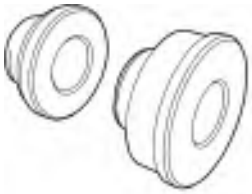
Engine

Base Part Number: Base Part Number: 6L084

Special Tool(s) / General Equipment

 E234304	205-142 (T80T-4000-J) Installer, Differential Bearing Cone
 E133913	205-153 (T80T-4000-W) Handle
 E175042	303-1247 VCT Spark Plug Tube Seal Remover and Installer TKIT-2006UF-FLM TKIT-2006UF-ROW
 ST2980-A	303-1250 Seal Installer, Rear Main TKIT-2006UFFLM
 E216458	303-1531 Installer, Front Crank Seal and Damper

 E222985	303-335 (T88T-6701-A) Installer, Front Cover Oil Seal TKIT-1988-F TKIT-1988-FLM
	303-448 (T93P-6303-A) Holding Tool, Crankshaft TKIT-1993-FLM TKIT-1993-LM
	303-F047 Lifting Bracket, Engine
Strap Wrench	
Floor Crane	
Mounting Stand	
Piston Ring Compressor	

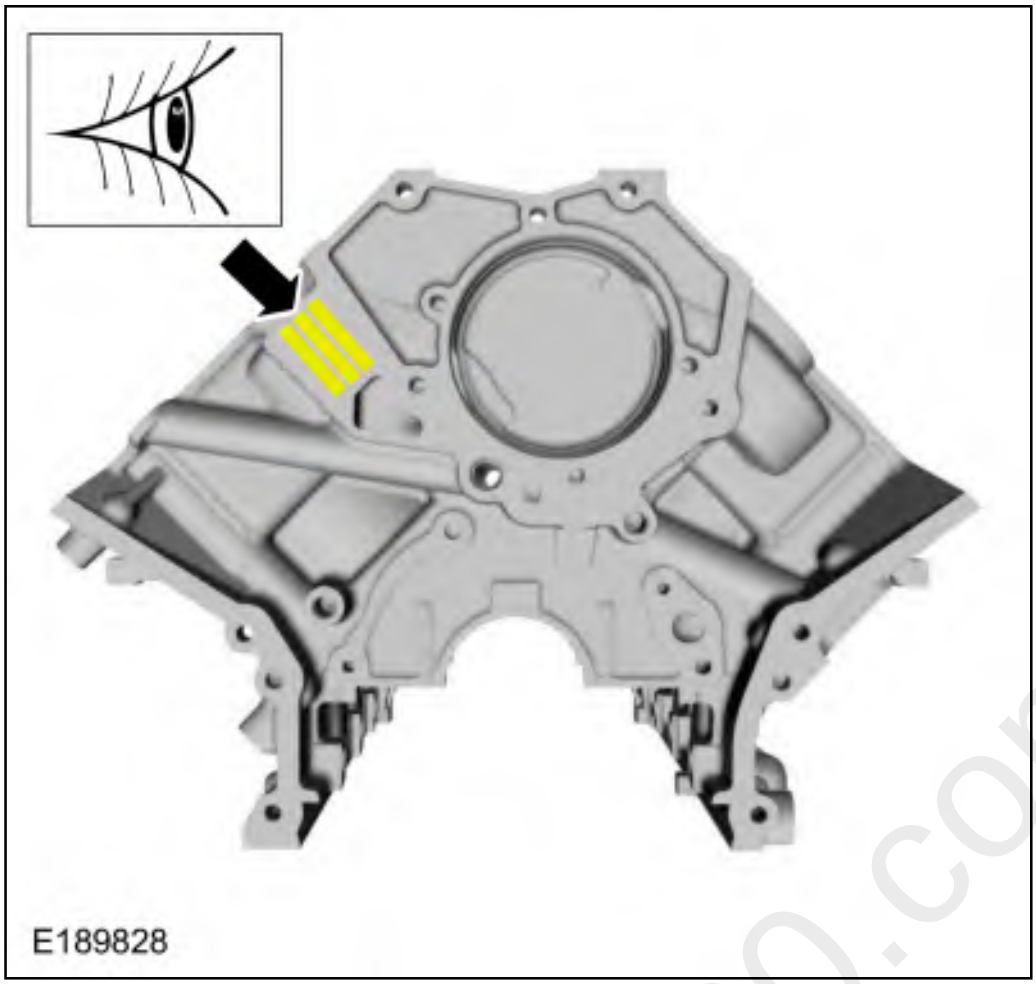
Materials

Name	Specification
Motorcraft® Silicone Gasket and Sealant TA-30	WSE-M4G323-A4
Motorcraft® Orange Concentrated Antifreeze/Coolant VC-3-B	WSS-M97B44-D

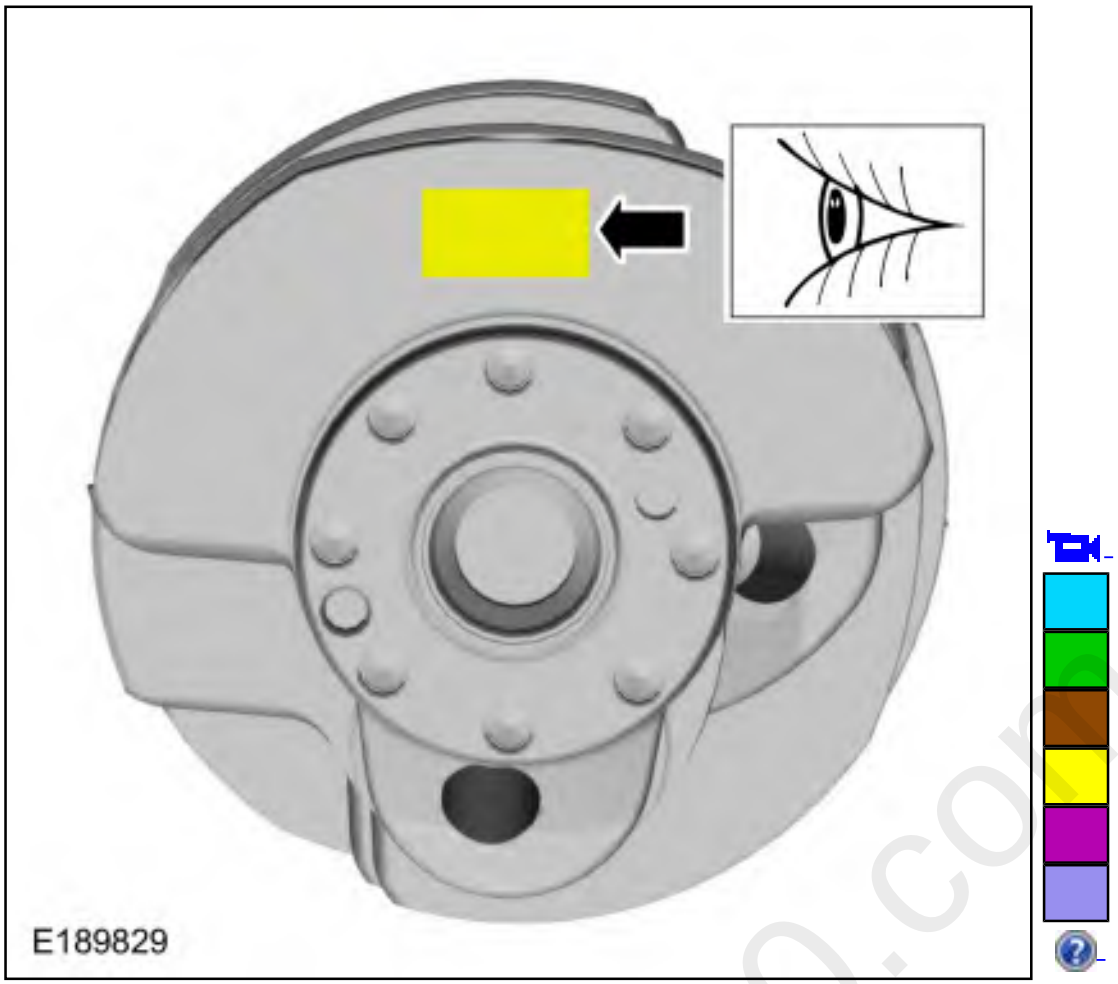
NOTICE: During engine repair procedures, cleanliness is extremely important. Any foreign material, including any material created while cleaning gasket surfaces, that enters the oil passages, coolant passages or the oil pan, can cause engine failure.

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

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



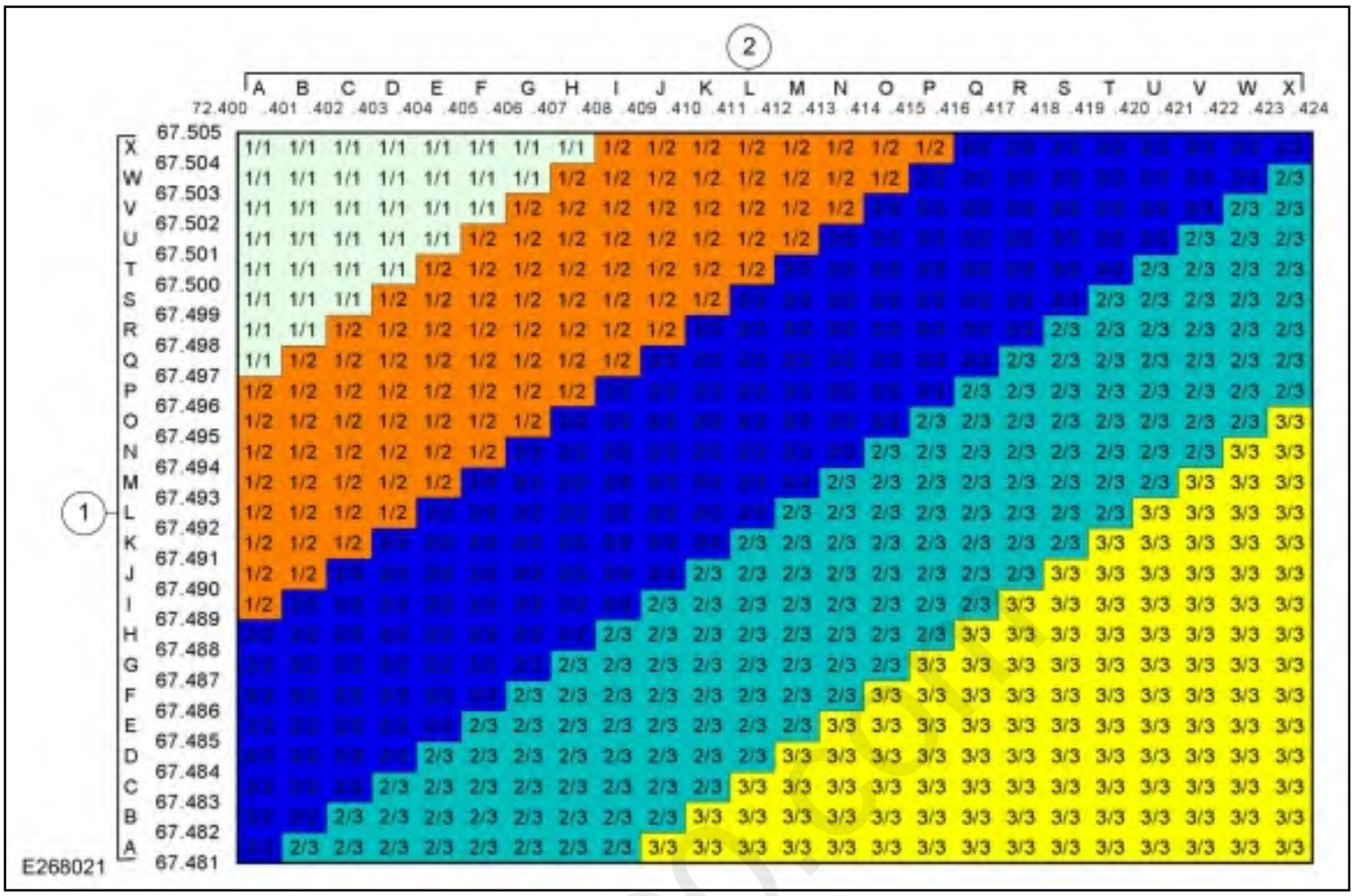
2. Record the main bearing code found on the rear of the crankshaft.



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

   Using the data recorded earlier and the Bearing Select Fit Chart, Standard Bearings, determine the required bearing grade for main bearings 1 and 5.
   1. Maximum crankshaft journal diameter
   2. Minimum block bore diameter

   - Read the first letter of the engine block main bearing code and the first letter of the crankshaft main bearing code.
   - Read down the column below the engine block main bearing code letter and across the row next to the crankshaft main bearing code letter, until the 2 intersect. This is the required bearing grade(s) for the No. 1 crankshaft main bearing.
   - As an example, if the engine block code letter is "F" and the crankshaft code letter is "P", the correct bearing grade for this main bearing is a "1" for the upper bearing and a "2" for the lower bearing.
   - Repeat the above steps using the fifth letter of the block and crankshaft codes to select the No. 5 bearing.

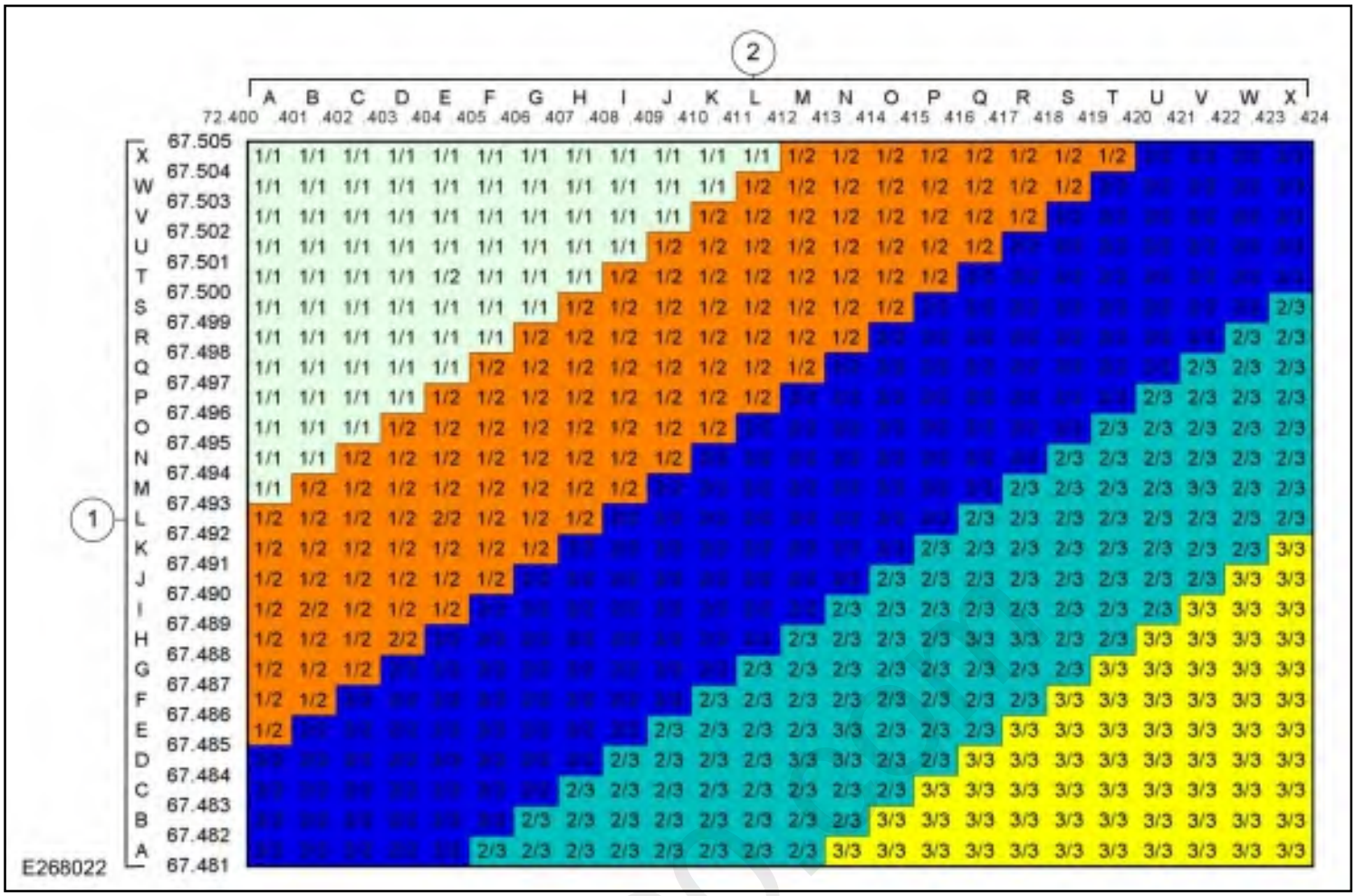


4. **NOTE:** *This chart is for selecting main bearings 2, 3 and 4 only.*

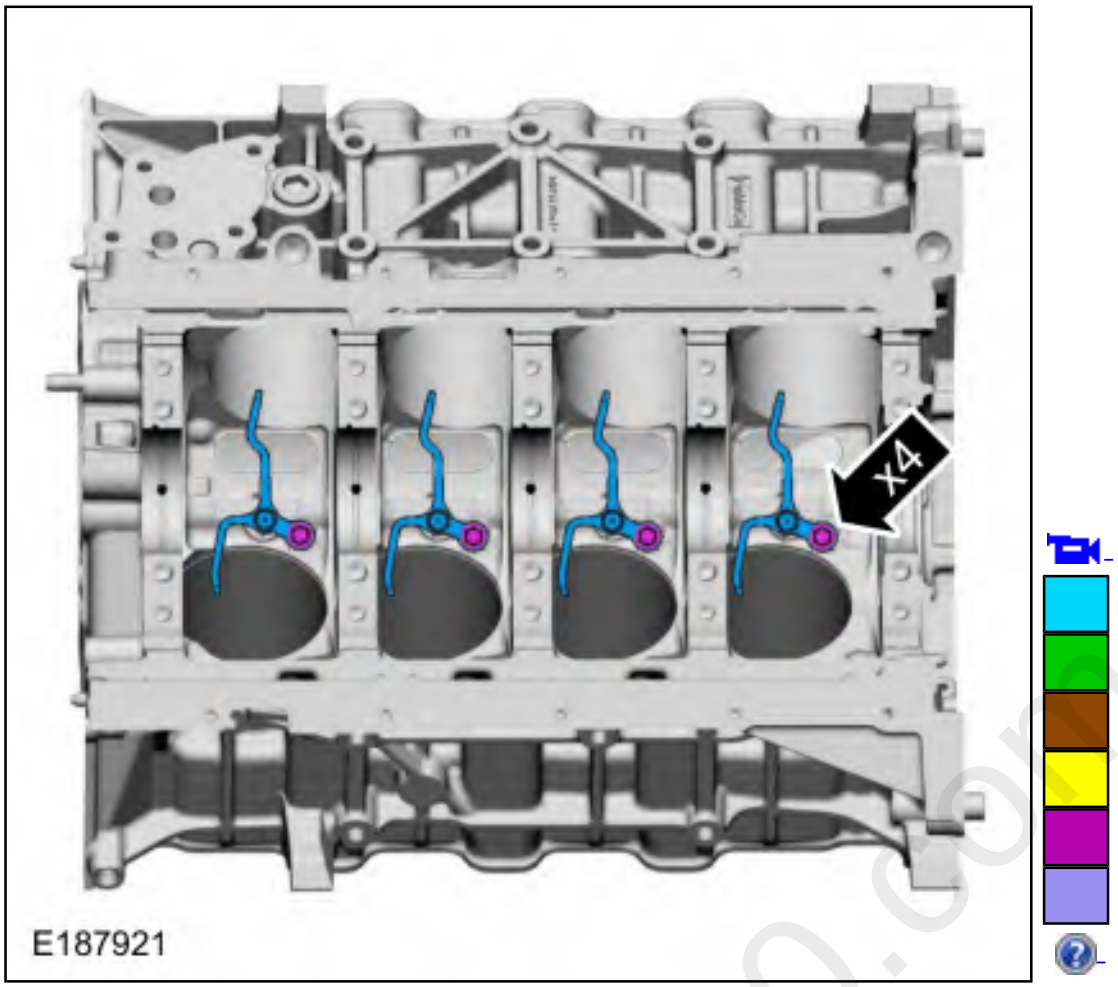
Using the data recorded earlier and the Bearing Select Fit Chart, Standard Bearings, determine the required bearing grade for main bearings 2, 3 and 4.

1. Maximum crankshaft journal diameter
2. Minimum block bore diameter

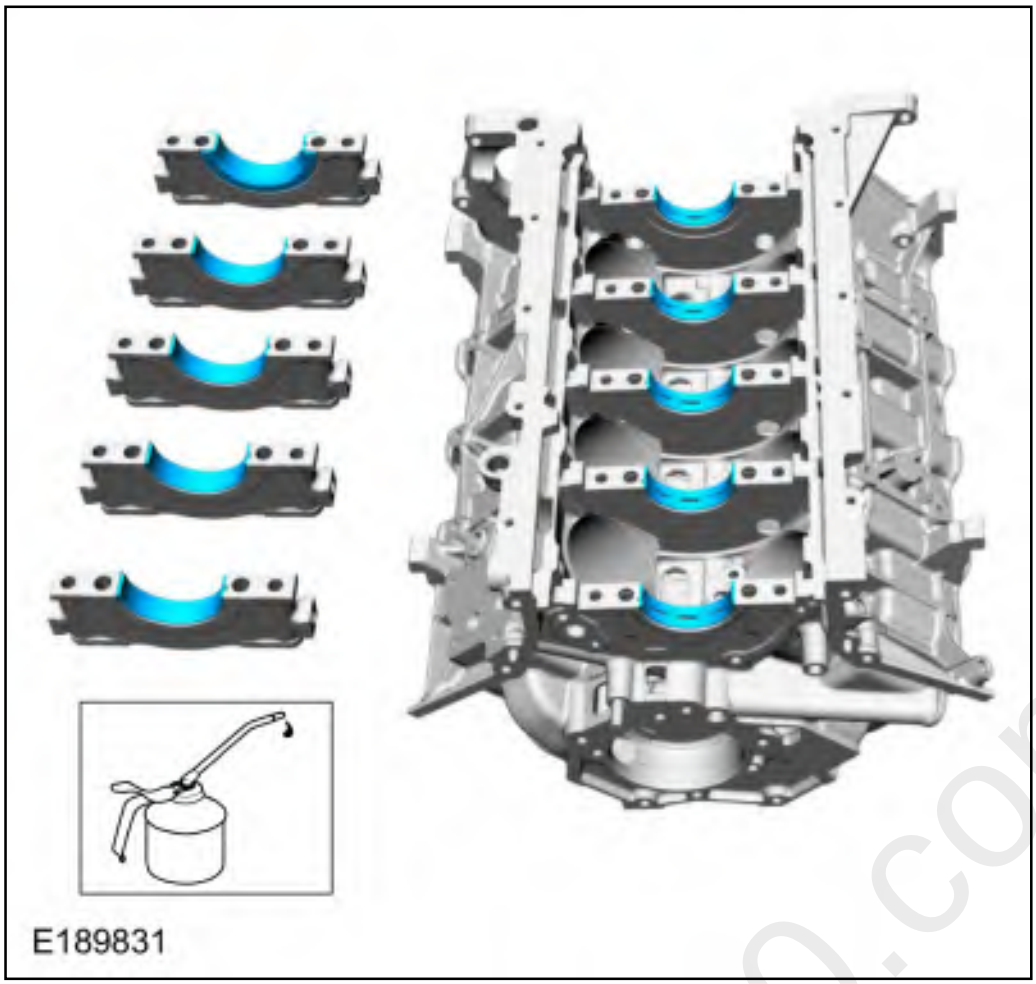
- Read the second letter of the engine block main bearing code and the second letter of the crankshaft main bearing code.
- Read down the column below the engine block main bearing code letter and across the row next to the crankshaft main bearing code letter, until the 2 intersect. This is the required bearing grade(s) for the No. 2 crankshaft main bearing
- As an example, if the engine block code letter is "F" and the crankshaft code letter is "P", the correct bearing grade for this main bearing is a "1" for the upper bearing and a "2" for the lower bearing
- Repeat the above steps using the third and fourth letters of the block and crankshaft codes to select the No. 3 and No. 4 bearings.



5. Install the piston cooling jets and bolts.
   Torque:
   Stage 1: 89 lb.in (10 Nm)
   Stage 2: 45°

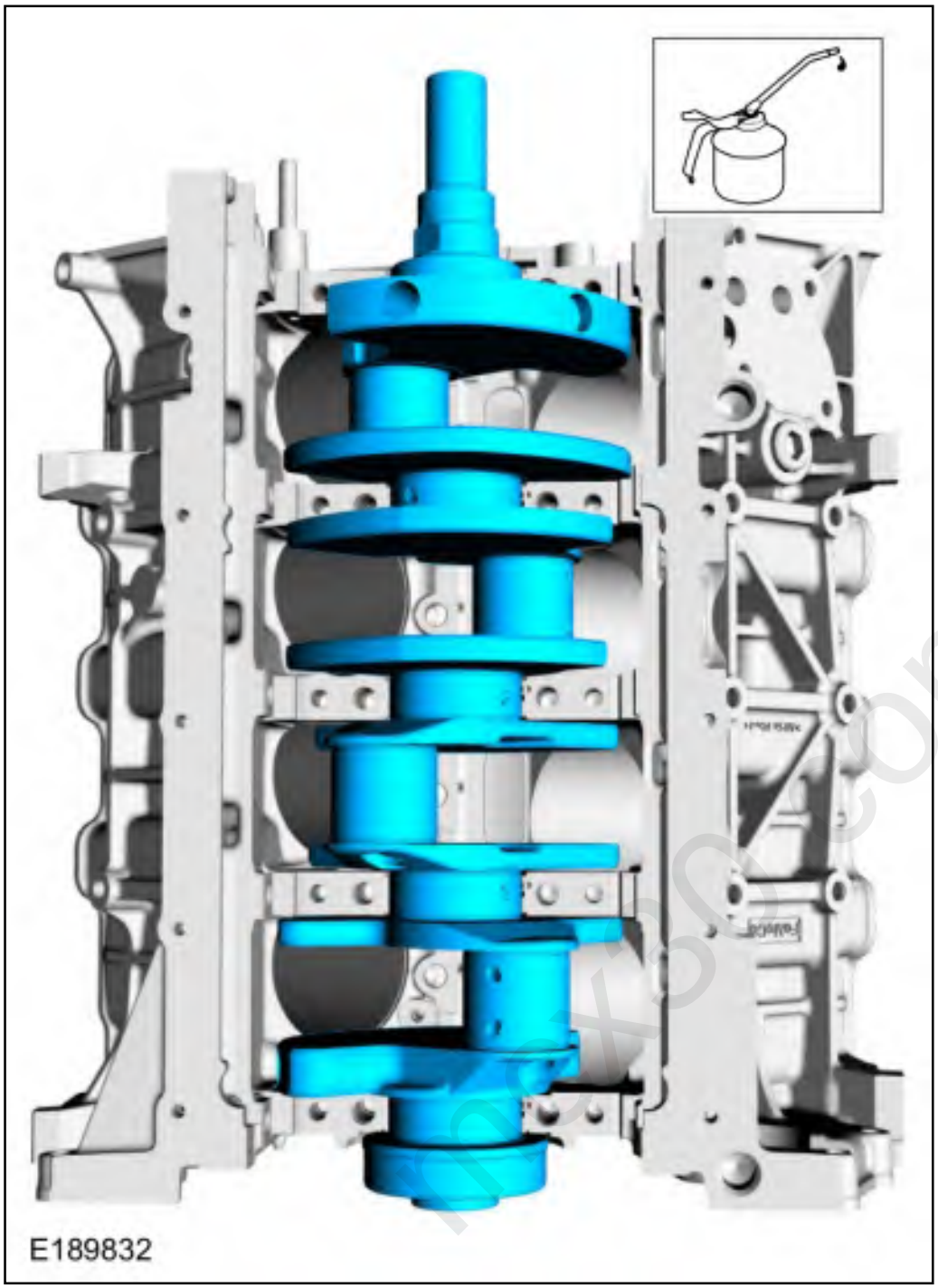


6. Install the crankshaft main bearings.
    - Install the crankshaft upper main bearings into the cylinder block.
    - Install the crankshaft lower main bearings and thrust bearing into the bearing caps.
    - Make sure all oil passages are aligned.
    - Lubricate all main bearings with clean engine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



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

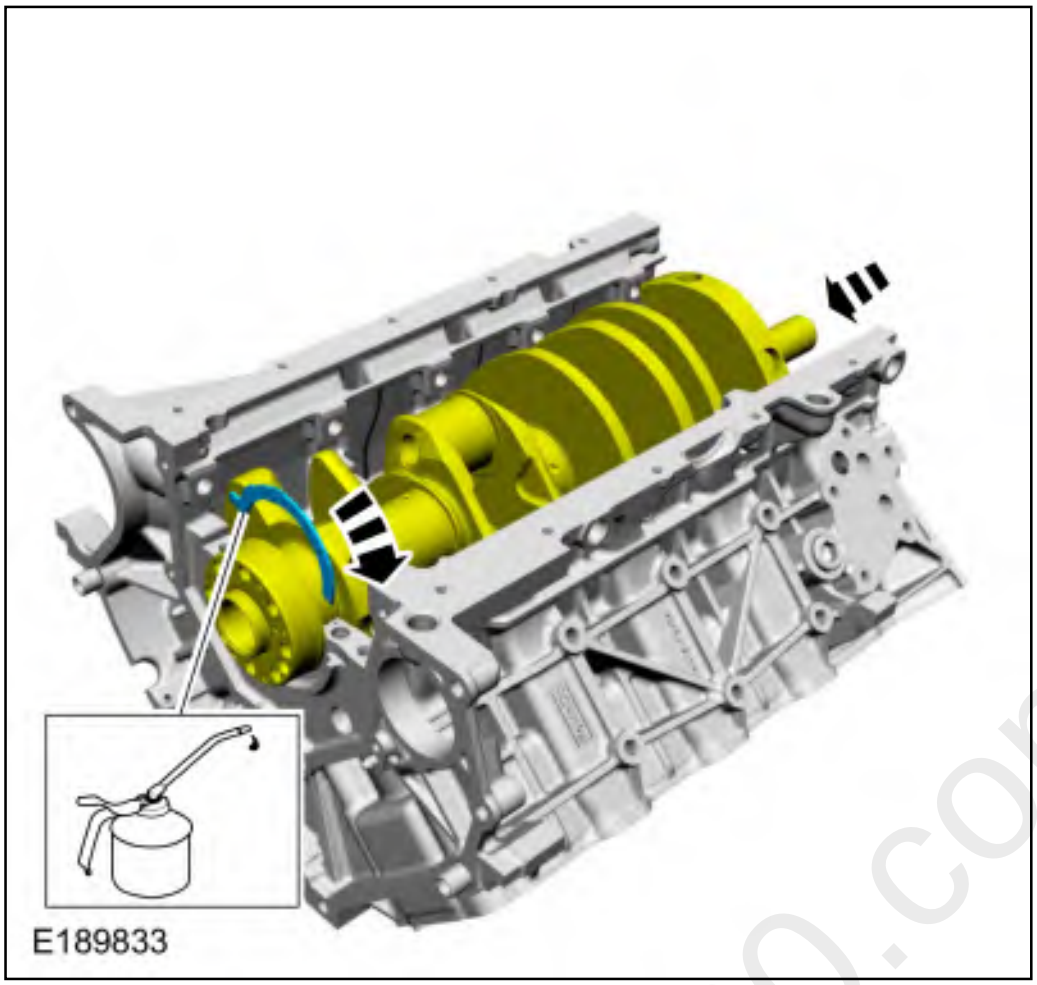
   Install the crankshaft into the cylinder block.



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

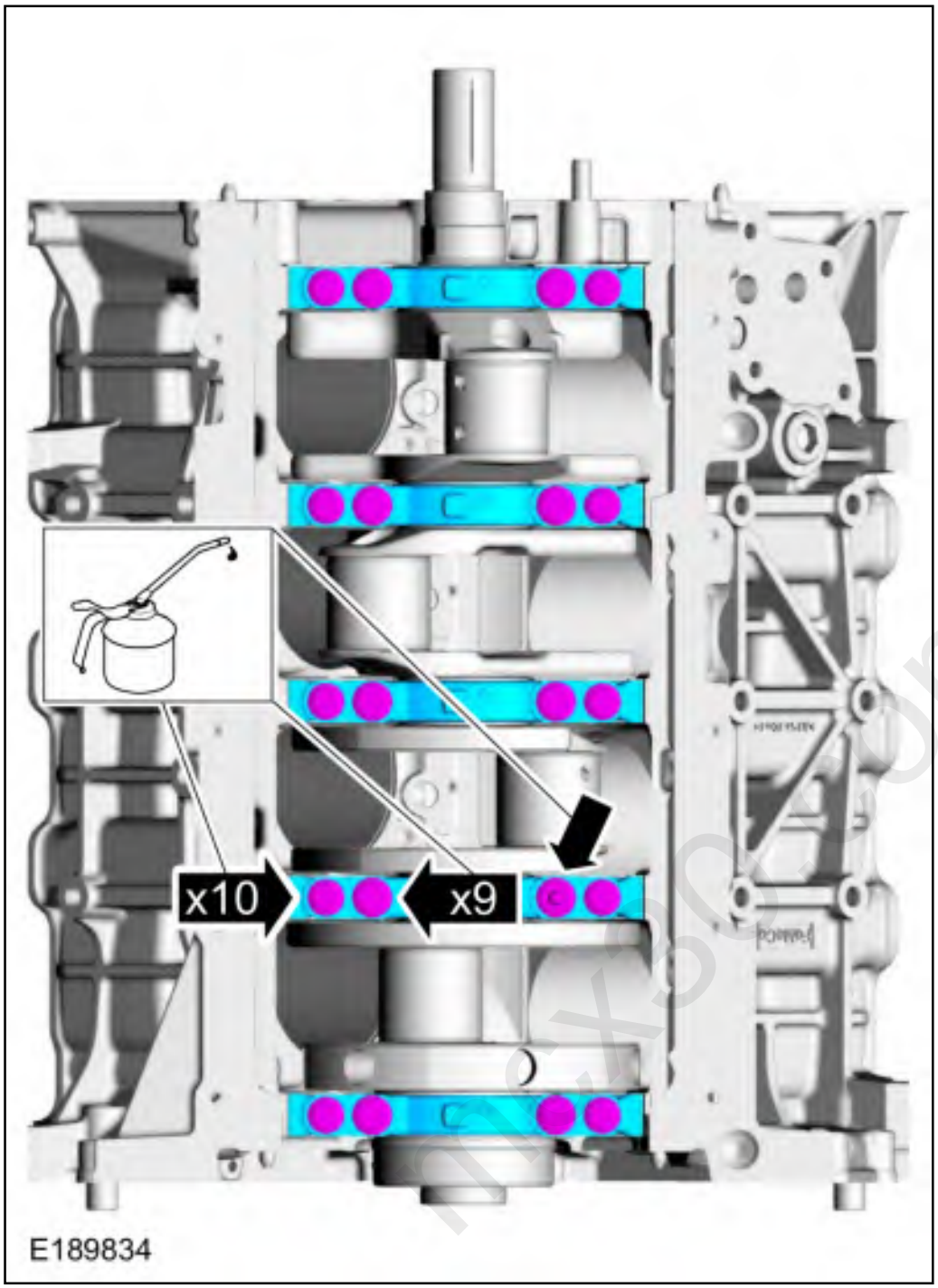
   NOTE: *Lubricate the thrust washer with clean engine oil.*

   Push the crankshaft rearward and install the rear crankshaft upper thrust washer at the back of the No. 5 main boss.

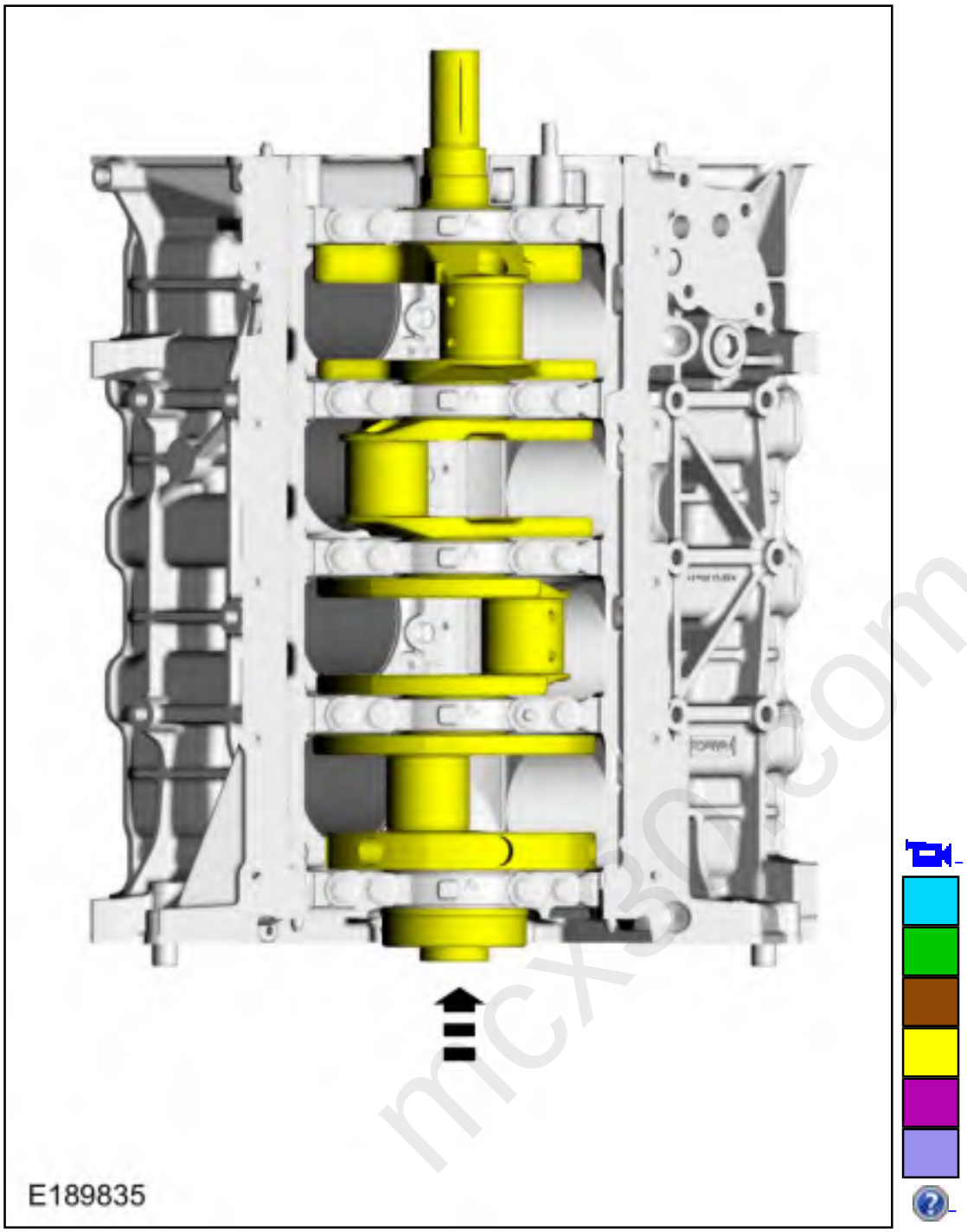


9. **NOTE:** *Lubricate the fastener threads with clean engine oil.*

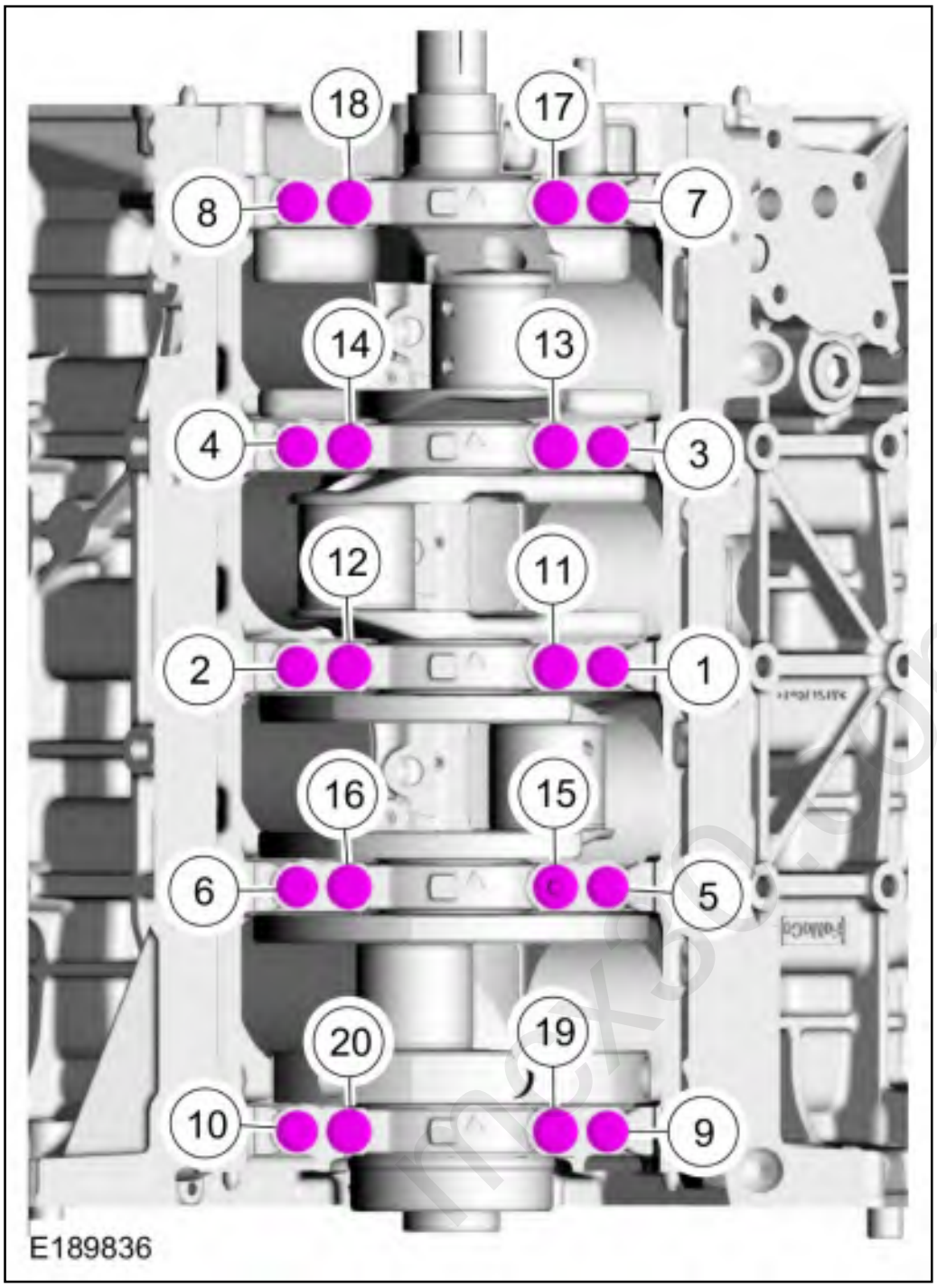
   Install the main bearing caps and fasteners on the cylinder block and, keeping the caps as square as possible, alternately draw the caps down evenly using the cap fasteners.



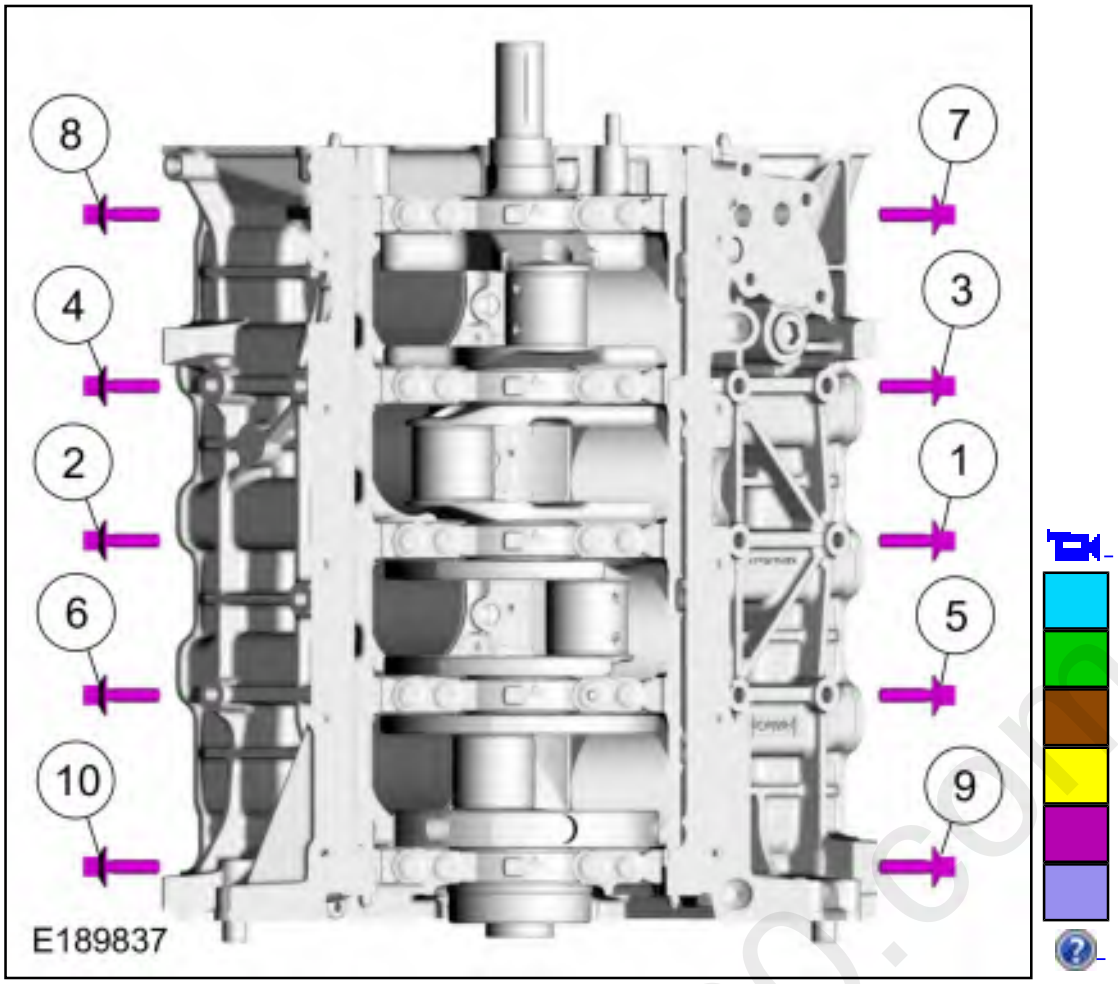
10. Push the crankshaft forward to seat the crankshaft thrust washer.



11. Tighten the vertical main bearing cap fasteners.
    Torque:
    Stage 1: 1 through 20: 177 lb.in (20 Nm)
    Stage 2: 1 through 10: 30 lb.ft (40 Nm)
    Stage 3: 11 through 20 : 48 lb.ft (65 Nm)
    Stage 4: 1 through 20: 90°

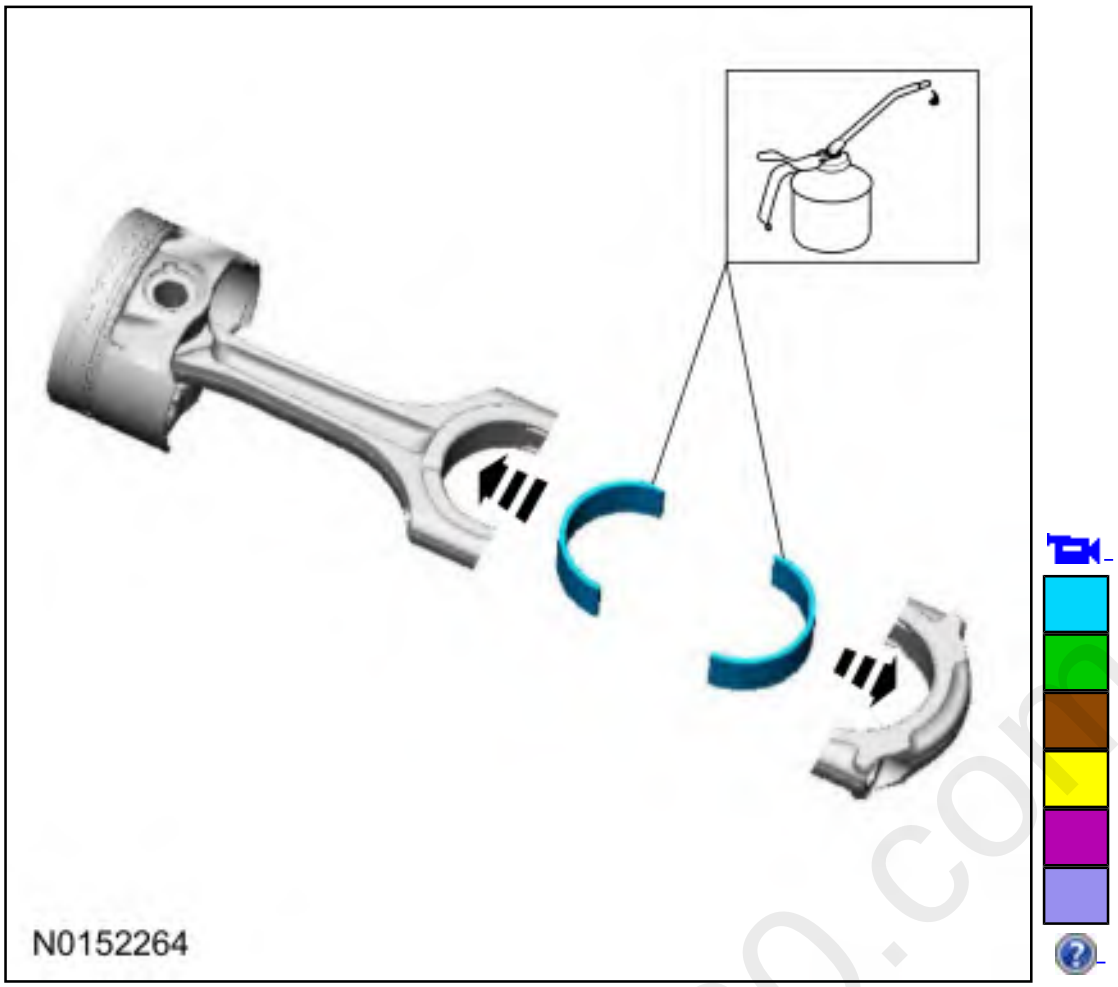


12. Install the cross-mounted main bearing cap fasteners.
    Torque:
    Stage 1: 89 lb.in (10 Nm)
    Stage 2: 22 lb.ft (30 Nm)
    Stage 3: 60°



- Check the crankshaft end play.
  Refer to: Specifications (303-01 Engine - 5.0L 32V Ti-VCT) .
- Check that crankshaft torque-to-turn does not exceed 6 Nm (53 lb-in).
- Check the piston-to-cylinder block and piston ring clearances.
  Refer to: Specifications (303-01 Engine - 5.0L 32V Ti-VCT) .
- Assemble the pistons and position the piston ring gaps.
  Refer to: Piston (303-01 Engine - 5.0L 32V Ti-VCT) .

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



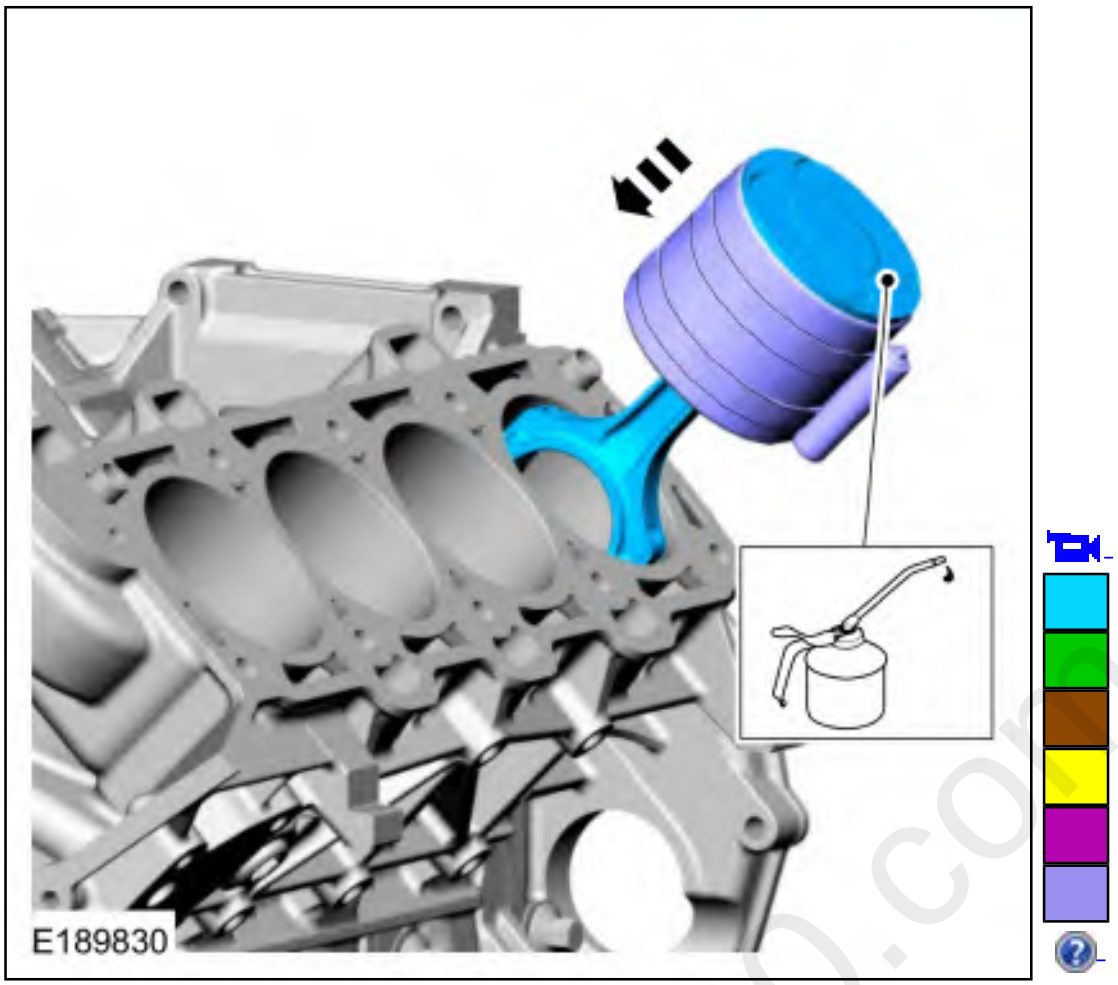
15. **NOTICE: Do not allow the piston connecting rods to come in contact with the piston cooling jets or engine damage may occur.**

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

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

    NOTE: *Lubricate the piston with clean engine oil.*

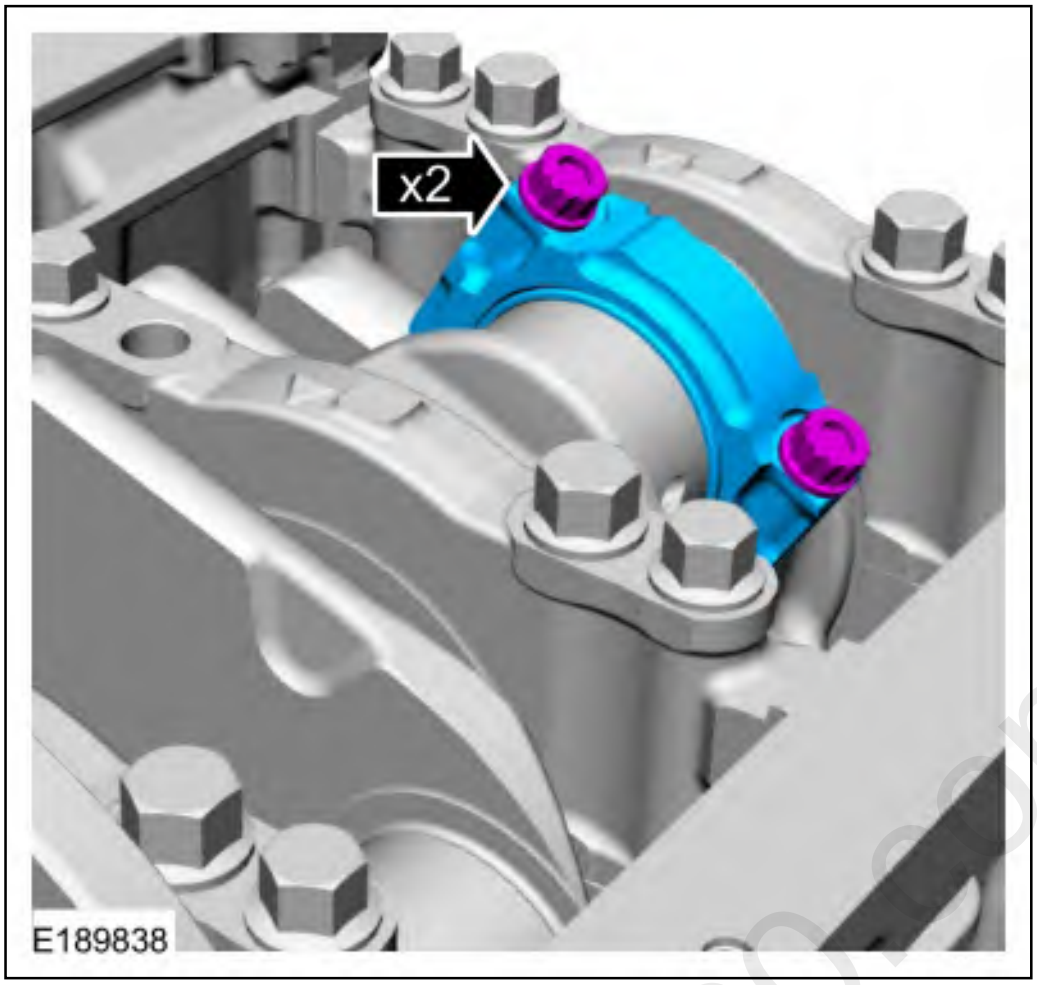
    - Using a piston ring compressor, install the piston.
      Use the General Equipment: Piston Ring Compressor



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

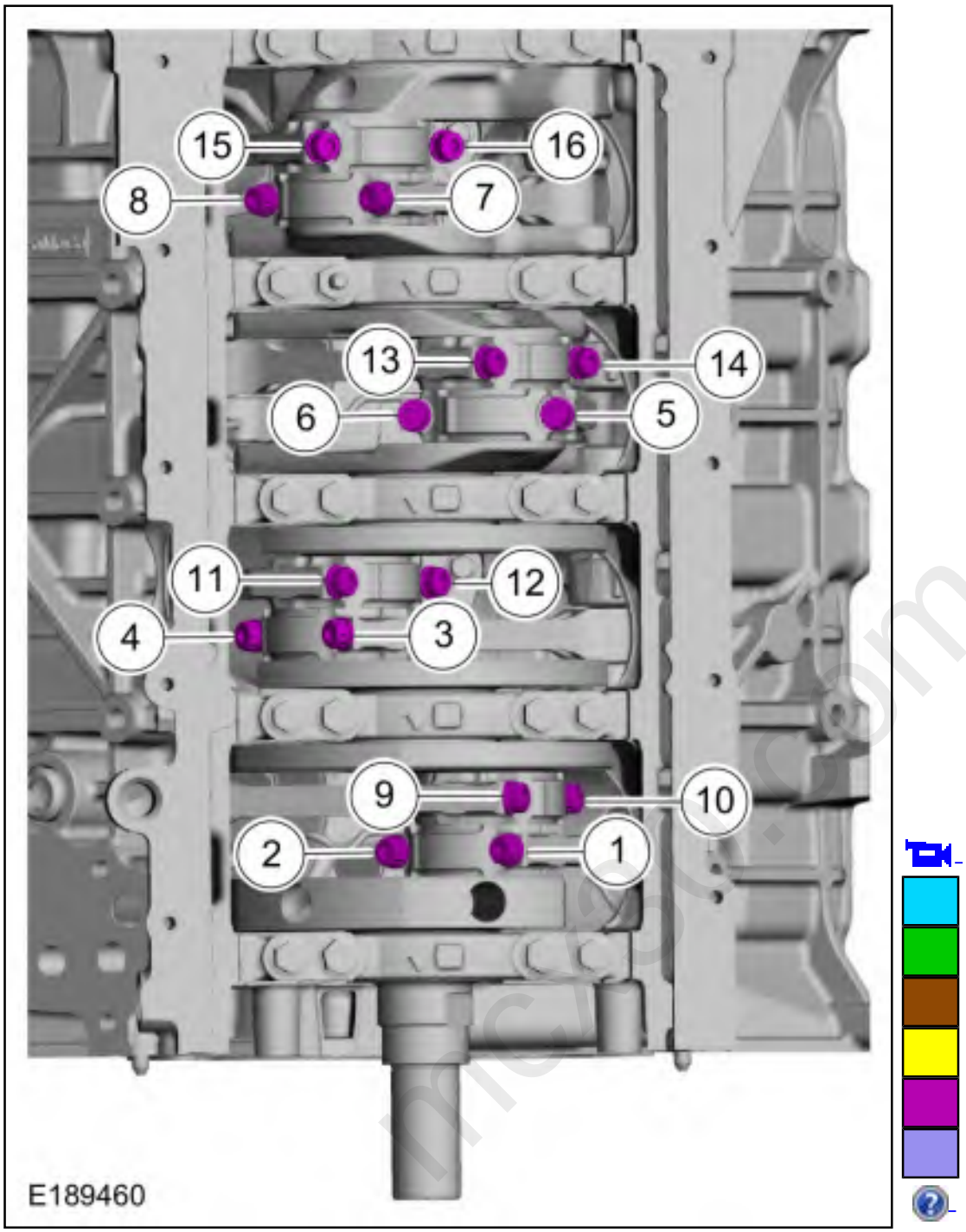
    NOTE: *The connecting rod caps are of the "cracked" design and must mate with the connecting rod ends. Excessive bearing clearance will result if not mated correctly.*

    Install the connecting rod cap and bearing.
    - Install the new bolts hand tight.



