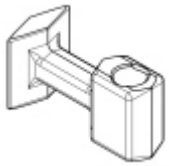
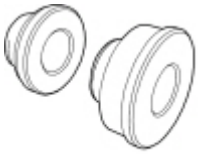
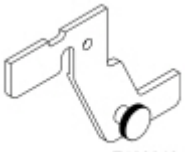
303-01D Engine - 2.3L EcoBoost (257kW/350PS) - MI4
Assembly

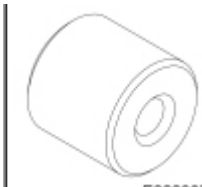
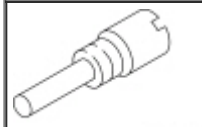
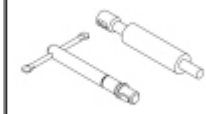
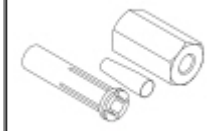
2017 Focus
Procedure revision date: 06/1/2018

Engine

Base Part Number: 6L084

Special Tool(s) / General Equipment

 E139373	100-002 (TOOL-4201-C) Holding Fixture with Dial Indicator Gauge
 E133913	205-153 (T80T-4000-W) Handle
	303-096 (T74P-6150-A) Installer, Camshaft Front Oil Seal TKIT-2009TC-F
 E222983	303-103 (T74P-6375-A) Holding Tool, Flywheel T74P-77000-A TKIT-2009TC-F
 E175042	303-1247 VCT Spark Plug Tube Seal Remover and Installer TKIT-2006UF-FLM TKIT-2006UF-ROW
 E121926	303-1521 Alignment Tool, Crankshaft Position Sensor TKIT-2010C-FLM
 E133912	303-1565 Alignment Tool, Camshaft TKIT-2010C-FLM
	303-1567 Sizer, Teflon Seal TKIT-2010C-FLM

 E222987	
 E134675	303-328 (T88P-6701-B1) Replacer, Rear Seal TKIT-1988-FLM TKIT-1988-F TKIT-1988-LM
 PZ21210	303-507 Timing Peg, Crankshaft TDC TKIT-2001N-FLM TKIT-2001N-ROW
 E223046	310-205 Fuel Injector Brush
 E223047	310-207 Installer, Fuel Injector Seal Assembly TKIT-2009A-FLM
Feeler Gauge	
Floor Crane	
Mounting Stand	
Clutch Alignment Tool	
Hose Clamp Remover/Installer	
Round-Ended Steel Rule	
Piston Ring Compressor	

Materials

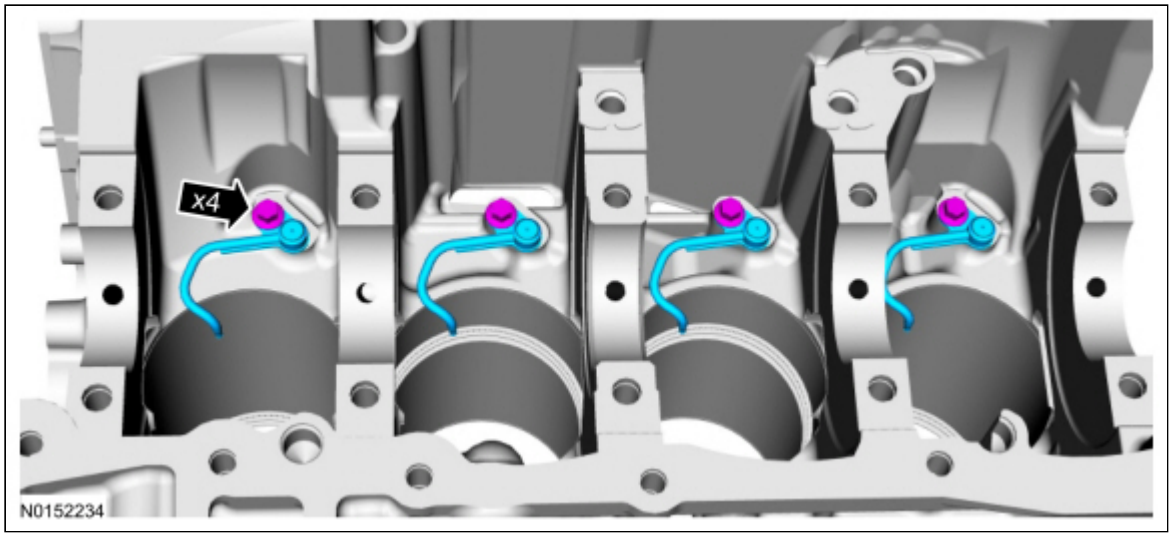
Name	Specification
Motorcraft® Metal Surface Prep Wipes ZC-31-B	-
Motorcraft® Silicone Gasket and Sealant TA-30	WSE-M4G323-A4
Motorcraft® Gasket Maker TA-16	WSK-M2G348-A5
Motorcraft® Orange Concentrated Antifreeze/Coolant VC-3-B	WSS-M97B44-D

NOTICE: Do not loosen or remove the crankshaft pulley bolt without first installing the special tools as instructed in this procedure. The crankshaft pulley and the crankshaft timing sprocket are not keyed to the crankshaft. The crankshaft, the crankshaft sprocket and the pulley are fitted together by friction. For that reason, the crankshaft sprocket is also unfastened if the pulley bolt is loosened. Before any repair requiring loosening or removal of the crankshaft pulley bolt, the crankshaft and camshafts must be locked in place by the special service tools, otherwise severe engine damage can occur.

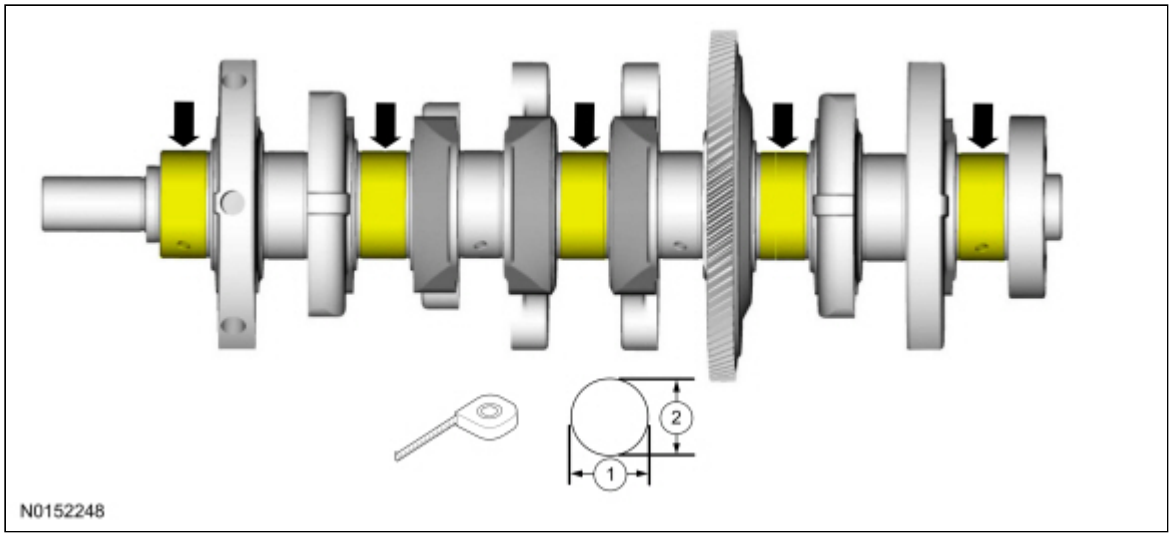
NOTICE: During engine repair procedures, cleanliness is extremely important. All parts must be thoroughly cleaned and any foreign material, including any material created while cleaning gasket surfaces, that enters the oil passages, coolant passages or the oil pan, can cause engine failure.

NOTE: *If it is necessary to install a new timing chain tensioner, a cast iron tensioner is to be replaced with an aluminum tensioner (6K254). The existing bolts must be discarded and replaced with new bolts (6K282).*

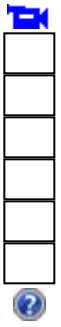
1. Install the engine piston oil cooler valves and the bolts.
   Torque: 89 lb.in (10 Nm)

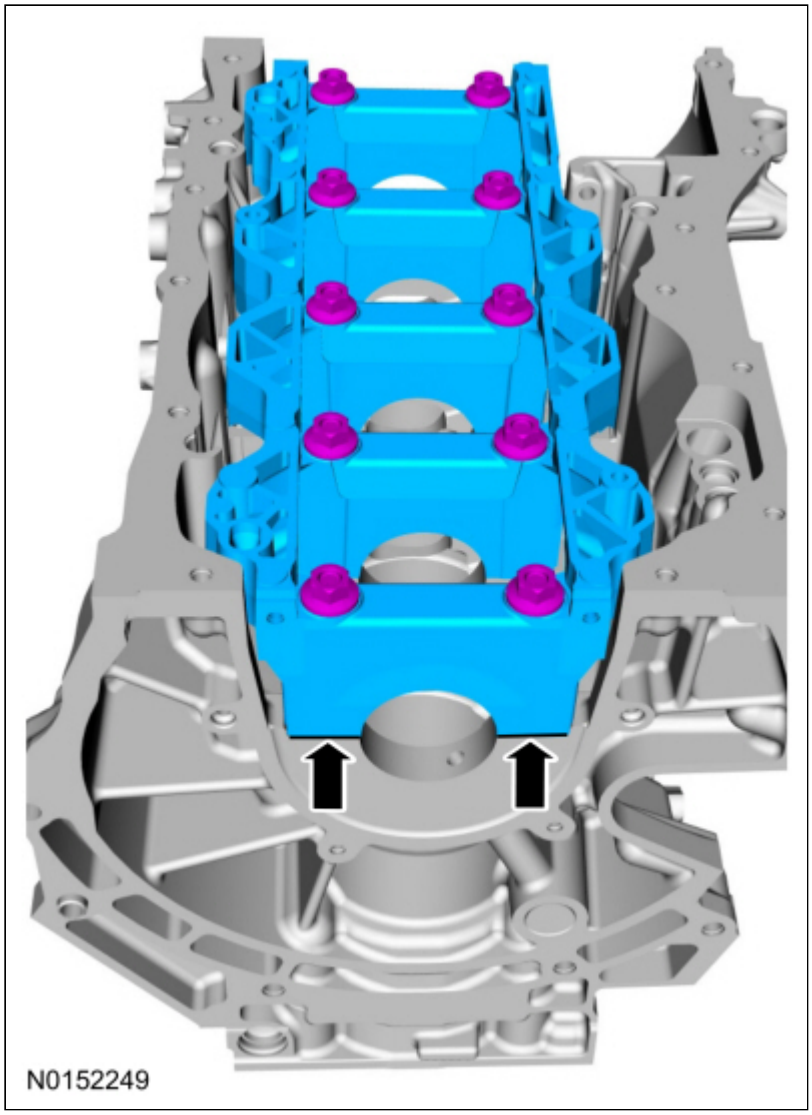


2.
   - Measure the length or distance in two directions.
   - Record the smallest measurement for each crankshaft main bearing journal.

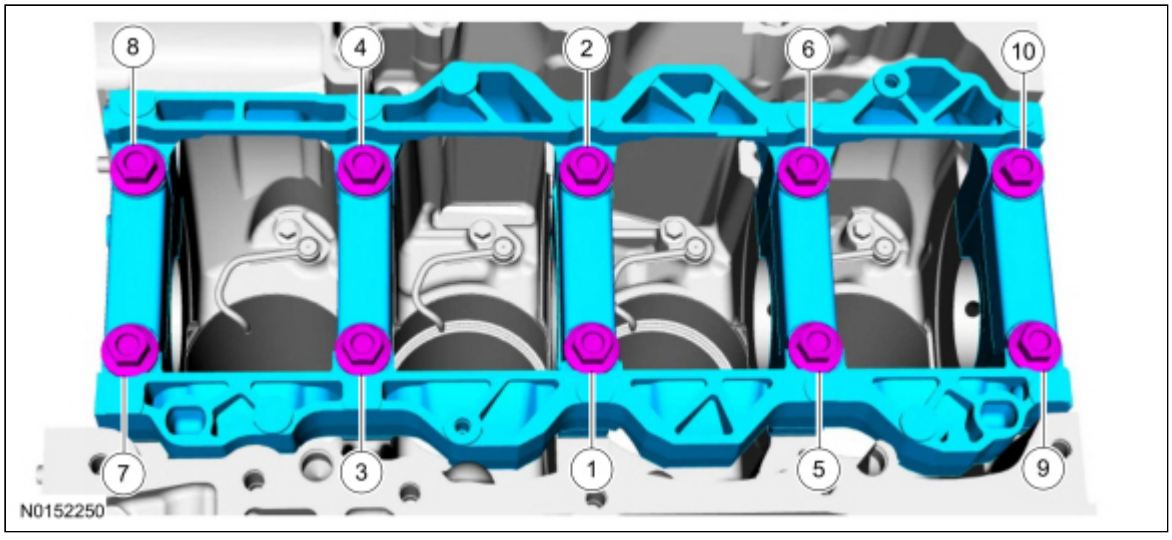


3. Mounted flush and original main bearing beam bolts finger tight.

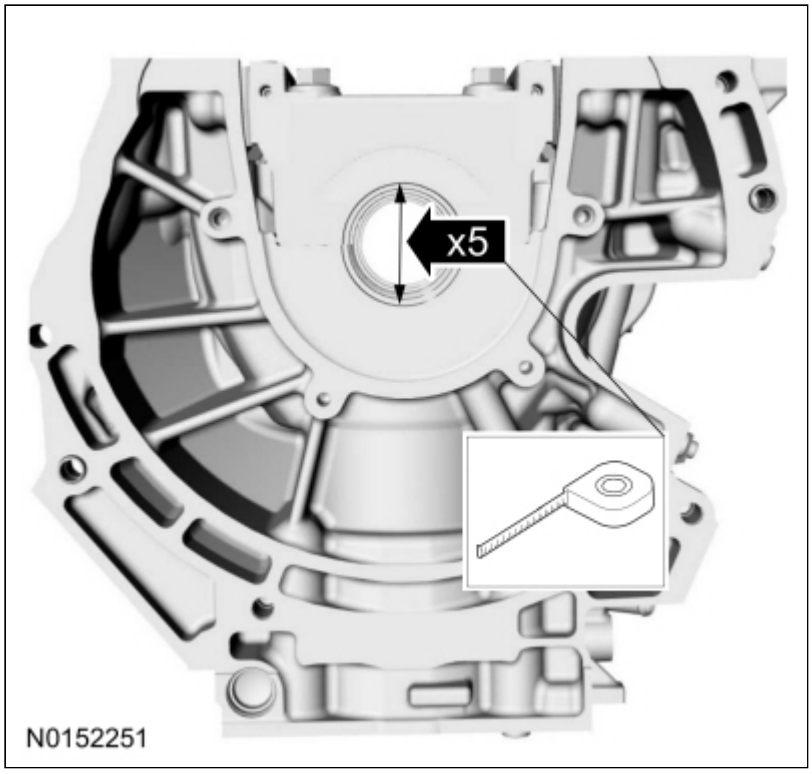




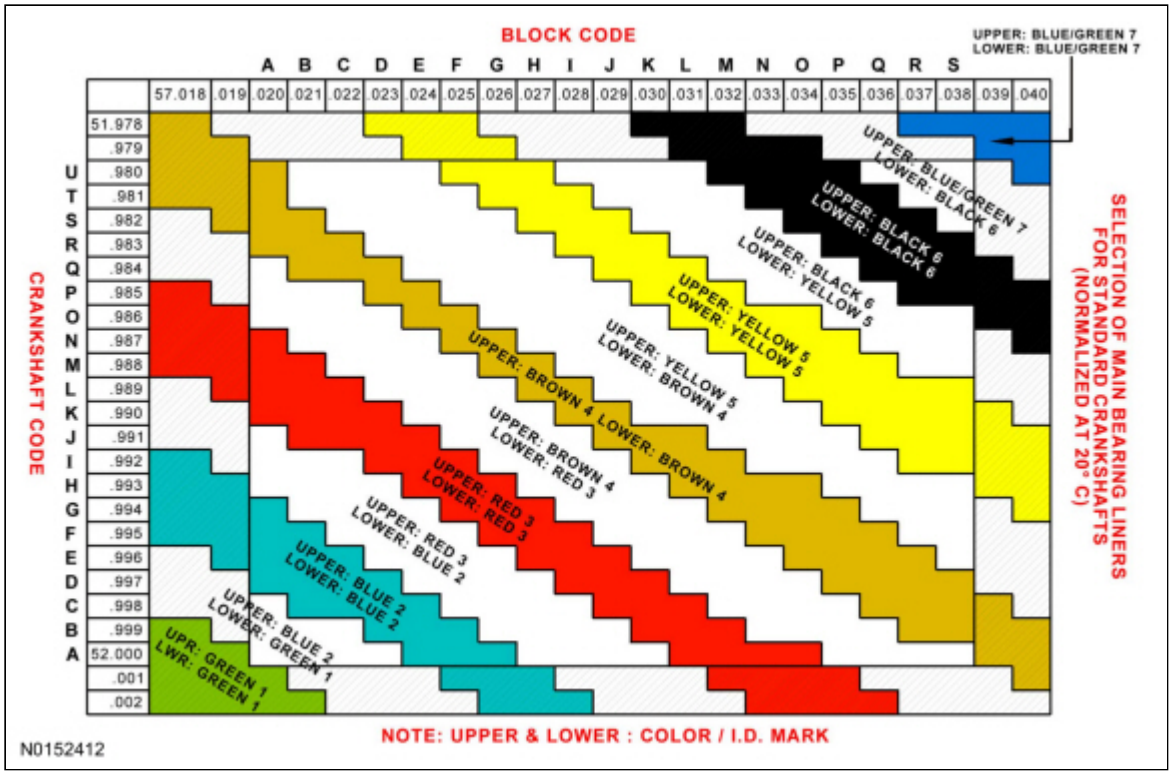
4. Tighten in sequence shown.
   Torque:
   Stage 1: 44 lb.in (5 Nm)
   Stage 2: 18 lb.ft (25 Nm)
   Stage 3: 90°



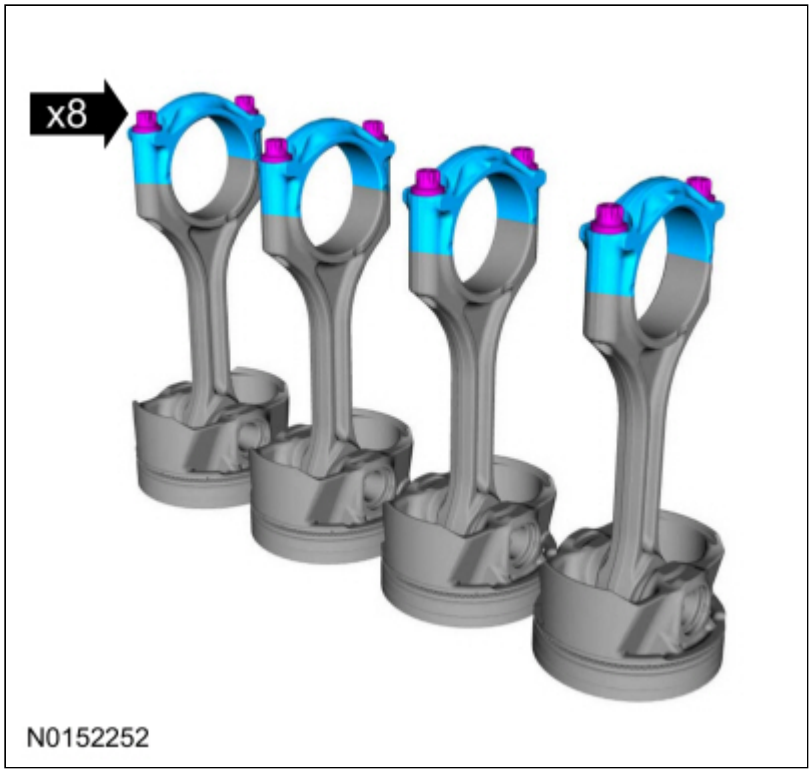
5. Measure each crankshaft block main bearing bore diameter.



6. Using the chart, select the crankshaft main bearings.

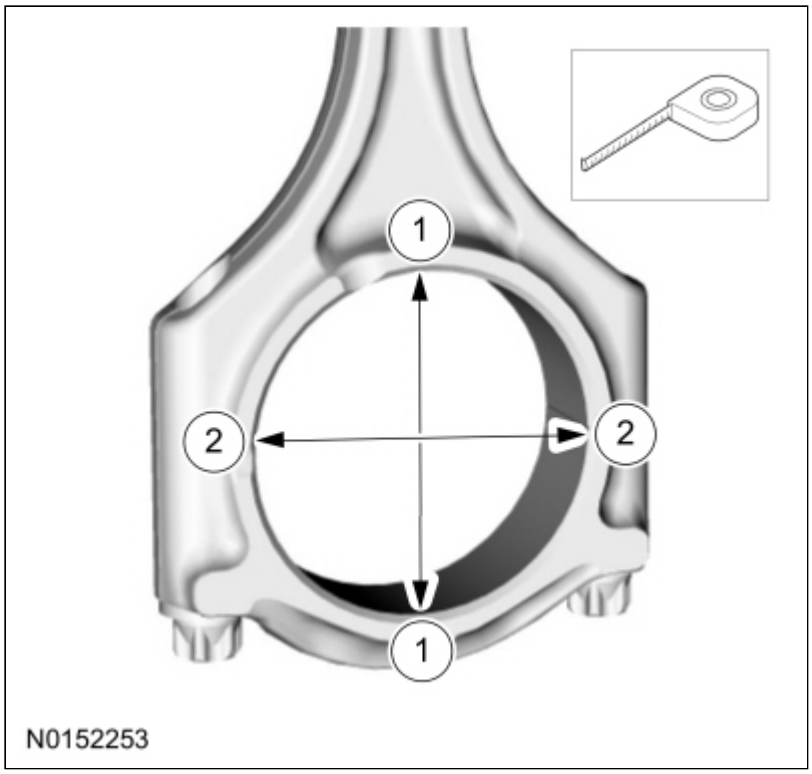


7. Using the original bolts, install the connecting rod caps.
   Torque:
   Stage 1: 89 lb.in (10 Nm)
   Stage 2: 21 lb.ft (29 Nm)
   Stage 3: 90°



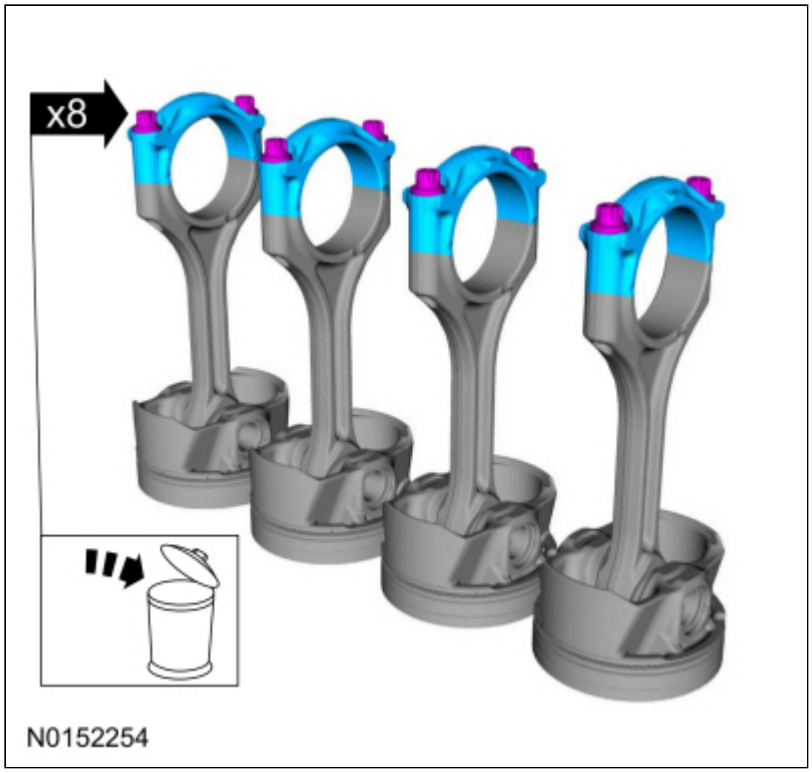
8.

- Measure the length or distance in two directions.
- Record the smallest measurement for each connecting rod.



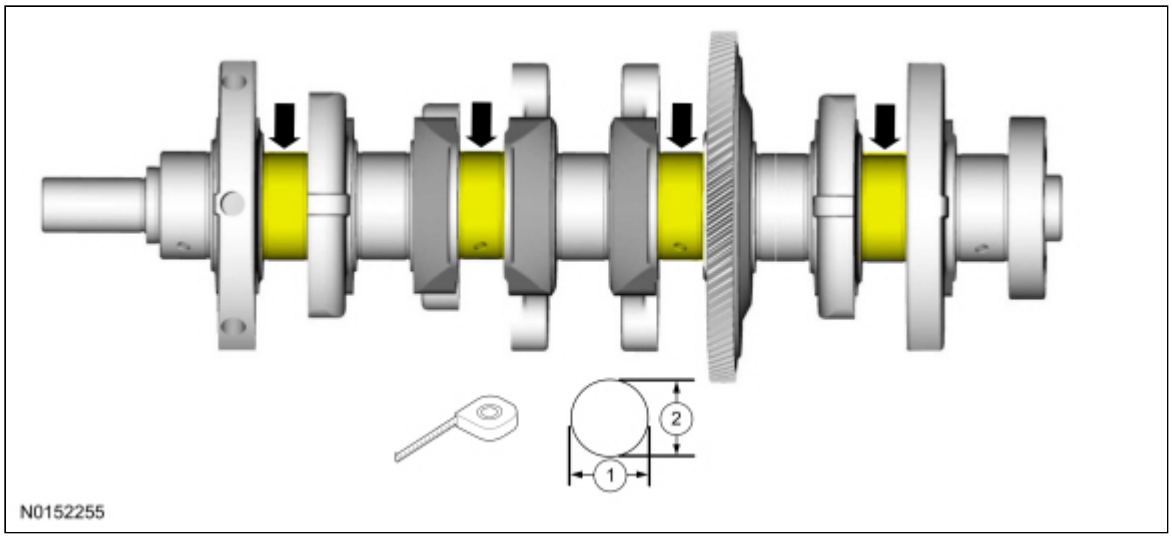
9.

- Remove the bolts and the connecting rod caps.
- Discard the bolts.

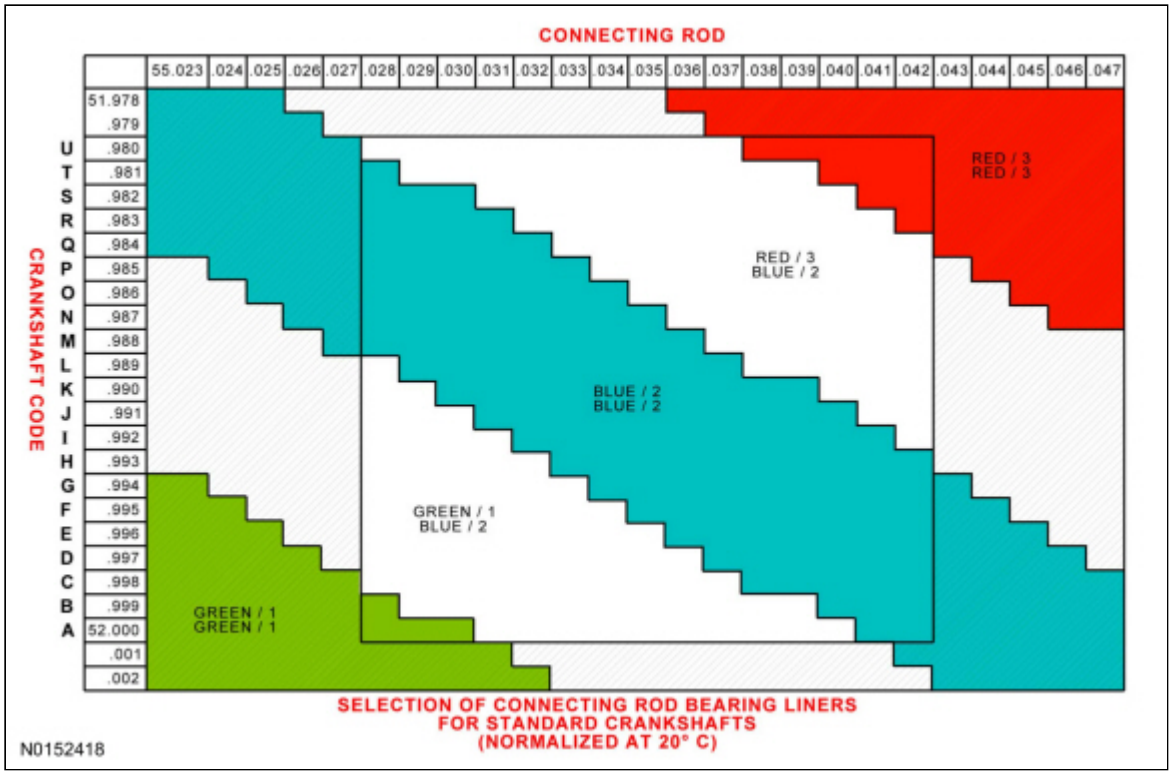


10.

- Measure the length or distance in two directions.
- Record the smallest measurement for each connecting rod journal.

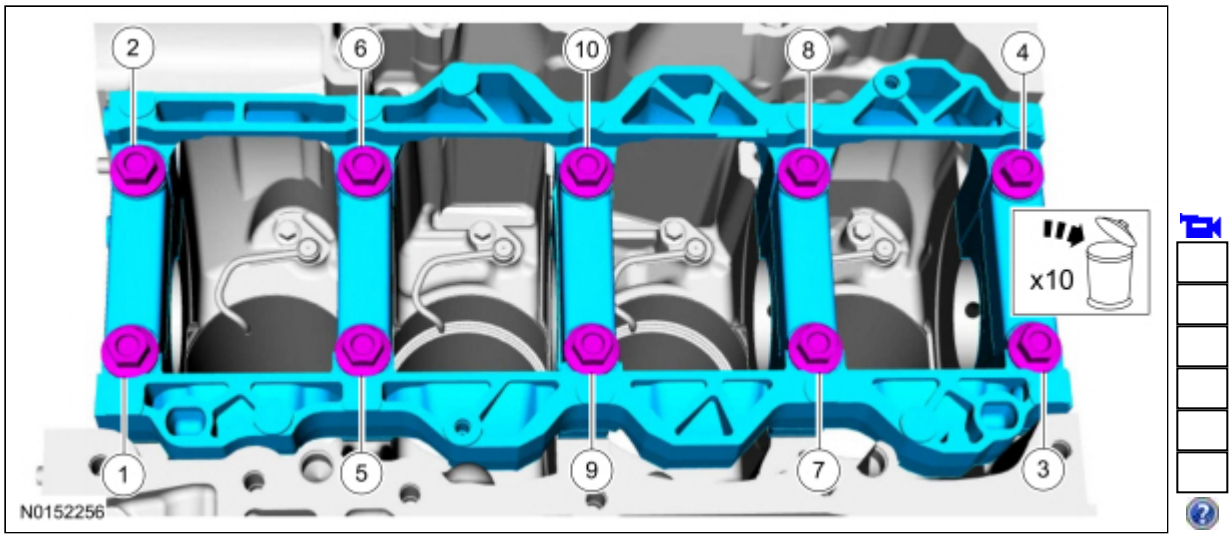


11. Using the chart, select the correct connecting rod bearings for each crankshaft connecting rod journal.



12.

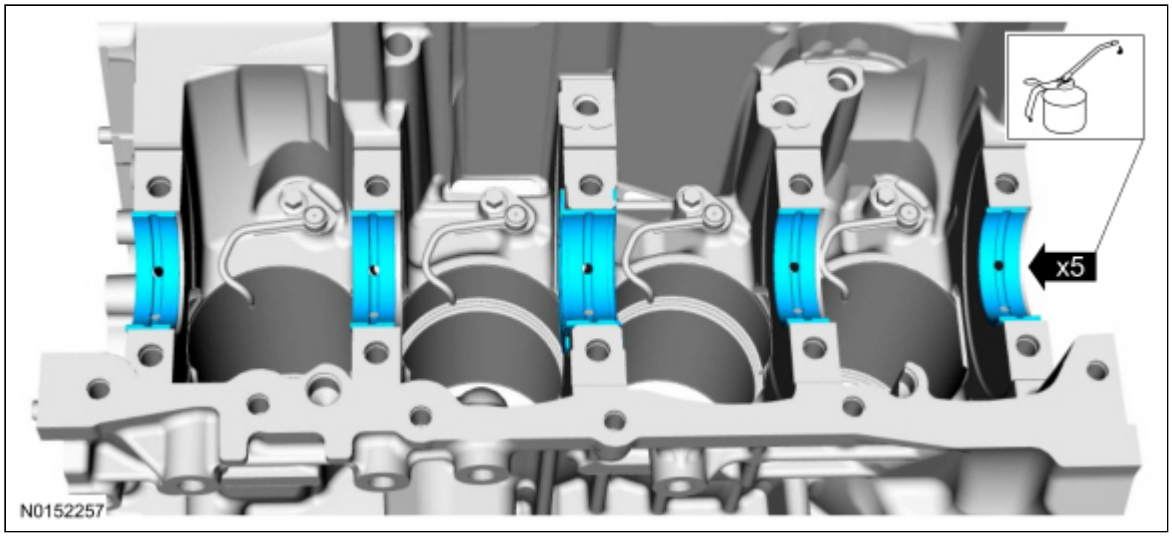
- Remove and discard the bolts in sequence shown.
- Remove the main bearing beam.



13. **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.*

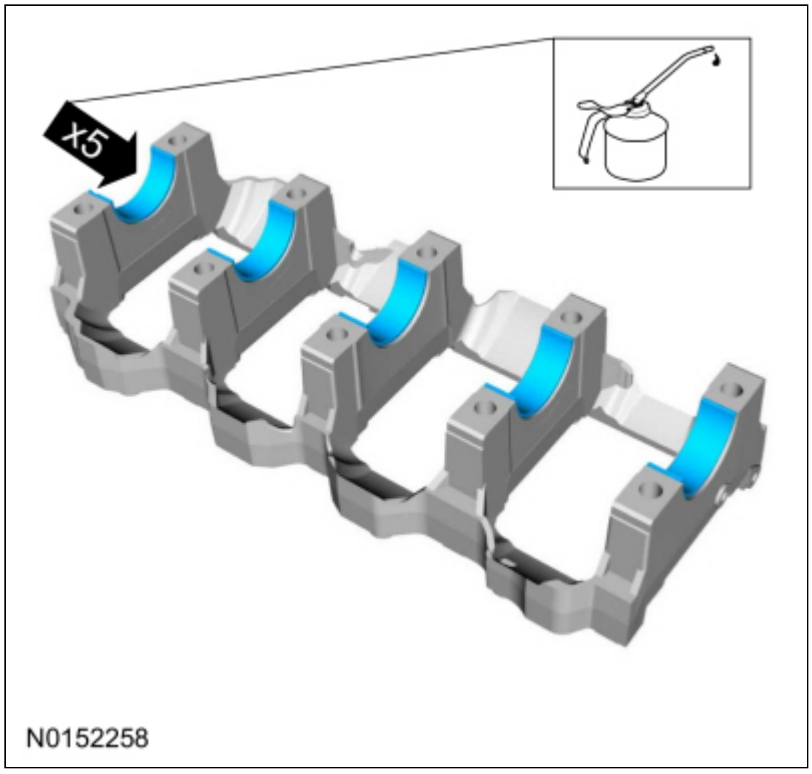
NOTE: *If reusing the crankshaft main bearings, install them in their original positions and orientation as noted during disassembly.*

Lubricate with clean engine oil and install the crankshaft main bearings.

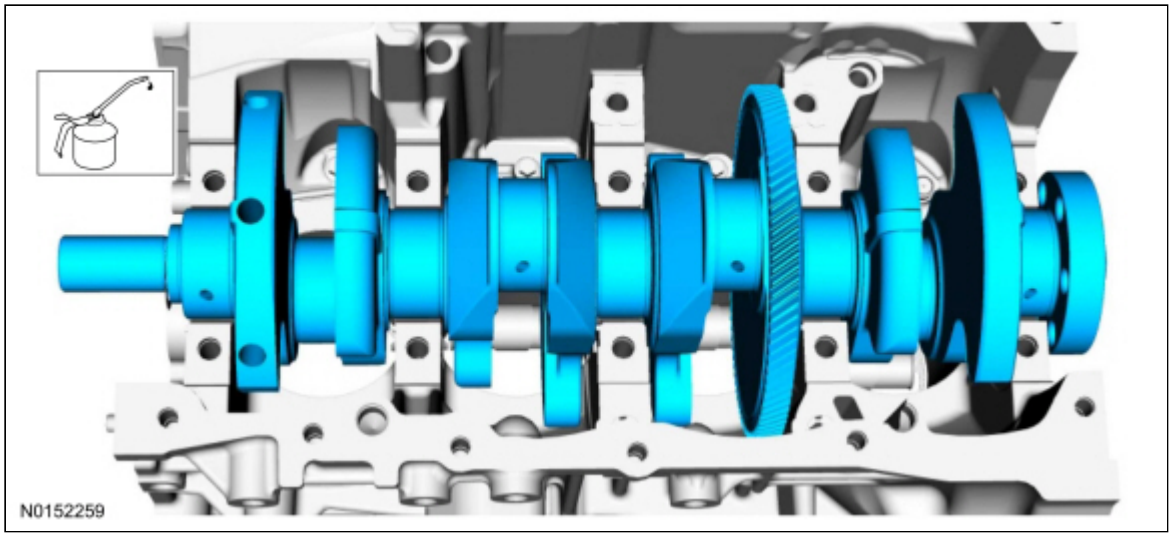


14. **NOTE:** *If reusing the crankshaft main bearings, install them in their original positions and orientation as noted during disassembly.*

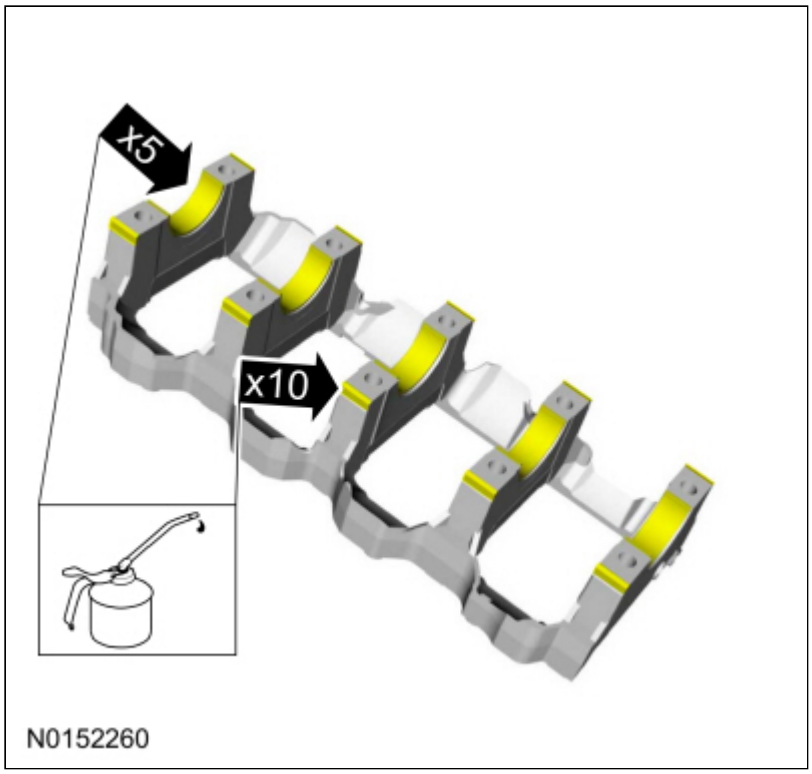
    Lubricate with clean engine oil and install the main bearing beam bearings.



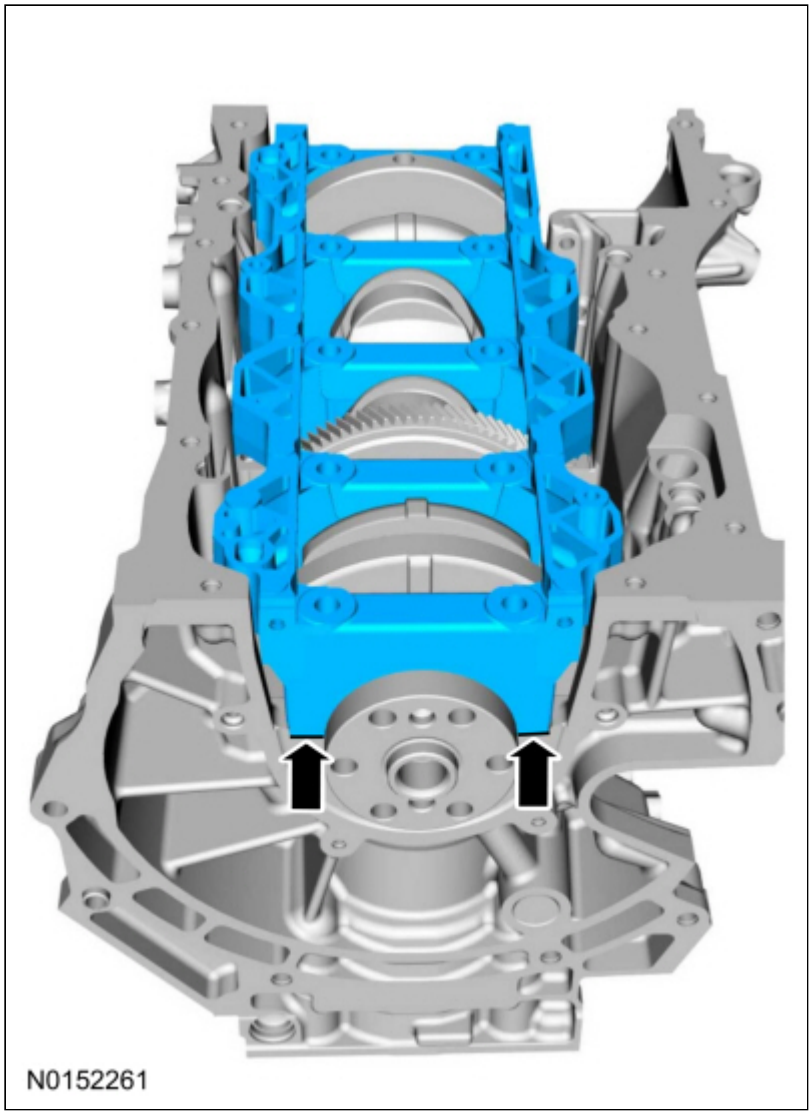
15. Lubricate with clean engine oil and install the crankshaft.



16. Lubricate with clean engine oil.



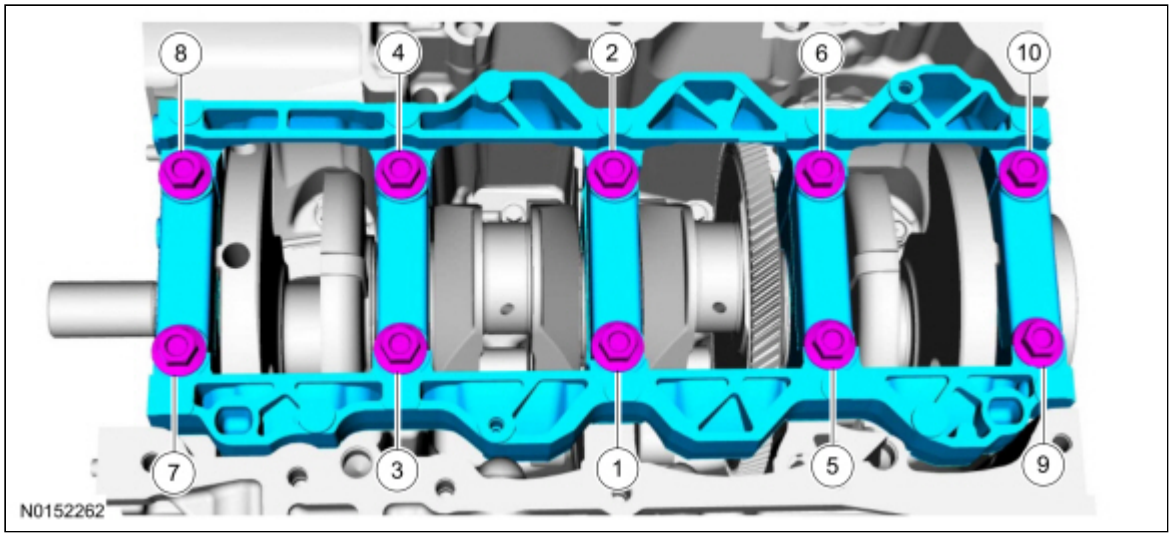
17. Install the main bearing beam flush.



18. **NOTE:** *Lubricate the new main bearing beam bolts threads and under the bolt heads with clean engine oil.*

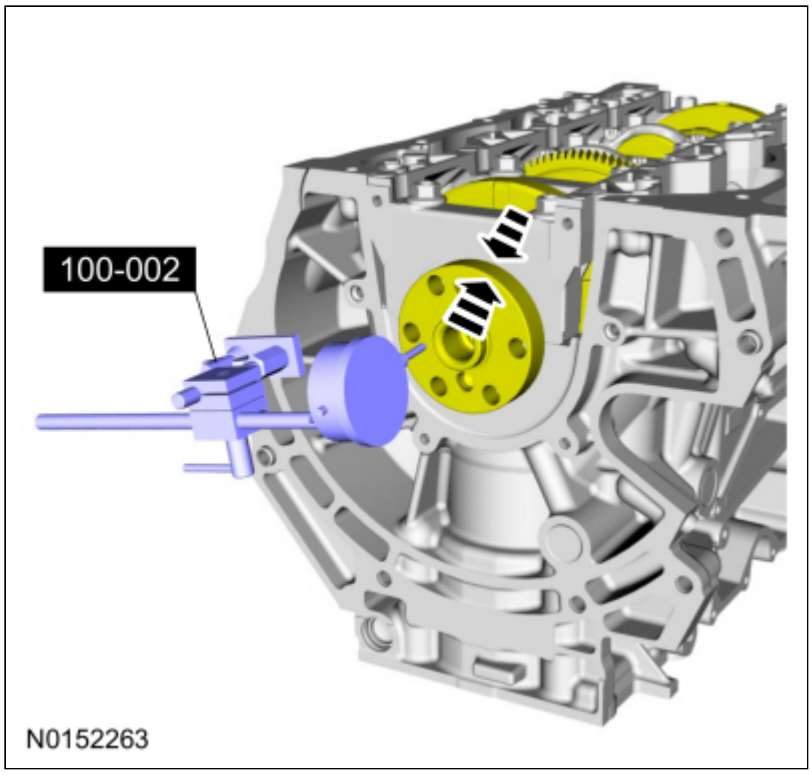
    NOTE: *Position the crankshaft to the rear of the cylinder block, then position the crankshaft to the front of the cylinder block before tightening the main bearing beam bolts.*

    Install the bolts and tighten in sequence shown.
    Torque:
    Stage 1: 44 lb.in (5 Nm)
    Stage 2: 18 lb.ft (25 Nm)
    Stage 3: 90°



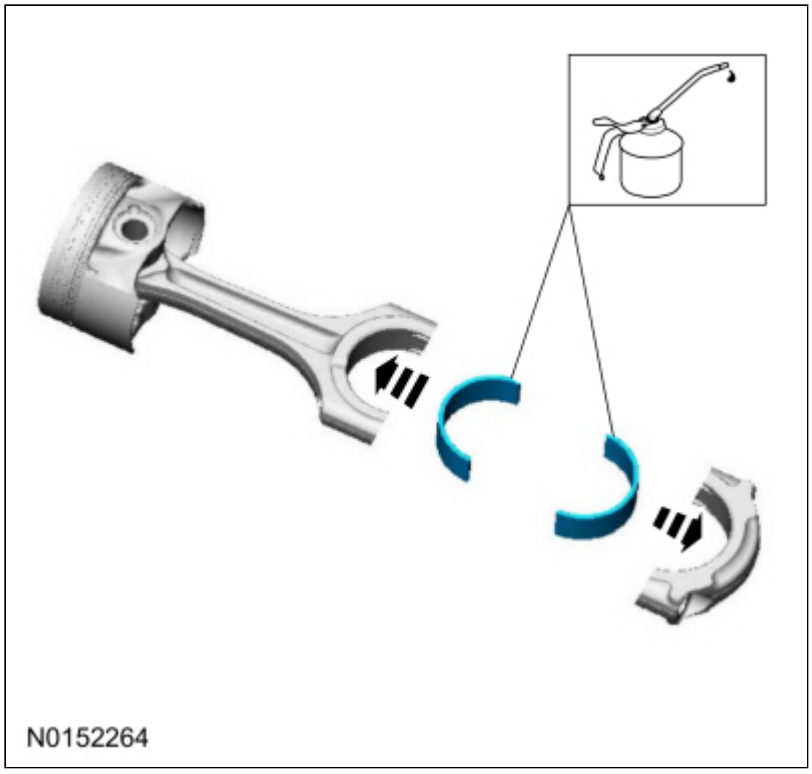
19.

1. Position the crankshaft to the rear of the cylinder block.
2. Zero the Dial Indicator Gauge with Holding Fixture.
   Use Special Service Tool: 100-002 (TOOL-4201-C) Holding Fixture with Dial Indicator Gauge.
3. Move the crankshaft to the front of the cylinder block. Note and record the crankshaft end play.
4. Acceptable crankshaft end play is 0.220-0.450 mm (0.0087-0.0177 in). If the crankshaft end play exceeds the specified range, install new parts as necessary.



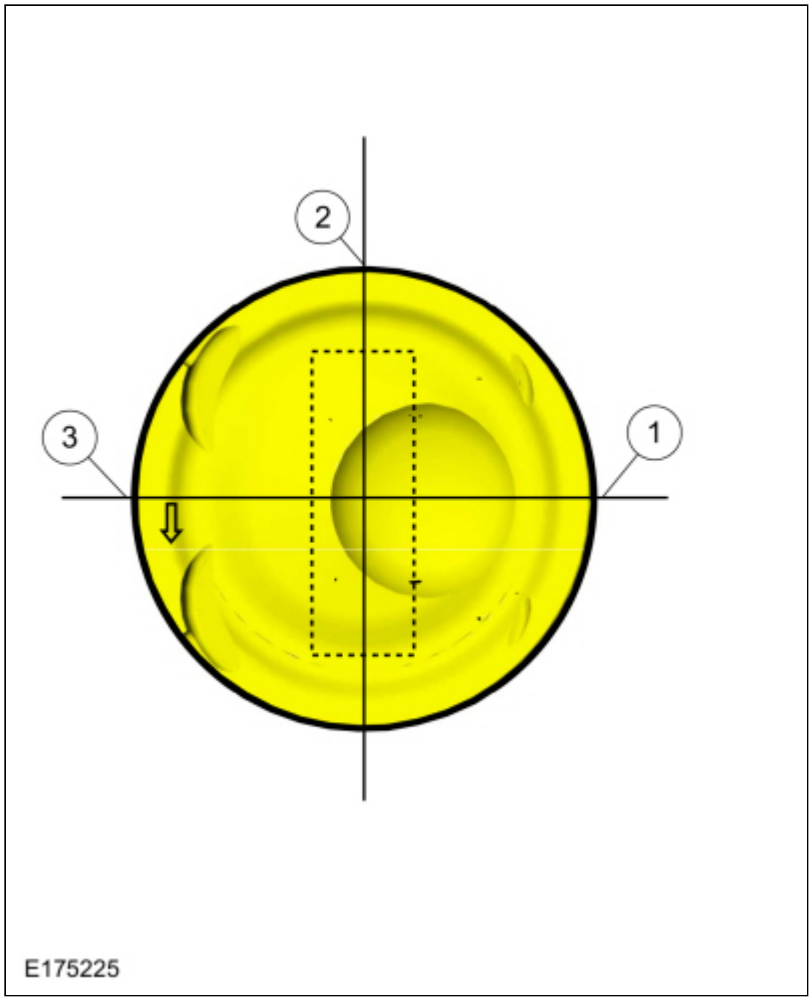
20. **NOTE:** *If reusing the connecting rod bearings, install them in their original positions and orientation as noted during disassembly.*

    Lubricate with clean engine oil and install the connecting rod bearings.



