

# Engine - Overview

Base Part Number: Base Part Number: 6L084

## Engine Information

**NOTE:** When repairing engines, all parts must be contamination free. If contamination/foreign material is present when repairing an engine, premature engine failure may occur.

**NOTE:** Specifications show the expected minimum or maximum condition. Refer to the appropriate section in Group 303 for the specifications.

**NOTE:** If a component fails to meet the specifications, it is necessary to refinish it or install a new component. Wear limits are provided as an aid to determine if the component can be refinished. A new component must be installed when any component fails to meet specifications and cannot be refinished.

**NOTE:** This section contains information, steps and procedures that may not be specific to this engine.

This section covers general procedures and diagnosis and testing of the engine system, except for exhaust emission control devices, which are covered in the PC/ED manual.

The engine incorporates the following features: Refer to the appropriate section in Group 303 for the procedure.

- Crankcase ventilation or breather system
- Exhaust emission control system
- EVAP

Some engines incorporate a fail-safe cooling system. Refer to the appropriate section in Group 303 for the procedure.

The engine, fuel system, ignition system, emissions system and exhaust system all affect exhaust emission levels and must be maintained according to the maintenance schedule. Refer to the Scheduled Maintenance Guide.

Correct engine identification is required to order parts. Refer to the appropriate section in Group 303 for the procedure.

For complete vehicle and engine identification codes,

Refer to: [Identification Codes - 3.0L Power Stroke Diesel](#) (100-01 Identification Codes, Description and Operation).

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# Engine

Base Part Number: Base Part Number: 6L084

## Inspection and Verification - Engine Performance

**NOTE:** There are 2 diagnostic paths that can be followed depending on the type of engine concern. Carry out Inspection and Verification - Engine Performance or Inspection and Verification - NVH.

**NOTE:** Some engines and transmissions are equipped with PTLP (powertrain limiting and protection) strategy that will limit power under various conditions to protect the engine and the transmission.

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical or electrical damage.
3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.
4. **NOTE:** Make sure to use the latest scan tool software release.

If the cause is not visually evident, connect the scan tool to the DLC.

5. **NOTE:** The VCM LED prove out confirms power and ground from the DLC are provided to the VCM.

If the scan tool does not communicate with the VCM:

- check the VCM connection to the vehicle.
- check the scan tool connection to the VCM.
- check for No Power To The Scan Tool, to diagnose no power to the scan tool.  
REFER to: Communications Network (418-00 Module Communications Network) .

6. If the scan tool does not communicate with the vehicle:
  - verify the ignition key is in the ON position.
  - verify the scan tool operation with a known good vehicle.

- to diagnose no response from the PCM,  
REFER to: Communications Network (418-00 Module Communications Network) .
7. Carry out the network test.
    - If the scan tool responds with no communication for one or more modules,  
REFER to: Communications Network (418-00 Module Communications Network) .
    - If the network test passes, retrieve and record continuous memory DTCs.
  8. Clear the continuous DTCs and carry out the self-test diagnostics for the PCM.
  9. If the DTCs retrieved are related to the concern, refer to the appropriate 303-14 section.
  10. If no DTCs related to the concern are retrieved, GO to Symptom Chart - Engine Performance.

## **Inspection and Verification - NVH**

1. NVH symptoms should be identified using the diagnostic tools and techniques that are available. For a list of these techniques, tools, an explanation of their uses and a glossary of common terms, REFER to: [Noise, Vibration and Harshness \(NVH\)](#) (100-04 Noise, Vibration and Harshness, Diagnosis and Testing).  
or REFER to: [Noise, Vibration and Harshness \(NVH\) - Raptor](#) (100-04 Noise, Vibration and Harshness, Diagnosis and Testing).  
Since it is possible that any one of multiple systems may be the cause of the symptom, it may be necessary to use a process of elimination type of diagnostic approach to pinpoint the responsible system.
2. Verify the customer concern by operating the engine to duplicate the condition.
3. Check the engine oil level and check the oil for contamination. Low engine oil level or contaminated oil are a common cause of engine noise. If the oil is contaminated, the source of the contamination must be identified and repaired as necessary.
4. Visually inspect for obvious signs of mechanical damage.
5. If the inspection reveals obvious concerns that can be readily identified, repair as necessary.
6. **NOTE:** *Make sure to use the latest scan tool software release.*

If the cause is not visually evident, connect the scan tool to the DLC.



7. **NOTE:** The VCM LED prove out confirms power and ground from the DLC are provided to the VCM.

If the scan tool does not communicate with the VCM:

- check the VCM connection to the vehicle.
- check the scan tool connection to the VCM.
- check for No Power To The Scan Tool, to diagnose no power to the scan tool.

REFER to: Communications Network (418-00 Module Communications Network) .

8. If the scan tool does not communicate with the vehicle:

- verify the ignition key is in the ON position.
- verify the scan tool operation with a known good vehicle.
- to diagnose no response from the PCM,

REFER to: Communications Network (418-00 Module Communications Network) .

9. Carry out the network test.

- If the scan tool responds with no communication for one or more modules,

REFER to: Communications Network (418-00 Module Communications Network) .

- If the network test passes, retrieve and record continuous memory DTCs.

10. Clear the continuous DTCs and carry out the self-test diagnostics for the PCM.

11. If the DTCs retrieved are related to the concern, go to the appropriate 303-14 section.

12. If no DTCs related to the concern are retrieved, continue the inspection and verification if a noise concern is related to the engine. For vibration concerns and noise concerns such as powertrain mounts, air intake system and starter GO to Symptom Chart - NVH.

In some cases, a noise may be a normal characteristic of that engine type. In other cases the noise may require further investigation. Comparing the noise to a similar year/model vehicle equipped with the same engine will aid in determining if the noise is normal or abnormal.

Once a customer concern has been identified as an abnormal engine noise, it is critical to determine the location of the specific noise. Use the EngineEAR/ChassisEAR or stethoscope (the noise will always be louder closer to the noise source) to isolate the location of the noise to one of the following areas.

- Fuel injector(s)
- Upper end of engine
- Lower end of engine
- Front of engine
- Rear of engine

## **Fuel injector noise**

A common source of an engine ticking noise can be related to the fuel injection pump GTDI (gasoline turbocharged direct injection) engine or fuel injector(s). This is normal engine noise that can be verified by listening to another vehicle. If the injector noise is excessive or irregular, use the EngineEAR/ChassisEAR or stethoscope to isolate the noise to a specific fuel injector.

## **Upper end engine noise**

A common source of upper end engine noise (ticking, knocking or rattle) include the camshaft(s) and valve train. Upper end engine noise can be determined using the EngineEAR/ChassisEAR or stethoscope on the valve cover bolts. If the noise is loudest from the valve cover bolts, then the noise is upper end. The EngineEAR/ChassisEAR or stethoscope can be used to further isolate the noise to the specific cylinder bank and cylinder. Removal of the valve covers will be required to pinpoint the source of the noise.

## **Lower end engine noise**

A common source of lower end engine noise (ticking or knocking) include the crankshaft, connecting rod (s) and bearings. Lower end noises can be determined by using the oil pan or lower cylinder block. If the noise is loudest from these areas, then the noise is lower end. If an engine noise is isolated to the lower end, some disassembly of the engine may be required to inspect for damage or wear.

## **Front of engine noise**

A common source of noise from the front of the engine (squeal, chirp, whine or hoot) is the FEAD components. To isolate FEAD noise, carry out the Engine Accessory Test, REFER to: [Noise, Vibration and Harshness \(NVH\)](#) (100-04 Noise, Vibration and Harshness, Diagnosis and Testing).  
or REFER to: [Noise, Vibration and Harshness \(NVH\) - Raptor](#) (100-04 Noise, Vibration and Harshness, Diagnosis and Testing).

Some other noises from the front of the engine (ticking, tapping or rattle) may be internal to the engine. Use the EngineEAR/ChassisEAR or stethoscope on the engine front cover to determine if the noise is internal to the engine. Removal of the engine front cover may be necessary to inspect internal engine components.

## **Rear of engine noise**

A common source of noise from the rear of the engine (knocking) is the flywheel/flexplate. Inspection of the flywheel/flexplate will be necessary.

Some engines have timing drive components at the rear of the engine and may be the source of noise (ticking, knocking or rattle). Use the EngineEAR/ChassisEAR or stethoscope on the rear of the engine if the noise is suspected to be internal to the engine. Some disassembly of the engine may be required to inspect for damage or wear.

### Turbocharger noise GTDI (gasoline turbocharged direct injection) engine

A common source of noise is the turbocharger. Some whine or air rush noise is an acceptable condition.

13. After the noise is localized, note the characteristics of the noise, including type of noise, frequency and conditions when the noise occurs and GO to Symptom Chart - NVH.

## Symptom Chart - Engine Performance

## Symptom Chart - Engine Performance

| Symptom                                                                | Possible Sources                                                                                                                                                                                                                                                                       | Action                                                                                                                                                                               |
|------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>• Difficult starting</li> </ul> | <ul style="list-style-type: none"> <li>• Inoperative or damaged ignition system</li> <li>• Air or vacuum leak</li> <li>• Inoperative or damaged fuel system</li> <li>• Inoperative or damaged starting system</li> <li>• Inoperative or damaged VCT oil control solenoid(s)</li> </ul> | <ul style="list-style-type: none"> <li>• Refer to the appropriate section in Group 303 for the procedure. Refer to Powertrain Control/Emissions Diagnosis (PC/ED) manual.</li> </ul> |

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|--------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>• Damaged charging system/ battery</li> </ul> | <ul style="list-style-type: none"> <li>• REFER to: <a href="#">Charging System - 2.7L EcoBoost (238kW/324PS)/3.5L EcoBoost (272kW/370PS)</a> (414-00 Charging System - General Information, Diagnosis and Testing).<br/>or REFER to: <a href="#">Charging System - 3.3L Duratec - V6/5.0L 32V Ti-VCT</a> (414-00 Charging System - General Information, Diagnosis and Testing).</li> </ul> |
| <ul style="list-style-type: none"> <li>• Burnt valve</li> </ul>                      | <ul style="list-style-type: none"> <li>• INSTALL a new cylinder head. TEST the system for normal operation after the repair.</li> </ul>                                                                                                                                                                                                                                                    |
| <ul style="list-style-type: none"> <li>• Worn piston</li> </ul>                      | <ul style="list-style-type: none"> <li>• INSTALL a new piston. TEST the system for normal operation after the repair.</li> </ul>                                                                                                                                                                                                                                                           |
| <ul style="list-style-type: none"> <li>• Worn piston rings</li> </ul>                | <ul style="list-style-type: none"> <li>• INSTALL new piston rings. TEST the system for normal operation after the repair.</li> </ul>                                                                                                                                                                                                                                                       |
| <ul style="list-style-type: none"> <li>• Worn cylinder</li> </ul>                    | <ul style="list-style-type: none"> <li>• INSTALL a new cylinder block. TEST the system for normal operation after the repair.</li> </ul>                                                                                                                                                                                                                                                   |

|                                                                 |                                                                                                                                                                             |                                                                                                                                                                                      |
|-----------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                 | <ul style="list-style-type: none"> <li>• Damaged head gasket</li> </ul>                                                                                                     | <ul style="list-style-type: none"> <li>• INSTALL a new cylinder head gasket. TEST the system for normal operation after the repair.</li> </ul>                                       |
|                                                                 | <ul style="list-style-type: none"> <li>• Inoperative or damaged cooling system</li> </ul>                                                                                   | <ul style="list-style-type: none"> <li>• Refer to the appropriate section in Group 303 for the procedure.</li> </ul>                                                                 |
|                                                                 | <ul style="list-style-type: none"> <li>• Fail-safe cooling invoked (if equipped)</li> </ul>                                                                                 | <ul style="list-style-type: none"> <li>• Refer to Powertrain Control/Emissions Diagnosis (PC/ED) manual.</li> </ul>                                                                  |
| <ul style="list-style-type: none"> <li>• Poor idling</li> </ul> | <ul style="list-style-type: none"> <li>• Vacuum leaks</li> <li>• Inoperative or damaged EGR system</li> <li>• Inoperative or damaged VCT oil control solenoid(s)</li> </ul> | <ul style="list-style-type: none"> <li>• Refer to the appropriate section in Group 303 for the procedure. Refer to Powertrain Control/Emissions Diagnosis (PC/ED) manual.</li> </ul> |
|                                                                 | <ul style="list-style-type: none"> <li>• Inoperative or damaged ignition system</li> </ul>                                                                                  | <ul style="list-style-type: none"> <li>• Refer to the appropriate section in Group 303 for the procedure.</li> </ul>                                                                 |
|                                                                 | <ul style="list-style-type: none"> <li>• Inoperative or damaged cooling system</li> <li>• Inoperative or damaged fuel system</li> </ul>                                     | <ul style="list-style-type: none"> <li>• Refer to the appropriate section in Group 303 for the procedure.</li> </ul>                                                                 |
|                                                                 | <ul style="list-style-type: none"> <li>• Fail-safe cooling invoked (if equipped)</li> </ul>                                                                                 | <ul style="list-style-type: none"> <li>• Refer to Powertrain Control/Emissions Diagnosis (PC/ED) manual.</li> </ul>                                                                  |

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|                                                                       | <ul style="list-style-type: none"> <li>• Incorrect valve clearance</li> </ul>                                                                                                                                                                                                                                      | <ul style="list-style-type: none"> <li>• ADJUST valve clearance. Refer to the appropriate section in Group 303 for the procedure. TEST the system for normal operation after the repair.</li> </ul> |
|                                                                       | <ul style="list-style-type: none"> <li>• Incorrect valve-to-valve seat contact</li> </ul>                                                                                                                                                                                                                          | <ul style="list-style-type: none"> <li>• INSTALL a new cylinder head. TEST the system for normal operation after the repair.</li> </ul>                                                             |
|                                                                       | <ul style="list-style-type: none"> <li>• Damaged head gasket</li> </ul>                                                                                                                                                                                                                                            | <ul style="list-style-type: none"> <li>• INSTALL a new cylinder head gasket. TEST the system for normal operation after the repair.</li> </ul>                                                      |
| <ul style="list-style-type: none"> <li>• Engine runs rough</li> </ul> | <ul style="list-style-type: none"> <li>• Inoperative or damaged fuel system</li> <li>• Air or vacuum leaks</li> <li>• EGR system fault</li> <li>• Inoperative or damaged cooling system</li> <li>• Inoperative or damaged ignition system</li> <li>• Inoperative or damaged VCT oil control solenoid(s)</li> </ul> | <ul style="list-style-type: none"> <li>• Refer to the appropriate section in Group 303 for the procedure. Refer to Powertrain Control/Emissions Diagnosis (PC/ED) manual.</li> </ul>                |

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|                                                                               | <ul style="list-style-type: none"> <li>• Fail-safe cooling invoked (if equipped)</li> </ul>           | <ul style="list-style-type: none"> <li>• Refer to Powertrain Control/Emissions Diagnosis (PC/ED) manual.</li> </ul>                                                          |
|                                                                               | <ul style="list-style-type: none"> <li>• Burnt or sticking valve</li> </ul>                           | <ul style="list-style-type: none"> <li>• INSTALL a new valve. TEST the system for normal operation after the repair.</li> </ul>                                              |
|                                                                               | <ul style="list-style-type: none"> <li>• Weak or broken valve spring</li> </ul>                       | <ul style="list-style-type: none"> <li>• INSTALL a new valve spring. TEST the system for normal operation after the repair.</li> </ul>                                       |
|                                                                               | <ul style="list-style-type: none"> <li>• Carbon accumulation in combustion chamber</li> </ul>         | <ul style="list-style-type: none"> <li>• ELIMINATE carbon buildup. TEST the system for normal operation after the repair.</li> </ul>                                         |
| <ul style="list-style-type: none"> <li>• Excessive oil consumption</li> </ul> | <ul style="list-style-type: none"> <li>• Leaking oil</li> </ul>                                       | <ul style="list-style-type: none"> <li>• REPAIR oil leakage. TEST the system for normal operation after the repair.</li> </ul>                                               |
|                                                                               | <ul style="list-style-type: none"> <li>• Blocked or restricted turbocharger oil drain pipe</li> </ul> | <ul style="list-style-type: none"> <li>• INSPECT the turbocharger drain pipe. REPAIR as necessary. TEST the system for normal operation after the repair.</li> </ul>         |
|                                                                               | <ul style="list-style-type: none"> <li>• Damaged or collapsed air intake hoses and tubes</li> </ul>   | <ul style="list-style-type: none"> <li>• Tighten hoses clamps. INSPECT for damage and REPAIR as necessary. TEST the system for normal operation after the repair.</li> </ul> |

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| <ul style="list-style-type: none"> <li>• Damaged exhaust or exhaust leaks at turbocharger housing or exhaust manifold.</li> </ul> | <ul style="list-style-type: none"> <li>• INSPECT for leaks. Leaks can be detected audibility or visually, by a discoloration caused by escaping hot exhaust gases. REPAIR as necessary. TEST the system for normal operation after the repair.</li> </ul>                                                                                                                                                              |
| <ul style="list-style-type: none"> <li>• Turbocharger oil seals leaking</li> </ul>                                                | <ul style="list-style-type: none"> <li>• REFER to Turbocharger Internal Oil Leak Test. REFER to: Turbocharger (303-04 Fuel Charging and Controls - Turbocharger - 2.7L EcoBoost (238kW/324PS)) . or REFER to: <a href="#">Turbocharger</a> (303-04F Fuel Charging and Controls - Turbocharger - 3.5L EcoBoost (272kW/370PS), Diagnosis and Testing). TEST the system for normal operation after the repair.</li> </ul> |
| <ul style="list-style-type: none"> <li>• Inoperative PCV system</li> </ul>                                                        | <ul style="list-style-type: none"> <li>• REPAIR or INSTALL new components as necessary. TEST the system for normal operation after the repair.</li> </ul>                                                                                                                                                                                                                                                              |
| <ul style="list-style-type: none"> <li>• Incorrect oil</li> </ul>                                                                 | <ul style="list-style-type: none"> <li>• CHANGE oil to correct specification. TEST the system for normal operation after the repair.</li> </ul>                                                                                                                                                                                                                                                                        |



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|                                                                  | <ul style="list-style-type: none"> <li>Worn valve stem seal</li> </ul>                                                               | <ul style="list-style-type: none"> <li>INSTALL a new valve stem seal. TEST the system for normal operation after the repair.</li> </ul>                                                                                                              |
|                                                                  | <ul style="list-style-type: none"> <li>Worn valve stem or valve guide</li> </ul>                                                     | <ul style="list-style-type: none"> <li>INSTALL a new cylinder head. TEST the system for normal operation after the repair.</li> </ul>                                                                                                                |
|                                                                  | <ul style="list-style-type: none"> <li>Sticking piston rings</li> </ul>                                                              | <ul style="list-style-type: none"> <li>INSTALL new piston rings. TEST the system for normal operation after the repair.</li> </ul>                                                                                                                   |
|                                                                  | <ul style="list-style-type: none"> <li>Worn piston ring groove</li> <li>Missing or damaged oil control ring</li> </ul>               | <ul style="list-style-type: none"> <li>INSTALL a new piston and piston pin. TEST the system for normal operation after the repair.</li> </ul>                                                                                                        |
|                                                                  | <ul style="list-style-type: none"> <li>Worn piston or cylinder</li> </ul>                                                            | <ul style="list-style-type: none"> <li>INSTALL a new piston or cylinder block. TEST the system for normal operation after the repair.</li> </ul>                                                                                                     |
| <ul style="list-style-type: none"> <li>Oil in coolant</li> </ul> | <ul style="list-style-type: none"> <li>Leaking head gasket</li> <li>Damaged cylinder block</li> <li>Damaged cylinder head</li> </ul> | <ul style="list-style-type: none"> <li>INSPECT the engine components. INSTALL new engine components as necessary. Refer to the appropriate section in Group 303 for the procedure. TEST the system for normal operation after the repair.</li> </ul> |

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|                                                                      | <ul style="list-style-type: none"> <li>Leaking oil cooler</li> </ul>                                                                                                                                                                             | <ul style="list-style-type: none"> <li>INSPECT the oil cooler and seal for damage. INSTALL new components as necessary. Refer to the appropriate section in Group 303 for the procedure.</li> </ul>                                                  |
| <ul style="list-style-type: none"> <li>Coolant in oil</li> </ul>     | <ul style="list-style-type: none"> <li>Leaking head gasket</li> <li>Damaged cylinder block</li> <li>Damaged cylinder head</li> </ul>                                                                                                             | <ul style="list-style-type: none"> <li>INSPECT the engine components. INSTALL new engine components as necessary. Refer to the appropriate section in Group 303 for the procedure. TEST the system for normal operation after the repair.</li> </ul> |
|                                                                      | <ul style="list-style-type: none"> <li>Leaking oil cooler</li> </ul>                                                                                                                                                                             | <ul style="list-style-type: none"> <li>INSPECT the oil cooler and seal for damage. INSTALL new components as necessary. Refer to the appropriate section in Group 303 for the procedure.</li> </ul>                                                  |
| <ul style="list-style-type: none"> <li>Insufficient power</li> </ul> | <ul style="list-style-type: none"> <li>Inoperative or damaged ignition system</li> <li>Air intake system blockage</li> <li>Lubrication system blockage</li> <li>Inoperative or damaged fuel system</li> <li>Inoperative or damaged TB</li> </ul> | <ul style="list-style-type: none"> <li>Refer to the appropriate section in Group 303 for the procedure. Refer to Powertrain Control/ Emissions Diagnosis (PC/ ED) manual.</li> </ul>                                                                 |

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|  | (throttle body)                                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|  | <ul style="list-style-type: none"> <li>• Turbocharger turbine or compressor wheel damage</li> </ul>                              | <ul style="list-style-type: none"> <li>• INSPECT the turbocharger. REFER to the Check for Free Rotation— Off Vehicle.<br/>REFER to: Turbocharger (303-04 Fuel Charging and Controls - Turbocharger - 2.7L EcoBoost (238kW/324PS)) .<br/>or REFER to: <a href="#">Turbocharger</a> (303-04F Fuel Charging and Controls - Turbocharger - 3.5L EcoBoost (272kW/370PS), Diagnosis and Testing).<br/>TEST the system for normal operation after the repair.</li> </ul> |
|  | <ul style="list-style-type: none"> <li>• Damaged exhaust or exhaust leaks at turbocharger housing or exhaust manifold</li> </ul> | <ul style="list-style-type: none"> <li>• INSPECT for leaks. Leaks can be detected audibility or visually, by a discoloration caused by escaping hot exhaust gases. REPAIR as necessary. TEST the system for normal operation after the repair.</li> </ul>                                                                                                                                                                                                         |
|  | <ul style="list-style-type: none"> <li>• Malfunctioning turbocharger bypass valve</li> </ul>                                     | <ul style="list-style-type: none"> <li>• Refer to Powertrain Control/Emissions Diagnosis (PC/ED) manual.</li> </ul>                                                                                                                                                                                                                                                                                                                                               |
|  | <ul style="list-style-type: none"> <li>• Oil level too high</li> </ul>                                                           | <ul style="list-style-type: none"> <li>• DRAIN oil to correct level.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                   |

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| <ul style="list-style-type: none"> <li>• Incorrect engine oil</li> </ul>                                                                    | <ul style="list-style-type: none"> <li>• INSTALL correct specification engine oil. TEST the system for normal operation after the repair.</li> </ul> |
| <ul style="list-style-type: none"> <li>• Excessive accessory drive belt loading</li> <li>• Inoperative or damaged cooling system</li> </ul> | <ul style="list-style-type: none"> <li>• Refer to the appropriate section in Group 303 for the procedure.</li> </ul>                                 |
| <ul style="list-style-type: none"> <li>• Fail-safe cooling invoked (if equipped)</li> </ul>                                                 | <ul style="list-style-type: none"> <li>• Refer to Powertrain Control/Emissions Diagnosis (PC/ED) manual.</li> </ul>                                  |
| <ul style="list-style-type: none"> <li>• Damaged or plugged exhaust system</li> </ul>                                                       | <ul style="list-style-type: none"> <li>• INSPECT exhaust system. TEST the system for normal operation after the repair.</li> </ul>                   |
| <ul style="list-style-type: none"> <li>• Incorrect tire size</li> </ul>                                                                     | <ul style="list-style-type: none"> <li>• REFER to: Suspension System (204-00 Suspension System - General Information) .</li> </ul>                   |
| <ul style="list-style-type: none"> <li>• Dragging brakes</li> </ul>                                                                         | <ul style="list-style-type: none"> <li>• REFER to: Brake System (206-00 Brake System - General Information) .</li> </ul>                             |
| <ul style="list-style-type: none"> <li>• Slipping transmission</li> </ul>                                                                   | <ul style="list-style-type: none"> <li>• Refer to the appropriate section in Group 307 for the procedure.</li> </ul>                                 |

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| <ul style="list-style-type: none"> <li>• Slipping clutch</li> </ul>                                                                               | <ul style="list-style-type: none"> <li>• Refer to the appropriate section in Group 308 for the procedure.</li> </ul>                                                                                |
| <ul style="list-style-type: none"> <li>• Incorrect valve clearance</li> </ul>                                                                     | <ul style="list-style-type: none"> <li>• ADJUST valve clearance. Refer to the appropriate section in Group 303 for the procedure. TEST the system for normal operation after the repair.</li> </ul> |
| <ul style="list-style-type: none"> <li>• Worn or damaged valve tappet</li> </ul>                                                                  | <ul style="list-style-type: none"> <li>• INSTALL a new valve tappet. TEST the system for normal operation after the repair.</li> </ul>                                                              |
| <ul style="list-style-type: none"> <li>• Damaged valve guide</li> <li>• Compression leakage at valve seat</li> <li>• Seized valve stem</li> </ul> | <ul style="list-style-type: none"> <li>• INSTALL a new cylinder head assembly. TEST the system for normal operation after the repair.</li> </ul>                                                    |
| <ul style="list-style-type: none"> <li>• Weak or broken valve spring</li> </ul>                                                                   | <ul style="list-style-type: none"> <li>• INSTALL a new valve spring. TEST the system for normal operation after the repair.</li> </ul>                                                              |
| <ul style="list-style-type: none"> <li>• Worn or damaged cam</li> </ul>                                                                           | <ul style="list-style-type: none"> <li>• INSTALL a new camshaft. TEST the system for normal operation after the repair.</li> </ul>                                                                  |

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|                                                                                                     | <ul style="list-style-type: none"> <li>• Damaged head gasket</li> </ul>                               | <ul style="list-style-type: none"> <li>• INSTALL a new head gasket. TEST the system for normal operation after the repair.</li> </ul>                                    |
|                                                                                                     | <ul style="list-style-type: none"> <li>• Cracked or distorted cylinder head</li> </ul>                | <ul style="list-style-type: none"> <li>• INSTALL a new cylinder head assembly. TEST the system for normal operation after the repair.</li> </ul>                         |
|                                                                                                     | <ul style="list-style-type: none"> <li>• Damaged, worn or sticking piston ring (s)</li> </ul>         | <ul style="list-style-type: none"> <li>• INSTALL a new piston ring (s). TEST the system for normal operation after the repair.</li> </ul>                                |
|                                                                                                     | <ul style="list-style-type: none"> <li>• Worn or damaged piston</li> </ul>                            | <ul style="list-style-type: none"> <li>• INSTALL a new piston and piston pin. TEST the system for normal operation after the repair.</li> </ul>                          |
| <ul style="list-style-type: none"> <li>• Engine emits excessive black smoke (black/blue)</li> </ul> | <ul style="list-style-type: none"> <li>• Clogged ACL (air cleaner) element</li> </ul>                 | <ul style="list-style-type: none"> <li>• INSTALL a new ACL element. TEST the system for normal operation after the repair.</li> </ul>                                    |
|                                                                                                     | <ul style="list-style-type: none"> <li>• Incorrect type or grade of oil</li> </ul>                    | <ul style="list-style-type: none"> <li>• DRAIN and FILL with specified oil.</li> </ul>                                                                                   |
|                                                                                                     | <ul style="list-style-type: none"> <li>• Blocked or restricted turbocharger oil drain pipe</li> </ul> | <ul style="list-style-type: none"> <li>• INSPECT the turbocharger oil drain pipe. REPAIR as necessary. TEST the system for normal operation after the repair.</li> </ul> |

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| <ul style="list-style-type: none"> <li>• Damaged/restricted or leaking turbocharger intake tube assembly</li> </ul> | <ul style="list-style-type: none"> <li>• REPAIR or INSTALL a new tube as necessary. TEST the system for normal operation after the repair.</li> </ul>                                                                                                                                                                                                                                                                  |
| <ul style="list-style-type: none"> <li>• Engine wear (piston rings, valve guides)</li> </ul>                        | <ul style="list-style-type: none"> <li>• REPAIR as necessary. TEST the system for normal operation after the repair.</li> </ul>                                                                                                                                                                                                                                                                                        |
| <ul style="list-style-type: none"> <li>• Plugged crankcase ventilation system</li> </ul>                            | <ul style="list-style-type: none"> <li>• Visually INSPECT the crankcase ventilation system.</li> </ul>                                                                                                                                                                                                                                                                                                                 |
| <ul style="list-style-type: none"> <li>• Turbocharger oil seals leaking</li> </ul>                                  | <ul style="list-style-type: none"> <li>• REFER to Turbocharger Internal Oil Leak Test. REFER to: Turbocharger (303-04 Fuel Charging and Controls - Turbocharger - 2.7L EcoBoost (238kW/324PS)) . or REFER to: <a href="#">Turbocharger</a> (303-04F Fuel Charging and Controls - Turbocharger - 3.5L EcoBoost (272kW/370PS), Diagnosis and Testing). TEST the system for normal operation after the repair.</li> </ul> |

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| <ul style="list-style-type: none"> <li>• Low or no oil pressure after an oil change (2.7L GTDI only)</li> </ul> | <ul style="list-style-type: none"> <li>• Oil filter housing</li> </ul> | <ul style="list-style-type: none"> <li>• REMOVE the oil filter housing. INSPECT the oil filter housing for a missing or damaged center stem. INSPECT for a missing or damaged O-ring seal on the stem. REPAIR as necessary. TEST the system for normal operation after the repair.</li> </ul> |
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**Symptom Chart - NVH**

Symptom Chart - NVH

| Symptom                                                              | Possible Sources                                                        | Action                                                                                                                                                                                                                                                                                                            |
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| <ul style="list-style-type: none"> <li>• Drone type noise</li> </ul> | <ul style="list-style-type: none"> <li>• Powertrain mount(s)</li> </ul> | <ul style="list-style-type: none"> <li>• CARRY OUT the Powertrain/Drivetrain Mount Neutralizing procedure. REFER to: <a href="#">Powertrain/Drivetrain Mount Neutralizing</a> (303-00 Engine System - General Information, General Procedures). TEST the system for normal operation after the repair.</li> </ul> |
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| <ul style="list-style-type: none"> <li>● Drumming noise - occurs inside the vehicle during idle or high idle, hot or cold. Very low-frequency drumming is very rpm dependent</li> </ul> | <ul style="list-style-type: none"> <li>● Engine vibration excites the body resonances inducing interior noise</li> </ul> | <ul style="list-style-type: none"> <li>● CARRY OUT the Powertrain/Drivetrain Mount Neutralizing procedure.<br/>REFER to: <a href="#">Powertrain/Drivetrain Mount Neutralizing</a> (303-00 Engine System - General Information, General Procedures).<br/>TEST the system for normal operation after the repair.</li> </ul>  |
| <ul style="list-style-type: none"> <li>● Engine drumming noise - accompanied by vibration</li> </ul>                                                                                    | <ul style="list-style-type: none"> <li>● Powertrain mount(s)</li> </ul>                                                  | <ul style="list-style-type: none"> <li>● CARRY OUT the Powertrain/Drivetrain Mount Neutralizing procedure.<br/>REFER to: <a href="#">Powertrain/Drivetrain Mount Neutralizing</a> (303-00 Engine System - General Information, General Procedures).<br/>TEST the system for normal operation after the repair.</li> </ul>  |
| <ul style="list-style-type: none"> <li>● Rattle - occurs at idle or at light acceleration from a stop</li> </ul>                                                                        | <ul style="list-style-type: none"> <li>● Powertrain mount(s)</li> </ul>                                                  | <ul style="list-style-type: none"> <li>● CHECK the powertrain mounts for damage. INSTALL new mounts as necessary. For engine, Refer to the appropriate section in Group 303 for the procedure. For transaxle, Refer to the appropriate section in Group 307 or Group 308 for the procedure. TEST the system for</li> </ul> |

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|                                                                                                                         |                                                                          | normal operation after the repair.                                                                                                                                                                                                                                                                                                                          |
| <ul style="list-style-type: none"> <li>Whine/moan type noise - pitch increases or changes with vehicle speed</li> </ul> | <ul style="list-style-type: none"> <li>Powertrain mount(s)</li> </ul>    | <ul style="list-style-type: none"> <li>CHECK the powertrain mounts for damage. INSTALL new mounts as necessary. For engine, Refer to the appropriate section in Group 303 for the procedure. For transaxle, Refer to the appropriate section in Group 307 or Group 308 for the procedure. TEST the system for normal operation after the repair.</li> </ul> |
| <ul style="list-style-type: none"> <li>Clunk - occurs when shifting from PARK or between REVERSE and DRIVE</li> </ul>   | <ul style="list-style-type: none"> <li>Powertrain mounts</li> </ul>      | <ul style="list-style-type: none"> <li>CHECK the powertrain mounts for damage. INSTALL new mounts as necessary. For engine, Refer to the appropriate section in Group 303 for the procedure. For transaxle, Refer to the appropriate section in Group 307 or Group 308 for the procedure. TEST the system for normal operation after the repair.</li> </ul> |
|                                                                                                                         | <ul style="list-style-type: none"> <li>Idle speed is too high</li> </ul> | <ul style="list-style-type: none"> <li>CHECK for the correct idle speed. TEST the system for normal operation after the repair.</li> </ul>                                                                                                                                                                                                                  |

- Accessory drive bearing hoot - occurs at idle or high idle in cold temperatures of approximately 4°C (40°F) or colder at the first start of the day

- Accessory drive idler or tensioner pulley bearing is experiencing stick/slip between ball bearings and the bearing race

- CARRY OUT the Engine Cold Soak procedure.  
REFER to: [Noise, Vibration and Harshness \(NVH\)](#) (100-04 Noise, Vibration and Harshness, Diagnosis and Testing).  
or REFER to: [Noise, Vibration and Harshness \(NVH\) - Raptor](#) (100-04 Noise, Vibration and Harshness, Diagnosis and Testing).
- PLACE the EngineEAR probe directly on the idler/ tensioner center post or bolt to verify which bearing is making the noise.  
INSTALL new parts as necessary. Refer to the appropriate section in Group 303 for the procedure. TEST the system for normal operation after the repair.

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| <ul style="list-style-type: none"> <li>• Accessory drive belt noise, squeal or chirping</li> </ul>                   | <ul style="list-style-type: none"> <li>• Defective/worn or incorrect accessory drive belt</li> <li>• Misaligned pulley(s)</li> <li>• Pulley runout</li> <li>• Damaged or worn accessory drive component or idler</li> <li>• Fluid contamination of the accessory drive belt or pulleys</li> <li>• Damaged or worn accessory drive belt tensioner</li> <li>• Damaged pulley grooves</li> <li>• Damaged or worn coolant pump pulley</li> </ul> | <ul style="list-style-type: none"> <li>• CARRY OUT the Engine Accessory Test. REFER to: <a href="#">Noise, Vibration and Harshness (NVH)</a> (100-04 Noise, Vibration and Harshness, Diagnosis and Testing). or REFER to: <a href="#">Noise, Vibration and Harshness (NVH) - Raptor</a> (100-04 Noise, Vibration and Harshness, Diagnosis and Testing). INSPECT components and INSTALL new parts as necessary. Refer to the appropriate section in Group 303 for the procedure. TEST the system for normal operation after the repair.</li> </ul> |
| <ul style="list-style-type: none"> <li>• Pop noise - happens approximately 30 seconds after cold start up</li> </ul> | <ul style="list-style-type: none"> <li>• Turbocharger bypass valve</li> </ul>                                                                                                                                                                                                                                                                                                                                                                | <ul style="list-style-type: none"> <li>• Acceptable condition. The turbocharger bypass valve closes approximately 30 seconds after cold start up.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                      |

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| <ul style="list-style-type: none"> <li>● Clunking/moaning/grinding noise</li> </ul>                                                                   | <ul style="list-style-type: none"> <li>● Coolant pump has excessive end play or imbalance</li> </ul> | <ul style="list-style-type: none"> <li>● CHECK the coolant pump for excessive end play. INSPECT the coolant pump for imbalance with the drive belt off. INSTALL a new coolant pump as necessary. Refer to the appropriate section in Group 303 for the procedure. TEST the system for normal operation after the repair.</li> </ul> |
| <ul style="list-style-type: none"> <li>● Whine/hum - occurs when unlocking the vehicle or opening the door with the engine off (GTDI only)</li> </ul> | <ul style="list-style-type: none"> <li>● Fuel pump module</li> </ul>                                 | <ul style="list-style-type: none"> <li>● Acceptable condition. Fuel pump module turns on before engine starts to prime the fuel system.</li> </ul>                                                                                                                                                                                  |
| <ul style="list-style-type: none"> <li>● Whine or moaning noise</li> </ul>                                                                            | <ul style="list-style-type: none"> <li>● Air intake system</li> </ul>                                | <ul style="list-style-type: none"> <li>● CHECK the air cleaner and ducts for correct fit. INSPECT the air intake system for leaks or damage. REPAIR as necessary. TEST the system for normal operation after the repair.</li> </ul>                                                                                                 |

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| <ul style="list-style-type: none"> <li>● Whistling noise - normally accompanied with poor idle condition</li> </ul> | <ul style="list-style-type: none"> <li>● Air intake system</li> </ul>                                             | <ul style="list-style-type: none"> <li>● CHECK the air intake ducts, air cleaner, throttle body and vacuum hoses for leaks and correct fit. REPAIR or ADJUST as necessary. TEST the system for normal operation after the repair.</li> </ul>                      |
|                                                                                                                     | <ul style="list-style-type: none"> <li>● Turbocharger intake tube assembly leaking</li> </ul>                     | <ul style="list-style-type: none"> <li>● REPAIR or INSTALL a new tube as necessary. TEST the system for normal operation after the repair.</li> </ul>                                                                                                             |
|                                                                                                                     | <ul style="list-style-type: none"> <li>● Loose connections or damage to air intake hoses and tubes</li> </ul>     | <ul style="list-style-type: none"> <li>● TIGHTEN hose clamps. INSPECT for damage and REPAIR as necessary. TEST the system for normal operation after the repair.</li> </ul>                                                                                       |
|                                                                                                                     | <ul style="list-style-type: none"> <li>● Air leaks at turbine housing, blown joints or damaged exhaust</li> </ul> | <ul style="list-style-type: none"> <li>● INSPECT for leaks. Leaks can usually be detected audibility or visually, by a discoloration caused by escaping hot exhaust gases. REPAIR as necessary. TEST the system for normal operation after the repair.</li> </ul> |

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| <ul style="list-style-type: none"> <li>Carbon build up in the turbine housing</li> </ul>               | <ul style="list-style-type: none"> <li>INSPECT the turbocharger. REFER to the Check for Free Rotation - Off Vehicle. REFER to: <a href="#">Turbocharger</a> (303-04E Fuel Charging and Controls - Turbocharger - 2.7L EcoBoost (238kW/324PS), Diagnosis and Testing). or REFER to: <a href="#">Turbocharger</a> (303-04F Fuel Charging and Controls - Turbocharger - 3.5L EcoBoost (272kW/370PS), Diagnosis and Testing). TEST the system for normal operation after the repair.</li> </ul> |
| <ul style="list-style-type: none"> <li>Turbocharger imbalance due to foreign object/ damage</li> </ul> | <ul style="list-style-type: none"> <li>REPAIR as necessary. TEST the system for normal operation after the repair.</li> </ul>                                                                                                                                                                                                                                                                                                                                                               |
| <ul style="list-style-type: none"> <li>Turbine bearing failure</li> </ul>                              | <ul style="list-style-type: none"> <li>INSPECT the turbocharger. REFER to the Check for Free Rotation - Off Vehicle. REFER to: <a href="#">Turbocharger</a> (303-04E Fuel Charging and Controls - Turbocharger - 2.7L EcoBoost (238kW/324PS), Diagnosis and Testing). or REFER to: <a href="#">Turbocharger</a> (303-04F Fuel Charging and</li> </ul>                                                                                                                                       |

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|                                                                                                                                         |                                                                                           | <p>Controls - Turbocharger<br/>- 3.5L EcoBoost<br/>(272kW/370PS),<br/>Diagnosis and Testing).<br/>TEST the system for<br/>normal operation after<br/>the repair.</p>                                                                                                                                        |
|                                                                                                                                         | <ul style="list-style-type: none"> <li>• Inoperative turbocharger bypass valve</li> </ul> | <ul style="list-style-type: none"> <li>• Refer to Powertrain Control/Emissions Diagnosis (PC/ED) manual.</li> </ul>                                                                                                                                                                                         |
| <ul style="list-style-type: none"> <li>• Whine or air rush type noise</li> </ul>                                                        | <ul style="list-style-type: none"> <li>• Turbocharger</li> </ul>                          | <ul style="list-style-type: none"> <li>• Acceptable condition. Some whine or air noise is common.</li> </ul>                                                                                                                                                                                                |
| <ul style="list-style-type: none"> <li>• Chrip or whoosh sound</li> </ul>                                                               | <ul style="list-style-type: none"> <li>• Turbocharger bypass valve</li> </ul>             | <ul style="list-style-type: none"> <li>• CHECK the turbocharger bypass valve. REPAIR as necessary. TEST the system for normal operation after the repair.</li> </ul>                                                                                                                                        |
| <ul style="list-style-type: none"> <li>• Hissing noise - occurs during idle or high idle that is apparent with the hood open</li> </ul> | <ul style="list-style-type: none"> <li>• Vacuum leak</li> </ul>                           | <ul style="list-style-type: none"> <li>• Use the Ultrasonic Leak Detector/EngineEAR to locate the source. Scan the air intake system from the inlet to each cylinder intake port. DISCARD the leaking parts, and INSTALL a new component. TEST the system for normal operation after the repair.</li> </ul> |



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|                                                                                                    | <ul style="list-style-type: none"> <li>• Vehicles with a plastic intake manifold</li> </ul>  | <ul style="list-style-type: none"> <li>• Acceptable condition. Some plastic manifolds exhibit this noise, which is the effect of the plastic manifold.</li> </ul>                                                                                                                                          |
| <ul style="list-style-type: none"> <li>• Grinding noise - occurs during engine cranking</li> </ul> | <ul style="list-style-type: none"> <li>• Incorrect starter motor mounting</li> </ul>         | <ul style="list-style-type: none"> <li>• INSPECT the starter motor for correct mounting. REPAIR as necessary. Refer to the appropriate section in Group 303 for the procedure. TEST the system for normal operation after the repair.</li> </ul>                                                           |
|                                                                                                    | <ul style="list-style-type: none"> <li>• Starter motor</li> </ul>                            | <ul style="list-style-type: none"> <li>• CHECK the starter motor. INSTALL a new starter motor as necessary. Refer to the appropriate section in Group 303 for the procedure. TEST the system for normal operation after the repair.</li> </ul>                                                             |
|                                                                                                    | <ul style="list-style-type: none"> <li>• Incorrect starter motor drive engagement</li> </ul> | <ul style="list-style-type: none"> <li>• INSPECT the starter motor drive for wear or damage. INSTALL a new starter motor as necessary. Refer to the appropriate section in Group 303 for the procedure. TEST the system for normal operation after the repair.</li> <li>• INSPECT the flywheel/</li> </ul> |

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|                                                                                                                                                     |                                                                                                   | <p>flexplate for wear or damage. INSTALL a new flywheel/flexplate as necessary. Refer to the appropriate section in Group 303 for the procedure. TEST the system for normal operation after the repair.</p>                                                                                                                                                                                                                    |
| <ul style="list-style-type: none"> <li>• Engine noise, front of engine - knocking noise from lower front of engine</li> </ul>                       | <ul style="list-style-type: none"> <li>• Damaged or separated crankshaft pulley/damper</li> </ul> | <ul style="list-style-type: none"> <li>• CHECK for obvious signs of damage or wobble during operation. INSTALL new as necessary. Refer to the appropriate section in Group 303 for the procedure. TEST the system for normal operation after the repair.</li> </ul>                                                                                                                                                            |
| <ul style="list-style-type: none"> <li>• Engine noise, front of engine - ticking, tapping or rattling noise from the front of the engine</li> </ul> | <ul style="list-style-type: none"> <li>• Timing drive components</li> </ul>                       | <ul style="list-style-type: none"> <li>• REMOVE the accessory drive belt. Refer to the appropriate section in Group 303 for the procedure.</li> <li>• USE the EngineEAR to isolate the noise to the engine front cover.</li> <li>• REMOVE the engine front cover and INSPECT the timing drive components. INSTALL new parts as necessary. Refer to the appropriate section in Group 303 for the procedure. TEST the</li> </ul> |

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|                                                                                                                                  |                                                                                                            | system for normal operation after the repair.                                                                                                                                                                                                                                                                                                       |
| <ul style="list-style-type: none"> <li>Engine noise, upper end - ticking noise near the fuel rail and intake manifold</li> </ul> | <ul style="list-style-type: none"> <li>Fuel rail clip</li> <li>Fuel injector</li> </ul>                    | <ul style="list-style-type: none"> <li>CHECK for loose or damaged fuel rail clip (s). REPAIR as necessary.</li> <li>USE the EngineEAR to isolate the noisy injector (s). INSTALL a new injector(s) as necessary. Refer to the appropriate section in Group 303 for the procedure. TEST the system for normal operation after the repair.</li> </ul> |
|                                                                                                                                  | <ul style="list-style-type: none"> <li>Fuel injection pump (DI (direct injection) engines only)</li> </ul> | <ul style="list-style-type: none"> <li>This is a normal engine noise that can be verified by listening to another vehicle. If noise is excessive, REPAIR as necessary. TEST the system for normal operation after the repair.</li> </ul>                                                                                                            |

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| <ul style="list-style-type: none"> <li>Engine noise, upper end - ticking, knocking or rattle noise that occurs during idle or high idle during the first cold start of the day and may disappear as the engine warms</li> </ul> | <ul style="list-style-type: none"> <li>Valve train noise (bled down lifter/lash adjuster)</li> </ul> | <ul style="list-style-type: none"> <li>CARRY OUT the Valve Train Analysis Component Test in this section. INSTALL new parts as necessary. Refer to the appropriate section in Group 303 for the procedure. TEST the system for normal operation after the repair.</li> </ul> |
| <ul style="list-style-type: none"> <li>Engine noise, upper end - occurs mostly with a warm engine at light/medium acceleration</li> </ul>                                                                                       | <ul style="list-style-type: none"> <li>Worn or damaged spark plugs</li> </ul>                        | <ul style="list-style-type: none"> <li>REMOVE the spark plugs. INSPECT and INSTALL new as necessary. Refer to the appropriate section in Group 303 for the procedure. TEST the system for normal operation after the repair.</li> </ul>                                      |
| <ul style="list-style-type: none"> <li>Engine noise, upper end - rattling noise from the valve train. Worse when the engine is cold</li> </ul>                                                                                  | <ul style="list-style-type: none"> <li>Low oil level</li> </ul>                                      | <ul style="list-style-type: none"> <li>CHECK the oil level. FILL as necessary.</li> </ul>                                                                                                                                                                                    |
|                                                                                                                                                                                                                                 | <ul style="list-style-type: none"> <li>Thin or diluted oil</li> </ul>                                | <ul style="list-style-type: none"> <li>INSPECT the oil for contamination. If the oil is contaminated, CHECK for the source. REPAIR as necessary. CHANGE the oil and filter. TEST the system for normal operation after the repair.</li> </ul>                                |

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| <ul style="list-style-type: none"> <li>• Low oil pressure</li> </ul>            | <ul style="list-style-type: none"> <li>• CARRY OUT the Oil Pressure Test in this section. If not within specifications, REMOVE the engine oil pan. Refer to the appropriate section in Group 303 for the procedure. INSPECT for a blocked oil pick up tube. TEST the system for normal operation after the repair.</li> </ul> |
| <ul style="list-style-type: none"> <li>• Worn valve train components</li> </ul> | <ul style="list-style-type: none"> <li>• CARRY OUT the Valve Train Analysis Component Test in this section. INSTALL new parts as necessary. Refer to the appropriate section in Group 303 for the procedure. TEST the system for normal operation after the repair.</li> </ul>                                                |
| <ul style="list-style-type: none"> <li>• Worn valve guides</li> </ul>           | <ul style="list-style-type: none"> <li>• CARRY OUT the Valve Guide Inner Diameter procedure. REFER to: <a href="#">Valve Guide Inner Diameter</a> (303-00 Engine System - General Information, General Procedures).</li> </ul>                                                                                                |

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|                                                                                           | <ul style="list-style-type: none"> <li>Excessive runout of the valve seats on the valve face</li> </ul> | <ul style="list-style-type: none"> <li>INSPECT for abnormalities on the valve face and valve seat. INSTALL a new cylinder head assembly if abnormalities are found.</li> </ul>                                      |
| <ul style="list-style-type: none"> <li>Engine noise, upper end - pinging noise</li> </ul> | <ul style="list-style-type: none"> <li>Gasoline octane too low</li> </ul>                               | <ul style="list-style-type: none"> <li>VERIFY with customer the type of gasoline used. CORRECT as necessary. TEST the system for normal operation after the repair.</li> </ul>                                      |
|                                                                                           | <ul style="list-style-type: none"> <li>KS operation</li> </ul>                                          | <ul style="list-style-type: none"> <li>CHECK the KS operation. INSTALL a new KS. Refer to the appropriate section in Group 303 for the procedure. TEST the system for normal operation after the repair.</li> </ul> |
|                                                                                           | <ul style="list-style-type: none"> <li>Incorrect spark timing</li> </ul>                                | <ul style="list-style-type: none"> <li>CHECK the spark timing. REPAIR as necessary. TEST the system for normal operation after the repair.</li> </ul>                                                               |

|                                                                                                                                     |                                                                                |                                                                                                                                                                                                                                                                                                                                                                |
|-------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                     | <ul style="list-style-type: none"> <li>• High operating temperature</li> </ul> | <ul style="list-style-type: none"> <li>• INSPECT the cooling system for leaks. CHECK the coolant level. REFILL as necessary. CHECK the coolant for the correct mix ratio. DRAIN and REFILL as needed. VERIFY the engine operating temperature is within specifications. REPAIR as necessary. TEST the system for normal operation after the repair.</li> </ul> |
|                                                                                                                                     | <ul style="list-style-type: none"> <li>• Spark plug</li> </ul>                 | <ul style="list-style-type: none"> <li>• CHECK the spark plugs. REPAIR or INSTALL new spark plugs as necessary. TEST the system for normal operation after the repair.</li> </ul>                                                                                                                                                                              |
|                                                                                                                                     | <ul style="list-style-type: none"> <li>• Catalytic converter</li> </ul>        | <ul style="list-style-type: none"> <li>• Compare with a similar vehicle for what is acceptable noise.</li> </ul>                                                                                                                                                                                                                                               |
| <ul style="list-style-type: none"> <li>• Engine noise, lower end - ticking or knocking noise near the oil filter adapter</li> </ul> | <ul style="list-style-type: none"> <li>• Oil pump</li> </ul>                   | <ul style="list-style-type: none"> <li>• USE the EngineEAR to verify the oil pump as the source of the noise at low rpm. REPAIR as necessary. Refer to the appropriate section in Group 303 for the procedure. TEST the system for normal operation after the repair.</li> </ul>                                                                               |

|                                                                                                                                                                                                                                                                      |                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                 |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>Engine noise, lower end - light knocking noise, also described as piston slap. Noise is most noticeable when the engine is cold with light to medium acceleration. The noise disappears as the engine warms</li> </ul>        | <ul style="list-style-type: none"> <li>Excessive clearance between the piston and the cylinder wall</li> </ul> | <ul style="list-style-type: none"> <li>CARRY OUT the Piston Diameter procedure. REFER to: Piston Diameter (303-00 Engine System - General Information) . Measure the cylinder bore diameter. Subtract the piston diameter from the cylinder bore diameter to find the piston-to-cylinder bore clearance. REFER to the appropriate 303-01 Section for specifications.</li> </ul> |
| <ul style="list-style-type: none"> <li>Engine noise, lower end - light double knock or sharp rap sound. Occurs mostly with a warm engine at idle or low speeds in drive. Increases in relation to engine load. Associated with a poor lubrication history</li> </ul> | <ul style="list-style-type: none"> <li>Excessive clearance between the piston and the piston pin</li> </ul>    | <ul style="list-style-type: none"> <li>MEASURE the piston pin bore and the piston pin in 2 directions on each side. REFER to the appropriate 303-01 Section for specifications.</li> </ul>                                                                                                                                                                                      |
|                                                                                                                                                                                                                                                                      |                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                                 |



|                                                                                                                                                                                                                                |                                                                                                                              |                                                                                                                                                                                                                                                                             |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>Engine noise, lower end - light knocking noise. The noise is most noticeable when the engine is warm. The noise tends to decrease when the vehicle is coasting or in neutral</li> </ul> | <ul style="list-style-type: none"> <li>Excessive clearance between the connecting rod bearings and the crankshaft</li> </ul> | <ul style="list-style-type: none"> <li>CARRY OUT the Connecting Rod Bearing Journal Clearance procedure. REFER to: <a href="#">Connecting Rod Bearing Journal Clearance</a> (303-00 Engine System - General Information, General Procedures).</li> </ul>                    |
| <ul style="list-style-type: none"> <li>Engine noise, lower end - deep knocking noise. The noise is most noticeable when the engine is warm, at lower rpm and under a light load and then at float</li> </ul>                   | <ul style="list-style-type: none"> <li>Worn or damaged crankshaft main bearings</li> </ul>                                   | <ul style="list-style-type: none"> <li>CARRY OUT the Crankshaft Main Bearing Journal Clearance procedure. REFER to: <a href="#">Crankshaft Main Bearing Journal Clearance</a> (303-00 Engine System - General Information, General Procedures).</li> </ul>                  |
| <ul style="list-style-type: none"> <li>Engine noise, rear of engine - knocking noise at rear of engine</li> </ul>                                                                                                              | <ul style="list-style-type: none"> <li>Damaged flywheel/flexplate</li> </ul>                                                 | <ul style="list-style-type: none"> <li>INSPECT the flywheel/flexplate for wear or damage. INSTALL a new flywheel/flexplate as necessary. Refer to the appropriate section in Group 303 for the procedure. TEST the system for normal operation after the repair.</li> </ul> |
|                                                                                                                                                                                                                                |                                                                                                                              |                                                                                                                                                                                                                                                                             |

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|--------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>Engine vibration - vibration felt at all times</li> </ul> | <ul style="list-style-type: none"> <li>Excessive engine pulley runout</li> </ul>      | <ul style="list-style-type: none"> <li>CARRY OUT the Engine Accessory Test. REFER to: <a href="#">Noise, Vibration and Harshness (NVH)</a> (100-04 Noise, Vibration and Harshness, Diagnosis and Testing). or REFER to: <a href="#">Noise, Vibration and Harshness (NVH) - Raptor</a> (100-04 Noise, Vibration and Harshness, Diagnosis and Testing). INSTALL a new engine pulley as necessary. Refer to the appropriate section in Group 303 for the procedure. TEST the system for normal operation after the repair.</li> </ul> |
|                                                                                                  | <ul style="list-style-type: none"> <li>Damaged or worn accessory component</li> </ul> | <ul style="list-style-type: none"> <li>CARRY OUT the Engine Accessory Test. REFER to: <a href="#">Noise, Vibration and Harshness (NVH)</a> (100-04 Noise, Vibration and Harshness, Diagnosis and Testing). or REFER to: <a href="#">Noise, Vibration and Harshness (NVH) - Raptor</a> (100-04 Noise, Vibration and Harshness, Diagnosis and Testing). REPAIR or INSTALL a new component as</li> </ul>                                                                                                                              |

|                                                                                                                                                                        |                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                    |
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|                                                                                                                                                                        |                                                                                             | necessary. TEST the system for normal operation after the repair.                                                                                                                                                                                                                                                                                                                                  |
| <ul style="list-style-type: none"> <li>Engine vibration - at idle, a low-frequency vibration (5-20 Hz) or mild shake that is felt through the seat/floorpan</li> </ul> | <ul style="list-style-type: none"> <li>Cylinder misfire</li> </ul>                          | <ul style="list-style-type: none"> <li>Using the scan tool, CARRY OUT the cylinder power balance and the relative compression test. REPAIR as necessary. Refer to the appropriate section in Group 303 for the procedure. TEST the system for normal operation after the repair.</li> </ul>                                                                                                        |
|                                                                                                                                                                        | <ul style="list-style-type: none"> <li>Engine or torque converter out of balance</li> </ul> | <ul style="list-style-type: none"> <li>VERIFY the torque converter to crankshaft pilot clearance is correct. REPAIR as necessary. RE-INDEX the torque converter on the flex plate by 120 degrees for a 3- bolt converter or 180 degrees for a 4-bolt converter. Refer to the appropriate section in Group 307 for the procedure. TEST the system for normal operation after the repair.</li> </ul> |

|                                                                                                                         |                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                               |
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| <ul style="list-style-type: none"> <li>Engine vibration - is felt with increases and decreases in engine rpm</li> </ul> | <ul style="list-style-type: none"> <li>Powertrain mount(s)</li> </ul>                        | <ul style="list-style-type: none"> <li>CHECK the powertrain mounts for damage. INSTALL new mounts as necessary. For engine, Refer to the appropriate section in Group 303 for the procedure. For transaxle, Refer to the appropriate section in Group 307 or Group 308 for the procedure. TEST the system for normal operation after the repair.</li> </ul>                                   |
|                                                                                                                         | <ul style="list-style-type: none"> <li>Engine or transmission grounded to chassis</li> </ul> | <ul style="list-style-type: none"> <li>INSPECT the powertrain/ drivetrain for correct clearances. REPAIR as necessary. TEST the system for normal operation after the repair.</li> </ul>                                                                                                                                                                                                      |
| <ul style="list-style-type: none"> <li>Engine vibration - increases intensity as the engine rpm is increased</li> </ul> | <ul style="list-style-type: none"> <li>Engine out-of-balance</li> </ul>                      | <ul style="list-style-type: none"> <li>CARRY OUT the NERU Test. REFER to: <a href="#">Noise, Vibration and Harshness (NVH)</a> (100-04 Noise, Vibration and Harshness, Diagnosis and Testing). or REFER to: <a href="#">Noise, Vibration and Harshness (NVH) - Raptor</a> (100-04 Noise, Vibration and Harshness, Diagnosis and Testing). ROTATE the torque converter, 120 degrees</li> </ul> |

|                                                                                                                                                     |                                                                                 |                                                                                                                                                                                                                                                                                                 |
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|                                                                                                                                                     |                                                                                 | <p>for 3- bolt or 180 degrees for 4- bolt. INSPECT the torque converter pilot outer diameter-to-crankshaft pilot inner diameter. REPAIR as necessary. Refer to the appropriate section in Group 307 for the procedure. TEST the system for normal operation after the repair.</p>               |
| <ul style="list-style-type: none"> <li>• Engine vibration - mostly at coast/ neutral coast. Condition improves with vehicle acceleration</li> </ul> | <ul style="list-style-type: none"> <li>• Combustion instability</li> </ul>      | <ul style="list-style-type: none"> <li>• CHECK the ignition system. INSTALL new components as necessary. Refer to the appropriate section in Group 303 for the procedure. TEST the system for normal operation after the repair.</li> </ul>                                                     |
| <ul style="list-style-type: none"> <li>• Engine vibration or shudder - occurs with light to medium acceleration above 56 km/h (35 mph)</li> </ul>   | <ul style="list-style-type: none"> <li>• Worn or damaged spark plugs</li> </ul> | <ul style="list-style-type: none"> <li>• INSPECT the spark plugs for cracks, high resistance or broken insulators. INSTALL a new spark plug(s) as necessary. Refer to the appropriate section in Group 303 for the procedure. TEST the system for normal operation after the repair.</li> </ul> |
|                                                                                                                                                     |                                                                                 |                                                                                                                                                                                                                                                                                                 |

|  |                                                                           |                                                                                                                                                                                                                            |
|--|---------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  | <ul style="list-style-type: none"> <li>● Plugged fuel injector</li> </ul> | <ul style="list-style-type: none"> <li>● REPAIR or INSTALL a new injector as necessary. Refer to the appropriate section in Group 303 for the procedure. TEST the system for normal operation after the repair.</li> </ul> |
|  | <ul style="list-style-type: none"> <li>● Contaminated fuel</li> </ul>     | <ul style="list-style-type: none"> <li>● INSPECT the fuel for contamination. DRAIN the fuel system and refill. TEST the system for normal operation after the repair.</li> </ul>                                           |

### Component Tests

The following component tests are used to diagnose engine concerns.

### Engine Oil Leaks

**NOTE:** *If an overnight drive is done, the fan air or road air blast can cause erroneous readings.*

**NOTE:** *When diagnosing engine oil leaks, the source and location of the leak must be positively identified prior to repair.*

Prior to carrying out this procedure, clean the cylinder block, cylinder heads, valve covers, oil pan and flywheel/flexplate with a suitable solvent to remove all traces of oil.

### Engine Oil Leaks - Fluorescent Oil Additive Method

**NOTE:** *If the factory fill engine oil with dye is present, change the engine oil and the oil filter prior to using the Dye-Lite® Oil-Based Fluid Dye (164-TP33200601).*

Use the UV Long-Wave W/12-foot Cord & Alligator Clips (164-R3748) or Leak Tracker UV-LED Leak Detection Flashlight (164-TP8695) to carry out the following procedure for oil leak diagnosis.

1. Add 29.6 ml (1 oz) of Dye-Lite® Oil-Based Fluid Dye (164-TP33200601) to a minimum of

0.47L (1/2 qt) and a maximum of 0.95L (1 qt) engine oil. Thoroughly premix the oil based fluid dye or it will not have enough time to reach the crankcase, oil galleries and seal surfaces during this particular 15 minute test. The additive must be added through the oil fill. Check the level on the oil level indicator to determine what amount of oil to premix. If it is in the middle of the crosshatch area or below the full mark, use 0.95L (1 qt). If it is at the full mark, use 0.47L (1/2 qt).

2. **NOTE:** *For best results allow the customer to drive the vehicle for a day.*

Run the engine for 15 minutes. Stop the engine and inspect all seal and gasket areas for leaks using the UV Leak Detector Kit. A fluoresces white area will identify the leak. For extremely small leaks, several hours may be required for the leak to appear.

3. At the end of test, make sure the oil level is within the upper and lower oil indicator marks. Remove oil as necessary if it registers above the full mark.

### **Leakage Points - Underhood**

Examine the following areas for oil leakage:

- Valve cover gaskets
- Cylinder head gaskets
- Oil cooler, if equipped
- Oil filter adapter
- Engine front cover
- Oil filter adapter and filter body
- Oil level indicator tube connection
- Oil pressure switch or EOP sensor
- Turbocharger oil tubes

### **Leakage Points - Under Engine, With Vehicle on Hoist**

Examine the following areas for oil leakage:

- Oil pan gaskets
- Oil pan sealer
- Engine front cover gasket
- Crankshaft front seal
- Crankshaft rear oil seal
- Oil filter adapter and filter body
- Oil cooler, if equipped
- Turbocharger oil tubes

## Leakage Points - With Transmission and Flywheel/Flexplate Removed

Examine the following areas for oil leakage:

- Crankshaft rear oil seal
- Rear main bearing cap parting line
- Flexplate mounting bolt holes (with flexplate installed)
- Pipe plugs at the end of oil passages

## Compression Test

1. Make sure the oil in the crankcase is of the correct viscosity and at the correct level and that the battery is correctly charged. Operate the vehicle until the engine is at normal operating temperature. Turn the ignition switch to the OFF position, then remove all the spark plugs.
2. Set the throttle plates in the wide-open position.
3. Install a compression gauge in the No. 1 cylinder.
4. Install an auxiliary starter switch in the starting circuit. With the ignition switch in the OFF position, and using the auxiliary starter switch, crank the engine a minimum of 5 compression strokes and record the highest reading. Note the approximate number of compression strokes necessary to obtain the highest reading.
5. Repeat the test on each cylinder, cranking the engine approximately the same number of compression strokes.

## Compression Test - Test Results

The indicated compression pressures are considered within specification if the lowest reading cylinder is at least 75% of the highest reading. Refer to the Compression Pressure Limit Chart.

## Compression Pressure Limit Chart

**NOTE:** *The indicated compression pressures are considered within specification if the lowest reading cylinder is at least 75% of the highest reading. Refer to the Compression Pressure Limit Chart.*



| <b>Maximum Cylinder Pressure - Minimal Cylinder Pressure</b> | <b>Maximum Cylinder Pressure - Minimal Cylinder Pressure</b> | <b>Maximum Cylinder Pressure - Minimal Cylinder Pressure</b> | <b>Maximum Cylinder Pressure - Minimal Cylinder Pressure</b> |
|--------------------------------------------------------------|--------------------------------------------------------------|--------------------------------------------------------------|--------------------------------------------------------------|
| 134.0–100.9 psi (924–696 kPa)                                | 164.0–123.0 psi (1,131–848 kPa)                              | 194.1–145.0 psi (1,338–1,000 kPa)                            | 223.9–168.0 psi (1,544–1,158 kPa)                            |
| 136.0–102.0 psi (938–703 kPa)                                | 166.1–124.0 psi (1,145–855 kPa)                              | 195.9–147.1 psi (1,351–1,014 kPa)                            | 226.0–169.0 psi (1,558–1,165 kPa)                            |
| 138.1–104.0 psi (952–717 kPa)                                | 168.0–126.0 psi (1,158–869 kPa)                              | 198.0–147.9 psi (1,365–1,020 kPa)                            | 228.0–171.0 psi (1,572–1,179 kPa)                            |
| 140.0–105.0 psi (965–724 kPa)                                | 170.0–127.1 psi (1,172–876 kPa)                              | 200.0–150.0 psi (1,379–1,034 kPa)                            | 230.0–172.0 psi (1,586–1,186 kPa)                            |
| 142.0–107.0 psi (979–738 kPa)                                | 172.0–128.9 psi (1,186–889 kPa)                              | 201.9–151.0 psi (1,392–1,041 kPa)                            | 232.1–174.0 psi (1,600–1,200 kPa)                            |
| 143.9–108.1 psi (992–745 kPa)                                | 174.0–131.0 psi (1,200–903 kPa)                              | 204.1–153.0 psi (1,407–1,055 kPa)                            | 233.9–175.1 psi (1,613–1,207 kPa)                            |
| 146.1–109.9 psi (1,007–758 kPa)                              | 176.1–132.0 psi (1,214–910 kPa)                              | 206.0–154.0 psi (1,420–1,062 kPa)                            | 236.0–176.9 psi (1,627–1,220 kPa)                            |
| 147.9–111.0 psi (1,020–765 kPa)                              | 178.0–133.0 psi (1,227–917 kPa)                              | 208.0–155.9 psi (1,434–1,075 kPa)                            | 238.0–178.0 psi (1,641–1,227 kPa)                            |
| 150.0–113.0 psi (1,034–779 kPa)                              | 180.0–135.0 psi (1,241–931 kPa)                              | 210.0–157.1 psi (1,448–1,083 kPa)                            | 240.0–180.0 psi (1,655–1,241 kPa)                            |
| 152.0–114.0 psi (1,048–786 kPa)                              | 182.0–135.8 psi (1,255–936 kPa)                              | 212.0–157.9 psi (1,462–1,089 kPa)                            | 242.1–181.0 psi (1,669–1,248 kPa)                            |
| 154.0–115.0 psi (1,062–793 kPa)                              | 184.1–138.1 psi (1,269–952 kPa)                              | 214.1–160.0 psi (1,476–1,103 kPa)                            | 244.0–183.0 psi (1,682–1,262 kPa)                            |
| 156.1–117.0 psi (1,076–807 kPa)                              | 185.9–140.0 psi (1,282–965 kPa)                              | 216.0–162.0 psi (1,489–1,117 kPa)                            | 246.0–184.1 psi (1,696–1,269 kPa)                            |
| 157.9–118.1 psi (1,089–814 kPa)                              | 188.0–141.0 psi (1,296–972 kPa)                              | 218.0–163.0 psi (1,503–1,124 kPa)                            | 248.0–174.3 psi (1,710–1,202 kPa)                            |
| 160.0–119.9 psi (1,103–827 kPa)                              | 190.0–142.0 psi (1,310–979 kPa)                              | 220.0–165.1 psi (1,517–1,138 kPa)                            | 250.0–187.0 psi (1,724–1,289 kPa)                            |
| 161.0–121.0 psi (1,110–834 kPa)                              | 192.0–144.0 psi (1,324–993 kPa)                              | 236.6–166.1 psi (1,631–1,145 kPa)                            | 251.9–189.0 psi (1,737–1,303 kPa)                            |

If one or more cylinders reads low, squirt approximately one tablespoon of engine oil meeting Ford

specification on top of the pistons in the low-reading cylinders. Repeat the compression pressure check on these cylinders.

### **Compression Test - Interpreting Compression Readings**

1. If compression improves considerably, piston rings are worn or damaged.
2. If compression does not improve, valves are sticking or not seating correctly.
3. If 2 adjacent cylinders indicate low compression pressures and squirting oil on each piston does not increase compression, the head gasket may be leaking between cylinders. Engine oil or coolant in cylinders could result from this condition. Use the Compression Pressure Limit Chart when checking cylinder compression so the lowest reading is within 75% of the highest reading.

### **Cylinder Leakage Detection**

When a cylinder produces a low reading, use of a cylinder leakage tester will be helpful in pinpointing the exact cause.

The leakage tester is inserted in the spark plug hole, the piston is brought up to TDC on the compression stroke, and compressed air is admitted.

Once the combustion chamber is pressurized, the leakage tester gauge will read the percentage of leakage. Leakage exceeding 20% is excessive.

While the air pressure is retained in the cylinder, listen for the hiss of escaping air. A leak at the intake valve will be heard in the TB (throttle body). A leak at the exhaust valve can be heard at the tailpipe. Leakage past the piston rings will be audible at the PCV connection. If air is passing through a blown head gasket to an adjacent cylinder, the noise will be evident at the spark plug hole of the cylinder into which the air is leaking. Cracks in the cylinder block or gasket leakage into the cooling system may be detected by a stream of bubbles in the radiator.

### **Excessive Engine Oil Consumption**

Nearly all engines consume oil, which is essential for normal lubrication of the cylinder bore walls and pistons and rings. Determining the level of oil consumption may require testing by recording how much oil is being added over a given set of miles.

Customer driving habits greatly influence oil consumption. Mileage accumulated during towing or heavy loading generates extra heat. Frequent short trips, stop-and-go type traffic or extensive idling, prevent the engine from reaching normal operating temperature. This prevents component clearances from reaching specified operating ranges.

The following diagnostic procedure may be utilized to determine internal oil consumption. Make sure that the concern is related to internal oil consumption, and not external leakage, which also consumes oil. Verify there are no leaks before carrying out the test. Once verified, the rate of internal oil consumption can be tested.

A new engine may require extra oil in the early stages of operation. Internal piston-to-bore clearances and sealing characteristics improve as the engine breaks in. Engines are designed for close tolerances and do not require break-in oils or additives. Use the oil specified in the Owner's Literature. Ambient temperatures may determine the oil viscosity specification. Verify that the correct oil is being used for the vehicle in the geographic region in which it is driven.

### **Basic Pre-checks**

1. For persistent complaints of oil consumption, interview the customer to determine the oil consumption characteristics. If possible, determine the brand and grade of oil currently in the oil pan. Look at the oil filter or oil-change station tags to determine if Ford-recommended maintenance schedules have been followed. Make sure that the oil has been changed at the specified mileage intervals. If vehicle mileage is past the first recommended drain interval, the OEM (original equipment manufacturer) production filter should have been changed.
2. Ask how the most current mileage was accumulated. That is, determine whether the vehicle was driven under the following conditions:
  - Extended idling or curbside engine operation
  - Stop-and-go traffic or taxi operation
  - Towing a trailer or vehicle loaded heavily
  - Frequent short trips (engine not up to normal operating temperature)
  - Excessive throttling or high engine-rpm driving
3. Verify that there are no external leaks. If necessary, review the diagnostic procedure under Engine Oil Leaks in the Diagnosis and Testing portion of this section.
4. Inspect the crankcase ventilation system for:
  - disconnected hoses at the valve cover or TB.
  - loose or missing valve cover fill cap.
  - missing or incorrectly seated engine oil level indicator.
  - incorrect or dirty PCV valve.
  - a PCV valve grommet unseated in the valve cover (if so equipped).
5. Inspect for signs of sludge. Sludge affects PCV performance and can plug or restrict cylinder head drainback wells. It can also increase oil pressure by restricting passages and reducing the drainback capability of piston oil control rings. Sludge can result from either excessive water

ingestion in the crankcase or operation at extremely high crankcase temperatures.

6. Inspect the air filter for dirt, sludge or damage. A hole in the filter element will allow unfiltered air to bypass into the air induction system. This can cause premature internal wear (engine dusting), allowing oil to escape past rings, pistons, valves and guides.
7. If the engine is hot or was recently shut down, wait at least 15-minutes to allow the oil to drain back. Ask the customer if this requirement has been followed. Adding oil without this wait period can cause an overfill condition, leading to excessive oil consumption and foaming which may cause engine damage.
8. Make sure the oil level indicator (dipstick) is correctly and fully seated in the indicator tube. Remove the oil level indicator and record the oil level.

### Detailed Pre-checks

1. Check the thermostat opening temperature to make sure that the cooling system is operating at the specified temperature. If it is low, internal engine parts are not running at specified internal operating clearances.
2. Verify the spark plugs are not oil saturated. Oil leaking into one or more cylinders will appear as an oil soaked condition on the plug. If a plug is saturated, a compression check may be necessary at the conclusion of the oil consumption test.

### Oil Consumption Test

1. **NOTE:** *Once all of the previous conditions are met, carry out an oil consumption test.*

Drain the engine oil and remove the oil filter. Install a new manufacturer-specified oil filter. Make sure the vehicle is positioned on a level surface. Refill the oil pan to a level one liter (quart) less than the specified fill level, using manufacturer-specified oil.

2. Run the engine for 3 minutes (if hot) or 10 minutes (if cold). Allow for a minimum 15-minute drainback period and then record the oil level shown on the oil level indicator. Place a mark on the backside of the oil level indicator noting the oil level location.
3. Add the final one liter (quart) to complete the normal oil fill. Restart the engine and allow it to idle for 2 minutes. Shut the engine down.
4. After a 15-minute drainback period, record the location of the oil level again. Mark the oil level indicator with the new oil level location. (Note: Both marks should be very close to the MIN-MAX upper and lower limits or the upper and lower holes on the oil level indicator. These marks

will exactly measure the engine's use of oil, with a one quart differential between the new marks.) Demonstrate to the customer that the factory-calibrated marks on the oil level indicator are where the oil should fall after an oil change with the specified fill amount. Explain however, that this may vary slightly between MIN-MAX or the upper and lower holes on the oil level indicator.

5. Record the vehicle mileage.
6. Advise the customer that oil level indicator readings must be taken every 320 km (200 mi) or weekly, using the revised marks as drawn. Remind the customer that the engine needs a minimum 15-minute drainback for an accurate reading and that the oil level indicator must be firmly seated in the tube prior to taking the reading.
7. When the subsequent indicator readings demonstrate a full liter (quart) has been used, record the vehicle mileage. The mileage driven should not be less than 4,800 km (3,000 mi). The drive cycle the vehicle has been operated under must be considered when making this calculation. It may be necessary to have the customer bring the vehicle in for a periodic oil level indicator reading to closely monitor oil usage.

### **Post Checks, Evaluation and Corrective Action**

1. If test results indicate excessive oil consumption, carry out a cylinder compression test. The cylinder compression test should be carried out with a fully charged battery and all spark plugs removed. See the Compression Test Chart in this section for pressure range limits.
2. Compression should be consistent across all cylinders. Refer to the Compression Testing portion of this section. If compression tested within the specifications found in this section, the excessive oil consumption may be due to wear on the valve guides, valves or valve seals.
3. A cylinder leak detection test can be carried out using a cylinder leakage detector. This can help identify valves, piston rings, or worn valve guides/valve stems, inoperative valve stem seals or other related areas as the source of oil consumption.
4. **NOTE:** *An oil-soaked appearance on the porcelain tips of the spark plugs also indicates excessive oil use. A typical engine with normal oil consumption will exhibit a light tan to brown appearance. A single or adjoining, multiple cylinder leak can be traced by viewing the tips.*

If an internal engine part is isolated as the root cause, determine if the repair will exceed cost limits and proceed with a repair strategy as required.

5. Once corrective action to engine is complete and verifying that all pre-check items were eliminated in the original diagnosis, repeat the Oil Consumption Test as described above and verify consumption results.

## Intake Manifold Vacuum Test

Bring the engine to normal operating temperature. Connect the Vacuum/Pressure Tester to the intake manifold. Run the engine at the specified idle speed.

The vacuum gauge should read between 51-74 kPa (15-22 in-Hg) depending upon the engine condition and the altitude at which the test is conducted. Subtract 4.0193 kPa (1 in-Hg) from the specified reading for every 304.8 m (1,000 feet) of elevation above sea level.

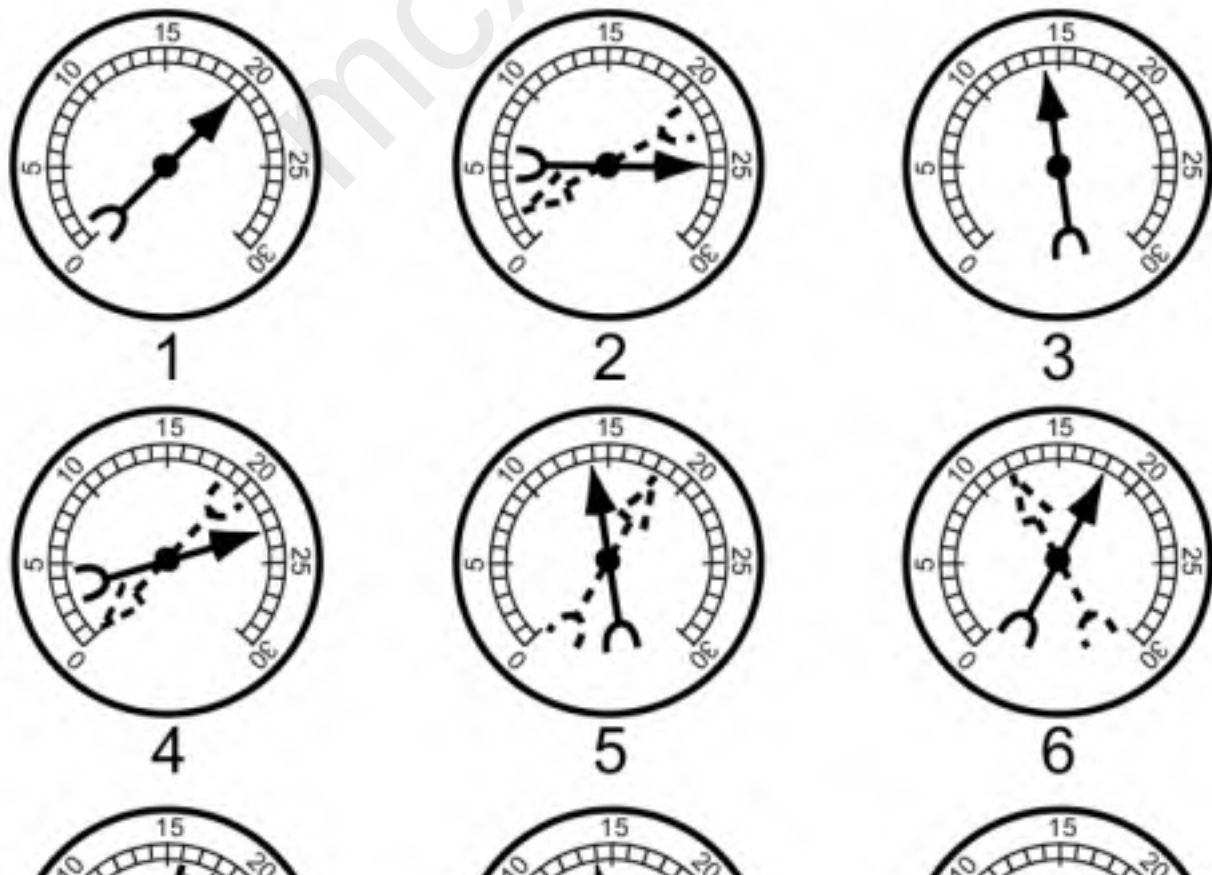
The reading should be steady. If necessary, adjust the gauge damper control (where used) if the needle is fluttering rapidly. Adjust the damper until the needle moves easily without excessive flutter.

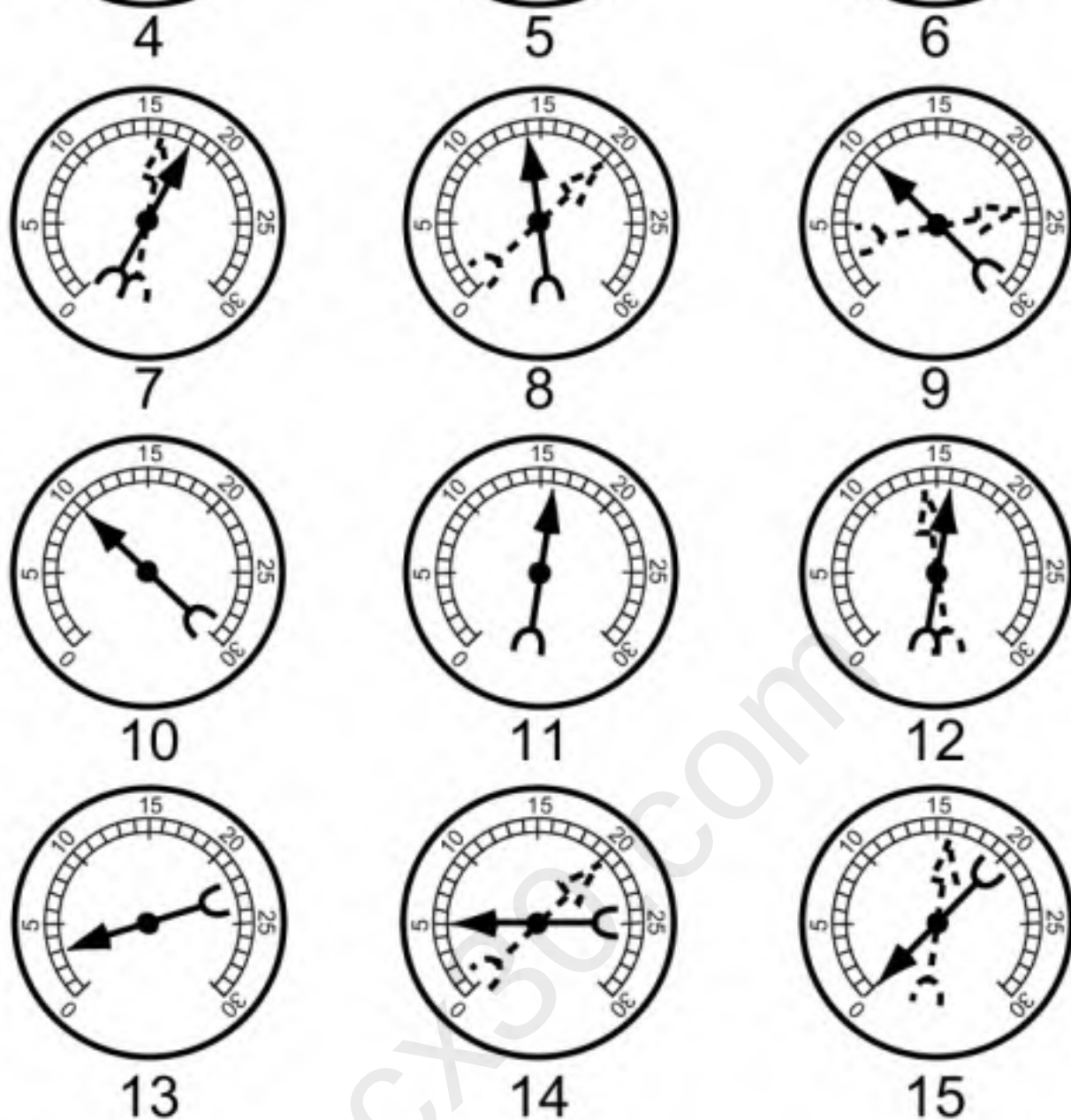
## Intake Manifold Vacuum Test - Interpreting Vacuum Gauge Readings

A careful study of the vacuum gauge reading while the engine is idling will help pinpoint trouble areas. Always conduct other appropriate tests before arriving at a final diagnostic decision. Vacuum gauge readings, although helpful, must be interpreted carefully.

Most vacuum gauges have a normal band indicated on the gauge face. The following are potential gauge readings. Some are normal; others should be investigated further.

The following are potential gauge readings. Some are normal; others should be investigated further.





E147860

1. **NORMAL READING:** Needle between 51-74 kPa (15-22 in-Hg) and holding steady.
2. **NORMAL READING DURING RAPID ACCELERATION AND DECELERATION:** When the engine is rapidly accelerated (dotted needle), the needle will drop to a low reading (not to zero). When the throttle is suddenly released, the needle will snap back up to a higher than normal figure.
3. **NORMAL FOR HIGH-LIFT CAMSHAFT WITH LARGE OVERLAP:** The needle will register as low as 51 kPa (15 in-Hg) but will be relatively steady. Some oscillation is normal.
4. **WORN RINGS OR DILUTED OIL:** When the engine is accelerated (dotted needle), the needle drops to 0 kPa (0 in-Hg). Upon deceleration, the needle runs slightly above 74 kPa (22 in-Hg).

5. **STICKING VALVES:** When the needle (dotted) remains steady at a normal vacuum but occasionally flicks (sharp, fast movement) down and back about 13 kPa (4 in-Hg), one or more valves may be sticking.
6. **BURNED OR WARPED VALVES:** A regular, evenly-spaced, downscale flicking of the needle indicates one or more burned or warped valves. Insufficient valve clearance will also cause this reaction.
7. **POOR VALVE SEATING:** A small but regular downscale flicking can mean one or more valves are not seating.
8. **WORN VALVE GUIDES:** When the needle oscillates over about a 13 kPa (4 in-Hg) range at idle speed, the valve guides could be worn. As engine speed increases, the needle will become steady if guides are responsible.
9. **WEAK VALVE SPRINGS:** When the needle oscillation becomes more violent as engine rpm is increased, weak valve springs are indicated. The reading at idle could be relatively steady.
10. **LATE VALVE TIMING:** A steady but low reading could be caused by late valve timing.
11. **IGNITION TIMING RETARDING:** Retarded ignition timing will produce a steady but somewhat low reading.
12. **INSUFFICIENT SPARK PLUG GAP:** When spark plugs are gapped too close, a regular, small pulsation of the needle can occur.
13. **INTAKE LEAK:** A low, steady reading can be caused by an intake manifold or TB gasket leak.
14. **BLOWN HEAD GASKET:** A regular drop of fair magnitude can be caused by a blown head gasket or warped cylinder head-to-cylinder block surface.
15. **RESTRICTED EXHAUST SYSTEM:** When the engine is first started and is idled, the reading may be normal, but as the engine rpm is increased, the back pressure caused by a clogged muffler, kinked tailpipe or other concerns will cause the needle to slowly drop to 0 kPa (0 in-Hg). The needle then may slowly rise. Excessive exhaust clogging will cause the needle to drop to a low point even if the engine is only idling.

When vacuum leaks are indicated, search out and correct the cause. Excess air leaking into the system will upset the fuel mixture and cause concerns such as rough idle, missing on acceleration or burned valves. If the leak exists in an accessory unit such as the power brake booster, the unit will not function correctly. Always fix vacuum leaks.

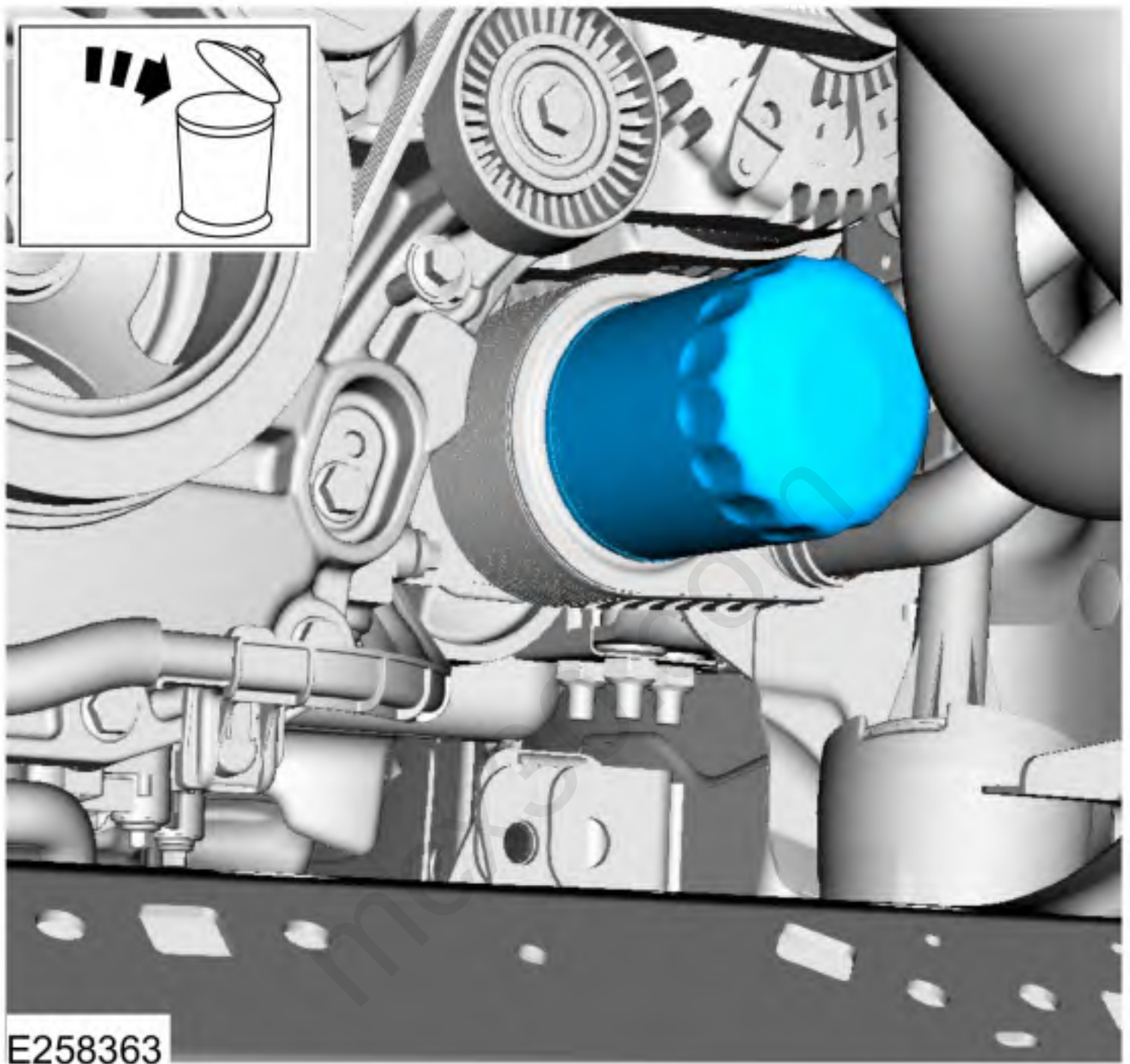


## Oil Pressure Test 2.7L EcoBoost & 3.3L Duratec & 5.0L Ti-VCT

1. Disconnect and remove the oil pressure switch (refer to the appropriate 303-01 engine section) or EOP sensor (refer to the appropriate 303-14 section).
2. Connect a commercially available oil pressure gauge to the oil galley port.
3. Run the engine until normal operating temperature is reached.
4. Run the engine at the specified rpm and record the gauge reading.
5. The oil pressure should be within specifications, refer to the specification chart in the appropriate 303-01 engine section.
6. If the pressure is not within specification, check the following possible sources:
  - Insufficient oil
  - Oil leakage
  - Worn or damaged oil pump
  - Oil pump screen cover and tube
  - Excessive main bearing clearance
  - Excessive connecting rod bearing clearance
  - Chain tensioner leak
7. Remove the commercially available oil pressure gauge.
8. Install and connect the oil pressure switch (refer to the appropriate 303-01 engine section) or EOP sensor (refer to the appropriate 303-14 section).

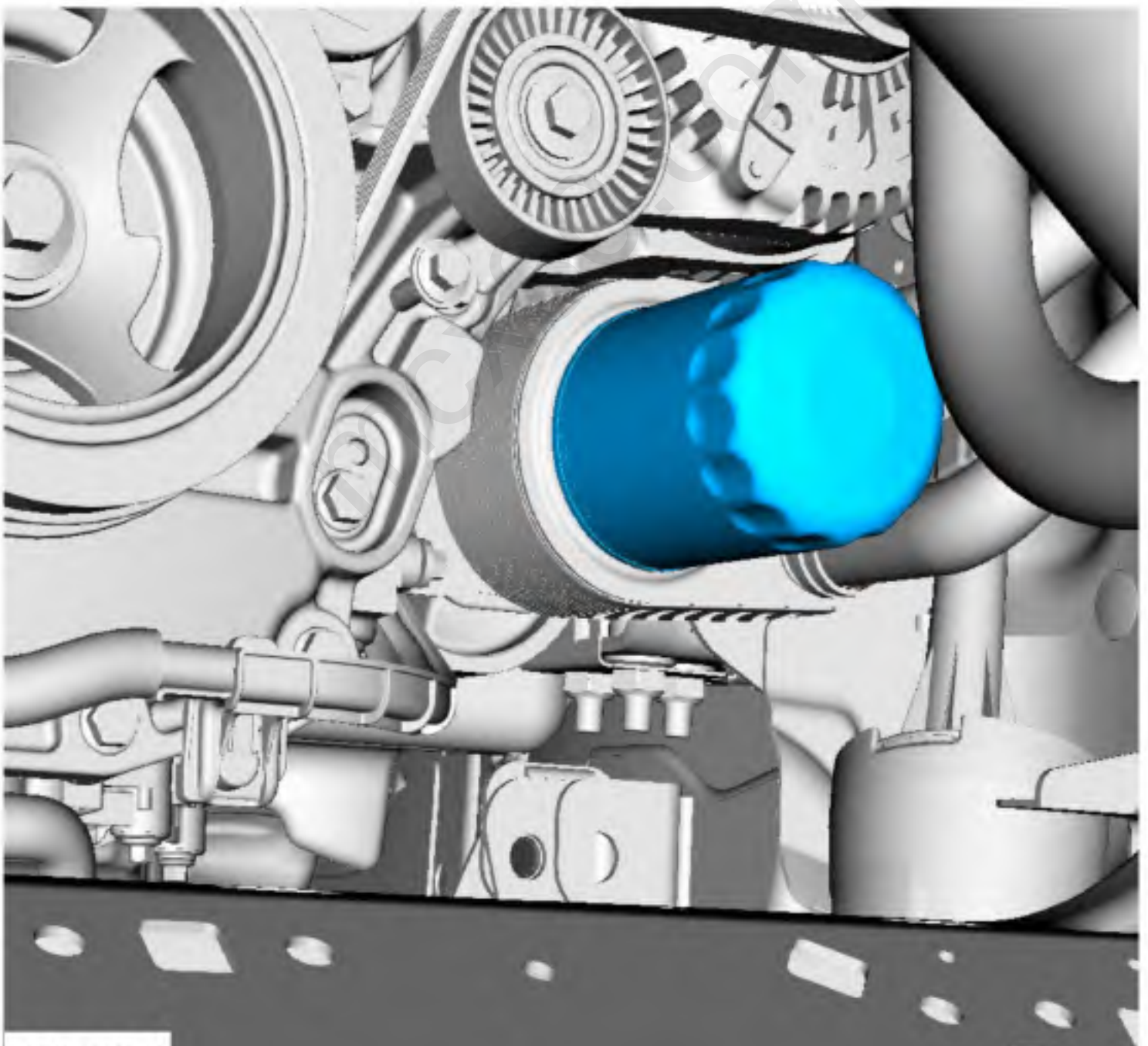
## Oil Pressure Test 3.5L EcoBoost

1. With the vehicle in NEUTRAL, position it on a hoist.  
REFER to: [Jacking and Lifting - Overview](#) (100-02 Jacking and Lifting, Description and Operation).
2. Remove and discard the oil filter.



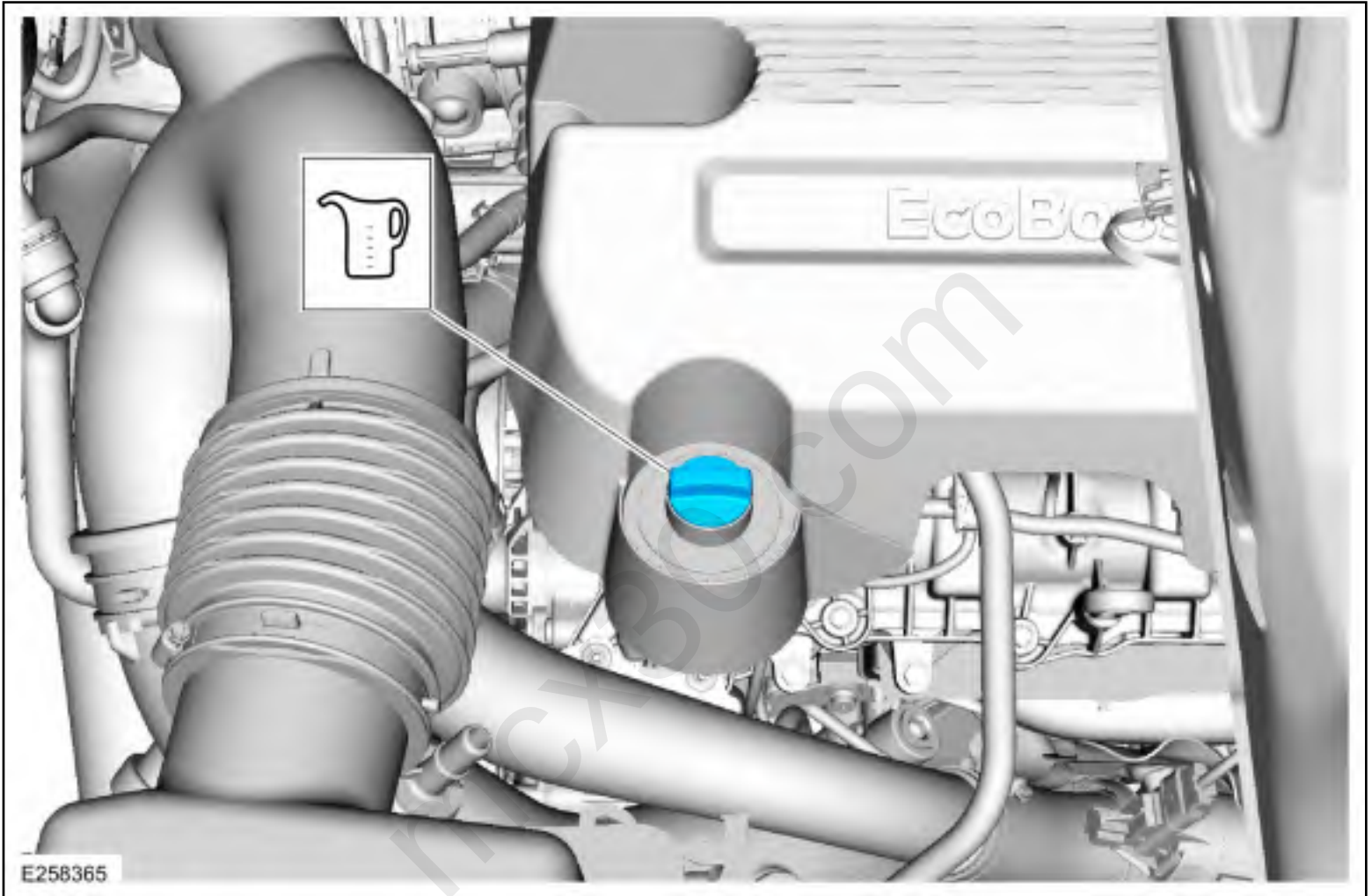
3. Connect a GearWrench 3289 Oil Pressure Tester Kit or equivalent oil pressure gauge to the oil filter housing.
4. Run the engine until normal operating temperature is reached.
5. Run the engine at the specified rpm and record the gauge reading.
6. The oil pressure should be within specifications, refer to the specification chart in the appropriate 303-01 engine section.

7. If the pressure is not within specification, check the following possible sources:
  - Insufficient oil
  - Oil leakage
  - Worn or damaged oil pump
  - Oil pump screen cover and tube
  - Excessive main bearing clearance
  - Excessive connecting rod bearing clearance
  - Chain tensioner leak
8. Remove the commercially available oil pressure gauge.
9. Install a new manufacturer-specified oil filter.



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10. Check and refill the oil as needed, using new manufacturer-specified oil.



## Valve Train Analysis

The following component tests are used to diagnose valve train concerns.

### Valve Train Analysis - Engine Off, Valve Cover Removed

Check for damaged or severely worn parts and correct assembly.

### Valve Train Analysis - Camshaft Lobe Lift

Check the lift of each camshaft lobe in consecutive order and make a note of the readings.



1. Remove the spark plugs.

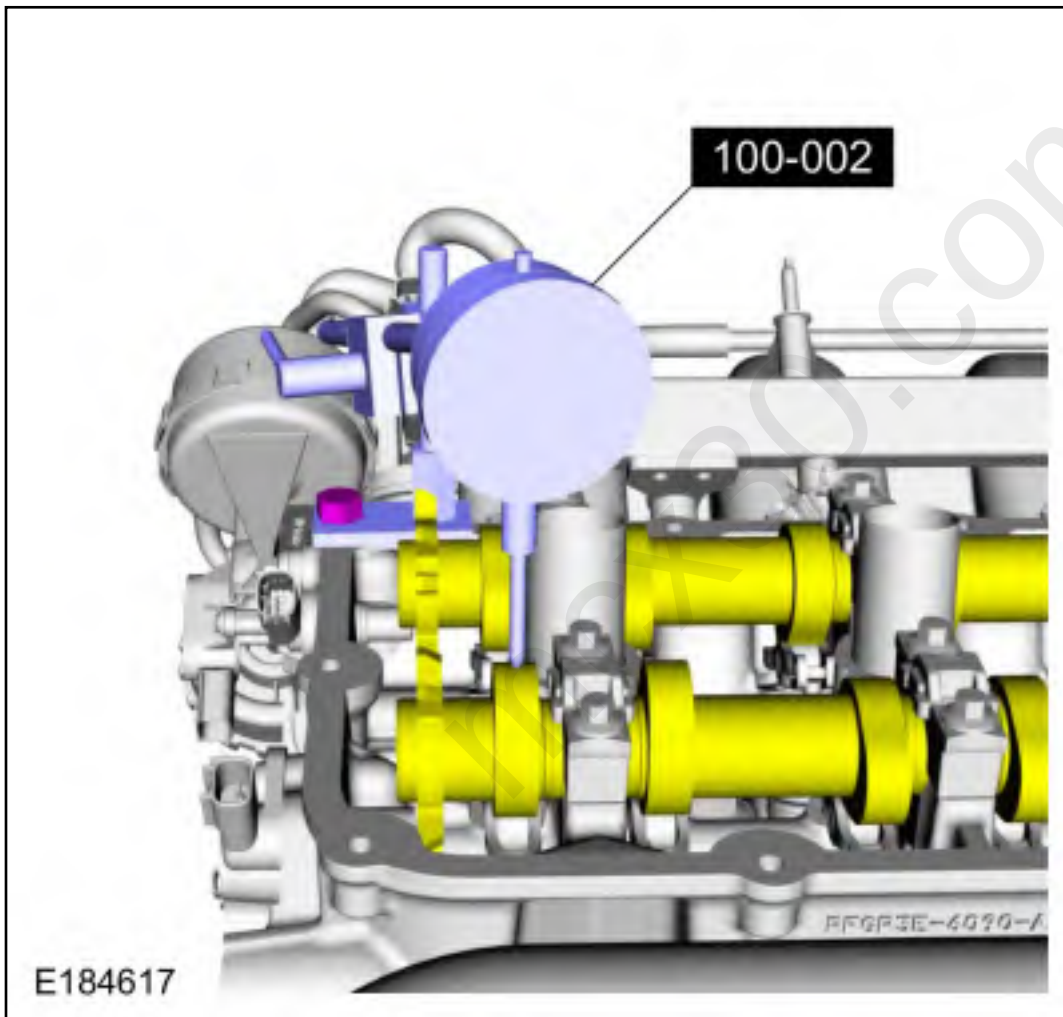
REFER to: [Spark Plugs](#) (303-07A Engine Ignition - 2.7L EcoBoost (238kW/324PS), Removal and Installation).

REFER to: [Spark Plugs](#) (303-07B Engine Ignition - 3.3L Duratec - V6, Removal and Installation).

REFER to: [Spark Plugs](#) (303-07C Engine Ignition - 3.5L EcoBoost (272kW/370PS), Removal and Installation).

REFER to: Spark Plugs (303-07E) .

2. Install the Dial Indicator Gauge with Holding Fixture so the rounded tip of the dial indicator is on top of the camshaft lobe and on the same plane as the valve tappet.



3. Rotate the crankshaft using a breaker bar and socket attached to the crankshaft pulley retainer bolt. Rotate the crankshaft until the base circle of the camshaft lobe is reached.
4. Zero the dial indicator. Continue to rotate the crankshaft until the high-lift point of the camshaft lobe is in the fully raised position (highest indicator reading).

5. To check the accuracy of the original dial indicator reading, continue to rotate crankshaft until the base circle is reached. The indicator reading should be zero. If zero reading is not obtained, repeat Steps 2 through 5.
6. If the lift on any lobe is below specified service limits, install a new camshaft and camshaft roller followers or valve tappets.
7. Install the spark plugs.  
REFER to: [Spark Plugs](#) (303-07A Engine Ignition - 2.7L EcoBoost (238kW/324PS), Removal and Installation).  
REFER to: [Spark Plugs](#) (303-07B Engine Ignition - 3.3L Duratec - V6, Removal and Installation).  
REFER to: [Spark Plugs](#) (303-07C Engine Ignition - 3.5L EcoBoost (272kW/370PS), Removal and Installation).  
REFER to: Spark Plugs (303-07E) .

# Cylinder Block Core Plug Replacement

## Special Tool(s) / General Equipment

|                                                                                  |                                      |
|----------------------------------------------------------------------------------|--------------------------------------|
|  | 100-001 (T50T-100-A)<br>Slide Hammer |
|----------------------------------------------------------------------------------|--------------------------------------|

## Materials

| Name                                | Specification |
|-------------------------------------|---------------|
| Motorcraft® Threadlock 262<br>TA-26 | WSK-M2G351-A6 |

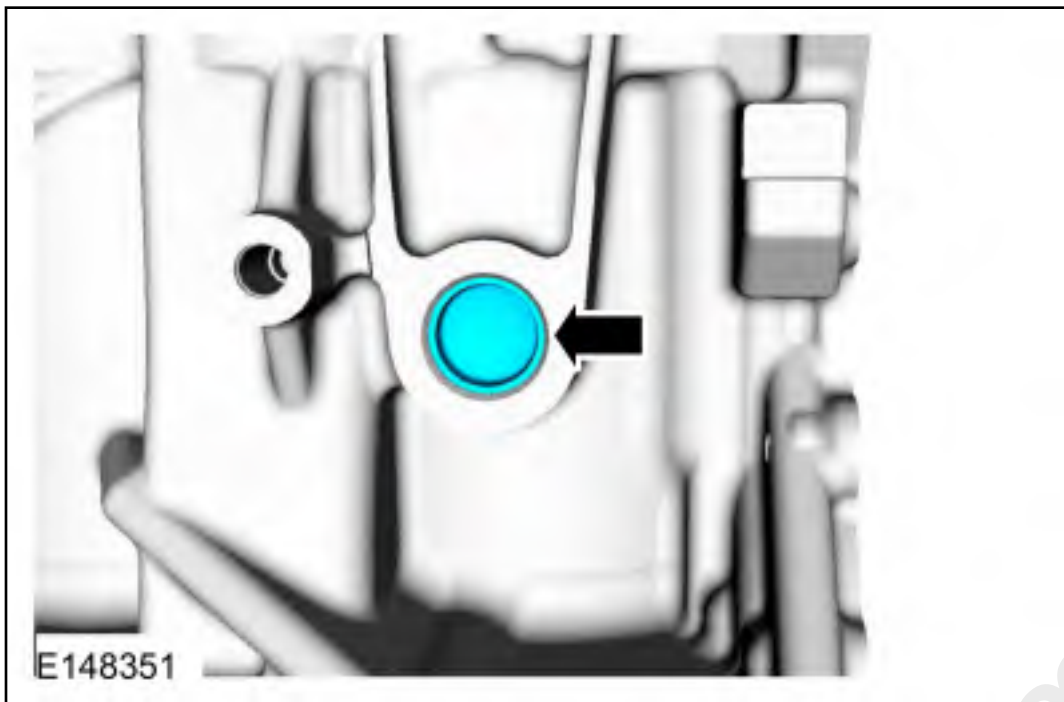
## Repair

### All core plugs

1. **NOTE:** *Cylinder block core plug shown, cylinder head core plug similar.*

Using the Slide Hammer and a commercially available body dent puller attachment or commercially available freeze plug puller remove the core plug.

Use Special Service Tool: 100-001 (T50T-100-A) Slide Hammer.



2. **NOTE:** *Oversize plugs are identified by the OS stamped in the flat located on the cup side of the plug.*

Inspect the core plug bore for any damage that would interfere with the correct sealing of the plug. If the core plug bore is damaged, bore for the next oversize plug.

### **Cup-type**

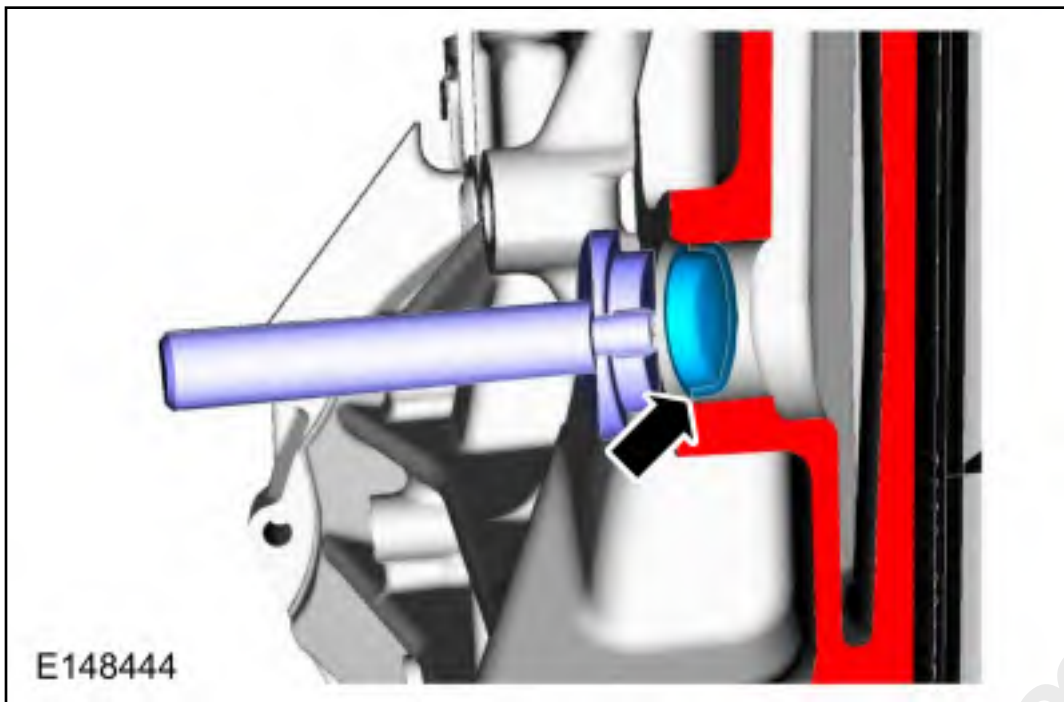
3. **NOTE:** *Use care during this procedure so as not to disturb or distort the cup sealing surface.*

**NOTE:** *When installed, the flanged edge must be below the chamfered edge of the bore to effectively seal the bore.*

Coat the cup-type core plug and bore lightly with sealant and install the core plug using a freeze plug installer. Remove the excess sealant after installation.

**Material:** Motorcraft® Threadlock 262 / TA-26 (WSK-M2G351-A6)



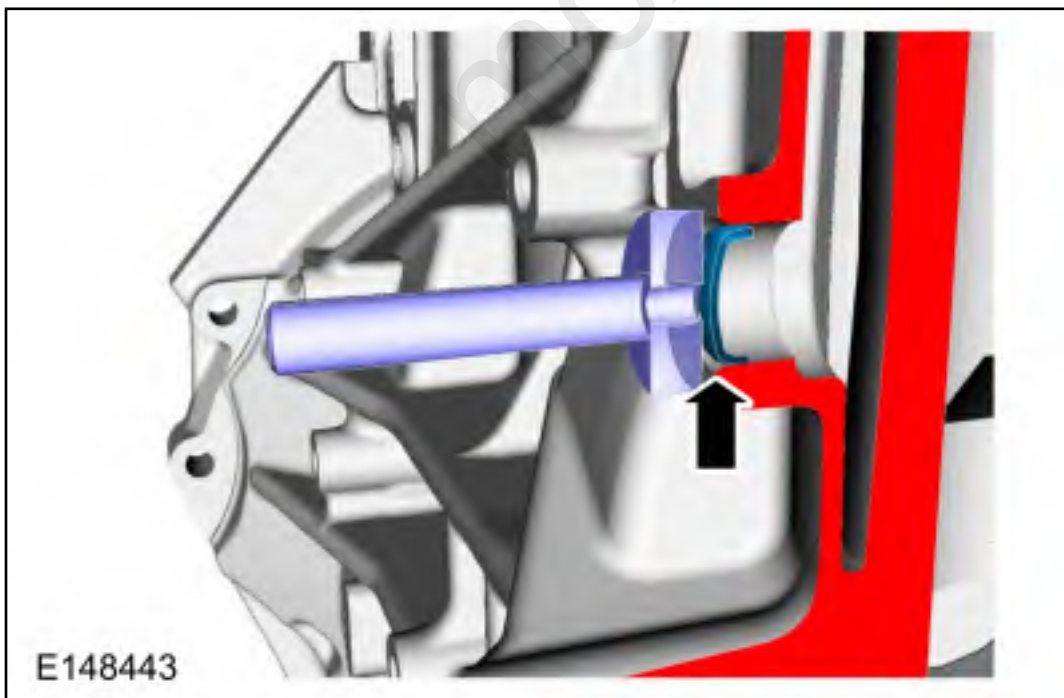


## Expansion-type

4. **NOTE:** Do not contact the crown when installing an expansion-type core plug. This could expand the plug before seating and result in leakage.

Coat the expansion-type core plug and bore lightly with sealant and install the core plug using a freeze plug installer. Remove the excess sealant after installation.

*Material:* Motorcraft® Threadlock 262 / TA-26 (WSK-M2G351-A6)



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# RTV Sealing Surface Cleaning and Preparation

## Special Tool(s) / General Equipment

|                 |
|-----------------|
| Plastic Scraper |
|-----------------|

## Materials

| Name                                                    | Specification |
|---------------------------------------------------------|---------------|
| Motorcraft® Silicone Gasket Remover<br>ZC-30-A          | -             |
| Motorcraft® Metal Surface Prep Wipes<br>ZC-31-B         | -             |
| Motorcraft® Metal Brake Parts Cleaner<br>PM-4-A, PM-4-B | -             |

## Cleaning

**NOTICE:** Place clean, lint-free towels over exposed cavities. Carefully remove the towels so foreign material is not dropped into the cavities. Any foreign material (including any material created while cleaning surfaces) that enters the fluid passages, may cause failure.

**NOTICE:** Do not use metal scrapers, wire brushes, power abrasive discs, or other abrasive means to clean sealing surfaces. These tools cause scratches and gouges which make leak paths.

1. Remove loose sealant by hand or with the aid of a plastic scraper.  
Use the General Equipment: Plastic Scraper
2. Apply Motorcraft® Silicone Gasket Remover to surface. Allow to set for several minutes.  
*Material:* Motorcraft® Silicone Gasket Remover / ZC-30-A
3. Use a lint-free towel and plastic scraper to remove any remaining sealant. A second application of Silicone Gasket Remover may be required.

Use the General Equipment: Plastic Scraper

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

4. Clean the surface with Motorcraft® Metal Brake Parts Cleaner to remove all residual sealant and oil.

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

5. **NOTE:** *Motorcraft® Metal Surface Prep Wipes is a pre-saturated disposable wipe to be used as a final step in surface preparation. It creates a conversion coating providing an improved base for RTV sealing. The wipe is a dry-in-place application and does not require rinsing.*

**NOTE:** *Discard wipe after a single use.*

Prep the surface with Motorcraft® Metal Surface Prep Wipes. All surfaces that are to be sealed with RTV are to be wiped. Make sure the surface is moistened with the fluid.

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

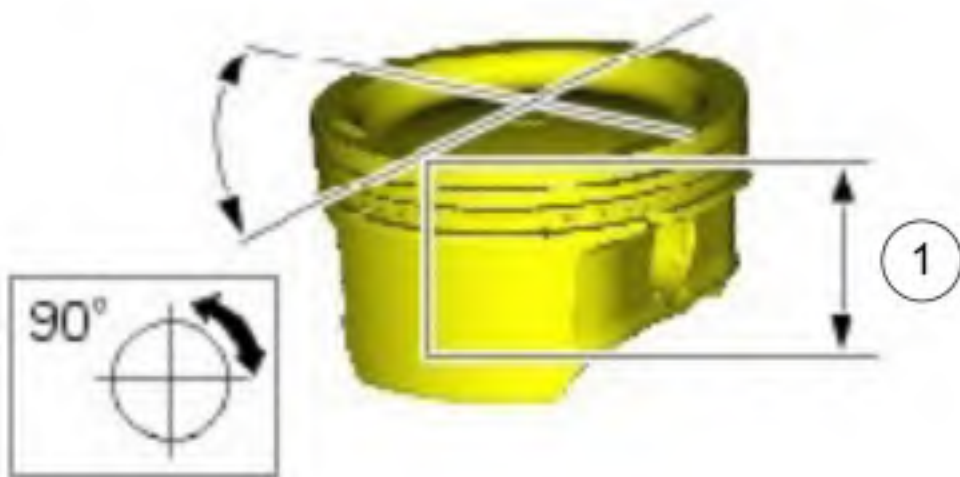
6. **NOTICE: Drying the surface with a towel will contaminate the surface and may cause oil leaks.**

Allow the surface to air dry. (Approximately 2 minutes.)

## Piston Diameter

### Check

1.
  - Measure the piston diameter 90 degrees from the piston pin and piston diameter (DN) height down from the top of the piston at the point indicated.
  - Refer to specifications for the piston diameter (DN) height.  
Refer to: [Specifications](#) (303-01A) .  
Refer to: [Specifications](#) (303-01B Engine - 3.3L Duratec - V6, Specifications).  
Refer to: [Specifications](#) (303-03C Engine Cooling - 3.5L EcoBoost (272kW/370PS), Specifications).  
Refer to: [Specifications - Raptor](#) (303-01C Engine - 3.5L EcoBoost (272kW/370PS), Specifications).



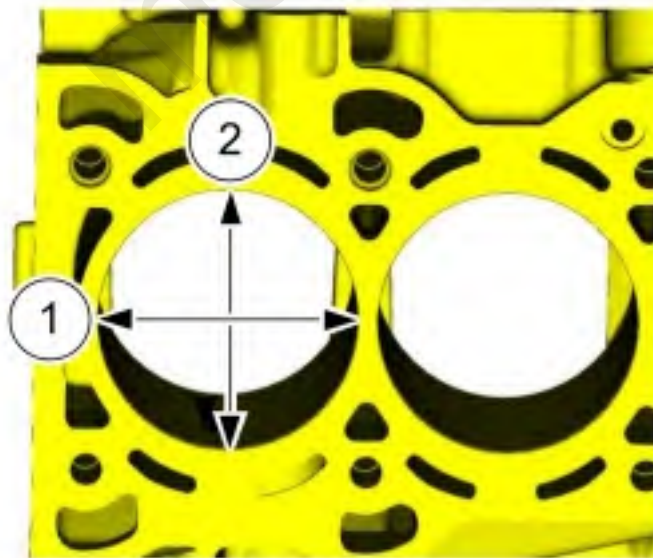
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## Piston Selection

### Check

1. Refer to specifications for piston selection.  
Refer to: [Specifications \(303-01A\)](#) .  
Refer to: [Specifications](#) (303-01B Engine - 3.3L Duratec - V6, Specifications).  
Refer to: [Specifications](#) (303-01C Engine - 3.5L EcoBoost (272kW/370PS), Specifications).  
Refer to: [Specifications - Raptor](#) (303-01C Engine - 3.5L EcoBoost (272kW/370PS), Specifications).  
Refer to: [Specifications](#) (303-01D Engine - 5.0L 32V Ti-VCT, Specifications).
2. **NOTE:** *The cylinder bore must be within the specifications for taper and out-of-round before fitting a piston.*
  - Measure the cylinder bore in 2 directions.
  - Select a piston size based on the cylinder bore.



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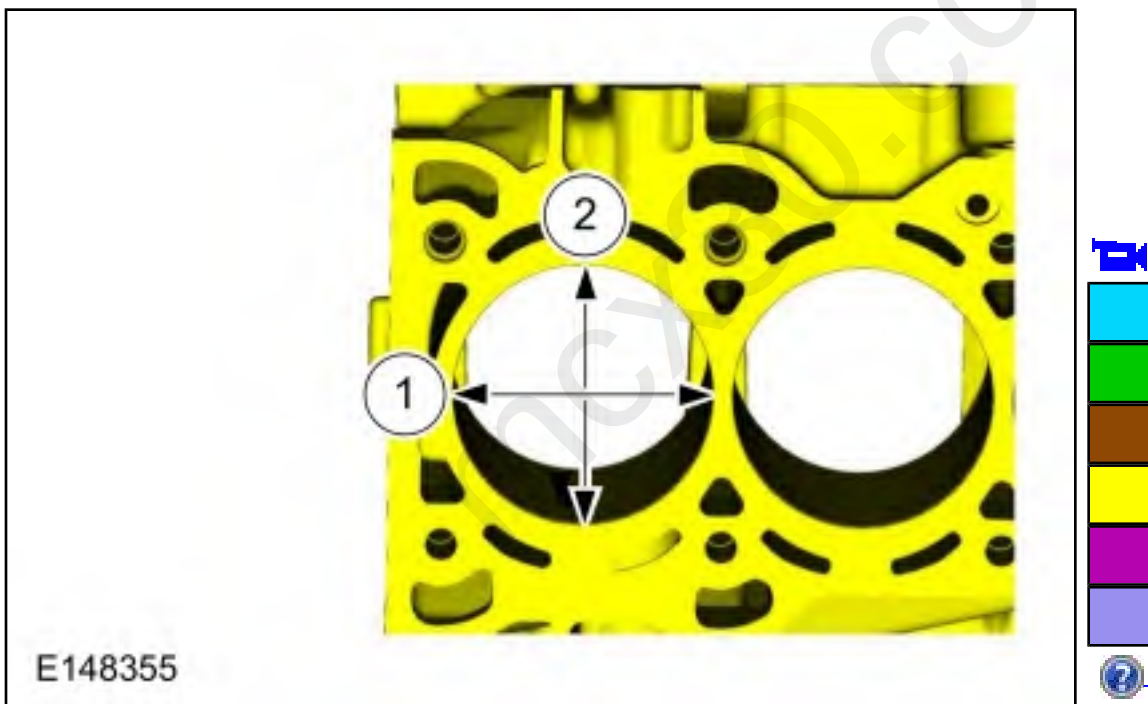


## Cylinder Bore Taper

### Check

**NOTE:** Refer to the appropriate Section 303-01 for the specification.

1. Measure the cylinder bore at the top, middle and bottom of piston ring travel in 2 directions as indicated. Verify the cylinder bore is within the wear limit. The difference indicates the cylinder bore taper. If the cylinder bore taper does not meet specification, bore the cylinder to the next oversize limit.



# Connecting Rod Bearing Journal Clearance

## Check

**NOTE:** Refer to the appropriate Section 303-01 for the specification.

1. **NOTE:** The crankshaft connecting rod journals must be within specifications to check the connecting rod bearing journal clearance.

Remove the connecting rod bearing cap and connecting rod bearing.

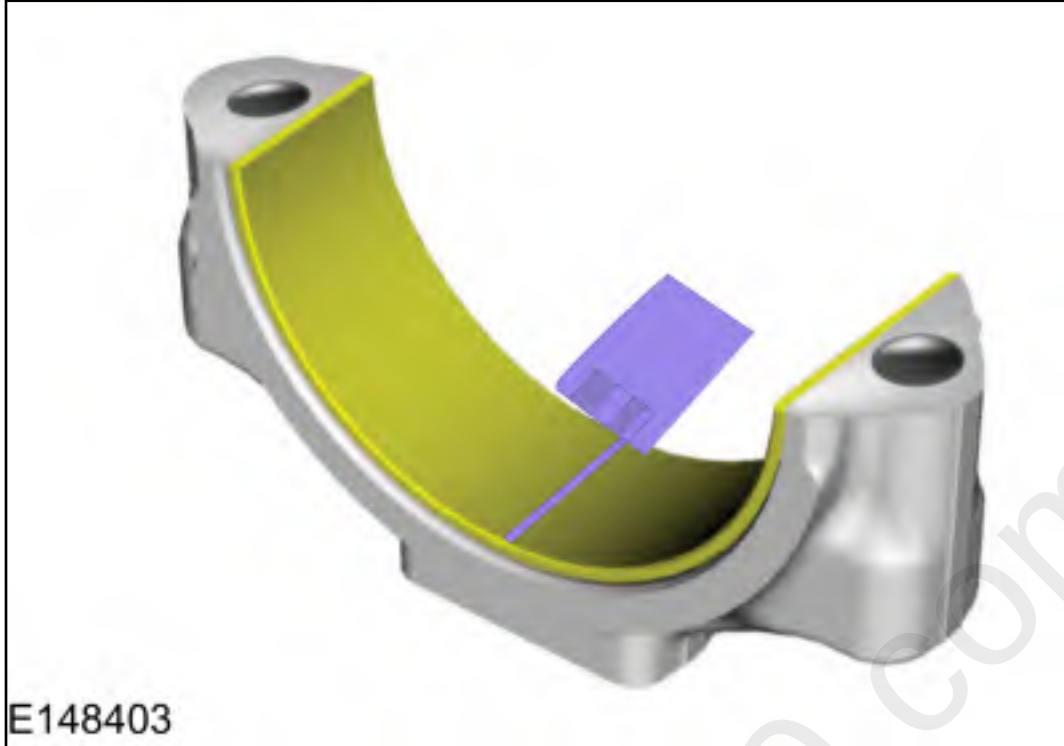
2. Position a piece of Plastigage across the bearing surface.



3. **NOTE:** Do not turn the crankshaft during this step.

Install and tighten to specifications, then remove the connecting rod bearing cap.

4. Measure the Plastigage to get the connecting rod bearing journal clearance. The Plastigage should be smooth and flat. A changing width indicates a tapered or damaged connecting rod or connecting rod bearing.



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## Piston Ring End Gap

### Special Tool(s) / General Equipment

Feeler Gauge

### Check

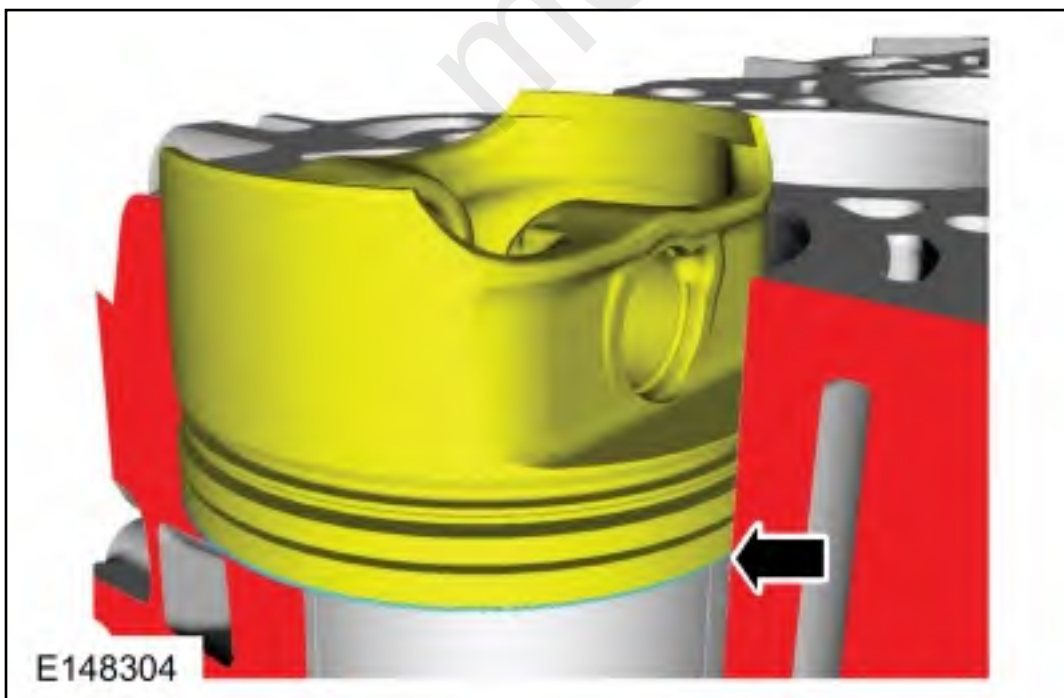
**NOTE:** Refer to the appropriate Section 303-01 for the specification.

1. **NOTE:** Use care when fitting piston rings to avoid possible damage to the piston ring or the cylinder bore.

**NOTE:** Piston rings should not be transferred from one piston to another.

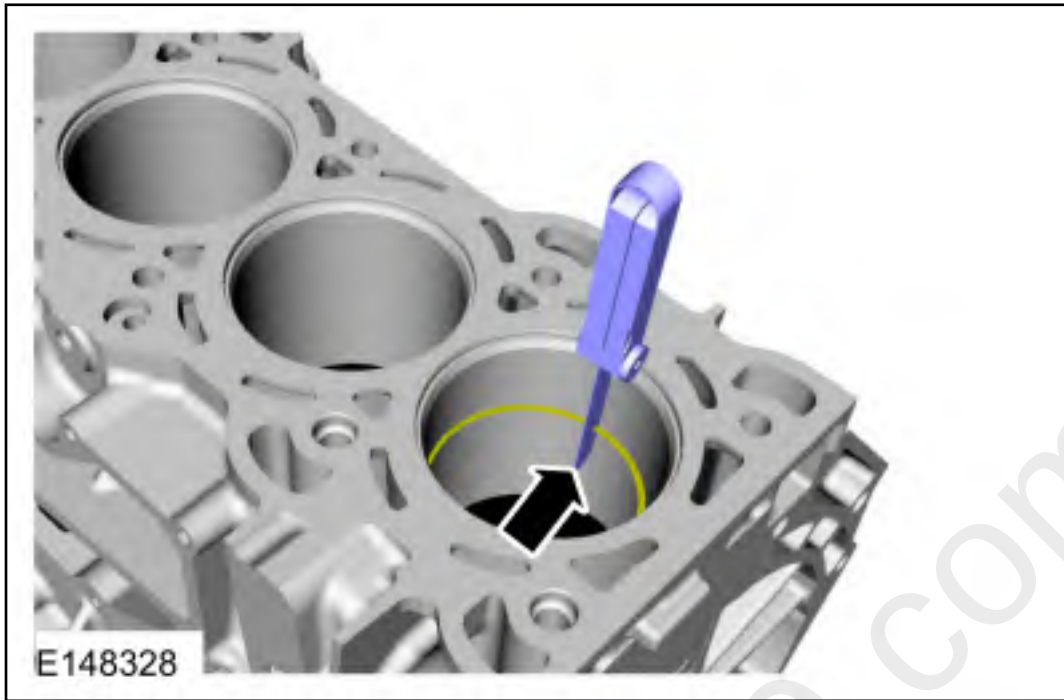
**NOTE:** The cylinder bore must be within specification for taper and out-of-round.

Use a piston without rings to push a piston ring in a cylinder to the bottom of ring travel.



2. Using the Feeler Gauge Set measure the top piston ring end gap and the second piston ring end gap

Use the General Equipment: Feeler Gauge



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# Cylinder Block Distortion

## Special Tool(s) / General Equipment

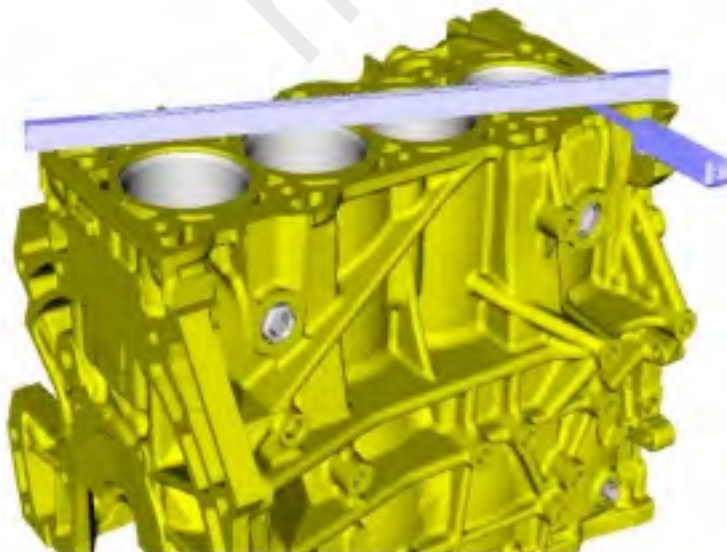
Feeler Gauge

## Check

**NOTE:** Refer to the appropriate Section 303-01 for the specification.

- NOTE:** Use a Straightedge that is calibrated by the manufacturer to be flat within 0.005 mm (0.0002 in) per running foot of length, such as Snap-On® GA438A or equivalent. For example, if the Straightedge is 61 cm (24 in) long, the machined edge must be flat within 0.010 mm (0.0004 in) from end to end.

Use a Straightedge and a Feeler Gauge Set to inspect the cylinder block for flatness.  
Use the General Equipment: Feeler Gauge



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# Exhaust Manifold Cleaning and Inspection

## Special Tool(s) / General Equipment

|              |
|--------------|
| Feeler Gauge |
|--------------|

## Cleaning

1. Clean the exhaust manifold using a suitable solvent. Use a plastic scraping tool to clean the gasket sealing surfaces.

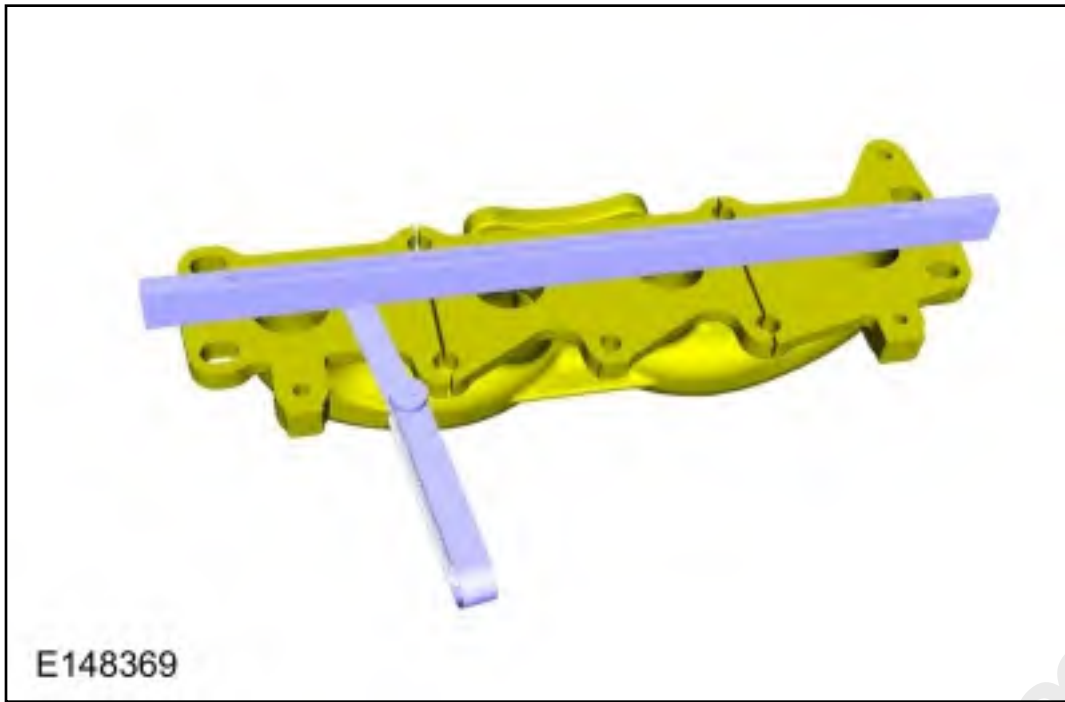
## Inspection

1. **NOTE:** *New exhaust manifold gaskets, studs, nuts and/or bolts must be installed when an exhaust manifold is serviced.*

**NOTE:** *Use a Straightedge that is calibrated by the manufacturer to be flat within 0.005 mm (0.0002 in) per running foot of length, such as Snap-On® GA438A or equivalent. For example, if the Straightedge is 61 cm (24 in) long, the machined edge must be flat within 0.010 mm (0.0004 in) from end to end.*

Using the Straightedge and a Feeler Gauge Set, check the exhaust manifold sealing surface for warpage. If the warpage is greater than 0.76 mm (0.0299 in), install a new exhaust manifold.  
Use the General Equipment: Feeler Gauge





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# Cylinder Head Distortion

## Special Tool(s) / General Equipment

|              |
|--------------|
| Feeler Gauge |
|--------------|

## Check

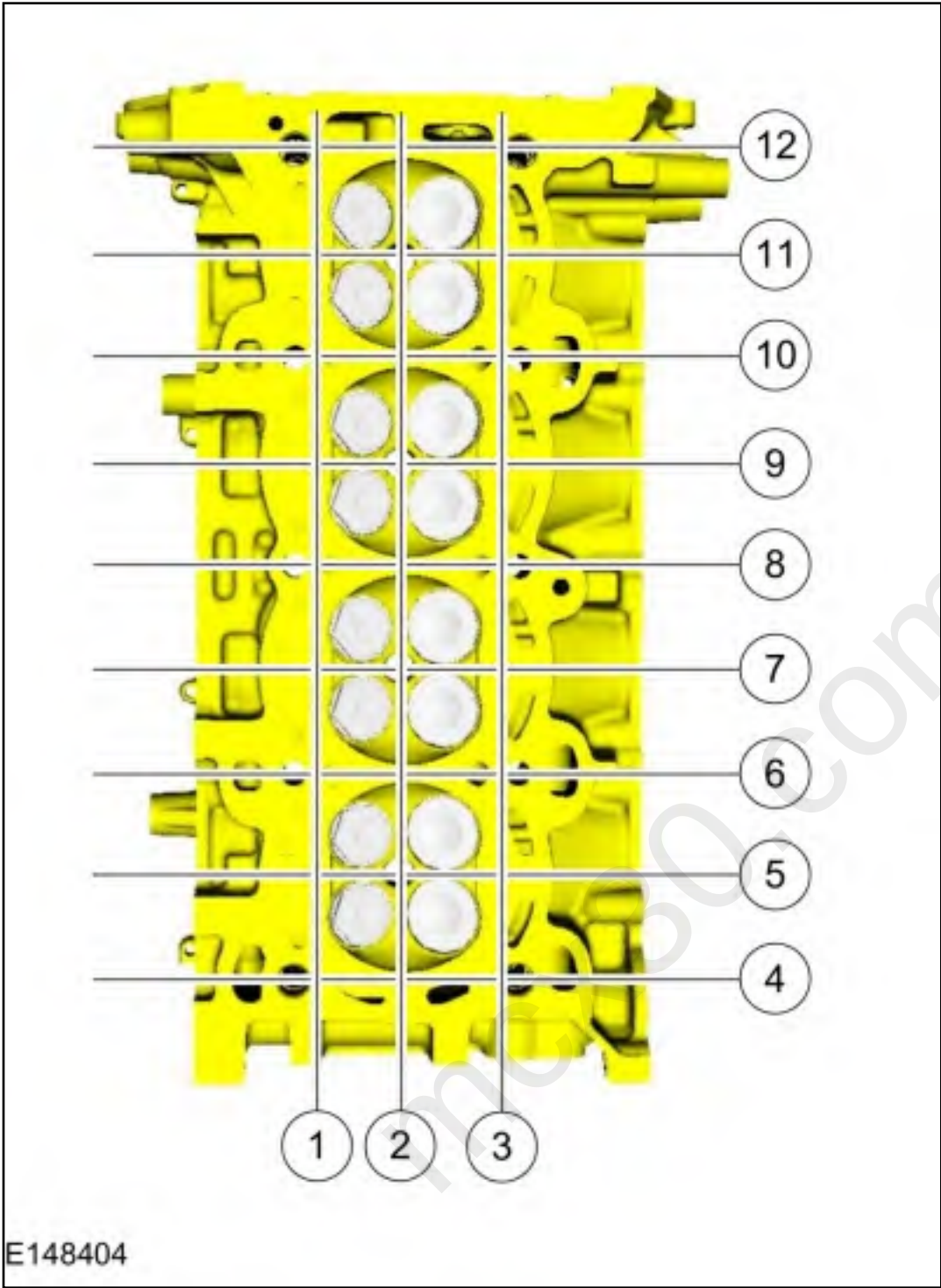
**NOTE:** Refer to the appropriate Section 303-01 for the specification.

1. **NOTE:** Make sure all cylinder head surfaces are clear of any gasket material, silicone sealant, oil and coolant. The cylinder head surface must be clean and dry before running a flatness check.

**NOTE:** Use a Straightedge that is calibrated by the manufacturer to be flat within 0.005 mm (0.0002 in) per running foot of length, such as Snap-On® GA438A or equivalent. For example, if the Straightedge is 61 cm (24 in) long, the machined edge must be flat within 0.010 mm (0.0004 in) from end to end.

Using a Straightedge and a Feeler Gauge Set, inspect the cylinder head for flatness in the sequence shown.

Use the General Equipment: Feeler Gauge



## Valve Guide Inner Diameter

### Check

**NOTE:** Refer to the appropriate Section 303-01 for the specification.

- NOTE:** Valve guides tend to wear in an hourglass pattern. The ball gauge can be inserted into the combustion chamber side of the valve guide, if necessary.
  - Use a ball gauge to determine the inside diameter of the valve guides in 2 directions at the top, middle and bottom of the valve guide.
  - Measure the ball gauge with a micrometer.
  - If the valve guide is not within specifications, install a new cylinder head assembly.

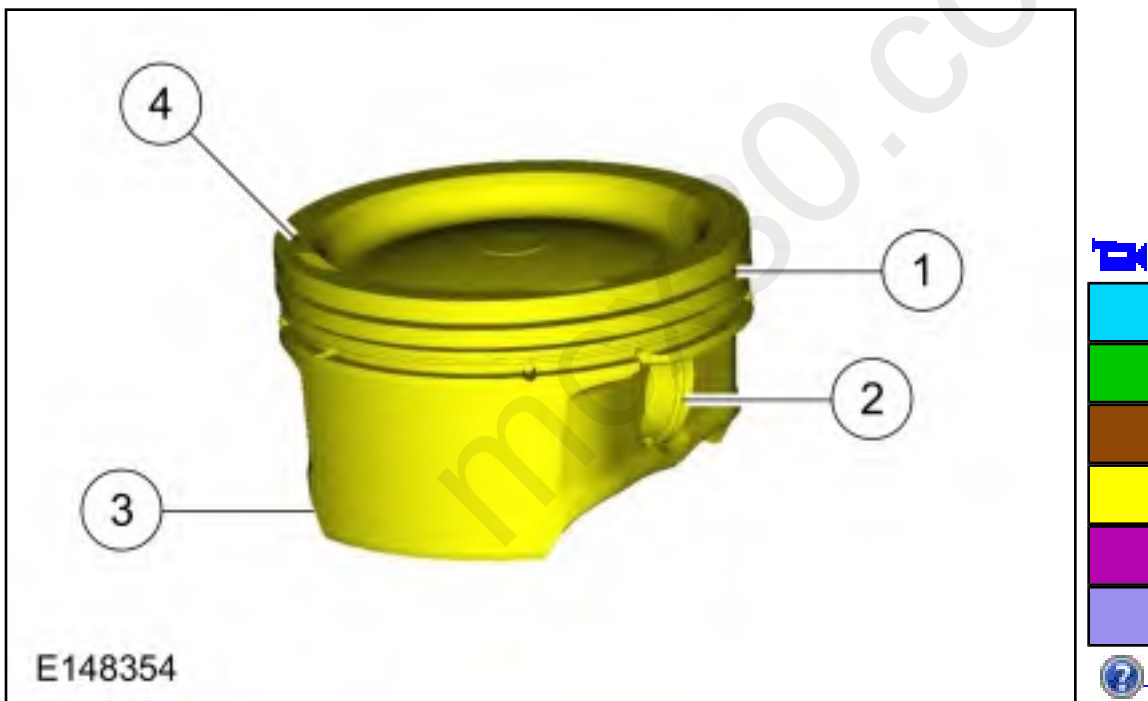


# Piston Inspection

## Inspection

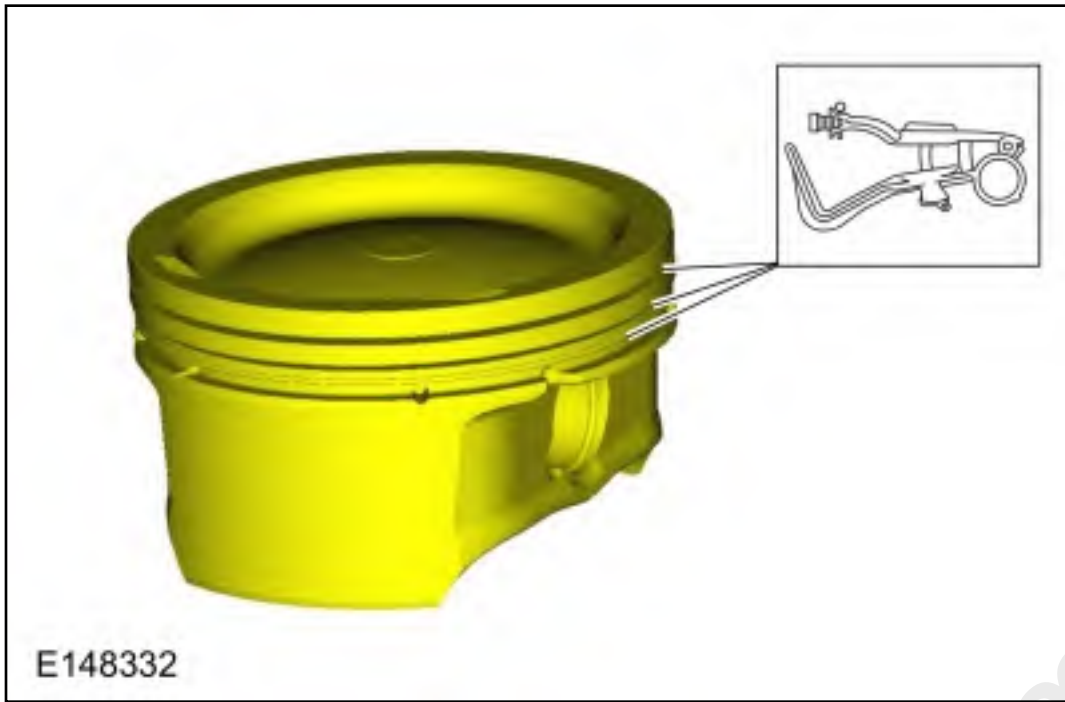
1. **NOTE:** Do not use a caustic cleaning solution or a wire brush to clean the pistons or damage can occur.

Clean and inspect the (1) ring lands, (2) pin bosses, (3) skirts and the (4) tops of the pistons. If wear marks, scores or glazing is found on the piston skirt, check for a bent or twisted connecting rod.



2. **NOTE:** Make sure the oil ring holes are clean.

Using a Piston Ring Groove Scraper, clean the piston ring grooves.



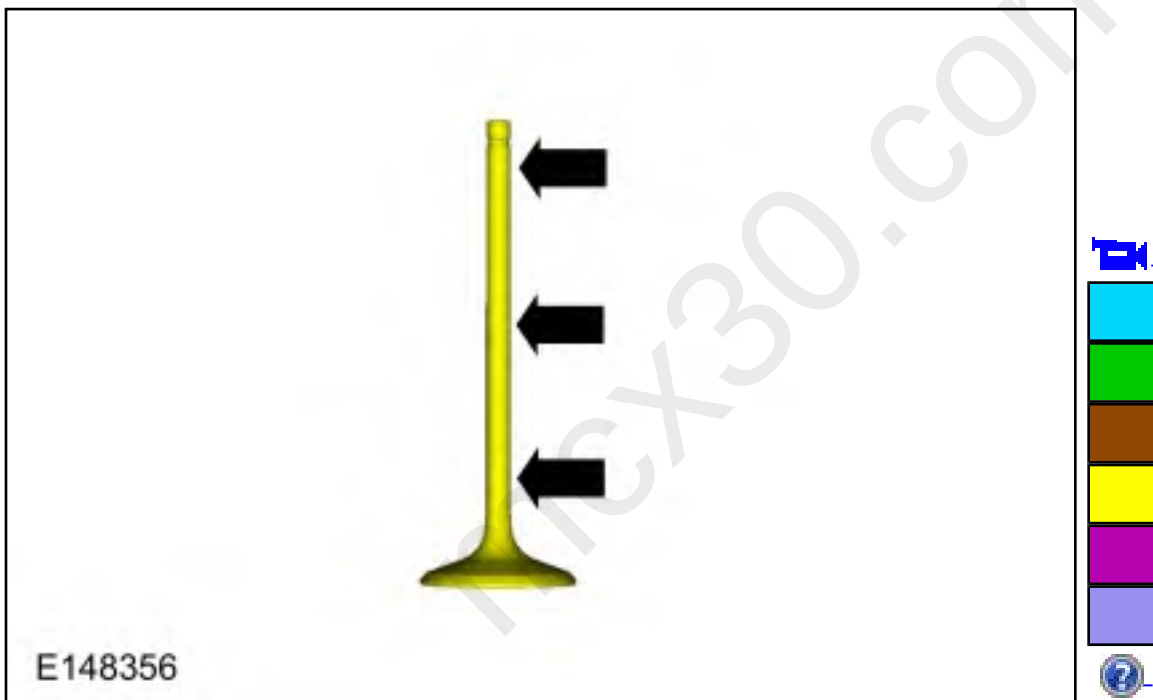
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## Valve Stem Diameter

### Check

**NOTE:** Refer to the appropriate Section 303-01 for the specification.

1. Measure the diameter of each intake and exhaust valve stem at the points shown. Verify the diameter is within specification.



# Crankshaft Main Bearing Journal Clearance

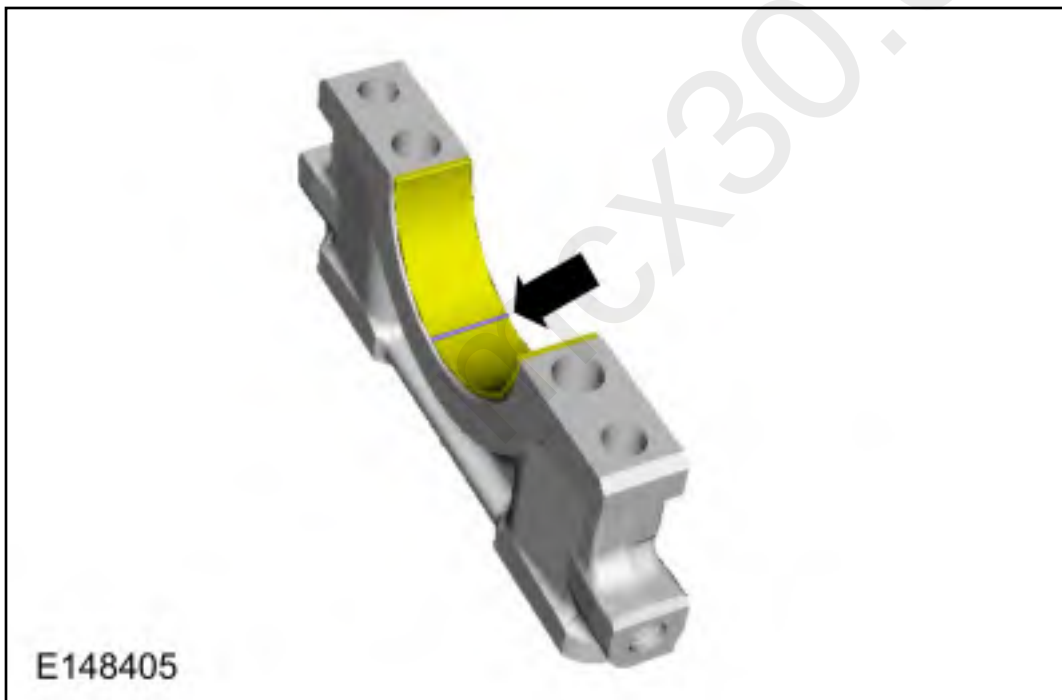
## Check

**NOTE:** Refer to the appropriate Section 303-01 for the specification.

1. **NOTE:** Crankshaft main bearing journals must be within specifications before checking journal clearance.

Remove the crankshaft main bearing cap and crankshaft main bearing.

2. Position a piece of Plastigage across the crankshaft main bearing surface.



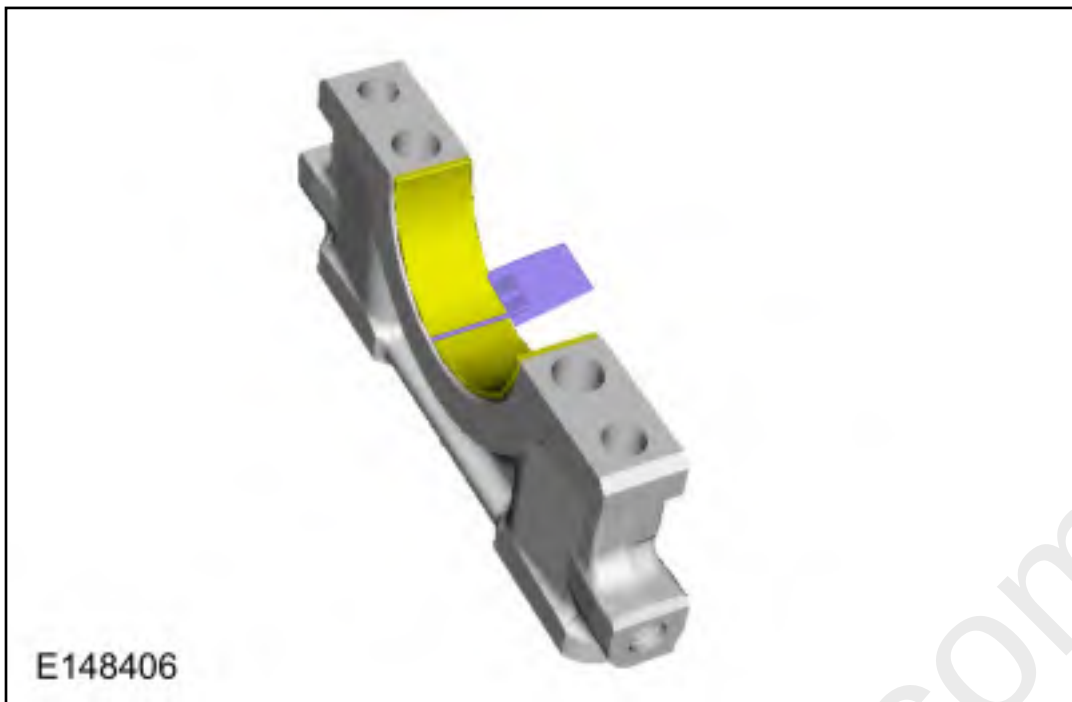
3. **NOTE:** Do not turn the crankshaft while carrying out this procedure.

Install and tighten to specifications, then remove the crankshaft main bearing cap.

4. Measure the Plastigage to get the crankshaft main bearing clearance. The Plastigage should be



smooth and flat. A changing width indicates a tapered or damaged crankshaft or crankshaft bearing.



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# Powertrain/Drivetrain Mount Neutralizing

## Adjustment

**NOTE:** Refer to the appropriate section and procedure for special instructions on loosening and tightening mount fasteners.

1. With the vehicle in NEUTRAL, position it on a hoist.  
Refer to: [Jacking and Lifting - Overview](#) (100-02 Jacking and Lifting, Description and Operation).
2. Loosen, but do not remove, the powertrain/drivetrain mount fasteners.
3. Lower the vehicle.
4. **NOTE:** Do not twist or strain the powertrain/drivetrain mounts or damage to the mounts may occur.

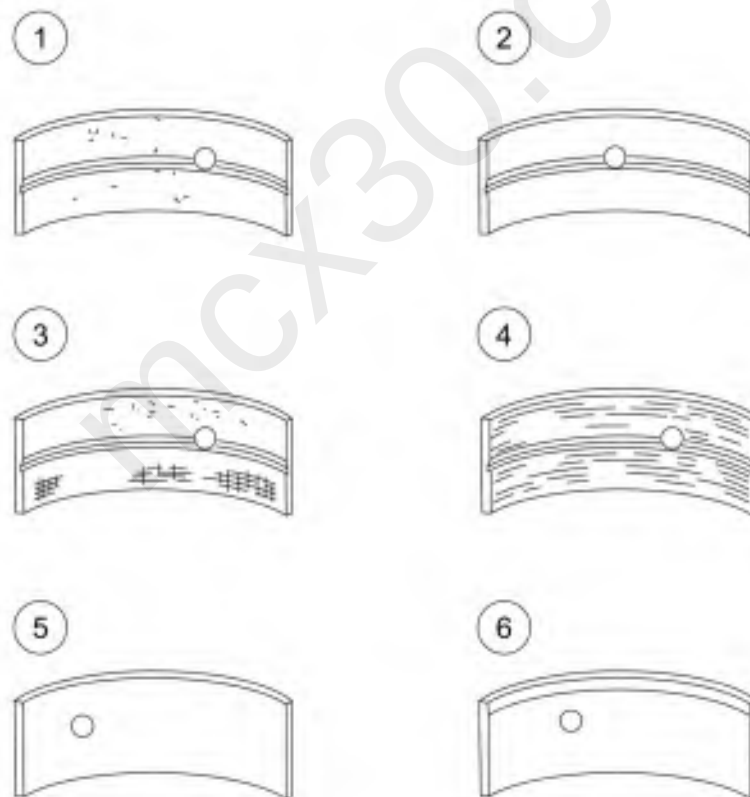
Start the vehicle and move it in forward 0.6 m (1.97 ft) - 1.2 m (3.94 ft). Then move the vehicle in reverse the same distance.

5. Raise and support the vehicle.
6. Tighten the powertrain/drivetrain mount fasteners.
7. Lower the vehicle.
8. Test the system for normal operation.

# Bearing Inspection

## Inspection

1. Cratering - fatigue failure
2. Spot glazing - incorrect seating
3. Scratching - dirty engine oil
4. Base exposed - poor lubrication
5. Both edges worn - journal damaged
6. One edge worn - journal tapered or bearing not seated



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# Spark Plug Inspection

## Inspection

**NOTE:** *Dropped spark plugs should always be discarded.*

## Unfired

- An unfired spark plug should appear very clean with a pure nickel finish to the threads and ground strap. The center electrode ceramic insulator surface is often a matte or dull finish and pure white in color. The external primary insulator is often a polished white ceramic with appropriate stamping labels. Some spark plugs have a smooth barrel while others have a ribbed barrel insulator. Ford spark plugs almost universally use a ribbed barrel with glazed blue rib peaks. The Anti-Fouling silicone oil treatment used on all Ford spark plugs may be tinted pink. Some suppliers use this to designate the silicone oil has been applied.
- No corrective action necessary.



## Normal Burning

- A normal burning spark plug will often present with a white or slightly off-white (brown or light gray) color center electrode and clean or mildly discolored ground strap.
- No corrective action necessary.



## Carbon Fouling

- Carbon fouling can cause engine misfire. As carbon deposits, created during incomplete combustion, adhere to center electrode insulator surfaces, insulator dielectric and isolation or shunt resistance are compromised. In the case that sufficient carbon deposits are present on the center electrode and insulator surface the primary conduction path can change from spark creation to shorting through carbon deposits. This is also known as spark leakage. Upon shorting through carbon deposits, available voltage delivered to the center electrode tip is reduced until no spark is delivered to the mixture and a misfire occurs. Proper Heat Range selection is necessary to avoid pre-ignition and carbon fouling. Even with the proper Heat Range, avoid excessive cold starts and/or excessive idling at cold engine temperatures without a warm-up drive cycle. For proper self-cleaning, be sure to warm the spark plug using a medium-load drive cycle. A normal operating temperature for a spark plug may be 450-850°C (842-1562°F), at which point carbon deposits will burn off during spark plug self-cleaning.
- A drive cycle of enough distance and rpm can clear the spark plugs of carbon fouling (ex: 4 mile drive at 3000 rpm).
- Should this fail, install new spark plugs.



## Lead Fouling and Erosion

- Lead fouling can occur in engines that use leaded gasoline. In modern engine applications, this failure mode is rare, as TEL (Tetraethyllead) was removed from consumer use at fuel filling stations long ago. Lead fouling can occur on engines used in high compression racing engines and, in some limited cases, aviation applications. Spark plugs that have been used in the presence of lead are characteristically identified by a yellow/brown tinted center electrode insulator and can cause engine misfire at high engine speed and high load. Additionally, ground strap electrodes will often be worn in engines exposed to leaded fuel for extended periods of time. This failure mode is caused by the tendency for lead compounds to react chemically with nickel electrode materials at high temperatures. These chemical reactions often cause increased brittleness and reduced material strength in the ground electrode.
- Alert the customer to avoid using leaded fuel and/or octane enhancer.
- Inspect the CMS (catalyst monitor sensor) and the HO2S for evidence of lead damage.
- Install new spark plugs.





### Coolant/Oil Wet Fouling

- Wet fouling is most often caused by excess fuel, oil, or coolant within the combustion chamber during operation. Spark plugs that are wet fouled often cause poor starting and misfiring. Often, a wet fouled spark plug is indicative of additional mechanical issues within the engine system such as a compromised head gasket, oil leakage past the control ring, or valve train leakage. In certain cases, other causes could be low compression, vacuum leaks, overly retarded timing, or improper spark plug heat range. The primary cause of misfire is the low resistance path created by oil, fuel, or coolant deposits. Wet materials provide a lower resistance path for spark leakage from the high voltage center electrode to ground. When driving with a coolant leak for an extended time, the plug may be cleaned.
- Check for wet, black deposits on the insulator shell bore electrodes, caused by excessive oil entering the combustion chamber through worn rings and pistons, excessive valve-to-guide clearance or worn or loose bearings.
- Correct the coolant or oil leak concern.
- Install new spark plugs.





## Deposit Buildup

- The presence of deposits on the spark plug can be indicative of oil leakage or poor fuel quality. Often, these ashy coatings cause misfires as a low resistance path from center electrode to ground is created.
- Correct the oil leak, if necessary.
- Inform the customer of possible poor quality fuel.
- Install new spark plugs.



### Abnormal Erosion/Corrosion/Oxidation

- Often, eroded, corroded, or oxidized spark plug conditions occur as a result of leaded gasoline, which reacts with electrode materials (see Lead Fouling). These symptoms appear as pitted, cracked, or eroded electrodes and on occasion will display with a green cast if copper oxidation is heavy. These conditions result in increased, improper spark plug gap and yield poor performance. More recently, the use of Ethanol fuel blends of E85 (85% Ethanol) can create this Oxidation condition. The Heat Range selection for E85 applications typically is 1 range colder due to added spark advance used to make up for the loss of performance. The hotter tip temperatures combined with the rapid thermal cycle on the electrode surface initiates surface cracks and eventual oxidation based corrosion.
- Verify E85 isn't being used in a vehicle not designated for E85 usage (Flex Fuel Vehicle).
- Install new spark plugs.



## Ground Electrode Breakage

- Ground electrode breakage can be caused by pre-ignition or any other excess shock load. Ground electrode breaks may be caused by incorrect ignition timing, wrong type of fuel, or unauthorized installation of a reduced thermal conductivity Heli-Coil insert in place of the spark plug threads.
- Confirm the proper fuel and ignition timing.
- Confirm the proper heat range of spark plugs.
- Confirm that the cylinder head threads have not been repaired with a Heli-Coil thread repair kit.
- Install new spark plugs.



### MMT Fouling (Hot Plug Fouling)

- MMT (Methylcyclopentadienyl Manganese Tricarbonyl) is often used as an octane booster in combination with poor quality fuels to bring octane levels within acceptable limits. If excess Mn (Manganese) levels are present in the fuel during combustion, Mn deposits can foul the combustion chamber, catalytic converters, and spark plugs. Mn in higher concentrations can lead to pre-ignition and engine misfire. Mn deposit become conductive as the surface exceeds  $\sim 550^{\circ}\text{C}$  ( $1022^{\circ}\text{F}$ ). For this reason the failure mode is referred to as Hot Plug Fouling. As MMT is high in manganese, a reddish coating will be present on the spark plug insulator and ground electrodes. The reddish coating is often covered up by carbon fouling if the spark plug is to the point of misfire.
- Advise the customer to avoid use of leaded fuel and/or octane enhancer.
- Inspect the CMS and the HO2S for evidence of MMT damage.
- Install new spark plugs.





### Ferrocene Fouling (Hot Plug Fouling)

- Ferrocene (metallocene) is an organometallic compound often used in place of MMT as an octane booster and presents itself with a bright orange surface color. If excess ferrocene levels are present in the fuel during combustion, ferrocene deposits can foul the combustion chamber, catalytic converters, and spark plugs. Deposit become conductive as the surface exceeds  $\sim 450^{\circ}\text{C}$  ( $842^{\circ}\text{F}$ ). For this reason the failure mode is referred to as Hot Plug Fouling. Ferrocene in higher concentrations can lead to pre-ignition and engine misfire.
- Advise the customer that they may be using leaded fuel and/or octane enhancer. Ask them to stop.
- Inspect the CMS and the HO2S for evidence of ferrocene damage.
- Install new spark plugs.



### Overheating and Melted Electrodes

- Symptoms of overheating include white or light gray spots and a bluish-burnt appearance of the electrodes. This is caused by engine overheating, wrong type of fuel, loose spark plugs, spark plugs with an incorrect heat range, low fuel pump pressure, or incorrect ignition timing. Fused deposits present with melted or spotty deposits resembling bubbles or blisters and are indicative of sudden acceleration.
- Confirm proper fuel and ignition timing.
- Confirm proper heat range of spark plugs.
- Check the coolant system for leaks and blockages, and check water pump for malfunction.
- Repair coolant system and refill coolant, as necessary.
- Install new spark plugs.



## Insulator Damage and Breakage

12. **NOTE:** *Upper right hand insert shows dielectric puncture typically due to excessively worn gaps.*

- Center electrode insulator breakage is often caused by a sudden thermal shock due to sudden heating or cooling. It can also be caused by mechanical load from an external source (droppage) or can even be caused by pre-ignition events where side loading from combustion pressure shock waves is strong enough to fracture the ceramic insulator material. Hotter heat range spark plugs have a longer insulator to reduce the spark plug fouling risk, but are also weaker to fracture during low speed pre-ignition events due to increase bending moment arm. Oil or Sulfur Oxide migration between the center electrode and the inner diameter of the insulator can cause internal outward force sufficient to create a “u” shaped fracture. See Sodium/Oil Migration section for further detail of this failure mode.
- Install new spark plugs.





## Sodium/Oil Migration

- In the case of oil migration, misted oil is absorbed into the combustion chamber during charge intake. For cylinder deactivation, valves remain closed and oil within the chamber does not combust. Misted oil adheres to the spark plug surfaces and oil penetrates into the clearance volume between the insulator and center electrode via capillary action. During cylinder reactivation, oil near the surface is burned off, while soot (carbon deposits) is generated within clearance volumes due to incomplete combustion. During spark plug reheating, the center electrode thermally expands at a much greater rate than the insulator, causing compressive stresses within the center electrode and tensile stresses on the electrode insulator exterior. These stresses can fracture the ceramic insulator if sufficiently high. In sodium migration, sodium sulfate is created during combustion and deposits form in the clearance volume between center electrode and insulator. Currently, the source of sodium sulfate is not known, although it is believed to originate from E100 fuel. Present theory suggests that failure is caused by electrode/insulator locking, where electrode and insulator are mechanically joined by the sodium sulfate. During cool down, the electrode contracts and increases in diameter, which pushes (via sodium sulfate) against the insulator and causes failure in the same manner as seen in oil migration.
- Install new spark plugs.





## Bridged Gap

- A bridged spark plug gap is often caused by fuel droplets present in the ion gap when spark is commanded. The spark event conducts through the fuel droplet leaving behind a carbon fiber. Other contributors include deposit build up on the electrode surface which is indicative of carbon or oil fouling. Often, this condition can present itself after many low and medium load cycles. Carbon deposits within the combustion chamber can break free during sudden applications of high load, lodge within the spark plug gap, and provide a dead short to ground.
- Install new spark plugs.
- A drive of between 4-10 miles targeting 3000 rpm will bring the plug to self-cleaning temperature.



## Wrench Breaking Cracks

- Wrench breaking cracks are typically caused either by side load or torque applied from a socket of incorrect size. Impact loading can and will often crack the insulator shell as the porcelain is very brittle with very little strength under tension. Force direction is often easily determined as the ceramic often cracks vertically (although typically asymmetric about the centerline).
- Avoid using anything but a spark plug socket and hand tools to better prevent these cracks.
- Install new spark plugs.



## Tracking/Flashover

- Tracking marks are markings left behind when a high voltage discharge occurs from electrode to ground through something other than the air gap at the spark plug end. Most often, these discharges occur along the primary insulator (under/near the boot) and on the center electrode insulator. These discharges typically scorch the porcelain ceramic and leave a brown burned visual indicator. In the primary photo, a large brown scorch mark is apparent. In the upper secondary photo, track marks are present along each rib. In the lower secondary photo, which shows a case of typical carbon fouling, track marks are present along the primary center electrode insulator as the spark current tracked along the insulator until it jumped sideways to the metal shell.
- Install new spark plugs.
- Install new ignition coil boot (if tracking is above the hex).
- If tracking is present above the hex, both of the above parts must be changed at the same time because the track is present on both components. If only one is changed, the problem will persist and a return visit is very likely.



## Corona Stain

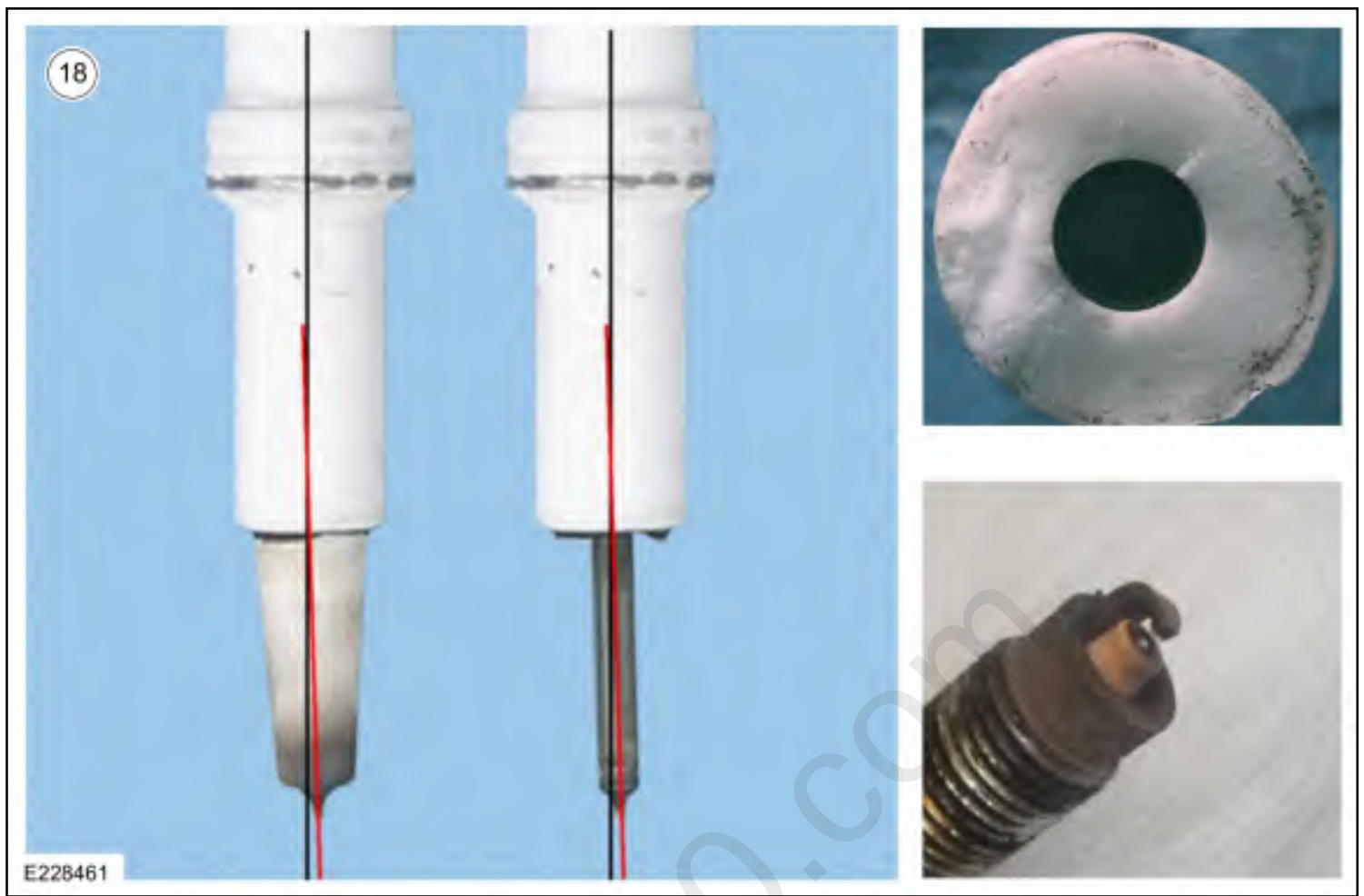
- A brown stain near where the insulator joins the metal shell of the spark plug is often called a corona stain and is produced when oil particles present in the air near the engine adhere to the insulator surface. Corona discharge occurs when high voltage applied to the conductor on top of the spark plug causes an insulation breakdown of the air gap between the insulator and metal shell. Corona stain does not affect spark plug performance. In the upper right photograph, tracking marks are present indicating evidence of flash over on ribs, but stop once the corona stain is reached. This suggests the corona stain is not conductive, even in the presence of high kilovolts during normal operation. The lower right photo demonstrates corona staining on the inside of a boot.
- No corrective action is necessary if only a corona stain is present.





### Center Electrode Bending/Breaking from Pre-Ignition Events (Rattler)

- Under extreme pre-ignition events, a shock wave traveling across the combustion chamber can bend the center electrode and break the center electrode porcelain insulator. Under these extreme circumstances, a “rattler” can be formed where the center electrode insulation breaks free of the spark plug and rattles under vibration. In the photos, a bent center electrode is highlighted in the main photo while the upper secondary photo shows the fracture surface of a broken insulator and the lower secondary photo shows a spark plug with a detached center electrode insulator.
- Install new spark plugs.



### Corrosion (Water Damage)

- Corrosion found on the wrench/threaded area can be a sign that the spark plug has experienced moisture and heat. Often this condition occurs when water has penetrated spark plug tube seals and entered the spark plug tube. Many times, this corroded spark plug also displays symptoms of misfire (as water provides a low resistance path from high voltage coil to ground) and the combustion chamber interface (center electrode and ground strap) will often be heavily carbon fouled.
- Check for the source of water intrusion and correct as necessary.
- Install new spark plugs.
- Install new ignition coil and boot assembly.
- Advise the customer to avoid direct water spray on the coil boots.



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## Specifications

### Engine

| Item                                           | Specification                 |
|------------------------------------------------|-------------------------------|
| Displacement                                   | 5.038 L (307 CID)             |
| No. of cylinders                               | 8                             |
| Bore                                           | 93.0 mm (3.661 in)            |
| Stroke                                         | 92.7 mm (3.649 in)            |
| Firing order                                   | 1-3-7-2-6-5-4-8               |
| Spark plug                                     | 12405                         |
| Spark plug gap                                 | 1.25-1.35 mm (0.049-0.053 in) |
| Compression ratio                              | 12:1                          |
| Engine weight (W/O accessory drive components) | 453.0 lb (205.5 kg)           |

### Lubricants

| Item                                                                                                                 | Specification                             |
|----------------------------------------------------------------------------------------------------------------------|-------------------------------------------|
| Motorcraft® SAE 5W-20 Premium Synthetic Blend Motor Oil (US); Motorcraft® SAE 5W-20 Super Premium Motor Oil (Canada) | XO-5W20-QSP (US); CXO-5W20-LSP12 (Canada) |



## Engine Oil Capacity

| Item                              | Specification    |
|-----------------------------------|------------------|
| Service fill including oil filter | 8.75 qt (8.28 L) |

## Oil Pressure

| Item                                                                 | Specification           |
|----------------------------------------------------------------------|-------------------------|
| Oil pressure @ idle with engine at normal operating temperature      | 10–15 psi (69–103 kPa)  |
| Oil pressure @ 2,000 rpm with engine at normal operating temperature | 30–40 psi (207–276 kPa) |

## Cylinder Head and Valve Train

| Item                                    | Specification                                          |
|-----------------------------------------|--------------------------------------------------------|
| Combustion chamber volume               | 3.33–3.51 in <sup>3</sup> (54.5–57.5 cm <sup>3</sup> ) |
| Valve stem diameter - intake            | 0.2352–0.2360 in (5.975–5.995 mm)                      |
| Valve stem diameter - exhaust           | 0.2343–0.2350 in (5.95–5.97 mm)                        |
| Valve stem-to-guide clearance - intake  | 0.0007–0.0027 in (.019–.069 mm)                        |
| Valve stem-to-guide clearance - exhaust | 0.0017–0.0037 in (.044–.094 mm)                        |
| Valve head diameter - intake            | 1.48 in (37.7 mm)                                      |
| Valve head diameter - exhaust           | 1.26 in (32 mm)                                        |
| Valve face runout                       | 0.0020 in (.05 mm)                                     |
| Valve face angle                        | 3 angle intake / 2 angle exhaust                       |
| Valve seat width - intake               | 0.047–0.055 in (1.2–1.4 mm)                            |
| Valve seat width - exhaust              | 0.055–0.063 in (1.4–1.6 mm)                            |
| Valve seat roundness                    | 0.0098 in (.25 mm)                                     |

|                                          |                                                                                                                                                       |
|------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| Valve seat to guide runout               | 0.0016 in (0.04 mm) at bottom of guide                                                                                                                |
| Valve seat angle (degrees) - Intake      | 120/90/54 degrees                                                                                                                                     |
| Valve seat angle (degrees) - Exhaust     | 120/100/60 degrees                                                                                                                                    |
| Valve spring free length - intake        | 2.201 in (55.9 mm)                                                                                                                                    |
| Valve spring free length - exhaust       | 2.201 in (55.9 mm)                                                                                                                                    |
| Valve spring perpendicularity - intake   | 0.067 in (1.7 mm)                                                                                                                                     |
| Valve spring perpendicularity - exhaust  | 0.067 in (1.7 mm)                                                                                                                                     |
| Valve spring compression force - intake  | 813 N                                                                                                                                                 |
| Valve spring compression force - exhaust | 813 N                                                                                                                                                 |
| Valve spring installed height - intake   | 1.7913 in (45.5 mm)                                                                                                                                   |
| Valve spring installed height - exhaust  | 1.7913 in (45.5 mm)                                                                                                                                   |
| Valve spring installed force - intake    | 293 N                                                                                                                                                 |
| Valve spring installed force - exhaust   | 293 N                                                                                                                                                 |
| Roller follower ratio                    | 2.039:1 intake / 2.041:1 exhaust, max                                                                                                                 |
| Cylinder head gasket surface flatness    | 0.025 mm (0.001 in) in any 25 mm (1 in) x 25 mm (1 in) area; 0.050 mm (0.002 in) in any 150 mm (6 in) x 150 mm (6 in) area; 0.1 mm (0.004 in) overall |

## Hydraulic Lash Adjuster

| Item                              | Specification                  |
|-----------------------------------|--------------------------------|
| Diameter — intake                 | 0.472 in (12 mm)               |
| Diameter — exhaust                | 0.472 in (12 mm)               |
| Clearance-to-bore                 | 0.0004–0.0020 in (.01–.051 mm) |
| Hydraulic leakdown rate — intake  | 0.45-3 seconds <sup>a</sup>    |
| Hydraulic leakdown rate — exhaust | 0.45-3 seconds <sup>a</sup>    |
| Collapsed lash adjuster gap       | 0.0138–0.0335 in (.35–.85 mm)  |

## Camshaft

| Item                                                              | Specification                       |
|-------------------------------------------------------------------|-------------------------------------|
| Lobe lift - intake                                                | 0.2728 in (6.9279 mm)               |
| Lobe lift - exhaust                                               | 0.2727 in (6.9254 mm)               |
| Journal diameter                                                  | 1.1268 in (28.62 mm)                |
| Camshaft bearing bore inside diameter - Journal 1 (exhaust front) | 1.3783–1.3792 in (35.008–35.032 mm) |
| Camshaft bearing bore inside diameter - Journal 2-10              | 1.1292–1.1282 in (28.682–28.657 mm) |
| Journal-to-bearing clearance - Journal 1 (exhaust front)          | 0.0011–0.0028 in (.028–.072 mm)     |
| Journal-to-bearing clearance - Journal 2-10                       | 0.0009–0.0030 in (.024–.075 mm)     |
| Runout                                                            | 0.0016 in (.04 mm)                  |
| End play - Intake                                                 | 0.0028–0.0067 in (.07–.17 mm)       |
| End play - Exhaust                                                | 0.0030–0.0065 in (.075–.165 mm)     |

## Cylinder Block

| Item                               | Specification                                           |
|------------------------------------|---------------------------------------------------------|
| Cylinder bore diameter             | 3.6614–3.6622 in (93–93.02 mm)                          |
| Cylinder bore maximum taper        | 0.0005 in (.013 mm)                                     |
| Cylinder bore maximum out-of-round | 0.0004 in (.01 mm)                                      |
| Main bearing bore inside diameter  | 2.850–2.851 in (72.4–72.424 mm)                         |
| Head gasket surface flatness       | 0.0254 mm (0.001 in) across any 38.1 mm (1.5 in) square |

## Crankshaft

| Item                                           | Specification                     |
|------------------------------------------------|-----------------------------------|
| Main bearing journal diameter                  | 2.657–2.658 in (67.481–67.505 mm) |
| Main bearing journal maximum taper             | 0.0002 in (.004 mm)               |
| Main bearing journal maximum out-of-round      | 0.0002 in (.006 mm)               |
| Main bearing journal-to-main bearing clearance | 0.0010–0.0018 in (.025–.045 mm)   |
| Connecting rod journal diameter                | 2.086–2.087 in (52.983–53.003 mm) |
| Connecting rod journal maximum taper           | 0.0002 in (.004 mm)               |
| Connecting rod journal maximum out-of-round    | 0.0002 in (.006 mm)               |
| Crankshaft maximum end play                    | 0.0110 in (.28 mm)                |

## Piston and Connecting Rod

| Item                                                           | Specification                       |
|----------------------------------------------------------------|-------------------------------------|
| Piston diameter - single grade                                 | 3.6284–3.6289 in (92.161–92.175 mm) |
| Piston-to-cylinder bore clearance (at grade size) <sup>b</sup> | 0.0010–0.0023 in (.025–.059 mm)     |
| Piston ring end gap - top                                      | 0.0079–0.0118 in (.2–.3 mm)         |
| Piston ring end gap - intermediate                             | 0.0197–0.0315 in (.5–.8 mm)         |
| Piston ring end gap — oil control                              | 0.0059–0.0177 in (.15–.45 mm)       |
| Piston ring groove width - top                                 | 0.0480–0.0492 in (1.22–1.25 mm)     |
| Piston ring groove width - intermediate                        | 0.0480–0.0488 in (1.22–1.24 mm)     |
| Piston ring groove width— oil control                          | 0.0799–0.0807 in (2.03–2.05 mm)     |
| Piston ring width - top                                        | 0.0461–0.0469 in (1.17–1.19 mm)     |
| Piston ring width - intermediate                               | 0.0461–0.0469 in (1.17–1.19 mm)     |
| Piston ring-to-groove clearance - top                          | 0.0012–0.0031 in (.03–.08 mm)       |
| Piston ring-to-groove clearance - intermediate                 | 0.0012–0.0028 in (.03–.07 mm)       |
| Piston pin bore diameter                                       | 0.8663–0.8665 in (22.004–22.01 mm)  |
| Piston pin diameter                                            | 0.8660–0.8661 in (21.997–22 mm)     |

|                                                                       |                                     |
|-----------------------------------------------------------------------|-------------------------------------|
| Piston pin length                                                     | 2.390–2.402 in (60.7–61 mm)         |
| Piston pin-to-piston fit (clearance)                                  | 0.0002–0.0005 in (.004–.013 mm)     |
| Connecting rod-to-pin clearance                                       | 0.0001–0.0007 in (.003–.018 mm)     |
| Connecting rod pin bore diameter                                      | 0.8663–0.8667 in (22.003–22.015 mm) |
| Connecting rod length (center-to-center)                              | 5.93 in (150.7 mm)                  |
| Connecting rod maximum allowed bend                                   | 0.0015 in (.038 mm)                 |
| Connecting rod maximum allowed twist                                  | 0.0020 in (.05 mm)                  |
| Connecting rod bearing-to-crankshaft clearance                        | 0.0011–0.0027 in (.028–.069 mm)     |
| Connecting rod side clearance (as assembled to crank) — standard play | 0.0128 in (.325 mm)                 |
| Connecting rod side clearance (as assembled to crank) — max. play     | 0.0197 in (.5 mm)                   |

- Time required for the plunger to leak down 1.6 mm of travel with 222 N force and leakdown fluid in the lash adjuster
- Before Grafal coating.

# Engine - Overview

Base Part Number: Base Part Number: 6L084

## Overview

The 5.0L is a V-8 engine with the following features:

- Interference design engine
- Dual overhead camshafts
- Four valves per cylinder
- SFI
- Direct fuel injection
- Aluminum cylinder heads
- Aluminum, 90-degree V-cylinder block
- Twin independent VCT system
- Individually chain-driven camshafts with a hydraulic timing chain tensioner on each timing chain
- Electronic ignition system with 8 ignition coils

## Engine Identification

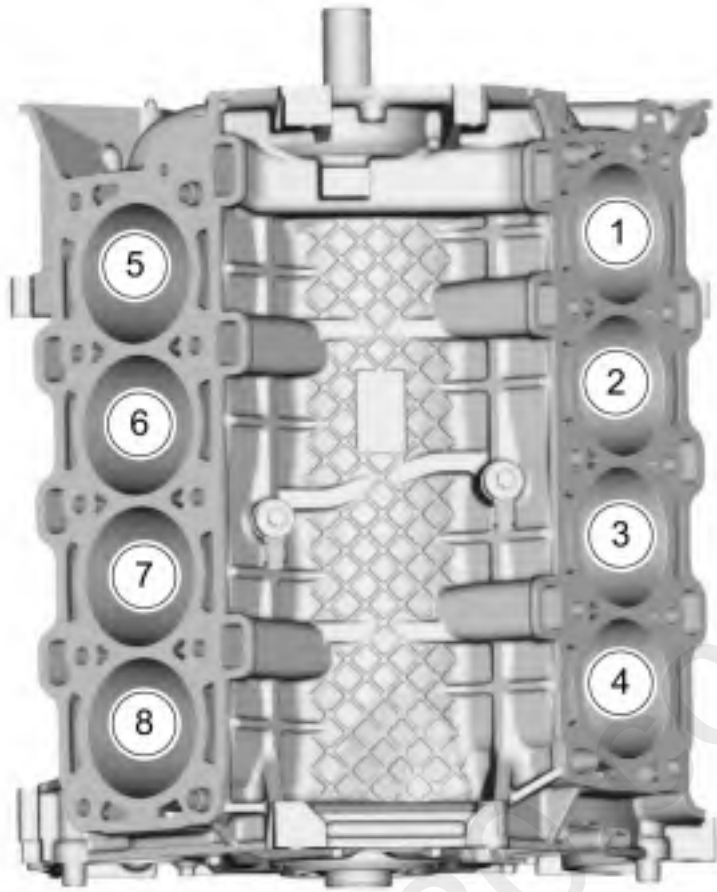
Always refer to these labels when installation of new parts is necessary or when checking engine calibrations. The engine parts often differ within a CID family. Verification of the identification codes will make sure the correct parts are obtained. The codes contain all the pertinent information relating to the dates, optional equipment and revisions.

## Engine Code Information Label



| Item | Description                         |
|------|-------------------------------------|
| 1    | Essex engine plant                  |
| 2    | Engine displacement                 |
| 3    | Engine build calender date (DDMMYY) |
| 4    | Engine build Julian date (YYJJJ)    |

**Engine Cylinder Identification**

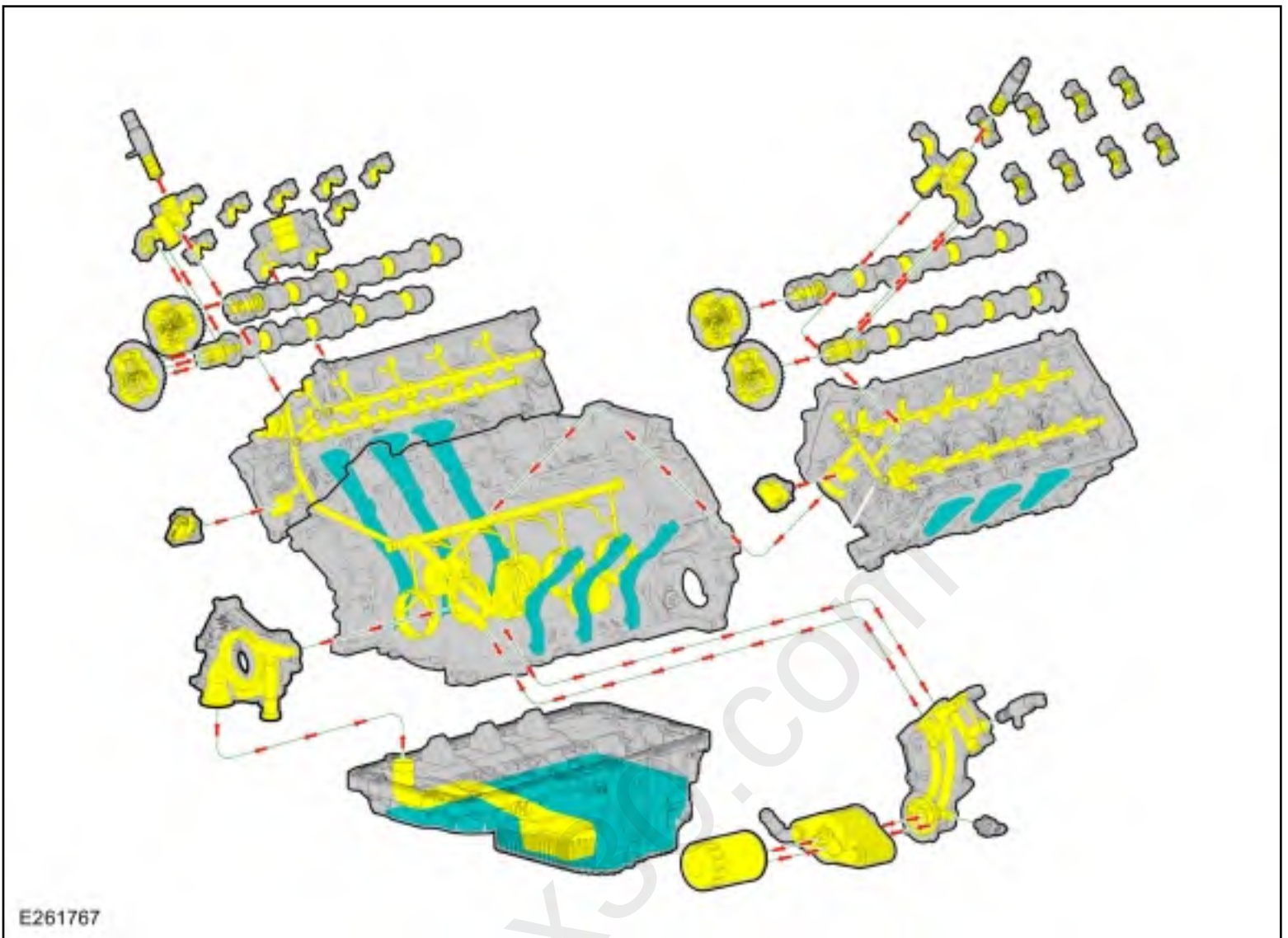


E189504

## Engine Oil Flow Illustration

### Oil Flow





| Item   | Description             |
|--------|-------------------------|
| Yellow | High pressure oil       |
| Blue   | Oil return low pressure |

## Lubrication System

The engine lubrication system is of the force-feed type in which oil is supplied under full pressure to the:

- crankshaft main bearings.
- crankshaft thrust main bearing.
- connecting rod bearings.
- oil galleries.

All other parts are lubricated by splash of the oil.

The lubrication system of the 5.0L (4V) engine is designed to provide optimum oil flow to critical components of the engine through its entire operating range. The heart of the system is a positive displacement internal gear oil pump using top seal rotors.

The heart of the system is a positive displacement internal gear oil pump.

Generically, this design is known as a gerotor pump, which operates as follows:

- The oil pump is mounted on the front face of the cylinder block.
- The inner rotor is piloted on the crankshaft post and is driven through flats on the crankshaft.
- System pressure is limited by an integral, internally-vented relief valve which directs the bypassed oil back to the inlet side of the oil pump.
- Oil pump displacement has been selected to provide adequate volume to make sure of correct oil pressure both at hot idle and maximum speed.
- The relief valve calibration protects the system from excessive pressure during high viscosity conditions.
- The relief valve is designed to provide adequate connecting rod bearing lubrication under high-temperature and high-speed conditions.

## **Valve Train**

The valves are actuated by a hydraulic lash adjuster and roller follower. The hydraulic lash adjusters and roller followers:

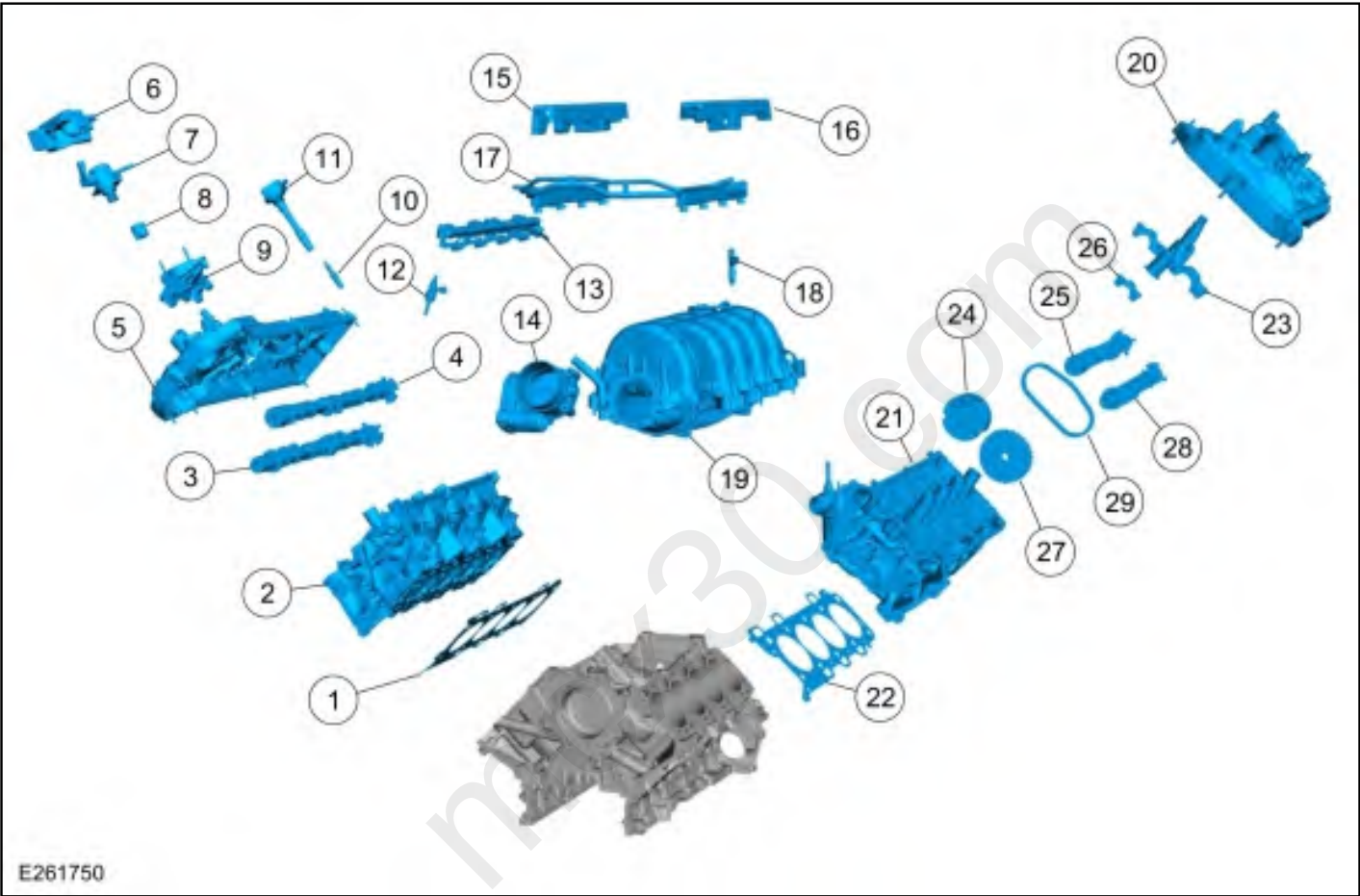
- provide hydraulic lash adjustment.
- ride on the camshaft lobes.

## **Twin Independent VCT System**

The twin independent VCT system allows variable control of the valves which optimizes combustion at full load providing improved power and low speed torque (broadening the torque curve) which enables variable valve overlap which provides better fuel economy and emissions and provides optimized cold start operation with improved exhaust emissions.

# Engine Component View

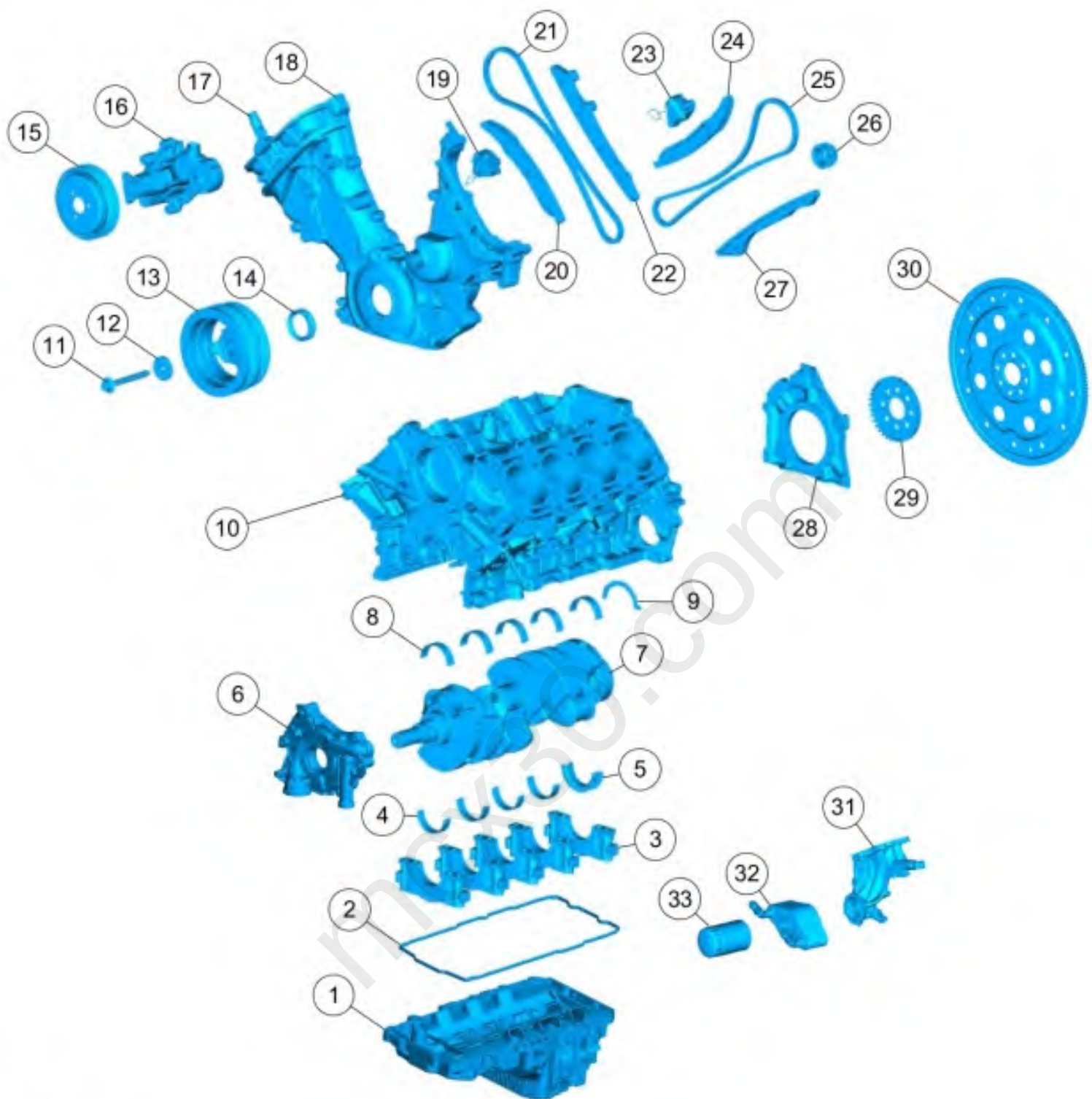
## Engine — Upper Components



| Item | Part Number | Description             |
|------|-------------|-------------------------|
| 1    | 6051        | RH cylinder head gasket |
| 2    | 6049        | RH cylinder head        |
| 3    | 6A272       | RH exhaust camshaft     |
| 4    | 6A270       | RH intake camshaft      |
| 5    | 6582        | RH valve cover          |
| 6    | 9U550       | Insulator               |
| 7    | 9D376       | High pressure fule pump |
|      |             |                         |

|    |       |                                                              |
|----|-------|--------------------------------------------------------------|
| 8  | 9C587 | Tappet                                                       |
| 9  | —     | Camshaft bearing cap (part of 6049)                          |
| 10 | 12405 | Spark plug (8 required)                                      |
| 11 | 12029 | Ignition coil on plug (8 required)                           |
| 12 | 9G929 | Fuel injector (Direct injection) (8 required)                |
| 13 | 9F797 | Fuel rail (Direct injection) (2 required)                    |
| 14 | 9F991 | Throttle body                                                |
| 15 | 6P013 | RH fuel injector insulator shield                            |
| 16 | 6P013 | LH fuel injector insulator shield                            |
| 17 | 9F792 | Fuel rail (PFI)                                              |
| 18 | 9F593 | Fuel injector (PFI) (8 required)                             |
| 19 | 9424  | Intake manifold                                              |
| 20 | 6582  | LH valve cover                                               |
| 21 | 6049  | LH cylinder head                                             |
| 22 | 6051  | LH cylinder head gasket                                      |
| 23 | —     | Camshaft bearing cap (part of 6049) (2 required)             |
| 24 | 6256  | Intake camshaft Variable Camshaft Timing (VCT) (2 required)  |
| 25 | 6A271 | LH intake camshaft                                           |
| 26 | —     | Camshaft bearing cap (part of 6049) (14 required)            |
| 27 | 6C525 | Exhaust camshaft Variable Camshaft Timing (VCT) (2 required) |
| 28 | 6A273 | LH exhaust camshaft                                          |
| 29 | 6268  | Secondary timing chain (2 required)                          |

## Engine — Lower Components



E261749

| Item | Part Number | Description                                             |
|------|-------------|---------------------------------------------------------|
| 1    | 6675        | Oil pan                                                 |
| 2    | 6C878       | Oil pan gasket                                          |
| 3    | —           | Crankshaft main bearing cap (part of 6010) (5 required) |
| 4    | 6A338       | Crankshaft lower main bearing (4 required)              |



|    |         |                                                                     |
|----|---------|---------------------------------------------------------------------|
| 5  | 6A339   | Crankshaft lower thrust main bearing                                |
| 6  | 6600    | Oil pump                                                            |
| 7  | 6303    | Crankshaft                                                          |
| 8  | 6333    | Crankshaft upper main bearing (5 required)                          |
| 9  | 6A341   | Thrust washer                                                       |
| 10 | 6010    | Cylinder block                                                      |
| 11 | 6A340   | Crankshaft pulley bolt                                              |
| 12 | N807033 | Crankshaft pulley washer                                            |
| 13 | 6316    | Crankshaft pulley                                                   |
| 14 | 6700    | Crankshaft front oil seal                                           |
| 15 | 8509    | Coolant pump pulley                                                 |
| 16 | 8501    | Coolant pump                                                        |
| 17 | 6B297   | Variable Camshaft Timing (VCT) variable force solenoid (2 required) |
| 18 | 6019    | Engine front cover                                                  |
| 19 | 6L266   | RH primary timing chain tensioner                                   |
| 20 | 6K255   | RH timing chain tensioner arm                                       |
| 21 | 6268    | RH primary timing chain                                             |
| 22 | 6M256   | RH timing chain guide                                               |
| 23 | 6L266   | LH primary timing chain tensioner                                   |
| 24 | 6K255   | LH timing chain tensioner arm                                       |
| 25 | 6268    | LH primary timing chain                                             |
| 26 | 6306    | Crankshaft sprocket                                                 |
| 27 | 6B274   | LH timing chain guide                                               |
| 28 | 6K318   | Crankshaft rear seal retainer plate                                 |
| 29 | 12A227  | Crankshaft sensor ring                                              |
| 30 | 6375    | Flexplate (automatic transmission)                                  |
| 31 | 6881    | Oil filter adapter                                                  |
| 32 | 6A642   | Oil cooler                                                          |
| 33 | 6731    | Oil filter                                                          |

# Engine

Base Part Number: Base Part Number: 6L084

1. For basic mechanical concerns.

REFER to: Engine (303-00 Engine System - General Information) .

For driveability concerns. Refer to Powertrain Control/Emissions Diagnosis (PC/ED) manual.

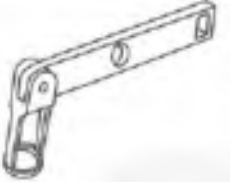
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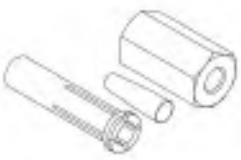
## Cylinder Head

Base Part Number: Base Part Number: 6051

### Special Tool(s) / General Equipment

|                                                                                               |                                                                                                                                 |
|-----------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------|
| <br>E223048   | 303-1249<br>Valve Spring Compressor<br>TKIT-2006UF-FLM<br>TKIT-2006UF-ROW                                                       |
| <br>E222987  | 303-1418<br>Compressor, Valve Spring<br>TKIT-2008ET-FLM<br>TKIT-2008ET-ROW                                                      |
| <br>E222987 | 303-1567<br>Sizer, Teflon Seal<br>TKIT-2010C-FLM                                                                                |
| <br>E134677 | 303-300 (T87C-6565-A)<br>Set, Valve Spring Compressor<br>T88C-1000-ST<br>TKIT-1988-FESTIVA<br>TKIT-1988-TRACER<br>TKIT-2009TC-F |
| <br>E134678 | 303-350 (T89P-6565-A)<br>Compressor, Valve Spring<br>TKIT-1989-F<br>TKIT-1989-FLM<br>TKIT-1989-FM<br>TKIT-1990-LMH              |



|                                                                                              |                                                                     |
|----------------------------------------------------------------------------------------------|---------------------------------------------------------------------|
| <br>E222982  | 307-005 (T59L-100-B)<br>Slide Hammer                                |
| <br>E223046  | 310-205<br>Fuel Injector Brush                                      |
| <br>E168032  | 310-206<br>Remover, Fuel Injector<br>TKIT-2009A-FLM                 |
| <br>E223047 | 310-207<br>Installer, Fuel Injector Seal Assembly<br>TKIT-2009A-FLM |

## Materials

| Name                                                           | Specification |
|----------------------------------------------------------------|---------------|
| Motorcraft® SAE 5W-20 Synthetic Blend Motor Oil<br>XO-5W20-QSP | WSS-M2C945-A  |
| Motorcraft® Orange Concentrated Antifreeze/Coolant<br>VC-3-B   | WSS-M97B44-D  |

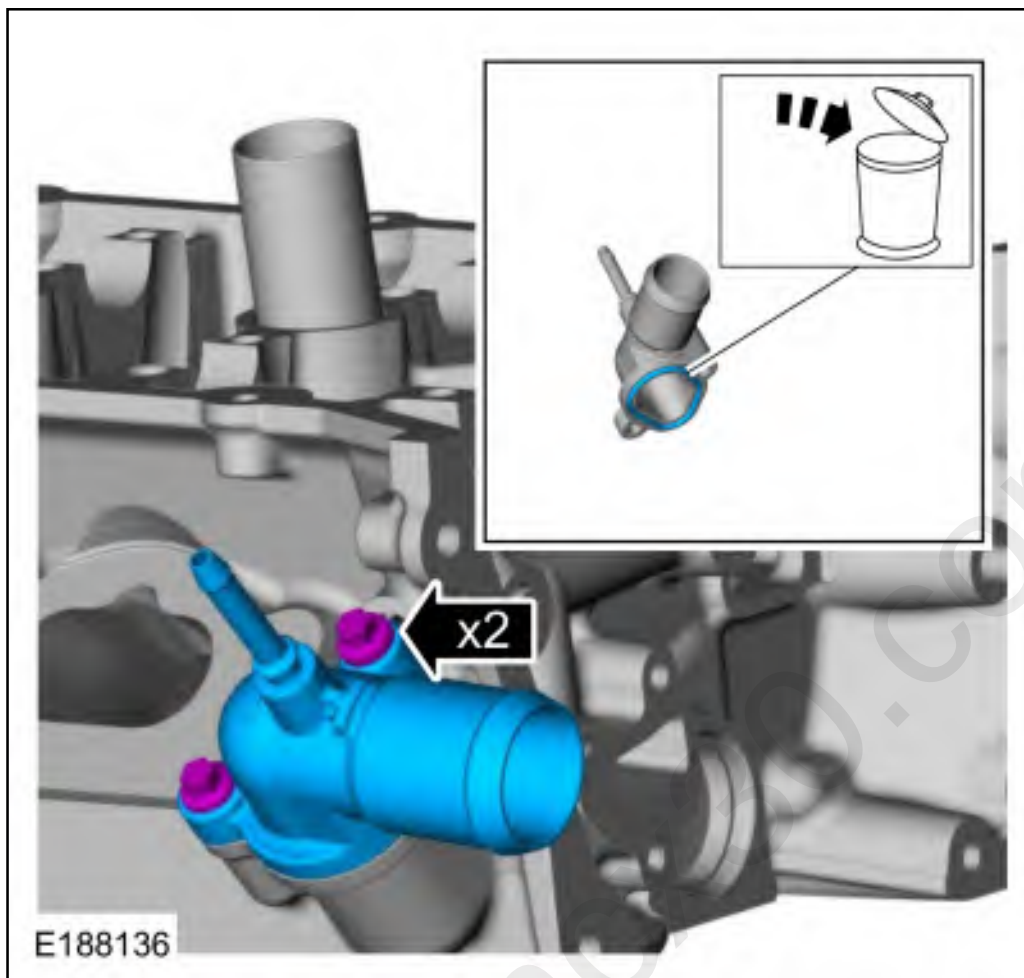
## DISASSEMBLY

**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:** If the components are to be reinstalled, they must be installed in their original locations. Mark the components for installation into their original locations.

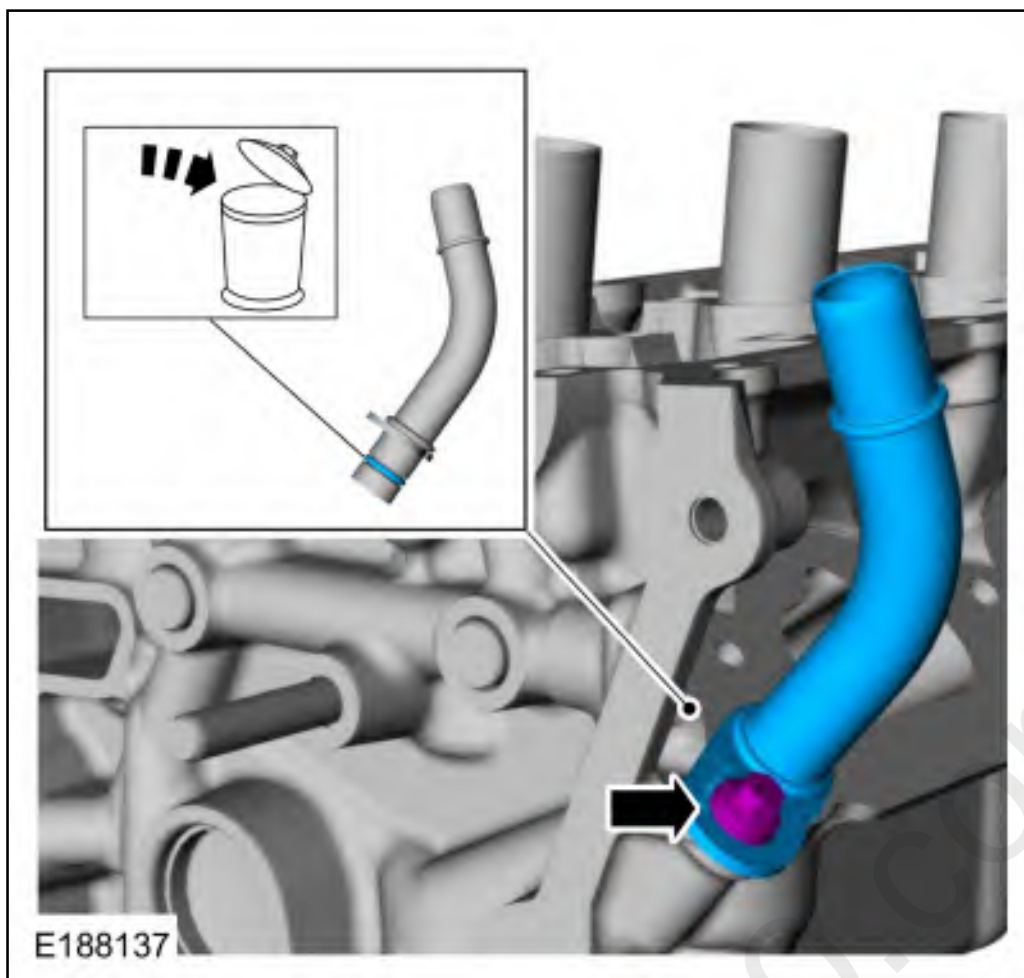
## LH cylinder heads

1. Remove the bolts and the coolant outlet.
  - Discard the gasket.

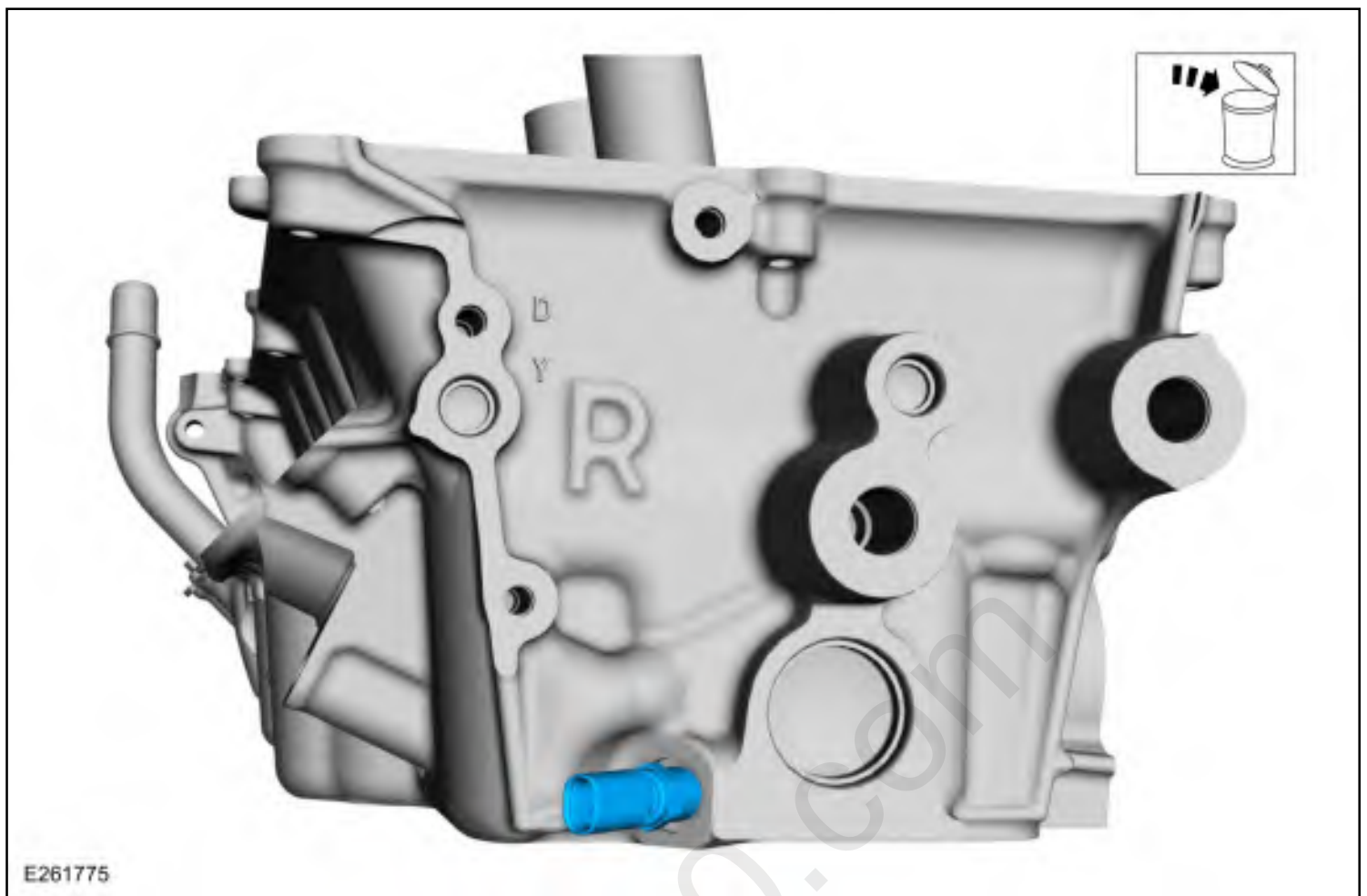


## RH cylinder heads

2. Remove the bolt and the coolant outlet.
  - Discard the O-ring seal.

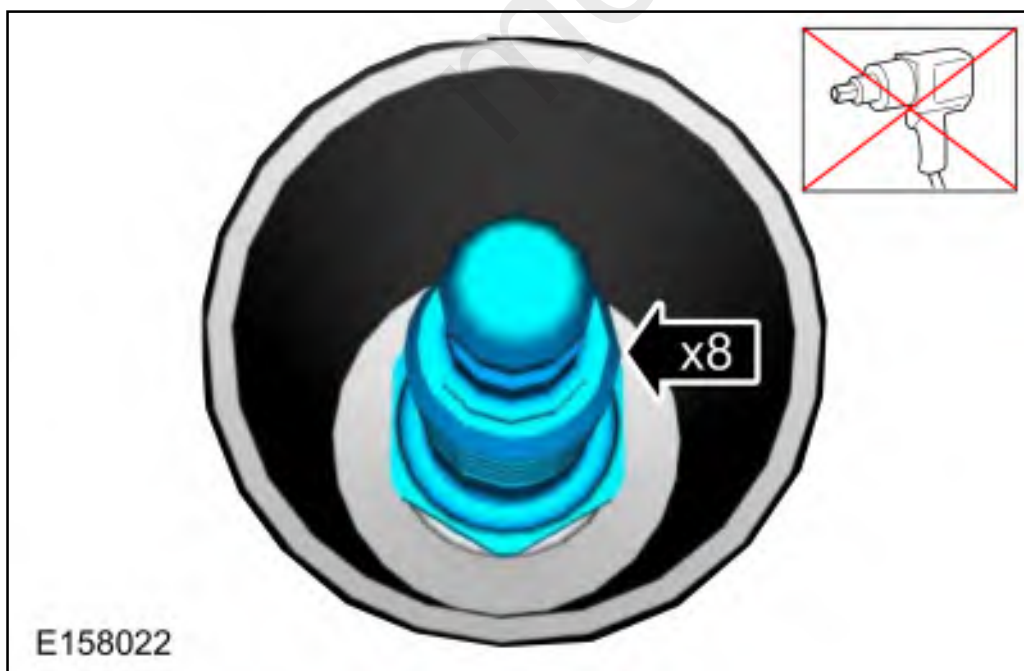


3. Remove and discard the CHT sensor.



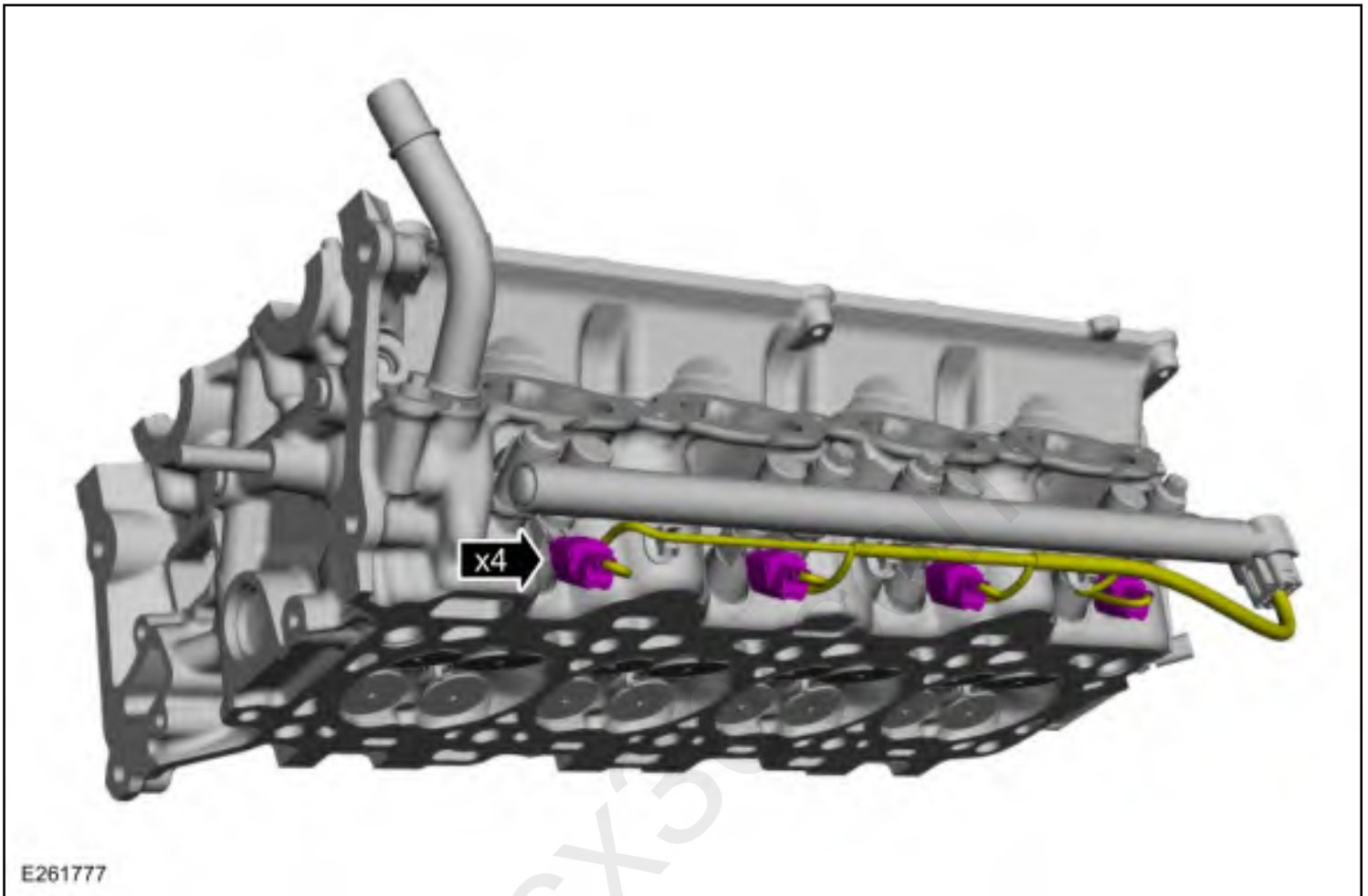
## All cylinder heads

4. Remove the spark plugs.



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

Disconnect the fuel injector electrical connectors.



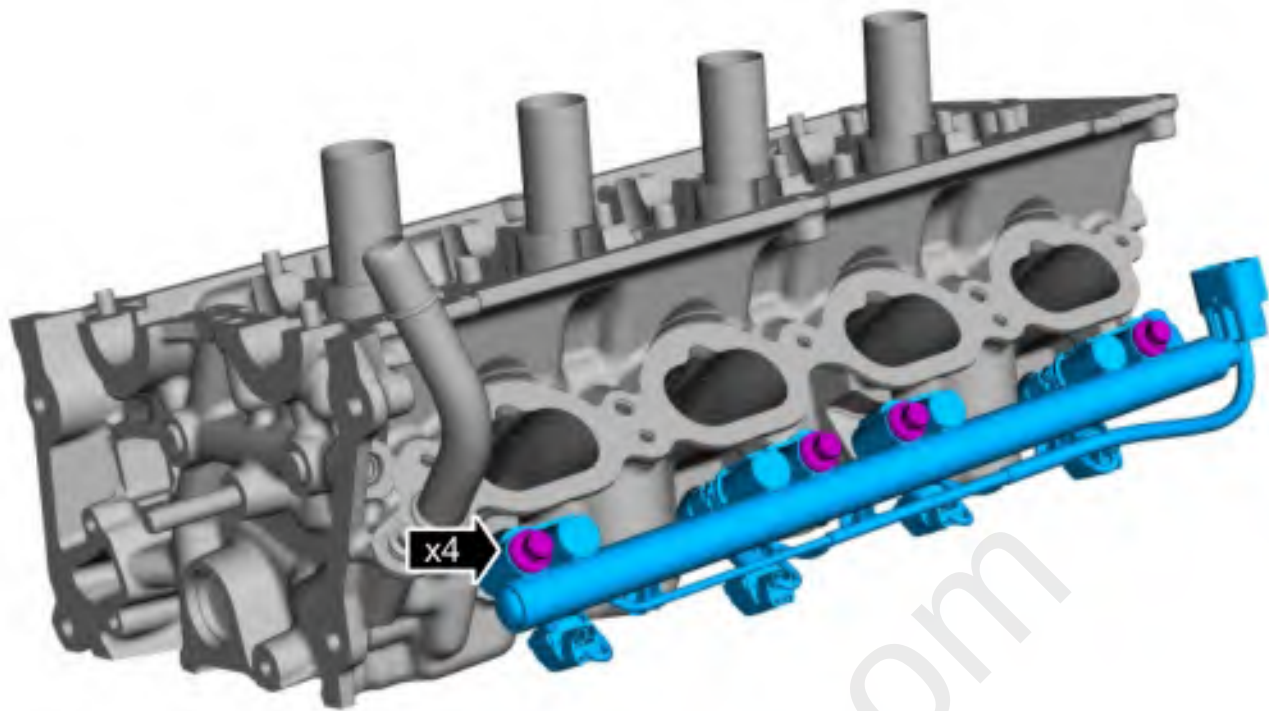
6. **NOTICE:** Pull out the fuel rails in the direction of the fuel injector axis or damage may occur to the fuel injectors.

**NOTE:** Use compressed air and remove any dirt or foreign material from the cylinder head, block and general surrounding area of the fuel rail and injectors.

**NOTE:** When removing the fuel rails, the fuel injectors may remain in the cylinder heads and require the use of a Fuel Injector Remover tool to extract. Wiggling the injector by hand to break it loose may allow the injector to be removed by hand.

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

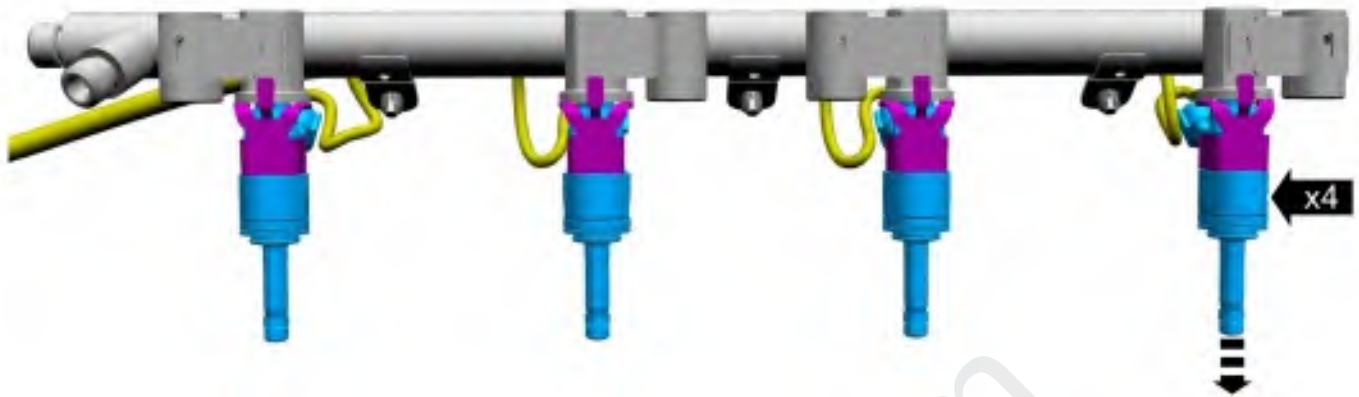
Remove the fuel rail bolts, then remove the fuel rail.



E261778

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

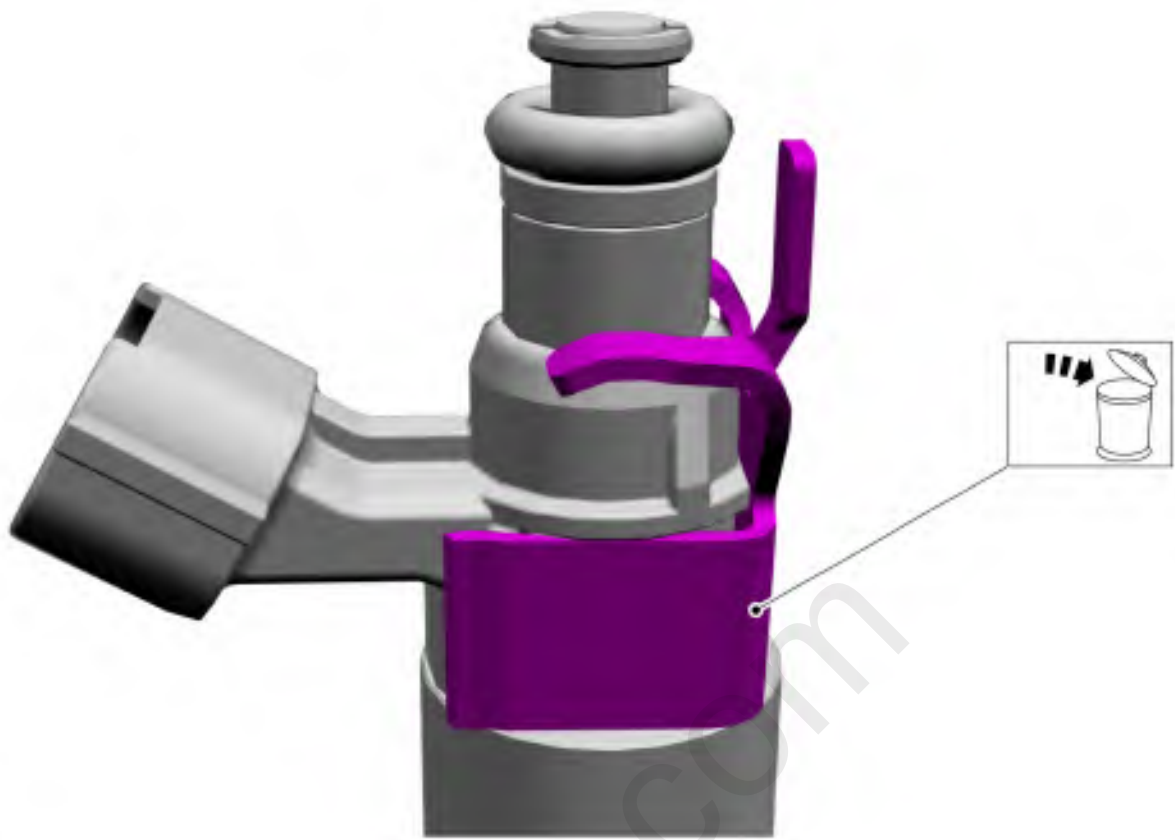
Remove the fuel injectors from the fuel rail.



E258569

8. Remove and discard the fuel injector clips.





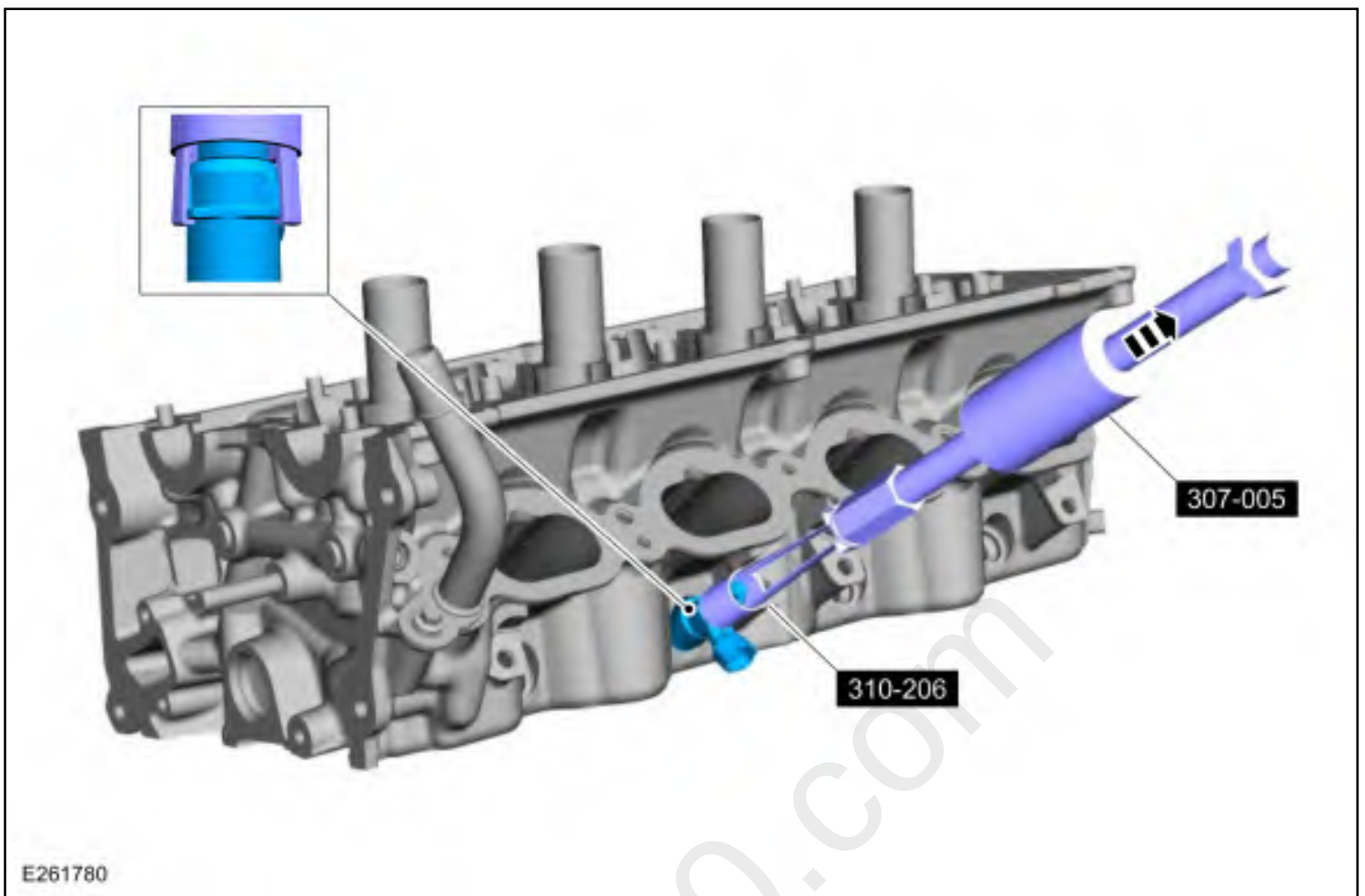
9. **NOTICE:** Use minimal force to remove the fuel injectors that remained in the cylinder head with the Fuel Injector Remover tool or damage to the fuel injector assembly may occur. Wiggling the injector by hand to break it loose may allow the injector to be removed by hand.

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

Using the special tools, remove any of the fuel injectors that remained in the cylinder head.

Use Special Service Tool: 307-005 (T59L-100-B) Slide Hammer. , 310-206 Remover, Fuel Injector.





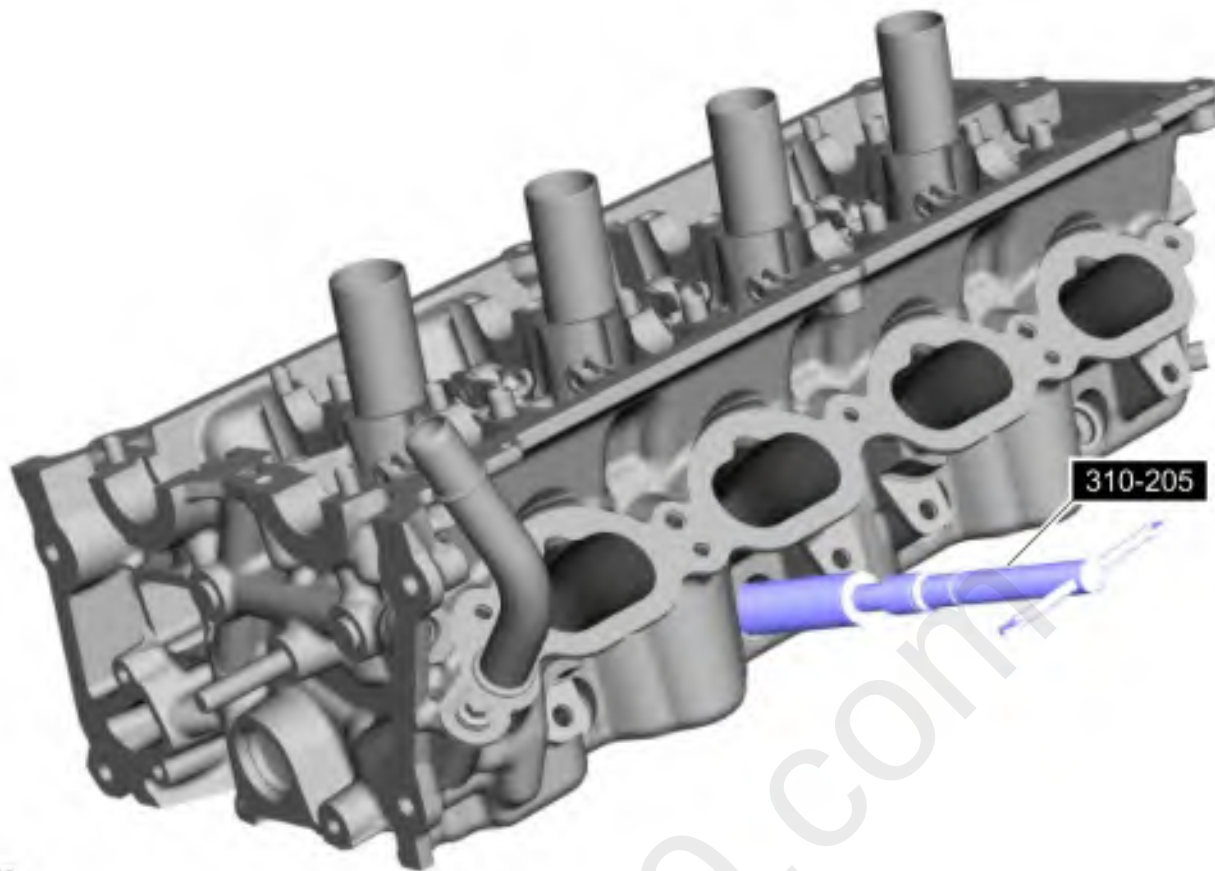
10. **NOTICE:** Make sure to thoroughly clean any residual fuel or foreign material from the cylinder head, block and the general surrounding area of the fuel rails and injectors.

**NOTICE:** Do not use compressed air to clean the tip of the fuel injector.

**NOTICE:** Do not use a brush to clean the tip of the fuel injector.

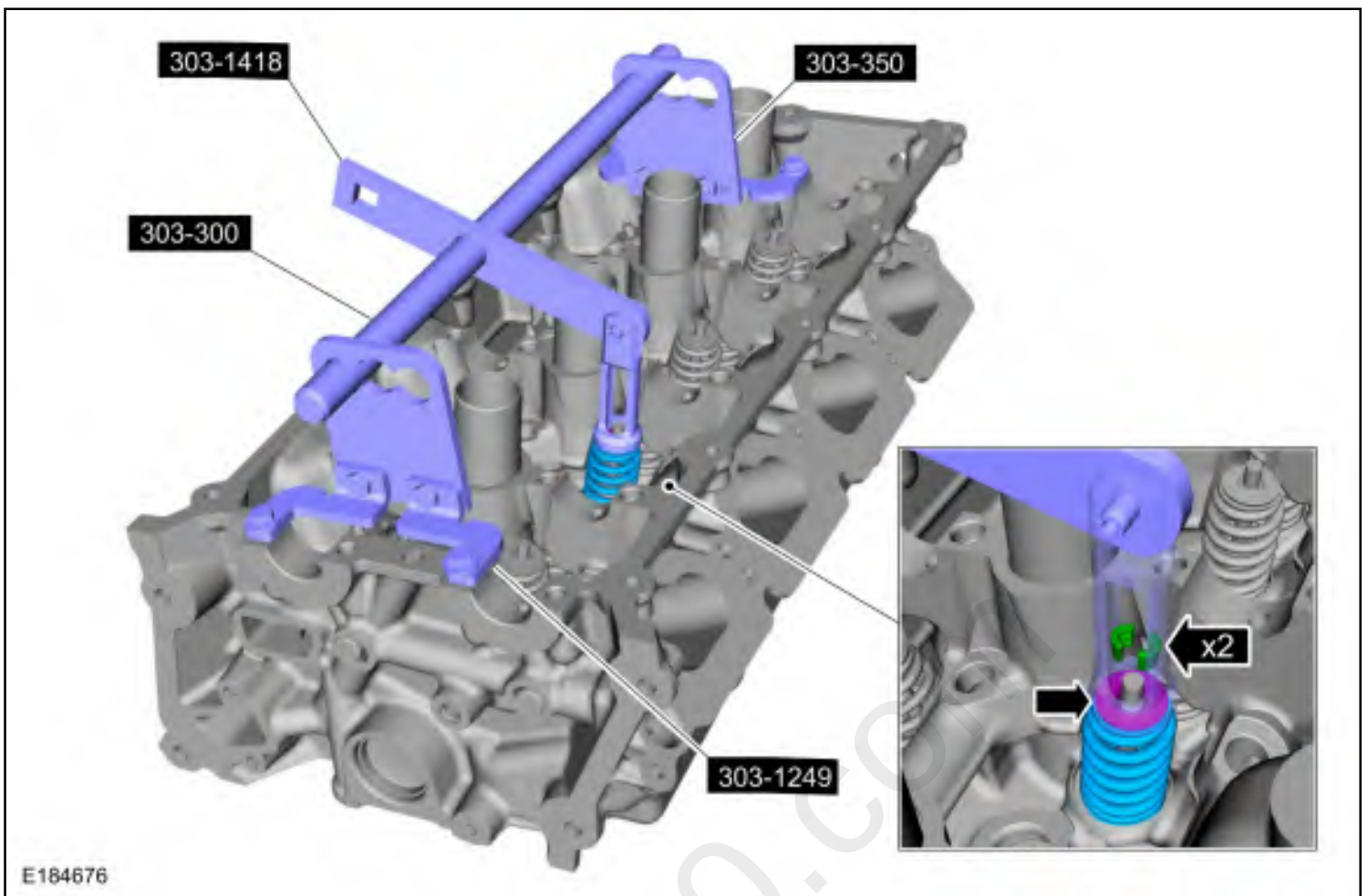
**NOTE:** RH shown, LH similar.

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

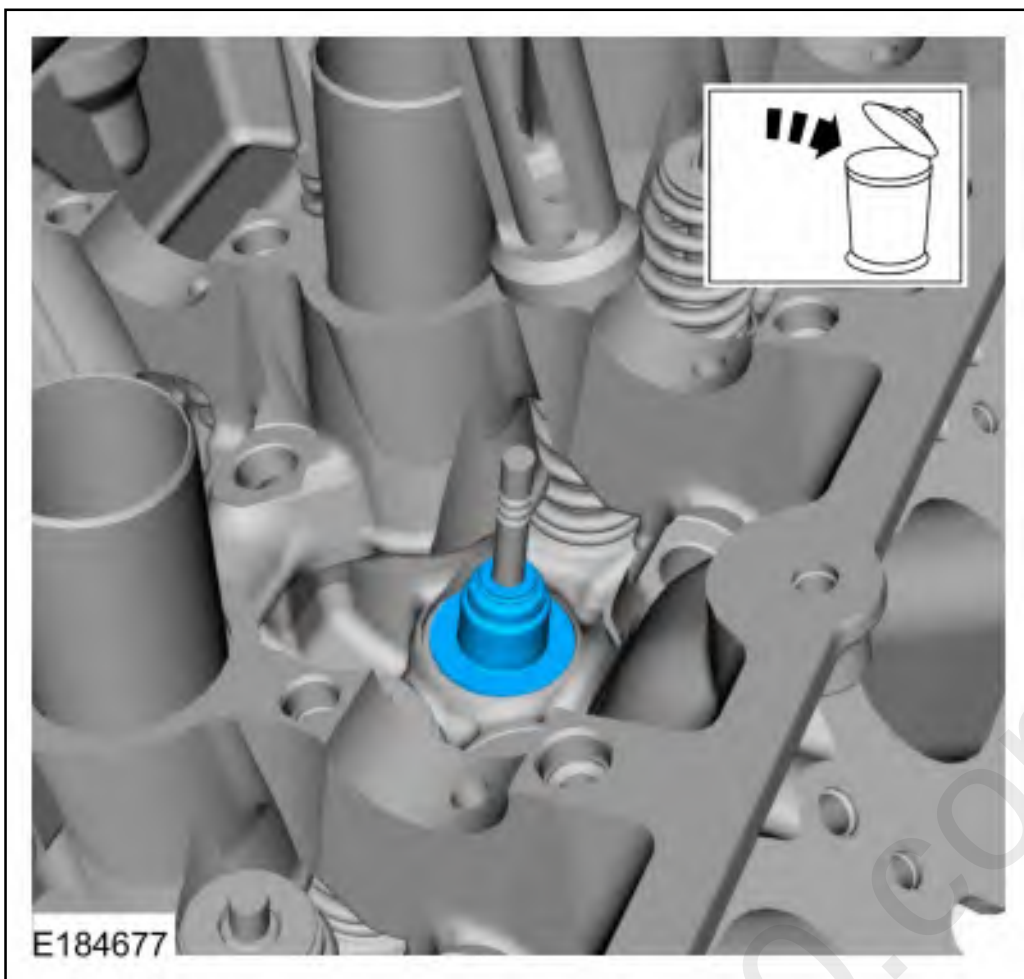


E261779

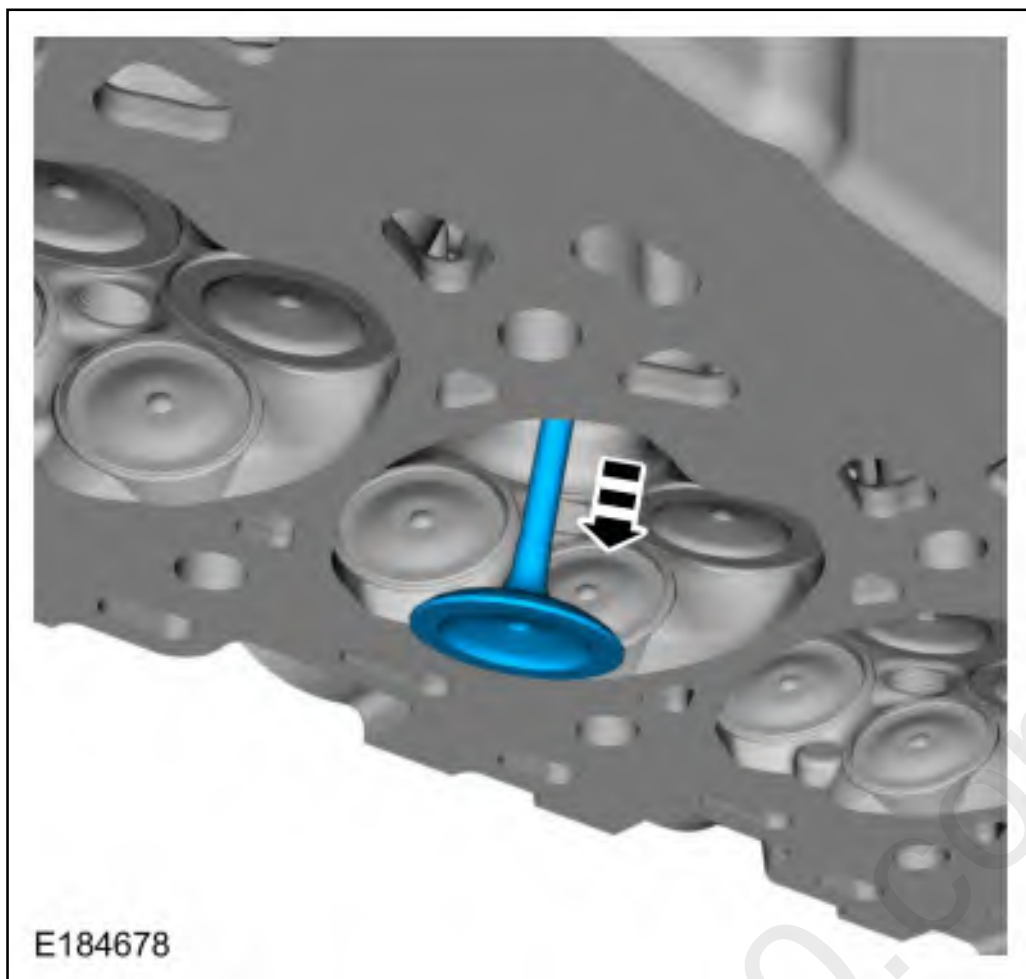
11. Using the special tools, remove the keys, retainer and spring.  
Use Special Service Tool: 303-300 (T87C-6565-A) Set, Valve Spring Compressor. , 303-350 (T89P-6565-A) Compressor, Valve Spring. , 303-1249 Valve Spring Compressor. , 303-1418 Compressor, Valve Spring.



12. Remove and discard the valve stem seal.



13. Remove the valve from the cylinder head.



14. Repeat the previous steps for each of the remaining valves.

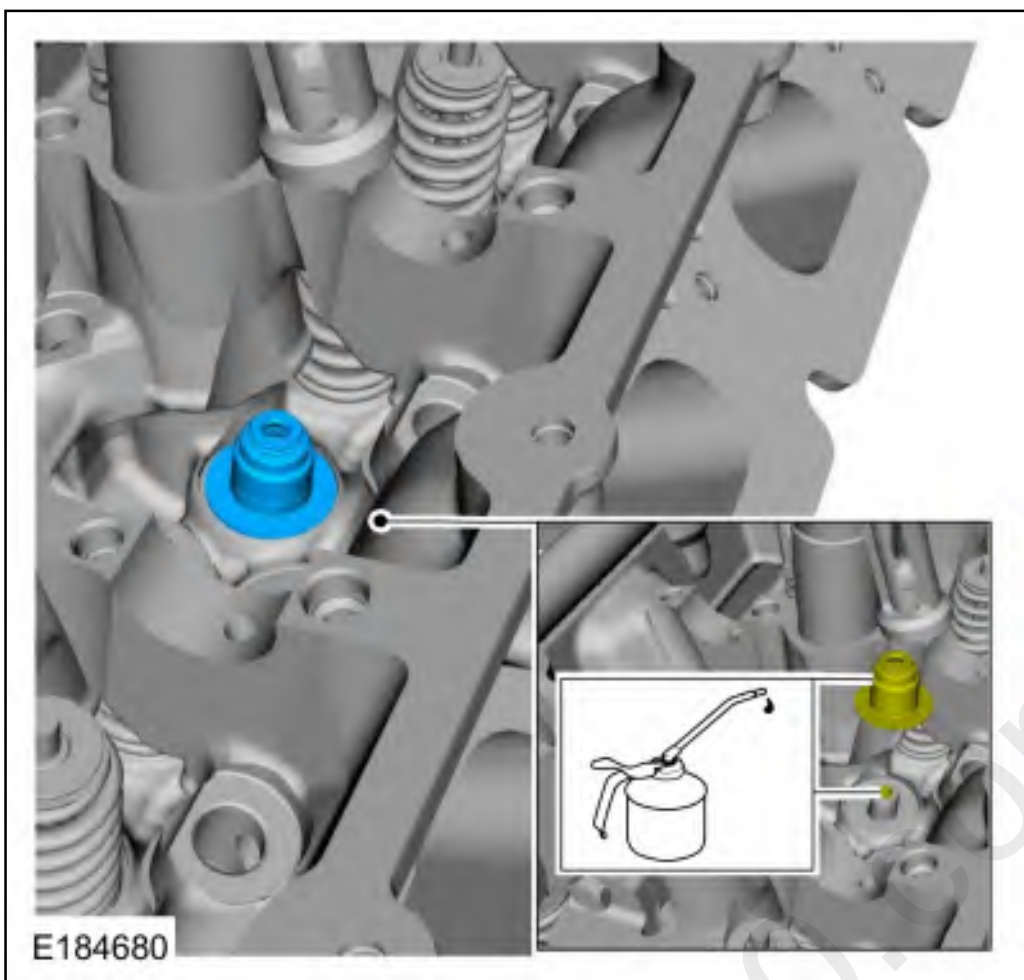
## ASSEMBLY

### All cylinder heads

1. **NOTE:** *Lubricate the new valve stem seal and valve guide bore with clean engine oil.*

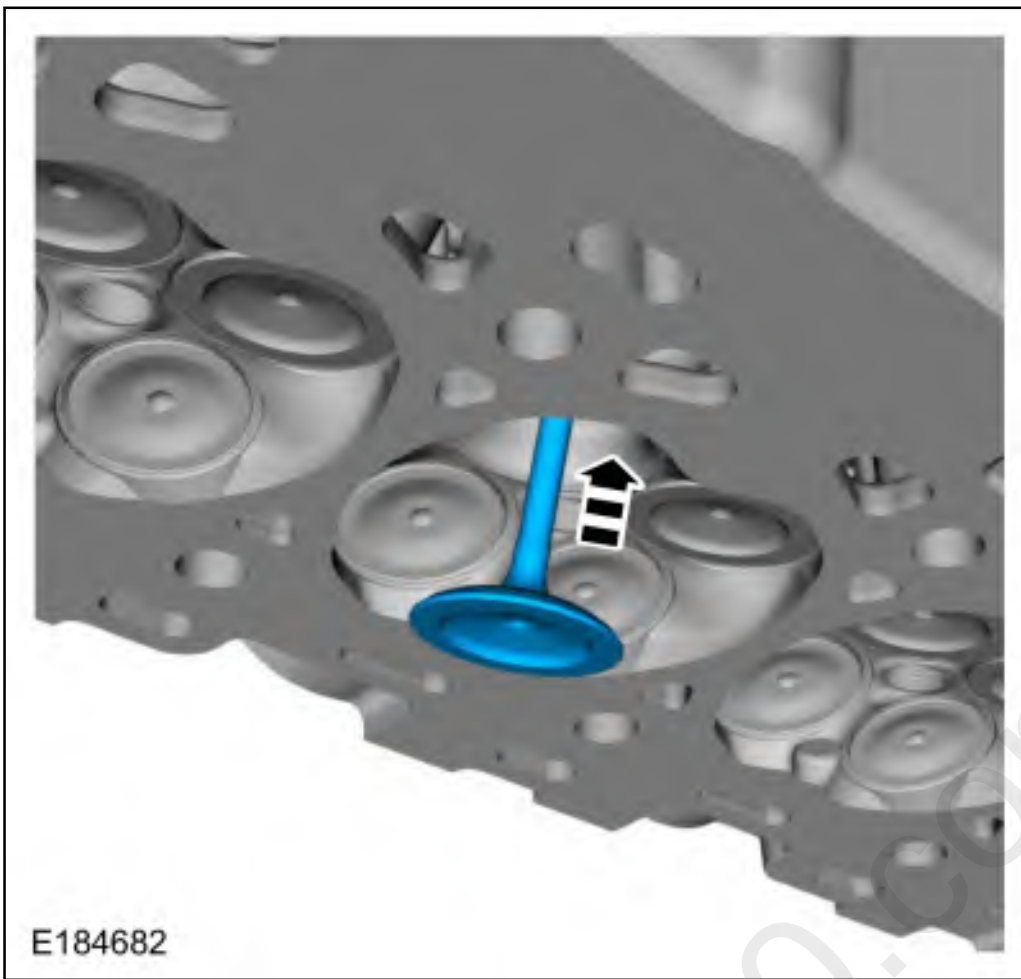
Install the new valve stem seal.

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



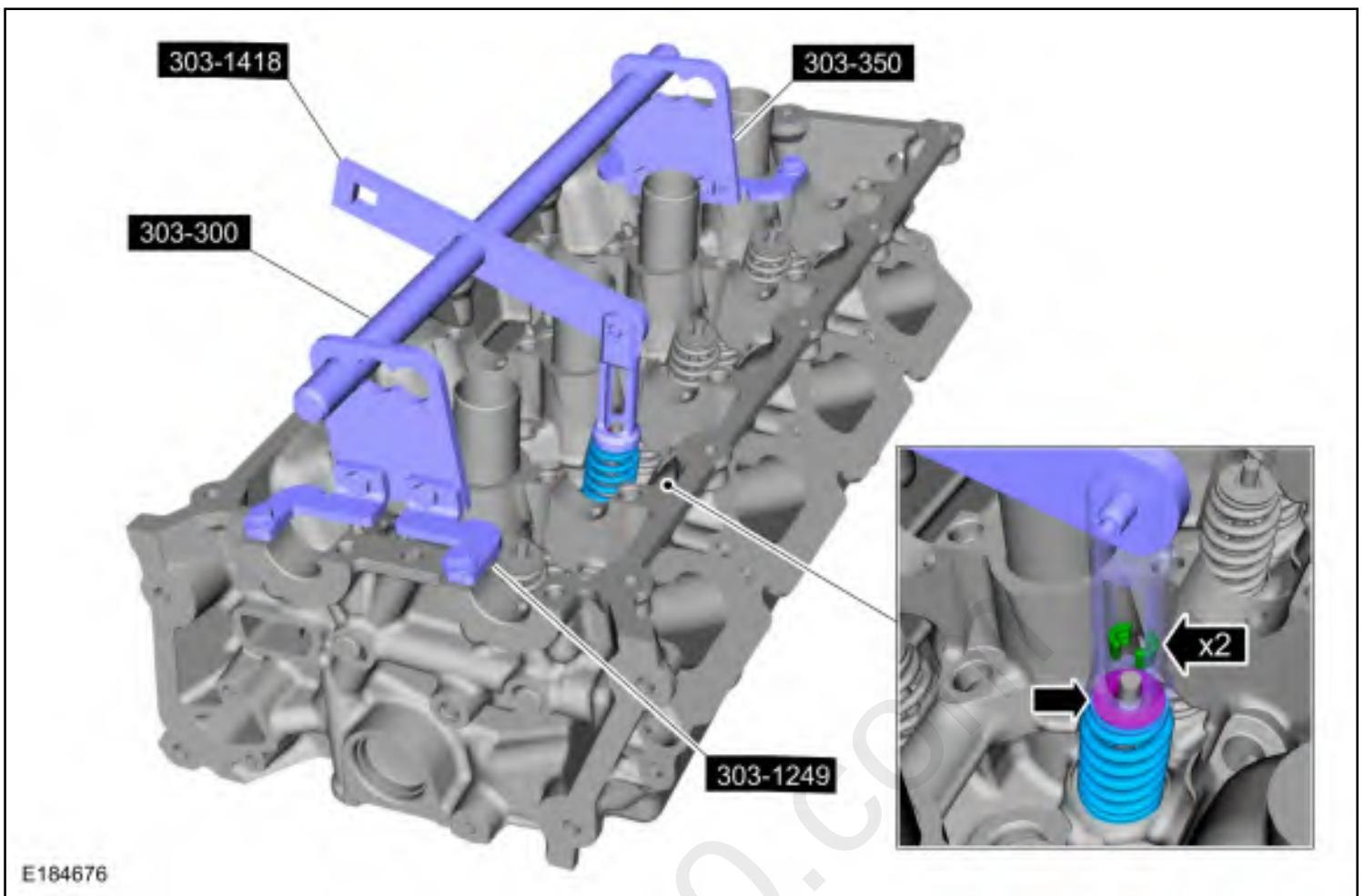
2. Install the valve into the cylinder head.





3. Using the special tools, install the spring, retainer and keys.

Use Special Service Tool: 303-300 (T87C-6565-A) Set, Valve Spring Compressor. , 303-350 (T89P-6565-A) Compressor, Valve Spring. , 303-1249 Valve Spring Compressor. , 303-1418 Compressor, Valve Spring.



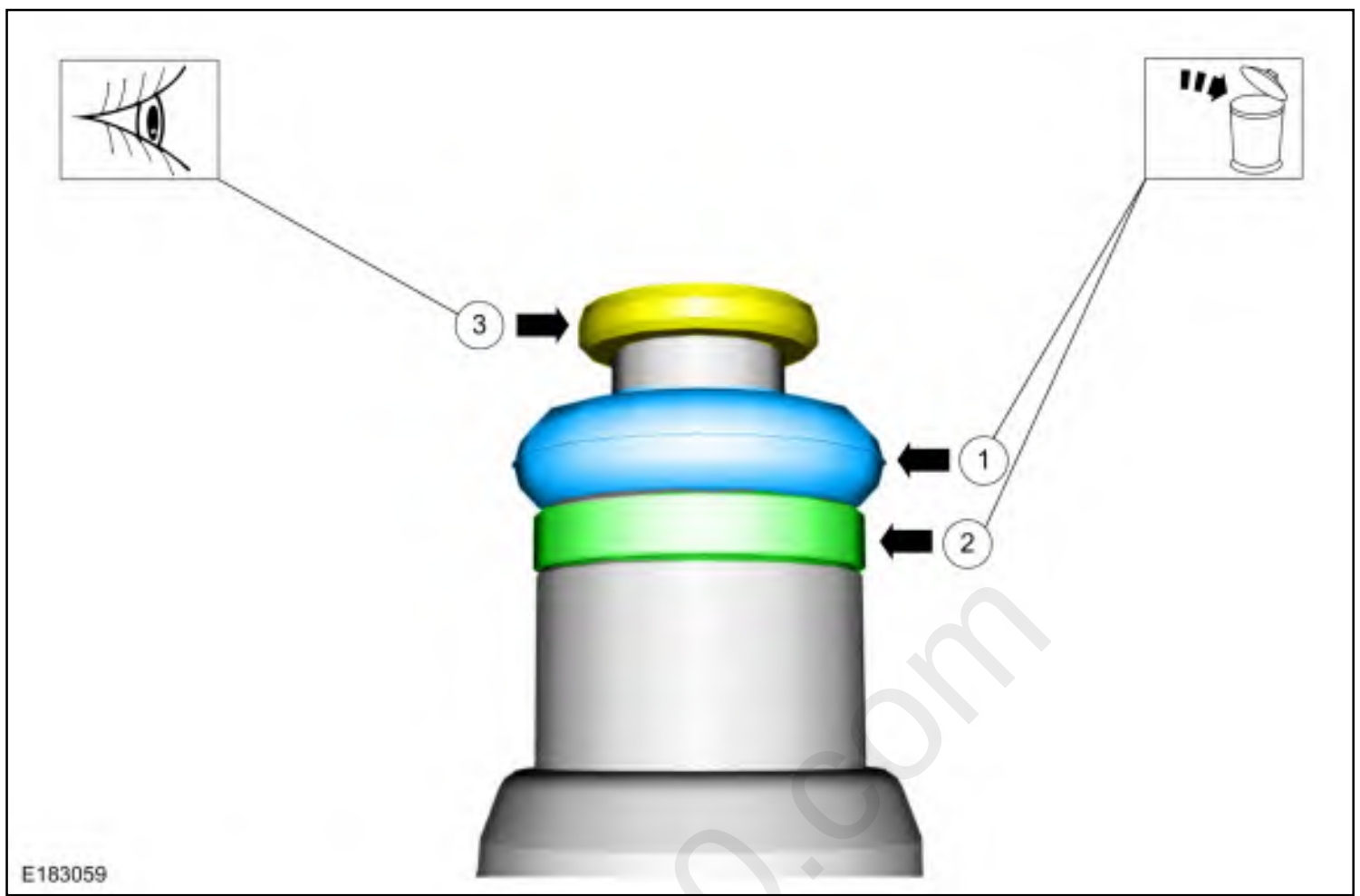
4. Repeat the previous steps for each of the remaining valves.

1. Remove and discard the fuel injector O-ring seals.
2. **NOTE:** Note the correct orientation of the fuel injector support rings for correct installation of the NEW fuel injector support rings.

Remove and discard the fuel injector support rings.

3. Inspect the inlet stopper, if it is damaged or comes off then discard the inlet stopper. The inlet stopper is not needed for proper function. Ensure that any debris from the inlet stopper are removed. If the inlet stopper is intact and undamaged do not remove the inlet stopper from the fuel injector.

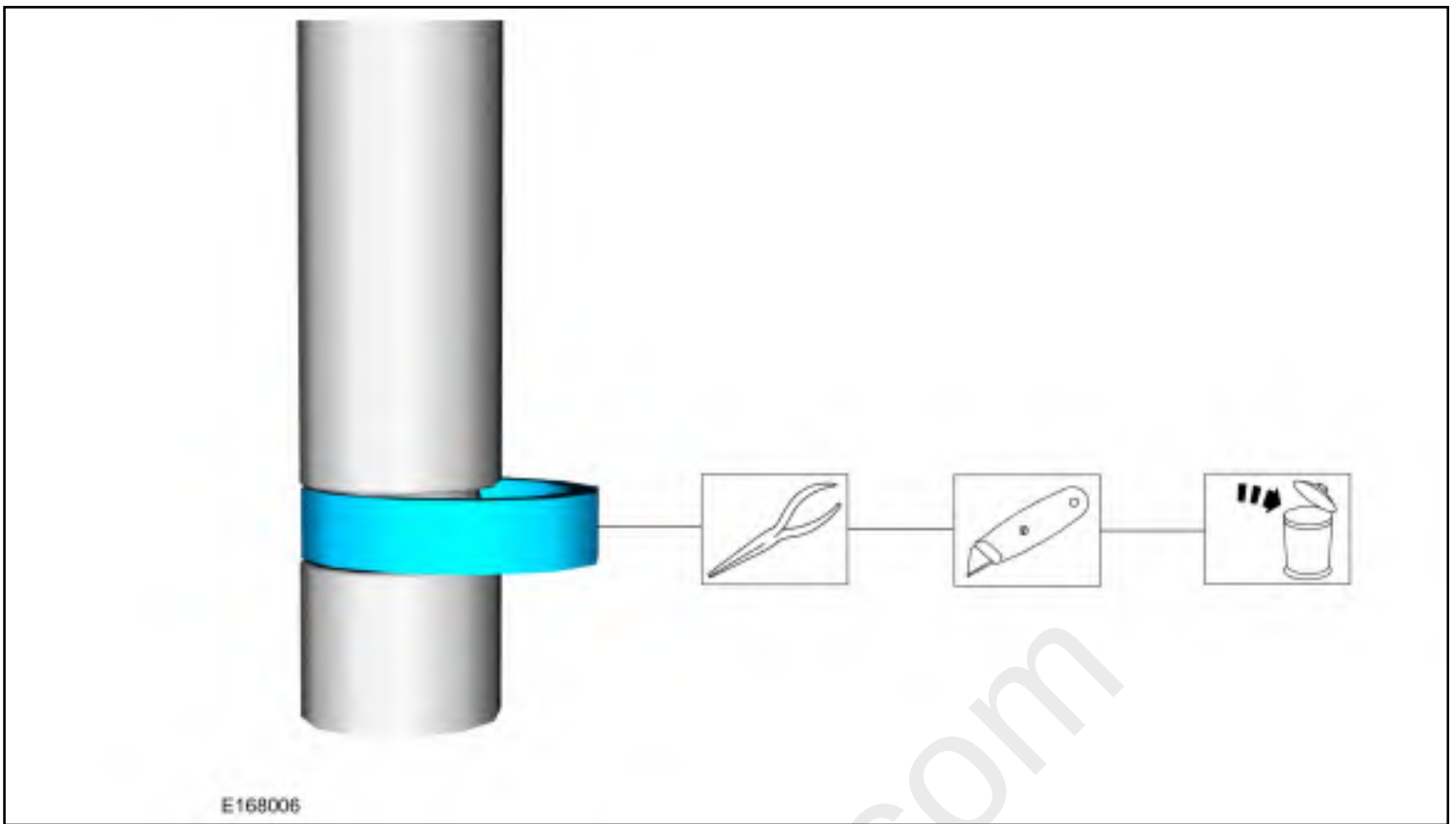




6. **NOTICE:** Use care when removing the lower Teflon® seals, not to scratch, nick or gouge the fuel injector.

**NOTICE:** Do not attempt to cut the lower Teflon® seal without first pulling it away from the fuel injector or damage to the injector may occur.

1. Pull the lower Teflon® seal away from the injector.
2. Carefully cut and discard the lower fuel injector Teflon® seal.



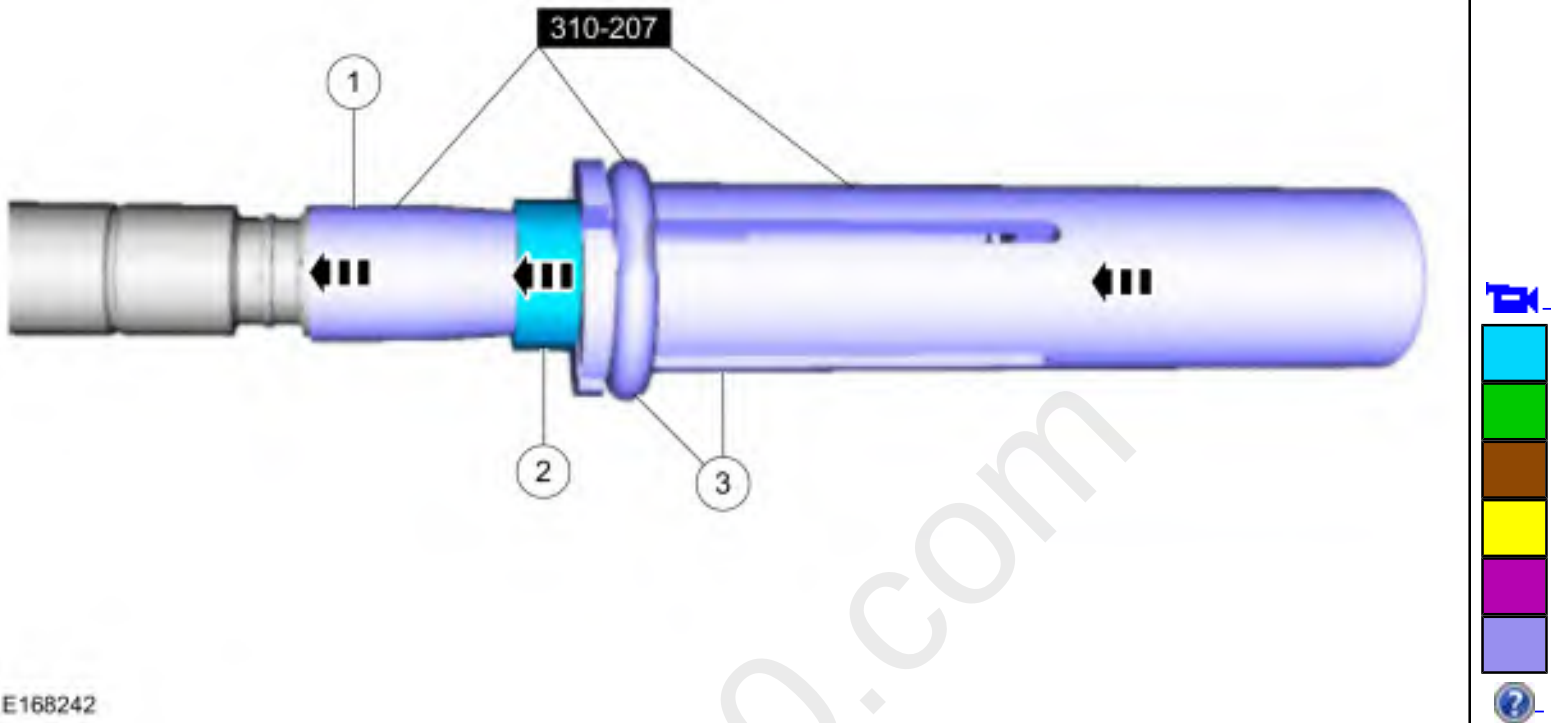
7. **NOTICE: Do not lubricate the NEW lower Teflon® fuel injector seals.**

1. Install the Teflon® Seal Guide onto the fuel injector tip.  
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.**

**NOTE:** Make sure that NEW lower fuel injector Teflon® seals are installed.

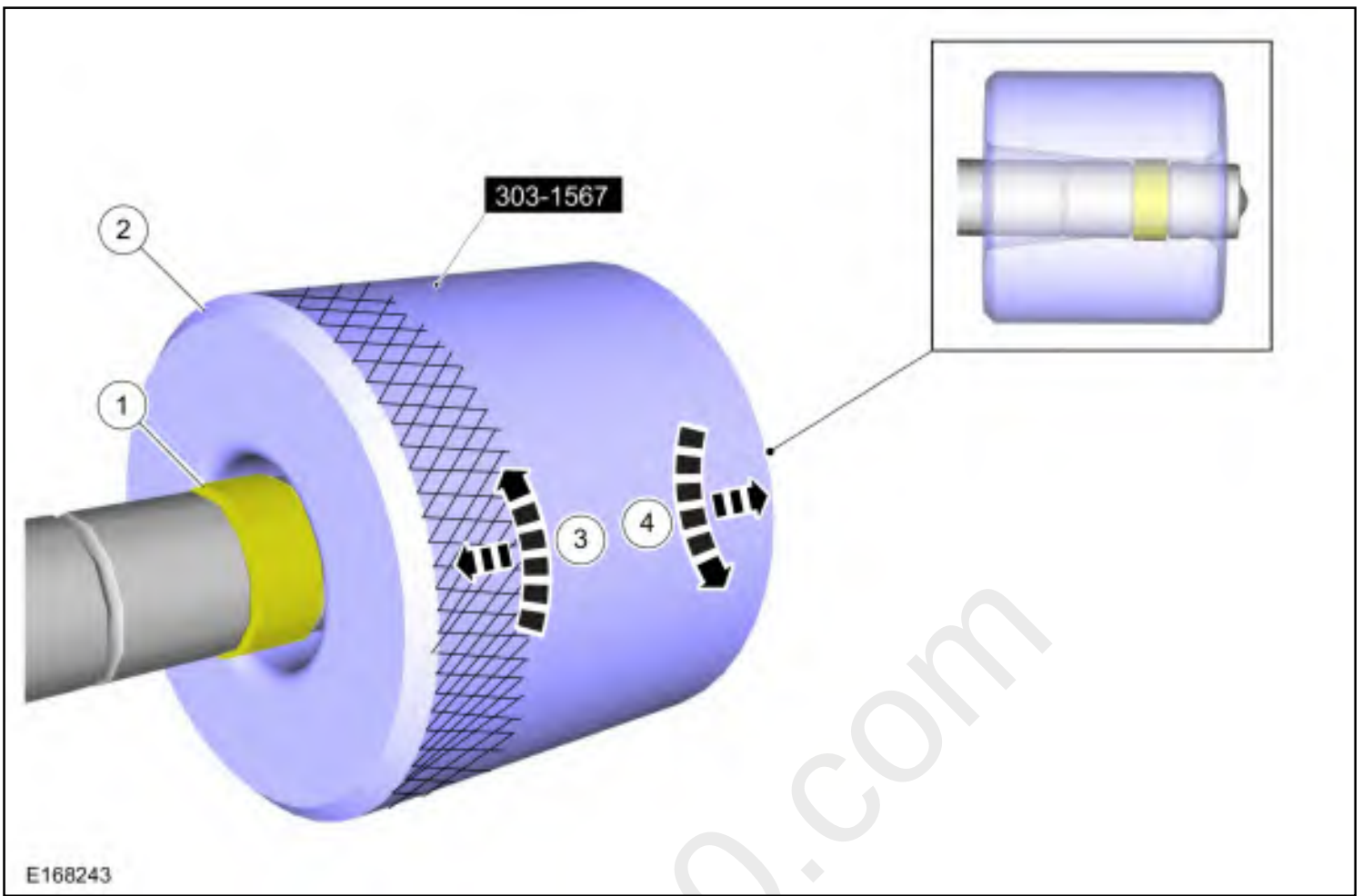
Install the NEW Teflon® seals onto the Teflon® Seal Guide, using the Pusher Tool, slide the Teflon® seals along the Teflon® Seal Guide.

3. Using the Pusher Tool, slide the Teflon® seals off of the Teflon® Seal Guide and into the groove on the fuel injectors.  
Use Special Service Tool: 310-207 Installer, Fuel Injector Seal Assembly.
4. Remove the special tools.



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

1. Massage and warm the Teflon® seal with your fingers before the Teflon® seal sizer tool is installed. This will aid in installing the Teflon® seal sizer 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 Teflon® seal sizer tool is installed, check and make sure the Teflon® seal is in the sizing portion of the Teflon® seal sizer tool.
4. After one minute, turn the Teflon® seal sizer tool back 180 degrees and remove.

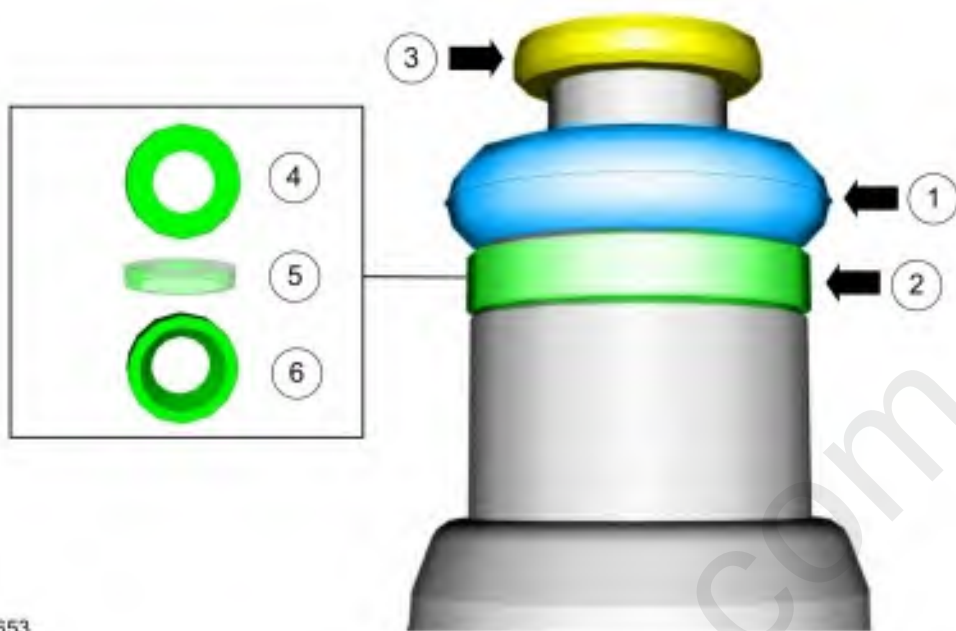


9. **NOTE:** Make sure that *NEW* fuel injector support rings and *NEW* fuel injector O-ring seals are installed.

1. Install the new fuel injector O-rings. The O-rings are pre-lubricated, NO ADDITIONAL lubricant is required.
2. **NOTICE:** The *NEW* the fuel injector support rings must be installed in the correct orientation with the wide surface area facing up against the fuel injector O-ring seals. Improperly installed support rings may cause the fuel system to leak.

Install the *NEW* the fuel injector support rings.

3. Inspect the inlet stopper, if it is damaged or comes off then discard the inlet stopper. The inlet stopper is not needed for proper function. Ensure that any debris from the inlet stopper are removed. If the inlet stopper is intact and undamaged do not remove the inlet stopper from the fuel injector.
4. The upper side of the support ring has the wide surface area.
5. Fuel injector support ring.
6. The lower side of the support ring has the narrow surface area.



E199653

10. Install the NEW fuel injector clips.

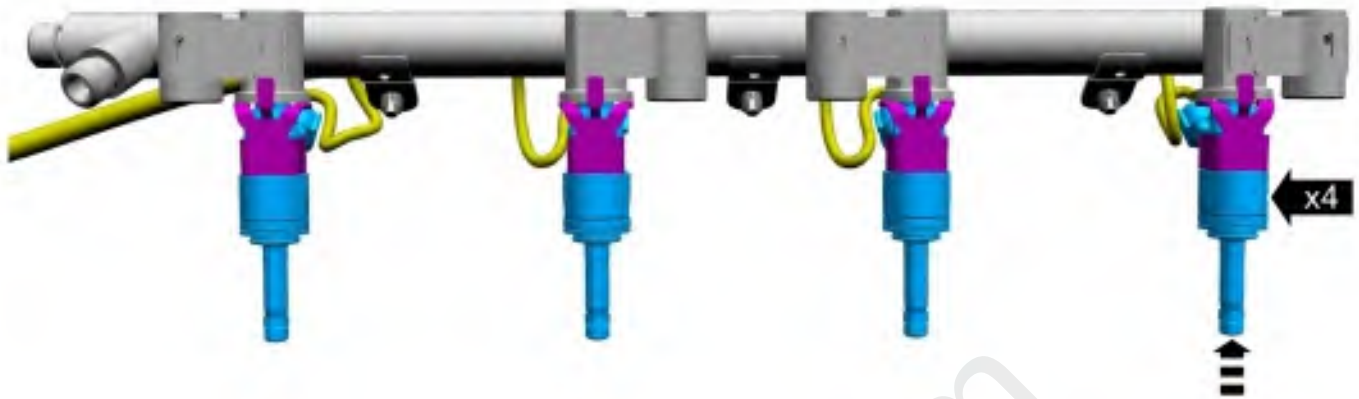


E257412

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

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

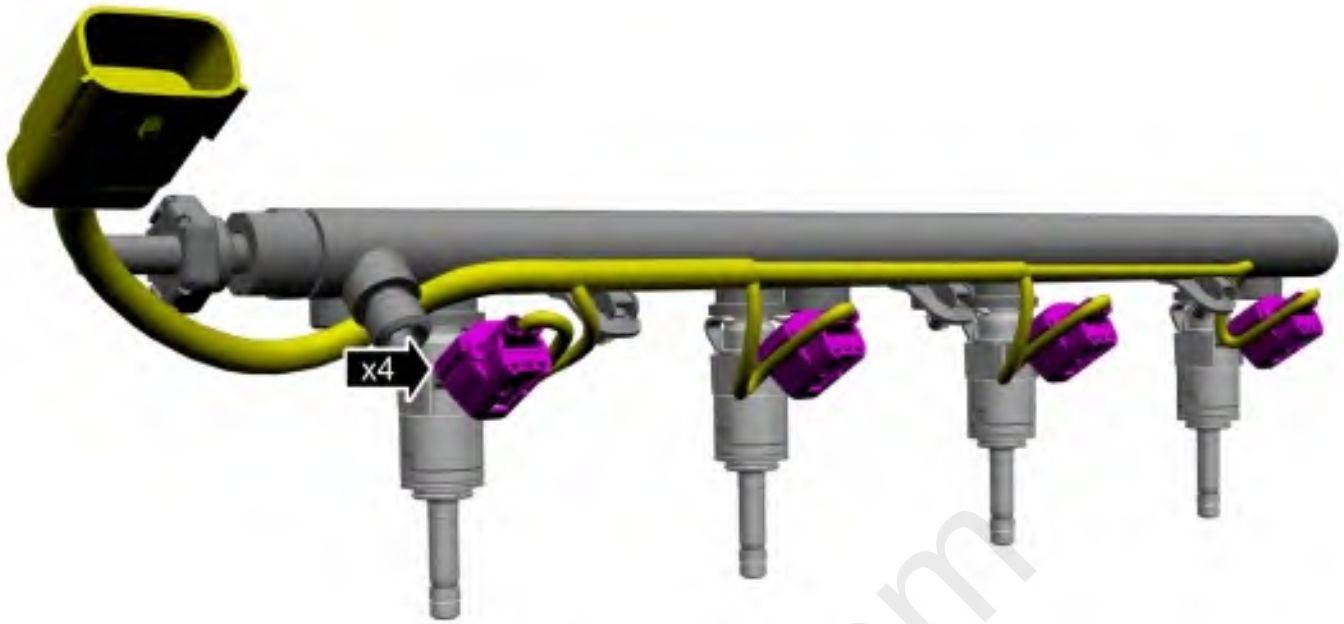
Install the fuel injectors to the fuel rail and then connect the fuel injector electrical connectors.



E258570

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

Connect the fuel injector electrical connectors.



E257411

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

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

Install the fuel rail, push down on the fuel rail above the injectors.

- Hand start all of the fuel rail bolts and finger tighten the fuel rail bolts so they are uniformly in light contact with fuel rail bosses.
- Tighten the fuel rail bolts approximately 90 degrees, in the sequence shown. Repeat to evenly draw down the fuel rail, until the fuel rail bosses are in contact with the cylinder head.

