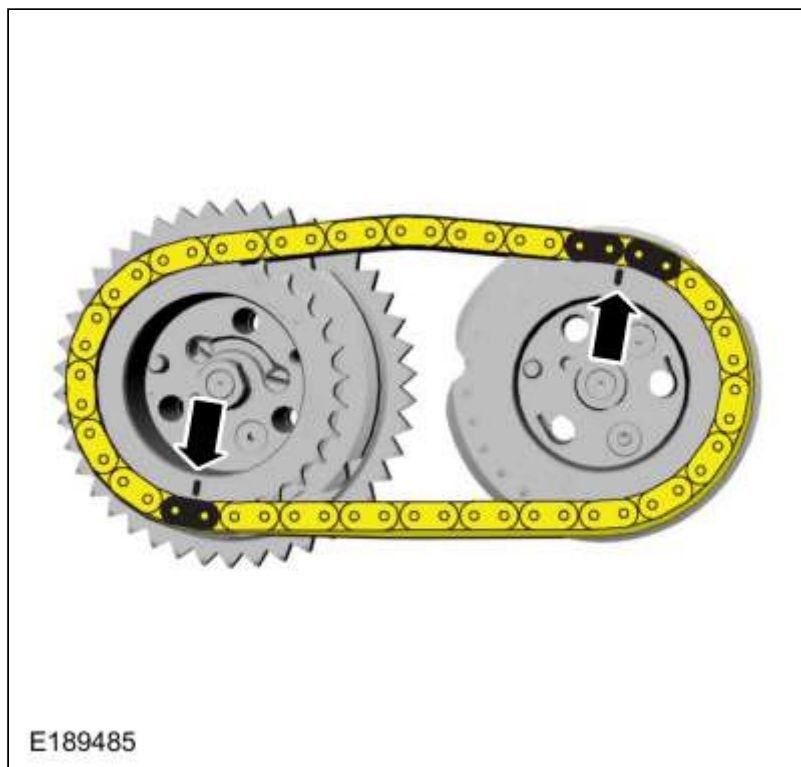


44. Position the secondary timing chain onto the VCT assemblies. Align the colored links on the secondary timing chain with the timing marks on the VCT assemblies as shown in the illustration.

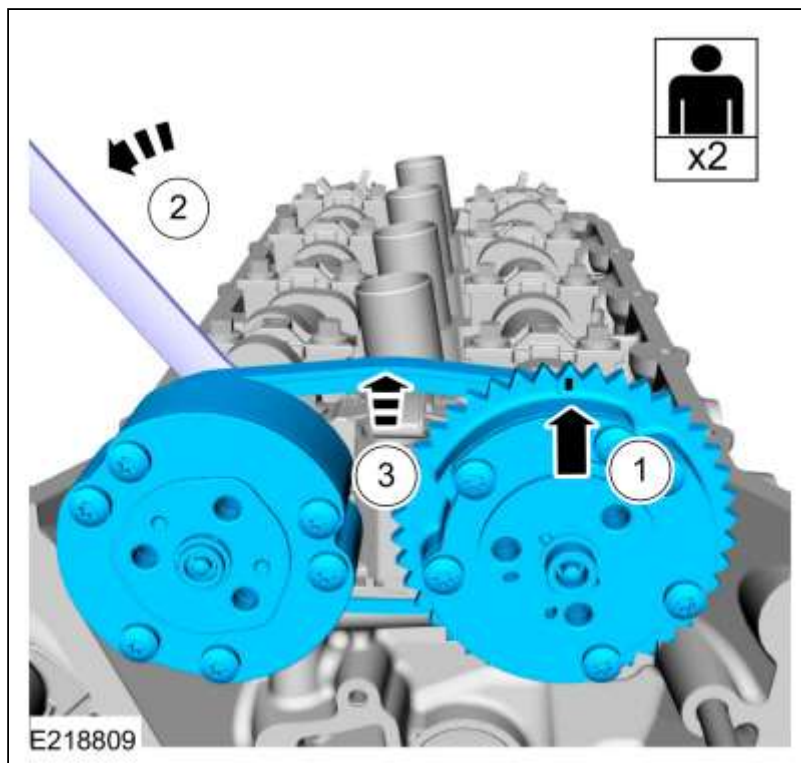
- The timing mark on the intake VCT assembly should align between the 2 consecutive colored links.
- The timing mark on the exhaust VCT assembly should align with the single colored link.



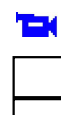


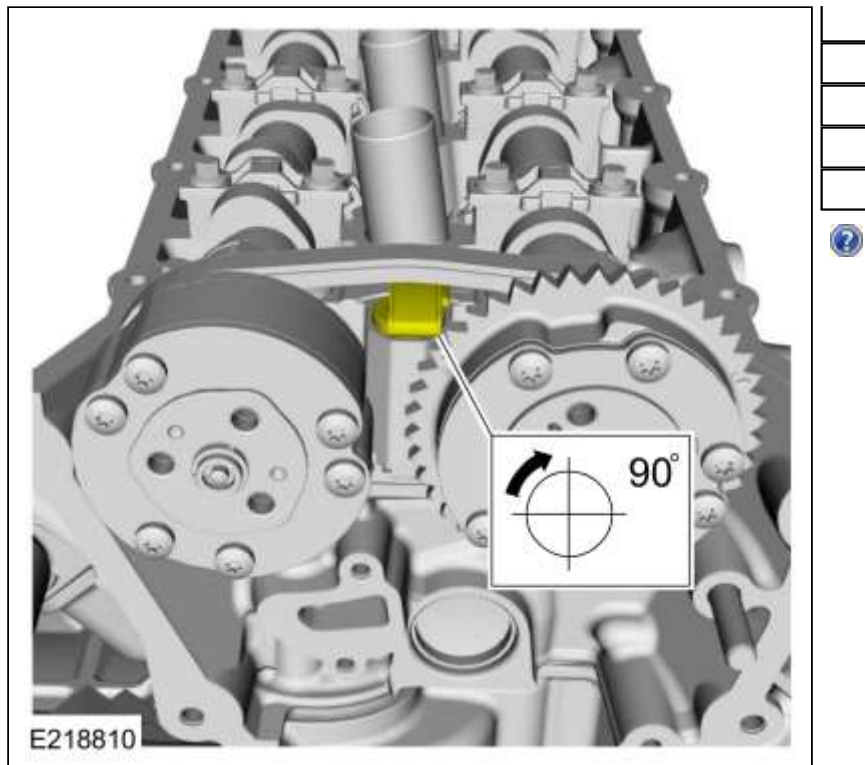


- 45.
1. Install the VCT unit and the secondary timing chain onto the camshafts. The timing mark on the exhaust VCT assembly should be approximately in the 12 o'clock position.
  2. Using a wrench on the flats of the camshaft, have an assistant rotate the intake camshaft counterclockwise until the locating pin of the VCT engages into the end of the camshaft.
  3. Slide the VCT assemblies onto the camshafts until they are fully seated.



46. Rotate the secondary timing chain tensioner 90 degrees so the ramped area is facing forward.





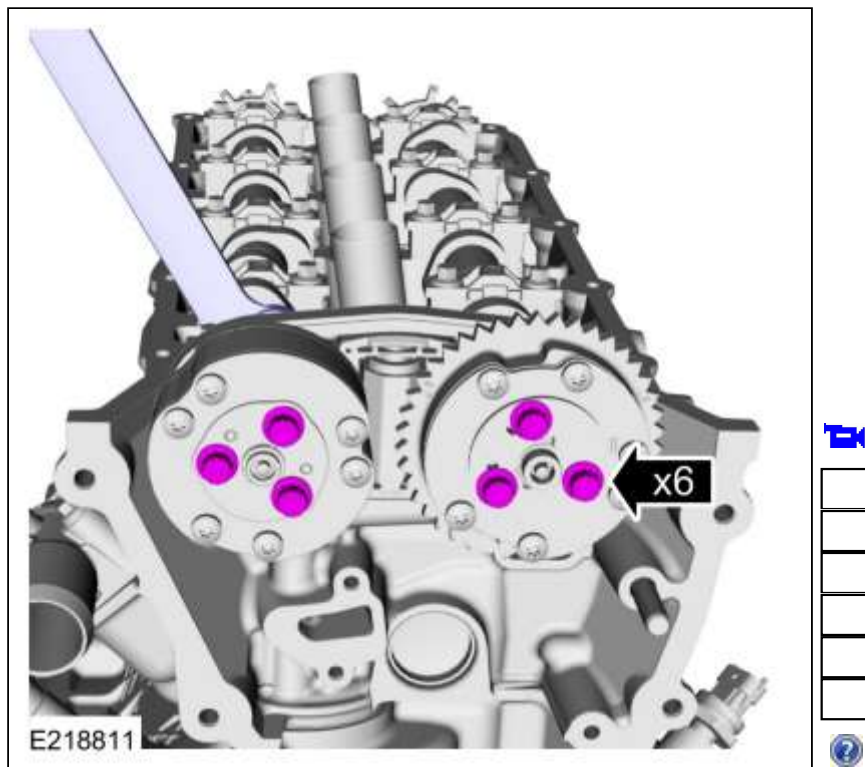
47. **NOTE:** Use a wrench on the flats of the camshaft to hold the camshafts while tightening the VCT assembly bolts.

Install the new intake and exhaust VCT assembly bolts.

*Torque:*

Stage 1: 133 lb.in (15 Nm)

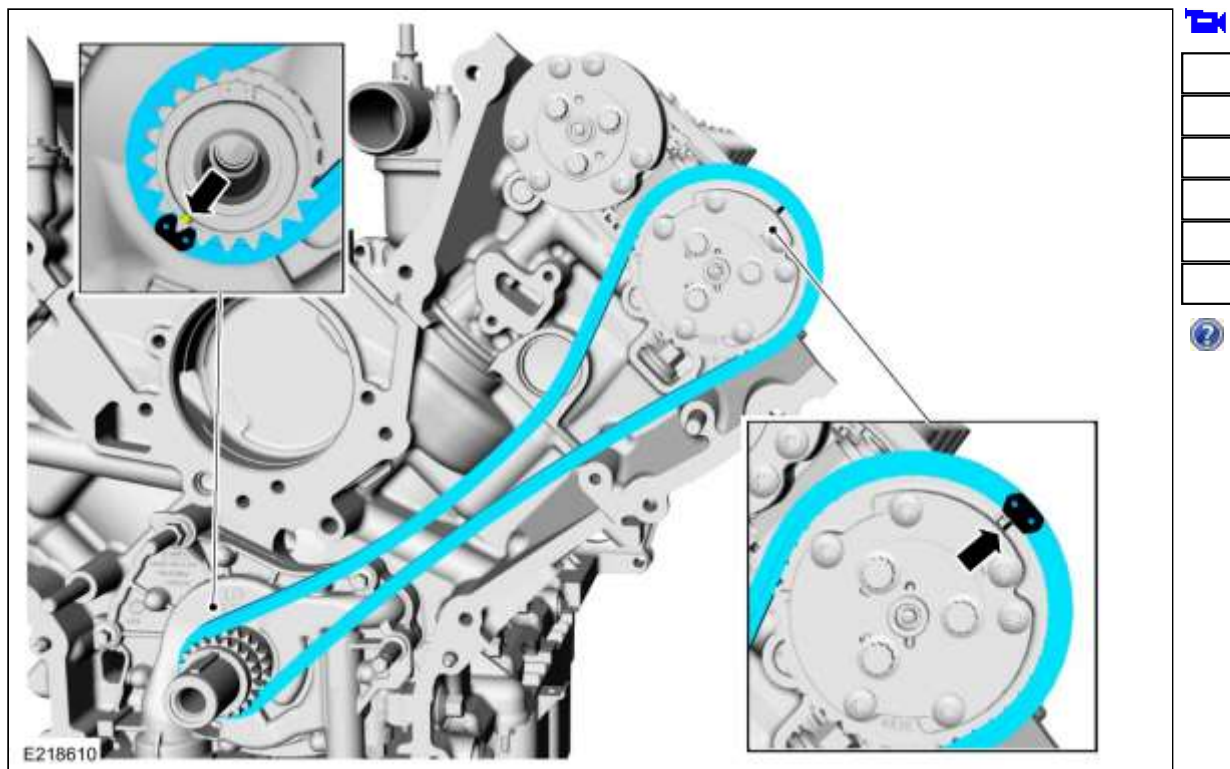
Stage 2: 90°



48. Install the LH timing chain.

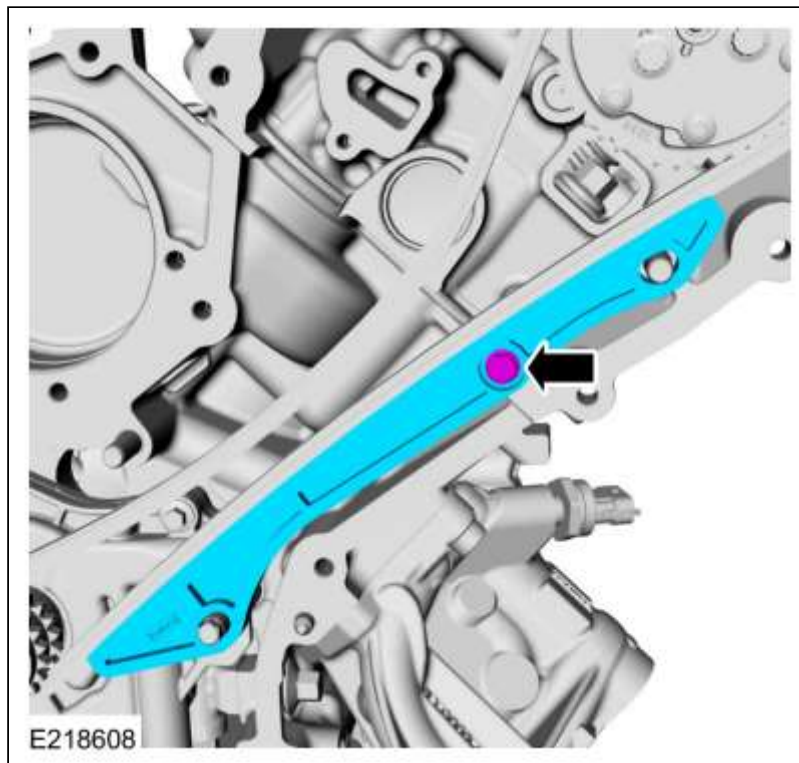
- Align the colored link on the timing chain with the timing mark on the LH VCT assembly.
- Align the remaining colored link on the timing chain with the timing mark on the crankshaft sprocket.





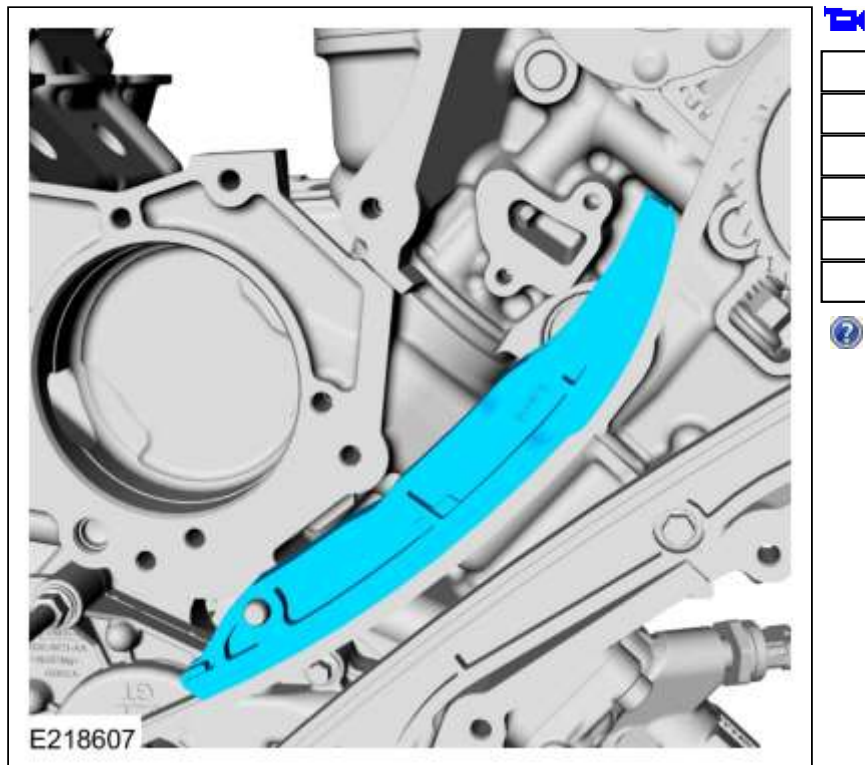
49. **NOTE:** It may be necessary to rotate the crankshaft slightly to provide enough slack in the chain to install the LH timing chain guide. Return the crankshaft keyway to the 12:30 position after installing the LH timing chain guide.

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

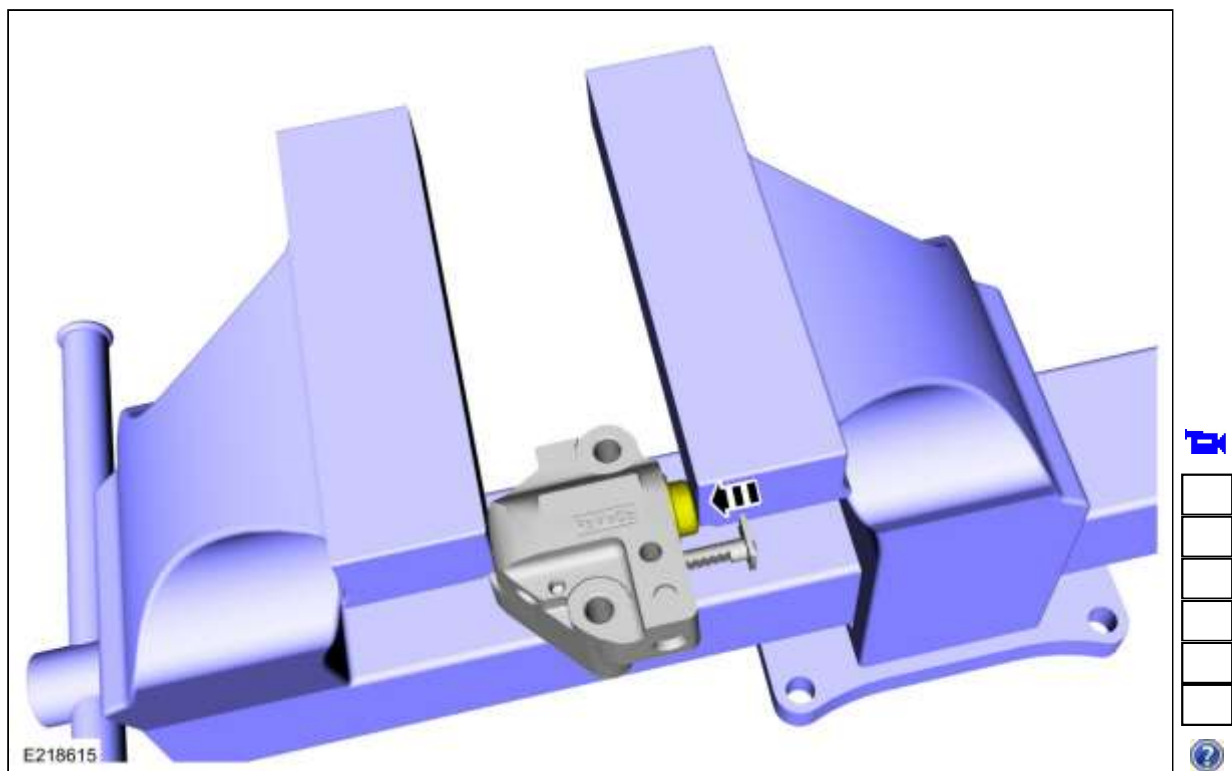


50. **NOTE:** It may be necessary to rotate the crankshaft slightly to provide enough slack in the chain to install the LH timing chain arm. Return the crankshaft keyway to the 12:30 position after installing the LH timing chain arm.

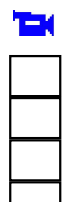
Install the LH timing chain tensioner arm.

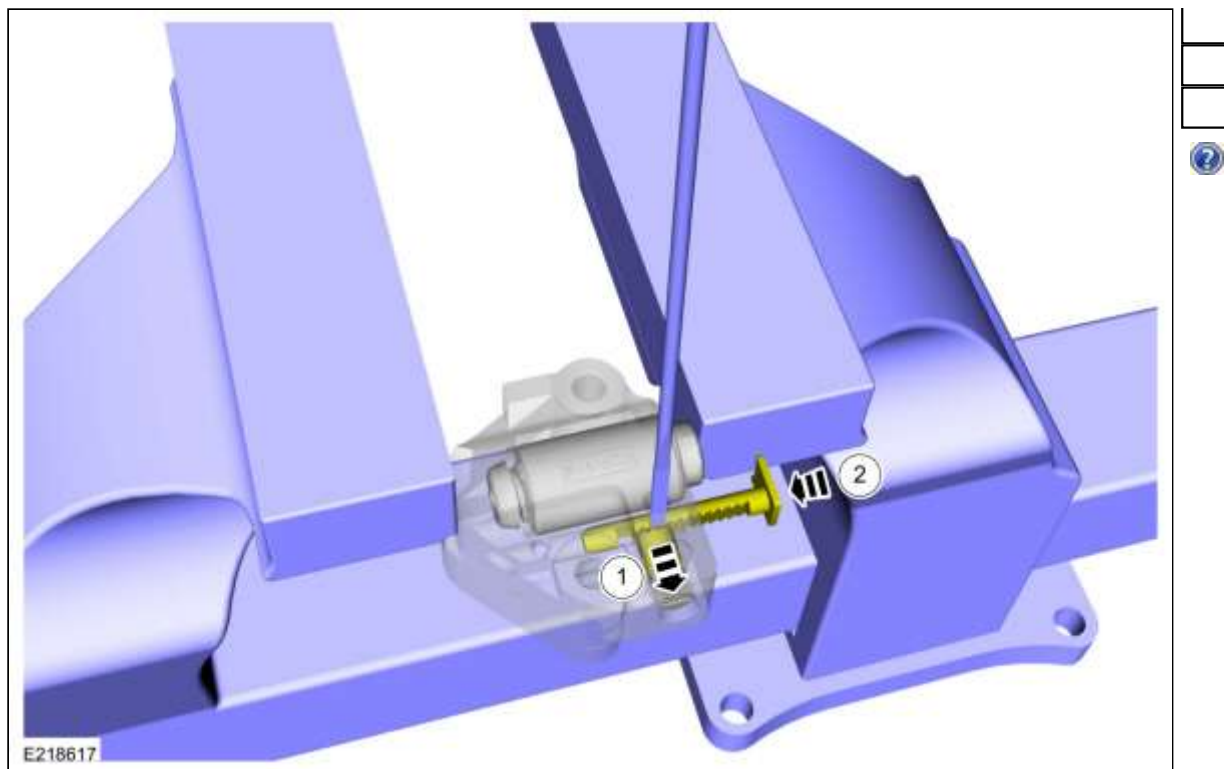


51. Compress the primary timing chain tensioner plunger, using an edge of a vise.

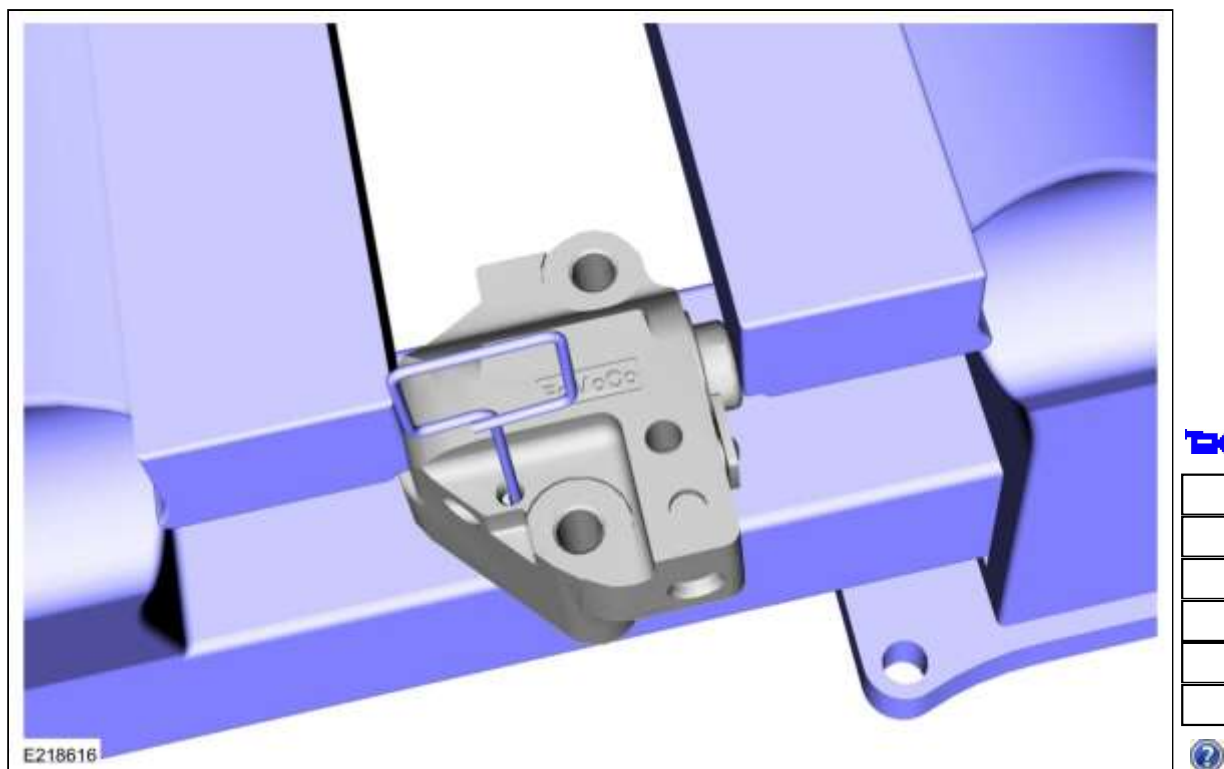


52. 1. Using a small screwdriver, release and hold the ratchet lock mechanism.  
2. Push the ratchet arm into the tensioner.