21. **NOTE:** *Align the piston rings on the piston.*

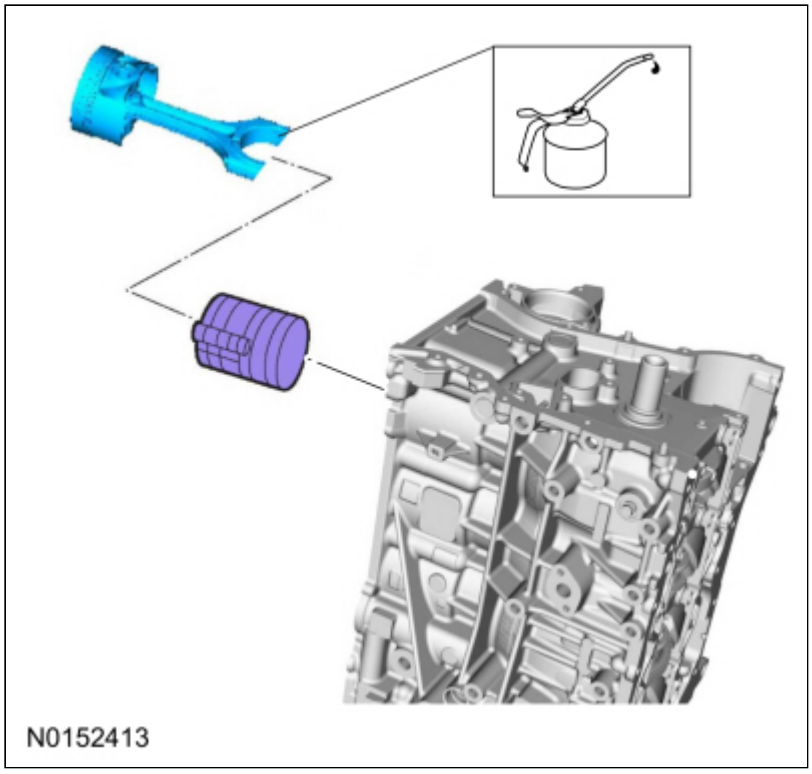
    1. Upper oil control segment ring gap location.
    2. Oil control spacer gap location.
    3. Lower oil control segment ring gap location.



22. **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: *Make sure the piston arrow on top is facing toward the front of the engine.*

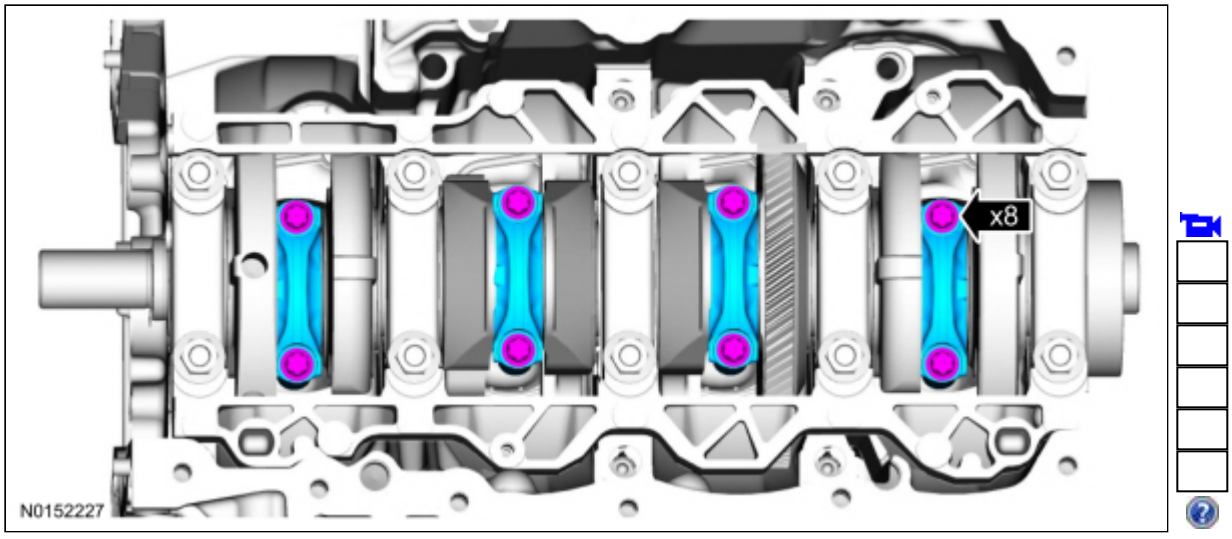
    Lubricate with clean engine oil. Using a piston ring compressor, install the pistons.
    Use the General Equipment: Piston Ring Compressor



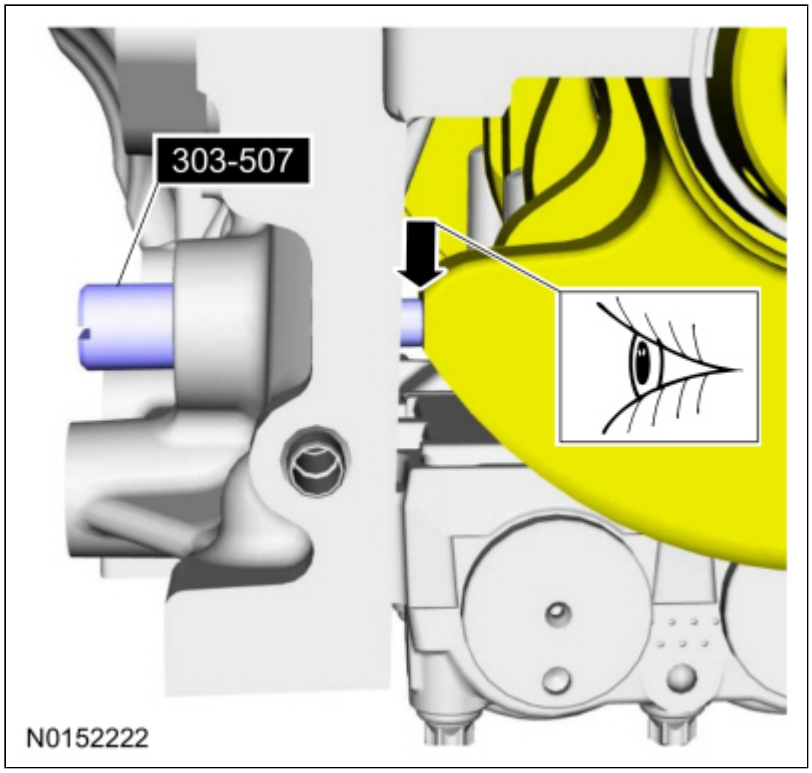
23. **NOTICE: The rod cap installation must keep the same orientation as marked during disassembly or engine damage may occur.**

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

    Install the connecting rod caps, bolts and tighten in 3 stages.
    Torque:
    Stage 1: 89 lb.in (10 Nm)
    Stage 2: 21 lb.ft (29 Nm)
    Stage 3: 90°



24.
- Install Special Service Tool: 303-507 Timing Peg, Crankshaft TDC.
- Rotate the crankshaft slowly clockwise until the crankshaft balance weight is up against the special tool. The engine is now at TDC.

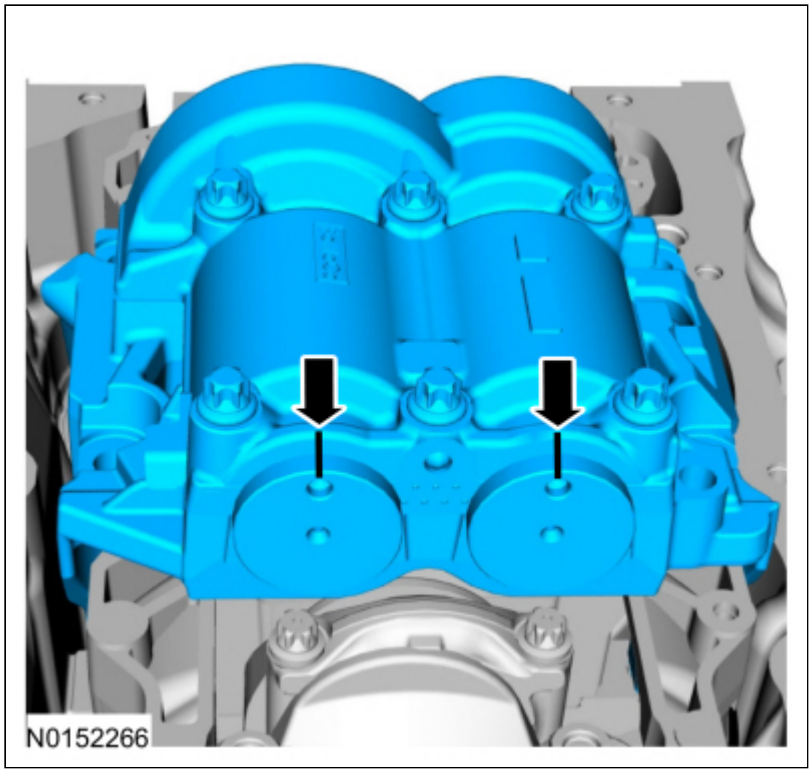


25. **NOTE:** *Due to the precision interior construction of the balancer unit, it should not be disassembled.*

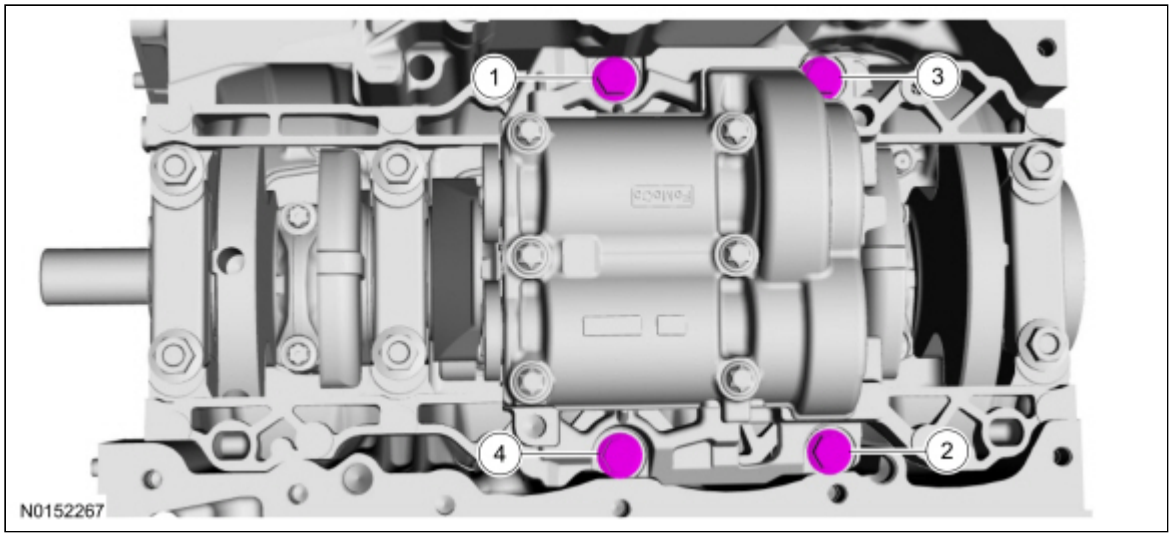
    NOTE: *The original adjustment shims must be installed in their original positions.*

    NOTE: *Confirm by visual inspection that there is no damage to the balancer unit gear and verify that the shaft turns smoothly. If there is any damage or malfunction, replace the balancer unit.*

    Install the adjustment shims in their original positions on the seat faces of the balancer unit. With the balancer unit shaft marks in the TDC position, slowly install the balancer unit to the cylinder block to avoid interference between the crankshaft drive gear and the balancer unit driven gear.

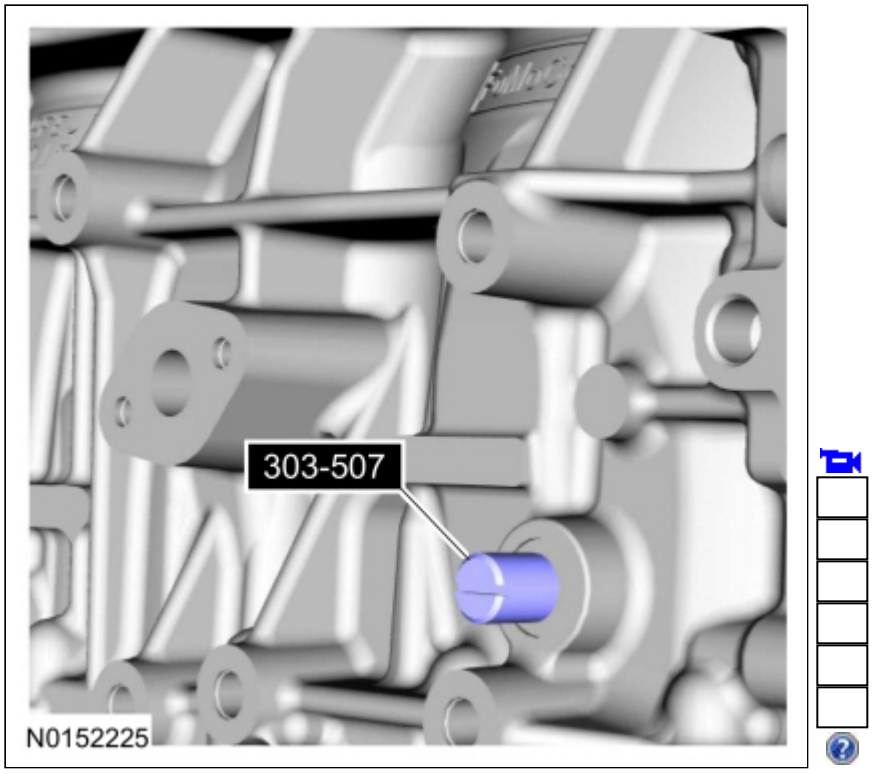


26. Install the bolts and tighten in 2 stages.
Torque:
Stage 1: 18 lb.ft (25 Nm)
Stage 2: 31 lb.ft (42 Nm)



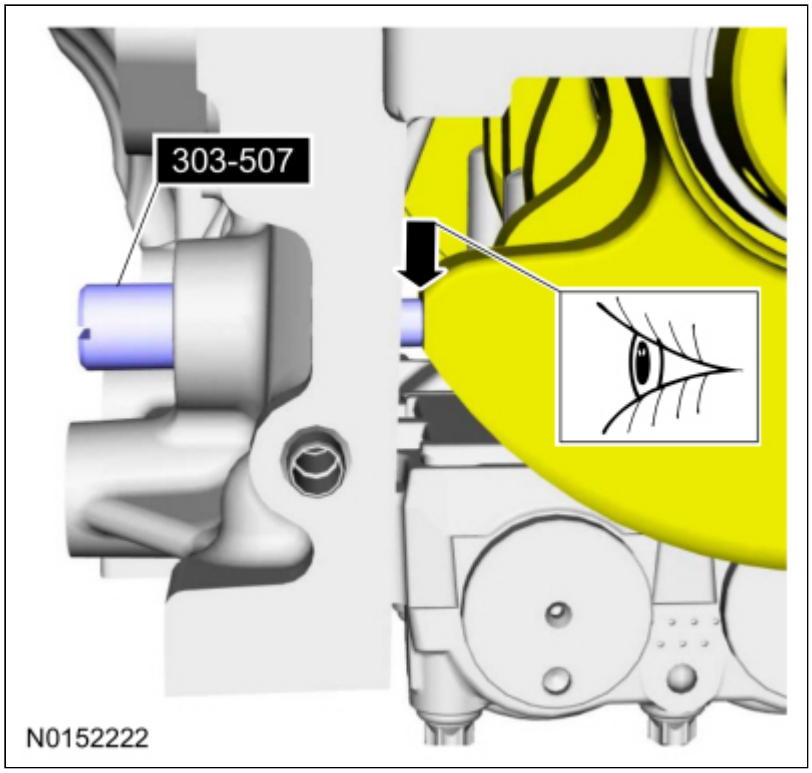
27.

- Remove Special Service Tool: 303-507 Timing Peg, Crankshaft TDC.
- Rotate the crankshaft to confirm that there are no meshing problems between the balancer unit gear and the crankshaft gear.



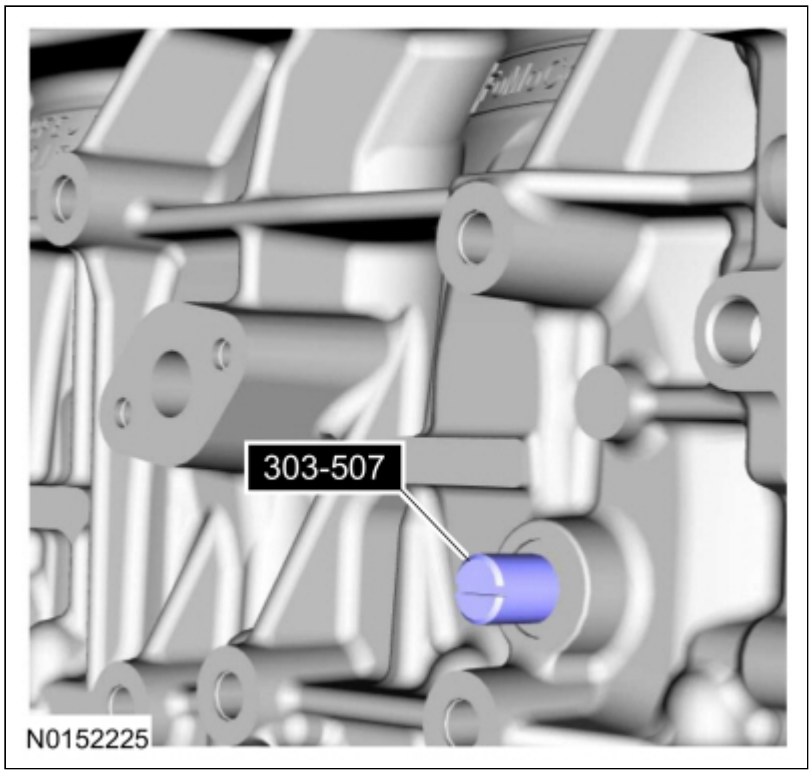
28.

1. Install Special Service Tool: 303-507 Timing Peg, Crankshaft TDC.
2. Rotate the crankshaft slowly clockwise until the crankshaft balance weight is up against the special tool. The engine is now at TDC.



29.

- Remove Special Service Tool: 303-507 Timing Peg, Crankshaft TDC.



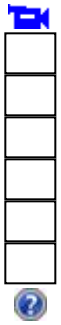
30. **NOTE:** *Measure the backlash and verify that it is within specified range at all of the following 6 positions: 10 degrees, 30 degrees, 100 degrees, 190 degrees, 210 degrees and 280 degrees. It will be necessary to reset the measuring equipment between measurements.*

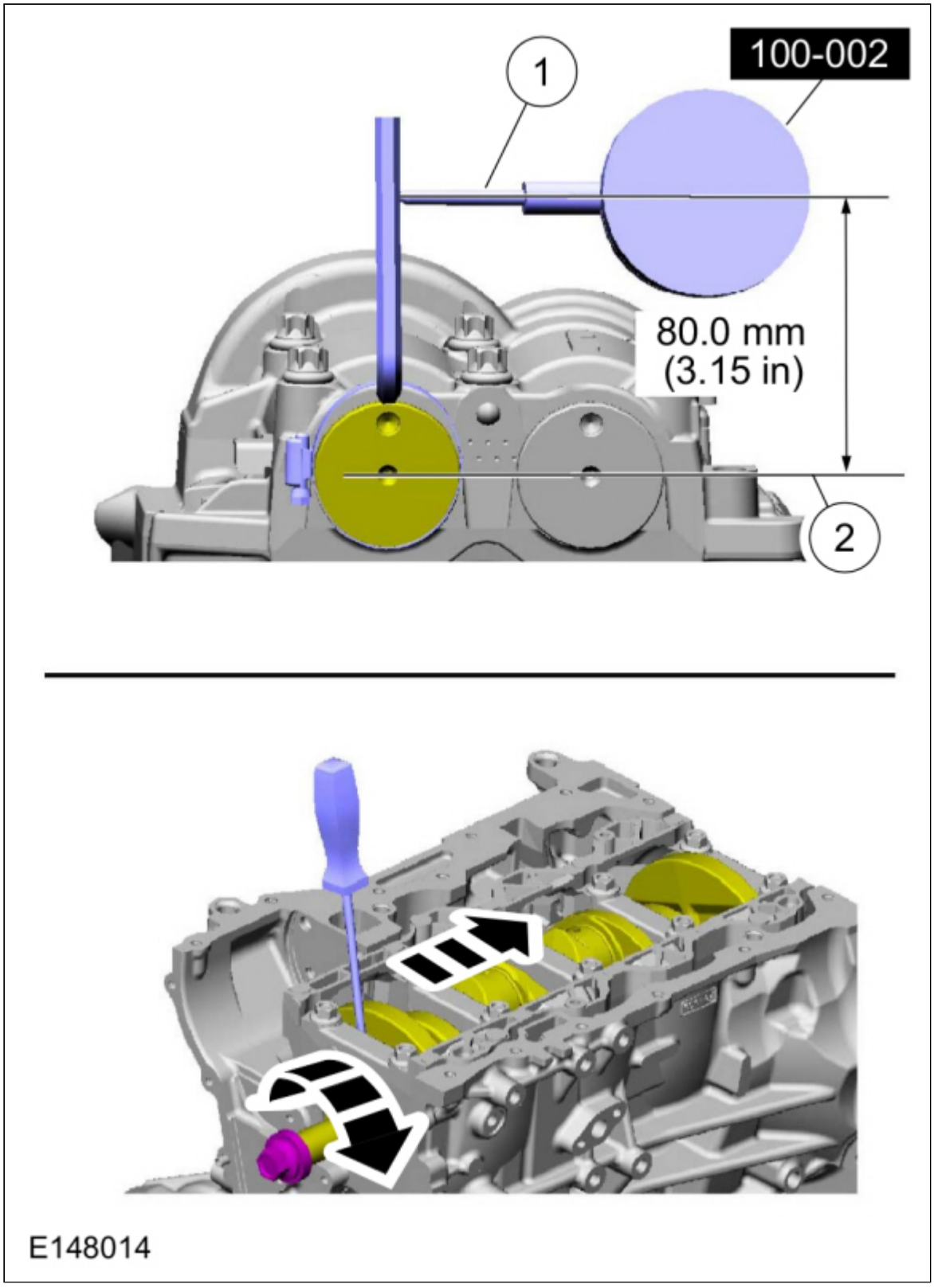
    NOTE: *The measurement must be taken with the Dial Indicator Gauge with Holding Fixture, a 5-mm Allen wrench and worm clamp set up as shown. Mark the allen wrench with a file 80 mm (3.149 in) above the driven gear shaft center. Make sure the worm clamp and Allen wrench are not touching the balance shaft housing.*

NOTE: *For an accurate measurement while measuring the gear backlash, insert a screwdriver as shown into the crankshaft No. 1 crankweight area and set both the rotation and the thrust direction with the screwdriver, using a prying action as shown.*

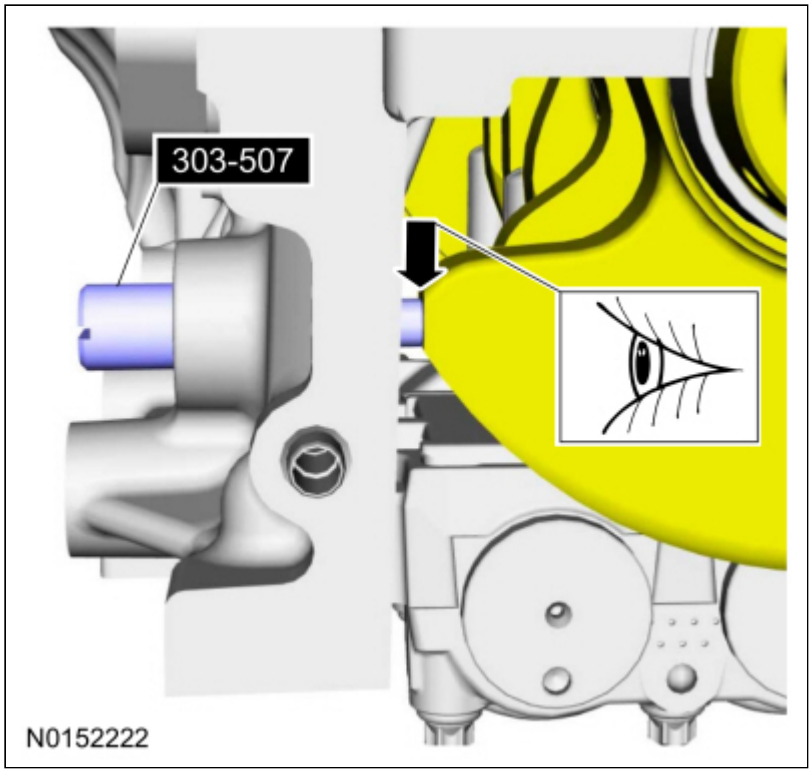
NOTE: *Position the Dial Indicator Gauge with Holding Fixture as shown. Measure the gear backlash.*

1. Position the Dial Indicator Gauge with Holding Fixture (1) on the Allen wrench 80 mm (3.149 in) above the driven gear shaft center (2) on the balancer unit.
2. Rotate the crankshaft clockwise and measure the backlash at all of the following 6 positions: 10 degrees, 30 degrees, 100 degrees, 190 degrees, 210 degrees and 280 degrees.
3. Backlash specifications are 0.040 to 0.140 mm (0.00157 to 0.0055 in).
4. If the backlash exceeds the specified range, carry out the Balance Shaft Backlash procedure.
   Refer to: Balance Shaft Backlash (303-01D Engine - 2.3L EcoBoost (257kW/350PS) - MI4, General Procedures).

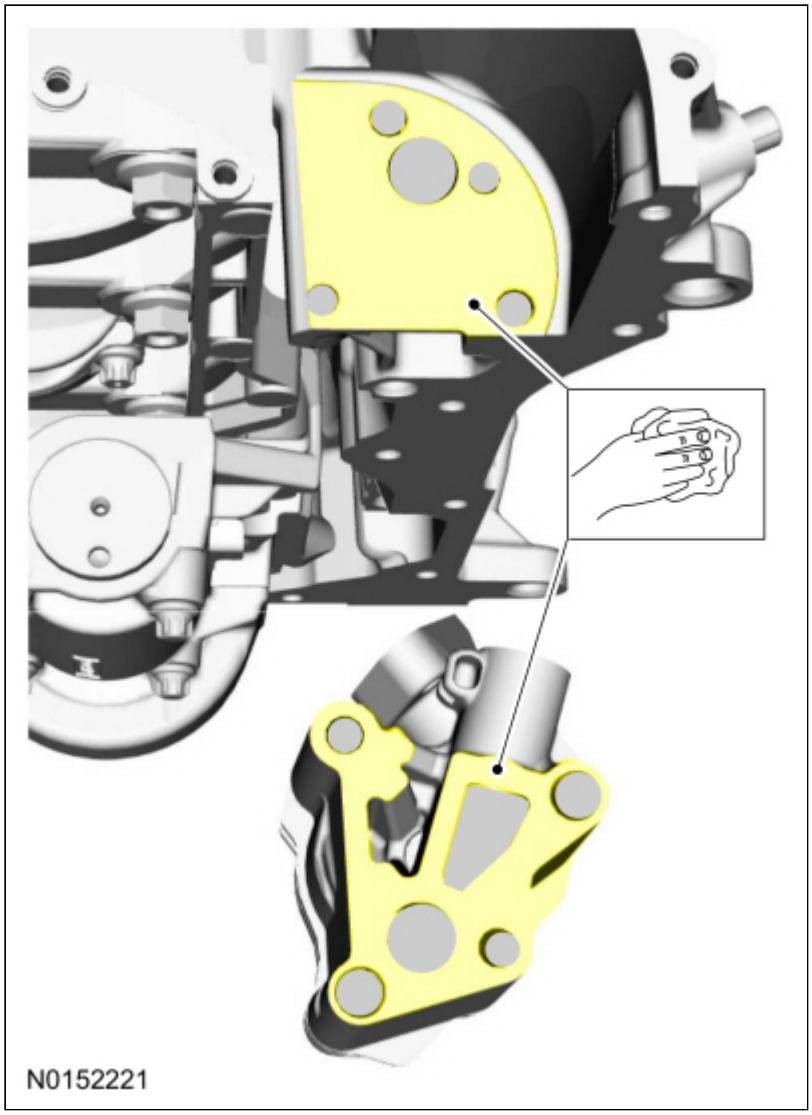




31. Rotate the crankshaft slowly clockwise until the crankshaft balance weight is up against the special tool. The engine is now at TDC and must remain at the TDC position until the timing drive components and crankshaft pulley are installed.

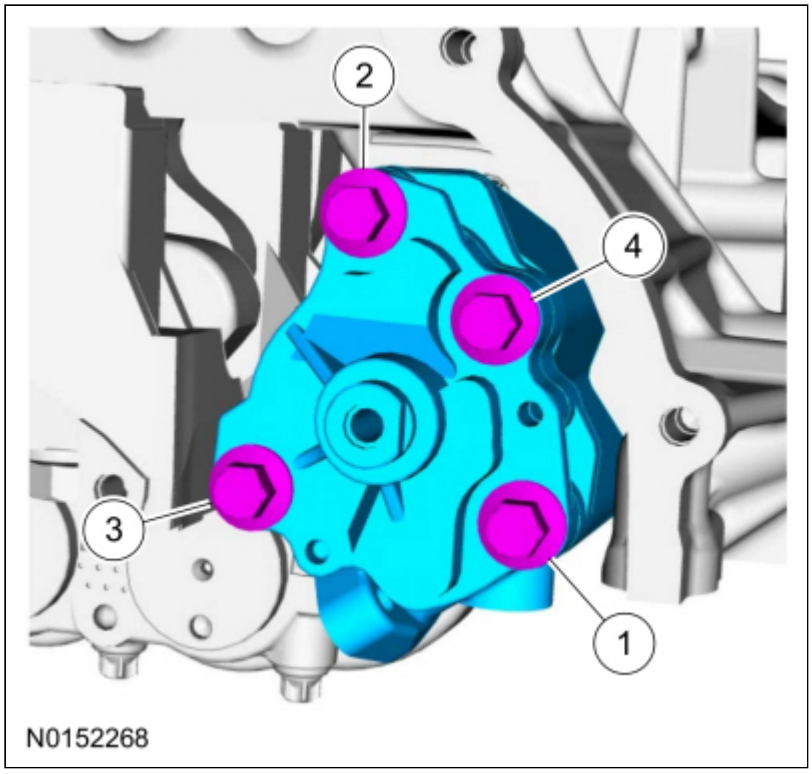


32. Clean the oil pump sealing surfaces.
    Material: Motorcraft® Metal Surface Prep Wipes / ZC-31-B

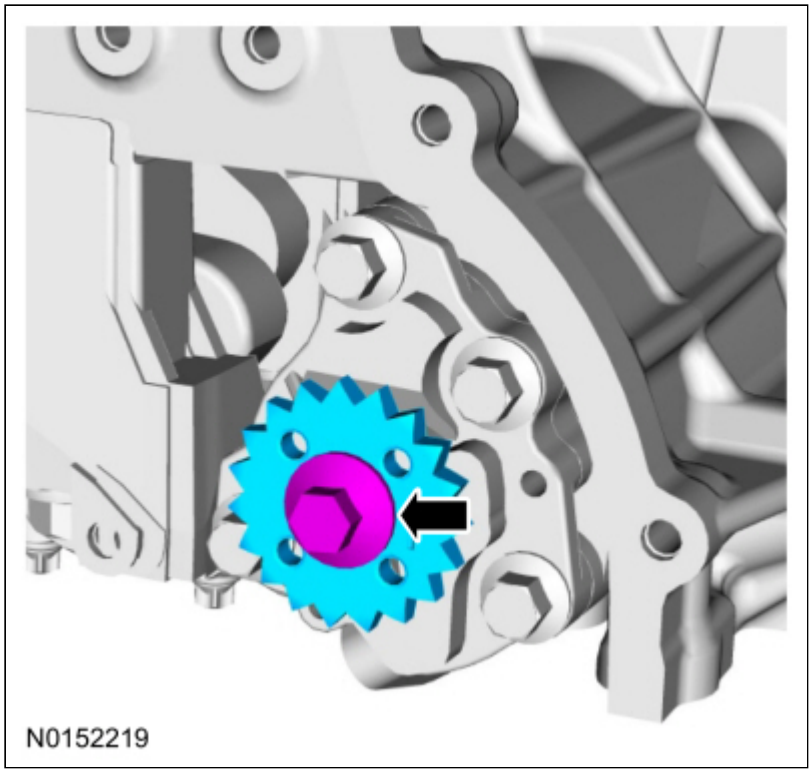


33. Prime the oil pump. Add 2 tablespoons of clean engine oil to the oil pump and rotate the oil pump by hand.

34. Install the oil pump and the bolts and tighten in the sequence shown in 2 stages.
    Torque:
    Stage 1: 89 lb.in (10 Nm)
    Stage 2: 177 lb.in (20 Nm)

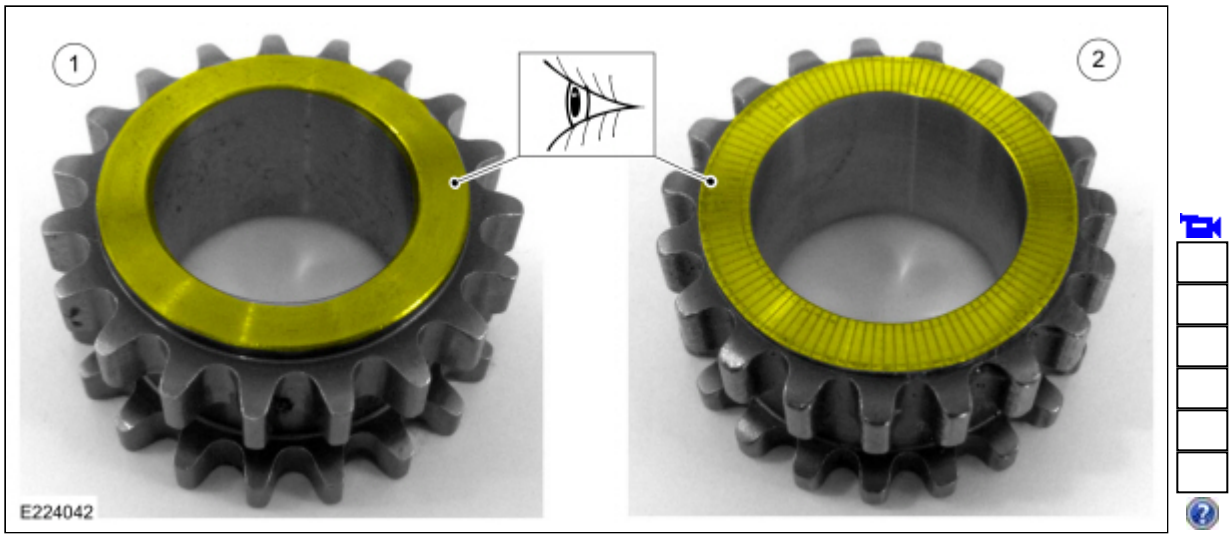


35. Install the oil pump sprocket and bolt.
Torque: 18 lb.ft (25 Nm)



36. **NOTE:** *Early build engines are equipped with a diamond washer on each side of the crankshaft sprocket. Late build engines have a laser etched crankshaft sprocket and do NOT require diamond washers. If an early build engine requires crankshaft sprocket replacement, discard the diamond washers and the sprocket and install a new laser etched sprocket (service part). Diamond washers should NEVER be installed with the laser etched sprocket.*

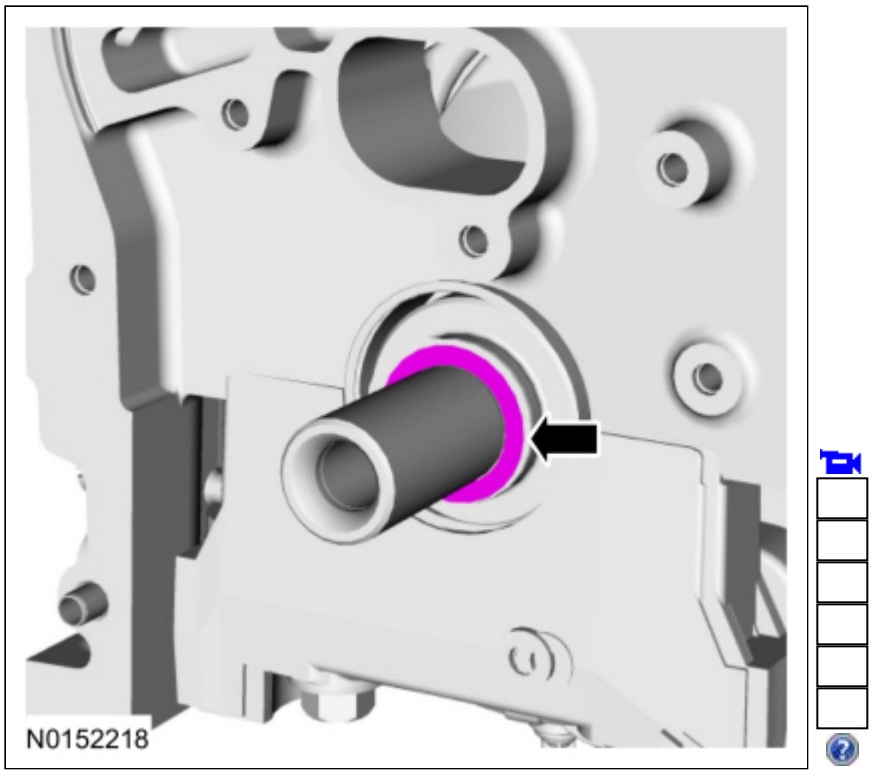
Identify crankshaft sprocket type.
1. Early build engine - Flat faced sprocket (requires diamond washers).
2. Late build engine - Laser etched sprocket (does **NOT** require diamond washers).



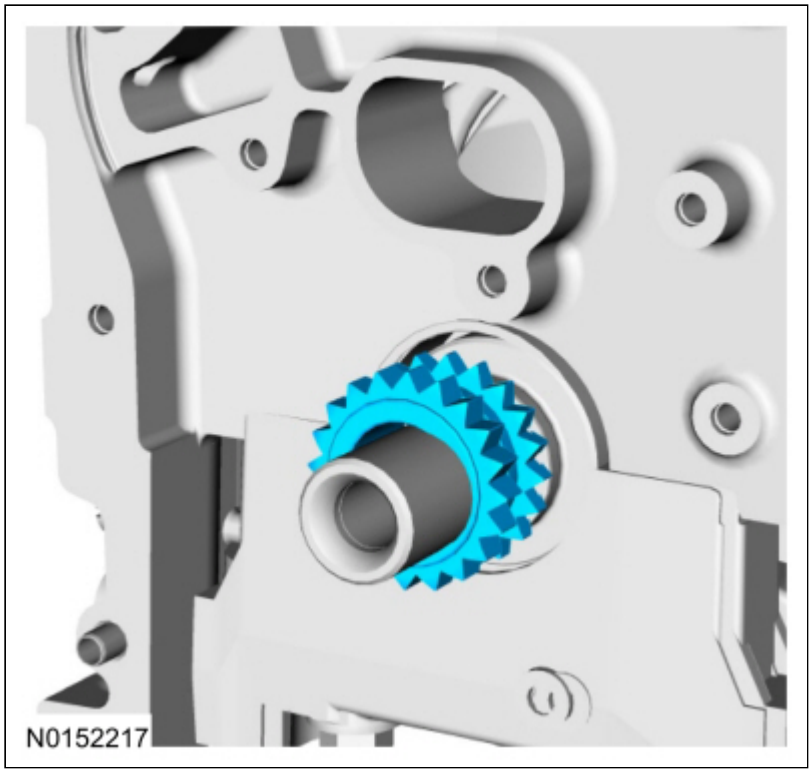
37. **NOTICE: If equipped, the diamond washer should be cleaned and inspected for any damage. If damage is evident, replace the diamond washer. If no damage, the diamond washer is to be reused. If the diamond washer is not installed, engine damage may occur.**

    NOTE: *Early build engines are equipped with a diamond washer on each side of the crankshaft sprocket. Late build engines have a laser etched crankshaft sprocket and do NOT require diamond washers. If an early build engine requires crankshaft sprocket replacement, discard the diamond washers and the sprocket and install a new laser etched sprocket (service part). Diamond washers should NEVER be installed with the laser etched sprocket.*

    If equipped, install the diamond washer.

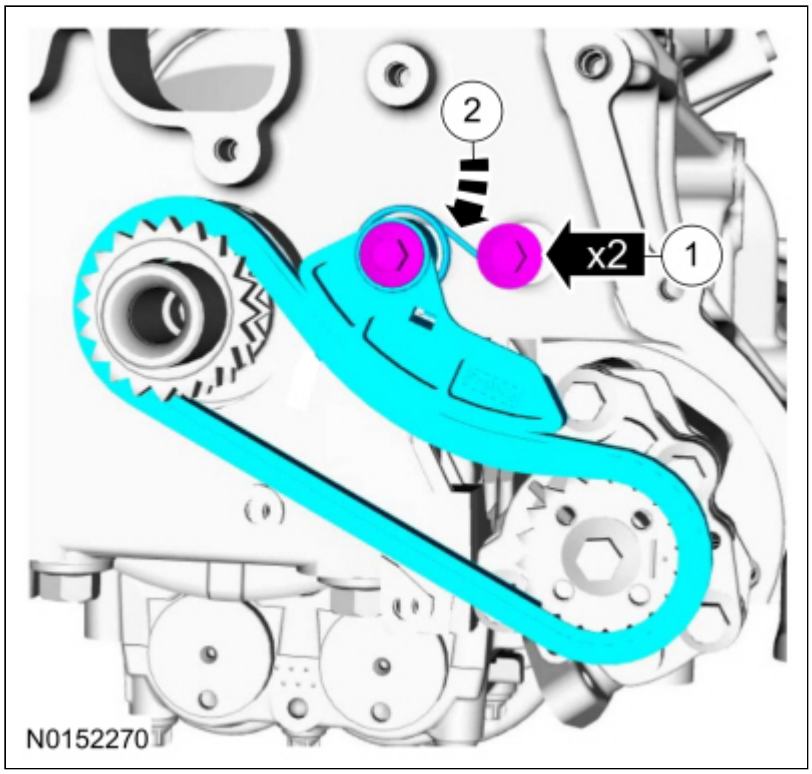


38. Install the crankshaft sprocket.



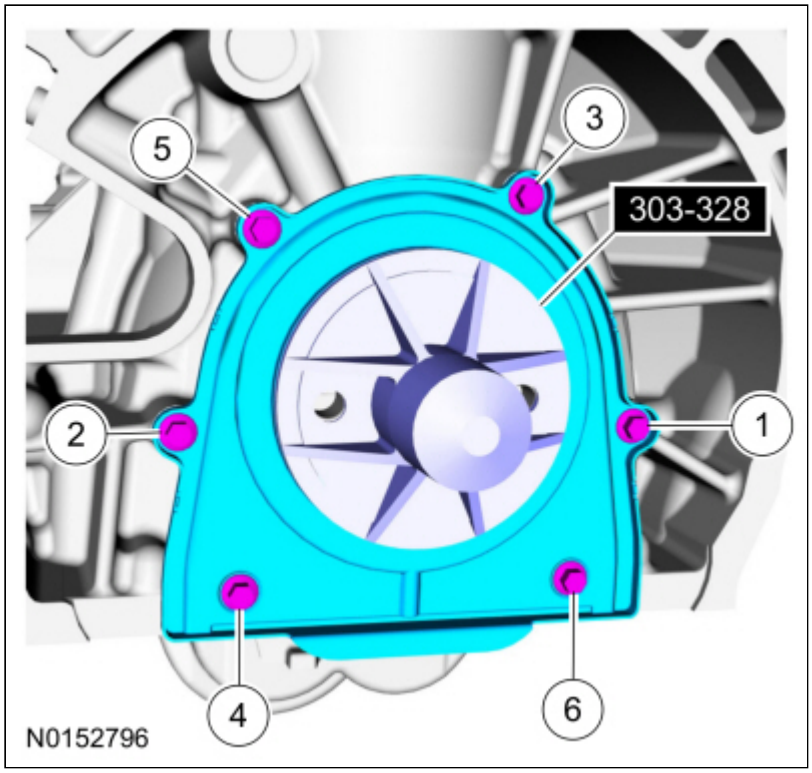
39.

1. Install the timing chain, tensioner and the shoulder bolts.
   Torque: 89 lb.in (10 Nm)
2. Push the tensioner spring down and position the spring under the shoulder bolt.

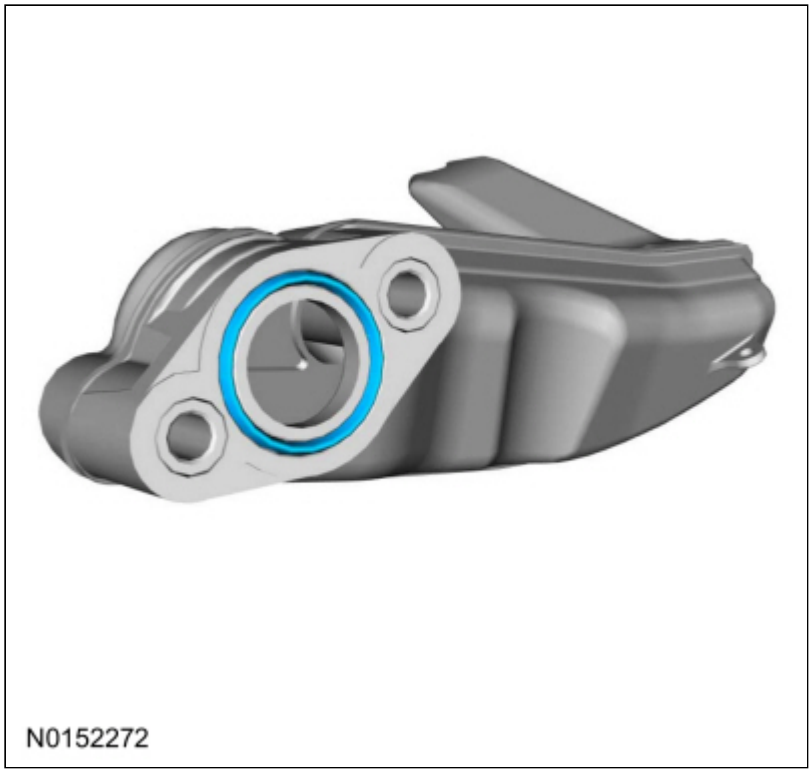


40.

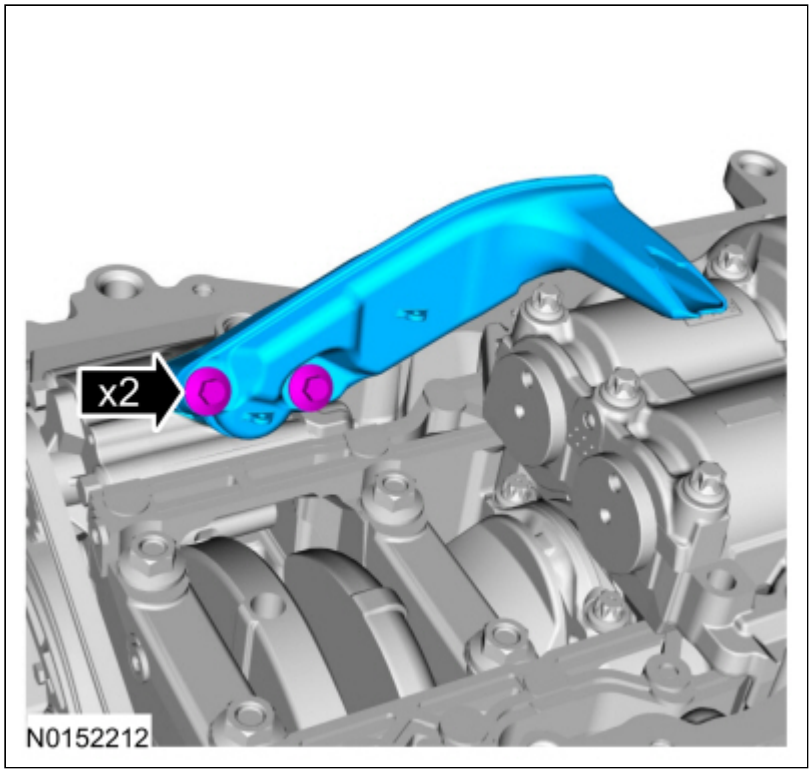
- Using the special tool, position the crankshaft rear oil seal onto the crankshaft.
  Use Special Service Tool: 303-328 (T88P-6701-B1) Replacer, Rear Seal.
- Install the bolts and tighten in sequence shown.
  Torque: 89 lb.in (10 Nm)



41. Install a new O-ring seal on the oil pickup and screen.

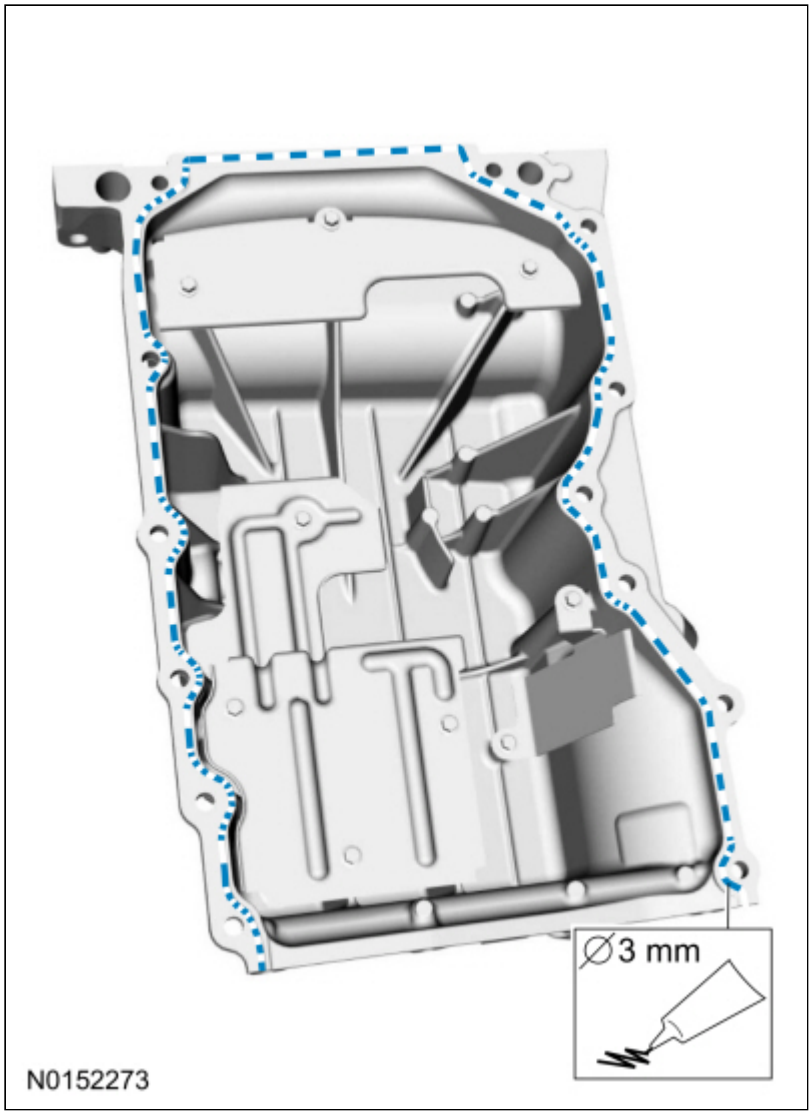


42. Install the oil pickup and screen and the bolts.
    Torque: 89 lb.in (10 Nm)

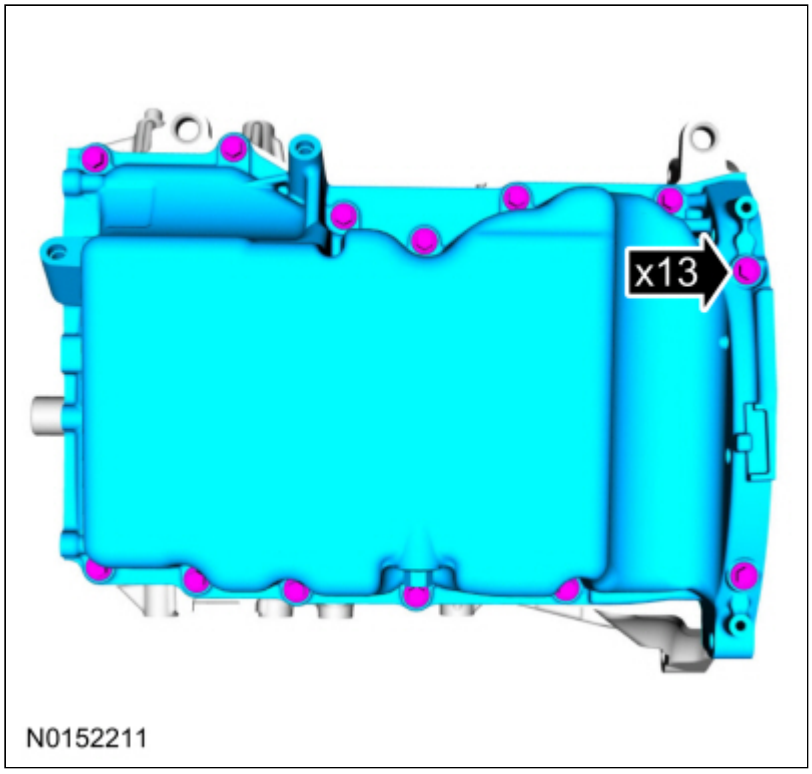


43. **NOTE:** *If the oil pan is not secured within 10 minutes of silicone sealant application, the silicone sealant must be removed and the sealing area cleaned with metal surface prep. Allow to dry until there is no sign of wetness, or 10 minutes, whichever is longer. Failure to follow this procedure can cause future oil leakage.*

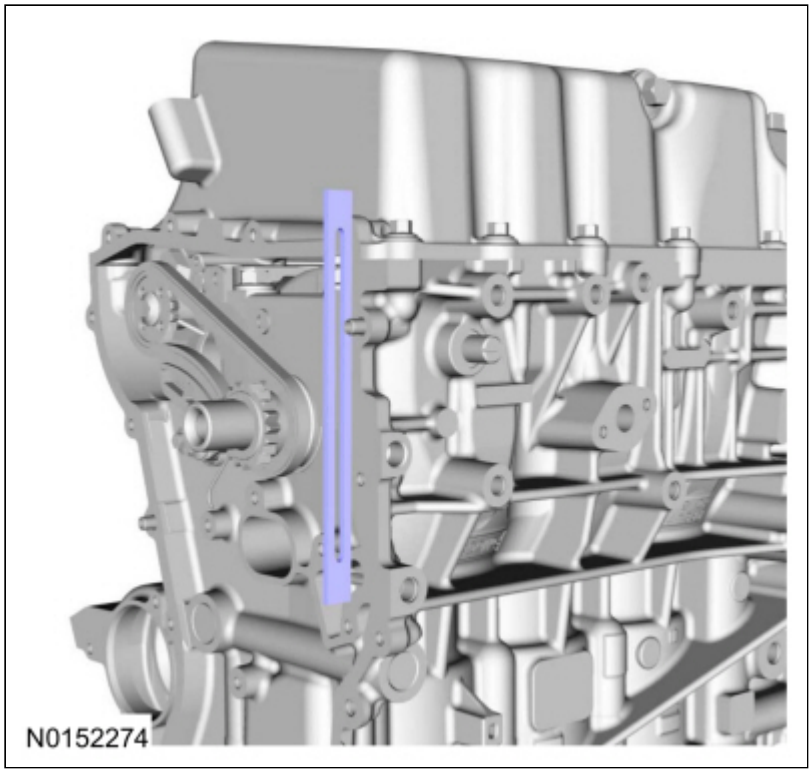
    Apply a 3 mm bead of silicone sealant.
    Material: Motorcraft® Silicone Gasket and Sealant / TA-30 (WSE-M4G323-A4)



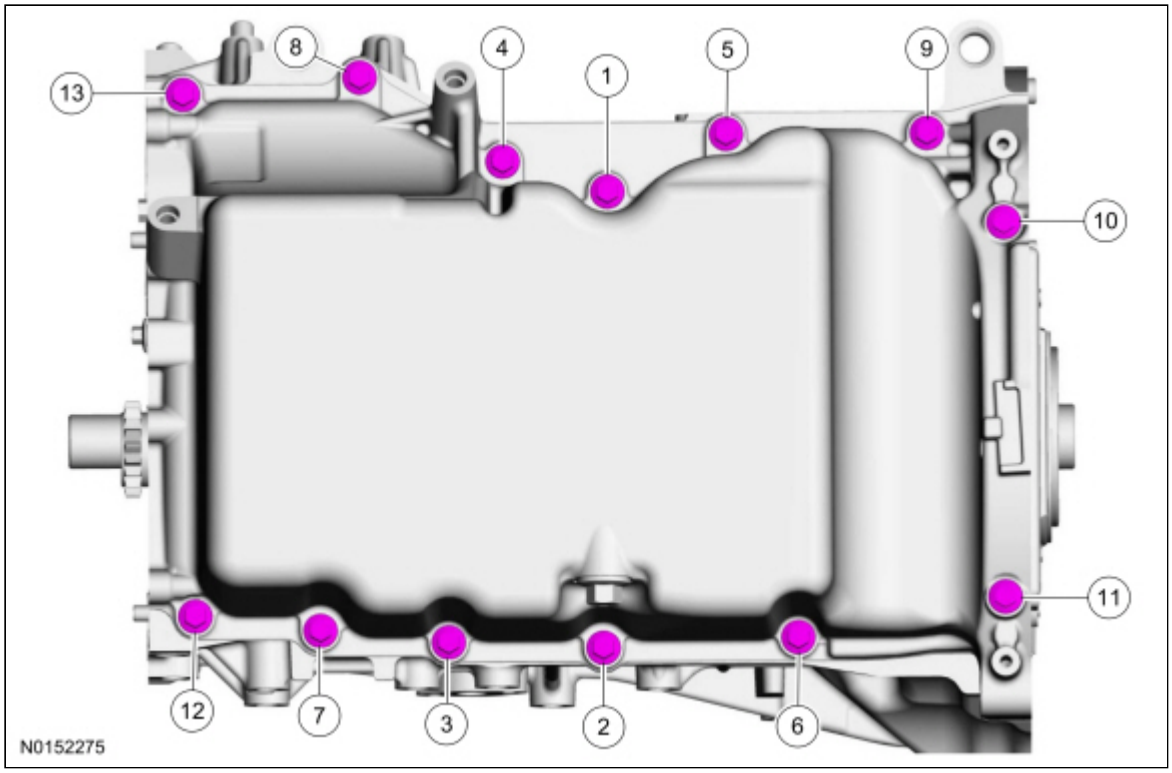
44. Install the oil pan and the bolts finger tight.



