2.

Upper compression ring gap location.

3.

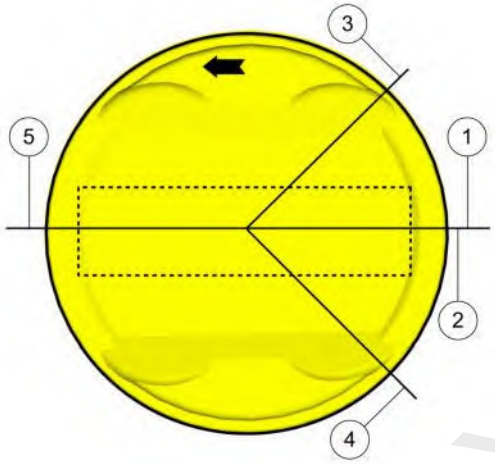
Upper oil control segment ring gap location.

4.

Lower oil control segment ring gap location.

5.

Expander ring and lower compression ring gap location.

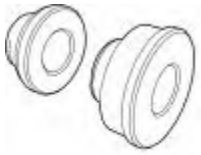
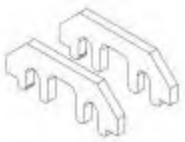


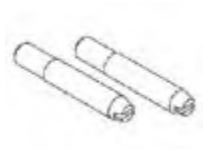
E176334

ASSEMBLY > ENGINE

Special Tool(s) / General Equipment

 E139373	100-002 (TOOL-4201-C) Holding Fixture with Dial Indicator Gauge

 E234304	205-142 (T80T-4000-J) Installer, Differential Bearing Cone
 E234305	205-149 (T80T-4000-R) Installer, Spindle Bearing
 E133913	205-153 (T80T-4000-W) Handle
 303-102	303-102 Installer, Crankshaft Pulley
	303-1245 Engine Lift Eye TKIT-2006UF-FLM TKIT-2006UF-ROW
 E175042	303-1247 VCT Spark Plug Tube Seal Remover and Installer TKIT-2006UF-FLM TKIT-2006UF-ROW
 E216421	303-1248 Camshaft holding tools TKIT-2006UF-FLM TKIT-2006UF-ROW
	303-1251 Installer, Front Seal TKIT-2006UF-FLM TKIT-2006UF-ROW

	303-1530 Tool, Chain Tensioner Hold Down TKIT-2010A-F TKIT-2010A-LM TKIT-2010A-ROW
	303-335 (T88T-6701-A) Installer, Front Cover Oil Seal TKIT-1988-F TKIT-1988-FLM
	307-399 Alignment Pins, Transmission Fluid Pump TKIT-2000AP-FLM/LM TKIT-2002N-DEW
Feeler Gauge	
Strap Wrench	
Floor Crane	
Mounting Stand	
Hose Clamp Remover/Installer	
Round-Ended Steel Rule	
Piston Ring Compressor	

Materials

Name	Specification
Motorcraft ® SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP	WSS-M2C945-A
Motorcraft ® High Performance Engine RTV Silicone TA-357	WSE-M4G323-A6
Motorcraft ® Silicone Gasket Remover ZC-30-A	-
Motorcraft ® Metal Surface Prep ZC-31-B	-

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

NOTE: Assembly of the engine requires various inspections/measurements of the engine components. These inspections/measurements will aid in determining if the engine

components will require replacement. Refer to ENGINE SYSTEM - GENERAL INFORMATION .

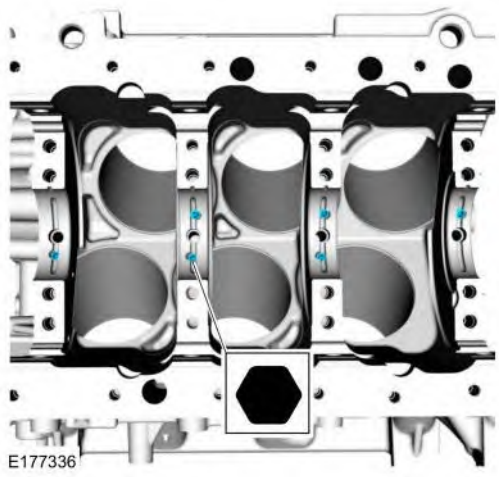
NOTE: If the cylinder head(s) is replaced, a new secondary timing chain tensioner will need to be installed.

1.

Using a hex bit, install the piston oil cool valves.

Torque

: 35 lb.in (4 Nm)



2.

NOTE: This step is for selecting the correct main bearings.

NOTE: The #1 main bearing is at the front of the engine block.

Select the crankshaft main bearings for each crankshaft journal.

Record the code that is on the cylinder block face.

Record the code that is on the crankshaft flange.

The first letter is for main No. 1 and the next letters are for mains 2, 3 and 4.

3.

NOTE: This chart is continued in the next step.

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

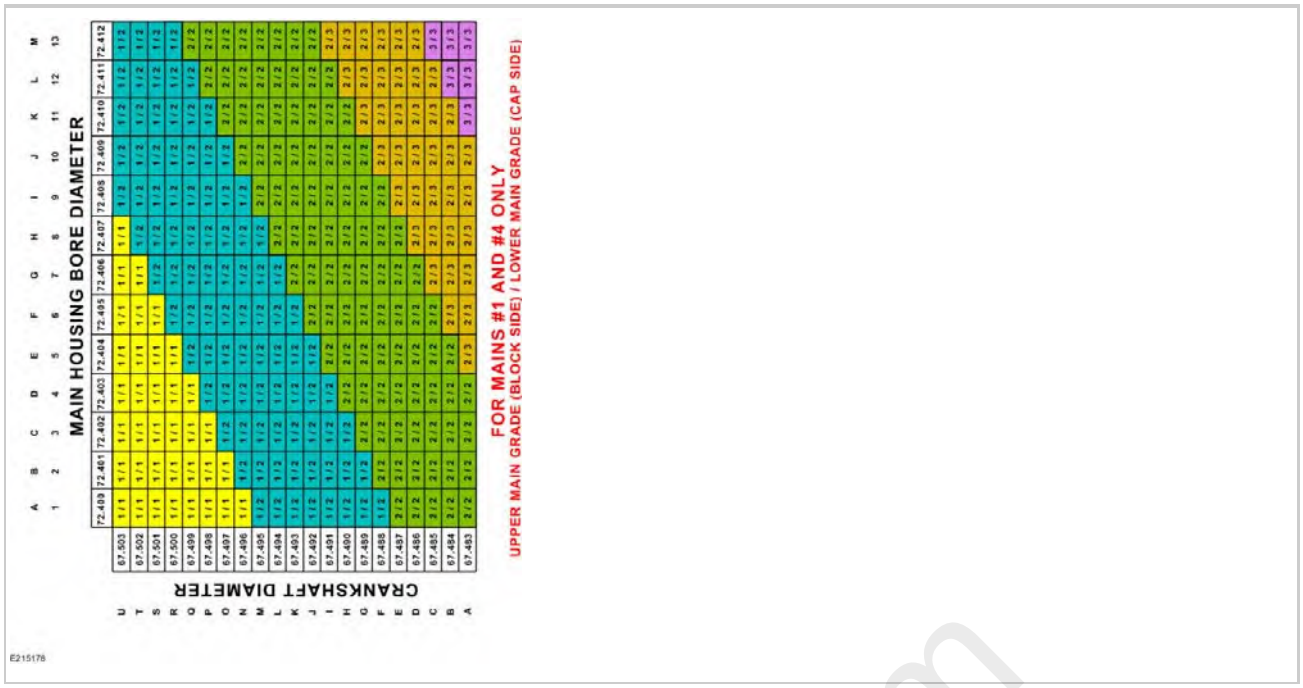
Using the data recorded earlier and the Bearing Select Fit Chart, Standard Bearings, determine the required bearing grade for main bearings 1 and 4.

Read the first letter of the engine block main bearing code and the first letter of the crankshaft main bearing code.

Read down the column below the engine block main bearing code letter and across the row next to the crankshaft main bearing code letter, until the 2 intersect. This is the required bearing grade(s) for the No. 1 crankshaft main bearing.

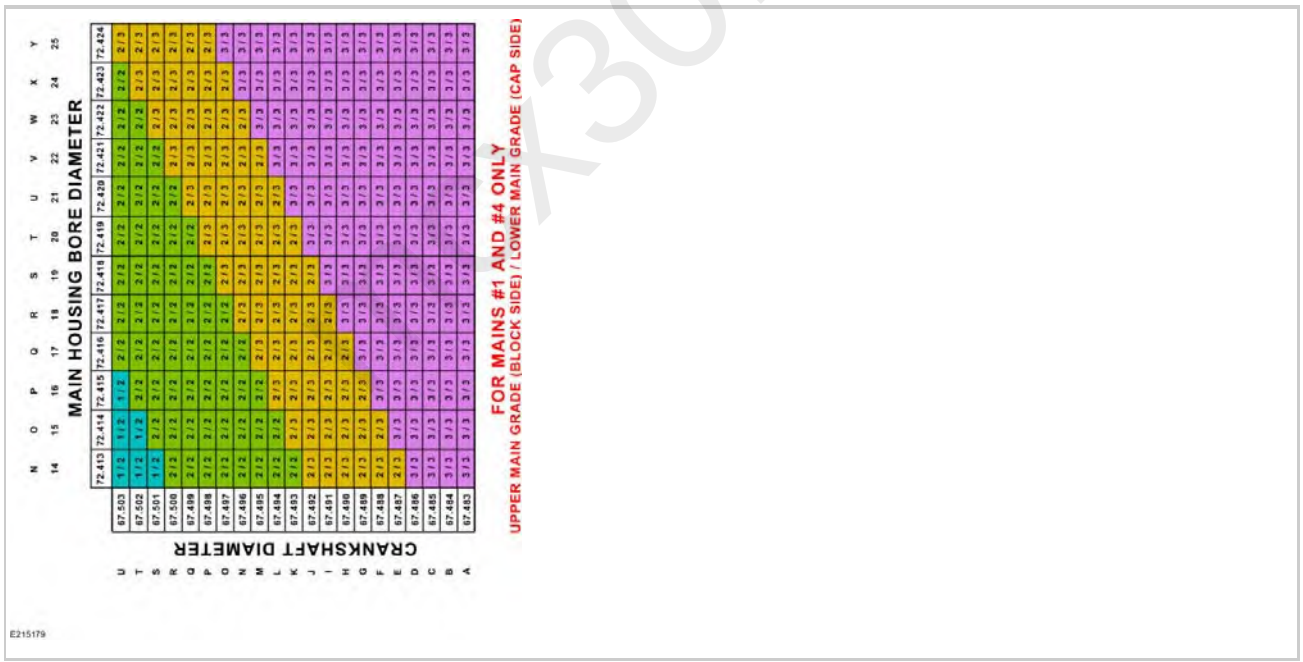
As an example, if the engine block code letter is "M" and the crankshaft code letter is "M", the correct bearing grade for this main bearing is a "2" for the upper bearing and a "2" for the lower bearing.

Repeat the above steps using the fourth letter of the block and crankshaft codes to select the No. 4 bearing.



4.

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



5.

NOTE: This chart is continued in the next step.

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

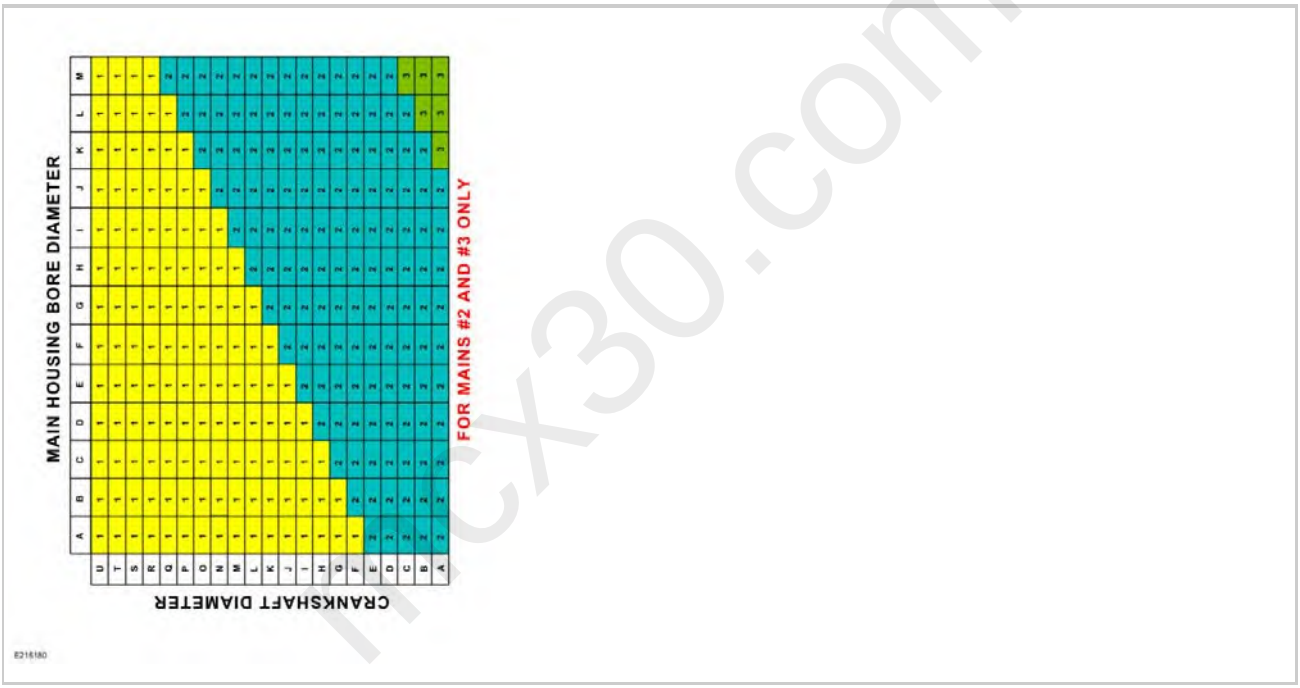
Using the data recorded earlier and the Bearing Select Fit Chart, Standard Bearings, determine the required bearing grade for main bearings 2 and 3.

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 for the No. 2 crankshaft main bearing.

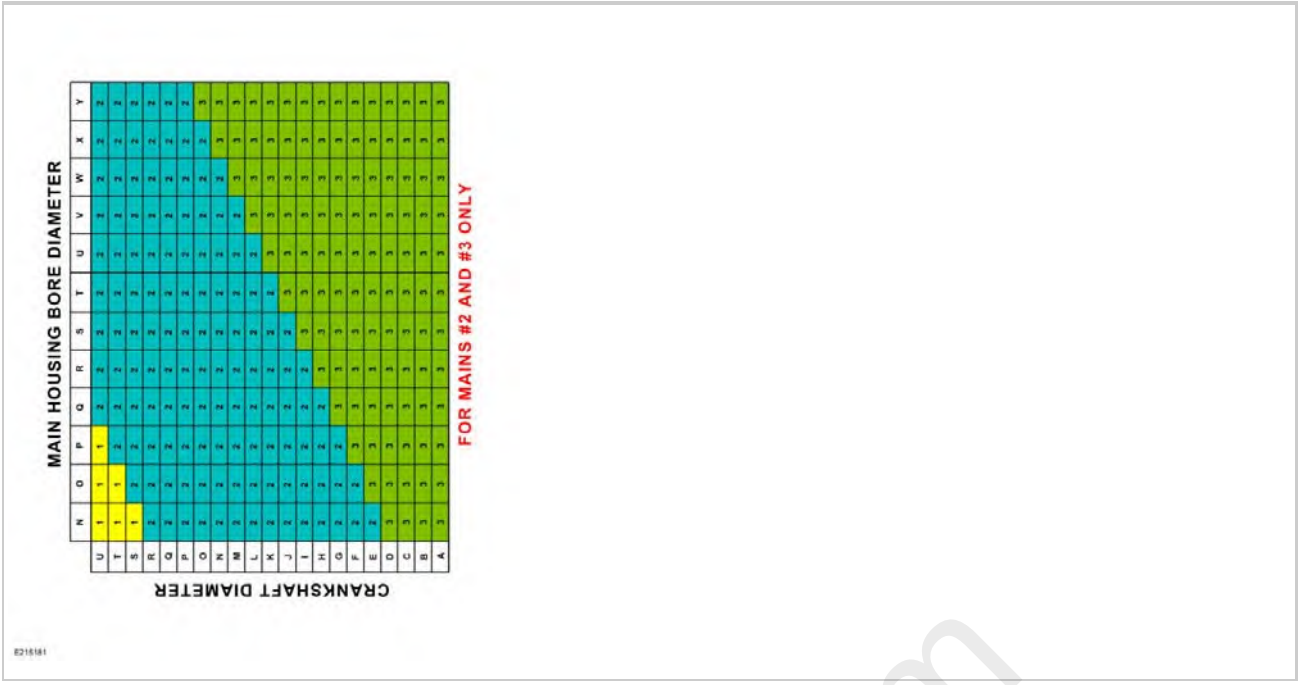
As an example, if the engine block code letter is "N" and the crankshaft code letter is "H", the correct bearing grade for this main bearing is "2".

Repeat the above steps using the third letter of the block and crankshaft codes to select the No. 3.



6.

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



7.

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

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

Torque

: Stage 1: 17 lb.ft (23 Nm) Stage 2: 32 lb.ft (43 Nm) Stage 3: 90 °

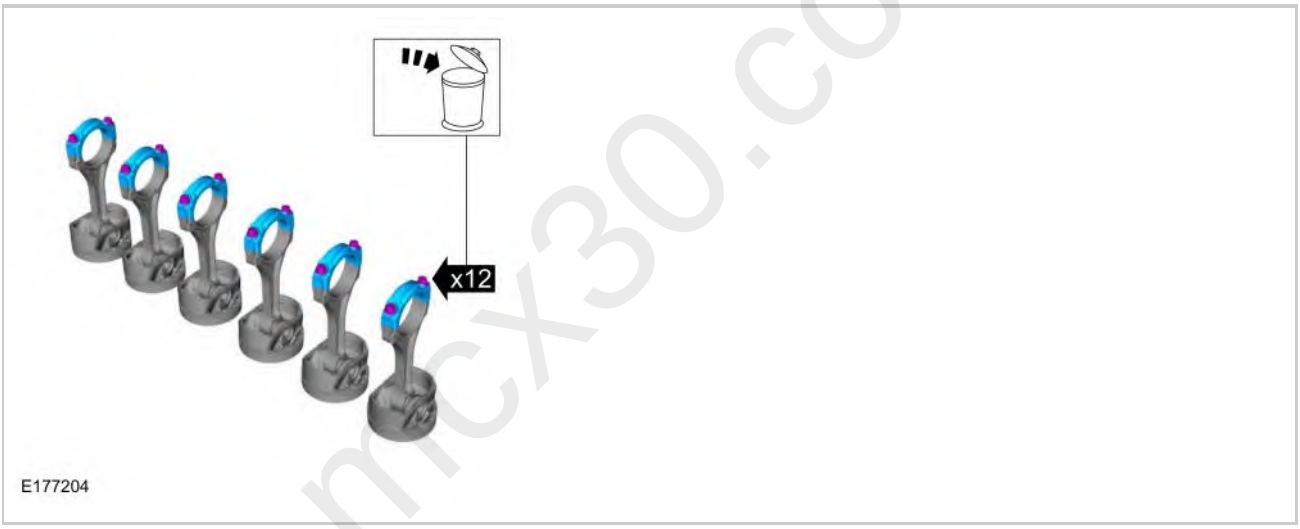
8.

Measure the connecting rod large end bore in 2 directions.

9.

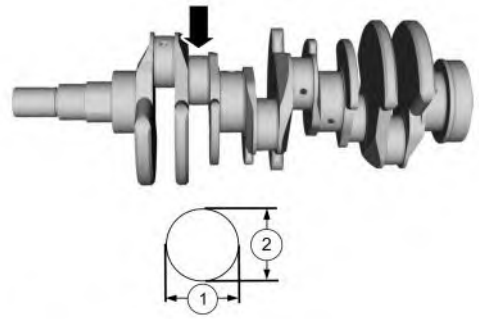
Remove the bolts and the rod cap.

Discard the bolts.



10.

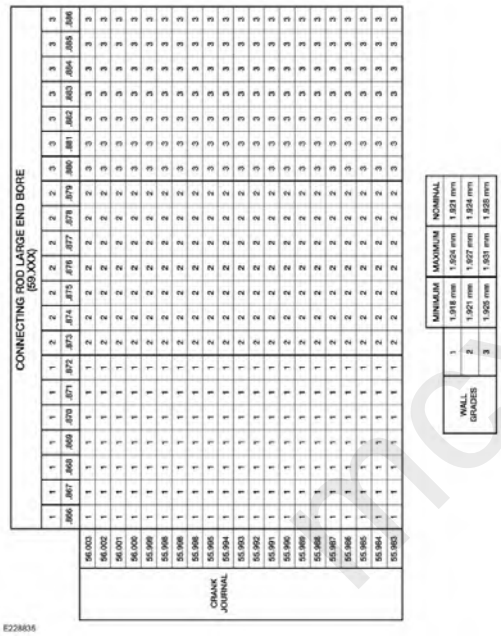
Measure each of the crankshaft connecting rod bearing journal diameters in at least 2 directions.



E177205

11.

Using the chart, select the correct connecting rod bearings for each crankshaft connecting rod journal.



E228836

12.

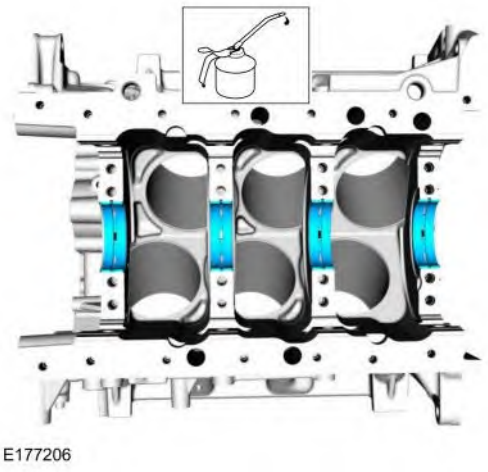
NOTE: Before assembling the cylinder block, all sealing surfaces must be free of chips, dirt, paint and foreign material. Also, make sure the coolant and oil passages are clear.

Lubricate the upper crankshaft main bearings with clean engine oil and install in the cylinder block.

Material

: Motorcraft ® SAE 5W-20 Premium Synthetic Blend Motor Oil / XO-5W20-QSP

(WSS-M2C945-A)


E177206

13.

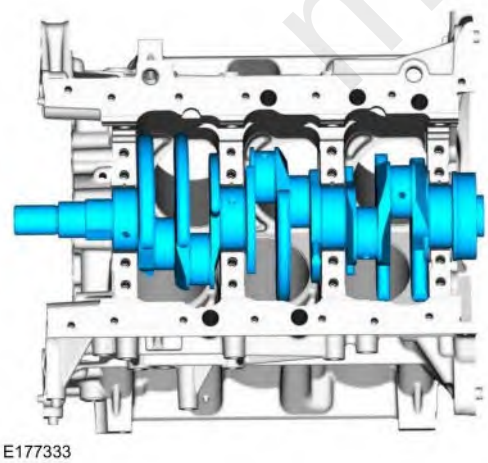
NOTE: Do not install the upper thrust bearings until the crankshaft is installed.

NOTE: Lubricate the thrust surfaces of the crankshaft with clean engine oil.

Install the crankshaft.

Material

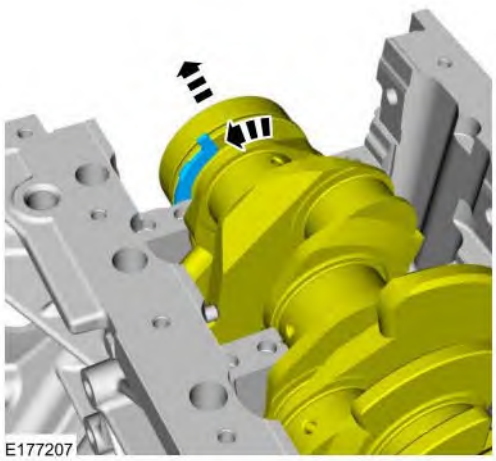
: Motorcraft ® SAE 5W-20 Premium Synthetic Blend Motor Oil / XO-5W20-QSP
(WSS-M2C945-A)


E177333

14.

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

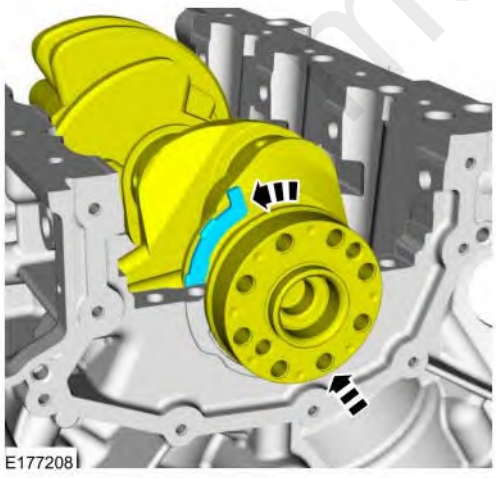
Push the crankshaft rearward and install the rear crankshaft upper thrust washer at the back of the No. 4 rear bulkhead.



15.

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

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

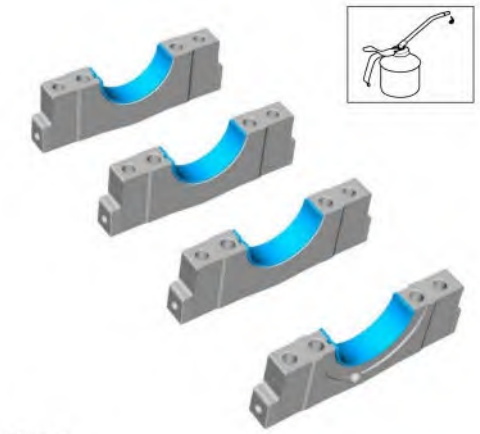


16.