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

18. Tighten the connecting rod bolts.
    Torque:
    Stage 1: 177 lb.in (20 Nm)
    Stage 2: 28 lb.ft (38 Nm)
    Stage 3: 105°

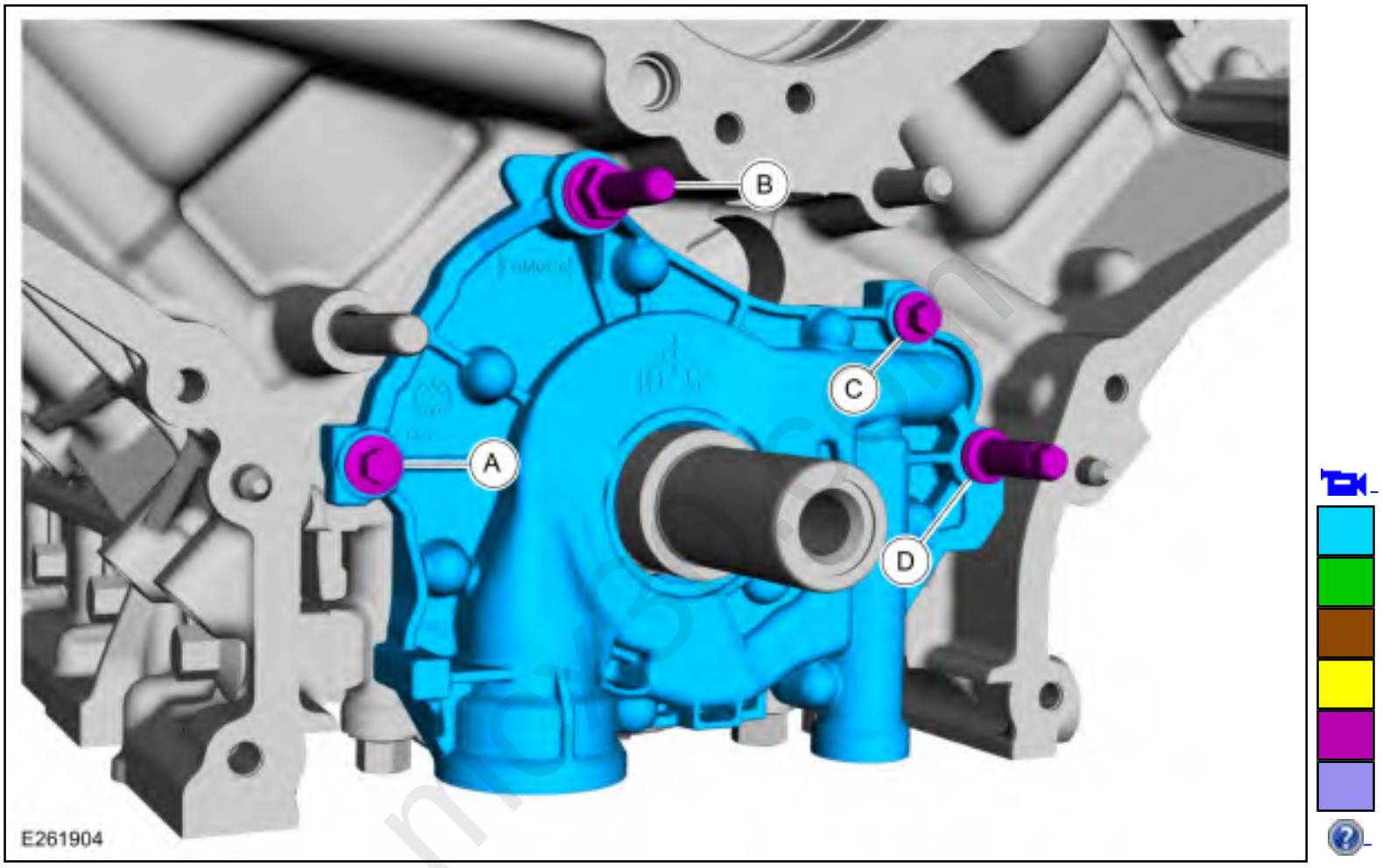


19. Prime the oil pump. Add 2 tablespoons of clean engine oil to the oil pump and rotate the oil pump by hand.

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

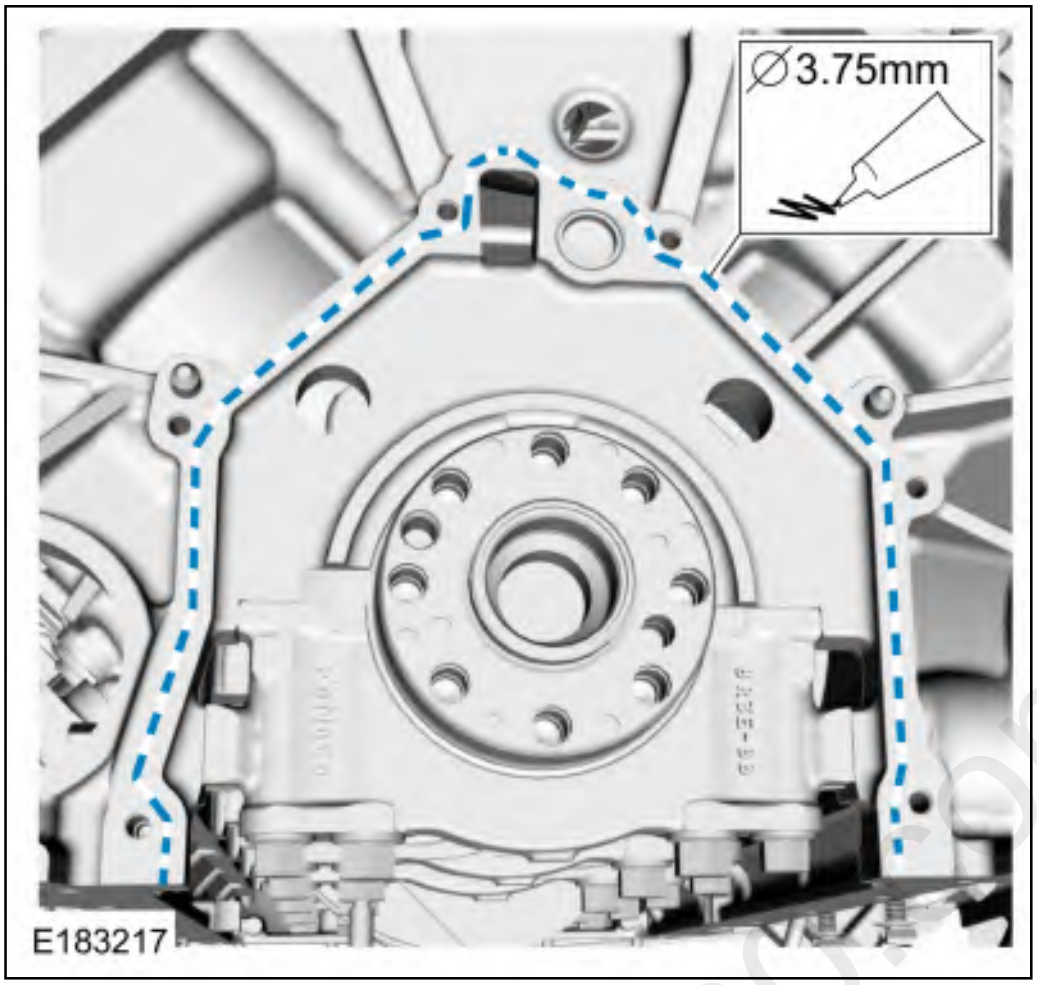
    - Rotate the inner rotor of the oil pump assembly to align the flats on the crankshaft and slip the oil pump over the crankshaft until seated against the block.
    - Rotate the oil pump until the bolt holes are aligned to the block and install the fasteners hand tight.
      Torque:
      Stage 1: A: 89 lb.in (10 Nm)

Stage 2: B: 18 lb.ft (25 Nm)
Stage 3: C: 89 lb.in (10 Nm)
Stage 4: D: 177 lb.in (20 Nm)
Stage 5: A: 45°
Stage 6: B: 75°
Stage 7: C: 45°
Stage 8: D: 60°

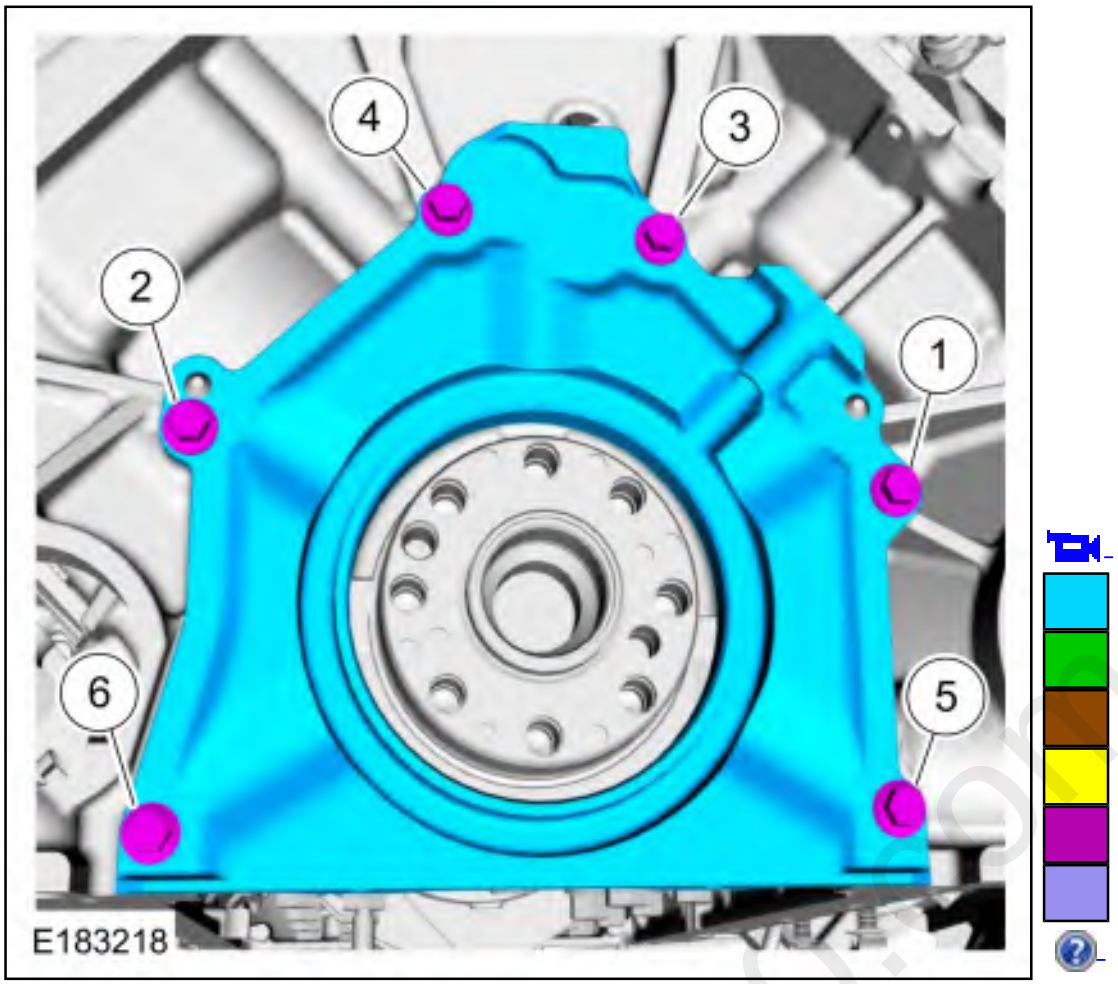


21. **NOTE:** *If the rear crankshaft seal retaining plate is not secured within 4 minutes, the sealant must be removed and the sealing area cleaned. Failure to follow this procedure may cause future oil leaks.*

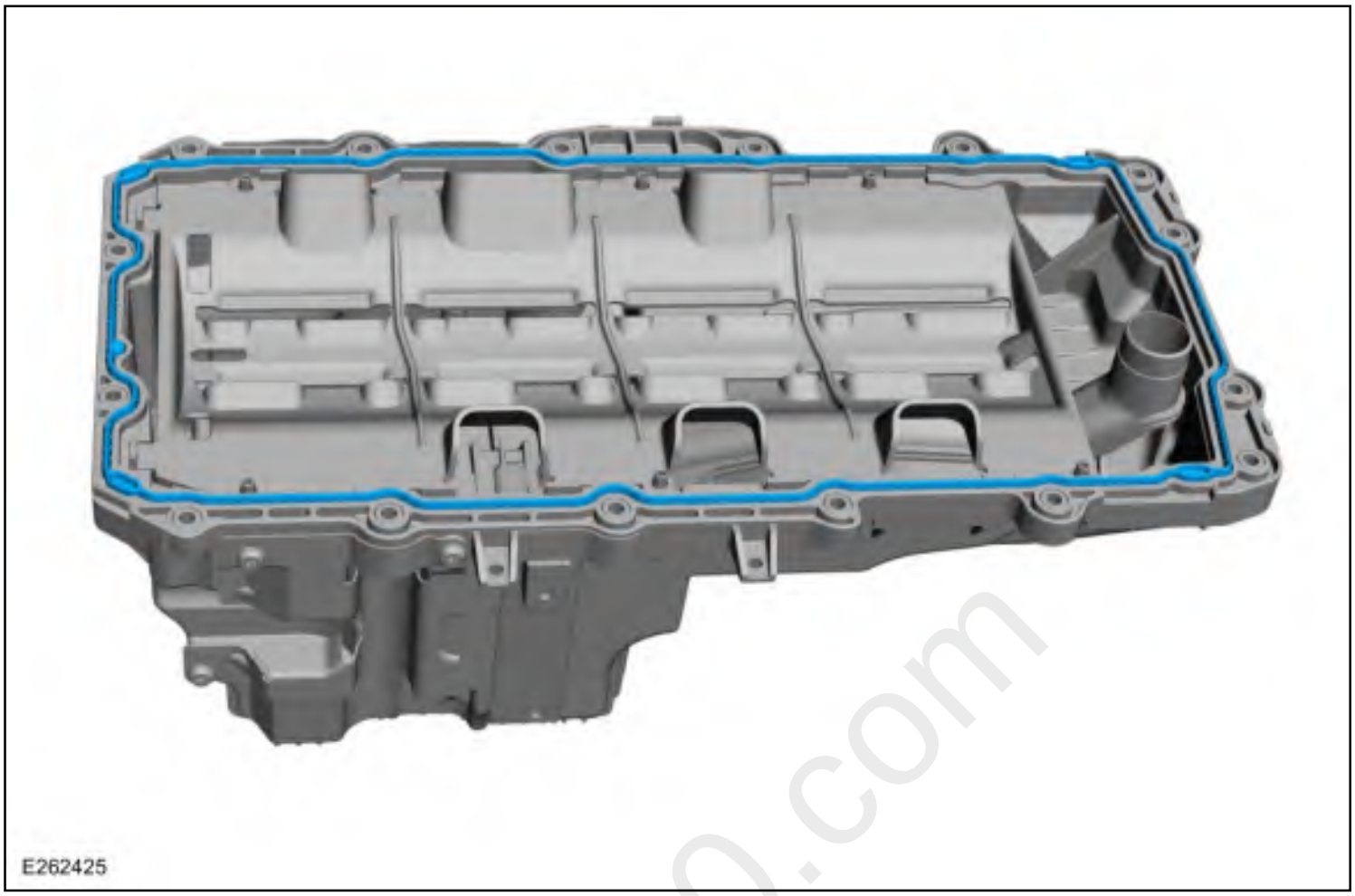
    Apply a 3.75 mm (0.147 in) bead of silicone gasket and sealant to the rear crankshaft seal retainer mating surface on the engine block.
    Material: Motorcraft® Silicone Gasket and Sealant / TA-30 (WSE-M4G323-A4)



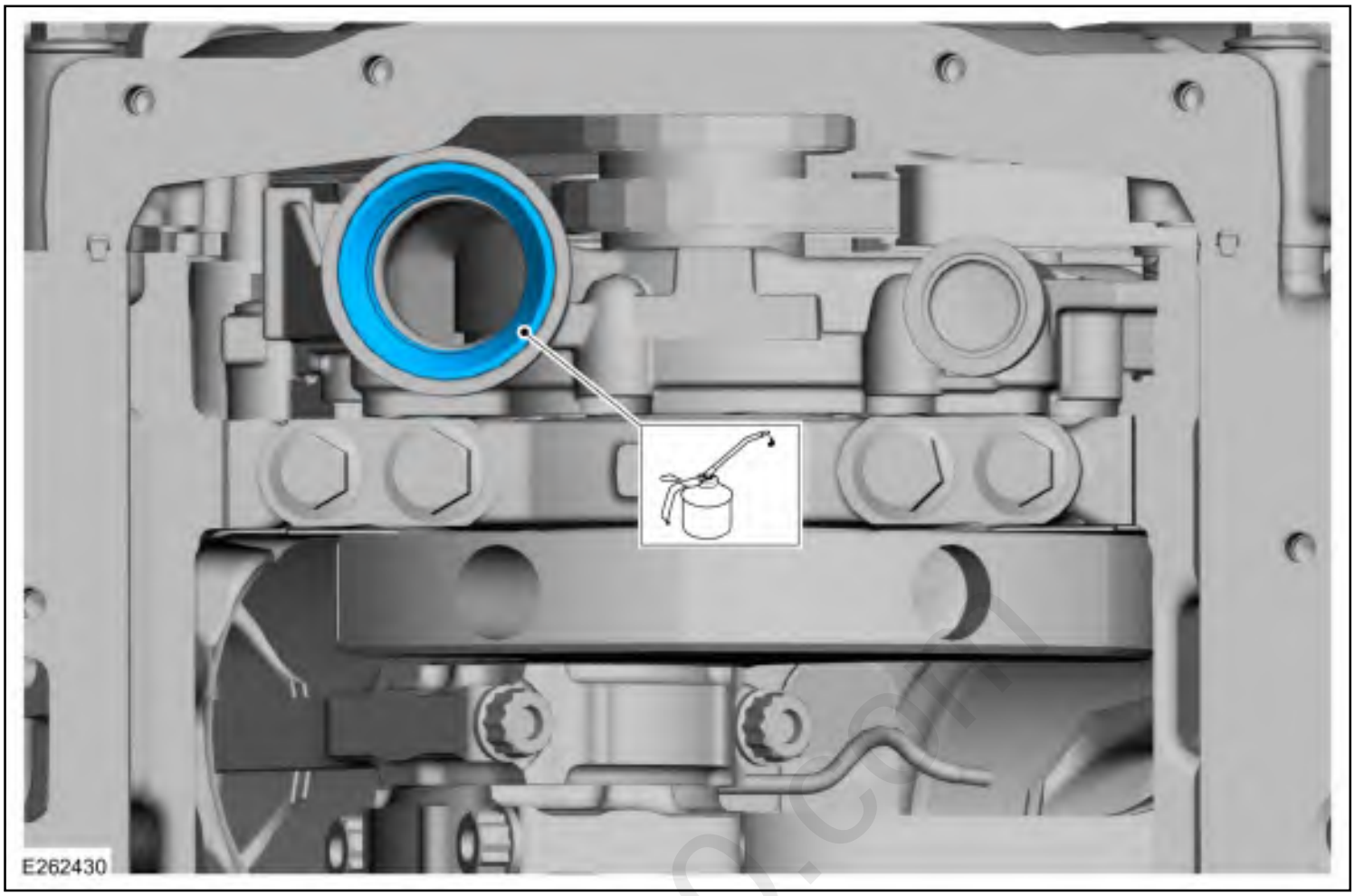
22. Install the crankshaft rear seal retainer plate and the bolts.
    Torque:
    Stage 1: 89 lb.in (10 Nm)
    Stage 2: 30°



23. Install a new oil pan gasket.

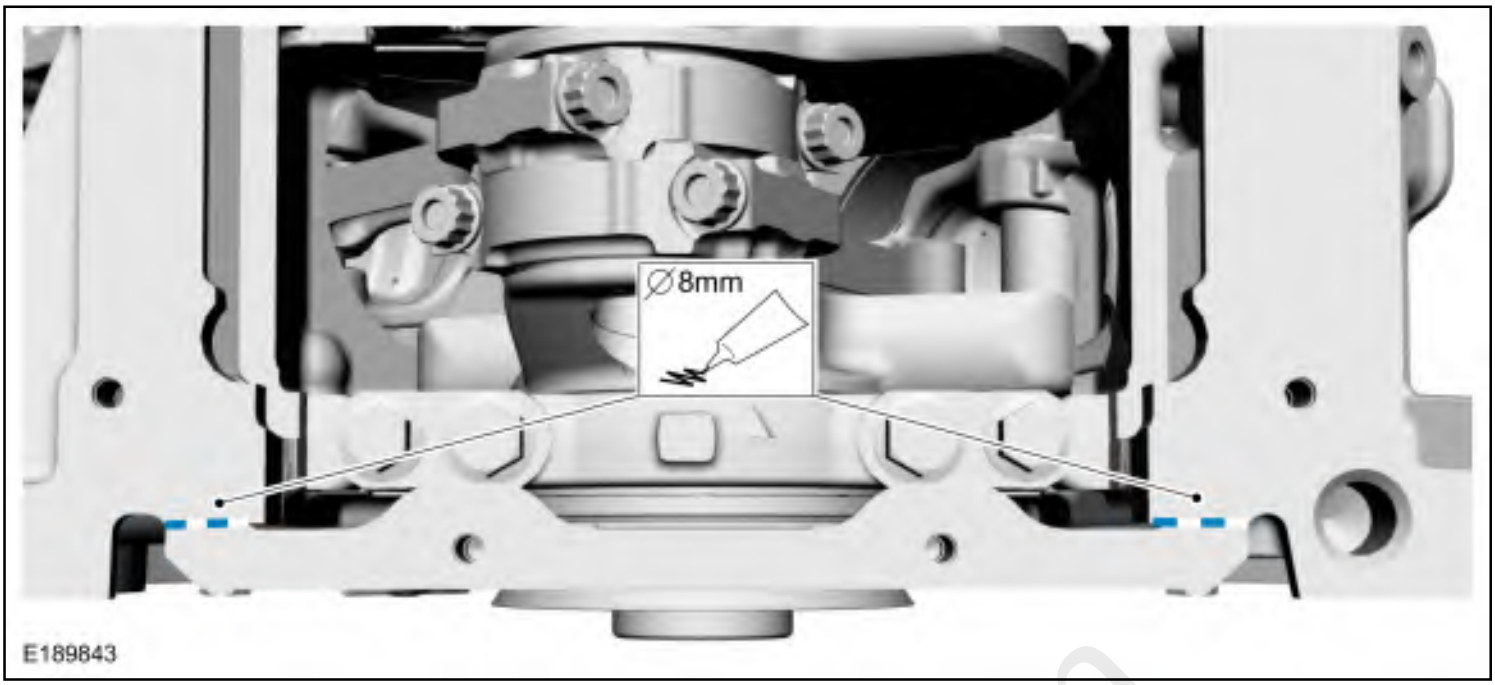


24. Install a new oil pump pickup seal and lubricate with clean engine oil.

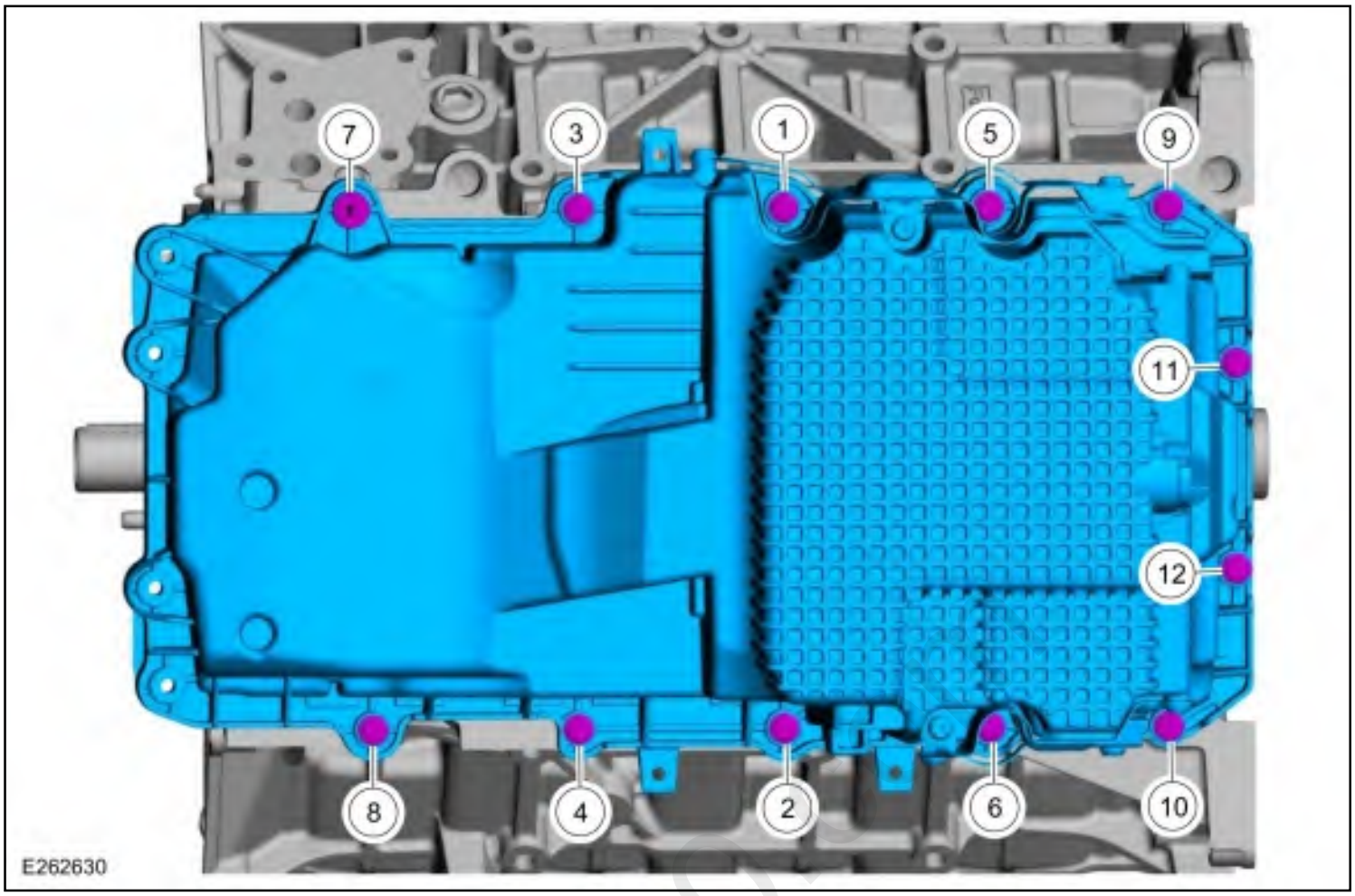


25. **NOTE:** *If the oil pan is not installed and the fasteners tightened within 5 minutes, the sealant must be removed and the sealing area cleaned. Failure to follow this procedure can cause future oil leakage. If this timing cannot be met, tighten fasteners 7, 8, 9 and 10 to 8 Nm (71 lb-in) within 5 minutes of applying the sealer and final torque all of the fasteners within 1 hour of applying the sealer.*

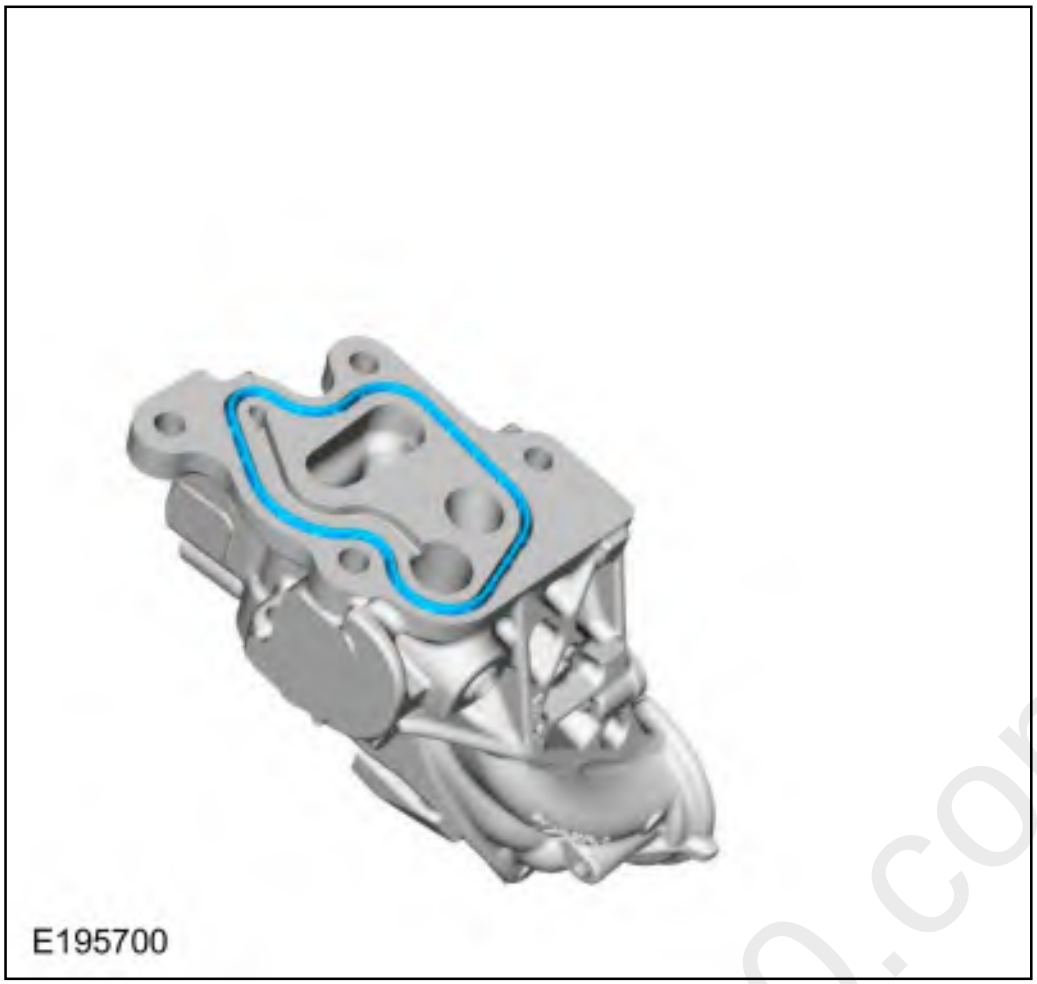
    Apply an 8 mm (0.31 in) bead of silicone gasket and sealant to the crankshaft rear seal retainer plate-to-cylinder block sealing surfaces.
    Material: Motorcraft® Silicone Gasket and Sealant / TA-30 (WSE-M4G323-A4)
    Torque: 18 lb.ft (25 Nm)



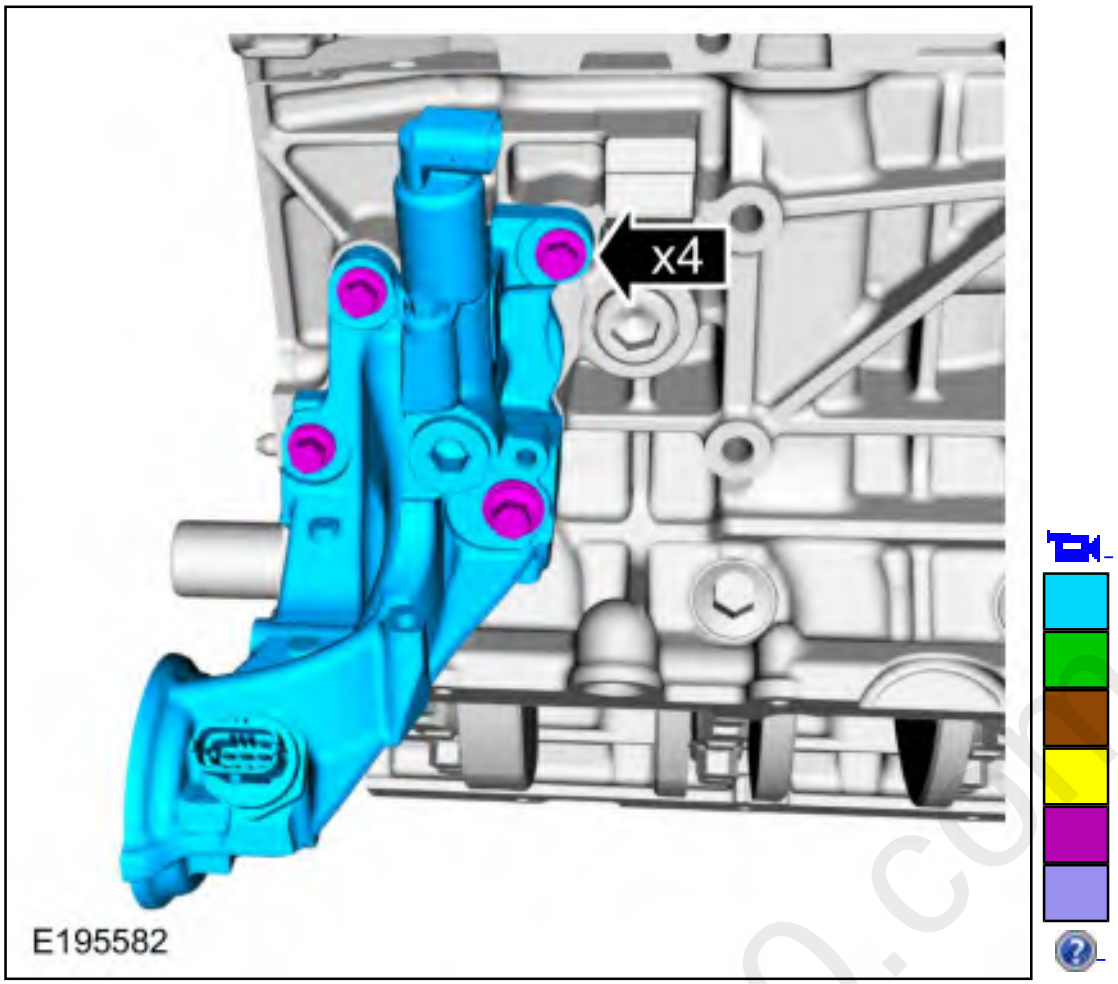
26. Install the oil pan and the fasteners.
    Torque:
    Stage 1: 18 lb.in (2 Nm)
    Stage 2: 89 lb.in (10 Nm)
    Stage 3: 45°



27. Install a new oil filter adapter gasket.

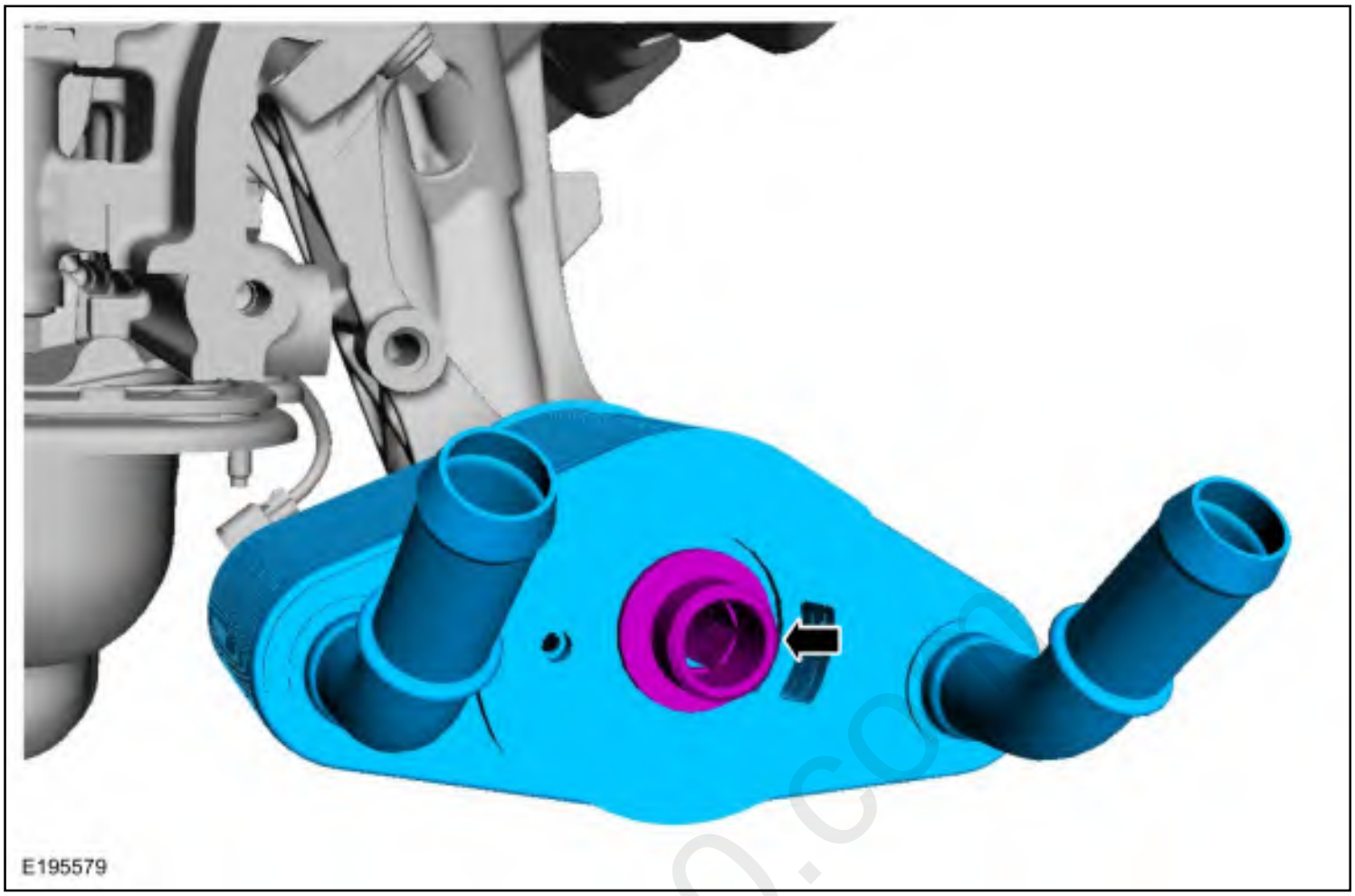


28. Install the oil filter adapter and the bolts.
    Torque:
    Stage 1: 177 lb.in (20 Nm)
    Stage 2: 60°



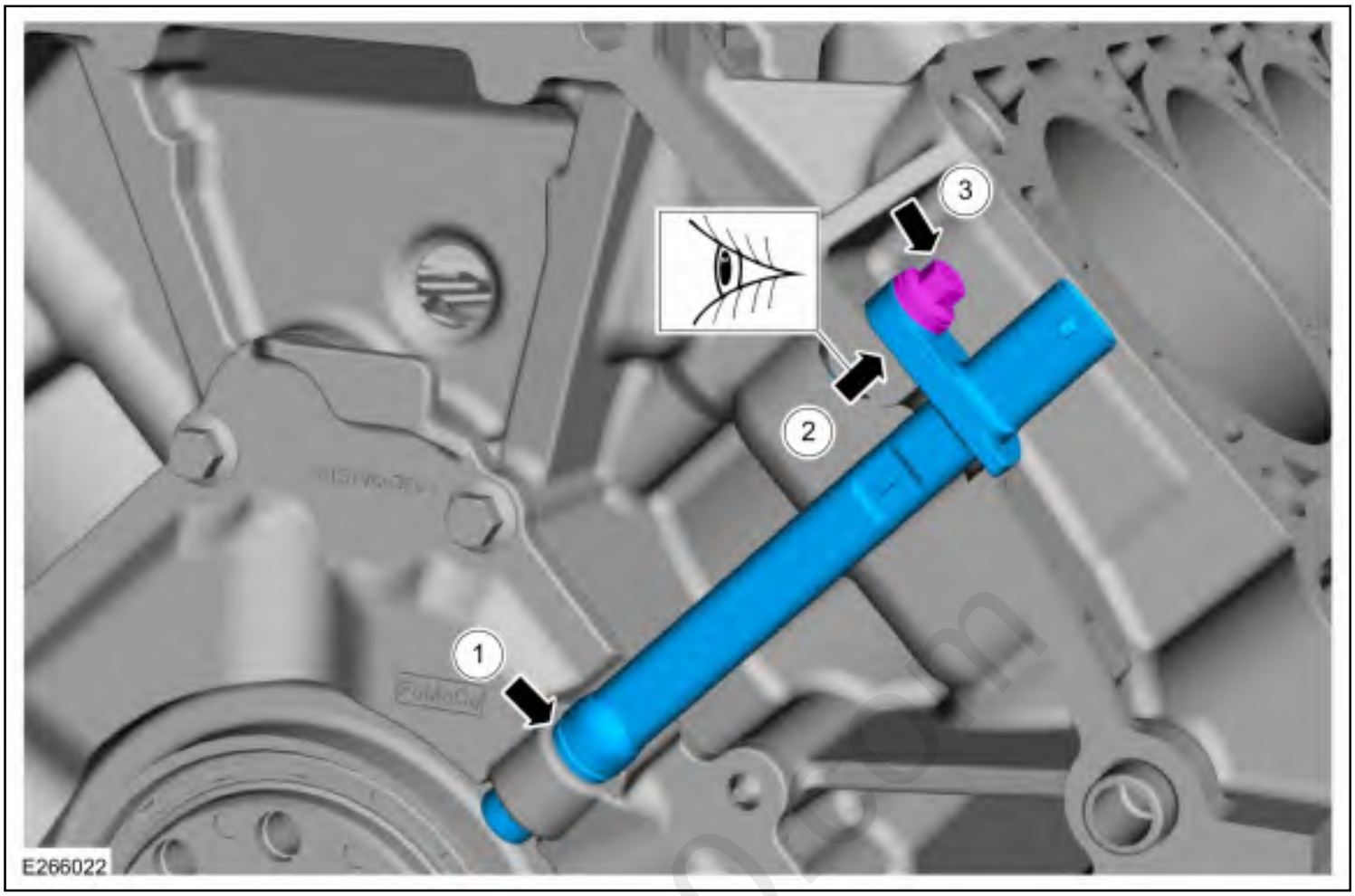
29. **NOTICE: A new oil cooler must be installed or severe damage to the engine can occur.**

    Install a new oil cooler with a new gasket and the threaded fitting.
    Torque: 43 lb.ft (58 Nm)

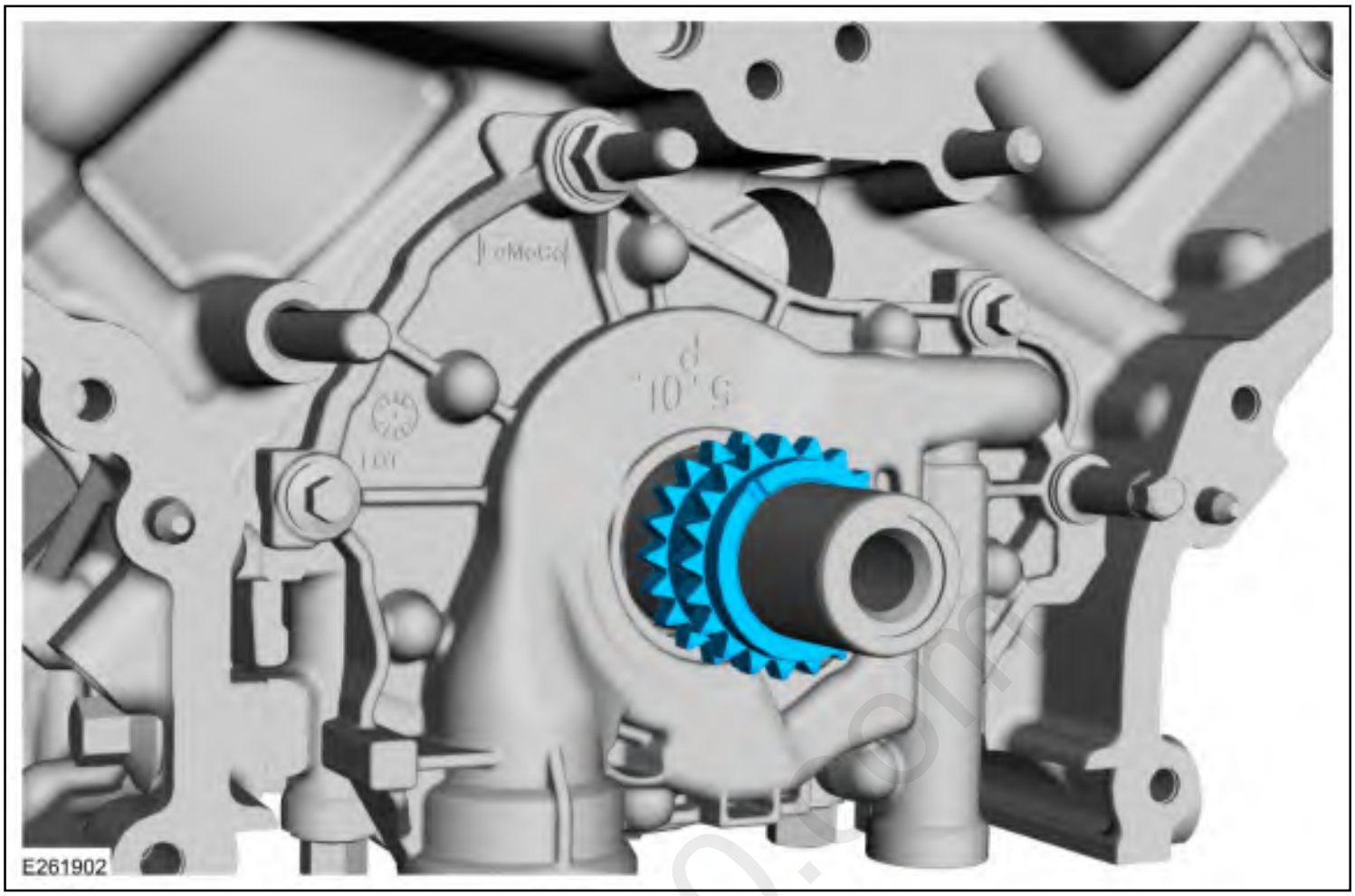


30. **NOTICE: The CKP sensor must be positioned into the crankshaft rear seal retainer plate and be flush against the boss on the engine block before the bolt is installed. If the CKP sensor is installed incorrectly, the CKP sensor can be damaged.**

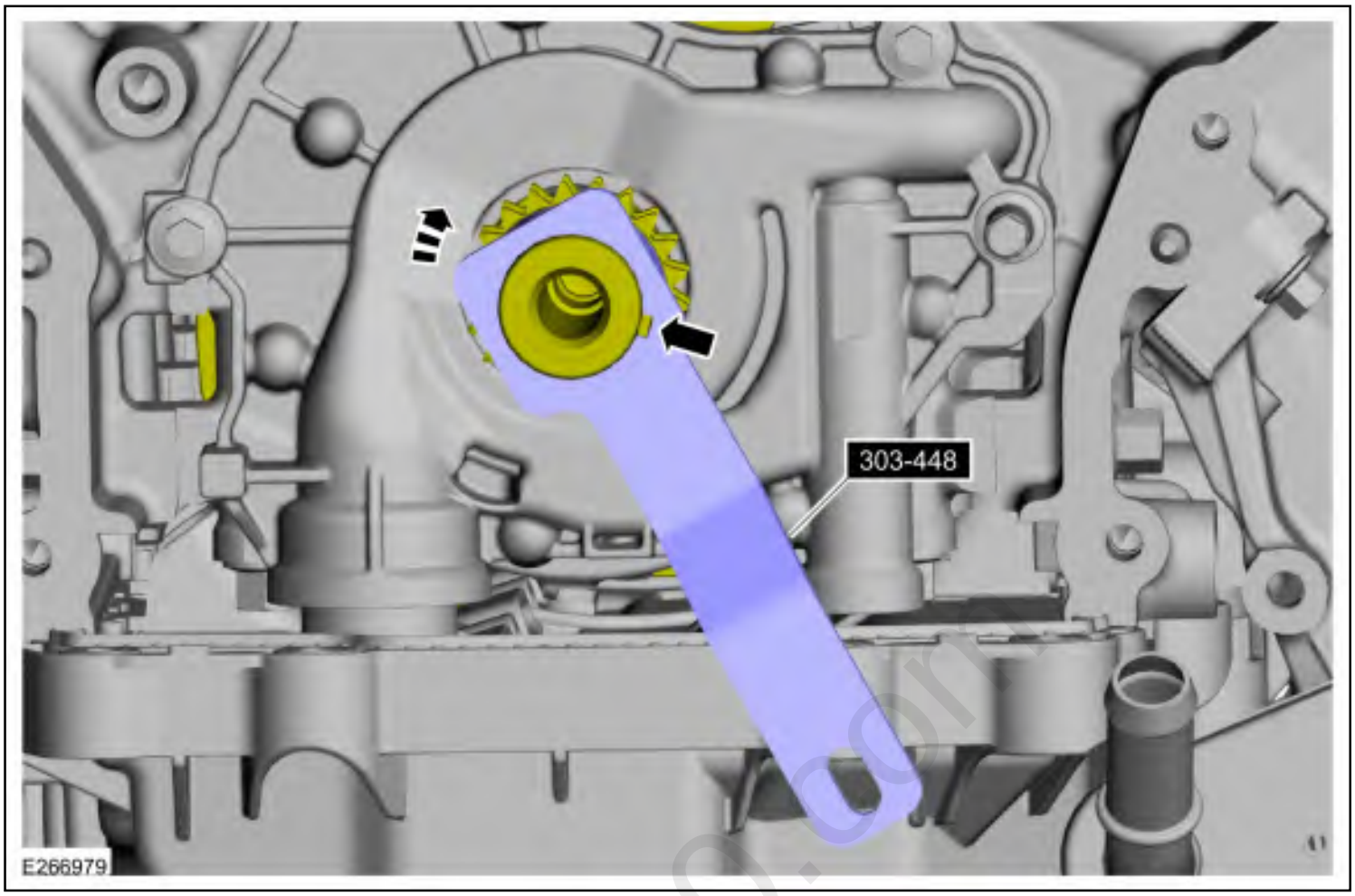
    - Install the CKP sensor must be positioned into the crankshaft rear seal retainer plate.
    - Make sure the CKP sensor is flush with the engine block boss.
    - Install the bolt.
      Torque: 89 lb.in (10 Nm)



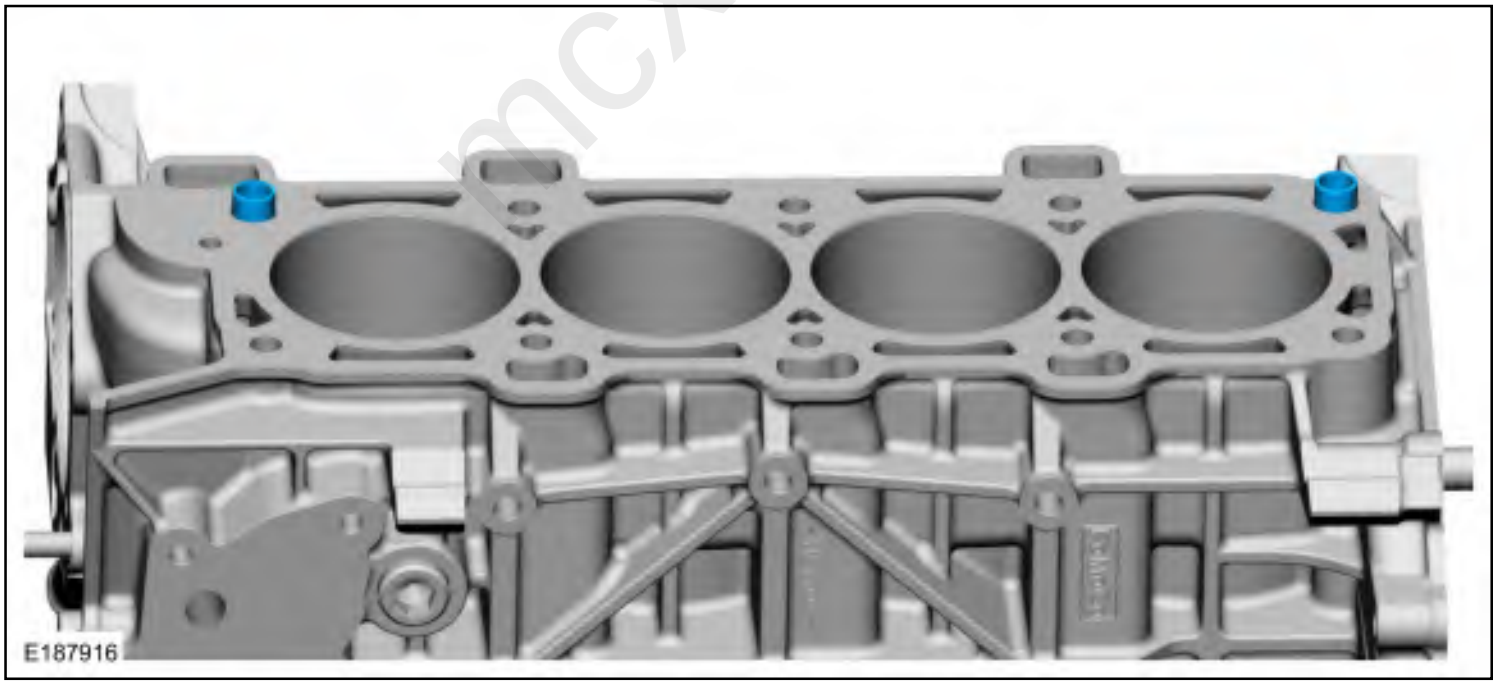
31. Install the crankshaft sprocket.



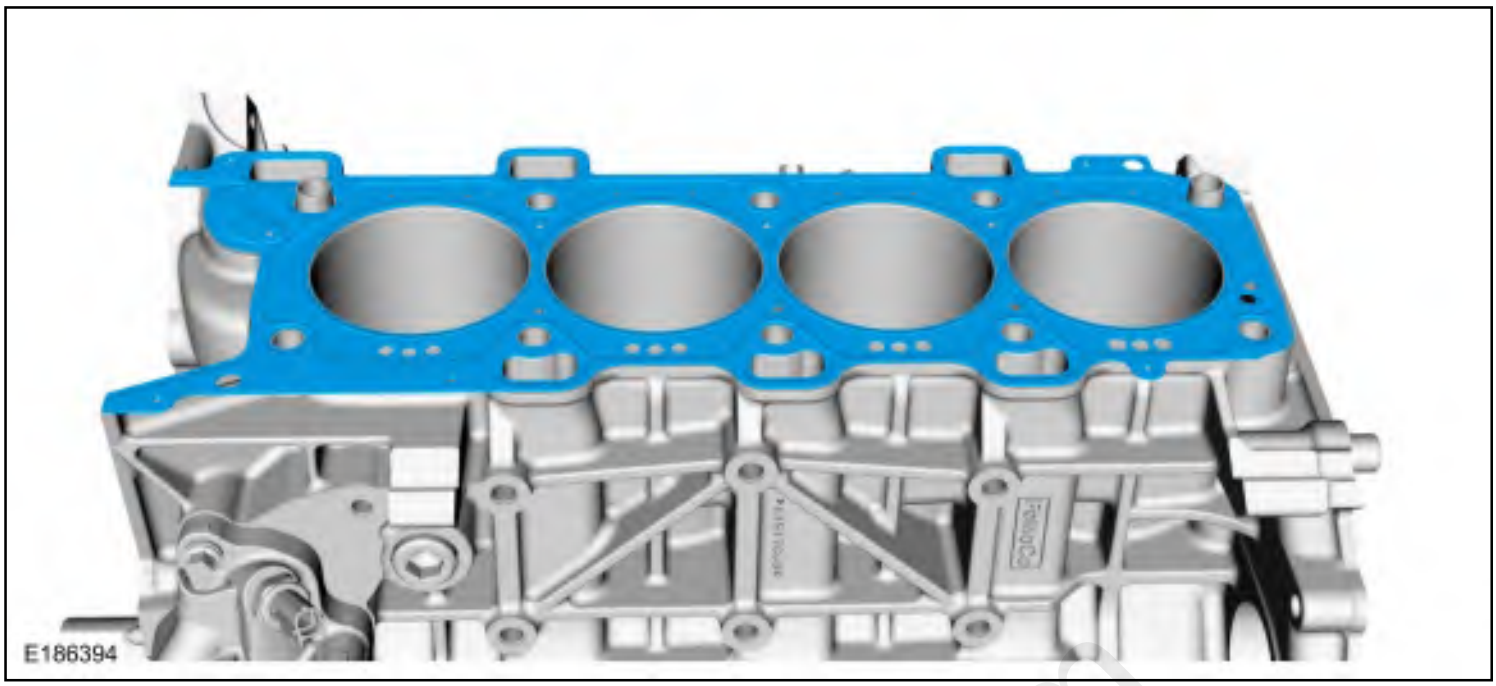
32. Using the special tool, rotate the crankshaft clockwise until the keyway is at the 3:30 position. Use Special Service Tool: 303-448 (T93P-6303-A) Holding Tool, Crankshaft.