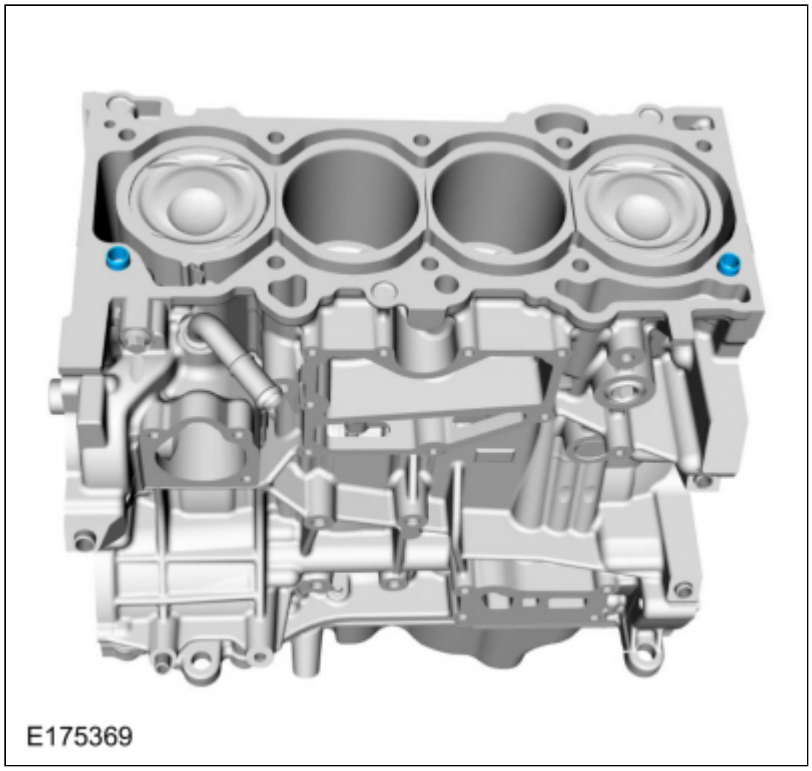
45. Using a straight edge, align the front surface of the oil pan flush with the front surface of the engine block.
Use the General Equipment: Round-Ended Steel Rule



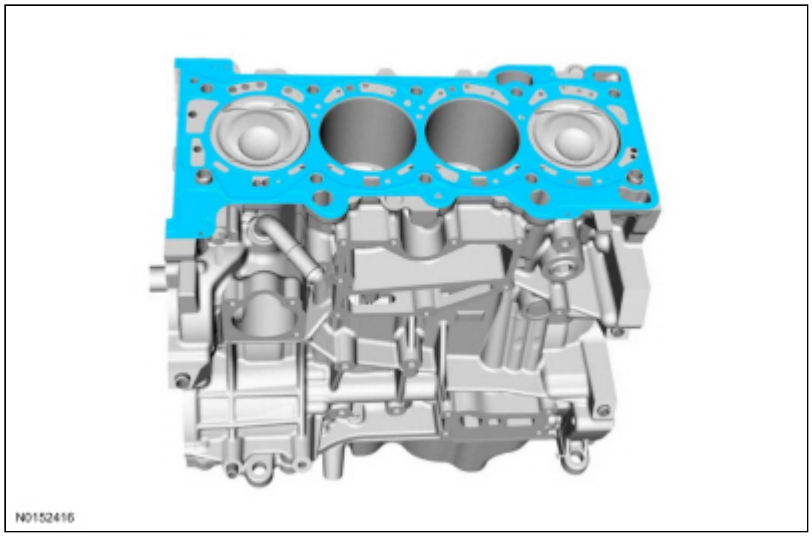
46. Tighten the bolts in sequence shown.
Torque: 18 lb.ft (25 Nm)



47. Install the cylinder block bushings.

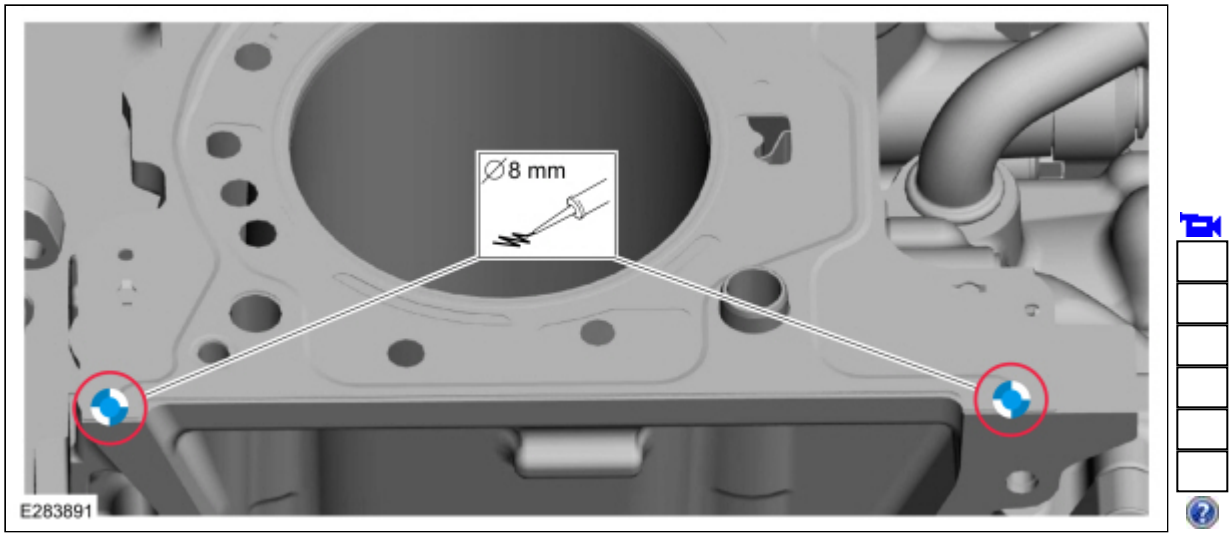


48. Install a new cylinder head gasket.



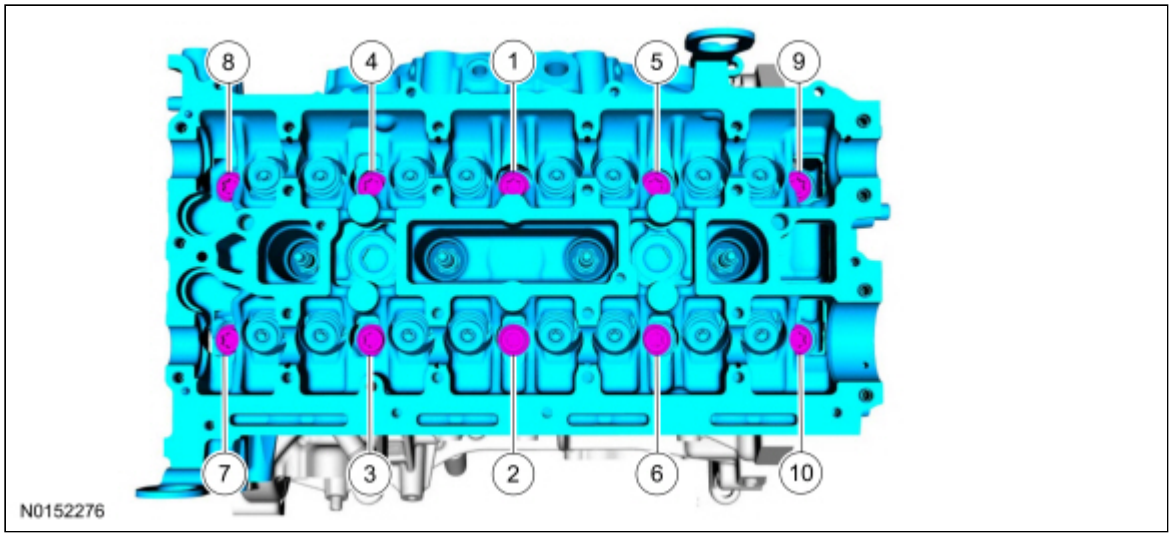
49. **NOTICE: Do not allow RTV sealant in or near the high-pressure oil feed hole. Any restriction in the high-pressure oil feed may result in engine damage.**

    Apply a 7.5 mm (0.3 in) drop of silicone sealant at positions shown.
    Material: Motorcraft® Silicone Gasket and Sealant / TA-30 (WSE-M4G323-A4)

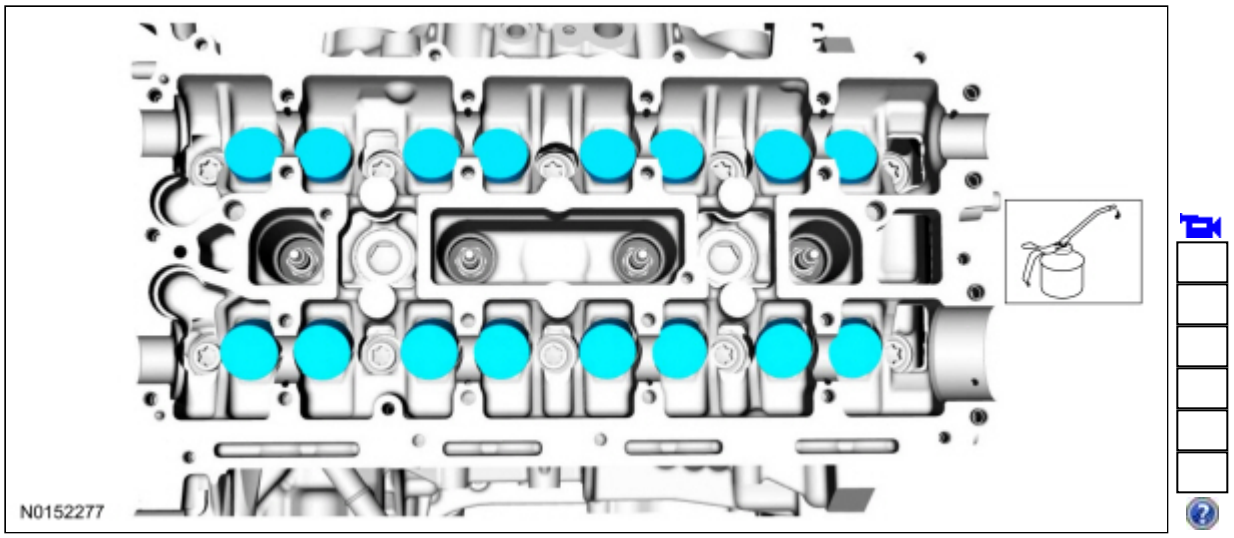


50. **NOTE:** *The cylinder head bolts are torque-to-yield and must not be reused. New cylinder head bolts must be installed.*

    Install the cylinder head and bolts and tighten in sequence shown in 5 stages.
    Torque:
    Stage 1: 62 lb.in (7 Nm)
    Stage 2: 133 lb.in (15 Nm)
    Stage 3: 41 lb.ft (55 Nm)
    Stage 4: 90°
    Stage 5: 90°

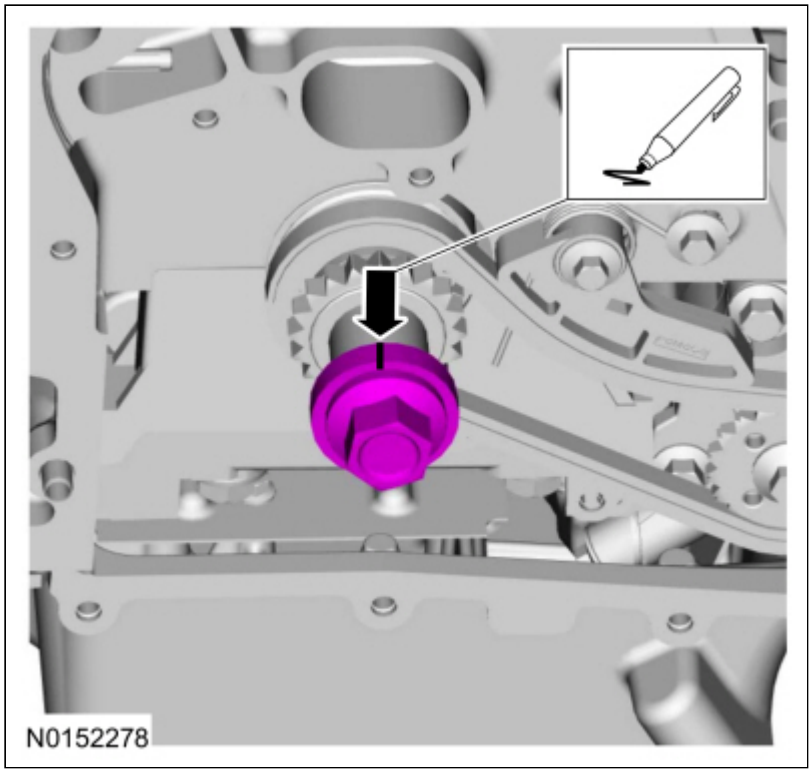


51. Lubricate with clean engine oil and install the valve tappets.



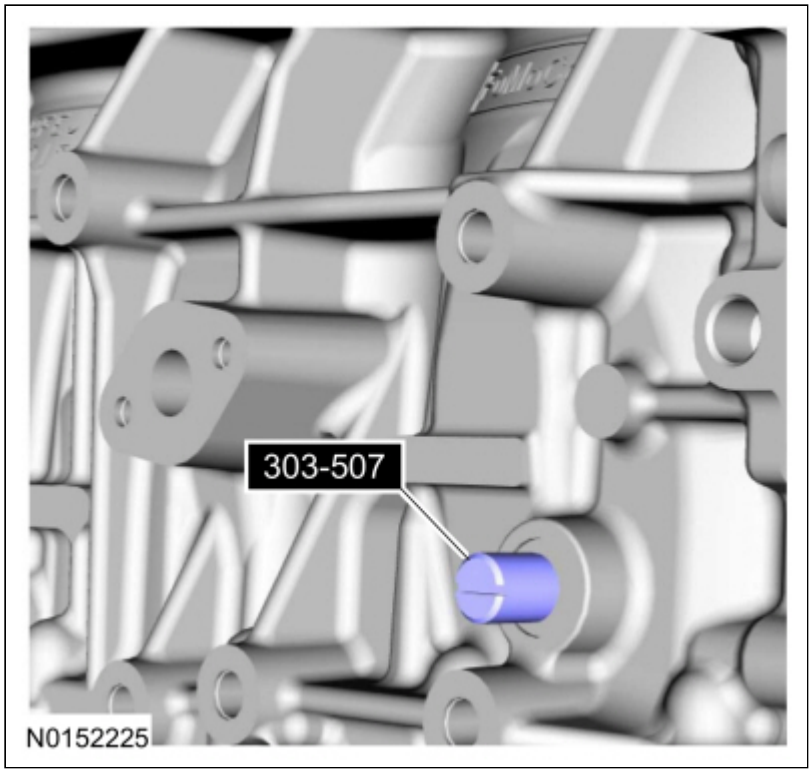
52. **NOTICE: If any new parts are being installed (cylinder head, valves, tappets, camshafts) it is necessary to check the valve clearance, follow the next 12 steps exactly or serious damage to the engine may occur. If the original parts are being installed it is not necessary to check the valve clearance so proceed to step 63.**

    Install the crankshaft bolt and place a paint mark on the crankshaft bolt at the 12 o'clock position.



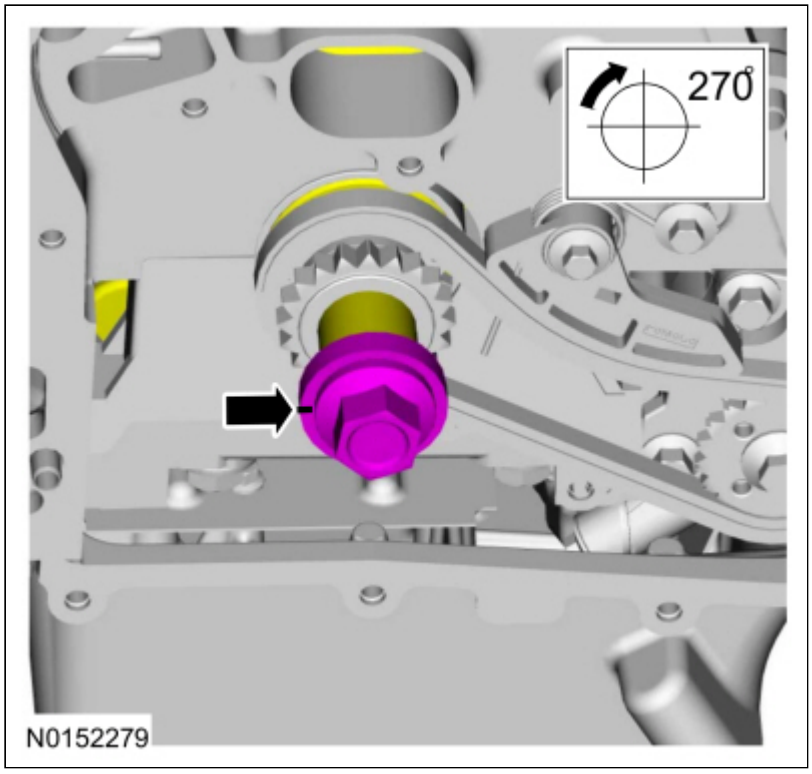
53.

- Remove Special Service Tool: 303-507 Timing Peg, Crankshaft TDC.



54. **NOTE:** *Rotating the crankshaft will position all of the pistons below the deck of the cylinder block and allow the camshafts to be installed and the valve clearance checked without the possibility of damage to the valves or pistons.*

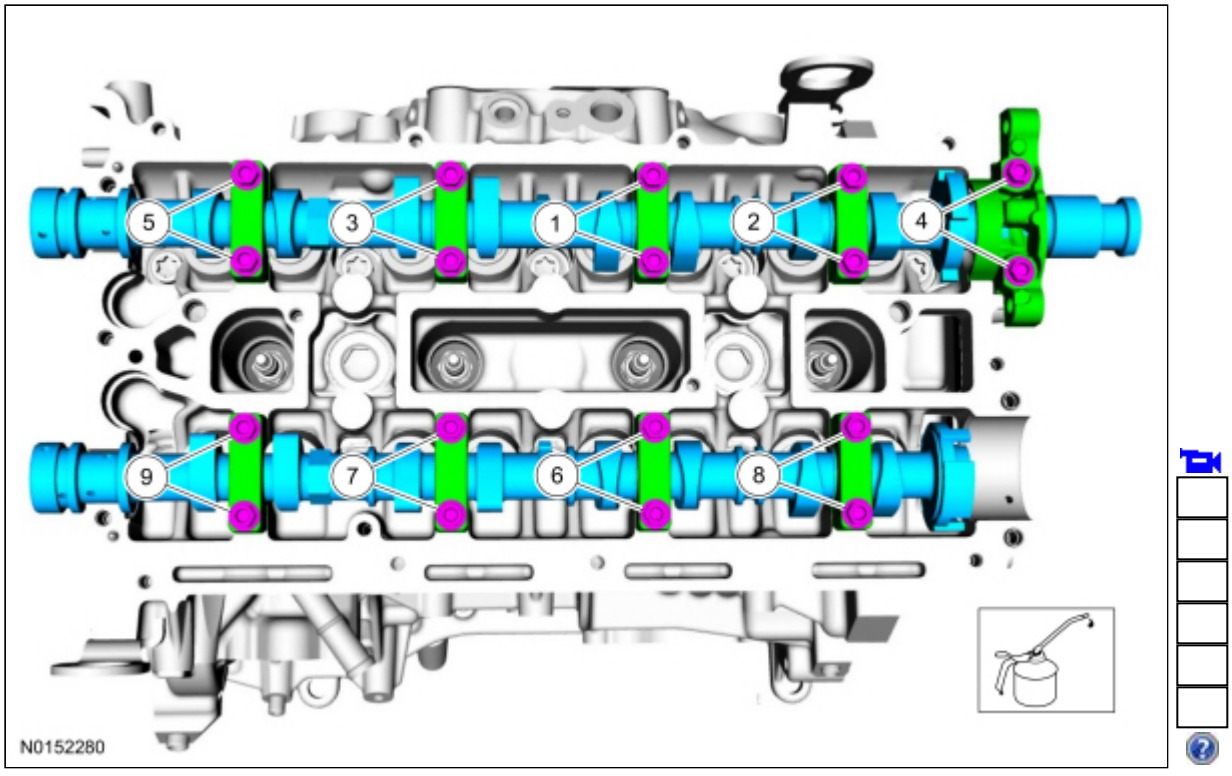
Using the crankshaft bolt and washer, rotate the crankshaft clockwise 270 degrees until the paint mark is at the 9 o'clock position.



55. **NOTICE: Failure to follow the camshaft tightening procedure can result in damage to the camshafts.**

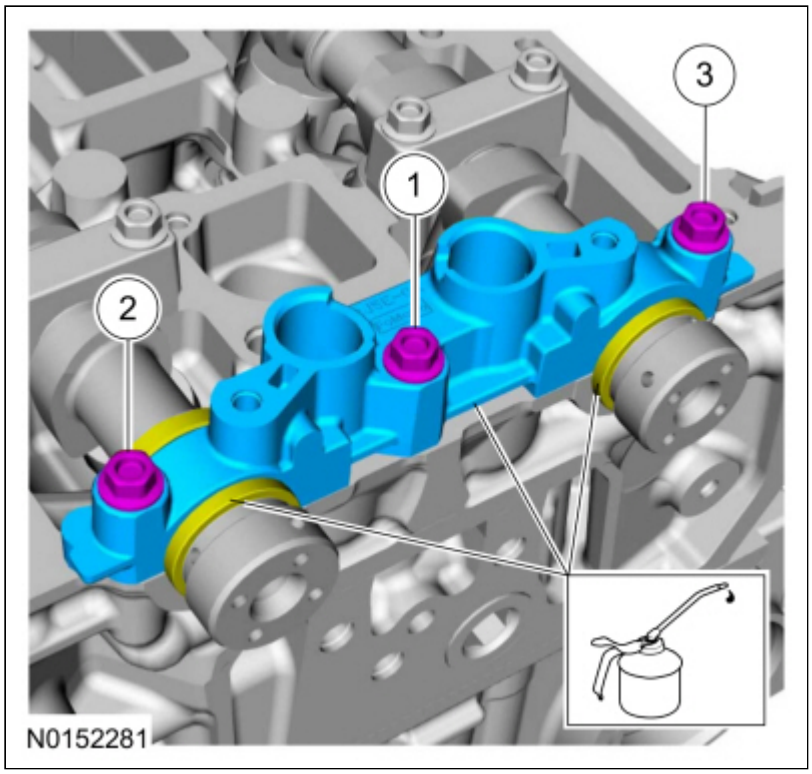
    NOTE: *Lubricate the camshaft journals and camshaft bearing caps with clean engine oil.*

    - Lubricate the camshafts and caps with clean engine oil and install the camshafts, caps and bolts.
    - Tighten 2 turns at a time in the sequence shown in 2 stages.
      Torque:
      Stage 1: 62 lb.in (7 Nm)
      Stage 2: 142 lb.in (16 Nm)



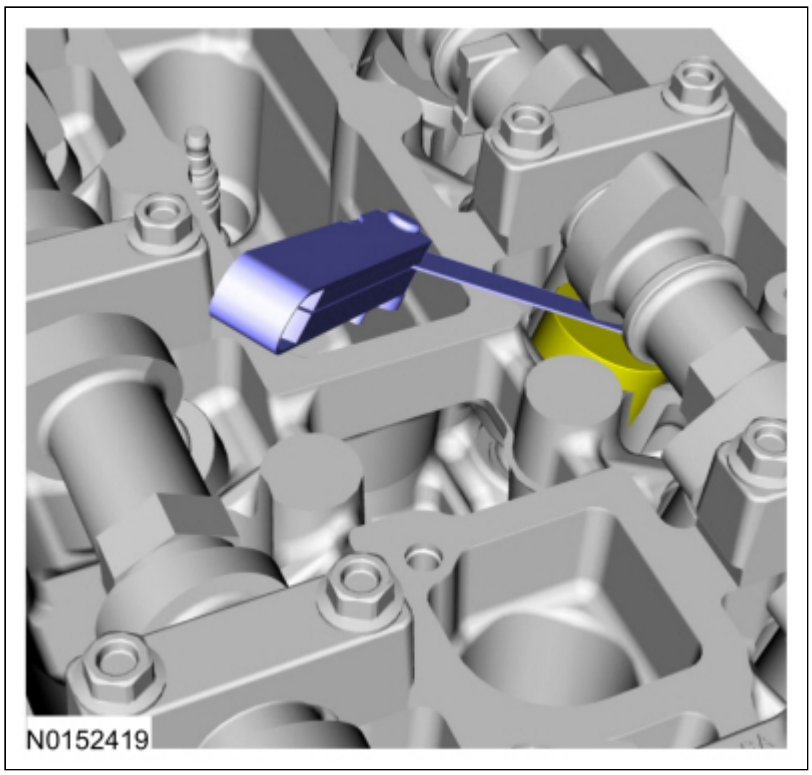
56. Lubricate the camshaft journals with clean engine oil and install the front camshaft bearing cap and bolts and tighten in the sequence shown in 2 stages.

Torque:
Stage 1: 62 lb.in (7 Nm)
Stage 2: 142 lb.in (16 Nm)



57.

1. Using the flats of the camshaft, rotate the camshaft to place the cam lobe at base circle, with the lobe pointed away from the tappet.
2. Use a feeler gauge to measure the clearance of each valve and record its location.
   Use the General Equipment: Feeler Gauge
3. Repeat to measure all of the lobe/tappet clearances.



58. **NOTE:** *The number on the valve tappet only reflects the digits that follow the decimal. For example, a tappet with the number 0.650 has the thickness of 3.650 mm.*

    NOTE: *Select tappets using this formula: tappet thickness = measured clearance + the existing tappet thickness - nominal clearance.*

    NOTE: *The nominal clearance is:*

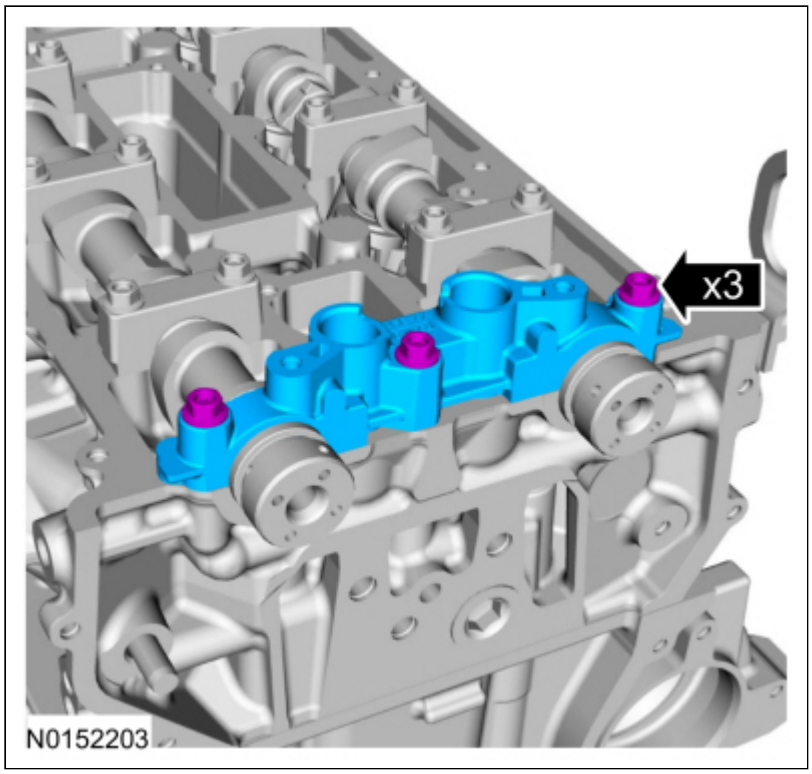
    - *intake: 0.25 mm (0.0095 in).*
    - *exhaust: 0.36 mm (0.0142 in).*

    NOTE: *The acceptable clearances after being fully installed are:*

    - *intake: 0.19-0.31 mm (0.007-0.012 in).*
    - *exhaust: 0.30-0.42 mm (0.012-0.017 in).*

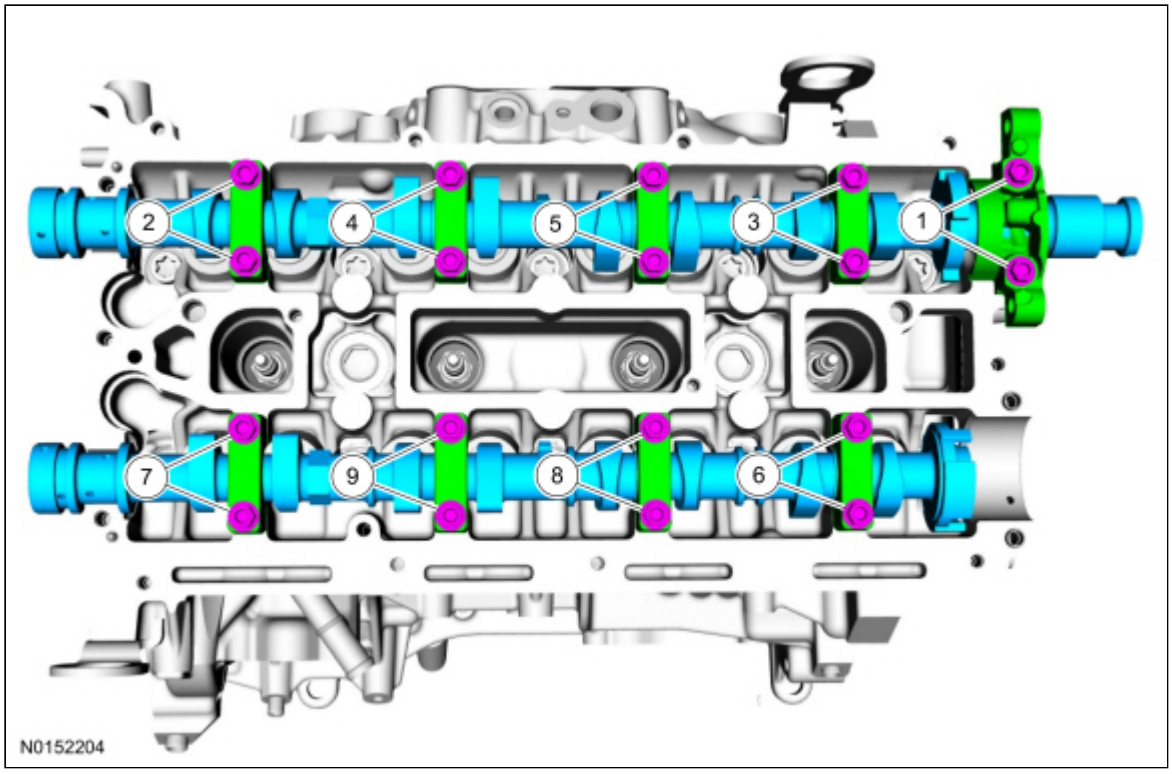
    Select the closest tappet size to the ideal tappet thickness available and mark the installation location.

59. Remove the bolts and the front camshaft bearing cap.

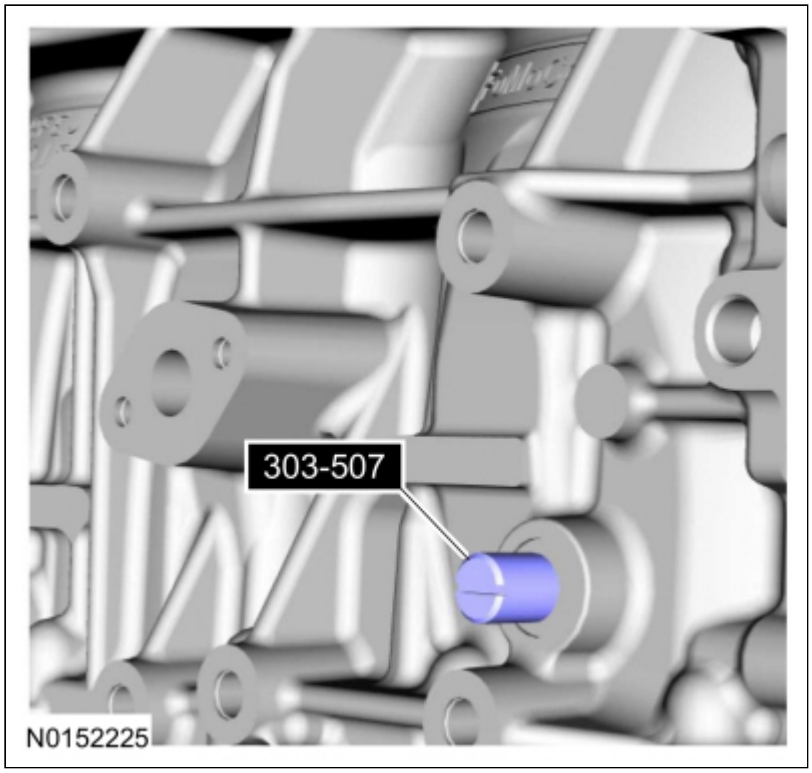


60. **NOTICE: Failure to follow the camshaft loosening procedure can result in damage to the camshafts.**

    Loosen the camshaft bearing caps in sequence 2 turns at a time until all tension is released from the camshaft bearing caps. Remove the bolts, caps and camshafts.

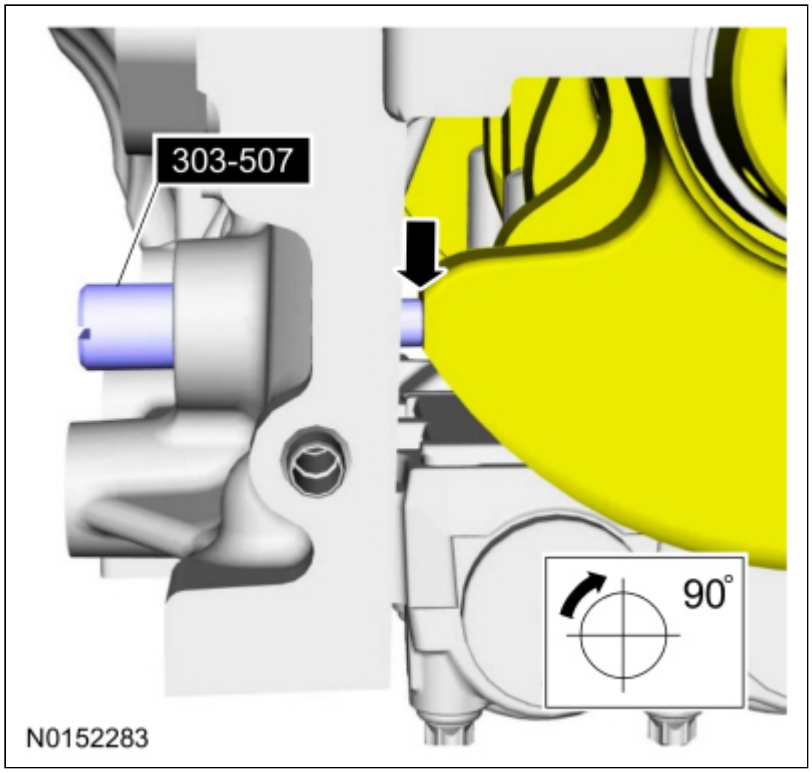


61. Install Special Service Tool: 303-507 Timing Peg, Crankshaft TDC.

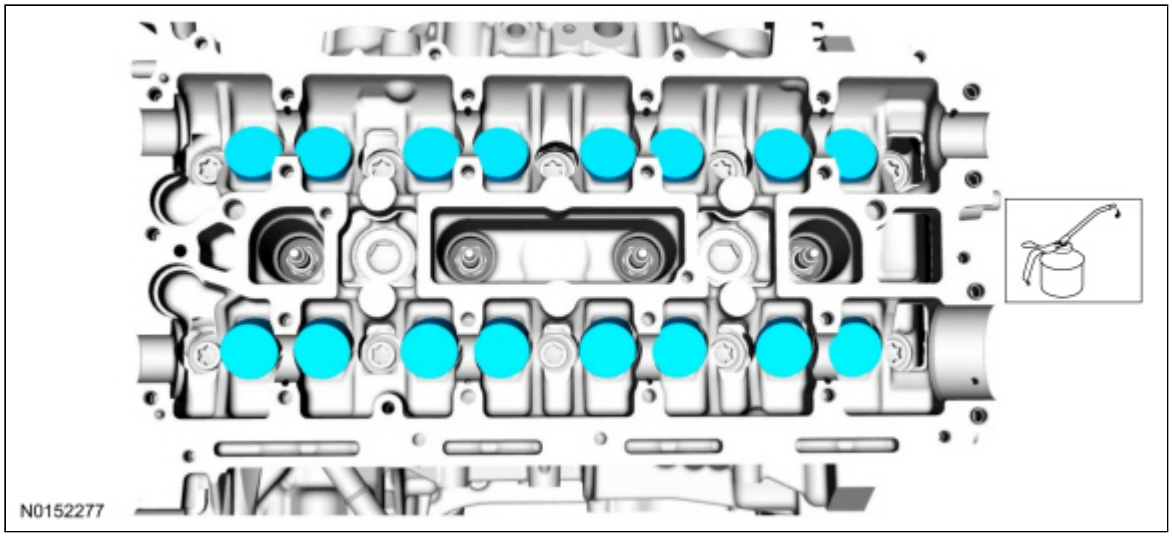


62. **NOTE:** *Rotating the crankshaft will position the engine at TDC and allow you to install the camshafts in the same position as noted during the disassembly.*

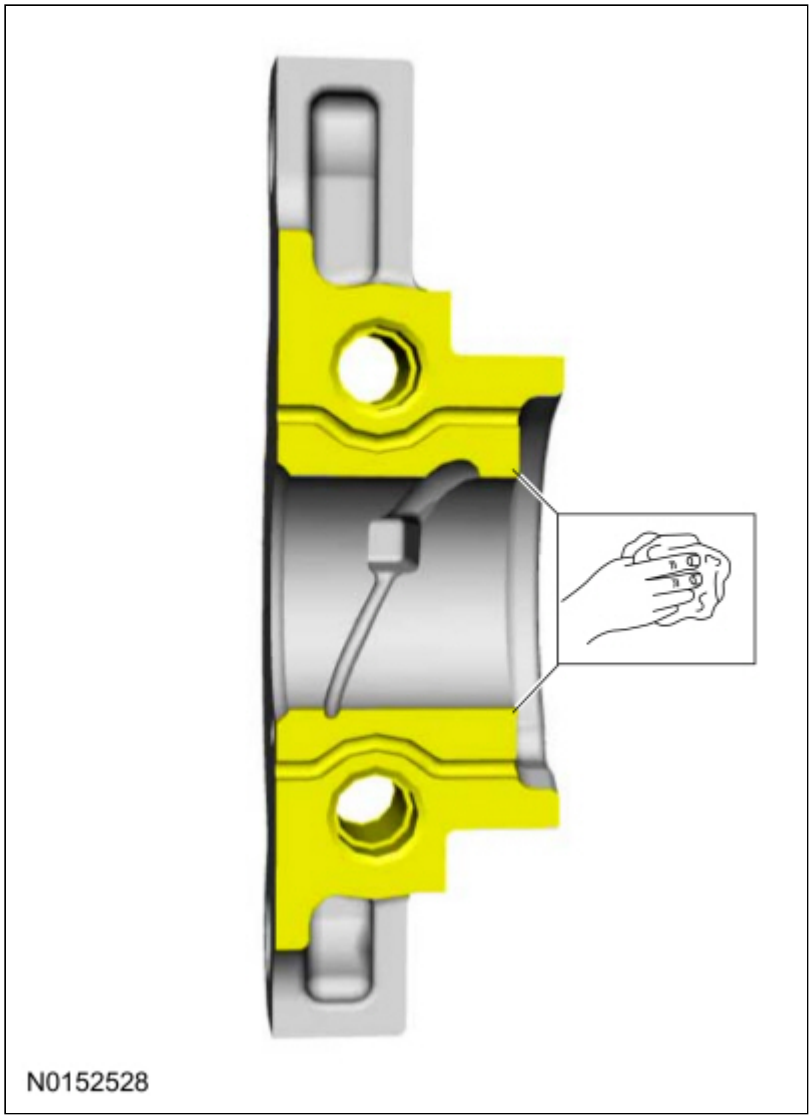
    Rotate the crankshaft clockwise 90 degrees so the crankshaft contacts the special tool.



63. If necessary, replace any tappets with the correct tappets selected during the valve clearance check and lubricate with clean engine oil.



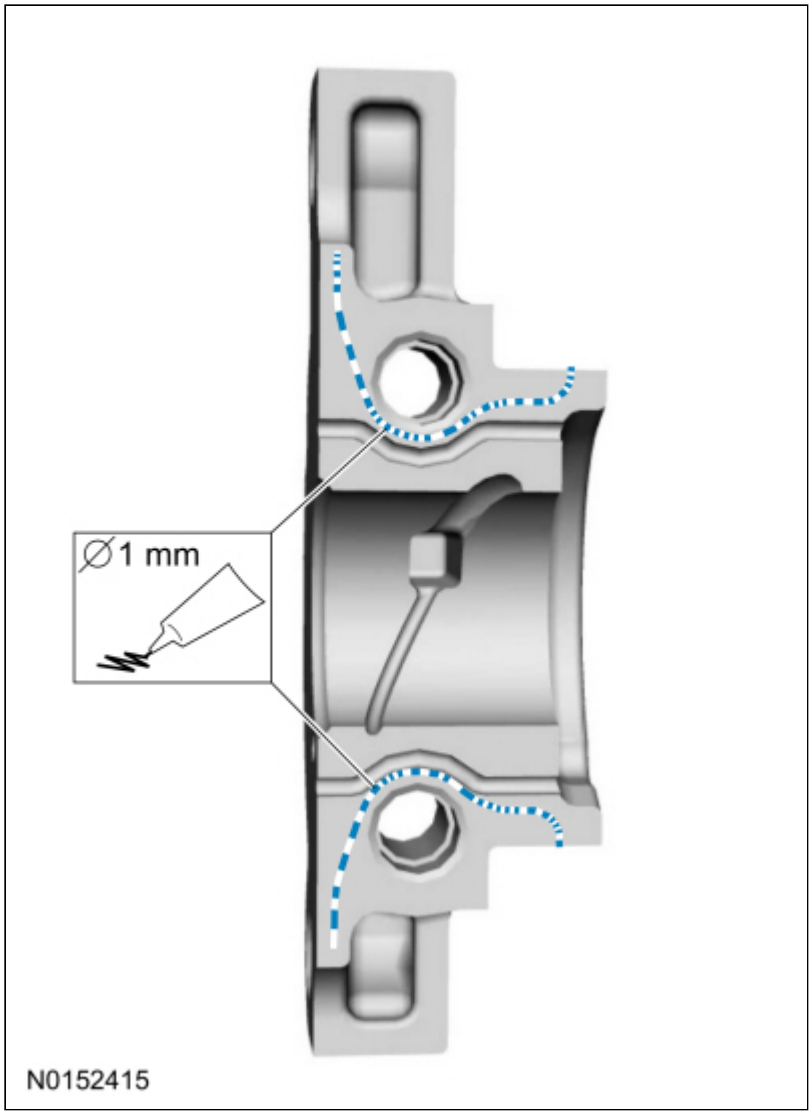
64. Clean the rear camshaft cap.
Material: Motorcraft® Metal Surface Prep Wipes / ZC-31-B



65. **NOTE:** *The exhaust camshaft rear bearing cap must be secured within 10 minutes of gasket maker application. If the bearing cap is not secured within 10 minutes, the gasket maker must be removed and the sealing area cleaned with Motorcraft® Metal Surface Prep.*

    NOTE: *Do not allow silicone sealant to enter the camshaft bearing journal. If gasket maker is applied to the camshaft bearing journal, the journal and sealing area must be cleaned with Motorcraft® Metal Surface Prep.*

    Apply a 1 mm bead of gasket maker.
    Material: Motorcraft® Gasket Maker / TA-16 (WSK-M2G348-A5)
    Material: Motorcraft® Metal Surface Prep Wipes / ZC-31-B



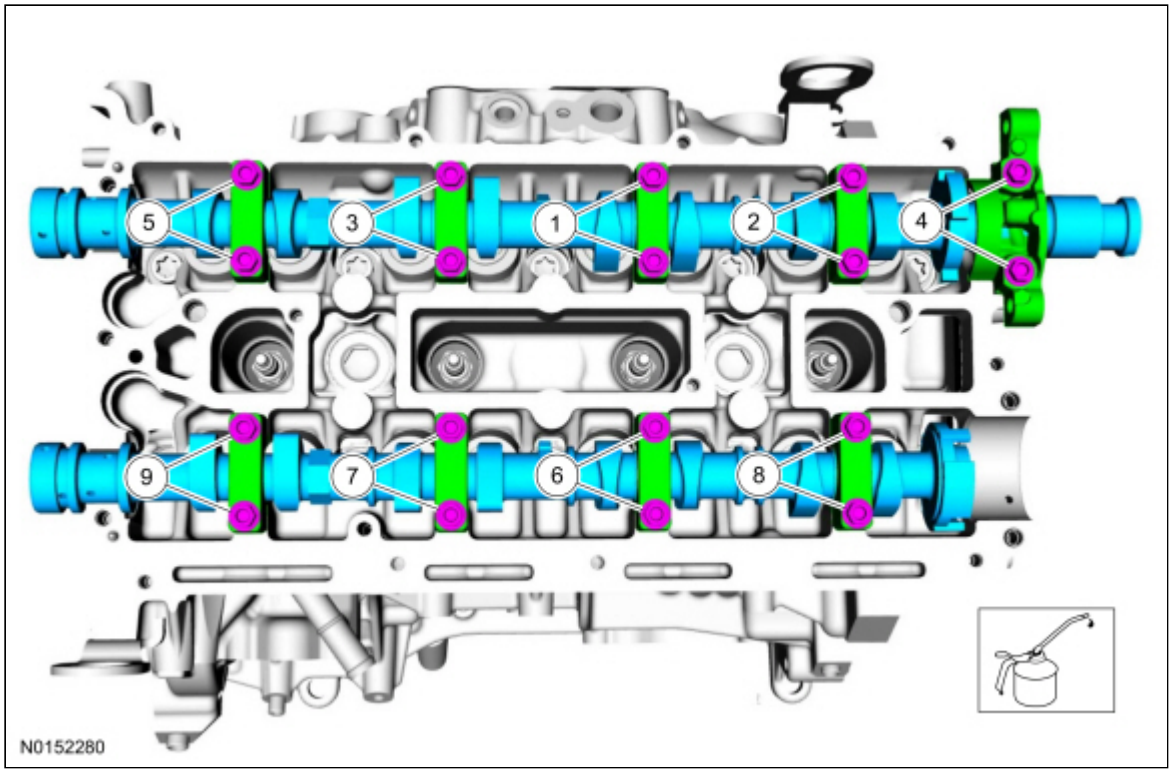
66. **NOTICE: Install the camshafts with the alignment slots in the camshafts lined up so the Camshaft Alignment Plate can be installed without rotating the camshafts. Make sure the lobes on the No. 1 cylinder are in the same position as noted in the removal procedure. Rotating the camshafts when the timing chain is removed, or installing the camshafts 180 degrees out of position can cause severe damage to the valves and pistons.**

    NOTICE: Failure to follow the camshaft tightening procedure can result in damage to the camshafts.

    NOTICE: Wipe off any excess gasket maker from the fuel injection pump housing sealing surface of the cylinder head and rear camshaft cap.