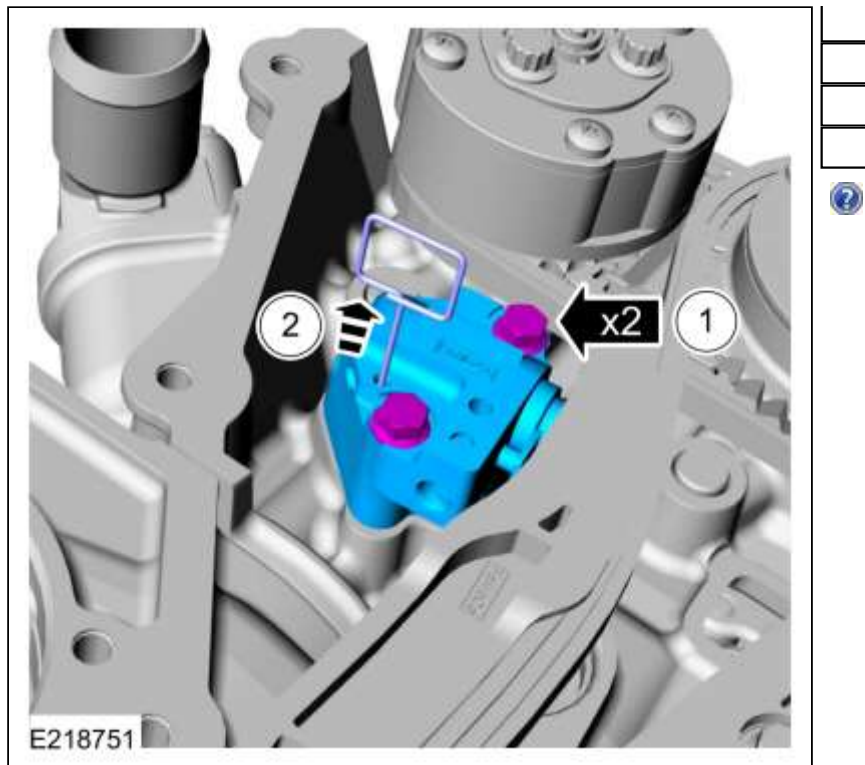


53. Install a pin into the hole of the tensioner housing to hold the plunger in place during installation.

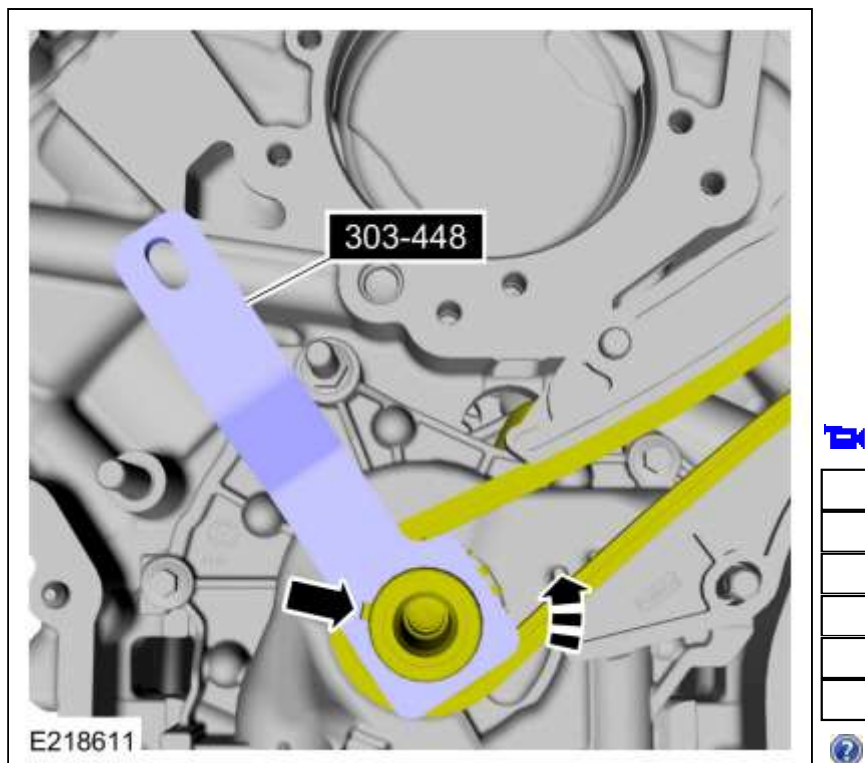


54. 1. Install the LH primary timing chain tensioner and bolts.  
*Torque: 89 lb.in (10 Nm)*  
 2. Remove the holding pin from the tensioner.





55. Using the special tool, rotate the crankshaft counterclockwise until the keyway is at the 9:30 position.  
Use Special Service Tool: [303-448 \(T93P-6303-A\) Holding Tool, Crankshaft](#).



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

1. **NOTE:** Early build date engines are not equipped with spring clips on the camshaft roller followers.

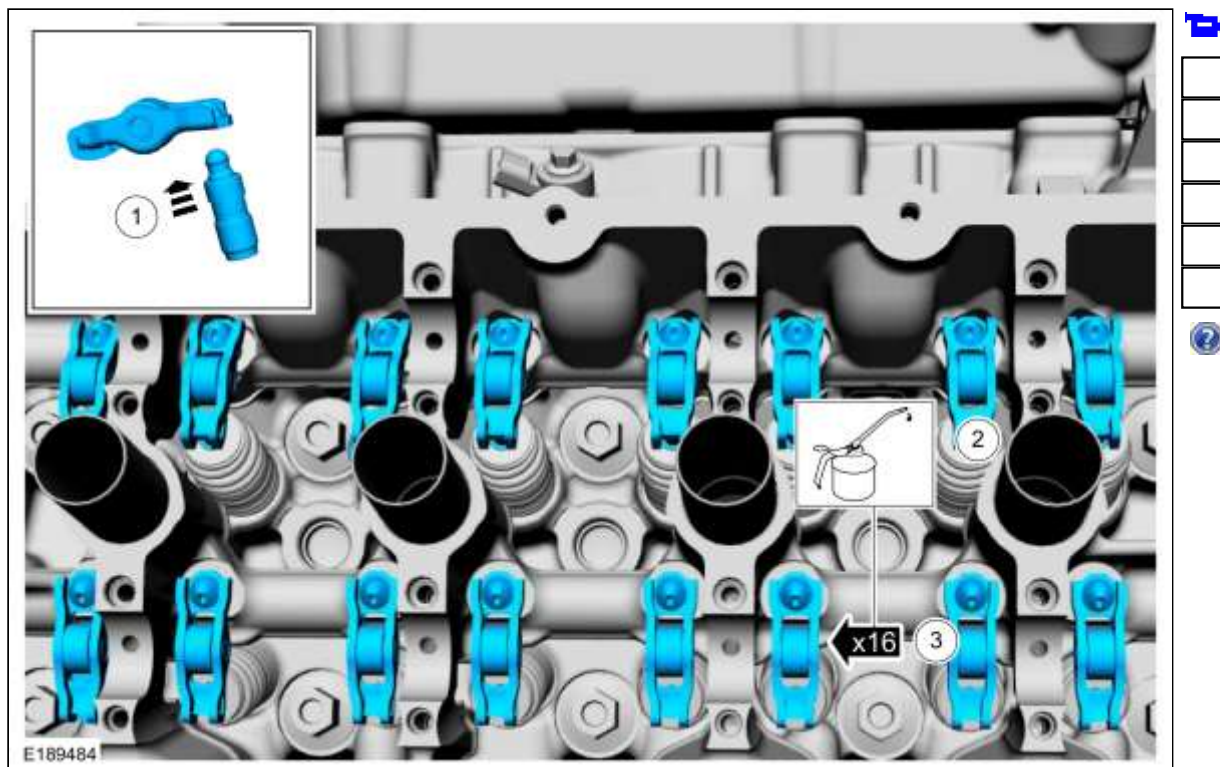
Assemble the hydraulic lash adjusters onto the spring clips on the camshaft roller followers.

2. Lubricate the camshaft roller followers and hydraulic lash adjusters with clean engine oil.

*Material:* Motorcraft® SAE 5W-50 Full Synthetic Motor Oil / XO-5W50-QGT (WSS-M2C931-C)

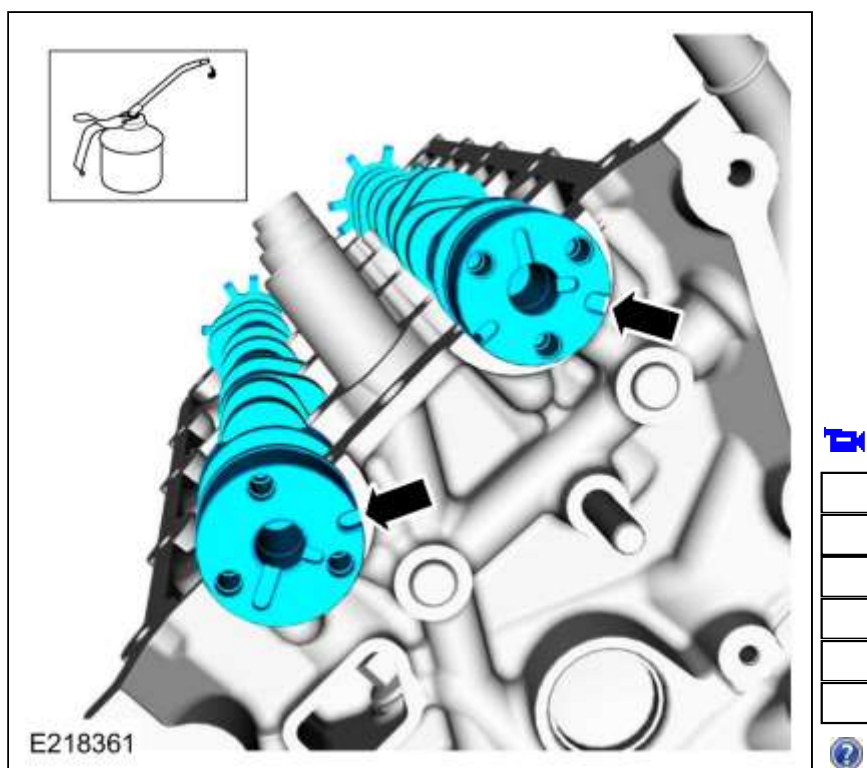
3. Install the camshaft roller followers and hydraulic lash adjusters.





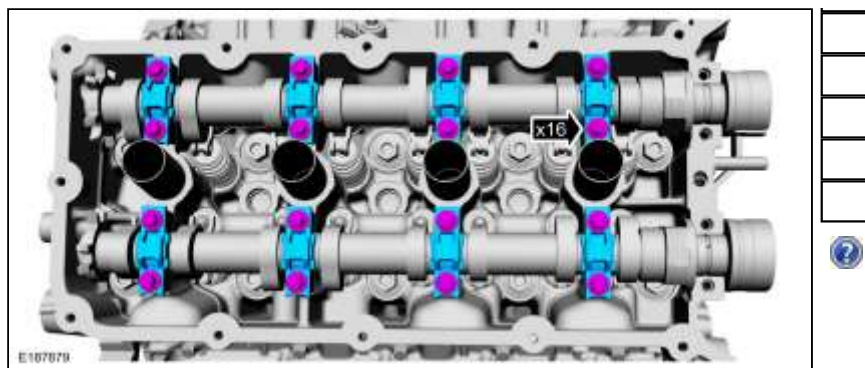
57. **NOTE:** Lubricate the camshaft journals and lobes with clean engine oil prior to installation.

Install the intake and exhaust camshafts in the neutral position. Align the D-slots as shown in the illustration.  
 Material: Motorcraft® SAE 5W-50 Full Synthetic Motor Oil / XO-5W50-QGT (WSS-M2C931-C)



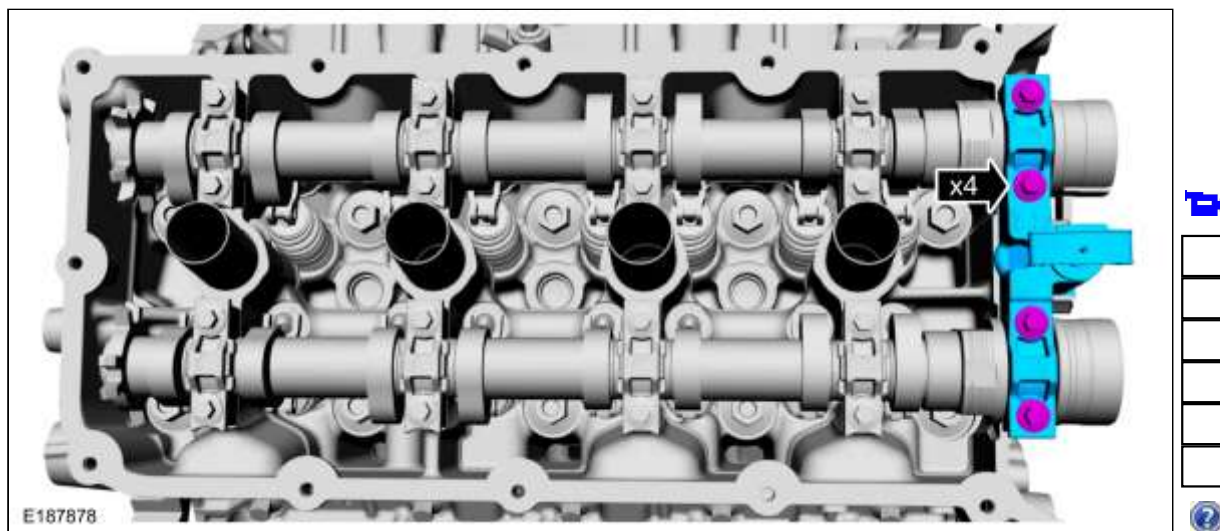
58. **NOTE:** Do not tighten at this time.

Install the camshaft bearing caps and the bolts.



59. **NOTE:** Do not tighten at this time.

Install the front camshaft bearing mega cap and the bolts.

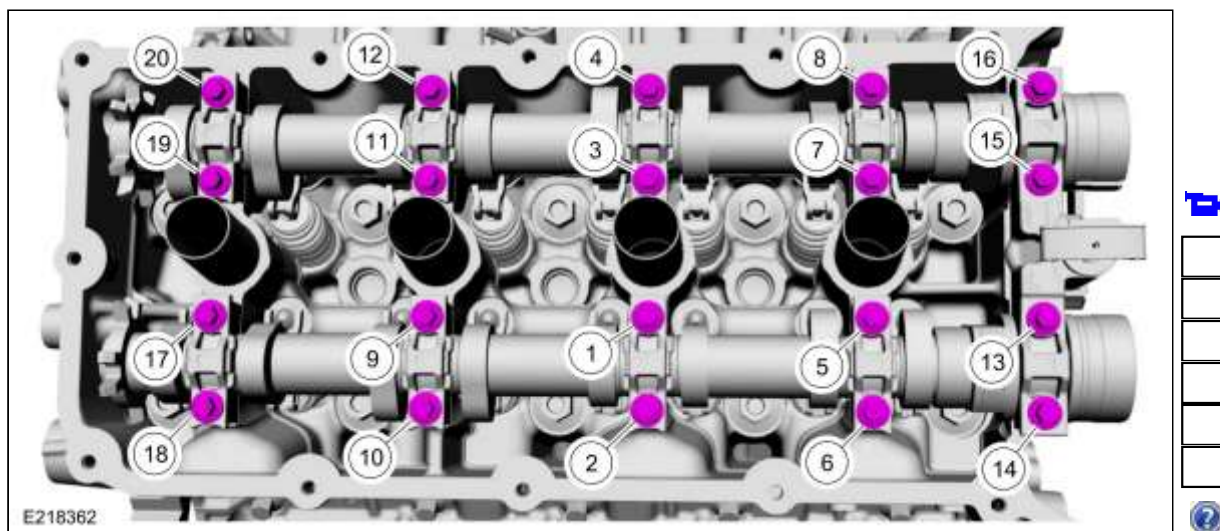


60. Tighten the bolts.

*Torque:*

Stage 1: 53 lb.in (6 Nm)

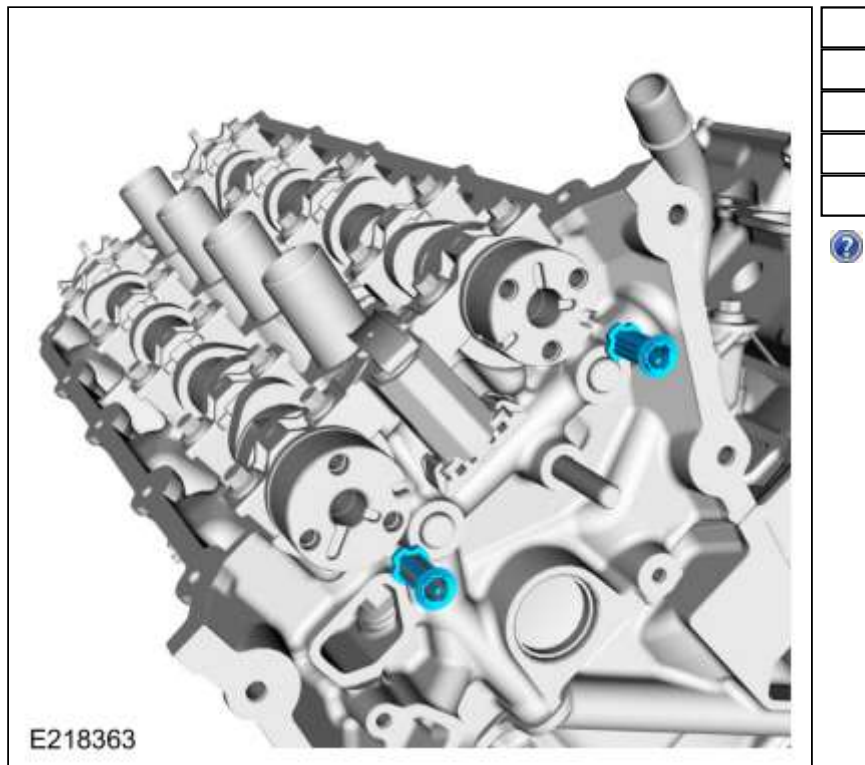
Stage 2: 53 lb. in (6 Nm) plus an additional : 45°



61. Install the VCT system oil filters into the camshafts.

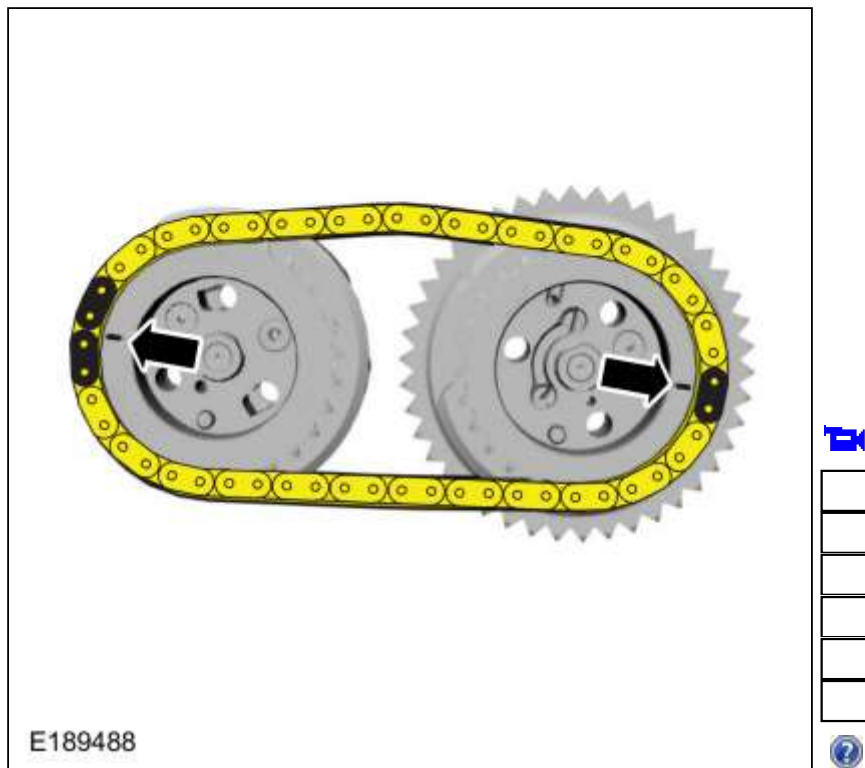




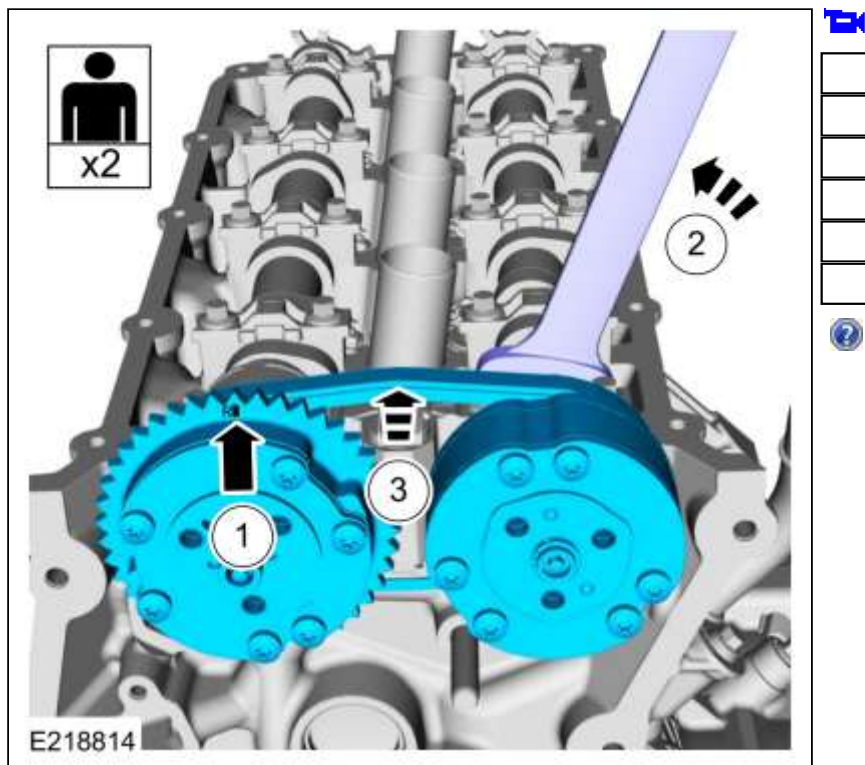


62. Position the secondary timing chain onto the VCT assemblies. Align the colored links on the secondary timing chain with the timing marks on the VCT assemblies as shown in the illustration.