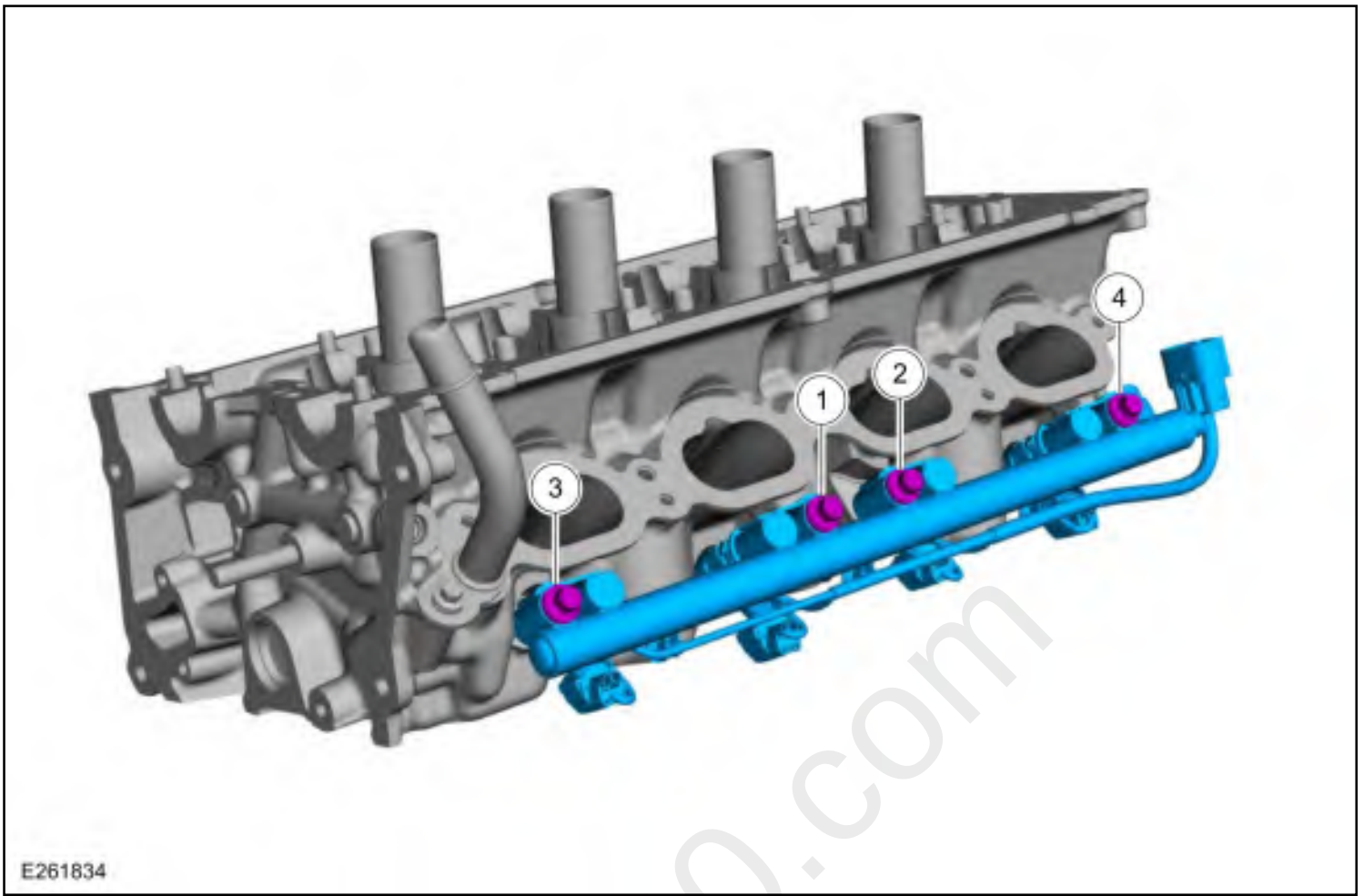
*Torque:*

Stage 1: Tighten the fuel rail bolts in the sequence shown to : 89 lb.in (10 Nm)

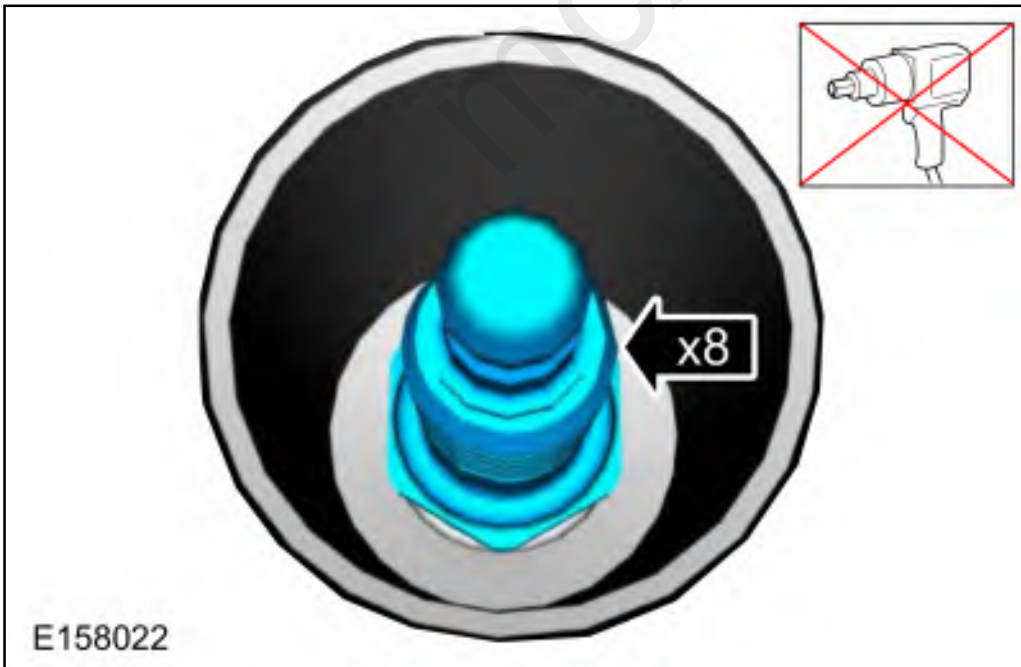
Stage 2: Tighten the fuel rail bolts in the sequence shown to : 21 lb.ft (28 Nm)

Stage 3: Tighten the fuel rail bolts in the sequence shown an additional : 25°



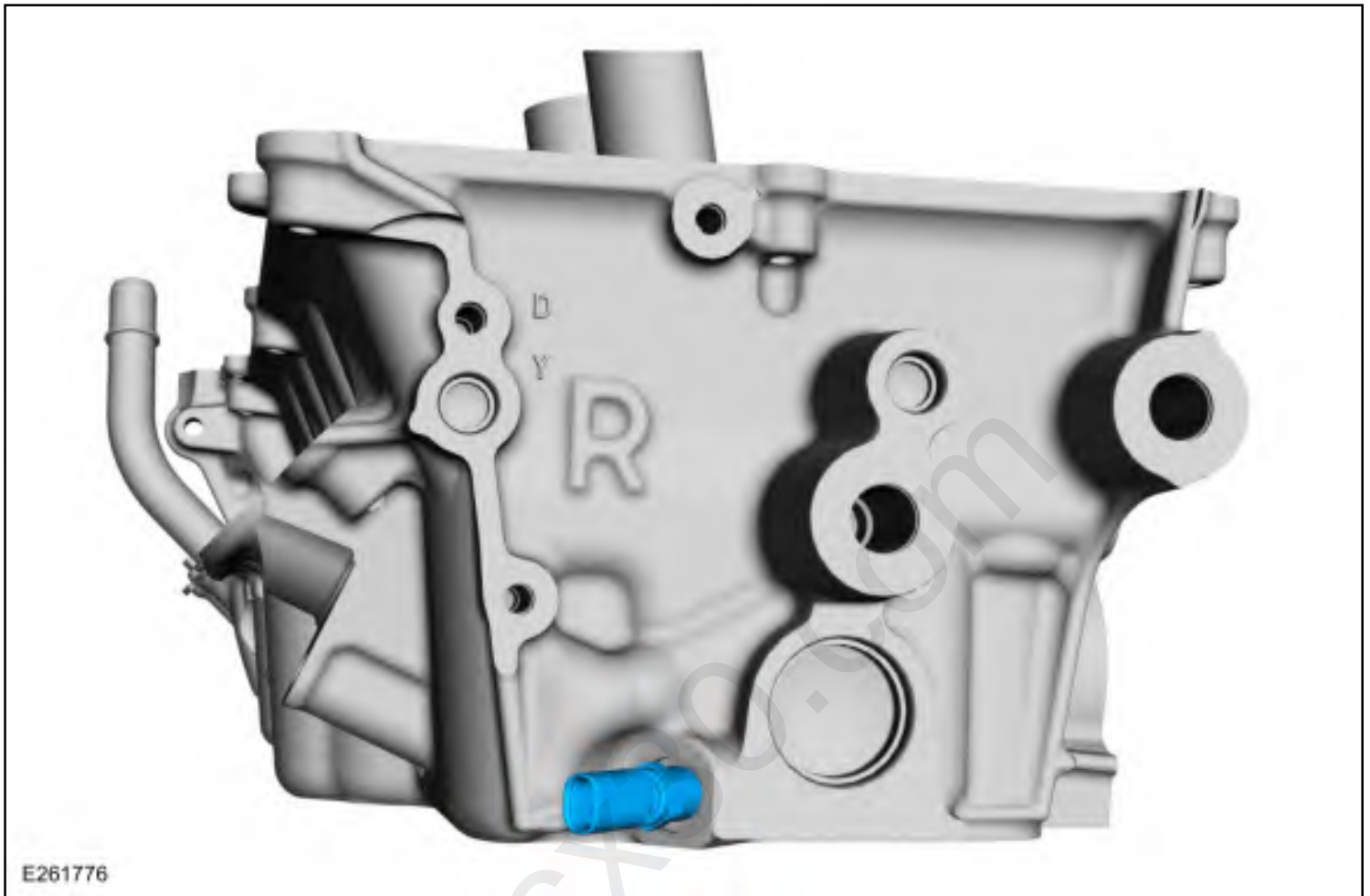


14. Install the spark plugs.  
*Torque: 128 lb.in (14.5 Nm)*



**RH cylinder heads**

15. Install a new CHT sensor.  
*Torque: 97 lb.in (11 Nm)*

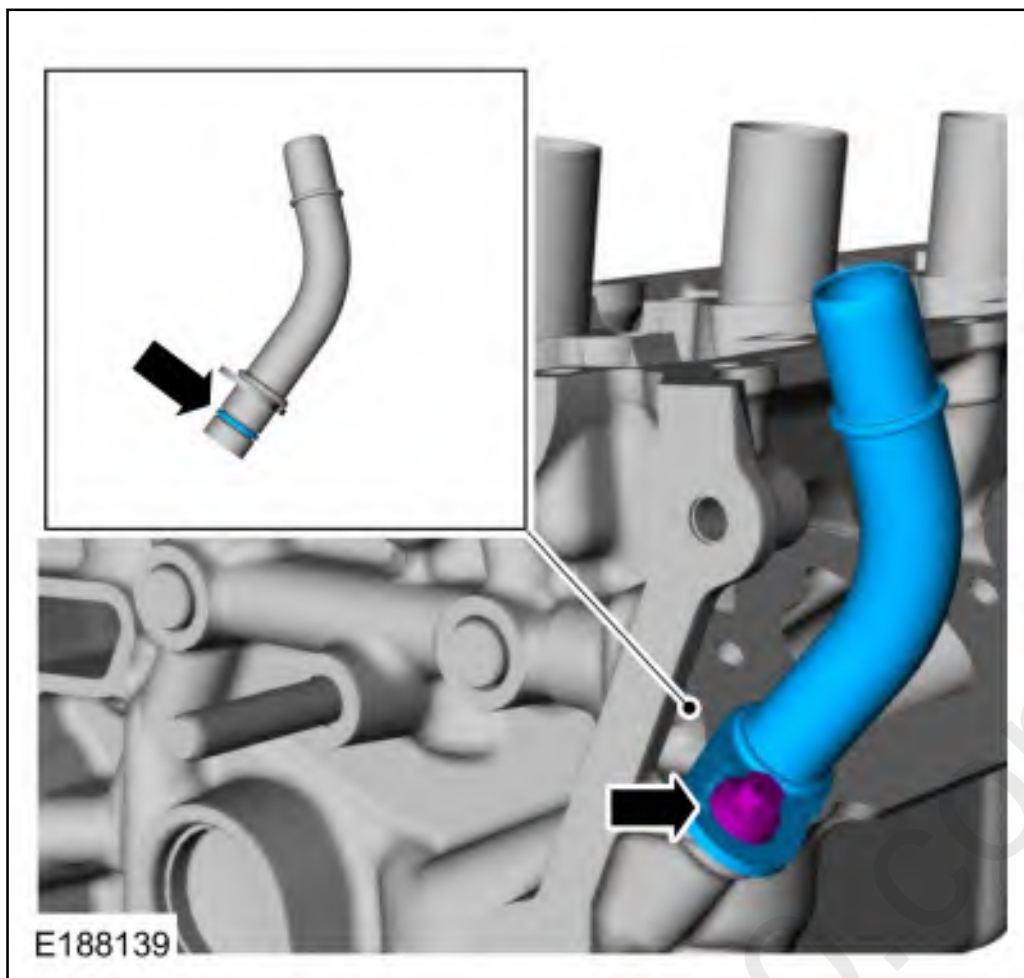


16. **NOTE:** *Lubricate the O-ring seal with clean engine coolant prior to installing.*

Using a new O-ring seal, install the coolant outlet pipe.

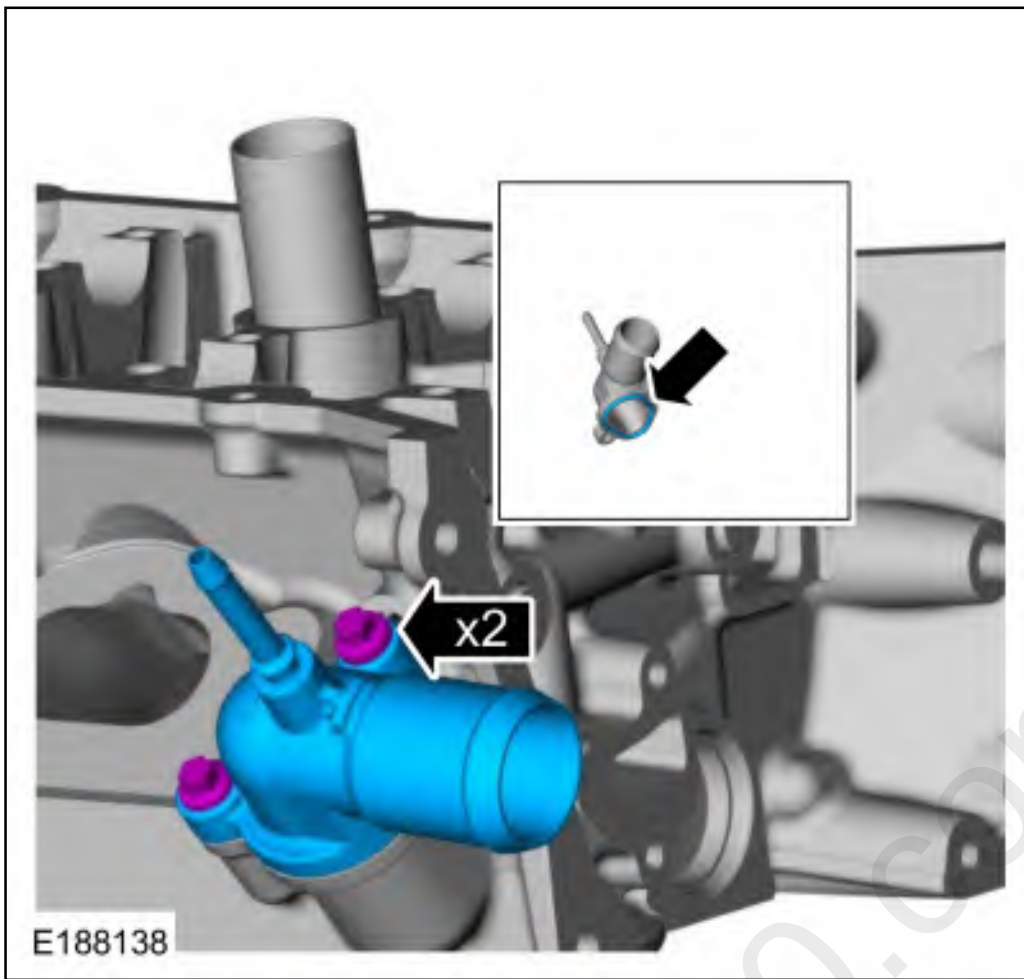
*Material:* Motorcraft® Orange Concentrated Antifreeze/Coolant / VC-3-B (WSS-M97B44-D)

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



## LH cylinder heads

17. Using a new gasket, install the coolant outlet and the bolts.  
*Torque: 89 lb.in (10 Nm)*



# Piston

## Materials

| Name                                                           | Specification |
|----------------------------------------------------------------|---------------|
| Motorcraft® SAE 5W-20 Synthetic Blend Motor Oil<br>XO-5W20-QSP | WSS-M2C945-A  |

## DISASSEMBLY

1. Remove and discard the piston rings.



2. Remove and discard the piston pin retainers.
  - Remove the piston pin.



E184459

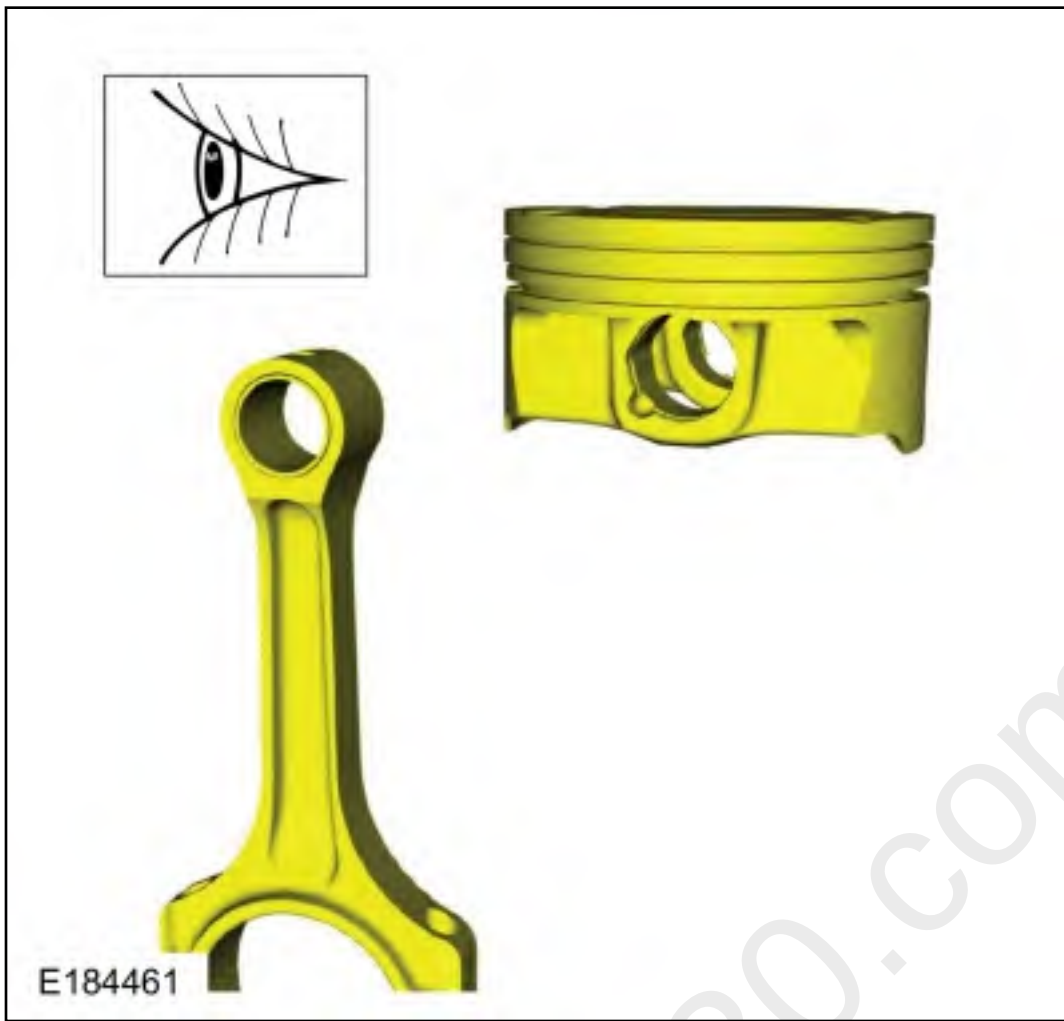
3. **NOTE:** *If the piston and connecting rod are to be reinstalled, they must be assembled in the same orientation. Mark the piston orientation to the connecting rod for reassembly.*

Separate the piston from the connecting rod.



4. Clean and inspect the piston and connecting rod.

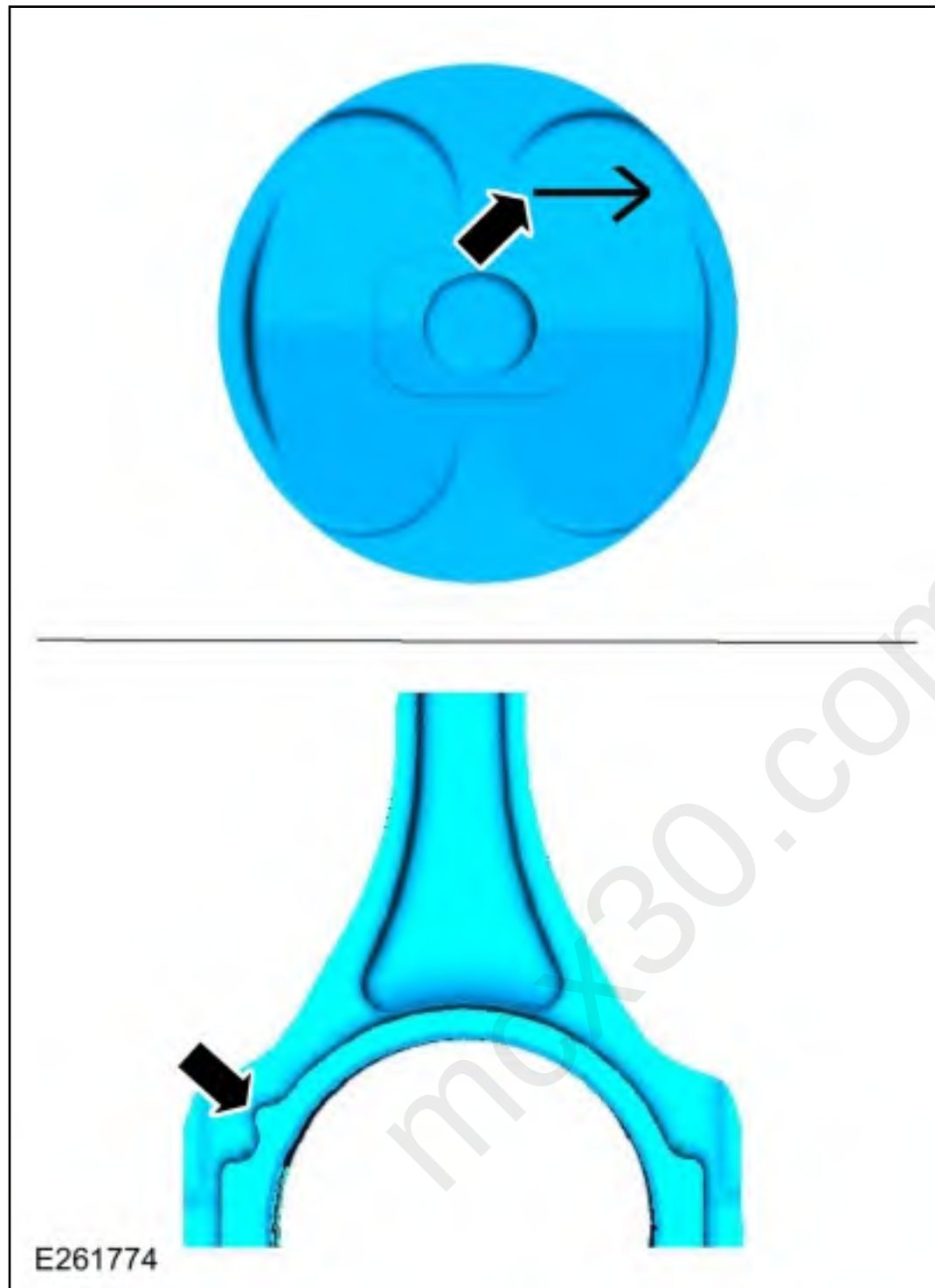
Refer to: [Piston Inspection](#) (303-00 Engine System - General Information, General Procedures).



## ASSEMBLY

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





2. Position the piston on the connecting rod.



3. Lubricate and install the piston pin.

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



4. **NOTE:** *The piston pin retainer gap orientation must be toward the top of the piston.*

Install the piston pin retainers.



5. Lubricate and install the oil control rings.

1. Upper oil control ring.
2. Oil control expander ring.
3. Lower oil control ring.

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



6. Install the lower compression ring.

1. The "O" mark on the ring pointing up toward the top of the piston.
2. Hook feature will point down toward the bottom of piston.

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



7. Install the upper compression ring.

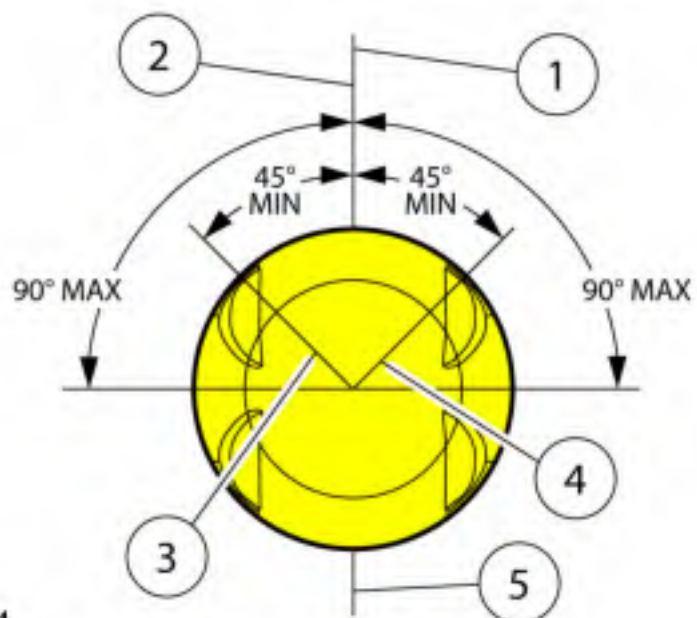
1. The "O" mark on the ring pointing up toward the top of the piston.

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



8. Position the piston ring gaps.

1. Center line of the piston parallel to the wrist pin bore.
2. Upper compression ring gap.
3. Upper oil control ring gap.
4. Lower oil control ring gap.
5. Oil control expander ring and lower compression ring gap.



E153734



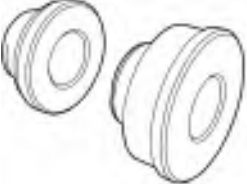
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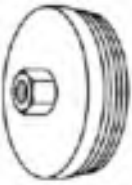


# Engine

Base Part Number: Base Part Number: 6L084

## Special Tool(s) / General Equipment

|                                                                                               |                                                                                                  |
|-----------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
| <br>E129694   | 100-001 (T50T-100-A)<br>Slide Hammer                                                             |
| <br>E234304  | 205-142 (T80T-4000-J)<br>Installer, Differential Bearing Cone                                    |
| <br>E133913 | 205-153 (T80T-4000-W)<br>Handle                                                                  |
| <br>E175042 | 303-1247<br>VCT Spark Plug Tube Seal Remover and Installer<br>TKIT-2006UF-FLM<br>TKIT-2006UF-ROW |
| <br>E134603 | 303-409 (T92C-6700-CH)<br>Remover, Crankshaft Seal<br>TKIT-1992-FH/FMH/FLMH<br>TKIT-1993-LMH/MH  |

|                                                                                   |                                                                                                      |
|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|
|   | 303-448 (T93P-6303-A)<br>Holding Tool, Crankshaft<br>TKIT-1993-FLM<br>TKIT-1993-LM                   |
|  | 303-519 (T95P-6701-EH)<br>Remover, Crankshaft Rear Oil Seal<br>TKIT-1995-FH/FLMH<br>TKIT-1995-LMH/MH |
|   | 303-F047<br>Lifting Bracket, Engine                                                                  |
| Floor Crane                                                                       |                                                                                                      |
| Three Leg Puller                                                                  |                                                                                                      |
| Mounting Stand                                                                    |                                                                                                      |
| Plastic Scraper                                                                   |                                                                                                      |

## Materials

| Name                                                    | Specification |
|---------------------------------------------------------|---------------|
| Motorcraft® Silicone Gasket Remover<br>ZC-30-A          | -             |
| Motorcraft® Metal Surface Prep Wipes<br>ZC-31-B         | -             |
| Motorcraft® Metal Brake Parts Cleaner<br>PM-4-A, PM-4-B | -             |

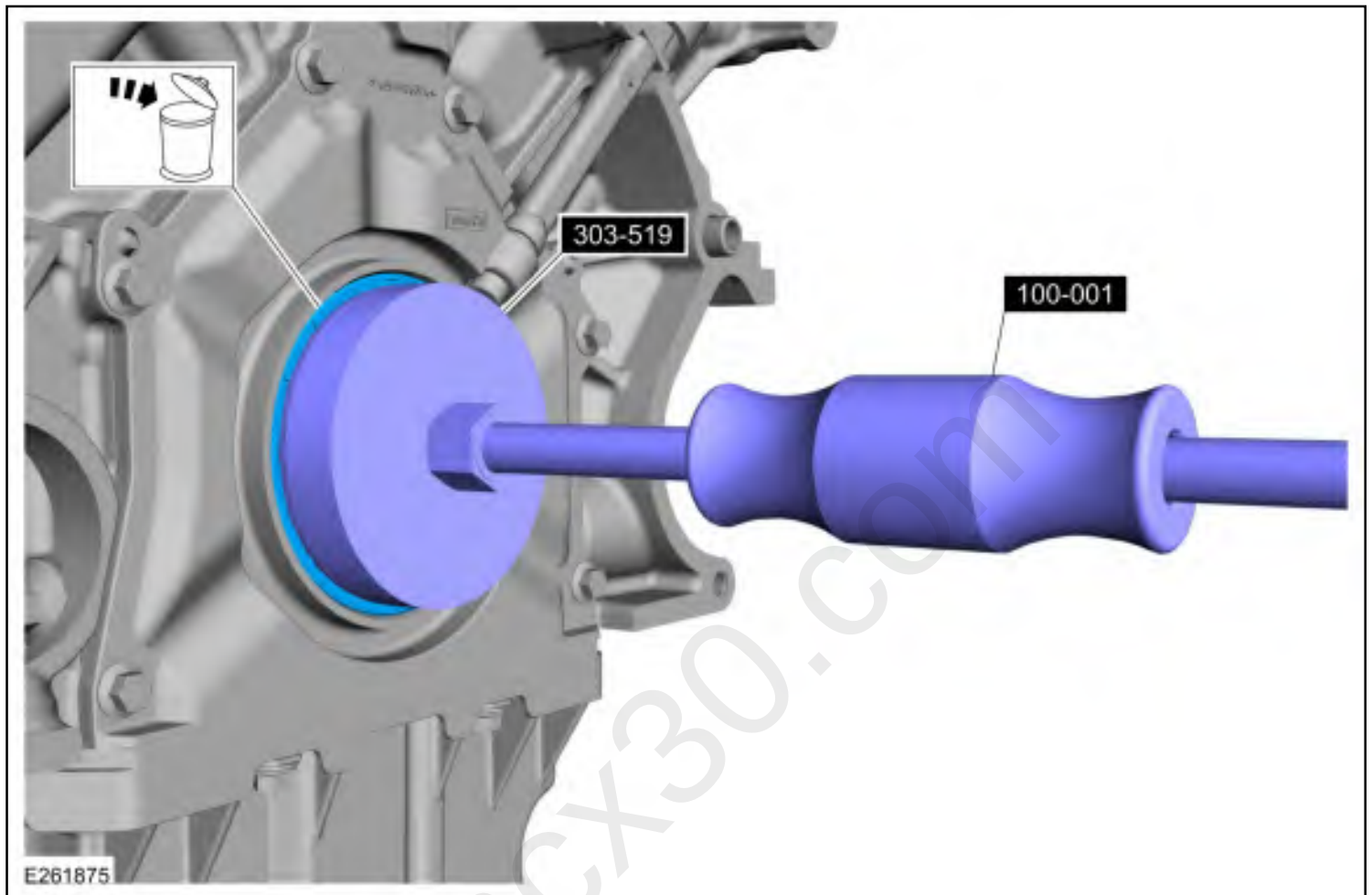
**NOTICE:** During engine repair procedures, cleanliness is extremely important. Any foreign material, including any material created while cleaning gasket surfaces, that enters the oil passages, coolant passages or the oil pan, can cause engine failure.

**NOTICE:** Remove the cylinder heads before removing the crankshaft. Failure to do so can result in engine damage.

**NOTE:** If the components are to be reinstalled, they must be installed in their original location. Mark the components for installation into their original location.

**NOTE:** Refer to the exploded view under the Engine Component View in the Description and Operation.

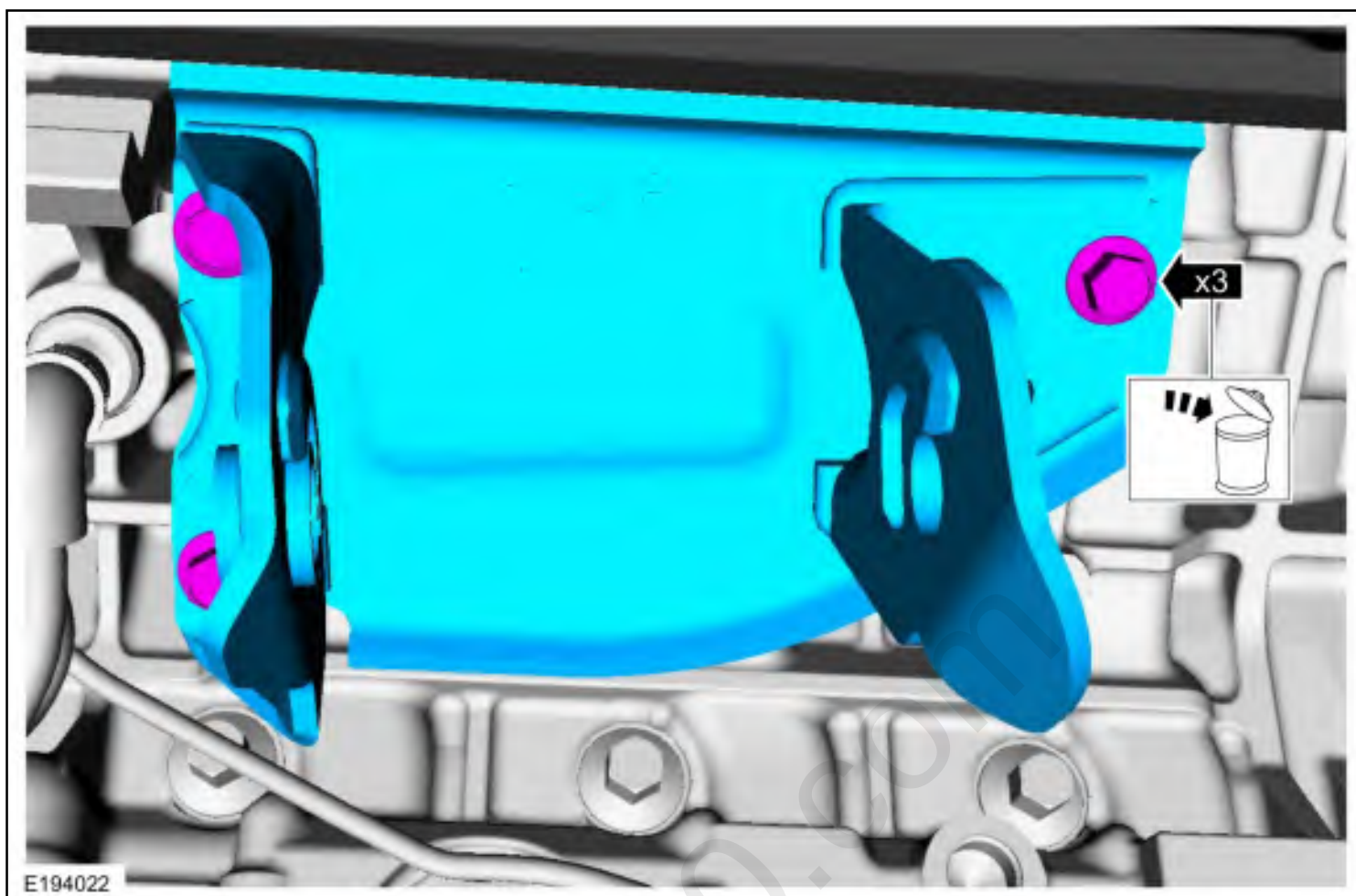
1. Using the special tools, remove and discard the crankshaft rear seal.  
Use Special Service Tool: 303-519 (T95P-6701-EH) Remover, Crankshaft Rear Oil Seal. , 100-001 (T50T-100-A) Slide Hammer.



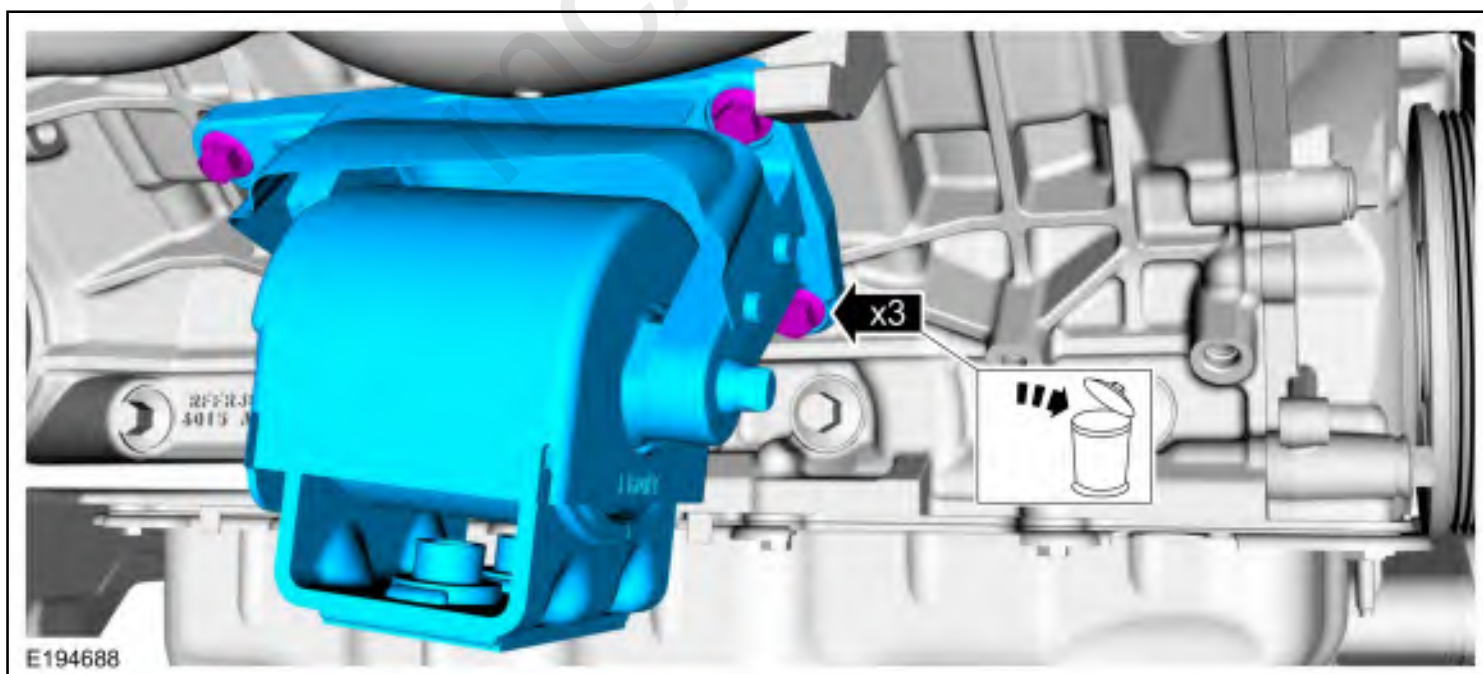
2. Using a floor crane, install the engine on a mounting stand and remove the special tool.  
Remove Special Service Tool: 303-F047 Lifting Bracket, Engine.  
Use the General Equipment: Floor Crane  
Use the General Equipment: Mounting Stand



3. Remove the bolts and the LH engine mount-to-cylinder block bracket.
  - Discard the bolts.

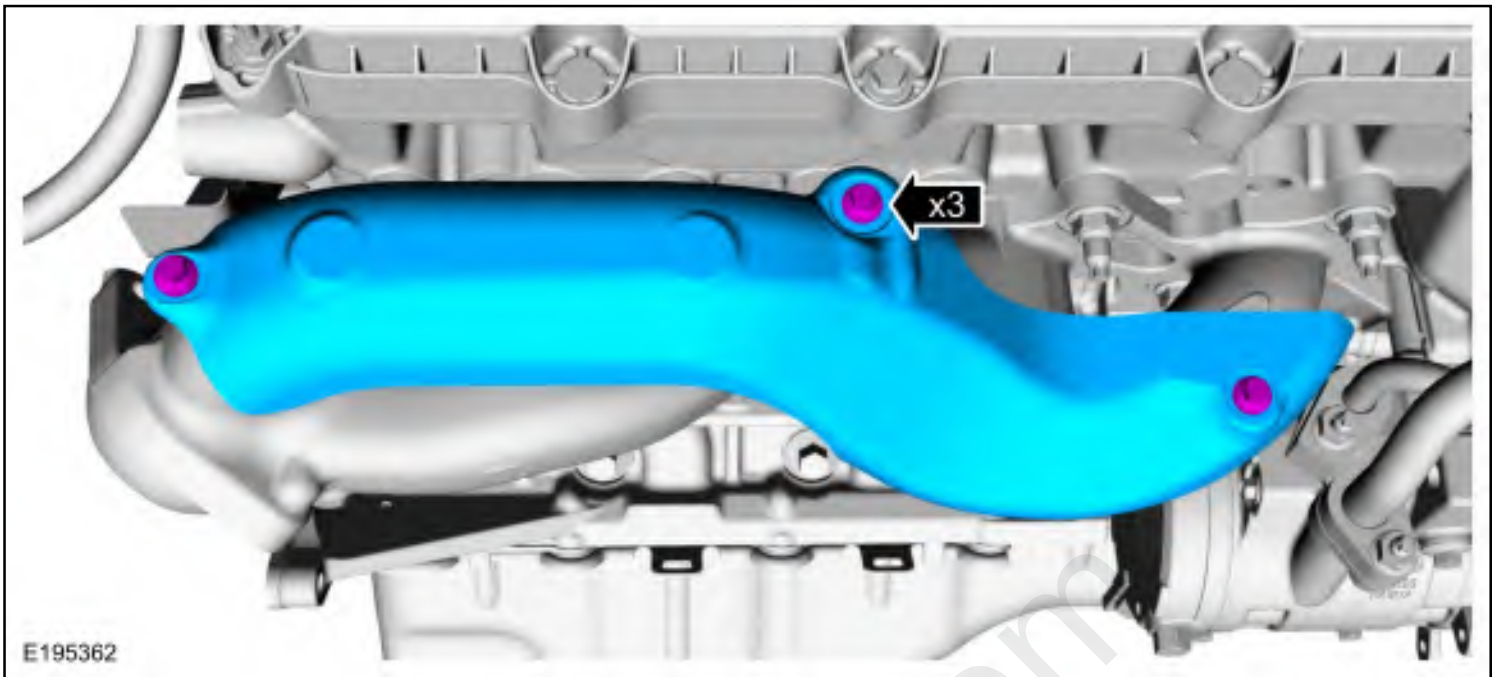


4. Remove the bolts and the RH engine mount and bracket as an assembly.
- Discard the bolts.





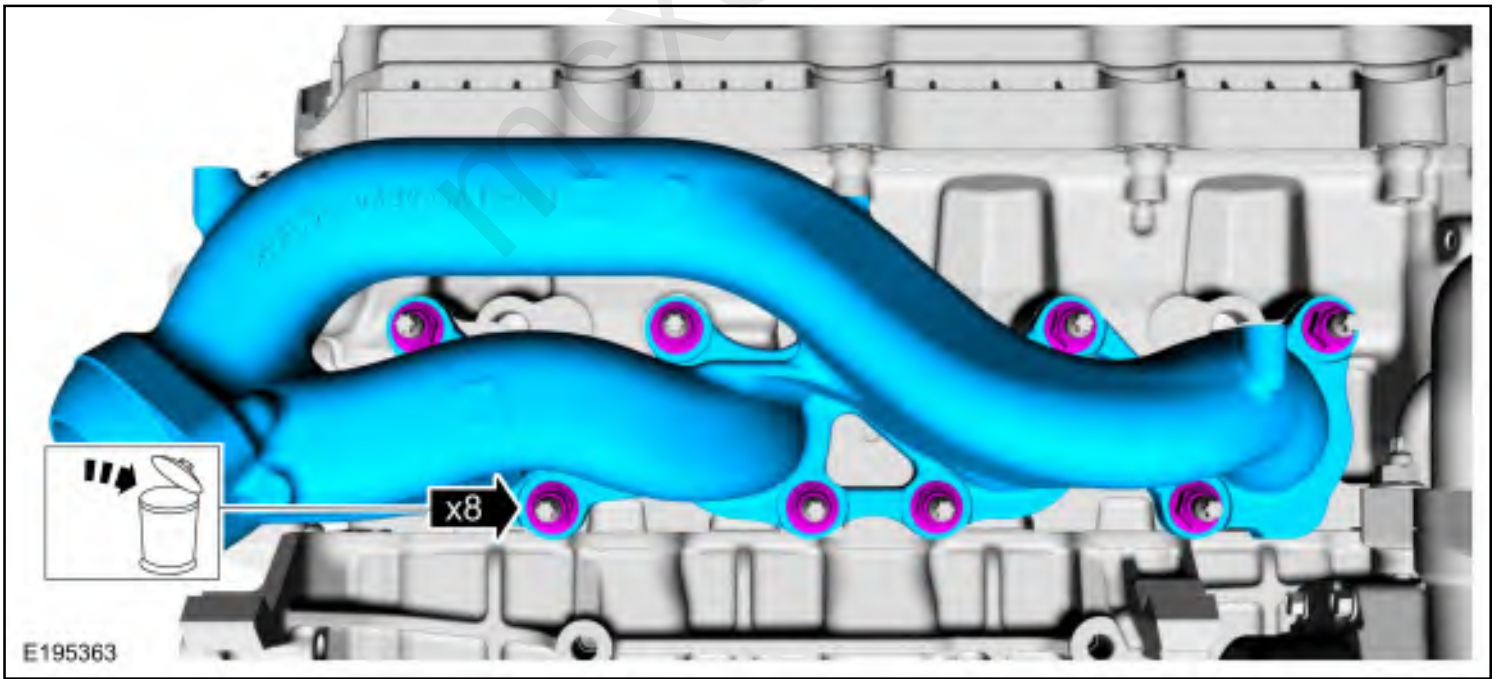
5. Remove the bolts and the RH exhaust manifold heat shield.



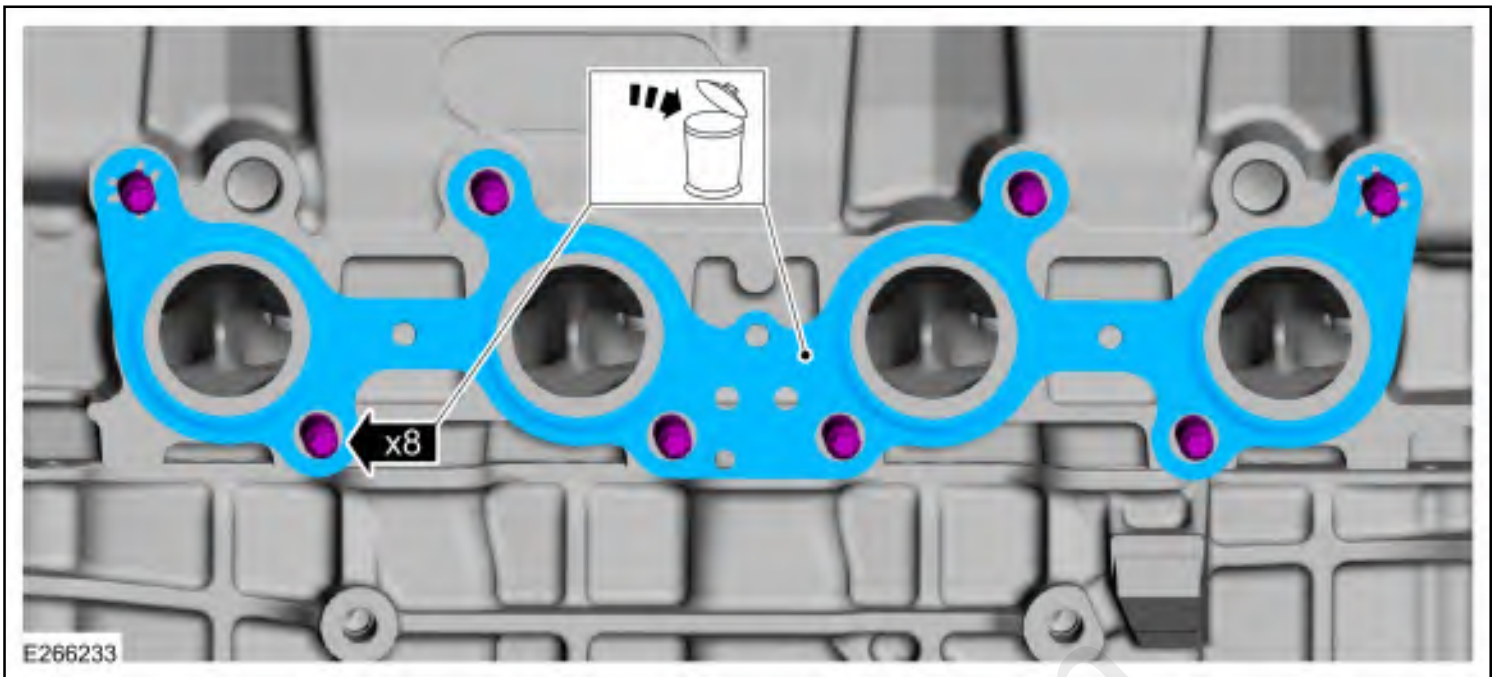
6. Remove and discard the nuts.

- Remove the exhaust manifold.
- Clean and inspect the exhaust manifold.

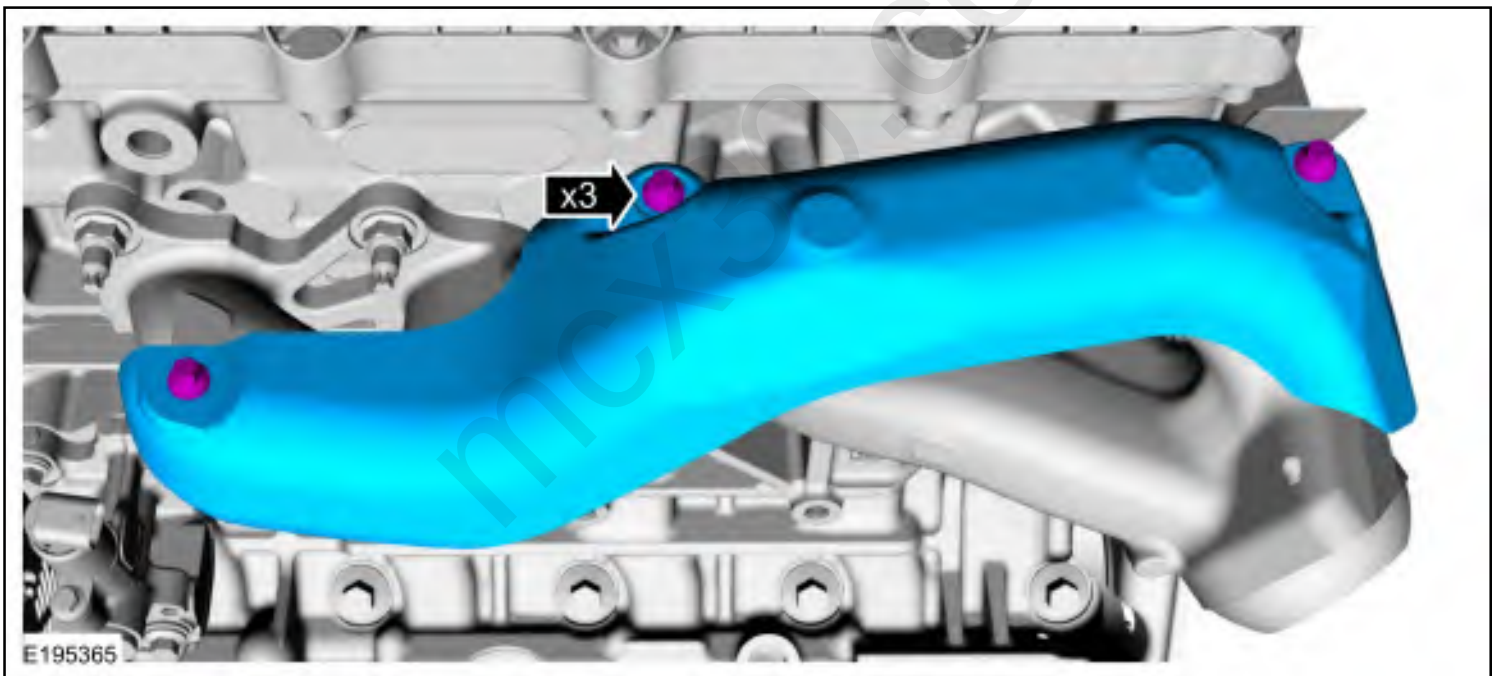
Refer to: [Exhaust Manifold Cleaning and Inspection](#) (303-00 Engine System - General Information, General Procedures).



7. Remove and discard the gasket and studs.



8. Remove the bolts and the LH exhaust manifold heat shield.

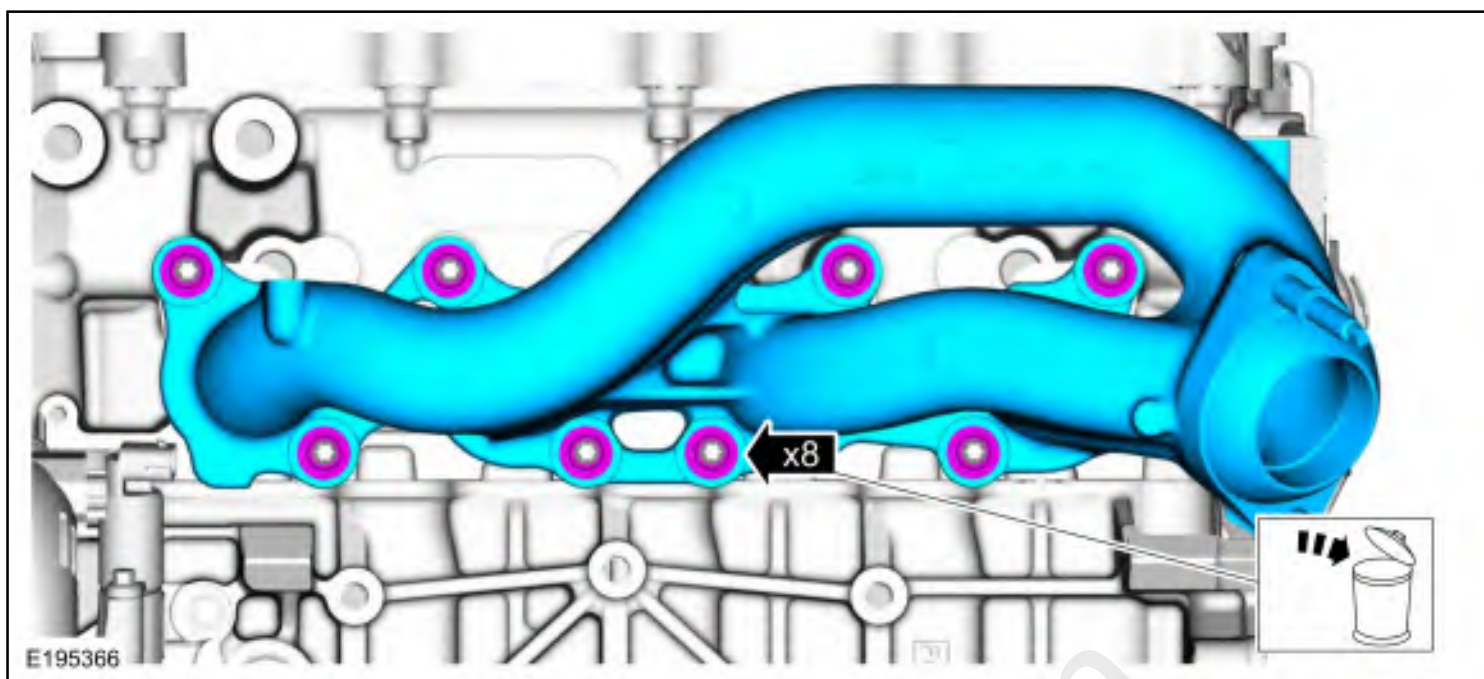


9. Remove and discard the nuts.

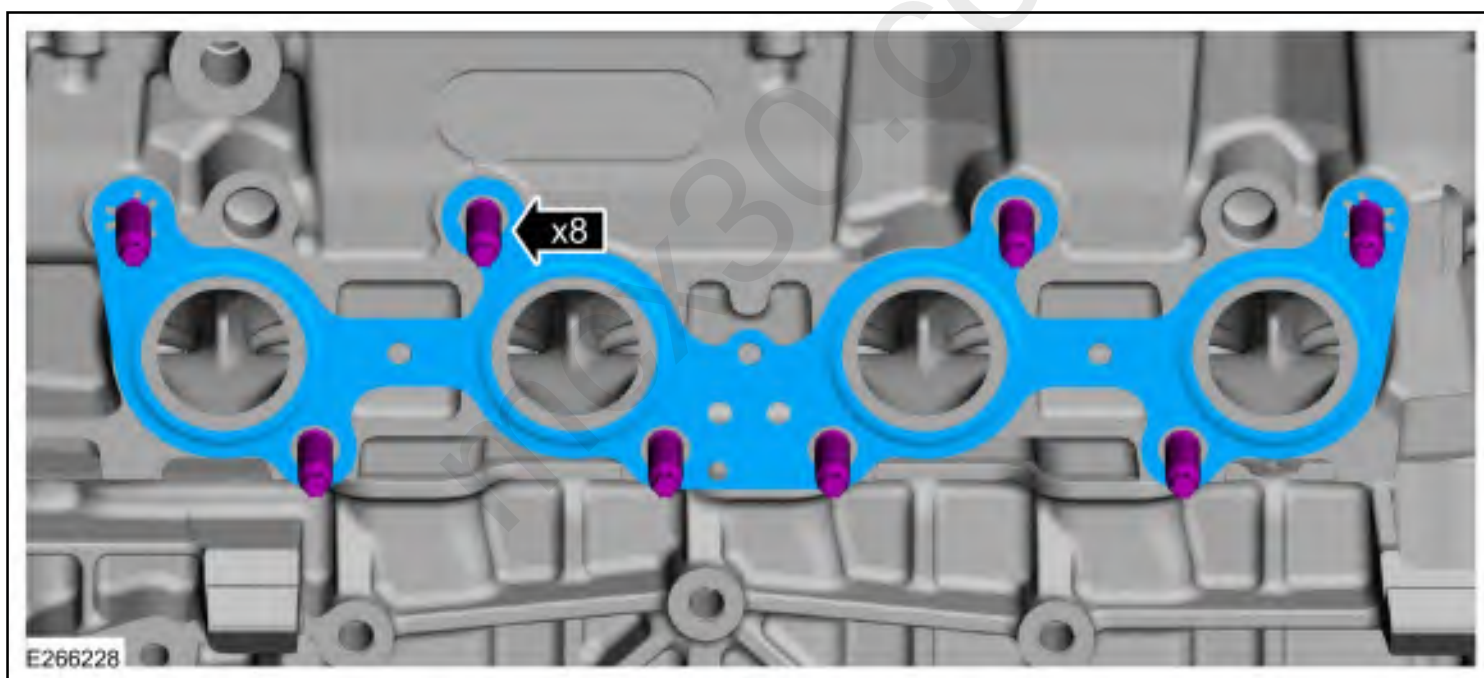
- Remove the exhaust manifold.
- Clean and inspect the exhaust manifold.

Refer to: [Exhaust Manifold Cleaning and Inspection](#) (303-00 Engine System - General Information, General Procedures).



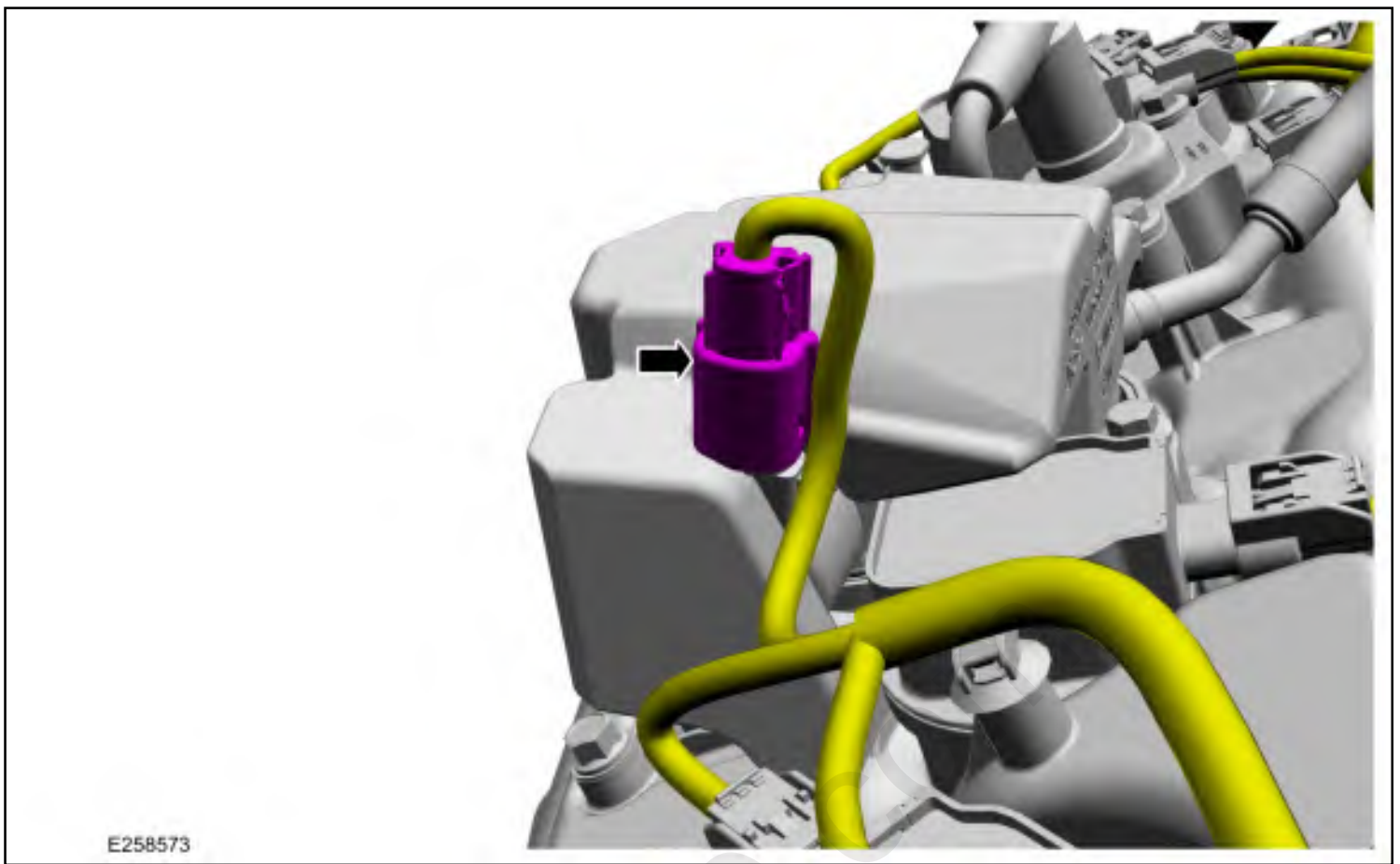


10. Remove and discard the gasket and studs.



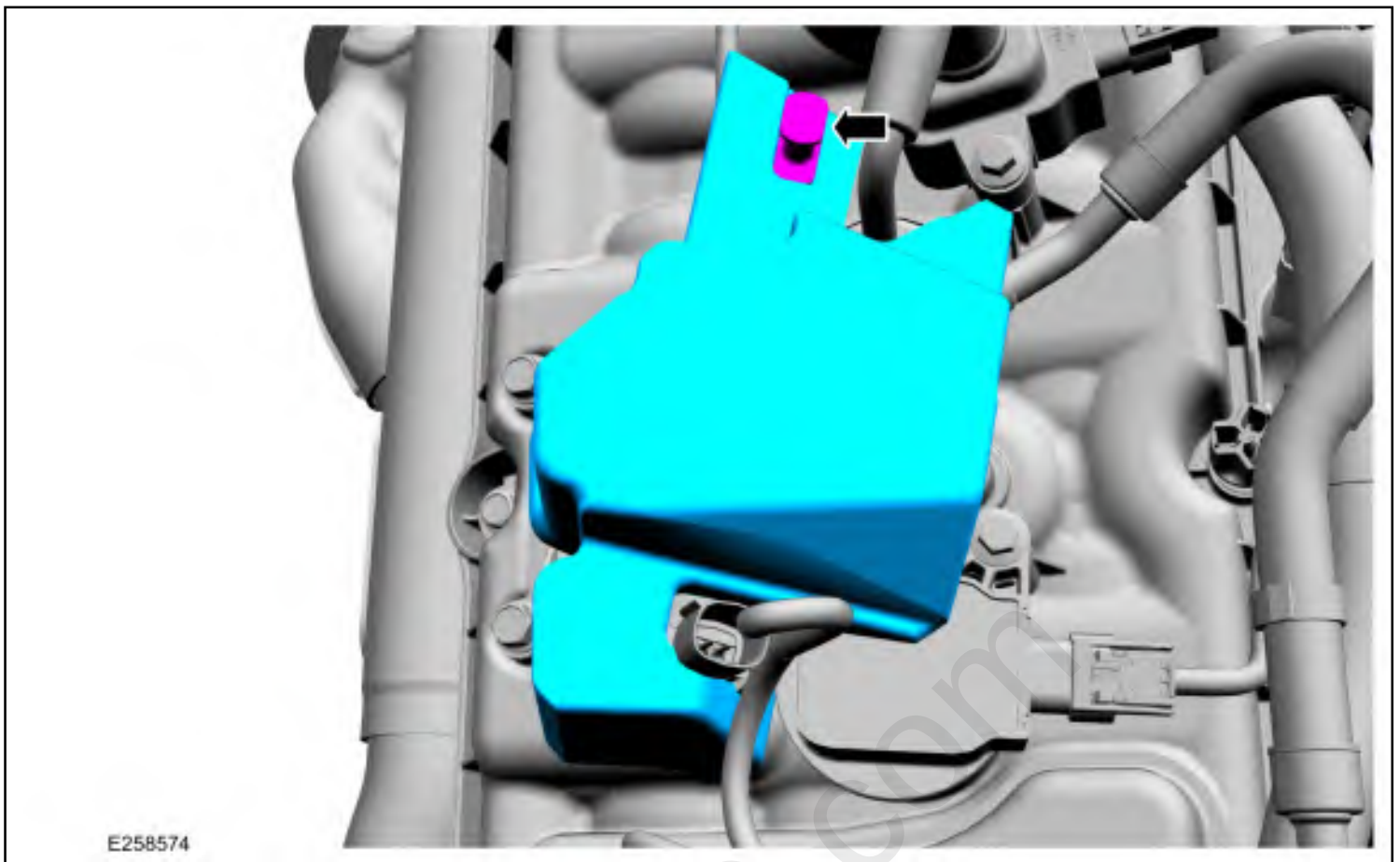
11. Disconnect the high-pressure fuel pump electrical connector.



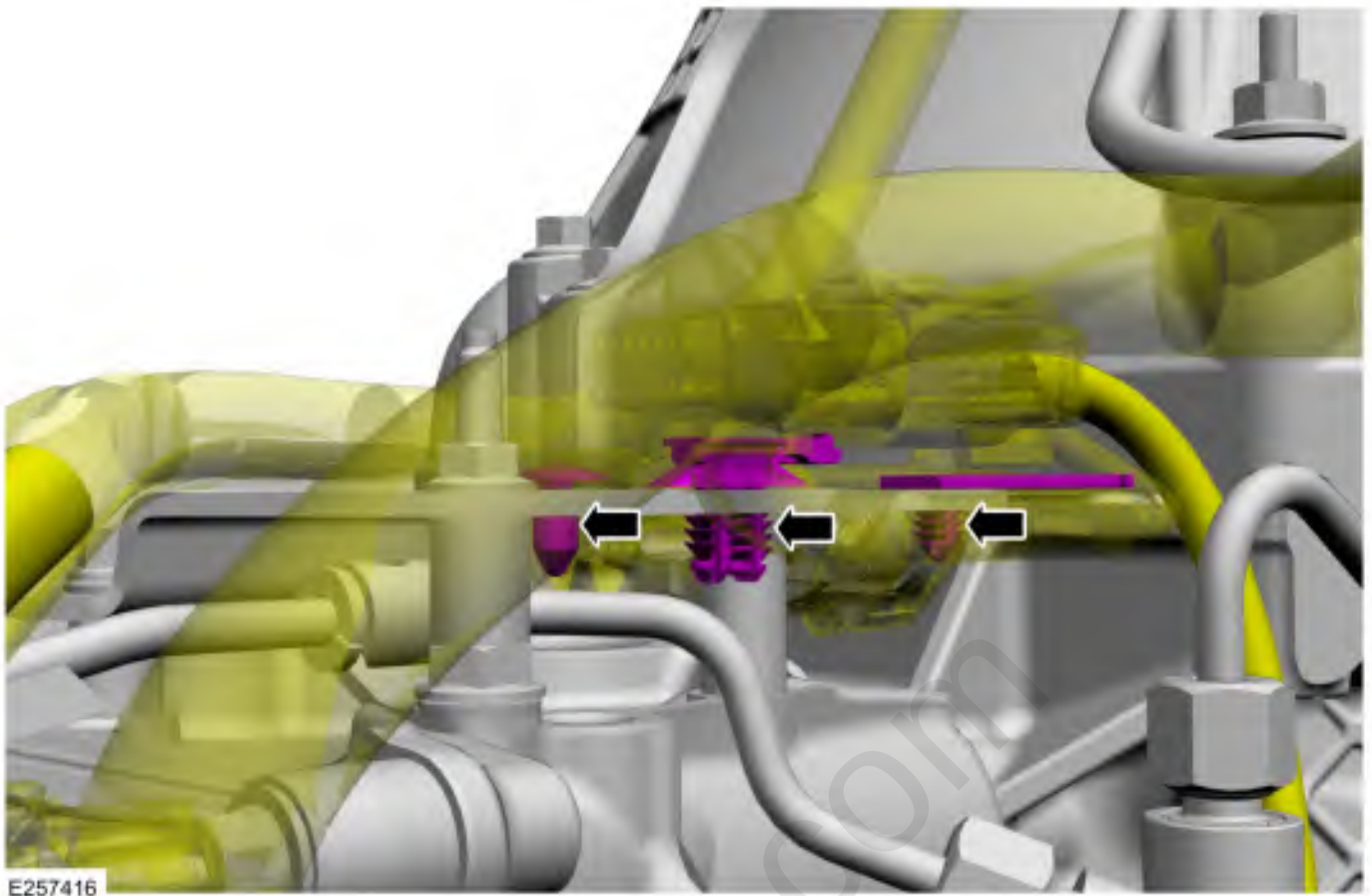


12. **NOTE:** *When removing or installing the fuel injection pump noise insulator, spreading the openings will reduce the risk of damage.*

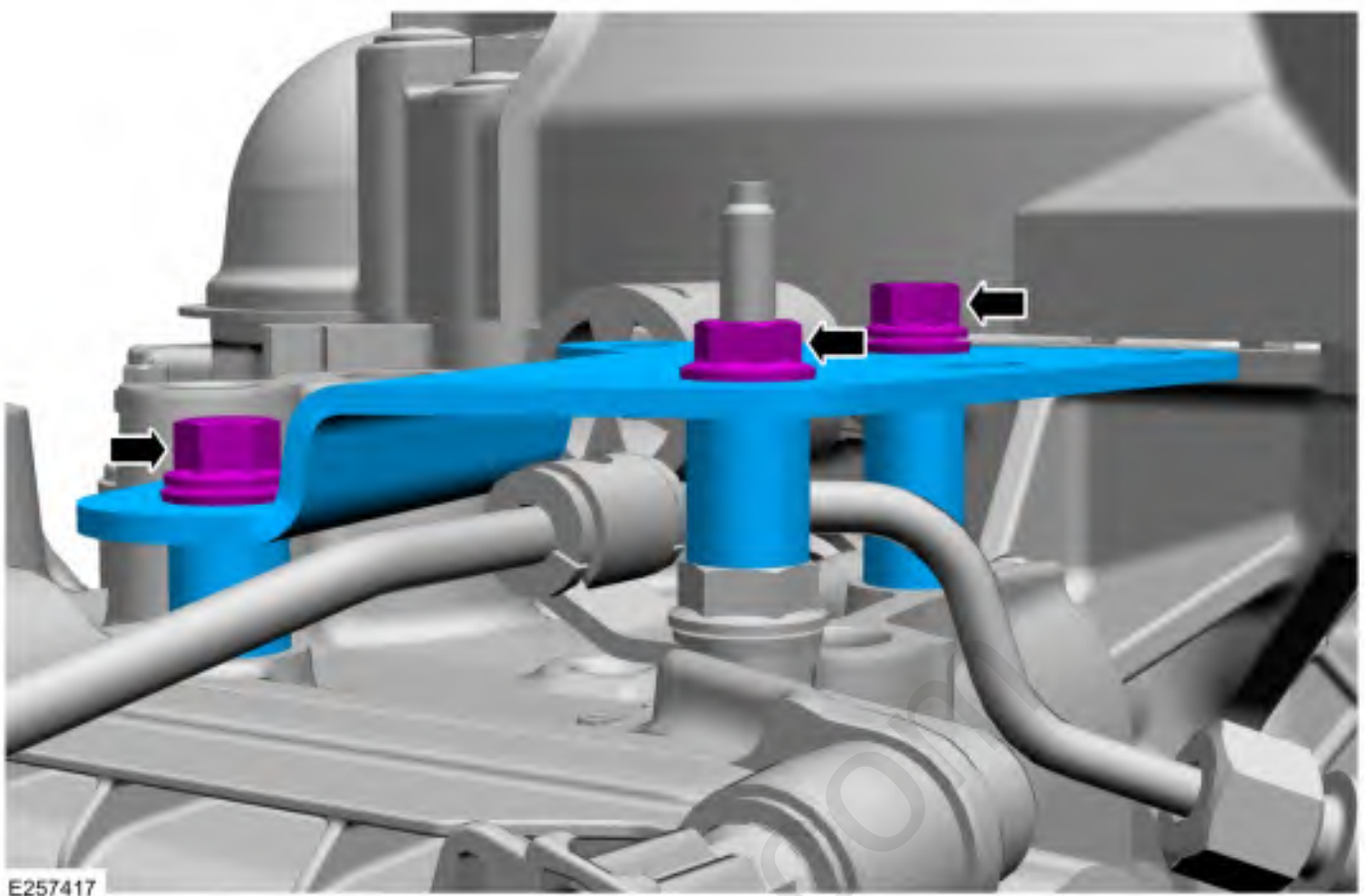
Release the retainer, then remove the fuel injection pump noise insulator.



13. Detach the wiring harness retainers from high-pressure fuel line shield.

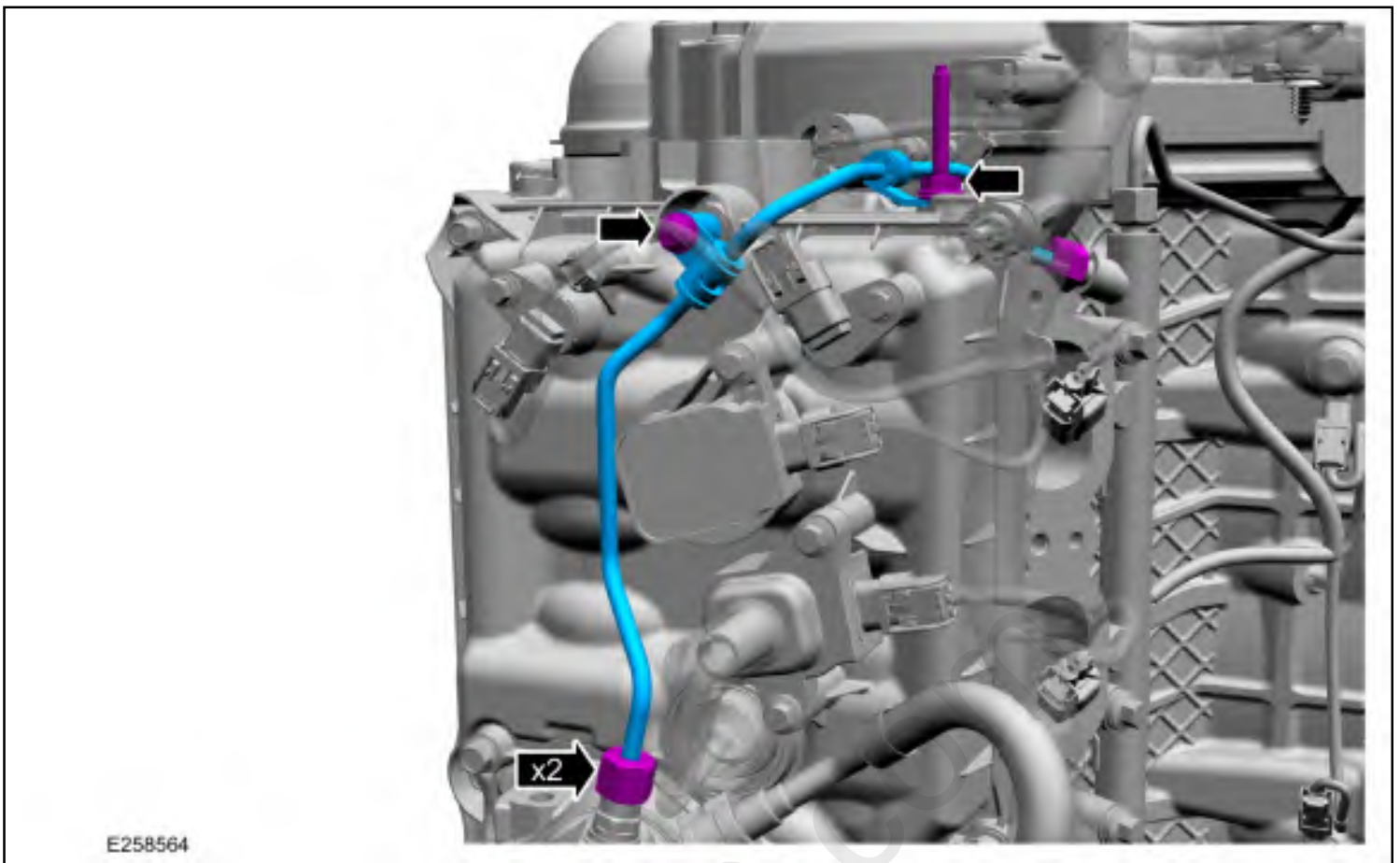


14. Remove the high-pressure fuel line shield retainers, then remove high-pressure fuel line shield.



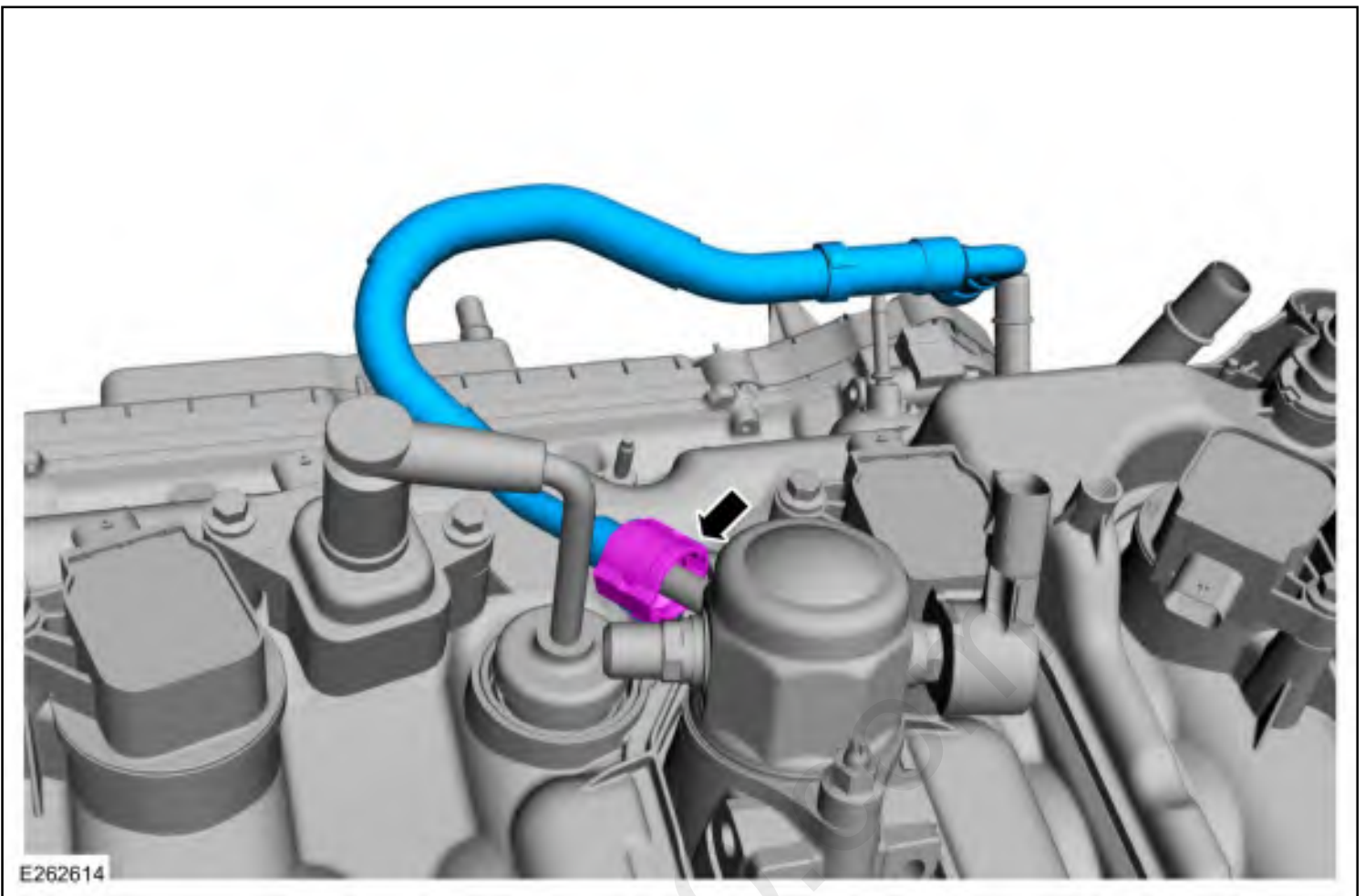
15. **NOTICE:** To release the fuel pressure in the high-pressure fuel tube, wrap the high-pressure fuel tube flare nuts with a shop towel to absorb any residual fuel pressure during the loosening of the high-pressure fuel tube flare nuts.

Remove the high-pressure fuel tube retainers. Disconnect the high-pressure fuel tube flare nuts, then remove and discard the high-pressure fuel tube.

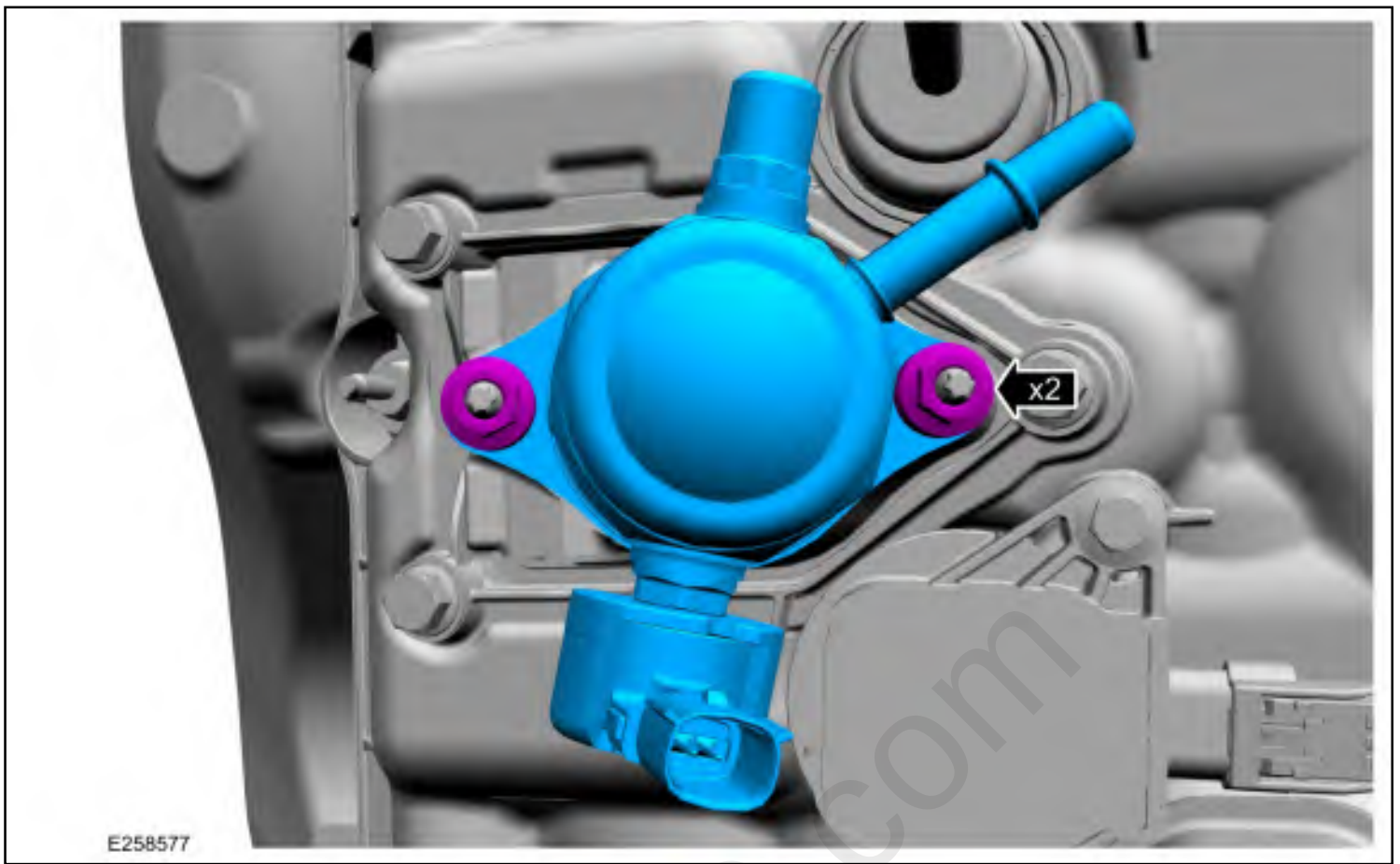


16. Disconnect the quick release coupling and remove the high-pressure fuel tube.  
Refer to: [Quick Release Coupling](#) (310-00D Fuel System - General Information - 5.0L 32V Ti-VCT, General Procedures).

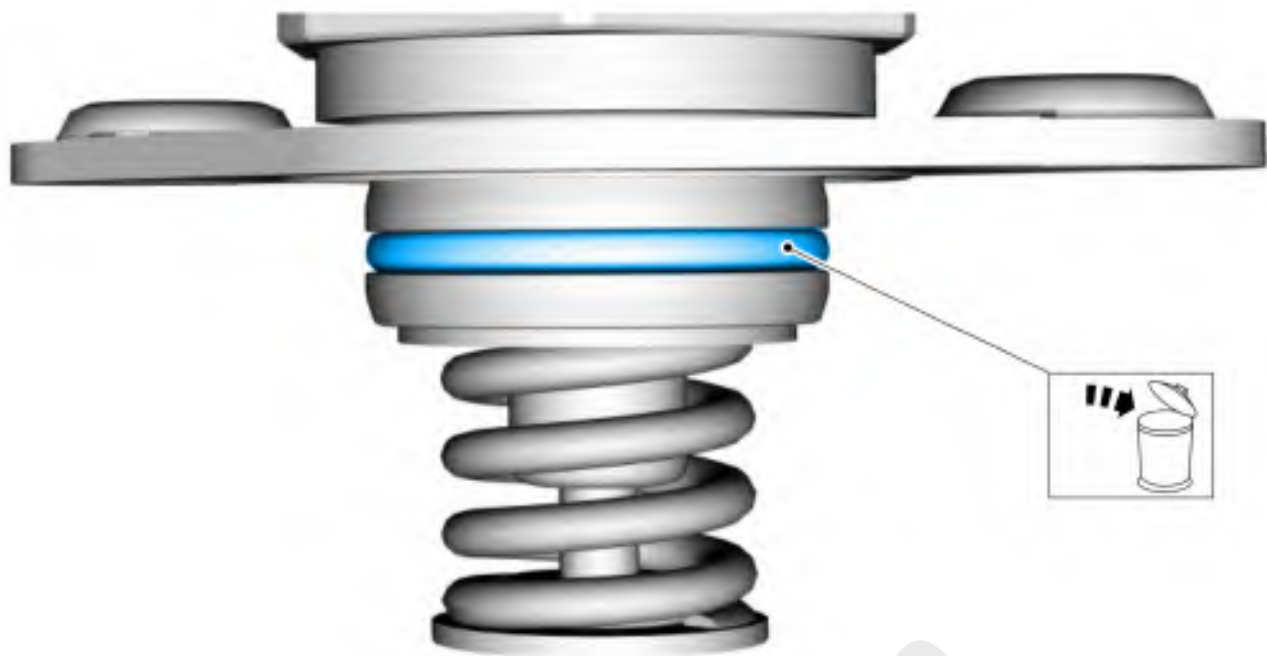




17. Alternately loosen the high-pressure fuel pump nuts one complete revolution at a time and remove, then remove the high-pressure fuel pump.



18. Remove and discard the high-pressure fuel pump O-ring seal.



E242552

19. Remove the high-pressure fuel pump roller tappet.



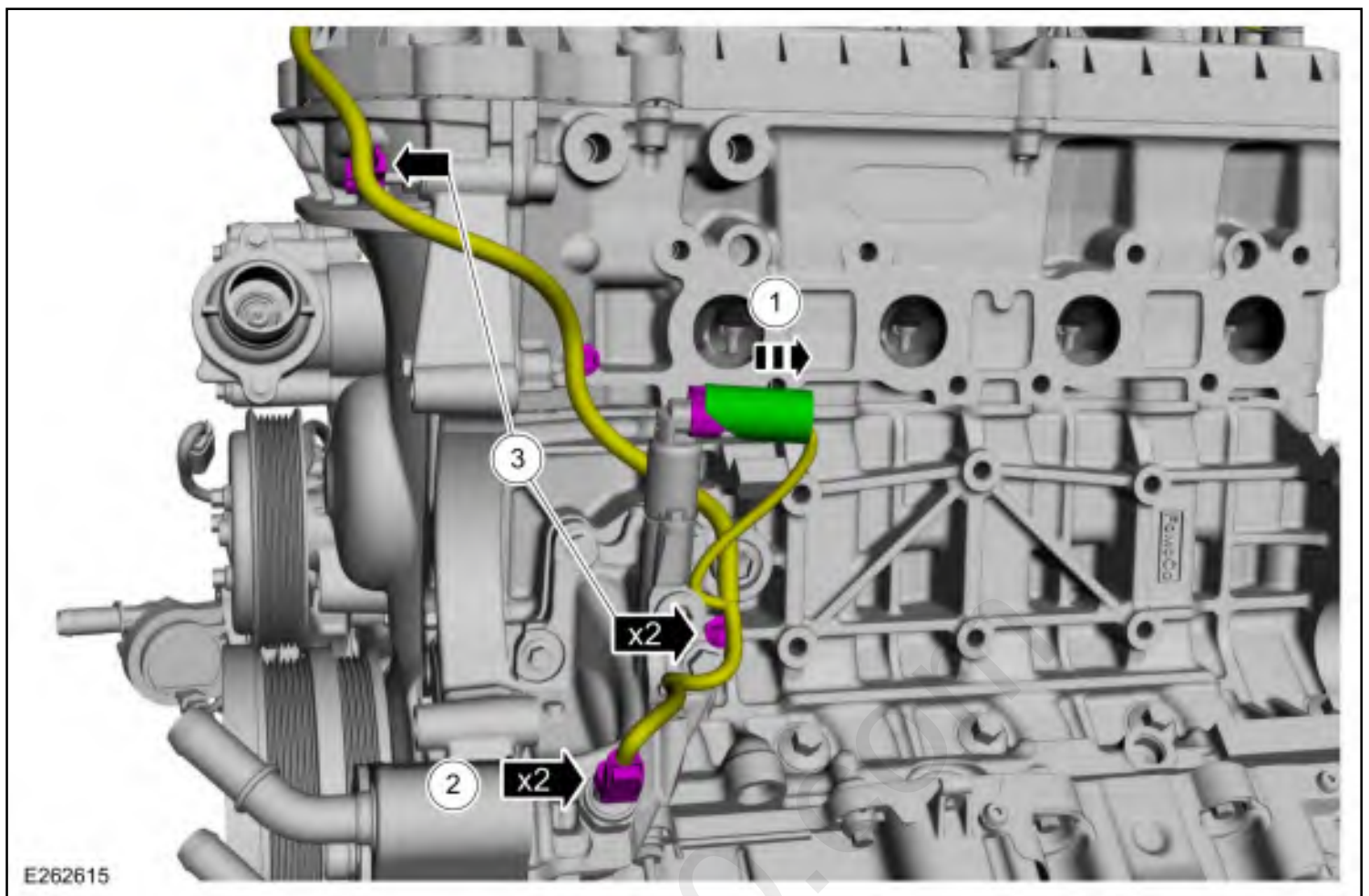


20. Inspect the high-pressure fuel pump roller tappet. If any flat spots or scoring are found, especially in the indicated areas, then inspect the high-pressure fuel pump and the high-pressure fuel pump roller tappet drive lobe. Install new components as needed.

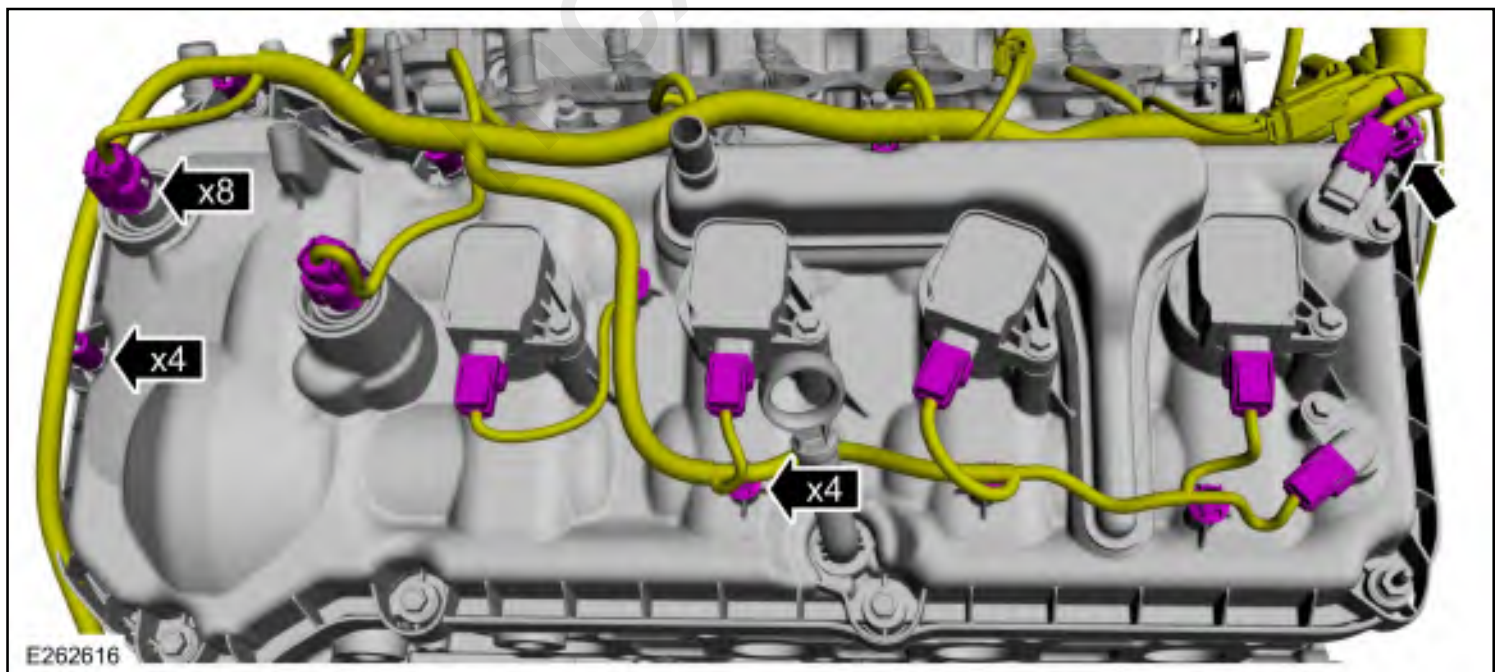


E175709

1. Reposition the wiring harness insulator.
2. Disconnect the engine wiring harness electrical connectors.
3. Detach the engine wiring harness retainers.

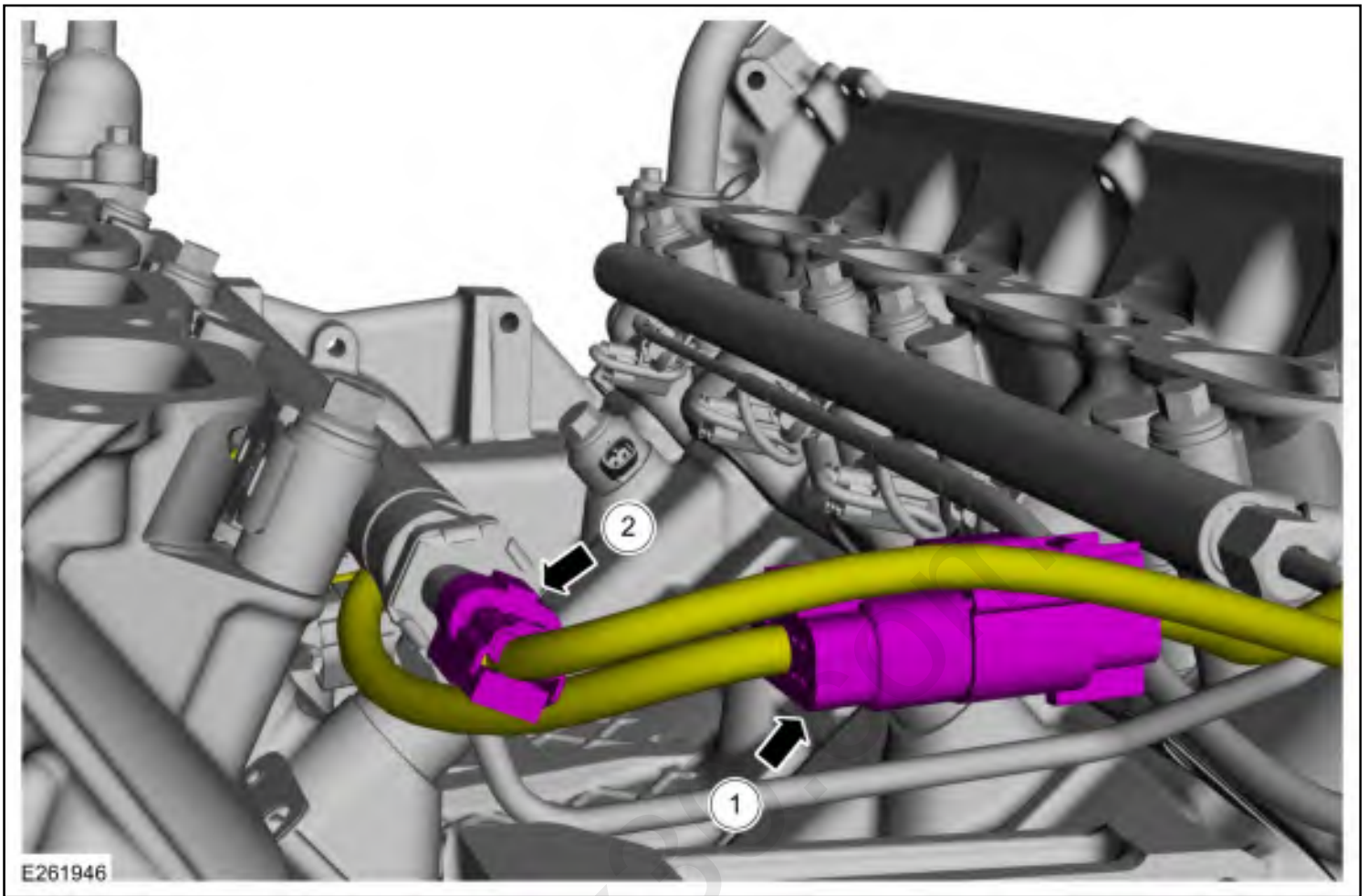


1. Disconnect the engine wiring harness electrical connectors.
2. Detach the wiring harness retainers.



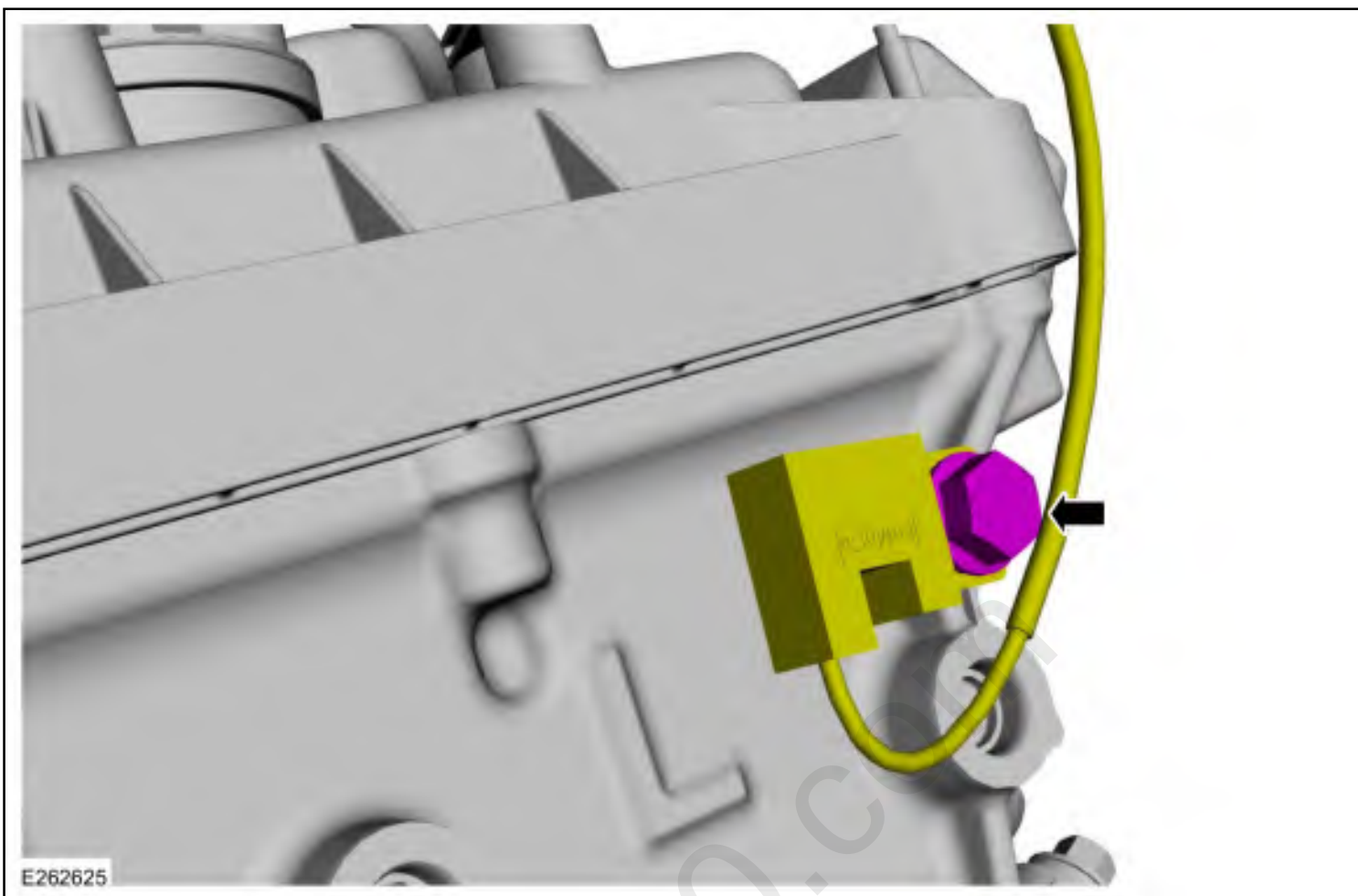
1. Disconnect the fuel rail electrical connector.

2. Disconnect the fuel sensor electrical connector.

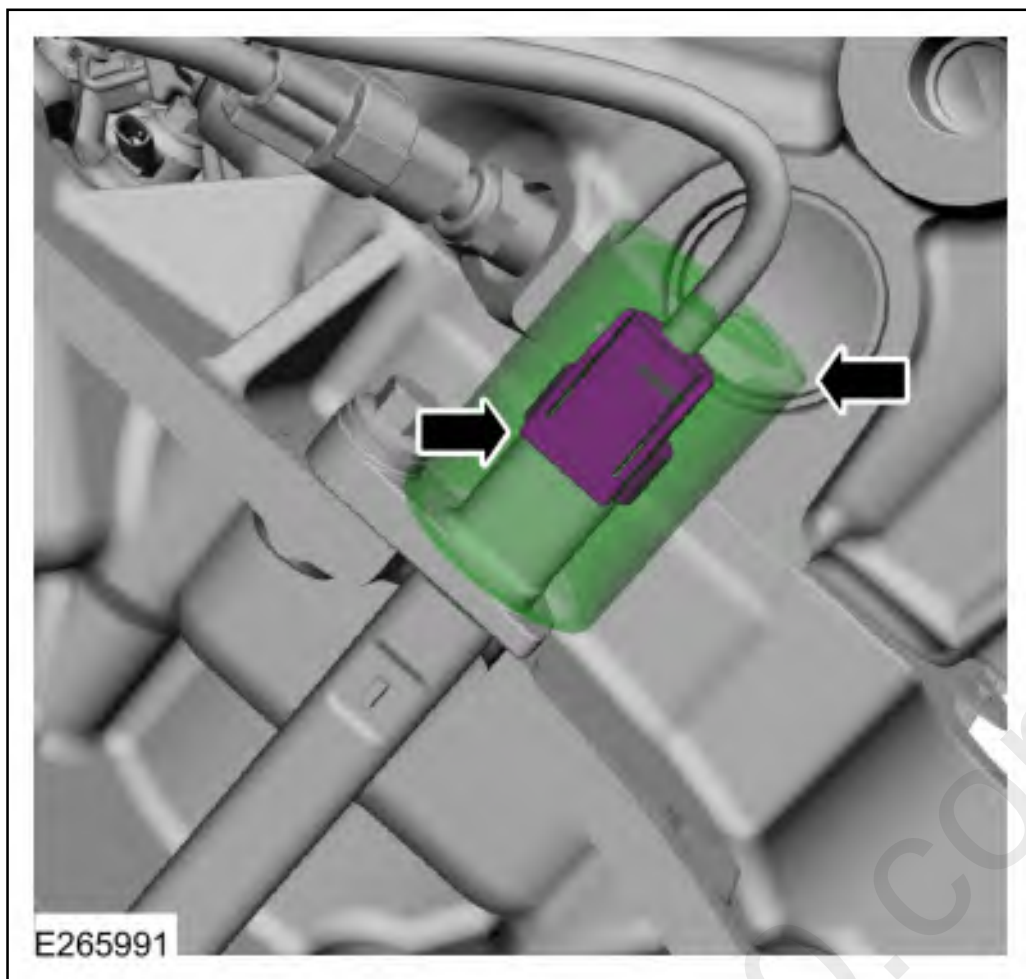


24. Remove the bolt and position the capacitor aside.

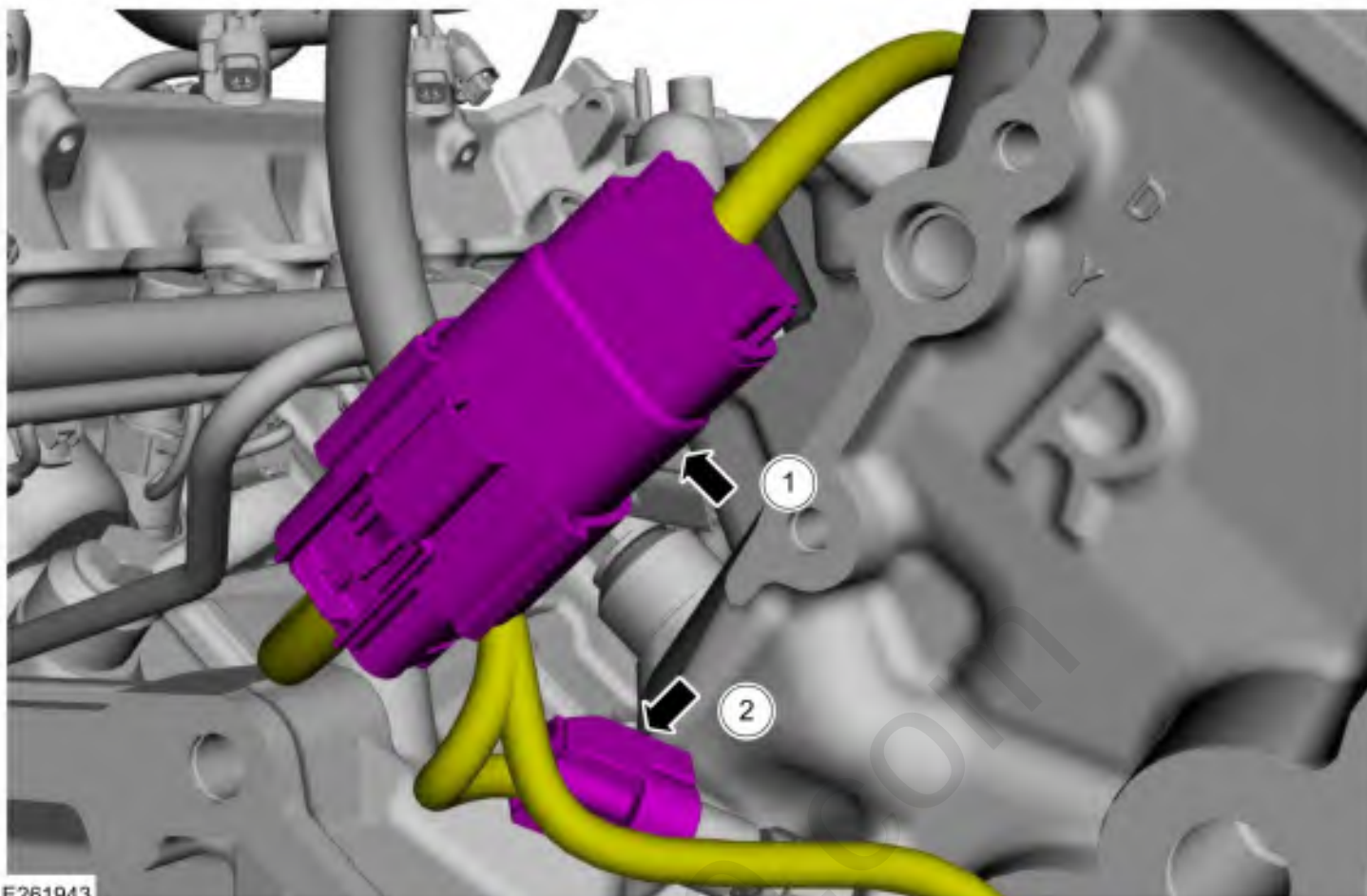




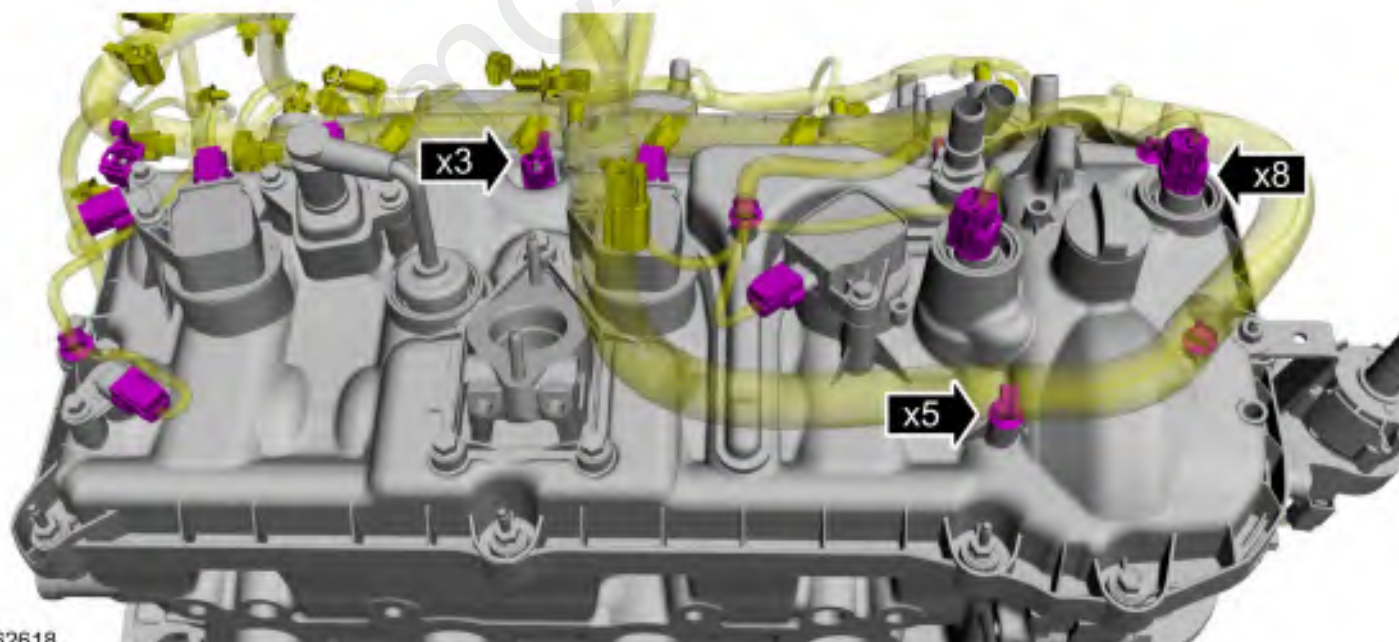
1. Position the wiring harness insulator aside.
2. Disconnect the CKP sensor electrical connector.



1. Disconnect the fuel rail electrical connector.
2. Disconnect the CHT sensor electrical connector.



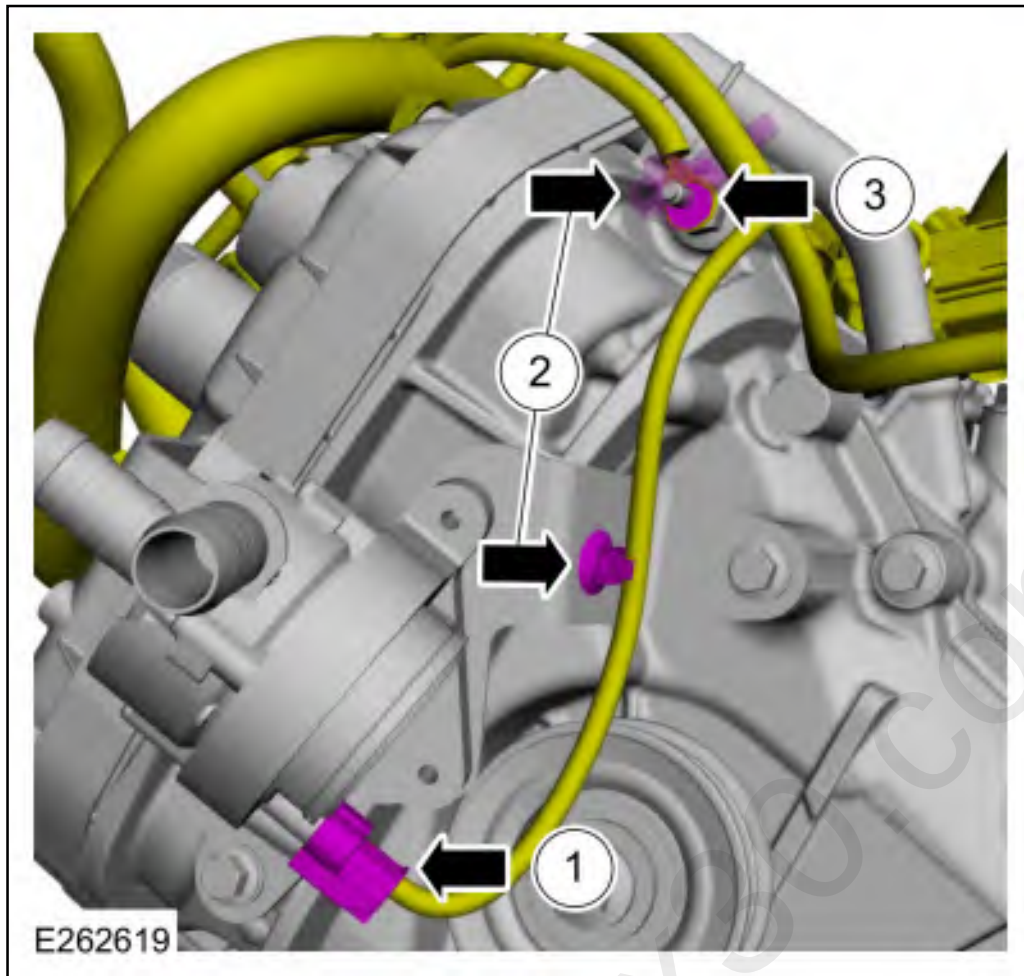
1. Disconnect the engine wiring harness electrical connectors.
2. Detach the wiring harness retainers.



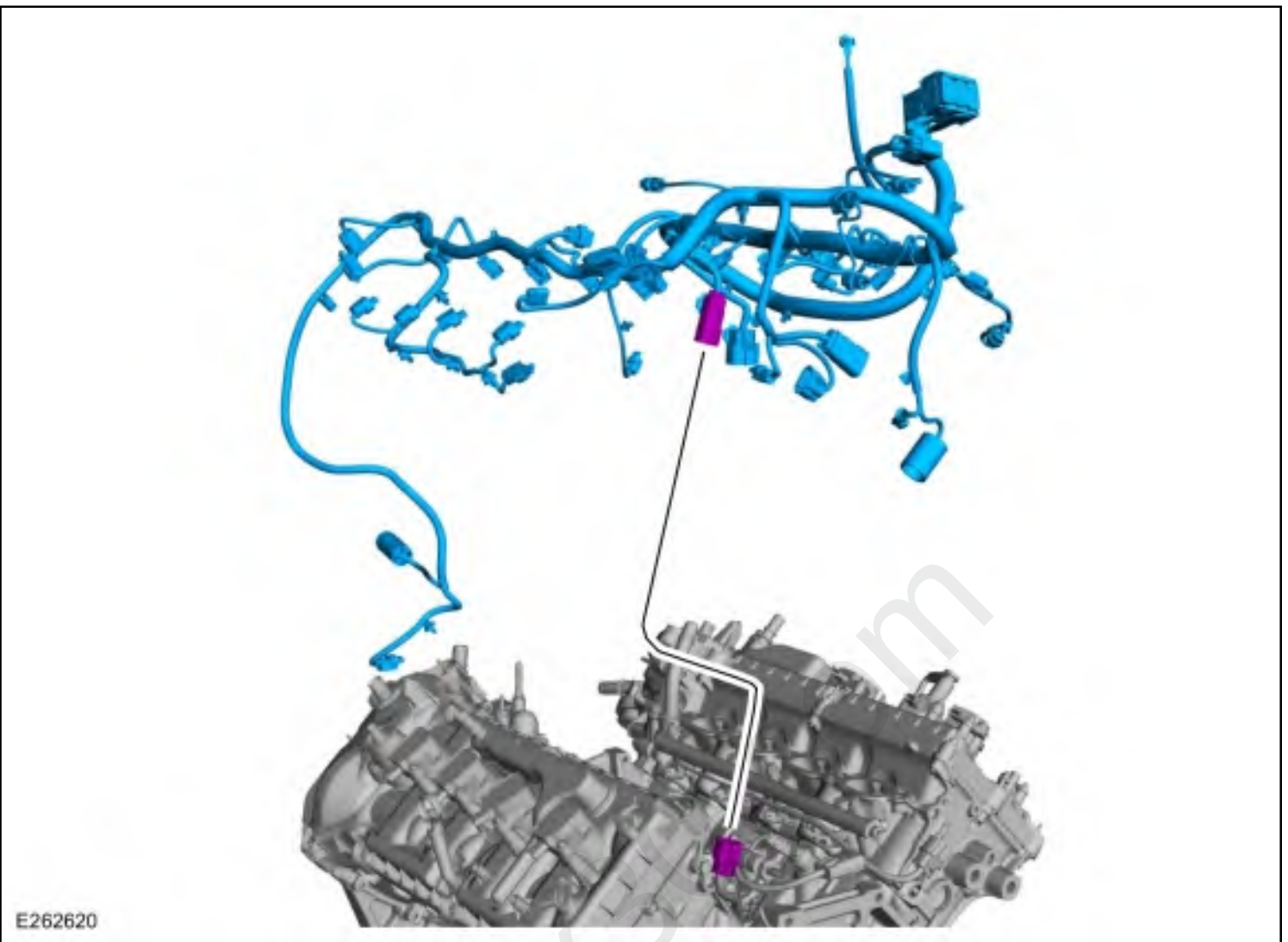
1. Disconnect the engine wiring harness electrical connector.



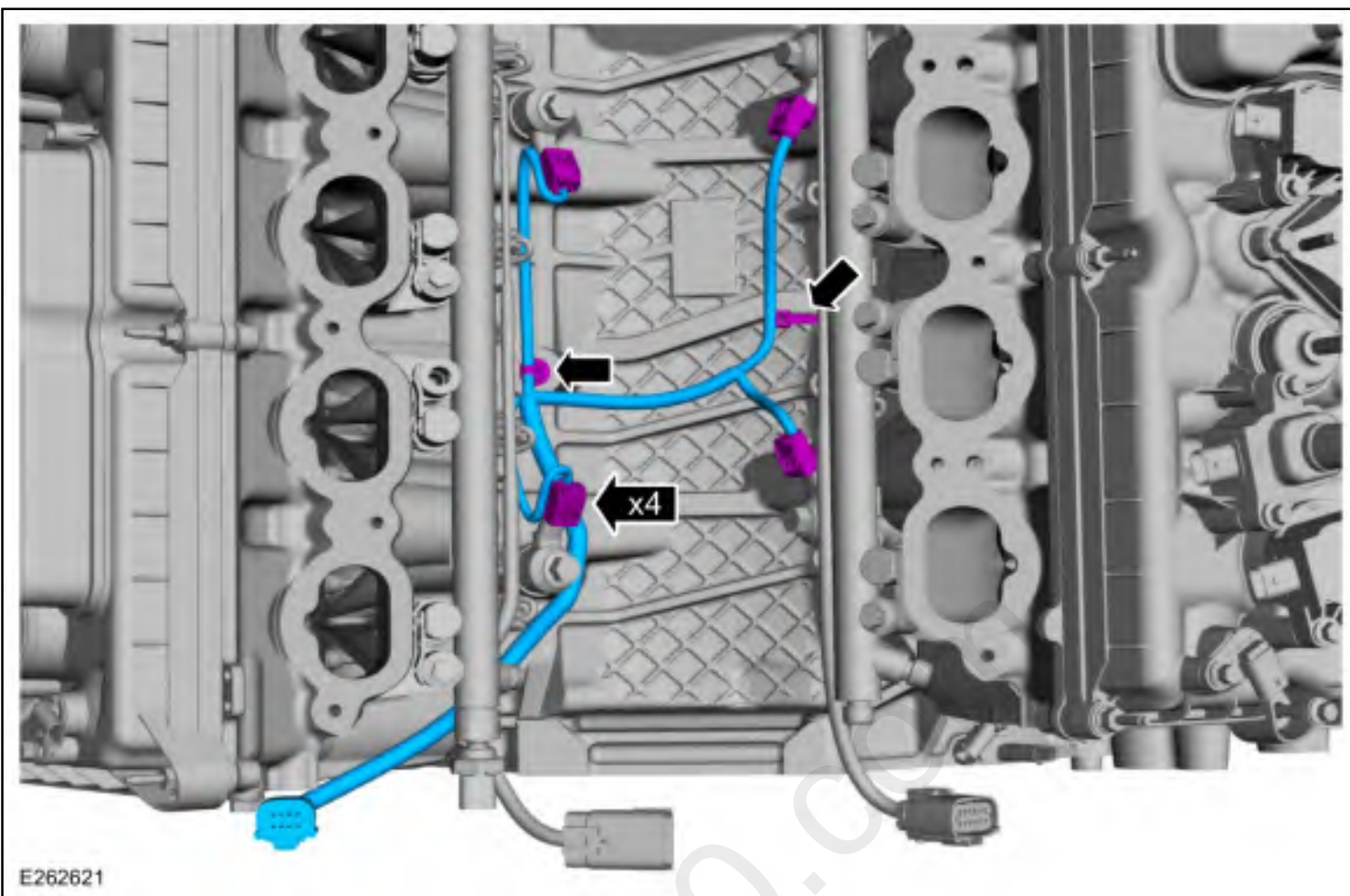
2. Detach the engine wiring harness retainers.
3. Remove the nut and the ground wire eyelet.



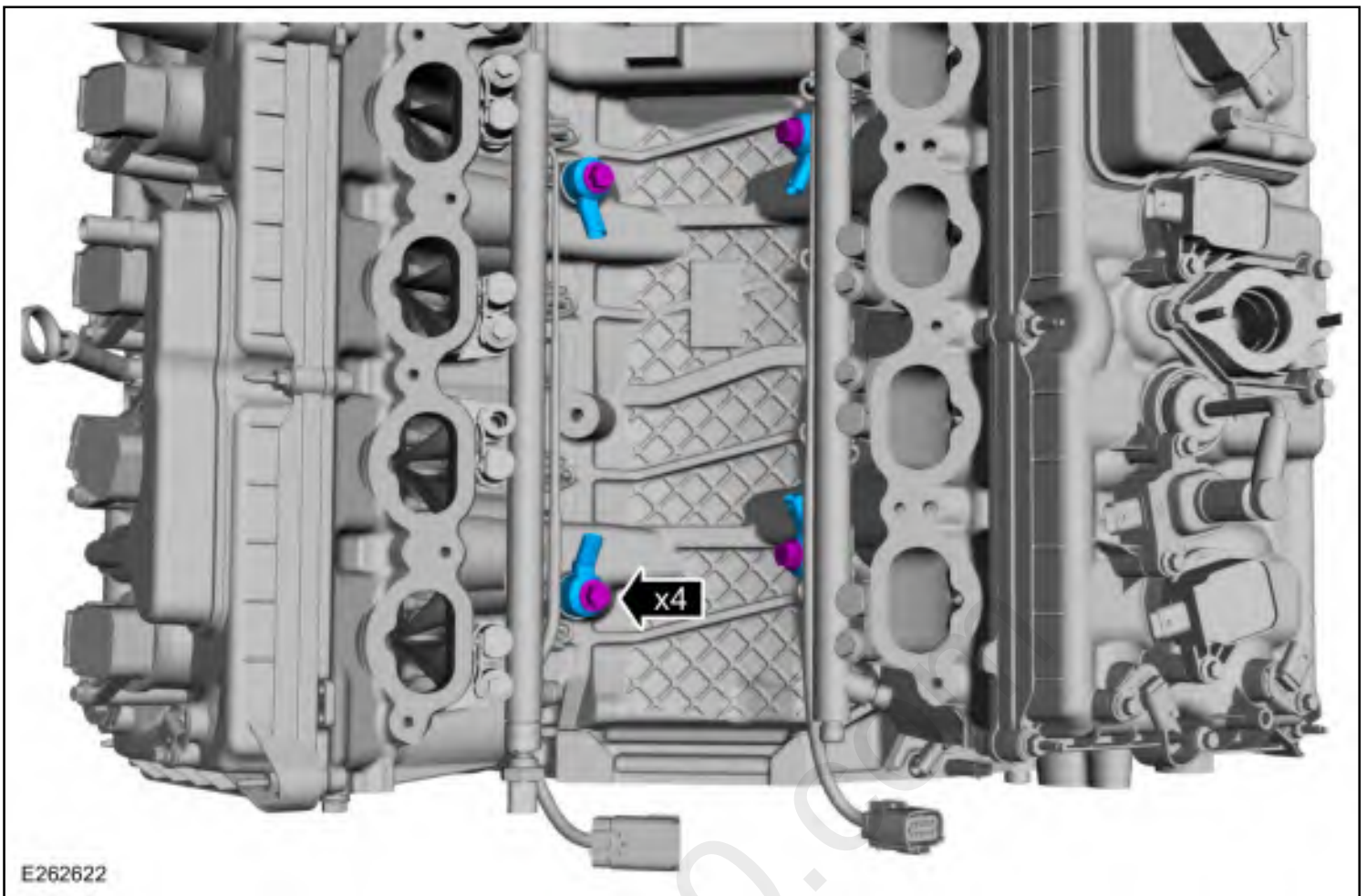
29. Disconnect the engine wiring harness and remove the harness from the engine.



1. Disconnect the KS electrical connectors.
2. Detach the wiring harness retainers.
3. Remove the KS harness from the engine.



31. Remove the bolts and the KSs.

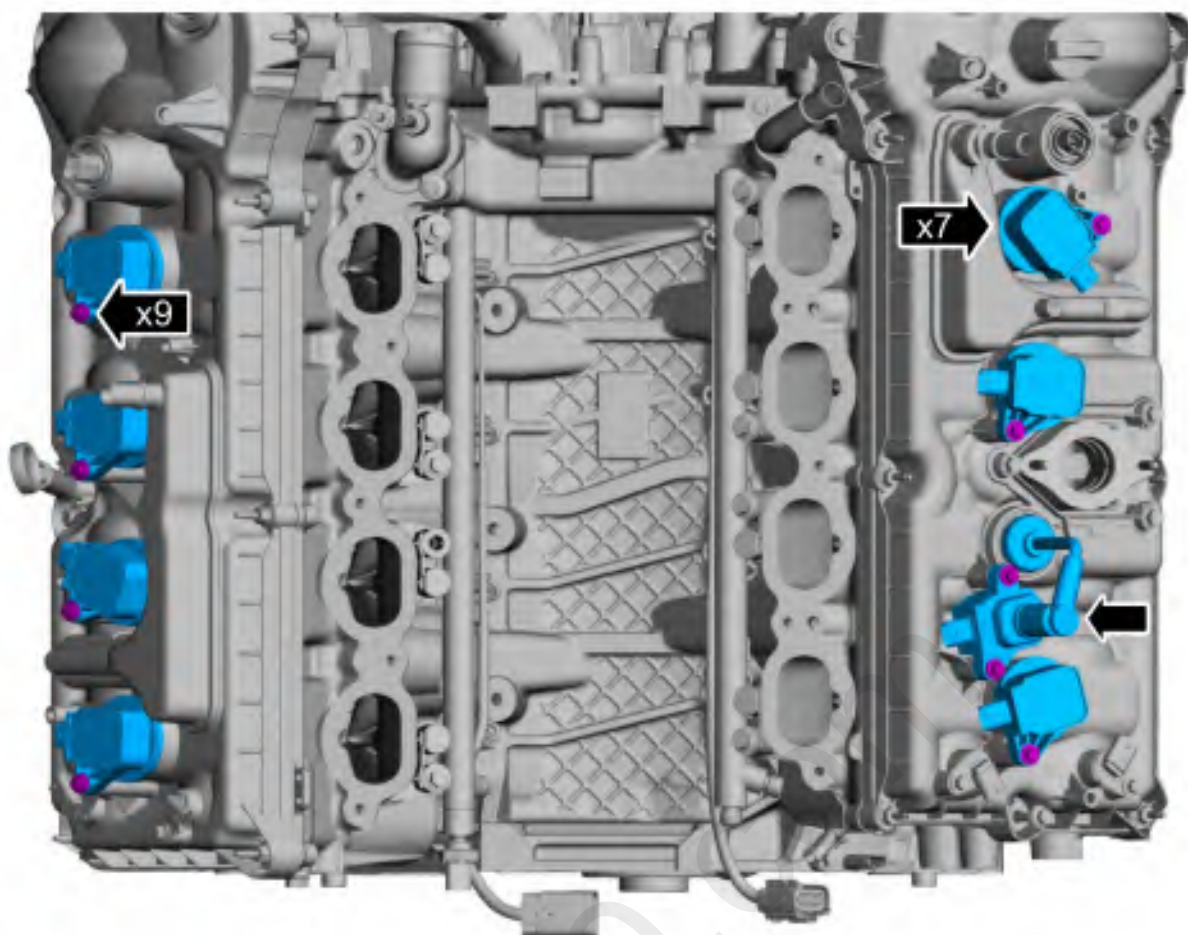


32. **NOTE:** Use compressed air to remove any foreign material from the ignition coil-on-plugs and surrounding area before removing the ignition coil-on-plugs.

**NOTE:** When removing the ignition coil-on-plugs, a slight twisting motion will break the seal and ease removal.

1. Remove the ignition coil-on-plug retaining bolts.
2. Remove the ignition coil-on-plugs.





E262623

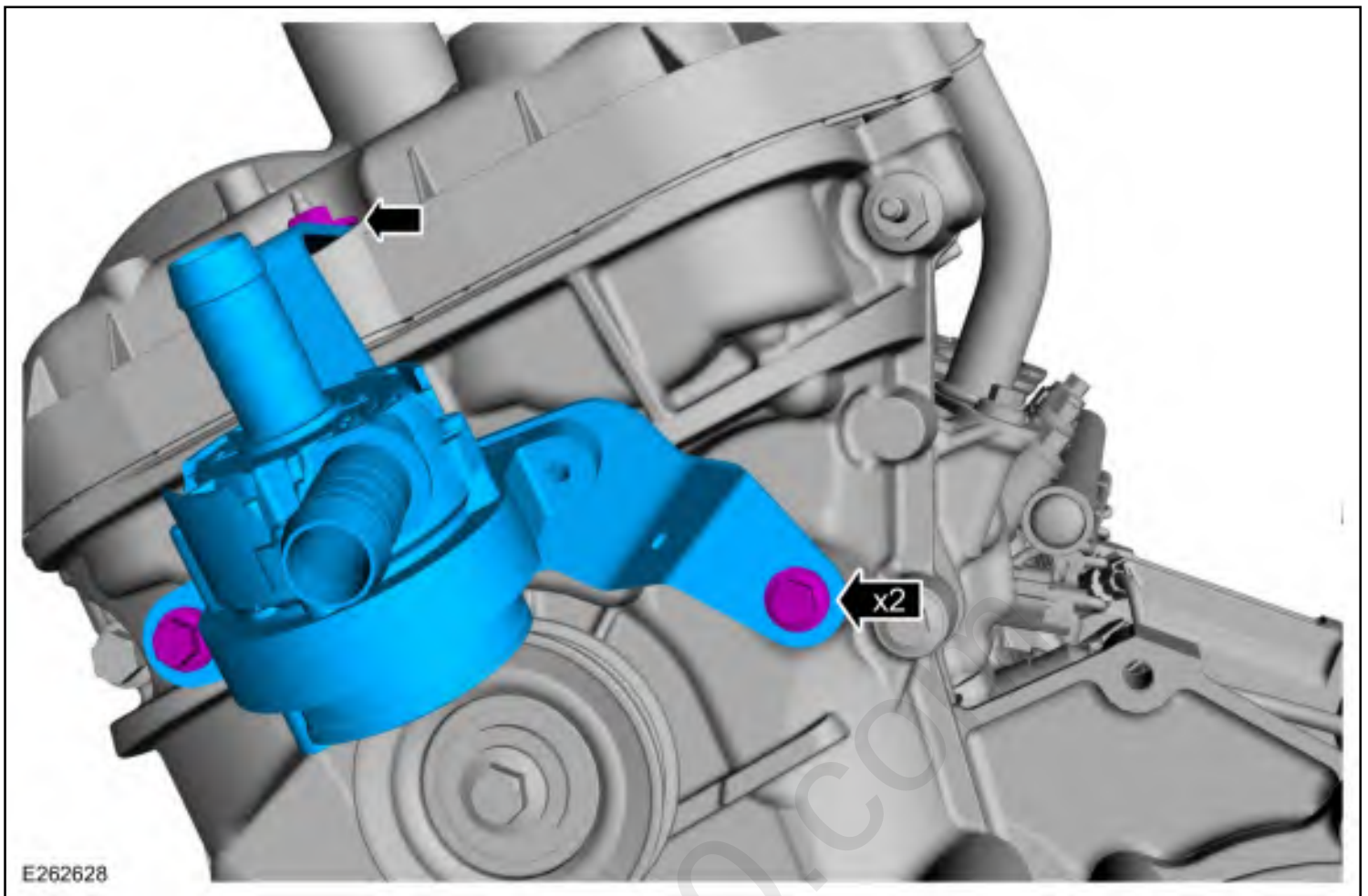
33. Inspect the ignition coil-on-plug assembly for cracks, rips, or tears. Replace any damaged coil-on-plug assemblies.



E254986

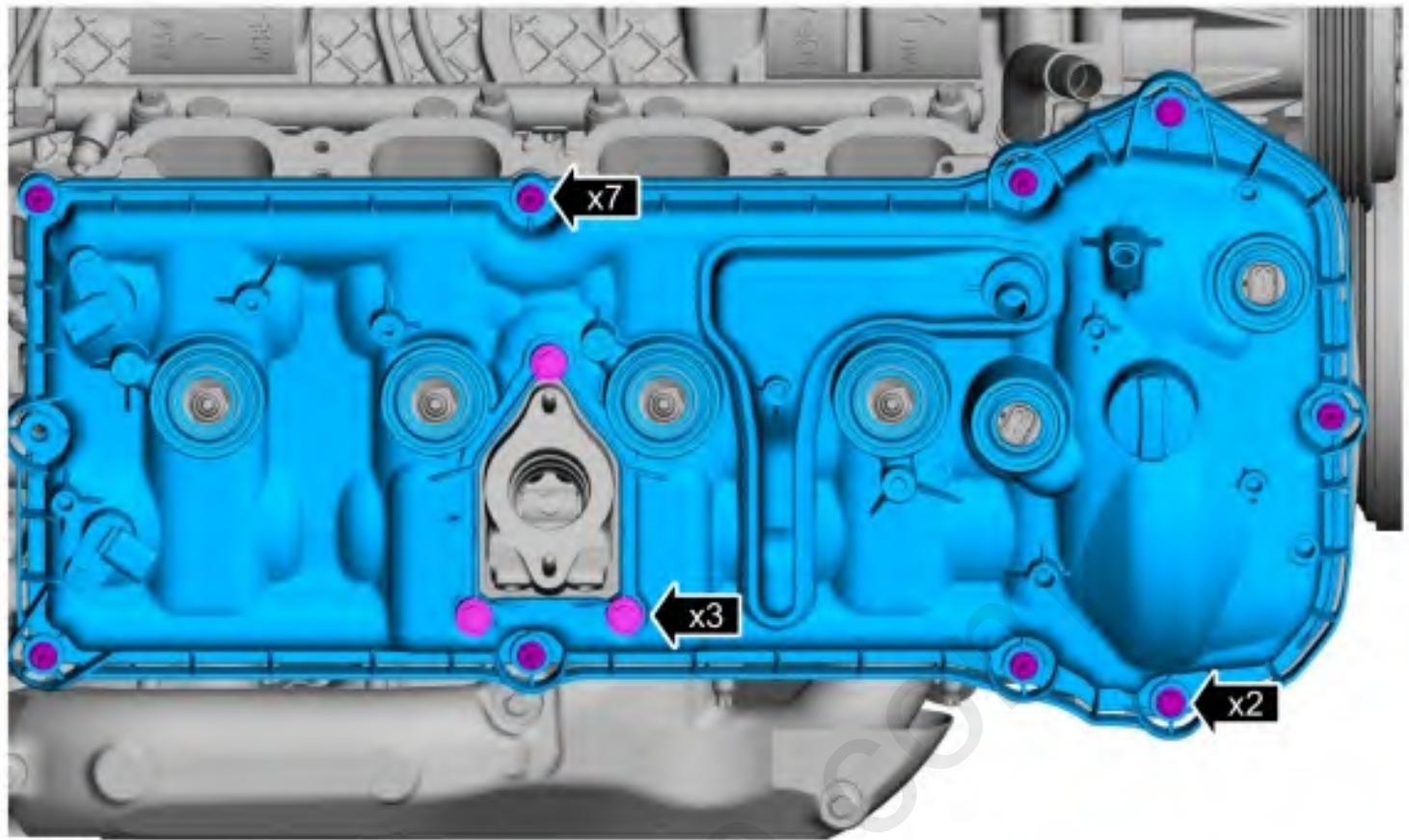


34. Remove the fasteners and the coolant pump.



35. Loosen the bolts and remove the valve cover.





E262355



36. **NOTE:** Clean the valve cover gasket groove with soap and water or a suitable solvent.

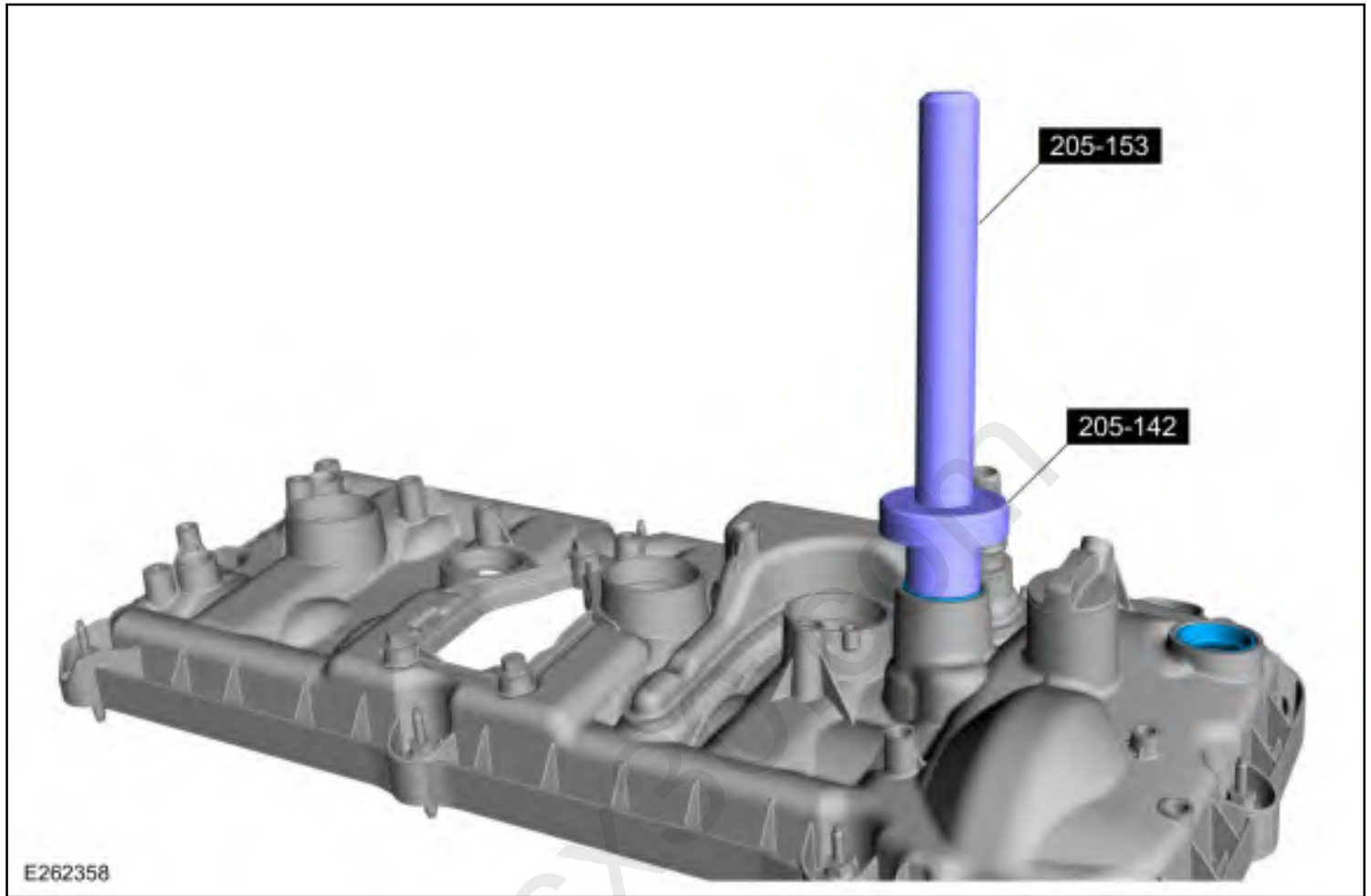
Remove and discard the gaskets.



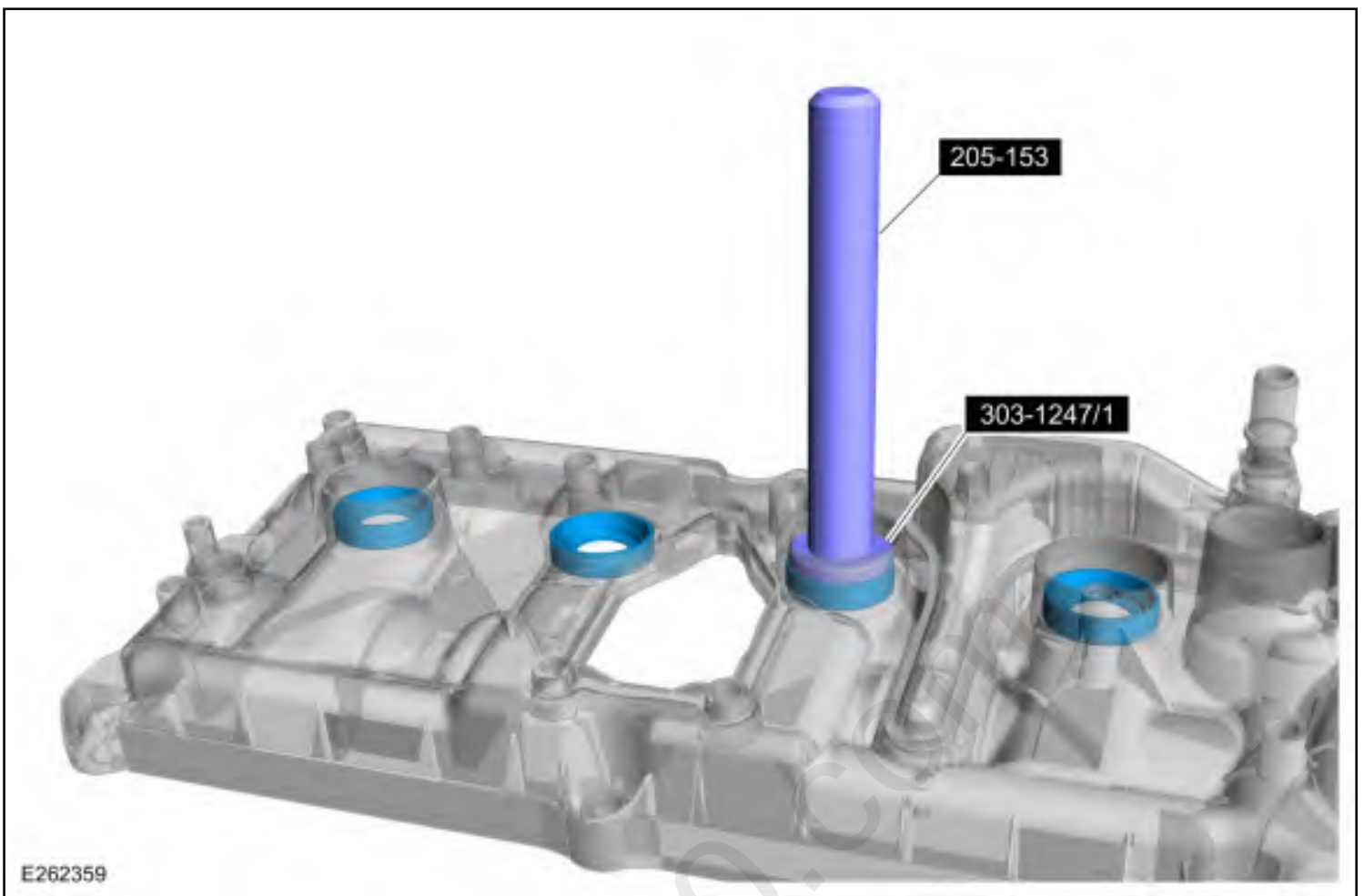
E262356



37. Inspect the VCT variable force solenoid seals. Remove any damaged seals using the special tools. Use Special Service Tool: 205-153 (T80T-4000-W) Handle. , 205-142 (T80T-4000-J) Installer, Differential Bearing Cone.



38. Inspect the spark plug seals. Remove any damaged seals using the special tools. Use Special Service Tool: 205-153 (T80T-4000-W) Handle. , 303-1247 VCT Spark Plug Tube Seal Remover and Installer.



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

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

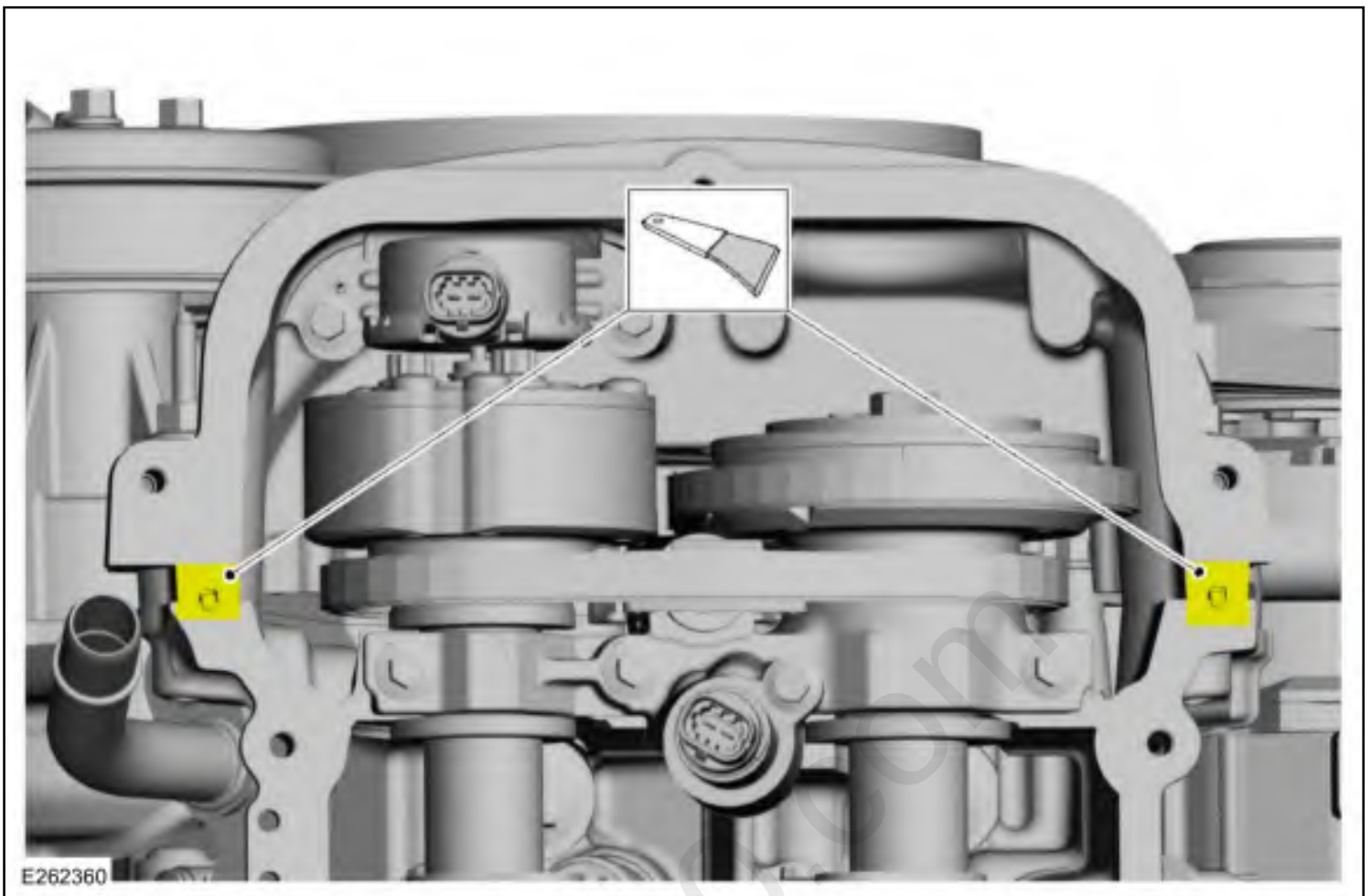
Refer to: [RTV Sealing Surface Cleaning and Preparation](#) (303-00 Engine System - General Information, General Procedures).

Use the General Equipment: Plastic Scraper

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

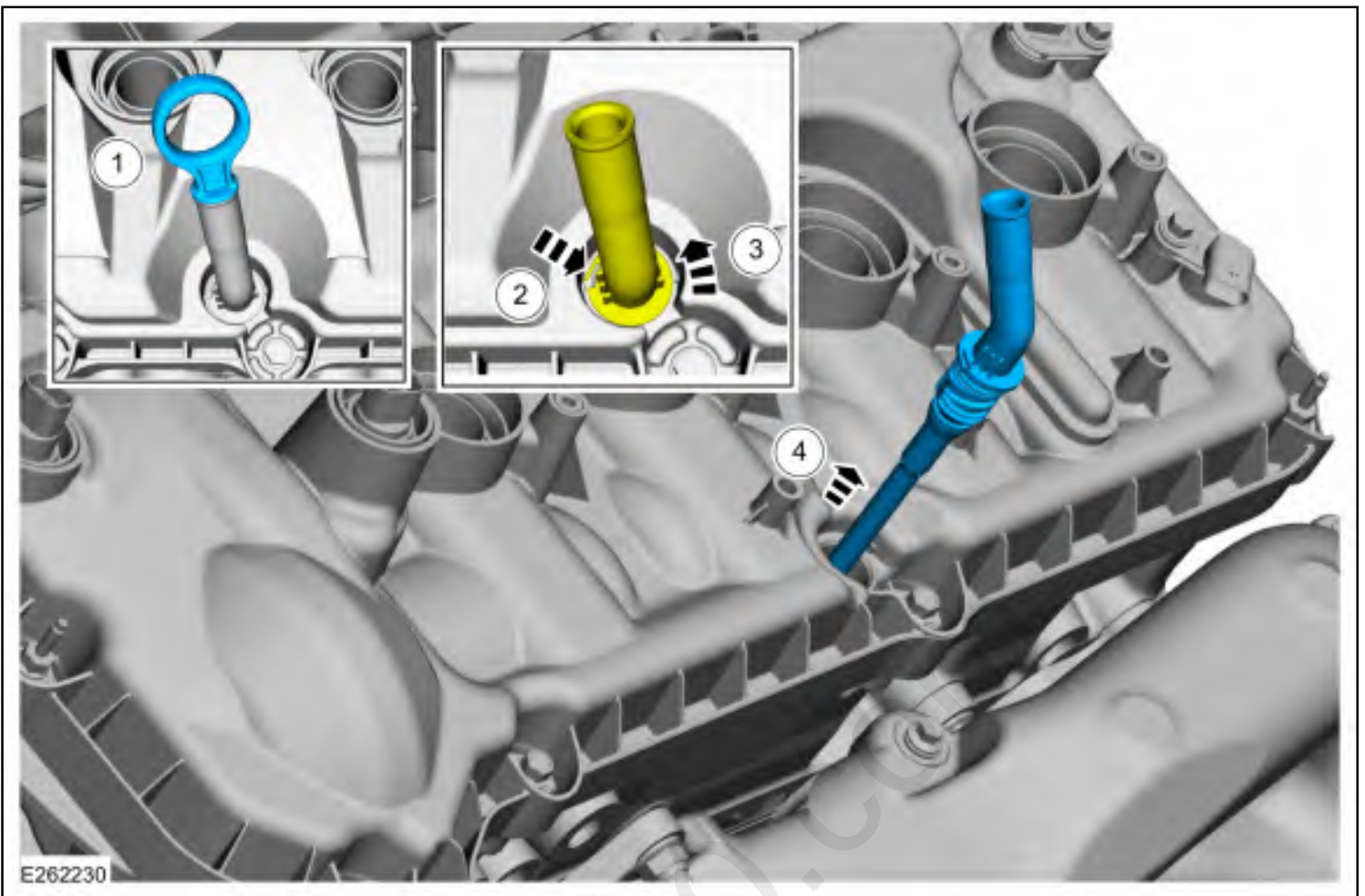
*Material:* Motorcraft® Metal Surface Prep Wipes / ZC-31-B

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

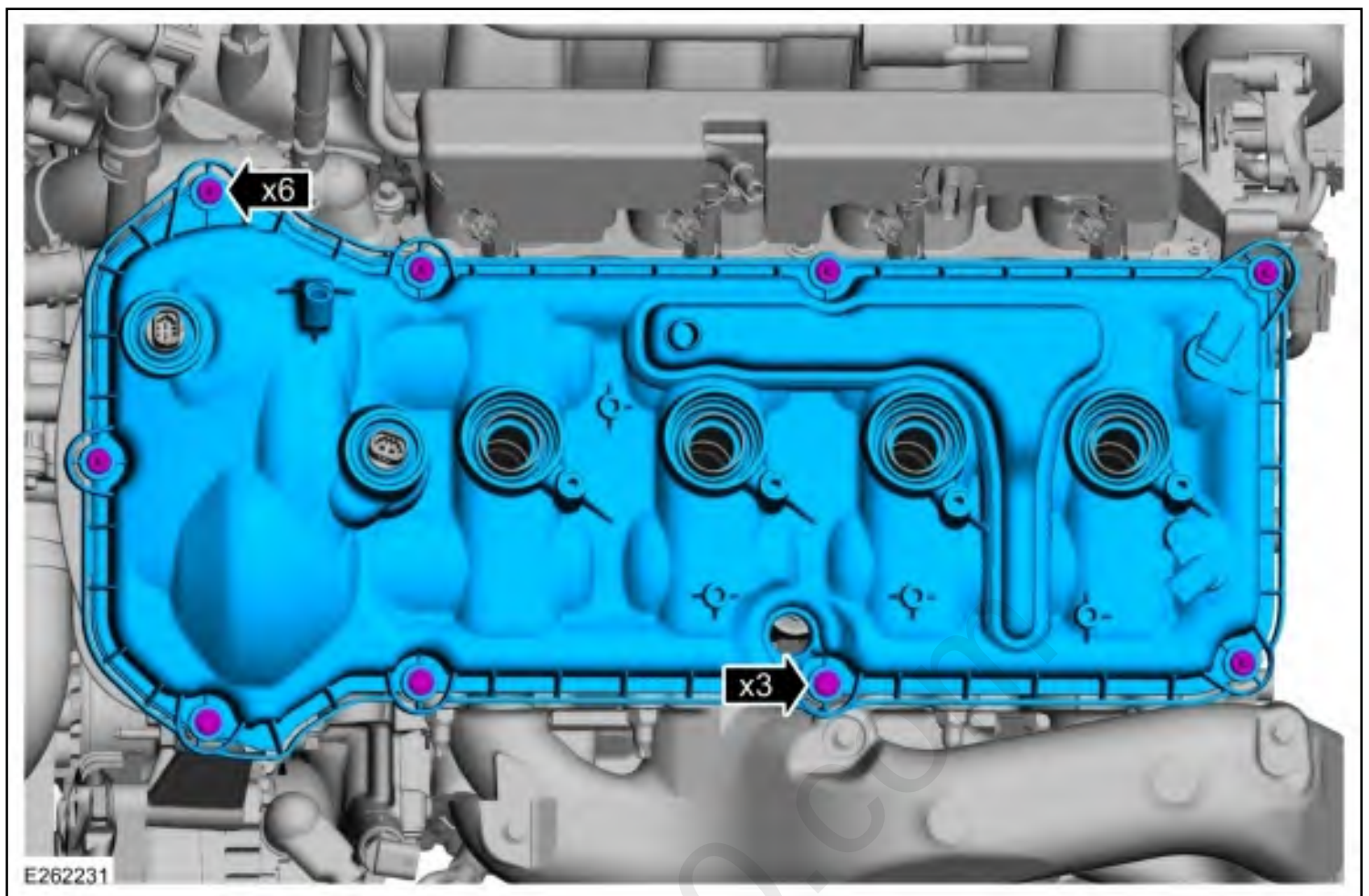


1. Remove the oil level indicator.
2. Depress the tab.
3. Rotate the oil level indicator tube counterclockwise.
4. Pull the oil level indicator tube from the engine.



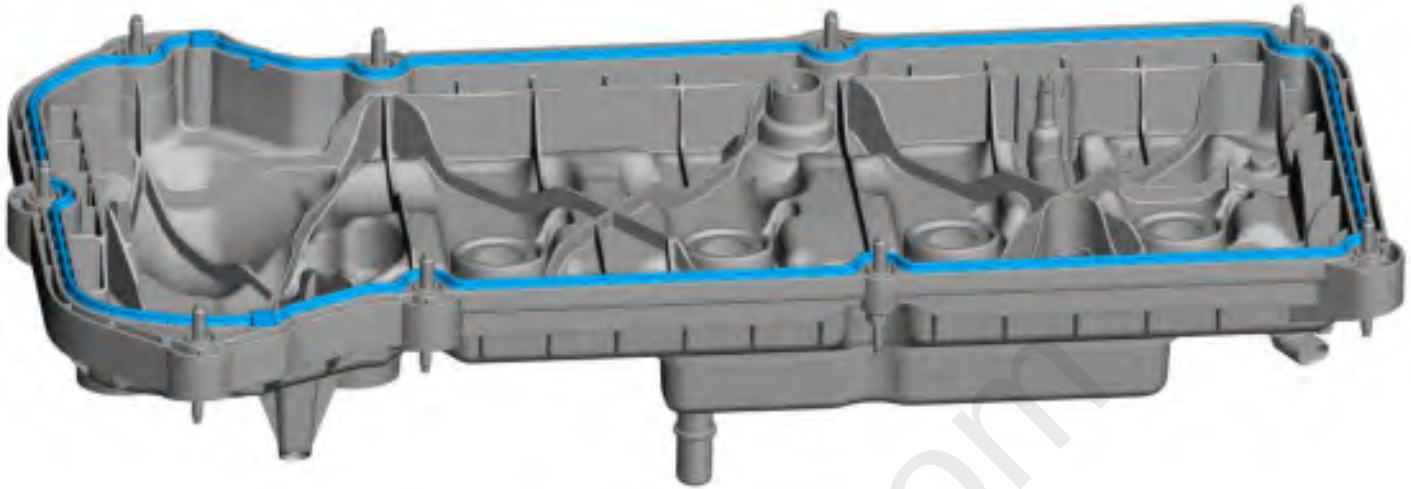


41. Loosen the fasteners and remove the valve cover.



42. **NOTE:** Clean the valve cover gasket groove with soap and water or a suitable solvent.

Remove and discard the gasket.

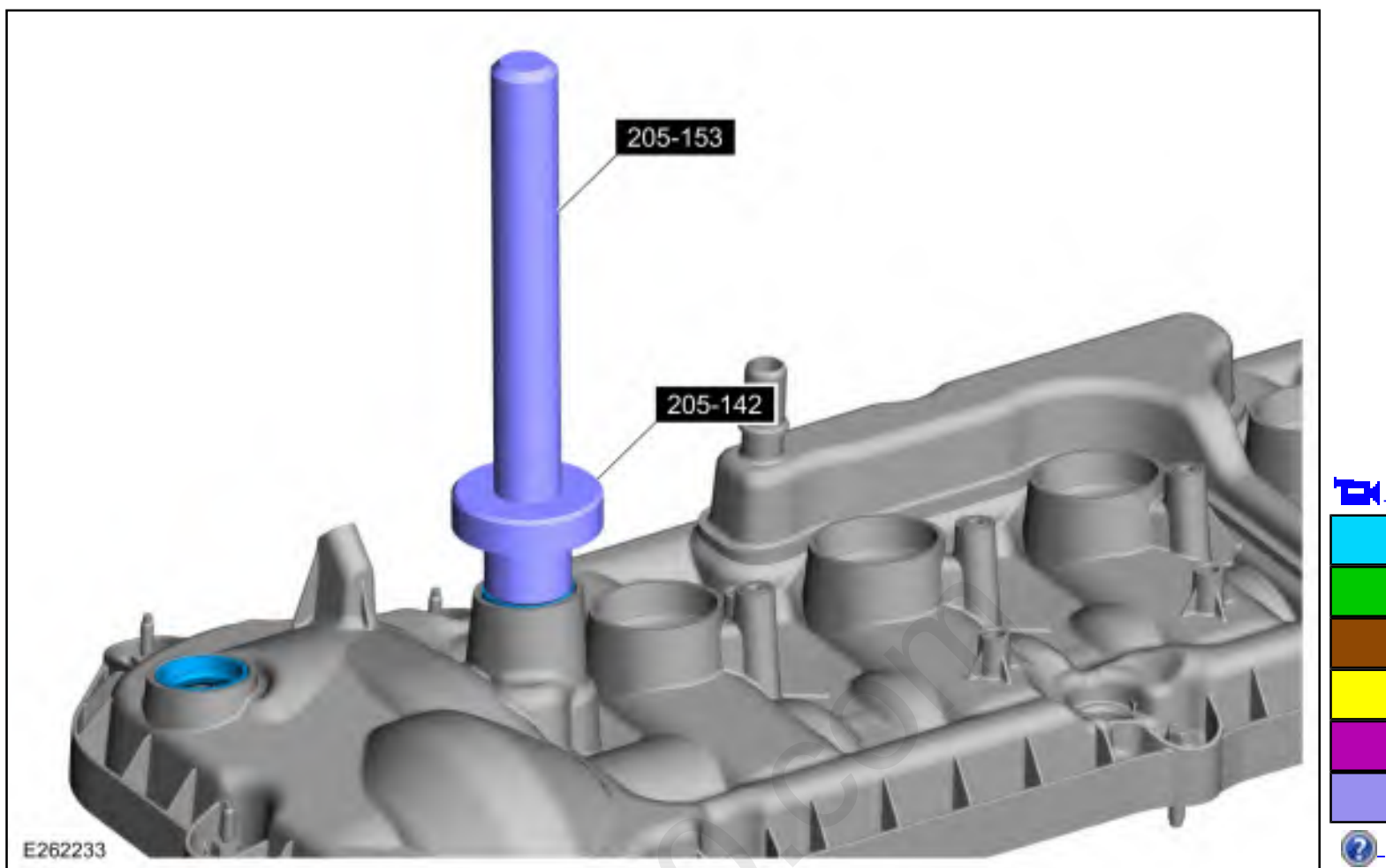


E262232

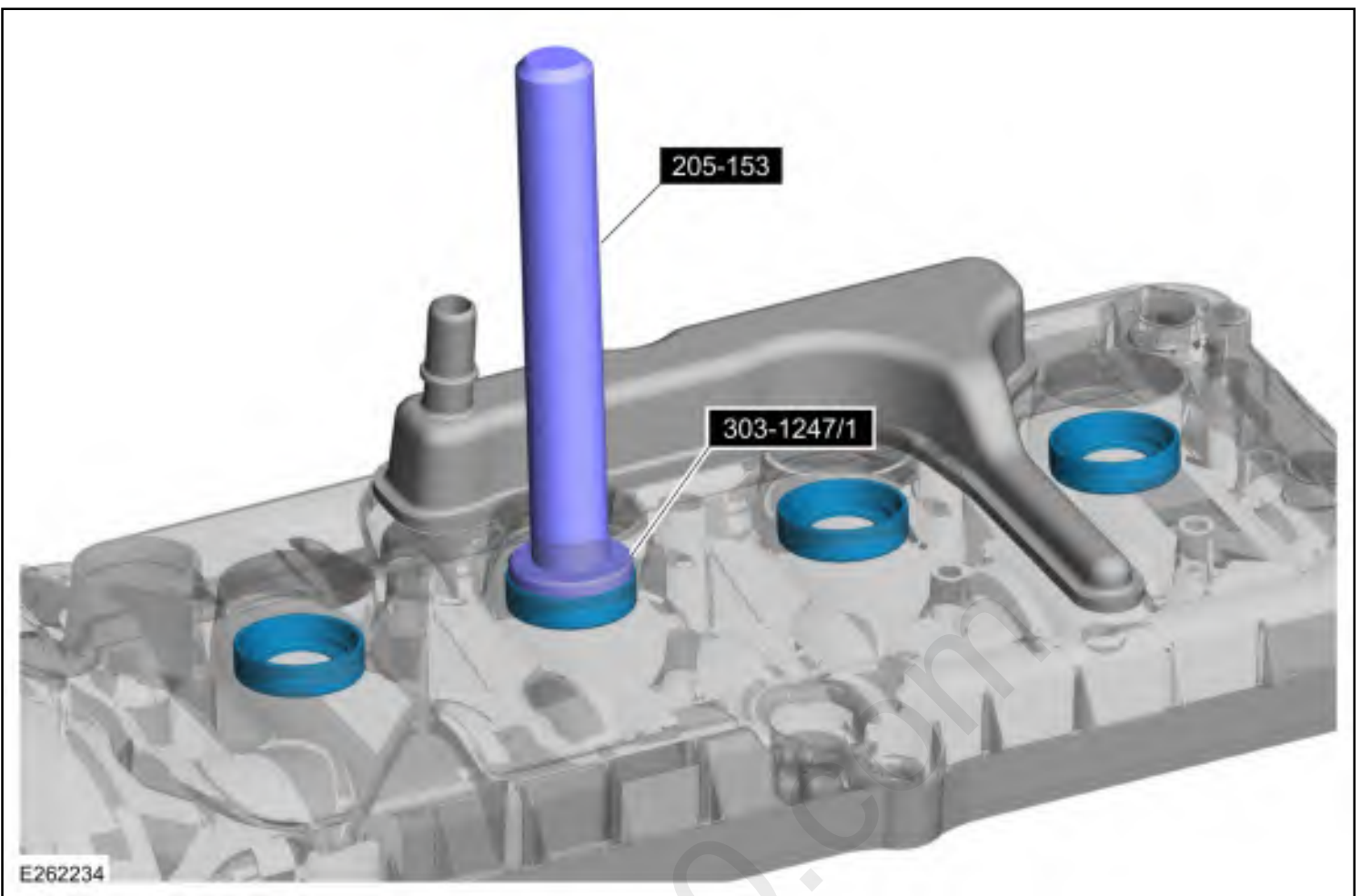


43. Inspect the VCT variable force solenoid seals. Remove any damaged seals using the special tools. Use Special Service Tool: 205-153 (T80T-4000-W) Handle. , 205-142 (T80T-4000-J) Installer, Differential Bearing Cone.





44. Inspect the spark plug seals. Remove any damaged seals using the special tools.  
Use Special Service Tool: 205-153 (T80T-4000-W) Handle. , 303-1247 VCT Spark Plug Tube Seal Remover and Installer.



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

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

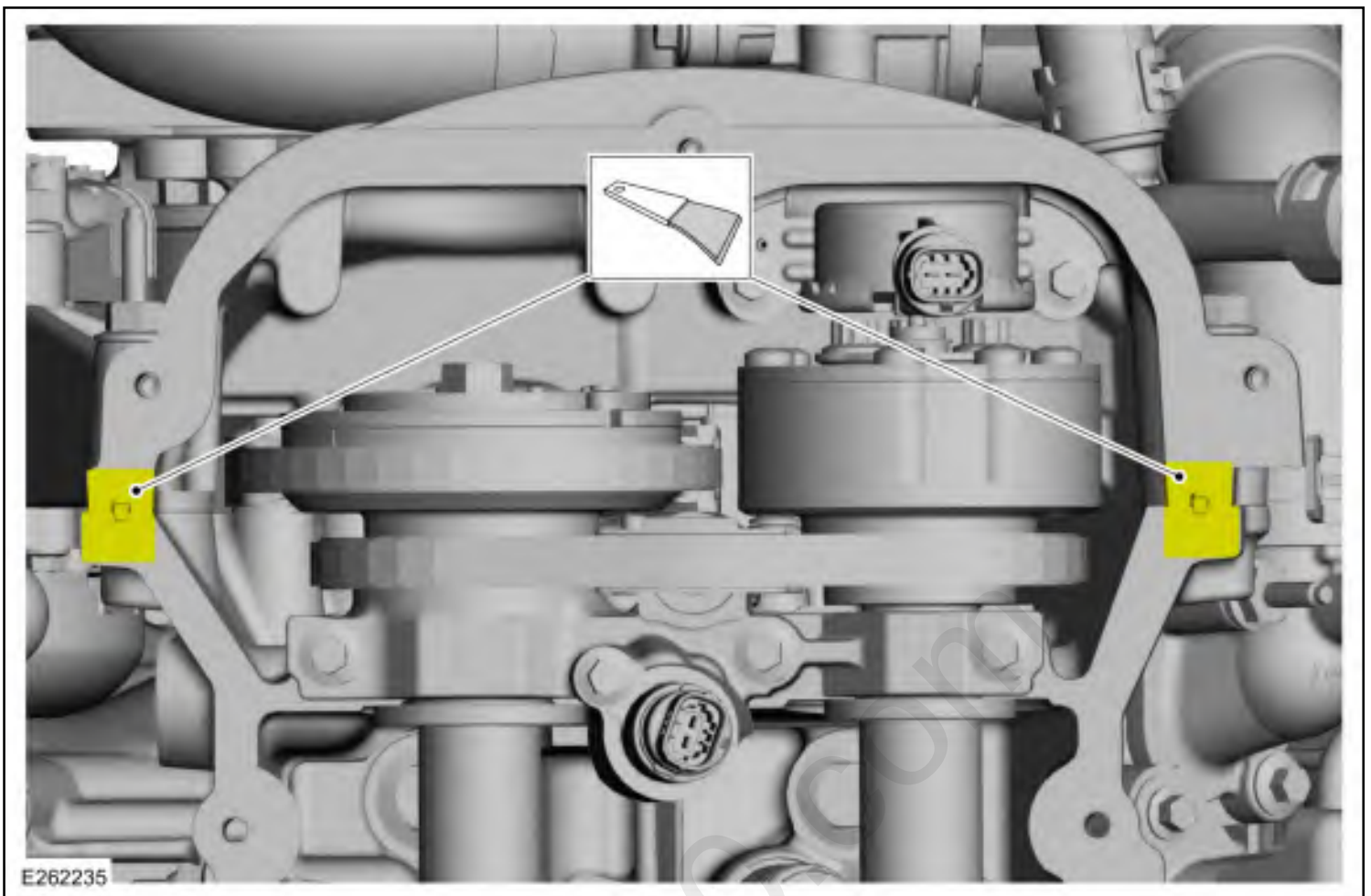
Refer to: [RTV Sealing Surface Cleaning and Preparation](#) (303-00 Engine System - General Information, General Procedures).

Use the General Equipment: Plastic Scraper

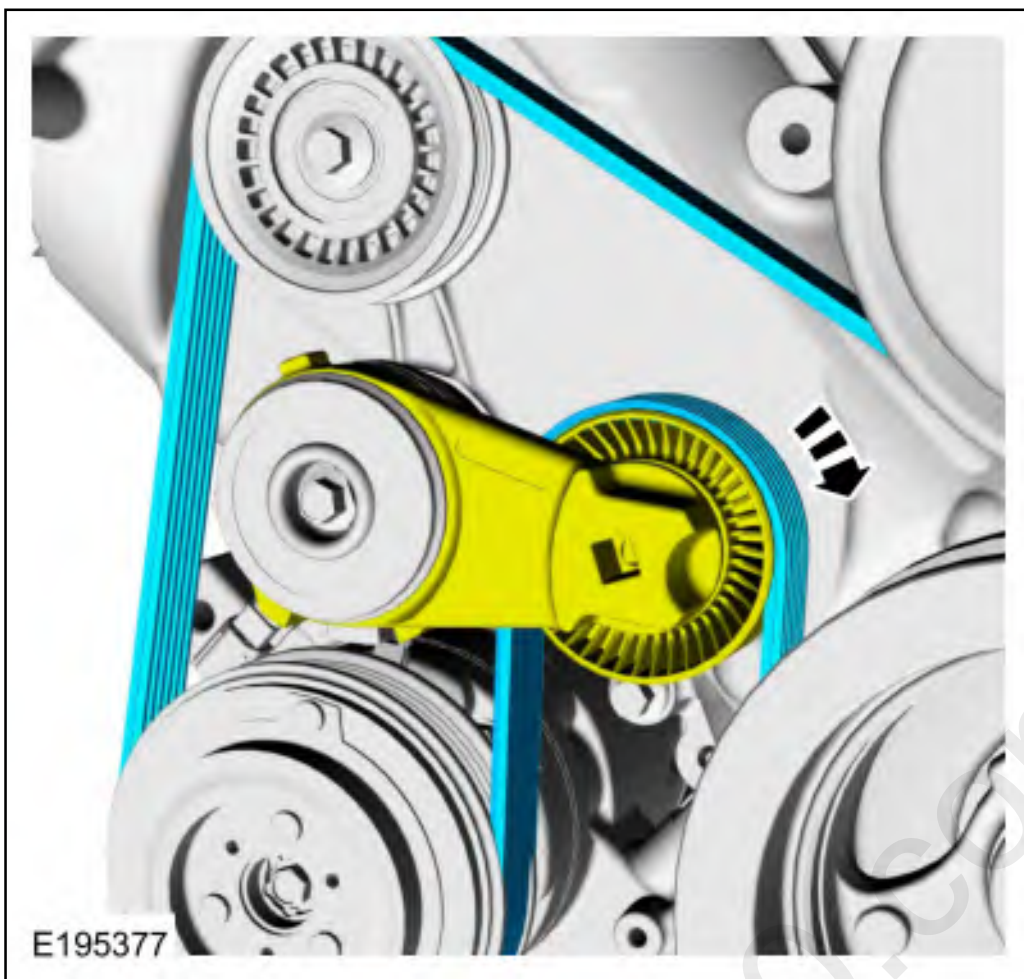
*Material:* Motorcraft® Silicone Gasket Remover / ZC-30-A

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

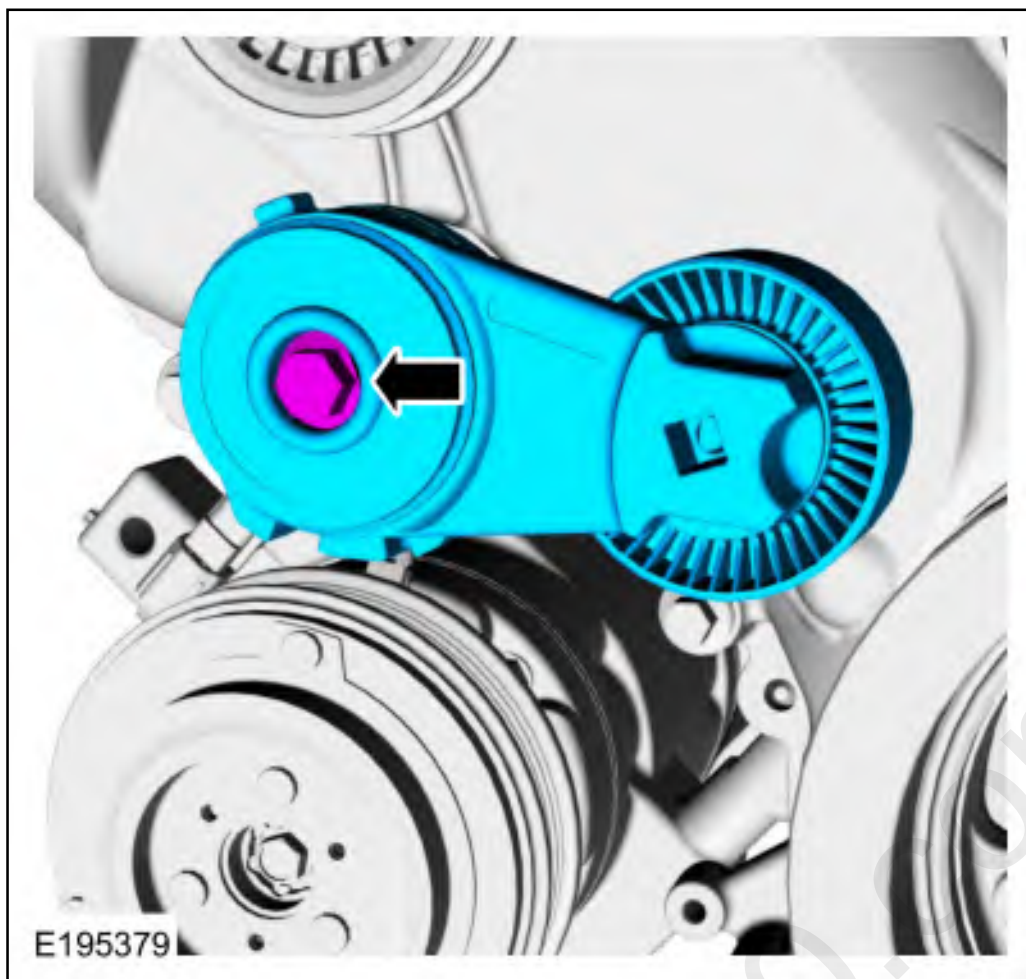
*Material:* Motorcraft® Metal Brake Parts Cleaner / PM-4-A, PM-4-B



46. Rotate the A/C compressor belt tensioner clockwise and remove the A/C compressor belt.

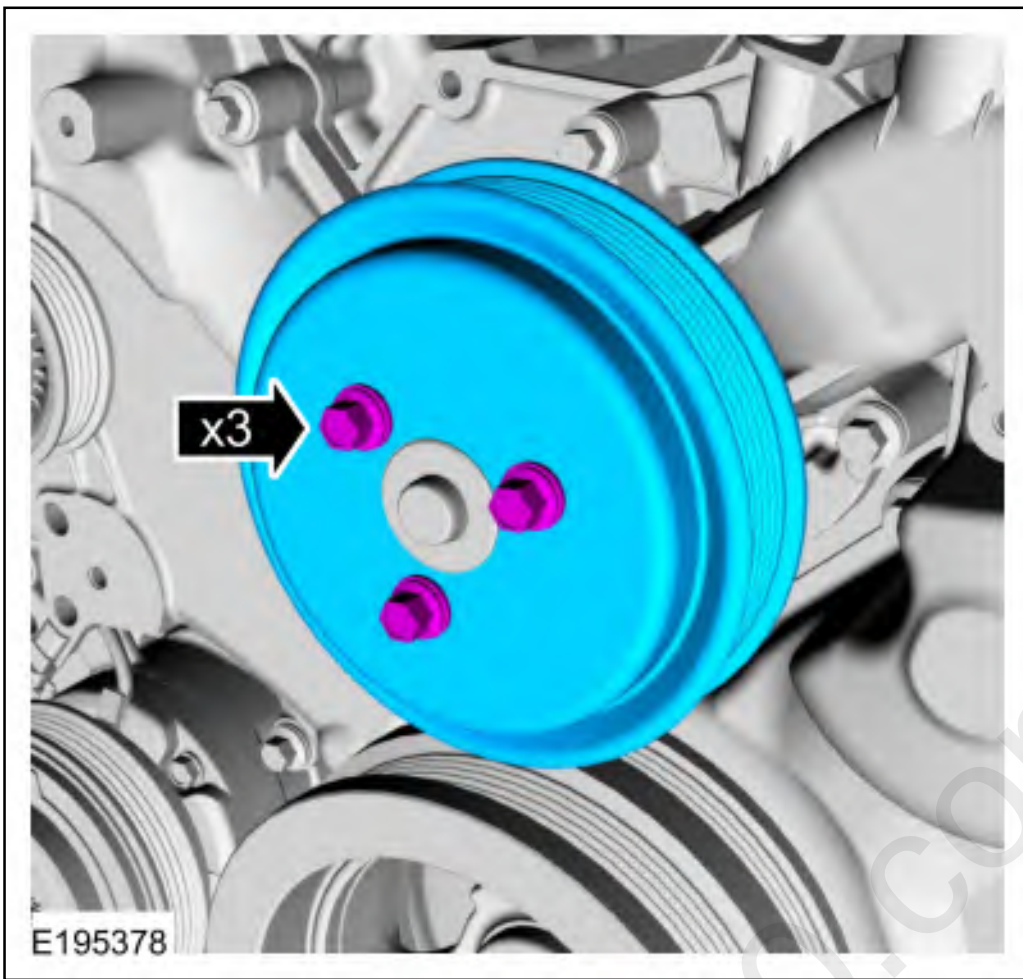


47. Remove the bolt and the A/C compressor belt tensioner.

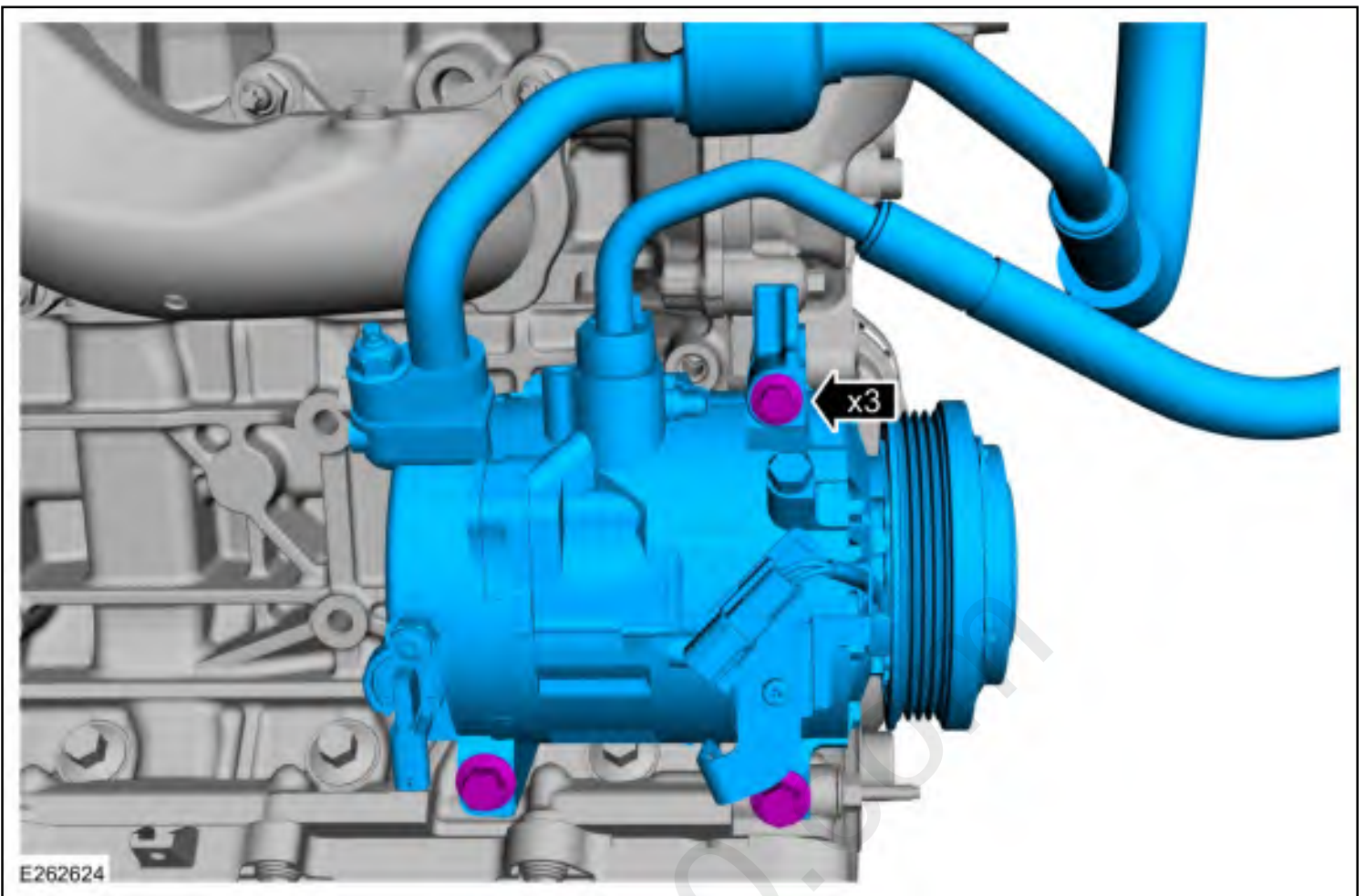


48. Remove the bolts and the coolant pump pulley.



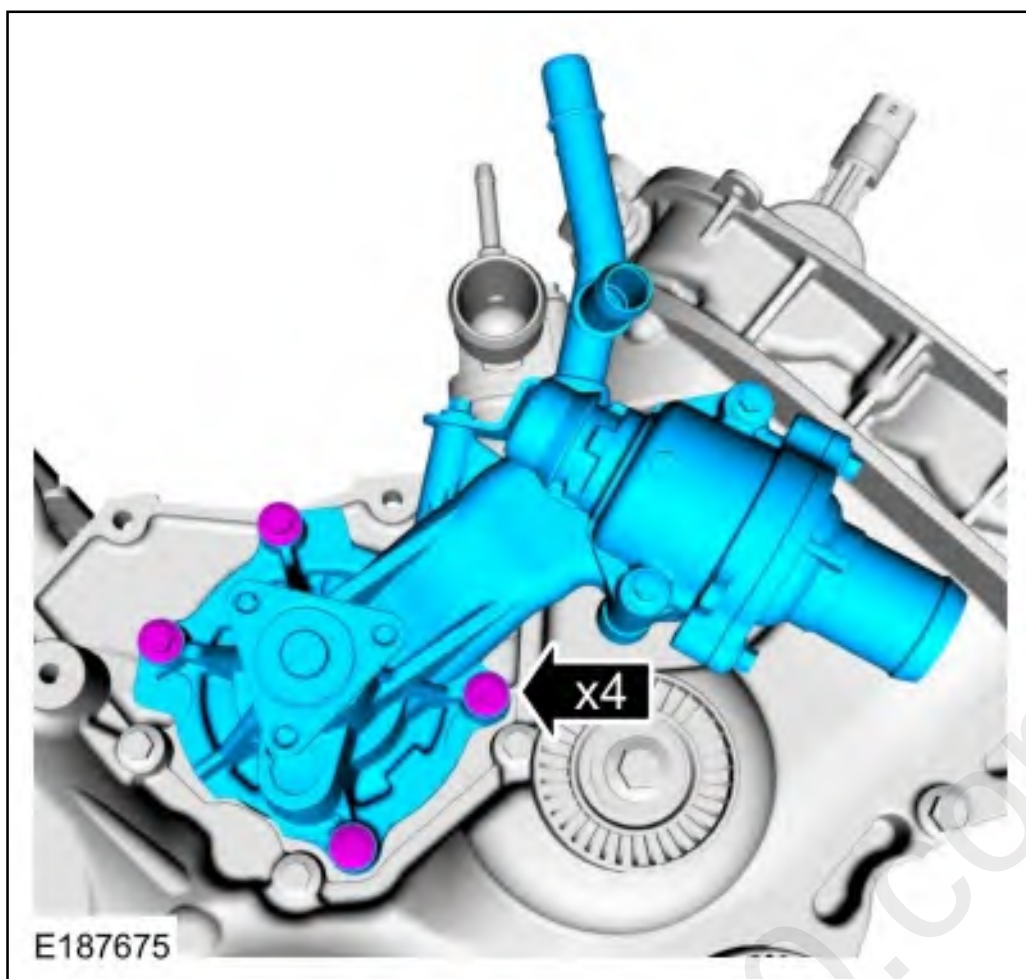


49. Remove the bolts and the A/C compressor.

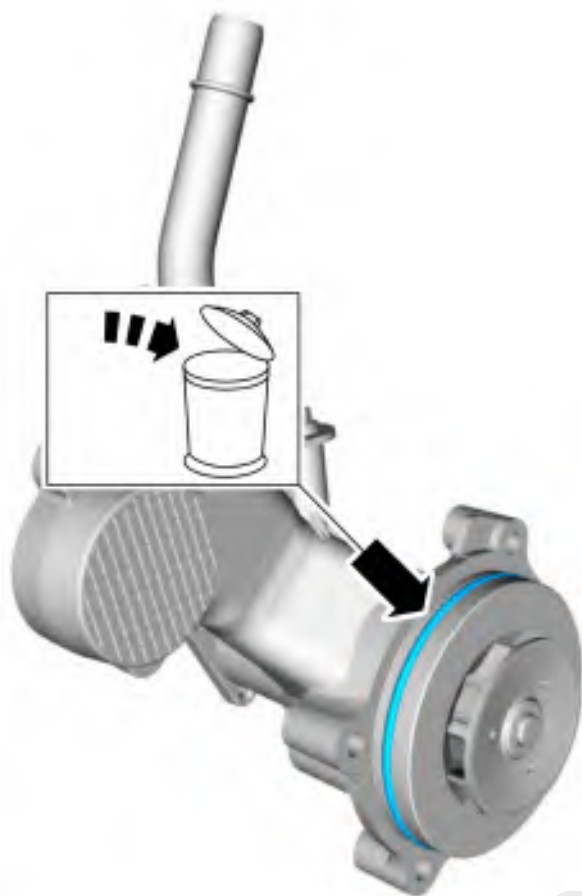


50. Remove the bolts and the coolant pump.



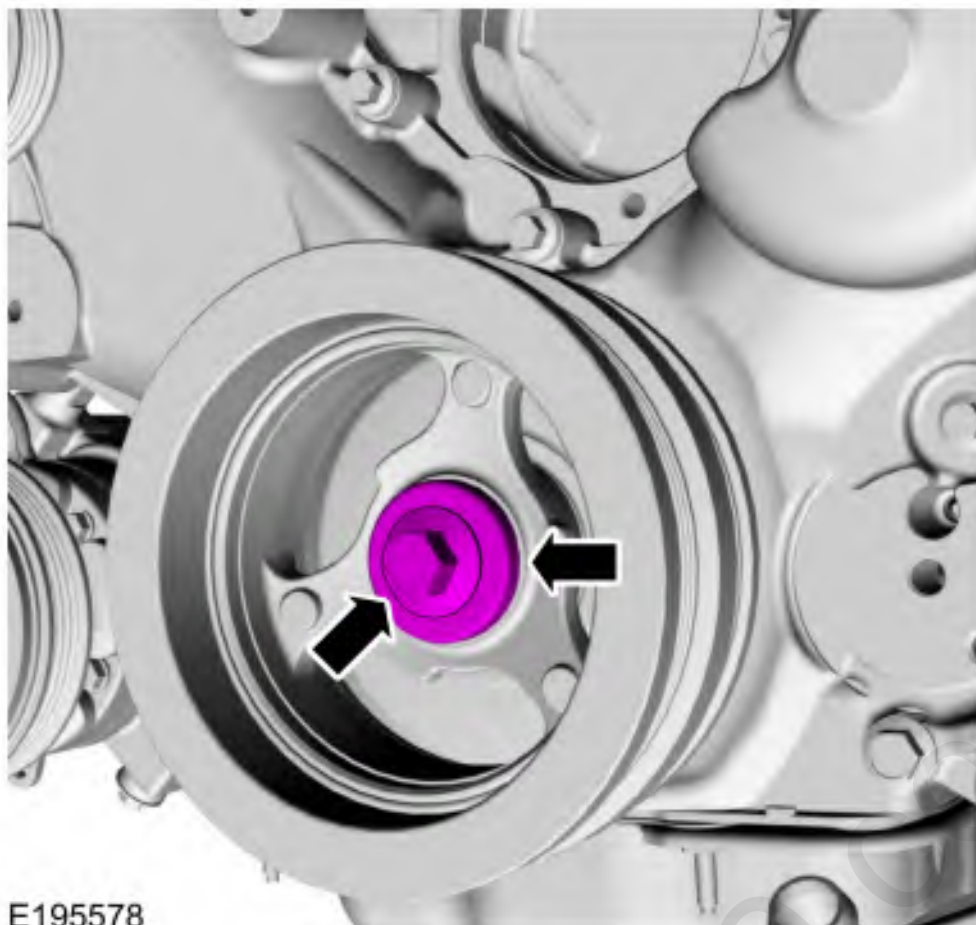


51. Remove and discard the coolant pump O-ring seal.

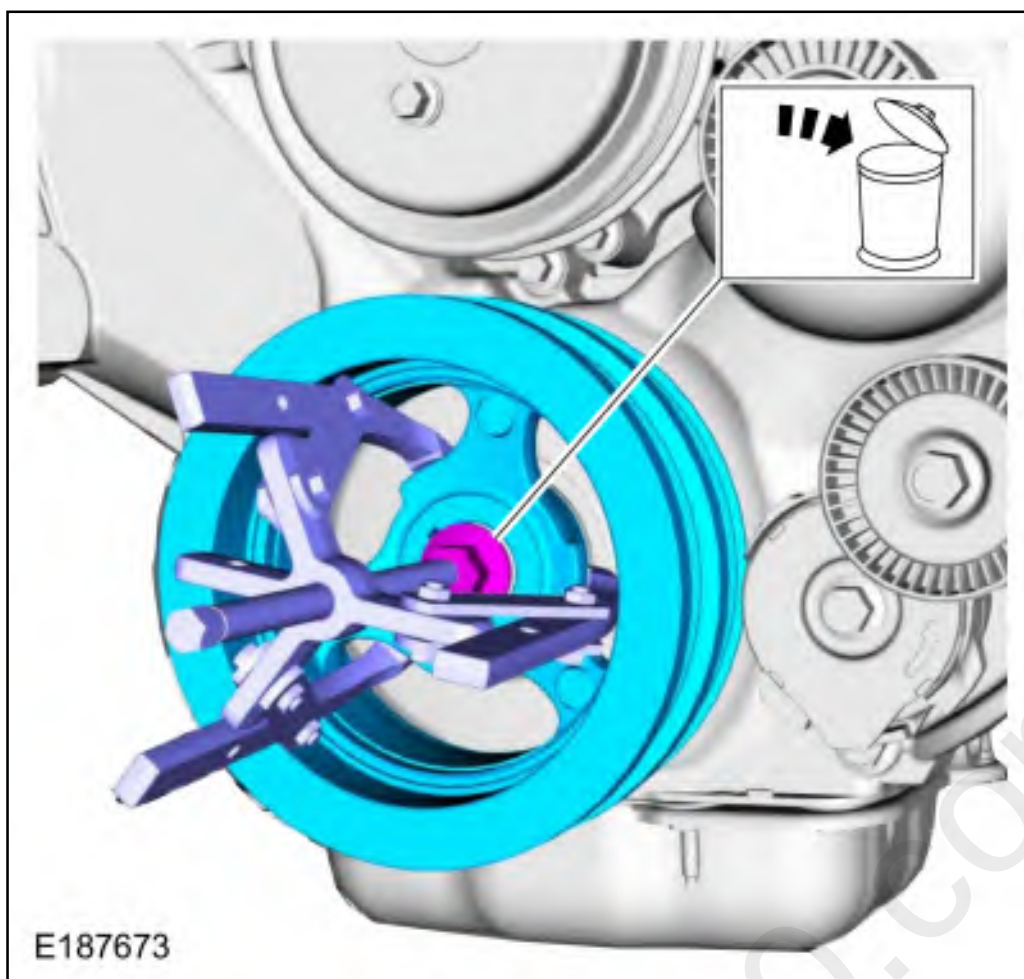


E183428

52. Remove the crankshaft pulley bolt and washer.



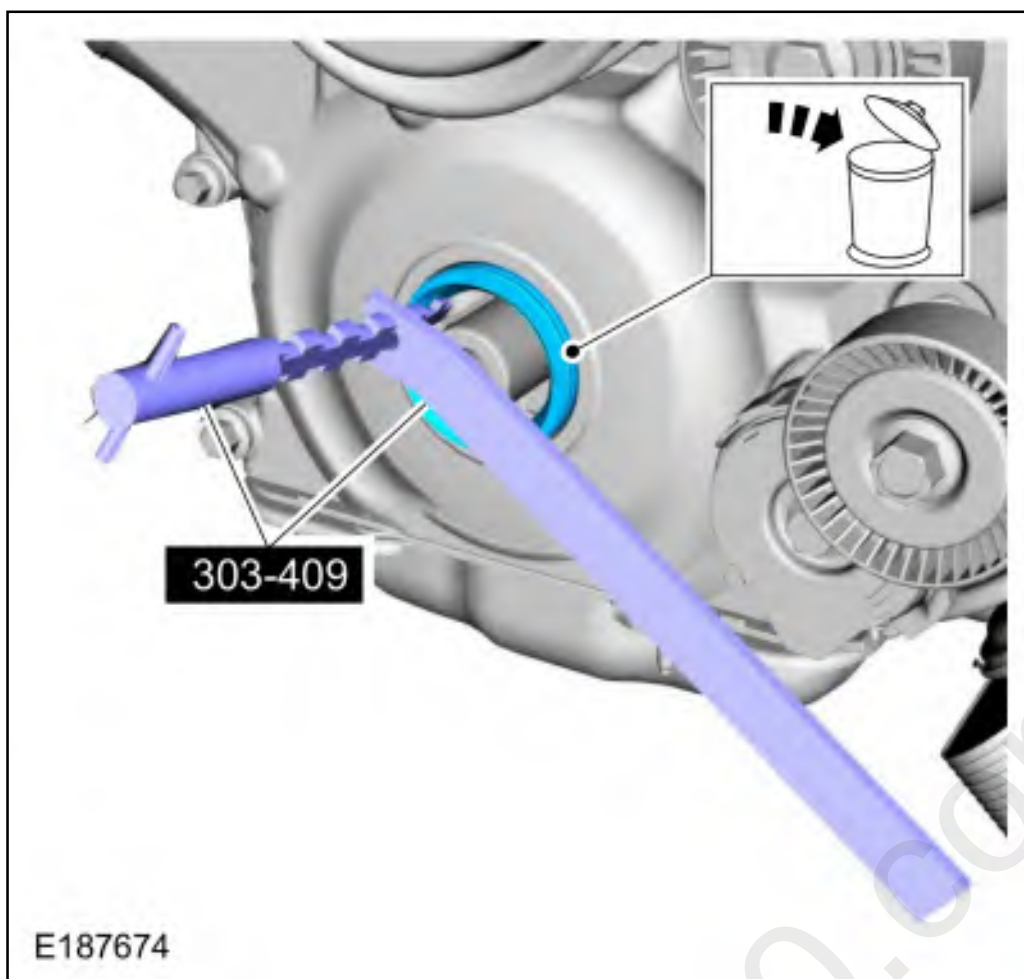
1. Using the 3 Leg Puller and the crankshaft pulley bolt, remove the crankshaft pulley.  
Use the General Equipment: Three Leg Puller
2. Discard the crankshaft pulley bolt.



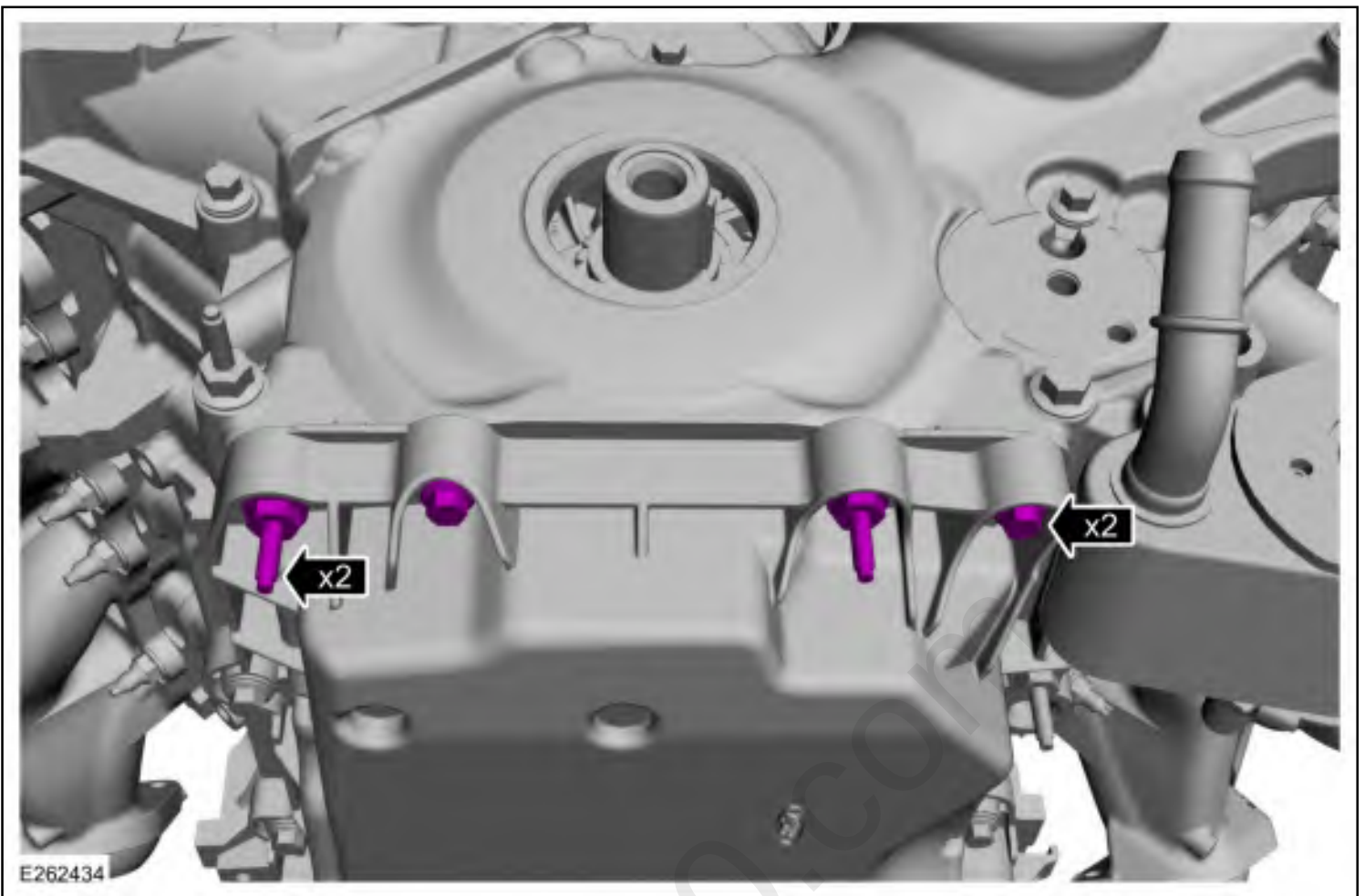
54. **NOTICE:** Use care not to damage the engine front cover or the crankshaft when removing the seal.

Using the special tool, remove and discard the crankshaft front oil seal.

Use Special Service Tool: 303-409 (T92C-6700-CH) Remover, Crankshaft Seal.

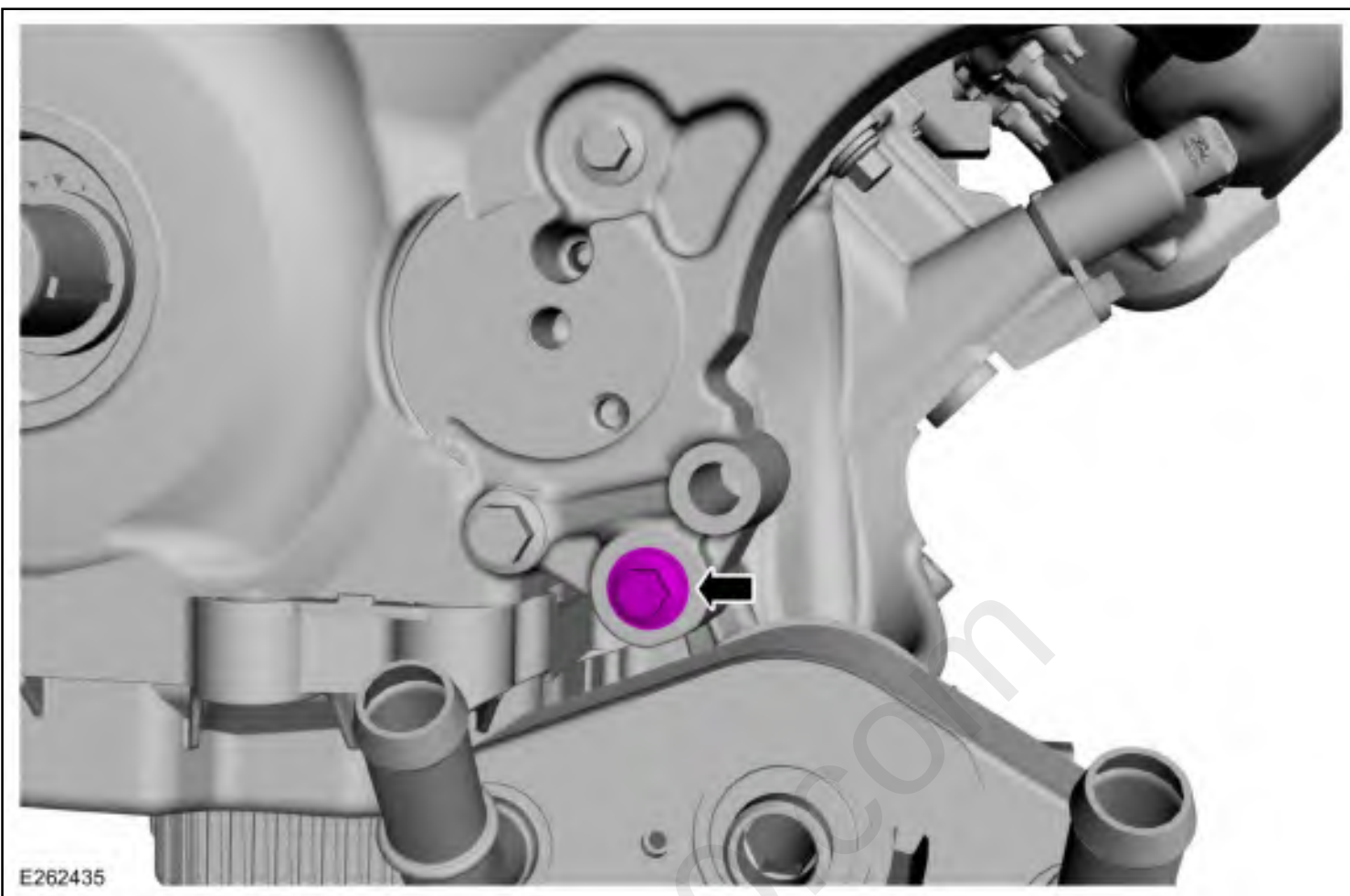


55. Remove the bolts and stud bolts.



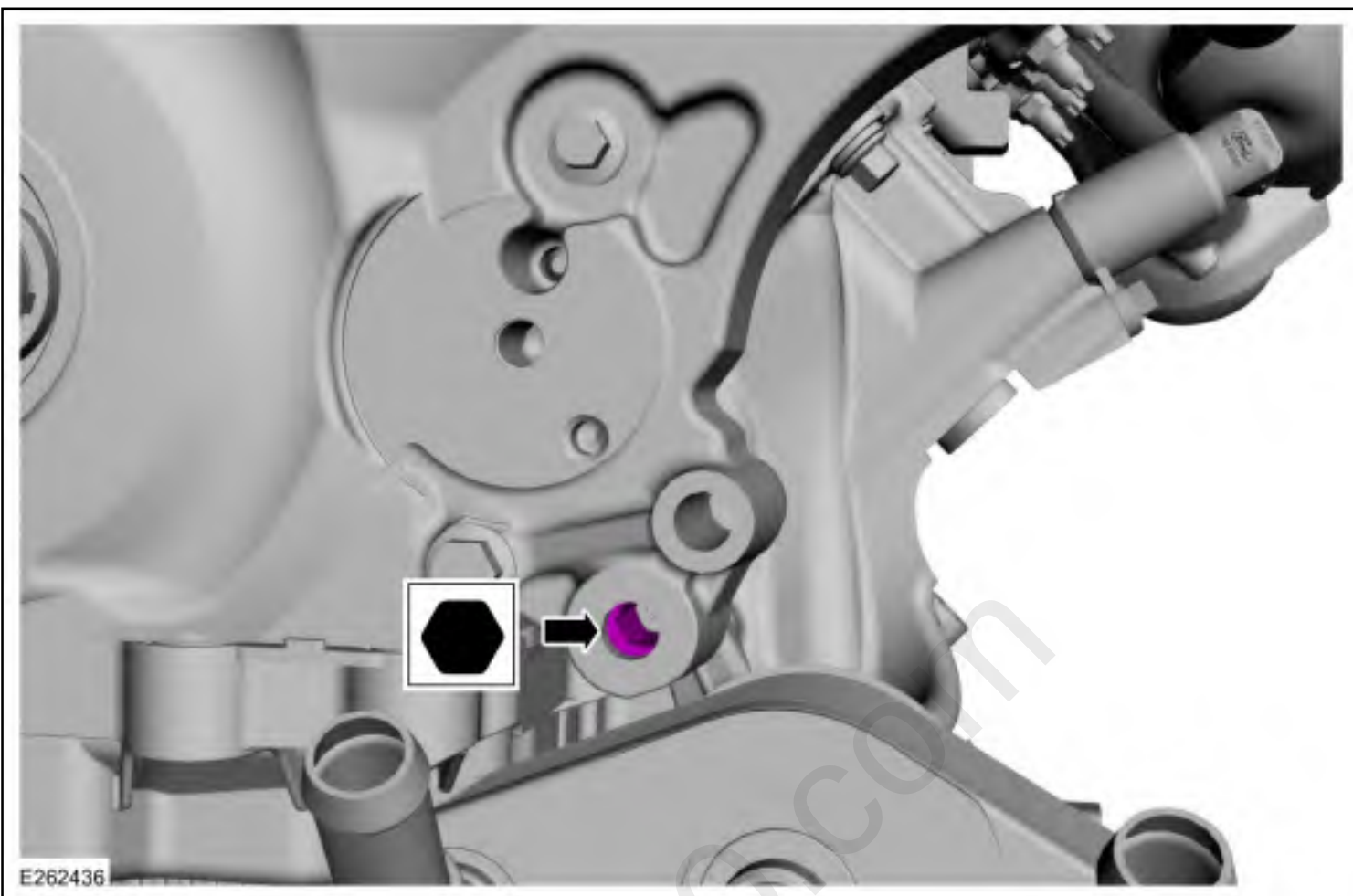
56. Remove the engine front cover-to-oil filter adapter bolt.





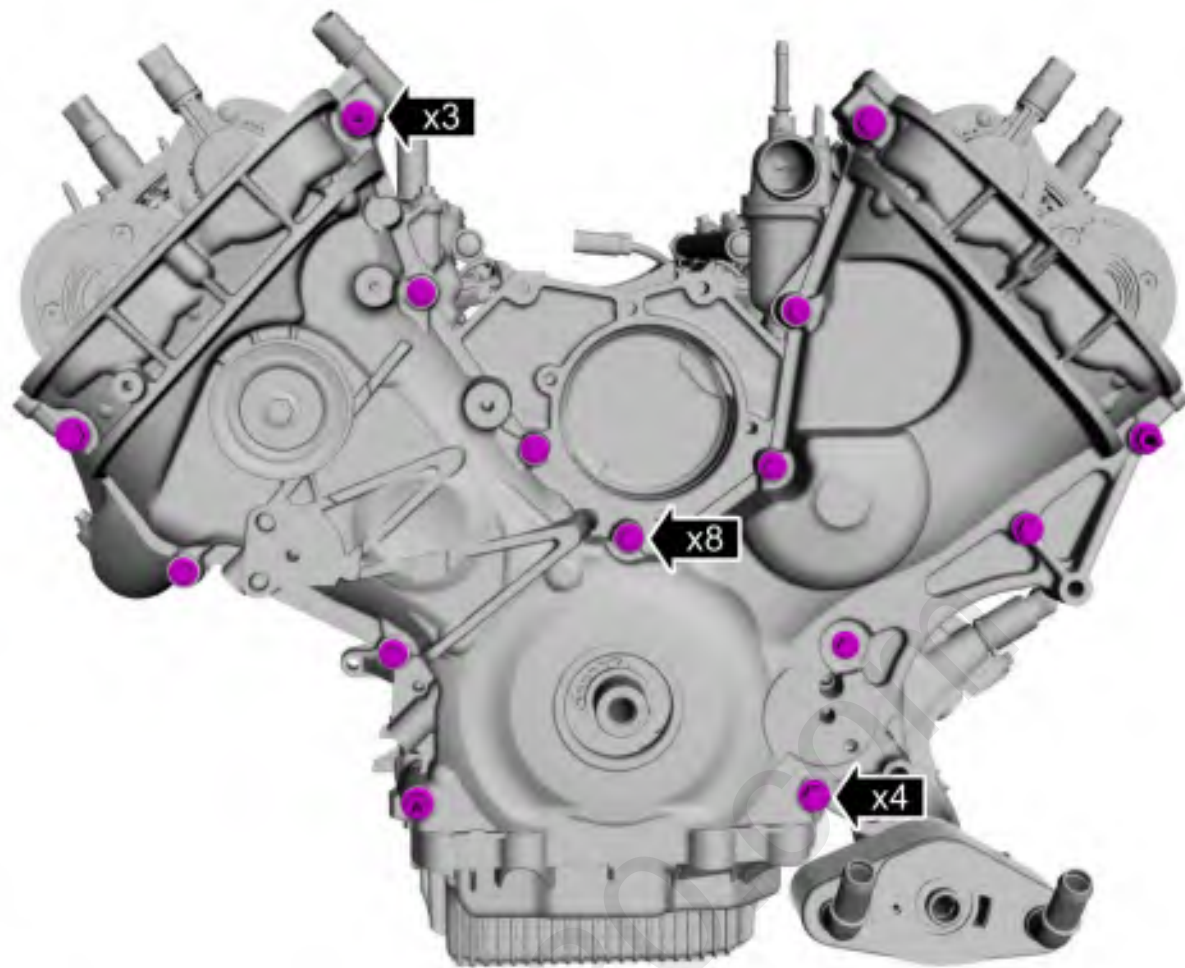
57. Using a 10 mm Hex Bit loosen the engine front cover-to-oil filter adapter jack screw.





58. **NOTE:** *There are 3 different fasteners used, note the location of fasteners for assembly.*

Remove the bolts and stud bolts.

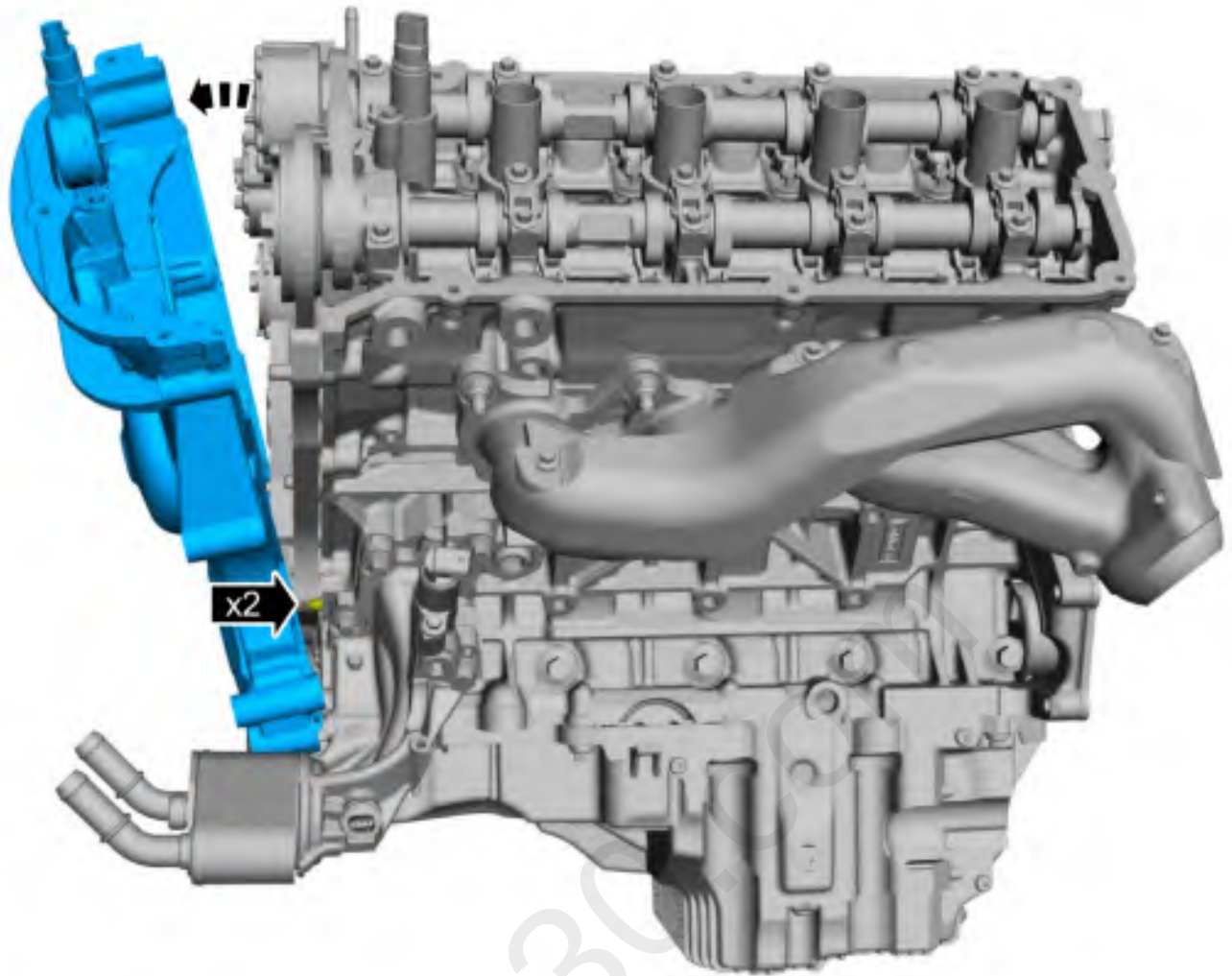


E262437



59. **NOTE:** *Timing drive components removed from view for clarity.*

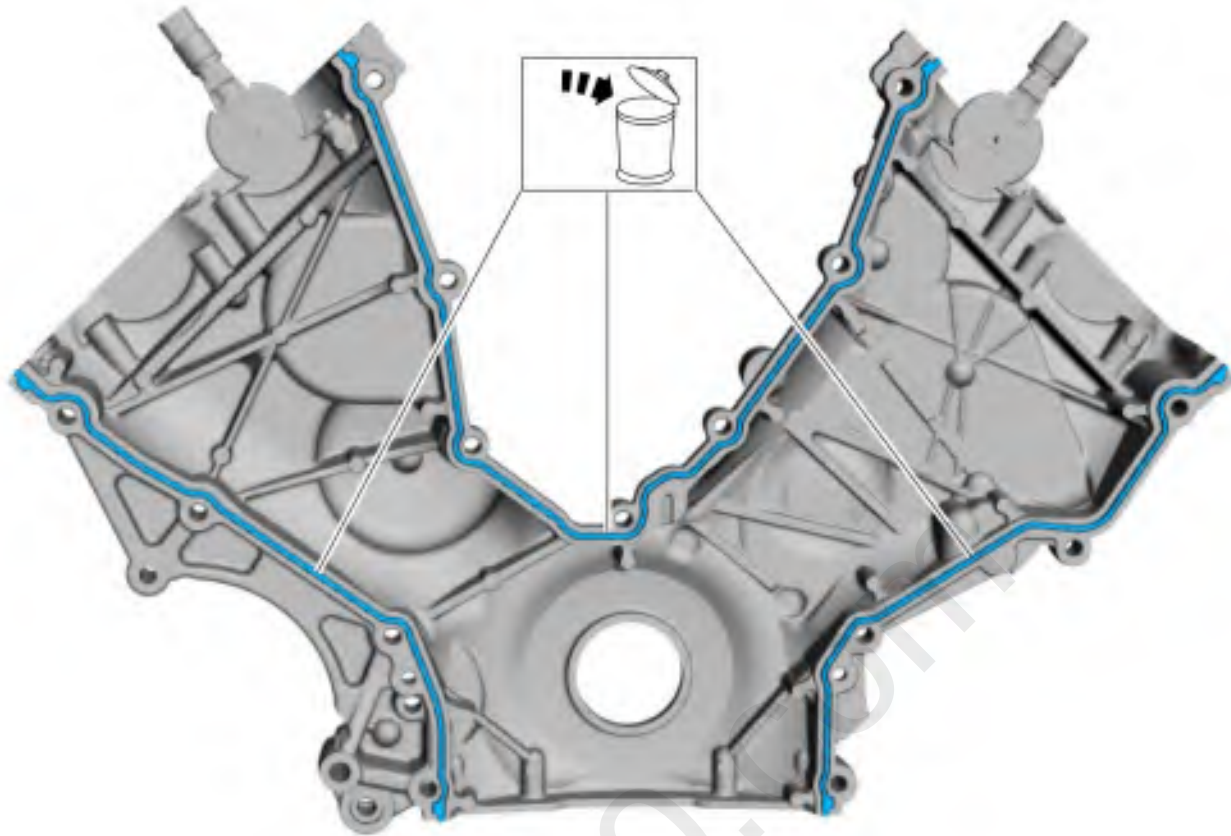
Remove the engine front cover from the front cover-to-cylinder block dowels.



E262438



60. Remove and discard the gaskets.



E262439

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

Clean and inspect the mating surface.

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

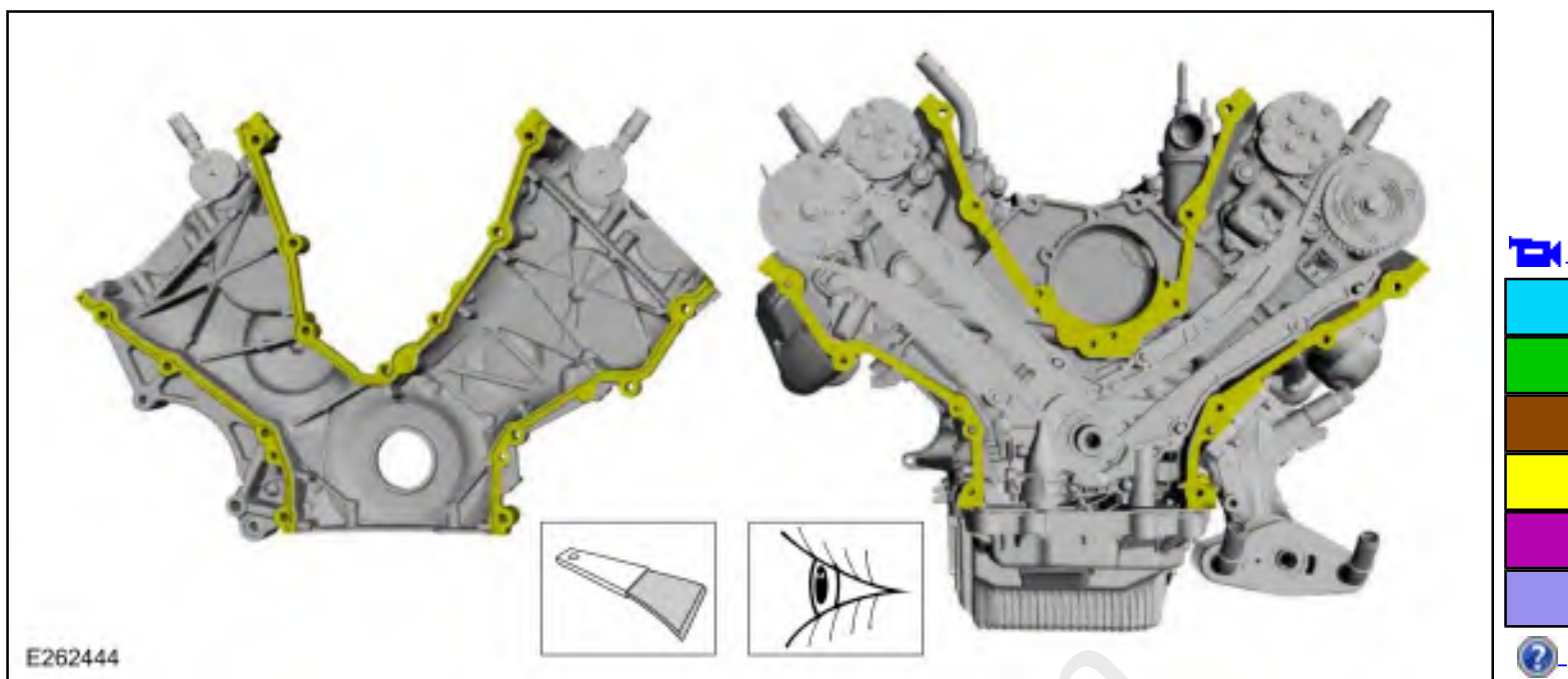
Use the General Equipment: Plastic Scraper

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

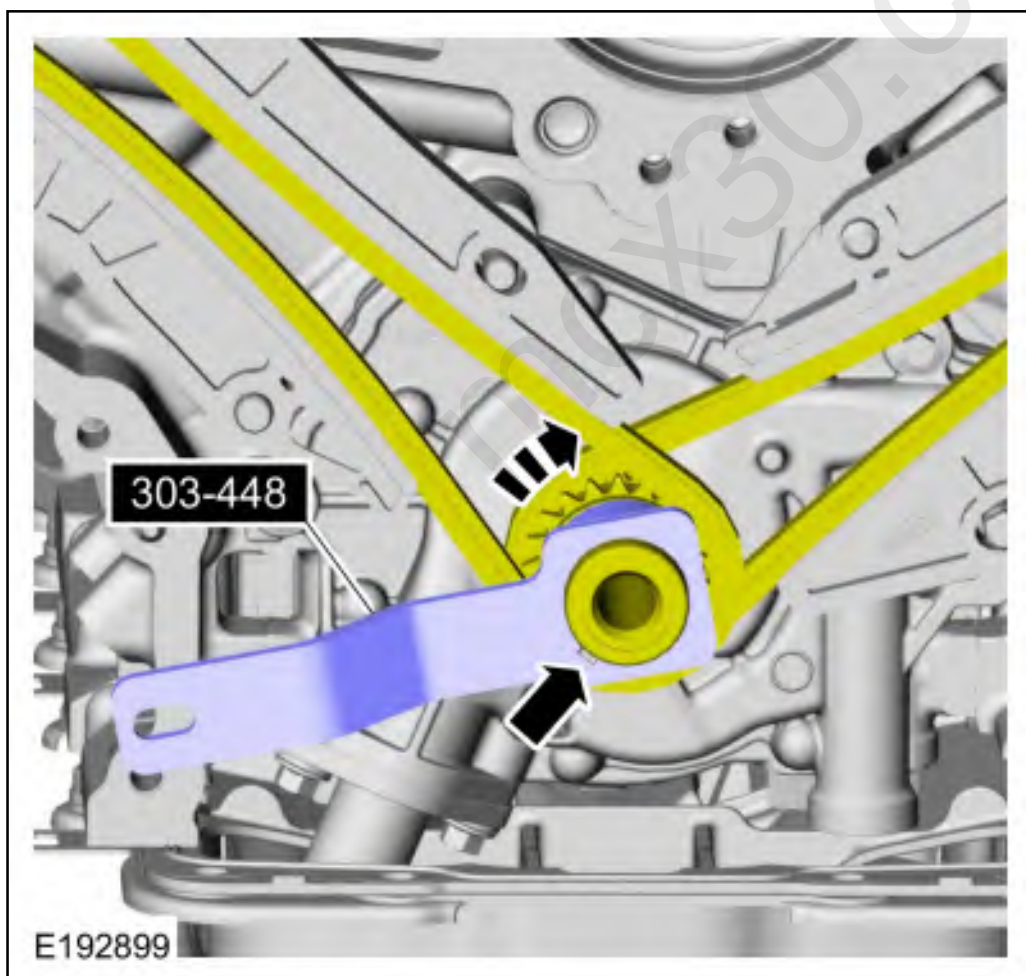
*Material:* Motorcraft® Metal Brake Parts Cleaner / PM-4-A, PM-4-B

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



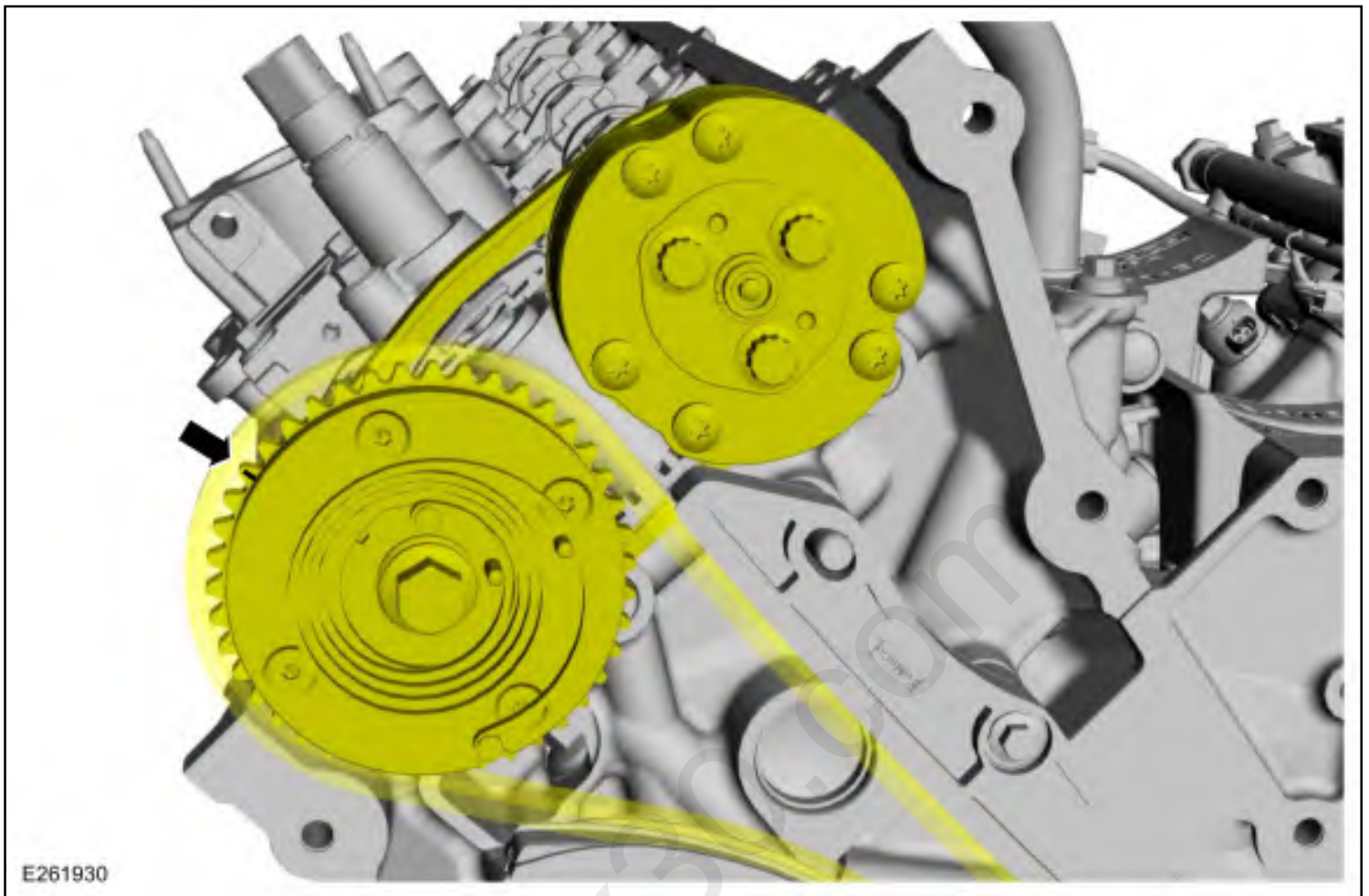


62. Using the special tool, rotate the crankshaft clockwise until the keyway is at the 7:30 position.  
Use Special Service Tool: 303-448 (T93P-6303-A) Holding Tool, Crankshaft.

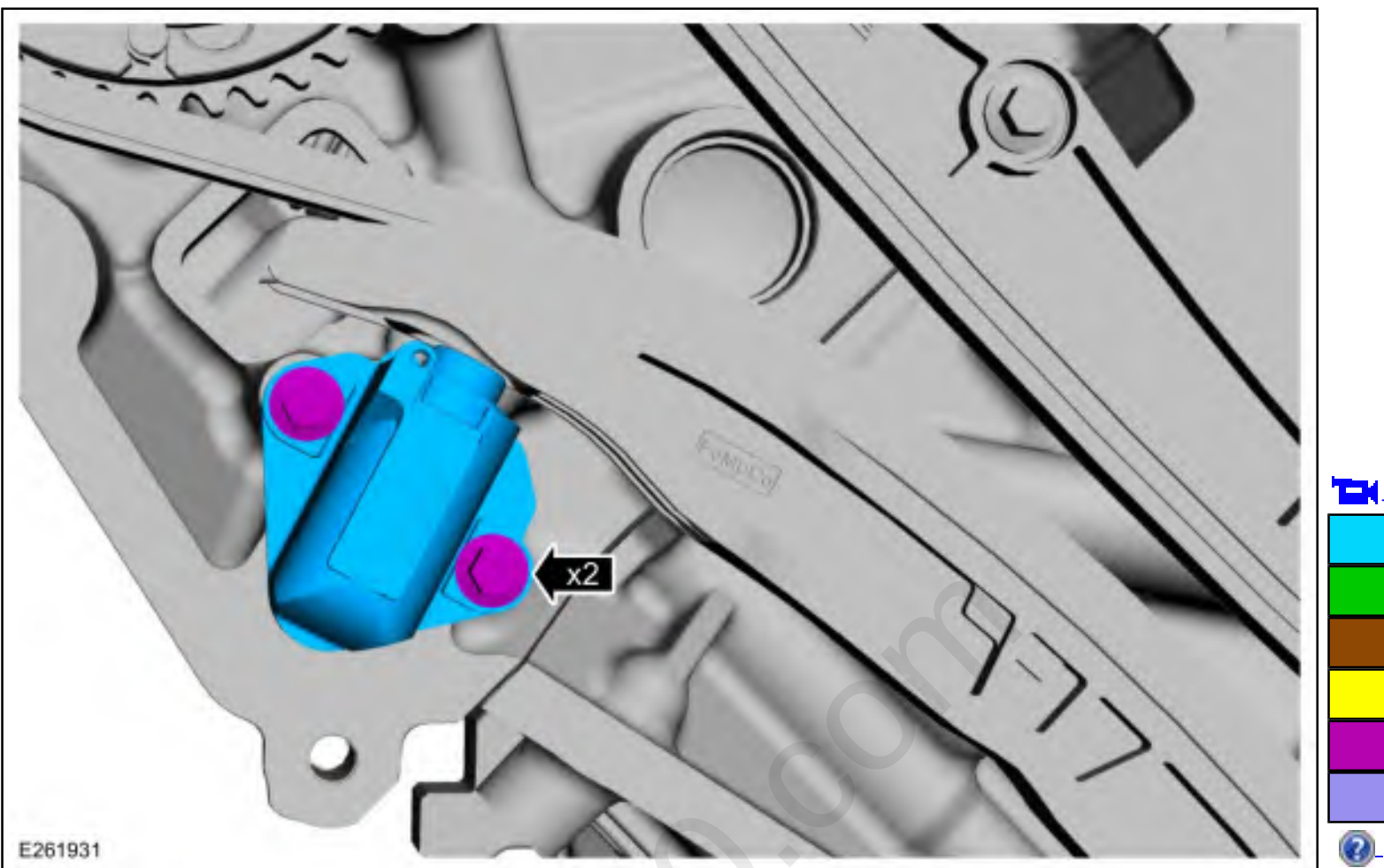


63. Verify the timing mark on the RH VCT unit is on top, if not, rotate the crankshaft clockwise one

complete revolution so the keyway is at the 7:30 position.



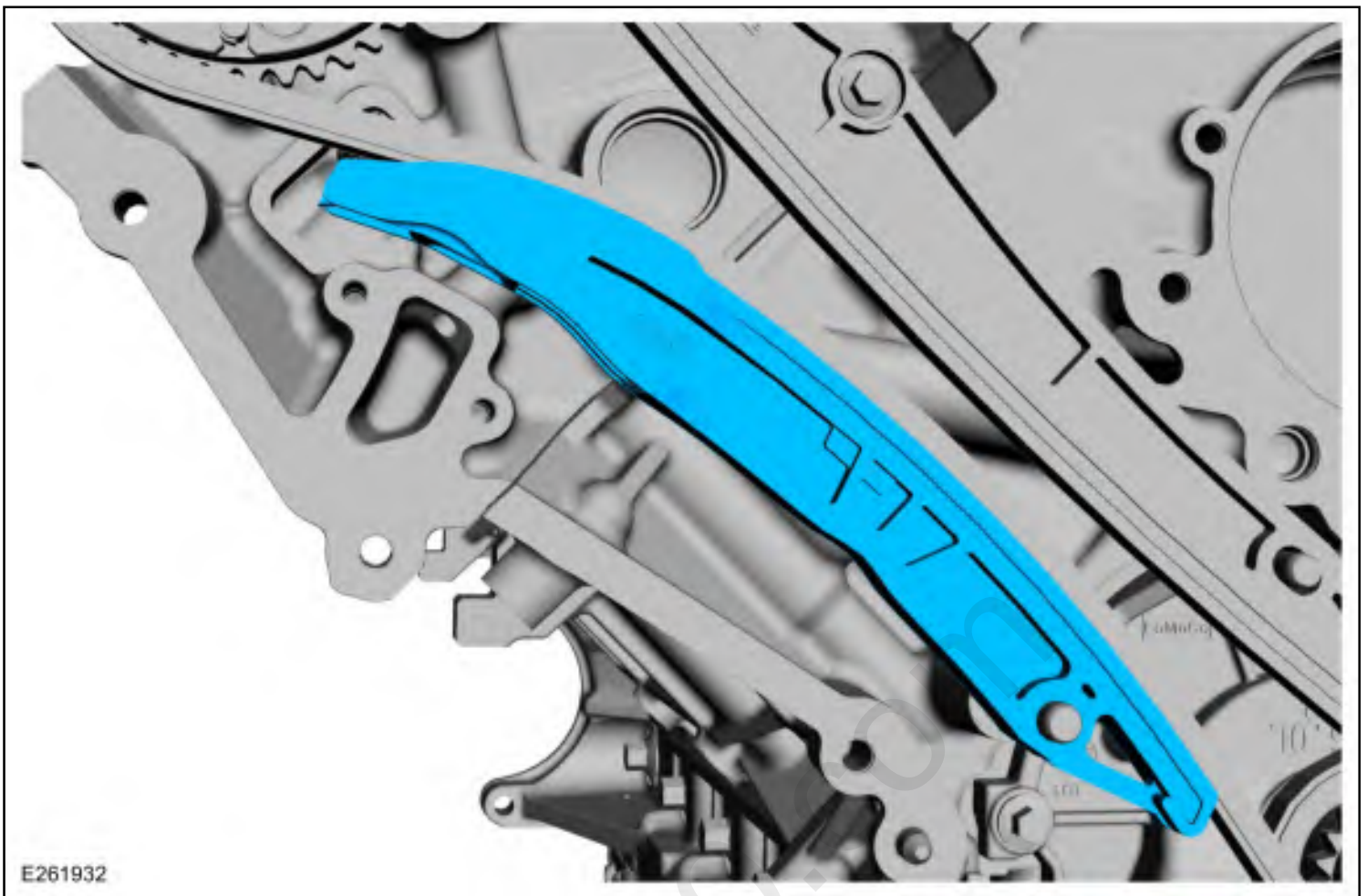
64. Remove the bolts and the RH primary timing chain tensioner.



65. **NOTE:** It may be necessary to rotate the crankshaft slightly to provide enough slack in the chain to remove the RH timing chain tensioner arm. Return the crankshaft keyway to the 7:30 position after removing the RH timing chain tensioner arm.

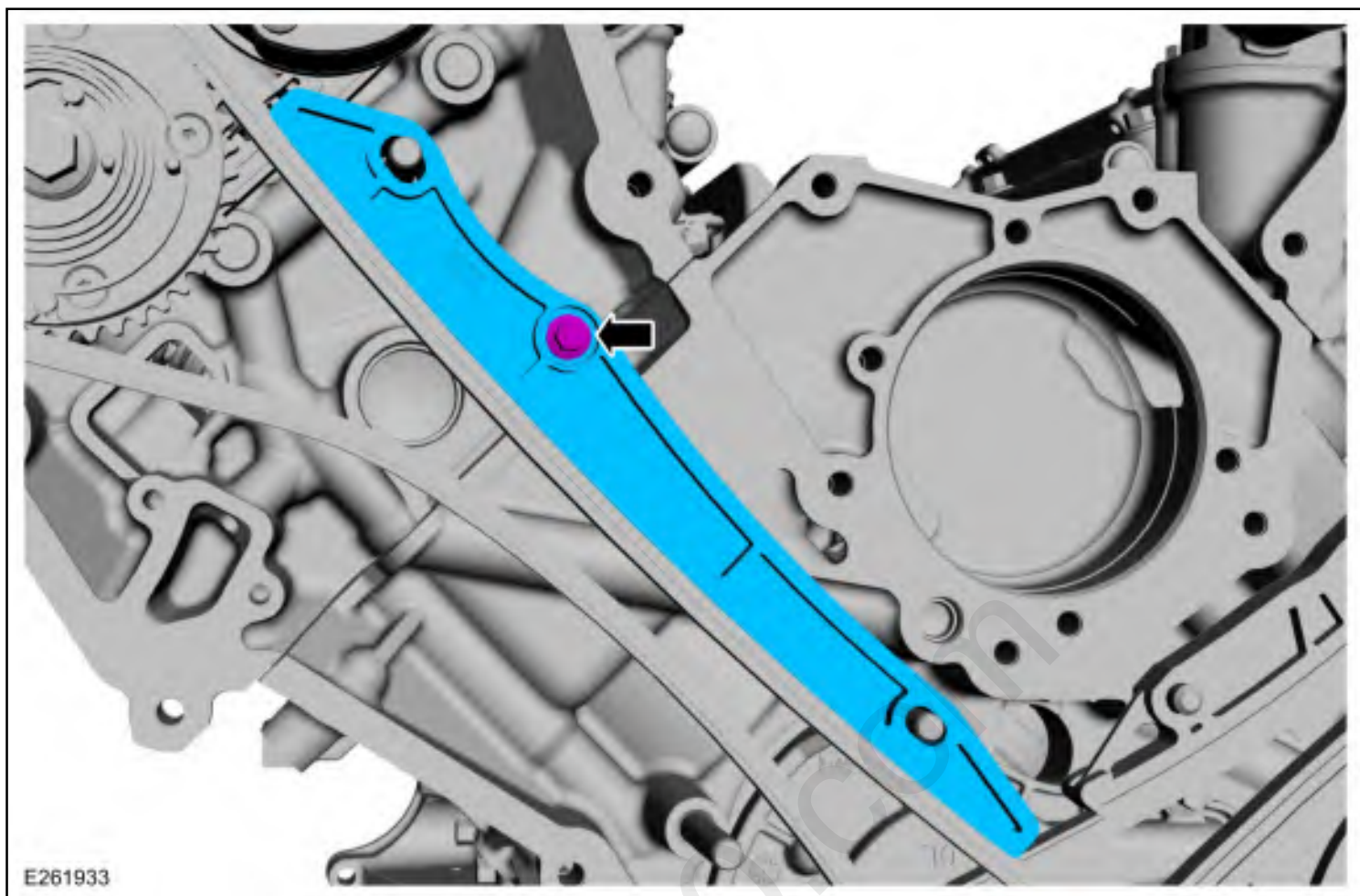
Remove the RH timing chain tensioner arm.



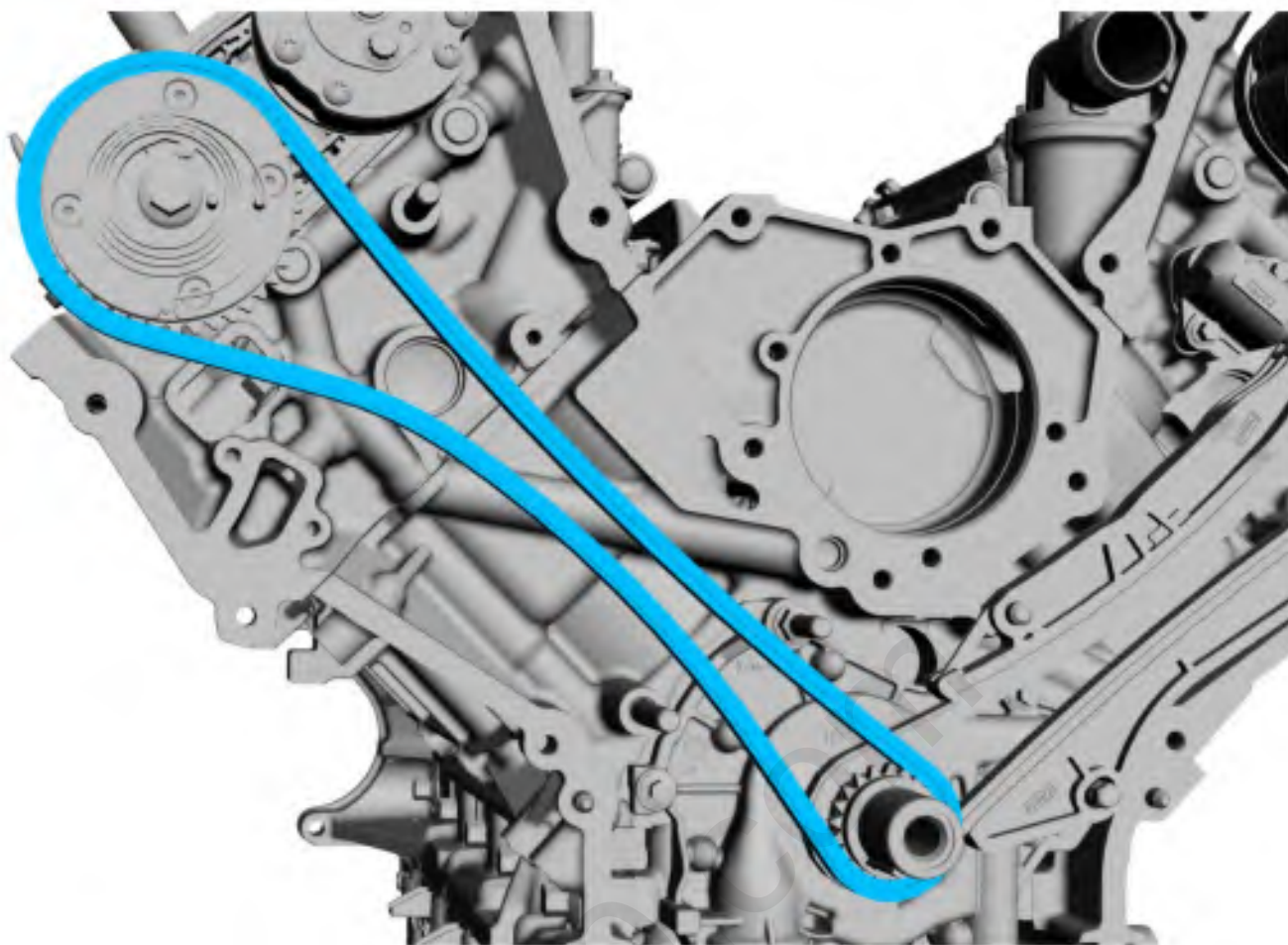


66. **NOTE:** *It may be necessary to rotate the crankshaft slightly to provide enough slack in the chain to remove the RH timing chain guide. Return the crankshaft keyway to the 7:30 position after removing the RH timing chain guide.*

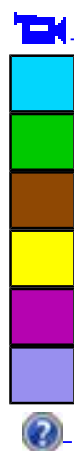
Remove the bolt and the RH timing chain guide.



67. Remove the RH timing chain.

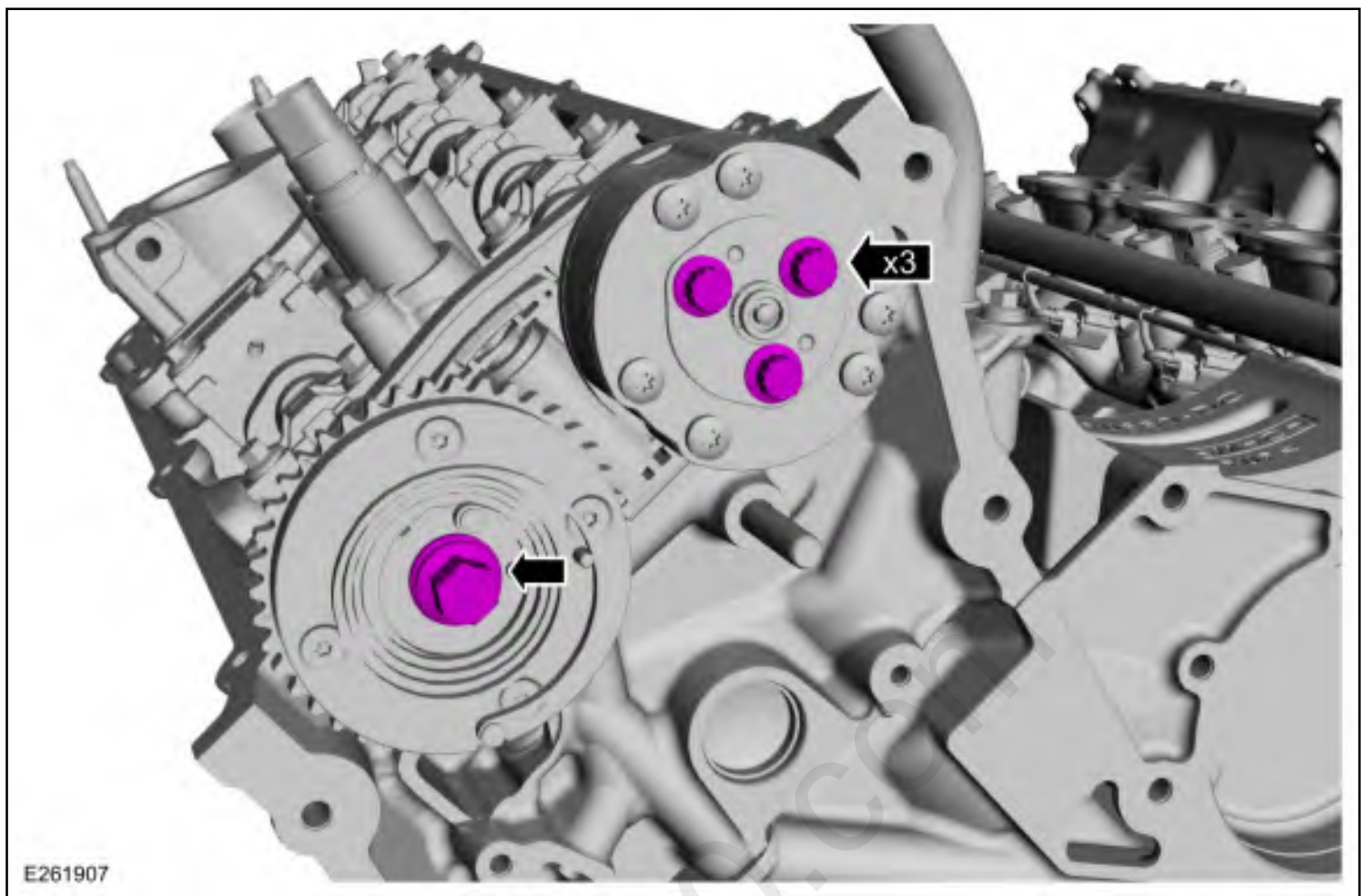


E261934

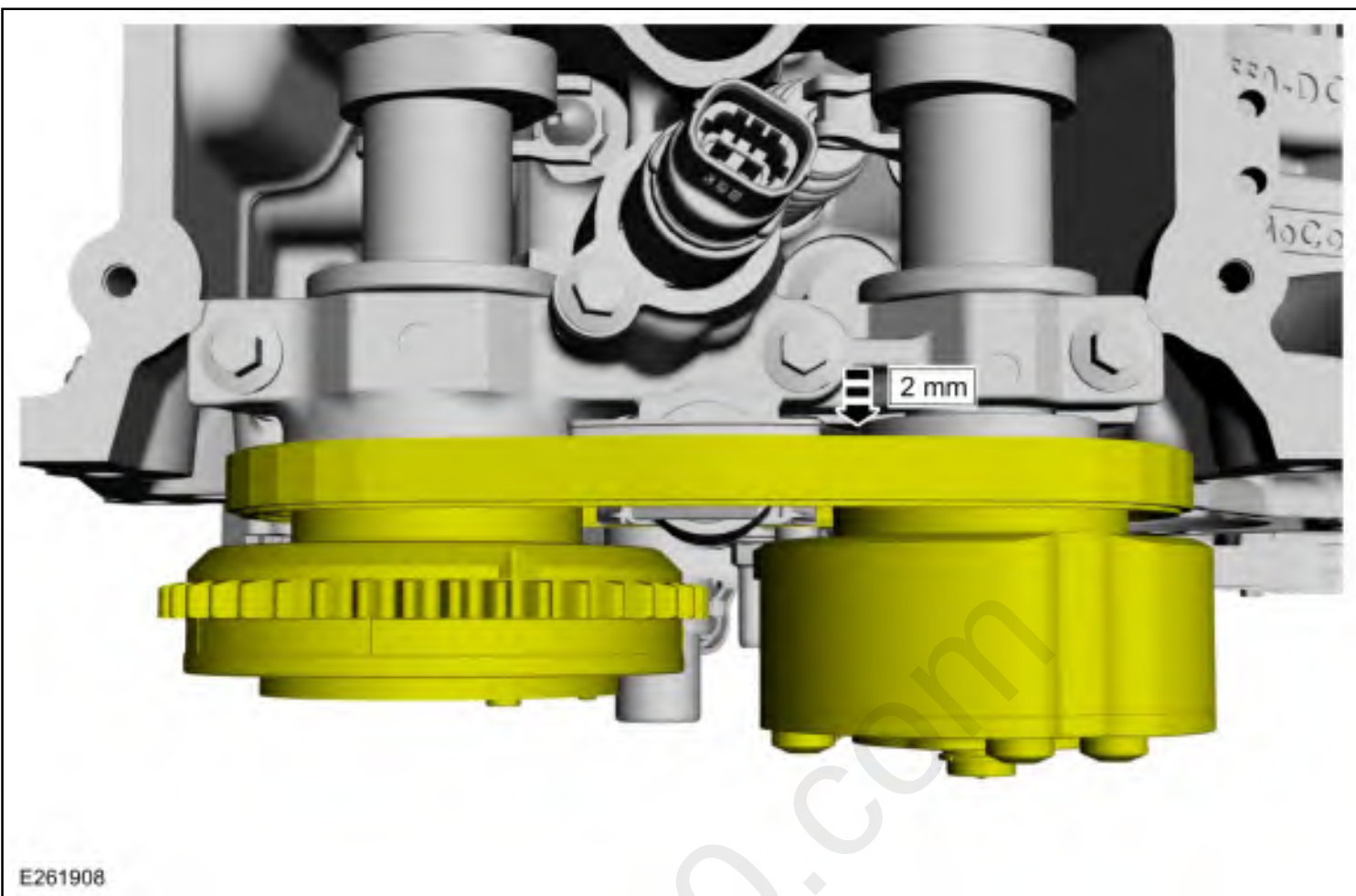


68. Remove the intake and exhaust VCT assembly bolts.

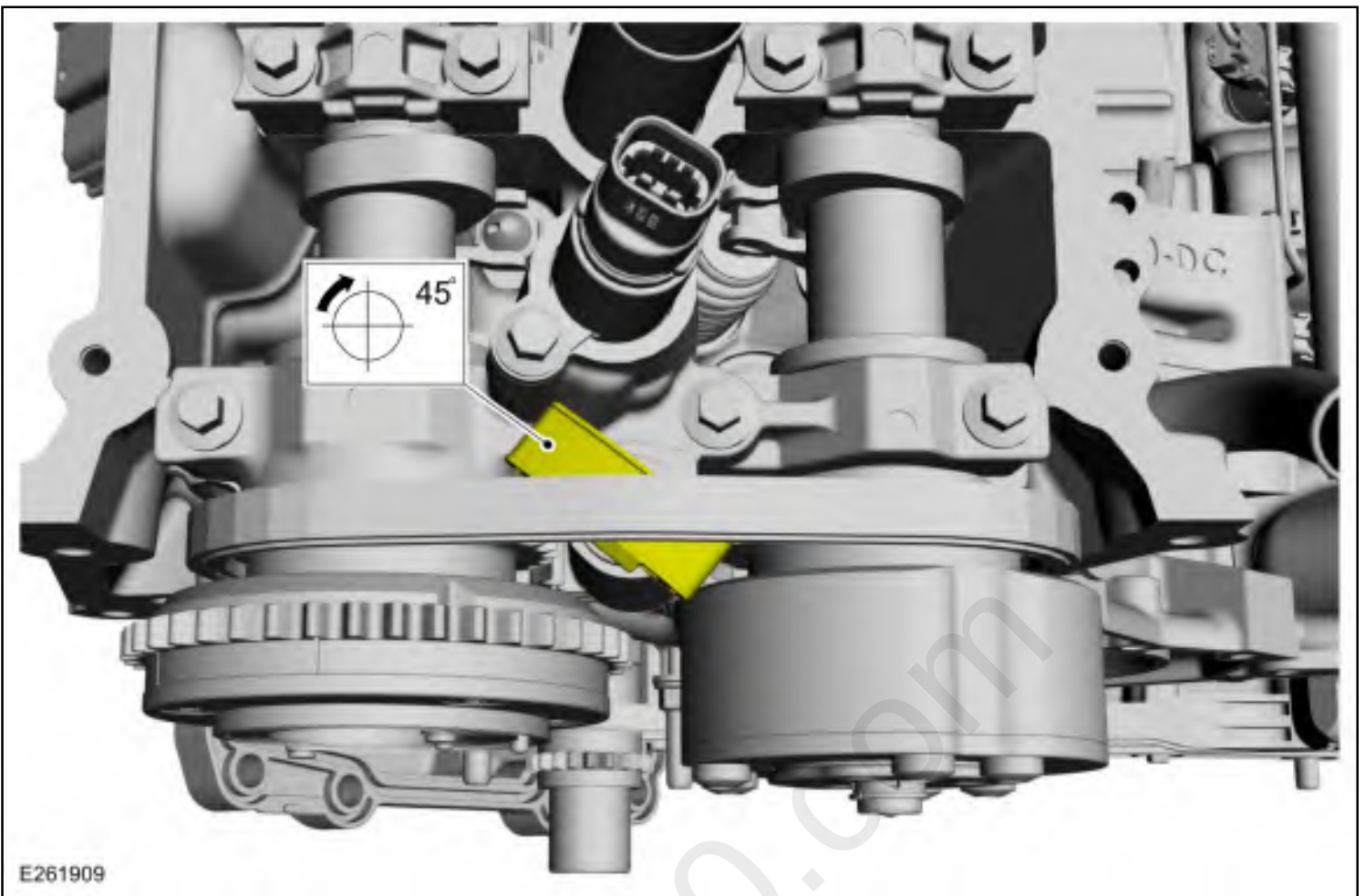




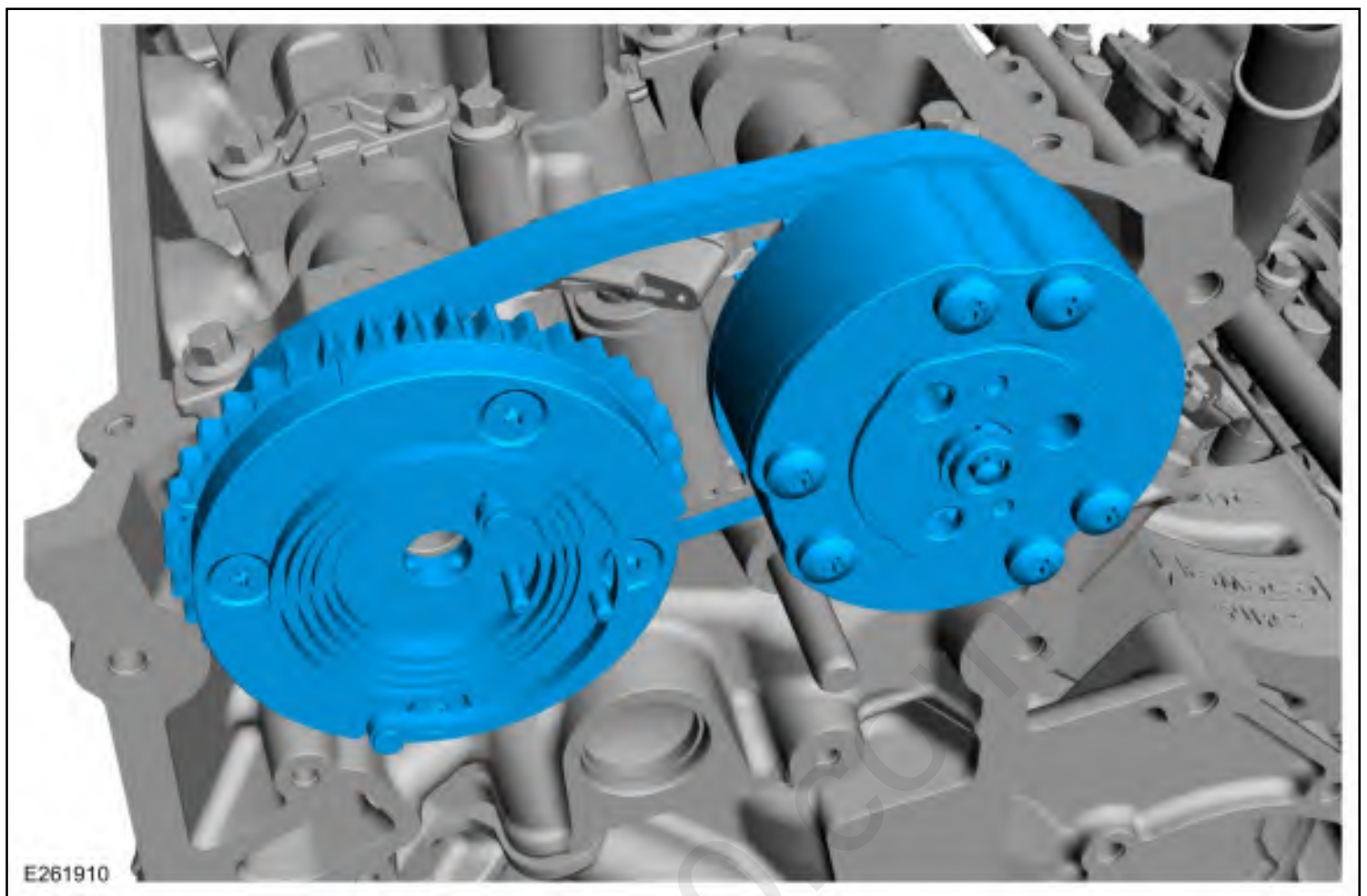
69. Slide the VCT assemblies and secondary timing chain forward 2 mm (0.078 in).



70. Depress and turn the secondary tensioner clockwise 45 degrees.

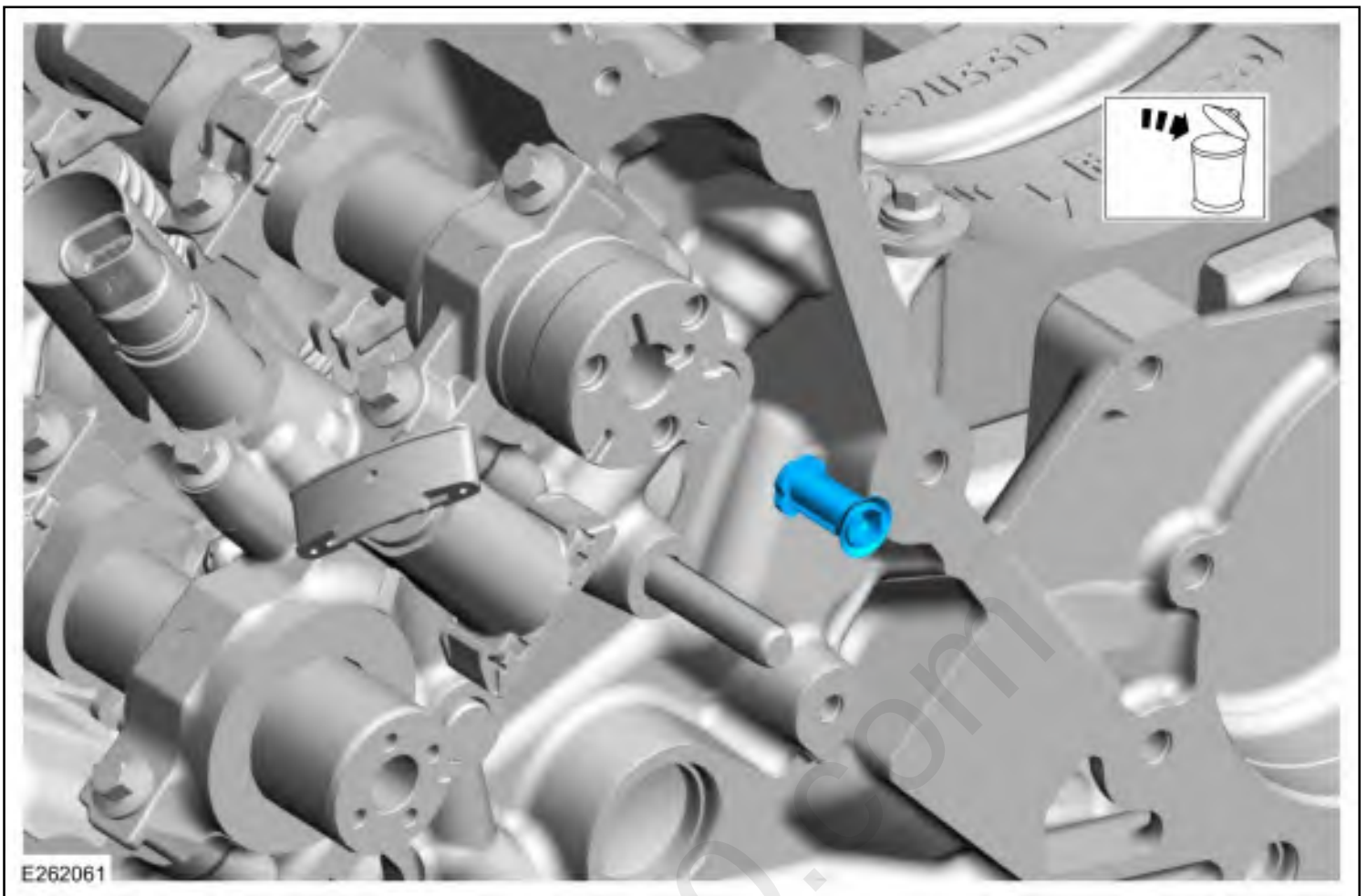


71. Remove the VCT assemblies and the secondary timing chain.



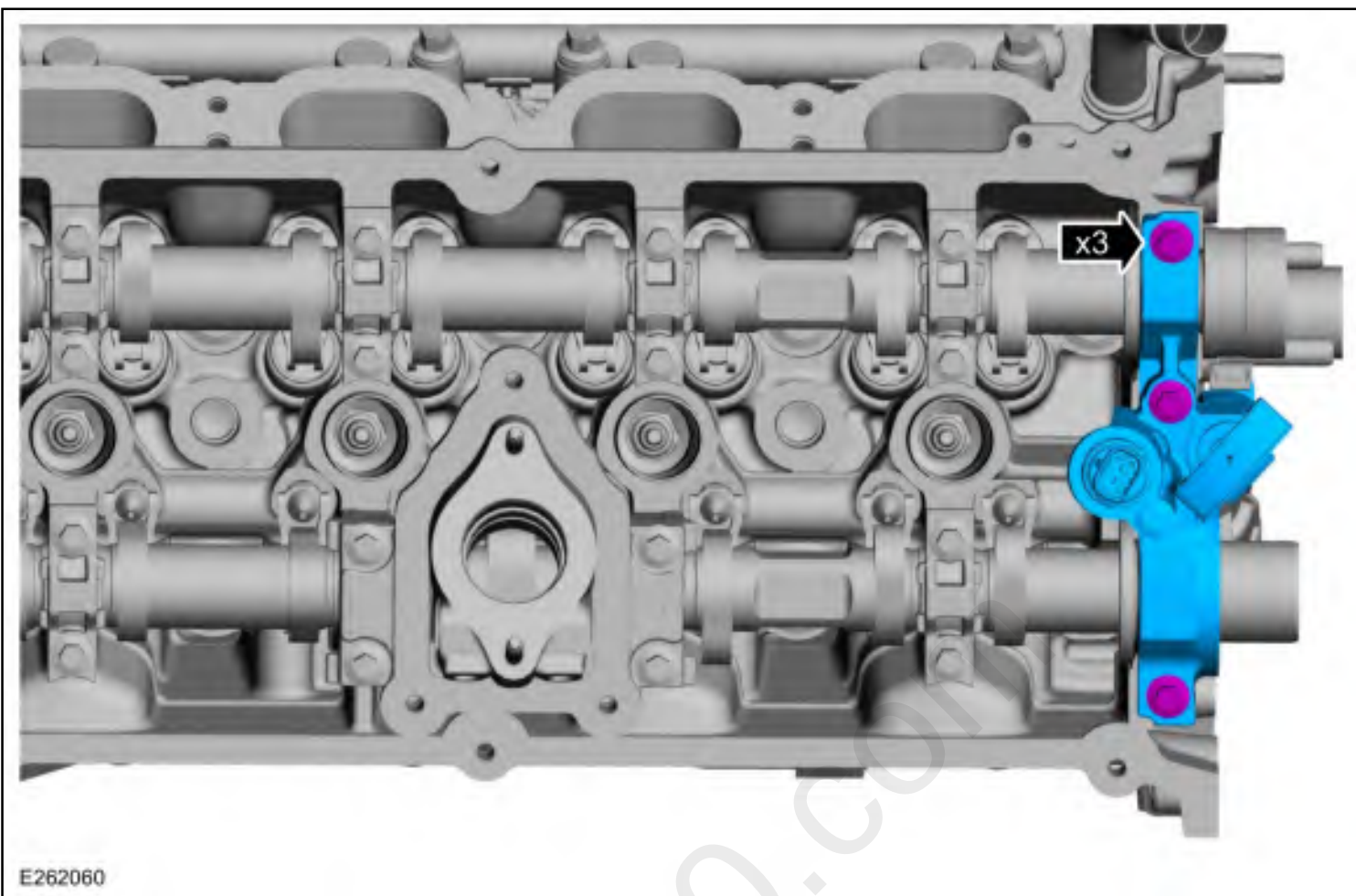
72. Remove and discard the VCT system oil filter.



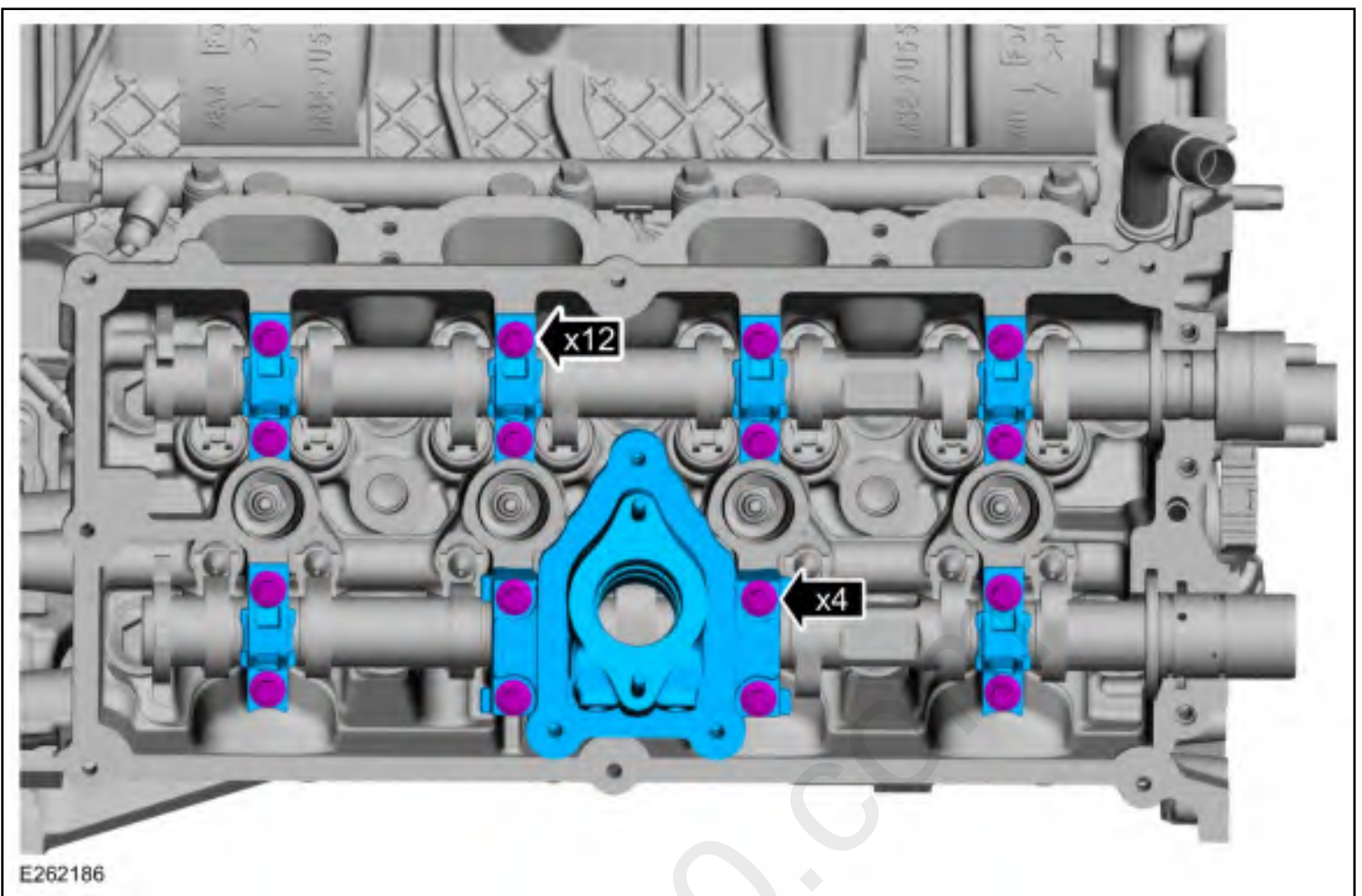


73. **NOTICE:** The front camshaft bearing mega cap must be removed first and then the remaining camshaft bearing caps. Failure to follow this direction may result in damage to the engine.

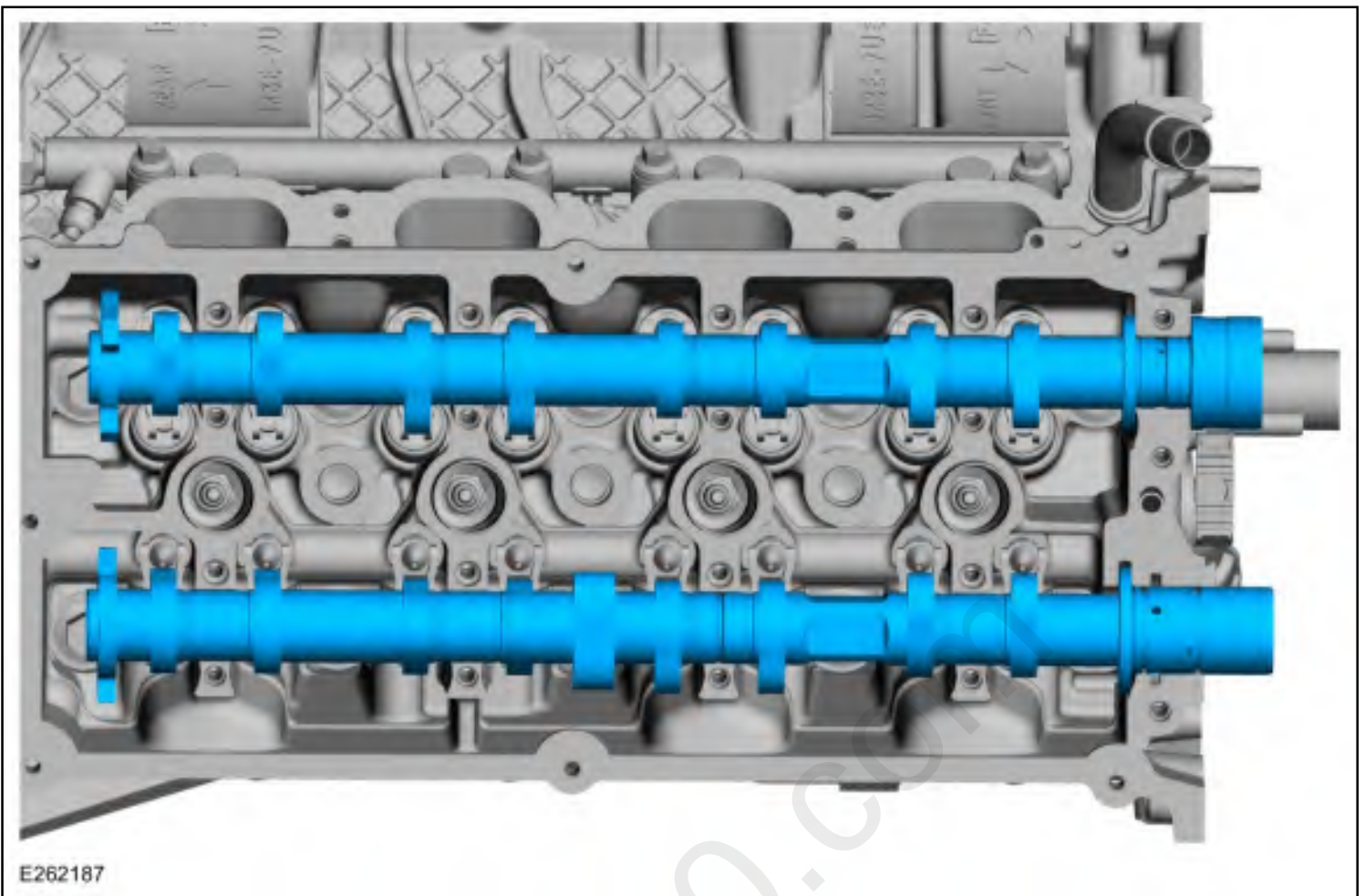
Remove the bolts and the front camshaft bearing mega cap.



74. Remove the bolts and the camshaft bearing caps.

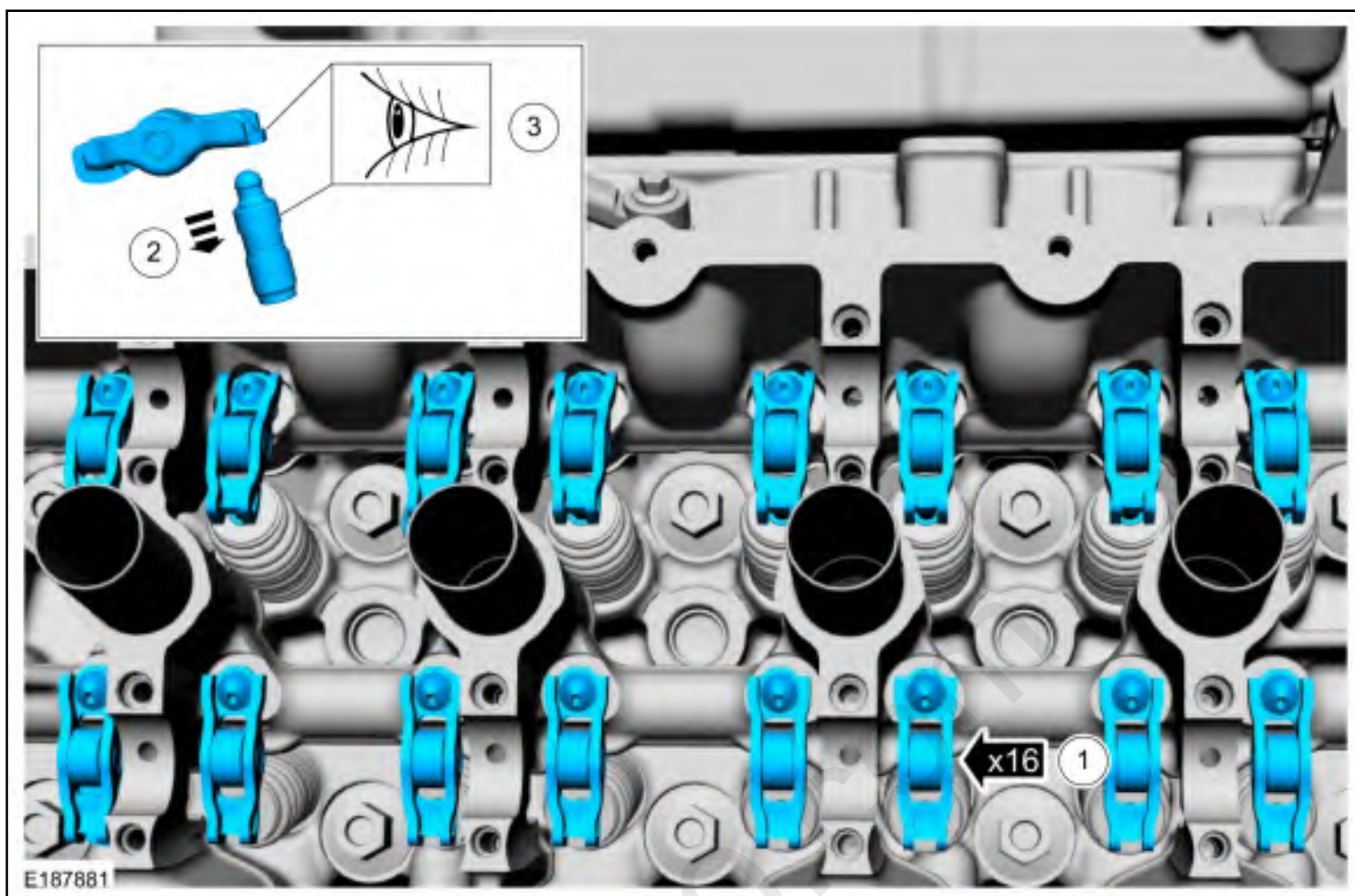


75. Remove the intake and exhaust camshafts.

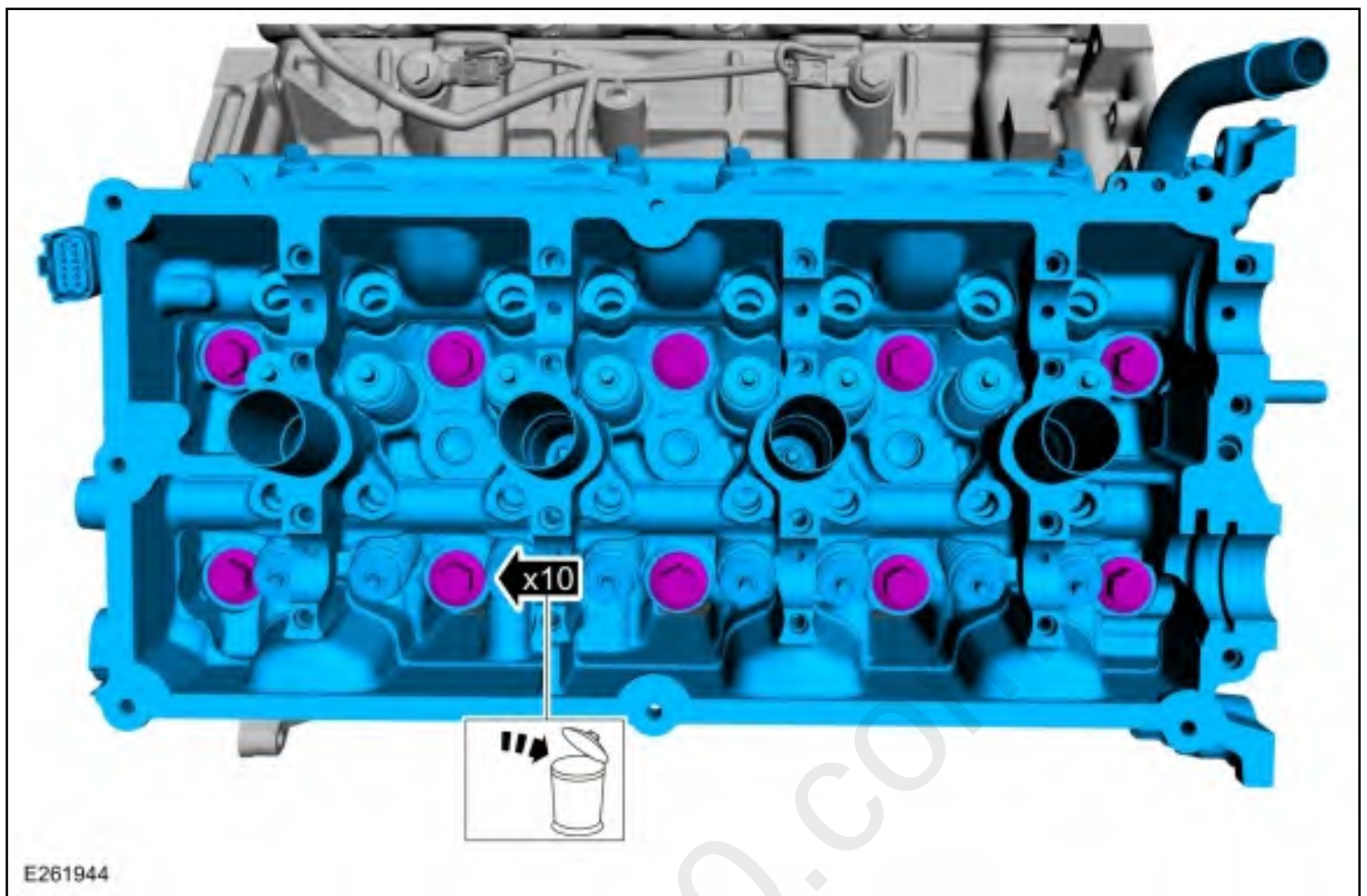


1. Remove the camshaft roller follower and hydraulic lash adjuster assemblies.
2. Separate the hydraulic lash adjusters from the spring clips on the camshaft roller followers.
3. Inspect the hydraulic lash adjuster and roller follower for damage. If any damage is found, inspect the camshaft lobes and valves for damage. Replace damaged components as necessary.