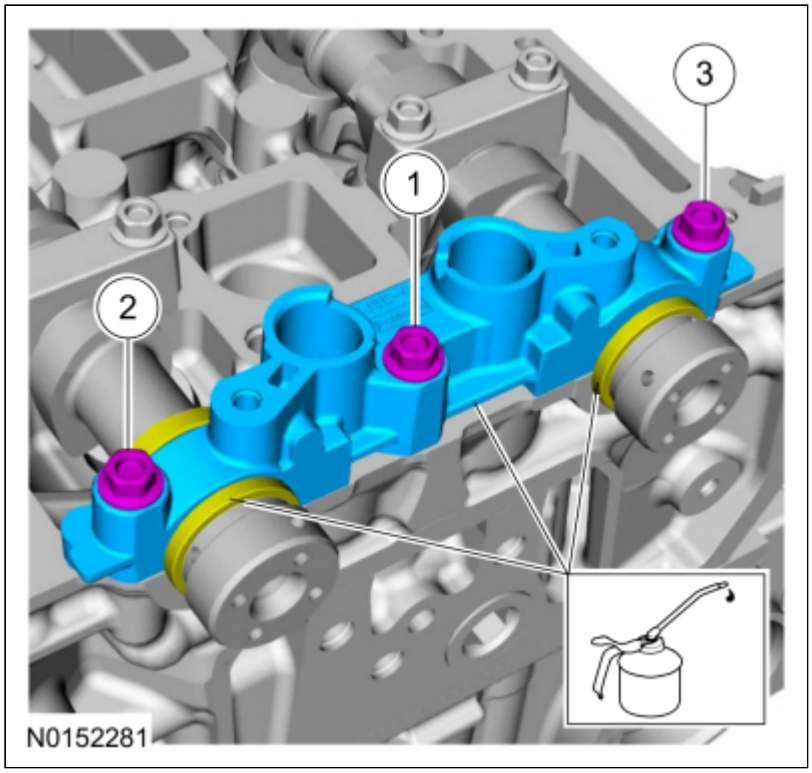
    NOTE: *Lubricate the camshaft journals and camshaft bearing caps with clean engine oil.*

    - Lubricate with clean engine oil and install the camshafts, caps and bolts.
    - Tighten the camshaft bearing cap bolts one turn at a time, until finger-tight.
    - Tighten 2 turns at a time in the sequence shown in 2 stages.
      Torque:
      Stage 1: 62 lb.in (7 Nm)
      Stage 2: 142 lb.in (16 Nm)

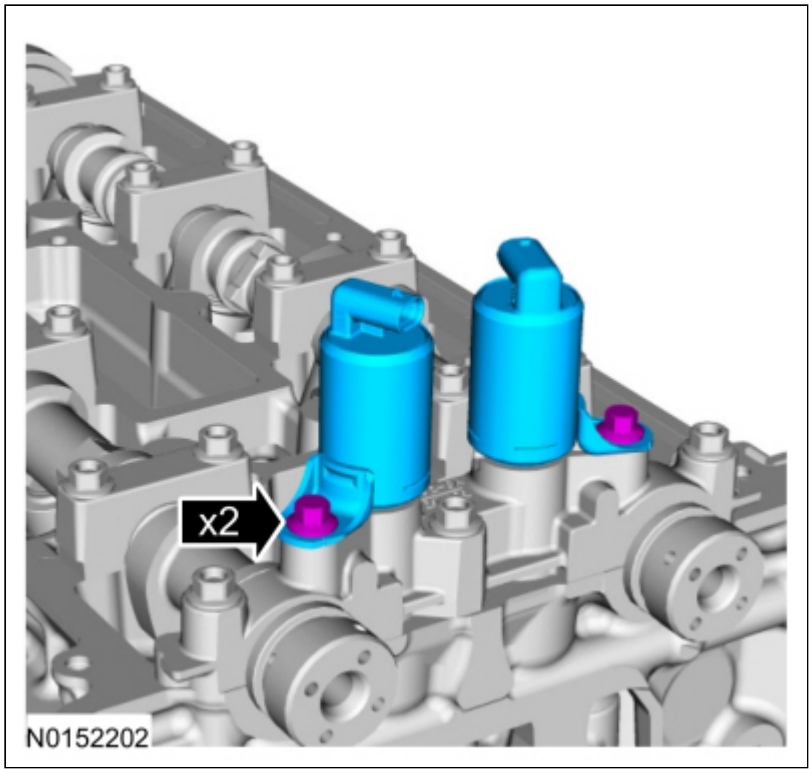


67.

- Lubricate the camshaft journals with clean engine oil.
- Install the front camshaft bearing cap and the bolts and tighten in sequence shown in 2 stages.
  Torque:
  Stage 1: 62 lb.in (7 Nm)
  Stage 2: 142 lb.in (16 Nm)

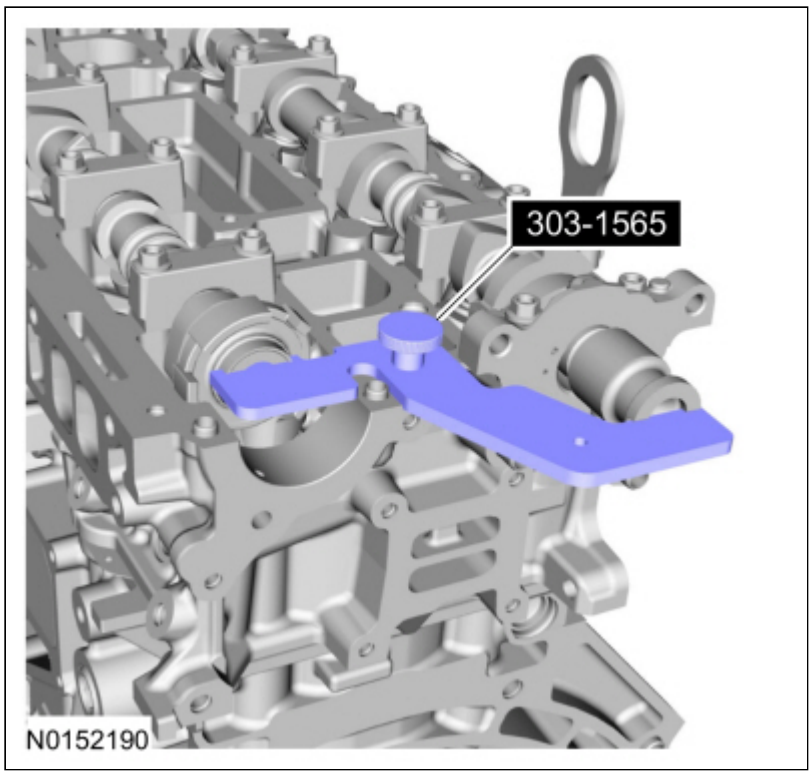


68. Install the VCT oil control solenoids and the bolts.
    Torque: 89 lb.in (10 Nm)



69. **NOTICE: The special tool is for camshaft alignment only. Using this tool to prevent engine rotation can result in engine damage.**

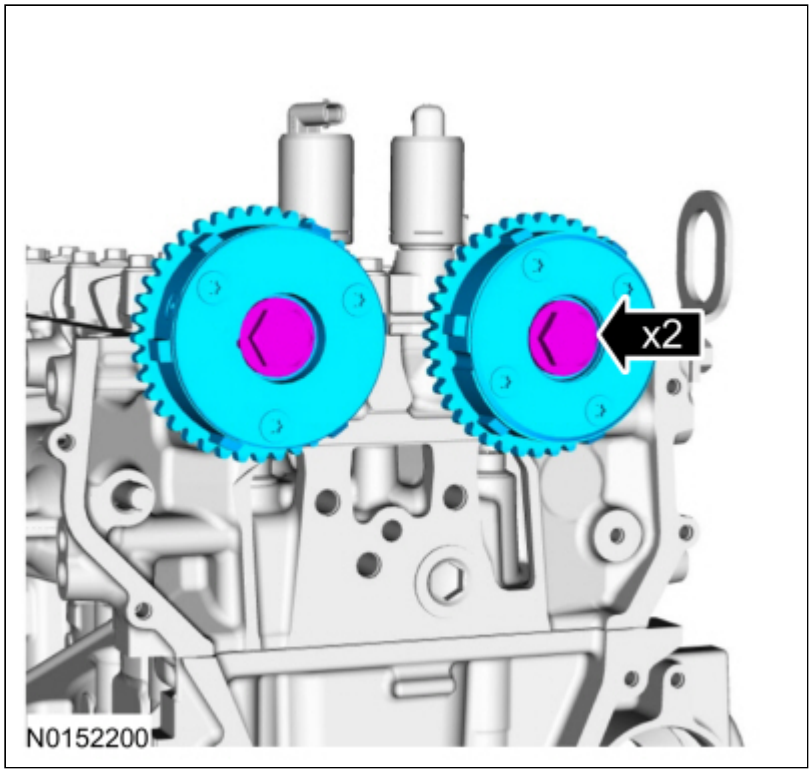
    Install Special Service Tool: 303-1565 Alignment Tool, Camshaft.



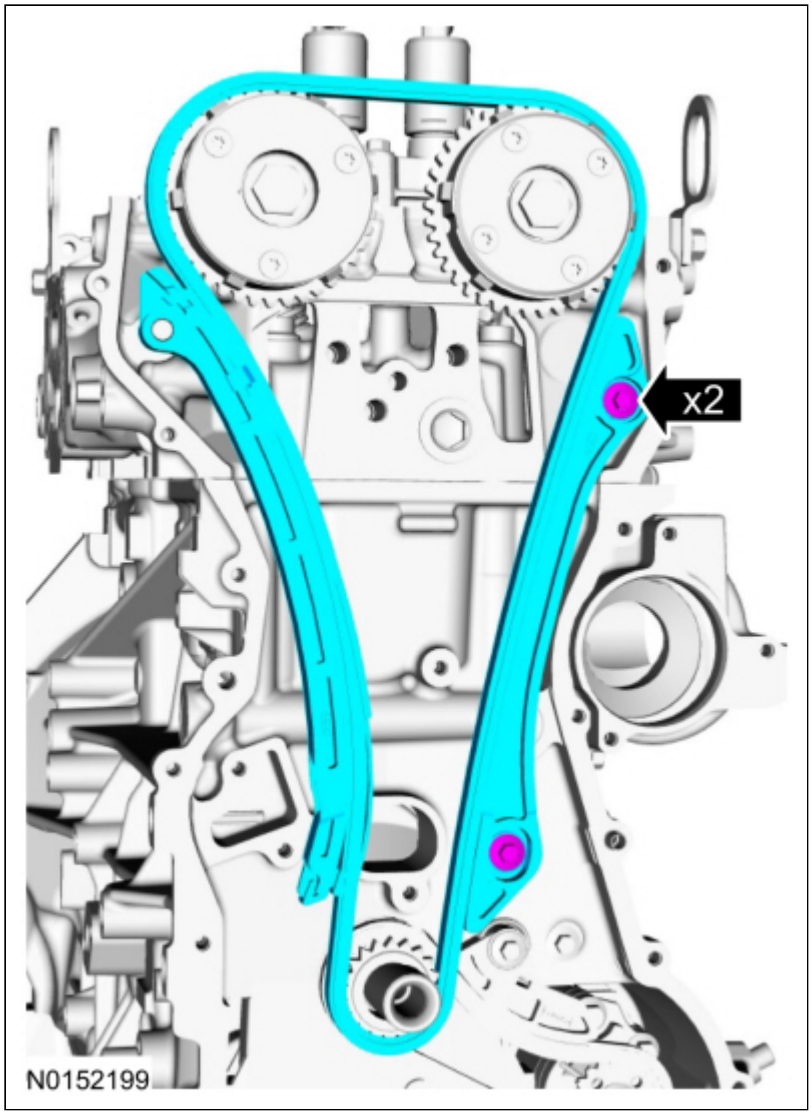
70. **NOTE:** *New bolts must be installed.*

    NOTE: *Do not tighten the VCT unit bolts at this time.*

    - Install the VCT units and the new bolts finger-tight.



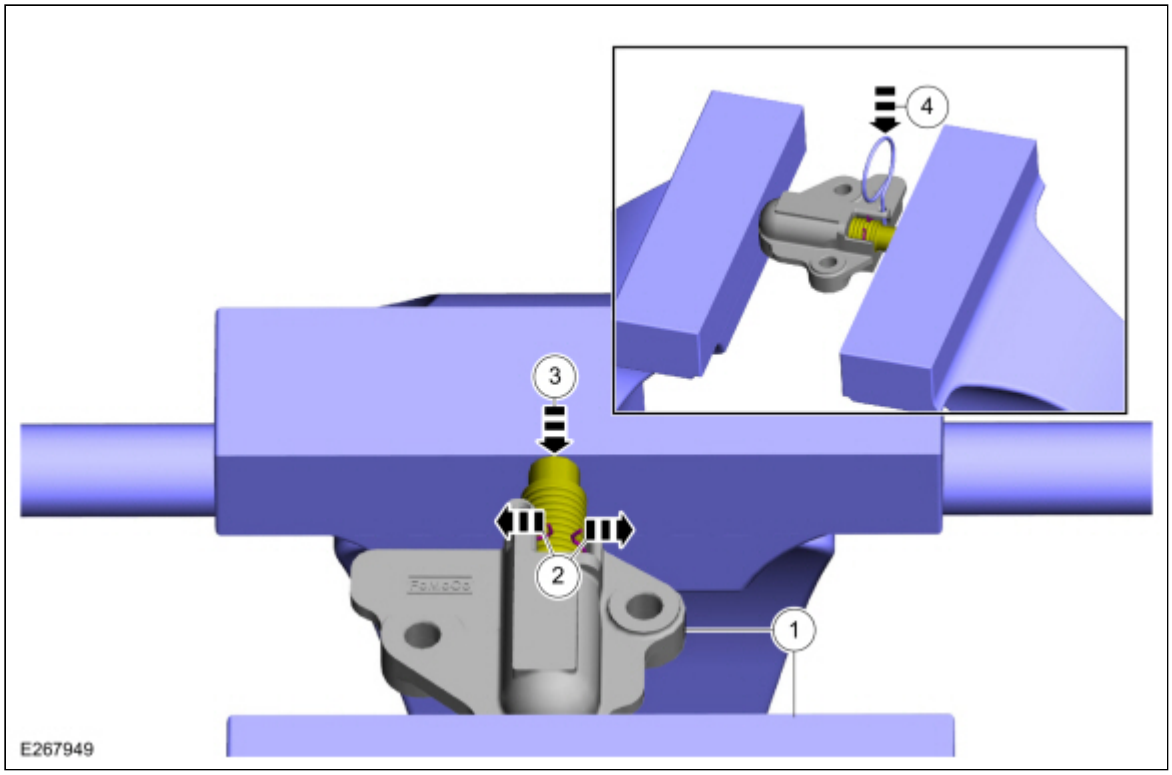
71. Install the tensioner arm, timing chain, timing chain guide and the bolts.
Torque: 89 lb.in (10 Nm)



NOTE: *If equipped with aluminum timing chain tensioner.*

NOTE: *If the timing chain tensioner plunger is not pinned in the compressed position, follow the next step.*

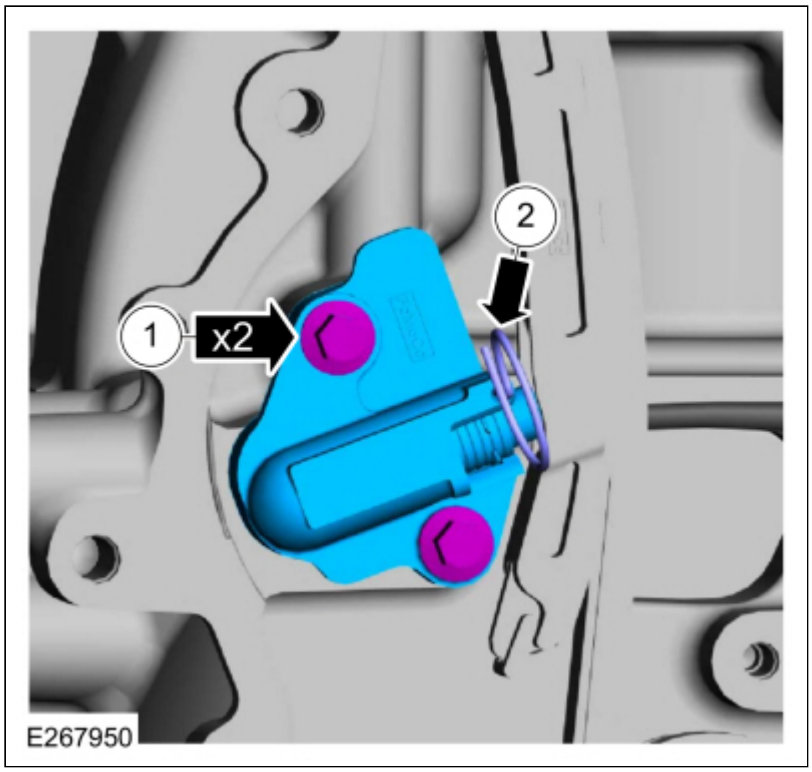
72. Reset the timing chain tensioner.
    1. Position the timing chain tensioner in a soft-jawed vise.
    2. Spread the ends of the ratchet wire clip apart.
    3. Using the soft-jawed vise, compress the plunger to the reset position.
    4. Install a locking pin in the 2 holes of the timing chain tensioner body to hold the plunger in place.



73. **NOTE:** *If equipped with aluminum timing chain tensioner.*

NOTE: *Do not remove the locking pin until the tensioner bolts are tightened.*

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

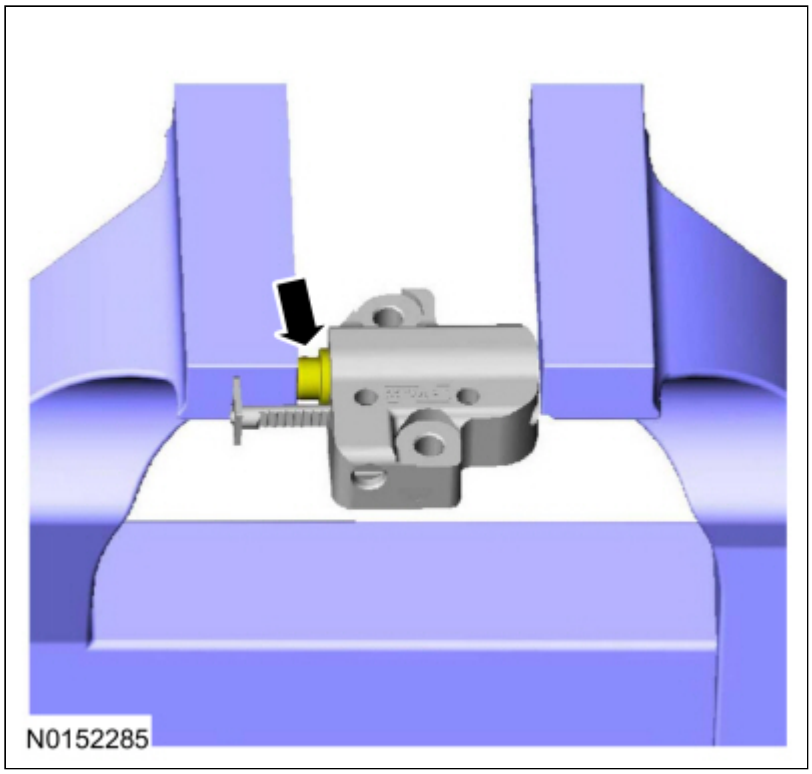


NOTE: *If equipped with cast iron timing chain tensioner.*

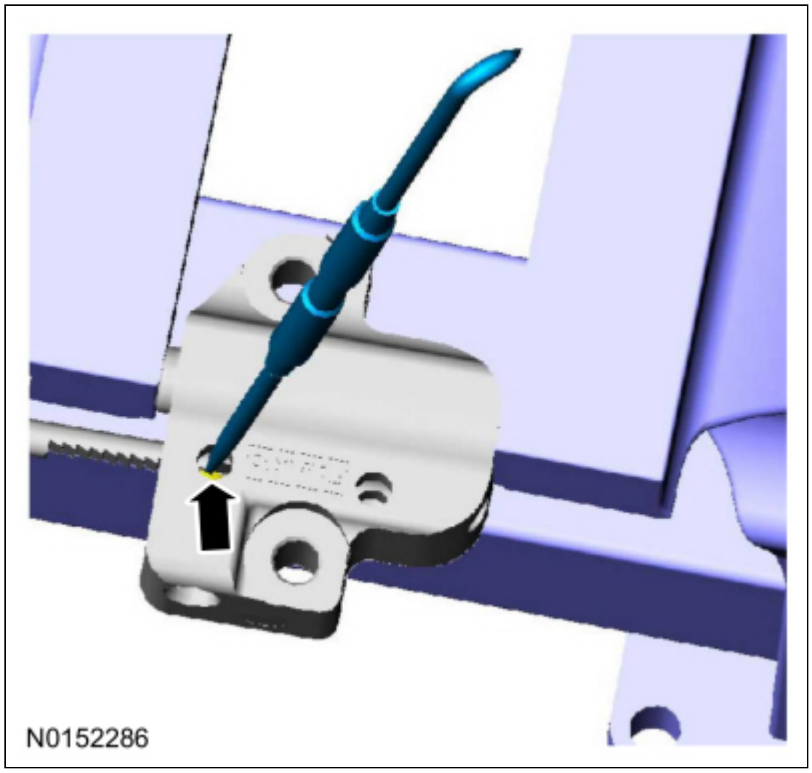
NOTE: *If the timing chain tensioner plunger and ratchet assembly are not pinned in the compressed position, follow the next 4 steps.*

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

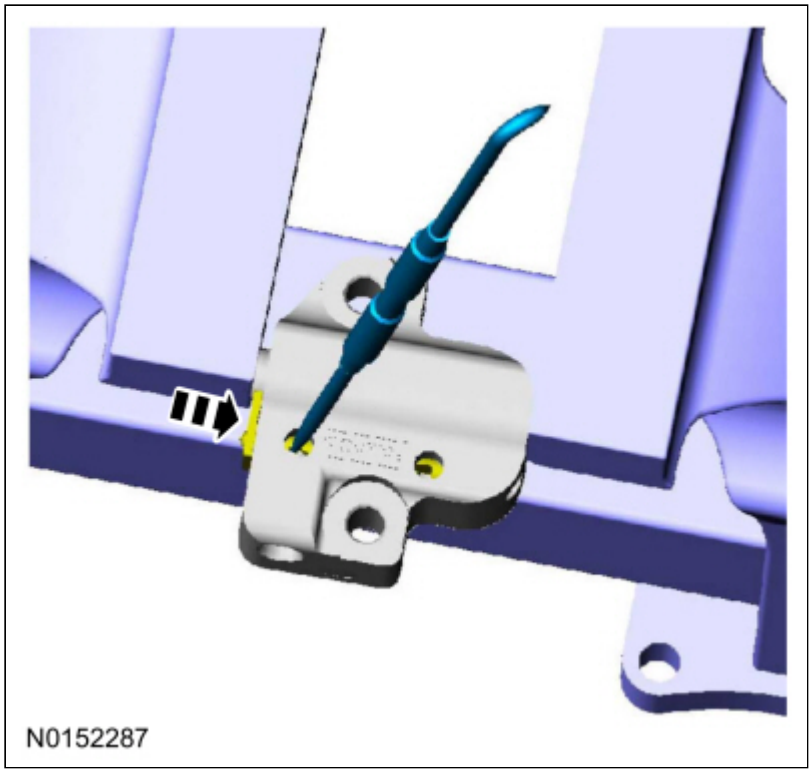
    Using the edge of a vise, compress the timing chain tensioner plunger.



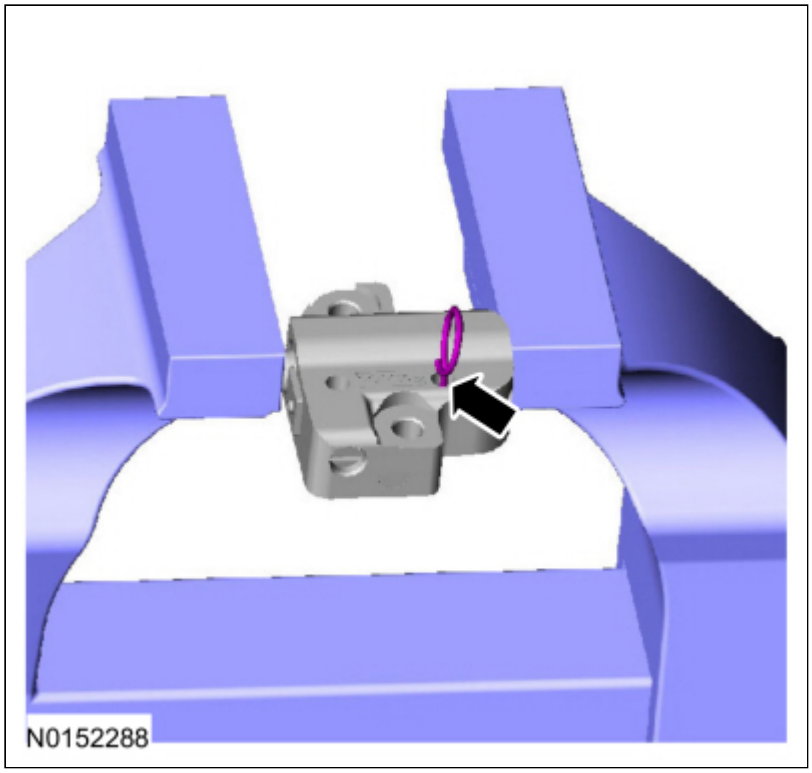
75. Using a small pick, push back and hold the ratchet mechanism.



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



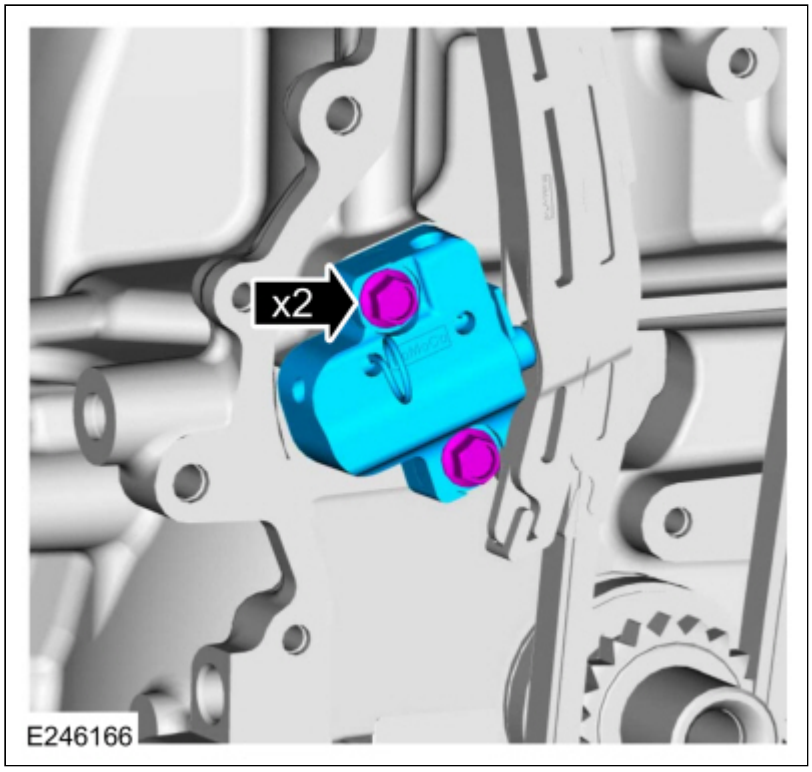
77. Install a locking pin into the hole in the tensioner housing to hold the ratchet assembly and the plunger in during installation.



78. **NOTE:** *If equipped with cast iron timing chain tensioner.*

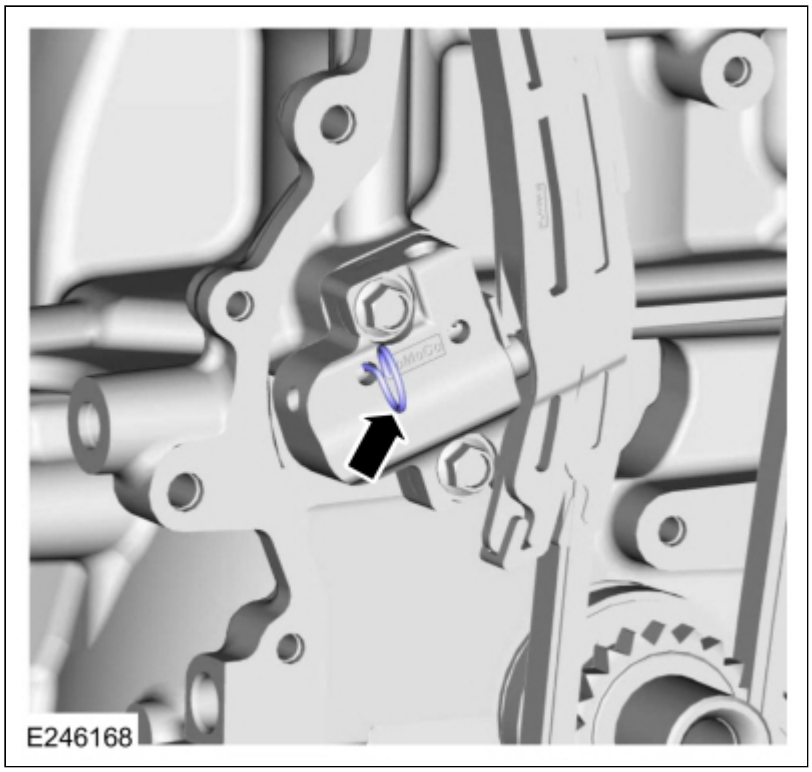
    NOTE: *Do not remove the locking pin until the tensioner bolts are tightened.*

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



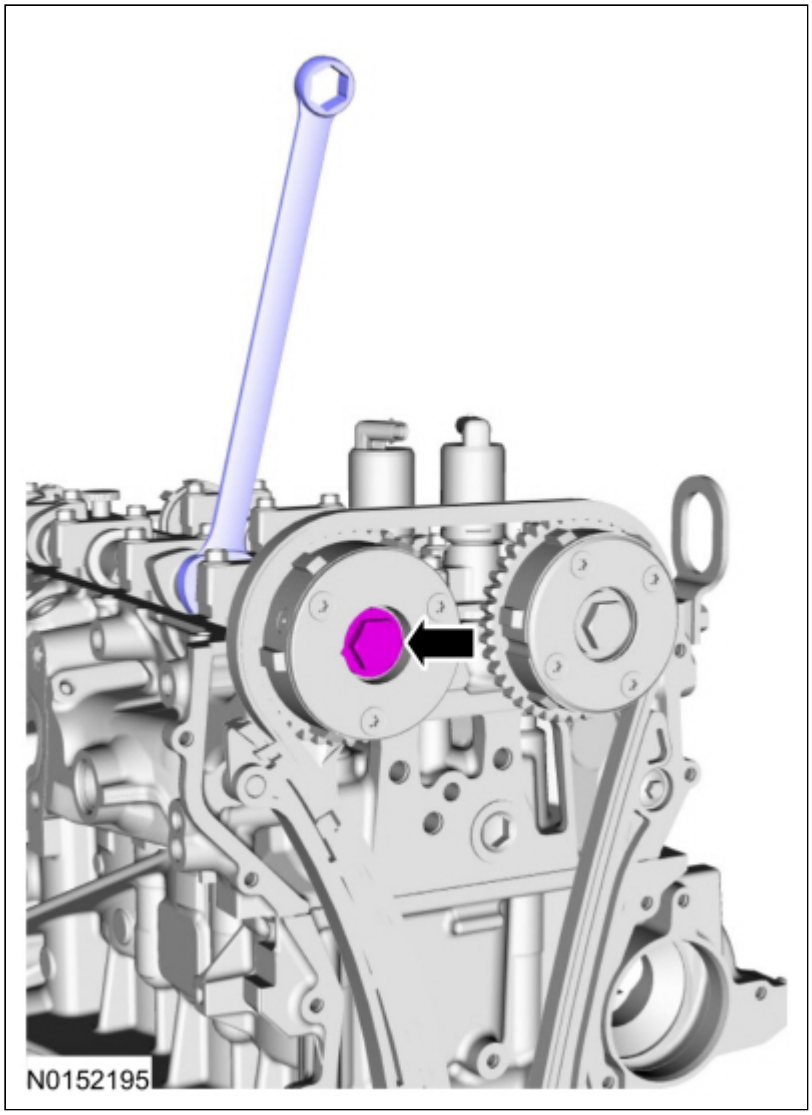
79. **NOTE:** *If equipped with cast iron timing chain tensioner.*

    Remove the locking pin.



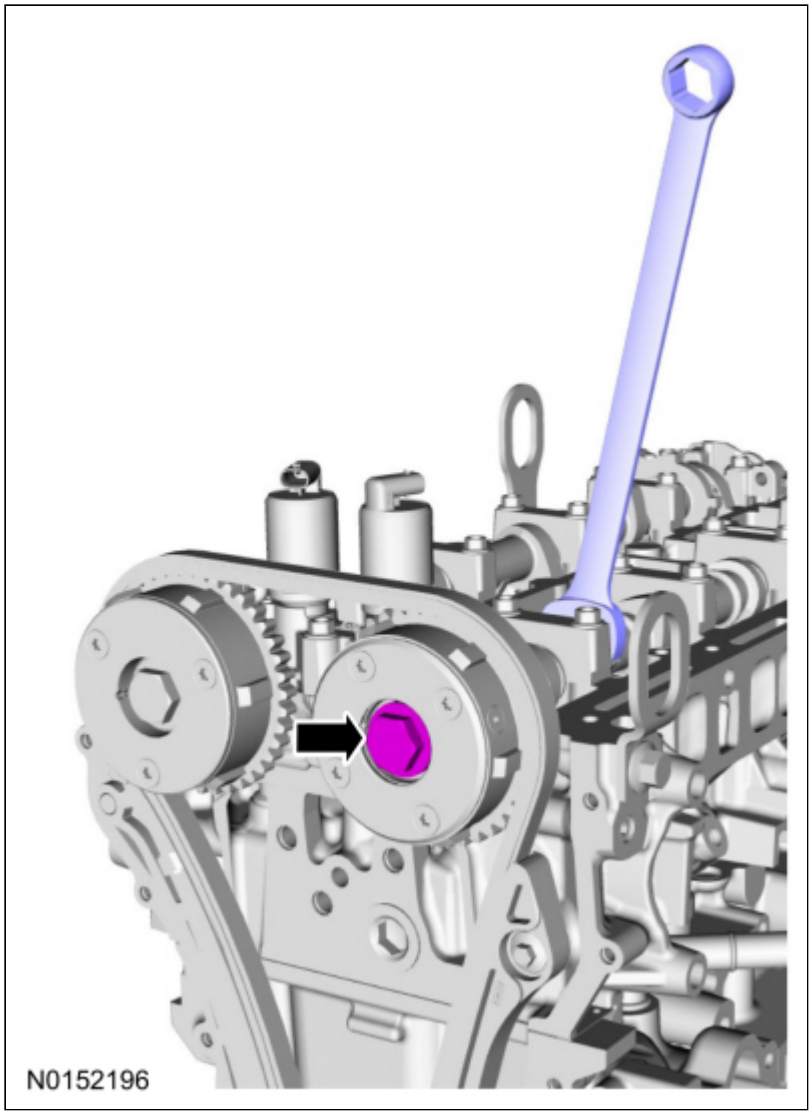
80. **NOTICE: Use an open-ended wrench to prevent the component from turning.**

    Tighten the exhaust VCT unit bolt in 2 stages.
    Torque:
    Stage 1: 30 lb.ft (40 Nm)
    Stage 2: 60°



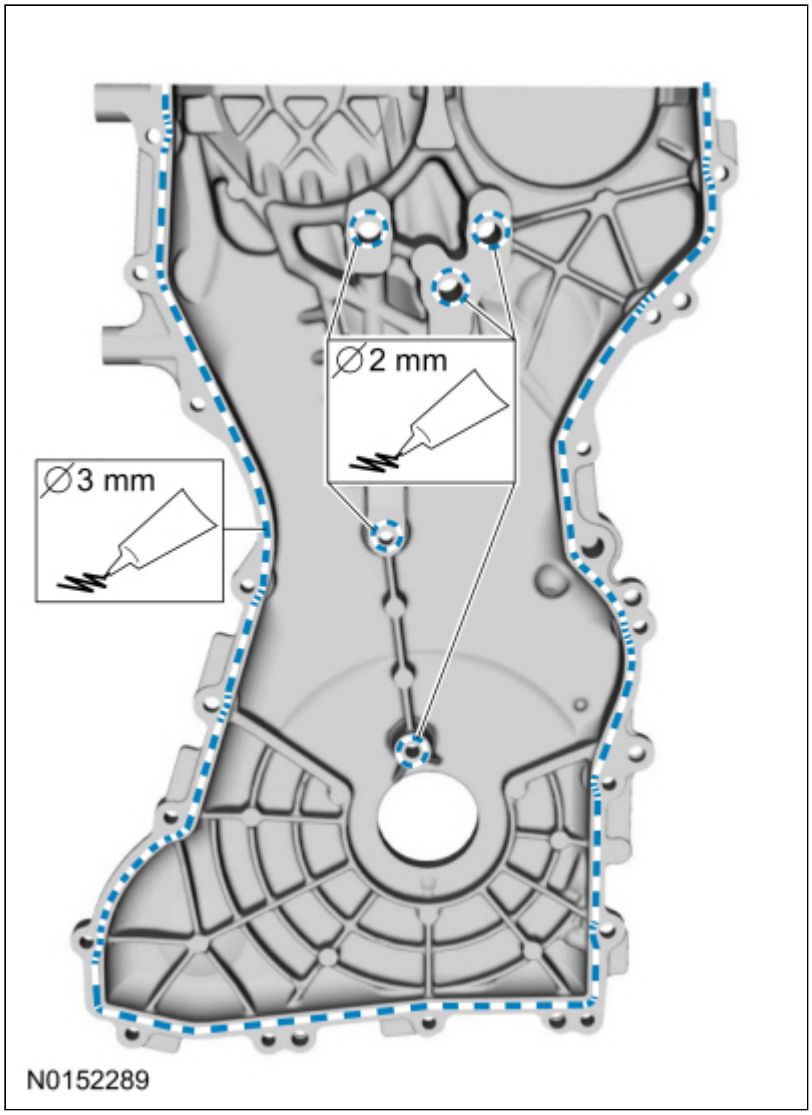
81. **NOTICE: Use an open-ended wrench to prevent the component from turning.**

Tighten the intake VCT unit bolt in 2 stages.
Torque:
Stage 1: 30 lb.ft (40 Nm)
Stage 2: 60°



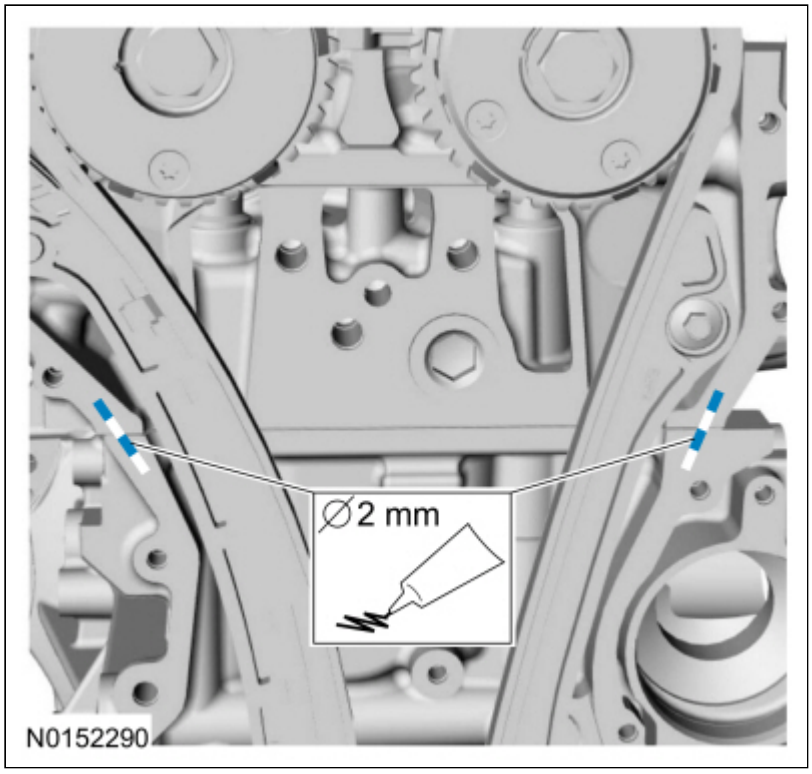
82. **NOTE:** *The engine front cover must be secured within 10 minutes of Silicone Gasket and Sealant application. If the engine front cover is not secured within 10 minutes, the silicone sealant must be removed and the sealing area cleaned with Motorcraft® Metal Surface Prep.*

    Apply silicone sealant.
    Material: Motorcraft® Silicone Gasket and Sealant / TA-30 (WSE-M4G323-A4)
    Material: Motorcraft® Metal Surface Prep Wipes / ZC-31-B

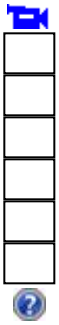


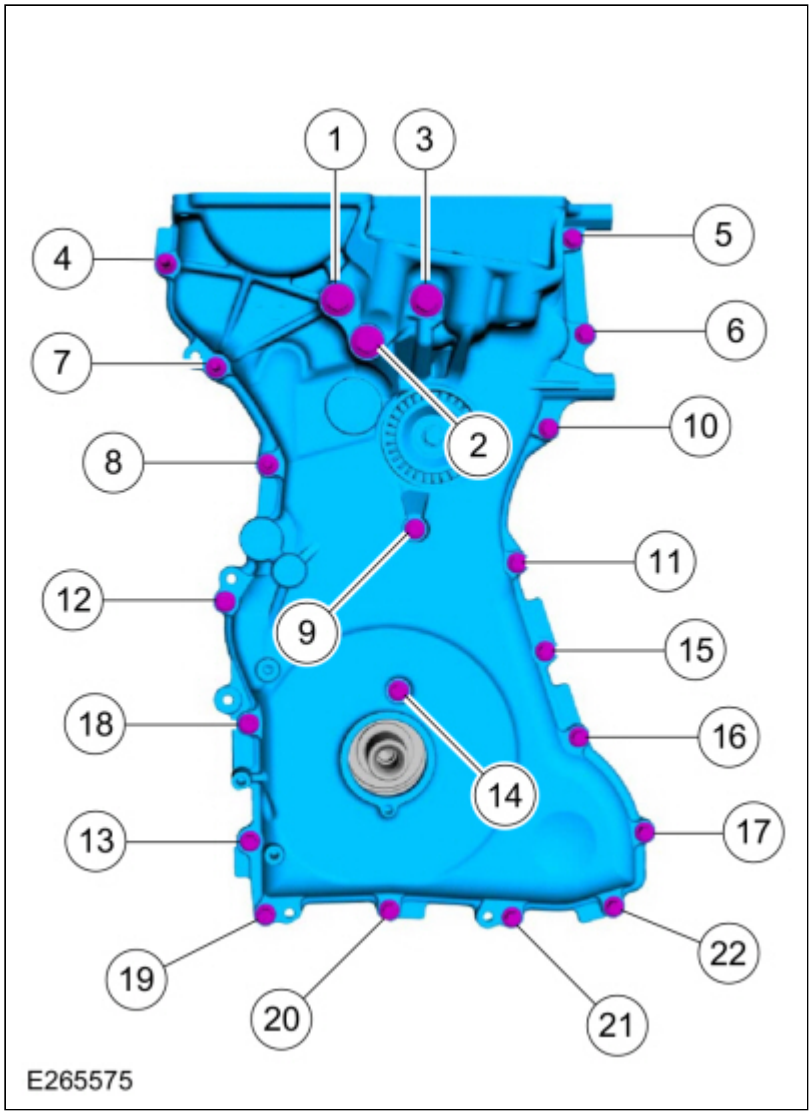
83. **NOTE:** *The engine front cover must be secured within 10 minutes of Silicone Gasket and Sealant application. If the engine front cover is not secured within 10 minutes, the silicone sealant must be removed and the sealing area cleaned with Motorcraft® Metal Surface Prep.*

    Apply beads of silicone sealant that are 2 mm (0.078 in) in diameter and 5 mm (0.19 in) in length across the cylinder head and cylinder block joint areas.
    Material: Motorcraft® Silicone Gasket and Sealant / TA-30 (WSE-M4G323-A4)
    Material: Motorcraft® Metal Surface Prep Wipes / ZC-31-B



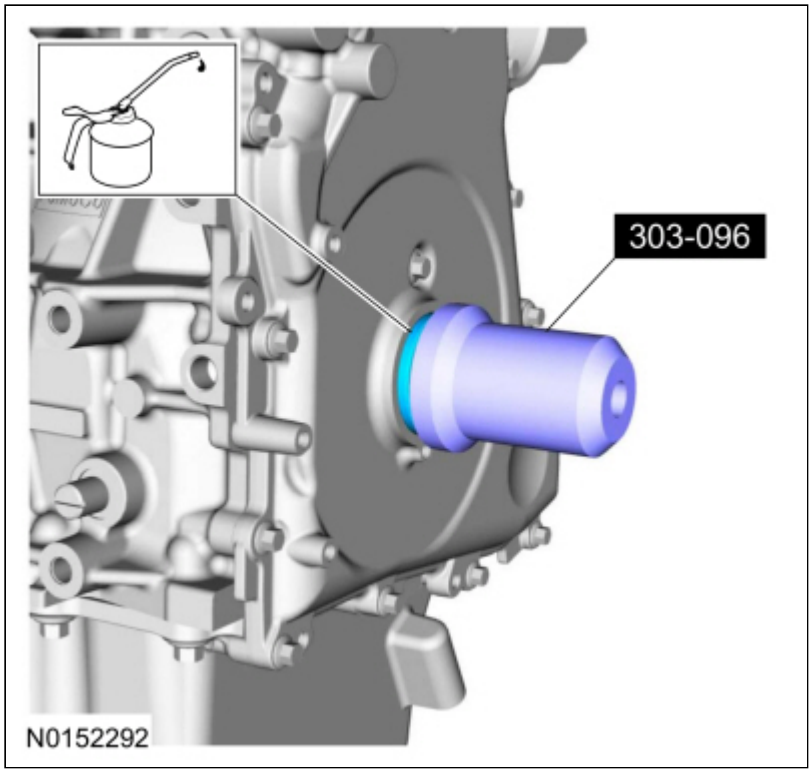
84. Install the engine front cover and the fasteners and tighten in the sequence shown.
Torque:
Bolts 1 - 3: 35 lb.ft (48 Nm)
Bolts 4 - 22: 89 lb.in (10 Nm)





85. **NOTE:** *Remove the through-bolt from the Camshaft Front Oil Seal Installer.*

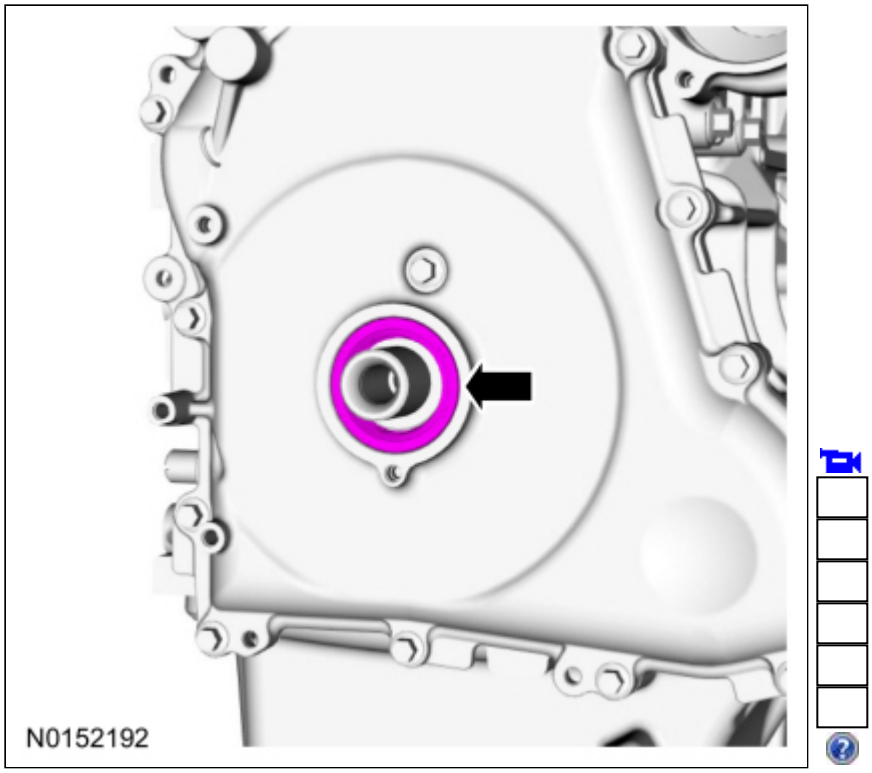
Lubricate with clean engine oil and using the special tool, install the crankshaft front seal.
Use Special Service Tool: 303-096 (T74P-6150-A) Installer, Camshaft Front Oil Seal.



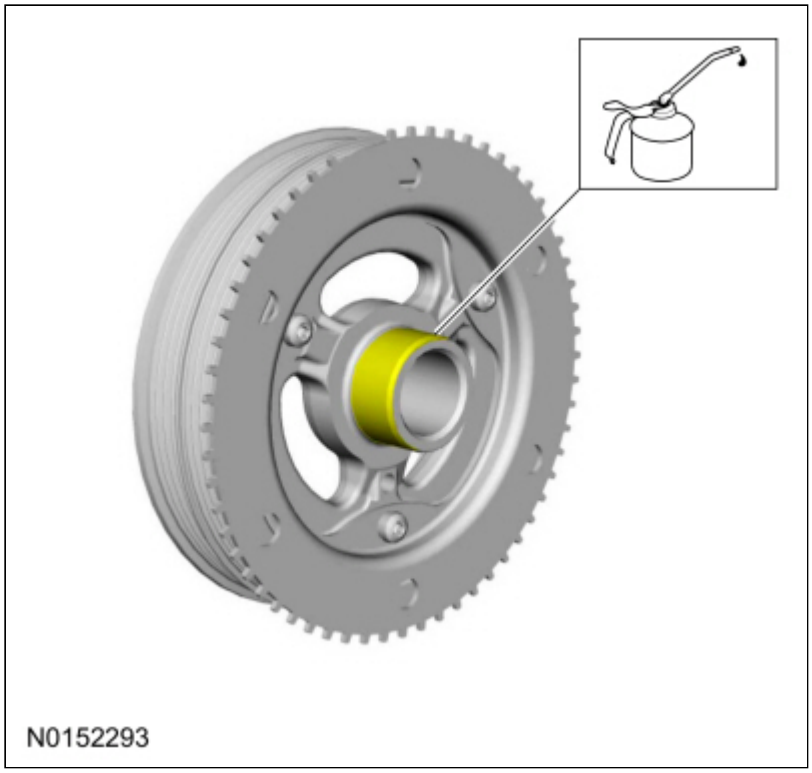
86. **NOTICE: If equipped, the diamond washer should be cleaned and inspected for any damage. If damage is evident, replace the diamond washer. If no damage, the diamond washer is to be reused. If the diamond washer is not installed, engine damage may occur.**

    NOTE: *Early build engines are equipped with a diamond washers on each side of the crankshaft sprocket. Late build engines have a laser etched crankshaft sprocket and do NOT require diamond washers. If an early build engine requires crankshaft sprocket replacement, discard the diamond washers and the sprocket and install a new laser etched sprocket (service part). Diamond washers should NEVER be installed with the laser etched sprocket.*

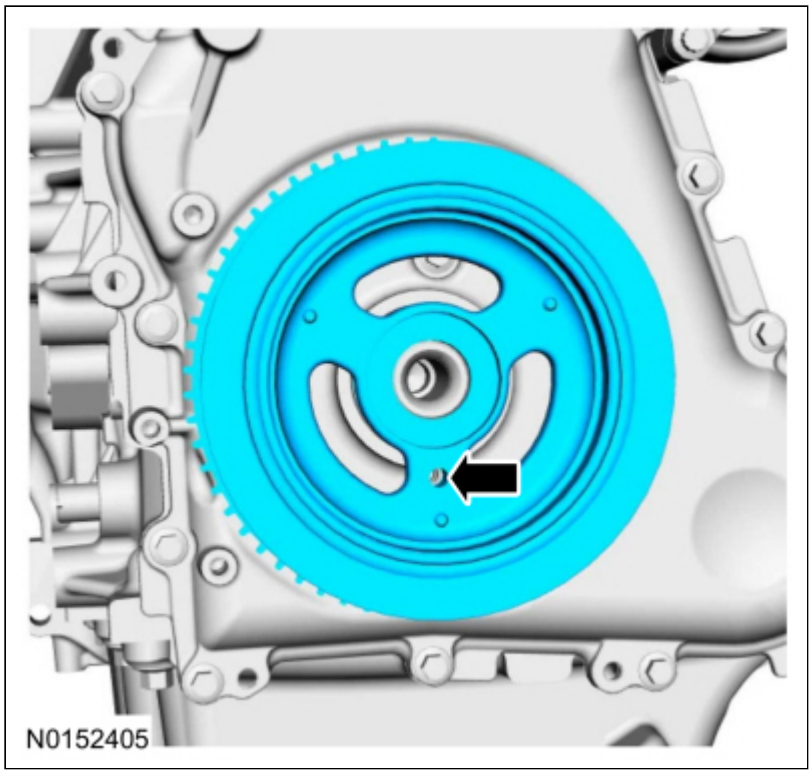
    If equipped, install the diamond washer onto the crankshaft.