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

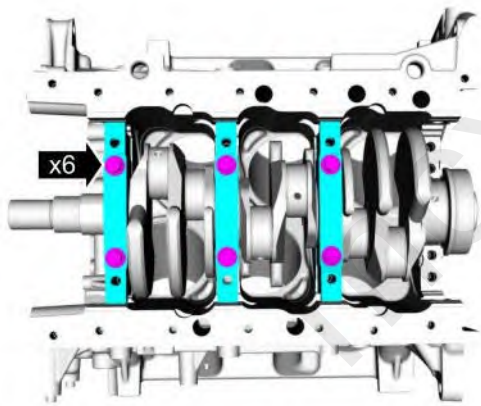
Material

: Motorcraft ® SAE 5W-20 Premium Synthetic Blend Motor Oil / XO-5W20-QSP (WSS-M2C945-A)



17.

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

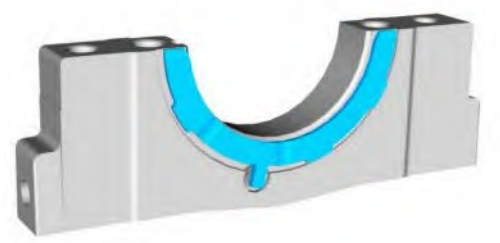


18.

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

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

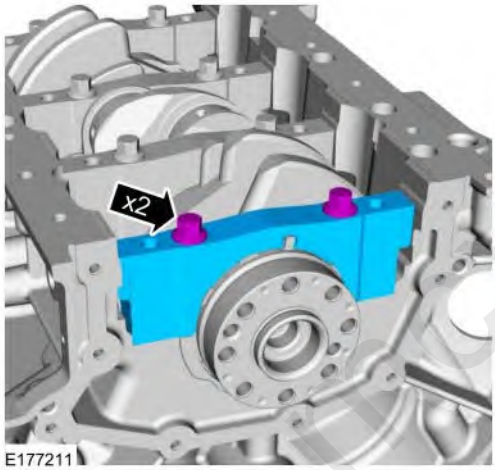
Install the lower crankshaft thrust washer to the back side of the No. 4 rear main bearing cap, with the tab aligned with the cutout in the main bearing cap.



E177331

19.

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



E177211

20.

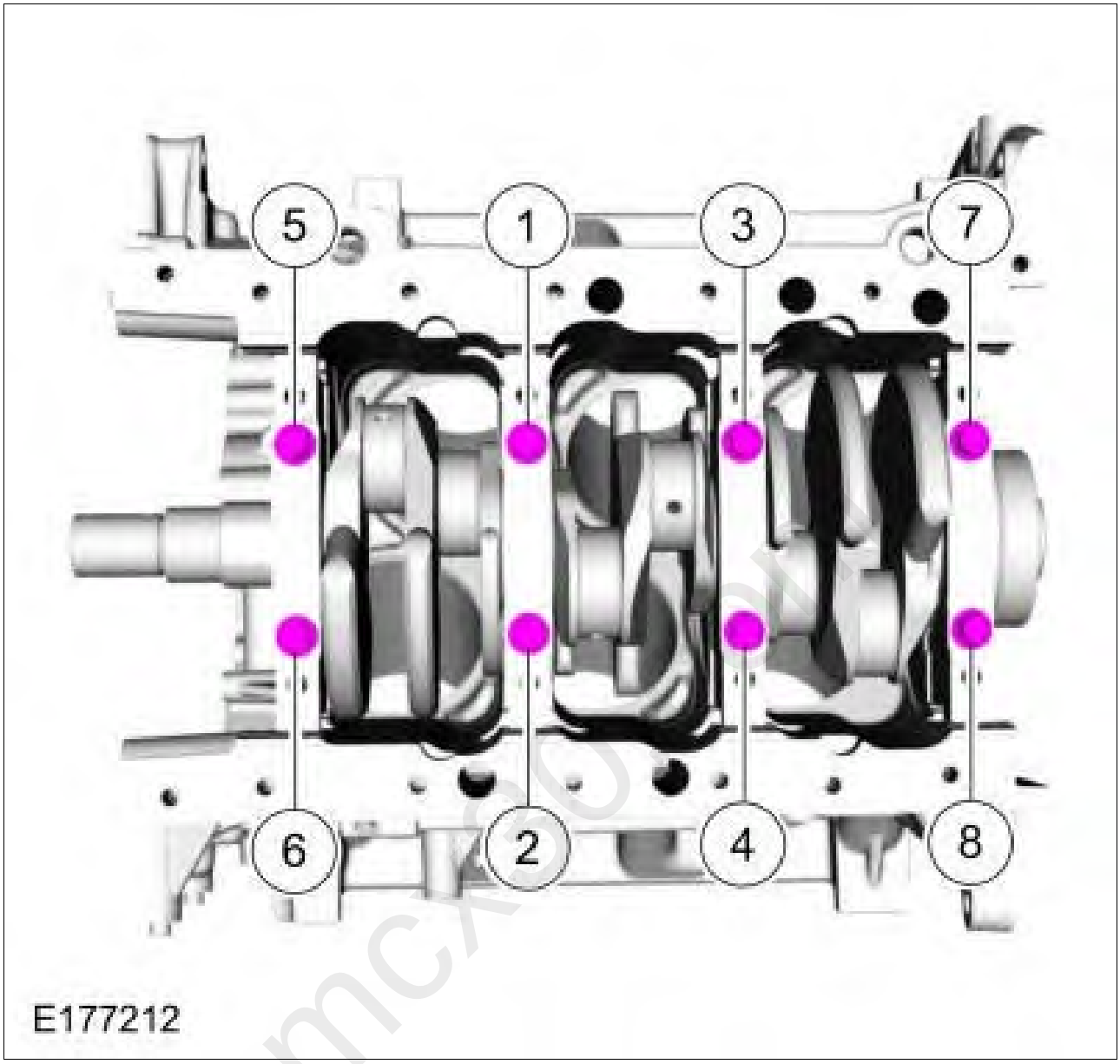
NOTE: While tightening the main bearing vertical bolts, push the crankshaft forward and the No. 4 main bearing cap rearward to seat the crankshaft thrust washers.

Tighten the main bearing bolts.

Torque

: Stage 1: 24 lb.ft (33 Nm) Stage 2: 135 °

Fig 1: Main Bearing Bolts Tightening Sequence



Courtesy of FORD MOTOR CO.

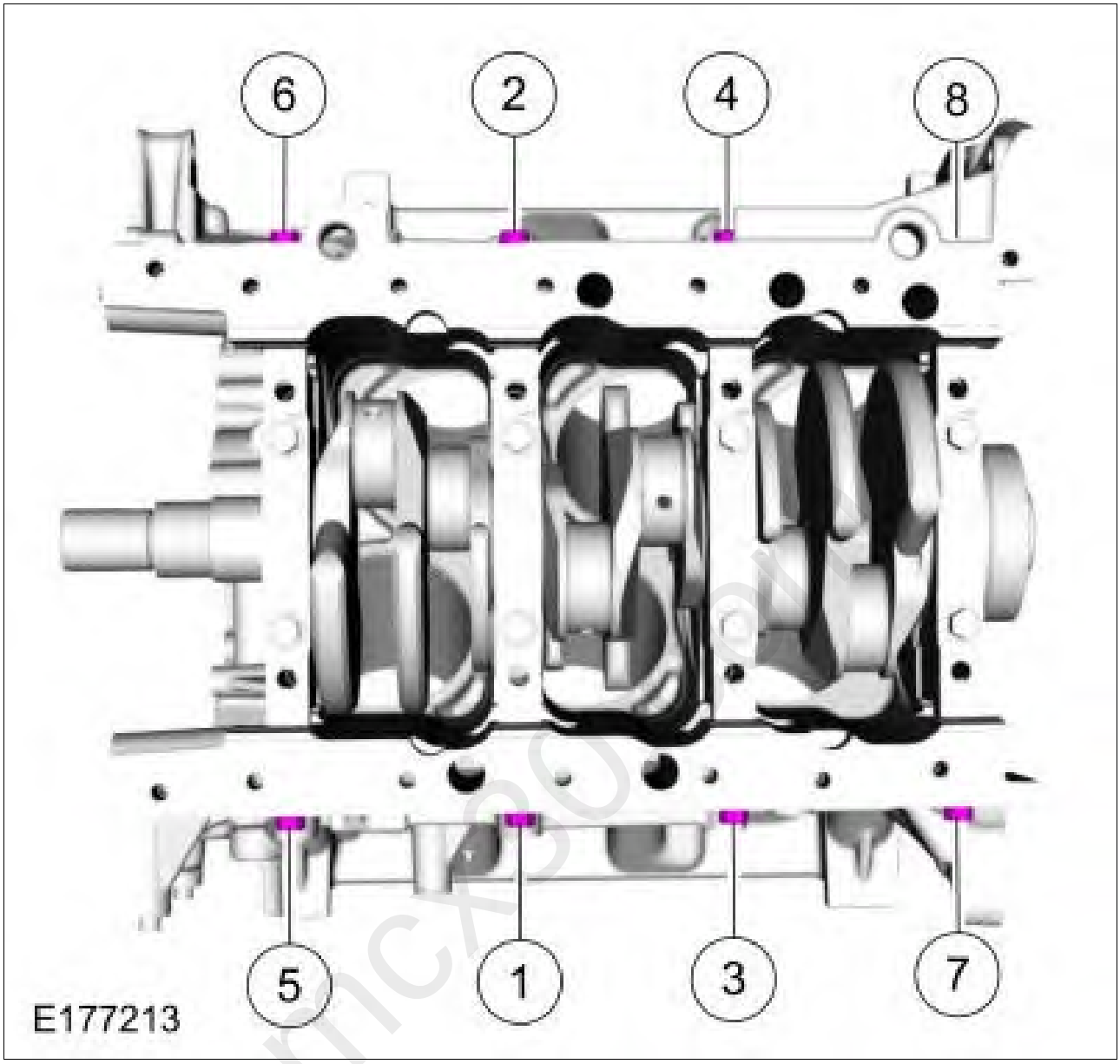
21.

Install the new main bearing cap side bolts.

Torque

: Stage 1: 33 lb.ft (45 Nm) Stage 2: 90 °

Fig 2: Main Bearing Cap Side Bolts Tightening Sequence



Courtesy of FORD MOTOR CO.

22.

1.

Position the crankshaft to the rear of the cylinder block. Use Special Service Tool: 100-002 (TOOL-4201-C) Holding Fixture with Dial Indicator Gauge.

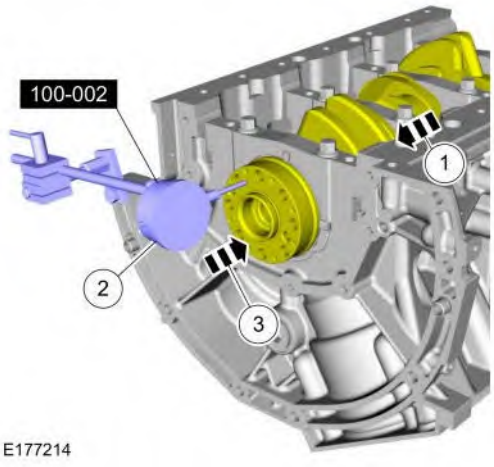
2.

Zero the Dial Indicator Gauge.

3.

Move the crankshaft to the front of the cylinder block. Measure and record the crankshaft

end play.



23.

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

Prepare the connecting rod and cap

Insert the new bolts in the rod cap.

Insert the upper and lower rod bearings into the rod and cap.

24.

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

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

1.

Center line of the piston parallel to the wrist pin bore.

2.

Upper compression ring gap location.

3.

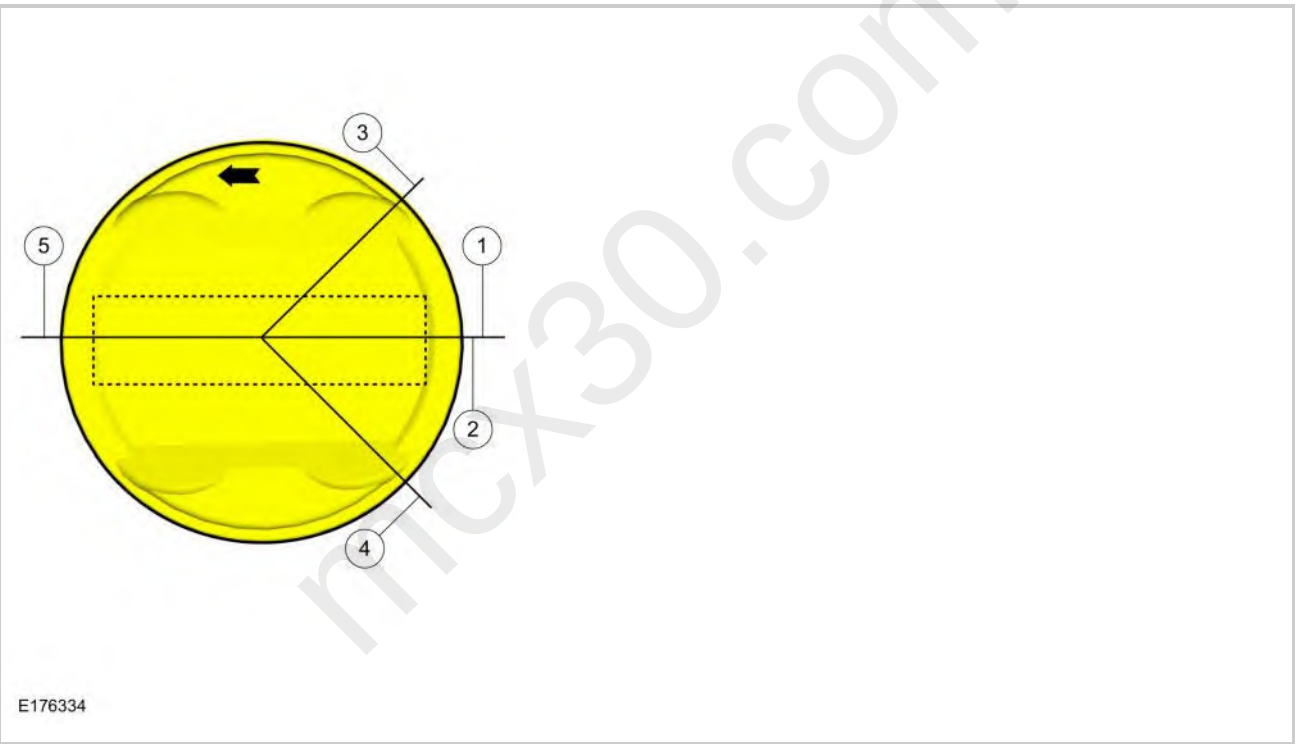
Upper oil control segment ring gap location.

4.

Lower oil control segment ring gap location.

5.

Expander ring and lower compression ring gap location.



25.

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

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

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

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

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

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


E177217

26.

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

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

Install the connecting rod cap and the new bolts.

Torque

: Stage 1: 17 lb.ft (23 Nm) Stage 2: 32 lb.ft (43 Nm) Stage 3: 90 °

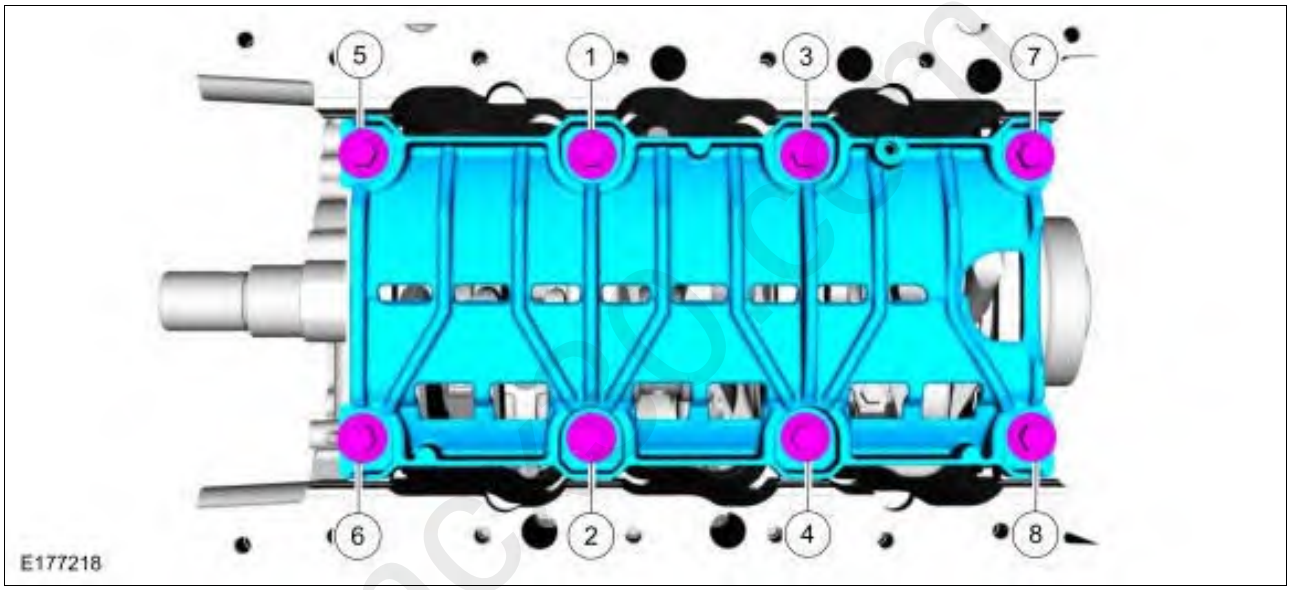
27.

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

Torque

: Stage 1: 18 lb.ft (24 Nm) Stage 2: 180 °

Fig 3: Main Bearing Cap Support Brace Bolts Tightening Sequence



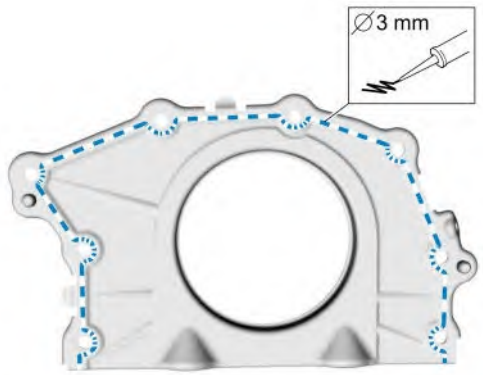
Courtesy of FORD MOTOR CO.

28.

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

NOTE: The crankshaft rear seal retainer must be installed and the bolts tightened within 4 minutes of sealant application.

Apply a 3 mm (0.11 in) bead of Motorcraft ® High Performance Engine RTV Silicone to the sealing surface of the crankshaft rear seal retainer.

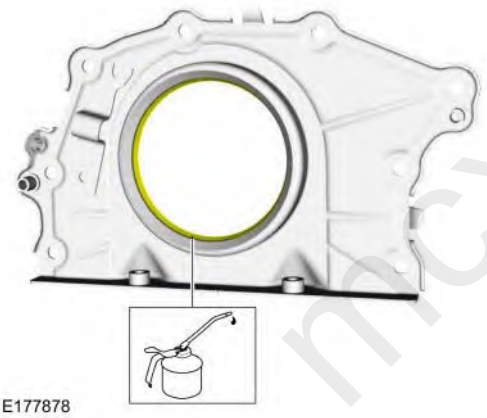


29.

Lubricate the crankshaft rear seal with clean engine oil.

Material

: Motorcraft ® SAE 5W-20 Premium Synthetic Blend Motor Oil / XO-5W20-QSP (WSS-M2C945-A)



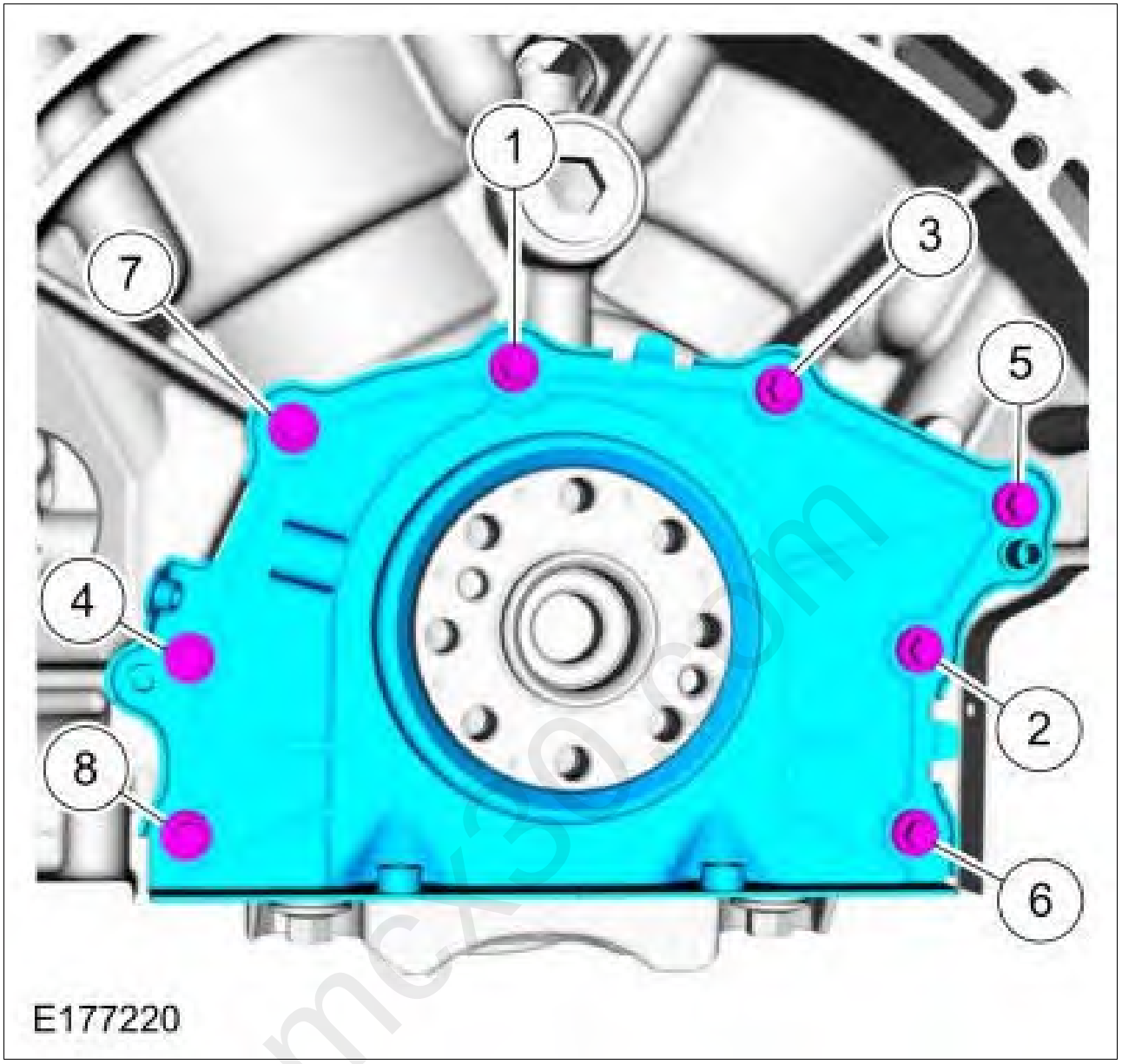
30.

Install the crankshaft rear seal and the bolts.

Torque

: 89 lb.in (10 Nm)

Fig 4: Crankshaft Rear Seal Retaining Plate Bolts Tightening Sequence



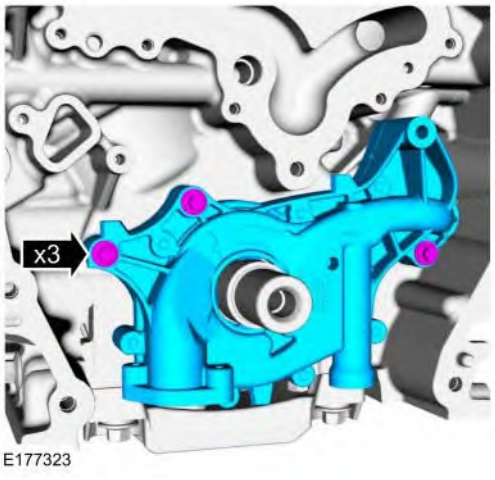
Courtesy of FORD MOTOR CO.

31.

Install the oil pump and the bolts.

Torque

: 89 lb.in (10 Nm)



32.

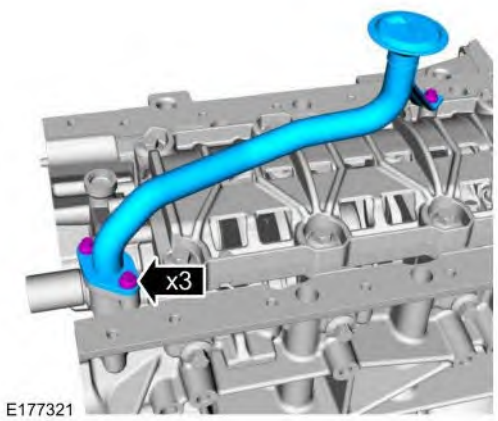
Install a new oil pump screen and pickup tube O-ring seal.

33.

Install the oil pump screen and pickup tube and the bolts.

Torque

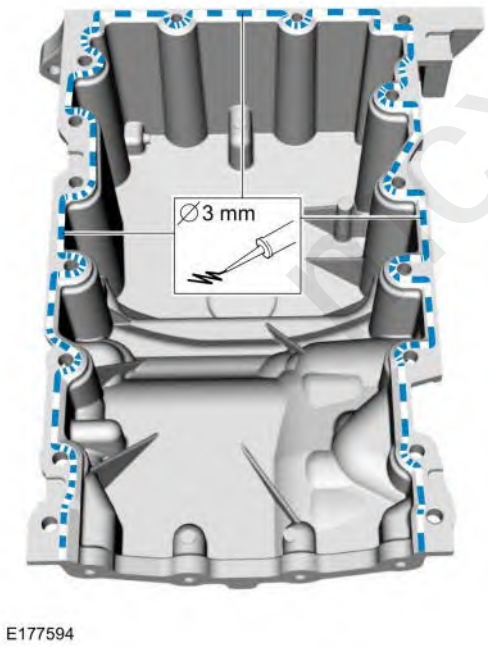
: 89 lb.in (10 Nm)



34.