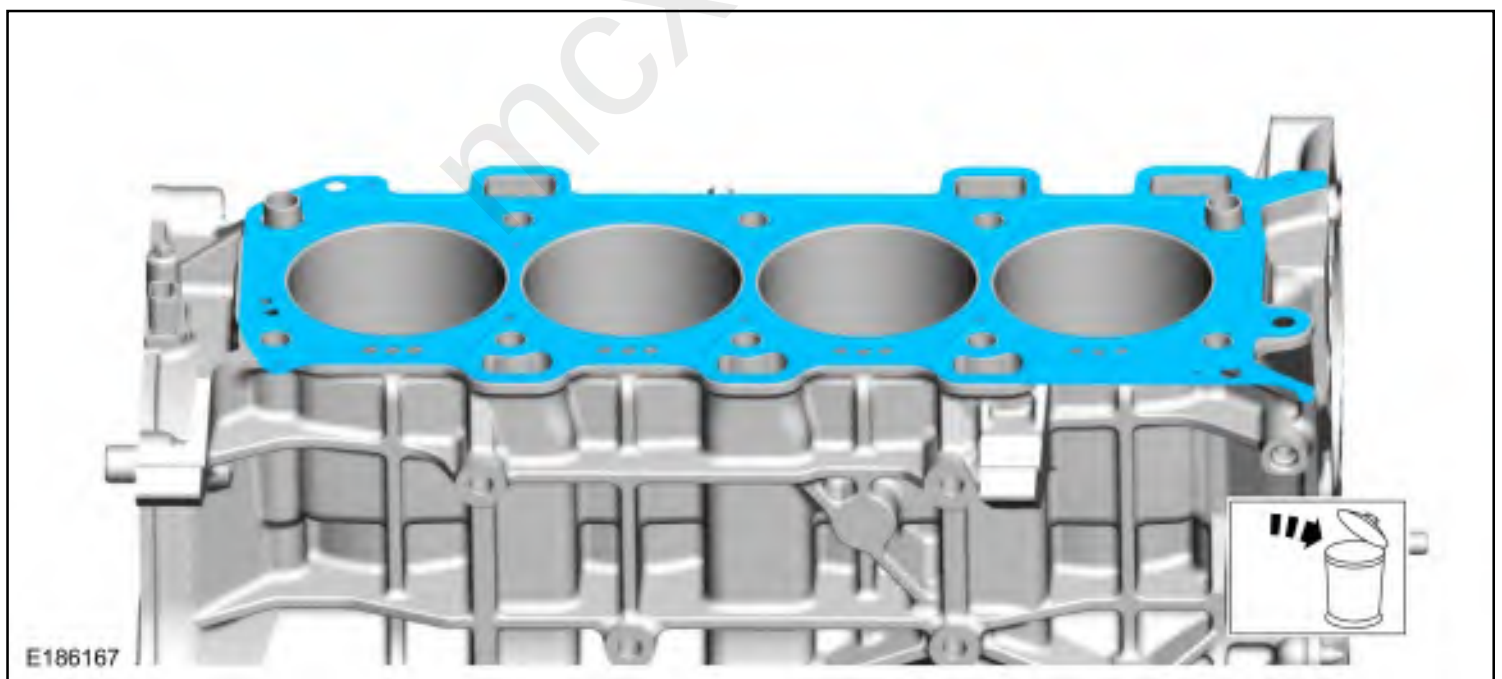




- Remove and discard the bolts.
- Remove the cylinder head.

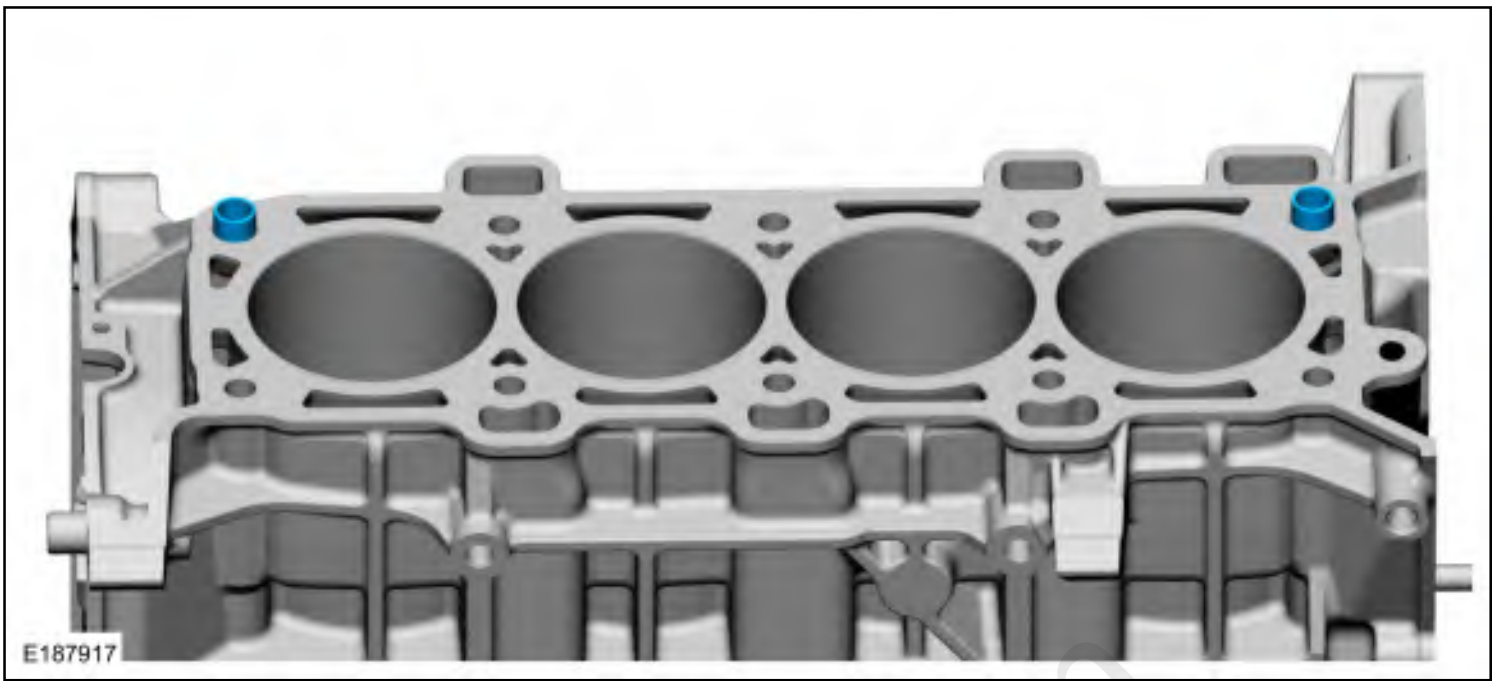


78. Remove and discard the cylinder head gasket.



79. Remove the dowels.

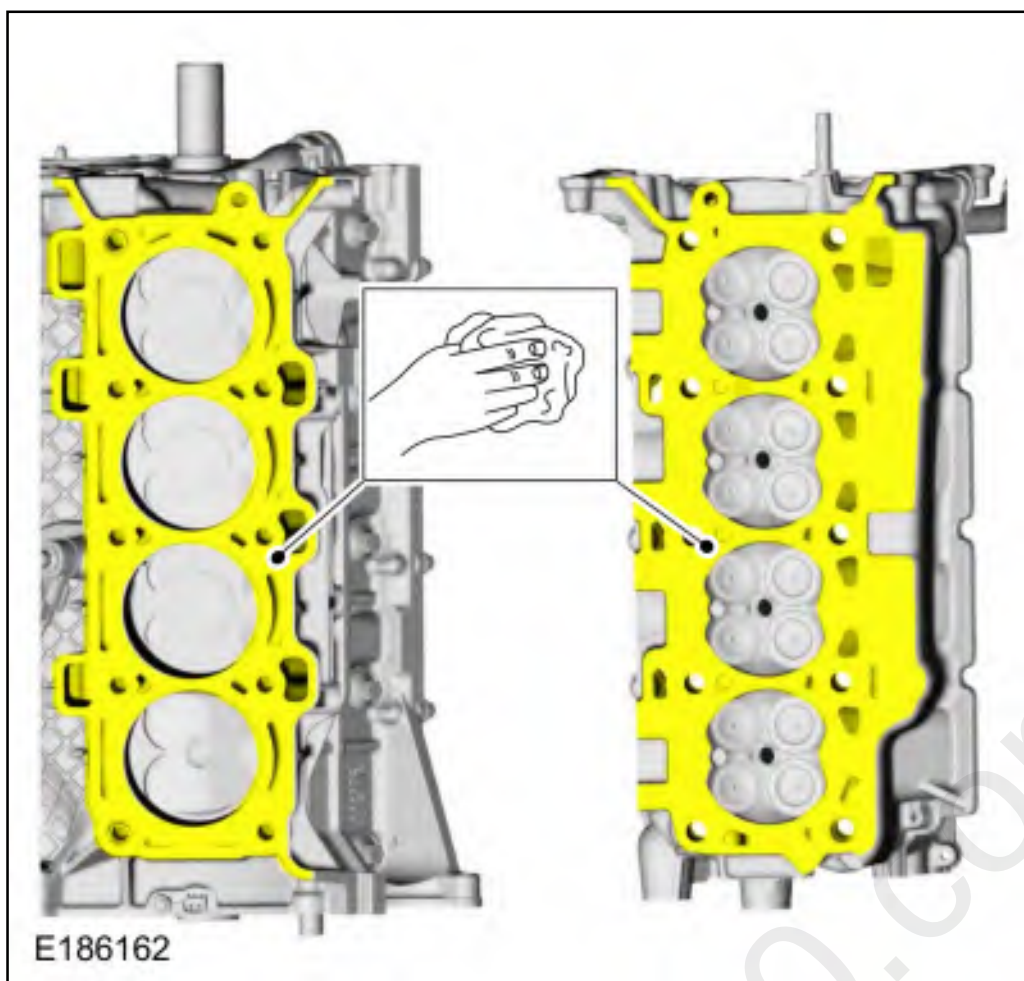




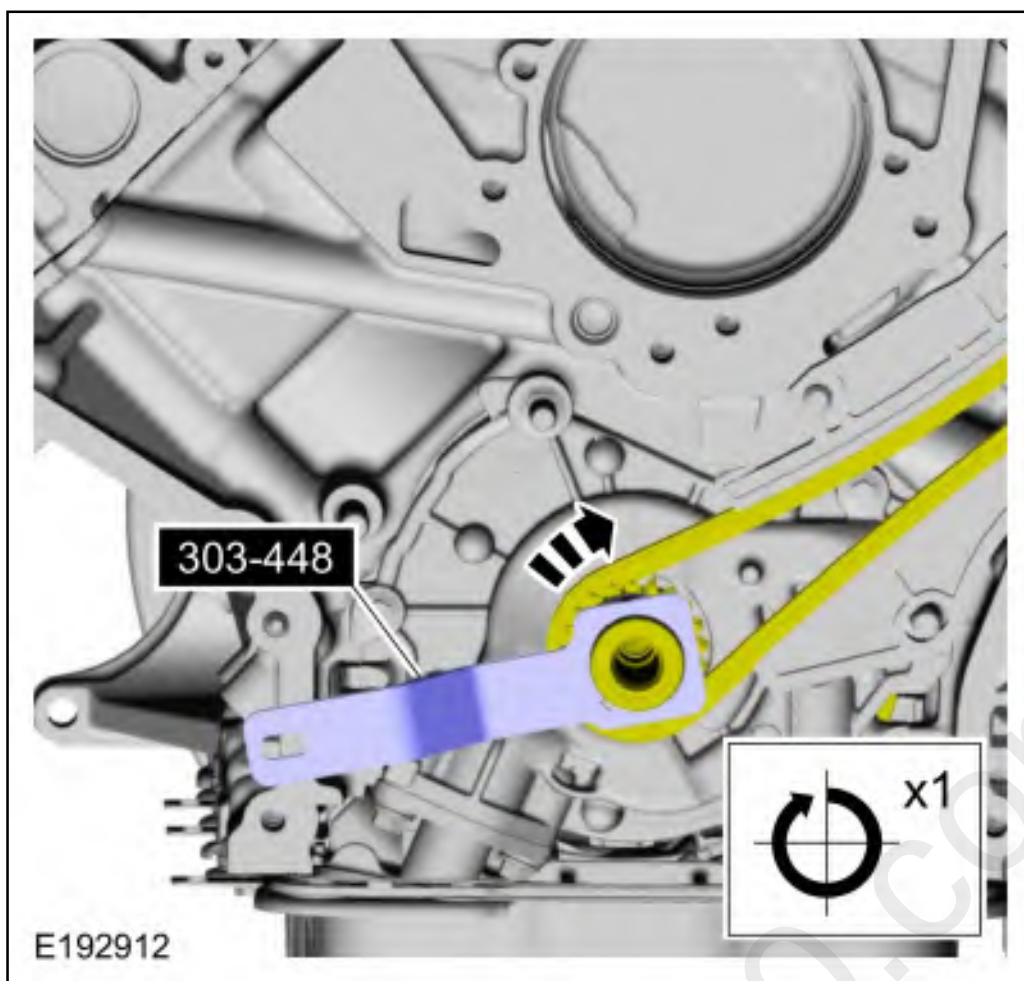
80. **NOTICE:** Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the sealing surfaces. These tools cause scratches and gouges which make leak paths.

**NOTE:** Clean the cylinder head bolt holes in the cylinder block using compressed air. Make sure all coolant, oil or other foreign material is removed.

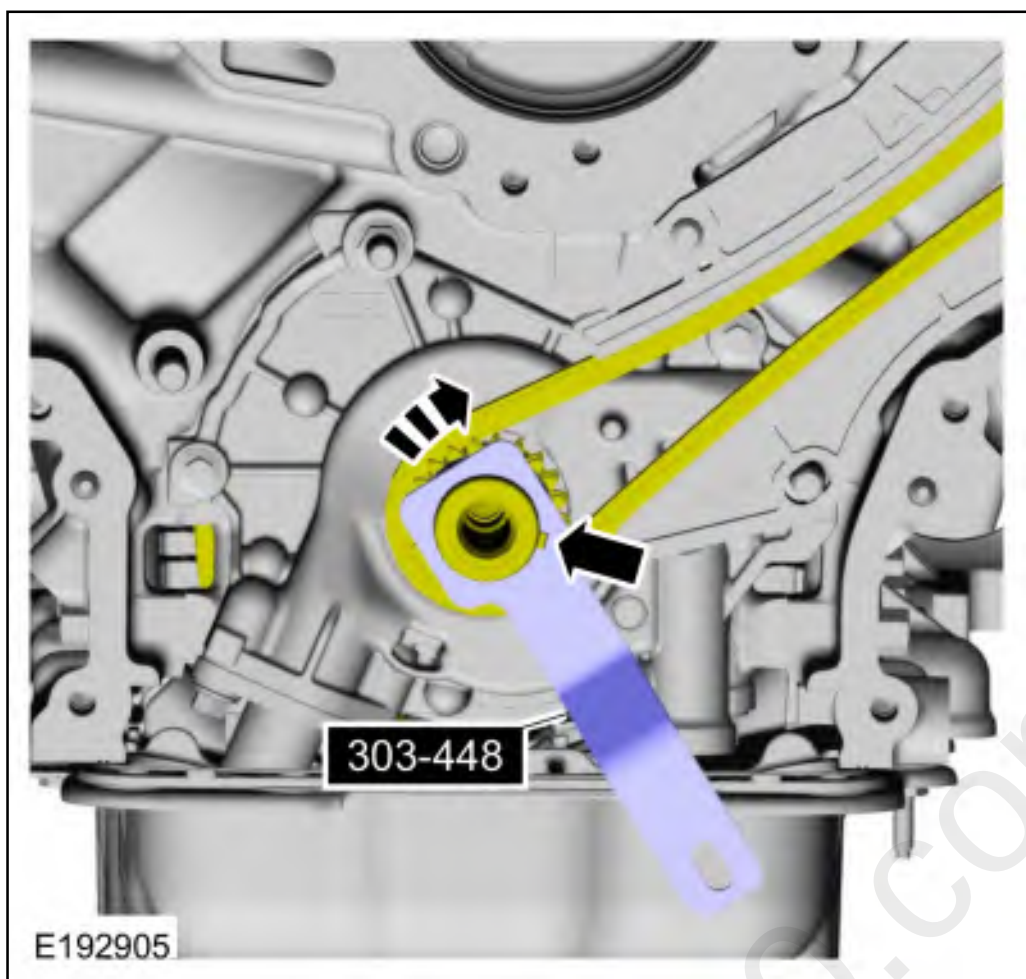
- Clean and inspect the cylinder head-to-cylinder block mating surfaces of both the cylinder head and the cylinder block
- Refer to: [Cylinder Head Distortion](#) (303-00 Engine System - General Information, General Procedures).
- Refer to: [Cylinder Block Distortion](#) (303-00 Engine System - General Information, General Procedures).



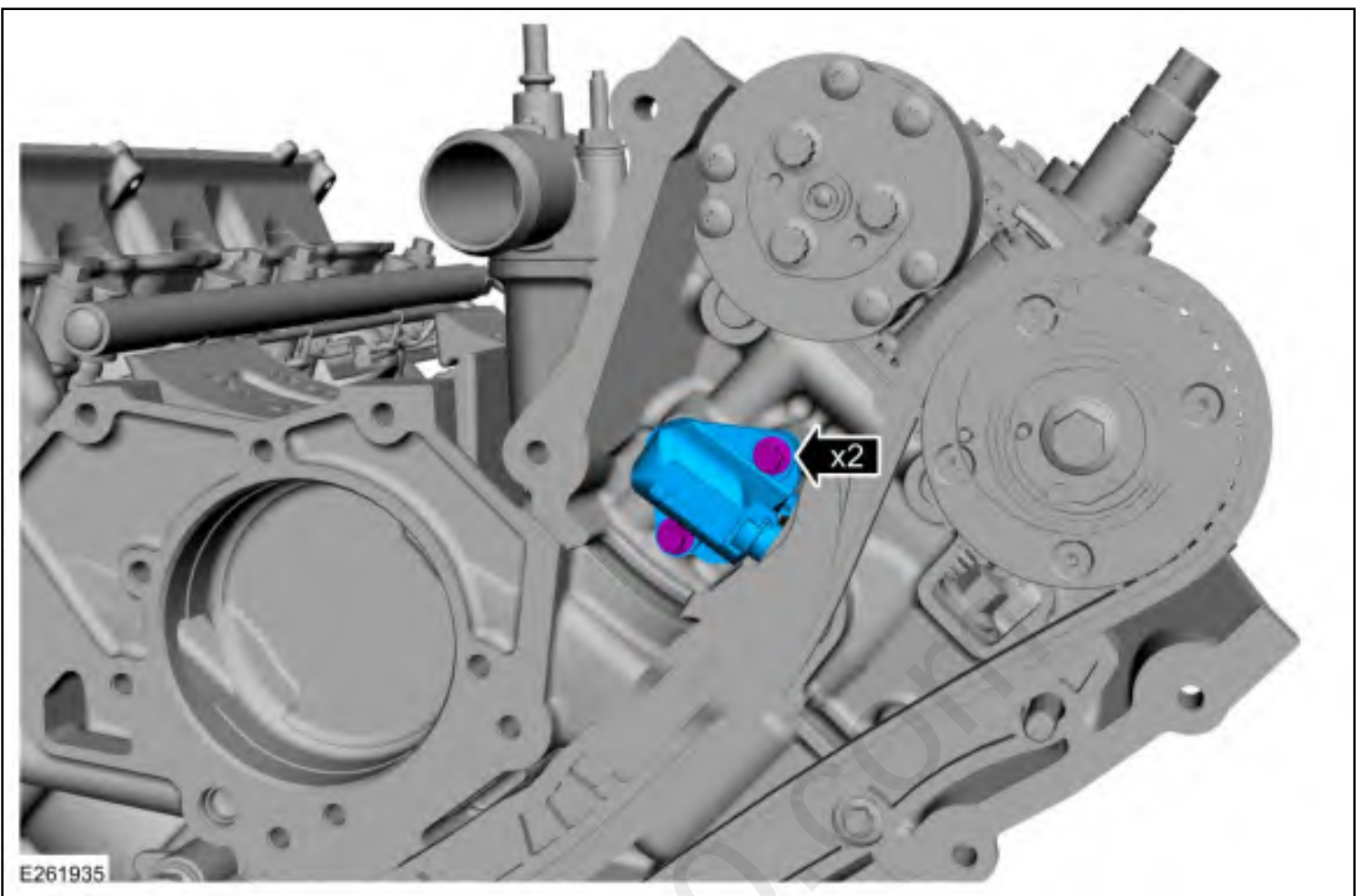
81. Using the special tool, rotate the crankshaft clockwise one complete revolution.  
Use Special Service Tool: 303-448 (T93P-6303-A) Holding Tool, Crankshaft.



82. 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.



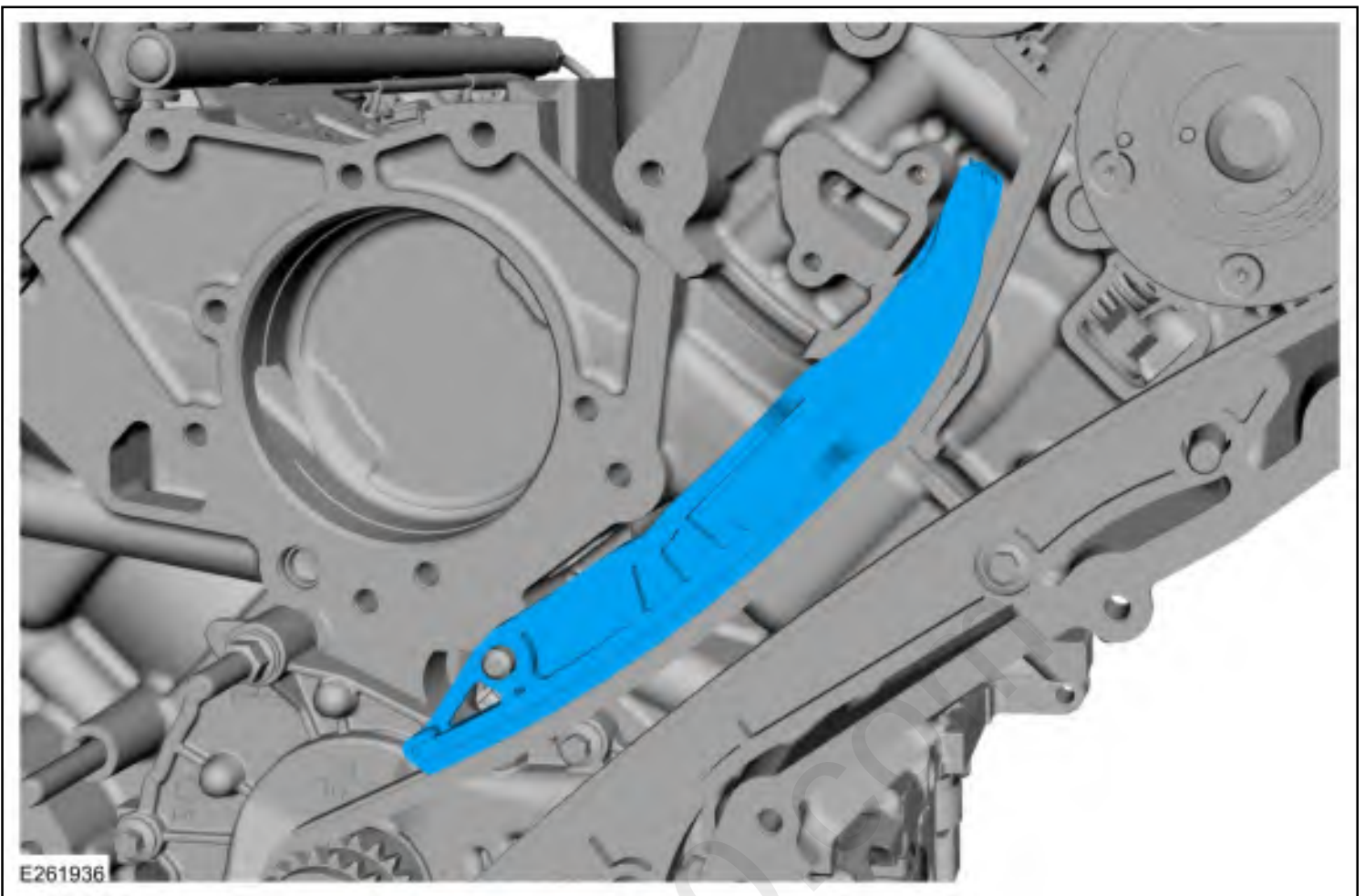
83. Remove the bolts and the LH primary timing chain tensioner.



84. **NOTE:** *It may be necessary to rotate the crankshaft slightly to provide enough slack in the chain to remove the LH timing chain tensioner arm. Return the crankshaft keyway to the 3:30 position after removing the LH timing chain tensioner arm.*

Remove the LH timing chain tensioner arm.

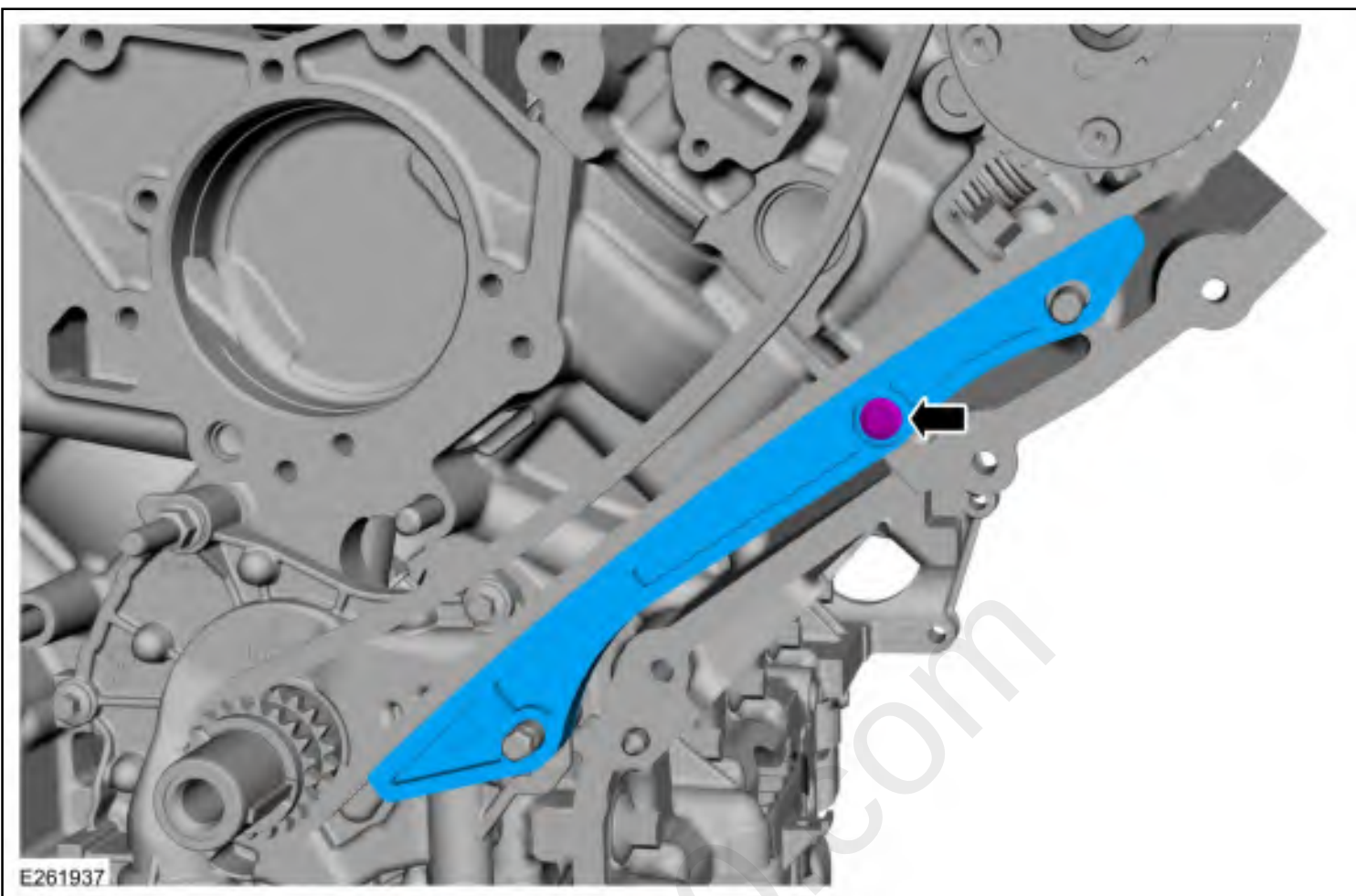




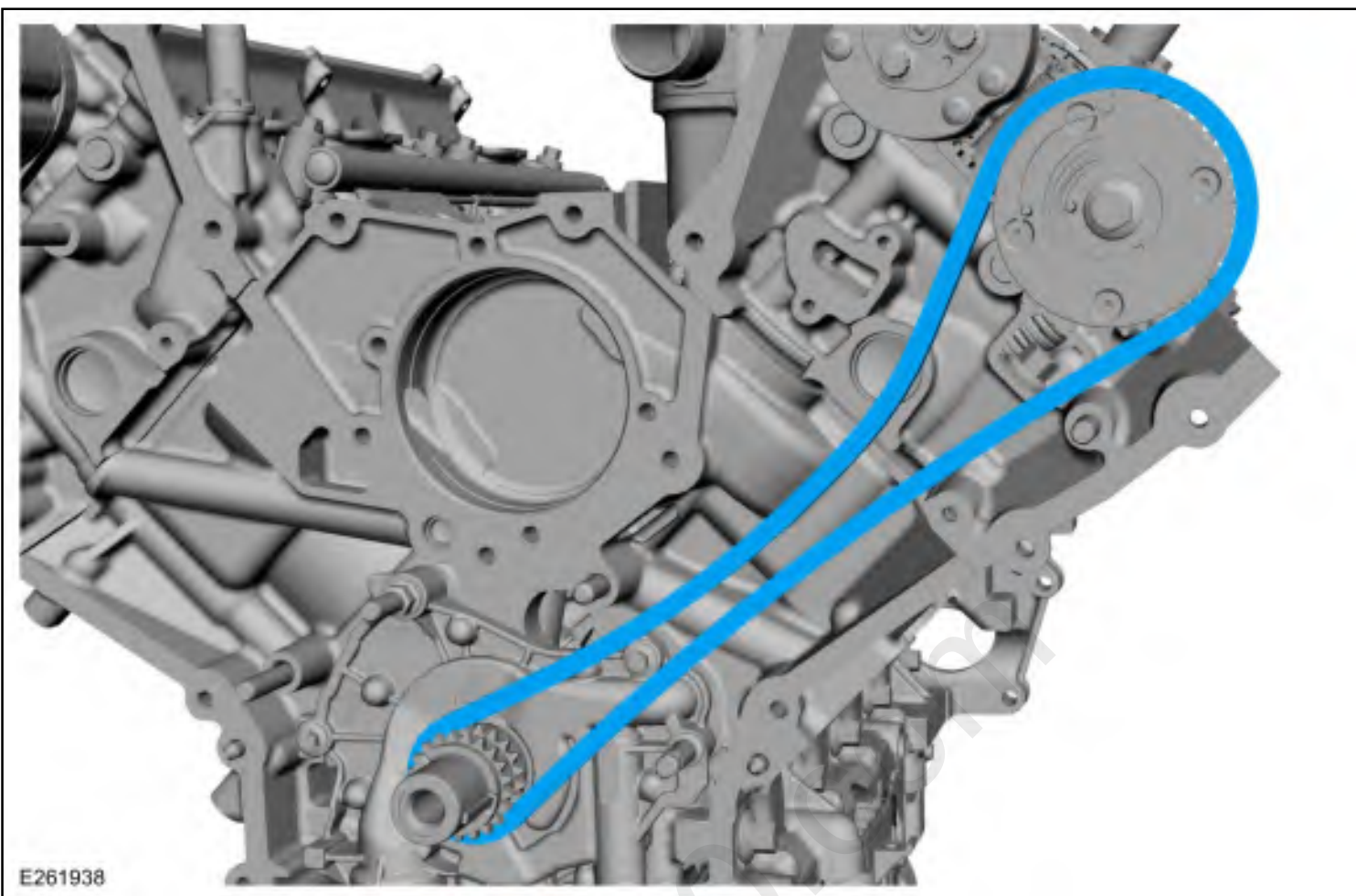
85. **NOTE:** *It may be necessary to rotate the crankshaft slightly to provide enough slack in the chain to remove the LH timing chain guide. Return the crankshaft keyway to the 3:30 position after removing the LH timing chain guide.*

Remove the bolt and the LH timing chain guide.

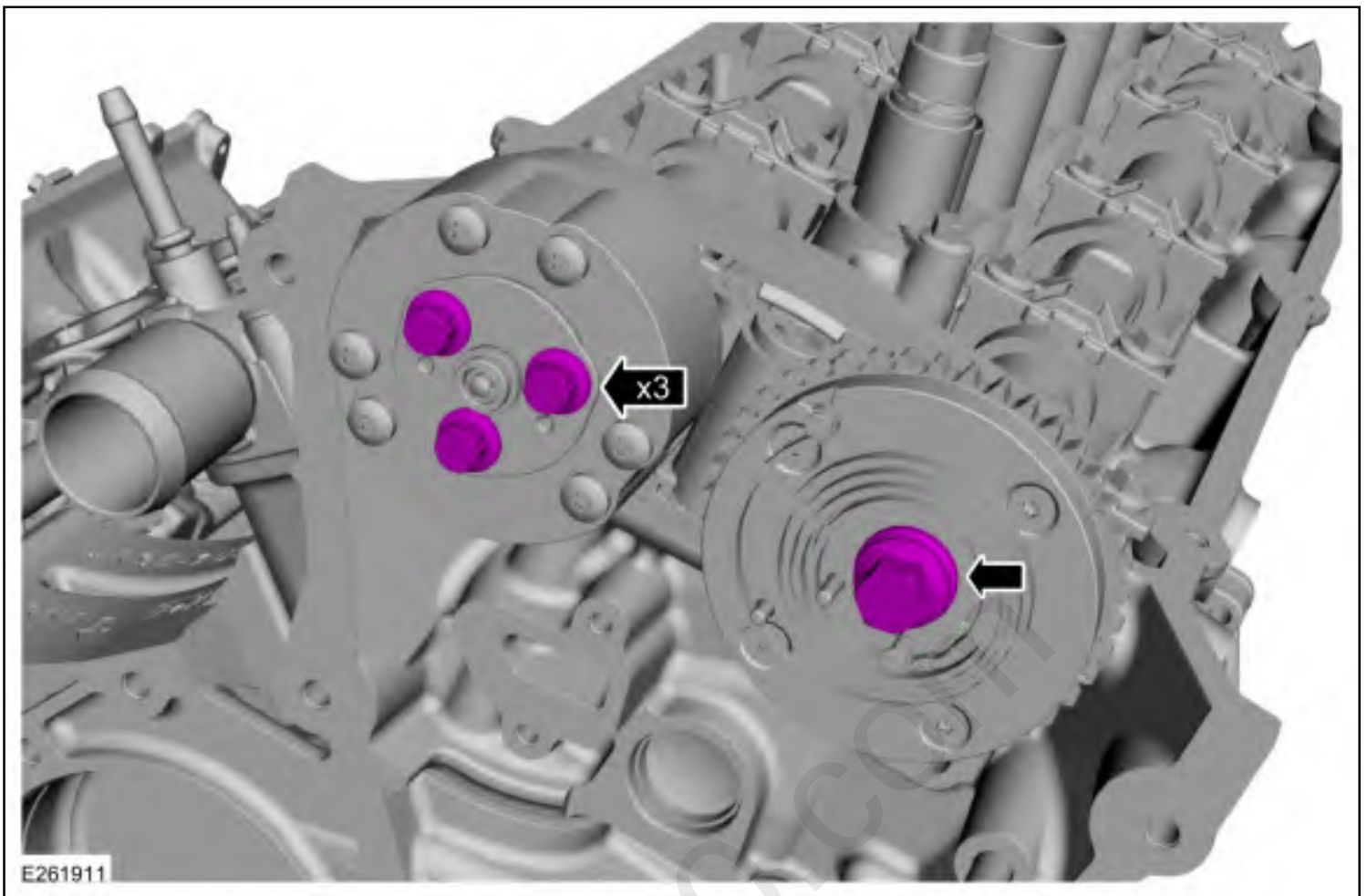




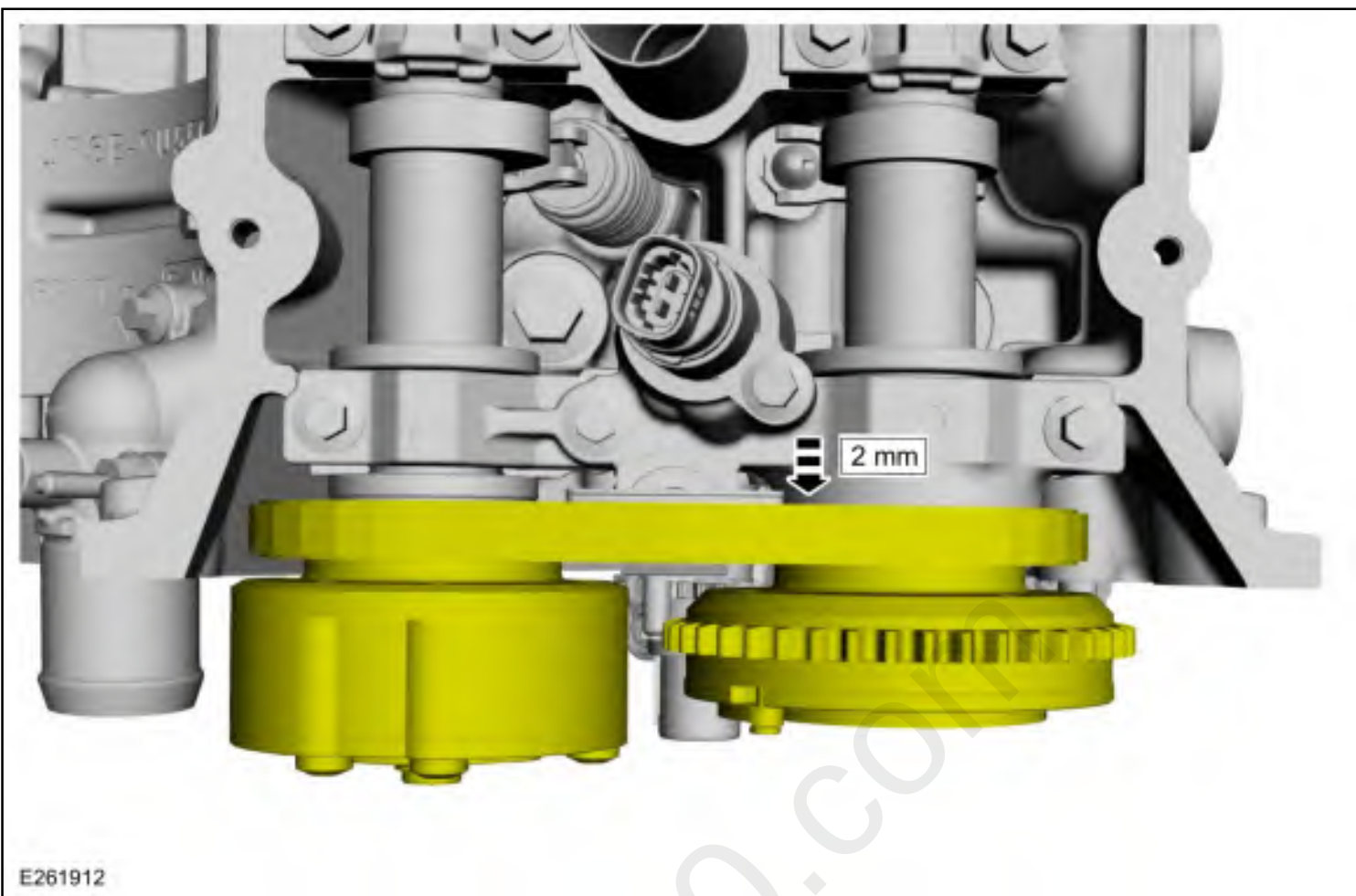
86. Remove the LH timing chain.



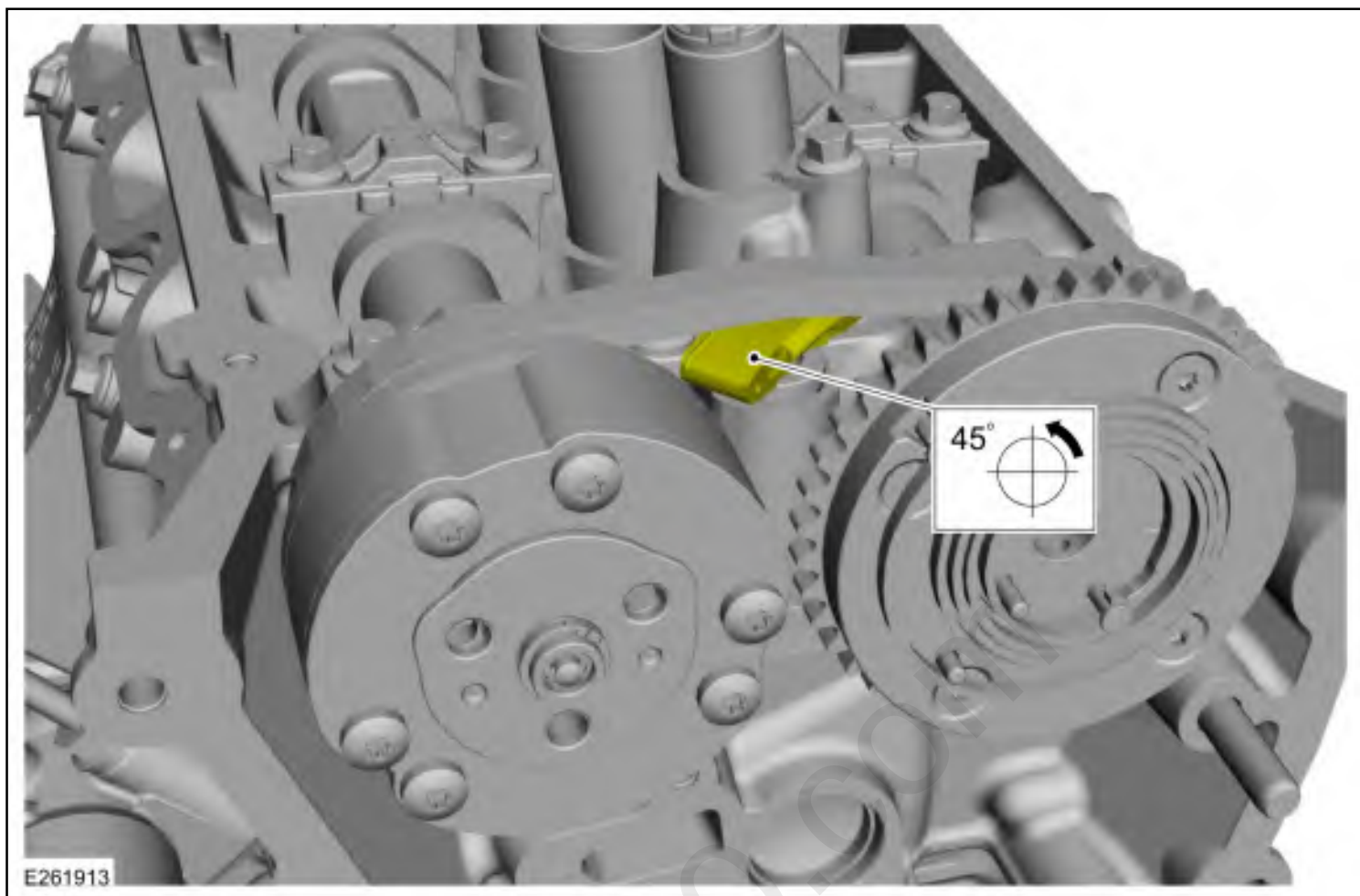
87. Remove the intake and exhaust VCT assembly bolts.



88. Slide the Variable Camshaft Timing VCT assemblies and secondary timing chain forward 2 mm (0.078 in).

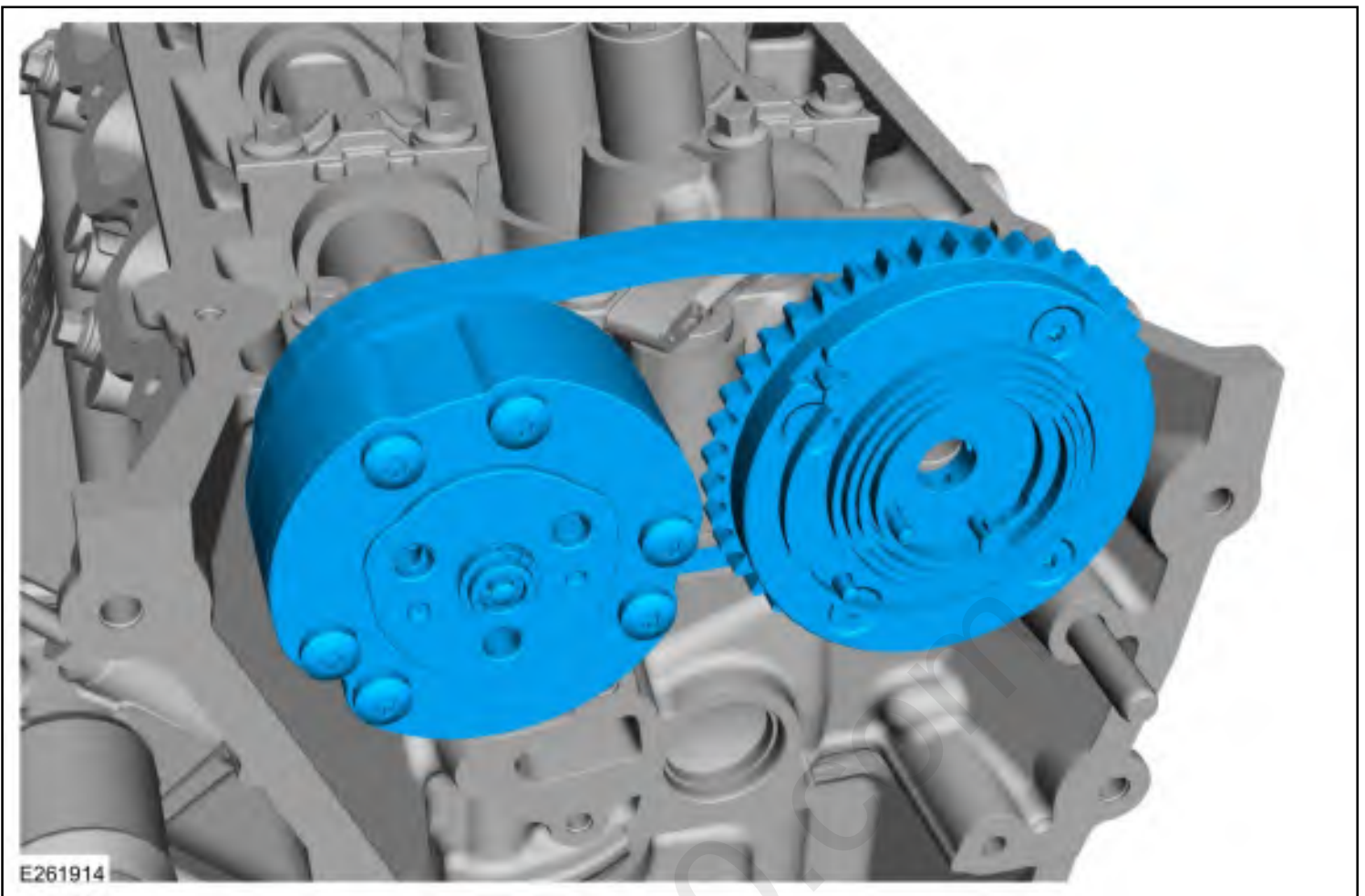


89. Depress and turn the secondary tensioner counterclockwise 45 degrees.



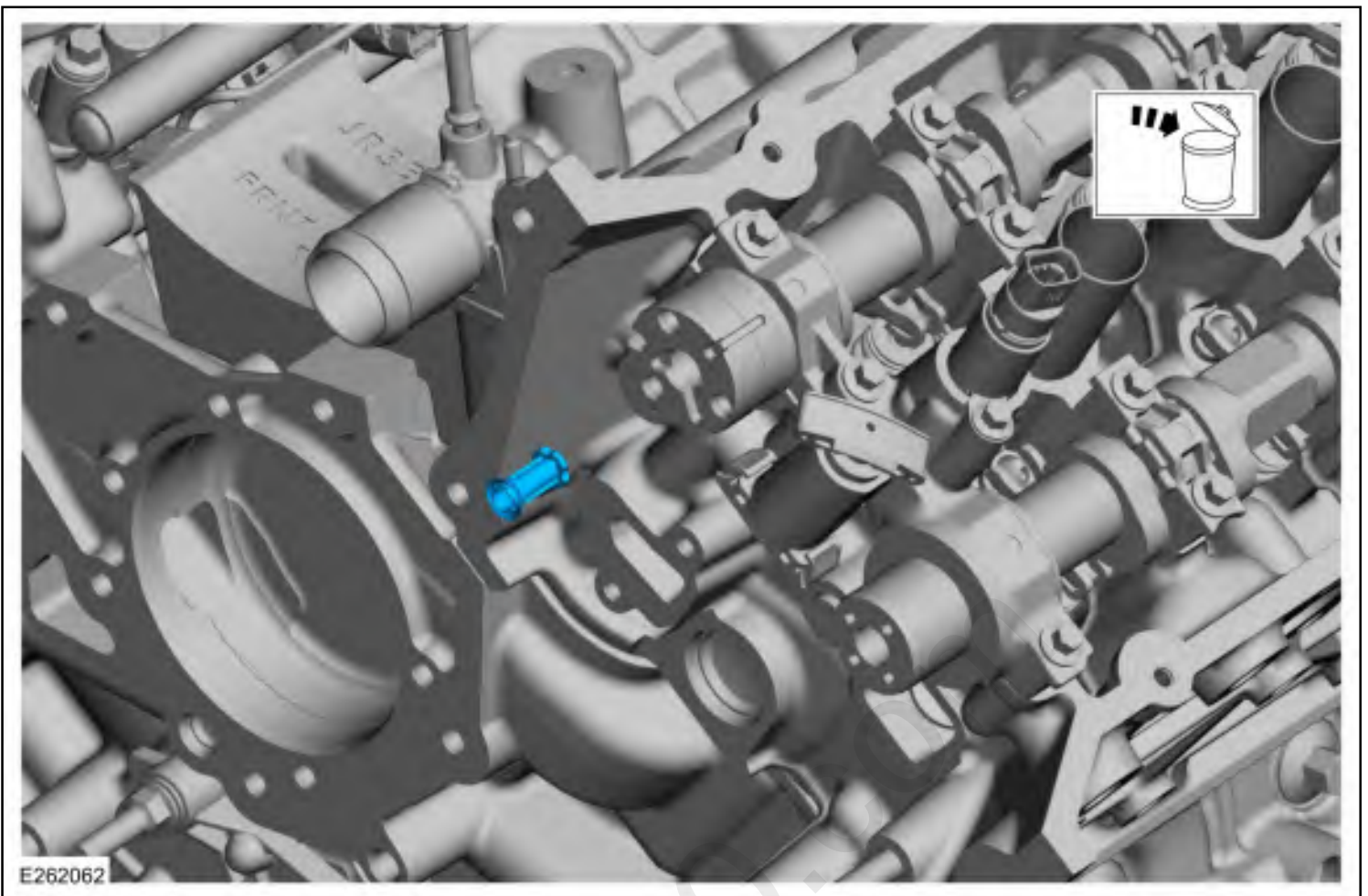
90. Remove the VCT assemblies and the secondary timing chain.





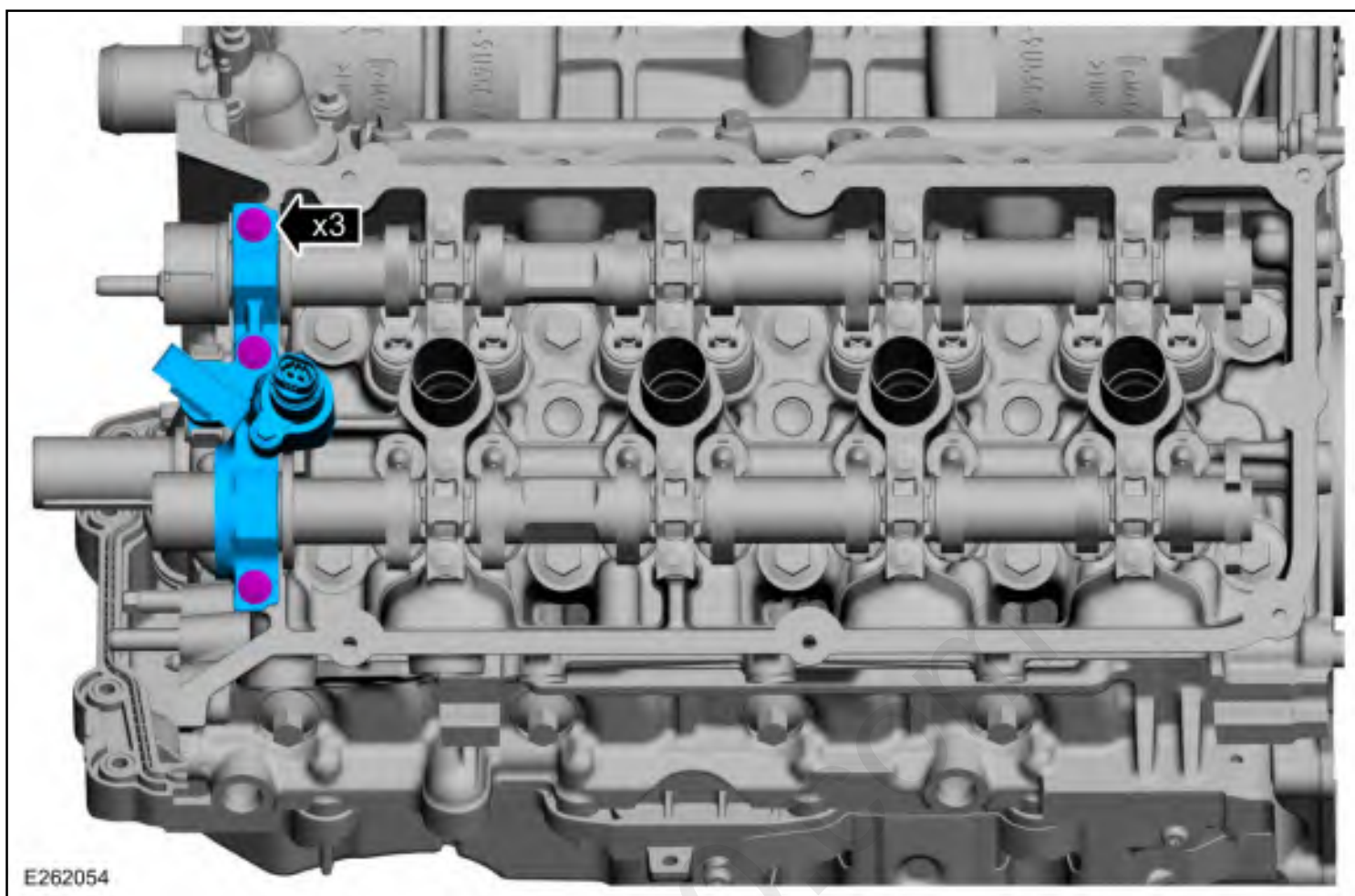
91. Remove and discard the VCT system oil filter.



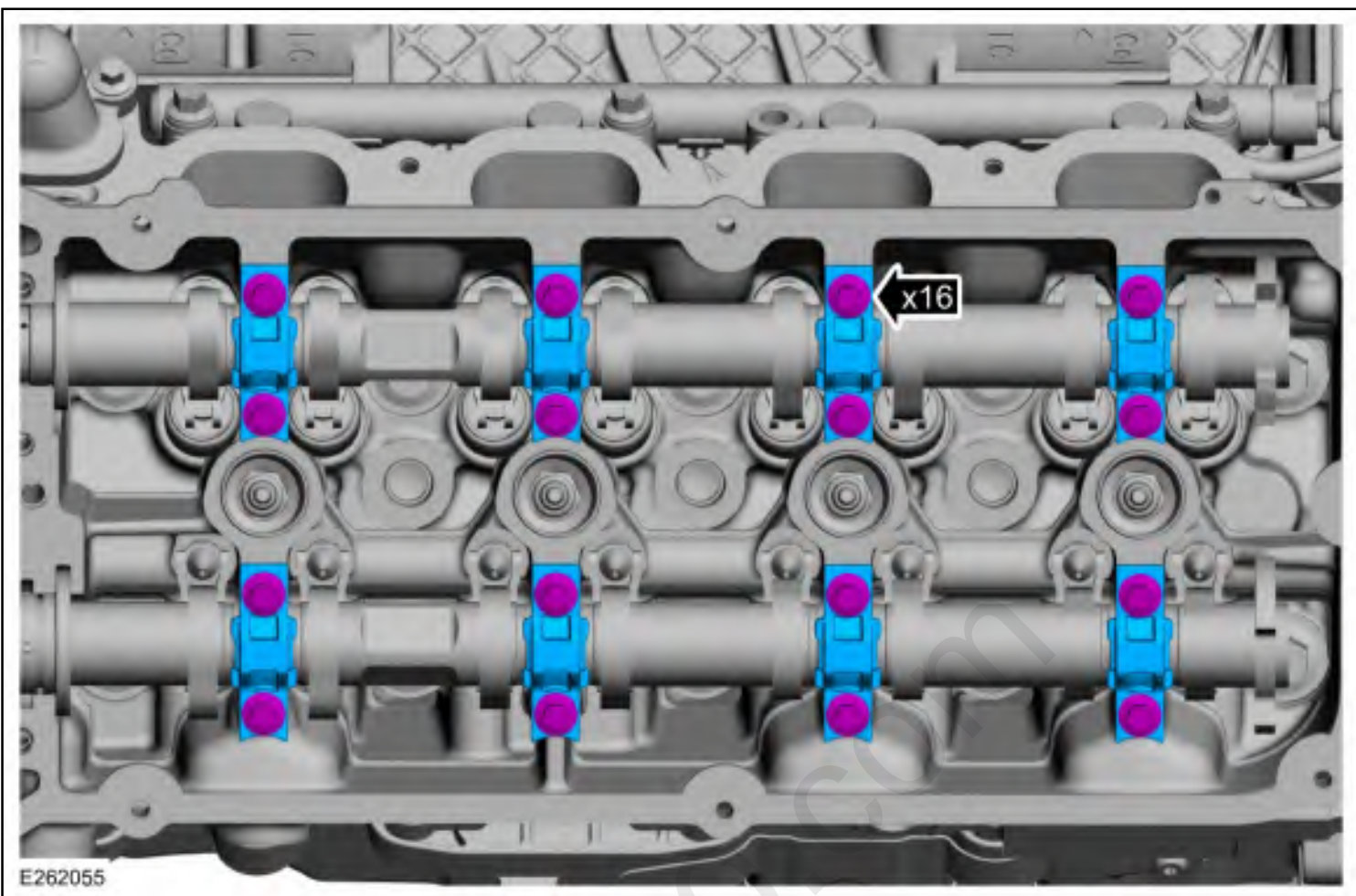


92. **NOTICE:** The front camshaft bearing mega cap must be removed first and then the remaining camshaft bearing caps. Failure to follow this direction may result in damage to the engine.

Remove the bolts and the front camshaft bearing mega cap.

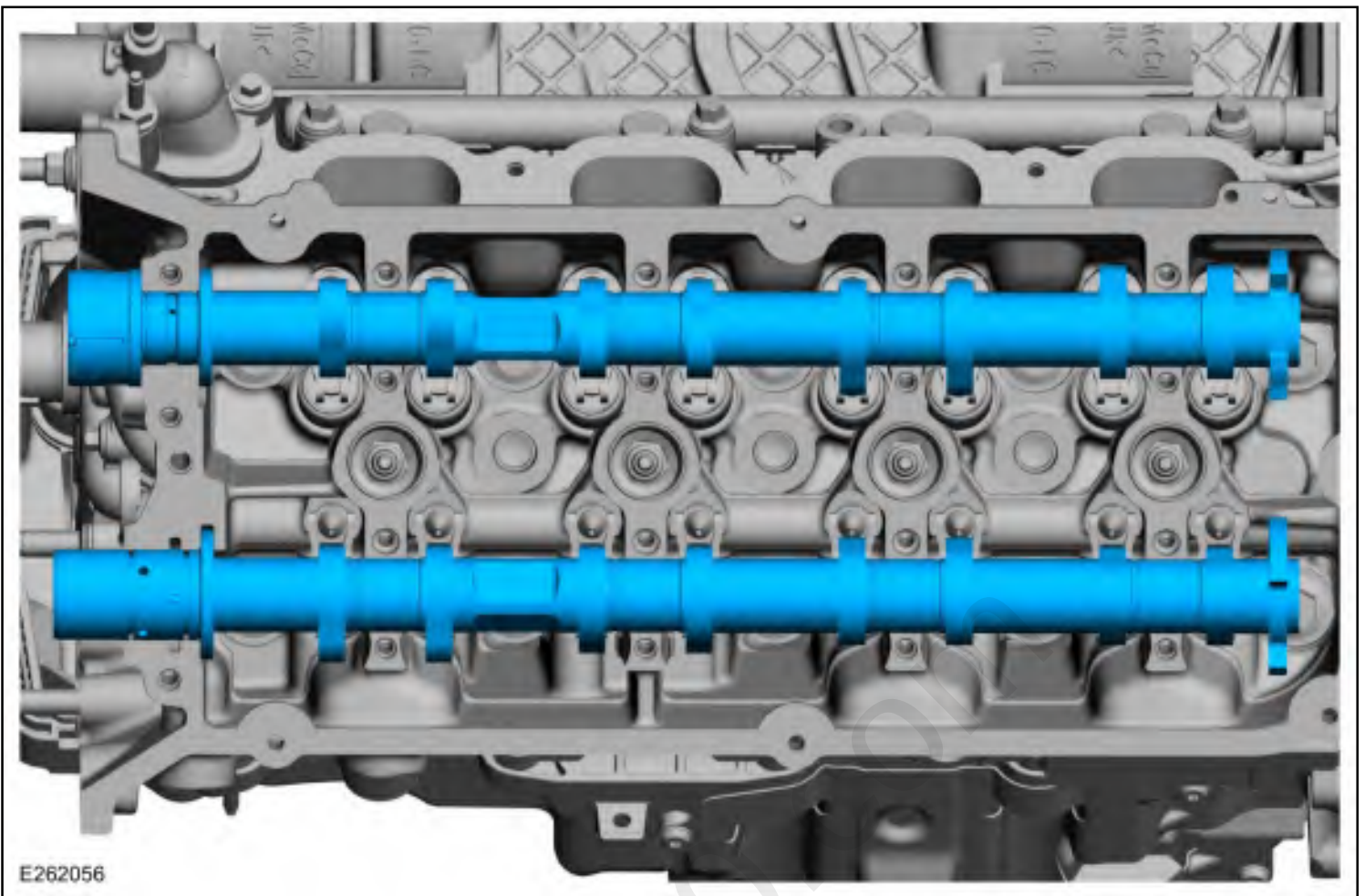


93. Remove the bolts and the camshaft bearing caps.

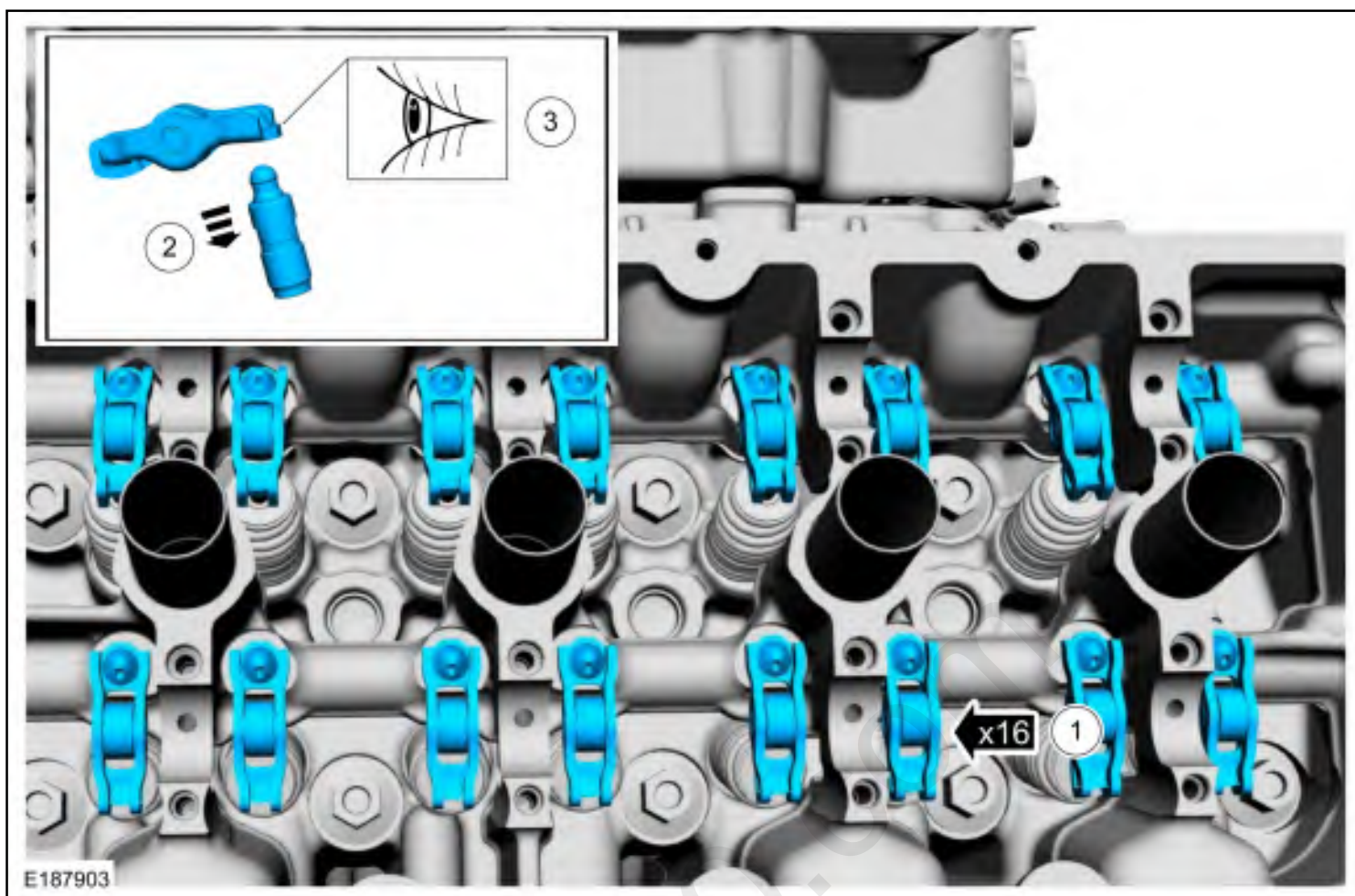


94. Remove the intake and exhaust camshafts.



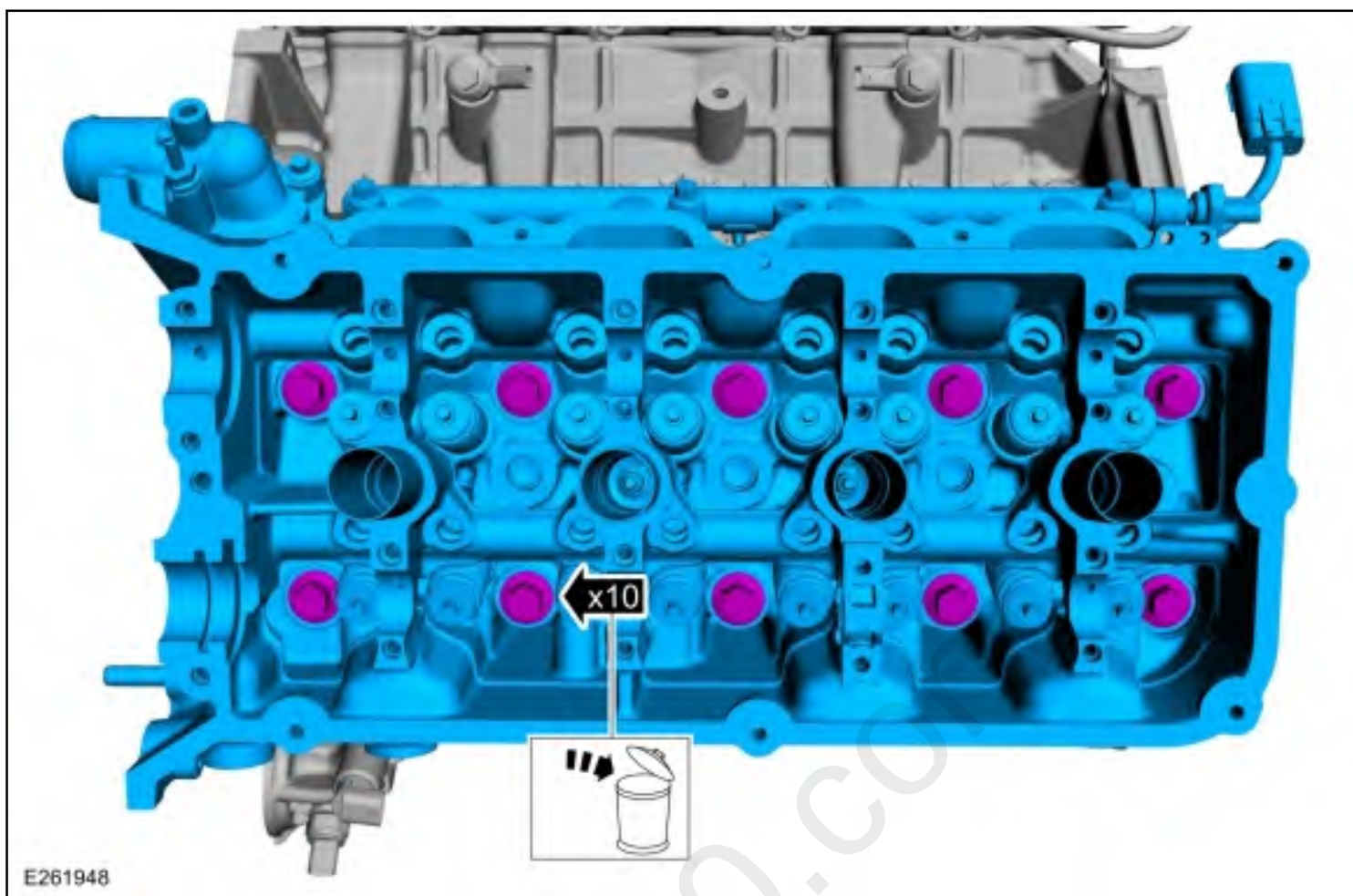


1. Remove the camshaft roller follower and hydraulic lash adjuster assemblies.
2. Separate the hydraulic lash adjusters from the spring clips on the camshaft roller followers.
3. Inspect the hydraulic lash adjuster and roller follower for damage. If any damage is found, inspect the camshaft lobes and valves for damage. Replace damaged components as necessary.

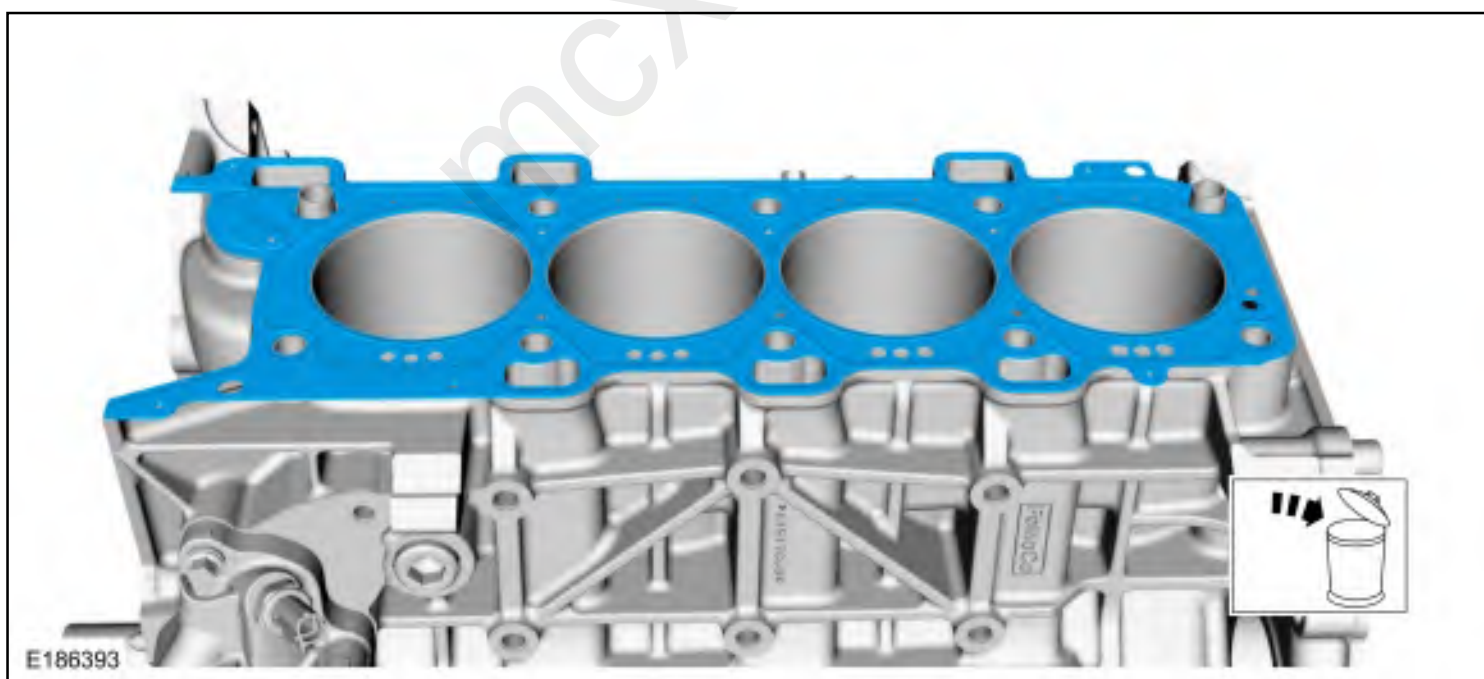


- Remove and discard the bolts.
- Remove the cylinder head.



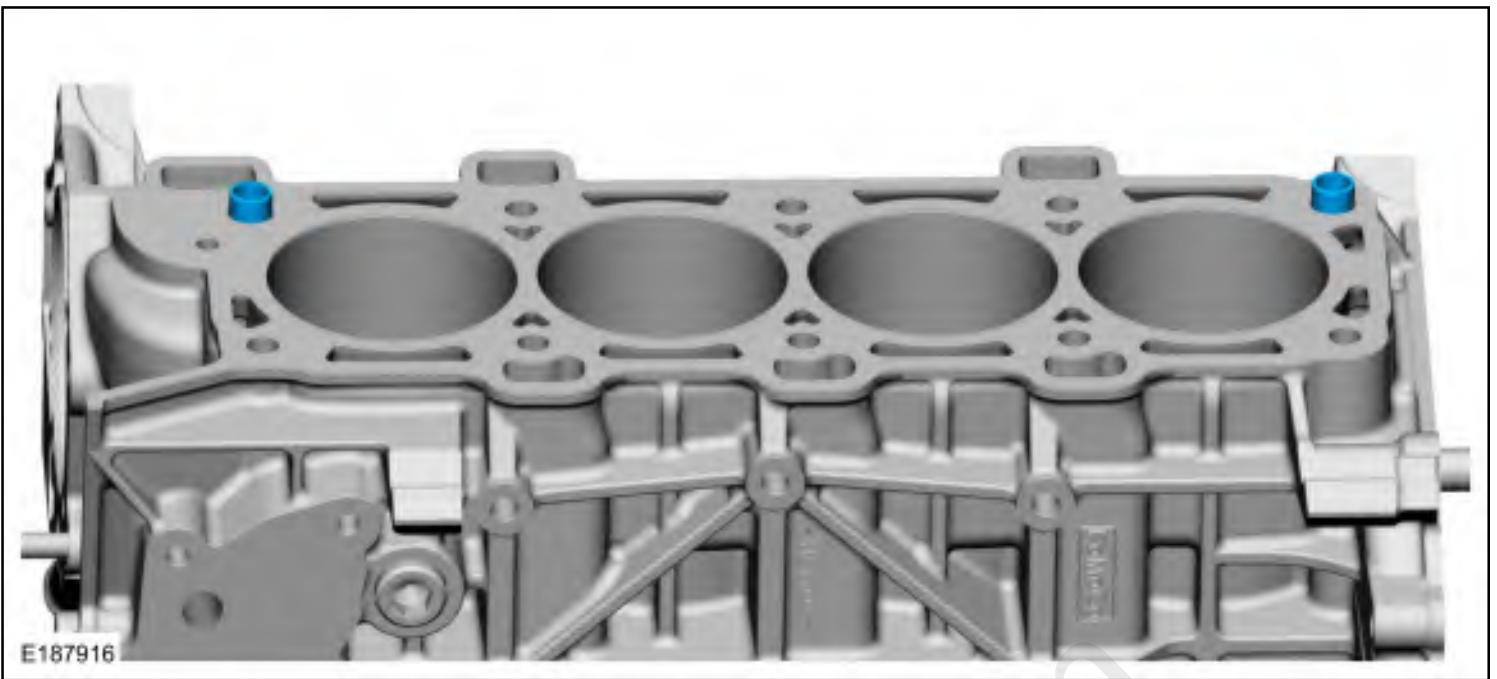


97. Discard the cylinder head gasket.



98. Remove the dowels.

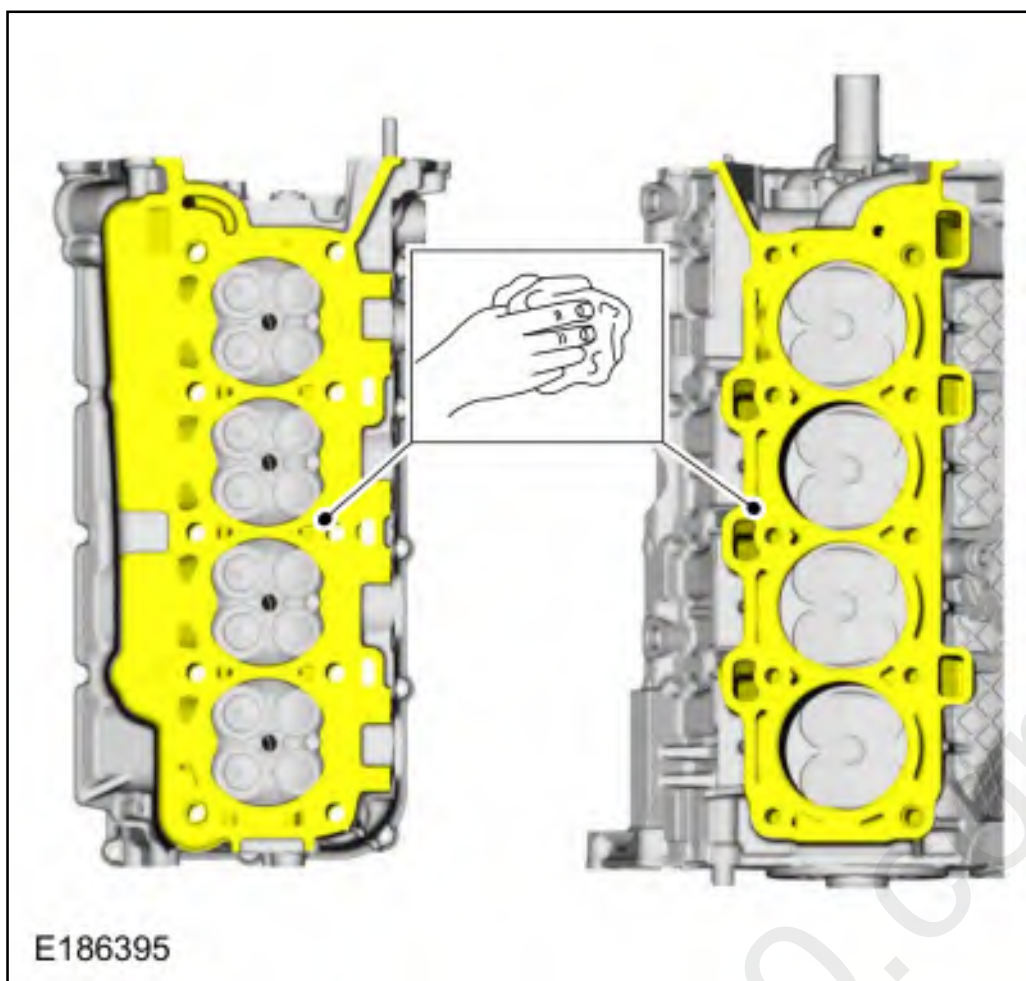




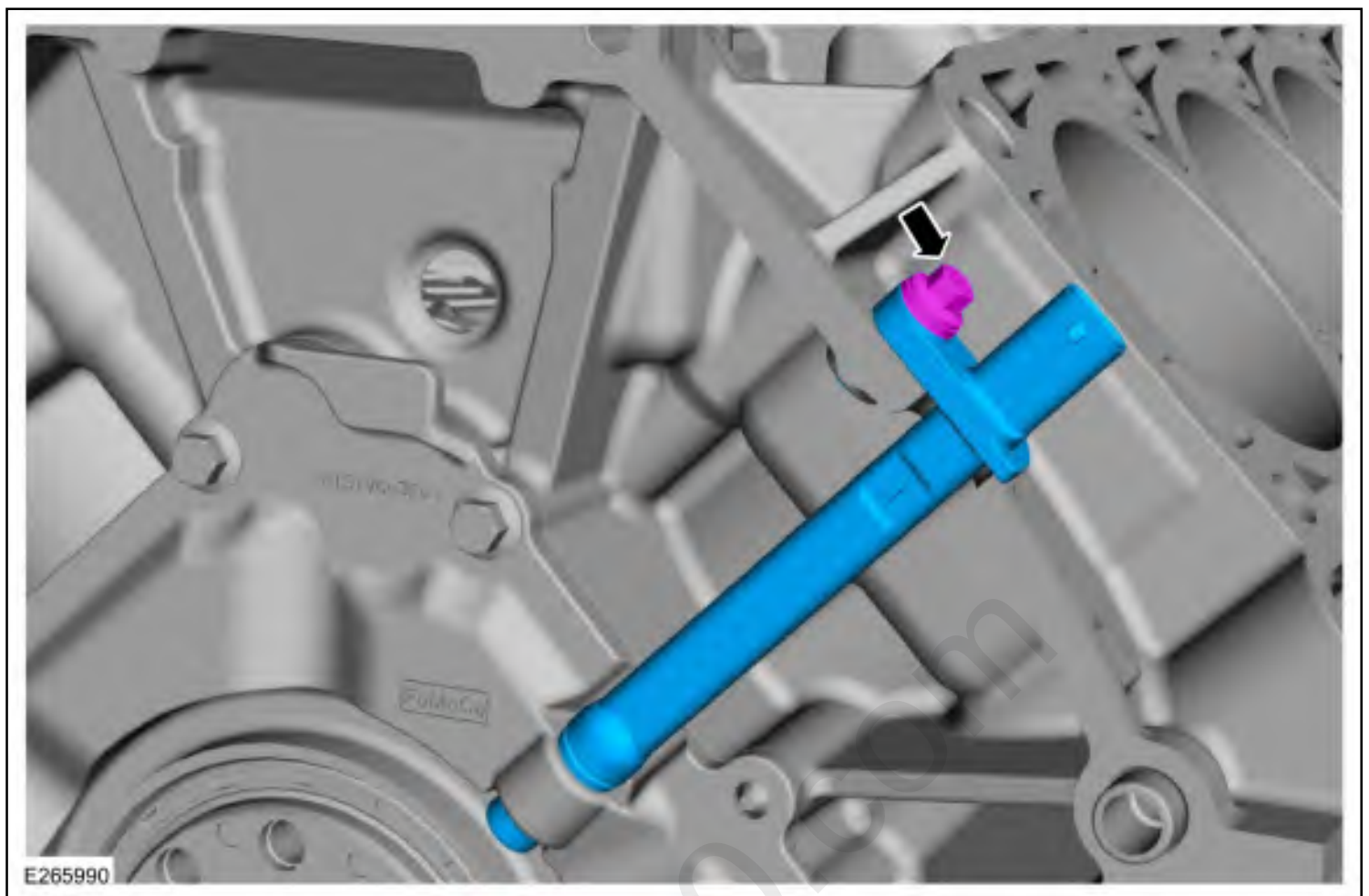
99. **NOTICE:** Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the sealing surfaces. These tools cause scratches and gouges which make leak paths.

**NOTE:** Clean the cylinder head bolt holes in the cylinder block using compressed air. Make sure all coolant, oil or other foreign material is removed.

- Clean and inspect the cylinder head-to-cylinder block mating surfaces of both the cylinder head and the cylinder block
- Refer to: [Cylinder Head Distortion](#) (303-00 Engine System - General Information, General Procedures).
- Refer to: [Cylinder Block Distortion](#) (303-00 Engine System - General Information, General Procedures).



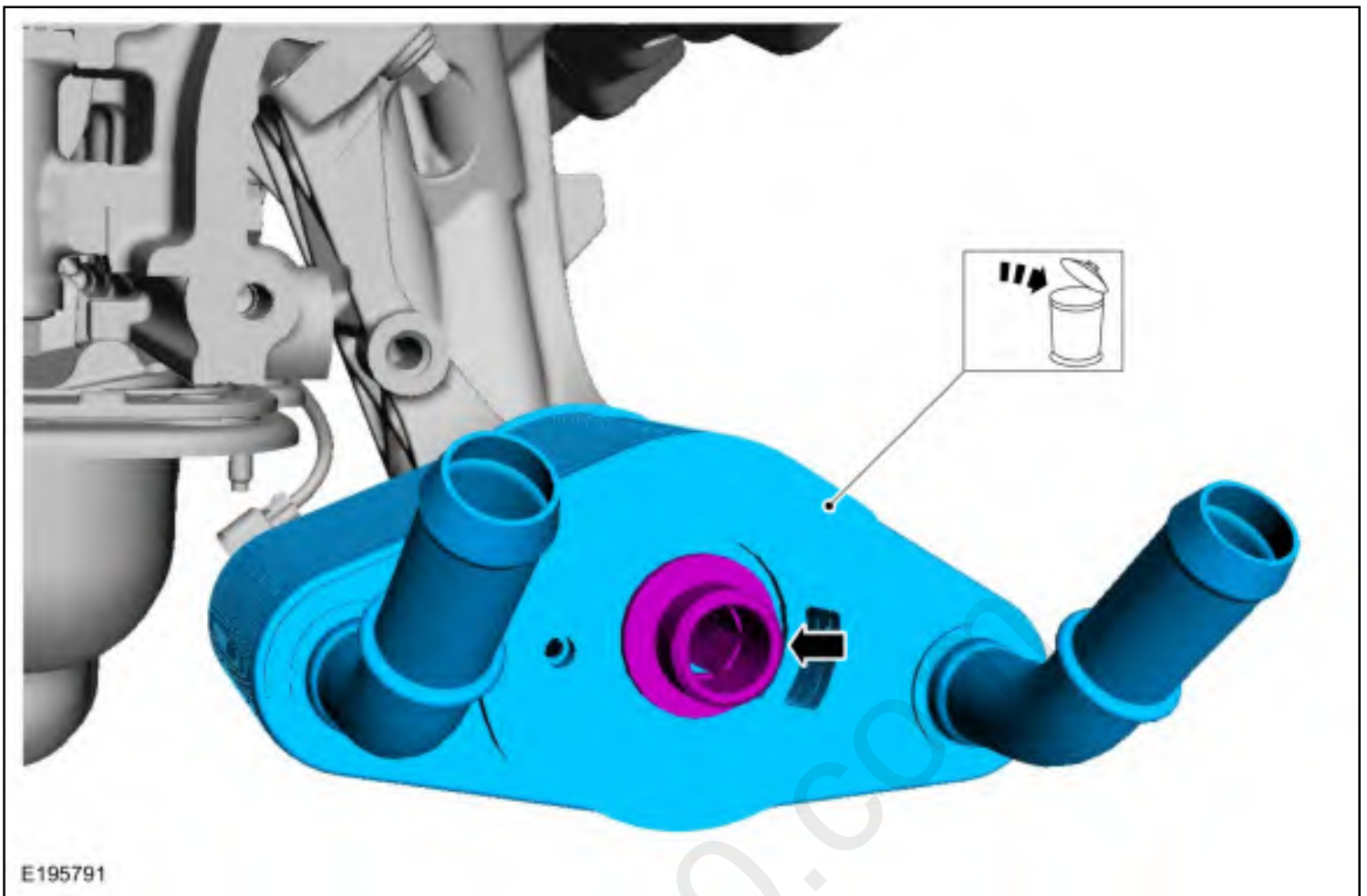
100. Remove the bolt and the CKP sensor.



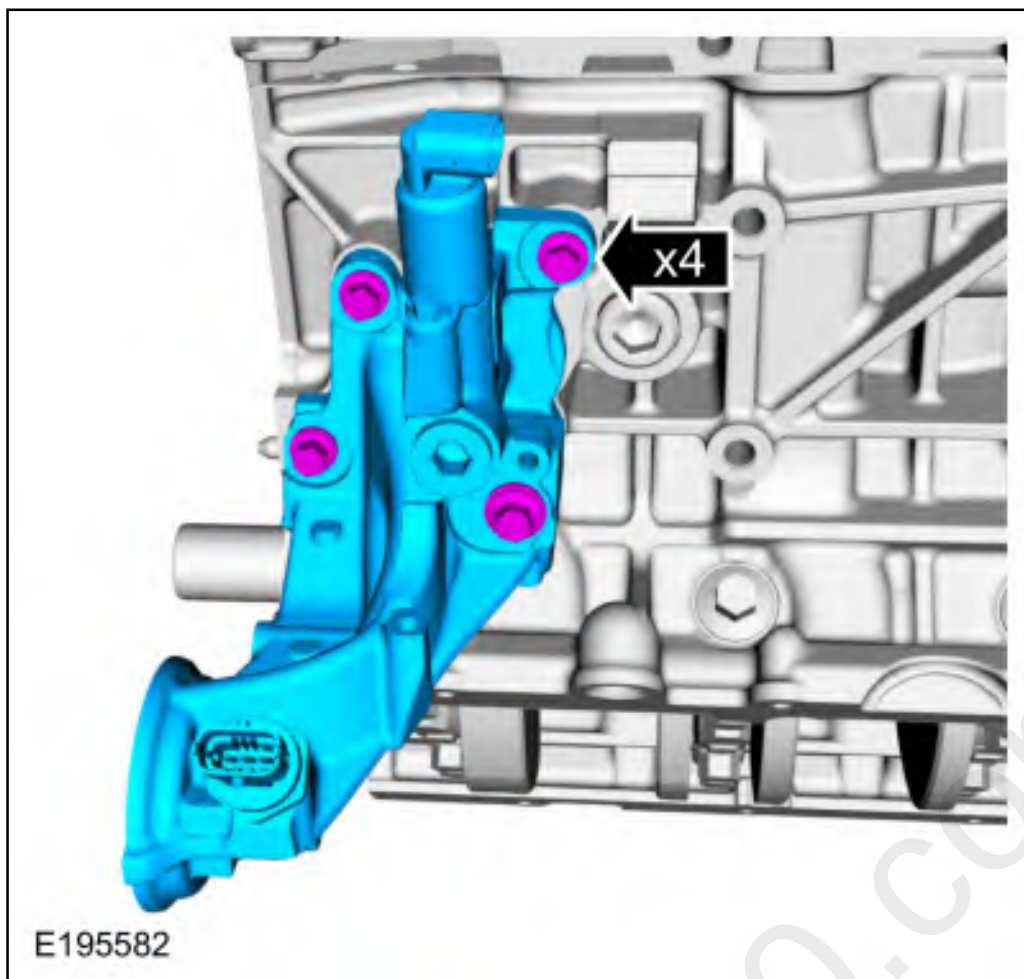
101. **NOTICE: A new oil cooler must be installed or severe damage to the engine can occur.**

Remove the threaded fitting and the oil cooler.

- Discard the oil cooler.



102. Remove the bolts and the oil filter adapter.

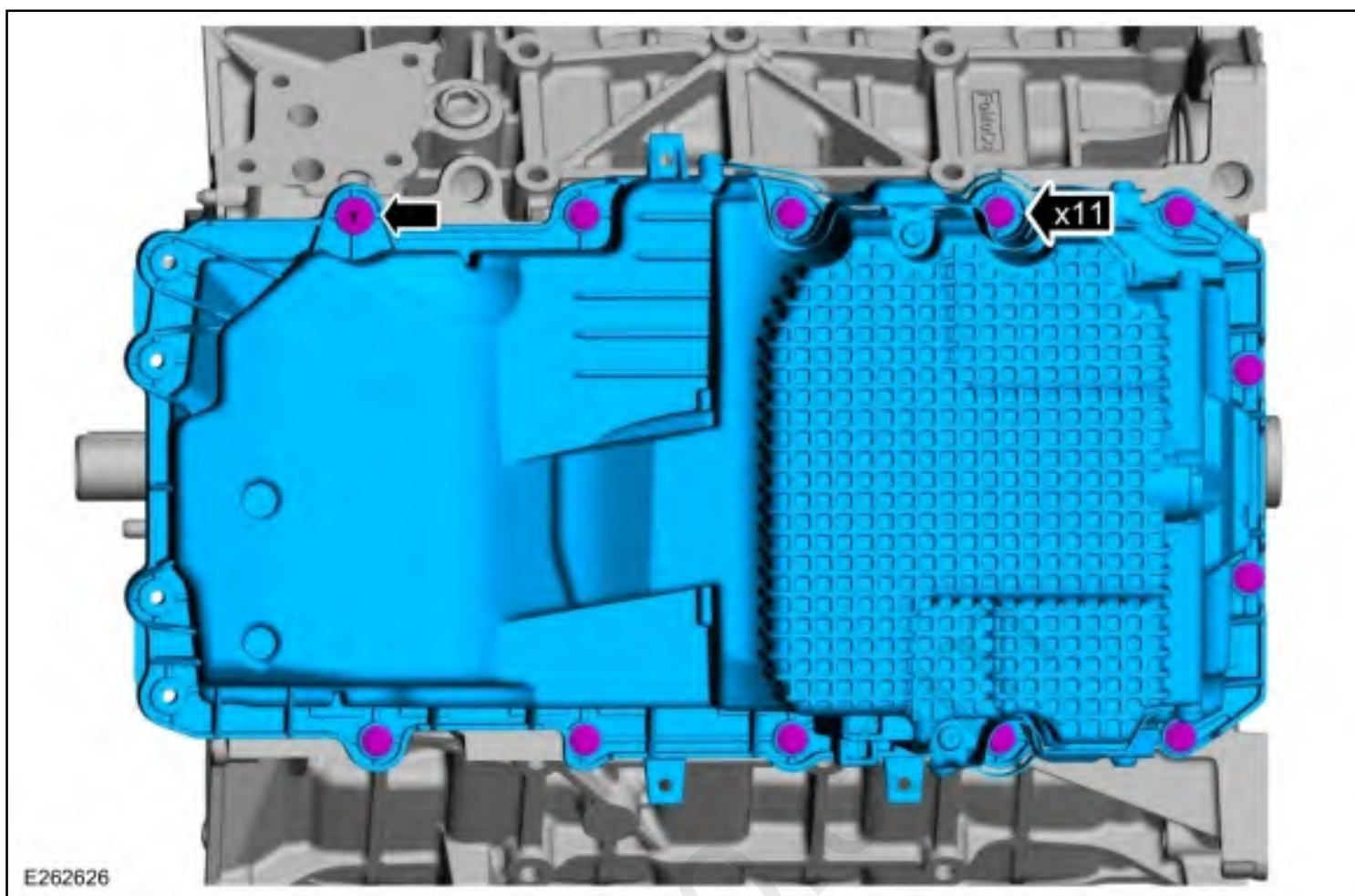


103. Discard the oil filter adapter gasket.

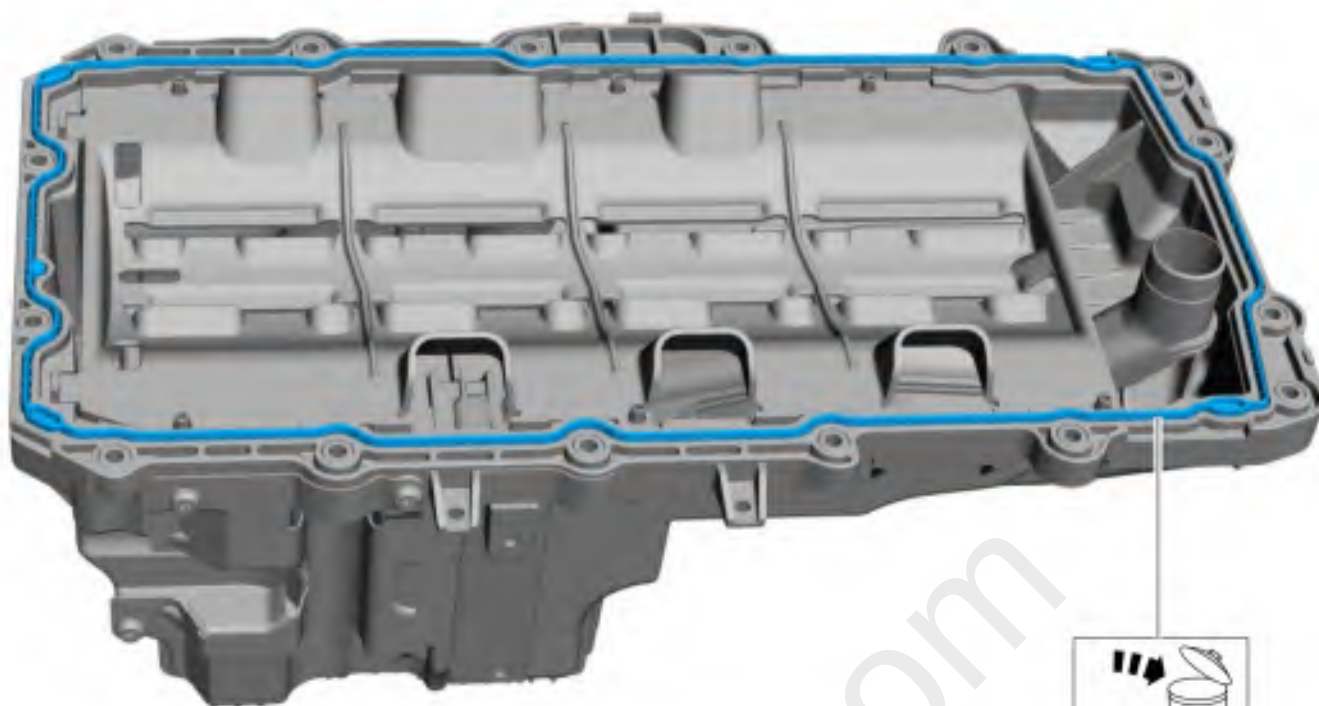


104. Remove the bolts, the stud bolt and the oil pan.





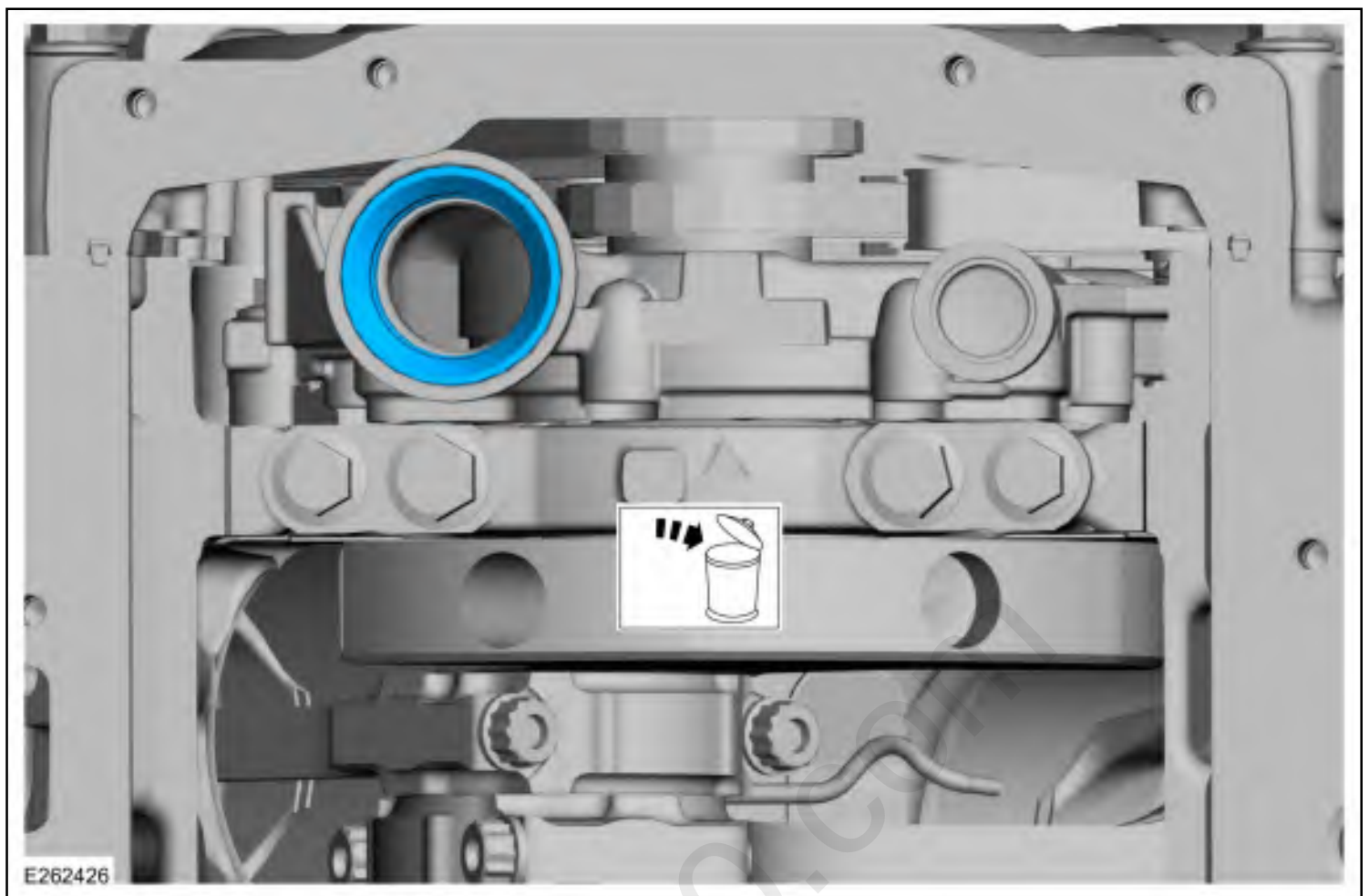
105. Remove and discard the oil pan gasket.



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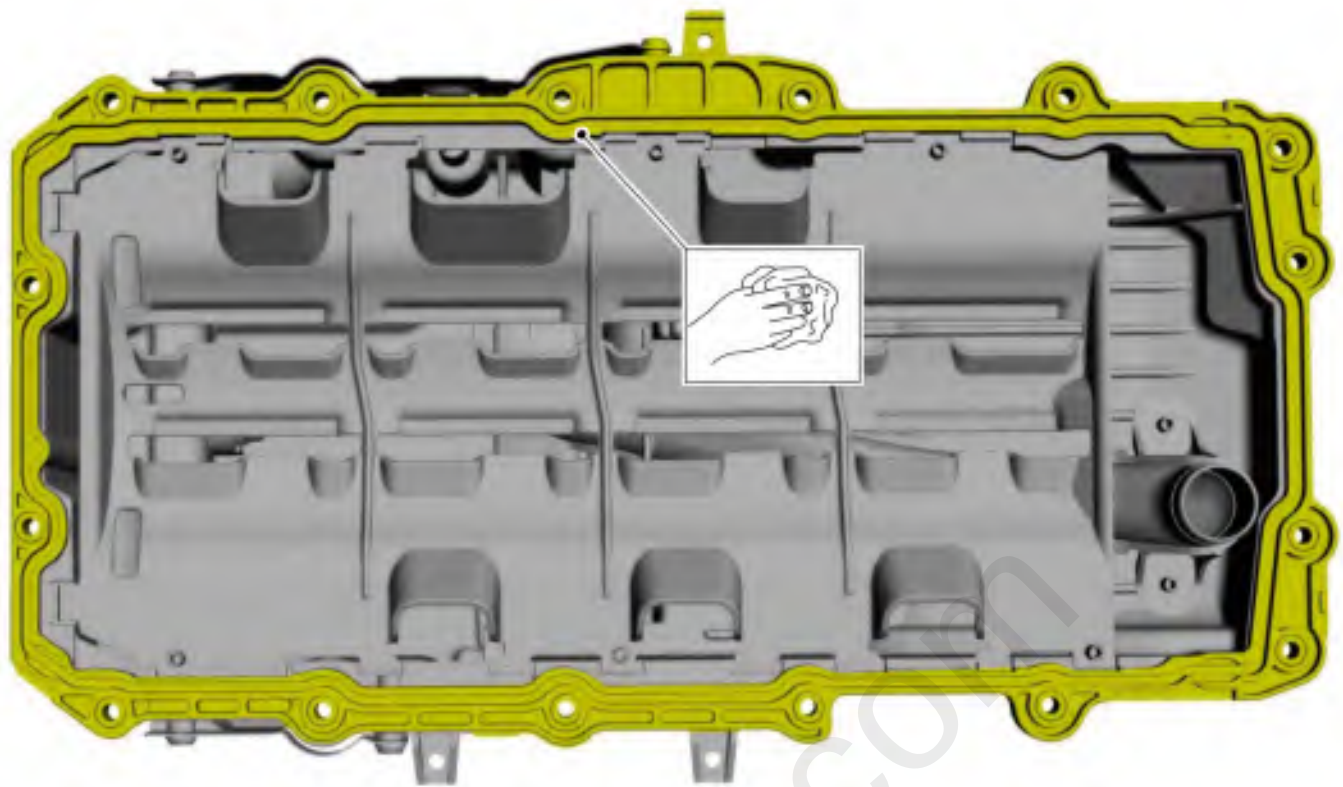
106. Remove and discard the oil pump pickup seal.





107. **NOTICE:** Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the sealing surfaces. These tools cause scratches and gouges, which make leak paths.

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



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

Clean the mating surface of the cylinder block.

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

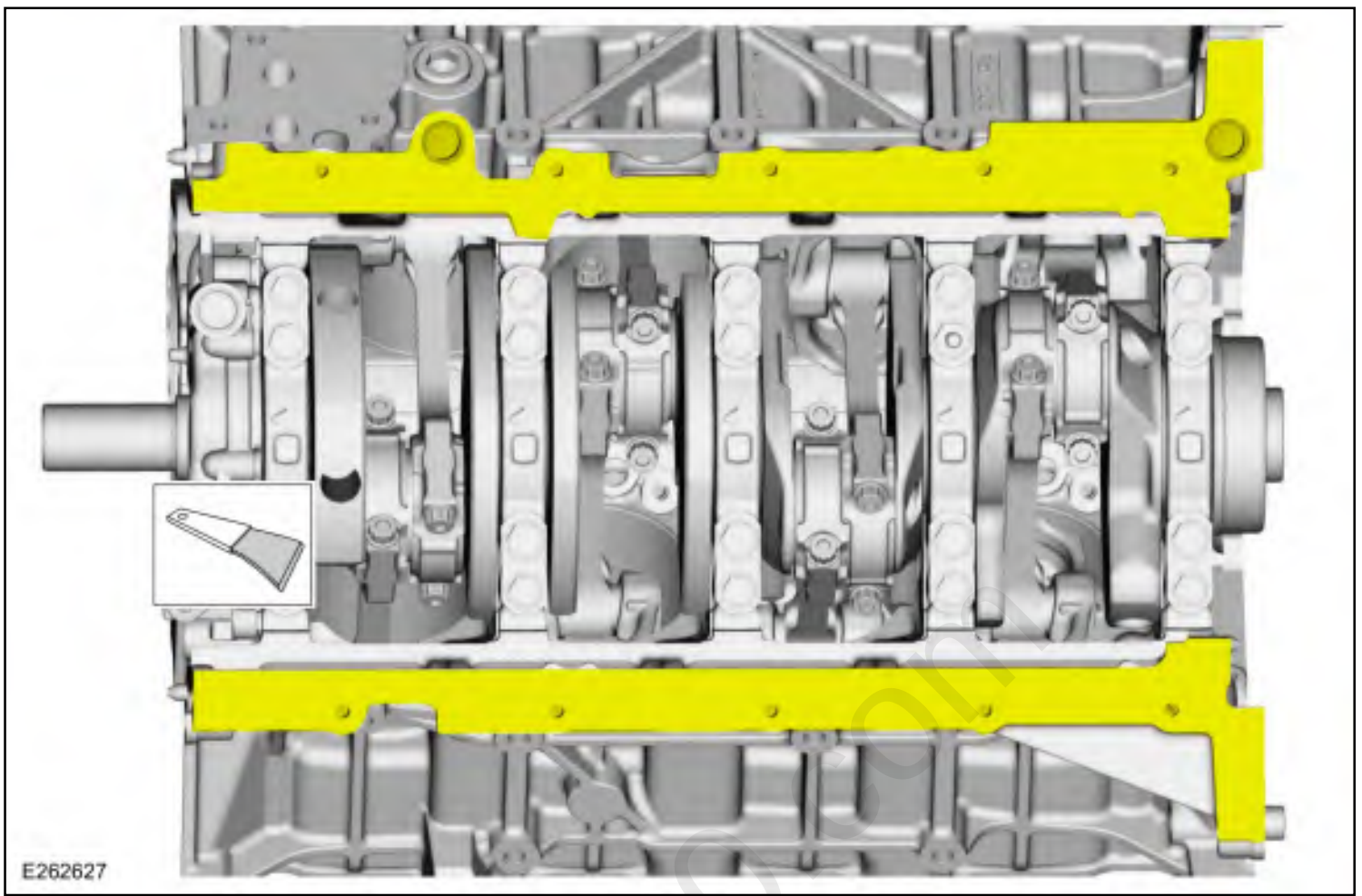
Use the General Equipment: Plastic Scraper

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

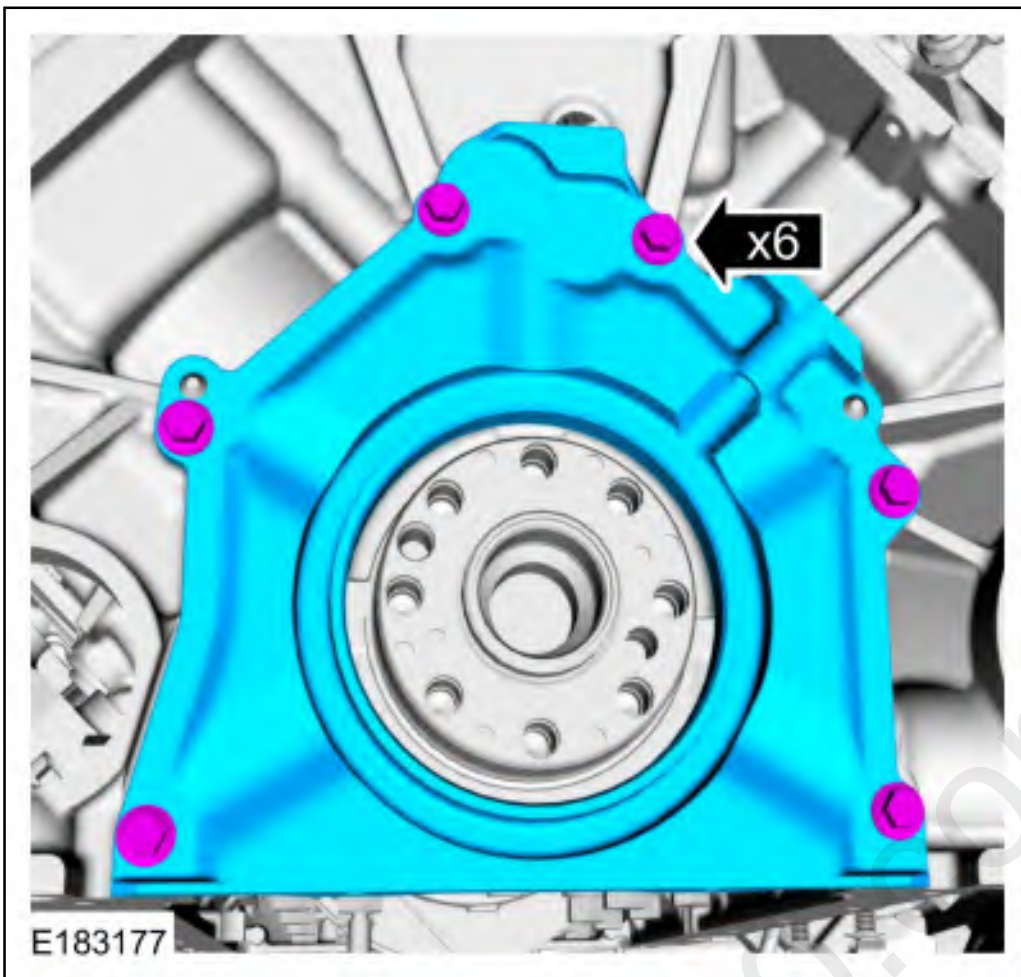
*Material:* Motorcraft® Metal Surface Prep Wipes / ZC-31-B

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





109. Remove the bolts and the crankshaft rear seal retainer plate.



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

Clean and inspect the mating surface.

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

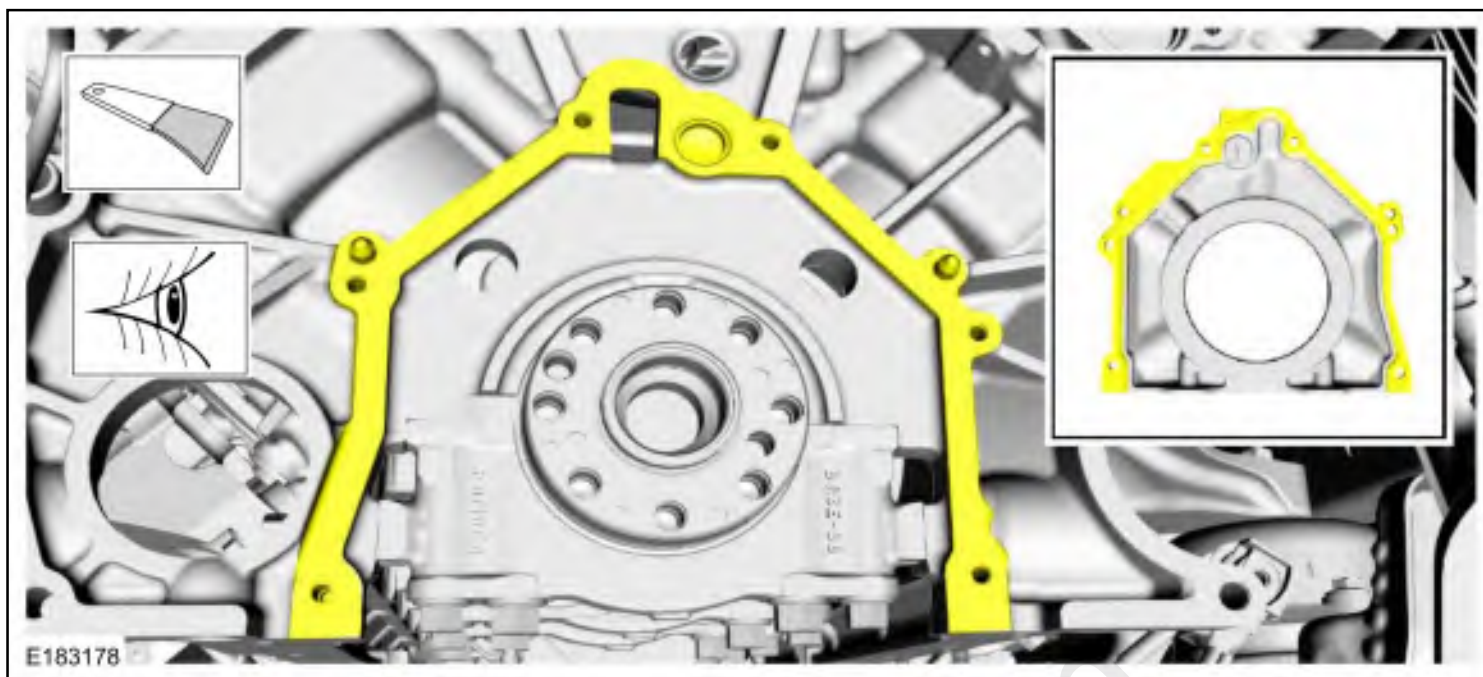
Use the General Equipment: Plastic Scraper

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

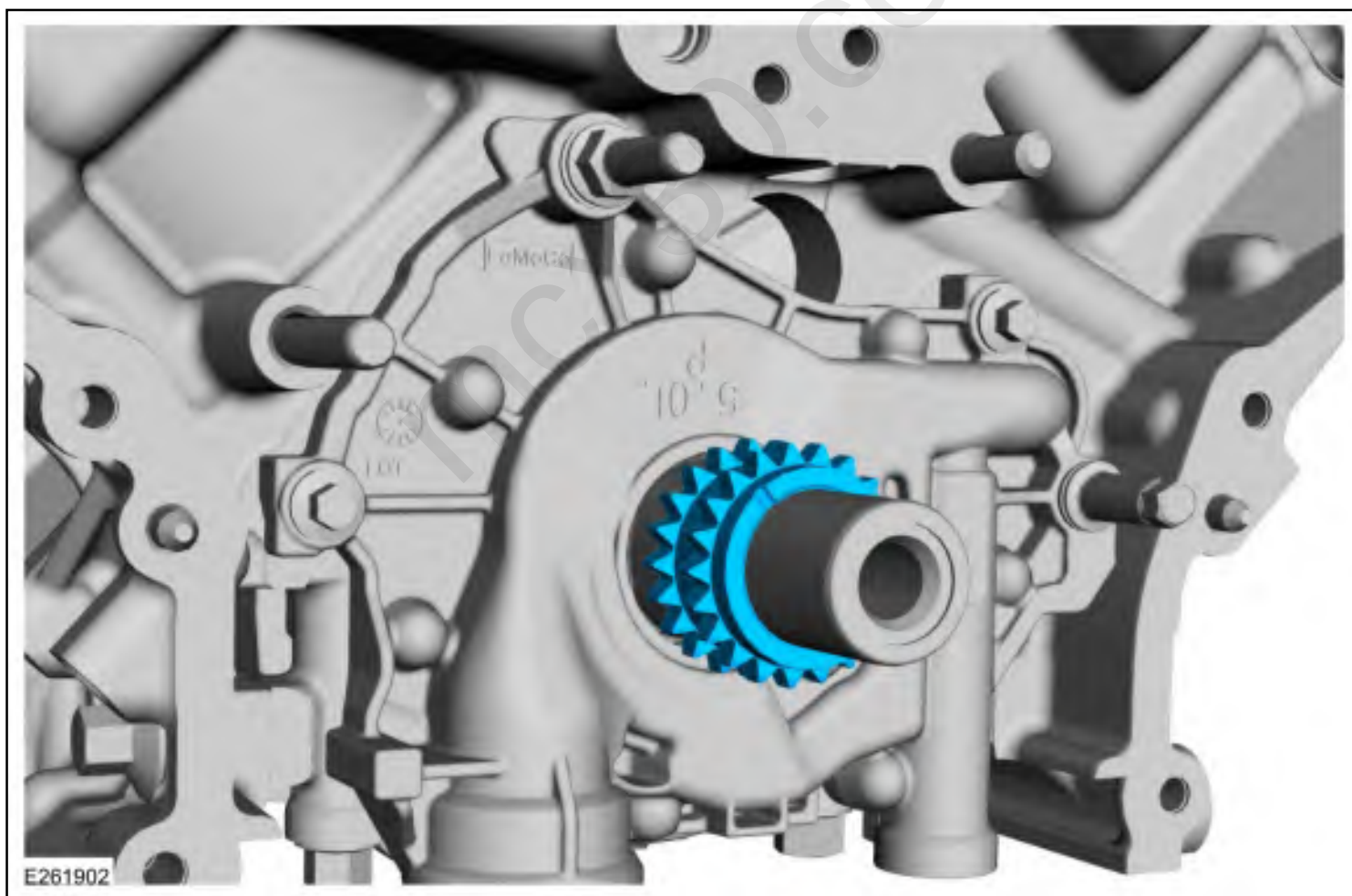
*Material:* Motorcraft® Metal Brake Parts Cleaner / PM-4-A, PM-4-B

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

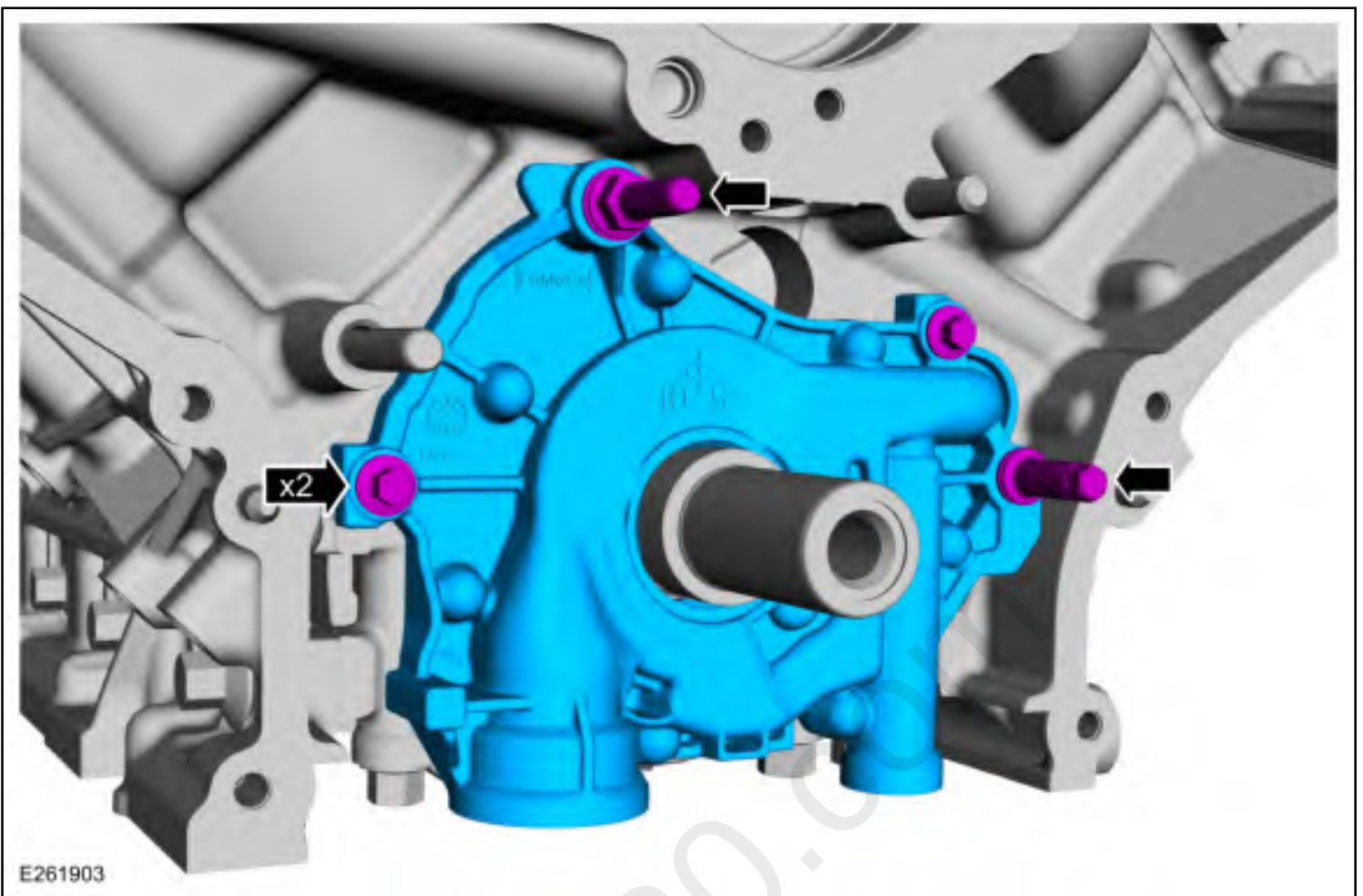




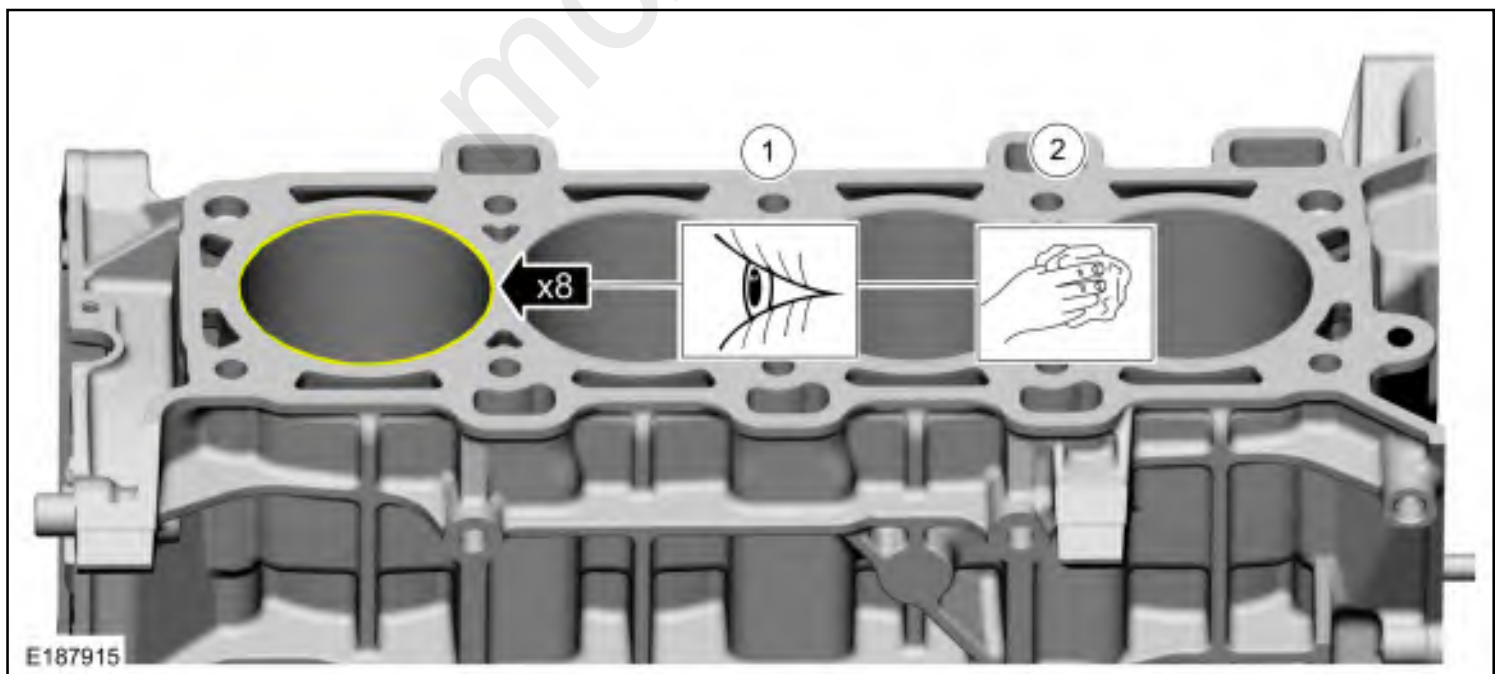
111. Remove the crankshaft sprocket.



112. Remove the bolts, stud bolts and the oil pump.

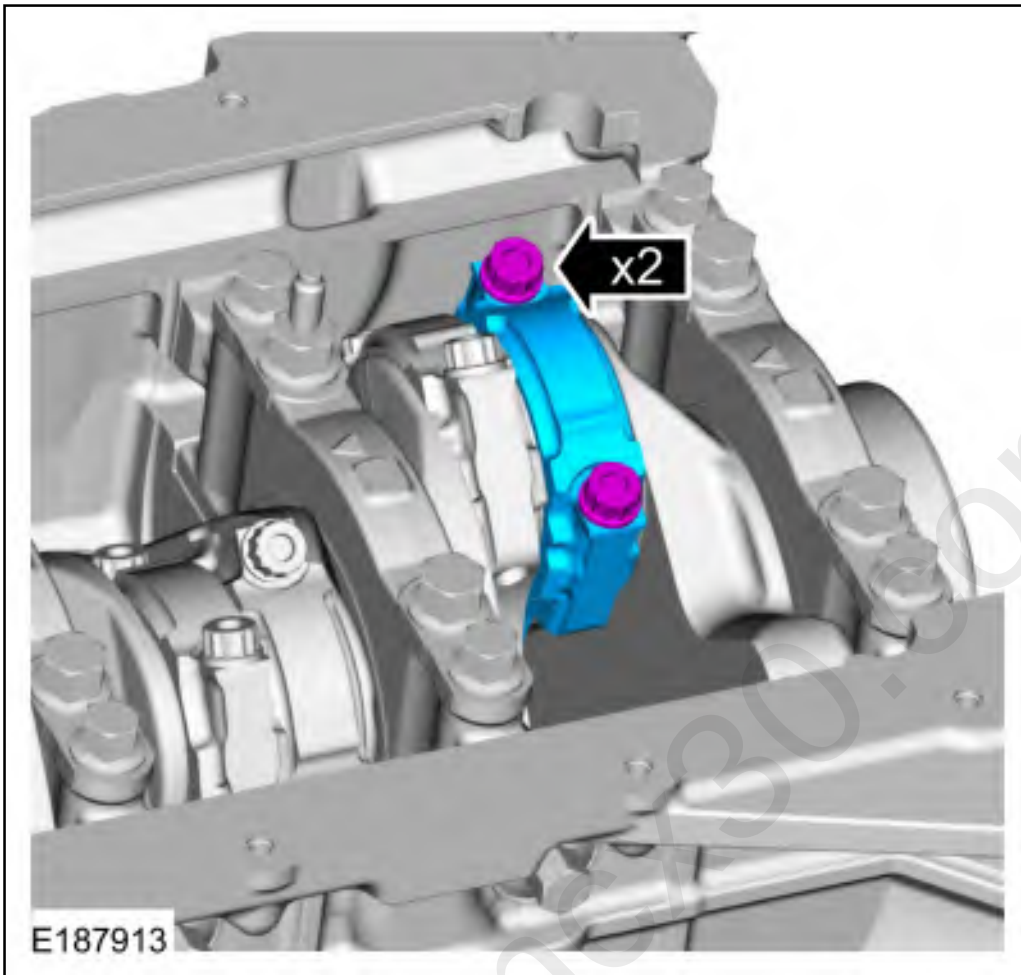


- Before removing the pistons, inspect the top of the cylinder bores.
- If necessary, remove the ridge or carbon deposits from each cylinder using an abrasive pad.



114. **NOTICE:** Verify that the connecting rod and rod cap have orientation numbers cast into them. If not, number the connecting rod and rod cap for correct orientation. Failure to do so can result in engine damage.

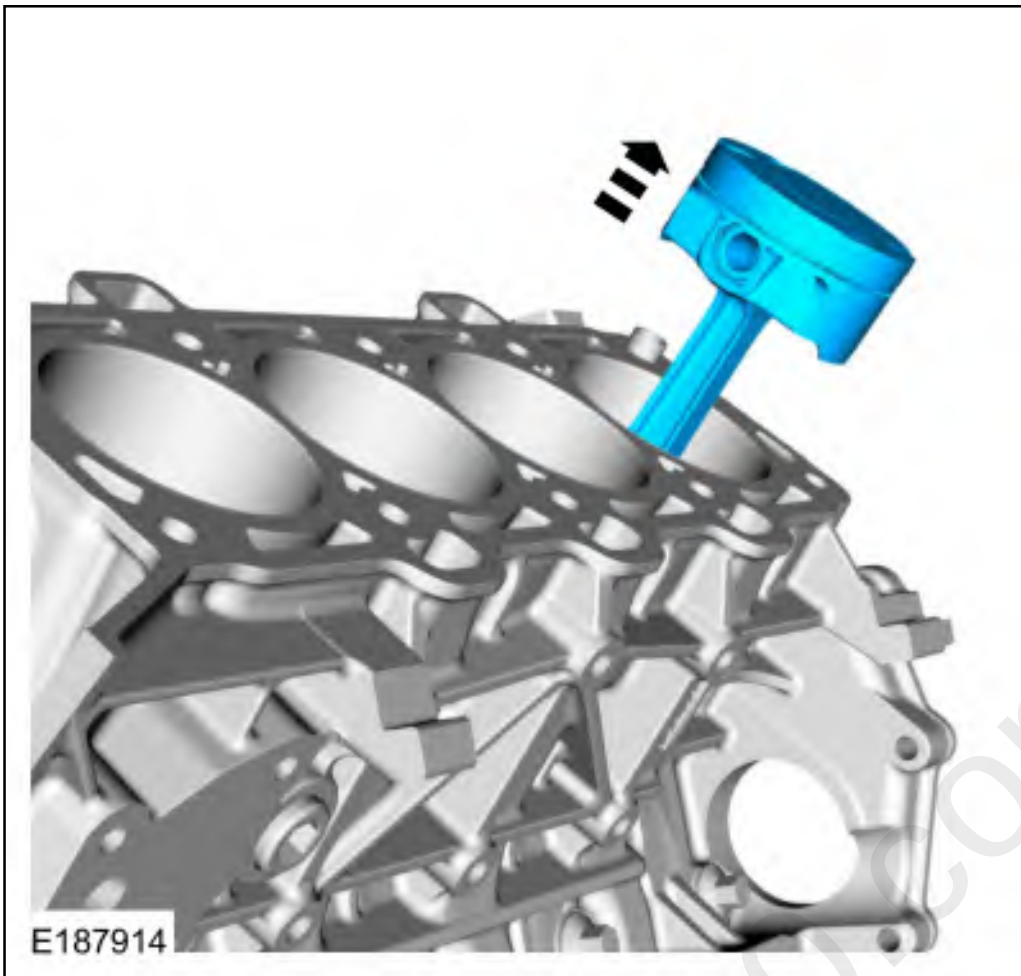
Remove the bolts and the connecting rod cap.



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

Remove the piston through the top of the cylinder block



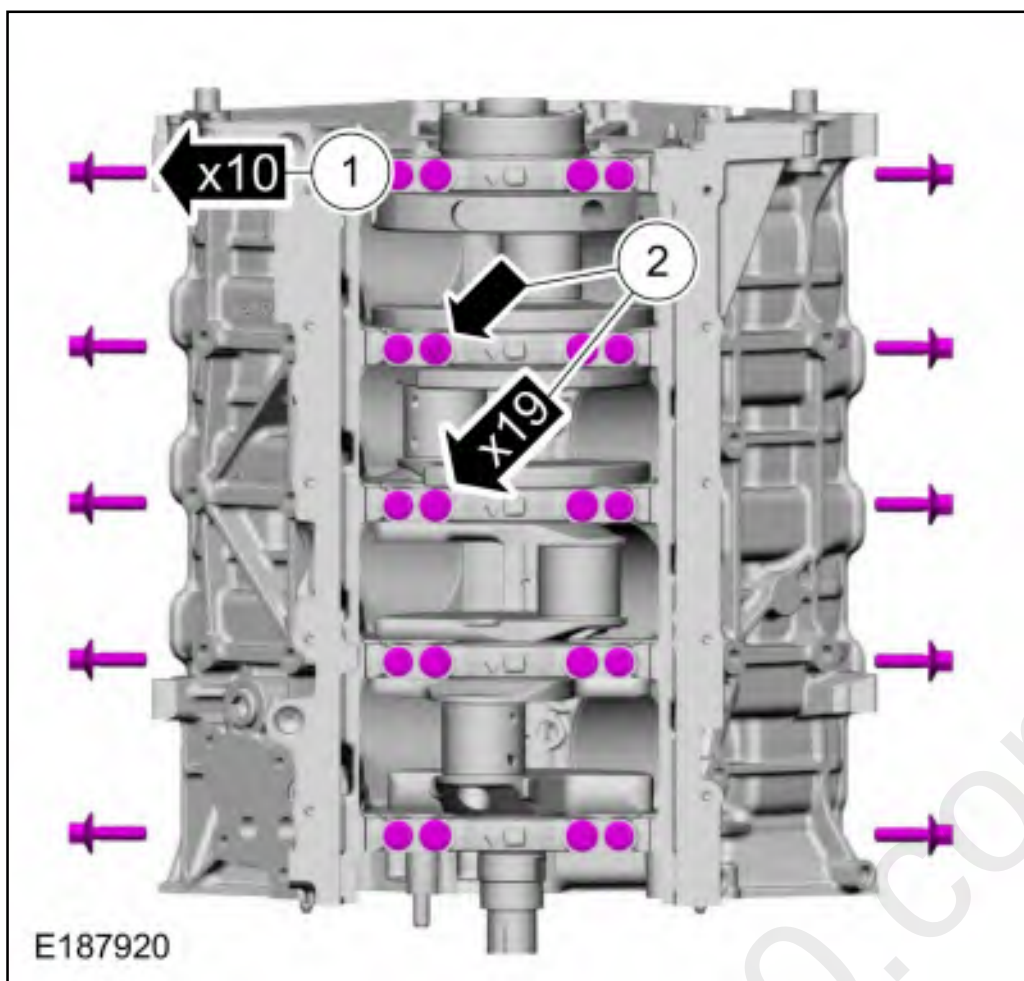


116. Repeat the previous 2 steps for each of the remaining pistons.

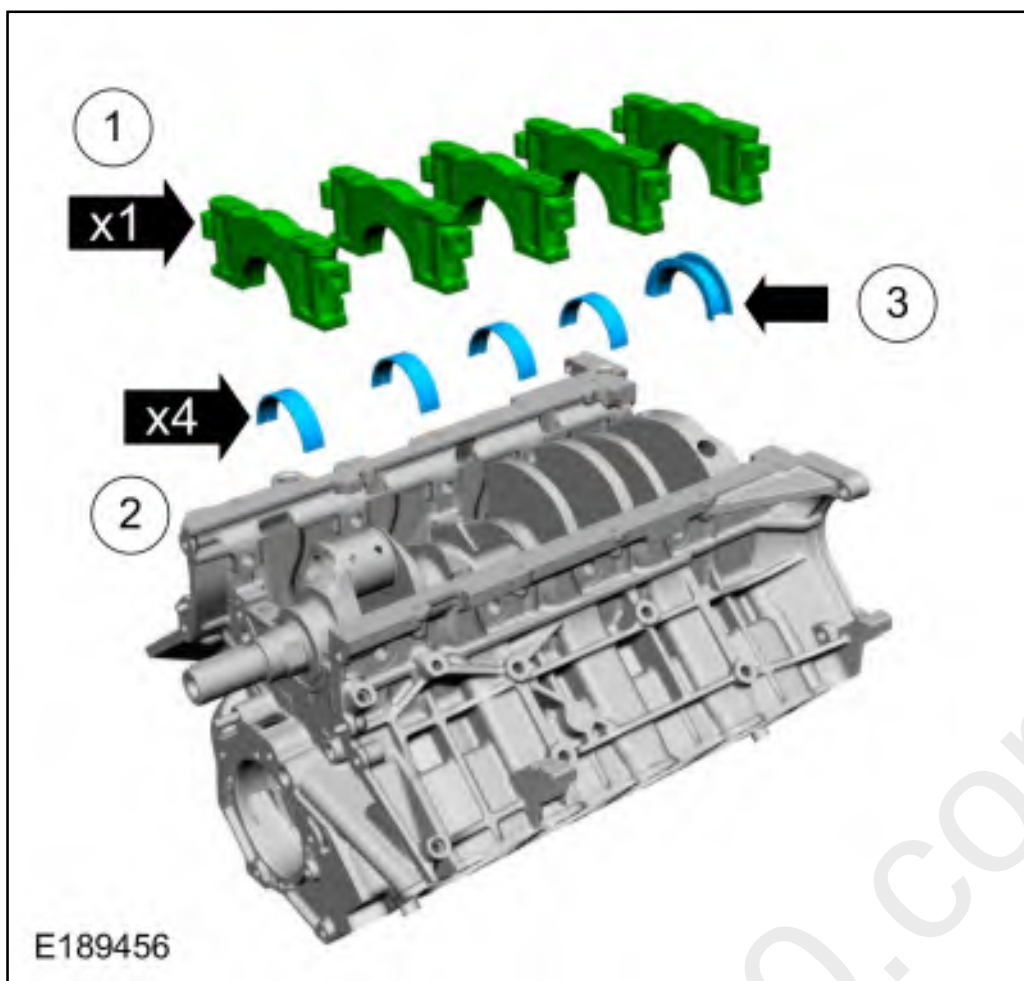
117. Disassemble the 8 pistons.

Refer to: [Piston Inspection](#) (303-00 Engine System - General Information, General Procedures).

1. Remove and discard the cross-mounted main cap bolts.
2. Remove and discard the main bearing cap bolts and stud bolt.

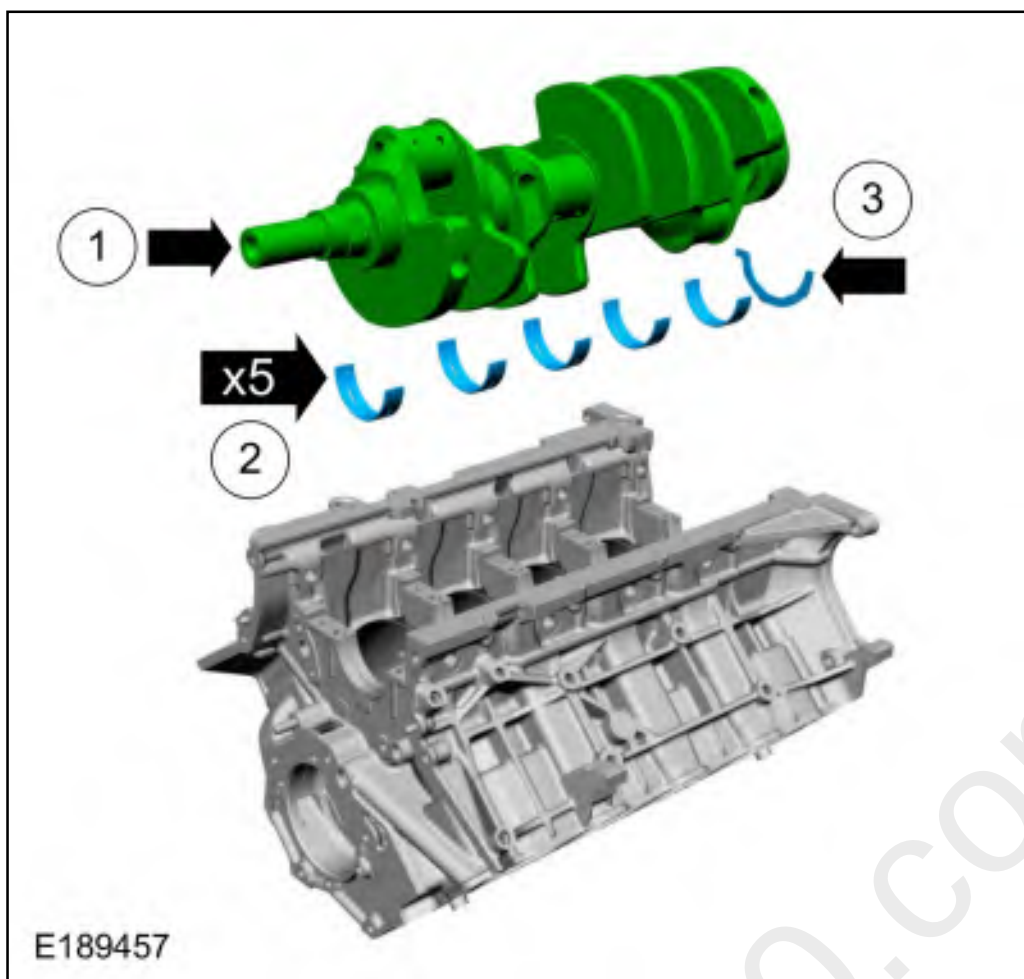


119. Remove the main bearing caps (1), the lower crankshaft main bearings (2) and the lower thrust bearing (3).

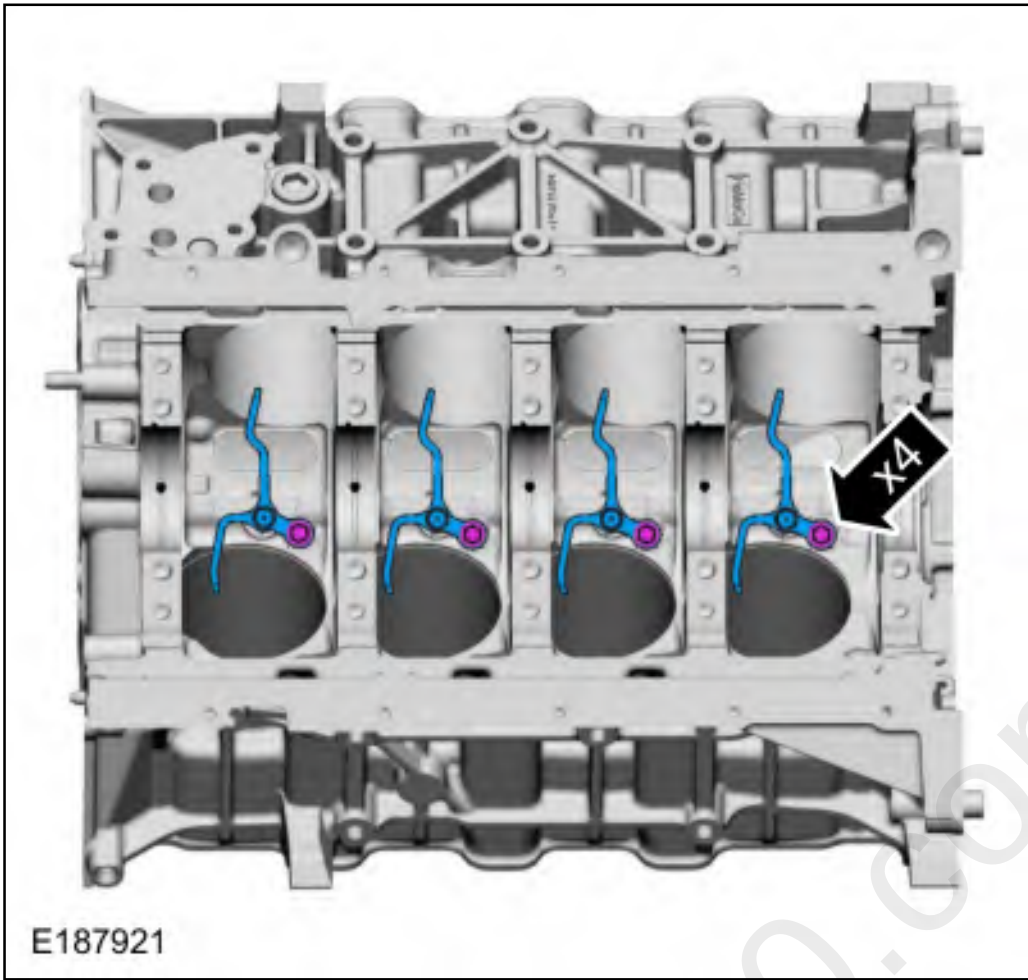


120. Remove the crankshaft (1), the upper crankshaft main bearings (2) and the upper thrust washer (3) from the cylinder block.





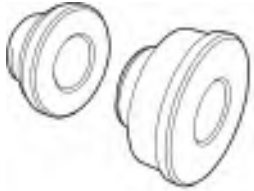
121. Remove the bolts and the piston cooling jets from the cylinder block.



## Engine

Base Part Number: Base Part Number: 6L084

### Special Tool(s) / General Equipment

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

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

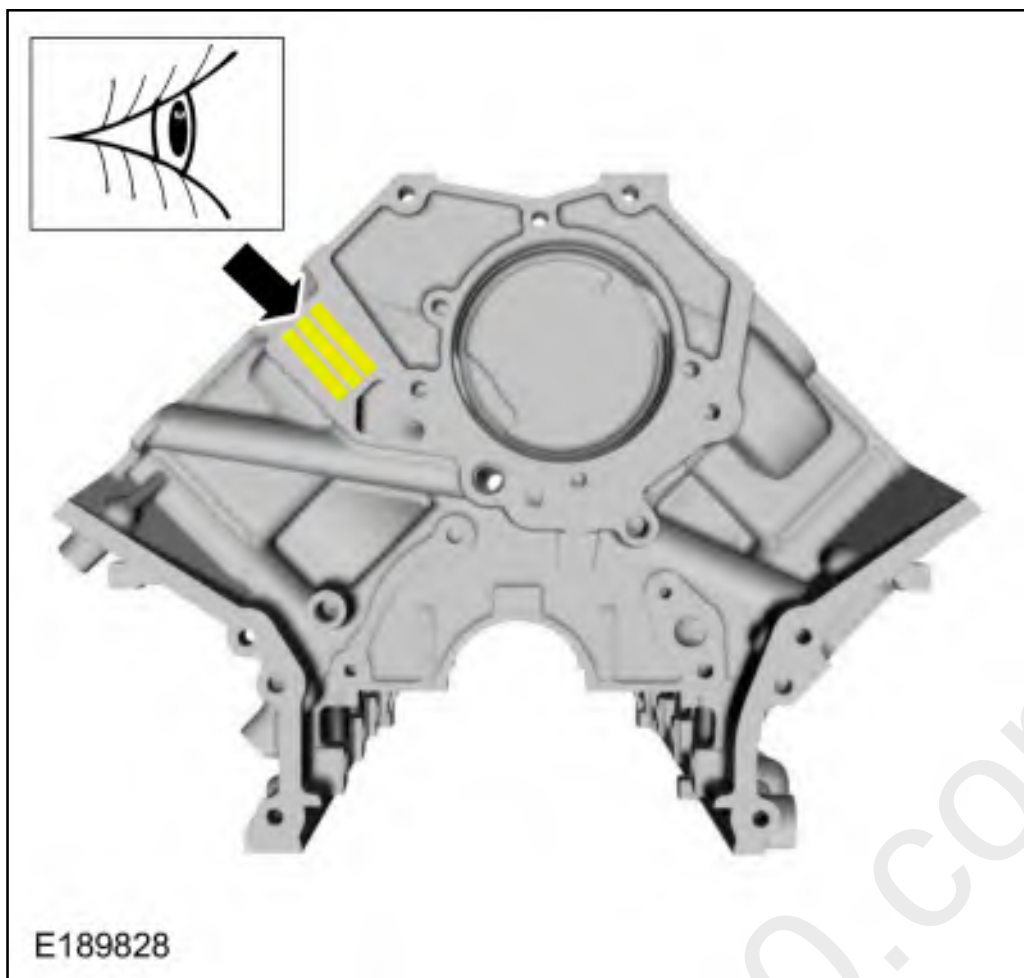
### Materials

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

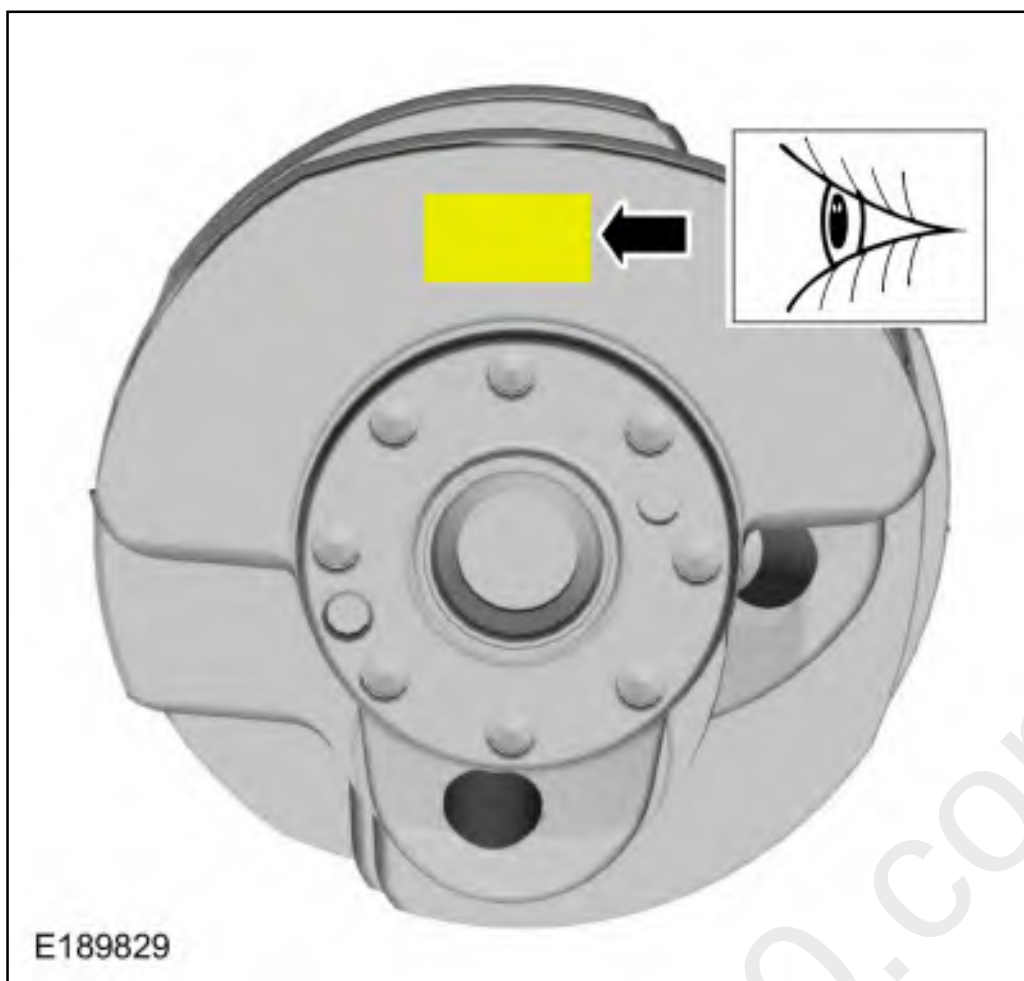
**NOTICE:** During engine repair procedures, cleanliness is extremely important. Any foreign material, including any material created while cleaning gasket surfaces, that enters the oil passages, coolant passages or the oil pan, can cause engine failure.

**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.



2

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

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

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

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.

2

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

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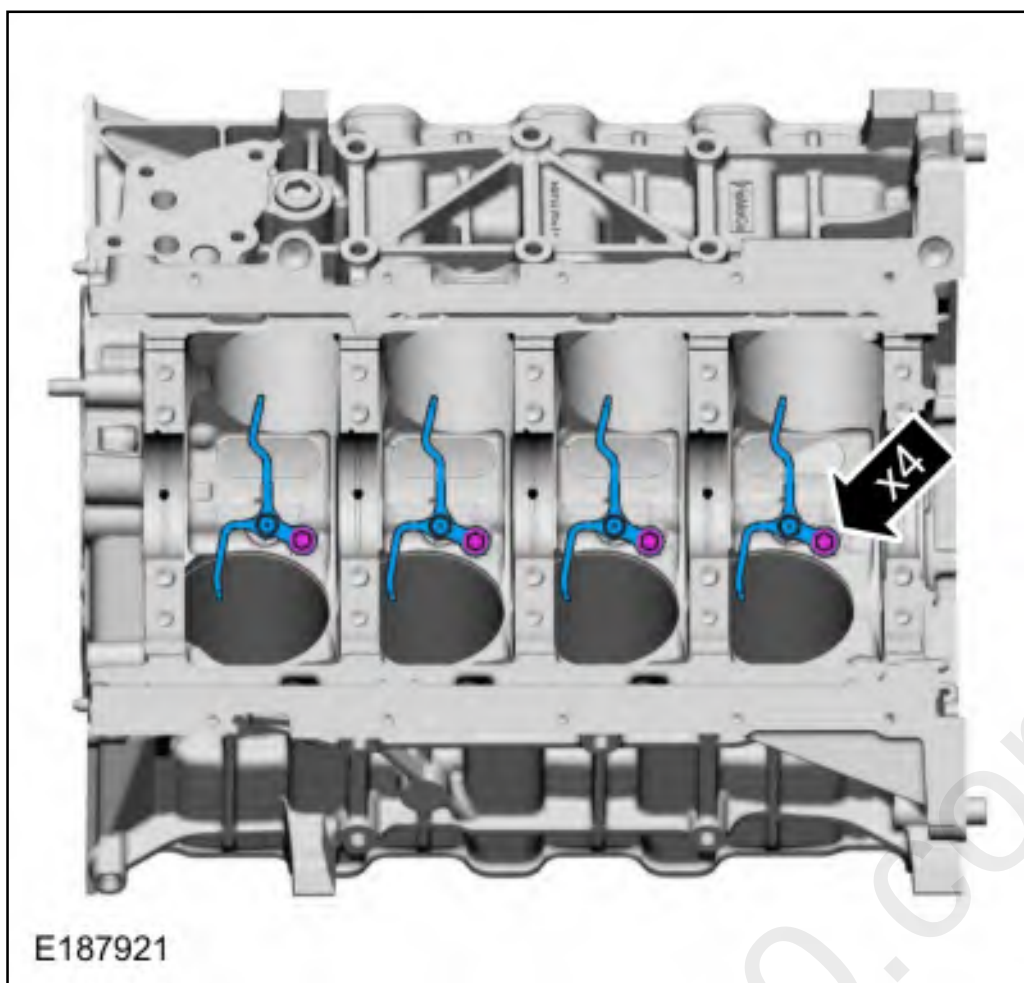
1

5. Install the piston cooling jets and bolts.

*Torque:*

Stage 1: 89 lb.in (10 Nm)

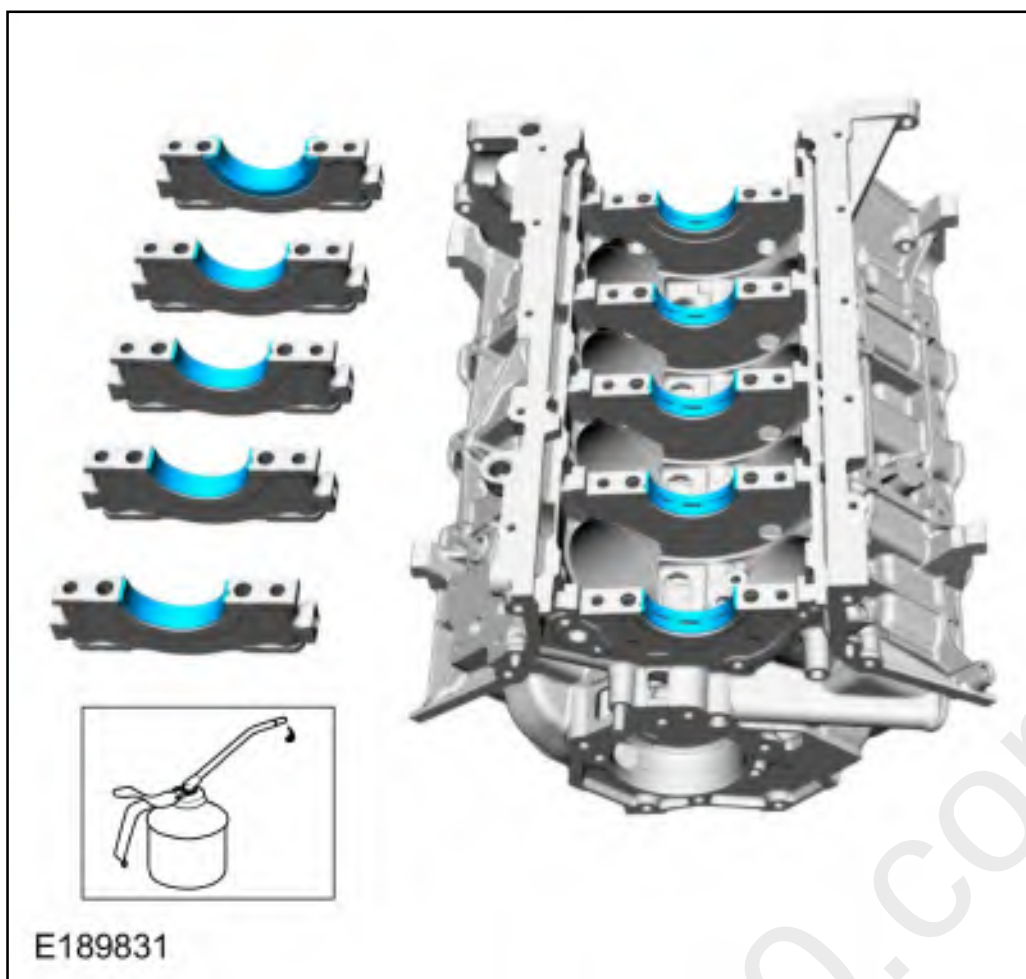
Stage 2: 45°



6. Install the crankshaft main bearings.

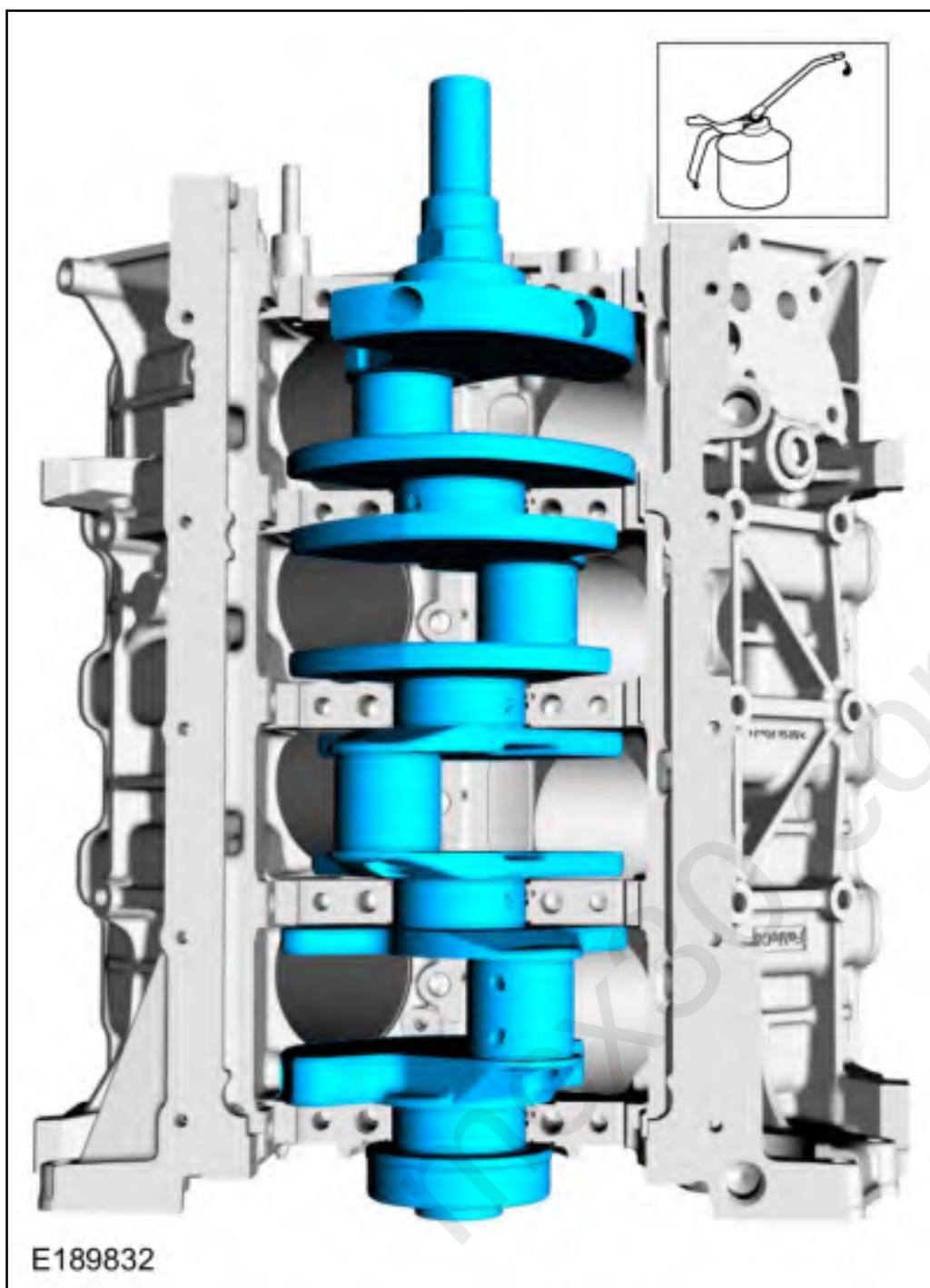
- Install the crankshaft upper main bearings into the cylinder block.
- Install the crankshaft lower main bearings and thrust bearing into the bearing caps.
- Make sure all oil passages are aligned.
- Lubricate all main bearings with clean engine oil.





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

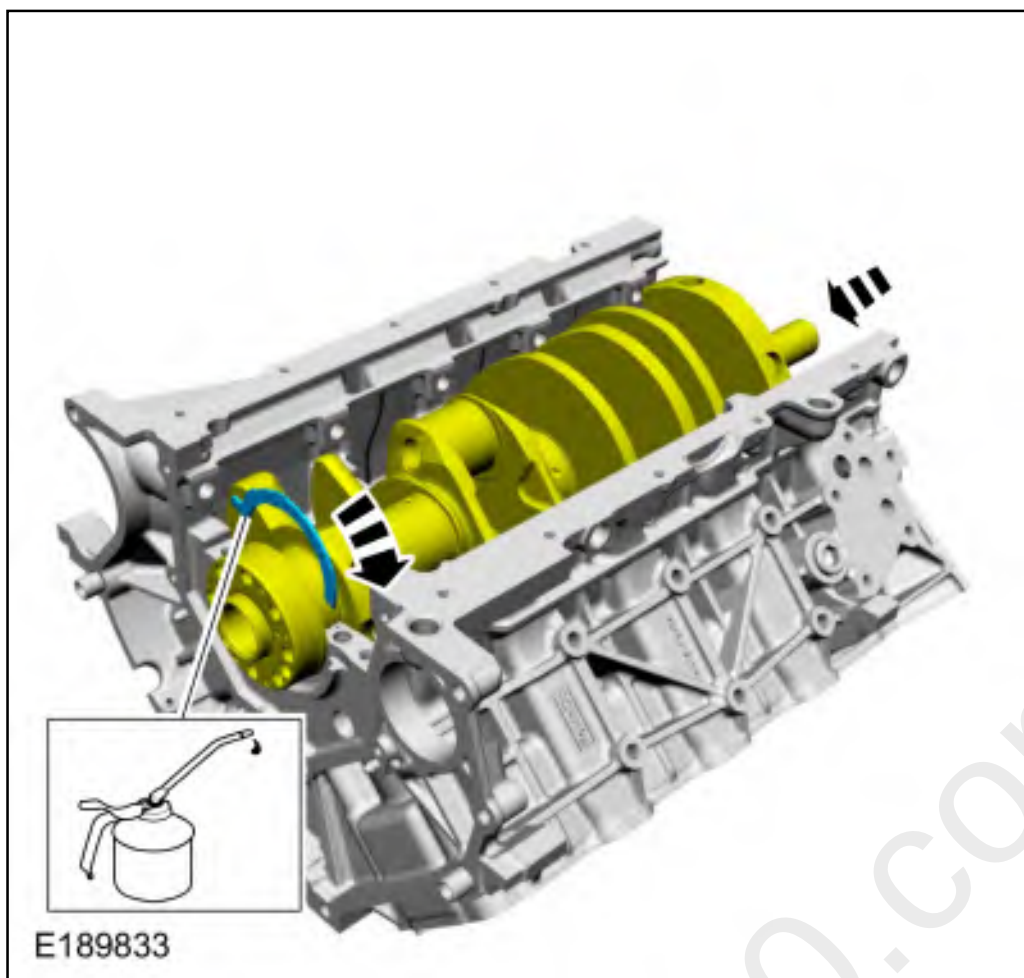
Install the crankshaft into the cylinder block.



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.*

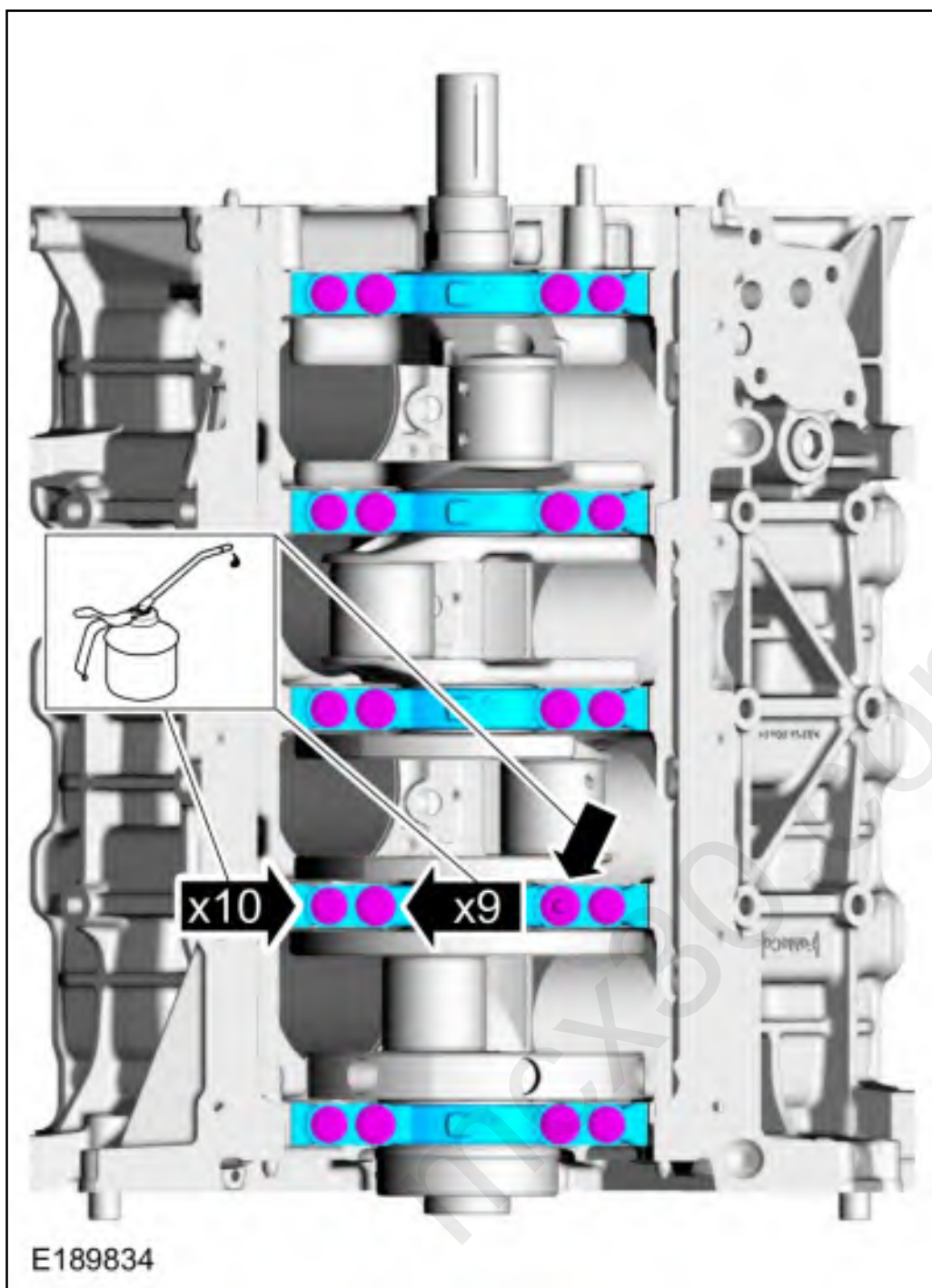
Push the crankshaft rearward and install the rear crankshaft upper thrust washer at the back of the No. 5 main boss.



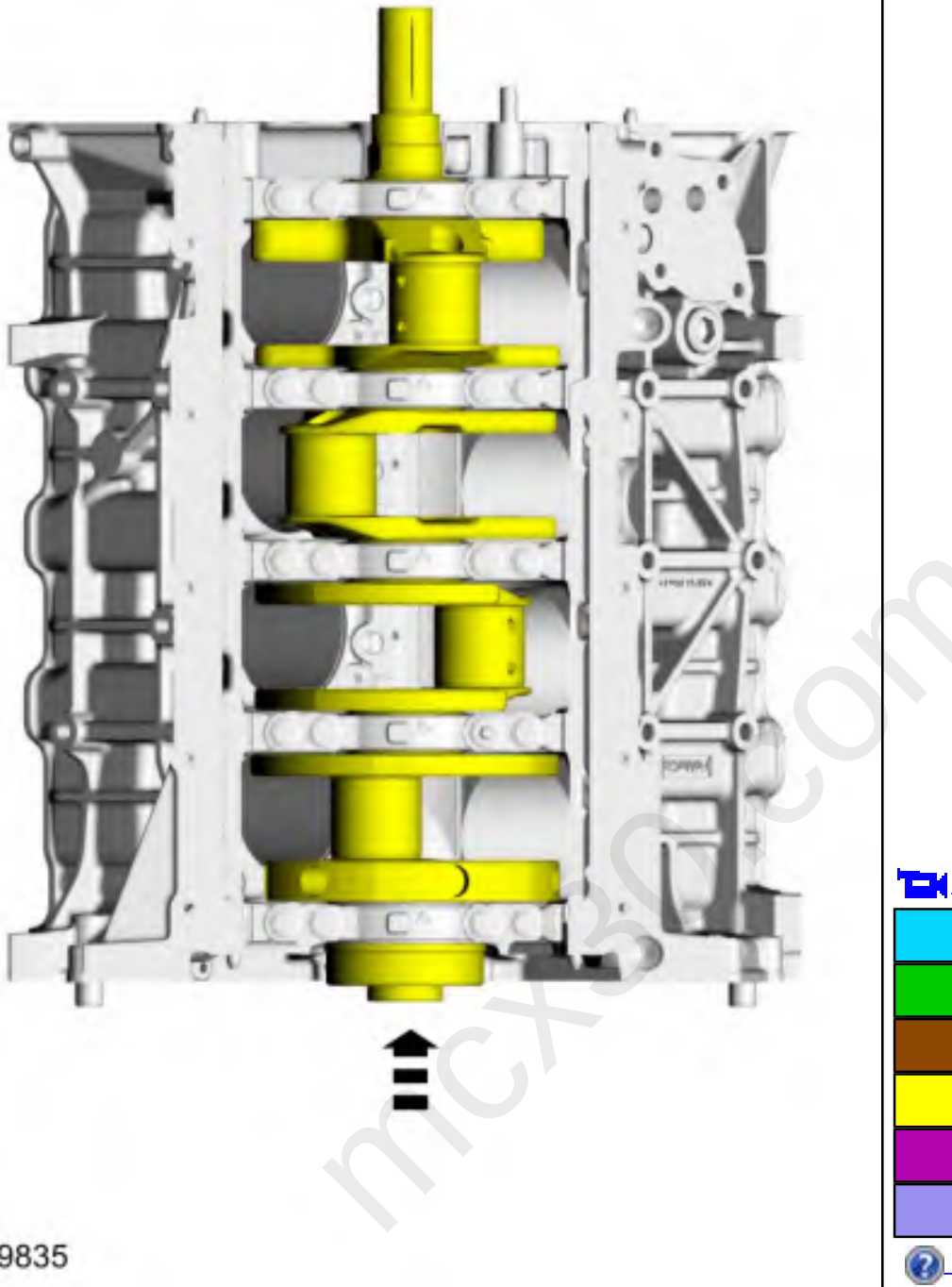
9. **NOTE:** *Lubricate the fastener threads with clean engine oil.*

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.

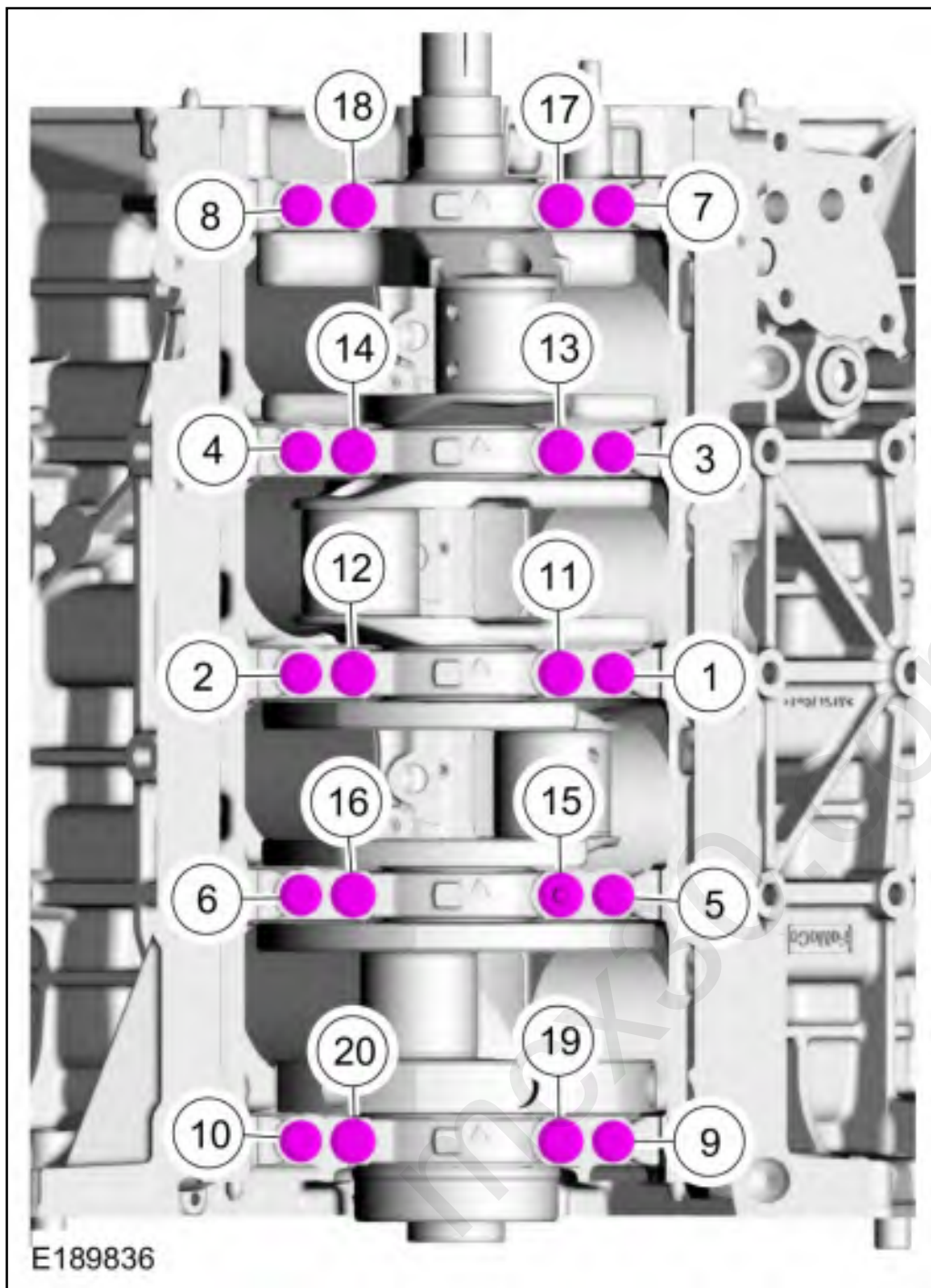
*Torque:*

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°



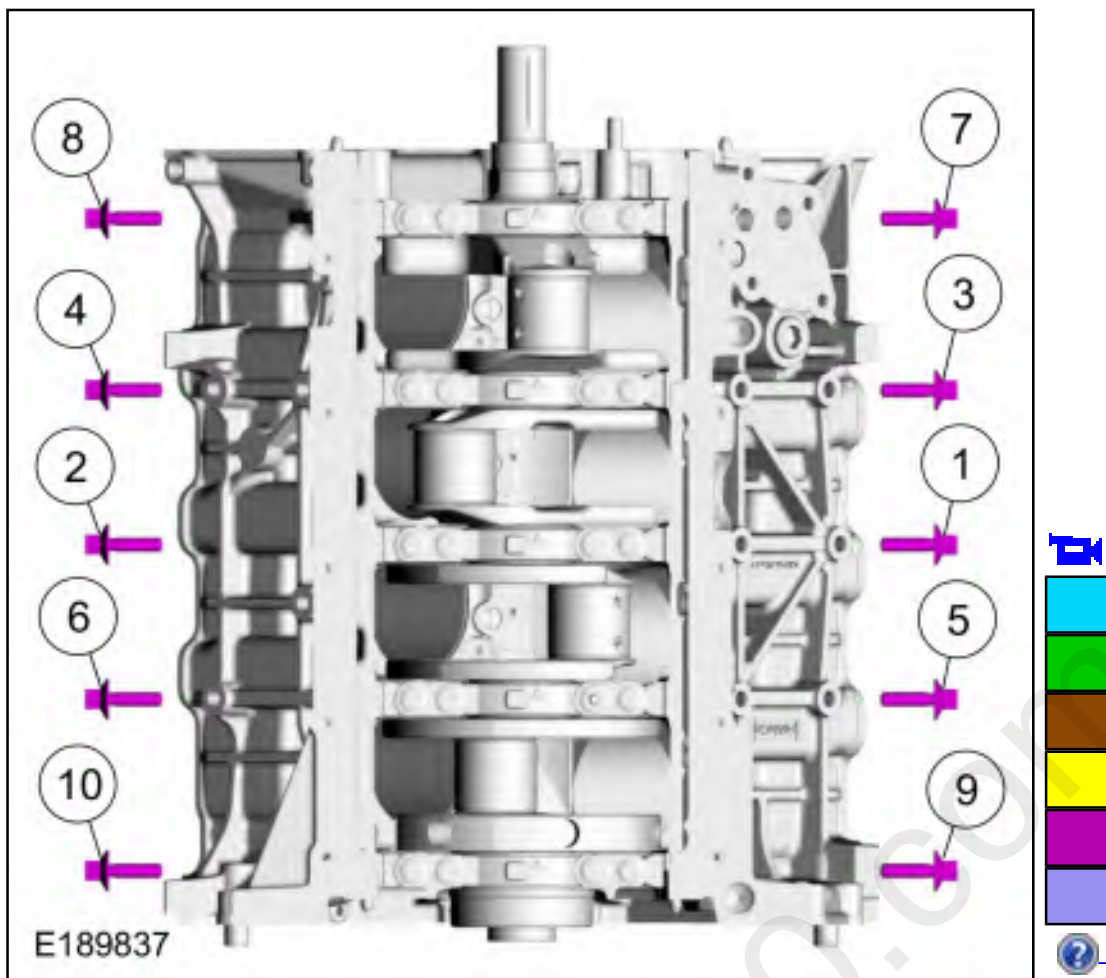
12. Install the cross-mounted main bearing cap fasteners.

*Torque:*

Stage 1: 89 lb.in (10 Nm)

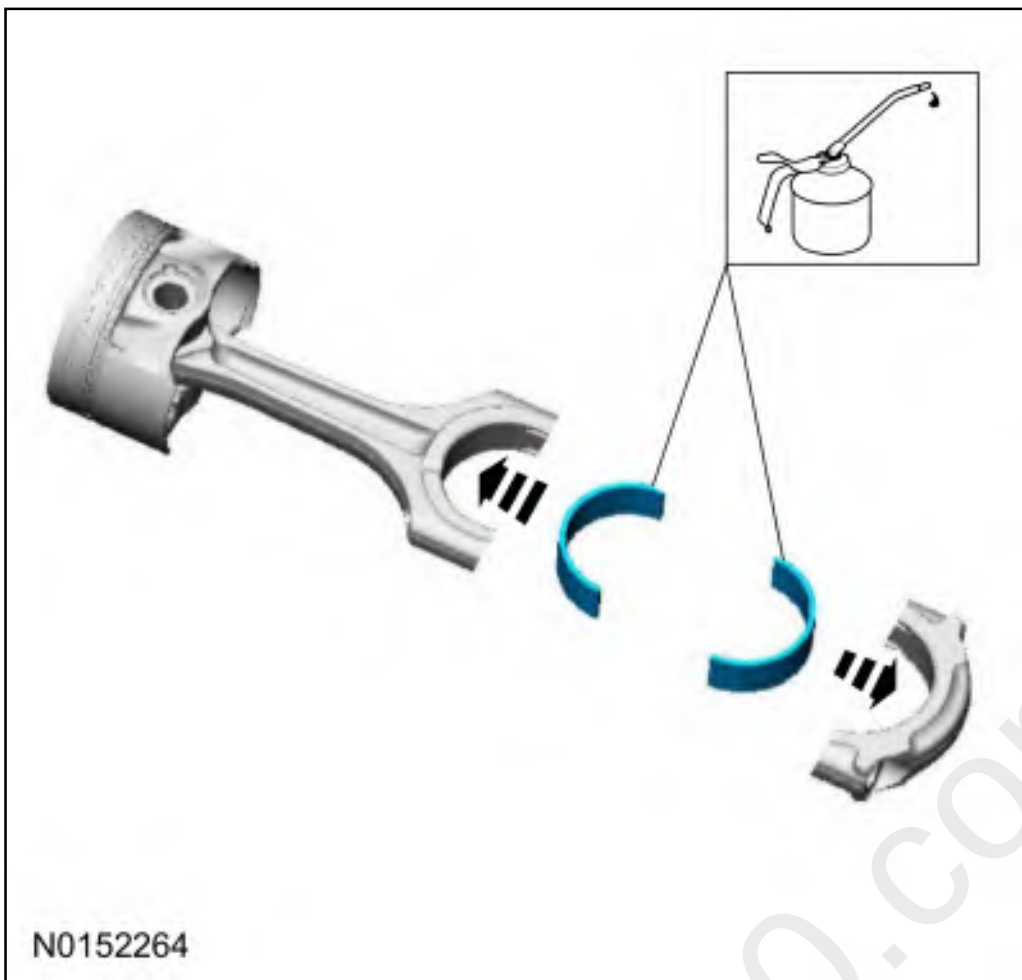
Stage 2: 22 lb.ft (30 Nm)

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.

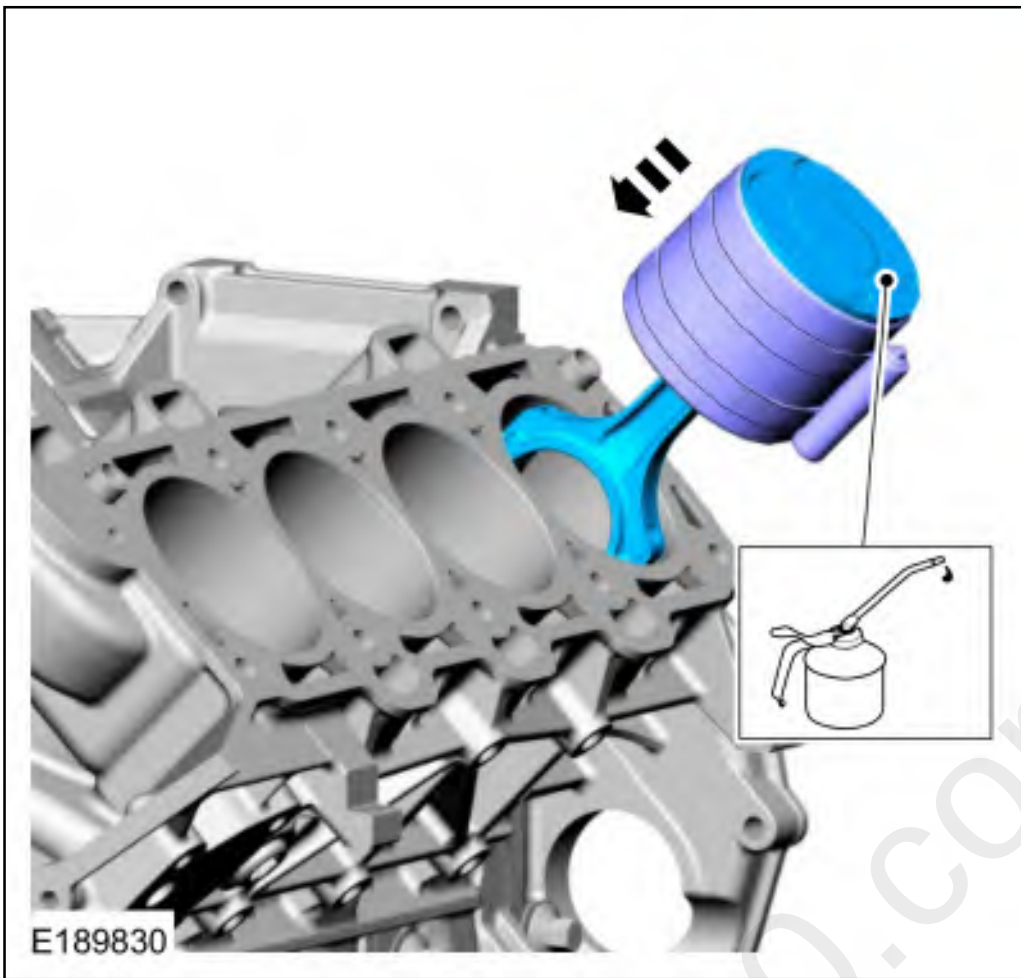
**NOTICE:** Be sure not to scratch the cylinder wall or crankshaft journal with the connecting rod. Push the piston down until the connecting rod bearing seats on the crankshaft journal.

**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





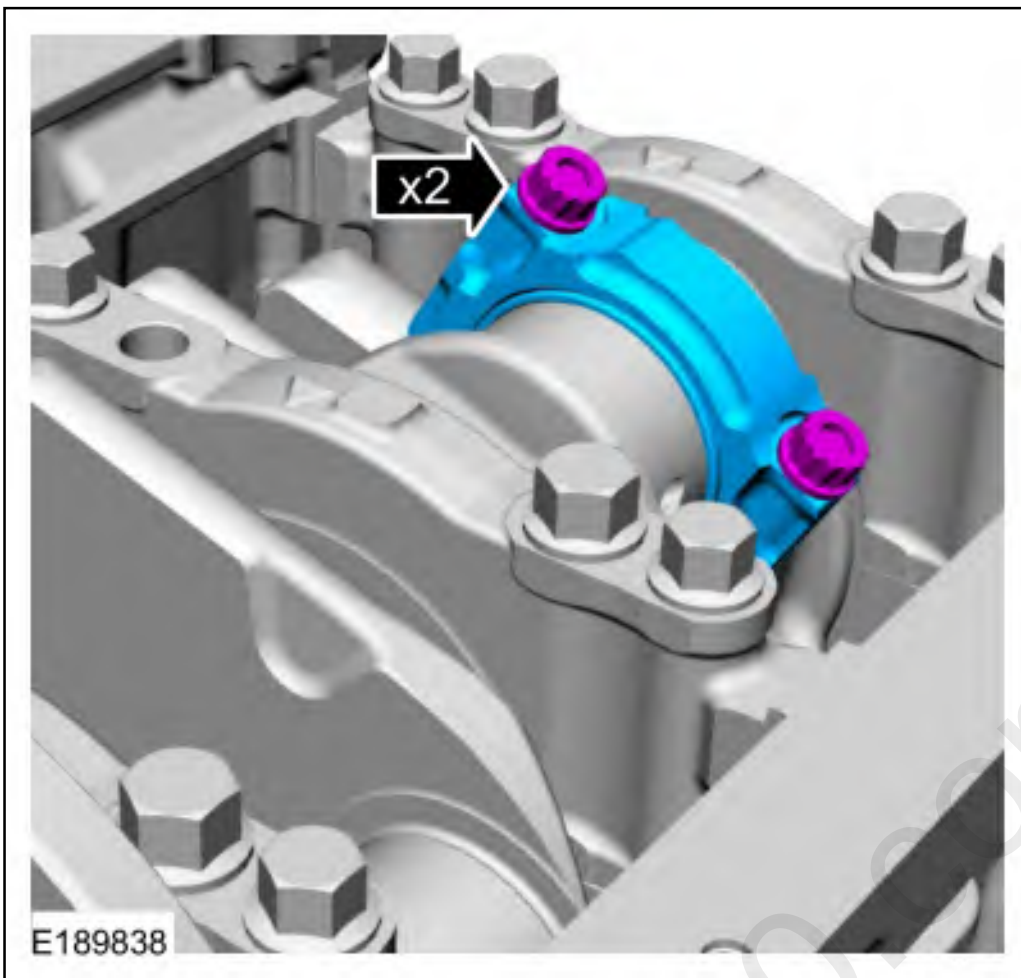
16. **NOTICE:** The rod cap installation must keep the same orientation as marked during disassembly or engine damage may occur.

**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.

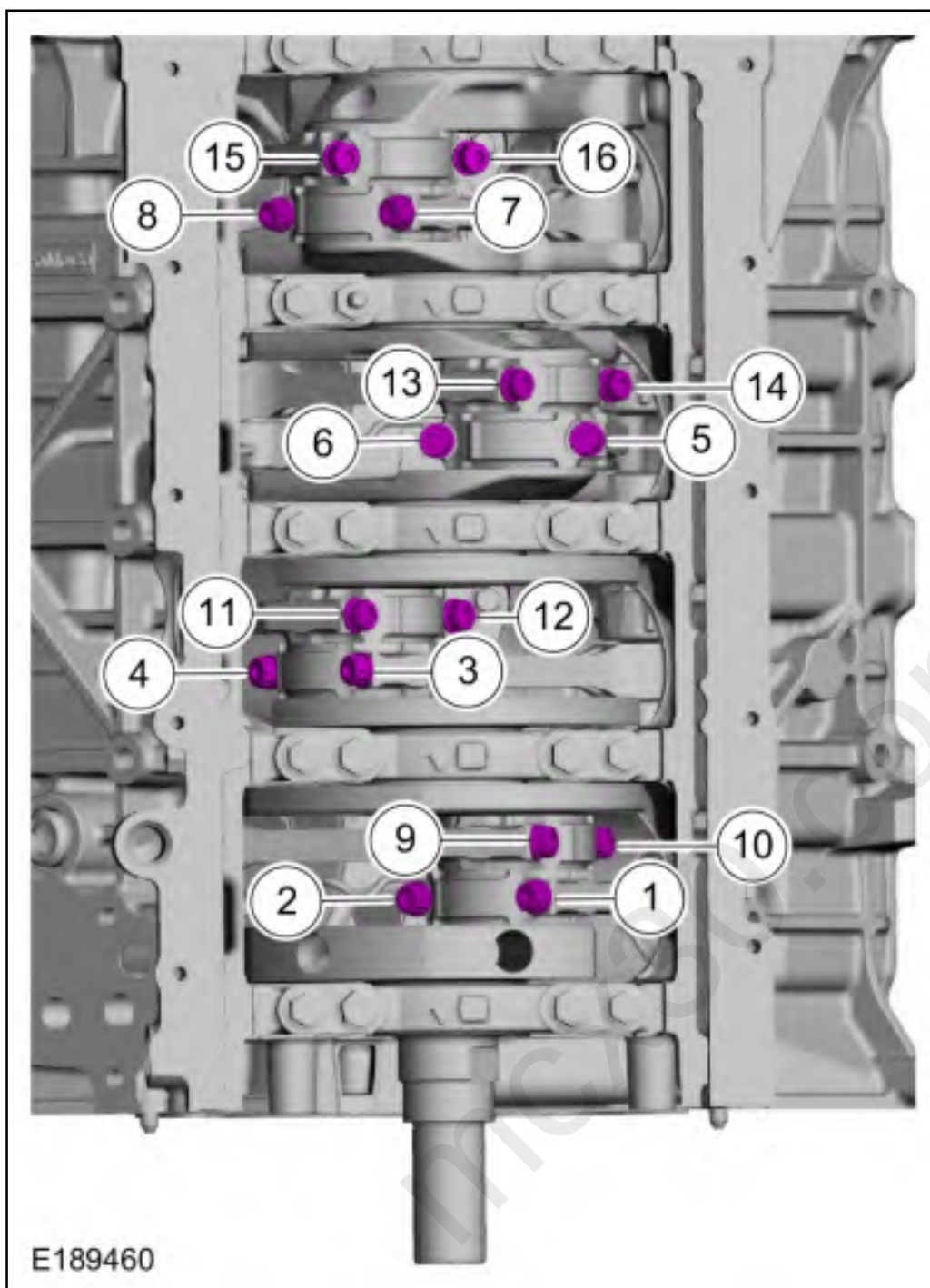
18. Tighten the connecting rod bolts.

*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.

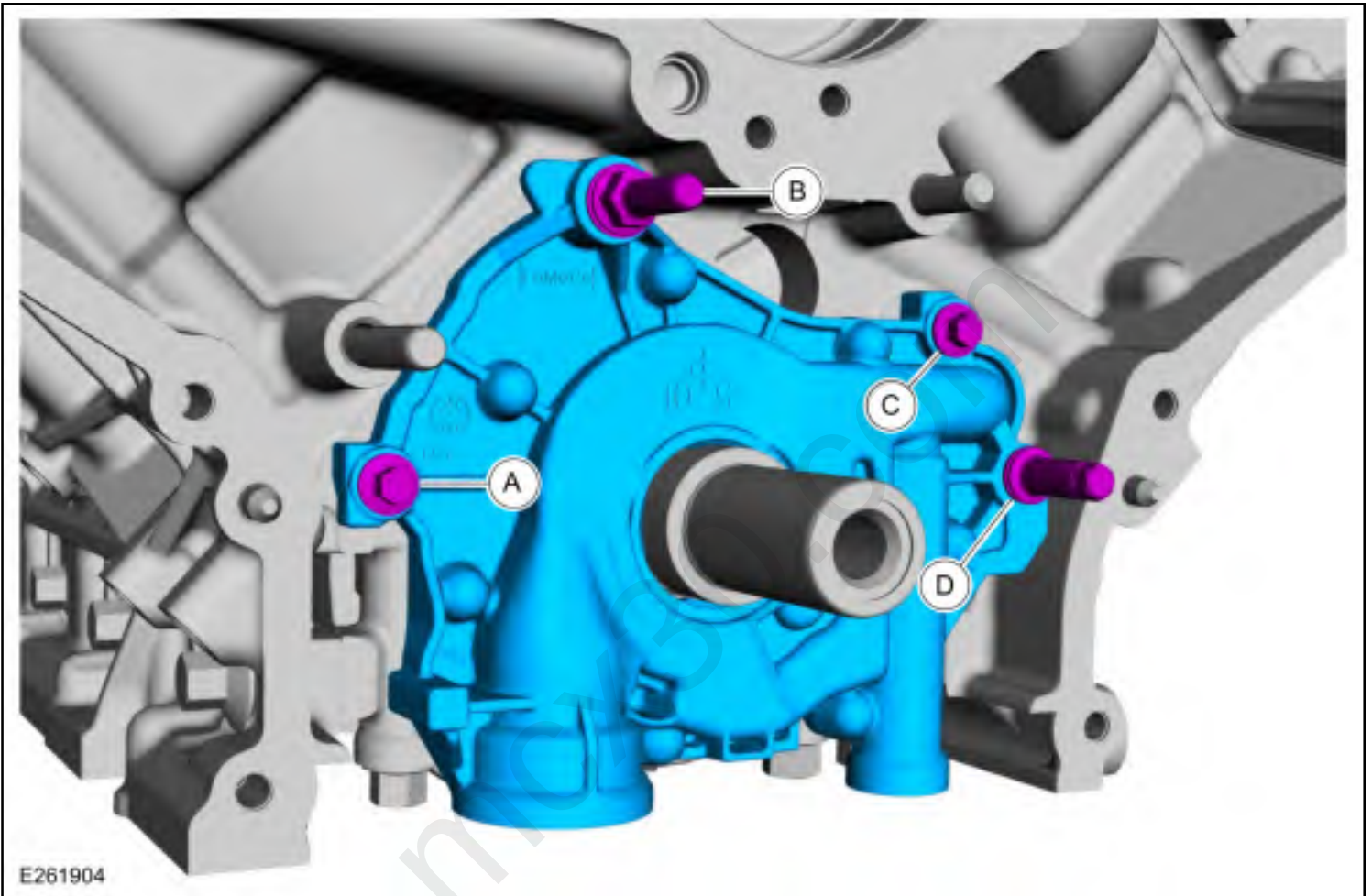
20. **NOTE:** Oil pump must be held against the cylinder block until all bolts are tightened.

- 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)

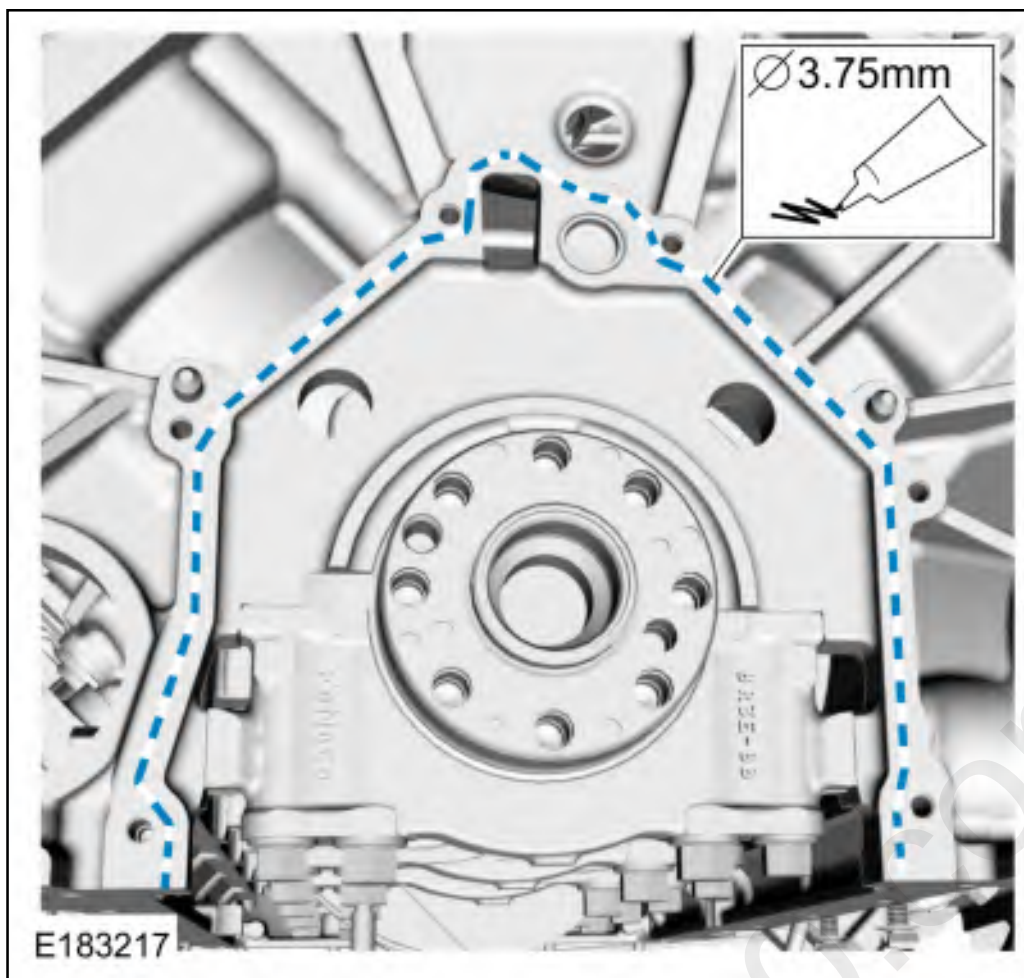
- Stage 2: B: 18 lb.ft (25 Nm)  
Stage 3: C: 89 lb.in (10 Nm)  
Stage 4: D: 177 lb.in (20 Nm)  
Stage 5: A: 45°  
Stage 6: B: 75°  
Stage 7: C: 45°  
Stage 8: D: 60°



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)



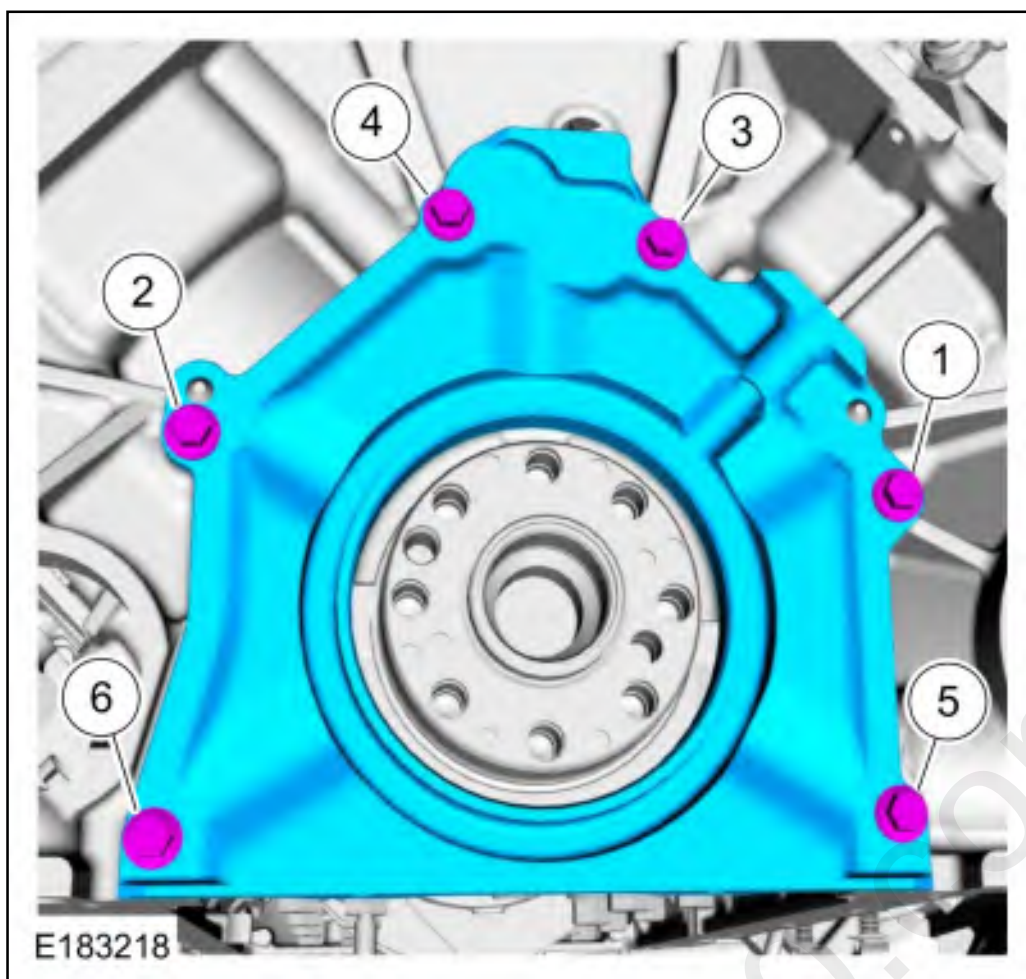
22. Install the crankshaft rear seal retainer plate and the bolts.

*Torque:*

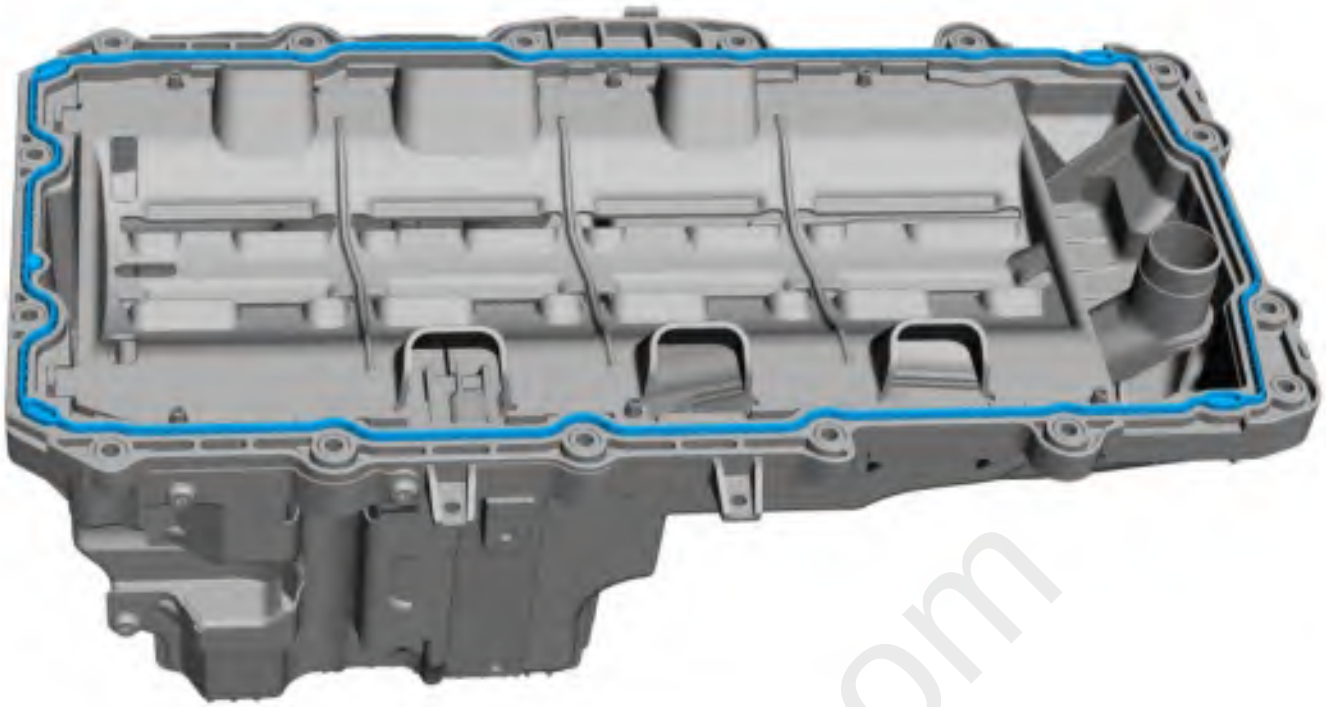
Stage 1: 89 lb.in (10 Nm)

Stage 2: 30°





23. Install a new oil pan gasket.

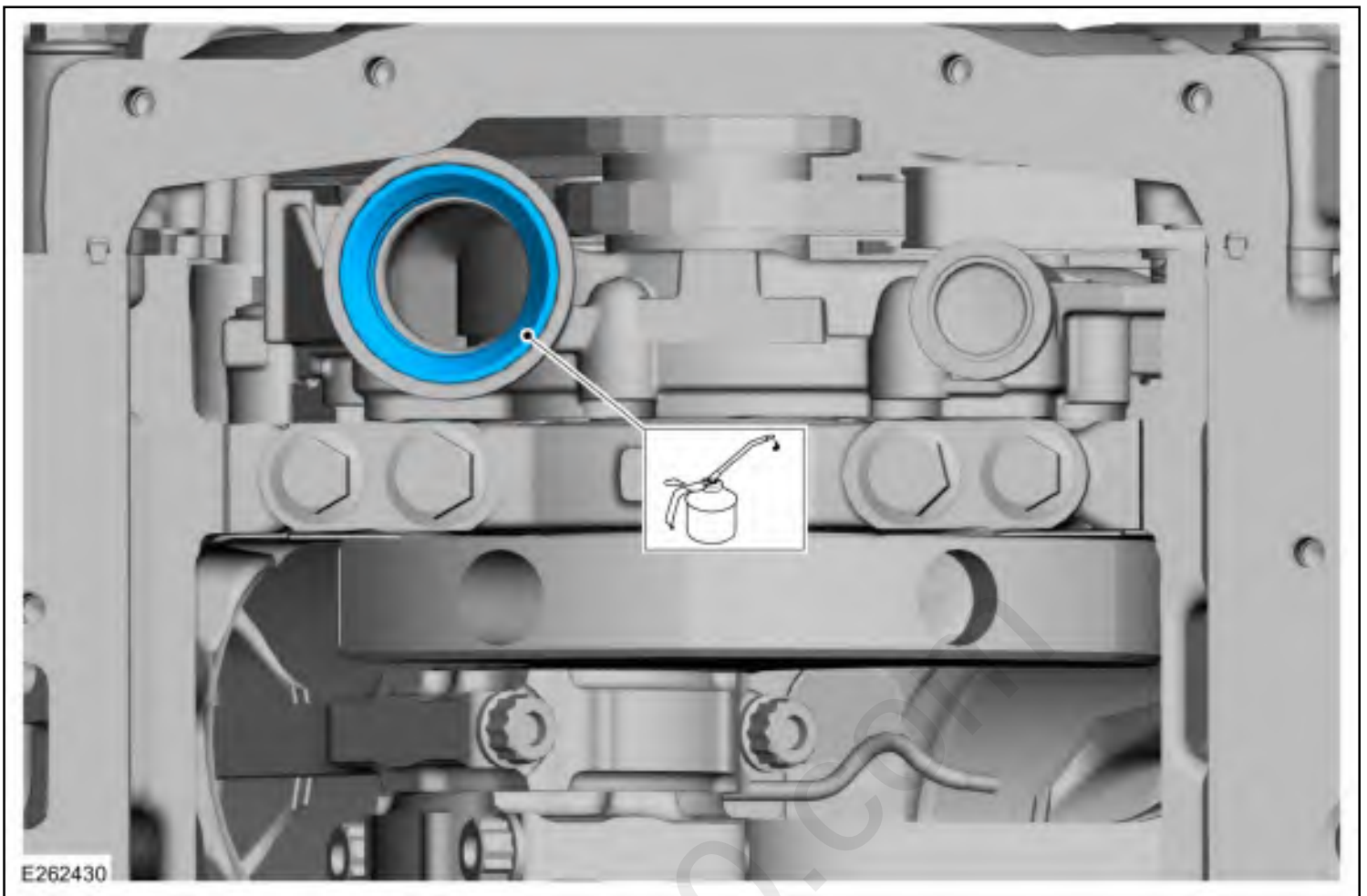


E262425



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



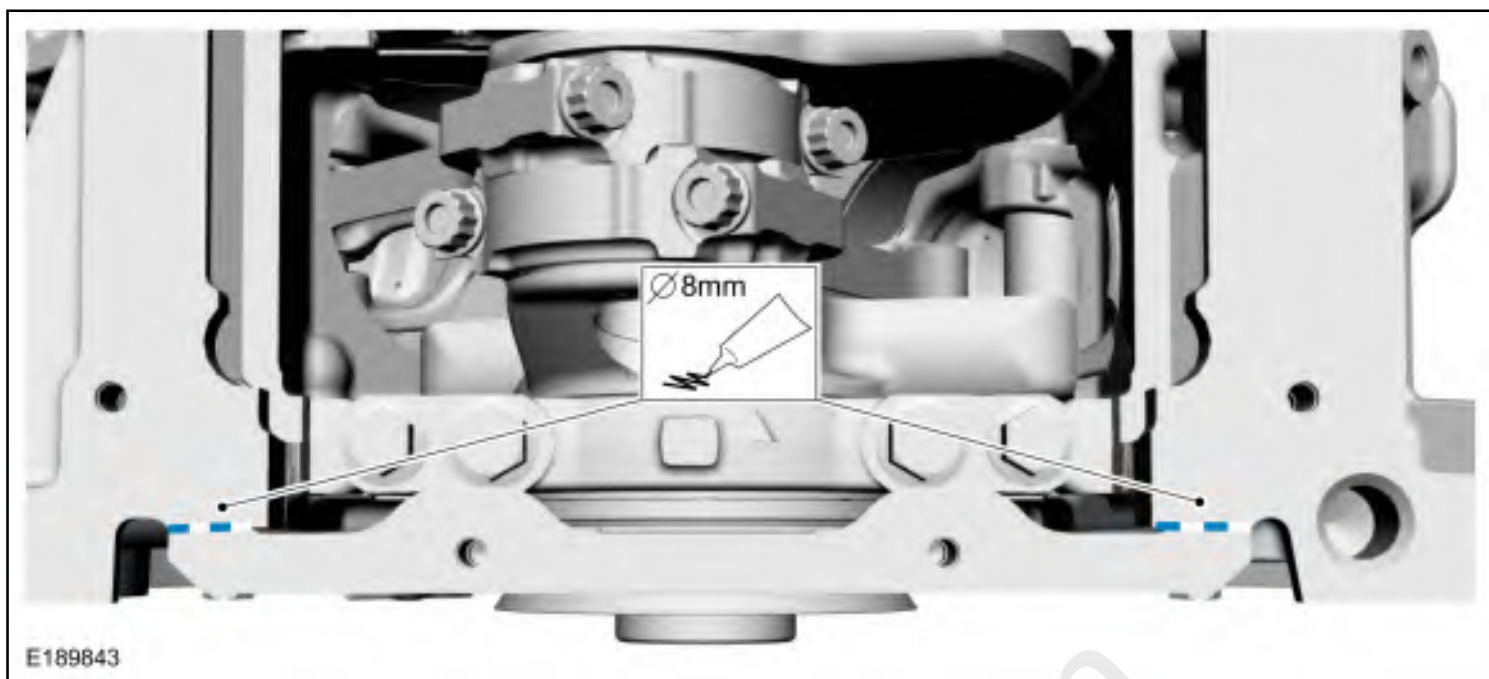


25. **NOTE:** *If the oil pan is not installed and the fasteners tightened within 5 minutes, the sealant must be removed and the sealing area cleaned. Failure to follow this procedure can cause future oil leakage. If this timing cannot be met, tighten fasteners 7, 8, 9 and 10 to 8 Nm (71 lb-in) within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



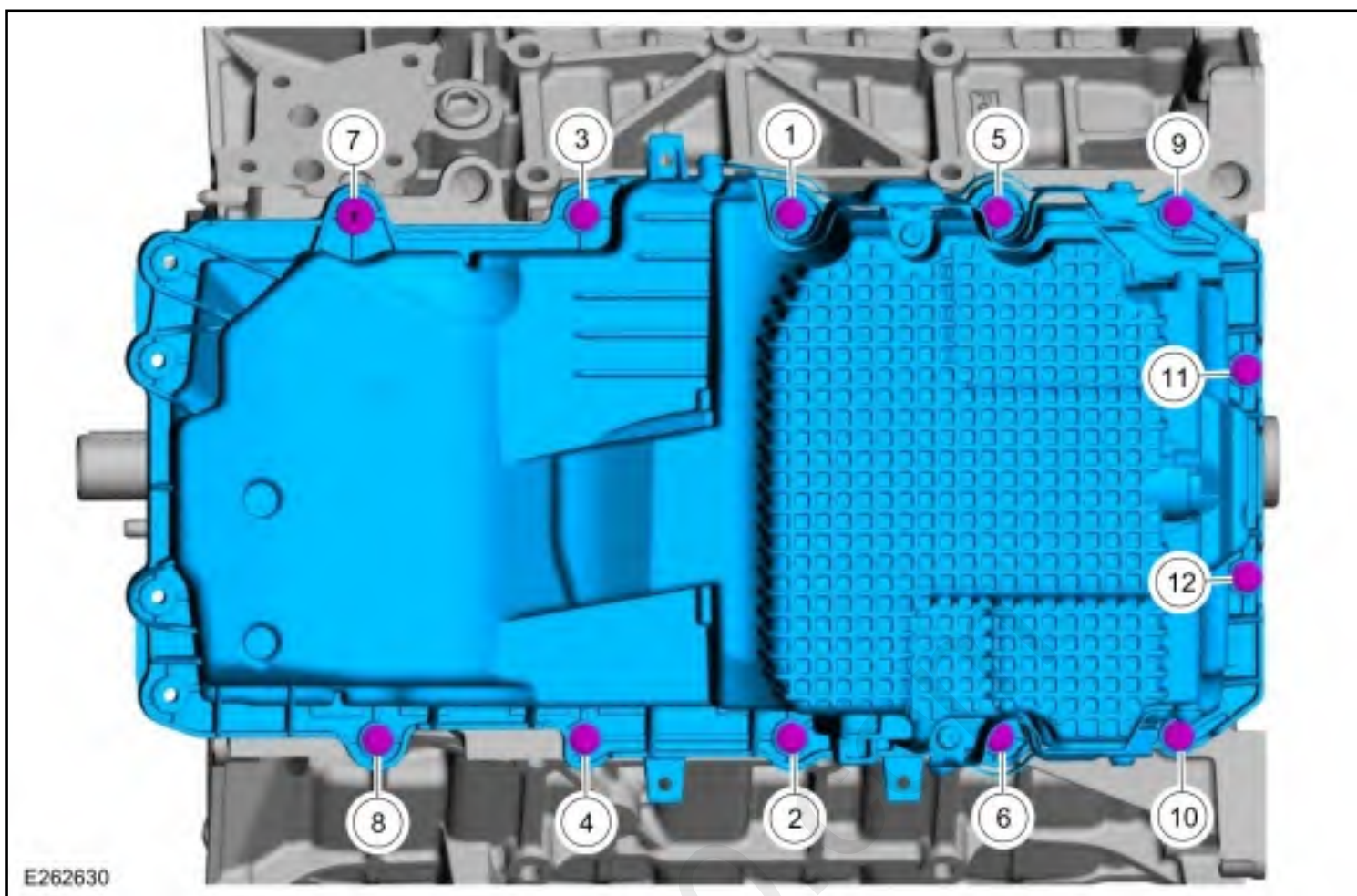
26. Install the oil pan and the fasteners.

*Torque:*

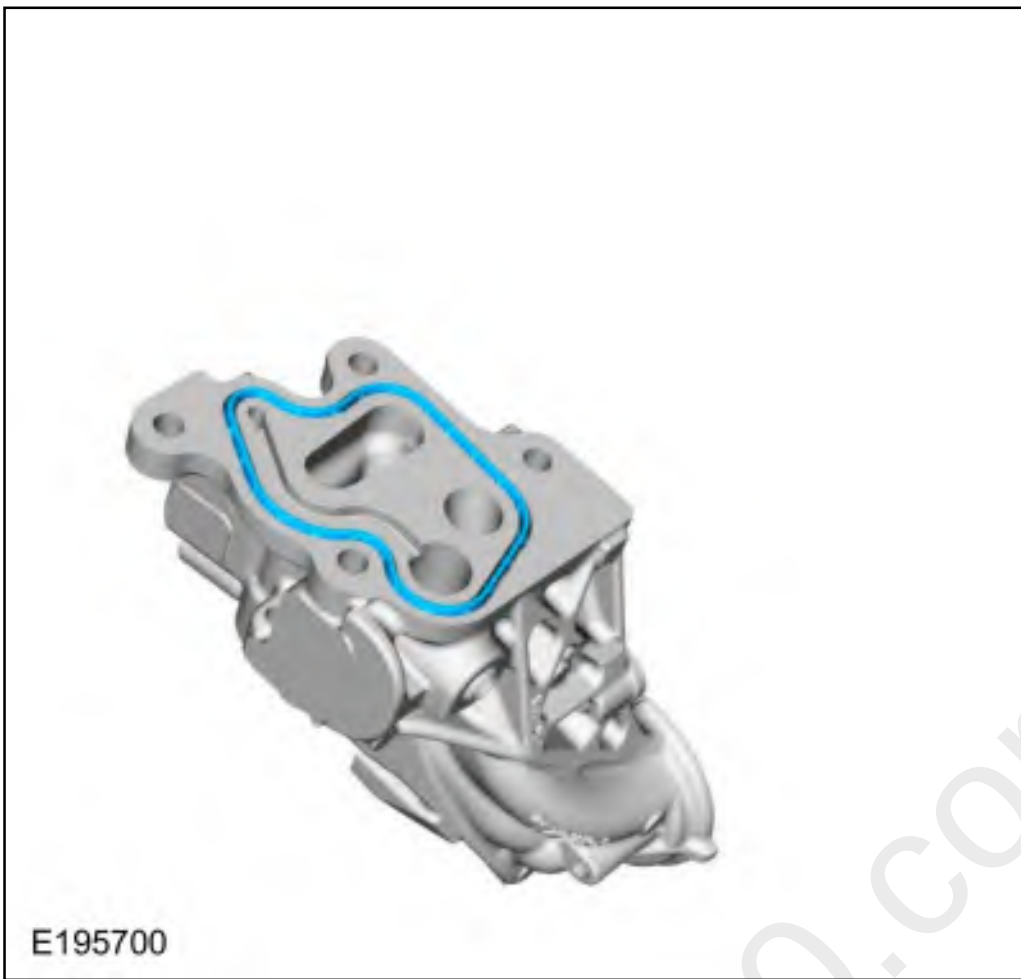
Stage 1: 18 lb.in (2 Nm)

Stage 2: 89 lb.in (10 Nm)

Stage 3: 45°



27. Install a new oil filter adapter gasket.

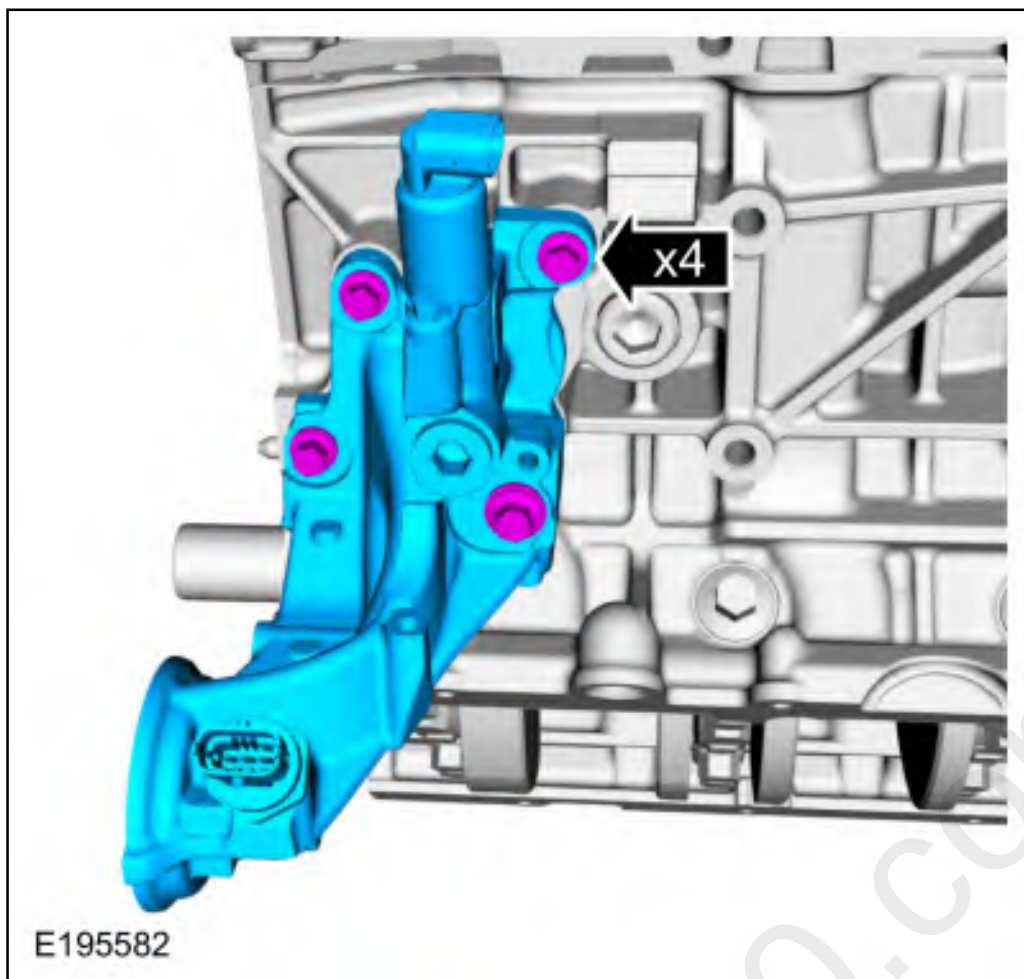


28. Install the oil filter adapter and the bolts.

*Torque:*

Stage 1: 177 lb.in (20 Nm)

Stage 2: 60°

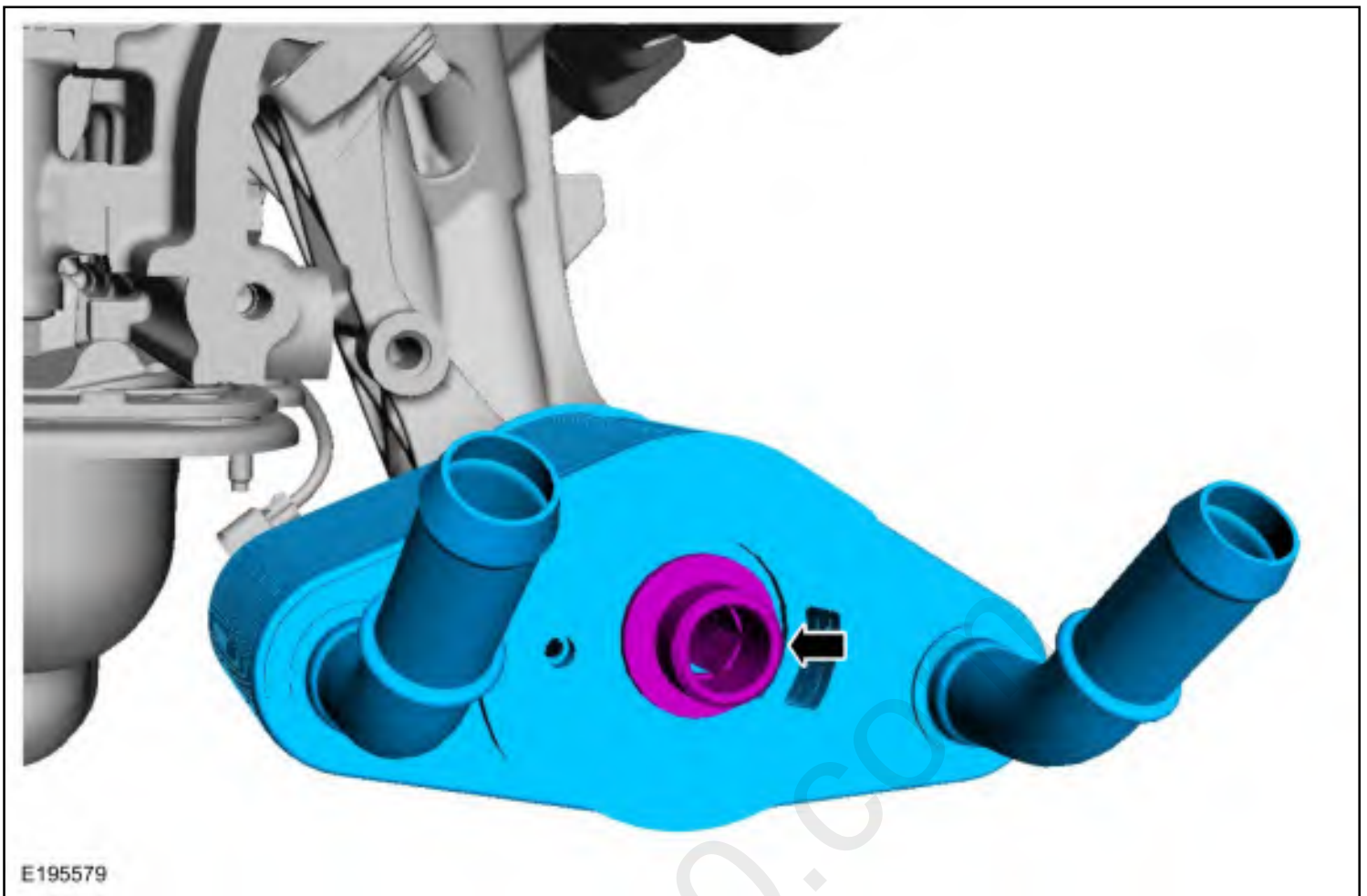


29. **NOTICE: A new oil cooler must be installed or severe damage to the engine can occur.**

Install a new oil cooler with a new gasket and the threaded fitting.

*Torque:* 43 lb.ft (58 Nm)



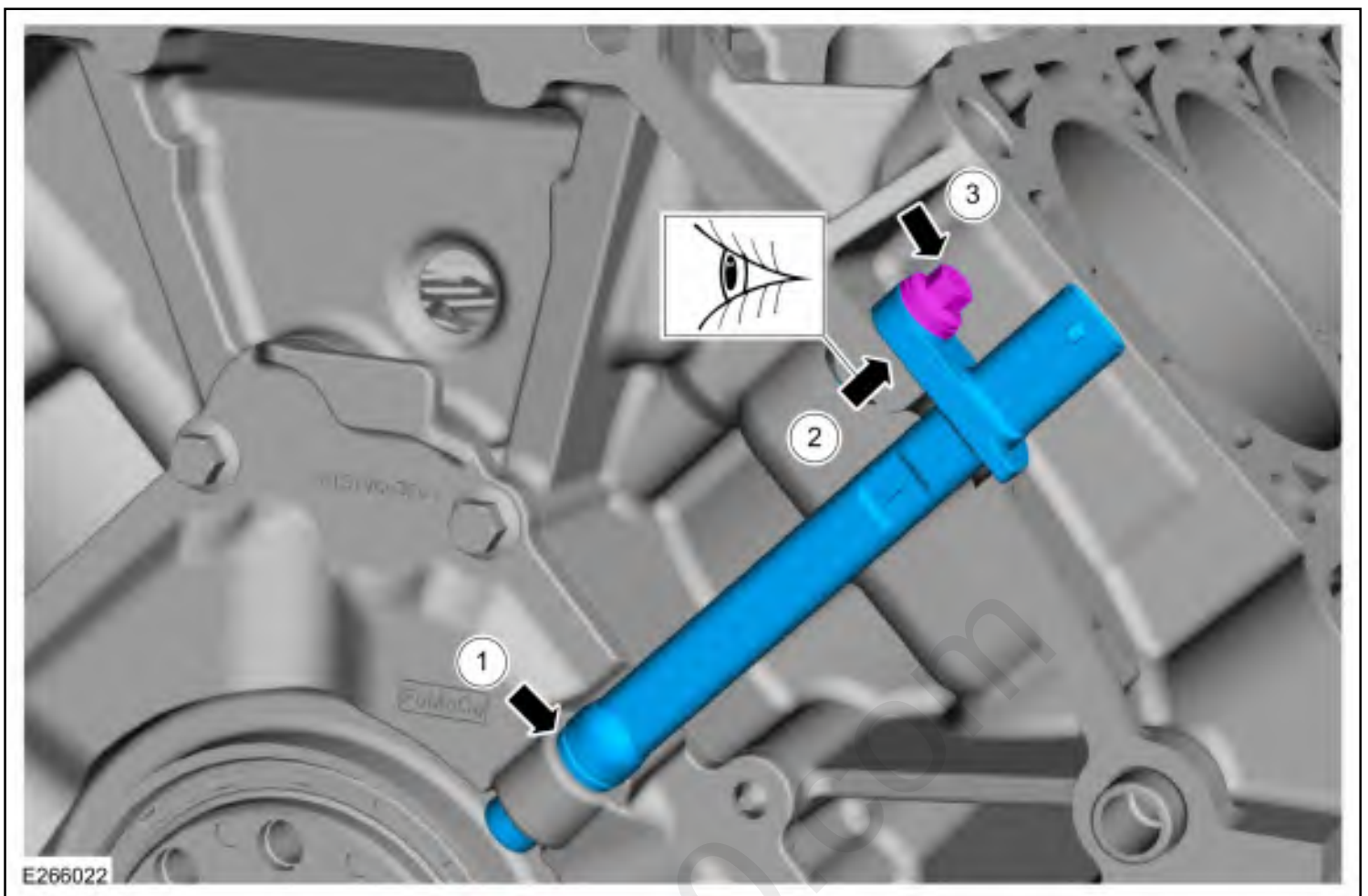


30. **NOTICE:** The CKP sensor must be positioned into the crankshaft rear seal retainer plate and be flush against the boss on the engine block before the bolt is installed. If the CKP sensor is installed incorrectly, the CKP sensor can be damaged.

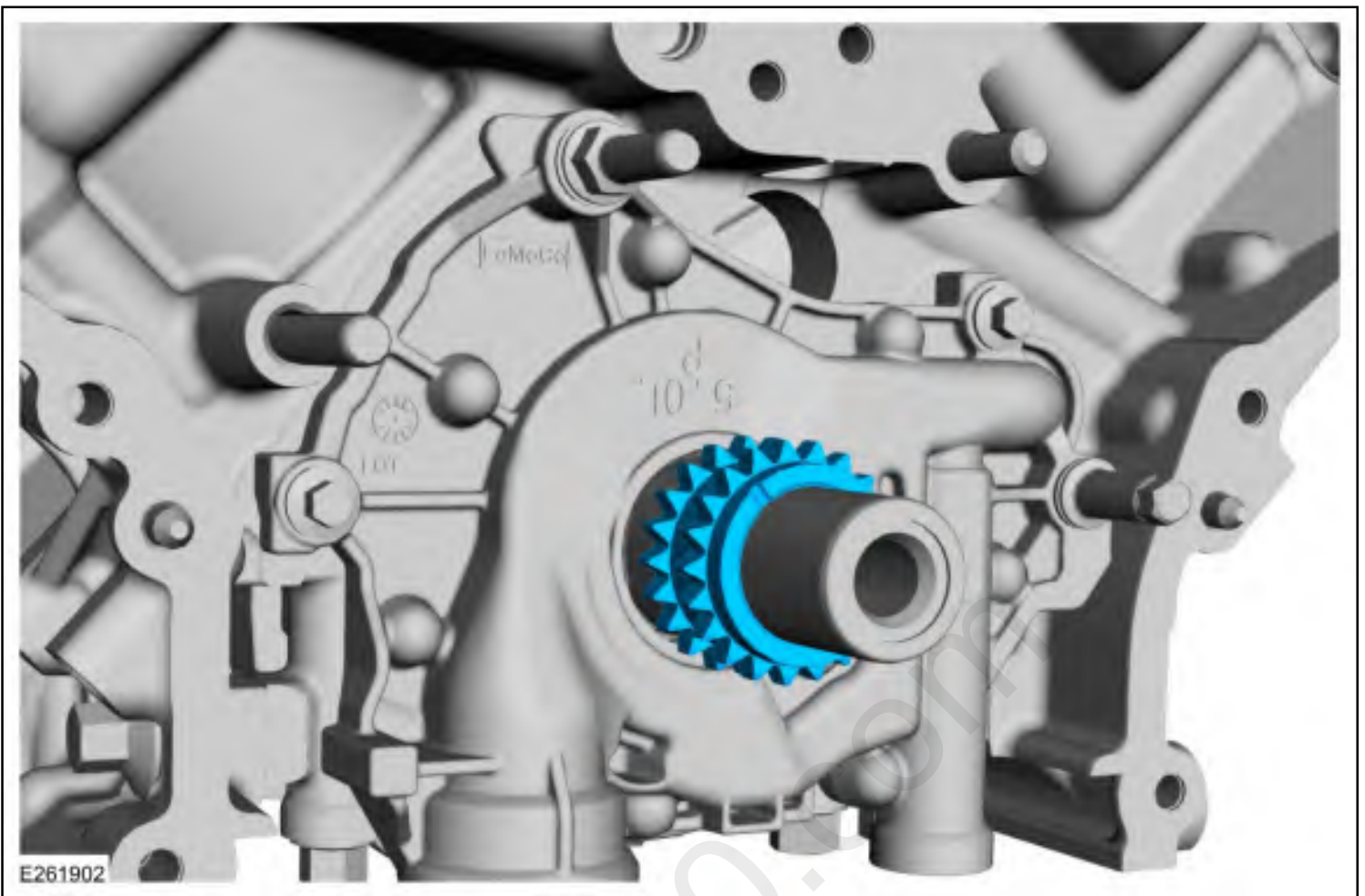
- Install the CKP sensor must be positioned into the crankshaft rear seal retainer plate.
- Make sure the CKP sensor is flush with the engine block boss.
- Install the bolt.

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

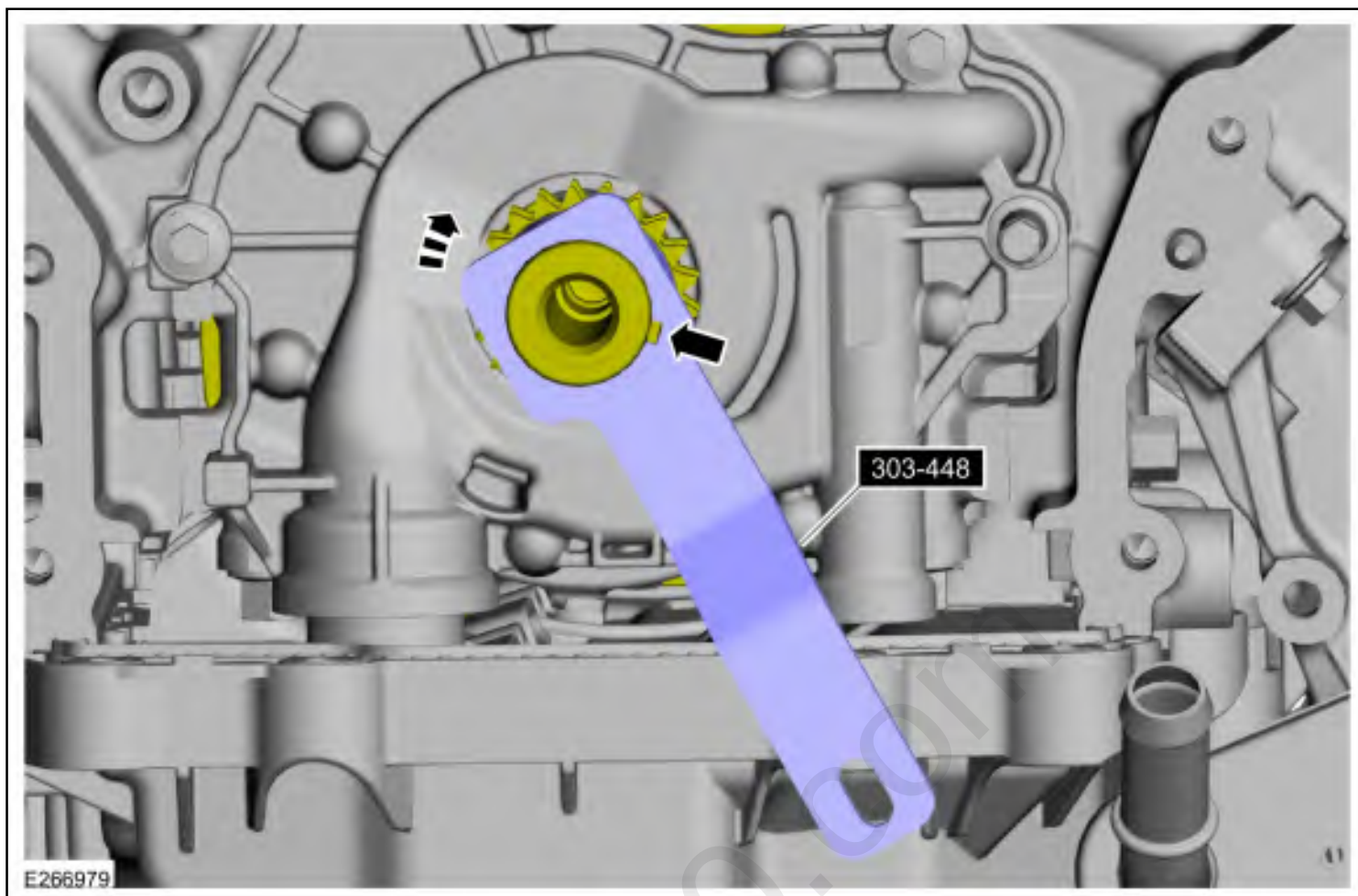




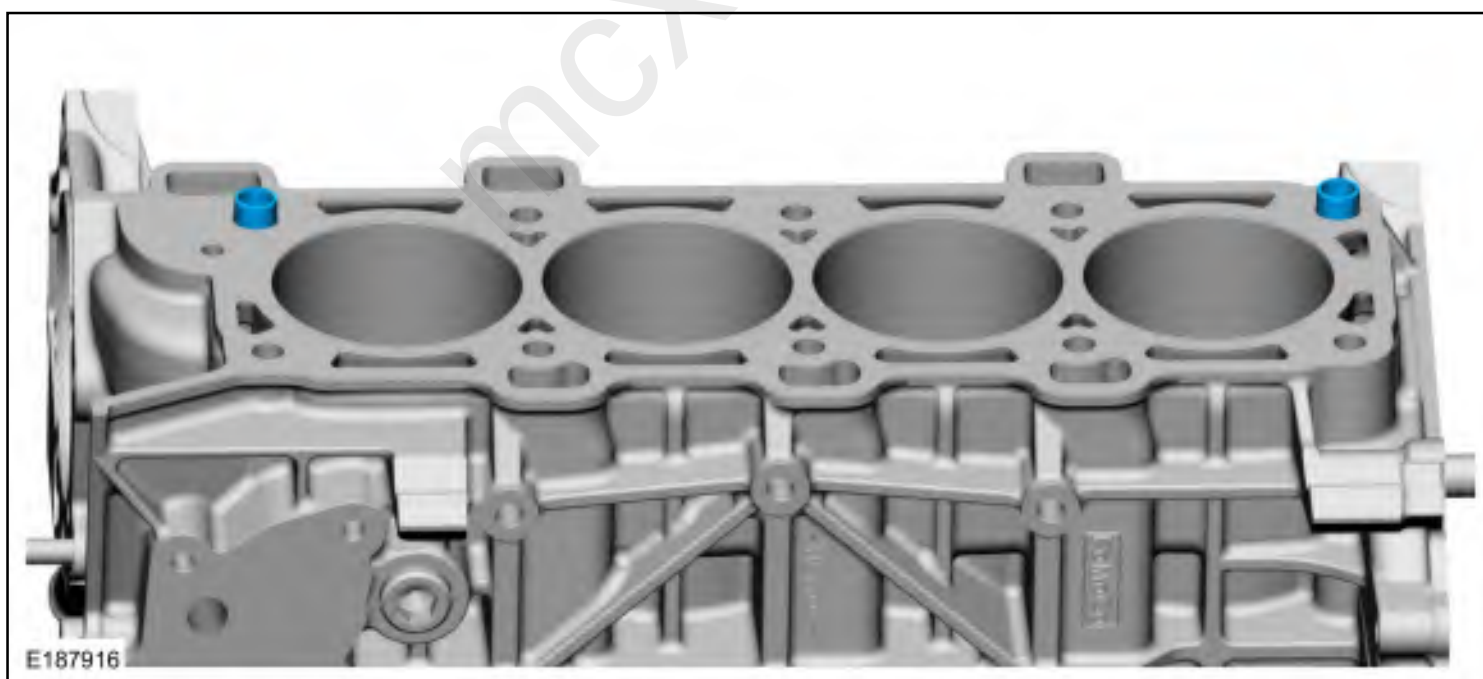
31. Install the crankshaft sprocket.



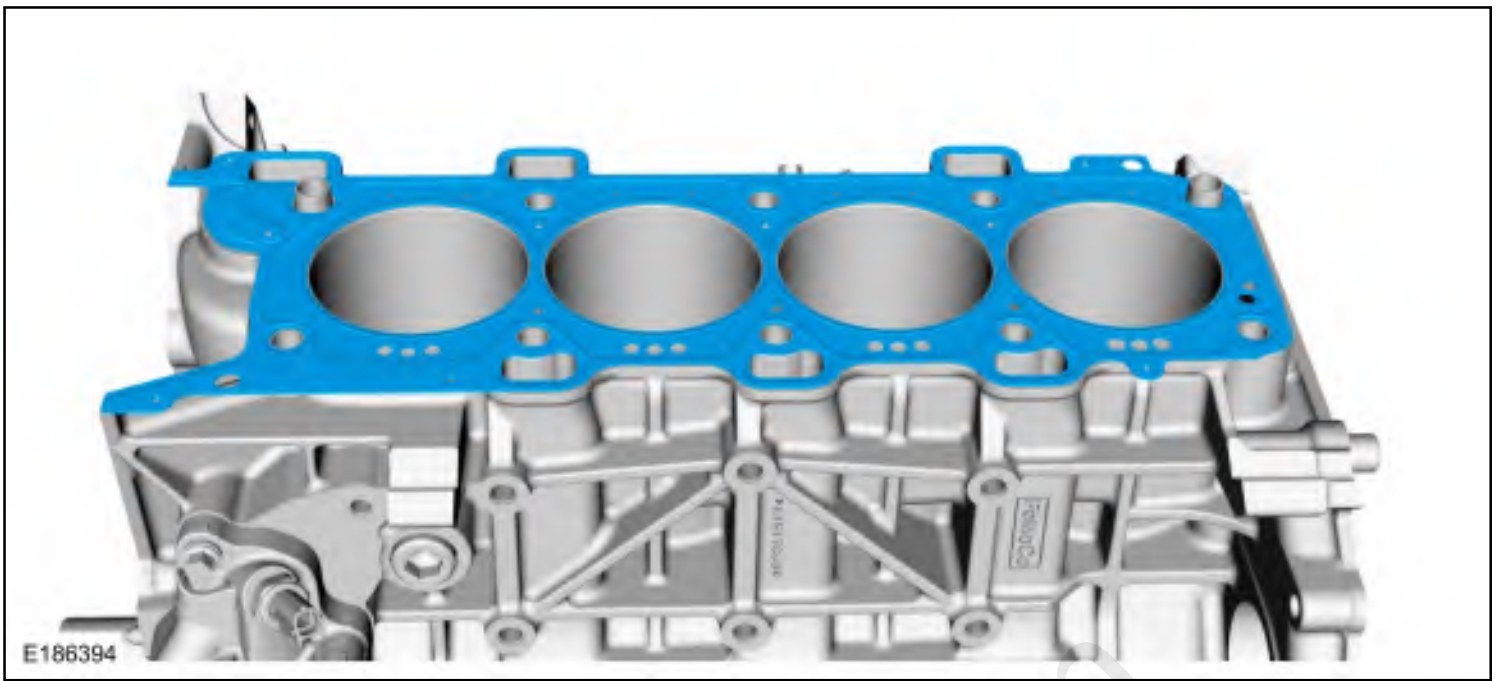
32. Using the special tool, rotate the crankshaft clockwise until the keyway is at the 3:30 position.  
Use Special Service Tool: 303-448 (T93P-6303-A) Holding Tool, Crankshaft.



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)

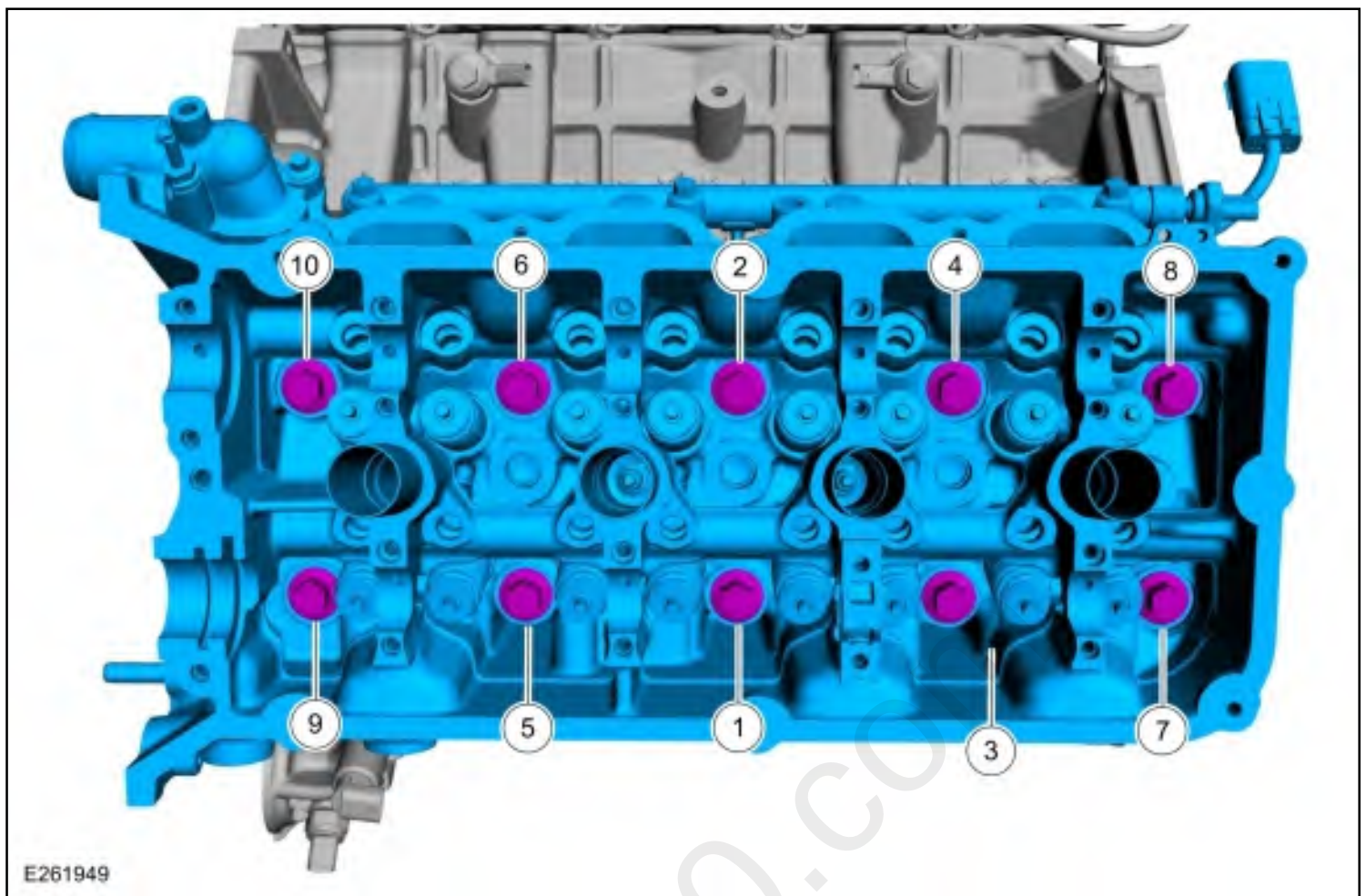
Stage 3: Bolt 1: Loosen: 180°

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).

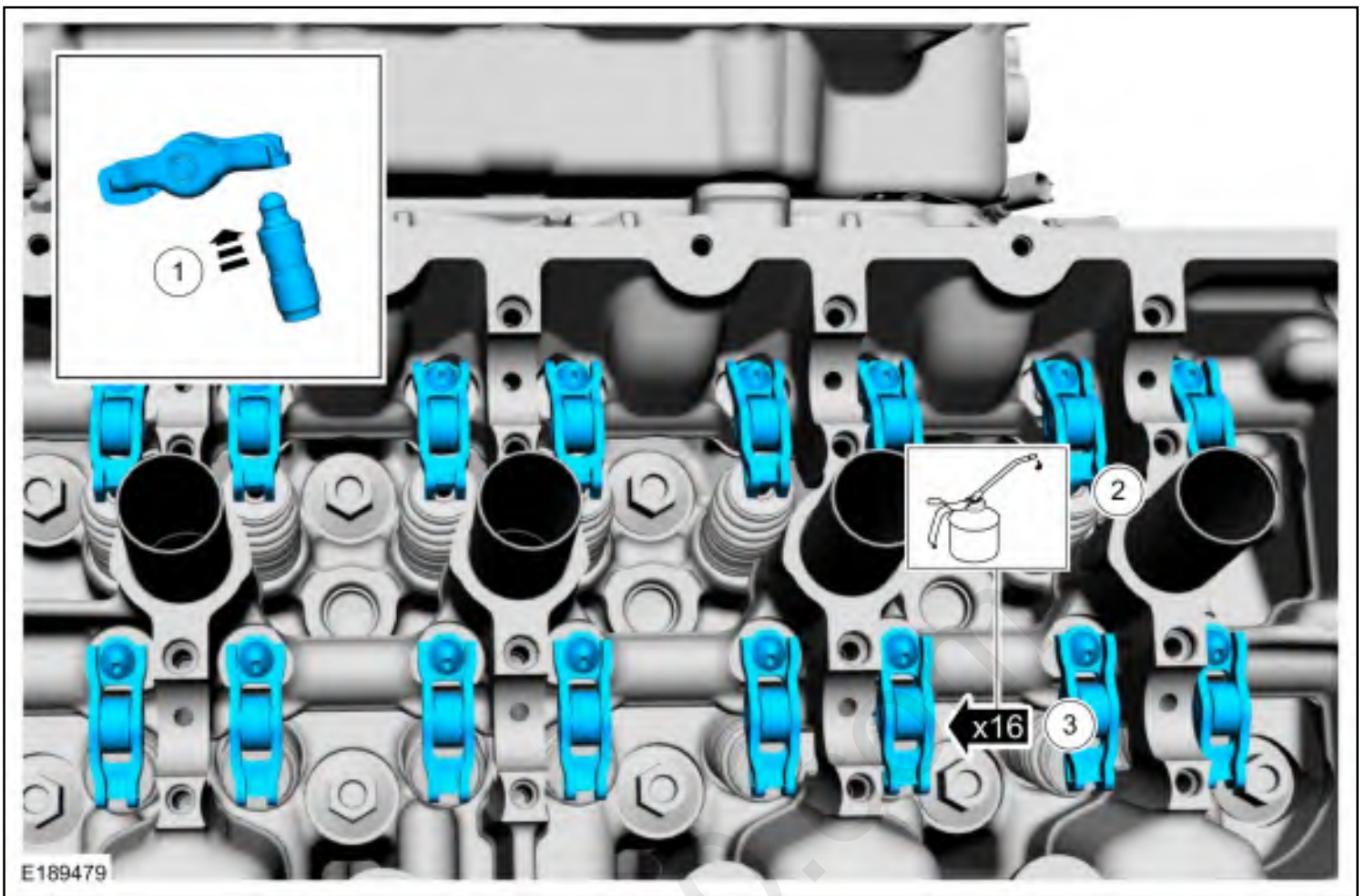




**NOTICE:** The LH camshafts, VCT units and timing chains must be installed first. Only turn the crankshaft as instructed. Failure to do so may result in the camshafts installed out of phase and serious damage to the engine will result.

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

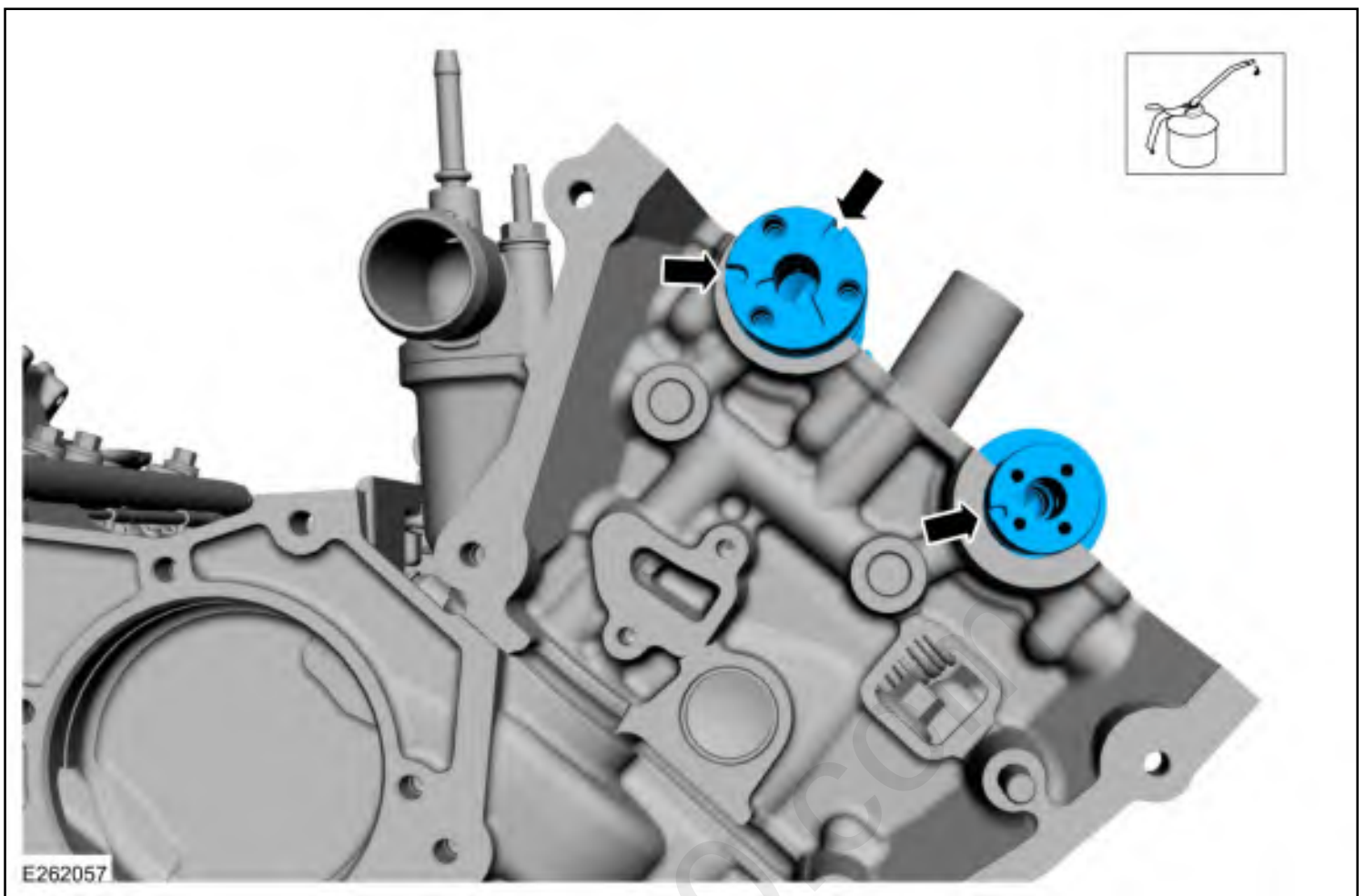
1. Assemble the hydraulic lash adjusters onto the spring clips on the camshaft roller followers.
2. Lubricate the camshaft roller follower and hydraulic lash adjuster assemblies with clean engine oil.
3. Install the camshaft roller follower and hydraulic lash adjuster assemblies.



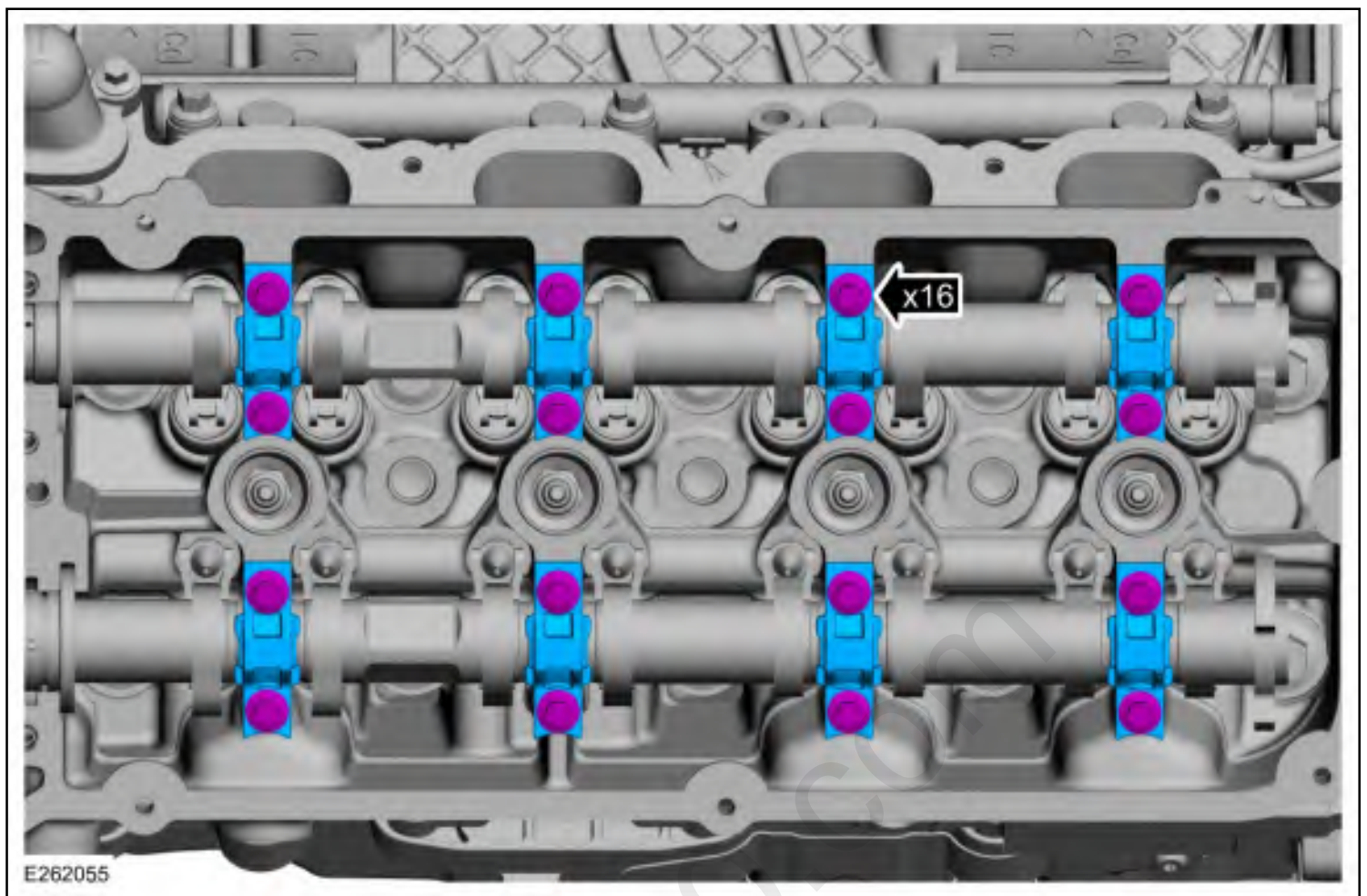
37. **NOTE:** *Lubricate the camshafts with clean engine oil prior to installation.*

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

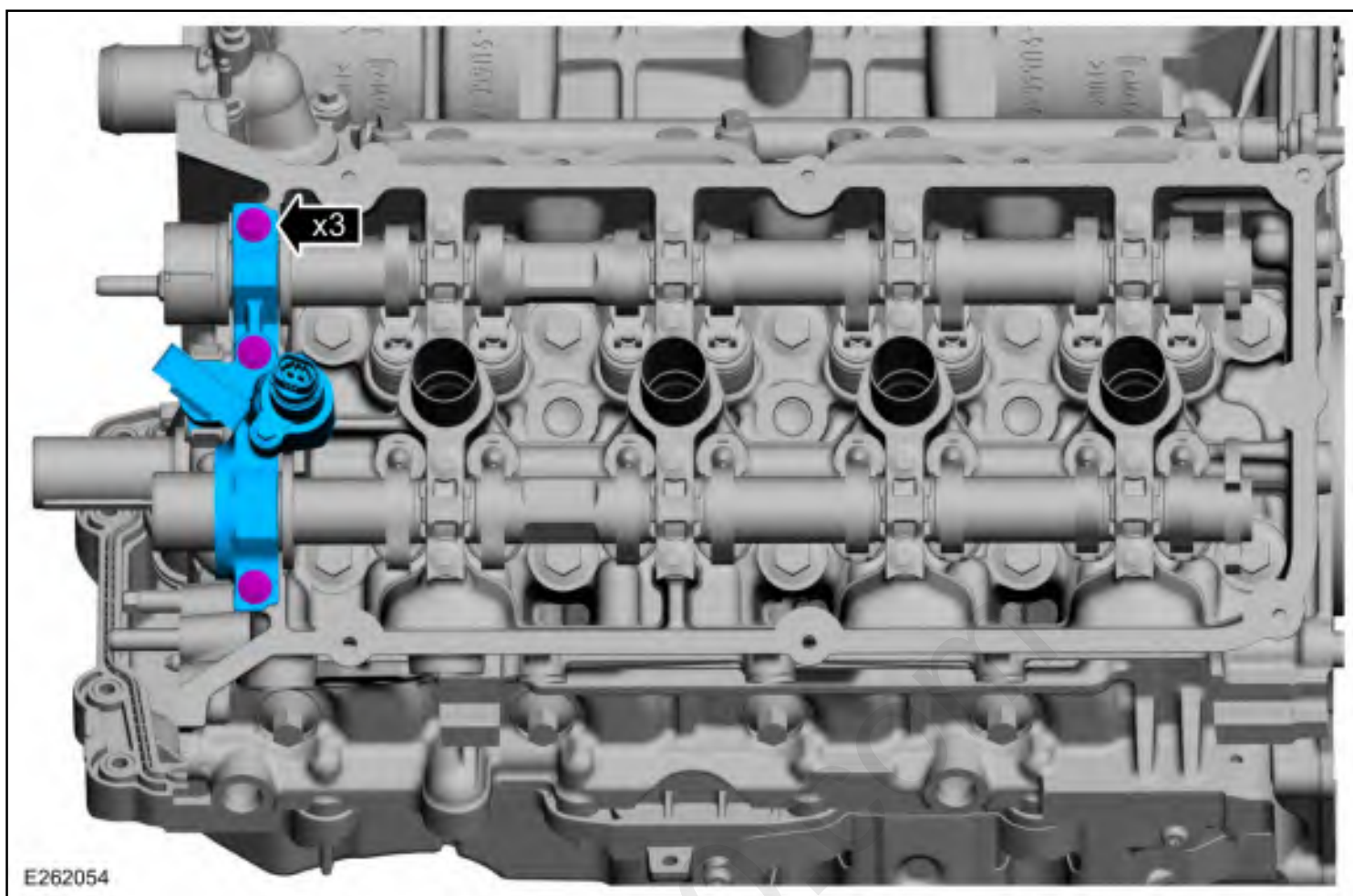




38. Install the camshaft bearing caps and the bolts. Do not tighten at this time.



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

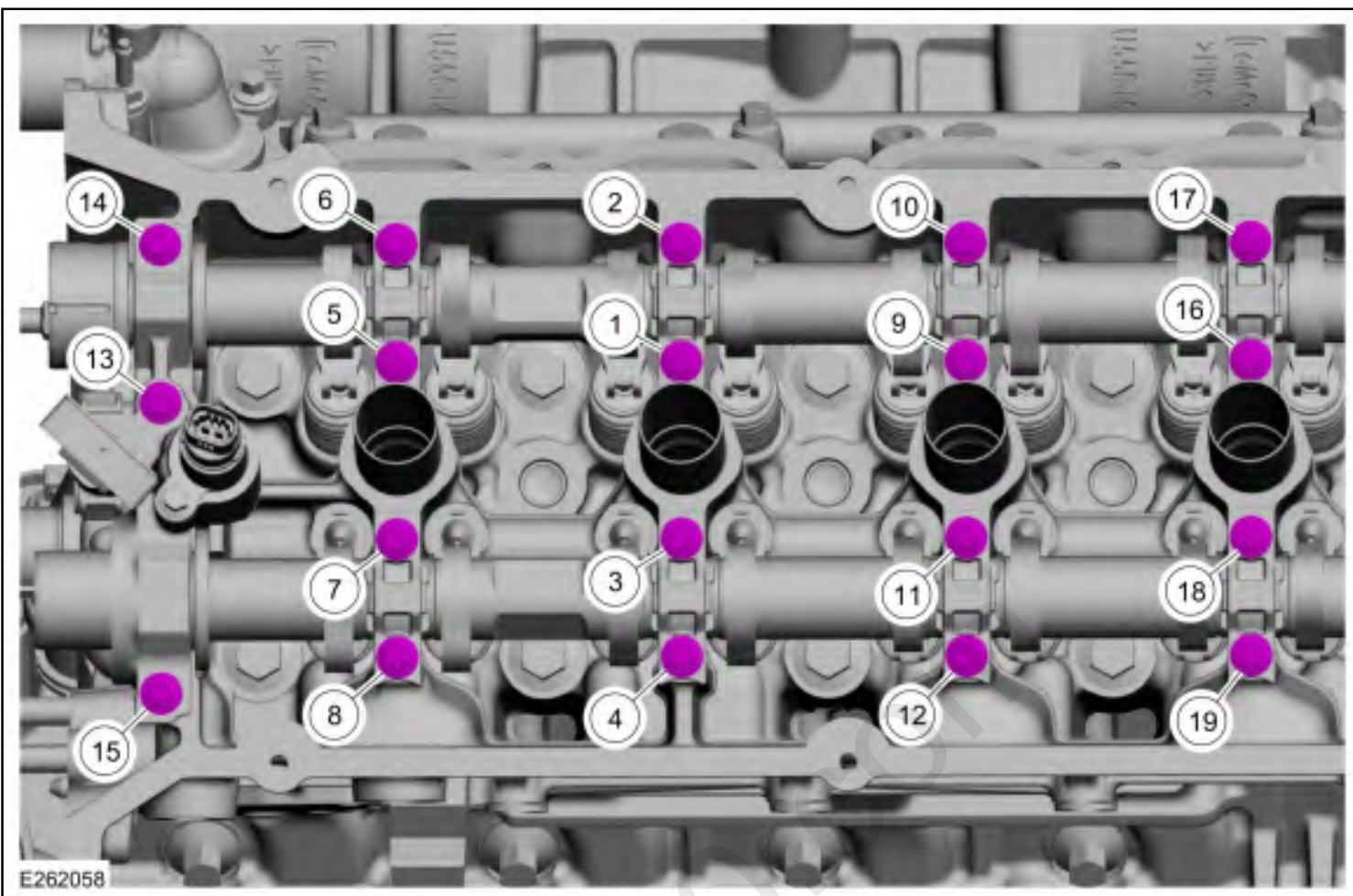


40. Tighten the bolts.

*Torque:*

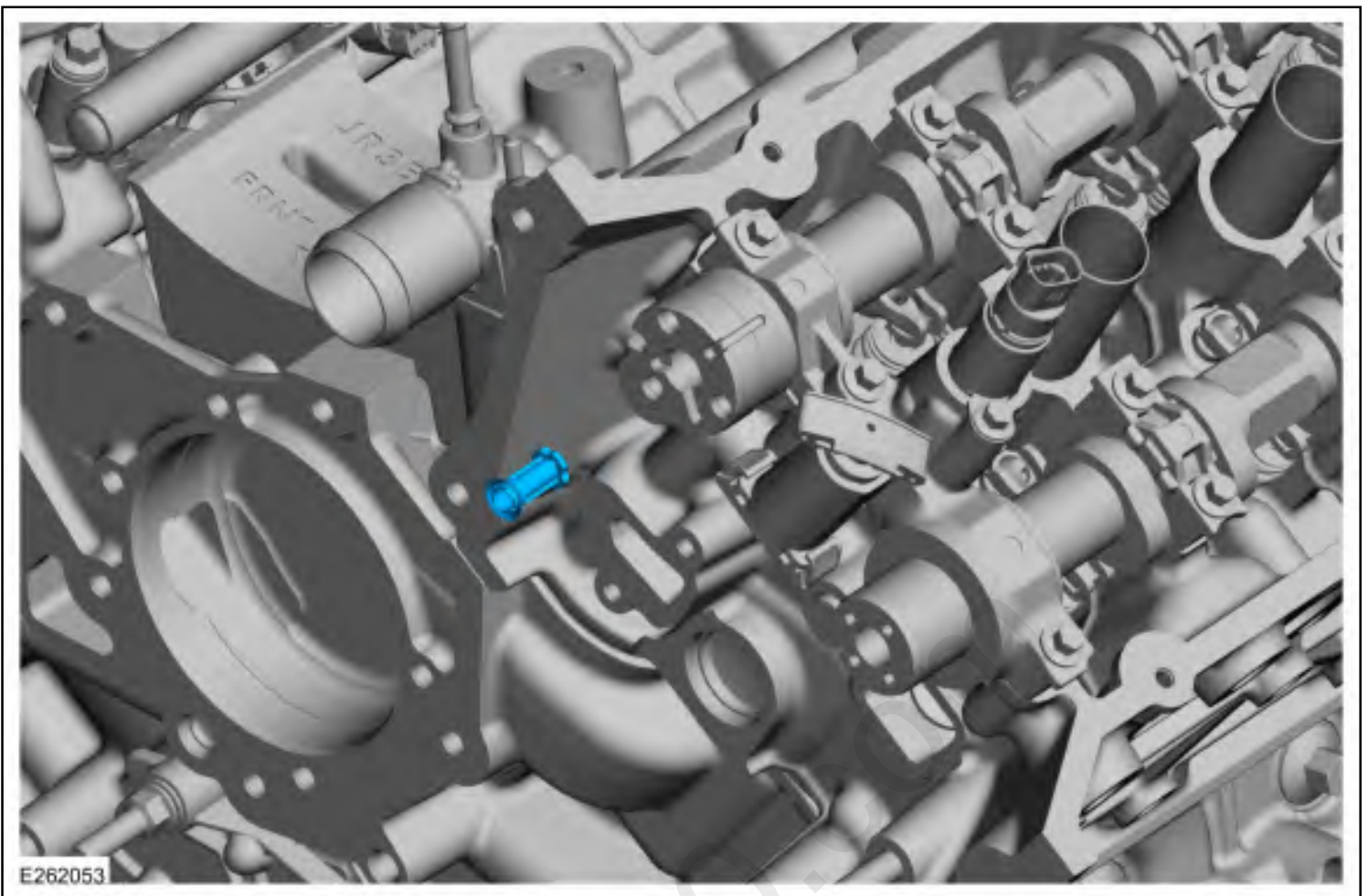
Stage 1: 53 lb.in (6 Nm)

Stage 2: 45°

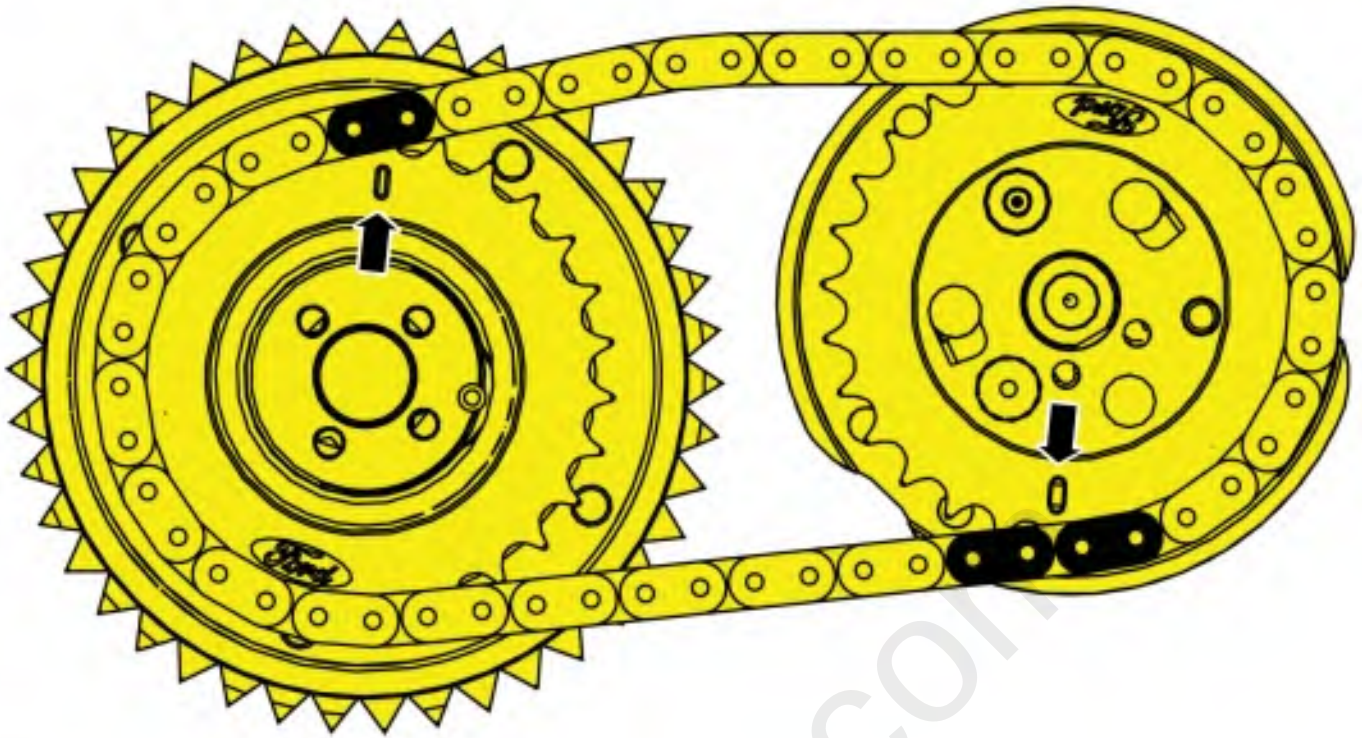


41. Install new VCT system oil filter into the camshaft.





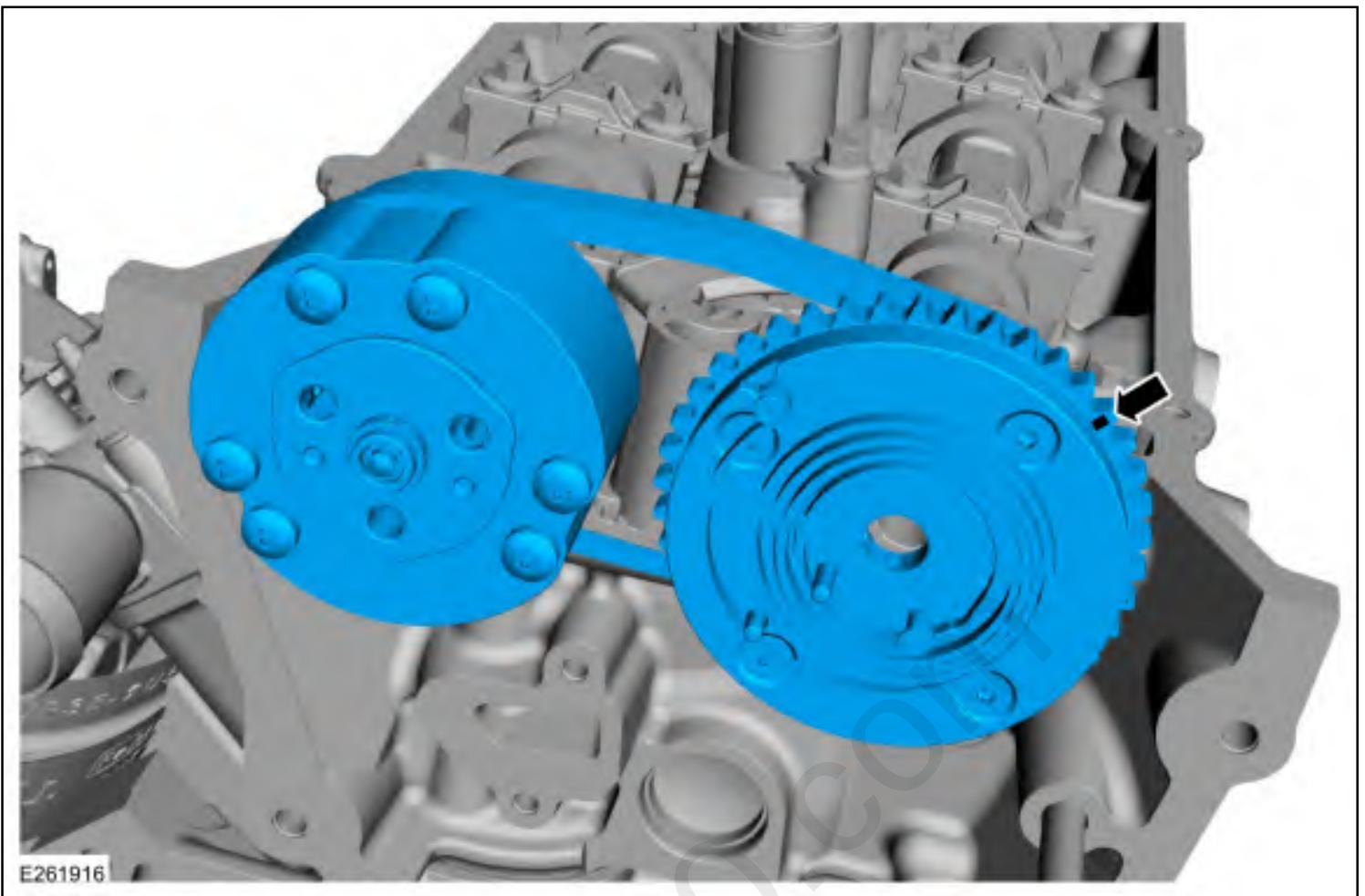
42. Position the secondary timing chain onto the VCT assemblies. Align the colored links on the secondary timing chain with the timing marks on the VCT assemblies as shown in the illustration.
- The timing mark on the intake VCT assembly should align between the 2 consecutive colored links.
  - The timing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



E261915

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.