87. Lubricate the crankshaft pulley with clean engine oil.

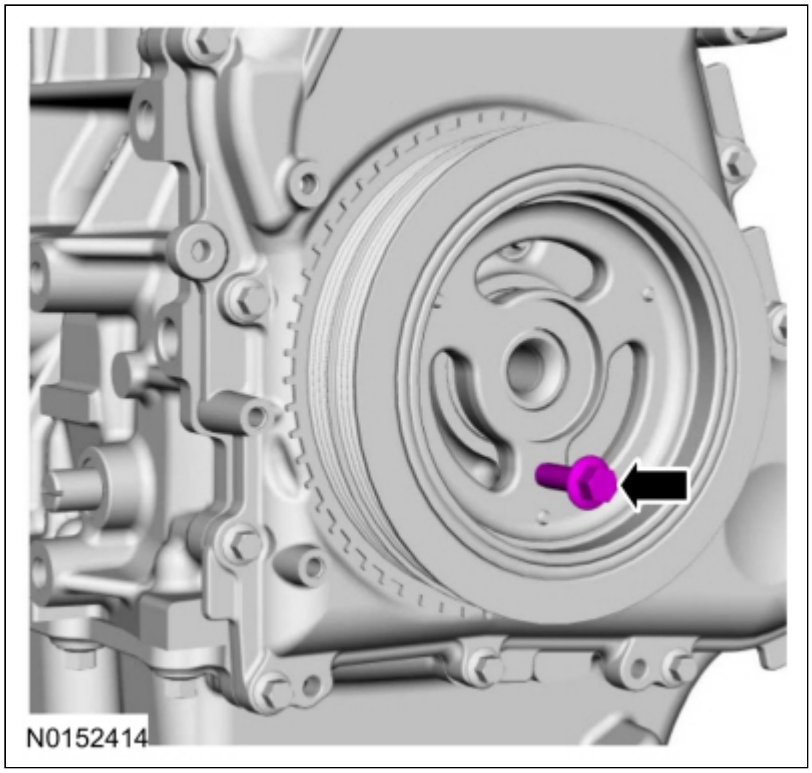


88. Install the crankshaft pulley.



89. **NOTE:** *This step will correctly align the crankshaft pulley to the crankshaft.*

Install an M6 bolt.

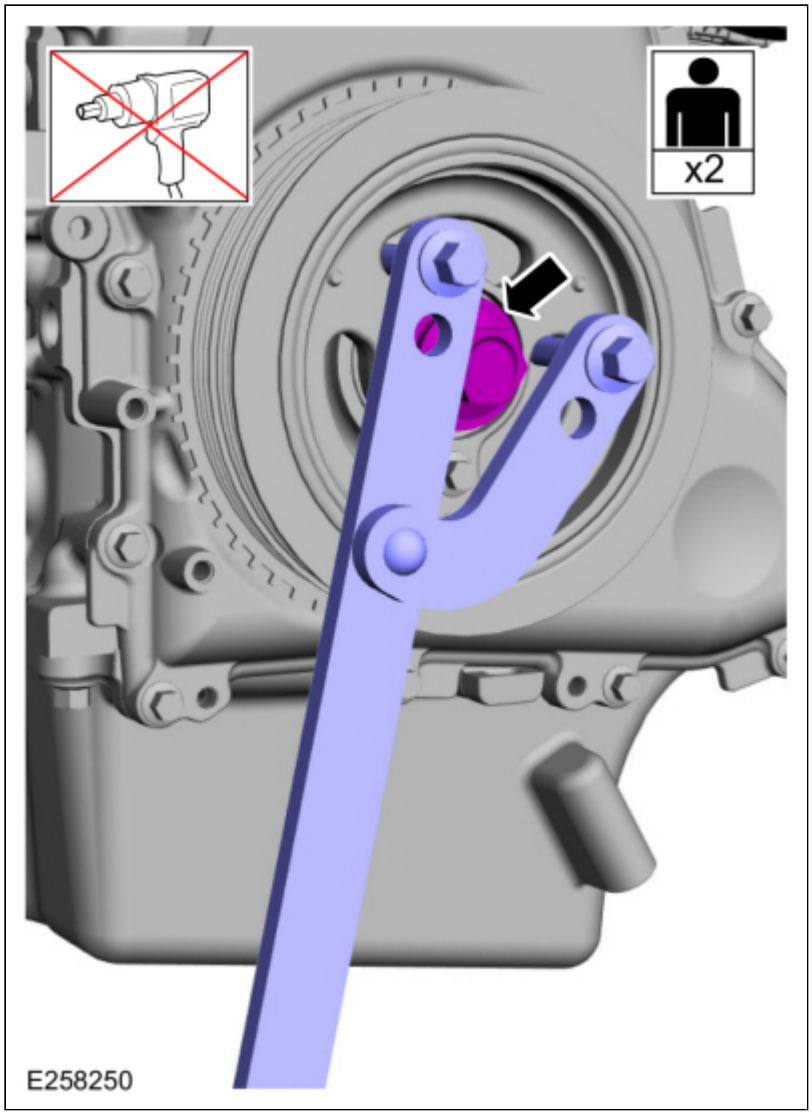


90. **NOTICE: The crankshaft must remain in the TDC position during installation of the pulley bolt or damage to the engine can occur. Therefore, the crankshaft pulley must be held in place with the pulley holder and the bolt should be installed using hand tools only.**

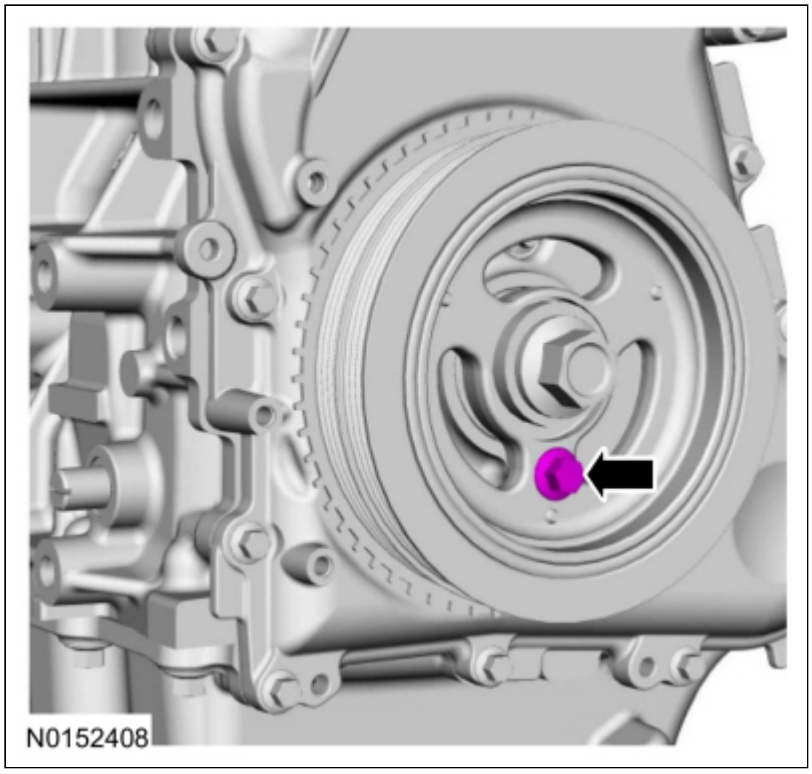
    NOTE: *Use a universal pulley holder (such as an OTC 4754, or equivalent).*

    NOTE: *A small amount of oil applied to the crankshaft bolt threads will ease the tightening process.*

    Install the crankshaft bolt and washer and tighten.
    Torque:
    Stage 1: 74 lb.ft (100 Nm)
    Stage 2: 180°

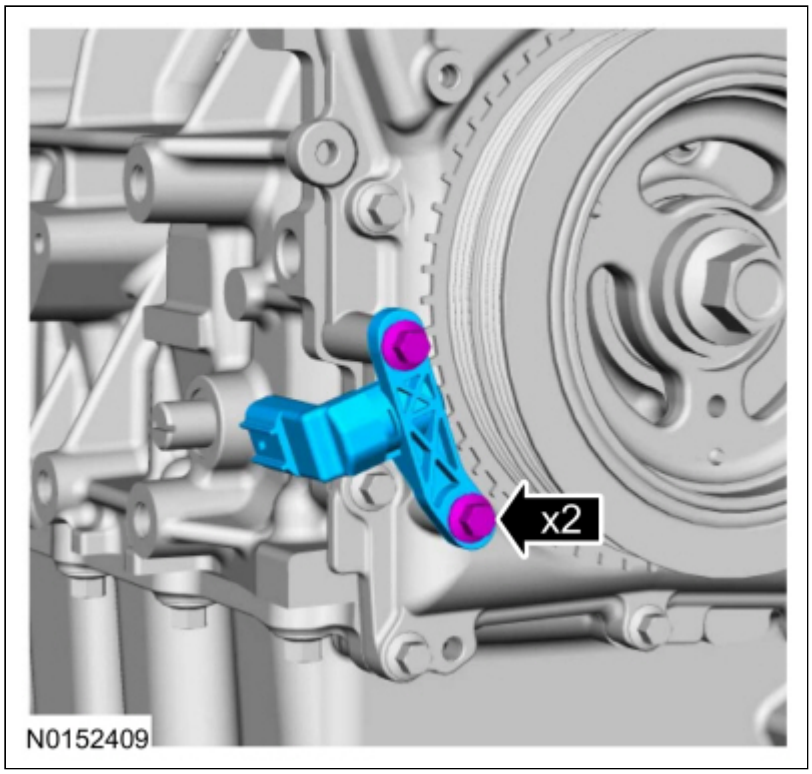


91. Remove the M6 bolt.

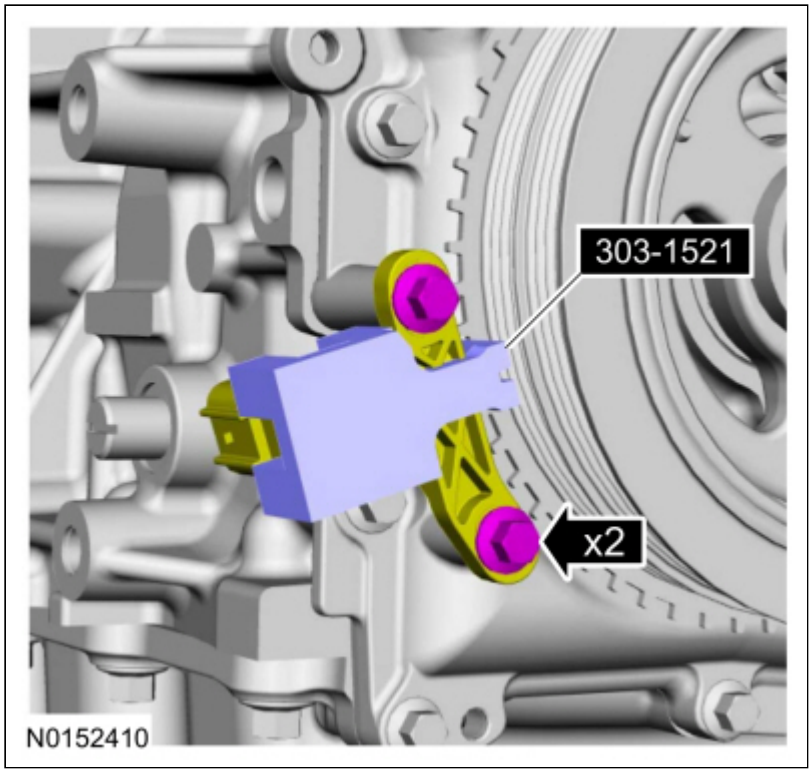


92. **NOTE:** *Do not tighten the CKP sensor bolts at this time.*

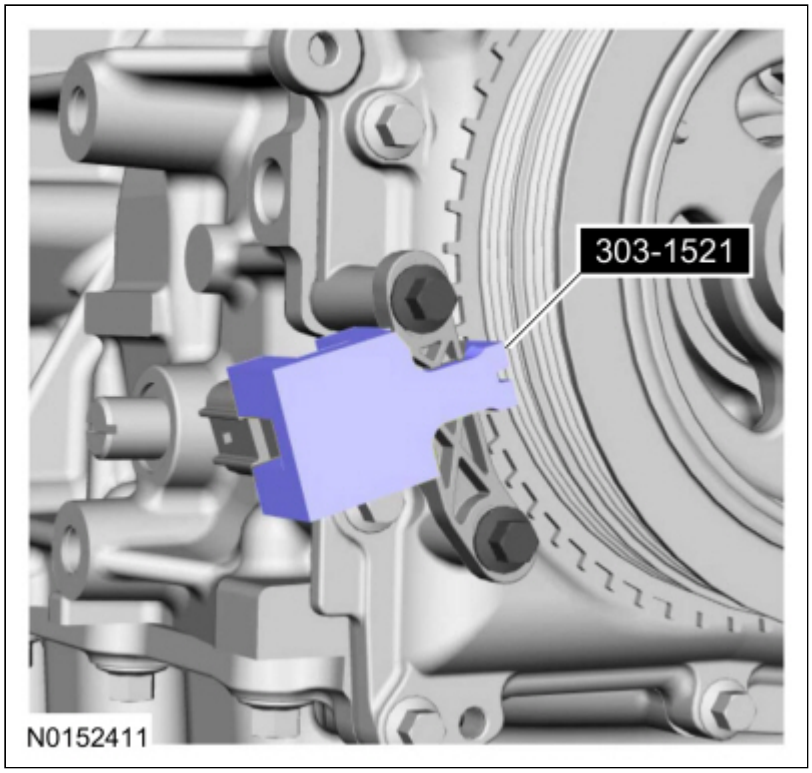
    Install the CKP sensor and the bolts finger-tight.



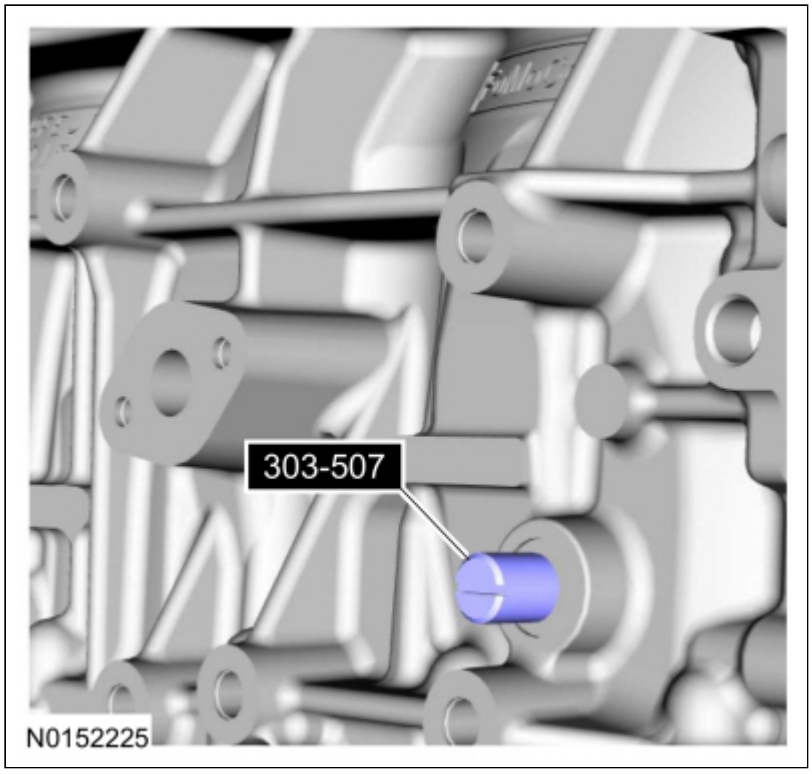
93. Install the Special Tool onto the CKP sensor and the tooth of the crankshaft pulley trigger wheel.
    Use Special Service Tool: 303-1521 Alignment Tool, Crankshaft Position Sensor.
    Torque: 62 lb.in (7 Nm)



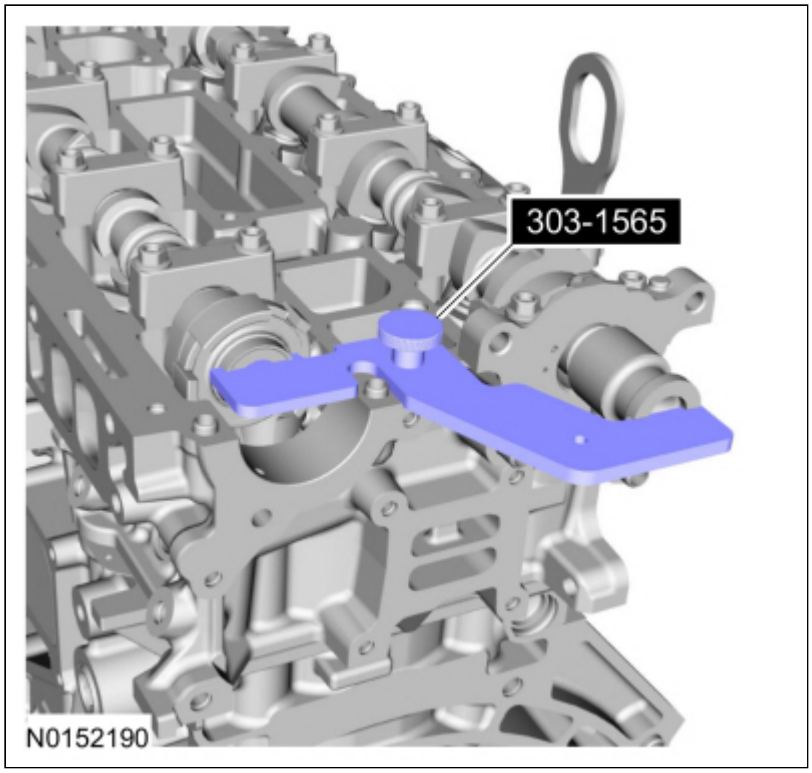
94. Remove Special Service Tool: 303-1521 Alignment Tool, Crankshaft Position Sensor.



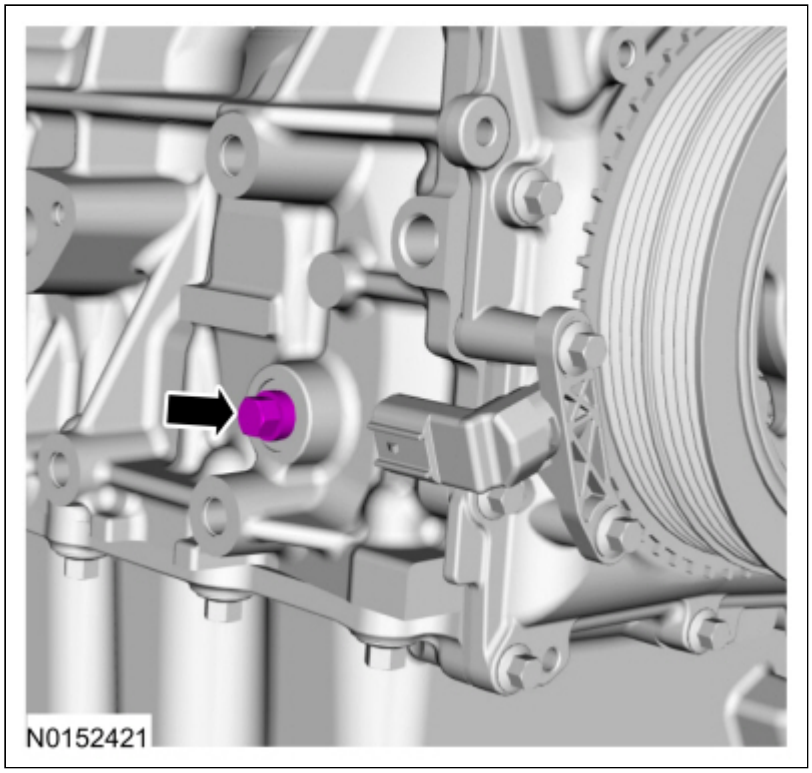
95. Remove Special Service Tool: 303-507 Timing Peg, Crankshaft TDC.



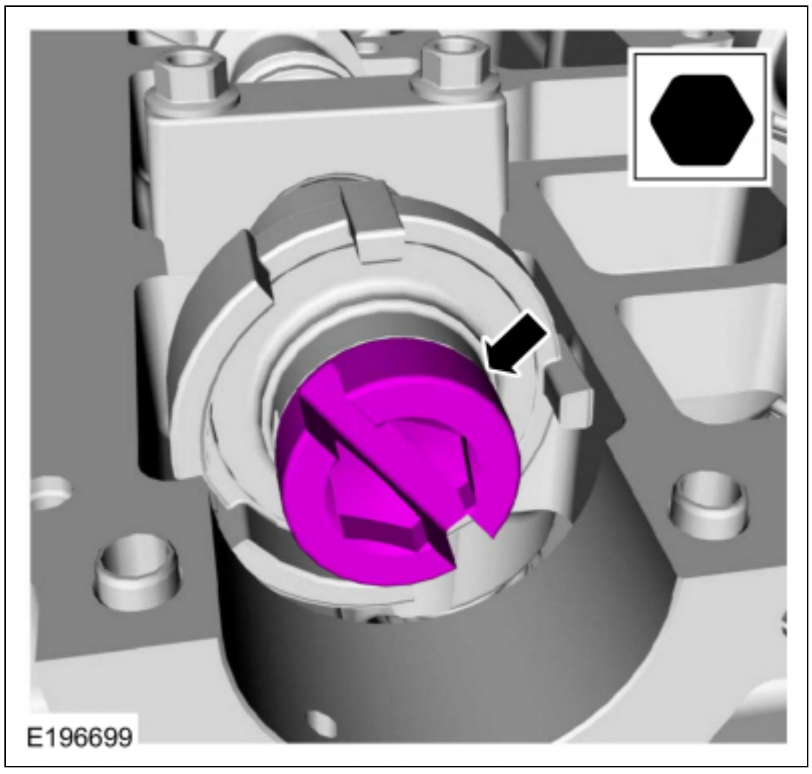
96. Remove Special Service Tool: 303-1565 Alignment Tool, Camshaft.



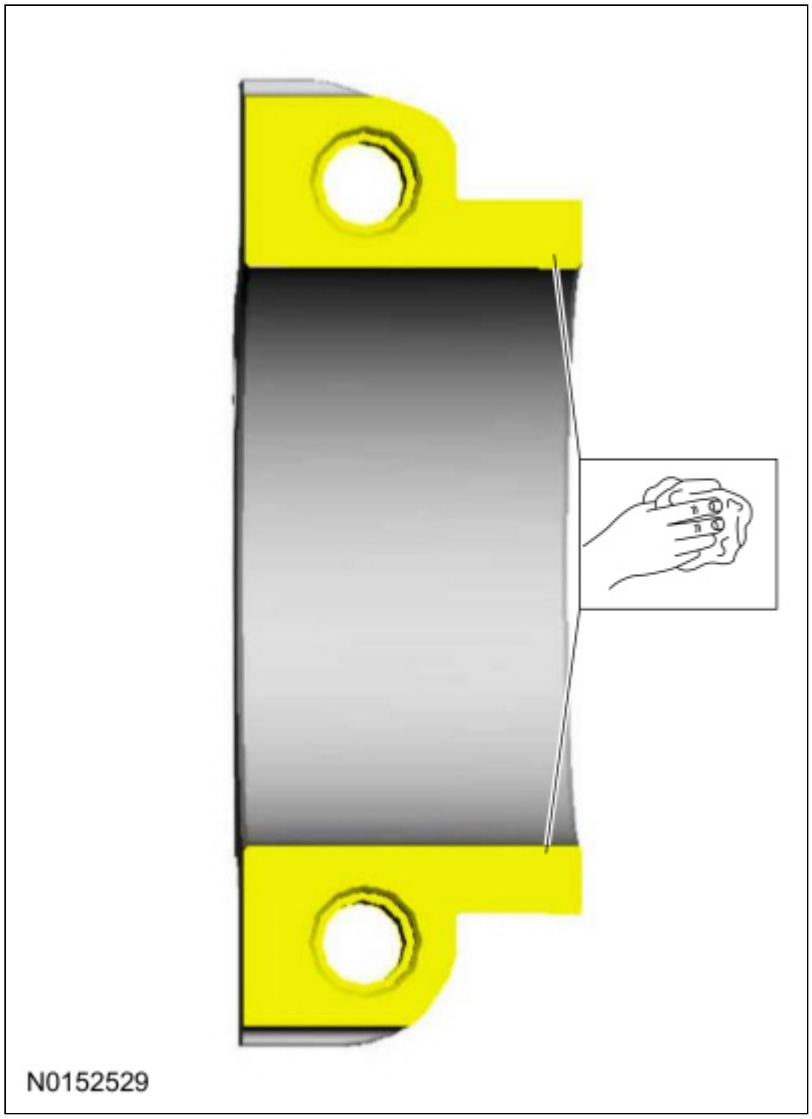
97. Install the engine plug bolt.
Torque: 177 lb.in (20 Nm)



98. Using a wrench on the flats of the intake camshaft to prevent cam rotation, install the camshaft drive adapter.
Torque: 46 lb.ft (63 Nm)

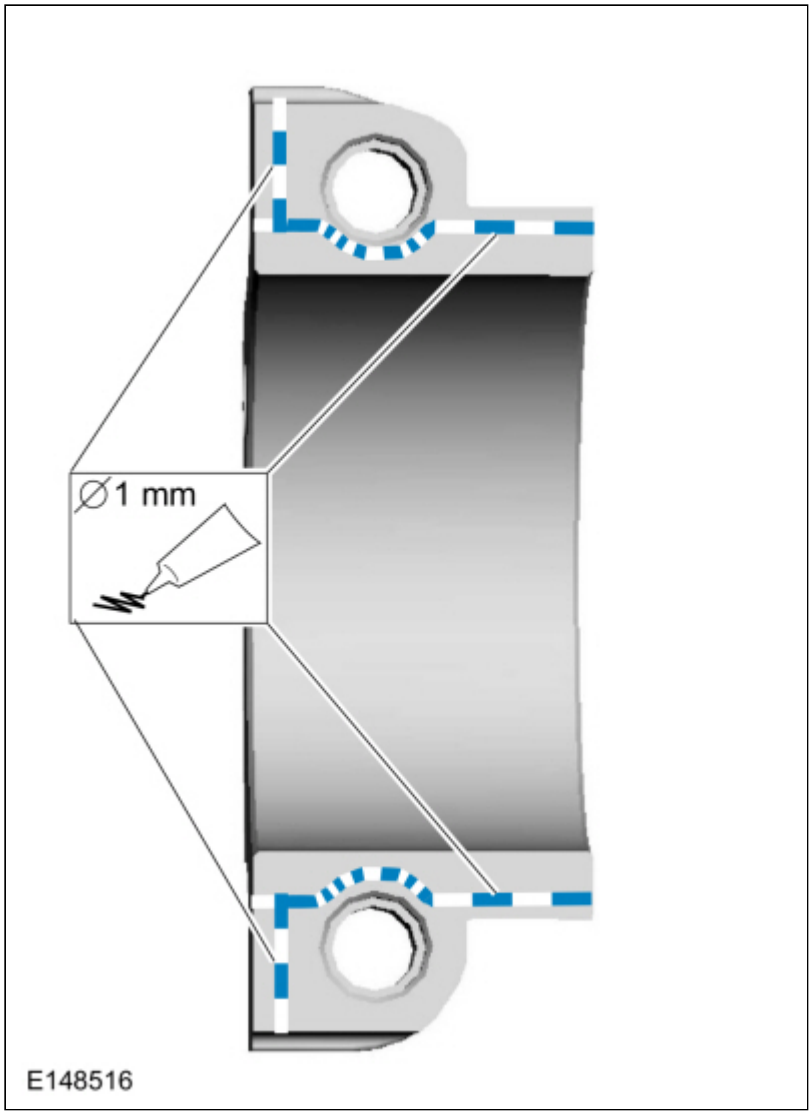


99. Clean the camshaft rear bearing cap.
Material: Motorcraft® Metal Surface Prep Wipes / ZC-31-B



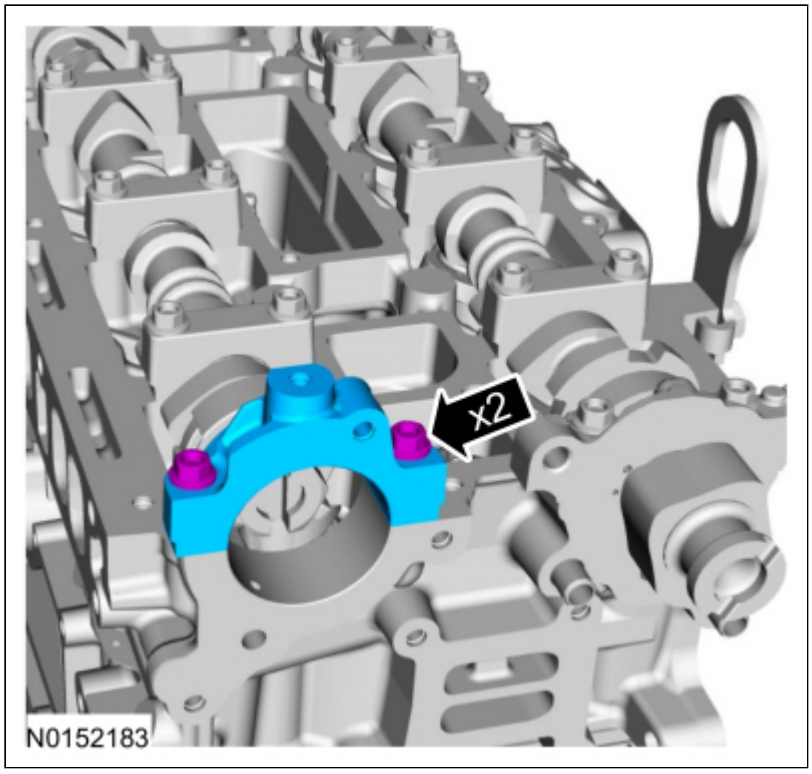
100. **NOTE:** *The intake camshaft rear bearing cap must be secured within 10 minutes of gasket maker application. If the bearing cap is not secured within 10 minutes, the gasket maker must be removed and the sealing area cleaned with Motorcraft® Metal Surface Prep.*

    Apply a 1 mm bead of gasket maker.
    Material: Motorcraft® Gasket Maker / TA-16 (WSK-M2G348-A5)
    Material: Motorcraft® Metal Surface Prep Wipes / ZC-31-B



101. **NOTICE: Wipe off any excess gasket maker from the vacuum pump sealing surface of the cylinder head and camshaft cap.**

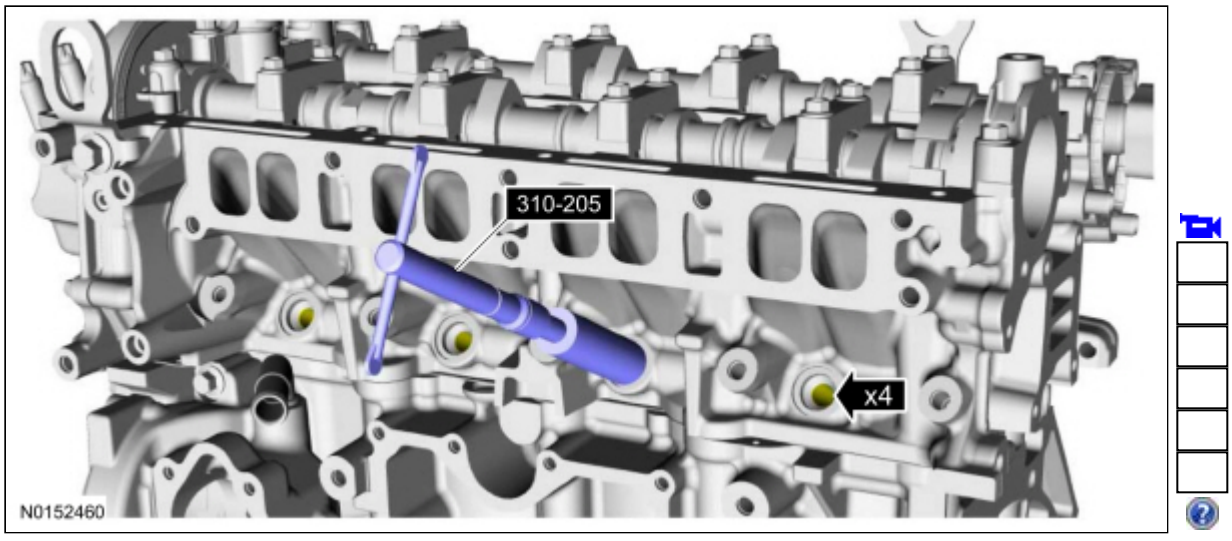
Install camshaft rear bearing cap and the bolts.
Torque:
Stage 1: 62 lb.in (7 Nm)
Stage 2: 142 lb.in (16 Nm)



102. **NOTICE: Do not use compressed air or the Fuel Injector Brush to clean the tip of the fuel injectors. Failure to follow this instruction may result in damage to the fuel injectors.**

    NOTE: *Make sure to thoroughly clean any residual fuel or foreign material from the cylinder head, block and the general surrounding area of the fuel rails and injectors.*

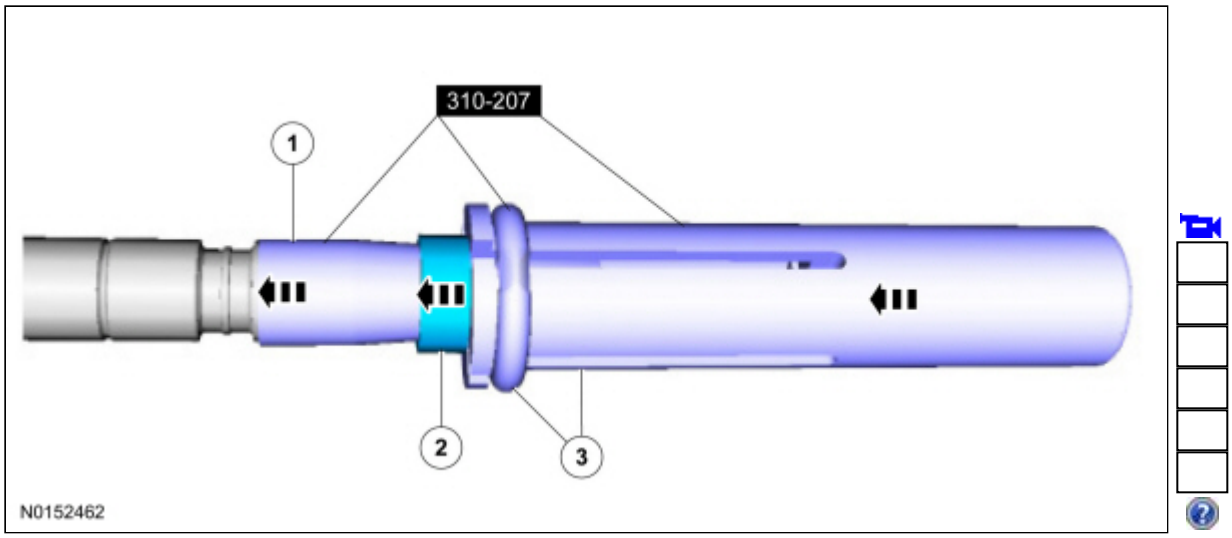
    Using the special tool, clean the fuel injector bores.
    Use Special Service Tool: 310-205 Fuel Injector Brush.



103. **NOTICE: Do not lubricate the new lower Teflon® fuel injector seals.**

    1. Use Special Service Tool: 310-207 Installer, Fuel Injector Seal Assembly.
    2. **NOTICE: Once the Teflon® seal is installed on the Teflon® Seal Guide, it should immediately be installed onto the fuel injector to avoid excessive expansion of the Teflon® seal.**

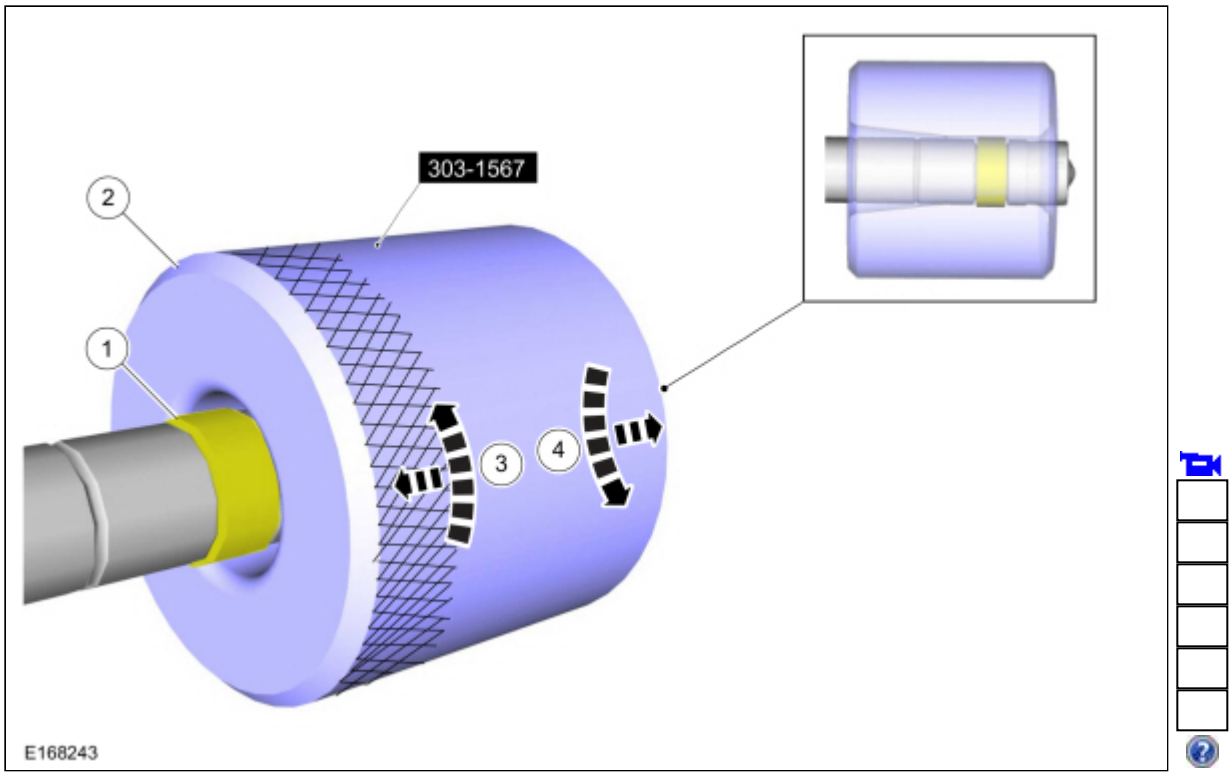
       Make sure that new lower fuel injector Teflon® seals are installed.
       Use Special Service Tool: 310-207 Installer, Fuel Injector Seal Assembly.
    3. Using the special tool, slide the Teflon® seals off of the Teflon® Seal Guide and into the groove on the fuel injectors.



104. **NOTICE: Install the fuel injectors into the cylinder head within 15 minutes of sizing the seals due to Teflon® seal expansion.**

    NOTE: *Make sure the Teflon® seal is fully seated in the groove on the fuel injector before sizing the Teflon® seal.*

    1. Some massaging of the Teflon® seal with your fingers before the special tool is installed will aid in installing the special tool.
    2. Position the Teflon® seal sizer tool with the larger opening towards the Teflon® seal. Push while turning the Teflon® seal sizer tool 180 degrees.
       Use Special Service Tool: 303-1567 Sizer, Teflon Seal.
    3. Once the special tool is installed, check and make sure the Teflon® seal is in the sizing portion of the special tool. After one minute, turn the special tool back 180 degrees and remove.

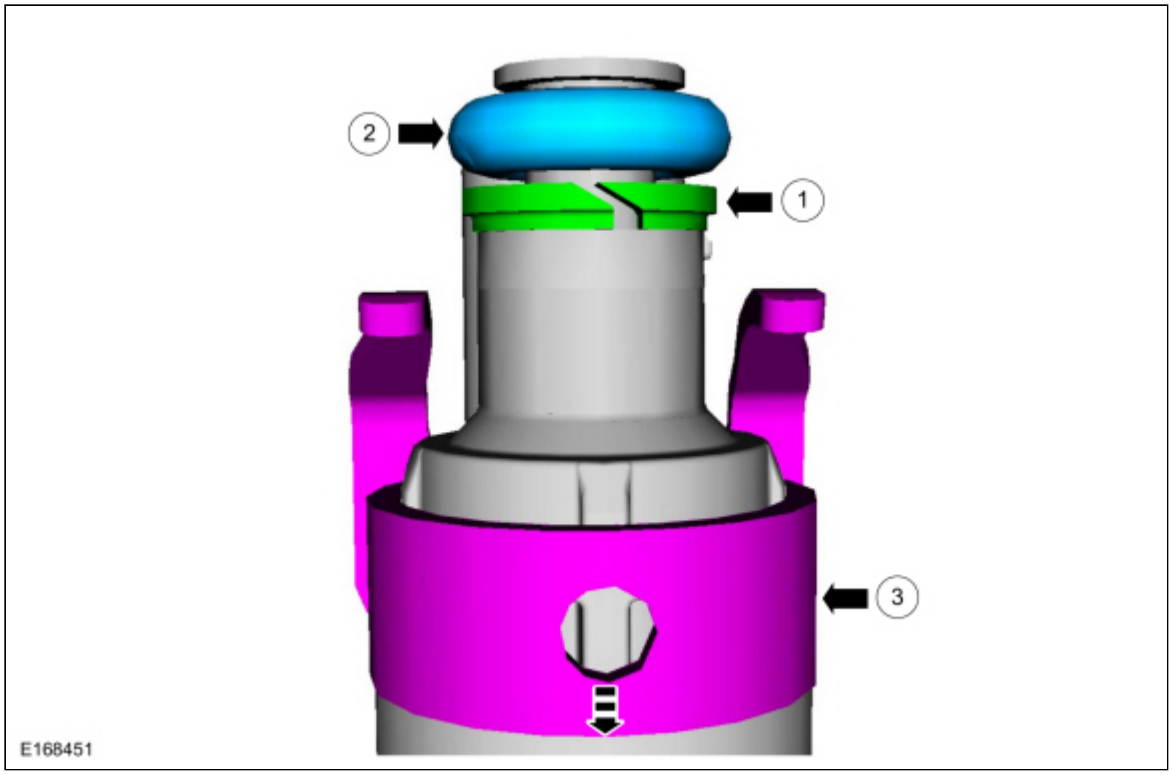


105. **NOTICE: Use fuel injector O-ring seals that are made of special fuel-resistant material. The use of ordinary O-ring seals may cause the fuel system to leak. Do not reuse the O-ring seals.**

    NOTE: *Do not lubricate the new lower Teflon® fuel injector seals.*

    1. Install the fuel injector seal.
    2. Lubricate with clean engine oil and install the fuel injector O-ring seal.

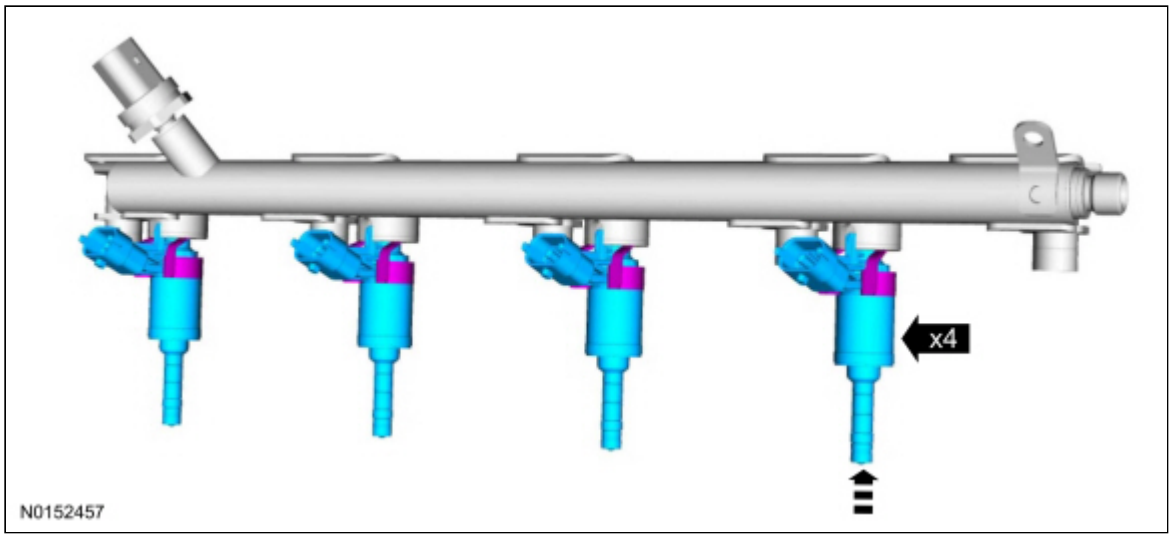
3. Install the fuel injector seal



106. **NOTICE: The FRP sensor must be replaced if it is removed from the fuel rail.**

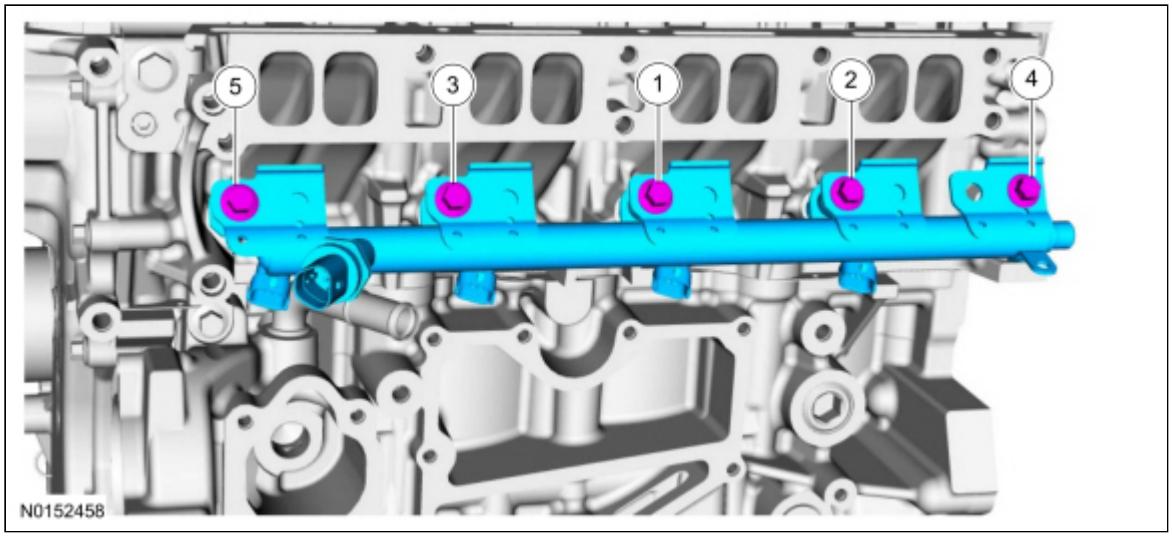
NOTE: *The anti-rotation finger of the fuel injector clip must slip into the groove of the fuel rail cup.*

Install the fuel injectors in the fuel rail.



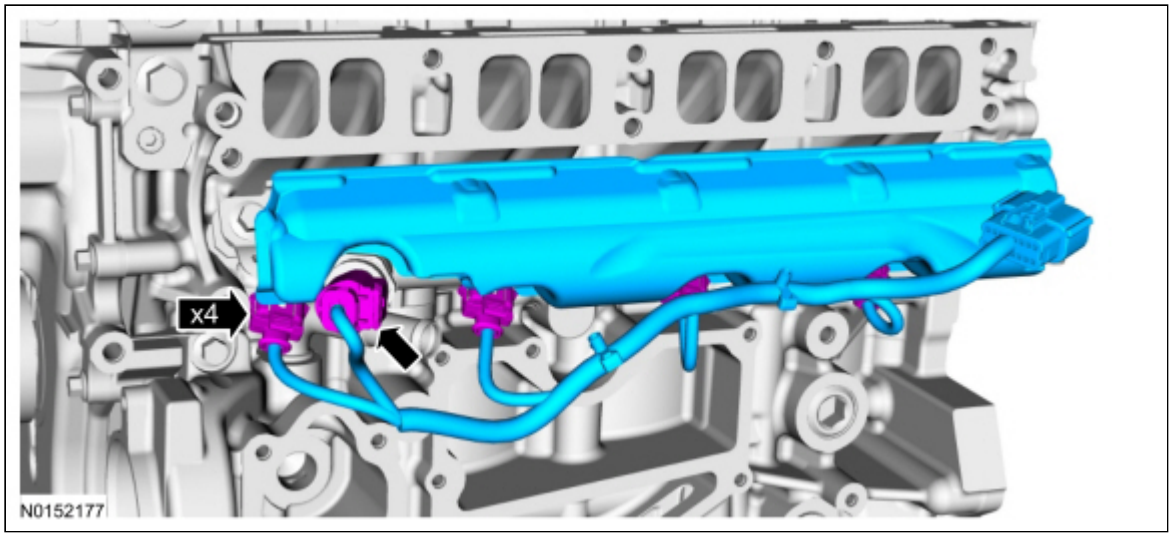
107. **NOTE:** *Do not lubricate the new lower Teflon® fuel injector seals.*

- Install the fuel rail by push down on the fuel rail above the injectors.
- Install the bolts and tighten in sequence shown in 2 stages.
  Torque:
  Stage 1: 71 lb.in (8 Nm)
  Stage 2: 26°

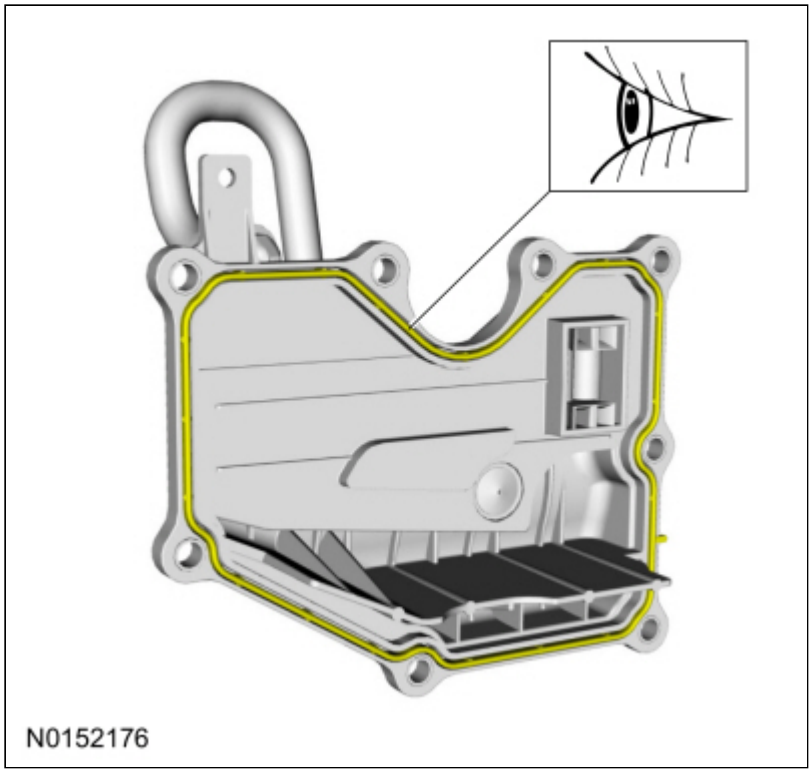


108.

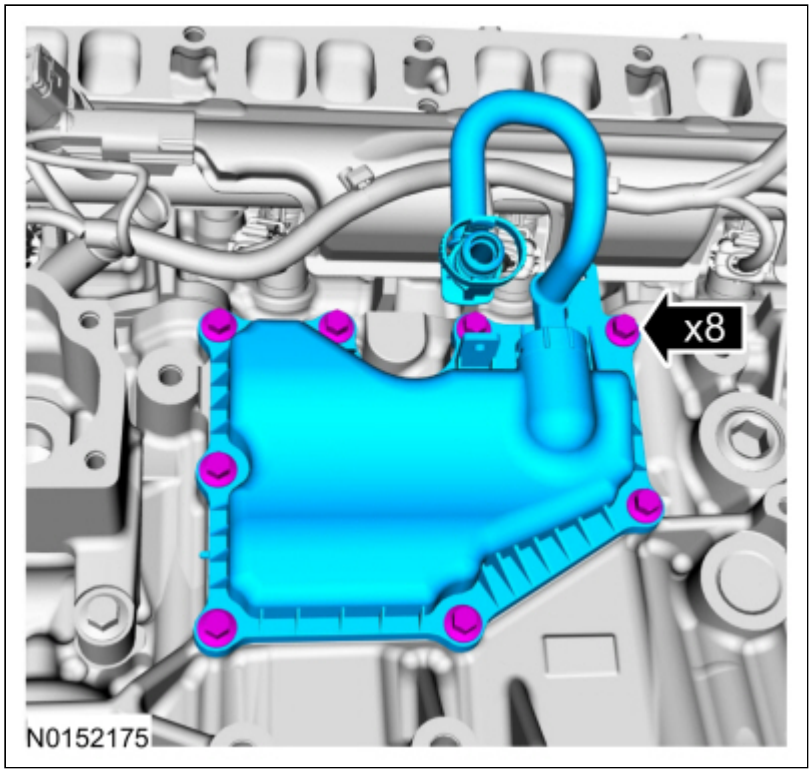
- Connect the fuel rail electrical connectors.
- Install the fuel rail shield.