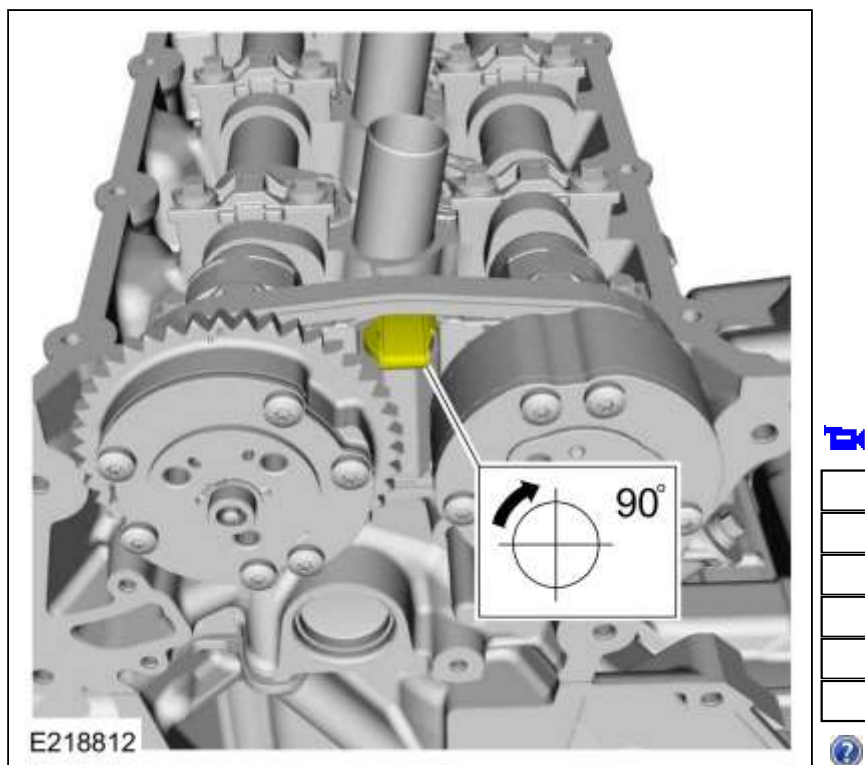
- The timing mark on the intake VCT assembly should align between the 2 consecutive colored links.
- The timing mark on the exhaust VCT assembly should align with the single colored link.



- 63.
1. Install the VCT unit and the secondary timing chain onto the camshafts. The timing mark on the exhaust VCT assembly should be approximately in the 12 o'clock position.
  2. Using a wrench on the flats of the camshaft, have an assistant rotate the intake camshaft counterclockwise until the locating pin of the VCT engages into the end of the camshaft.
  3. Slide the VCT assemblies onto the camshafts until they are fully seated.



64. Rotate the secondary timing chain tensioner 90 degrees so the ramped area is facing forward.



65. **NOTE:** Use a wrench on the flats of the camshaft to hold the camshafts while tightening the VCT assembly bolts.

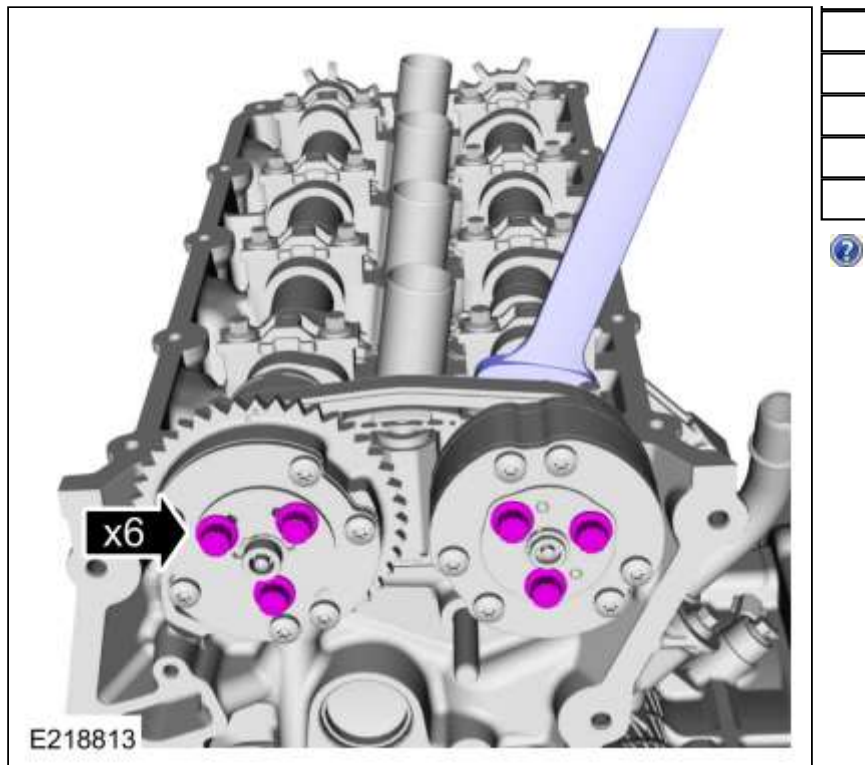
Install the new intake and exhaust VCT assembly bolts.

*Torque:*

Stage 1: 133 lb.in (15 Nm)

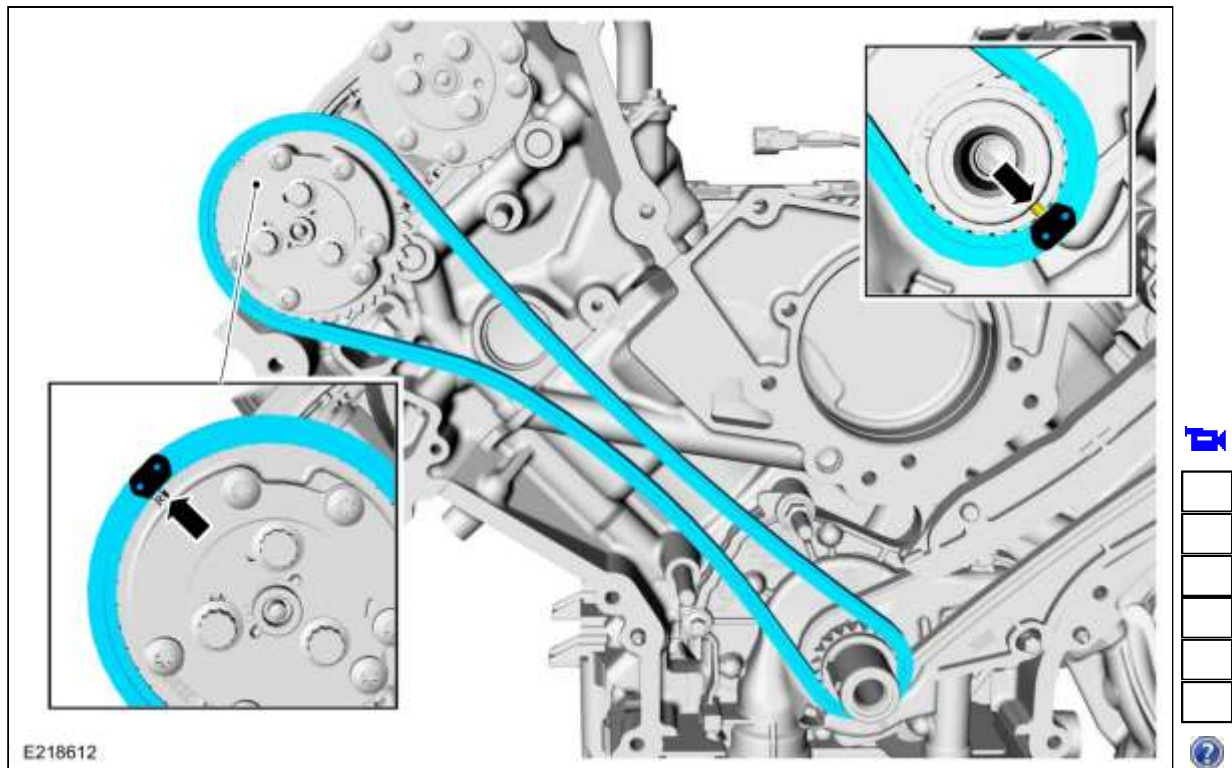
Stage 2: 90°





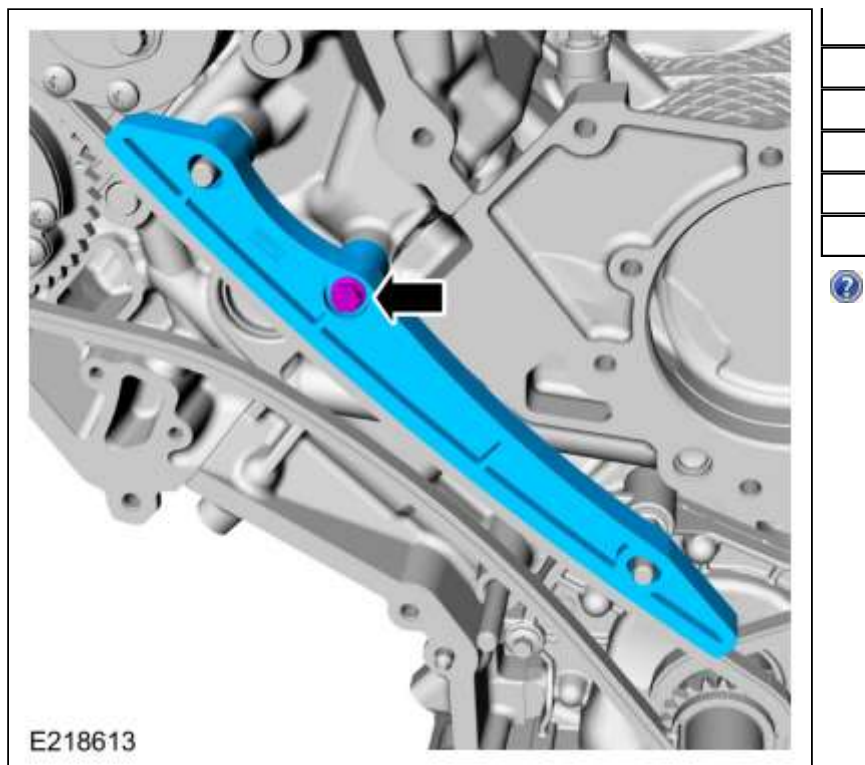
66. Install the RH timing chain.

- Align the colored link on the timing chain with the timing mark on the RH VCT assembly.
- Align the remaining colored link on the timing chain with the timing mark on the crankshaft sprocket.



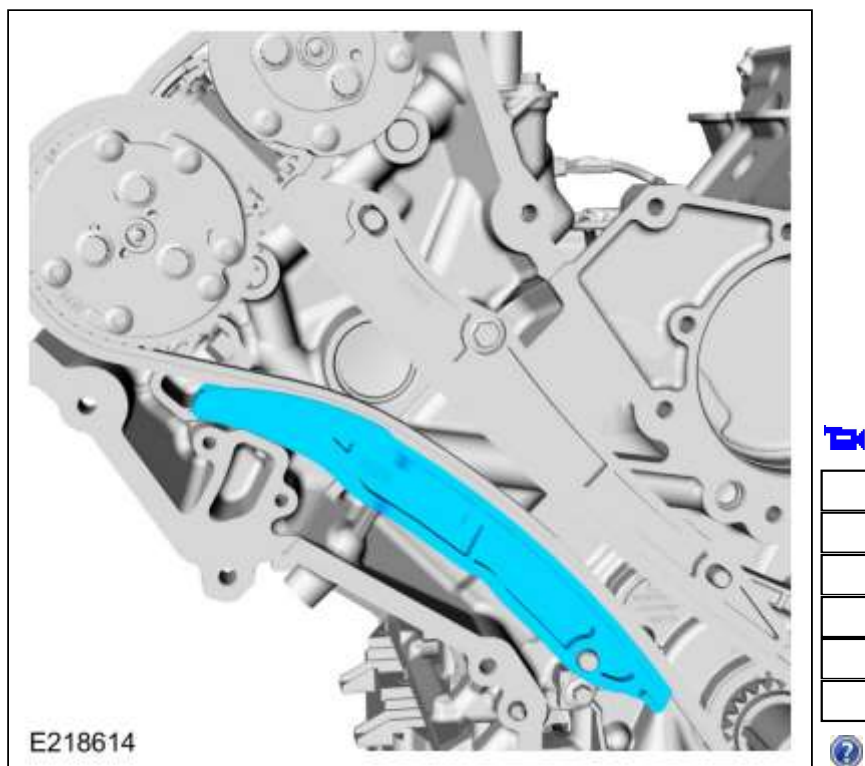
67. **NOTE:** It may be necessary to rotate the crankshaft slightly to provide enough slack in the chain to install the RH timing chain guide. Return the crankshaft keyway to the 9:30 position after installing the RH timing chain guide.

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



68. **NOTE:** It may be necessary to rotate the crankshaft slightly to provide enough slack in the chain to install the RH timing chain arm. Return the crankshaft keyway to the 9:30 position after installing the RH timing chain arm.

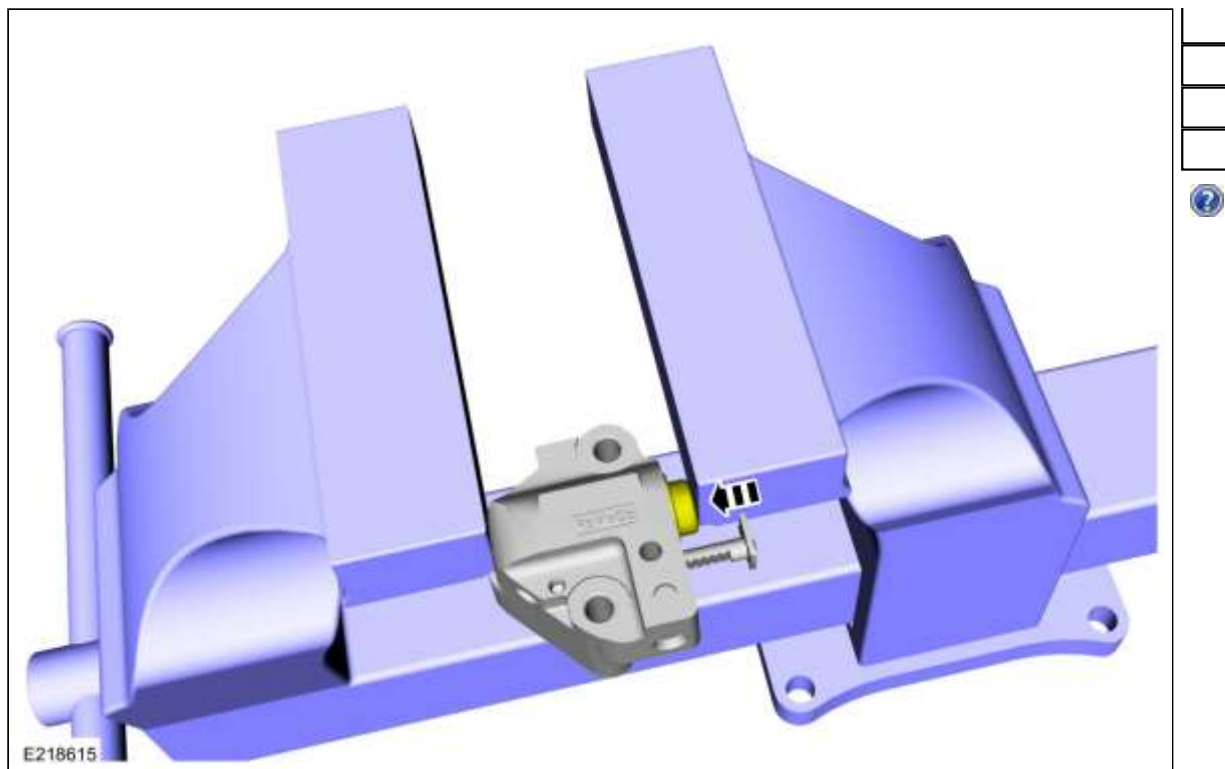
Install the RH timing chain tensioner arm.



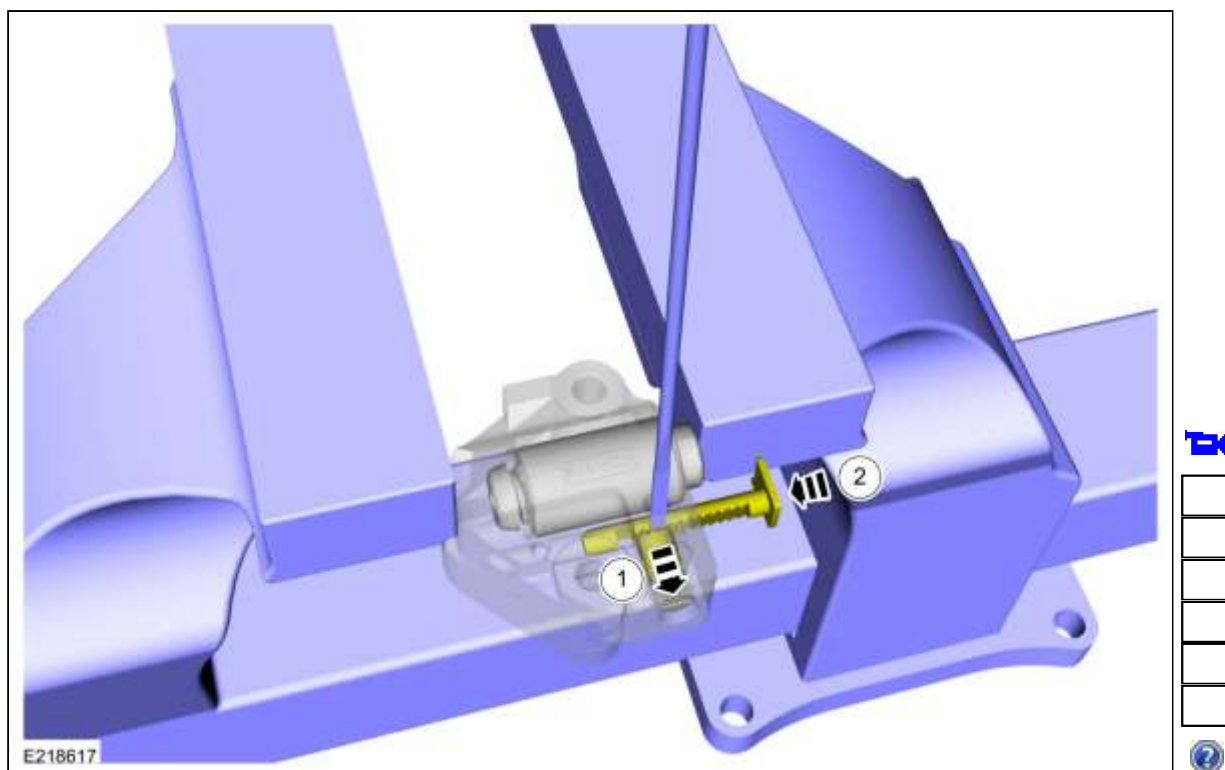
69. Compress the primary timing chain tensioner plunger, using an edge of a vise.



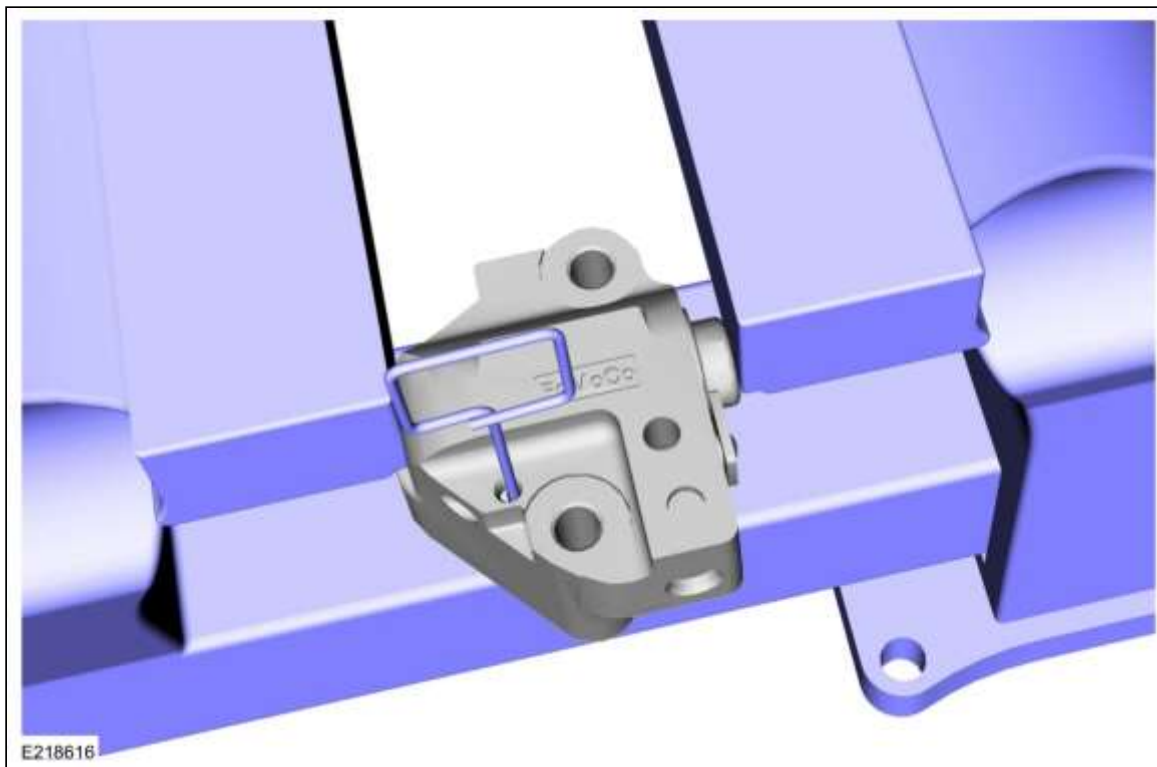




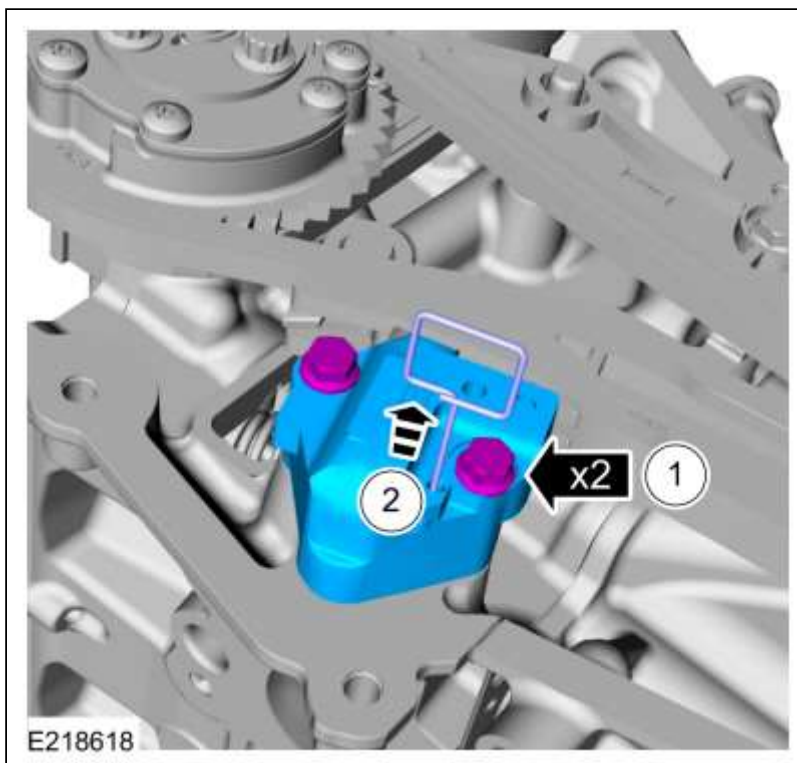
70. 1. Using a small screwdriver, release and hold the ratchet lock mechanism.  
2. Push the ratchet arm into the tensioner.



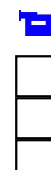
71. Install a pin into the hole of the tensioner housing to hold the plunger in place during installation.