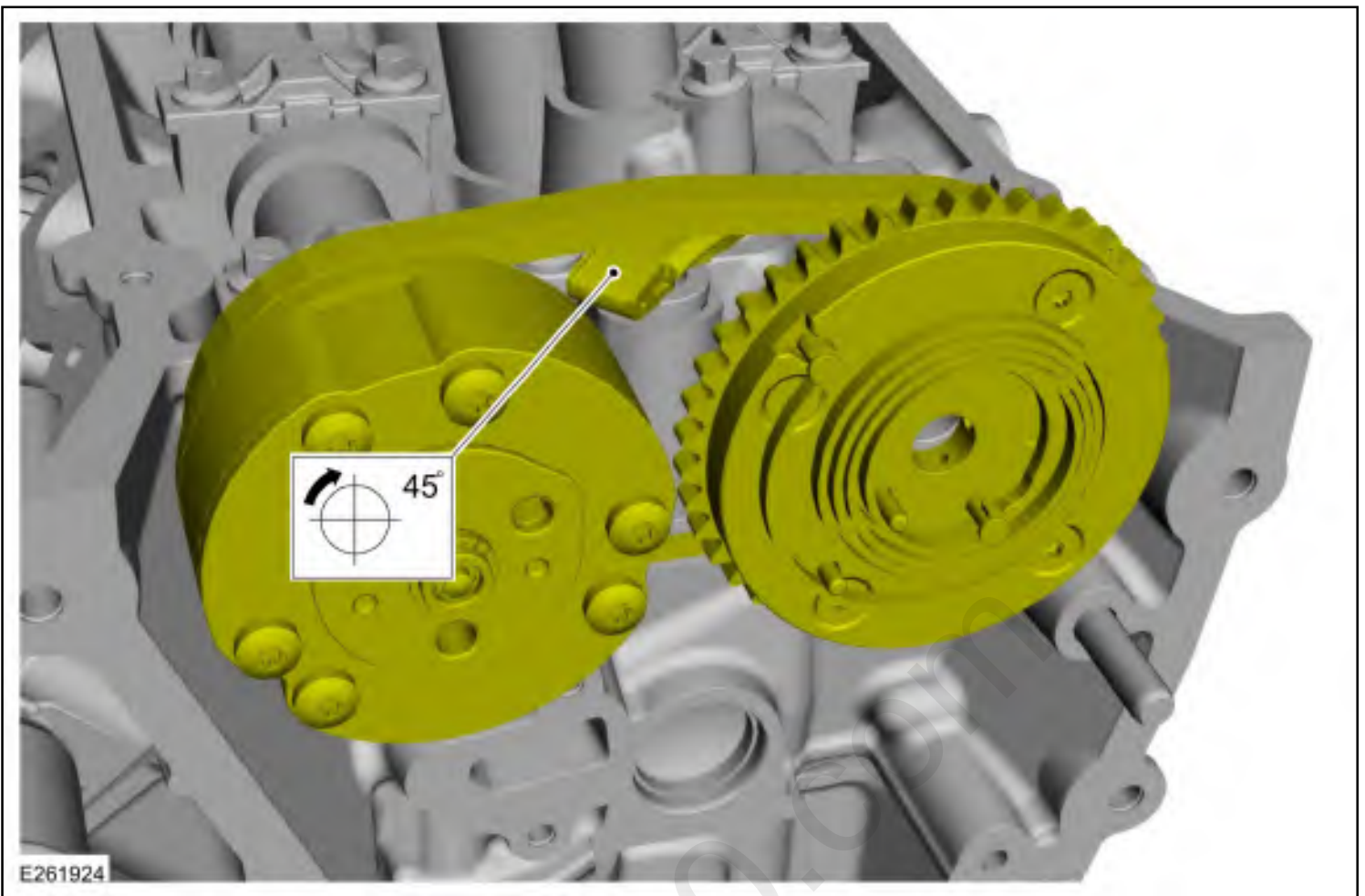




44. **NOTE:** *It may be necessary to rotate the exhaust camshaft slightly (using a wrench on the flats of the camshaft) to seat the VCT assemblies onto the camshafts.*

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.

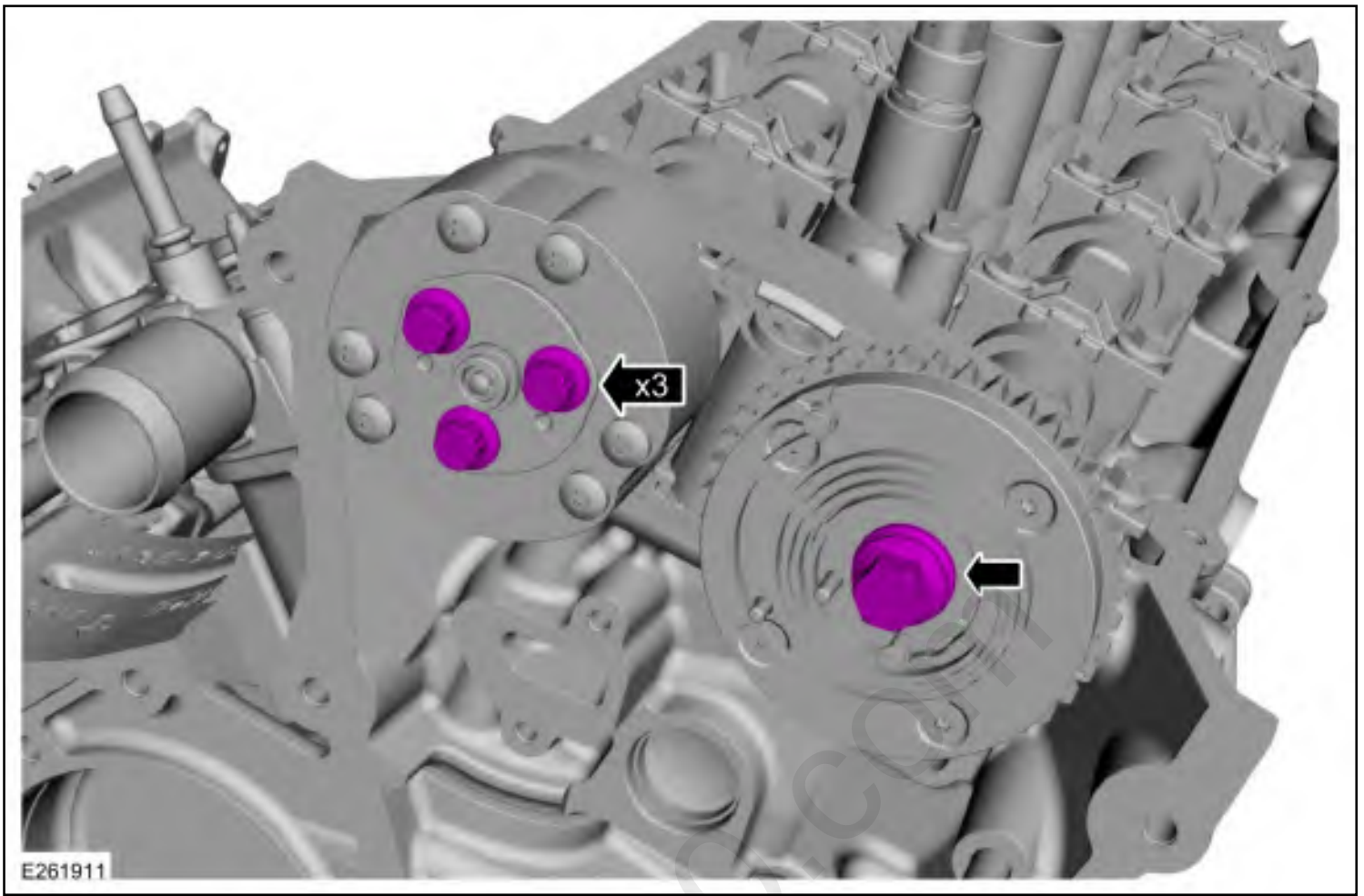
*Torque:*

Stage 1: 30 lb.ft (40 Nm)

Stage 2: Loosen: 360°

Stage 3: 20 lb.ft (27 Nm)

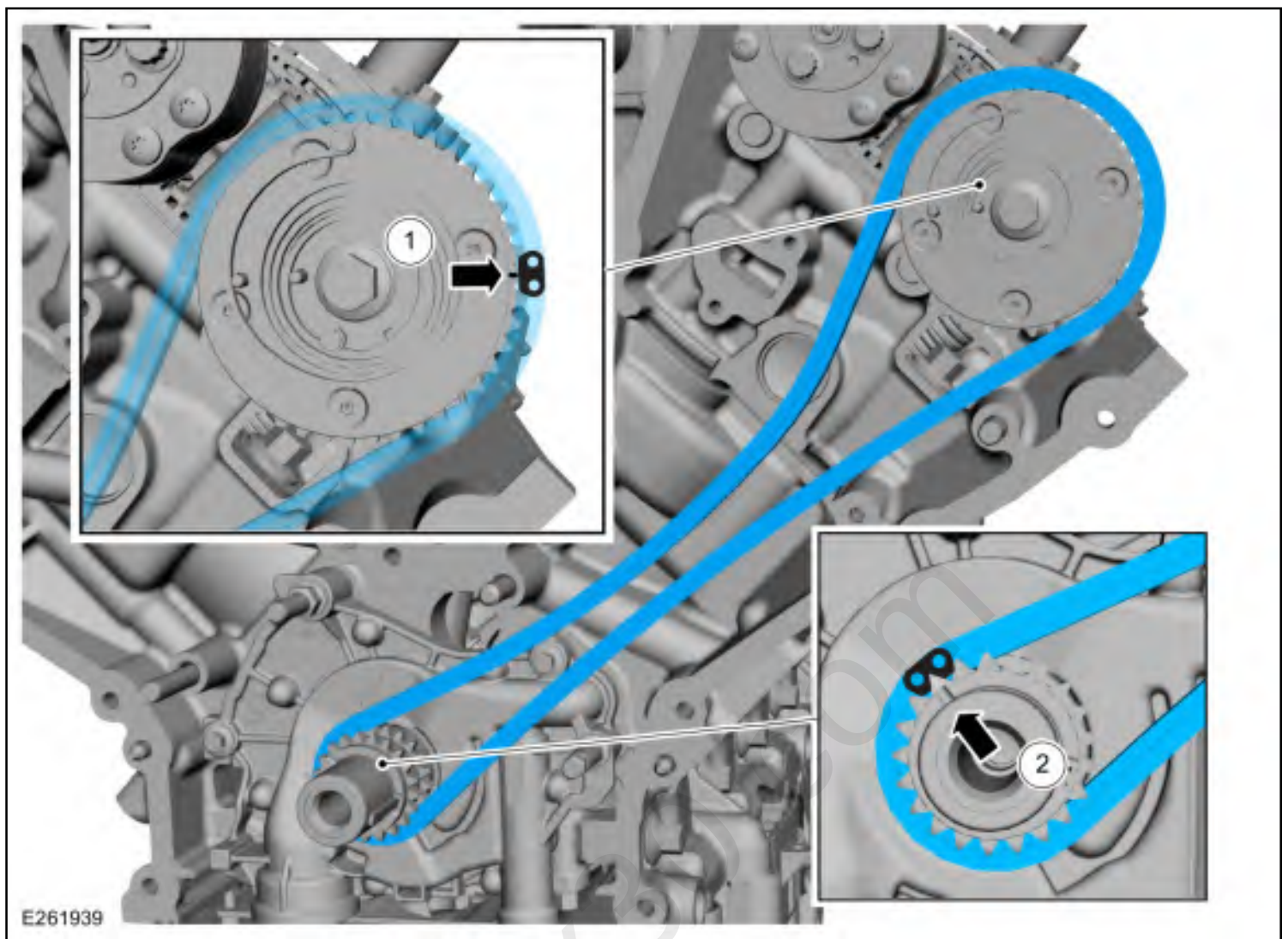
Stage 4: 150°



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.





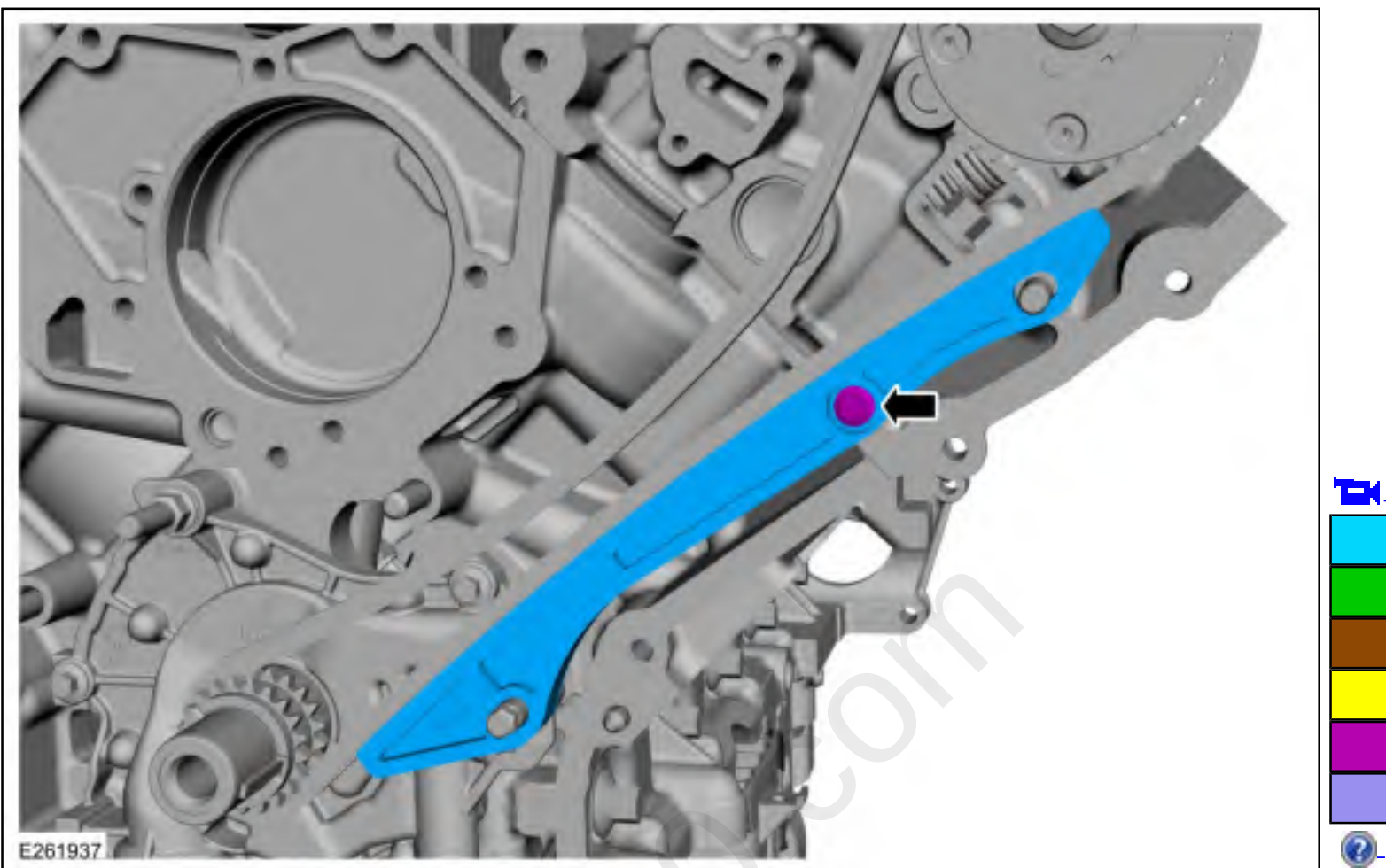
47. **NOTE:** It may be necessary to rotate the crankshaft slightly to provide enough slack in the chain to install the LH timing chain guide. Return the crankshaft keyway to the 3:30 position after installing the LH timing chain guide.

Install the LH timing chain guide and bolt.

*Torque:*

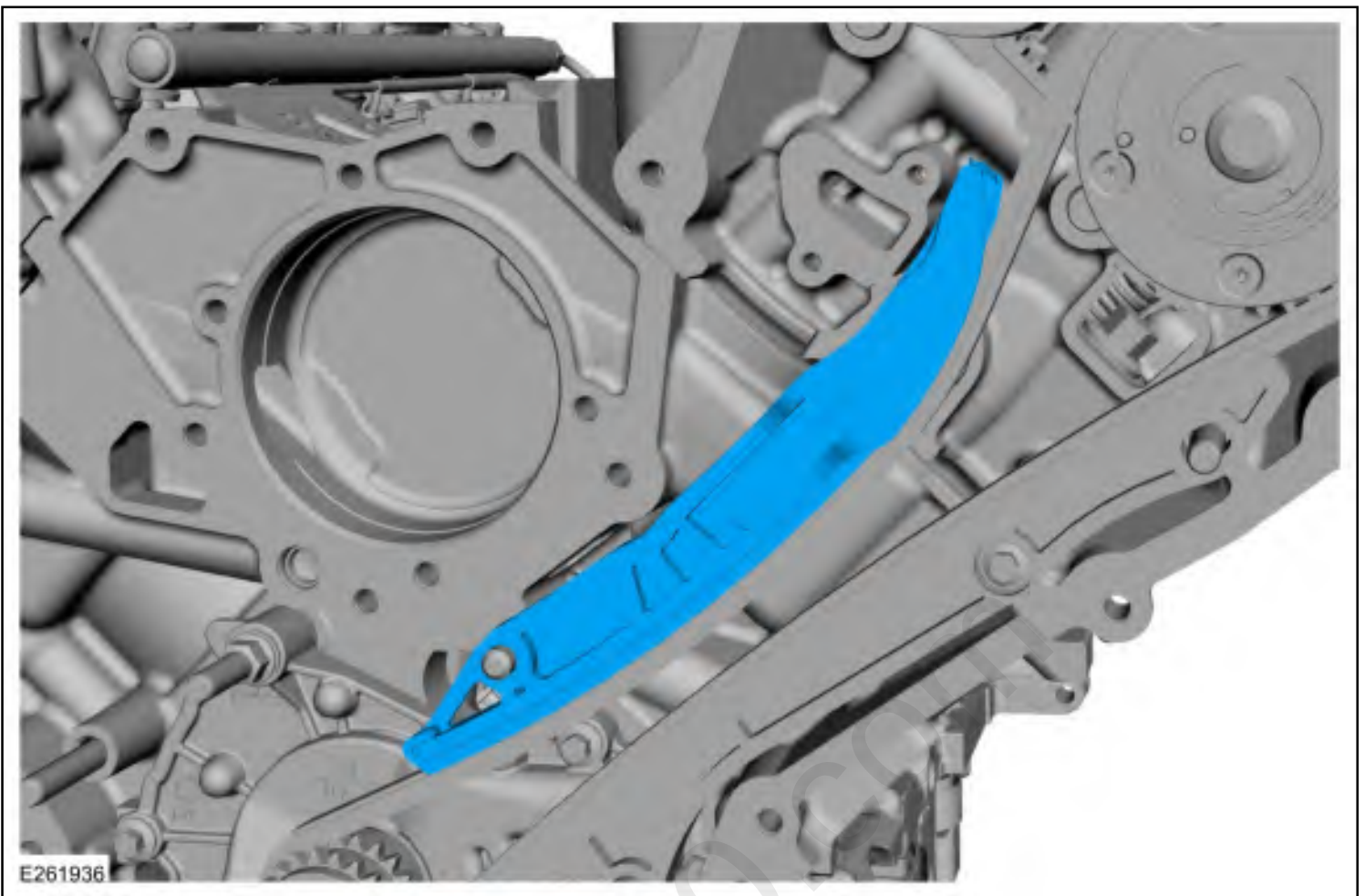
Stage 1: 89 lb.in (10 Nm)

Stage 2: 25°



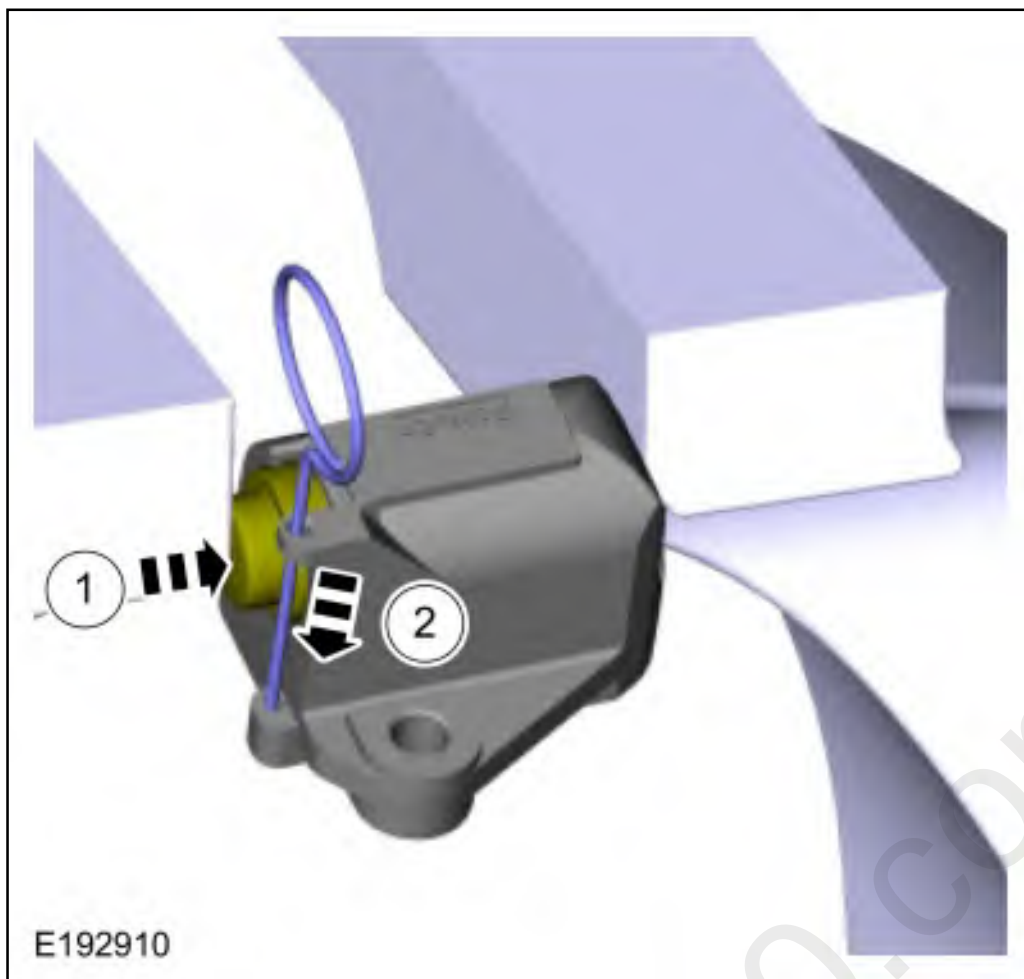
48. **NOTE:** *It may be necessary to rotate the crankshaft slightly to provide enough slack in the chain to install the LH timing chain arm. Return the crankshaft keyway to the 3:30 position after installing the LH timing chain arm.*

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.





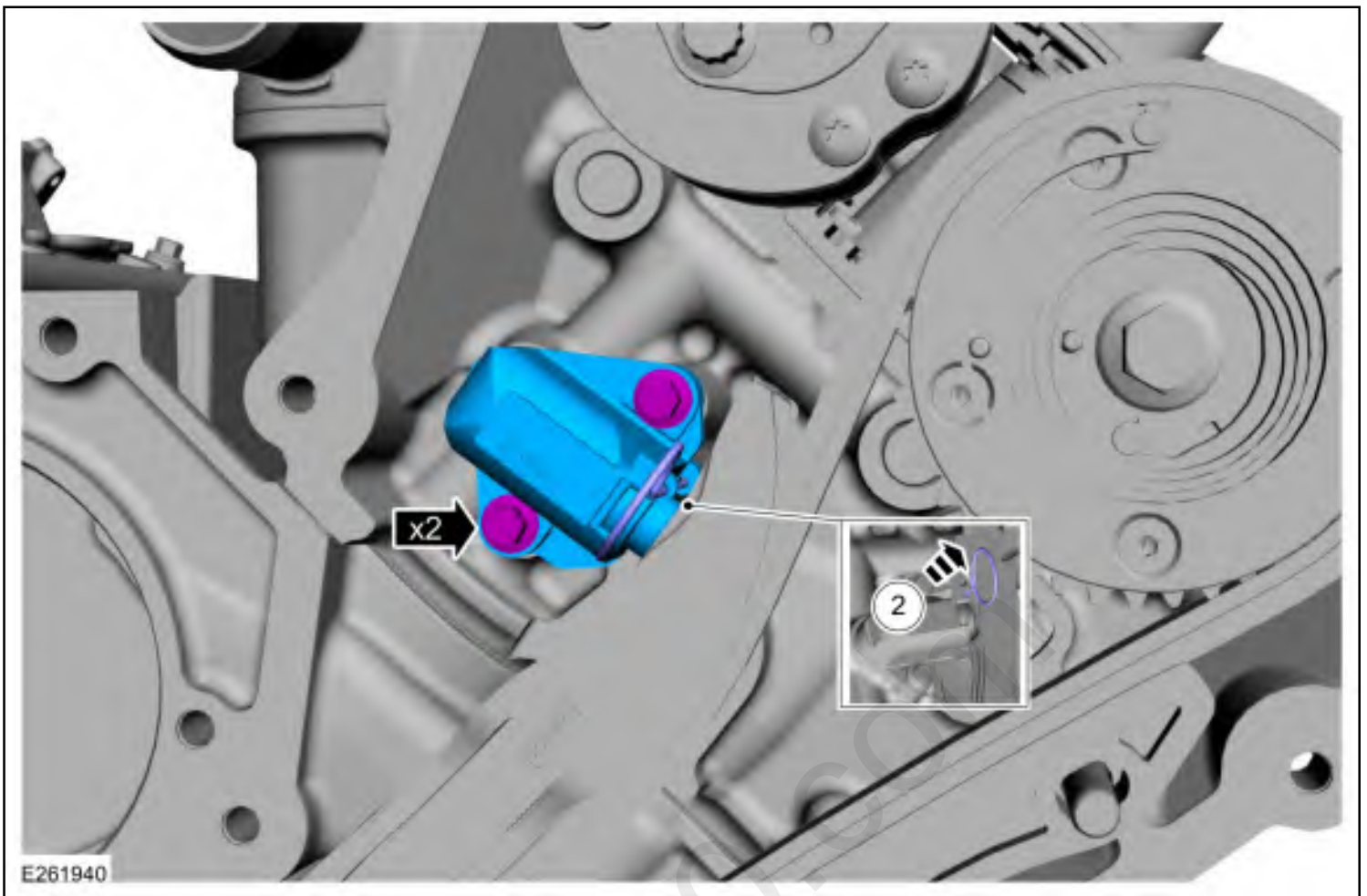
1. Install the LH primary timing chain tensioner and bolts.

*Torque:*

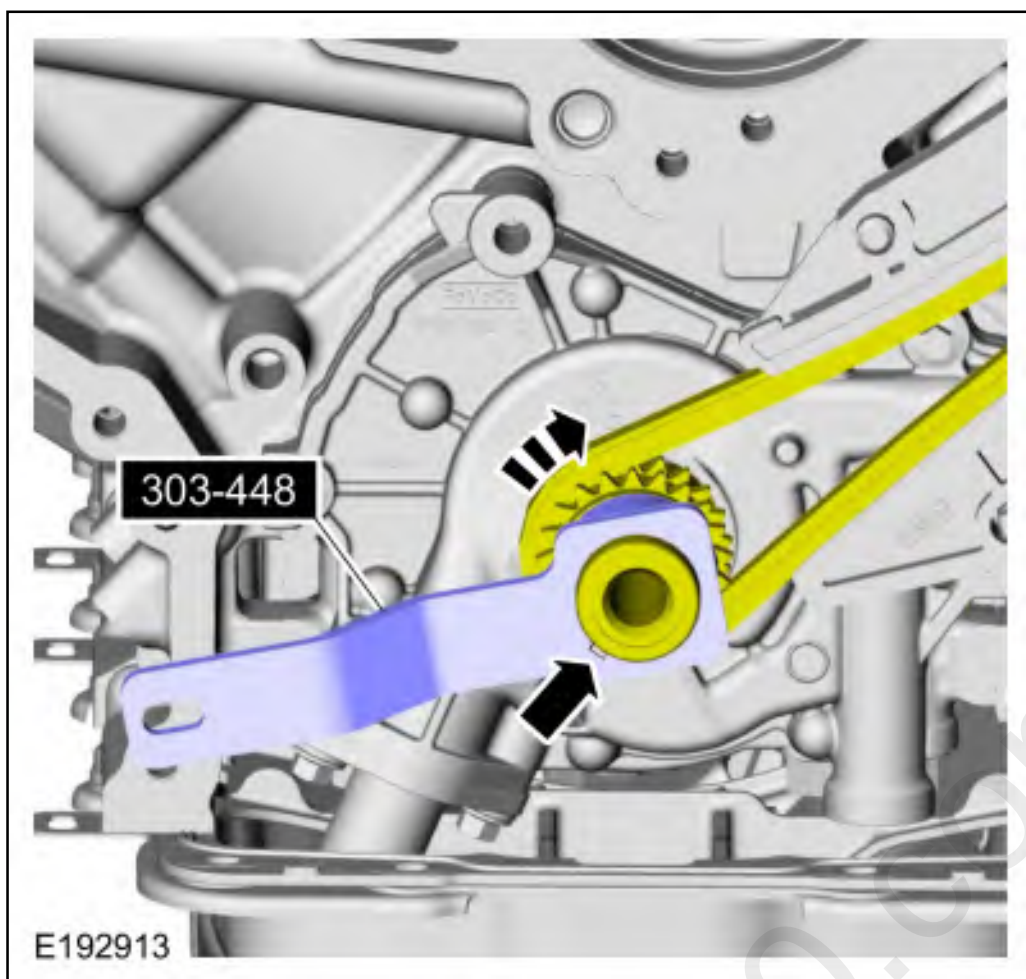
Stage 1: 89 lb.in (10 Nm)

Stage 2: 25°

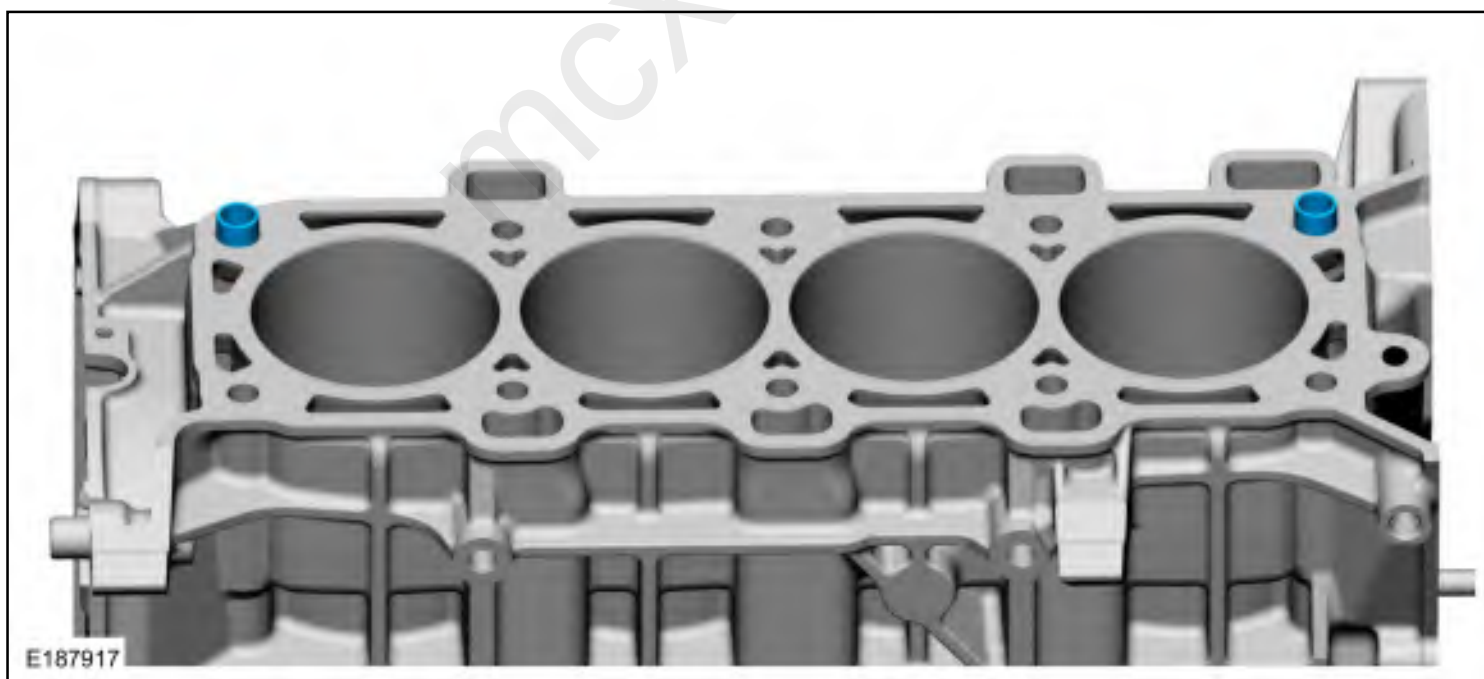
2. Remove the holding pin from the tensioner.



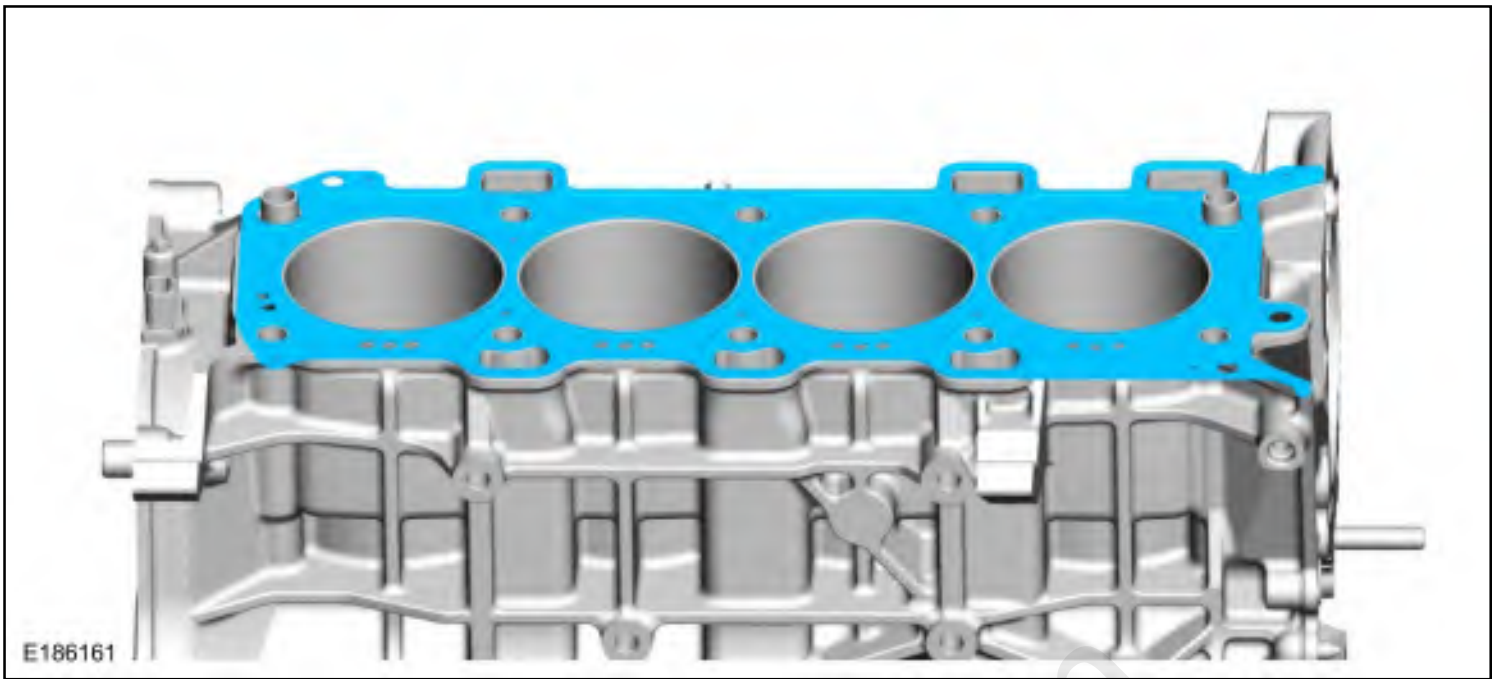
51. Using the special tool, rotate the crankshaft clockwise until the keyway is at the 7:30 position.  
Use Special Service Tool: 303-448 (T93P-6303-A) Holding Tool, Crankshaft.



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)

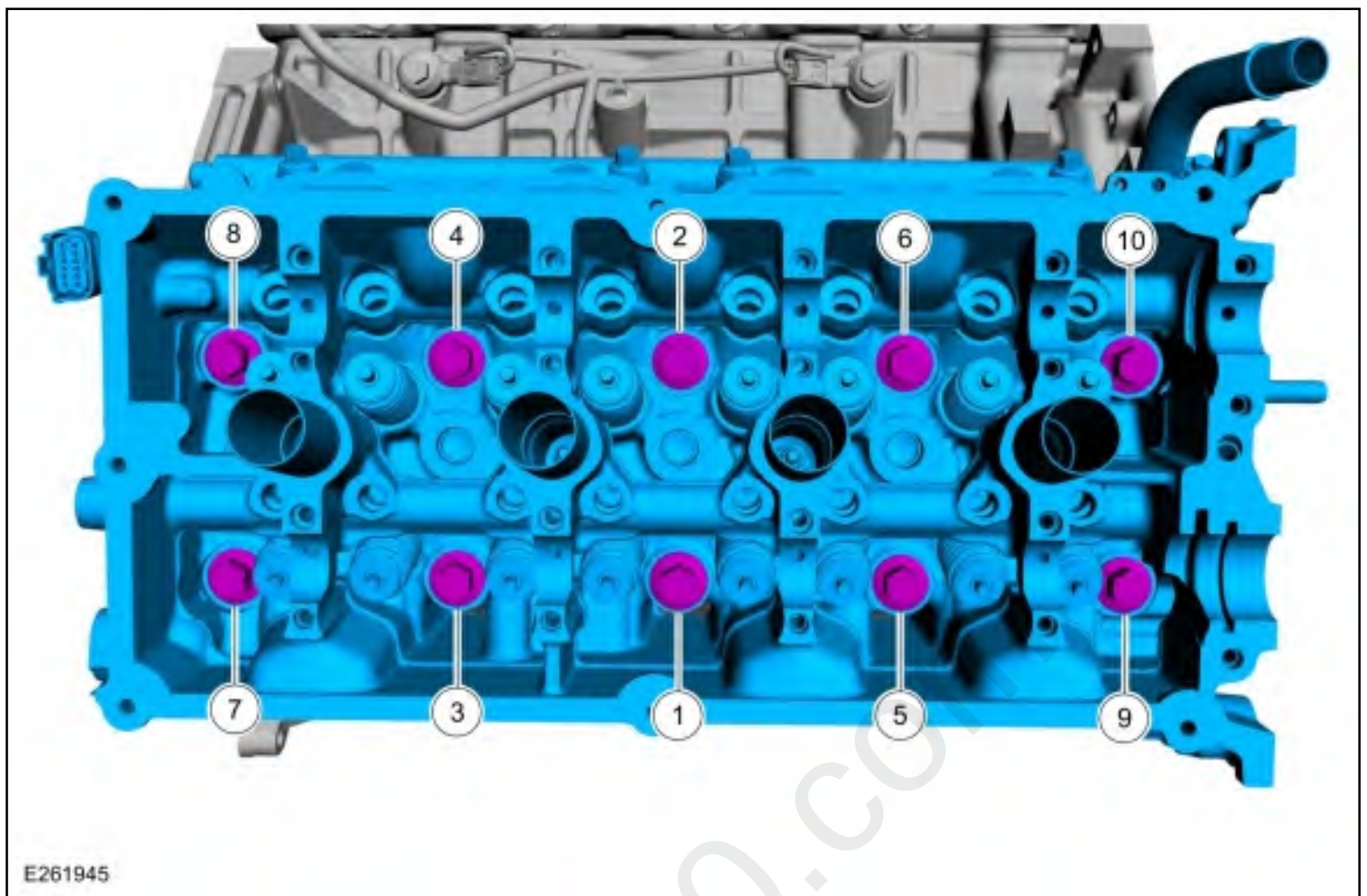
Stage 3: Bolt 1: Loosen: 180°

Stage 4: Bolt 1: 37 lb.ft (50 Nm)

Stage 5: Bolt 1: 240°

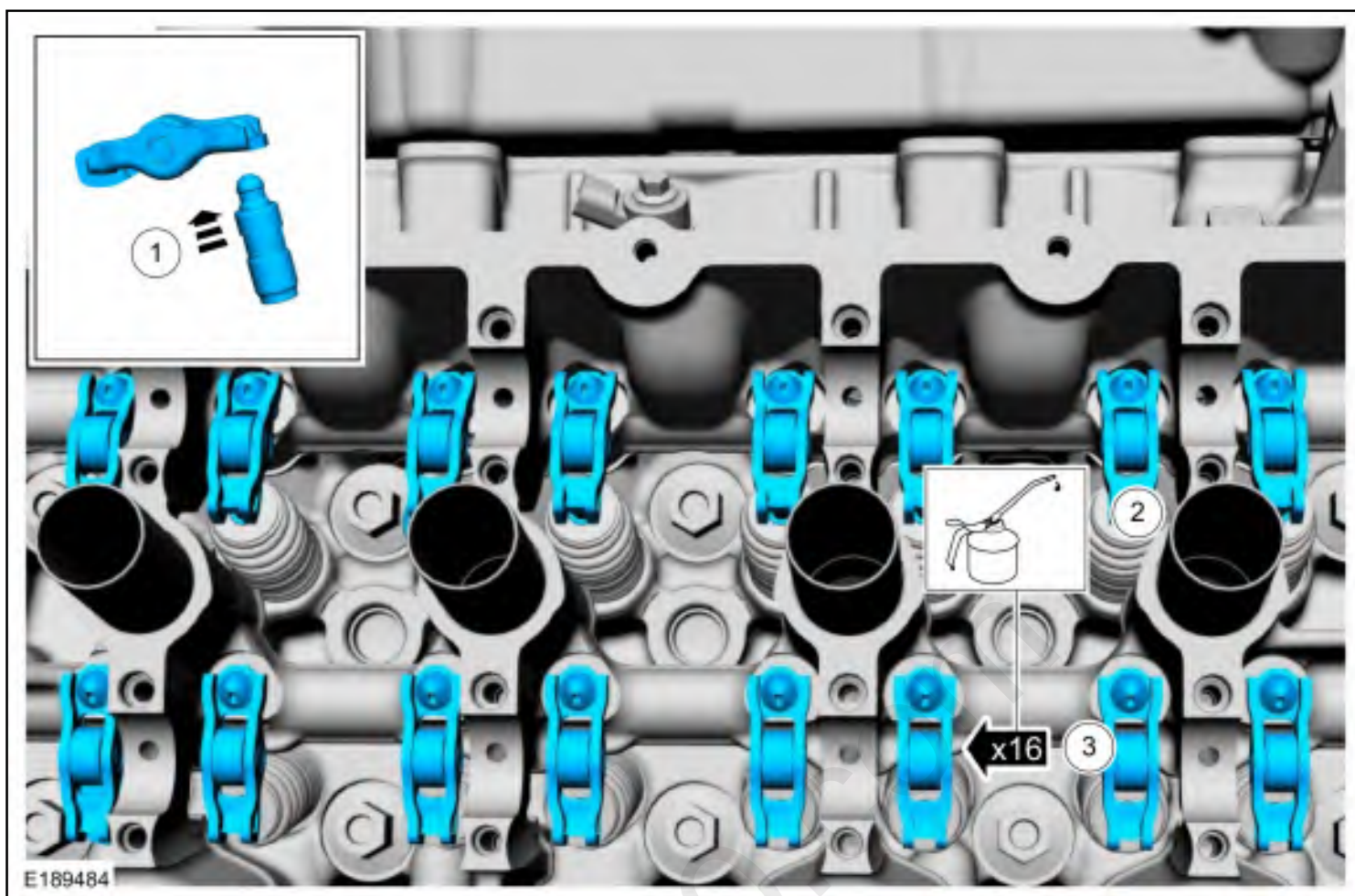
2. Perform stages 3, 4 and 5 on bolts 2 through 10 (complete all three stages to each bolt before moving on to the next bolt in sequence).





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

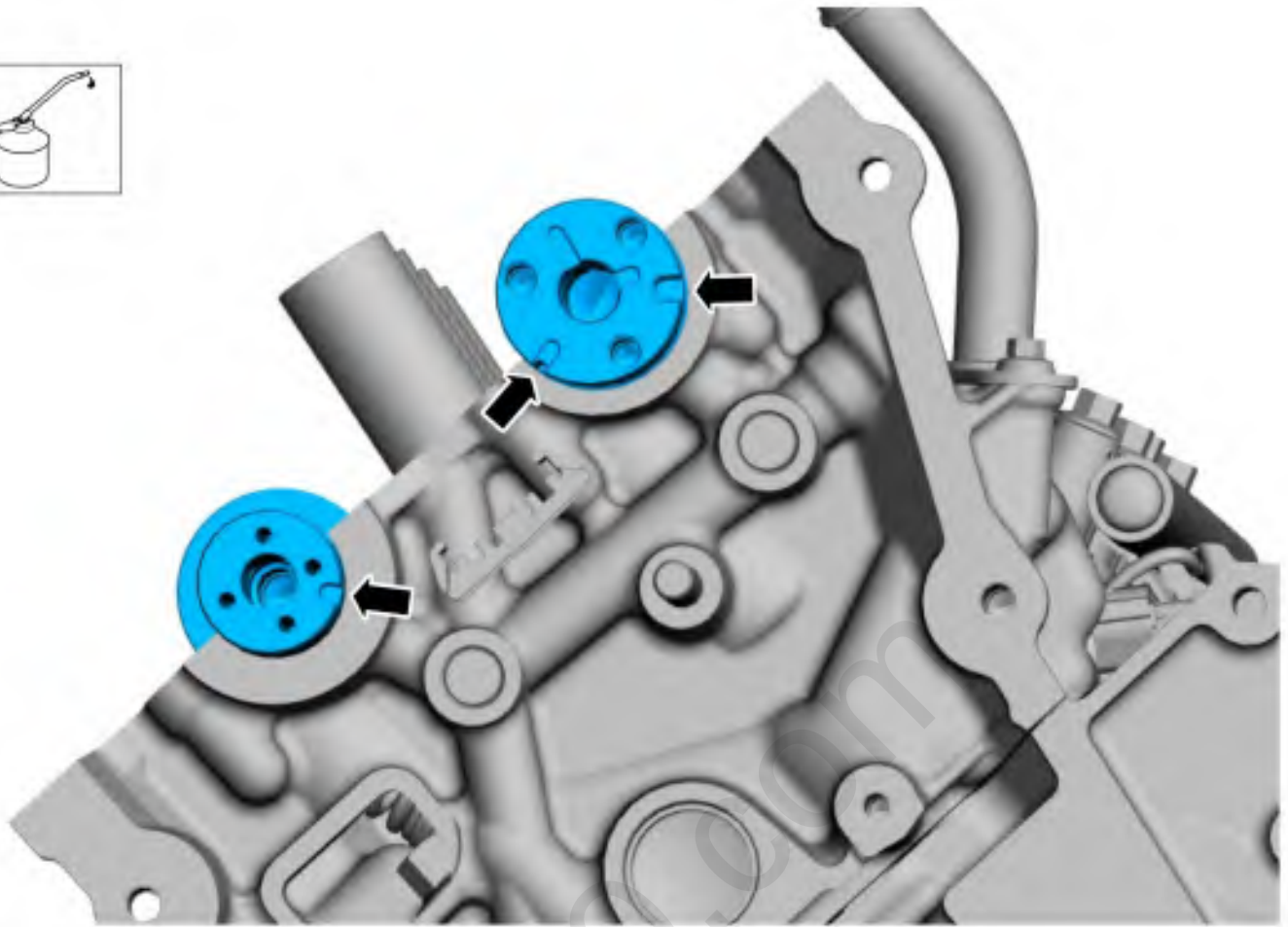
1. Assemble the hydraulic lash adjusters onto the spring clips on the camshaft roller followers.
2. Lubricate the camshaft roller follower and hydraulic lash adjuster assemblies with clean engine oil.
3. Install the camshaft roller follower and hydraulic lash adjuster assemblies.



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.

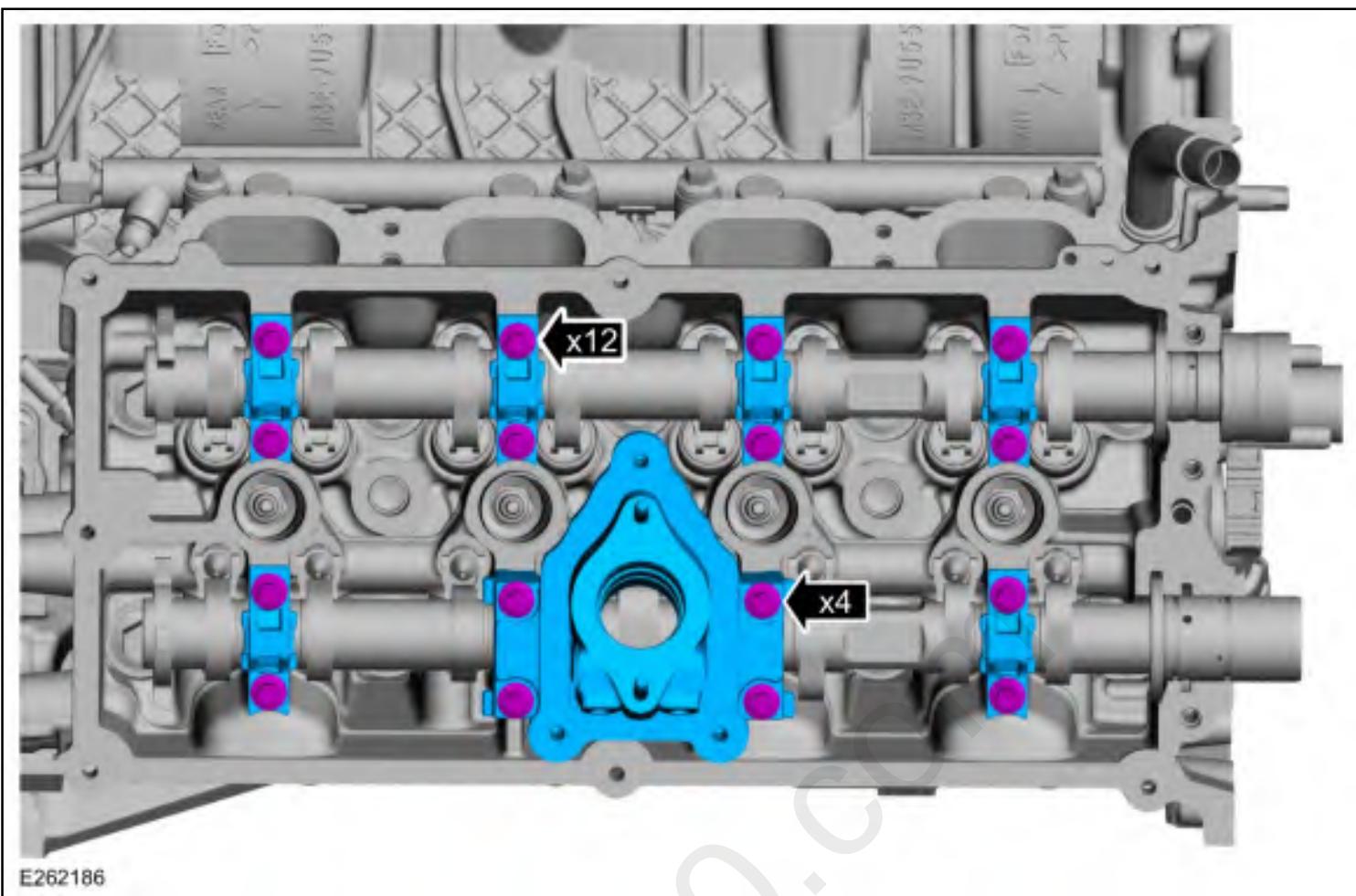




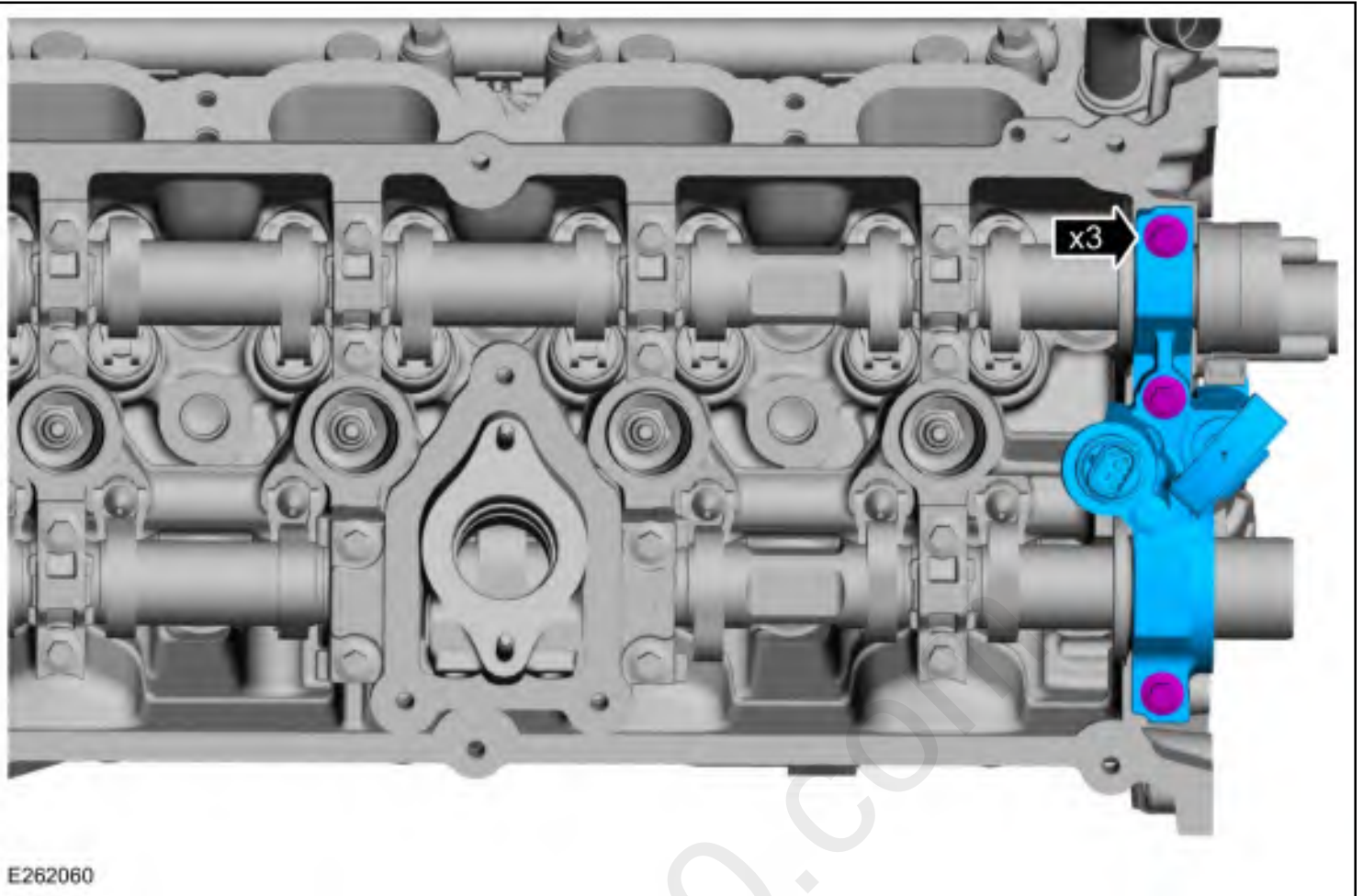
E262188



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.

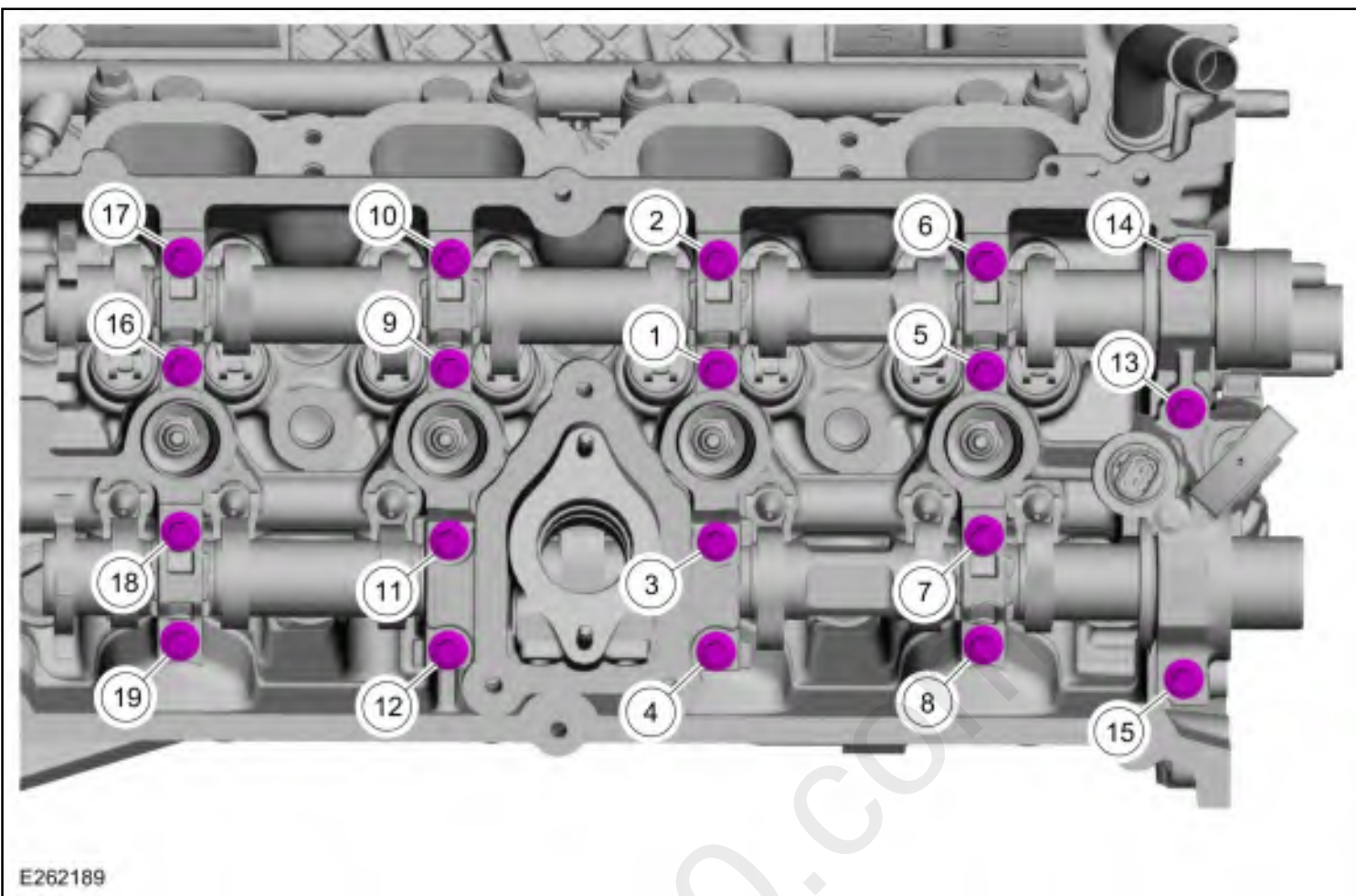


59. Tighten the bolts in sequence.

*Torque:*

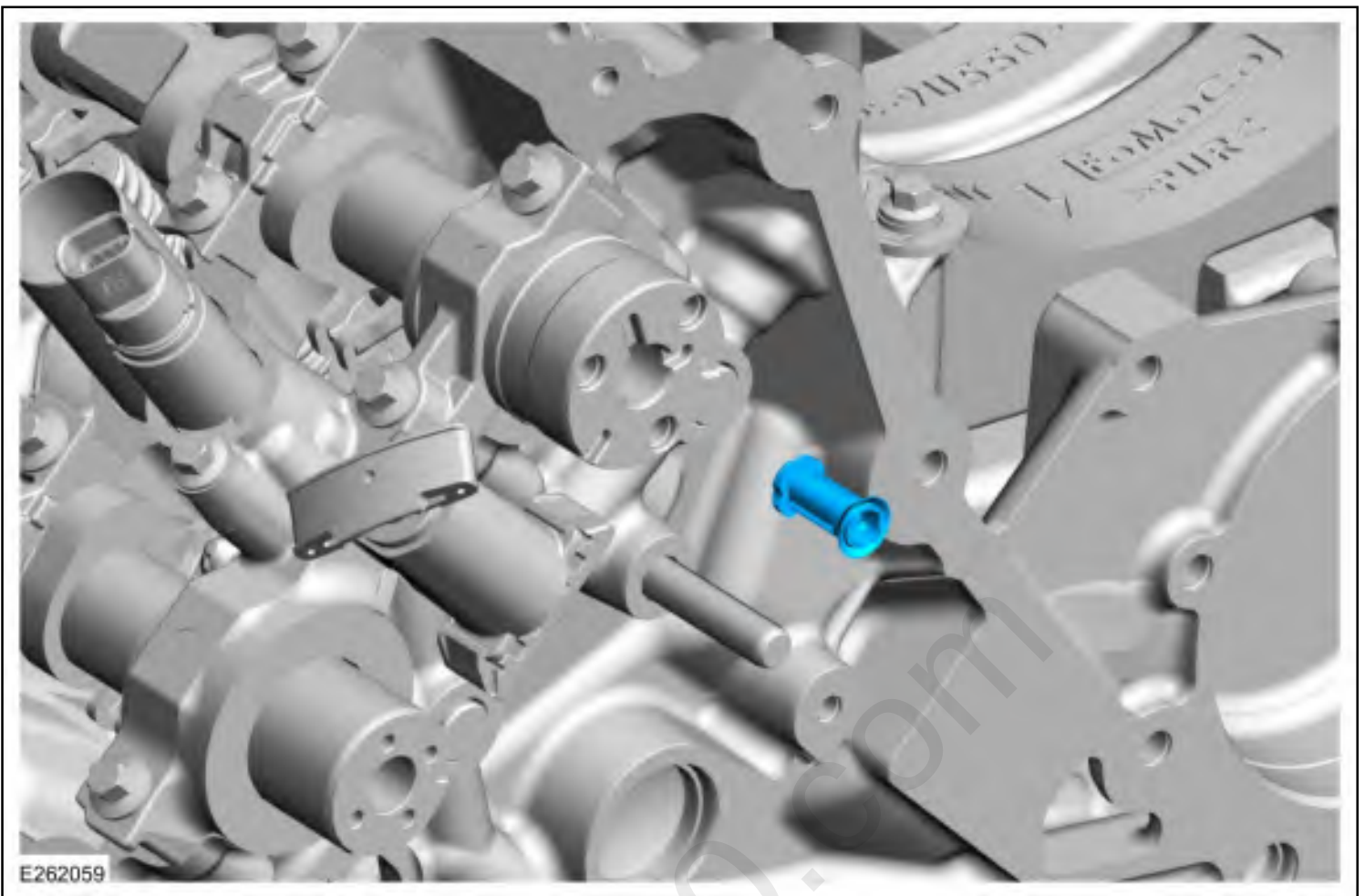
Stage 1: Bolts 1-19: 53 lb.in (6 Nm)

Stage 2: Bolts 1-2, 5-10, 13-19: 45° Bolts 3-4, 11-12: 90°

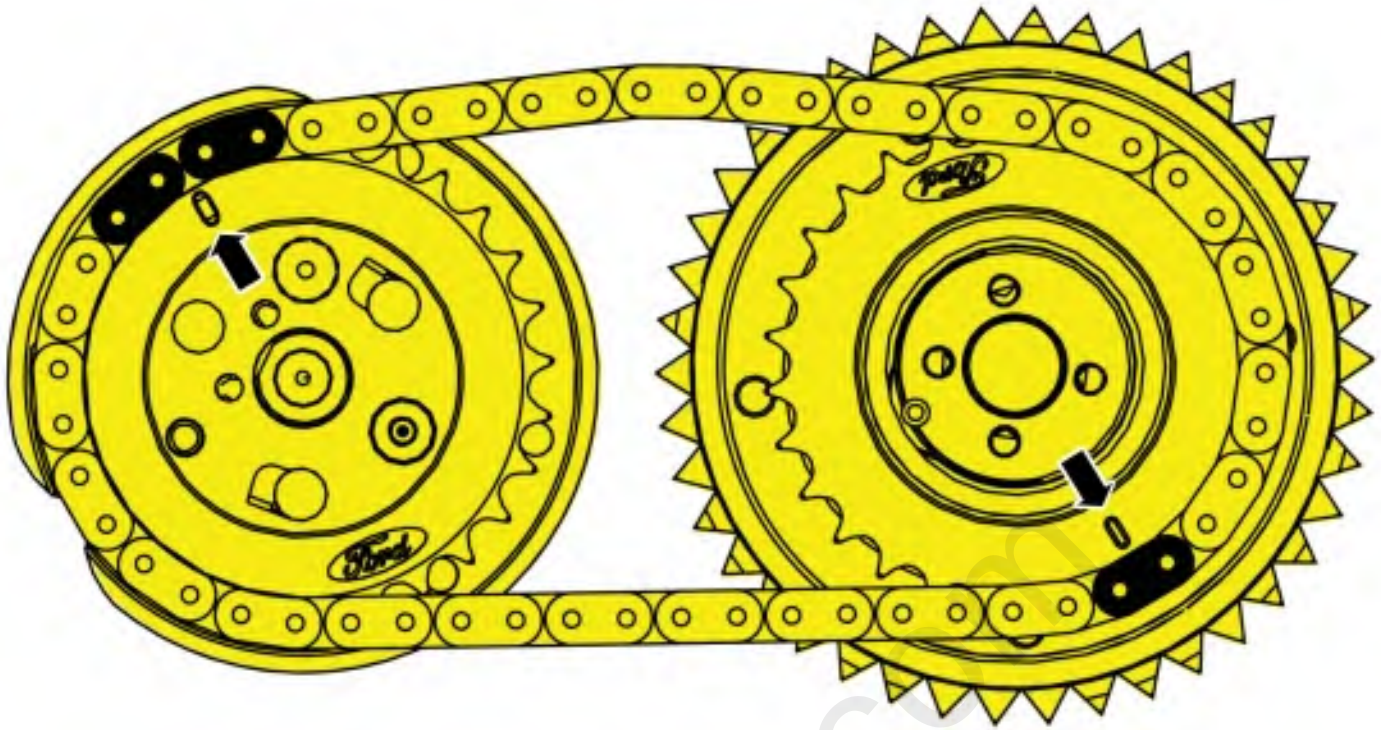


60. Install a new VCT system oil filter into the camshaft.





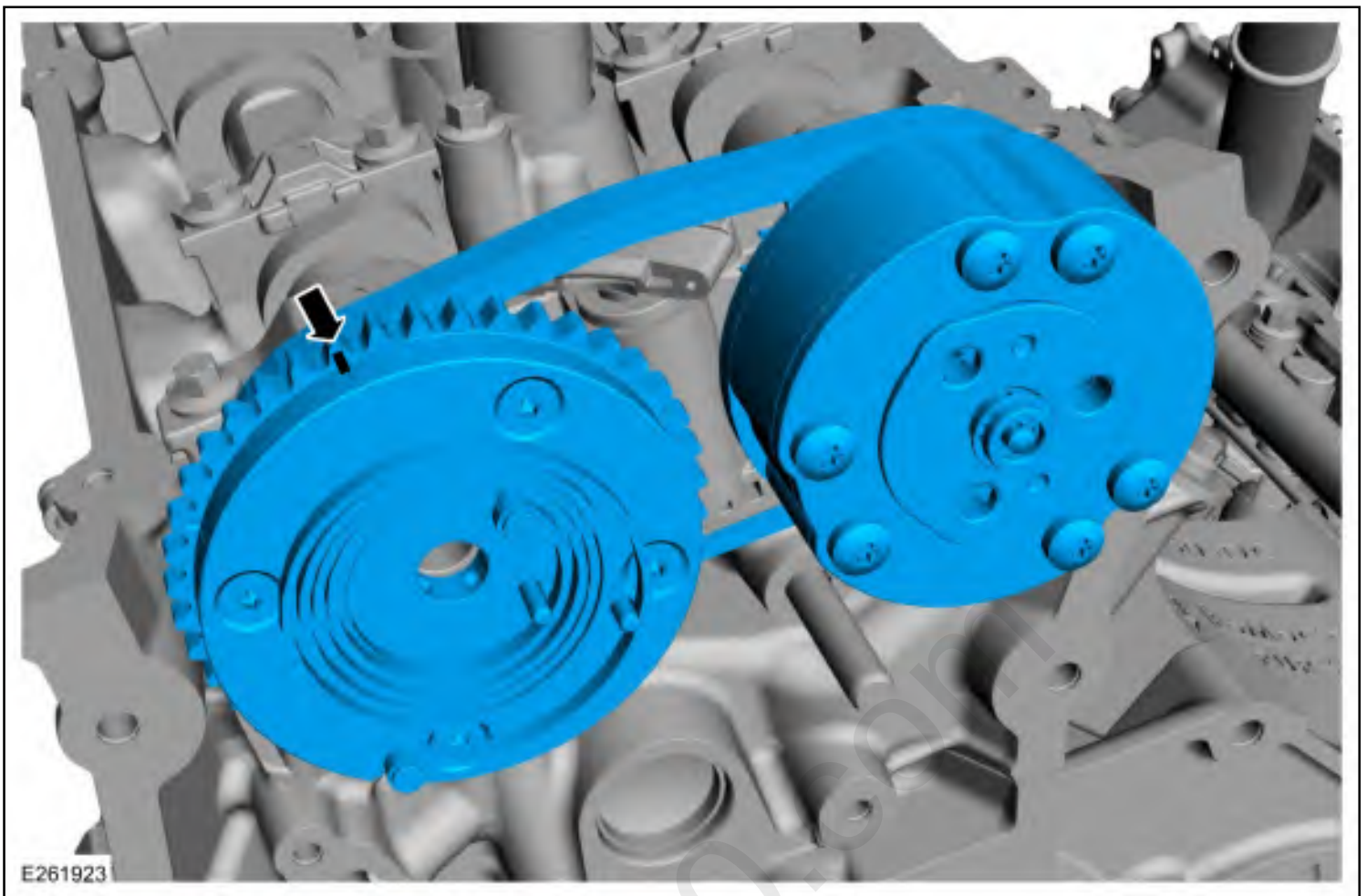
61. Position the secondary timing chain onto the VCT assemblies. Align the colored links on the secondary timing chain with the timing marks on the VCT assemblies as shown in the illustration.
- The timing mark on the intake VCT assembly should align between the 2 consecutive colored links.
  - The timing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



E261922

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.

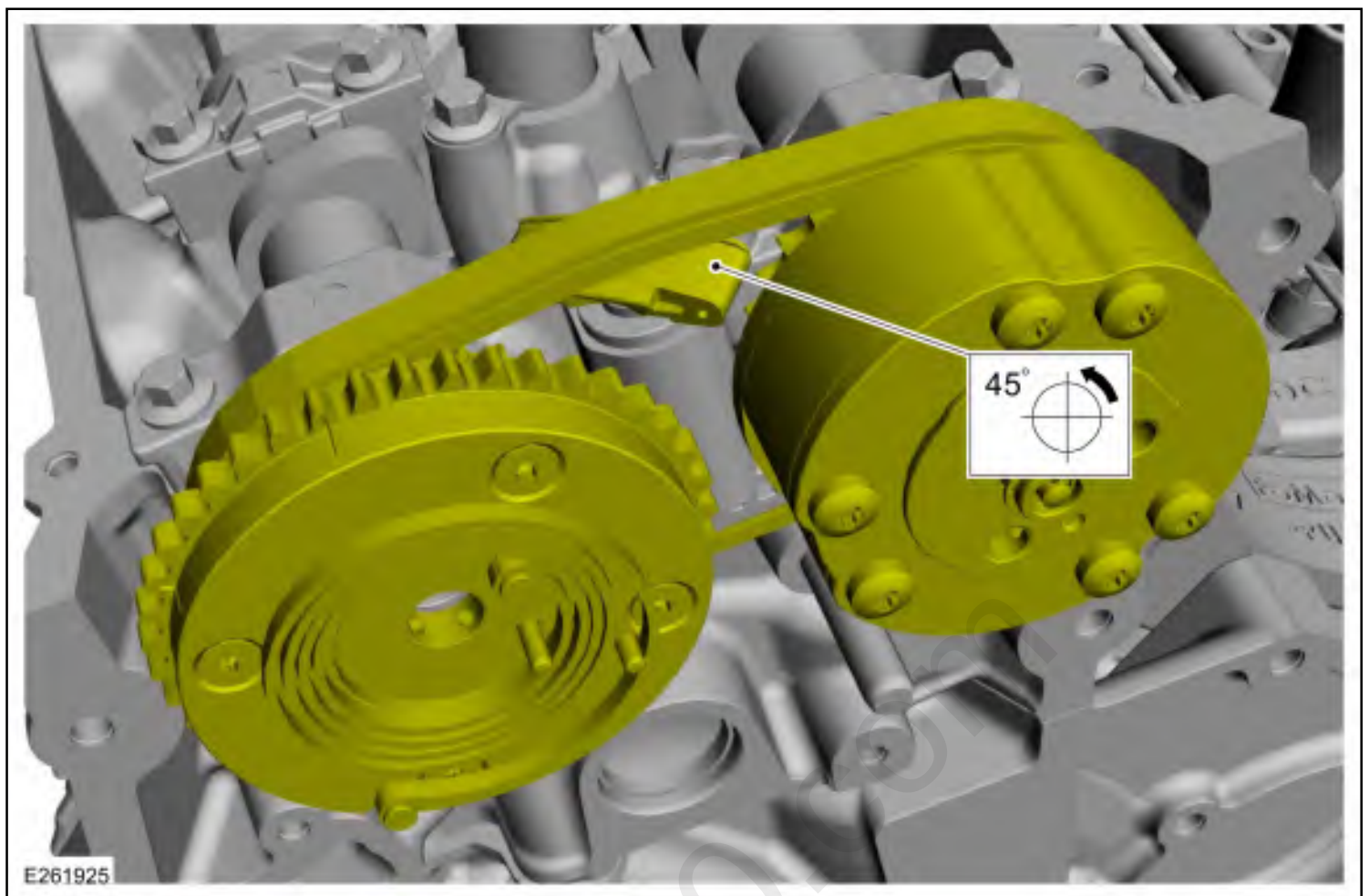




63. **NOTE:** *It may be necessary to rotate the exhaust camshaft slightly (using a wrench on the flats of the camshaft) to seat the VCT assemblies onto the camshafts.*

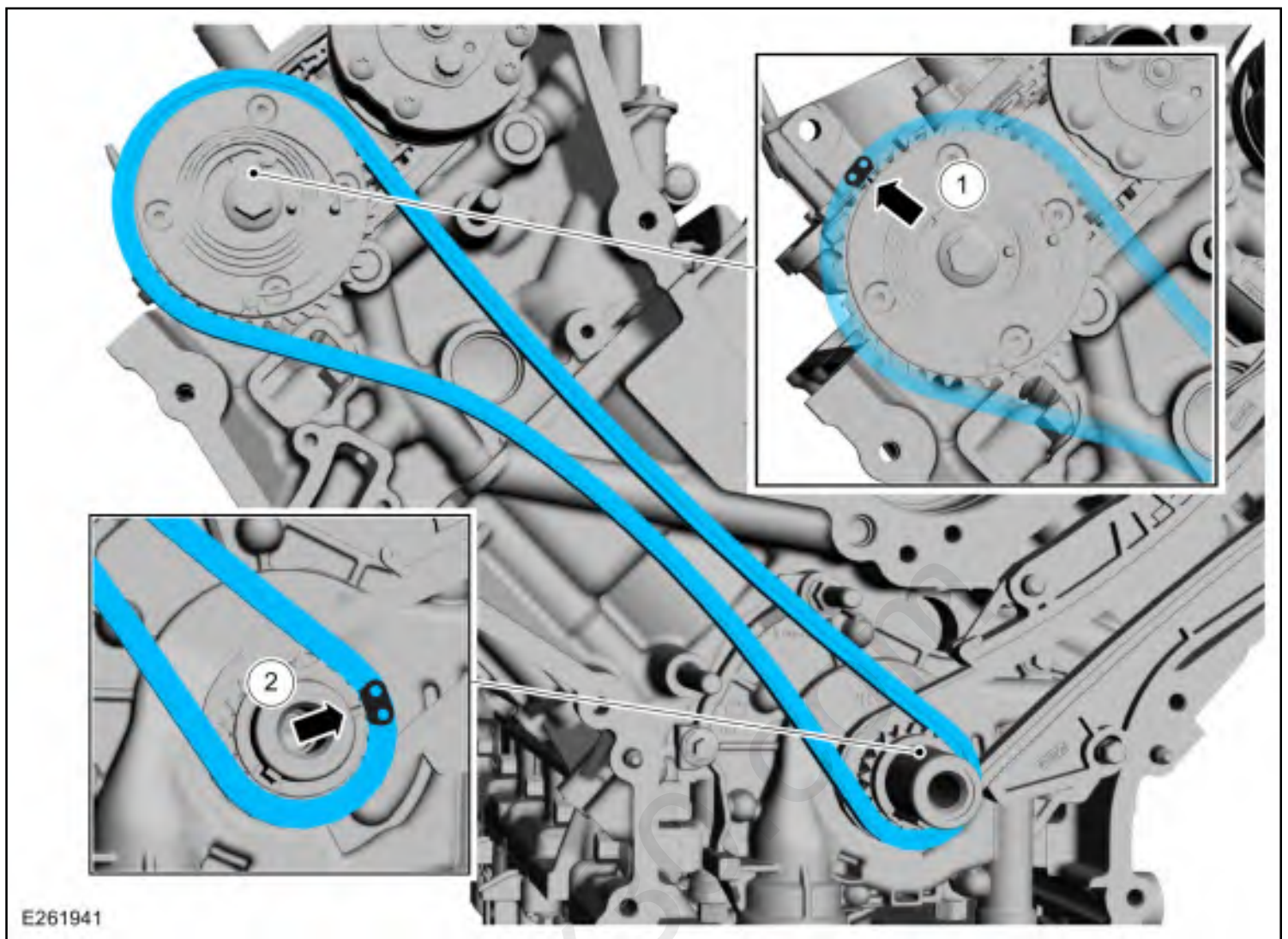
Rotate the secondary timing chain tensioner counterclockwise 45 degrees so the ramped area is facing forward and fully seat the VCT assemblies onto the camshafts.

- 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.

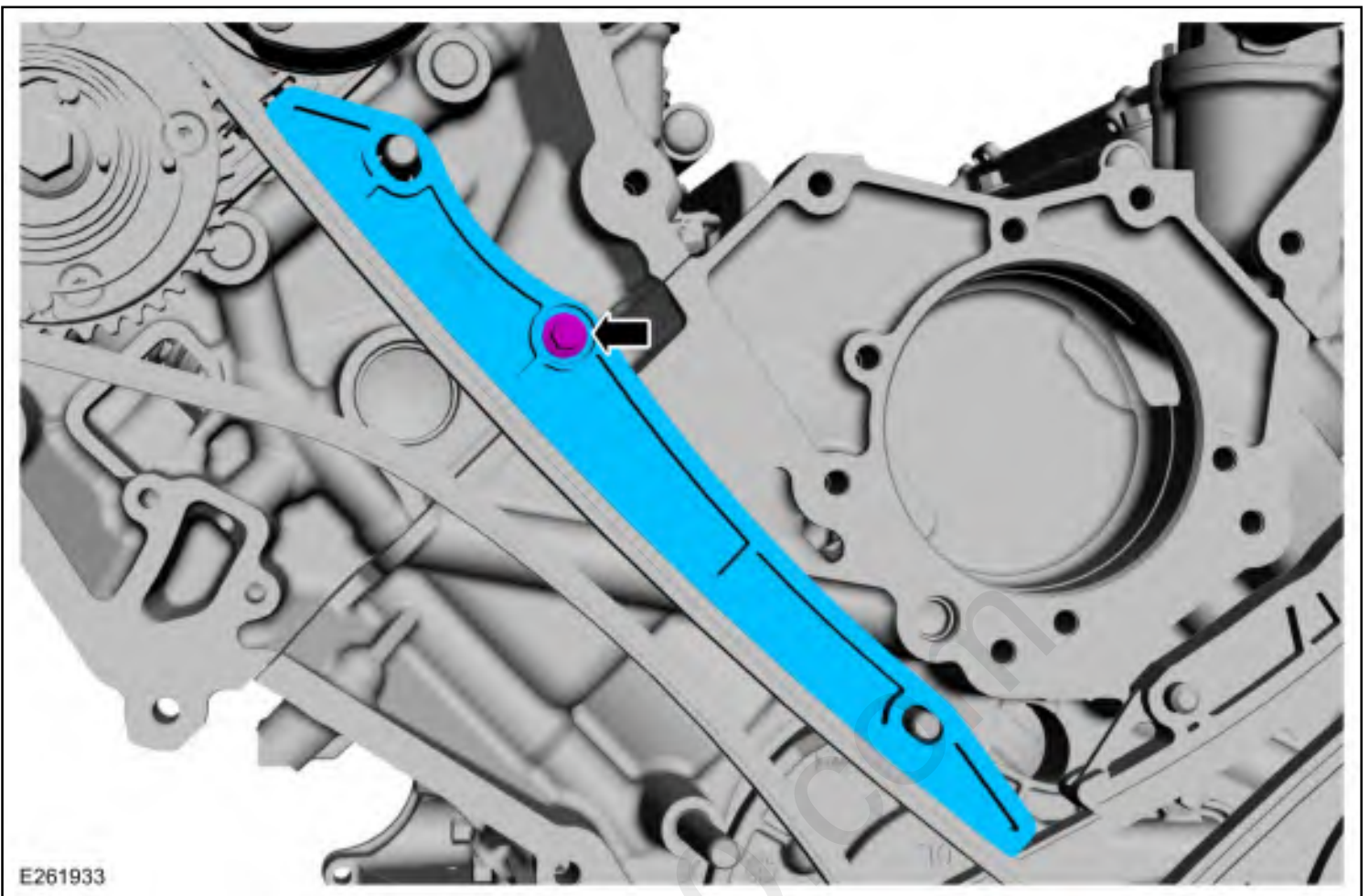
Install the RH timing chain guide and bolt.

*Torque:*

Stage 1: 89 lb.in (10 Nm)

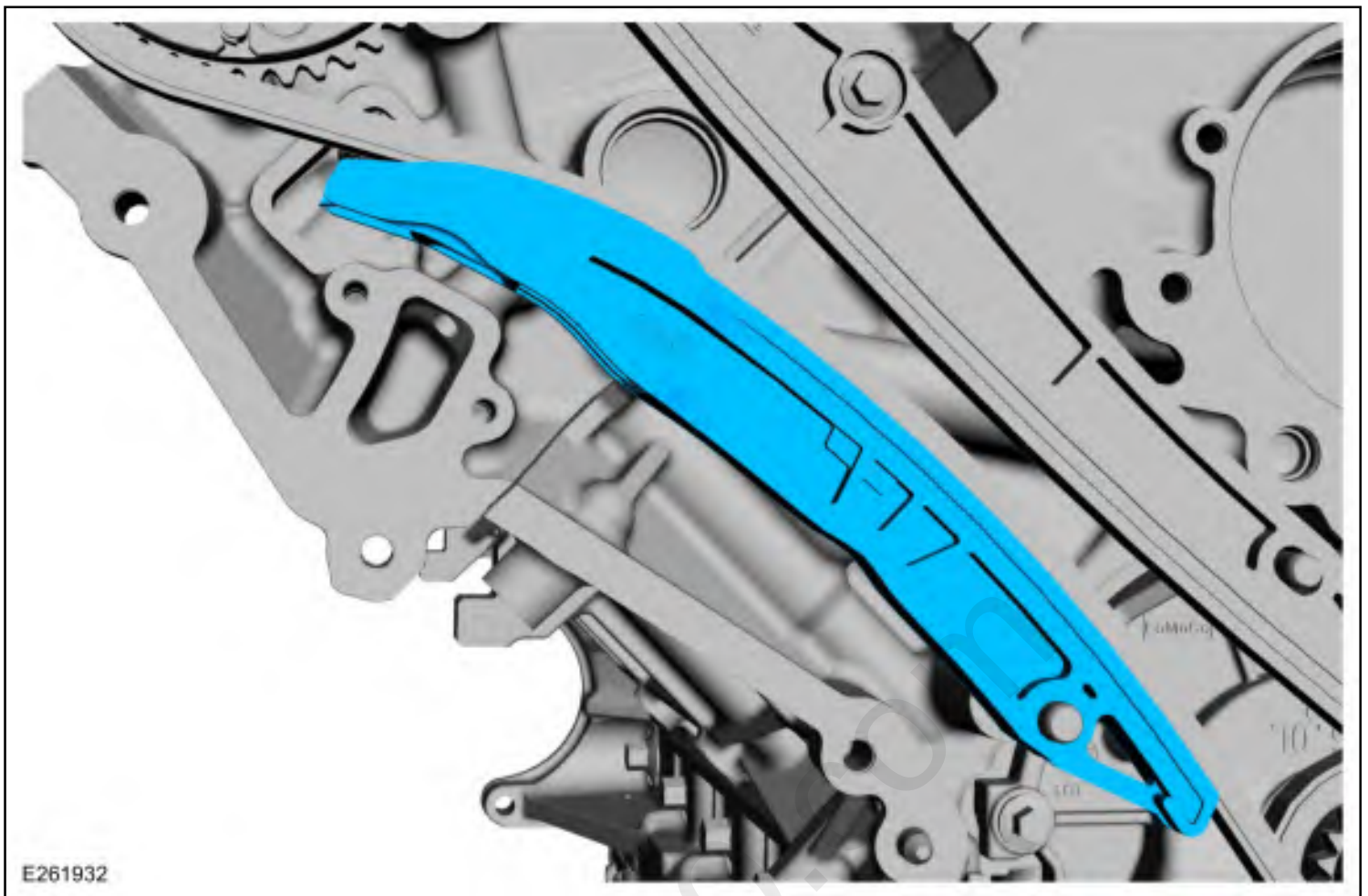
Stage 2: 25°





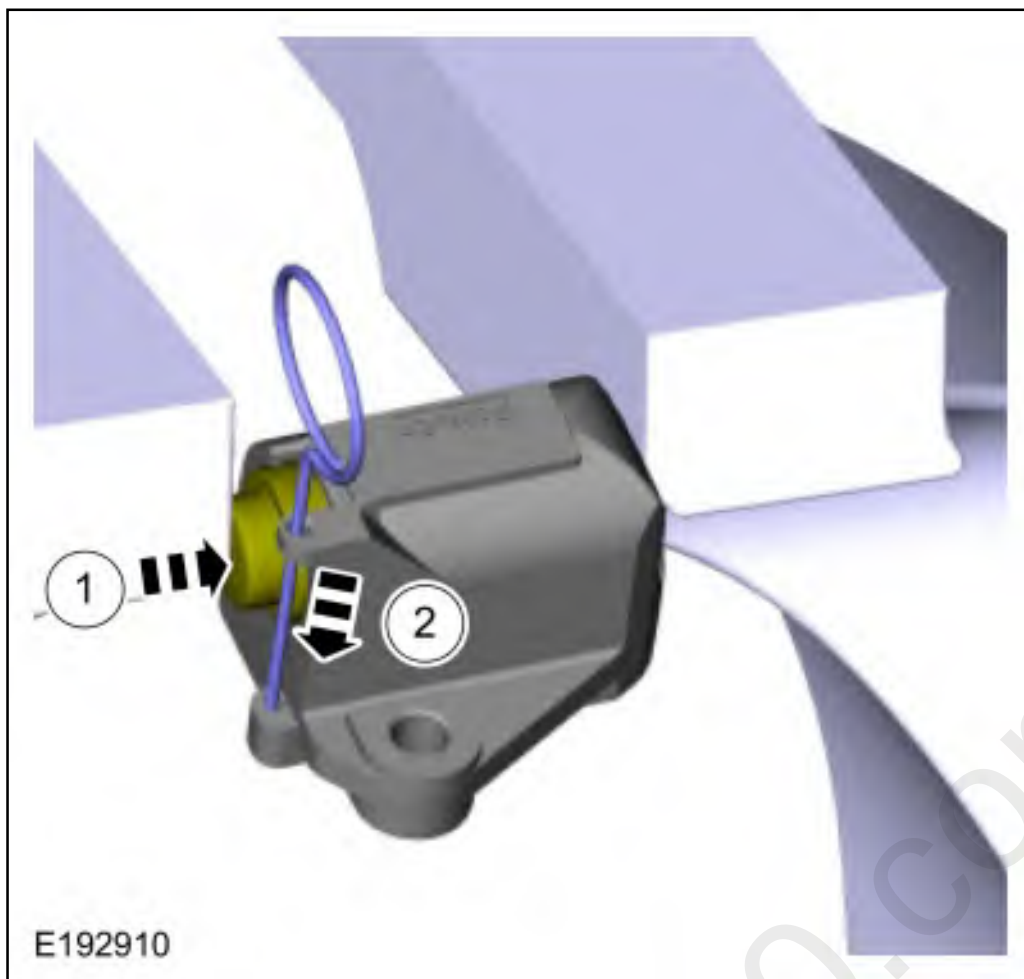
66. **NOTE:** *It may be necessary to rotate the crankshaft slightly to provide enough slack in the chain to install the RH timing chain arm. Return the crankshaft keyway to the 7:30 position after installing the RH timing chain arm.*

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.





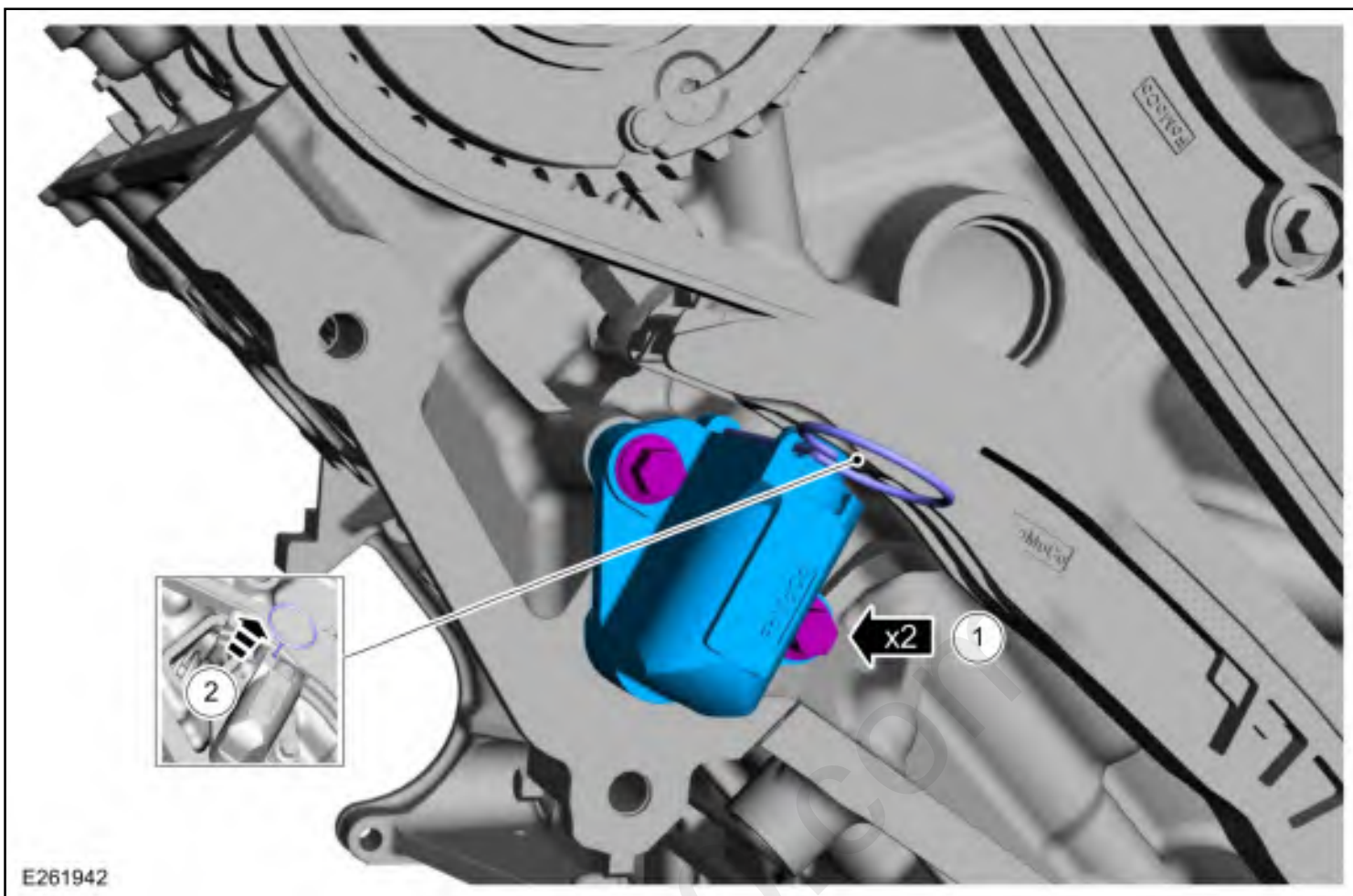
1. Install the RH primary timing chain tensioner and bolts.

*Torque:*

Stage 1: 89 lb.in (10 Nm)

Stage 2: 25°

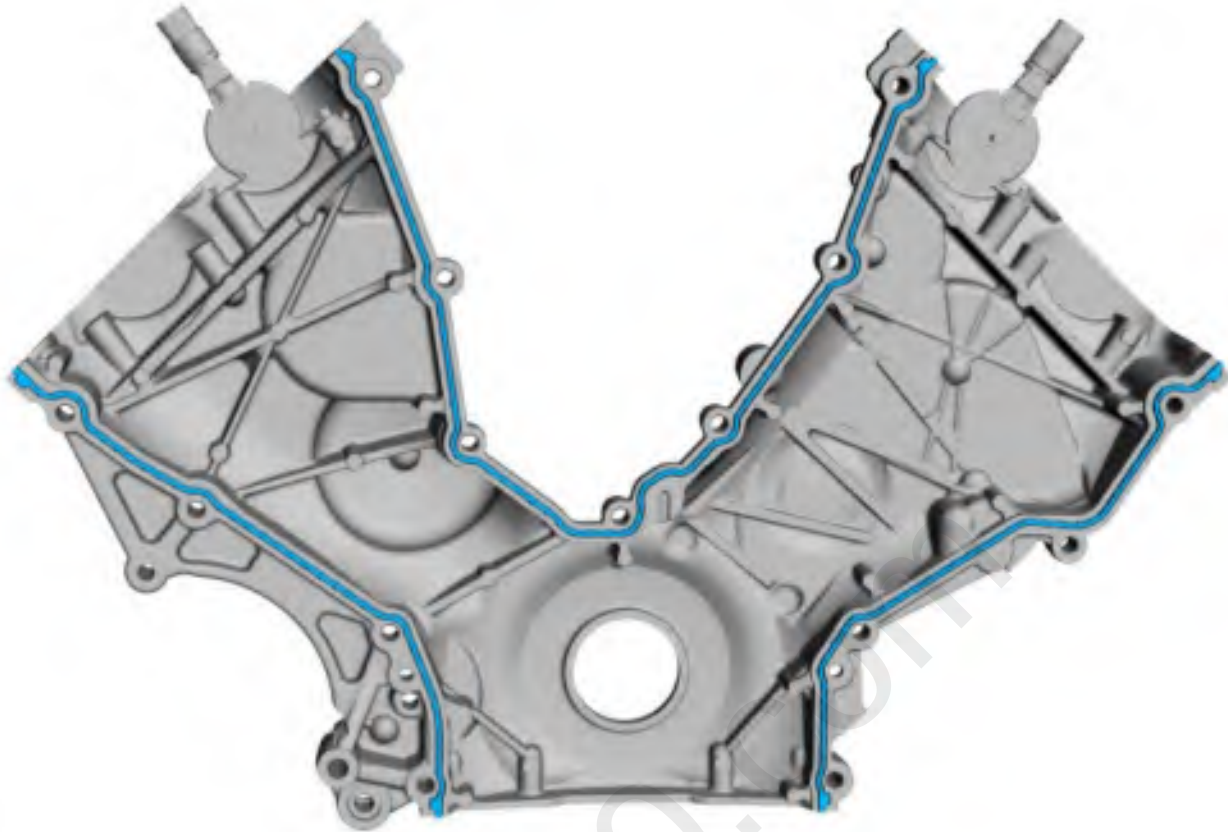
2. Remove the holding pin from the tensioner.



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.

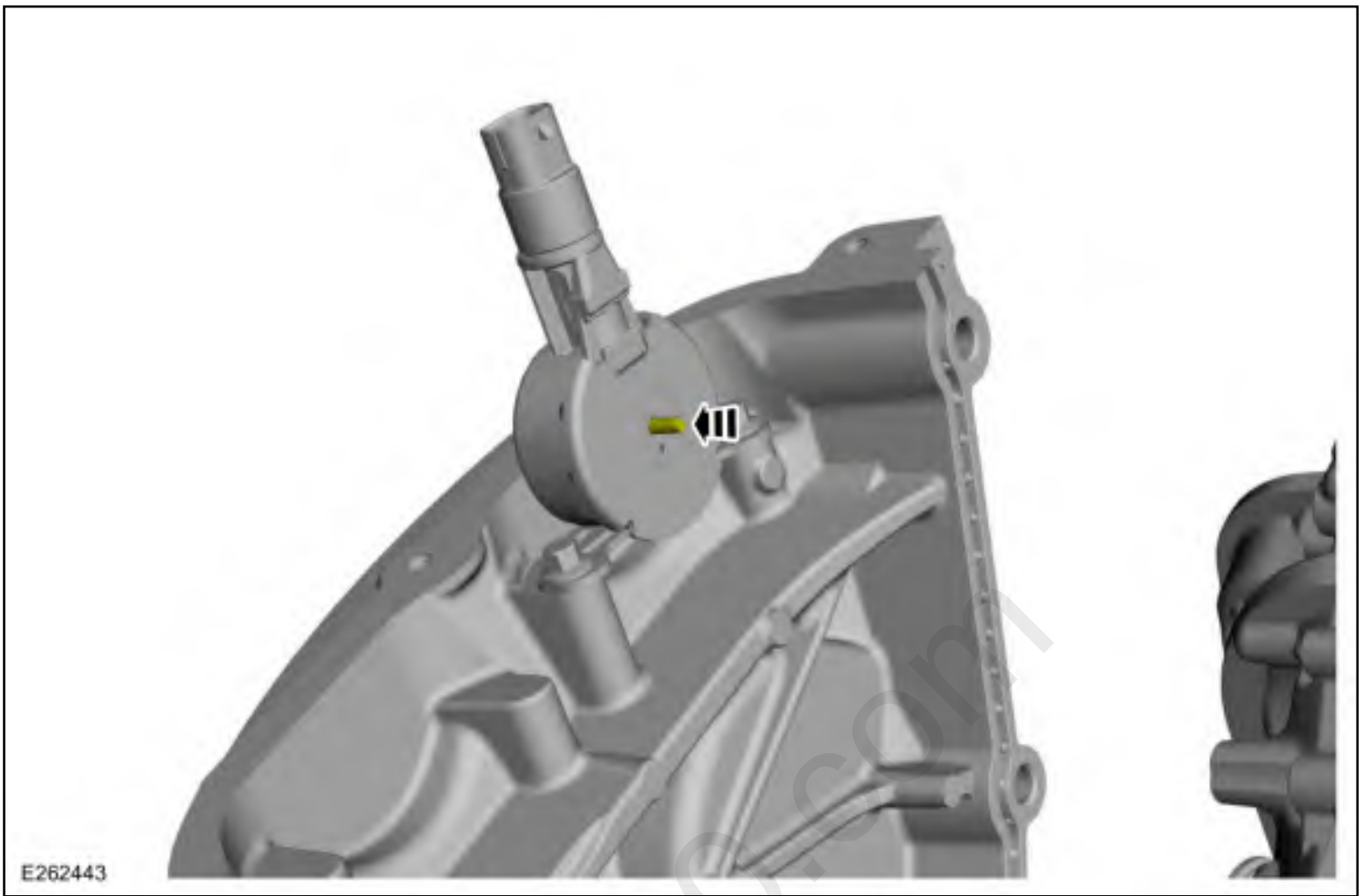


E262441

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.

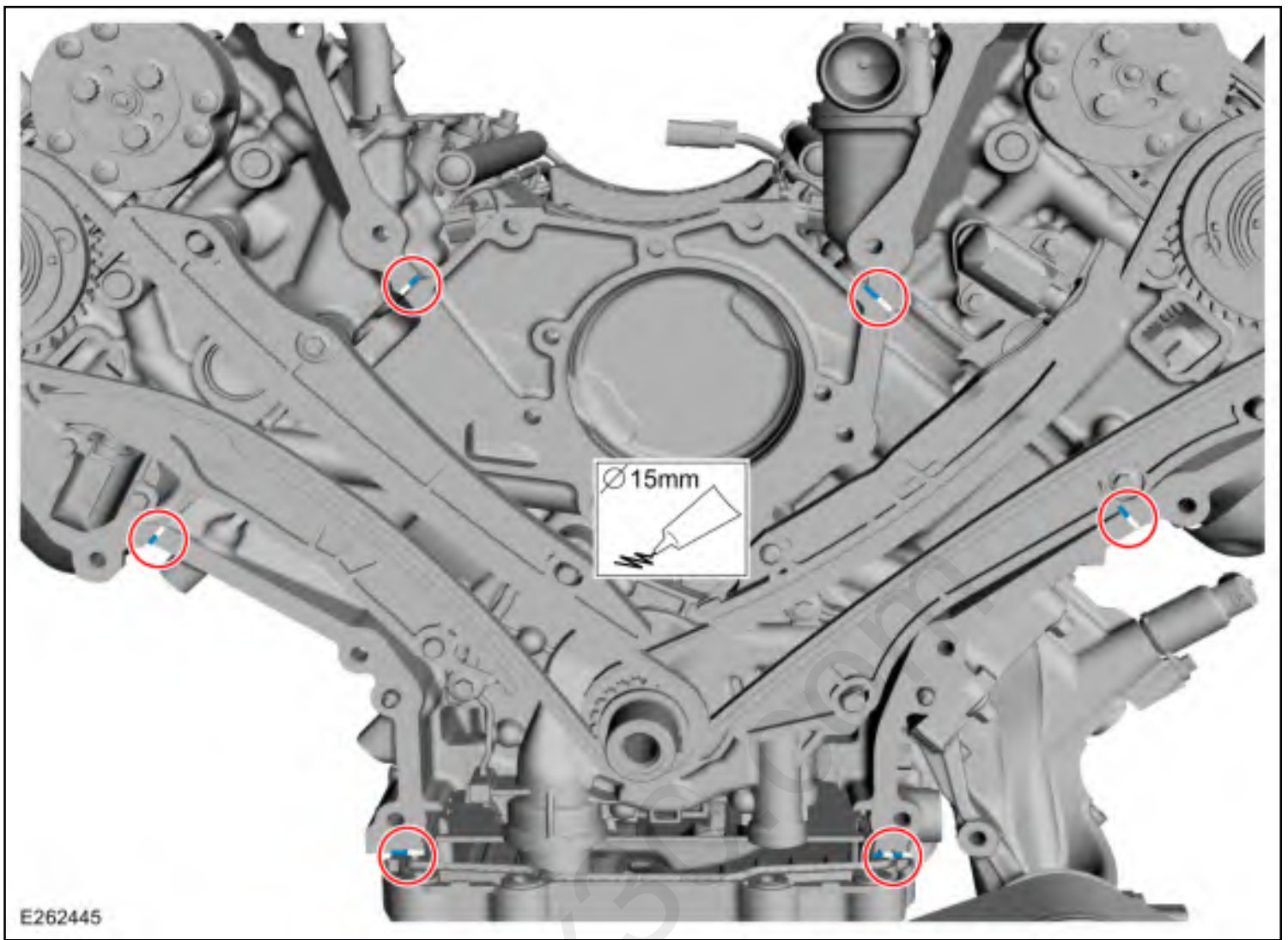
Fully depress the VCT variable force solenoid pins.



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.

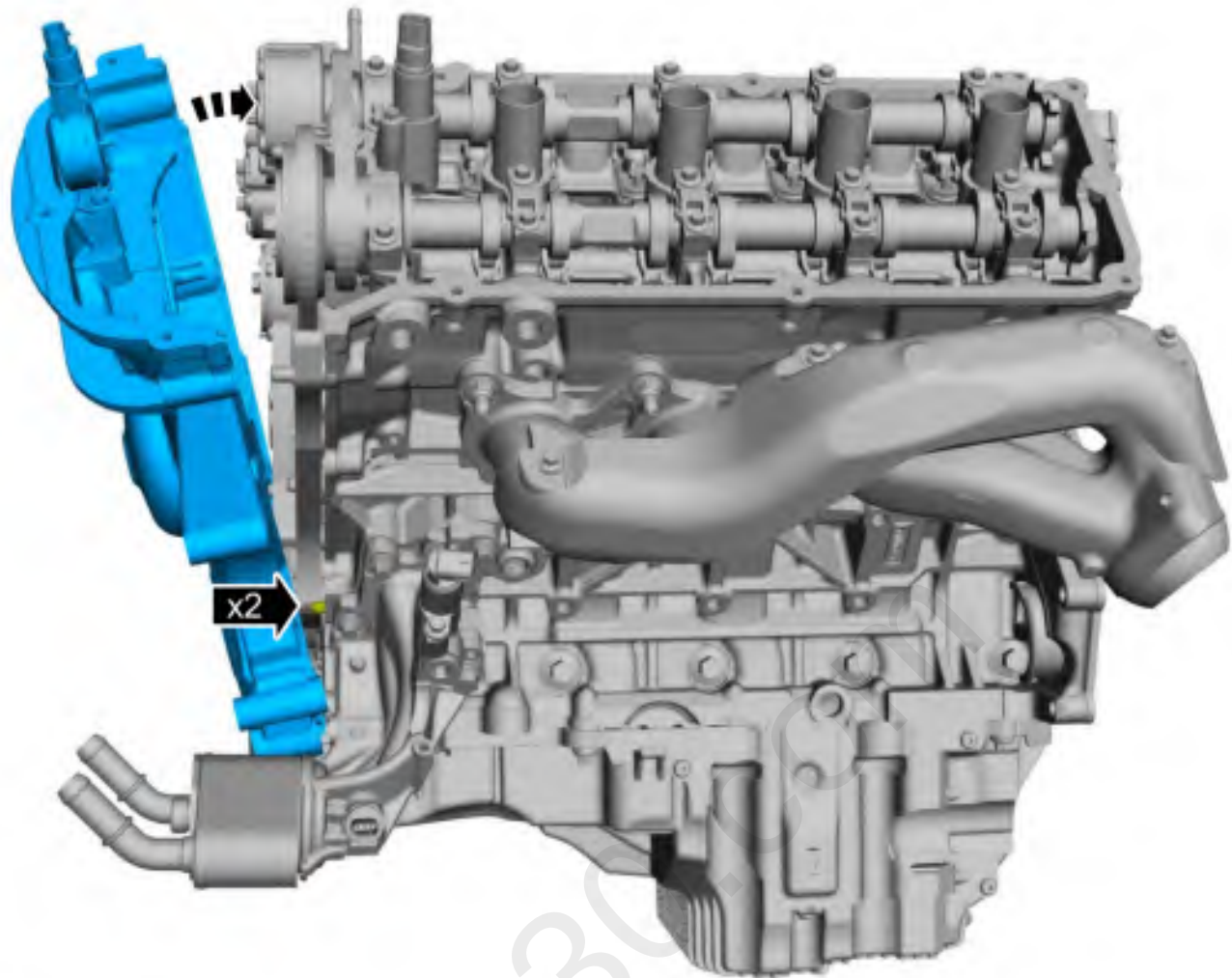
*Material:* Motorcraft® Silicone Gasket and Sealant / TA-30 (WSE-M4G323-A4)



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.





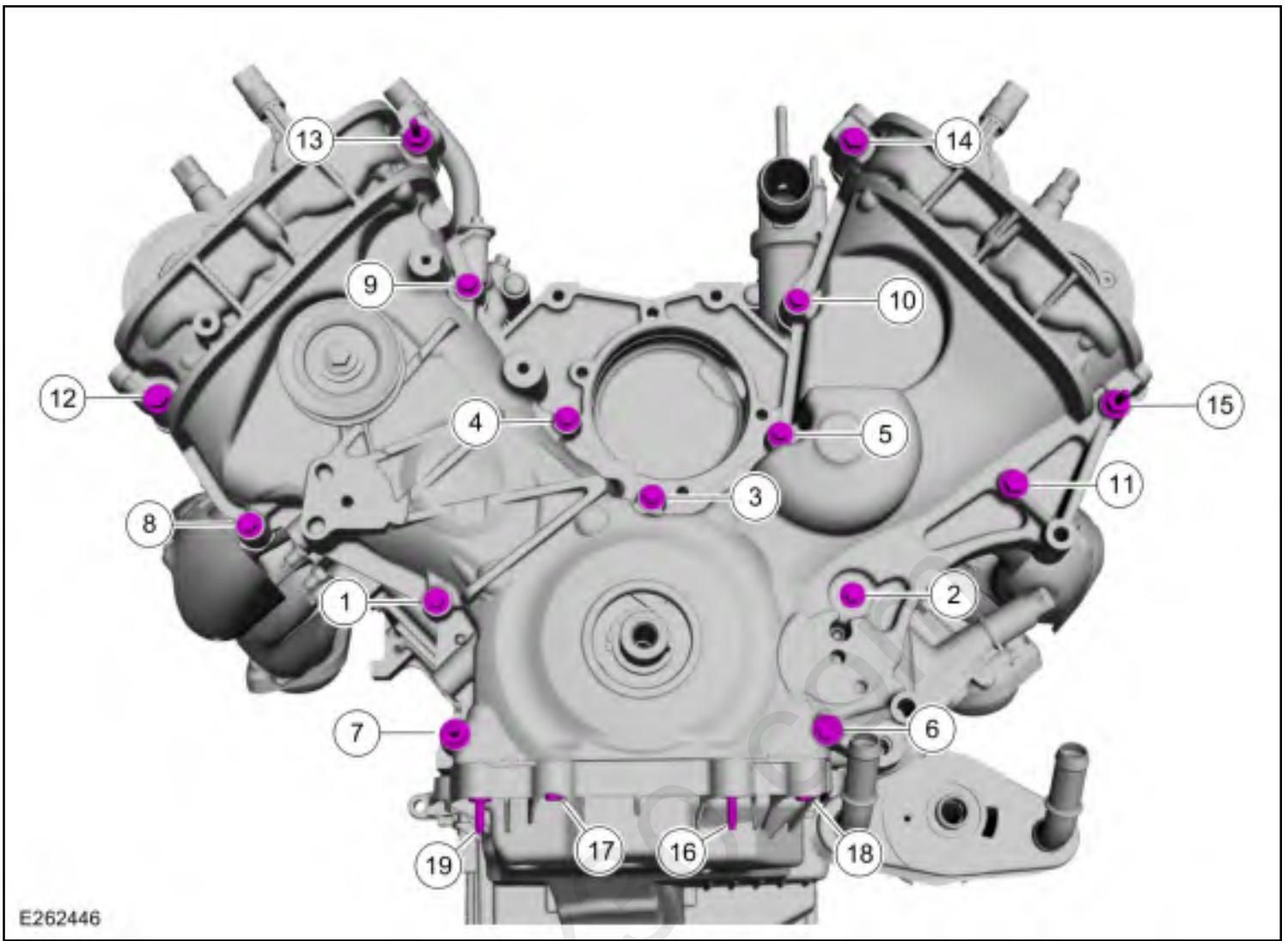
E262440

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.

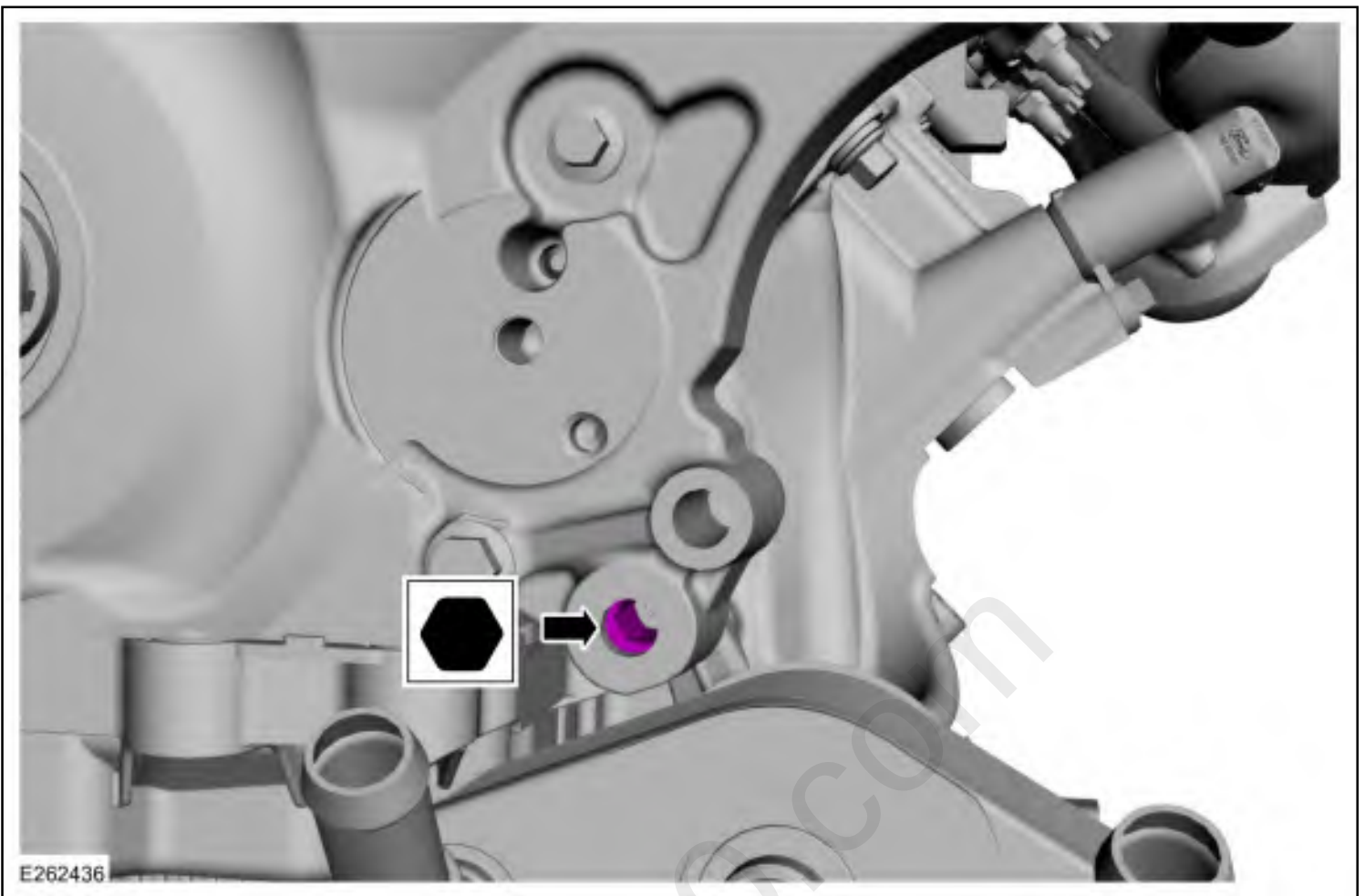
Install the bolts and stud bolts.

*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)*

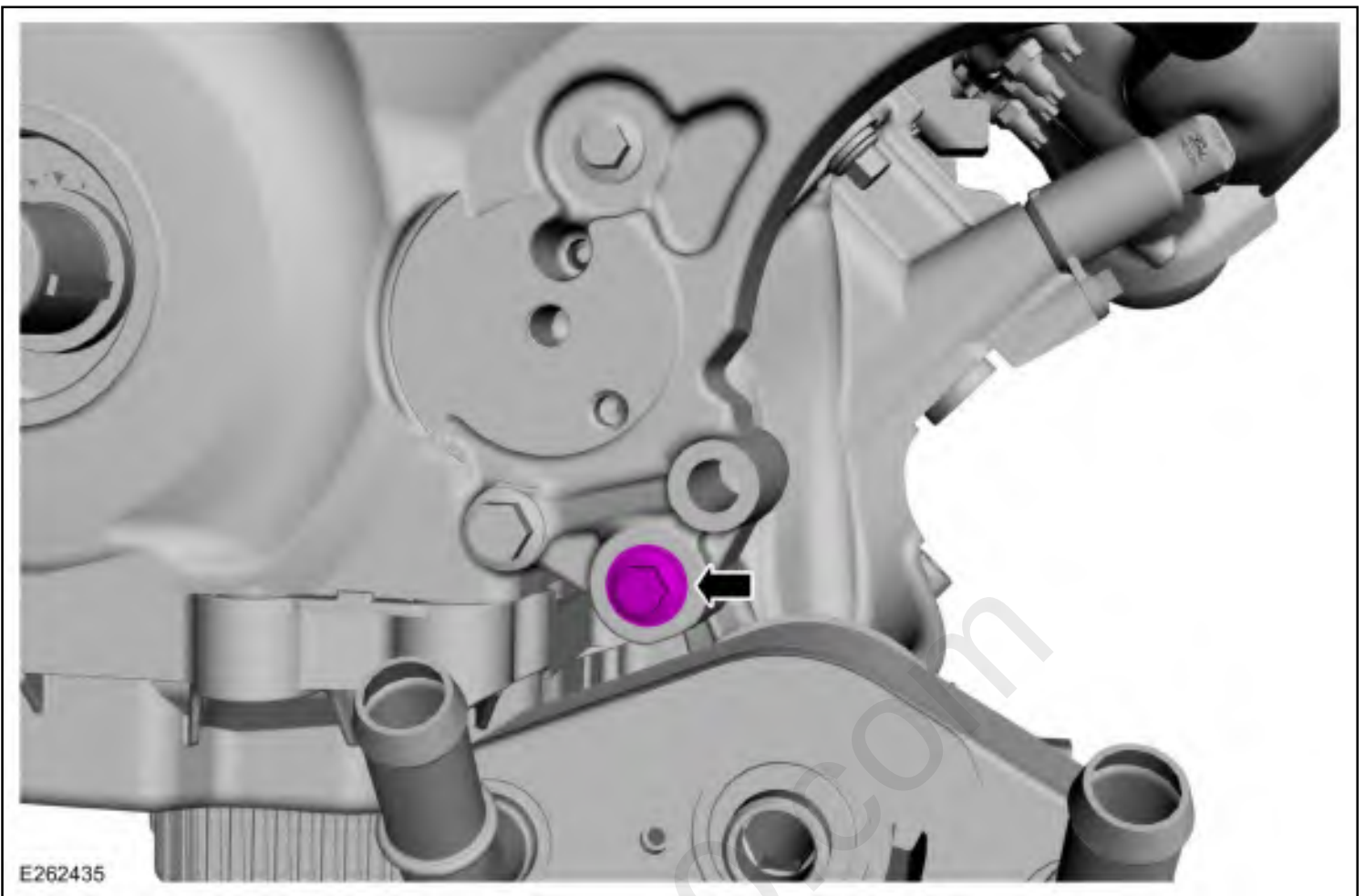


76. Install the engine front cover-to-oil filter adapter bolt.

*Torque:*

Stage 1: 18 lb.ft (25 Nm)

Stage 2: 60°



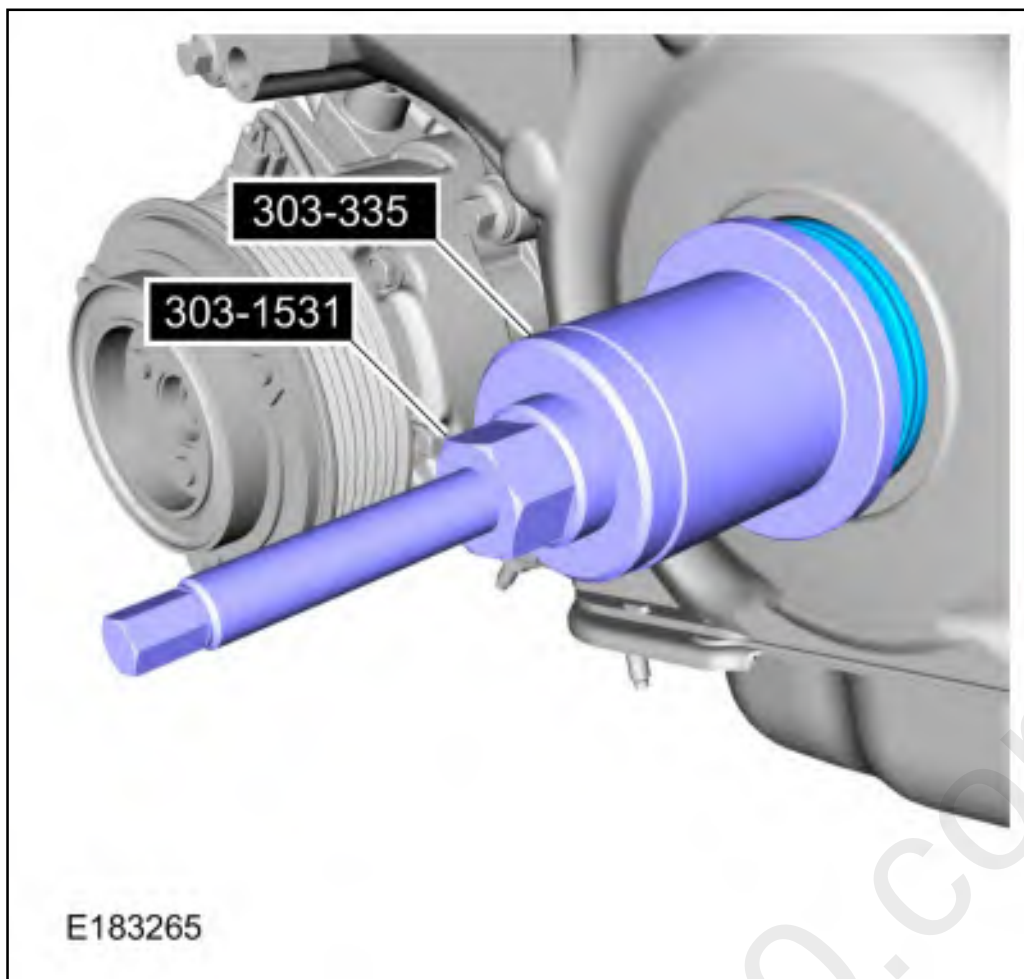
77. Lubricate the engine front cover bore and the crankshaft front oil seal inner lip with clean engine oil.



78. Using the special tools, install the new crankshaft front oil seal.

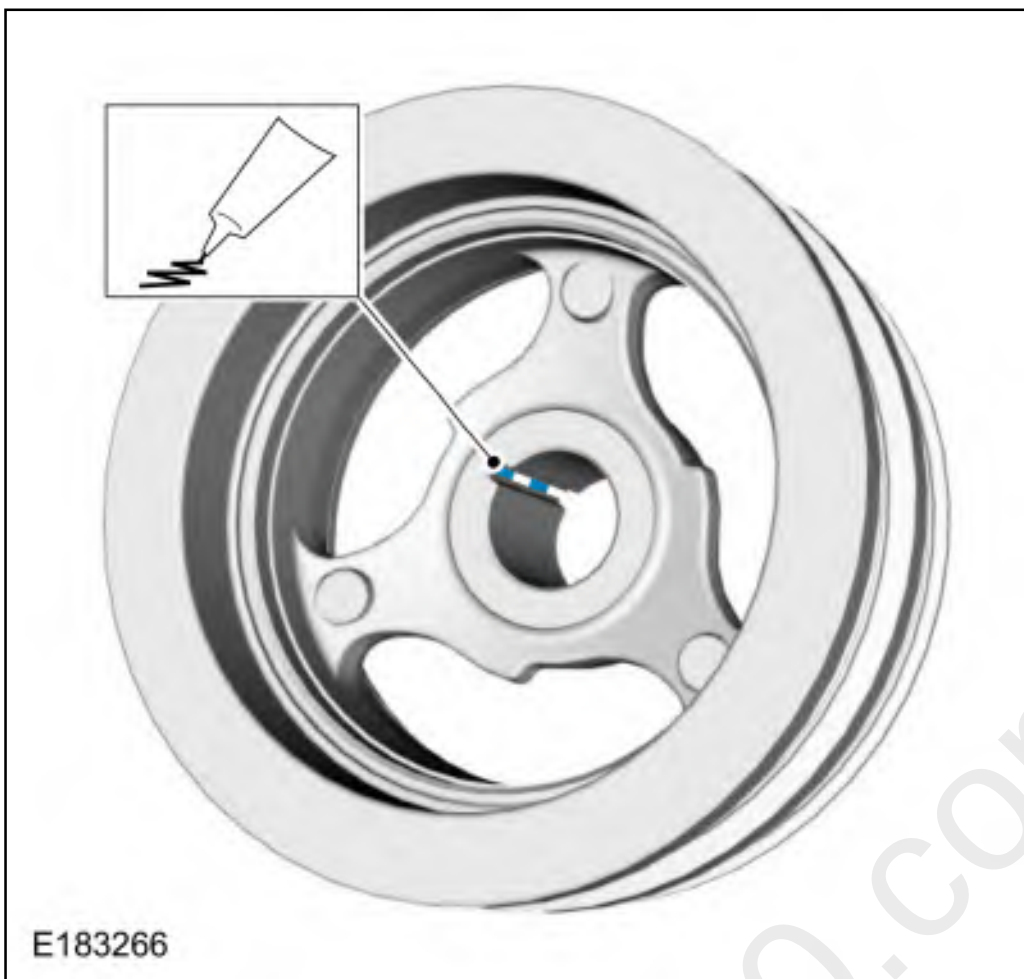
Use Special Service Tool: 303-335 (T88T-6701-A) Installer, Front Cover Oil Seal. , 303-1531  
Installer, Front Crank Seal and Damper.





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)

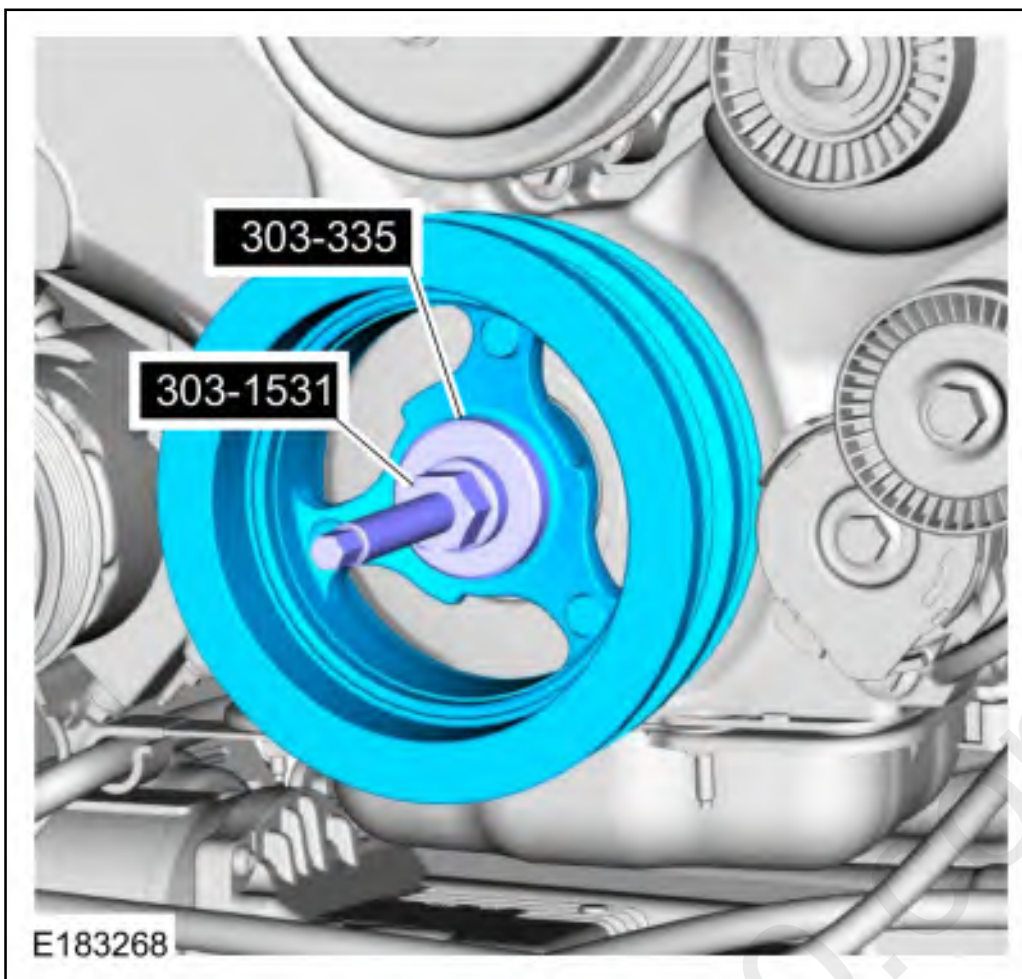


80. Lubricate the crankshaft pulley sealing surface with clean engine oil prior to installation.



81. Using the special tools, install the crankshaft pulley.

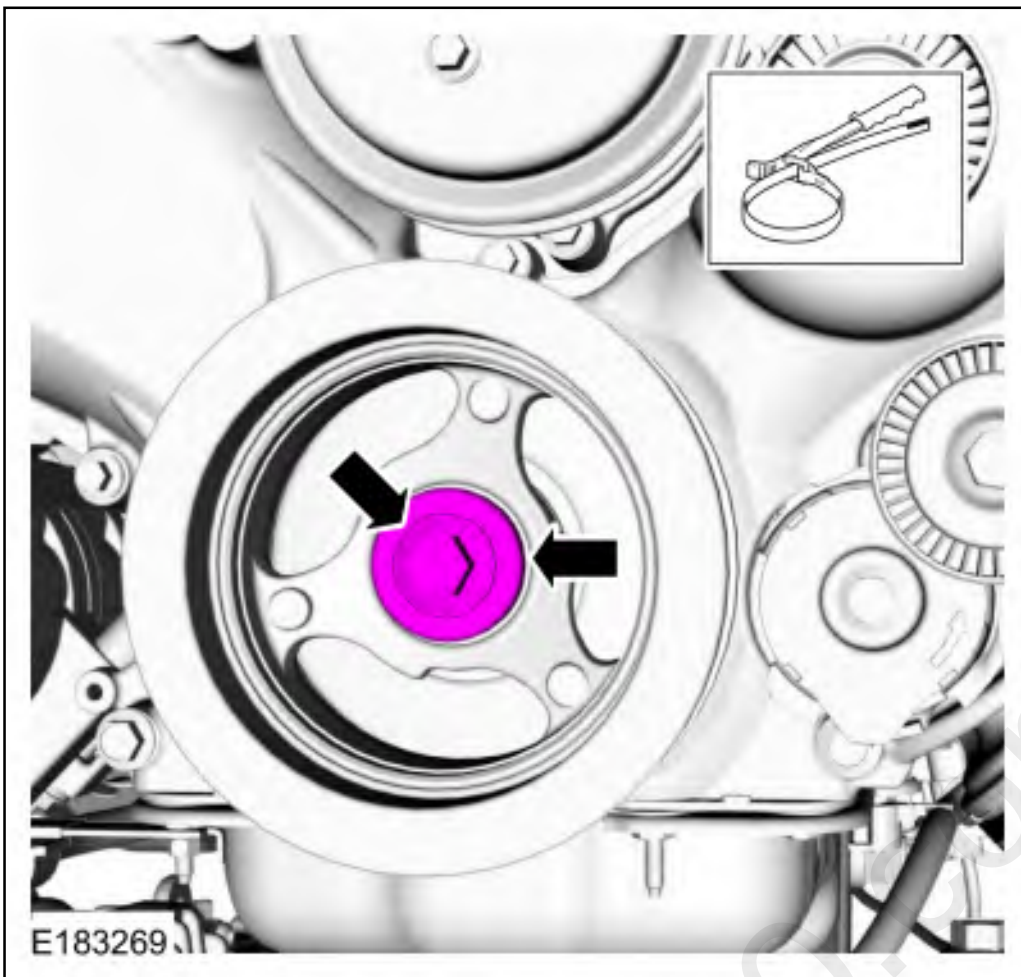
Use Special Service Tool: 303-335 (T88T-6701-A) Installer, Front Cover Oil Seal. , 303-1531  
Installer, Front Crank Seal and Damper.



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)



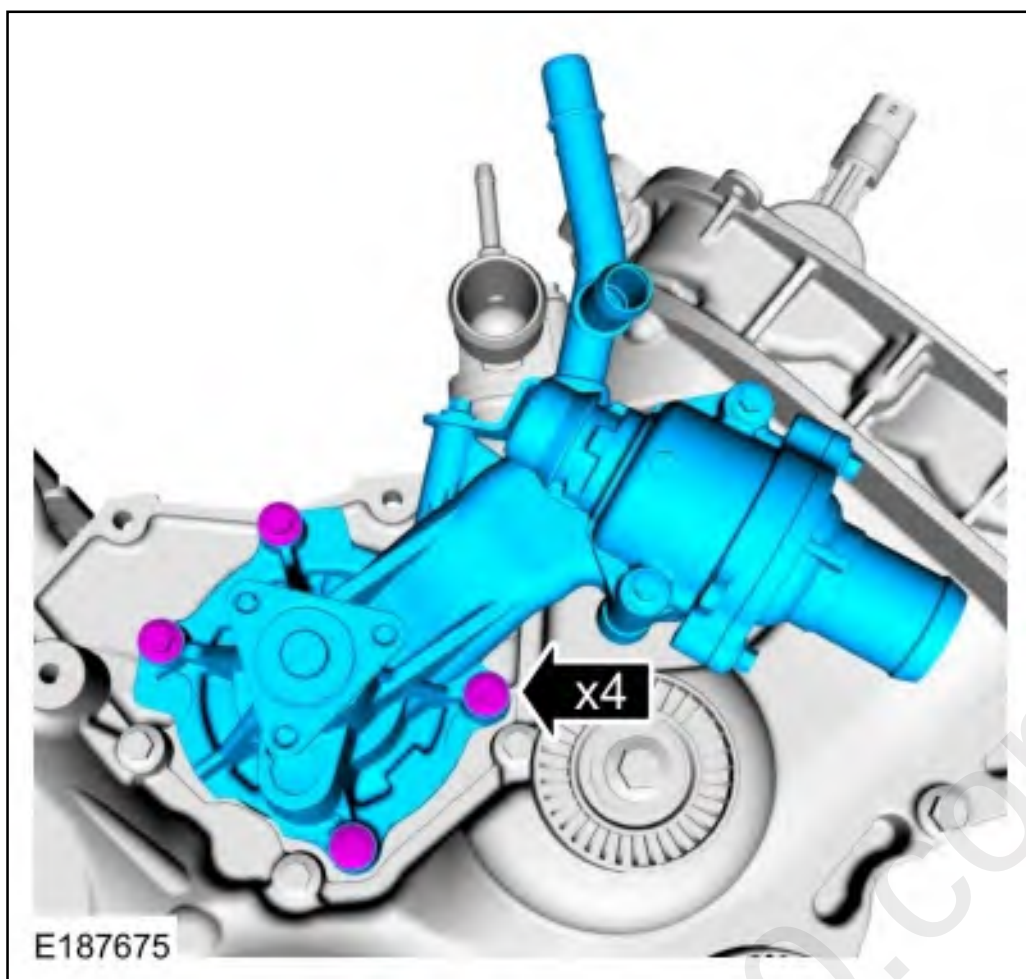


84. Install the coolant pump and bolts.

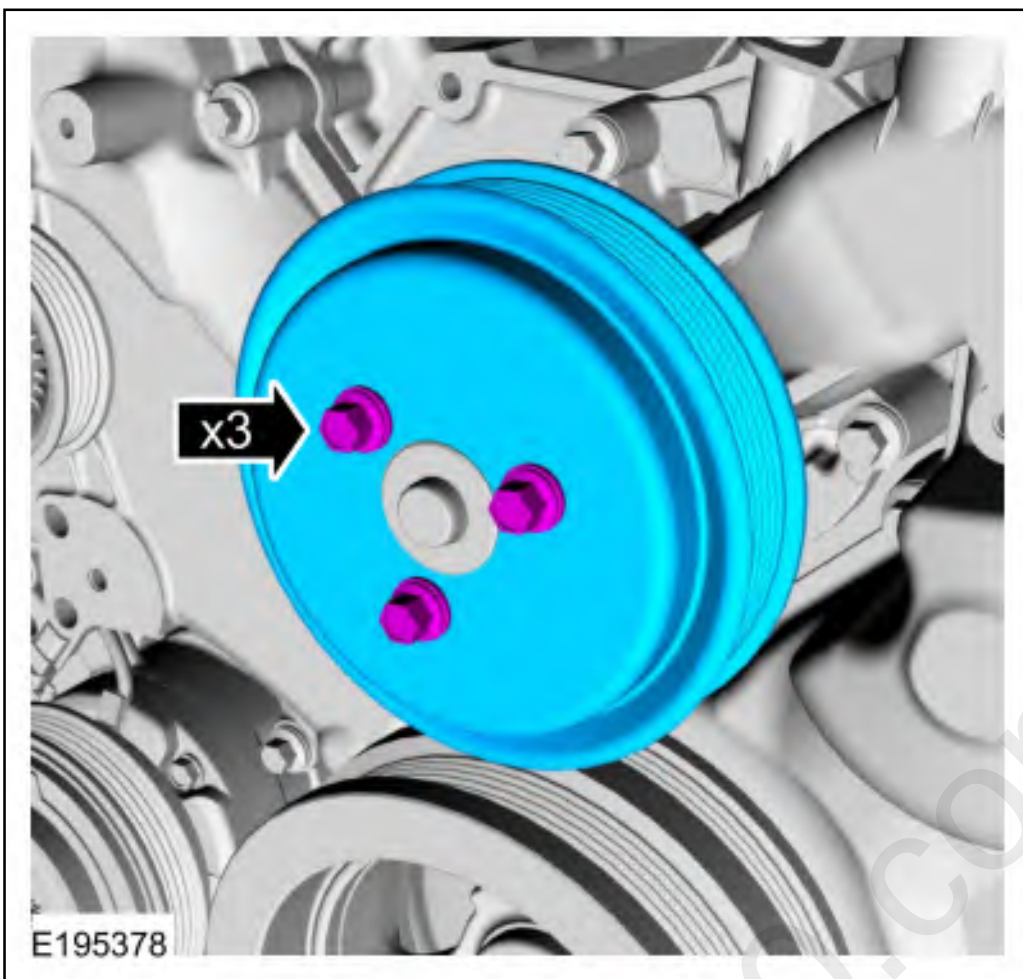
*Torque:*

Stage 1: 177 lb.in (20 Nm)

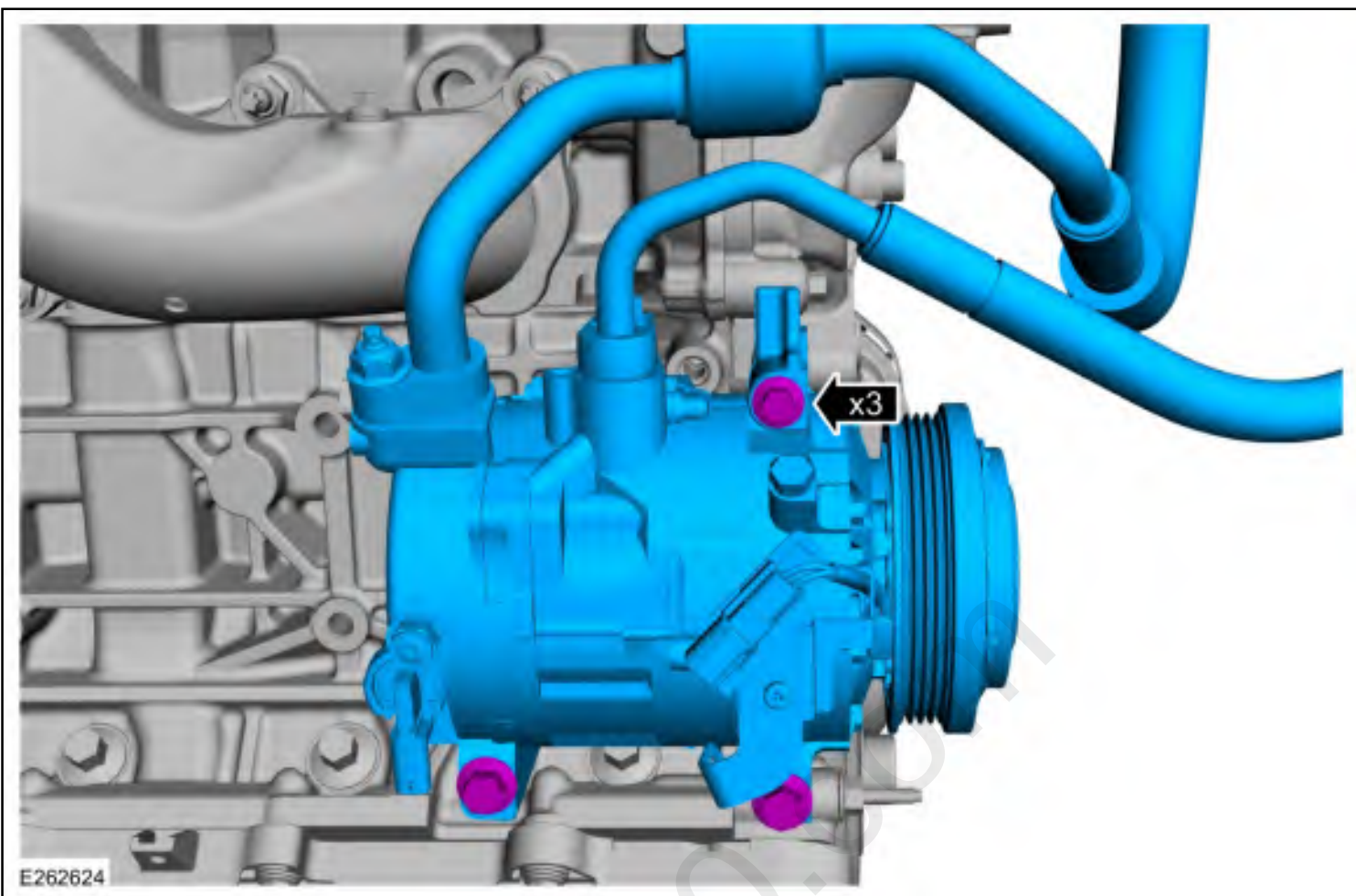
Stage 2: 60°



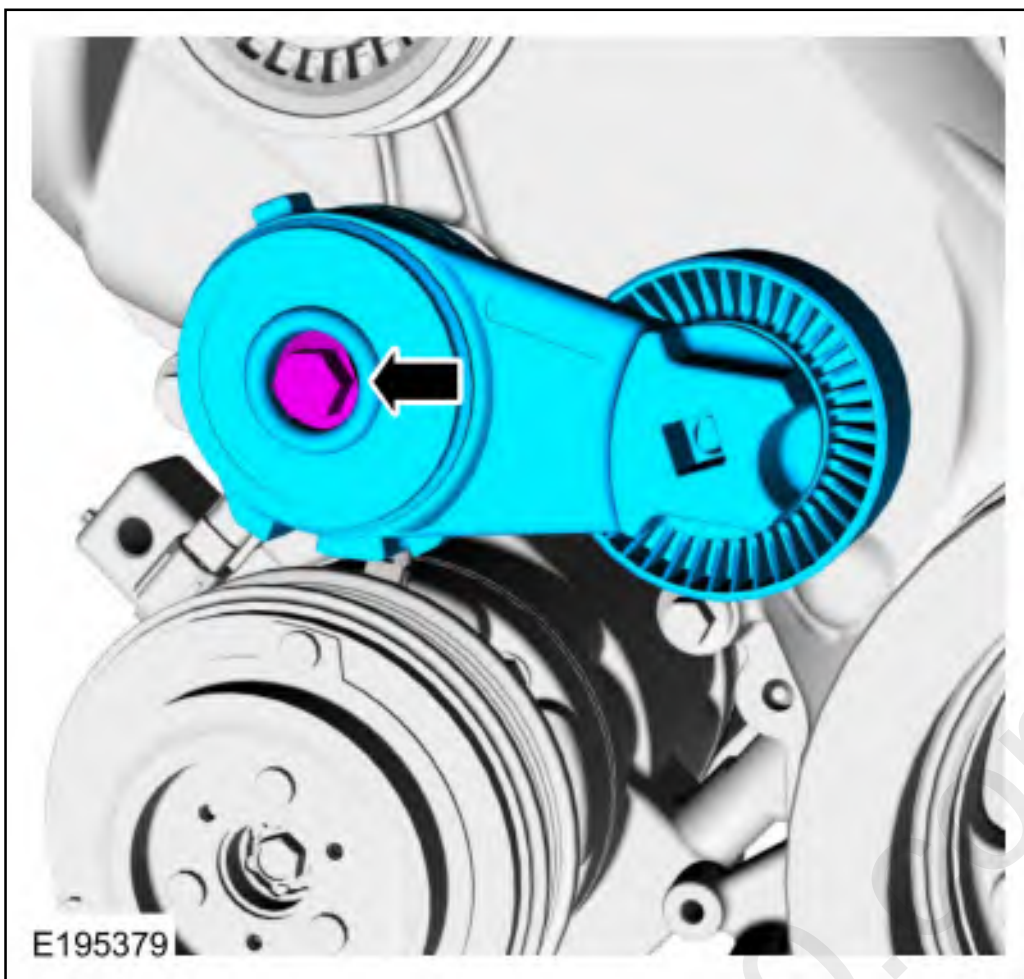
85. Install the coolant pump pulley and the bolts.  
*Torque: 18 lb.ft (25 Nm)*



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

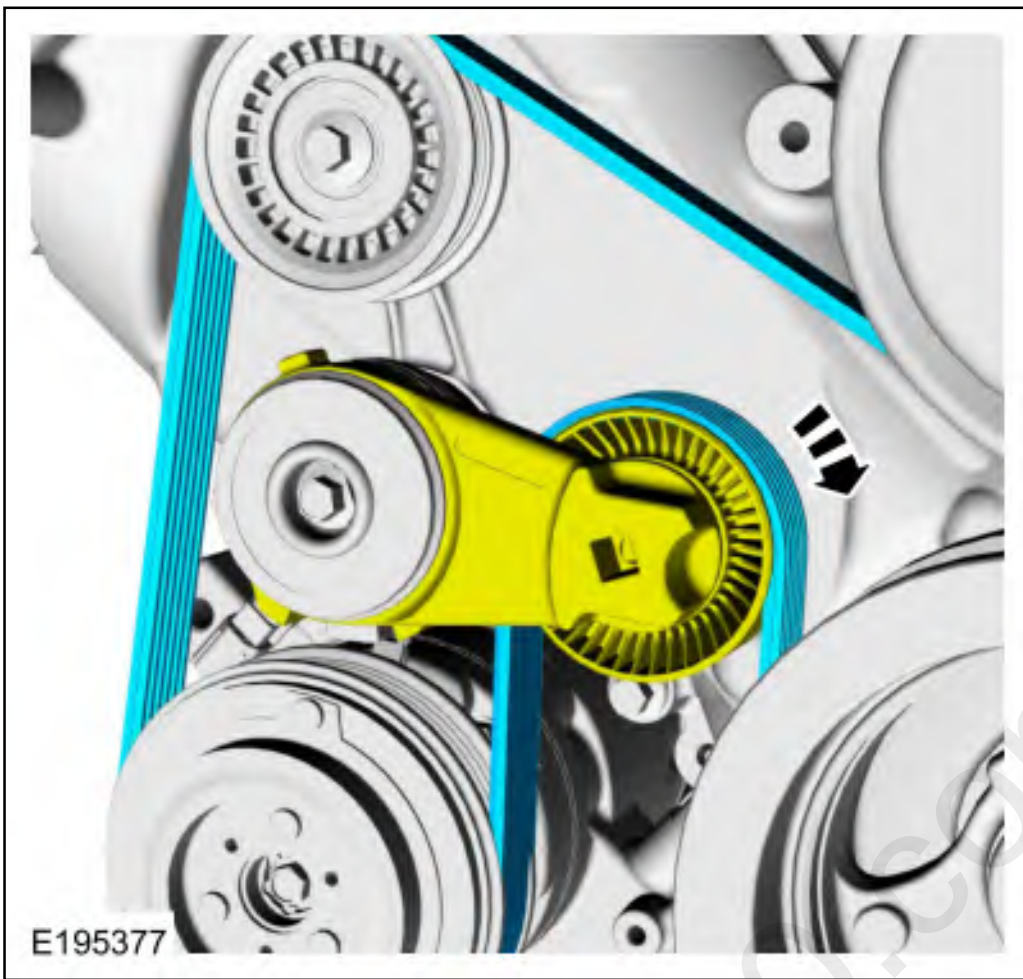


87. Install the A/C compressor belt tensioner and the bolt.  
*Torque: 18 lb.ft (25 Nm)*



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

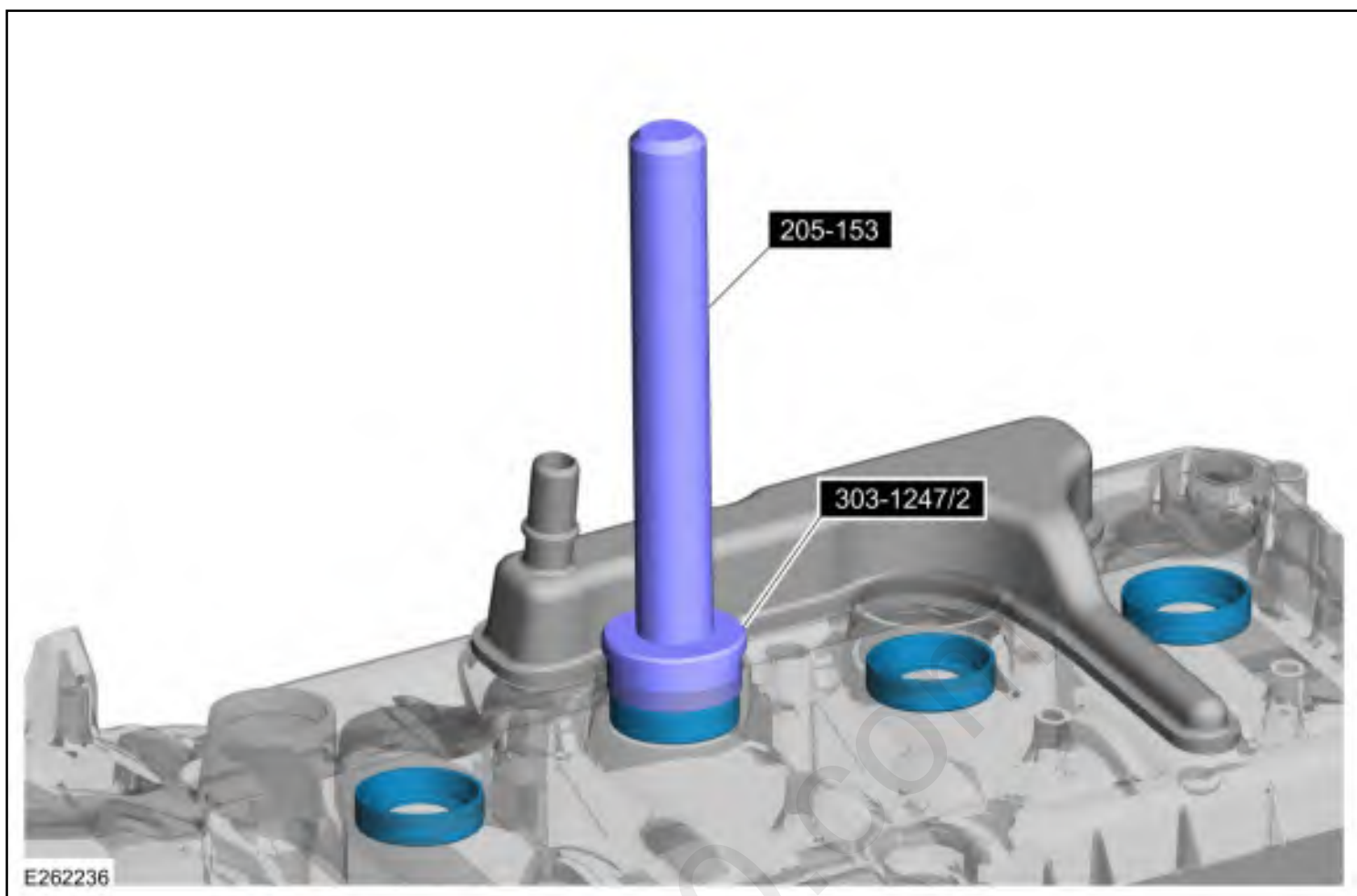




89. **NOTE:** *Installation of new seals is only required if damaged seals were removed.*

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

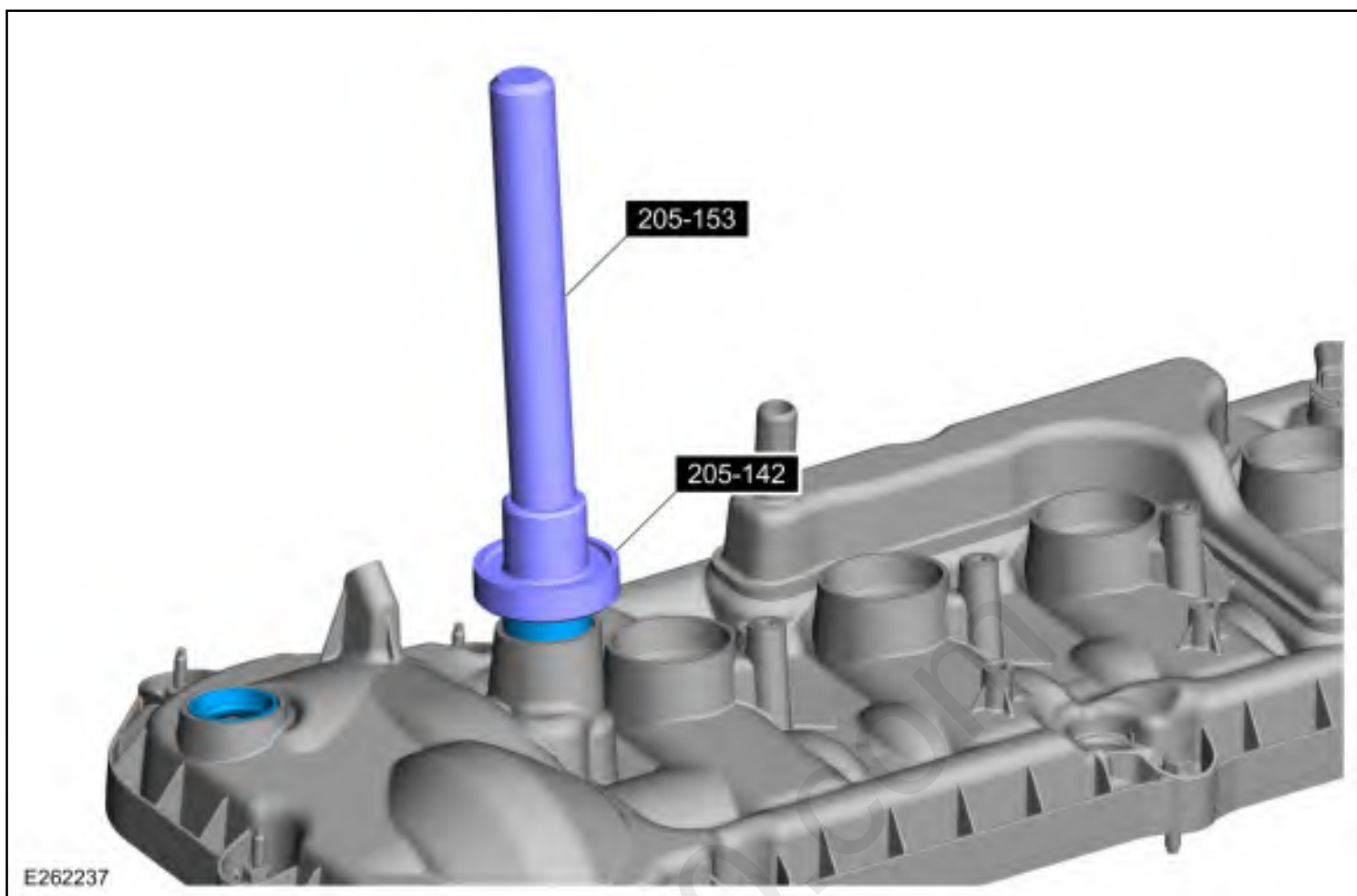
Use Special Service Tool: 205-153 (T80T-4000-W) Handle. , 303-1247 VCT Spark Plug Tube Seal Remover and Installer.



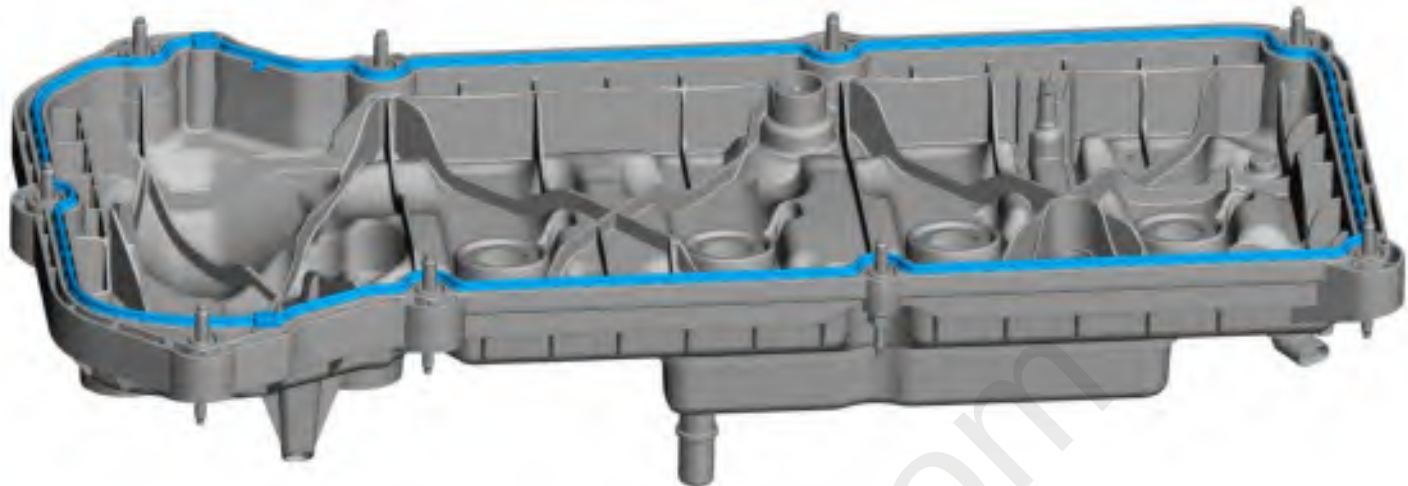
90. **NOTE:** *Installation of new seals is only required if damaged seals were removed.*

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.



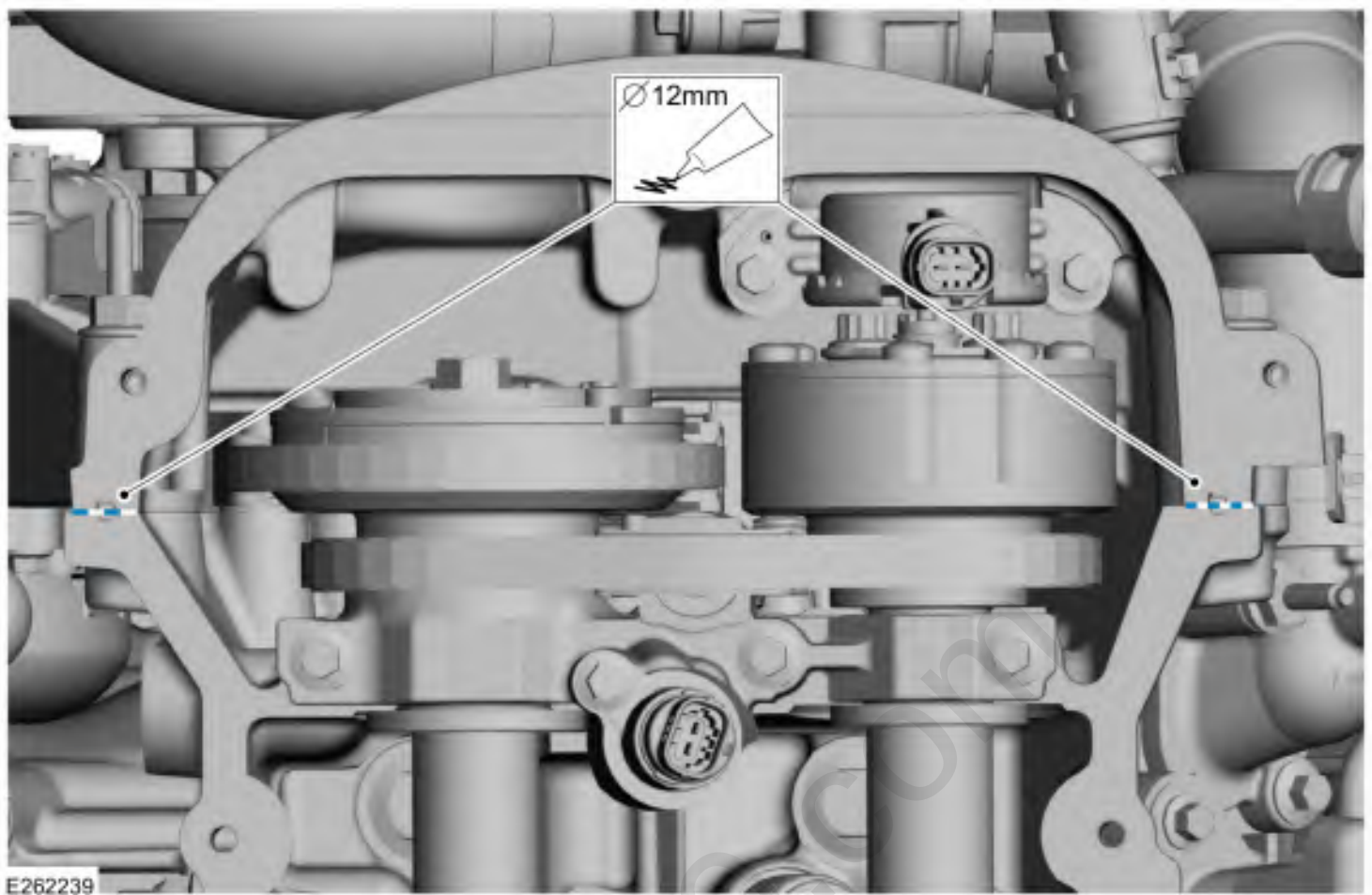
E262238



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.

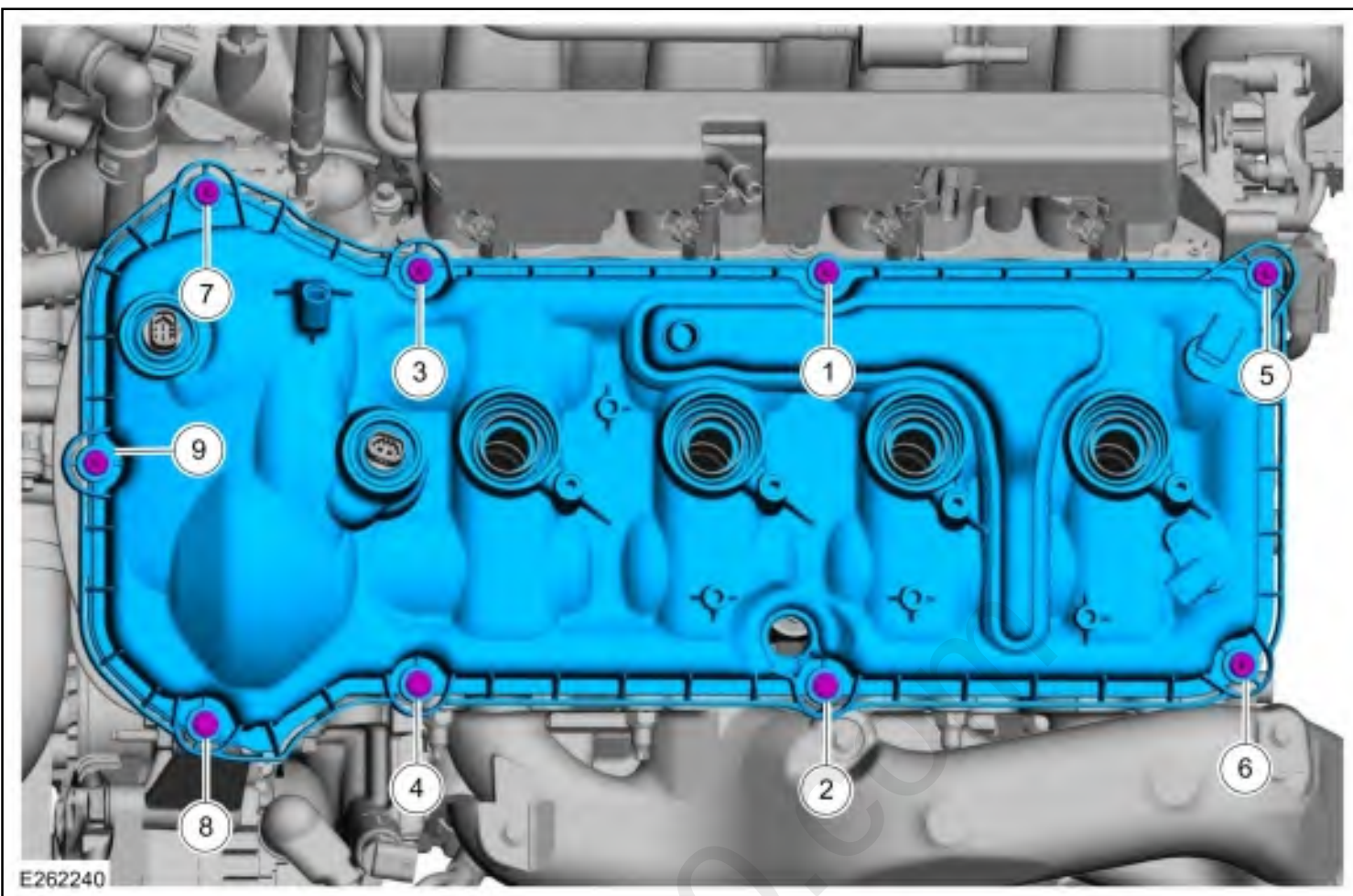
Apply an 12 mm (0.47 in) bead of silicone gasket and sealant to the engine front cover-to-cylinder head joints.

*Material:* Motorcraft® Silicone Gasket and Sealant / TA-30 (WSE-M4G323-A4)

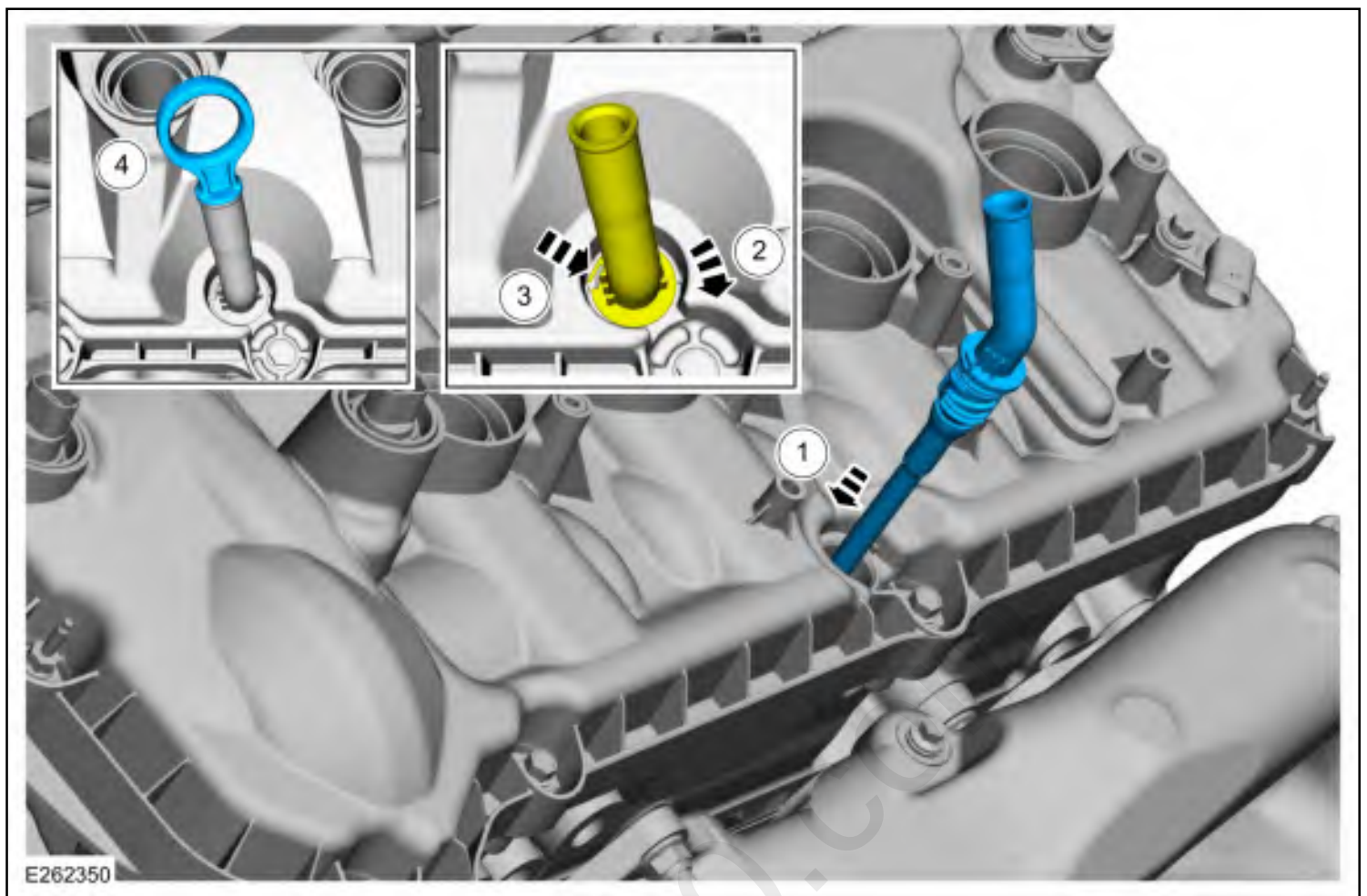


93. Install the valve cover and tighten the bolts.  
*Torque: 89 lb.in (10 Nm)*





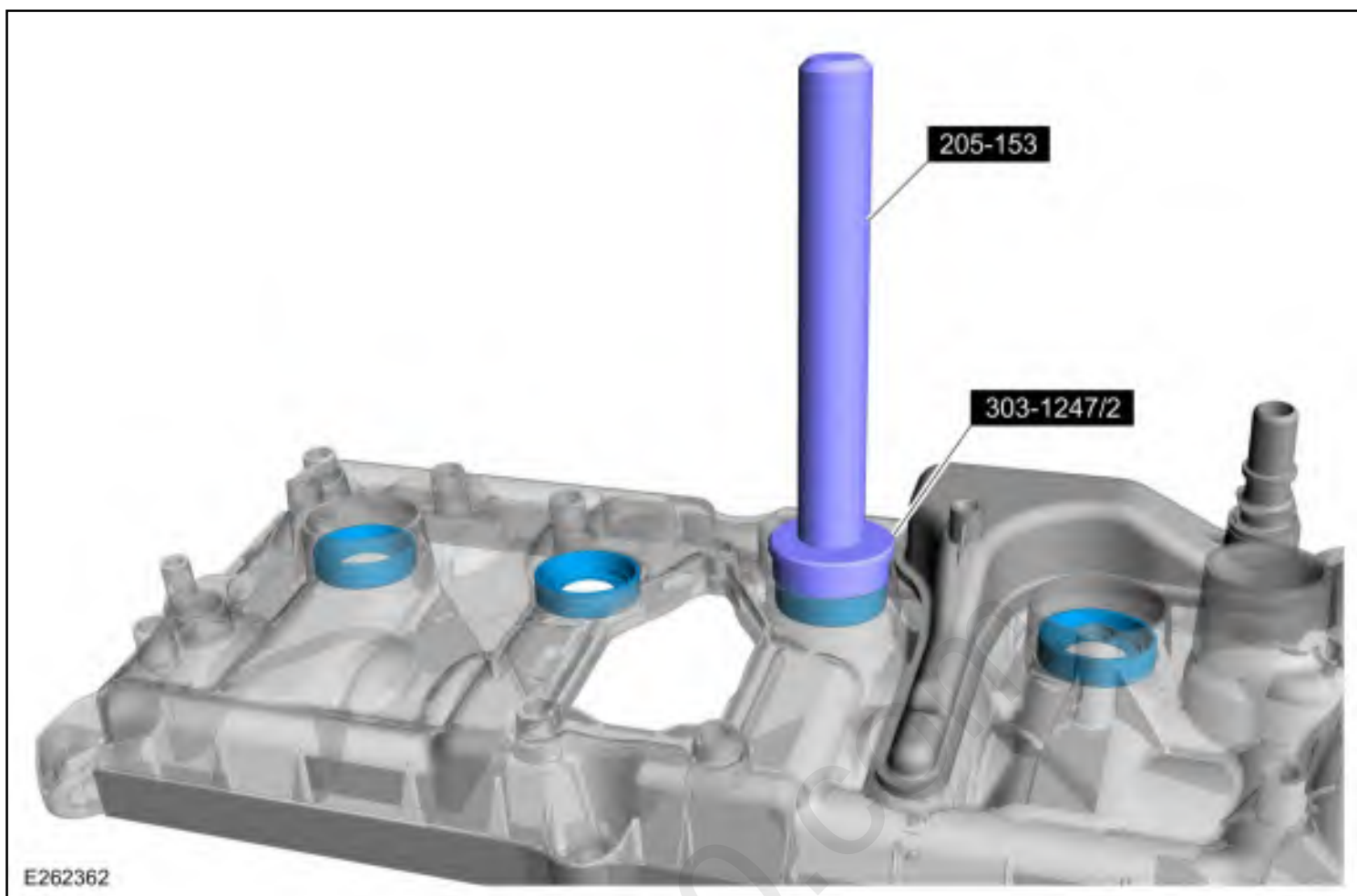
1. Push the oil level indicator tube into the engine.
2. Rotate the oil level indicator tube clockwise.
3. Verify the tab is locked in place.
4. Install the oil level indicator.



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

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

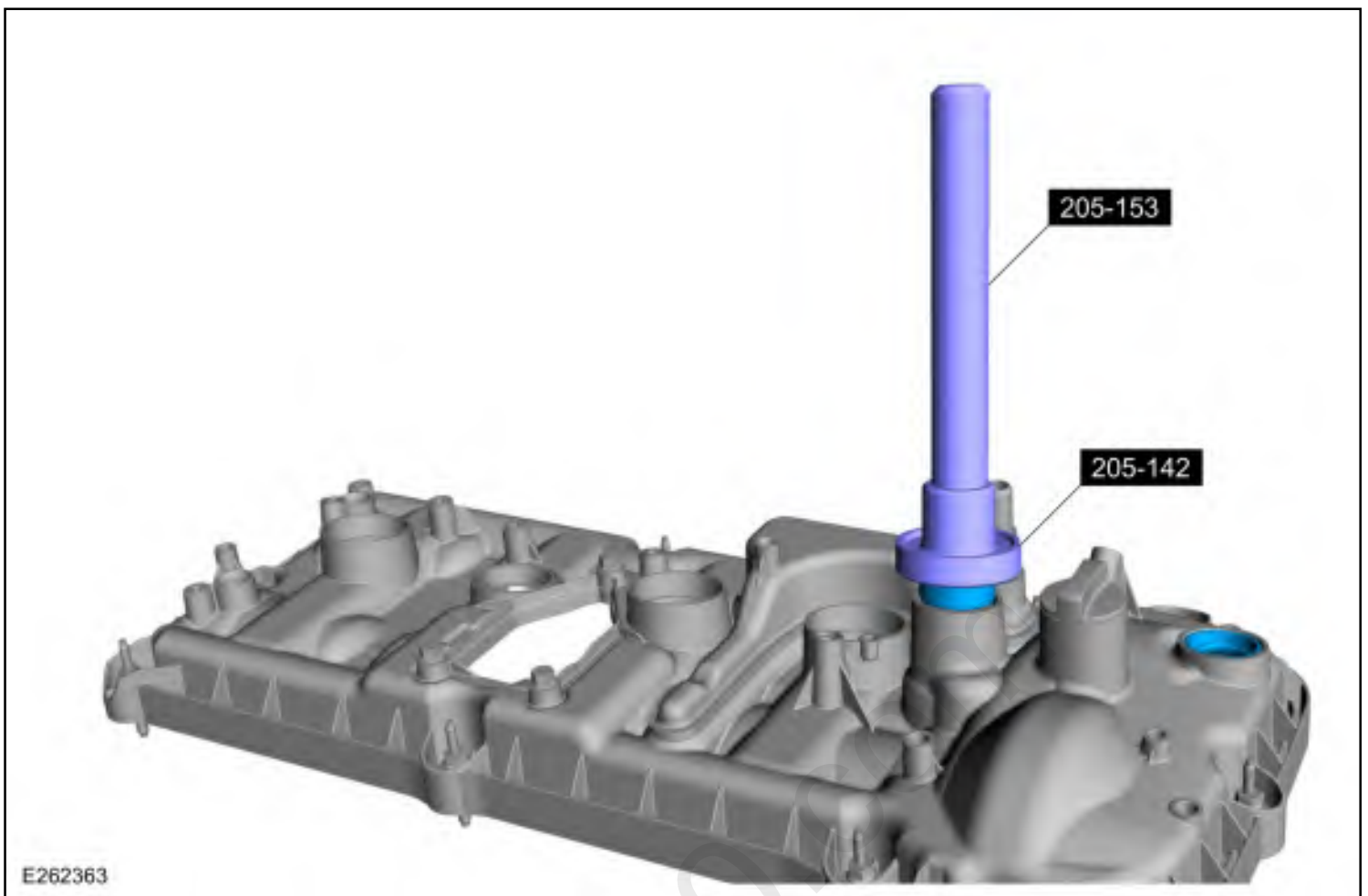
Use Special Service Tool: 205-153 (T80T-4000-W) Handle. , 303-1247 VCT Spark Plug Tube Seal Remover and Installer.



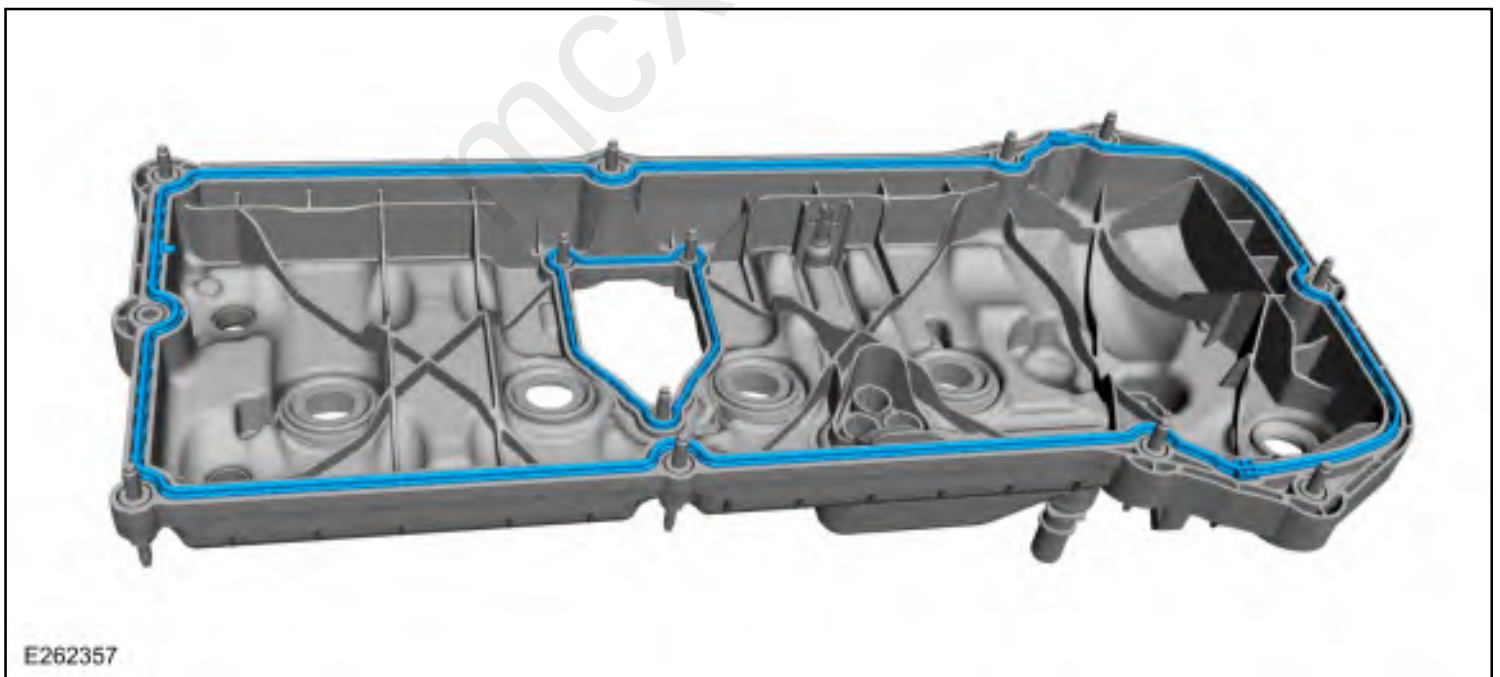
96. **NOTE:** *Installation of new seals is only required if damaged seals were removed.*

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.

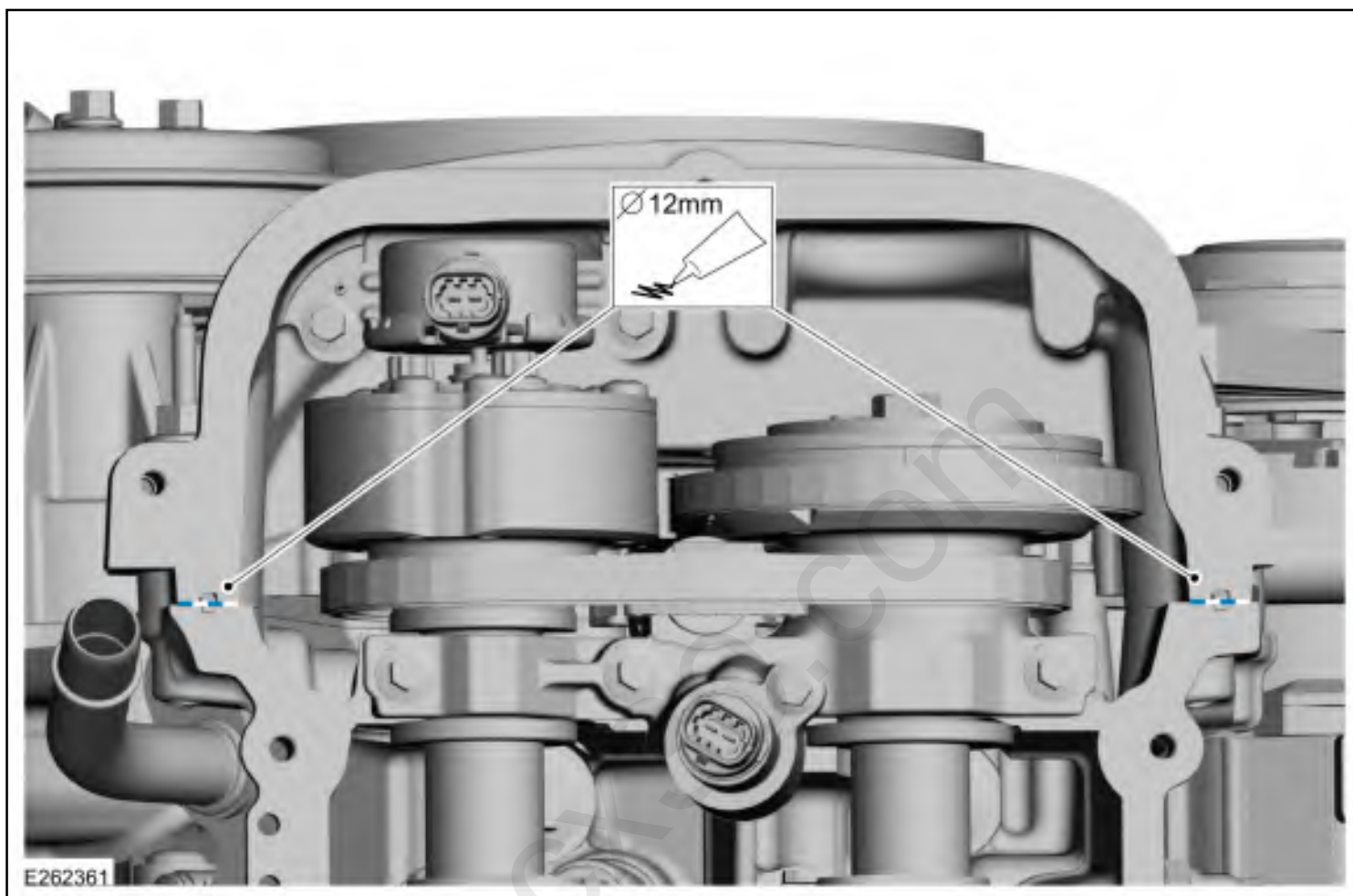


98. **NOTICE:** If the valve cover is not installed and the fasteners tightened within 5 minutes, the sealant must be removed and the sealing area cleaned.



Apply an 12 mm (0.47 in) bead of silicone gasket and sealant to the engine front cover-to-cylinder head joints.

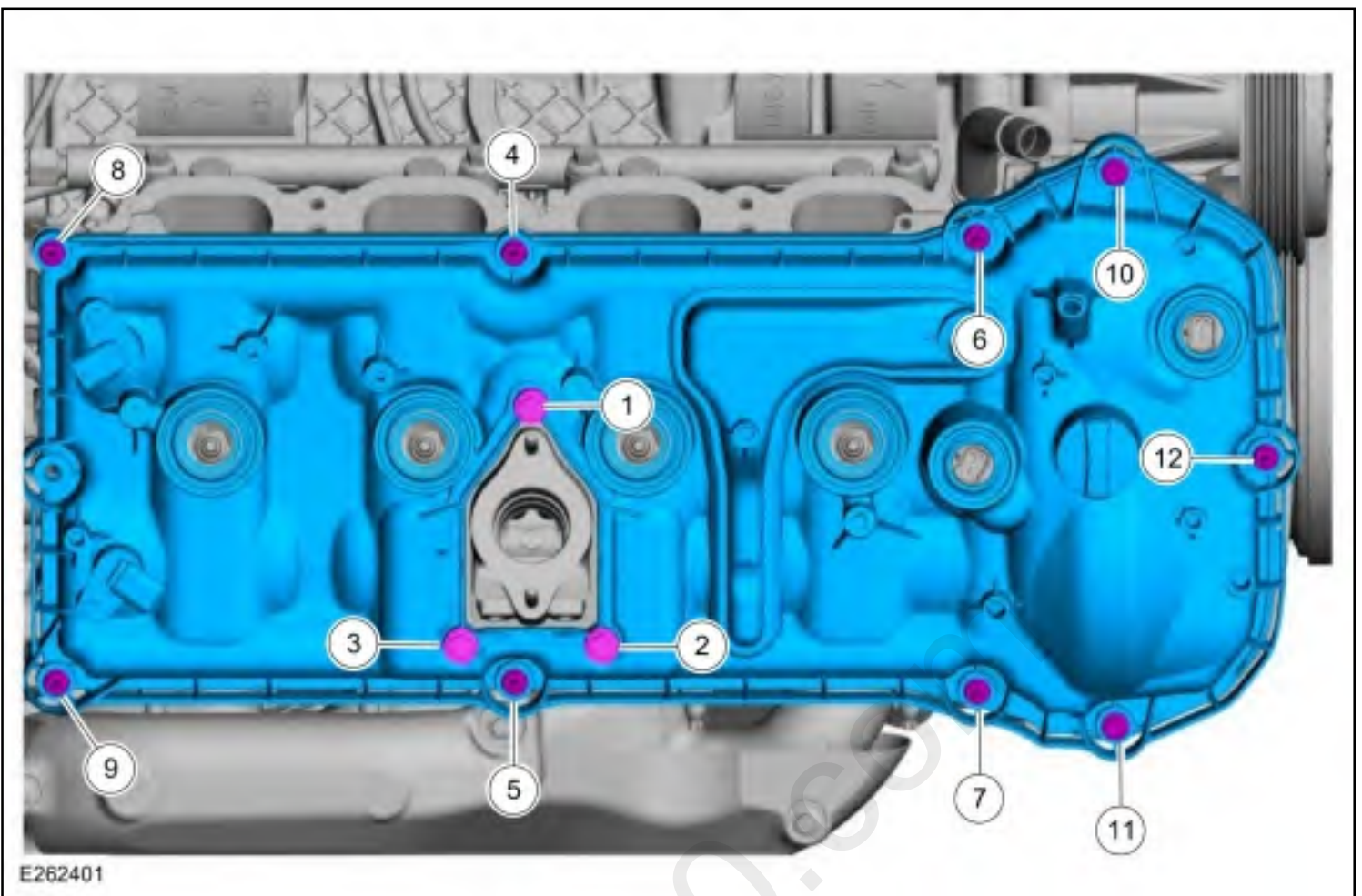
*Material:* Motorcraft® Silicone Gasket and Sealant / TA-30 (WSE-M4G323-A4)



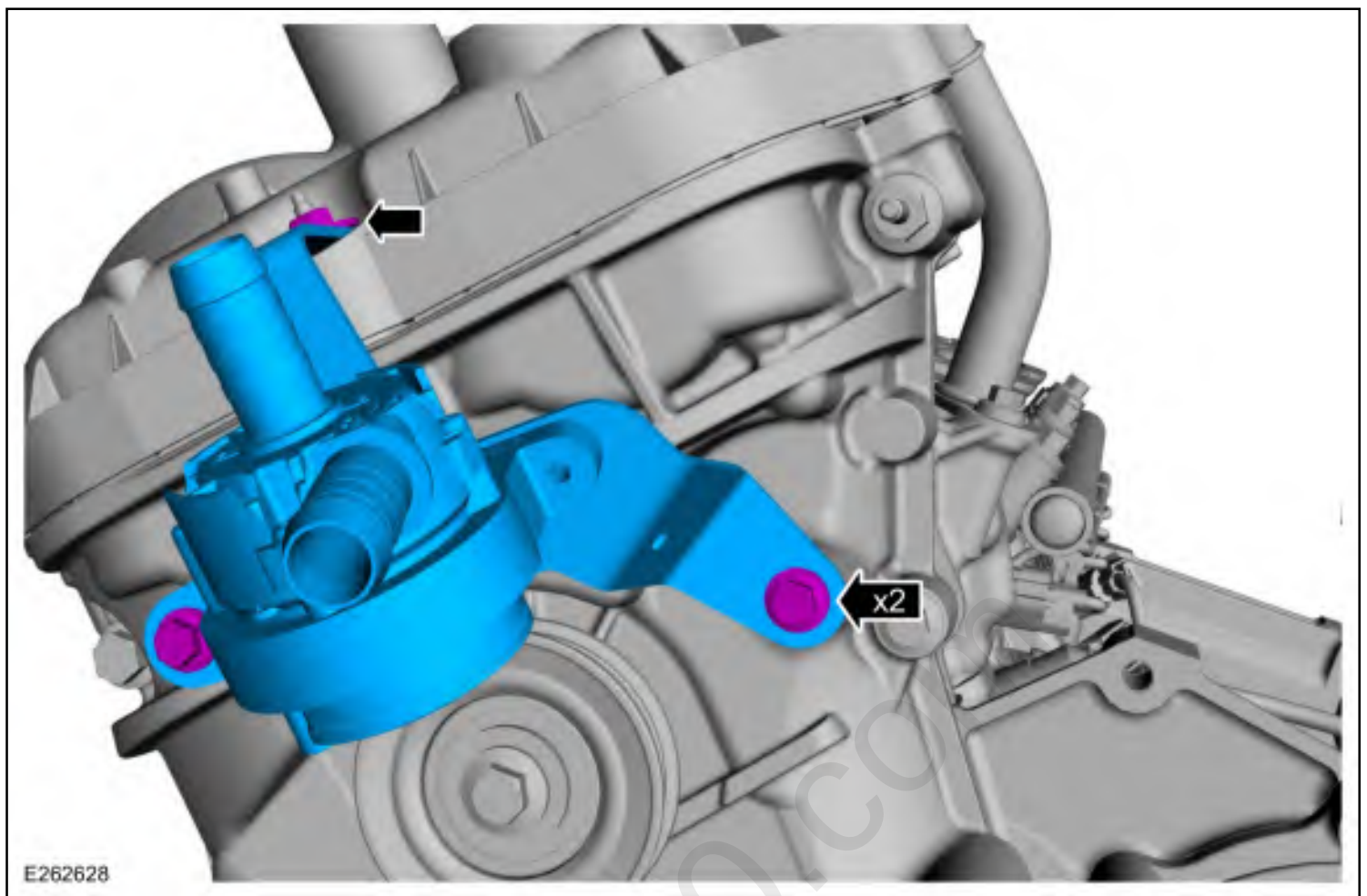
99. Install the valve cover and tighten the bolts.

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





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

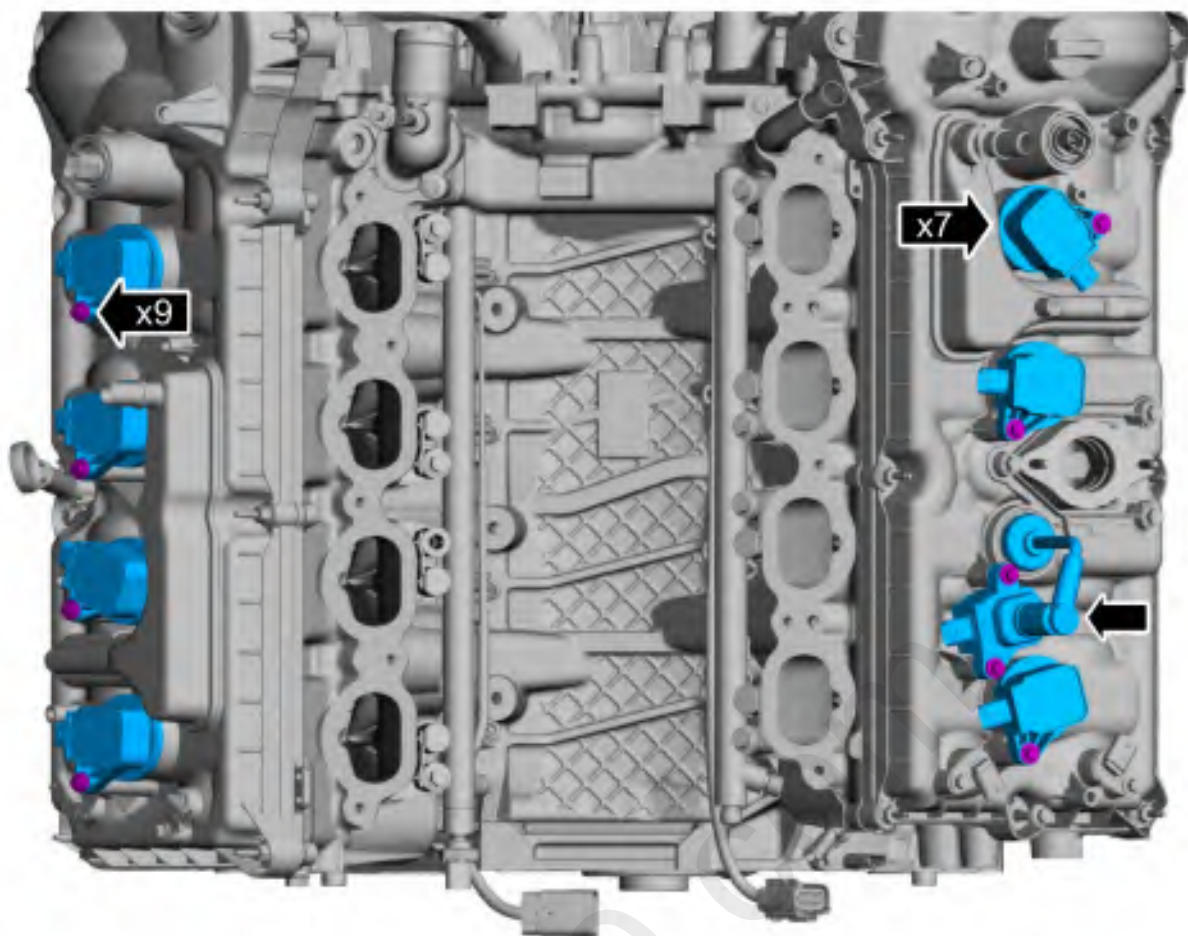


1. Install the ignition coil-on-plugs
2. Install and tighten the ignition coil-on-plug retaining bolts in the following 2 stages.

*Torque:*

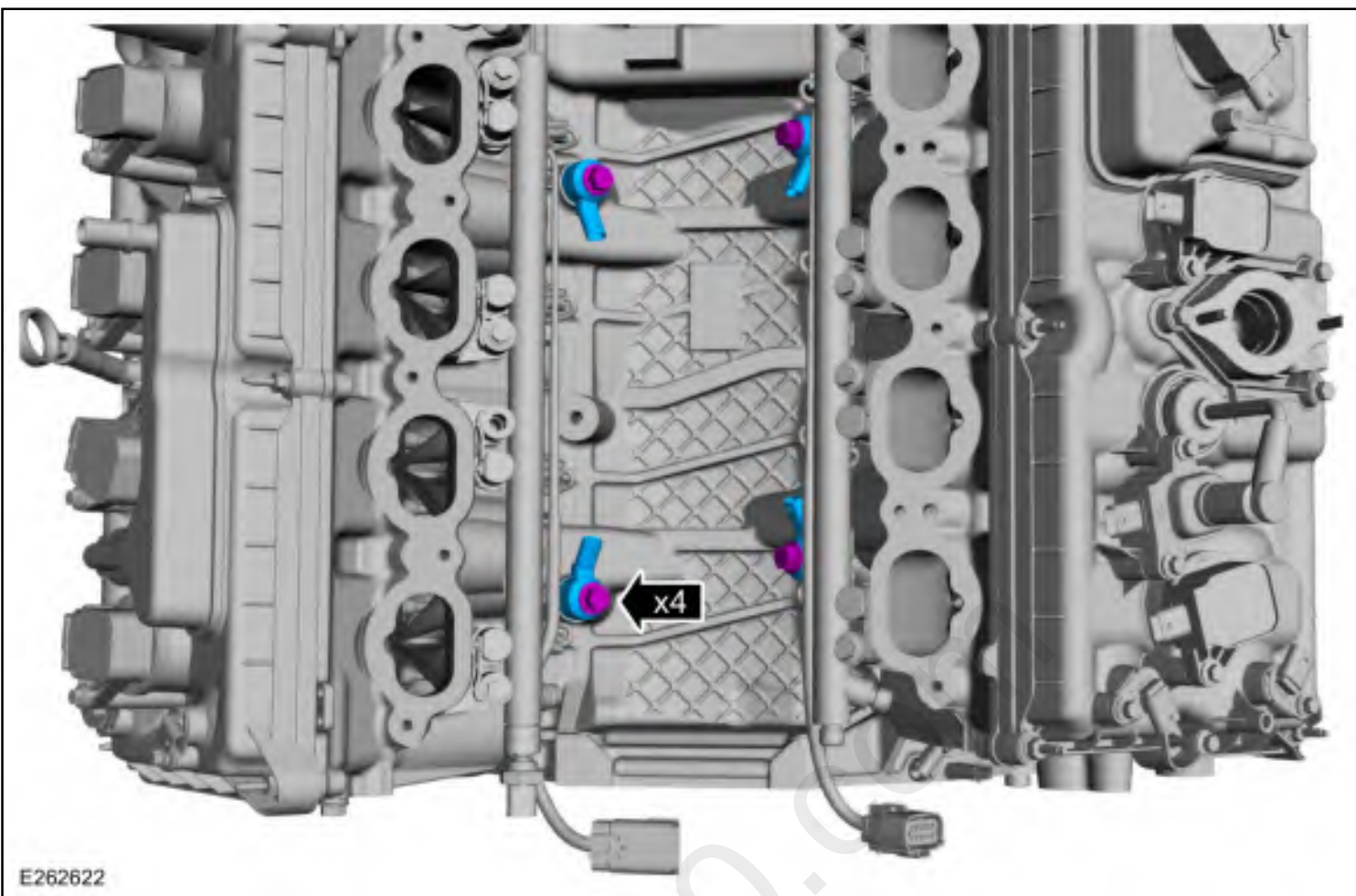
Stage 1: 62 lb.in (7 Nm)

Stage 2: 45°



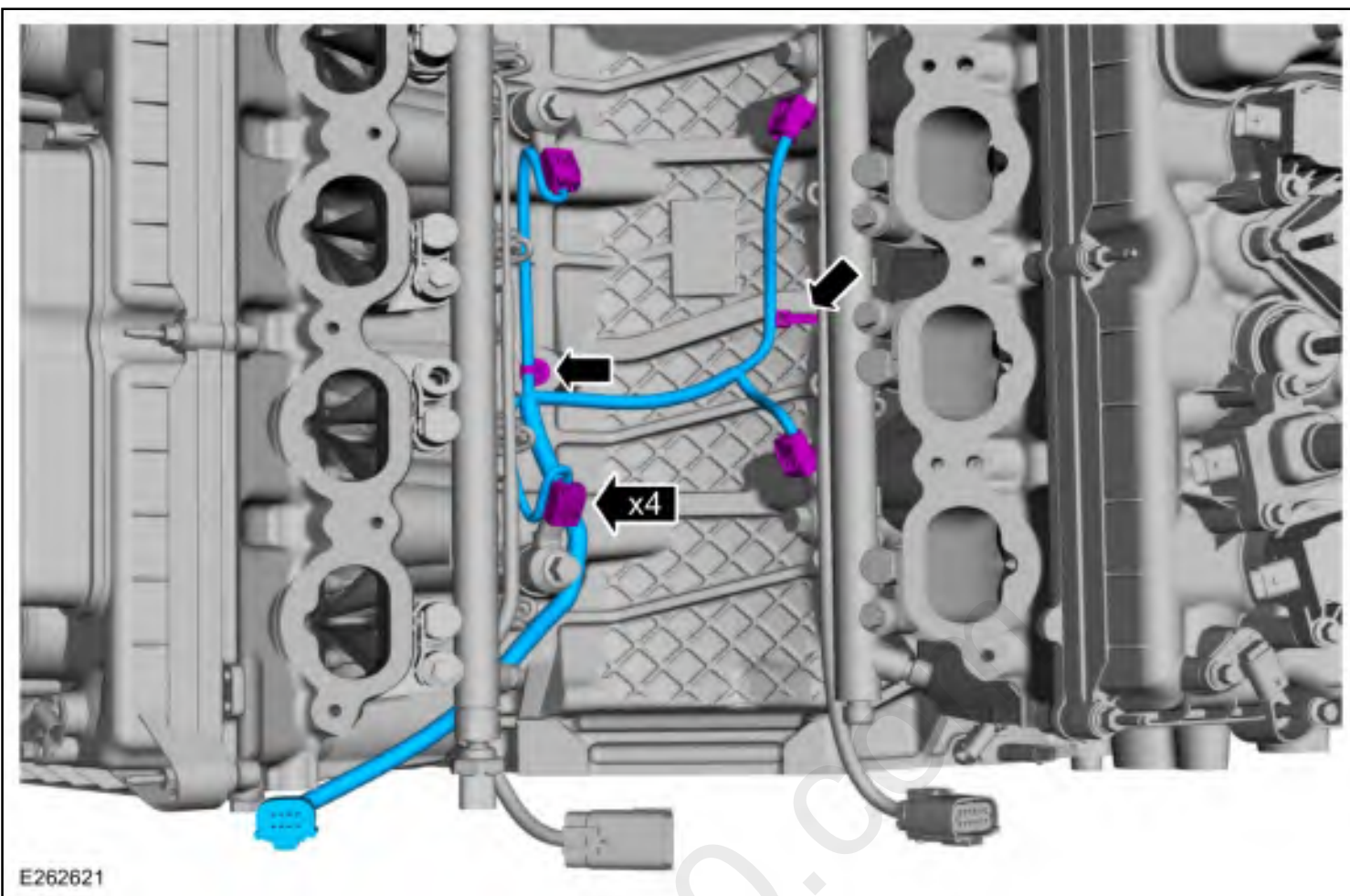
E262623

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



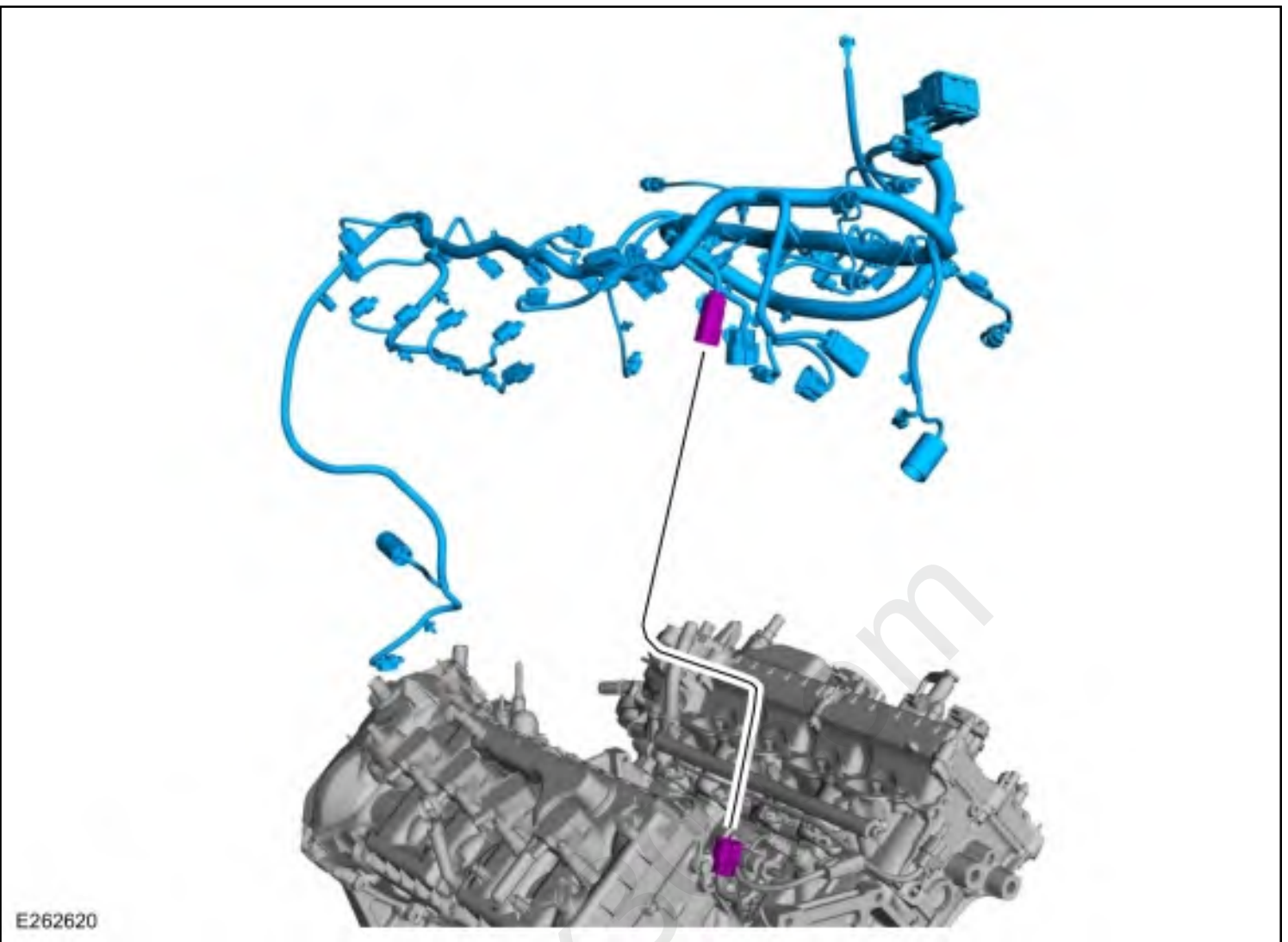
1. Install the KS harness onto the engine.
2. Attach the wiring harness retainers.
3. Connect the KS electrical connectors.



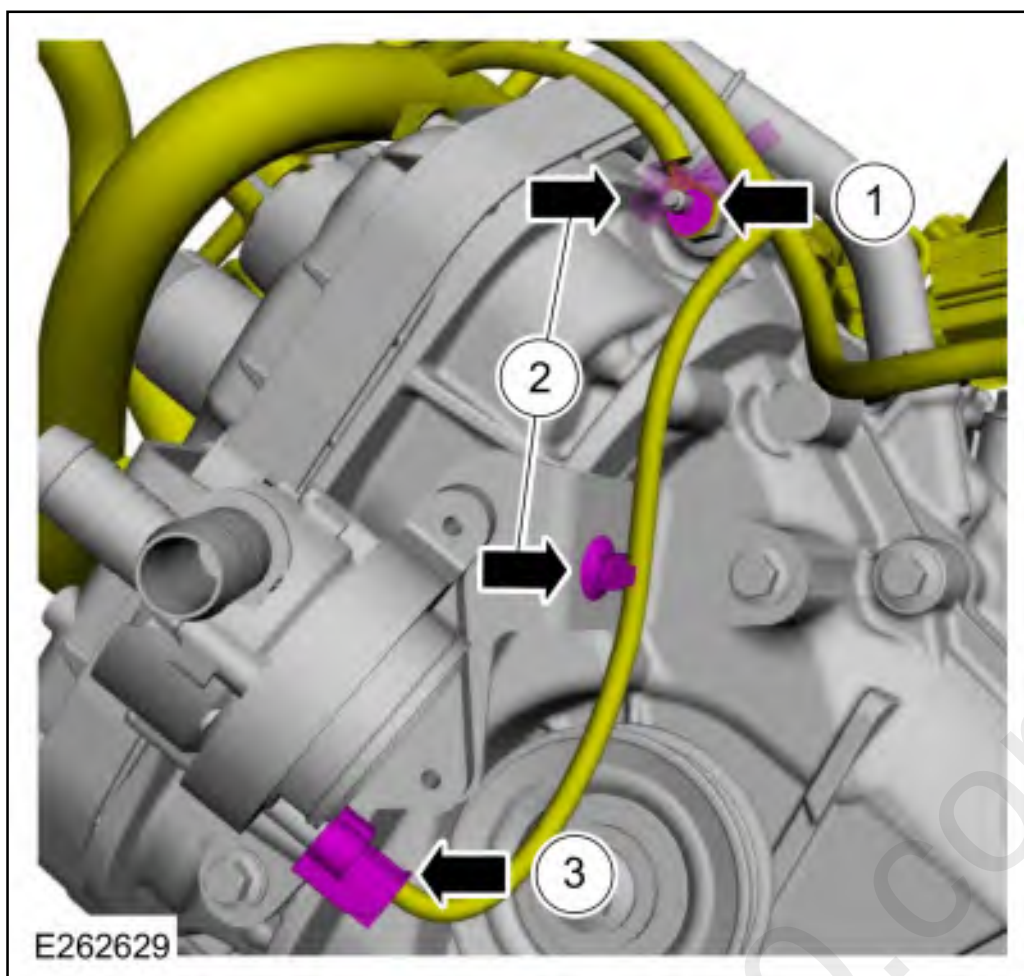


104. Install and connect the engine wiring harness.

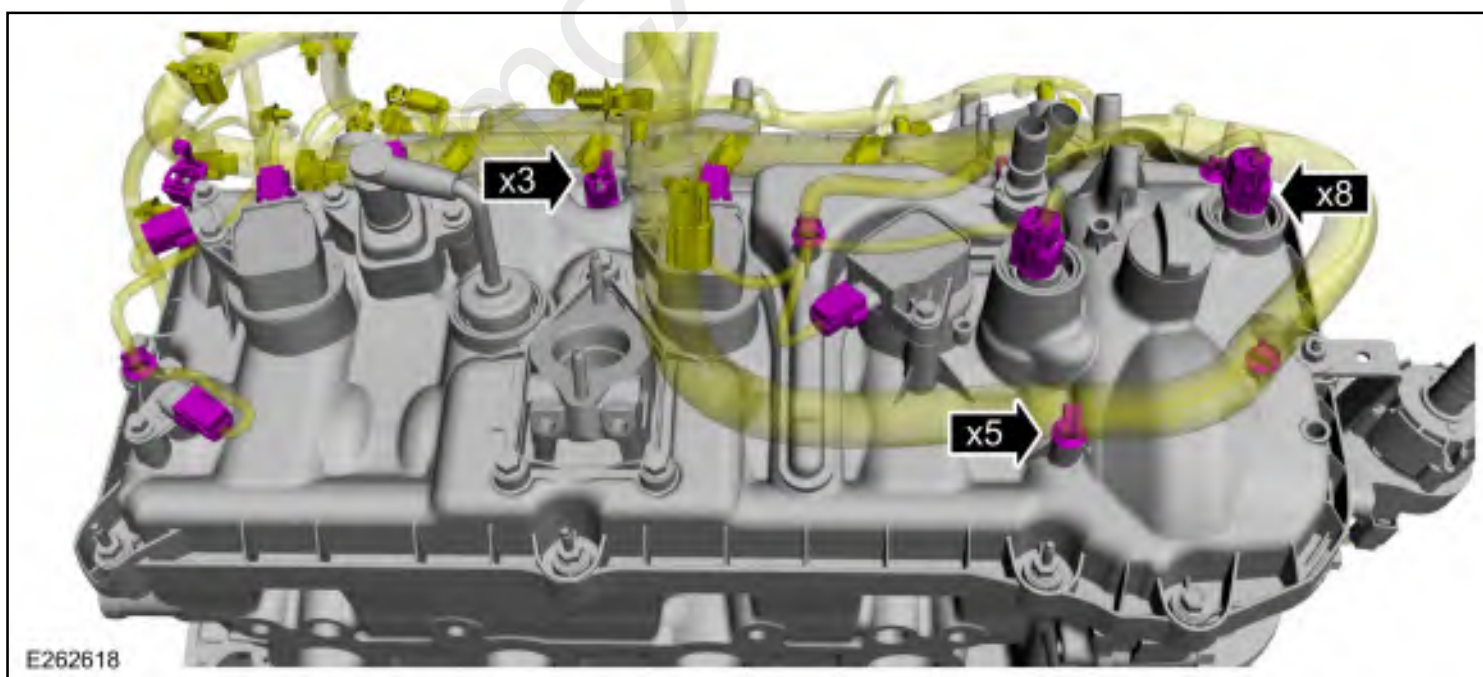




1. Install ground wire eyelet and the nut.  
*Torque: 89 lb.in (10 Nm)*
2. Attach the engine wiring harness retainers.
3. Connect the engine wiring harness electrical connector.

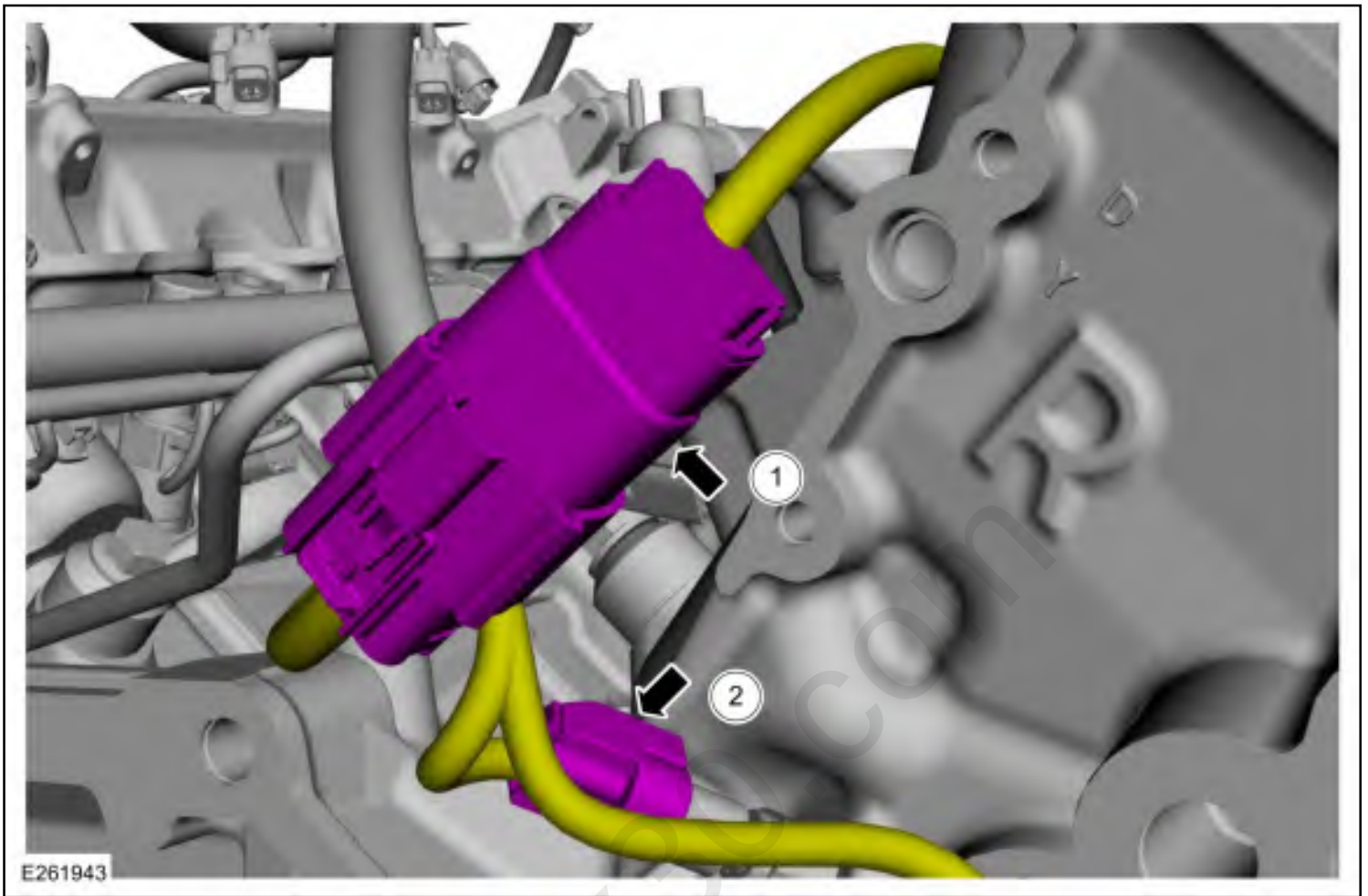


1. Connect the engine wiring harness electrical connectors.
2. Attach the wiring harness retainers.

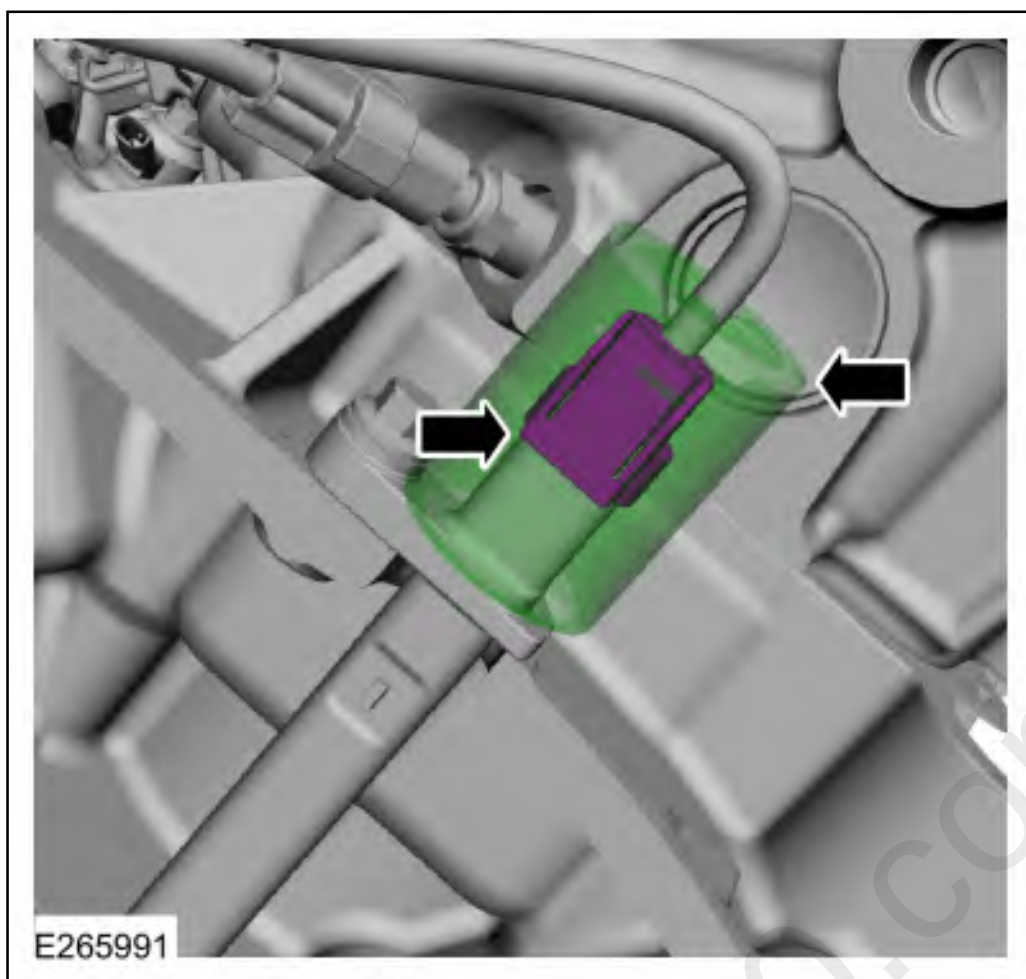


1. Connect the fuel rail electrical connector.

2. Connect the CHT sensor electrical connector.

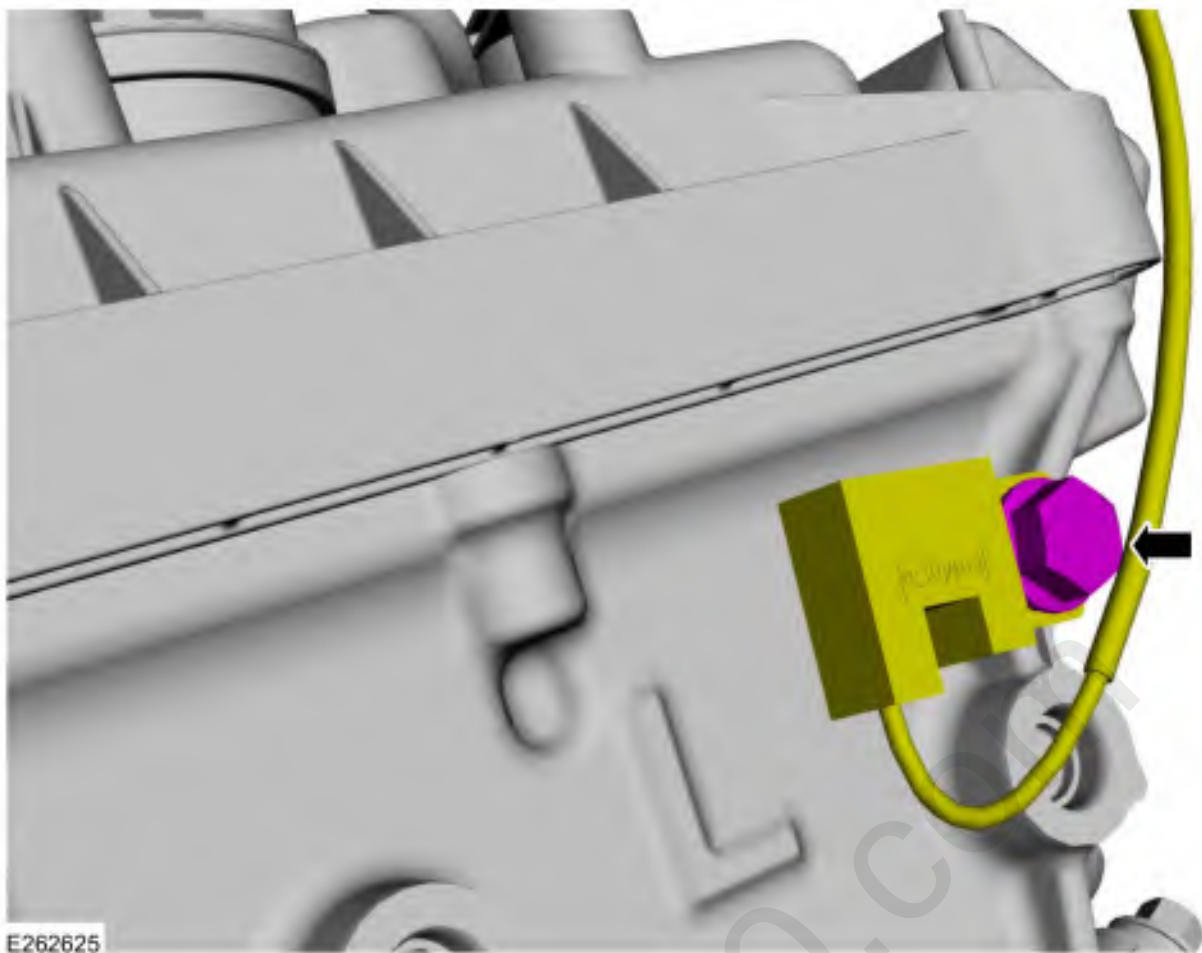


1. Connect the CKP sensor electrical connector.
2. Slide the insulator over the electrical connector.



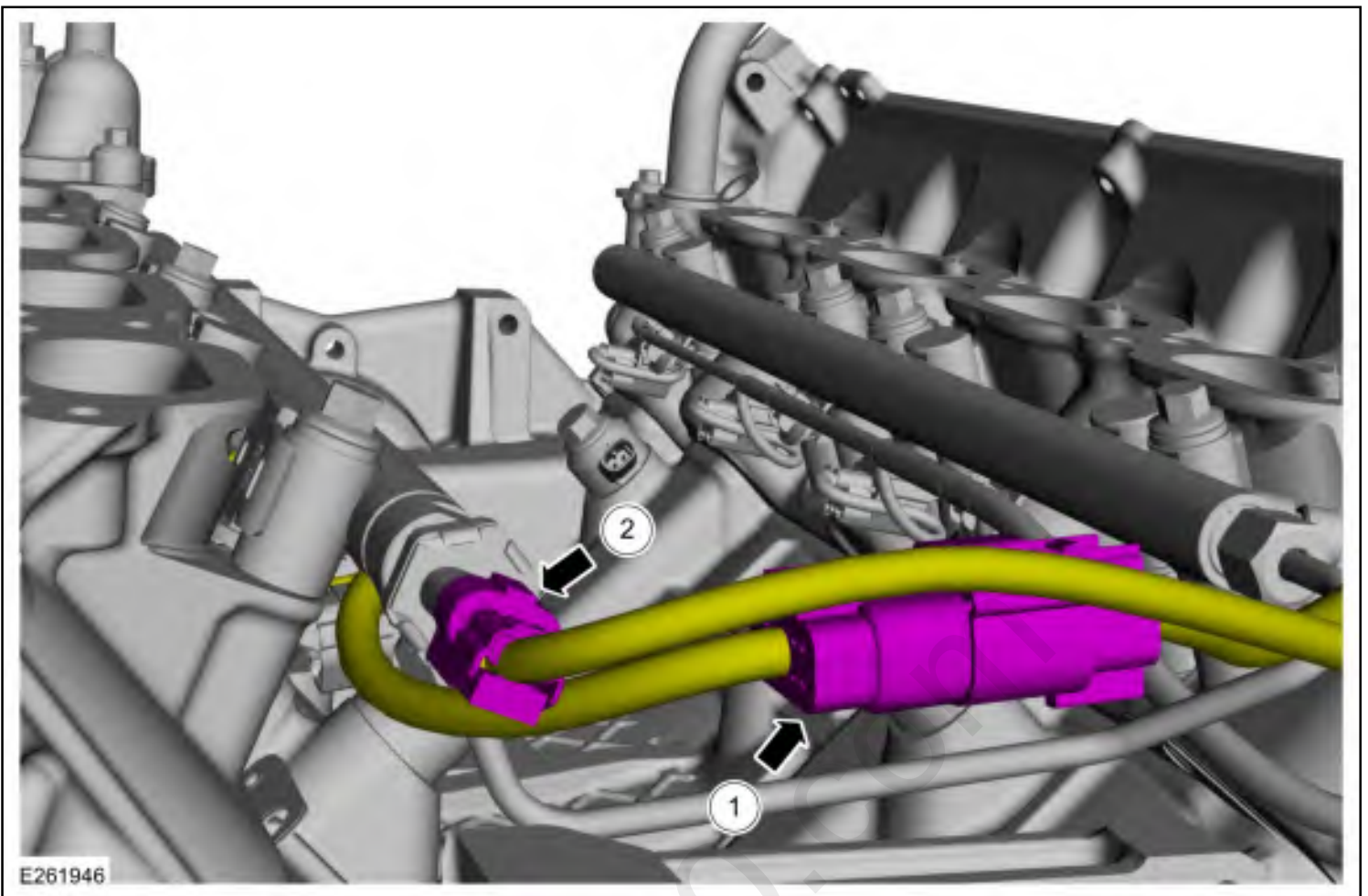
109. Remove the bolt and position the capacitor aside.  
*Torque: 89 lb.in (10 Nm)*



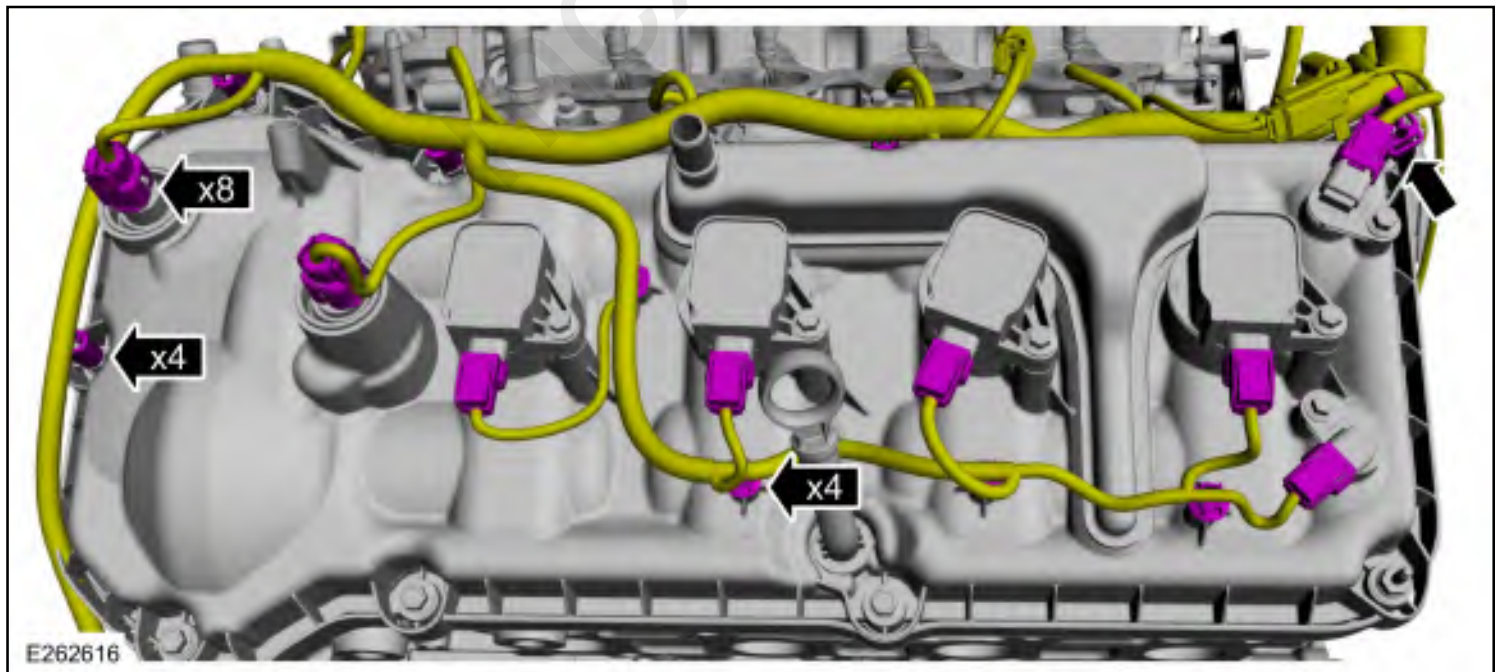


1. Connect the fuel rail electrical connector.
2. Connect the fuel sensor electrical connector.



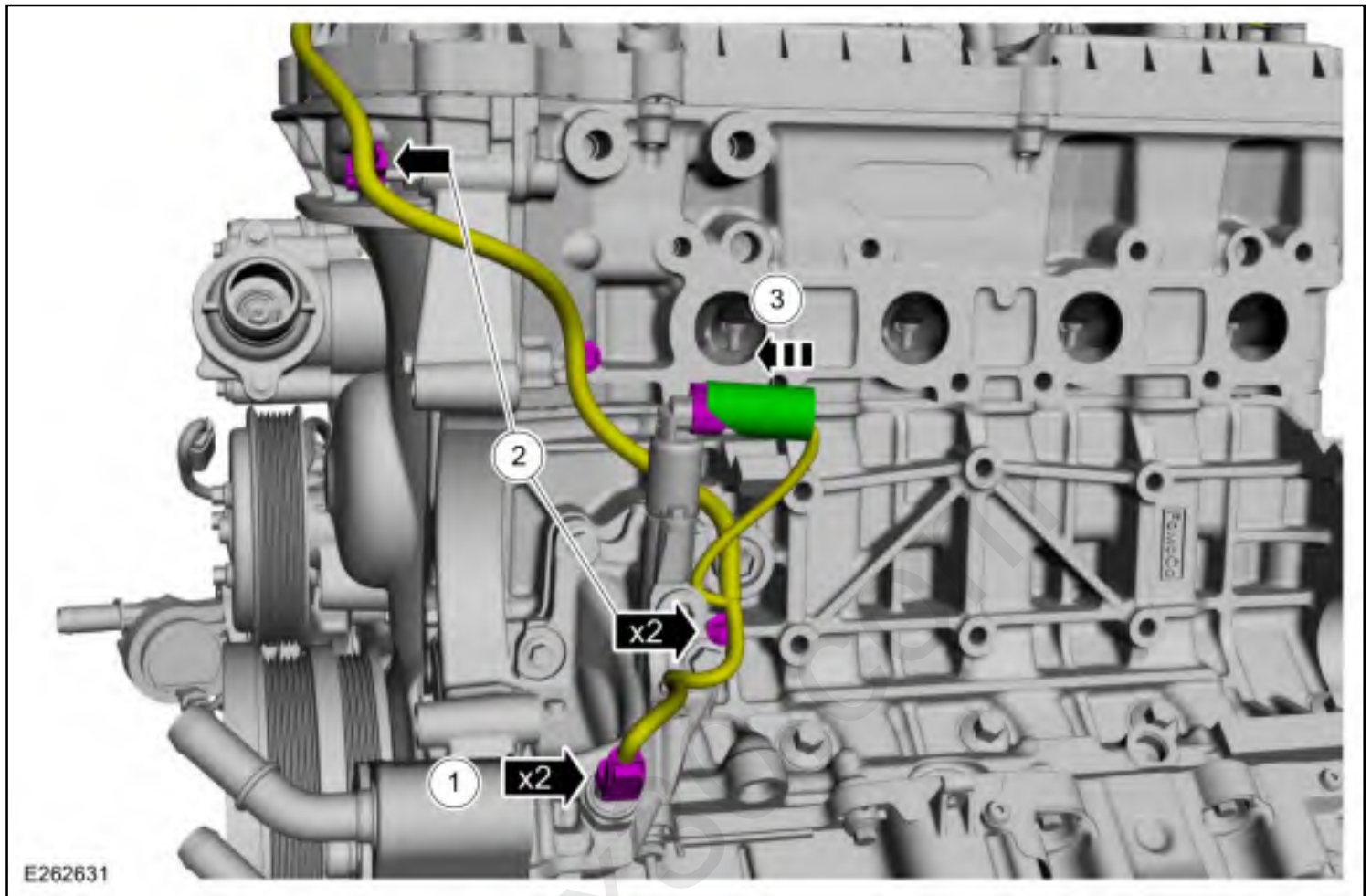


1. Connect the engine wiring harness electrical connectors.
2. Attach the wiring harness retainers.



1. Connect the engine wiring harness electrical connectors.

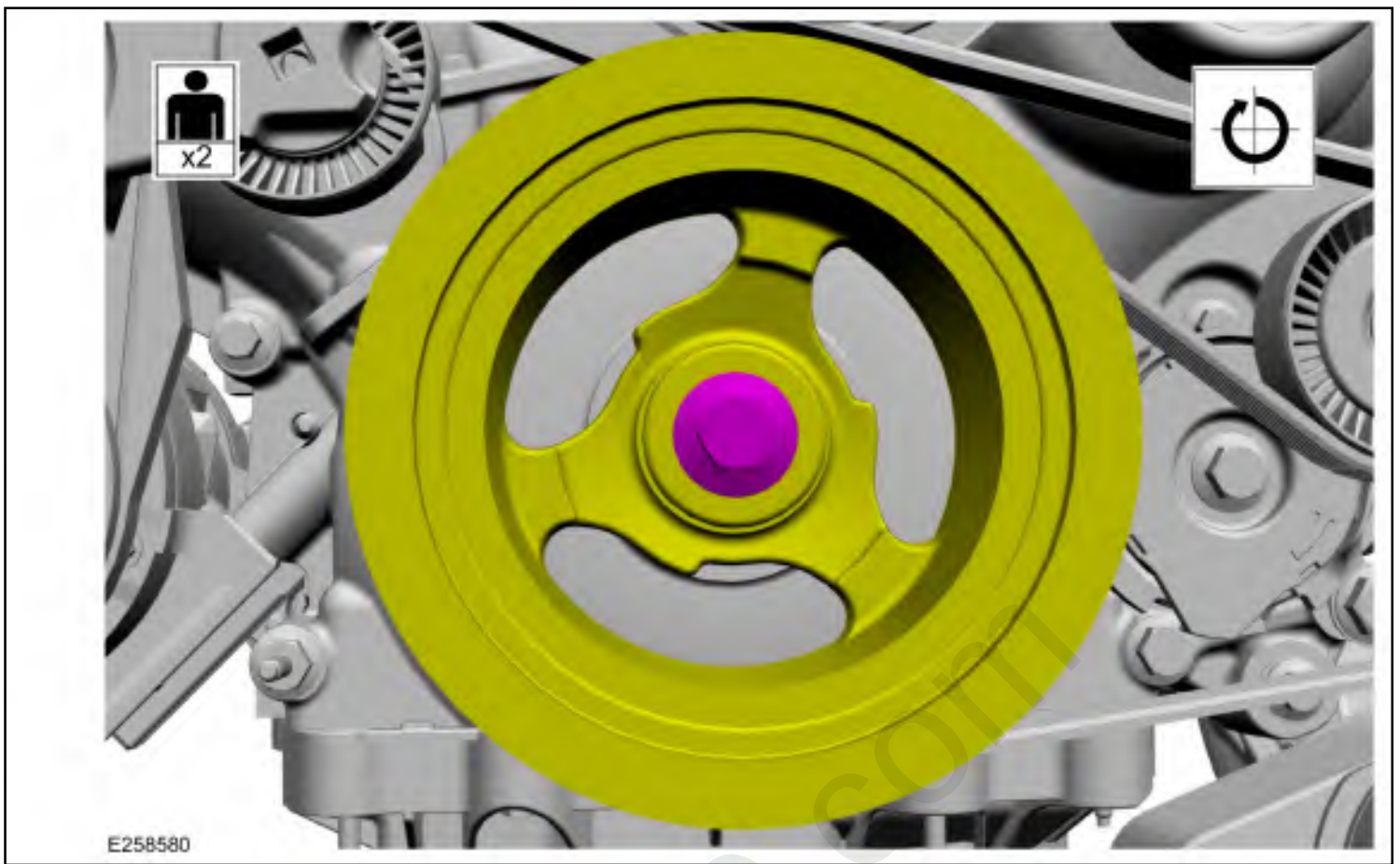
2. Attach the engine wiring harness retainers.
3. Position the wiring harness insulator.



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

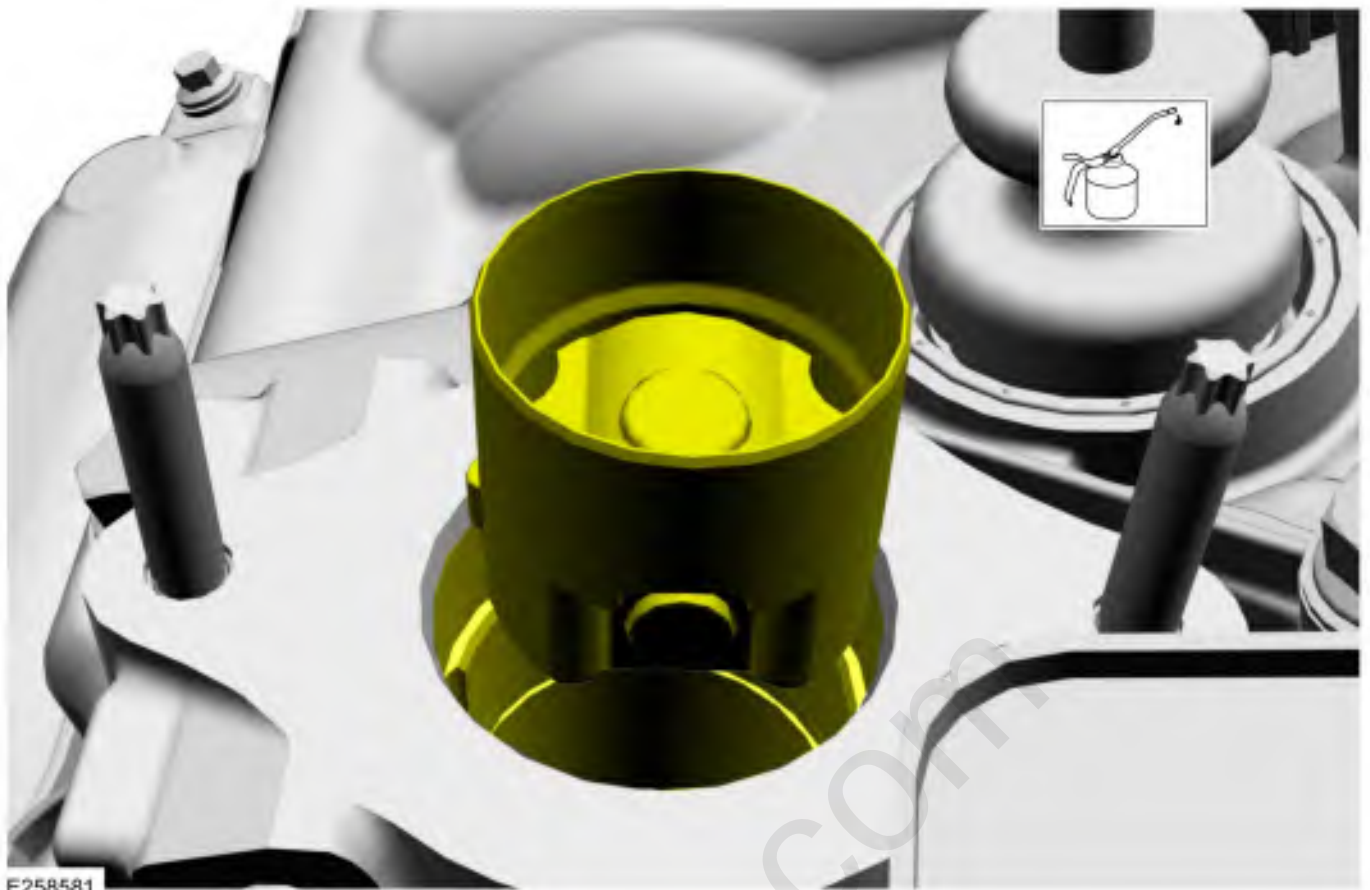
**NOTICE:** The drive lobe for the high-pressure fuel pump must be at BDC (bottom dead center) for the high-pressure fuel pump installation.

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.



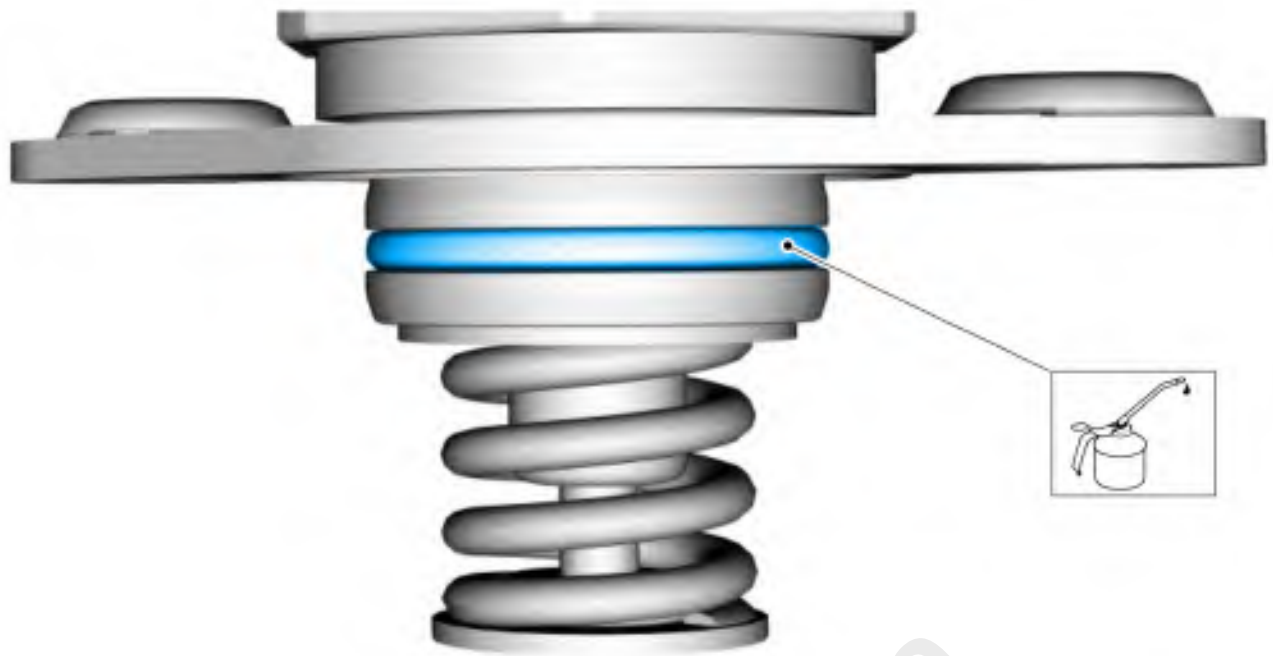


115. Install the high-pressure fuel pump roller tappet.



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





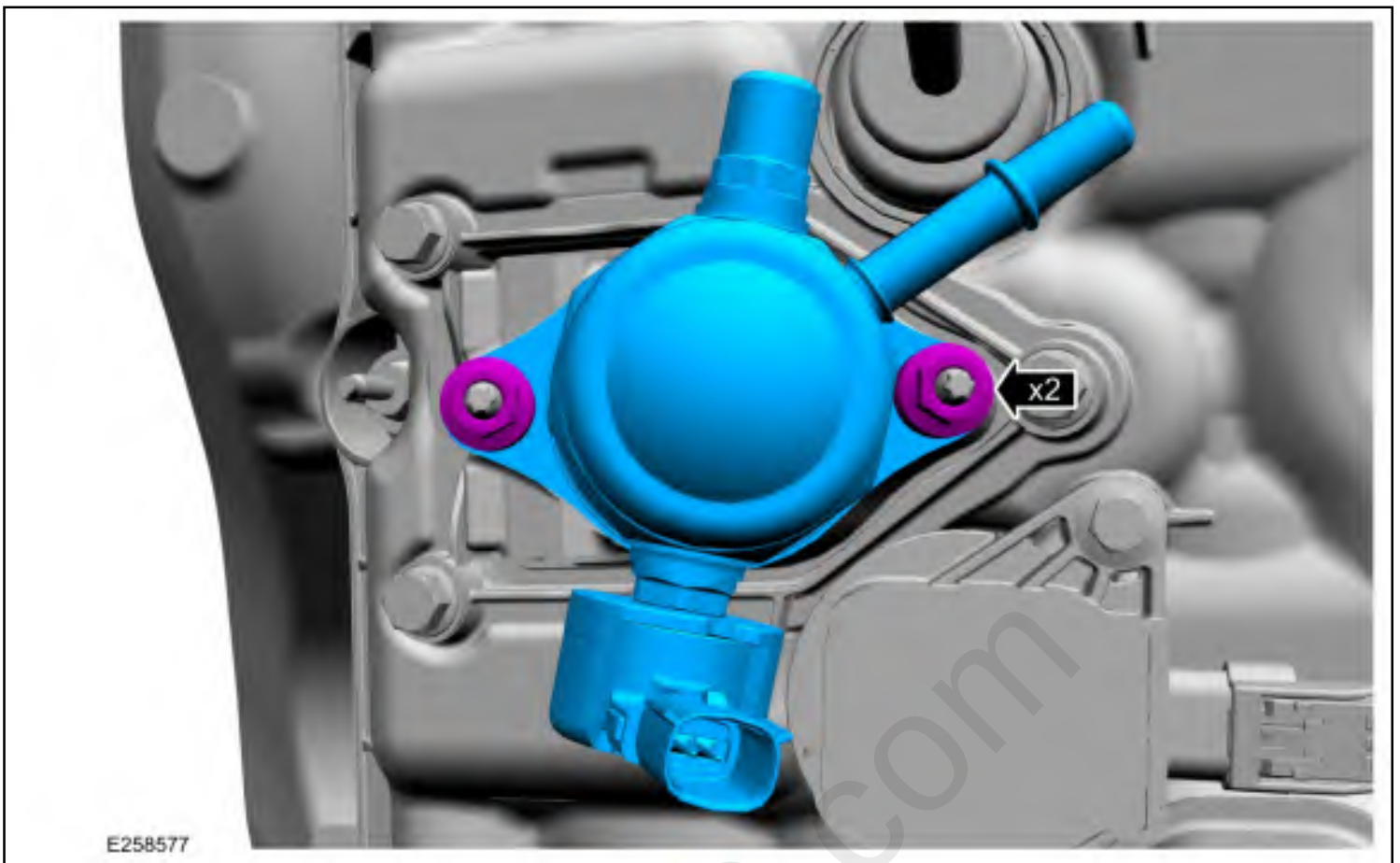
E242553

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)

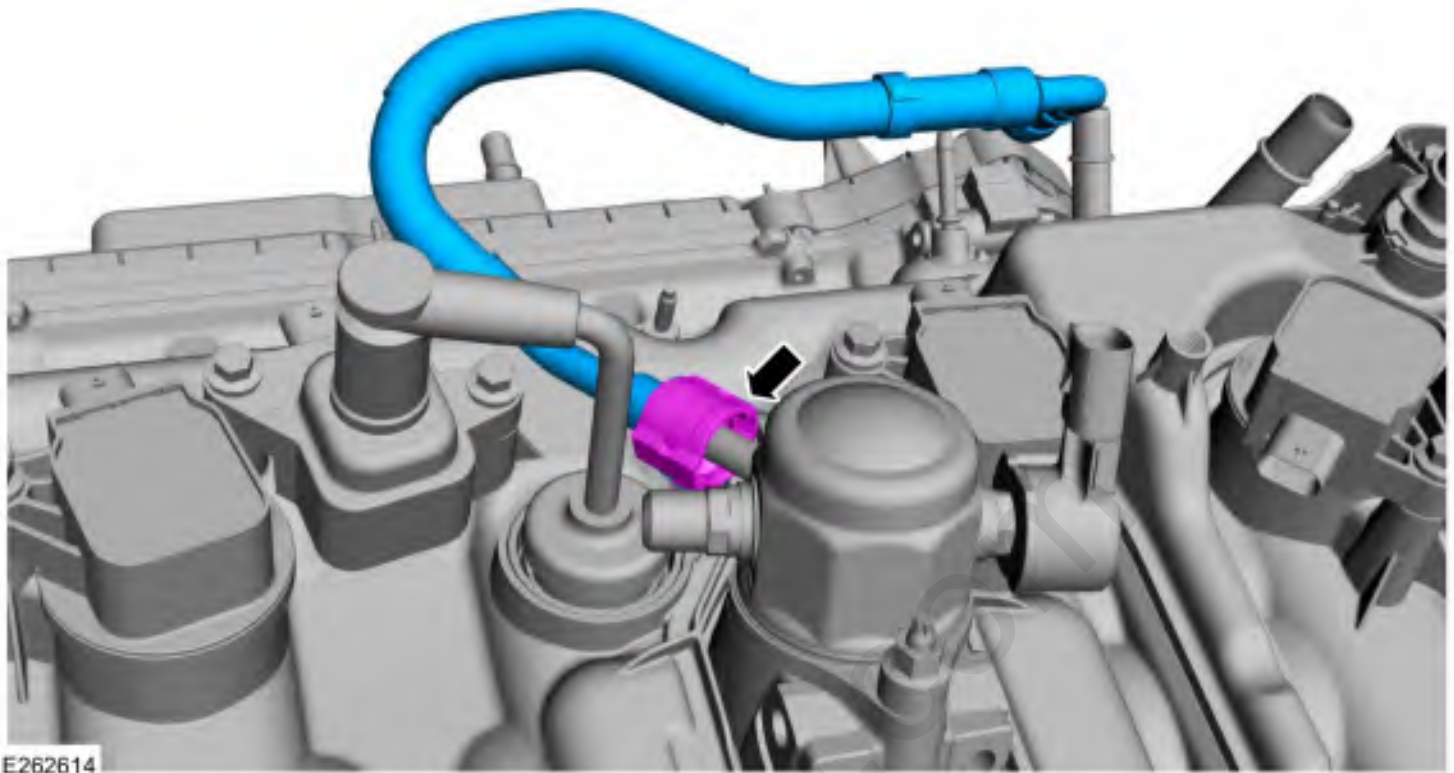
Stage 2: 30°



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.

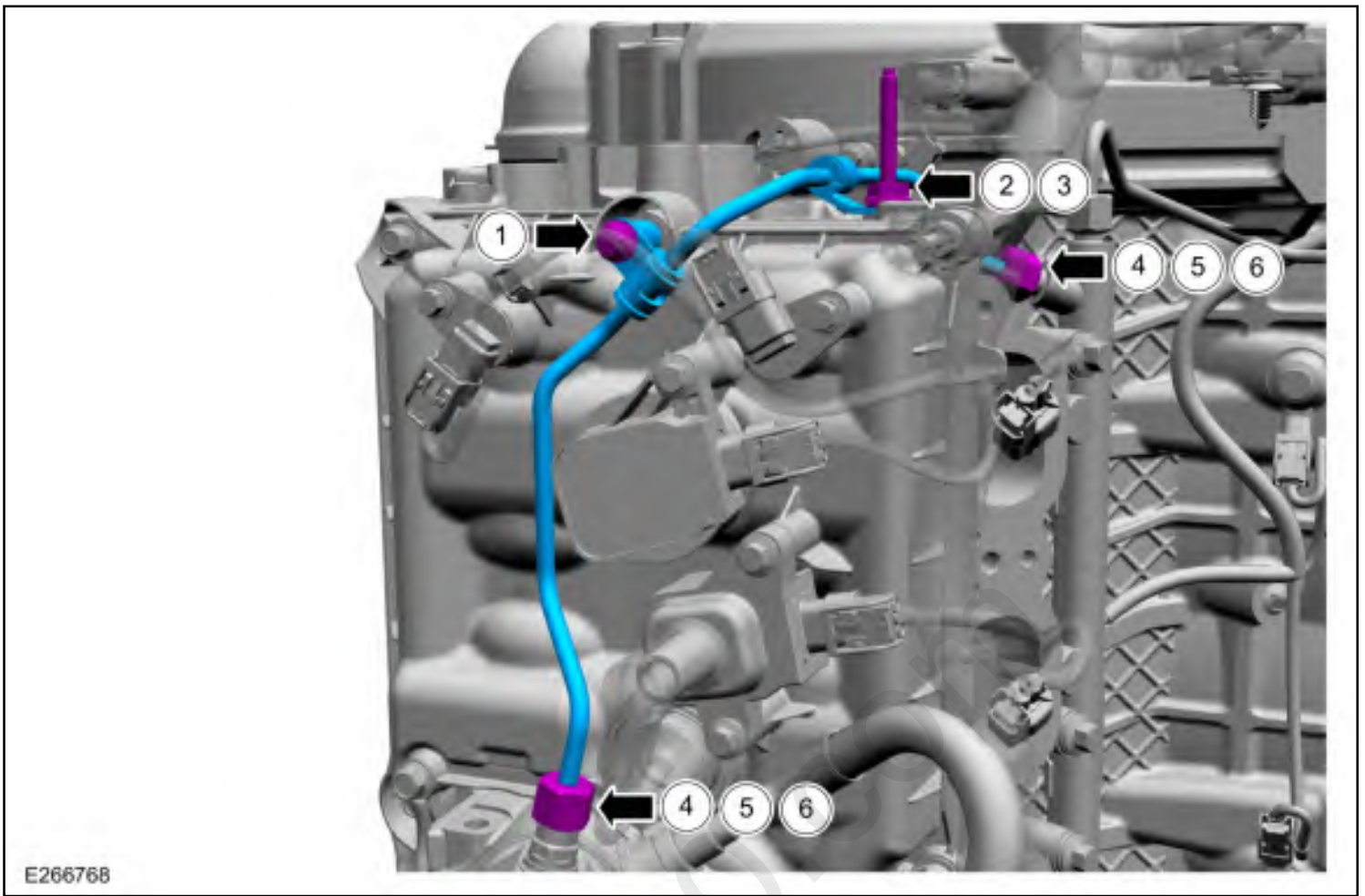
Install the high-pressure fuel tube and connect the quick release coupling.

Refer to: [Quick Release Coupling](#) (310-00D Fuel System - General Information - 5.0L 32V Ti-VCT, General Procedures).



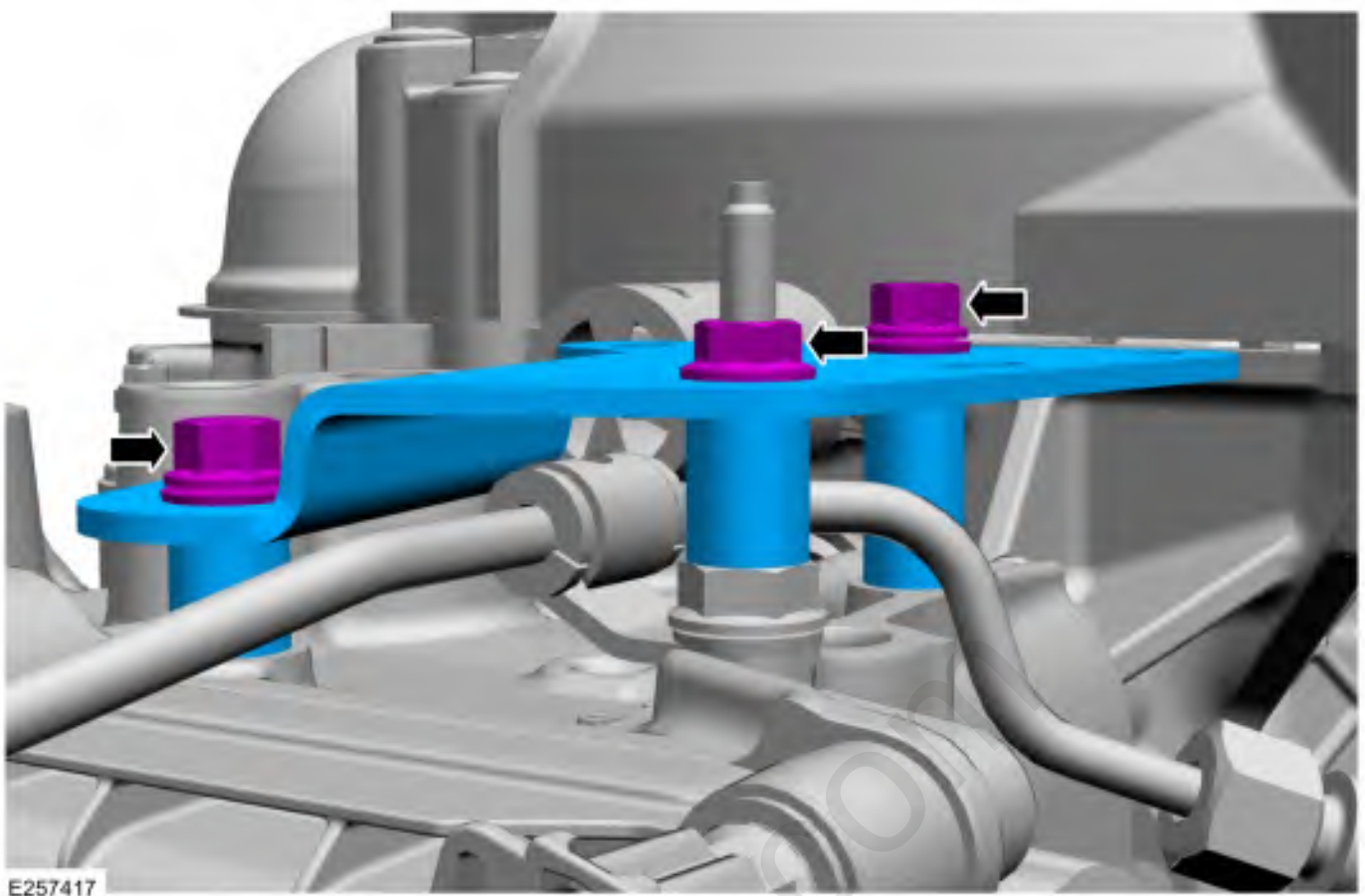
119. **NOTICE:** In stage 6, if the torque required to tighten any flare nut on the new high-pressure fuel tube reaches or exceeds 37 lb.ft (50 Nm), then that high pressure fuel tube must be discarded and replaced with another new high-pressure fuel tube.

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°



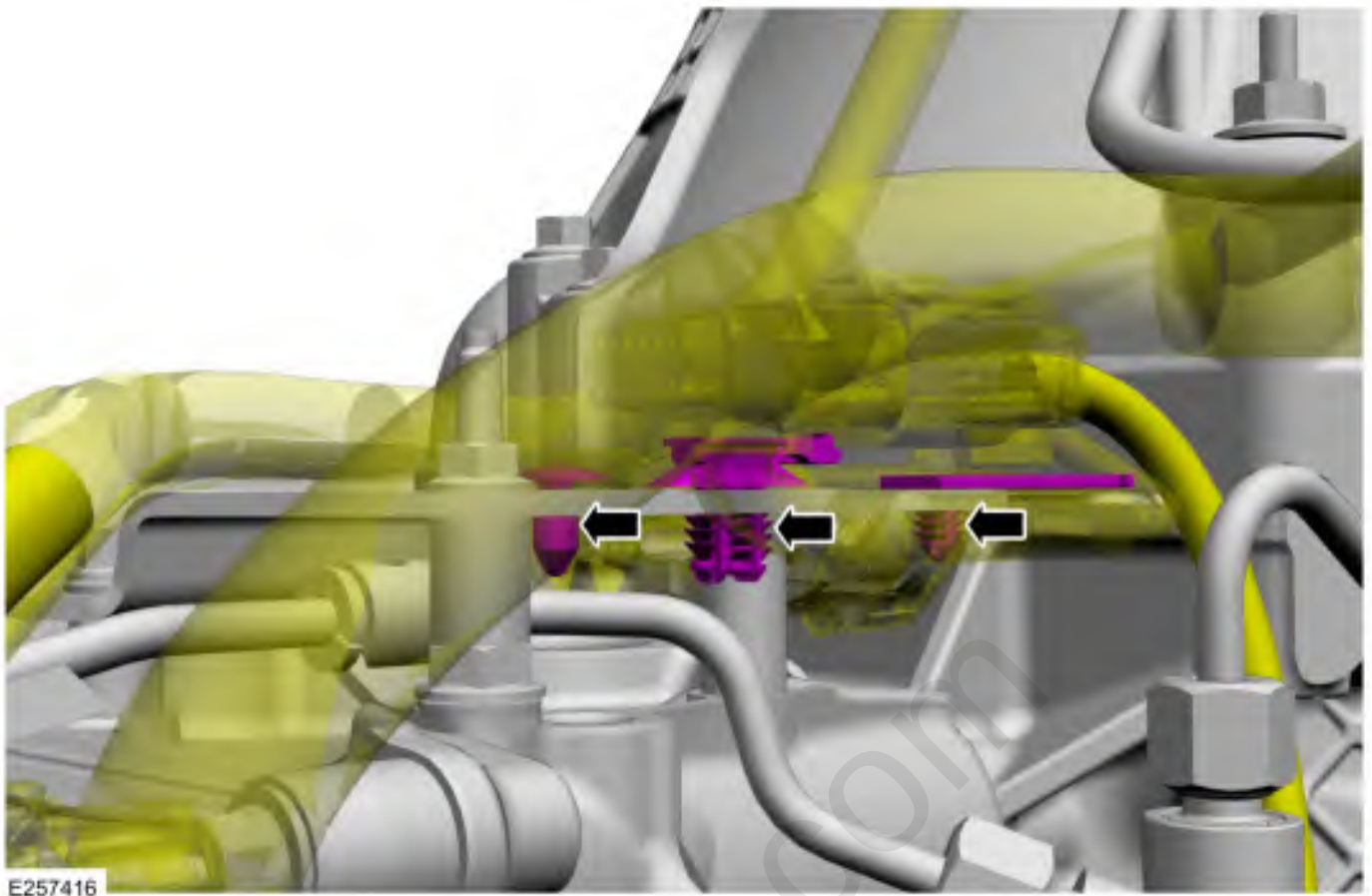
120. Install the high-pressure fuel line shield, then install and tighten the high-pressure fuel line shield retainers.

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



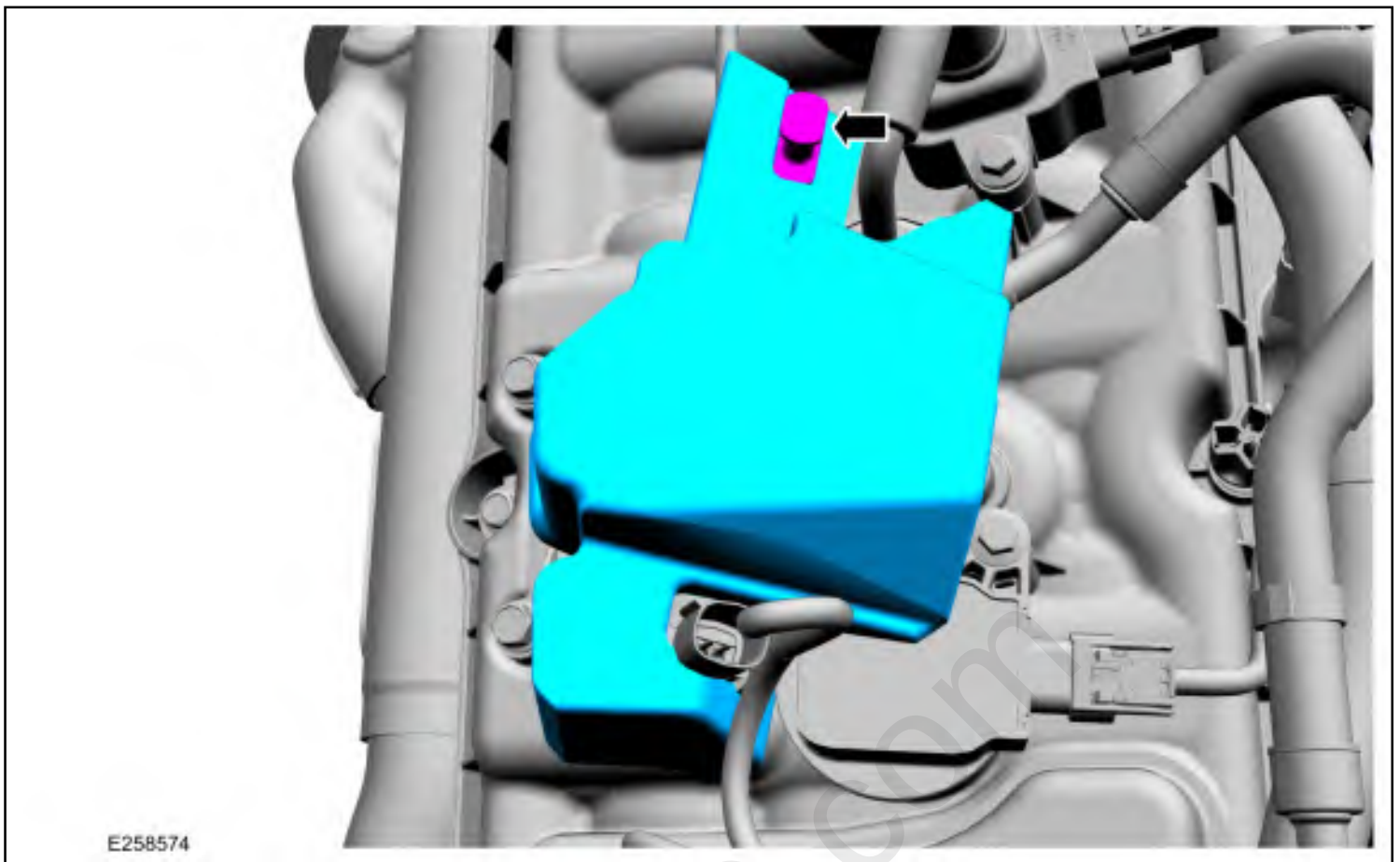
121. Attach the wiring harness retainers to high-pressure fuel line shield.



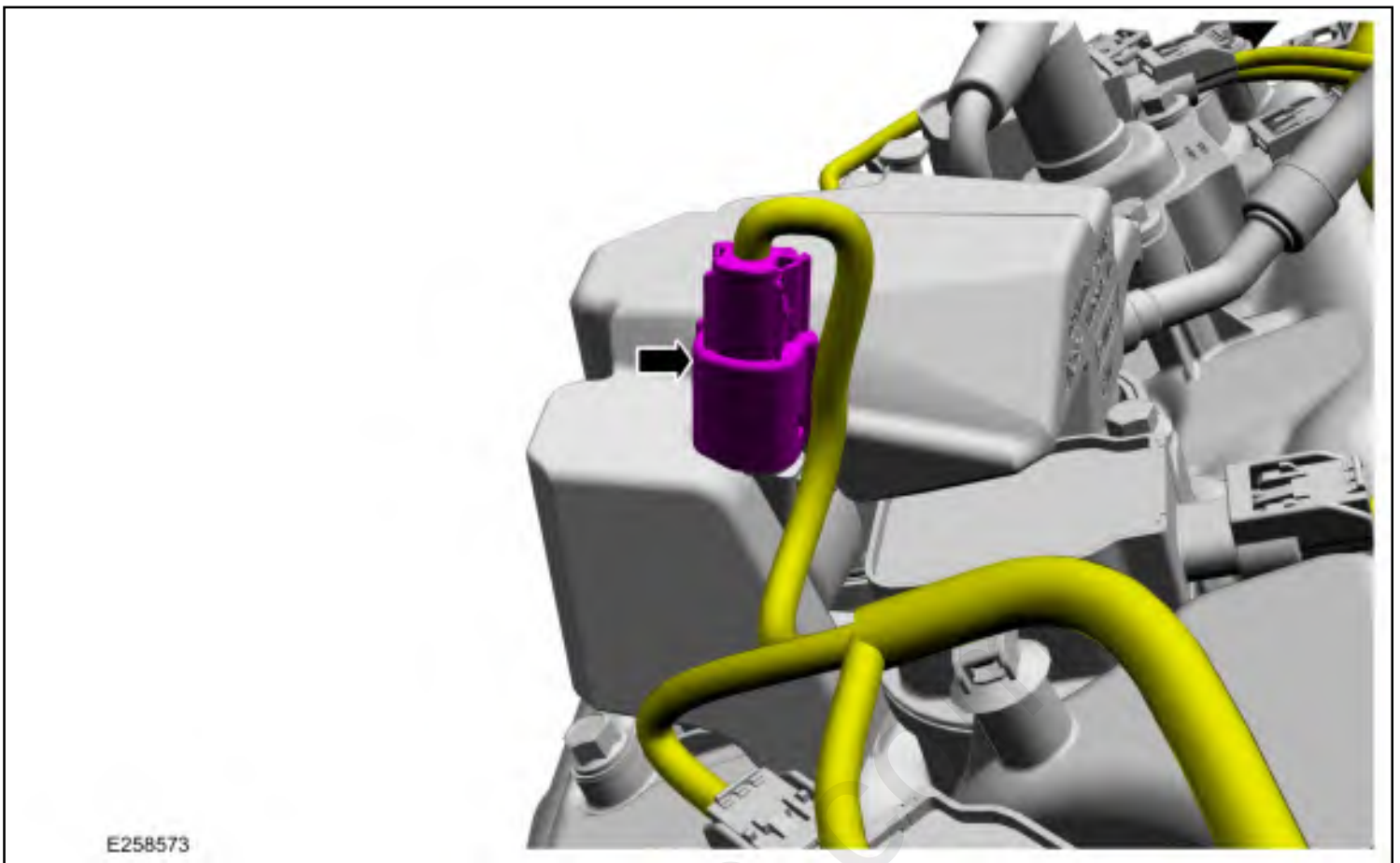


122. **NOTE:** When removing or installing the fuel injection pump noise insulator, spreading the openings will reduce the risk of damage.

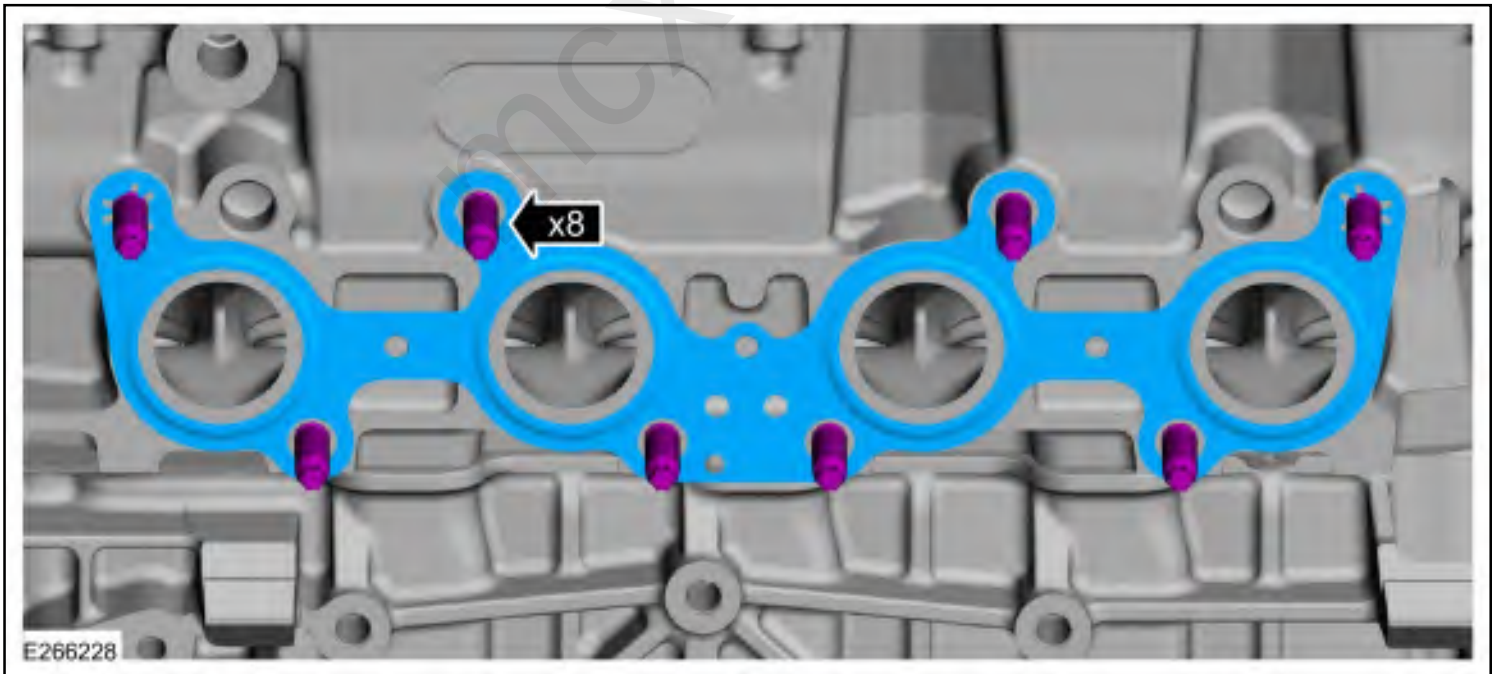
Install the fuel injection pump noise insulator, then engage the retainer.



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



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



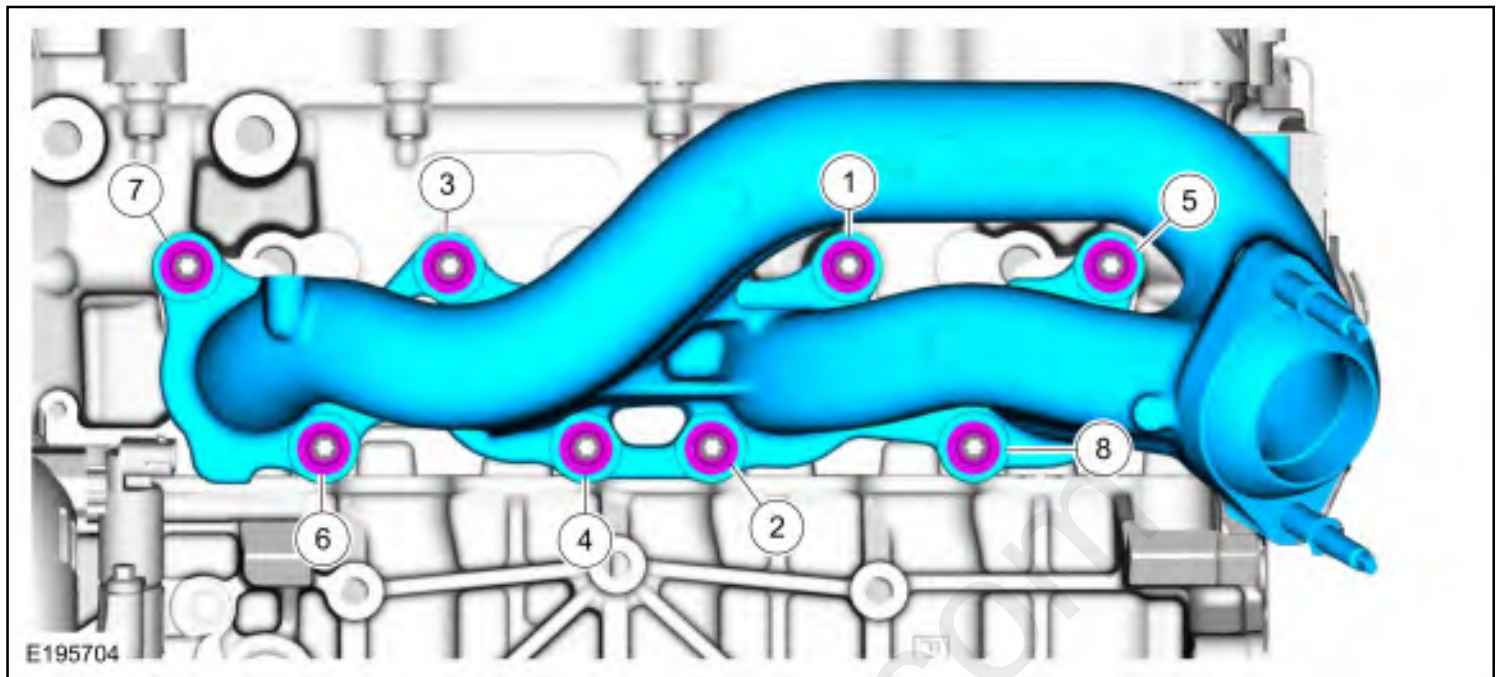
125. Install the exhaust manifold.  
• Install the new nuts.



*Torque:*

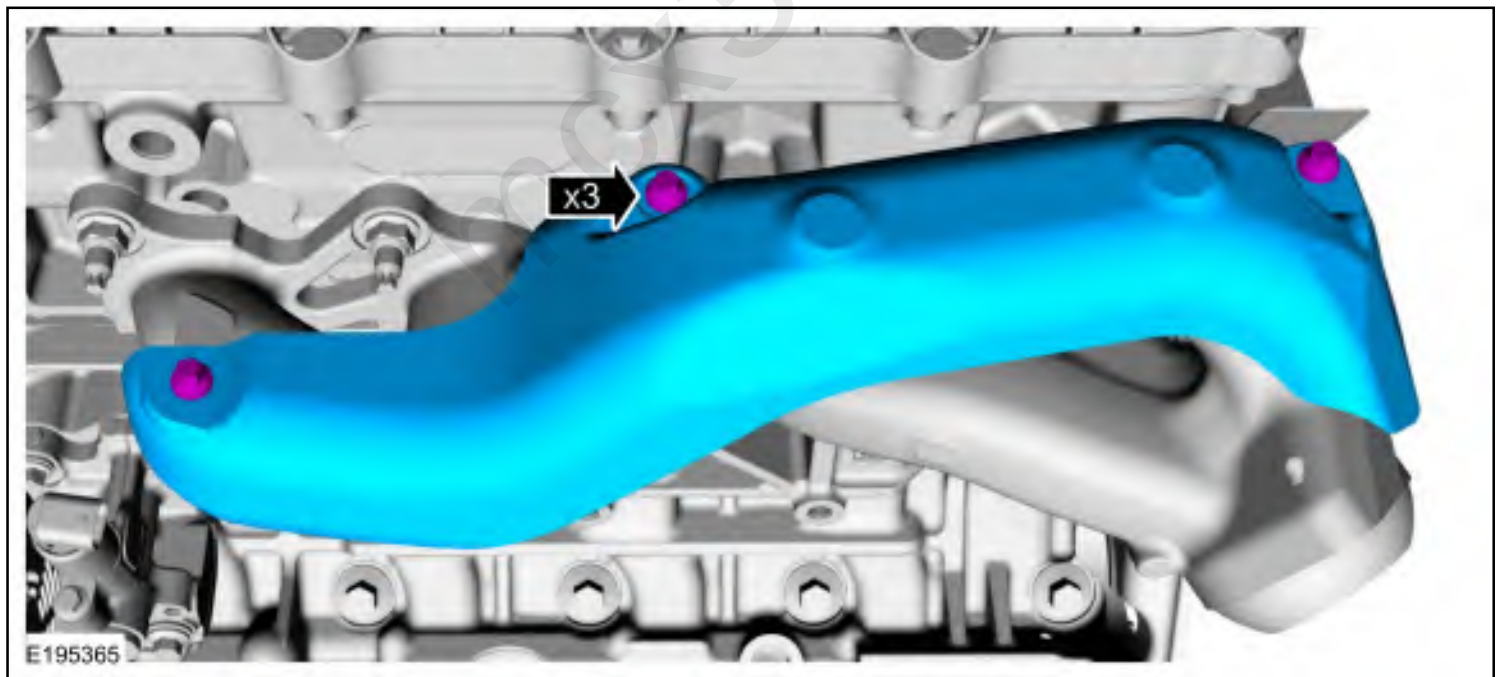
Stage 1: 18 lb.ft (24 Nm)

Stage 2: 24 lb.ft (32 Nm)



126. Install the heat shield and bolts.

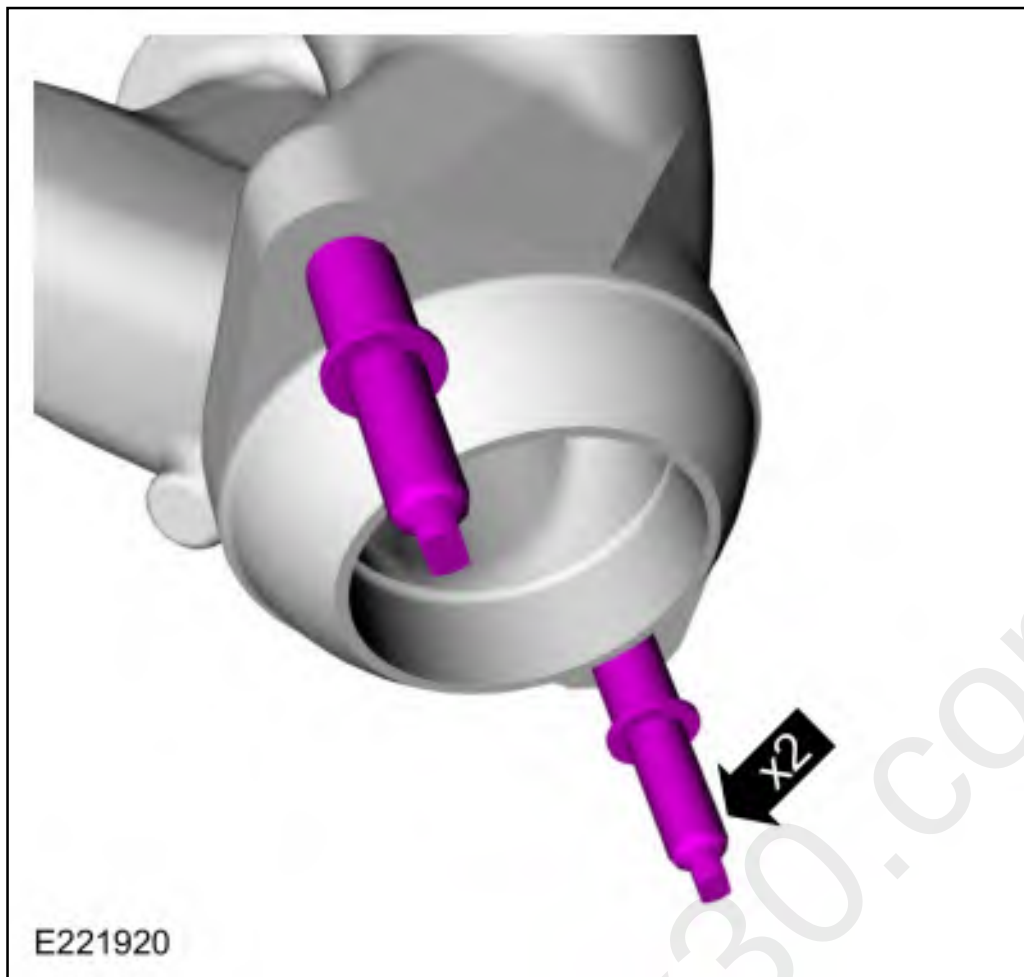
*Torque: 106 lb.in (12 Nm)*



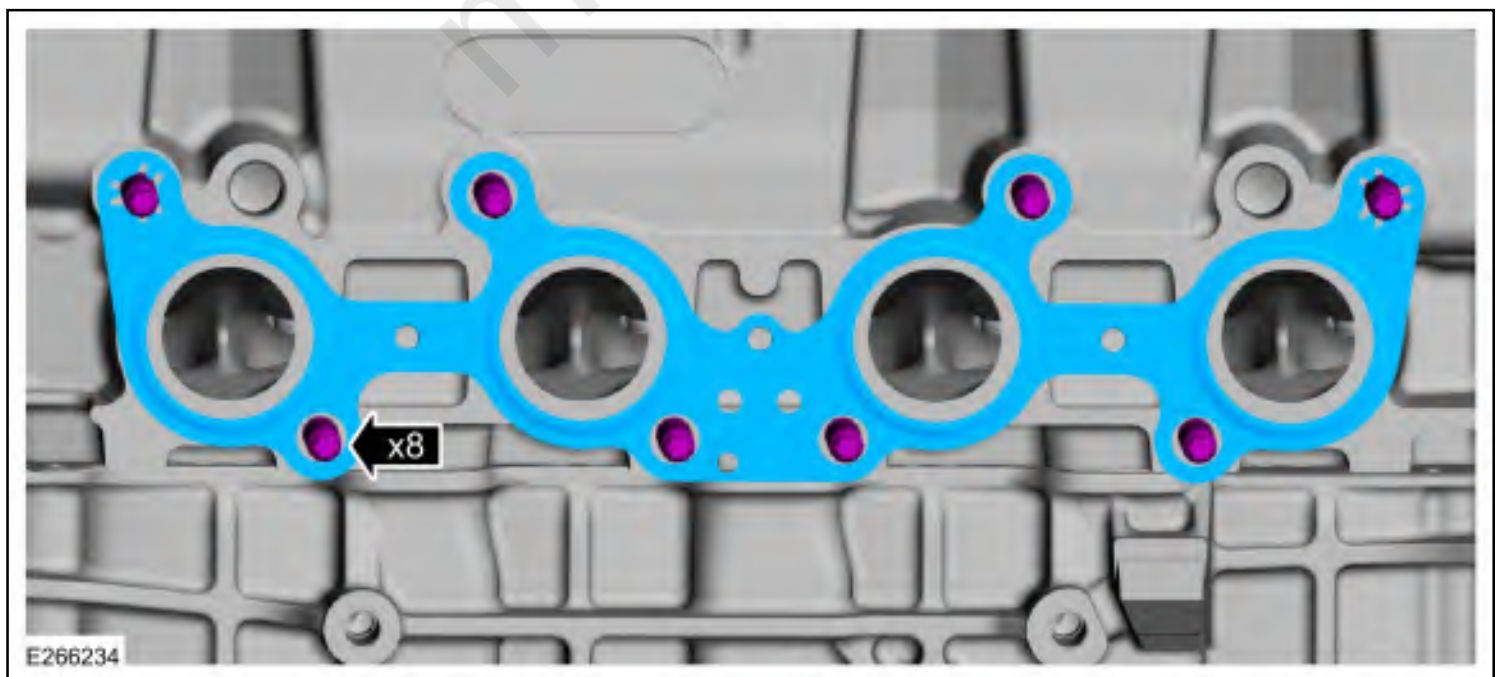
127. **NOTE:** Some replacement exhaust manifolds do not come with studs.