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

Apply a 3 mm (0.11 in) bead of Motorcraft ® High Performance Engine RTV Silicone to the sealing surface of the oil pan.

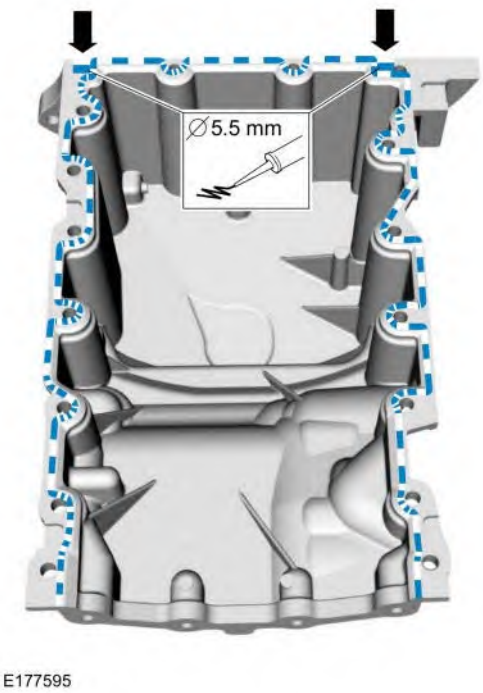


35.

NOTE: Failure to use Motorcraft ® High Performance Engine RTV Silicone may

cause the engine oil to foam excessively and result in serious engine damage.

Apply a 5.5 mm (0.21 in) bead of Motorcraft ® High Performance Engine RTV Silicone to the 2 crankshaft seal retainer plate-to-cylinder block joint areas on the sealing surface of the oil pan.

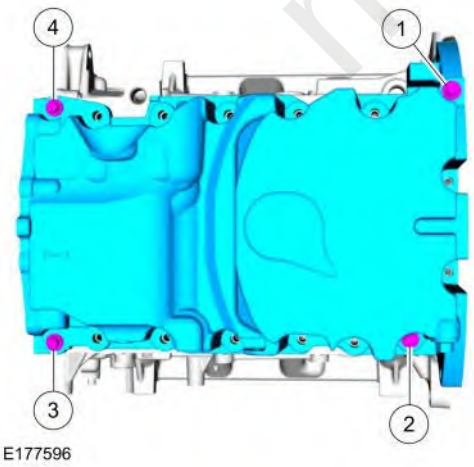


36.

Install the oil pan and bolts.

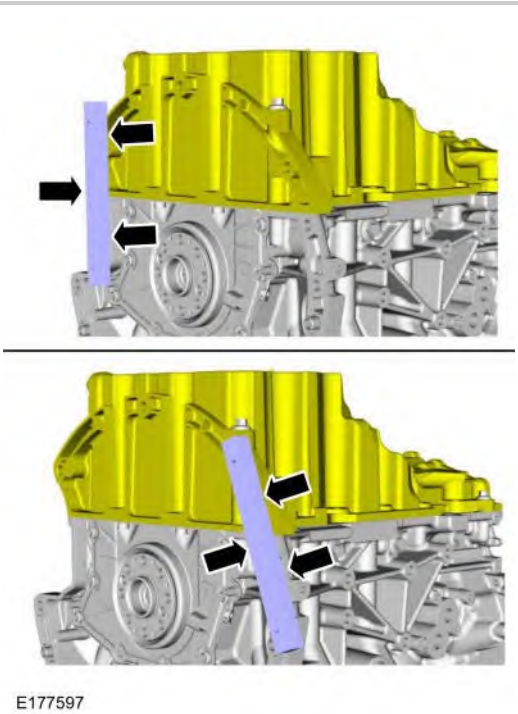
Torque

: Stage 1: 27 lb.in (3 Nm) Stage 2: Loosen:: 180 °



37.

Using a straight edge, align the oil pan flush with the rear of the cylinder block at the 2 areas shown. Use the General Equipment: Round-Ended Steel Rule



E177597

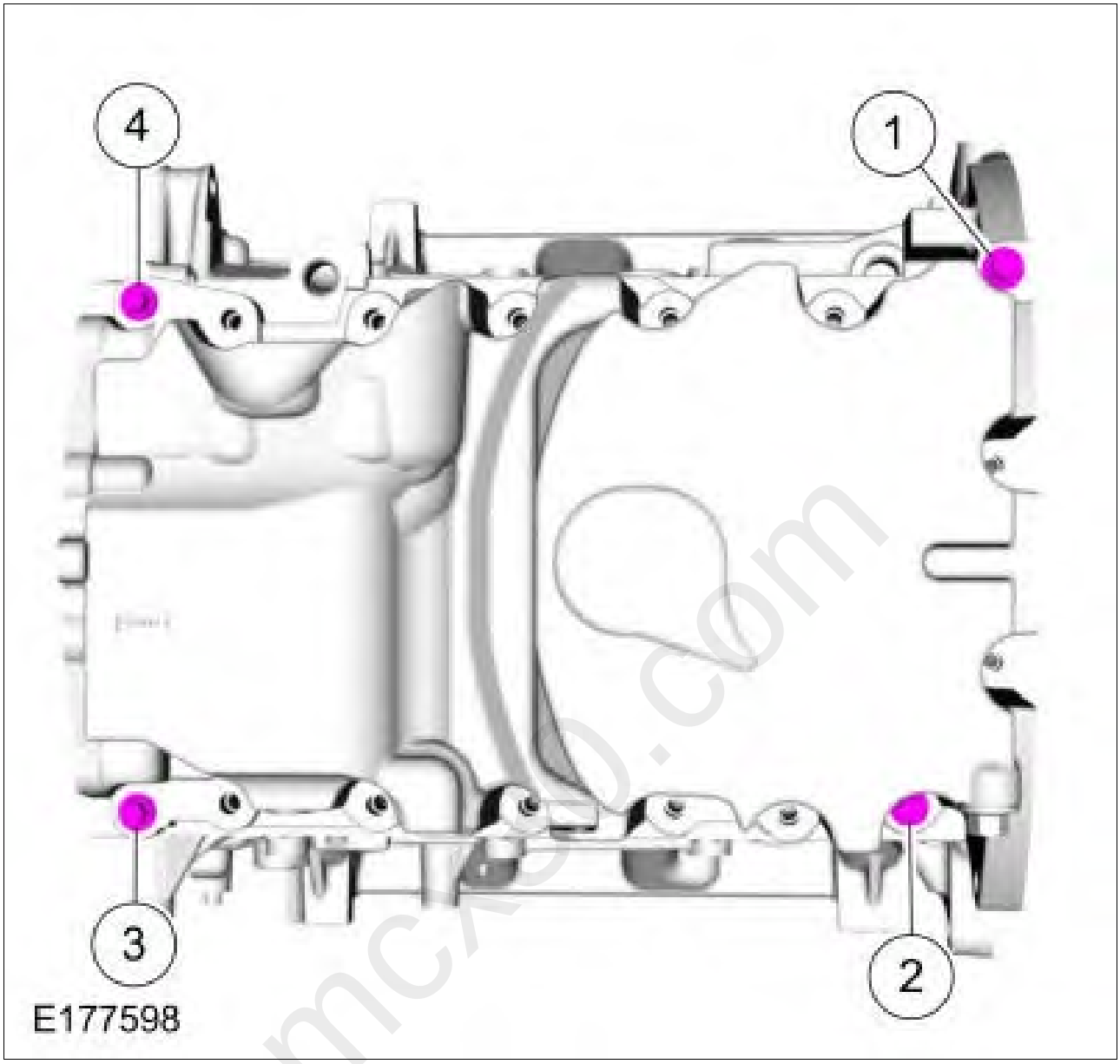
38.

Tighten the bolts in the sequence,

Torque

: 27 lb.in (3 Nm)

Fig 5: Oil Pan Bolts Tightening Sequence



Courtesy of FORD MOTOR CO.

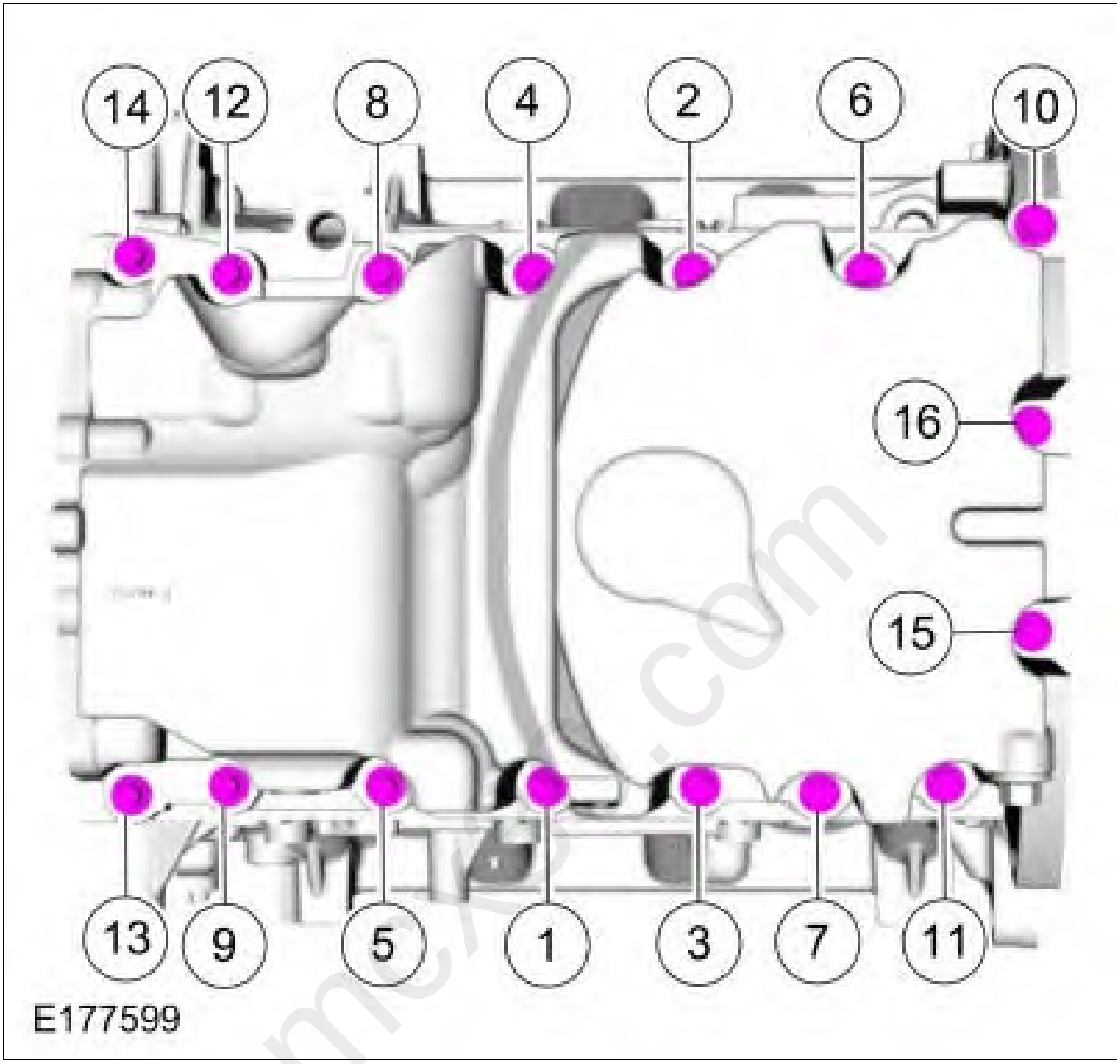
39.

Install the remaining oil pan bolts.

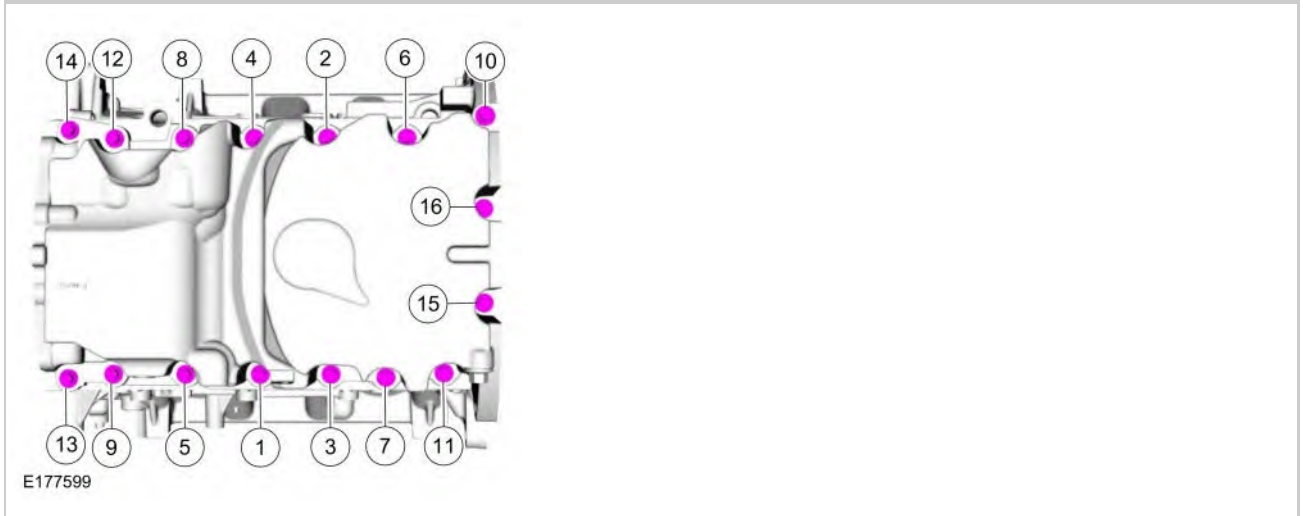
Torque

: Stage 1: Tighten bolts 1 through 14 to: 18 lb.ft (24 Nm) Stage 2: Tighten bolt 10 an additional: 90 ° Stage 3: Tighten bolts 15 and 16 to: 89 lb.in (10 Nm)

Fig 6: Oil Pan Bolts Tightening Sequence



Courtesy of FORD MOTOR CO.



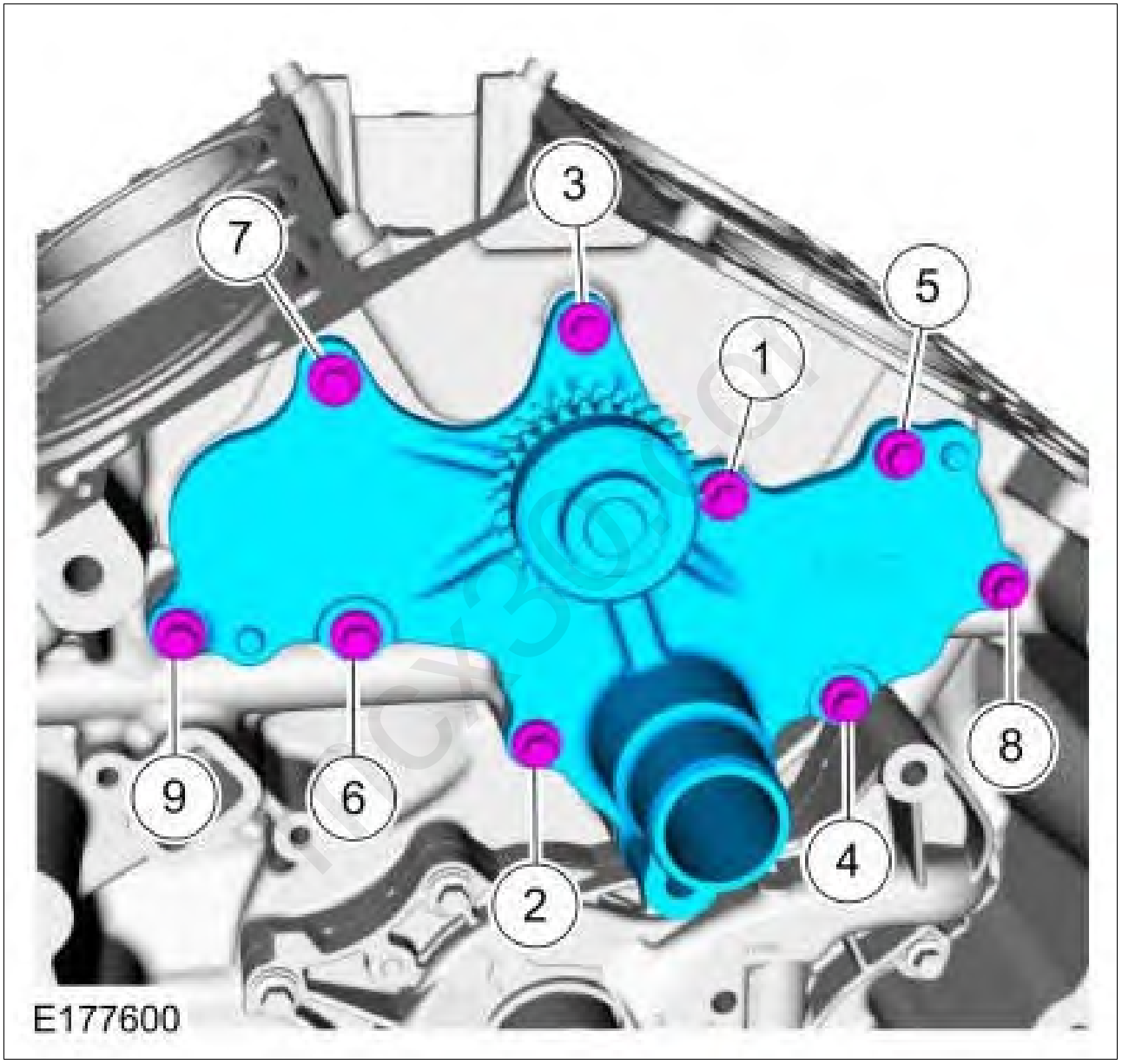
40.

Install the channel cover plate and the bolts.

Torque

: Stage 1: 89 lb.in (10 Nm) Stage 2: 45 °

Fig 7: Channel Cover Plate Bolts Tightening Sequence



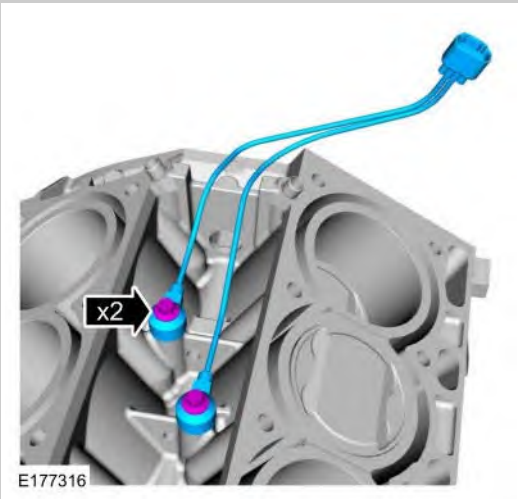
Courtesy of FORD MOTOR CO.

41.

Install the KS and the bolts.

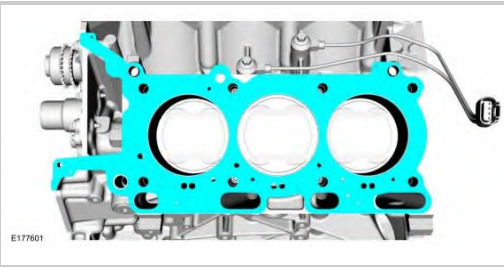
Torque

: 177 lb.in (20 Nm)



42.

Install the LH cylinder head gasket.



43.

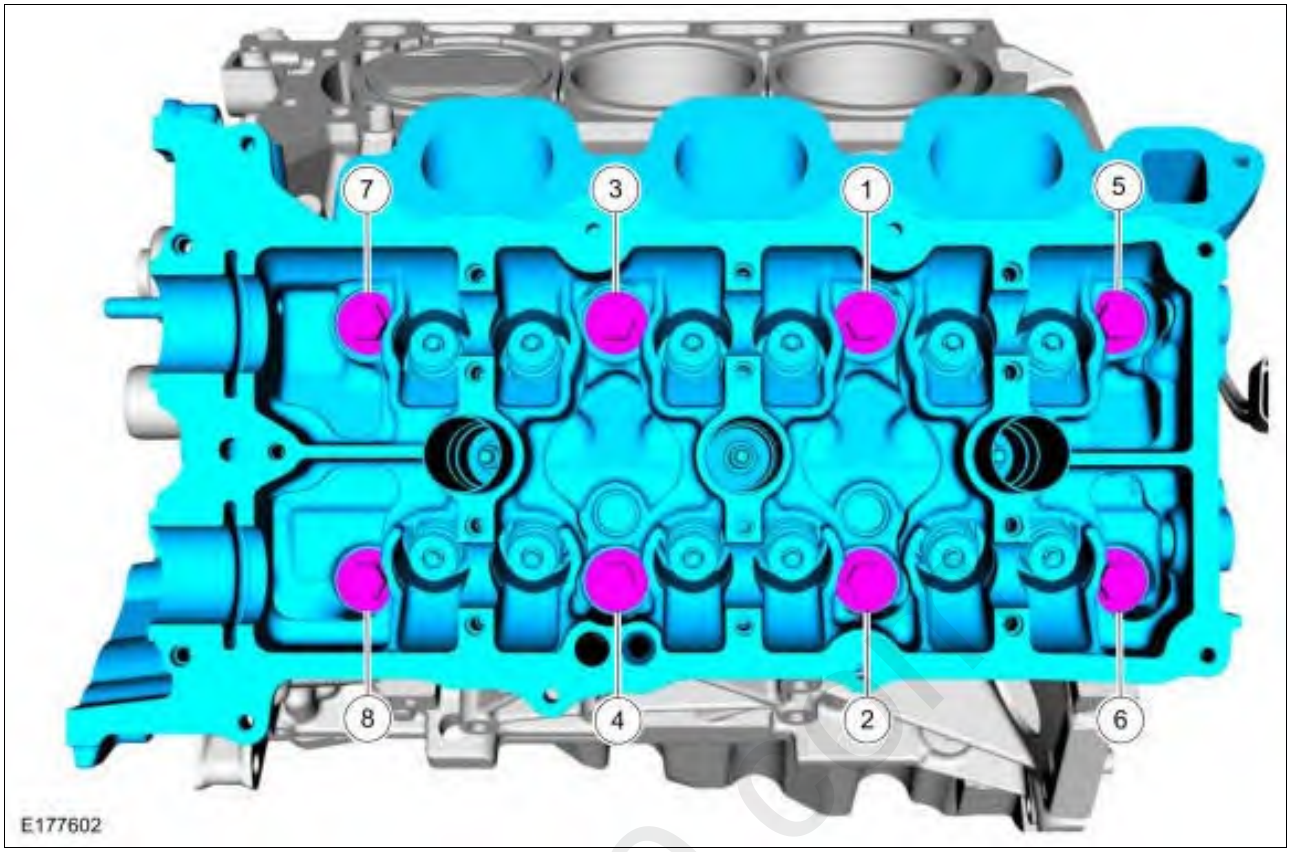
NOTE: If the cylinder head is replaced, a new secondary timing chain tensioner will need to be installed.

Install the cylinder head and the new bolts.

Torque

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

Fig 8: LH Cylinder Head Bolts Tightening Sequence



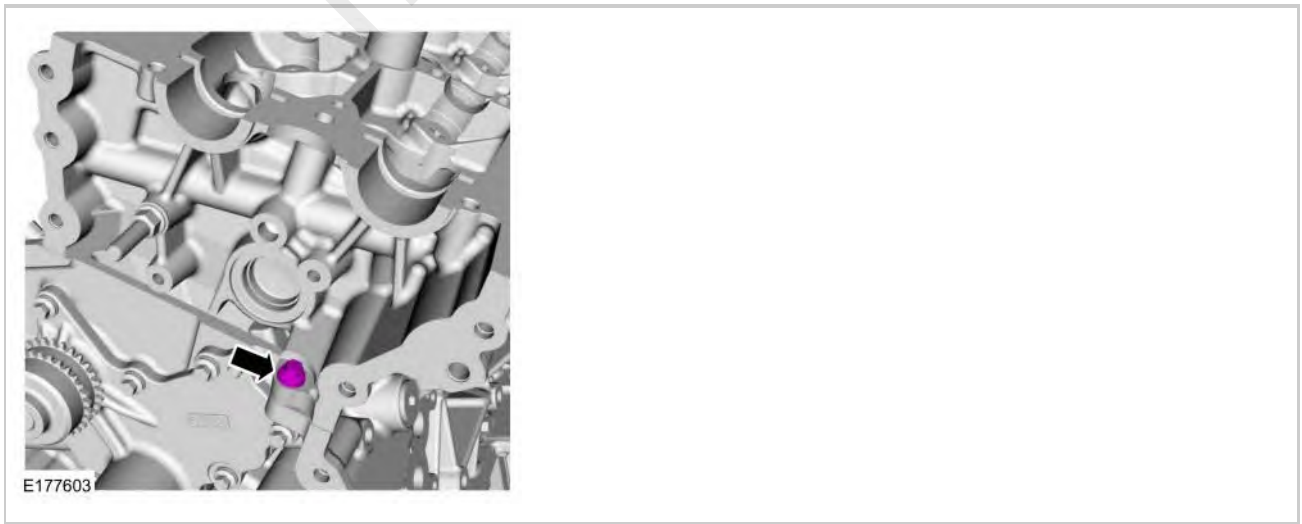
Courtesy of FORD MOTOR CO.

44.

Install the M6 bolt.

Torque

: 89 lb.in (10 Nm)



45.