109. Inspect and replace the crankcase vent separator gasket, if damaged.



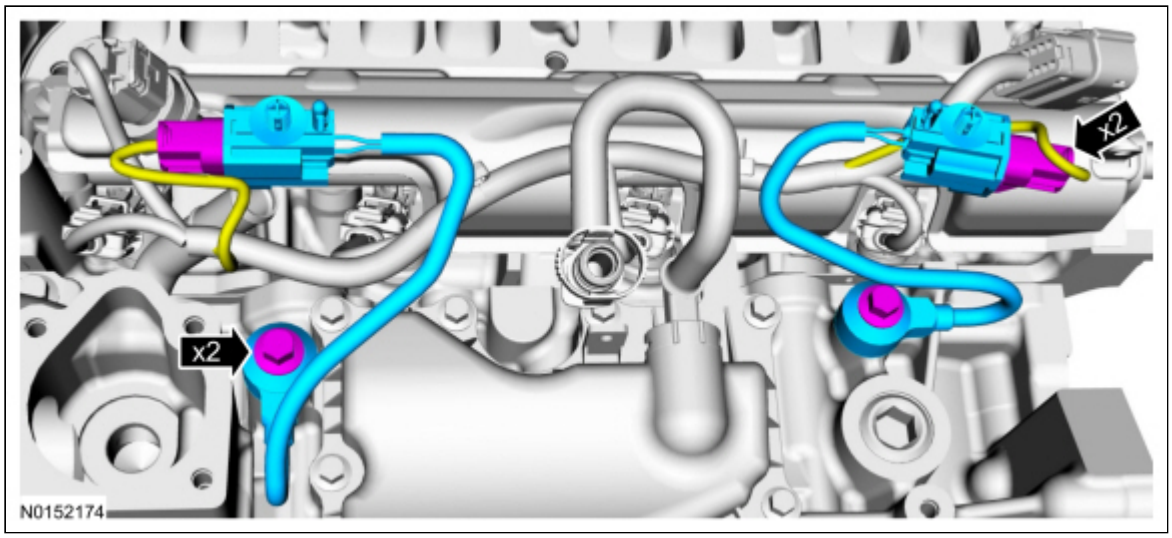
110. Install the crankcase vent separator and the bolts.
Torque: 89 lb.in (10 Nm)



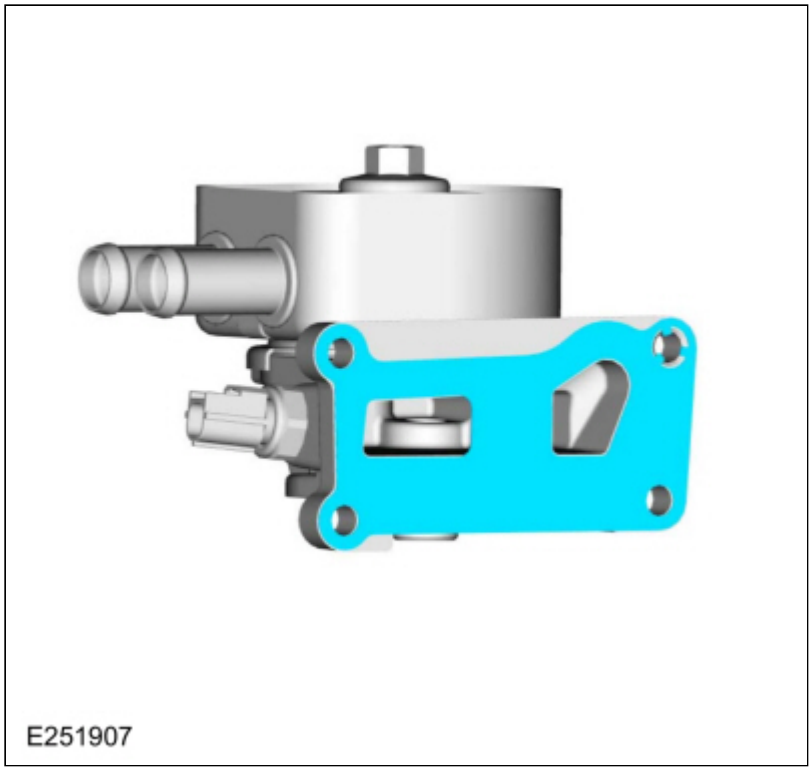
111.

- **NOTICE: The forward KS must be installed in the 6 o'clock position and the rearward KS must be installed in the 3 o'clock position as shown in the graphic. Failure to follow these instructions may result in damage to the engine.**

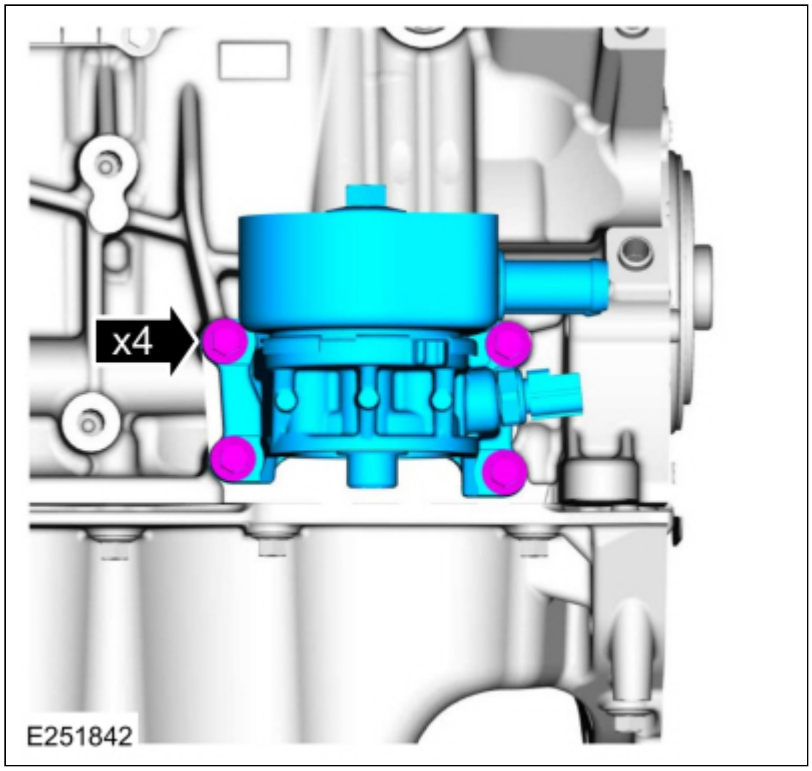
  Install the KS in their original position and install the bolts.
  Torque: 177 lb.in (20 Nm)
- Connect the KS electrical connectors.



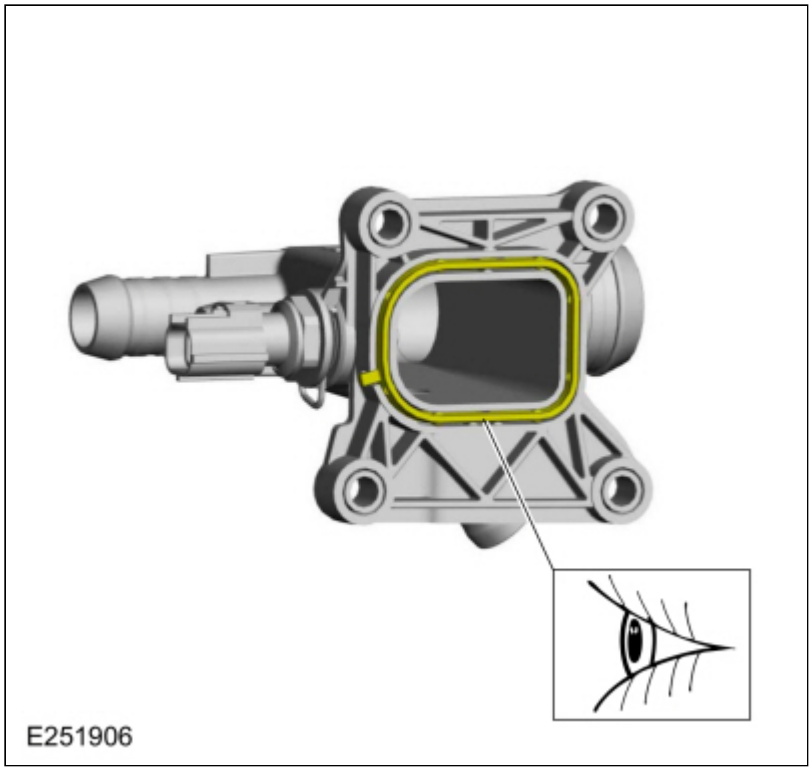
112. Install a new oil filter adapter gasket.



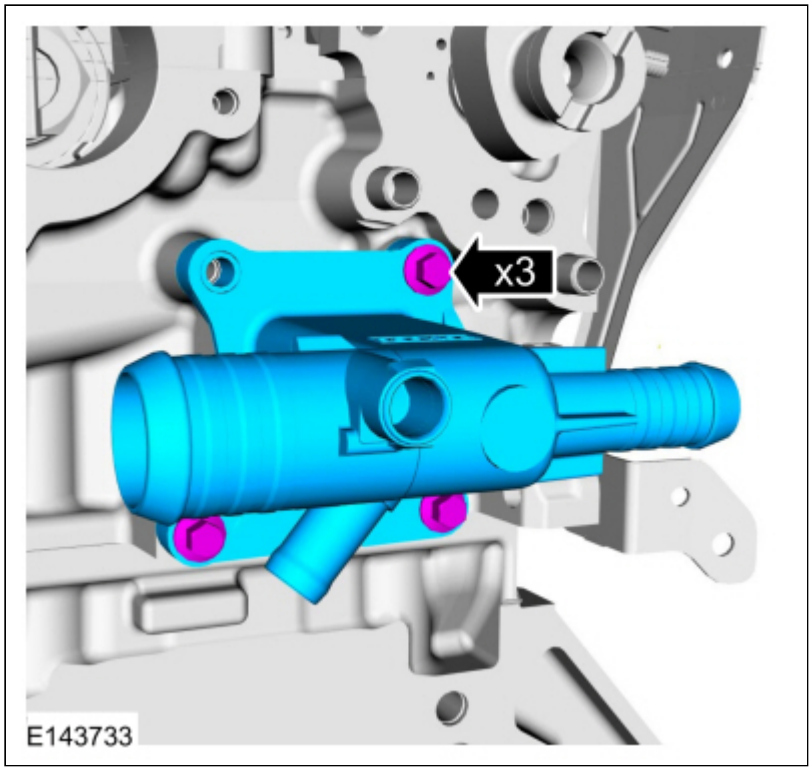
113. Install the oil filter adapter and the bolts.
Torque: 18 lb.ft (25 Nm)



114. Inspect and replace the coolant outlet gasket, if damaged.

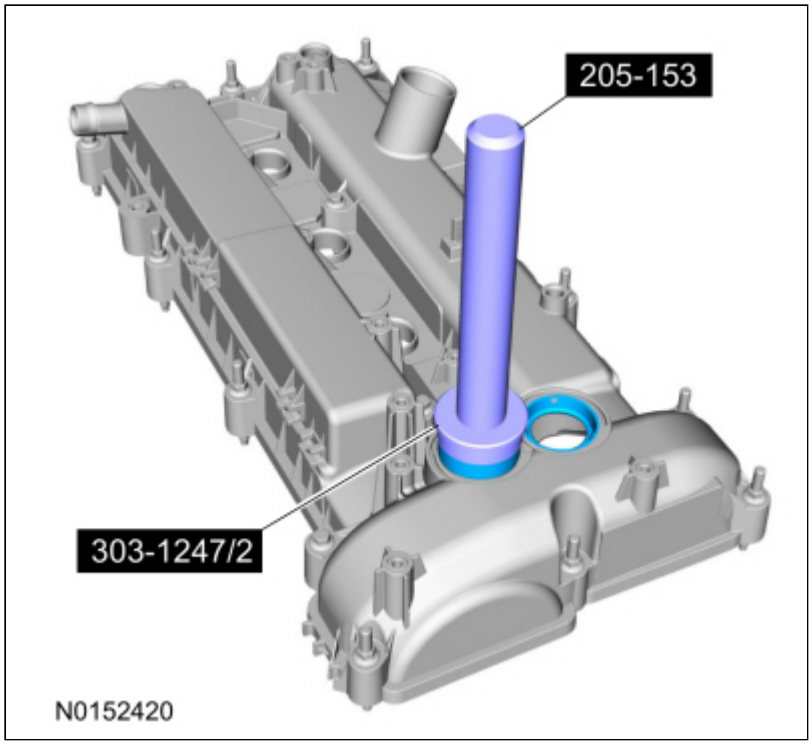


115. Install the coolant outlet and the bolts.
Torque: 89 lb.in (10 Nm)

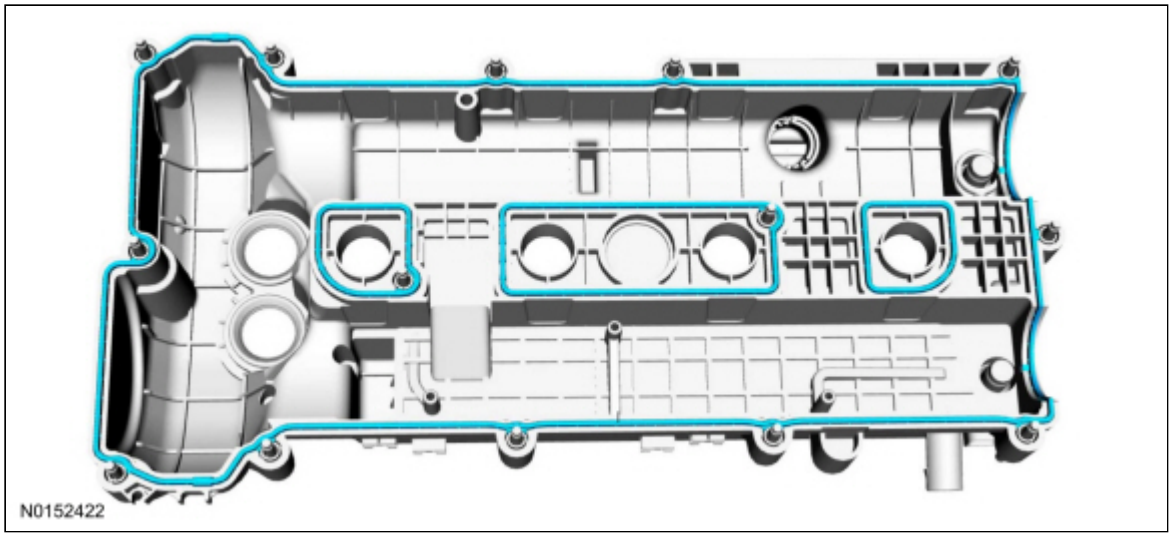


116. **NOTE:** *Installation of new seals is only required if damaged seals were removed during disassembly of the engine.*

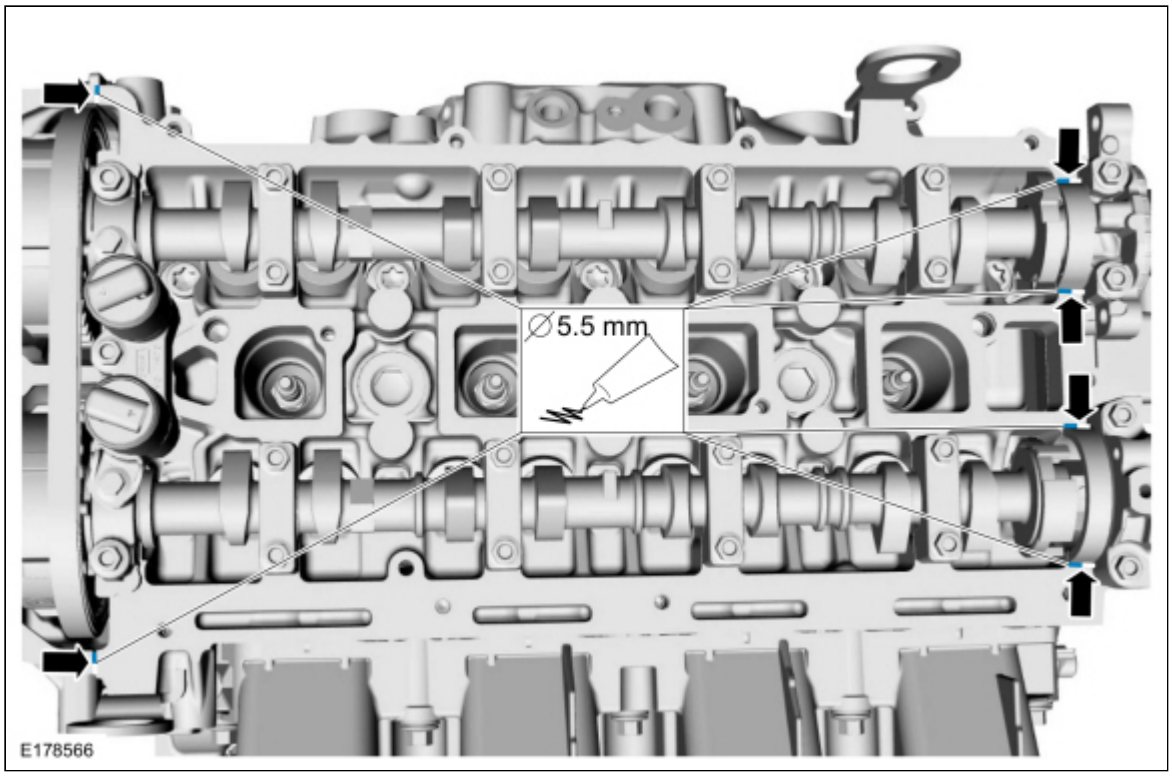
    If removed, using the special tools, install the VCT seals.
    Use Special Service Tool: 205-153 (T80T-4000-W) Handle. , 303-1247 VCT Spark Plug Tube Seal Remover and Installer.



117. Install a new valve cover gasket.

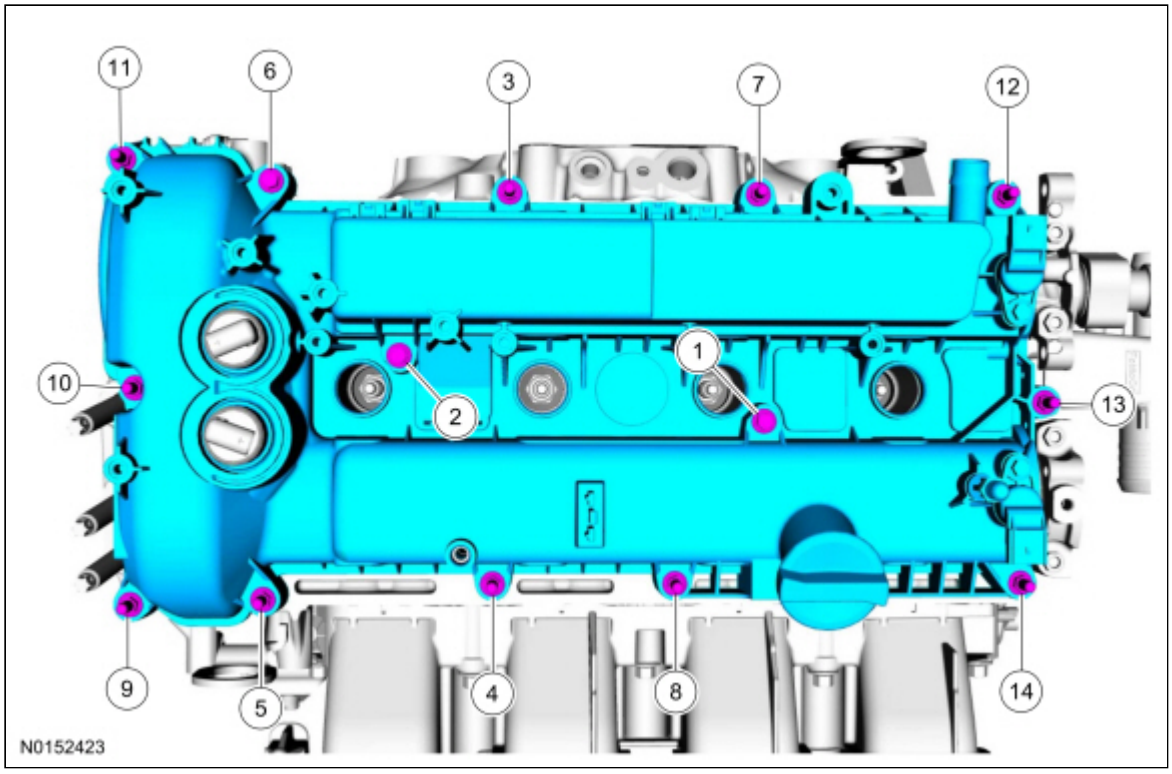


118. Apply a 5.5 mm bead of silicone sealant.
Material: Motorcraft® Silicone Gasket and Sealant / TA-30 (WSE-M4G323-A4)

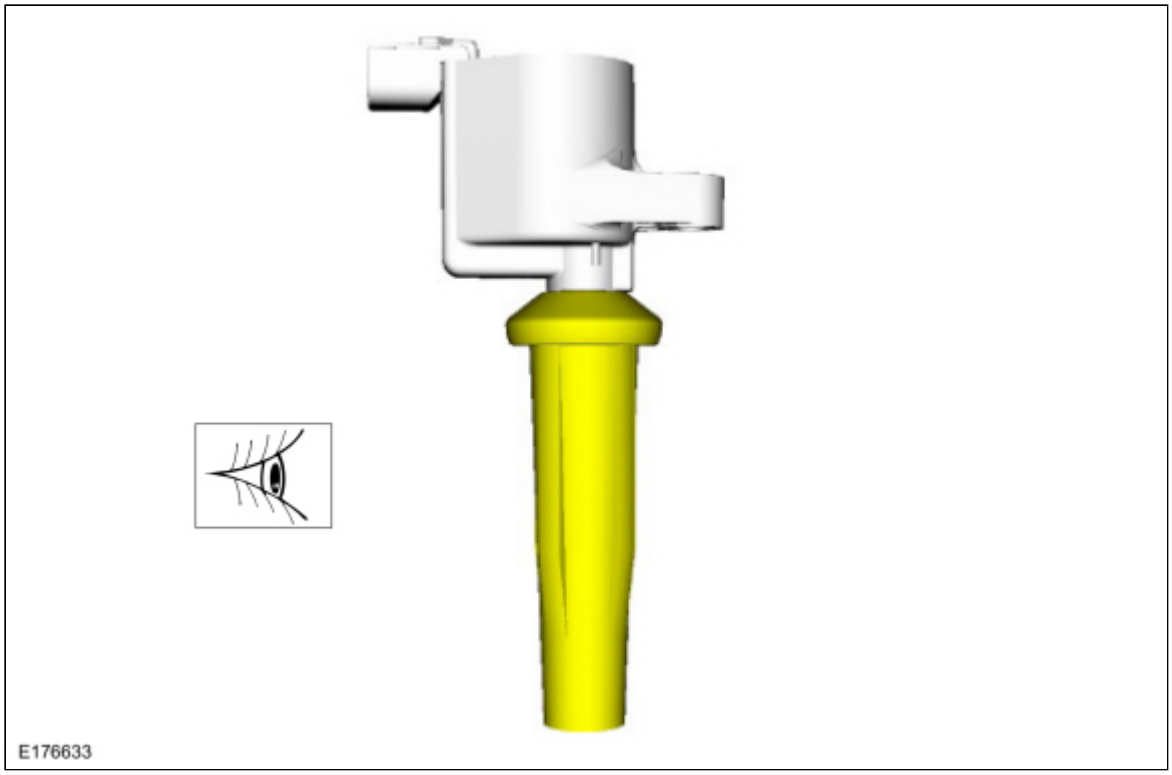


119. **NOTE:** *The valve cover must be secured within 10 minutes of silicone gasket application. If the valve cover is not secured within 10 minutes, the silicone sealant must be removed and the sealing area cleaned with metal surface prep.*

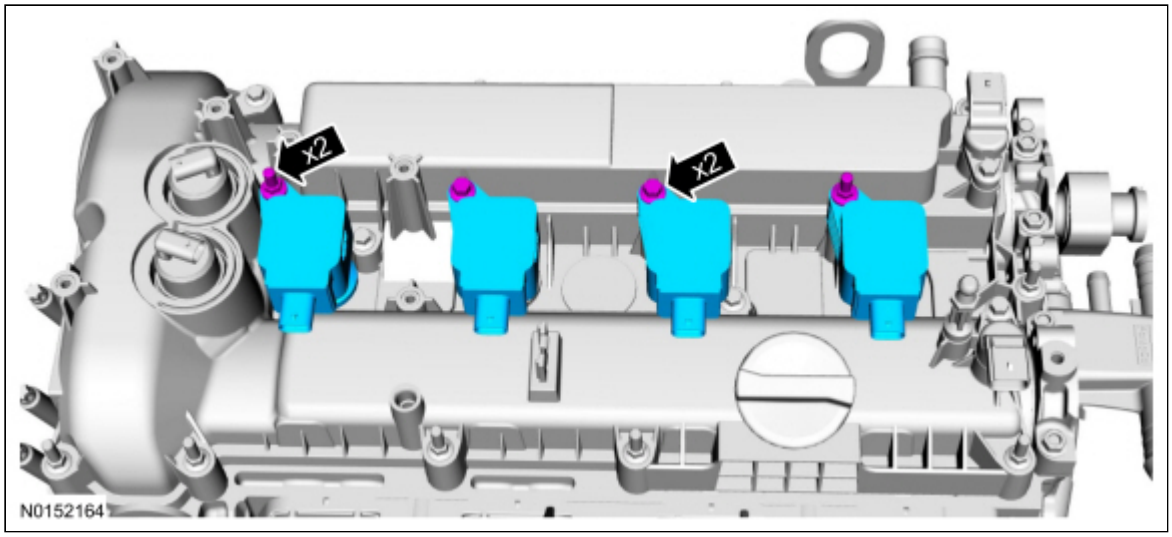
Install the valve cover and tighten the fasteners in the sequence shown.
Material: Motorcraft® Metal Surface Prep Wipes / ZC-31-B
Torque: 89 lb.in (10 Nm)



120. Inspect and replace any ignition coil-on-plug rubber boots with cracks, rips or tears.

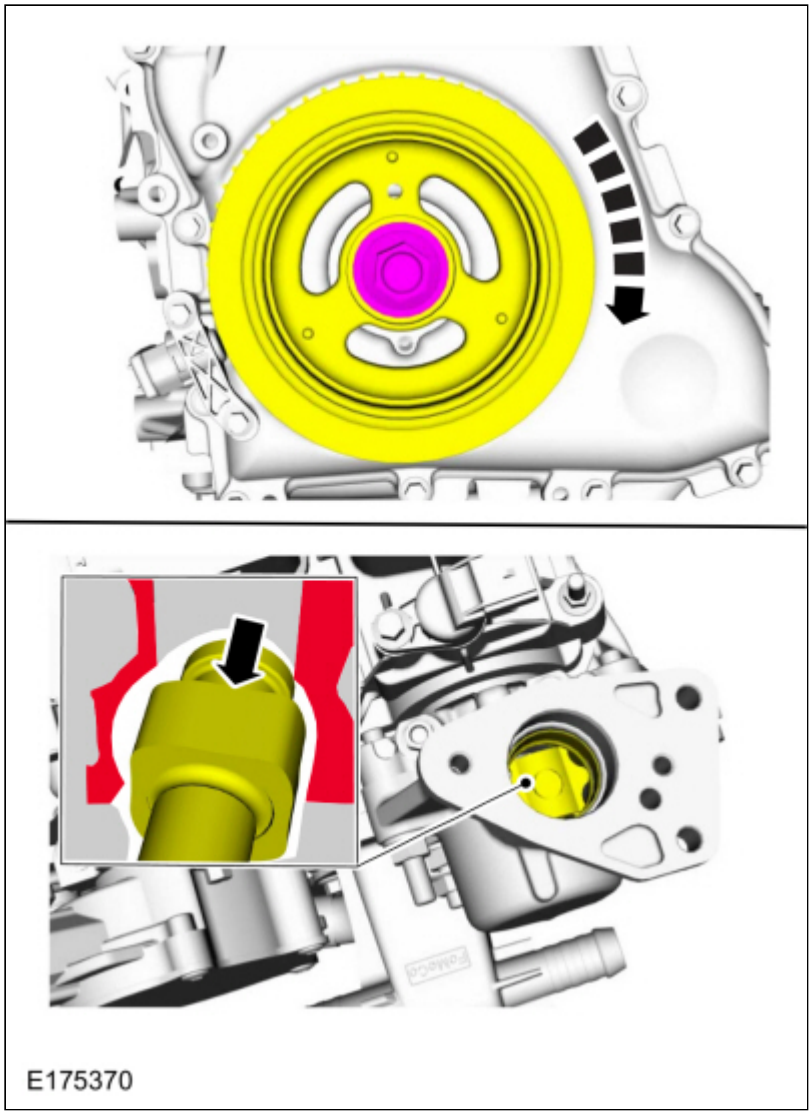


121. Install the ignition coil-on-plugs and the fasteners.
Torque: 53 lb.in (6 Nm)

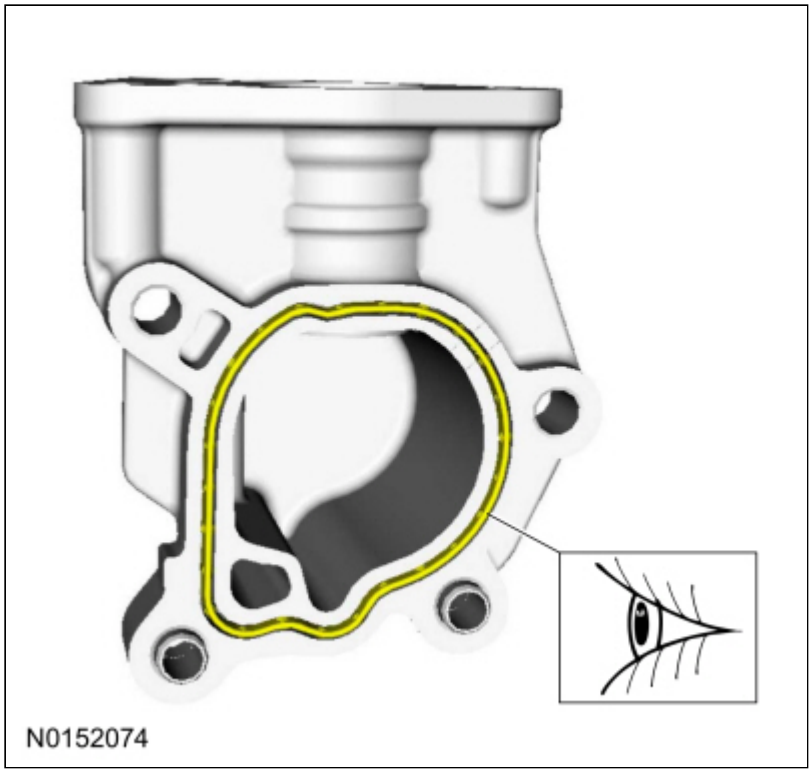


122. **NOTICE: The fuel injection cam lobe must be positioned at zero lift before installing the fuel injection pump housing.**

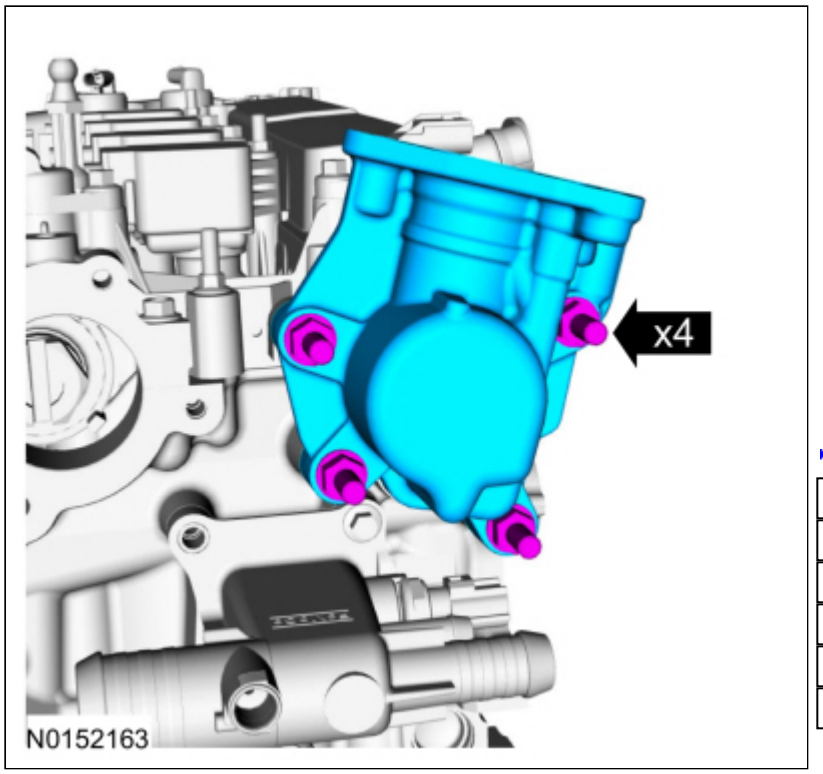
    Rotate the crankshaft to position the camshaft at zero lift.



123. Inspect and replace the fuel injection pump housing, if damaged.



124. Install the fuel injection pump housing and the stud bolts and tighten in 2 stages.
Torque:
Stage 1: 133 lb.in (15 Nm)
Stage 2: 60°

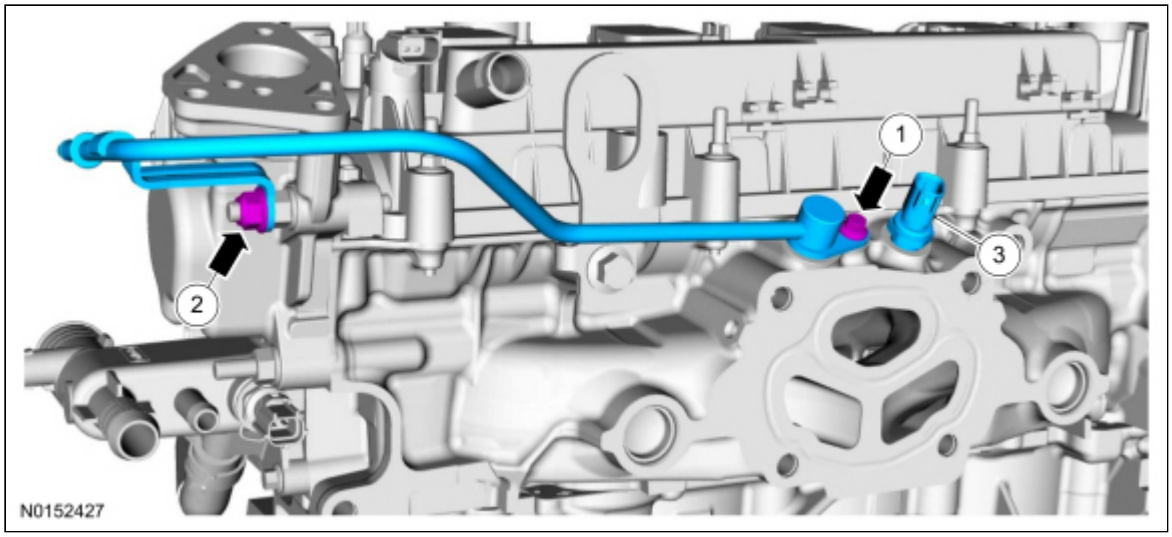


125.

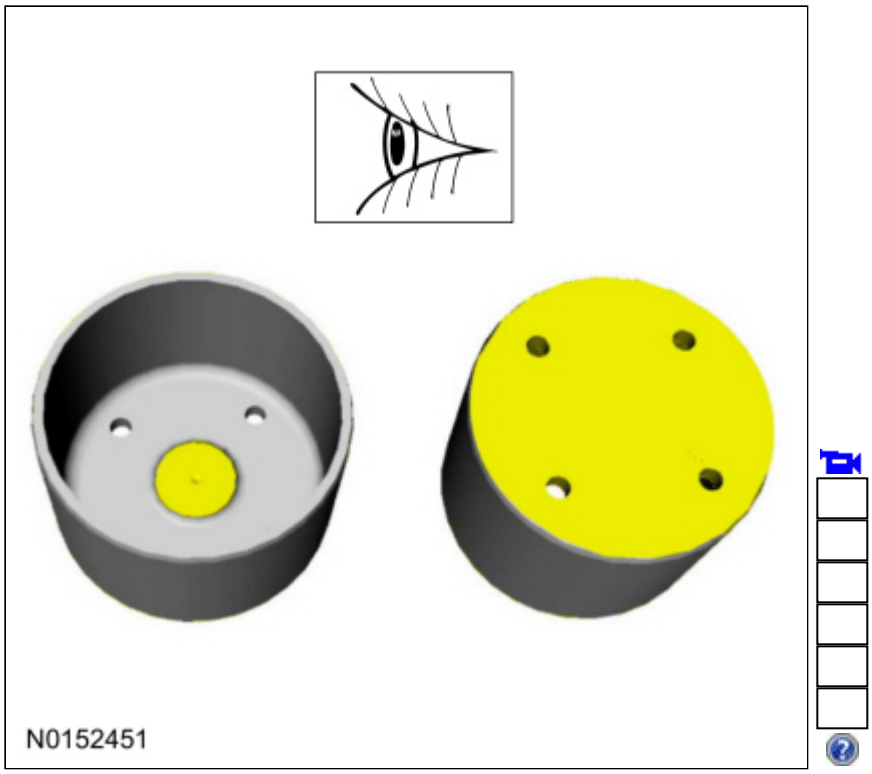
1. **NOTE:** *The coolant tube must be fully seated prior to tighten the bolt.*

Install the coolant tube and bolt.
Torque: 97 lb.in (11 Nm)

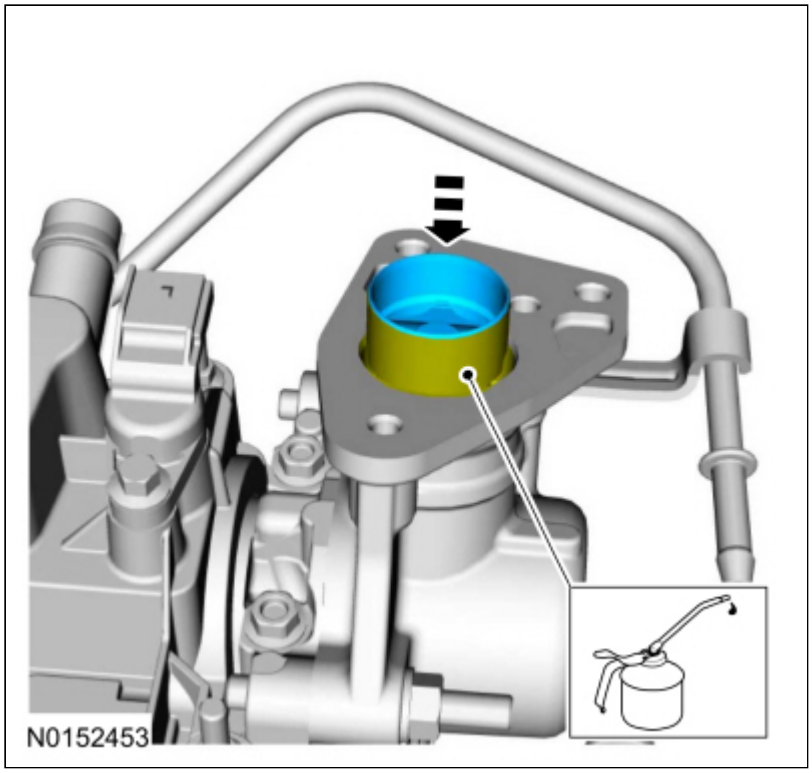
2. Install the coolant tube nut.
   Torque: 115 lb.in (13 Nm)
3. Install a new CHT sensor.
   Torque: 97 lb.in (11 Nm)



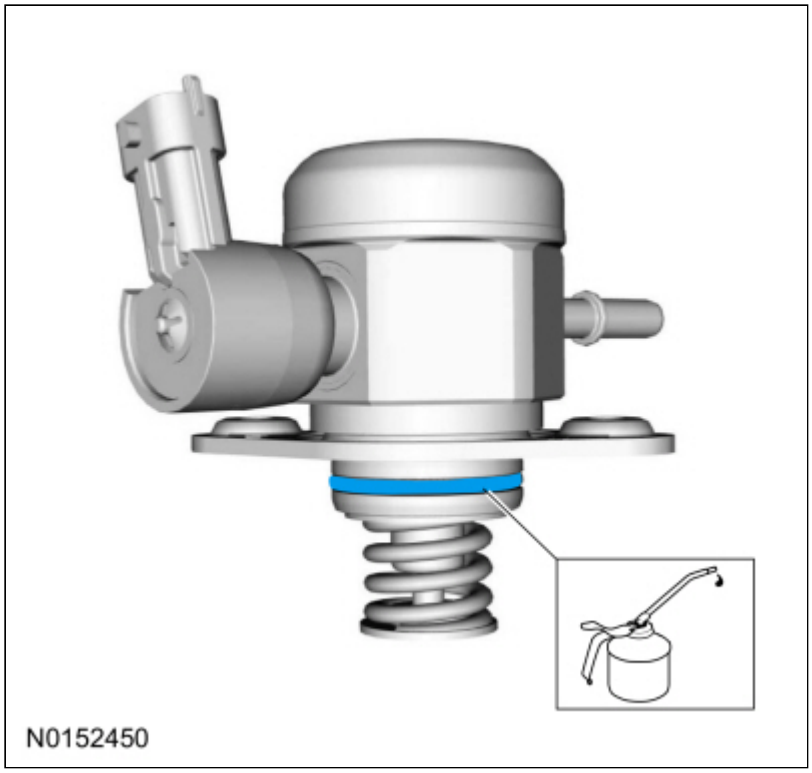
126. Inspect the fuel injection pump tappet for flat spots or scoring, especially in the indicated areas. If any damage is found, inspect the fuel injection pump and the fuel injection pump tappet drive lobe. Install new components as necessary.



127. Lubricate with clean engine oil and install the fuel injection pump tappet.

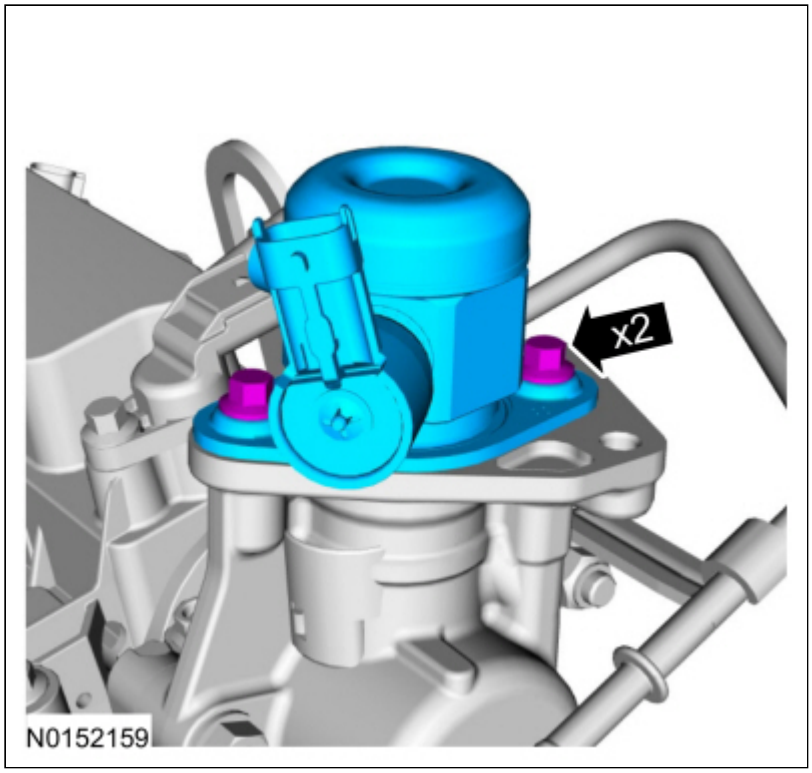


128. Install a new fuel injection pump O-ring seal.

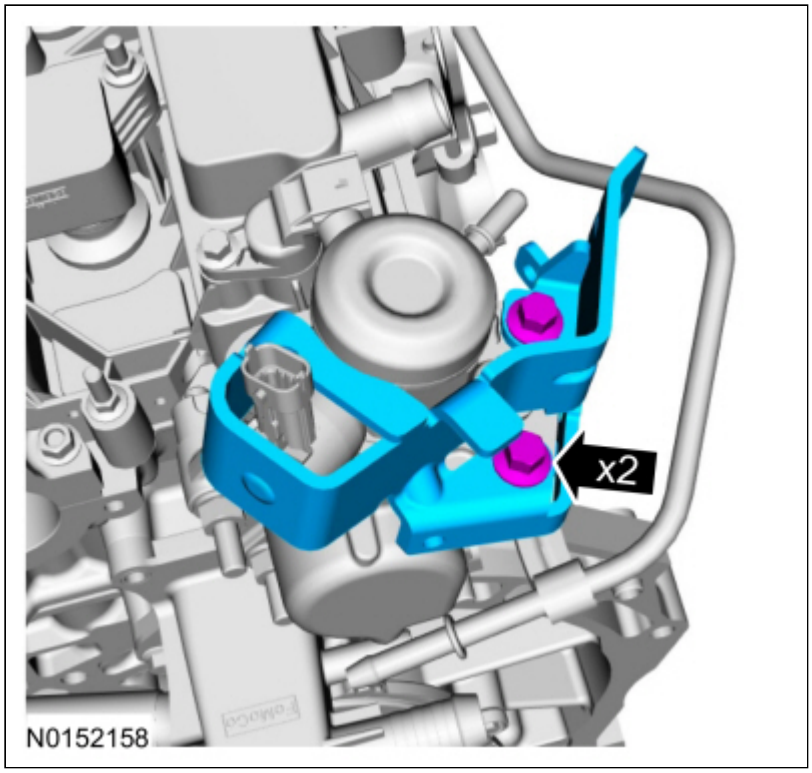


129. **NOTE:** *Install new bolts.*

Install the fuel injection pump and alternately tighten each bolt one complete revolution until seated in 2 stages.
Torque:
Stage 1: 44 lb.in (5 Nm)
Stage 2: 55°

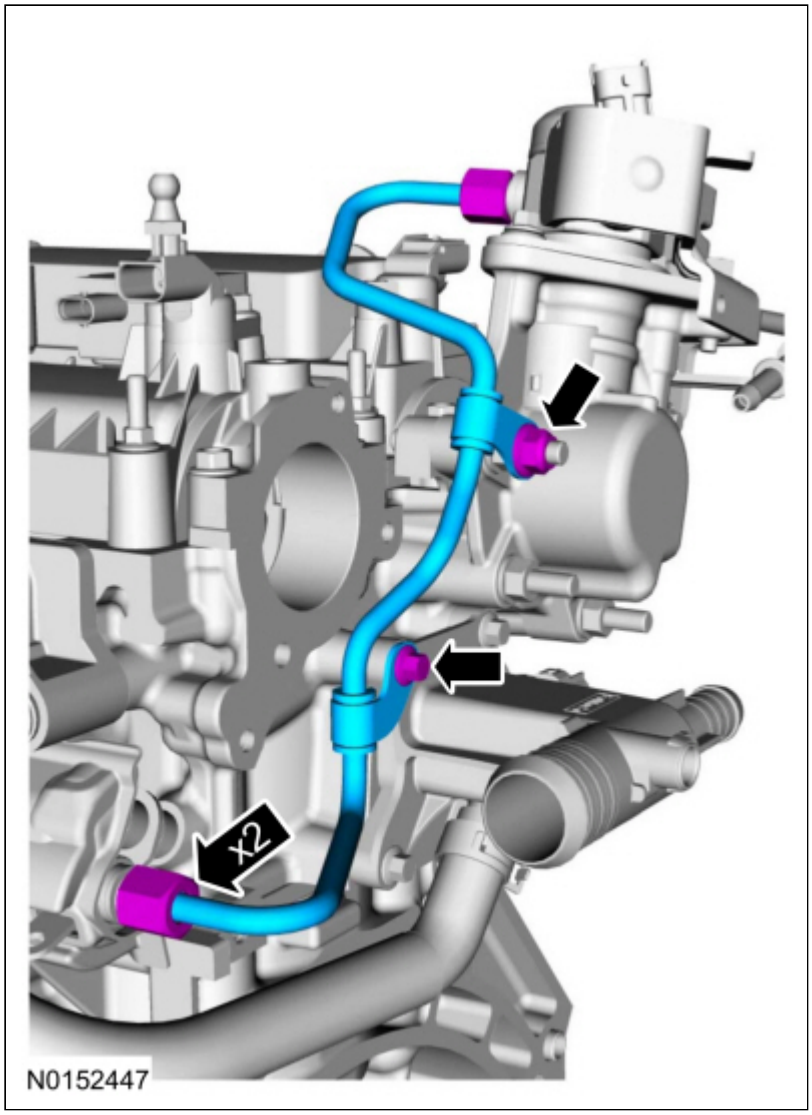


130. Install the fuel injection pump bracket and the bolts.
Torque: 150 lb.in (17 Nm)

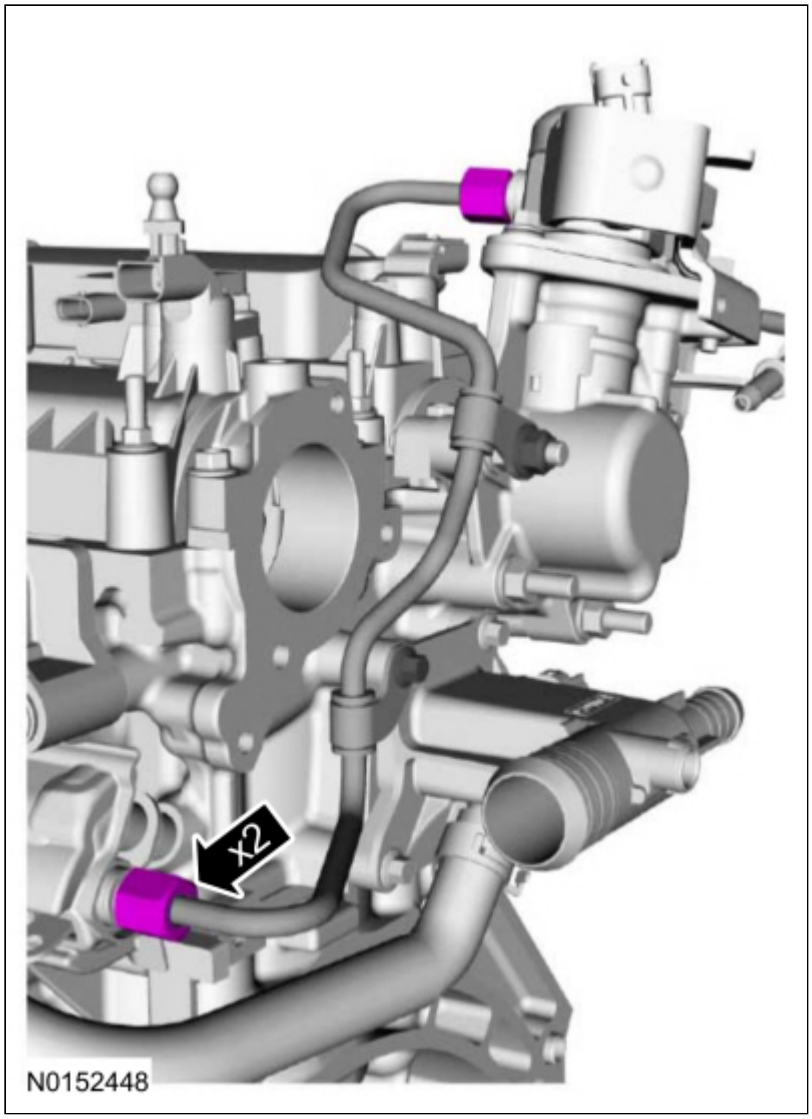


131. **NOTE:** *Install a new fuel tube.*

- Install the fuel tube, nut and the bolt finger-tight.
- Install the flare nuts finger-tight.