If necessary, install new studs.

*Torque: 30 lb.ft (40 Nm)*



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





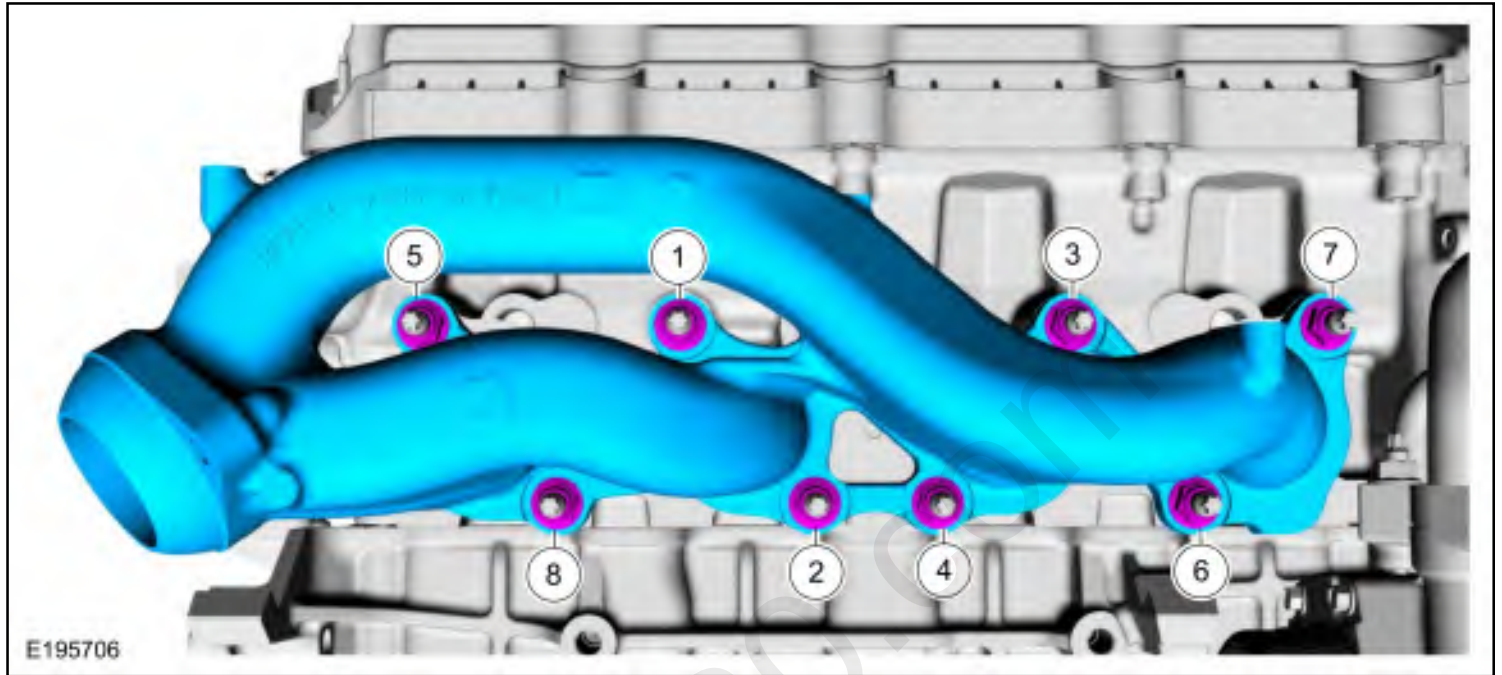
129. Install the exhaust manifold.

- Install the new nuts.

*Torque:*

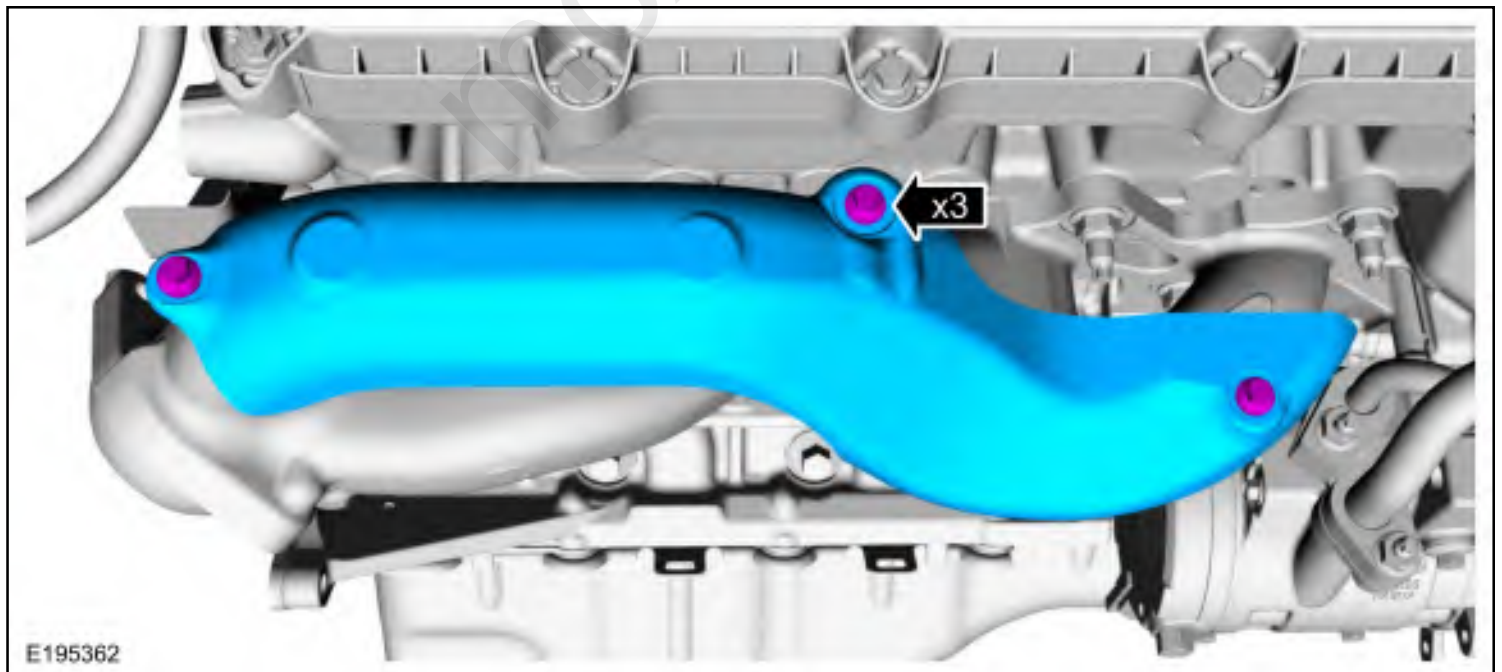
Stage 1: 18 lb.ft (24 Nm)

Stage 2: 24 lb.ft (32 Nm)



130. Install the heat shield and bolts.

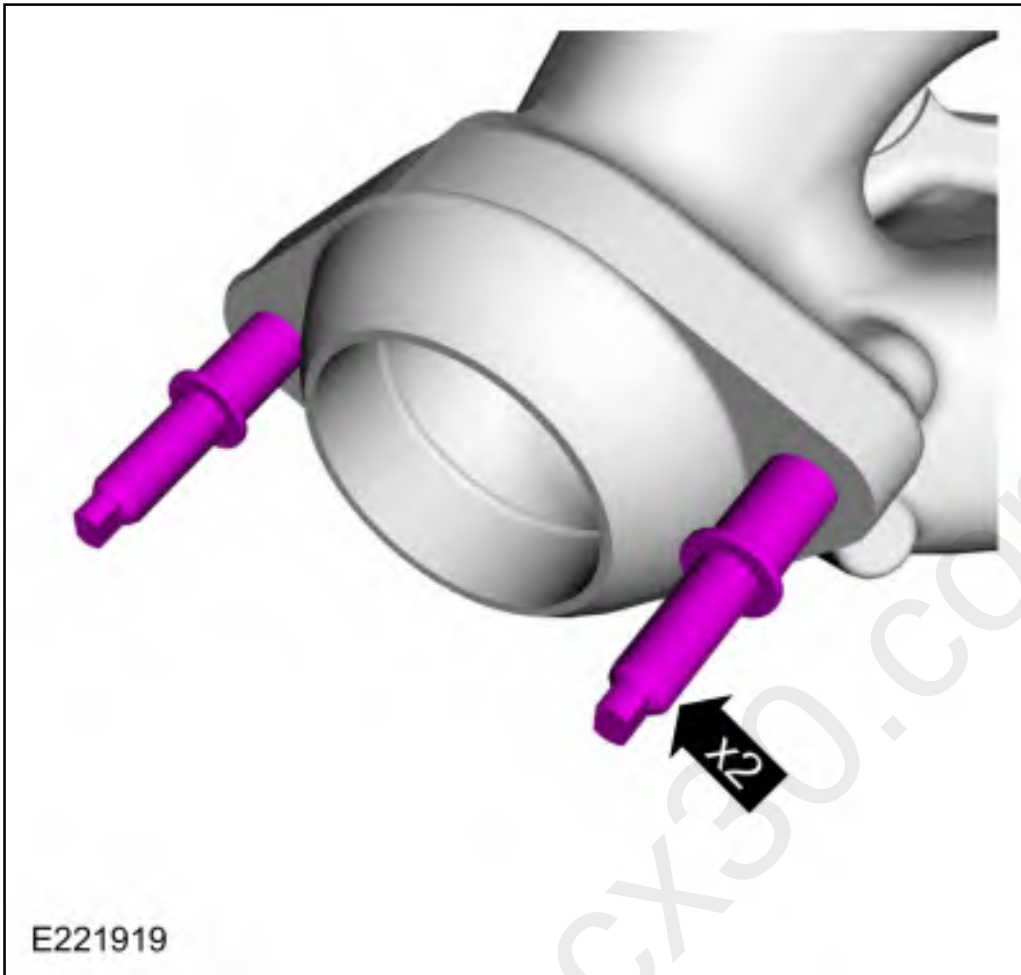
*Torque: 106 lb.in (12 Nm)*



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

If necessary, install new studs.

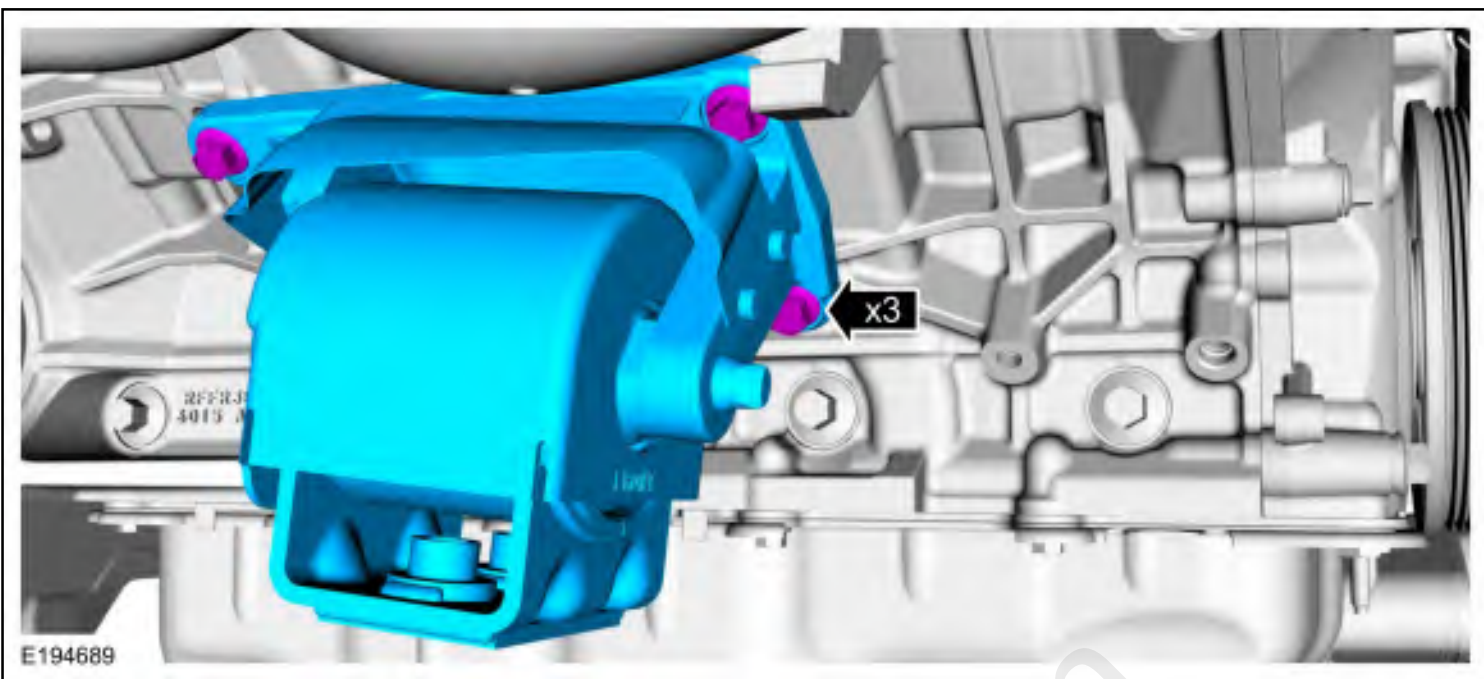
*Torque: 30 lb.ft (40 Nm)*



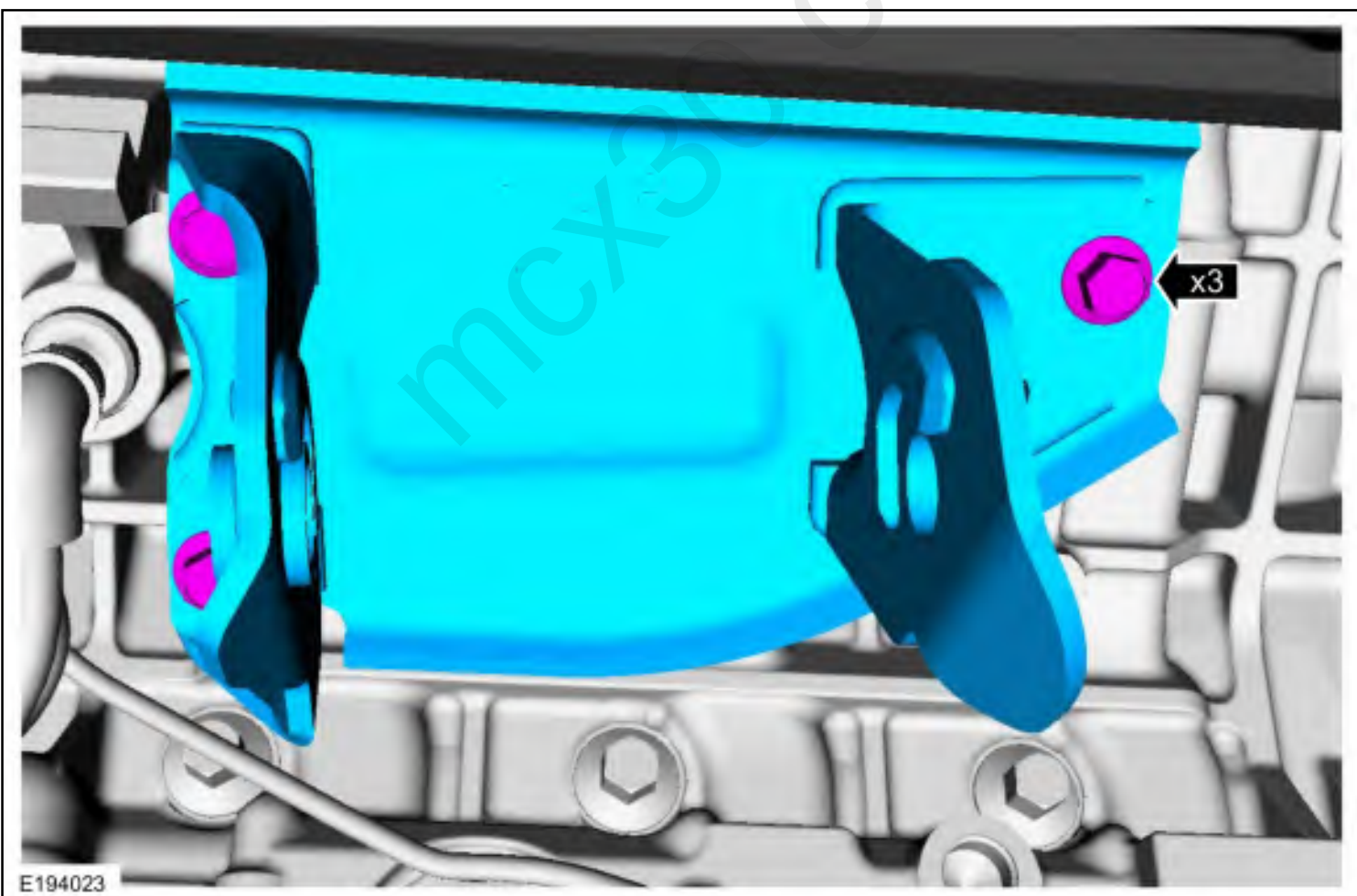
132. **NOTE:** *If a new RH engine mount is installed, remove the 2 studs prior to positioning the engine in the vehicle.*

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)*

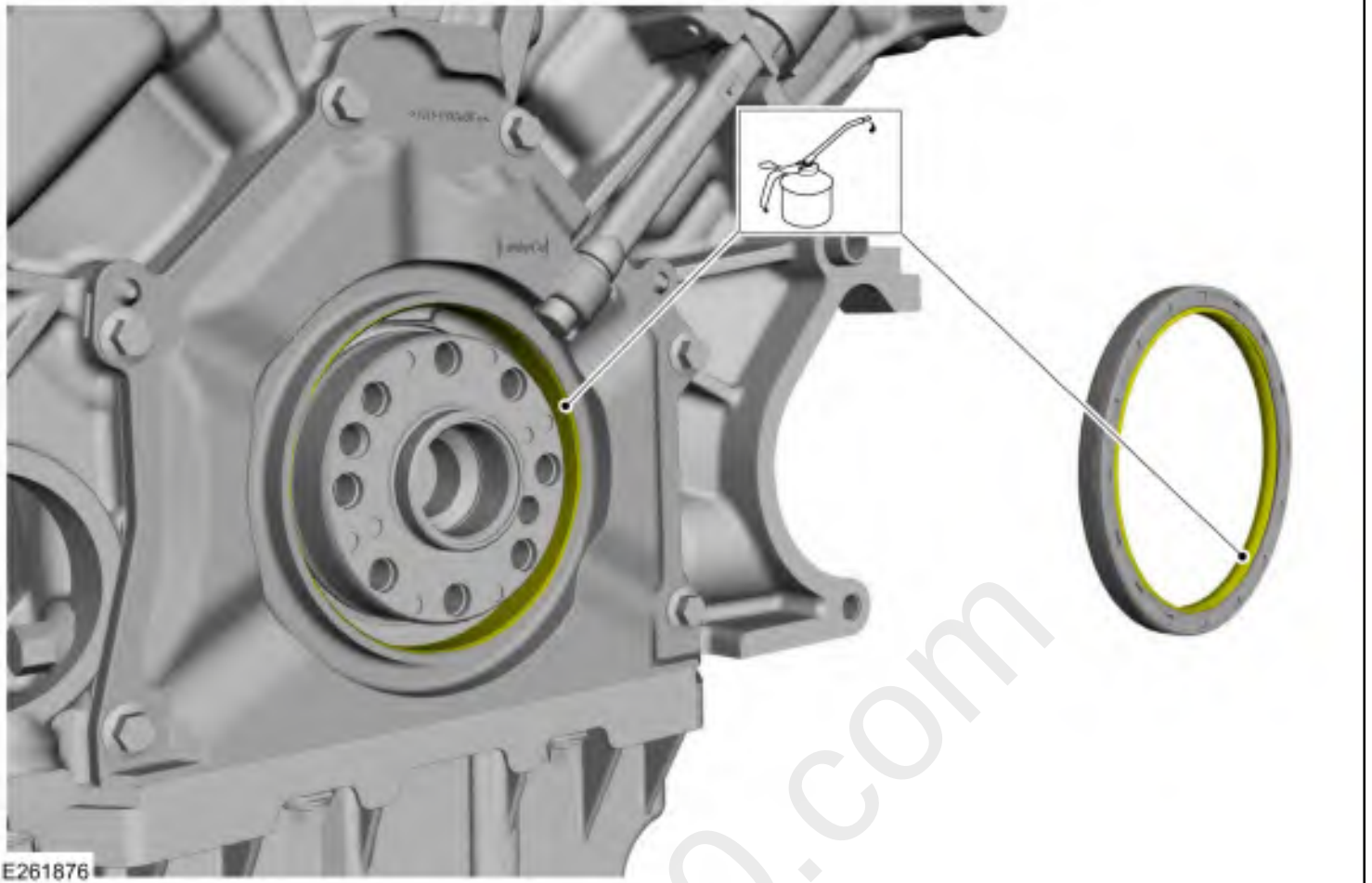




134. Install the special tool and remove the engine from the engine stand using a floor crane.  
Install Special Service Tool: 303-F047 Lifting Bracket, Engine.  
Use the General Equipment: Floor Crane  
Use the General Equipment: Mounting Stand

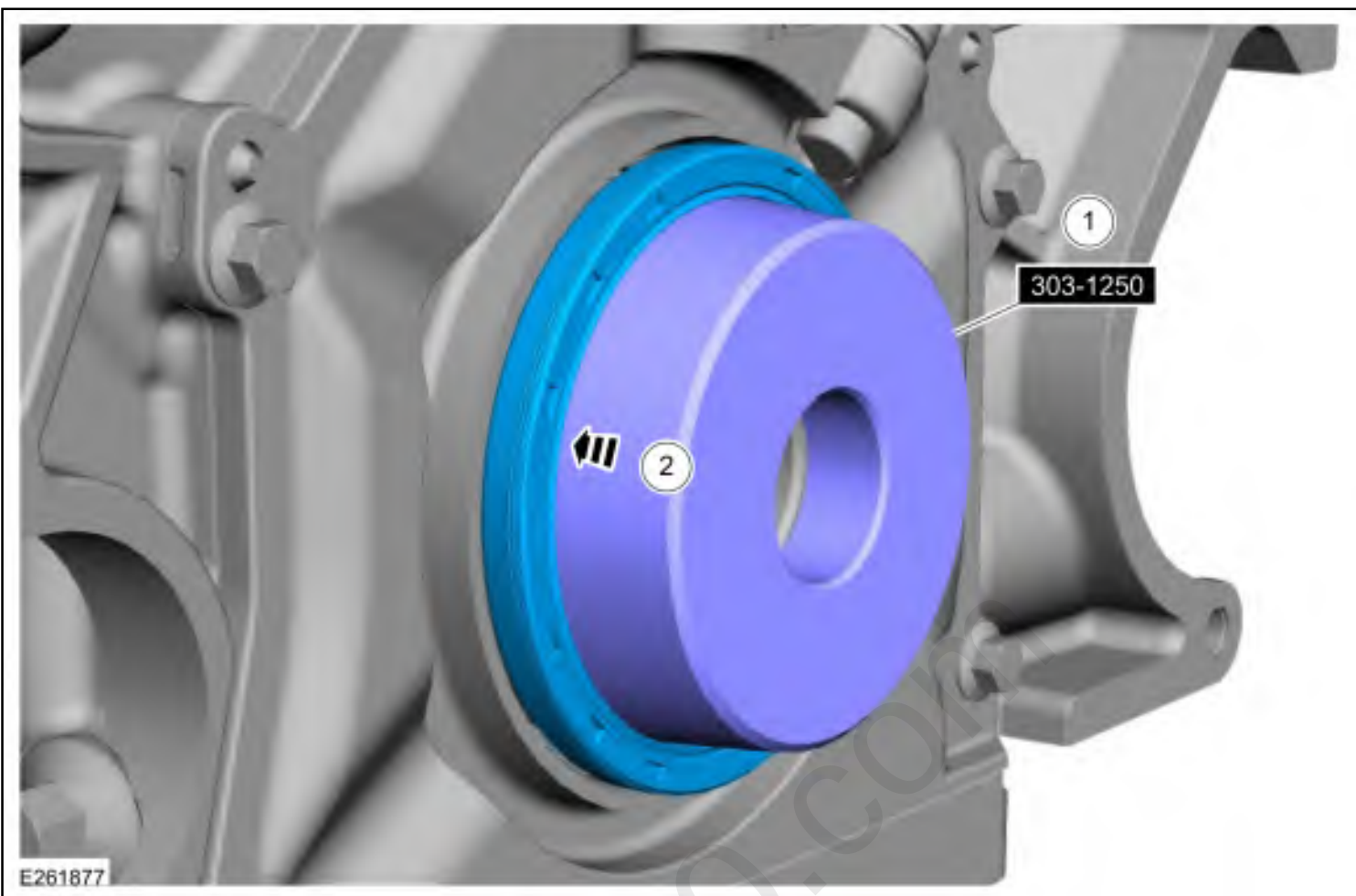


135. Lubricate the seal bore and the seal lips with clean engine oil.



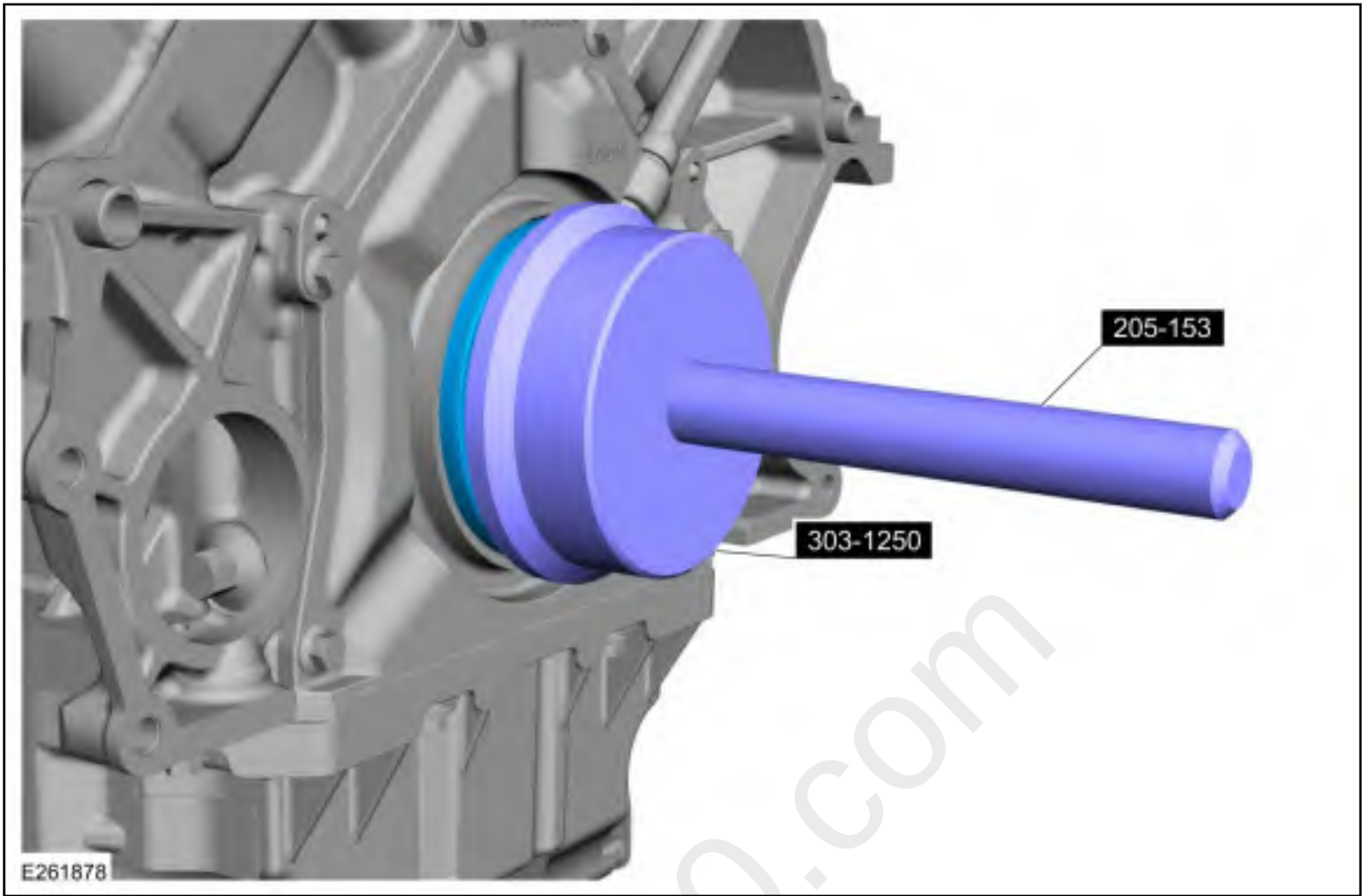
- Position the special tool onto the end of the crankshaft.  
Use Special Service Tool: 303-1250 Seal Installer, Rear Main.
- Slide the new crankshaft rear seal onto the tool.





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.

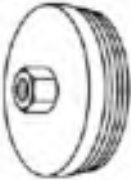


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## Crankshaft Rear Seal

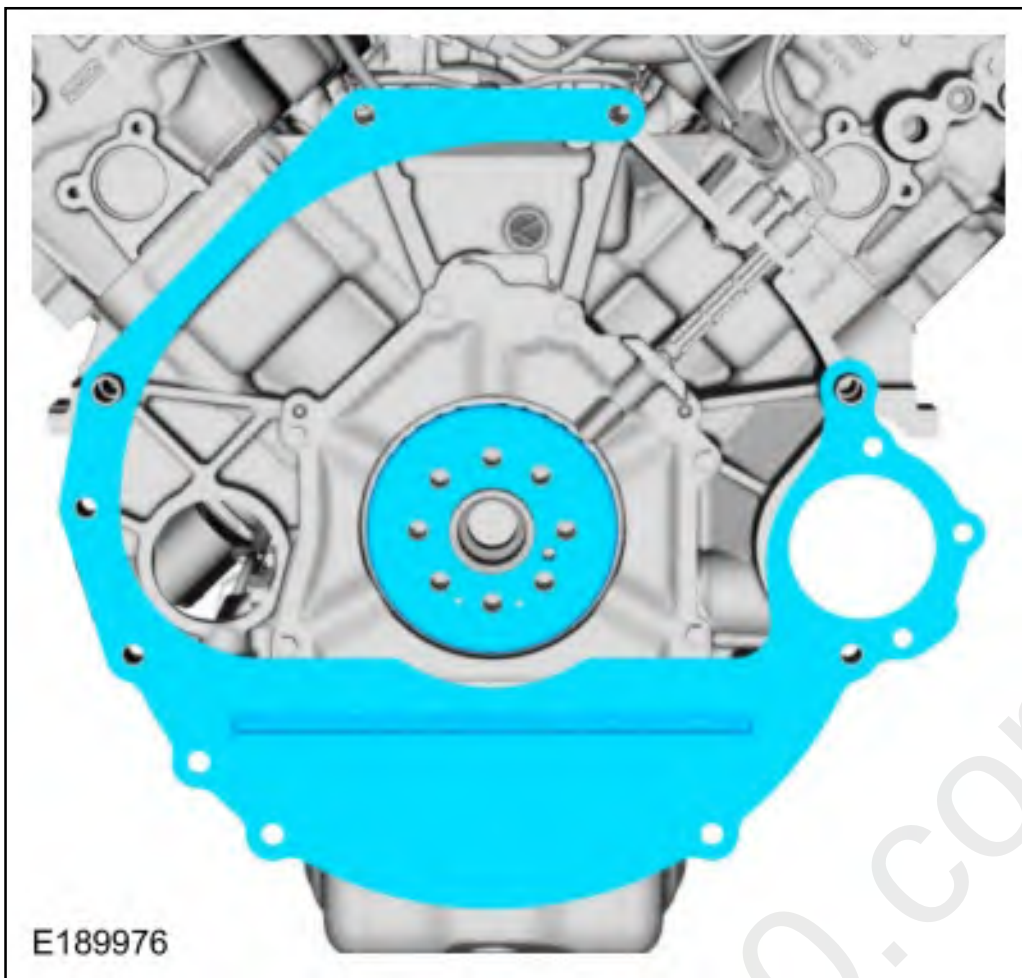
Base Part Number: Base Part Number: 6701

### Special Tool(s) / General Equipment

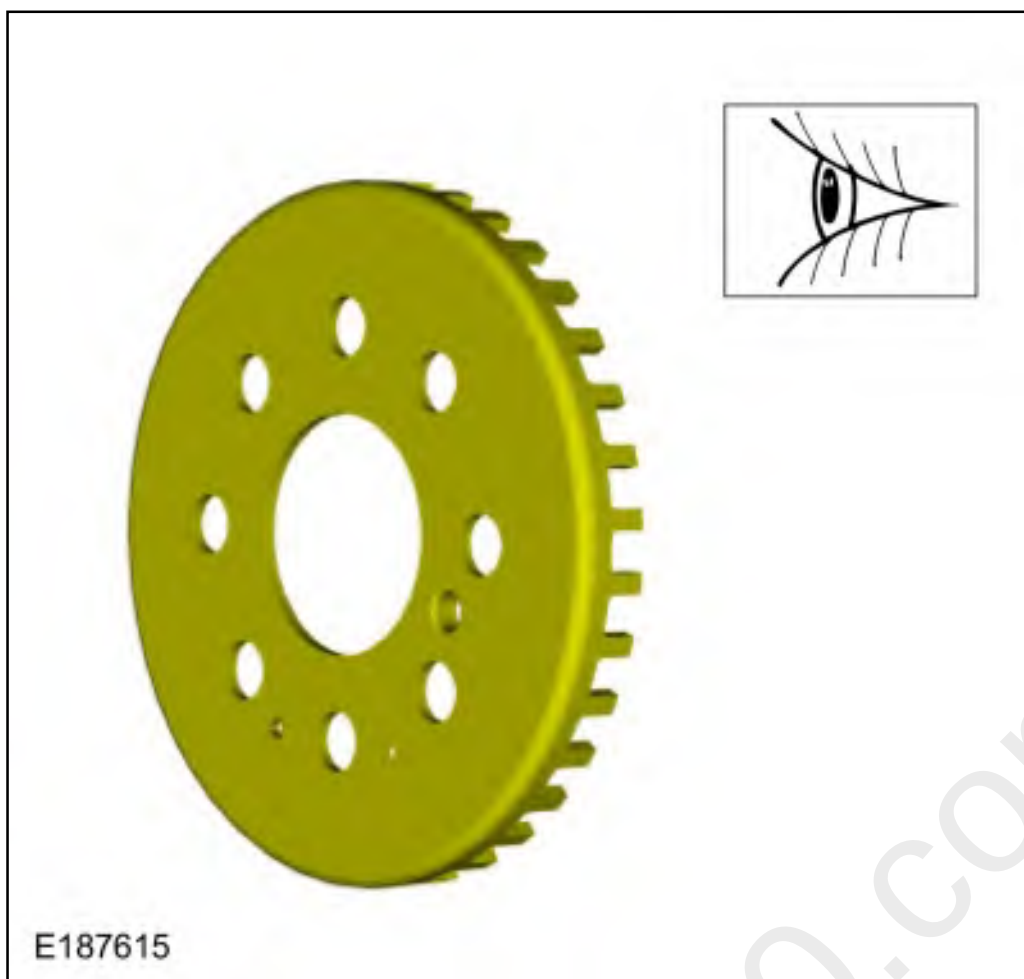
|                                                                                                |                                                                                                      |
|------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|
| <br>E129694    | 100-001 (T50T-100-A)<br>Slide Hammer                                                                 |
| <br>E133913   | 205-153 (T80T-4000-W)<br>Handle                                                                      |
| <br>ST2980-A | 303-1250<br>Seal Installer, Rear Main<br>TKIT-2006UFFLM                                              |
|              | 303-519 (T95P-6701-EH)<br>Remover, Crankshaft Rear Oil Seal<br>TKIT-1995-FH/FLMH<br>TKIT-1995-LMH/MH |

### Removal

1. Remove the flexplate.  
Refer to: Flexplate (303-01 Engine - 5.0L 32V Ti-VCT) .
2. Remove the crankshaft sensor ring and the engine-to-transmission spacer plate.

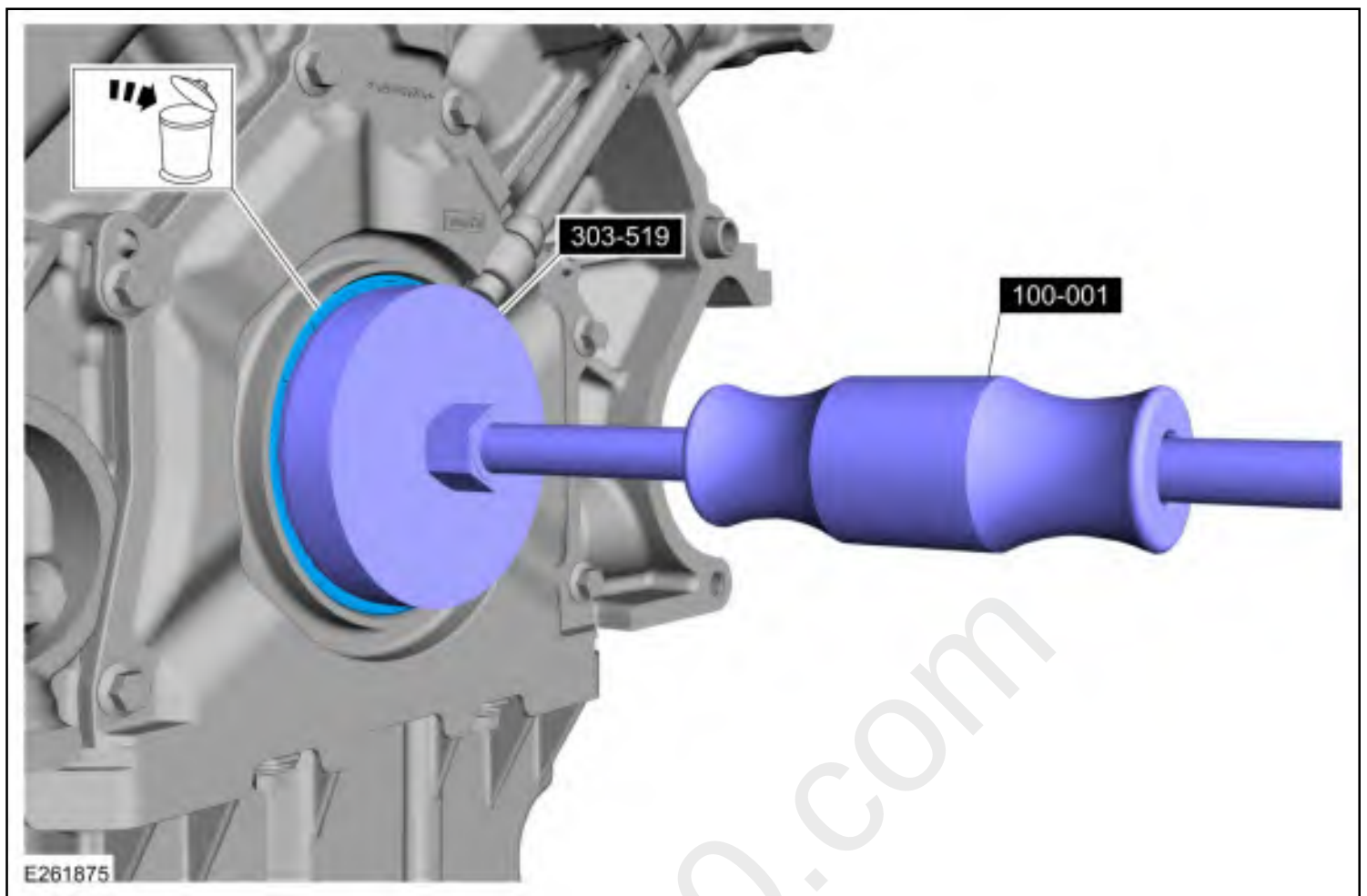


3. Inspect the crankshaft sensor ring for damage. If the crankshaft sensor ring has been dropped or has any visual damage, it must be discarded.



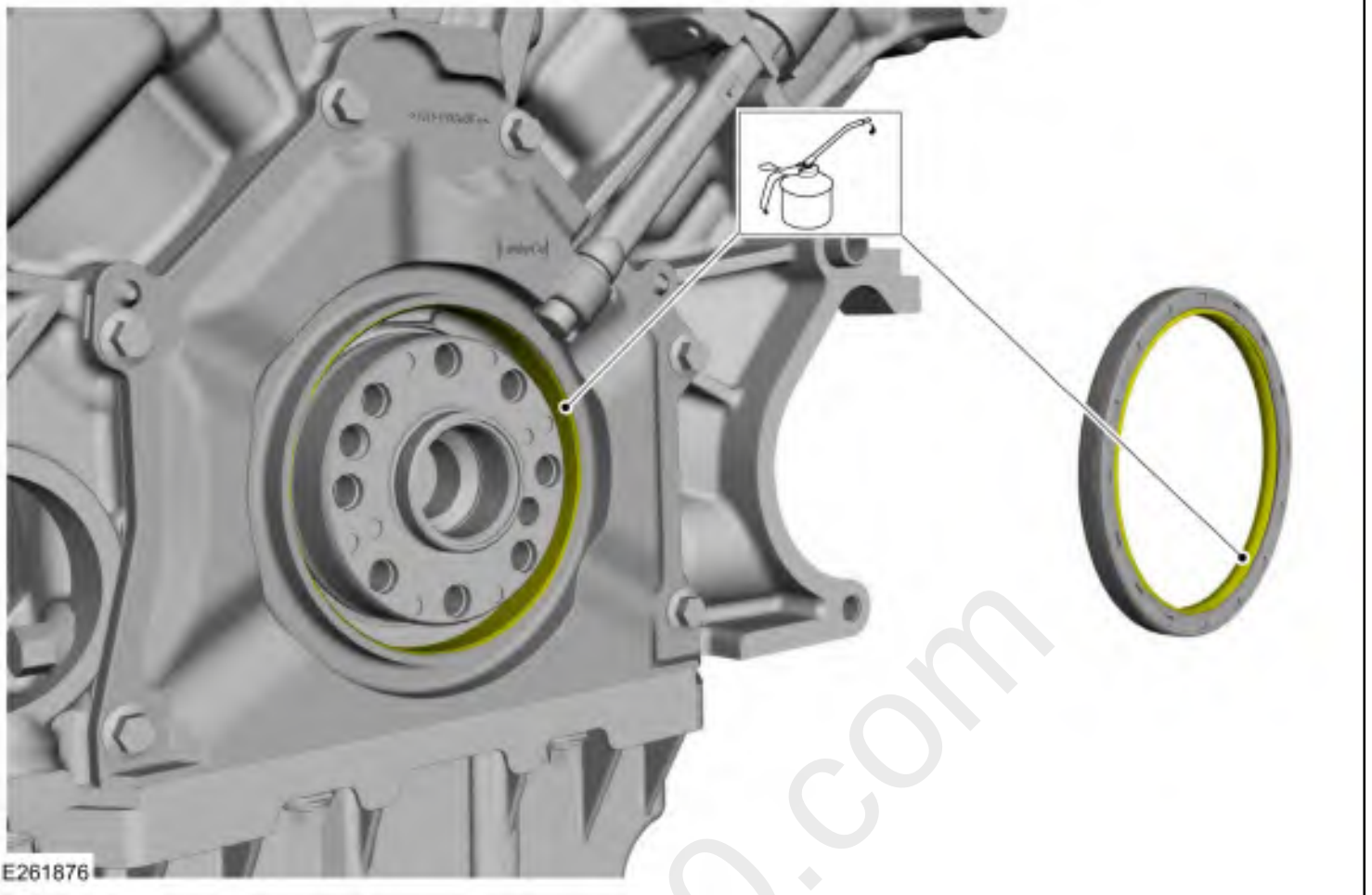
4. Using the special tools, remove and discard the crankshaft rear seal.  
Use Special Service Tool: 303-519 (T95P-6701-EH) Remover, Crankshaft Rear Oil Seal. , 100-001 (T50T-100-A) Slide Hammer.



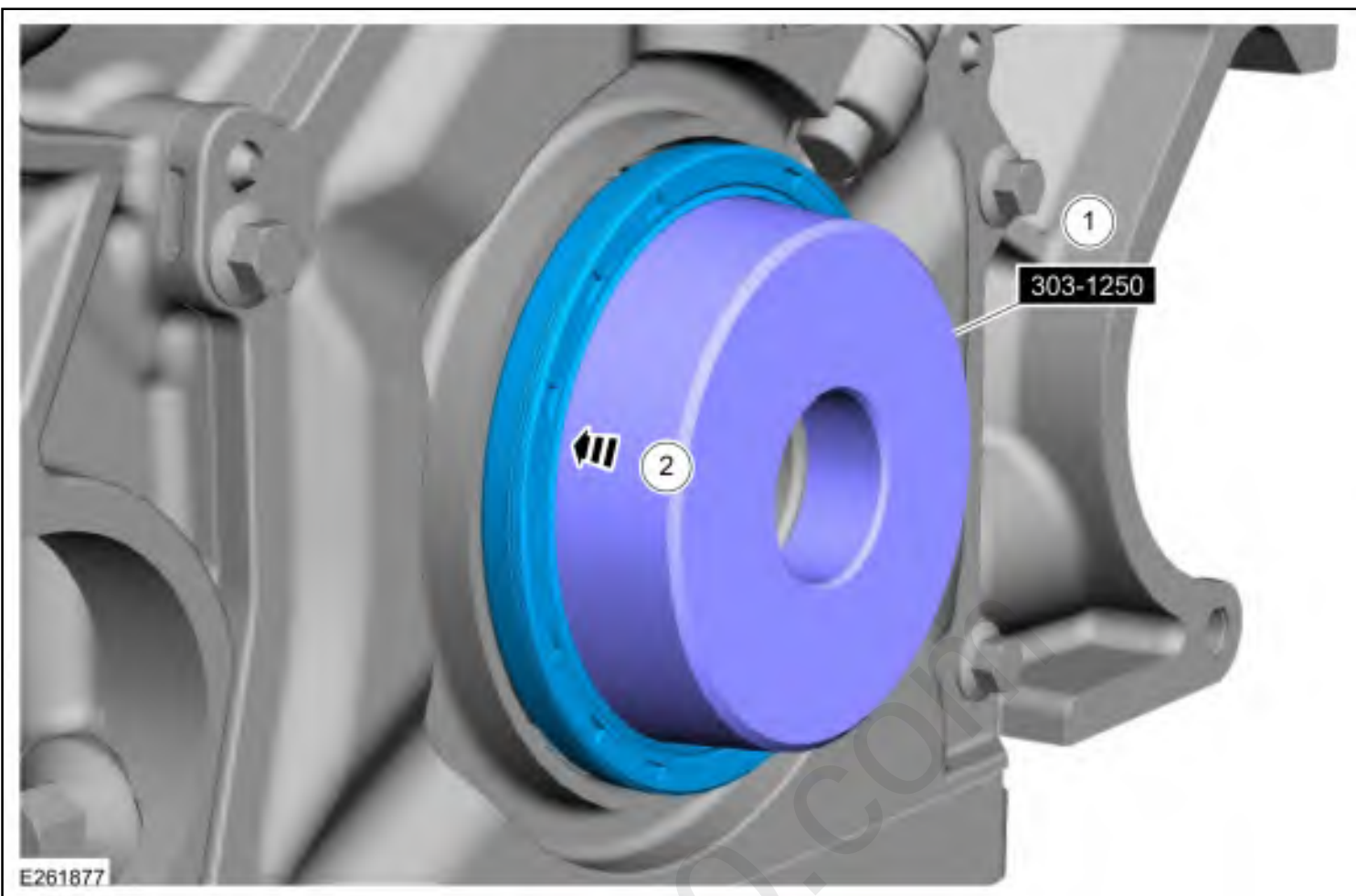


## Installation

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

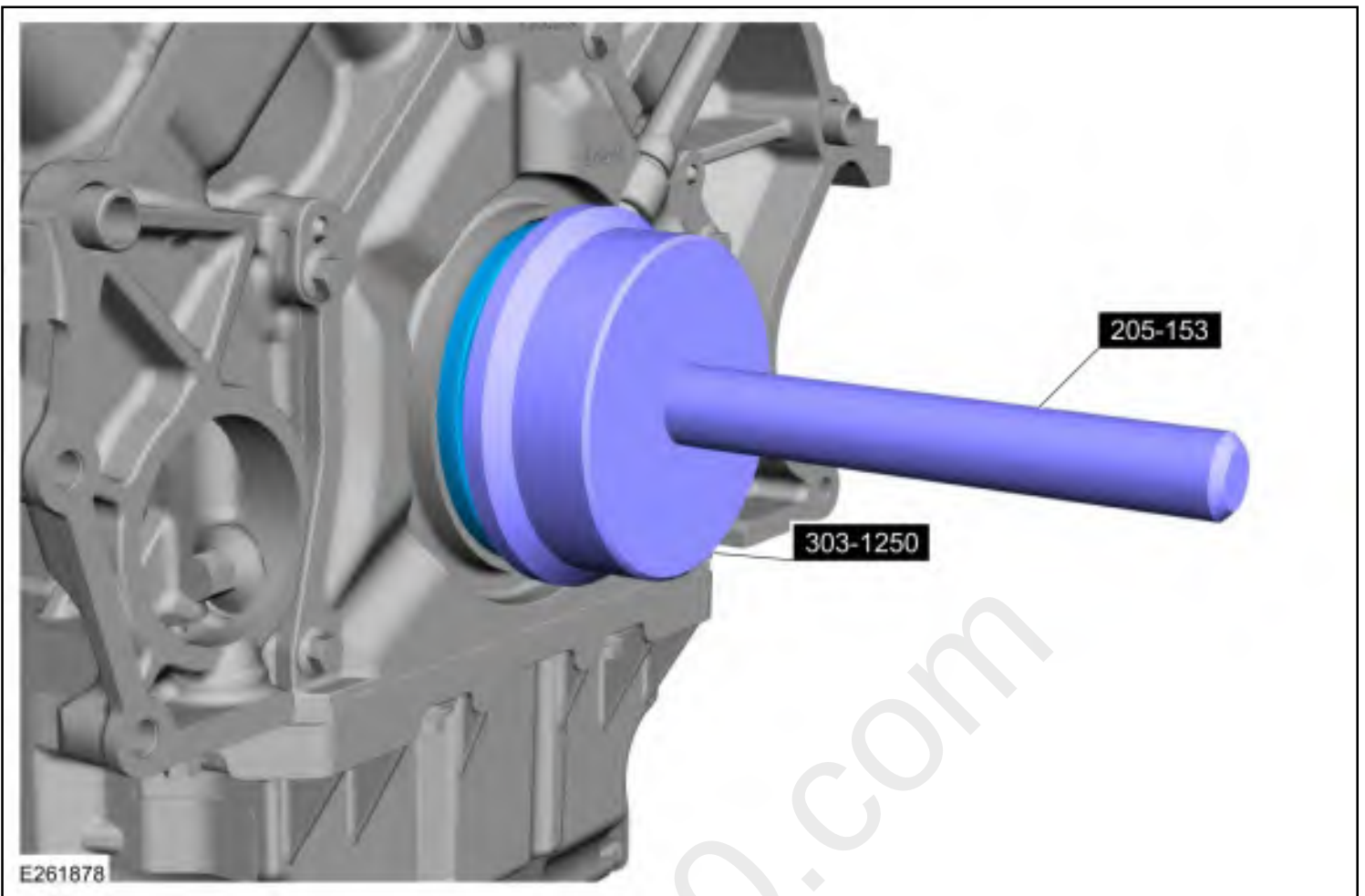


- Position the special tool onto the end of the crankshaft.  
Use Special Service Tool: 303-1250 Seal Installer, Rear Main.
- Slide the new crankshaft rear seal onto the tool.

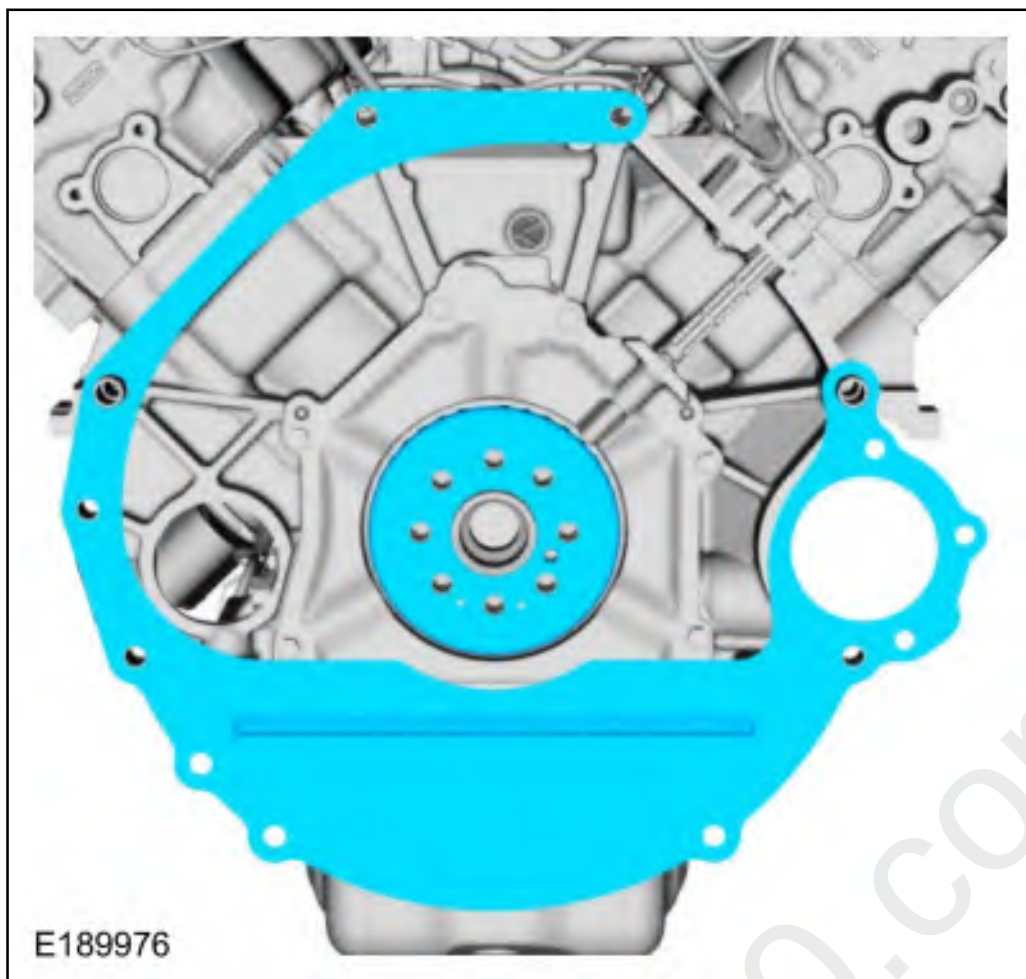


3. Using the special tools, install the crankshaft rear seal.

Use Special Service Tool: 205-153 (T80T-4000-W) Handle. , 303-1250 Seal Installer, Rear Main.



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



5. Install the flexplate.

Refer to: Flexplate (303-01 Engine - 5.0L 32V Ti-VCT) .



# Engine Front Cover

Base Part Number: Base Part Number: 6C086

## Special Tool(s) / General Equipment

Plastic Scraper

Oil Drain Equipment

Hose Clamp Remover/Installer

## Materials

| Name                                                 | Specification |
|------------------------------------------------------|---------------|
| Motorcraft® Silicone Gasket Remover ZC-30-A          | -             |
| Motorcraft® Metal Surface Prep Wipes ZC-31-B         | -             |
| Motorcraft® Silicone Gasket and Sealant TA-30        | WSE-M4G323-A4 |
| Motorcraft® Metal Brake Parts Cleaner PM-4-A, PM-4-B | -             |

## Removal

**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.

1. With the vehicle in NEUTRAL, position it on a hoist.  
Refer to: [Jacking and Lifting - Overview](#) (100-02 Jacking and Lifting, Description and Operation).
2. Release the fuel system pressure.  
Refer to: [Fuel System Pressure Release](#) (310-00D Fuel System - General Information - 5.0L 32V Ti-

VCT, General Procedures).

3. Disconnect the battery ground cable.

Refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables) .

4. Drain the engine cooling system.

Refer to: Cooling System Draining, Vacuum Filling and Bleeding (303-03 Engine Cooling - 5.0L 32V Ti-VCT) .

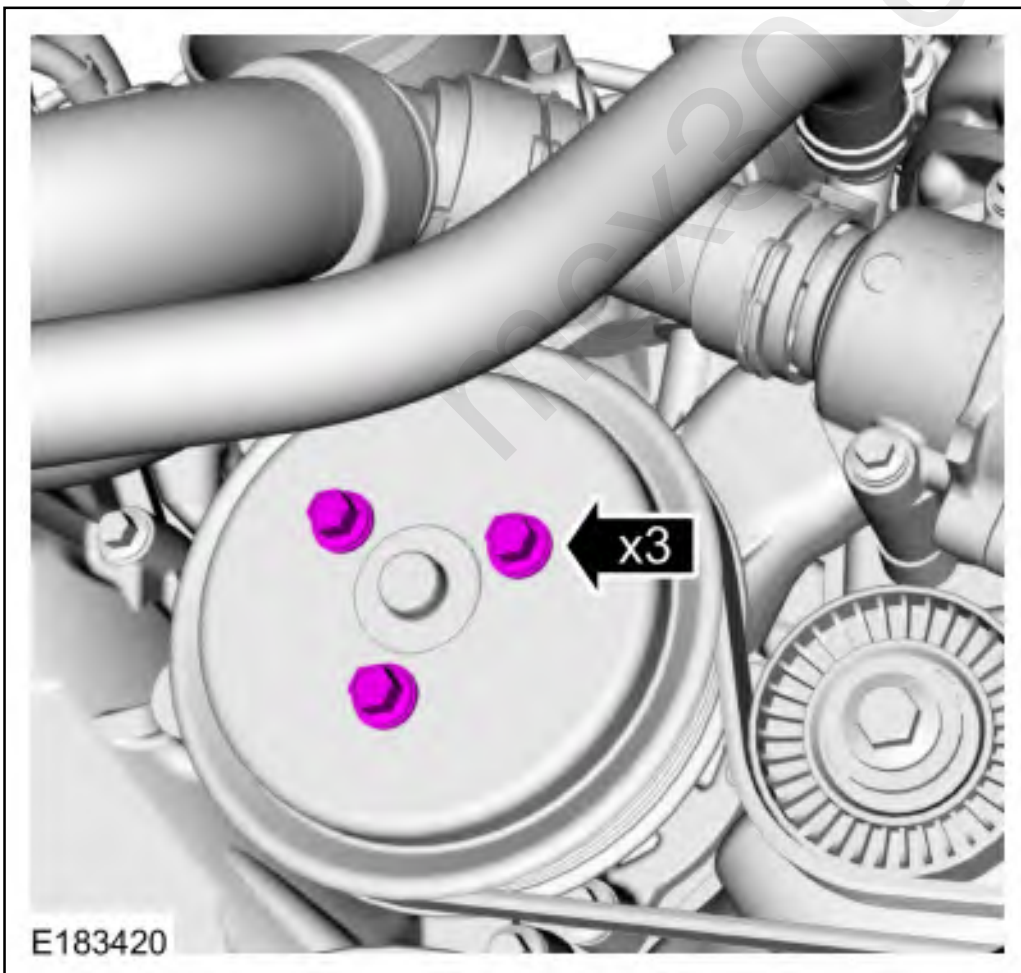
5. Remove the following items:

1. **NOTE:** *It is not necessary to clamp off the degas bottle hose with the cooling system drained.*

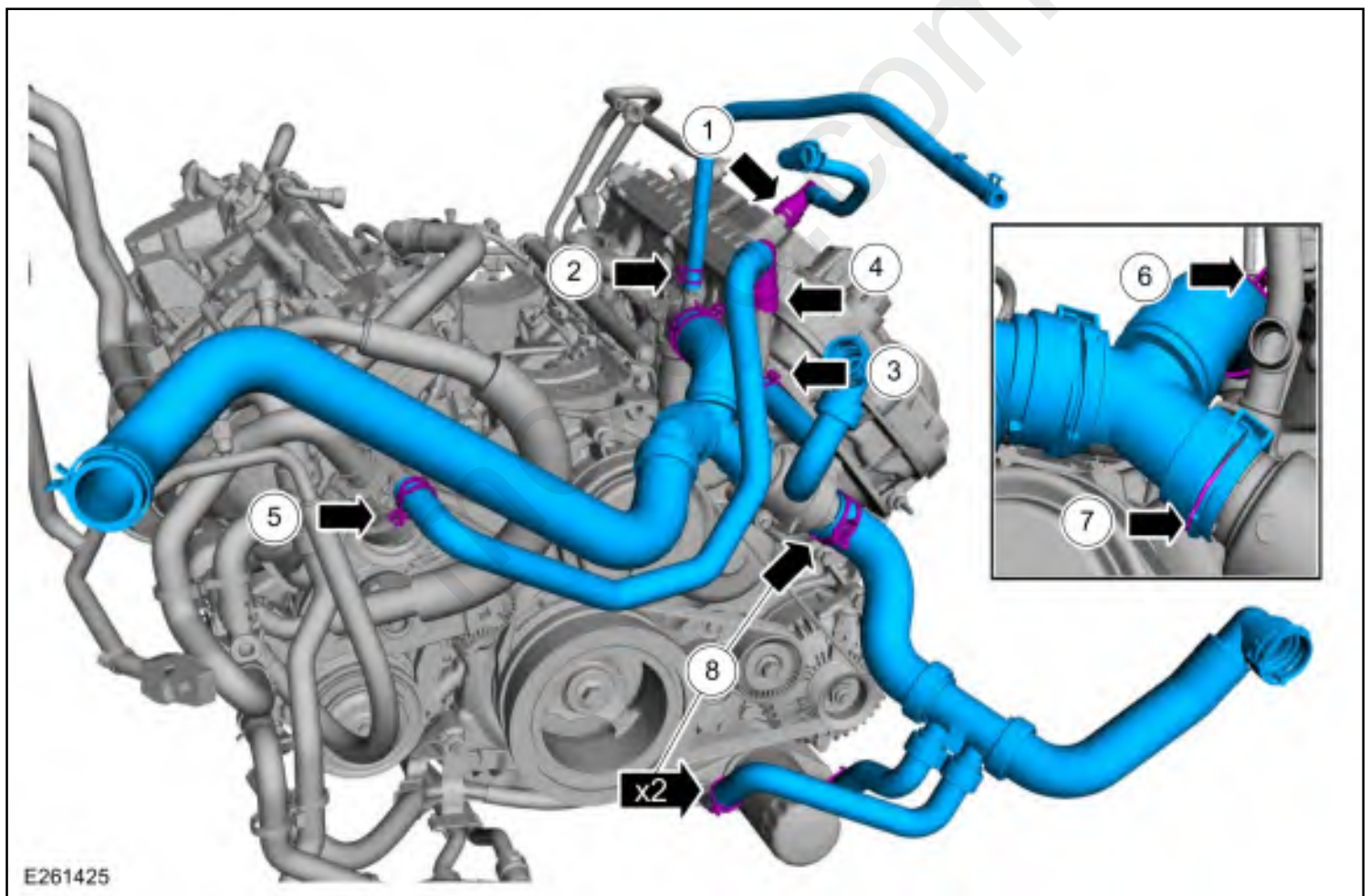
Refer to: [Degas Bottle](#) (303-03D Engine Cooling - 5.0L 32V Ti-VCT, Removal and Installation).

2. Refer to: Cooling Module (303-03 Engine Cooling - 5.0L 32V Ti-VCT) .
3. Refer to: Valve Cover LH (303-01 Engine - 5.0L 32V Ti-VCT) .
4. Refer to: Valve Cover RH (303-01 Engine - 5.0L 32V Ti-VCT) .

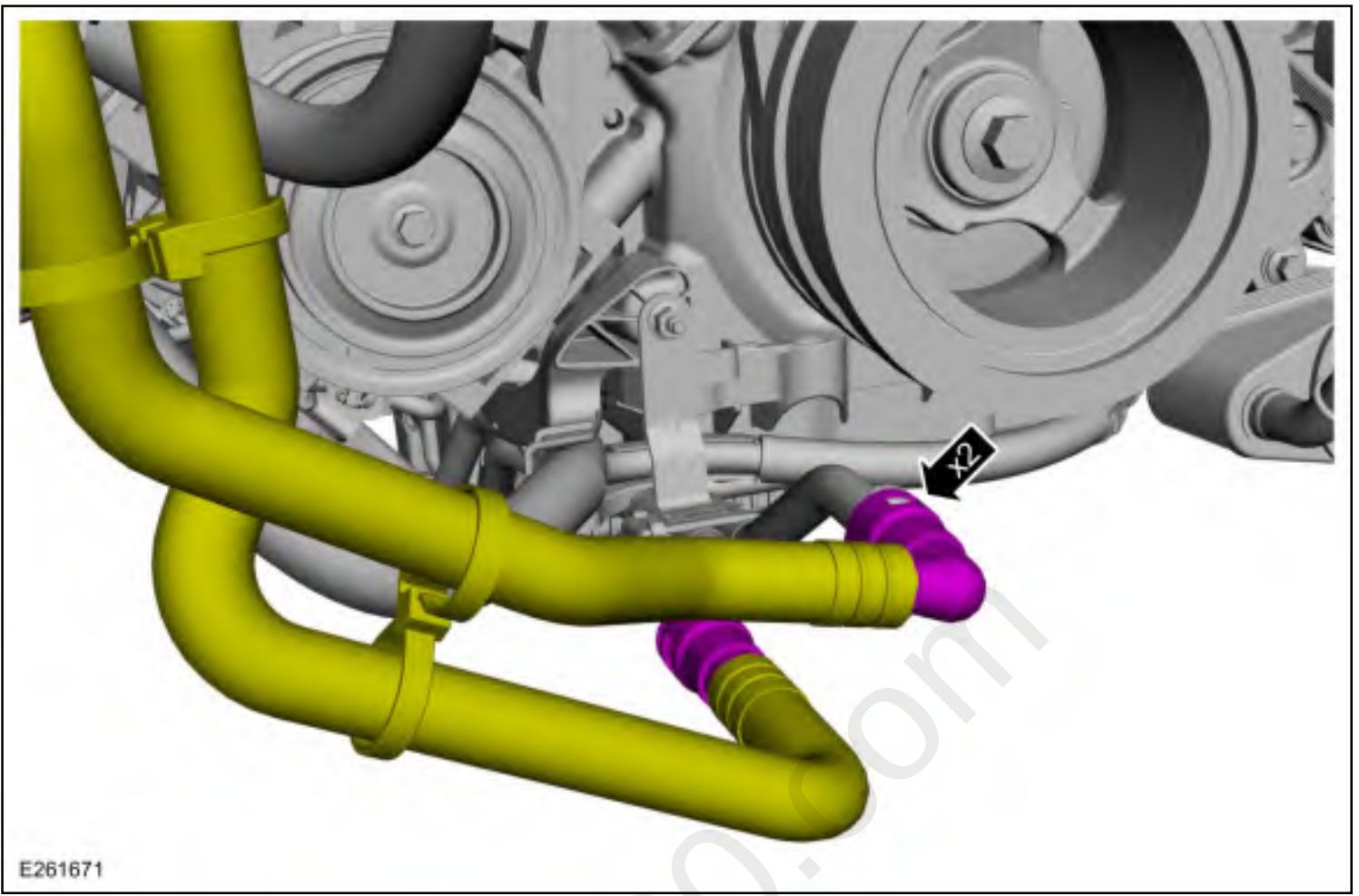
6. Loosen the coolant pump pulley bolts.



1. Disconnect the quick release coupling and remove the crankcase vent tube.  
Refer to: [Quick Release Coupling](#) (310-00D Fuel System - General Information - 5.0L 32V Ti-VCT, General Procedures).
2. Release the clamp and remove the coolant hose.  
Use the General Equipment: Hose Clamp Remover/Installer
3. Release the clamp and remove the coolant hose.  
Use the General Equipment: Hose Clamp Remover/Installer
4. Disconnect the quick release coupling.
5. Release the clamp and remove the coolant hose.  
Use the General Equipment: Hose Clamp Remover/Installer
6. Release the clamp and remove the coolant hose.  
Use the General Equipment: Hose Clamp Remover/Installer
7. Release the spring clip and remove the coolant bypass T assembly from the engine.
8. Release the clamps and remove the coolant hose assembly.  
Use the General Equipment: Hose Clamp Remover/Installer



8. Disconnect the coolant hose quick release couplings.

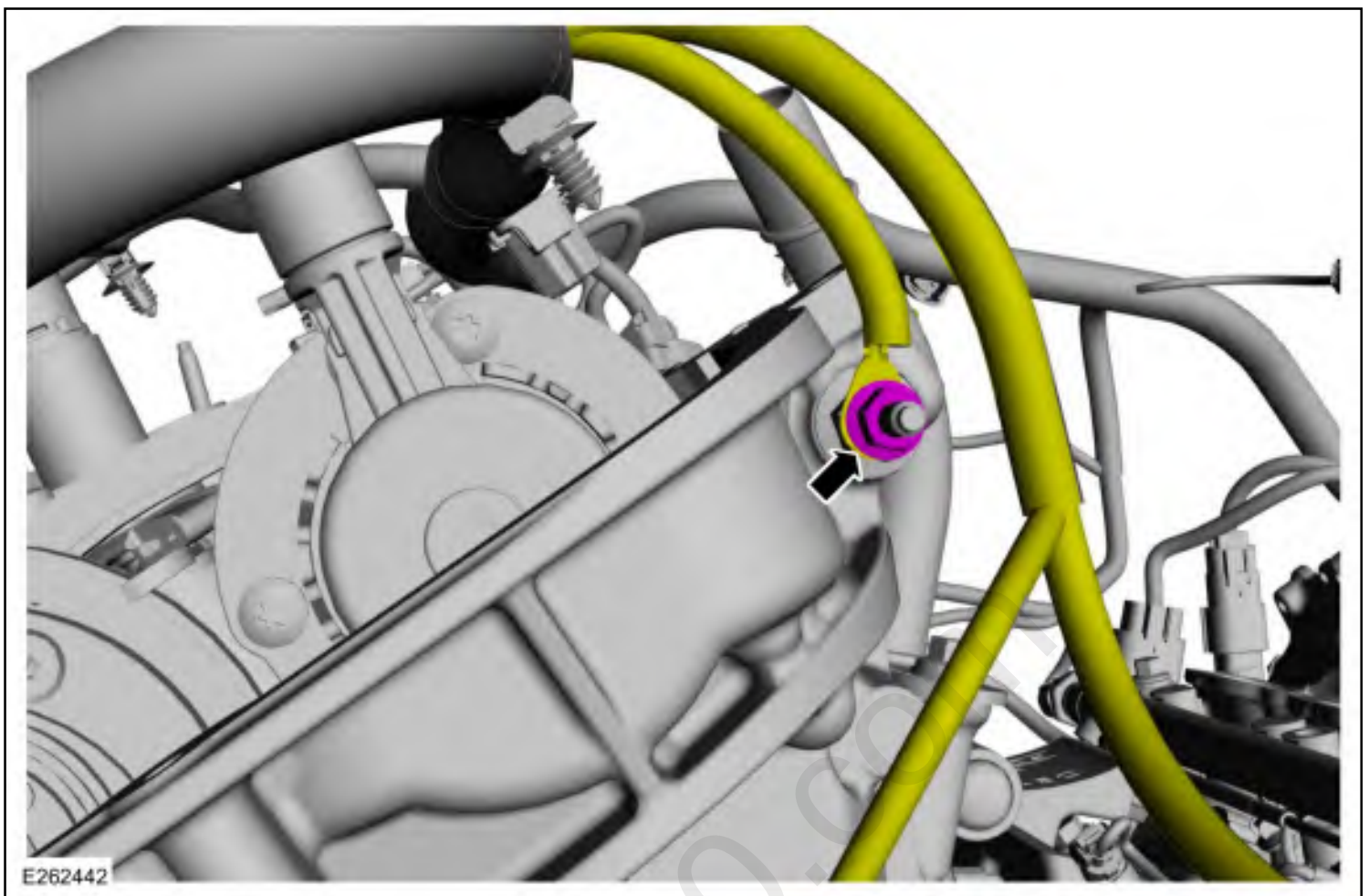


9. Remove the following items:

1. Refer to: Accessory Drive Belt (303-05 Accessory Drive - 5.0L 32V Ti-VCT) .
2. Refer to: Air Conditioning (A/C) Compressor Belt (303-05 Accessory Drive - 5.0L 32V Ti-VCT) .
3. Refer to: Accessory Drive Belt Tensioner (303-05 Accessory Drive - 5.0L 32V Ti-VCT) .
4. Refer to: Air Conditioning (A/C) Compressor Belt Tensioner (303-05 Accessory Drive - 5.0L 32V Ti-VCT) .
5. Refer to: [Coolant Pump](#) (303-03D Engine Cooling - 5.0L 32V Ti-VCT, Removal and Installation).
6. Refer to: Crankshaft Front Seal (303-01 Engine - 5.0L 32V Ti-VCT) .

10. Remove the nut and ground wire.





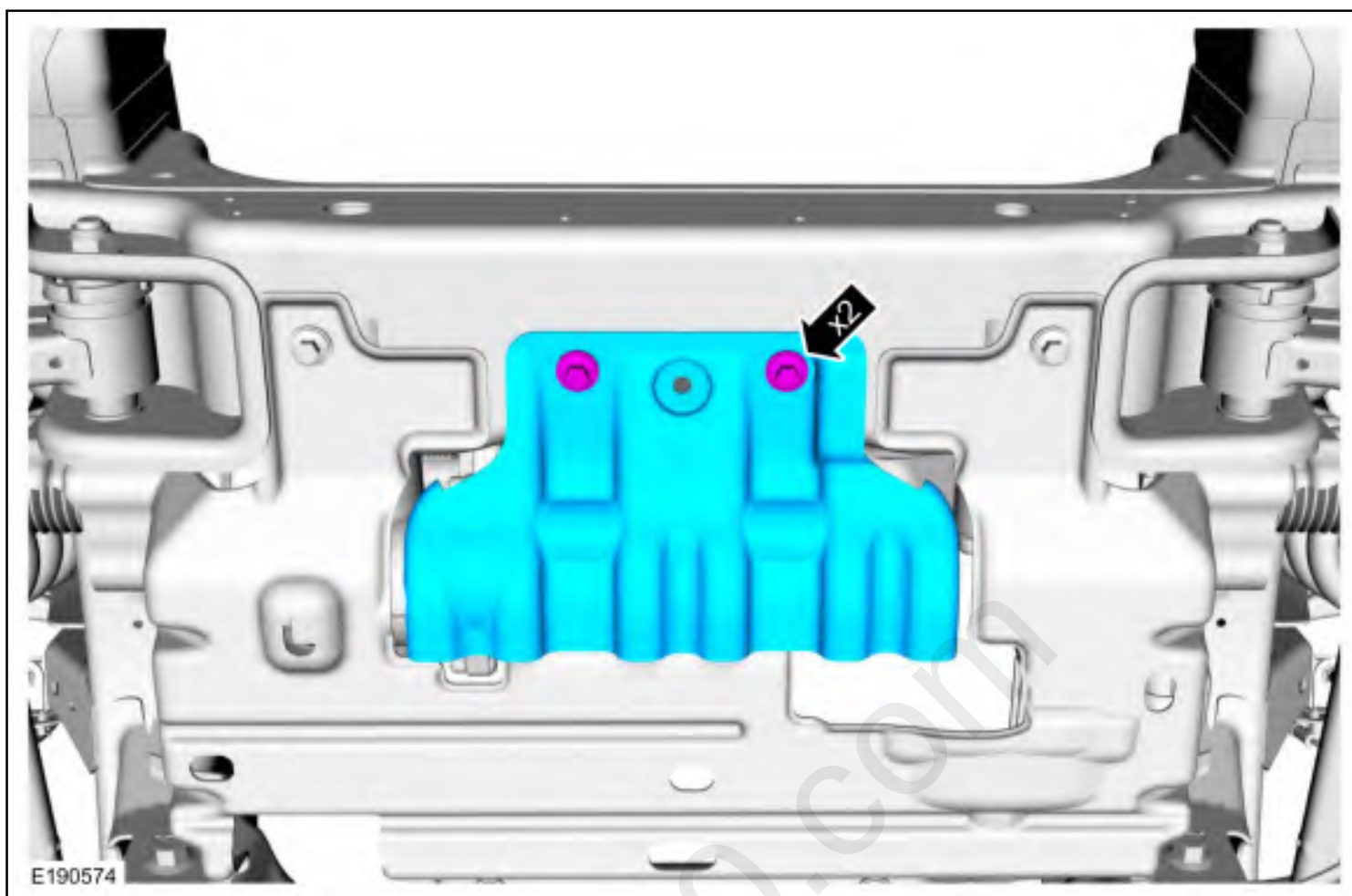
11. Remove the bolts and position the generator aside.





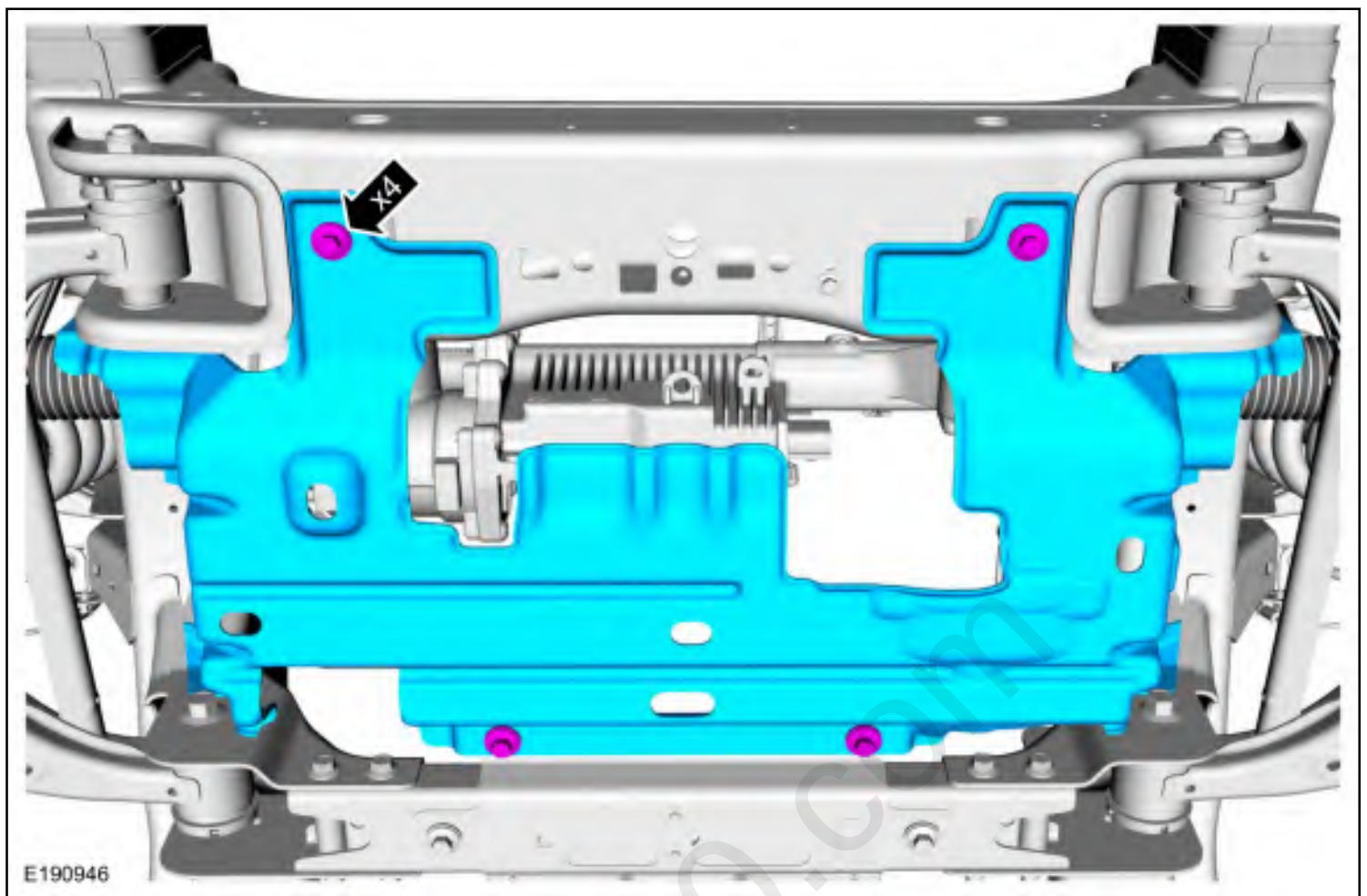
12. **NOTE:** *If equipped.*

Remove the bolts and the skid plate.



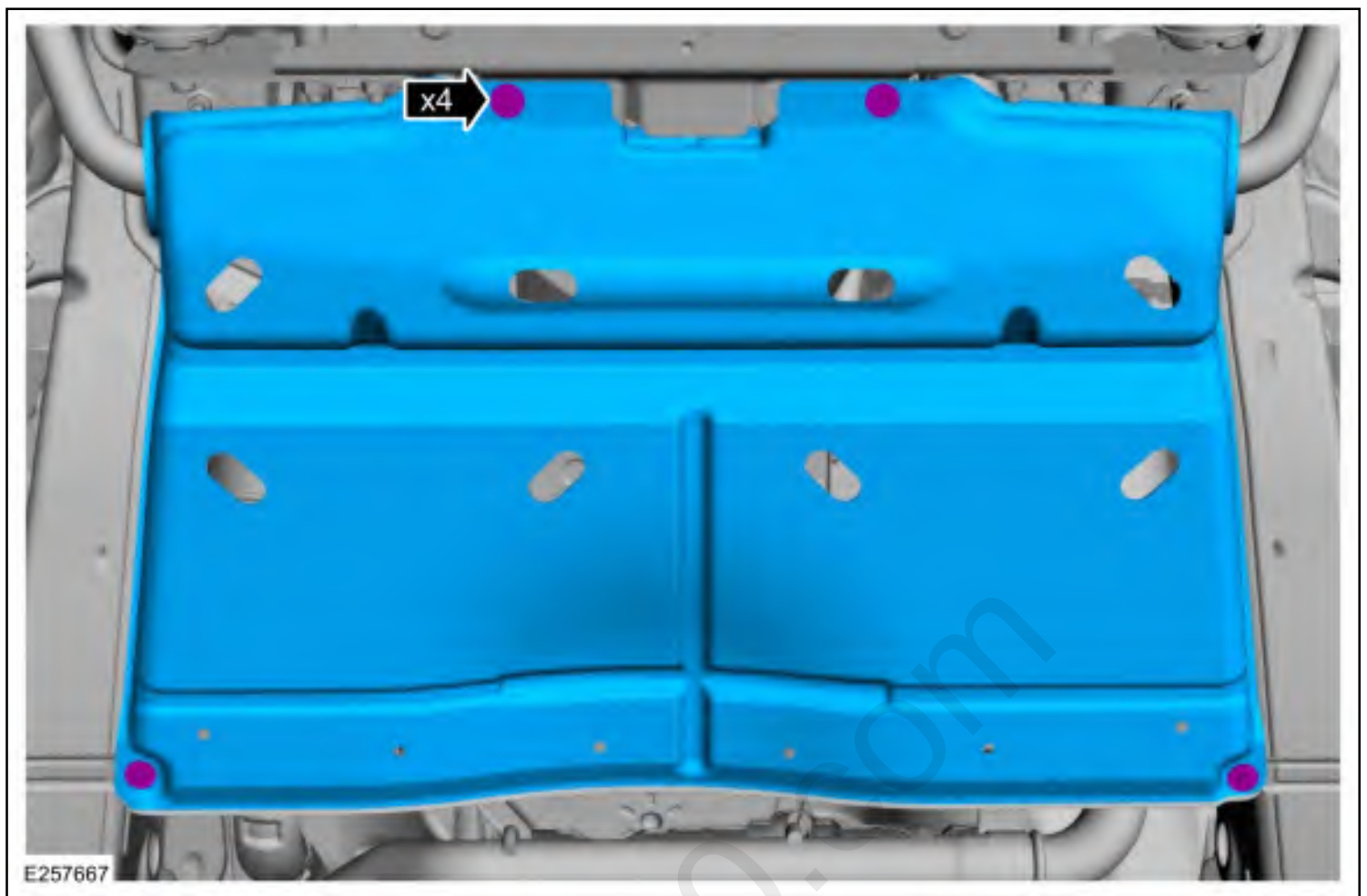
13. **NOTE:** *If equipped.*

Remove the fasteners and the underbody shield.



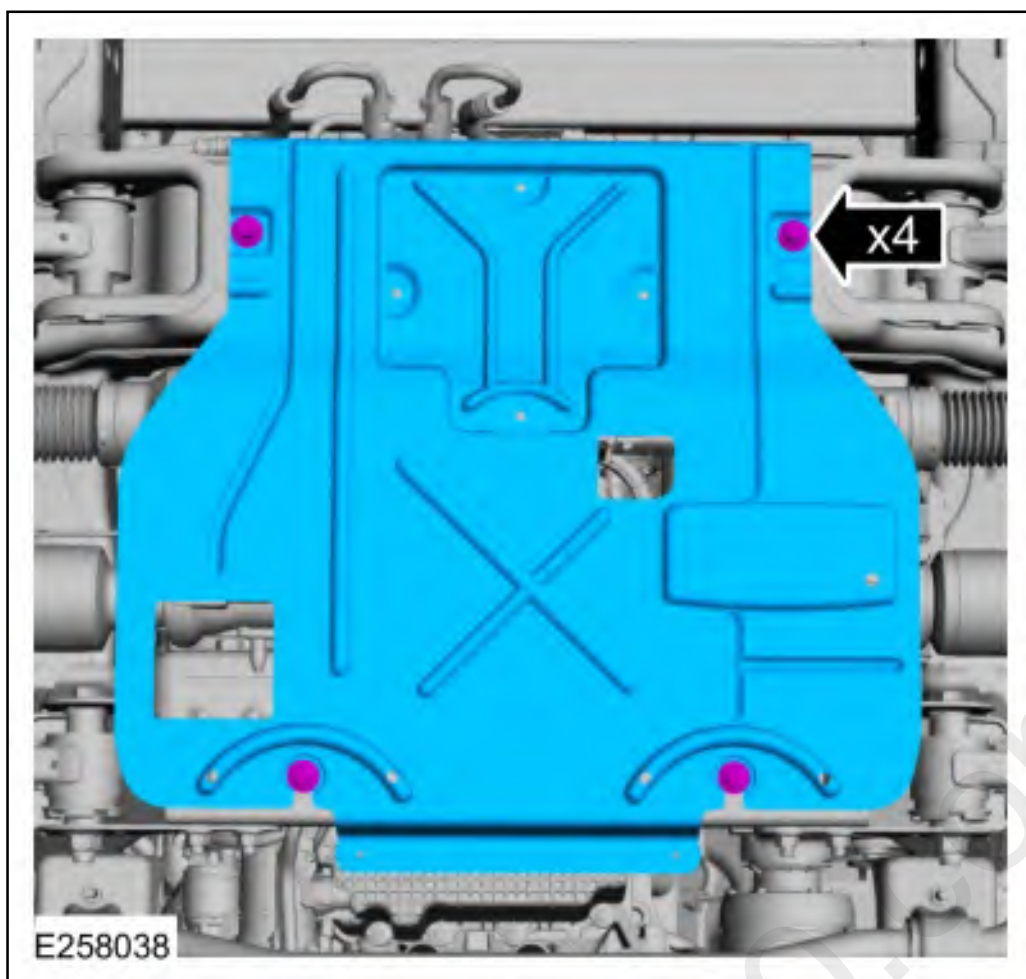
14. **NOTE:** *If equipped.*

Remove the bolts and the underbody shield.



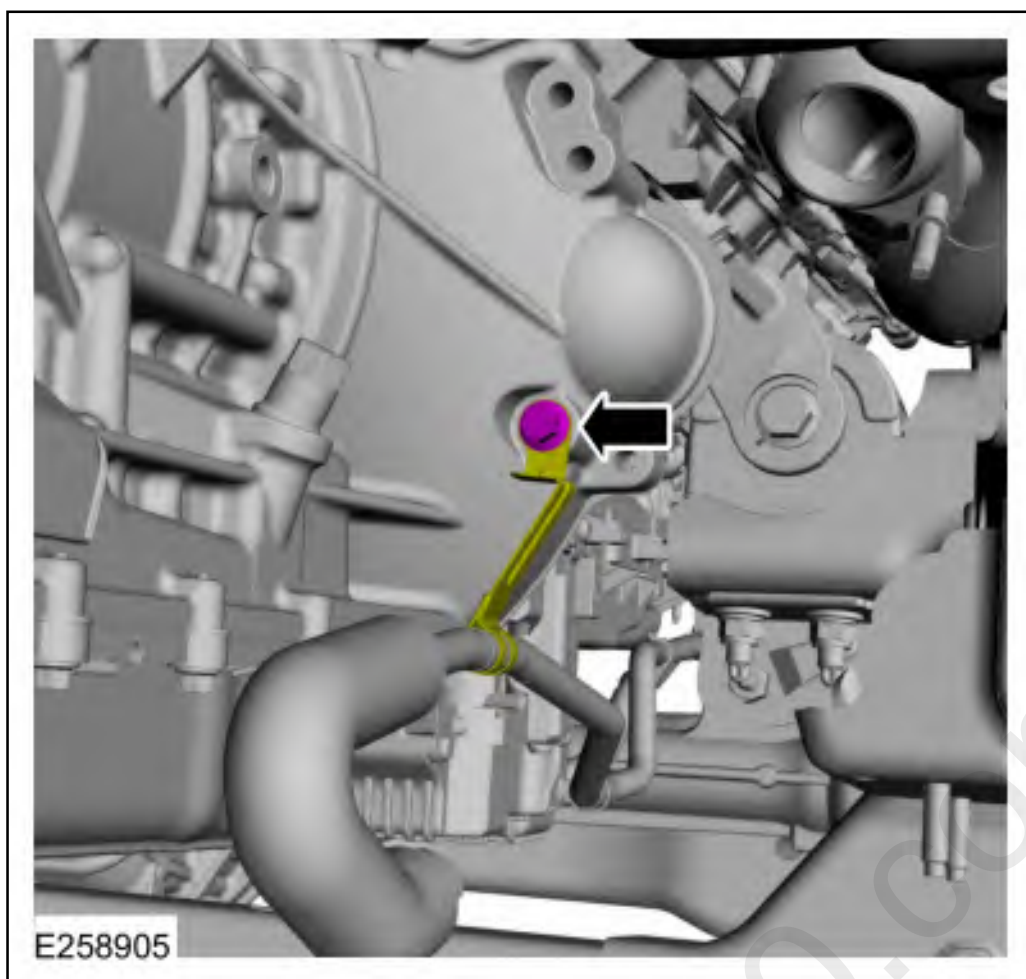
15. **NOTE:** *If equipped.*

Remove the bolts and the skid plate.

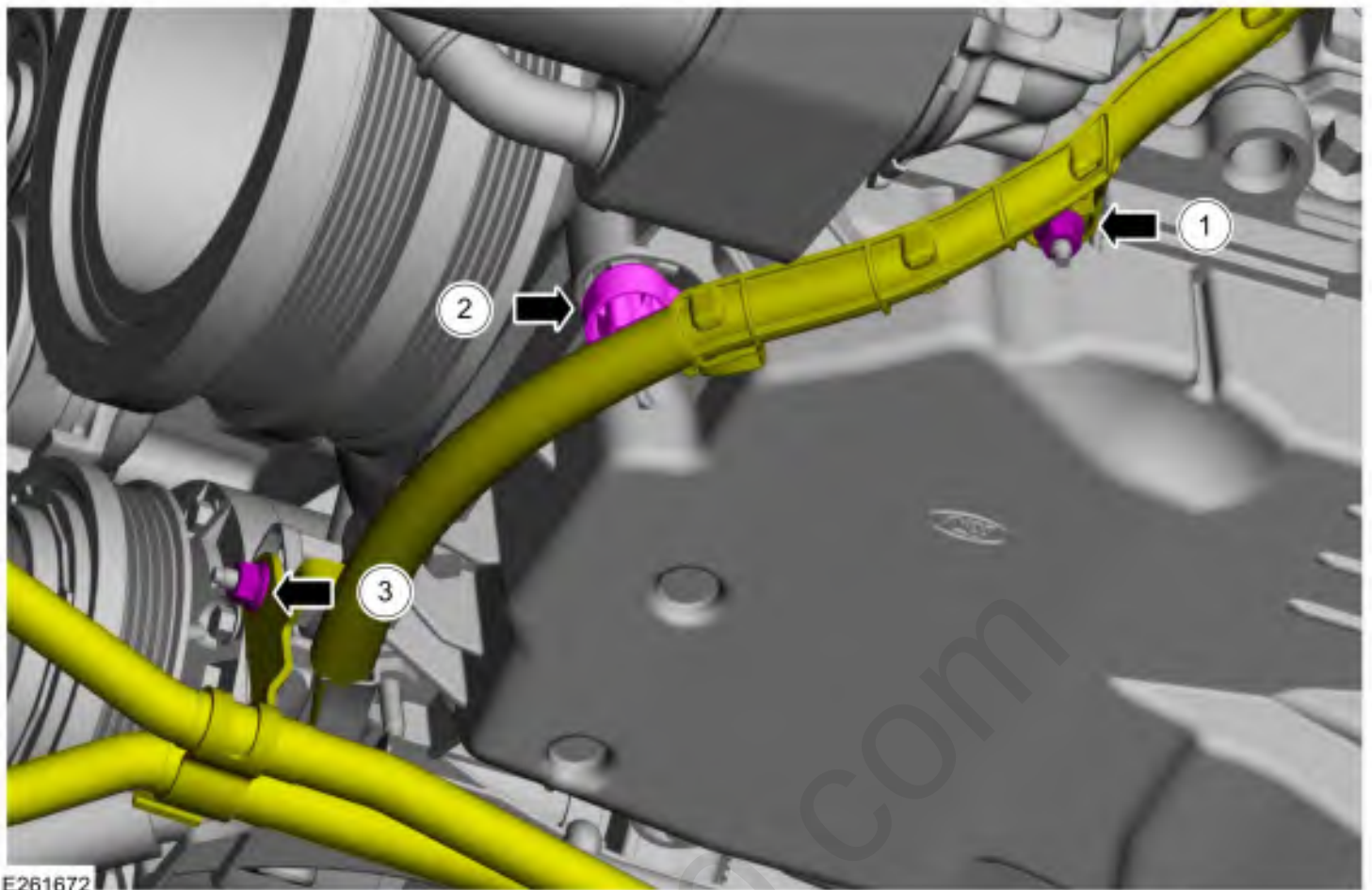


16. Remove the transmission-to-engine bolt and transmission cooler tube support bracket.

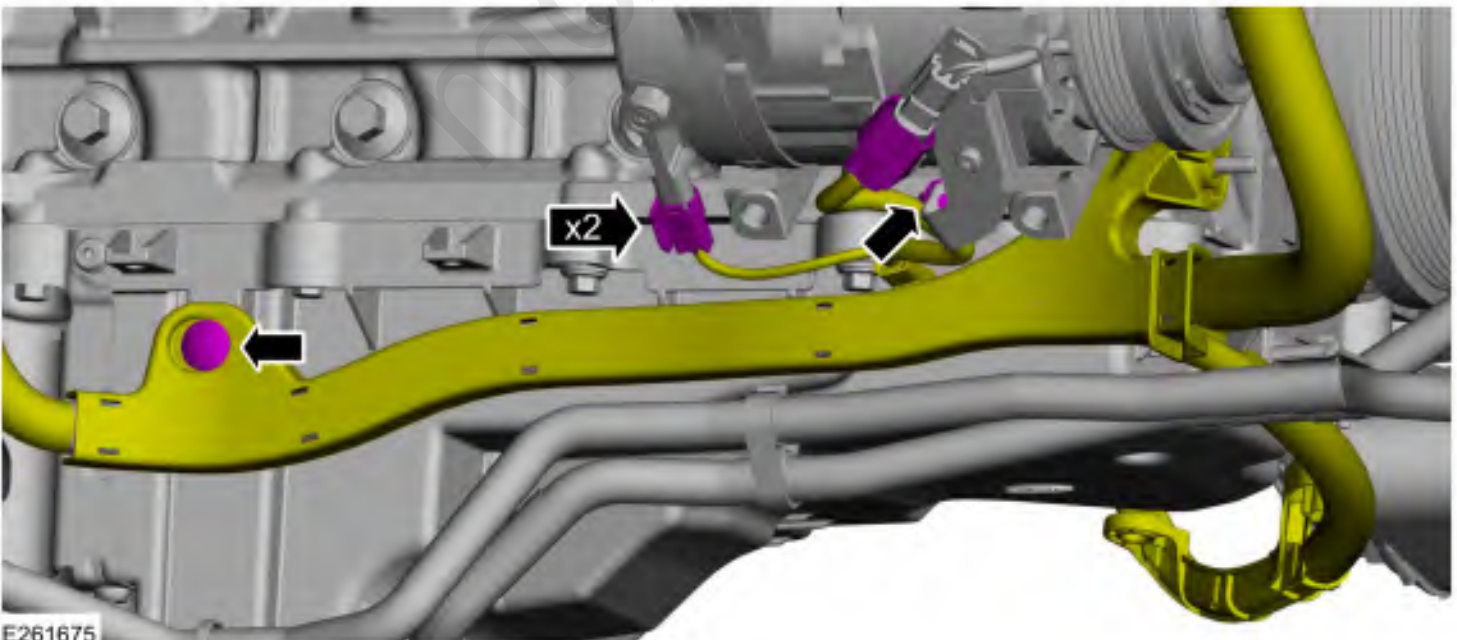




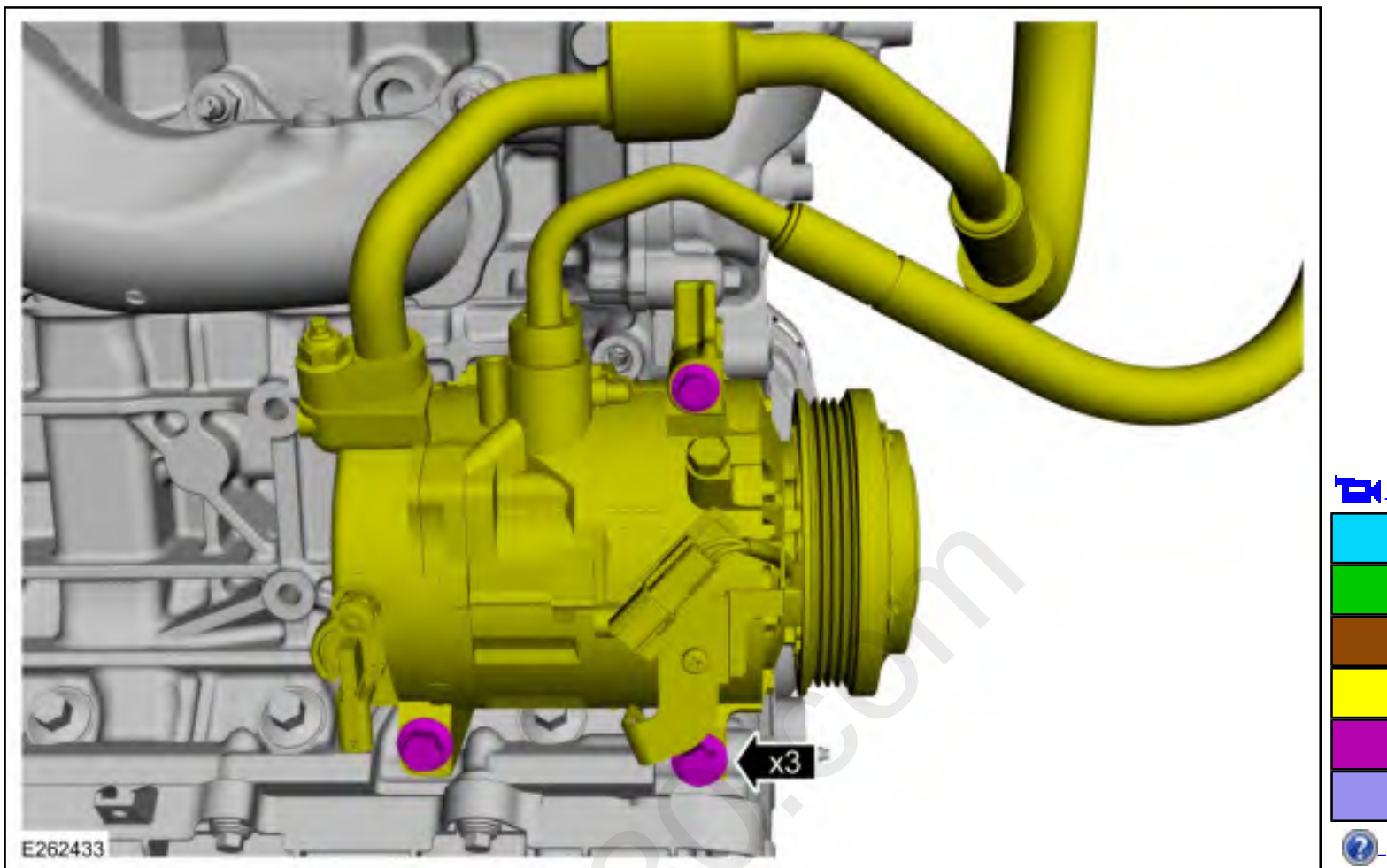
1. Remove the nut.
2. Detach the wiring harness retainer.
3. Remove the nut and position the coolant tube and wiring harness brackets aside.



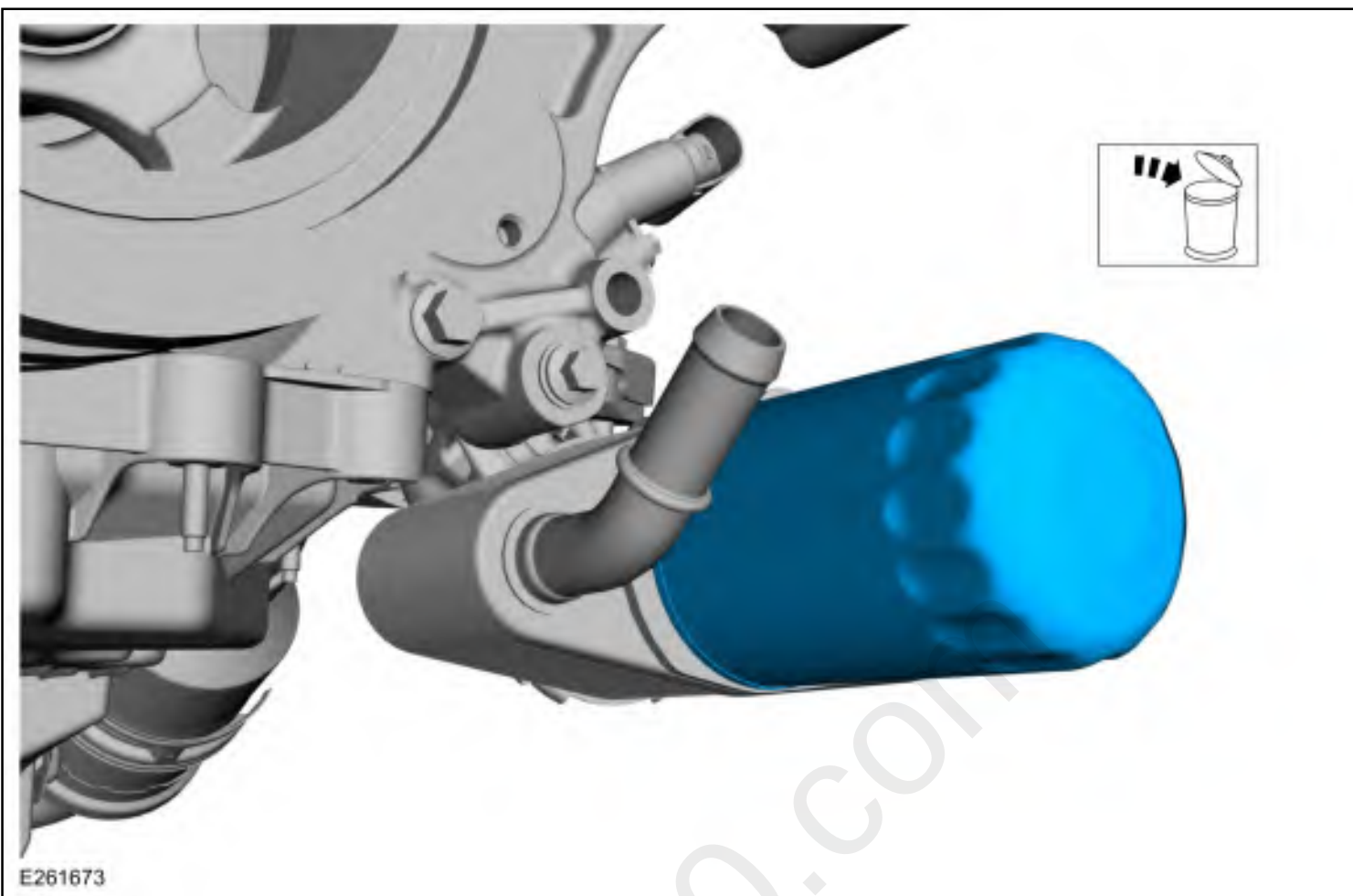
1. Disconnect the A/C compressor electrical connectors.
2. Detach the wiring harness retainers.



19. Remove the bolts and position the A/C compressor aside.

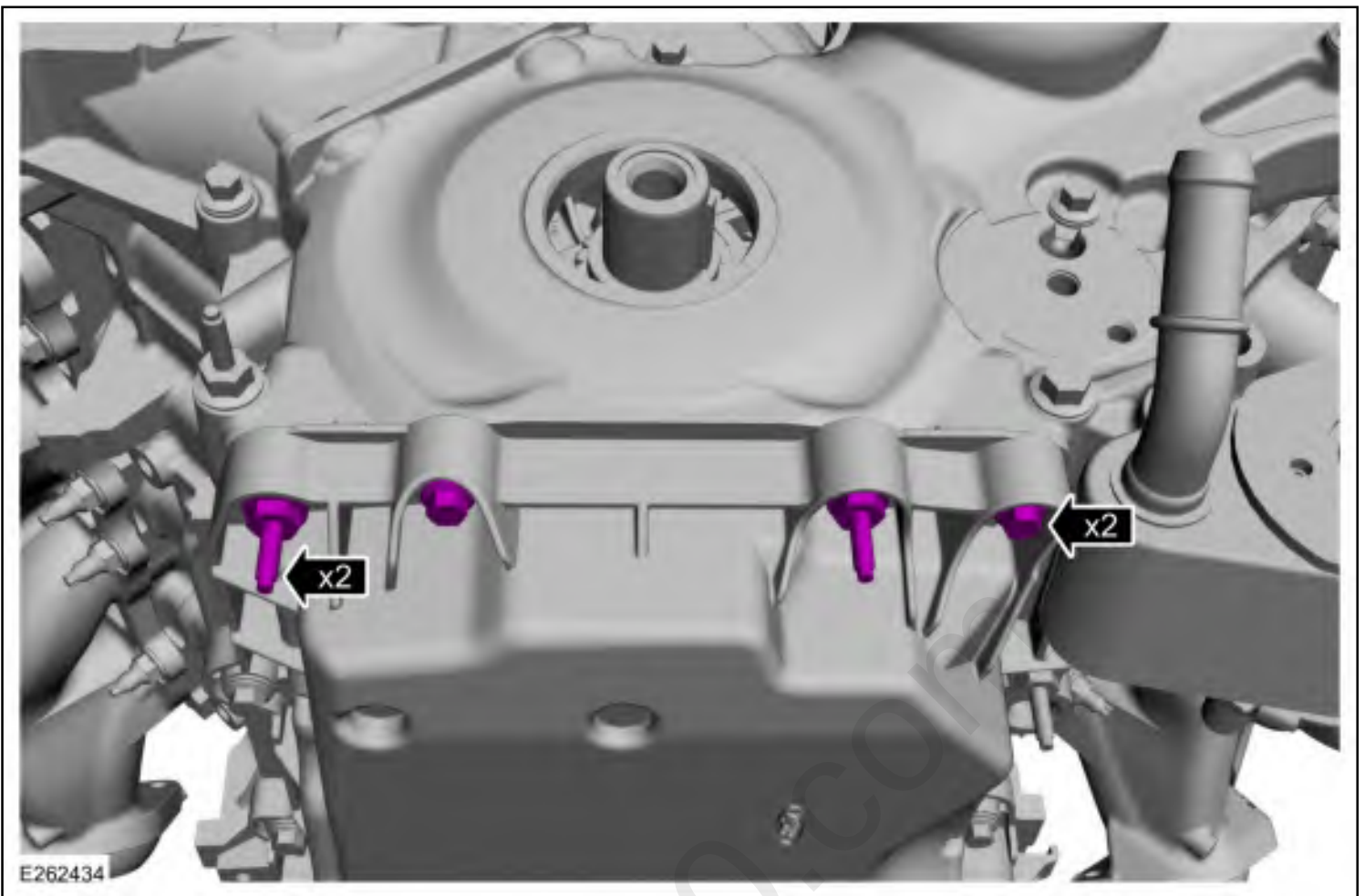


20. Remove and discard the engine oil filter.



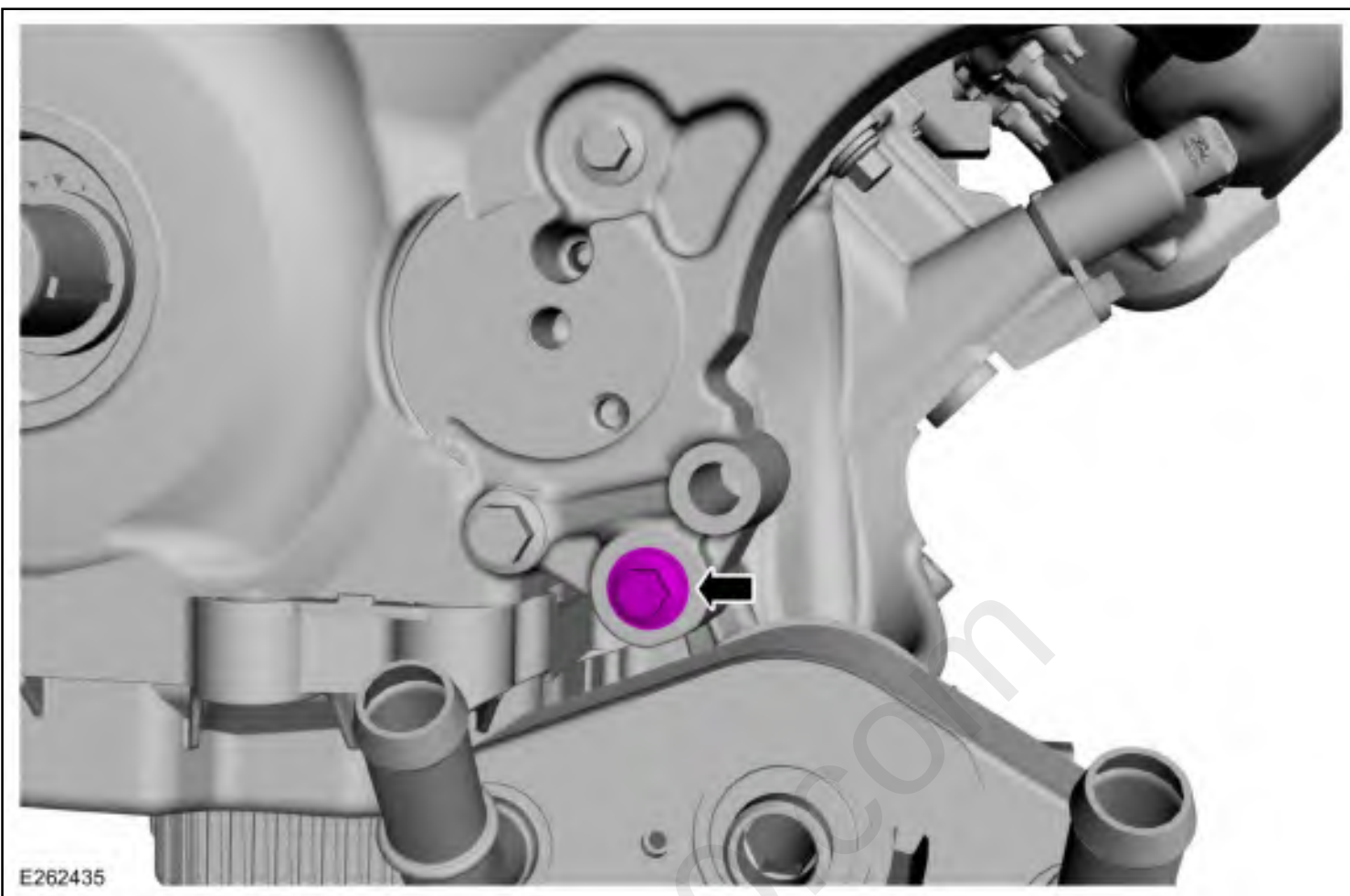
21. Remove the bolts and stud bolts.



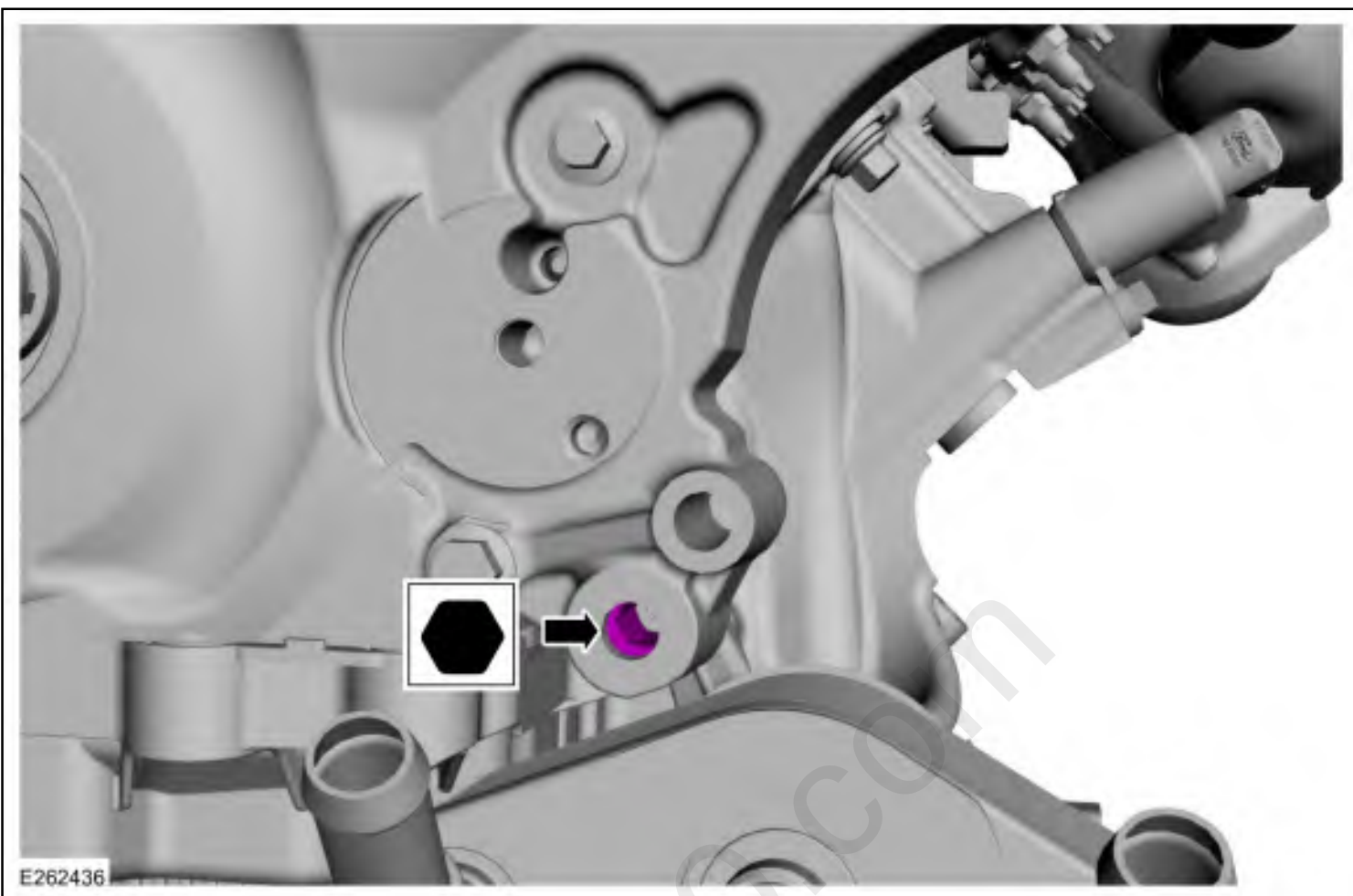


22. Remove the engine front cover-to-oil filter adapter bolt.



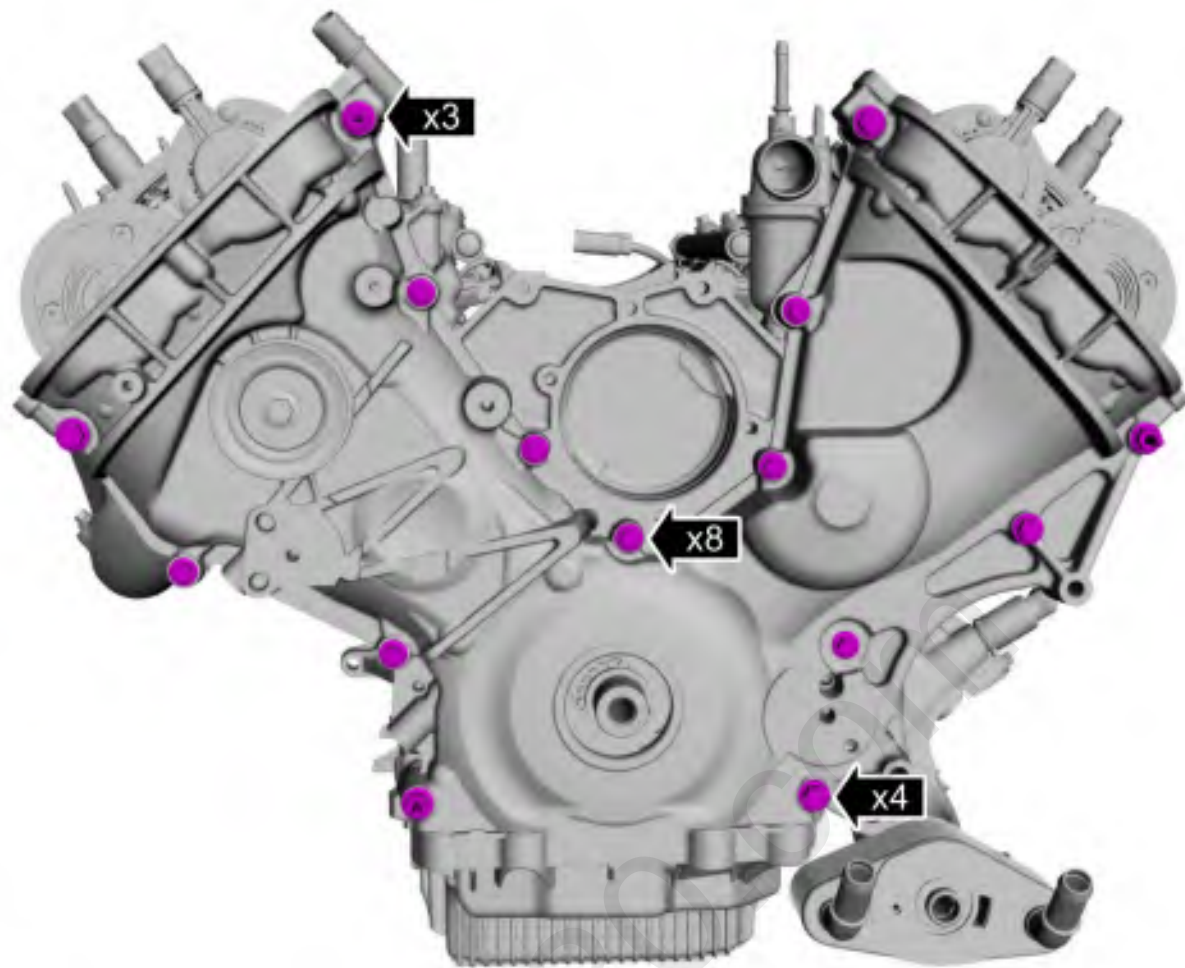


23. Using a 10 mm Hex Bit loosen the engine front cover-to-oil filter adapter jack screw.



24. **NOTE:** *There are 3 different fasteners used, note the location of fasteners for assembly.*

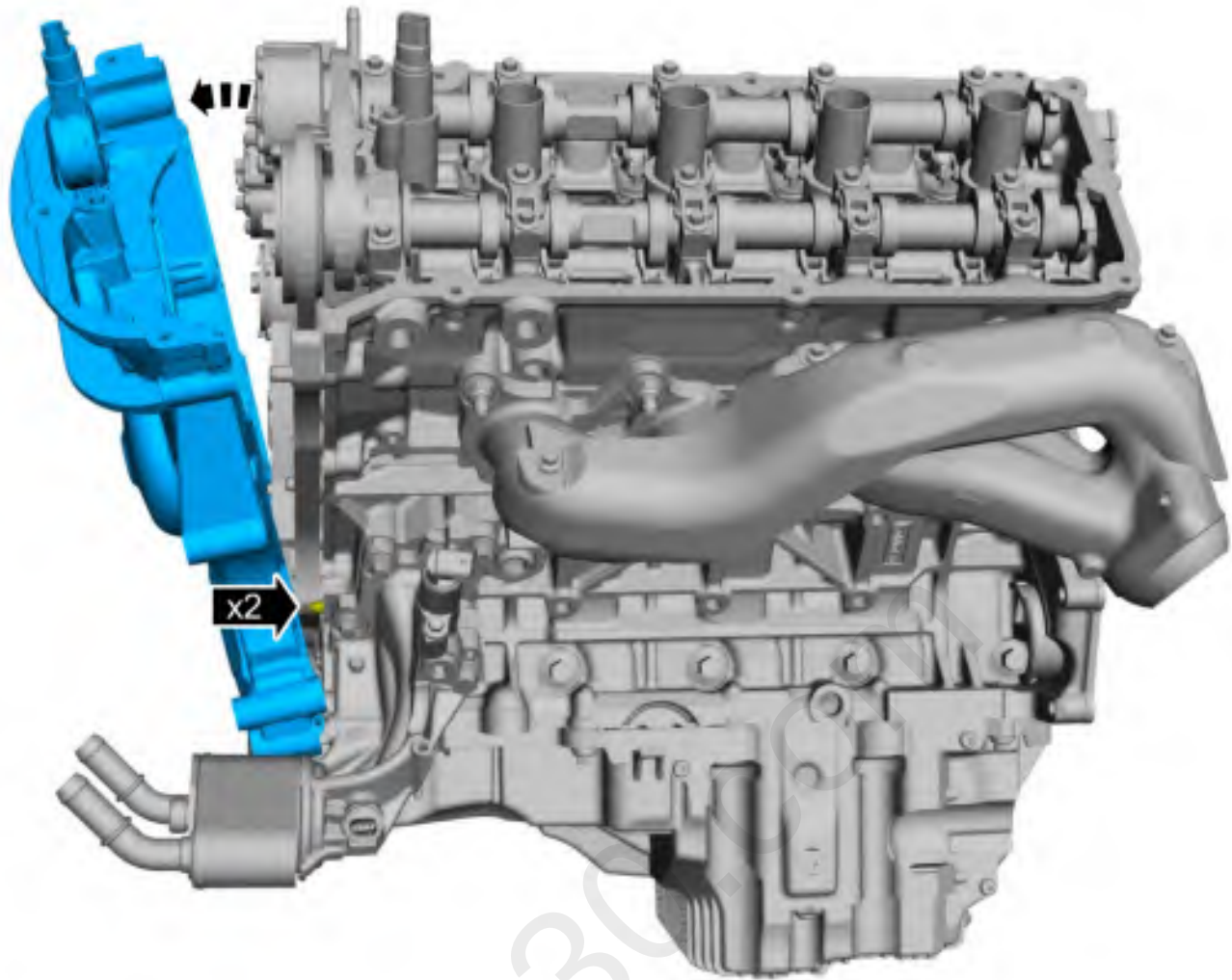
Remove the bolts and stud bolts.



E262437

25. **NOTE:** *Timing drive components removed from view for clarity.*

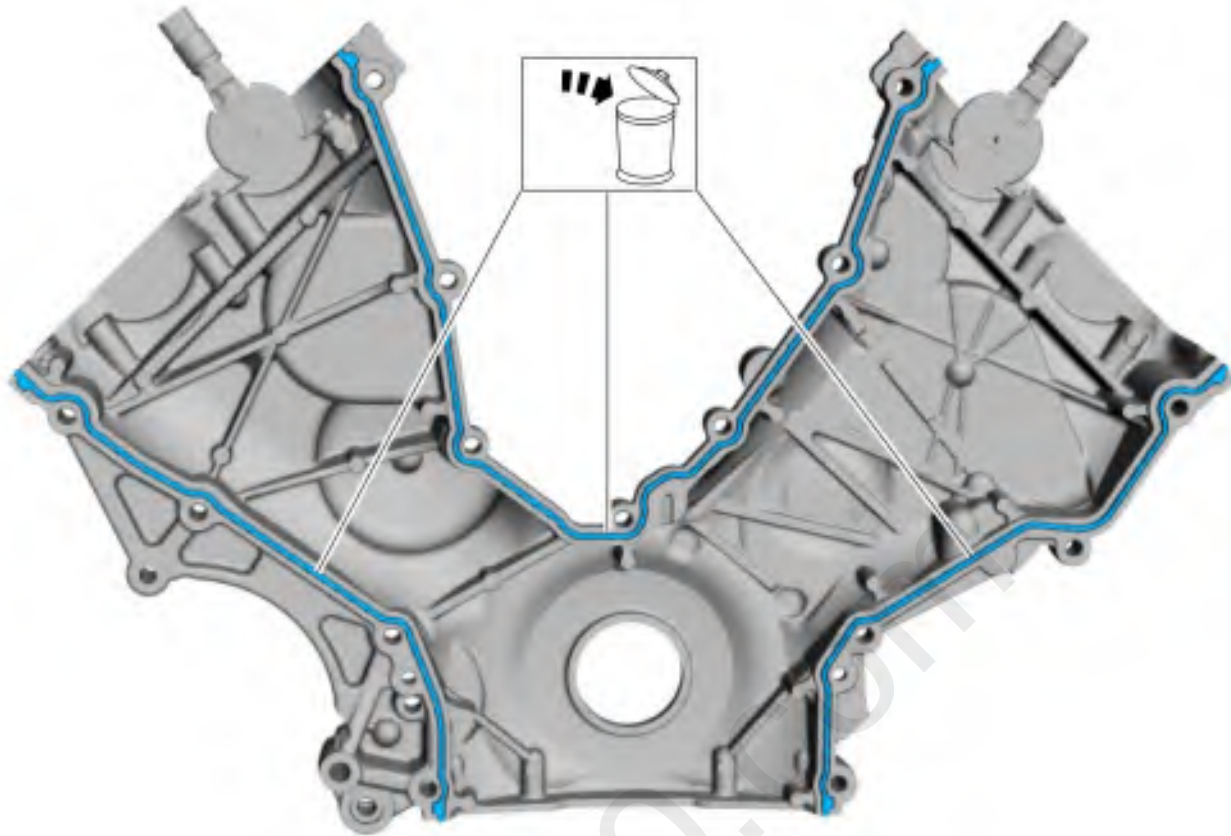
Remove the engine front cover from the front cover-to-cylinder block dowels.



E262438



26. Remove and discard the gaskets.



E262439

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

Clean and inspect the mating surface.

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

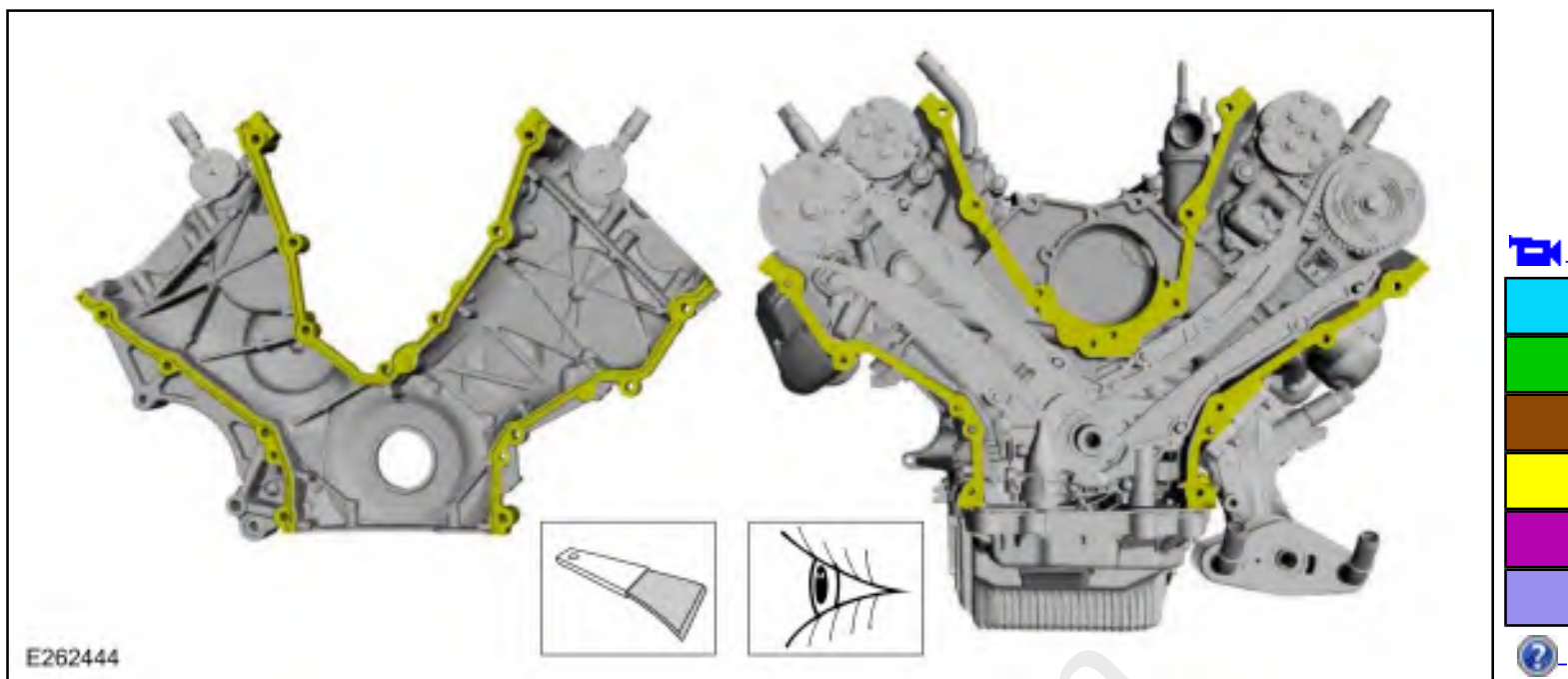
Use the General Equipment: Plastic Scraper

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

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

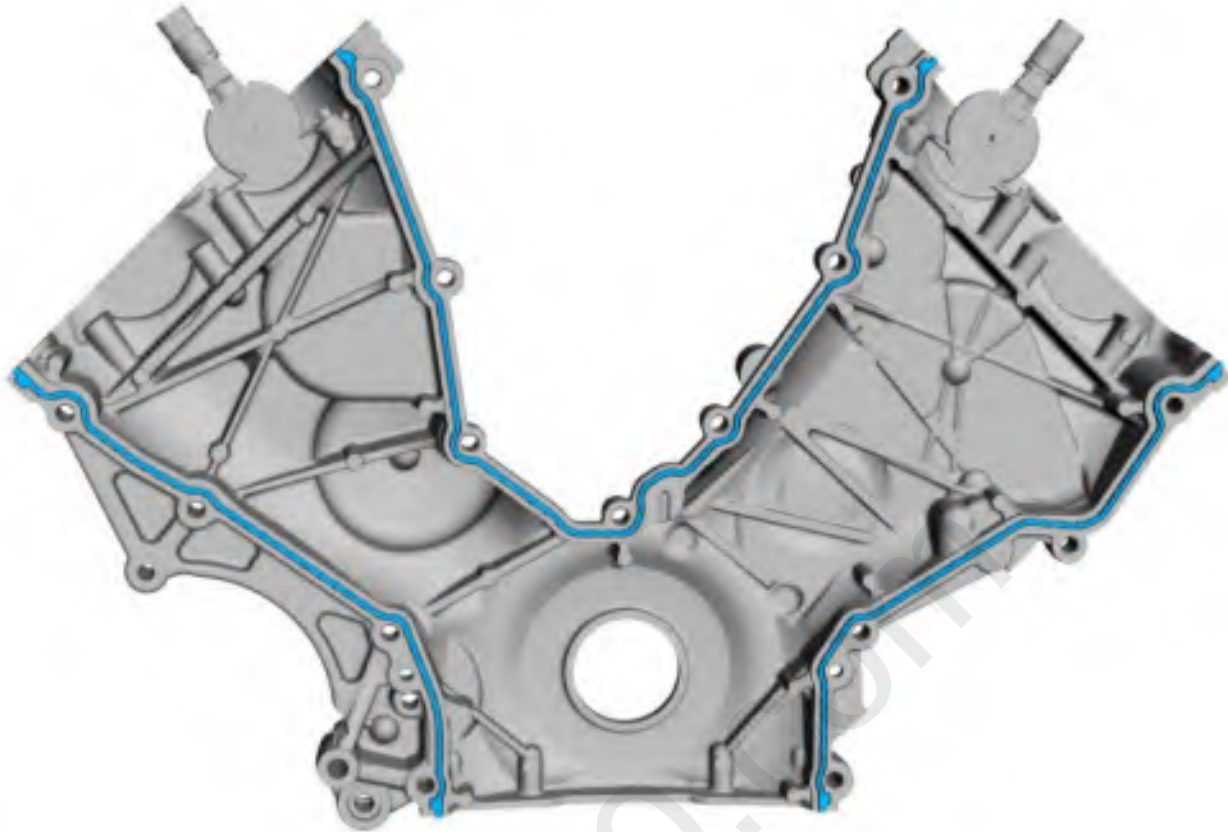
*Material:* Motorcraft® Metal Surface Prep Wipes / ZC-31-B





## Installation

1. Install new gaskets on the engine front cover.



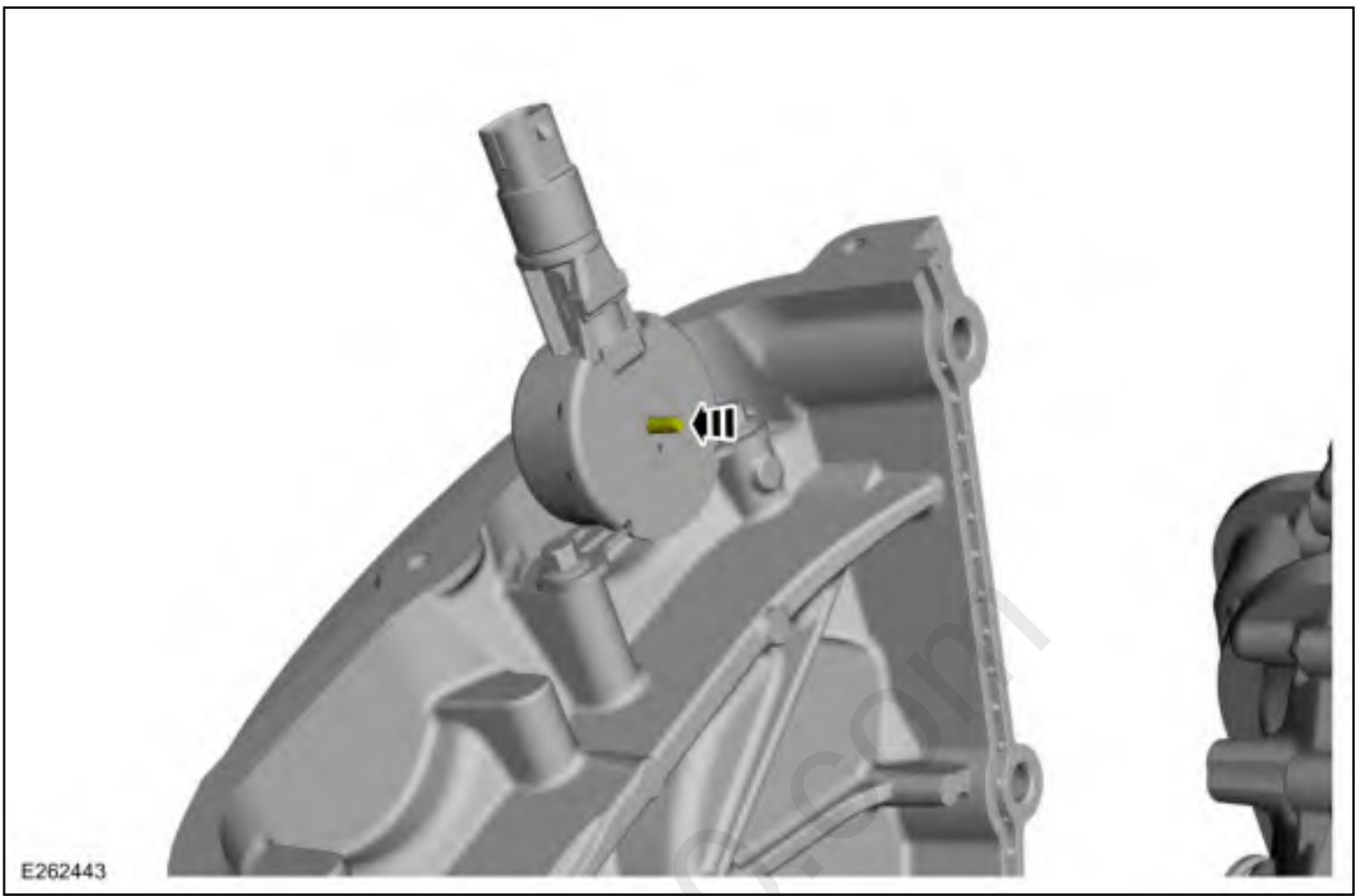
E262441



2. **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.*

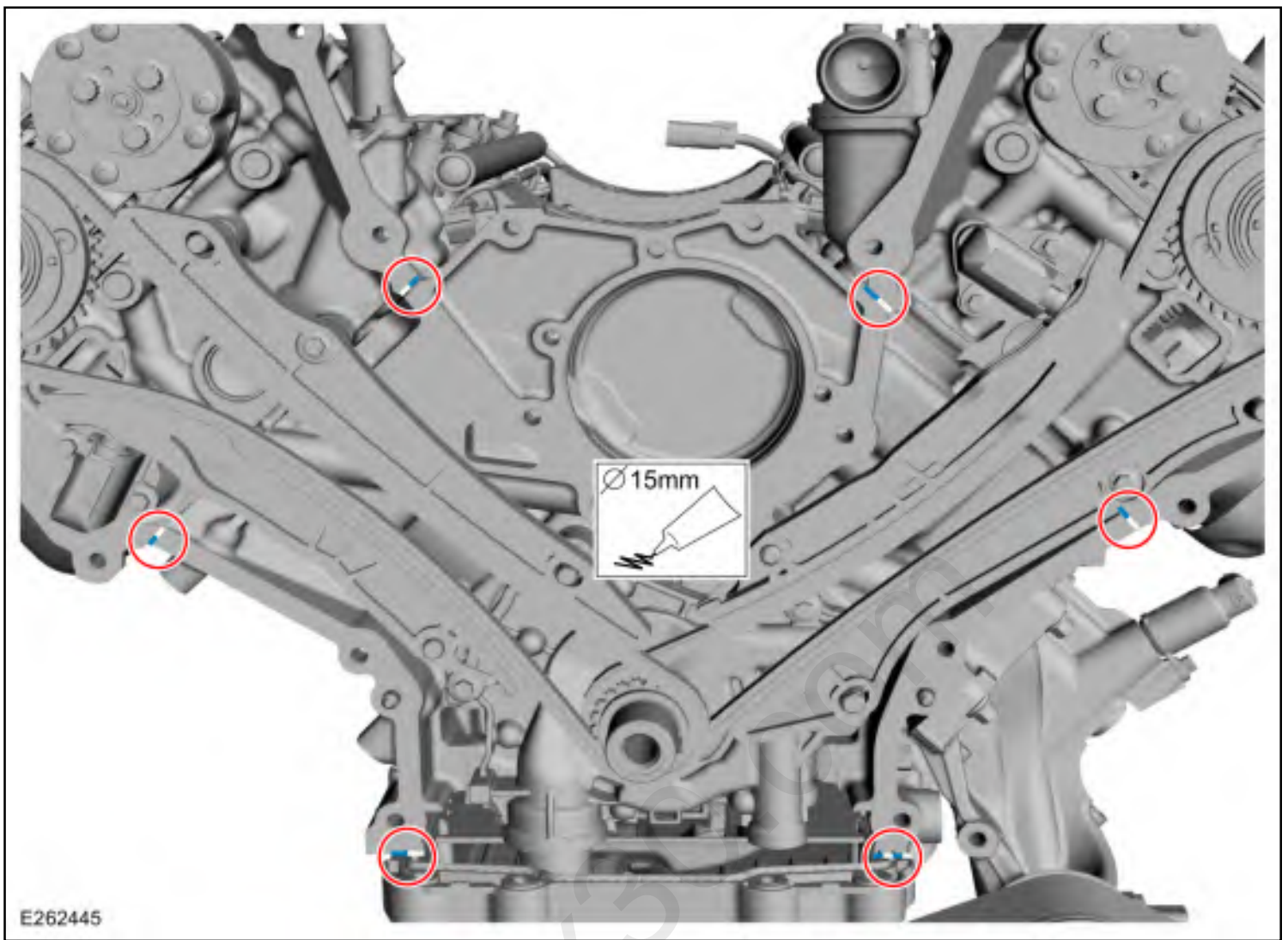
Fully depress the VCT variable force solenoid pins.



3. **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.

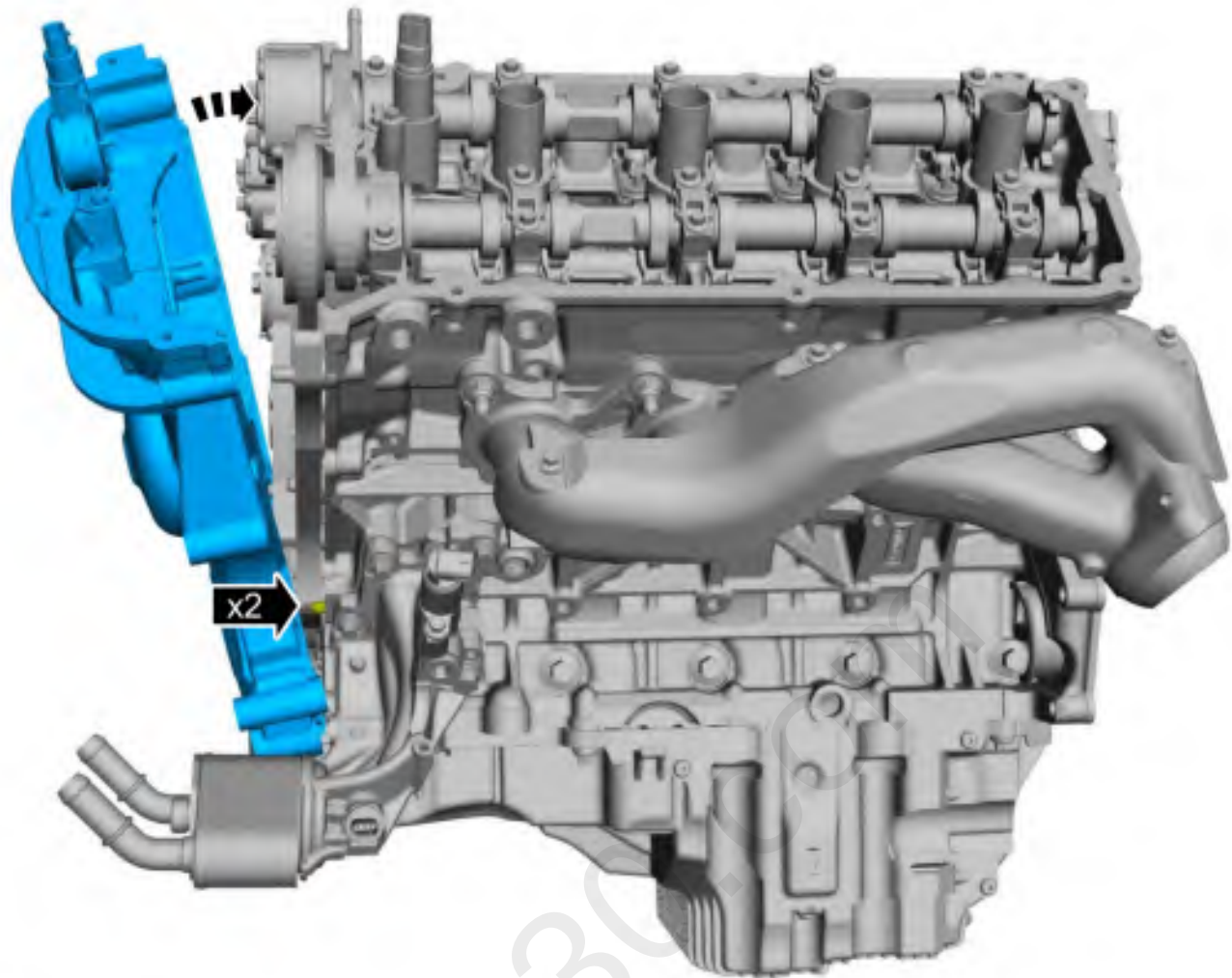
Apply a 15 mm (0.59 in) diameter drop of silicone gasket and sealant to the cylinder head-to-cylinder block joints and the oil pan-to-cylinder block joints.

*Material:* Motorcraft® Silicone Gasket and Sealant / TA-30 (WSE-M4G323-A4)



4. **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.



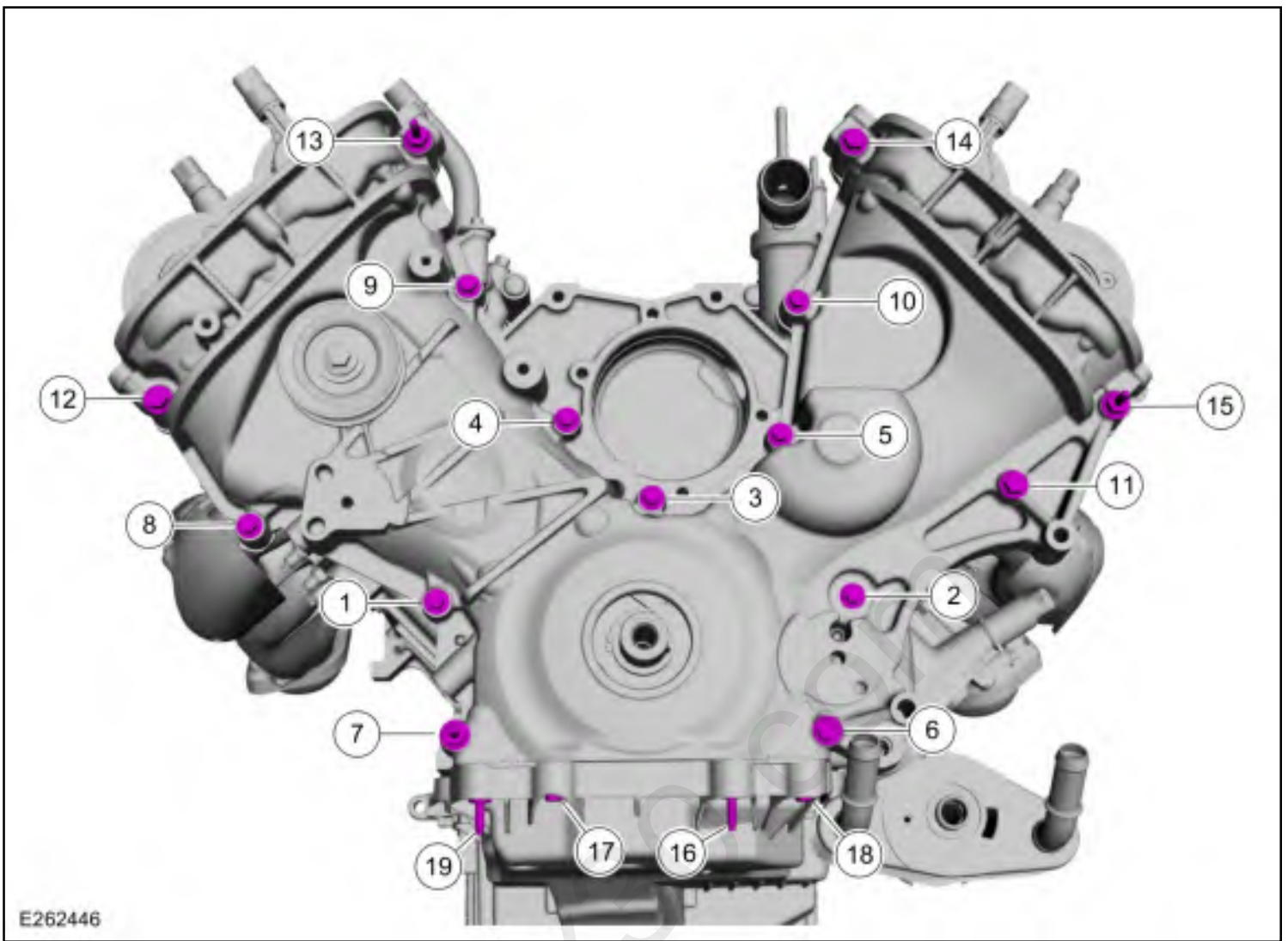
5. **NOTICE:** The engine front cover must be installed and all fasteners final tightened within 5 minutes of applying the sealer. If this cannot be accomplished, install the engine front cover and tighten fasteners 6, 7, 8, 9, 10 and 11 to 8 Nm (71 lb-in) within 5 minutes of applying the sealer. All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

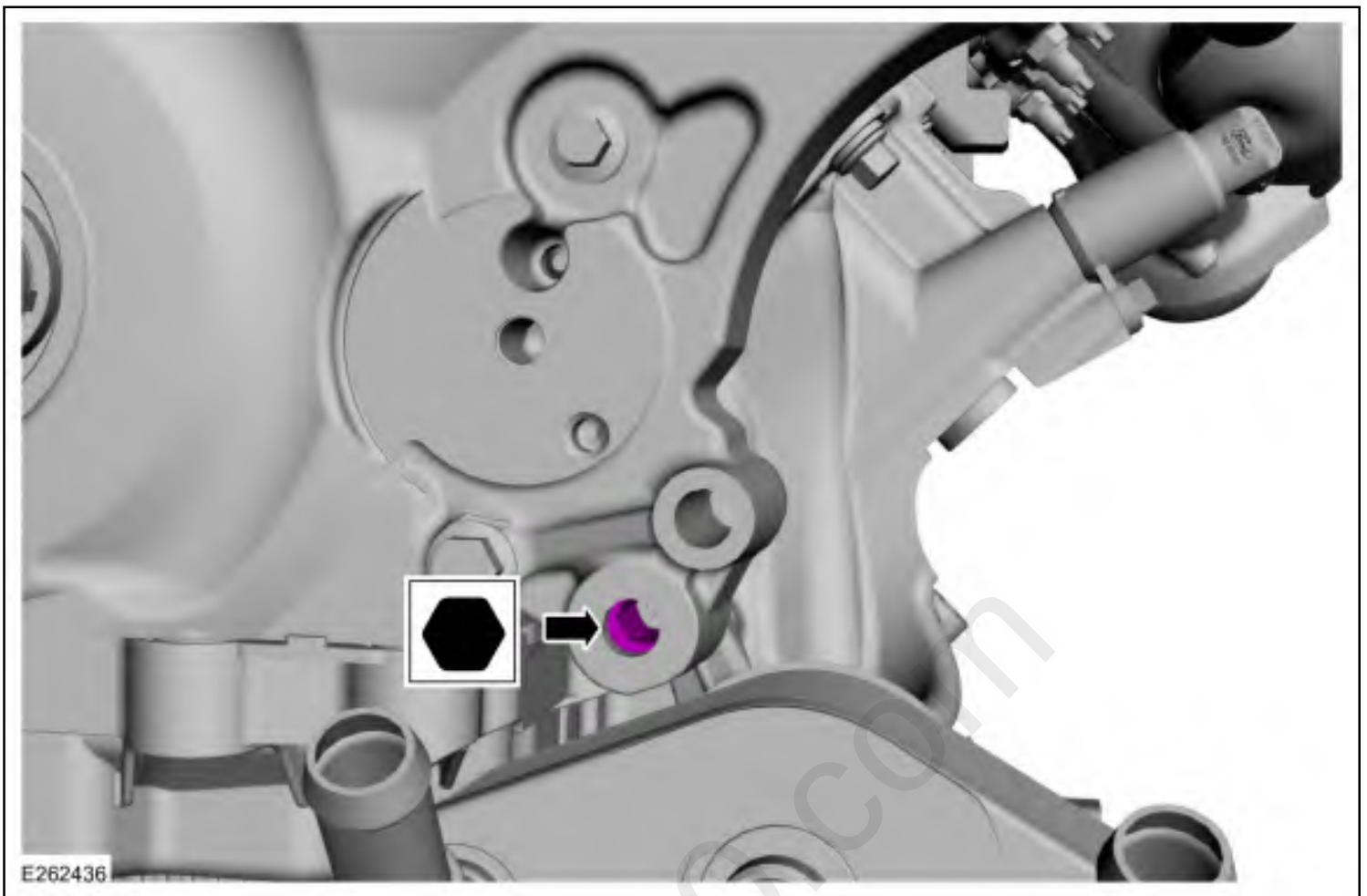
*Torque:*

- 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°





6. 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)*

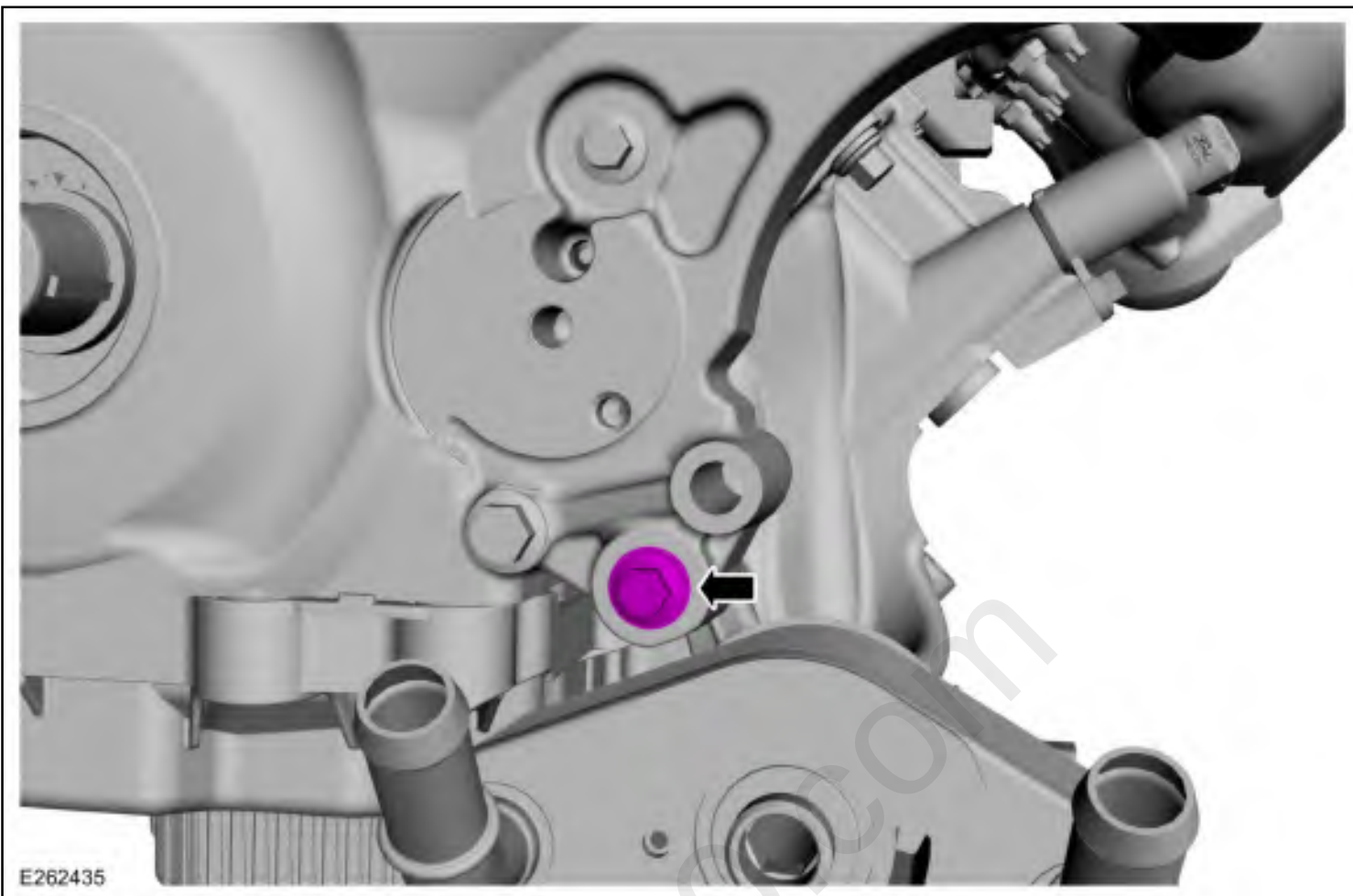


7. Install the engine front cover-to-oil filter adapter bolt.

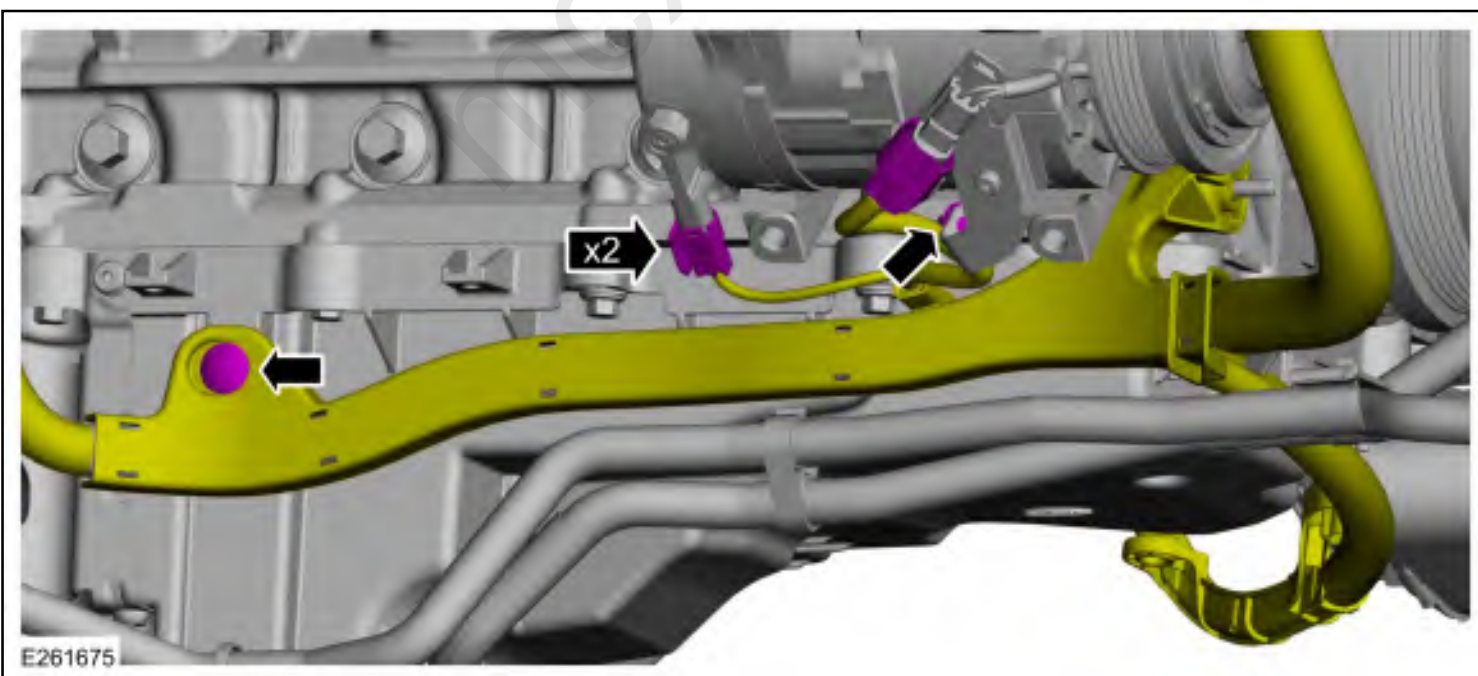
*Torque:*

Stage 1: 18 lb.ft (25 Nm)

Stage 2: 60°



1. Connect the A/C compressor electrical connectors.
2. Attach the wiring harness retainers.

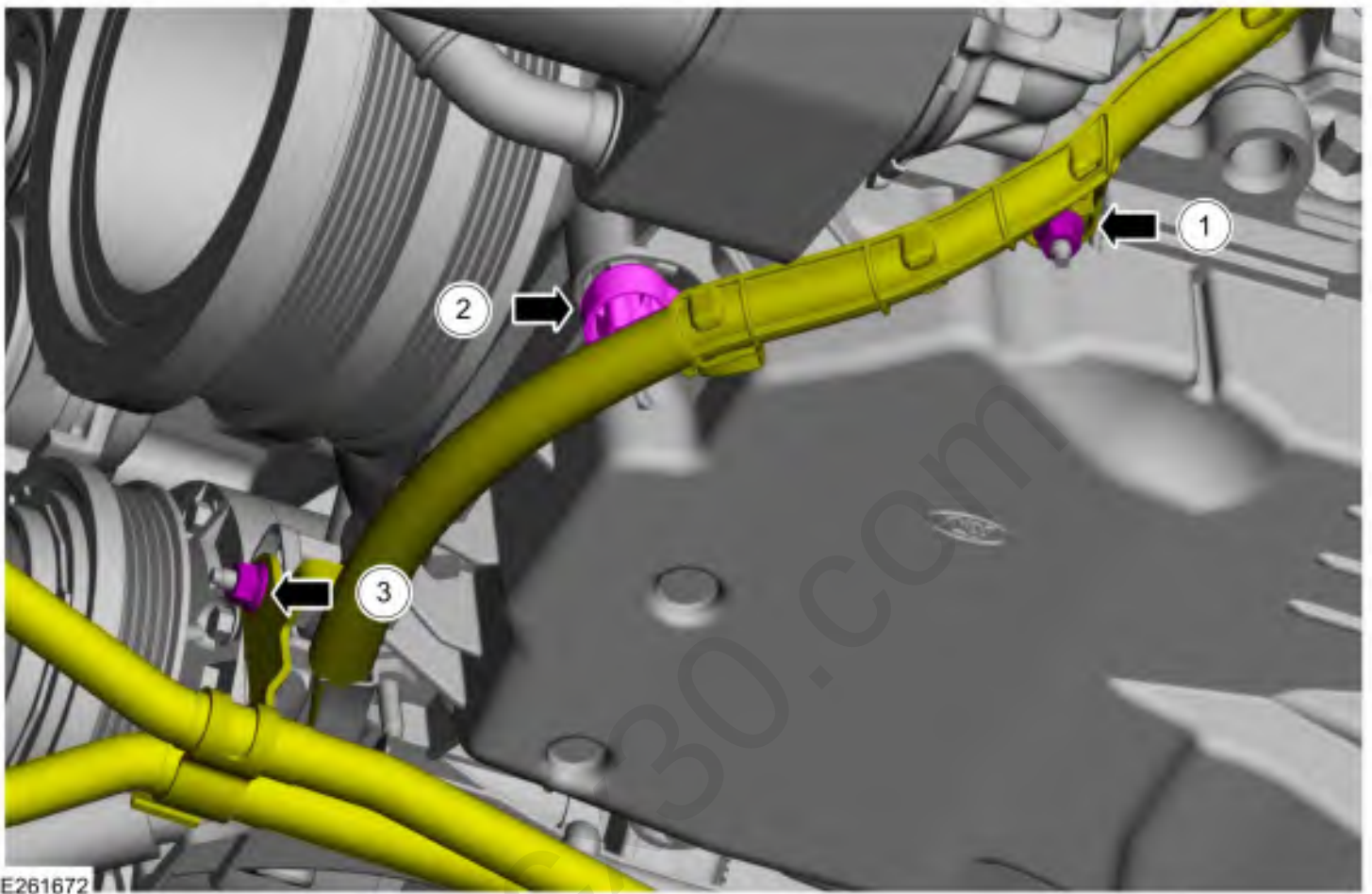


1. Install the nut.

*Torque: 106 lb.in (12 Nm)*

2. Attach the wiring harness retainer.
3. Position the coolant tube and wiring harness brackets and install the nut.

*Torque: 115 lb.in (13 Nm)*



10. Install the generator, the bolt and the nut.

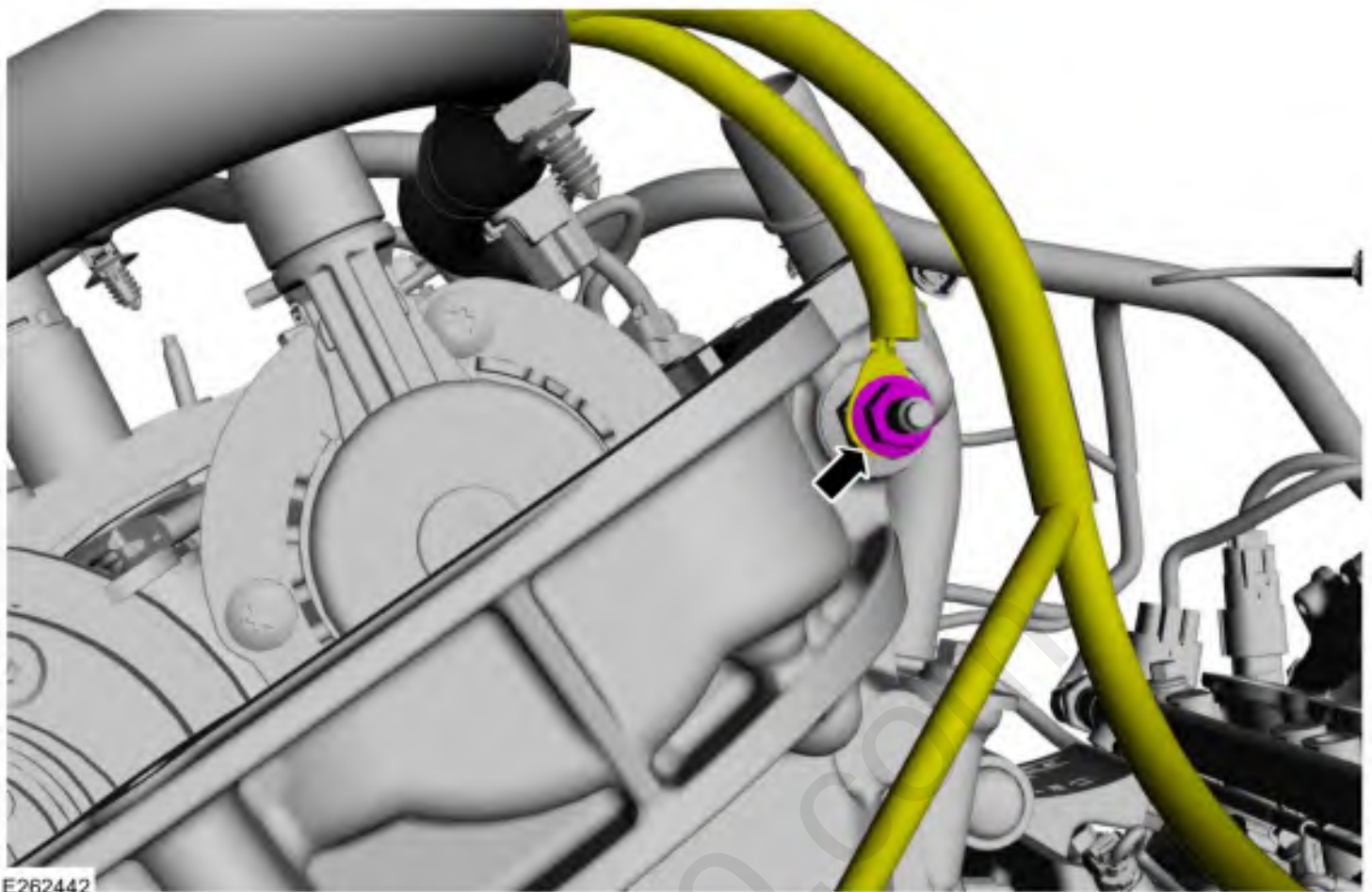
*Torque: 35 lb.ft (48 Nm)*





11. Install the ground wire and nut.  
*Torque: 89 lb.in (10 Nm)*





12. Install the following items:

1. Refer to: Crankshaft Front Seal (303-01 Engine - 5.0L 32V Ti-VCT) .
2. Refer to: [Coolant Pump](#) (303-03D Engine Cooling - 5.0L 32V Ti-VCT, Removal and Installation).
3. Refer to: Air Conditioning (A/C) Compressor Belt Tensioner (303-05 Accessory Drive - 5.0L 32V Ti-VCT) .
4. Refer to: Air Conditioning (A/C) Compressor Belt (303-05 Accessory Drive - 5.0L 32V Ti-VCT) .
5. Refer to: Accessory Drive Belt Tensioner (303-05 Accessory Drive - 5.0L 32V Ti-VCT) .
6. Refer to: Accessory Drive Belt (303-05 Accessory Drive - 5.0L 32V Ti-VCT) .

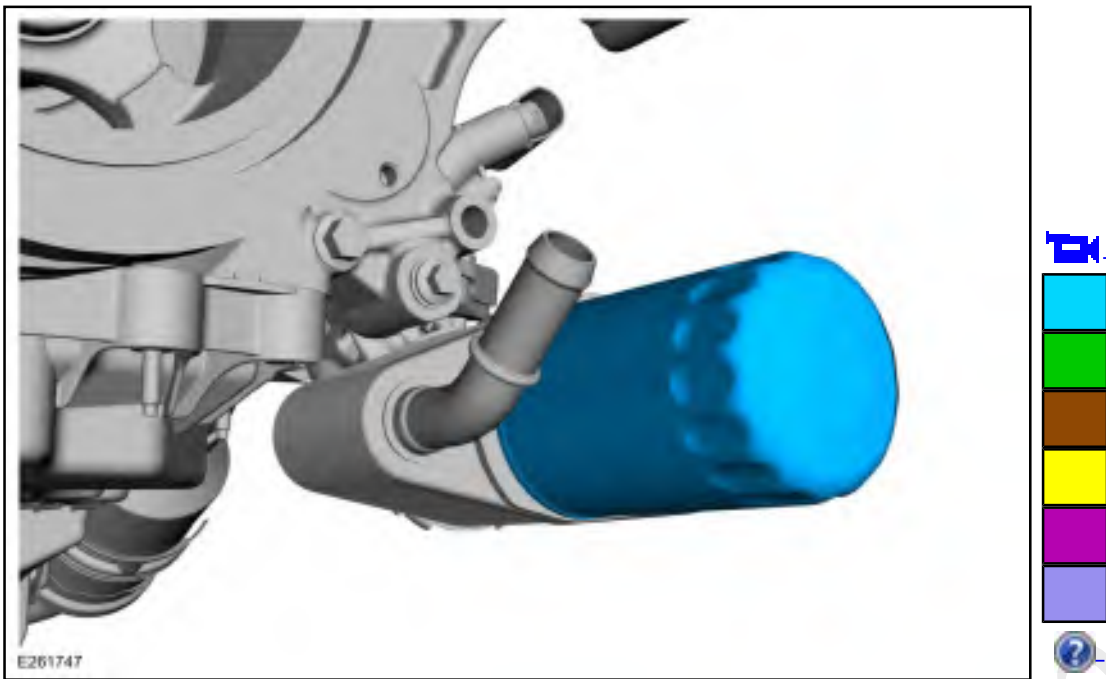
13. **NOTE:** *Do not lubricate the O-ring seal.*

Install a new oil filter.

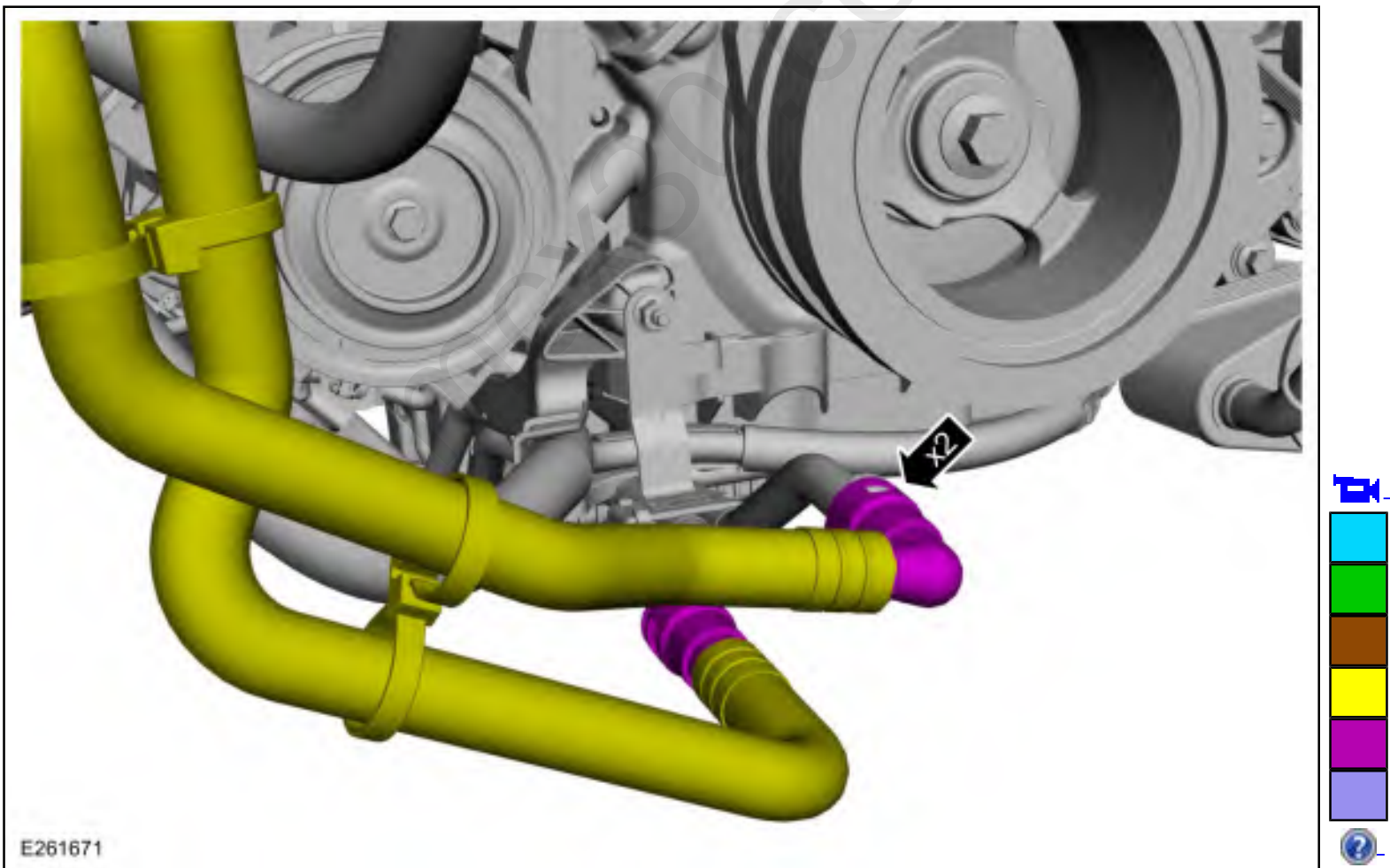
*Torque:*

Stage 1: 44 lb.in (5 Nm)

Stage 2: 180°



14. Connect the coolant hose quick release couplings.



1. Install the coolant hose assembly and the clamps.

- Use the General Equipment: Hose Clamp Remover/Installer
2. Install the coolant bypass T assembly and engage the spring clip.
  3. Install the coolant hose and clamp.

Use the General Equipment: Hose Clamp Remover/Installer

4. Install the coolant hose and clamp.

Use the General Equipment: Hose Clamp Remover/Installer

5. Connect the quick release coupling.

6. Install the coolant hose and clamp.

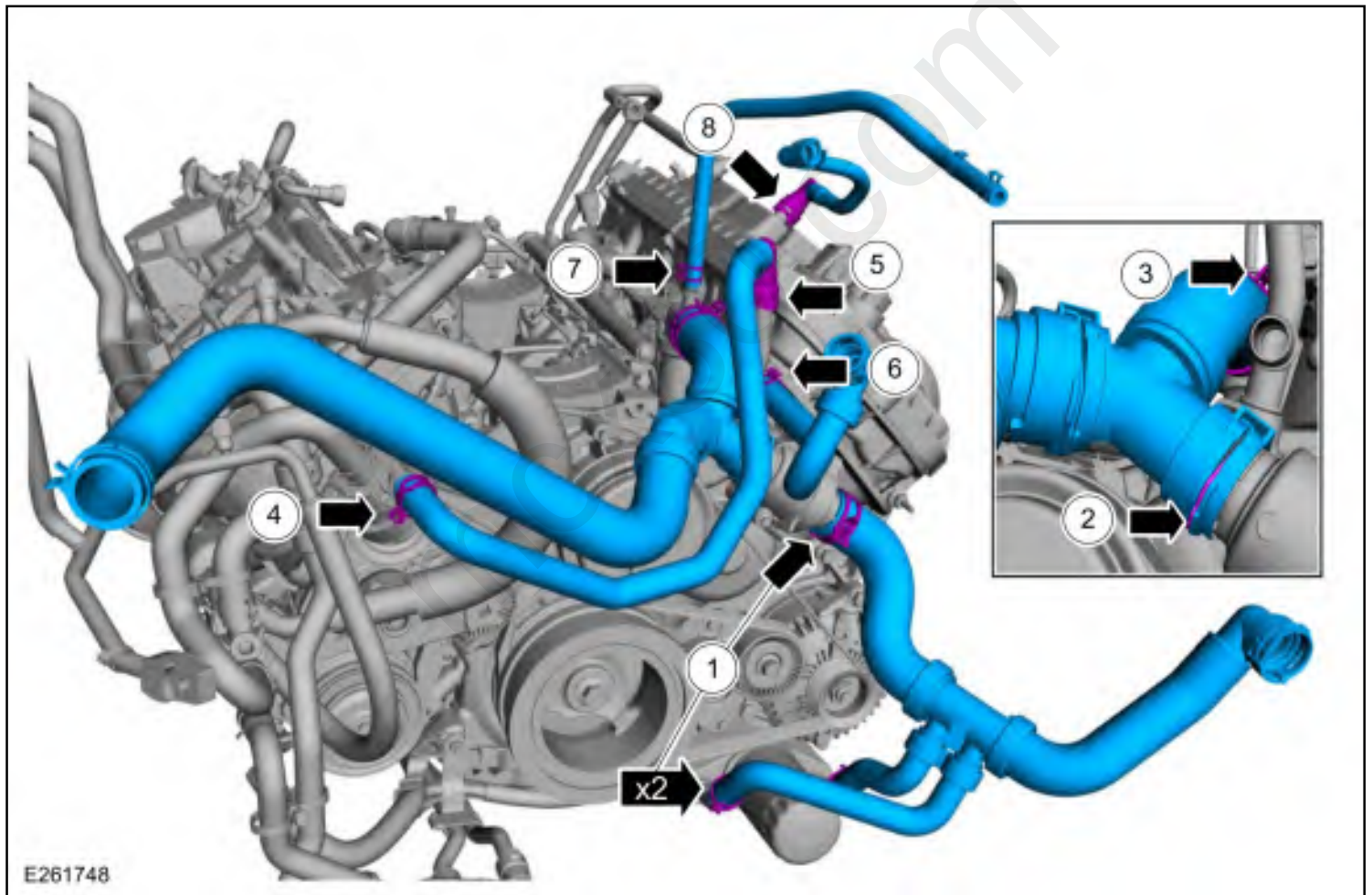
Use the General Equipment: Hose Clamp Remover/Installer

7. Install the coolant hose and clamp.

Use the General Equipment: Hose Clamp Remover/Installer

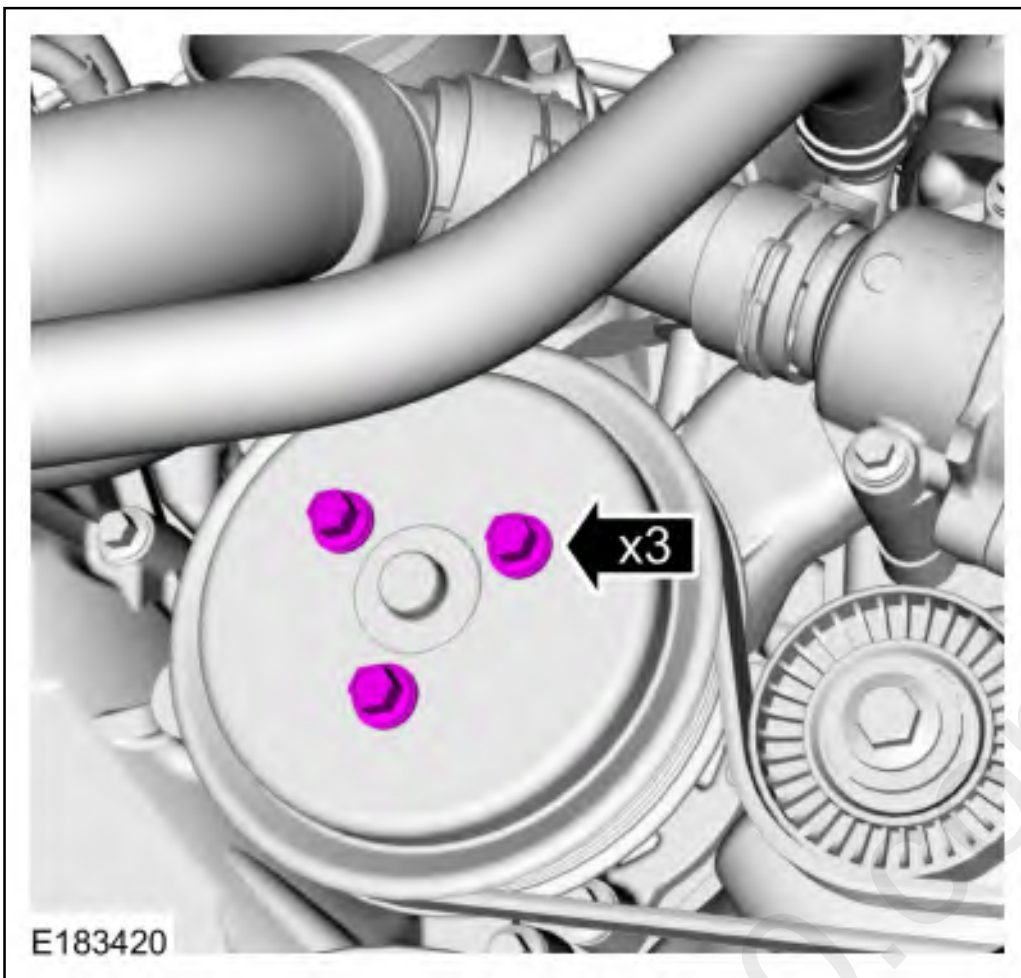
8. Install the crankcase vent tube and connect the quick release coupling.

Refer to: [Quick Release Coupling](#) (310-00D Fuel System - General Information - 5.0L 32V Ti-VCT, General Procedures).



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





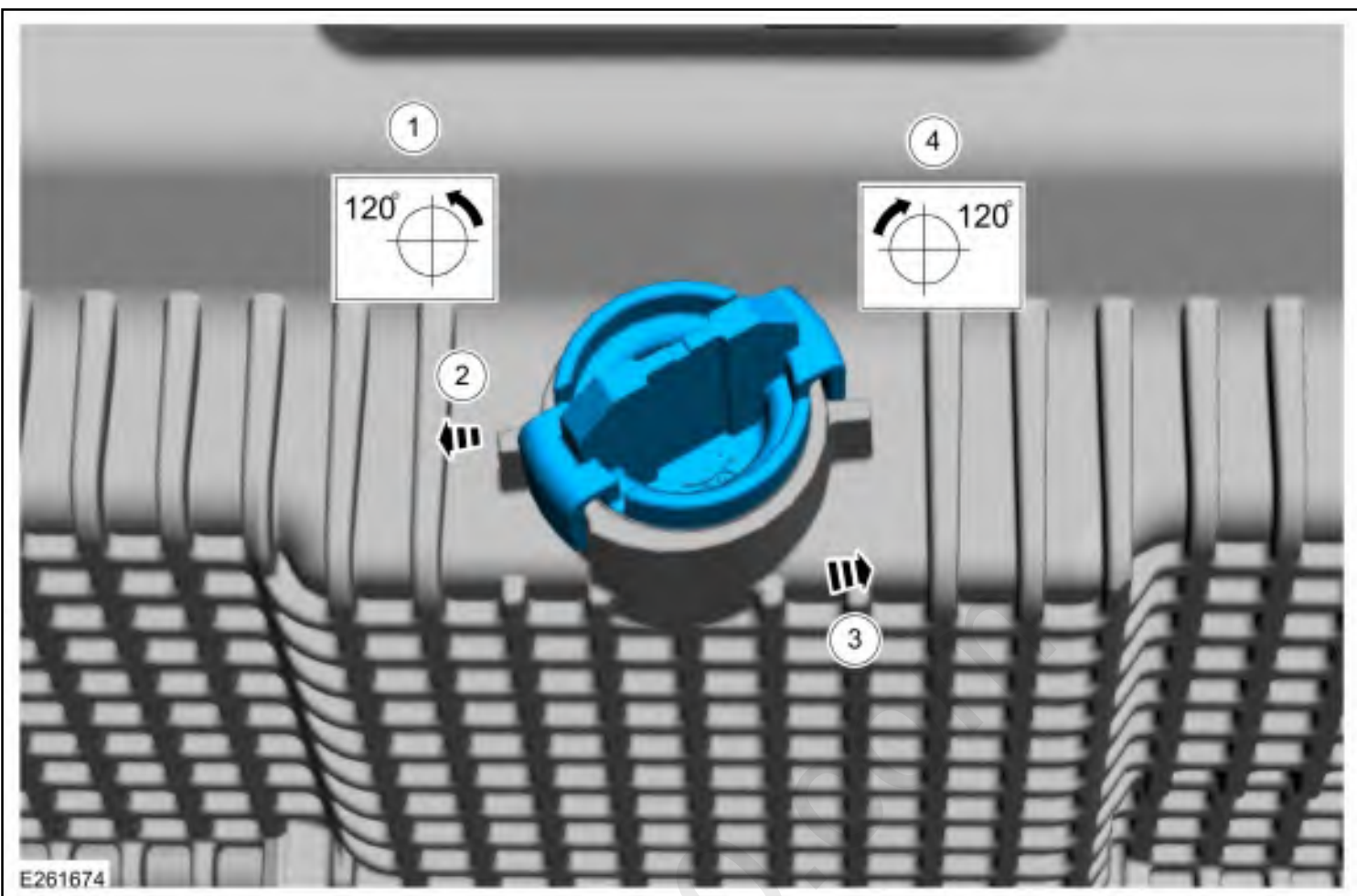
17. Install the following items:

1. Refer to: Valve Cover RH (303-01 Engine - 5.0L 32V Ti-VCT) .
2. Refer to: Valve Cover LH (303-01 Engine - 5.0L 32V Ti-VCT) .
3. Refer to: Cooling Module (303-03 Engine Cooling - 5.0L 32V Ti-VCT) .
4. Refer to: [Degas Bottle](#) (303-03D Engine Cooling - 5.0L 32V Ti-VCT, Removal and Installation).

18. **NOTE:** *The drain plug should be removed and installed by hand, do not use tools.*

1. Turn the oil drain plug by hand counterclockwise 120 degrees.  
Use the General Equipment: Oil Drain Equipment
2. Pull the oil drain plug out of the oil pan.
3. After the oil has drained, push the oil drain plug into the oil pan.
4. **NOTICE: Overtightening will damage the oil drain plug and possibly the oil pan.**

Turn the oil drain plug by hand clockwise 120 degrees.

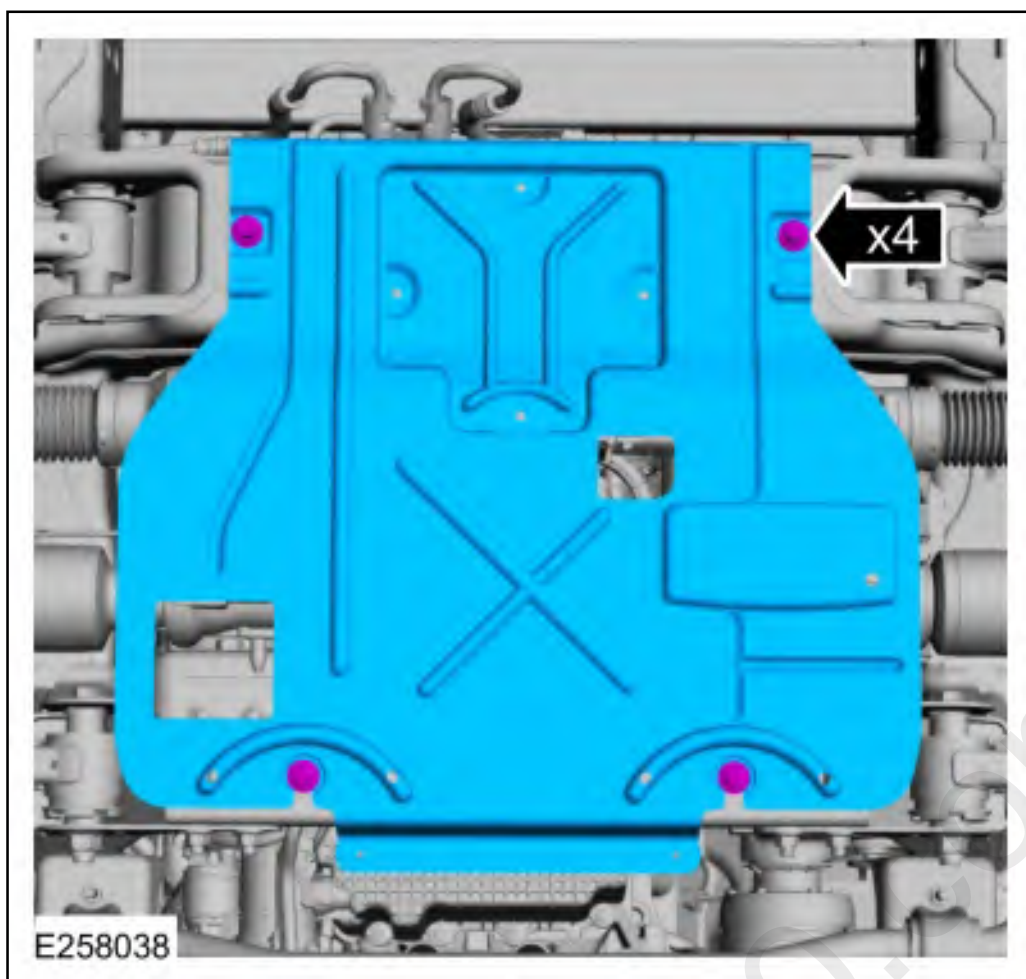


19. **NOTE:** *If equipped.*

Install the skid plate and bolts.

*Torque:* 30 lb.ft (40 Nm)

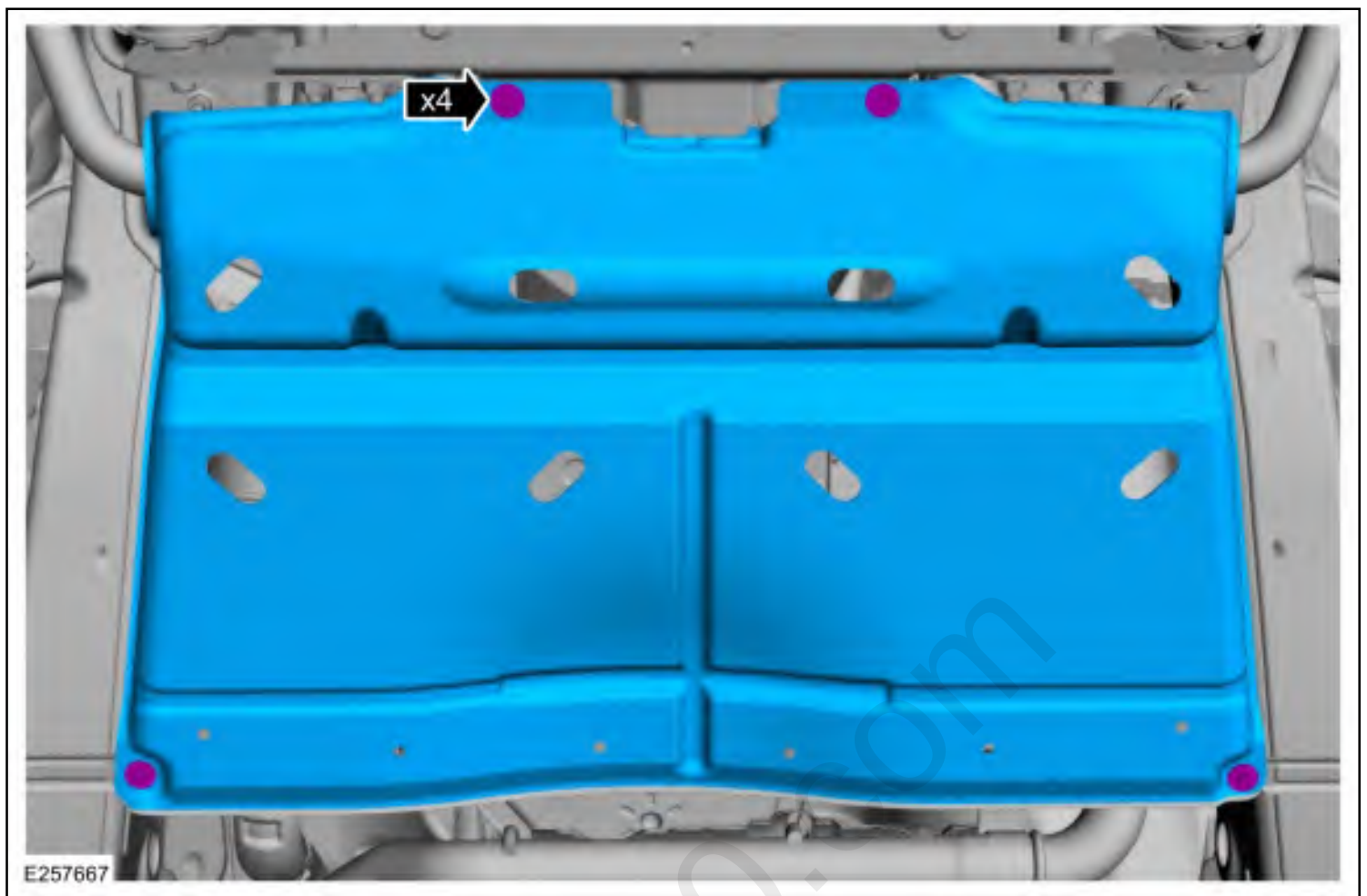




20. **NOTE:** *If equipped.*

Install the underbody shield and the bolts.

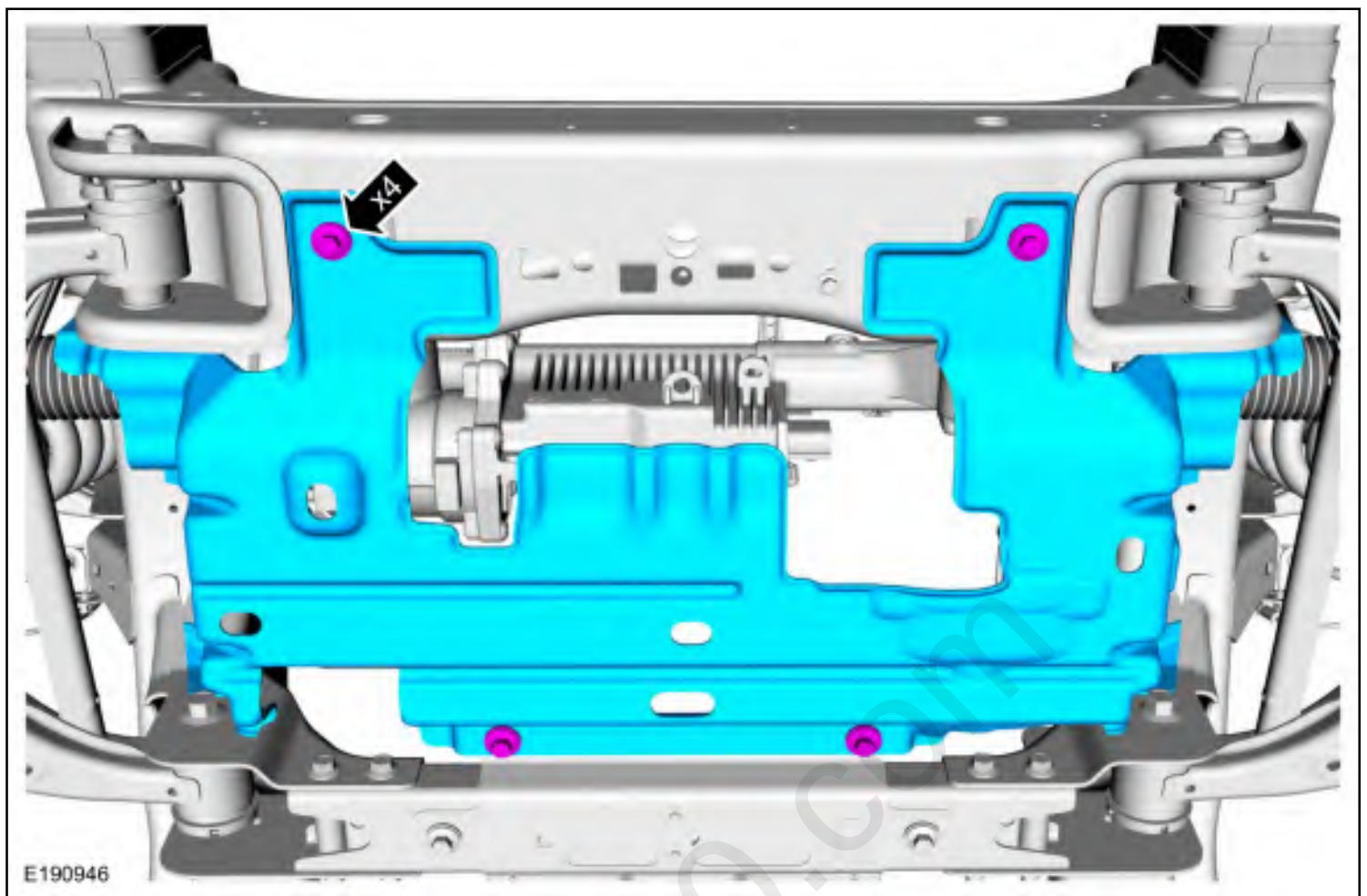
*Torque:* 71 lb.in (8 Nm)



21. **NOTE:** *If equipped.*

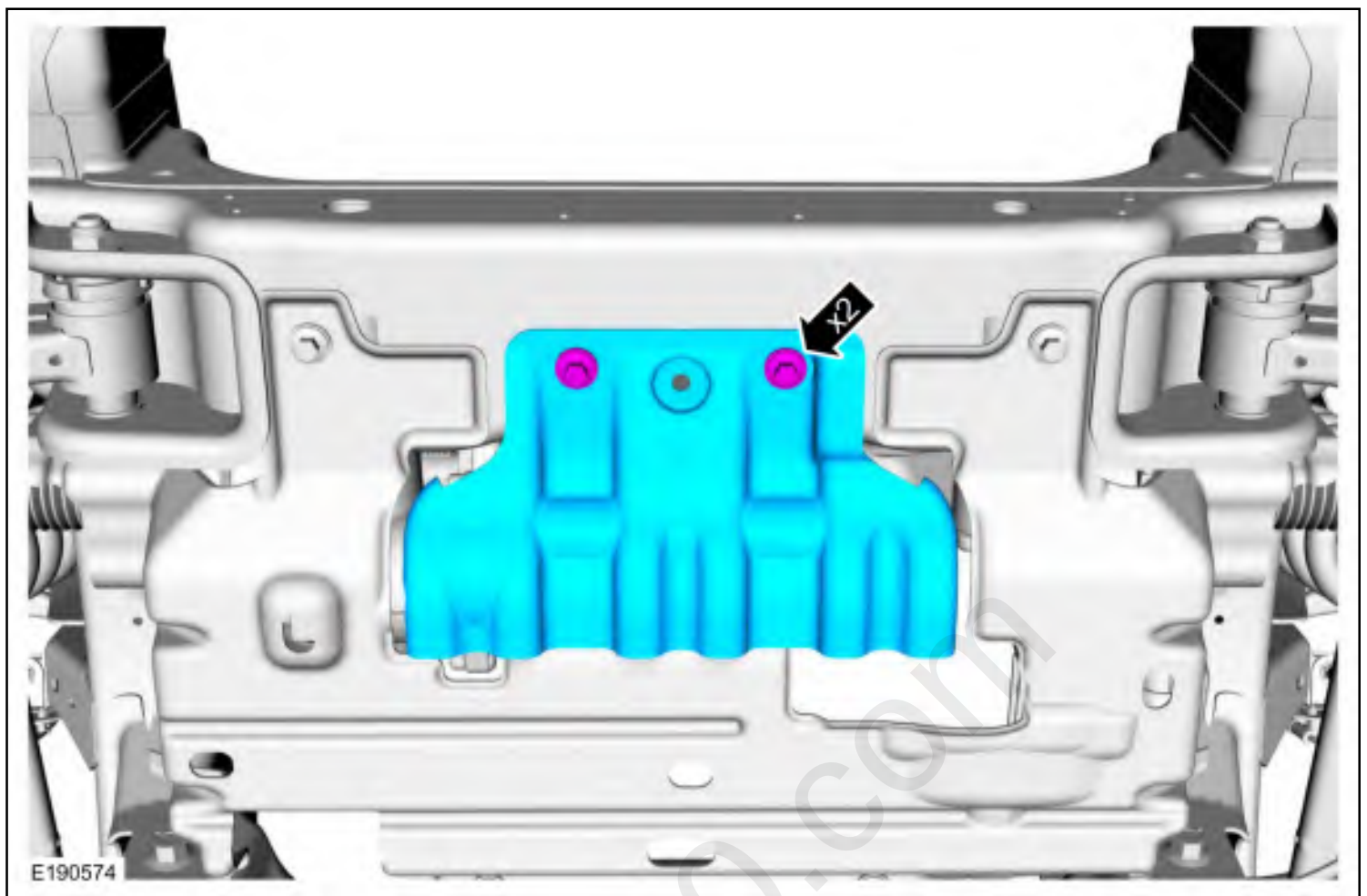
Install the underbody shield and fasteners.

*Torque:* 30 lb.ft (40 Nm)

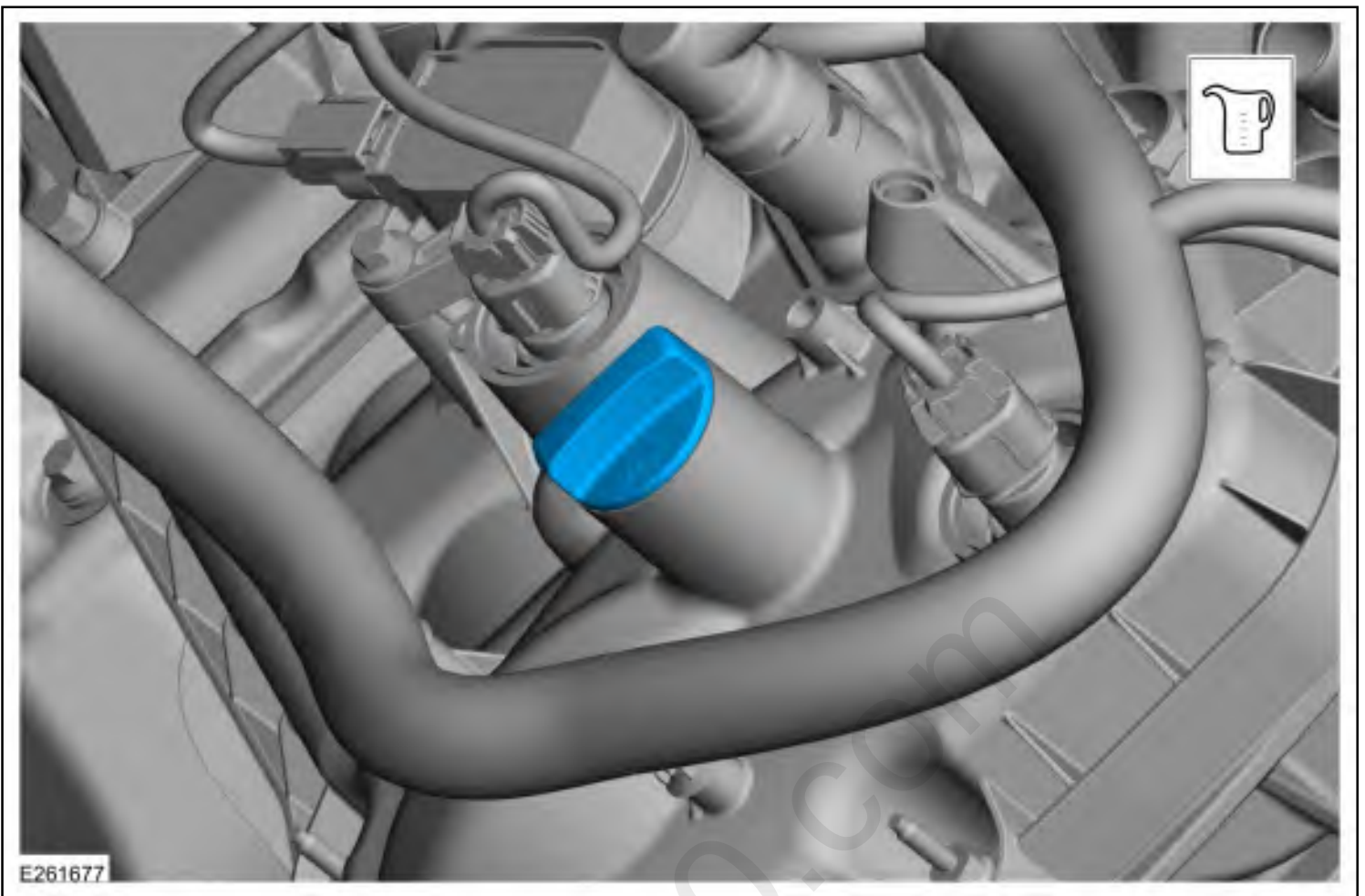


22. **NOTE:** *If equipped.*

Install the skid plate and bolts.  
Torque: 30 lb.ft (40 Nm)



23. Fill the engine with clean engine oil.  
Refer to: [Specifications](#) (303-01D Engine - 5.0L 32V Ti-VCT, Specifications).

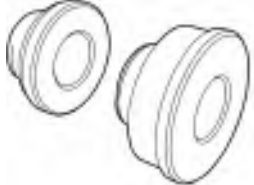


24. Connect the battery ground cable.  
Refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables) .
25. Fill and bleed the engine cooling system.  
Refer to: Cooling System Draining, Vacuum Filling and Bleeding (303-03 Engine Cooling - 5.0L 32V Ti-VCT) .
26. Use the Powertrain Control Module (PCM) Misfire Monitor Profile Correction routine in the diagnostic scan tool.



## Valve Cover LH

### Special Tool(s) / General Equipment

|                                                                                               |                                                                                                  |
|-----------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
| <br>E234304   | 205-142 (T80T-4000-J)<br>Installer, Differential Bearing Cone                                    |
| <br>E133913  | 205-153 (T80T-4000-W)<br>Handle                                                                  |
| <br>E175042 | 303-1247<br>VCT Spark Plug Tube Seal Remover and Installer<br>TKIT-2006UF-FLM<br>TKIT-2006UF-ROW |
| Plastic Scraper                                                                               |                                                                                                  |

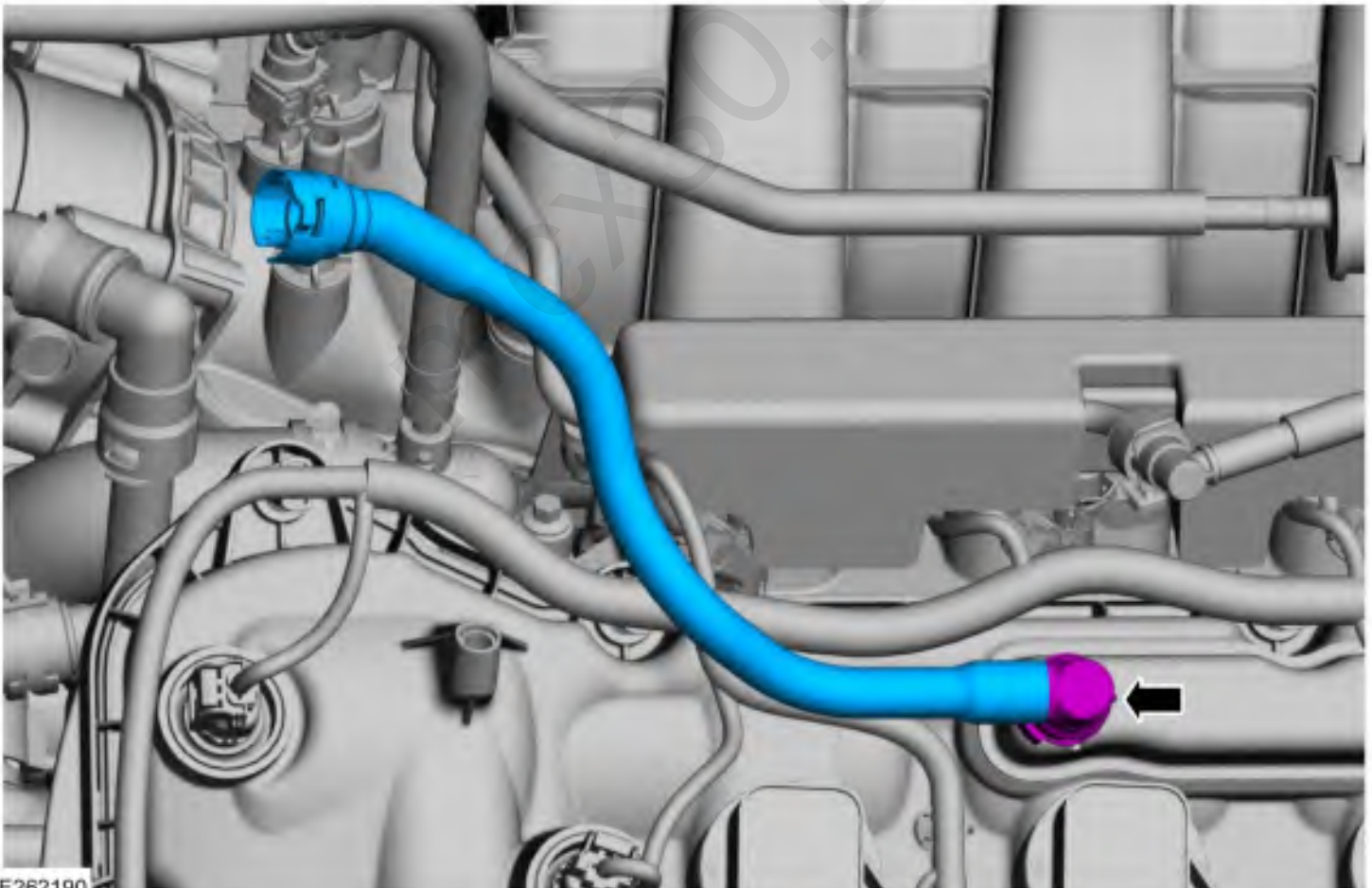
### Materials

| Name                                             | Specification |
|--------------------------------------------------|---------------|
| Motorcraft® Silicone Gasket Remover<br>ZC-30-A   | -             |
| Motorcraft® Metal Surface Prep Wipes<br>ZC-31-B  | -             |
| Motorcraft® Silicone Gasket and Sealant<br>TA-30 | WSE-M4G323-A4 |
|                                                  |               |

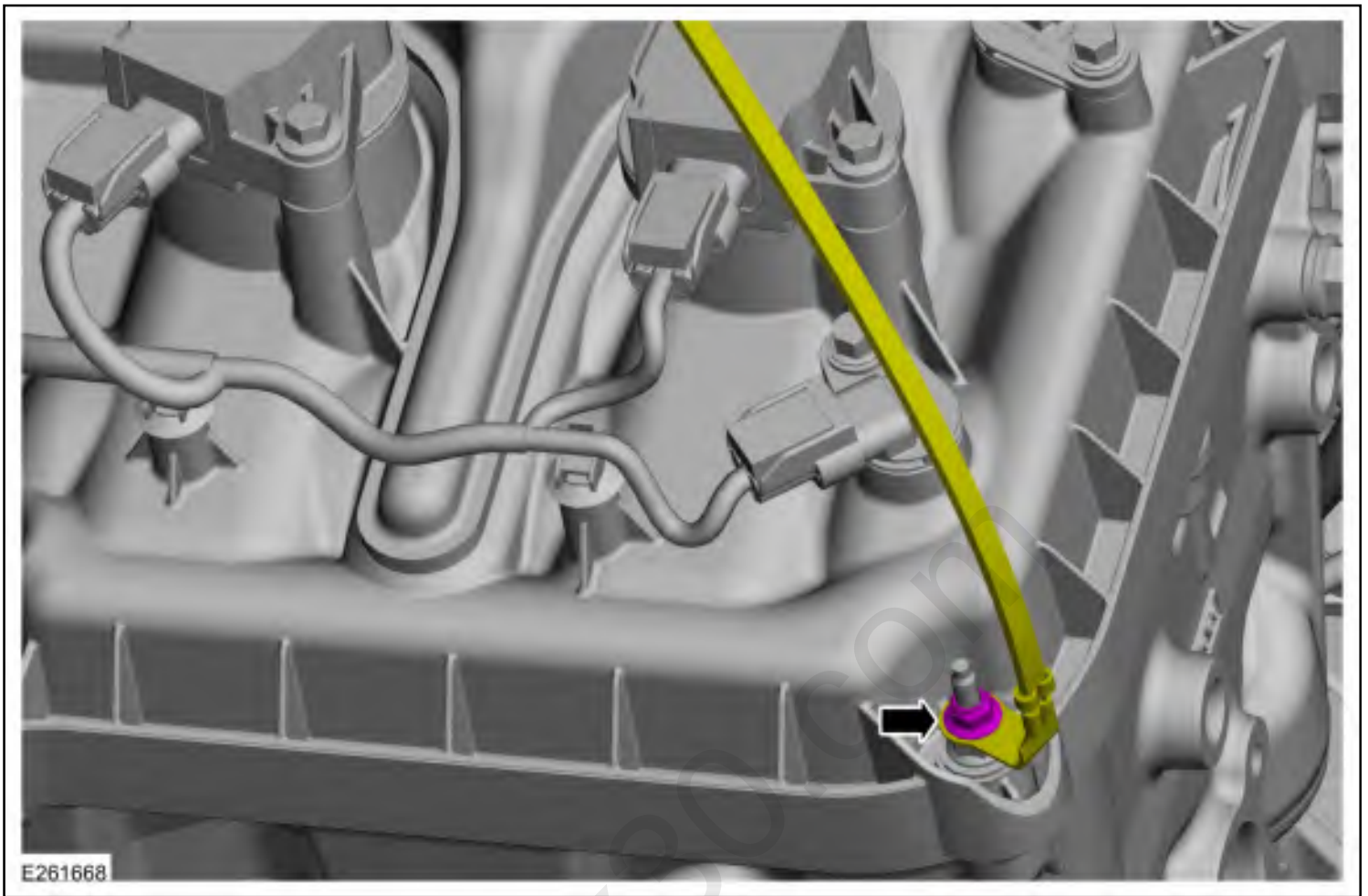
## Removal

**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.

1. Remove the following items:
  1. Refer to: [Air Cleaner Outlet Pipe](#) (303-12D Intake Air Distribution and Filtering - 5.0L 32V Ti-VCT, Removal and Installation).
  2. Refer to: [Air Cleaner](#) (303-12D Intake Air Distribution and Filtering - 5.0L 32V Ti-VCT, Removal and Installation).
2. Disconnect the quick release coupling and remove the PCV tube.  
Refer to: [Quick Release Coupling](#) (310-00D Fuel System - General Information - 5.0L 32V Ti-VCT, General Procedures).



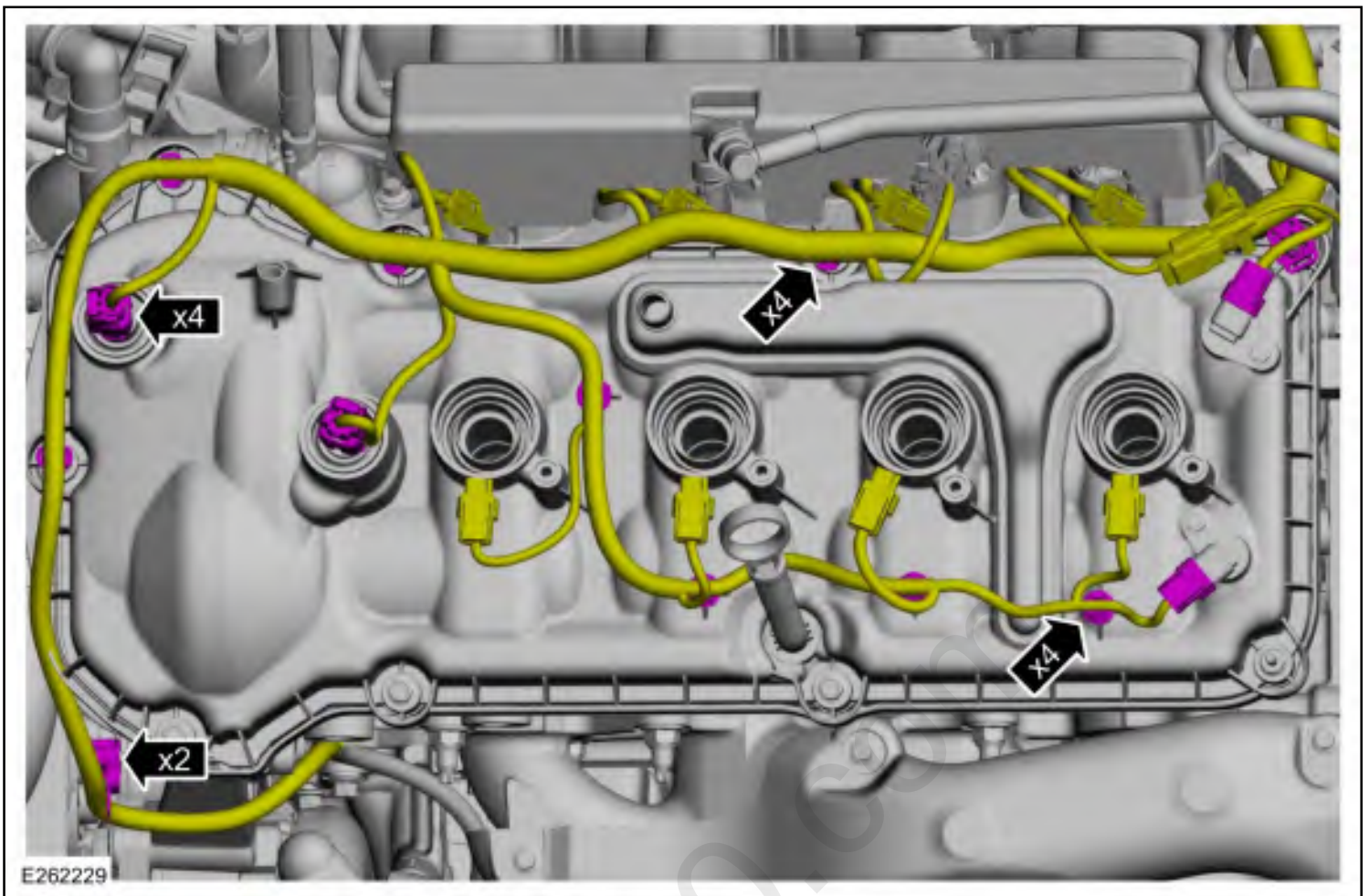
3. Remove the nut and ground wire.



4. Remove the LH ignition coils.

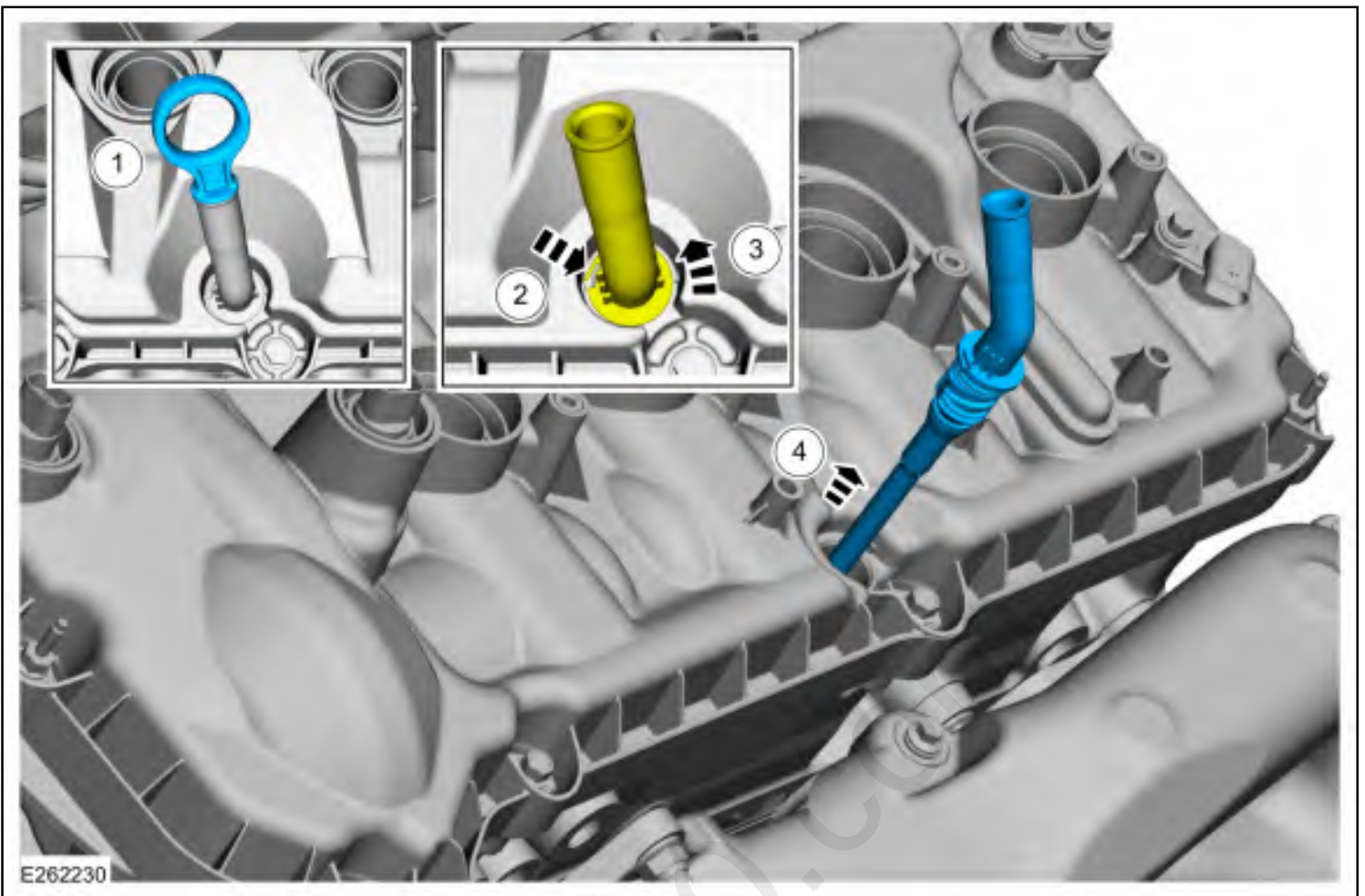
Refer to: Ignition Coil-On-Plug (303-07 Engine Ignition - 5.0L 32V Ti-VCT) .

- Disconnect the engine wiring harness electrical connectors.
- Detach the wiring harness retainers.



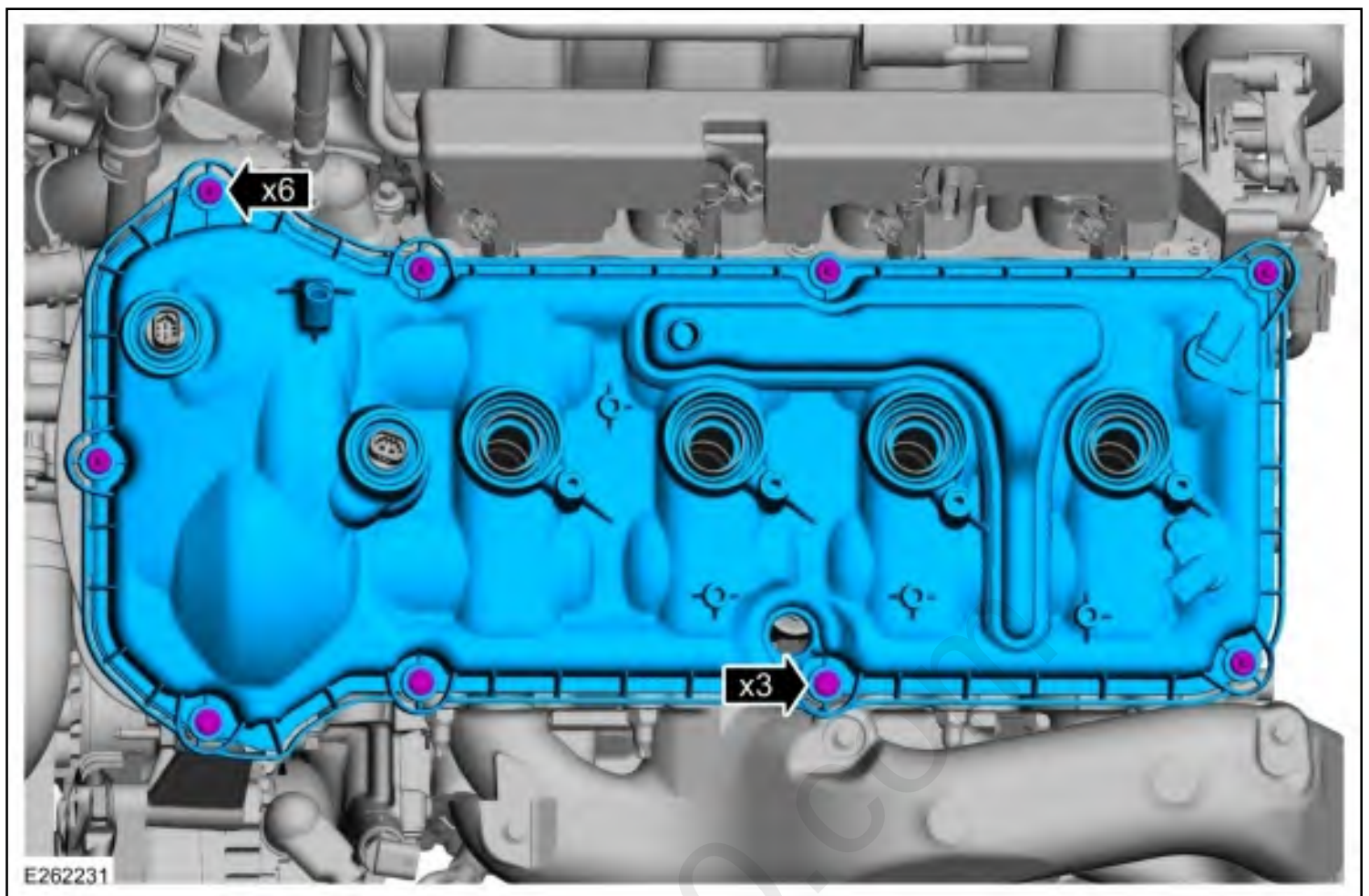
1. Remove the oil level indicator.
2. Depress the tab.
3. Rotate the oil level indicator tube counterclockwise.
4. Pull the oil level indicator tube from the engine.





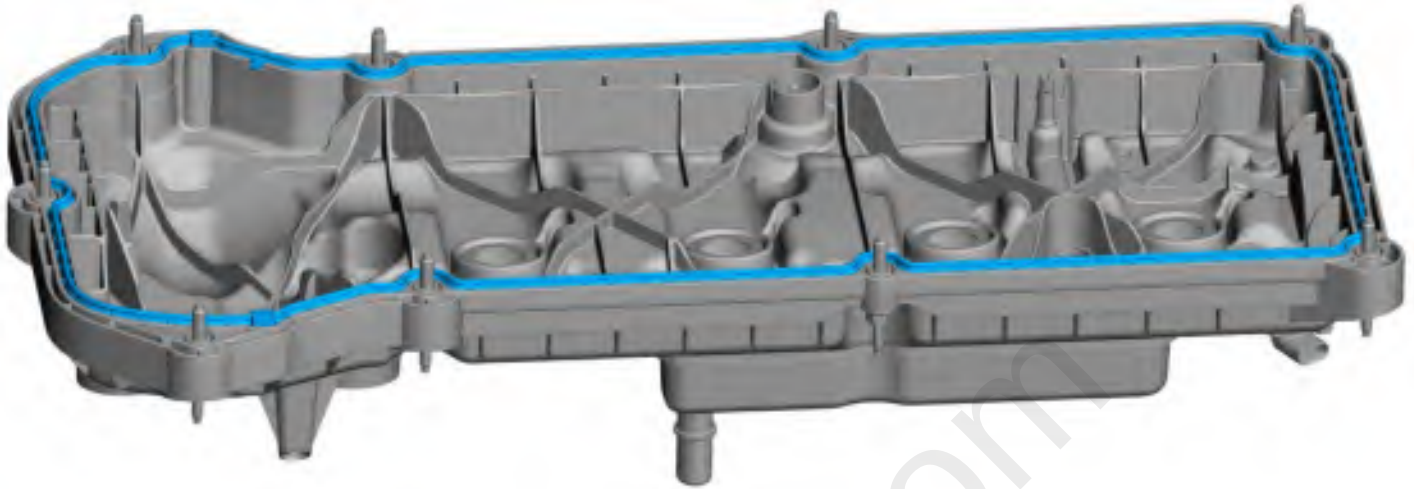
7. Loosen the fasteners and remove the valve cover.





8. **NOTE:** Clean the valve cover gasket groove with soap and water or a suitable solvent.

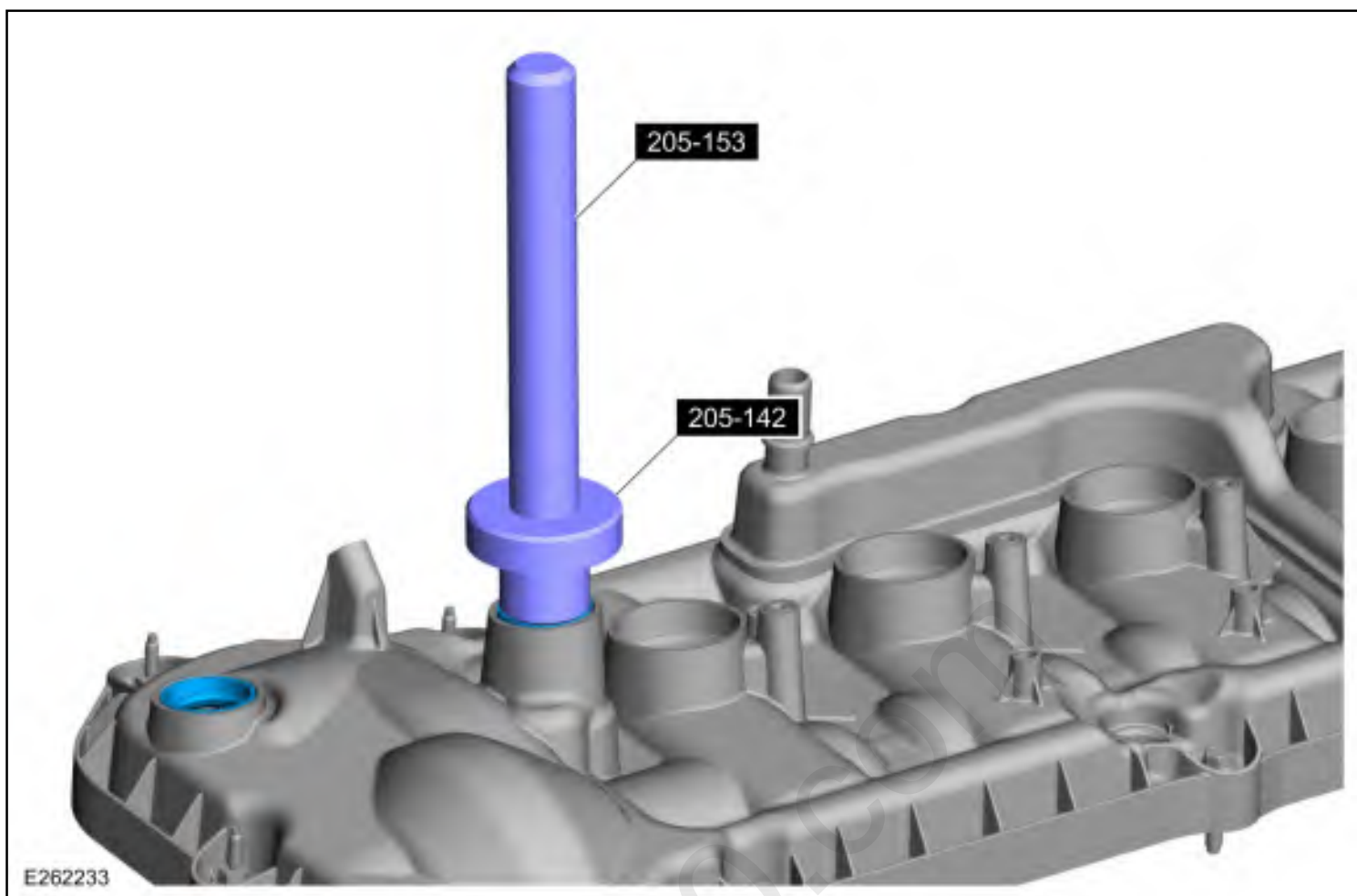
Remove and discard the gasket.



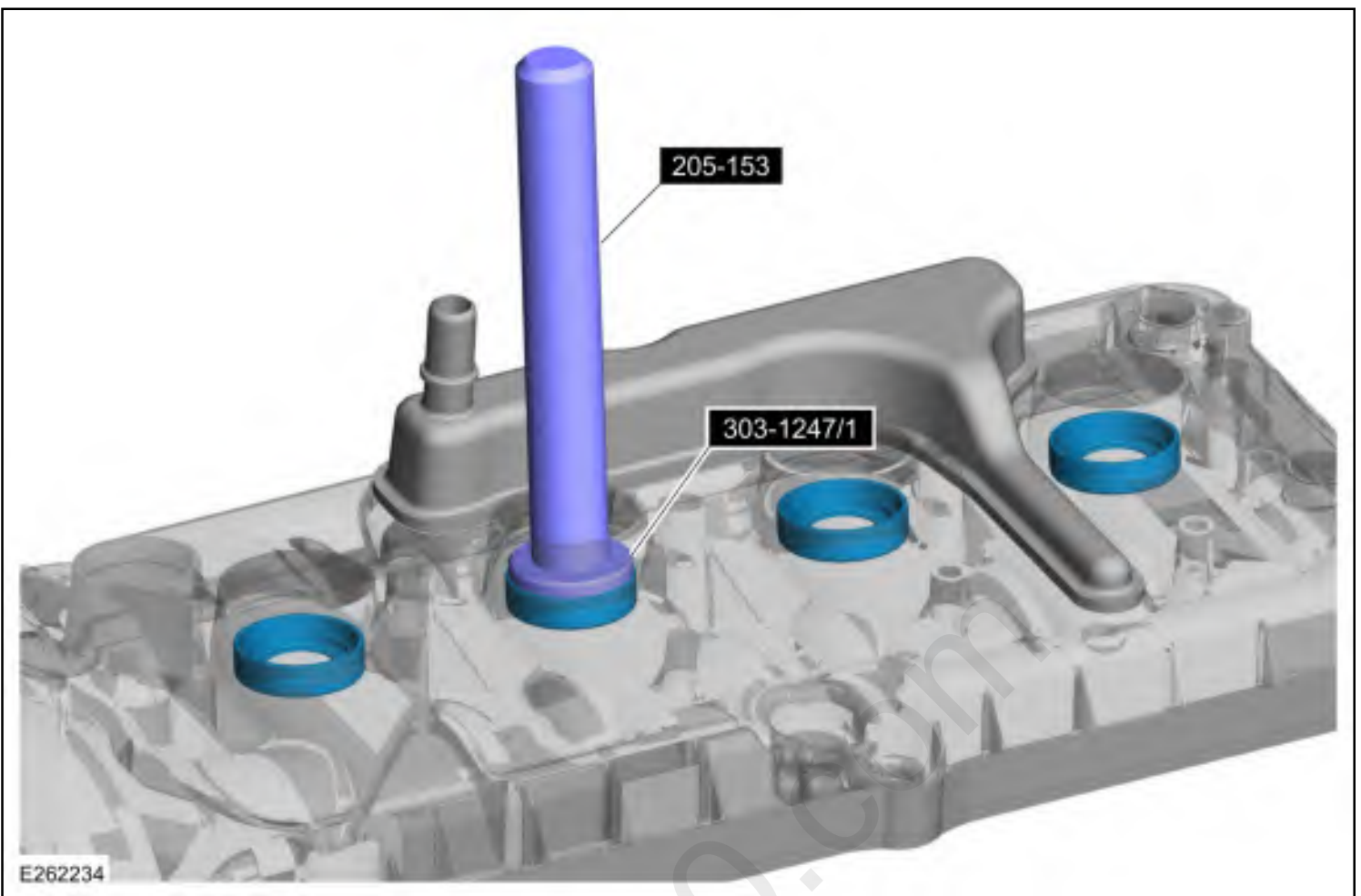
E262232



9. Inspect the VCT variable force solenoid seals. Remove any damaged seals using the special tools. Use Special Service Tool: 205-153 (T80T-4000-W) Handle. , 205-142 (T80T-4000-J) Installer, Differential Bearing Cone.



10. Inspect the spark plug seals. Remove any damaged seals using the special tools.  
Use Special Service Tool: 205-153 (T80T-4000-W) Handle. , 303-1247 VCT Spark Plug Tube Seal Remover and Installer.



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

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

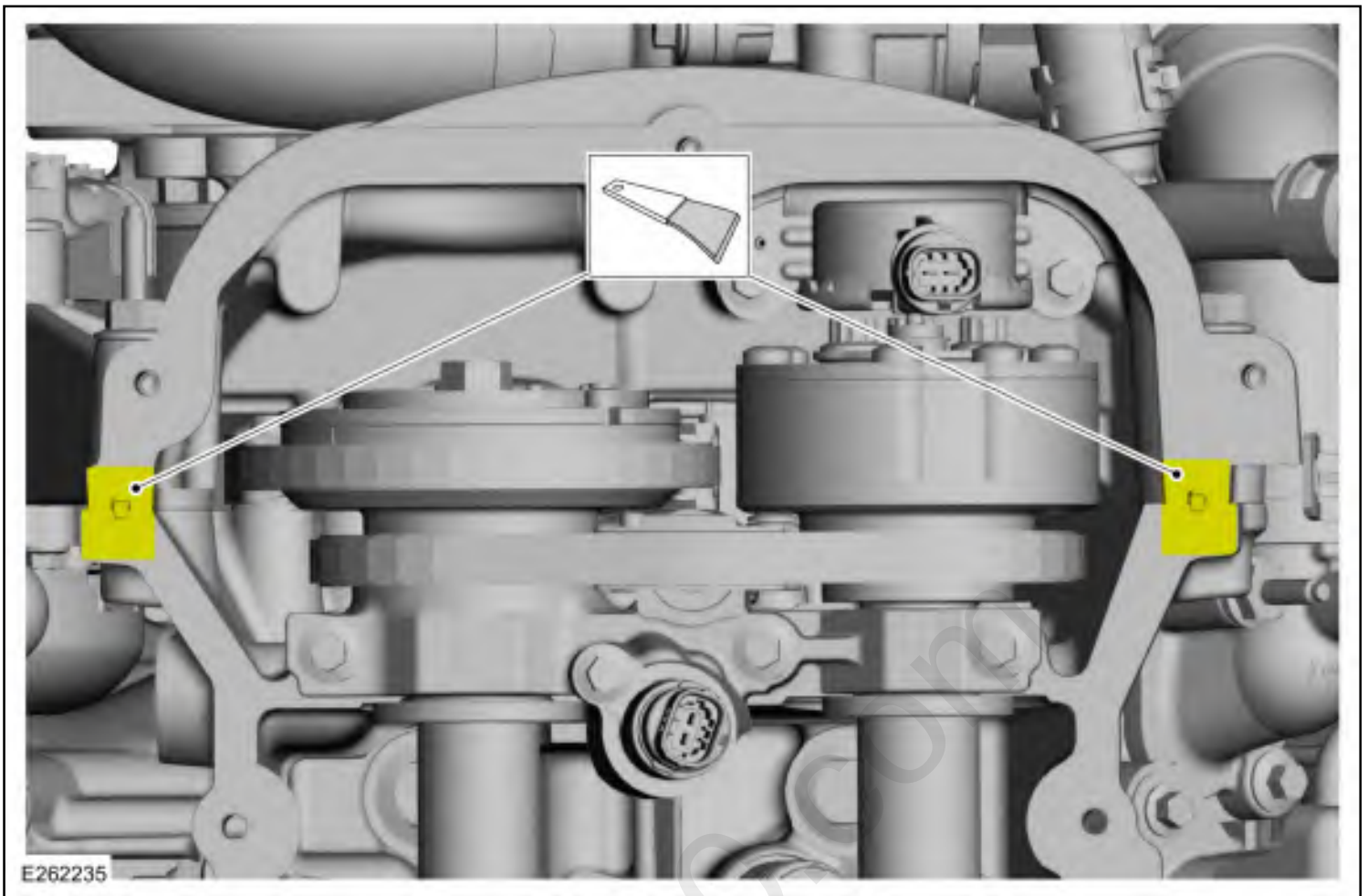
Refer to: [RTV Sealing Surface Cleaning and Preparation](#) (303-00 Engine System - General Information, General Procedures).

Use the General Equipment: Plastic Scraper

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

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

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



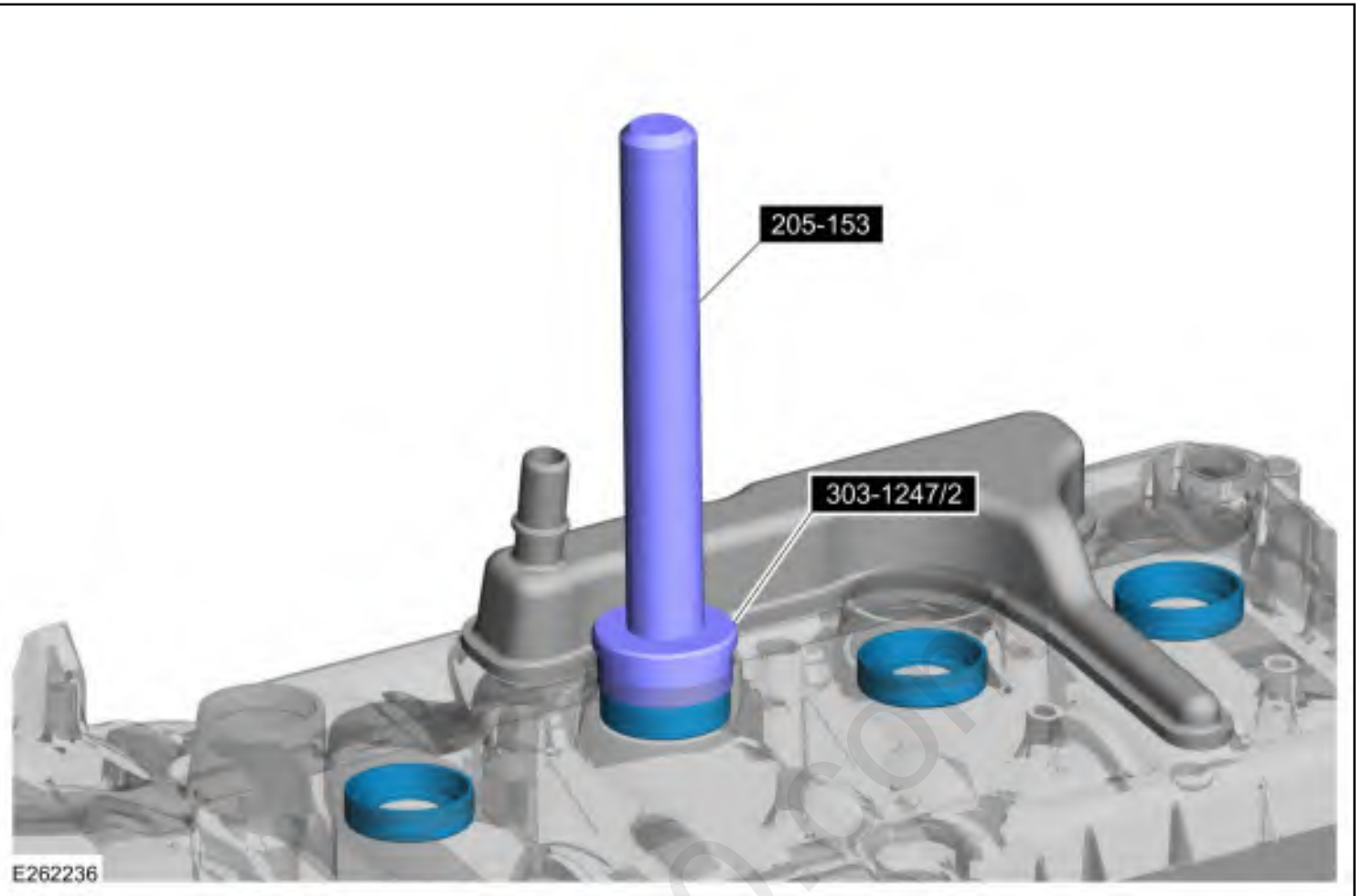
## Installation

1. **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.

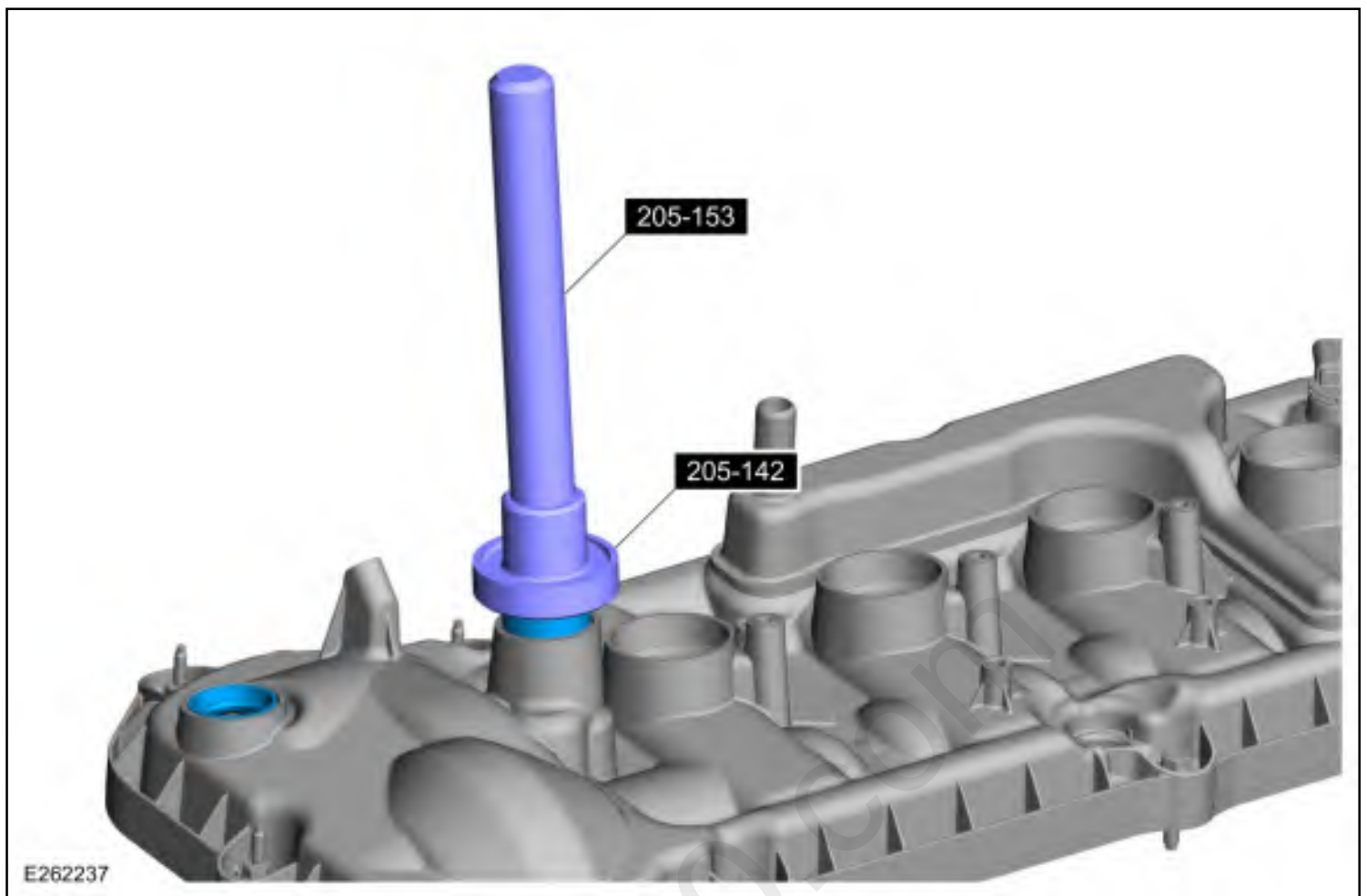




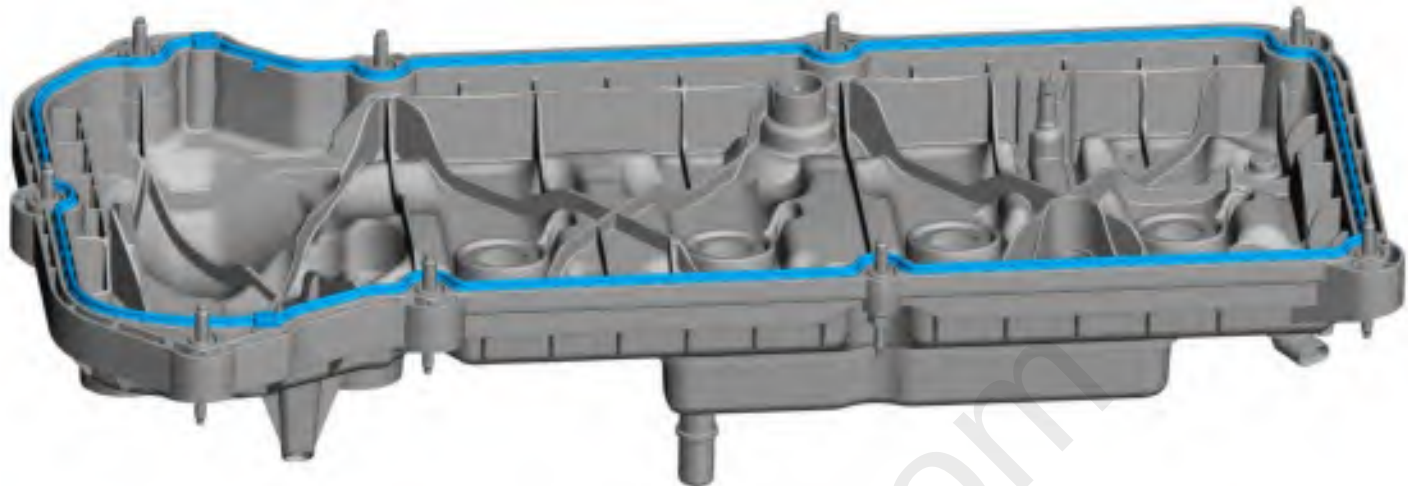
2. **NOTE:** *Installation of new seals is only required if damaged seals were removed.*

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.



3. Install a new gasket.



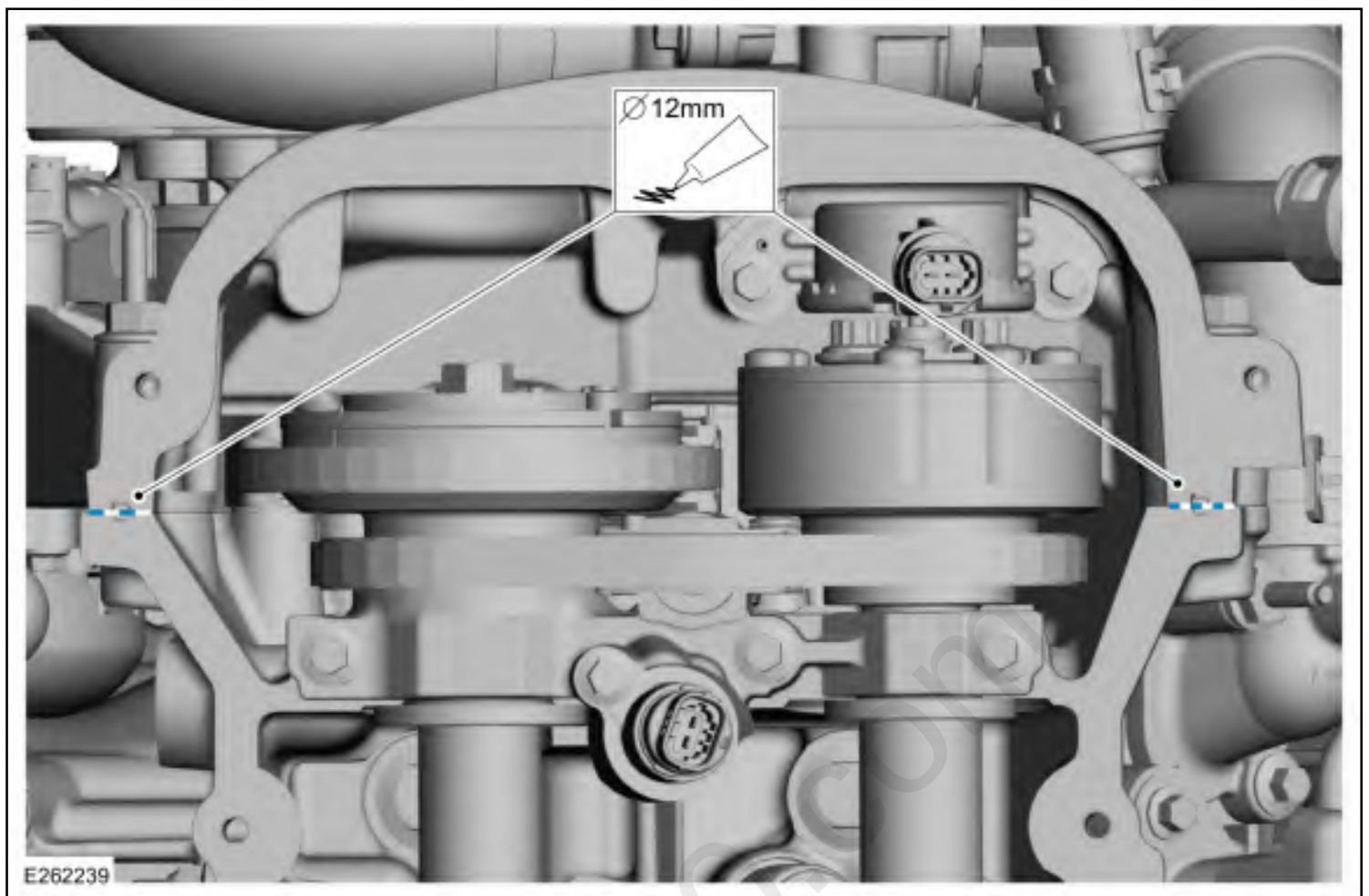
E262238



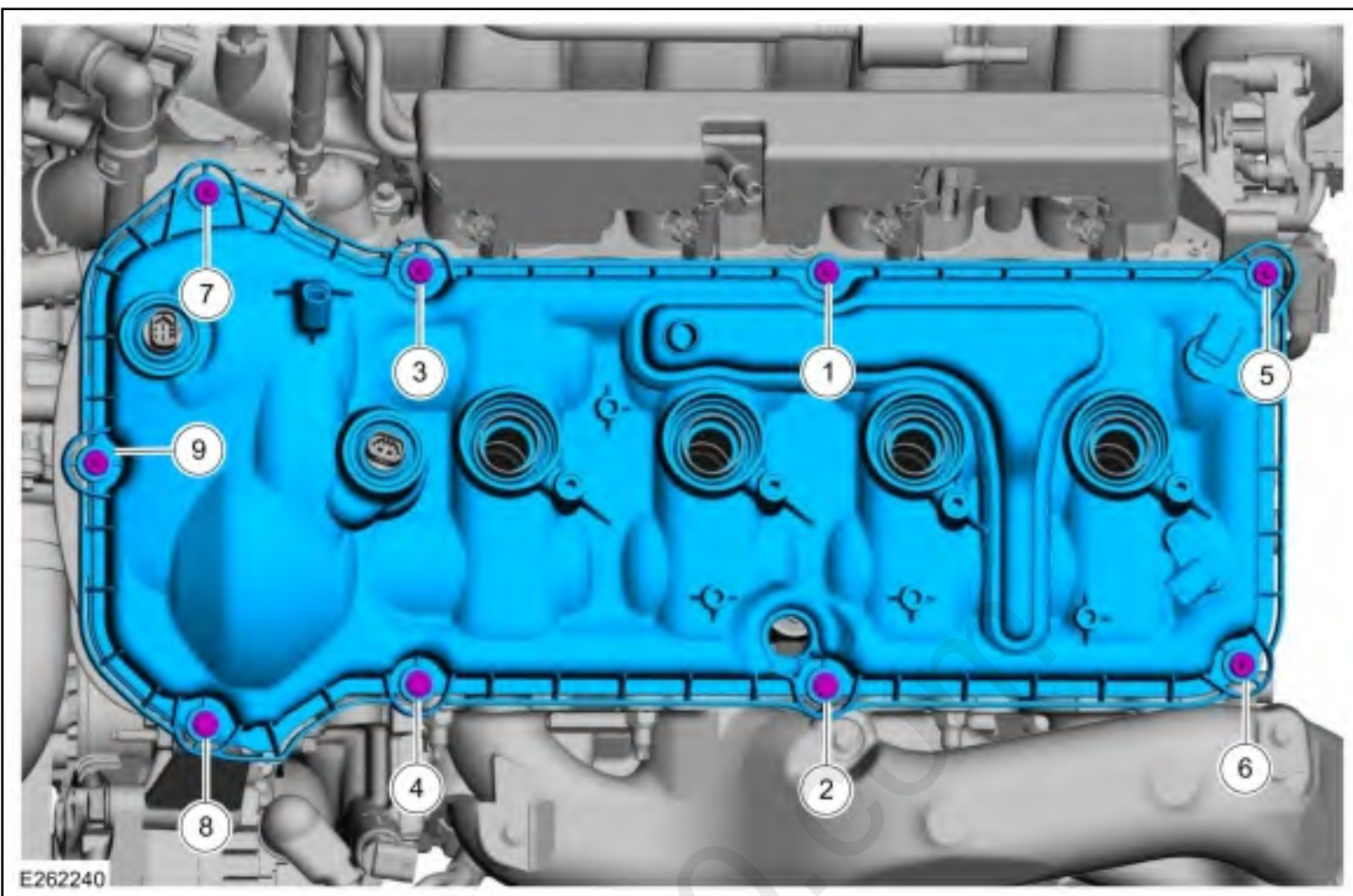
4. **NOTICE:** If the valve cover is not installed and the fasteners tightened within 5 minutes, the sealant must be removed and the sealing area cleaned.

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)

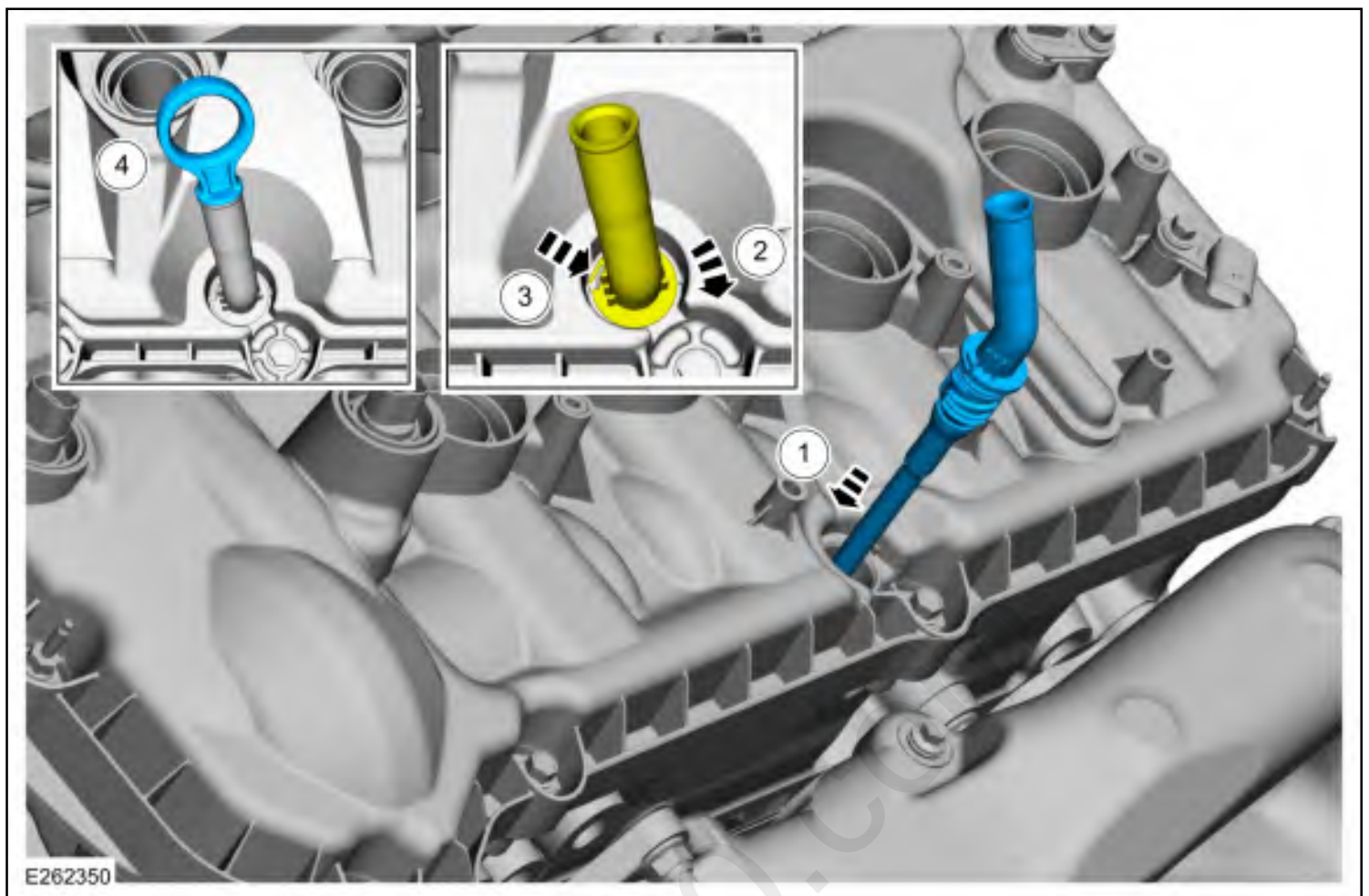


5. Install the valve cover and tighten the bolts.  
*Torque: 89 lb.in (10 Nm)*

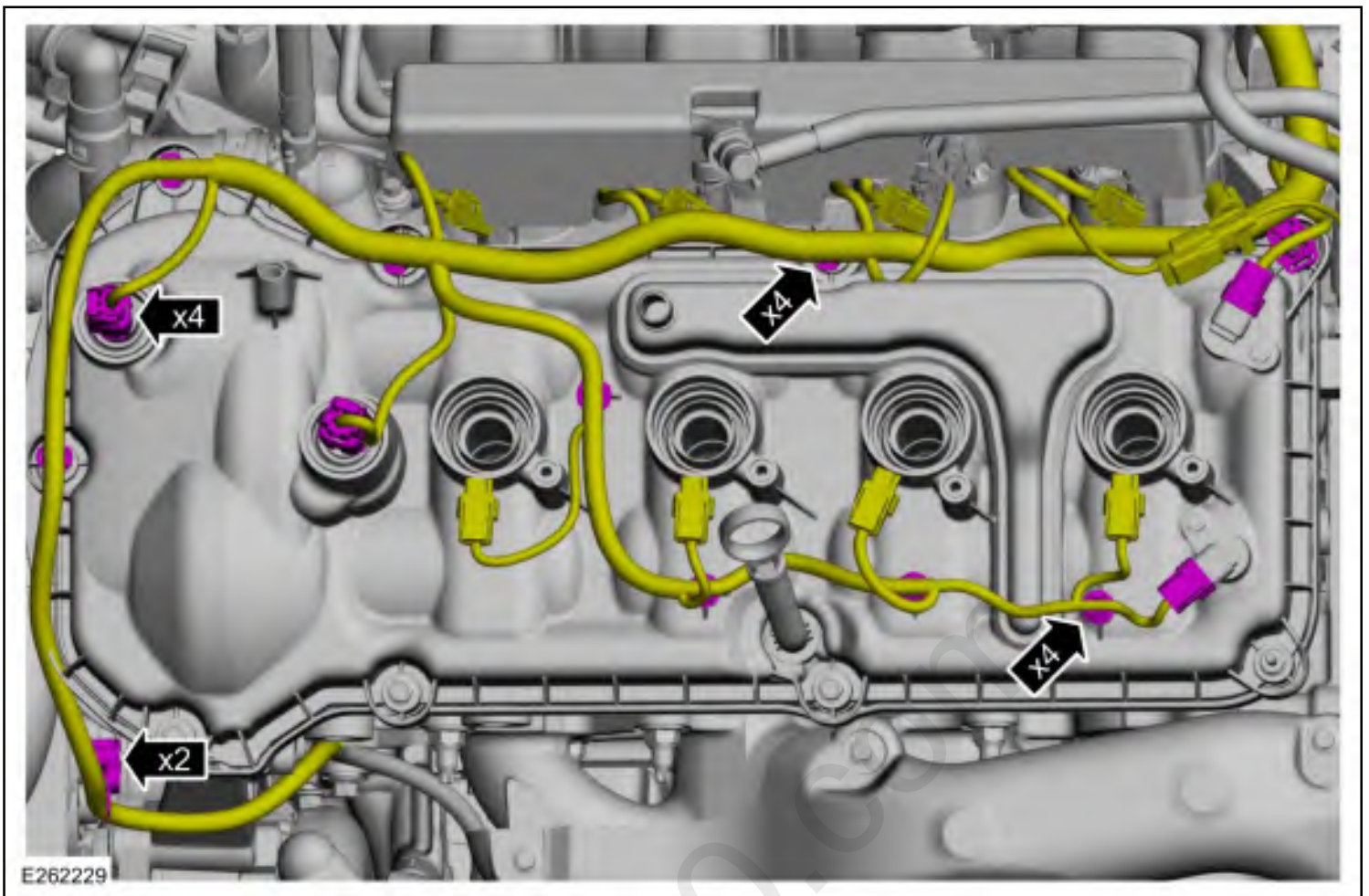


1. Push the oil level indicator tube into the engine.
2. Rotate the oil level indicator tube clockwise.
3. Verify the tab is locked in place.
4. Install the oil level indicator.

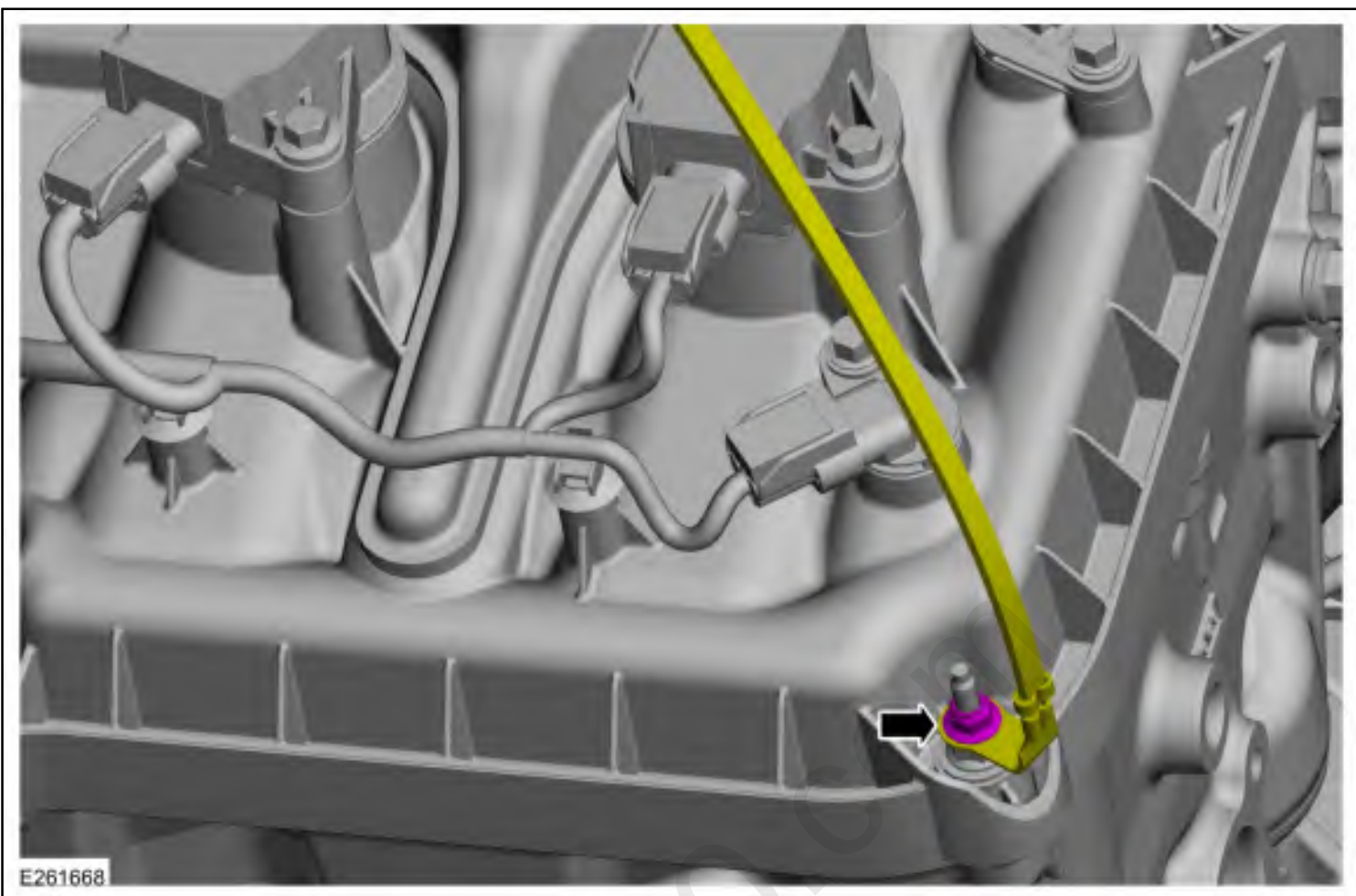




- Connect the engine wiring harness electrical connectors.
- Attach the wiring harness retainers.



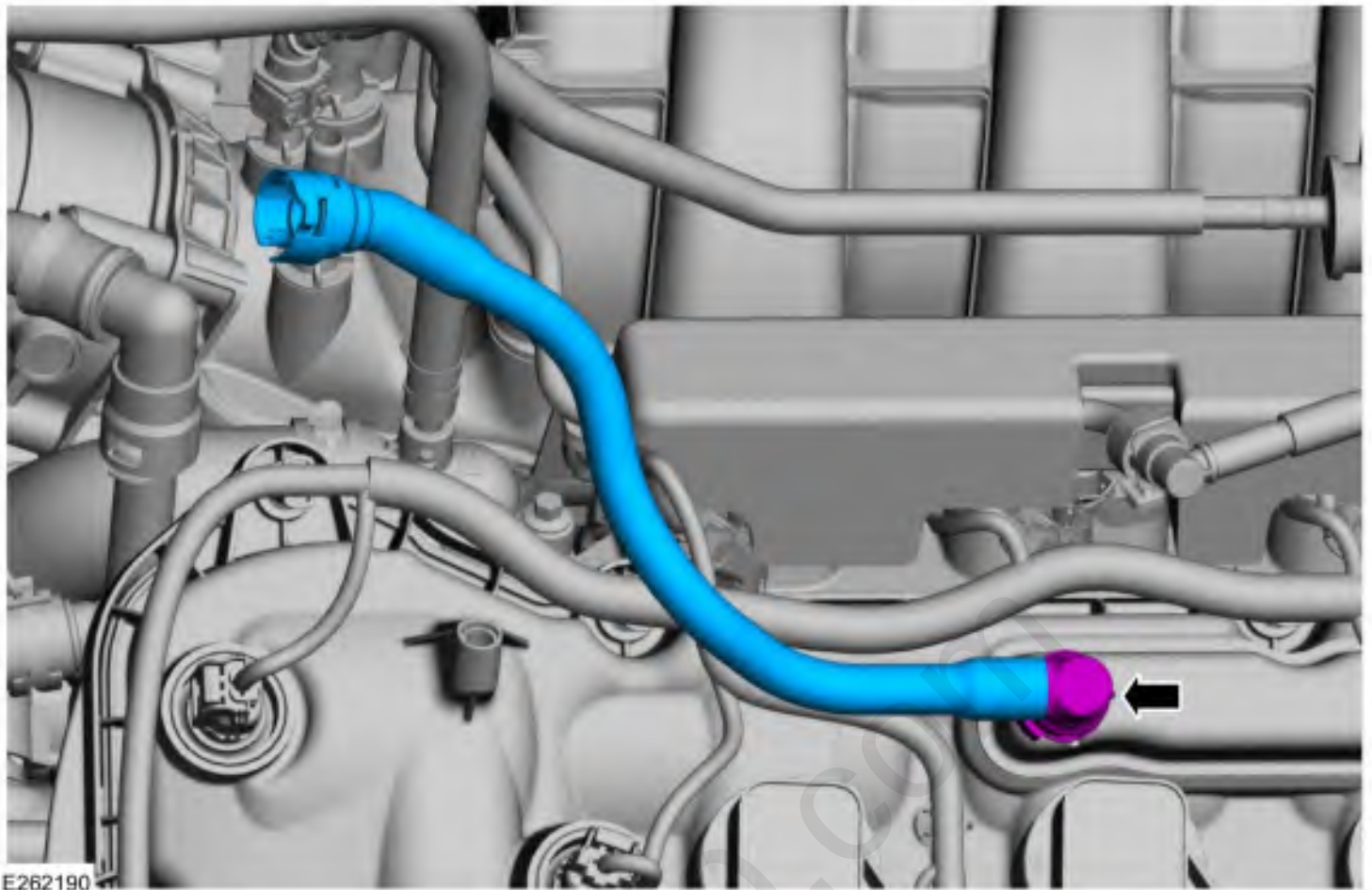
8. Install the LH ignition coils.  
Refer to: Ignition Coil-On-Plug (303-07 Engine Ignition - 5.0L 32V Ti-VCT) .
9. Install the ground wire and nut.  
*Torque: 53 lb.in (6 Nm)*



10. Position the PCV 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).



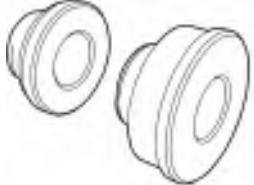


11. Install the following items:

1. Refer to: [Air Cleaner](#) (303-12D Intake Air Distribution and Filtering - 5.0L 32V Ti-VCT, Removal and Installation).
2. Refer to: [Air Cleaner Outlet Pipe](#) (303-12D Intake Air Distribution and Filtering - 5.0L 32V Ti-VCT, Removal and Installation).

## Valve Cover RH

### Special Tool(s) / General Equipment

|                                                                                               |                                                                                                  |
|-----------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
| <br>E234304   | 205-142 (T80T-4000-J)<br>Installer, Differential Bearing Cone                                    |
| <br>E133913  | 205-153 (T80T-4000-W)<br>Handle                                                                  |
| <br>E175042 | 303-1247<br>VCT Spark Plug Tube Seal Remover and Installer<br>TKIT-2006UF-FLM<br>TKIT-2006UF-ROW |
| Plastic Scraper                                                                               |                                                                                                  |

### Materials

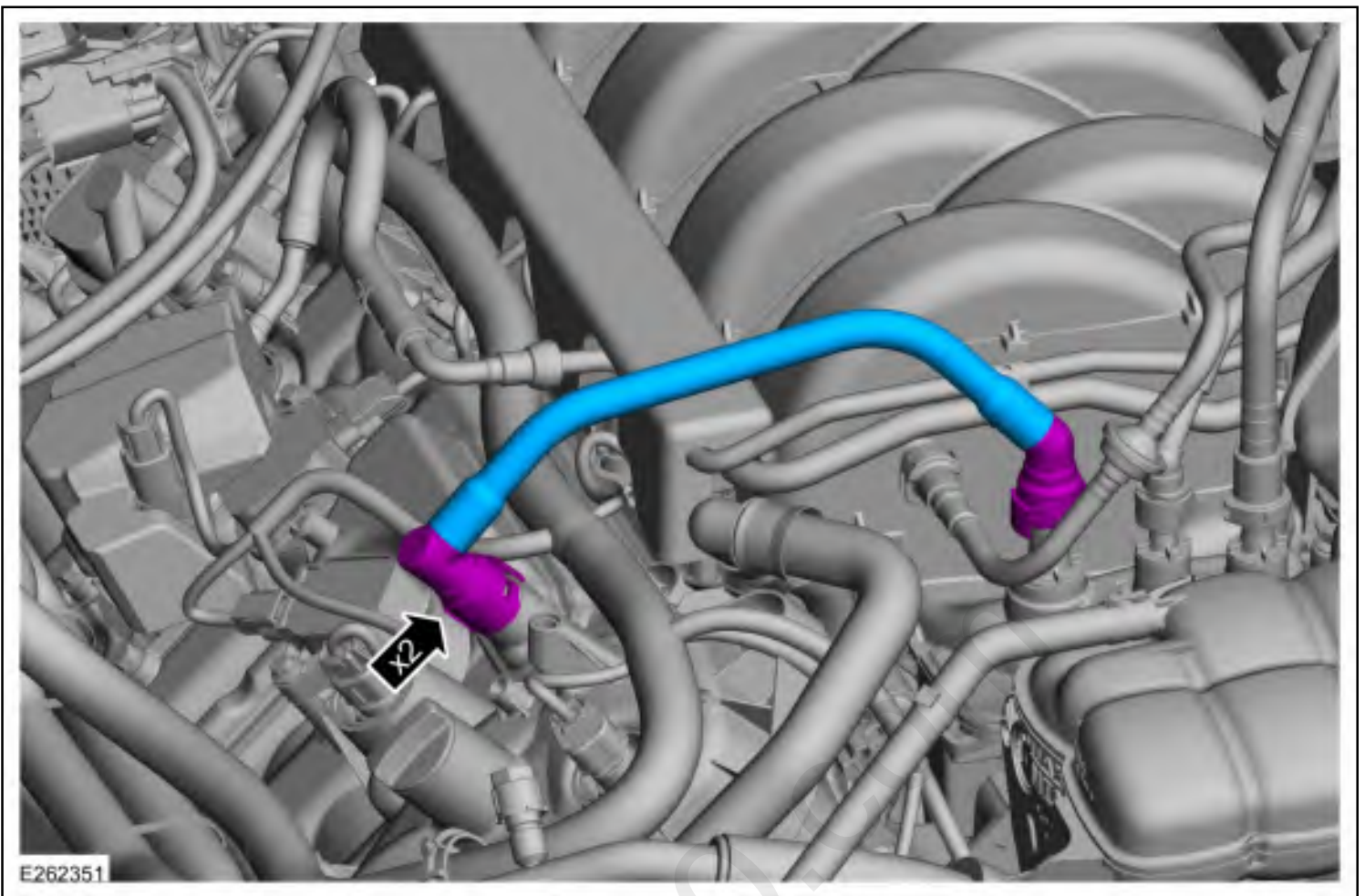
| Name                                             | Specification |
|--------------------------------------------------|---------------|
| Motorcraft® Silicone Gasket Remover<br>ZC-30-A   | -             |
| Motorcraft® Metal Surface Prep Wipes<br>ZC-31-B  | -             |
| Motorcraft® Silicone Gasket and Sealant<br>TA-30 | WSE-M4G323-A4 |
|                                                  |               |



## Removal

**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.

1. With the vehicle in NEUTRAL, position it on a hoist.  
Refer to: [Jacking and Lifting - Overview](#) (100-02 Jacking and Lifting, Description and Operation).
2. Release the fuel system pressure.  
Refer to: [Fuel System Pressure Release](#) (310-00D Fuel System - General Information - 5.0L 32V Ti-VCT, General Procedures).
3. Disconnect the battery ground cable.  
Refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables) .
4. Drain the engine cooling system.  
Refer to: Cooling System Draining, Vacuum Filling and Bleeding (303-03 Engine Cooling - 5.0L 32V Ti-VCT) .
5. Disconnect the quick release couplings and remove the PCV tube.  
Refer to: [Quick Release Coupling](#) (310-00D Fuel System - General Information - 5.0L 32V Ti-VCT, General Procedures).



6. Remove the following items:

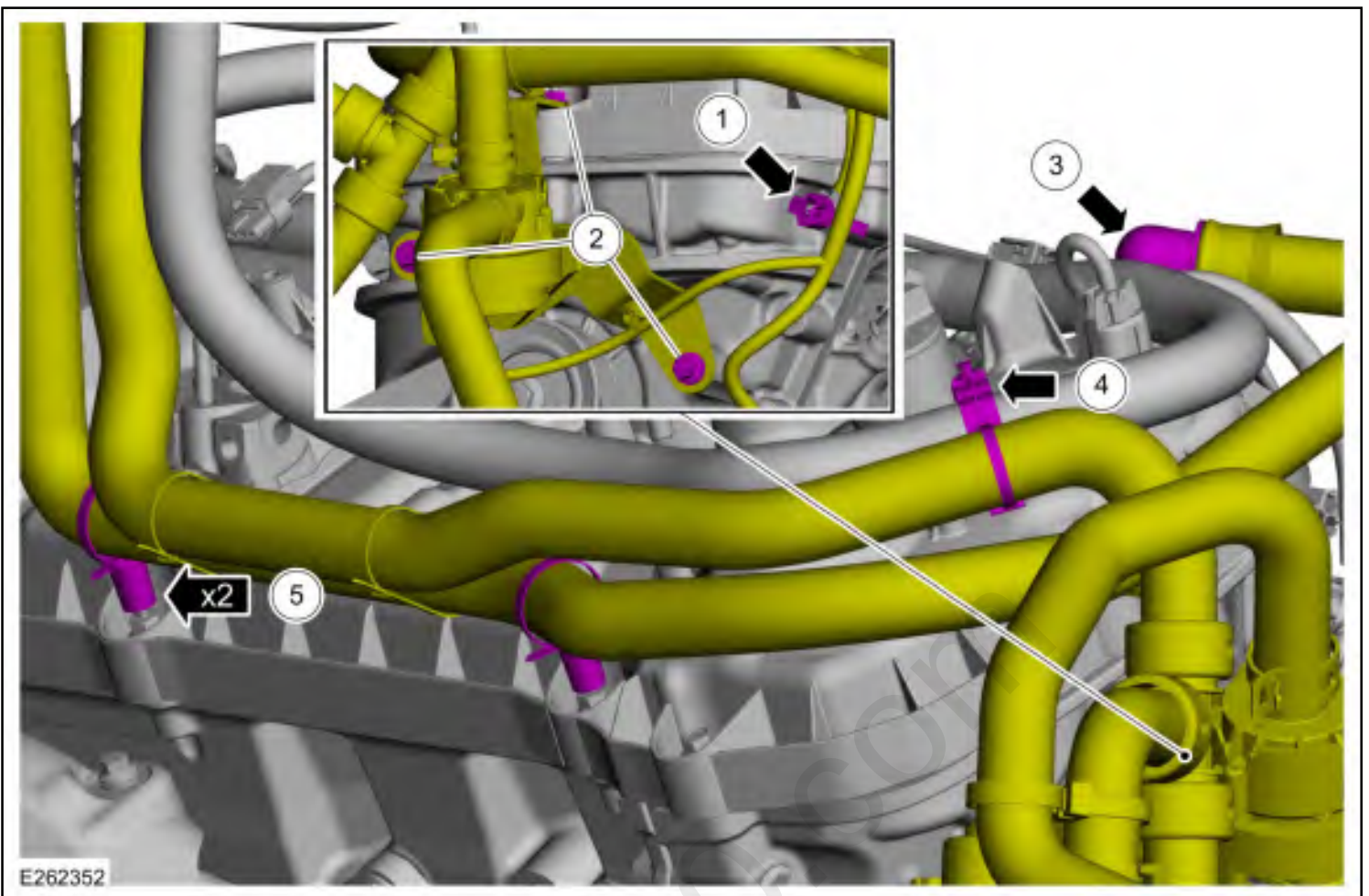
1. High pressure fuel pump.