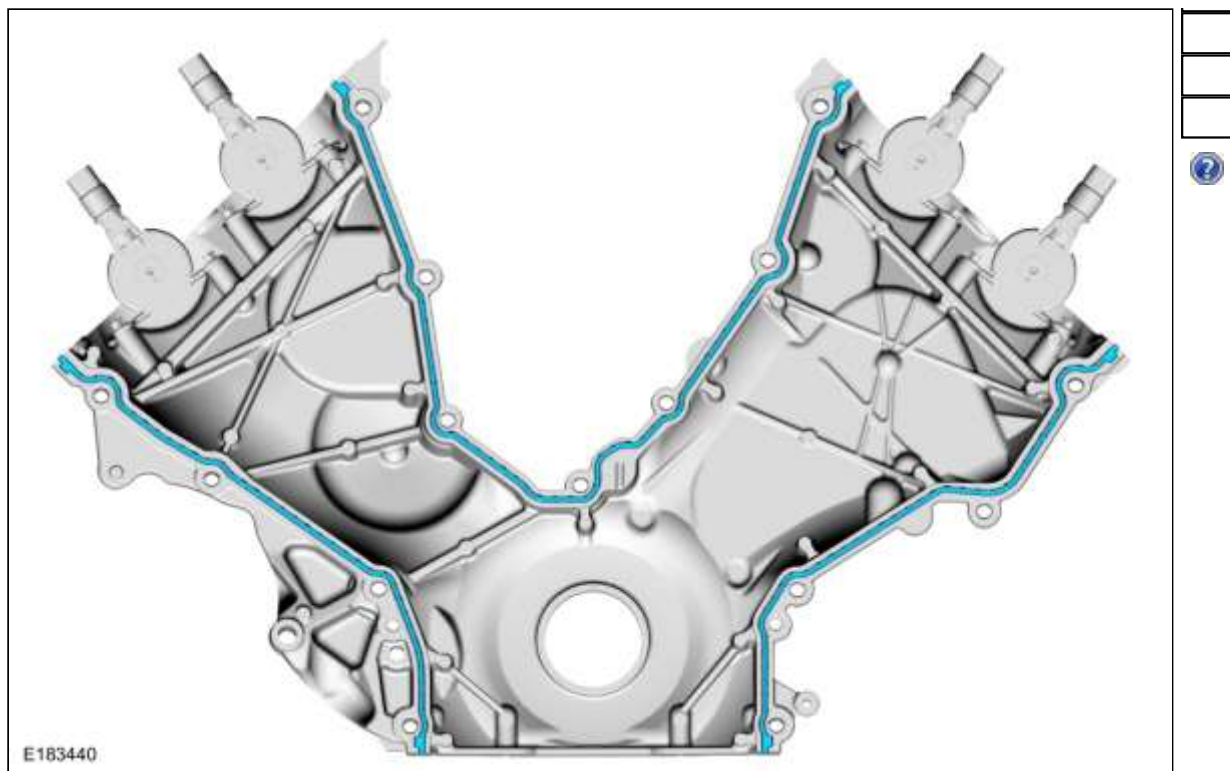


72. 1. Install the RH primary timing chain tensioner and bolts.  
*Torque: 89 lb.in (10 Nm)*  
 2. Remove the holding pin from the tensioner.



73. Install new gaskets on the engine front cover.

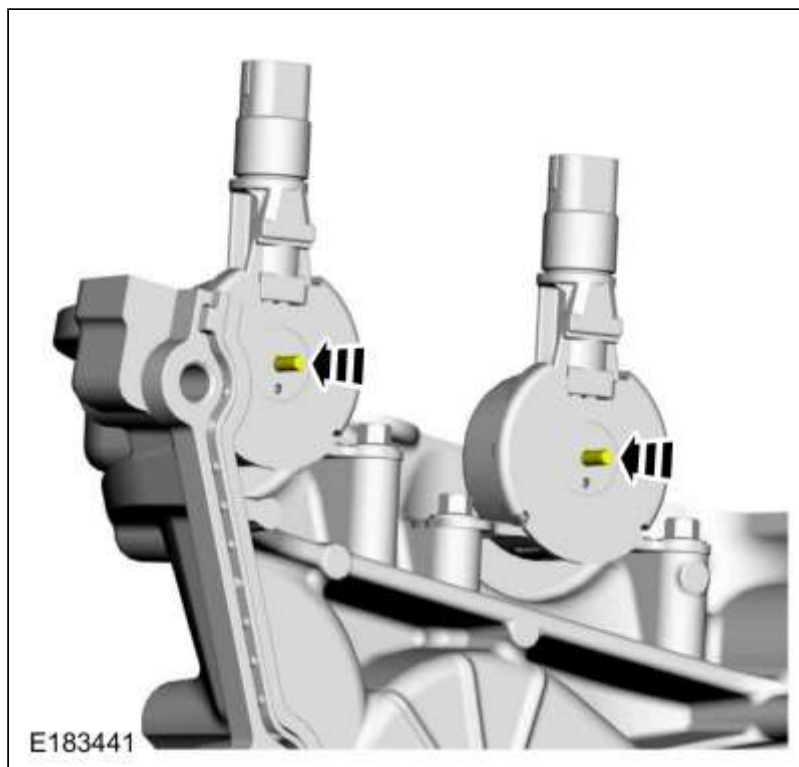




74. **NOTICE:** The VCT variable force solenoid pins must be fully depressed to avoid interference with the VCT valve tips when installing the engine front cover. Failure to follow these instructions can result in damage to the engine.

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

Fully depress the VCT variable force solenoid pins.

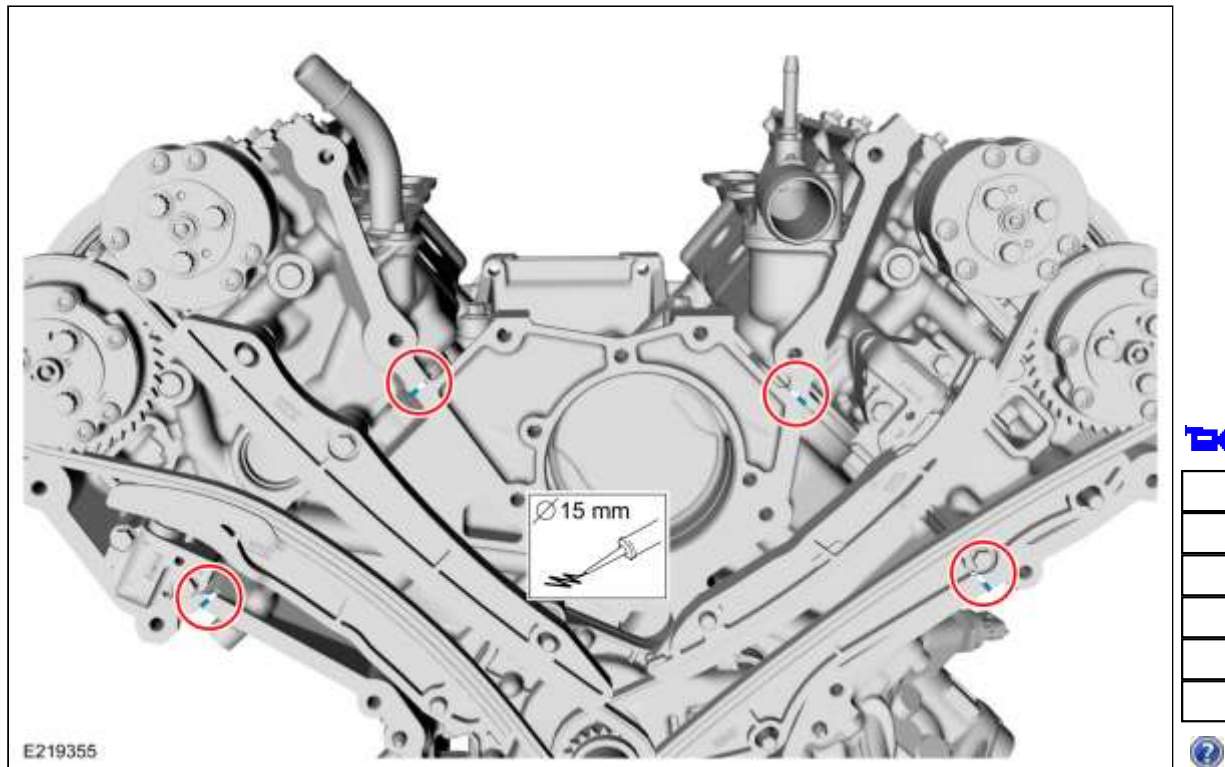


75. **NOTICE:** The engine front cover must be installed and all fasteners final tightened within 5 minutes of applying the sealer. If this cannot be accomplished, install the engine front cover and tighten fasteners 6, 7, 8, 9, 10 and 11 to 8 Nm (71 lb-in) within 5 minutes of applying the sealer. All of the fasteners must then be

final tightened within 1 hour of applying the sealer. If this time limit is exceeded, all sealant must be removed and the sealing area cleaned. Failure to follow this procedure can cause future oil leakage.

Apply a 15 mm (0.59 in) diameter drop of silicone gasket and sealant to the cylinder head-to-cylinder block joints and the oil pan-to-cylinder block joints.

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



76. **NOTICE:** The engine front cover must be installed and all fasteners final tightened within 5 minutes of applying the sealer. If this cannot be accomplished, install the engine front cover and tighten fasteners 6, 7, 8, 9, 10 and 11 to 8 Nm (71 lb-in) within 5 minutes of applying the sealer. All of the fasteners must then be final tightened within 1 hour of applying the sealer. If this time limit is exceeded, all sealant must be removed and the sealing area cleaned. Failure to follow this procedure can cause future oil leakage.

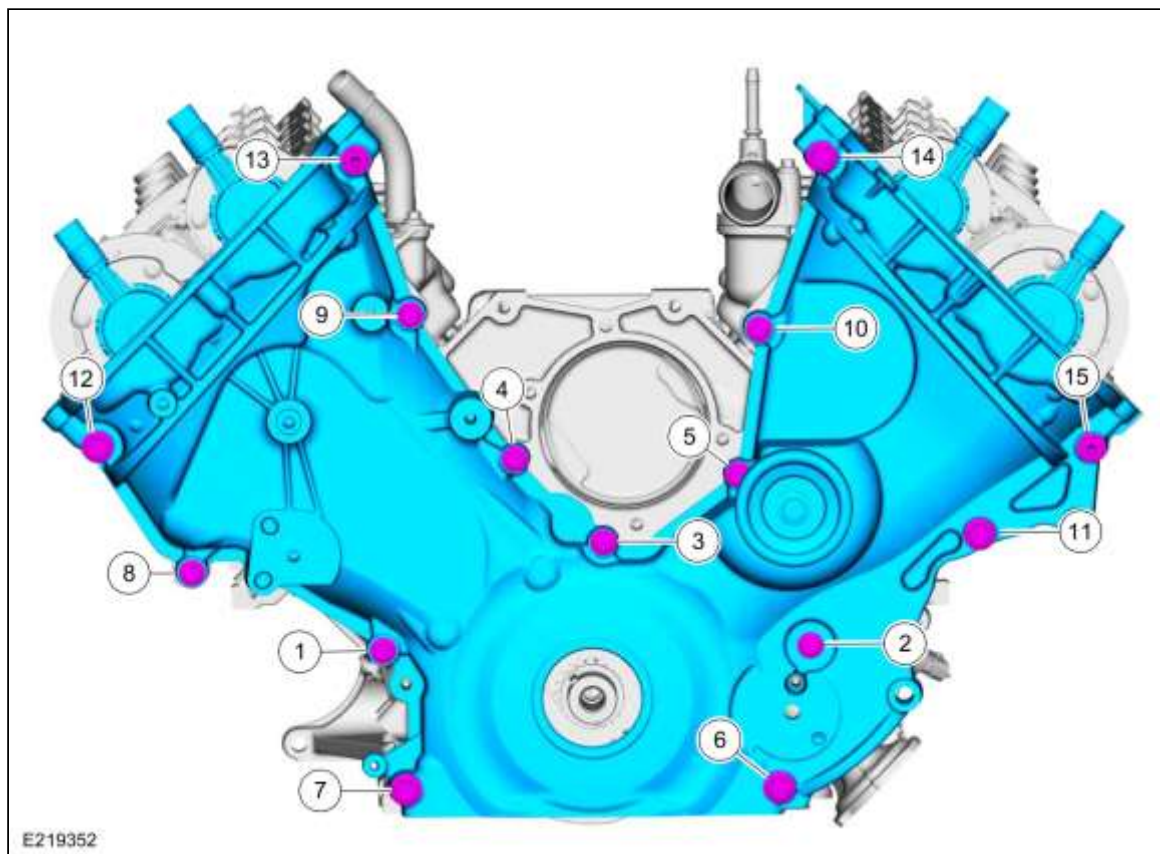
Install the engine front cover and the fasteners.

*Torque:*

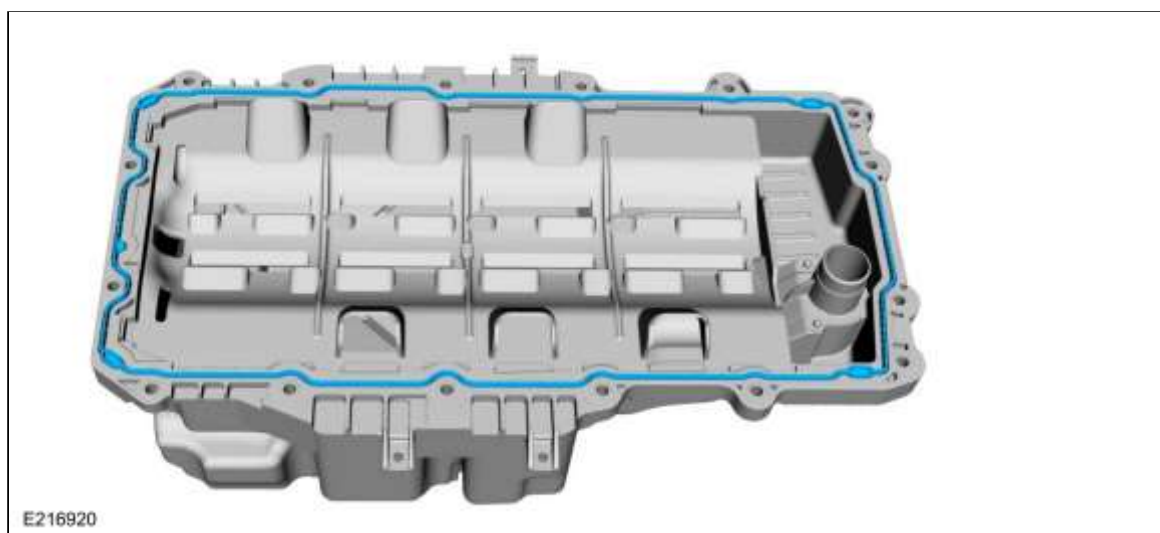
- Stage 1: Fasteners 1-15 : 18 lb.ft (25 Nm)
- Stage 2: Fasteners 16-19 : 89 lb.in (10 Nm)
- Stage 3: Fasteners 1-15 : 60°
- Stage 4: Fasteners 16-19 : 45°



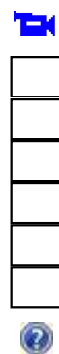


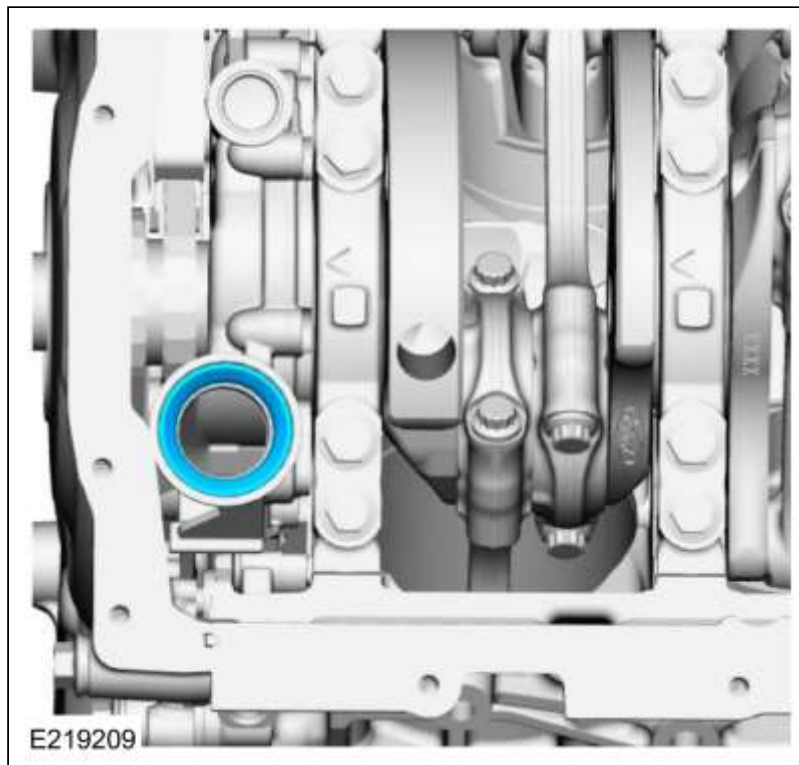


77. Install a new oil pan gasket.

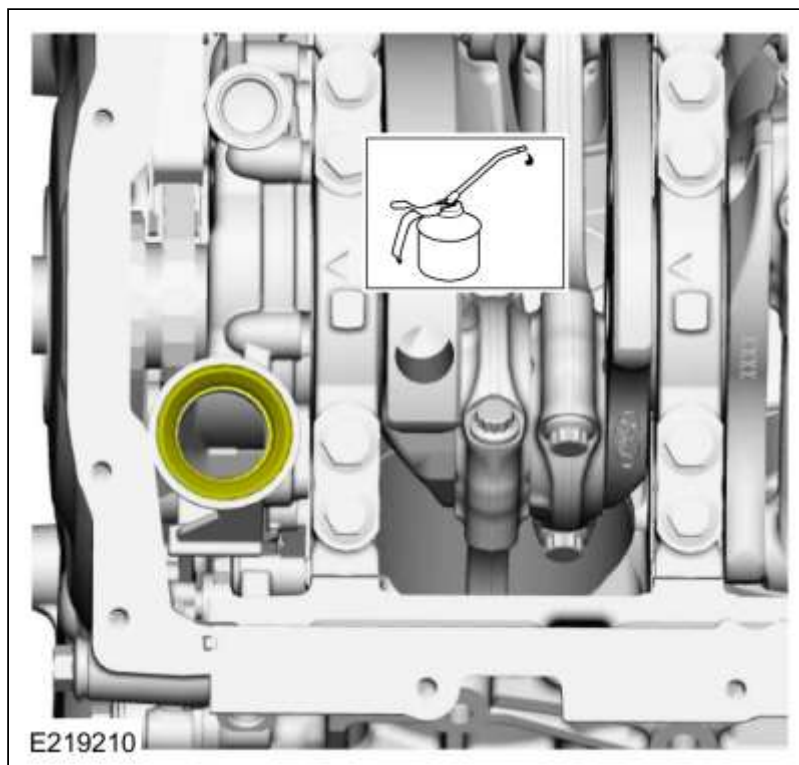


78. Install a new oil pump pickup seal.





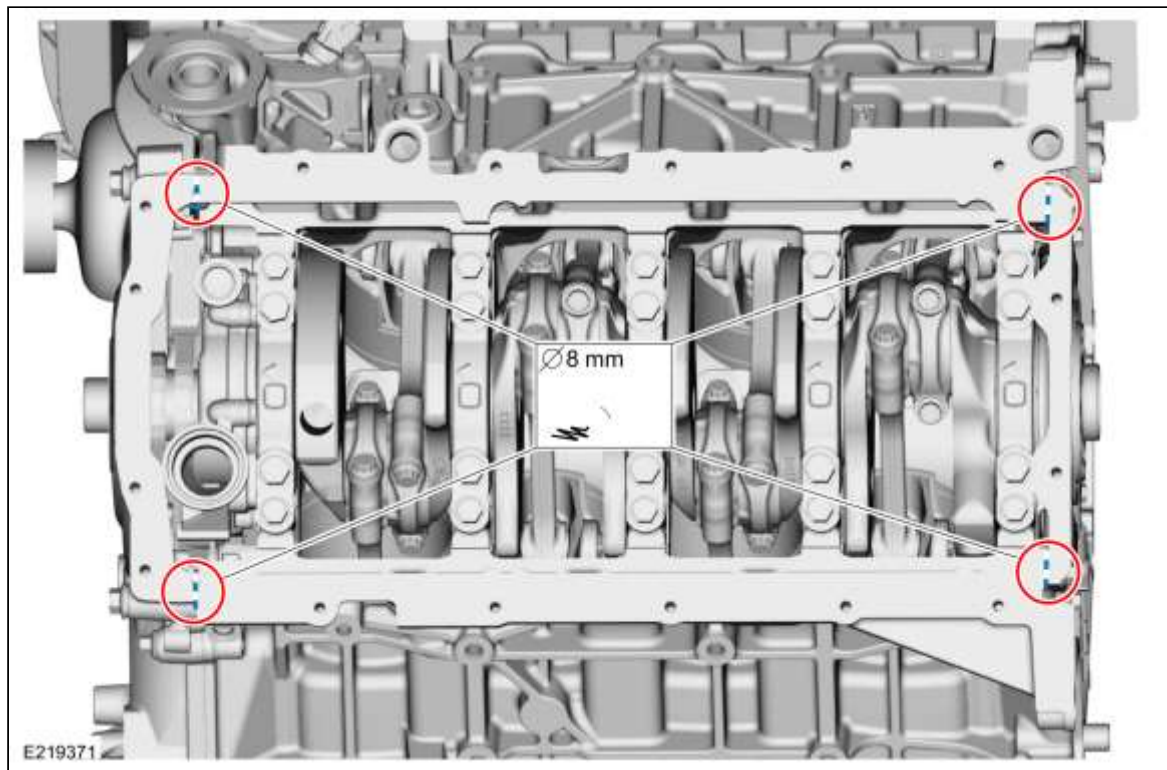
79. Lubricate the inner bore of the oil pump pickup seal with clean engine oil.  
 Material: Motorcraft® SAE 5W-50 Full Synthetic Motor Oil / XO-5W50-QGT (WSS-M2C931-C)



80. **NOTE:** If the oil pan is not installed and the fasteners tightened within 5 minutes, the sealant must be removed and the sealing area cleaned. Failure to follow this procedure can cause future oil leakage. If this timing cannot be met, tighten fasteners 6, 7, 13 and 15 to 8 Nm (71 lb-in) within 5 minutes of applying the sealer and final torque all of the fasteners within 1 hour of applying the sealer.

Apply an 8 mm (0.31 in) bead of silicone gasket and sealant to the crankshaft rear seal retainer plate-to-cylinder block sealing surfaces and the engine front cover-to-cylinder block sealing surfaces.

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



81. **NOTE:** If the oil pan is not installed and the fasteners tightened within 5 minutes, the sealant must be removed and the sealing area cleaned. Failure to follow this procedure can cause future oil leakage. If this timing cannot be met, tighten fasteners 6, 7, 13 and 15 to 8 Nm (71 lb-in) within 5 minutes of applying the sealer and final torque all of the fasteners within 1 hour of applying the sealer.

**NOTE:** Fastener locations 13, 14, 15 and 16 are stud bolts.

- Position the oil pan onto the engine and apply pressure to the outside of the oil pan at the pickup tube until the pickup tube is fully engaged into the oil pump seal.
- Install the fasteners.