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

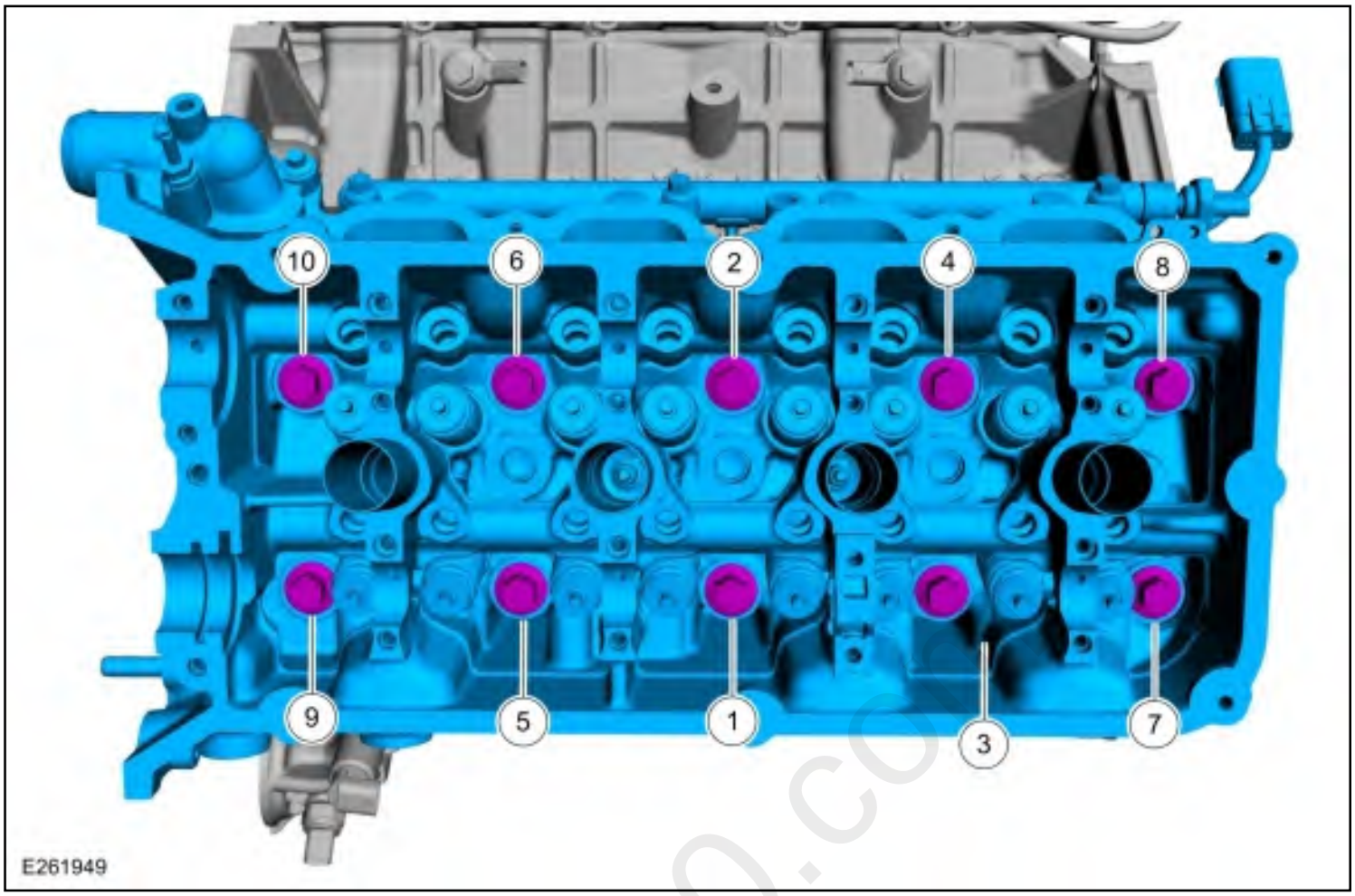


34. Install a new LH cylinder head gasket.



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

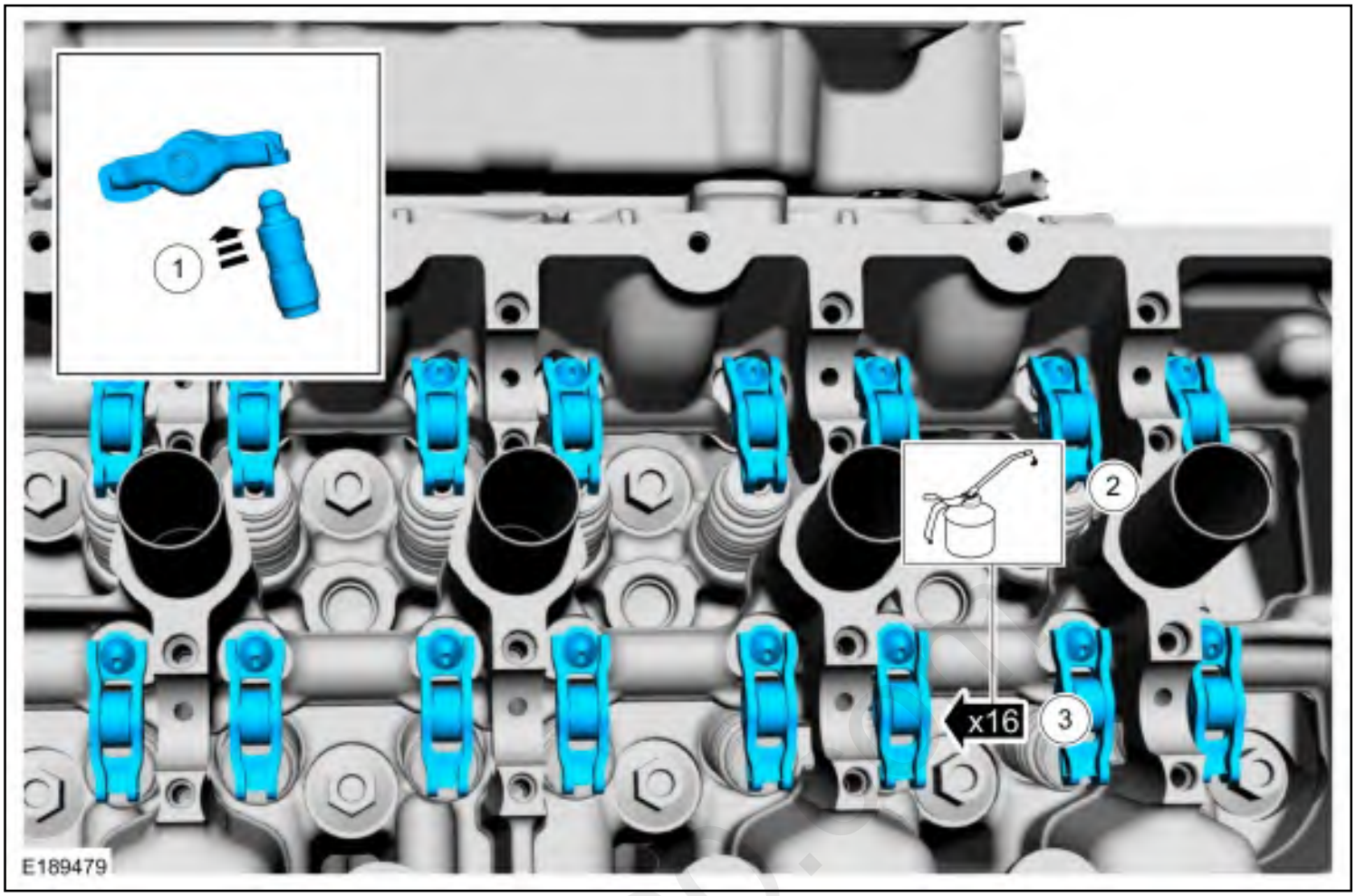
    1. Install the cylinder head and the new bolts.
       Torque:
       Stage 1: Bolts 1-10 in sequence: 18 lb.ft (25 Nm)
       Stage 2: Bolts 1-10 in sequence: 55 lb.ft (75 Nm)
       Stage 3: Bolt 1: Loosen: 180°
       Stage 4: Bolt 1: 37 lb.ft (50 Nm)
       Stage 5: Bolt 1: 240°
    2. Perform stages 3, 4 and 5 on bolts 2 through 10 (complete all three stages to each bolt before moving on to the next bolt in sequence).



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

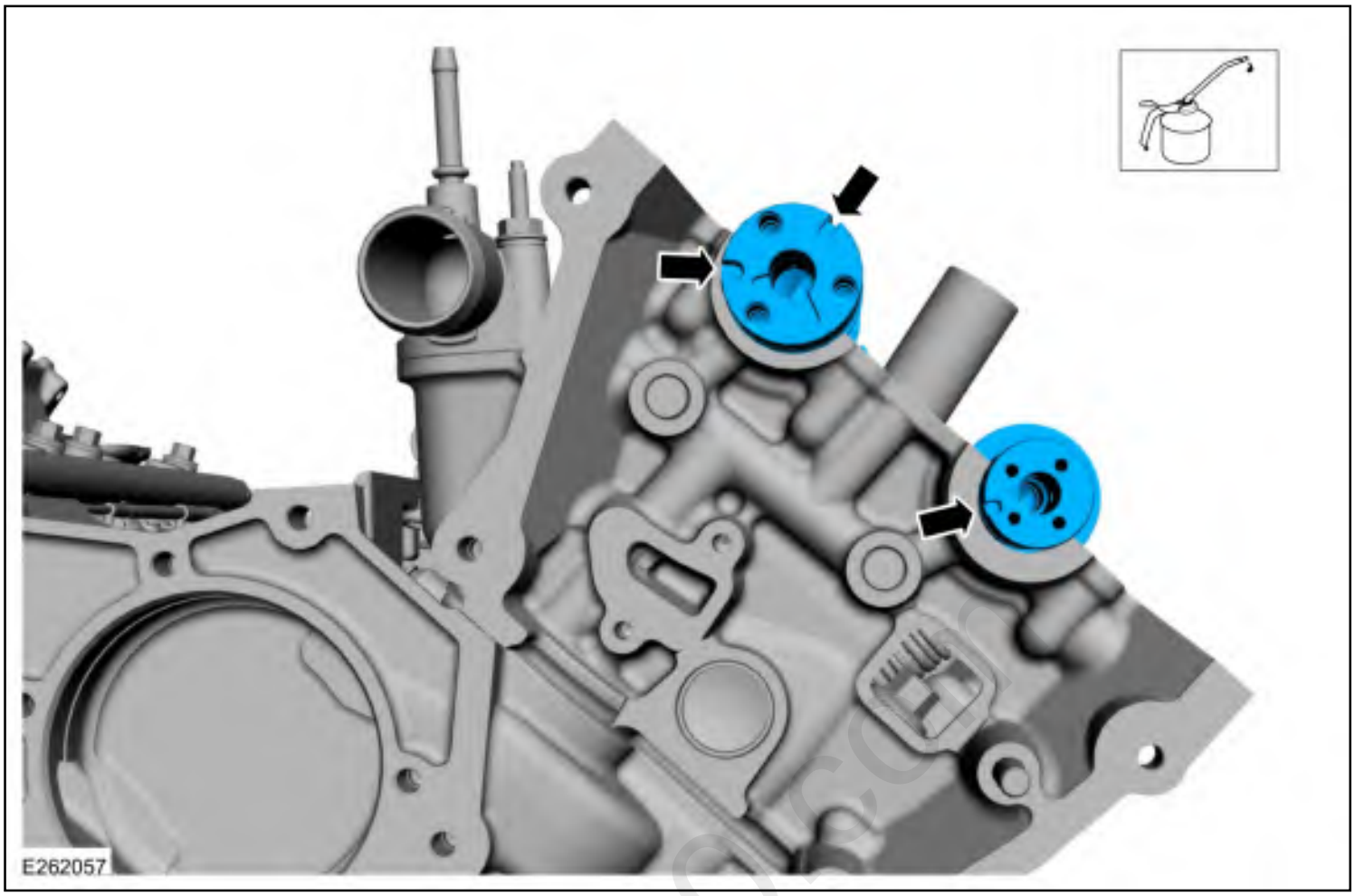
36. **NOTE:** *If the components are to be reinstalled, they must be installed in their original locations.*

    1. Assemble the hydraulic lash adjusters onto the spring clips on the camshaft roller followers.
    2. Lubricate the camshaft roller follower and hydraulic lash adjuster assemblies with clean engine oil.
    3. Install the camshaft roller follower and hydraulic lash adjuster assemblies.

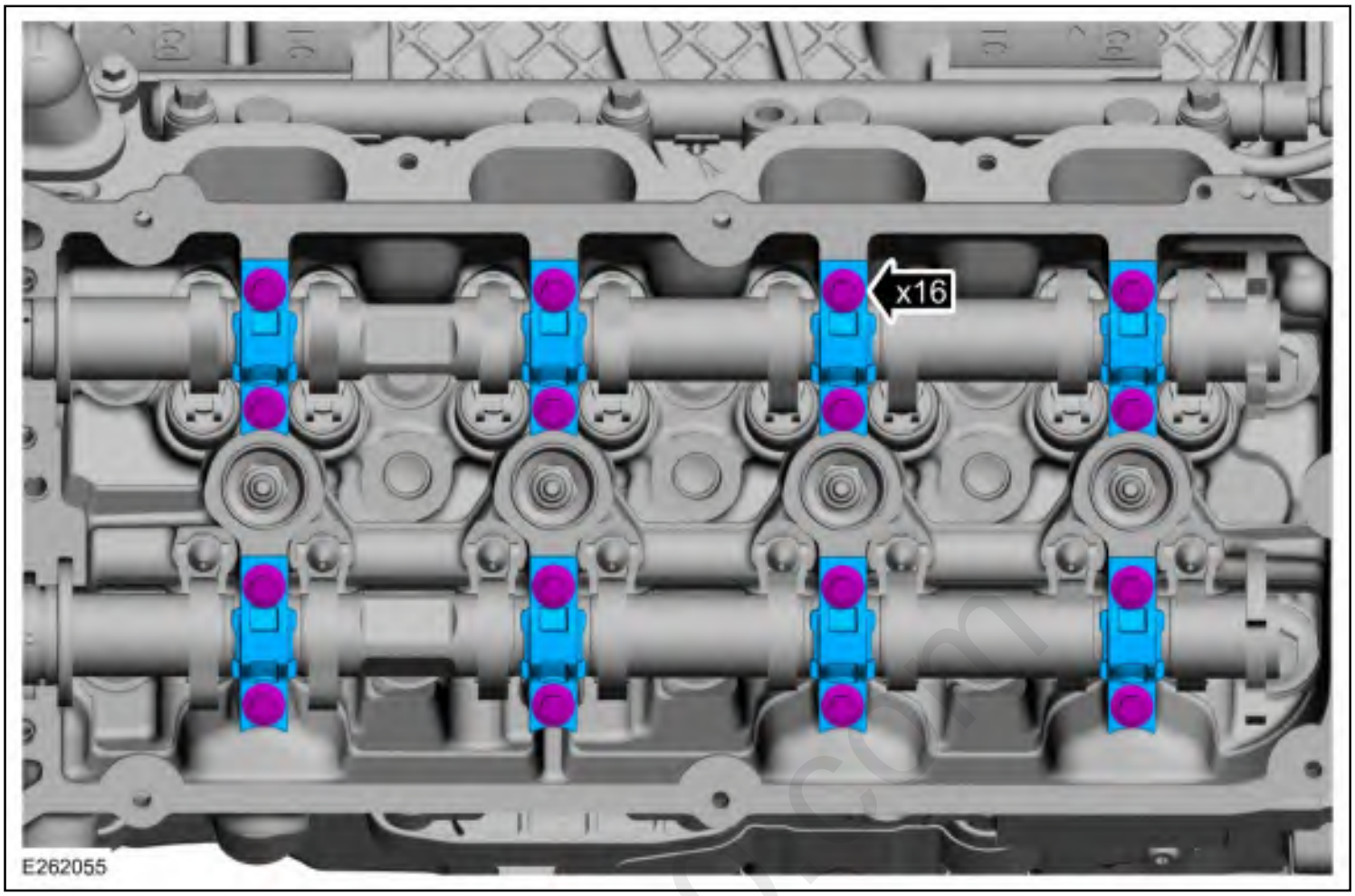


37. **NOTE:** *Lubricate the camshafts with clean engine oil prior to installation.*

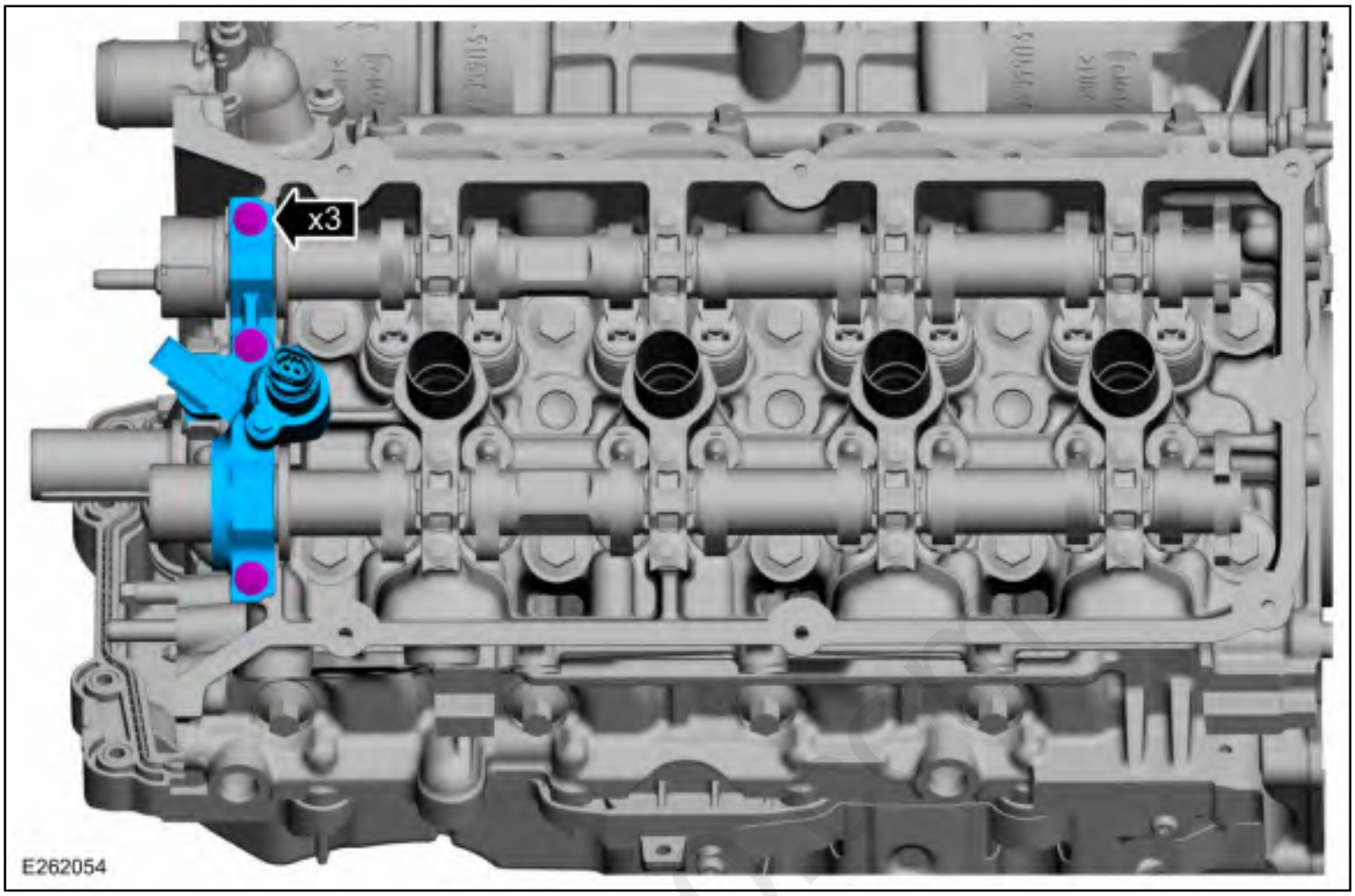
    Install the intake and exhaust camshafts in the neutral position. Align the D-slots as shown in the illustration.



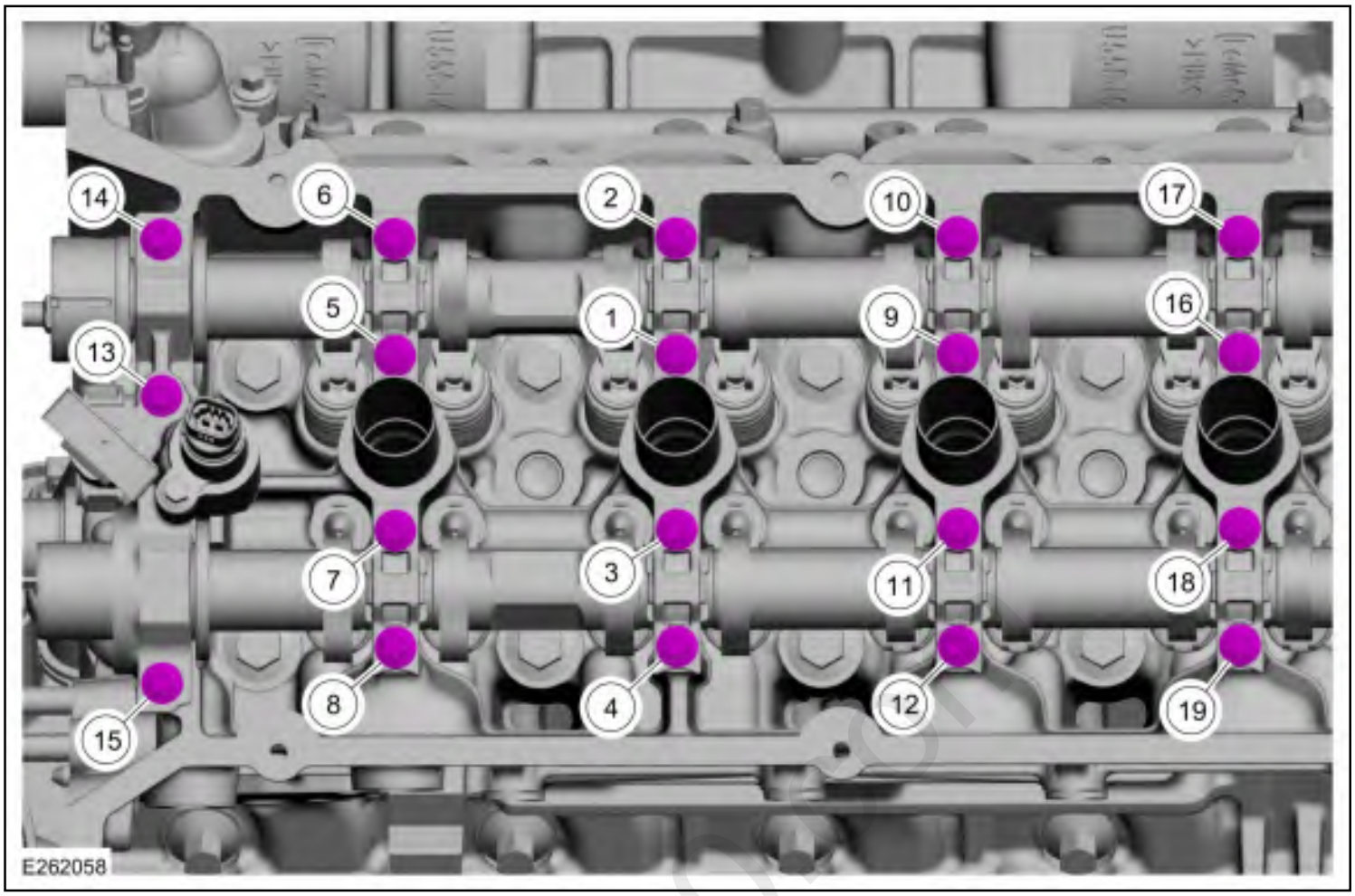
38. Install the camshaft bearing caps and the bolts. Do not tighten at this time.



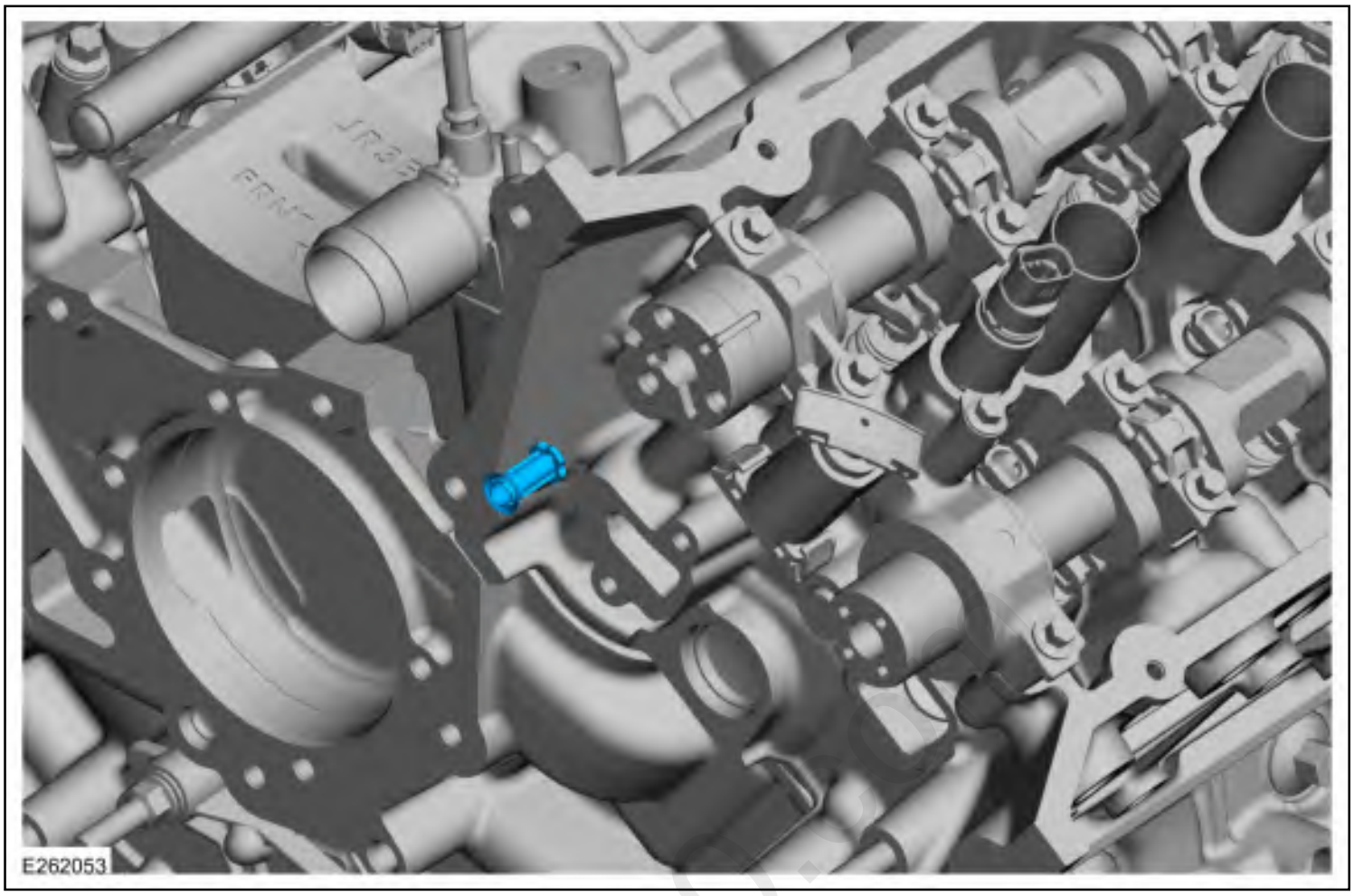
39. Install the front camshaft bearing mega cap and the bolts. Do not tighten at this time.



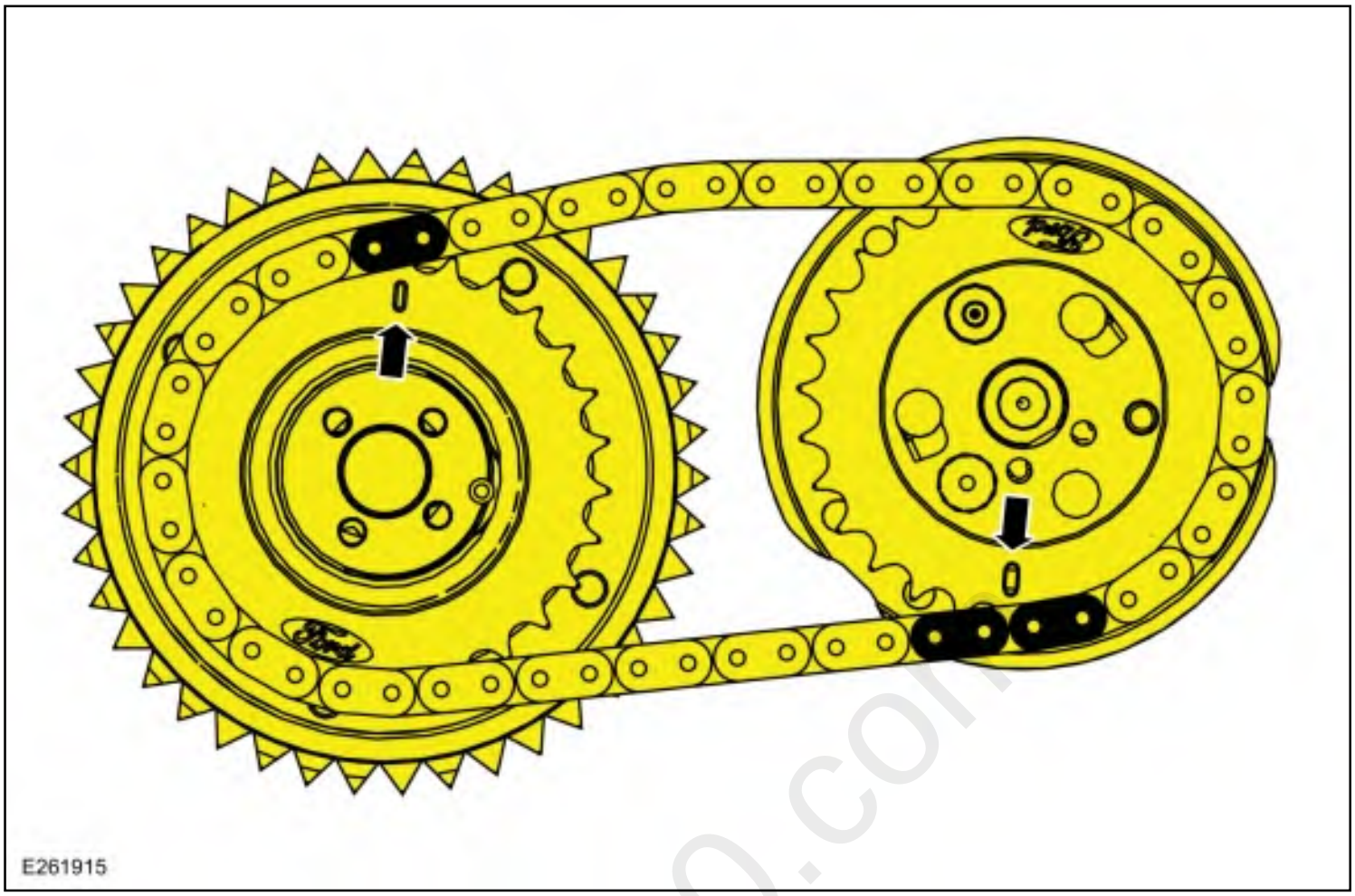
40. Tighten the bolts.
    Torque:
    Stage 1: 53 lb.in (6 Nm)
    Stage 2: 45°



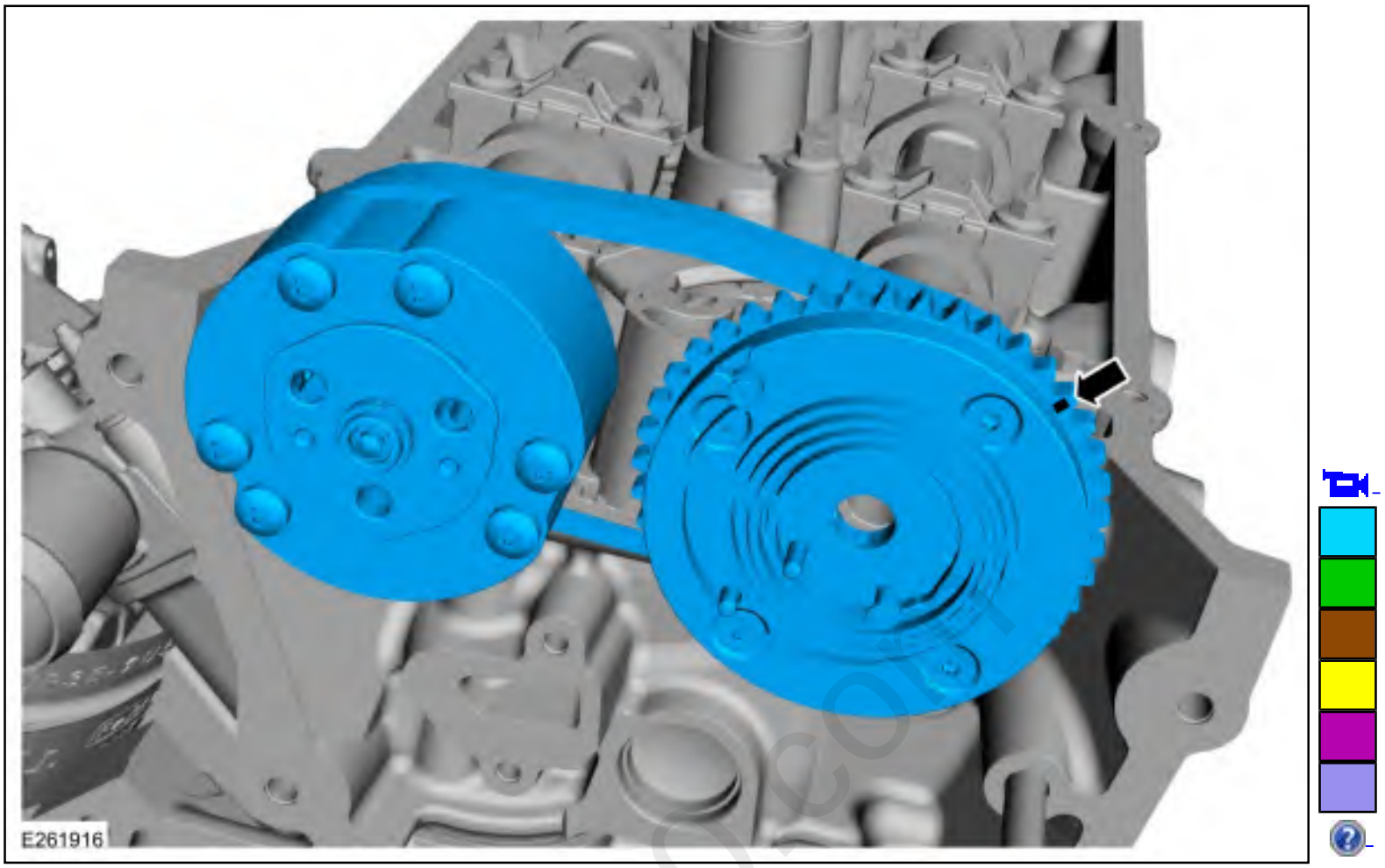
41. Install new VCT system oil filter into the camshaft.



42. Position the secondary timing chain onto the VCT assemblies. Align the colored links on the secondary timing chain with the timing marks on the VCT assemblies as shown in the illustration.
    - The timing mark on the intake VCT assembly should align between the 2 consecutive colored links.
    - The timing mark on the exhaust VCT assembly should align with the single colored link.

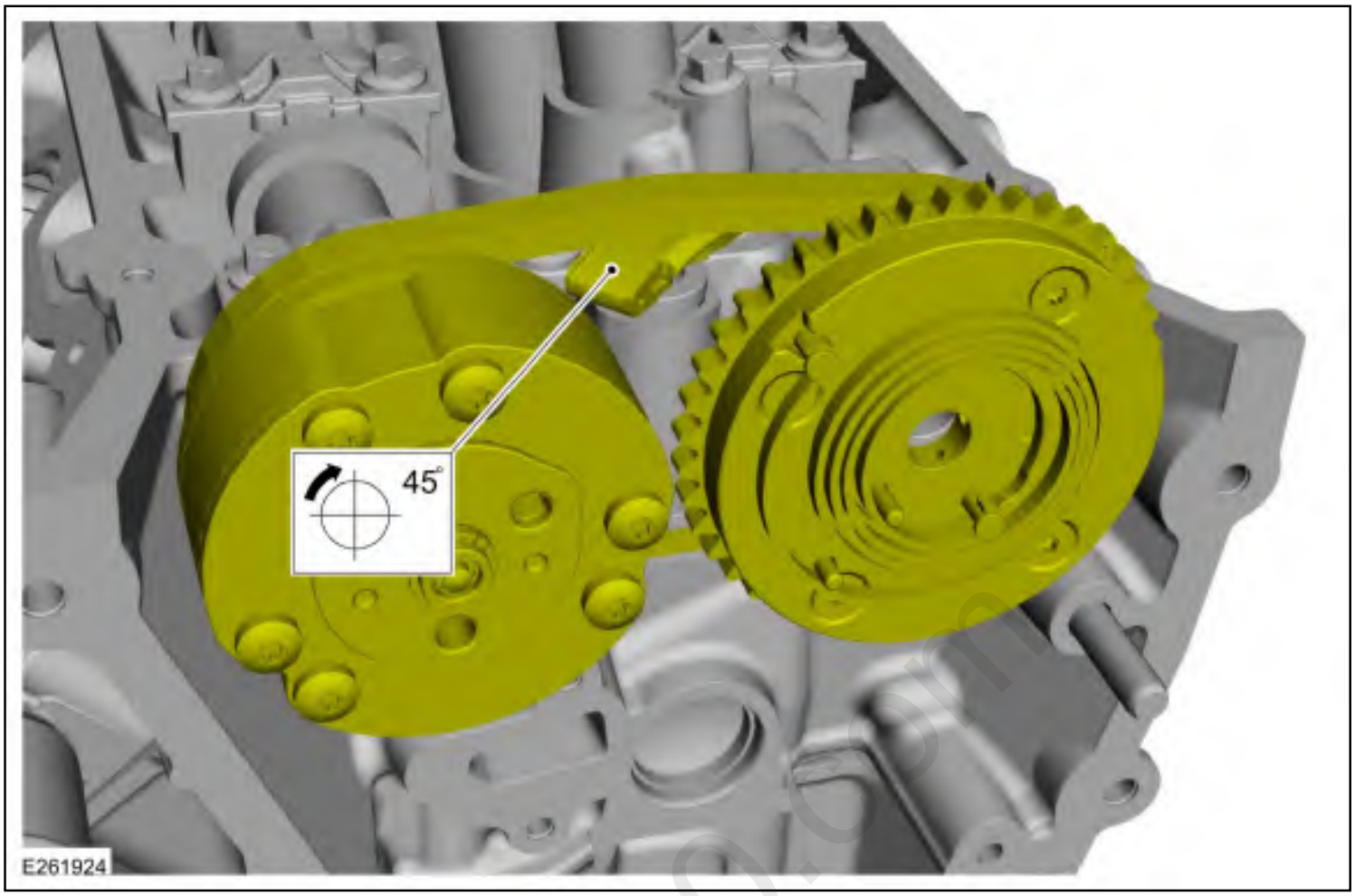


43. Install the VCT assemblies and the secondary timing chain onto the camshafts. The timing mark on the exhaust VCT assembly should be approximately in the 1 o'clock position.



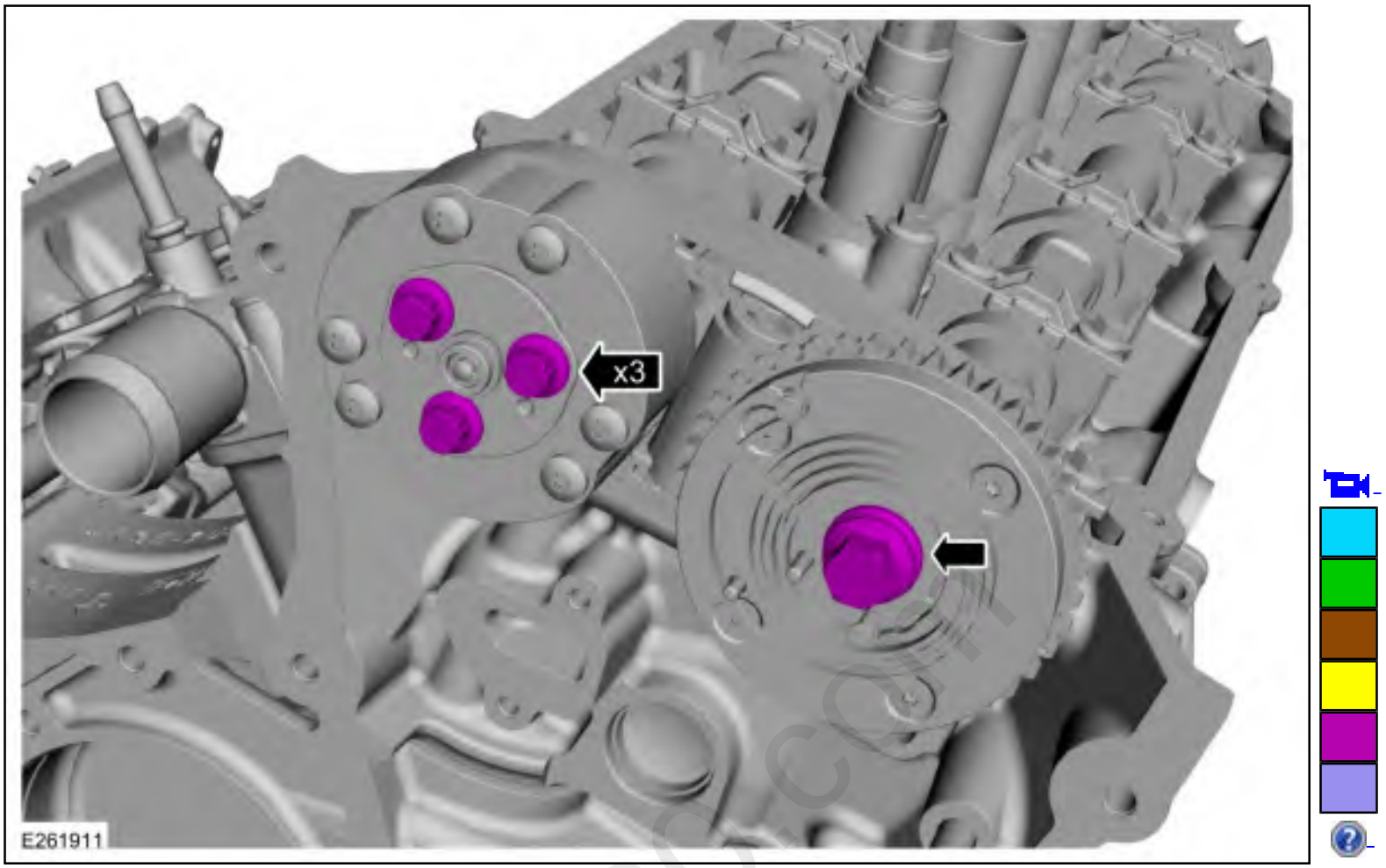
44. **NOTE:** *It may be necessary to rotate the exhaust camshaft slightly (using a wrench on the flats of the camshaft) to seat the VCT assemblies onto the camshafts.*

    Rotate the secondary timing chain tensioner clockwise 45 degrees so the ramped area is facing forward and fully seat the VCT assemblies onto the camshafts.
    - If the secondary timing chain is not centered over the tensioner, reposition the VCT assemblies until they are fully seated on the camshafts.

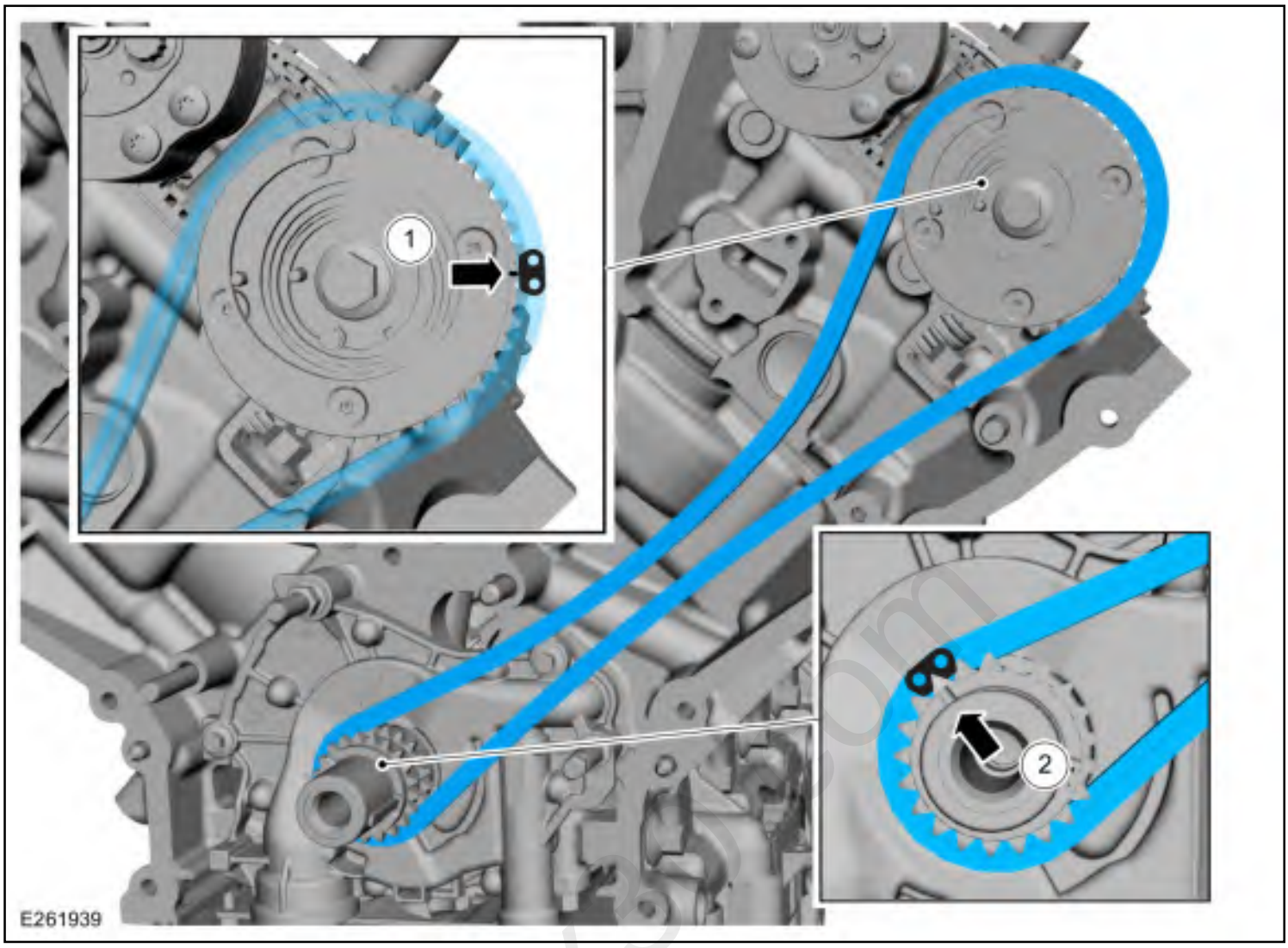


45. **NOTE:** *Use a wrench on the flats of the camshaft to hold the camshafts while tightening the VCT assembly bolts.*

    1. Install the intake VCT assembly bolts.
       Torque:
       Stage 1: 133 lb.in (15 Nm)
       Stage 2: 90°
    2. Install the exhaust VCT assembly bolt.
       Torque:
       Stage 1: 30 lb.ft (40 Nm)
       Stage 2: Loosen: 360°
       Stage 3: 20 lb.ft (27 Nm)
       Stage 4: 150°

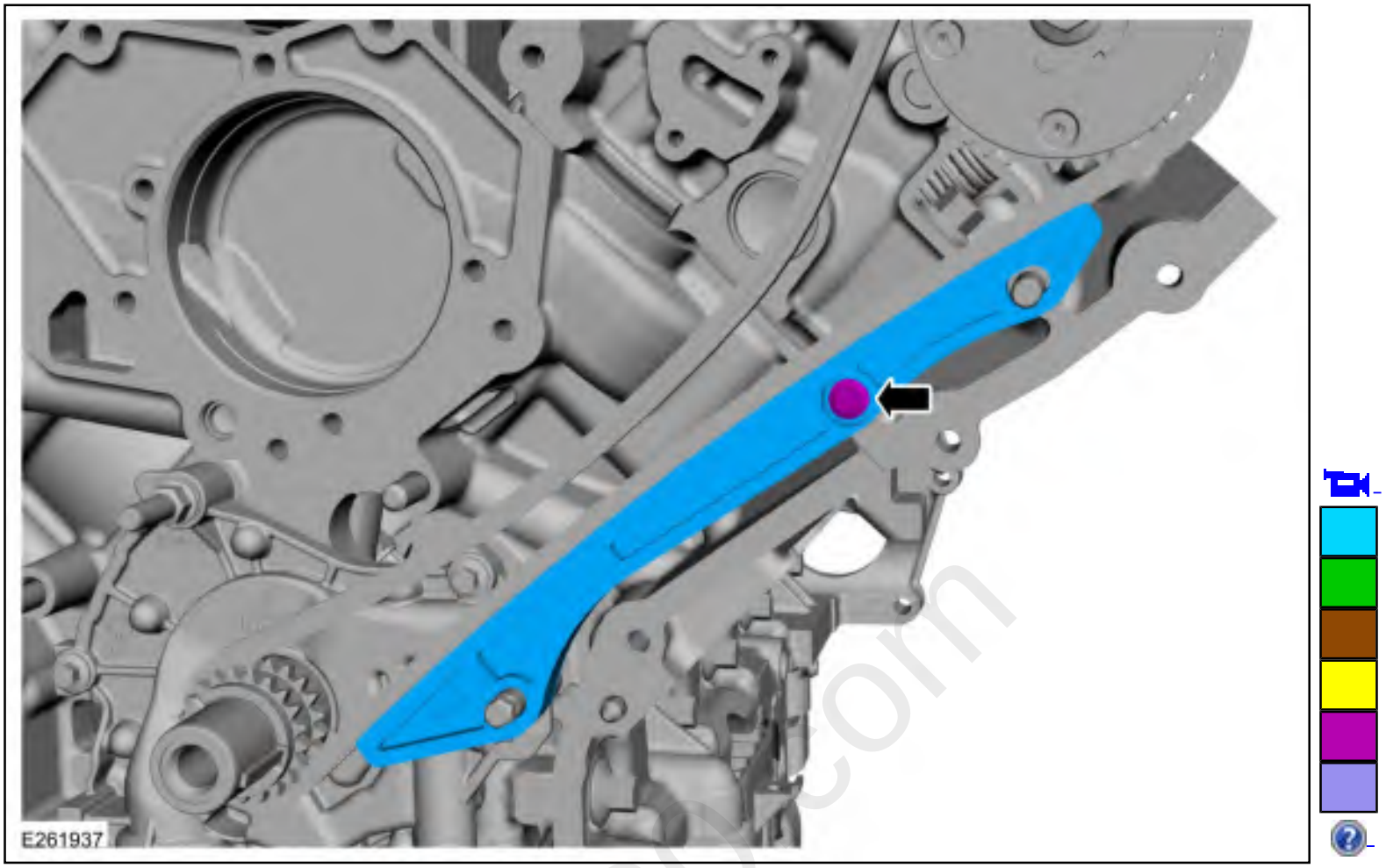


46. Install the LH timing chain.
    1. Align the colored link on the timing chain with the timing mark on the LH VCT assembly.
    2. Align the remaining colored link on the timing chain with the timing mark on the crankshaft sprocket.



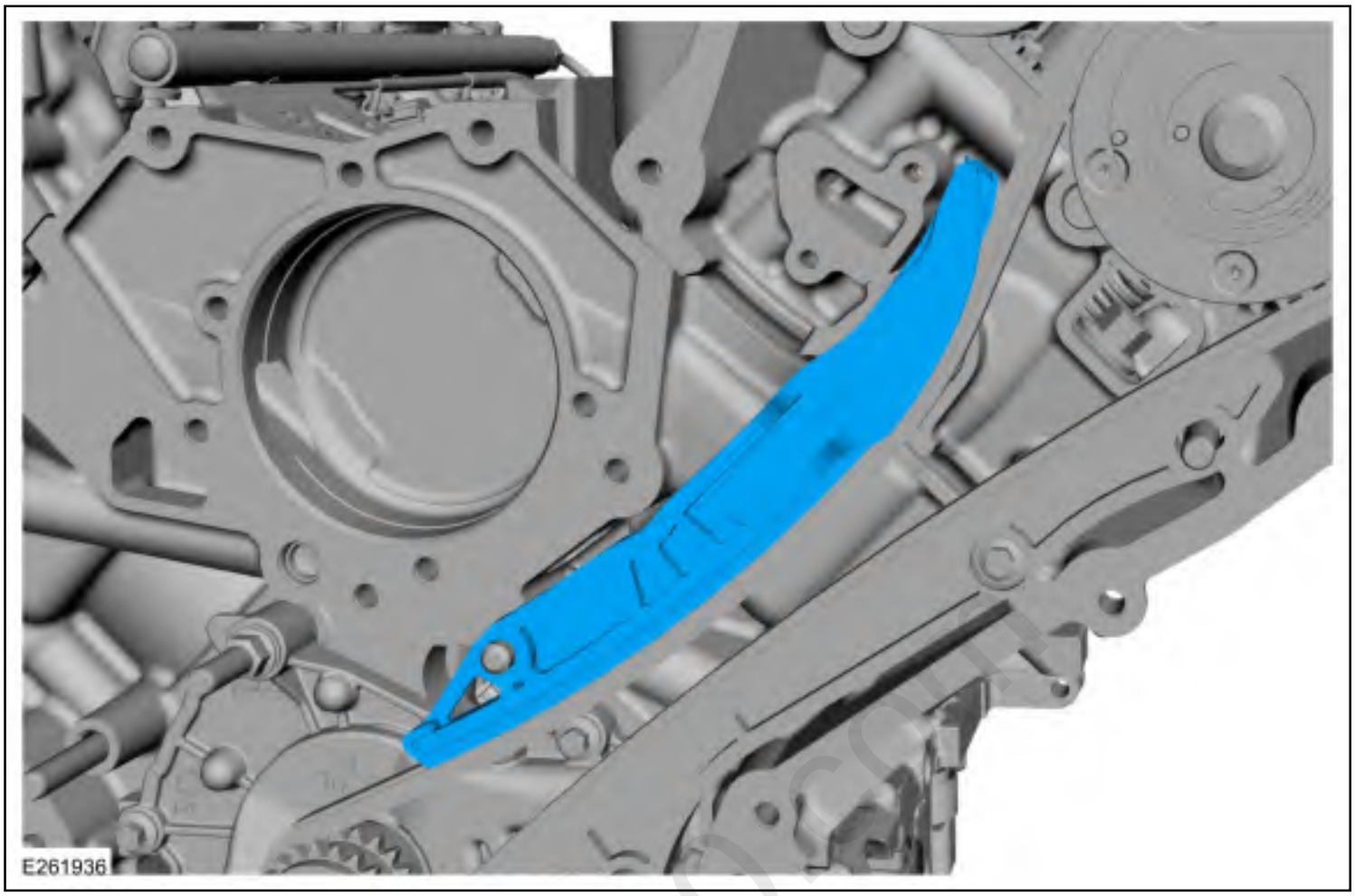
47. **NOTE:** *It may be necessary to rotate the crankshaft slightly to provide enough slack in the chain to install the LH timing chain guide. Return the crankshaft keyway to the 3:30 position after installing the LH timing chain guide.*

    Install the LH timing chain guide and bolt.
    Torque:
    Stage 1: 89 lb.in (10 Nm)
    Stage 2: 25°

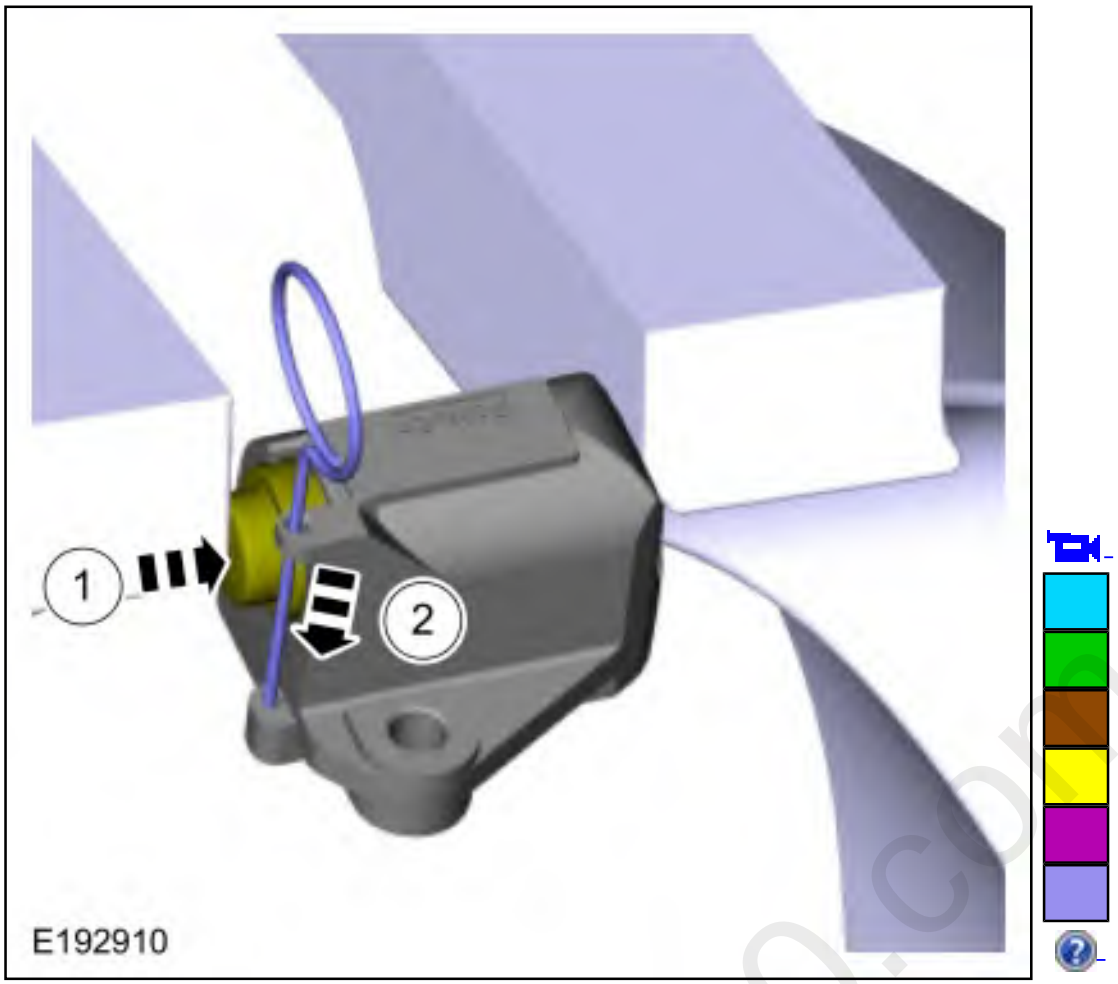


48. **NOTE:** *It may be necessary to rotate the crankshaft slightly to provide enough slack in the chain to install the LH timing chain arm. Return the crankshaft keyway to the 3:30 position after installing the LH timing chain arm.*

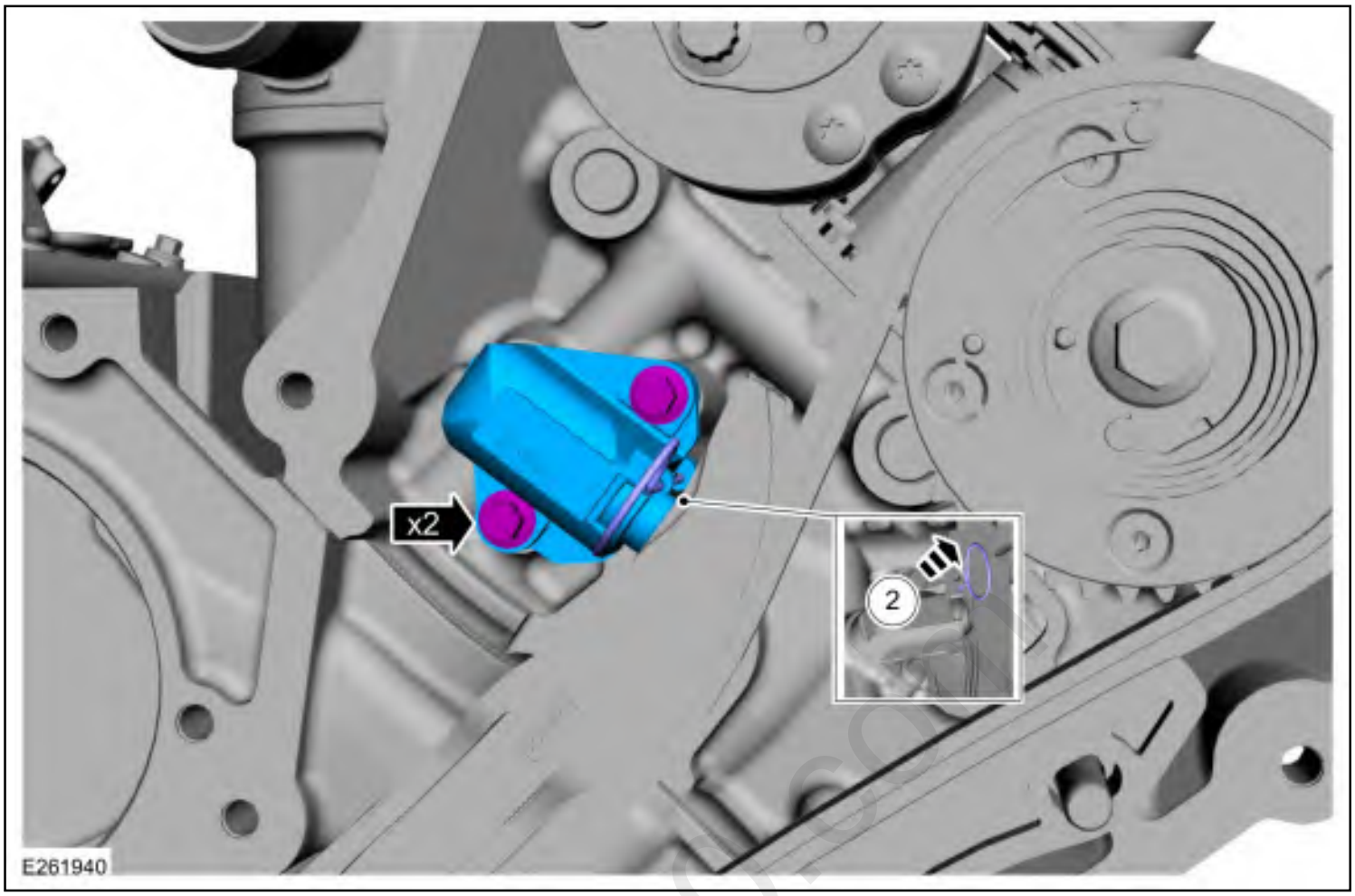
    Install the LH timing chain tensioner arm.