Refer to: [High-Pressure Fuel Pump](#) (303-04D Fuel Charging and Controls - 5.0L 32V Ti-VCT, Removal and Installation).

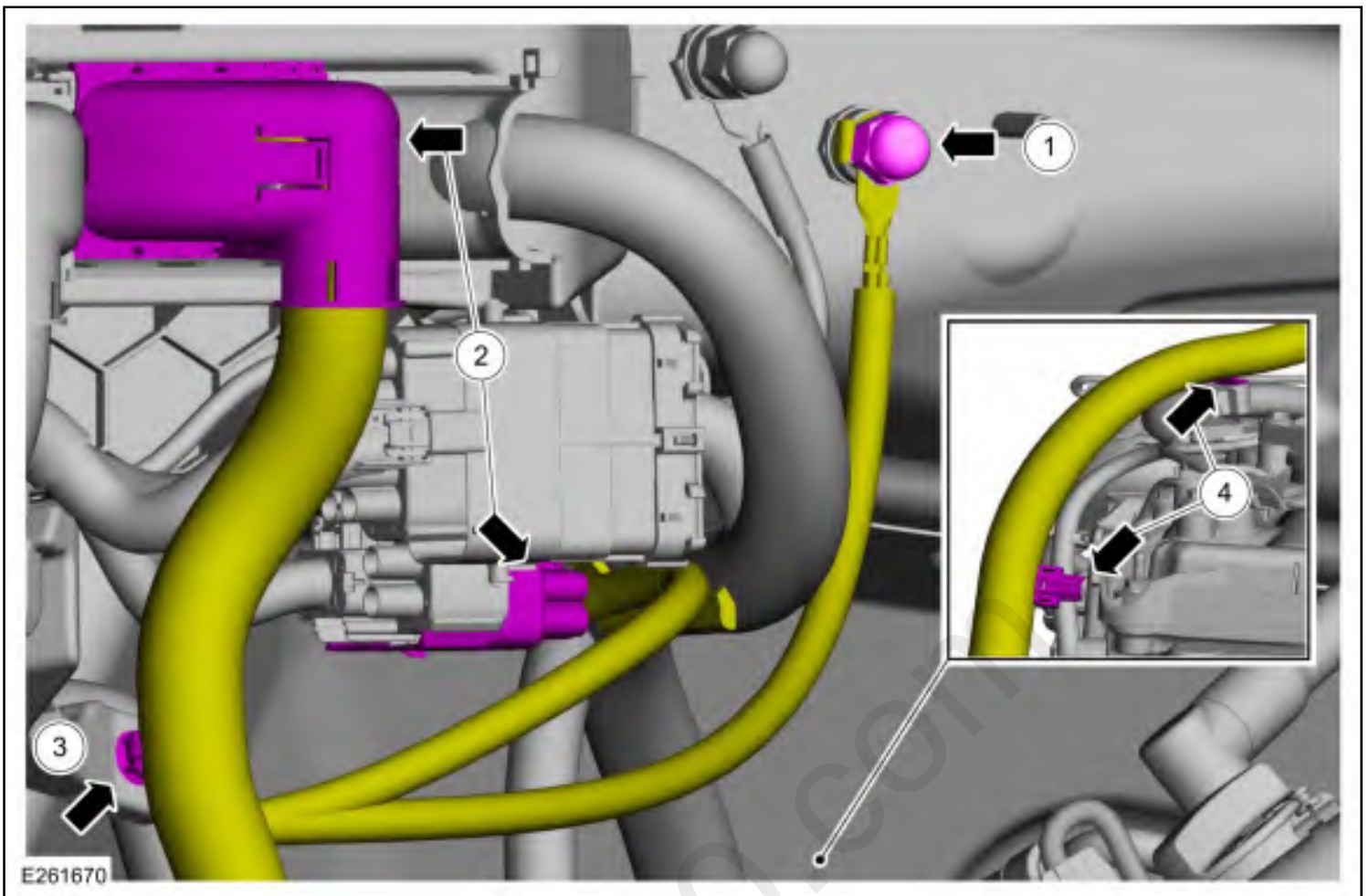
2. LH ignition coils.

Refer to: [Ignition Coil-On-Plug](#) (303-07D Engine Ignition - 5.0L 32V Ti-VCT, Removal and Installation).

1. Detach the wiring harness retainer.
2. Remove the fasteners and position the coolant pump aside.
3. Disconnect the heater hose.
4. Detach the coolant hose retainer.
5. Detach the coolant hose retainers.



1. Remove the nut and the ground strap.
2. Disconnect the engine wiring harness connectors.
3. Detach the engine wiring harness retainer.
4. Detach the transmission wiring harness retainers.

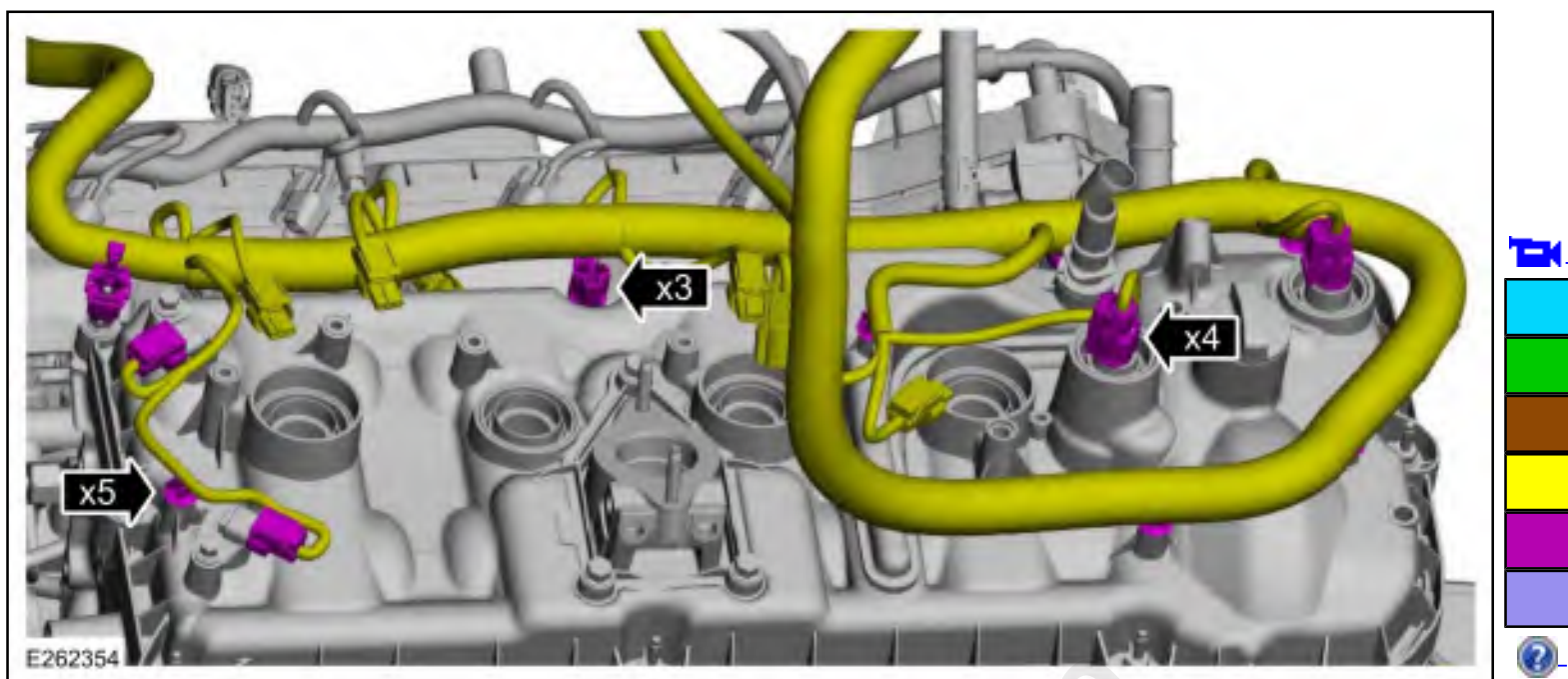


9. Remove the RH ignition coils.

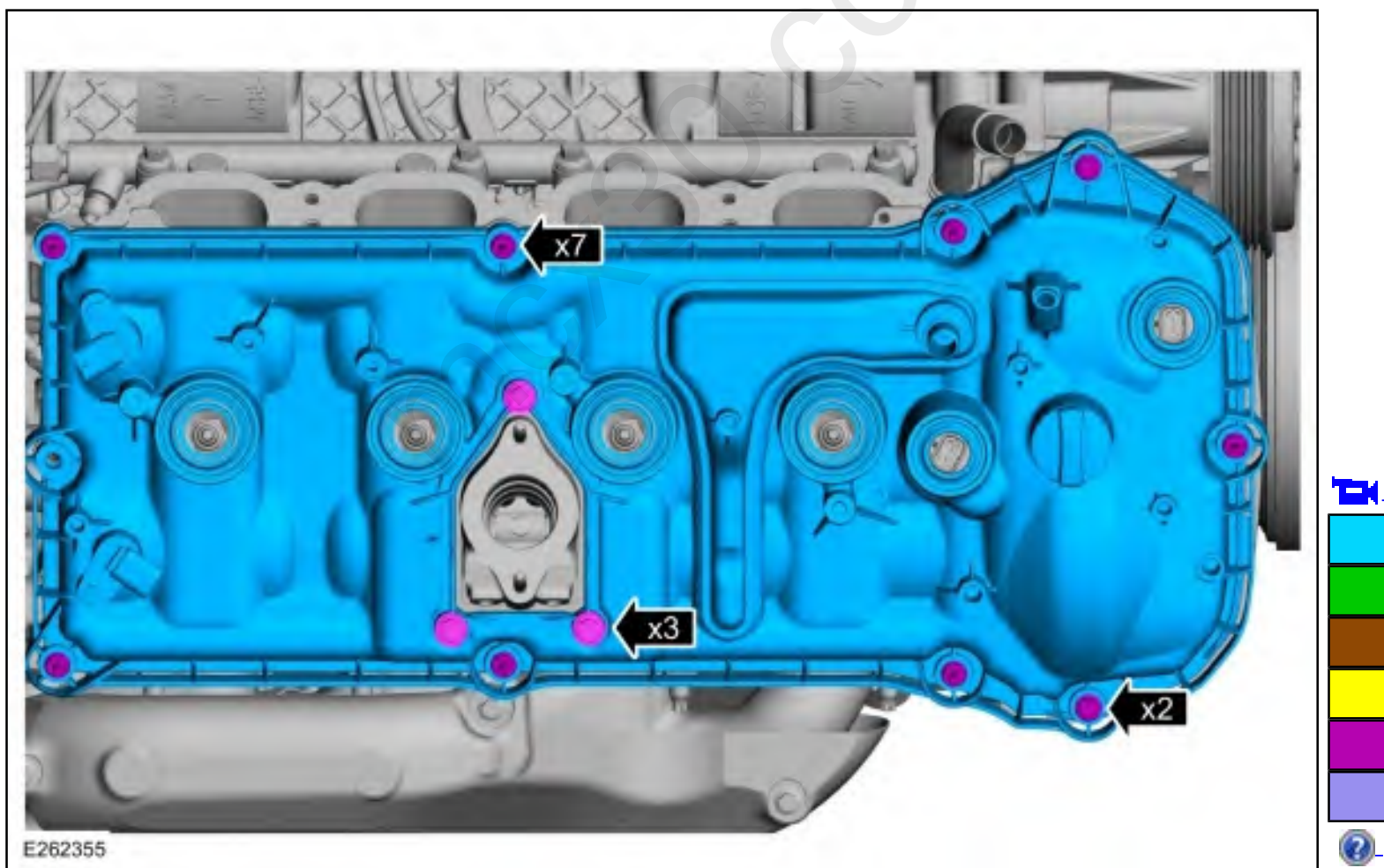
Refer to: Ignition Coil-On-Plug (303-07 Engine Ignition - 5.0L 32V Ti-VCT) .

- Disconnect the engine wiring harness electrical connectors.
- Detach the wiring harness retainers.





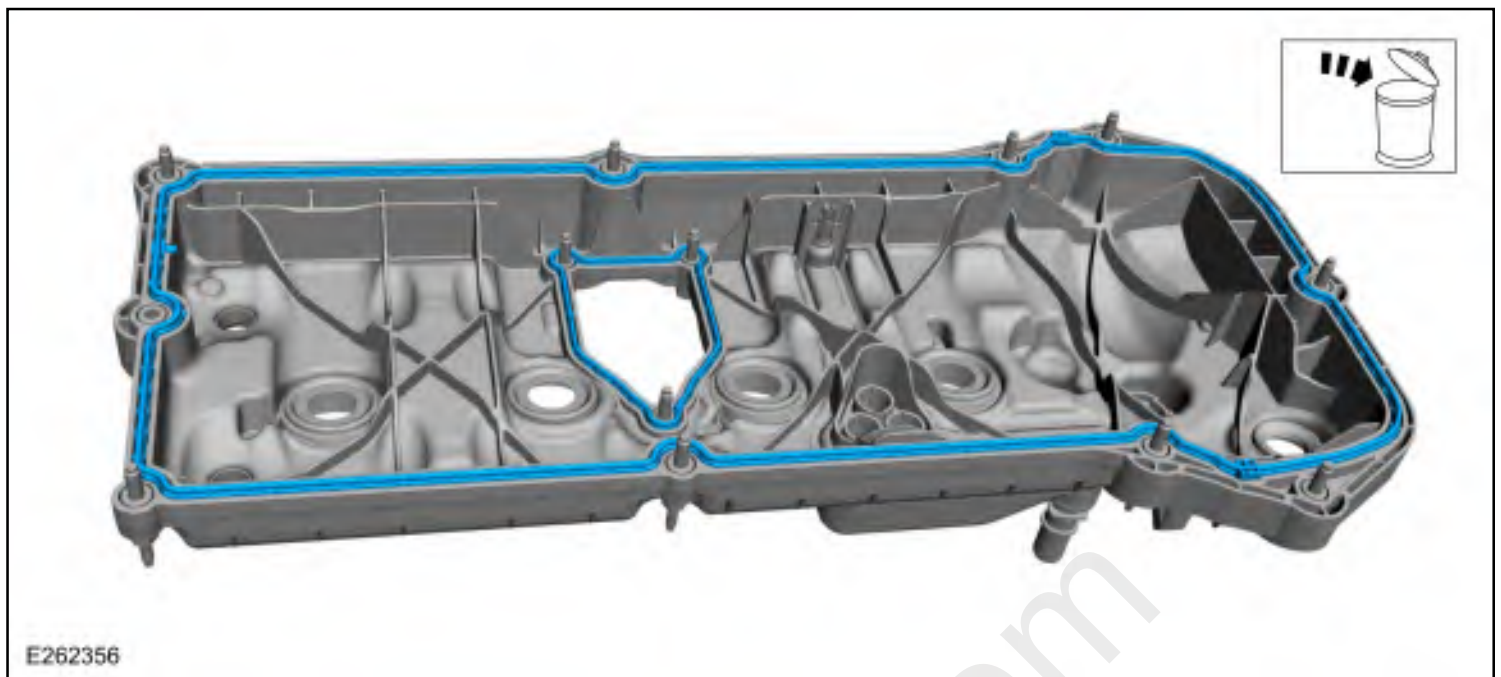
11. Loosen the bolts and remove the valve cover.



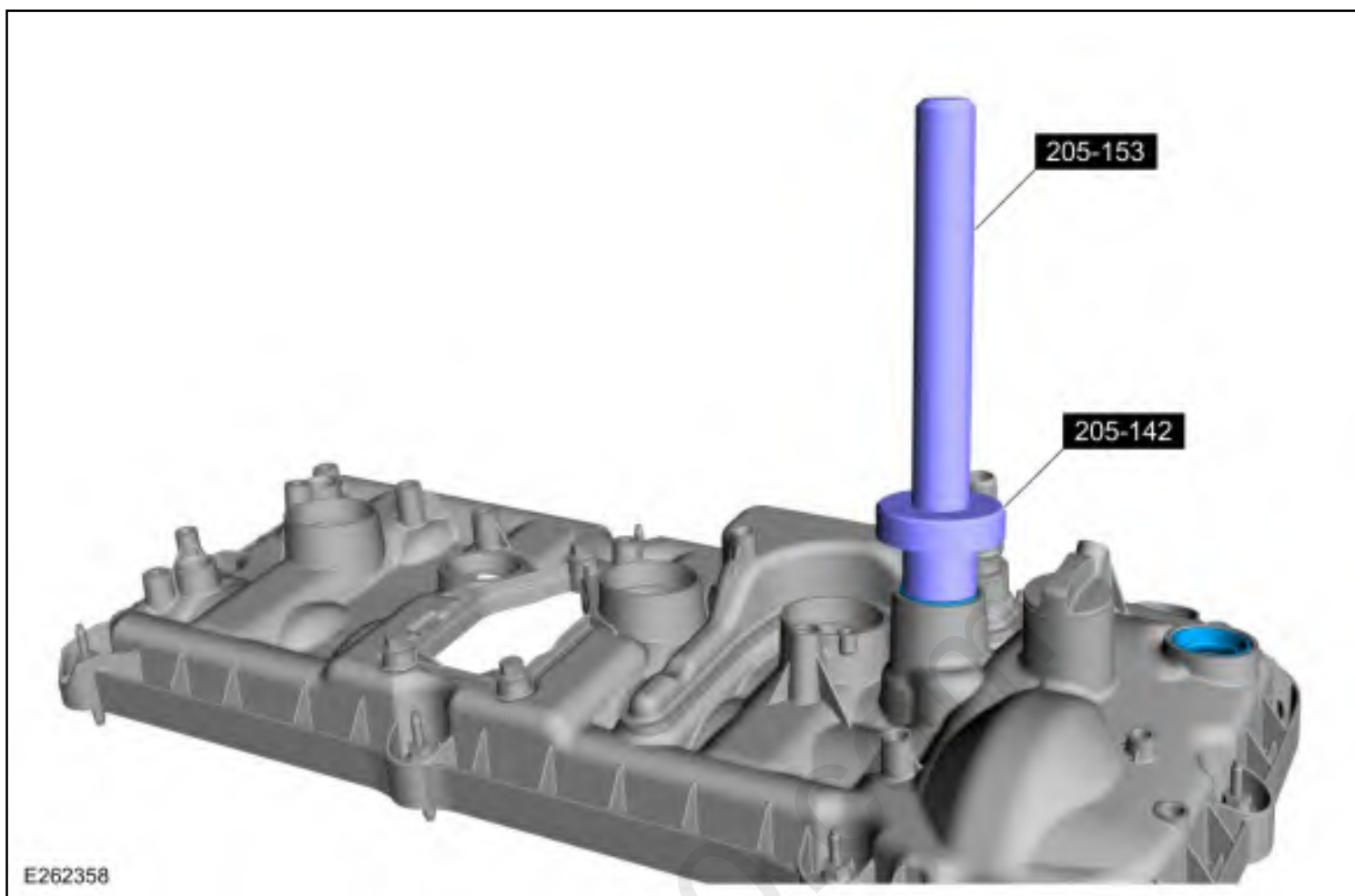
12. **NOTE:** Clean the valve cover gasket groove with soap and water or a suitable solvent.



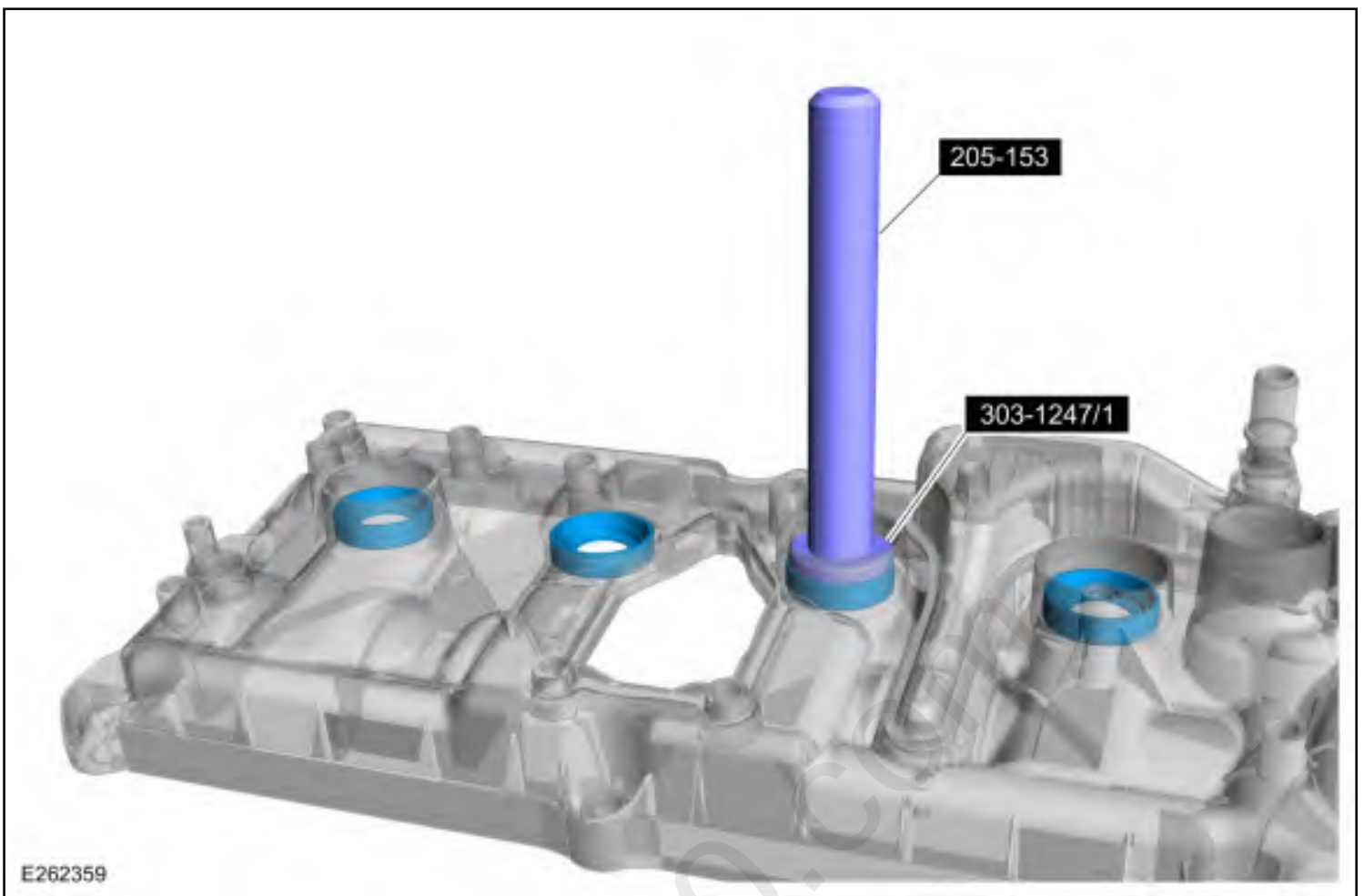
Remove and discard the gaskets.



13. Inspect the VCT variable force solenoid seals. Remove any damaged seals using the special tools. Use Special Service Tool: 205-153 (T80T-4000-W) Handle. , 205-142 (T80T-4000-J) Installer, Differential Bearing Cone.



14. Inspect the spark plug seals. Remove any damaged seals using the special tools.  
Use Special Service Tool: 205-153 (T80T-4000-W) Handle. , 303-1247 VCT Spark Plug Tube Seal Remover and Installer.



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

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

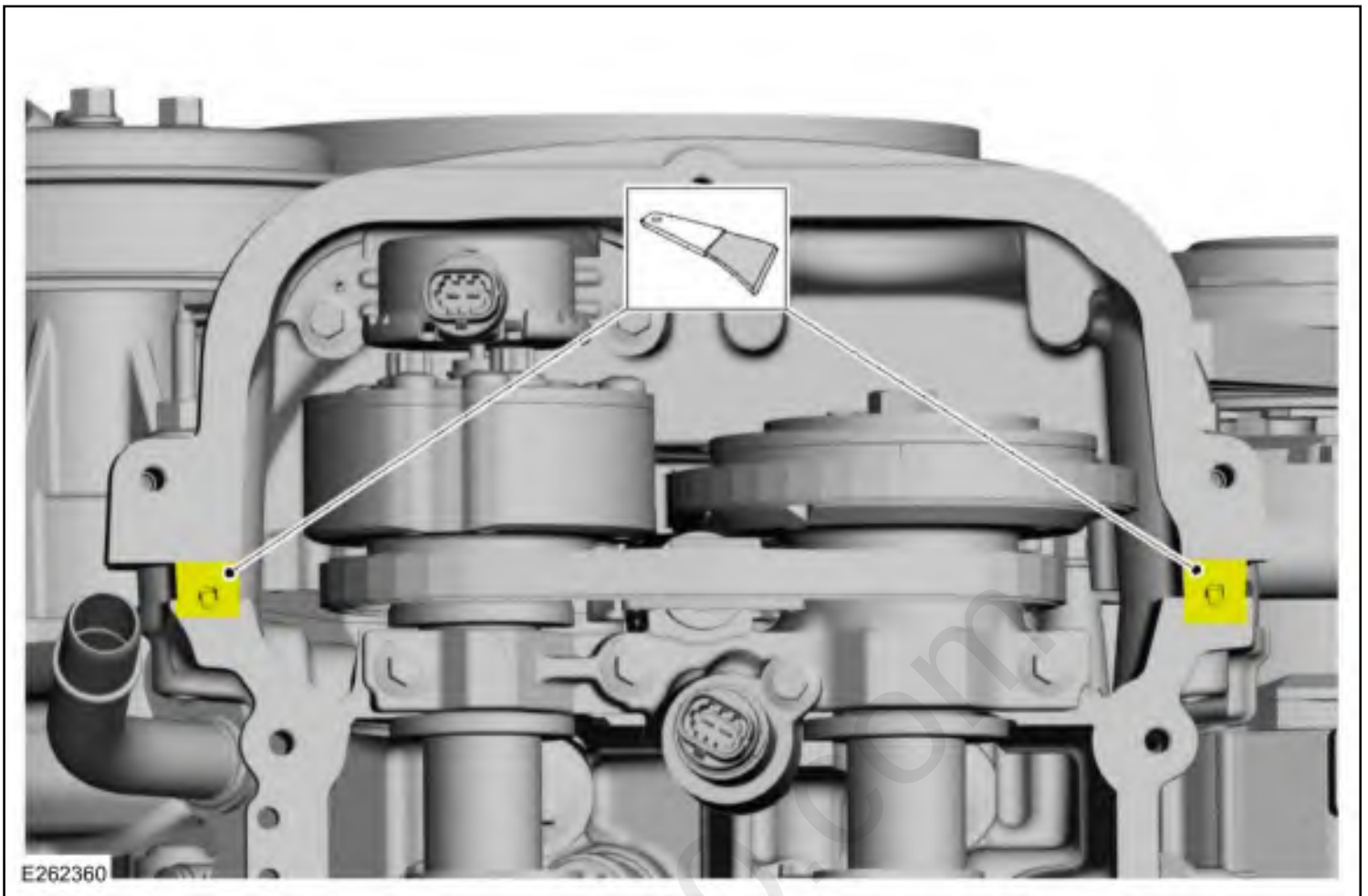
Refer to: [RTV Sealing Surface Cleaning and Preparation](#) (303-00 Engine System - General Information, General Procedures).

Use the General Equipment: Plastic Scraper

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

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

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

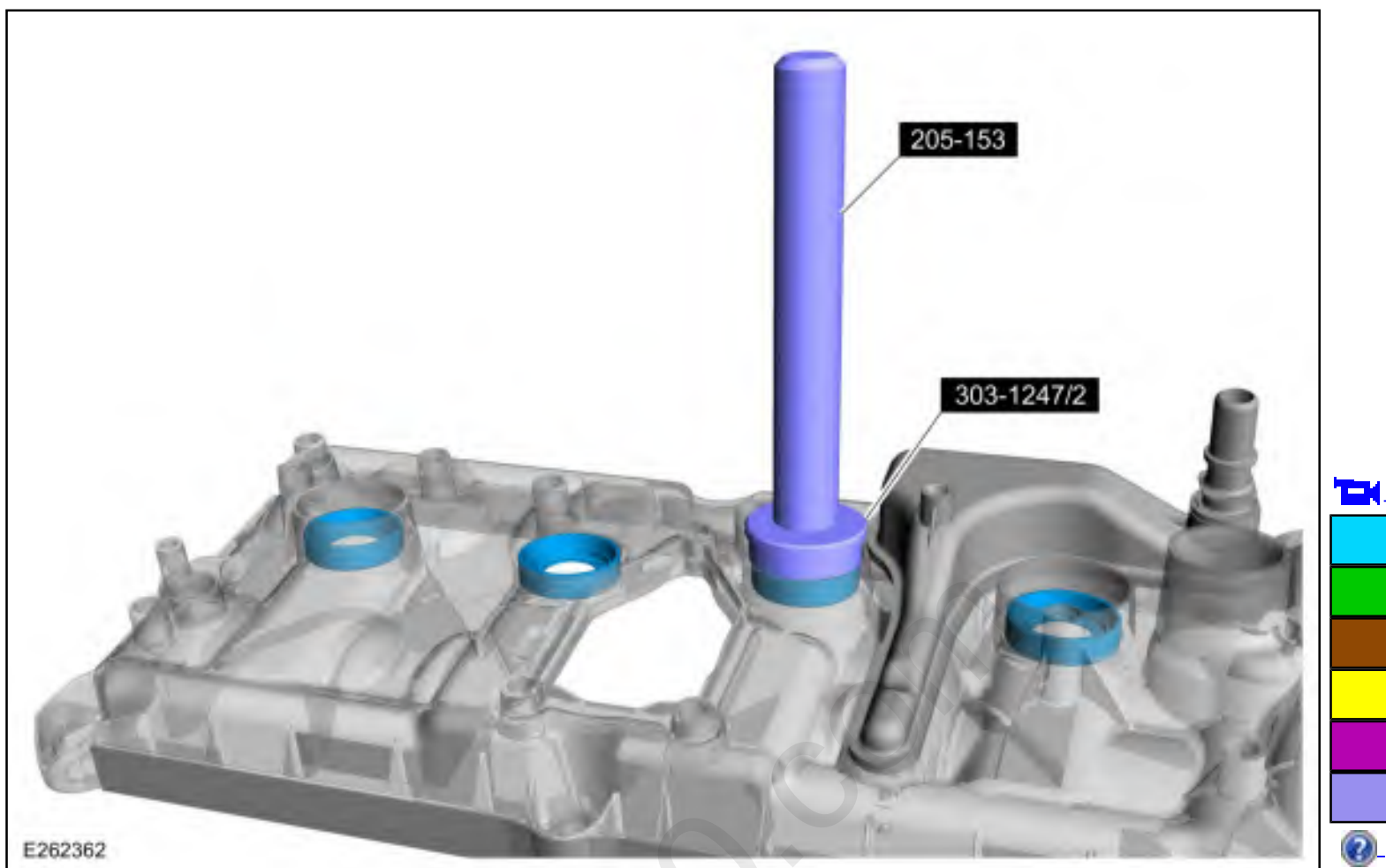


## Installation

1. **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.

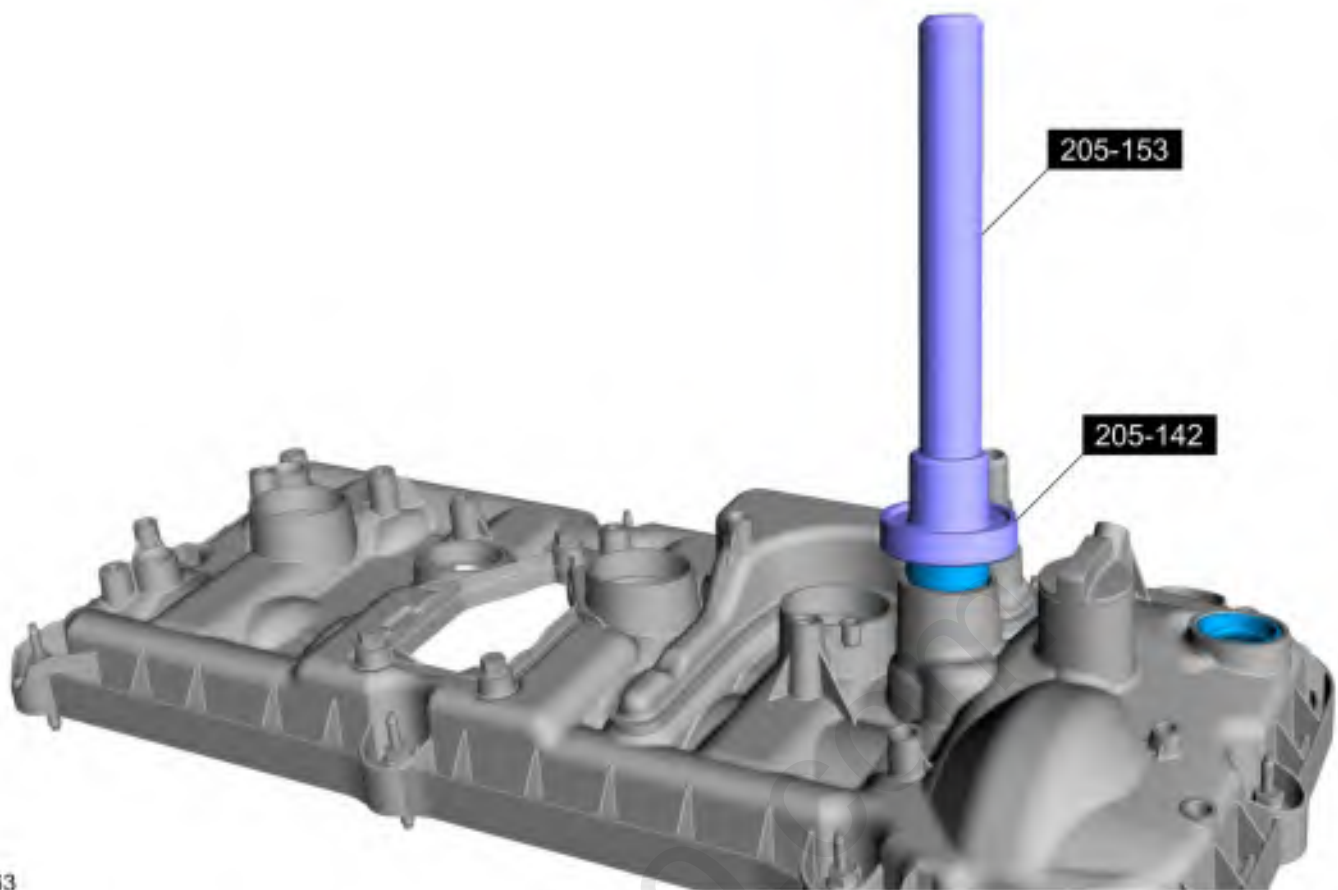


2. **NOTE:** *Installation of new seals is only required if damaged seals were removed.*

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.





E262363

3. Install new gaskets.

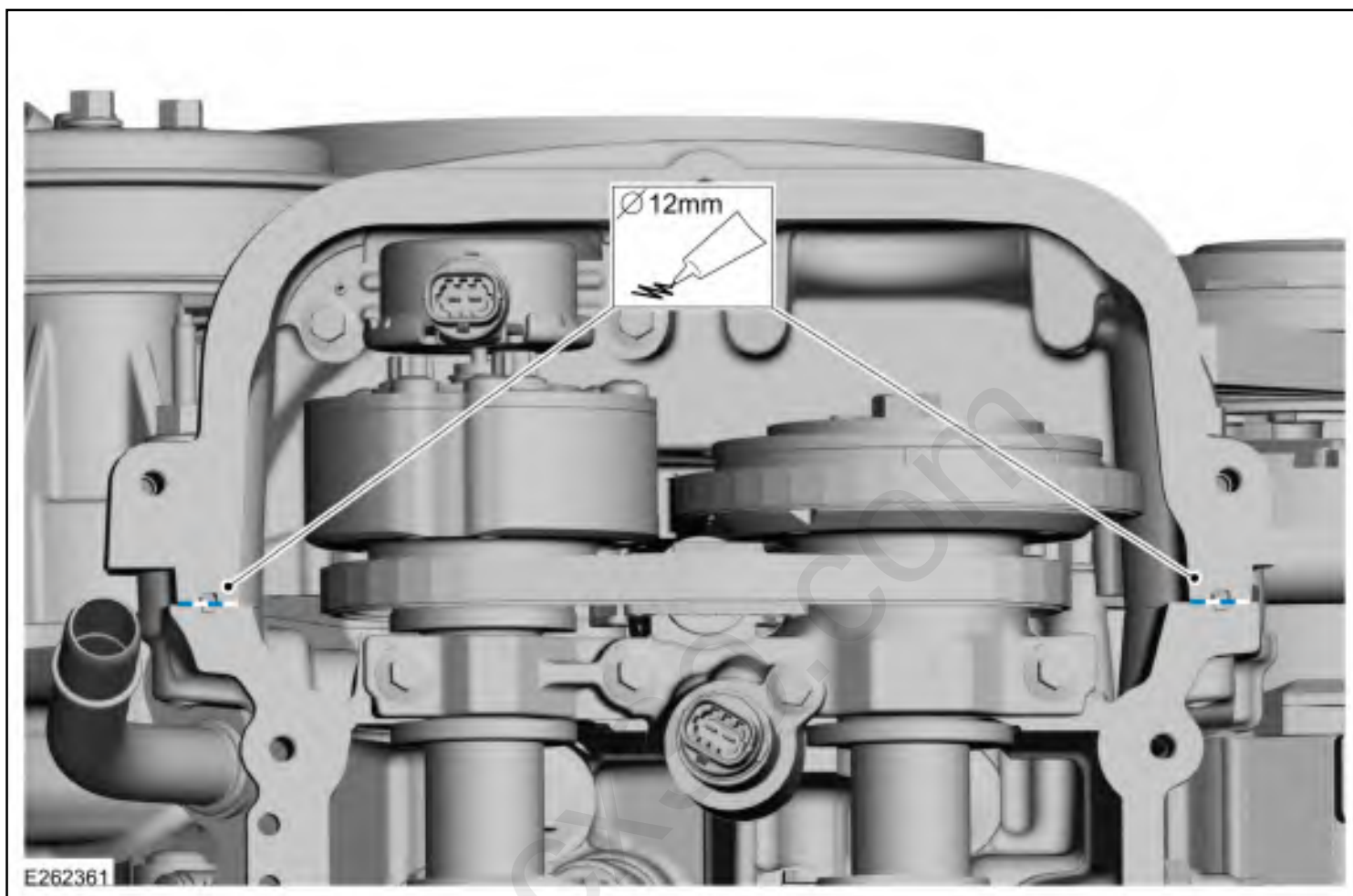


E262357

4. **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.

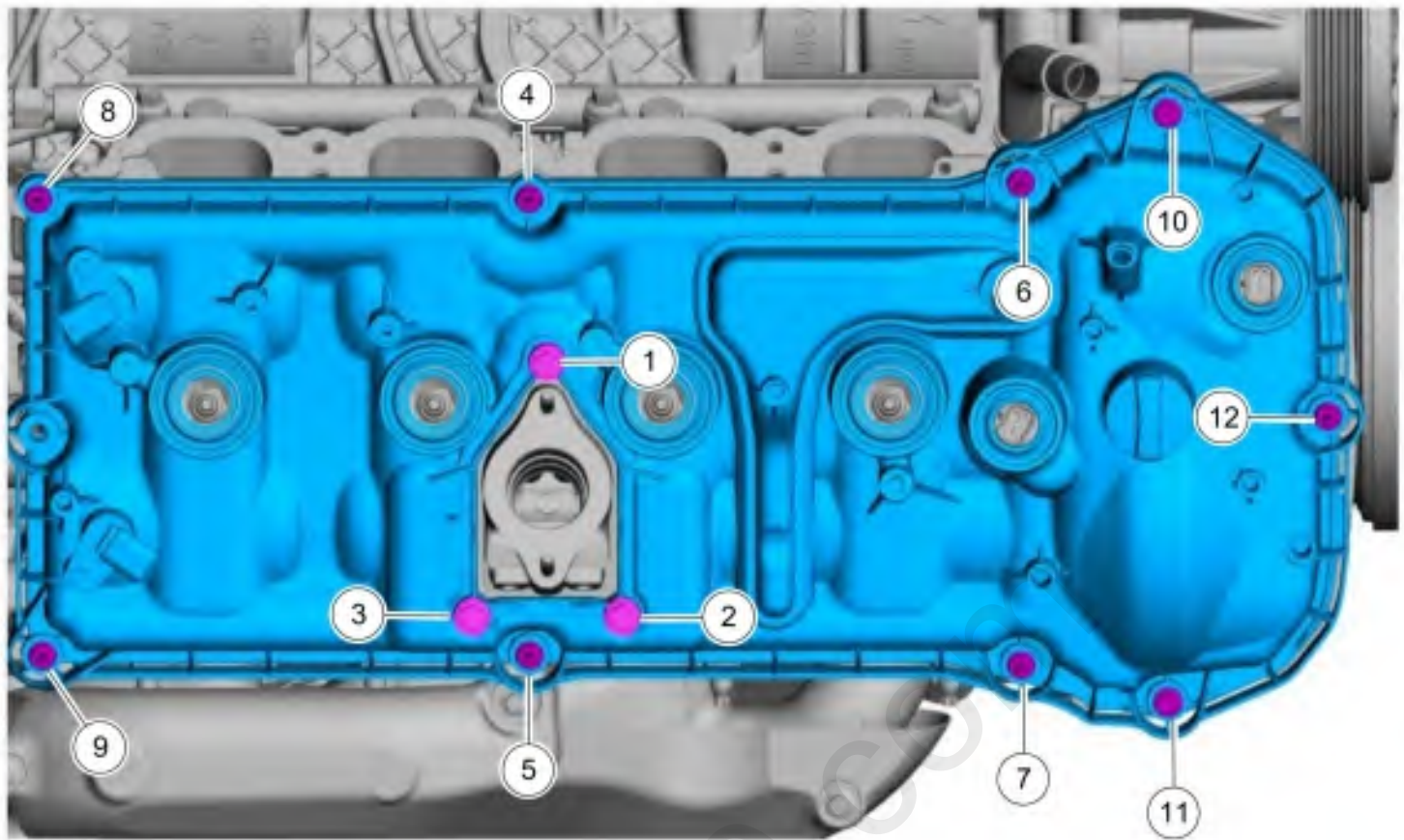
Apply an 12 mm (0.47 in) bead of silicone gasket and sealant to the engine front cover-to-cylinder head joints.

*Material:* Motorcraft® Silicone Gasket and Sealant / TA-30 (WSE-M4G323-A4)



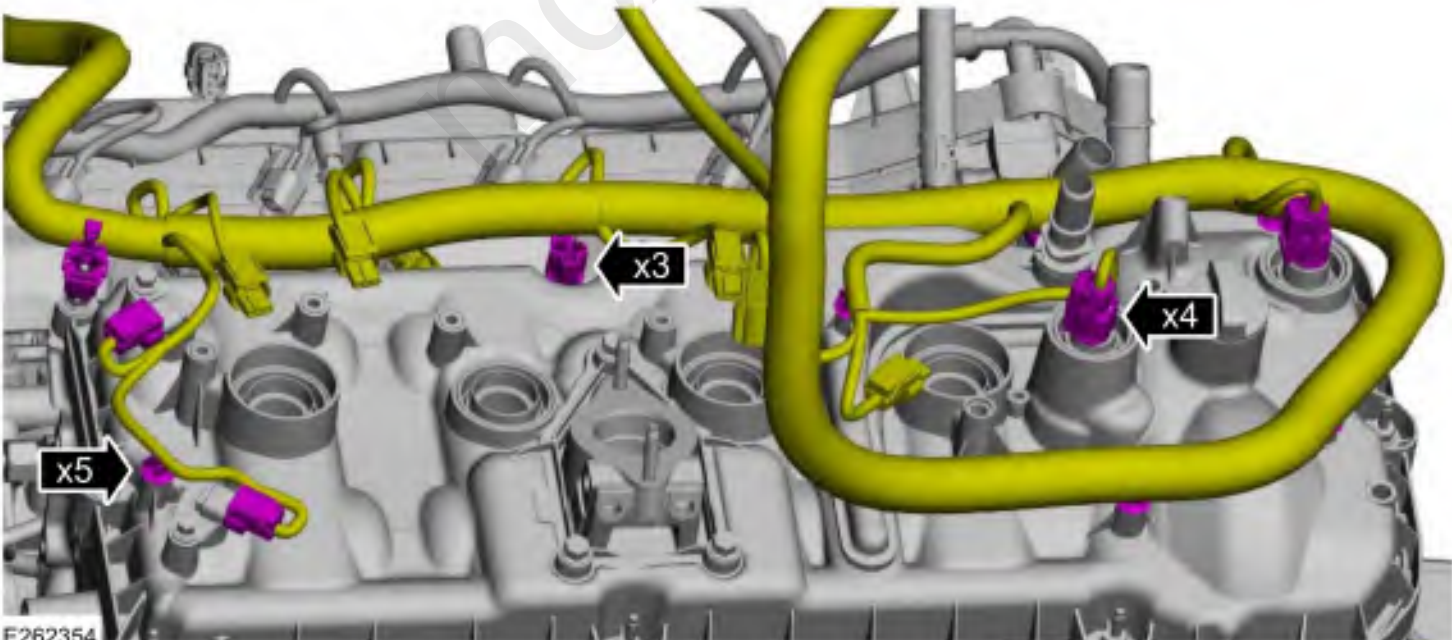
5. Install the valve cover and tighten the bolts.

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



E262401

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



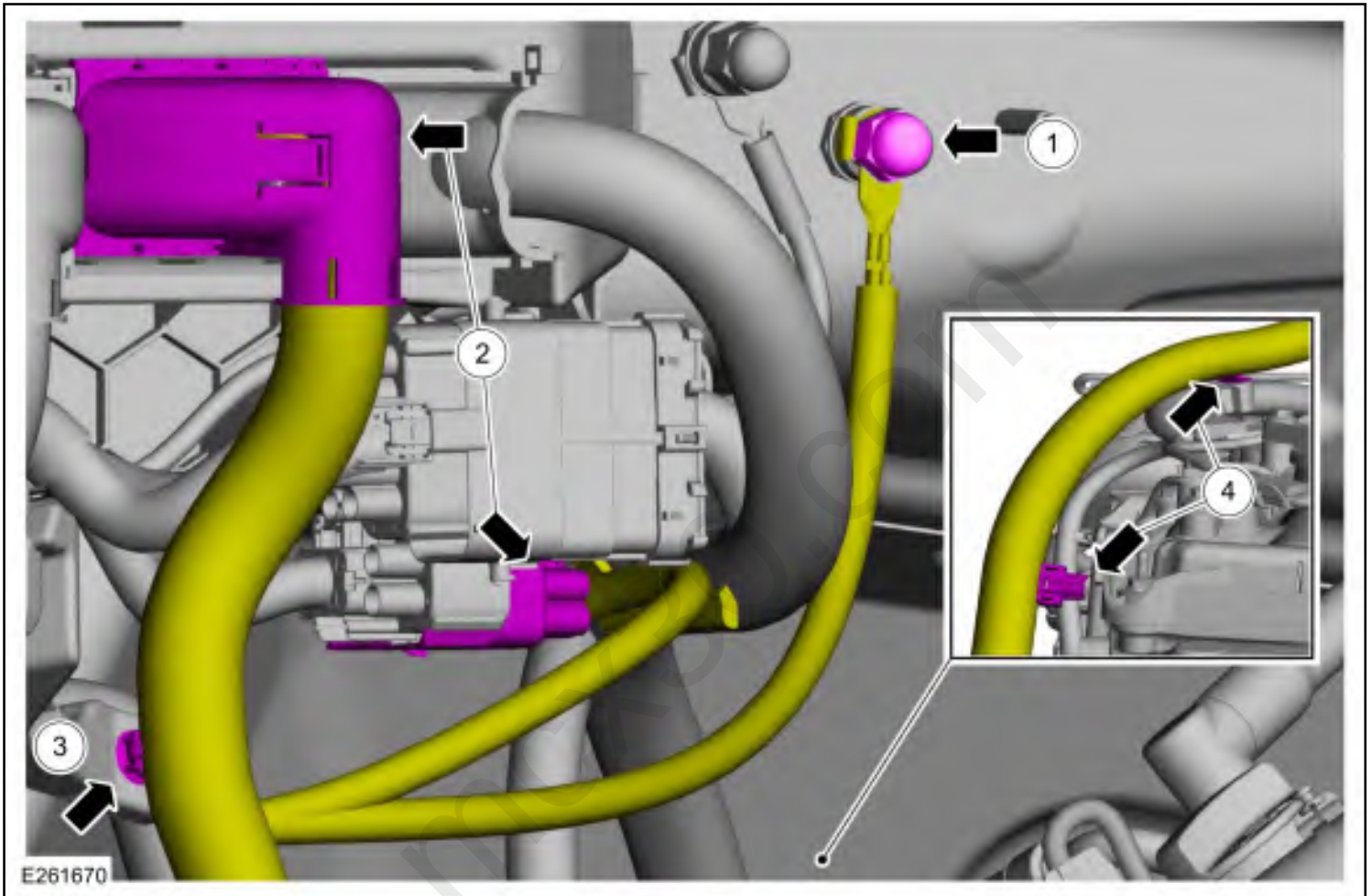
E262354

7. Install the RH ignition coils.

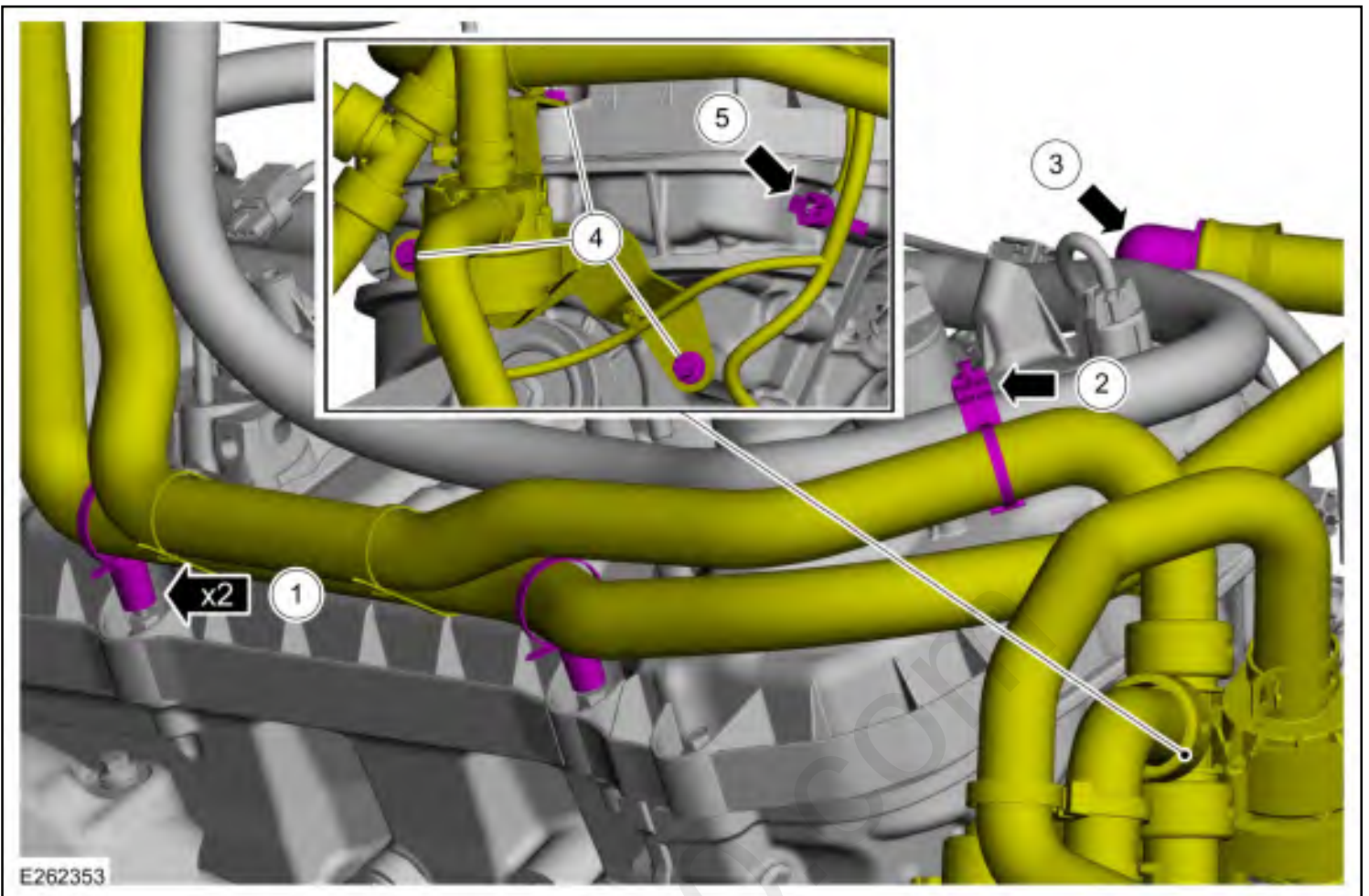


Refer to: Ignition Coil-On-Plug (303-07 Engine Ignition - 5.0L 32V Ti-VCT) .

1. Install the ground strap and the nut.  
*Torque: 106 lb.in (12 Nm)*
2. Connect the engine wiring harness connectors.
3. Attach the engine wiring harness retainer.
4. Attach the transmission wiring harness retainers.



1. Attach the coolant hose retainers.
2. Attach the coolant hose retainer.
3. Connect the heater hose.
4. Position the coolant pump and install the fasteners.  
*Torque: 62 lb.in (7 Nm)*
5. Attach the wiring harness retainer.



10. Install the following items:

1. LH ignition coils.

Refer to: [Ignition Coil-On-Plug](#) (303-07D Engine Ignition - 5.0L 32V Ti-VCT, Removal and Installation).

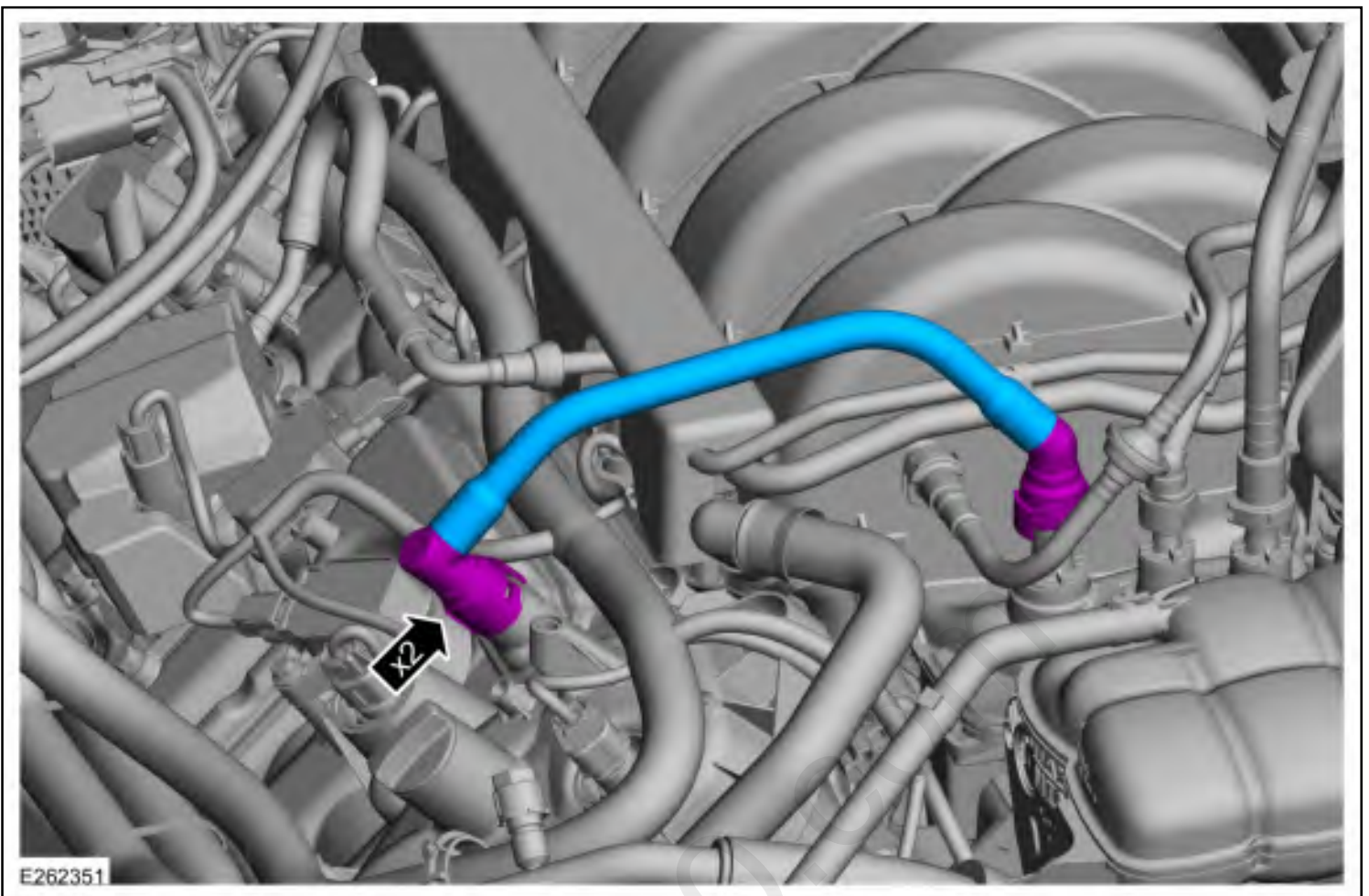
2. High pressure fuel pump.

Refer to: [High-Pressure Fuel Pump](#) (303-04D Fuel Charging and Controls - 5.0L 32V Ti-VCT, Removal and Installation).

11. Position the PCV tube and connect the quick release couplings.

Refer to: [Quick Release Coupling](#) (310-00D Fuel System - General Information - 5.0L 32V Ti-VCT, General Procedures).





12. Fill the engine cooling system.

Refer to: Cooling System Draining, Vacuum Filling and Bleeding (303-03 Engine Cooling - 5.0L 32V Ti-VCT) .

## Camshaft LH

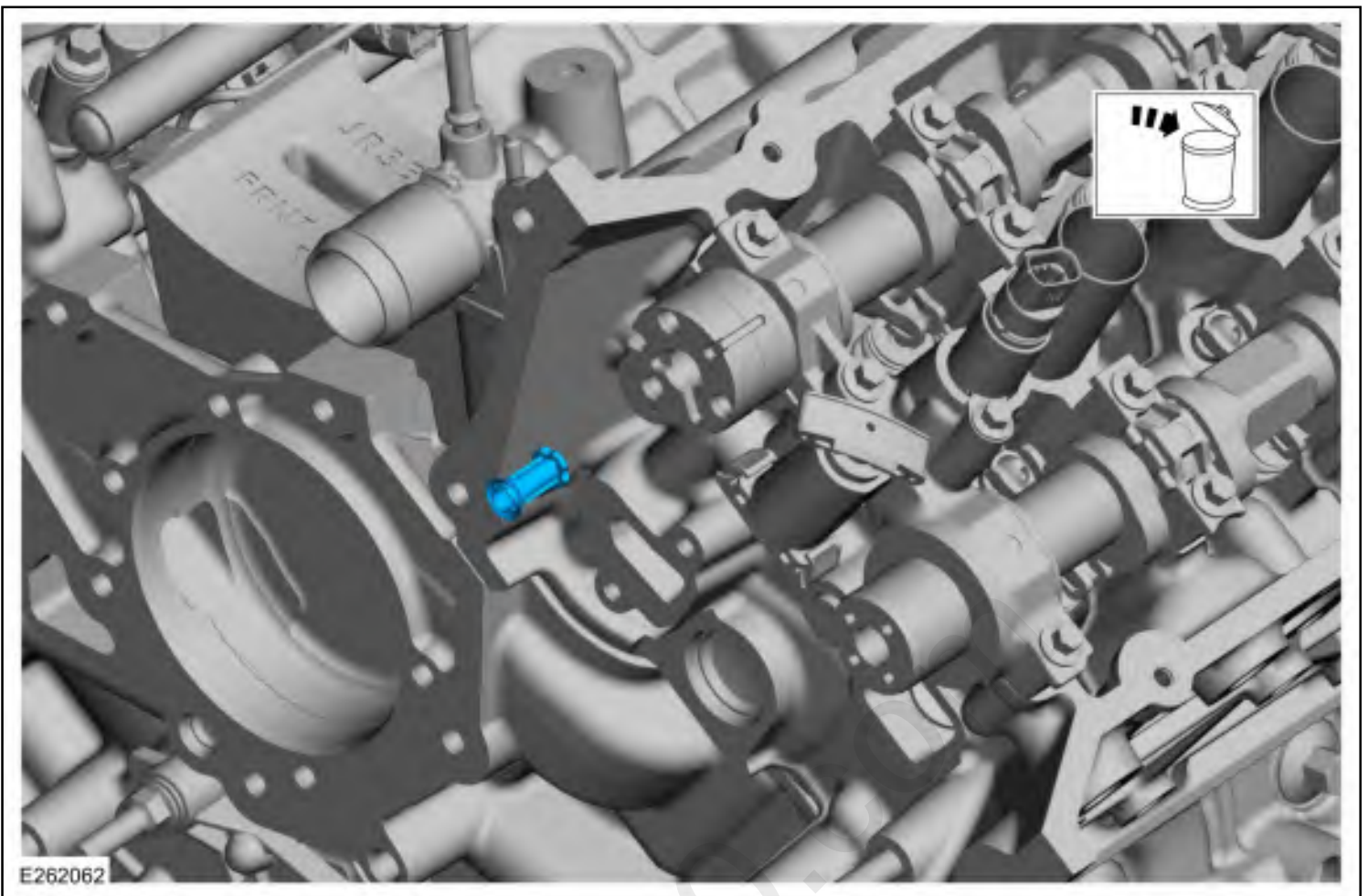
### Removal

**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:** If the RH camshafts are being serviced at the same time as the LH camshafts, remove the RH camshafts first. Refer to the procedure in this section.

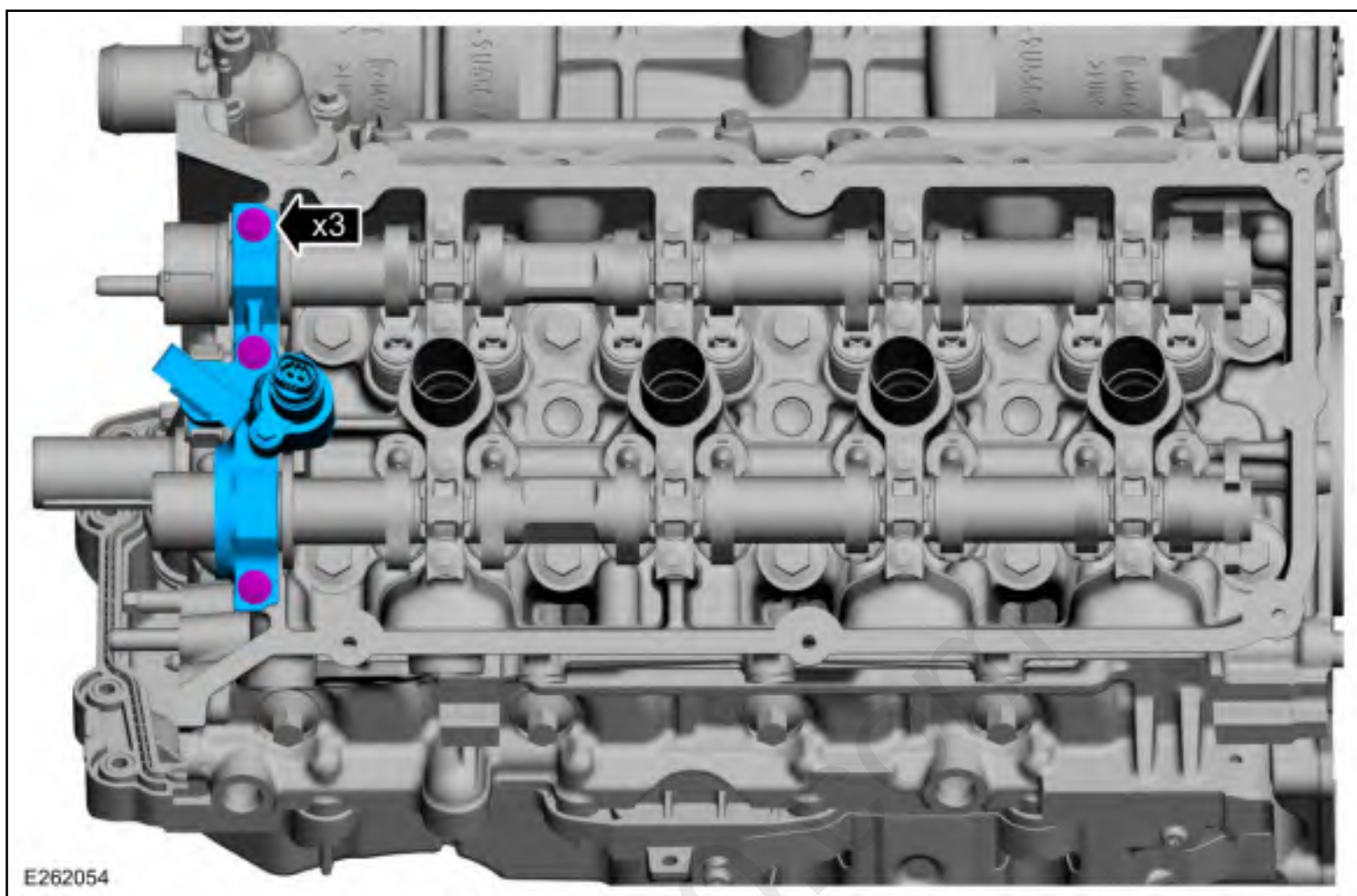
**NOTE:** If the components are to be reinstalled, they must be installed in their original locations.

1. Remove the LH VCT units.  
Refer to: Variable Camshaft Timing (VCT) Unit (303-01 Engine - 5.0L 32V Ti-VCT) .
2. Remove and discard the VCT system oil filter.



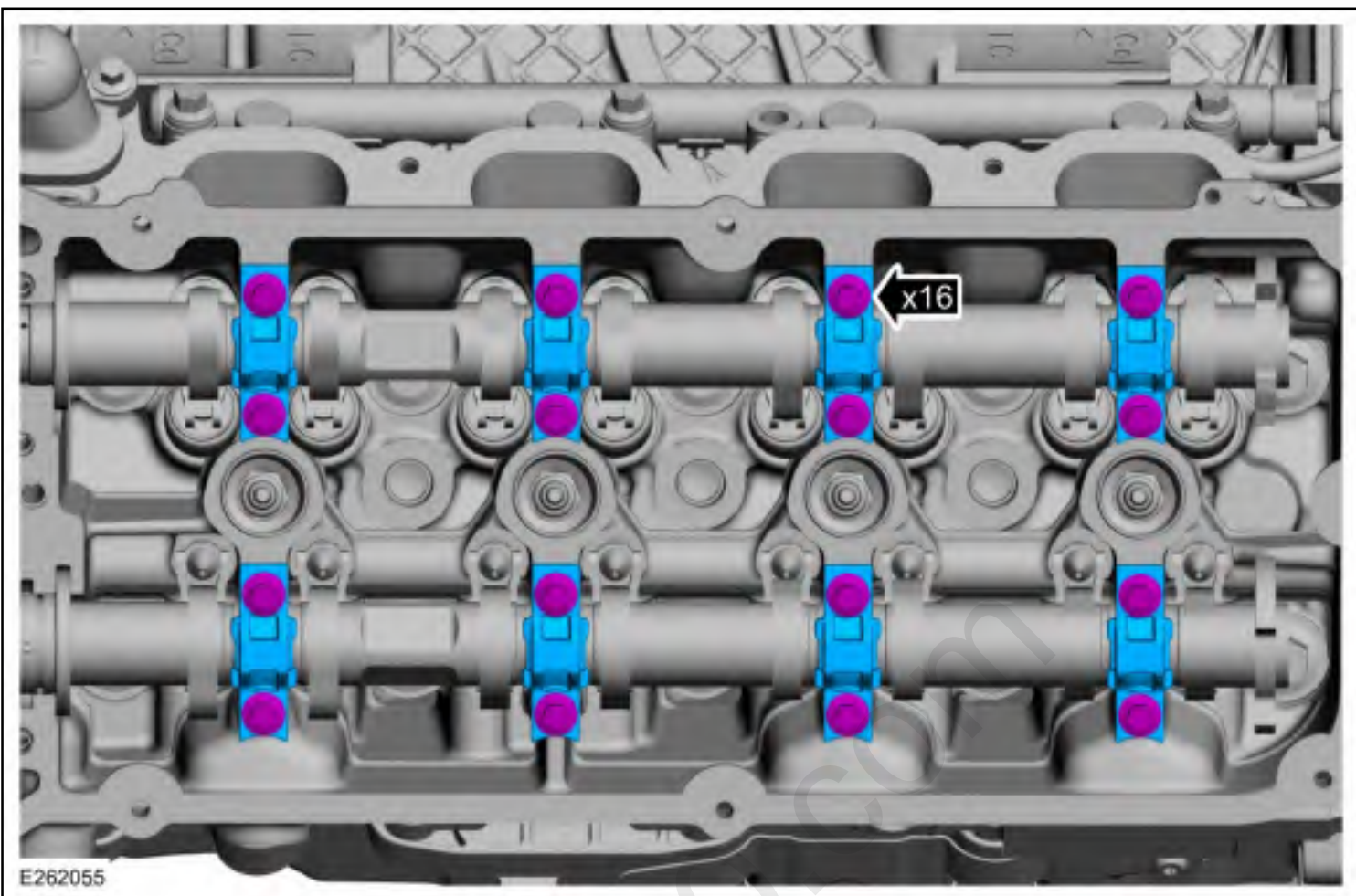
3. **NOTICE:** The front camshaft bearing mega cap must be removed first and then the remaining camshaft bearing caps. Failure to follow this direction may result in damage to the engine.

Remove the bolts and the front camshaft bearing mega cap.



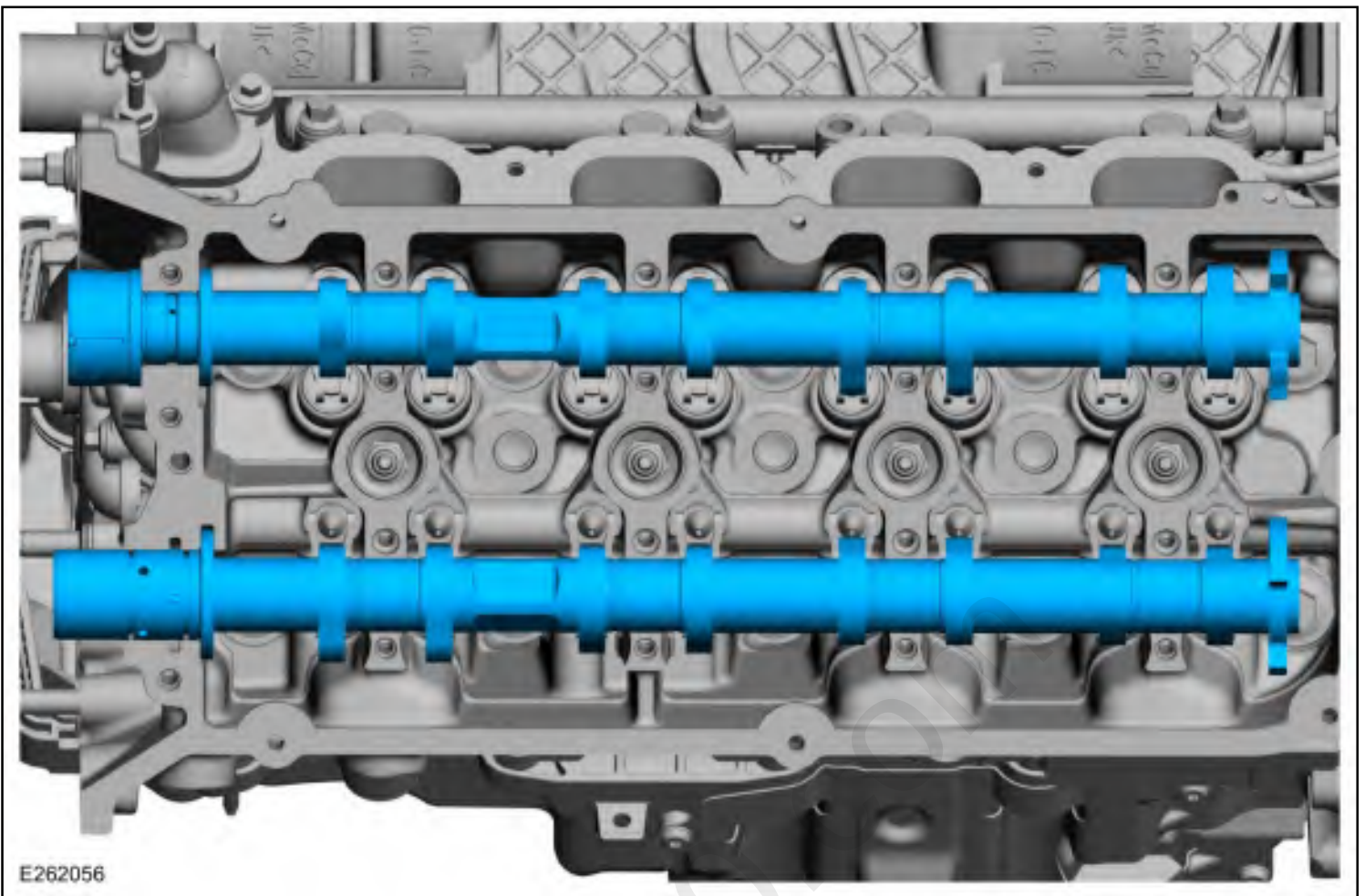
4. Remove the bolts and the camshaft bearing caps.



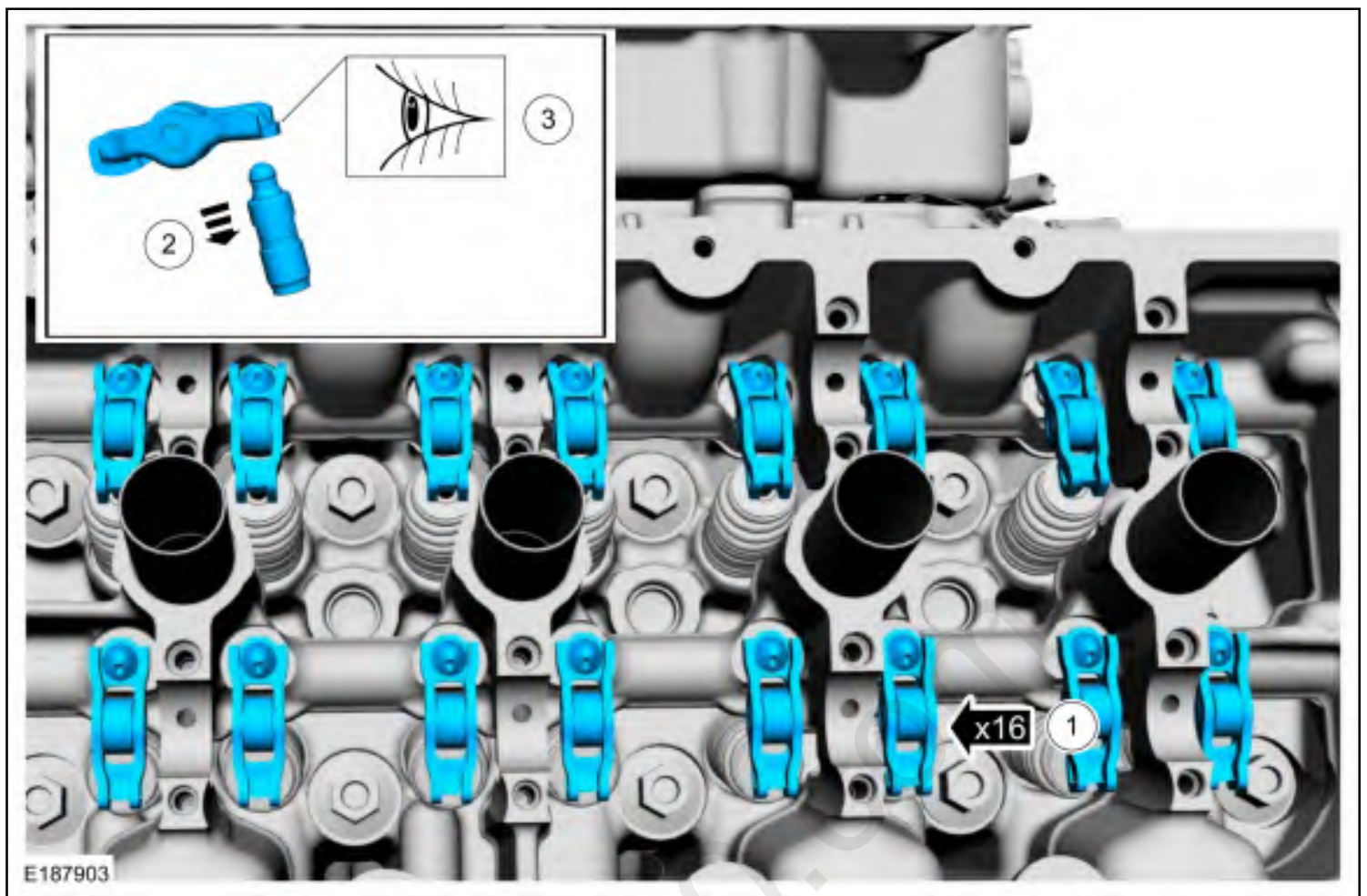


5. Remove the intake and exhaust camshafts.



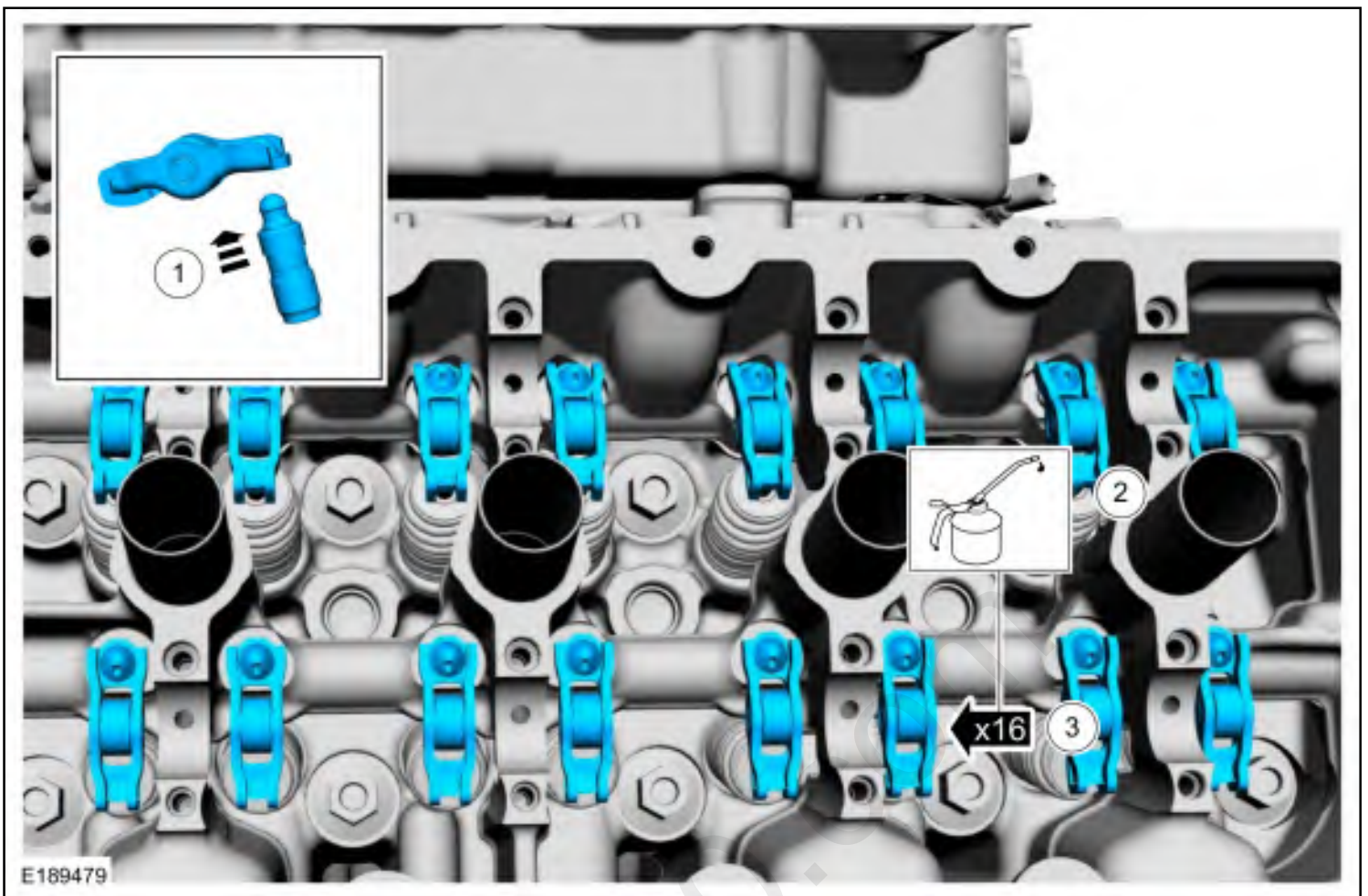


1. Remove the camshaft roller follower and hydraulic lash adjuster assemblies.
2. Separate the hydraulic lash adjusters from the spring clips on the camshaft roller followers.
3. Inspect the hydraulic lash adjuster and roller follower for damage. If any damage is found, inspect the camshaft lobes and valves for damage. Replace damaged components as necessary.



## Installation

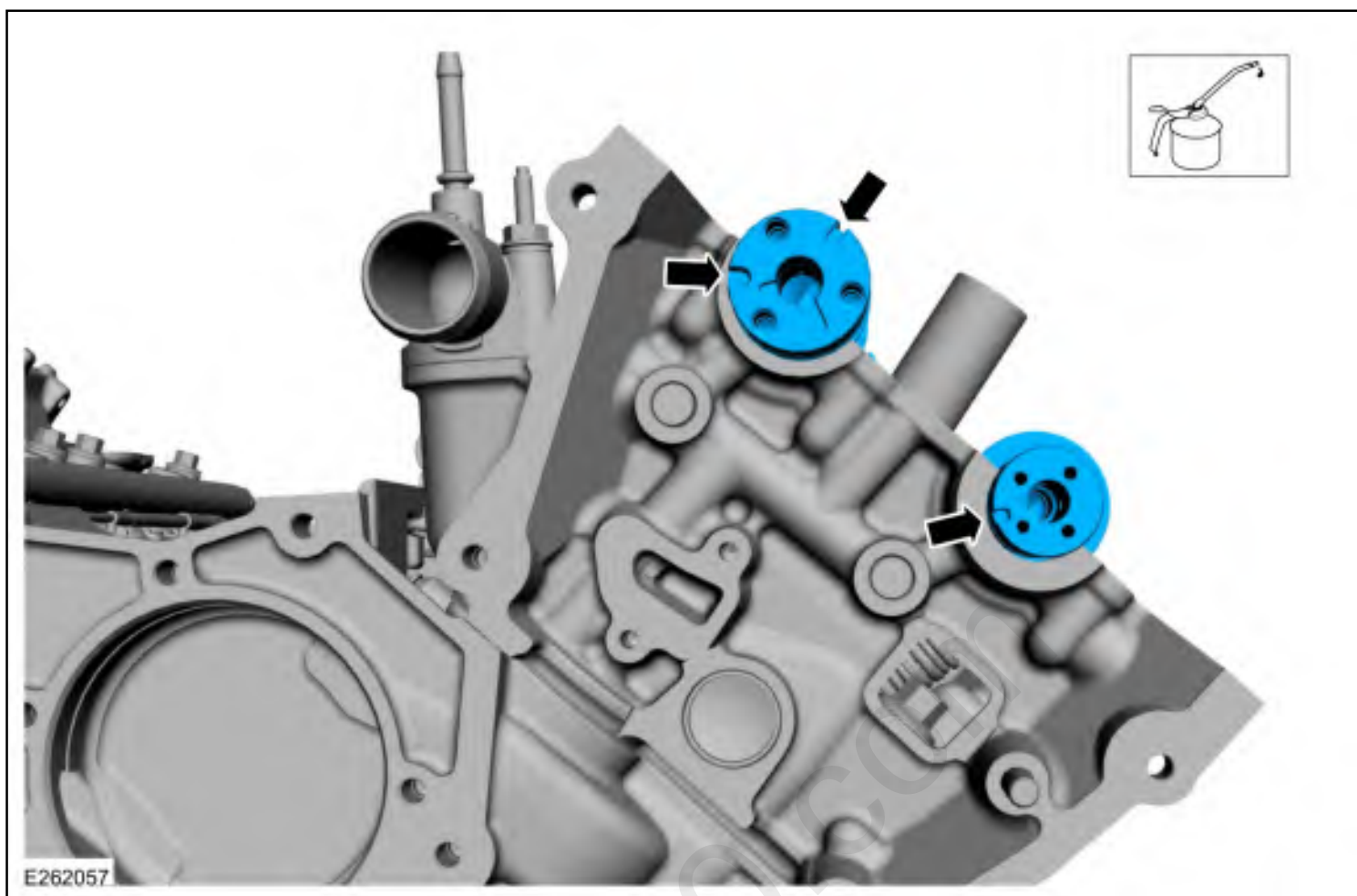
1. **NOTE:** *If the components are to be reinstalled, they must be installed in their original locations.*
1. Assemble the hydraulic lash adjusters onto the spring clips on the camshaft roller followers.
2. Lubricate the camshaft roller follower and hydraulic lash adjuster assemblies with clean engine oil.
3. Install the camshaft roller follower and hydraulic lash adjuster assemblies.



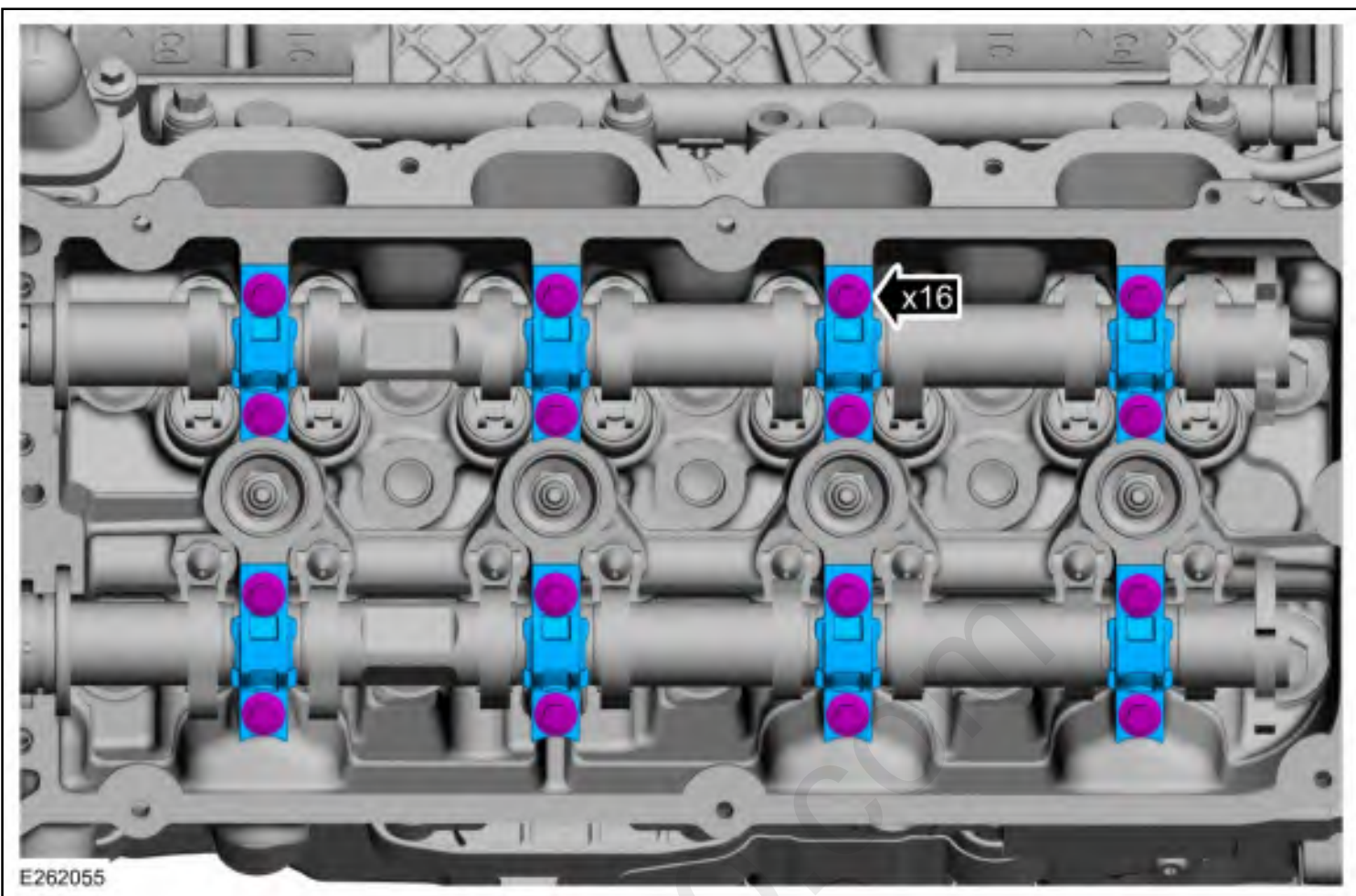
2. **NOTE:** *Lubricate the camshafts with clean engine oil prior to installation.*

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



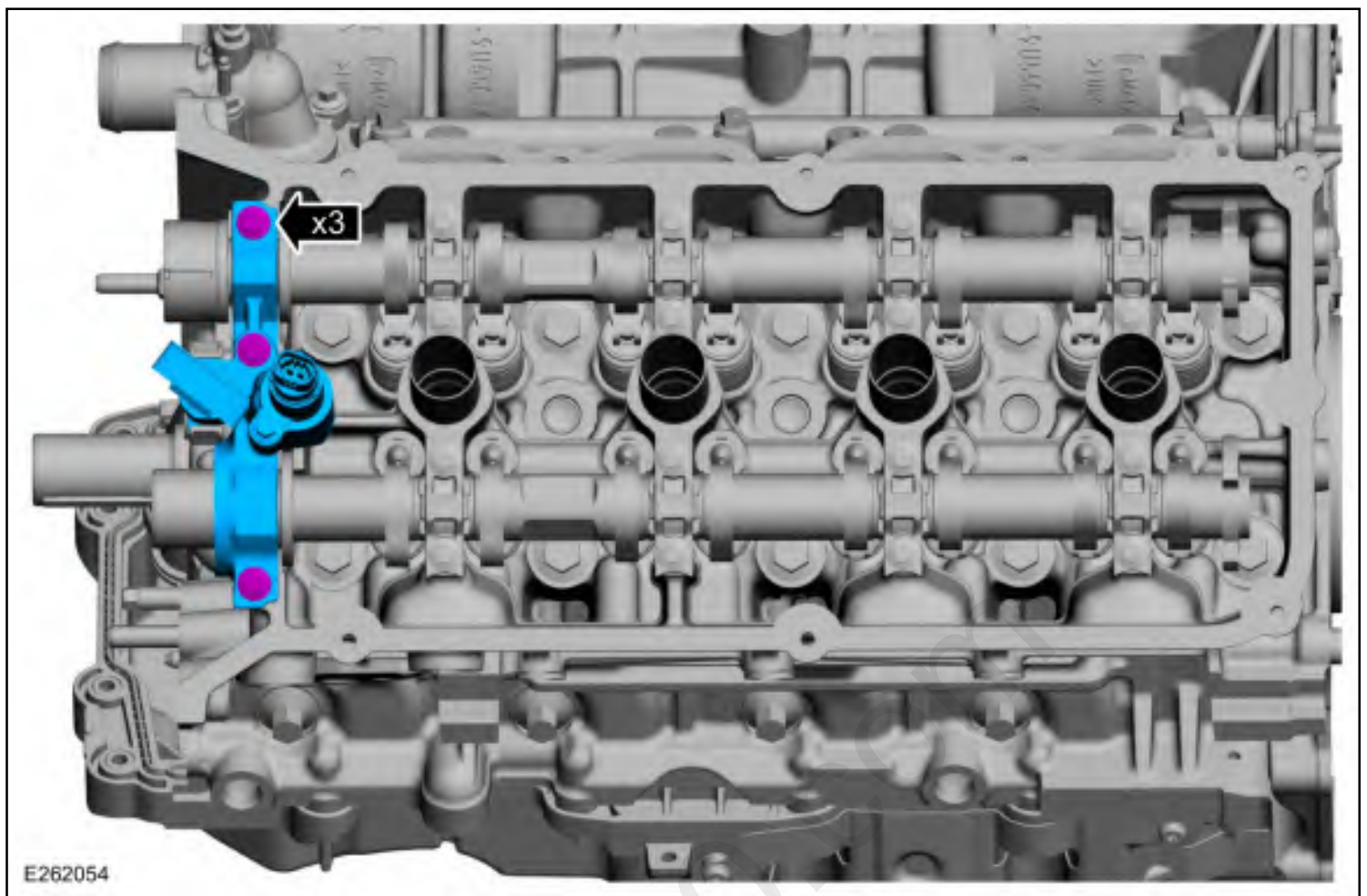


3. Install the camshaft bearing caps and the bolts. Do not tighten at this time.



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



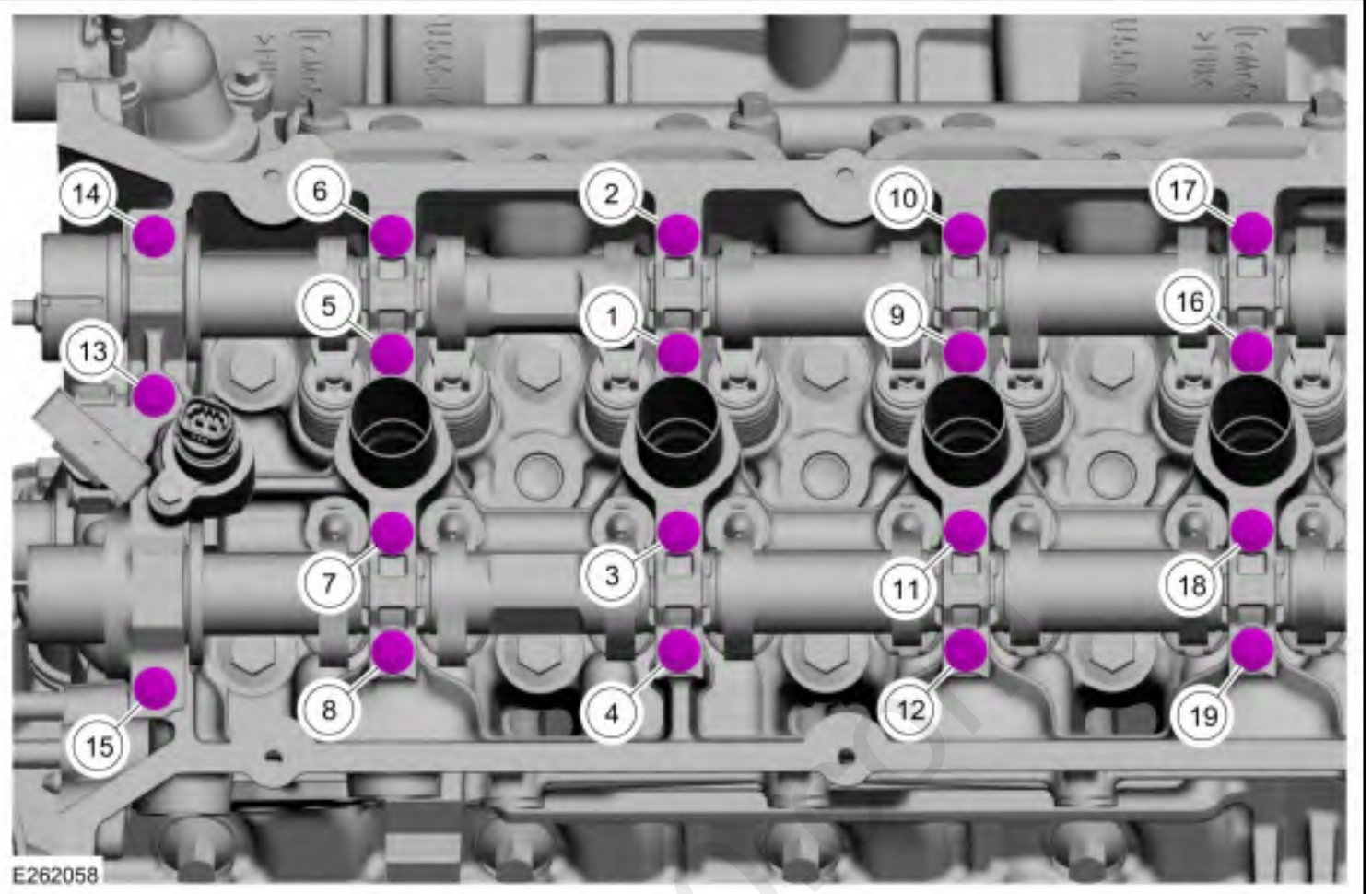


5. Tighten the bolts.

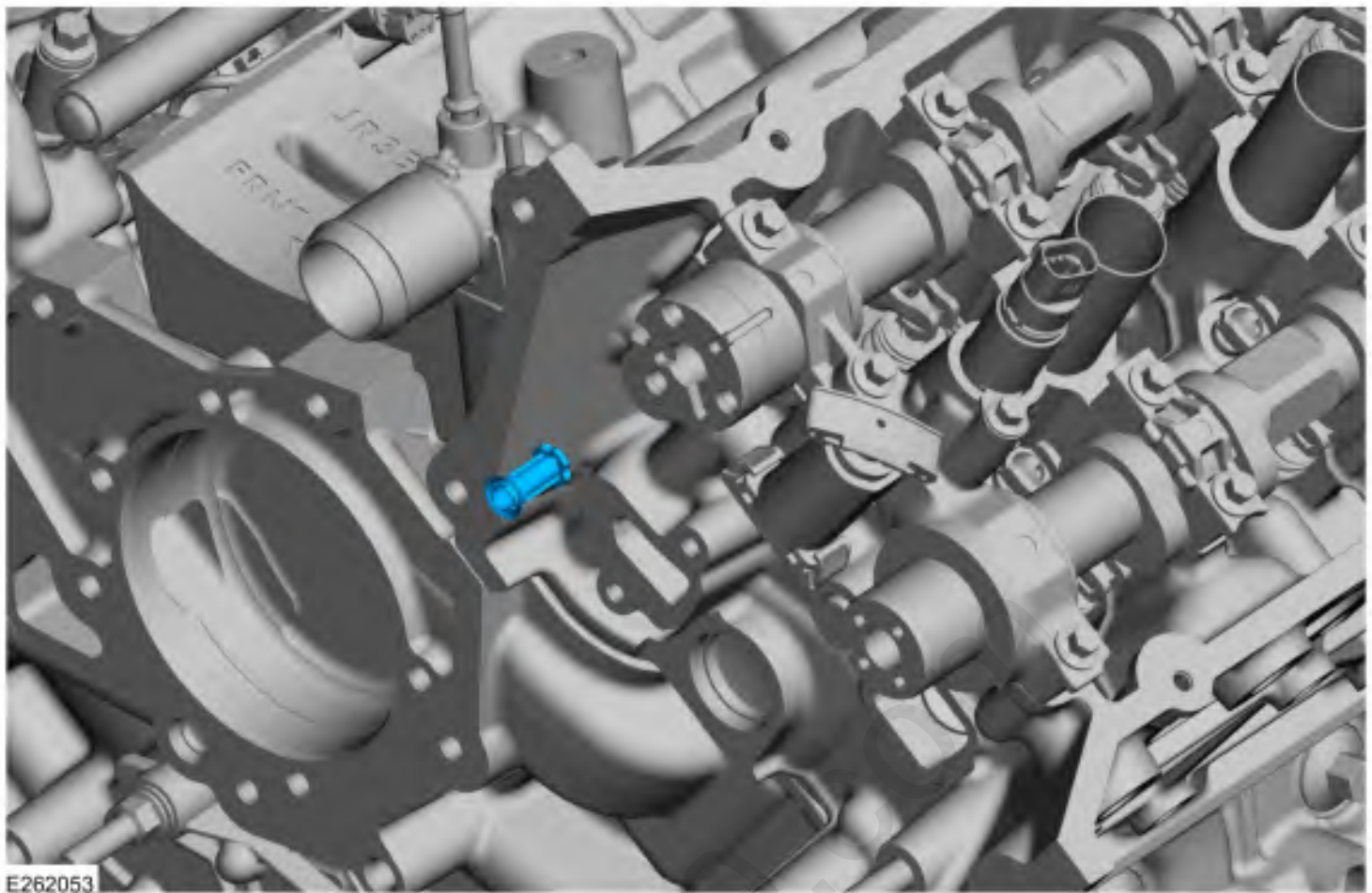
*Torque:*

Stage 1: 53 lb.in (6 Nm)

Stage 2: 45°



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



7. Install the LH VCT units.

Refer to: Variable Camshaft Timing (VCT) Unit (303-01 Engine - 5.0L 32V Ti-VCT) .



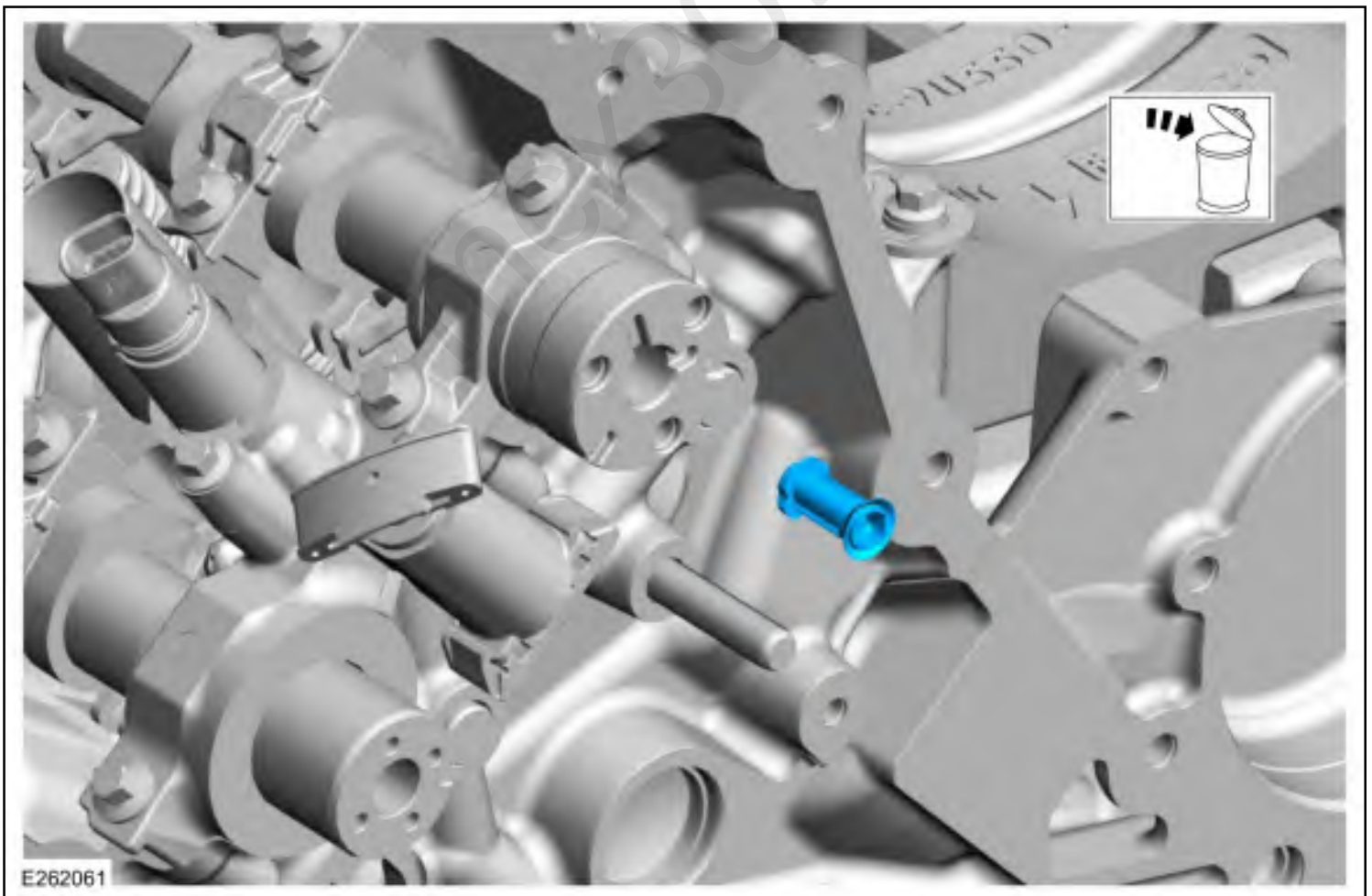
## Camshaft RH

### Removal

**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.

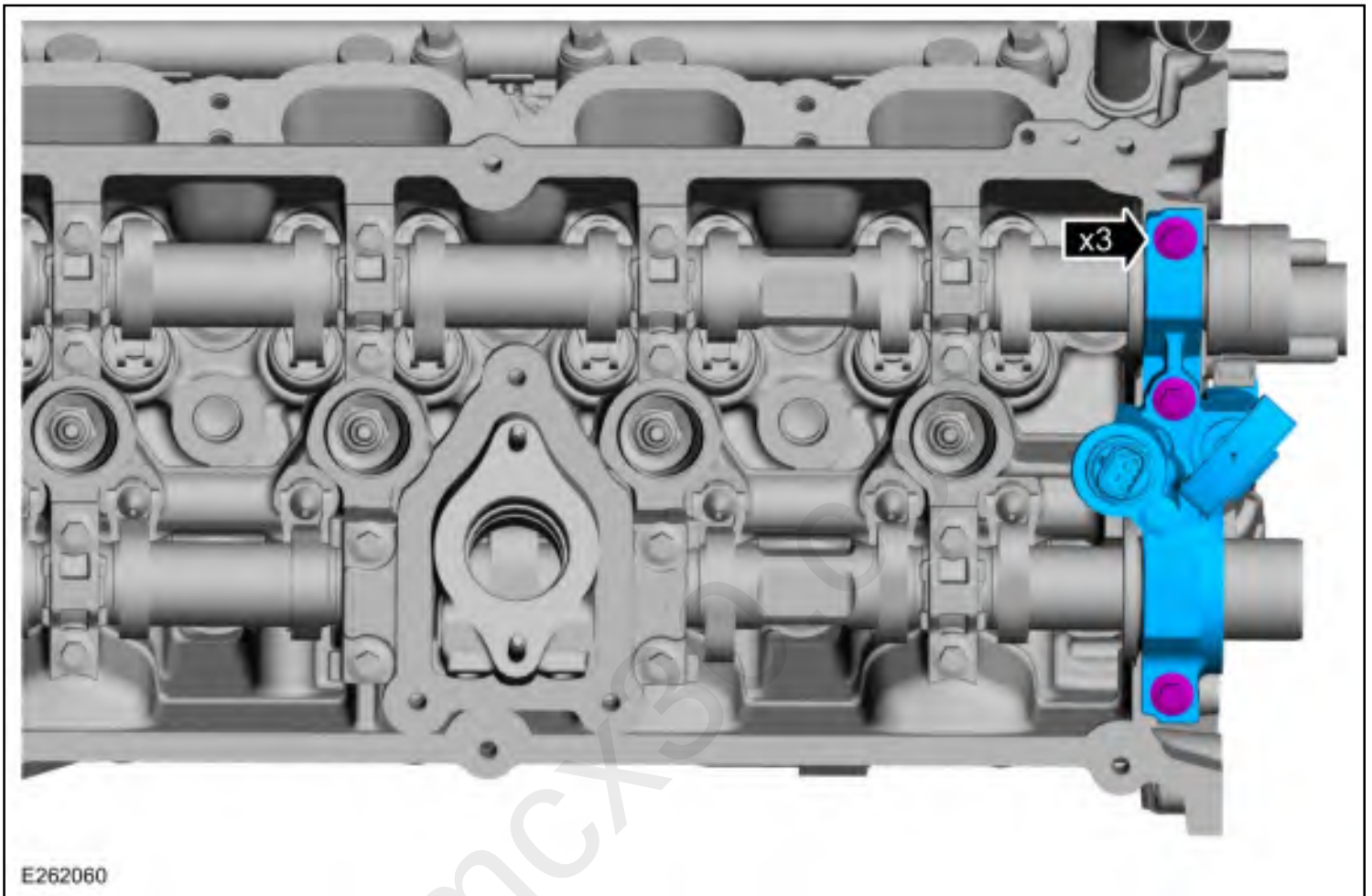
**NOTE:** If the components are to be reinstalled, they must be installed in their original locations.

1. Remove the RH VCT units.  
Refer to: Variable Camshaft Timing (VCT) Unit (303-01 Engine - 5.0L 32V Ti-VCT) .
2. Remove and discard the VCT system oil filter.



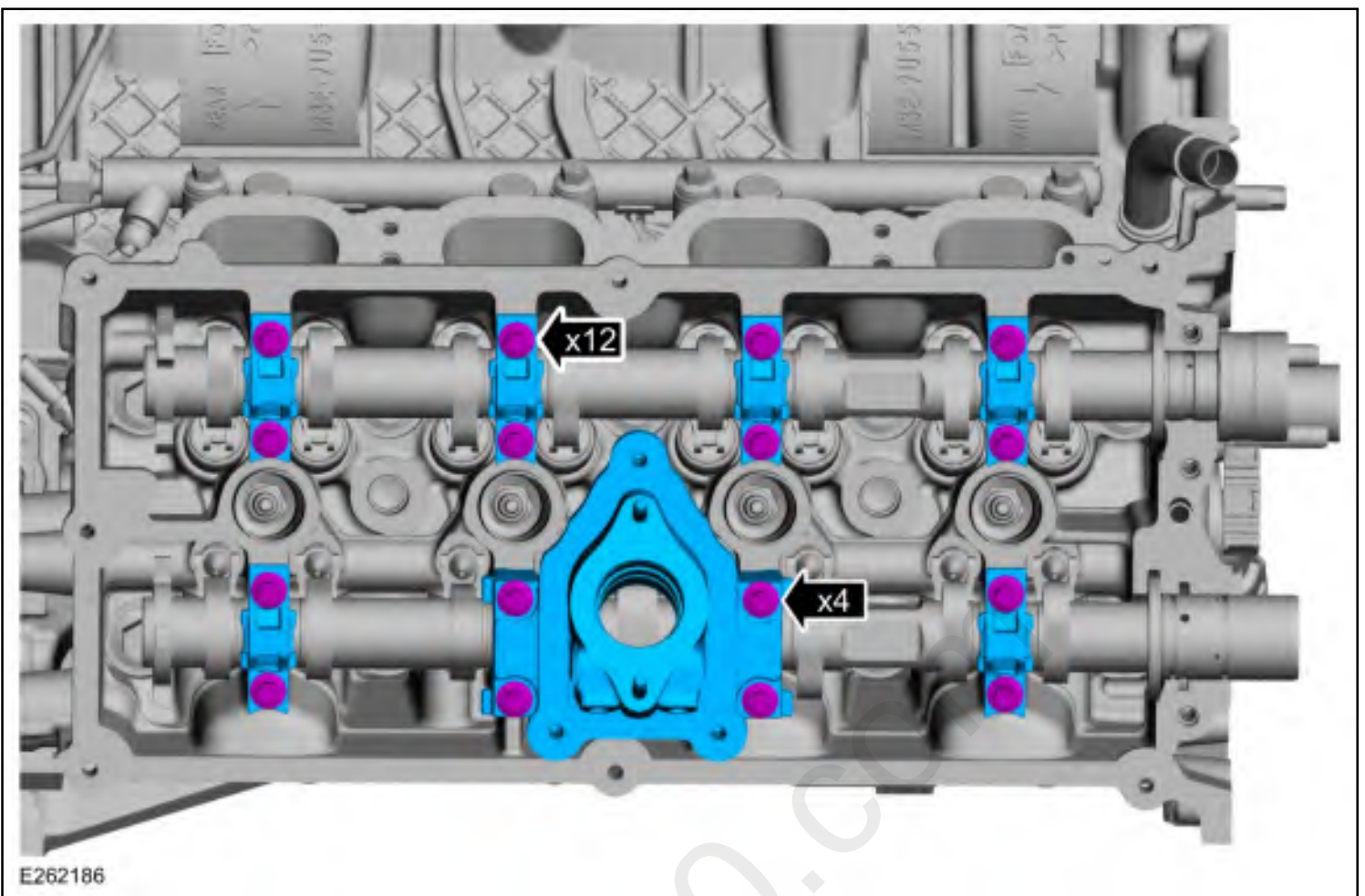
3. **NOTICE:** The front camshaft bearing mega cap must be removed first and then the remaining camshaft bearing caps. Failure to follow this direction may result in damage to the engine.

Remove the bolts and the front camshaft bearing mega cap.

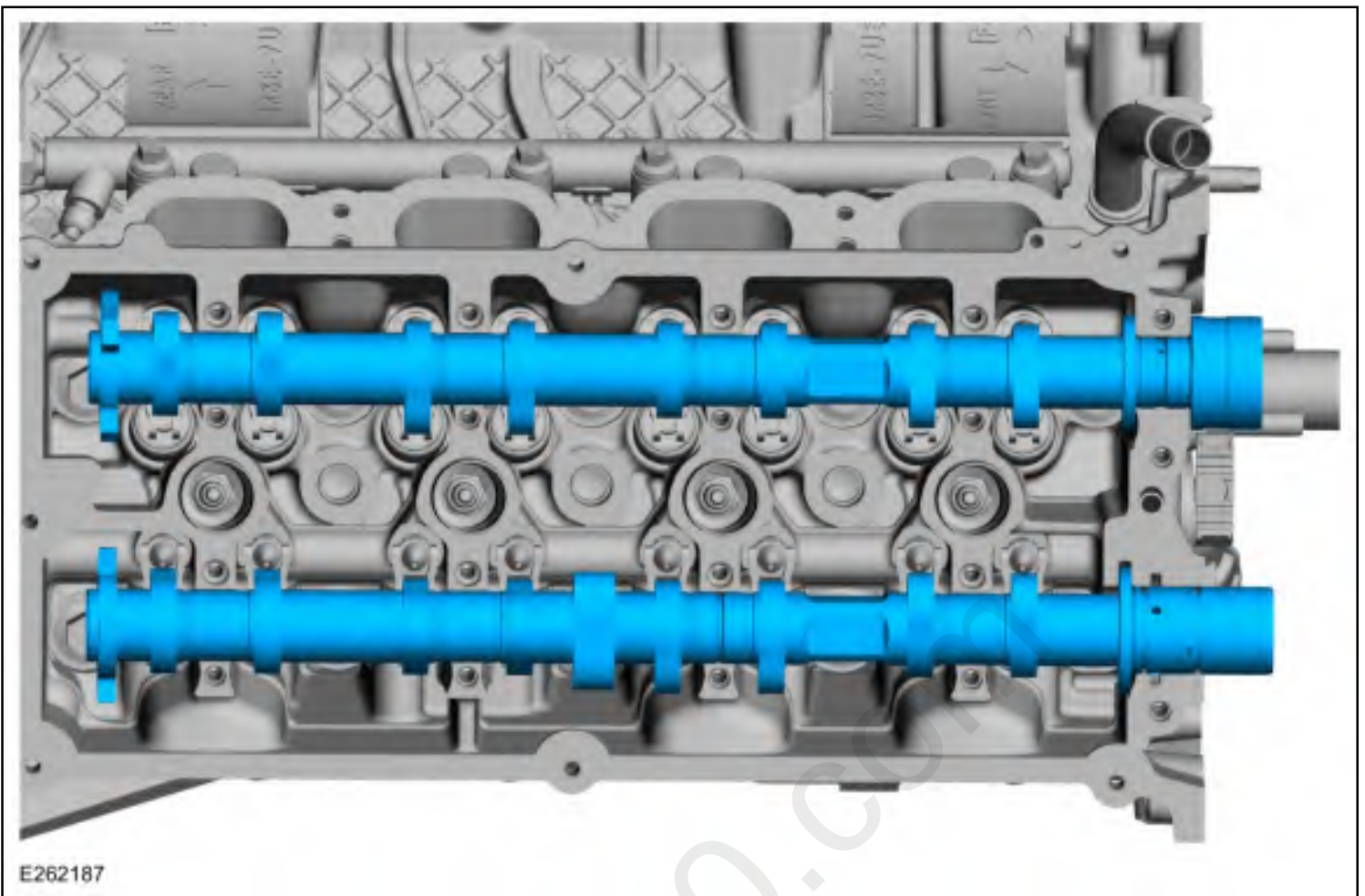


4. Remove the bolts and the camshaft bearing caps.

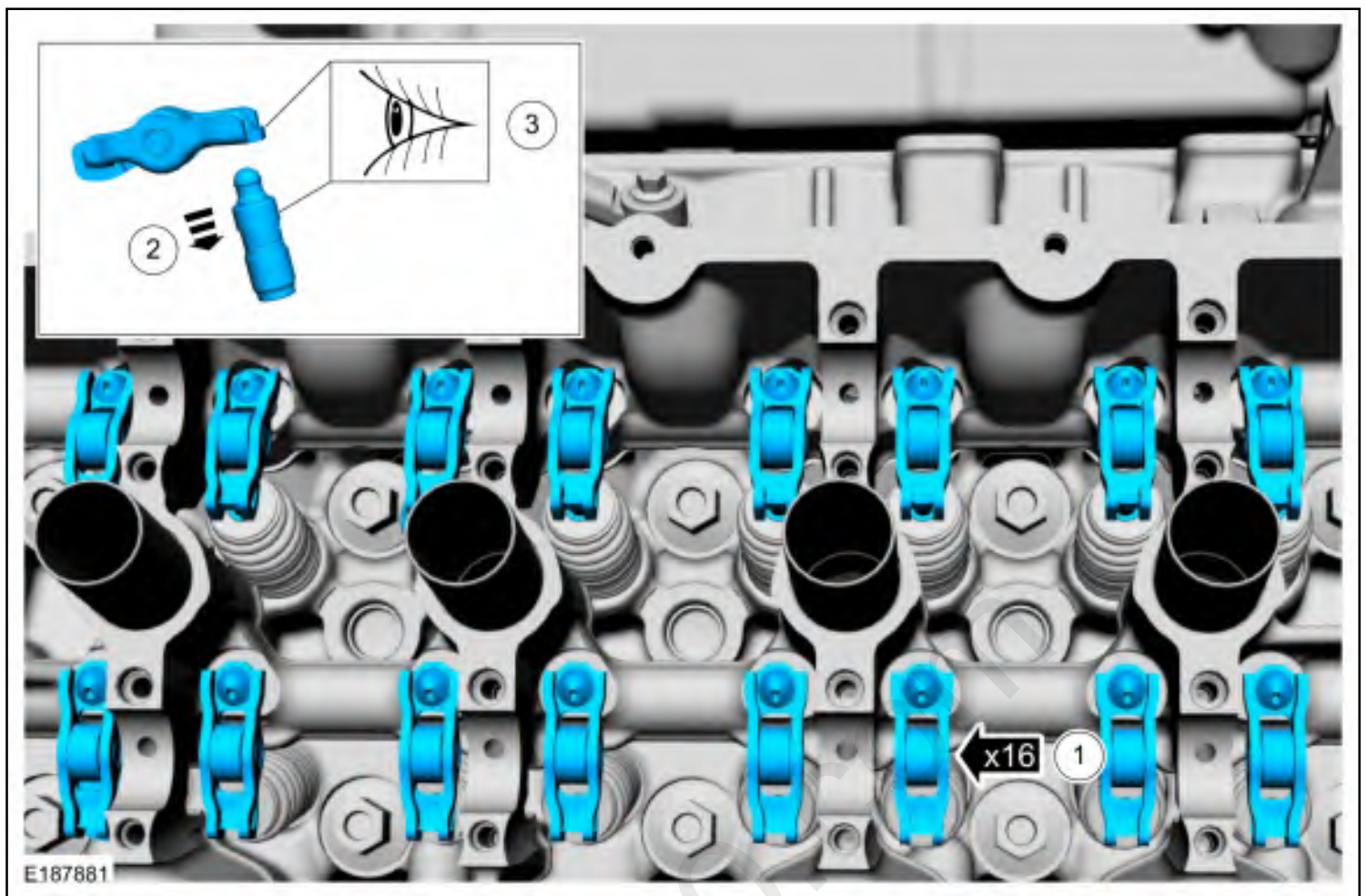




5. Remove the intake and exhaust camshafts.



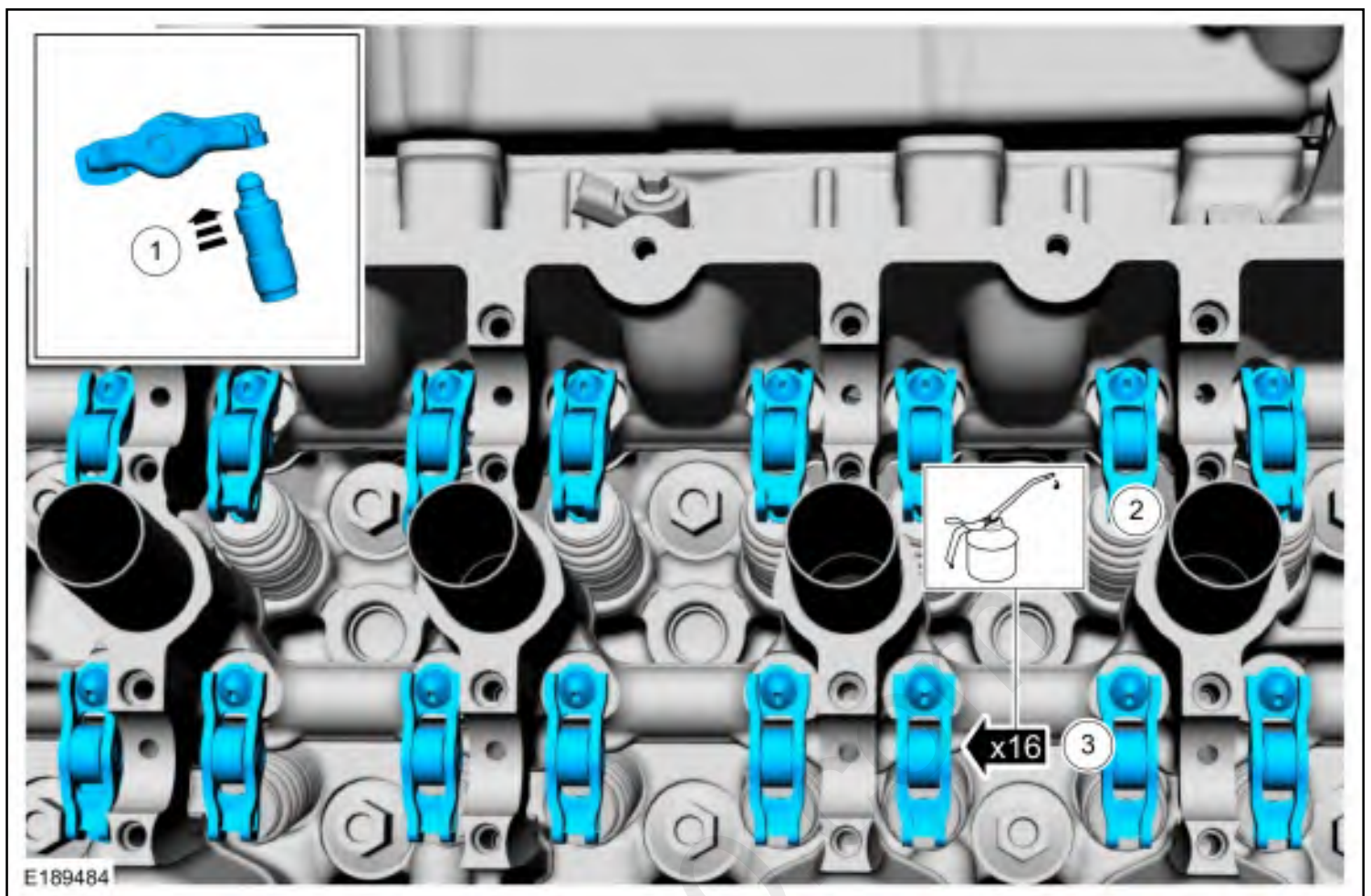
1. Remove the camshaft roller follower and hydraulic lash adjuster assemblies.
2. Separate the hydraulic lash adjusters from the spring clips on the camshaft roller followers.
3. Inspect the hydraulic lash adjuster and roller follower for damage. If any damage is found, inspect the camshaft lobes and valves for damage. Replace damaged components as necessary.



## Installation

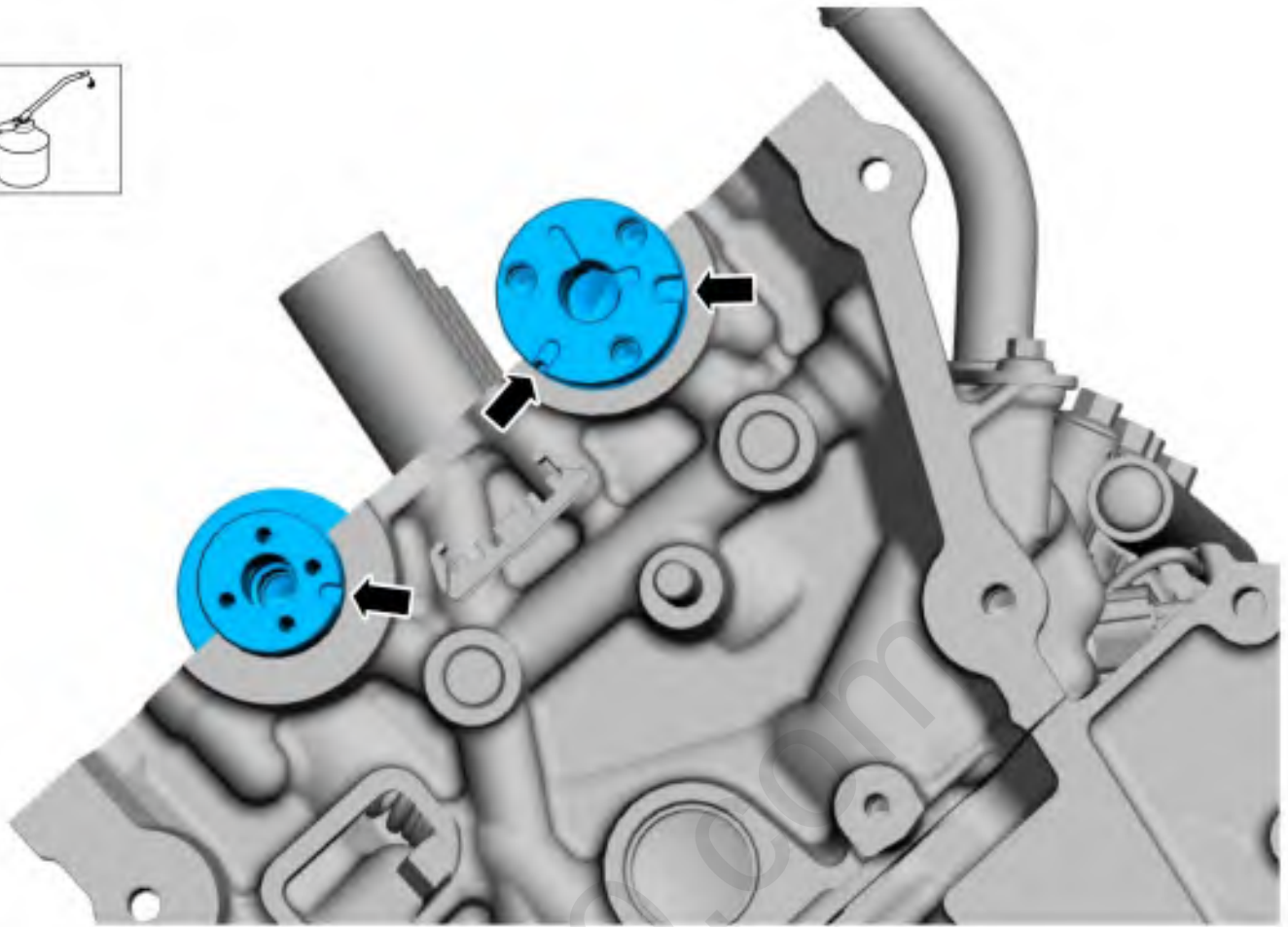
1. **NOTE:** *If the components are to be reinstalled, they must be installed in their original locations.*
  1. Assemble the hydraulic lash adjusters onto the spring clips on the camshaft roller followers.
  2. Lubricate the camshaft roller follower and hydraulic lash adjuster assemblies with clean engine oil.
  3. Install the camshaft roller follower and hydraulic lash adjuster assemblies.





2. **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.

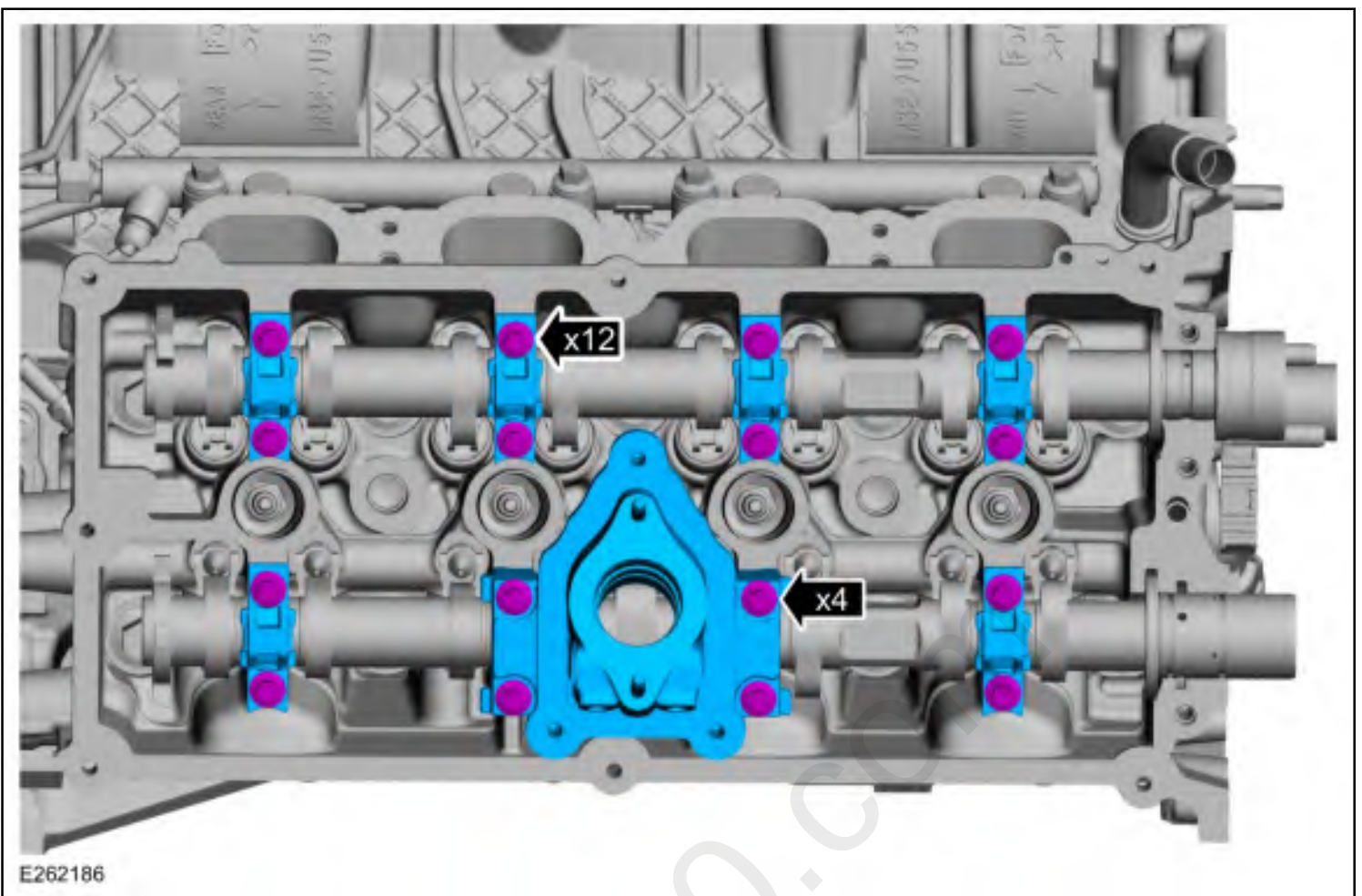


E262188

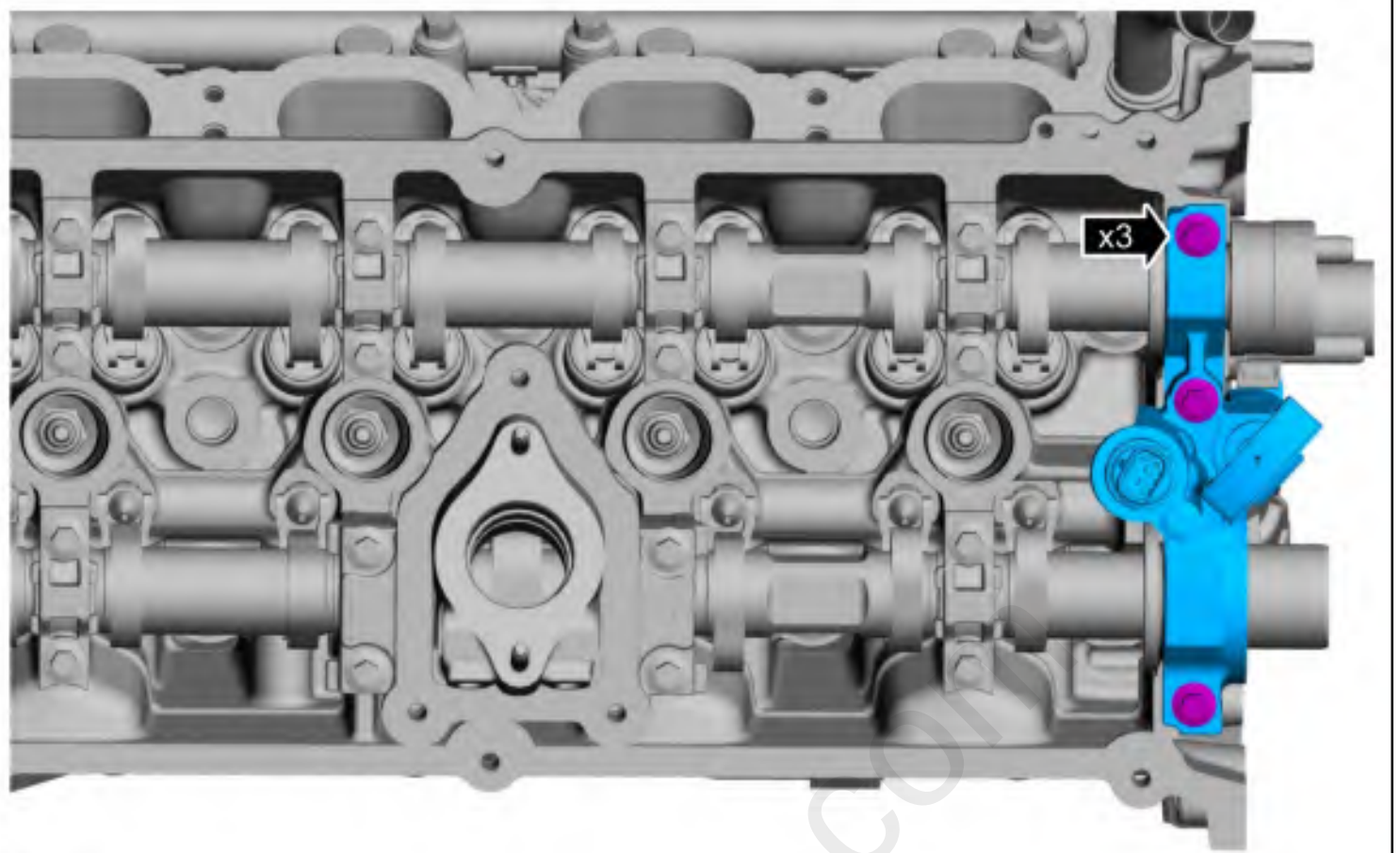


3. Install the camshaft bearing caps and the bolts. Do not tighten at this time.





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



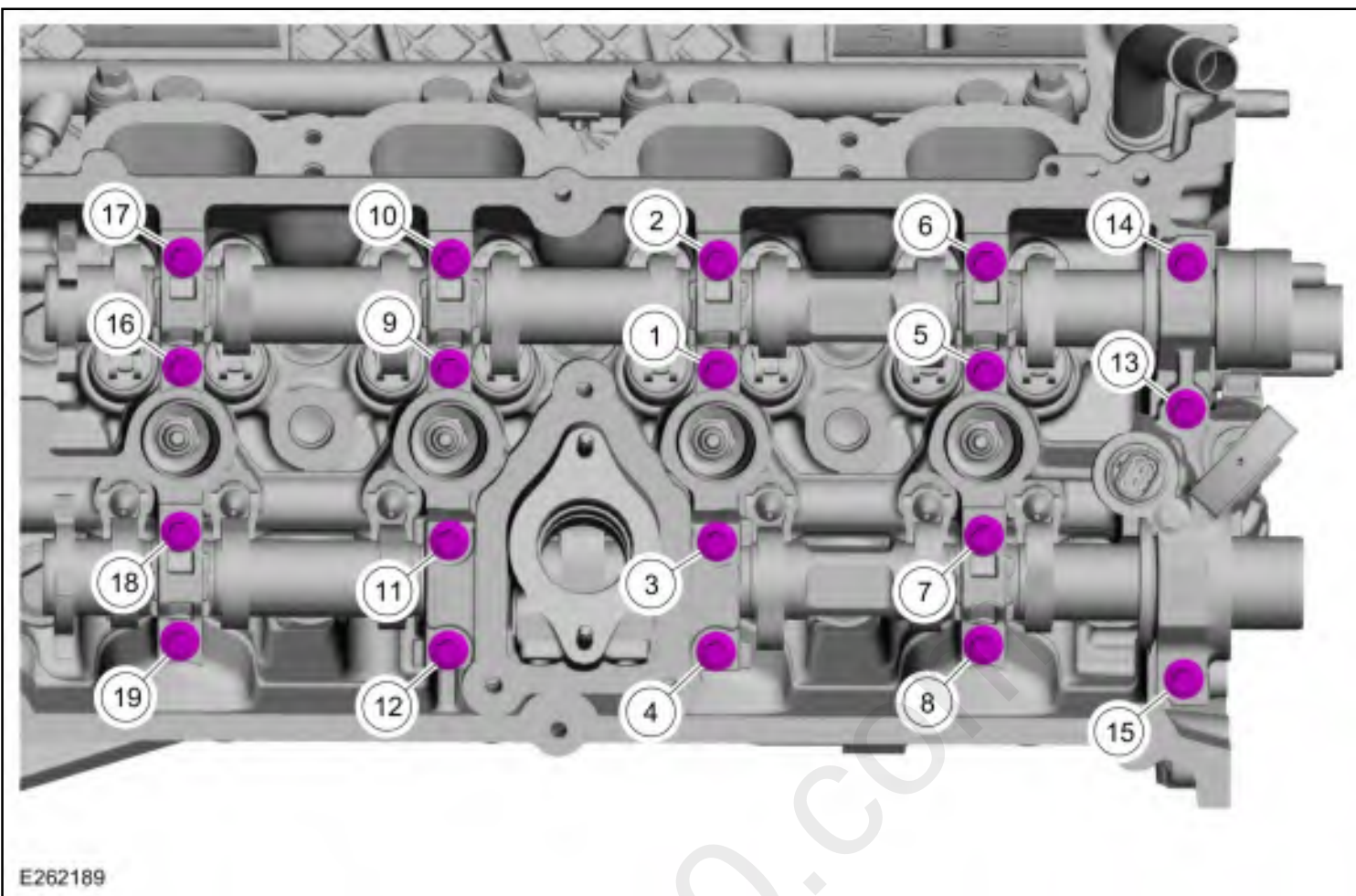
E262060

5. Tighten the bolts in sequence.

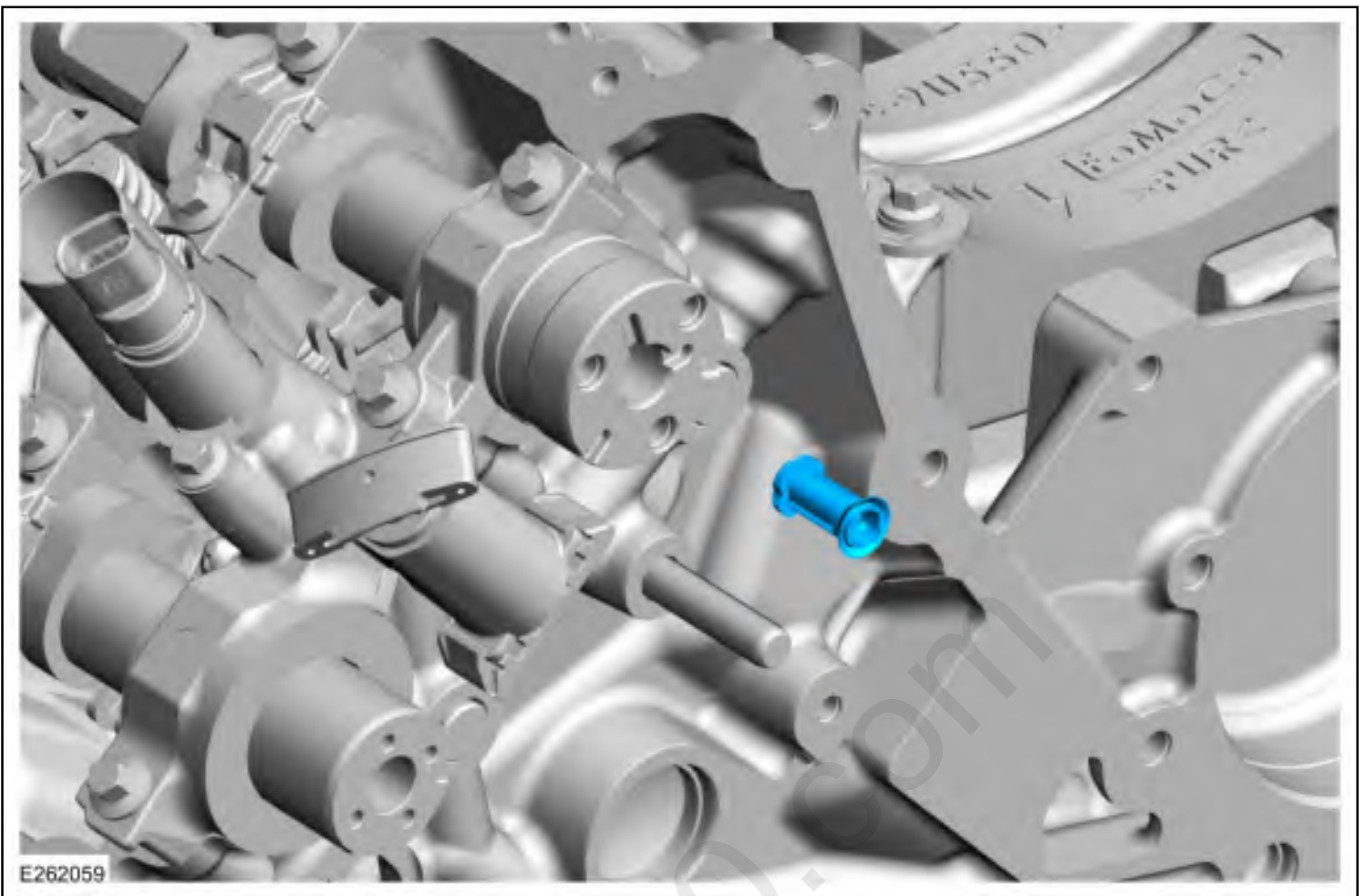
*Torque:*

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°



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



7. Install the RH VCT units.

Refer to: Variable Camshaft Timing (VCT) Unit (303-01 Engine - 5.0L 32V Ti-VCT) .



# Oil Pan

Base Part Number: Base Part Number: 6675

## Special Tool(s) / General Equipment

|                     |
|---------------------|
| Plastic Scraper     |
| Oil Drain Equipment |
| Vehicle/Axle Stands |

## Materials

| Name                                                 | Specification |
|------------------------------------------------------|---------------|
| Motorcraft® Silicone Gasket Remover ZC-30-A          | -             |
| Motorcraft® Metal Surface Prep Wipes ZC-31-B         | -             |
| Motorcraft® Silicone Gasket and Sealant TA-30        | WSE-M4G323-A4 |
| Motorcraft® Metal Brake Parts Cleaner PM-4-A, PM-4-B | -             |

## Removal

**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.

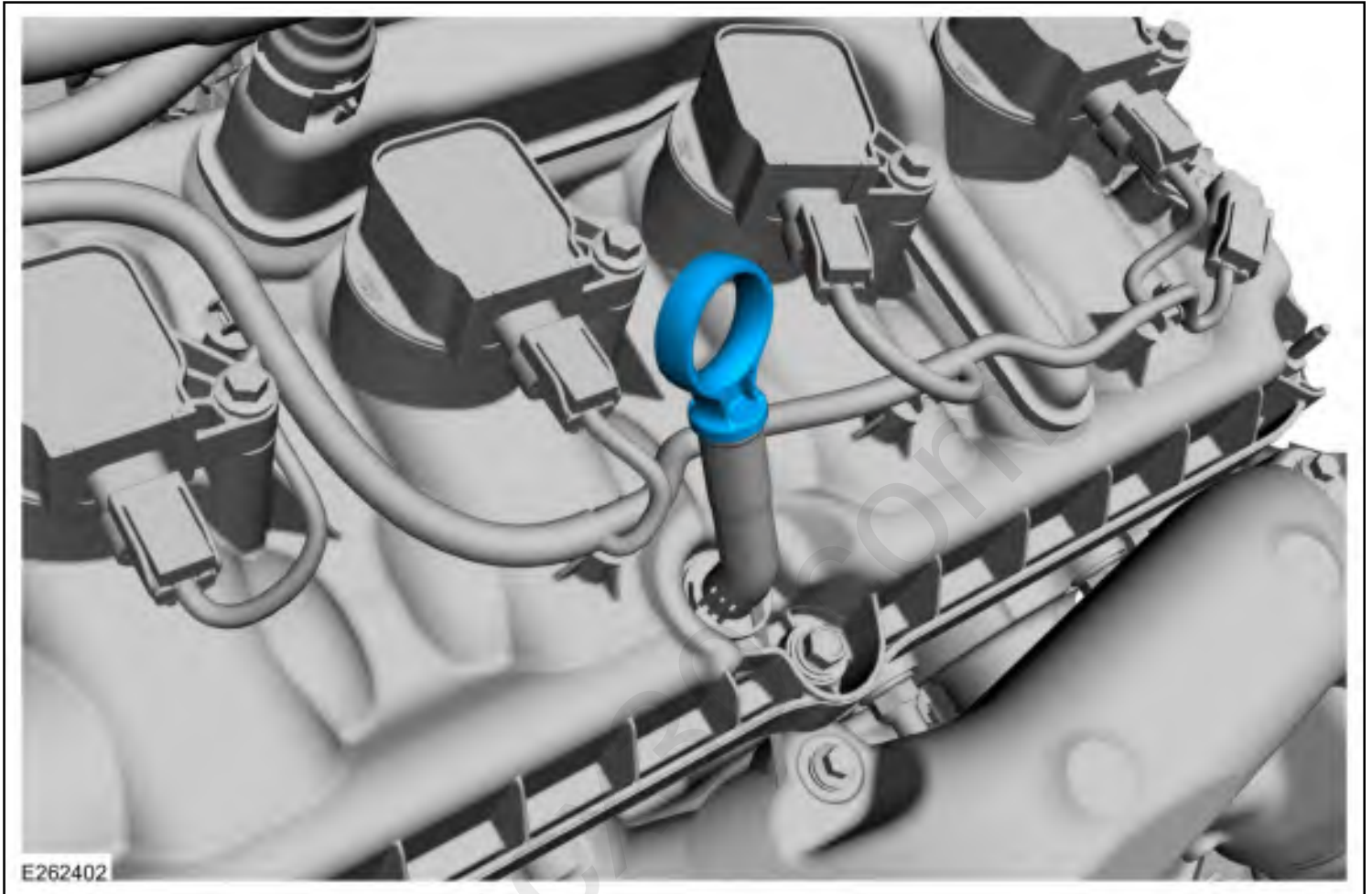
### 4x2/4x4

1. With the vehicle in NEUTRAL, position it on a hoist.

Refer to: [Jacking and Lifting - Overview](#) (100-02 Jacking and Lifting, Description and Operation).

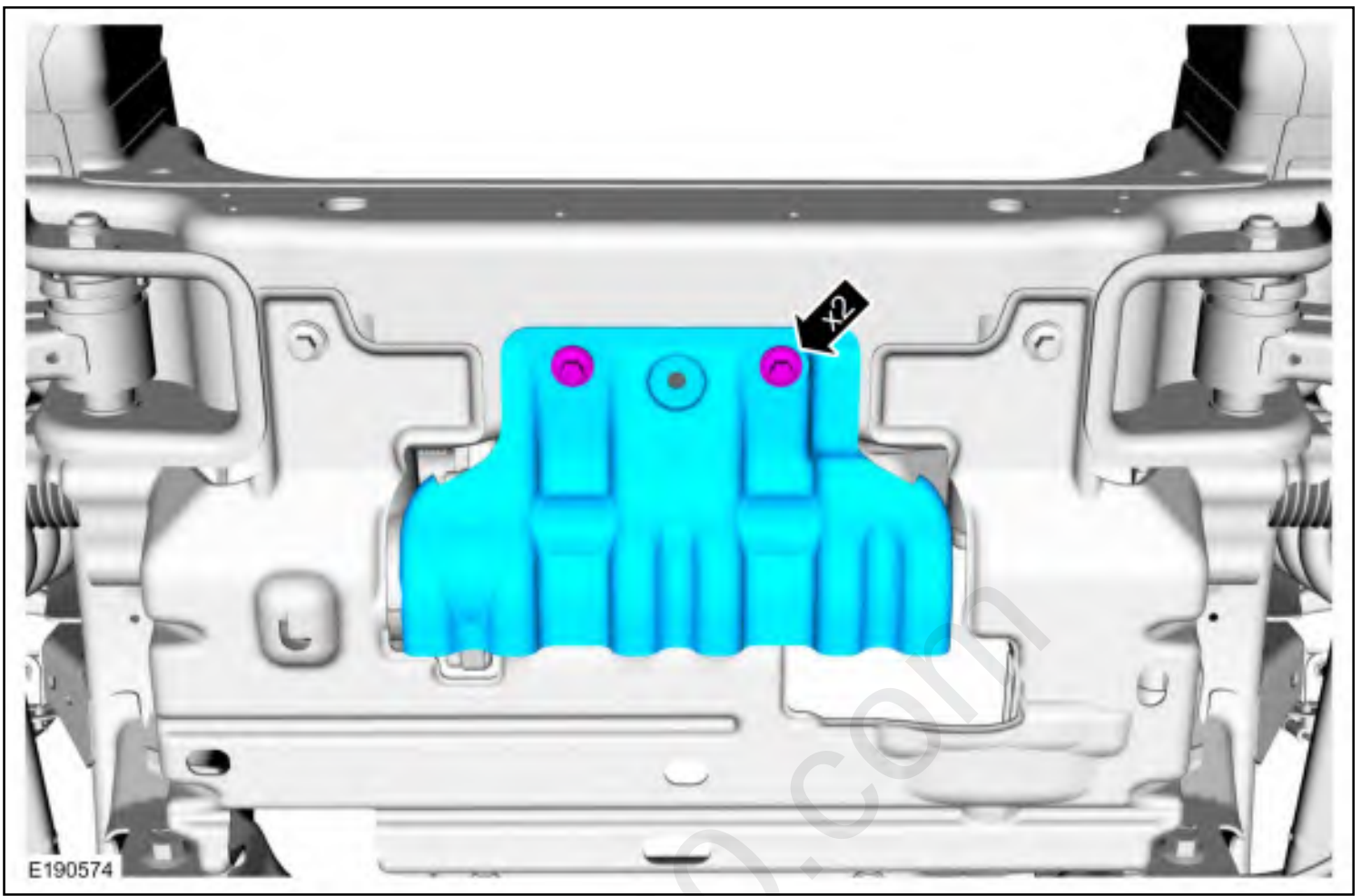


2. Disconnect the battery ground cable.  
Refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables) .
3. Remove the oil level indicator.



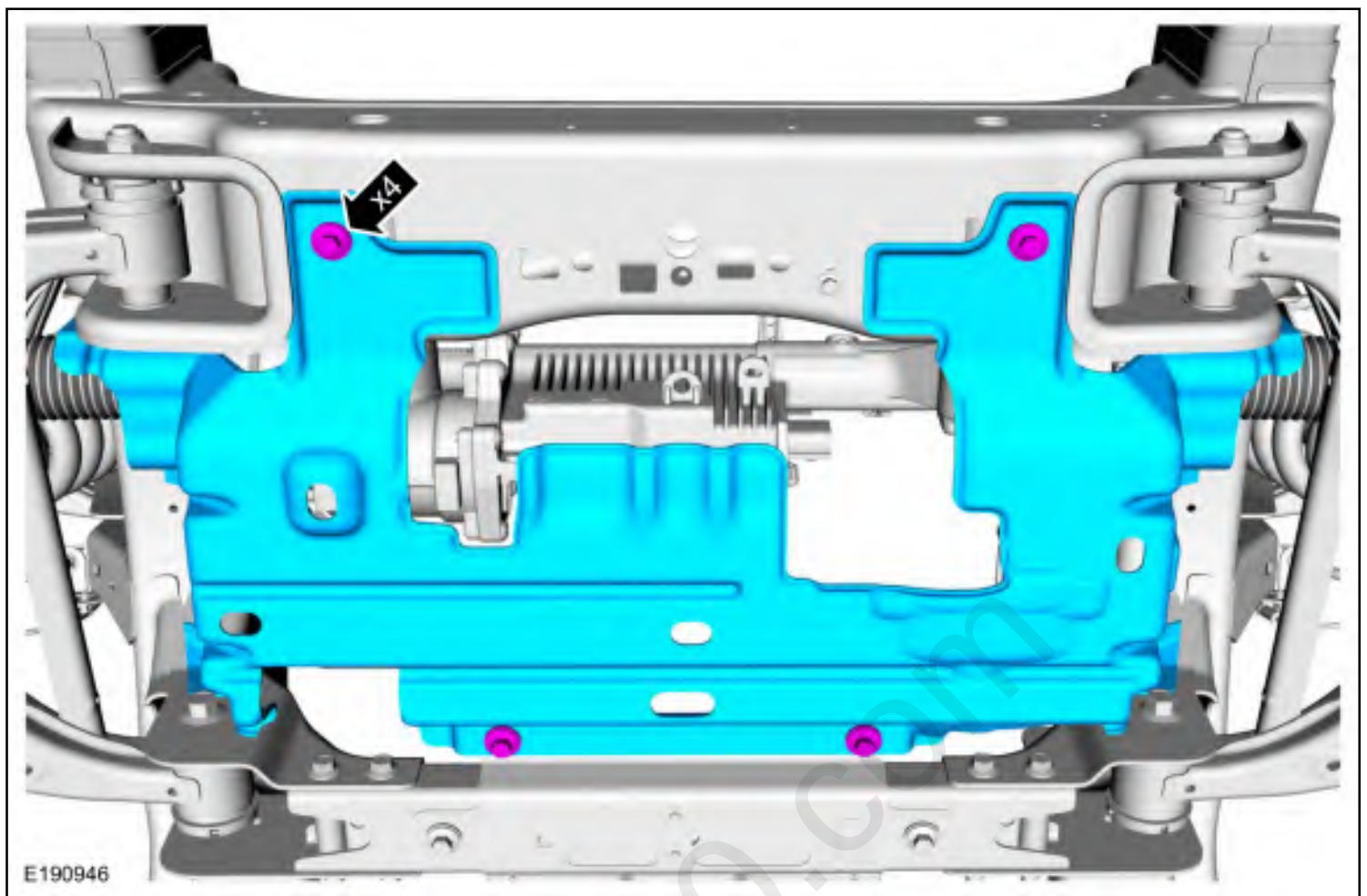
4. **NOTE:** *If equipped.*

Remove the bolts and the skid plate.



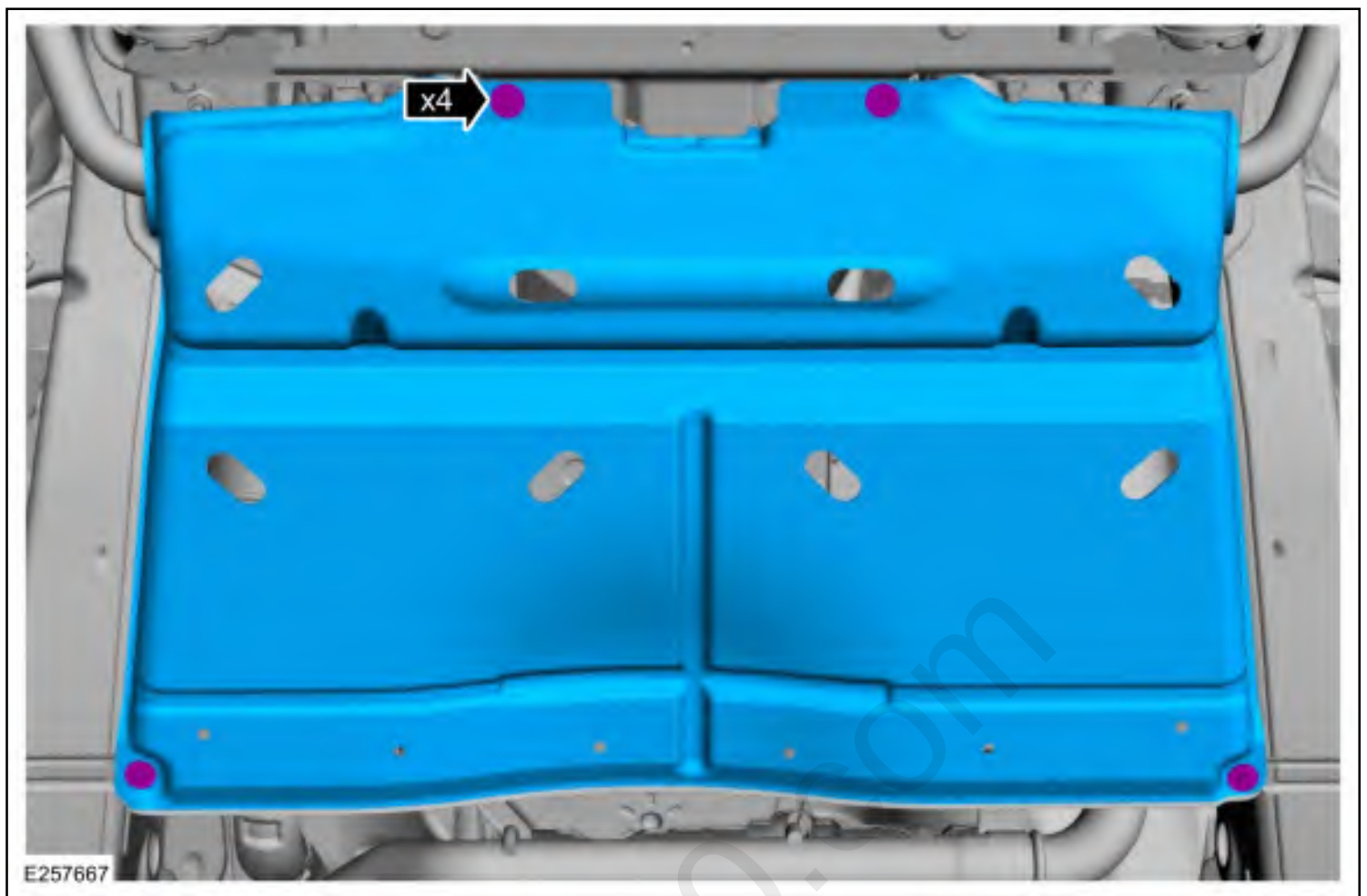
5. **NOTE:** *If equipped.*

Remove the fasteners and the underbody shield.



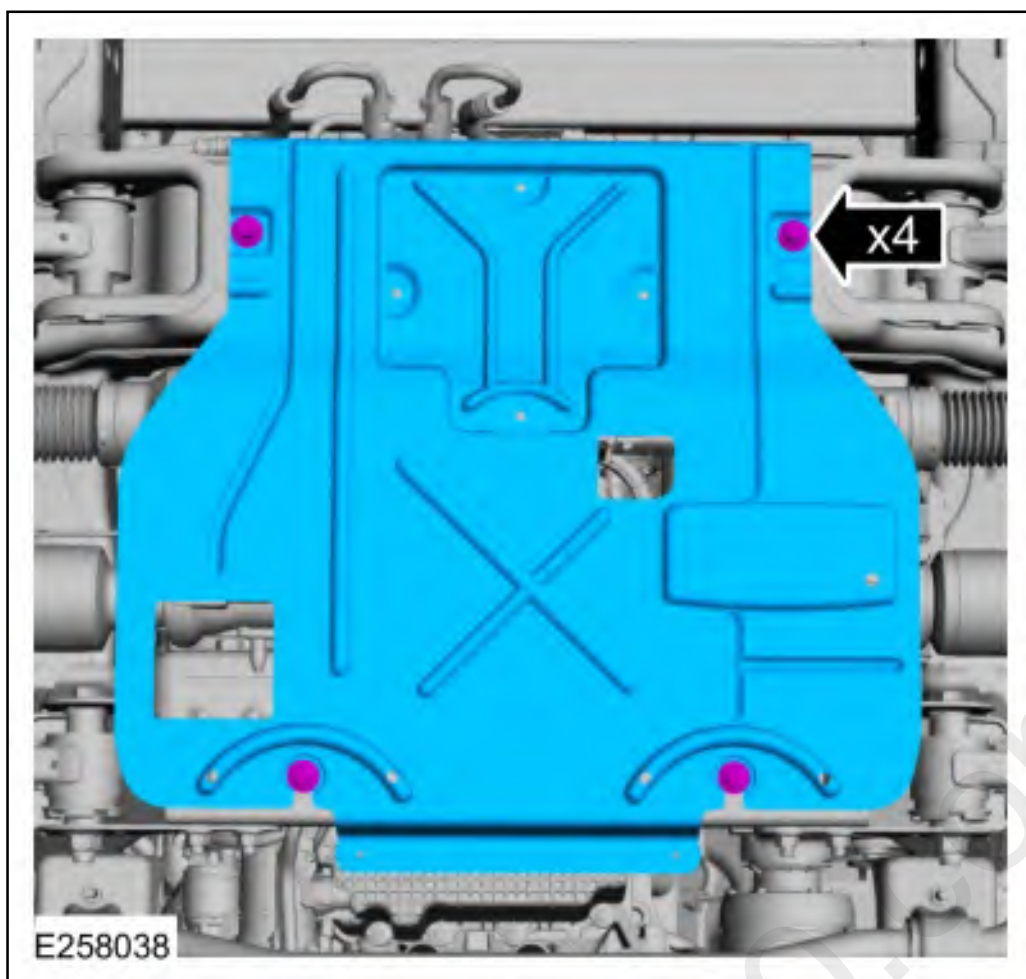
6. **NOTE:** *If equipped.*

Remove the bolts and the underbody shield.



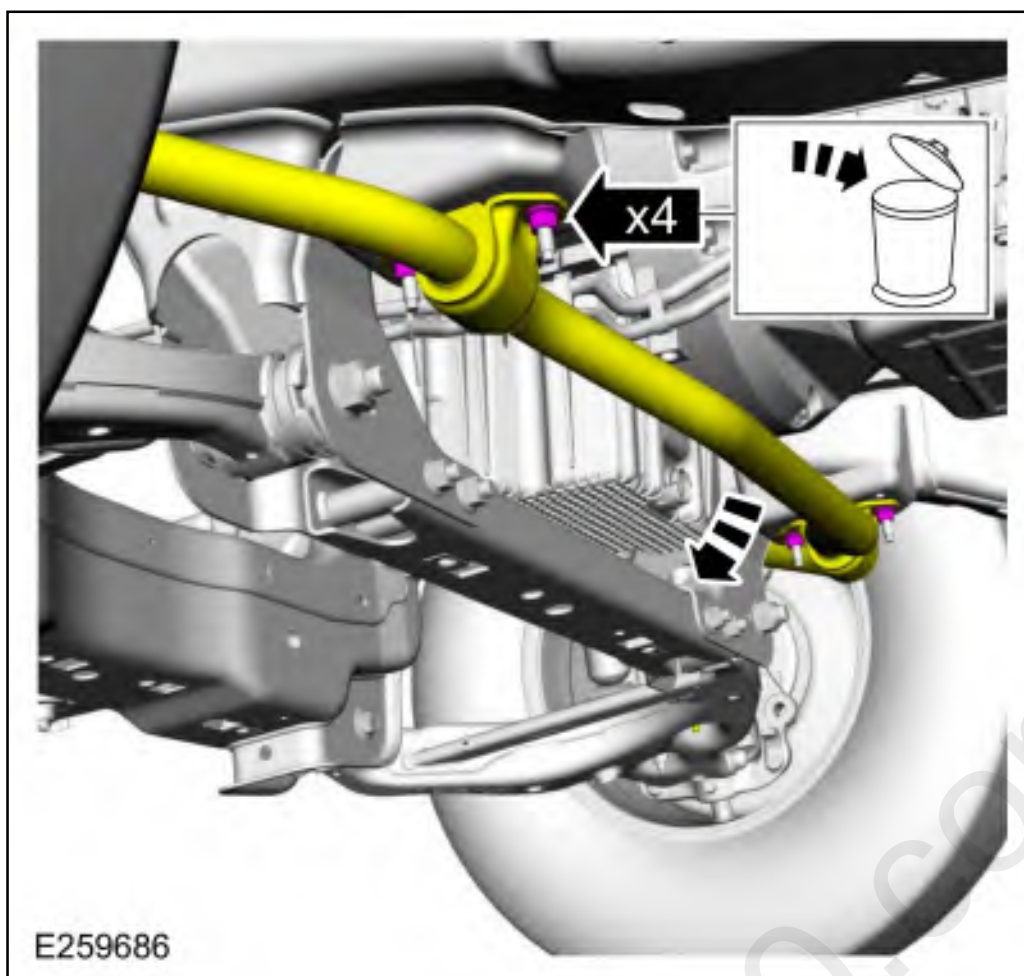
7. **NOTE:** *If equipped.*

Remove the bolts and the skid plate.

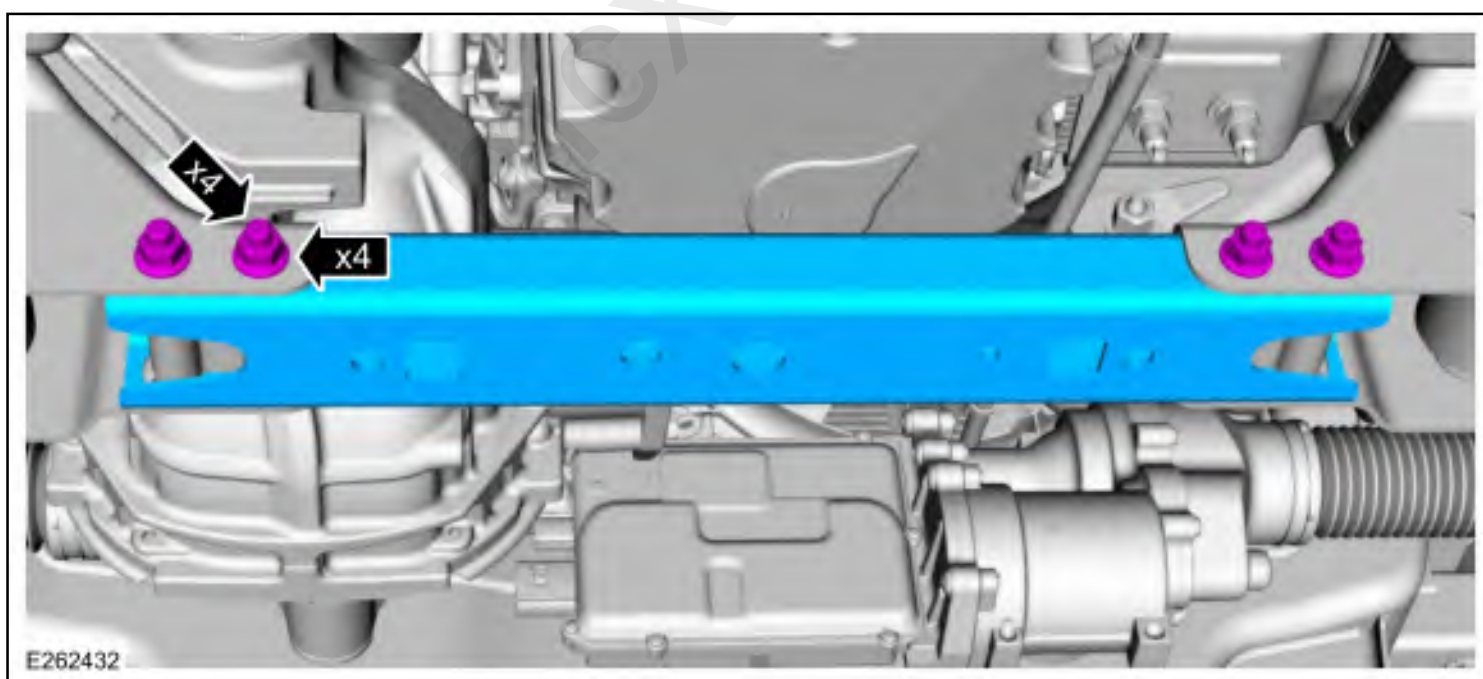


8. Remove and discard the stabilizer bar bracket nuts.
  - Allow the stabilizer bar to swing downward.





9. Remove the nuts, bolts and the crossmember.



10. Remove the following items:
1. Transmission fluid cooler.

Refer to: [Transmission Fluid Cooler - 2.7L EcoBoost \(238kW/324PS\)/3.5L EcoBoost \(272kW/370PS\)/5.0L 32V Ti-VCT \(307-02 Transmission Cooling, Removal and Installation\)](#).

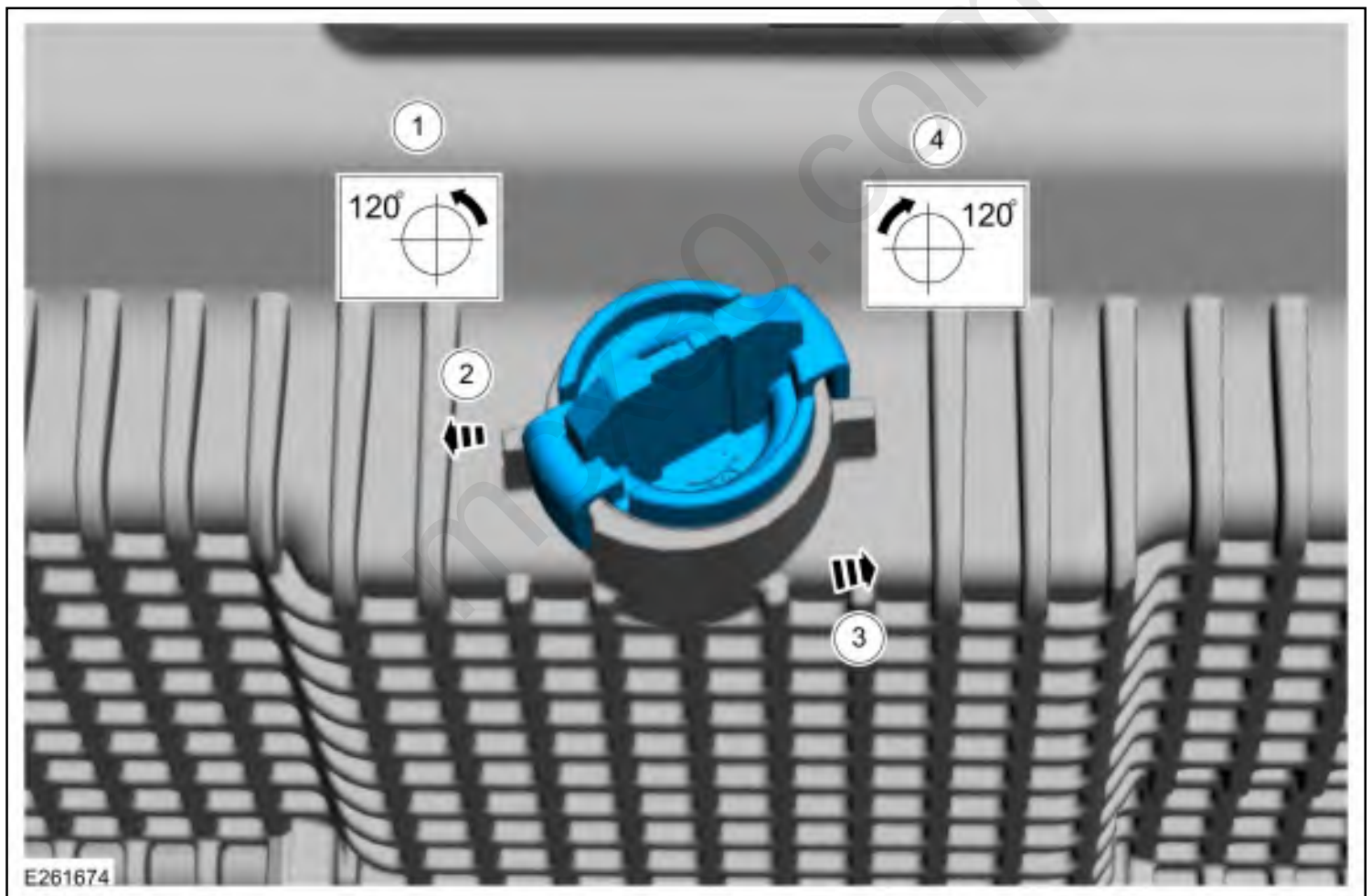
2. Engine oil cooler.

Refer to: [Oil Cooler](#) (303-01D Engine - 5.0L 32V Ti-VCT, Removal and Installation).

11. **NOTE:** *The drain plug should be removed and installed by hand, do not use tools.*

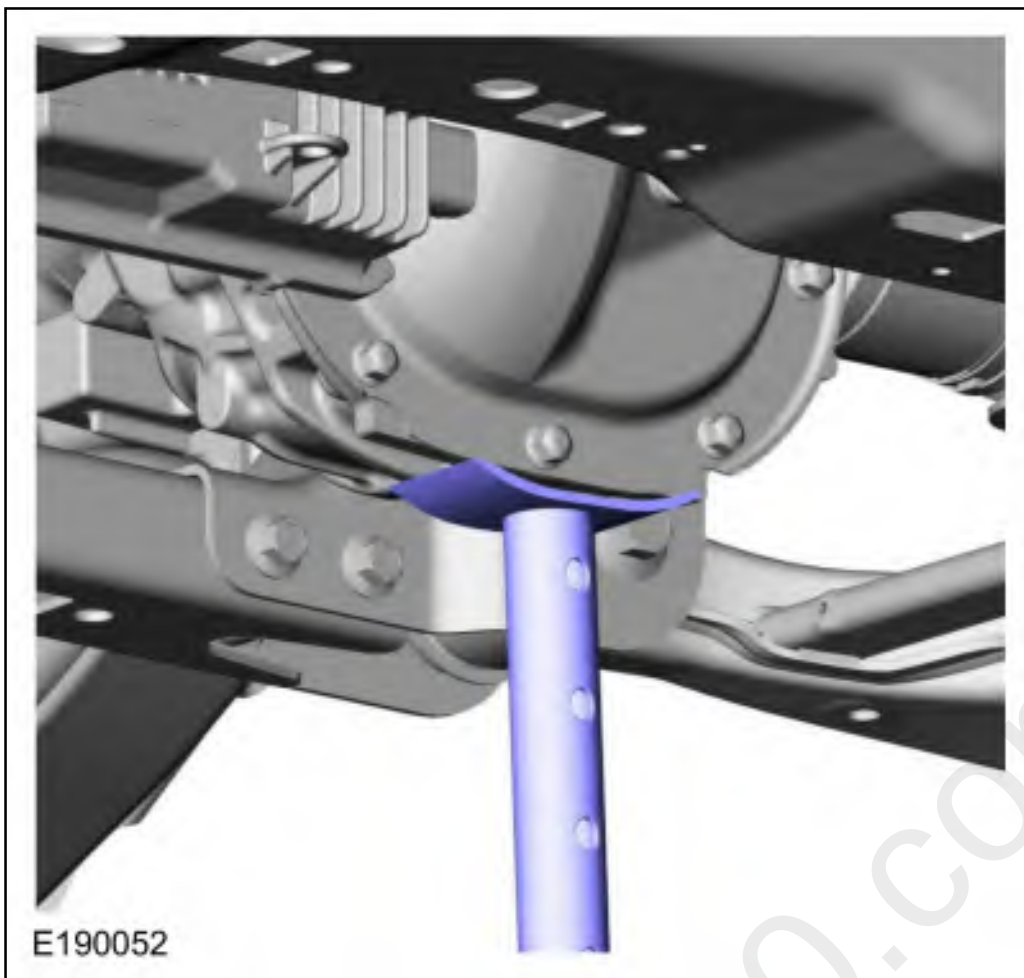
1. Turn the oil drain plug by hand counterclockwise 120 degrees.  
Use the General Equipment: Oil Drain Equipment
2. Pull the oil drain plug out of the oil pan.
3. After the oil has drained, push the oil drain plug into the oil pan.
4. **NOTICE: Overtightening will damage the oil drain plug and possibly the oil pan.**

Turn the oil drain plug by hand clockwise 120 degrees.

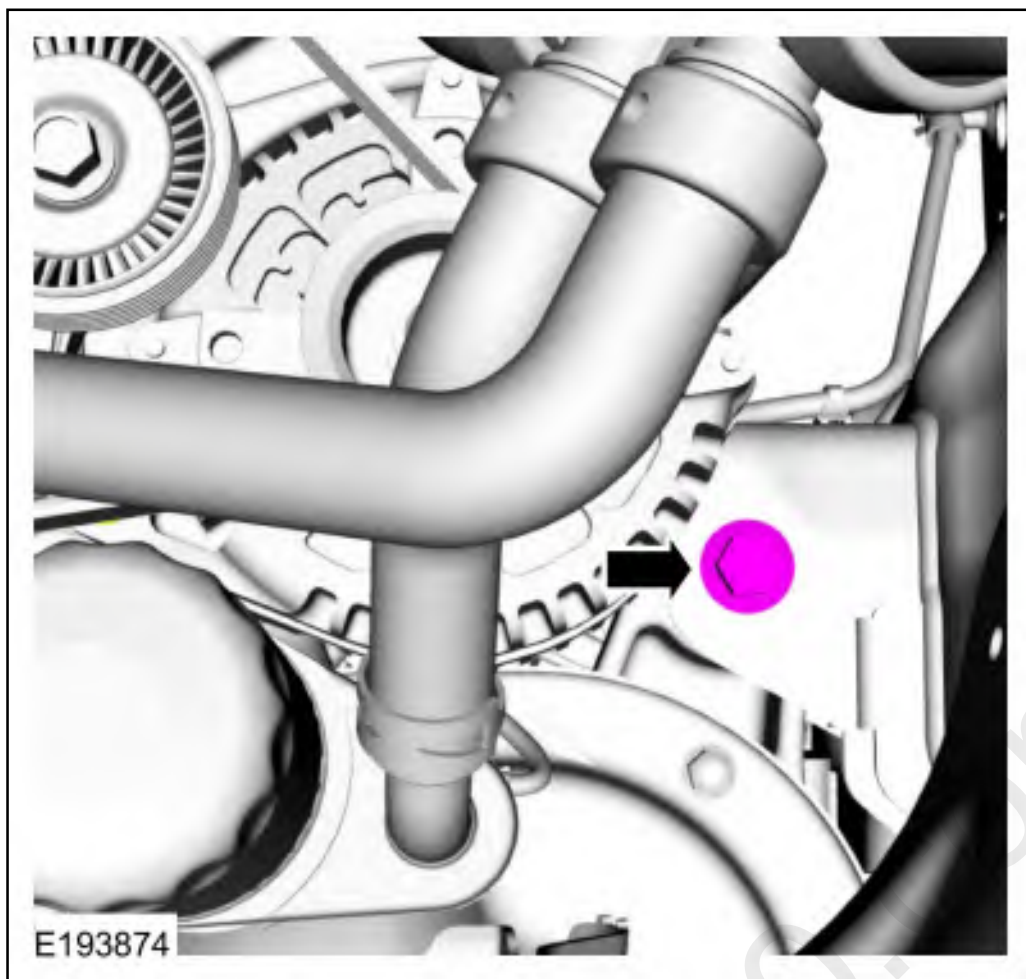


4x4

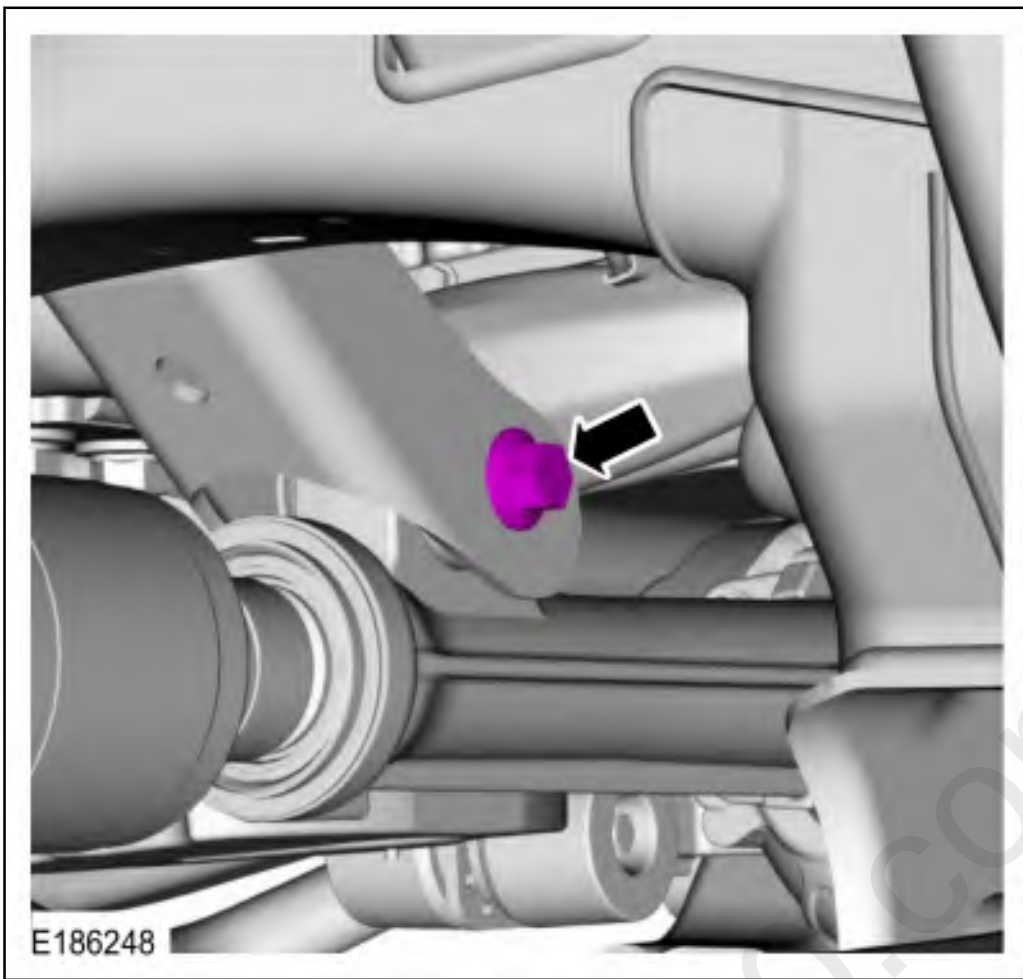
12. Using an adjustable stand, support the front axle.  
Use the General Equipment: Vehicle/Axle Stands



13. Remove the upper front axle carrier mounting bushing bolt.

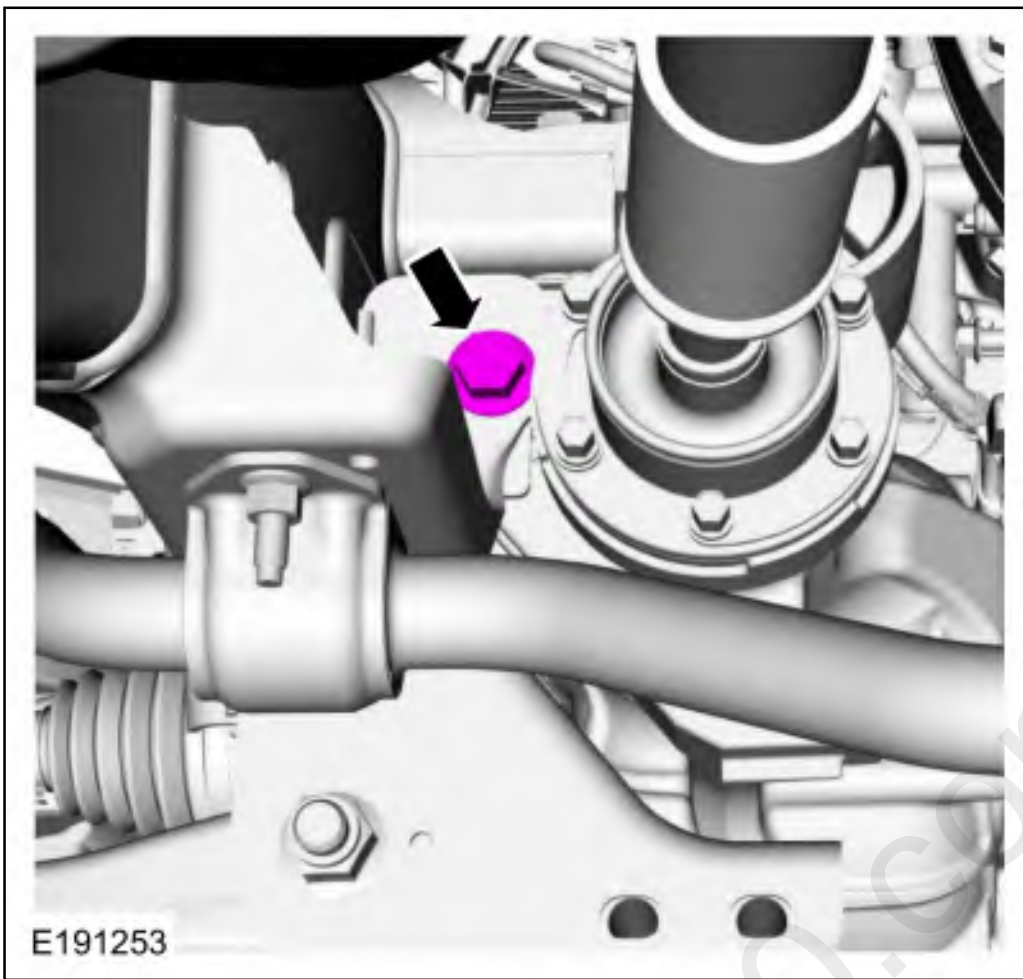


14. Remove the axle shaft housing carrier bushing bolt.

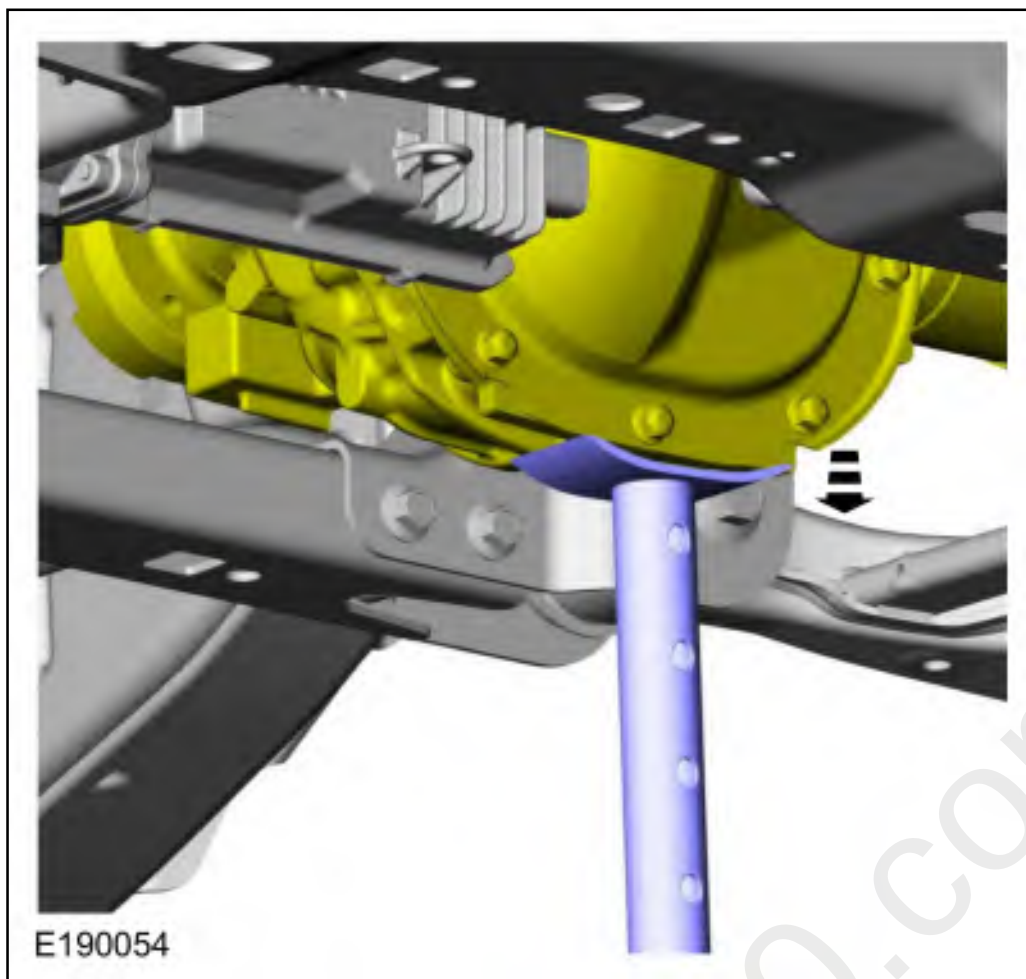


15. Remove the lower front axle carrier mounting bushing bolt.



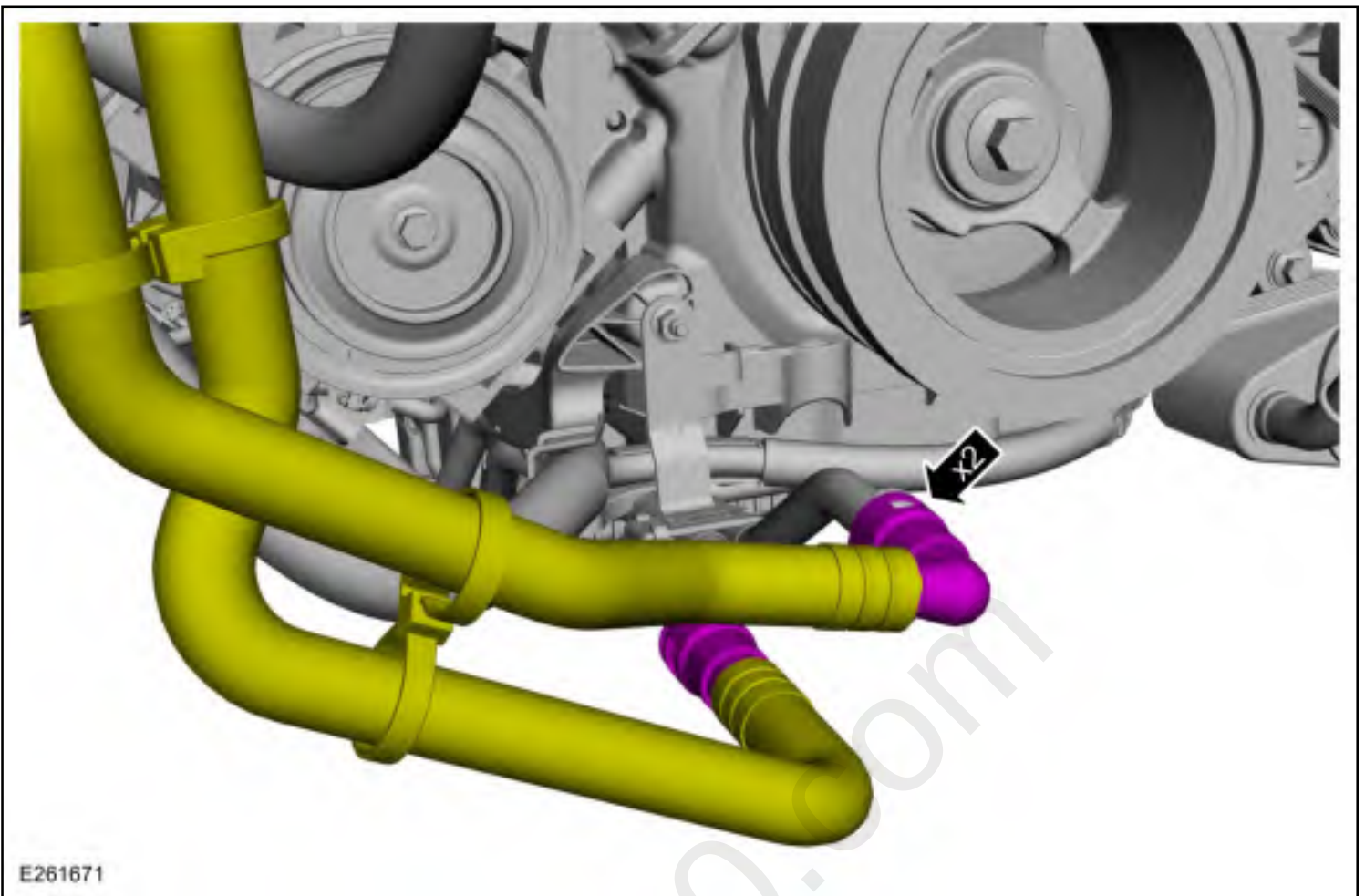


16. Using an adjustable stand, lower the axle to allow clearance for the oil pan to be removed.  
Use the General Equipment: Vehicle/Axle Stands

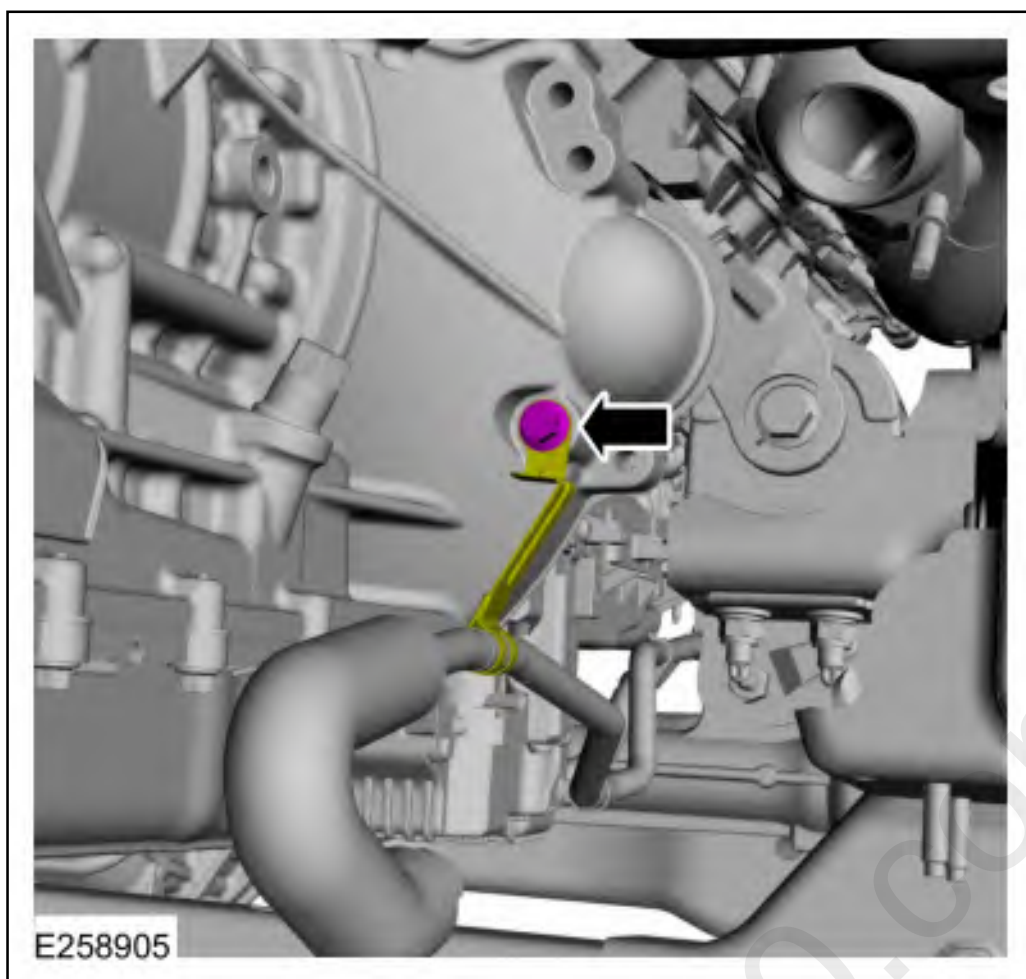


4x2/4x4

17. Disconnect the coolant hose quick release couplings.

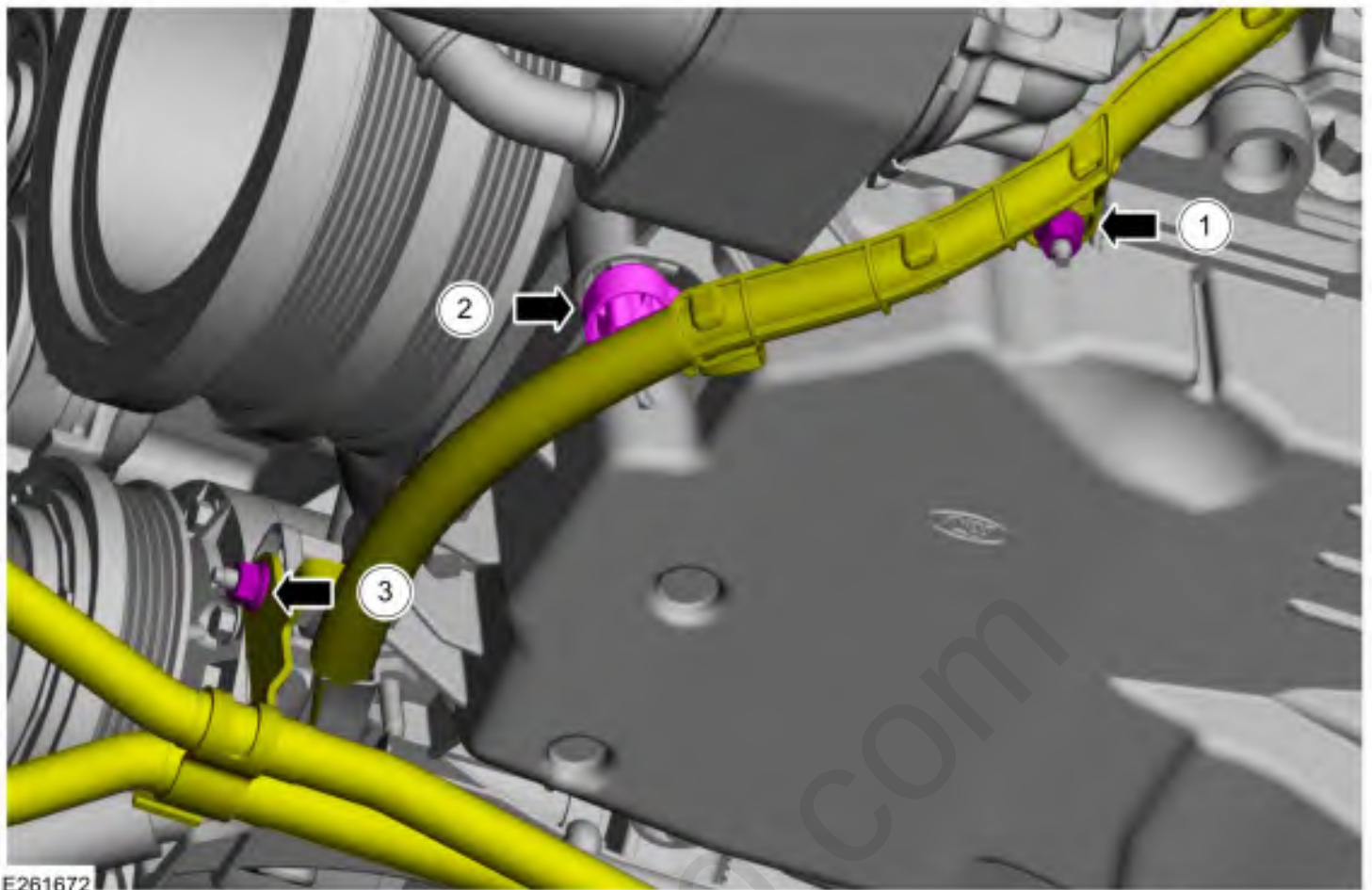


18. Remove the transmission-to-engine bolt and transmission cooler tube support bracket.

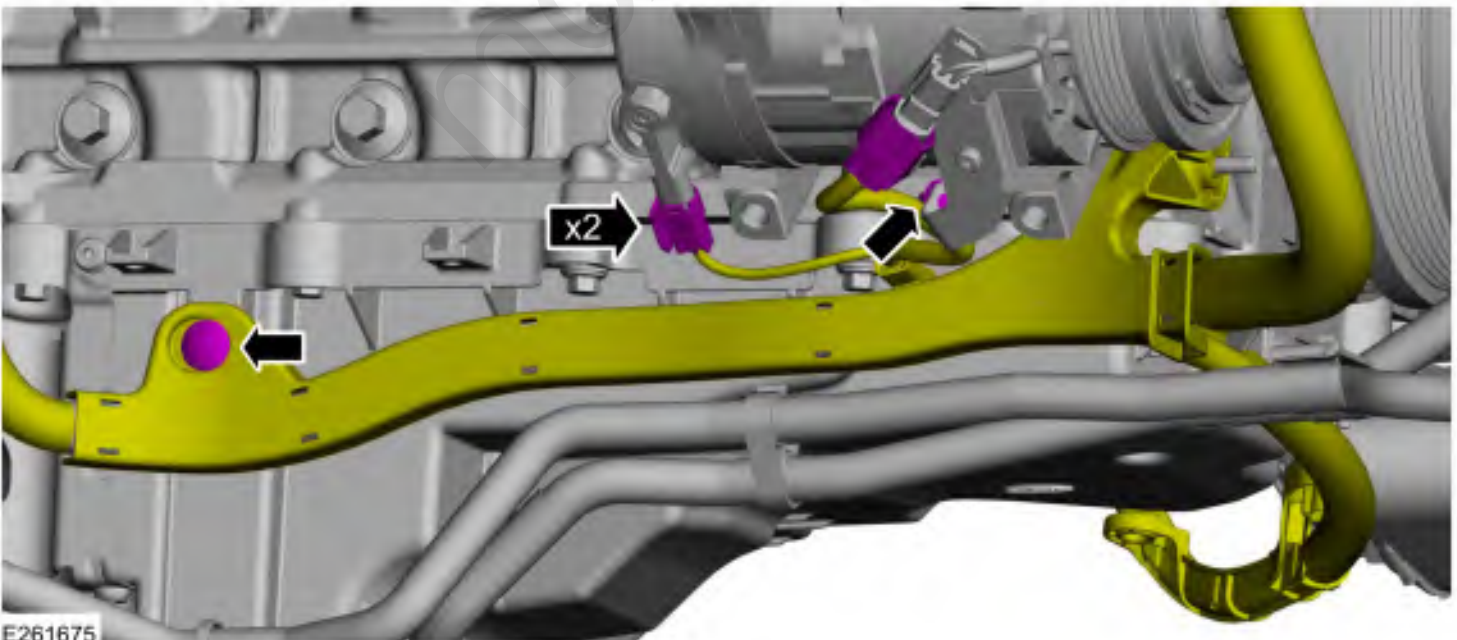


1. Remove the nut.
2. Detach the wiring harness retainer.
3. Remove the nut and position the coolant tube and wiring harness brackets aside.



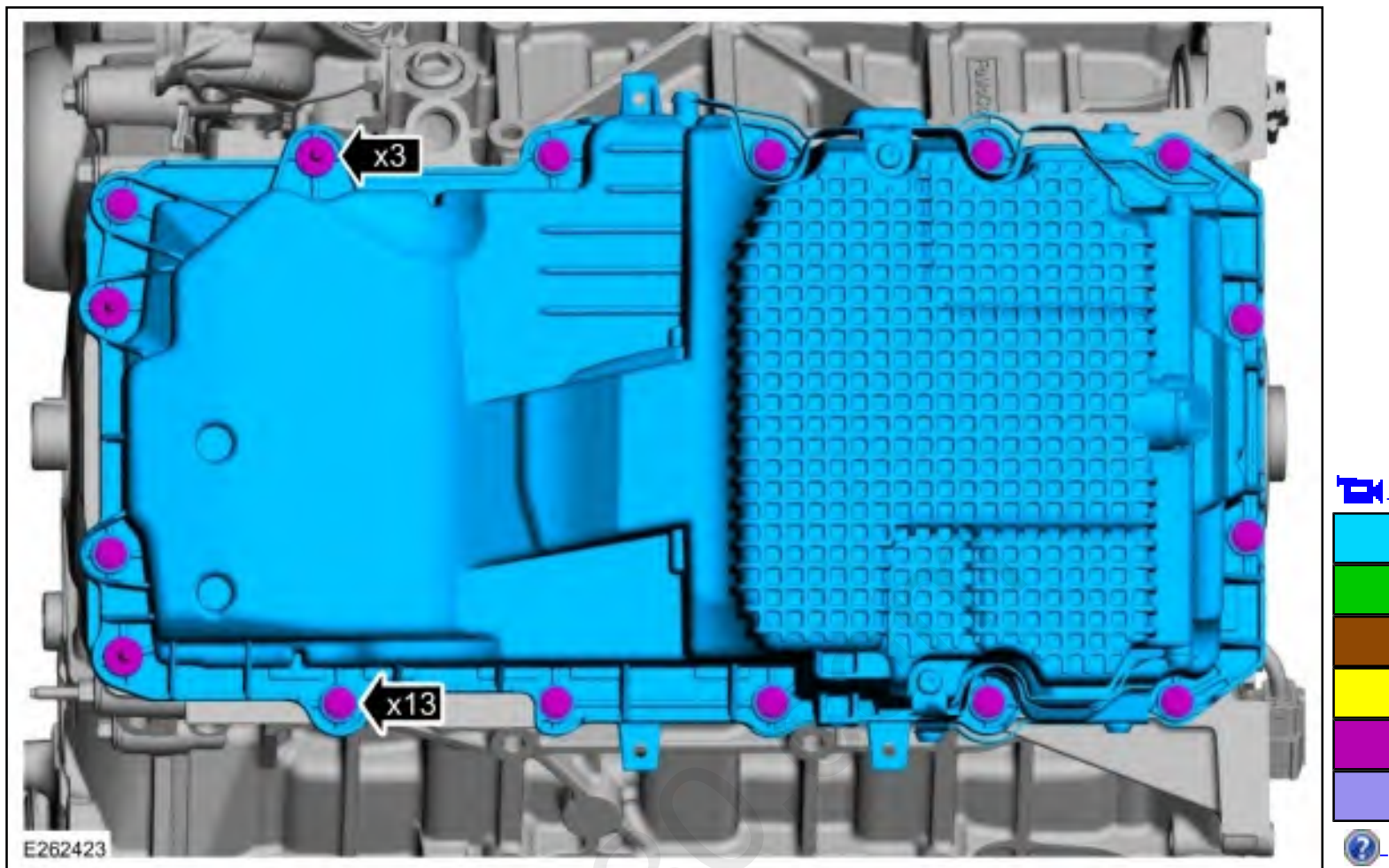


1. Disconnect the A/C compressor electrical connectors.
2. Detach the wiring harness retainers.

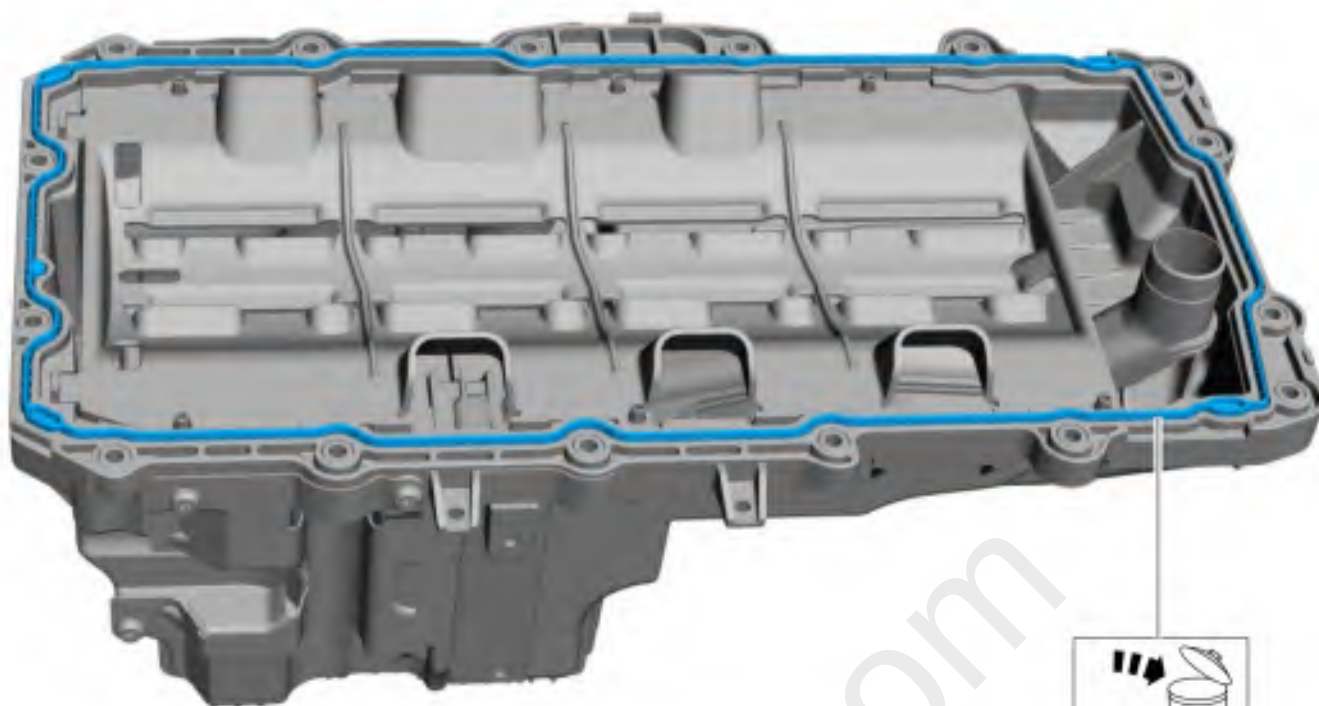


21. Remove the bolts, stud bolts and the oil pan.





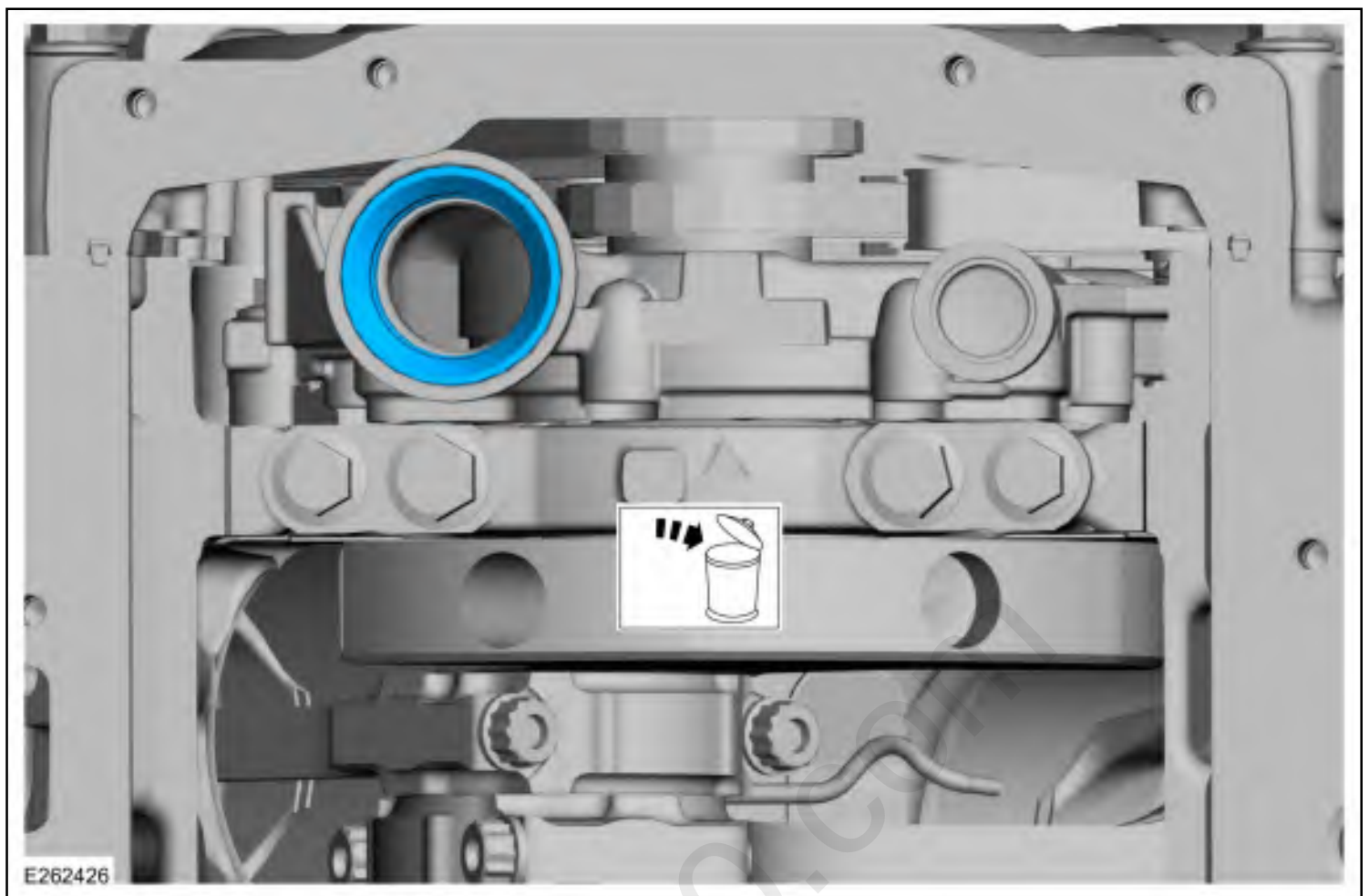
22. Remove and discard the oil pan gasket.



E262424

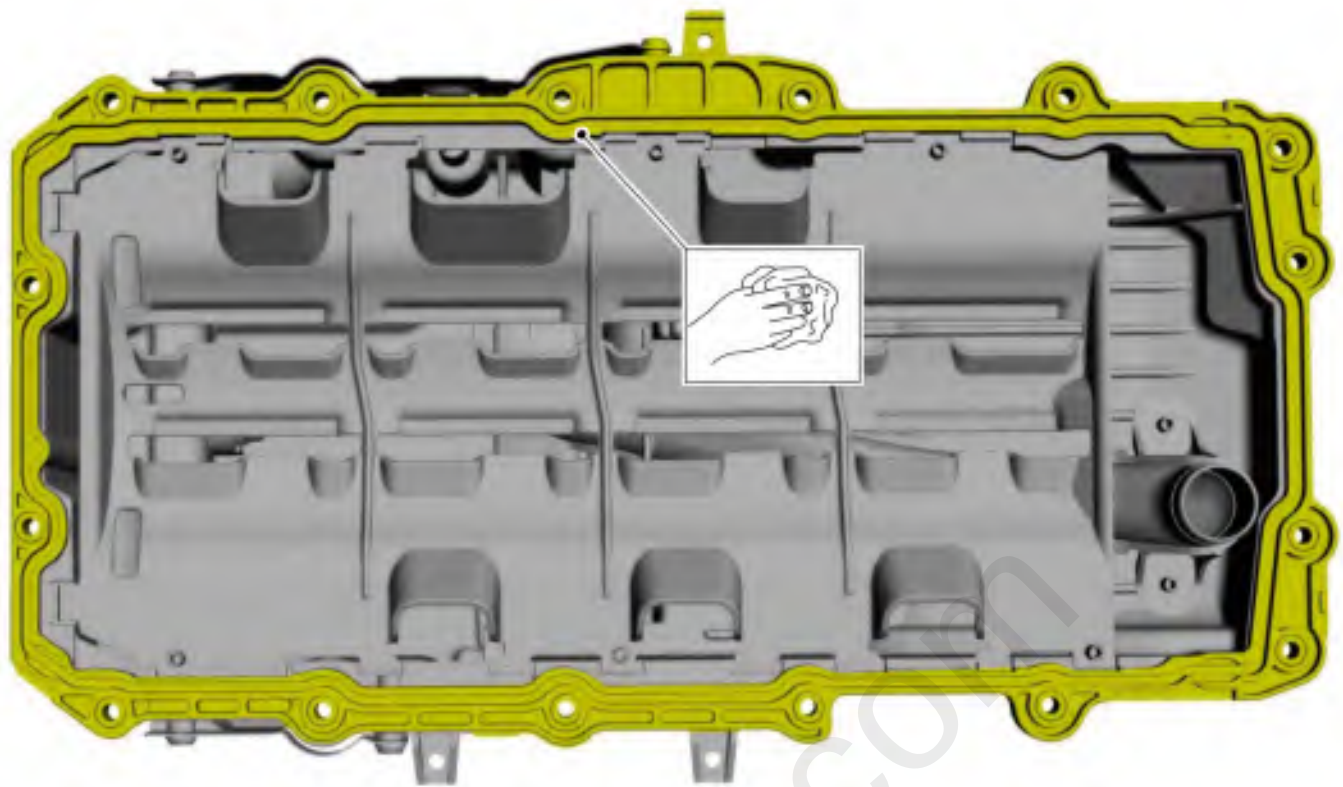
23. Remove and discard the oil pump pickup seal.





24. **NOTICE:** Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the sealing surfaces. These tools cause scratches and gouges, which make leak paths.

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



E262427

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

Make sure that the oil pan mating faces of the cylinder block, engine front cover and rear seal retaining plate are clean and free of foreign material.

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

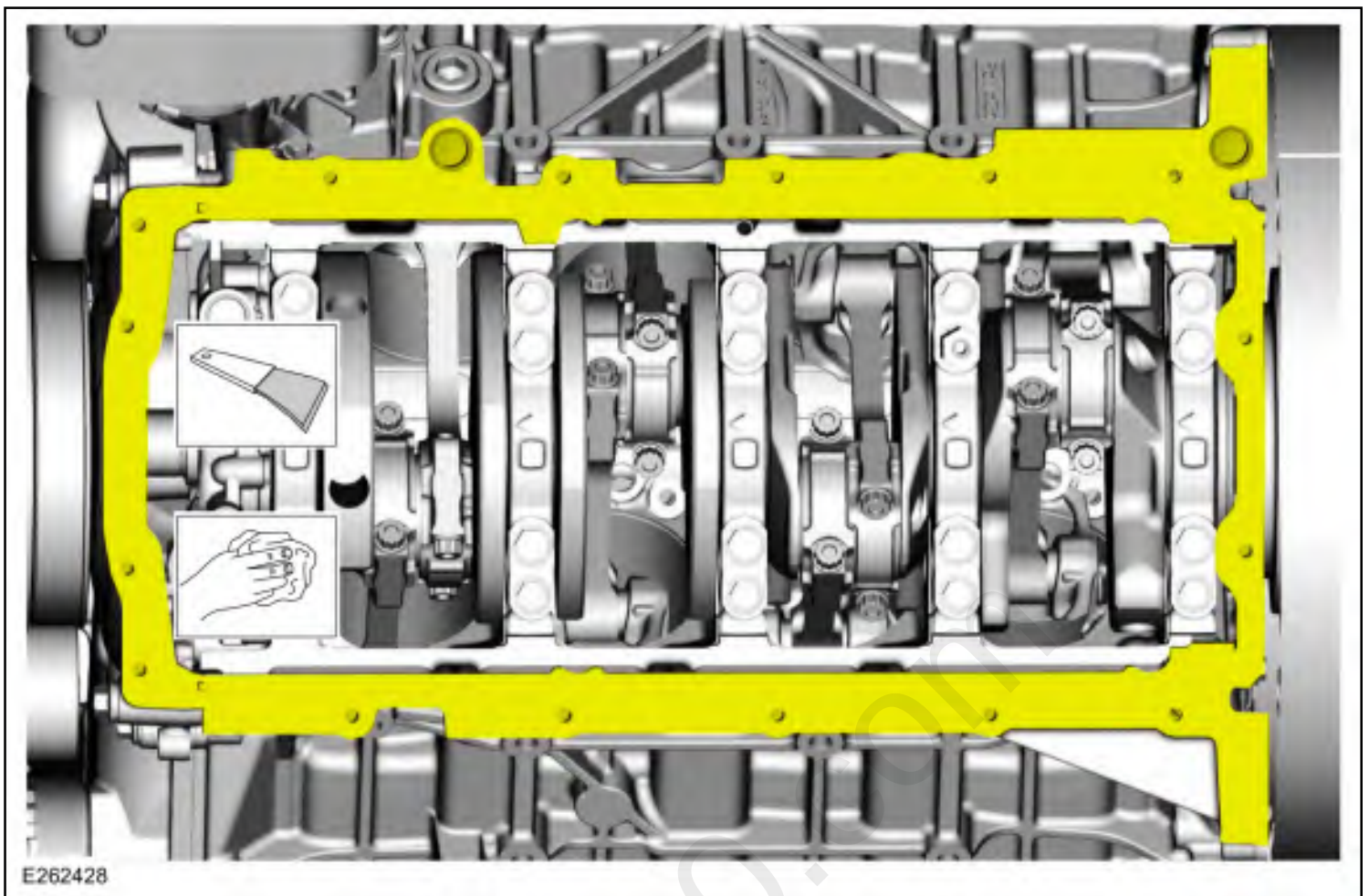
Use the General Equipment: Plastic Scraper

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

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

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



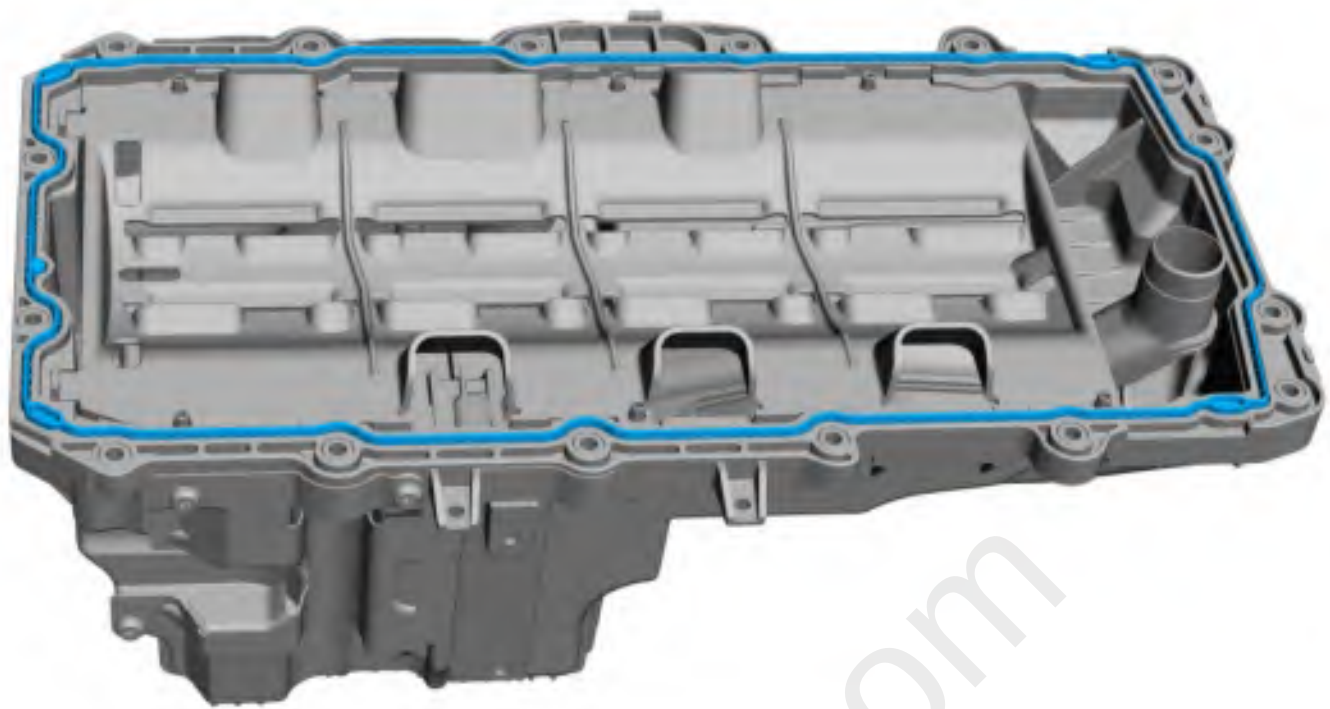


## Installation

### 4x2/4x4

1. Install a new oil pan gasket.

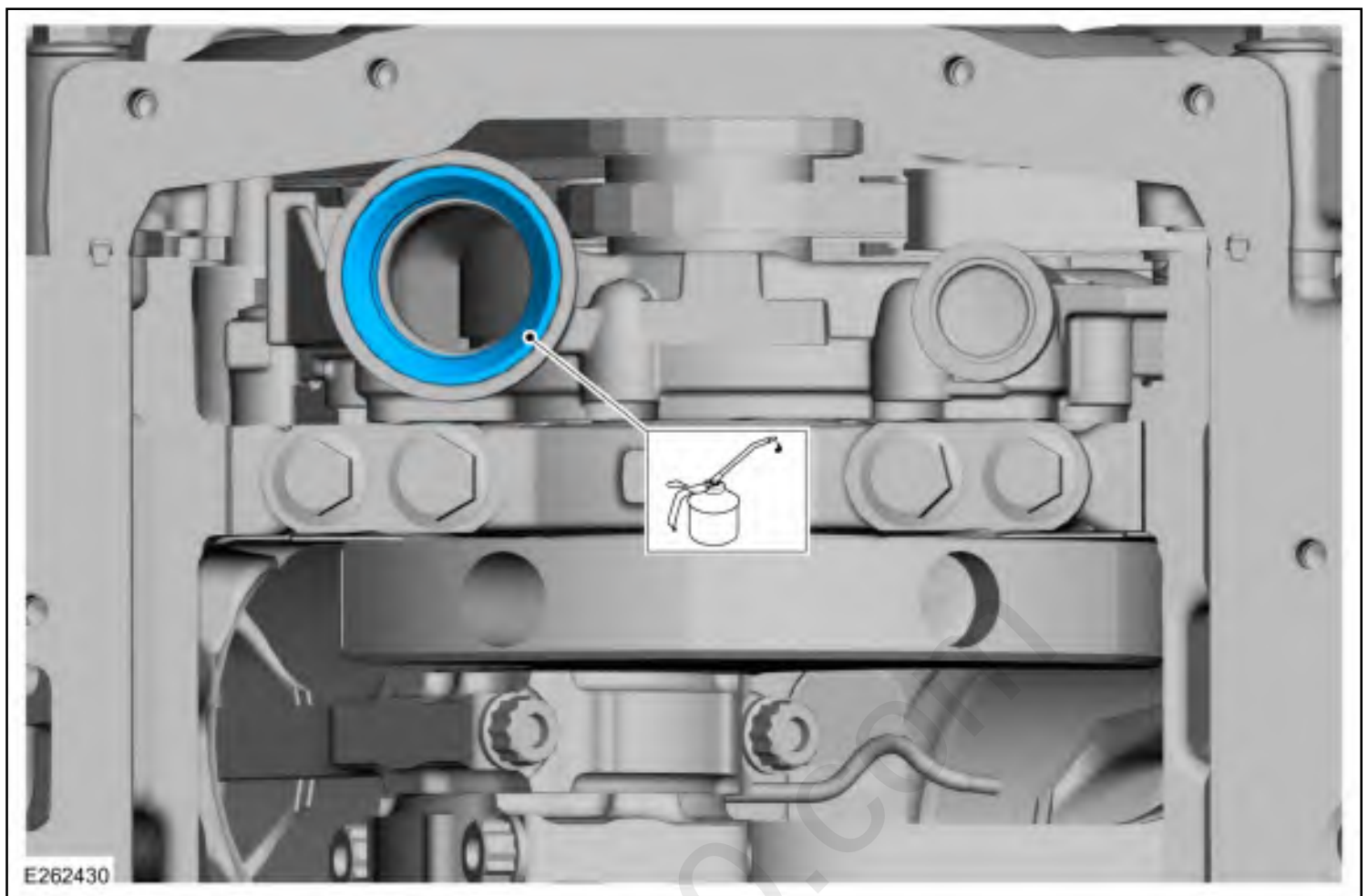




E262425



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

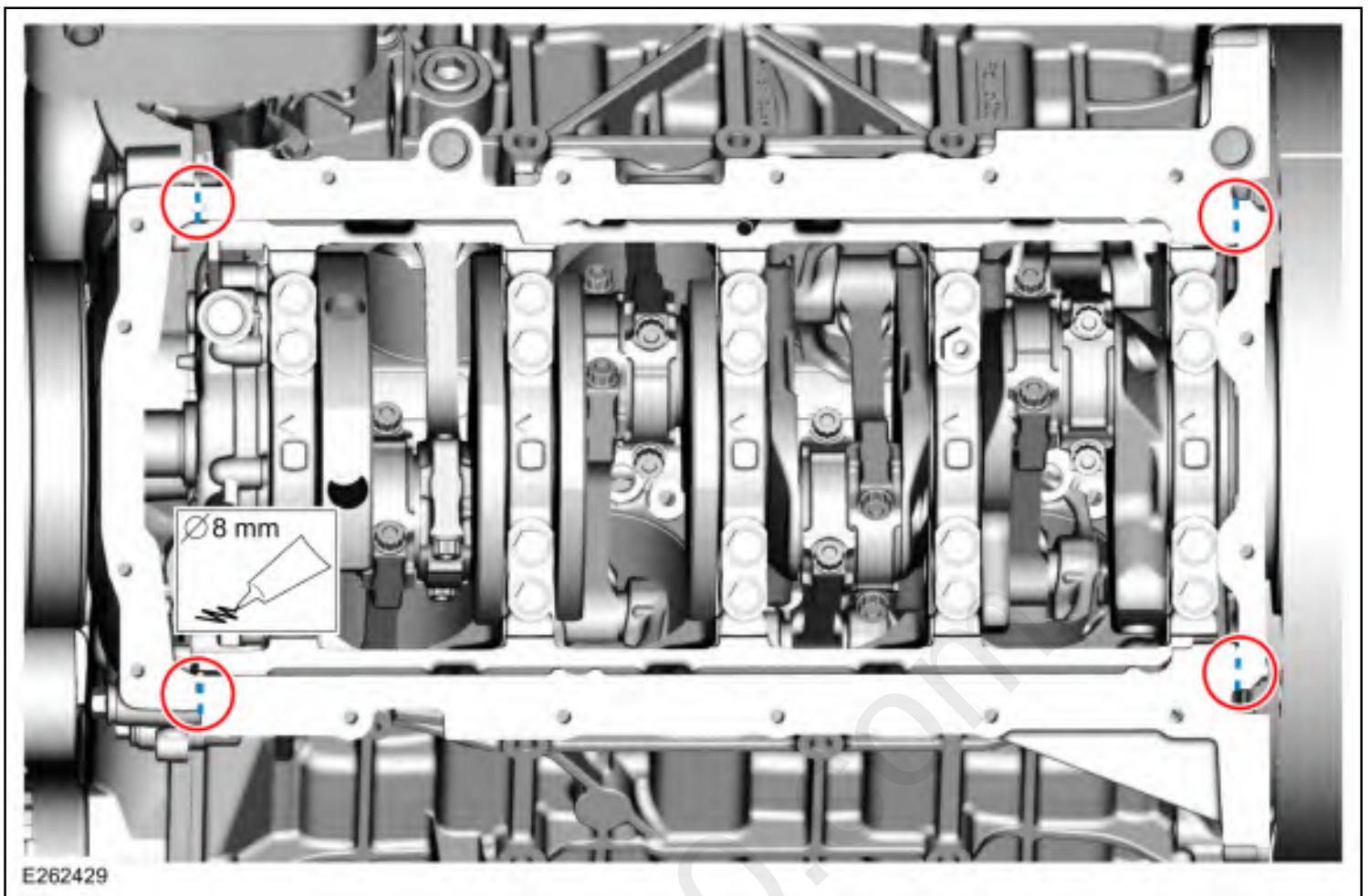


3. **NOTE:** *If the oil pan is not installed and the fasteners tightened within 5 minutes, the sealant must be removed and the sealing area cleaned. Failure to follow this procedure can cause future oil leakage. If this timing cannot be met, tighten fasteners 7, 8, 9 and 10 to 8 Nm (71 lb-in) within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

**NOTE:** *If the engine front cover has been removed, it is only necessary to apply sealant to the crankshaft rear seal retainer plate-to-cylinder block sealing surfaces.*

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

**Material:** Motorcraft® Silicone Gasket and Sealant / TA-30 (WSE-M4G323-A4)



4. **NOTE:** Fastener locations 7, 13 and 16 are stud bolts.

Using a new gasket, install the oil pan and the bolts.

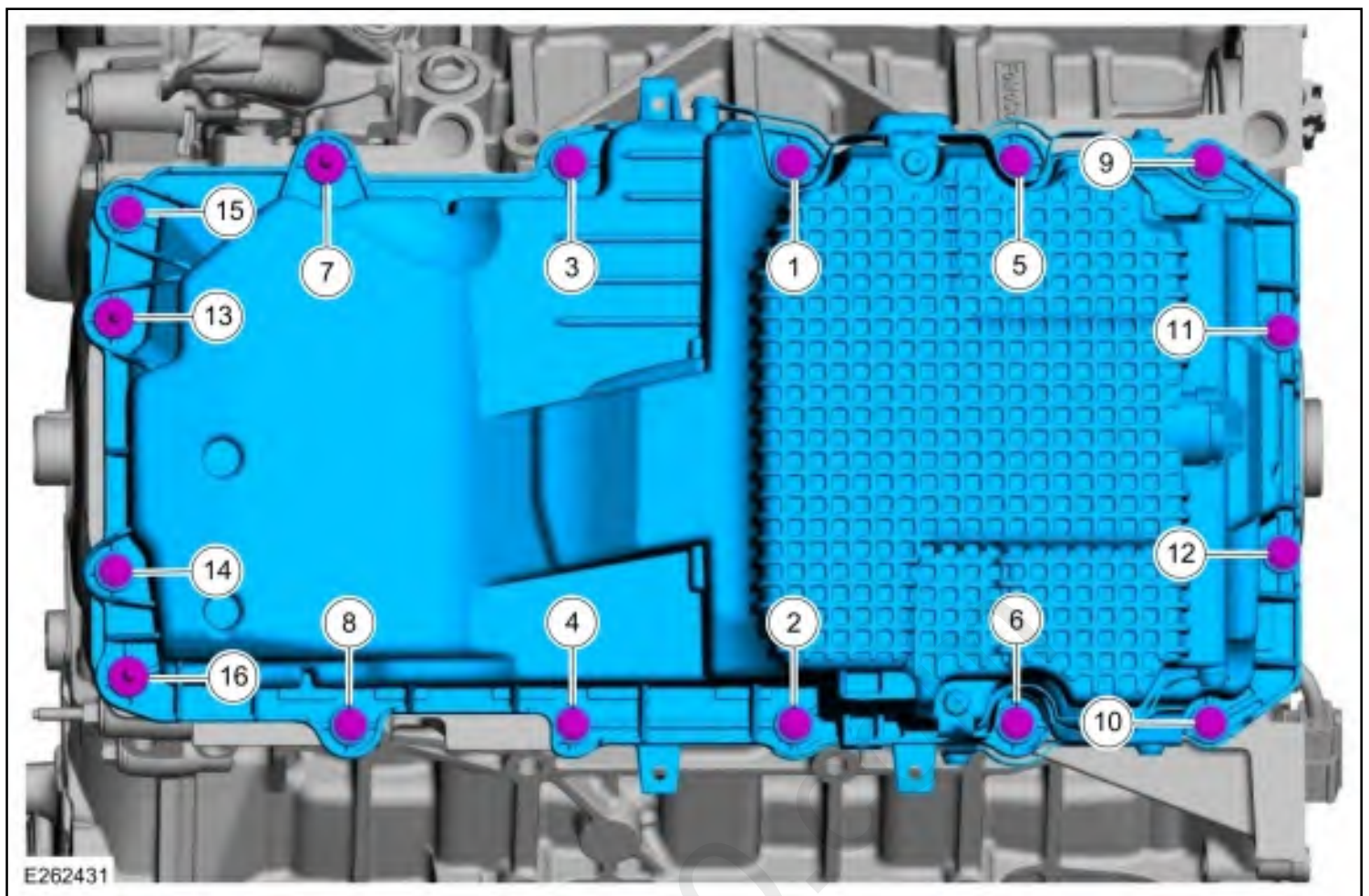
*Torque:*

Stage 1: 18 lb.in (2 Nm)

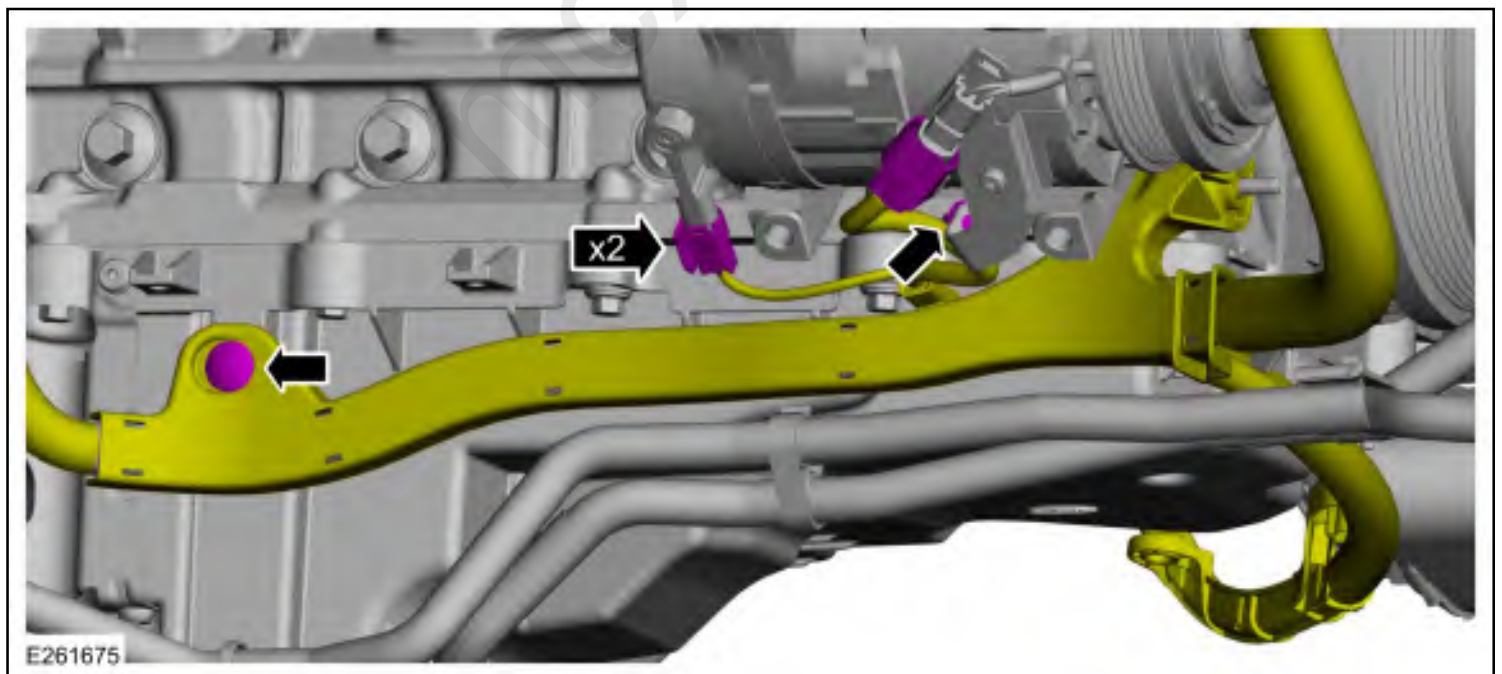
Stage 2: 89 lb.in (10 Nm)

Stage 3: 45°





1. Connect the A/C compressor electrical connectors.
2. Attach the wiring harness retainers.

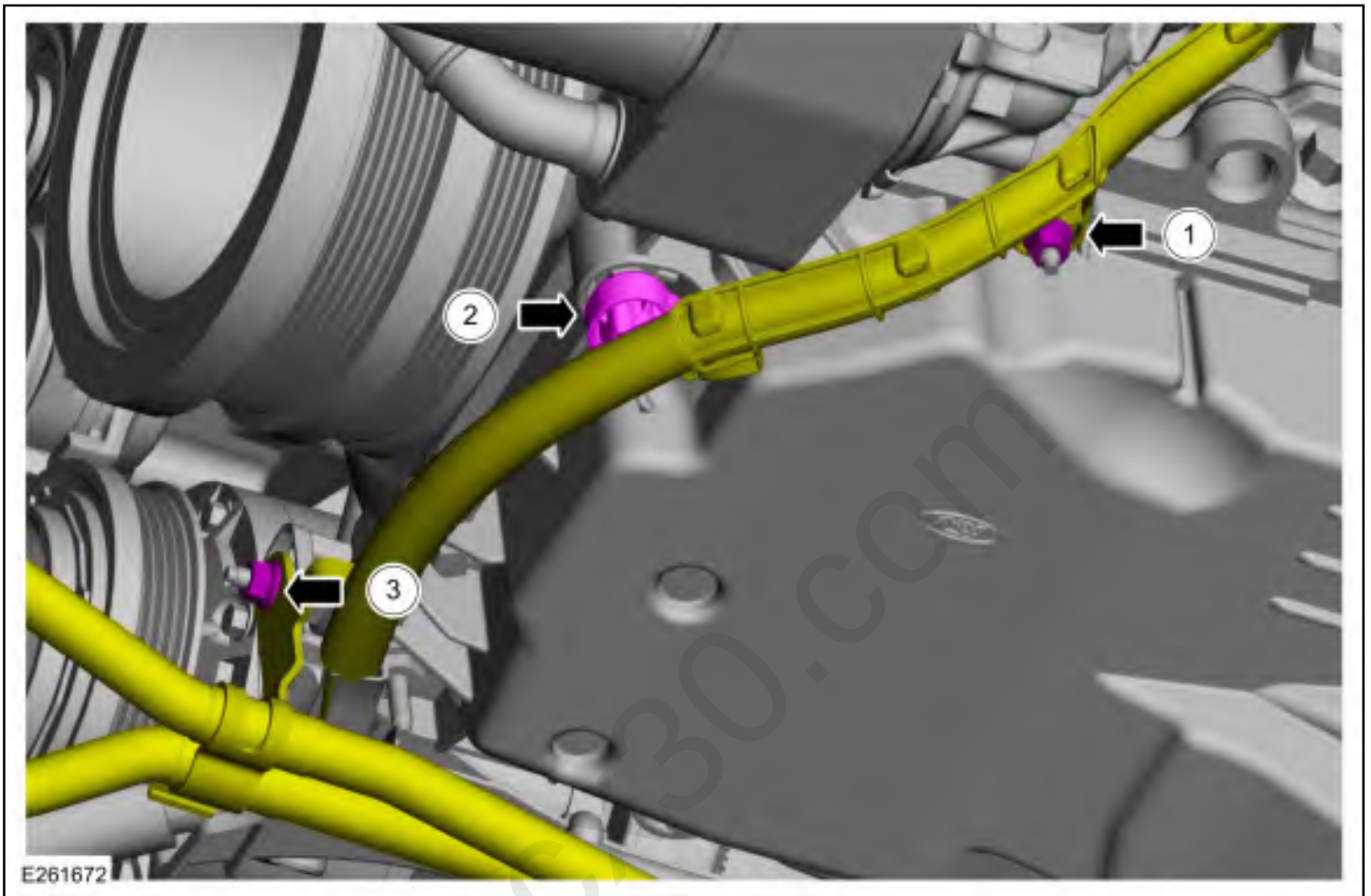


1. Install the nut.

*Torque: 106 lb.in (12 Nm)*

2. Attach the wiring harness retainer.
3. Position the coolant tube and wiring harness brackets and install the nut.

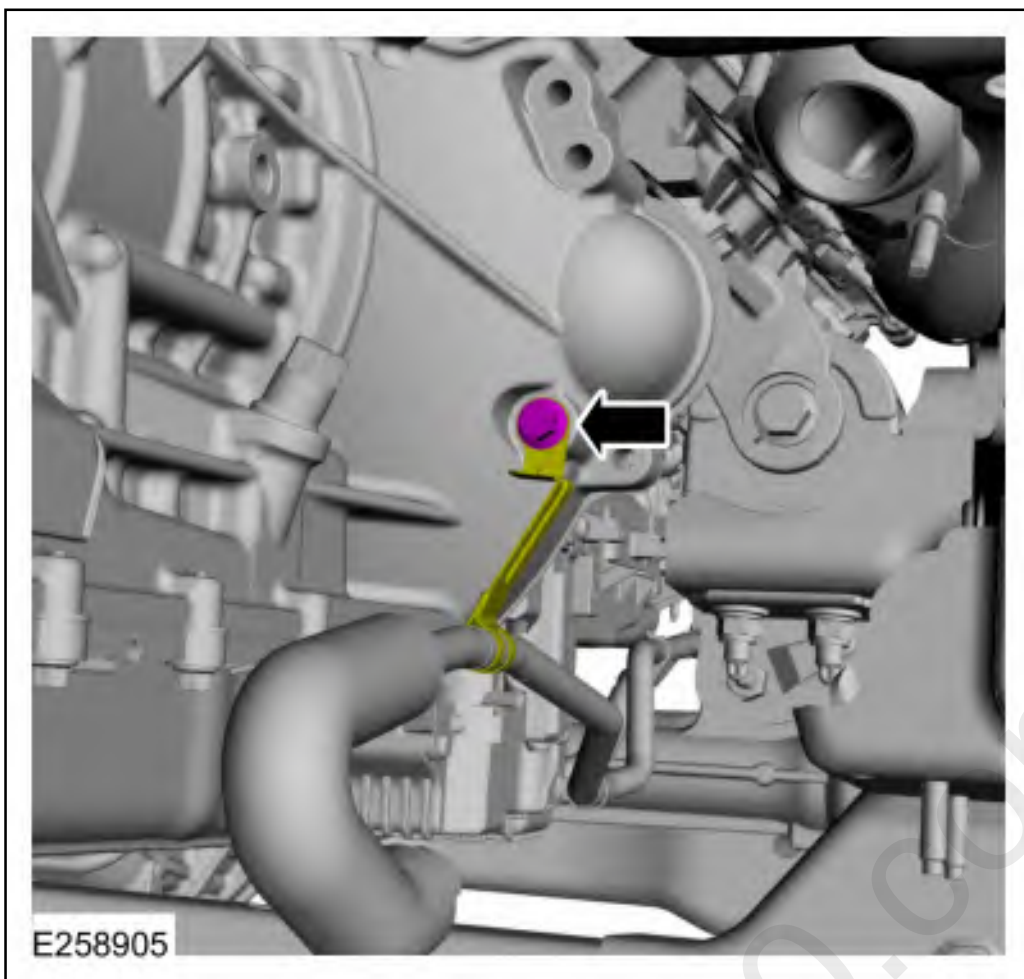
*Torque: 115 lb.in (13 Nm)*



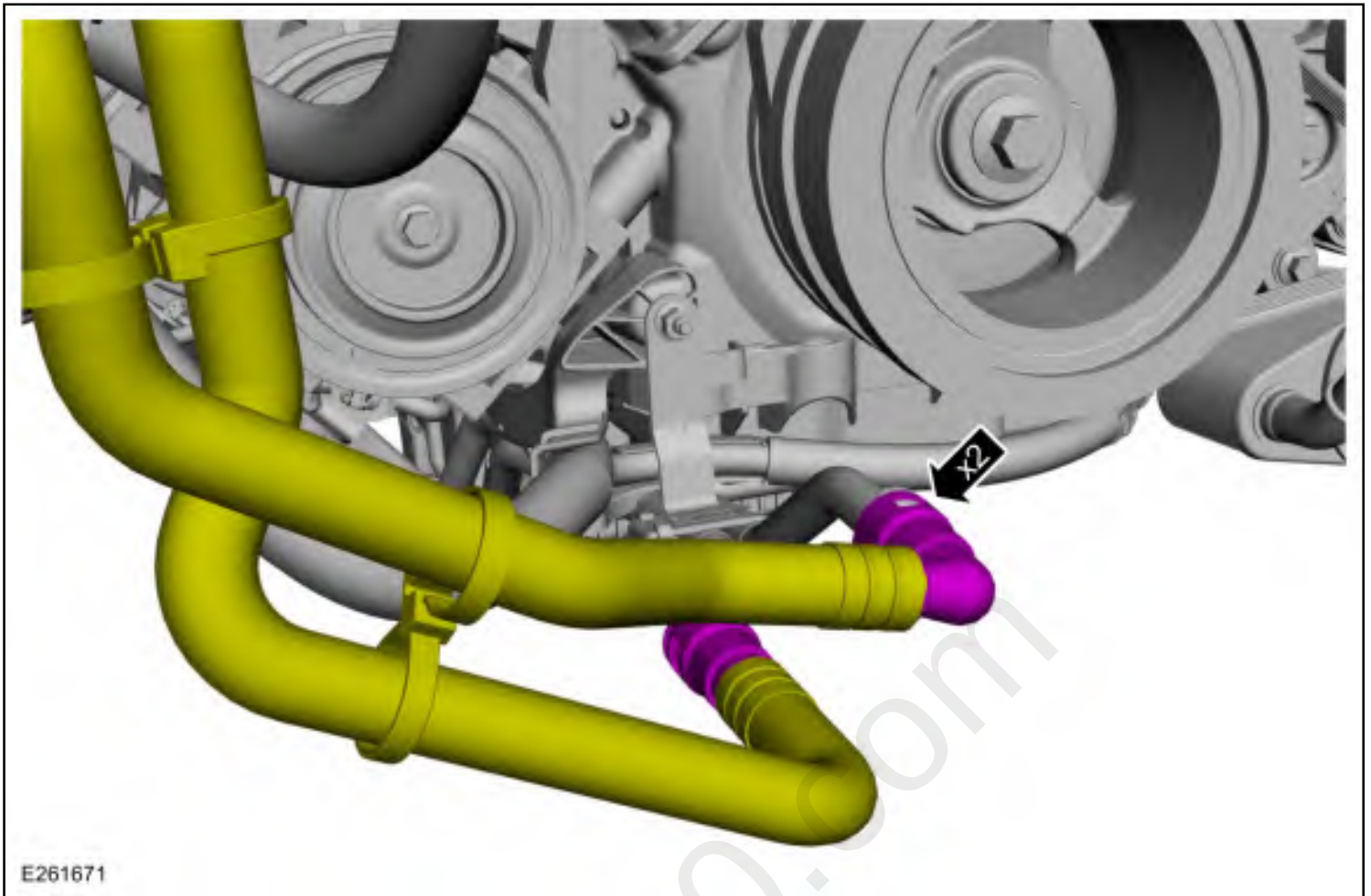
7. Install the transmission cooler tube support bracket and the transmission-to-engine bolt.

*Torque: 35 lb.ft (48 Nm)*



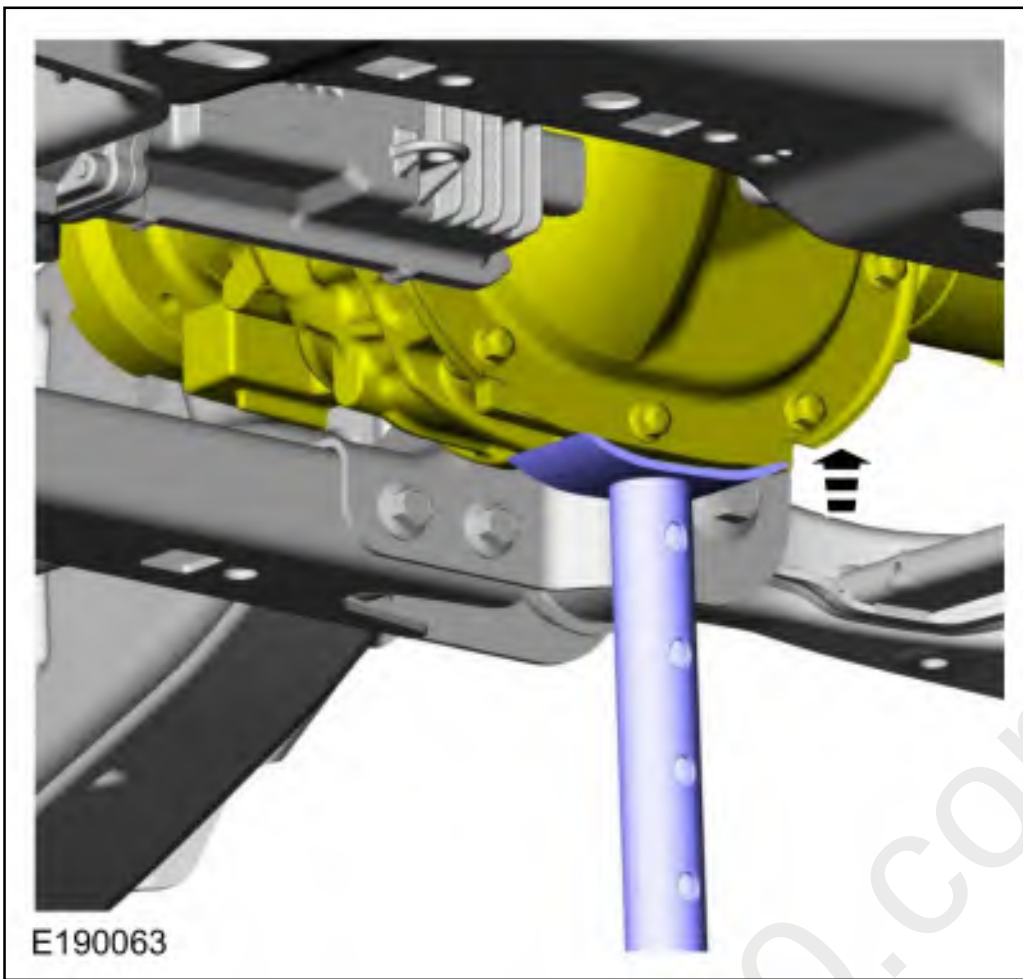


8. Connect the coolant hose quick release couplings.

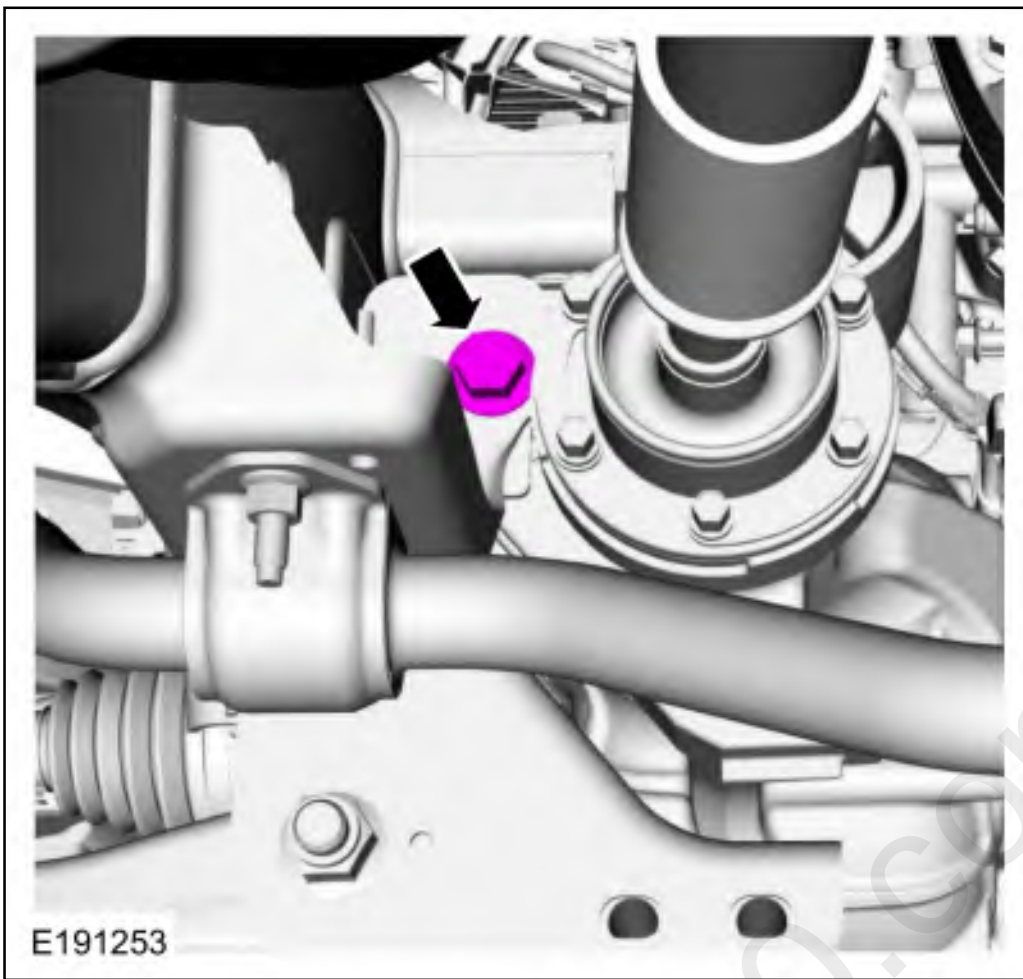


**4x4**

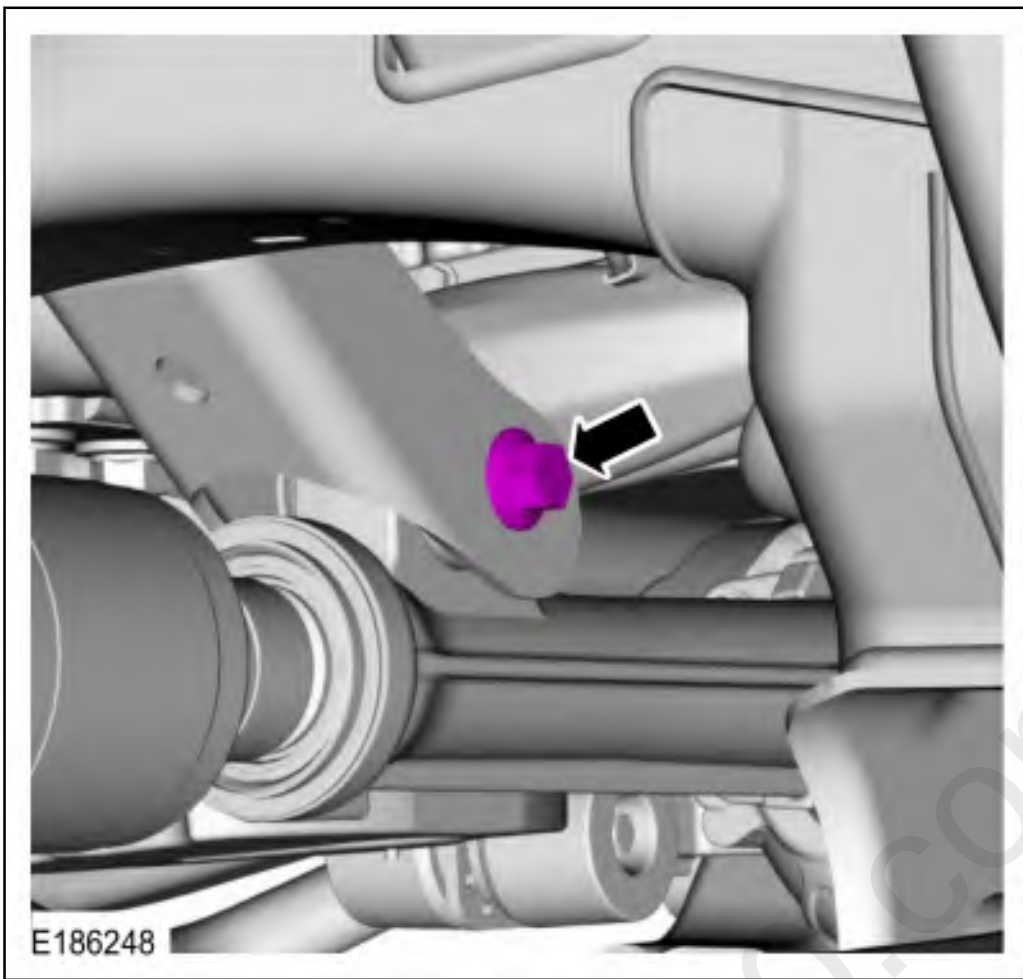
9. Using an adjustable stand, raise the front axle carrier into position.  
Use the General Equipment: Vehicle/Axle Stands



10. Install the lower front axle carrier mounting bushing bolt.  
*Torque: 85 lb.ft (115 Nm)*

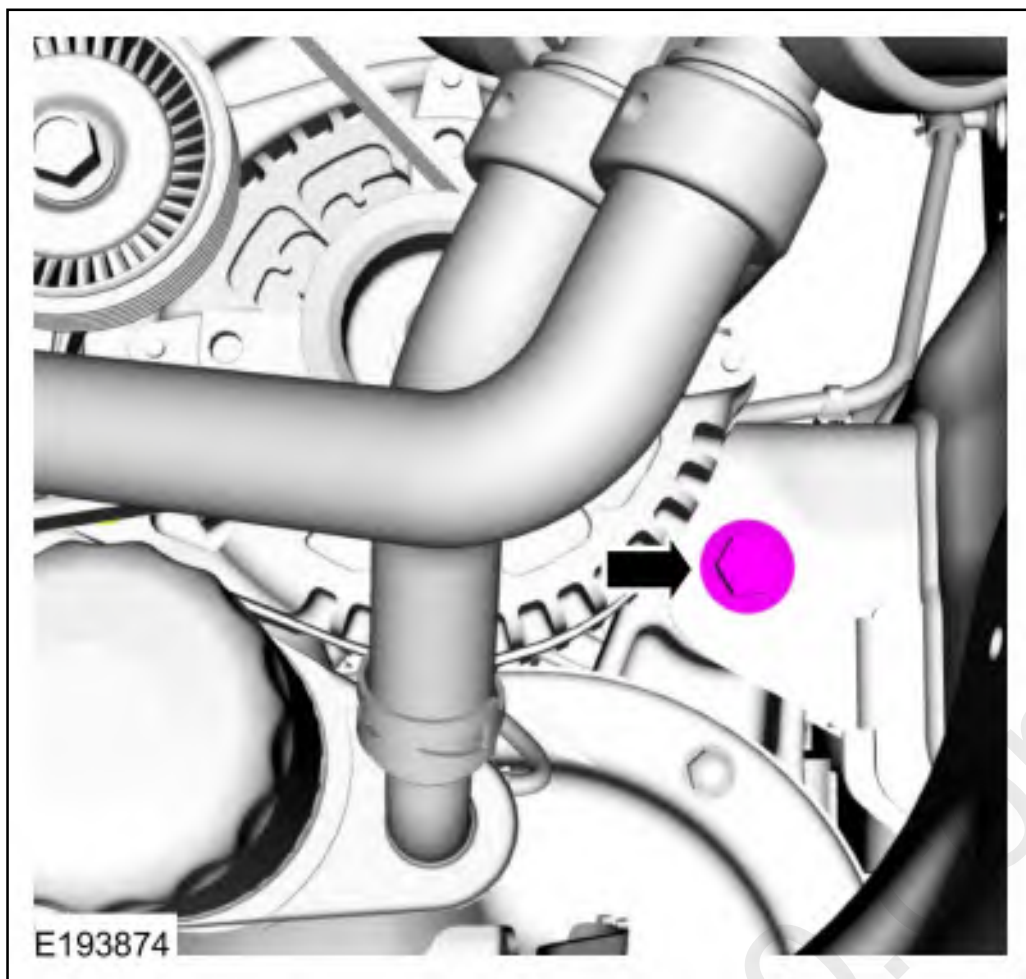


11. Install the axle shaft housing carrier bushing bolt.  
*Torque: 85 lb.ft (115 Nm)*

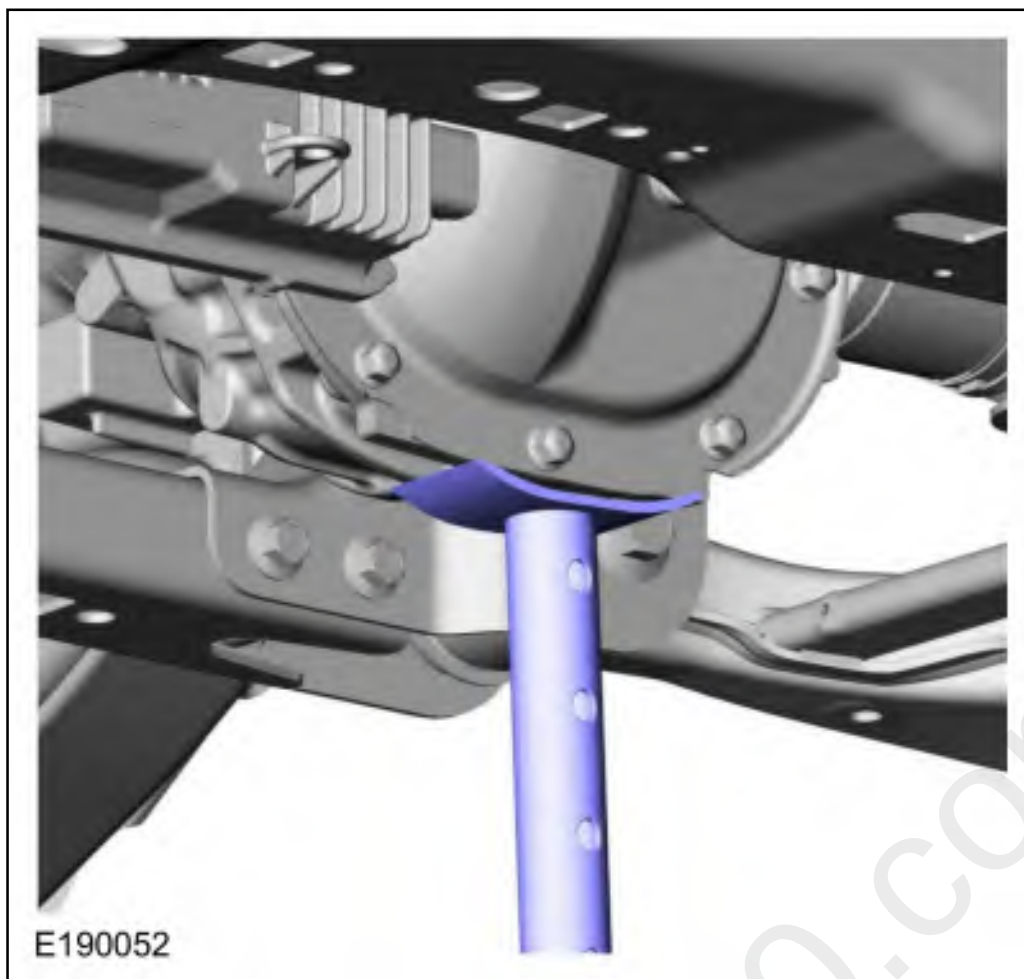


12. Install the upper front axle carrier mounting bushing bolt.  
*Torque: 85 lb.ft (115 Nm)*





13. Remove the adjustable stand.  
Use the General Equipment: Vehicle/Axle Stands



#### 4x2/4x4

14. Install the following items:

1. Engine oil cooler.

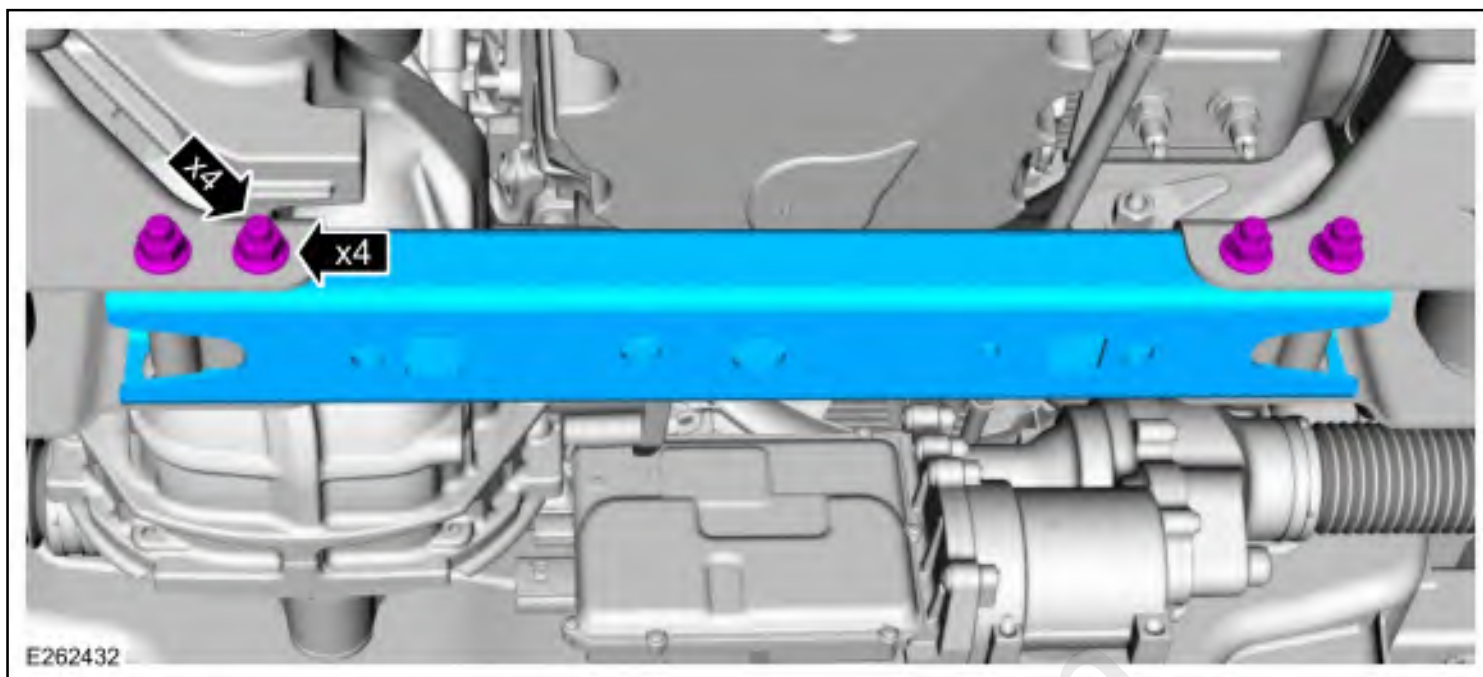
Refer to: [Oil Cooler](#) (303-01D Engine - 5.0L 32V Ti-VCT, Removal and Installation).

2. Transmission fluid cooler.

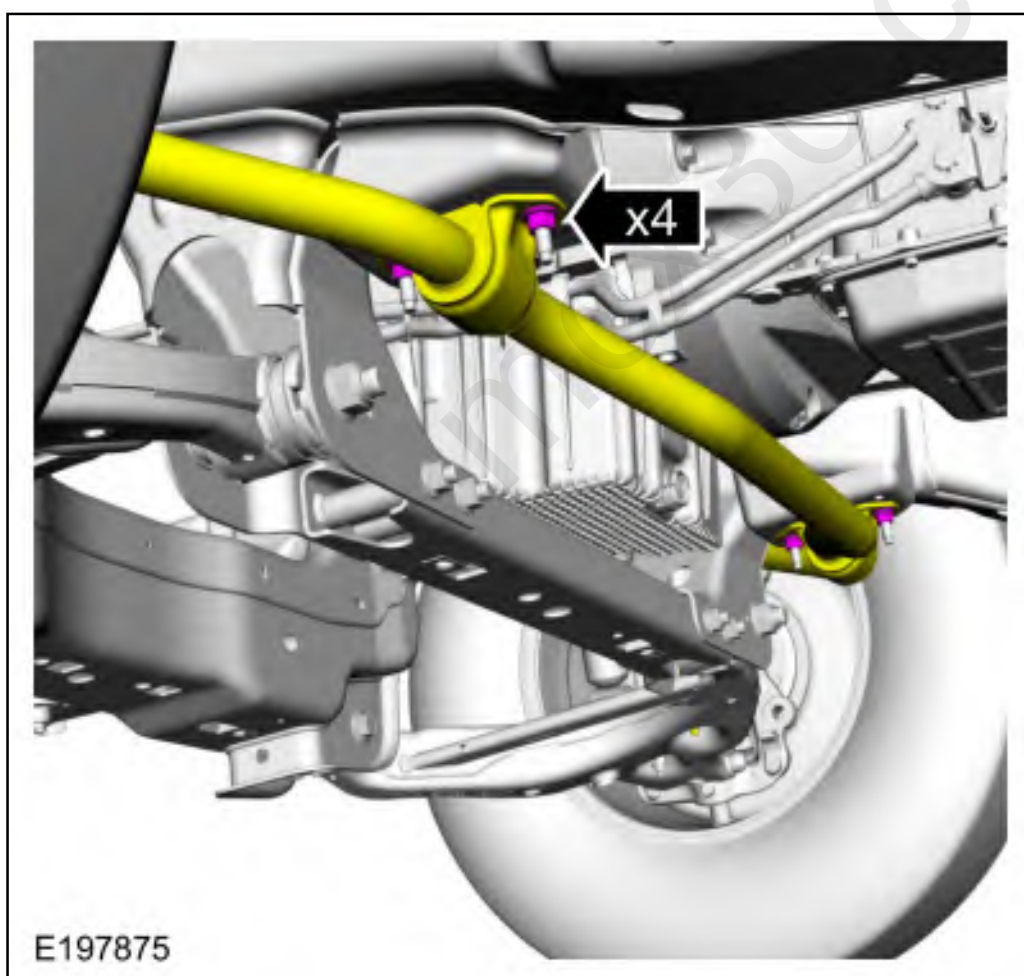
Refer to: [Transmission Fluid Cooler - 2.7L EcoBoost \(238kW/324PS\)/3.5L EcoBoost \(272kW/370PS\)/5.0L 32V Ti-VCT](#) (307-02 Transmission Cooling, Removal and Installation).

15. Install the crossmember, bolts and the nuts.

*Torque: 66 lb.ft (90 Nm)*



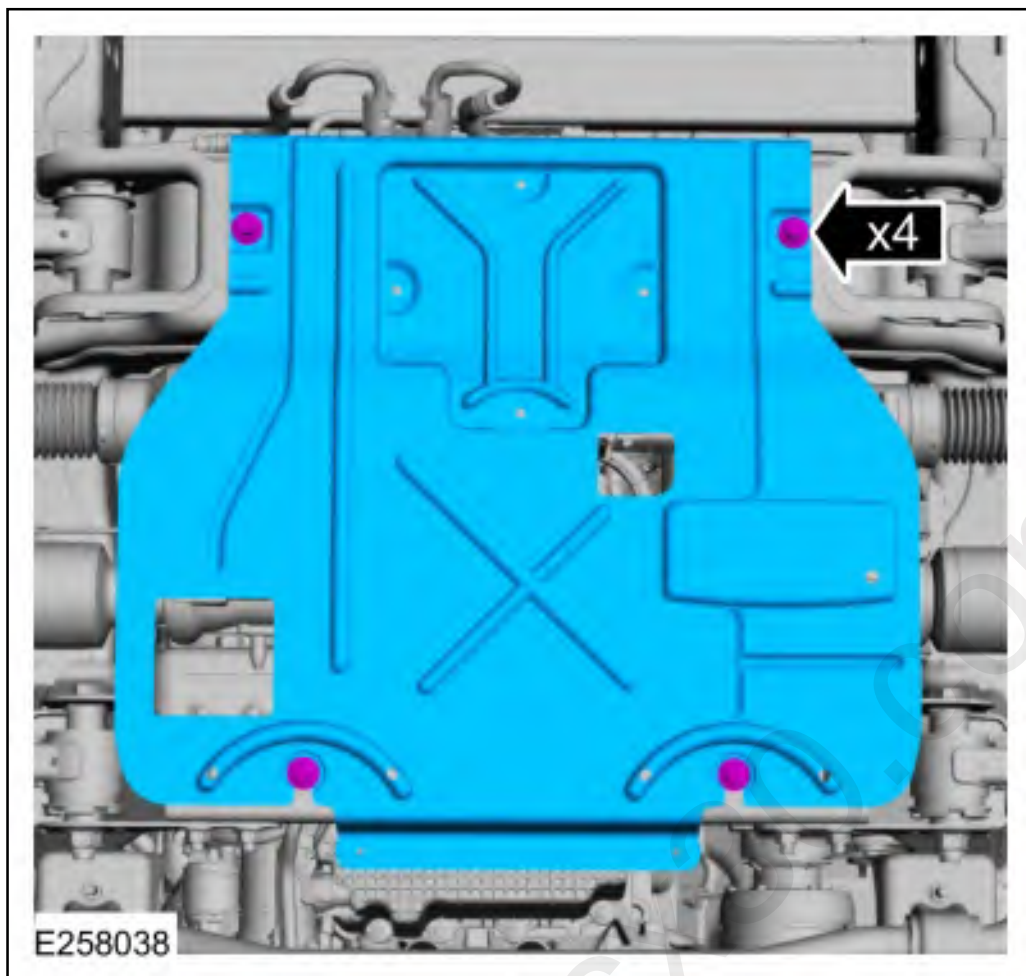
16. Position the stabilizer bar and install the new nuts.  
*Torque: 41 lb.ft (55 Nm)*



17. **NOTE:** *If equipped.*

Install the skid plate and bolts.

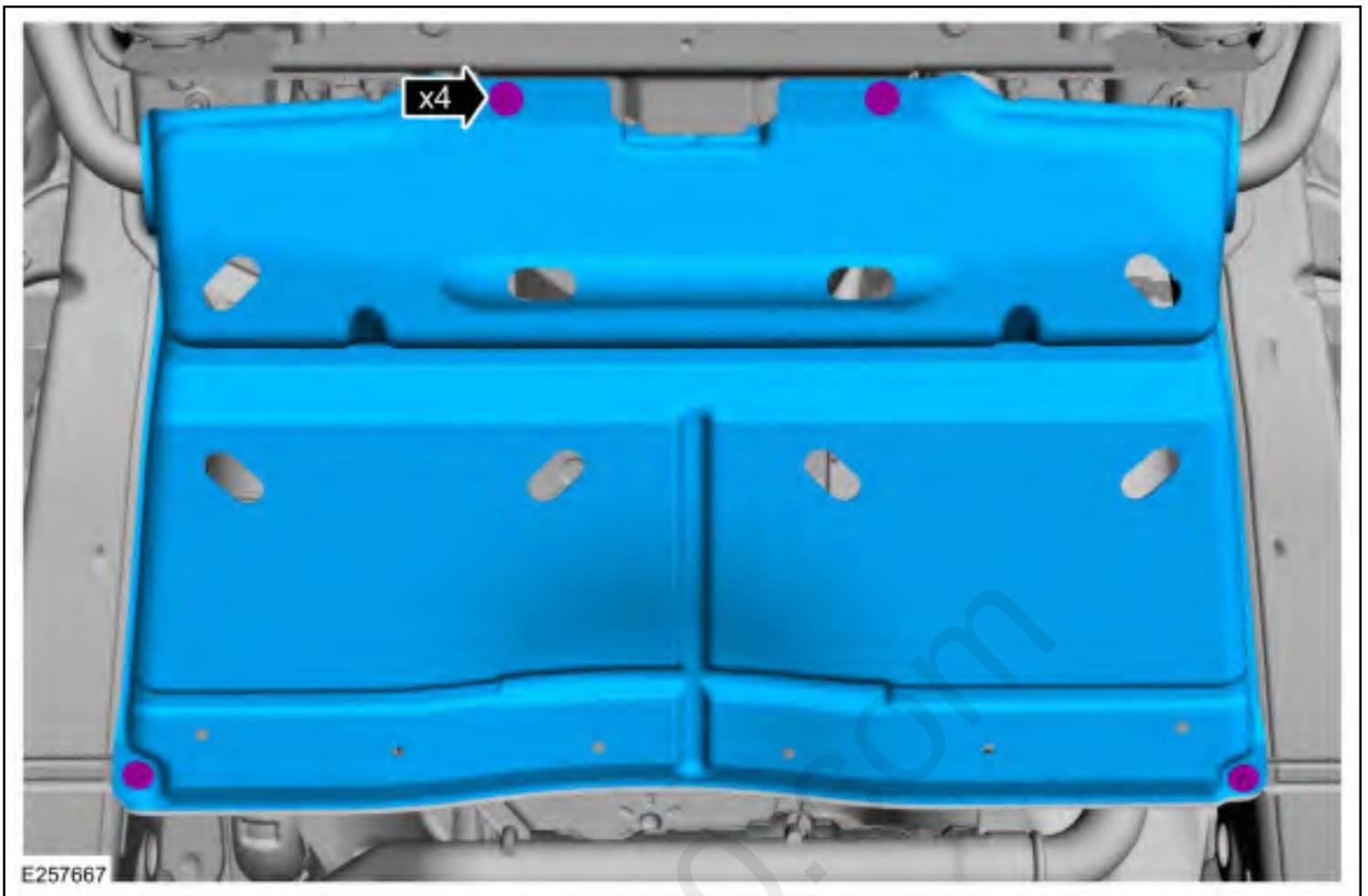
*Torque: 30 lb.ft (40 Nm)*



18. **NOTE:** *If equipped.*

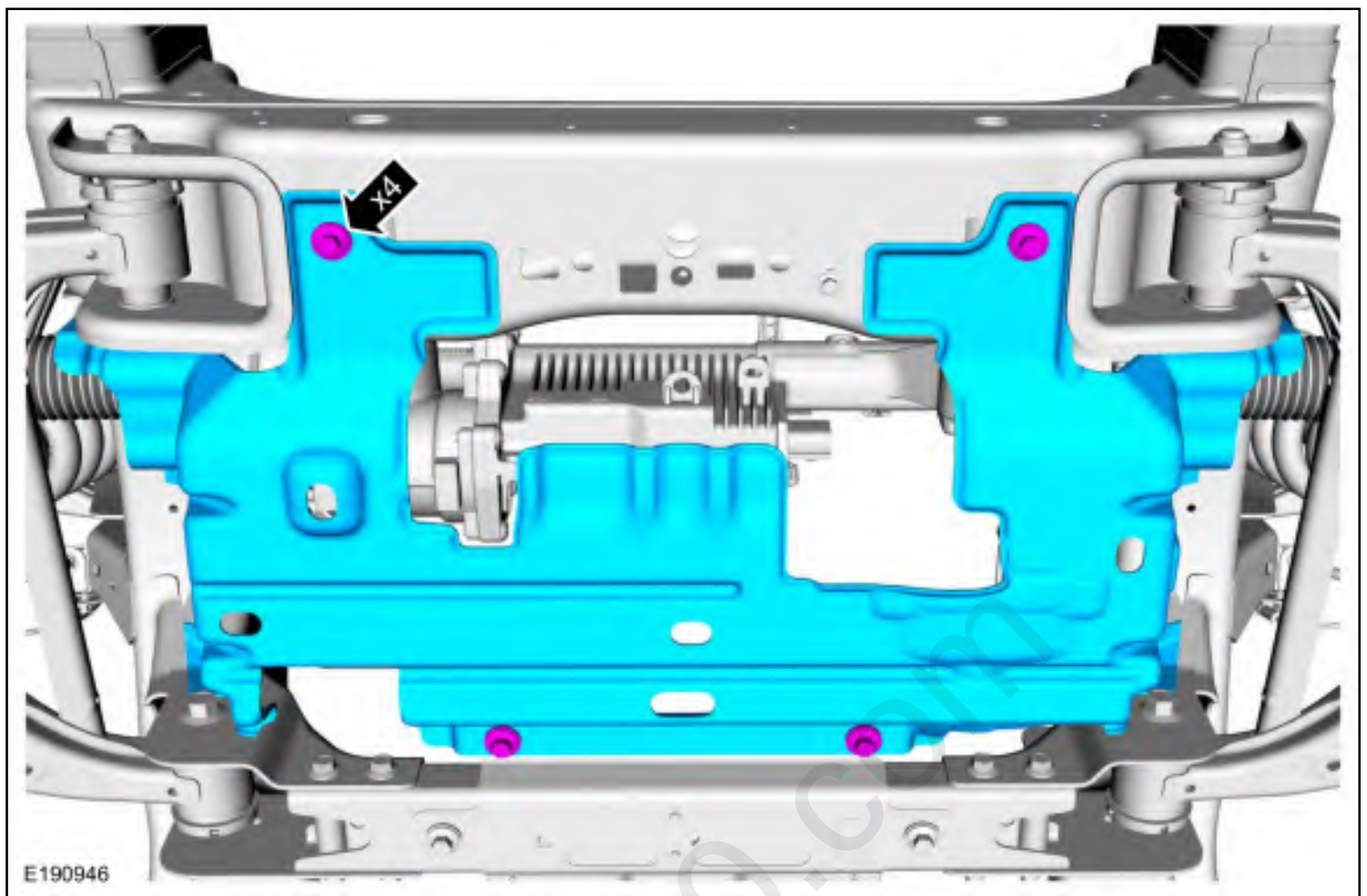
Install the underbody shield and the bolts.