Install the RH cylinder head gasket.

46.

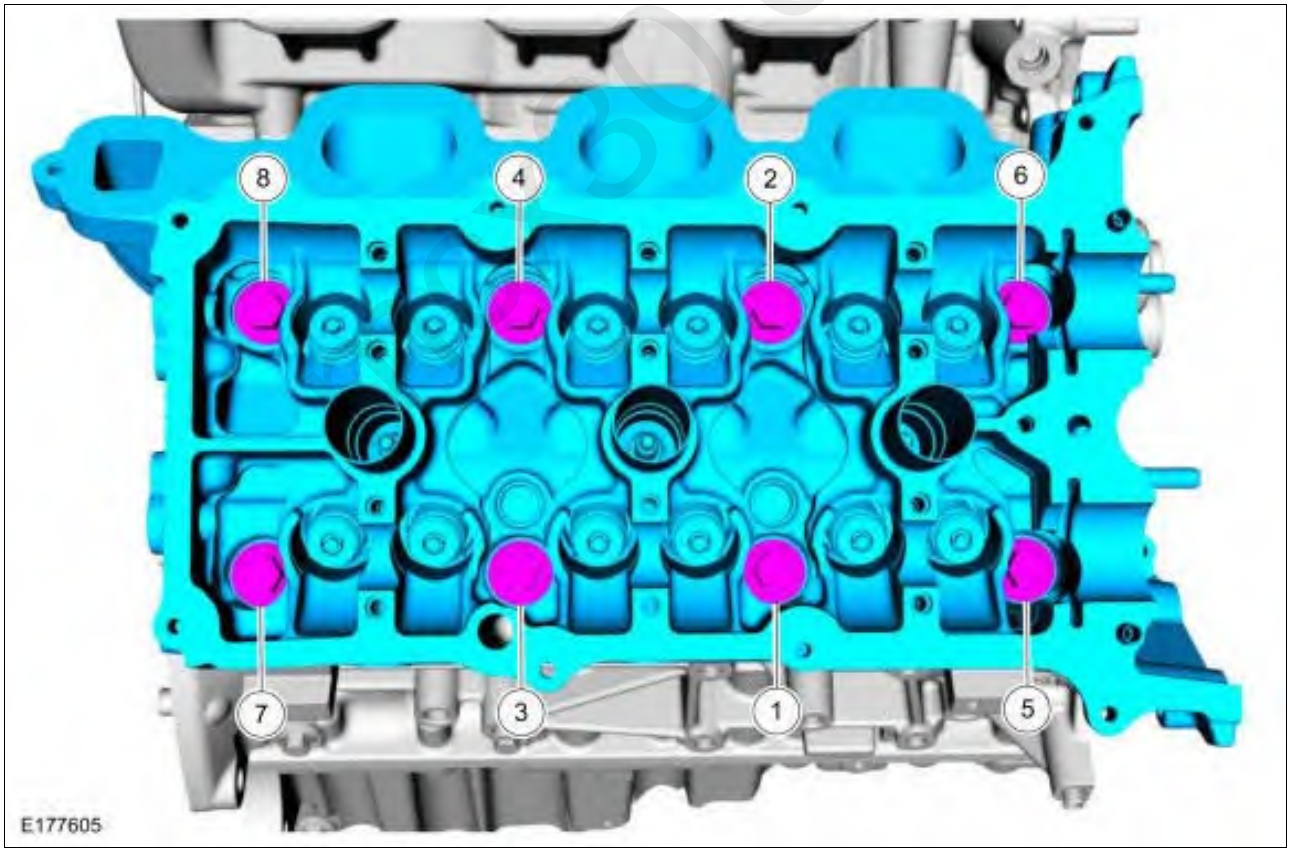
> *NOTE: If the cylinder head is replaced, a new secondary timing chain tensioner will need to be installed.*

Install the cylinder head and the new bolts.

Torque

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

Fig 9: RH Cylinder Head Bolts Tightening Sequence



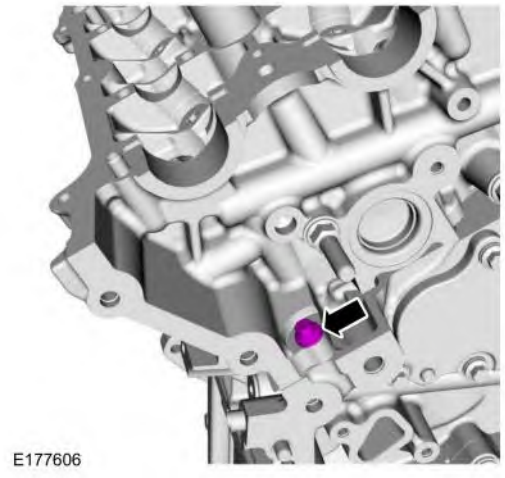
Courtesy of FORD MOTOR CO.

47.

Install the M6 bolt.

Torque

: 89 lb.in (10 Nm)



48.

NOTE: Coat the valve tappets with clean engine oil prior to installation.

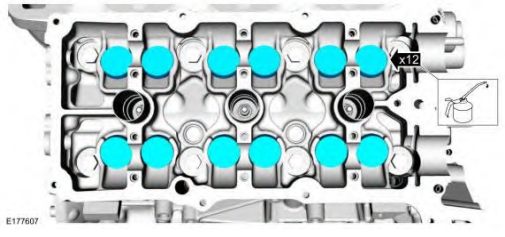
NOTE: The valve tappets must be installed in their original positions.

NOTE: RH shown, LH similar.

Install the valve tappets.

Material

: Motorcraft ® SAE 5W-20 Premium Synthetic Blend Motor Oil / XO-5W20-QSP (WSS-M2C945-A)

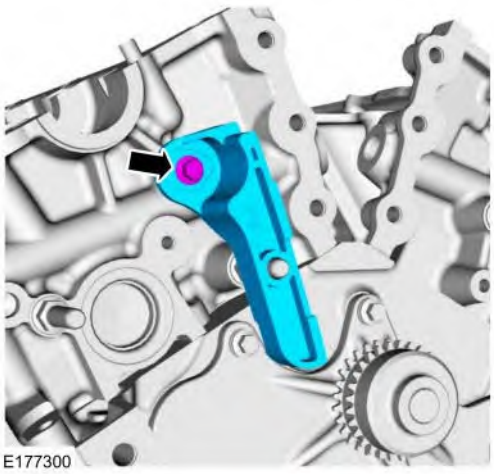


49.

Install the RH primary timing chain guide and the bolt.

Torque

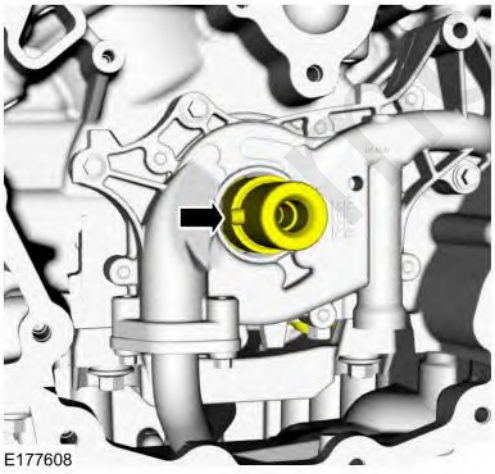
: 89 lb.in (10 Nm)



50.

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

Position the crankshaft dowel pin in the 9 o'clock position.



51.

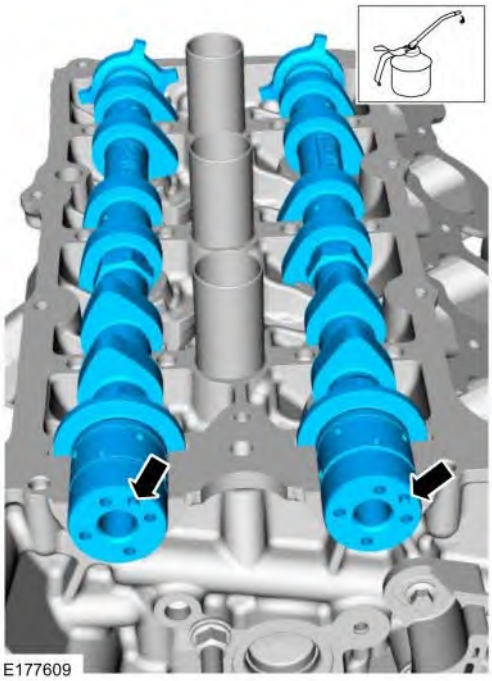
NOTE: Coat the camshafts with clean engine oil prior to installation.

Lubricate the camshafts with clean engine oil and position the camshafts onto the RH cylinder

head in the neutral position as shown.

Material

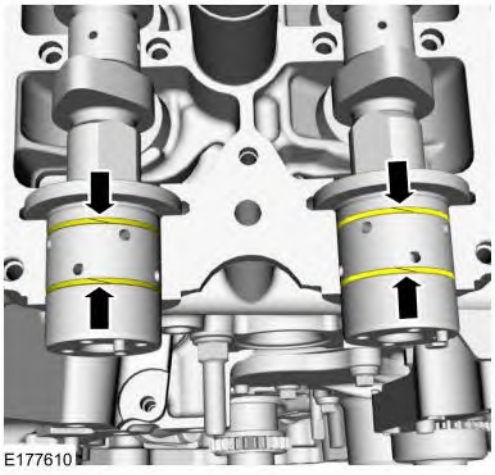
: Motorcraft ® SAE 5W-20 Premium Synthetic Blend Motor Oil / XO-5W20-QSP (WSS-M2C945-A)



52.

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

Position the RH camshaft seals gaps as shown.



53.

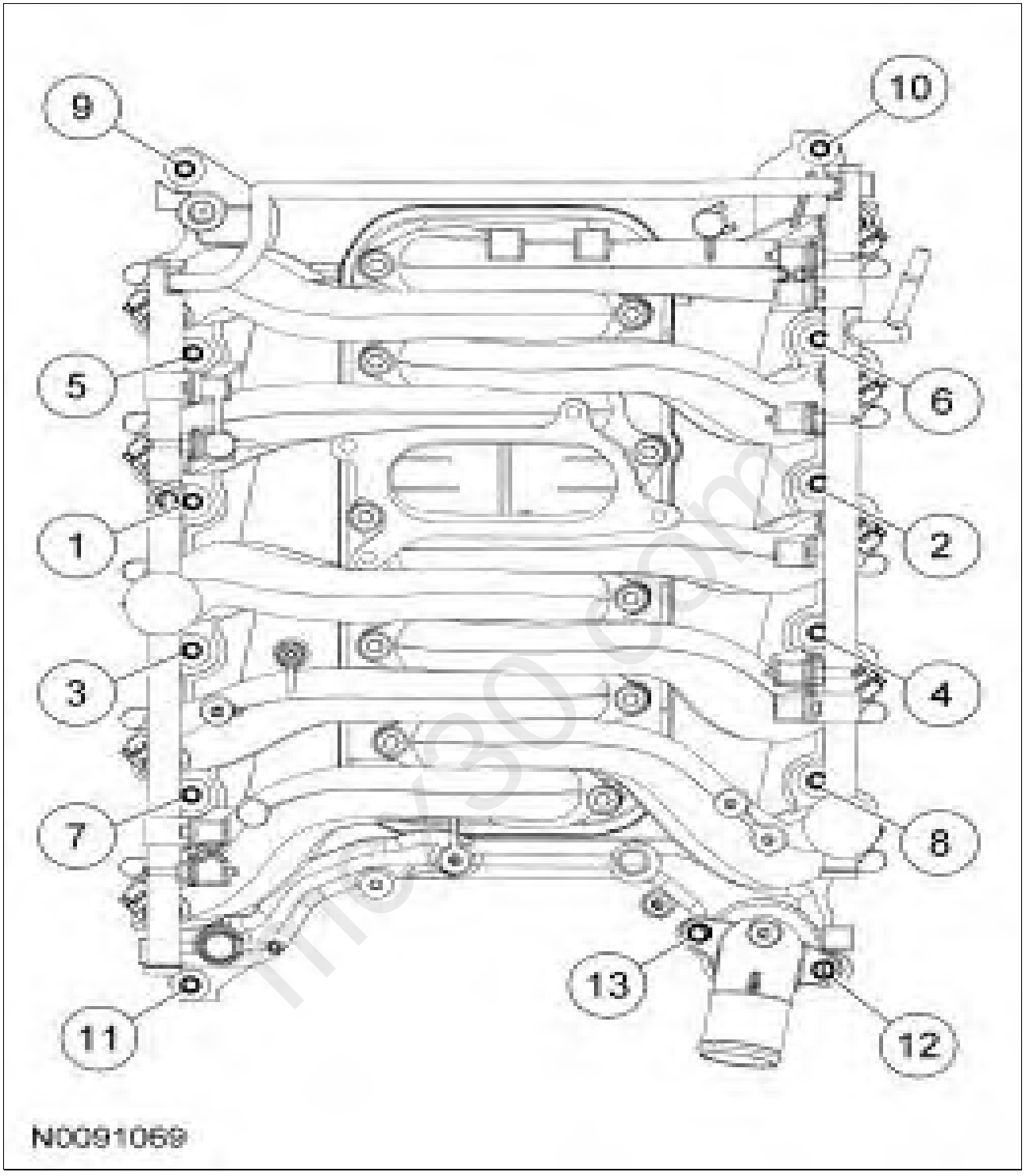
NOTE: Cylinder head camshaft bearing caps are numbered to verify that they are assembled in their original positions.

Install the camshaft caps, oil tube and the bolts.

Torque

: Stage 1: 71 lb.in (8 Nm) Stage 2: 45 °

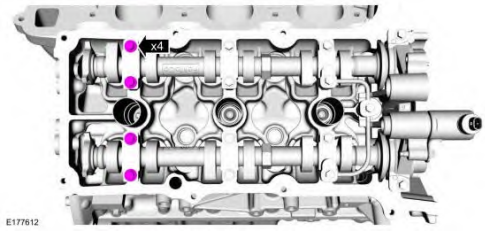
Fig 10: RH Camshaft Bolts Tightening Sequence



Courtesy of FORD MOTOR CO.

54.

Loosen the camshaft cap bolts.

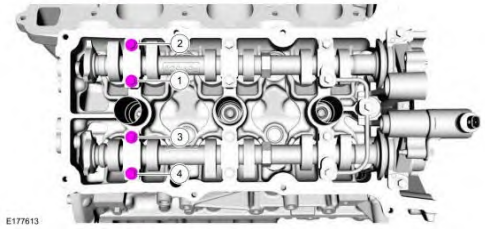


55.

Tighten the camshaft cap bolts.

Torque

: Stage 1: 71 lb.in (8 Nm) Stage 2: 45 °

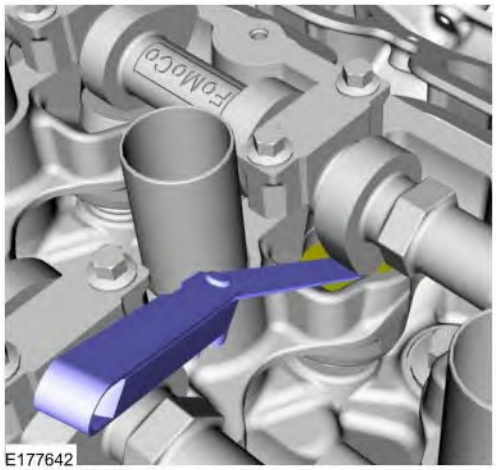


56.

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

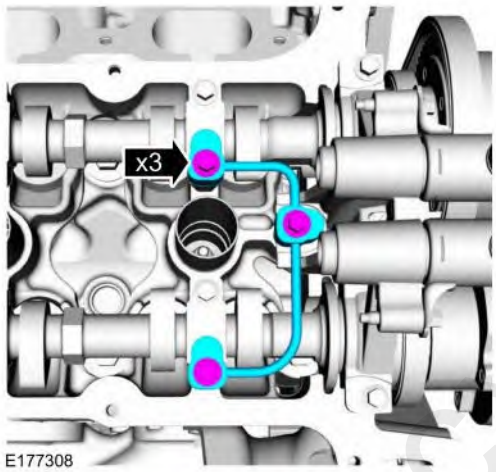
NOTE: Use a camshaft sprocket bolt to turn the camshafts.

Confirm that the valve tappet clearances are within specification. If valve tappet clearances are not within specification, the clearance must be adjusted by installing new valve tappet(s) of the correct size. Refer to: Valve Clearance Adjustment . Use the General Equipment: Feeler Gauge



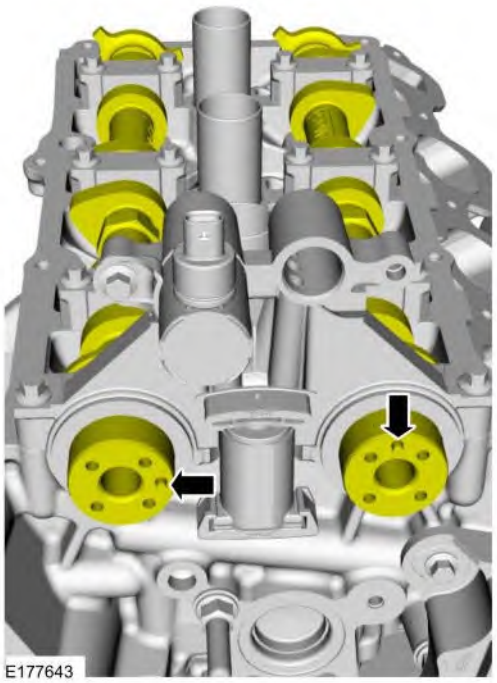
57.

Remove the bolts and the oil tube.



58.

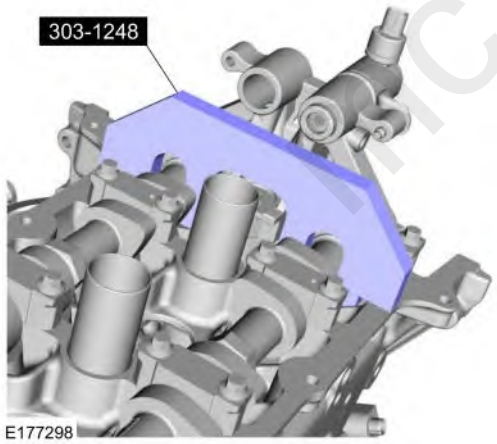
Rotate the RH camshafts to TDC.



59.

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

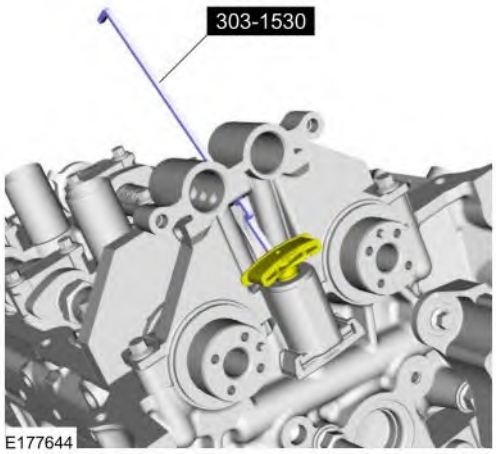
Install Special Service Tool: 303-1248 Camshaft holding tools.



60.

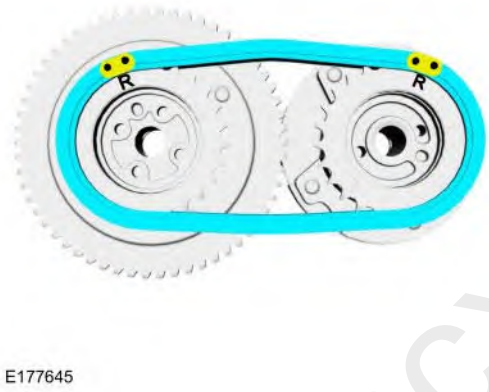
NOTE: The VCT oil control solenoids are removed for clarity.

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



61.

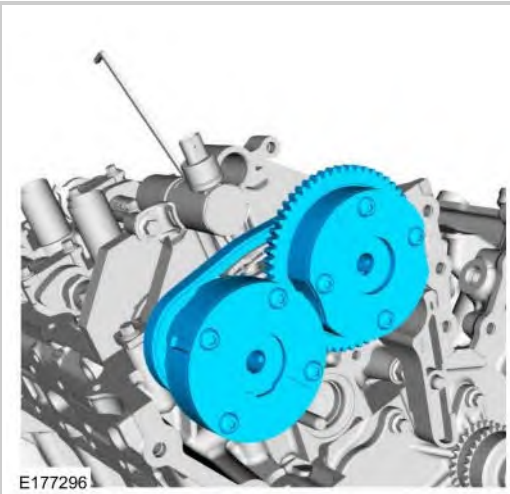
Align the colored links with the timing marks and assemble the RH VCT units.



62.

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

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

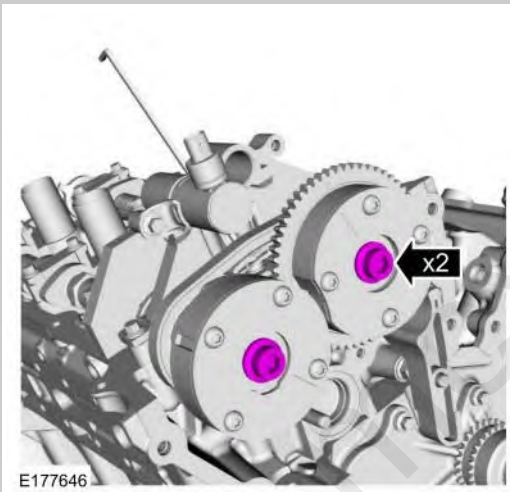


63.

Install the new RH VCT unit bolts.

Torque

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

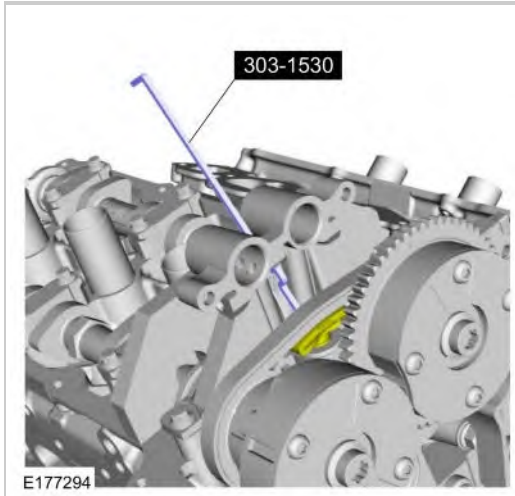


64.

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

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

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



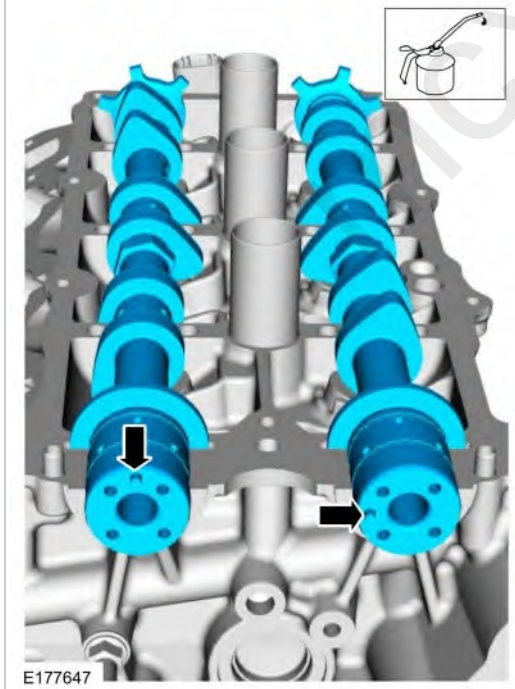
65.

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

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

Material

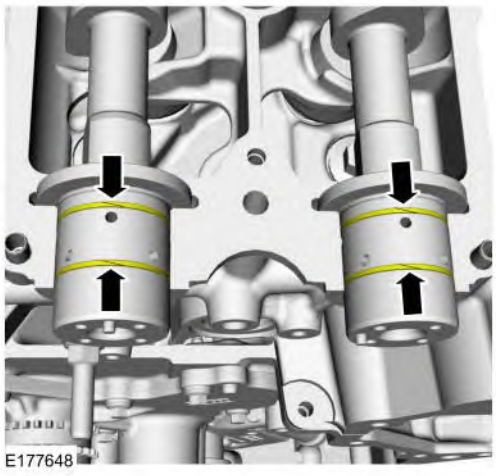
: Motorcraft ® SAE 5W-20 Premium Synthetic Blend Motor Oil / XO-5W20-QSP (WSS-M2C945-A)



66.

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

Position the LH camshaft seals gaps as shown.



67.

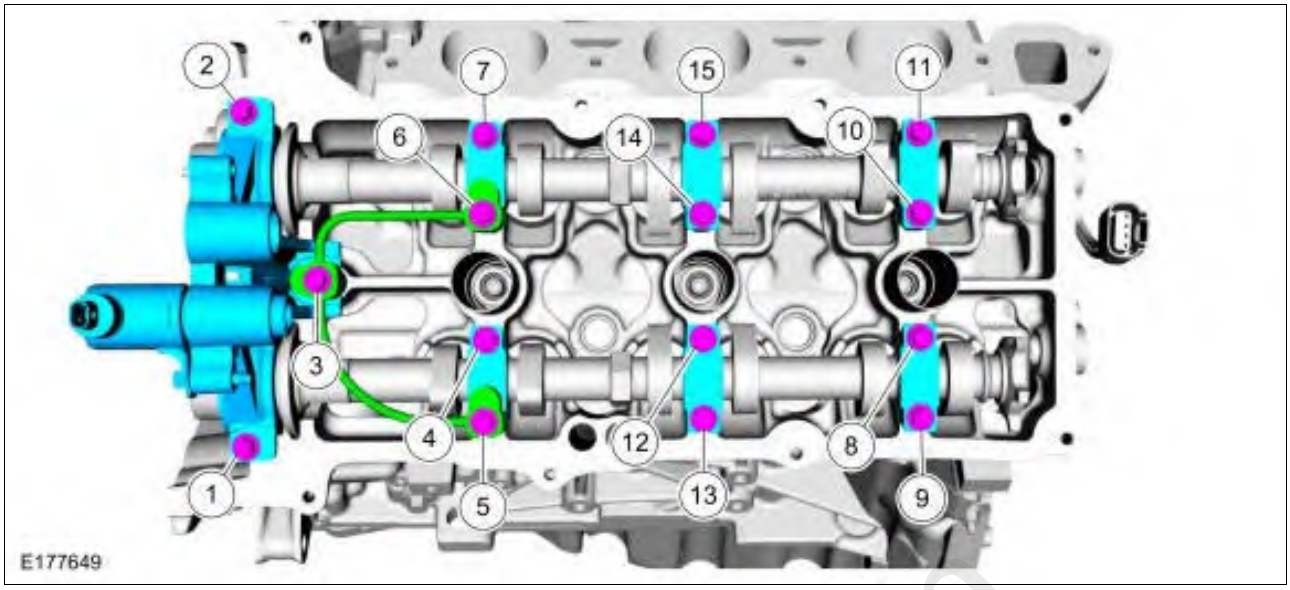
NOTE: Cylinder head camshaft bearing caps are numbered to verify that they are assembled in their original positions.