*Torque:*

Stage 1: 89 lb.in (10 Nm)

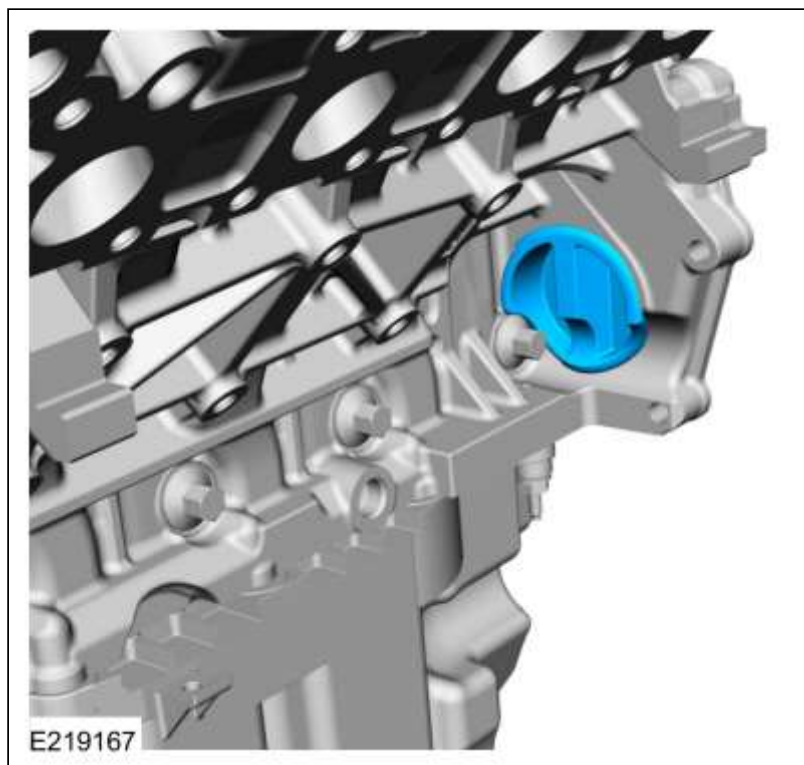
Stage 2: 45°



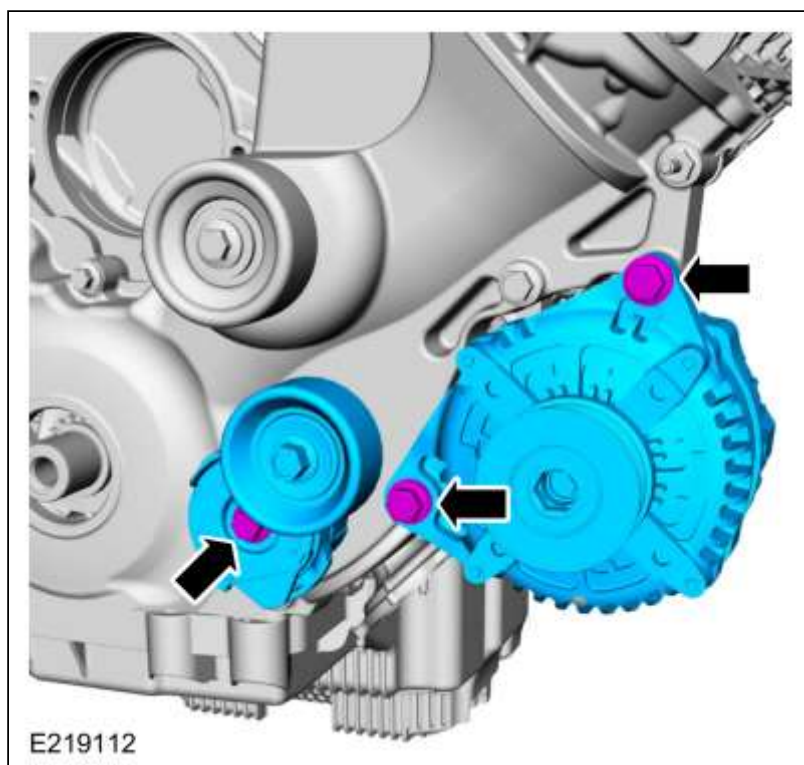






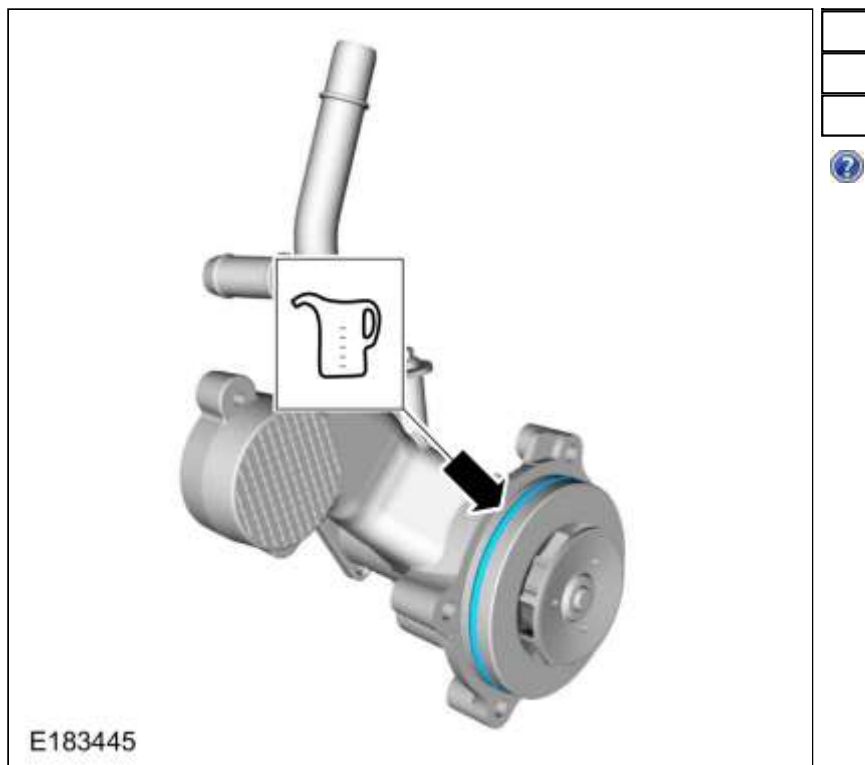


84. Install the generator, accessory drive belt tensioner and the fasteners.  
*Torque: 35 lb.ft (48 Nm)*



85. Install a new coolant pump O-ring seal and lubricate with clean engine coolant.  
*Material: Motorcraft® Orange Concentrated Antifreeze/Coolant / VC-3-B (WSS-M97B44-D)*



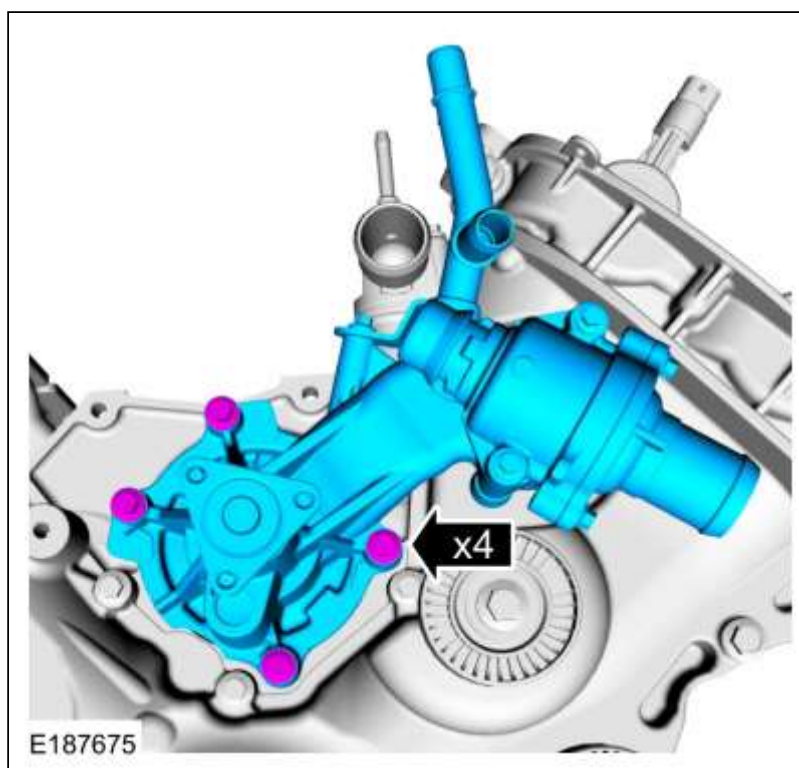


86. Install the coolant pump and bolts.

*Torque:*

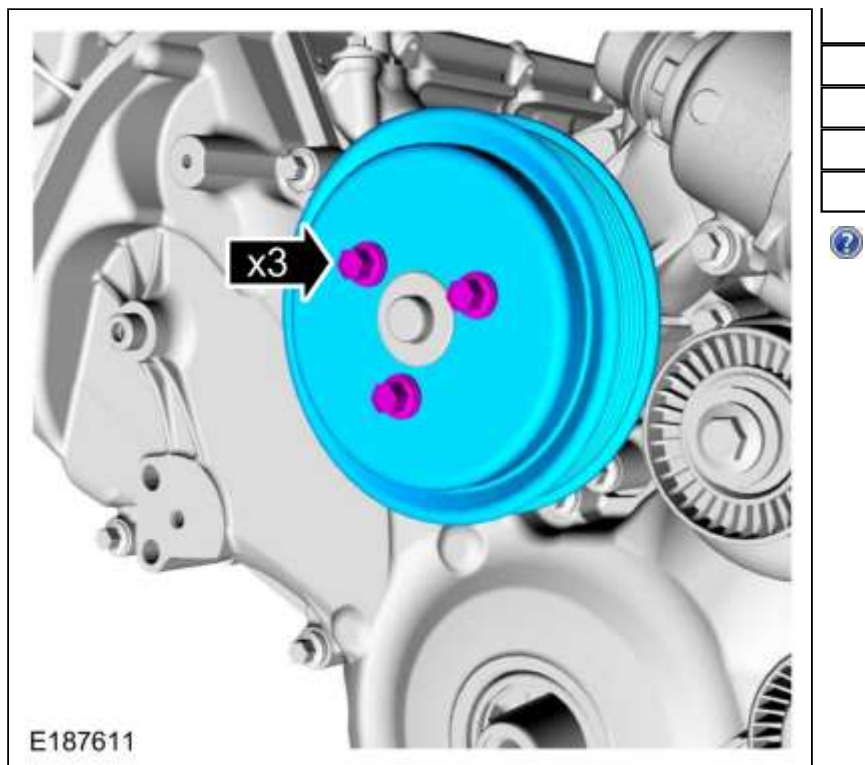
Stage 1: 177 lb.in (20 Nm)

Stage 2: 60°

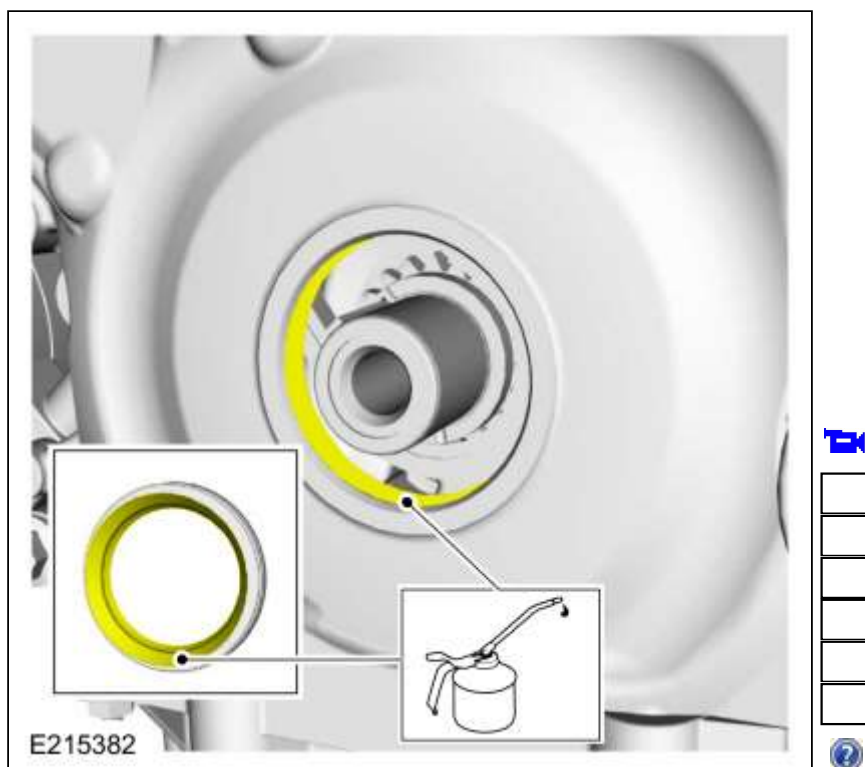


87. Install the coolant pump pulley and the bolts.

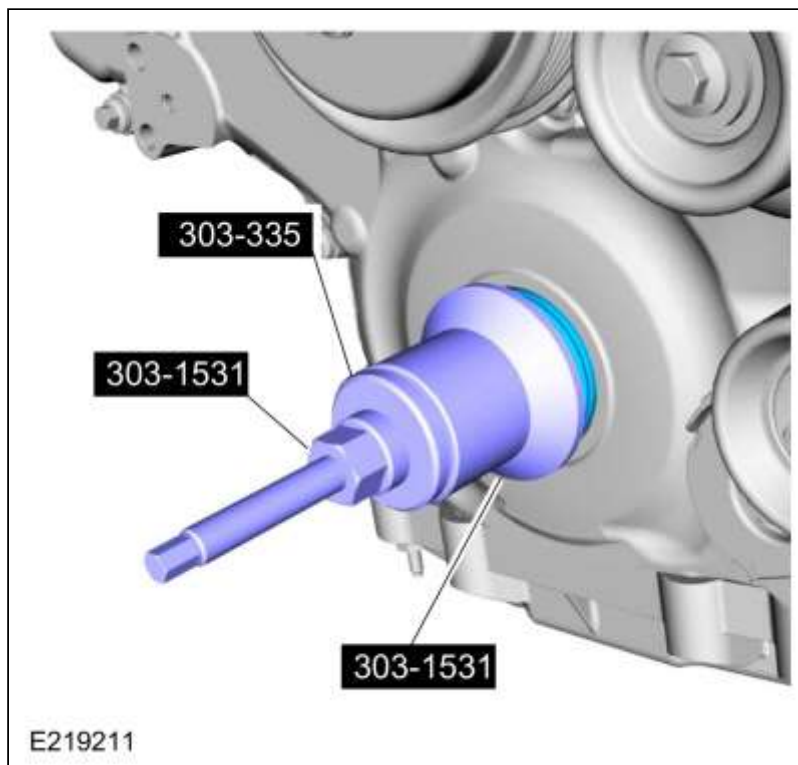
*Torque:* 18 lb.ft (25 Nm)



88. Lubricate the engine front cover bore and the crankshaft front oil seal inner lip with clean engine oil.  
*Material: Motorcraft® SAE 5W-50 Full Synthetic Motor Oil / XO-5W50-QGT (WSS-M2C931-C)*



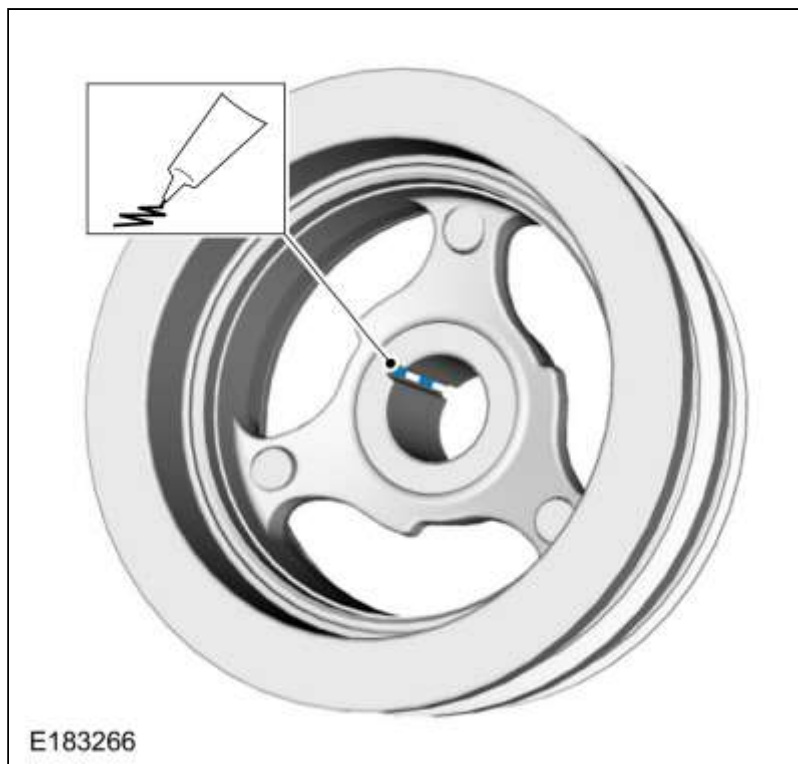
89. Using the special tools, install the new crankshaft front oil seal.  
 Use Special Service Tool: [303-335 \(T88T-6701-A\) Installer, Front Cover Oil Seal.](#) , [303-1531 Installer, Front Crank Seal and Damper.](#)



90. **NOTE:** If not secured within 5 minutes, the sealant must be removed and the sealing area cleaned. Failure to follow this procedure can cause future oil leakage.

Apply silicone sealant to the Woodruff key slot in the crankshaft pulley.

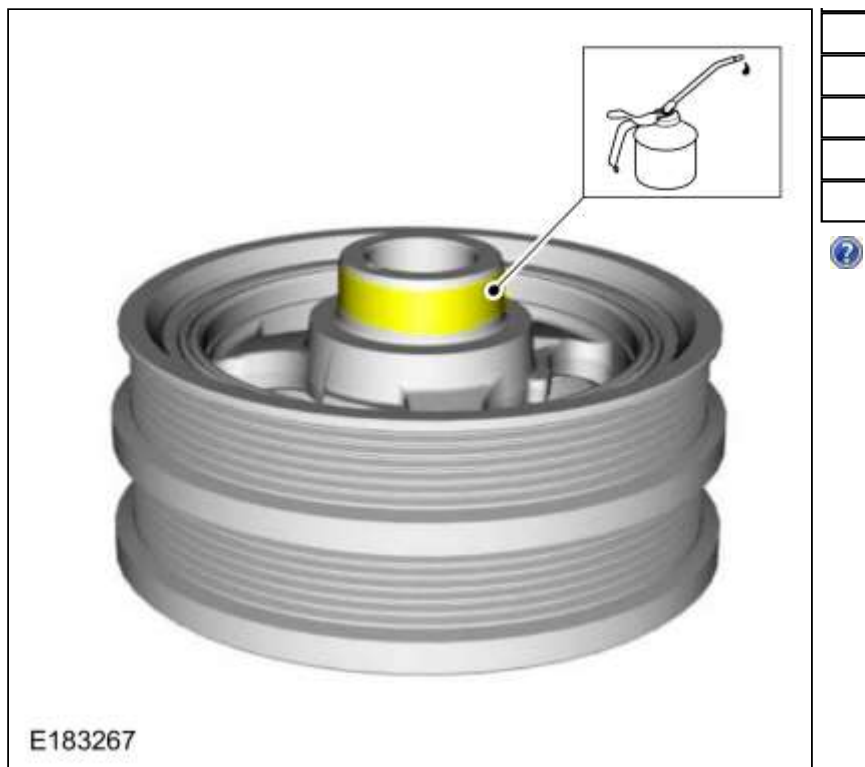
Material: Motorcraft® High Performance Engine RTV Silicone / TA-357 (WSE-M4G323-A6)



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

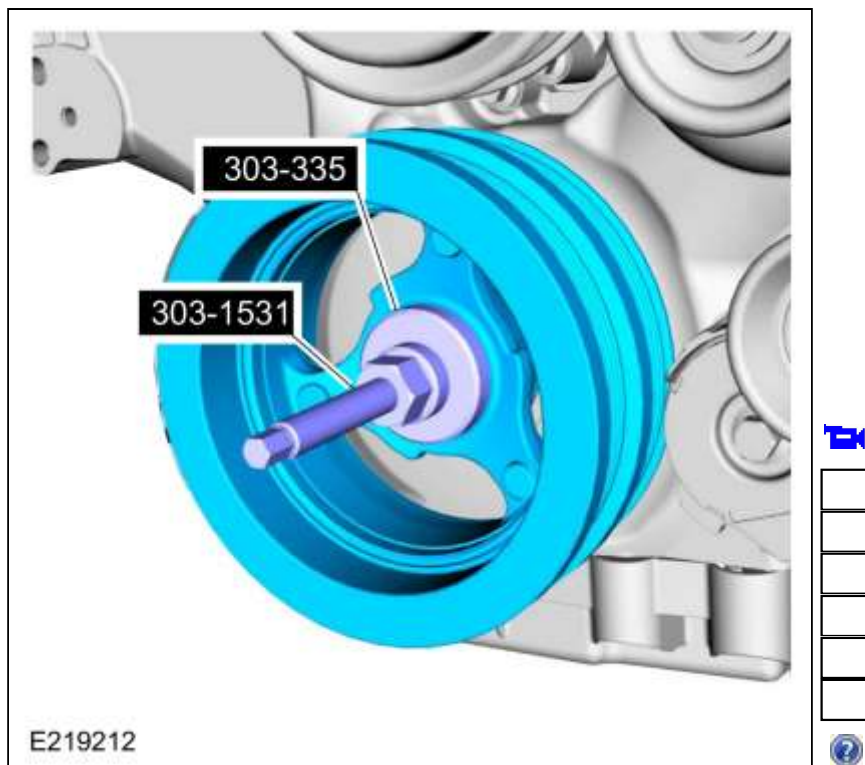
Material: Motorcraft® SAE 5W-50 Full Synthetic Motor Oil / XO-5W50-QGT (WSS-M2C931-C)





92. 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.](#)



93. Using the Strap Wrench, install a new crankshaft pulley bolt and the original washer.

Use the General Equipment: Strap Wrench

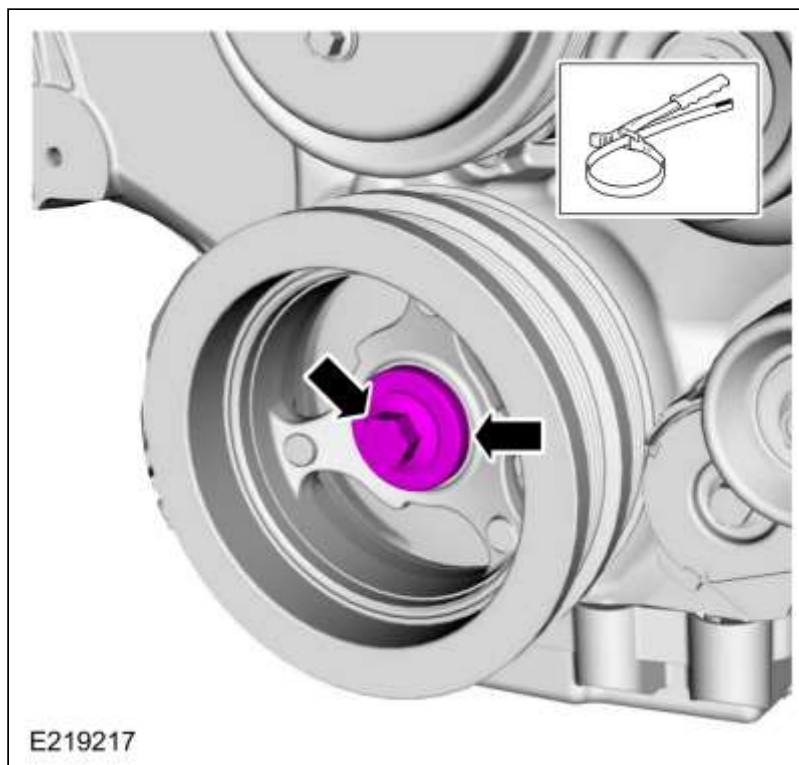
*Torque:*

Stage 1: 103 lb.ft (140 Nm)

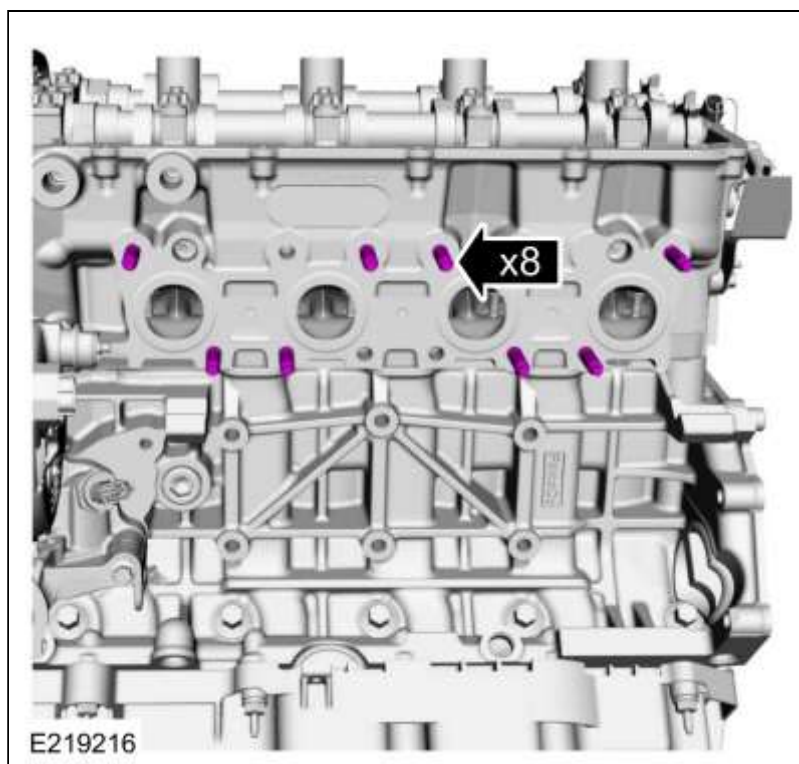
Stage 2: Loosen: 360°

Stage 3: 96 lb.ft (130 Nm)