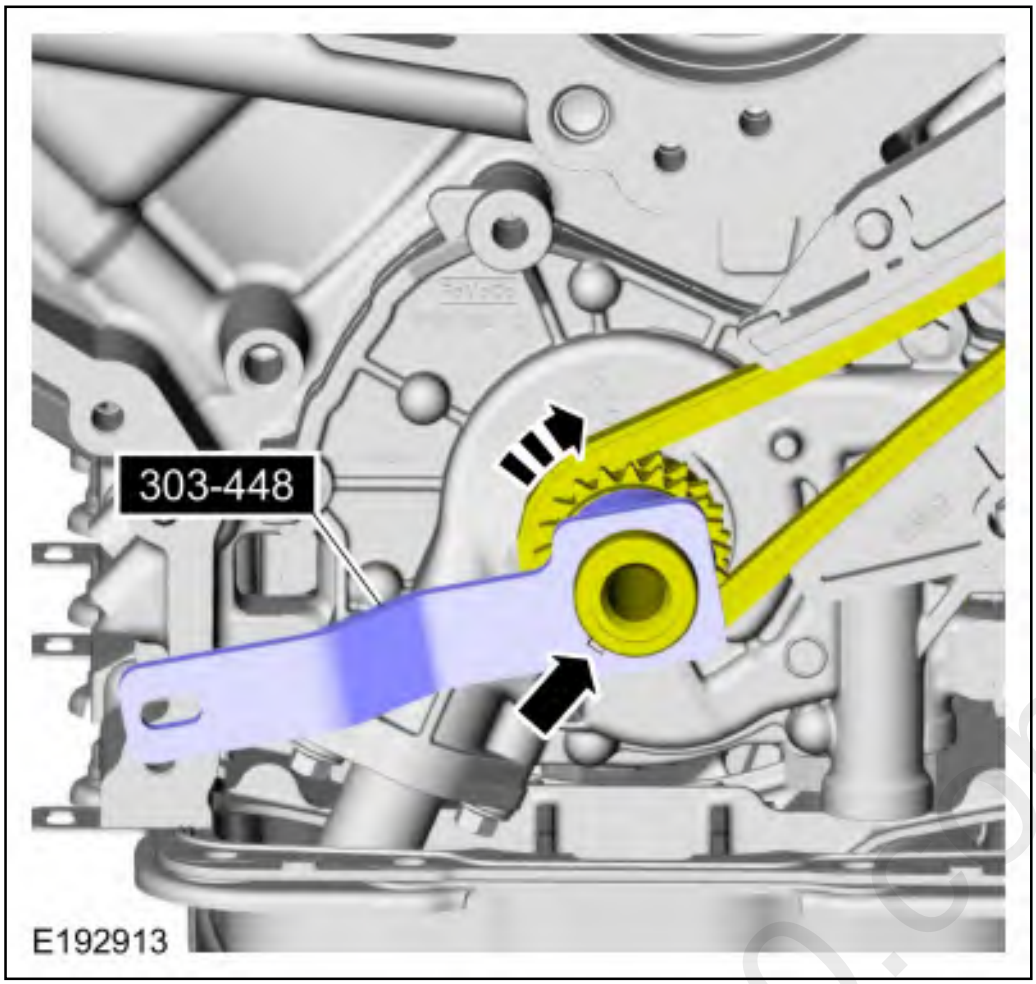
1. Compress the primary timing chain tensioner plunger, using an edge of a vise.
2. Install a suitable pin into the hole of the tensioner housing to hold the plunger in place during installation.



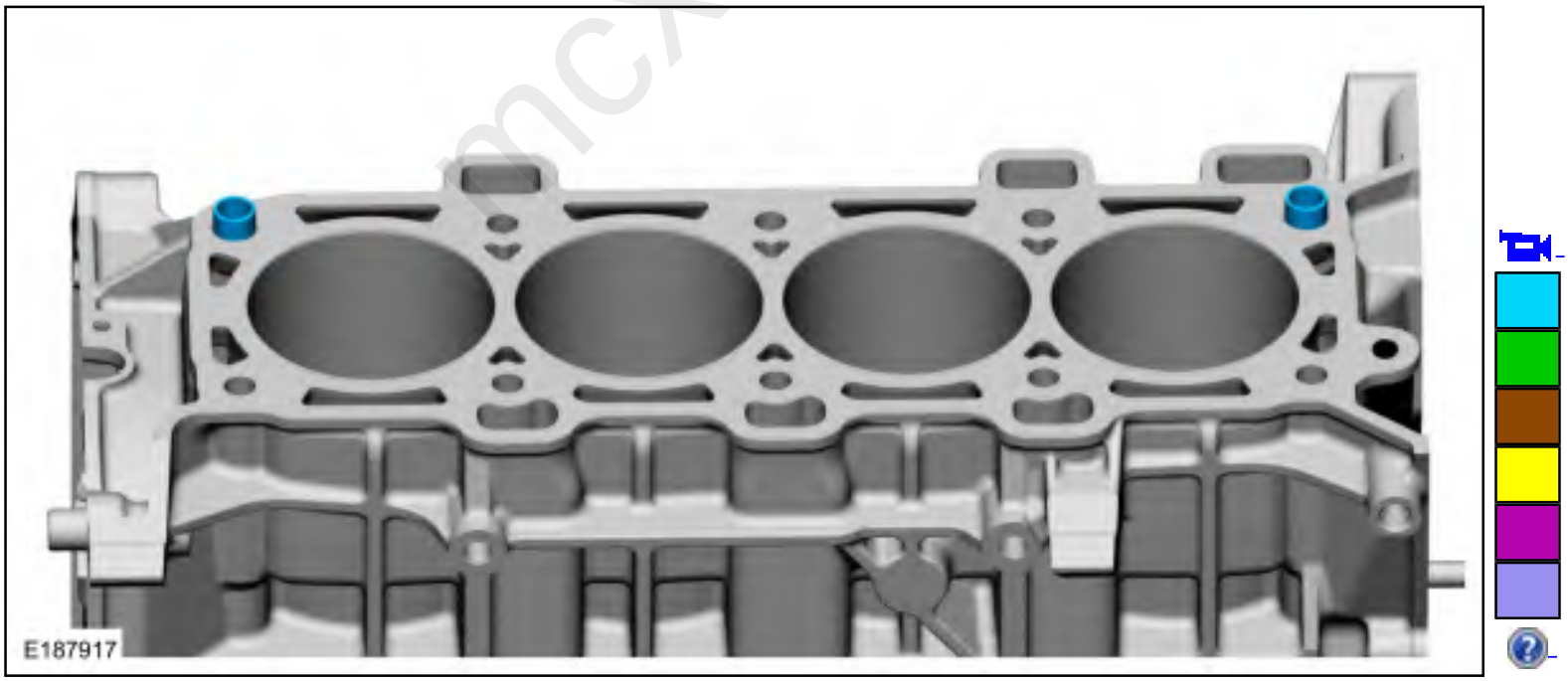
1. Install the LH primary timing chain tensioner and bolts.
   Torque:
   Stage 1: 89 lb.in (10 Nm)
   Stage 2: 25°
2. Remove the holding pin from the tensioner.



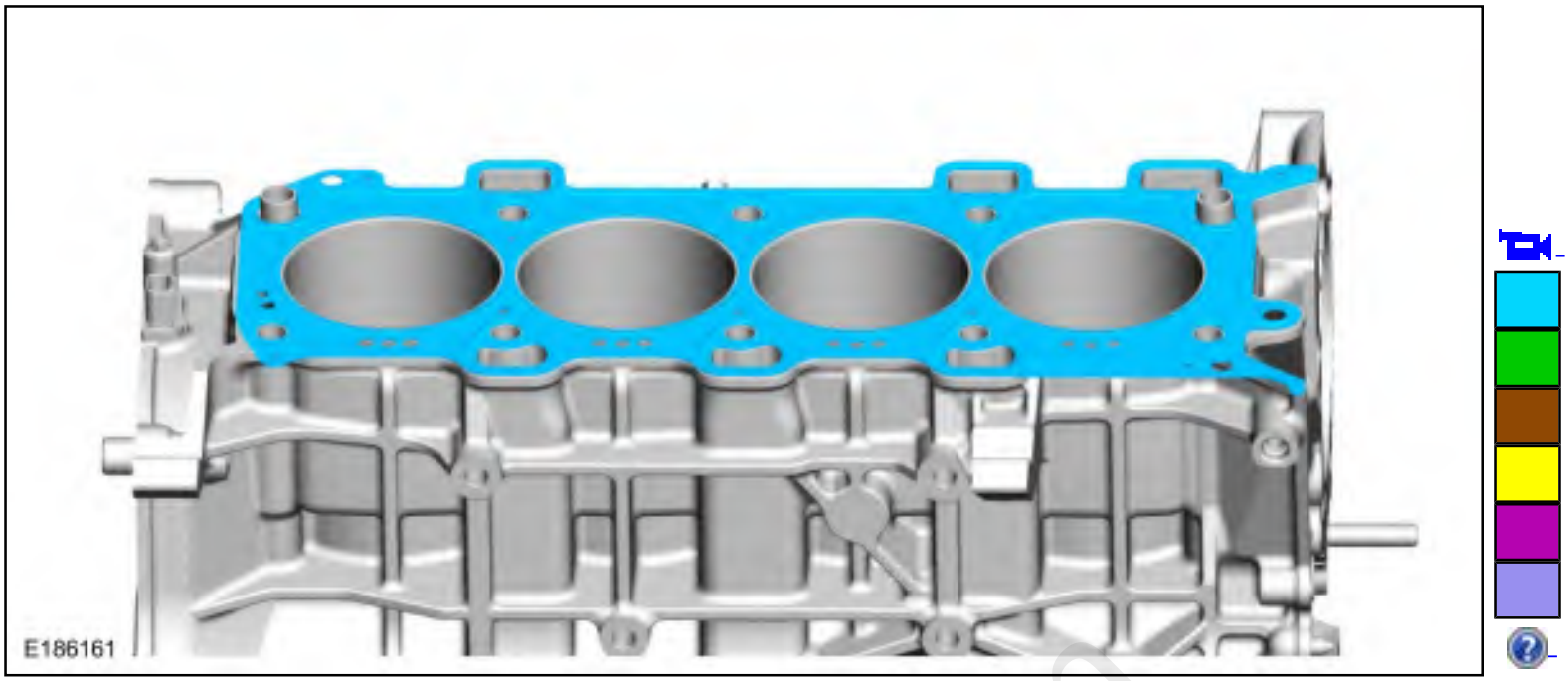
51. Using the special tool, rotate the crankshaft clockwise until the keyway is at the 7:30 position. Use Special Service Tool: 303-448 (T93P-6303-A) Holding Tool, Crankshaft.



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

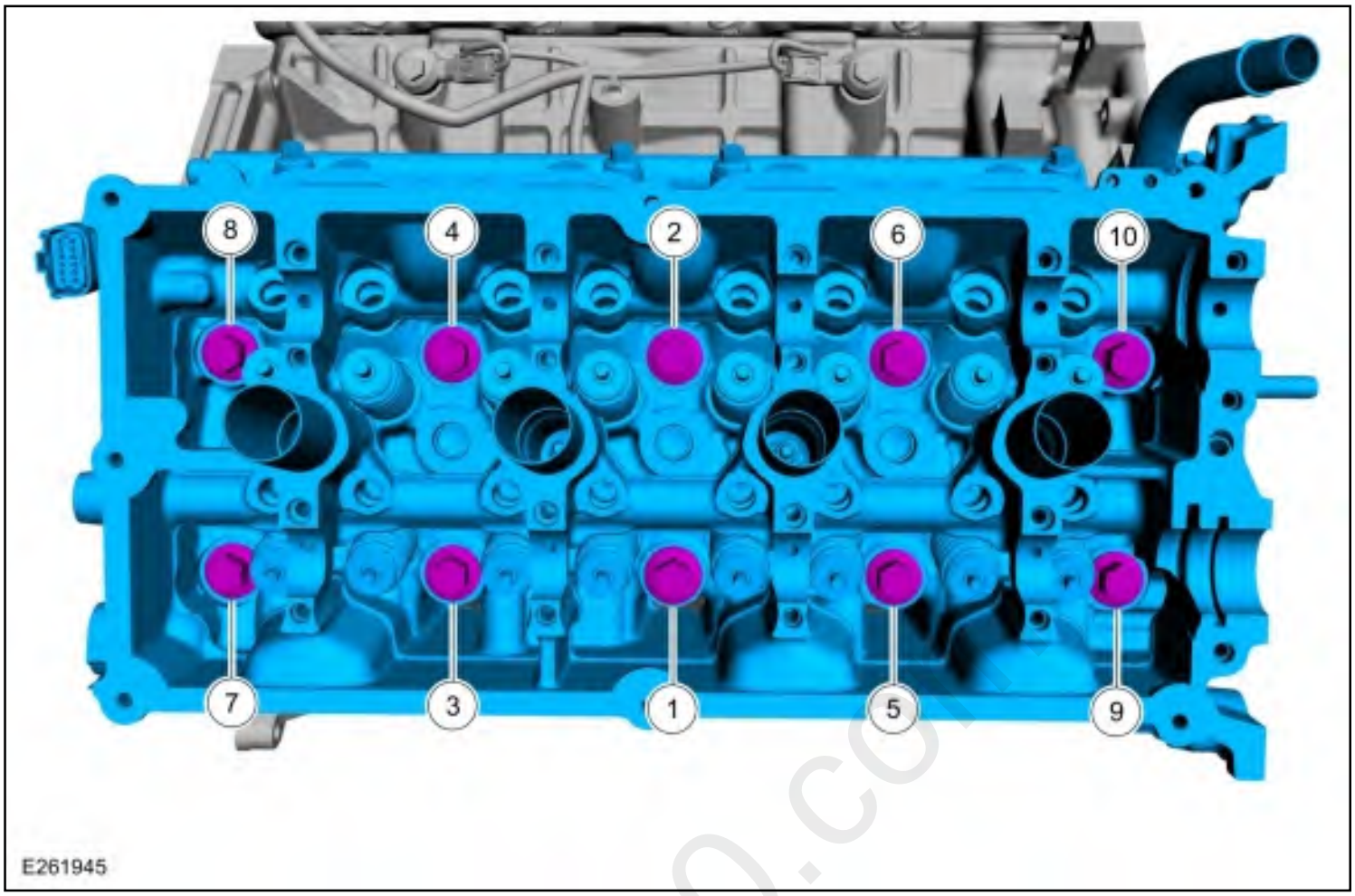


53. Install the new cylinder head gasket.



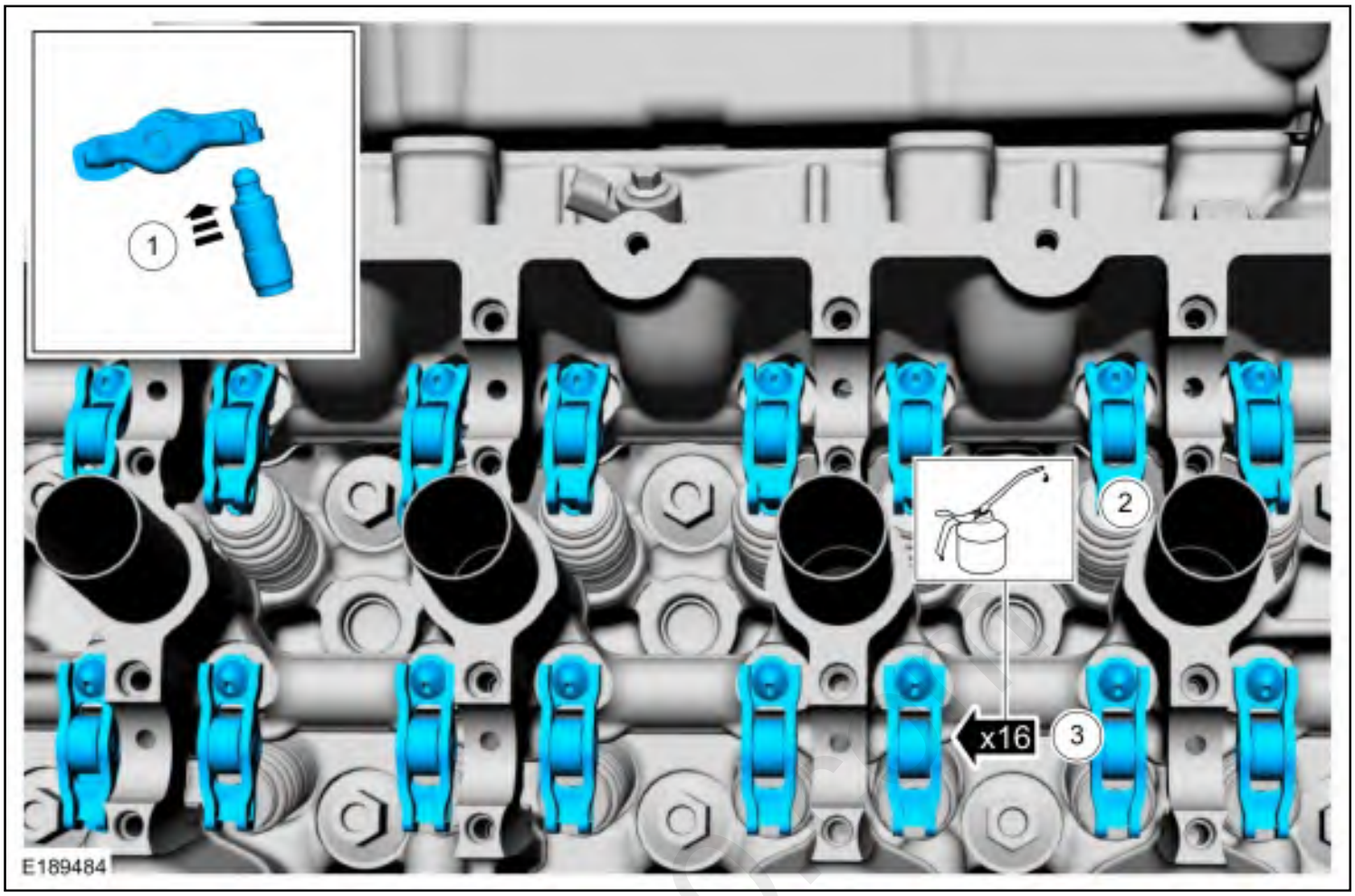
54. **NOTE:** *The cylinder head bolts are torque-to-yield and must not be reused. New cylinder head bolts must be installed.*

    1. Install the cylinder head and the new bolts.
       Torque:
       Stage 1: Bolts 1-10 in sequence: 18 lb.ft (25 Nm)
       Stage 2: Bolts 1-10 in sequence: 55 lb.ft (75 Nm)
       Stage 3: Bolt 1: Loosen: 180°
       Stage 4: Bolt 1: 37 lb.ft (50 Nm)
       Stage 5: Bolt 1: 240°
    2. Perform stages 3, 4 and 5 on bolts 2 through 10 (complete all three stages to each bolt before moving on to the next bolt in sequence).



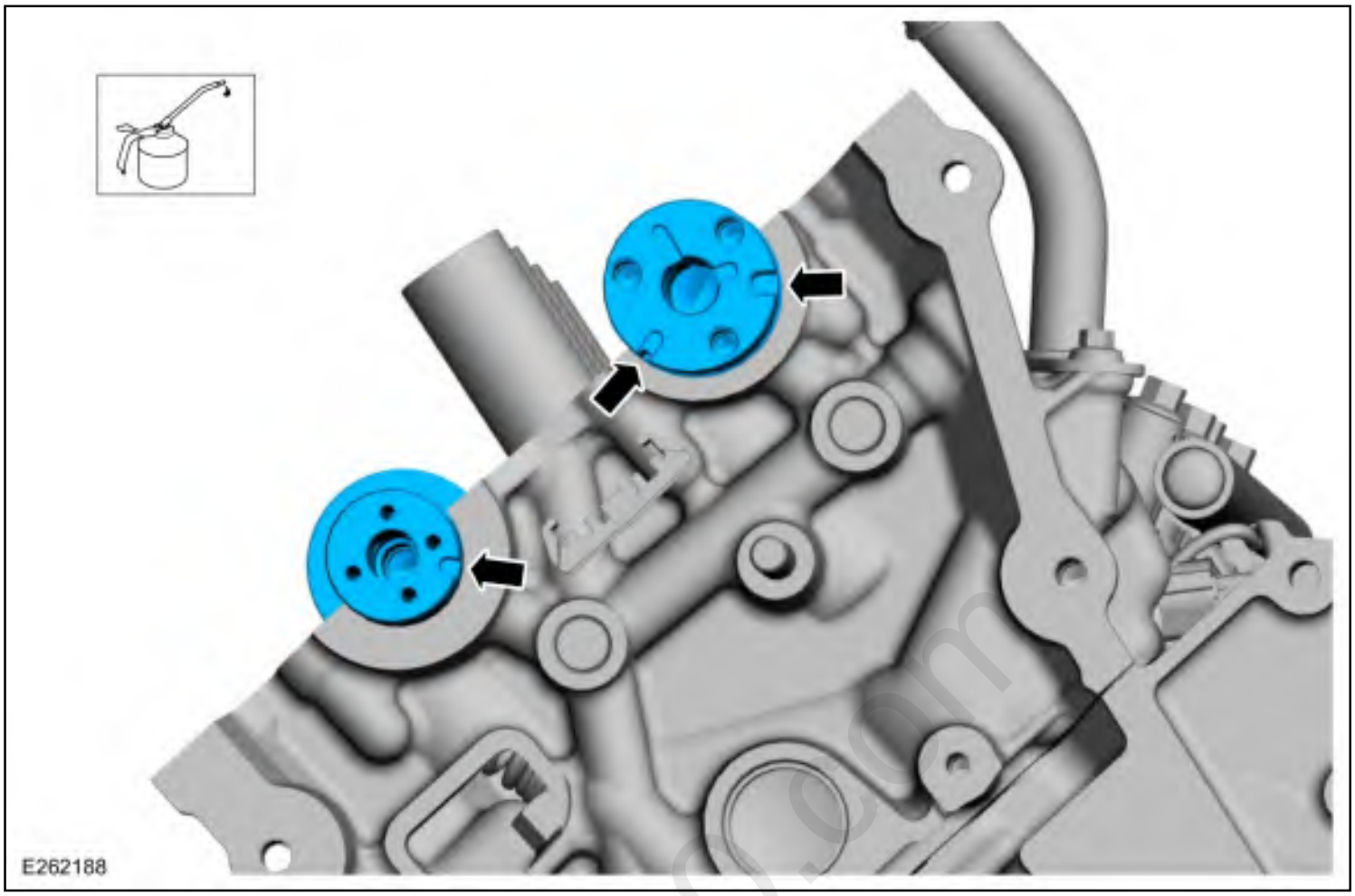
55. **NOTE:** *If the components are to be reinstalled, they must be installed in their original locations.*

1. Assemble the hydraulic lash adjusters onto the spring clips on the camshaft roller followers.
2. Lubricate the camshaft roller follower and hydraulic lash adjuster assemblies with clean engine oil.
3. Install the camshaft roller follower and hydraulic lash adjuster assemblies.

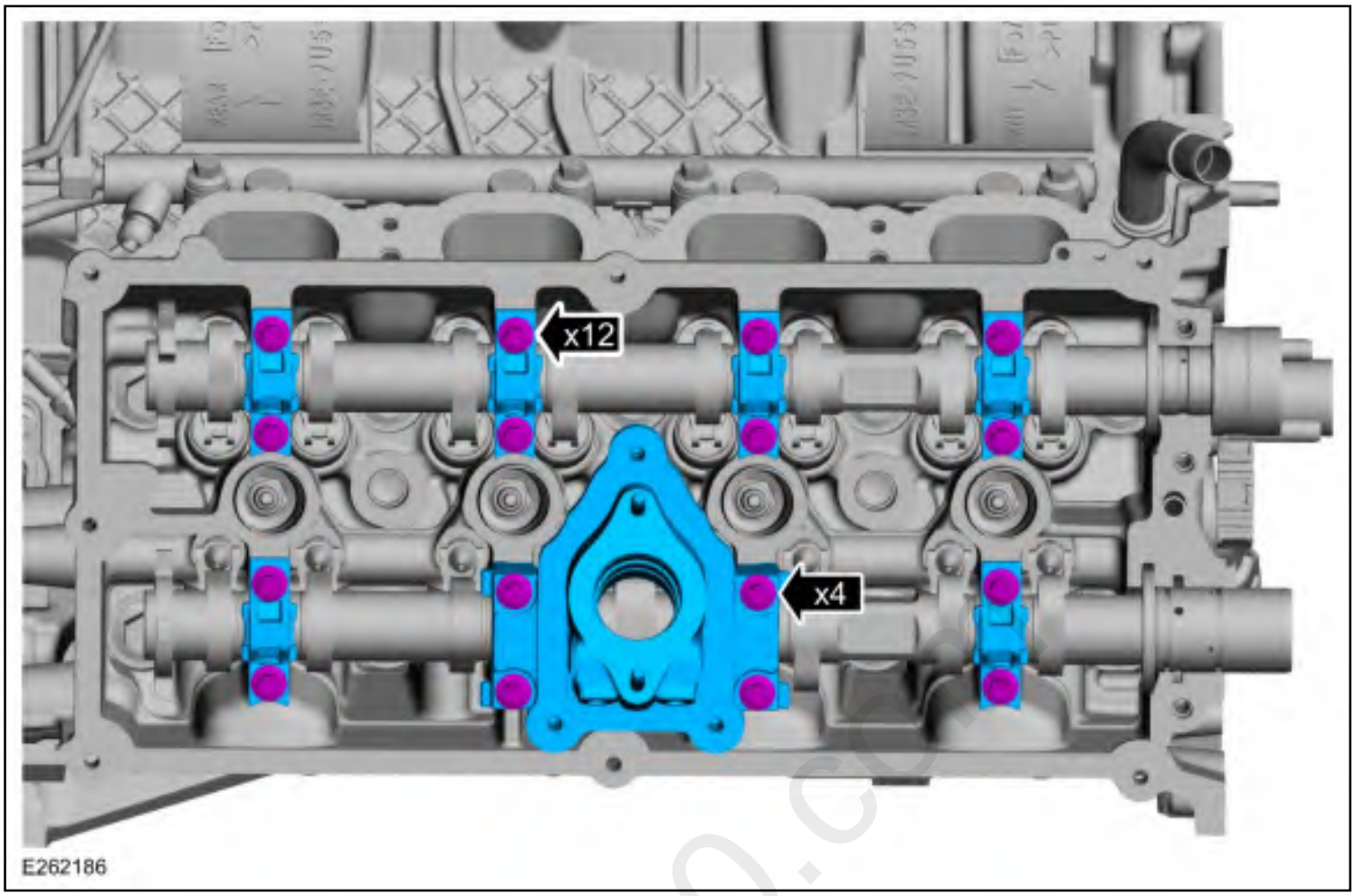


56. **NOTE:** *Lubricate the camshafts with clean engine oil prior to installation.*

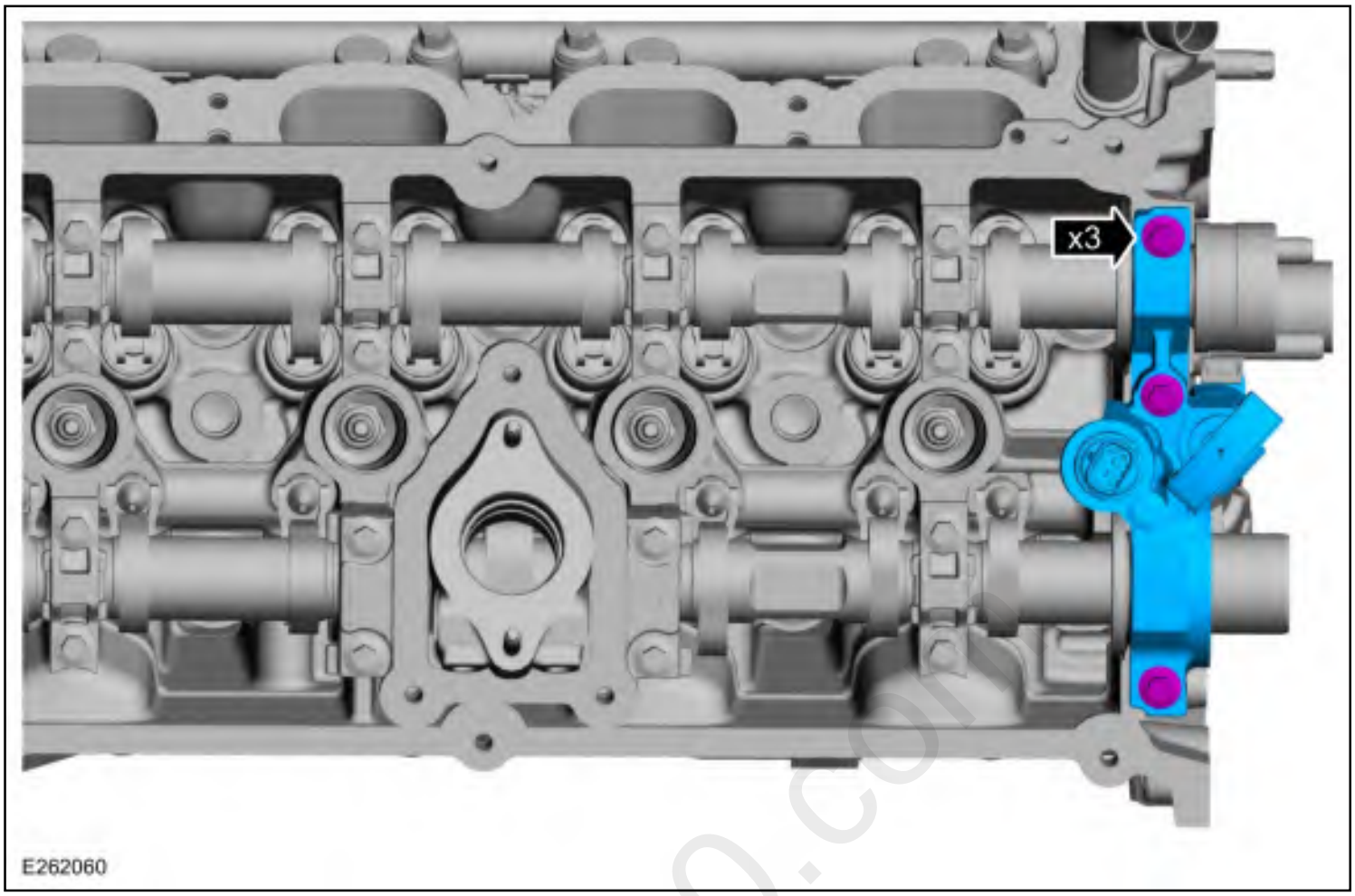
    Install the intake and exhaust camshafts in the neutral position. Align the D-slots as shown in the illustration.



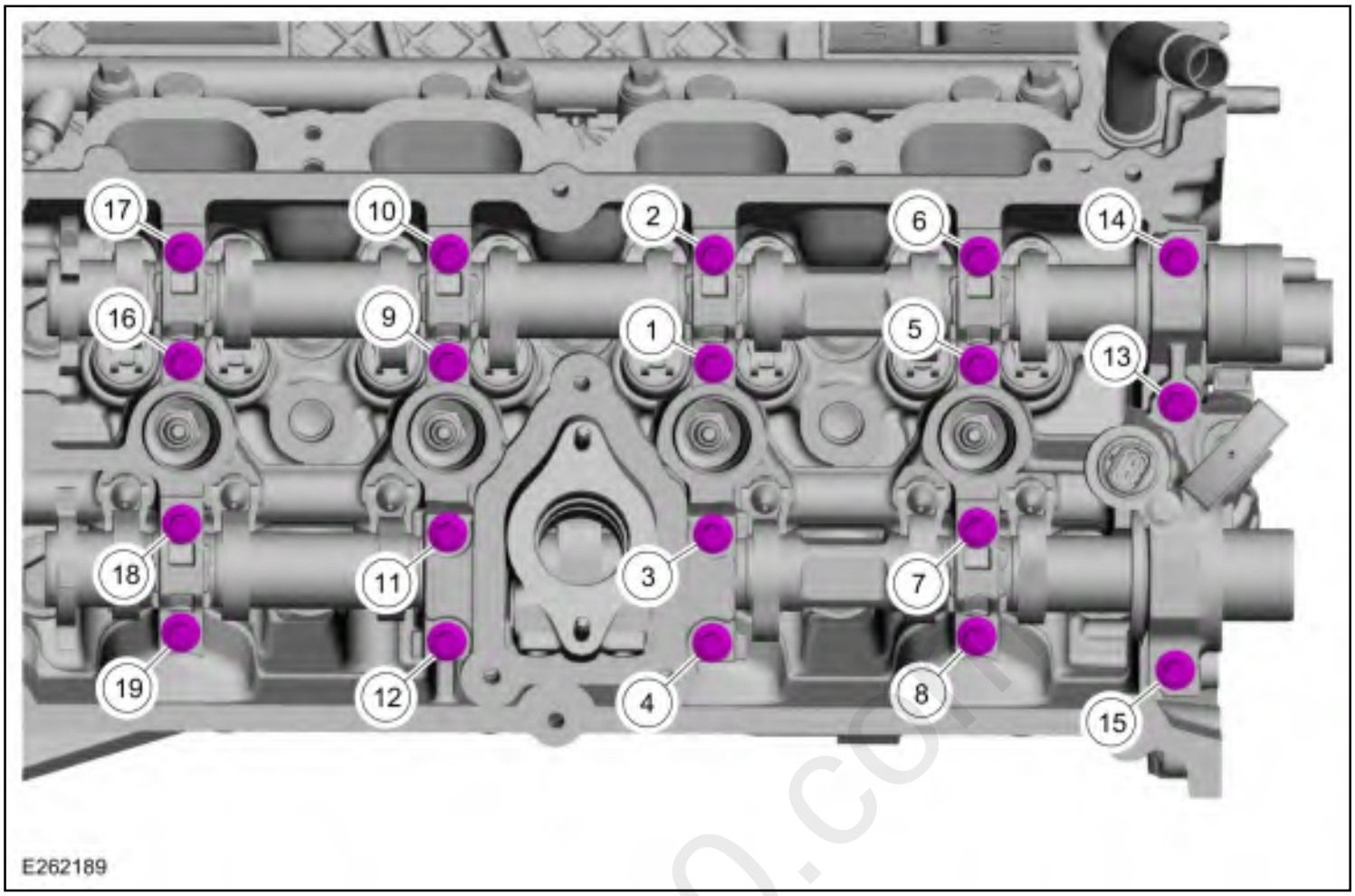
57. Install the camshaft bearing caps and the bolts. Do not tighten at this time.



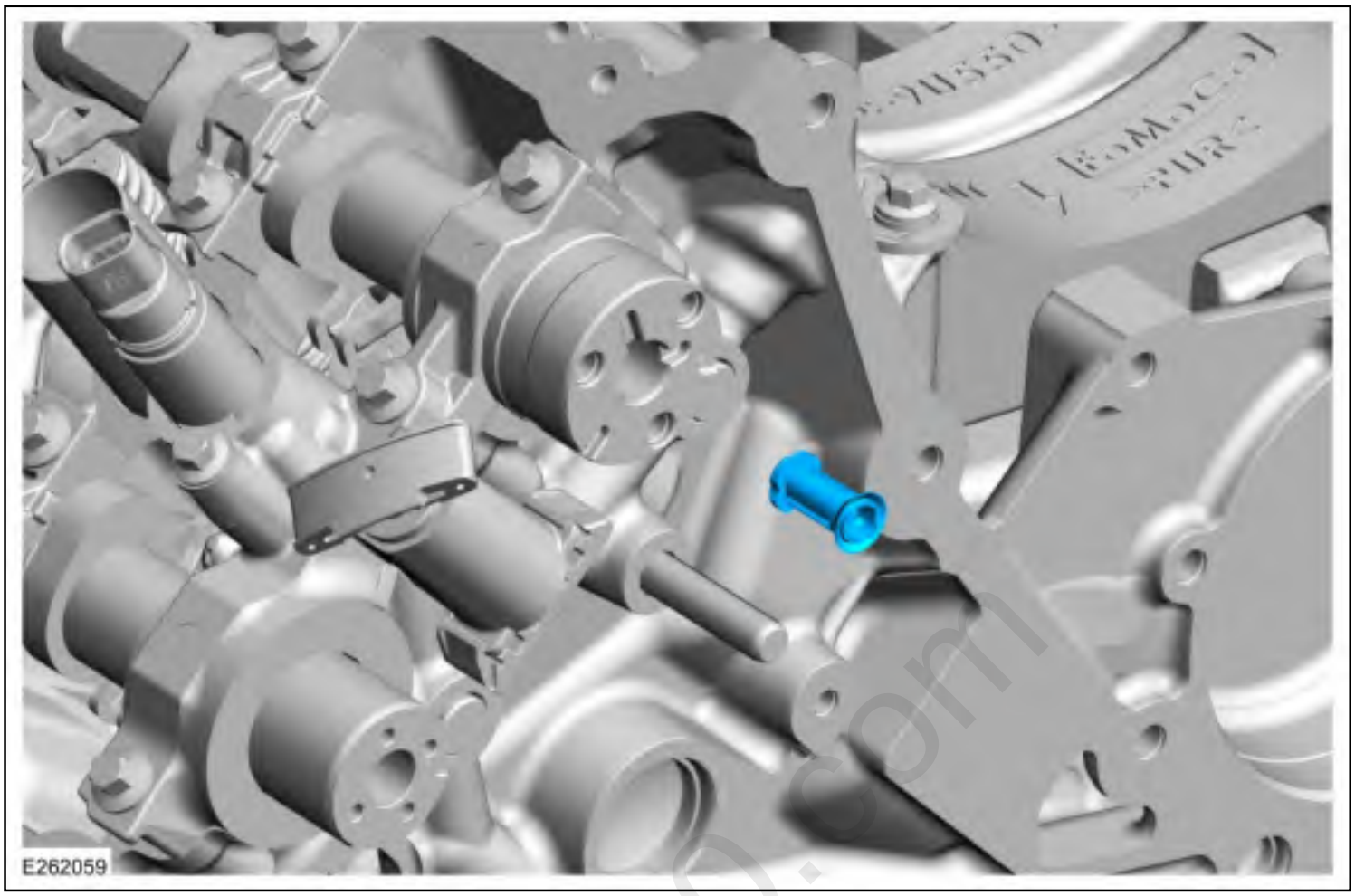
58. Install the front camshaft bearing mega cap and the bolts. Do not tighten at this time.



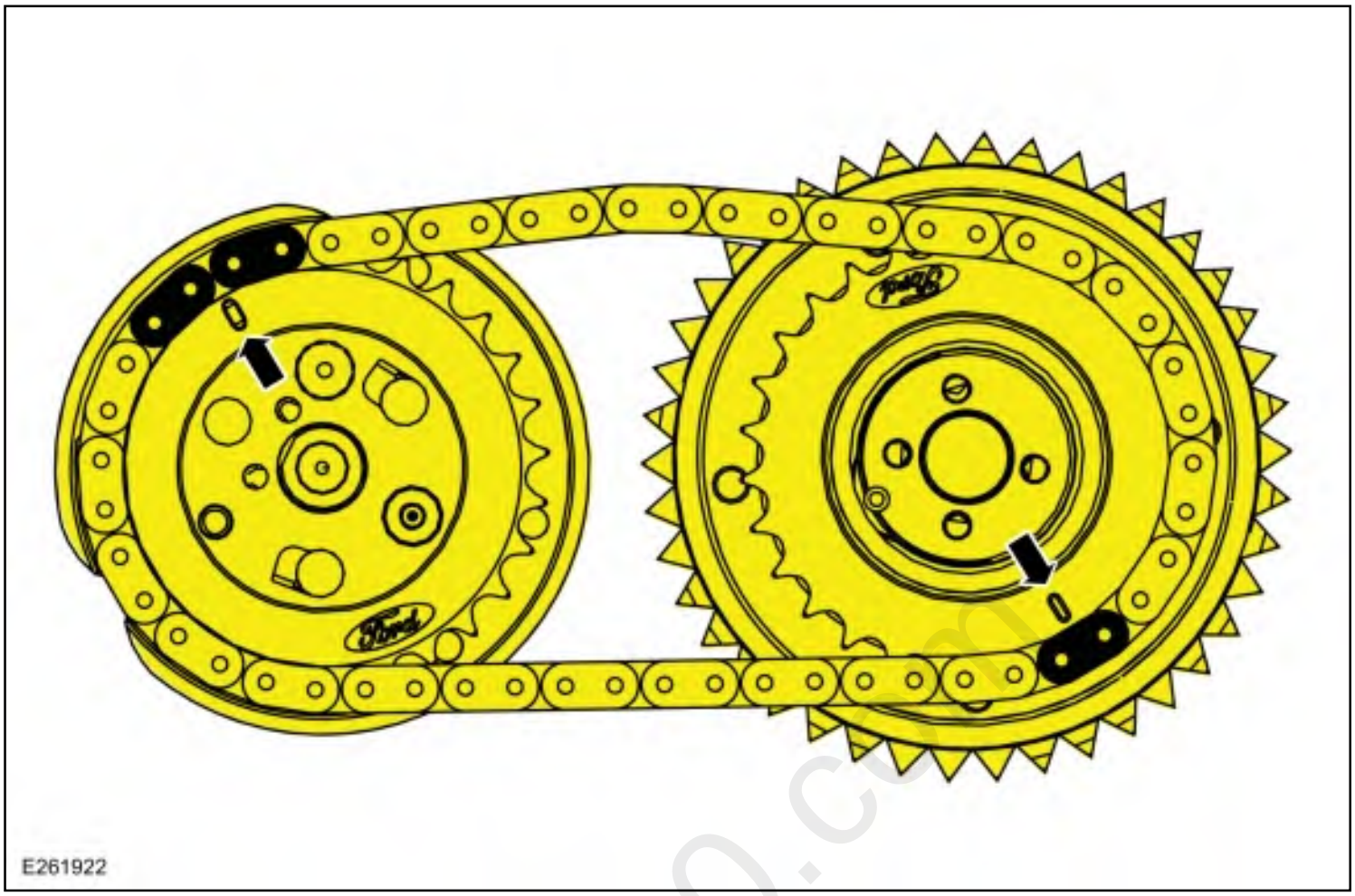
59. Tighten the bolts in sequence.
    Torque:
    Stage 1: Bolts 1-19: 53 lb.in (6 Nm)
    Stage 2: Bolts 1-2, 5-10, 13-19: 45°Bolts 3-4, 11-12: 90°



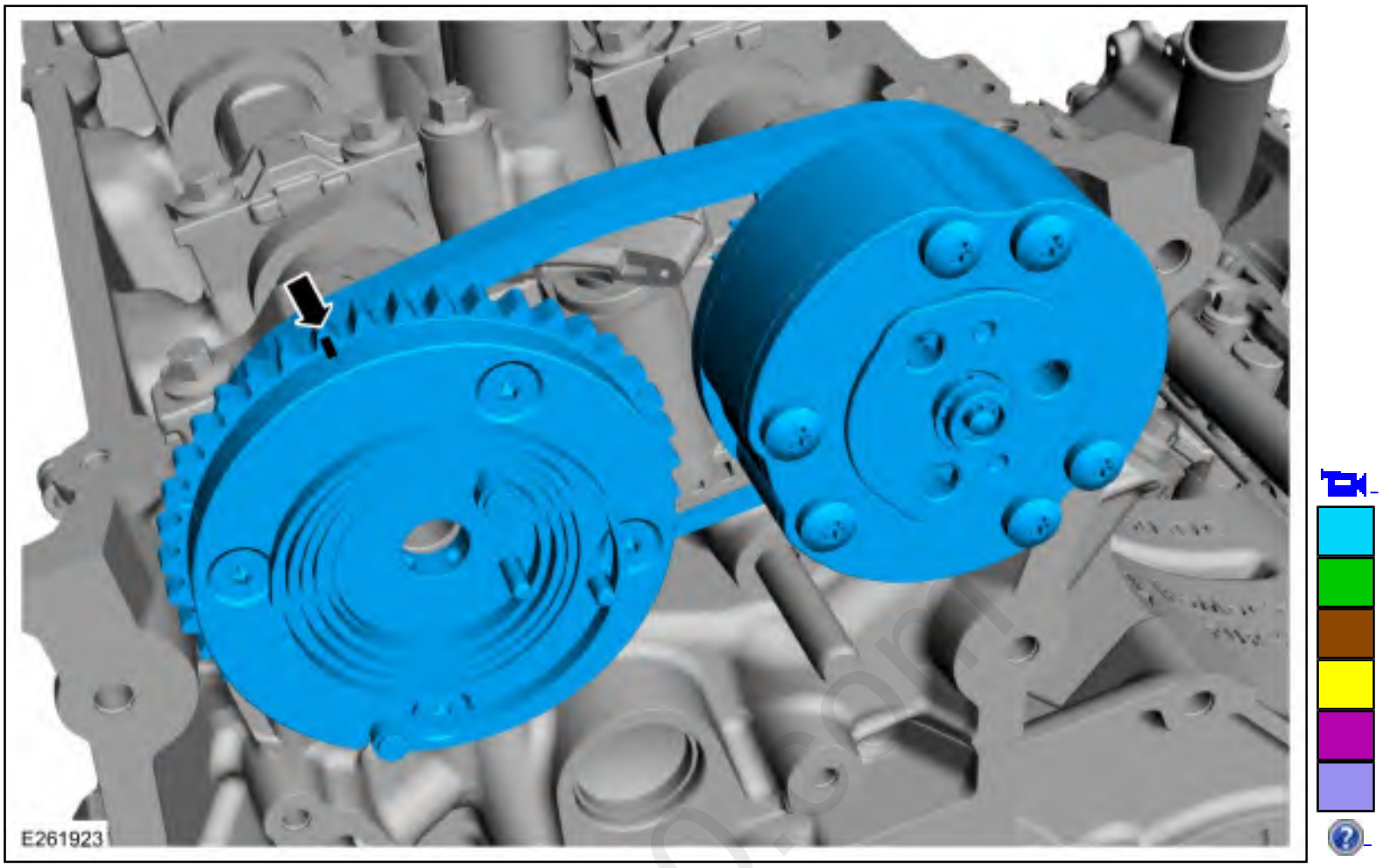
60. Install a new VCT system oil filter into the camshaft.



61. Position the secondary timing chain onto the VCT assemblies. Align the colored links on the secondary timing chain with the timing marks on the VCT assemblies as shown in the illustration.
    - The timing mark on the intake VCT assembly should align between the 2 consecutive colored links.
    - The timing mark on the exhaust VCT assembly should align with the single colored link.



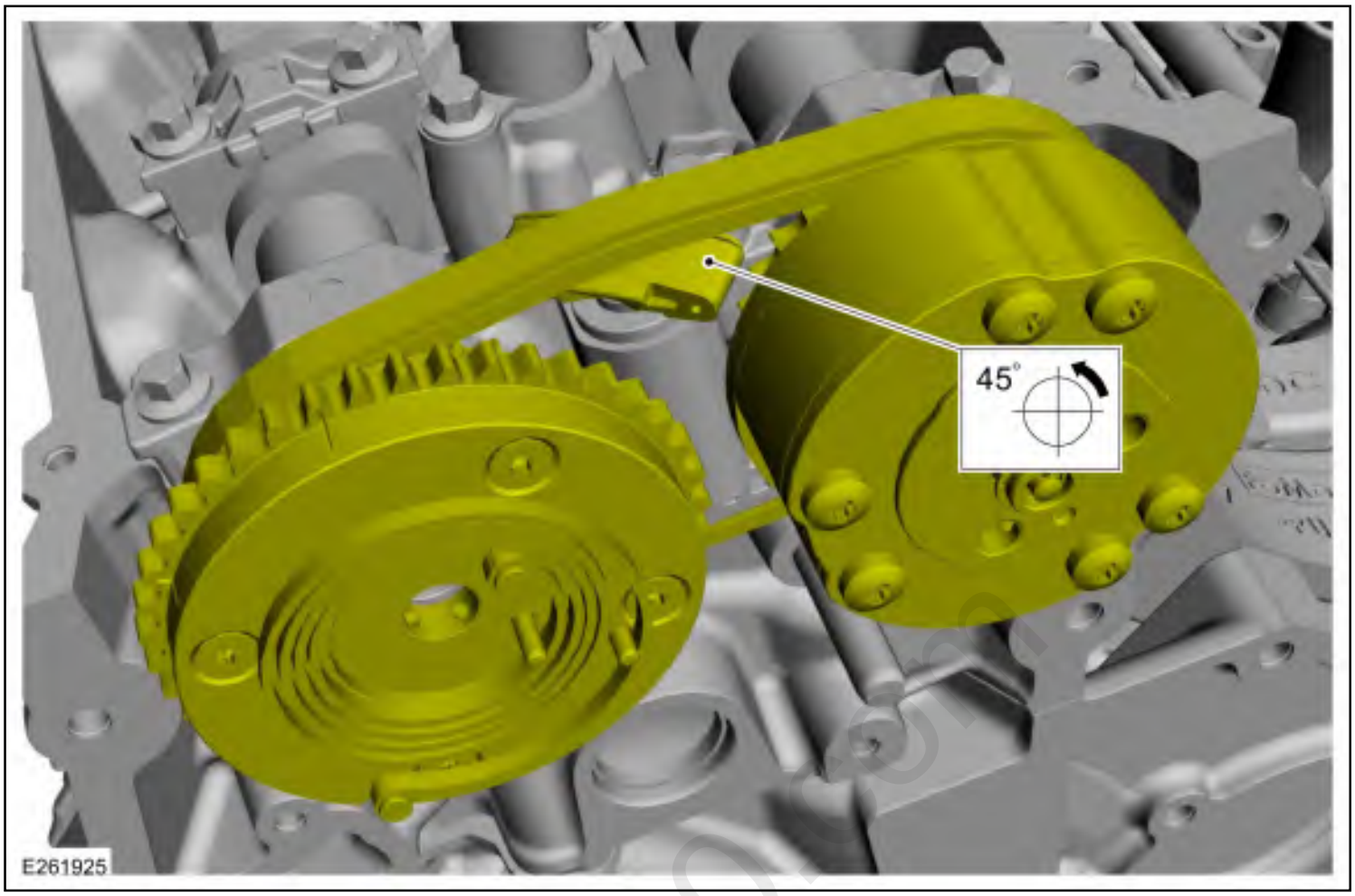
62. Install the VCT assemblies and the secondary timing chain onto the camshafts. The timing mark on the exhaust VCT assembly should be approximately in the 11 o'clock position.



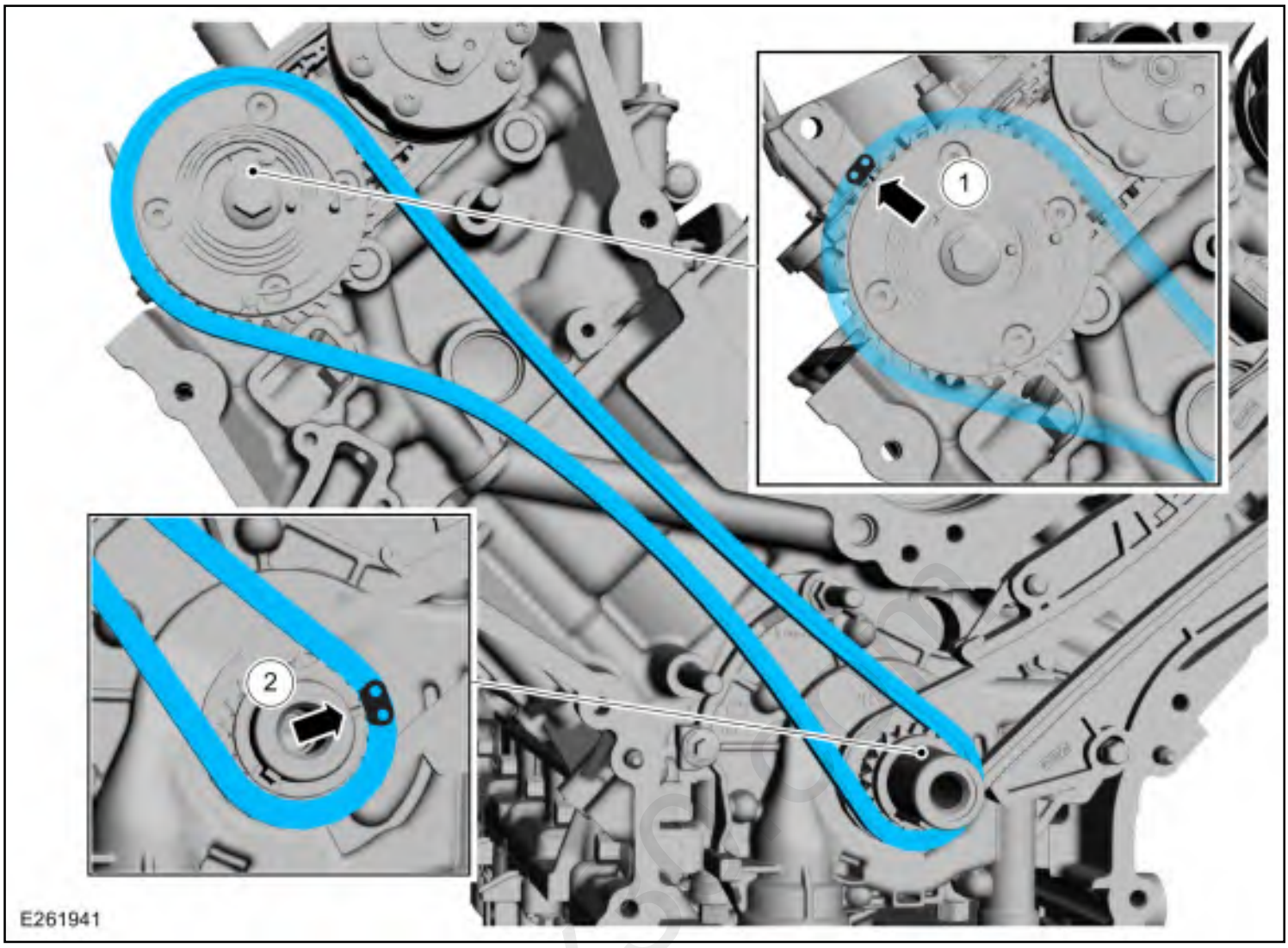
63. **NOTE:** *It may be necessary to rotate the exhaust camshaft slightly (using a wrench on the flats of the camshaft) to seat the VCT assemblies onto the camshafts.*

    Rotate the secondary timing chain tensioner counterclockwise 45 degrees so the ramped area is facing forward and fully seat the VCT assemblies onto the camshafts.

    - If the secondary timing chain is not centered over the tensioner, reposition the VCT assemblies until they are fully seated on the camshafts.

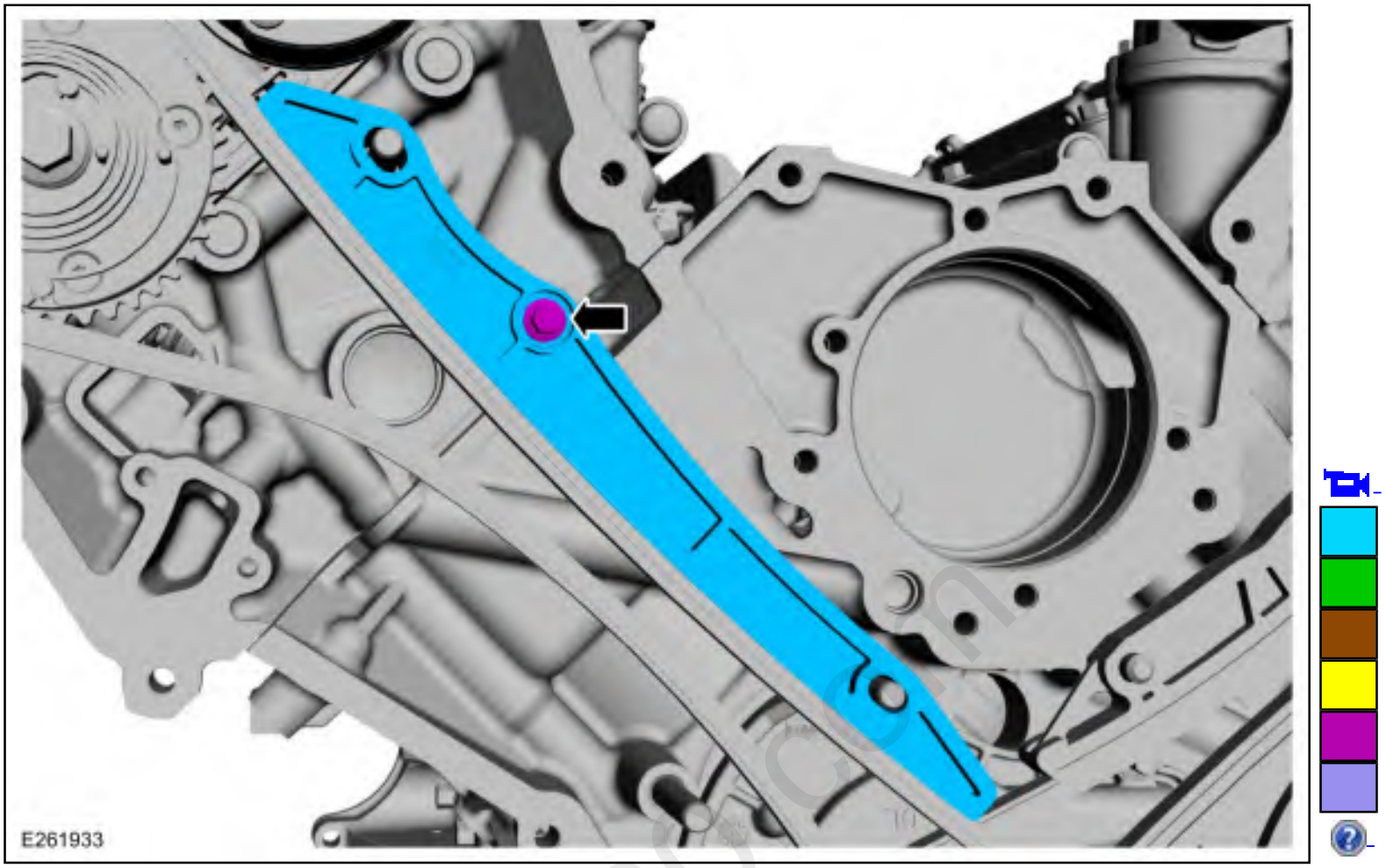


64. Install the RH timing chain.
    1. Align the colored link on the timing chain with the timing mark on the RH VCT assembly.
    2. Align the remaining colored link on the timing chain with the timing mark on the crankshaft sprocket.