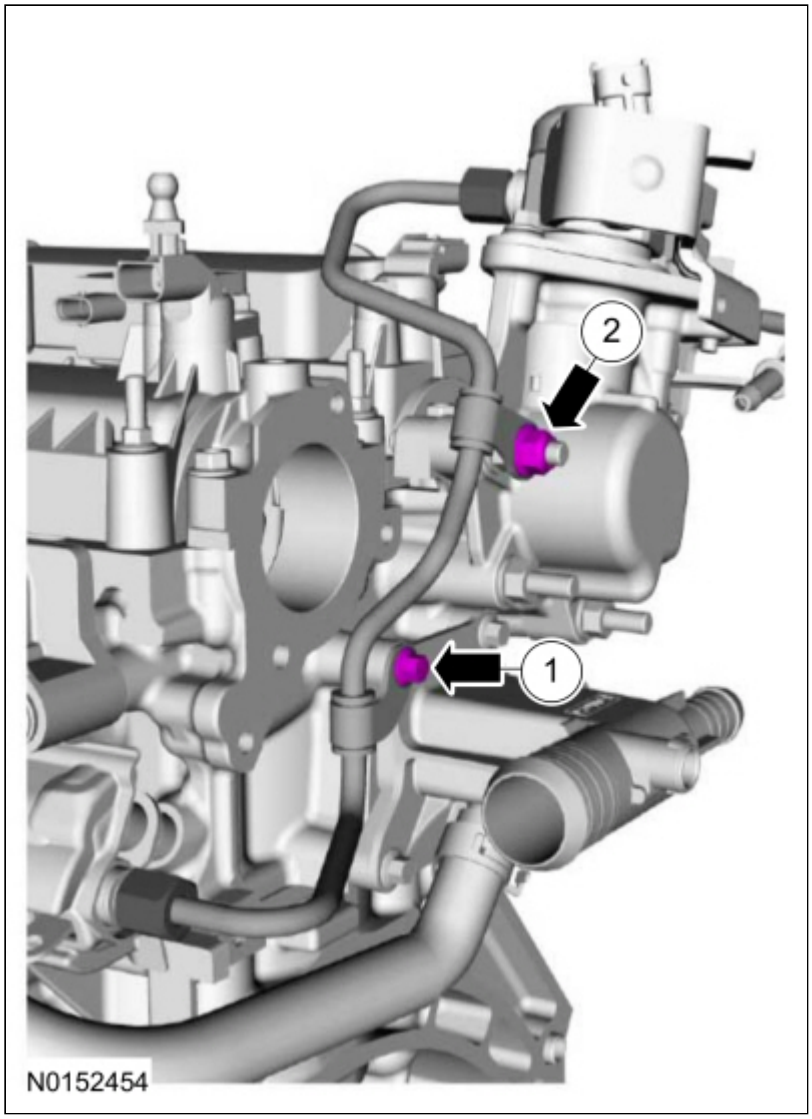


132. Tighten the flare nuts in 2 stages.
Torque:
Stage 1: 133 lb.in (15 Nm)
Stage 2: 30°

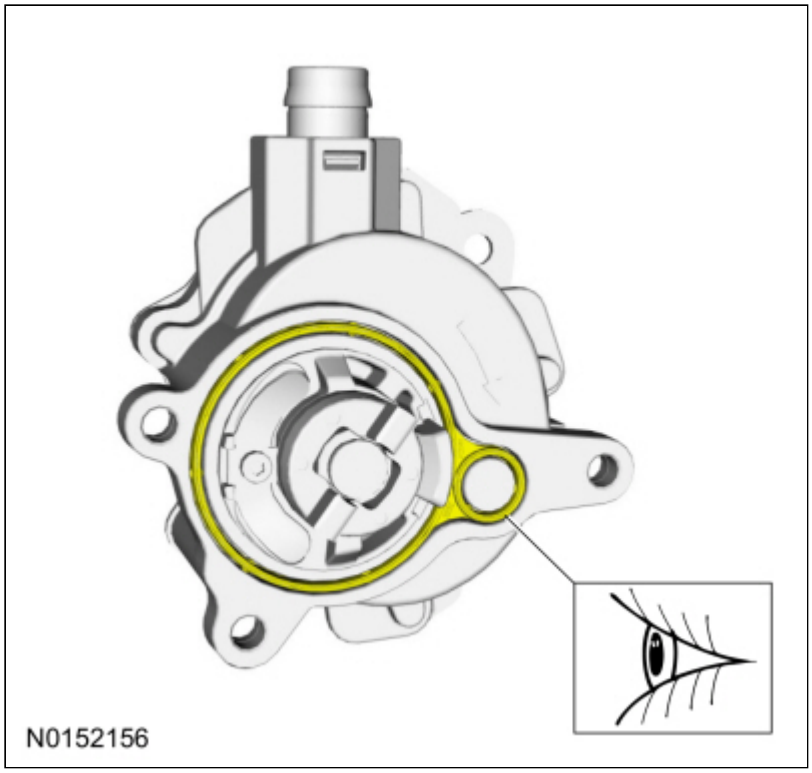


133.

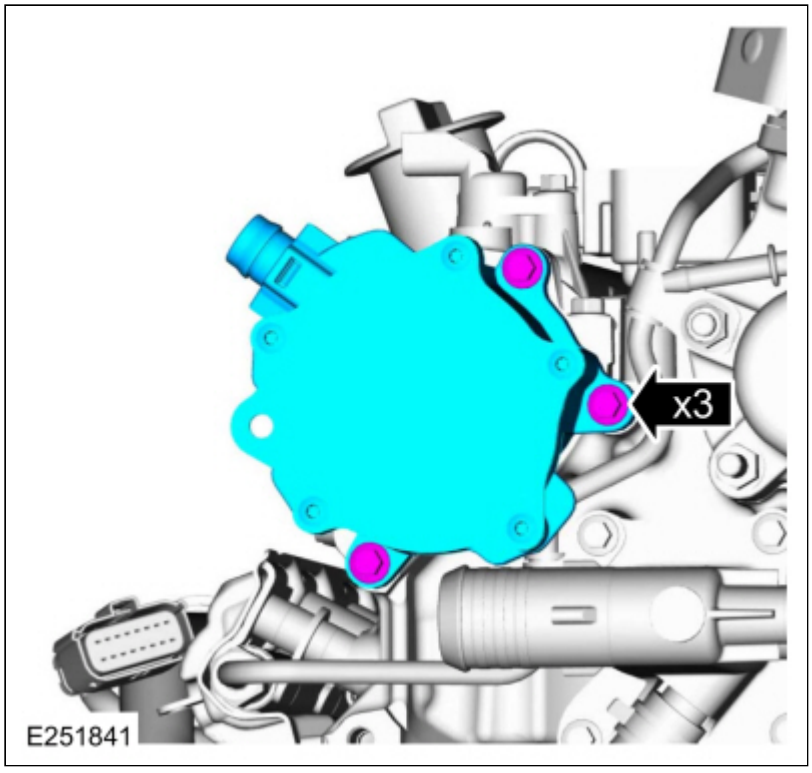
1. Tighten the bolt.
   Torque: 89 lb.in (10 Nm)
2. Tighten the nut.
   Torque: 150 lb.in (17 Nm)



134. Inspect and replace the brake vacuum pump gasket, if damaged.

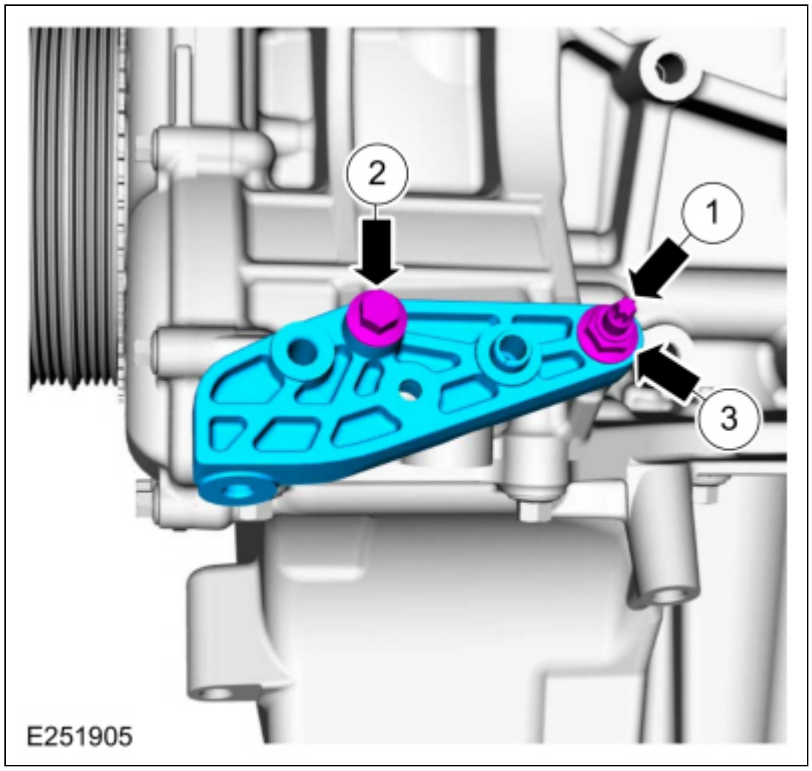


135. Install the brake vacuum pump and the bolts.
Torque: 89 lb.in (10 Nm)

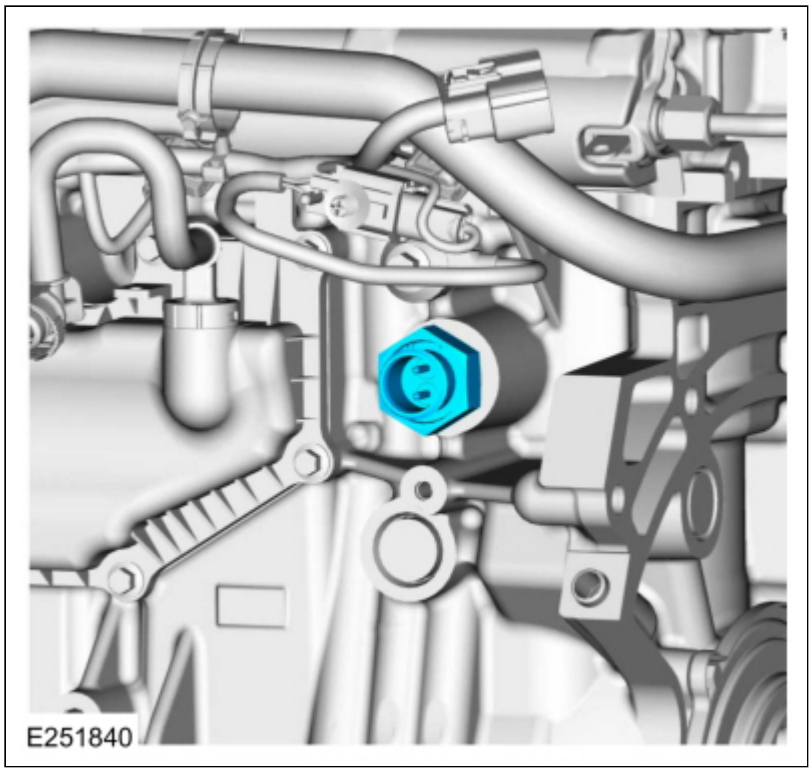


136.

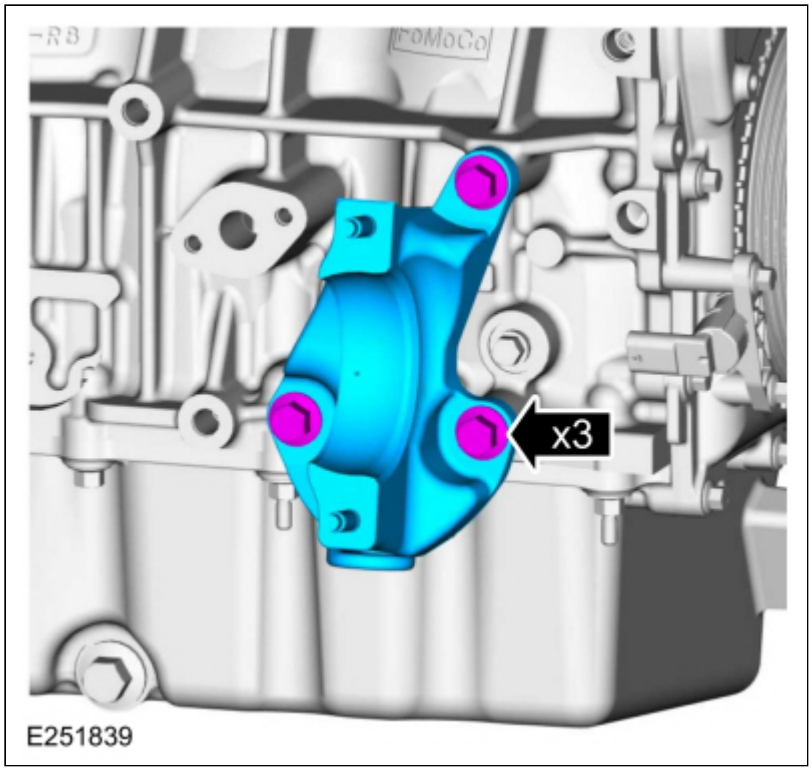
1. Install the stud.
Torque: 80 lb.in (9 Nm)
2. Install the A/C compressor bracket and the bolt.
Torque: 18 lb.ft (25 Nm)
3. Install the nut.
Torque: 18 lb.ft (25 Nm)



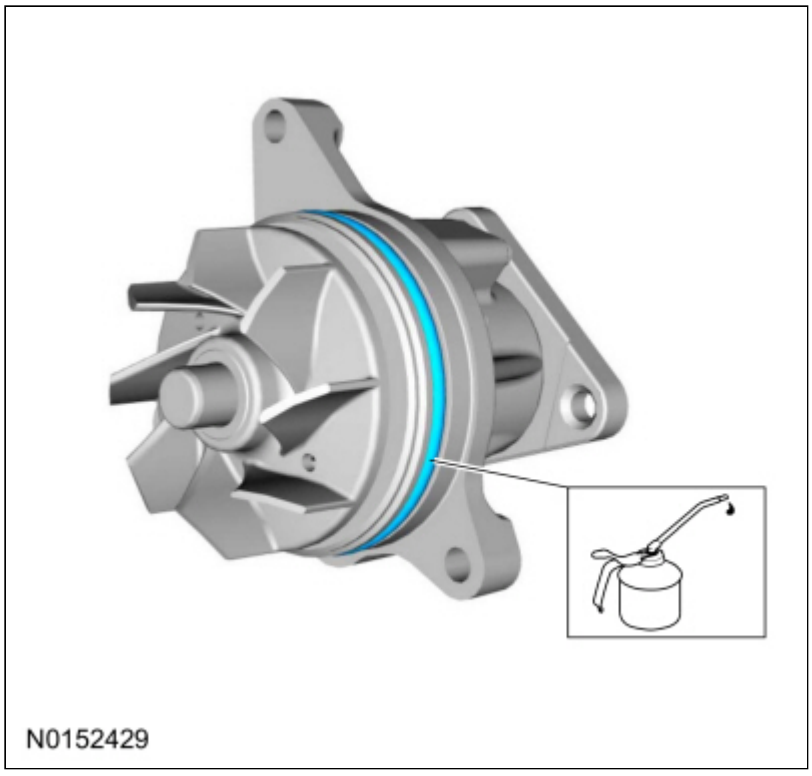
137. If equipped, install the block heater.
Torque: 30 lb.ft (40 Nm)



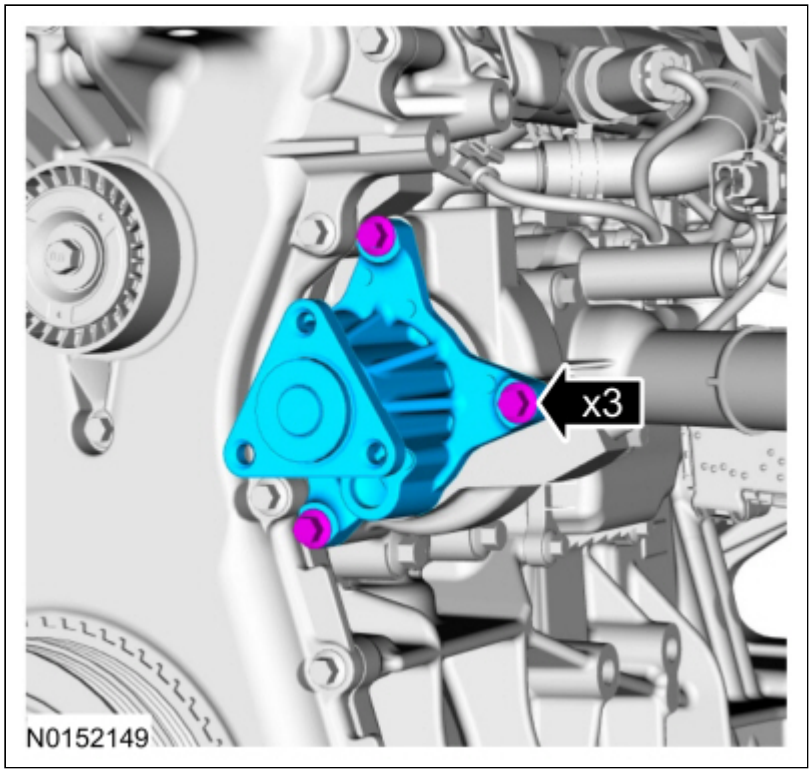
138. Install the halfshaft bracket and the bolts.
Torque: 35 lb.ft (48 Nm)



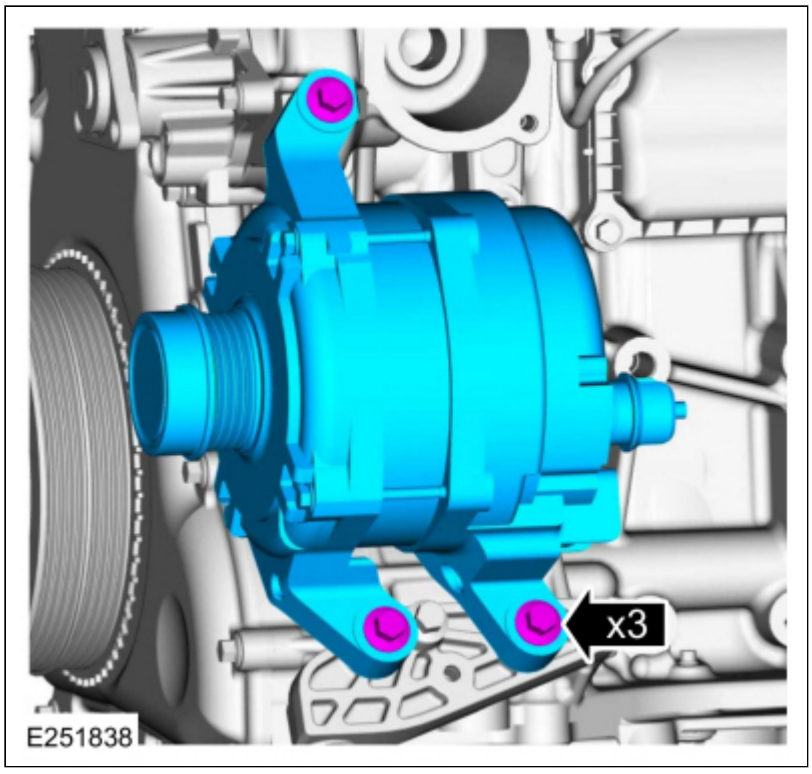
139. Lubricate the coolant pump O-ring seal with clean engine coolant.
Material: Motorcraft® Orange Concentrated Antifreeze/Coolant / VC-3-B (WSS-M97B44-D)



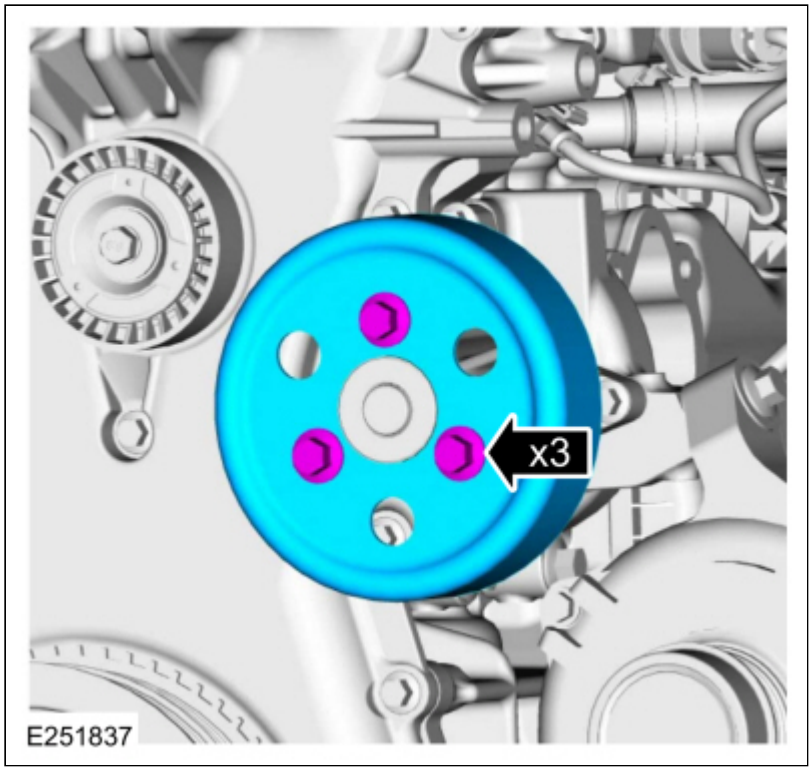
140. Install the coolant pump and the bolts.
Torque: 89 lb.in (10 Nm)



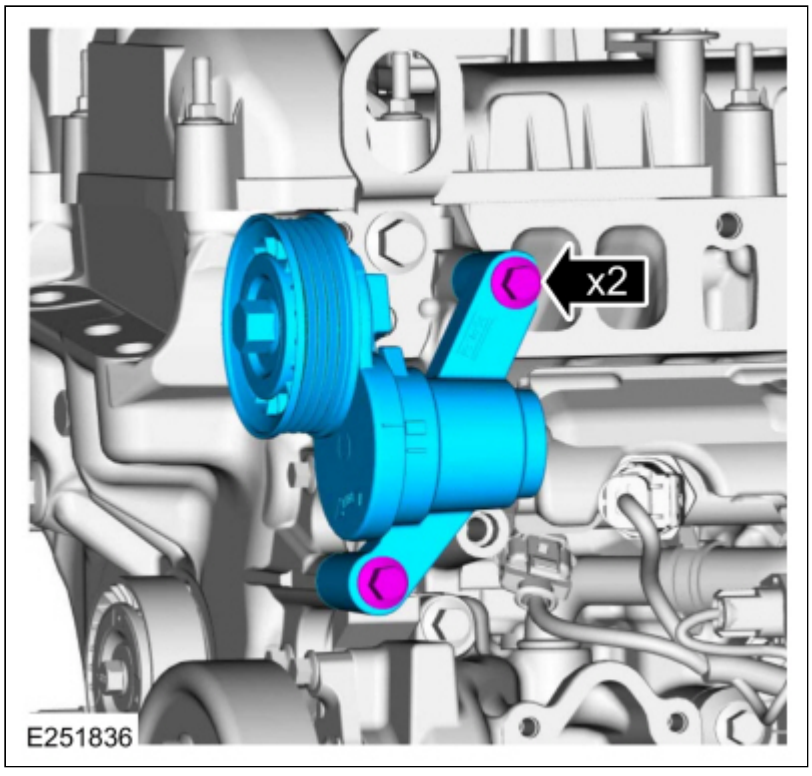
141. Install the generator and the bolts.
Torque: 18 lb.ft (25 Nm)



142. Install the coolant pump pulley and the bolts finger-tight.

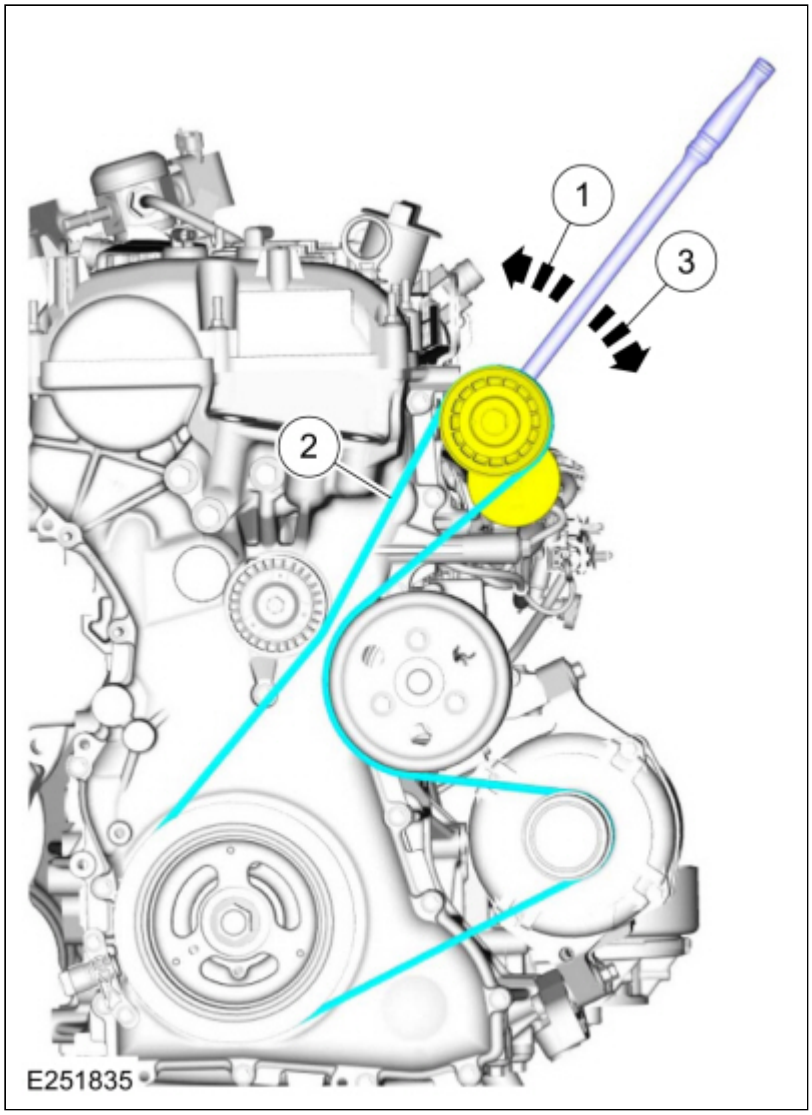


143. Install the accessory drive belt tensioner and the bolts.
Torque: 18 lb.ft (25 Nm)

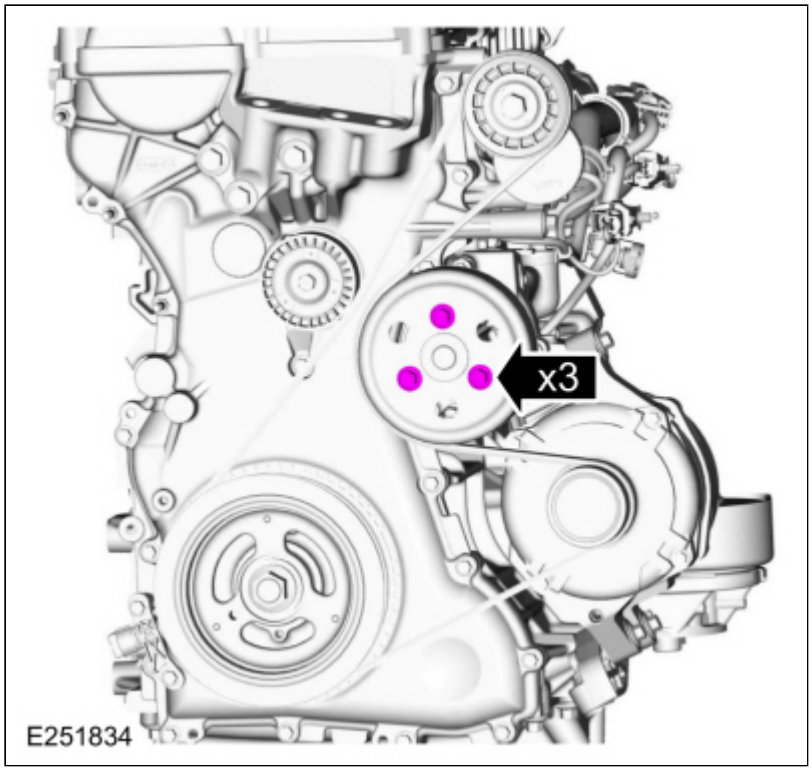


144.

1. Install tool and release the tension on the accessory drive belt tensioner.
2. Install the accessory drive belt.
3. Release the tool and remove.

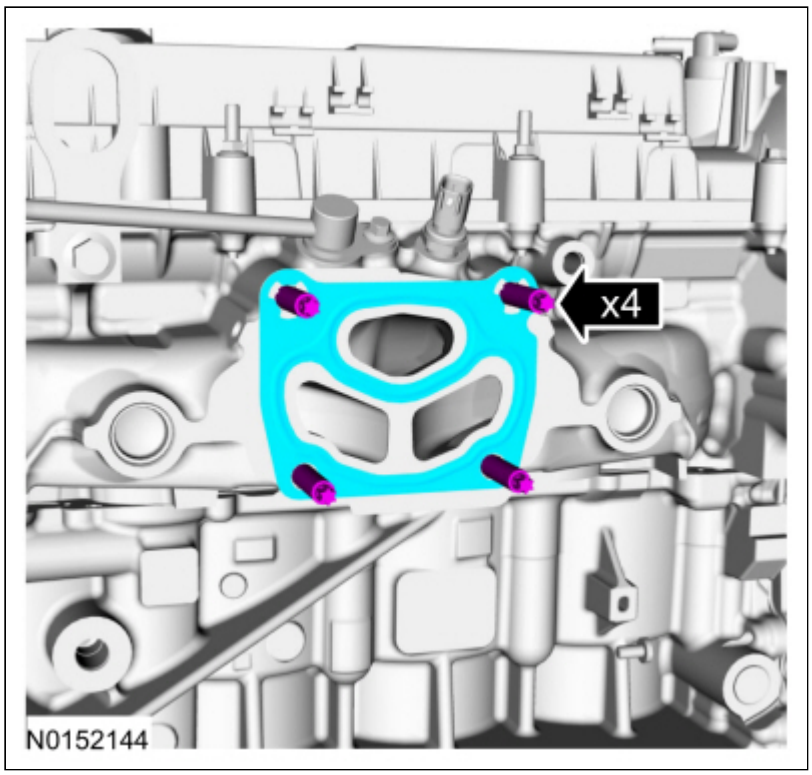


145. Tighten the coolant pump pulley bolts.
Torque: 177 lb.in (20 Nm)

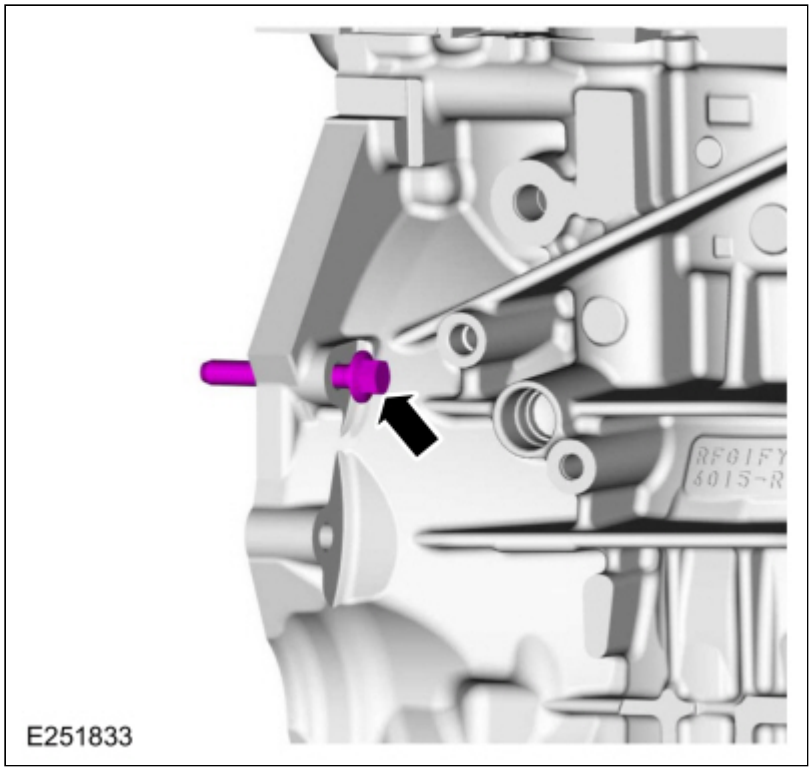


146. **NOTE:** *Make sure that the mating faces are clean and free of foreign material.*

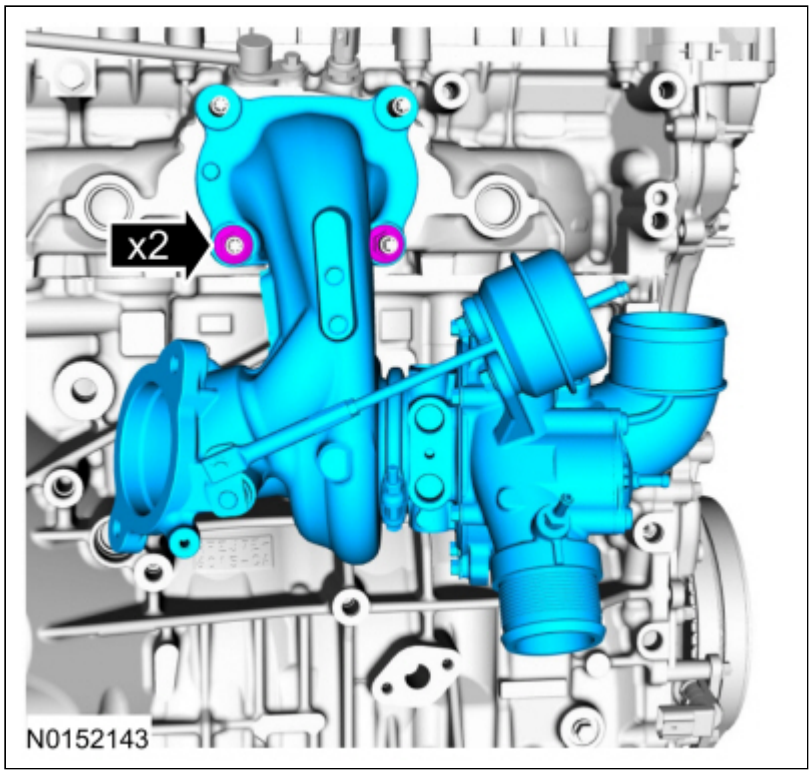
Install the studs and the turbocharger gasket.
Torque: 150 lb.in (17 Nm)



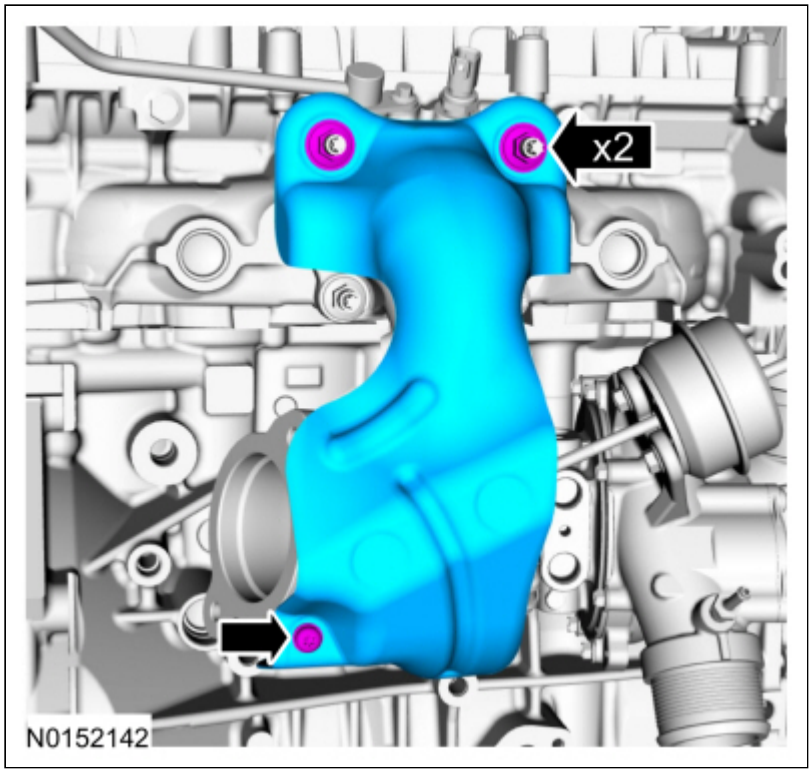
147. Install the bolt.



148. Install the turbocharger and the nuts.
Torque: 37 lb.ft (50 Nm)

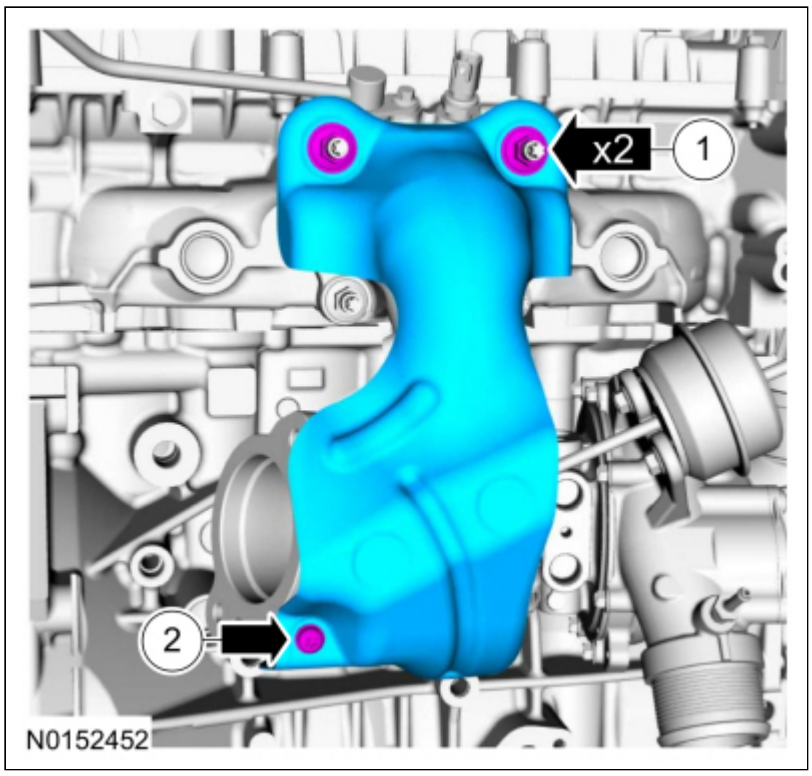


149. Install the heat shield, nuts and the bolt finger-tight.



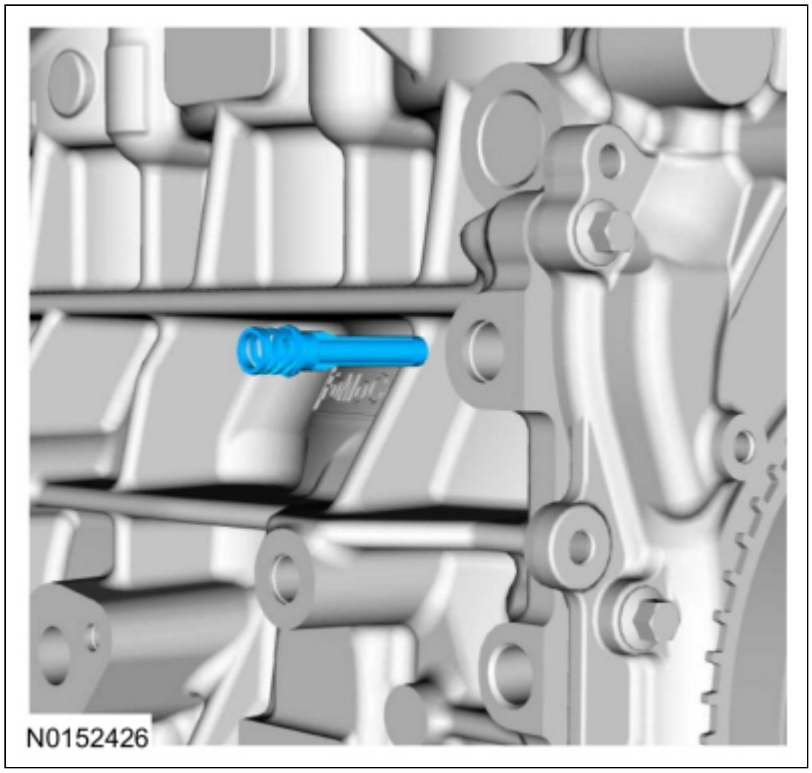
150.

1. Tighten the nuts.
   Torque: 37 lb.ft (50 Nm)
2. Tighten the bolt.
   Torque: 89 lb.in (10 Nm)



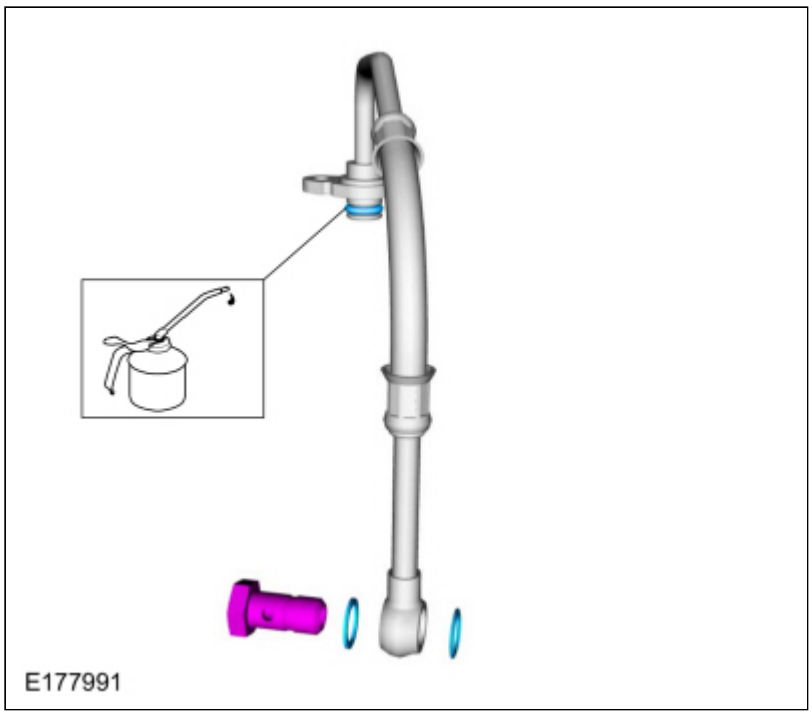
151. **NOTE:** *Do not reuse the turbocharger oil filter, a new part must be installed.*

Install a new turbocharger oil supply filter.



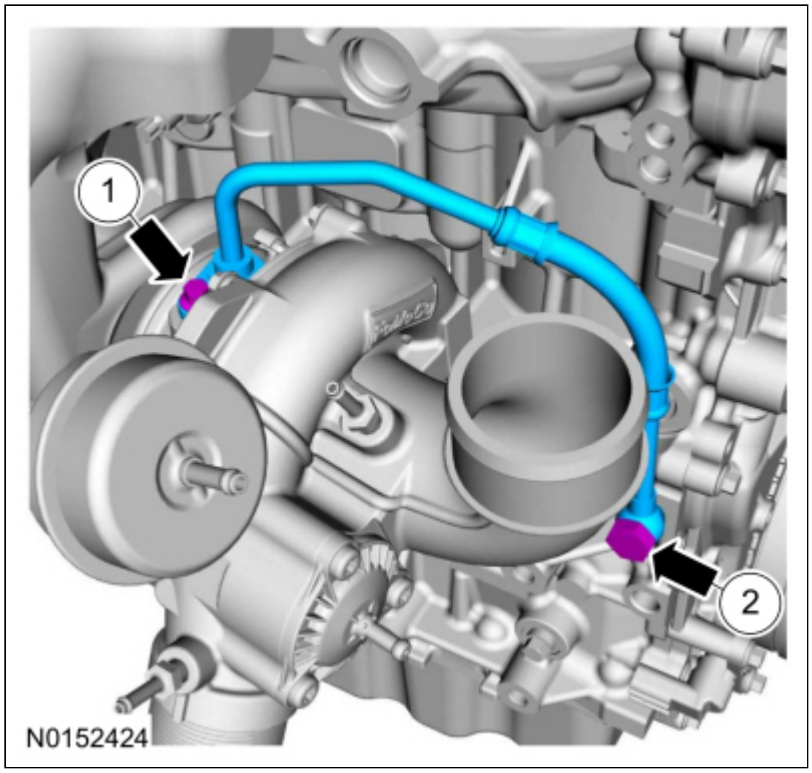
152. **NOTE:** *Install a new O-ring seal and new sealing washers.*

Lubricate and install the new turbocharger oil supply tube O-ring seal with clean engine oil. Install the new washers and the bolt.



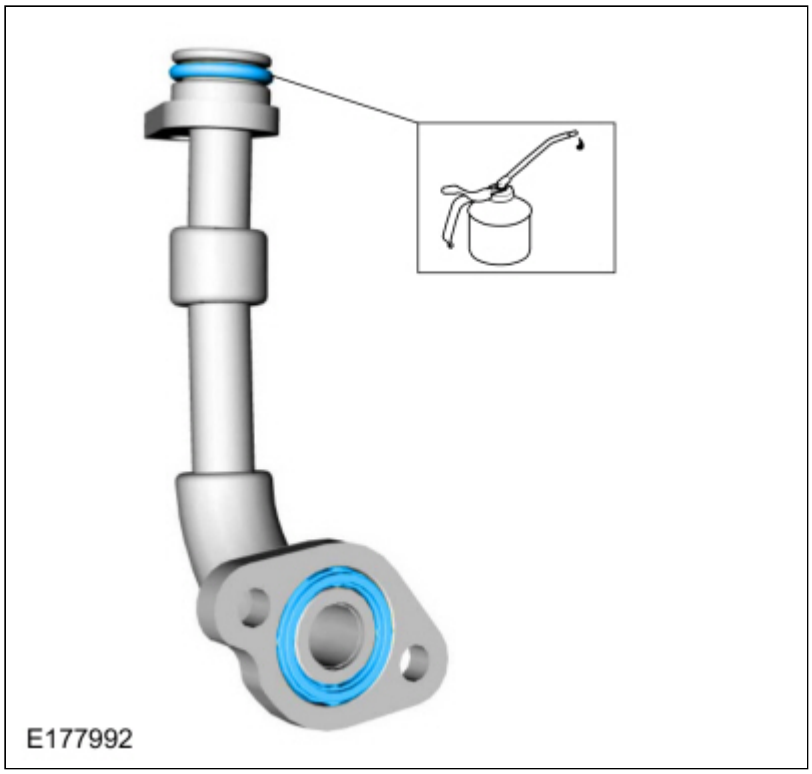
153. **NOTE:** *The oil feed hose must be fully seated prior to fastener rundown.*

1. Install the turbocharger oil supply tube and the bolt.
   Torque: 89 lb.in (10 Nm)
2. Tighten the bolt.
   Torque: 18 lb.ft (25 Nm)



154. **NOTE:** *Install a new O-ring seal and a new gasket.*

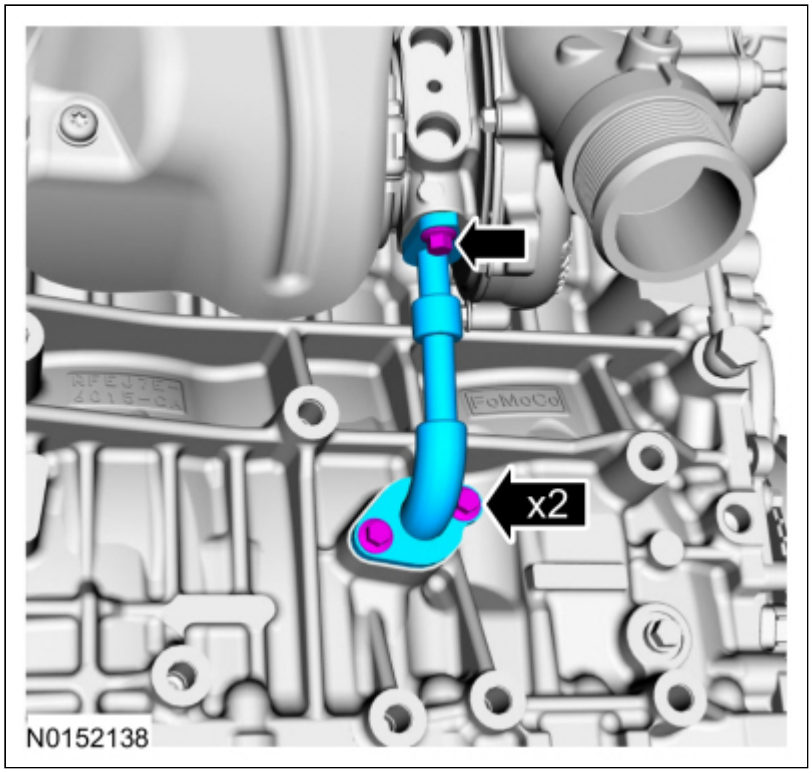
Install a new turbocharger O-ring seal and lubricate with clean engine oil and install a new turbocharger gasket.



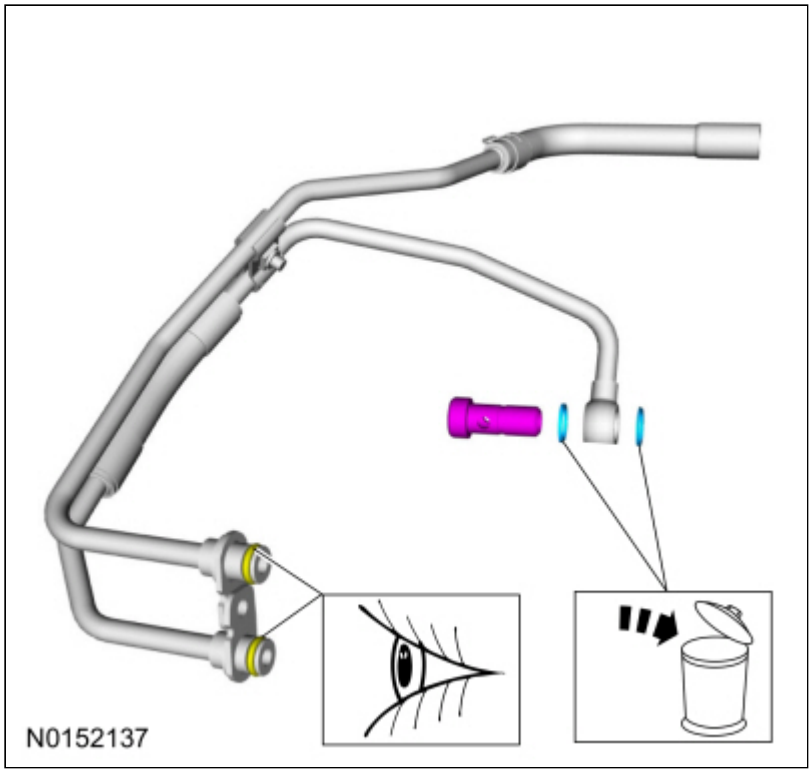
155. **NOTE:** *Install a new oil drain hose.*

NOTE: *The oil drain hose must be fully seated prior to fastener rundown.*

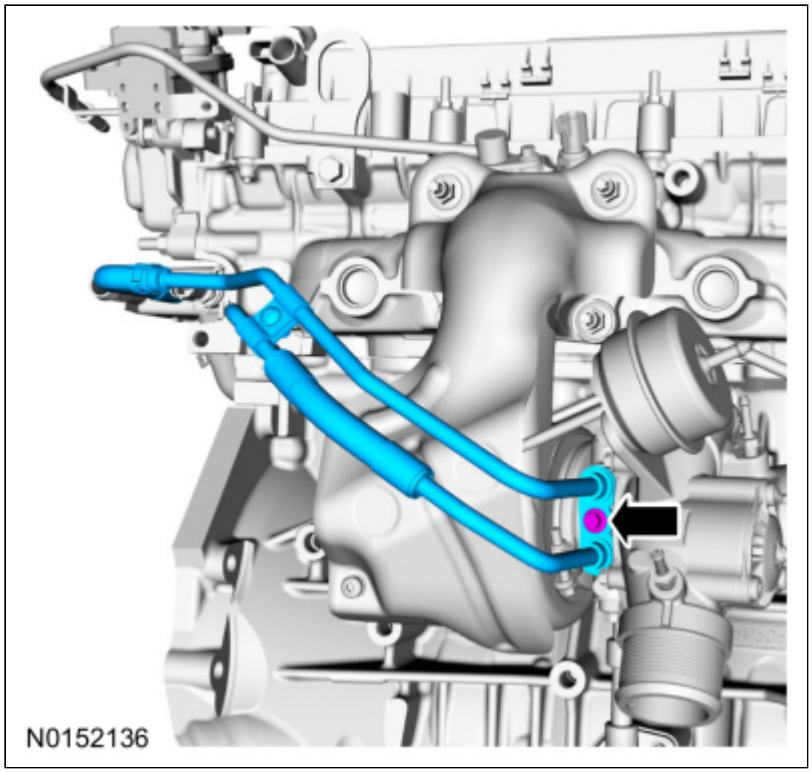
Install the turbocharger-to-cylinder block oil return pipe and the bolts.
Torque: 89 lb.in (10 Nm)



156. Inspect and lubricate the O-ring seals with engine coolant. Discard the washers and replace with new washers.

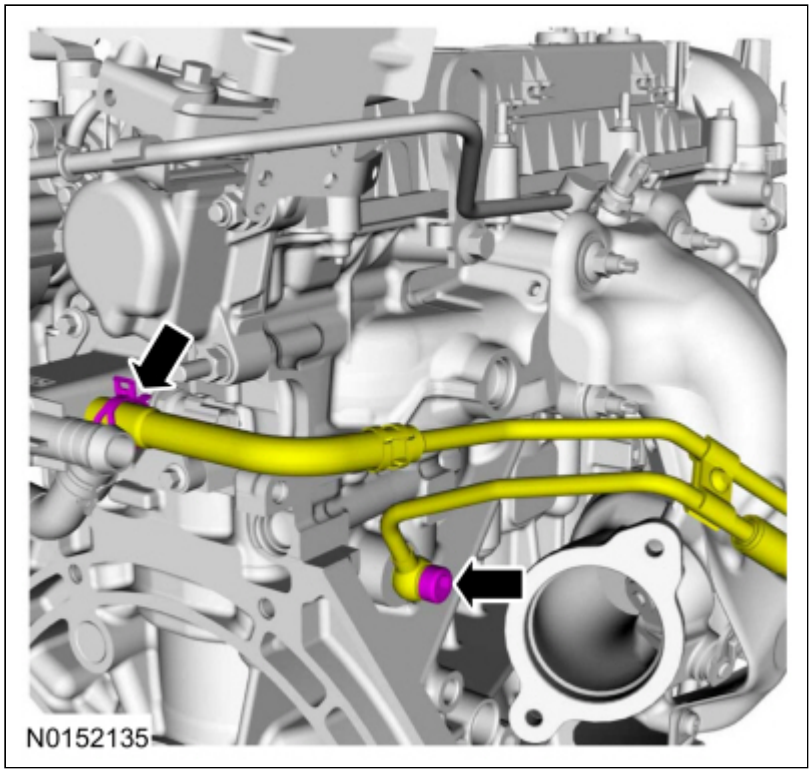


157. Fit the O-ring end of the turbocharger coolant tubes to the turbocharger. The lower coolant inlet tube goes into the turbocharger first. Install the bolt.
Torque: 89 lb.in (10 Nm)

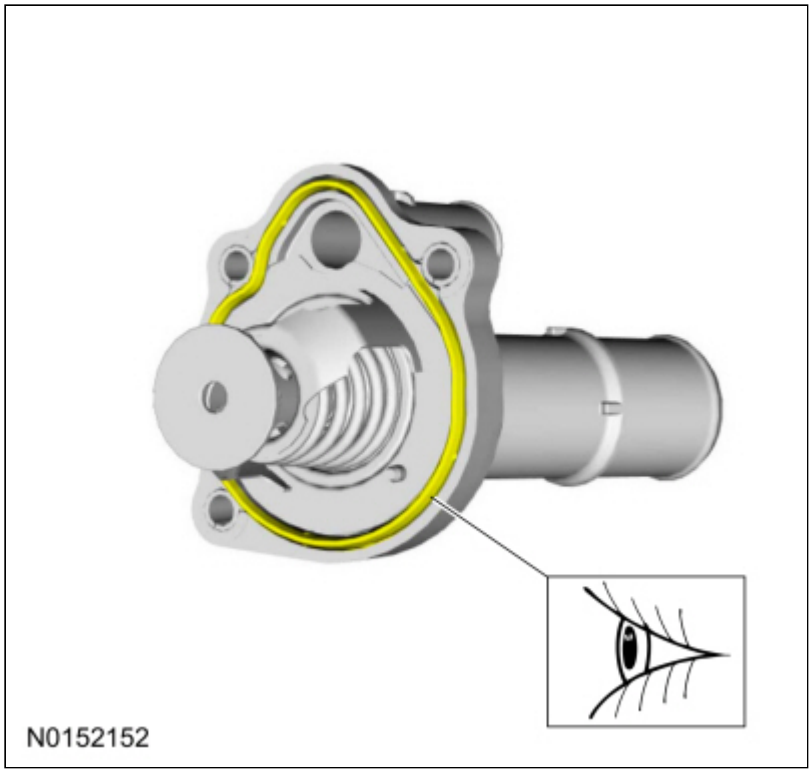


158.