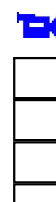
Stage 4: Tighten an additional : 90°

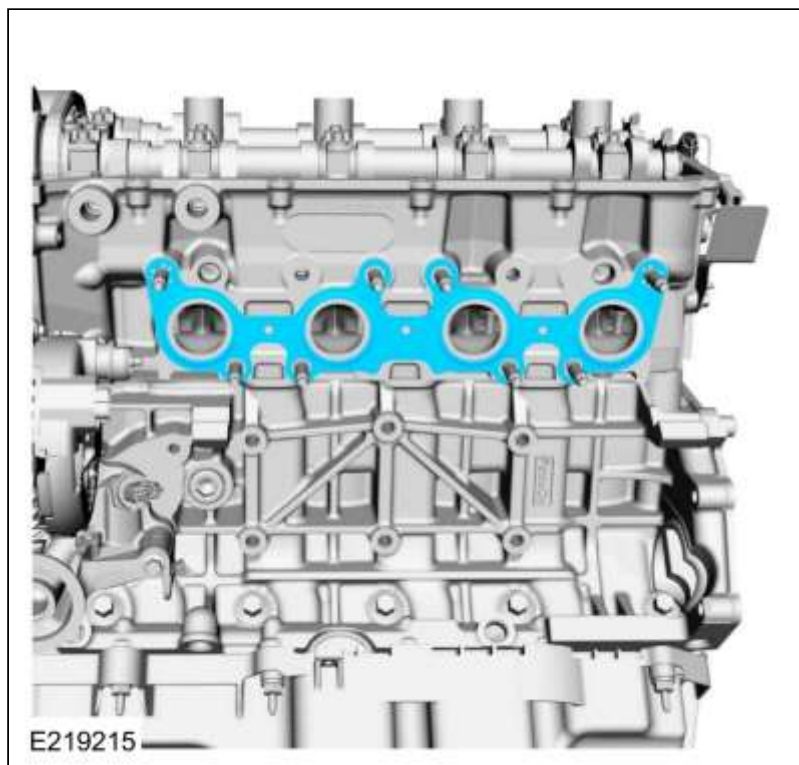


94. Install new studs.  
Torque: 18 lb.ft (25 Nm)

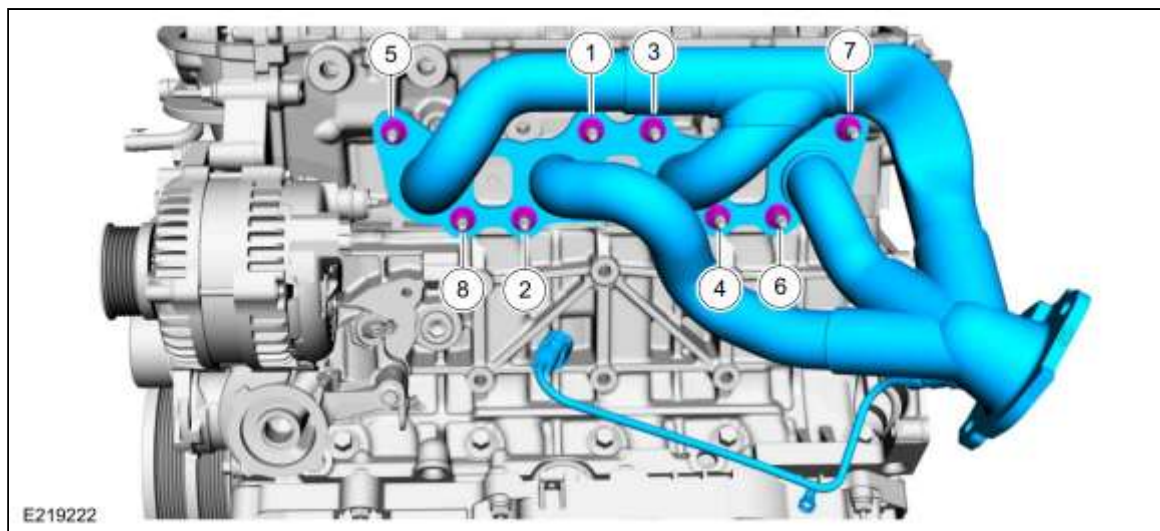


95. Install a new gasket.

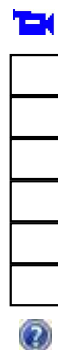


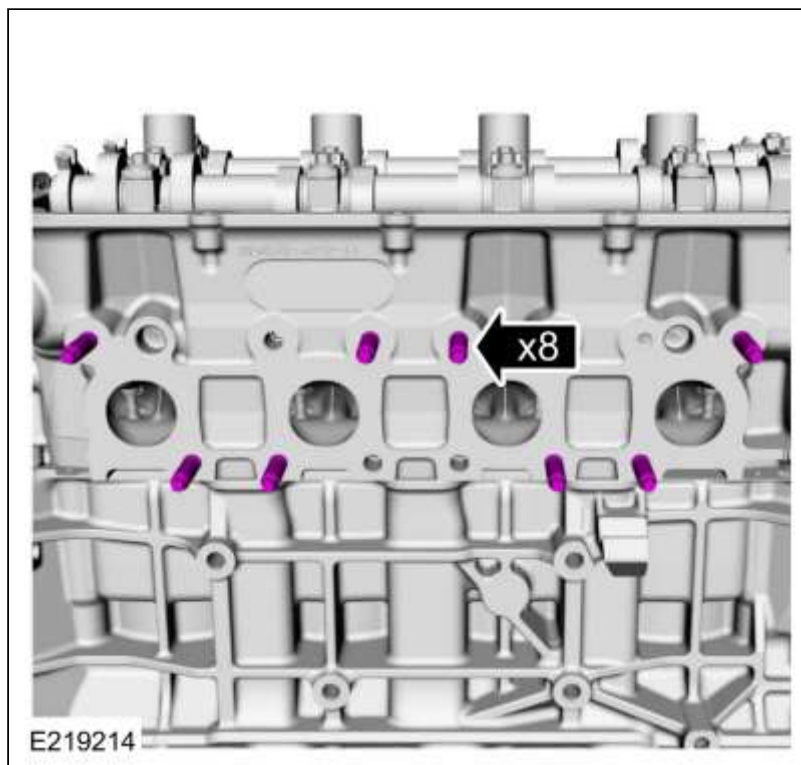


96. 1. Position the exhaust manifold onto the engine and finger-tighten the nuts.  
 2. Tighten the nuts in the sequence shown.  
*Torque: 24 lb.ft (32 Nm)*

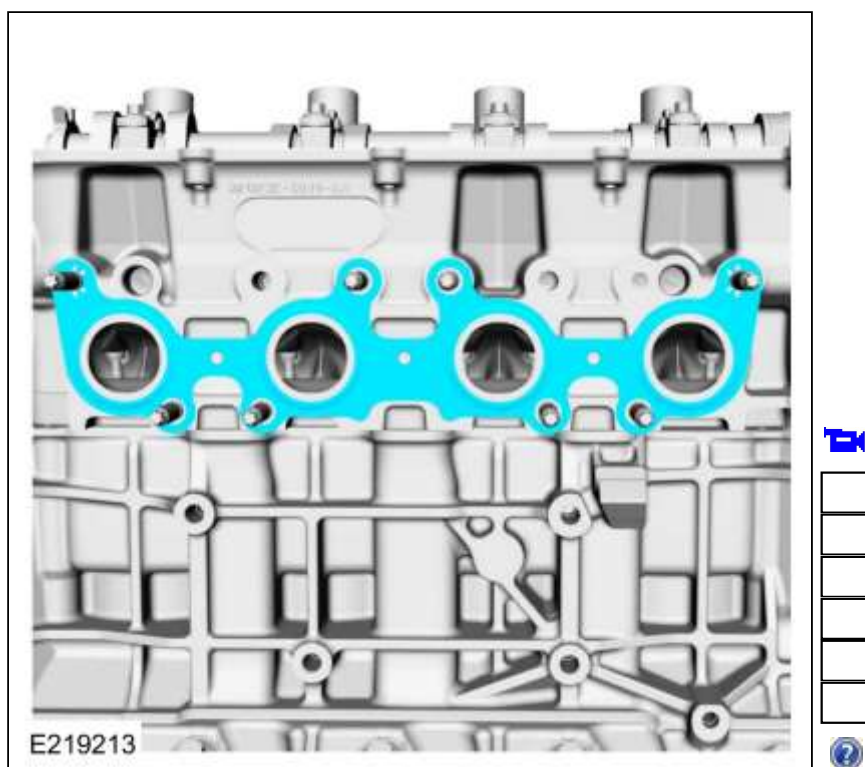


97. Install new studs.  
*Torque: 18 lb.ft (25 Nm)*





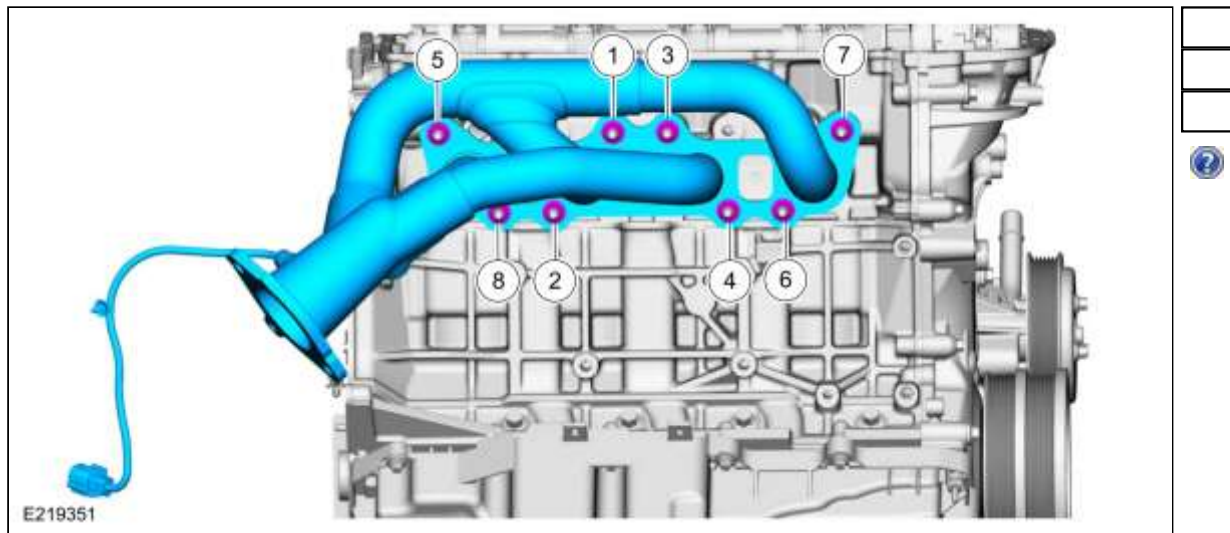
98. Install a new gasket.



99. 1. Position the exhaust manifold onto the engine and finger-tighten the nuts.  
 2. Tighten the nuts in the sequence shown.  
*Torque: 24 lb.ft (32 Nm)*



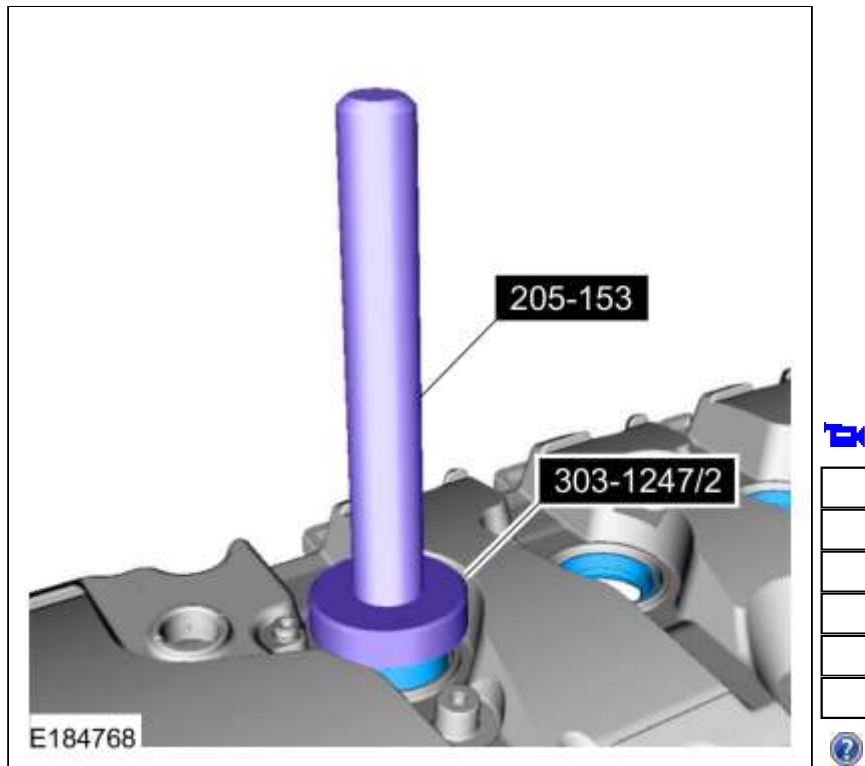




100. **NOTE:** Installation of new seals is only required if damaged seals were removed.

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

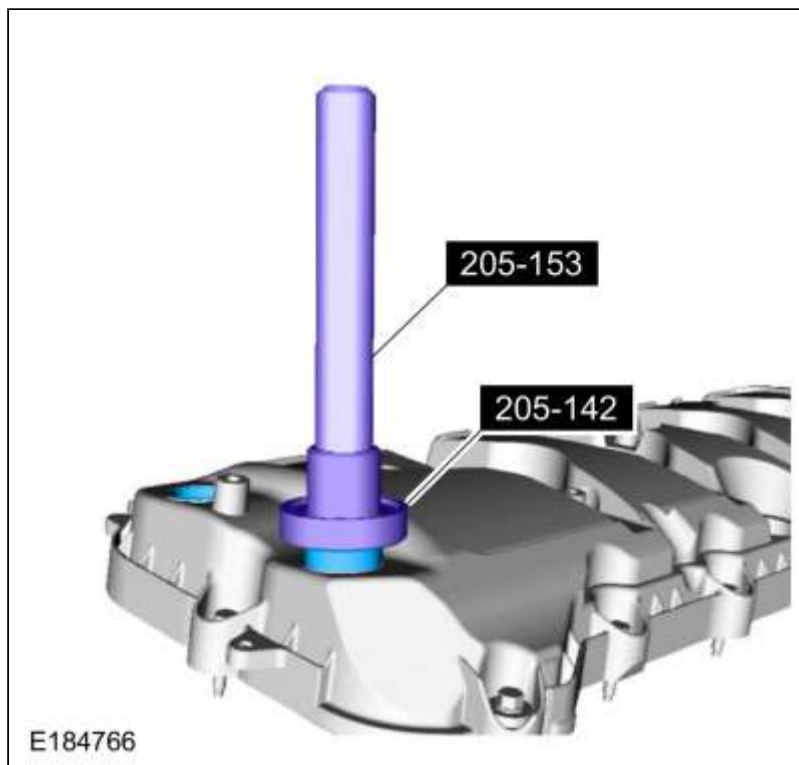
Use Special Service Tool: [205-153 \(T80T-4000-W\) Handle.](#) , [303-1247 VCT Spark Plug Tube Seal Remover and Installer.](#)



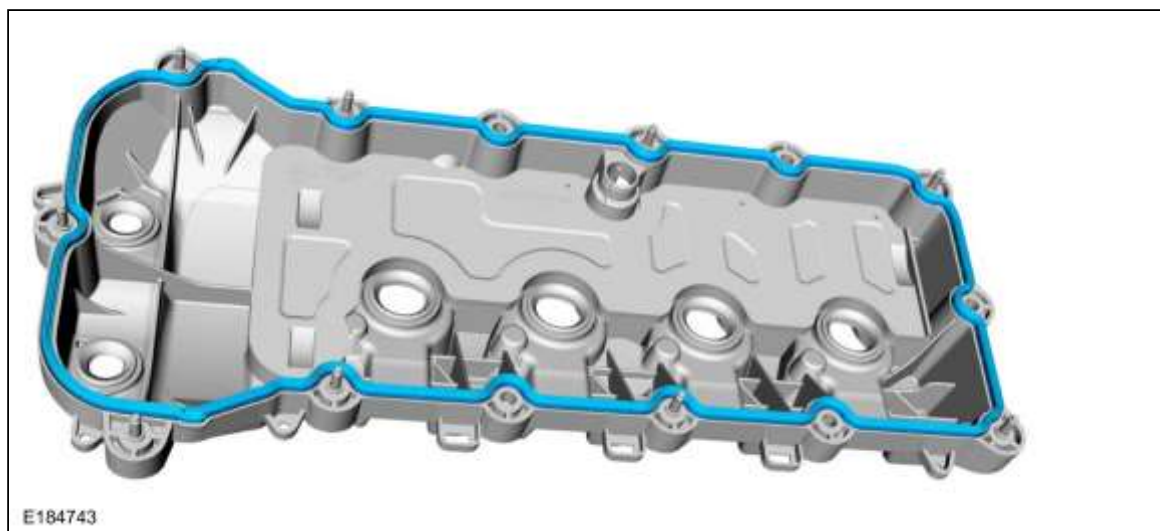
101. **NOTE:** Installation of new seals is only required if damaged seals were removed.

Using the special tools, install new VCT variable force solenoid seals.

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

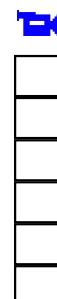


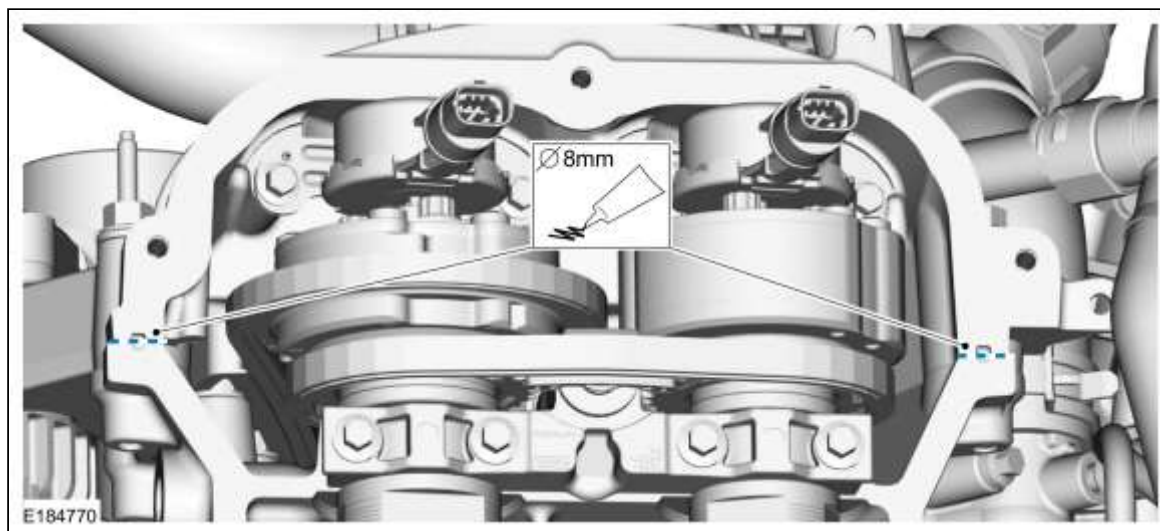
102. Install a new gasket.



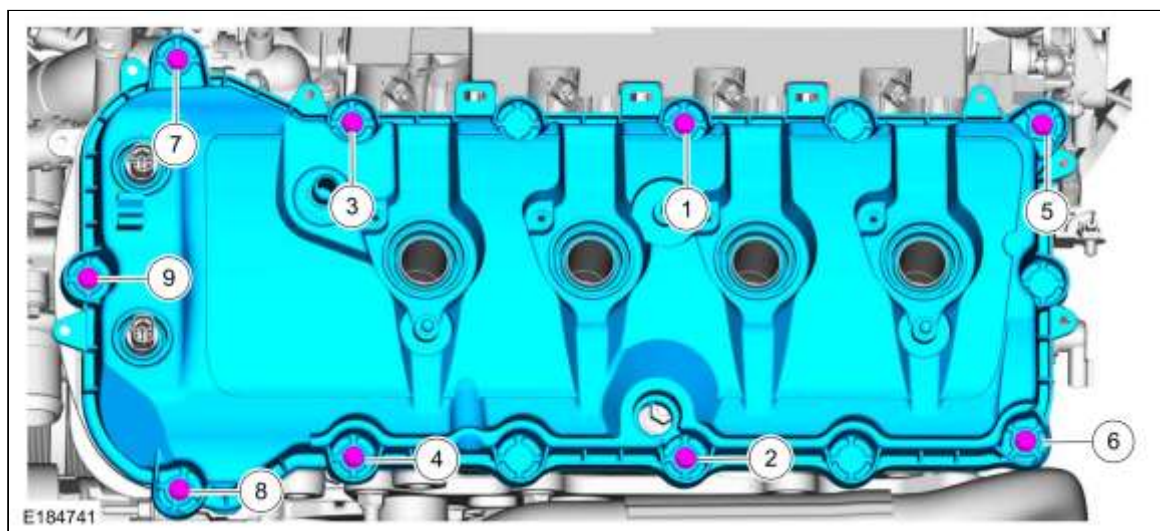
103. **NOTICE: If the valve cover is not installed and the fasteners tightened within 5 minutes, the sealant must be removed and the sealing area cleaned.**

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

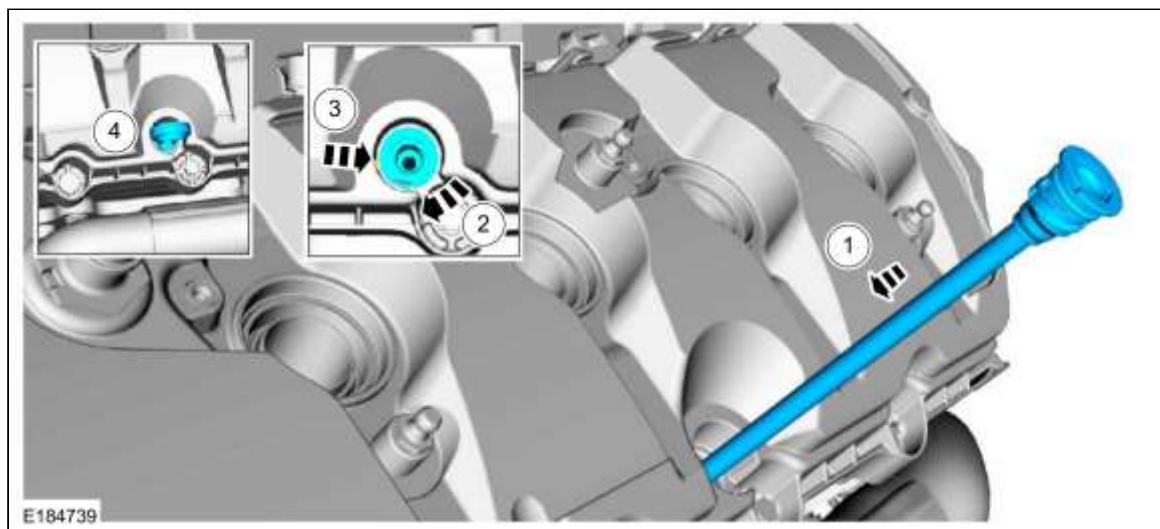




104. Install the valve cover and tighten the bolts.  
*Torque: 89 lb.in (10 Nm)*



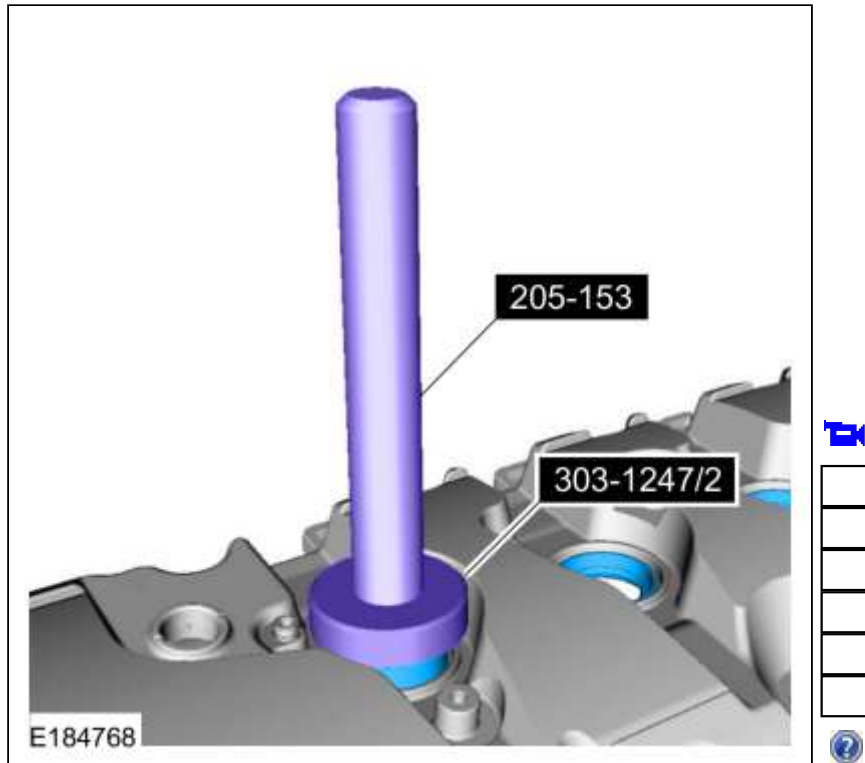
105. 1. Push the oil level indicator tube into the engine.  
 2. Rotate the oil level indicator tube clockwise.  
 3. Verify the tab is locked in place.  
 4. Install the oil level indicator.