*Torque: 71 lb.in (8 Nm)*

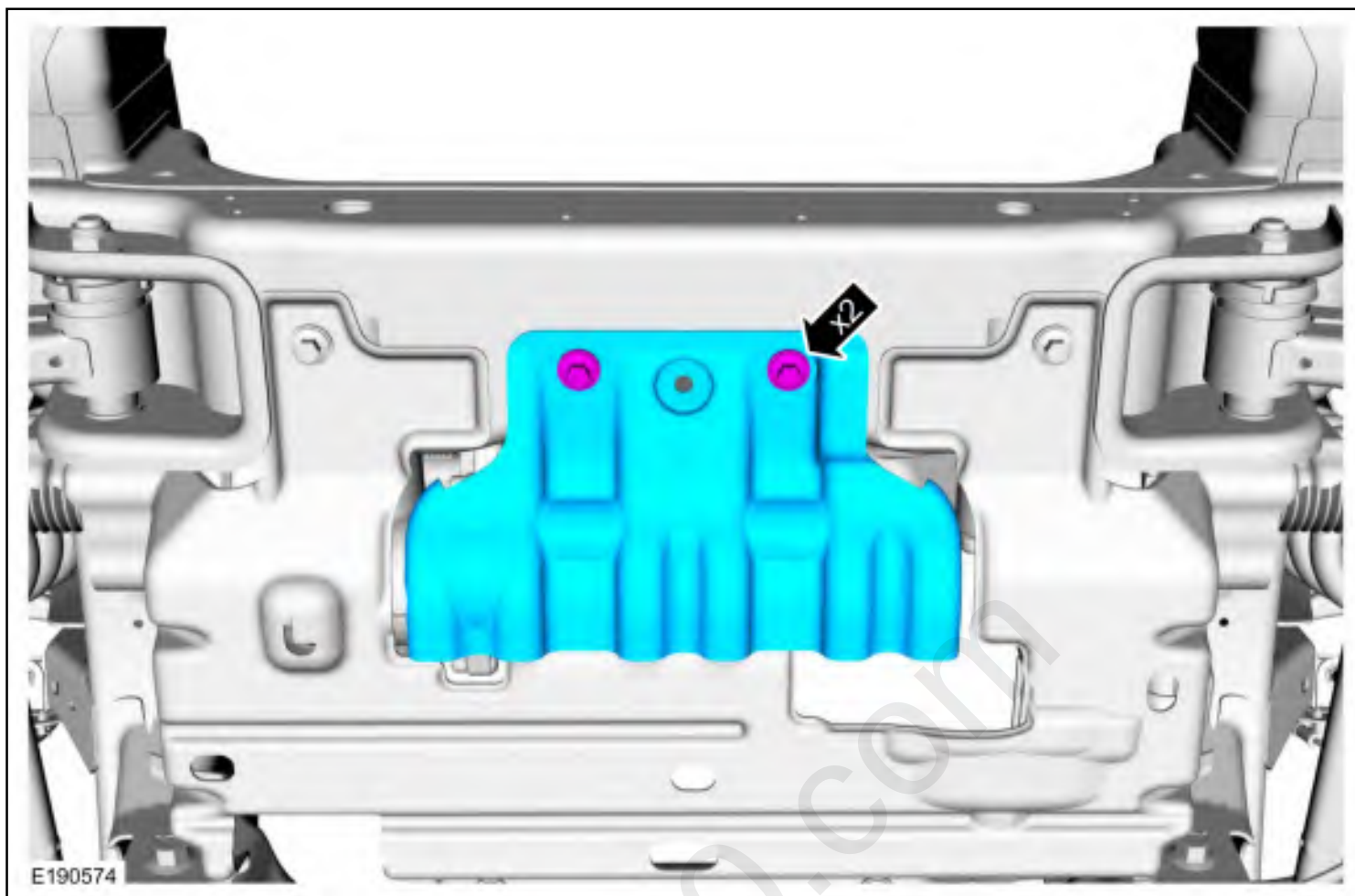


19. If equipped, install the underbody shield and fasteners.  
*Torque: 30 lb.ft (40 Nm)*

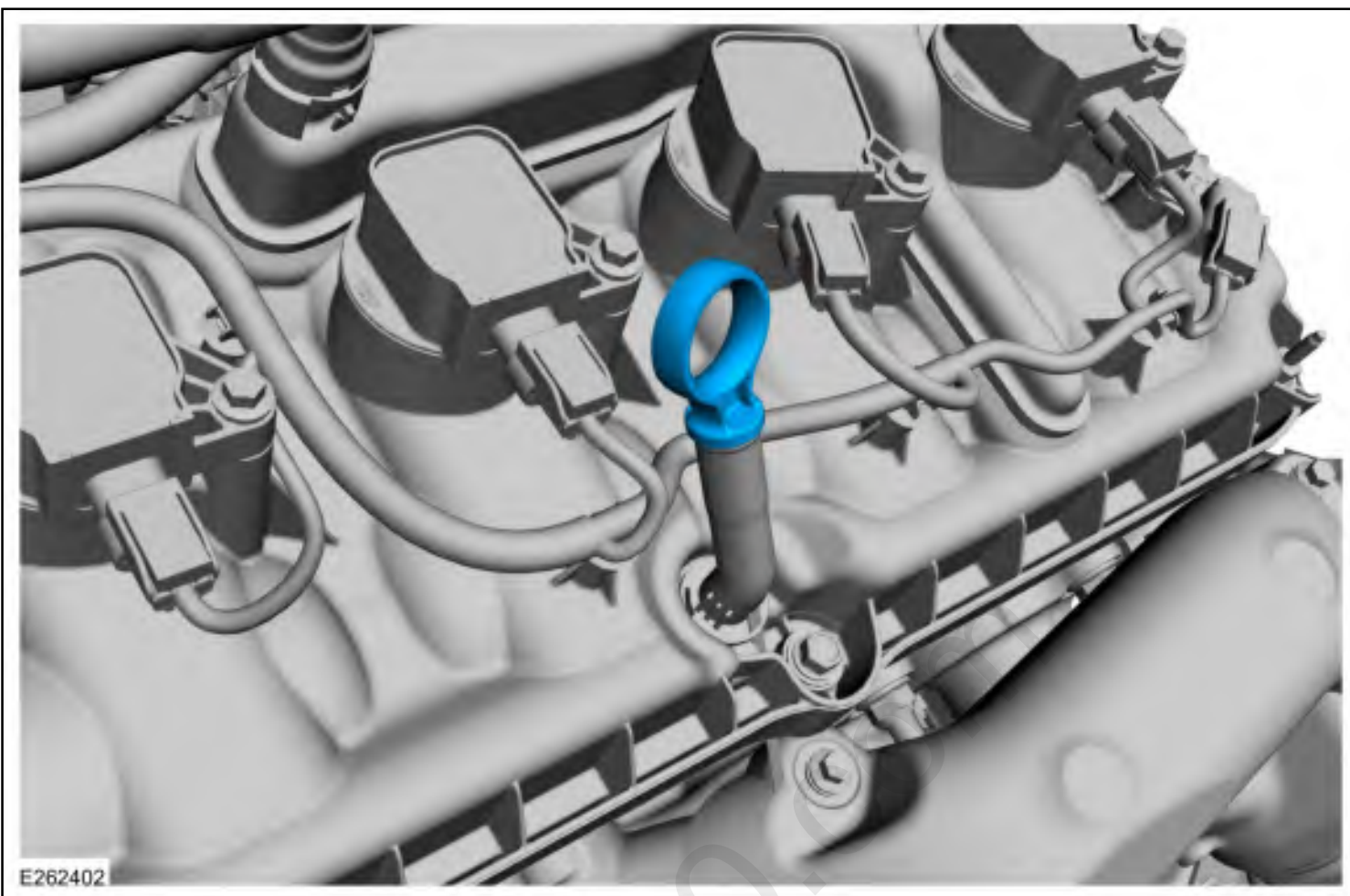




20. If equipped, install the skid plate and bolts.  
*Torque: 30 lb.ft (40 Nm)*

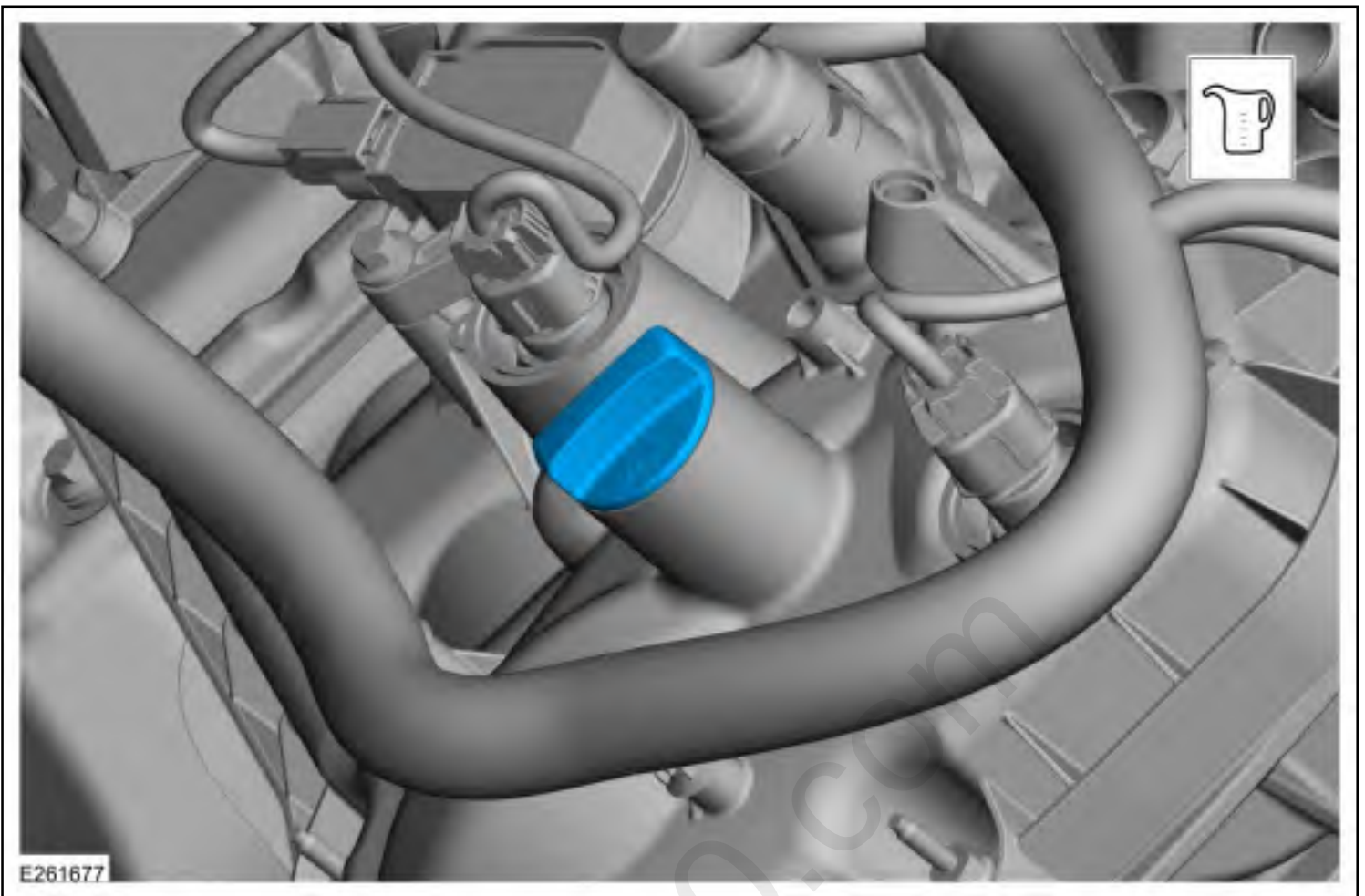


21. Install the oil level indicator.



22. Fill the engine with clean engine oil.

Refer to: [Specifications](#) (303-01D Engine - 5.0L 32V Ti-VCT, Specifications).



23. Connect the battery ground cable.

Refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables) .

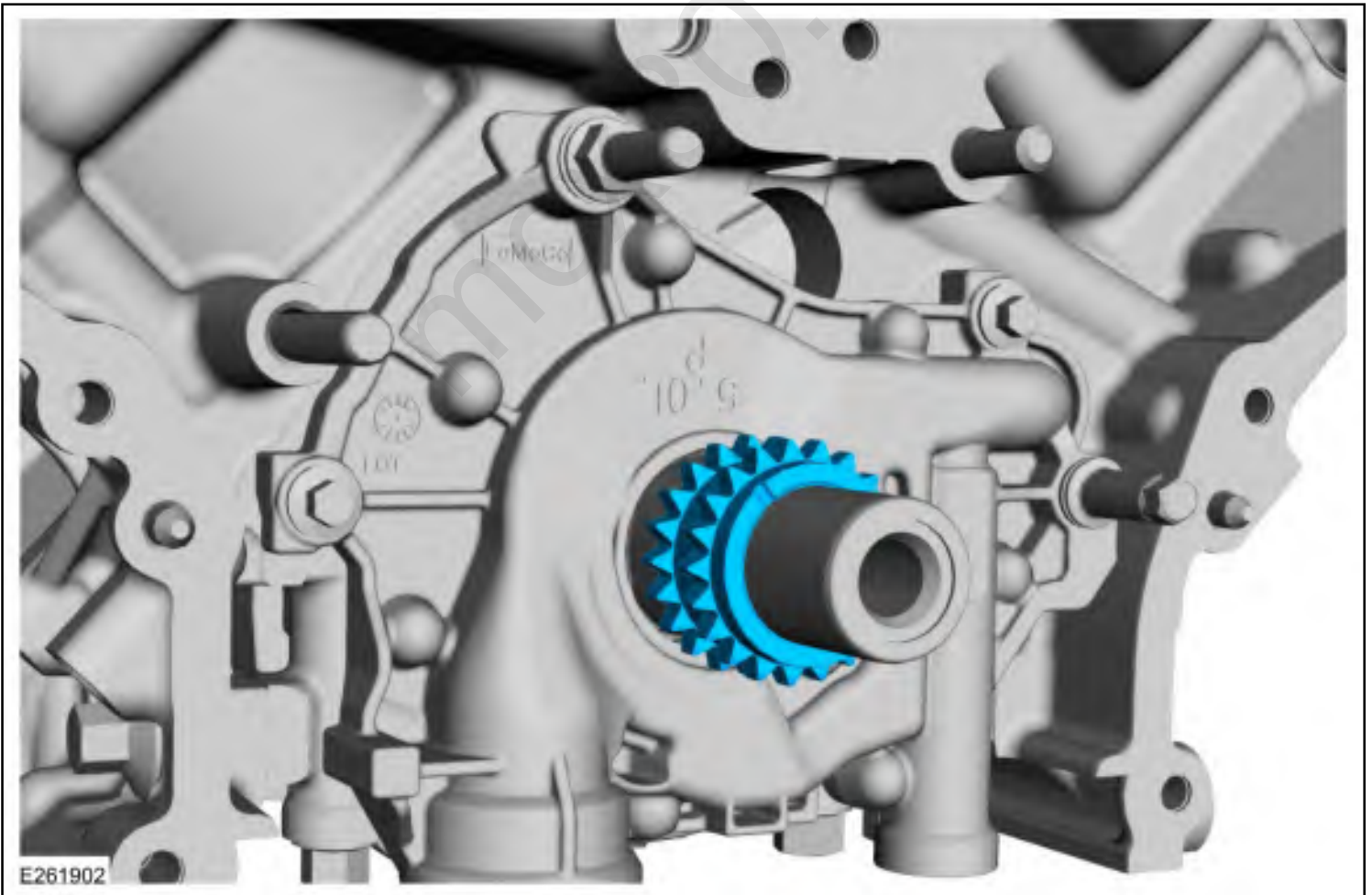


# Oil Pump

Base Part Number: Base Part Number: 6621

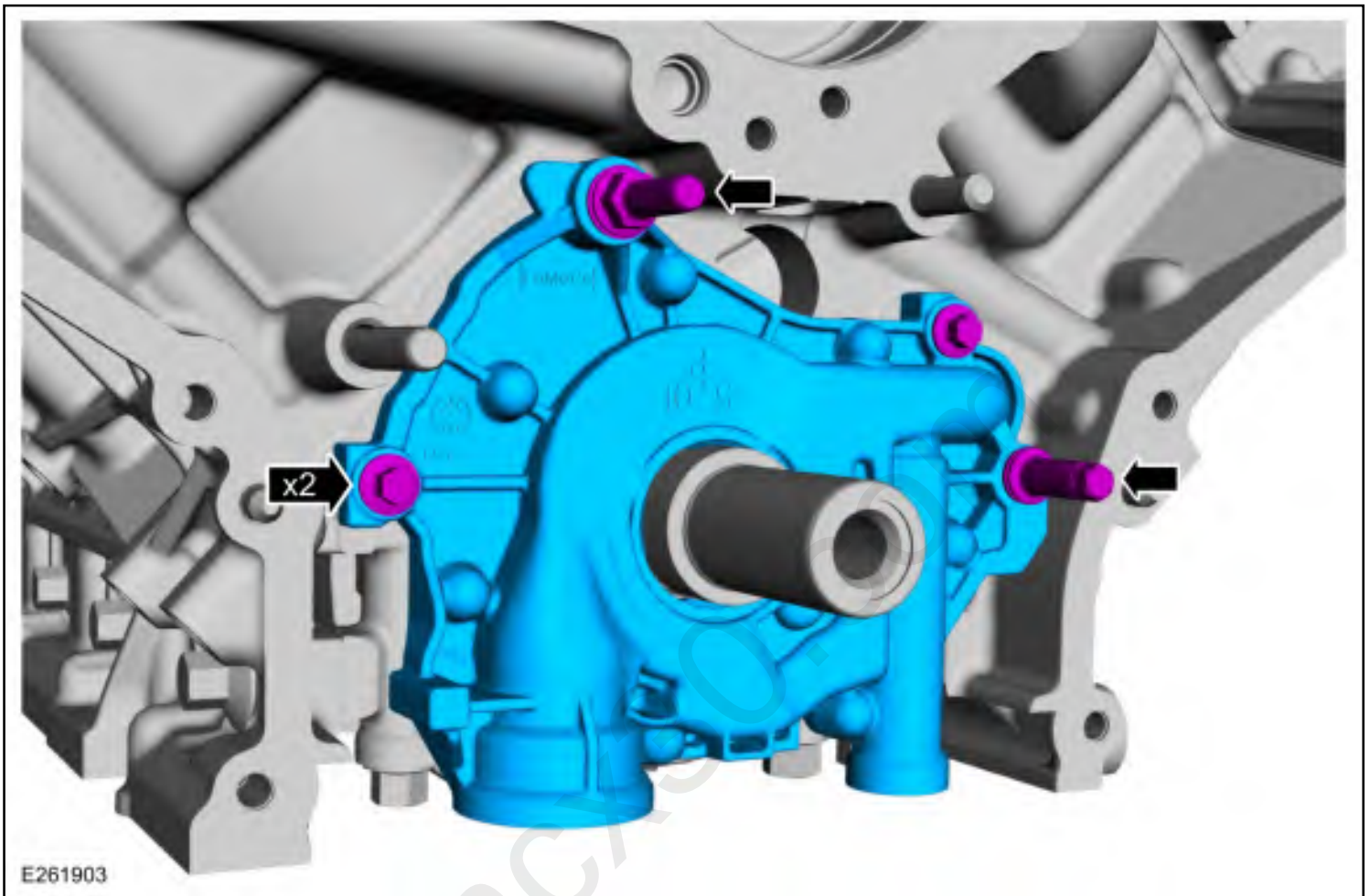
## Removal

1. With the vehicle in NEUTRAL, position it on a hoist.  
Refer to: [Jacking and Lifting - Overview](#) (100-02 Jacking and Lifting, Description and Operation).
2. Remove the timing chains.  
Refer to: Timing Chain (303-01 Engine - 5.0L 32V Ti-VCT).
3. Remove the crankshaft sprocket.





4. Remove the oil pan.  
Refer to: Oil Pan (303-01 Engine - 5.0L 32V Ti-VCT) .
5. Remove the bolts, stud bolts and the oil pump.



## Installation

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

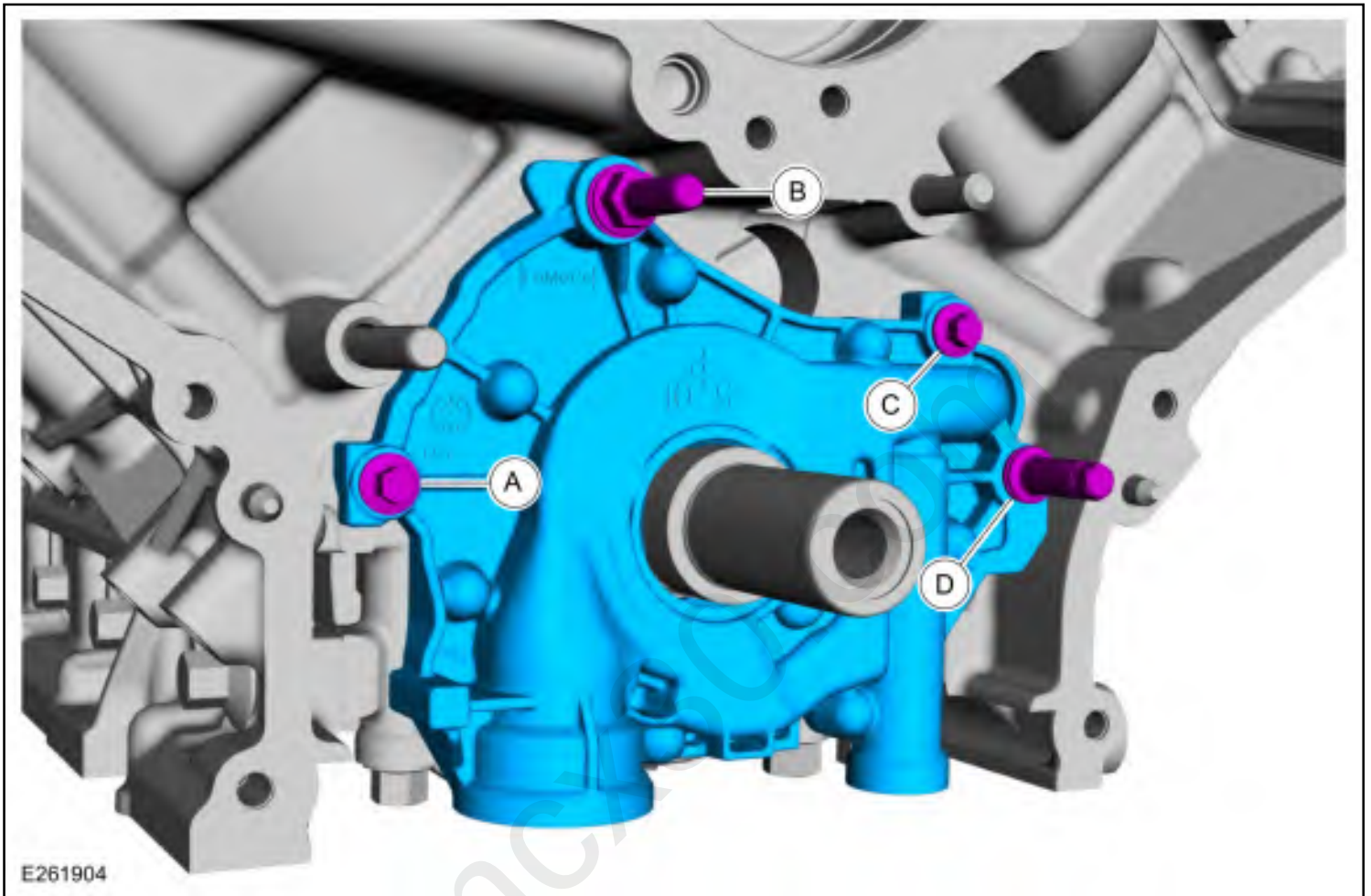
Stage 4: D: 177 lb.in (20 Nm)

Stage 5: A: 45°

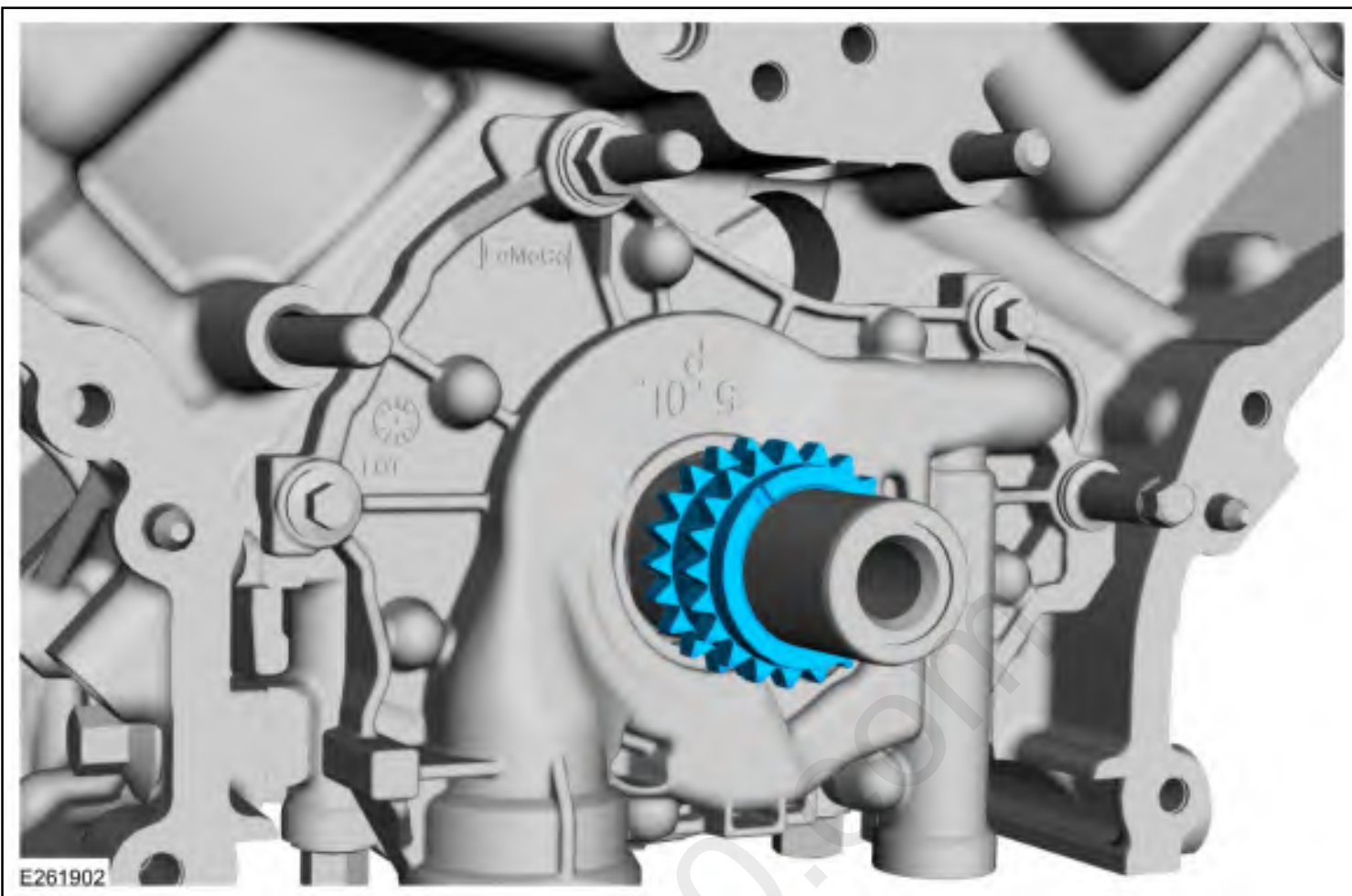
Stage 6: B: 75°

Stage 7: C: 45°

Stage 8: D: 60°



3. Install the oil pan.  
Refer to: Oil Pan (303-01 Engine - 5.0L 32V Ti-VCT) .
4. Install the crankshaft sprocket.



5. Install the timing chains.

Refer to: Timing Chain (303-01 Engine - 5.0L 32V Ti-VCT) .

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# Oil Cooler

## Special Tool(s) / General Equipment

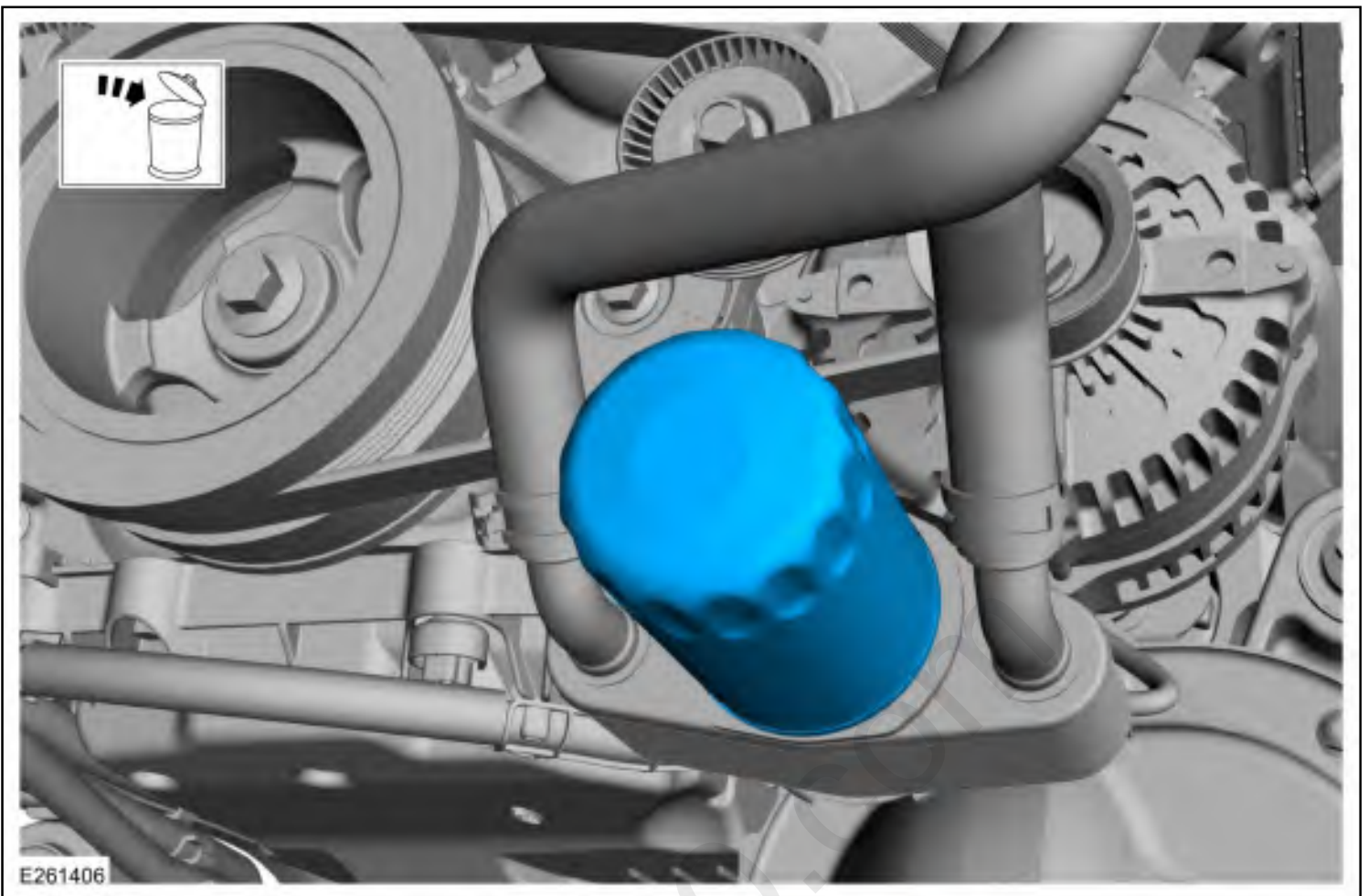
|                |
|----------------|
| Locking Pliers |
|----------------|

## Materials

| Name                                                      | Specification |
|-----------------------------------------------------------|---------------|
| Motorcraft® Orange Concentrated Antifreeze/Coolant VC-3-B | WSS-M97B44-D  |

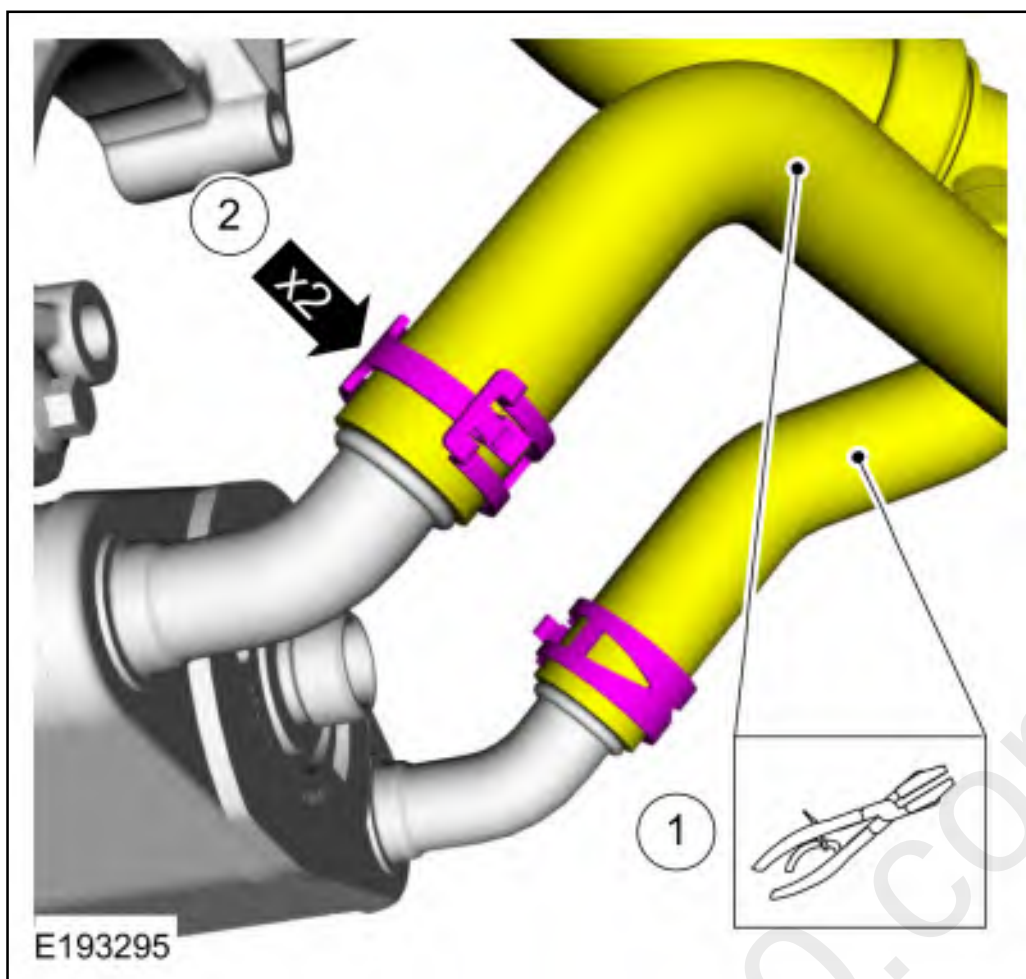
## Removal

1. With the vehicle in NEUTRAL, position it on a hoist.  
Refer to: [Jacking and Lifting - Overview](#) (100-02 Jacking and Lifting, Description and Operation).
2. Remove and discard the engine oil filter.

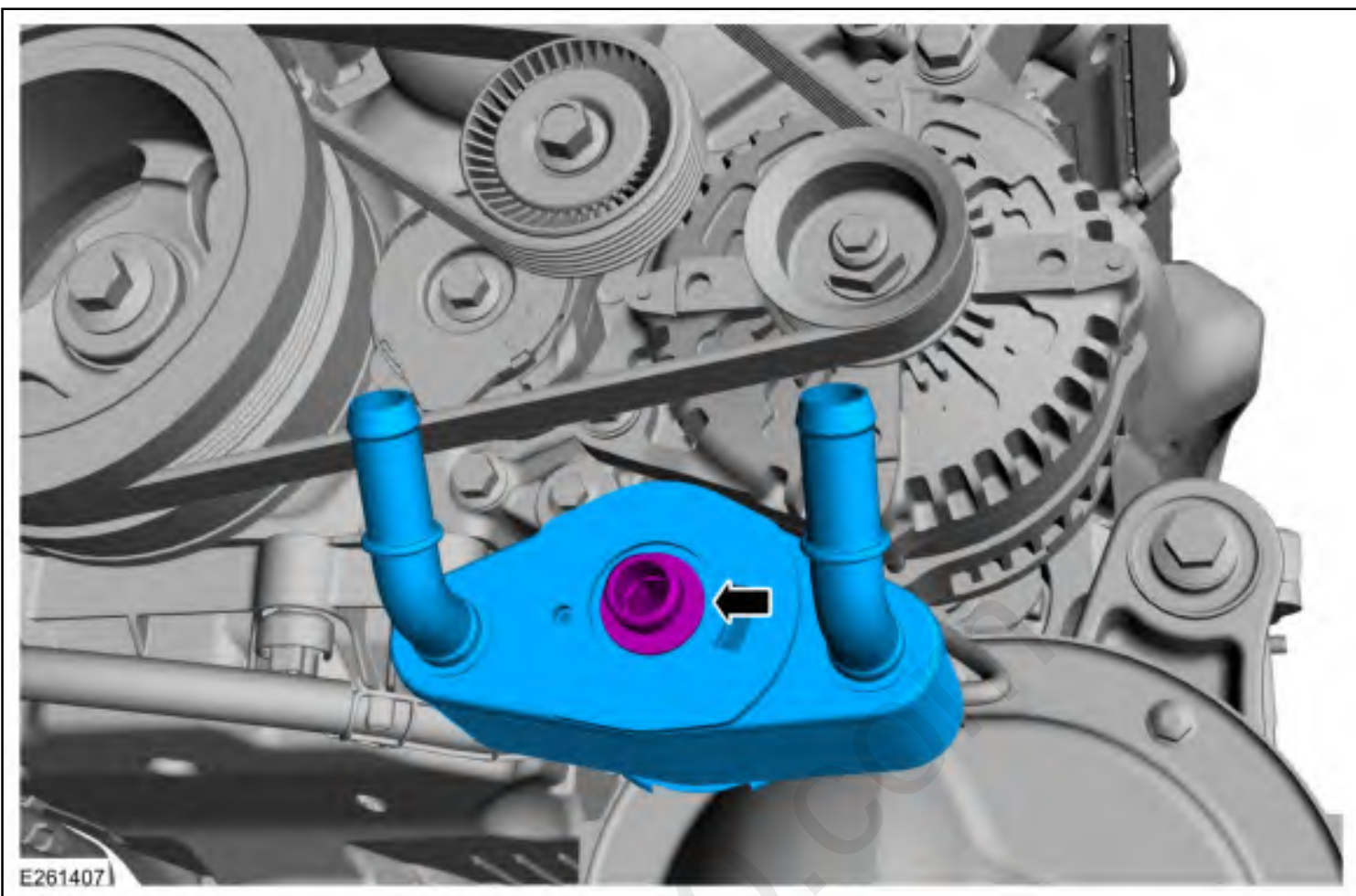


- Using hose locking pliers, clamp the oil cooler coolant hoses.  
Use the General Equipment: Locking Pliers
- Disconnect the coolant hoses.





4. Remove the retainer and the oil cooler.



5. Remove and discard the gasket.



6. **NOTICE:** If metal or aluminum material is present in the oil cooler, mechanical concerns exist. Failure to correct these concerns may cause engine failure. To diagnose mechanical concerns, refer to Section 303-00.

Inspect the oil cooler.



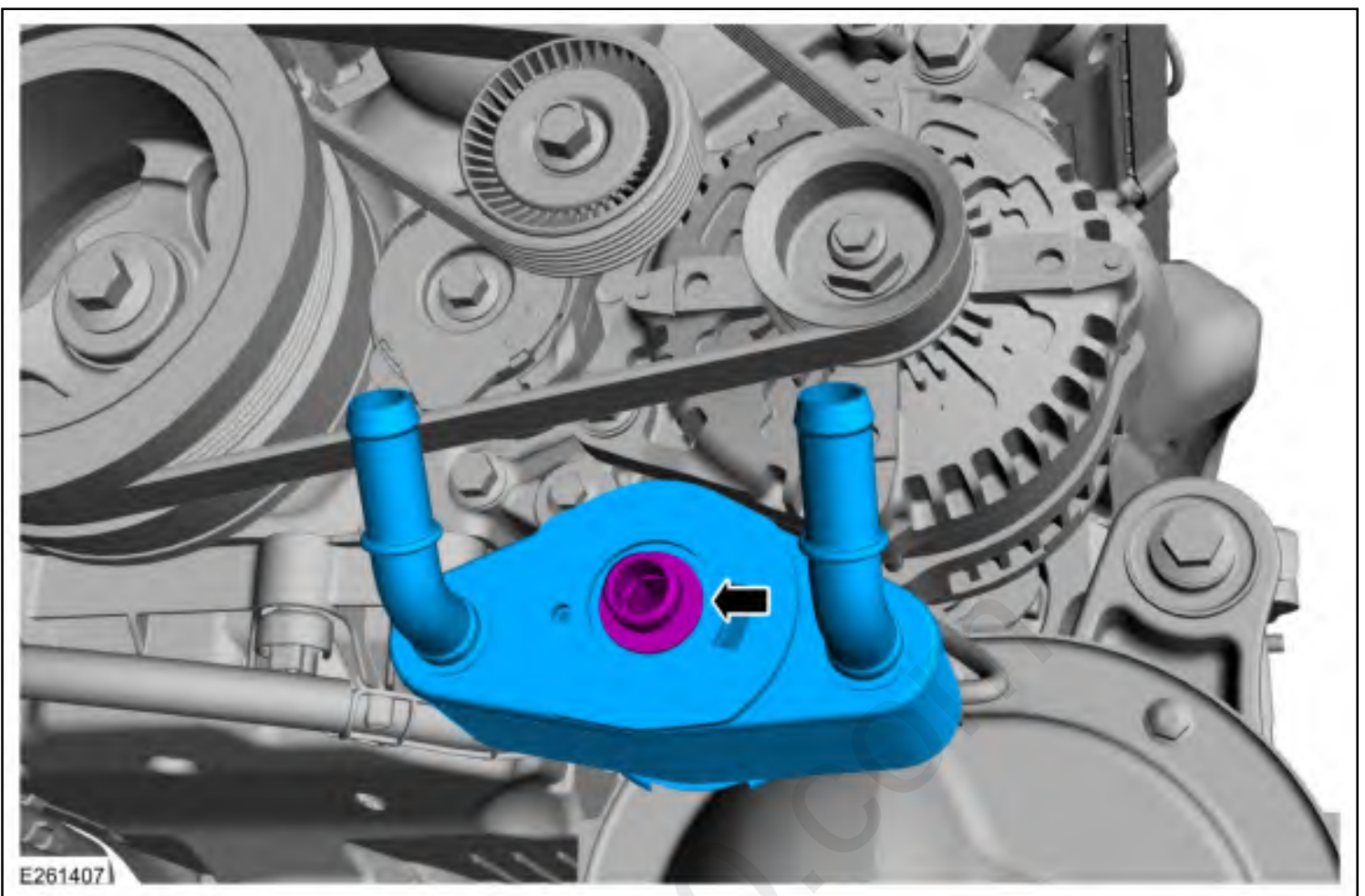
## Installation

1. Install a new gasket.

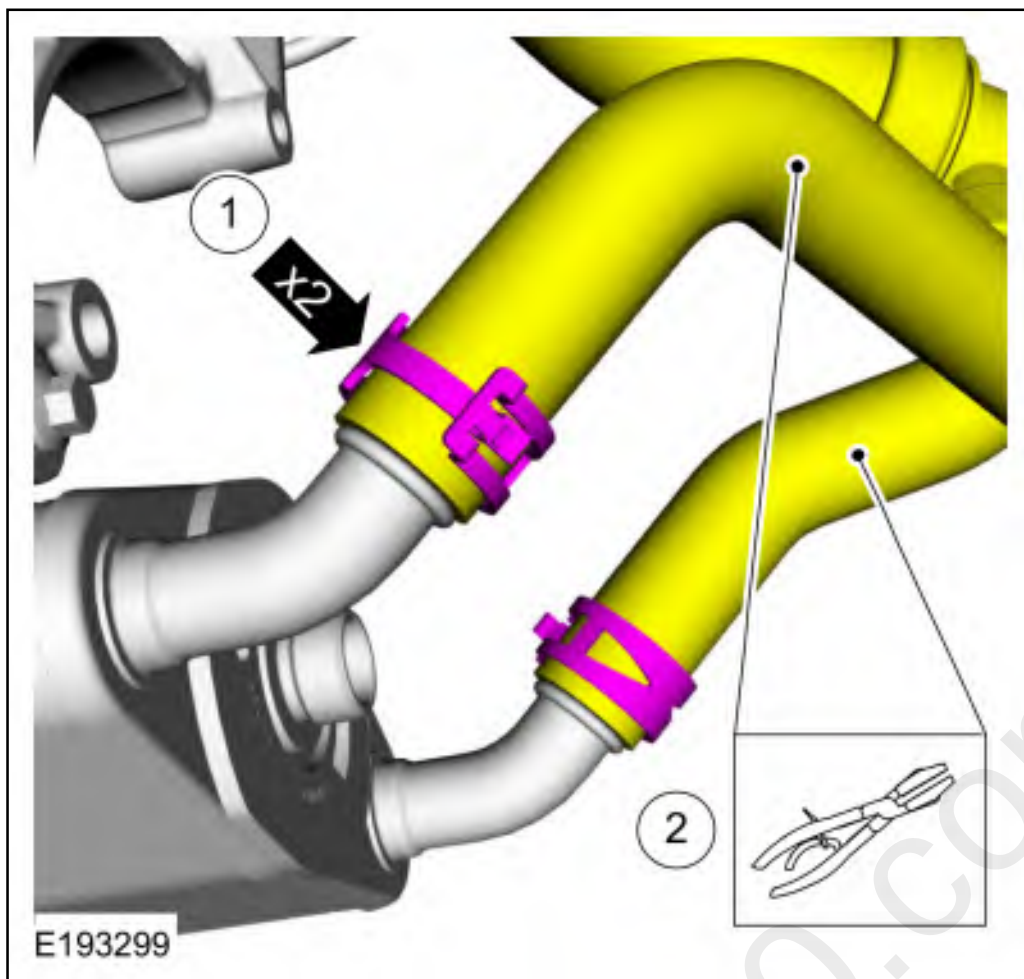


2. Install the oil cooler and the retainer.  
*Torque: 43 lb.ft (58 Nm)*





- Connect the coolant hoses.
- Remove the hose locking pliers.  
Use the General Equipment: Locking Pliers



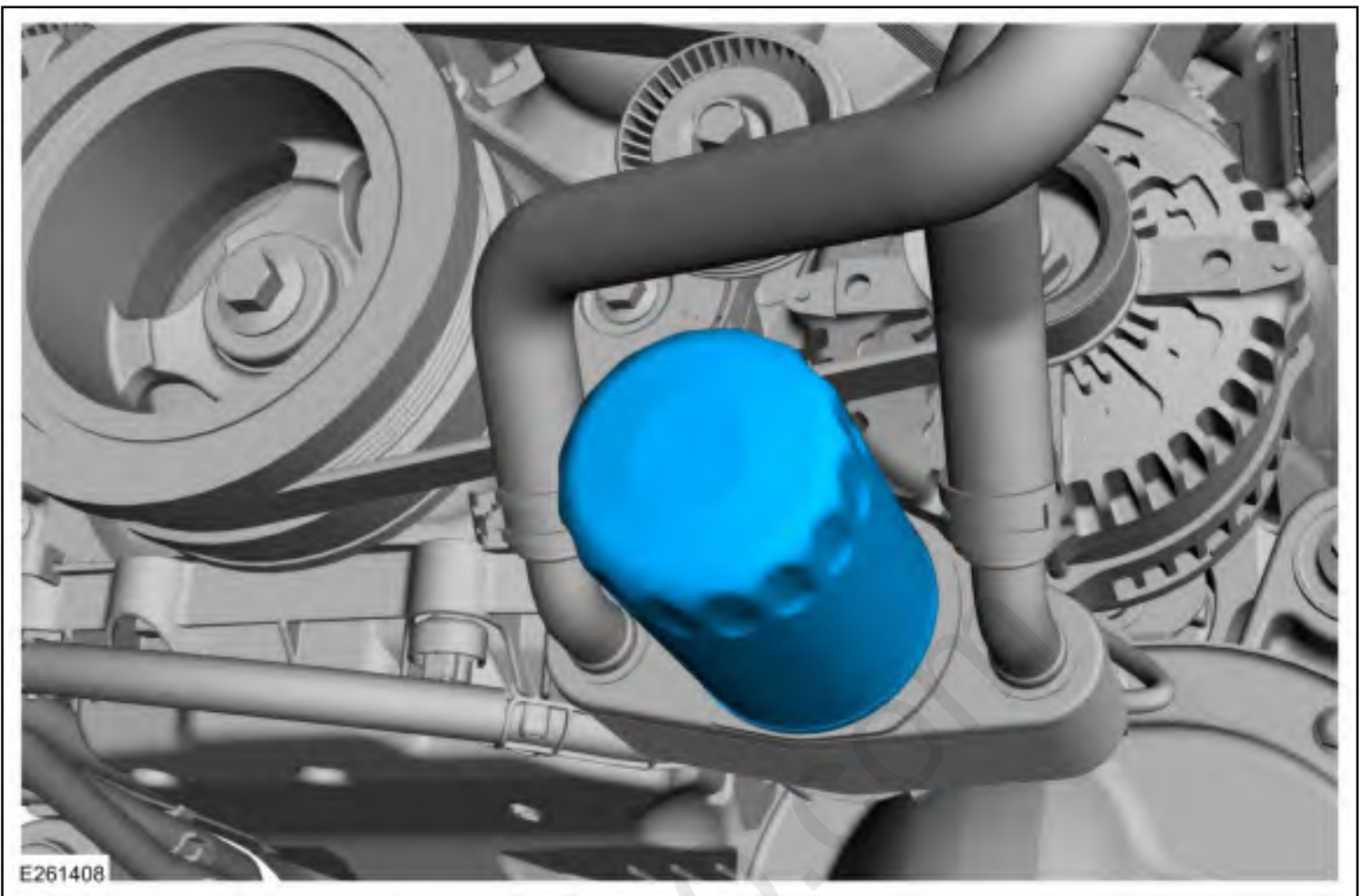
4. **NOTE:** Do not lubricate the O-ring seal.

Install a new oil filter.

*Torque:*

Stage 1: 44 lb.in (5 Nm)

Stage 2: 180°



5. Inspect and adjust the coolant level in the degas bottle

*Material:* Motorcraft® Orange Concentrated Antifreeze/Coolant / VC-3-B (WSS-M97B44-D)

6. Inspect and adjust the engine oil level.

Refer to: [Specifications](#) (303-01D Engine - 5.0L 32V Ti-VCT, Specifications).

# Flexplate

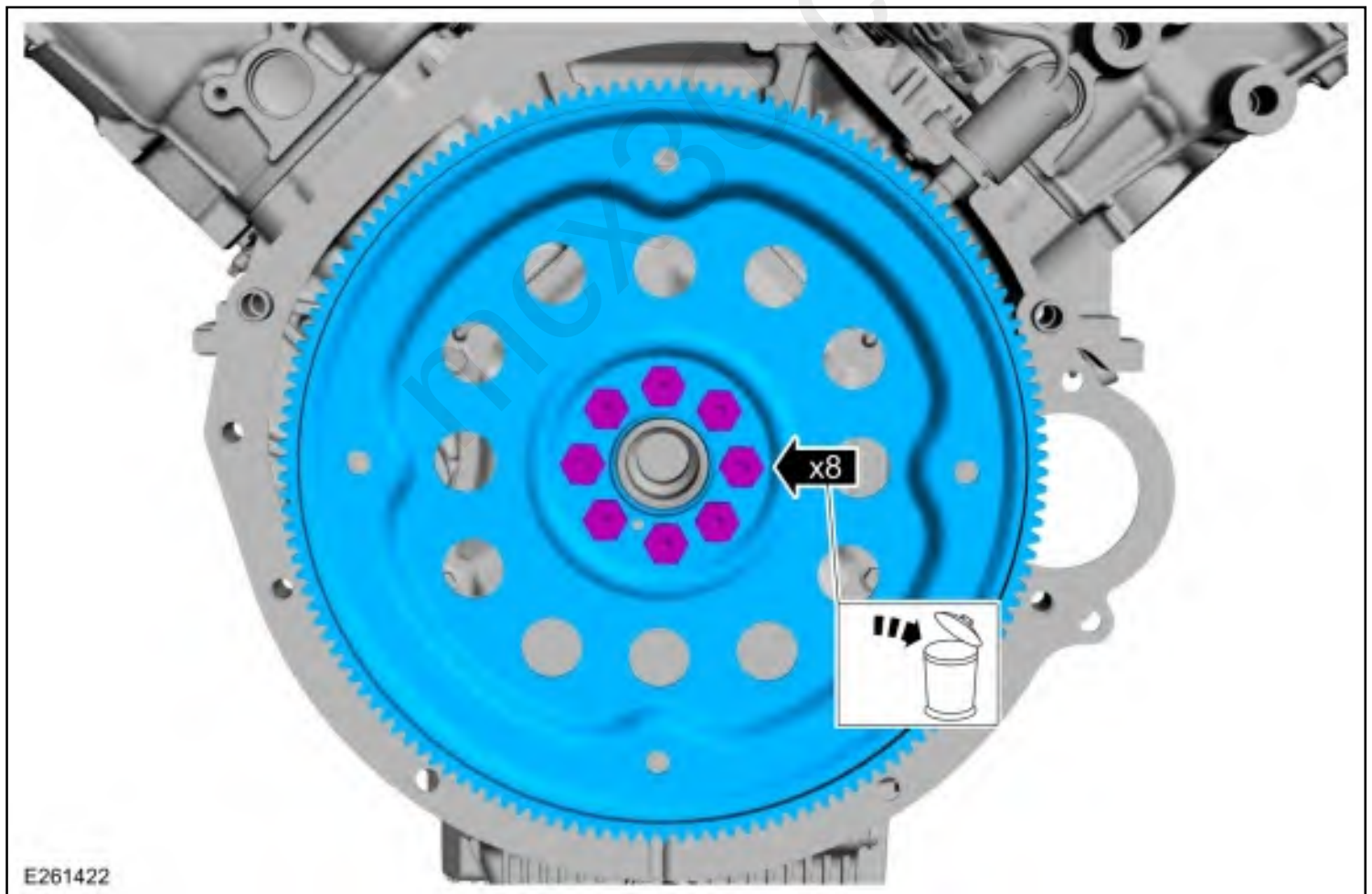
## Removal

1. Remove the transmission.

Refer to: Transmission - 5.0L 32V Ti-VCT (307-01 Automatic Transmission - 6-Speed Automatic Transmission - 6R80) .

2. **NOTE:** *The flexplate bolts are torque-to-yield design and are not reusable.*

- Remove and discard the bolts.
- Remove the flexplate.



## Installation

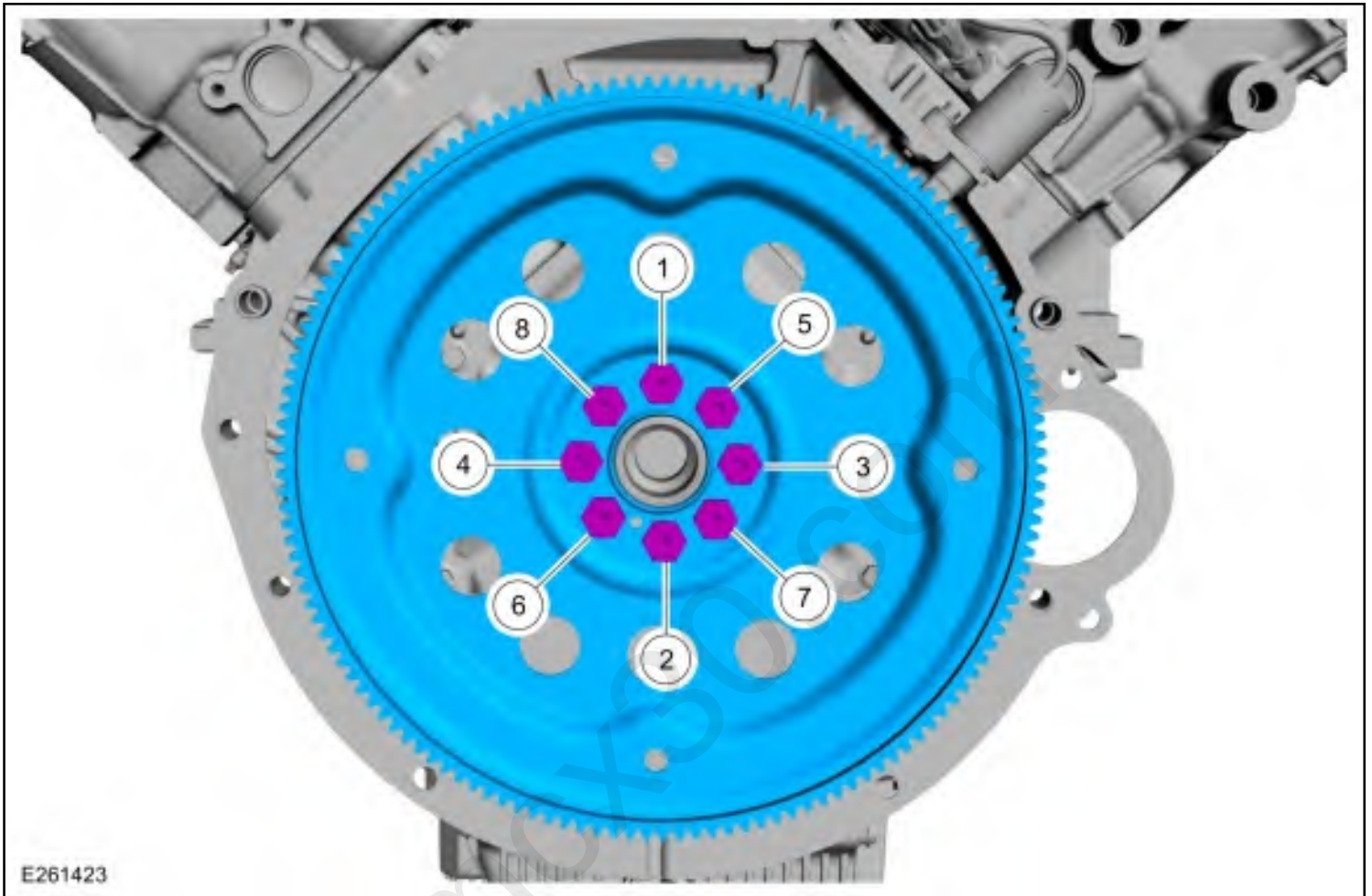


1. Install the flexplate and the bolts.

*Torque:*

Stage 1: 43 lb.ft (58 Nm)

Stage 2: 45°



2. Install the transmission.

Refer to: Transmission - 5.0L 32V Ti-VCT (307-01 Automatic Transmission - 6-Speed Automatic Transmission - 6R80) .

3. Use the Powertrain Control Module (PCM) Misfire Monitor Profile Correction routine in the diagnostic scan tool.



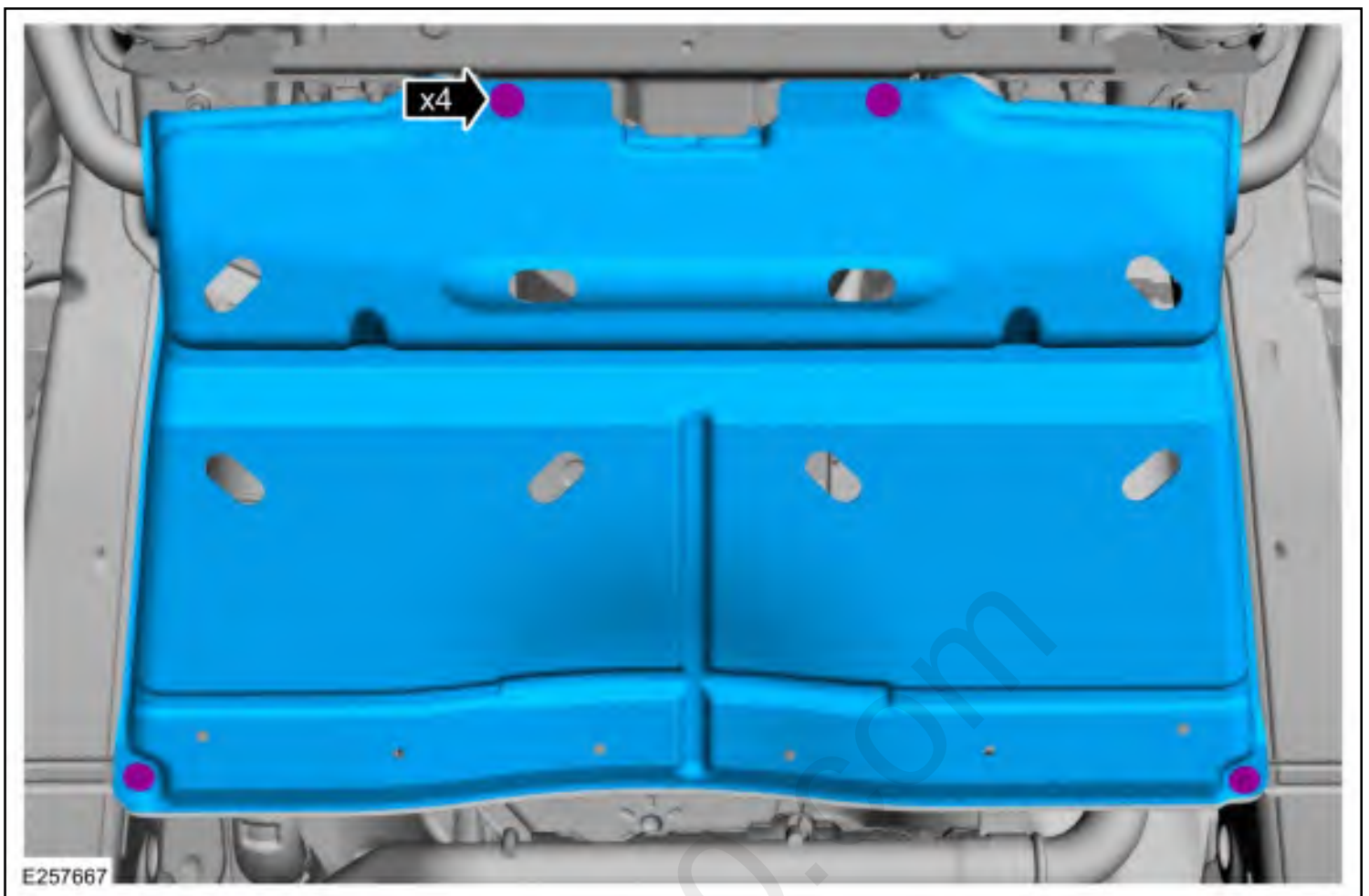
## Exhaust Manifold LH

Base Part Number: Base Part Number: 9431

### Removal

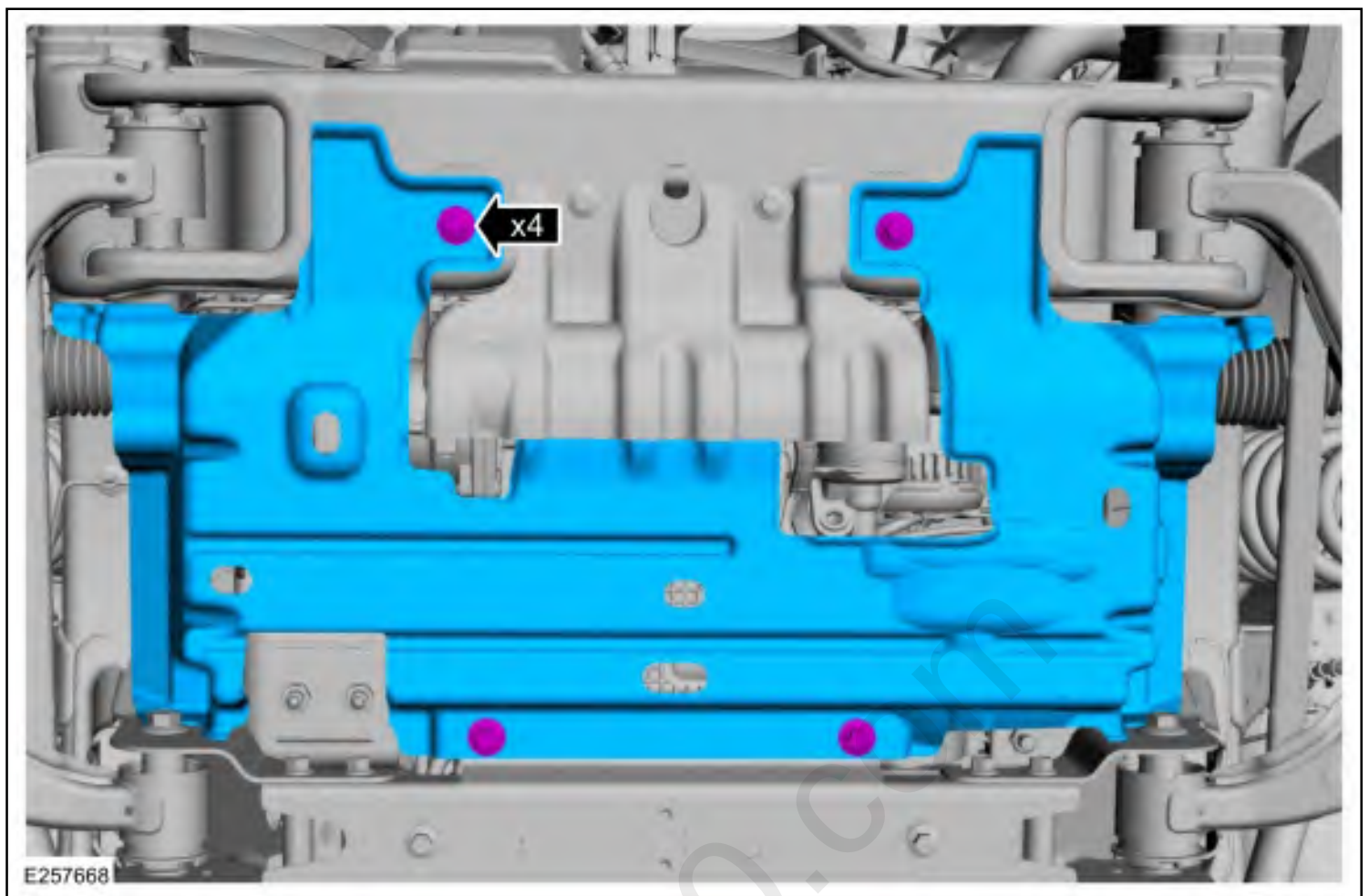
1. With the vehicle in NEUTRAL, position it on a hoist.  
Refer to: [Jacking and Lifting - Overview](#) (100-02 Jacking and Lifting, Description and Operation).
2. Disconnect the battery ground cable.  
Refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables) .
3. Remove the following items:
  1. **NOTE:** *It is not necessary to separate the air cleaner outlet pipe and the air cleaner, they can be removed as an assembly.*  
  
Refer to: [Air Cleaner Outlet Pipe](#) (303-12D Intake Air Distribution and Filtering - 5.0L 32V Ti-VCT, Removal and Installation).
  2. Refer to: [Air Cleaner](#) (303-12D Intake Air Distribution and Filtering - 5.0L 32V Ti-VCT, Removal and Installation).
  3. LH wheel and tire.  
Refer to: [Wheel and Tire](#) (204-04A Wheels and Tires, Removal and Installation).
  4. LH fender splash shield.  
Refer to: [Fender Splash Shield](#) (501-02 Front End Body Panels, Removal and Installation).
4. **NOTE:** *If equipped.*

Remove the bolts and the underbody shield.



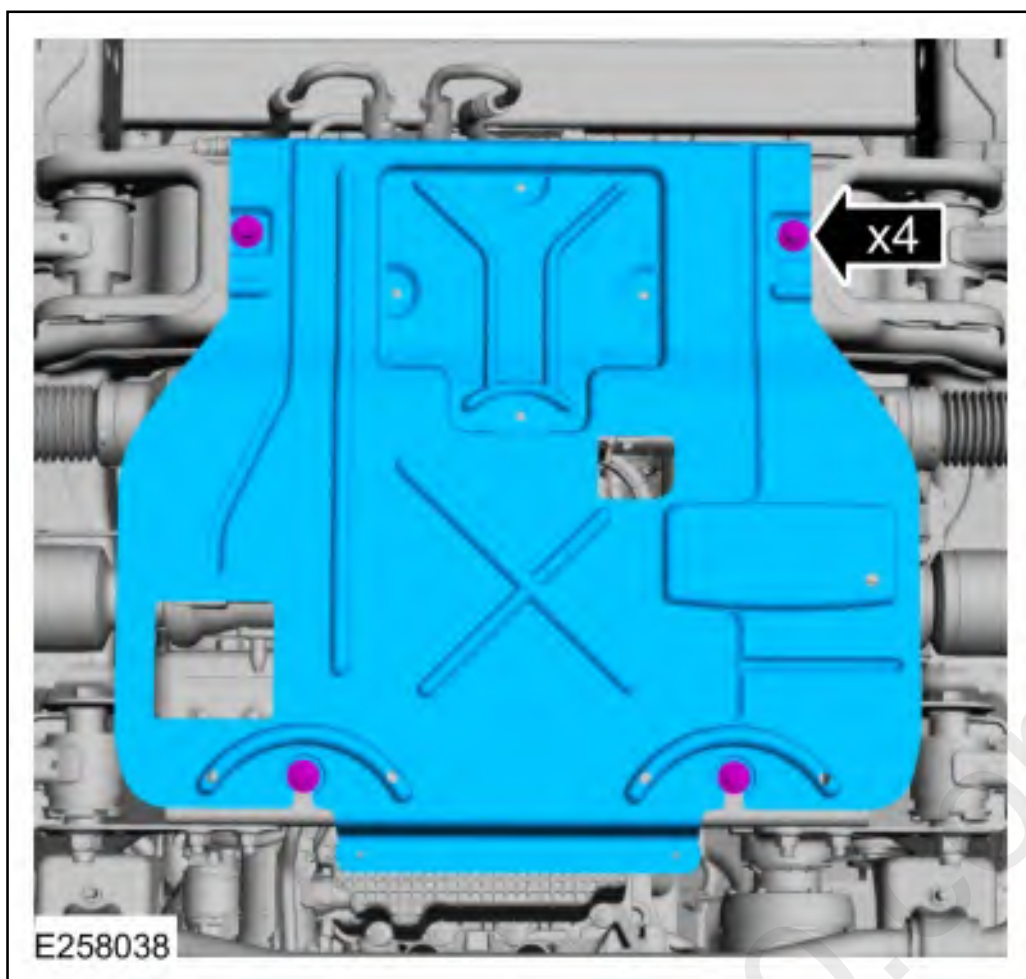
5. **NOTE:** *If equipped.*

Remove the bolts and the underbody shield.

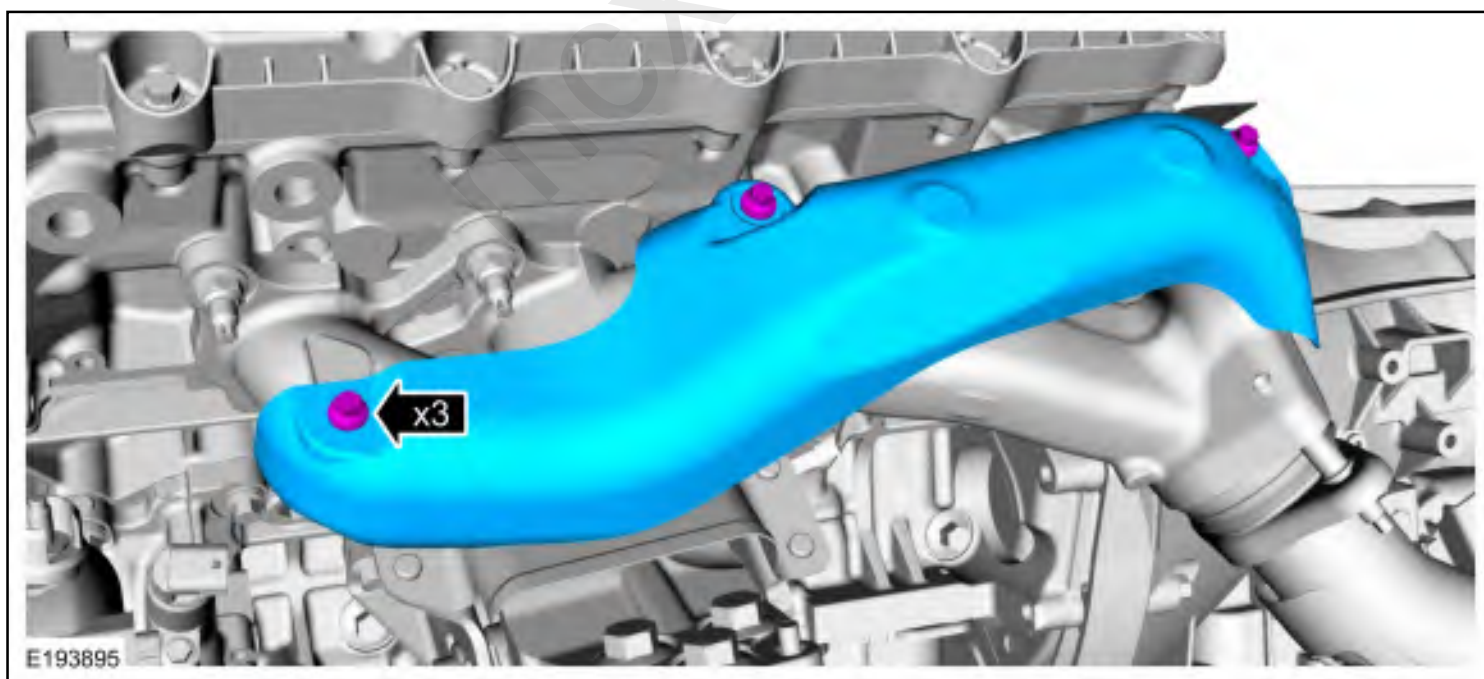


6. **NOTE:** *If equipped.*

Remove the bolts and the skid plate.

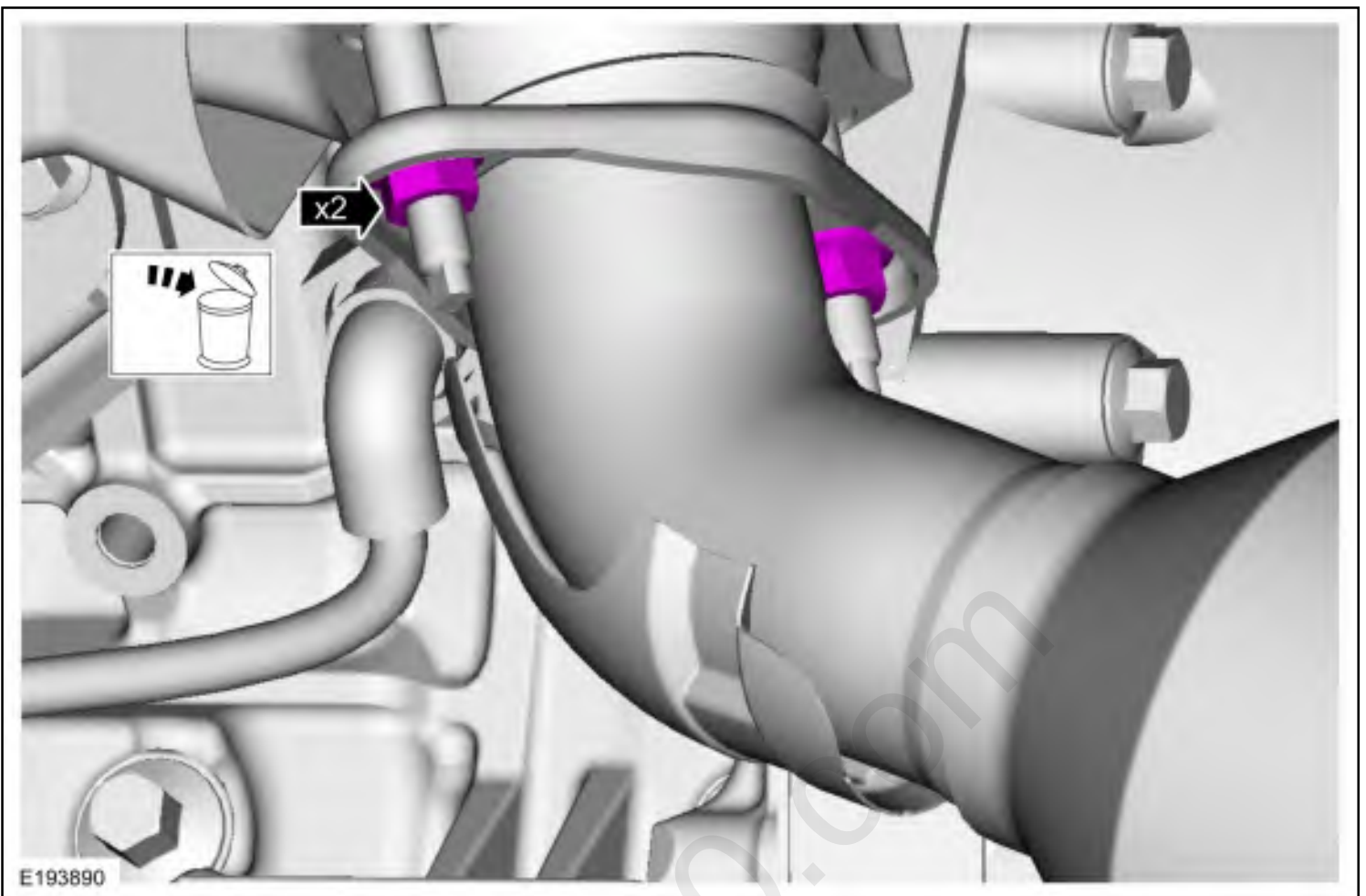


7. Remove the bolts and the LH exhaust manifold heat shield.



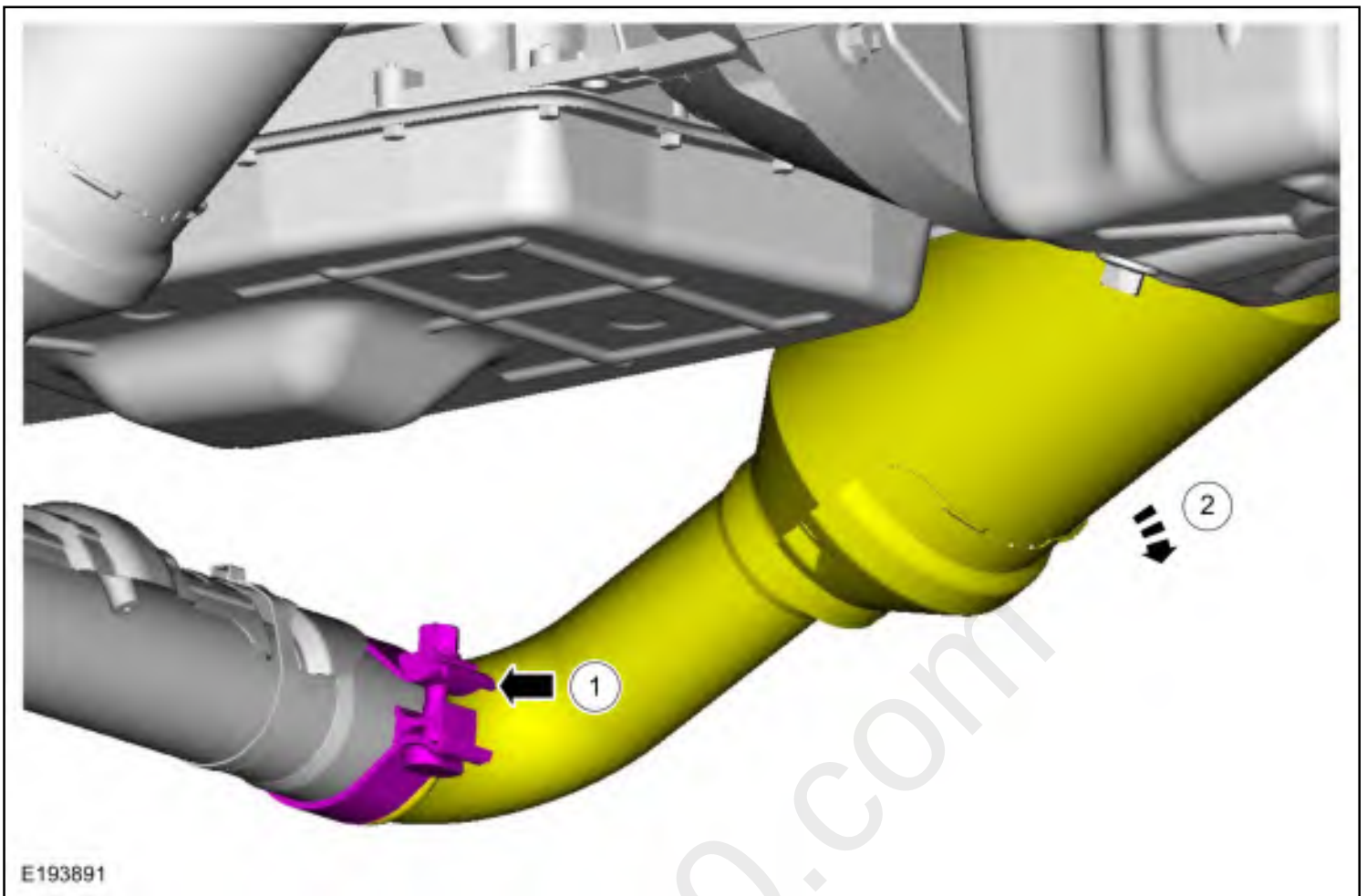
8. Remove and discard the catalytic converter-to-LH exhaust manifold nuts.





1. Loosen the LH catalytic converter-to- RH catalytic converter Torca® clamp.
2. Lower the catalytic converter to disengage the catalytic converter flange from the LH exhaust manifold studs.
  - Clean the catalytic converter-to-manifold mating surface.

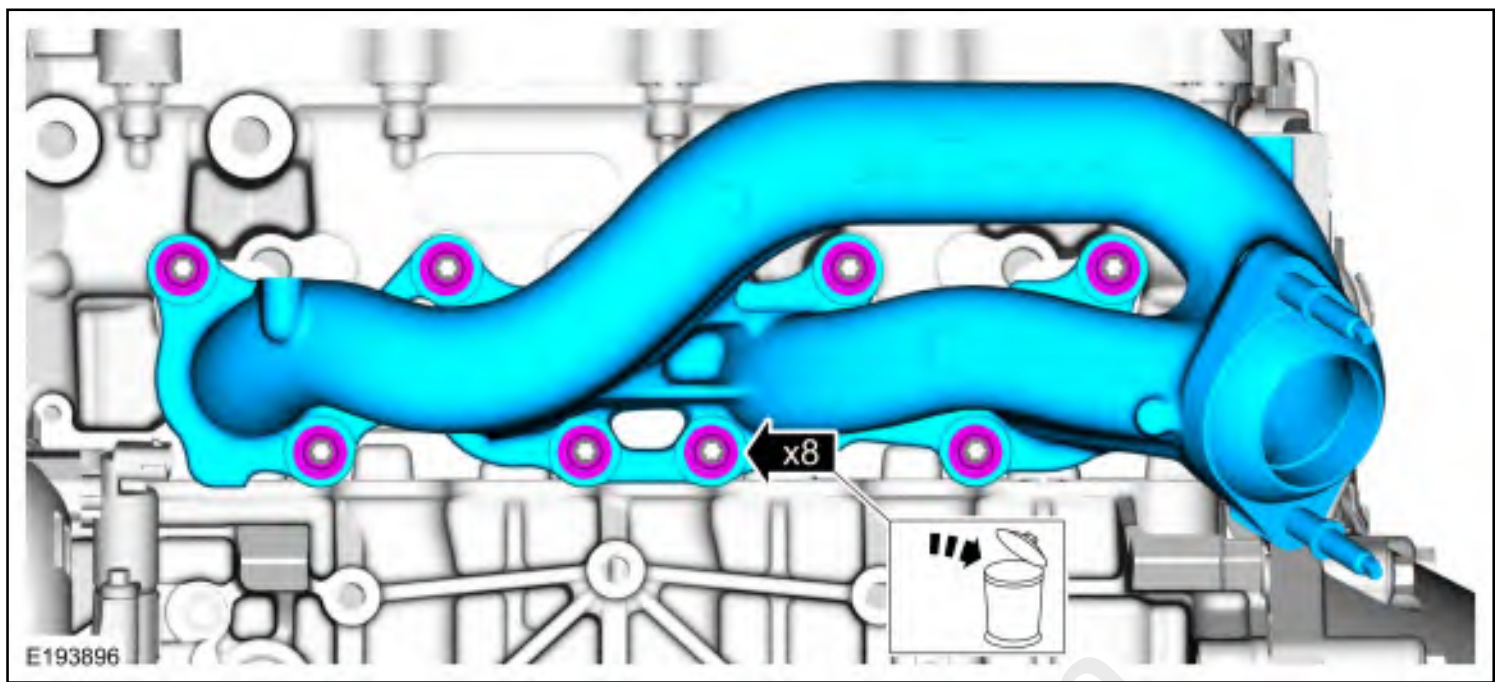




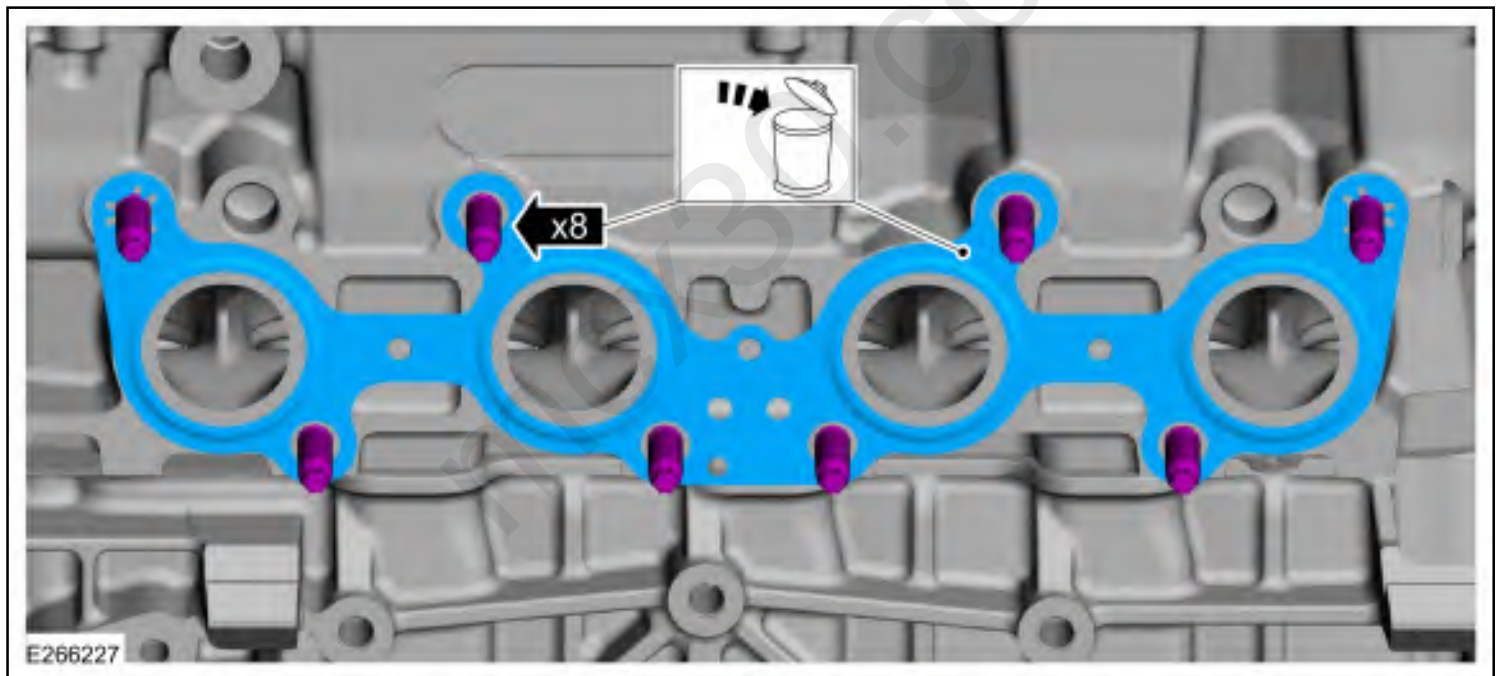
10. Remove and discard the nuts.

1. Remove the exhaust manifold.
2. Clean and inspect the exhaust manifold.

Refer to: [Exhaust Manifold Cleaning and Inspection](#) (303-00 Engine System - General Information, General Procedures).

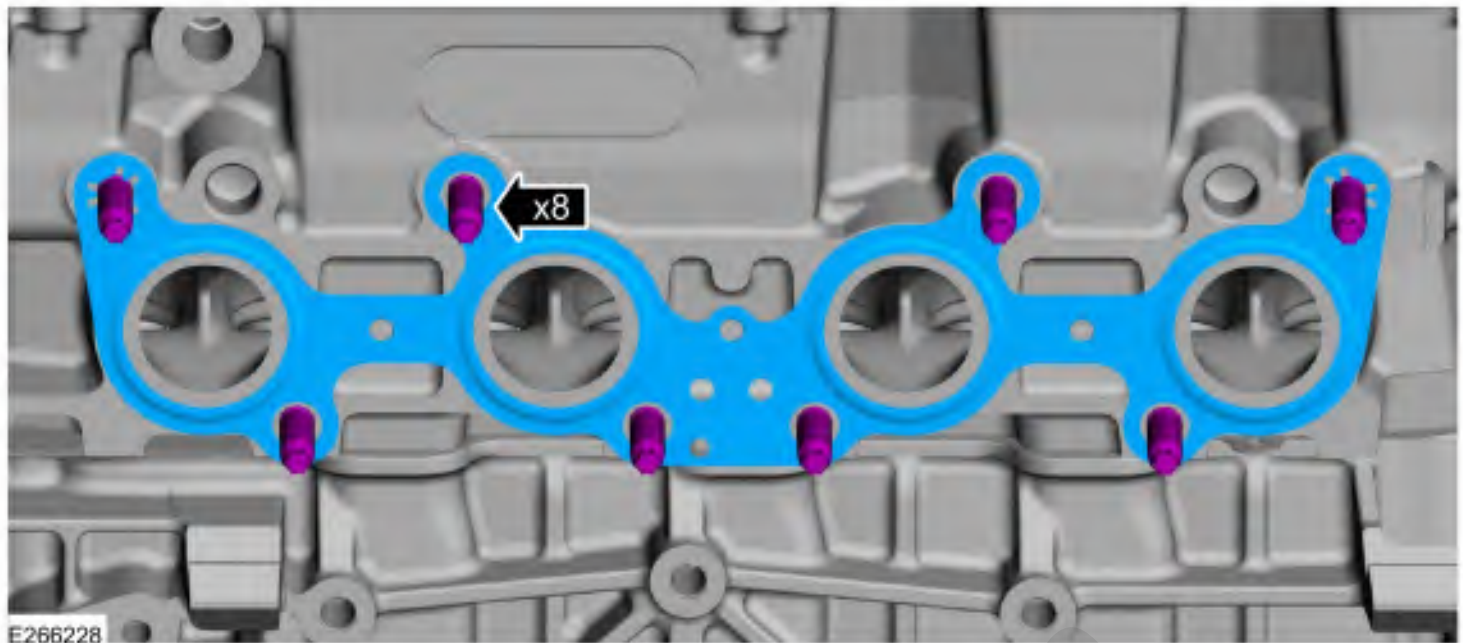


11. Remove and discard the gasket and studs.



## Installation

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



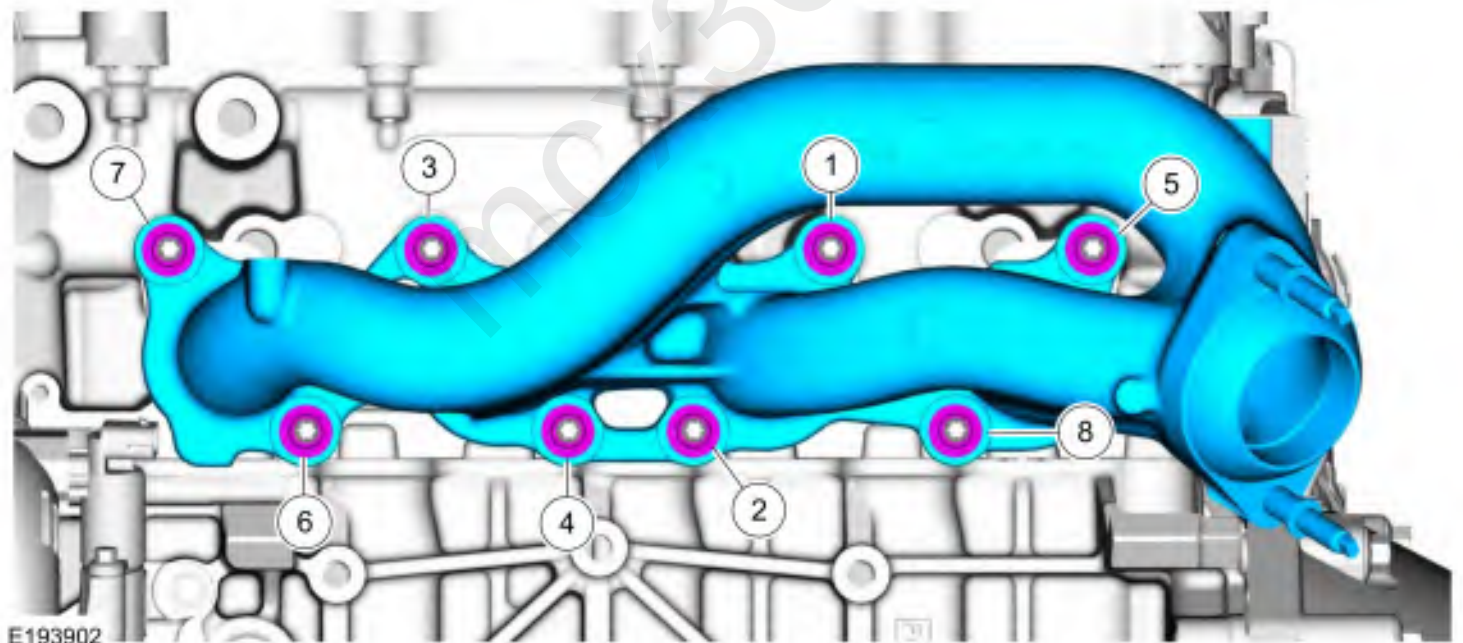
2. Install the exhaust manifold.

- Install the new nuts.

*Torque:*

Stage 1: 18 lb.ft (24 Nm)

Stage 2: 24 lb.ft (32 Nm)

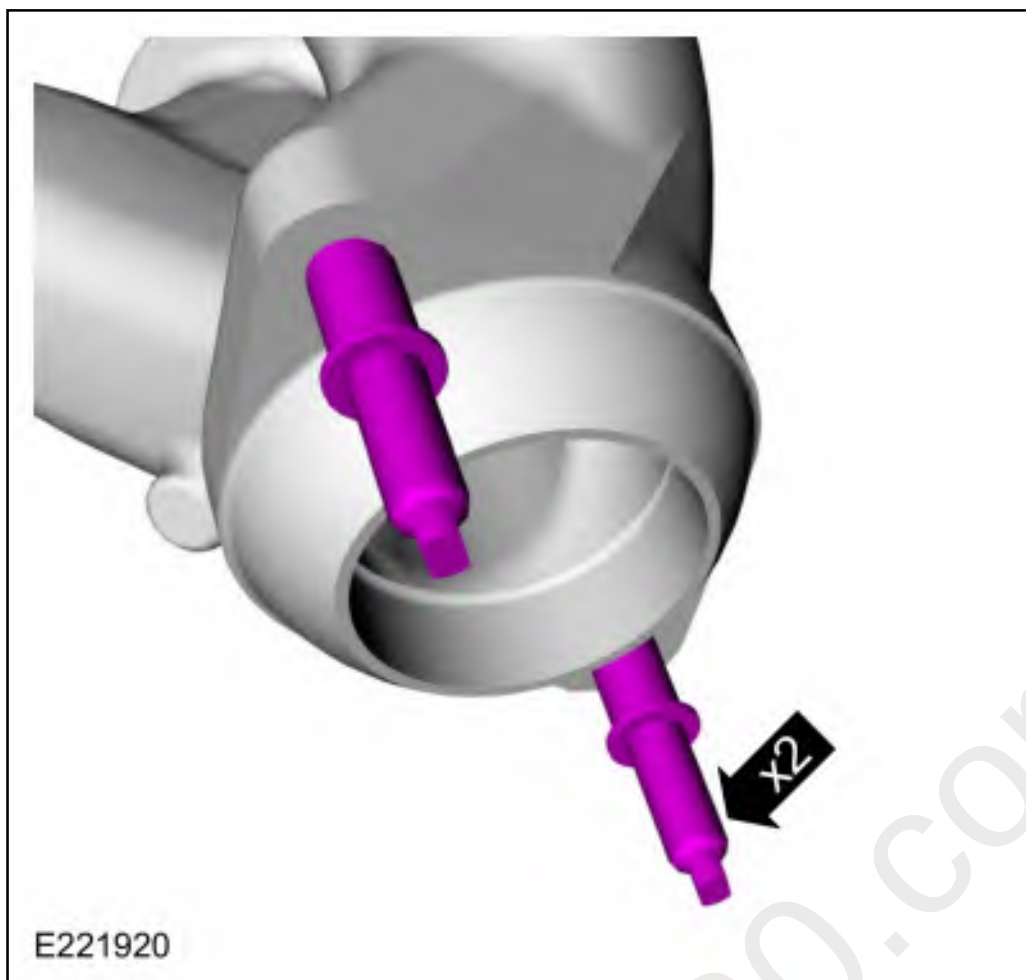


3. **NOTE:** Some replacement exhaust manifolds do not come with studs.

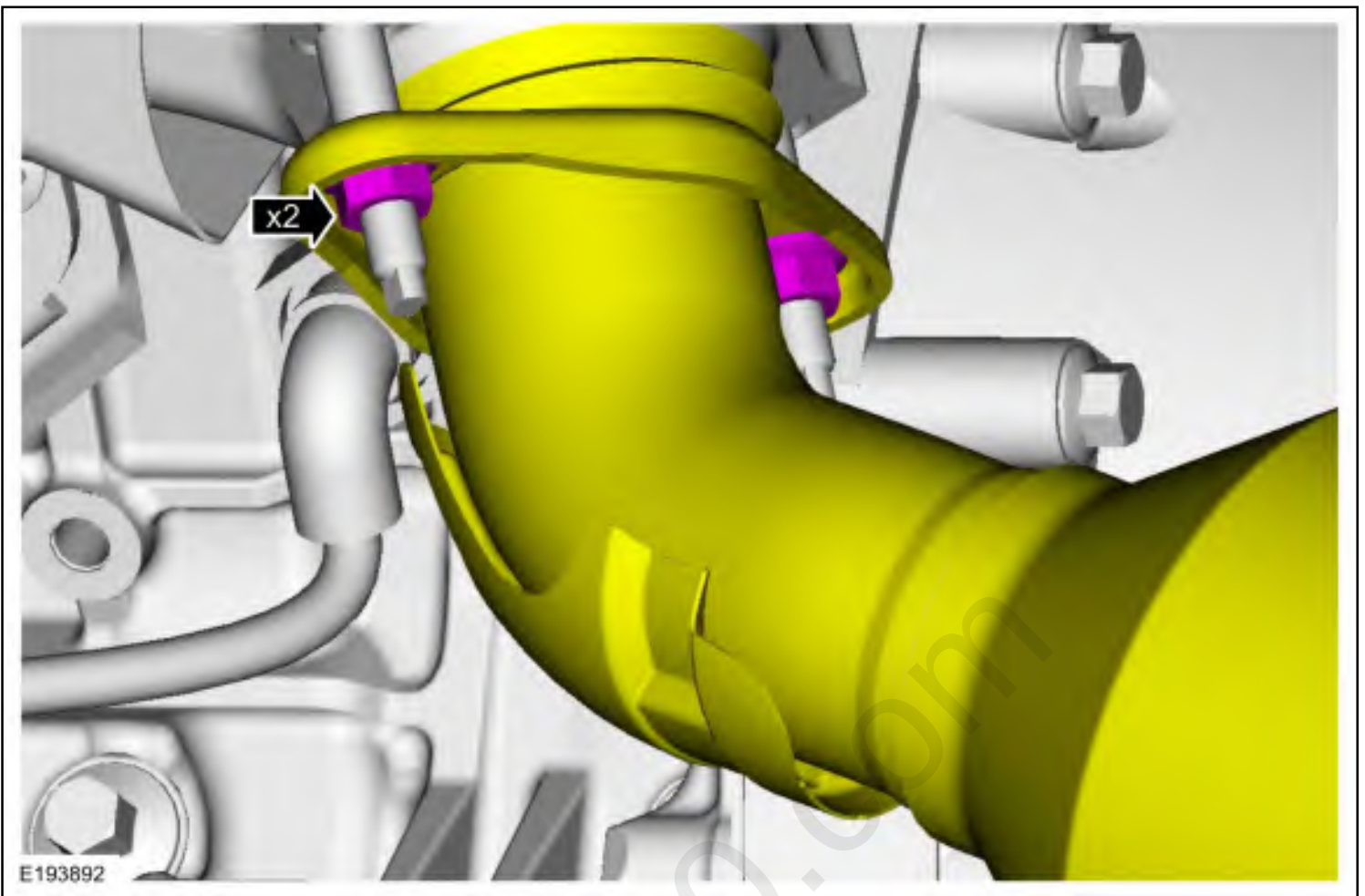
If necessary, install new studs.

*Torque:* 30 lb.ft (40 Nm)



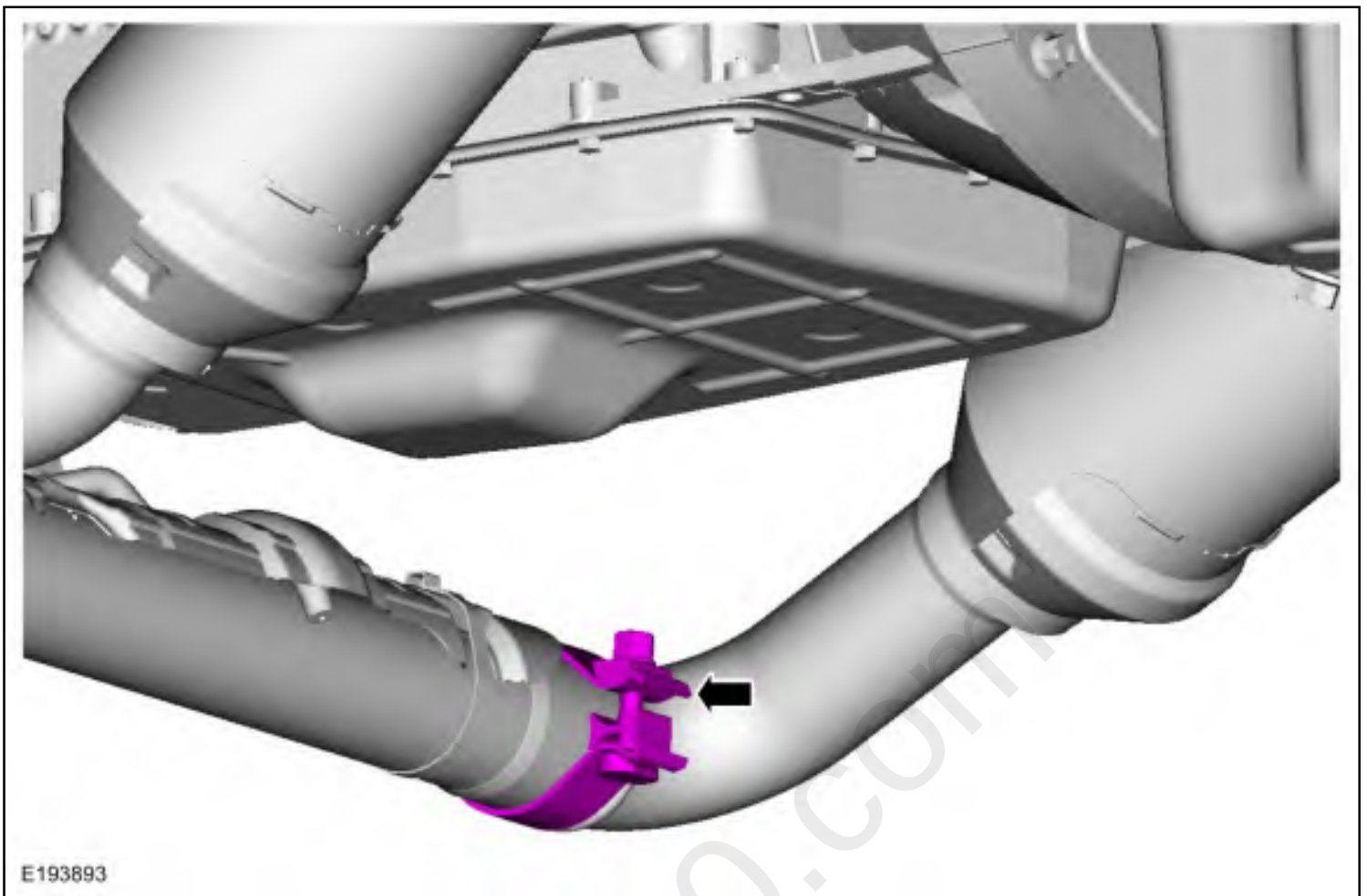


4. Position the LH catalytic converter onto the exhaust manifold and loosely install the new nuts.



5. Tighten the Torca® clamp.  
*Torque: 41 lb.ft (55 Nm)*



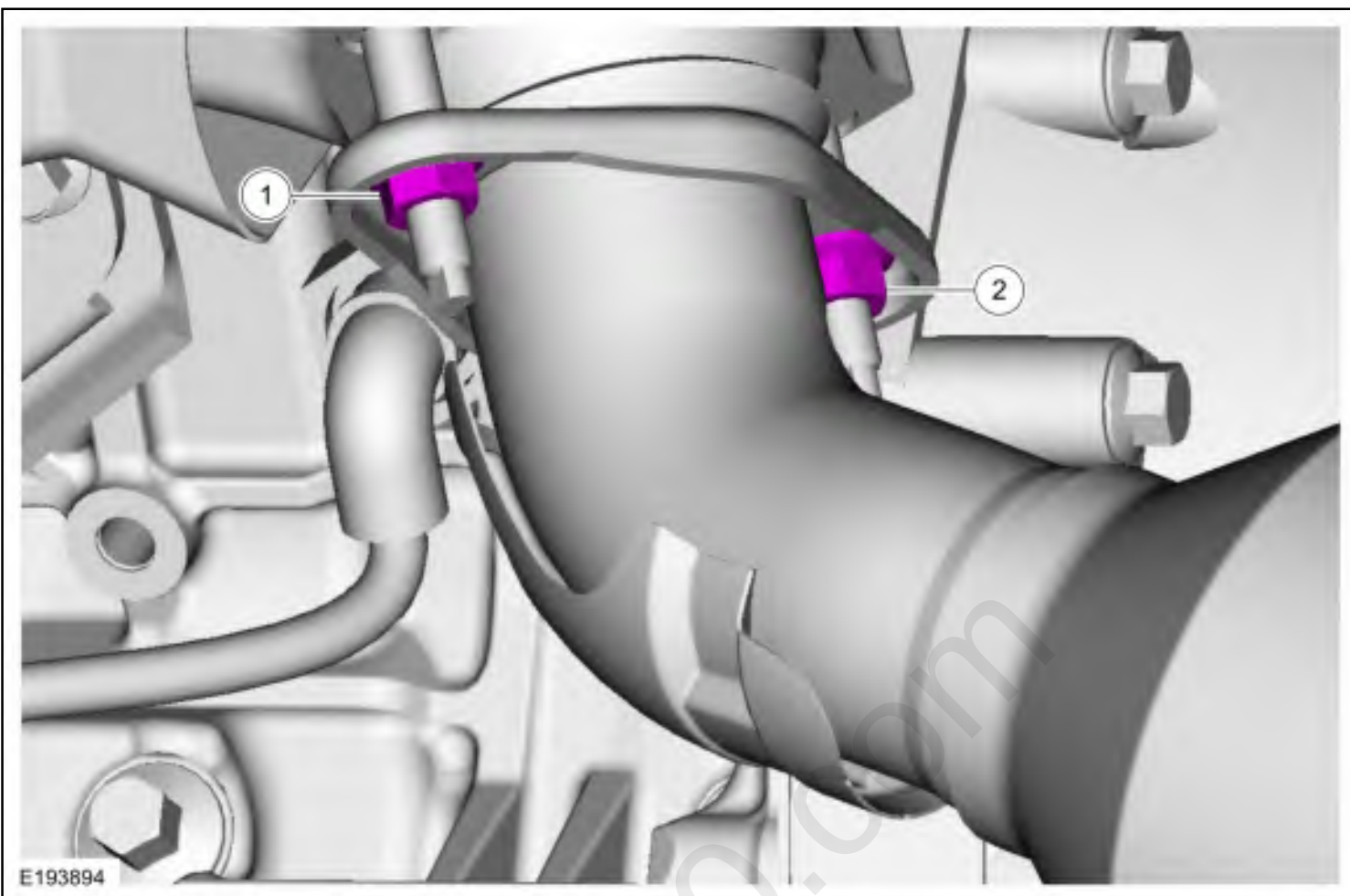


6. Tighten the nuts.

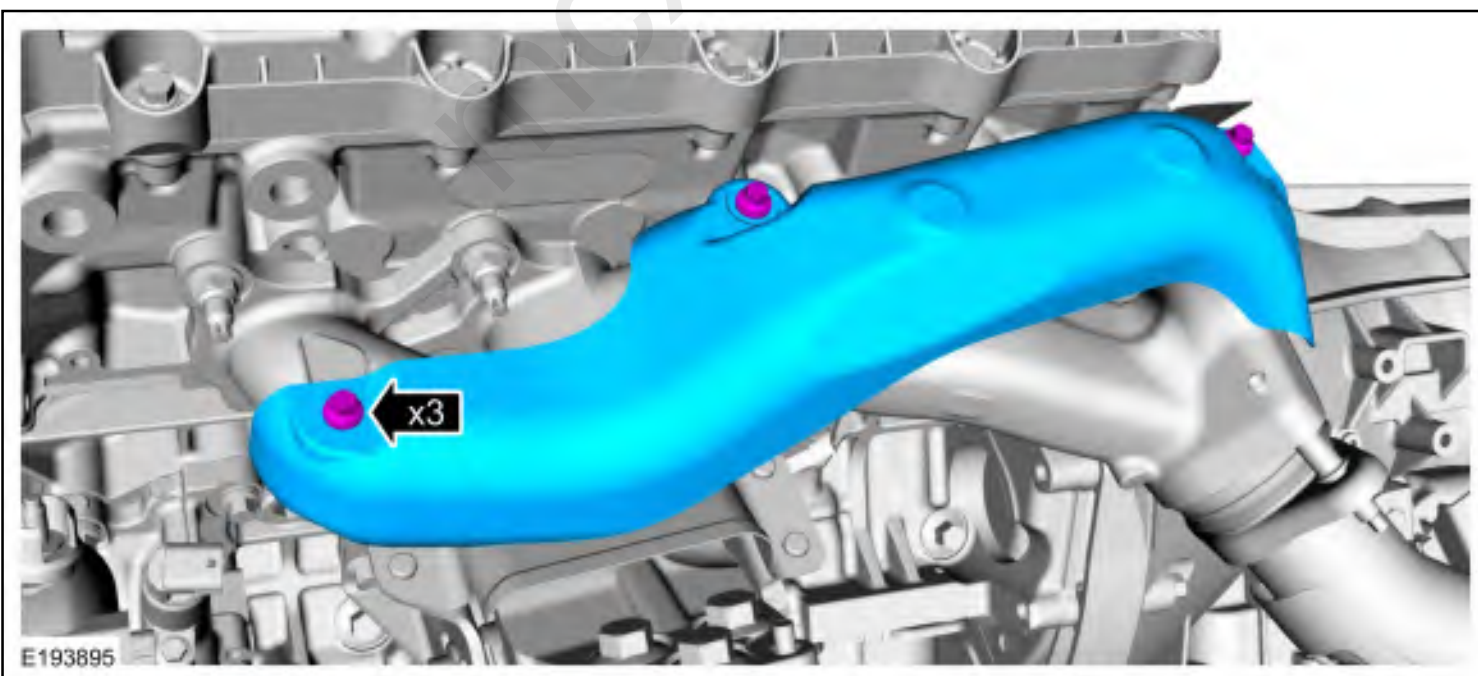
*Torque:*

Outer catalytic converter-to-exhaust manifold nut : 30 lb.ft (40 Nm)

Inner catalytic converter-to-exhaust manifold nut : 30 lb.ft (40 Nm)



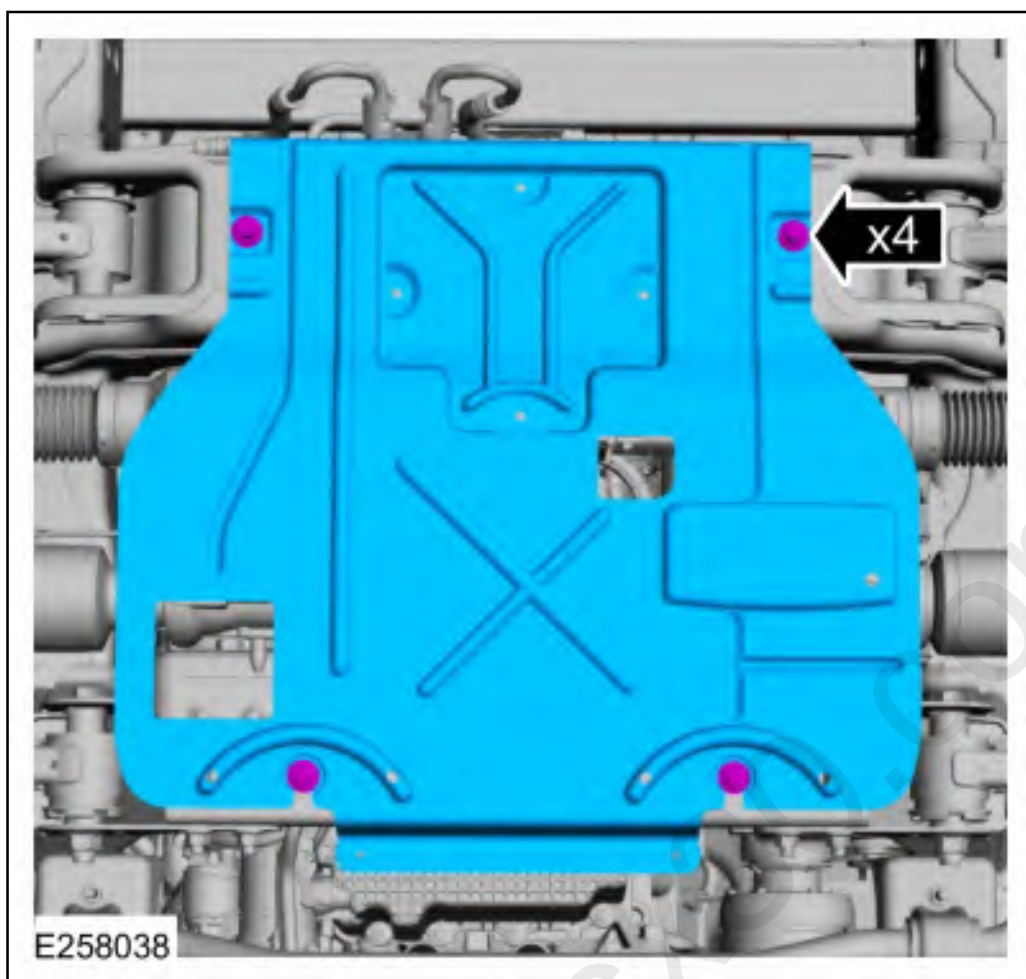
7. Install the heat shield and bolts.  
*Torque: 106 lb.in (12 Nm)*



8. **NOTE:** *If equipped.*

Install the skid plate and bolts.

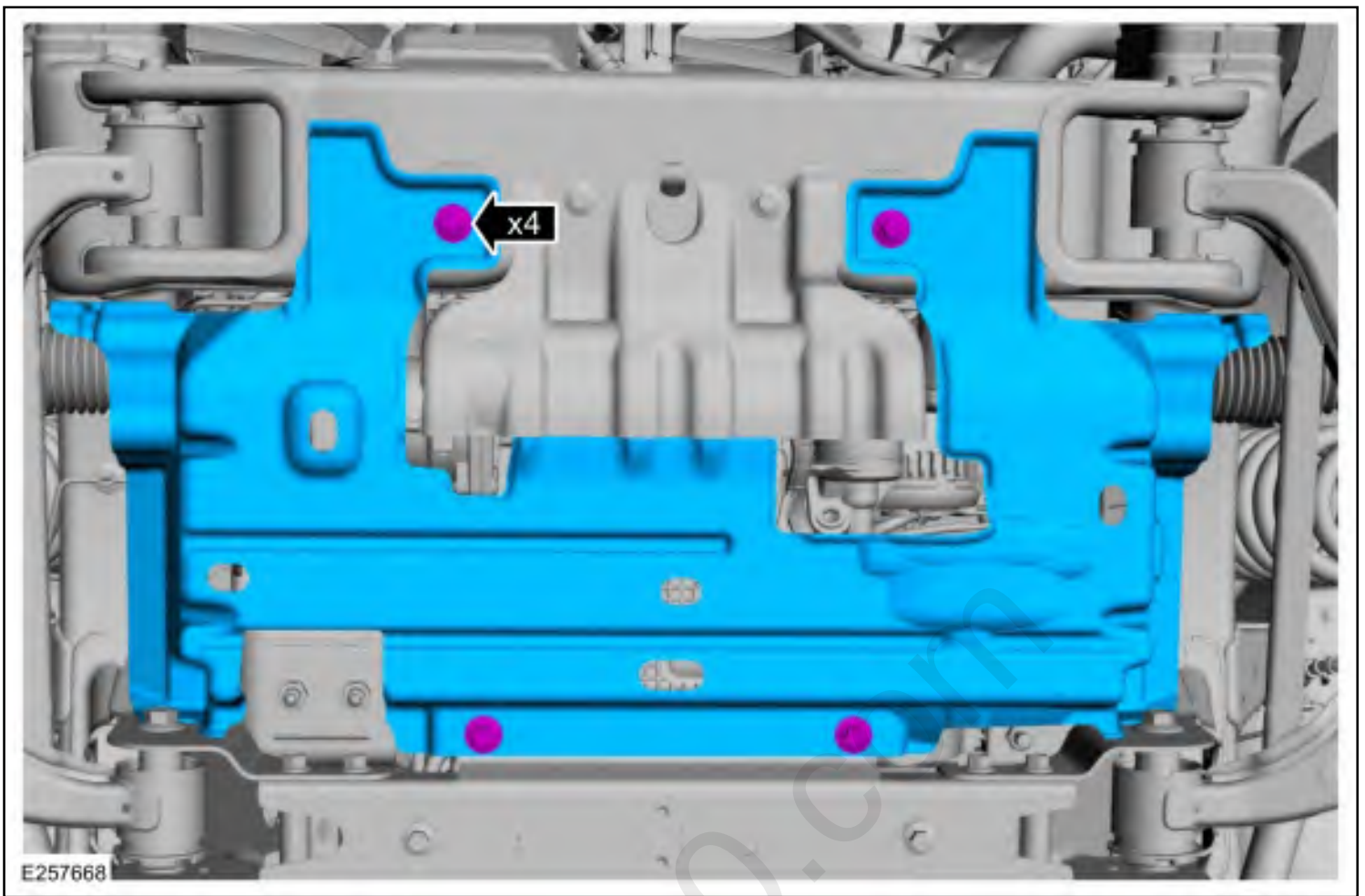
*Torque:* 30 lb.ft (40 Nm)



9. **NOTE:** *If equipped.*

Install the underbody shield and fasteners.

*Torque:* 30 lb.ft (40 Nm)

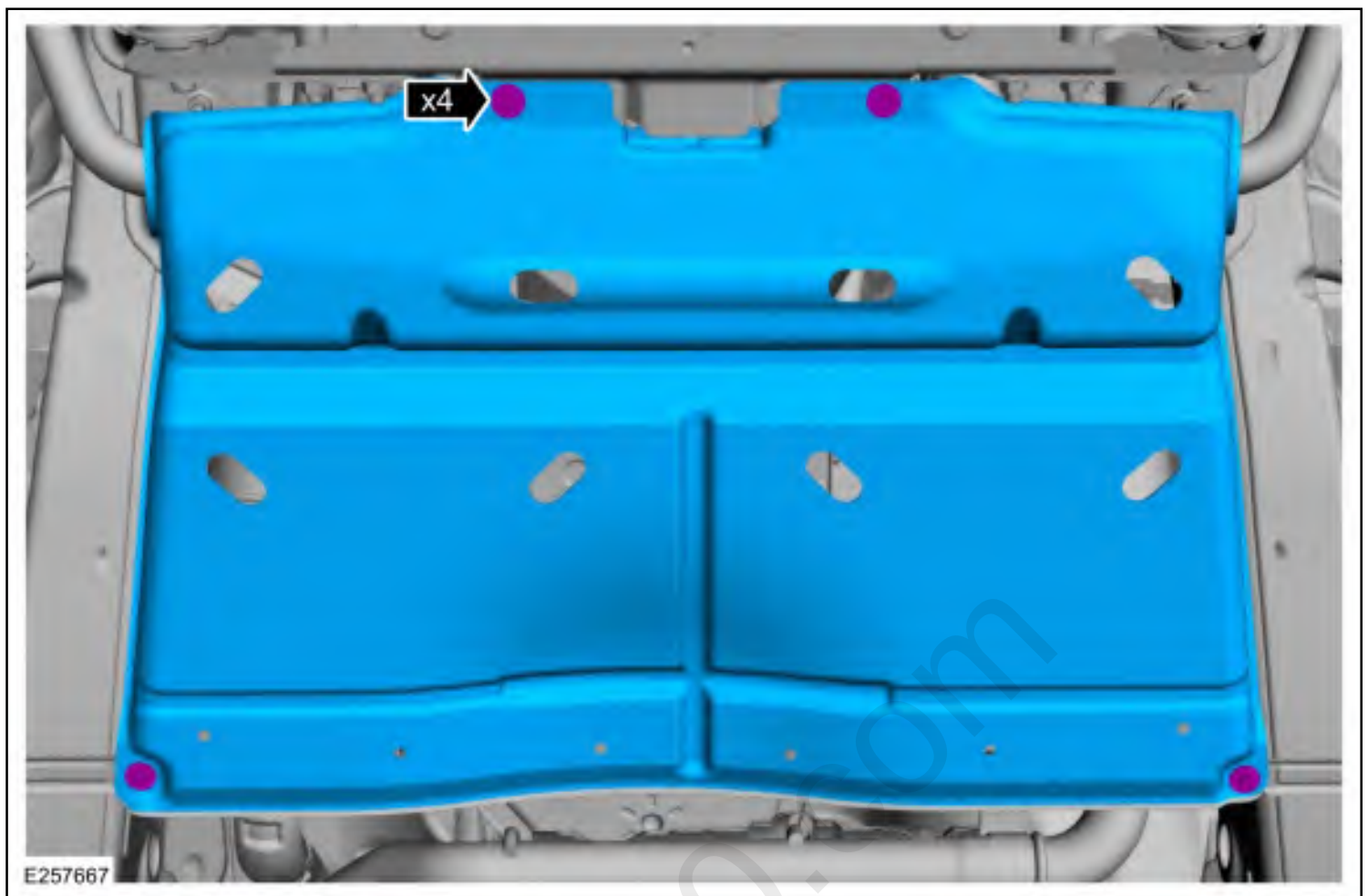


10. **NOTE:** *If equipped.*

Install the underbody shield and the bolts.

*Torque:* 71 lb.in (8 Nm)





11. Install the following items:

1. LH fender splash shield.  
Refer to: [Fender Splash Shield](#) (501-02 Front End Body Panels, Removal and Installation).
2. LH wheel and tire.  
Refer to: [Wheel and Tire](#) (204-04A Wheels and Tires, Removal and Installation).
3. **NOTE:** *It is not necessary to separate the air cleaner outlet pipe and the air cleaner, they can be installed as an assembly.*  
  
Refer to: [Air Cleaner](#) (303-12D Intake Air Distribution and Filtering - 5.0L 32V Ti-VCT, Removal and Installation).
4. Refer to: [Air Cleaner Outlet Pipe](#) (303-12D Intake Air Distribution and Filtering - 5.0L 32V Ti-VCT, Removal and Installation).

12. Connect the battery ground cable.

Refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables) .

13. Start the engine and check for exhaust leaks.



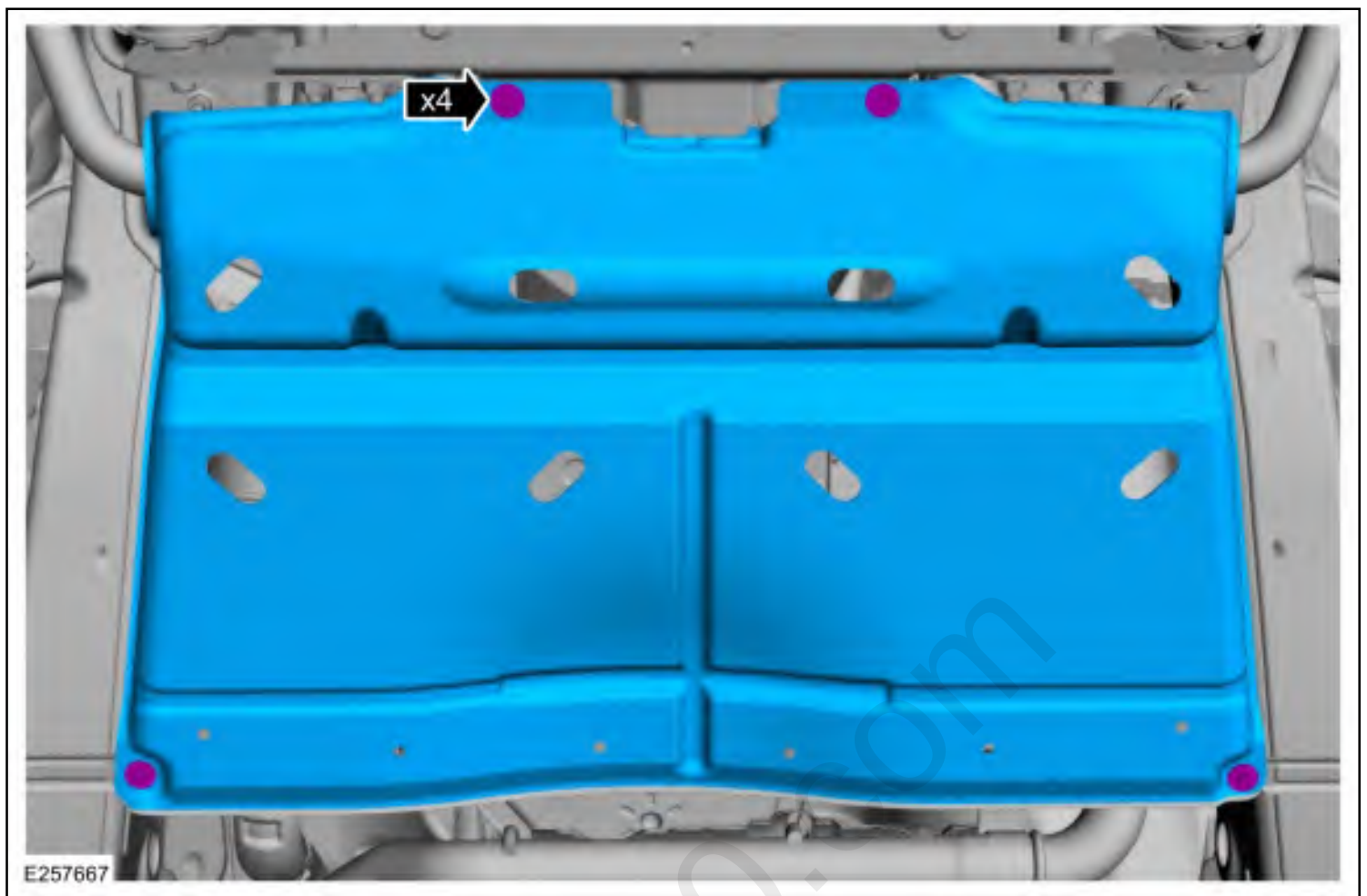
## Exhaust Manifold RH

Base Part Number: Base Part Number: 9431

### Removal

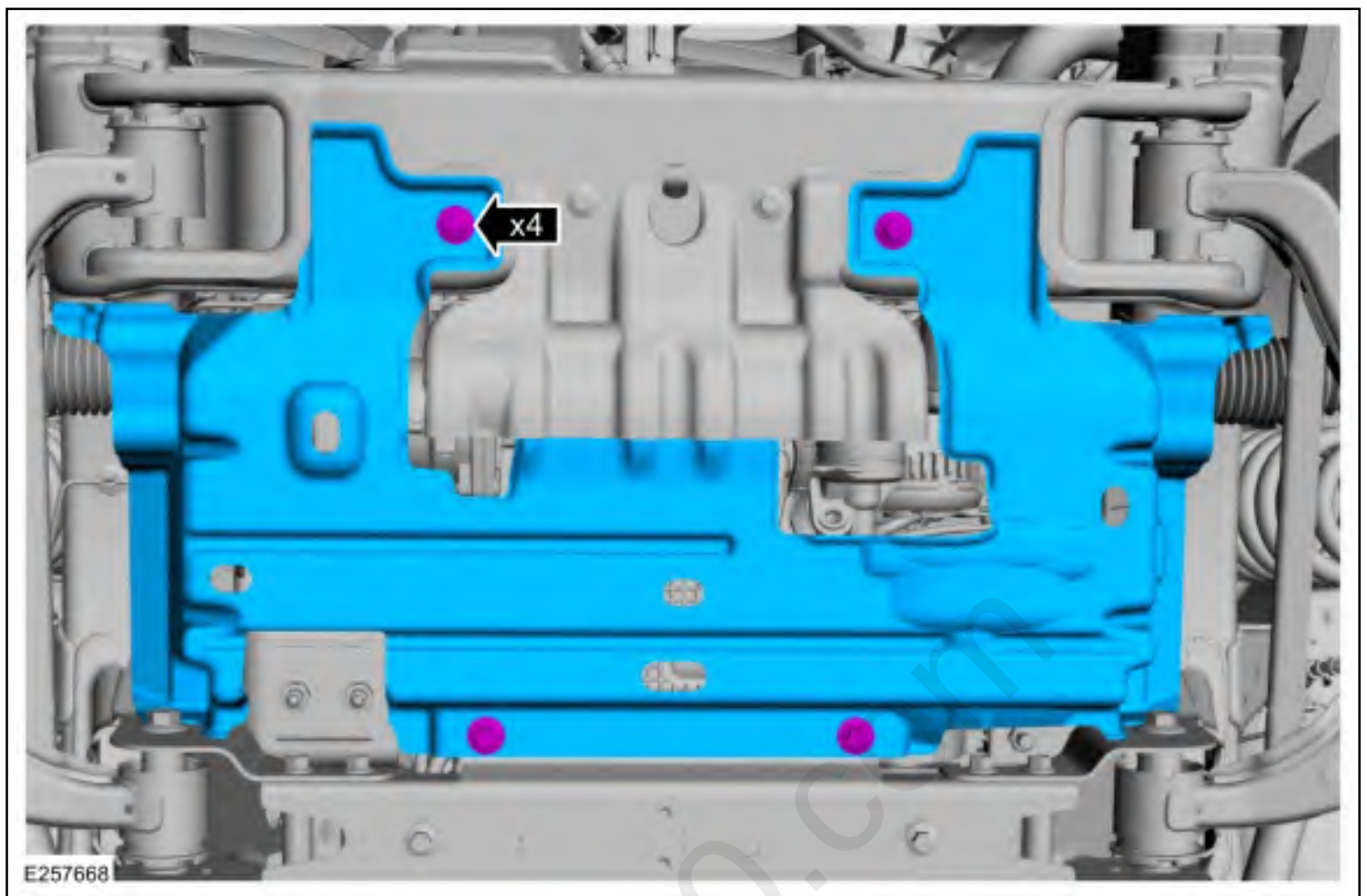
1. With the vehicle in NEUTRAL, position it on a hoist.  
Refer to: [Jacking and Lifting - Overview](#) (100-02 Jacking and Lifting, Description and Operation).
2. Disconnect the battery ground cable.  
Refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables) .
3. **NOTE:** *If equipped.*

Remove the bolts and the underbody shield.



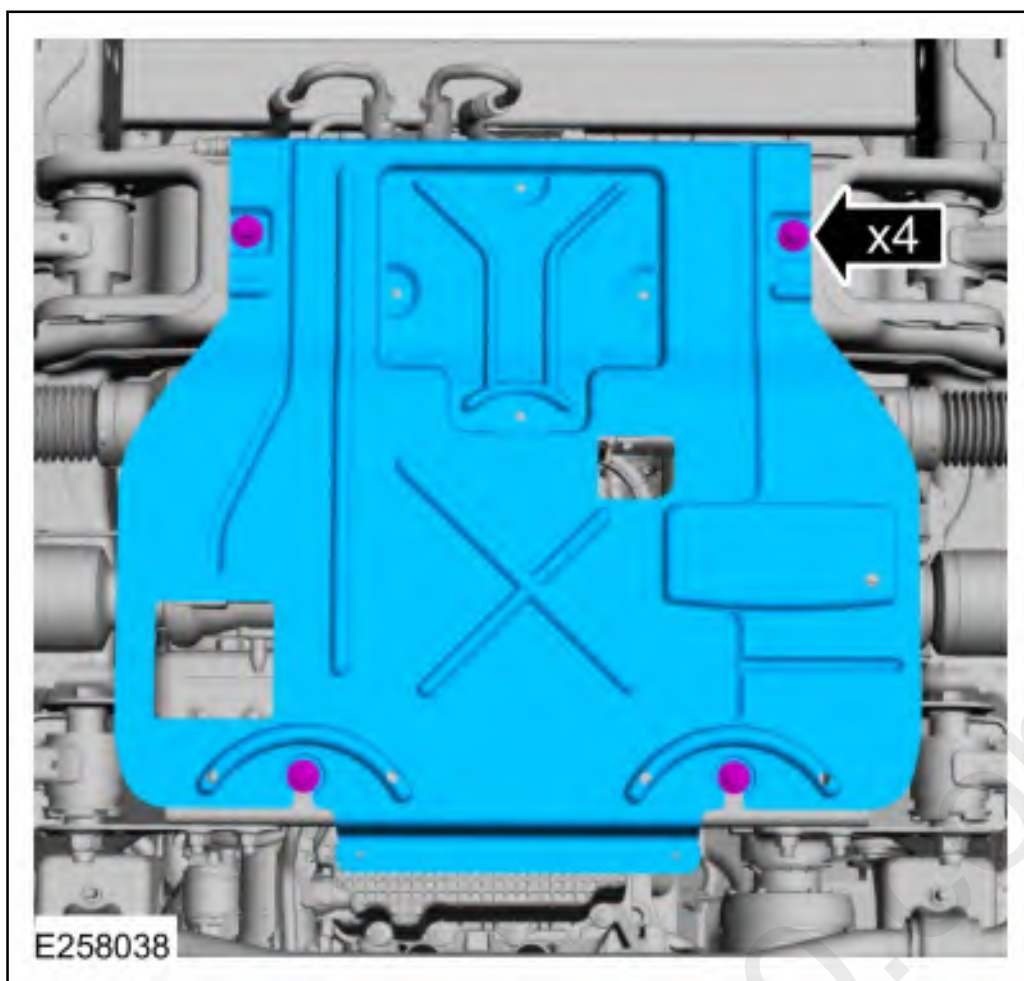
4. **NOTE:** *If equipped.*

Remove the bolts and the underbody shield.



5. **NOTE:** *If equipped.*

Remove the bolts and the skid plate.



6. Remove the following items:

1. RH wheel and tire.

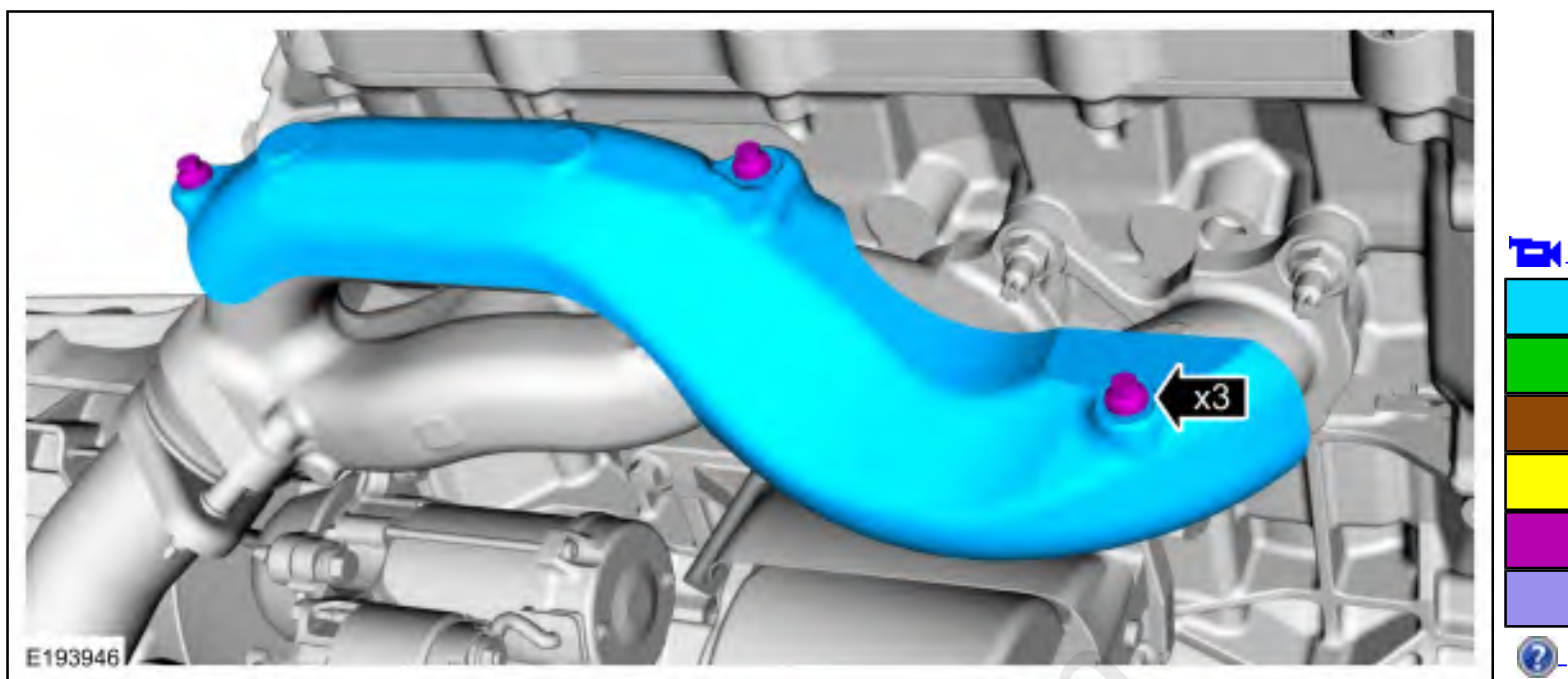
Refer to: [Wheel and Tire](#) (204-04A Wheels and Tires, Removal and Installation).

2. RH fender splash shield.

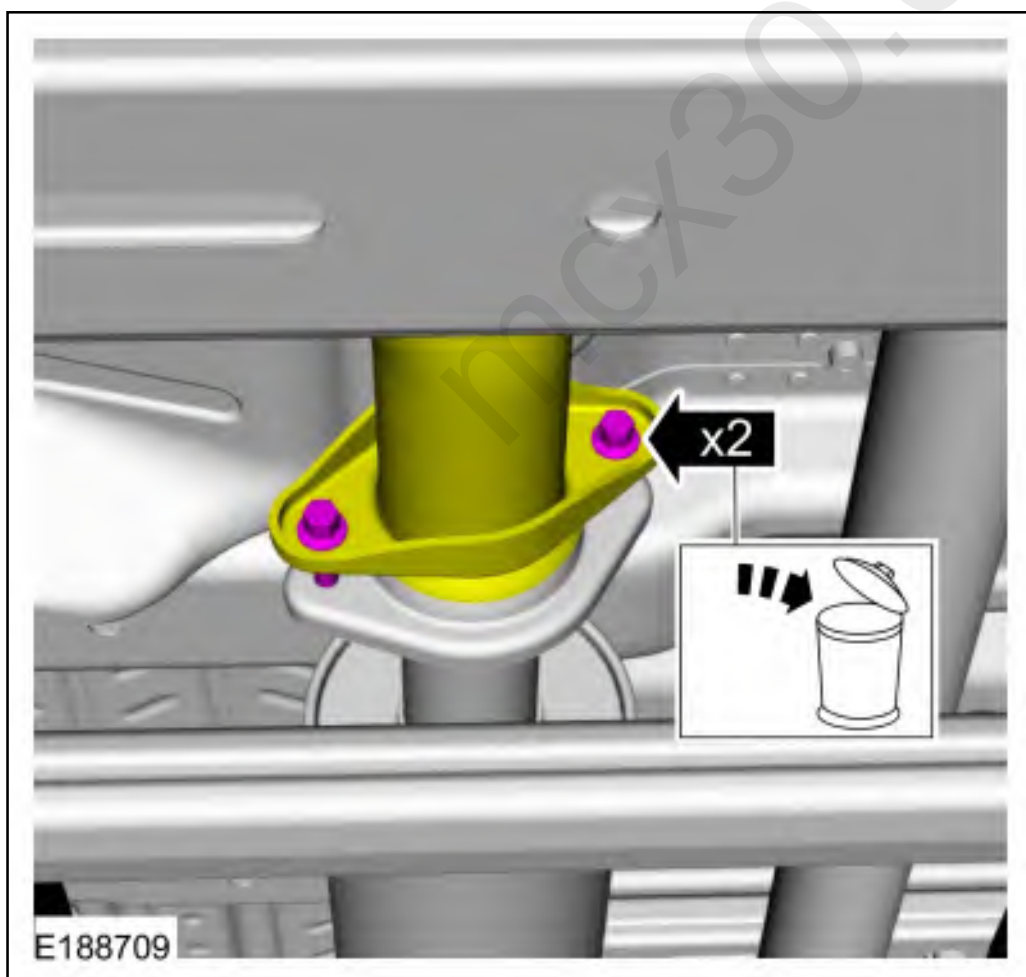
Refer to: [Fender Splash Shield](#) (501-02 Front End Body Panels, Removal and Installation).

3. Refer to: Air Conditioning (A/C) Compressor - 5.0L 32V Ti-VCT (412-00 Climate Control System - General Information) .

7. Remove the bolts and the RH exhaust manifold heat shield.

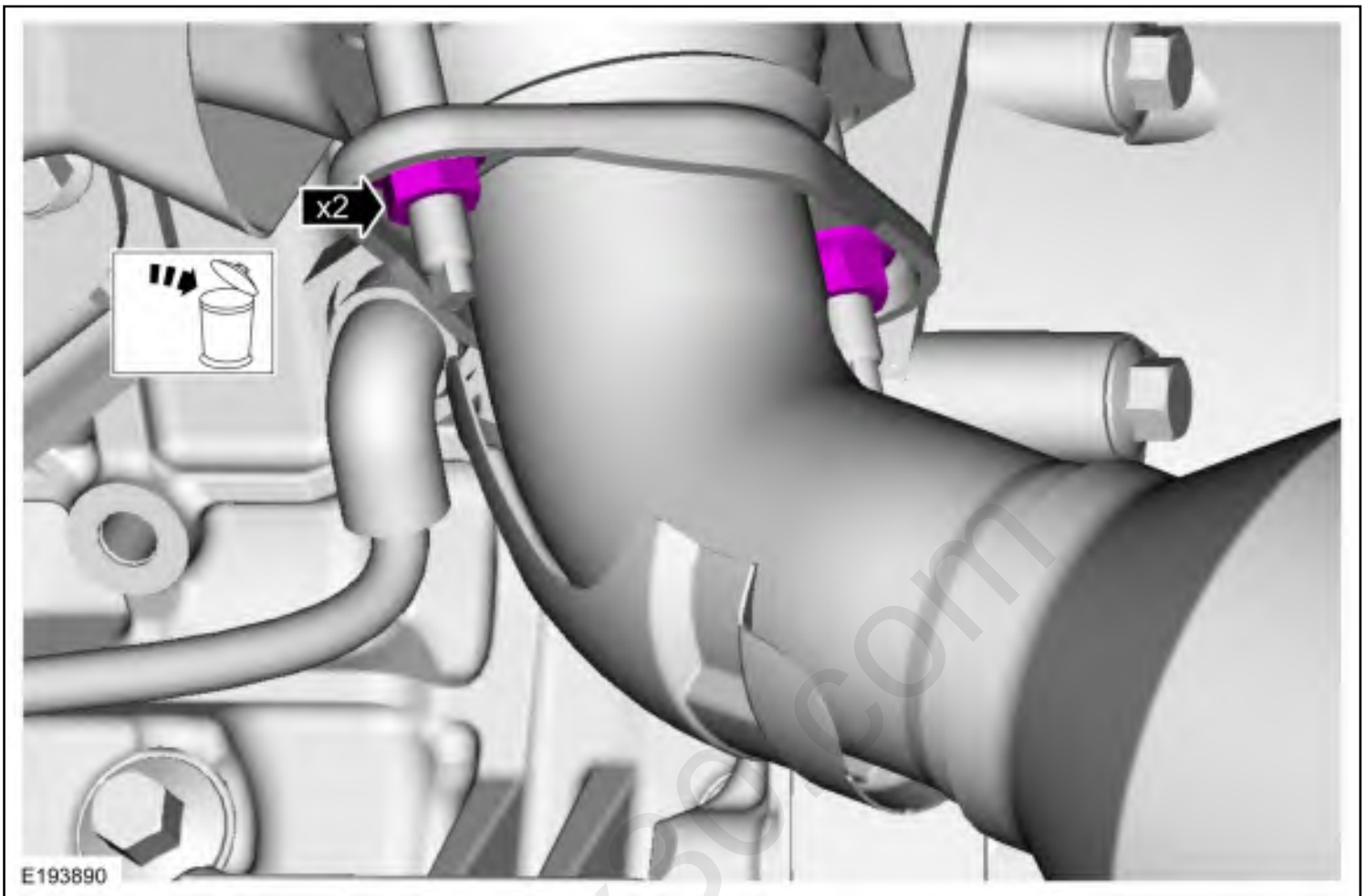


8. Remove and discard the exhaust Y-pipe dual catalytic converter-to-exhaust intermediate pipe bolts.
- Separate the pipe from the converter.
  - Clean the exhaust mating surfaces.



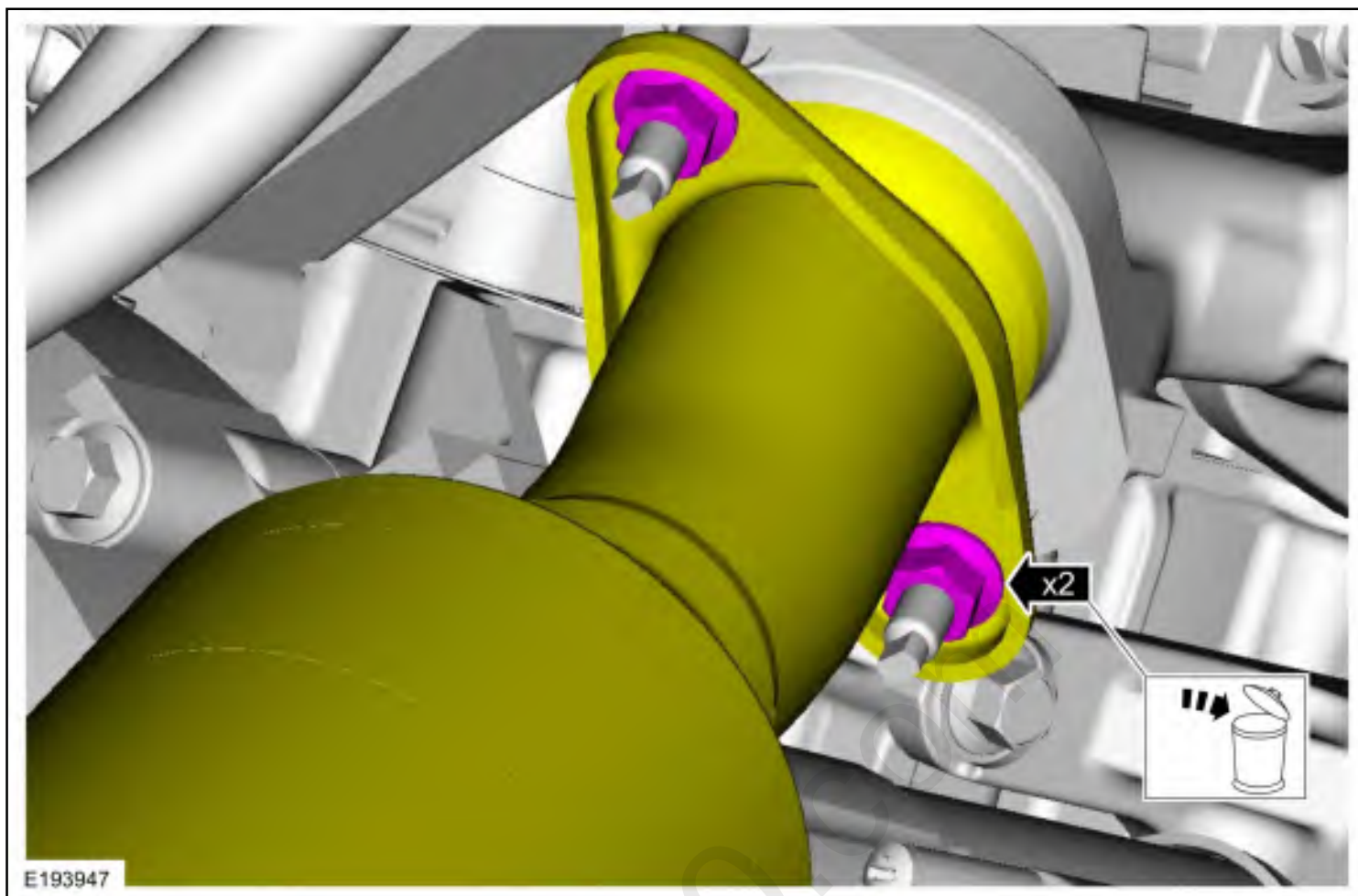


9. Remove and discard the catalytic converter-to-LH exhaust manifold nuts.

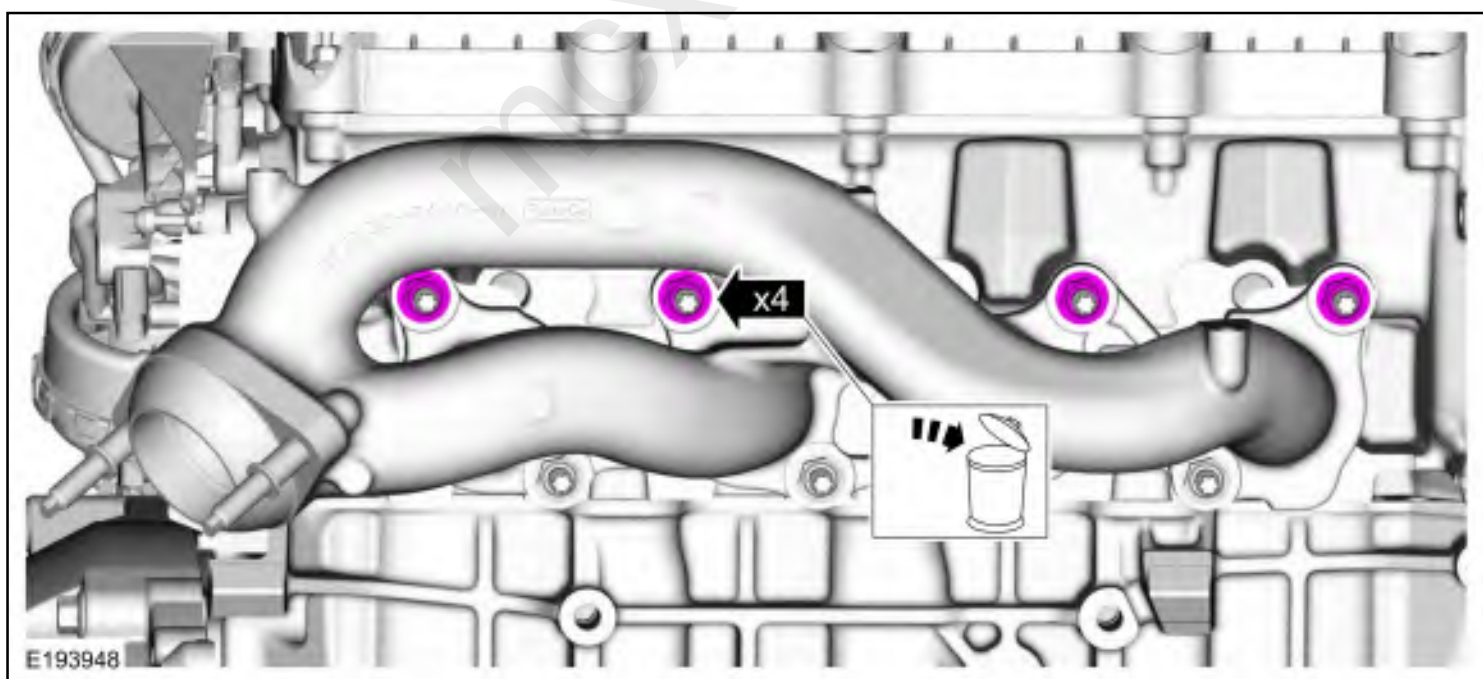


10. Remove and discard the catalytic converter-to-RH exhaust manifold nuts.

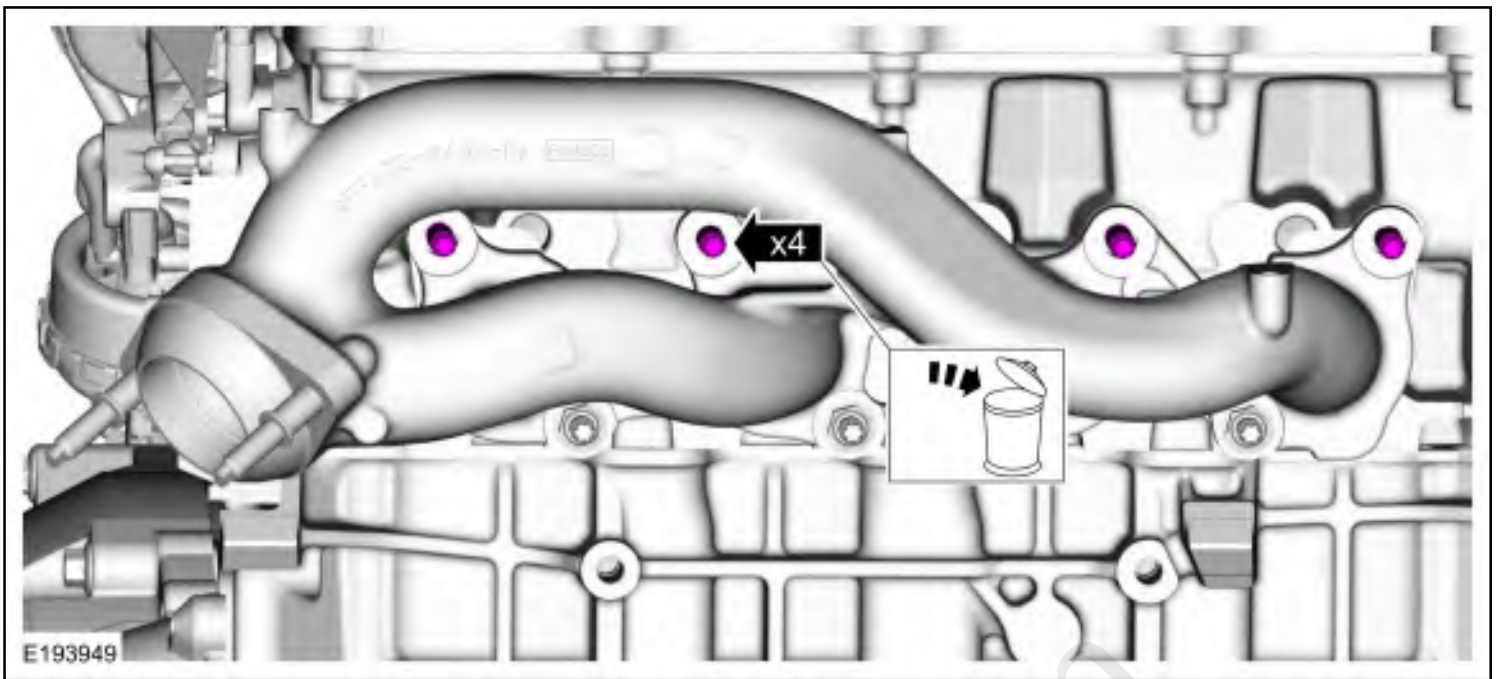
- Separate the exhaust Y-pipe dual catalytic converter from the exhaust manifolds.
- Clean the exhaust mating surfaces.



11. Remove and discard the RH exhaust manifold nuts.



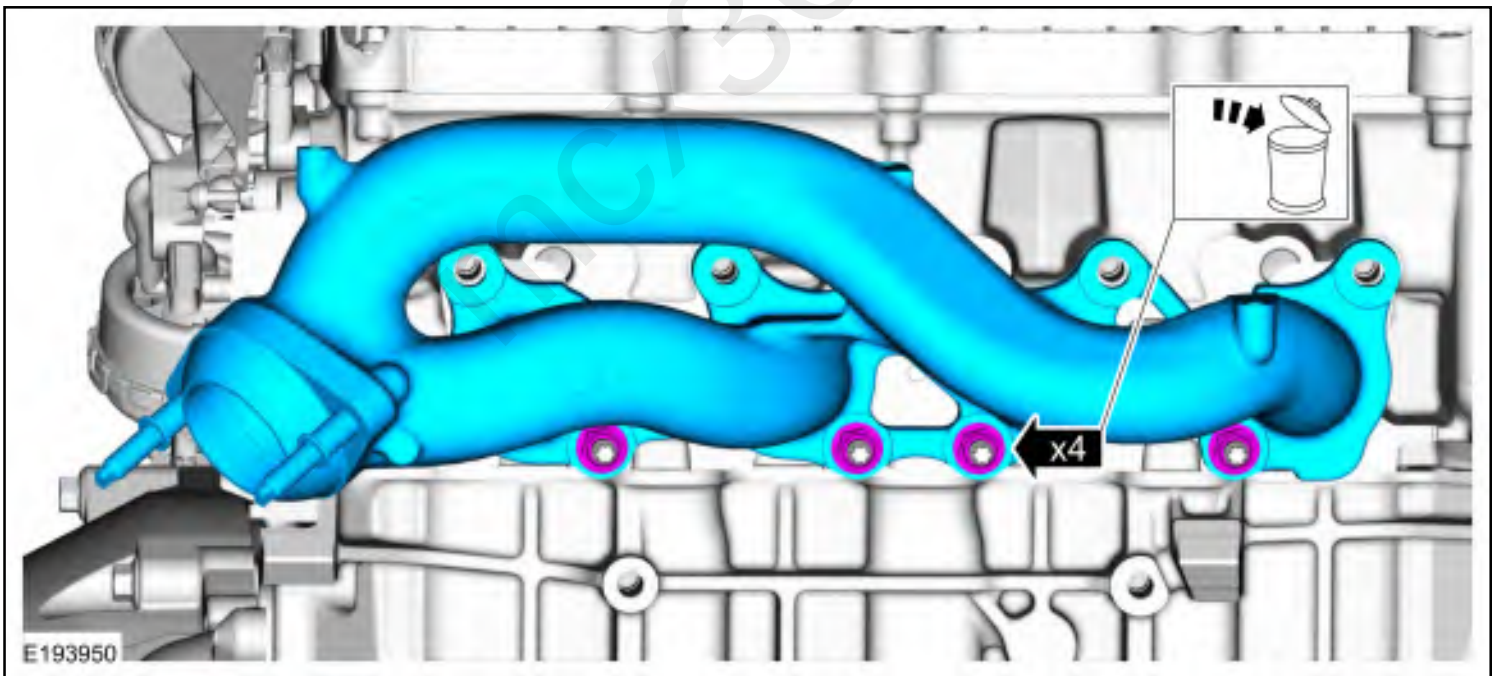
12. Remove and discard the RH exhaust manifold studs.



13. Remove and discard the nuts.

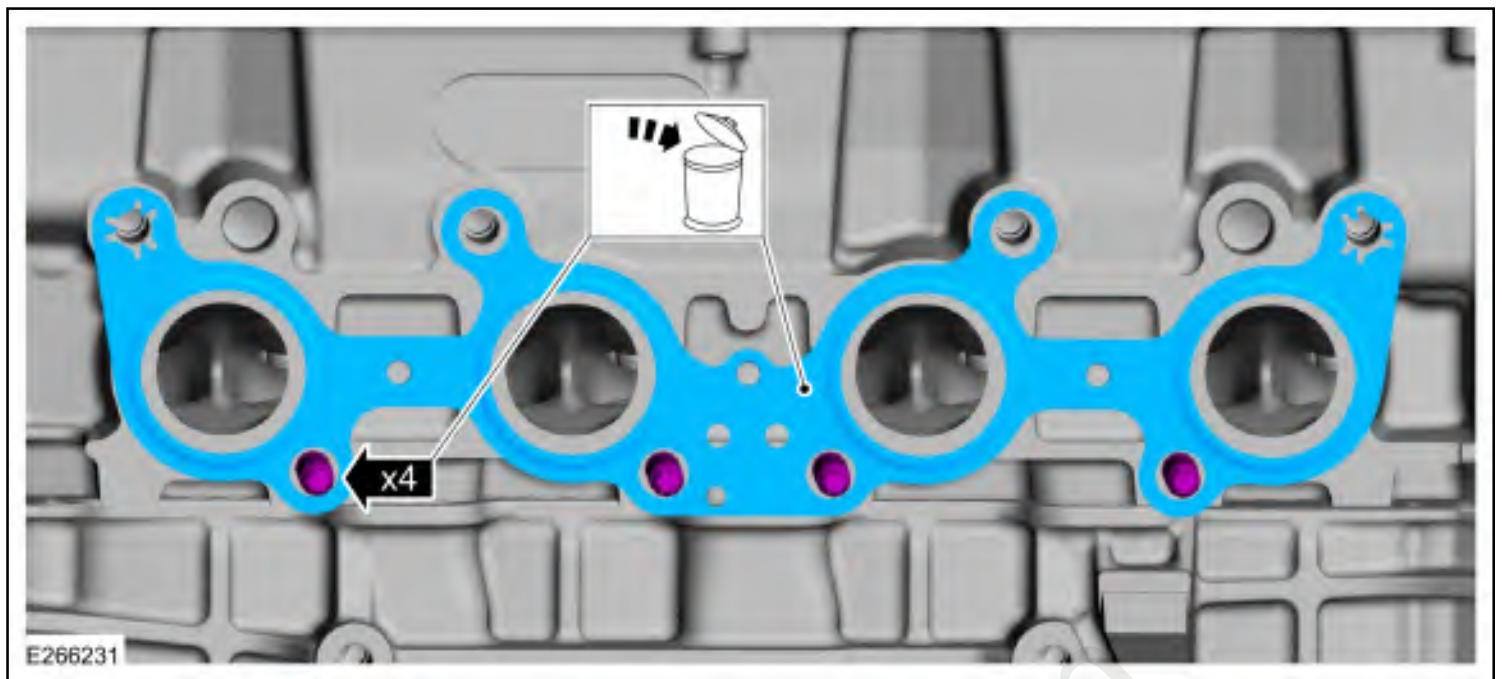
1. Remove the exhaust manifold.
2. Clean and inspect the exhaust manifold.

Refer to: [Exhaust Manifold Cleaning and Inspection](#) (303-00 Engine System - General Information, General Procedures).



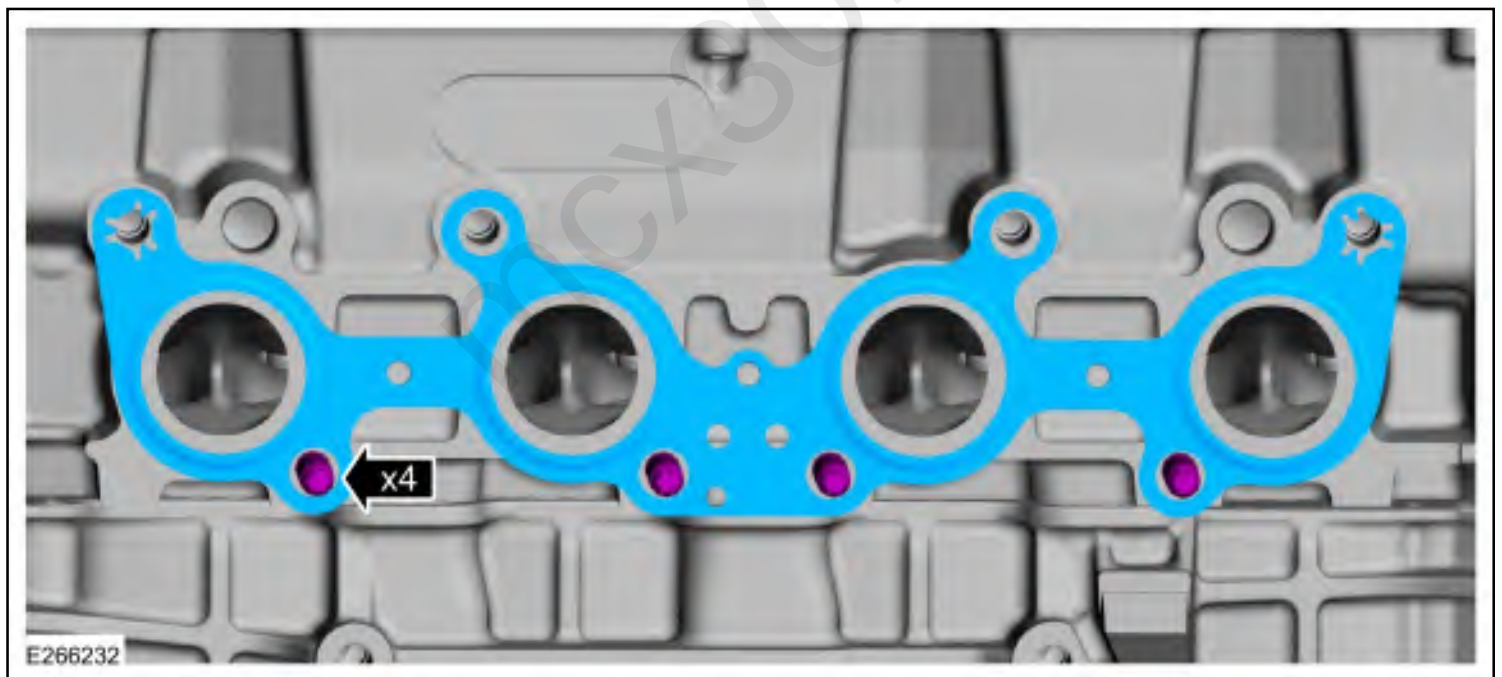
14. Remove and discard the gasket and studs.





## Installation

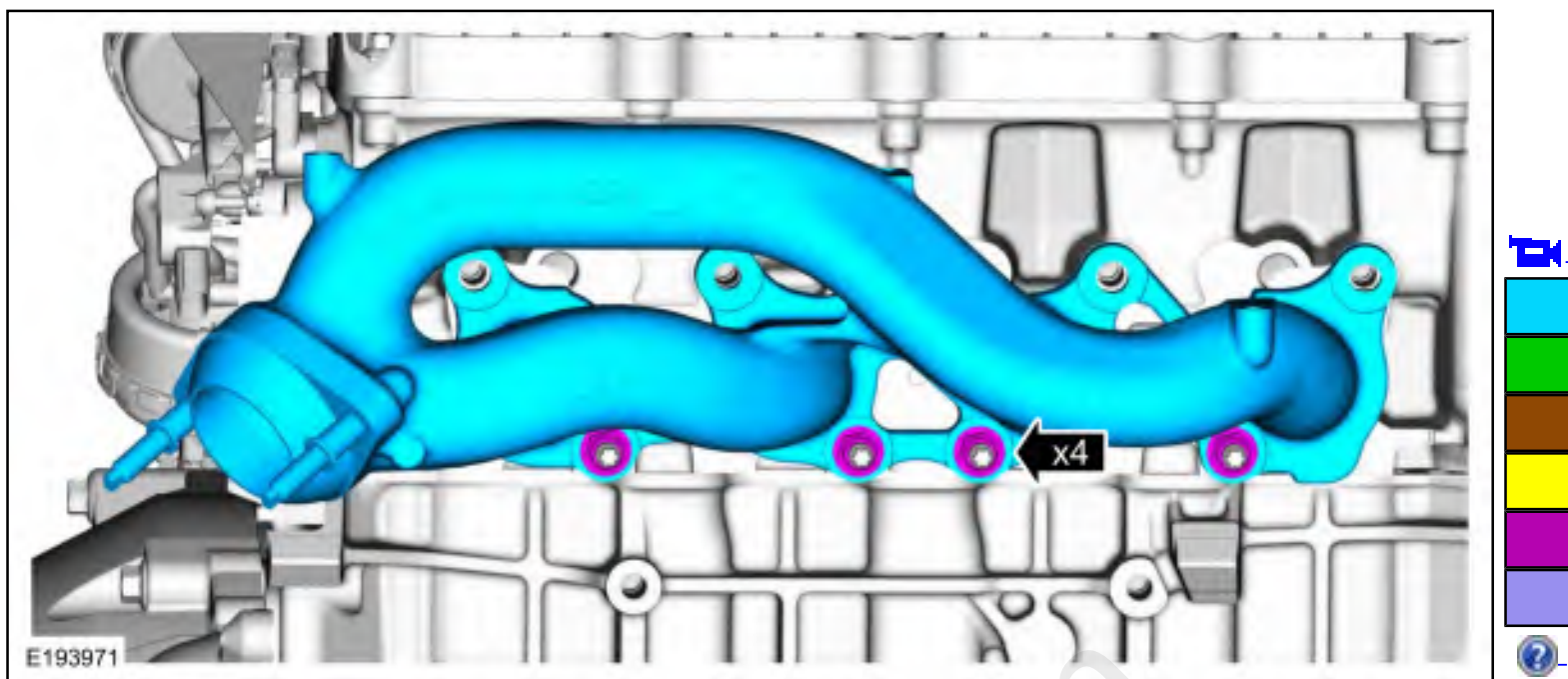
1. Install new studs and new gasket.  
*Torque: 18 lb.ft (25 Nm)*



2. **NOTE:** Do not tighten the exhaust manifold nuts at this time.

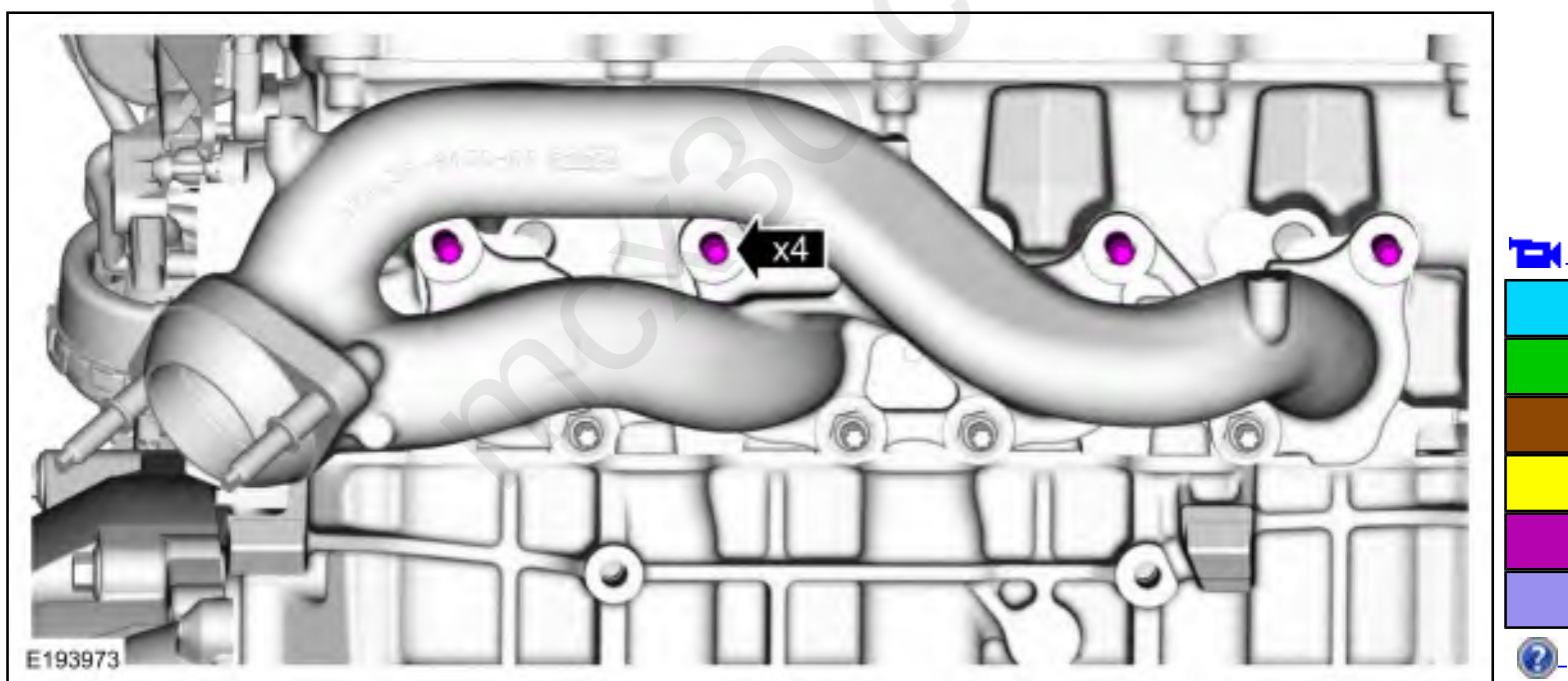
Install the exhaust manifold.

- Install the new nuts.



3. Install new studs.

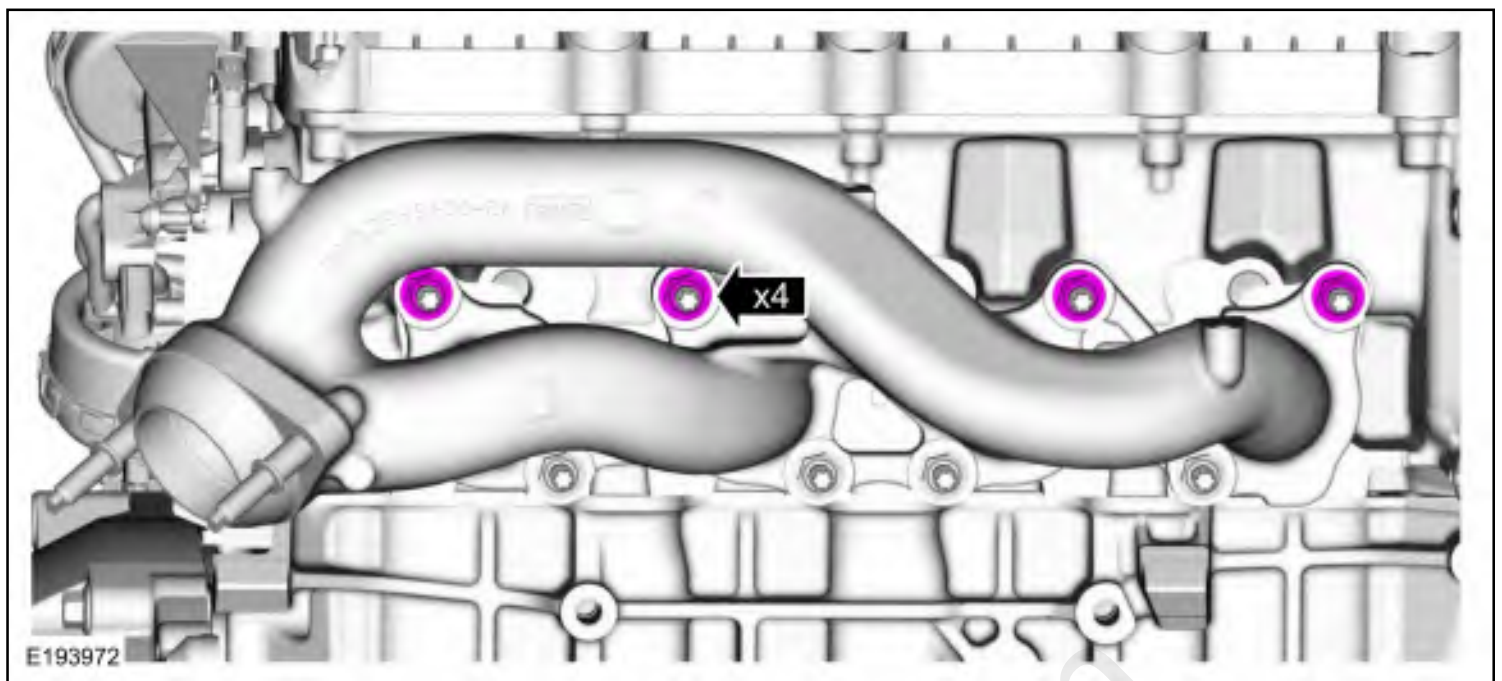
*Torque: 18 lb.ft (25 Nm)*



4. **NOTE:** *Do not tighten the exhaust manifold nuts at this time.*

Install the remaining new nuts.



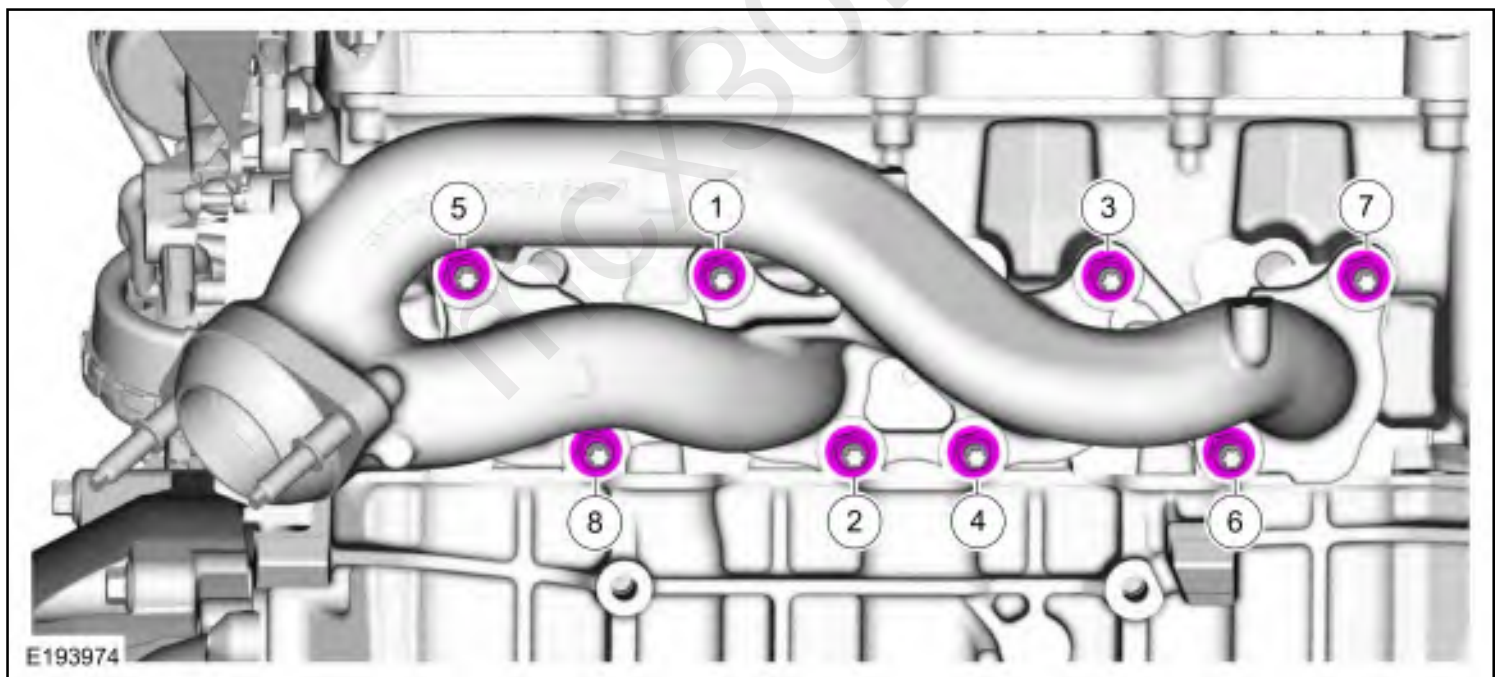


5. Tighten the nuts.

*Torque:*

Stage 1: 18 lb.ft (24 Nm)

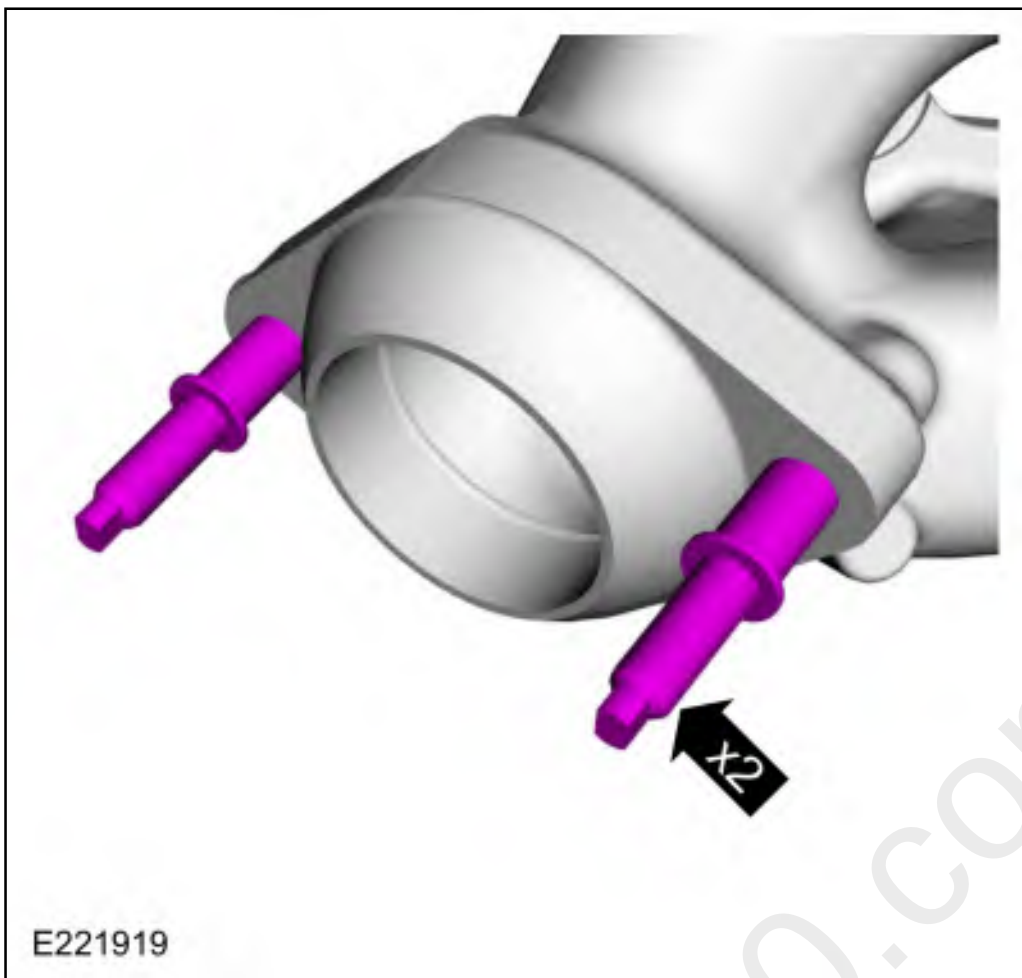
Stage 2: 24 lb.ft (32 Nm)



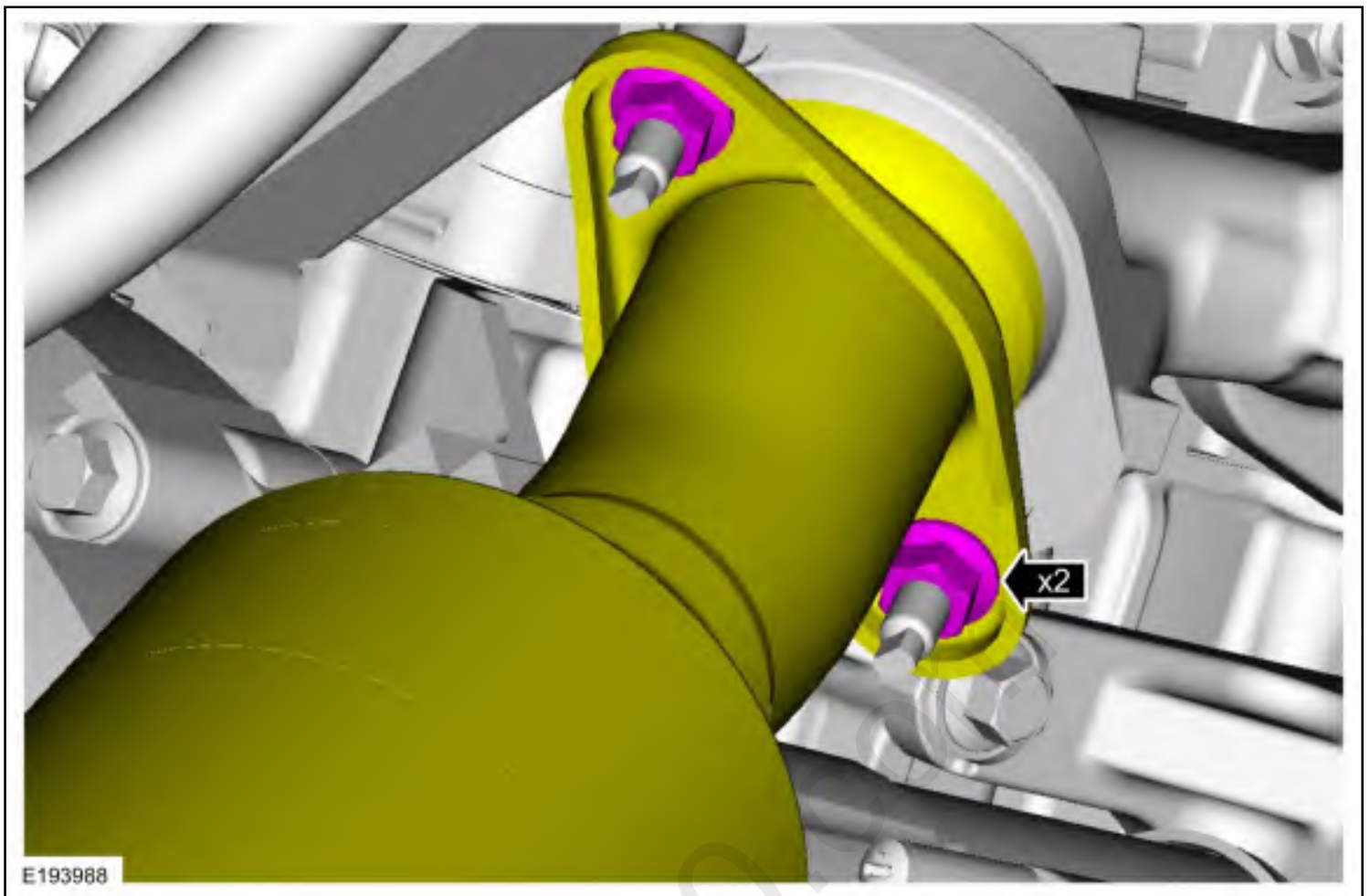
6. **NOTE:** Some replacement exhaust manifolds do not come with studs.

If necessary, install new studs.

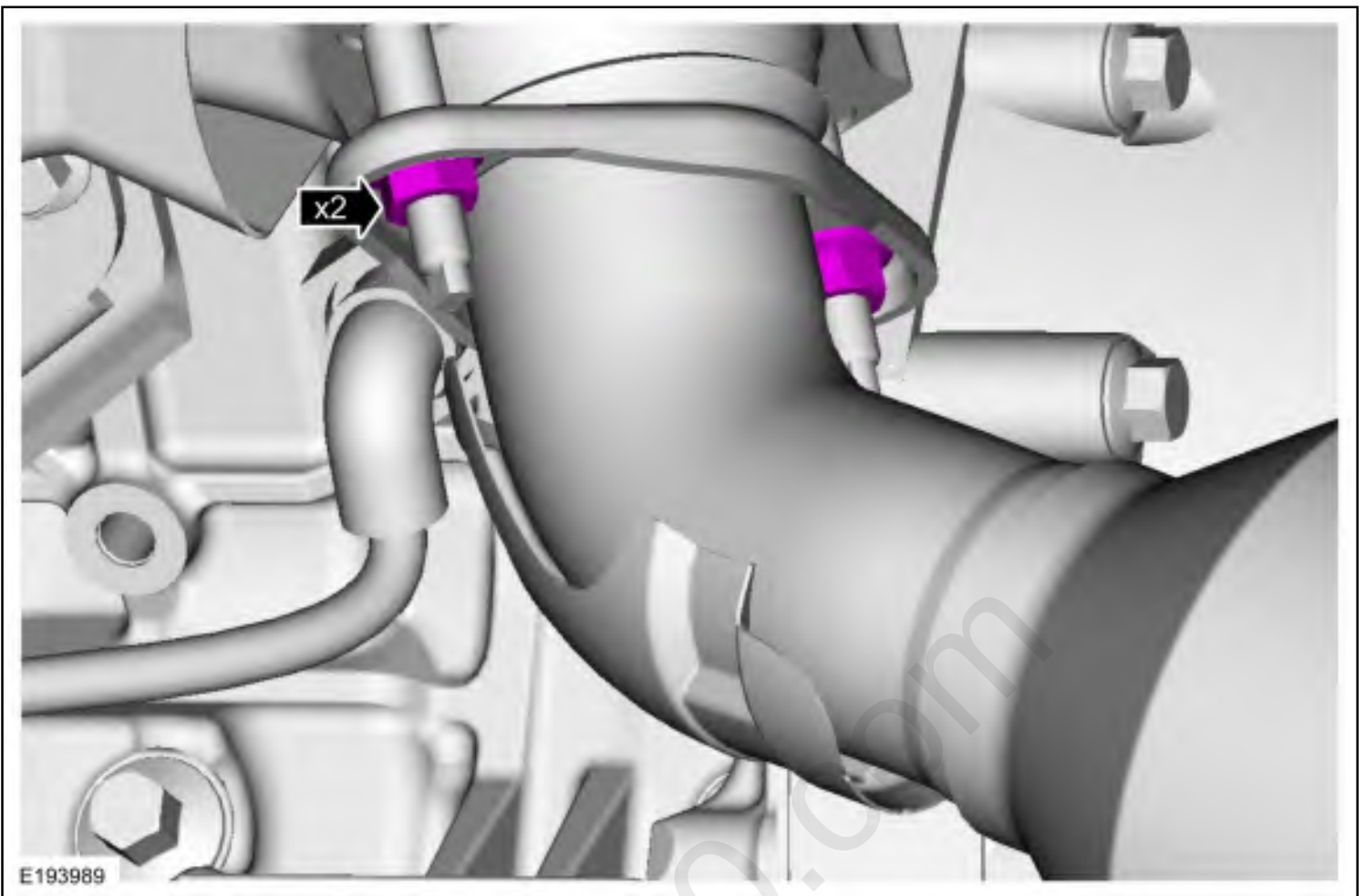
*Torque:* 30 lb.ft (40 Nm)



7. Position the exhaust Y-pipe dual catalytic converter onto the exhaust manifolds and loosely install new RH catalytic converter-to-exhaust manifold nuts.



8. Loosely install new LH catalytic converter-to-exhaust manifold nuts.

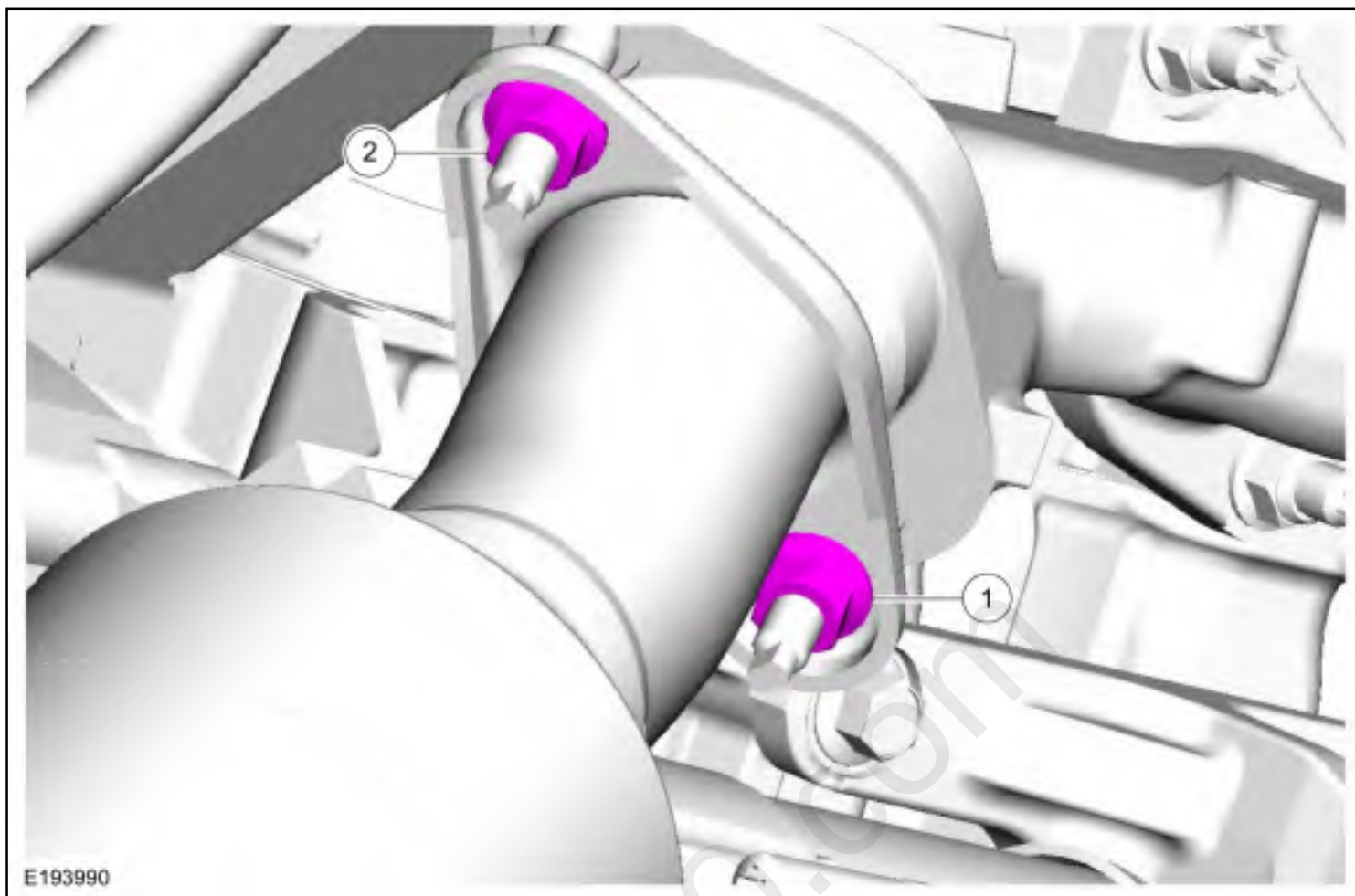


9. Tighten the nuts.

*Torque:*

1: 30 lb.ft (40 Nm)

2: 30 lb.ft (40 Nm)



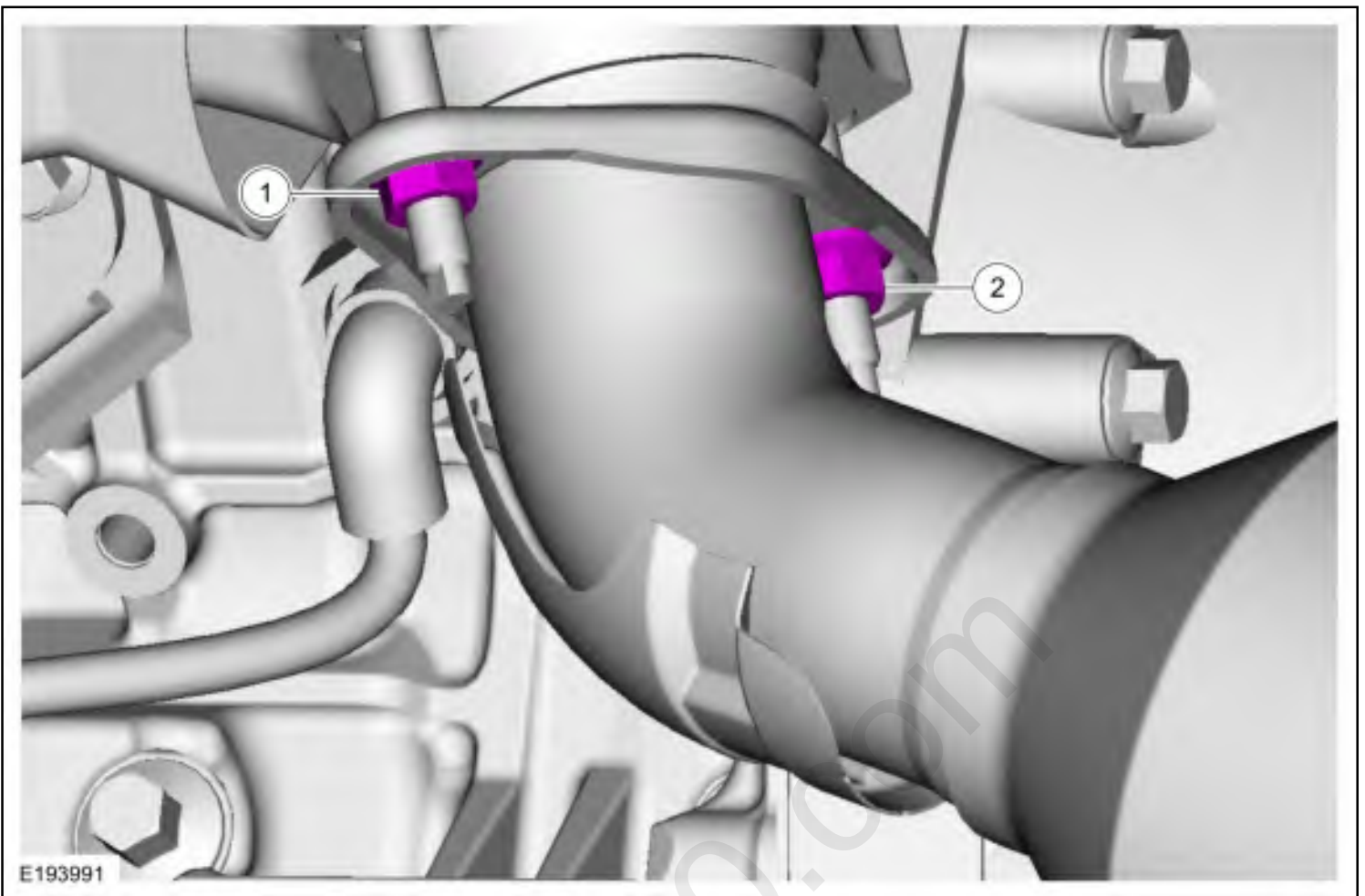
10. Tighten the nuts.

*Torque:*

1: 30 lb.ft (40 Nm)

2: 30 lb.ft (40 Nm)

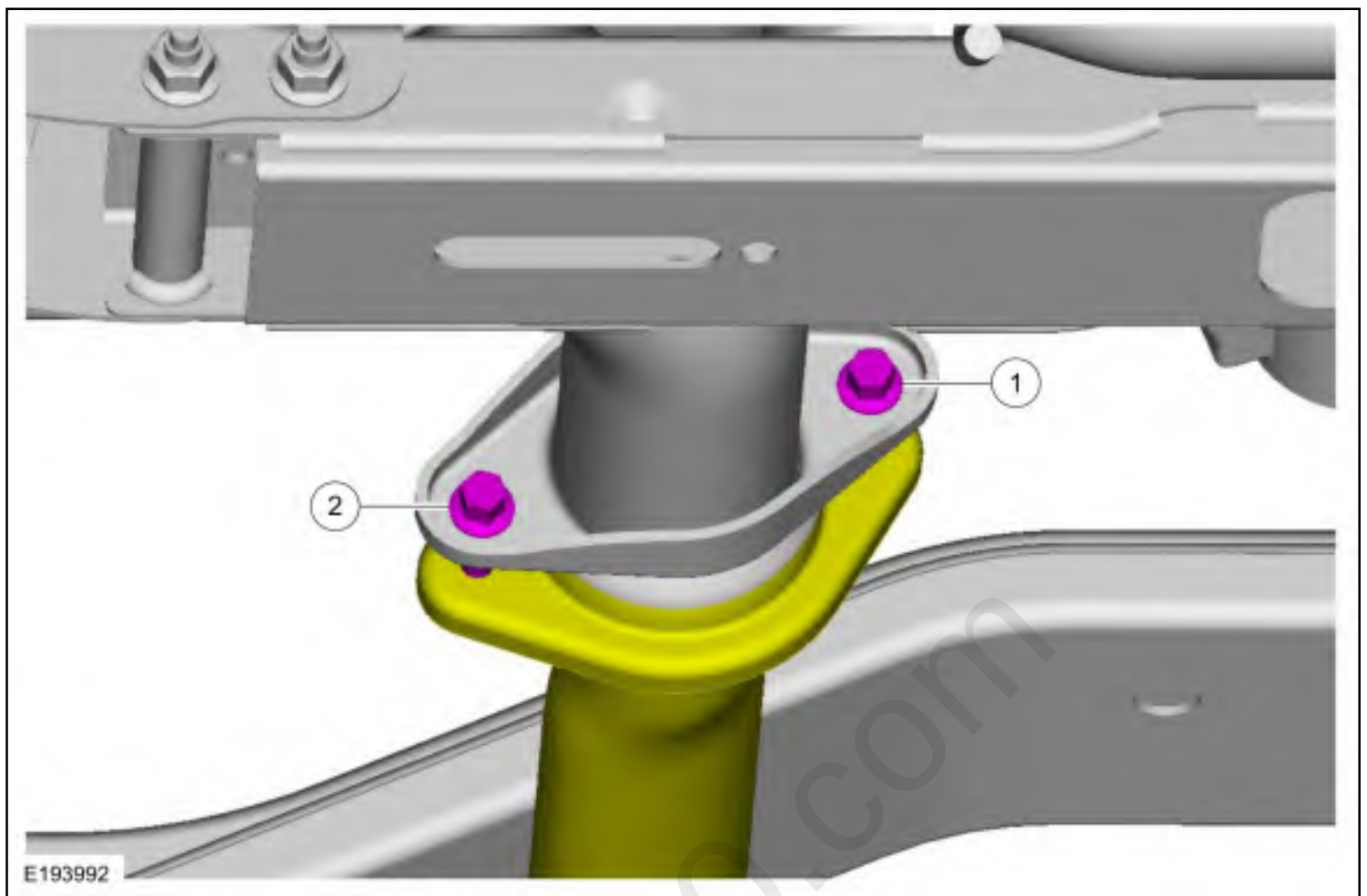




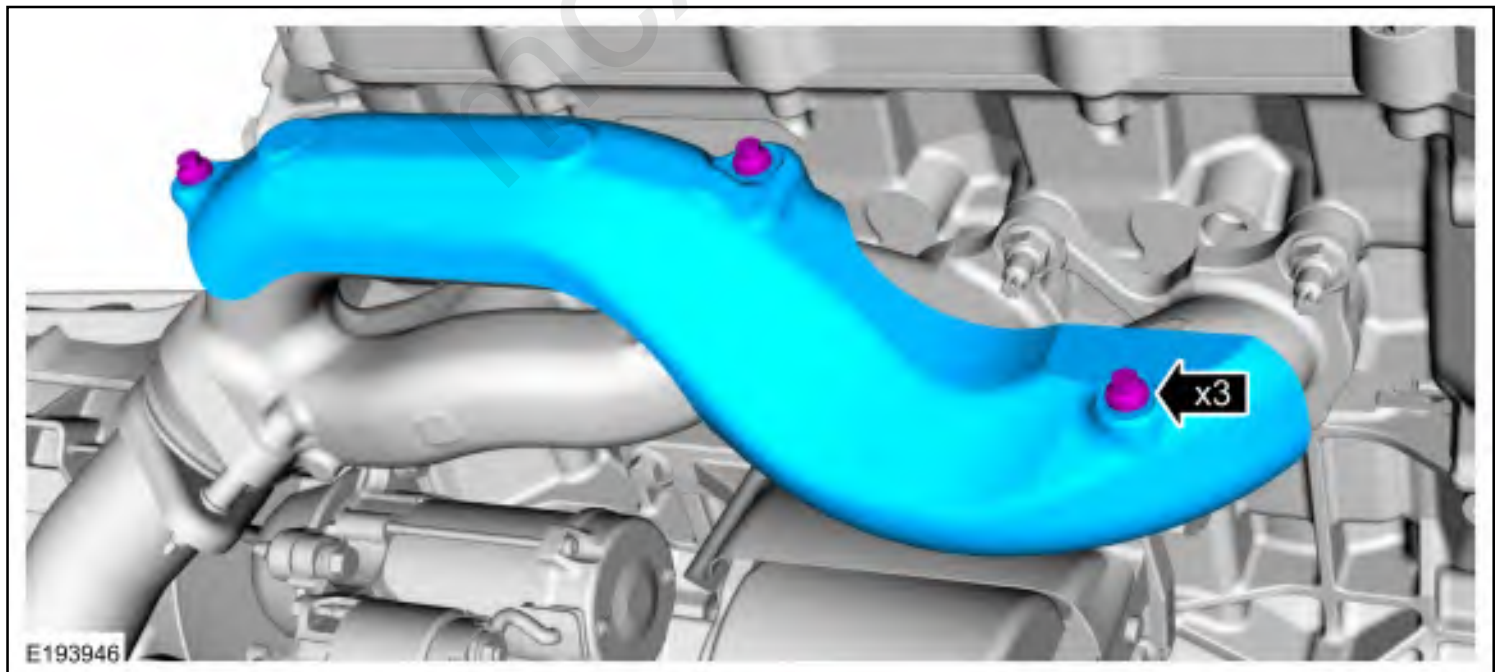
11. Position the exhaust Y-pipe dual catalytic converter-to-exhaust intermediate pipe and install new bolts.

*Torque:*

- 1: 46 lb.ft (63 Nm)
- 2: 46 lb.ft (63 Nm)



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



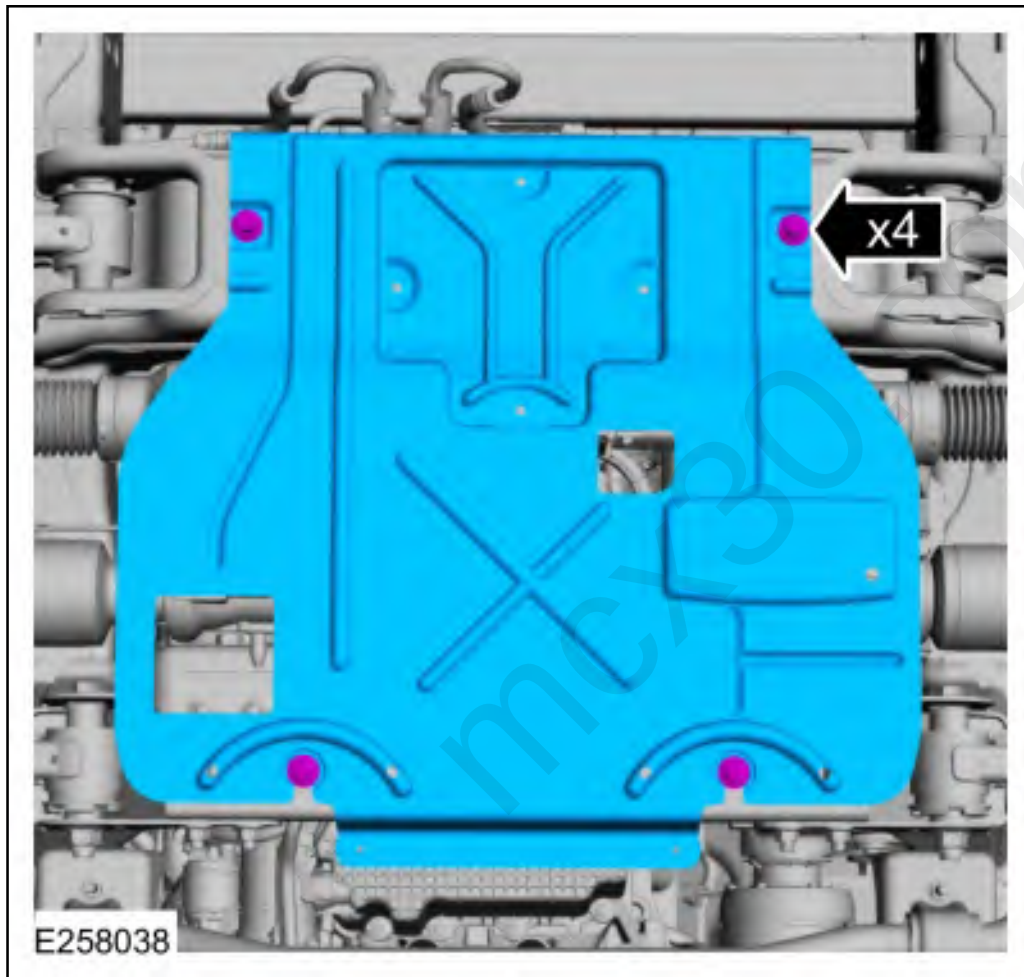
13. Install the following items:

1. Refer to: Air Conditioning (A/C) Compressor - 5.0L 32V Ti-VCT (412-00 Climate Control System - General Information) .
2. RH fender splash shield.  
Refer to: [Fender Splash Shield](#) (501-02 Front End Body Panels, Removal and Installation).
3. RH wheel and tire.  
Refer to: [Wheel and Tire](#) (204-04A Wheels and Tires, Removal and Installation).

14. **NOTE:** *If equipped.*

Install the skid plate and bolts.

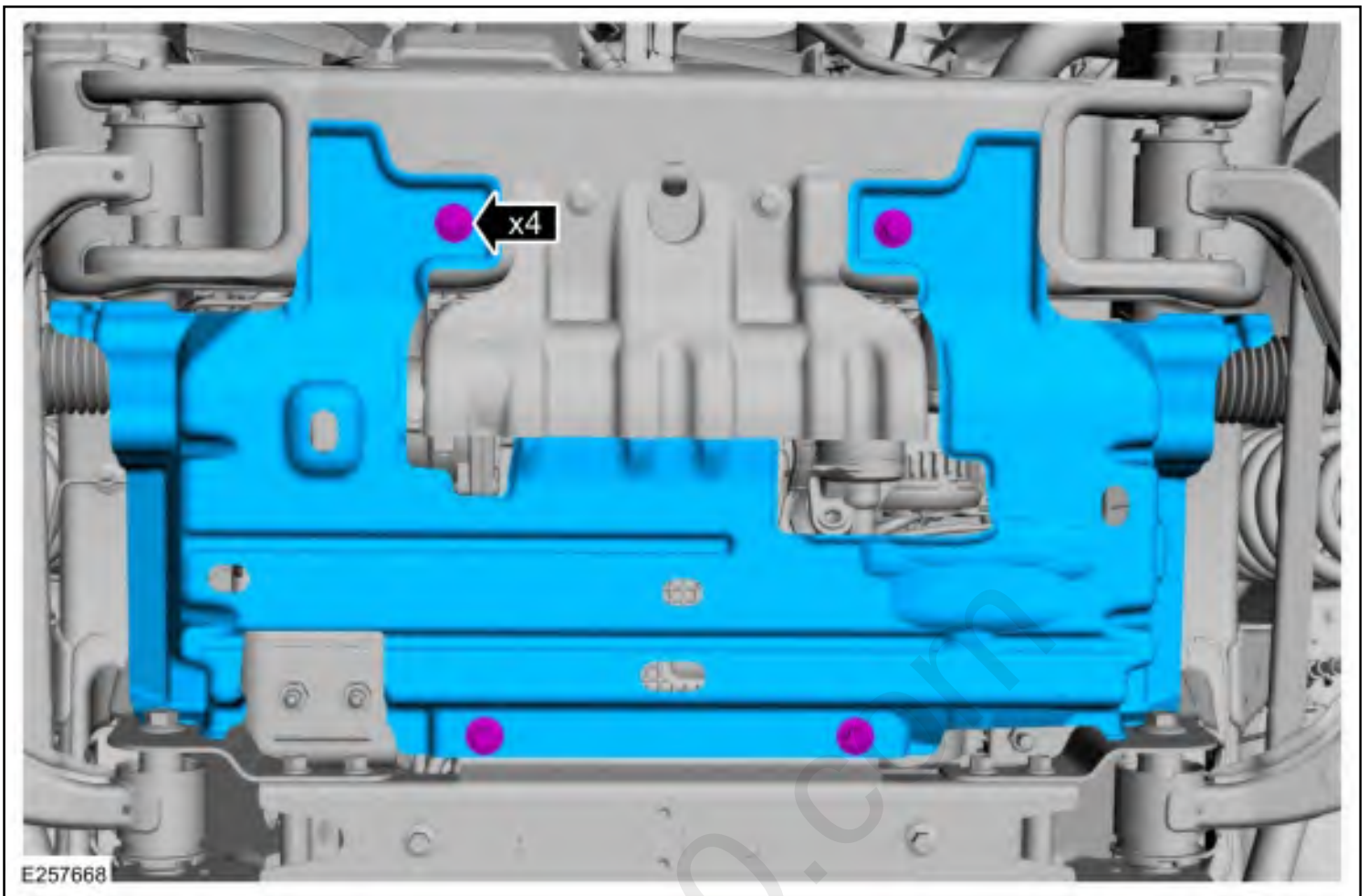
*Torque:* 30 lb.ft (40 Nm)



15. **NOTE:** *If equipped.*

Install the underbody shield and fasteners.

*Torque:* 30 lb.ft (40 Nm)

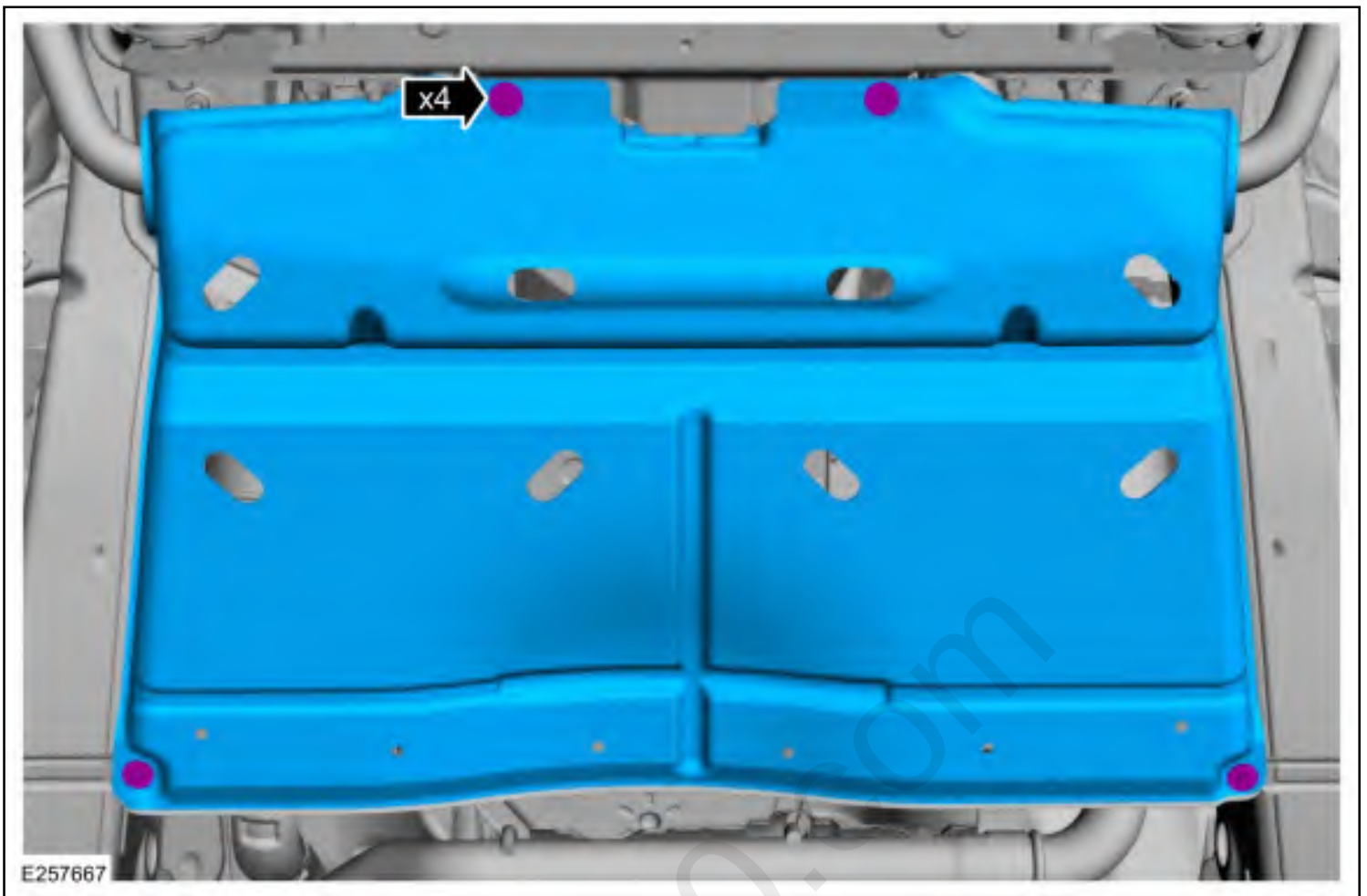


16. **NOTE:** *If equipped.*

Install the underbody shield and the bolts.

*Torque:* 71 lb.in (8 Nm)





17. Connect the battery ground cable.  
Refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables) .
18. Start the engine and check for exhaust leaks.



# Crankshaft Front Seal

Base Part Number: Base Part Number: 6700

## Special Tool(s) / General Equipment

|                                                                                                   |                                                                                                           |
|---------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|
|  <p>E216458</p>   | <p>303-1531<br/>Installer, Front Crank Seal and Damper</p>                                                |
|  <p>E222985</p>  | <p>303-335 (T88T-6701-A)<br/>Installer, Front Cover Oil Seal<br/>TKIT-1988-F<br/>TKIT-1988-FLM</p>        |
|  <p>E134603</p> | <p>303-409 (T92C-6700-CH)<br/>Remover, Crankshaft Seal<br/>TKIT-1992-FH/FMH/FLMH<br/>TKIT-1993-LMH/MH</p> |
| Strap Wrench                                                                                      |                                                                                                           |
| Three Leg Puller                                                                                  |                                                                                                           |

## Materials

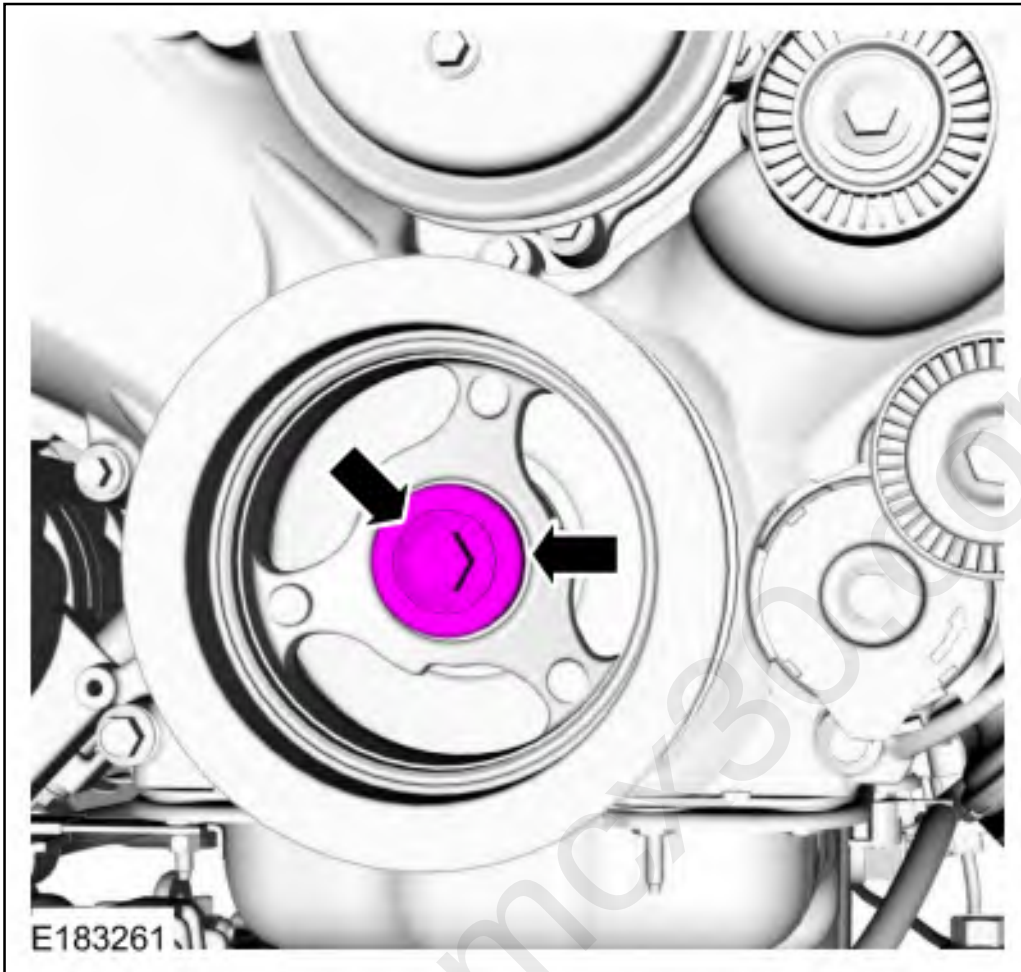
| Name                                             | Specification |
|--------------------------------------------------|---------------|
| Motorcraft® Silicone Gasket and Sealant<br>TA-30 | WSE-M4G323-A4 |

## Removal

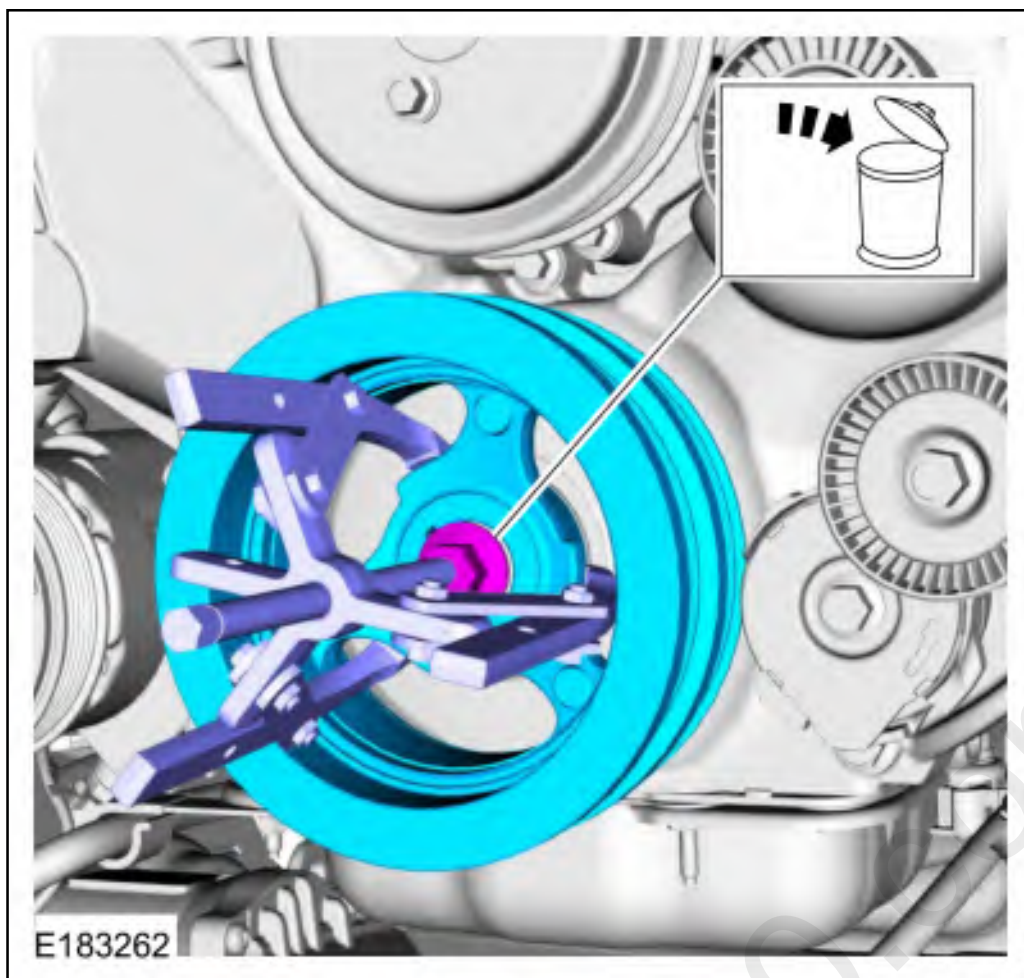
1. Remove the following items:

1. Refer to: Accessory Drive Belt (303-05 Accessory Drive - 5.0L 32V Ti-VCT) .
2. Refer to: Air Conditioning (A/C) Compressor Belt (303-05 Accessory Drive - 5.0L 32V Ti-VCT) .

2. Remove the crankshaft pulley bolt and washer.



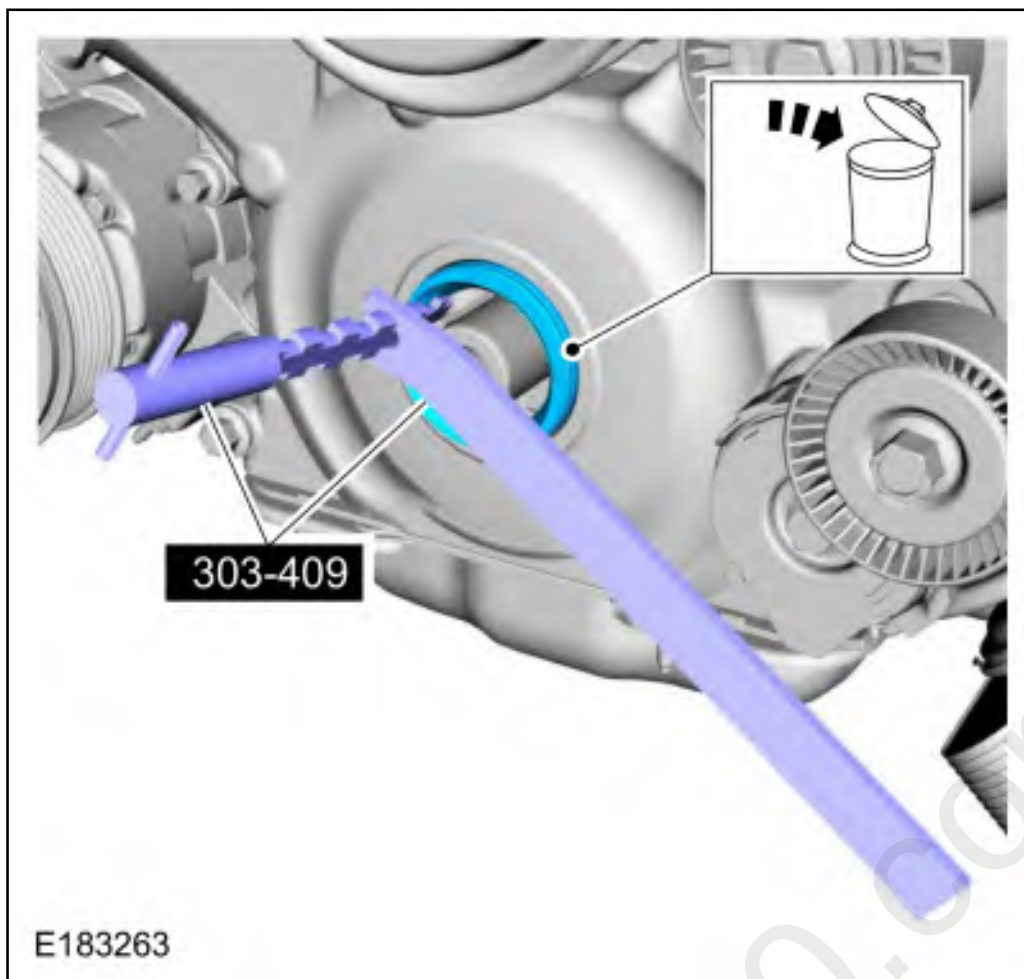
- Using the 3 Leg Puller and the crankshaft pulley bolt, remove the crankshaft pulley.  
Use the General Equipment: Three Leg Puller
- Discard the crankshaft pulley bolt.



4. **NOTICE:** Use care not to damage the engine front cover or the crankshaft when removing the seal.

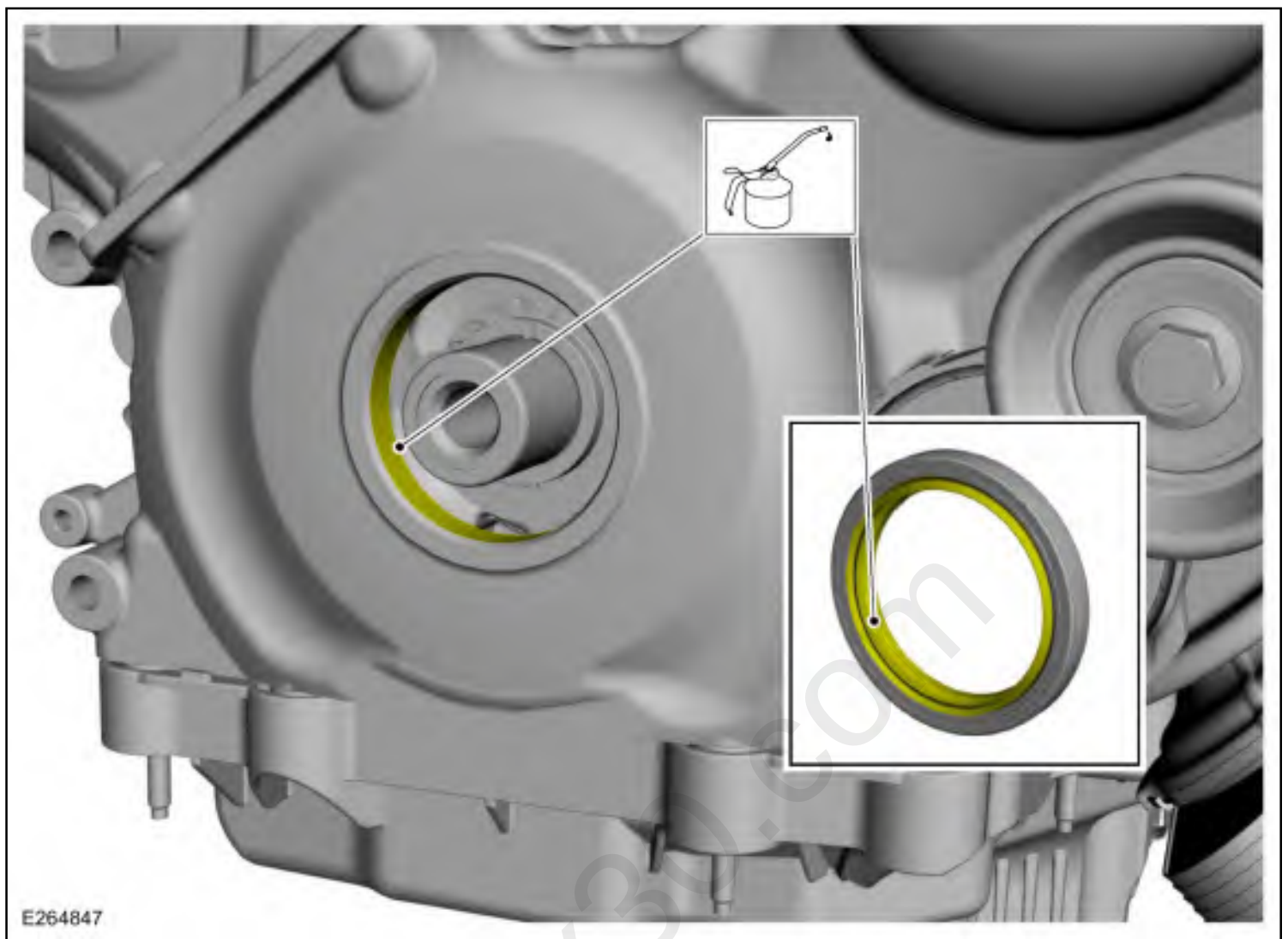
Using the special tool, remove and discard the crankshaft front oil seal.

Use Special Service Tool: 303-409 (T92C-6700-CH) Remover, Crankshaft Seal.



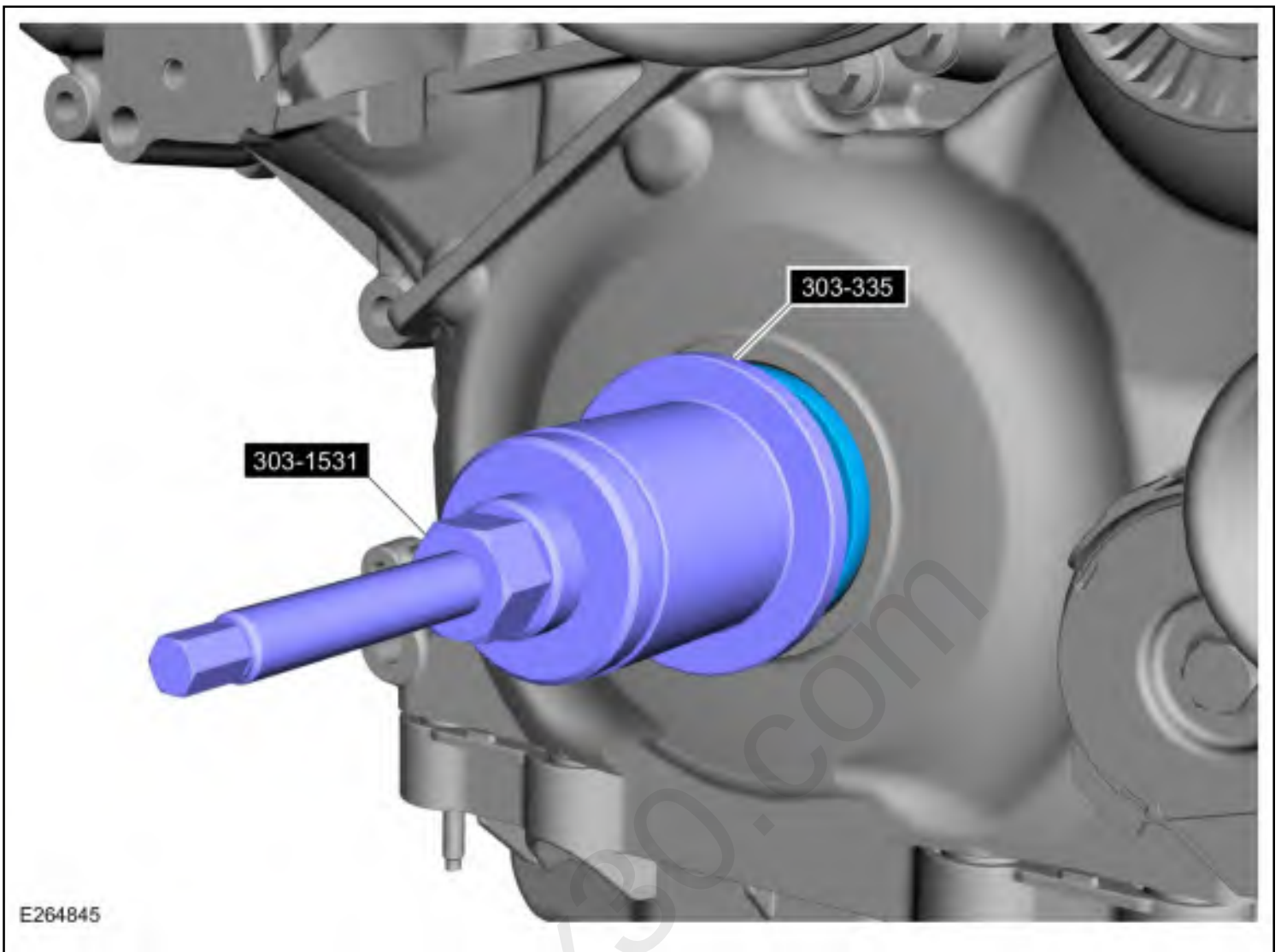
## Installation

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



2. 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.

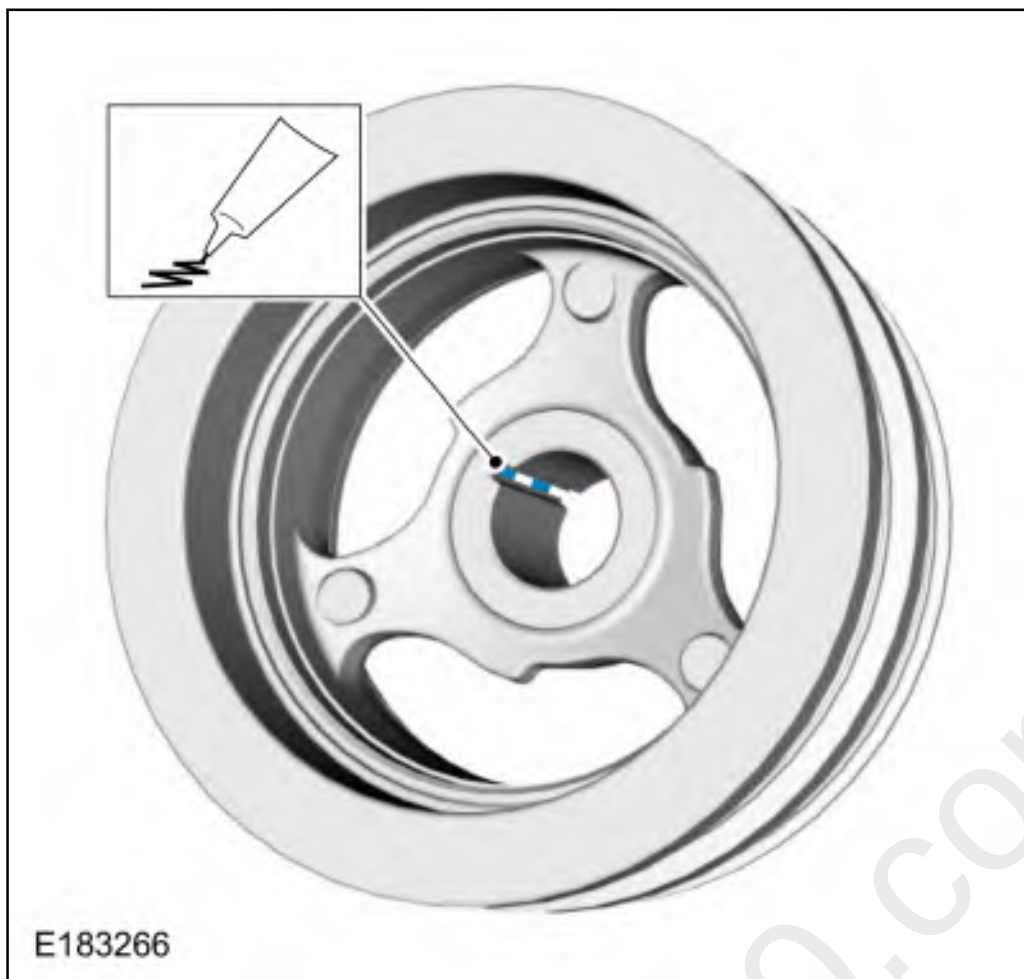




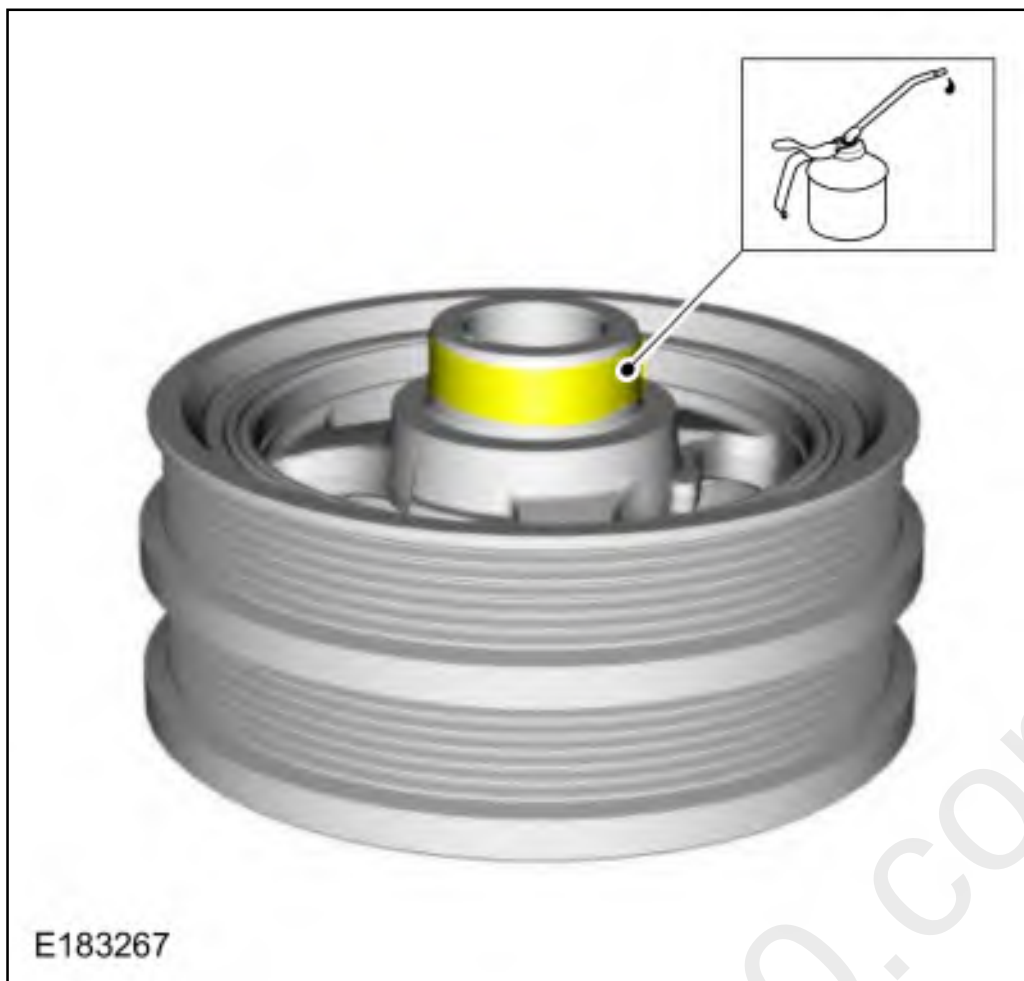
3. **NOTE:** *If not secured within 5 minutes, the sealant must be removed and the sealing area cleaned. Failure to follow this procedure can cause future oil leakage.*

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

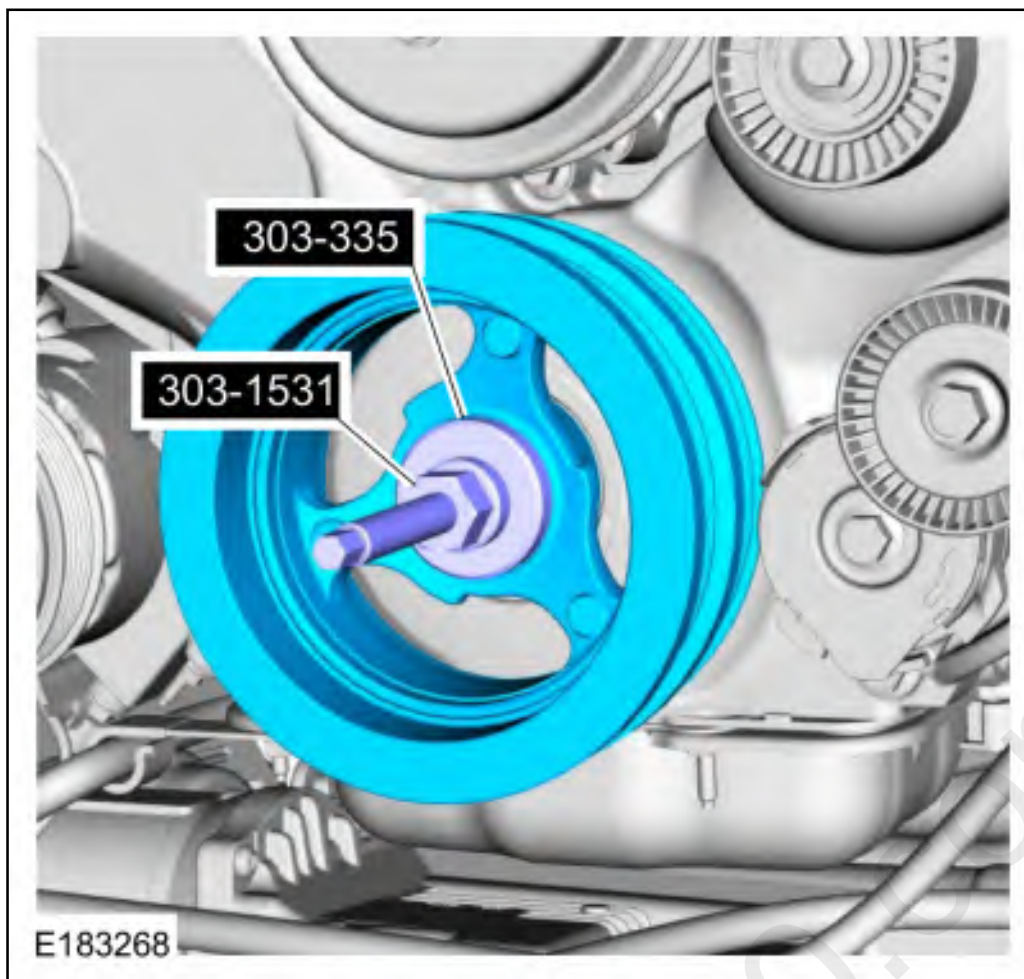
*Material:* Motorcraft® Silicone Gasket and Sealant / TA-30 (WSE-M4G323-A4)



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



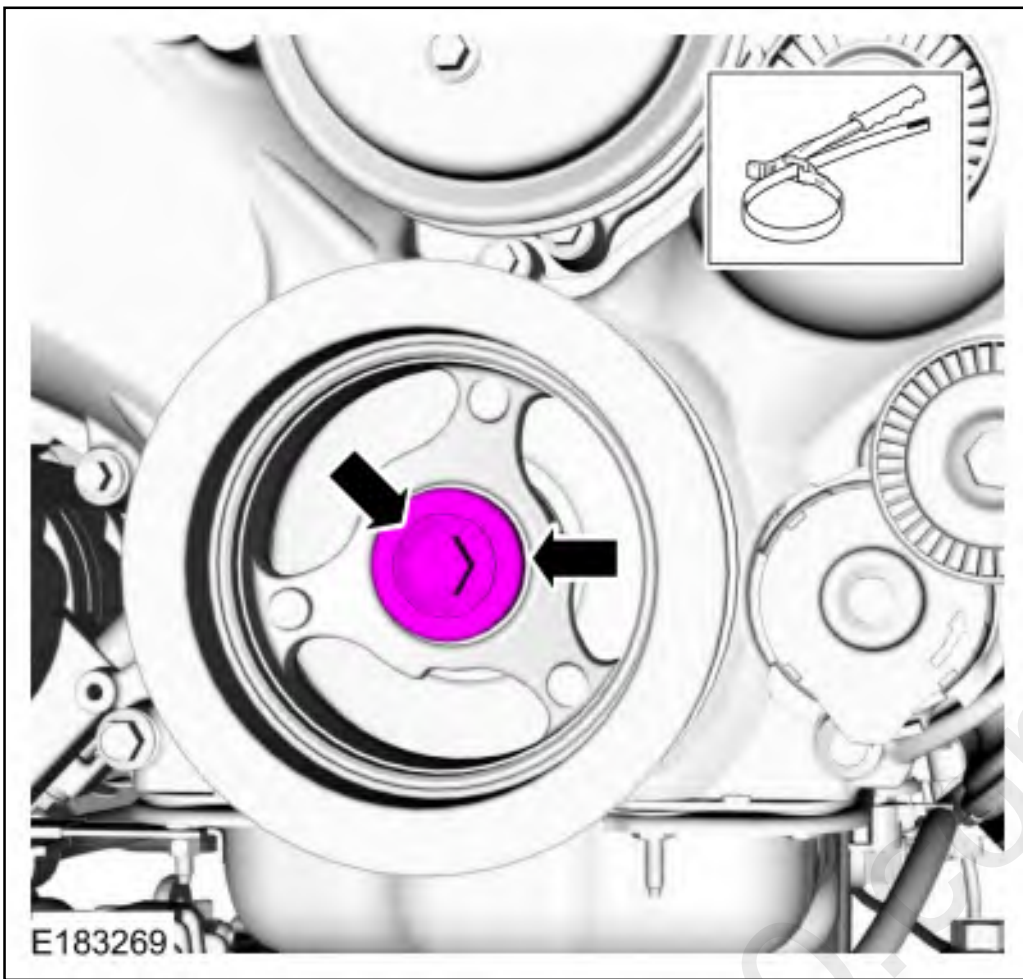
5. Using the special tools, install the crankshaft pulley.  
Use Special Service Tool: 303-335 (T88T-6701-A) Installer, Front Cover Oil Seal. , 303-1531  
Installer, Front Crank Seal and Damper.



6. 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°



7. Install the following items:

1. Refer to: Air Conditioning (A/C) Compressor Belt (303-05 Accessory Drive - 5.0L 32V Ti-VCT) .
2. Refer to: Accessory Drive Belt (303-05 Accessory Drive - 5.0L 32V Ti-VCT) .

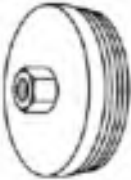
8. Use the Powertrain Control Module (PCM) Misfire Monitor Profile Correction routine in the diagnostic scan tool.



# Crankshaft Rear Seal with Retainer Plate

Base Part Number: Base Part Number: 6K301

## Special Tool(s) / General Equipment

|                                                                                                |                                                                                                      |
|------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|
| <br>E129694    | 100-001 (T50T-100-A)<br>Slide Hammer                                                                 |
| <br>E133913   | 205-153 (T80T-4000-W)<br>Handle                                                                      |
| <br>ST2980-A | 303-1250<br>Seal Installer, Rear Main<br>TKIT-2006UFFLM                                              |
|              | 303-519 (T95P-6701-EH)<br>Remover, Crankshaft Rear Oil Seal<br>TKIT-1995-FH/FLMH<br>TKIT-1995-LMH/MH |
| Plastic Scraper                                                                                |                                                                                                      |

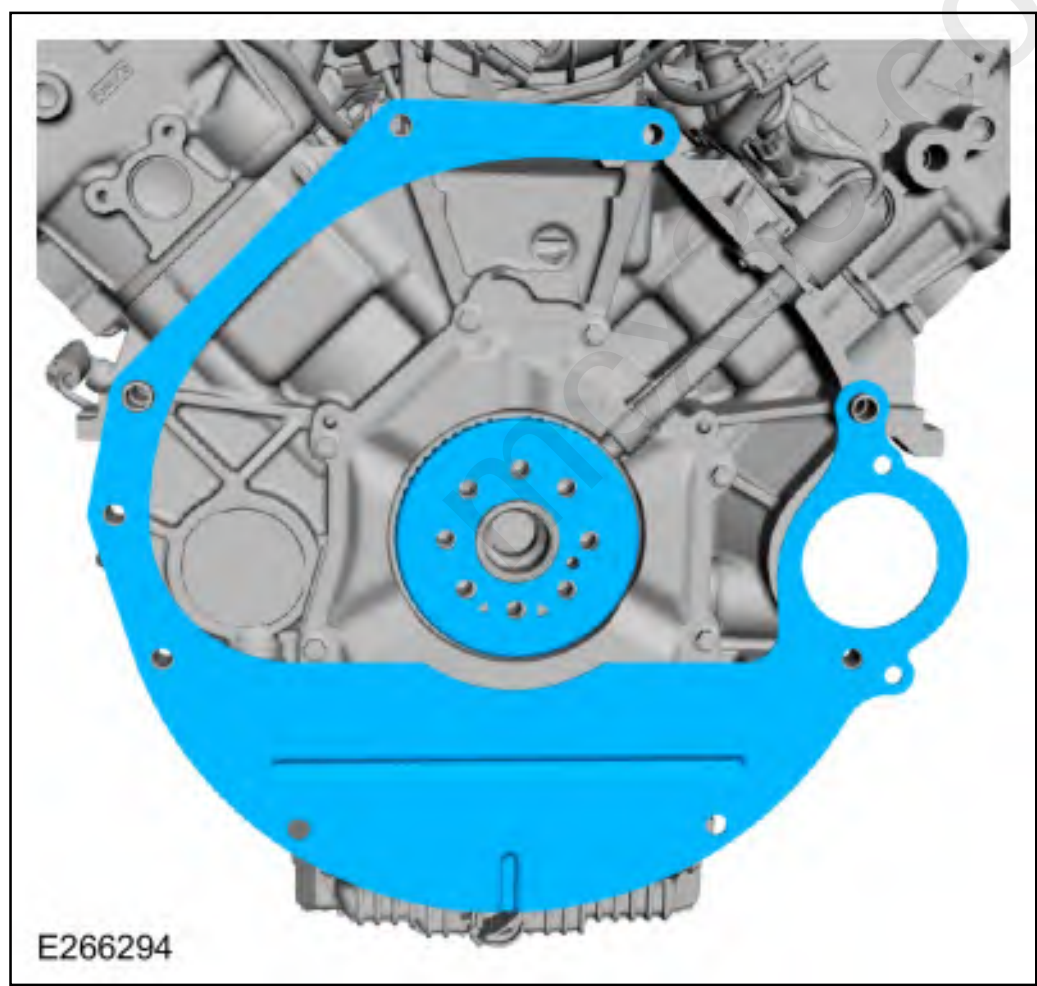
## Materials

| Name | Specification |
|------|---------------|
|      |               |

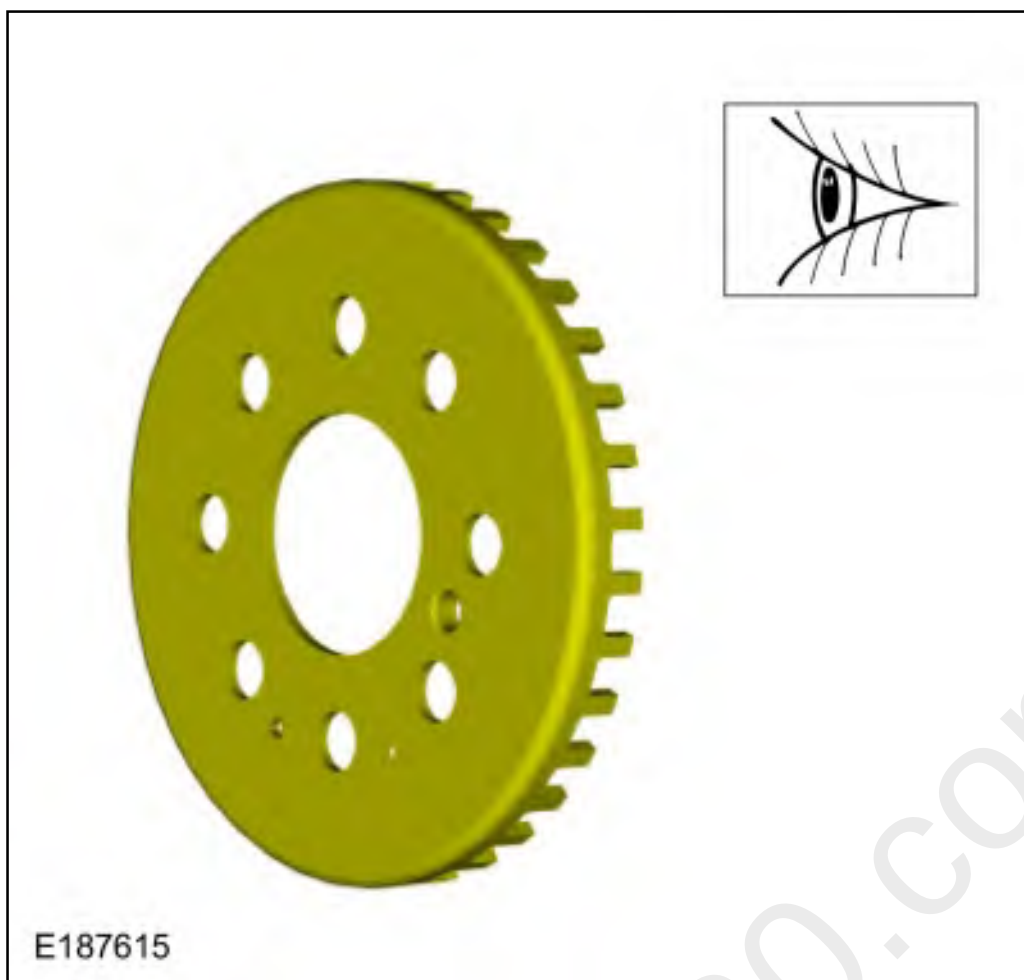
|                                                         |               |
|---------------------------------------------------------|---------------|
| Motorcraft® Silicone Gasket Remover<br>ZC-30-A          | -             |
| Motorcraft® Metal Surface Prep Wipes<br>ZC-31-B         | -             |
| Motorcraft® Silicone Gasket and Sealant<br>TA-30        | WSE-M4G323-A4 |
| Motorcraft® Metal Brake Parts Cleaner<br>PM-4-A, PM-4-B | -             |

## Removal

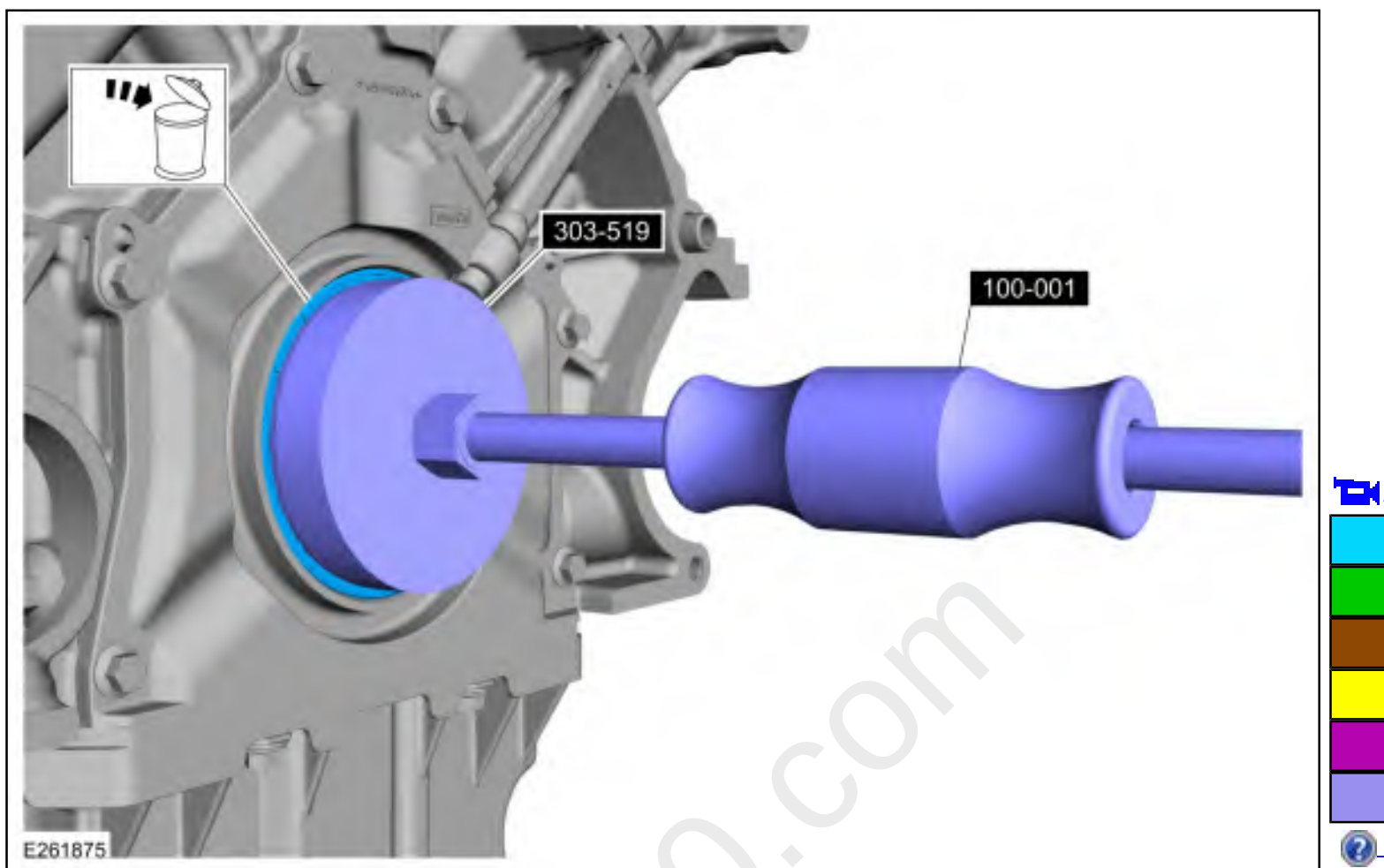
1. Remove the flexplate.  
Refer to: Flexplate (303-01 Engine - 5.0L 32V Ti-VCT) .
2. Remove the crankshaft sensor ring and the engine-to-transmission spacer plate.



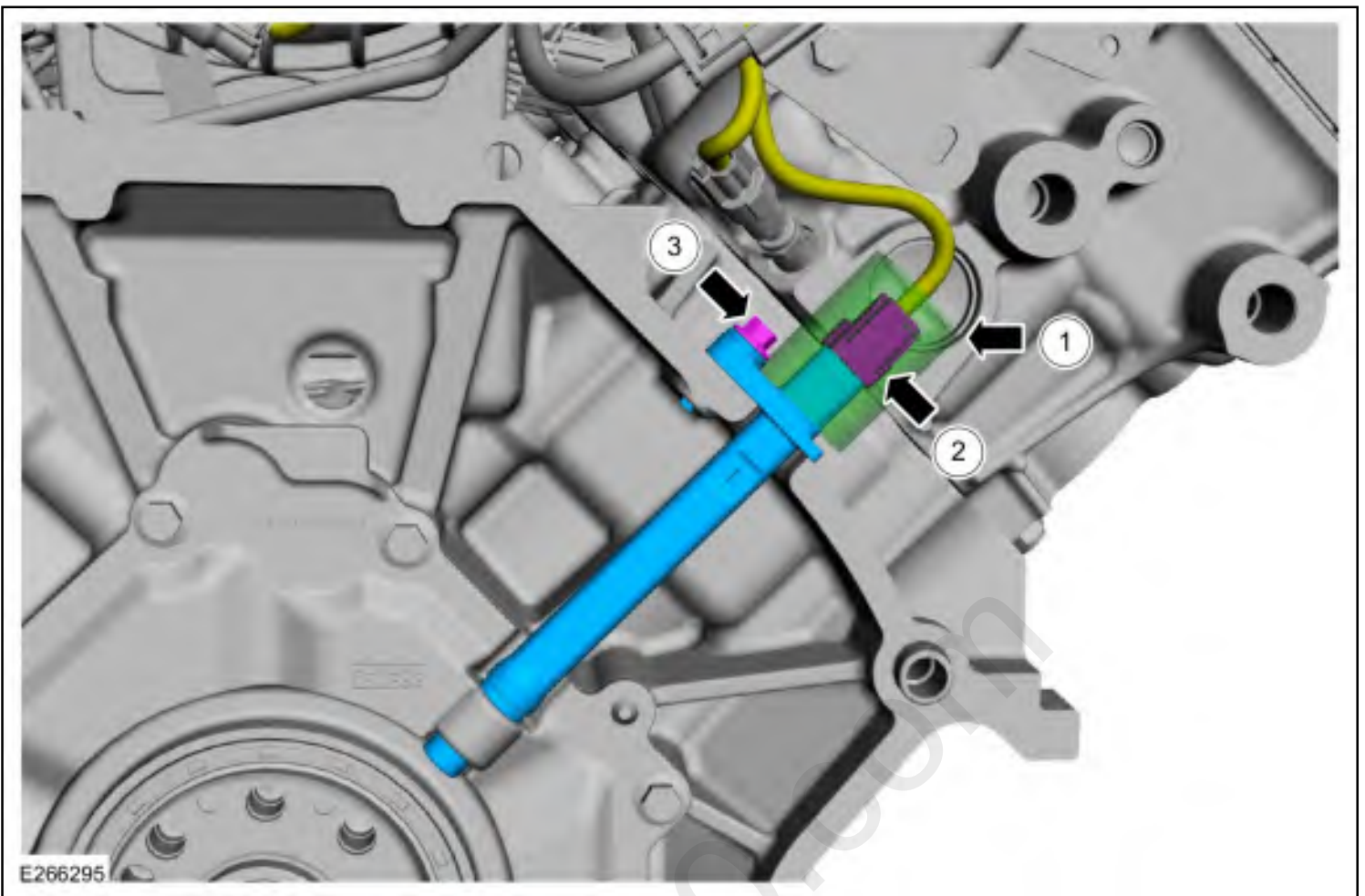
3. Inspect the crankshaft sensor ring for damage. If the crankshaft sensor ring has been dropped or has any visual damage, it must be discarded.



4. Using the special tools, remove and discard the crankshaft rear seal.  
Use Special Service Tool: 303-519 (T95P-6701-EH) Remover, Crankshaft Rear Oil Seal. , 100-001 (T50T-100-A) Slide Hammer.

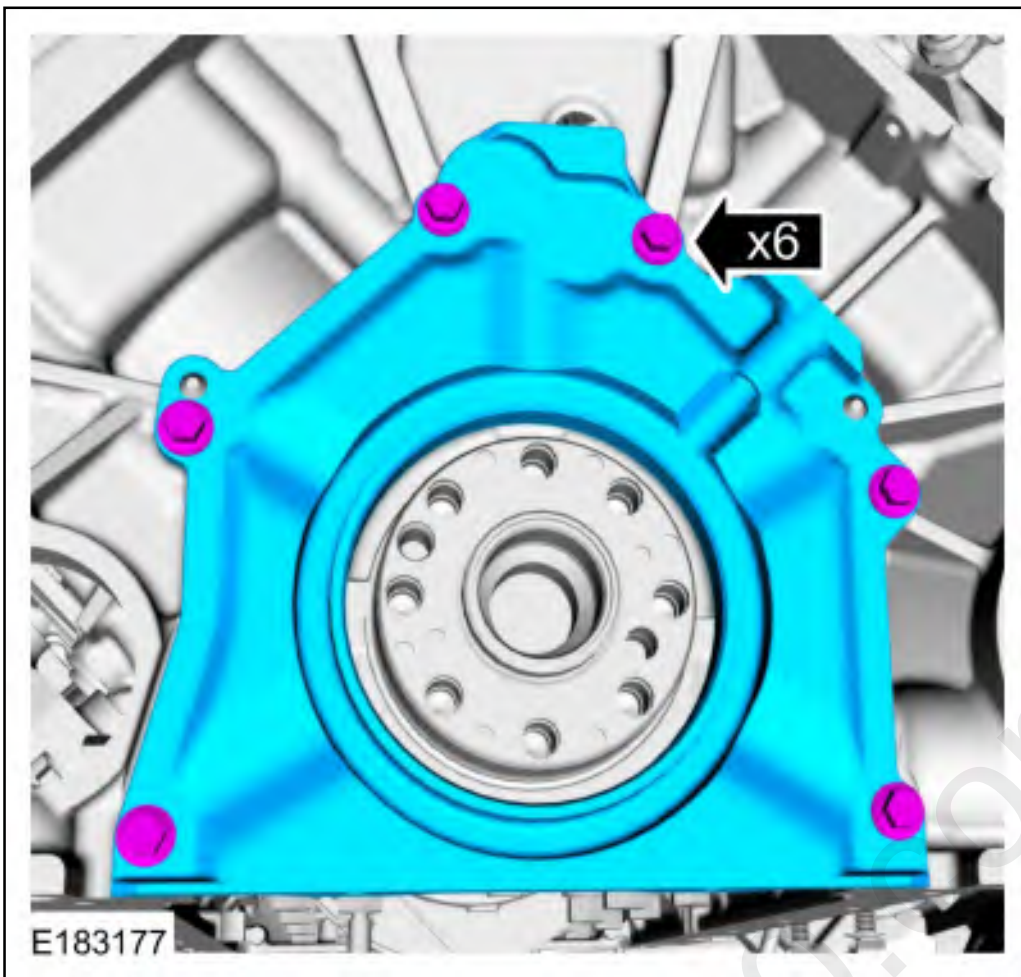


1. Slide the insulator off of the electrical connector.
2. Disconnect the CKP sensor electrical connector.
3. Remove the bolt and the CKP sensor.



6. Remove the oil pan.  
Refer to: Oil Pan (303-01 Engine - 5.0L 32V Ti-VCT) .
7. Remove the bolts and the crankshaft rear seal retainer plate.





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

Clean and inspect the mating surface.

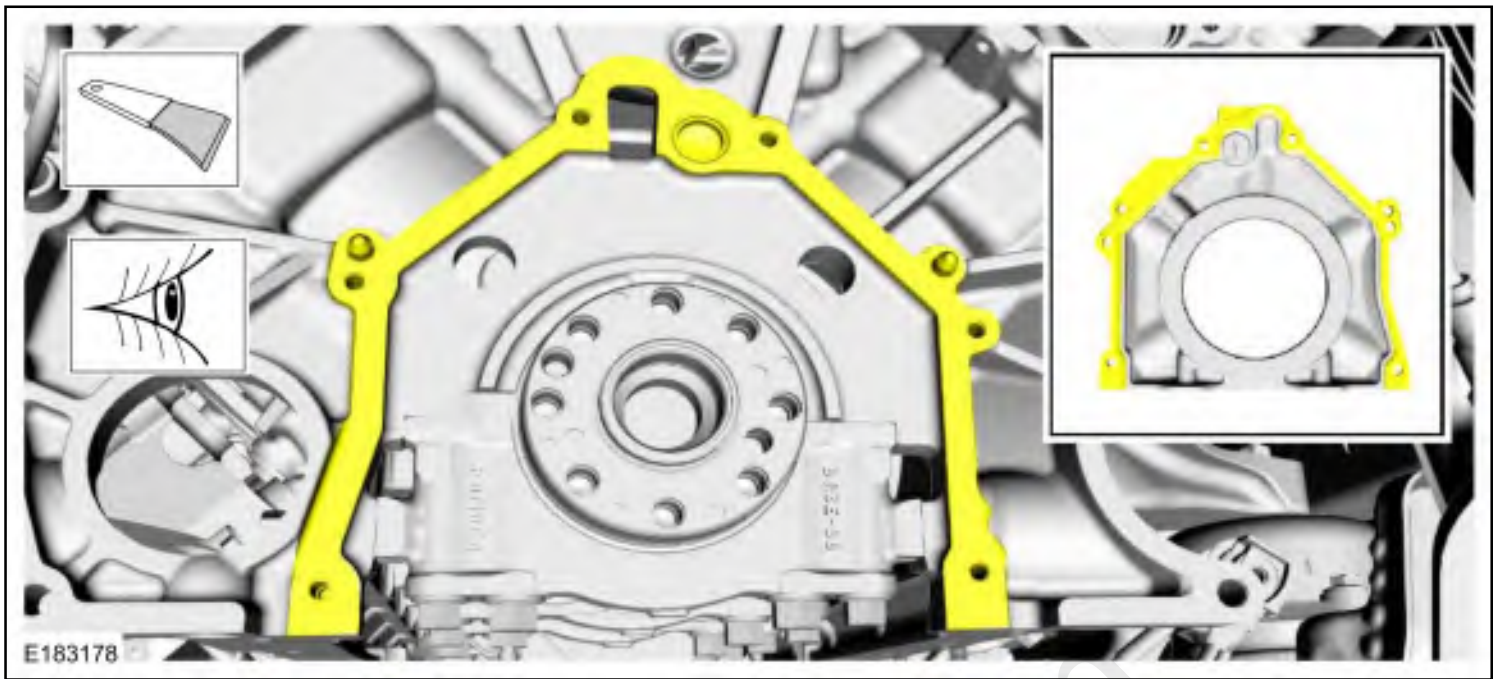
Refer to: [RTV Sealing Surface Cleaning and Preparation](#) (303-00 Engine System - General Information, General Procedures).

Use the General Equipment: Plastic Scraper

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

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

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

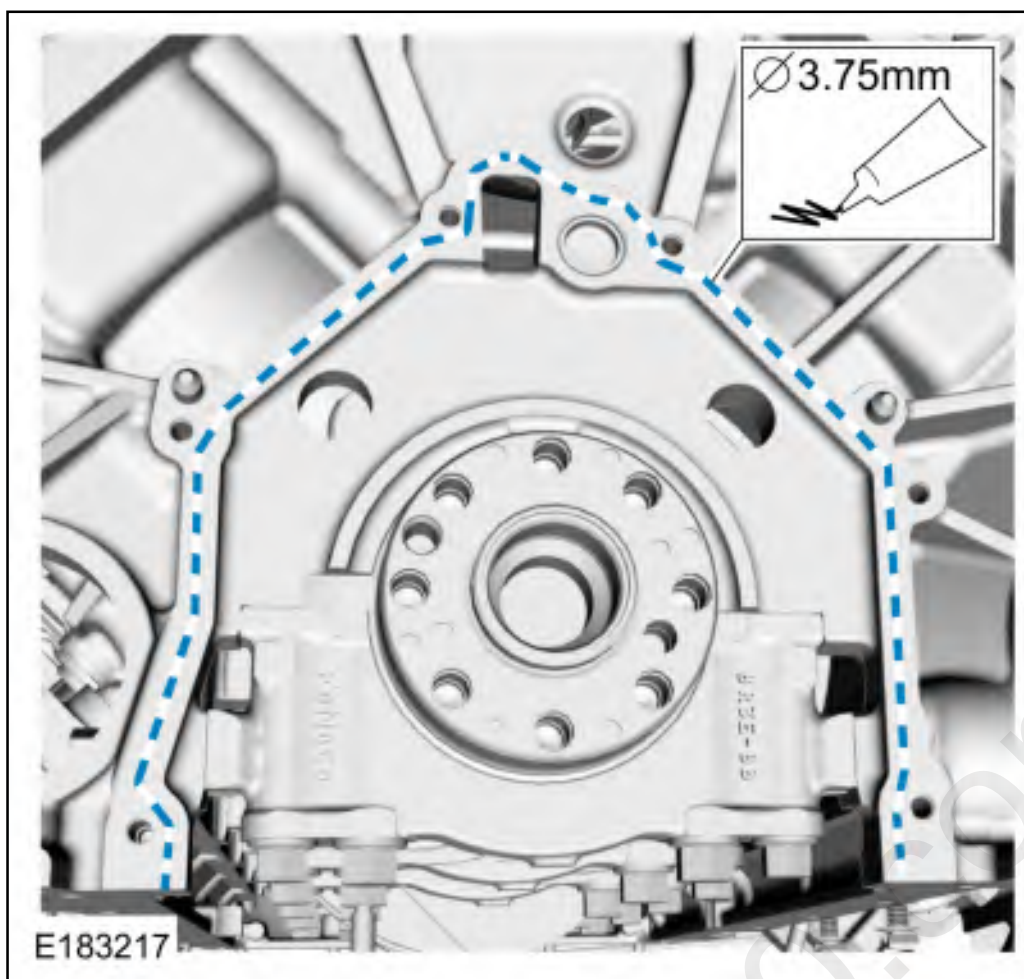


## Installation

1. **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)

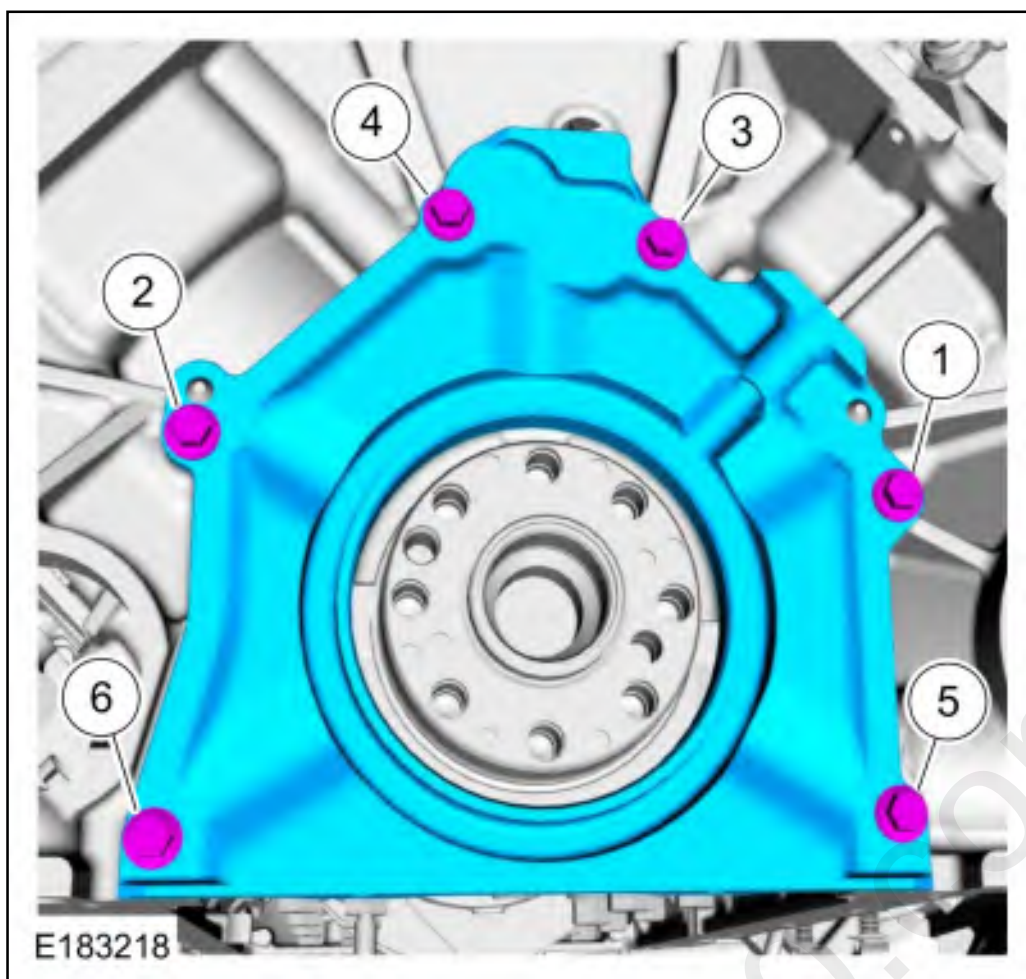


2. Install the crankshaft rear seal retainer plate and the bolts.

*Torque:*

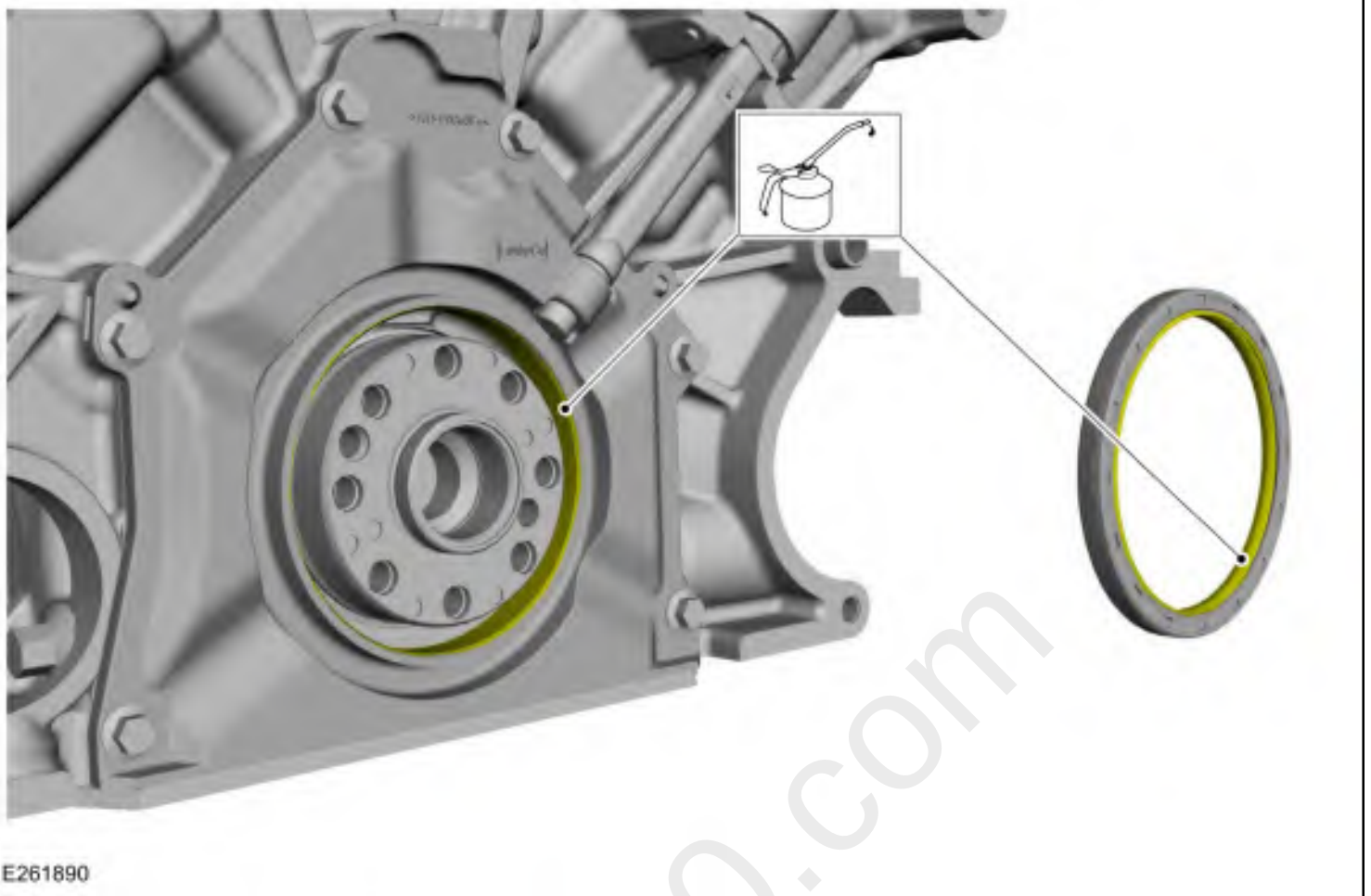
Stage 1: 89 lb.in (10 Nm)

Stage 2: 30°



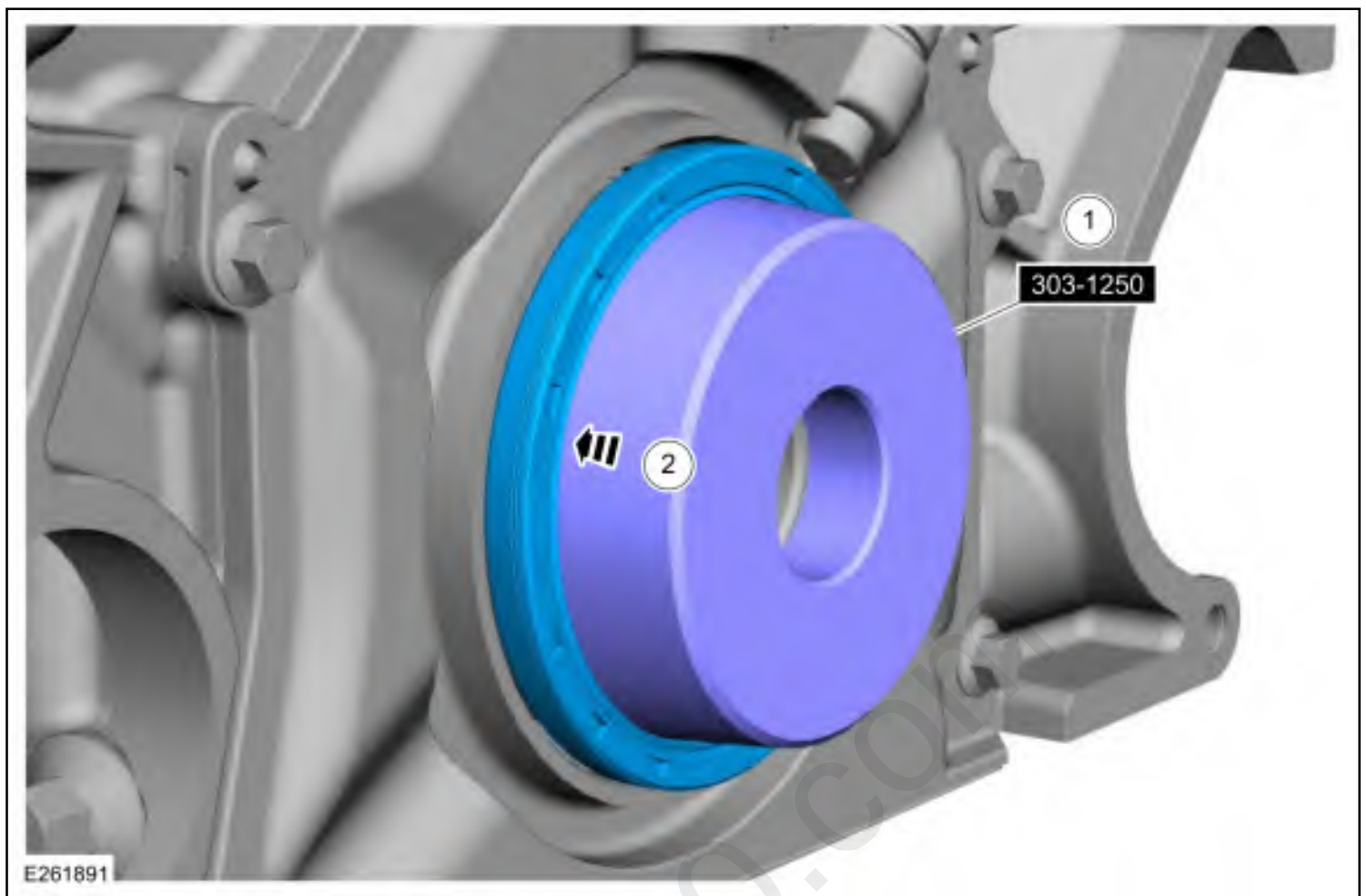
3. Lubricate the crankshaft rear seal bore and the seal lips with clean engine oil.