Install the camshaft caps, oil tube and the bolts.

Torque

: Stage 1: 71 lb.in (8 Nm) Stage 2: 45 °

Fig 11: LH Camshaft Bolts Tightening Sequence



Courtesy of FORD MOTOR CO.

68.

Loosen the camshaft cap bolts.

69.

Tighten the camshaft cap bolts.

Torque

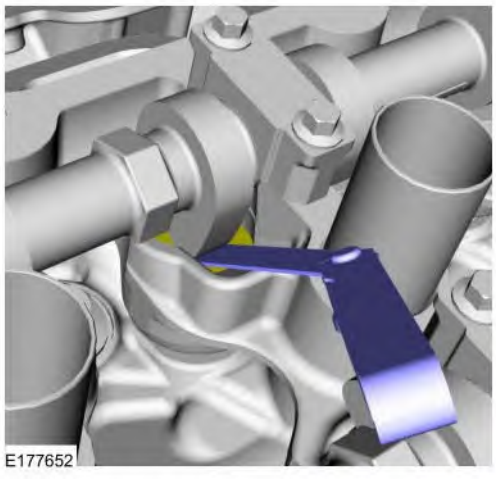
: Stage 1: 71 lb.in (8 Nm) Stage 2: 45 °

70.

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

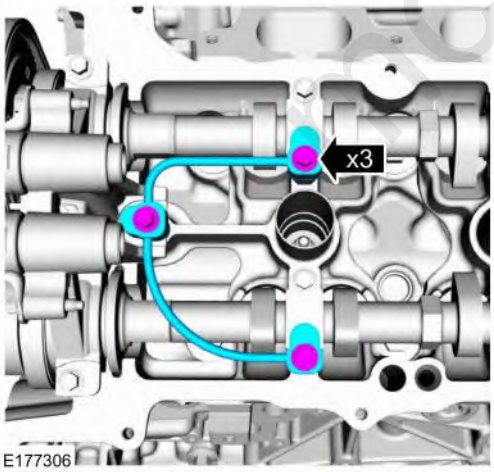
NOTE: Use a camshaft sprocket bolt to turn the camshafts.

Confirm that the valve tappet clearances are within specification. If valve tappet clearances are not within specification, the clearance must be adjusted by installing new valve tappet(s) of the correct size. Refer to: Valve Clearance Adjustment . Use the General Equipment: Feeler Gauge



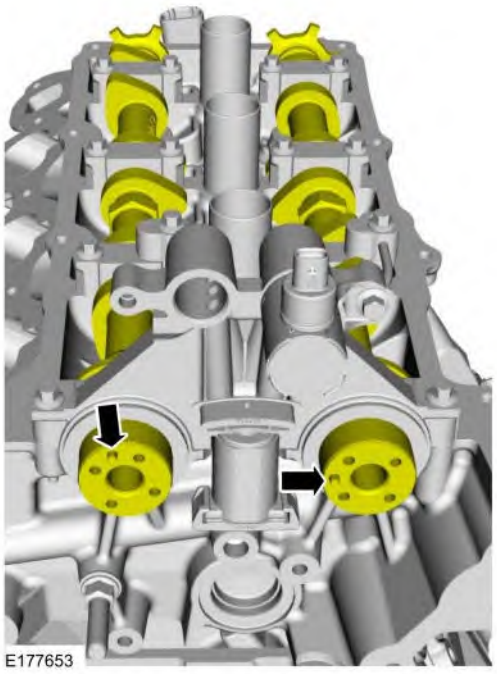
71.

Remove bolts and the oil tube.



72.

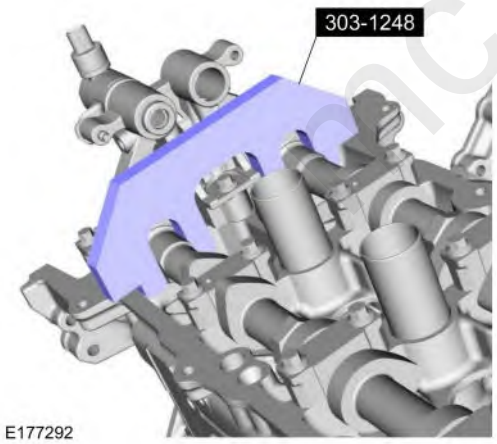
Rotate the LH camshafts to TDC.



73.

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

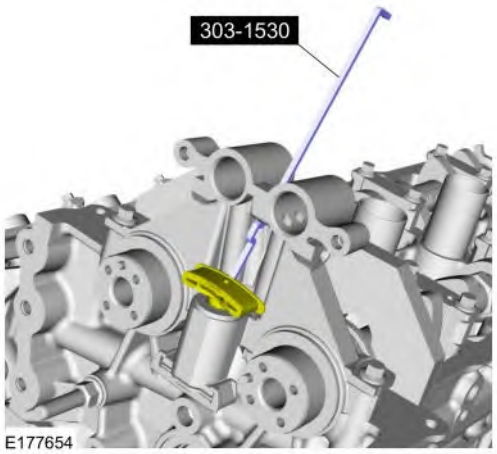
Install Special Service Tool: 303-1248 Camshaft holding tools.



74.

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

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



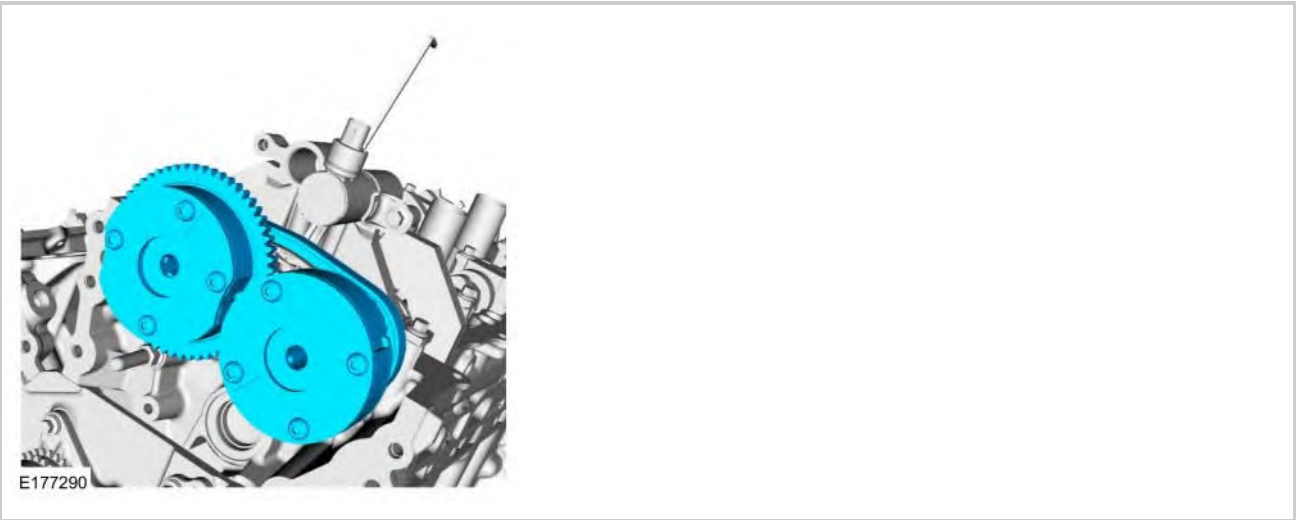
75.

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

76.

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

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

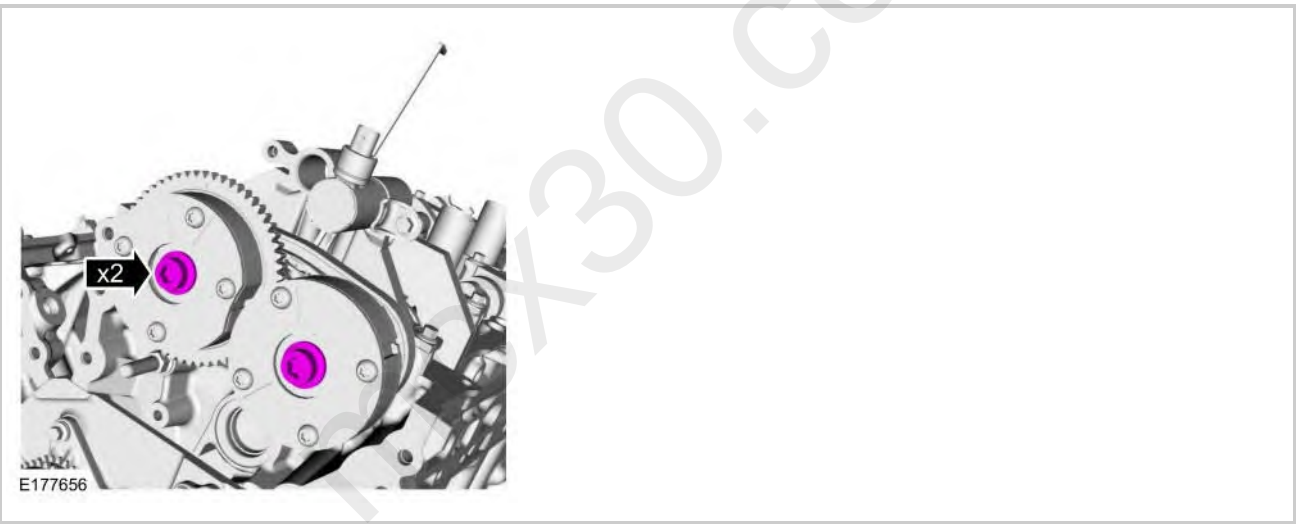


77.

Install the new LH VCT unit bolts.

Torque

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

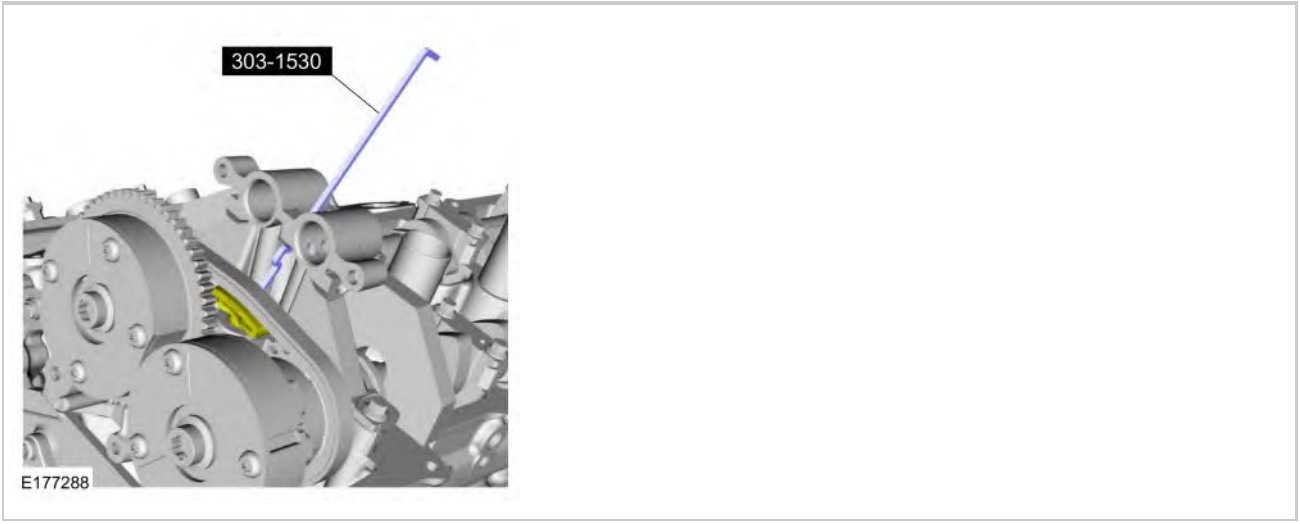


78.

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

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

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



79.

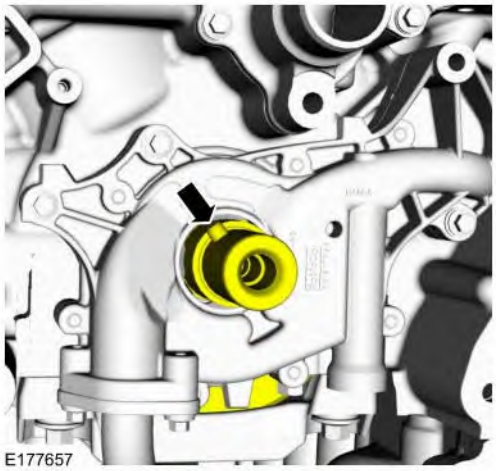
Install the LH upper primary timing chain guide and the bolt.

Torque

: 89 lb.in (10 Nm)

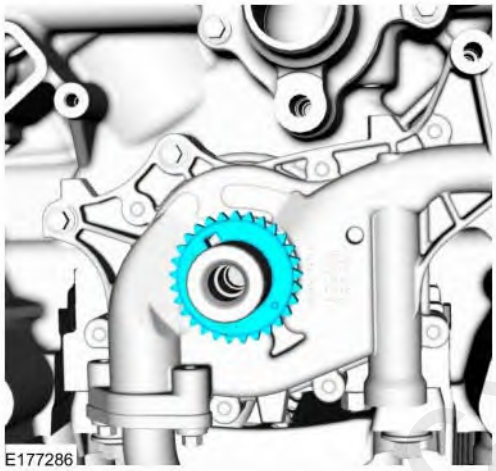
80.

Rotate the crankshaft clockwise 60 degrees to the TDC position (crankshaft dowel pin at 11 o'clock).



81.

Install the crankshaft sprocket.



82.

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

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

83.

Install the lower LH timing chain guide and the bolts.

Torque

: 89 lb.in (10 Nm)

84.

Install the timing chain tensioner arm.


E177282

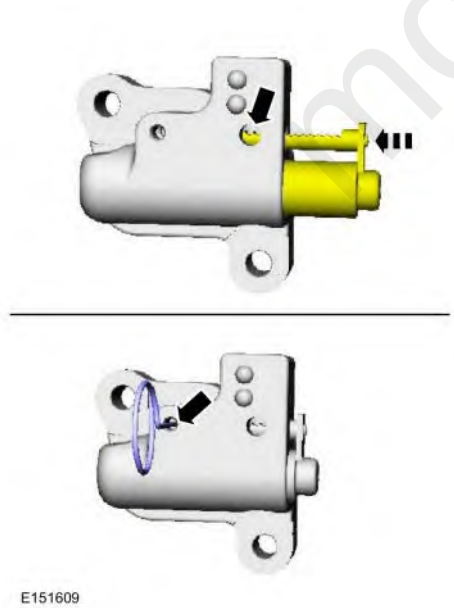
85.

Release the ratchet detent.

Using a soft-jawed vise, compress the ratchet plunger.

Align the hole in the ratchet plunger with the hole in the tensioner housing.

Install a lockpin.


E151609

86.

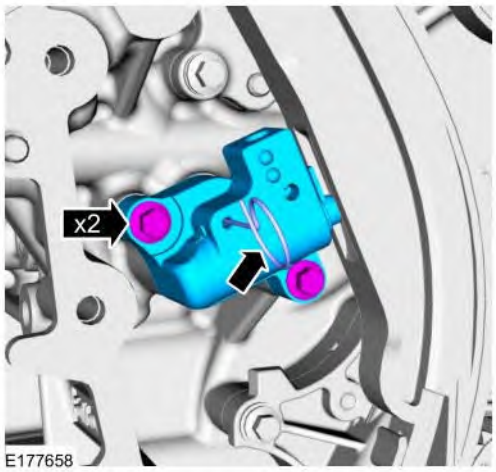
NOTE: It may be necessary to rotate the camshafts slightly to remove slack from the timing chain to install the tensioner.

Install the timing chain tensioner and the bolts.

Torque

: 89 lb.in (10 Nm)

Remove the lockpin.



87.

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

There are 48 links in between the RH intake VCT unit colored link (1) and the LH intake VCT unit colored link (2).

There are 35 links in between LH intake VCT unit colored link (2) and the 2 crankshaft sprocket links (3).

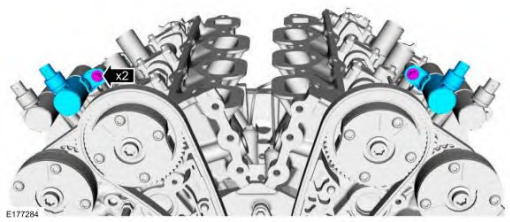
88.

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

Install the VCT oil control solenoids and the bolts.

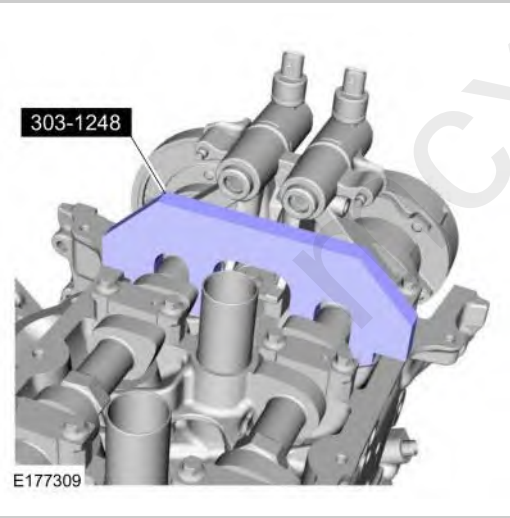
Torque

: Stage 1: 71 lb.in (8 Nm) Stage 2: 20 °



89.

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

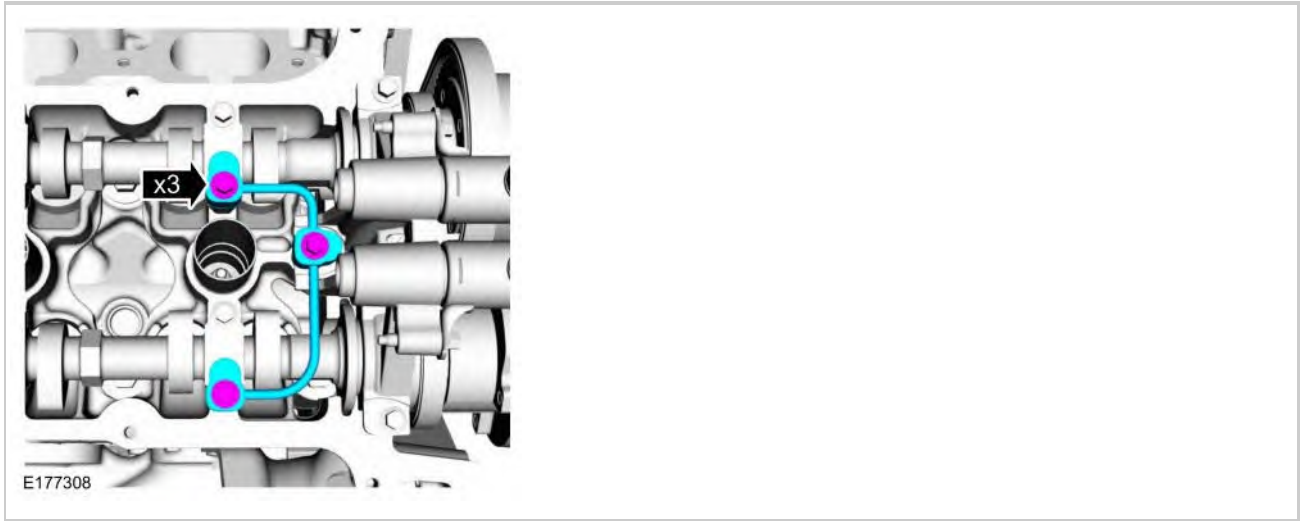


90.

Install the RH oil tube and the bolts.

Torque

: Stage 1: 71 lb.in (8 Nm) Stage 2: 45 °



91.

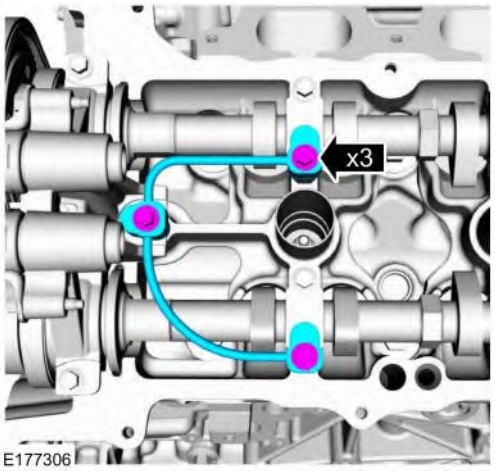
Remove Special Service Tool: 303-1248 Camshaft holding tools.

92.

Install the LH oil tube and the bolts.

Torque

: Stage 1: 71 lb.in (8 Nm) Stage 2: 45 °



93.

NOTE: Place clean, lint-free shop towels over exposed engine cavities. Carefully remove the towels so foreign material is not dropped into the engine. Any foreign material (including any material created while cleaning gasket surfaces) that enters the oil passages or the oil pan, may cause engine failure.

NOTE: 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 gasket.

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

Material

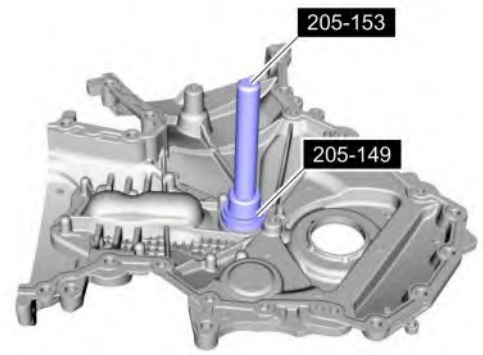
: Motorcraft ® Silicone Gasket Remover / ZC-30-A

Material

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

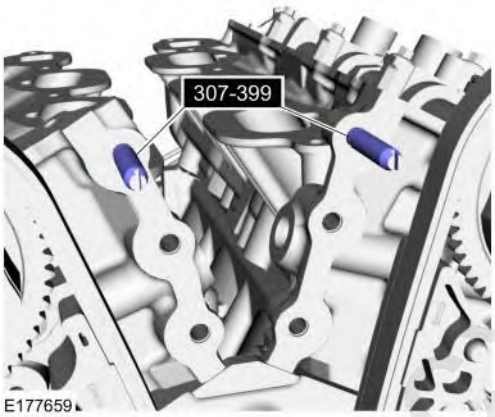
94.

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



95.

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



96.

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

NOTE: The engine front cover and 6 bolts must be installed within 4 minutes of the initial sealant application. The remainder of the engine front cover bolts must be installed and tightened within 35 minutes of the initial sealant application. If the time limits are exceeded, the sealant must be removed, the sealing area cleaned and sealant reapplied. To clean the sealing area, use silicone gasket remover and metal surface prep. Failure to follow this procedure can cause future oil leakage.

Apply a 3.0 mm (0.11 in) bead of Motorcraft ® High Performance Engine RTV Silicone to the engine front cover sealing surfaces including the inner bolt bosses.

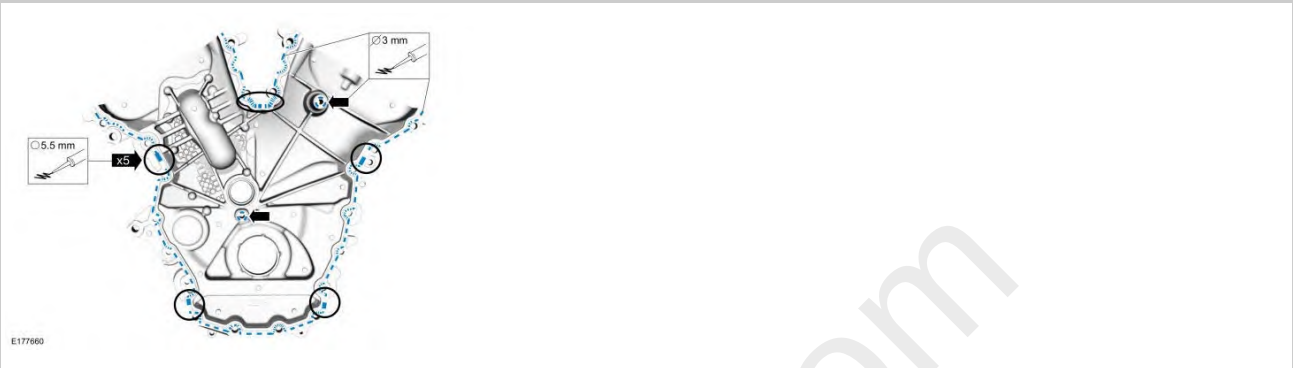
Material

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

Apply a 5.5 mm (0.21 in) bead of Motorcraft ® High Performance Engine RTV Silicone to the oil pan-to-cylinder block joint and the cylinder head-to-cylinder block joint areas of the engine front cover in places as indicated.

Material

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



97.