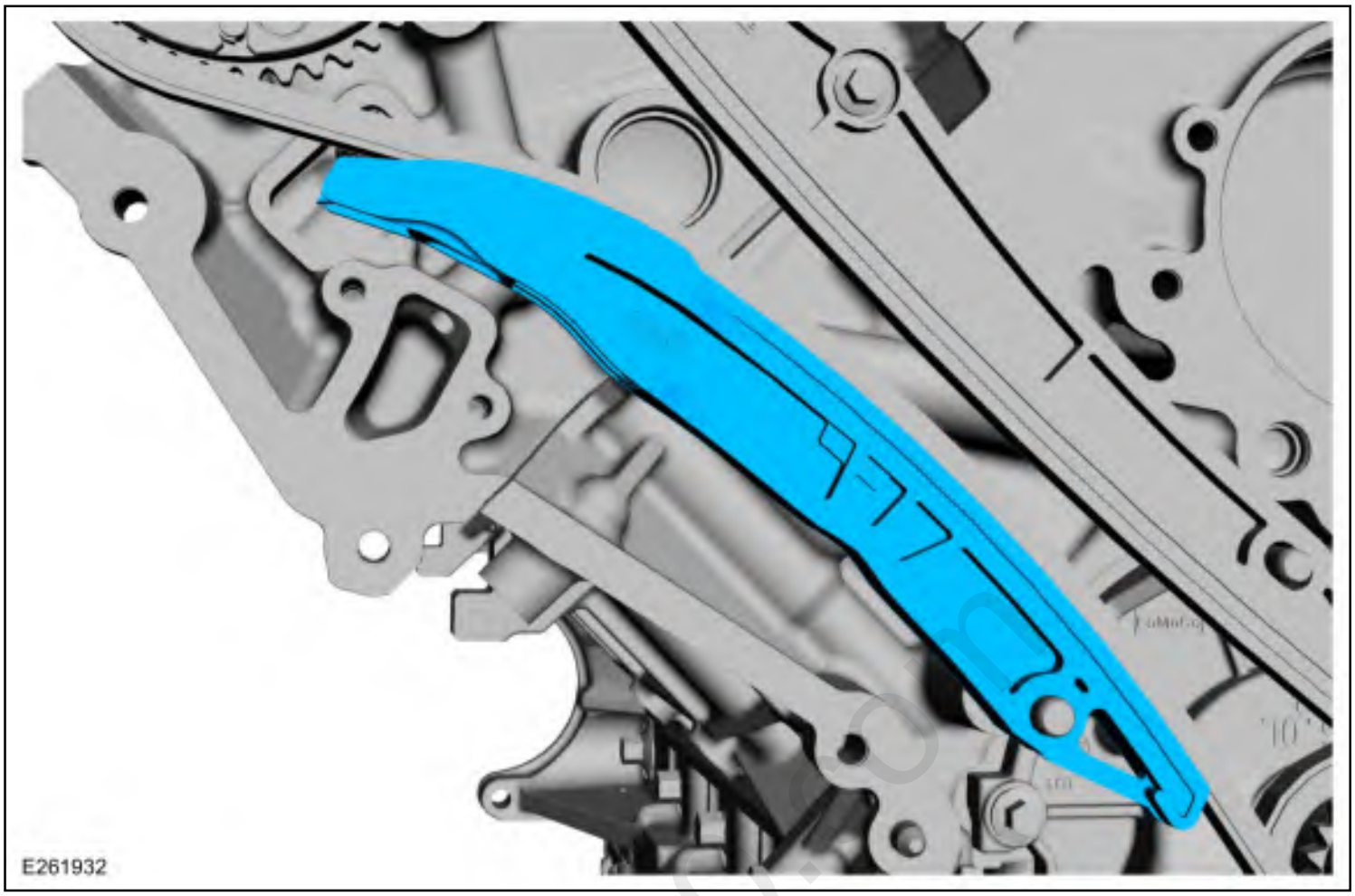
65. **NOTE:** *It may be necessary to rotate the crankshaft slightly to provide enough slack in the chain to install the RH timing chain guide. Return the crankshaft keyway to the 7:30 position after installing the RH timing chain guide.*

    Install the RH timing chain guide and bolt.
    Torque:
    Stage 1: 89 lb.in (10 Nm)
    Stage 2: 25°

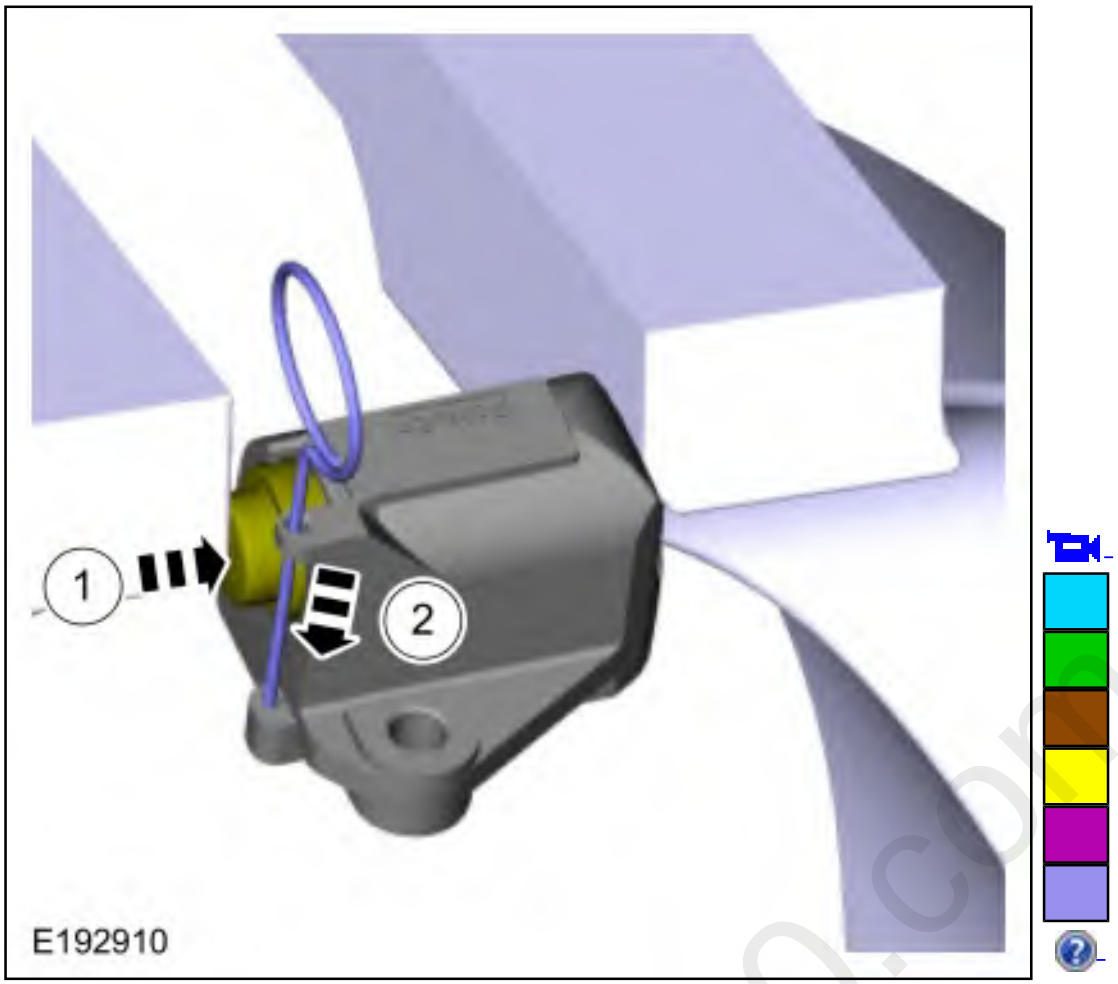


66. **NOTE:** *It may be necessary to rotate the crankshaft slightly to provide enough slack in the chain to install the RH timing chain arm. Return the crankshaft keyway to the 7:30 position after installing the RH timing chain arm.*

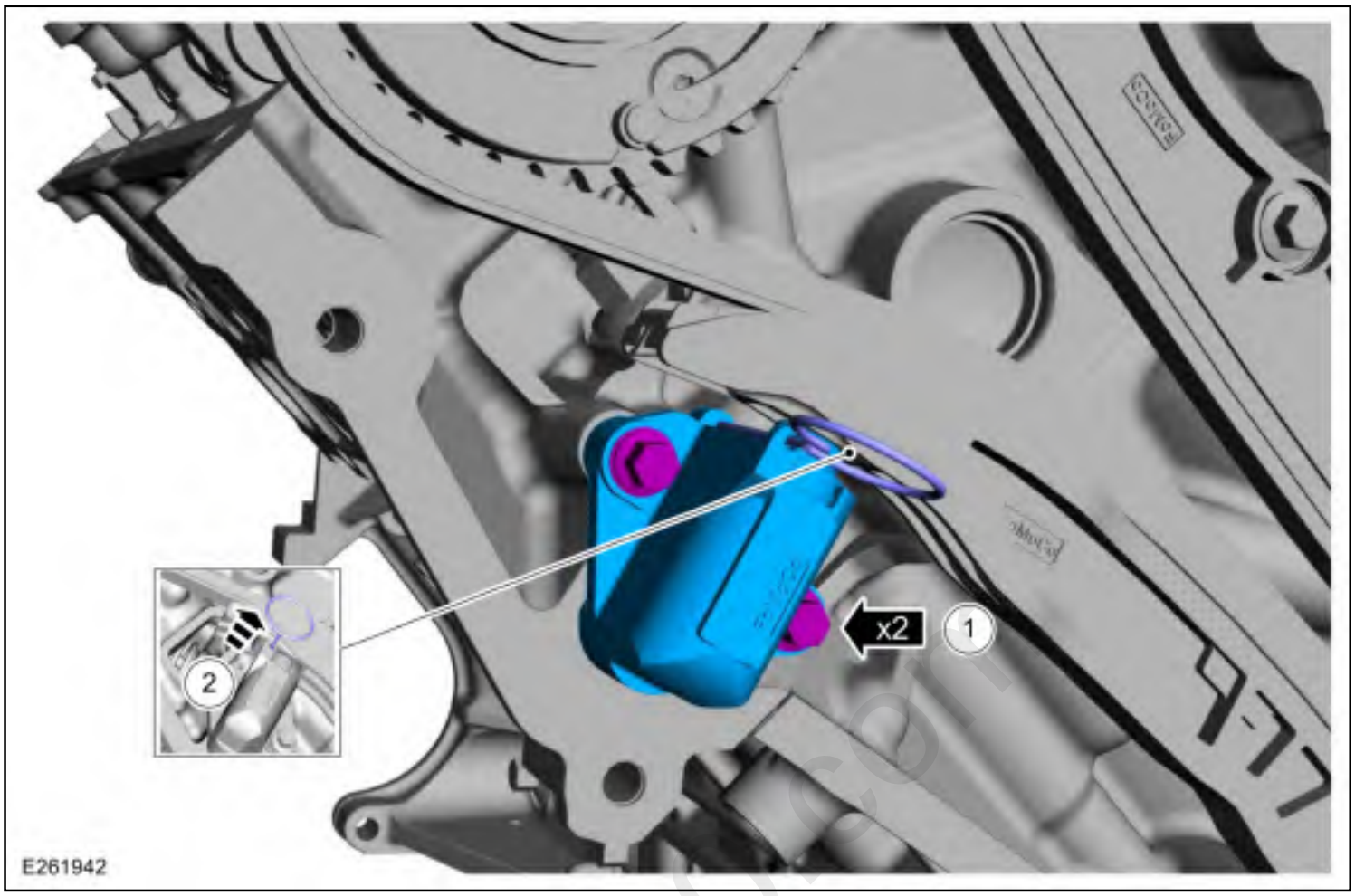
    Install the RH timing chain tensioner arm.



1. Compress the primary timing chain tensioner plunger, using an edge of a vise.
2. Install a suitable pin into the hole of the tensioner housing to hold the plunger in place during installation.

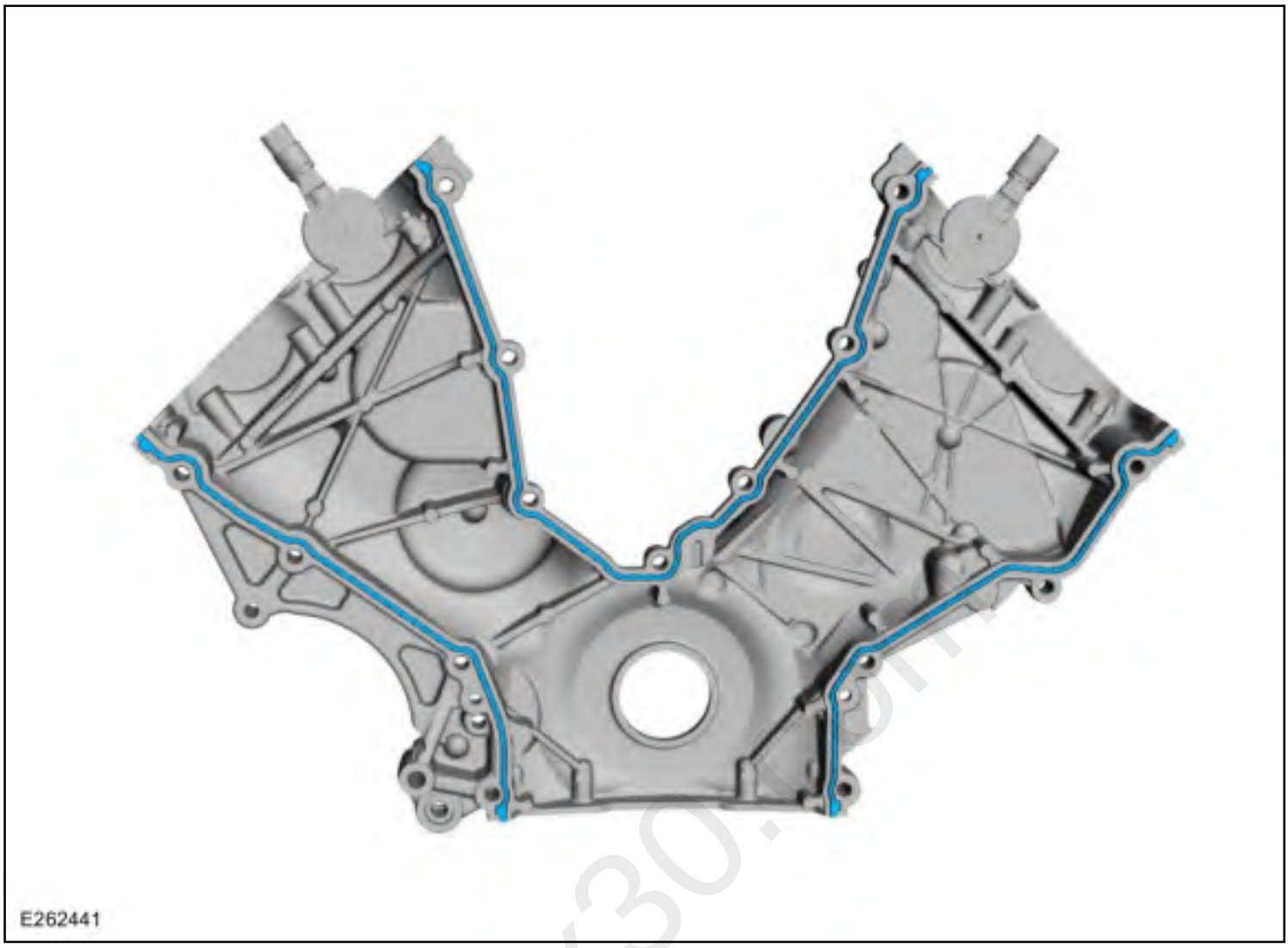


1. Install the RH primary timing chain tensioner and bolts.
   Torque:
   Stage 1: 89 lb.in (10 Nm)
   Stage 2: 25°
2. Remove the holding pin from the tensioner.



69. Install the engine front cover.
    Refer to: Engine Front Cover (303-01 Engine - 5.0L 32V Ti-VCT) .

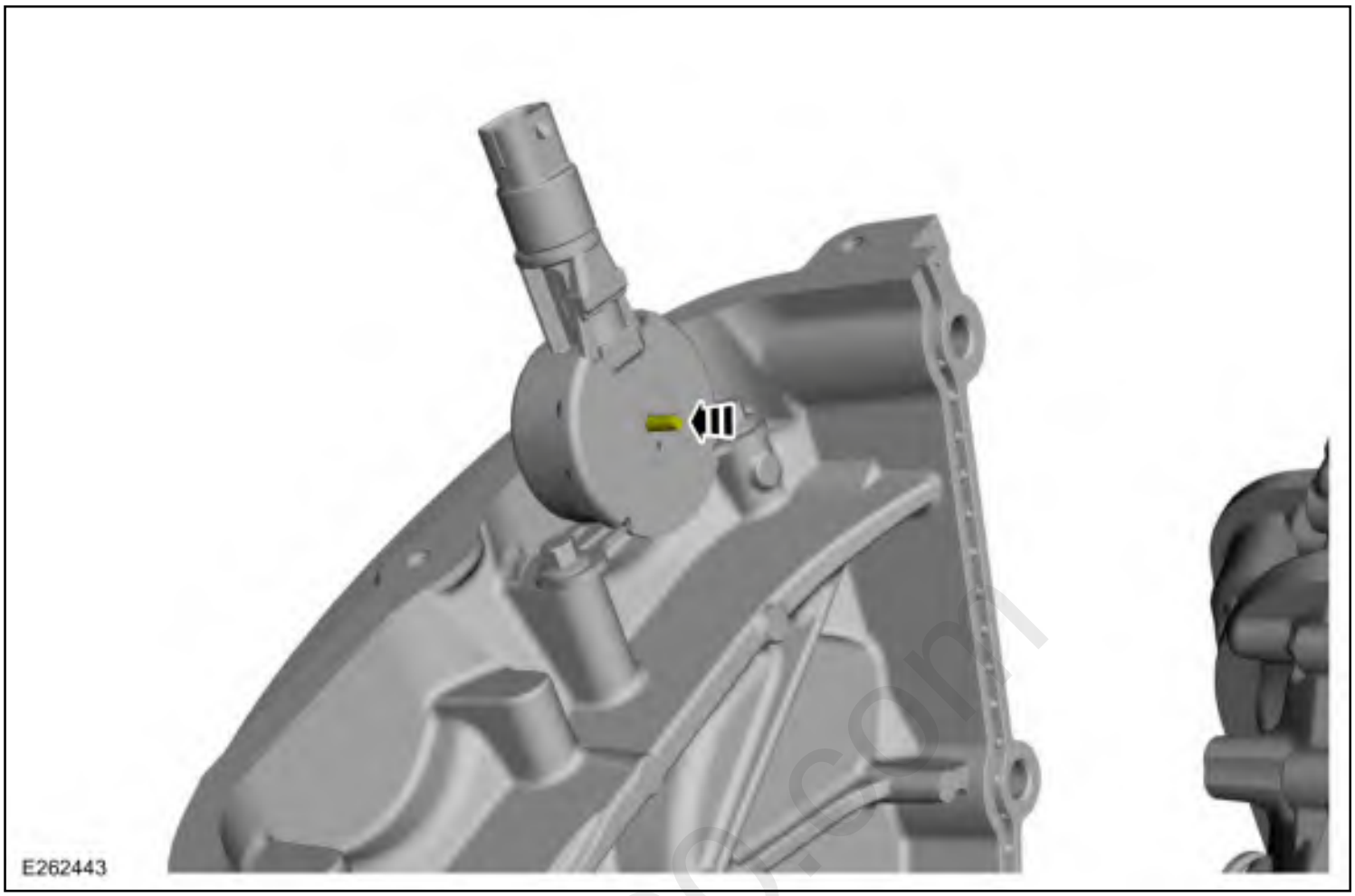
70. Install new gaskets on the engine front cover.



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

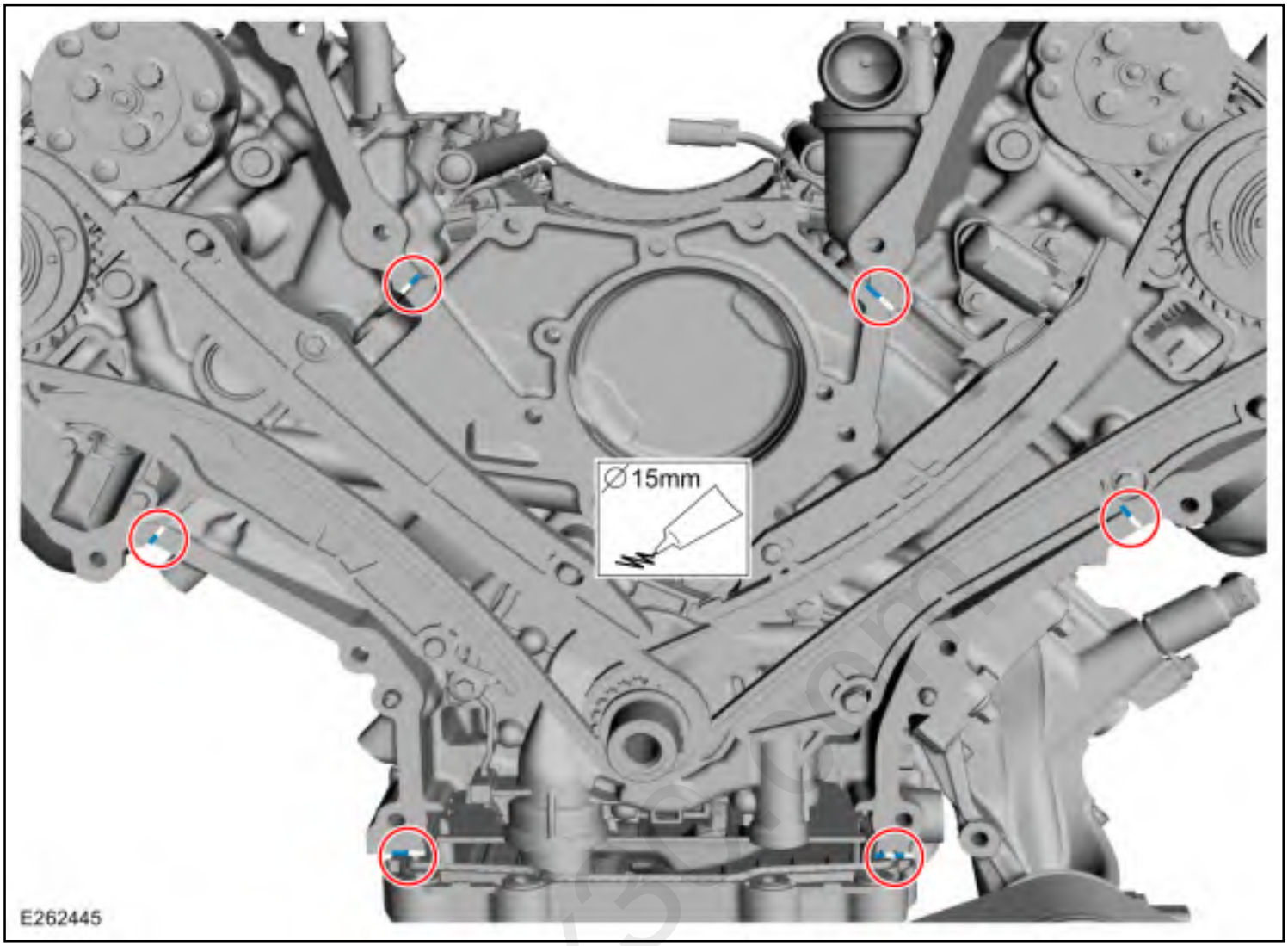
    NOTE: *RH shown, LH similar.*

    Fully depress the VCT variable force solenoid pins.



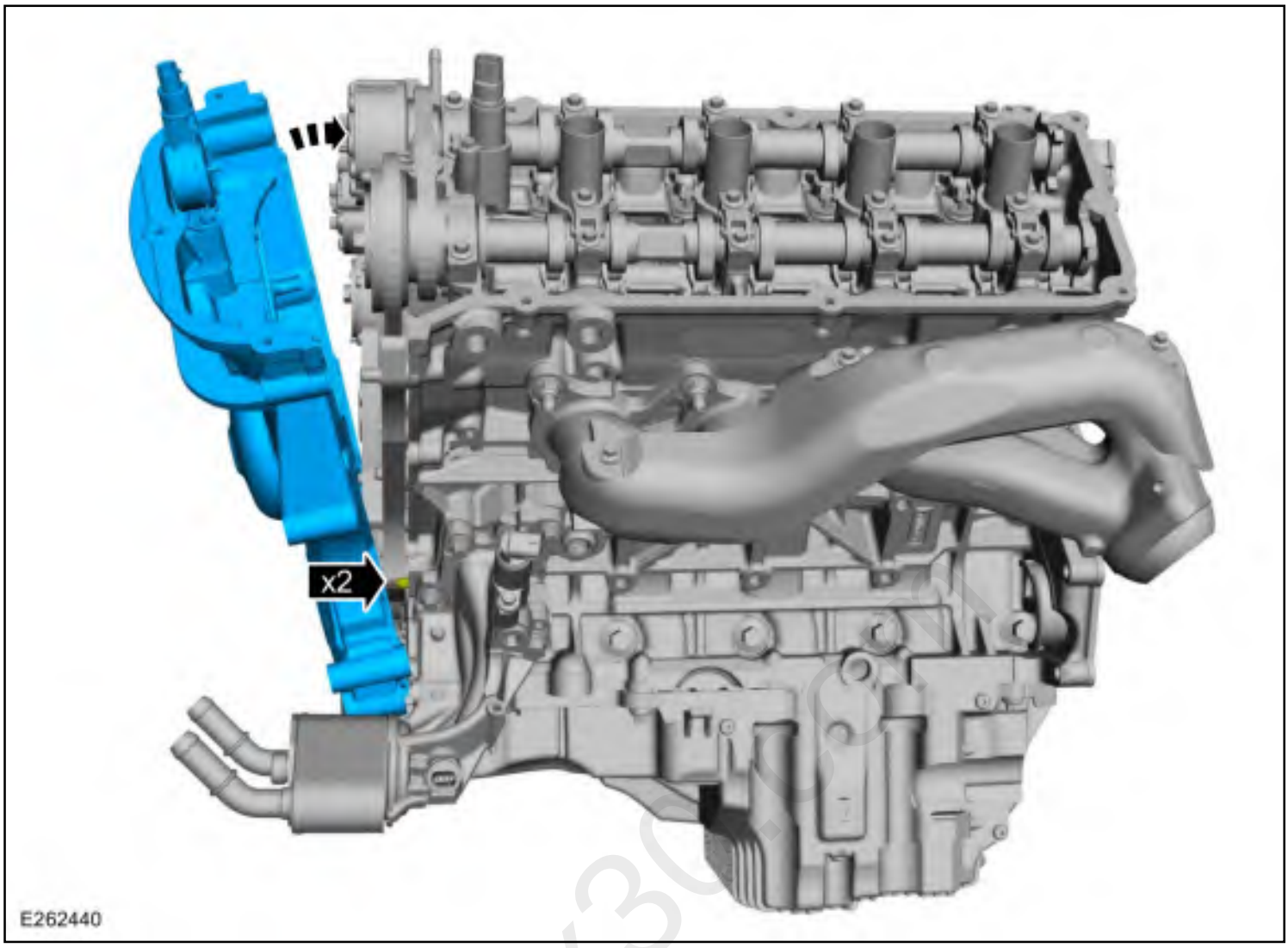
72. **NOTICE: The engine front cover must be installed and all fasteners final tightened within 5 minutes of applying the sealer. If this cannot be accomplished, install the engine front cover and tighten fasteners 6, 7, 8, 9, 10 and 11 to 8 Nm (71 lb-in) within 5 minutes of applying the sealer. All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

    Apply a 15 mm (0.59 in) diameter drop of silicone gasket and sealant to the cylinder head-to-cylinder block joints and the oil pan-to-cylinder block joints.
    Material: Motorcraft® Silicone Gasket and Sealant / TA-30 (WSE-M4G323-A4)



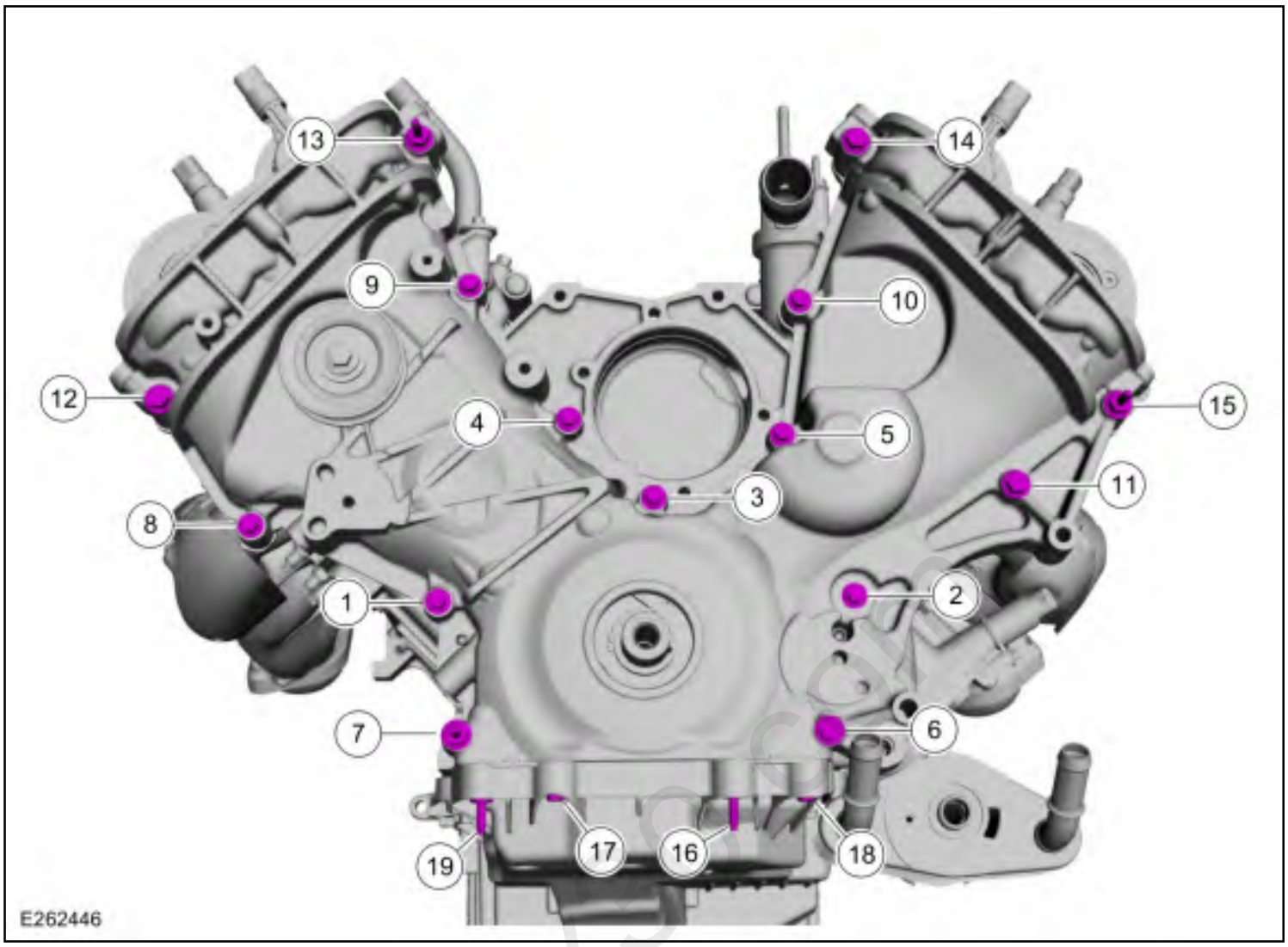
73. **NOTE:** *Make sure that the engine front cover gaskets are in place on the engine front cover before installation.*

    Position the engine front cover onto the dowels.

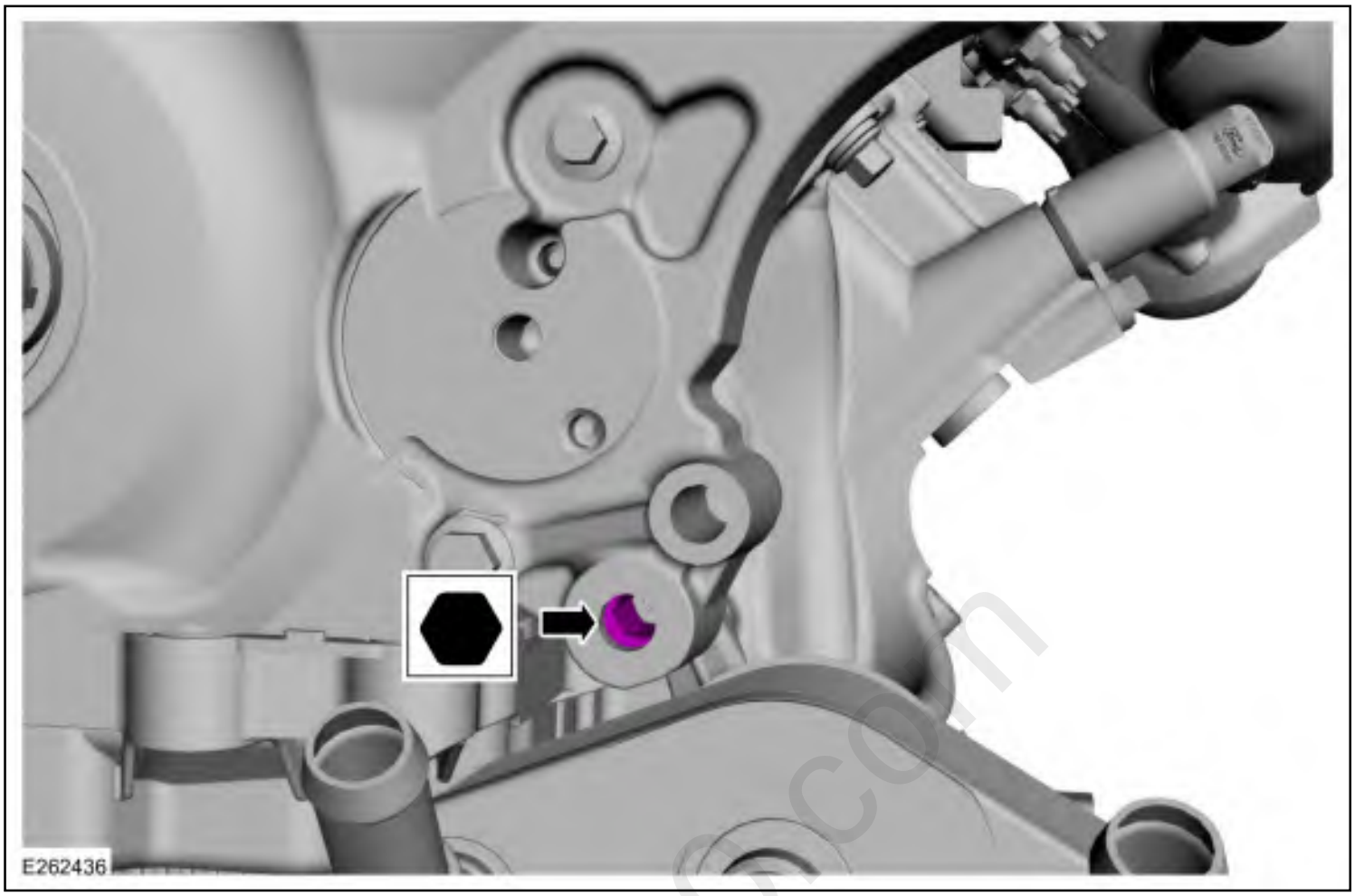


74. **NOTICE: The engine front cover must be installed and all fasteners final tightened within 5 minutes of applying the sealer. If this cannot be accomplished, install the engine front cover and tighten fasteners 6, 7, 8, 9, 10 and 11 to 8 Nm (71 lb-in) within 5 minutes of applying the sealer. All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

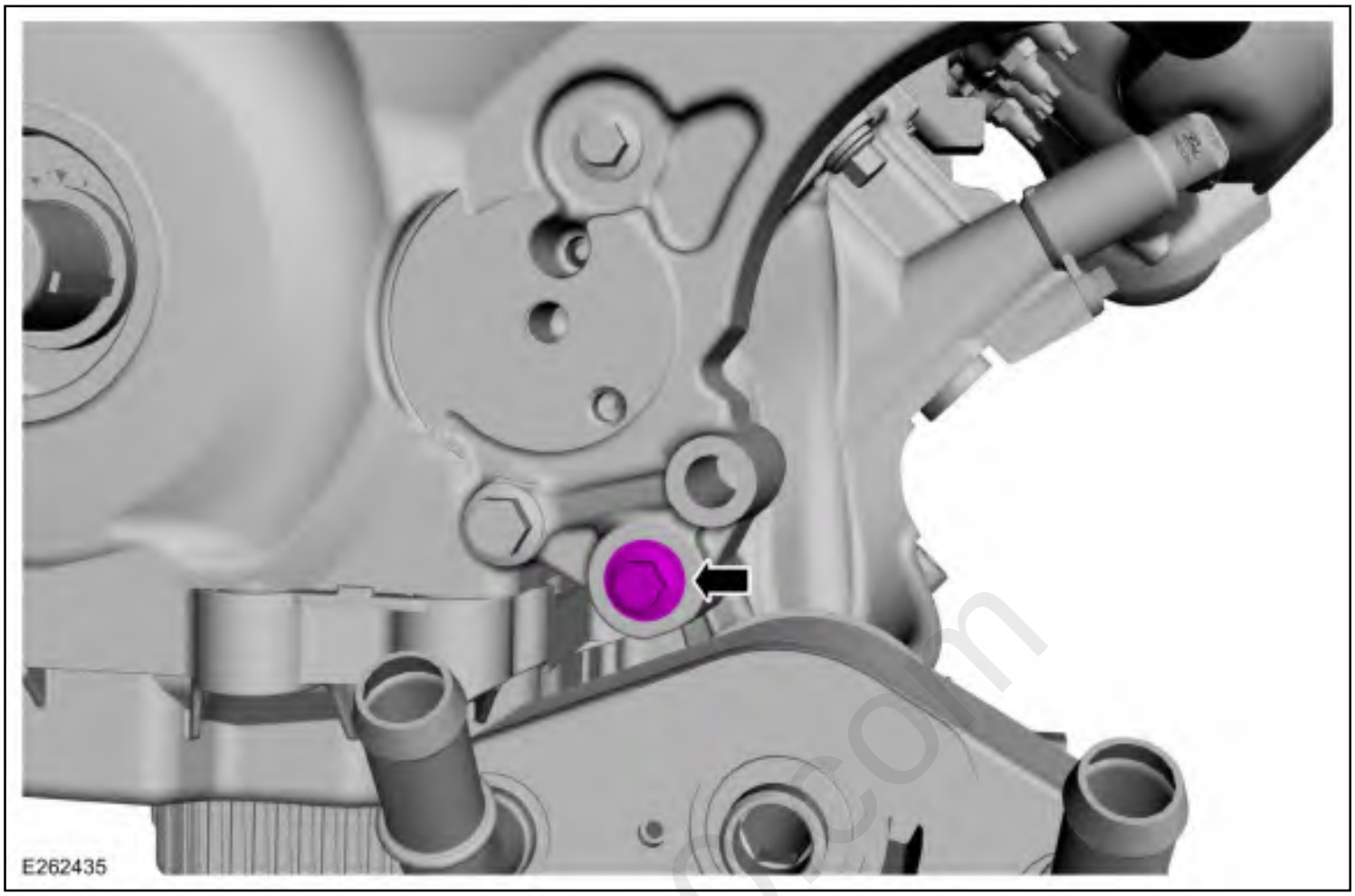
Install the bolts and stud bolts.
Torque:
Stage 1: Fasteners 1-15 : 18 lb.ft (25 Nm)
Stage 2: Fasteners 16-19 : 89 lb.in (10 Nm)
Stage 3: Fasteners 1-15 : 60°
Stage 4: Fasteners 16-19 : 45°



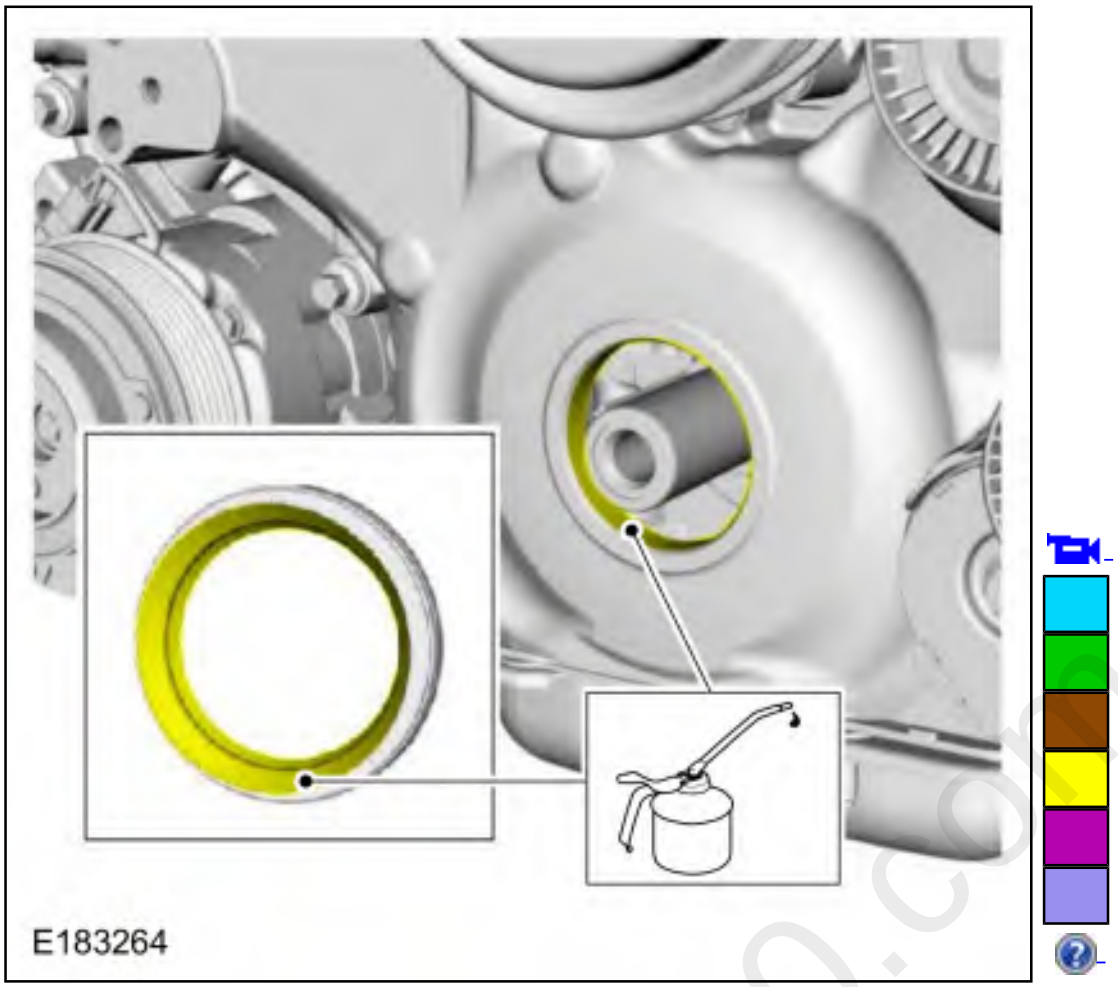
75. Using a 10 mm Hex Bit, turn the engine front cover-to-oil filter adapter jack screw into contact with the oil filter adapter.
    Torque: 44 lb.in (5 Nm)



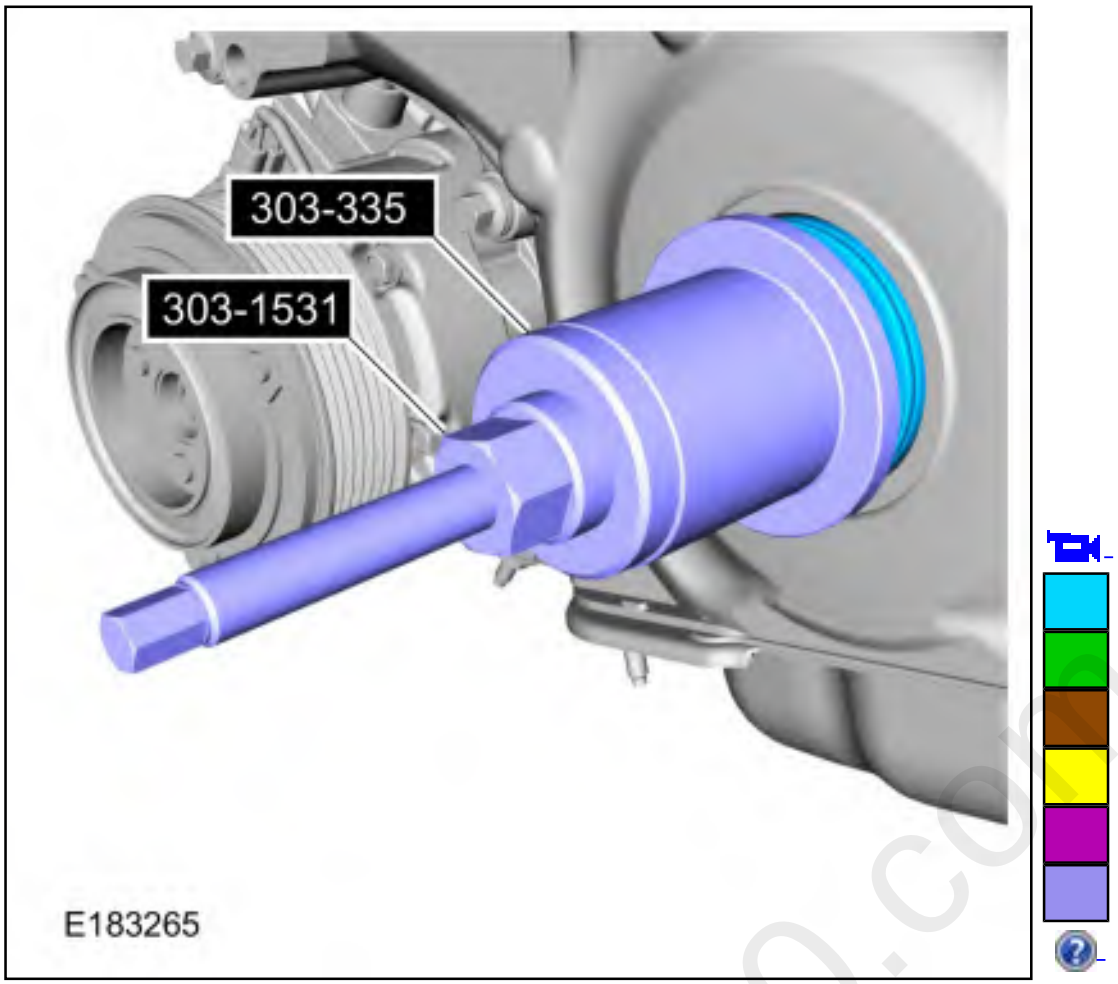
76. Install the engine front cover-to-oil filter adapter bolt.
    Torque:
    Stage 1: 18 lb.ft (25 Nm)
    Stage 2: 60°



77. Lubricate the engine front cover bore and the crankshaft front oil seal inner lip with clean engine oil.

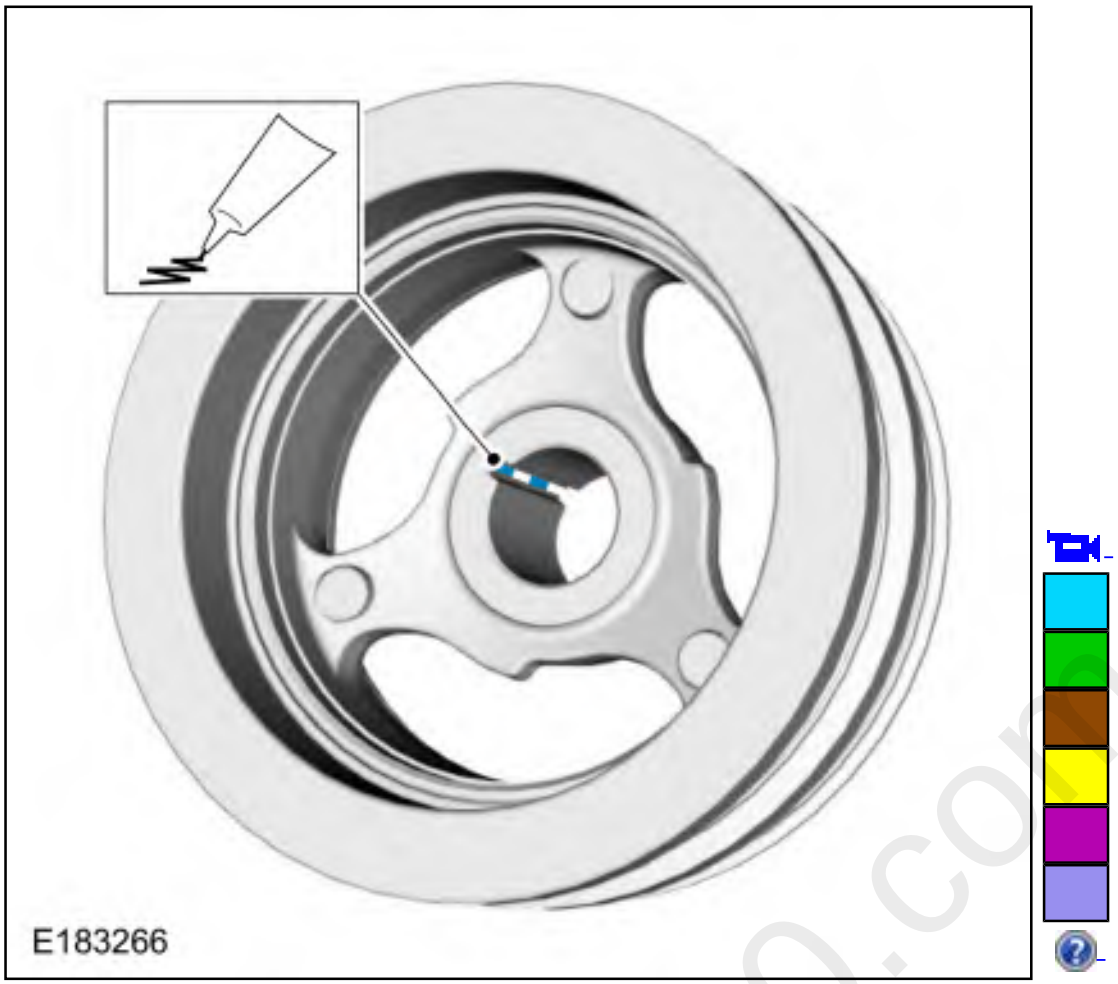


78. Using the special tools, install the new crankshaft front oil seal.
    Use Special Service Tool: 303-335 (T88T-6701-A) Installer, Front Cover Oil Seal. , 303-1531 Installer, Front Crank Seal and Damper.

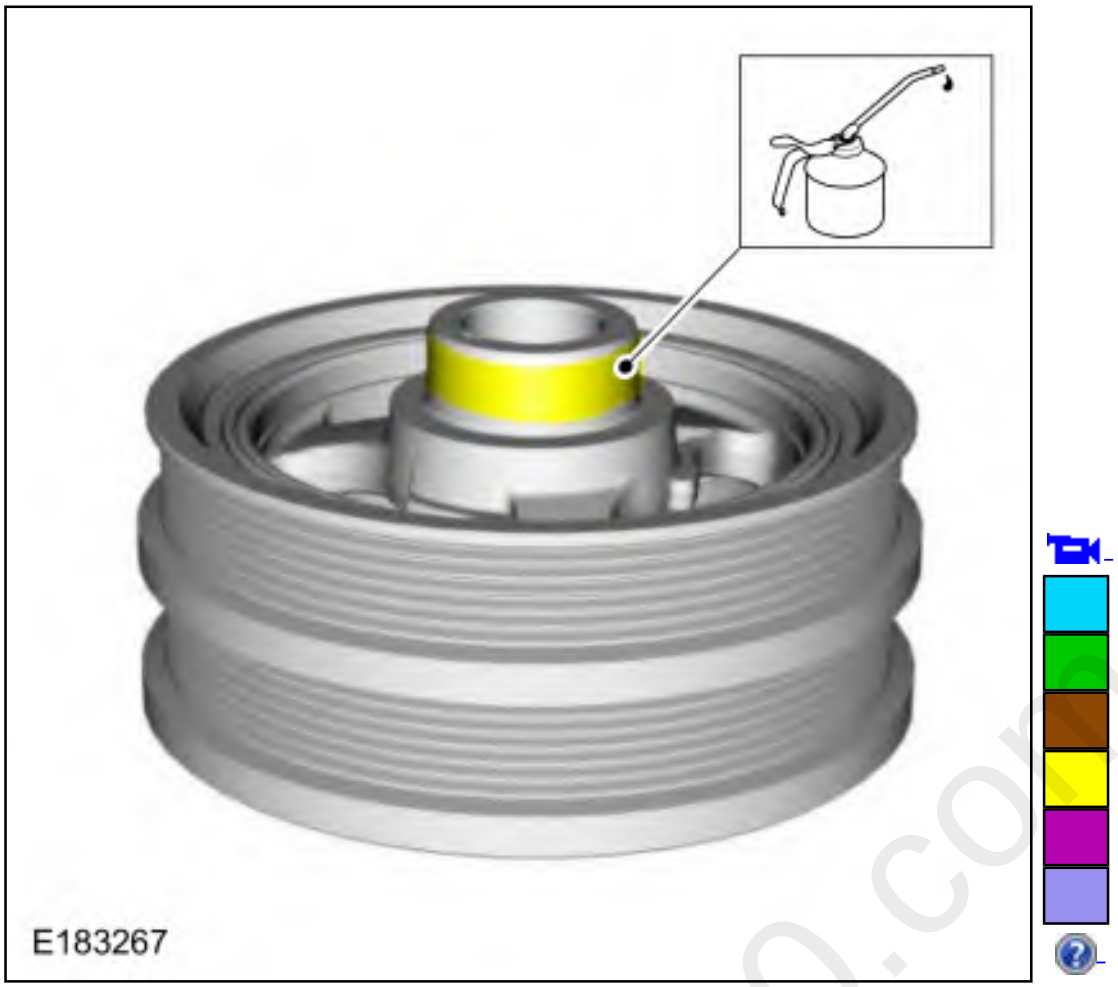


79. **NOTE:** *If not secured within 5 minutes, the sealant must be removed and the sealing area cleaned. Failure to follow this procedure can cause future oil leakage.*

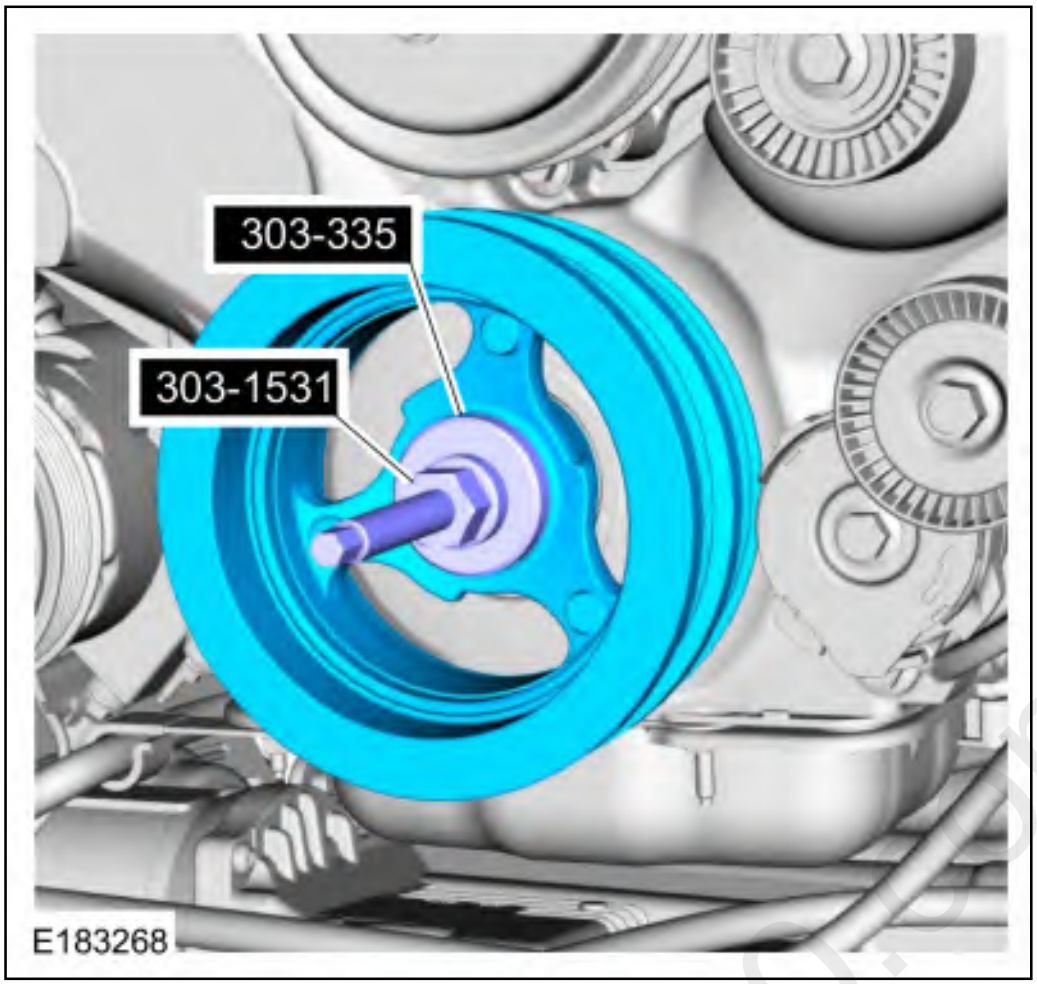
    Apply silicone gasket and sealant to the Woodruff key slot in the crankshaft pulley.
    Material: Motorcraft® Silicone Gasket and Sealant / TA-30 (WSE-M4G323-A4)



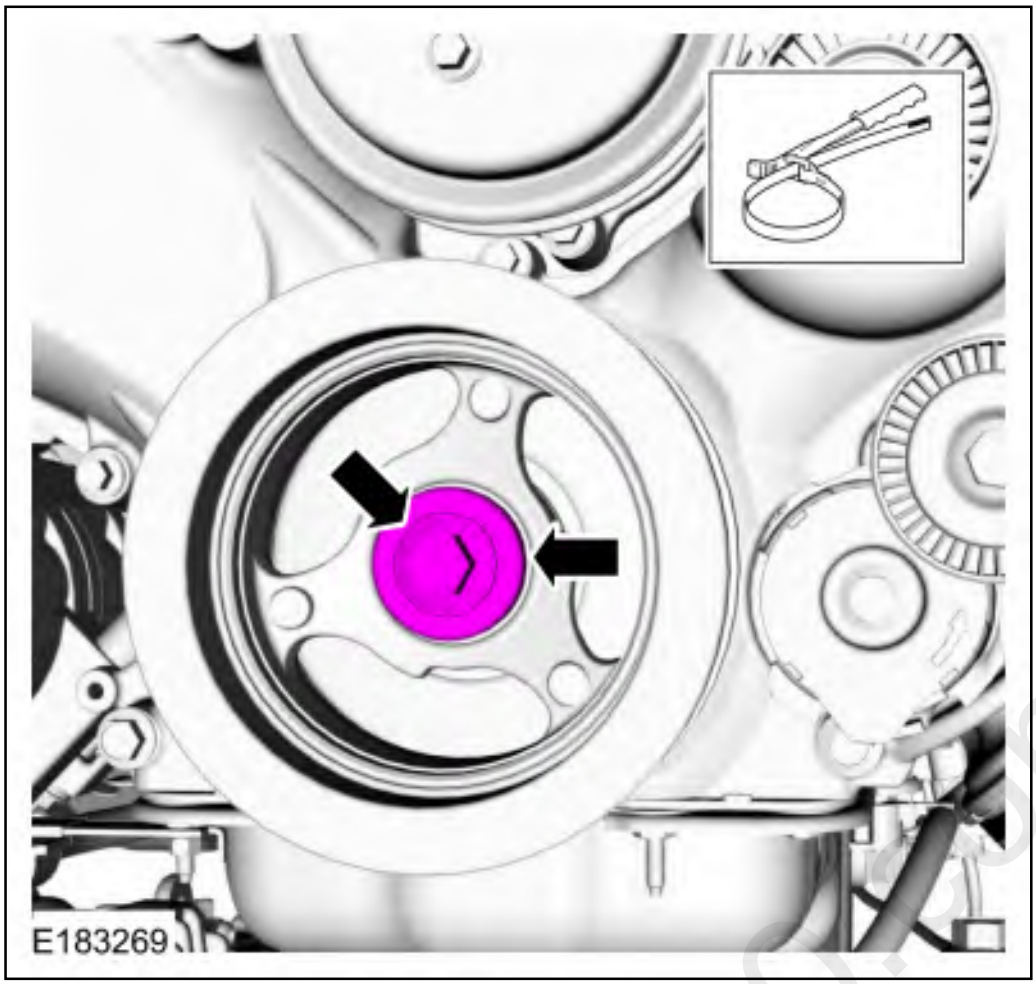
80. Lubricate the crankshaft pulley sealing surface with clean engine oil prior to installation.



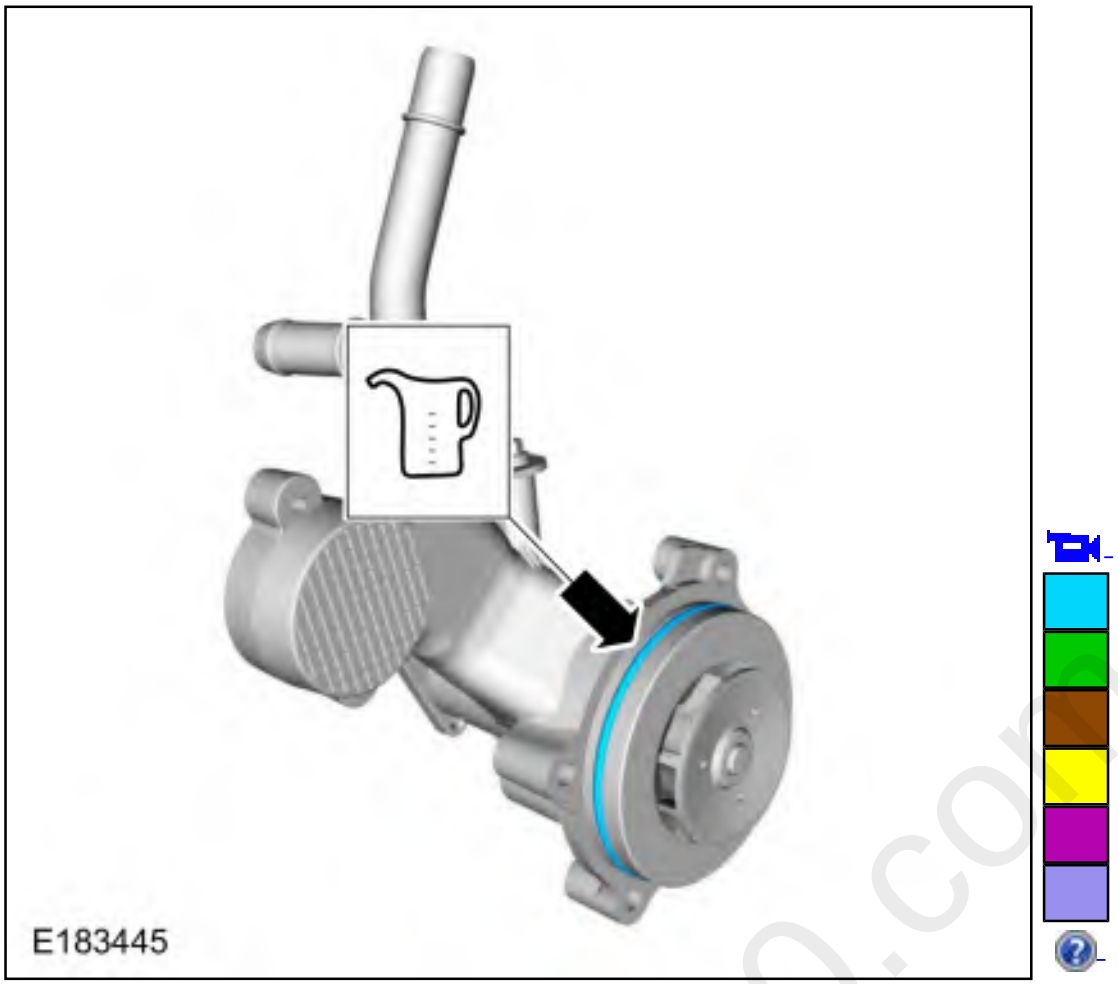
81. Using the special tools, install the crankshaft pulley.
    Use Special Service Tool: 303-335 (T88T-6701-A) Installer, Front Cover Oil Seal. , 303-1531 Installer, Front Crank Seal and Damper.