- Install the bolt for the turbocharger coolant inlet tube.
  Torque: 27 lb.ft (37 Nm)
- Connect the turbocharger coolant outlet tube.
  Use the General Equipment: Hose Clamp Remover/Installer

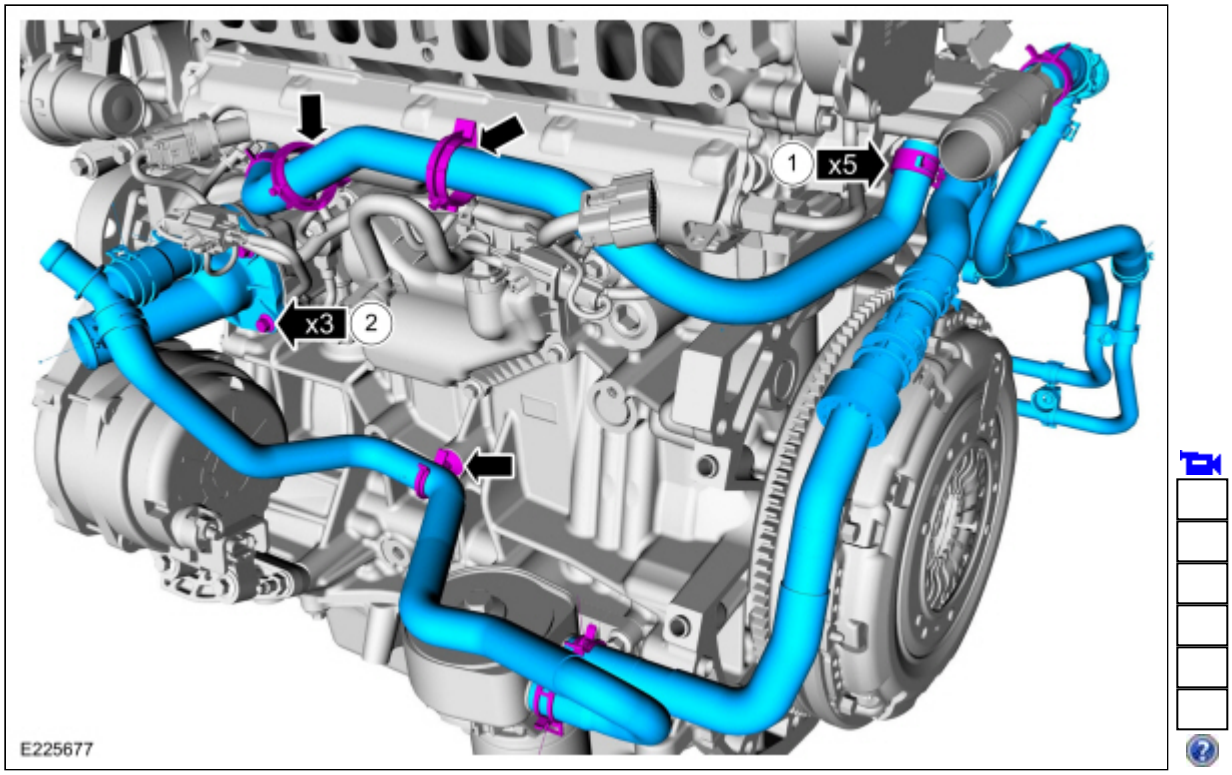


159. Inspect and replace the thermostat housing gasket, if damaged.



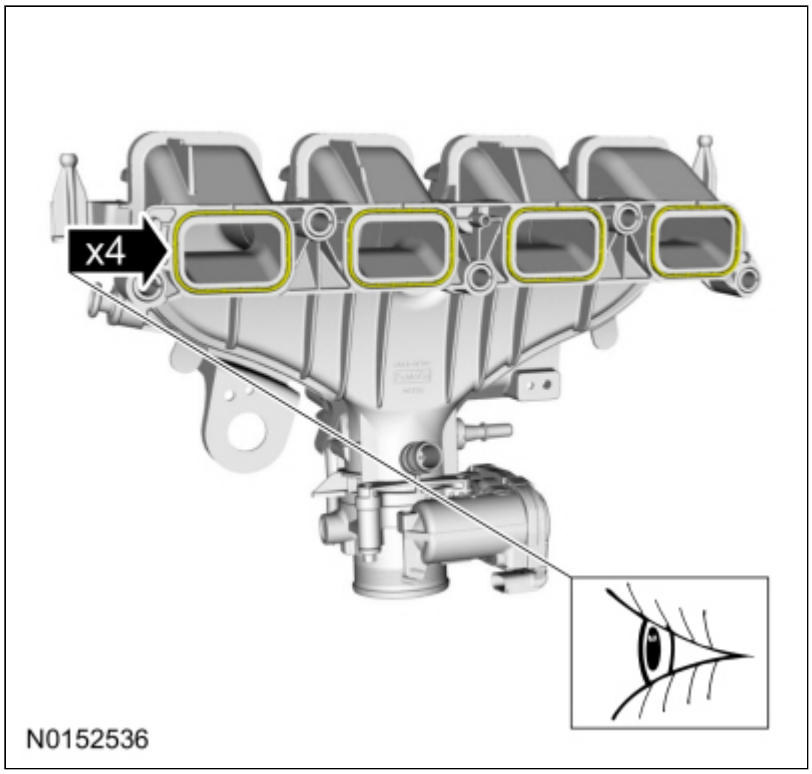
160.

1. Connect the coolant hoses and the coolant hose retainers.
   Use the General Equipment: Hose Clamp Remover/Installer
2. Install the thermostat housing and hoses and the bolts.
   Torque: 89 lb.in (10 Nm)

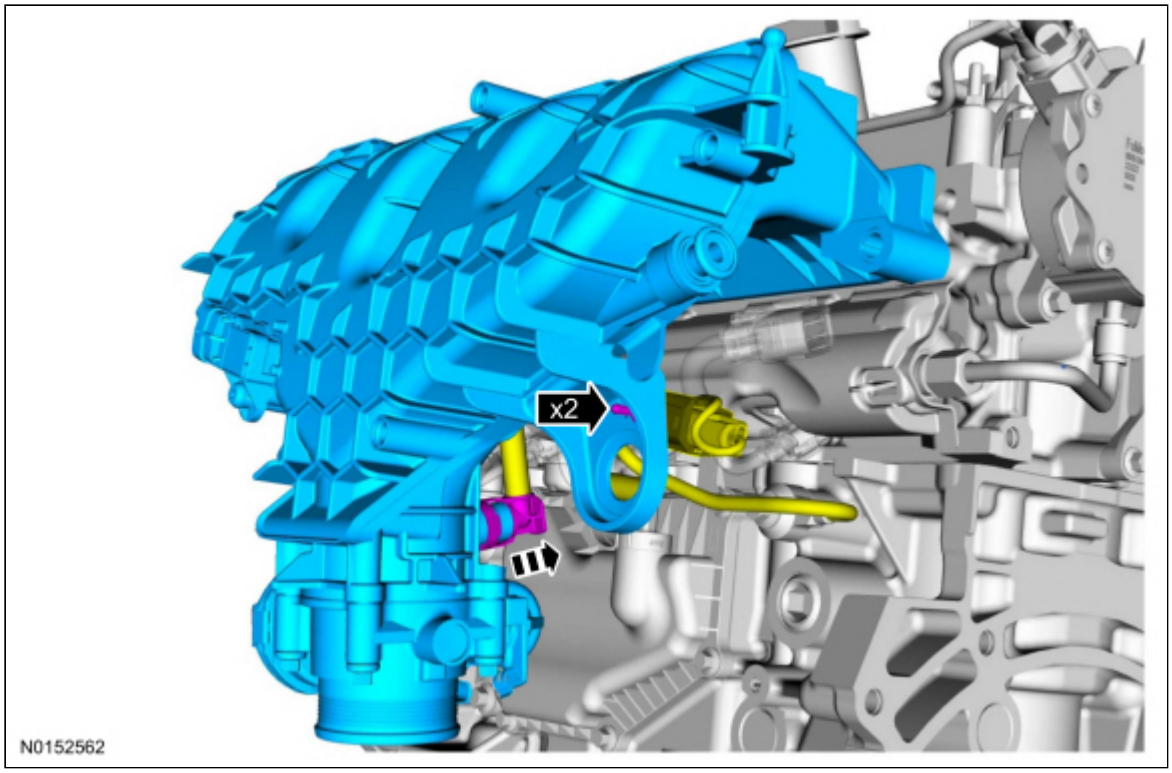


161. **NOTICE: If the engine is repaired or replaced because of upper engine failure, typically including valve or piston damage, check the intake manifold for metal debris. If metal debris is found, install a new intake manifold. Failure to follow these instructions can result in engine damage.**

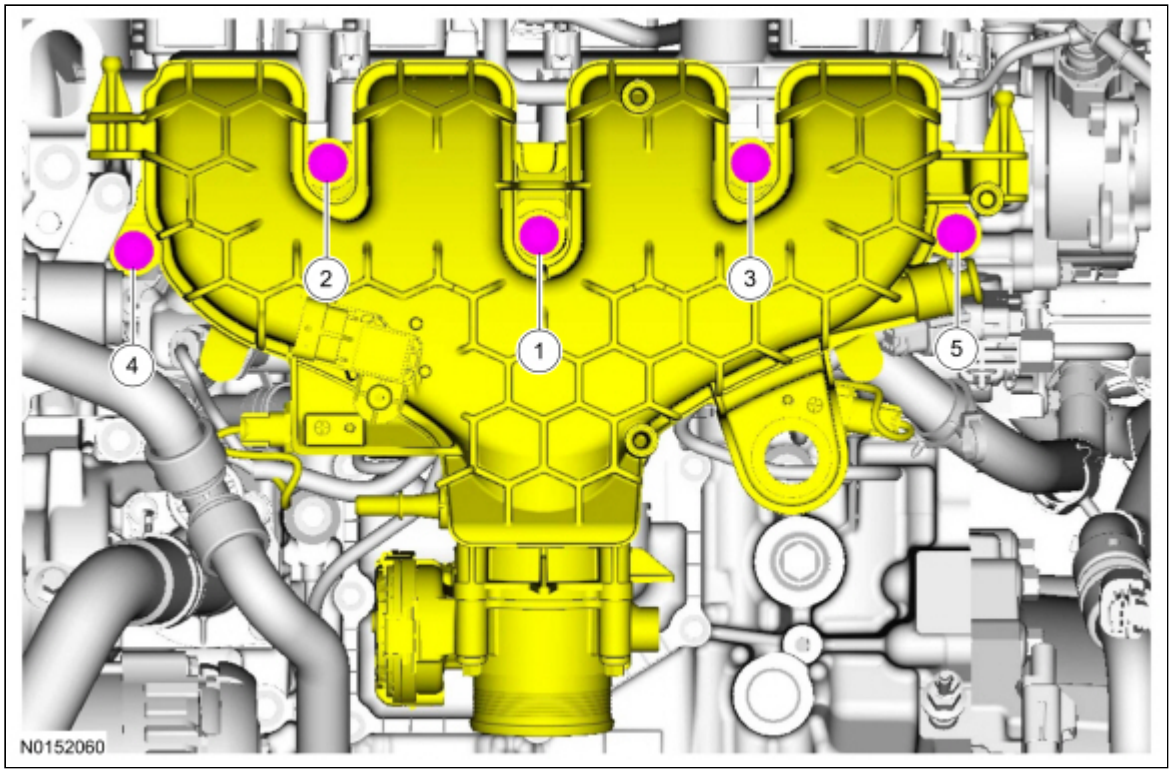
Visually inspect the intake manifold gaskets for nicks, cuts and abrasions. If these conditions are not present, the gaskets may be reused.



162. Install the intake manifold and connect the crankcase vent oil separator tube and the KS wiring harness electrical connector retainers.

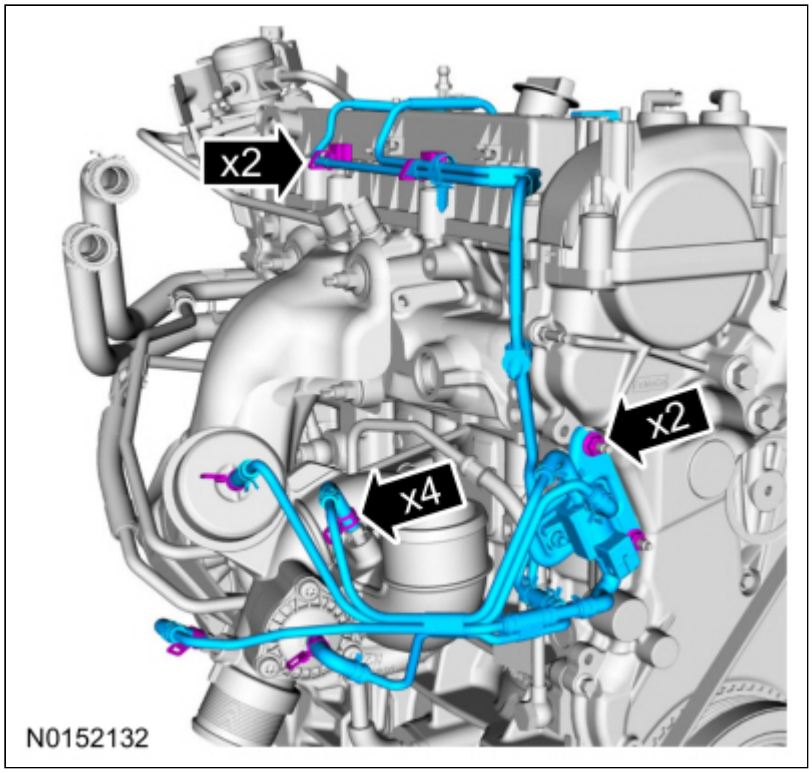


163. Position the intake manifold and install the bolts.
Torque: 177 lb.in (20 Nm)



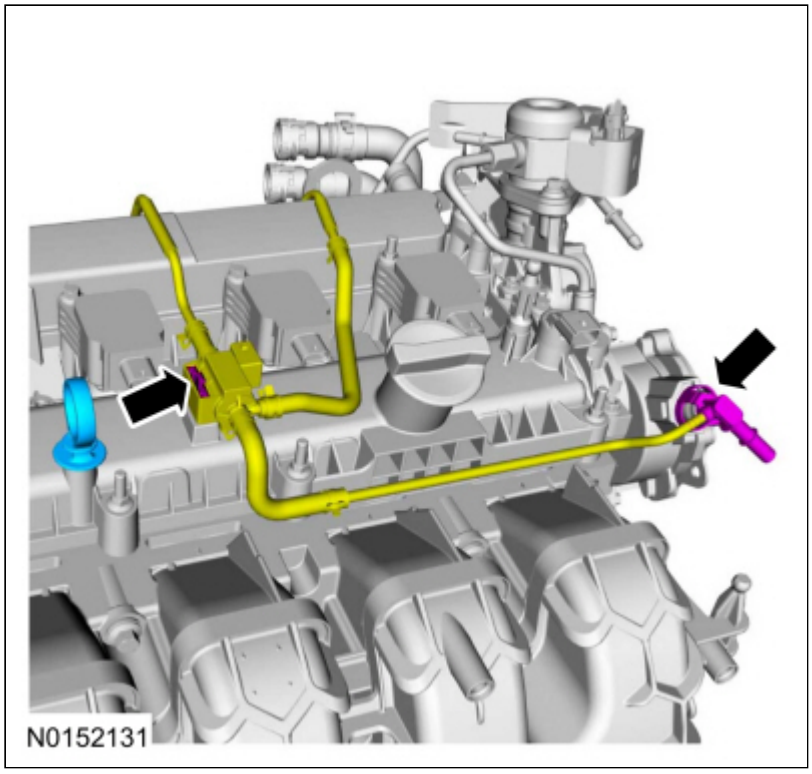
164.

- Install the turbocharger vacuum control valve and vacuum tube assembly and the nuts.
  Torque: 89 lb.in (10 Nm)
- Connect the vacuum tubes to the turbocharger.
  Use the General Equipment: Hose Clamp Remover/Installer
- Attach the vacuum tube retainers.

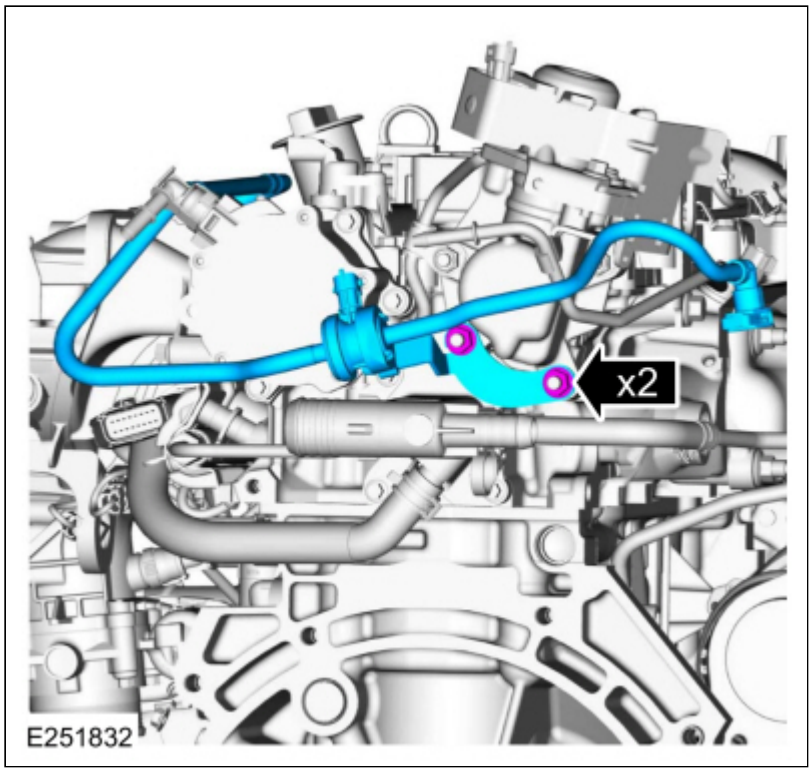


165.

- Install the oil indicator.
- Position and attach the vacuum valve to the valve cover.
- Connect the vacuum tube at the brake vacuum pump.

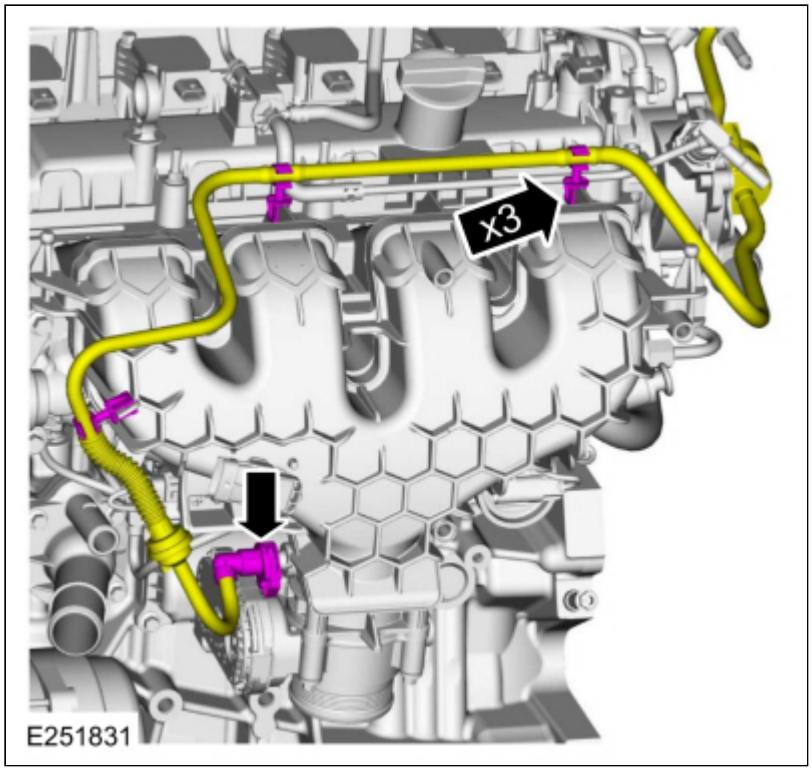


166. Install the EVAP canister purge valve and the nuts.
Torque: 97 lb.in (11 Nm)

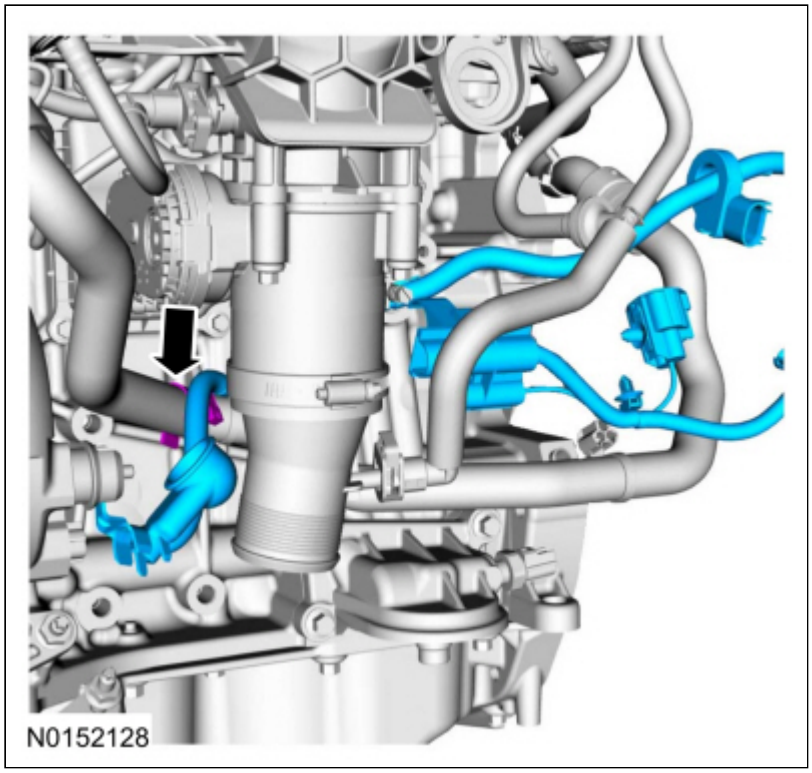


167.

- Attach the EVAP canister purge valve tube retainers.
- Connect the EVAP canister purge valve quick release coupling.
Refer to: Quick Release Coupling (310-00D Fuel System - General Information - 2.3L EcoBoost (257kW/350PS) - MI4, General Procedures).

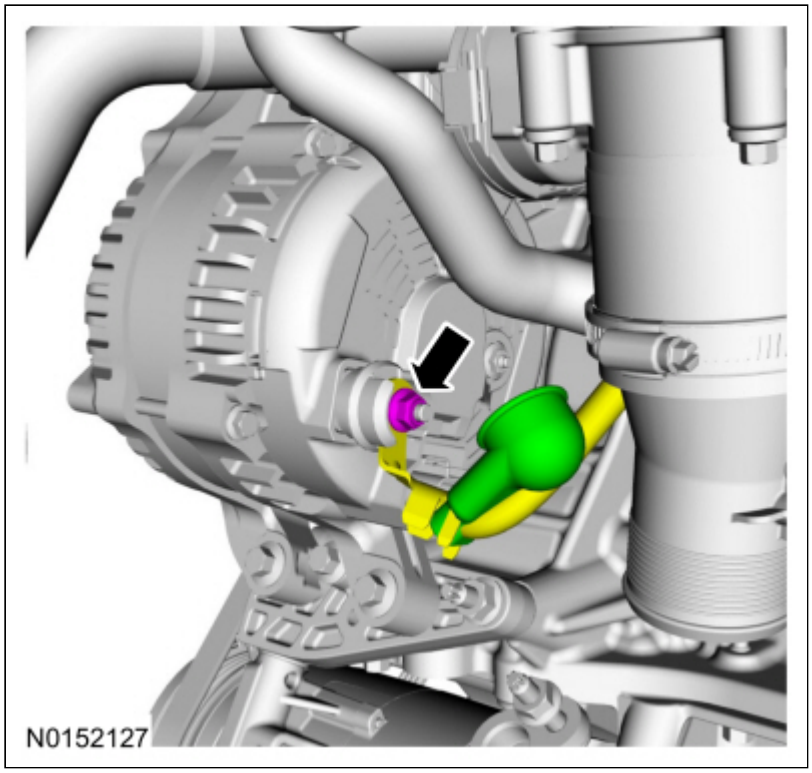


168. Install the wiring harness and attach the generator B+ wiring harness retainer.



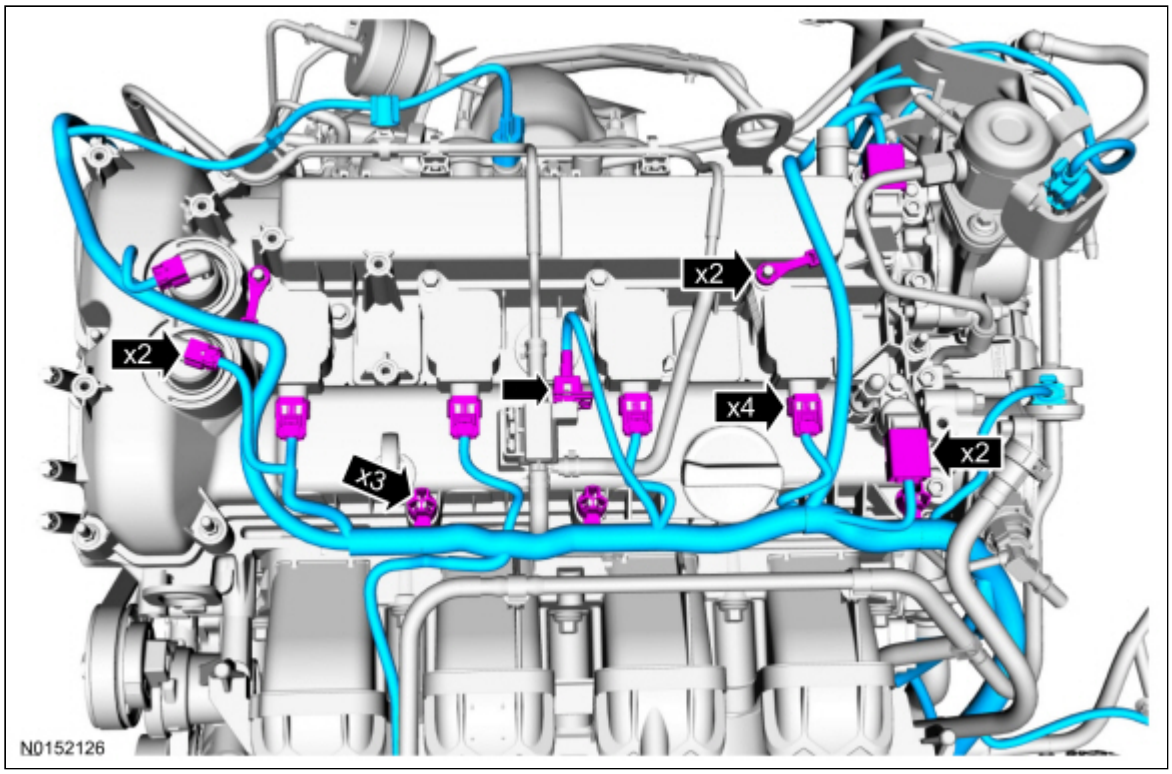
169.

- Install the generator B+ terminal wiring and nut.
  Torque: 150 lb.in (17 Nm)
- Install the generator B+ protective cover.



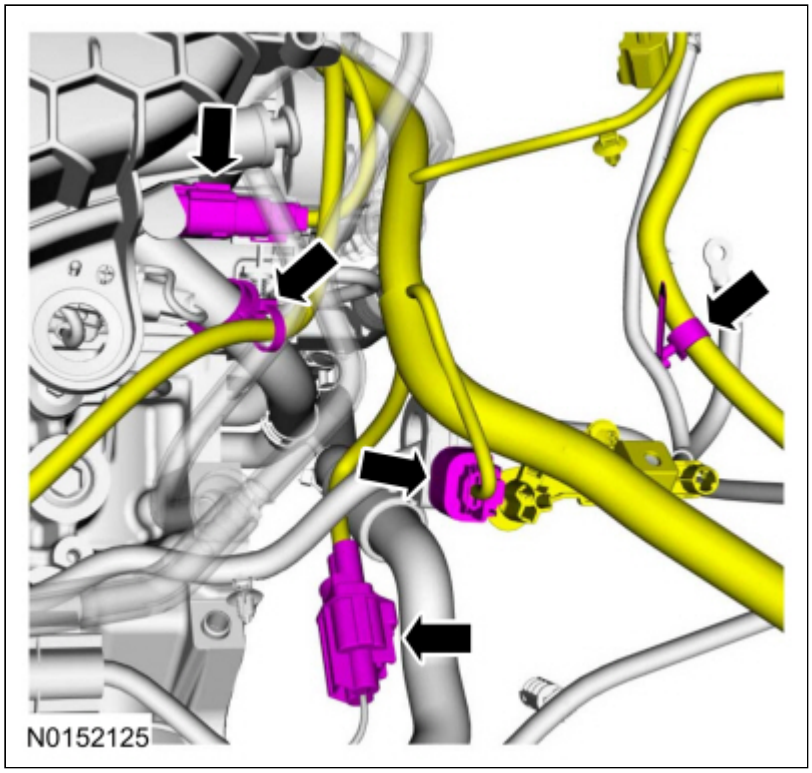
170.

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



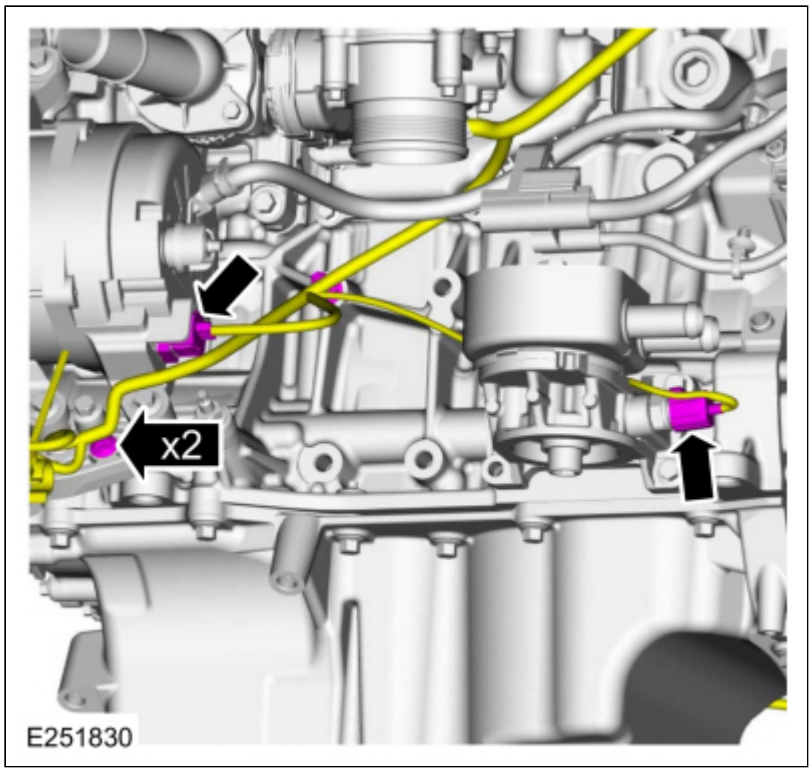
171.

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



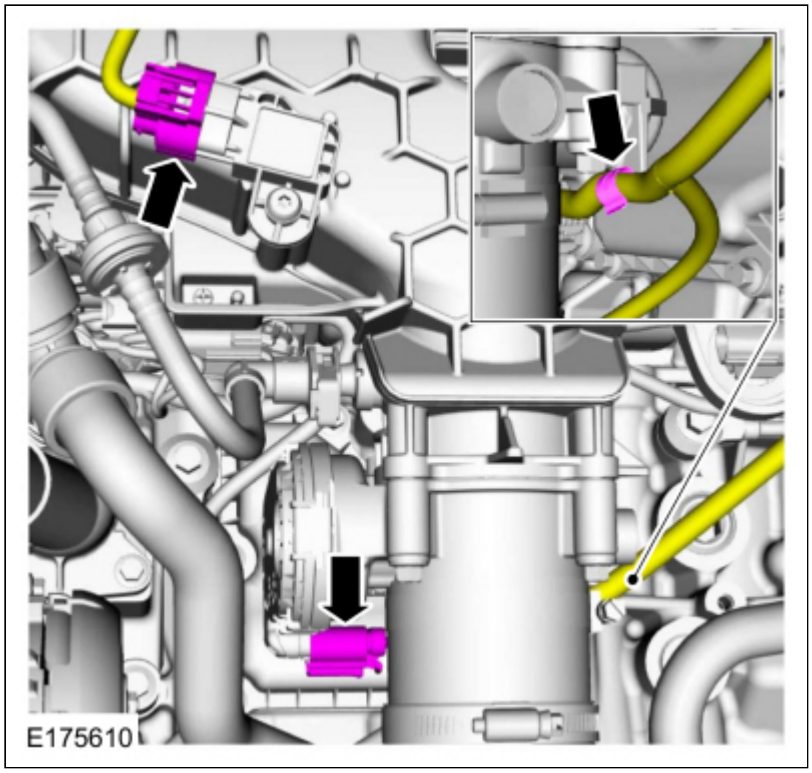
172.

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



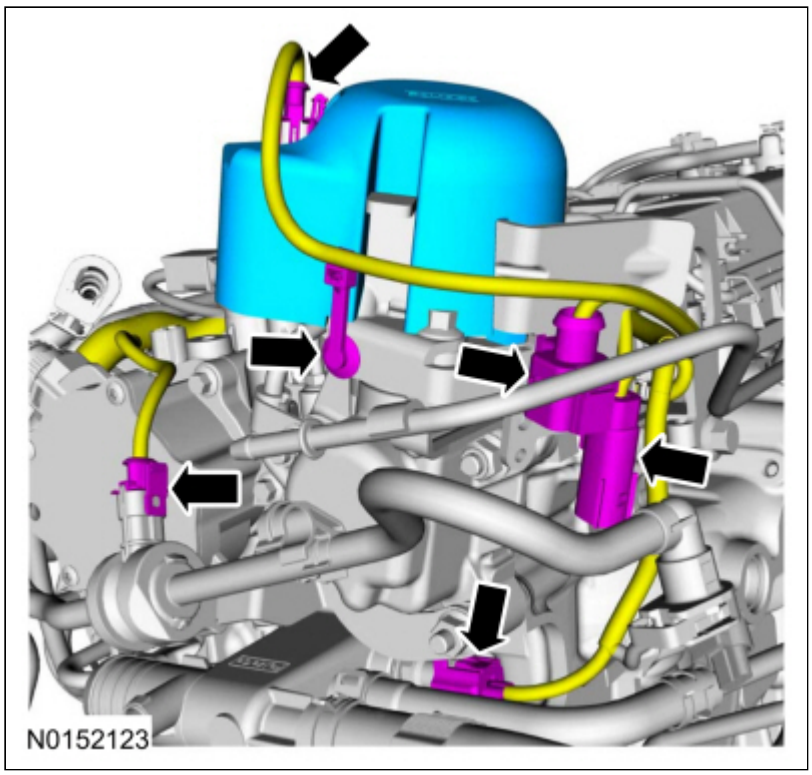
173.

- Position the wiring harness and connect the throttle body electrical connector and attach the retainer.
- Connect the MAP sensor electrical connector.



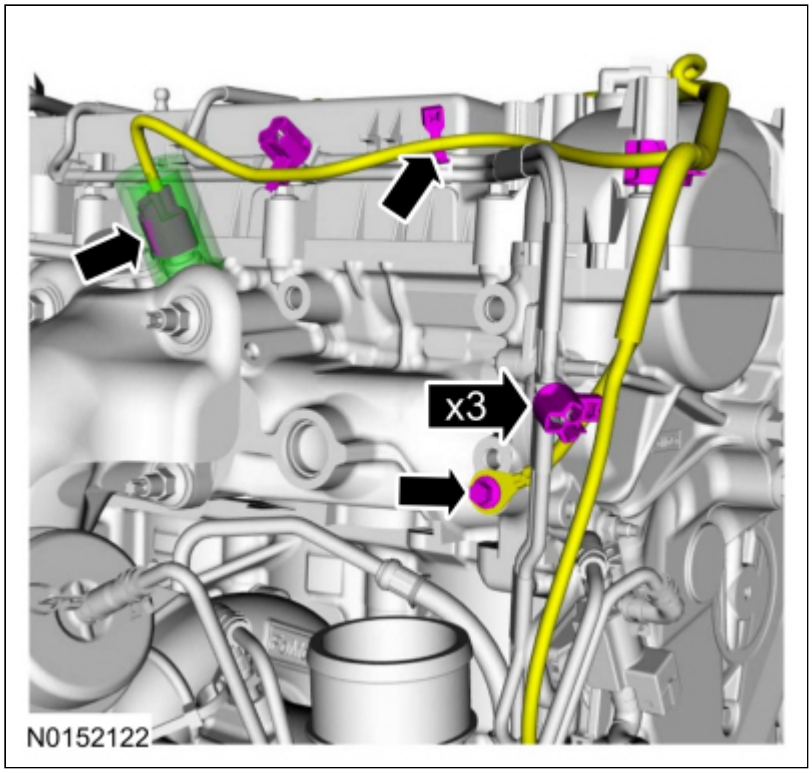
174.

- If equipped, install the fuel pump insulator.
- Attach the HO2S and catalyst monitor sensor electrical connectors to the bracket.
- Attach the wiring harness retainer.
- Connect the electrical connectors.

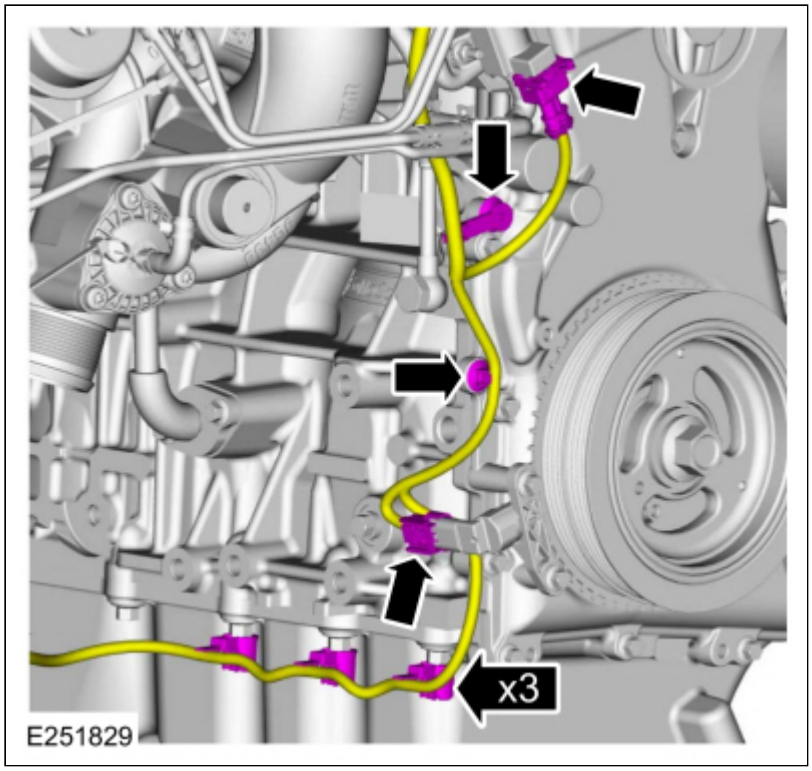


175.

- Position wiring harness and install the bolt for the ground wire.
- Attach the wiring harness retainers.
- Connect the CHT sensor electrical connector.

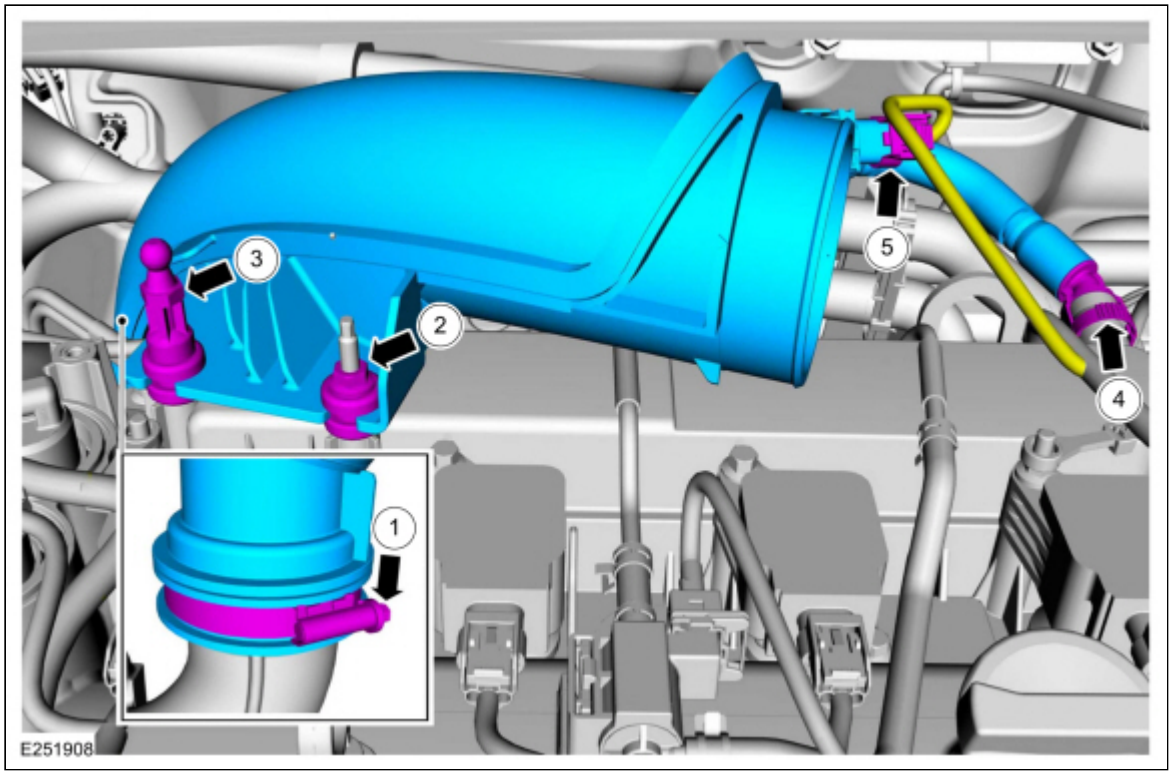


176. Connect the electrical connectors and the wiring harness retainers.

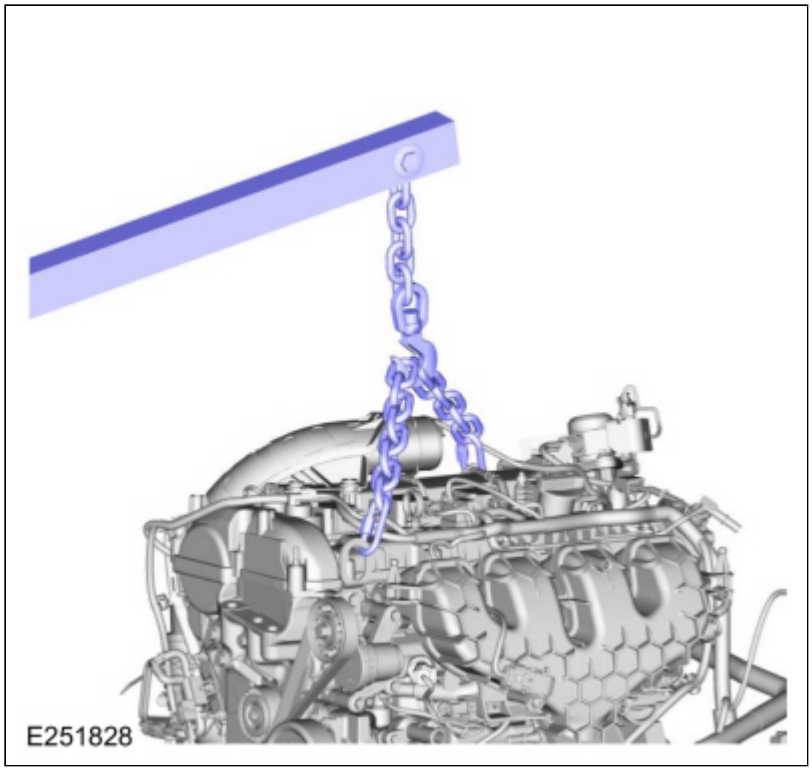


177.

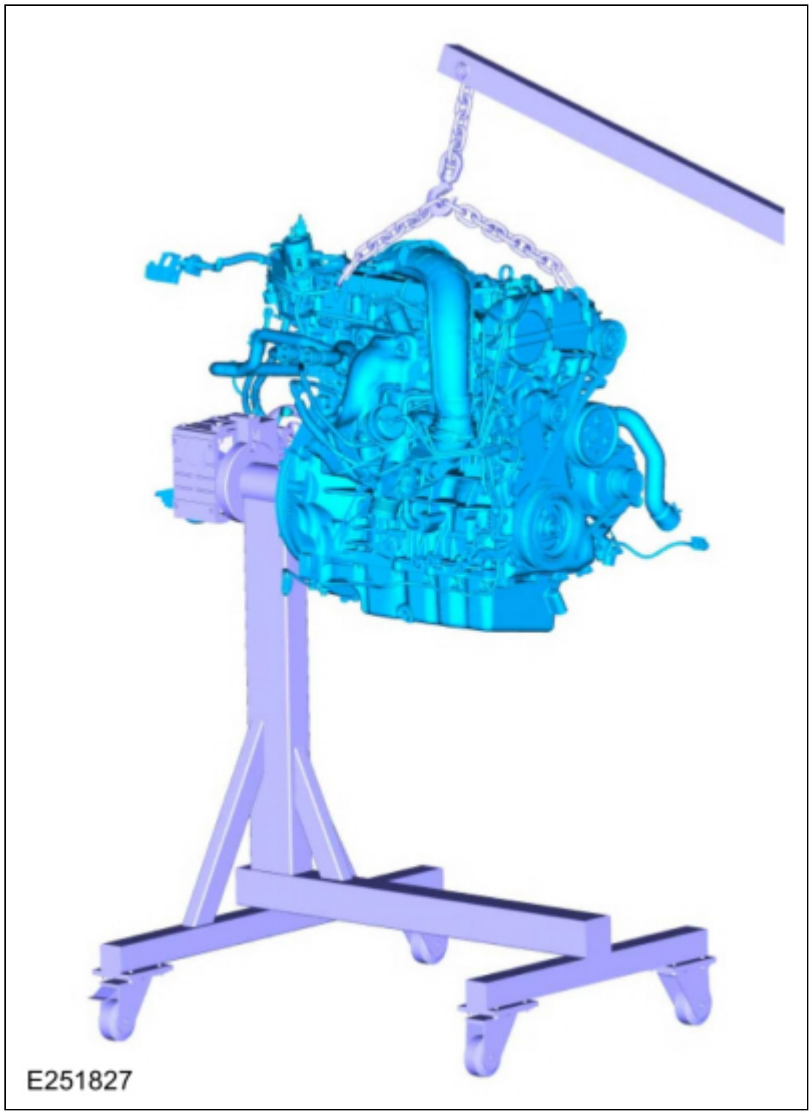
1. Install the turbocharger inlet pipe and tighten the clamp.
   Torque: 44 lb.in (5 Nm)
2. Install the turbocharger inlet pipe nut.
   Torque: 89 lb.in (10 Nm)
3. Install the engine cover mounting stud.
   Torque: 89 lb.in (10 Nm)
4. Connect the crankcase vent tube to the valve cover.
5. Connect the crankcase pressure sensor electrical connector.



178. Install the engine lifting equipment.
Use the General Equipment: Floor Crane

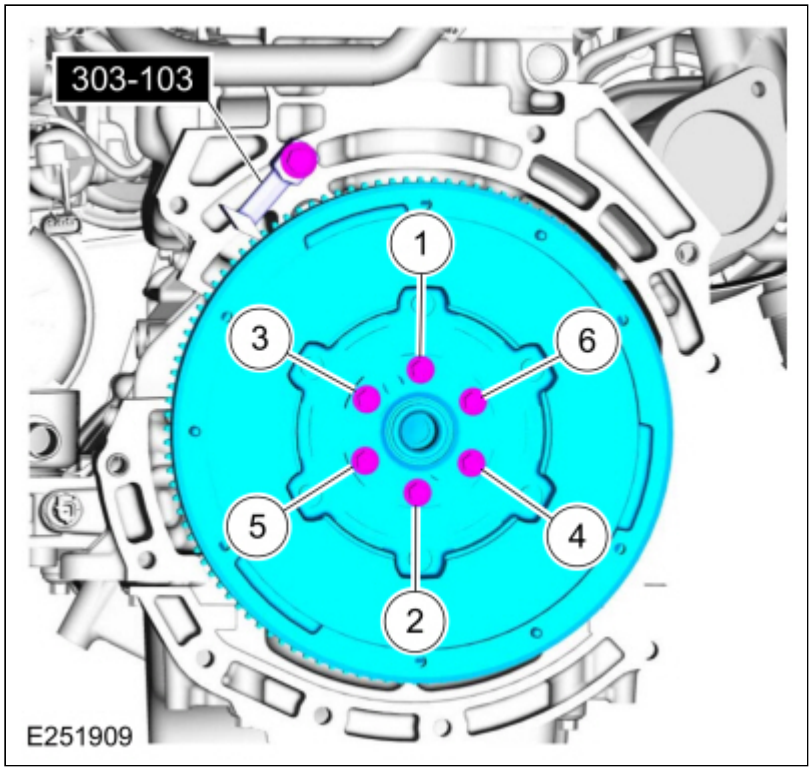


179. Remove engine from the mounting stand.
Use the General Equipment: Mounting Stand



180.

- Install the flywheel and the new bolts finger-tight.
- Install Special Service Tool: 303-103 (T74P-6375-A) Holding Tool, Flywheel.
- Tighten the bolts in sequence shown in 3 stages.
  Torque:
  Stage 1: 37 lb.ft (50 Nm)
  Stage 2: 59 lb.ft (80 Nm)
  Stage 3: 83 lb.ft (112 Nm)



181.

1. Install the clutch disc and pressure plate on the flywheel and center the clutch disc to the crankshaft with a clutch alignment tool. Tighten every other pressure plate bolt 2 turns at a time.
   Use the General Equipment: Clutch Alignment Tool
   Torque: 16 lb.ft (22 Nm)
2. Tighten all the pressure plate bolt 2 turns at a time.
   Torque: 21 lb.ft (29 Nm)