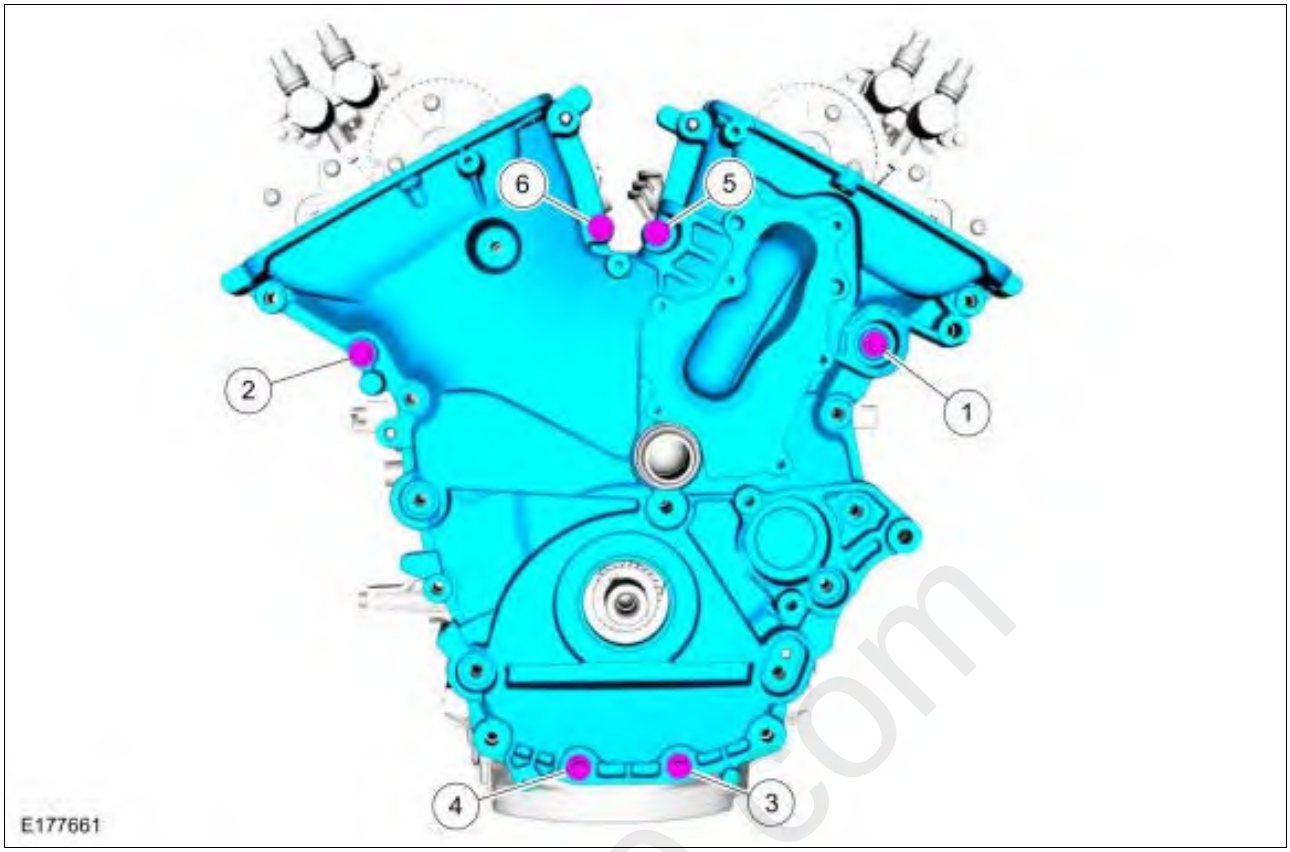
NOTE: Make sure the locating dowel pins are seated correctly in the cylinder block.

Install the engine front cover and the bolts.

Torque

: 27 lb.in (3 Nm)

Fig 12: Engine Front Cover Bolts Tightening Sequence



Courtesy of FORD MOTOR CO.

98.

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

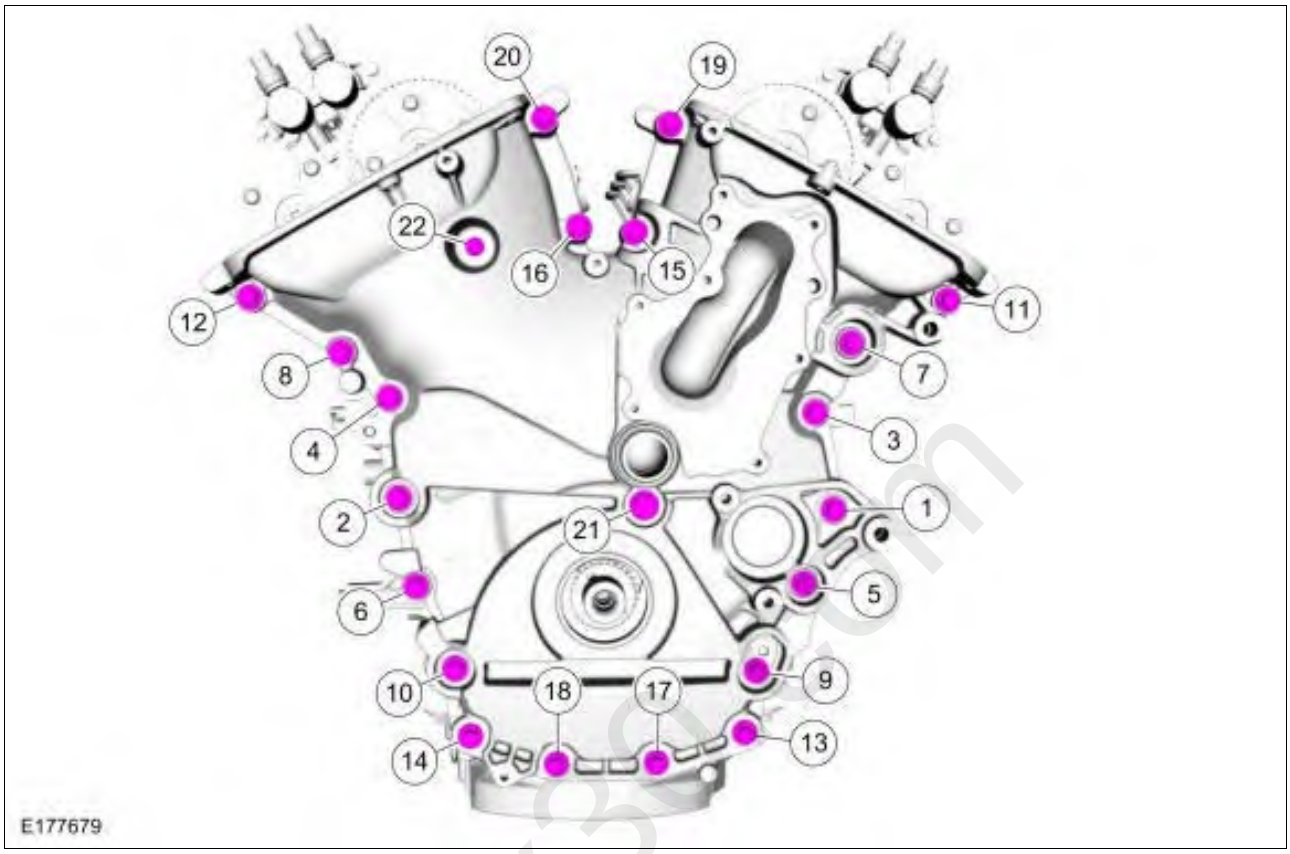
99.

Install the remaining engine front cover bolts.

Torque

: Stage 1: Tighten bolts 1 thru 21 to: 89 lb.in (10 Nm) Stage 2: Tighten bolts 1 thru 20 to: 18 lb.ft (24 Nm) Stage 3: Tighten bolt 21 to: 177 lb.in (20 Nm) Stage 4: Tighten bolt 21 an additional: 90 ° Stage 5: Tighten bolt 22 to: 89 lb.in (10 Nm) Stage 6: Tighten bolt 22 an additional: 45 °

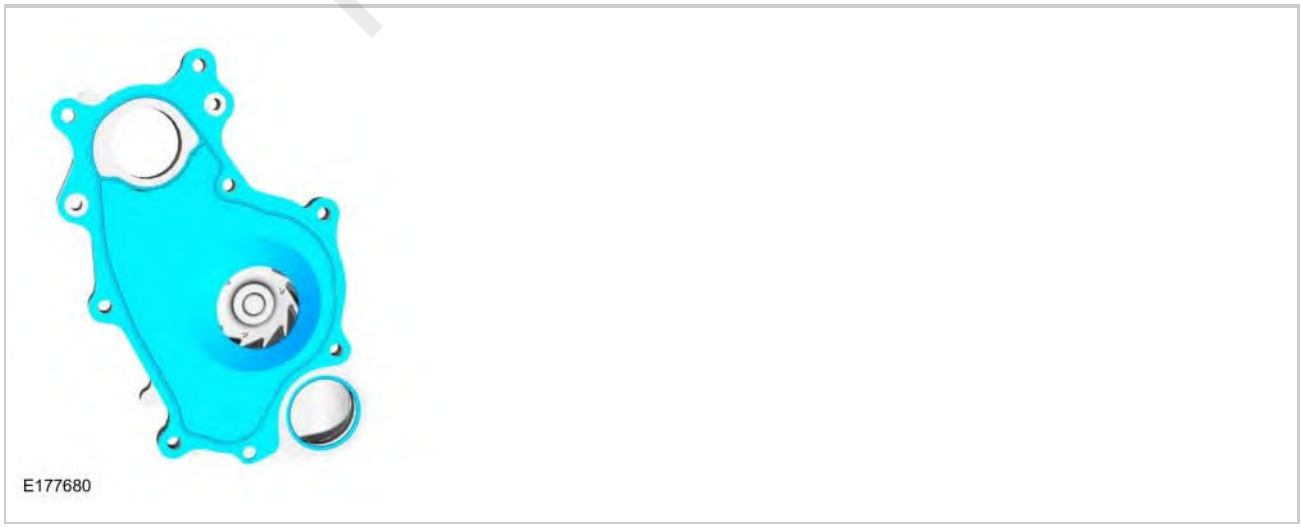
Fig 13: Engine Front Cover Bolts Tightening Sequence



Courtesy of FORD MOTOR CO.

100.

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



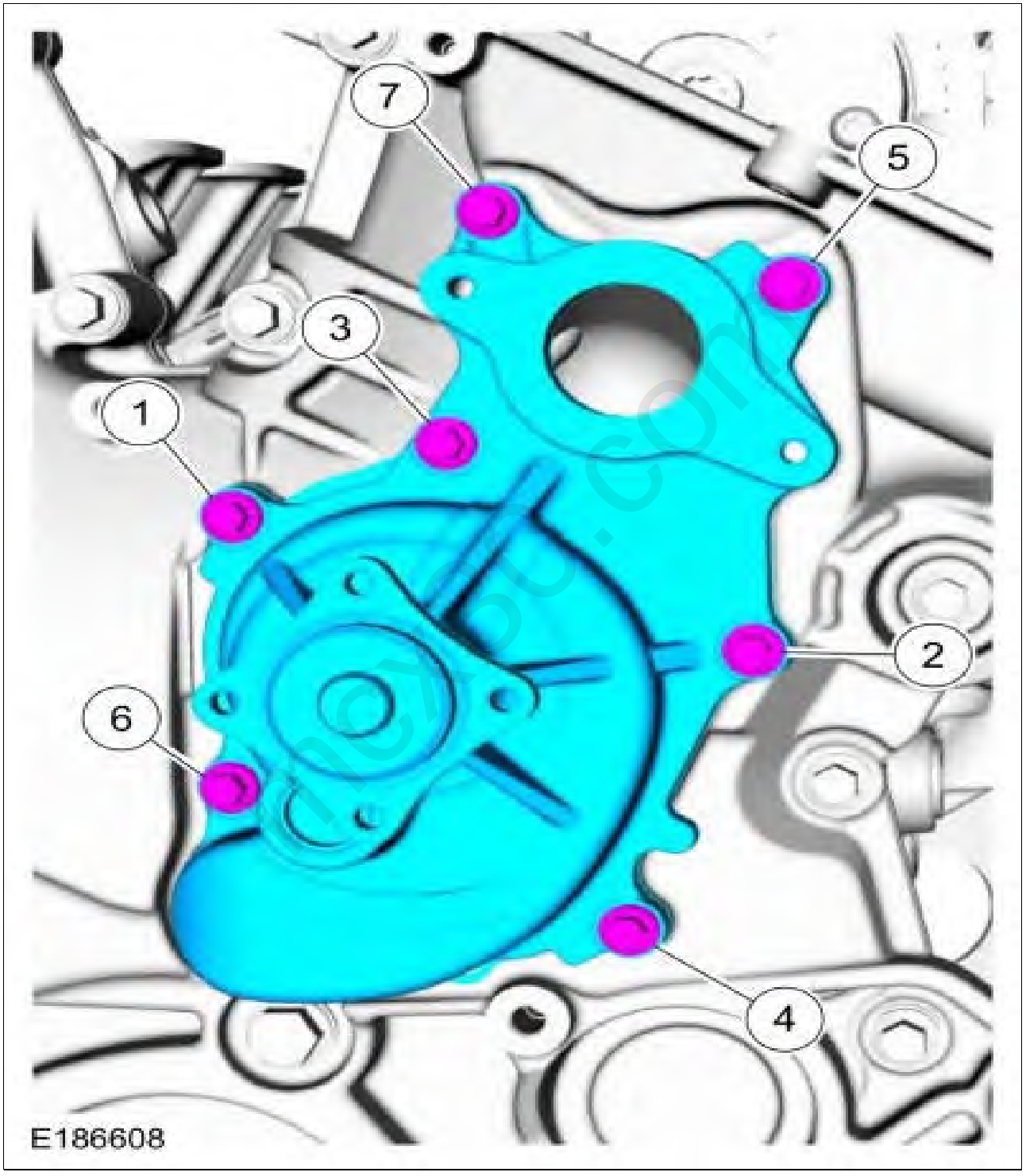
101.

Install the coolant pump and the bolts.

Torque

: Stage 1: 89 lb.in (10 Nm) Stage 2: 45 °

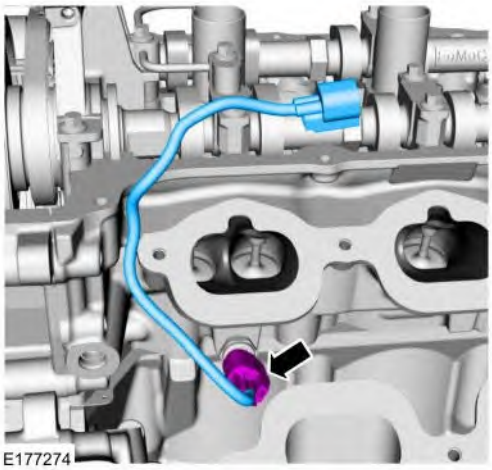
Fig 14: Coolant Pump Bolts Tightening Sequence



Courtesy of FORD MOTOR CO.

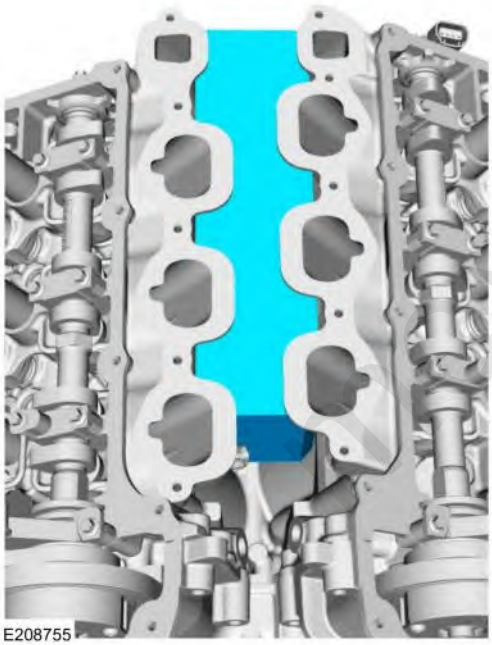
102.

Connect the CHT sensor electrical connector.



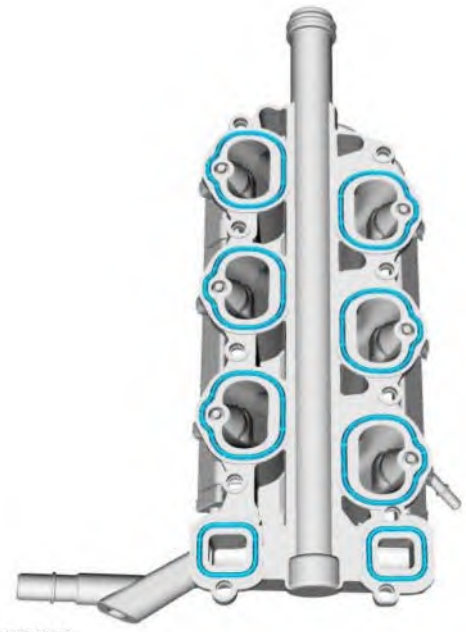
103.

Install the foam insulator.



104.

Install the new lower intake manifold gaskets.



105.

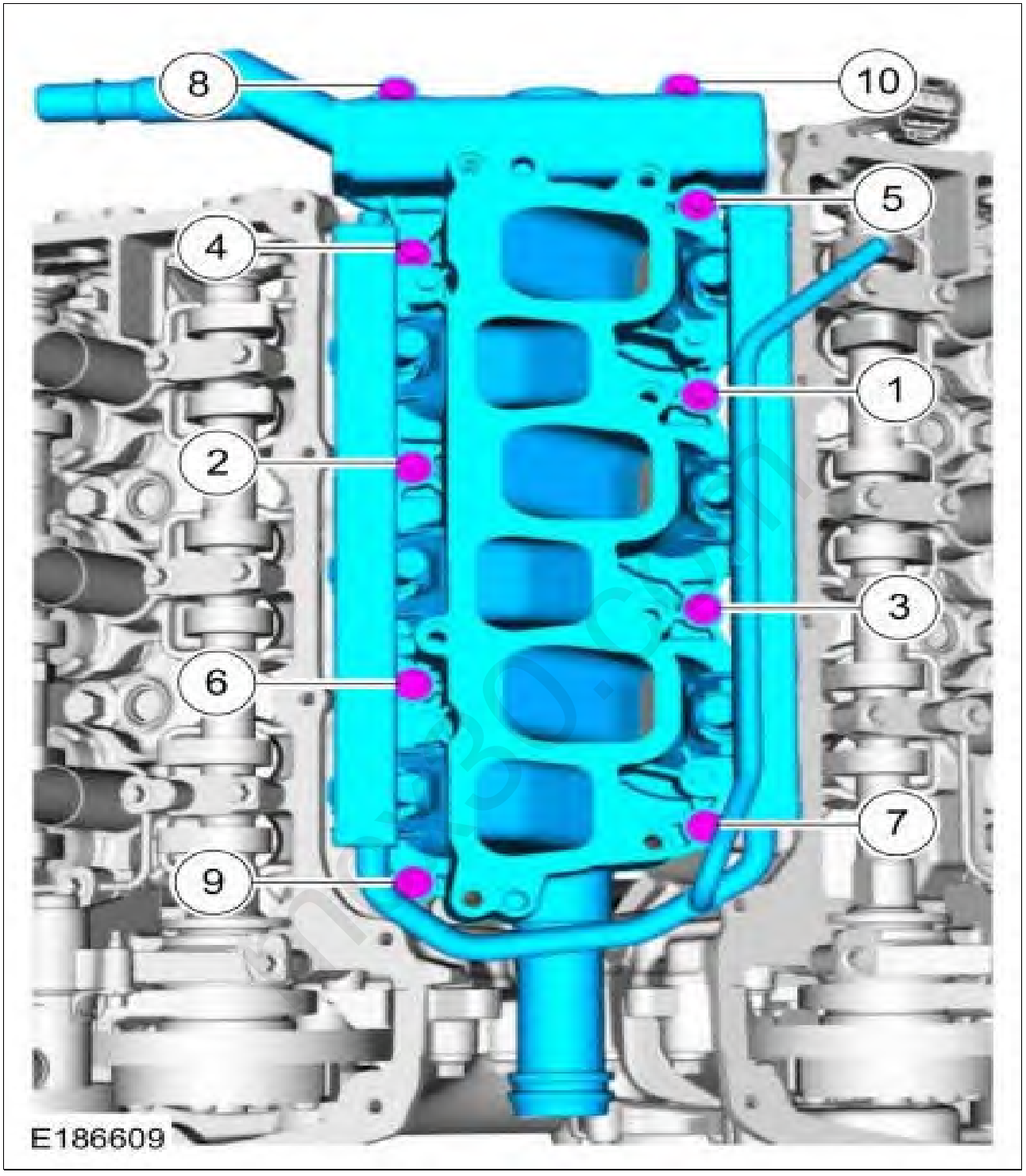
NOTE: If the engine is repaired or replaced because of upper engine failure, typically including valve or piston damage, check the intake manifold for metal debris. If metal debris is found, install a new intake manifold. Failure to follow these instructions can result in engine damage.

Install the lower intake manifold and the bolts.

Torque

: 89 lb.in (10 Nm)

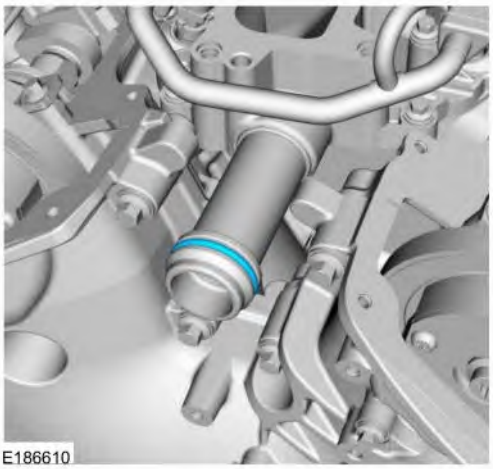
Fig 15: Lower Intake Manifold Bolts Tightening Sequence



Courtesy of FORD MOTOR CO.

106.

Install a new thermostat housing O-ring seal.



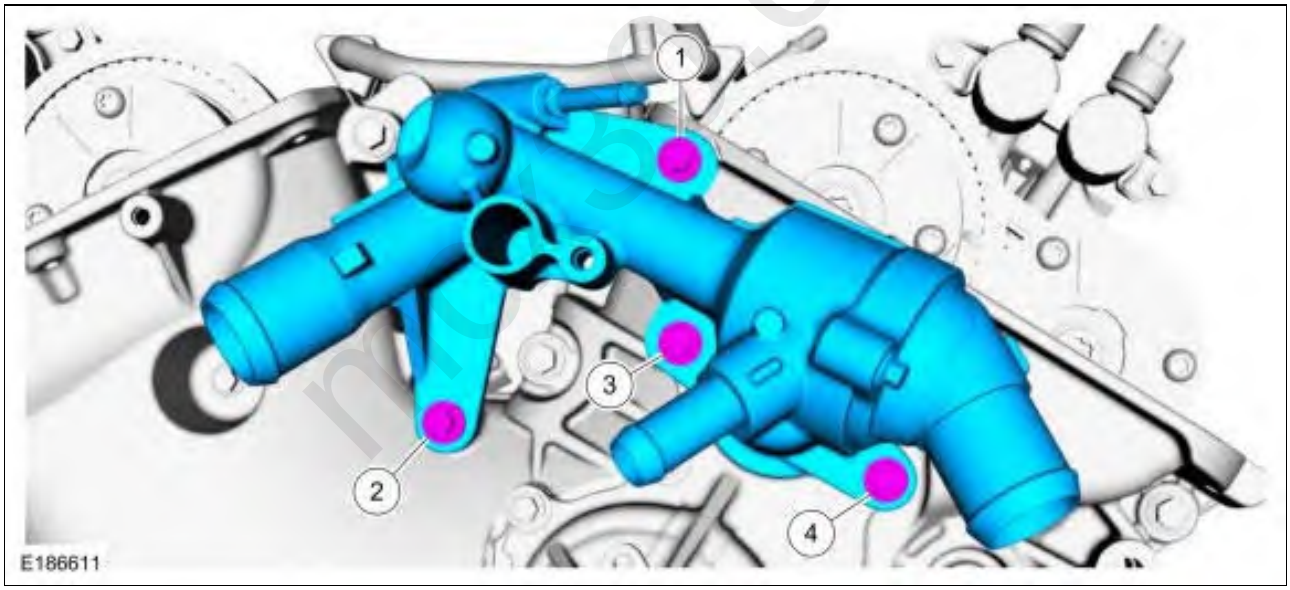
107.

Install the thermostat housing and the bolts.

Torque

: Stage 1: 71 lb.in (8 Nm) Stage 2: 45 °

Fig 16: Thermostat Housing Bolts Tightening Sequence



Courtesy of FORD MOTOR CO.

108.

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

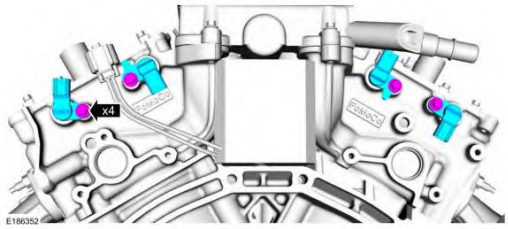
Install the CMP sensors and the bolts.

Material

: Motorcraft ® SAE 5W-20 Premium Synthetic Blend Motor Oil / XO-5W20-QSP (WSS-M2C945-A)

Torque

: 89 lb.in (10 Nm)

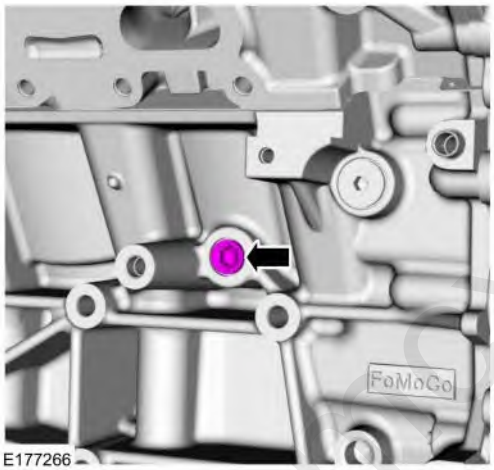


109.