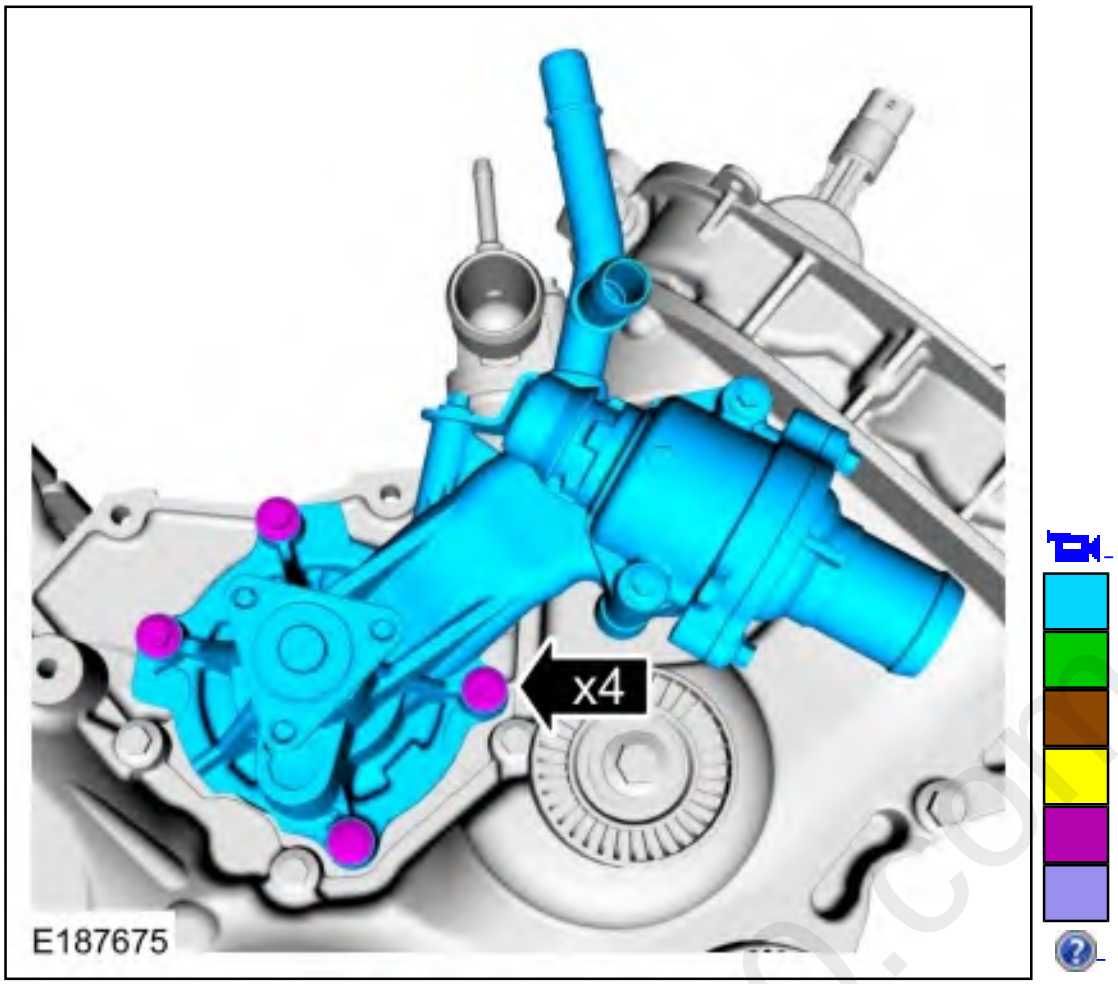
82. Using the Strap Wrench, install a new crankshaft pulley bolt and the original washer.
    Use the General Equipment: Strap Wrench
    Torque:
    Stage 1: 103 lb.ft (140 Nm)
    Stage 2: Loosen: 360°
    Stage 3: 74 lb.ft (100 Nm)
    Stage 4: 90°



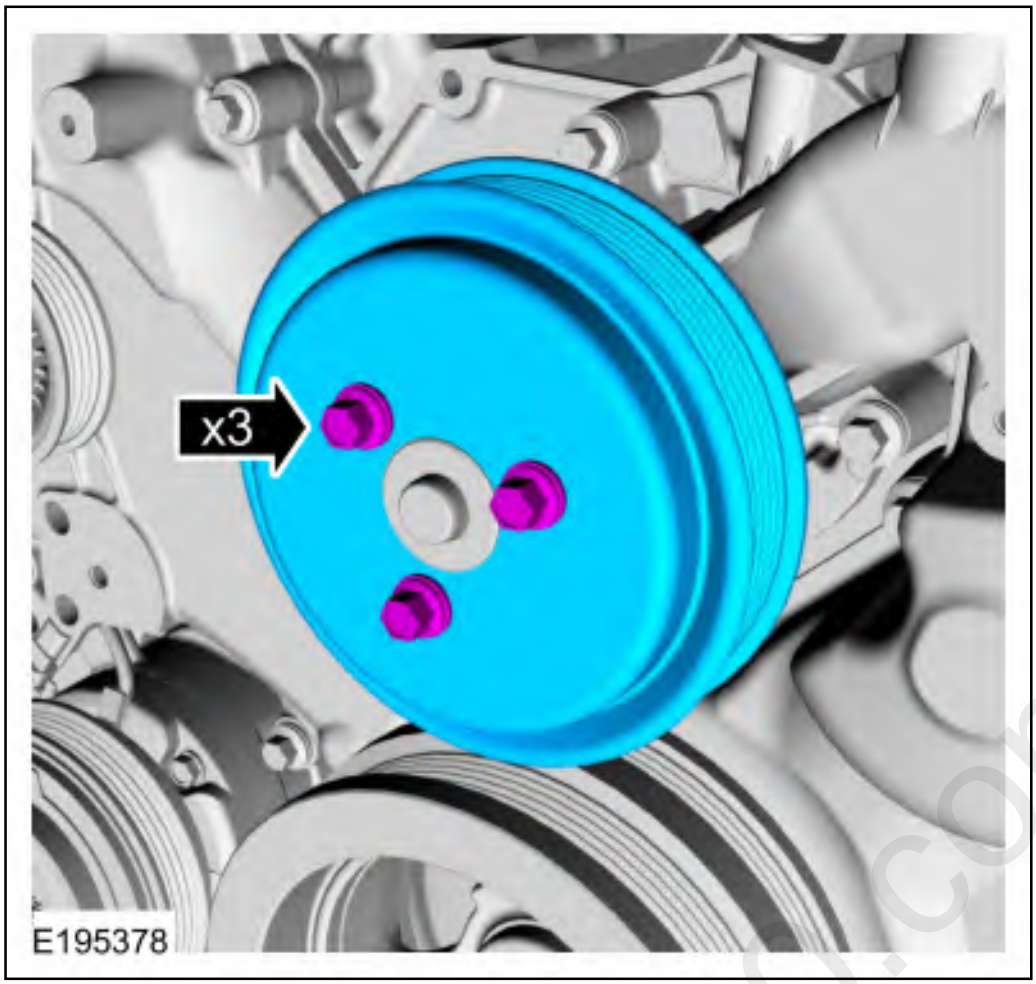
83. Install a new coolant pump O-ring seal and lubricate with clean engine coolant.
    Material: Motorcraft® Orange Concentrated Antifreeze/Coolant / VC-3-B (WSS-M97B44-D)



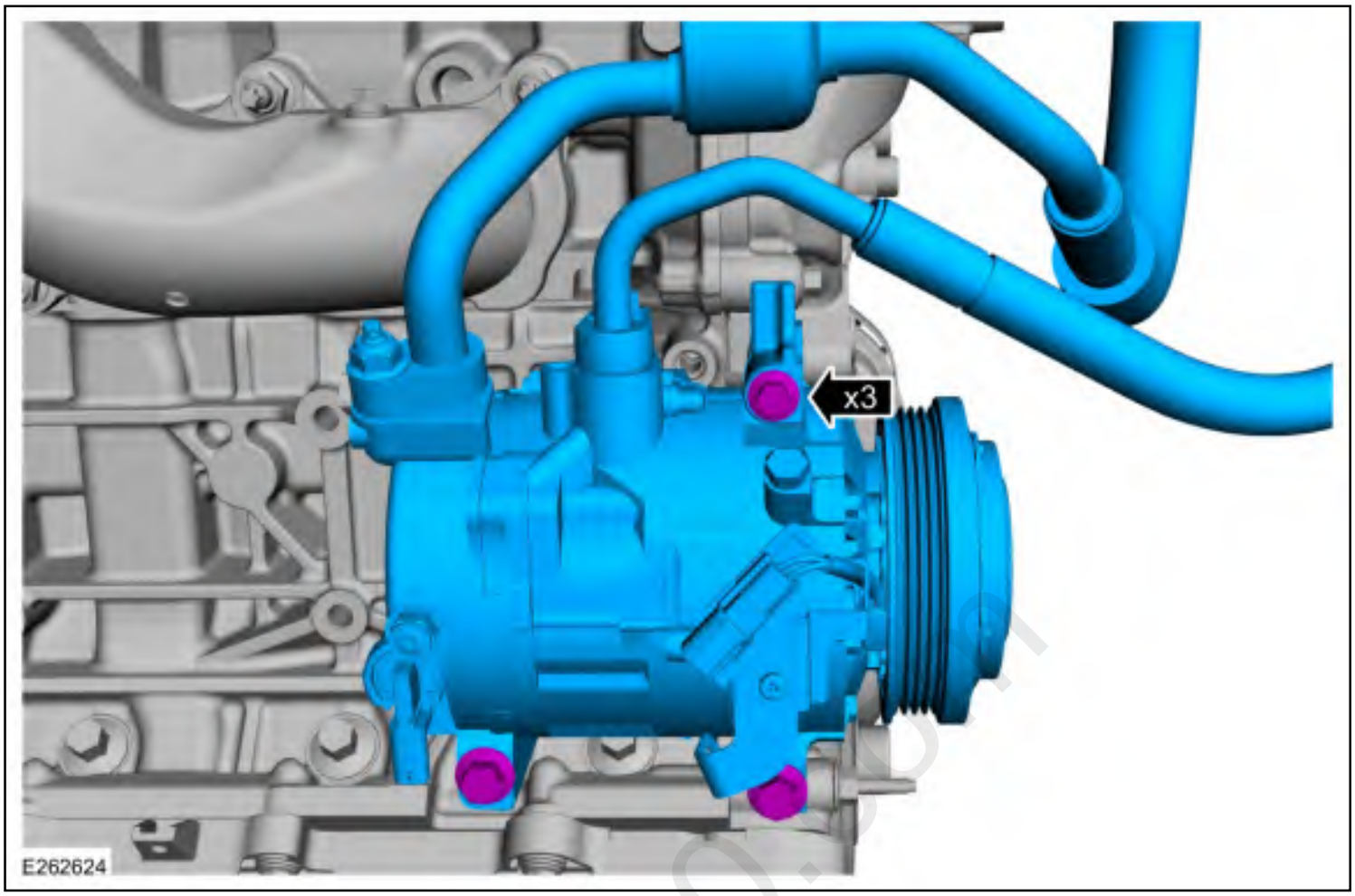
84. Install the coolant pump and bolts.
    Torque:
    Stage 1: 177 lb.in (20 Nm)
    Stage 2: 60°



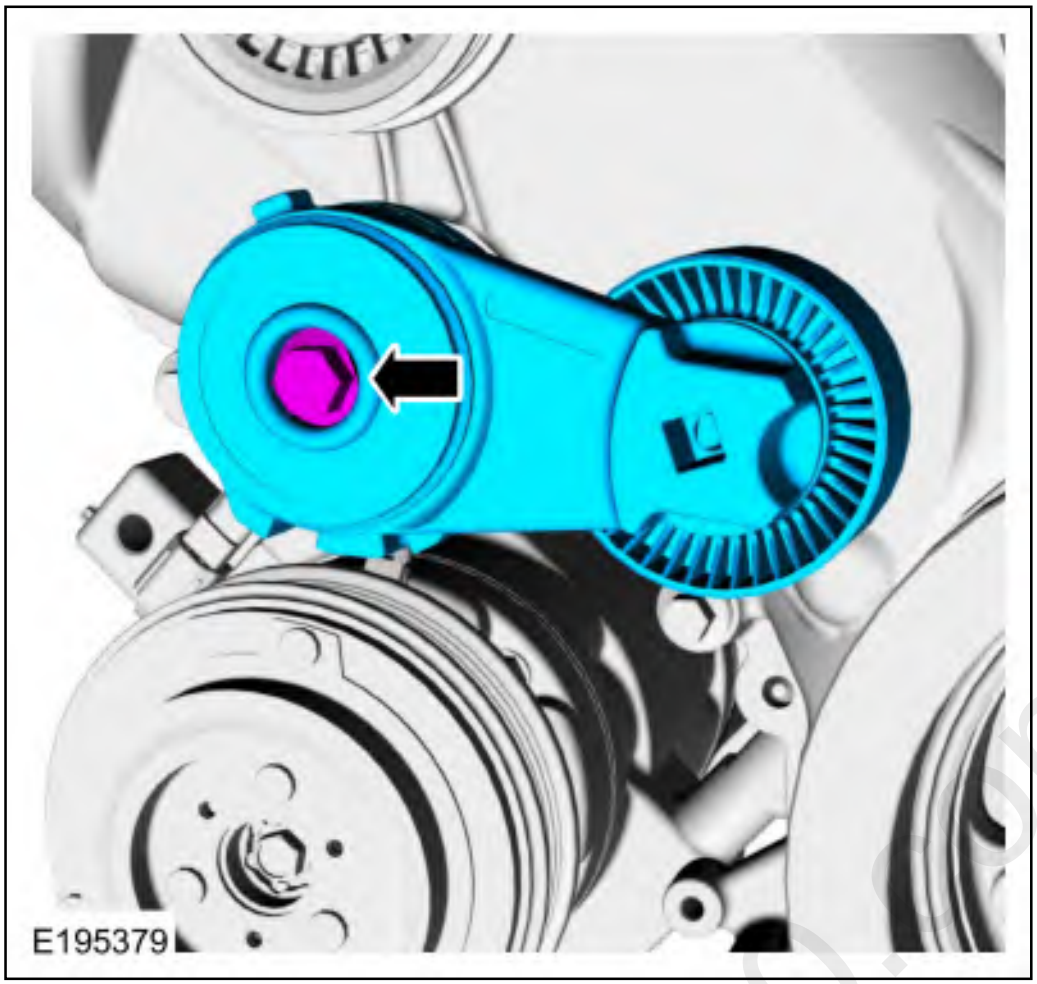
85. Install the coolant pump pulley and the bolts.
    Torque: 18 lb.ft (25 Nm)



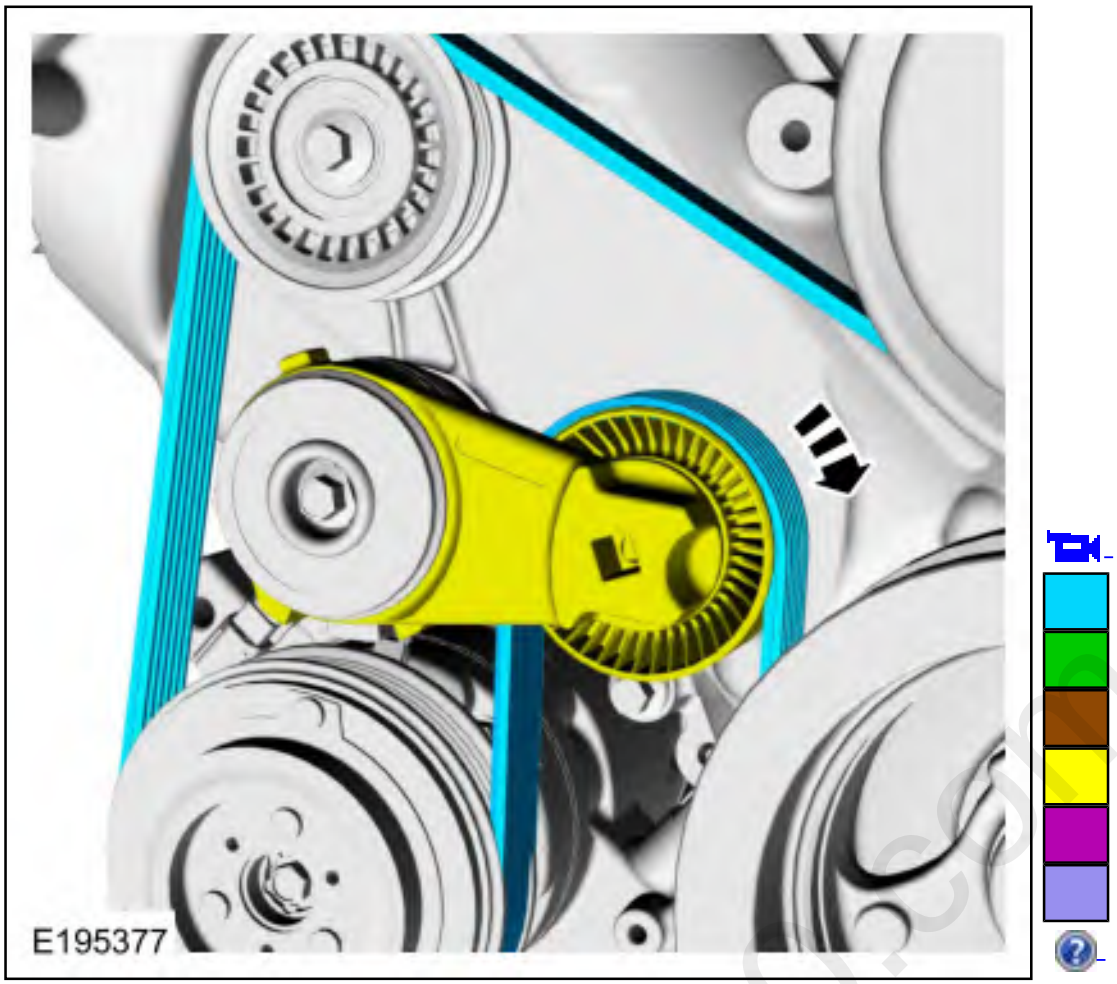
86. Install the A/C compressor and the bolts.
    Torque: 18 lb.ft (25 Nm)



87. Install the A/C compressor belt tensioner and the bolt.
    Torque: 18 lb.ft (25 Nm)

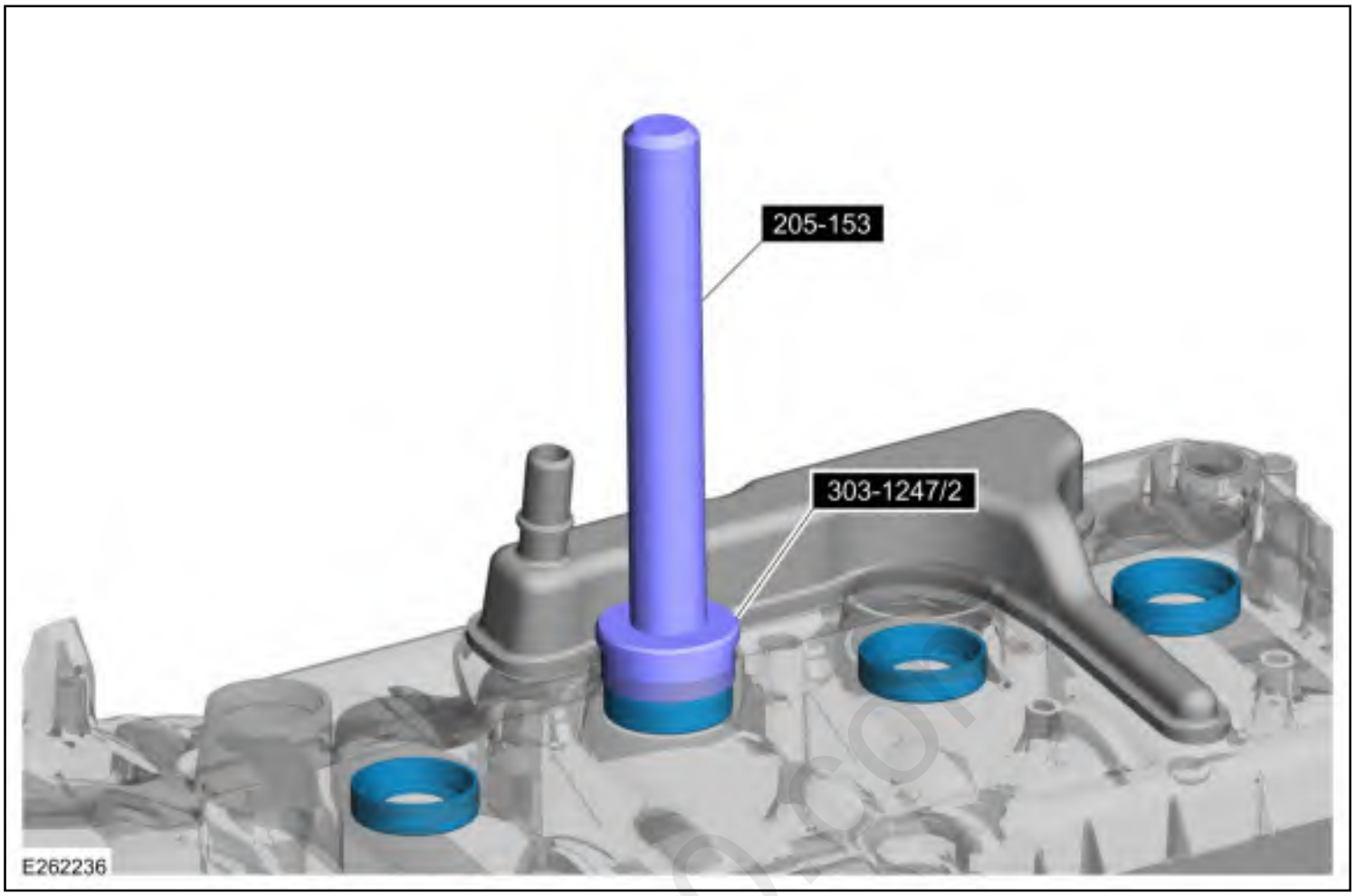


88. Rotate the A/C compressor belt tensioner clockwise and install the A/C compressor belt.



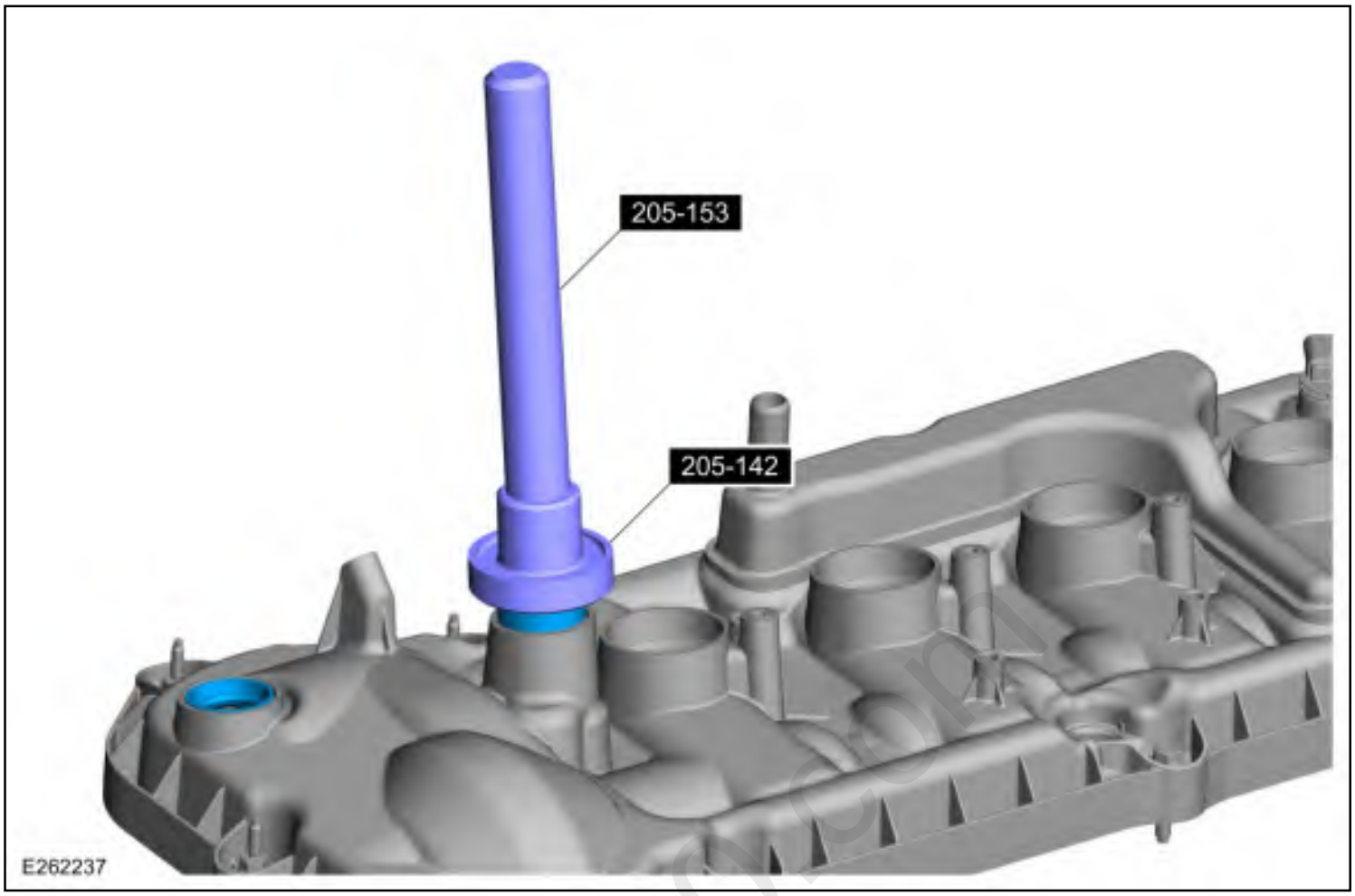
89. **NOTE:** *Installation of new seals is only required if damaged seals were removed.*

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



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

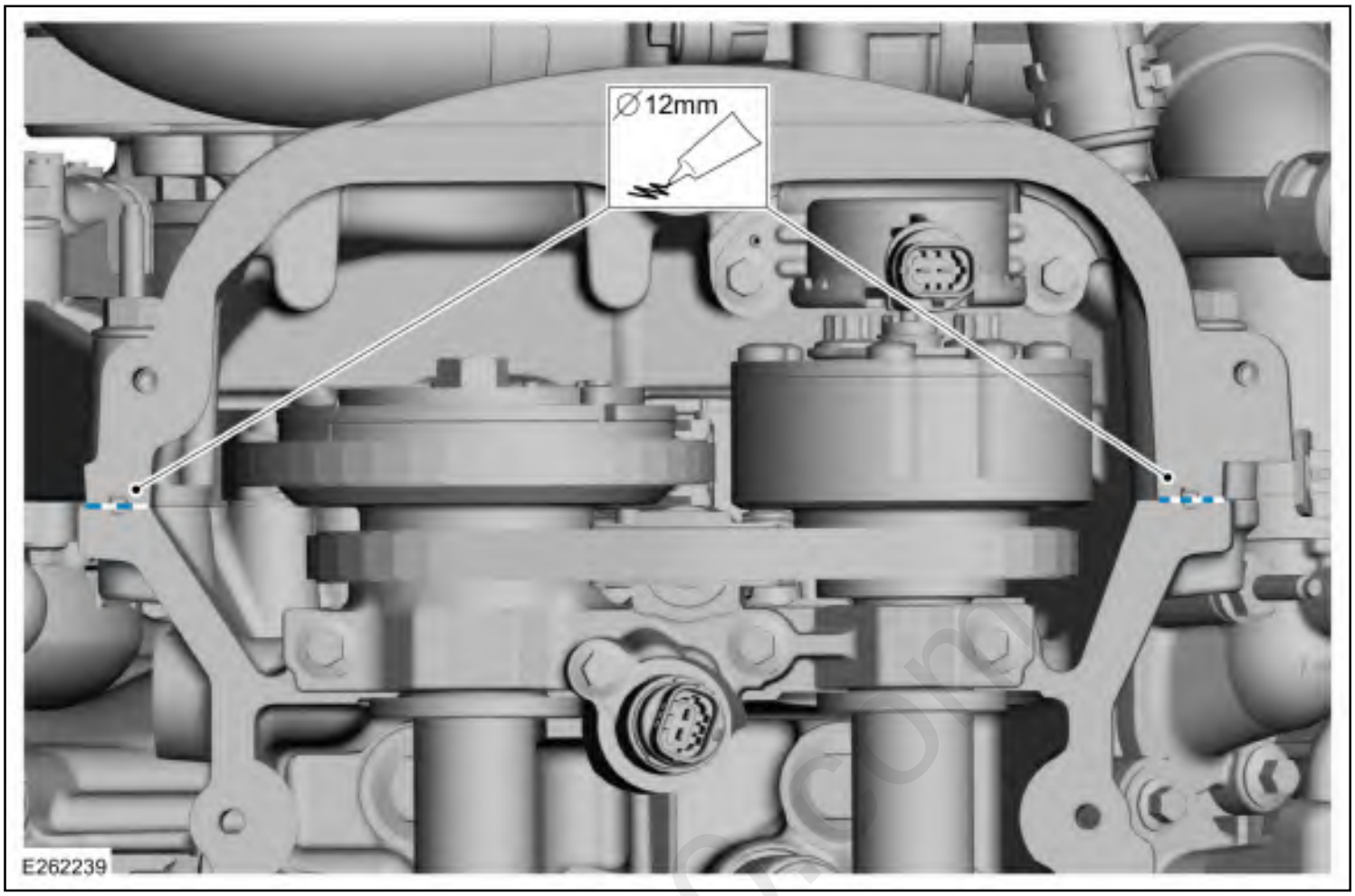
Using the special tools, install new VCT variable force solenoid seals.
Use Special Service Tool: 205-153 (T80T-4000-W) Handle. , 205-142 (T80T-4000-J) Installer, Differential Bearing Cone.



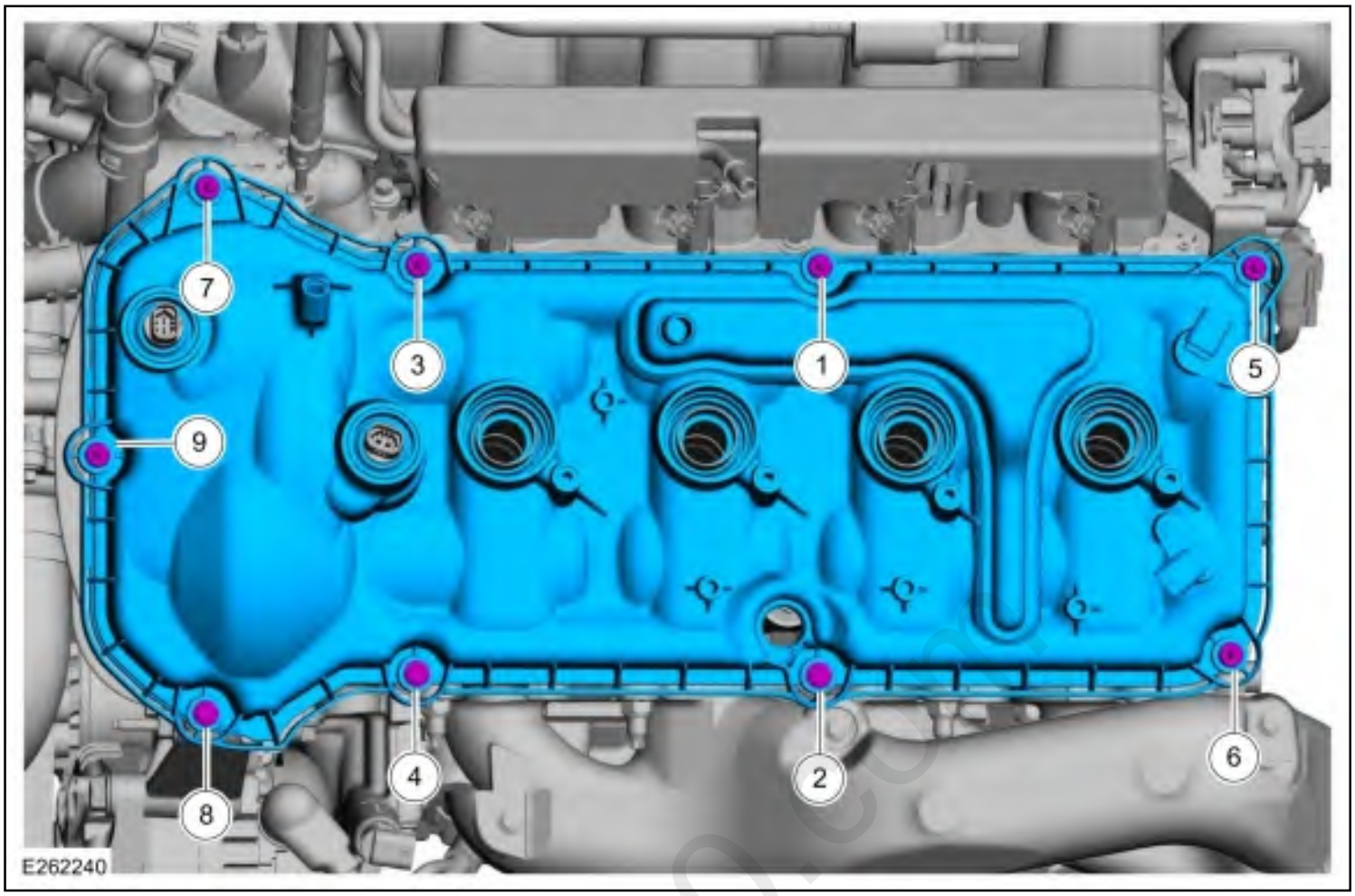
91. Install a new gasket.

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

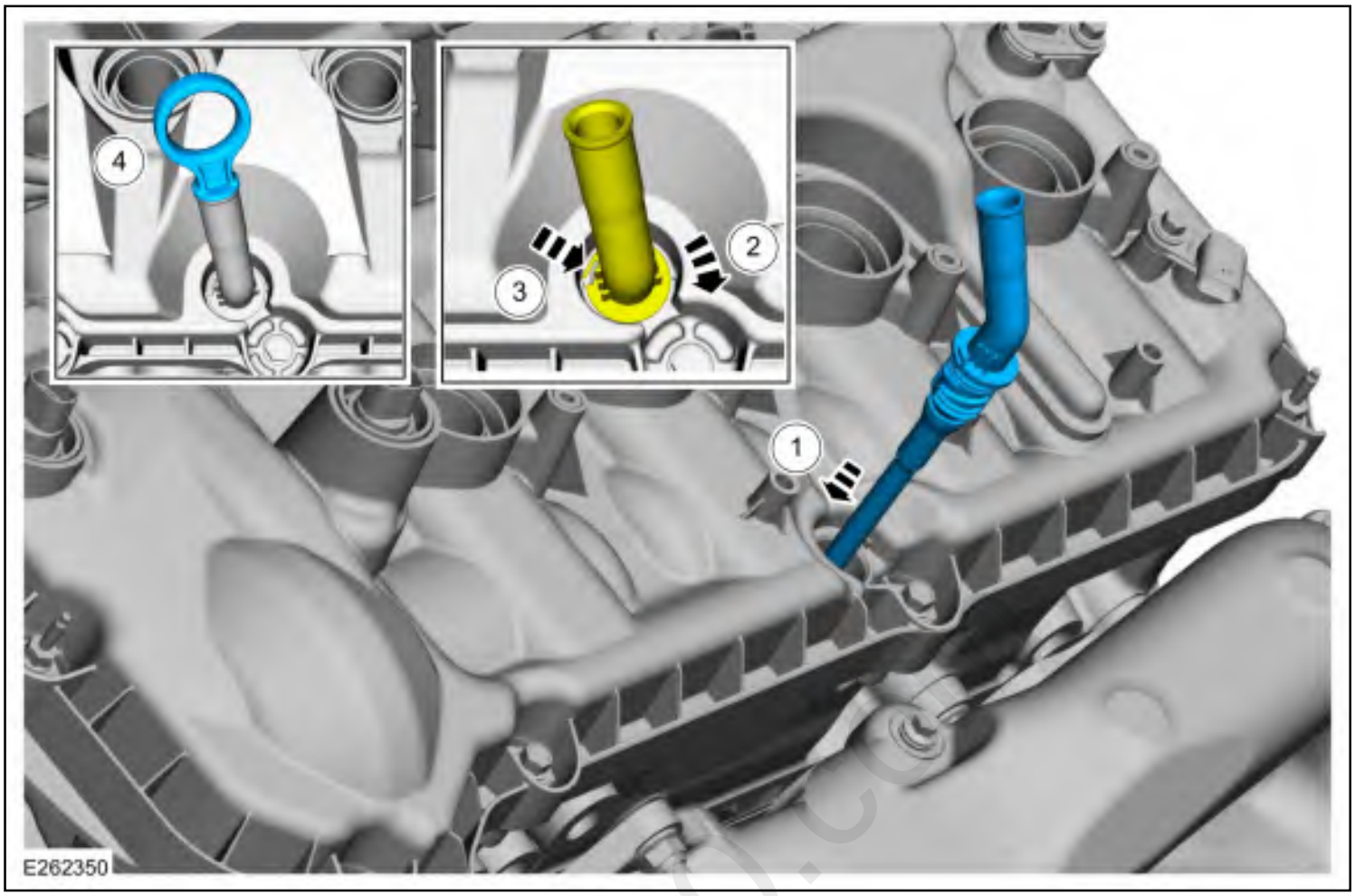
    Apply an 12 mm (0.47 in) bead of silicone gasket and sealant to the engine front cover-to-cylinder head joints.
    Material: Motorcraft® Silicone Gasket and Sealant / TA-30 (WSE-M4G323-A4)



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

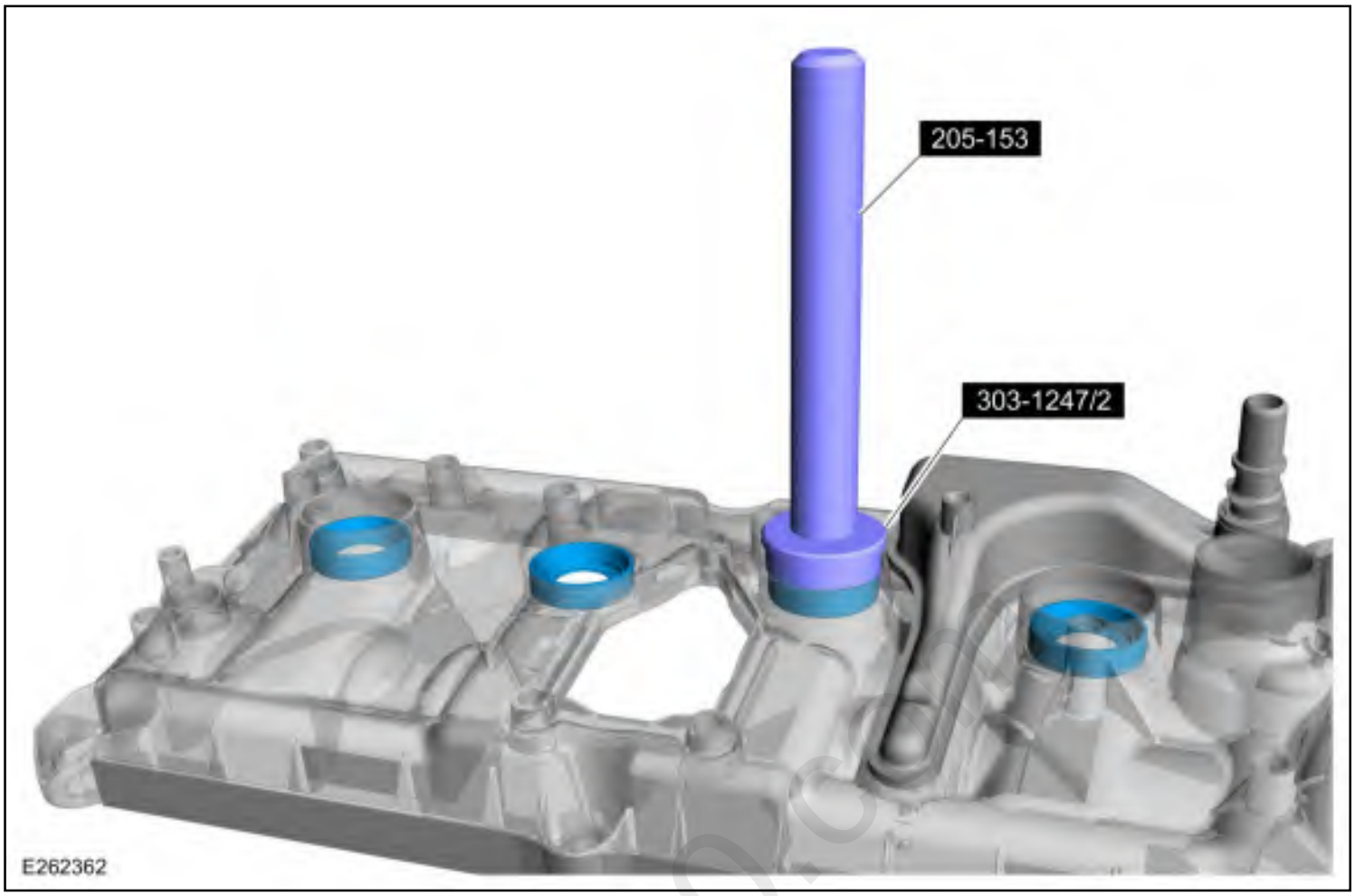


1. Push the oil level indicator tube into the engine.
2. Rotate the oil level indicator tube clockwise.
3. Verify the tab is locked in place.
4. Install the oil level indicator.



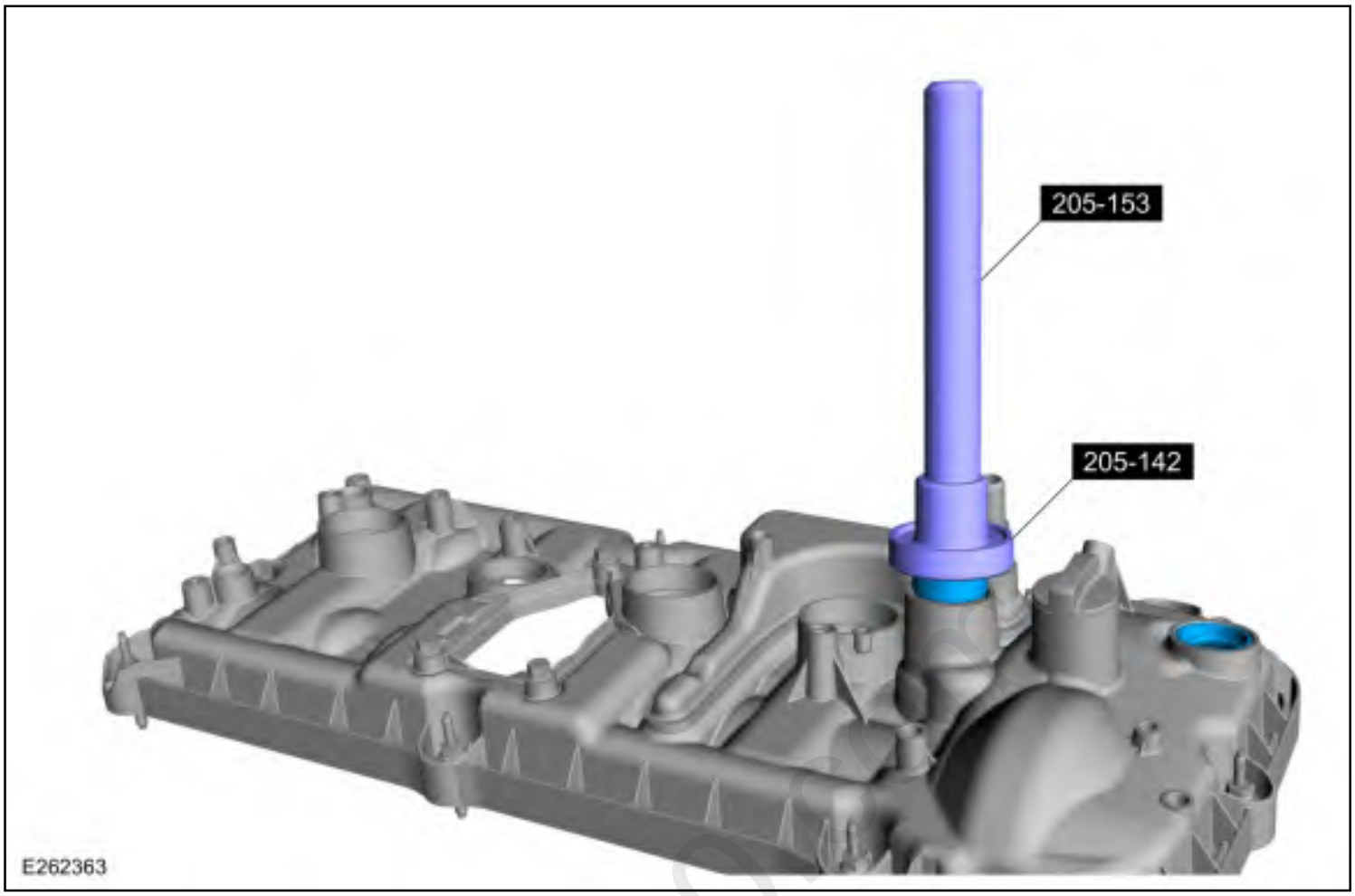
95. **NOTE:** *Installation of new seals is only required if damaged seals were removed.*

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

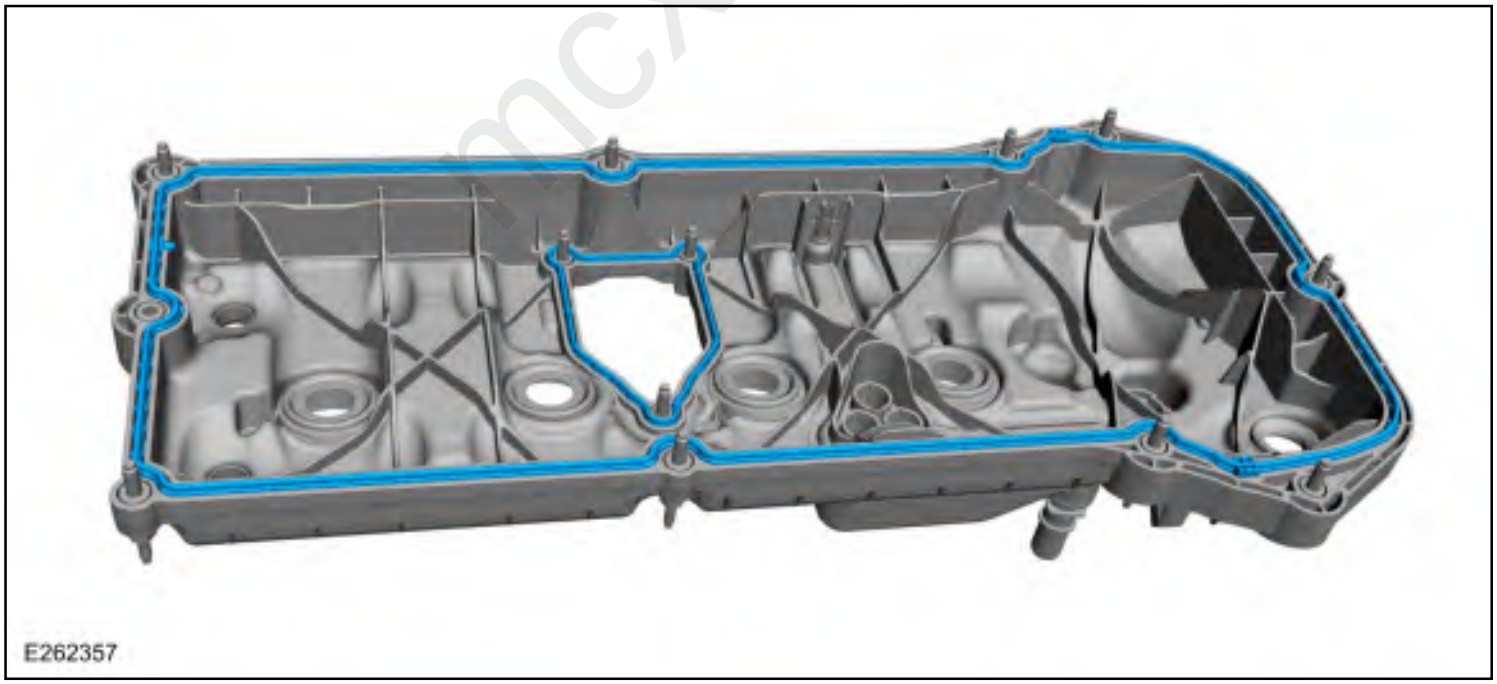


96. **NOTE:** *Installation of new seals is only required if damaged seals were removed.*

Using the special tools, install new VCT variable force solenoid seals.
Use Special Service Tool: 205-153 (T80T-4000-W) Handle. , 205-142 (T80T-4000-J) Installer, Differential Bearing Cone.

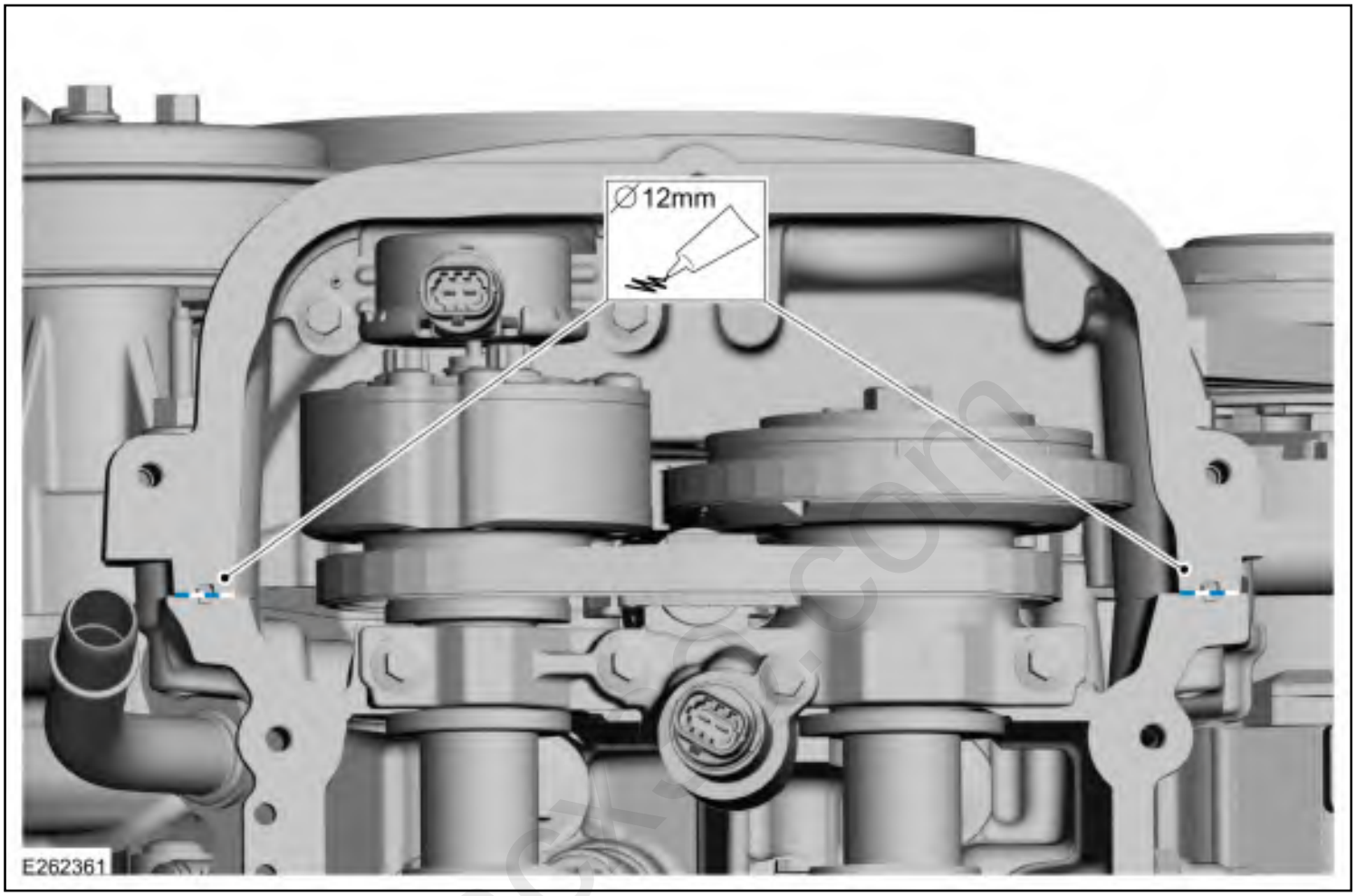


97. Install new gaskets.

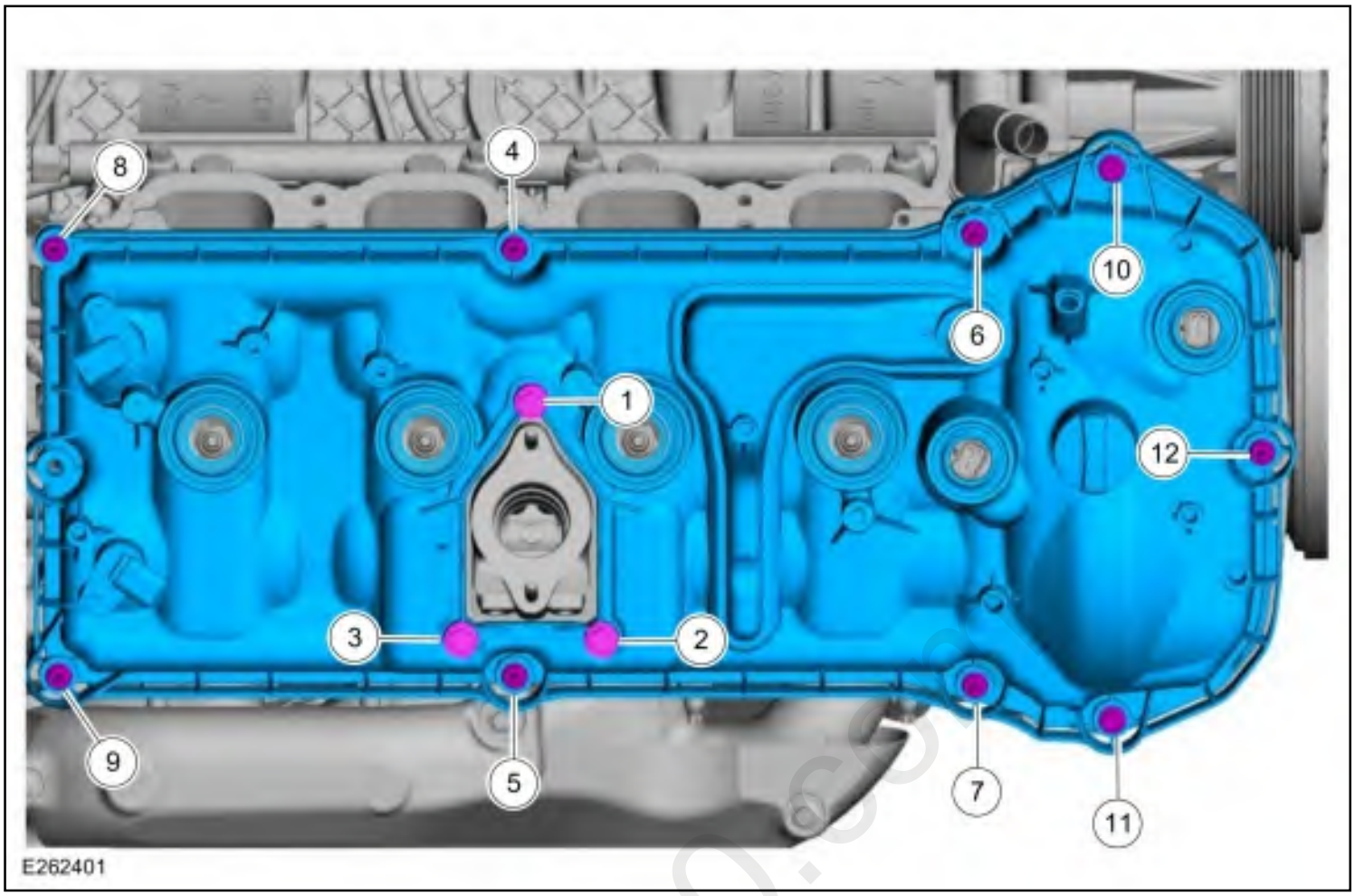


98. **NOTICE: If the valve cover is not installed and the fasteners tightened within 5 minutes, the sealant must be removed and the sealing area cleaned.**

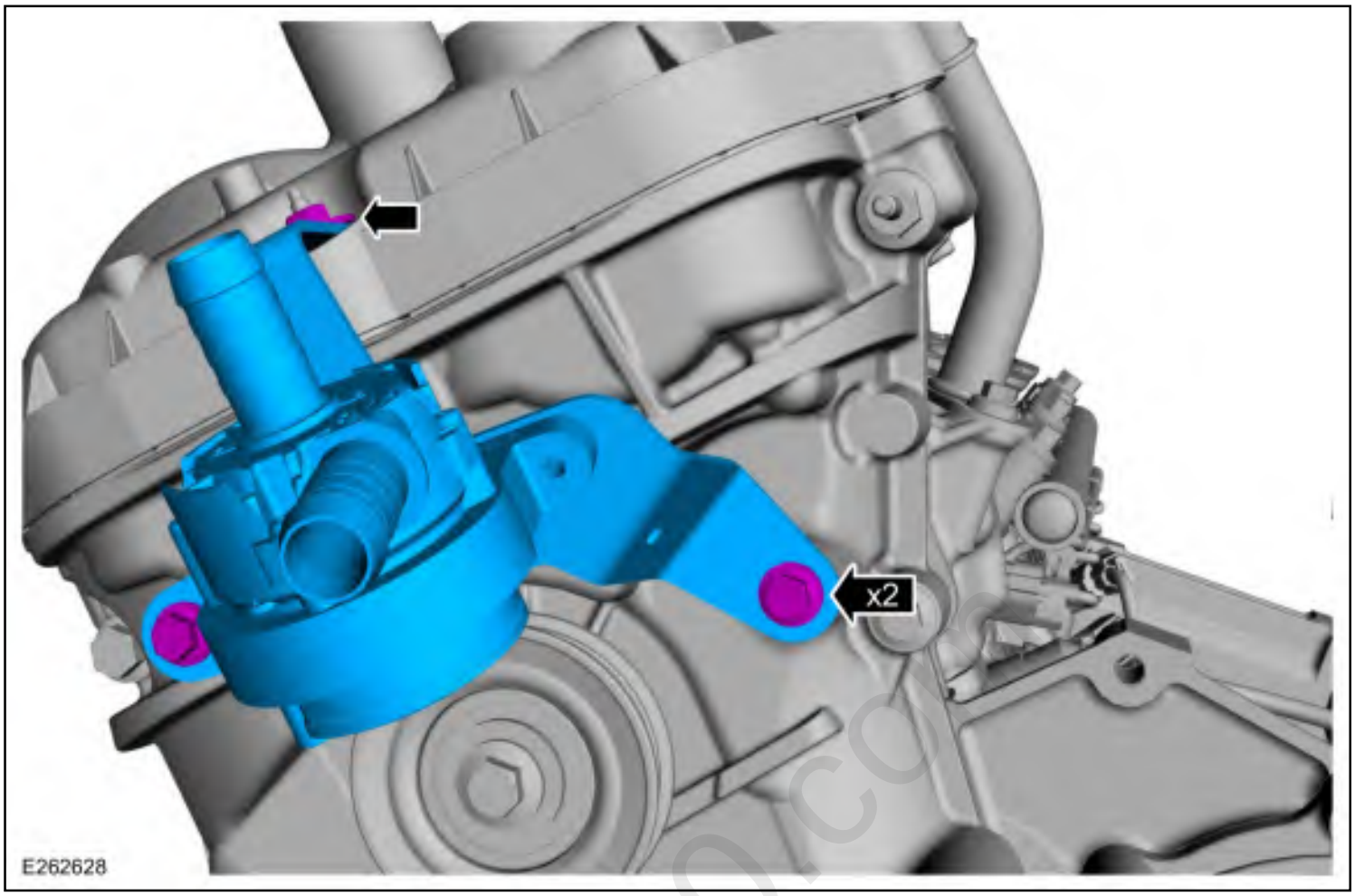
Apply an 12 mm (0.47 in) bead of silicone gasket and sealant to the engine front cover-to-cylinder head joints.
Material: Motorcraft® Silicone Gasket and Sealant / TA-30 (WSE-M4G323-A4)