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

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

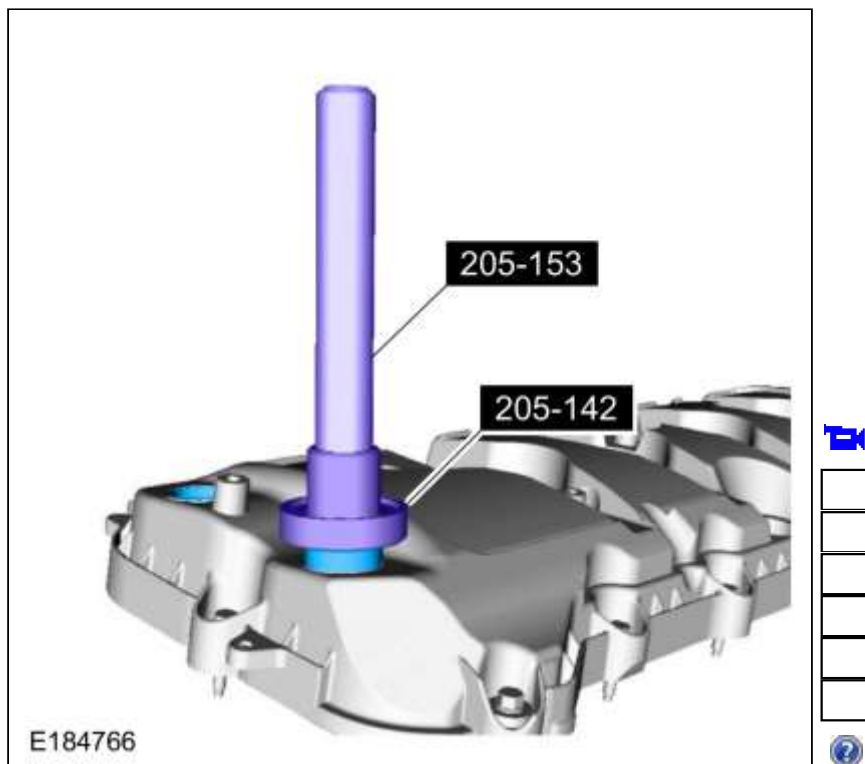
Use Special Service Tool: [205-153 \(T80T-4000-W\) Handle.](#) , [303-1247 VCT Spark Plug Tube Seal Remover and Installer.](#)



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

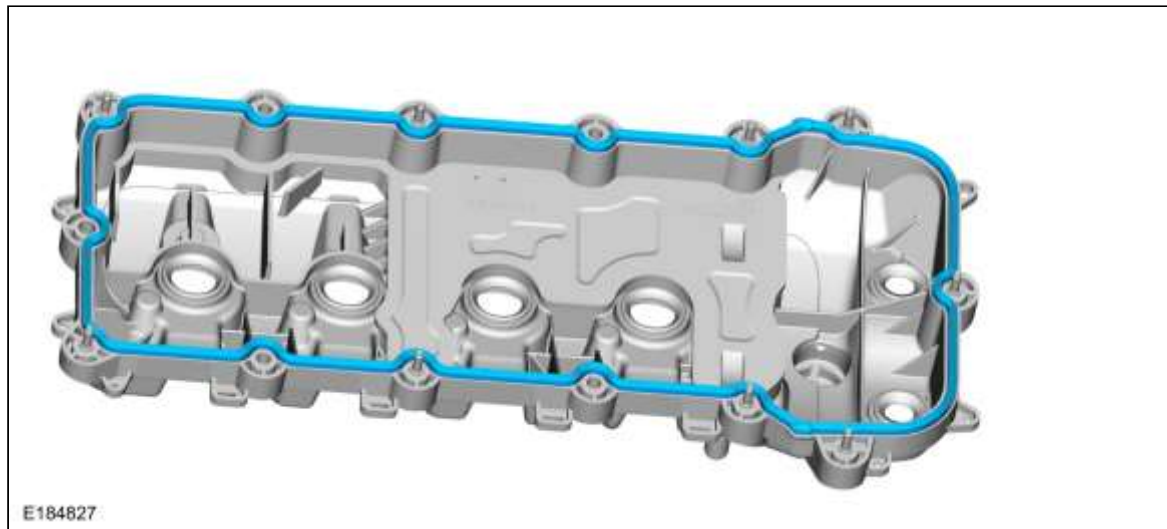
Using the special tools, install new VCT variable force solenoid seals.

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



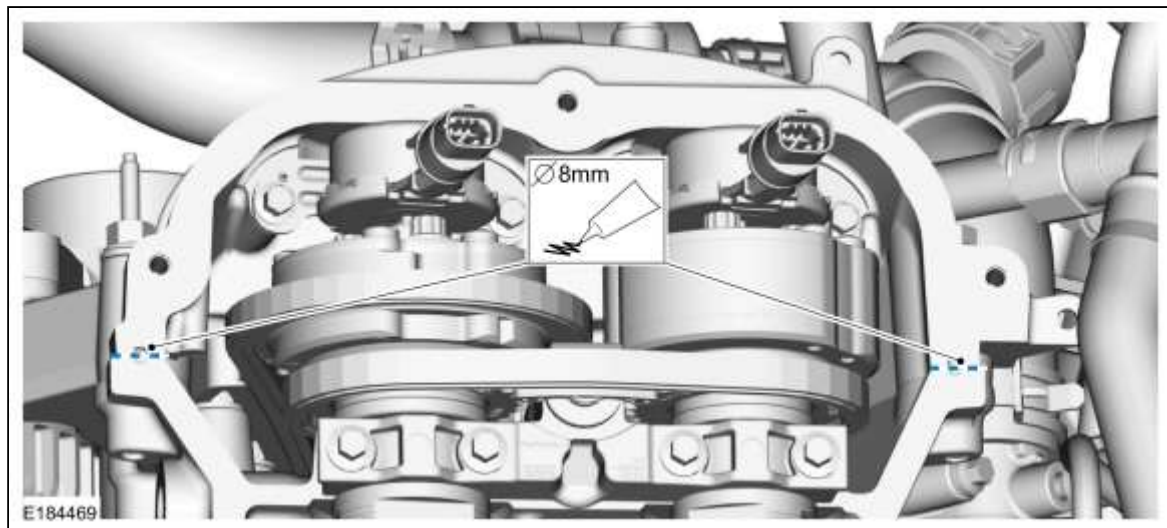


108. Install a new gasket.



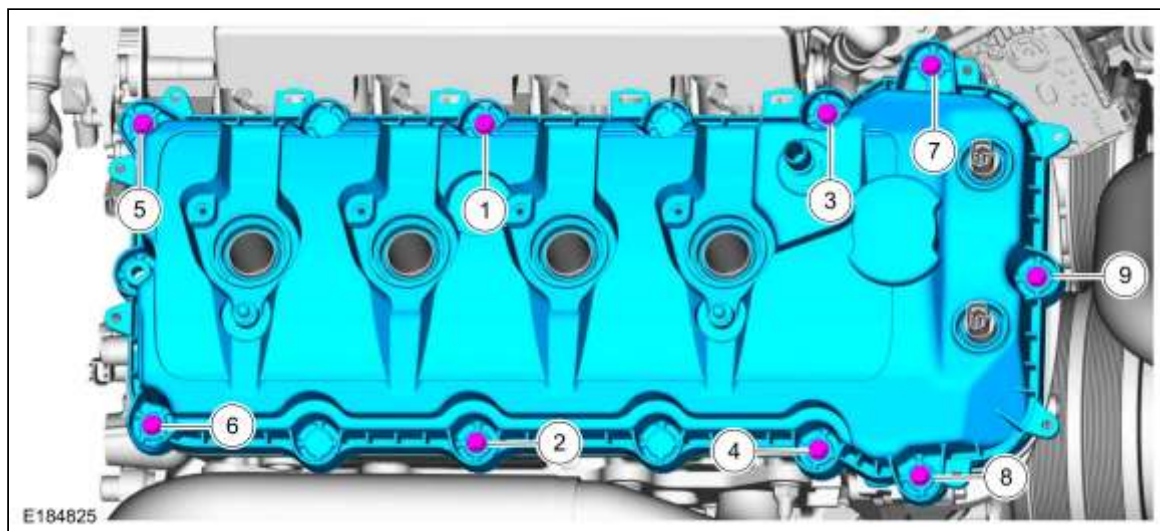
109. **NOTICE:** If the valve cover is not installed and the fasteners tightened within 5 minutes, the sealant must be removed and the sealing area cleaned.

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



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



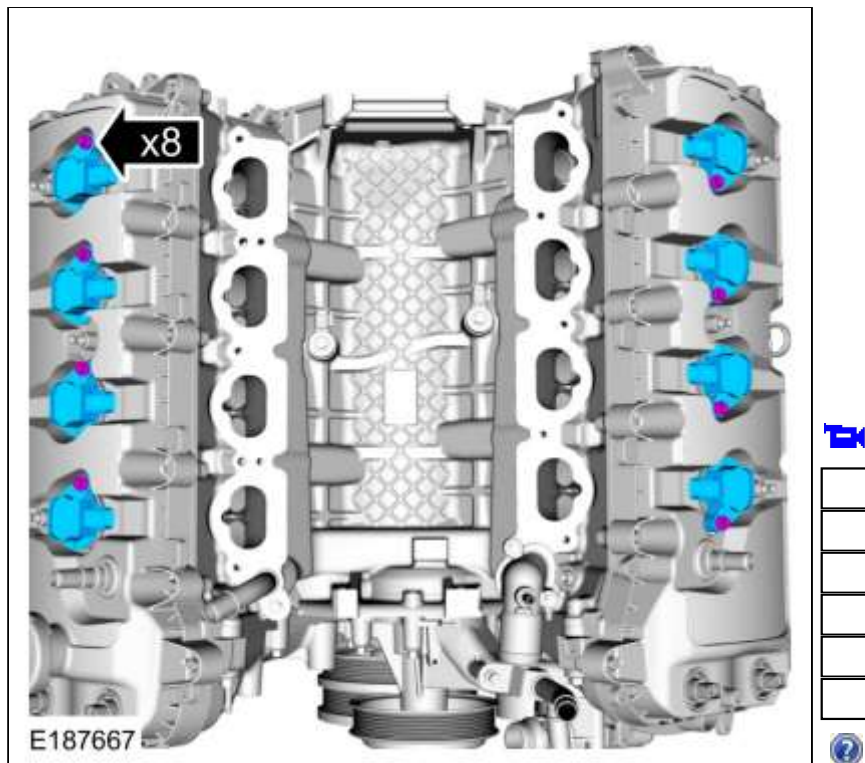


111. Install the ignition coils and the bolts.

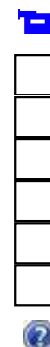
*Torque:*

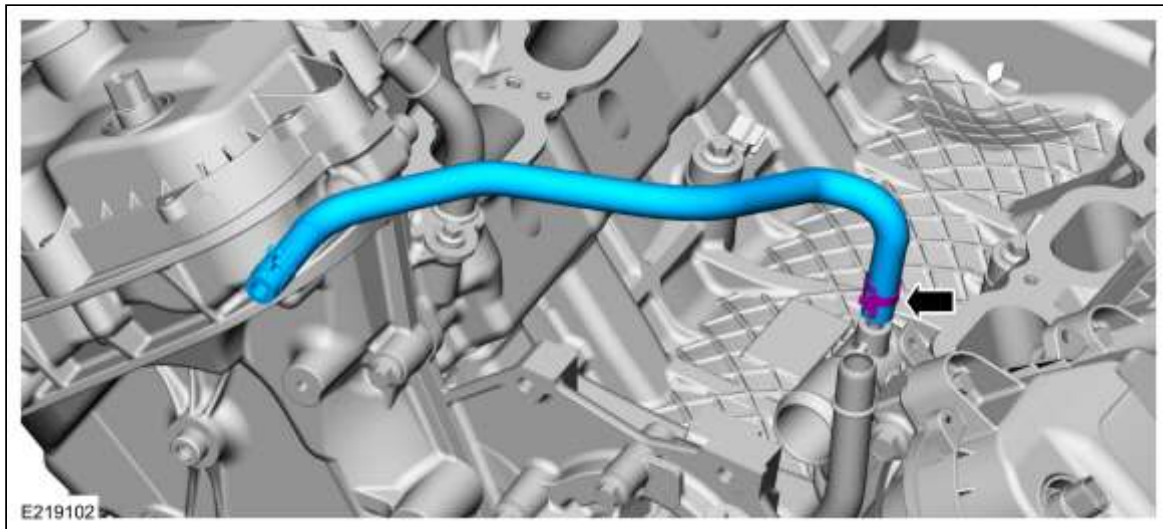
Stage 1: 62 lb.in (7 Nm)

Stage 2: 50°

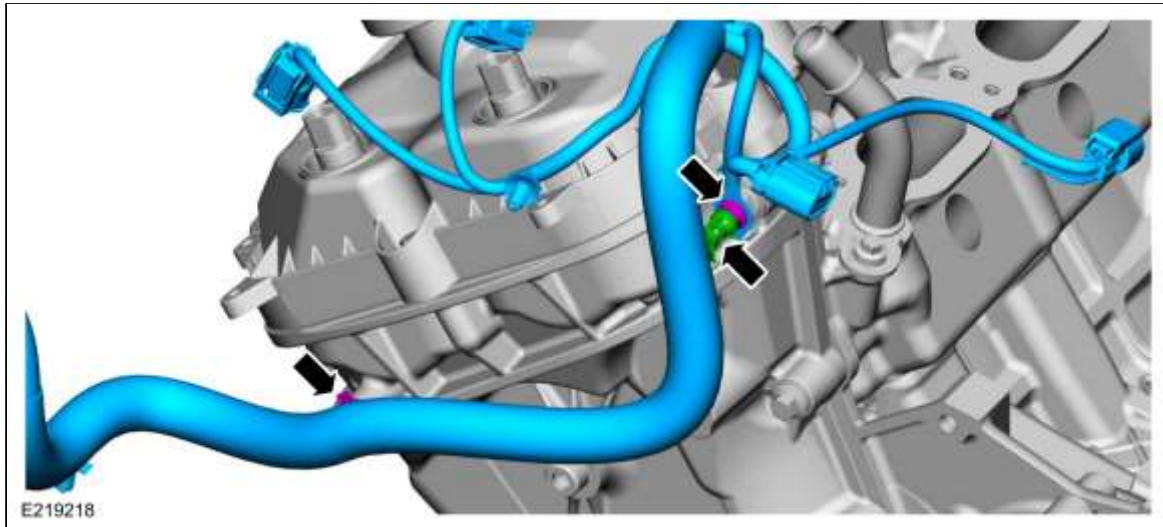


112. Install the coolant hose.

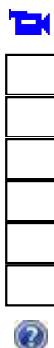
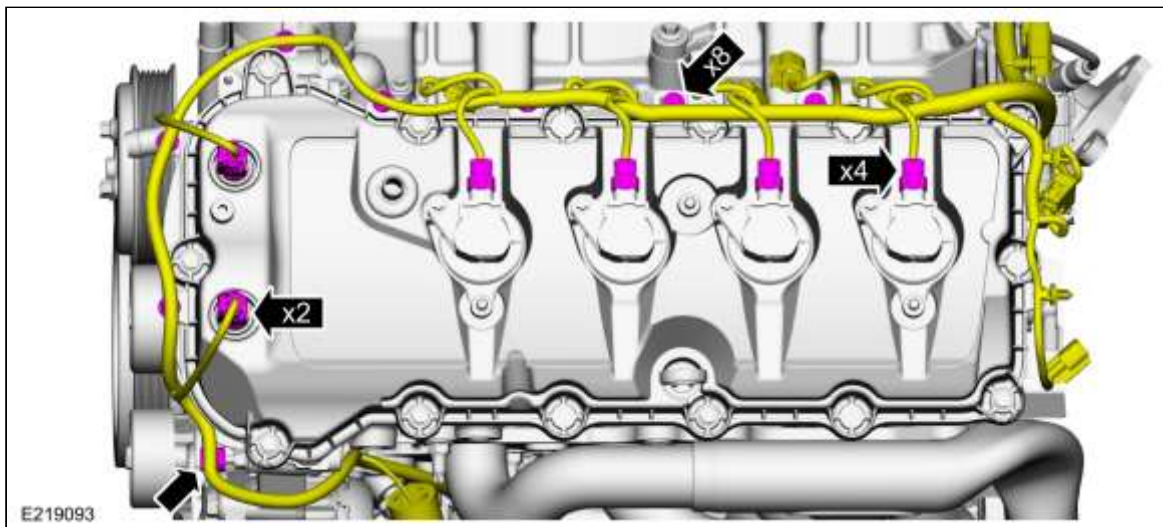




- 113.
- Position the wiring harness on the engine.
  - Install the ground wire and the nut.  
*Torque: 89 lb.in (10 Nm)*
  - Attach the wiring harness retainer to the engine front cover stud bolt.
  - Attach the wiring harness retainer to the engine front cover.

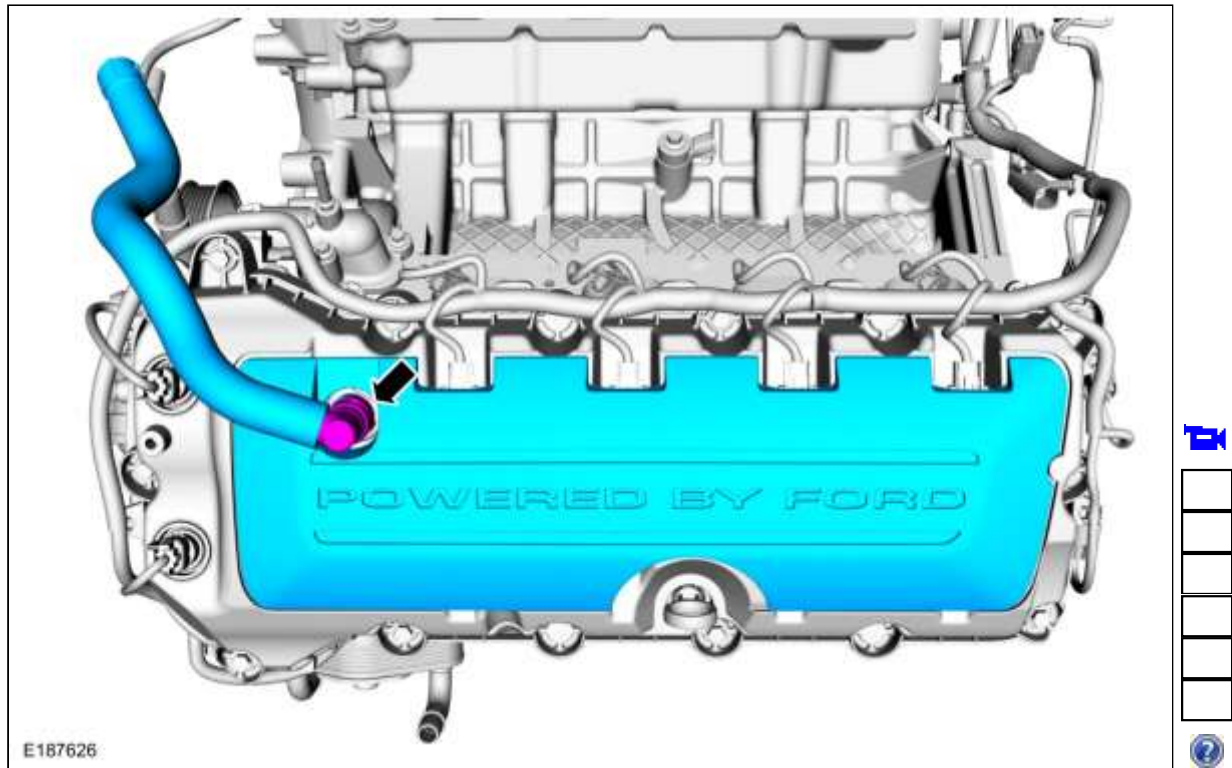


- 114.
- Position the harness and attach the wiring harness retainers.
  - Connect the engine wiring harness electrical connectors.

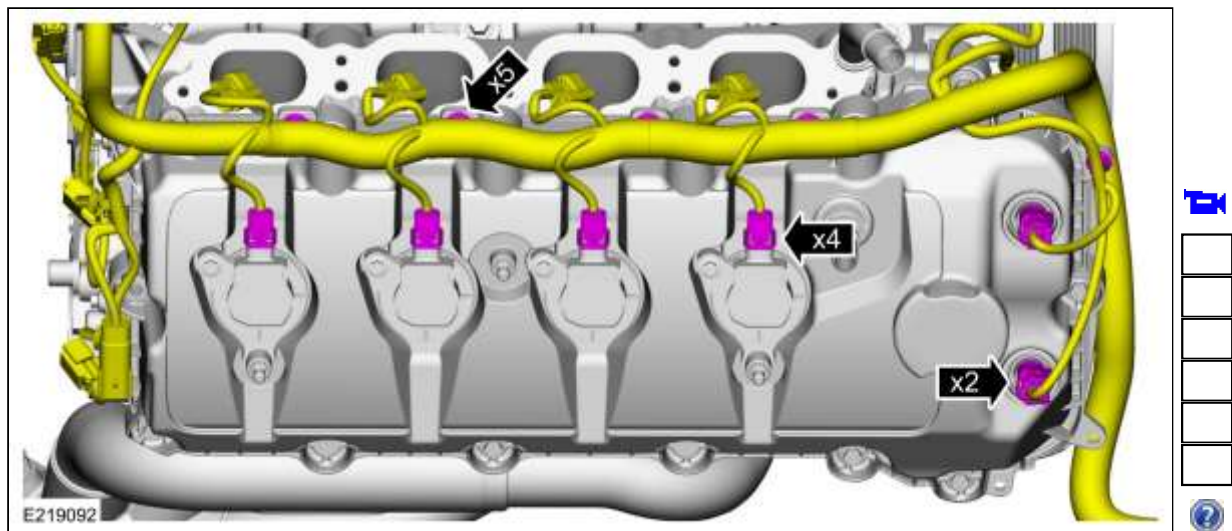




- 115.
- Install the LH spark plug cover.
  - Install the crankcase ventilation tube.
- Refer to: [Quick Release Coupling](#) (310-00D Fuel System - General Information - 5.2L 32V Ti-VCT, General Procedures).