Install the RH block coolant drain plug.

Torque

: Stage 1: 142 lb.in (16 Nm) Stage 2: 180 °

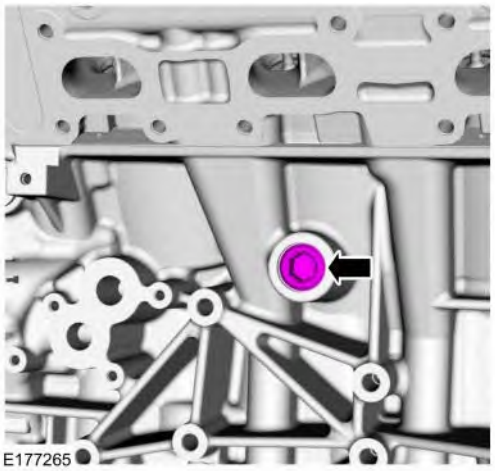


110.

Install the LH block coolant drain plug.

Torque

: 30 lb.ft (40 Nm)



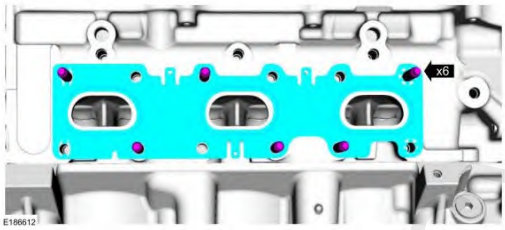
111.

Install the exhaust manifold studs.

Torque

: 106 lb.in (12 Nm)

Install the exhaust manifold gasket.



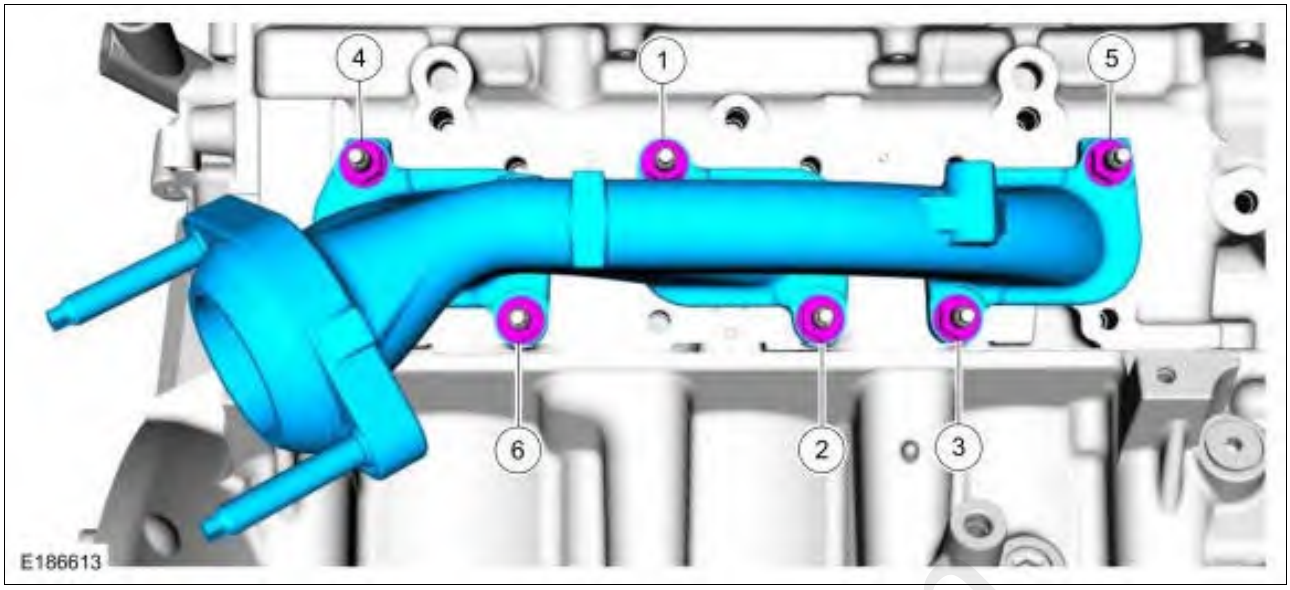
112.

Install the exhaust manifold and the new nuts.

Torque

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

Fig 17: RH Exhaust Manifold Nuts Tightening Sequence



Courtesy of FORD MOTOR CO.

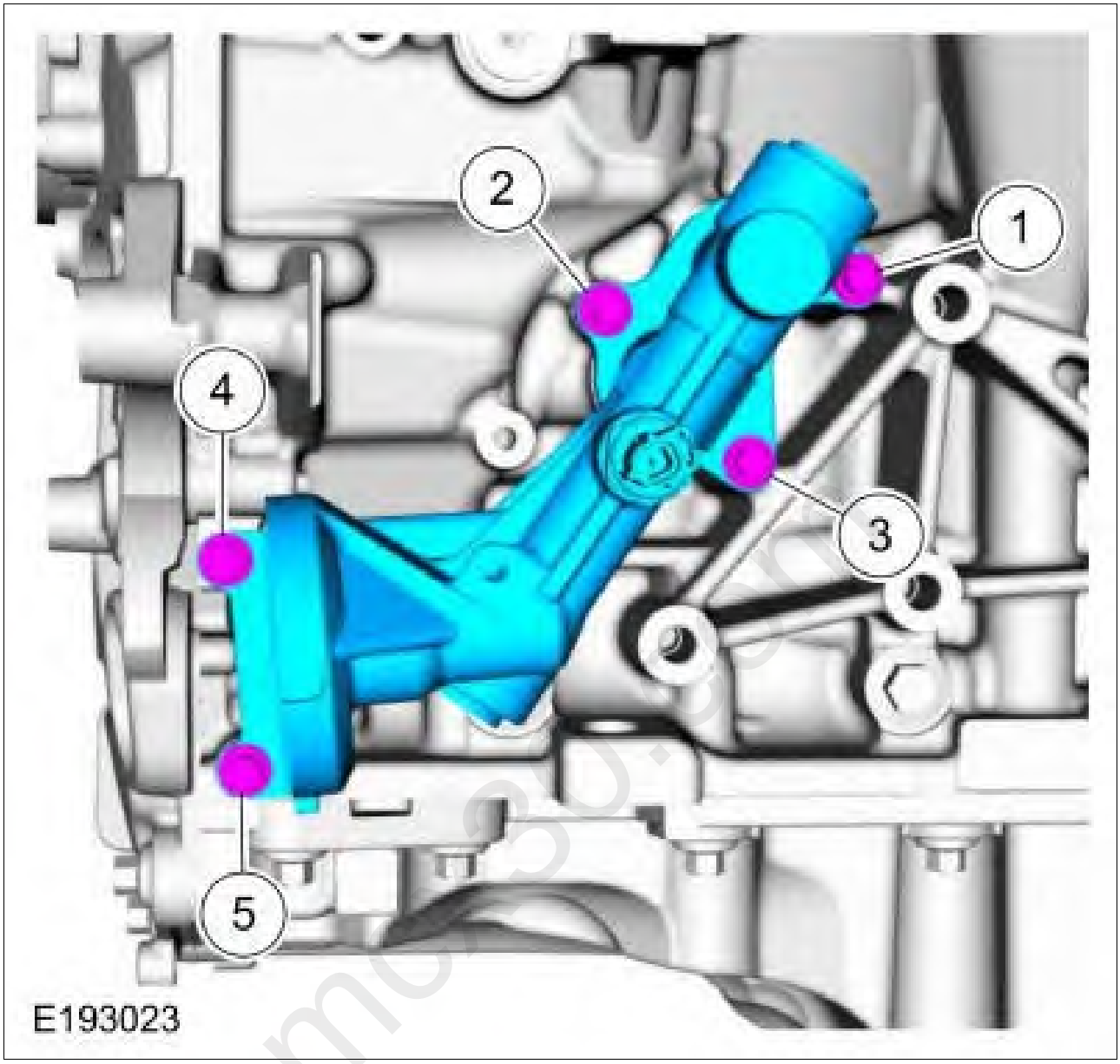
113.

Install the oil filter adapter and the bolts.

Torque

: Stage 1: 89 lb.in (10 Nm) Stage 2: 45 °

Fig 18: Oil Filter Adapter Bolts Tightening Sequence



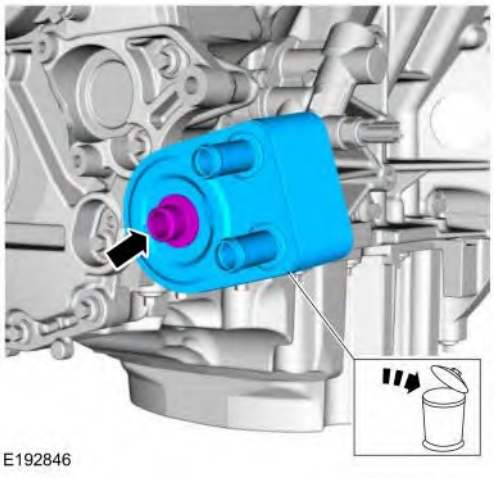
Courtesy of FORD MOTOR CO.

114.

Install the new oil cooler and bolt.

Torque

: 43 lb.ft (58 Nm)



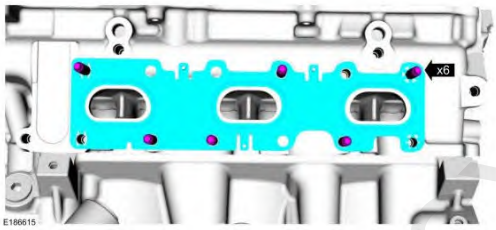
115.

Install the exhaust manifold studs.

Torque

: 106 lb.in (12 Nm)

Install the exhaust manifold gasket.



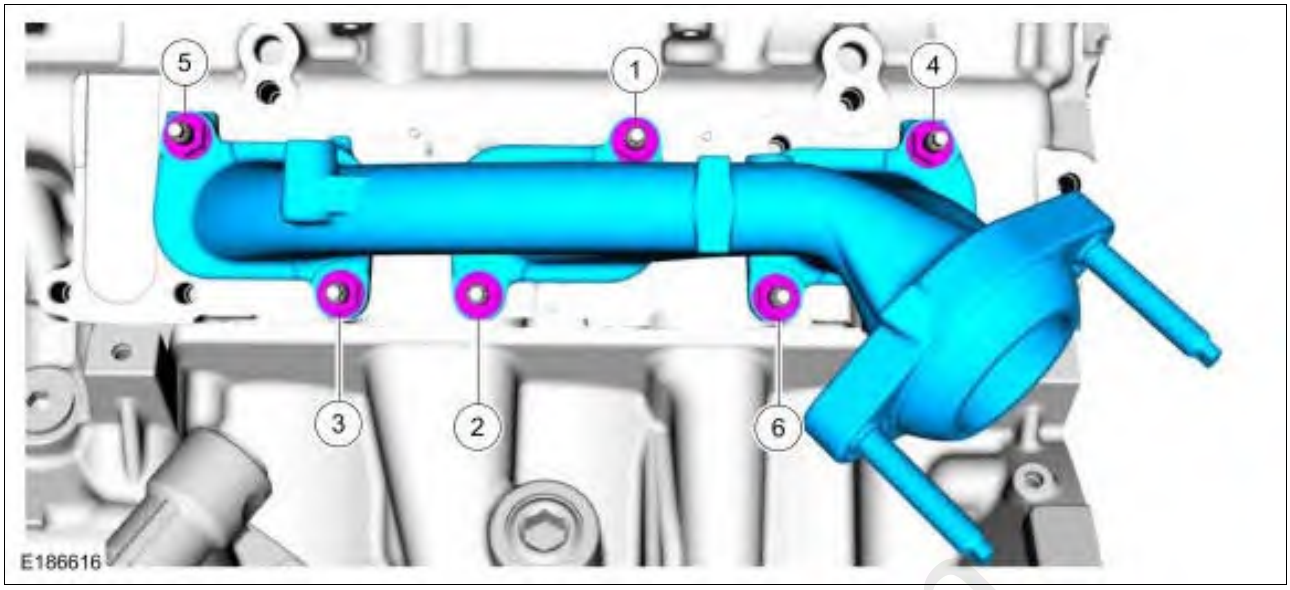
116.

Install the exhaust manifold and the new nuts.

Torque

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

Fig 19: LH Exhaust Manifold Nuts Tightening Sequence



Courtesy of FORD MOTOR CO.

117.

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

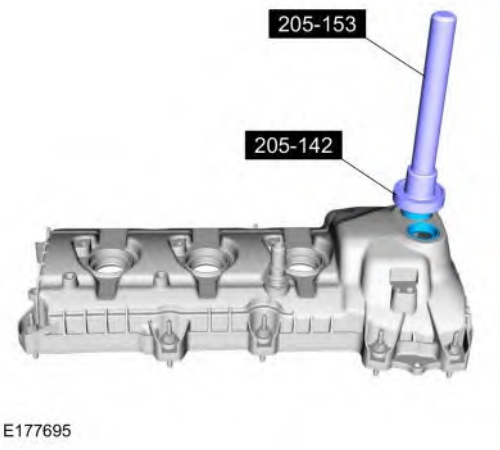
If removed, using the special tools, install the spark plug tube seals. Use Special Service Tool: 303-1247 VCT Spark Plug Tube Seal Remover and Installer., 205-153 (T80T-4000-W) Handle.

118.

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

If removed, using the special tools, install the VCT oil control solenoid seals. Use Special Service

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



119.

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

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

Material

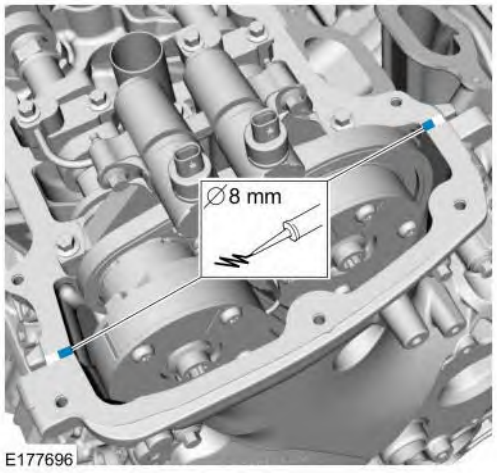
: Motorcraft ® Metal Surface Prep / ZC-31-B

Material

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

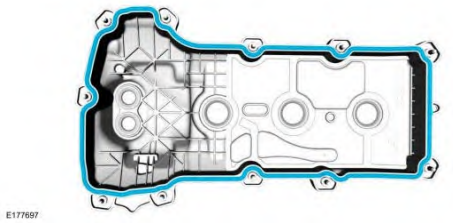
Material

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



120.

Install a new valve cover gasket.



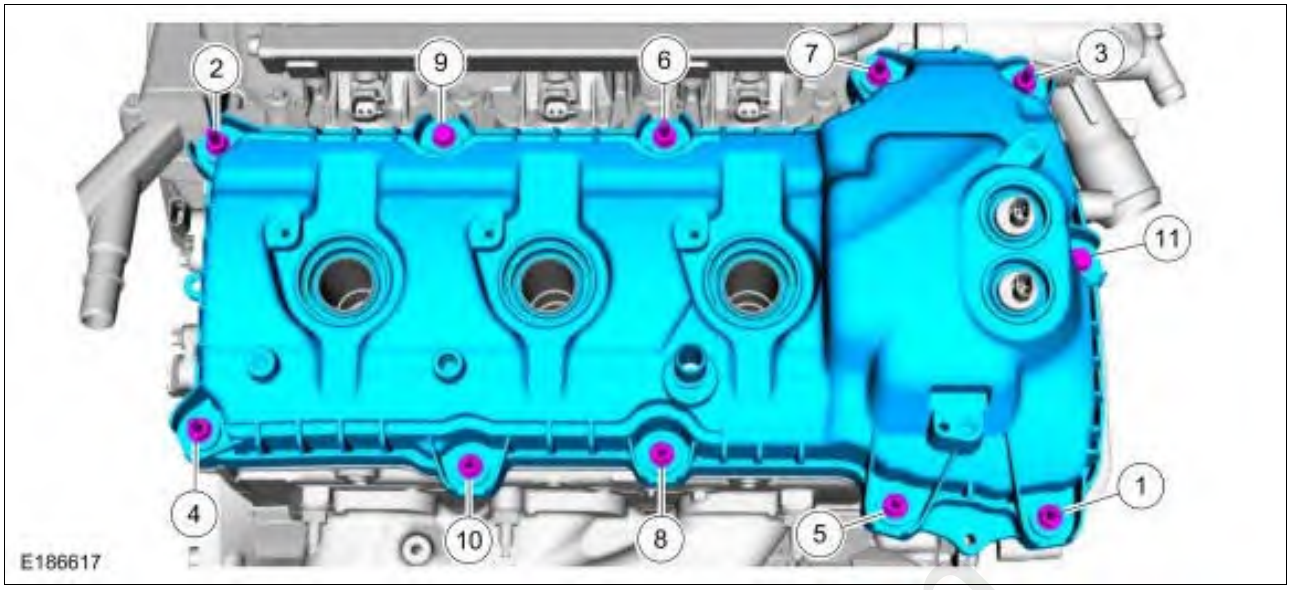
121.

Install the valve cover and tighten the bolts.

Torque

: 89 lb.in (10 Nm)

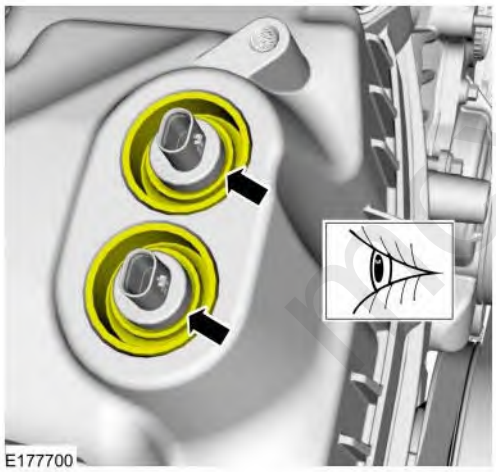
Fig 20: RH Valve Cover Bolts Tightening Sequence



Courtesy of FORD MOTOR CO.

122.

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

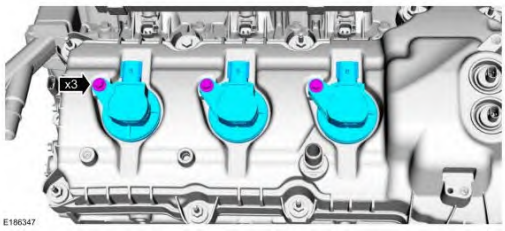


123.

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

Torque

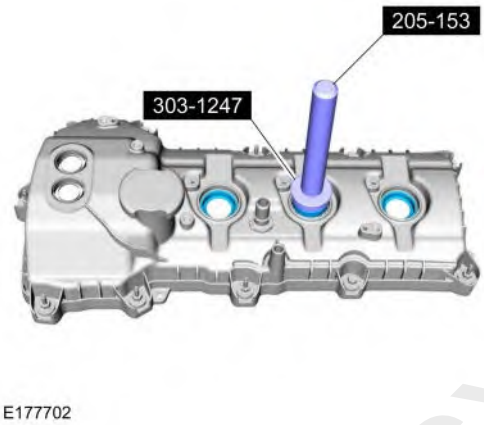
: 62 lb.in (7 Nm)



124.

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

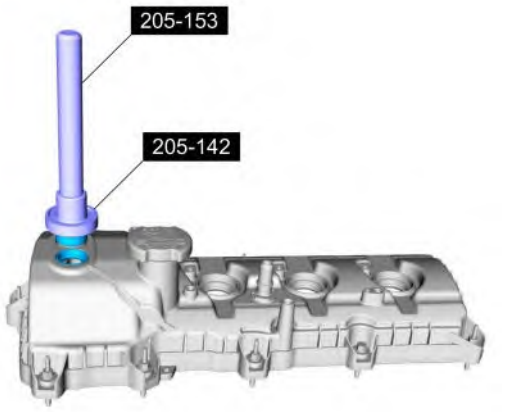
If removed, using the special tools, install the spark plug tube seals. Use Special Service Tool: 303-1247 VCT Spark Plug Tube Seal Remover and Installer., 205-153 (T80T-4000-W) Handle.



125.

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

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



126.

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

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

Material

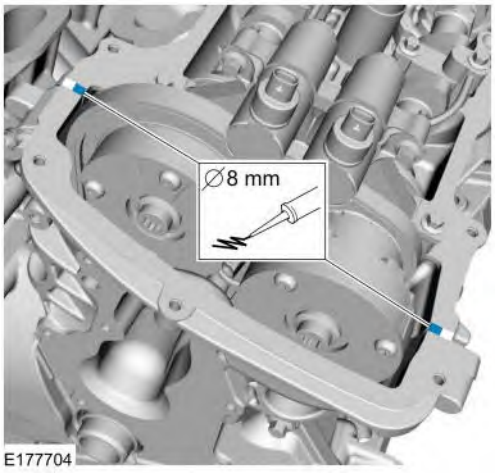
: Motorcraft ® Metal Surface Prep / ZC-31-B

Material

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

Material

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



127.

Install a new valve cover gasket.

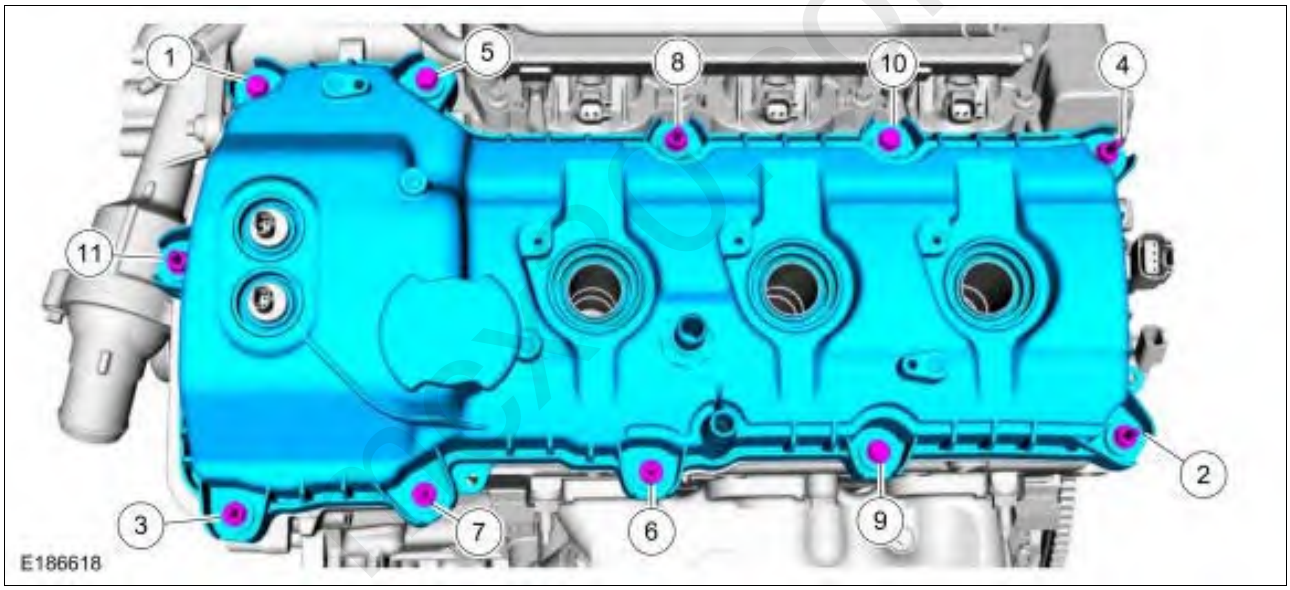
128.

Install the valve cover and tighten the bolts.

Torque

: 89 lb.in (10 Nm)

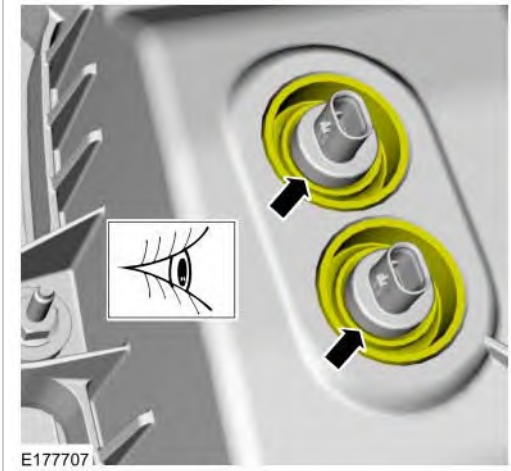
Fig 21: LH Valve Cover Bolts Tightening Sequence



Courtesy of FORD MOTOR CO.

129.

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



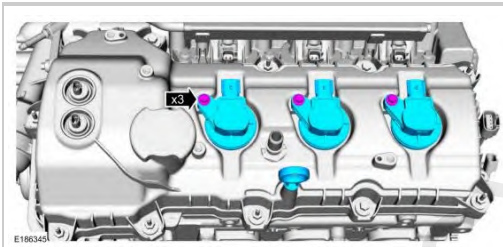
130.

Install the LH coil-on-plugs and the bolts.

Torque

: 62 lb.in (7 Nm)

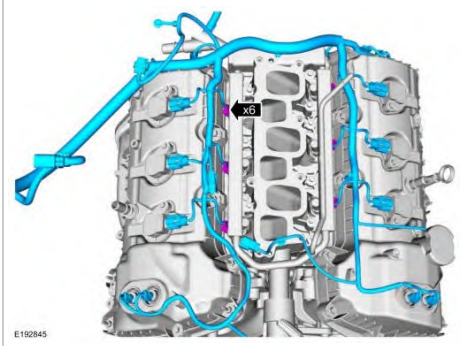
Install the oil level indicator.