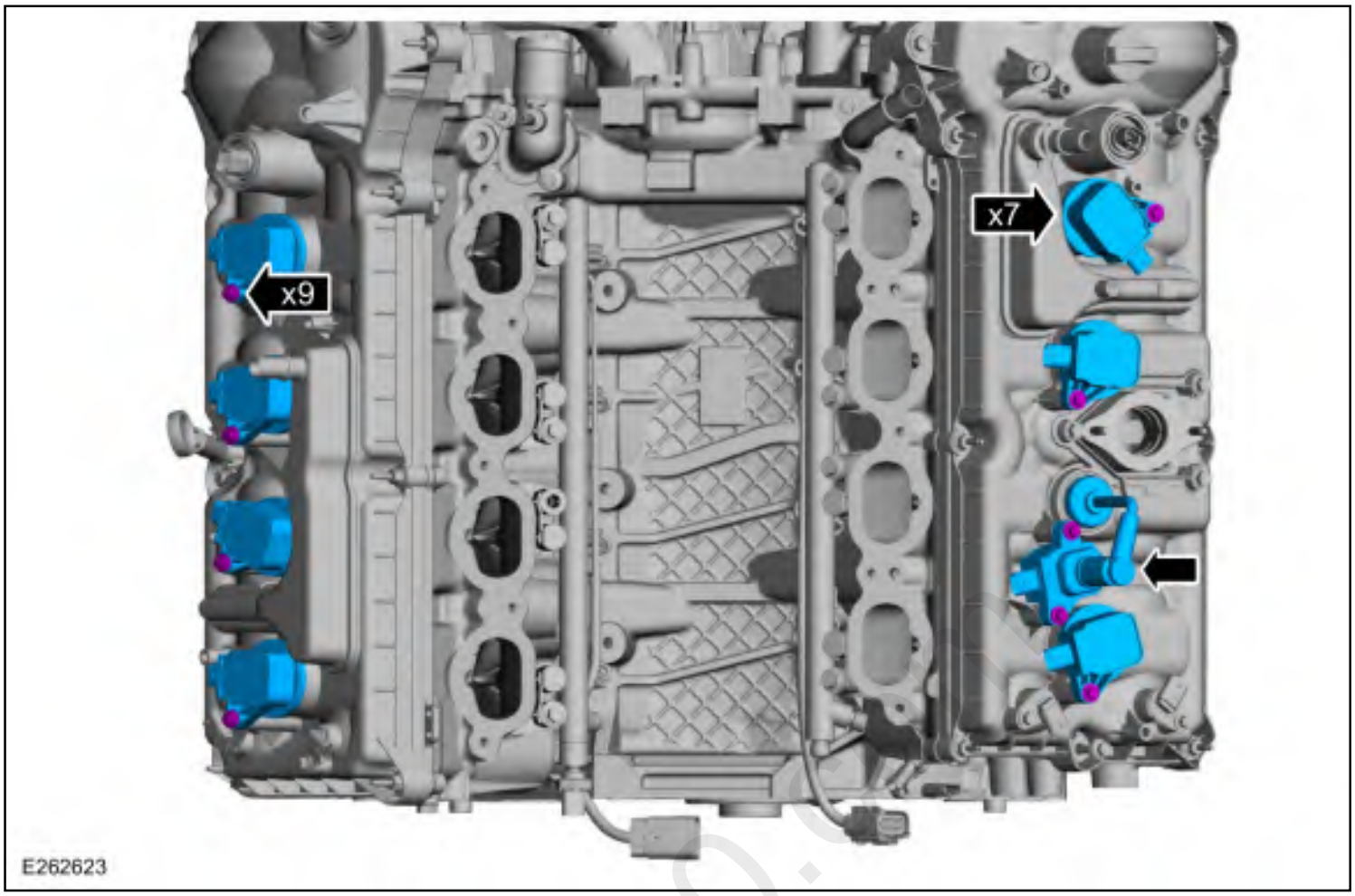
99. Install the valve cover and tighten the bolts.
Torque: 89 lb.in (10 Nm)



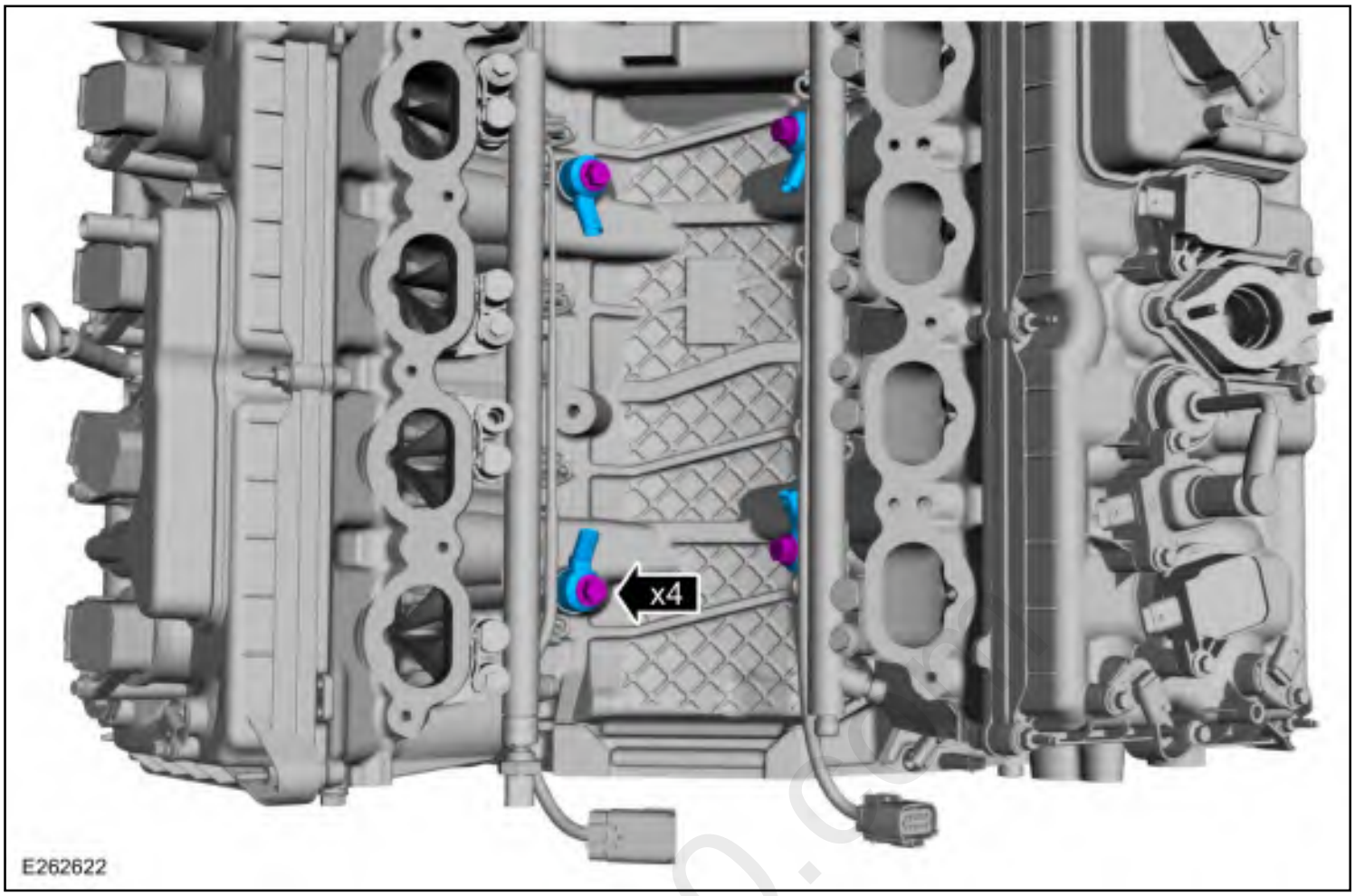
100. Install the coolant pump and the fasteners.
Torque: 62 lb.in (7 Nm)



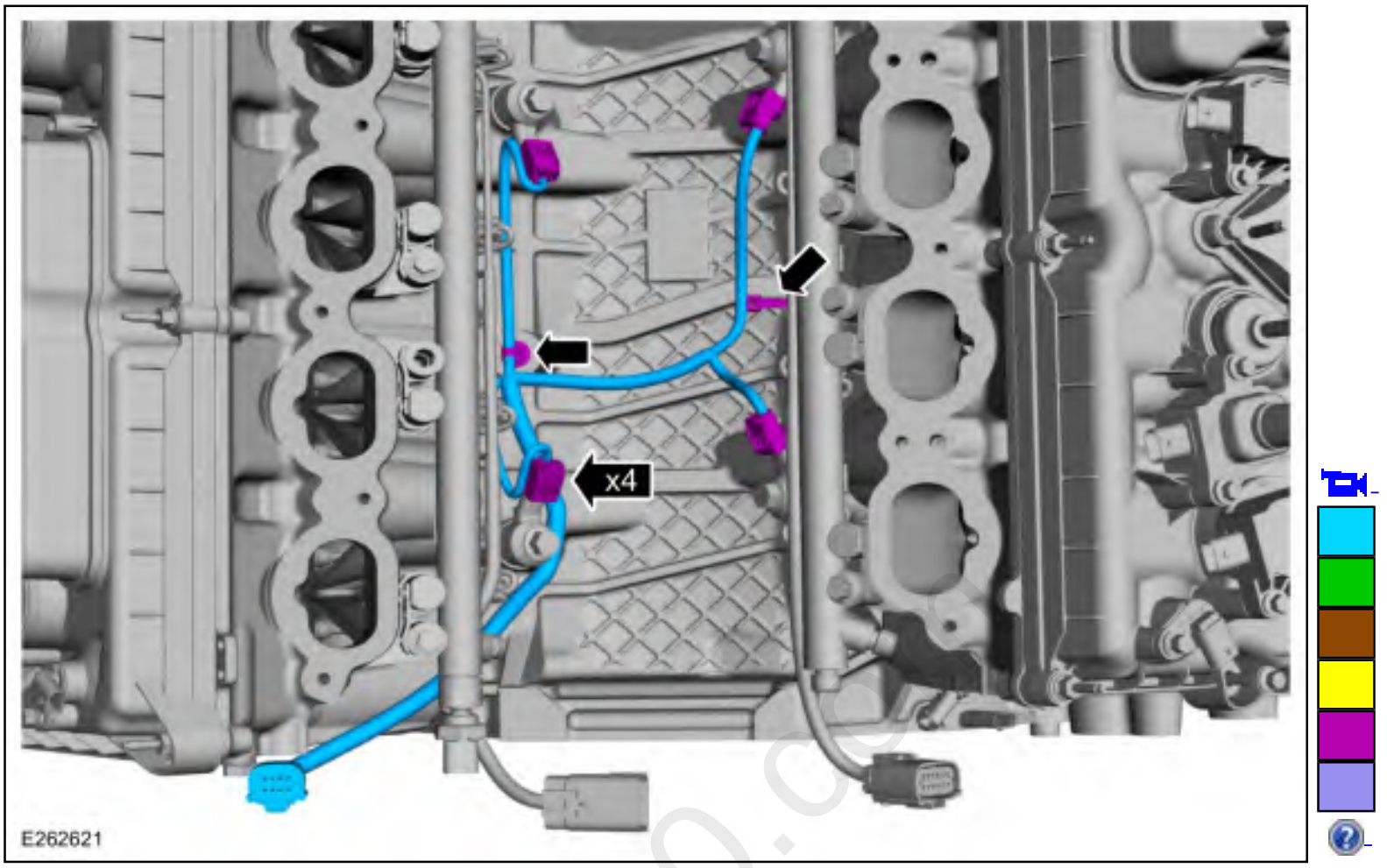
1. Install the ignition coil-on-plugs
2. Install and tighten the ignition coil-on-plug retaining bolts in the following 2 stages.
   Torque:
   Stage 1: 62 lb.in (7 Nm)
   Stage 2: 45°



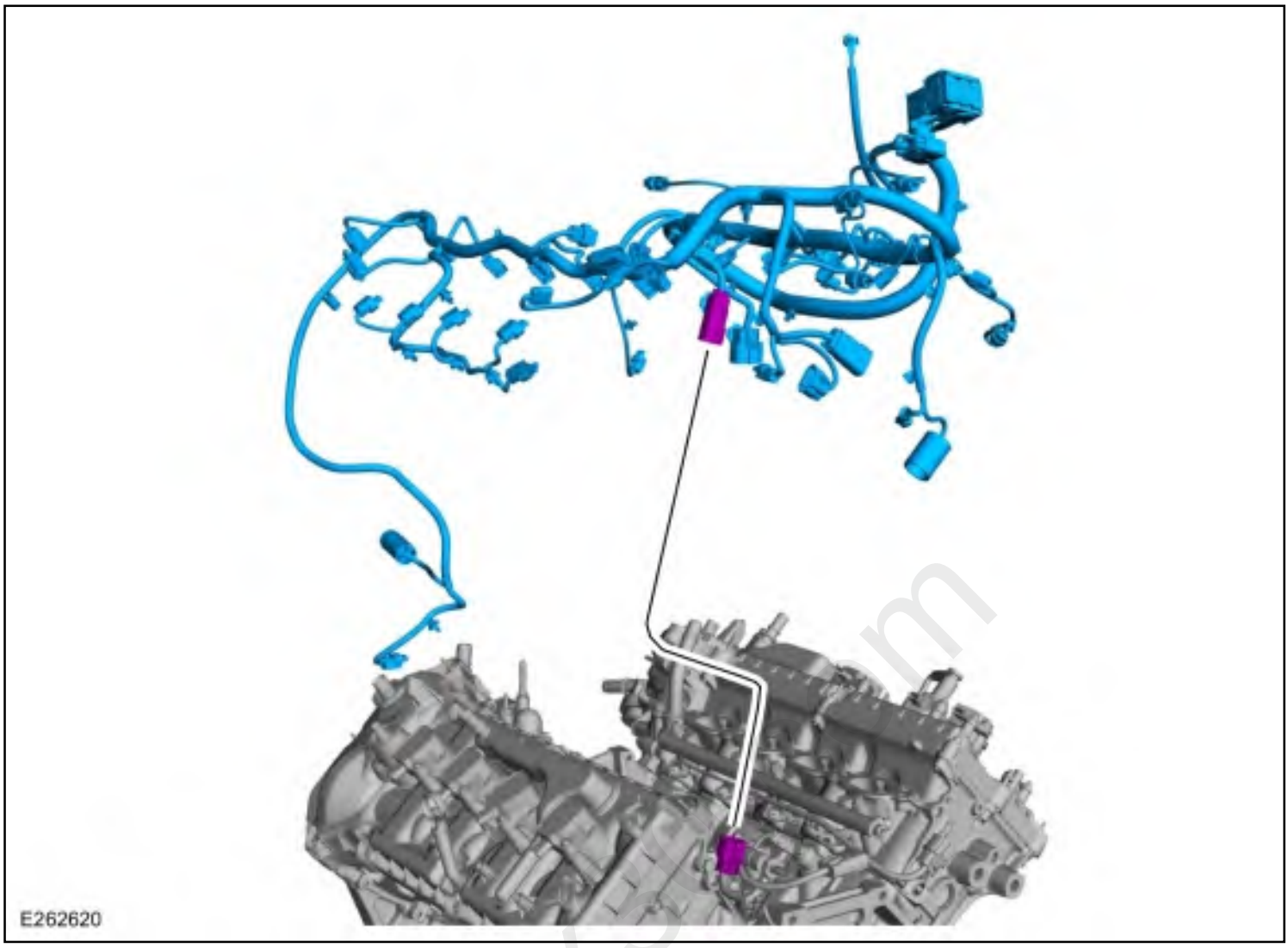
102. Install the KSs and the bolts.
Torque: 177 lb.in (20 Nm)



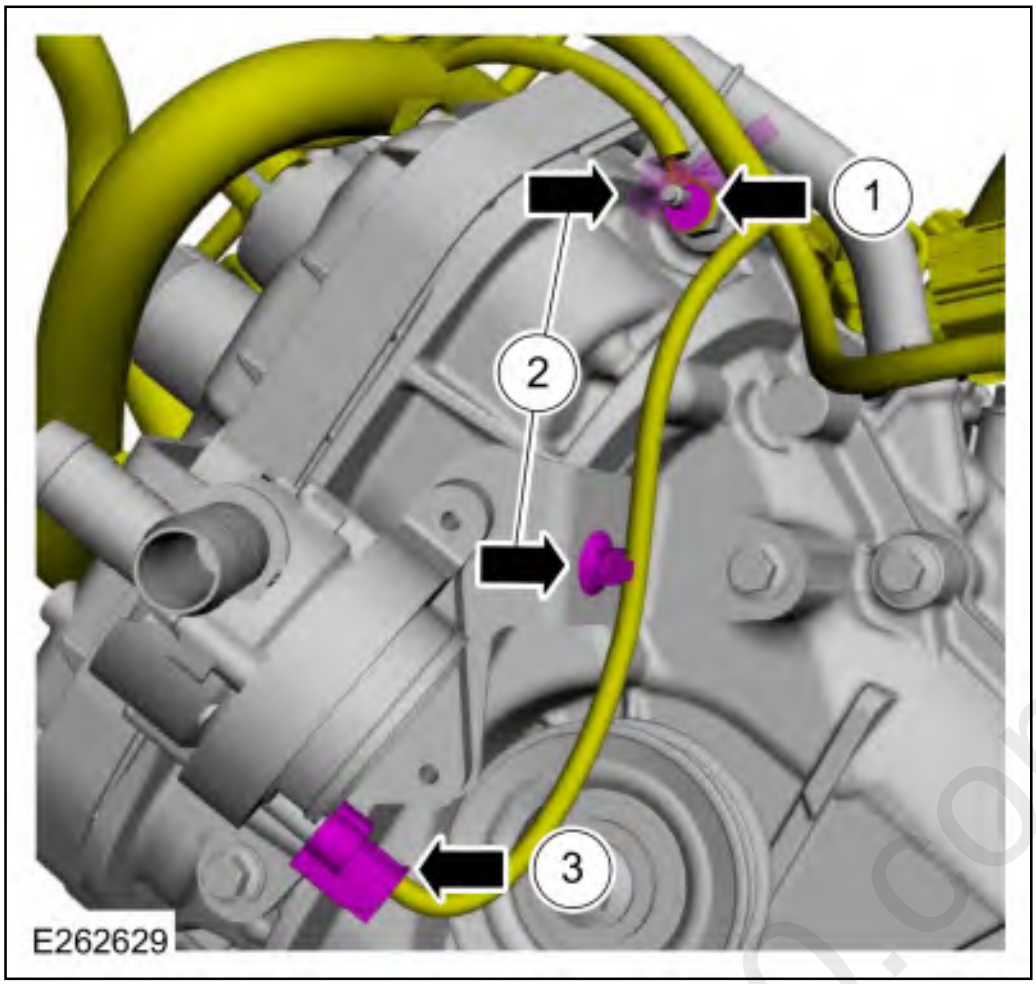
1. Install the KS harness onto the engine.
2. Attach the wiring harness retainers.
3. Connect the KS electrical connectors.



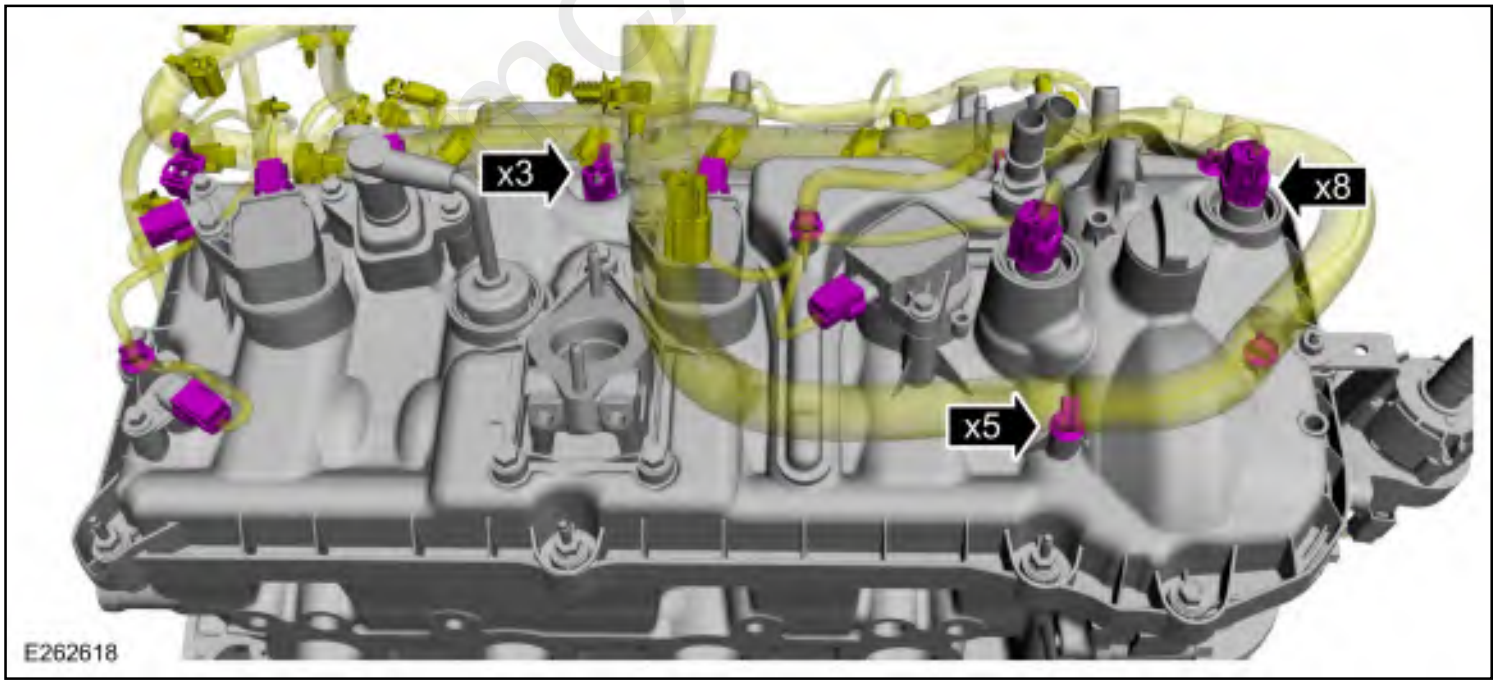
104. Install and connect the engine wiring harness.



1. Install ground wire eyelet and the nut.
   Torque: 89 lb.in (10 Nm)
2. Attach the engine wiring harness retainers.
3. Connect the engine wiring harness electrical connector.

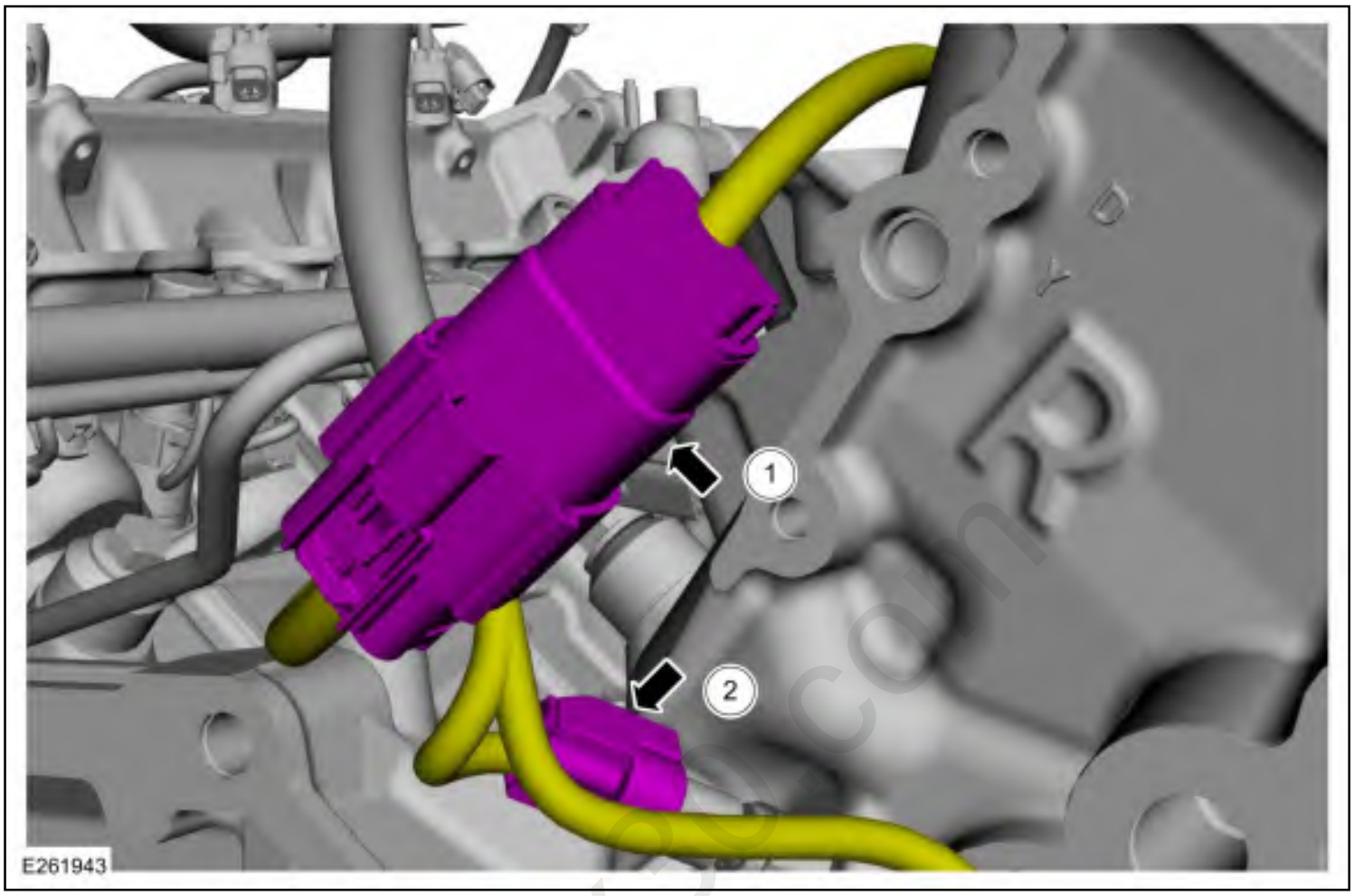


1. Connect the engine wiring harness electrical connectors.
2. Attach the wiring harness retainers.

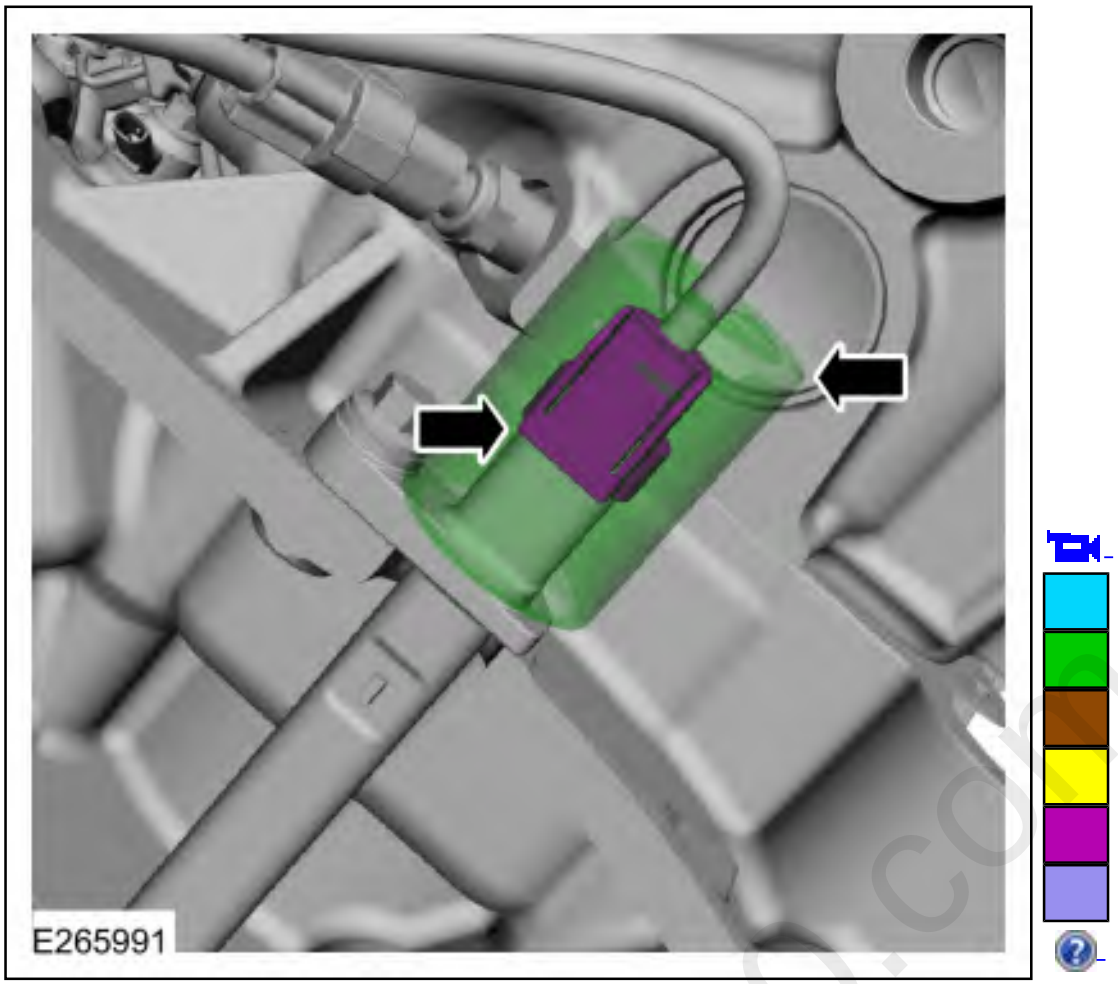


1. Connect the fuel rail electrical connector.

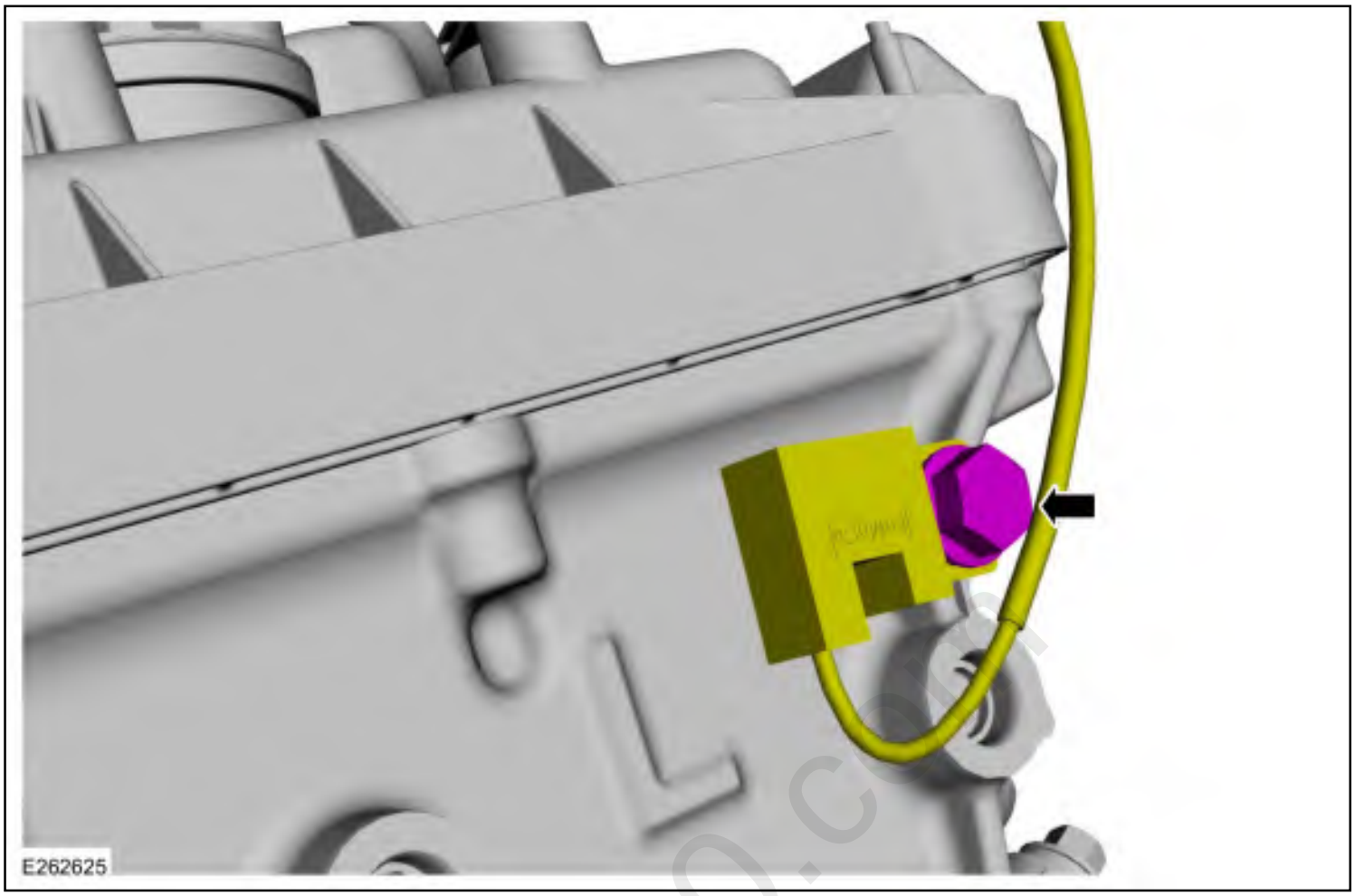
2. Connect the CHT sensor electrical connector.



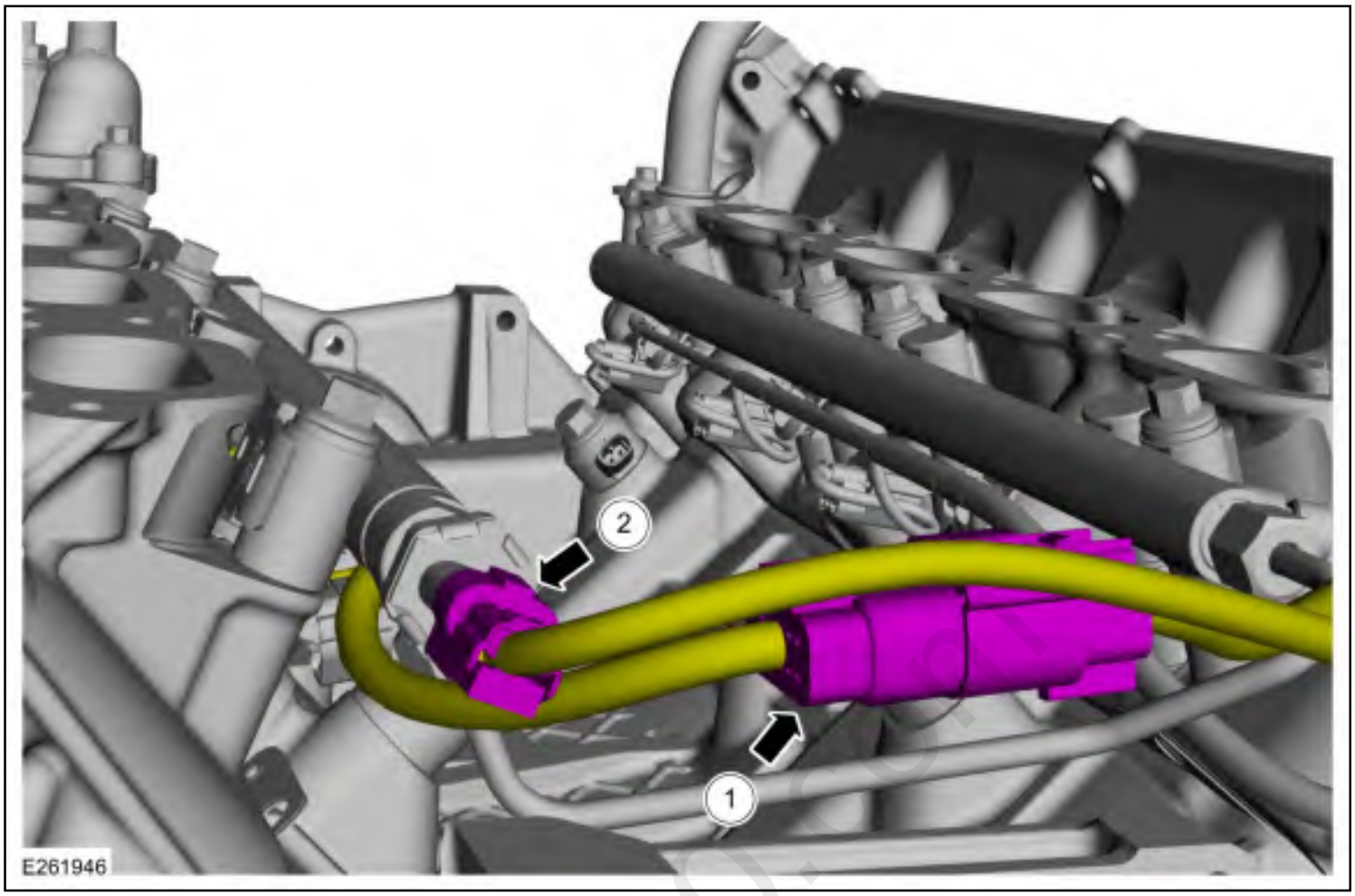
1. Connect the CKP sensor electrical connector.
2. Slide the insulator over the electrical connector.



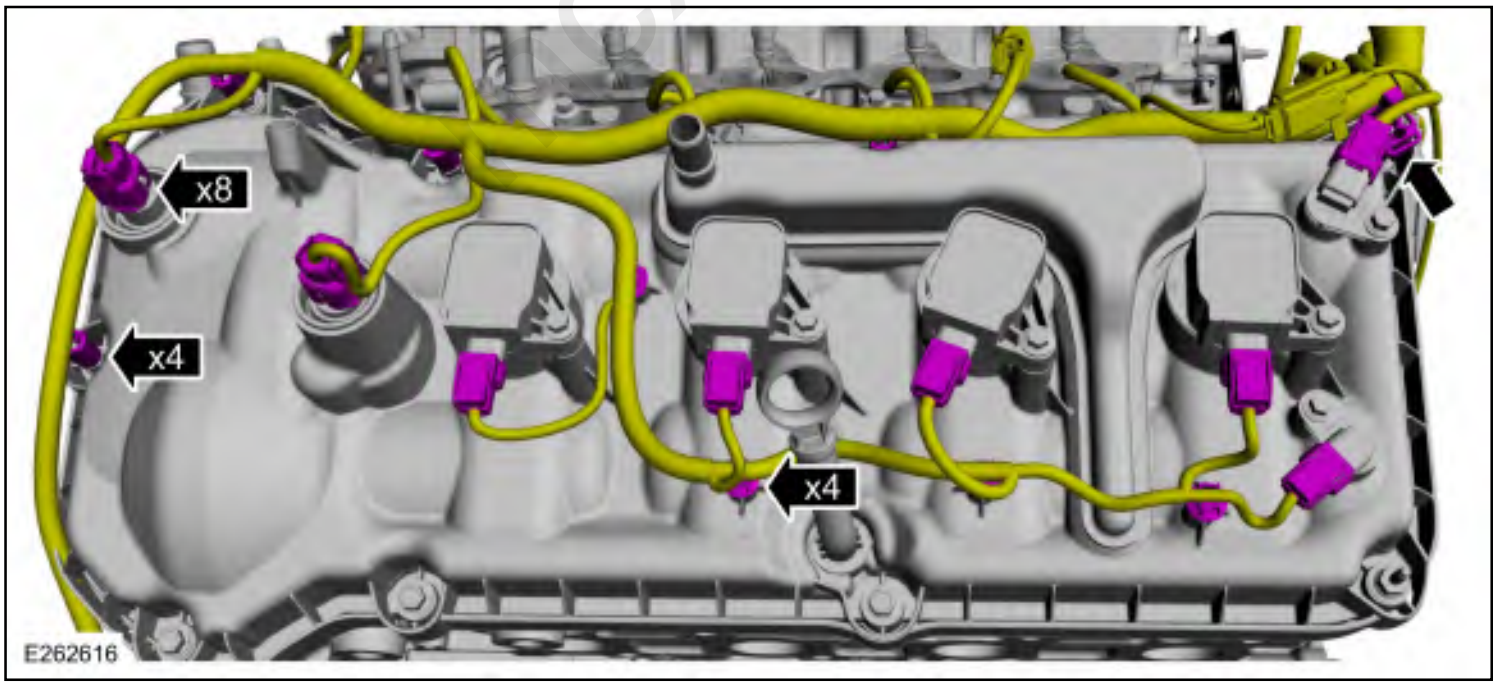
109. Remove the bolt and position the capacitor aside.
Torque: 89 lb.in (10 Nm)



1. Connect the fuel rail electrical connector.
2. Connect the fuel sensor electrical connector.

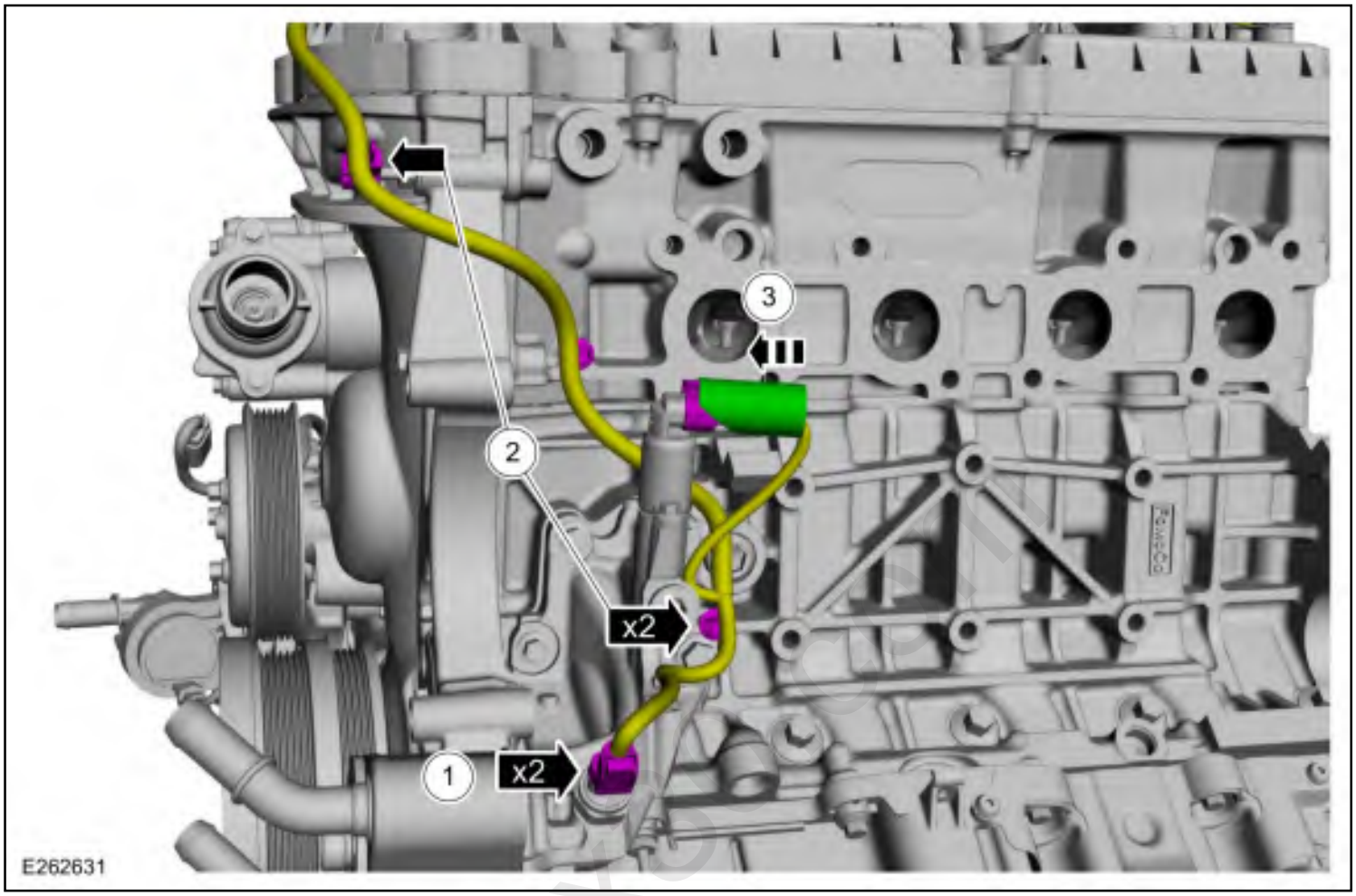


1. Connect the engine wiring harness electrical connectors.
2. Attach the wiring harness retainers.



1. Connect the engine wiring harness electrical connectors.

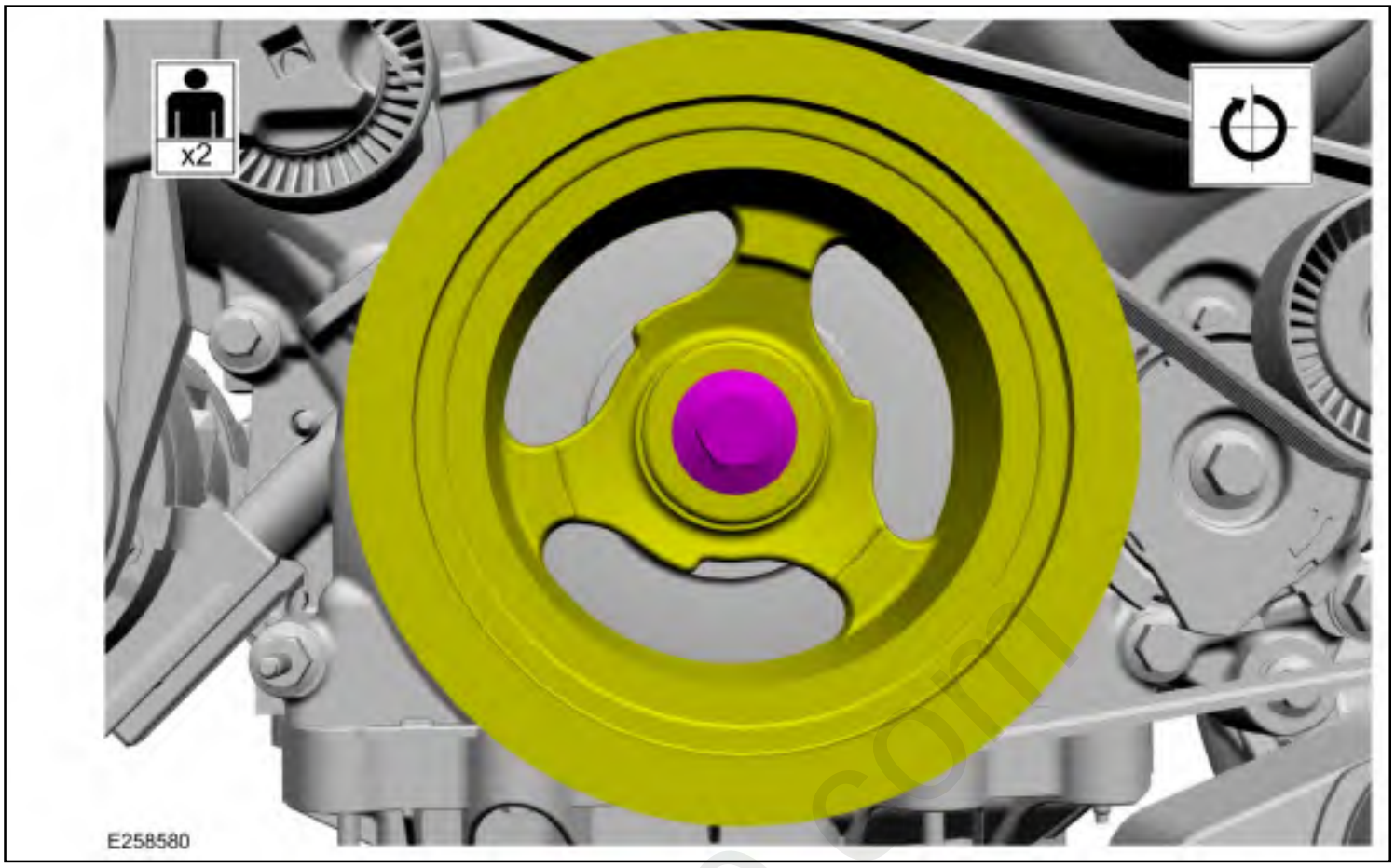
2. Attach the engine wiring harness retainers.
3. Position the wiring harness insulator.



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

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

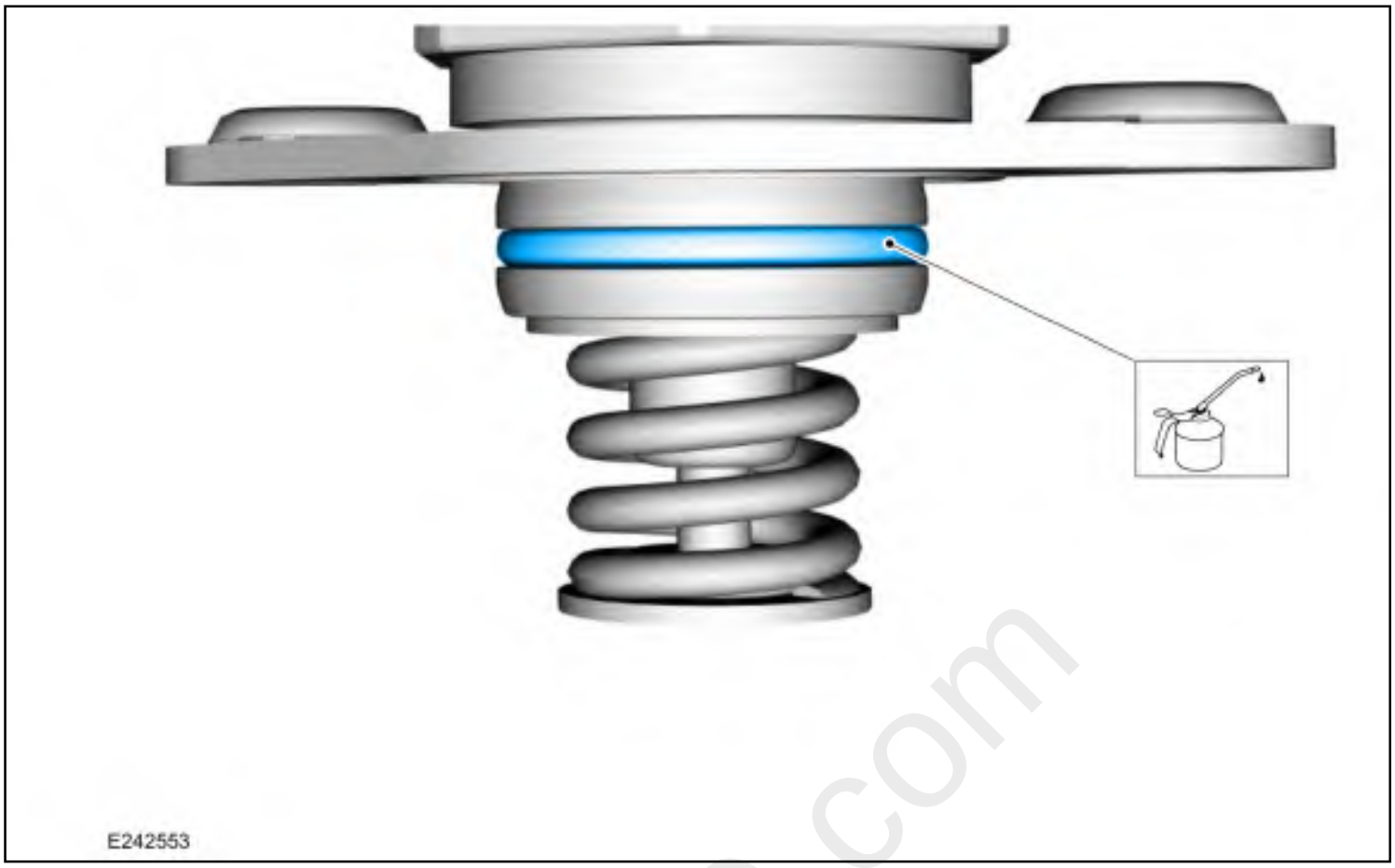
With the help of an assistant, using the crankshaft pulley bolt, turn the crankshaft until the high-pressure fuel pump drive lobe is at BDC.



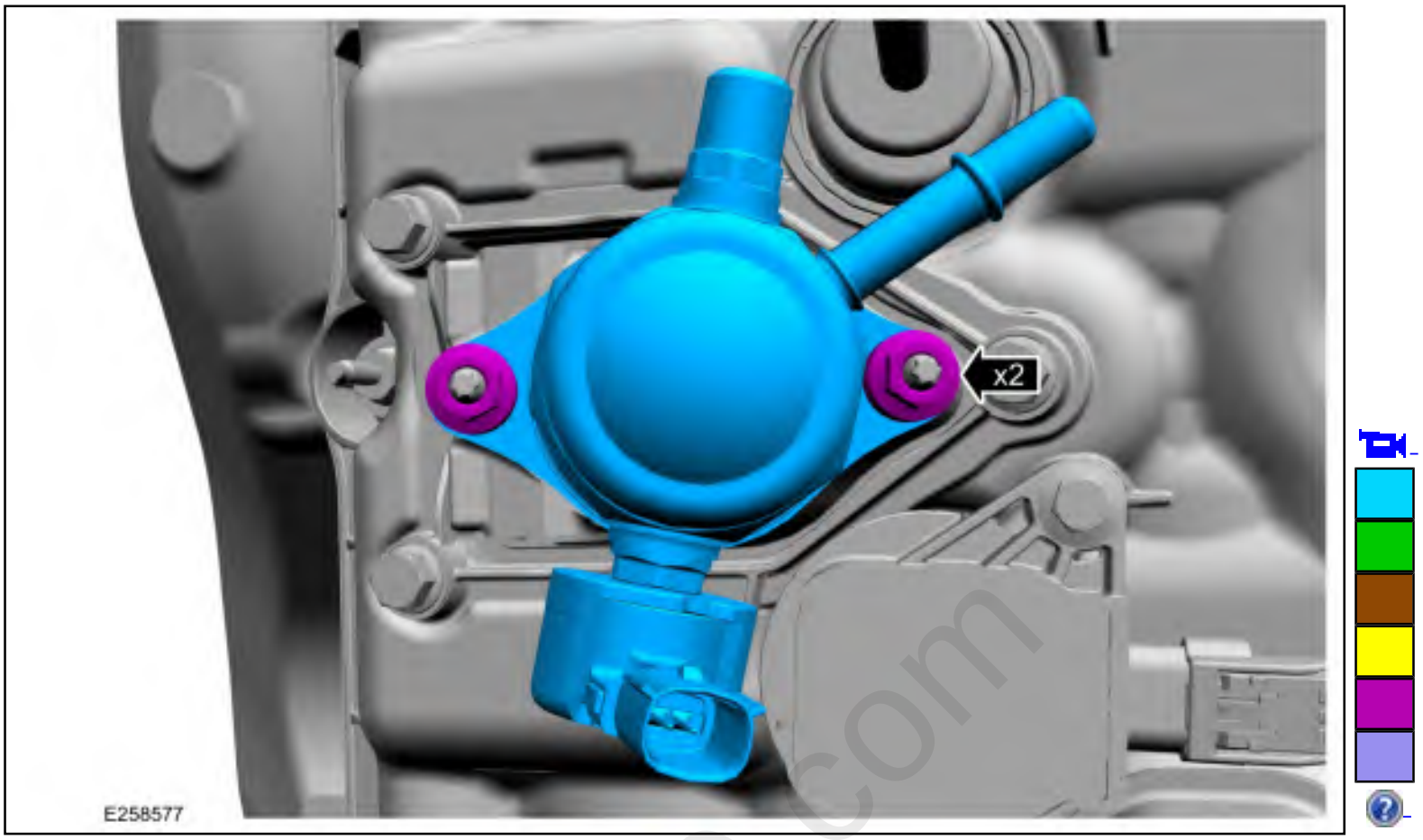
114. Apply clean engine oil to the high-pressure fuel pump mounting pedestal bore, the drive lobe and the roller tappet.

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

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

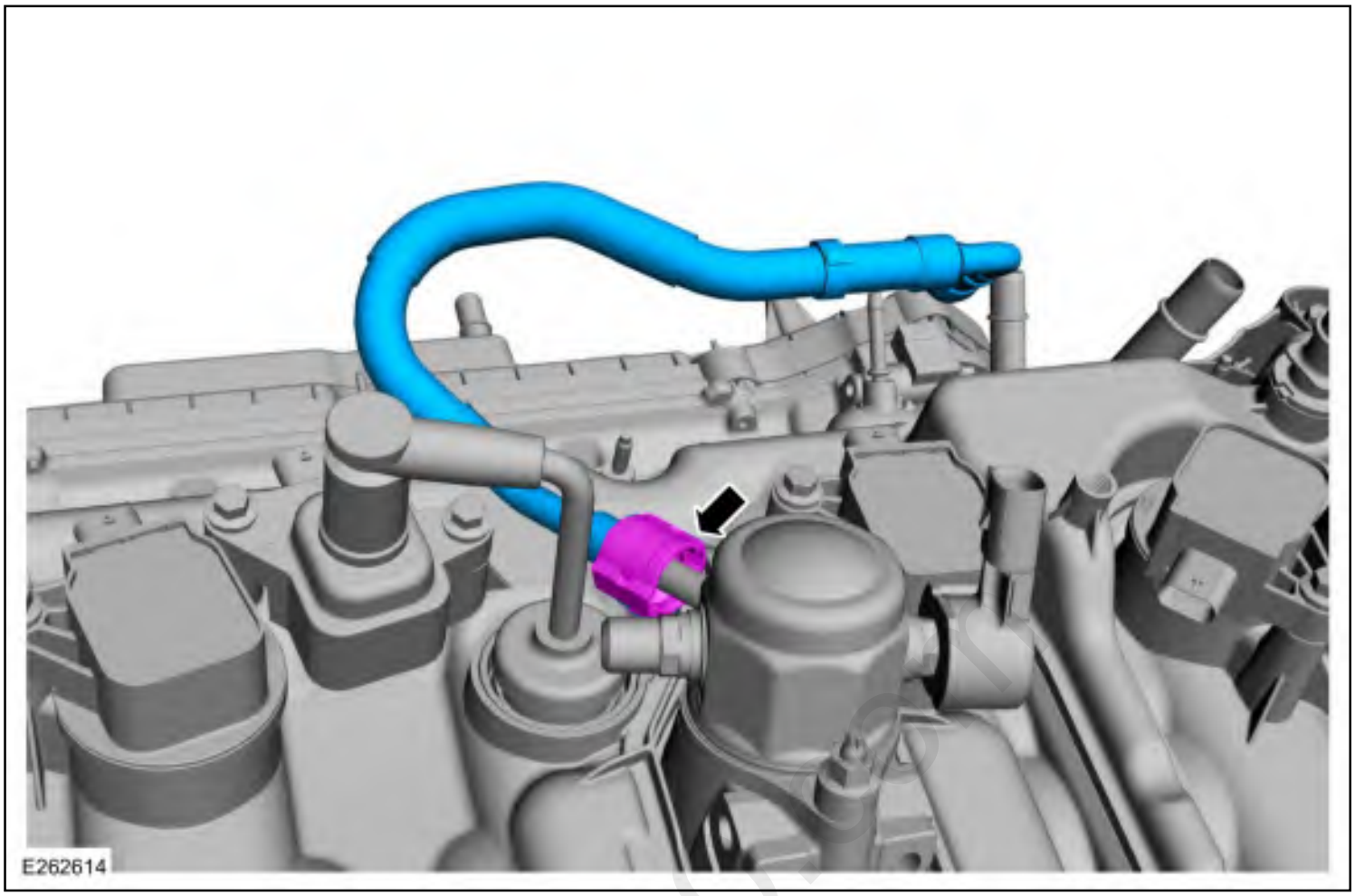


117. Install the high-pressure fuel pump, then install the mounting nuts finger tight. Alternately tighten each high-pressure fuel pump nut one complete revolution until seated. Tighten the fuel high-pressure fuel pump nuts in the following 2 stages.
Torque:
Stage 1: 89 lb.in (10 Nm)
Stage 2: 30°



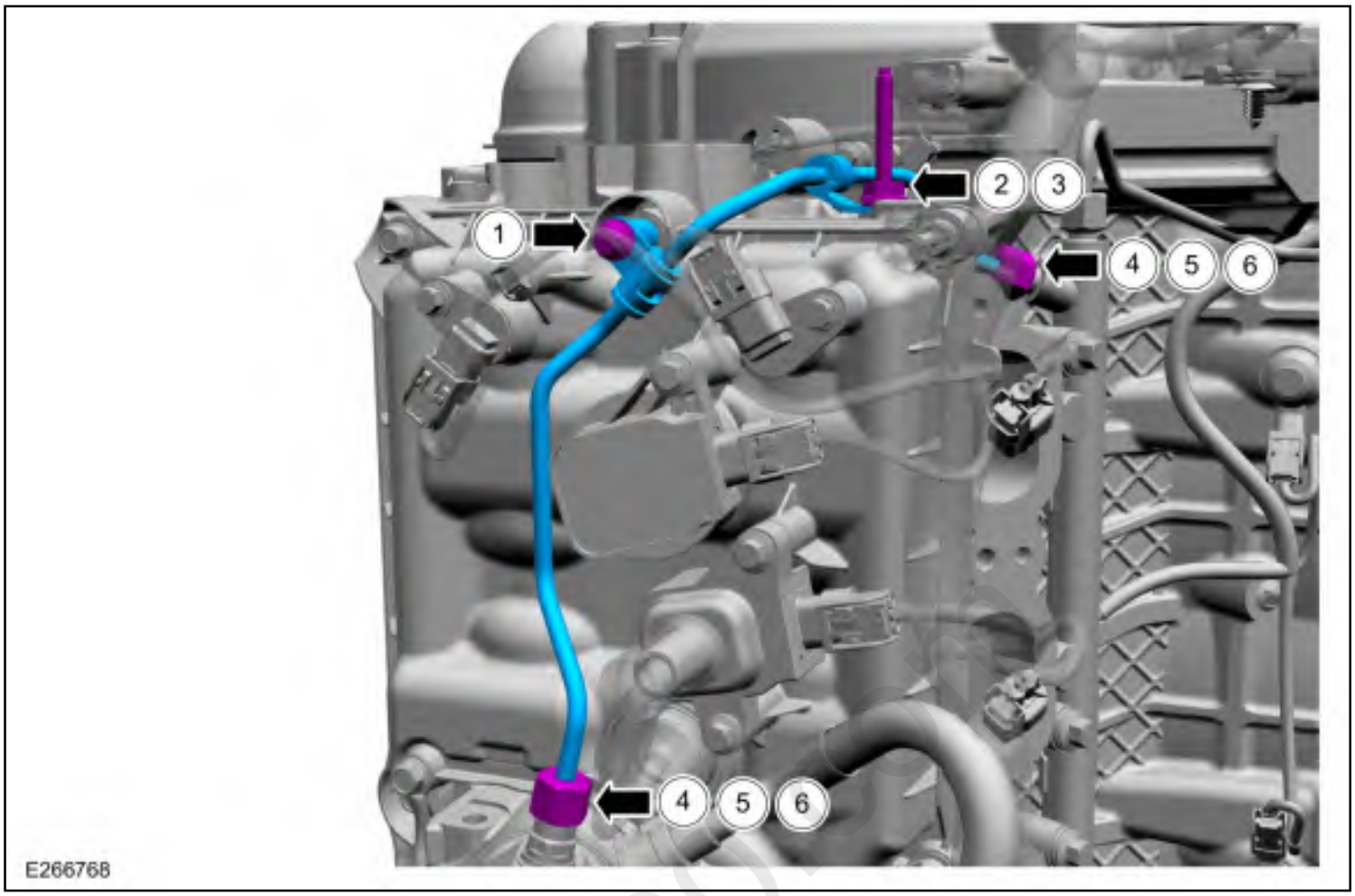
118. **NOTICE: The fuel high-pressure fuel pump supply tube must be installed with the 90 degree spring lock end installed to the port fuel rail; if it is installed backwards a check valve will prevent the engine from running properly.**

    Install the high-pressure fuel tube and connect the quick release coupling.
    Refer to: Quick Release Coupling (310-00D Fuel System - General Information - 5.0L 32V Ti-VCT, General Procedures).