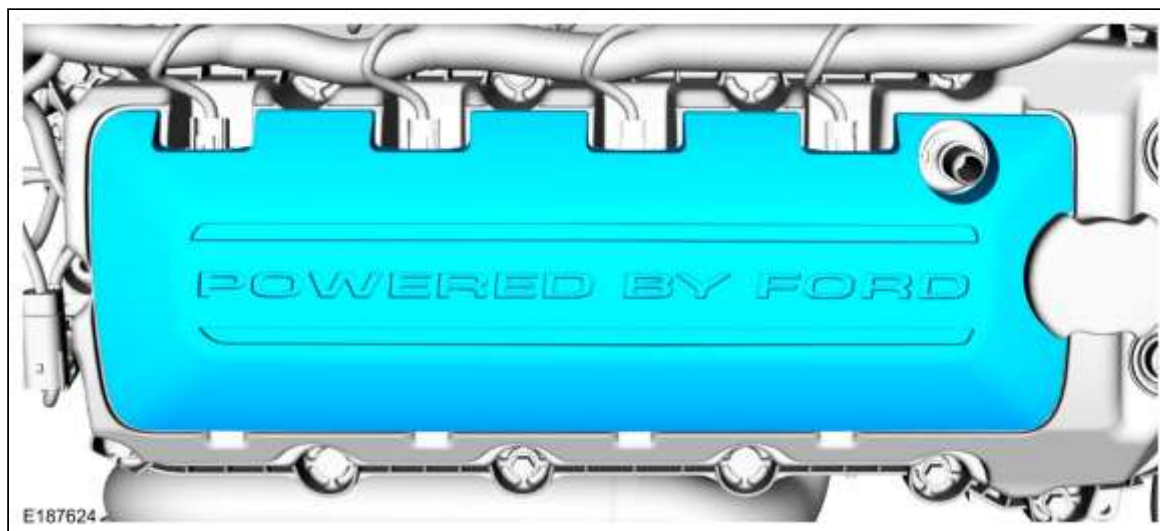
- 116.
- Position the harness and attach the wiring harness retainers.
  - Connect the engine wiring harness electrical connectors.



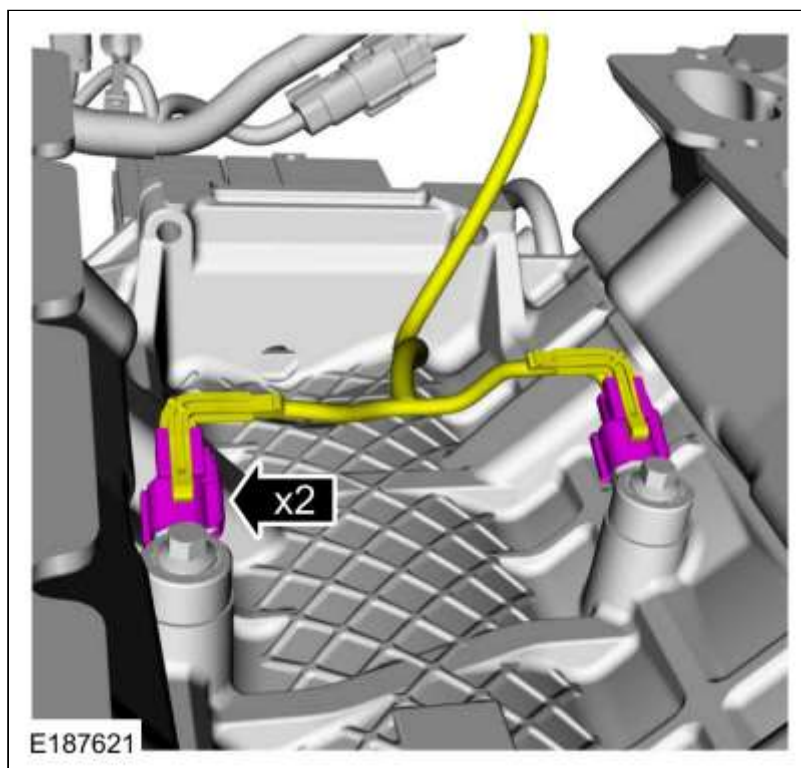
117. Install the spark plug cover.





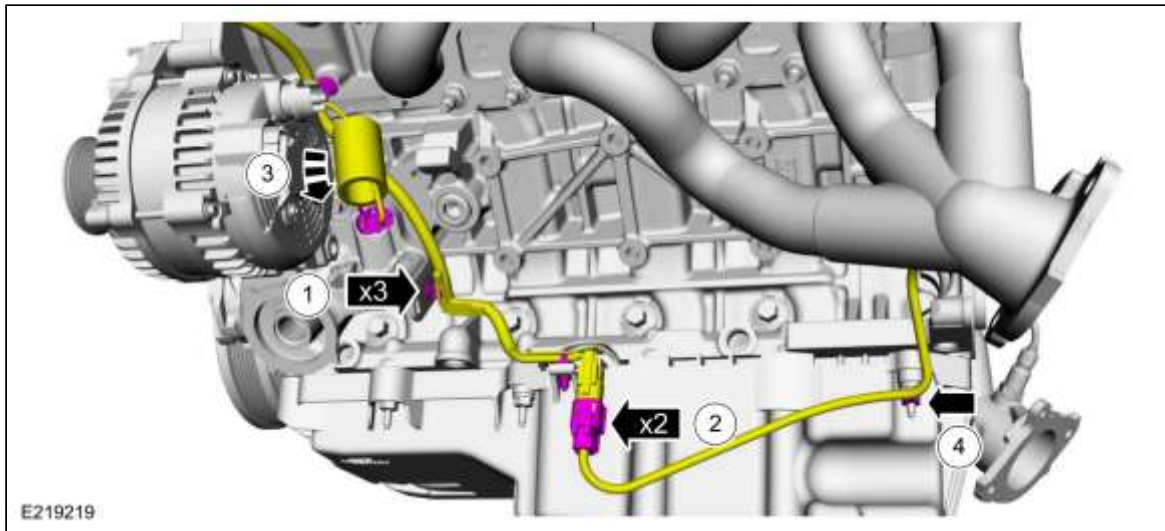


118. Disconnect the engine wiring harness electrical connectors.

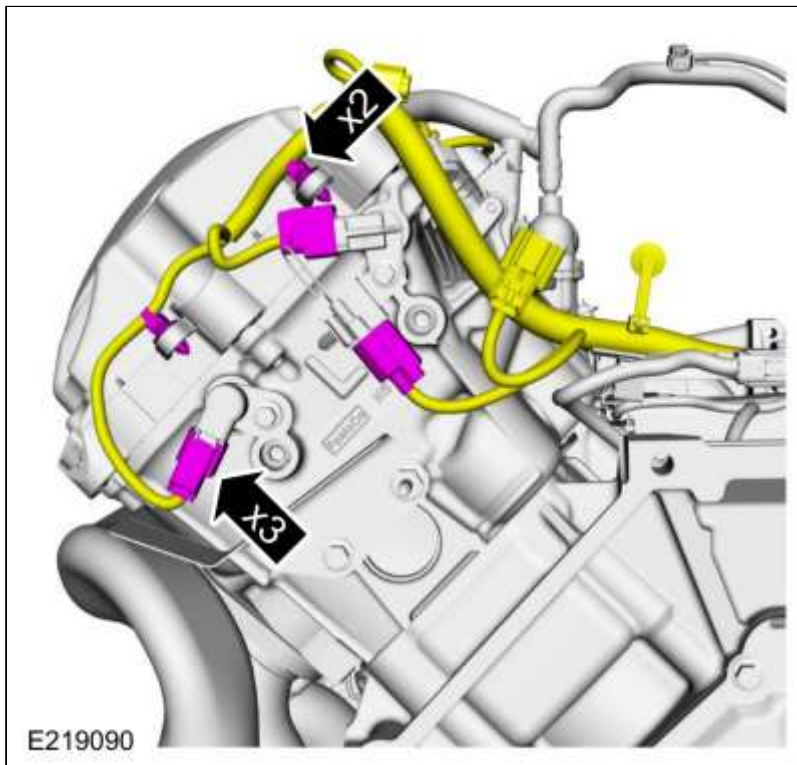


119. **NOTE:** Early build engine shown, late build engine similar.

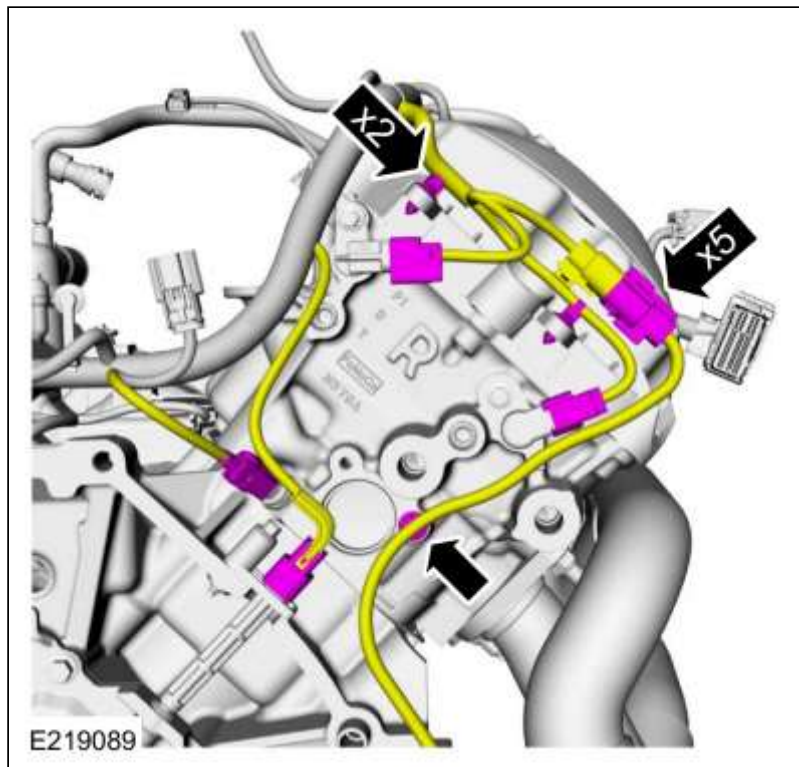
1. Position the harness and attach the wiring harness retainers.
2. Connect the engine wiring harness electrical connectors.
3. Slide the engine wiring harness insulator down to cover the electrical connector.
4. Attach the wiring harness retainer to the oil pan stud bolt.



- 120.
- Position the harness and attach the wiring harness retainers.
  - Connect the engine wiring harness electrical connectors.



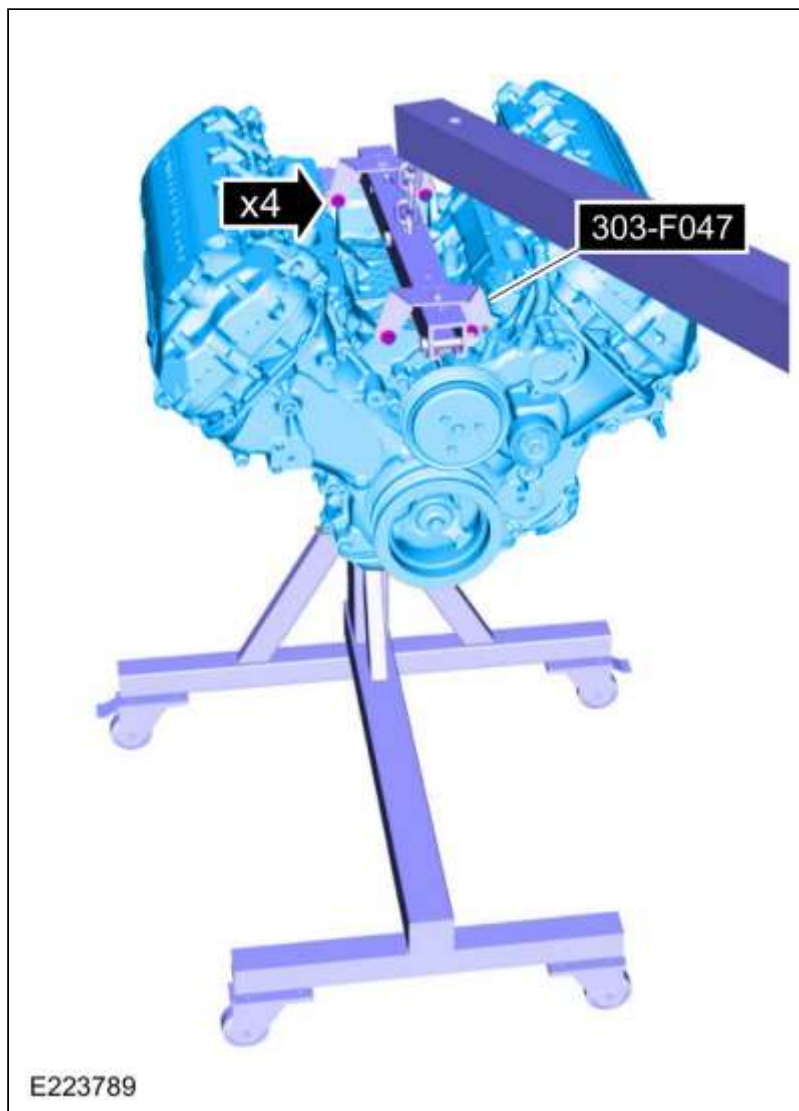
- 121.
- Position the harness and attach the wiring harness retainers.
  - Connect the engine wiring harness electrical connectors.



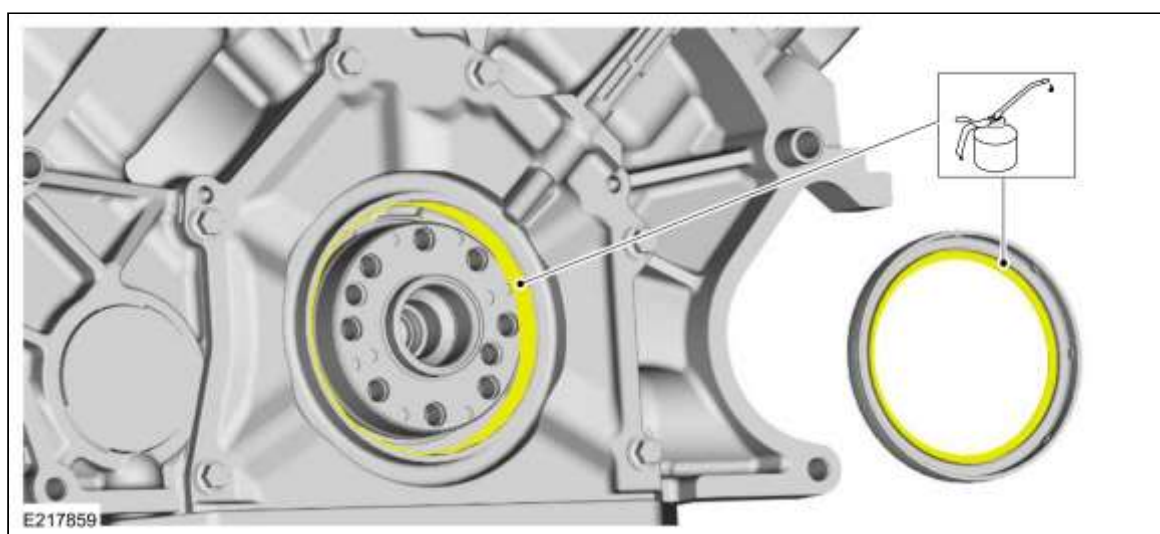
122. Install the special tool and remove the engine from the engine stand using a floor crane.  
 Install Special Service Tool: [303-F047 Lifting Bracket, Engine](#).  
 Use the General Equipment: Floor Crane  
 Use the General Equipment: Mounting Stand





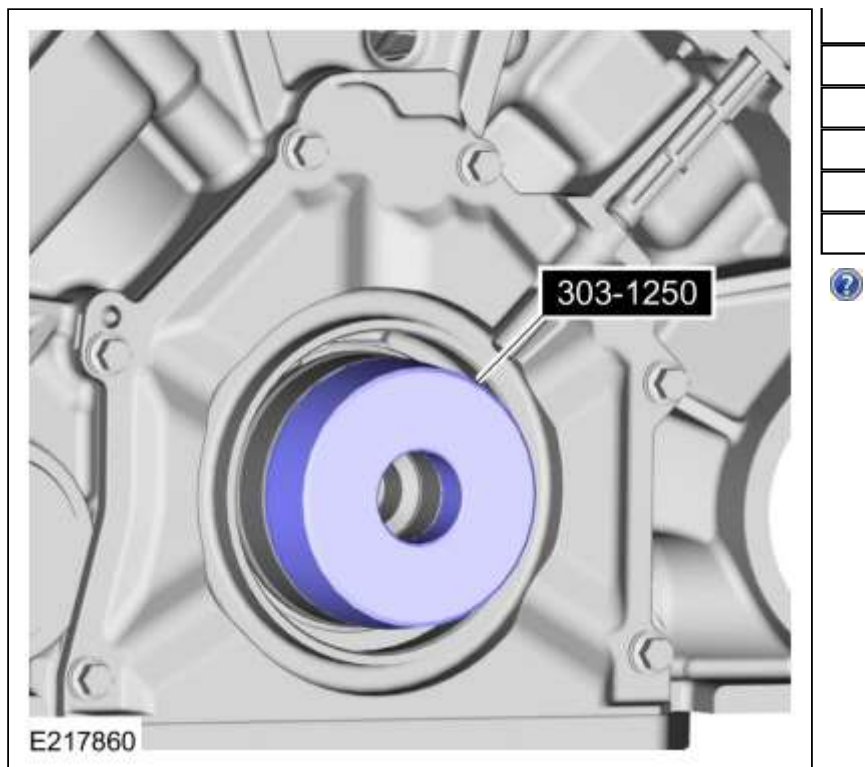



123. Lubricate the seal retaining plate bore and the seal lips with clean engine oil.  
*Material: Motorcraft® SAE 5W-50 Full Synthetic Motor Oil / XO-5W50-QGT (WSS-M2C931-C)*



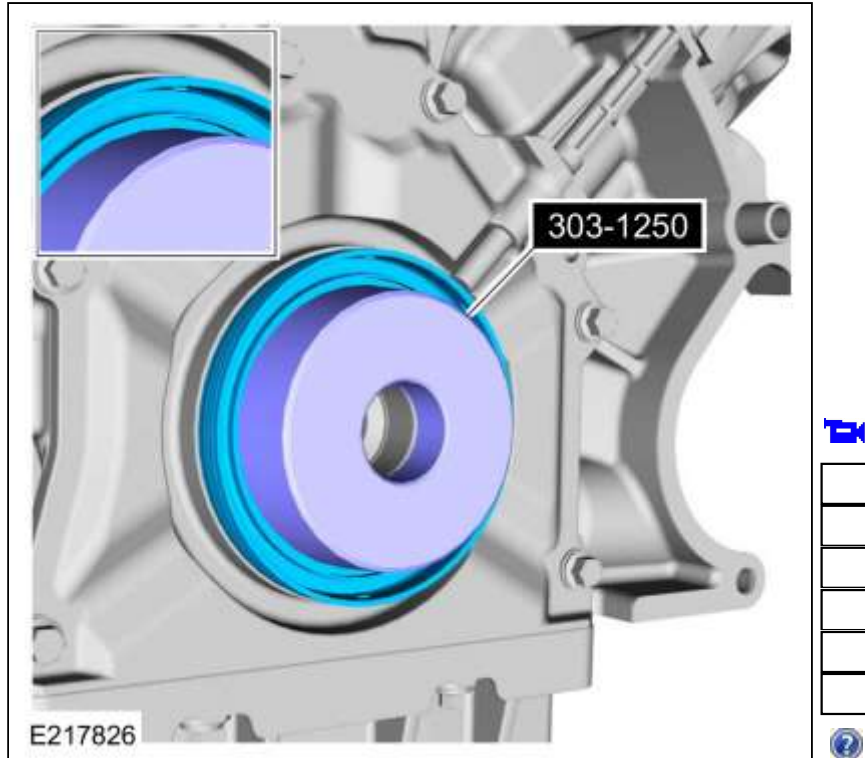
124. Position the special tool onto the end of the crankshaft.  
 Use Special Service Tool: [303-1250 Seal Installer, Rear Main](#).





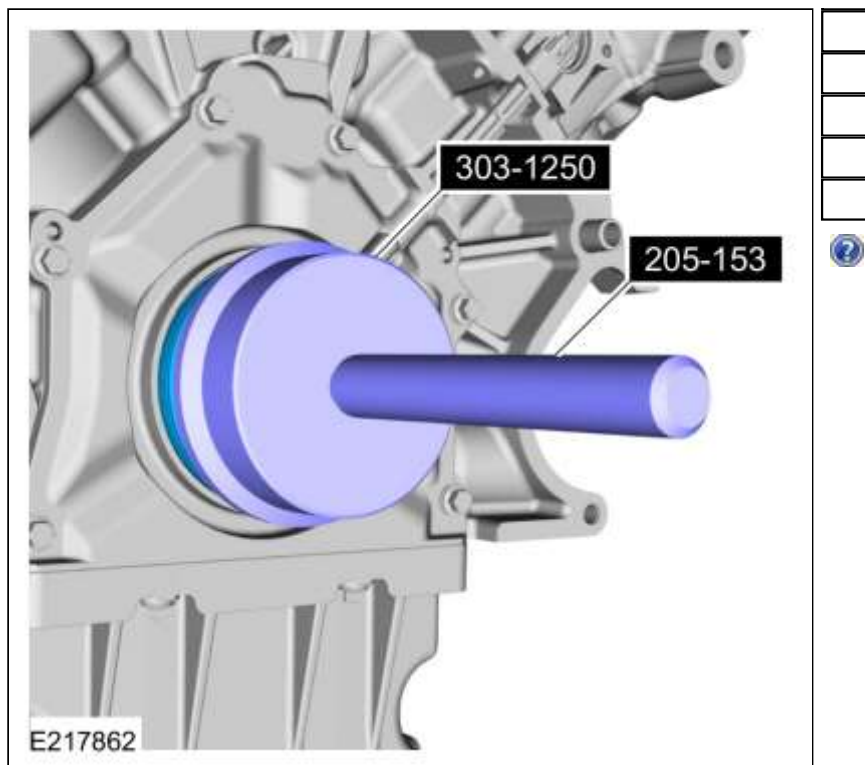
125. **NOTE:** The engine uses a rear seal that is unique from previous V-8 engines, note the orientation of the seal in the detail box in the graphic.

Slide the new crankshaft rear seal onto the tool.  
Use Special Service Tool: [303-1250 Seal Installer, Rear Main.](#)

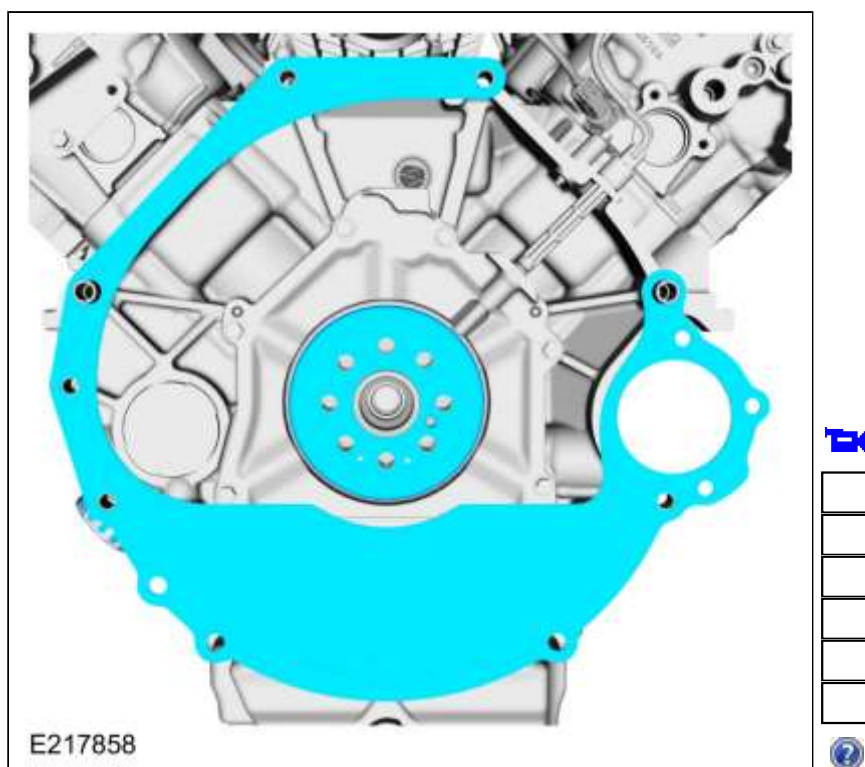


126. Using the special tools, install the crankshaft rear seal.  
Use Special Service Tool: [205-153 \(T80T-4000-W\) Handle.](#) , [303-1250 Seal Installer, Rear Main.](#)





127. Install the crankshaft sensor ring and the engine-to-transmission spacer plate.



128. Install the flywheel and the bolts.

*Torque:*

Stage 1: 89 lb.in (10 Nm)

Stage 2: 177 lb.in (20 Nm)

Stage 3: 59 lb.ft (80 Nm)