131.

Install the engine wiring harness.

Connect the fuel injector electrical connectors.



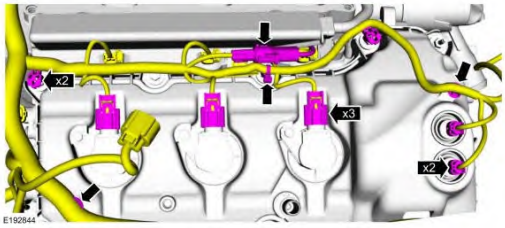
132.

Attach the wiring harness retainers.

Connect the CHT sensor electrical connector.

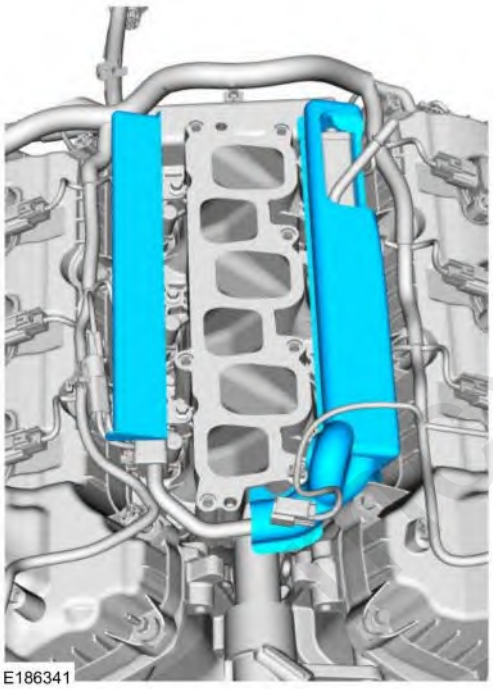
Connect the ignition coil-on-plug electrical connectors.

Connect the VCT oil control solenoids electrical connectors.



133.

Install the fuel rail sound insulators.



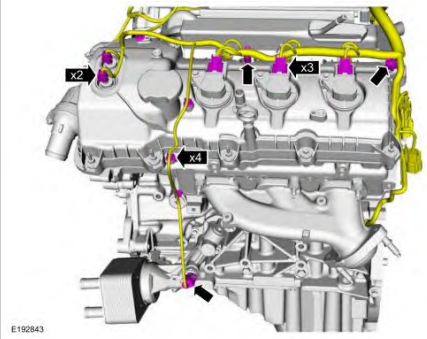
134.

Attach the wiring harness retainers.

Connect the oil pressure switch electrical connector.

Connect the ignition coil-on-plug electrical connectors.

Disconnect the VCT oil control solenoids electrical connectors.

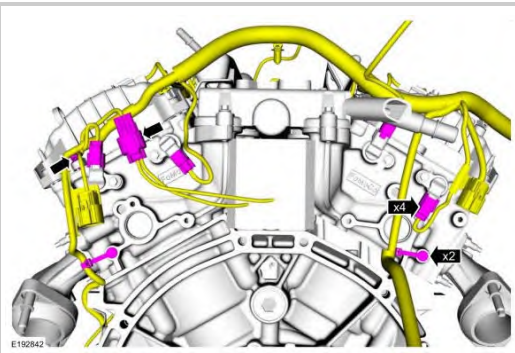


135.

Attach the wiring harness retainers.

Connect the CMP sensor electrical connectors.

Connect the KS sensor electrical connector.

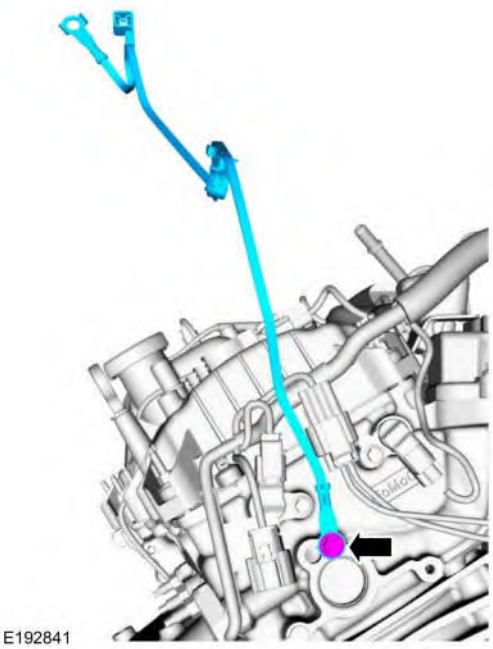


136.

Install the ground strap and the bolt.

Torque

: 106 lb.in (12 Nm)



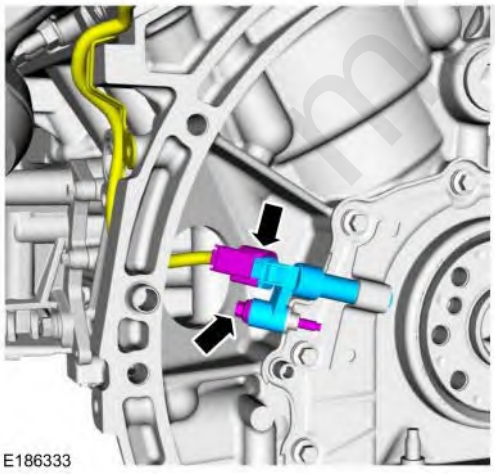
137.

Install the CKP sensor and the bolt.

Torque

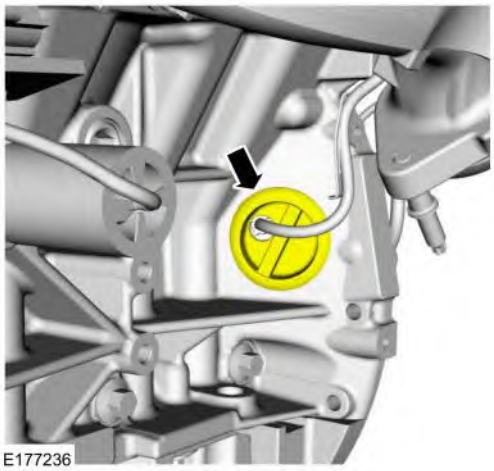
: 89 lb.in (10 Nm)

Connect the CKP sensor electrical connector.



138.

Install the wiring harness grommet.

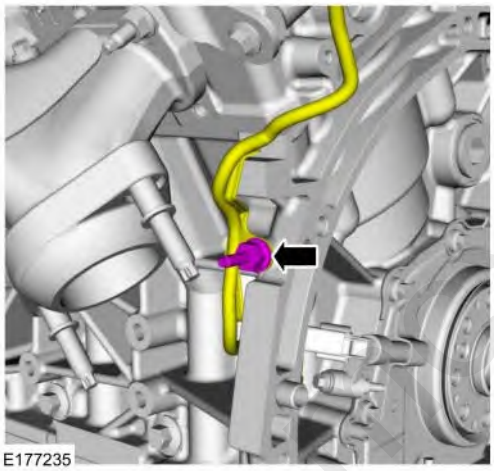


139.

Install the wiring harness retainer stud bolt.

Torque

: 89 lb.in (10 Nm)

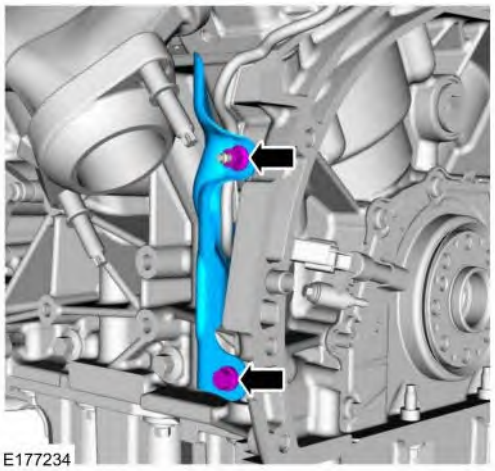


140.

Install the heat shield, nut and bolt.

Torque

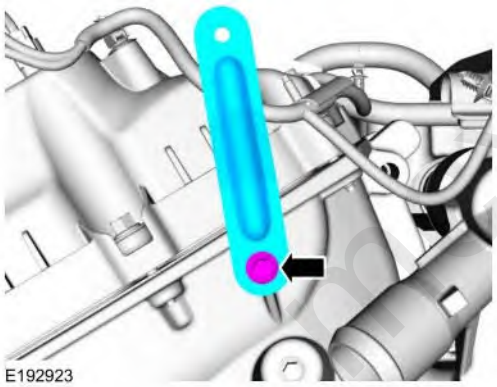
: 89 lb.in (10 Nm)



141.

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

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



142.

1.

Install the coolant pump pulley and the bolts.

Torque

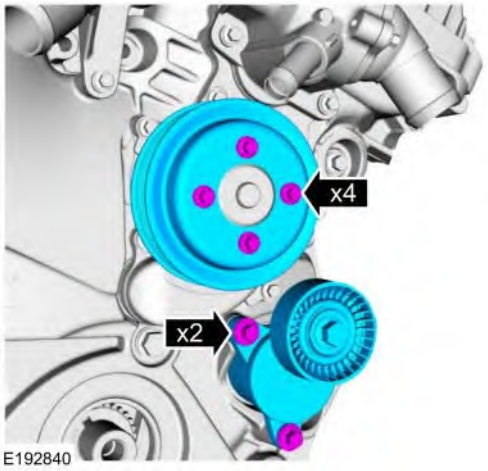
: 18 lb.ft (24 Nm)

2.

Install the accessory drive belt tensioner and the bolts.

Torque

: 18 lb.ft (25 Nm)

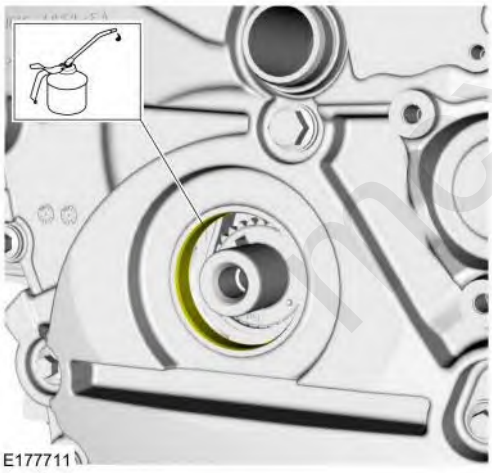


143.

Lubricate the crankshaft front seal bore with clean engine oil.

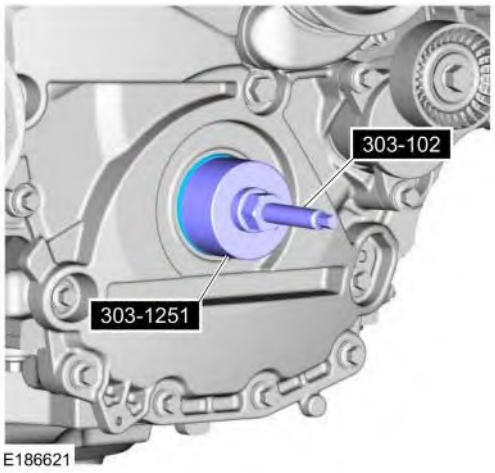
Material

: Motorcraft ® SAE 5W-20 Premium Synthetic Blend Motor Oil / XO-5W20-QSP (WSS-M2C945-A)



144.

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

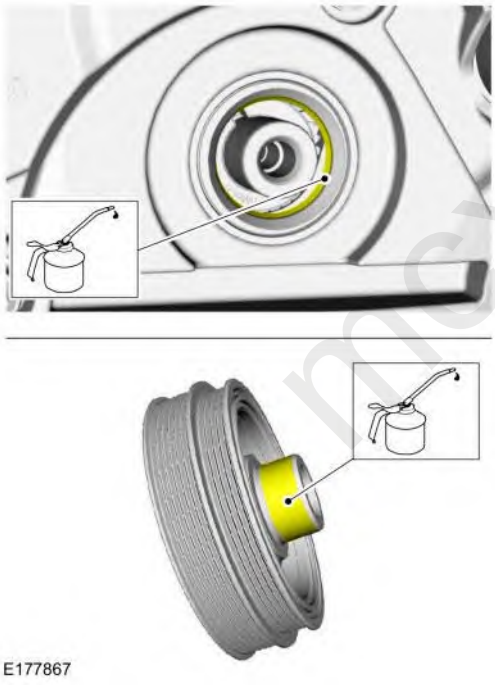


145.

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

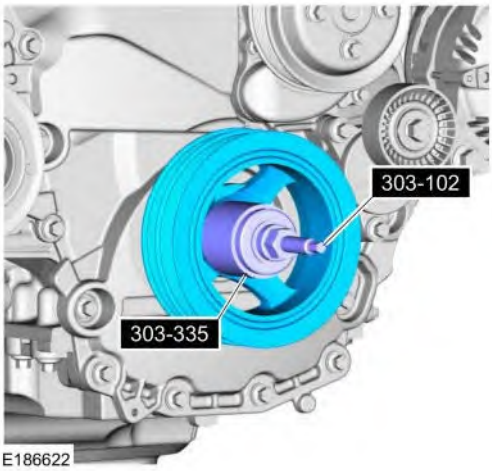
Material

: Motorcraft ® SAE 5W-20 Premium Synthetic Blend Motor Oil / XO-5W20-QSP (WSS-M2C945-A)



146.

Using the special tools, install the crankshaft pulley. Use Special Service Tool: 303-102 Installer, Crankshaft Pulley., 303-335 (T88T-6701-A) Installer, Front Cover Oil Seal.

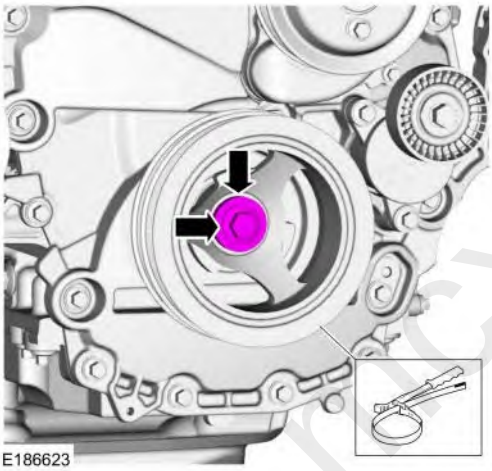


147.

Install the new crankshaft bolt and the washer. Use the General Equipment: Strap Wrench

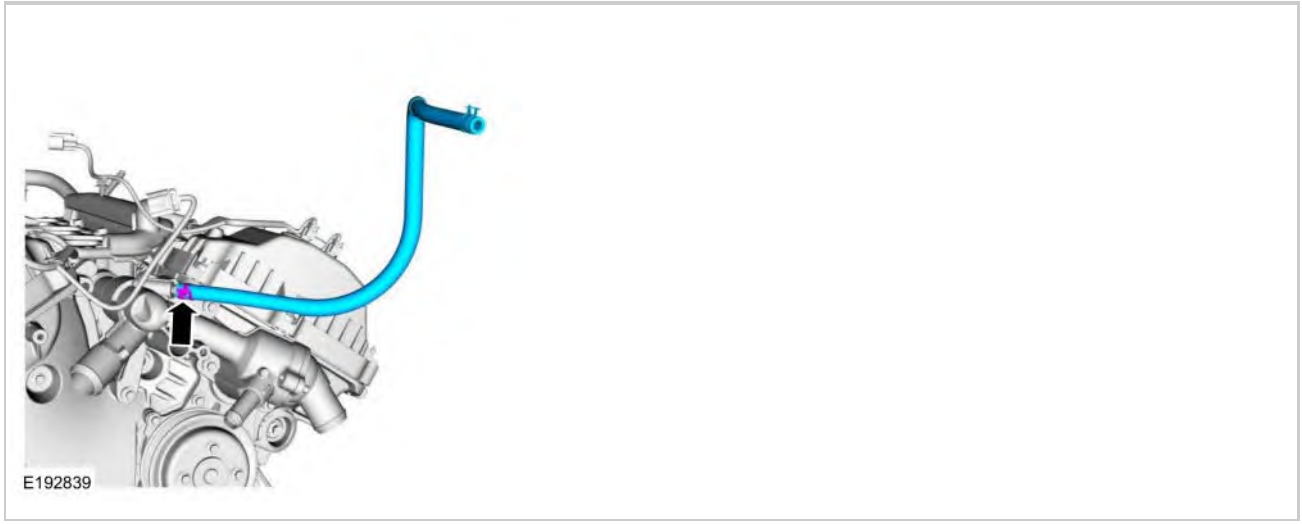
Torque

: Stage 1: 89 lb.ft (120 Nm) Stage 2: Loosen:: 1 turn(s) Stage 3: 37 lb.ft (50 Nm) Stage 4: 90 °



148.

Install the degas bottle hose. Use the General Equipment: Hose Clamp Remover/Installer



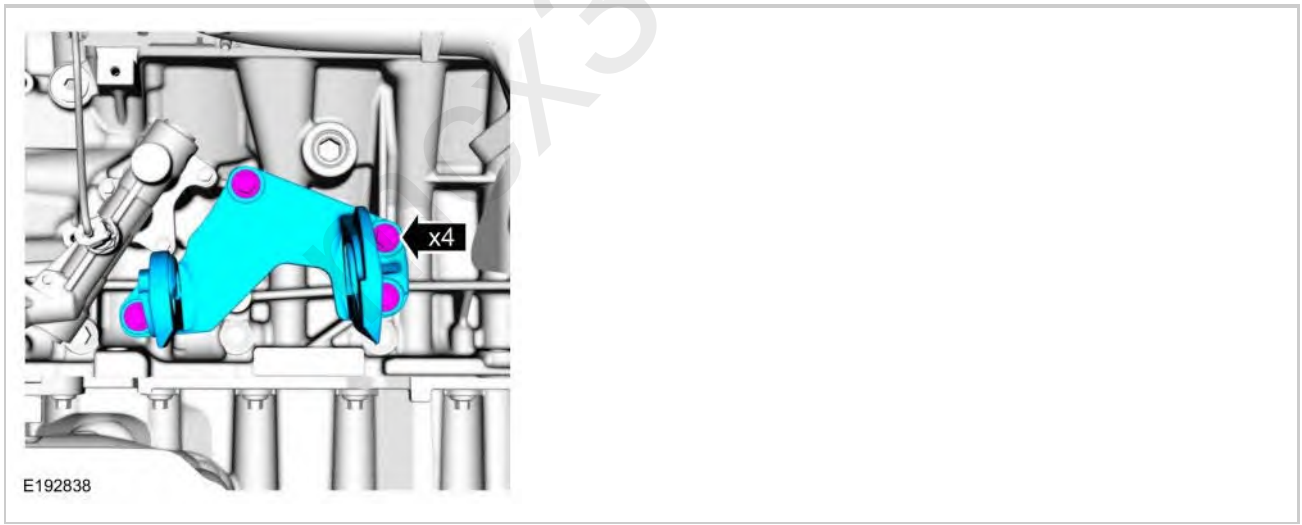
149.

> *NOTE: Clean the engine support insulator-to-cylinder block mating surfaces of any dirt or foreign material prior to installation.*

Install the LH engine mount bracket and the bolts.

Torque

: 46 lb.ft (63 Nm)



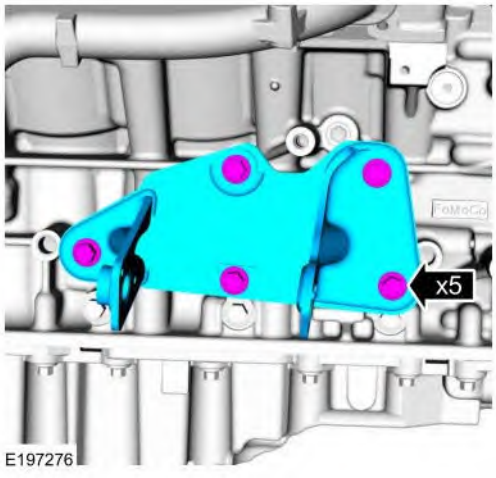
150.

> *NOTE: Clean the engine support insulator-to-cylinder block mating surfaces of any dirt or foreign material prior to installation.*

Install the RH engine mount bracket and the bolts.

Torque

: 57 lb.ft (77 Nm)

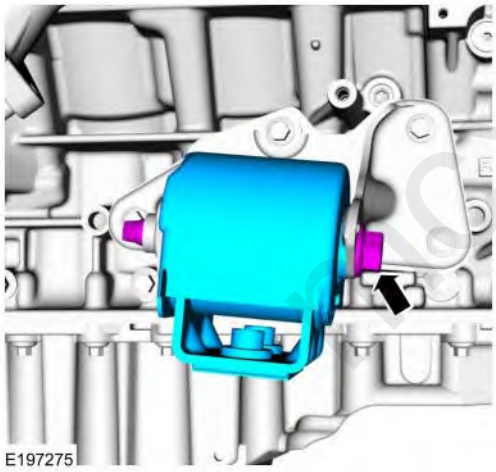


151.

Install the RH engine mount and the bolt.

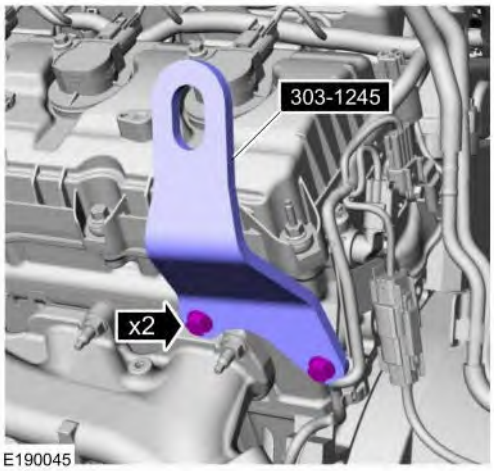
Torque

: 258 lb.ft (350 Nm)



152.

Install Special Service Tool: 303-1245 Engine Lift Eye.

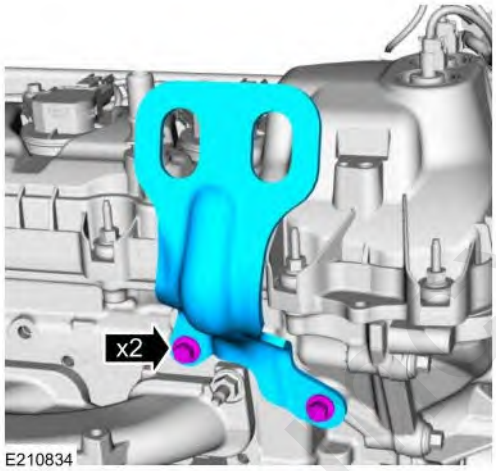


153.

Install the RH lift eye and the bolts.

Torque

: 25 lb.ft (34 Nm)

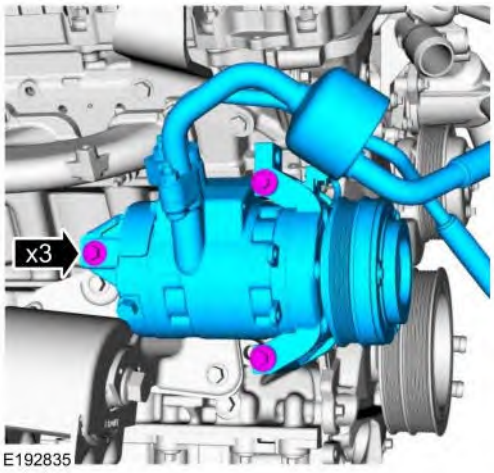


154.

Install the A/C compressor and the bolts.

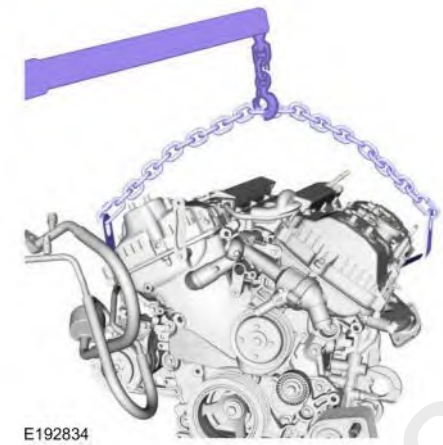
Torque

: 18 lb.ft (25 Nm)



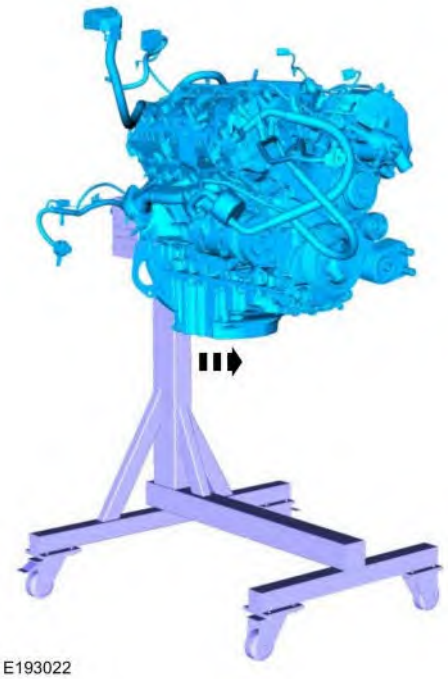
155.

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



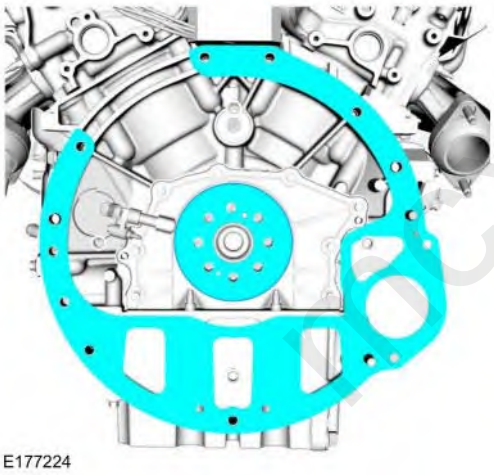
156.

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



157.

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



158.

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

Install the flexplate and the bolts.

Torque

: 59 lb.ft (80 Nm)