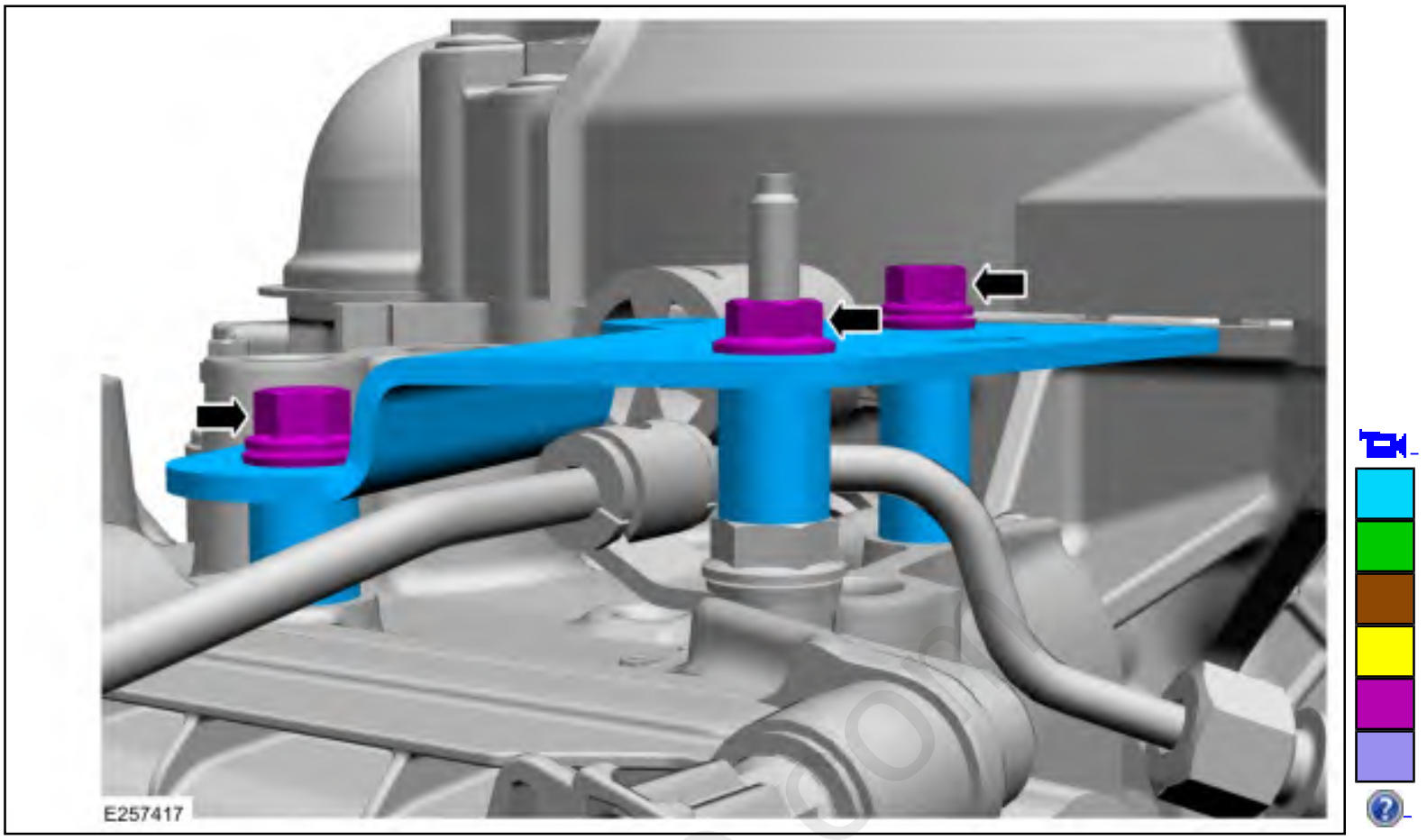


119. **NOTICE: In stage 6, if the torque required to tighten any flare nut on the new high-pressure fuel tube reaches or exceeds 37 lb.ft (50 Nm), then that high pressure fuel tube must be discarded and replaced with another new high-pressure fuel tube.**

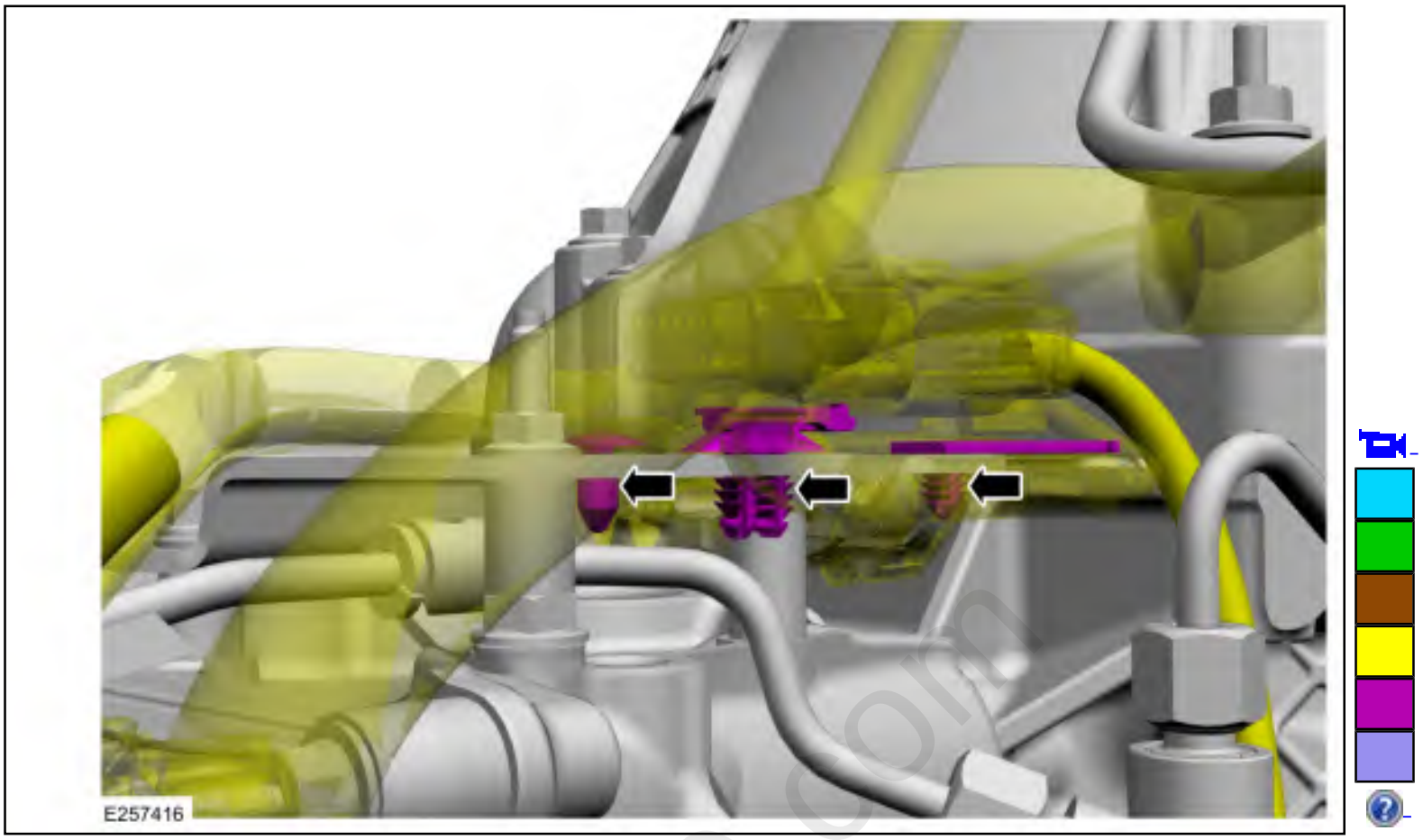
    1. *Torque*: 89 lb.in (10 Nm)
    2. *Torque*: 89 lb.in (10 Nm)
    3. *Torque*: 30°
    4. *Torque*: 71 lb.in (8 Nm)
    5. *Torque*: 89 lb.in (10 Nm)
    6. *Torque*: 25°



120. Install the high-pressure fuel line shield, then install and tighten the high-pressure fuel line shield retainers.
Torque: 89 lb.in (10 Nm)

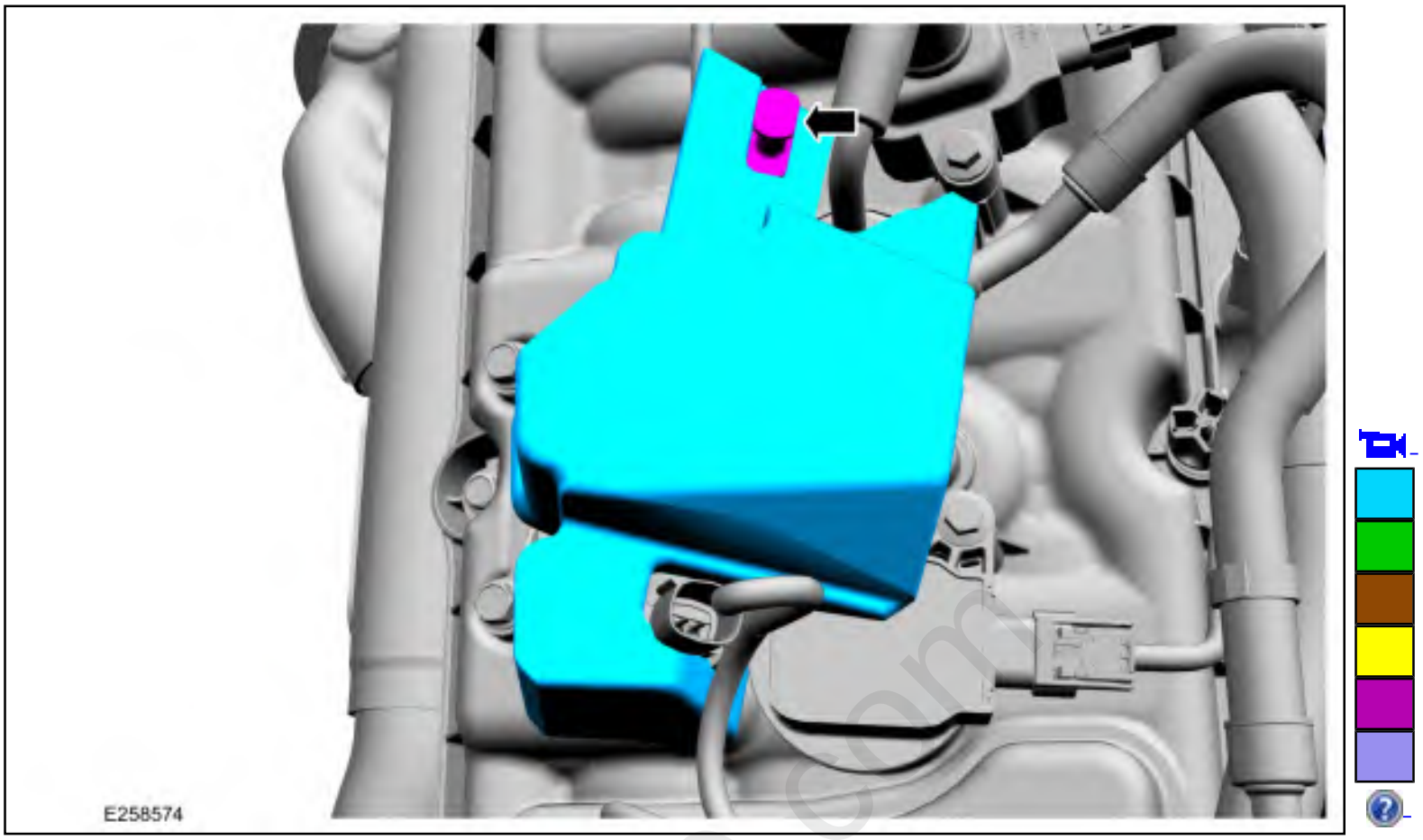


121. Attach the wiring harness retainers to high-pressure fuel line shield.

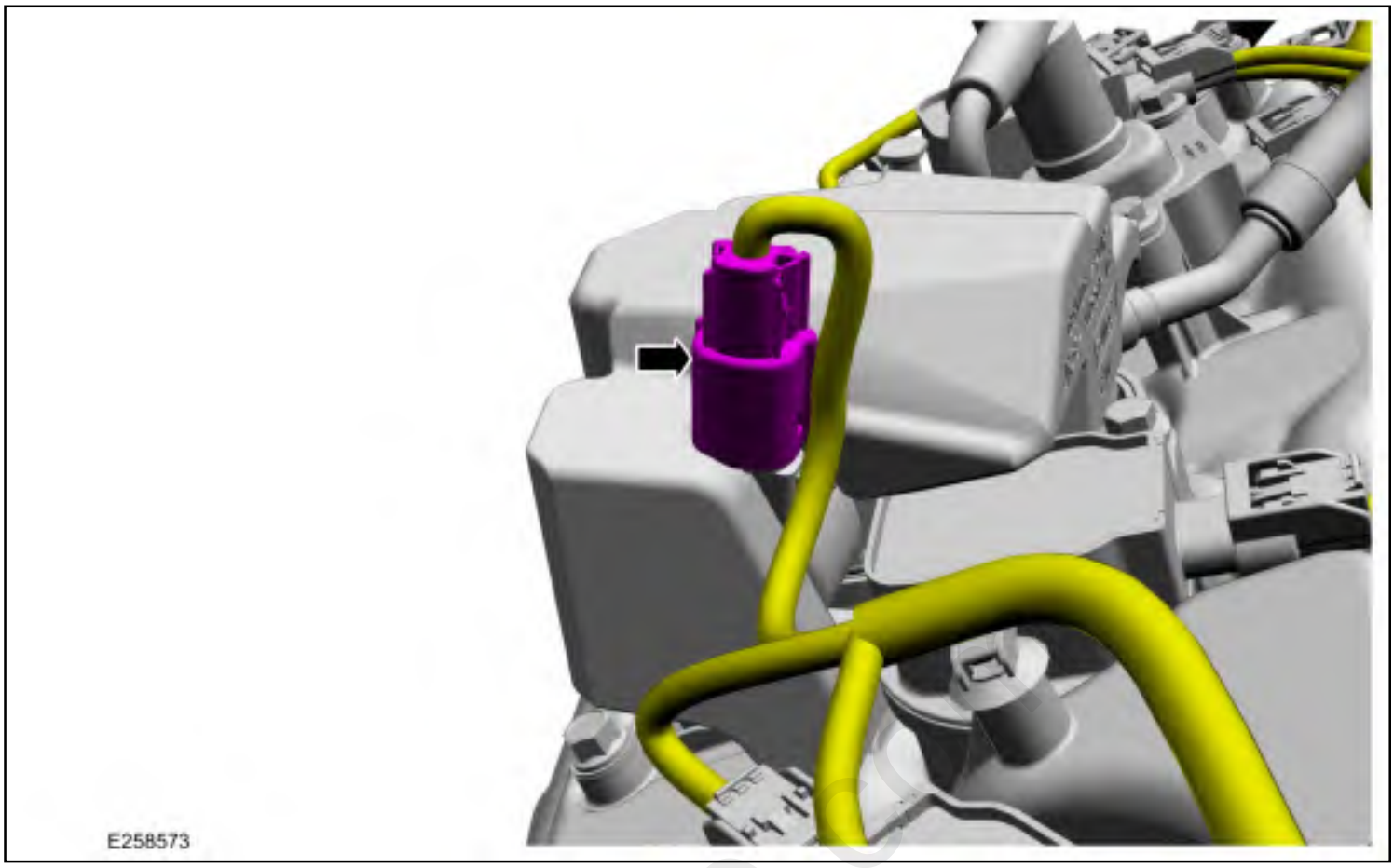


122. **NOTE:** *When removing or installing the fuel injection pump noise insulator, spreading the openings will reduce the risk of damage.*

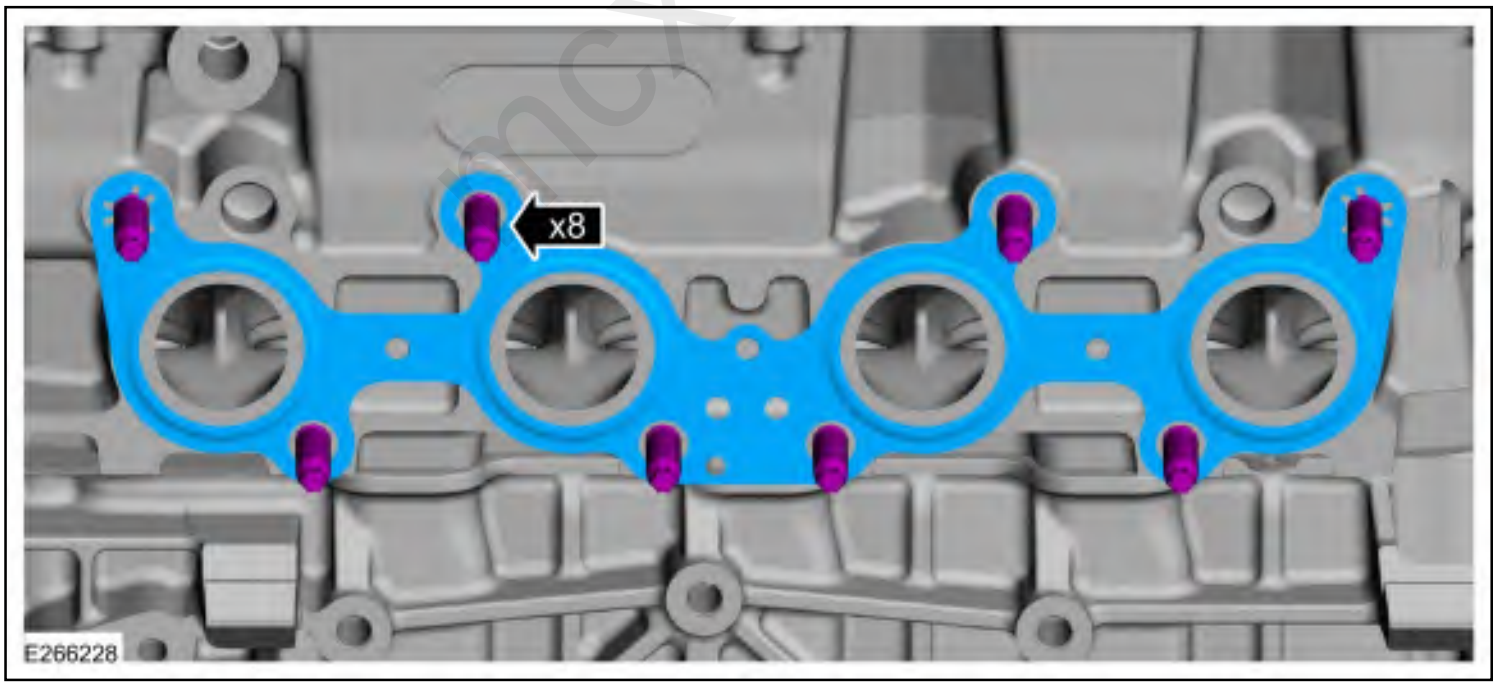
Install the fuel injection pump noise insulator, then engage the retainer.



123. Connect the high-pressure fuel pump electrical connector.

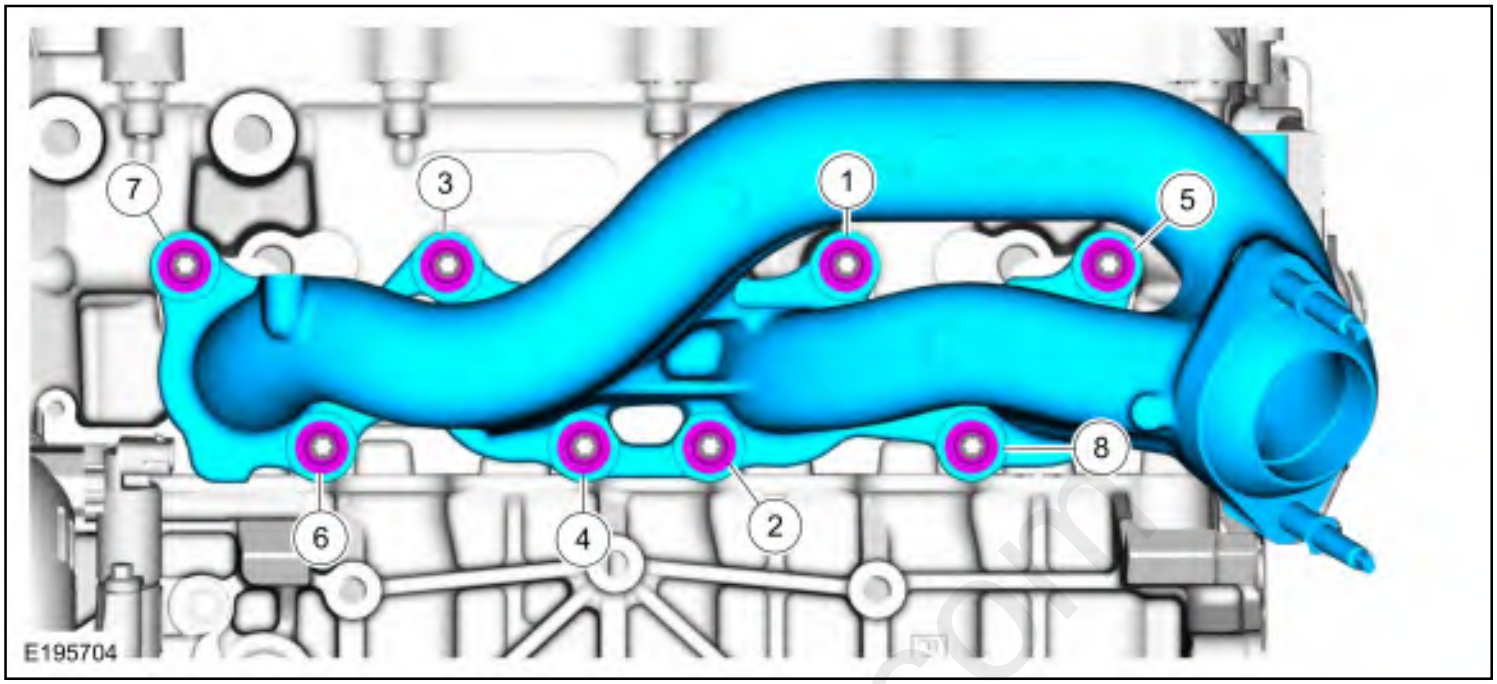


124. Install new studs and new gasket.
Torque: 18 lb.ft (25 Nm)

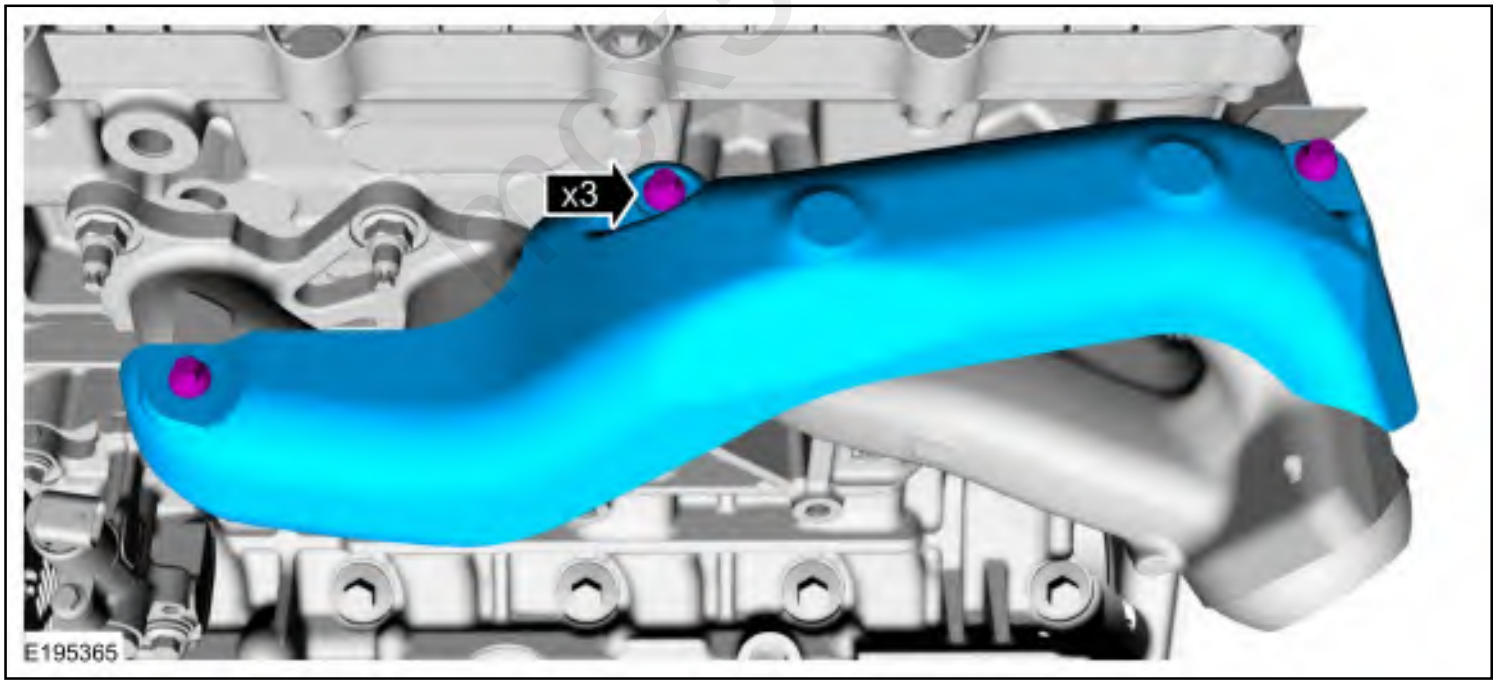


125. Install the exhaust manifold.
- Install the new nuts.

Torque:
Stage 1: 18 lb.ft (24 Nm)
Stage 2: 24 lb.ft (32 Nm)



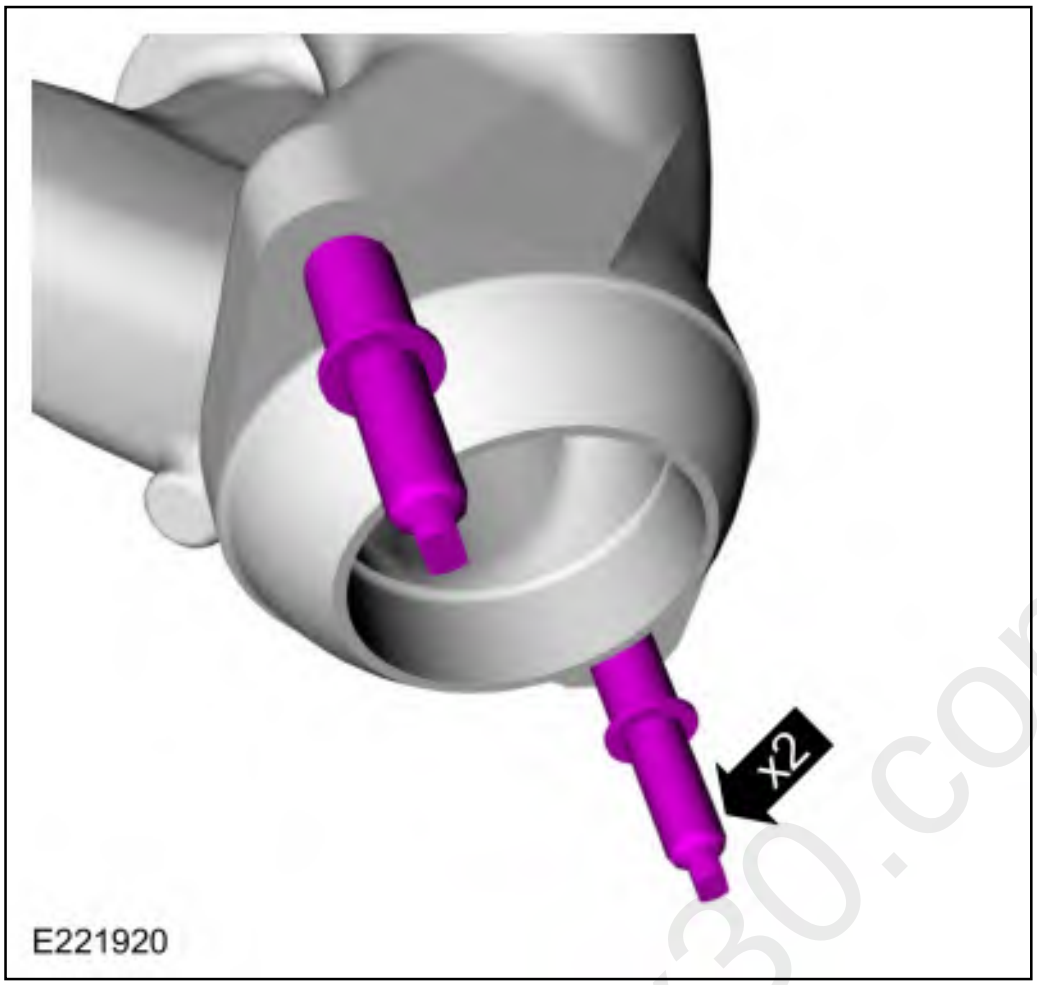
126. Install the heat shield and bolts.
Torque: 106 lb.in (12 Nm)



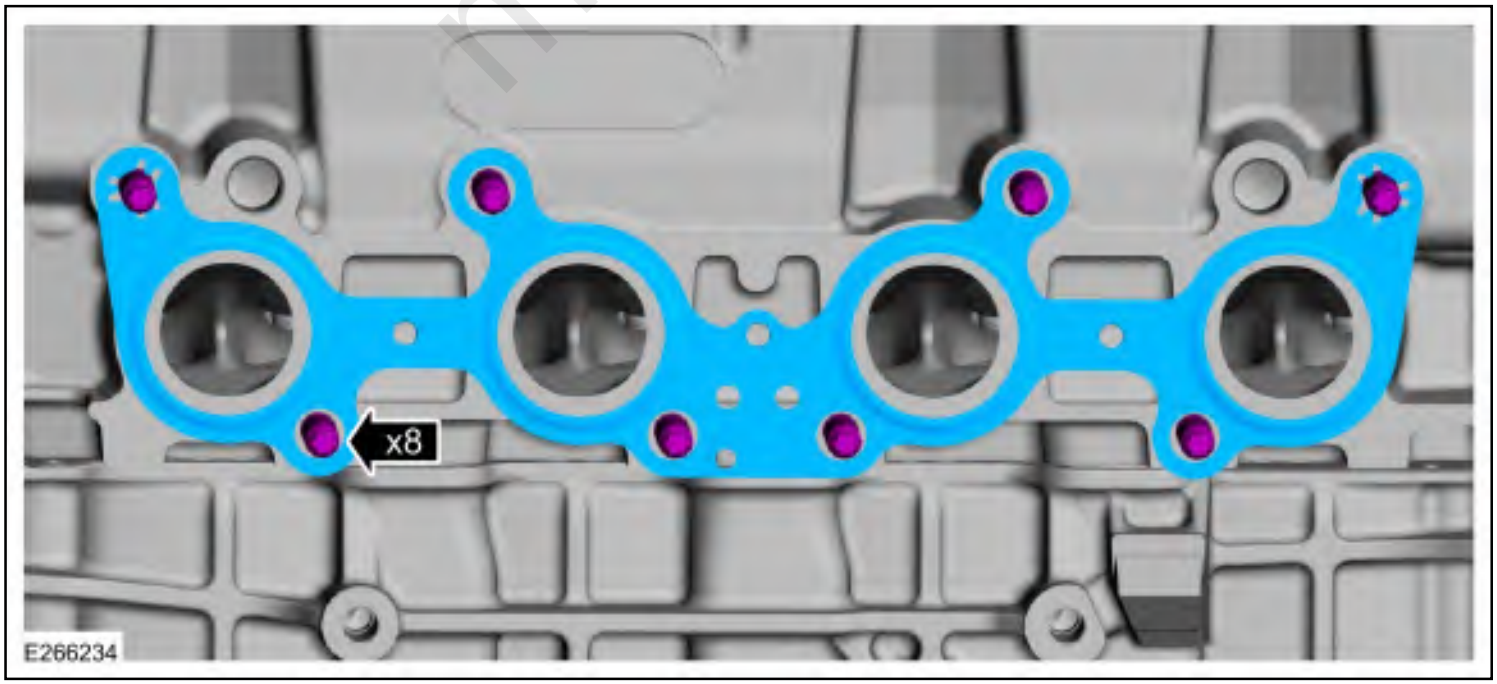
127. **NOTE:** *Some replacement exhaust manifolds do not come with studs.*

If necessary, install new studs.

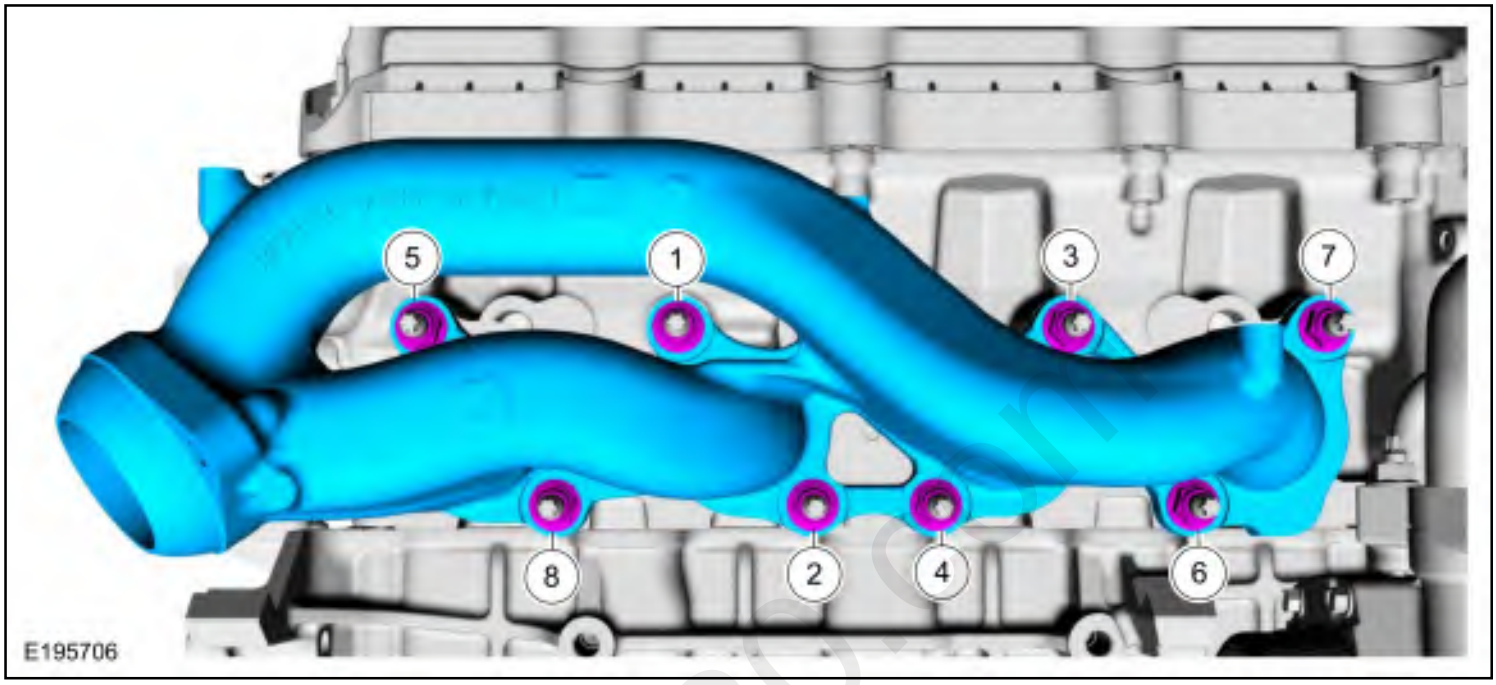
Torque: 30 lb.ft (40 Nm)



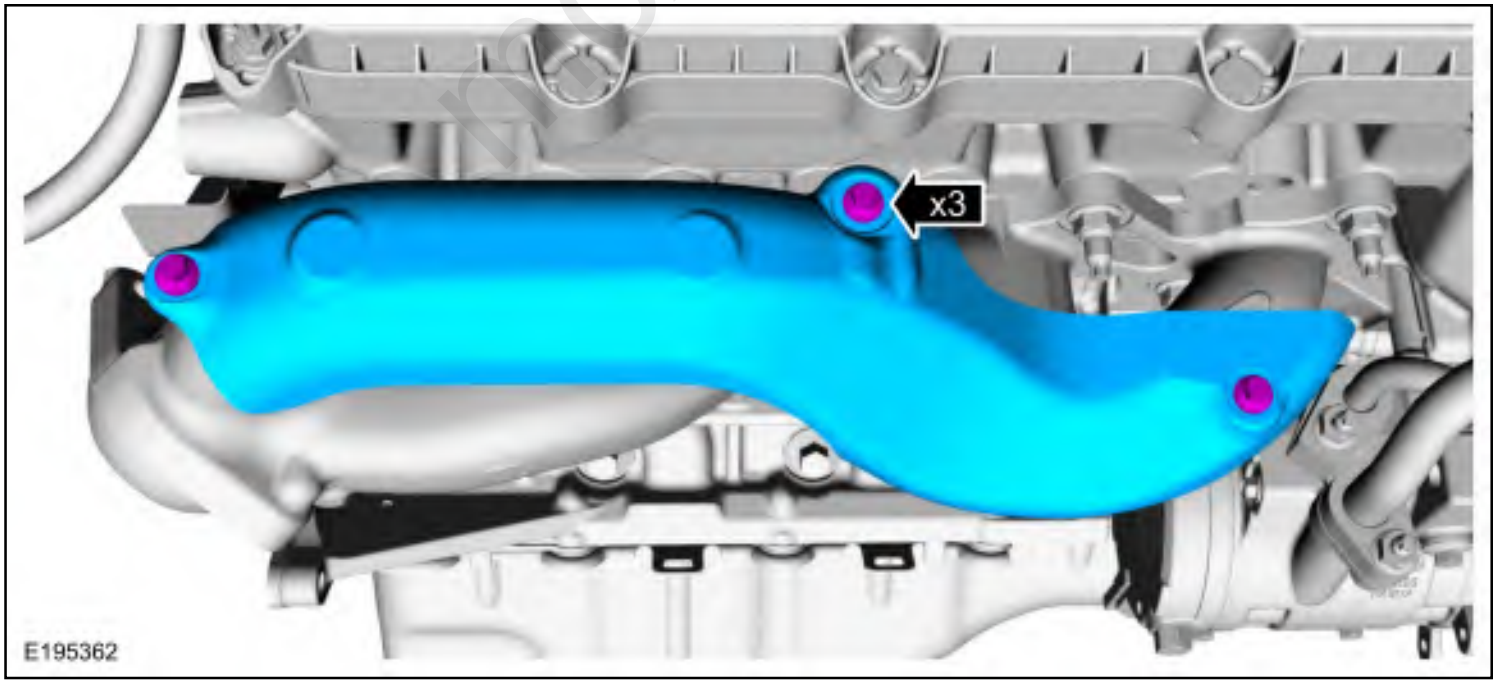
128. Install new studs and new gasket.
Torque: 18 lb.ft (25 Nm)



129. Install the exhaust manifold.
- Install the new nuts.
  Torque:
  Stage 1: 18 lb.ft (24 Nm)
  Stage 2: 24 lb.ft (32 Nm)

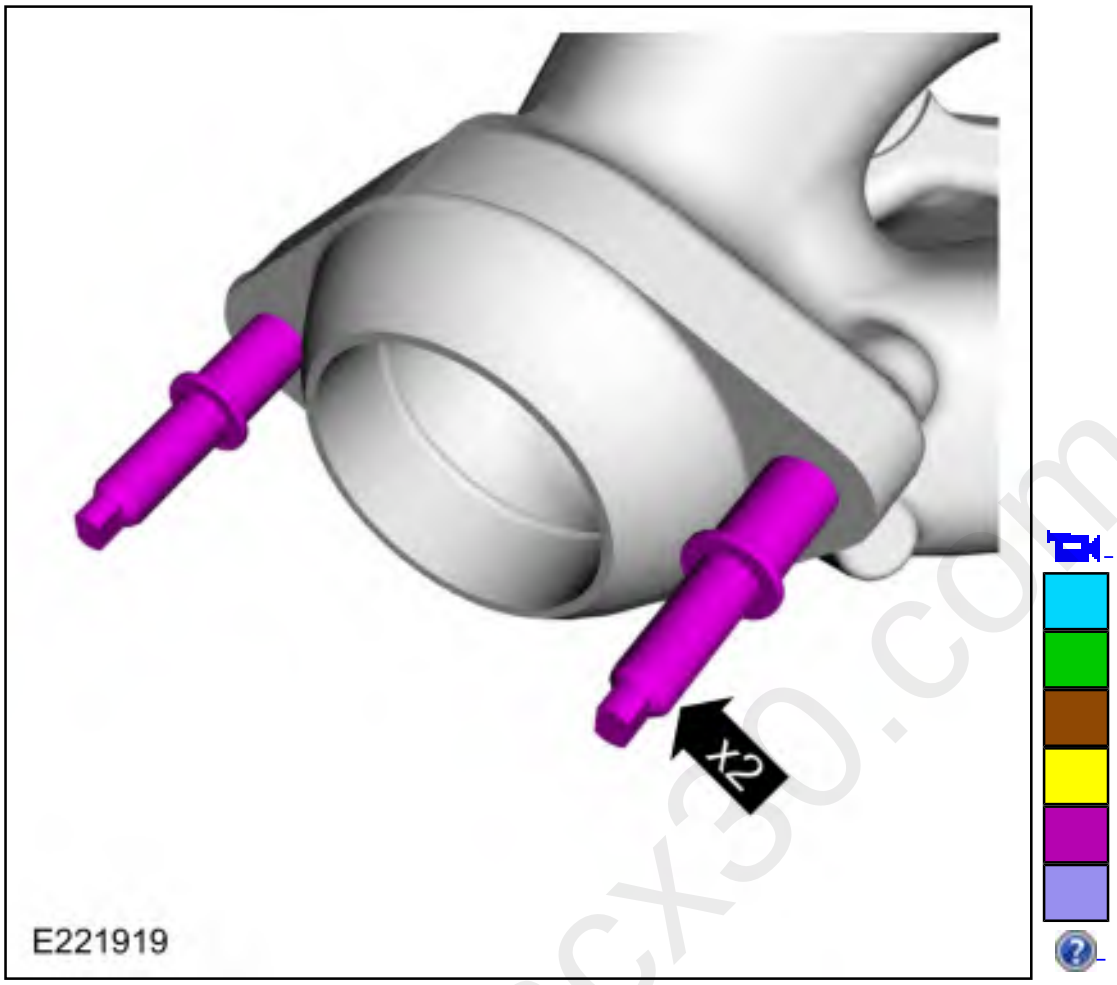


130. Install the heat shield and bolts.
Torque: 106 lb.in (12 Nm)



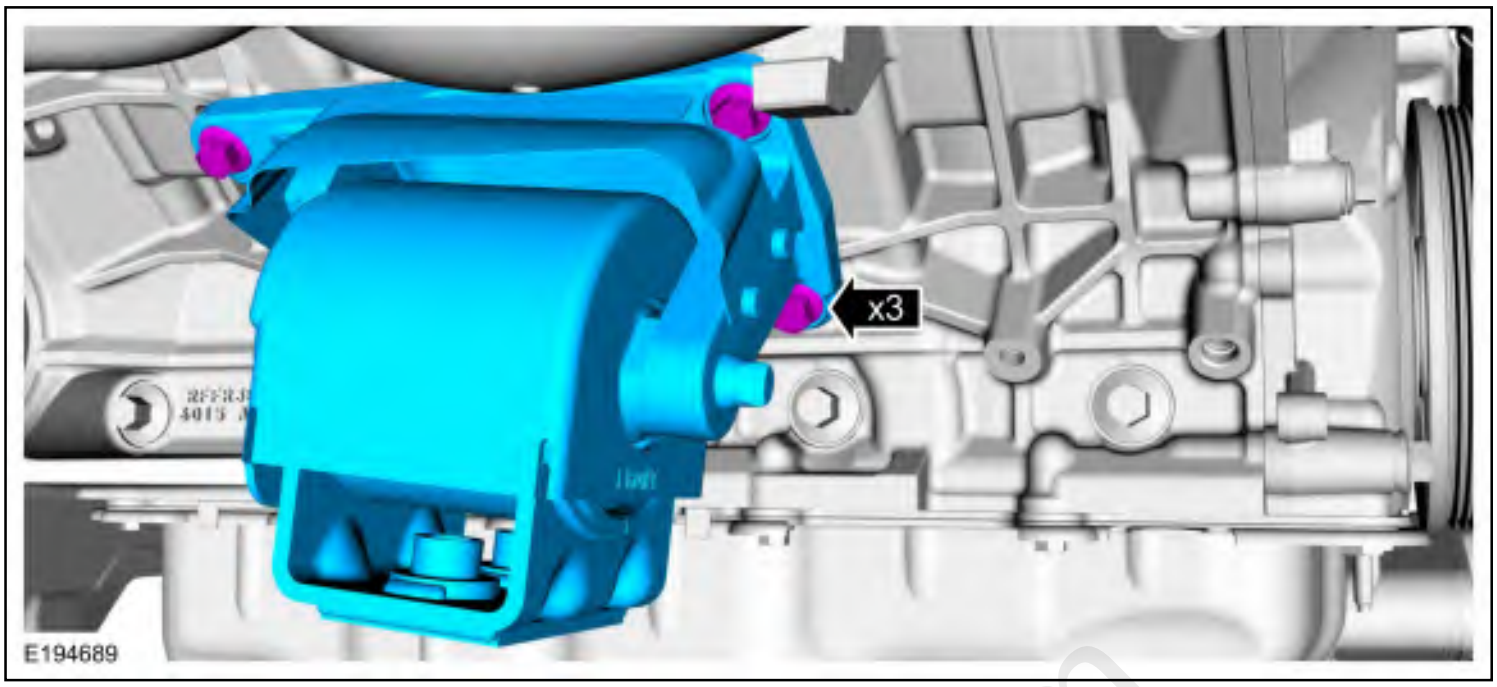
131. **NOTE:** *Some replacement exhaust manifolds do not come with studs.*

If necessary, install new studs.
Torque: 30 lb.ft (40 Nm)

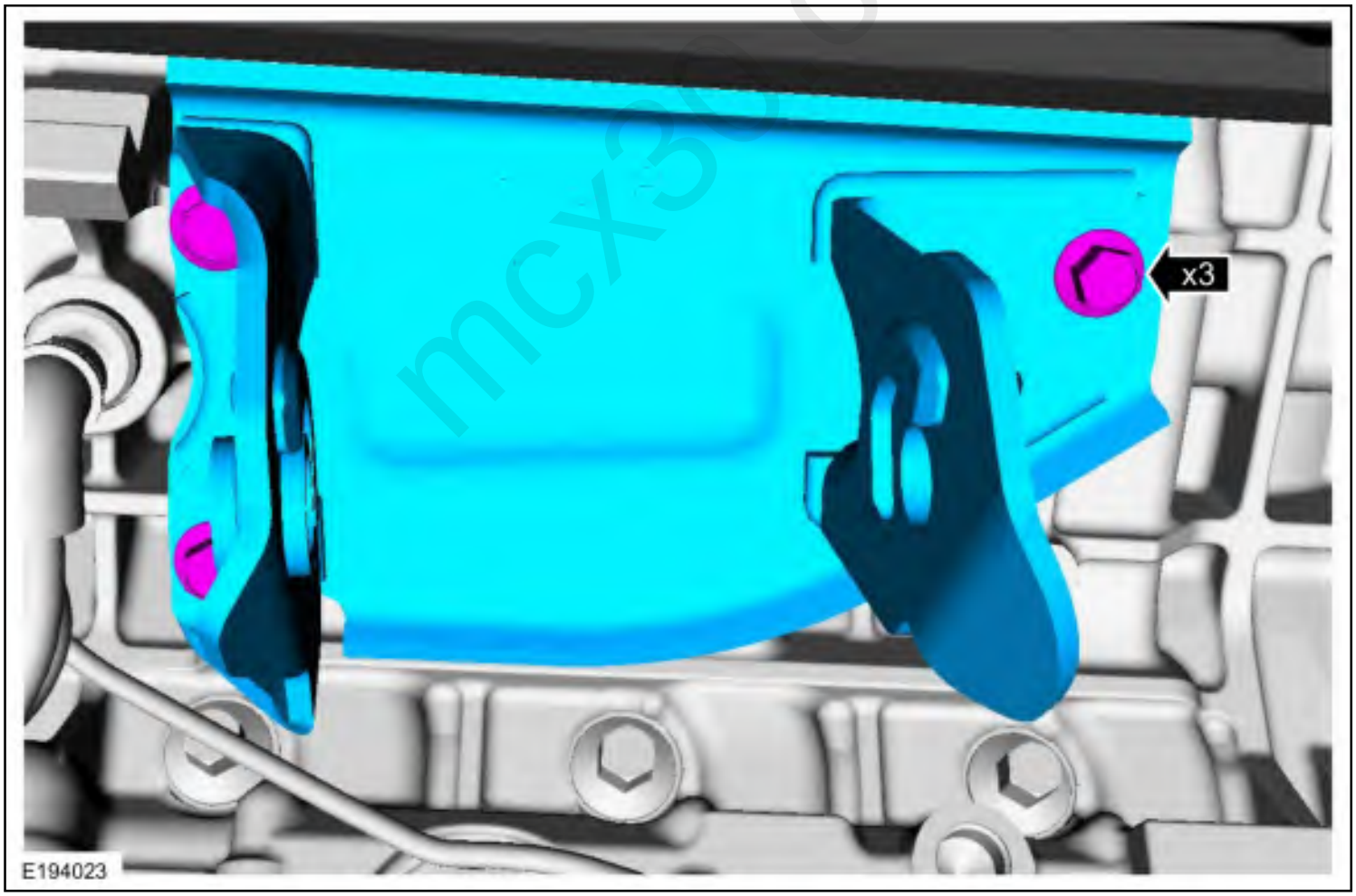


132. **NOTE:** *If a new RH engine mount is installed, remove the 2 studs prior to positioning the engine in the vehicle.*

Install the RH engine mount and the new bolts.
Torque: 57 lb.ft (77 Nm)

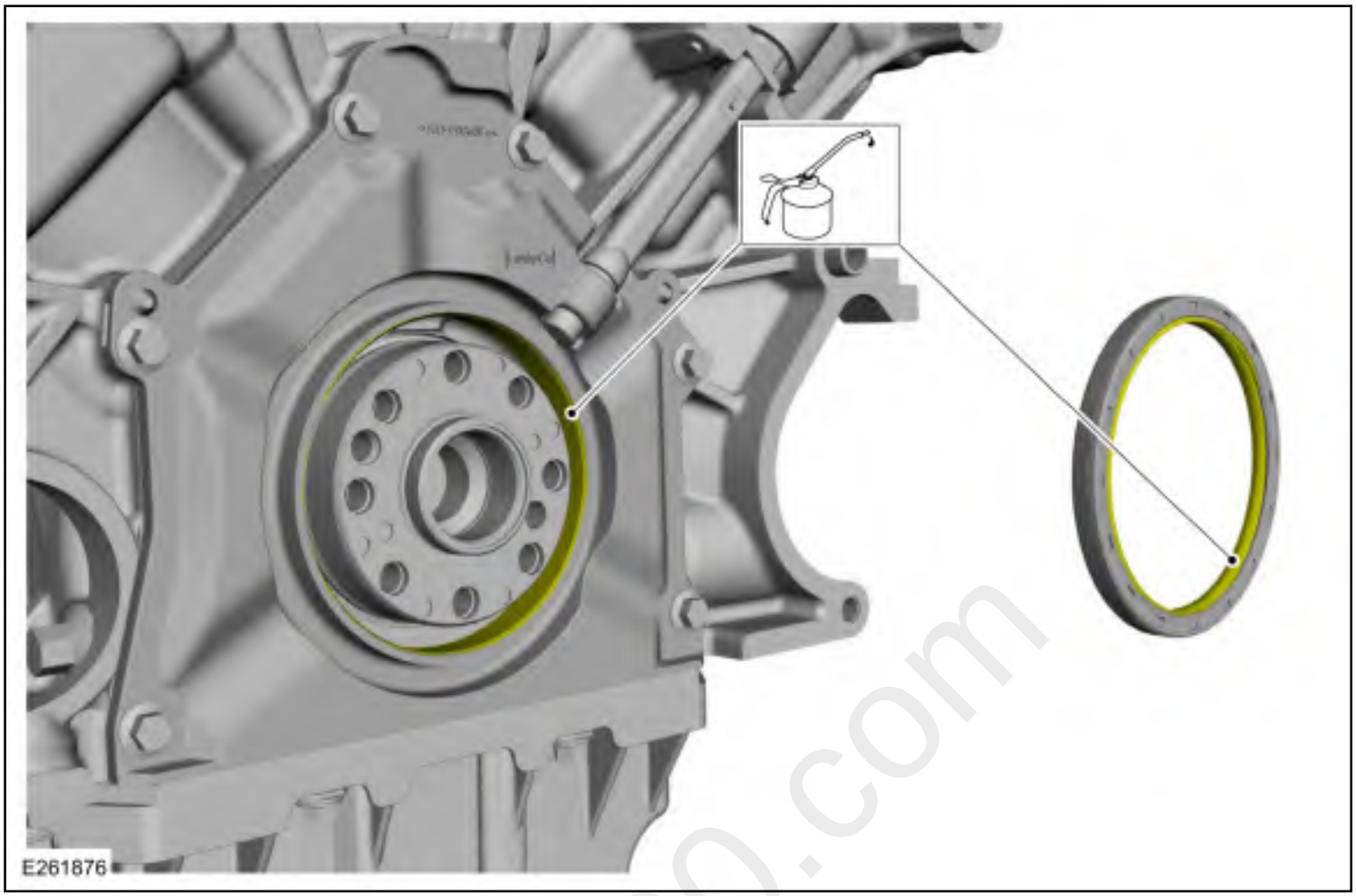


133. Install the LH engine mount-to-cylinder block bracket and the new bolts.
Torque: 57 lb.ft (77 Nm)

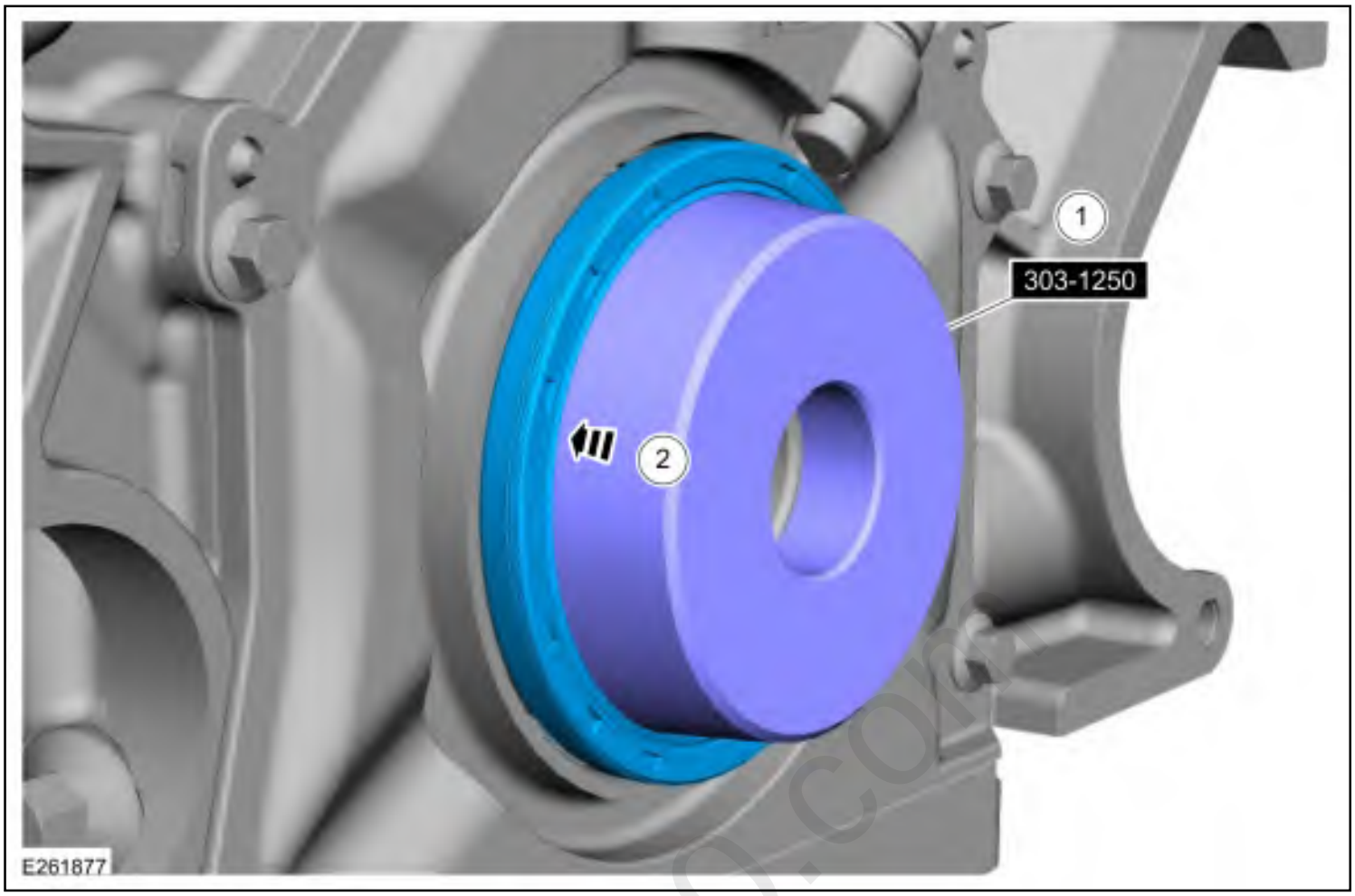


134. Install the special tool and remove the engine from the engine stand using a floor crane.
Install Special Service Tool: 303-F047 Lifting Bracket, Engine.
Use the General Equipment: Floor Crane
Use the General Equipment: Mounting Stand

135. Lubricate the seal bore and the seal lips with clean engine oil.



- Position the special tool onto the end of the crankshaft.
  Use Special Service Tool: 303-1250 Seal Installer, Rear Main.
- Slide the new crankshaft rear seal onto the tool.



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