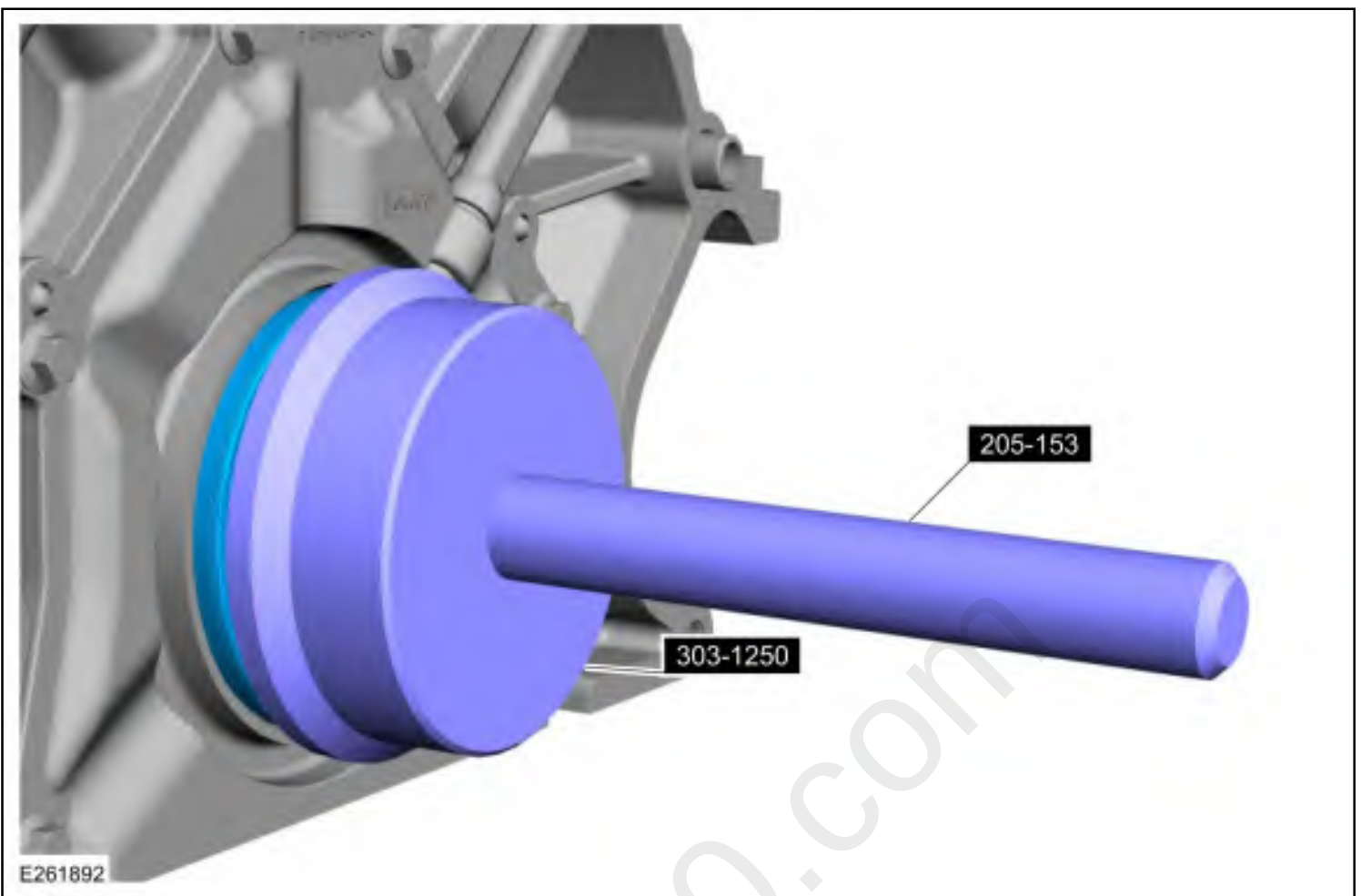
- Position the special tool onto the end of the crankshaft.  
Use Special Service Tool: 303-1250 Seal Installer, Rear Main.
- Slide the new crankshaft rear seal onto the tool.





5. Using the special tools, install the crankshaft rear seal.

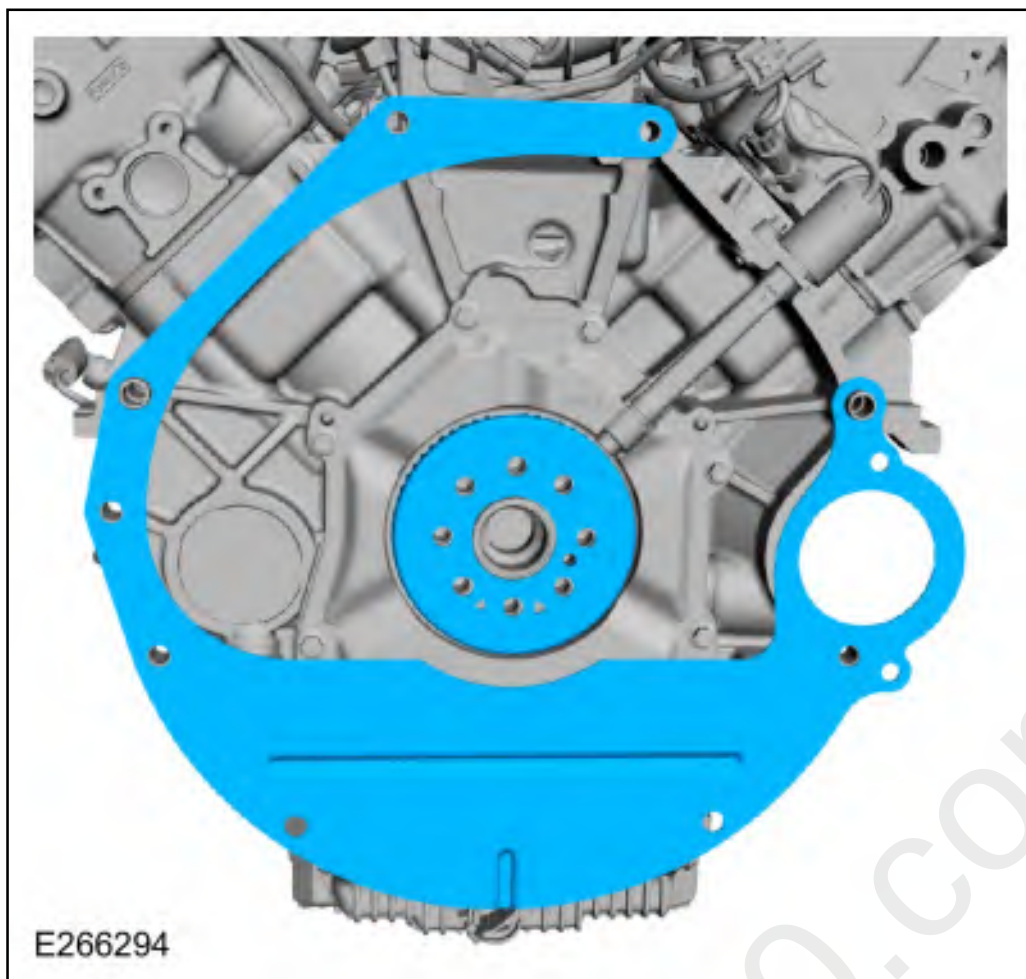
Use Special Service Tool: 205-153 (T80T-4000-W) Handle. , 303-1250 Seal Installer, Rear Main.



6. **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 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)*
- Connect the CKP sensor electrical connector.
- Slide the insulator onto the electrical connector.





9. Install the flexplate.  
Refer to: Flexplate (303-01 Engine - 5.0L 32V Ti-VCT) .

## Engine Mount LH

Base Part Number: Base Part Number: 6038

### Special Tool(s) / General Equipment

|                                                                                  |                                                                         |
|----------------------------------------------------------------------------------|-------------------------------------------------------------------------|
|  | 303-050 (T70P-6000)<br>Lifting Bracket, Engine                          |
|  | 303-F070<br>Support Bar, Engine<br>TKIT-1999A-F/LT<br>TKIT-1999A-FM/FLM |
| Vehicle/Axle Stands                                                              |                                                                         |

### Removal

#### 4x2/4x4

1. With the vehicle in NEUTRAL, position it on a hoist.  
Refer to: [Jacking and Lifting - Overview](#) (100-02 Jacking and Lifting, Description and Operation).

2. Remove the following items:

1. Refer to: [Hood](#) (501-02 Front End Body Panels, Removal and Installation).
2. **NOTE:** *It is not necessary to separate the air cleaner outlet pipe and the air cleaner, the 2 components can be removed as an assembly.*

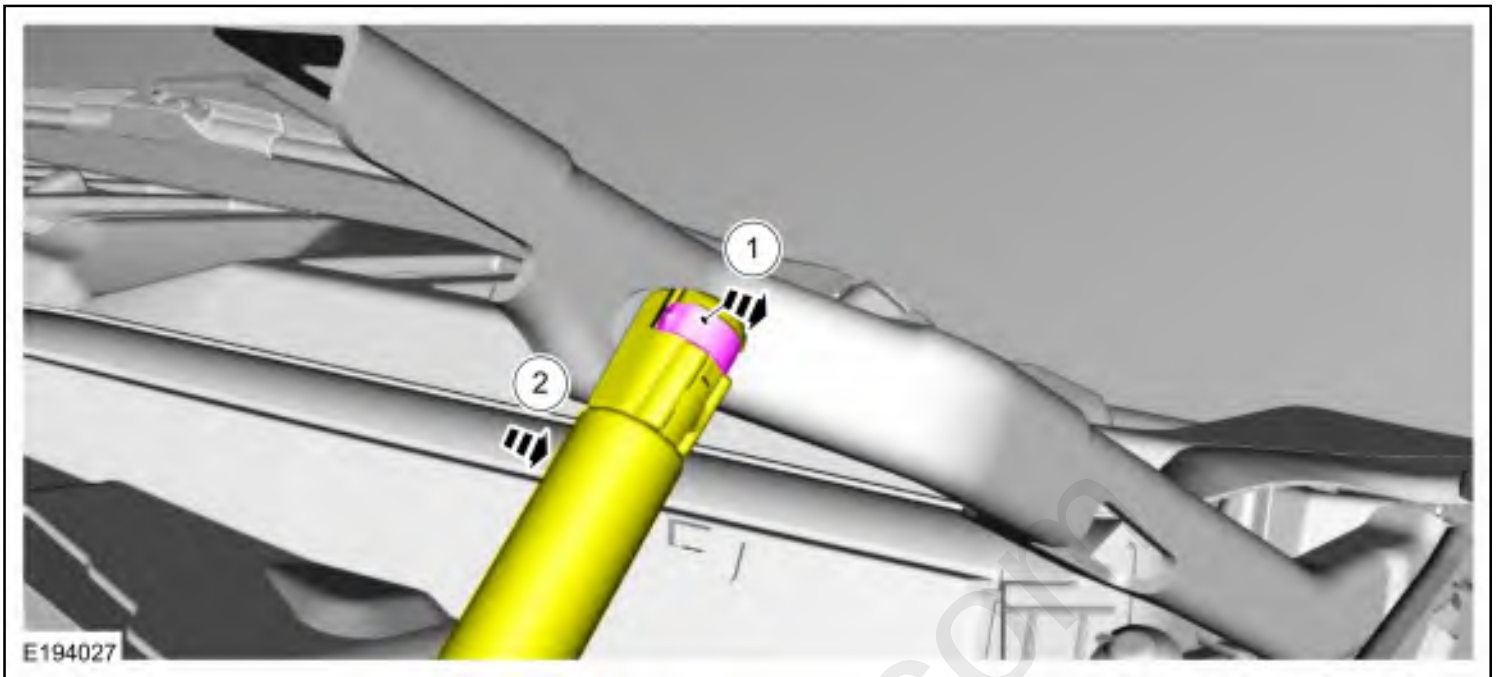
Refer to: [Air Cleaner Outlet Pipe](#) (303-12D Intake Air Distribution and Filtering - 5.0L 32V Ti-VCT, Removal and Installation).

3. Refer to: [Air Cleaner](#) (303-12D Intake Air Distribution and Filtering - 5.0L 32V Ti-VCT, Removal and Installation).

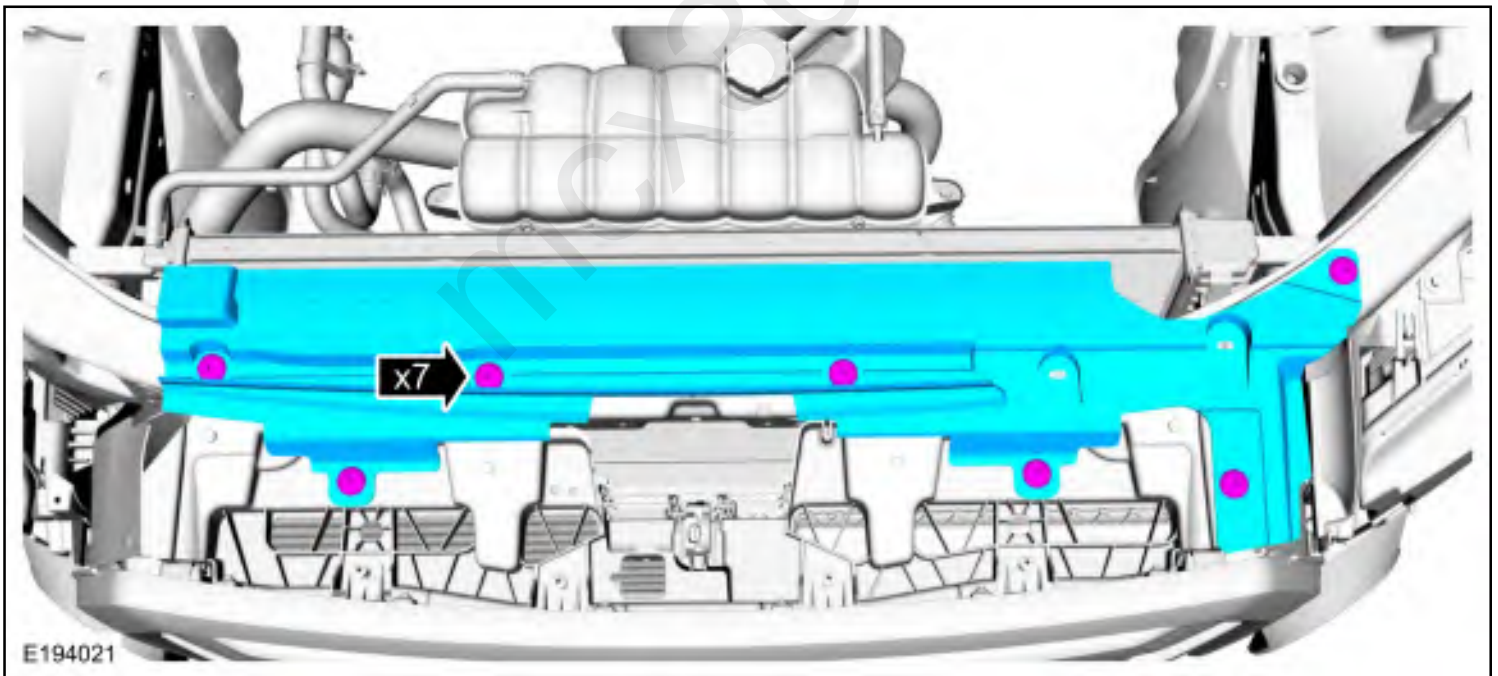
3. **NOTE:** *LH shown, RH similar.*



1. Release the clip.
2. Detach and position the hood shock aside.



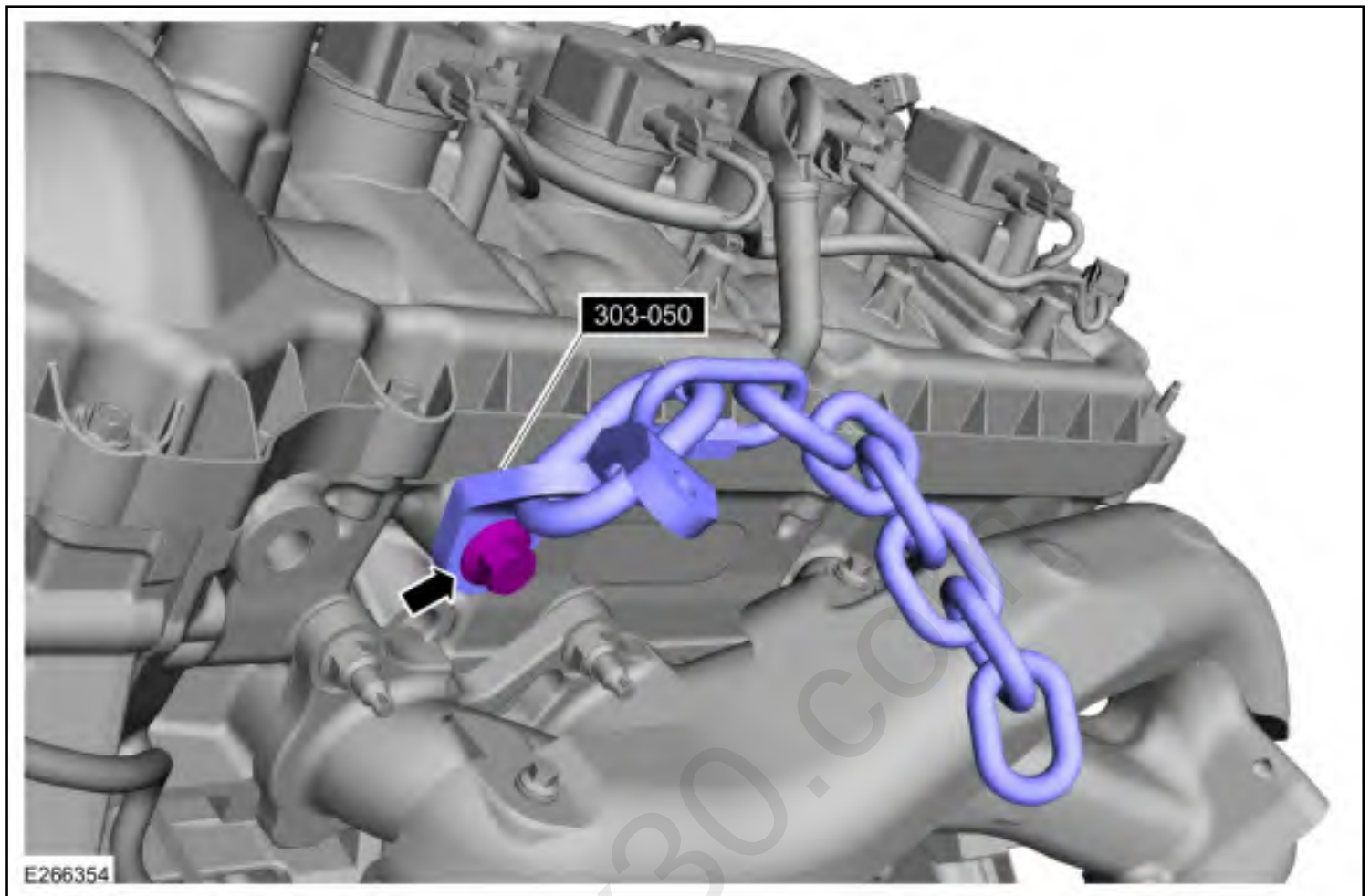
4. Remove the retainers and the radiator top shield.



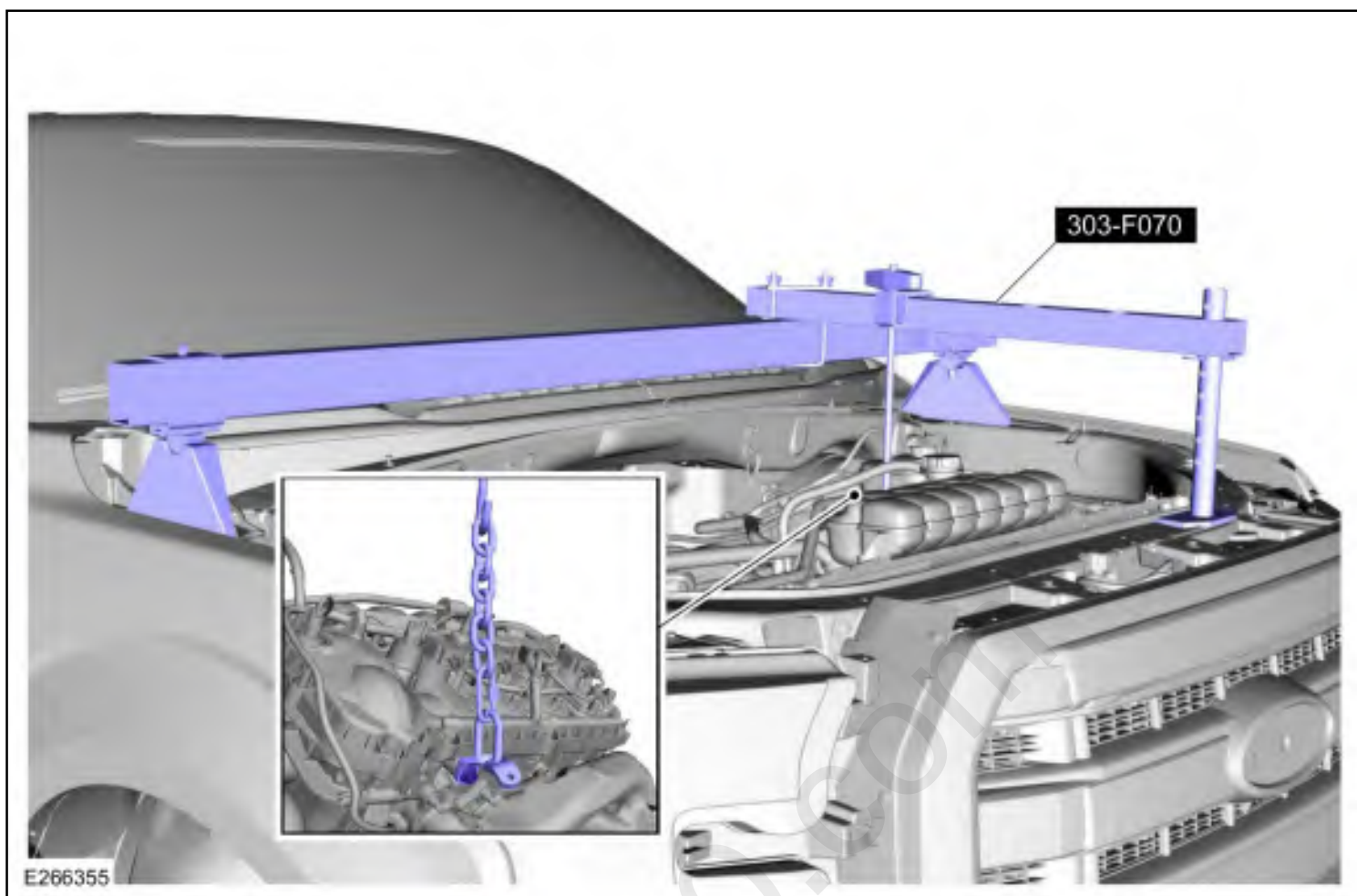
5. **NOTE:** It may be necessary to install washers between the Engine Lifting Bracket and the cylinder head to prevent the Engine Lifting Bracket from contacting the valve cover while supporting the engine.

- Install Special Service Tool: 303-050 (T70P-6000) Lifting Bracket, Engine.

- Attach a length of chain and a connecting link to the special tool.

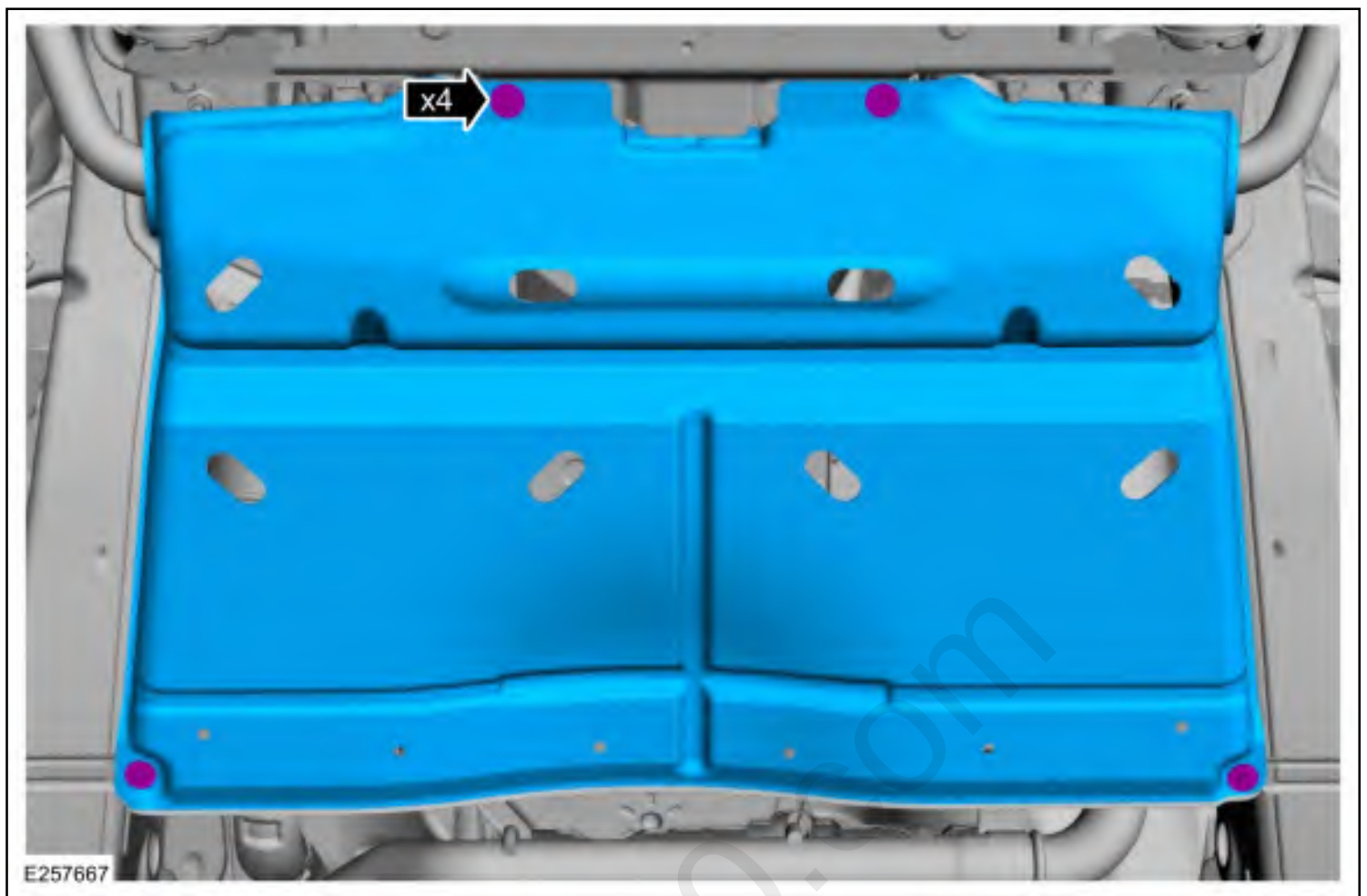


- Install Special Service Tool: 303-F070 Support Bar, Engine.
- Attach the chain installed in the previous step to the hook on the special tool.



7. **NOTE:** *If equipped.*

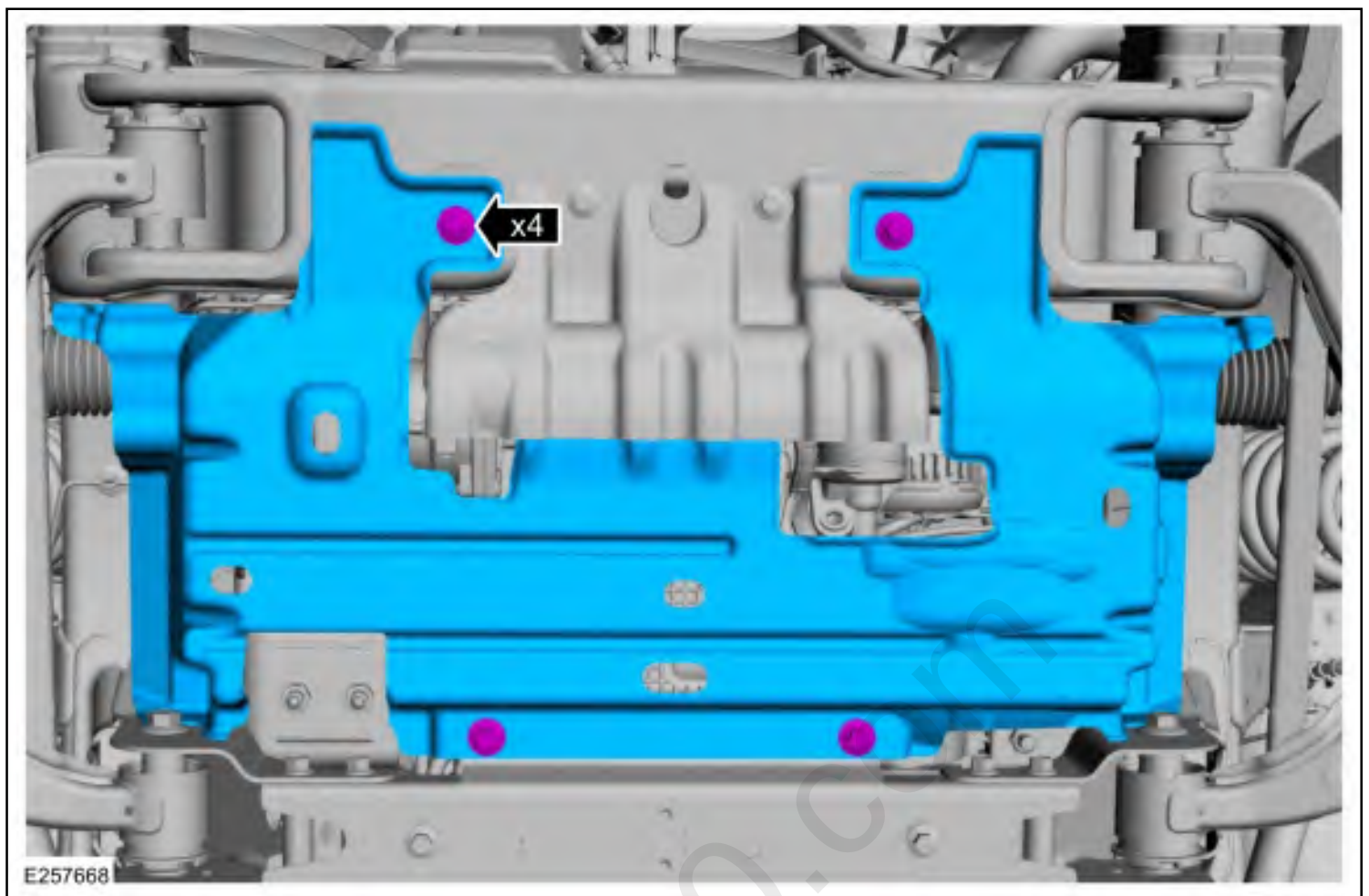
Remove the bolts and the underbody shield.



8. **NOTE:** *If equipped.*

Remove the bolts and the underbody shield.

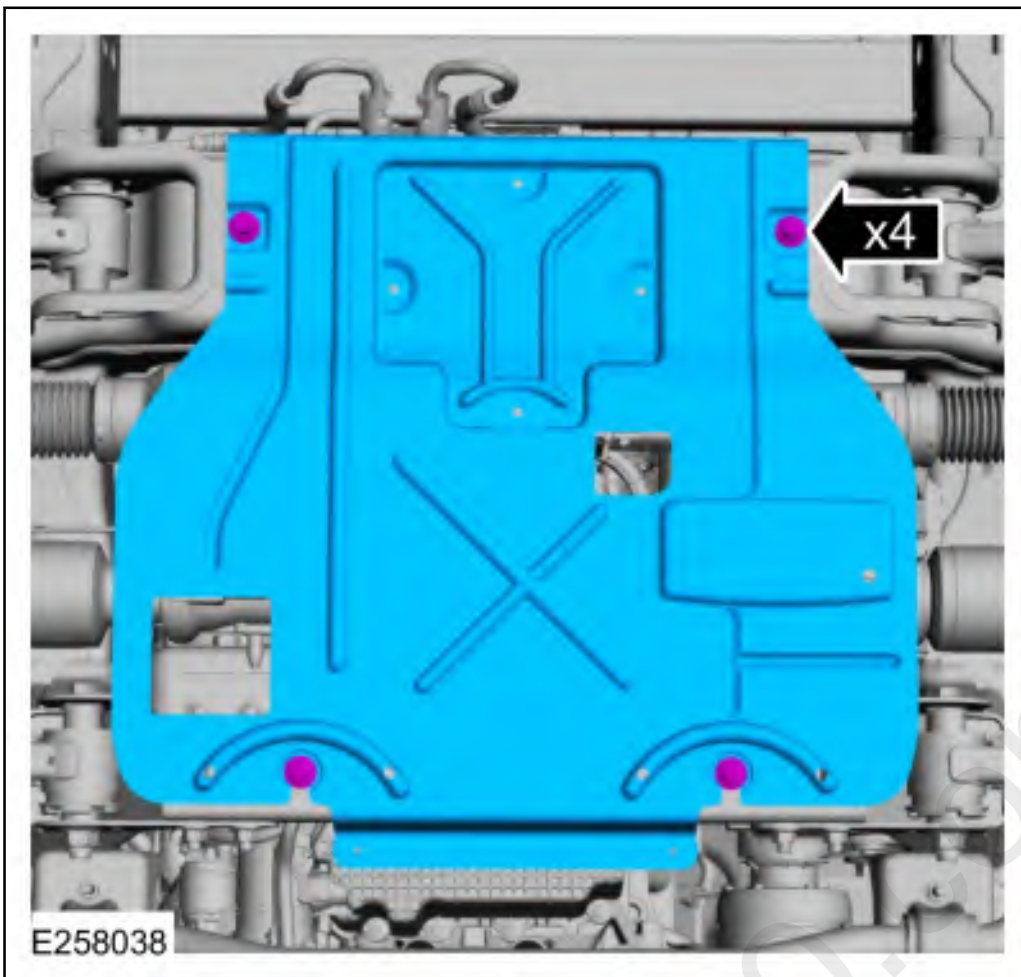




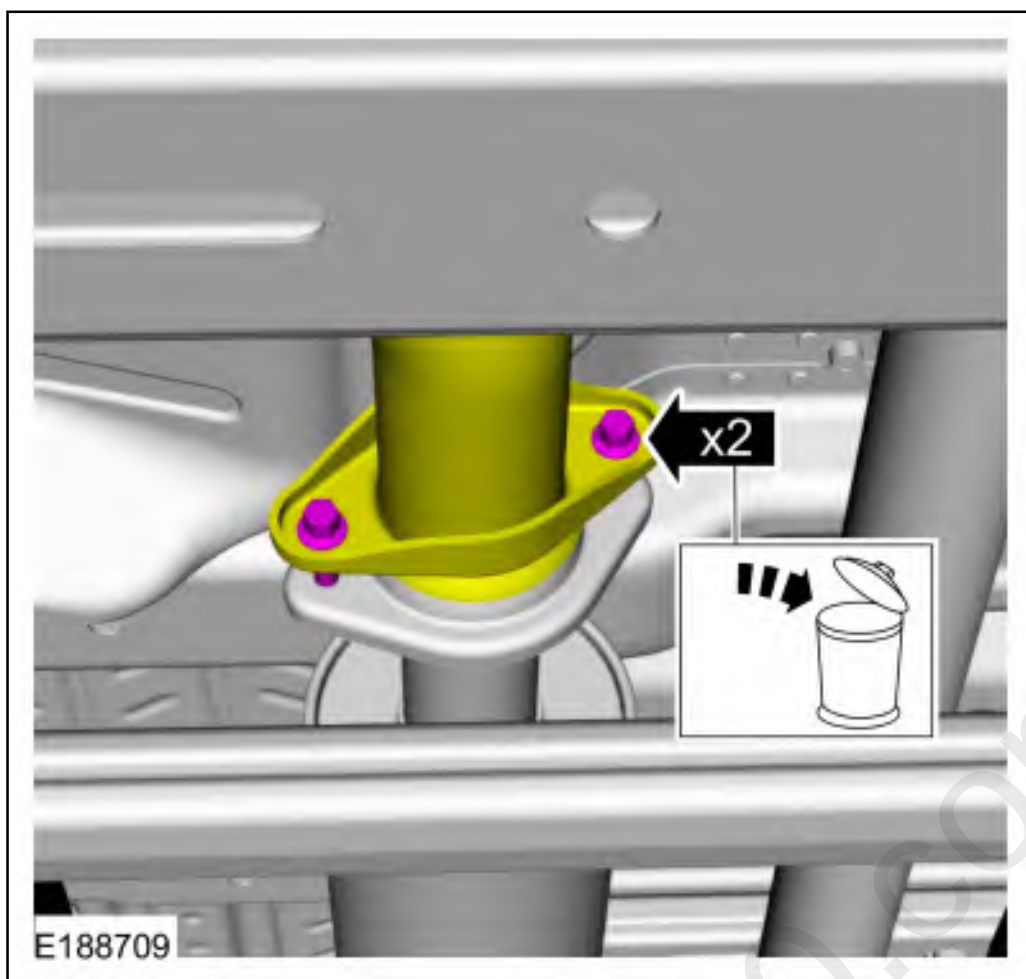
9. **NOTE:** *If equipped.*

Remove the bolts and the skid plate.



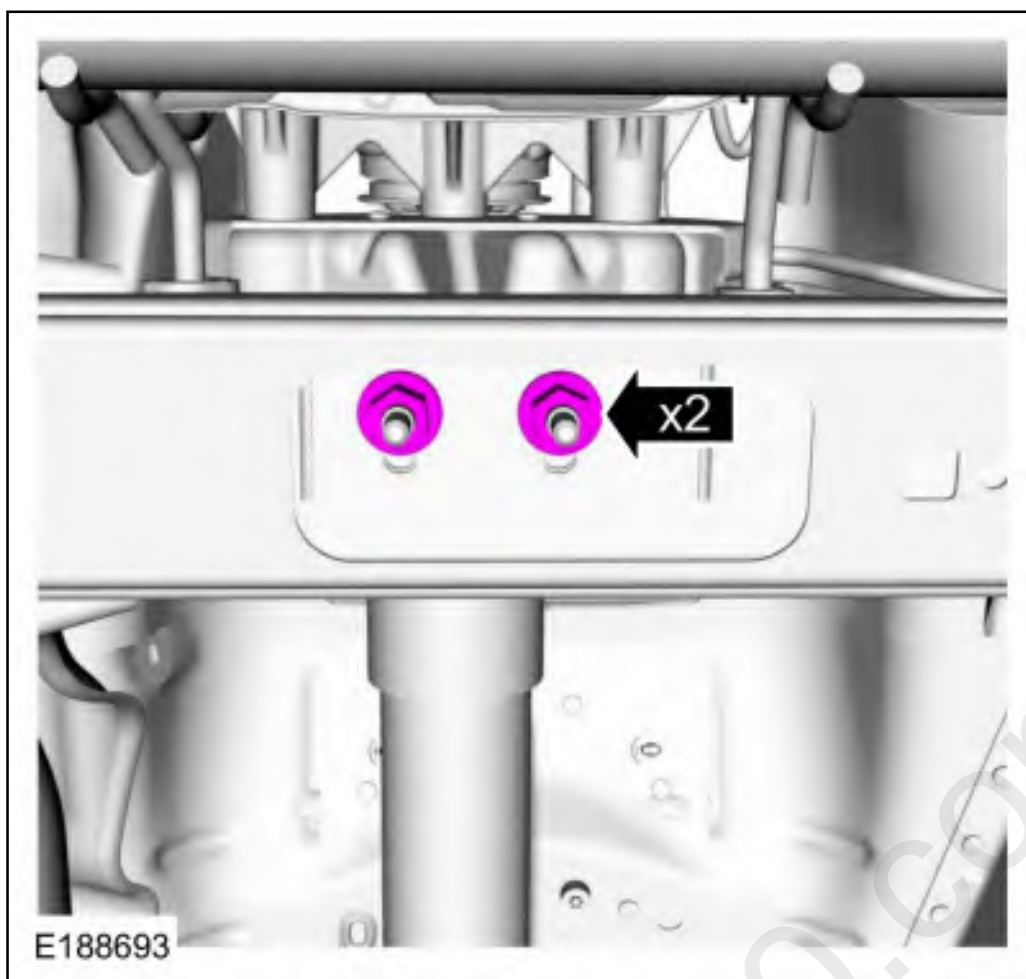


10. Remove and discard the exhaust Y-pipe dual catalytic converter-to-exhaust intermediate pipe bolts and separate.
  - Clean and inspect the mating surfaces.



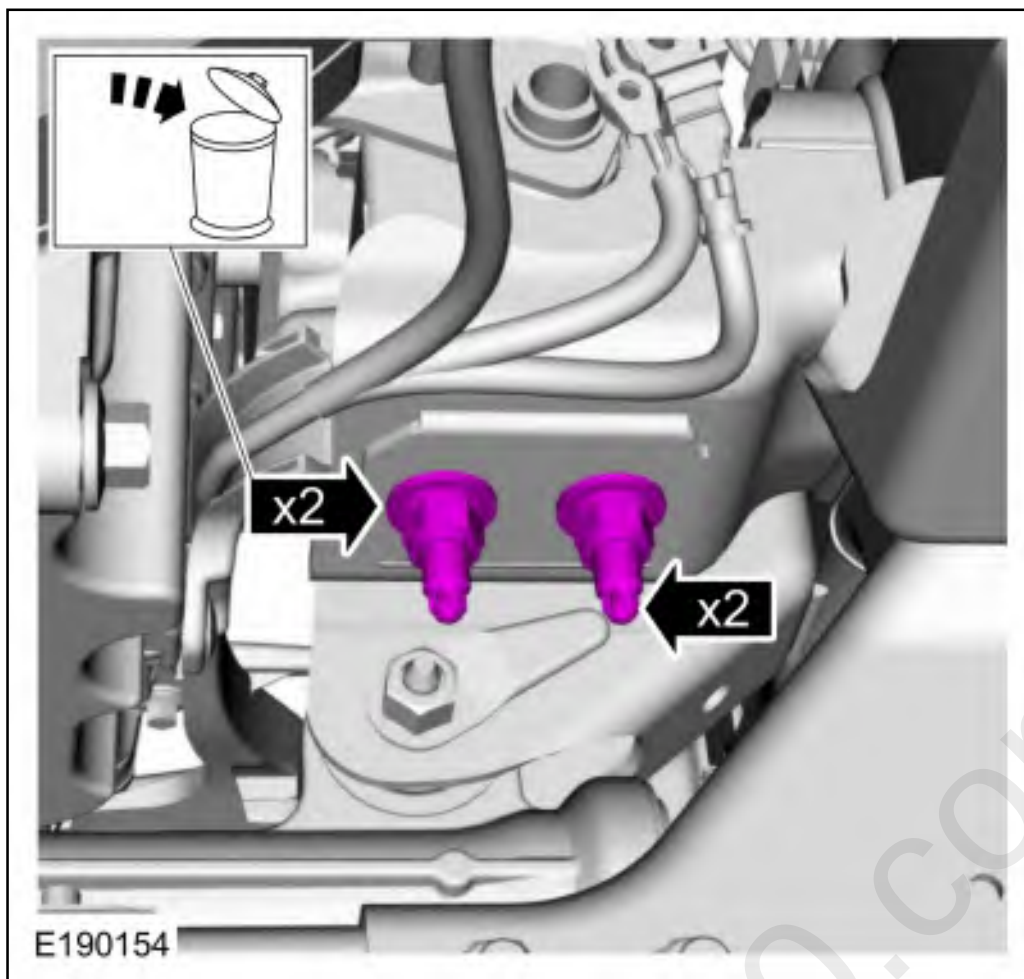
11. **NOTICE:** Only use hand tools when removing the transmission mount-to-crossmember nuts or damage to the transmission mount can occur.

Loosen the transmission mount-to-crossmember nuts.



12. **NOTICE:** Only use hand tools when removing the engine mount nuts, stud bolts or damage to the engine mount can occur.

Remove and discard the RH engine mount nuts and stud bolts.



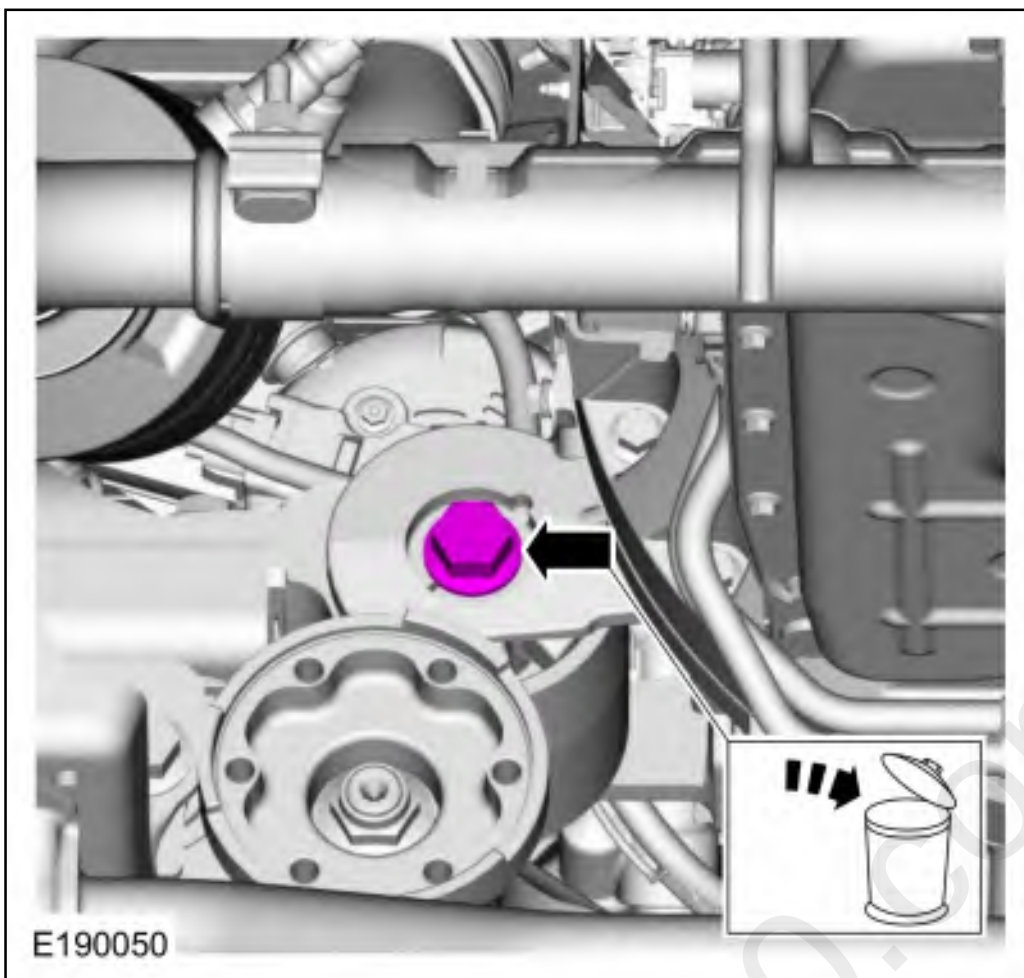
4x4

13. Remove the front drive shaft.  
Refer to: [Front Driveshaft](#) (205-01 Driveshaft, Removal and Installation).

4x2/4x4

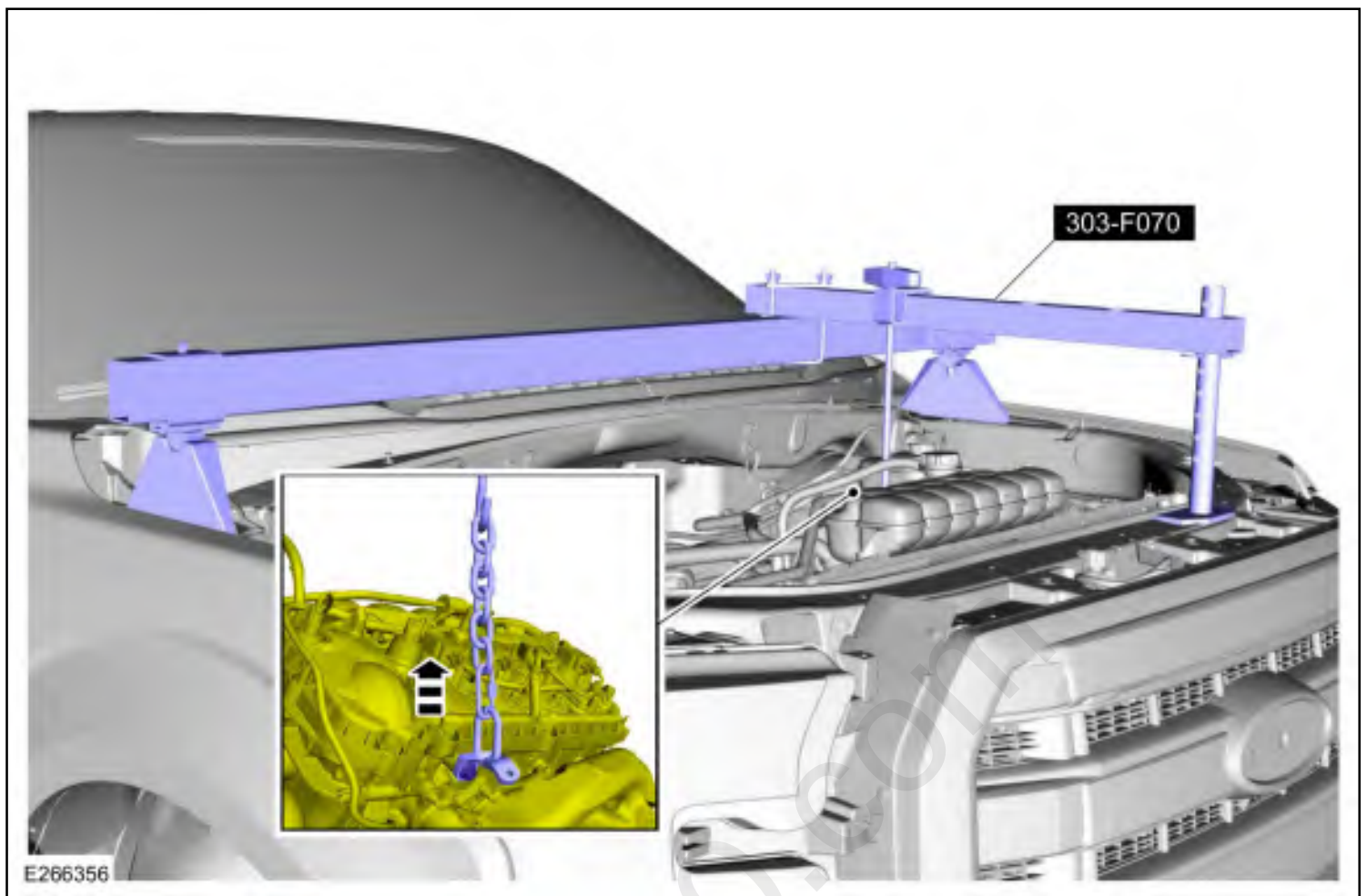
14. **NOTICE: Only use hand tools when loosening the engine mount through bolts or damage to the engine mount-to-cylinder block bracket can occur.**

Remove and discard the LH engine mount through bolt.



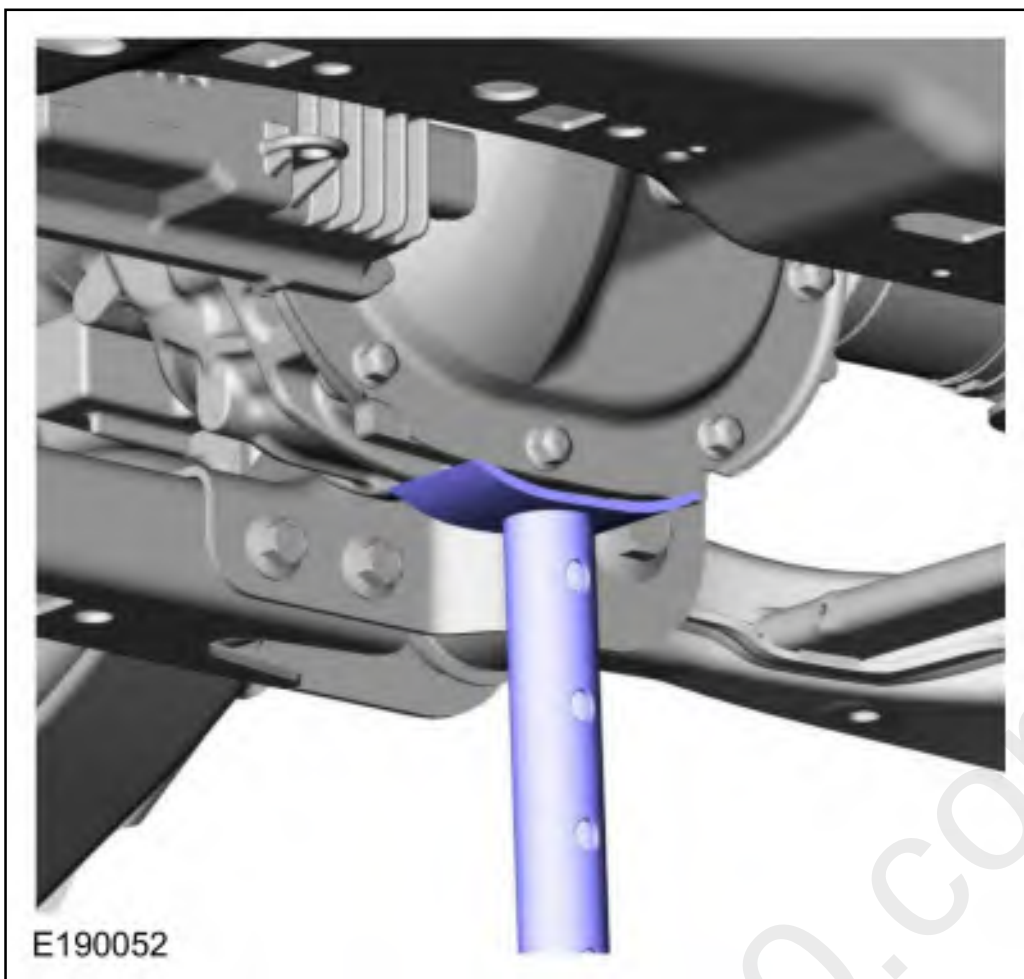
15. Using the special tool, raise the LH side of the engine 50 mm (2 in).



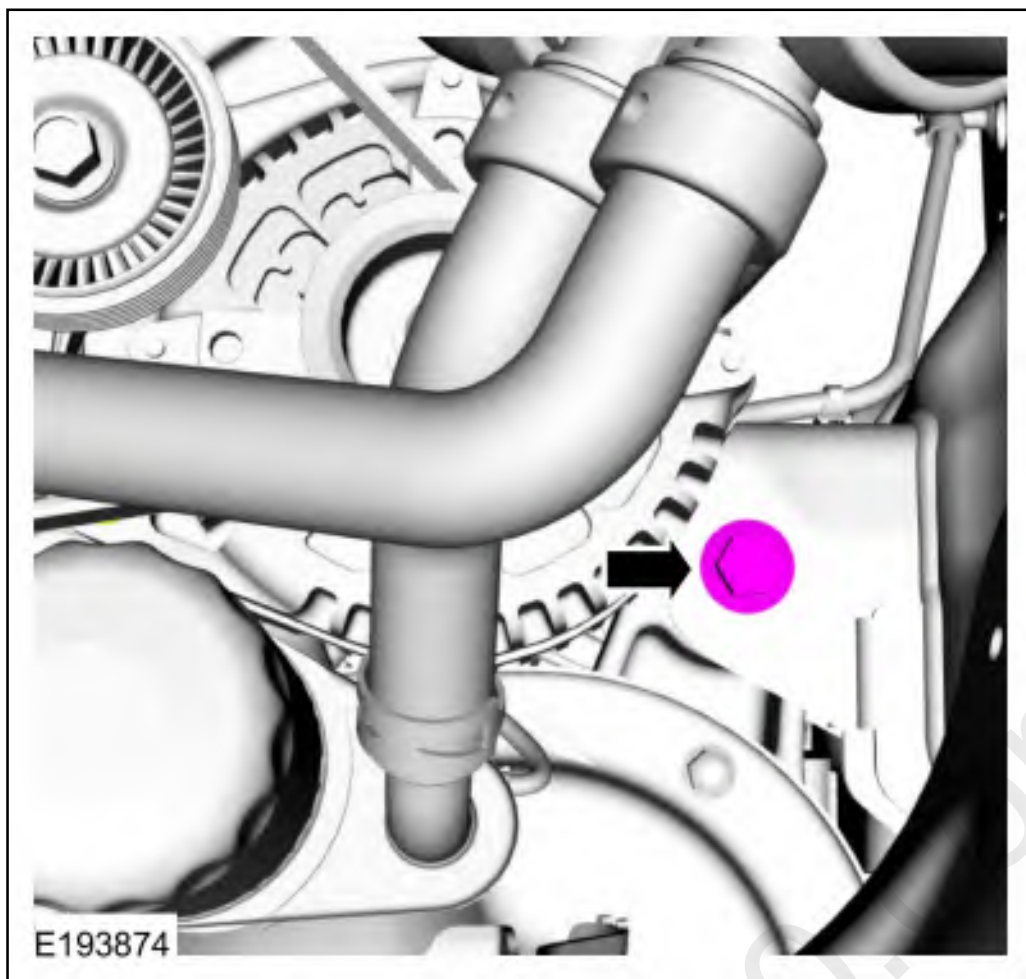


4x4

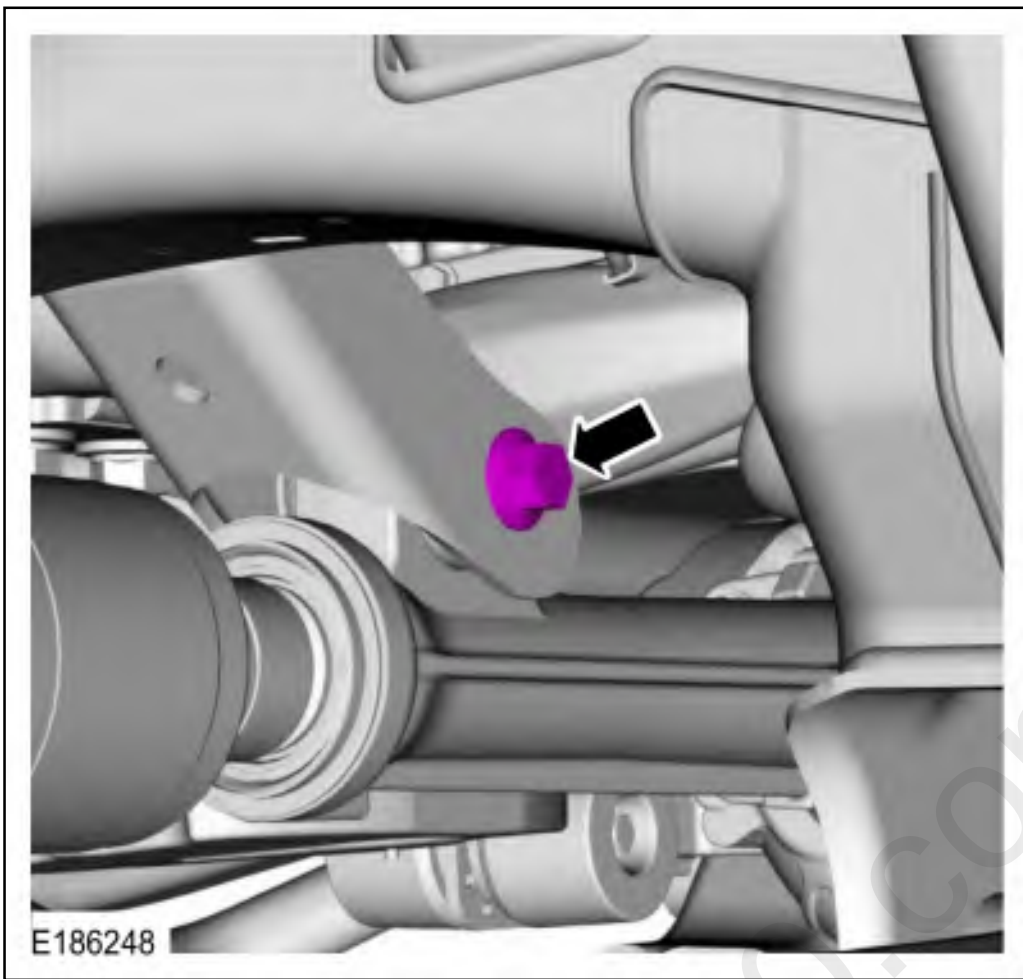
16. Using an adjustable stand, support the front axle.  
Use the General Equipment: Vehicle/Axle Stands



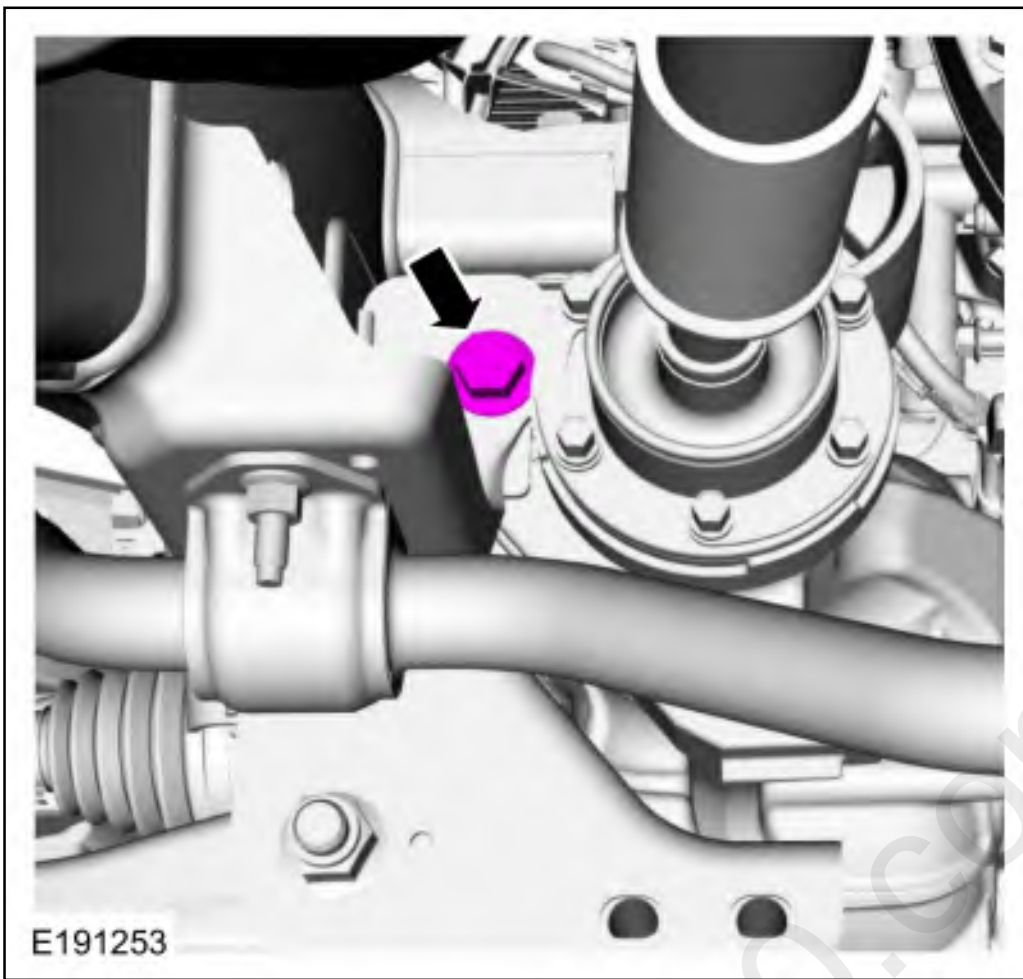
17. Remove the upper front axle carrier mounting bushing bolt.



18. Remove the axle shaft housing carrier bushing bolt.

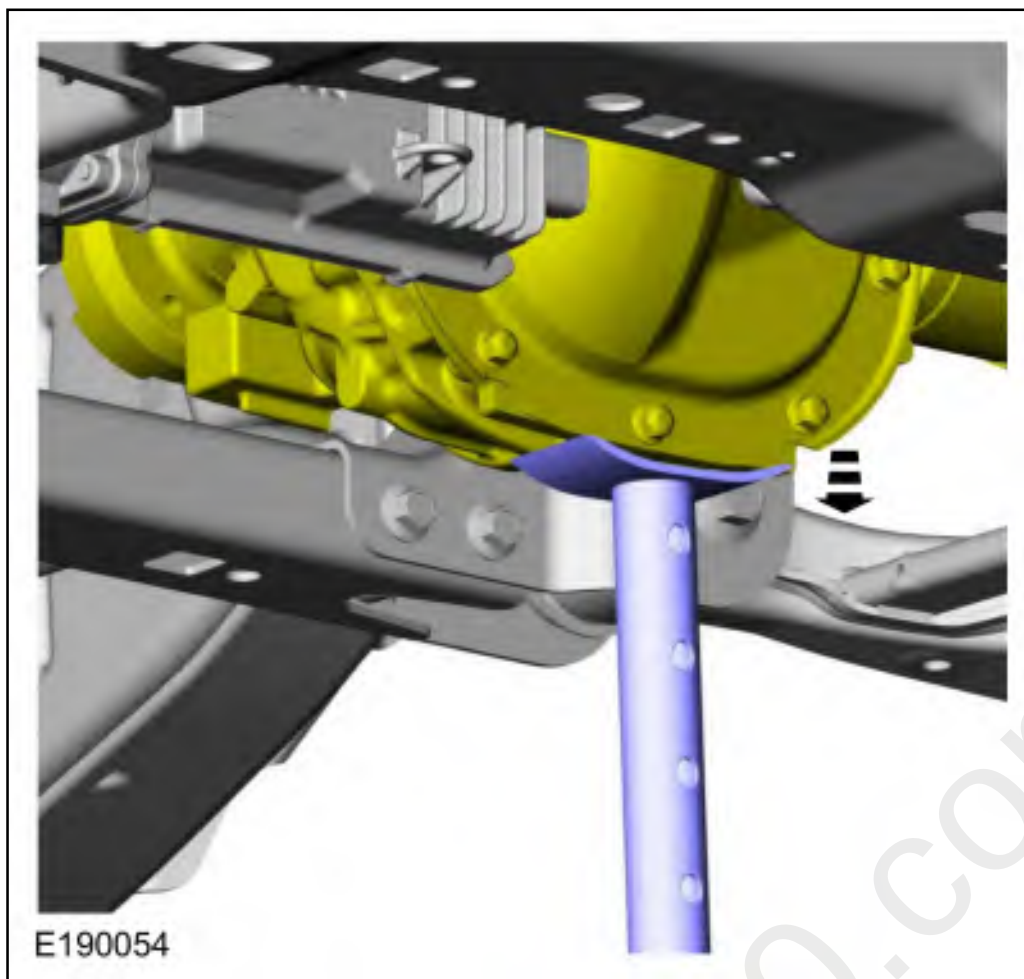


19. Remove the lower front axle carrier mounting bushing bolt.



20. Using an adjustable stand, lower the axle to allow clearance for the oil pan to be removed.  
Use the General Equipment: Vehicle/Axle Stands

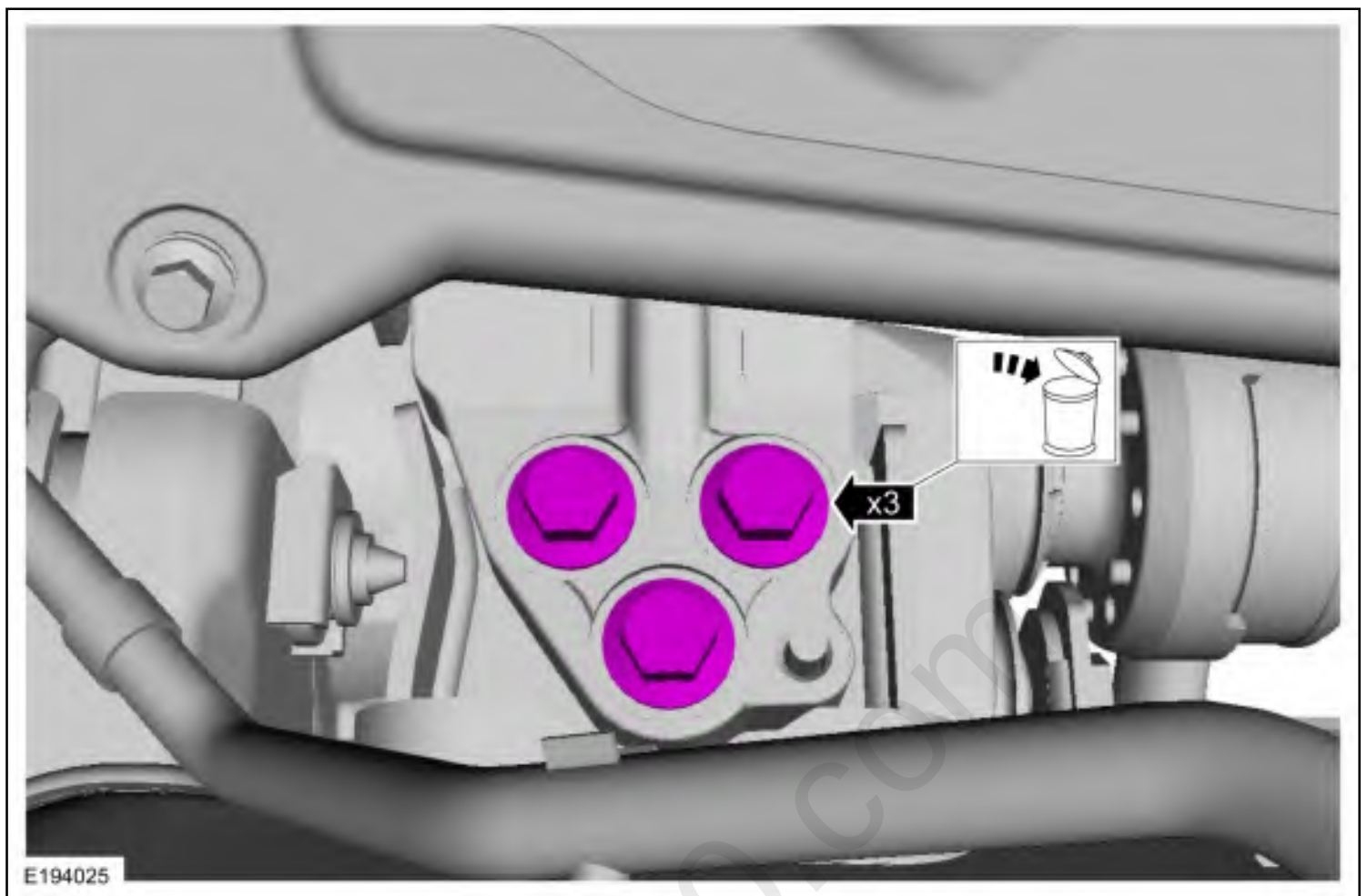




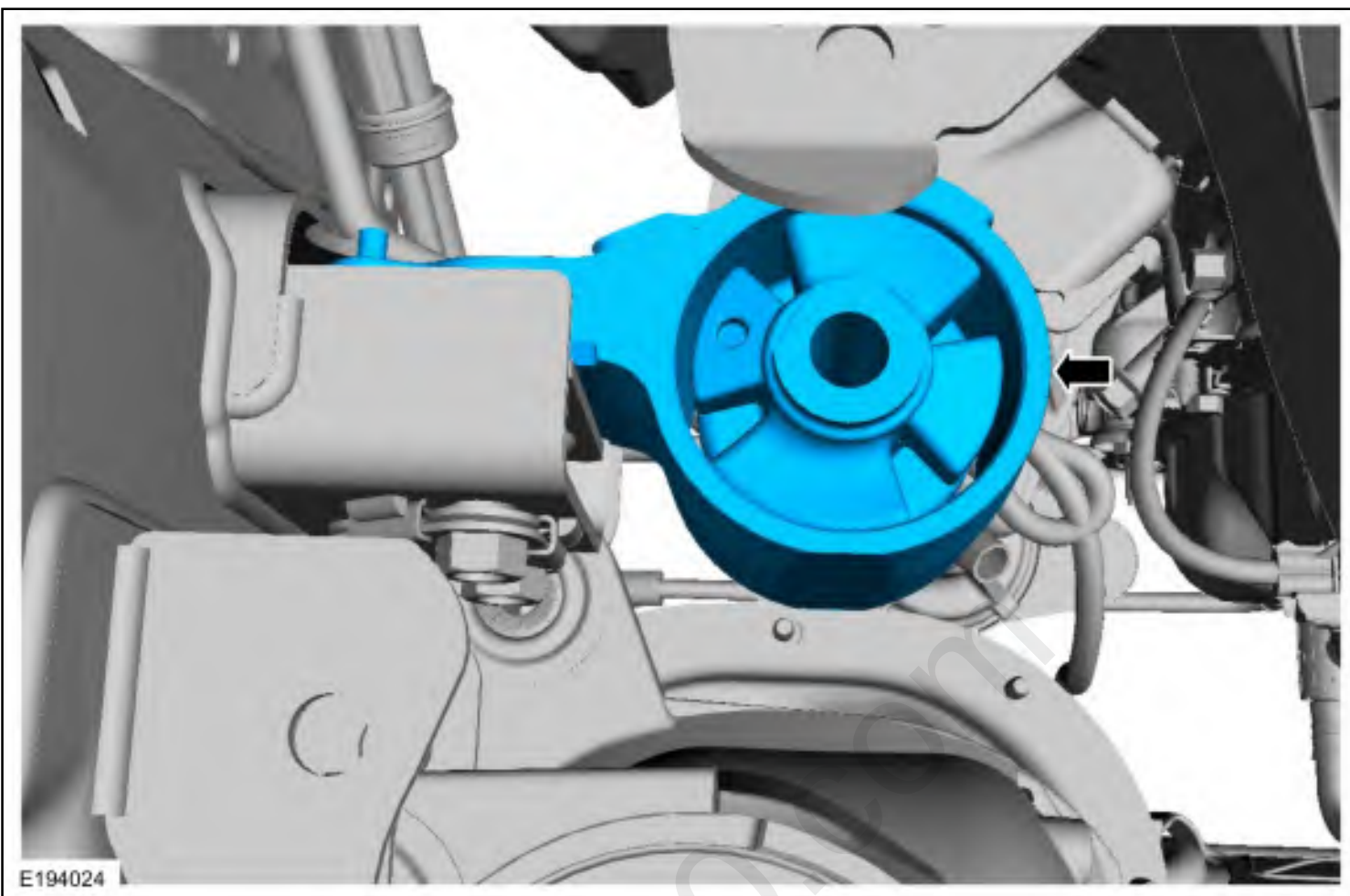
4x2/4x4

21. **NOTICE:** Only use hand tools when removing or installing the engine mount-to-frame bolts or damage to the engine mount-to-frame nut plate can occur.

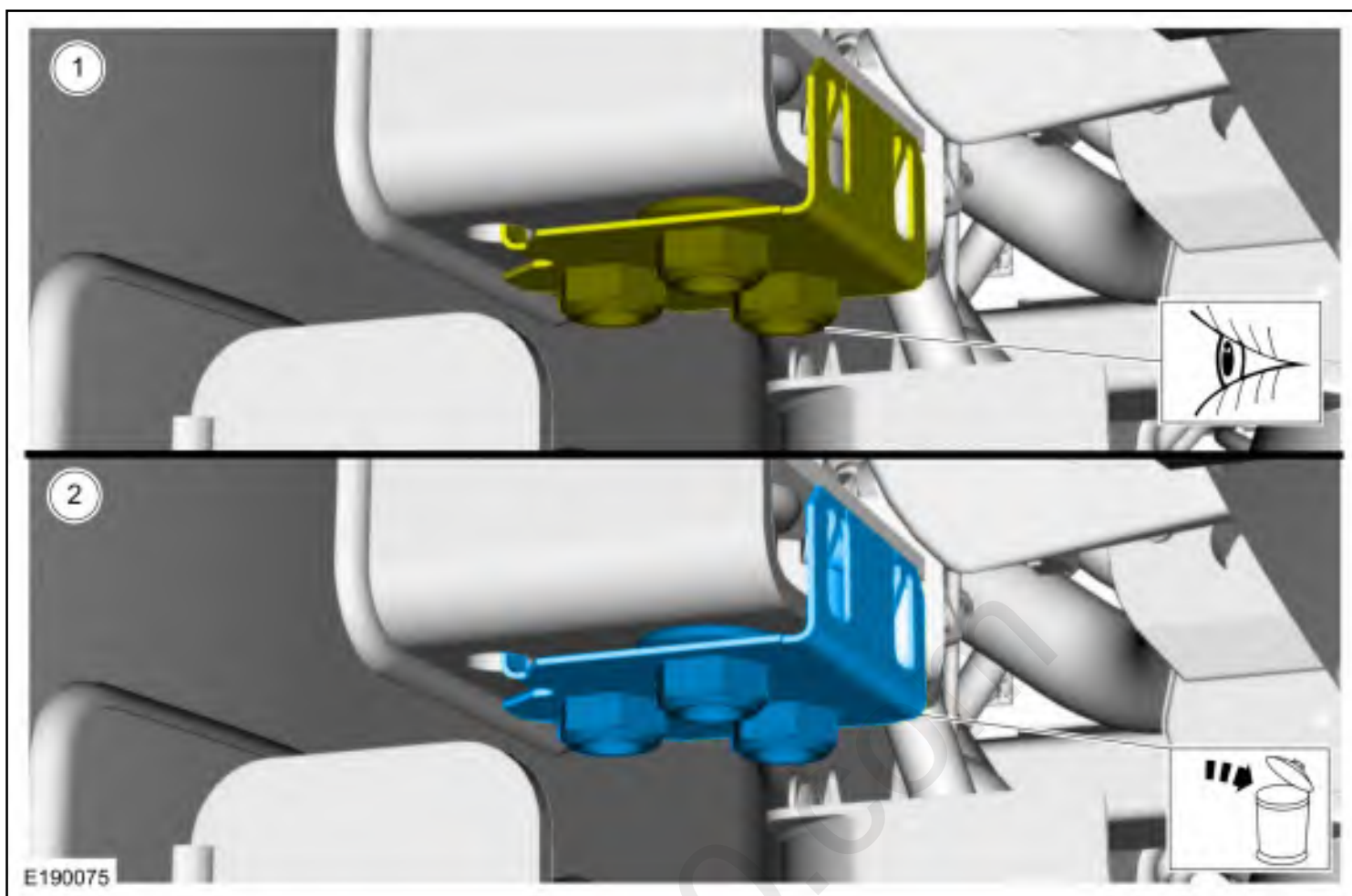
Remove and discard the LH engine mount-to-frame bolts.



22. Remove the LH engine mount.

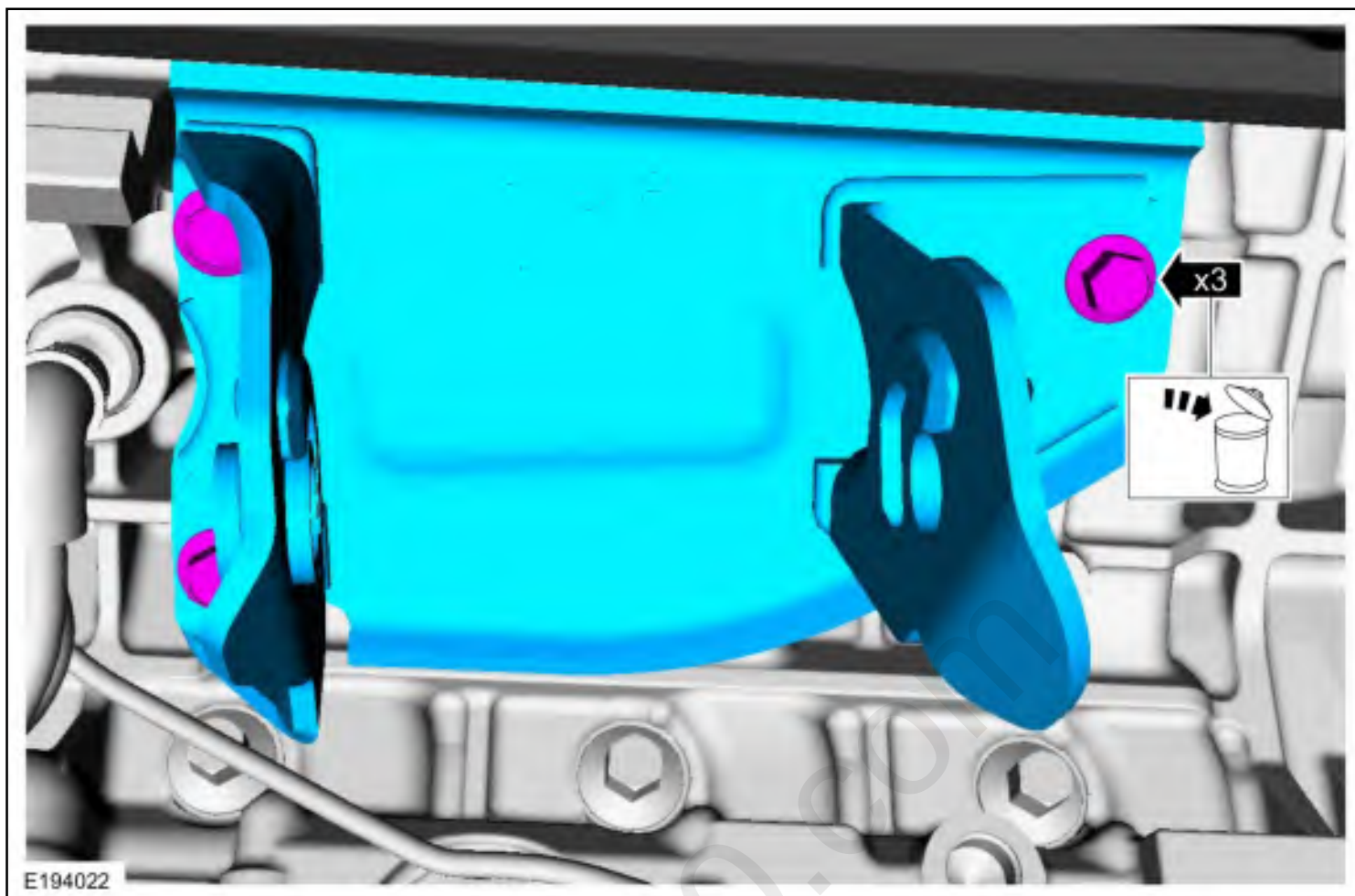


1. Inspect the engine mount-to-frame nut plate for thread damage.
2. If the nut plate is damaged, remove and discard the engine mount-to-frame nut plate.



24. Remove the bolts and the LH engine mount-to-cylinder block bracket.

- Discard the bolts.
- Clean the engine mount-to-cylinder block and engine mount-to-frame mating surfaces of any dirt or foreign material prior to installation.

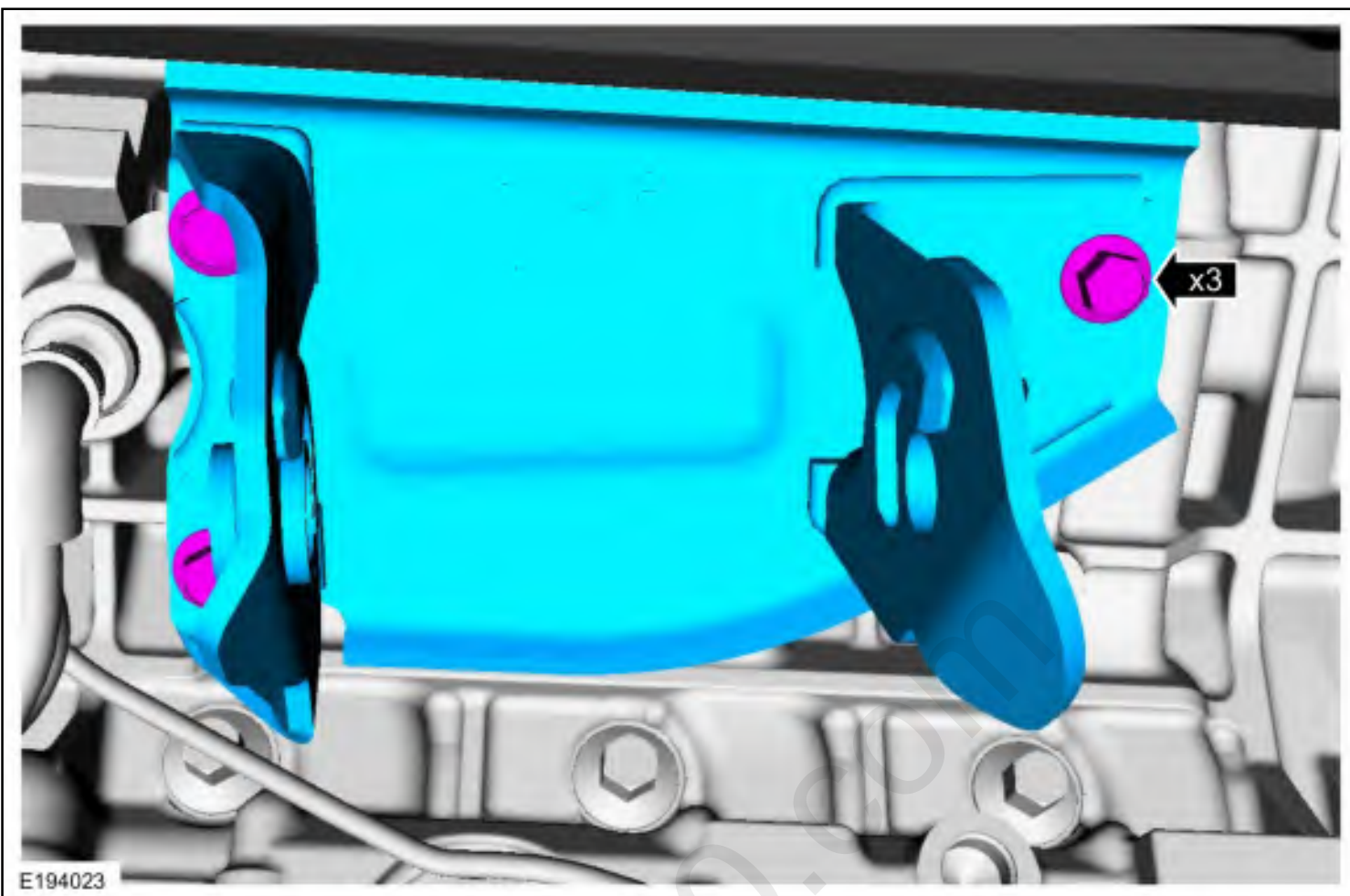


## Installation

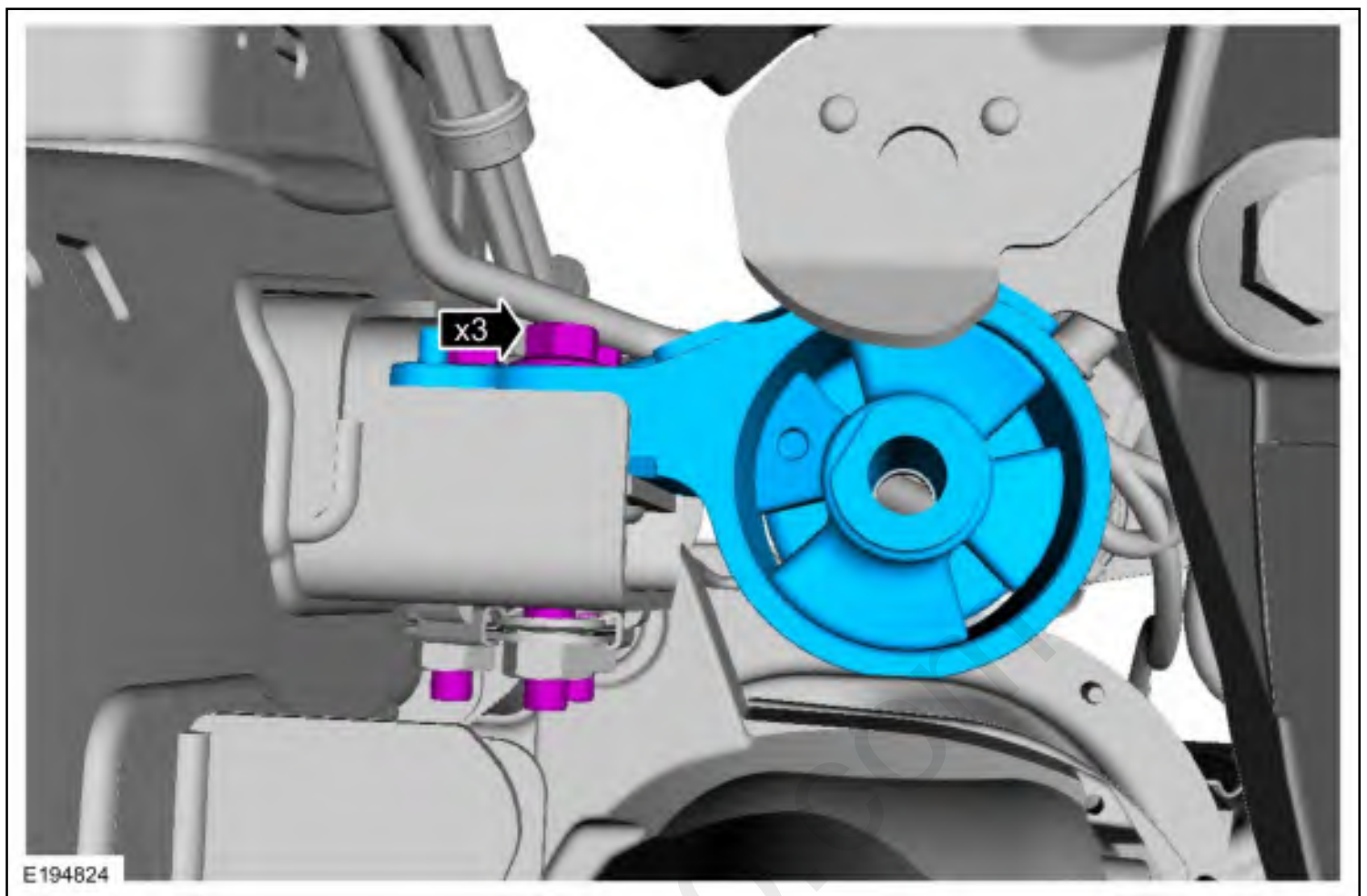
### 4x2/4x4

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



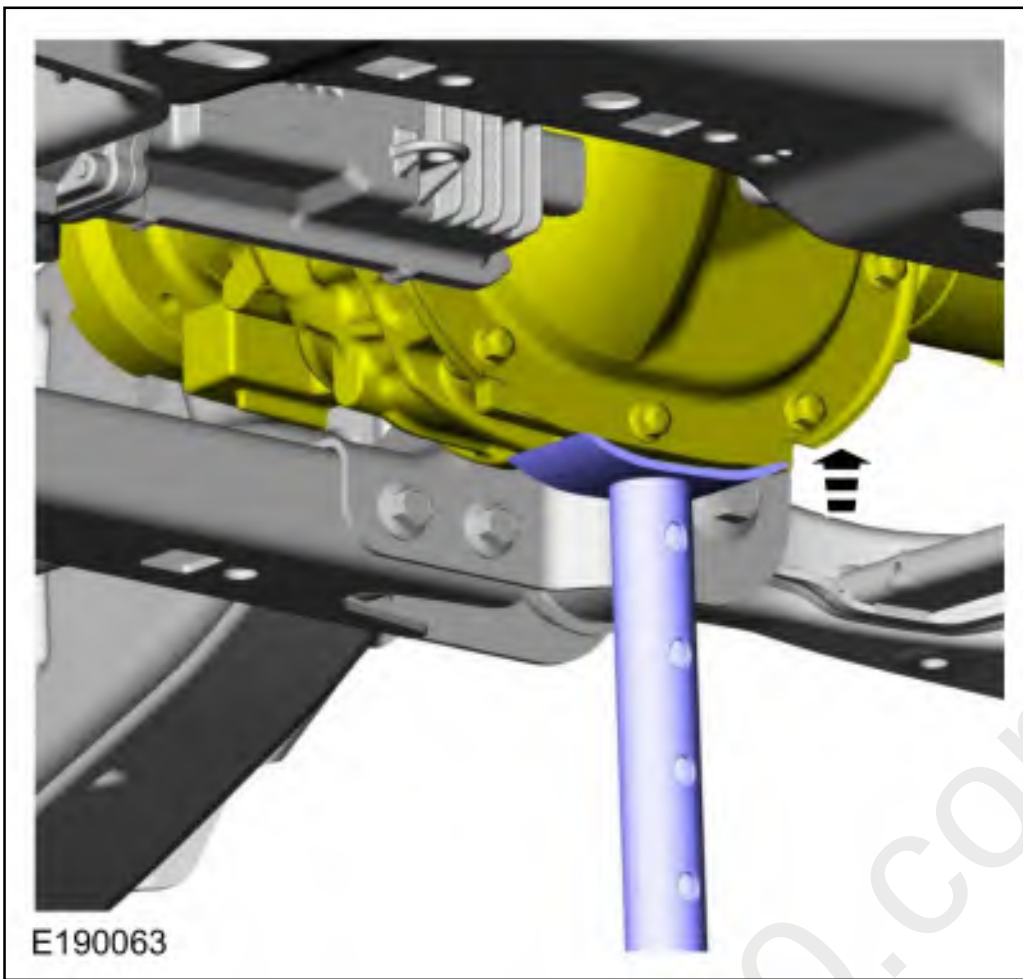


2. Position the LH engine mount and hand start the 3 new engine mount-to-frame bolts.
  - Do not tighten at this time.

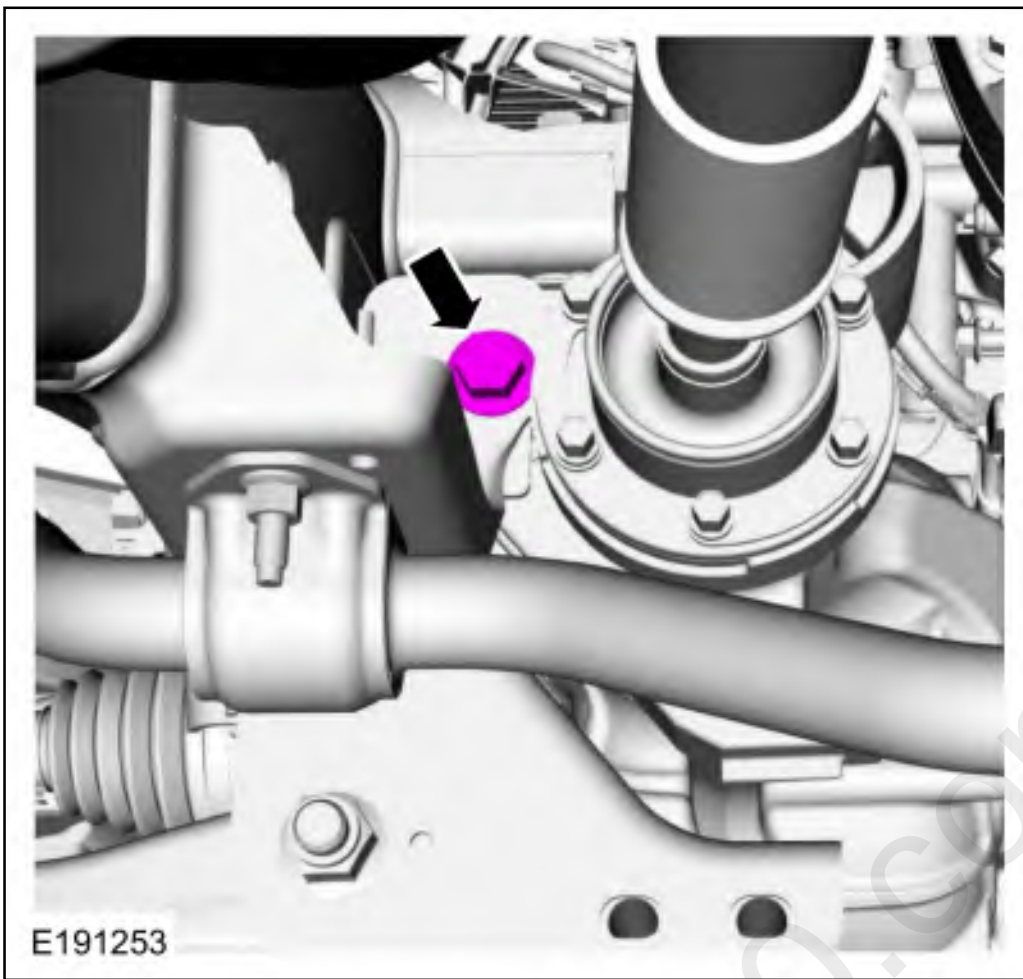


**4x4**

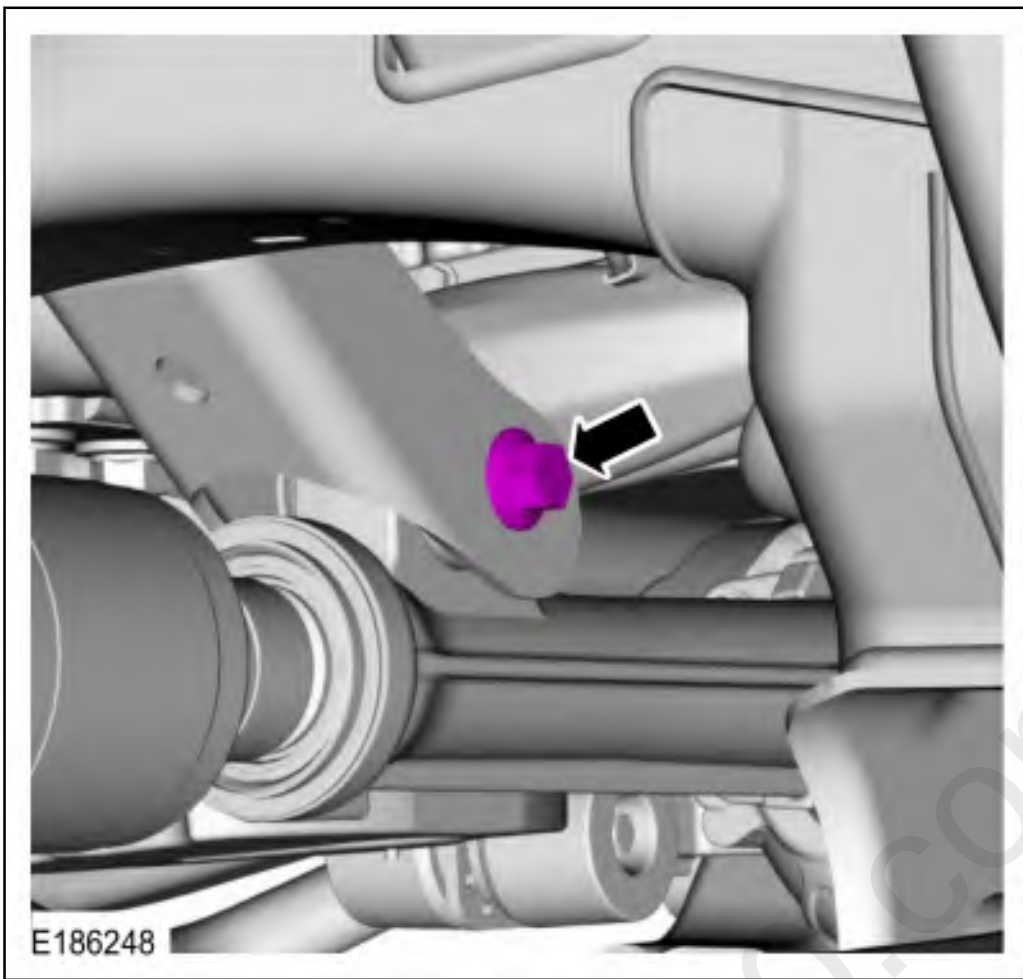
3. Using an adjustable stand, raise the front axle carrier into position.  
Use the General Equipment: Vehicle/Axle Stands



4. Install the lower front axle carrier mounting bushing bolt.  
*Torque: 85 lb.ft (115 Nm)*

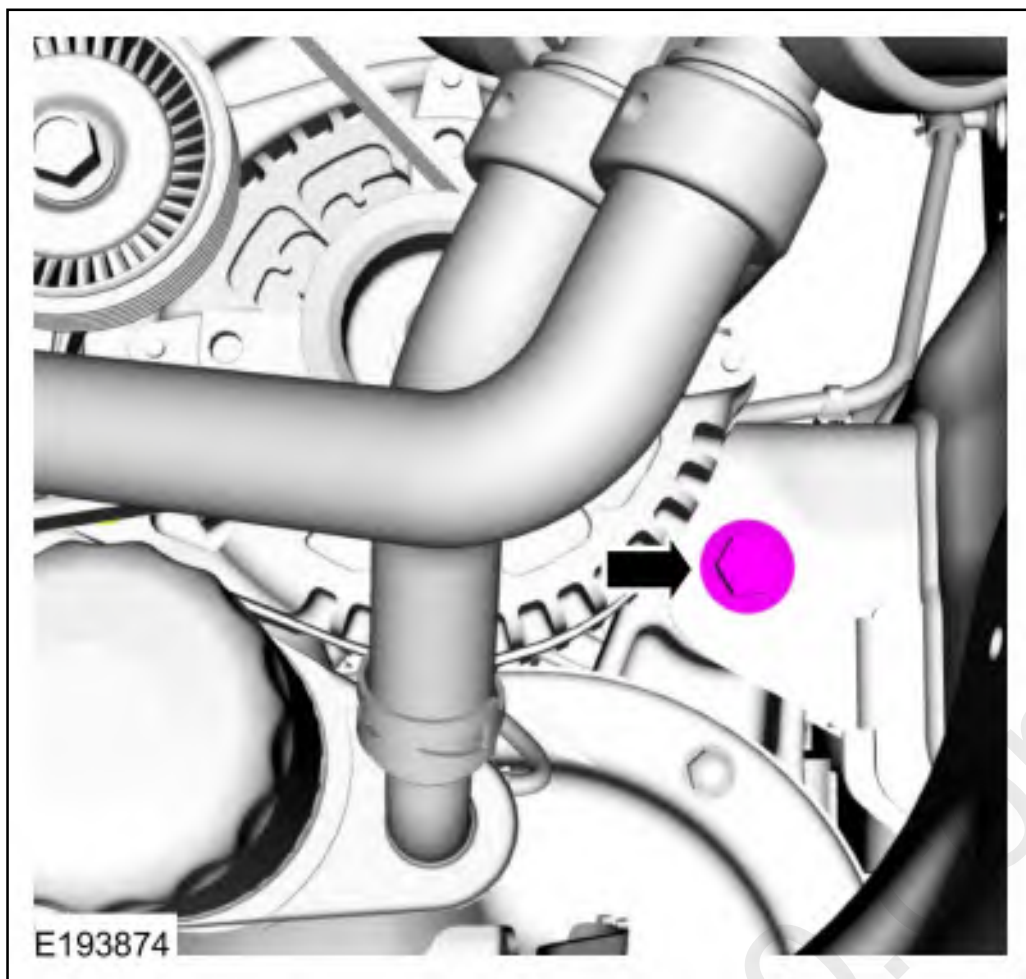


5. Install the axle shaft housing carrier bushing bolt.  
*Torque: 85 lb.ft (115 Nm)*

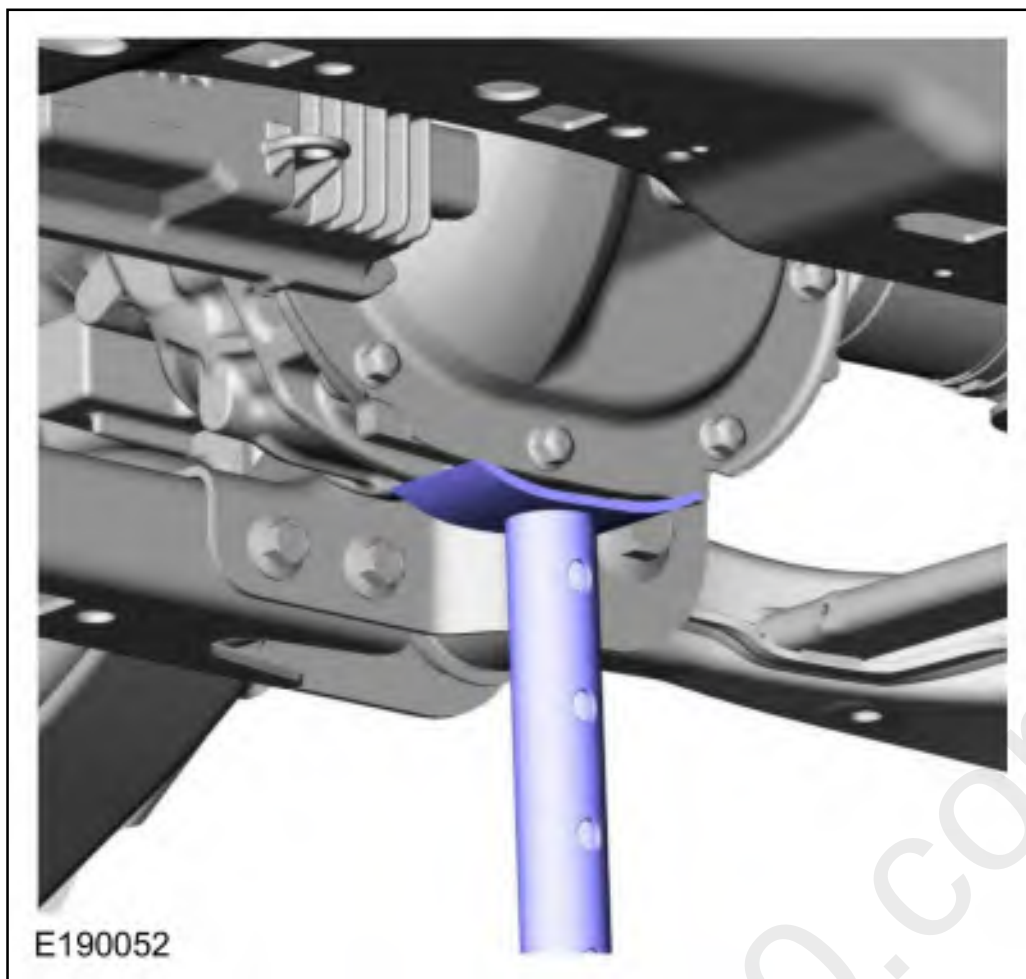


6. Install the upper front axle carrier mounting bushing bolt.  
*Torque: 85 lb.ft (115 Nm)*



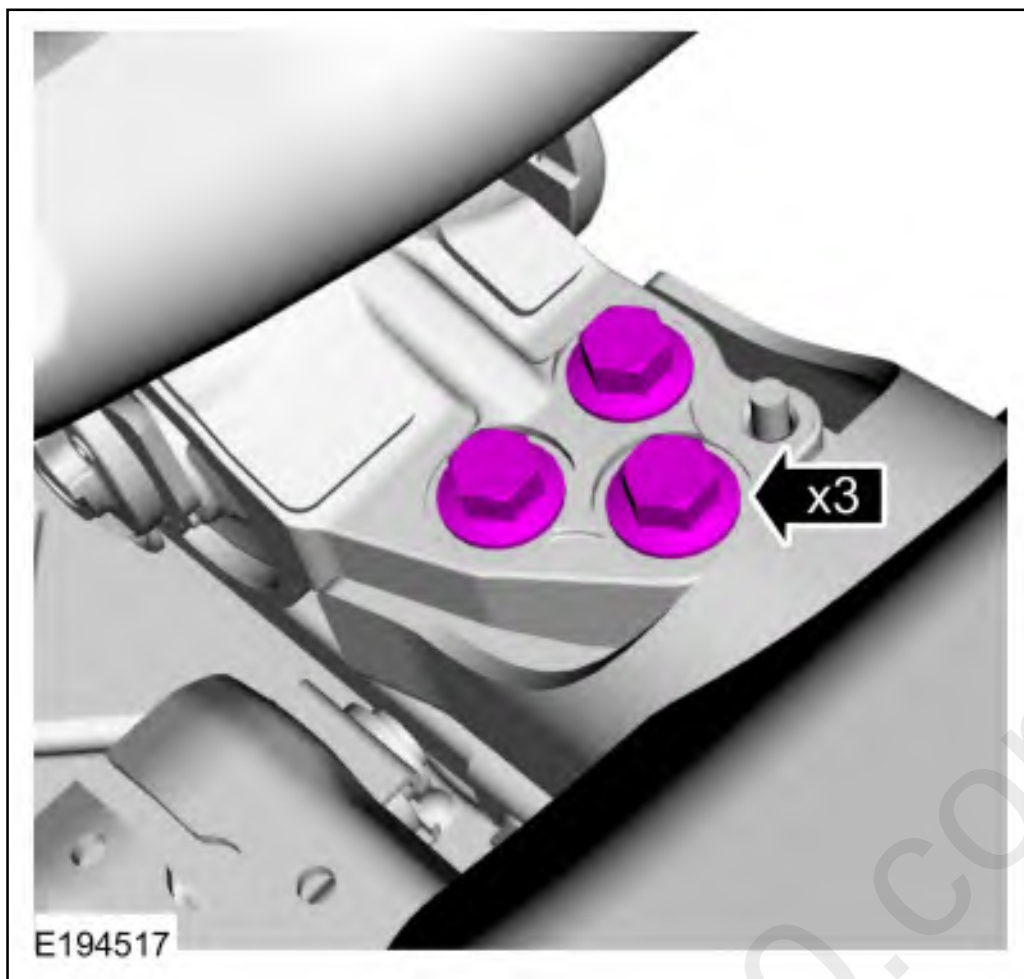


7. Remove the adjustable stand.  
Use the General Equipment: Vehicle/Axle Stands

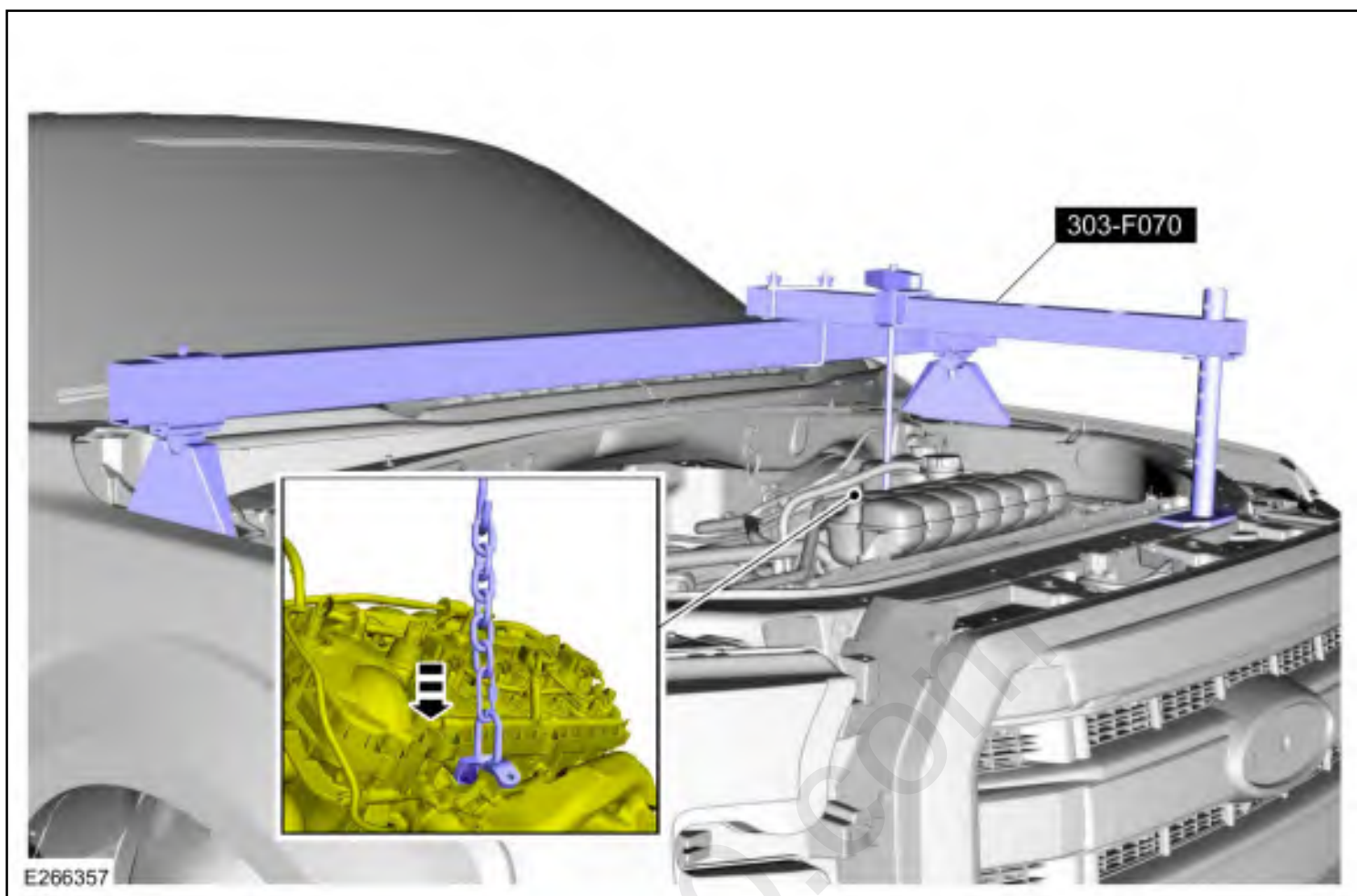


**4x2/4x4**

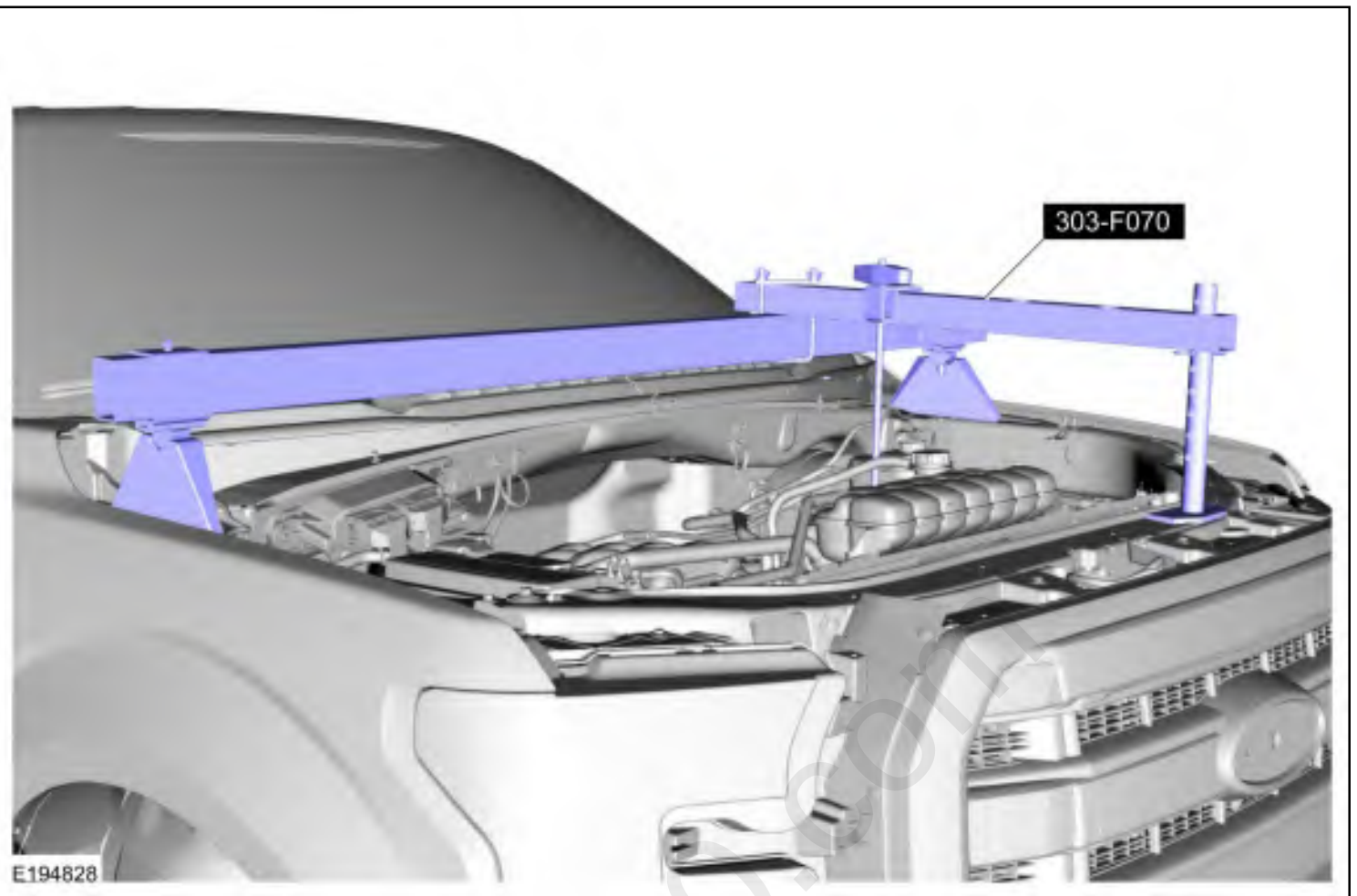
8. Tighten the LH engine mount bolts  
*Torque: 129 lb.ft (175 Nm)*



9. Using the special tool, lower the engine to the installed position.  
Use Special Service Tool: 303-F070 Support Bar, Engine.

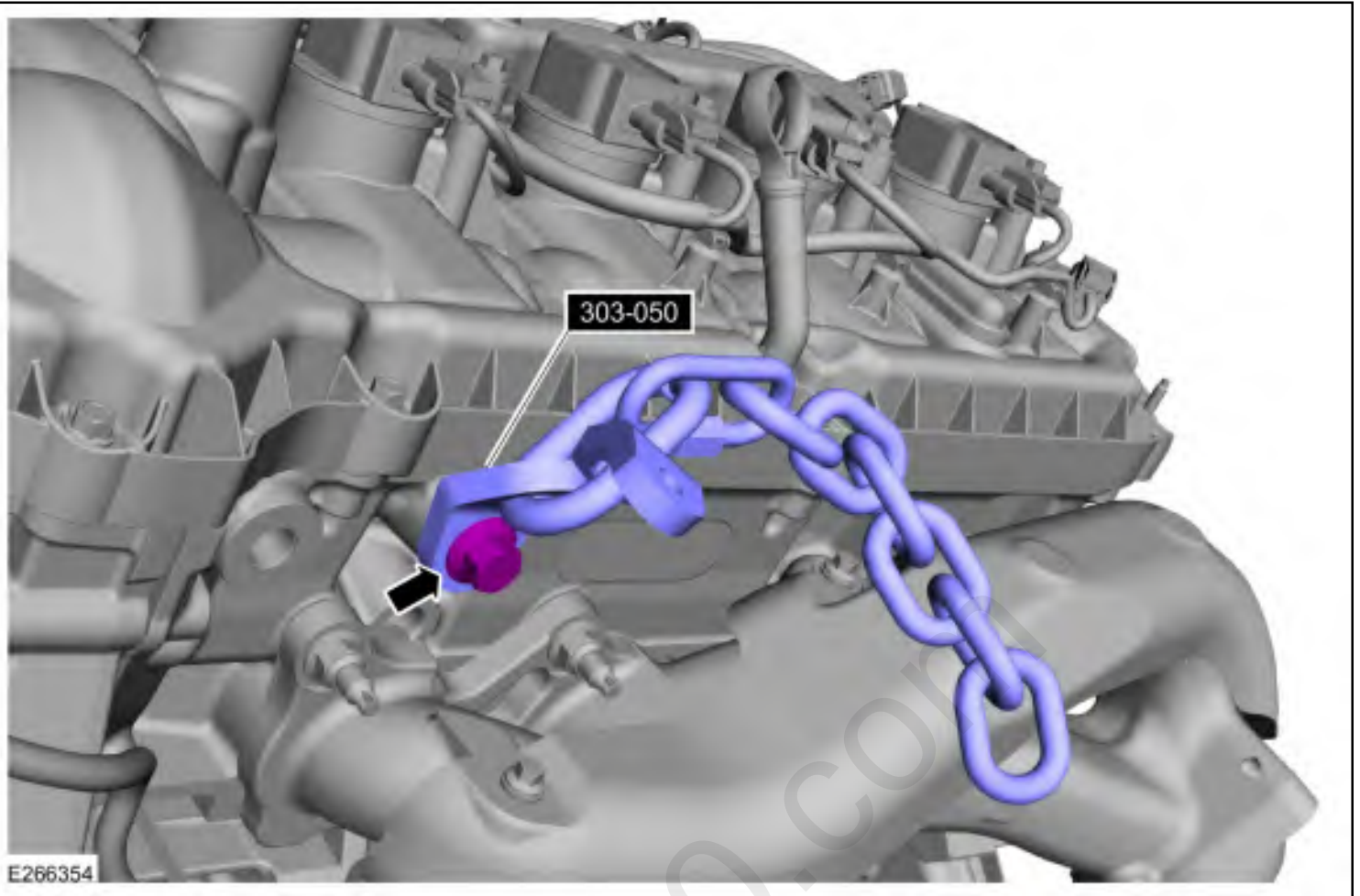


10. Remove Special Service Tool: 303-F070 Support Bar, Engine.



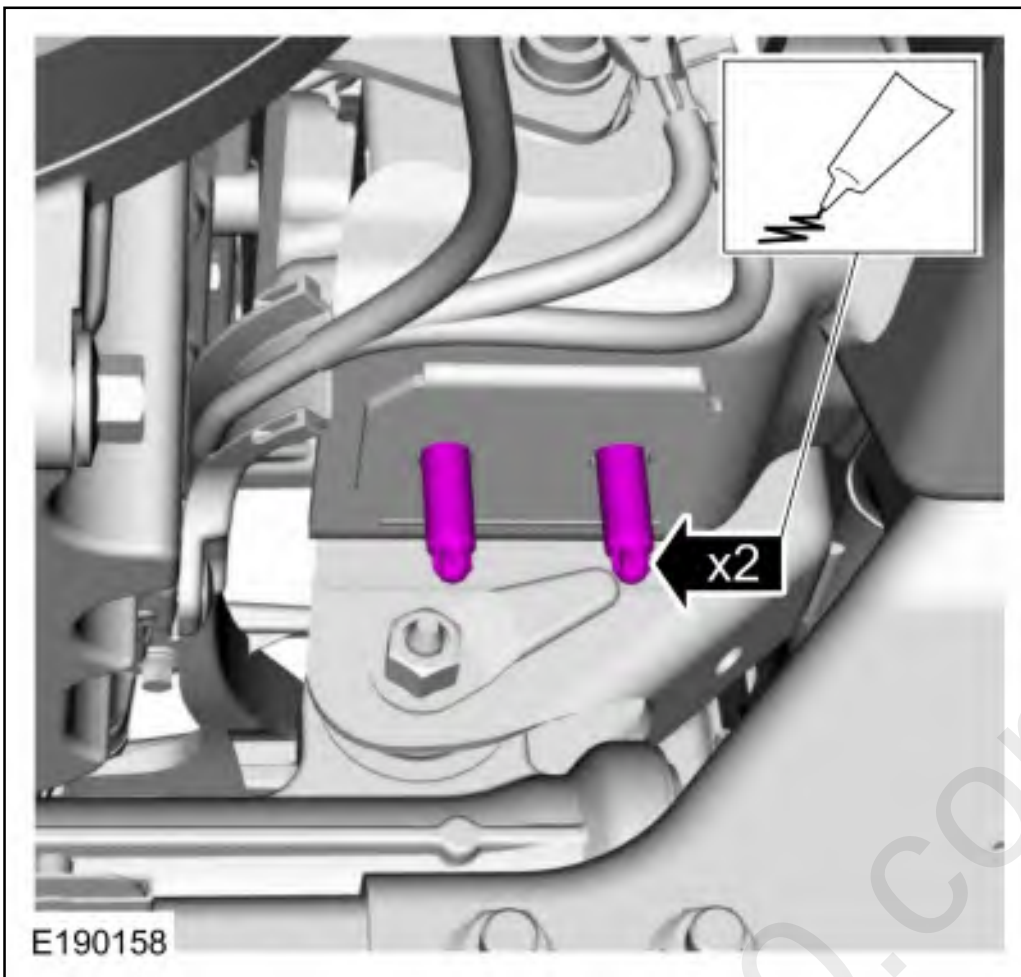
11. Remove the special tool and length of chain.  
Use Special Service Tool: 303-050 (T70P-6000) Lifting Bracket, Engine.





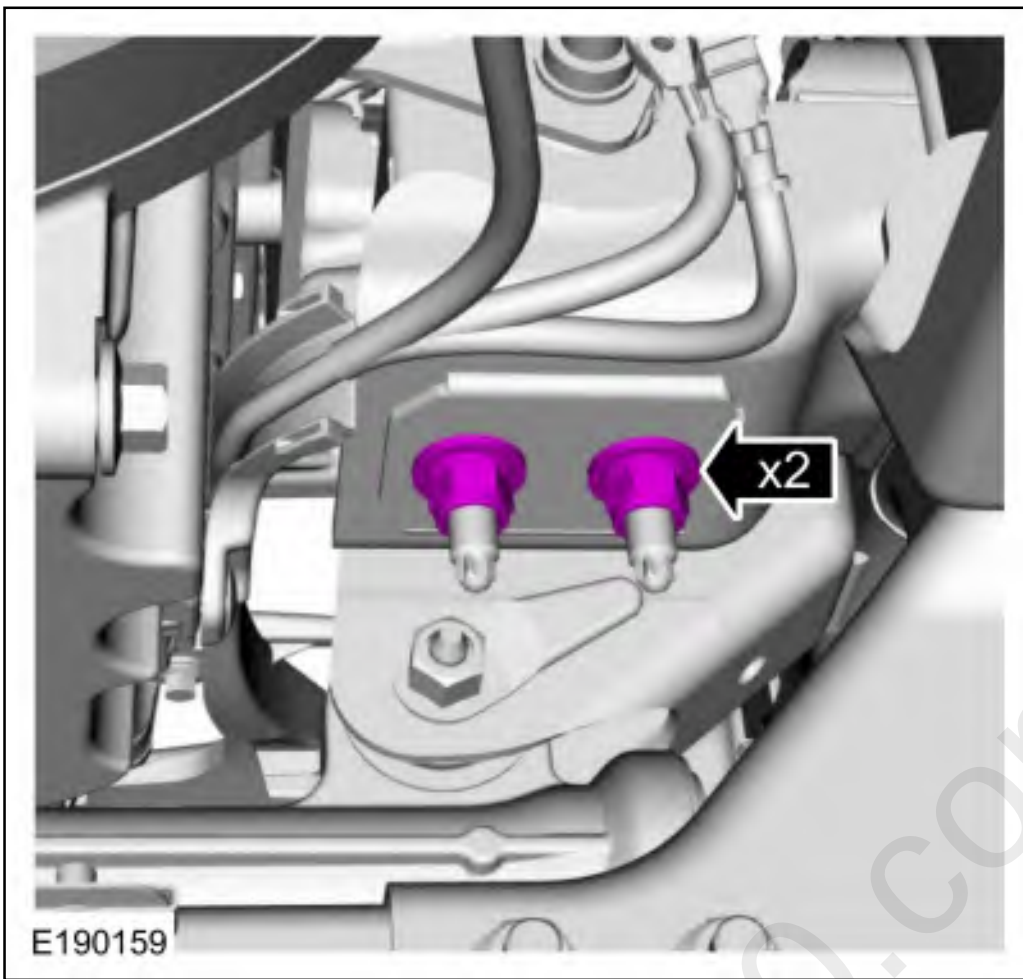
12. **NOTICE:** Only use hand tools when installing the engine mount stud bolts or damage to the engine mount can occur.

Install the new RH engine mount stud bolts.  
*Torque:* 22 lb.ft (30 Nm)



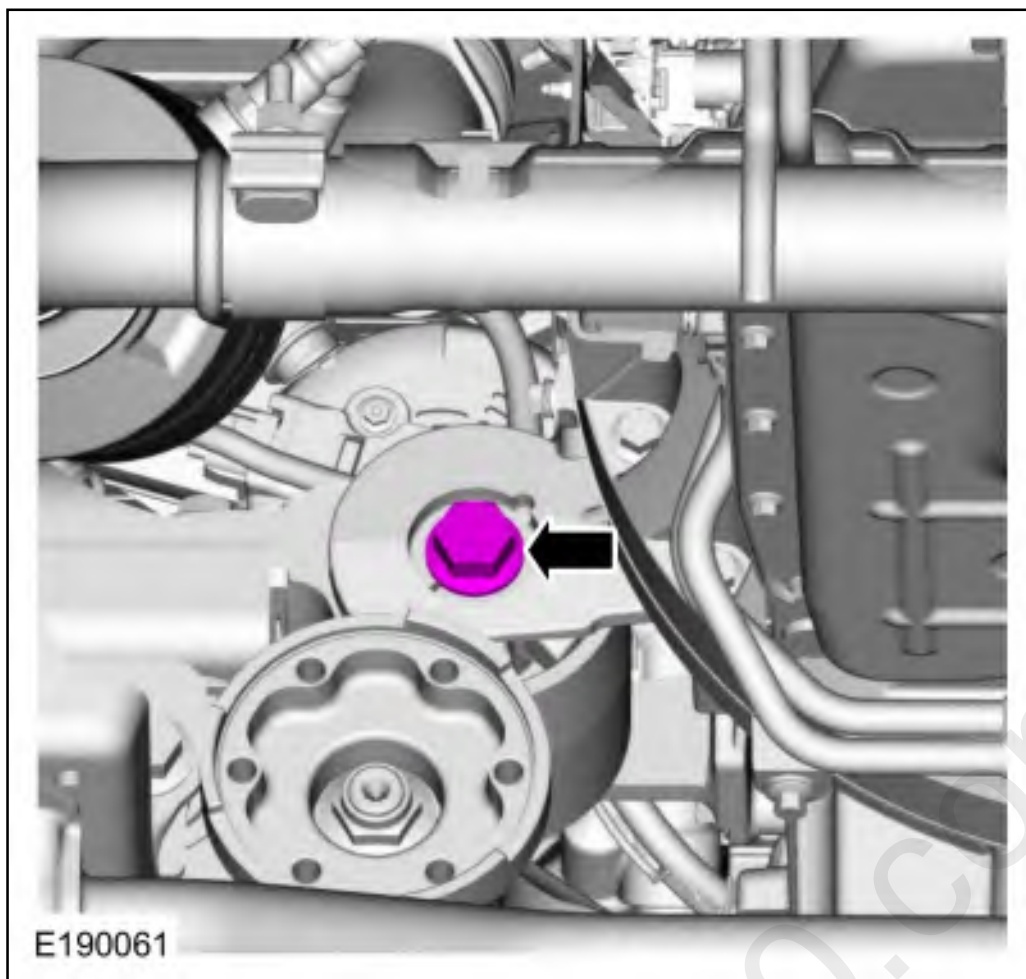
13. **NOTICE:** Only use hand tools when installing the engine mount nuts or damage to the engine mount can occur.

Install the new RH engine mount nuts.  
*Torque:* 111 lb.ft (150 Nm)



14. **NOTICE:** Only use hand tools when tightening the engine mount through bolts or damage to the engine mount-to-cylinder block bracket can occur.

Install the new LH engine mount through bolt.  
*Torque:* 258 lb.ft (350 Nm)



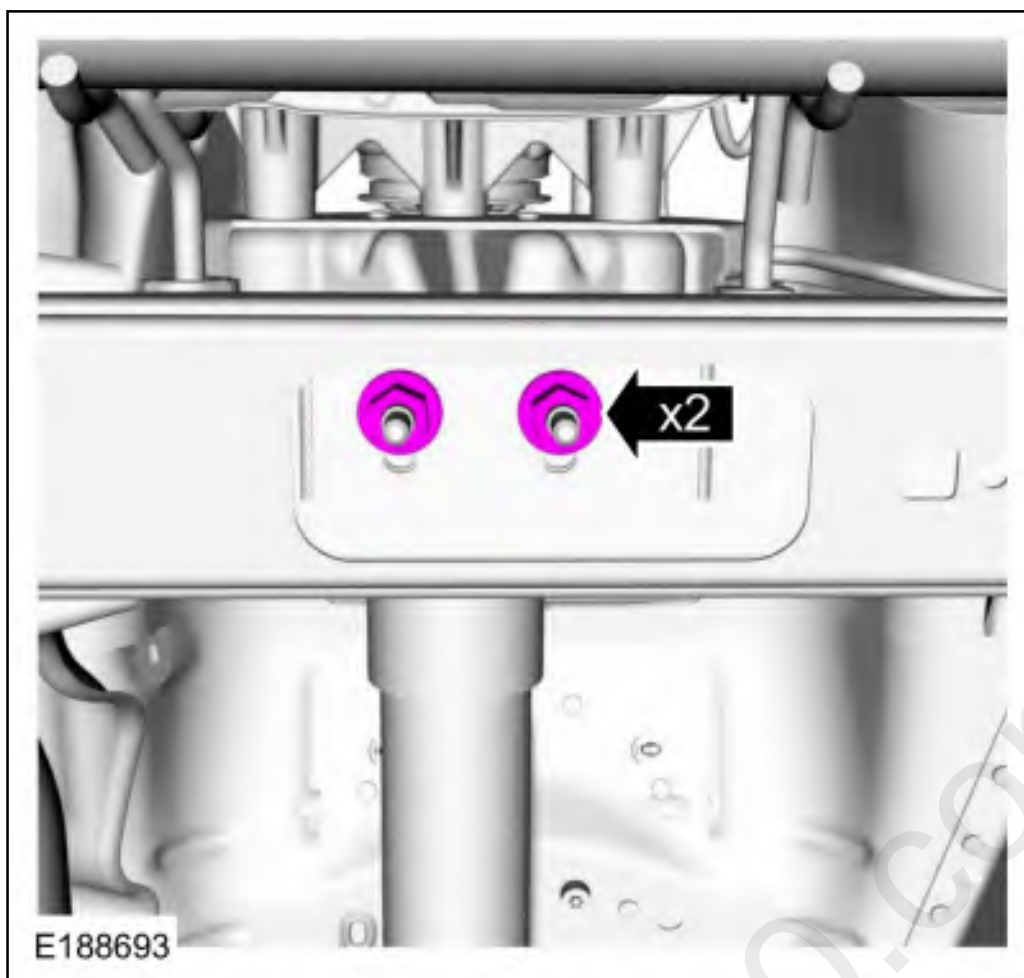
#### 4x4

15. Install the front drive shaft.  
Refer to: [Front Driveshaft](#) (205-01 Driveshaft, Removal and Installation).

#### 4x2/4x4

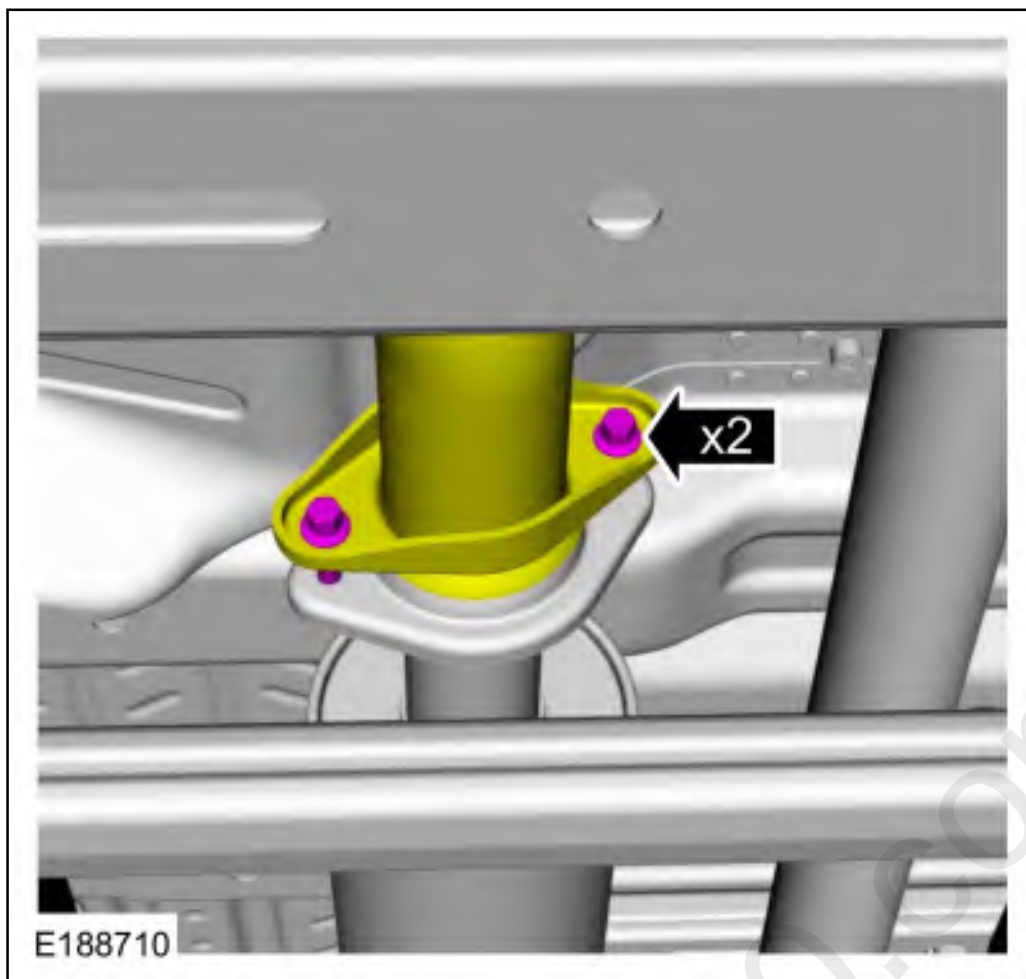
16. **NOTICE: Only use hand tools when installing the transmission mount-to-crossmember nuts or damage to the transmission mount can occur.**

Tighten the transmission mount-to-crossmember nuts.  
*Torque:* 85 lb.ft (115 Nm)



- Position the exhaust Y-pipe dual catalytic converter-to-exhaust intermediate pipe and install the new bolts.
- Tighten the inner exhaust Y-pipe dual catalytic converter-to-exhaust intermediate pipe bolt.  
*Torque: 46 lb.ft (63 Nm)*
- Tighten the outer exhaust Y-pipe dual catalytic converter-to-exhaust intermediate pipe bolt.  
*Torque: 46 lb.ft (63 Nm)*

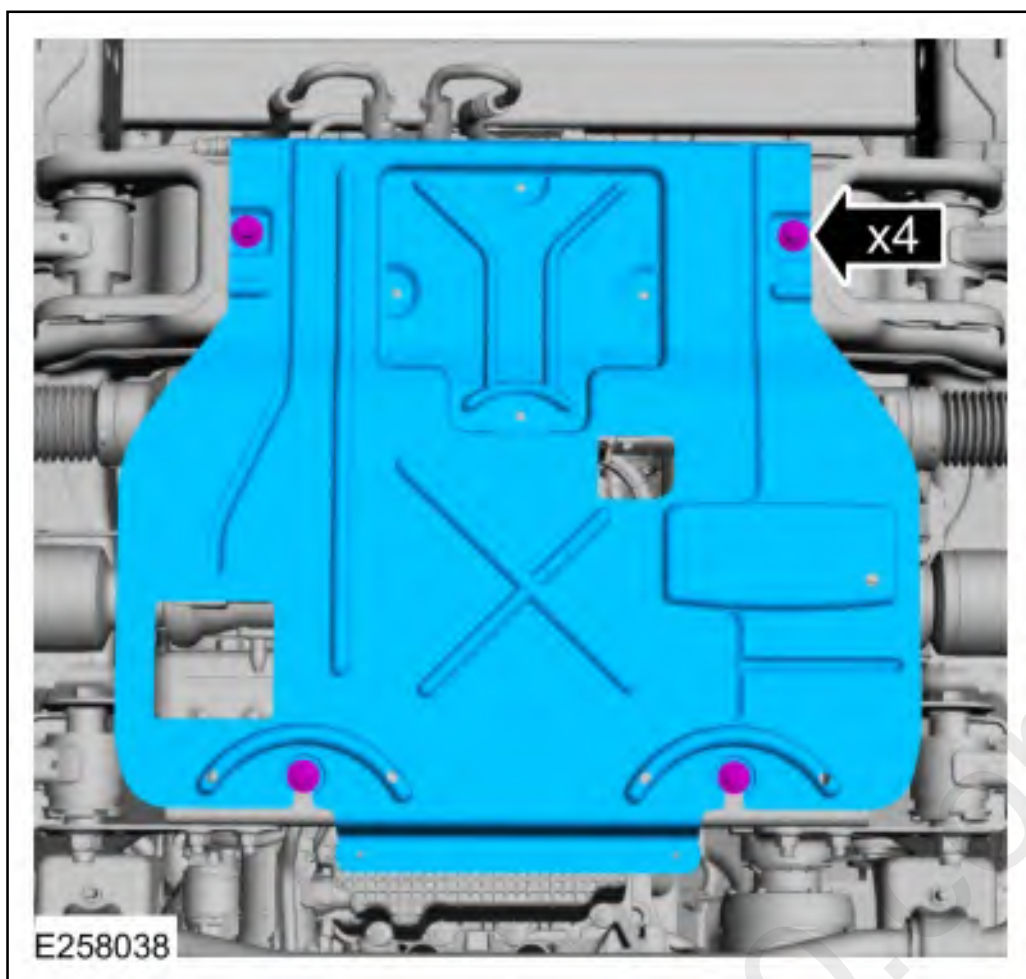




18. **NOTE:** *If equipped.*

Install the skid plate and bolts.

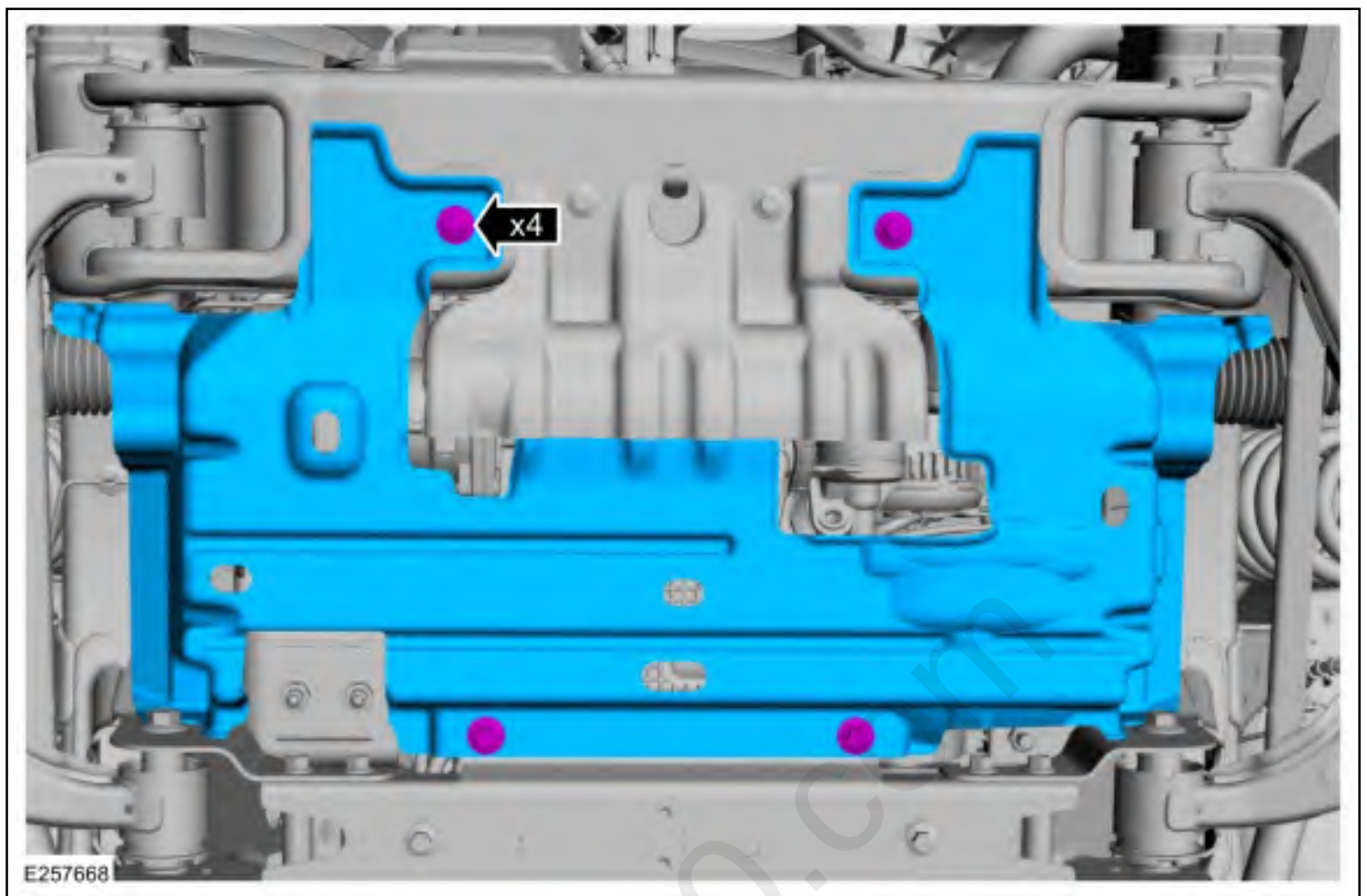
*Torque:* 30 lb.ft (40 Nm)



19. **NOTE:** *If equipped.*

Install the underbody shield and fasteners.

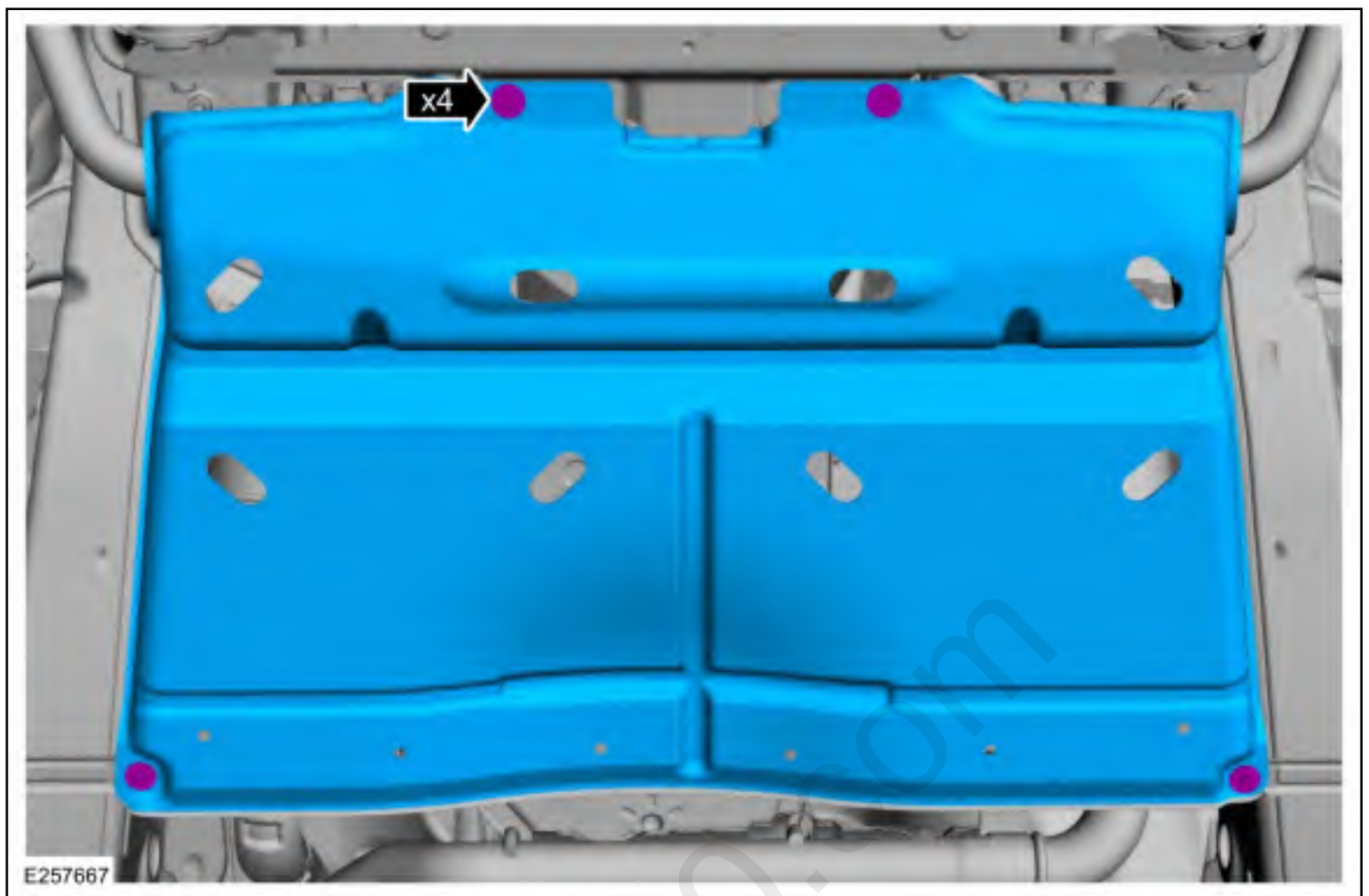
*Torque:* 30 lb.ft (40 Nm)



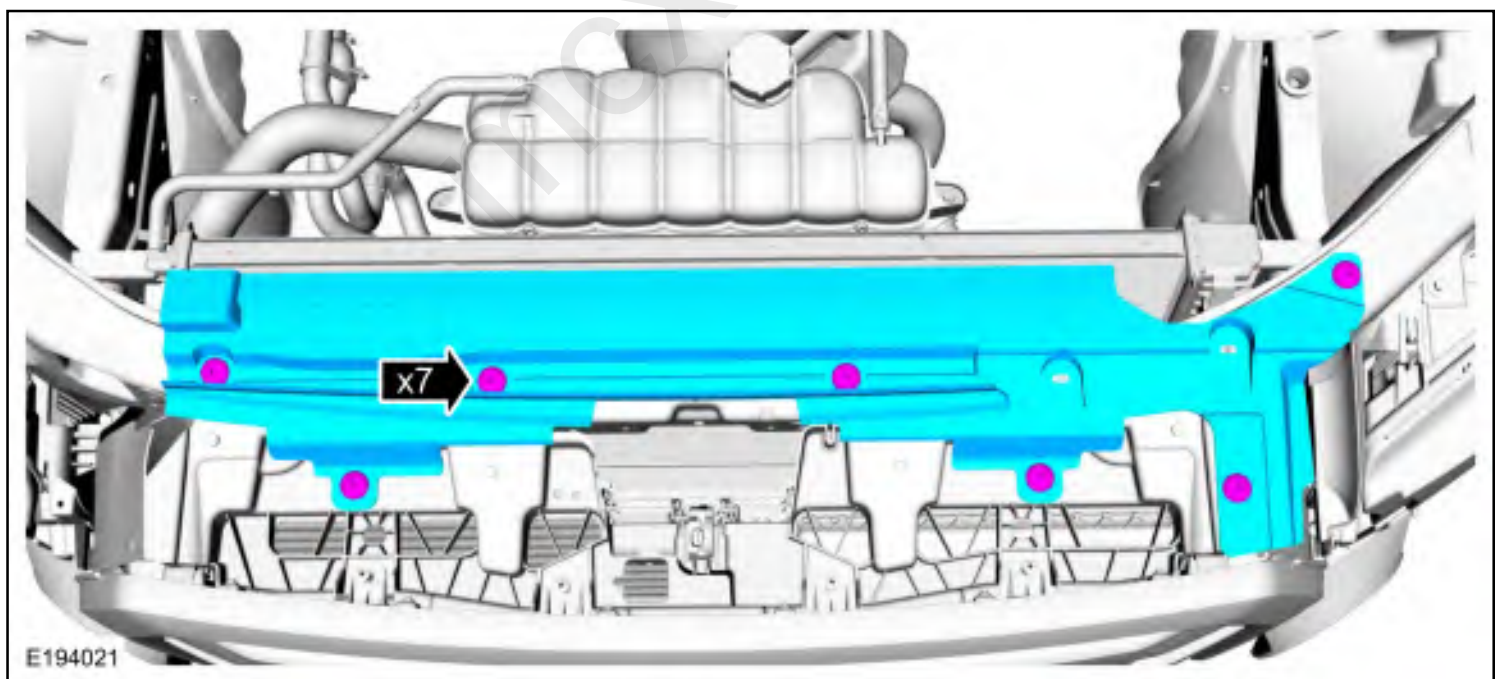
20. **NOTE:** *If equipped.*

Install the underbody shield and the bolts.

*Torque: 71 lb.in (8 Nm)*



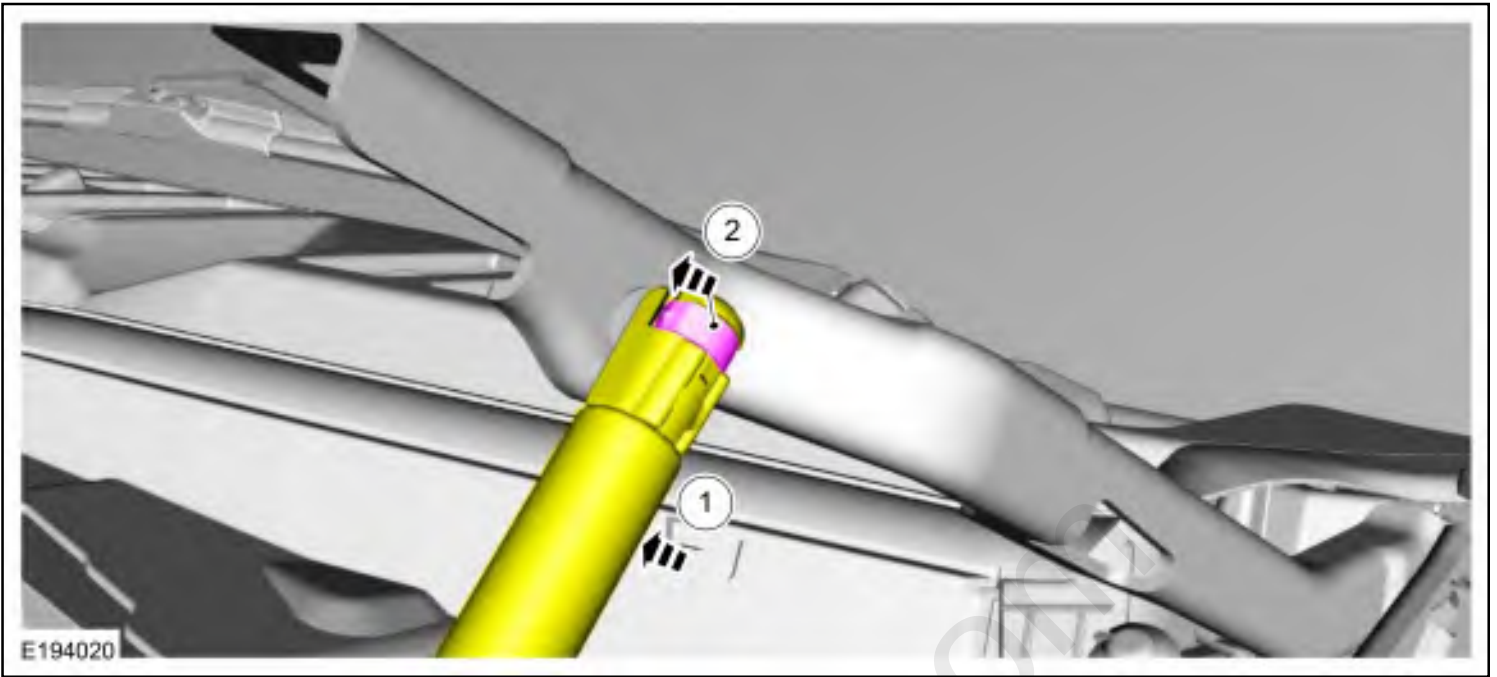
21. Install the radiator top shield and the fasteners.



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



1. Position the hood shock and attach.
2. Install the clip.



23. **NOTE:** *It is not necessary to separate the air cleaner outlet pipe and the air cleaner, the 2 components can be installed as an assembly.*

Install the following items:

1. Refer to: [Air Cleaner](#) (303-12D Intake Air Distribution and Filtering - 5.0L 32V Ti-VCT, Removal and Installation).
2. Refer to: [Air Cleaner Outlet Pipe](#) (303-12D Intake Air Distribution and Filtering - 5.0L 32V Ti-VCT, Removal and Installation).
3. Refer to: [Hood](#) (501-02 Front End Body Panels, Removal and Installation).

24. Start engine and check exhaust system for leaks.



## Engine Mount RH

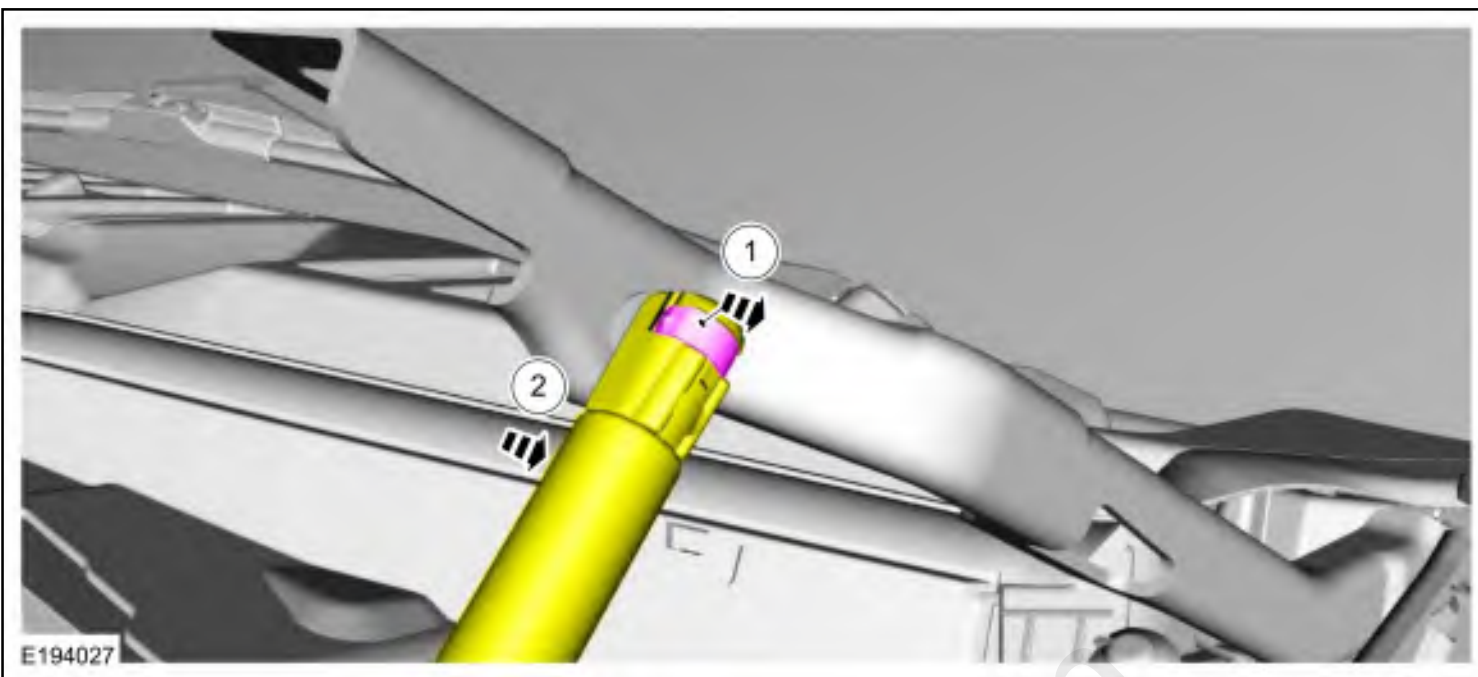
Base Part Number: Base Part Number: 6038

### Special Tool(s) / General Equipment

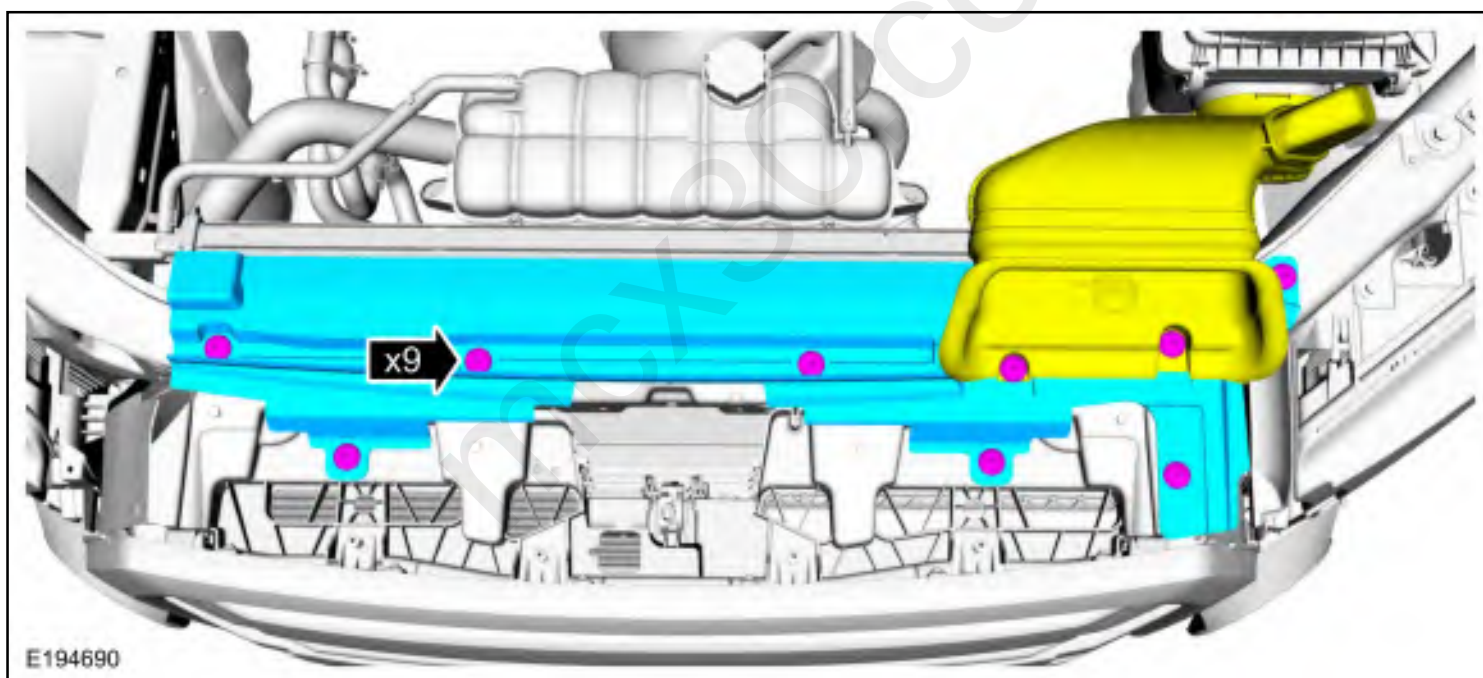
|                                                                                  |                                                                         |
|----------------------------------------------------------------------------------|-------------------------------------------------------------------------|
|  | 303-D099 (D94T-6000-C)<br>Lifting Bracket, Engine                       |
|  | 303-F070<br>Support Bar, Engine<br>TKIT-1999A-F/LT<br>TKIT-1999A-FM/FLM |

### Removal

1. With the vehicle in NEUTRAL, position it on a hoist.  
Refer to: [Jacking and Lifting - Overview](#) (100-02 Jacking and Lifting, Description and Operation).
2. Remove the hood.  
Refer to: [Hood](#) (501-02 Front End Body Panels, Removal and Installation).
3. **NOTE:** *LH shown, RH similar.*
  1. Release the clip.
  2. Detach and position the hood shock aside.

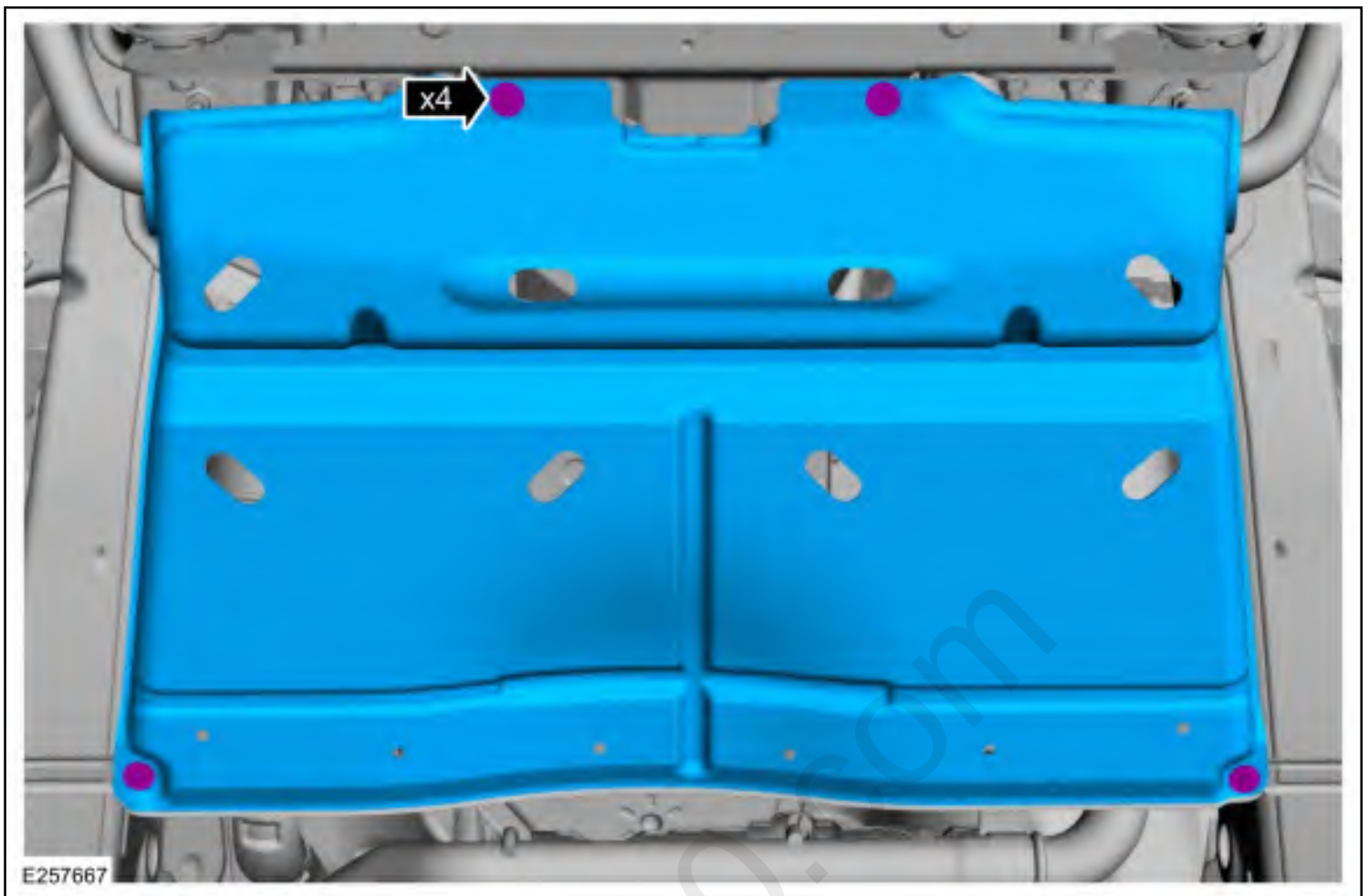


4. Remove the retainers and the radiator top shield.



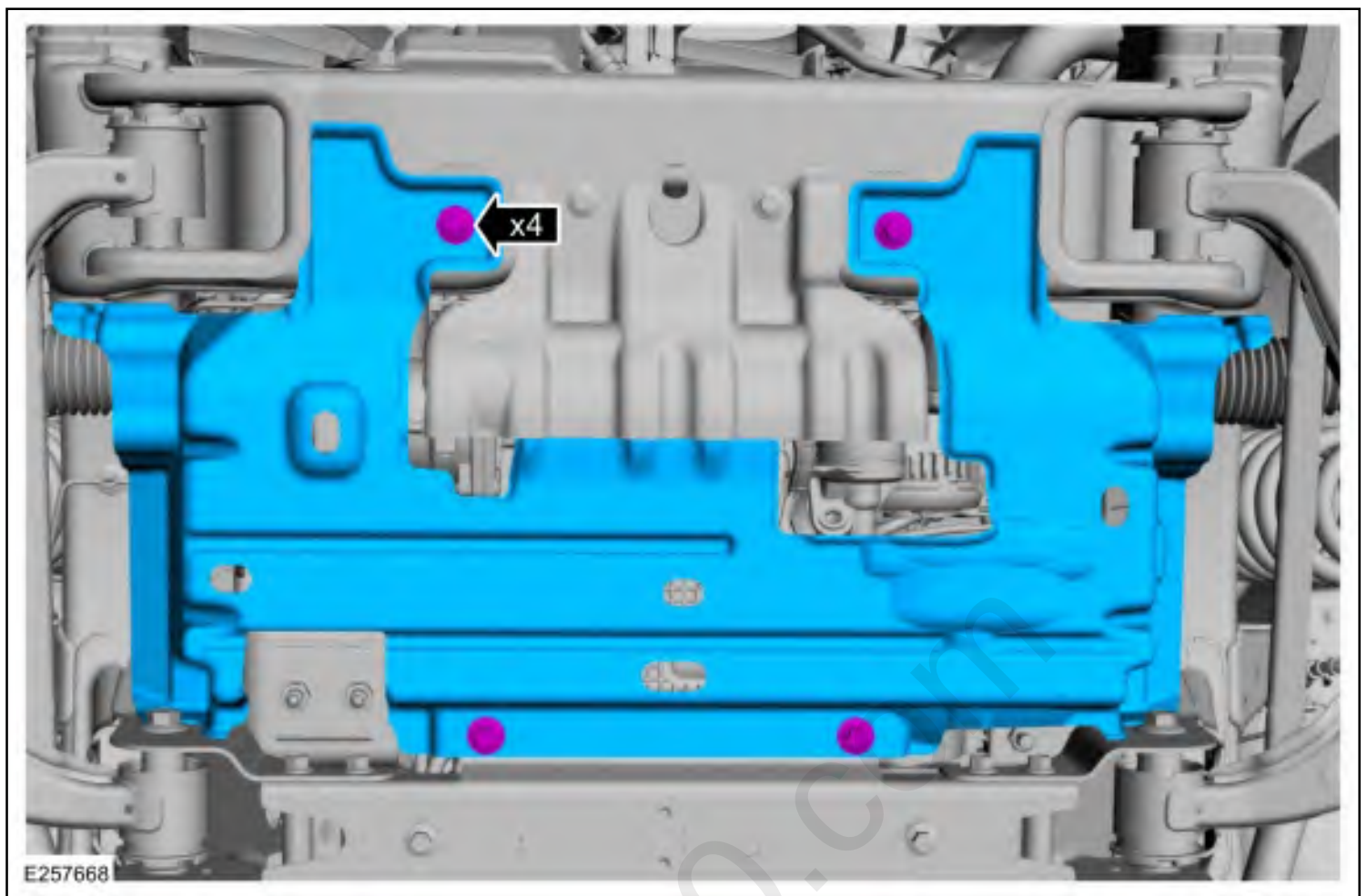
5. **NOTE:** *If equipped.*

Remove the bolts and the underbody shield.



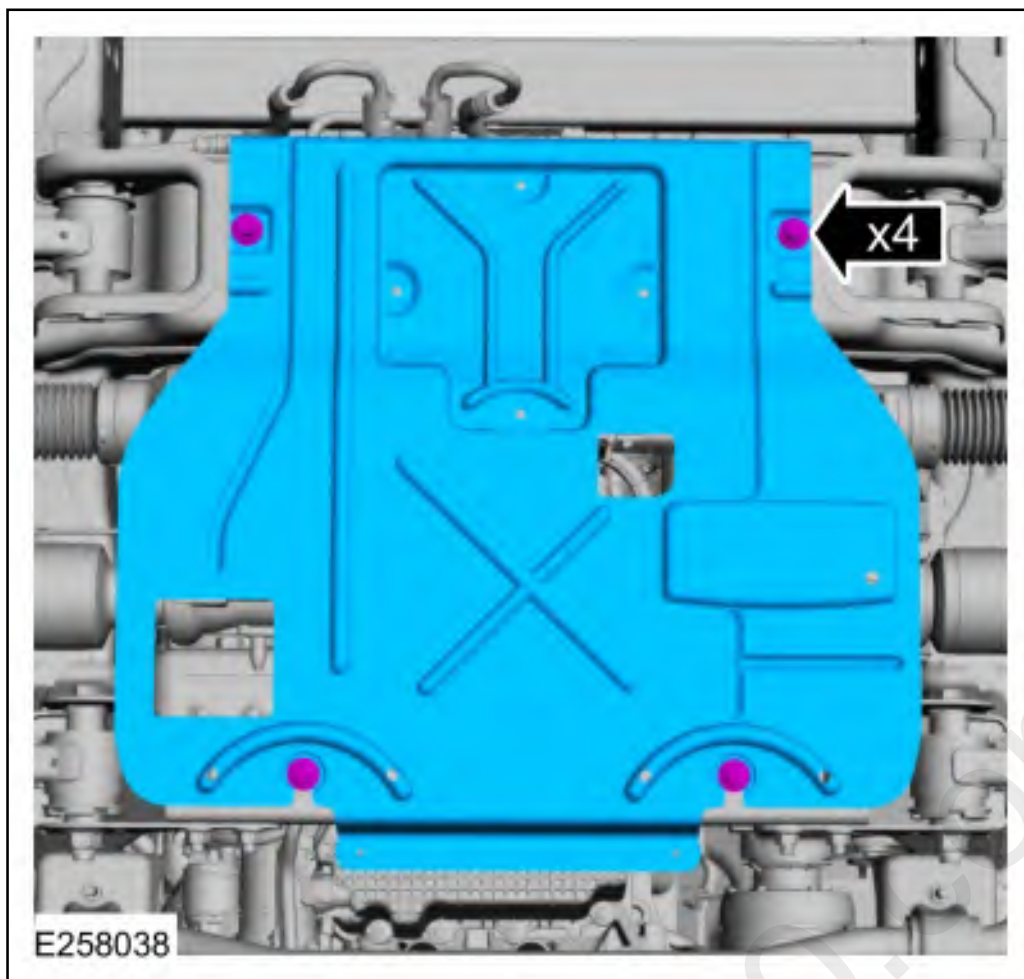
6. **NOTE:** *If equipped.*

Remove the bolts and the underbody shield.



7. **NOTE:** *If equipped.*

Remove the bolts and the skid plate.

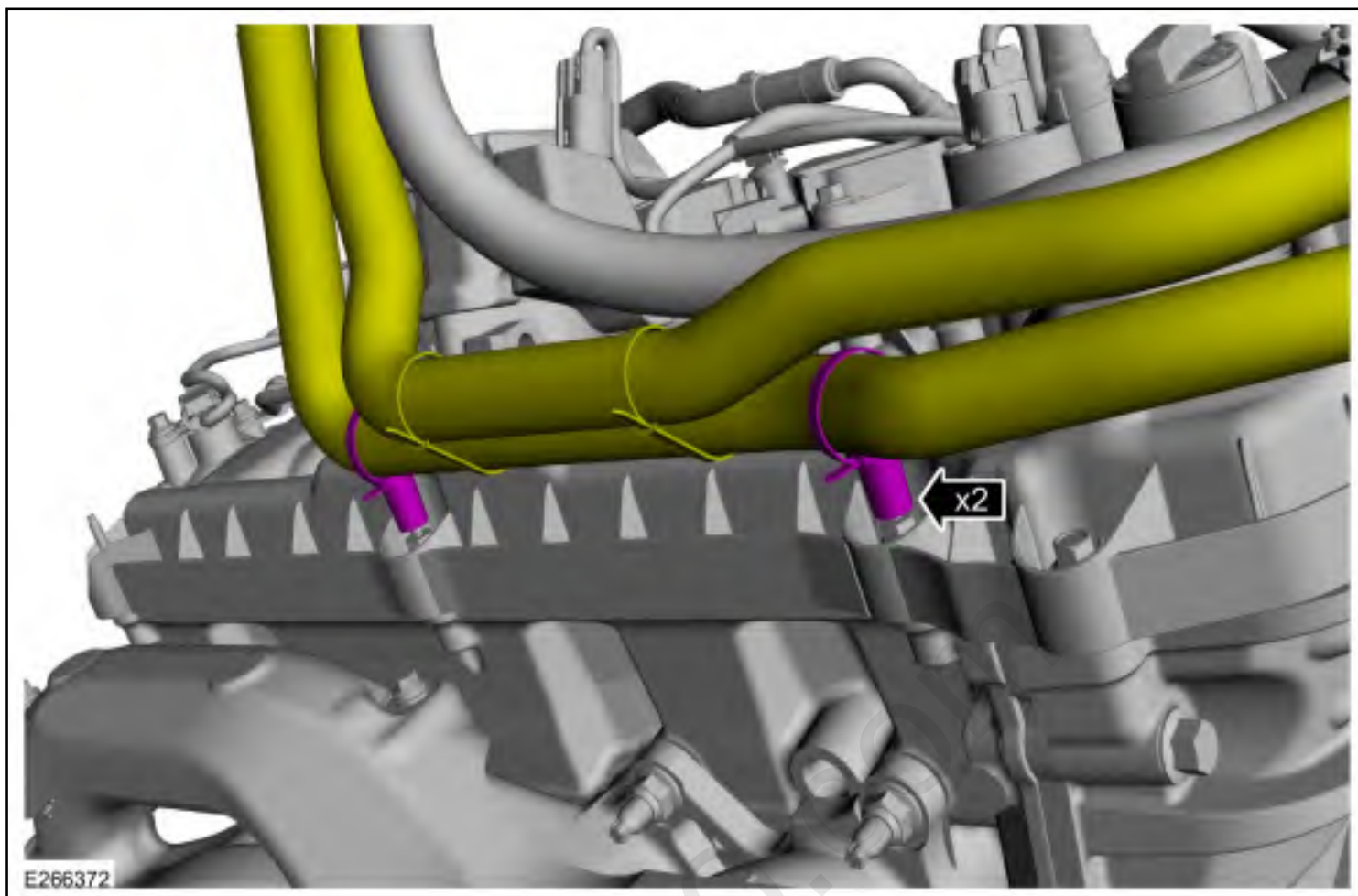


8. Remove the A/C compressor.

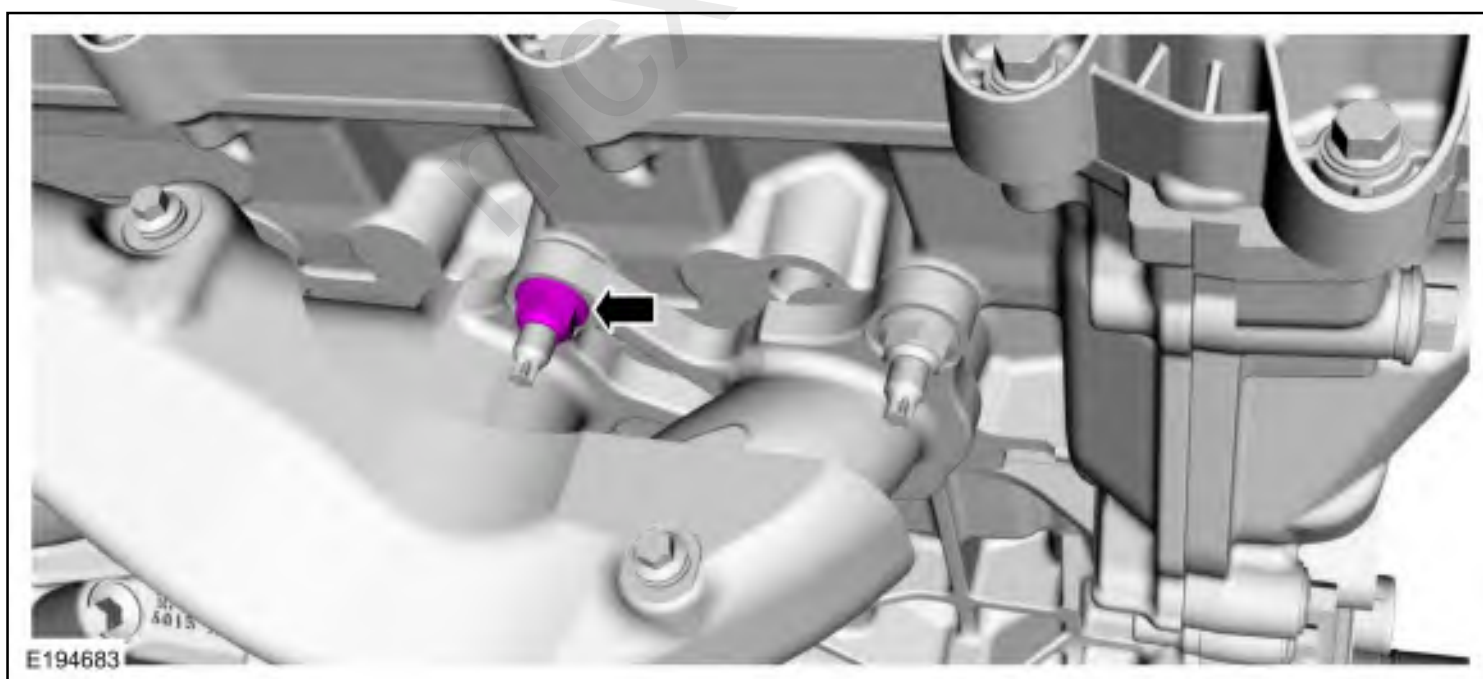
Refer to: Air Conditioning (A/C) Compressor - 5.0L 32V Ti-VCT (412-00 Climate Control System - General Information) .

9. Detach the heater hose retainers.

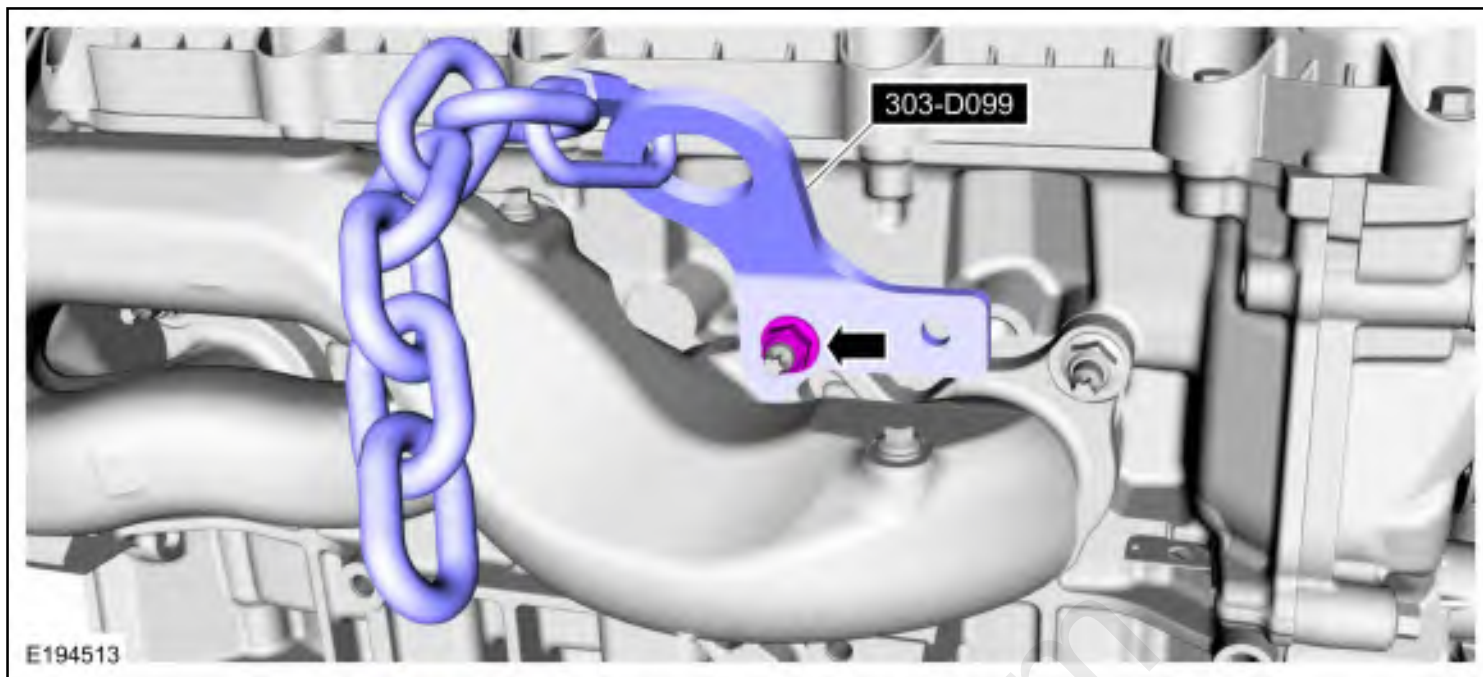




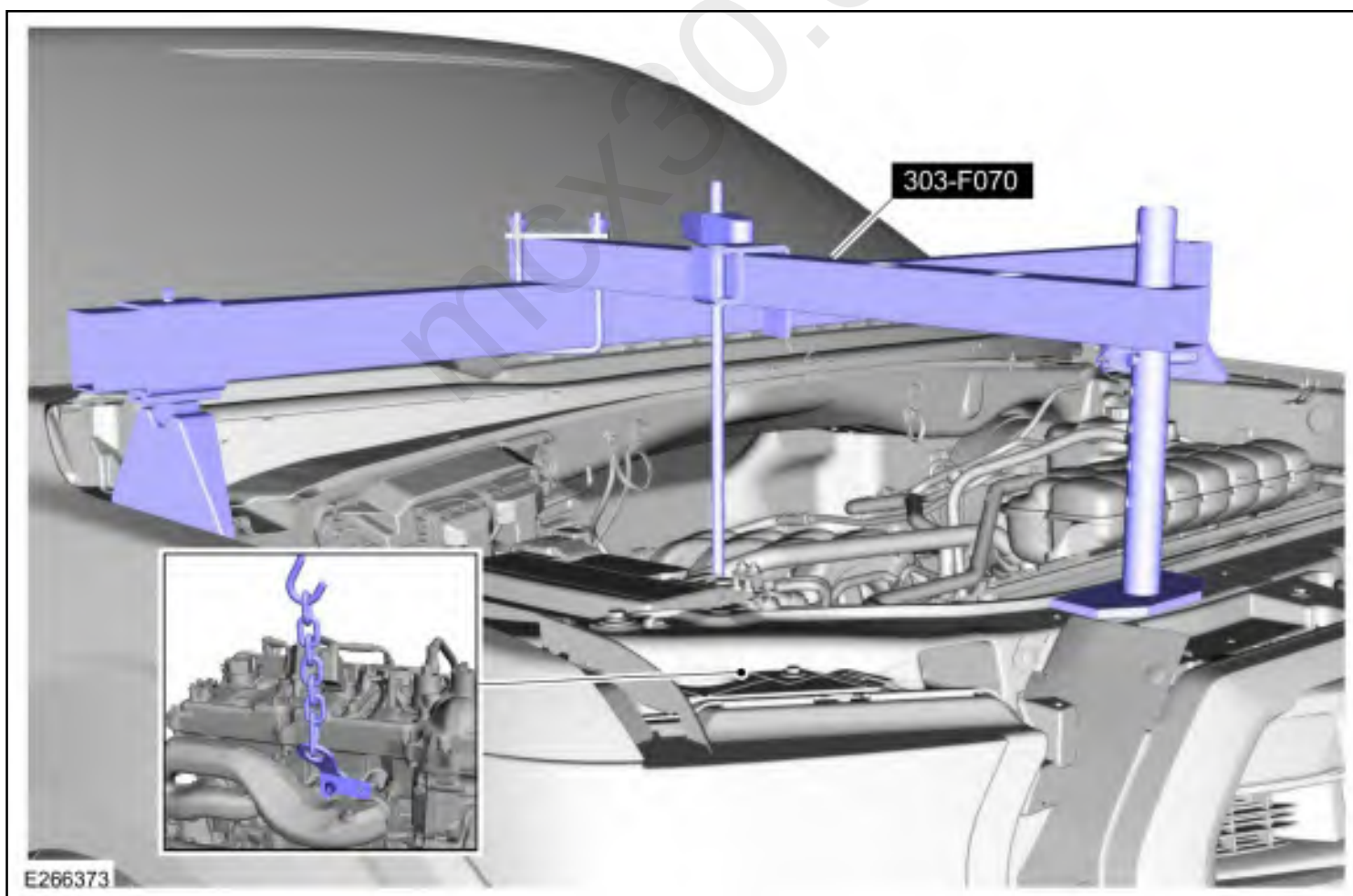
10. Remove the RH exhaust manifold nut.



11. Install the special tool, the exhaust manifold nut and a length of chain.  
Use Special Service Tool: 303-D099 (D94T-6000-C) Lifting Bracket, Engine.



1. Install Special Service Tool: 303-F070 Support Bar, Engine.
2. Attach the chain installed in the previous step to the hook on the special tool.



13. Remove the following items:

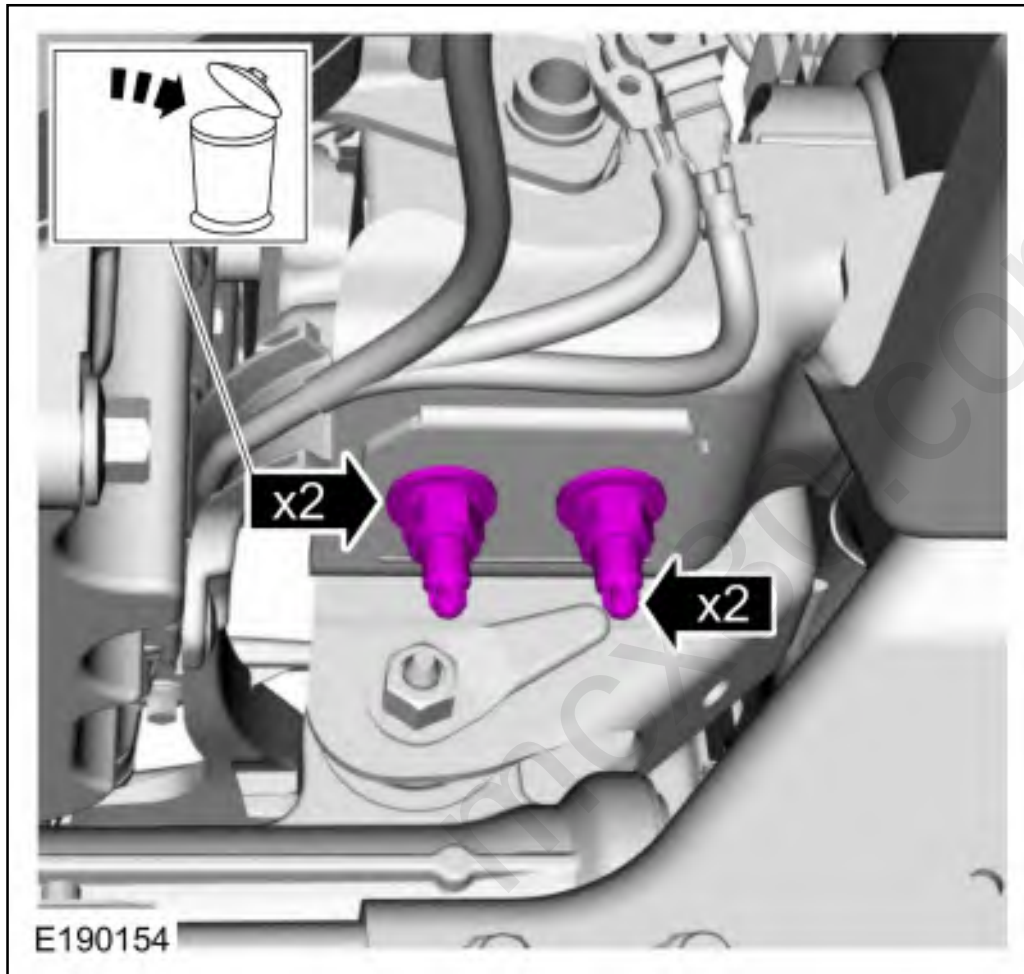
1. Refer to: Starter Motor (303-06 Starting System - 5.0L 32V Ti-VCT) .

2. If equipped.

Refer to: [Front Driveshaft](#) (205-01 Driveshaft, Removal and Installation).

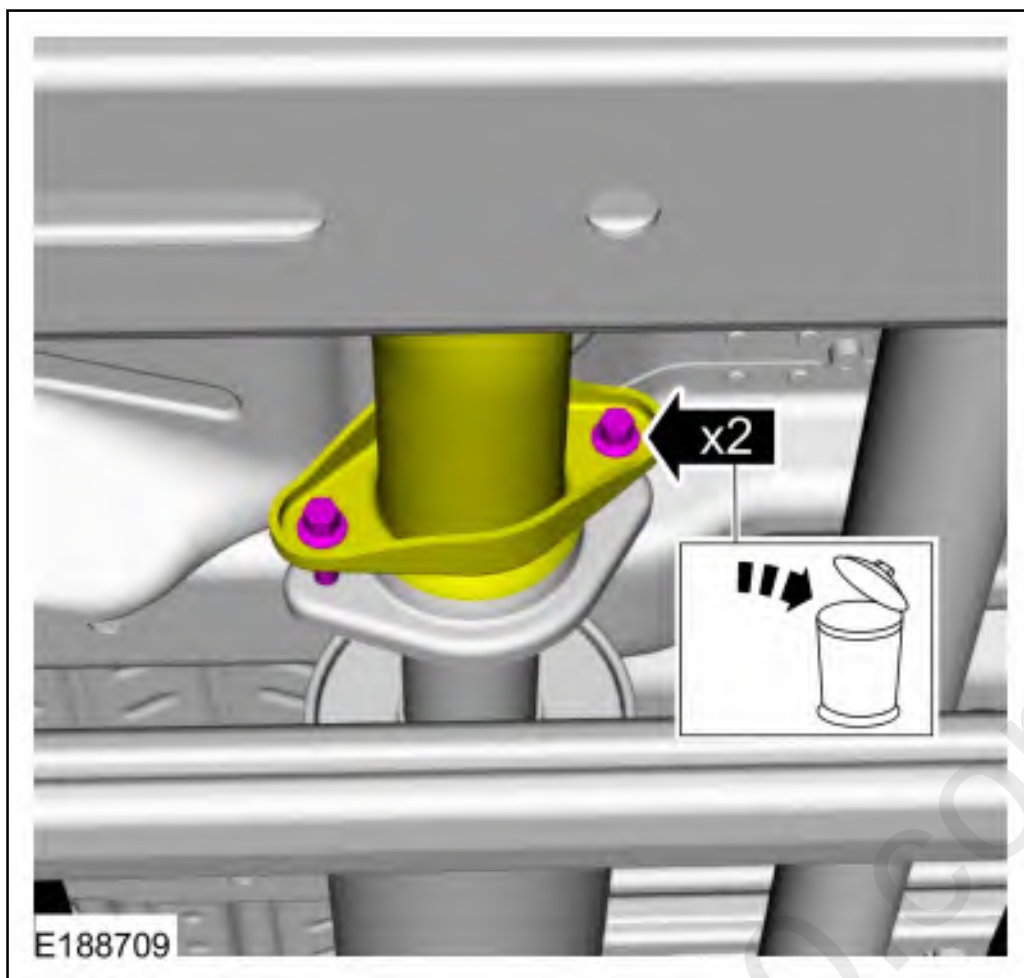
14. **NOTICE: Only use hand tools when removing the engine mount nuts, stud bolts or damage to the engine mount can occur.**

Remove and discard the RH engine mount nuts and stud bolts.



15. Remove and discard the exhaust Y-pipe dual catalytic converter-to-exhaust intermediate pipe bolts and separate.

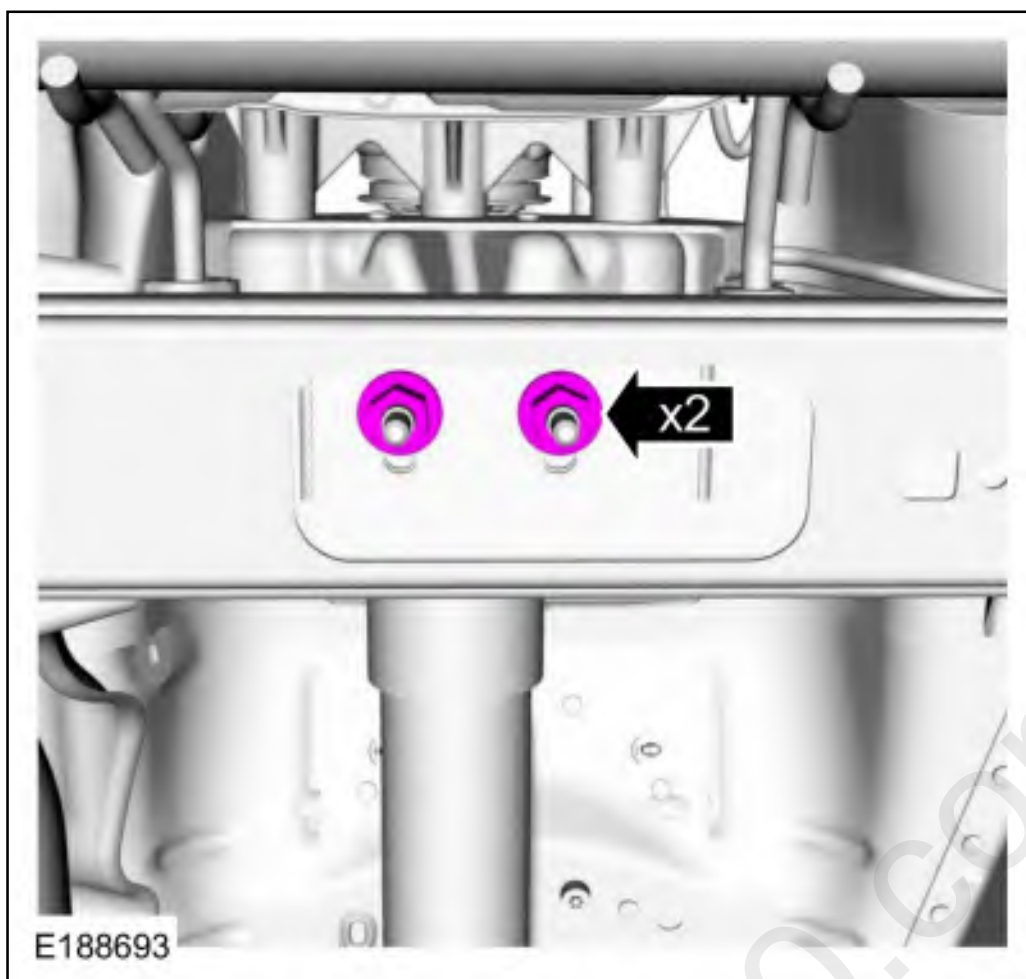
- Clean and inspect the mating surfaces.



16. **NOTICE:** Only use hand tools when removing the transmission mount-to-crossmember nuts or damage to the transmission mount can occur.

Loosen the transmission mount-to-crossmember nuts.

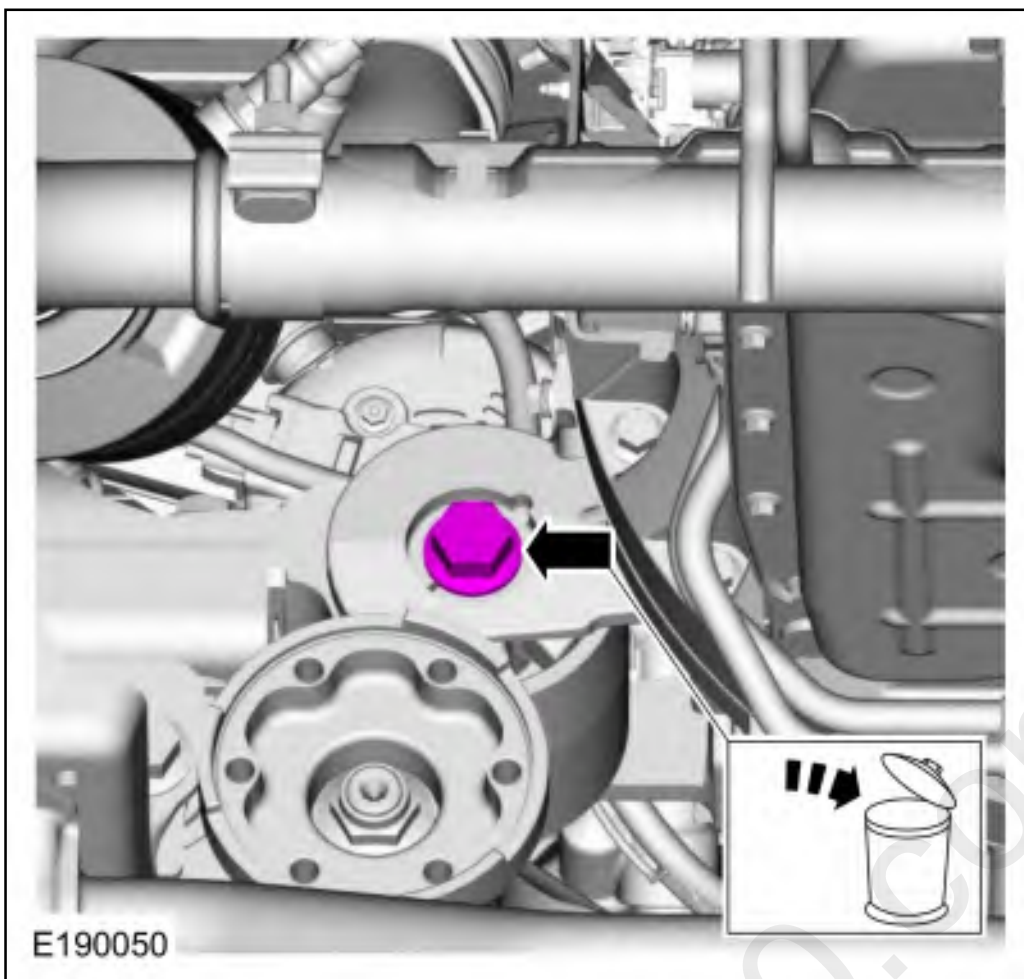




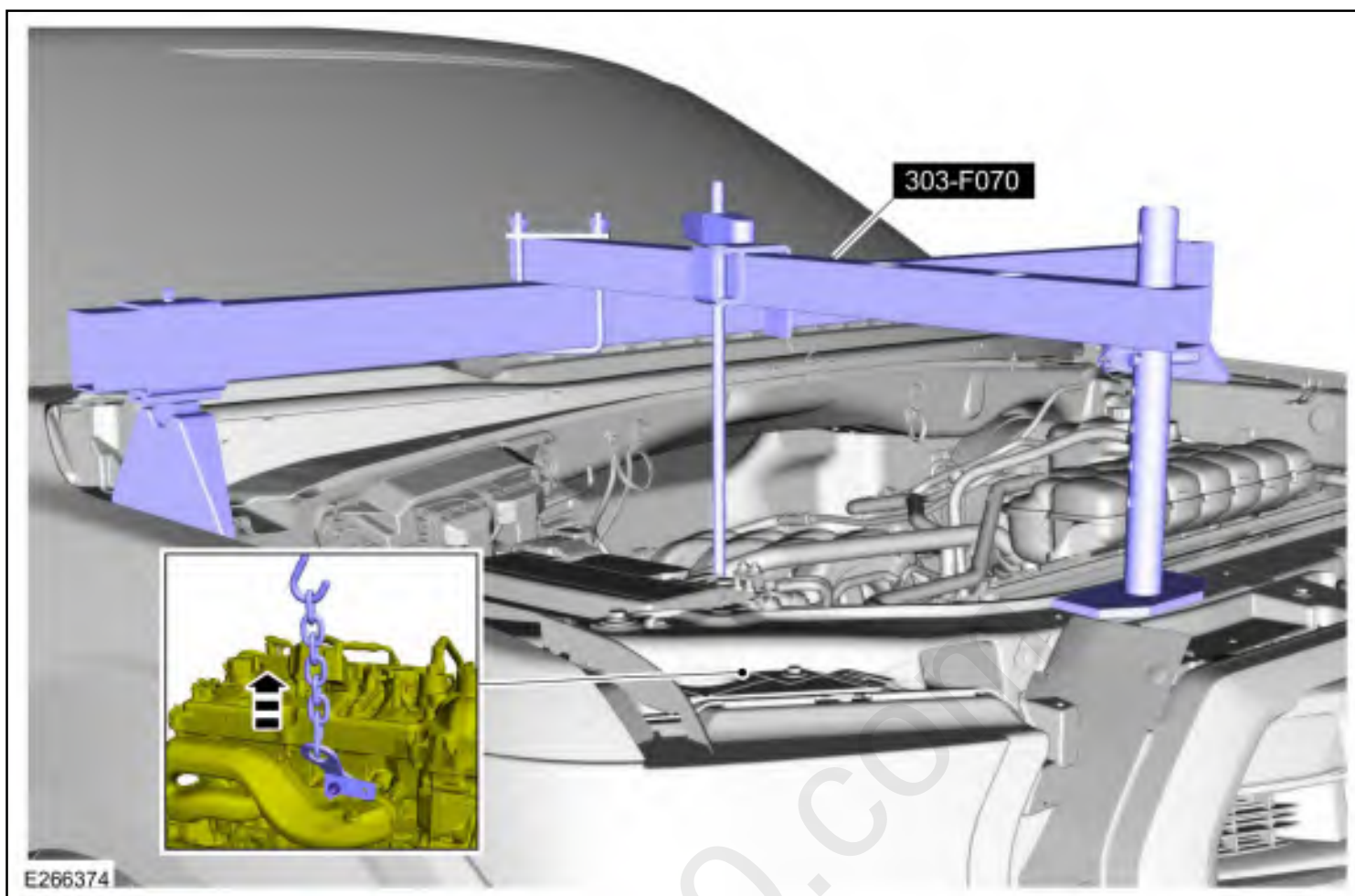
17. **NOTICE:** Only use hand tools when loosening the engine mount through bolts or damage to the engine mount-to-cylinder block bracket can occur.

Remove and discard the LH engine mount through bolt.



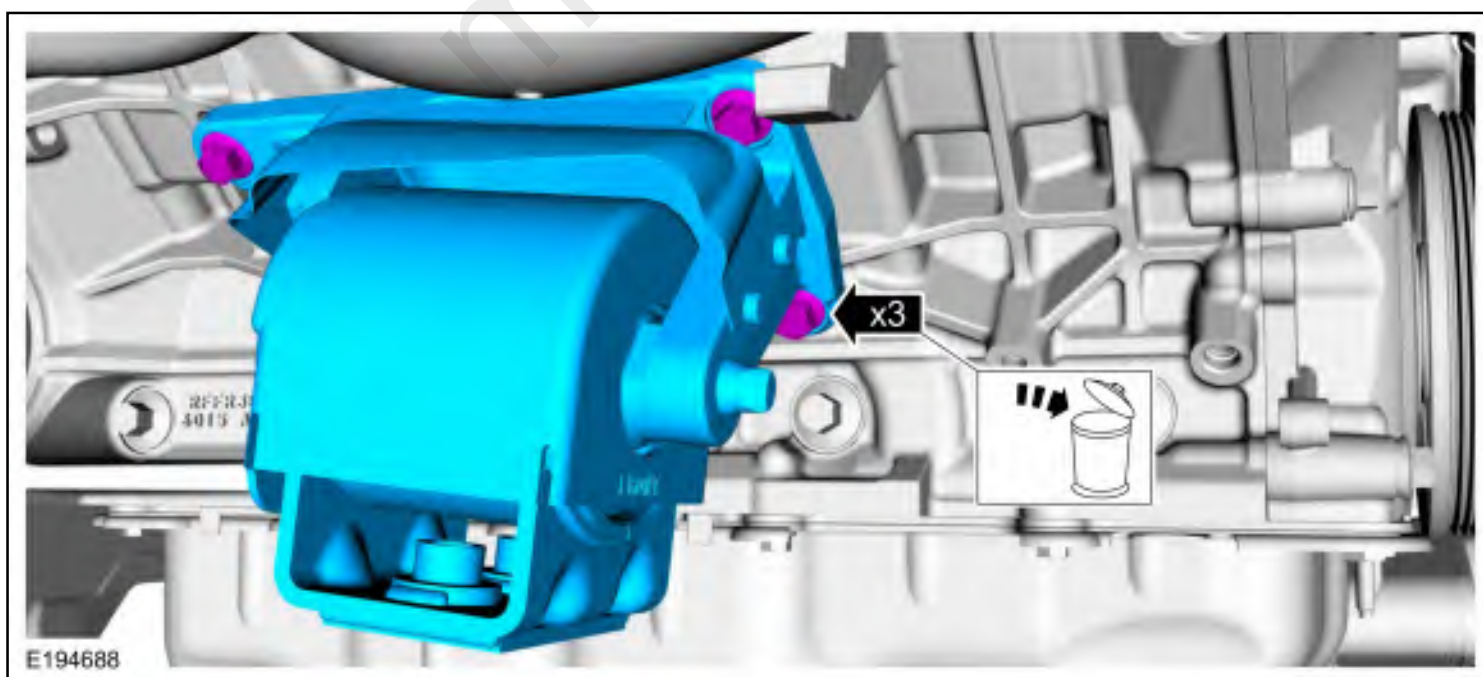


18. Using the special tool, raise the RH side of the engine 50 mm (2 in).  
Use Special Service Tool: 303-F070 Support Bar, Engine.



19. Remove and discard the RH engine mount bracket-to-engine bolts.

1. Remove the RH engine mount and bracket as an assembly.
2. Clean the engine mount bracket-to-cylinder block and engine mount-to-frame mating surfaces of any dirt or foreign material prior to installation.

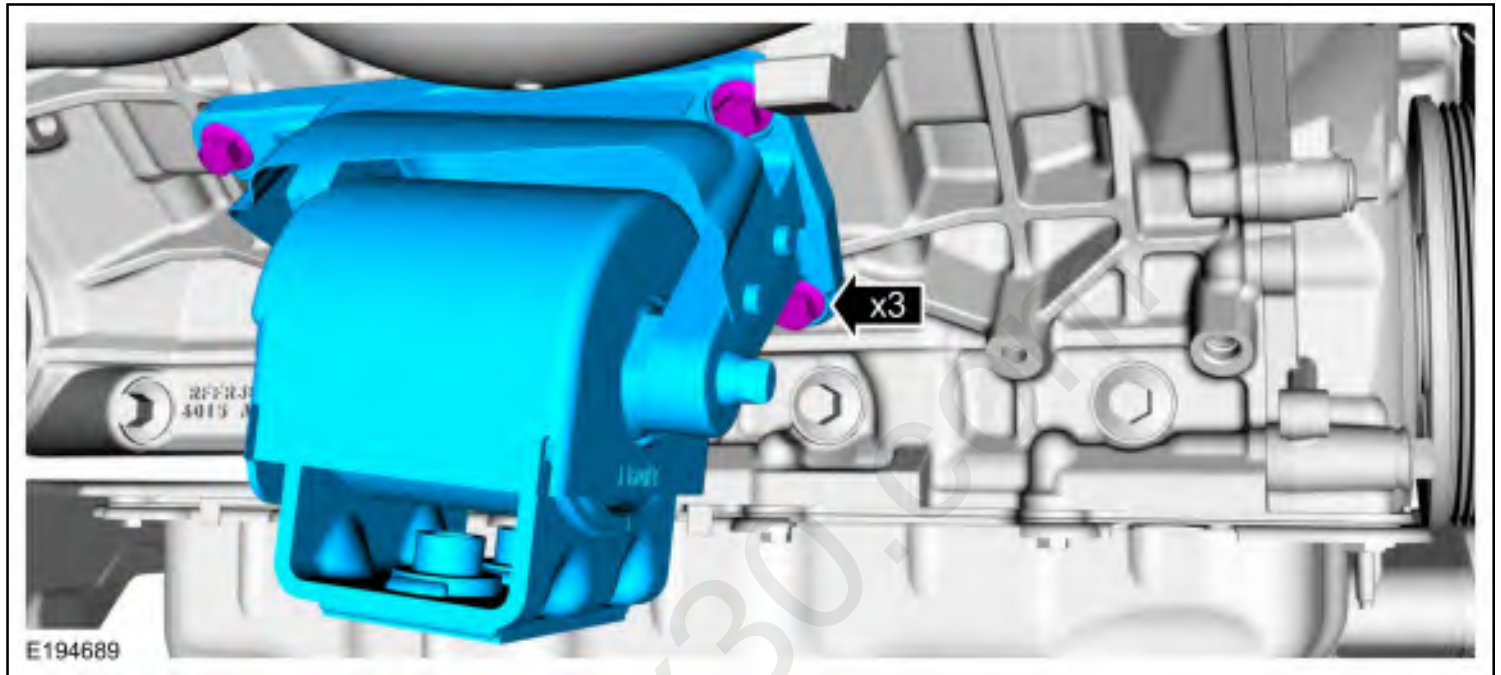


## Installation

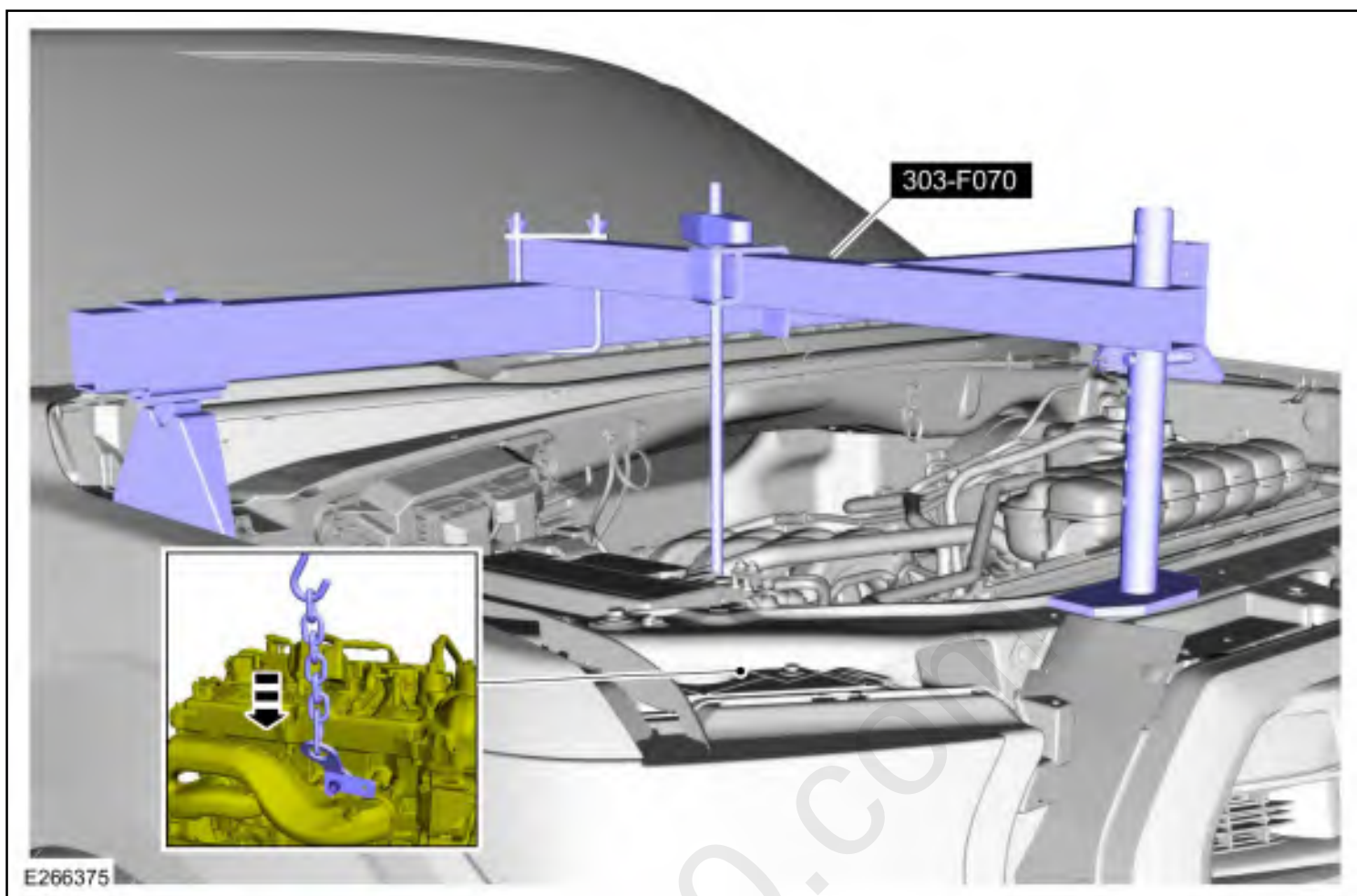
1. **NOTE:** *If a new RH engine mount is installed, remove the 2 studs prior to positioning the assembly in the vehicle.*

Install the RH engine mount and the new bolts.

*Torque: 57 lb.ft (77 Nm)*



2. Using the special tool, lower the engine to the installed position.  
Use Special Service Tool: 303-F070 Support Bar, Engine.

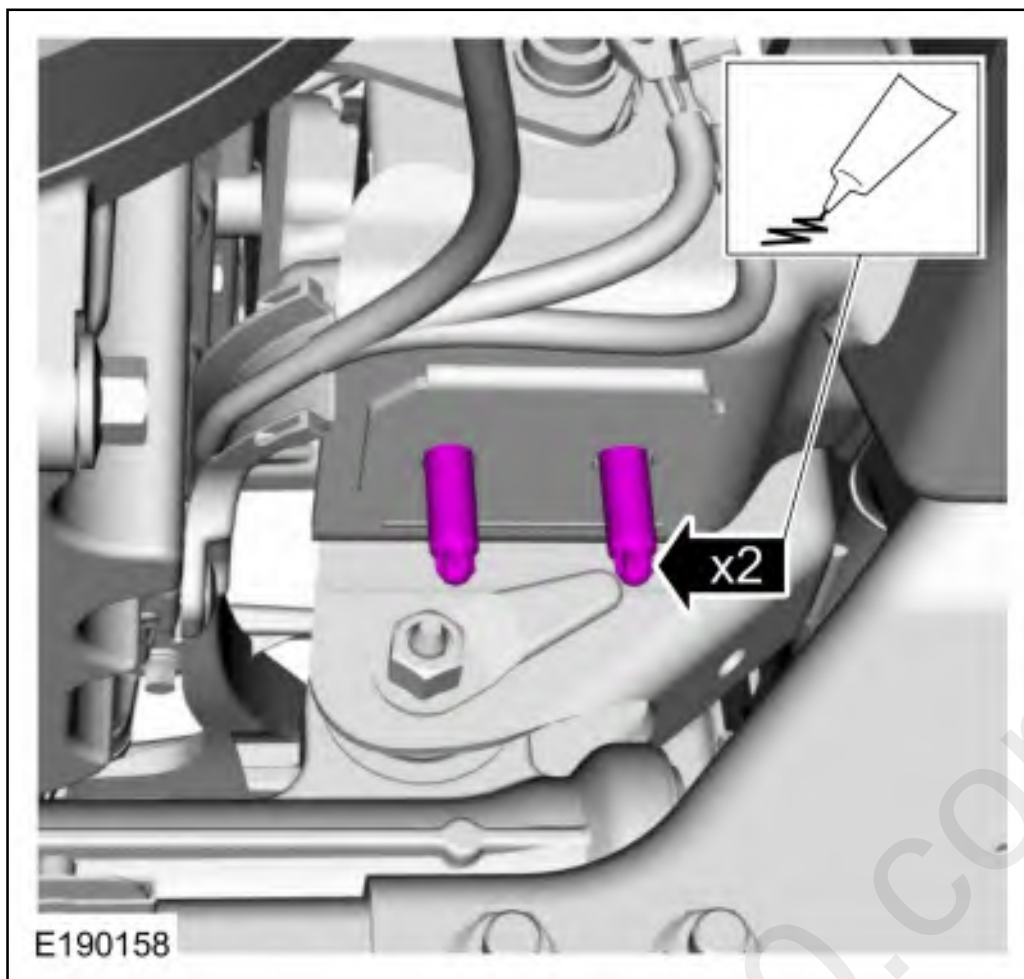


3. **NOTICE:** Only use hand tools when installing the engine mount stud bolts or damage to the engine mount can occur.

Install the new RH engine mount stud bolts.

*Torque:* 22 lb.ft (30 Nm)

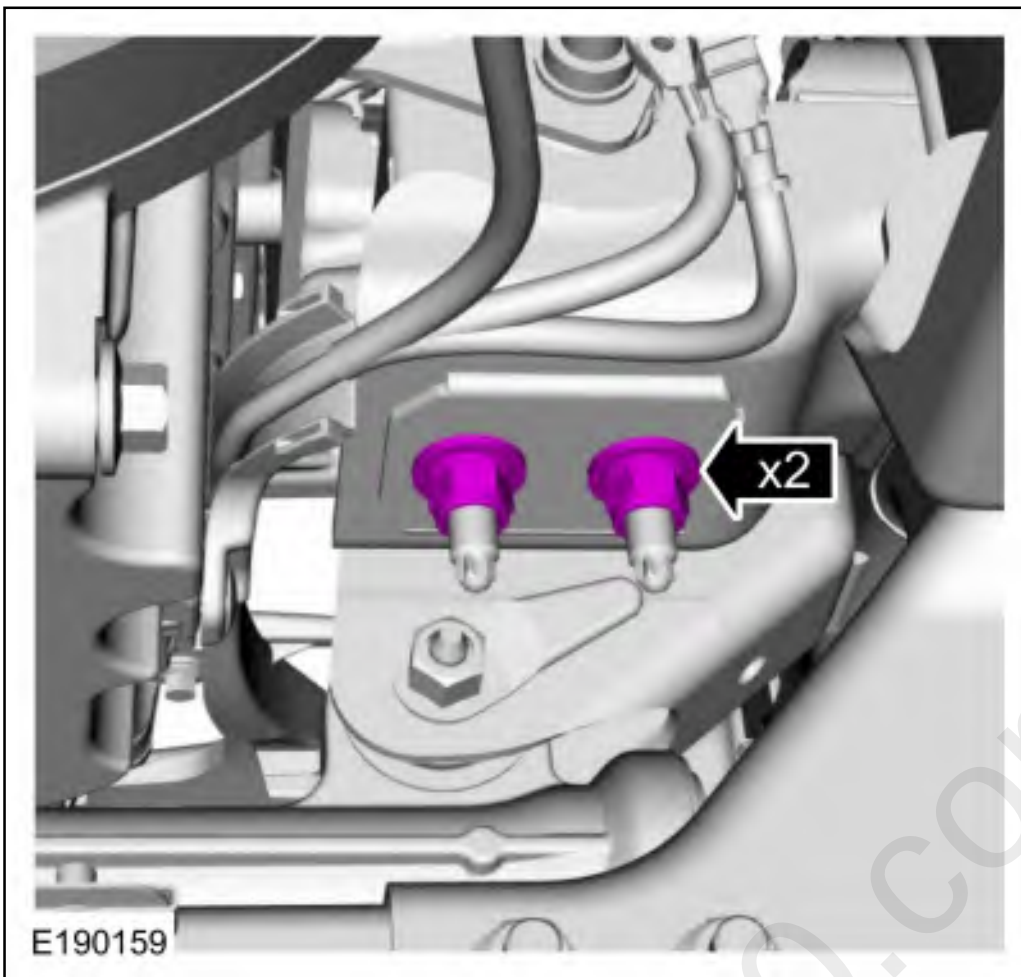




4. **NOTICE:** Only use hand tools when installing the engine mount nuts or damage to the engine mount can occur.

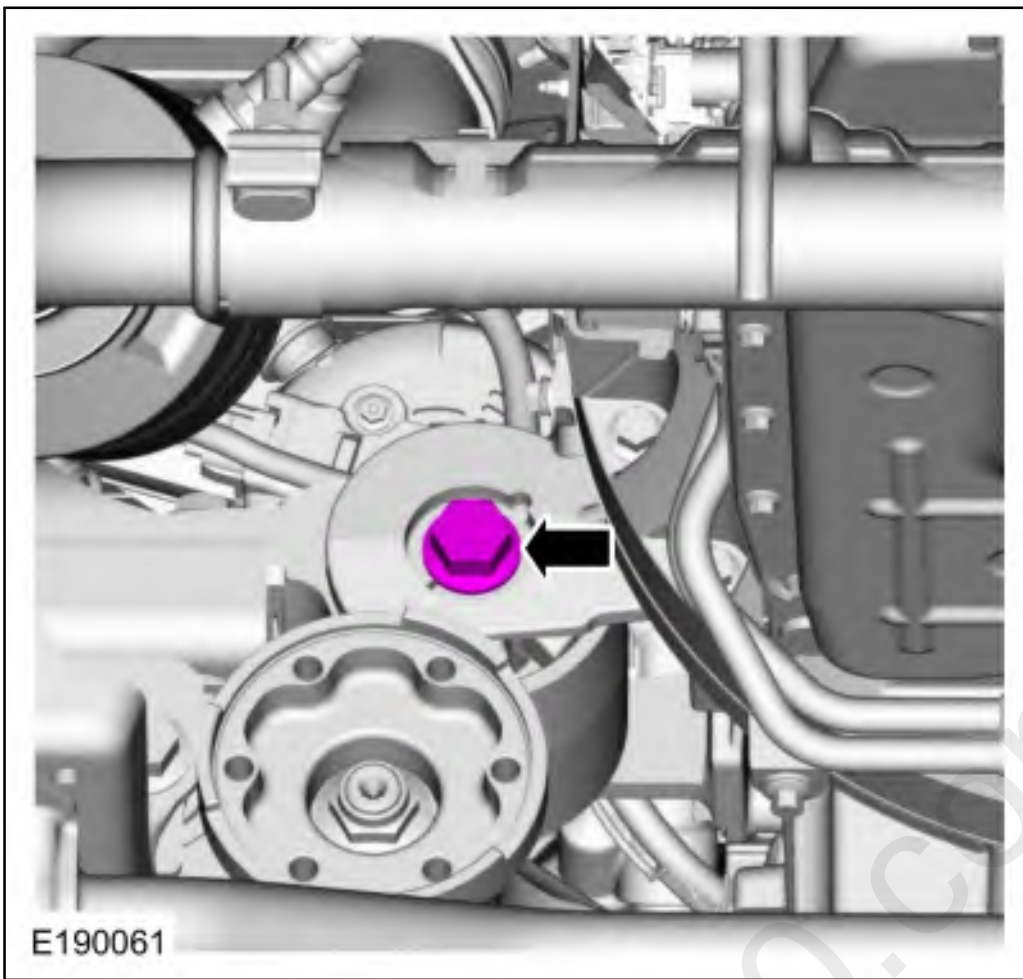
Install the new RH engine mount nuts.  
*Torque:* 111 lb.ft (150 Nm)





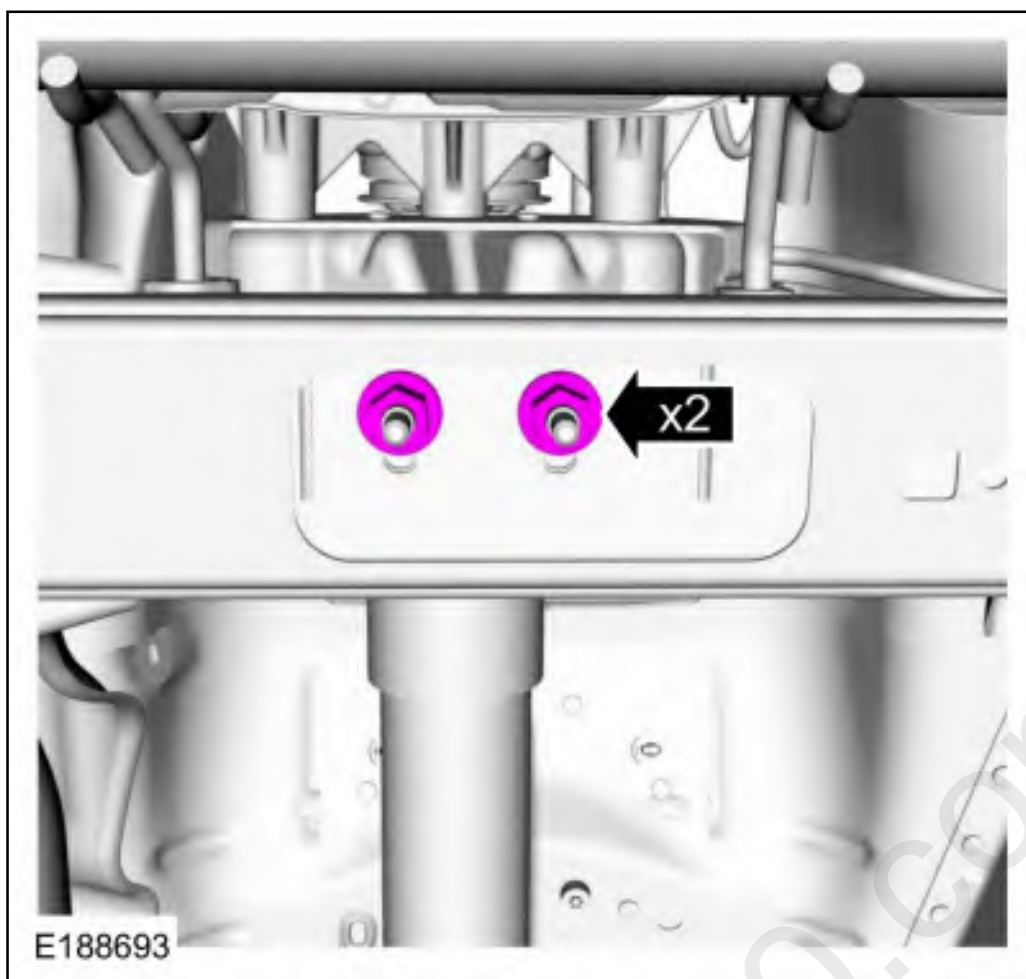
5. **NOTICE:** Only use hand tools when tightening the engine mount through bolts or damage to the engine mount-to-cylinder block bracket can occur.

Install the new LH engine mount through bolt.  
*Torque:* 258 lb.ft (350 Nm)

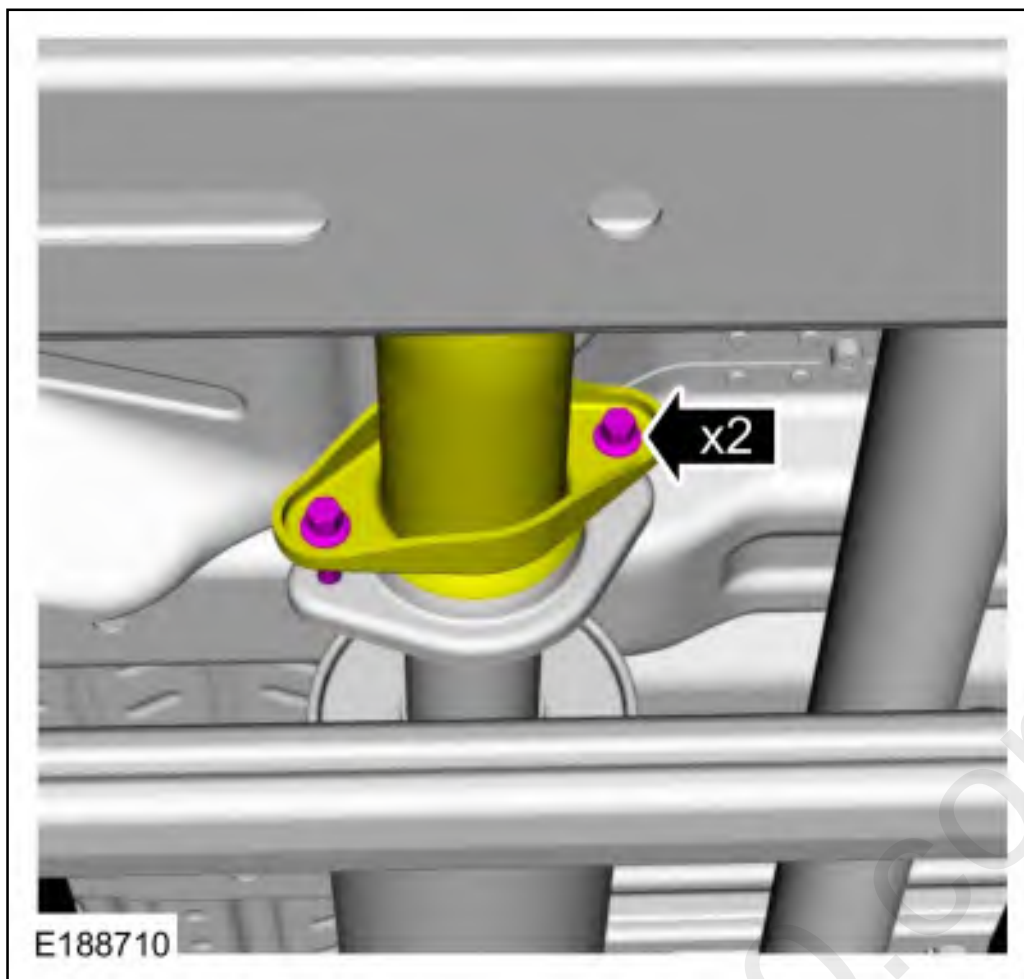


6. **NOTICE:** Only use hand tools when installing the transmission mount-to-crossmember nuts or damage to the transmission mount can occur.

Tighten the transmission mount-to-crossmember nuts.  
*Torque:* 85 lb.ft (115 Nm)



- Position the exhaust Y-pipe dual catalytic converter-to-exhaust intermediate pipe and install the new bolts.
- Tighten the inner exhaust Y-pipe dual catalytic converter-to-exhaust intermediate pipe bolt.  
*Torque: 46 lb.ft (63 Nm)*
- Tighten the outer exhaust Y-pipe dual catalytic converter-to-exhaust intermediate pipe bolt.  
*Torque: 46 lb.ft (63 Nm)*



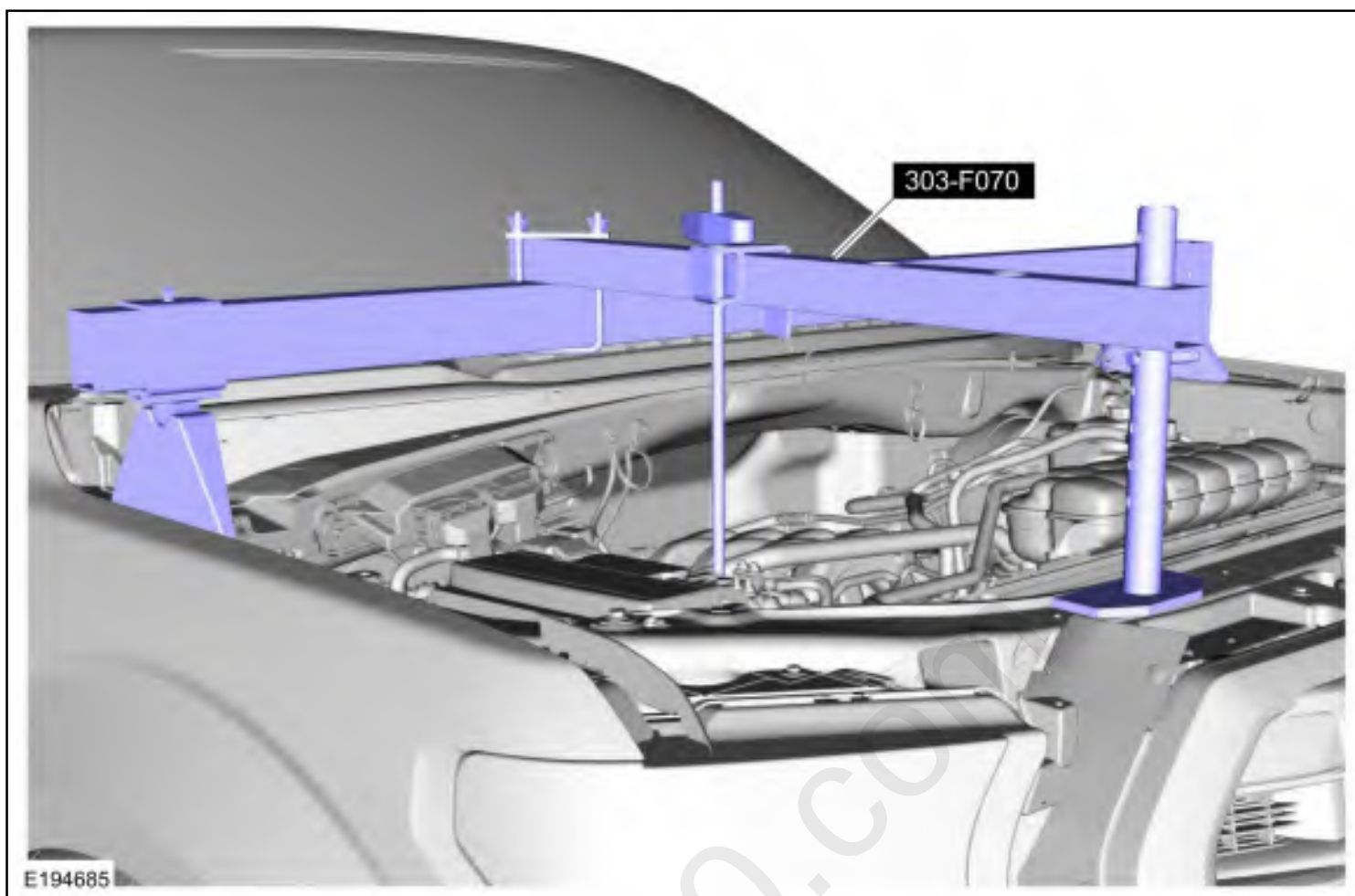
8. Install the following items:

1. If equipped.

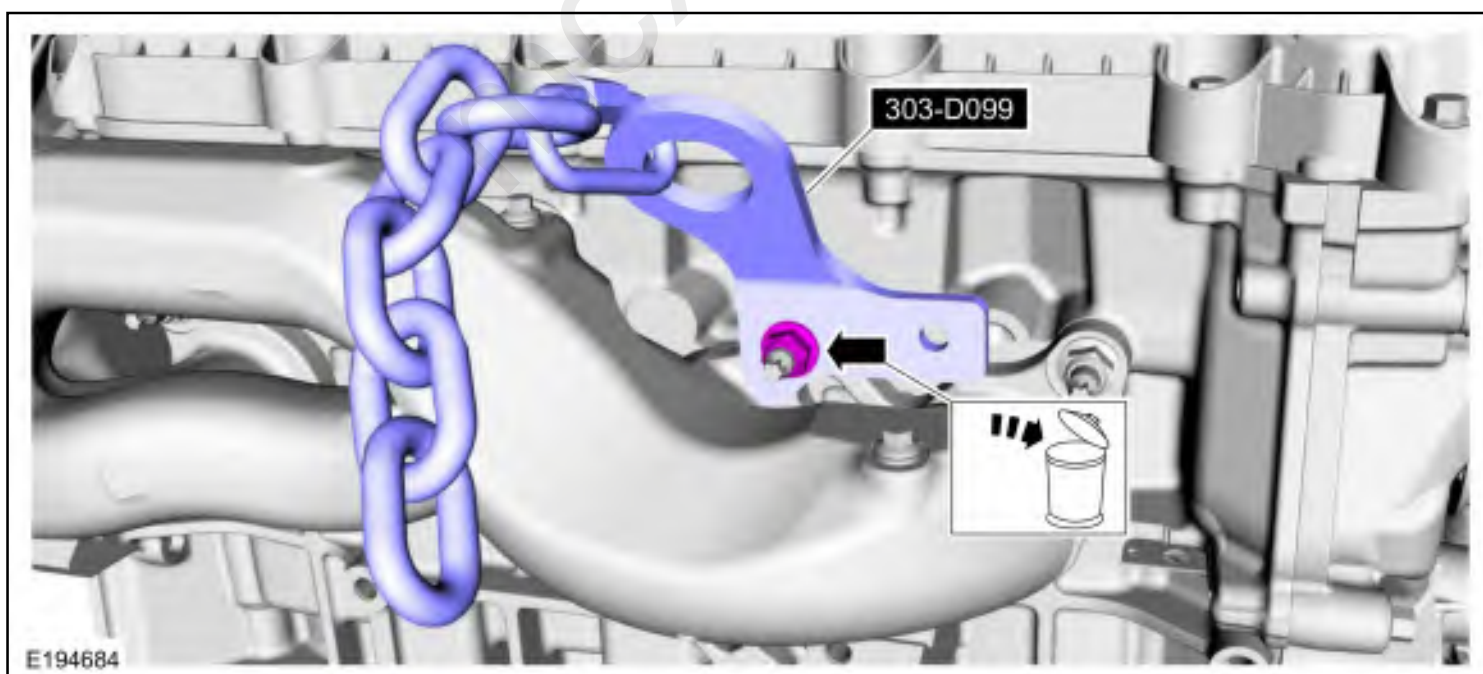
Refer to: [Front Driveshaft](#) (205-01 Driveshaft, Removal and Installation).

2. Refer to: Starter Motor (303-06 Starting System - 5.0L 32V Ti-VCT) .

9. Remove Special Service Tool: 303-F070 Support Bar, Engine.

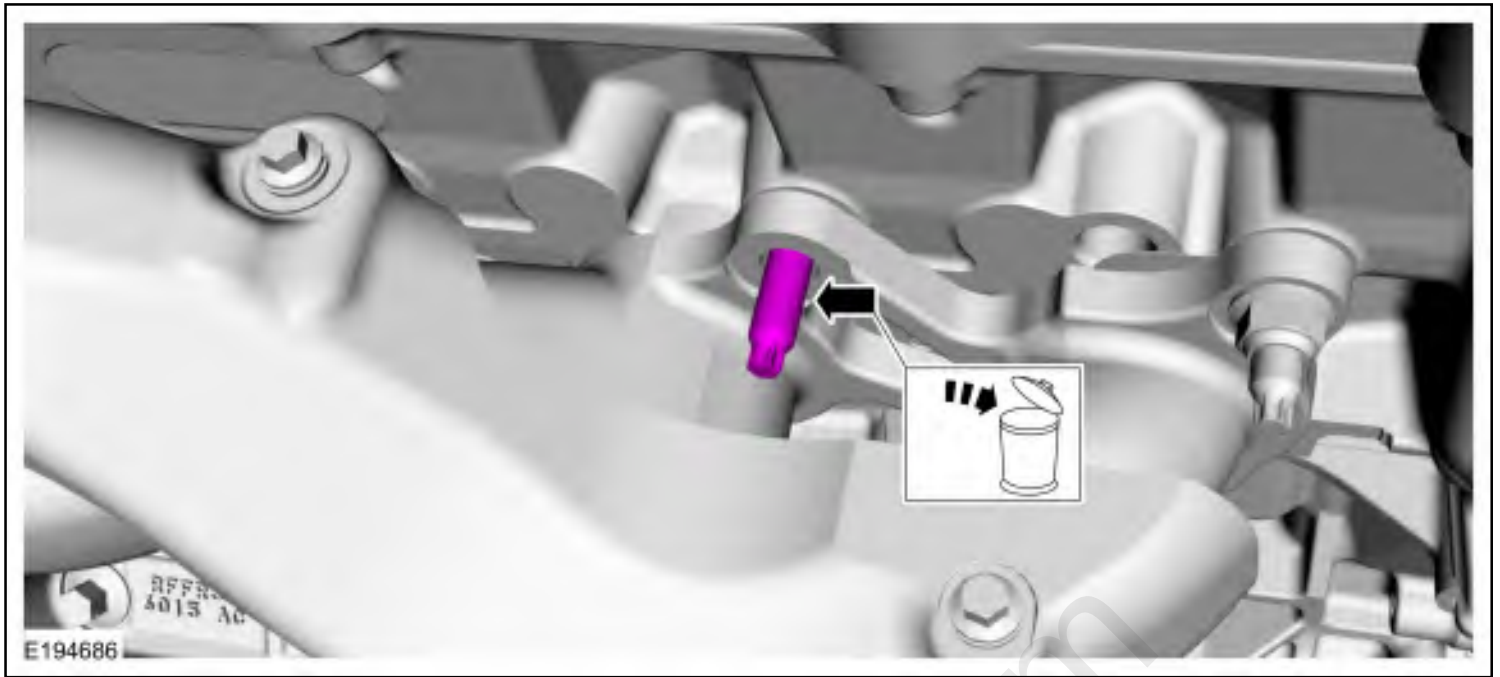


10. Remove and discard the exhaust manifold nut.  
Remove Special Service Tool: 303-D099 (D94T-6000-C) Lifting Bracket, Engine.

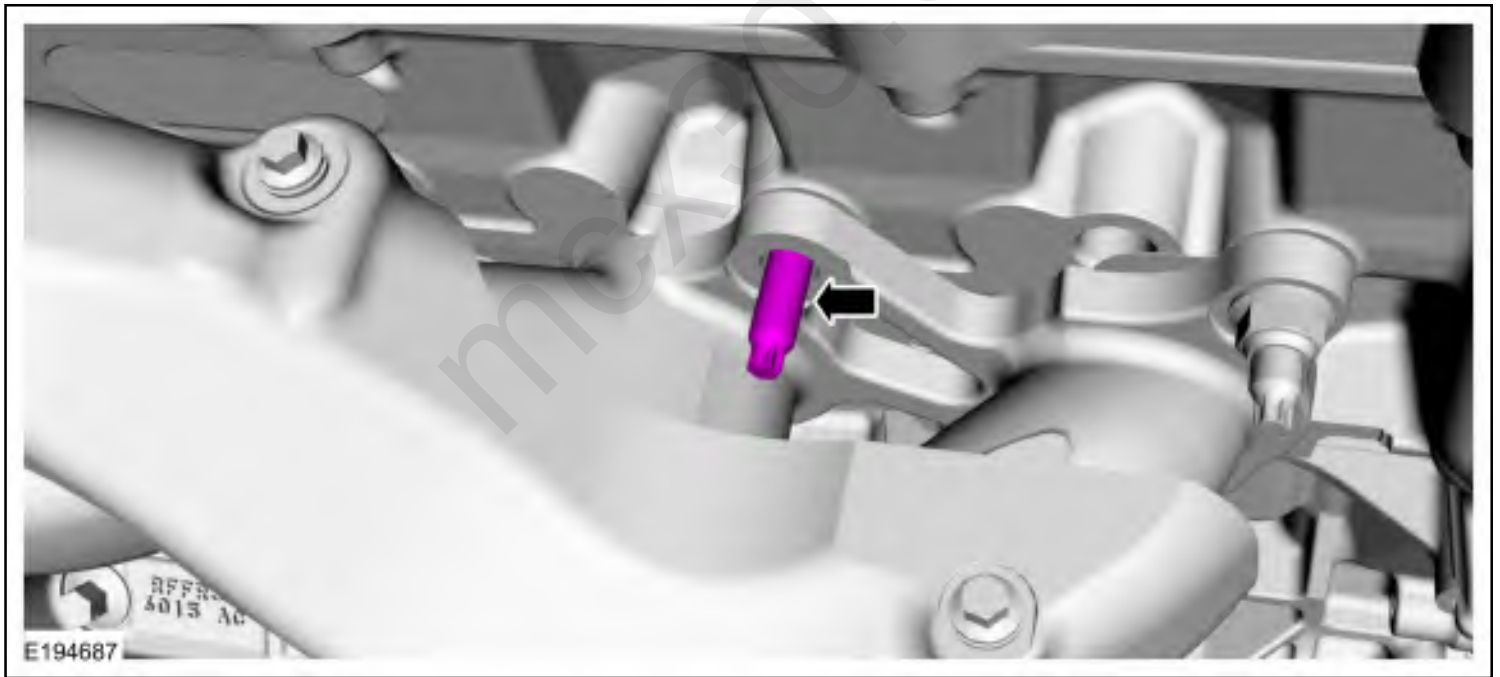


11. Remove and discard the exhaust manifold stud.

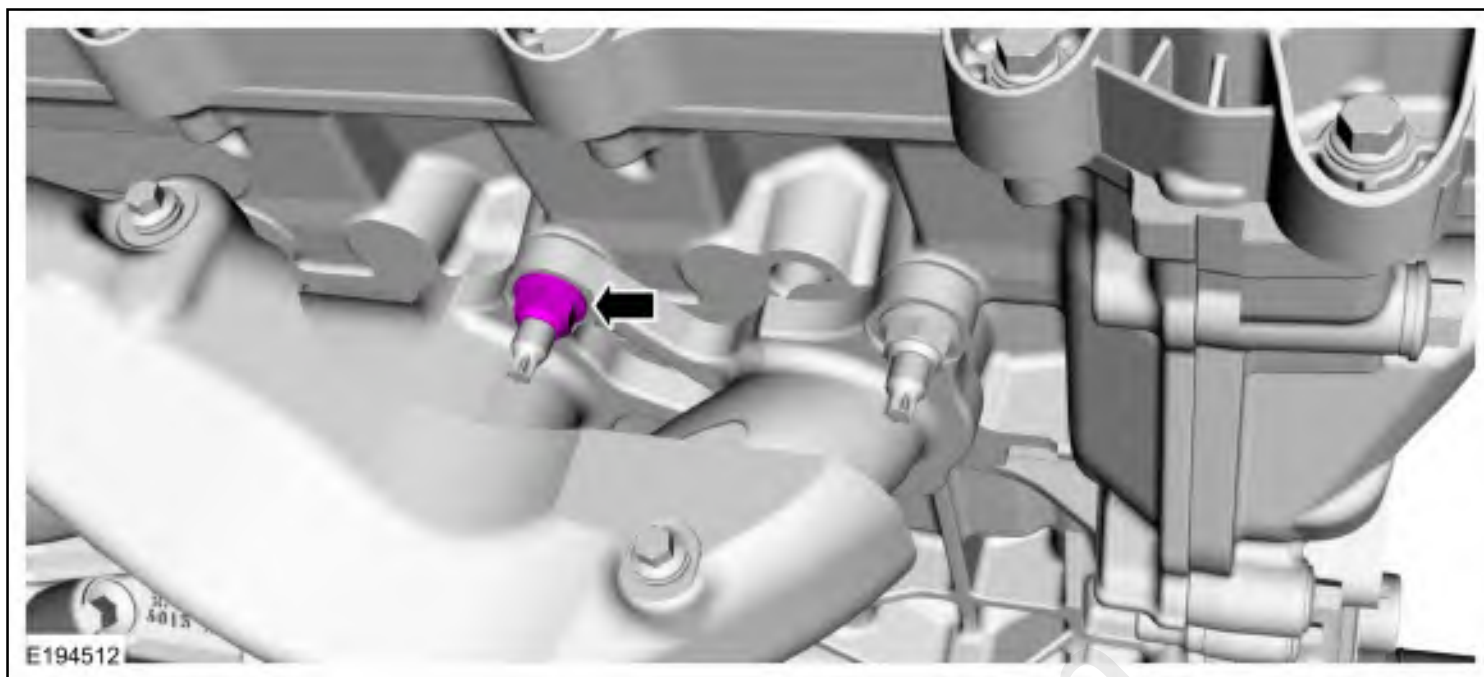




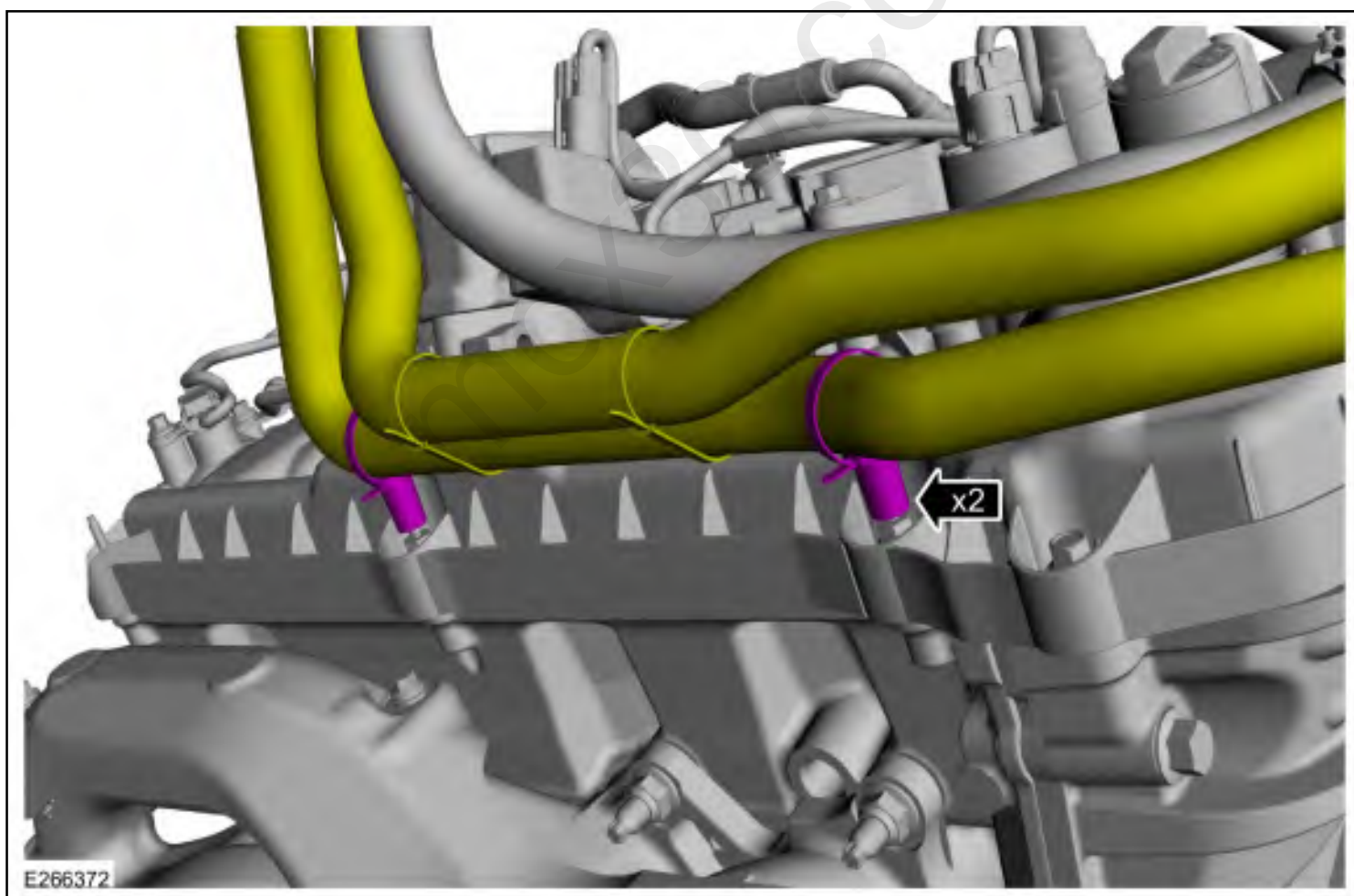
12. Install a new exhaust manifold stud.  
*Torque: 18 lb.ft (25 Nm)*



13. Install a new exhaust manifold nut.  
*Torque:*  
Stage 1: 18 lb.ft (24 Nm)  
Stage 2: 24 lb.ft (32 Nm)



14. Attach the heater hose retainers.



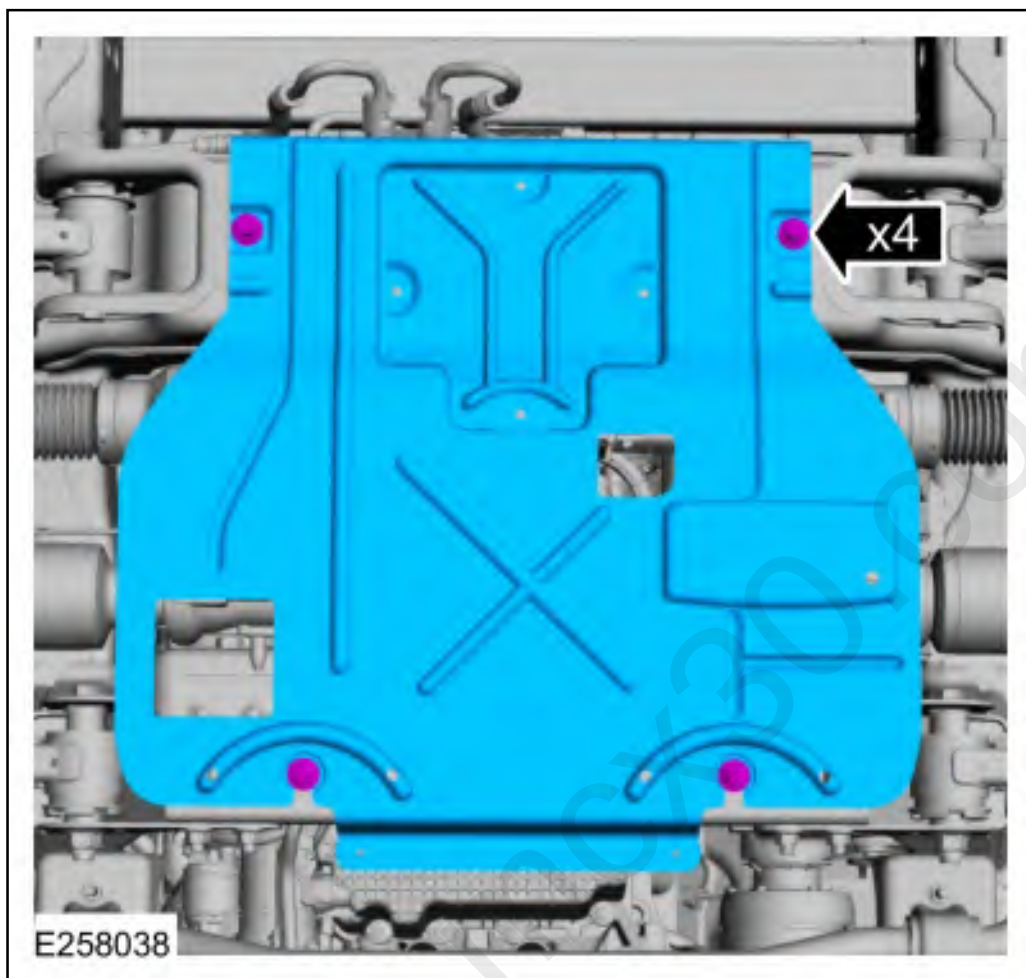
15. Install the A/C compressor.

Refer to: Air Conditioning (A/C) Compressor - 5.0L 32V Ti-VCT (412-00 Climate Control System - General Information) .

16. **NOTE:** *If equipped.*

Install the skid plate and bolts.

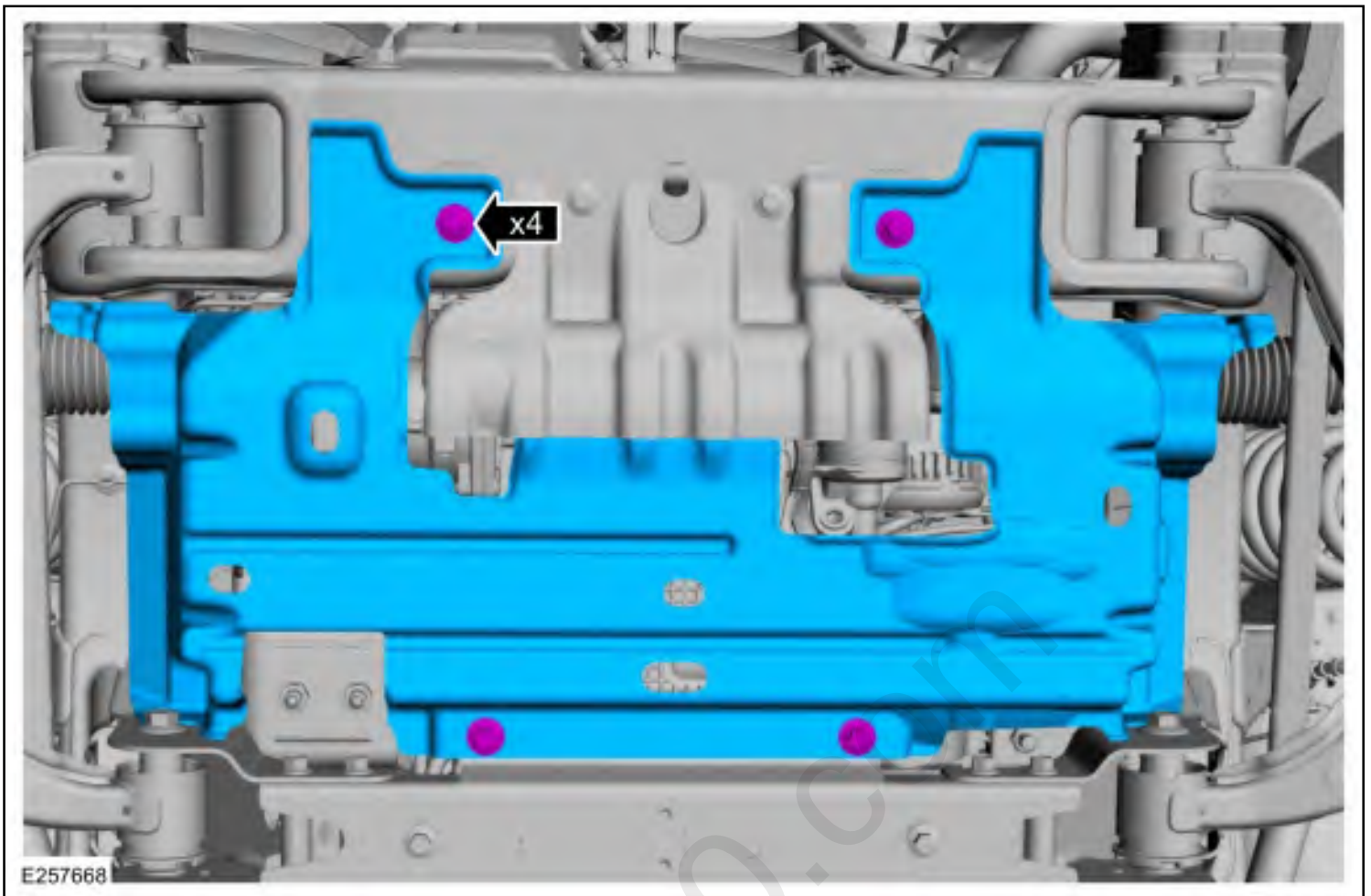
*Torque:* 30 lb.ft (40 Nm)



17. **NOTE:** *If equipped.*

Install the underbody shield and fasteners.

*Torque:* 30 lb.ft (40 Nm)

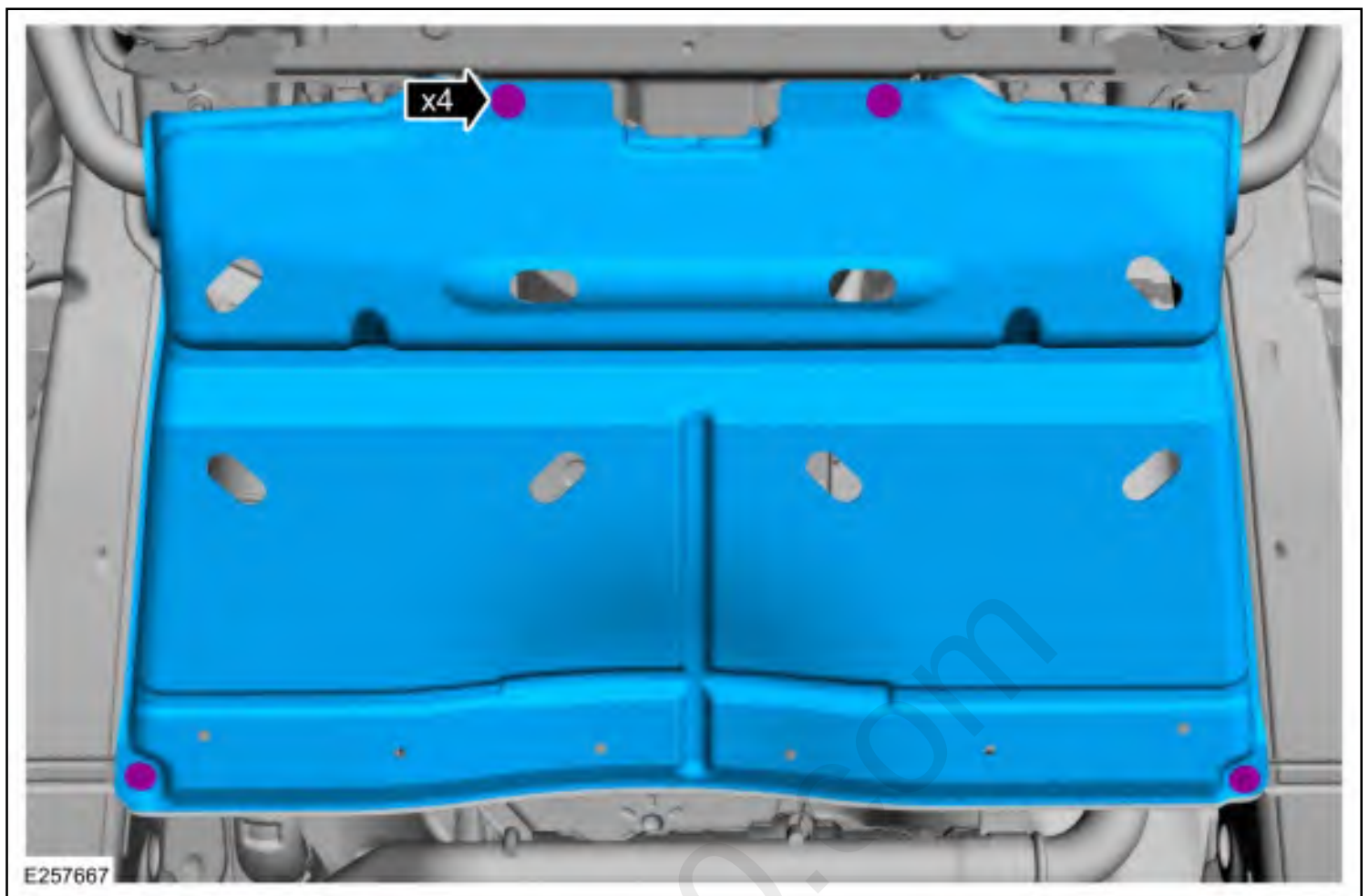


18. **NOTE:** *If equipped.*

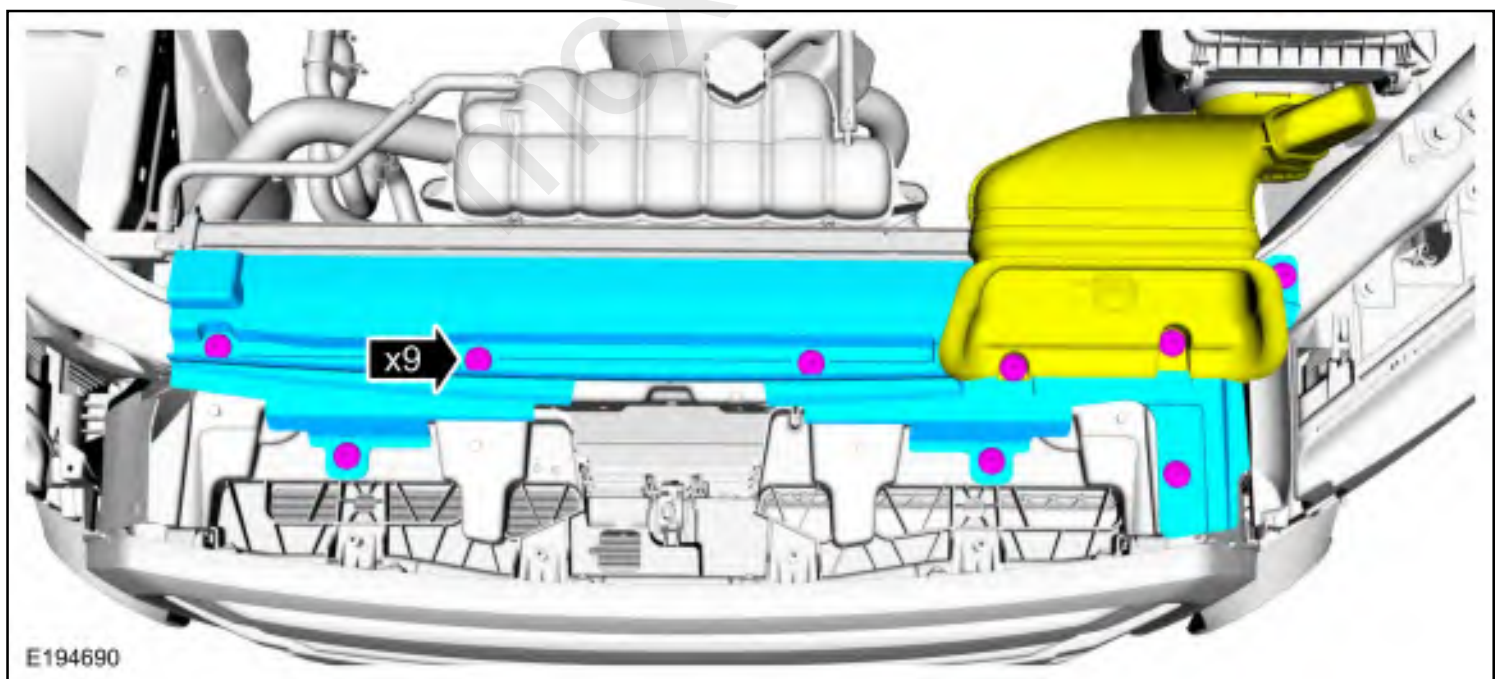
Install the underbody shield and the bolts.

*Torque:* 71 lb.in (8 Nm)





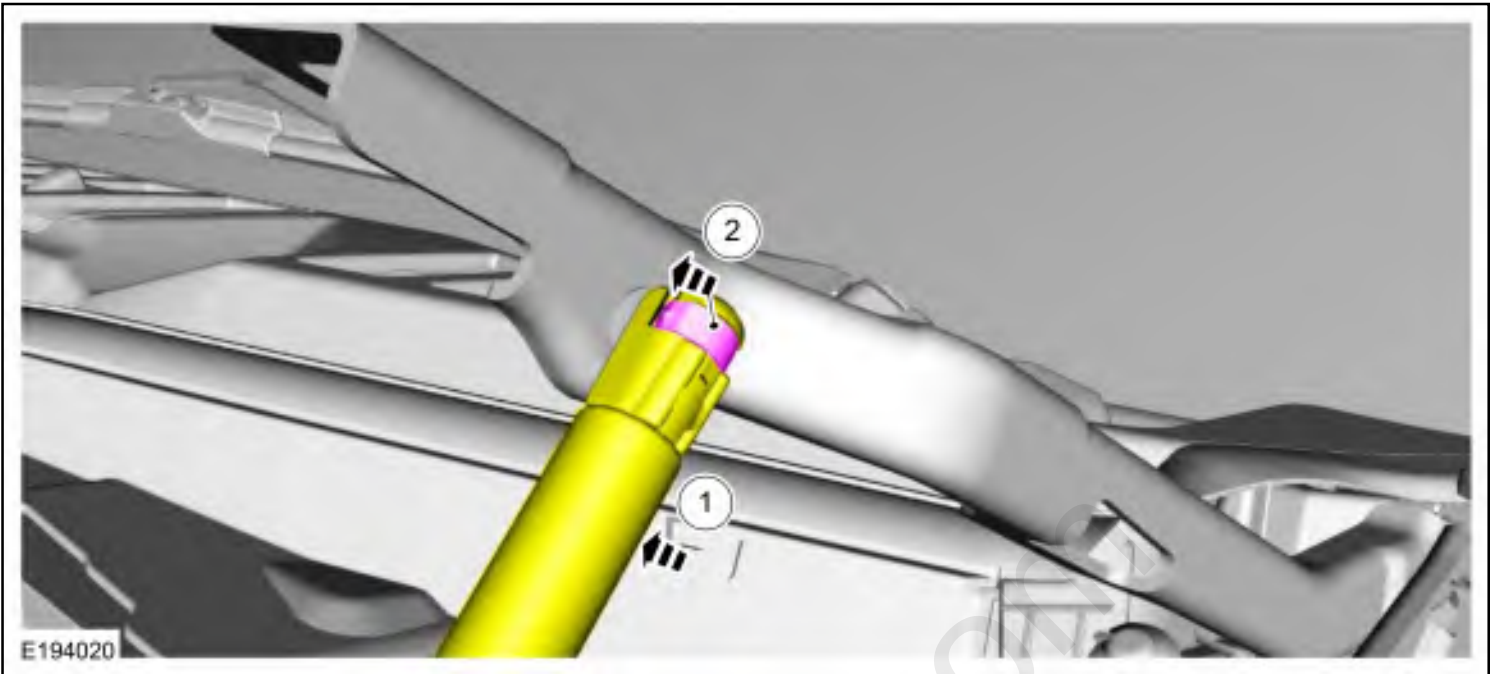
19. Install the radiator top shield and fasteners.



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



1. Position the hood shock and attach.
2. Install the clip.



21. Install the hood.

Refer to: [Hood](#) (501-02 Front End Body Panels, Removal and Installation).

22. Start engine and check exhaust system for leaks.

# Intake Manifold

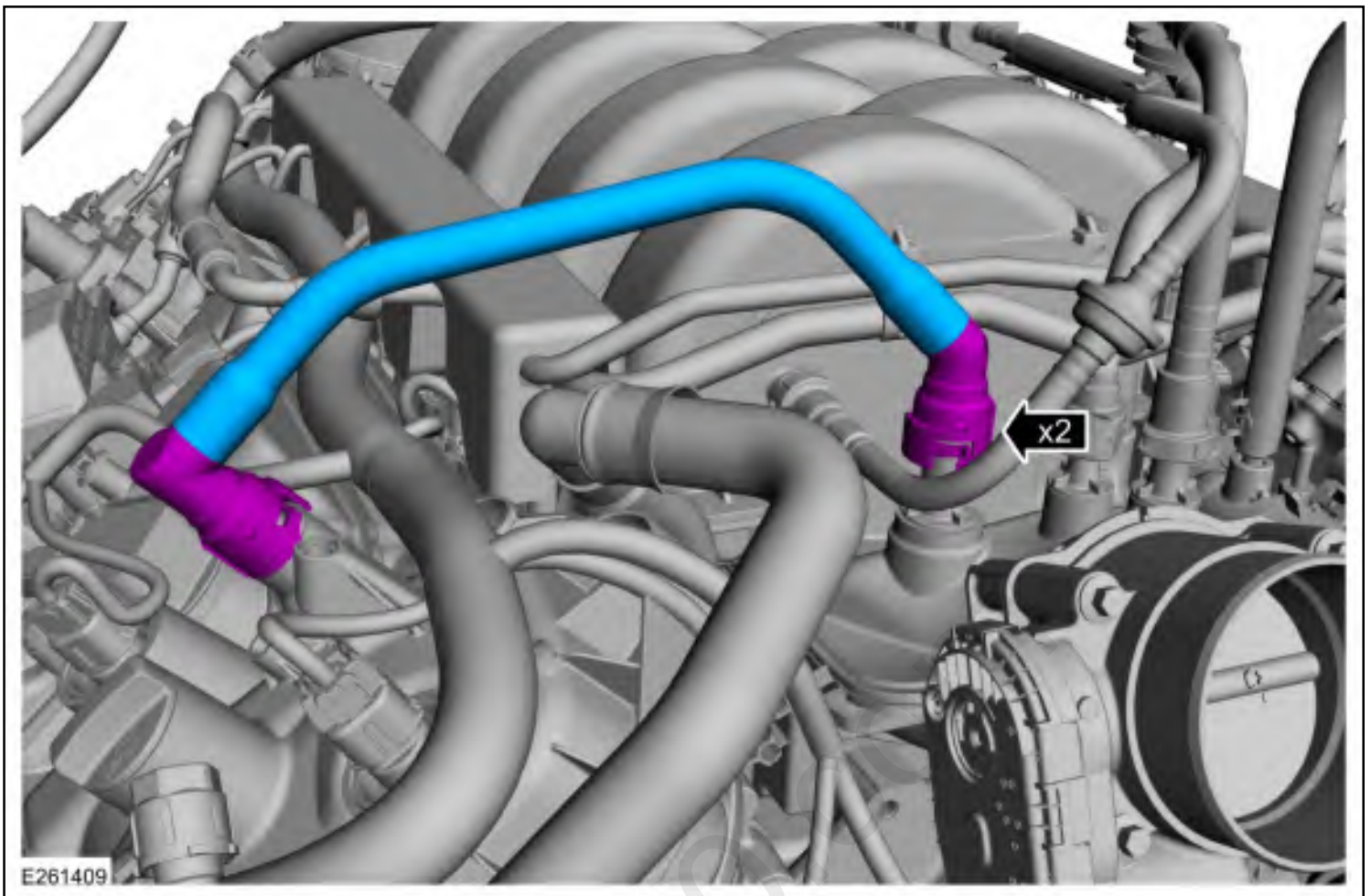
Base Part Number: Base Part Number: 9424

## Removal

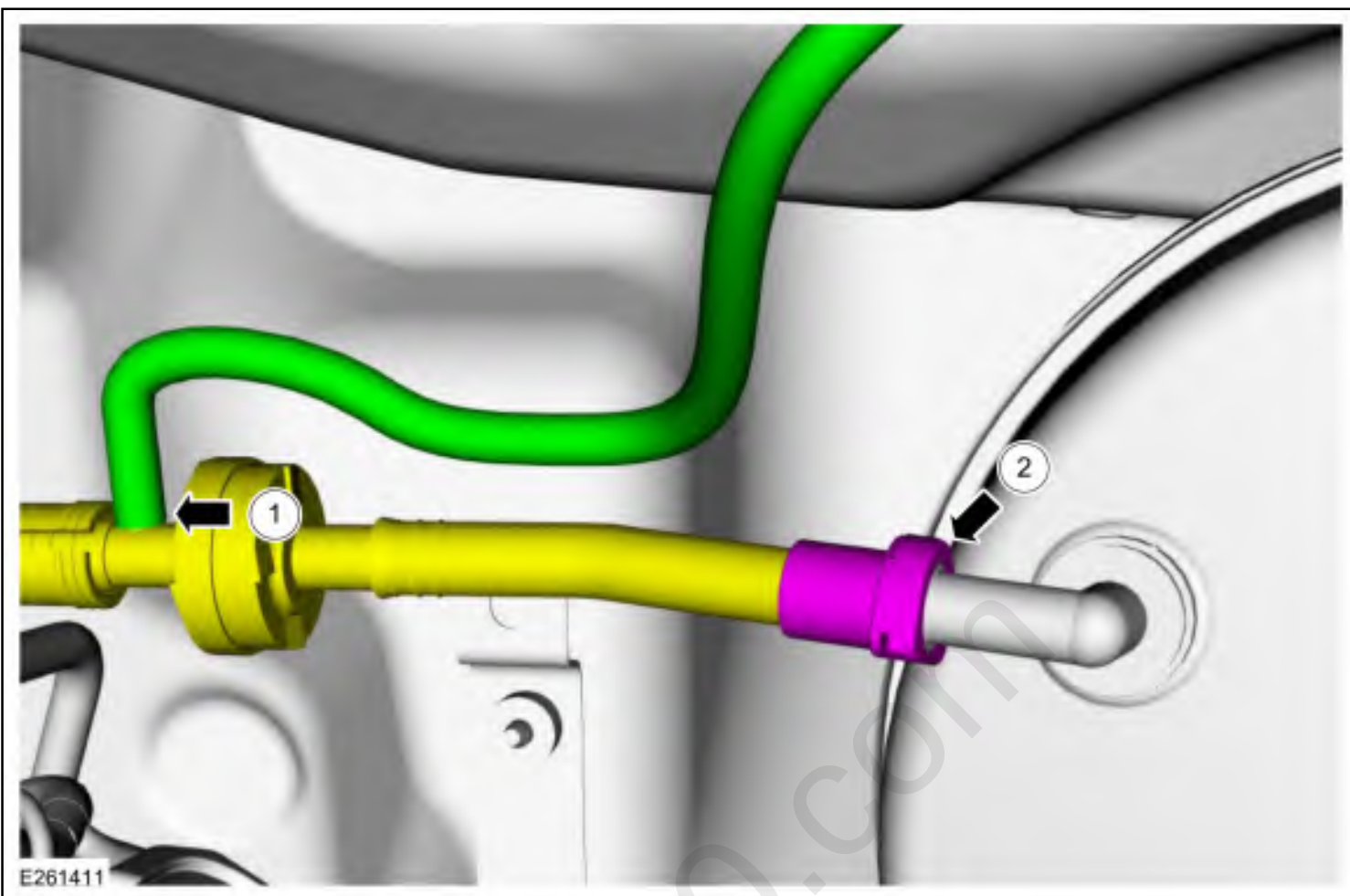
**NOTICE:** During engine repair procedures, cleanliness is extremely important. Any foreign material, including any material created while cleaning gasket surfaces, that enters the oil passages, coolant passages or the oil pan, can cause engine failure.

**NOTE:** Removal steps in this procedure may contain installation details.

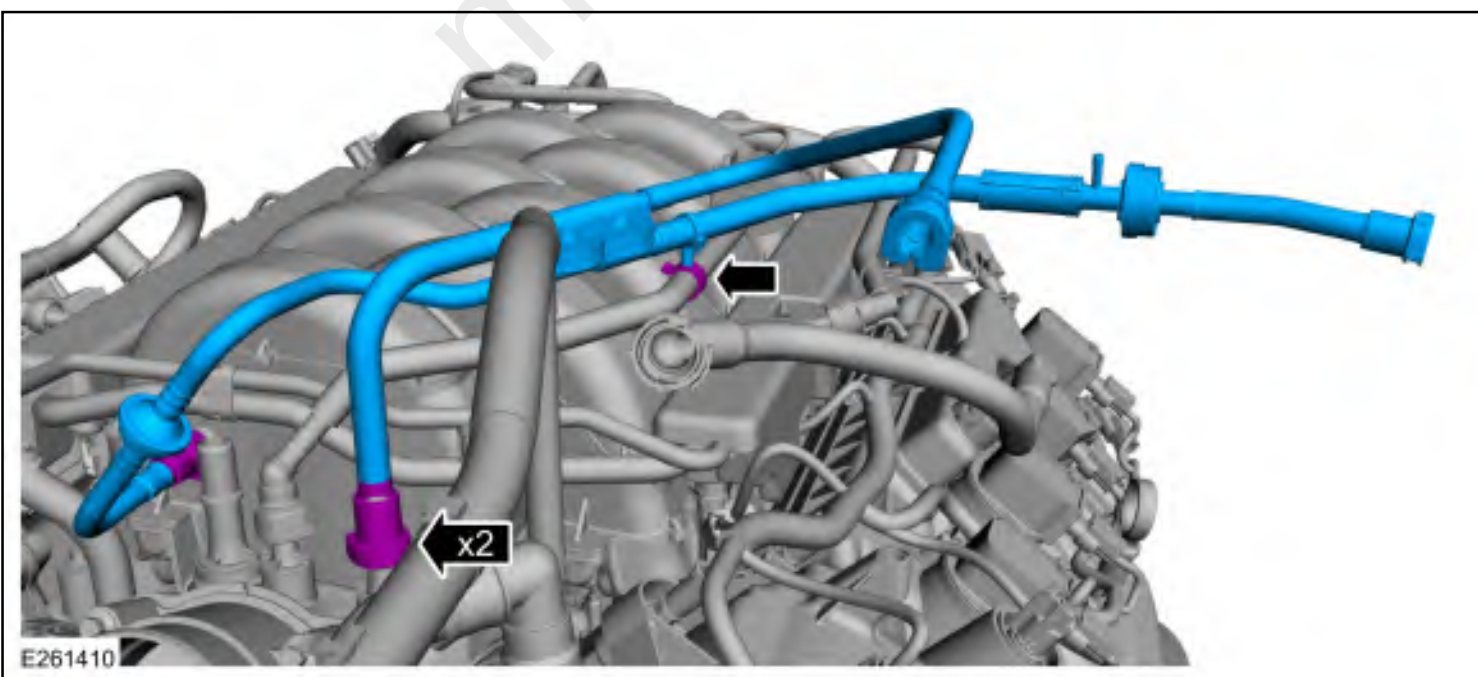
1. Release the fuel system pressure.  
Refer to: [Fuel System Pressure Release](#) (310-00D Fuel System - General Information - 5.0L 32V Ti-VCT, General Procedures).
2. Disconnect the battery ground cable.  
Refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables) .
3. Remove the air cleaner outlet pipe.  
Refer to: [Air Cleaner Outlet Pipe](#) (303-12D Intake Air Distribution and Filtering - 5.0L 32V Ti-VCT, Removal and Installation).
4. Disconnect the quick release couplings and remove the PCV tube.  
Refer to: [Quick Release Coupling](#) (310-00D Fuel System - General Information - 5.0L 32V Ti-VCT, General Procedures).



1. If equipped, disconnect the vacuum hose.
2. Disconnect the brake booster vacuum supply tube quick release coupling.  
Refer to: [Quick Release Coupling](#) (310-00D Fuel System - General Information - 5.0L 32V Ti-VCT, General Procedures).

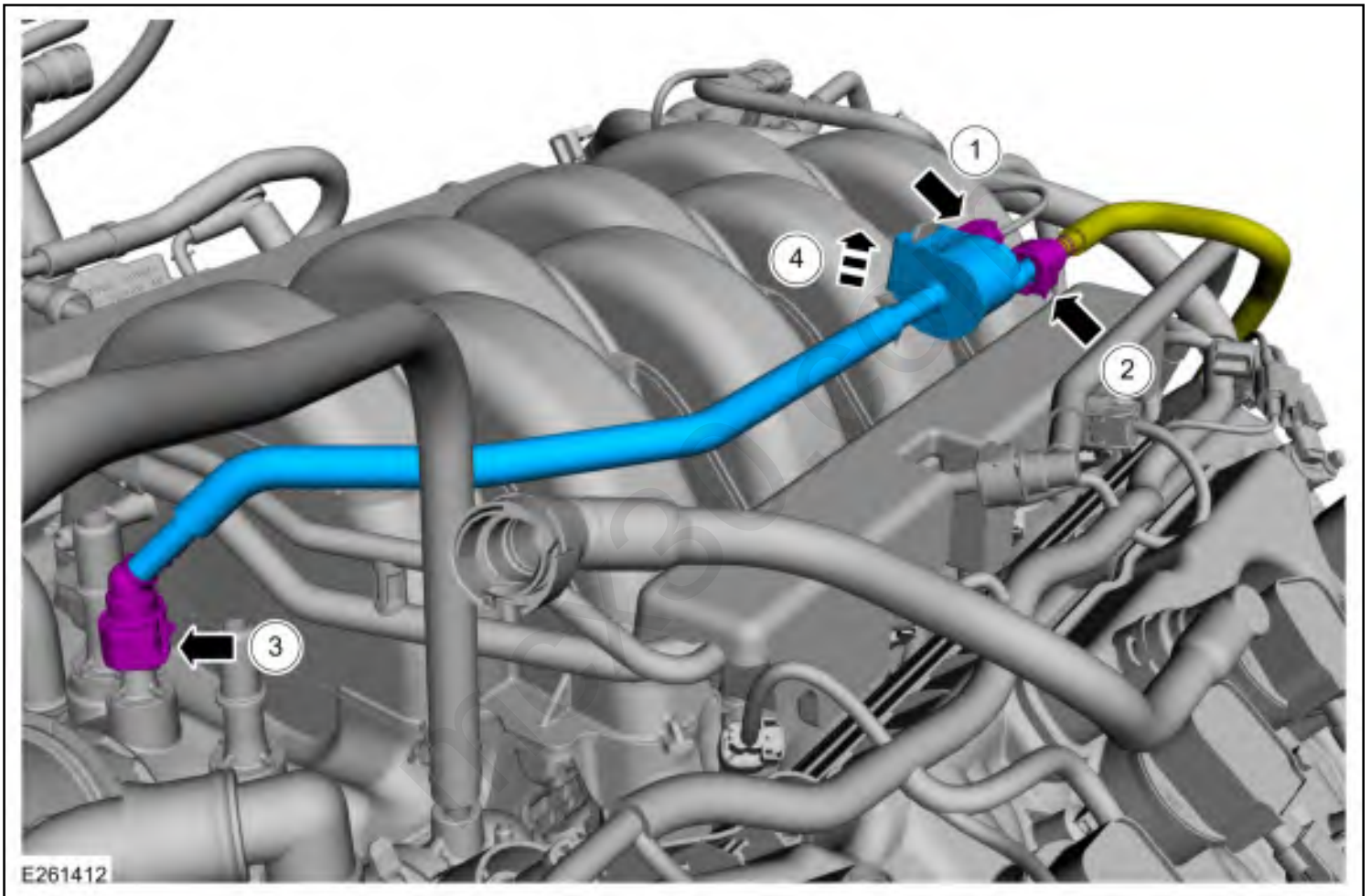


1. Disconnect the vacuum tube quick release couplings.  
Refer to: [Quick Release Coupling](#) (310-00D Fuel System - General Information - 5.0L 32V Ti-VCT, General Procedures).
2. Detach the vacuum tube retainer and remove the vacuum tube assembly.



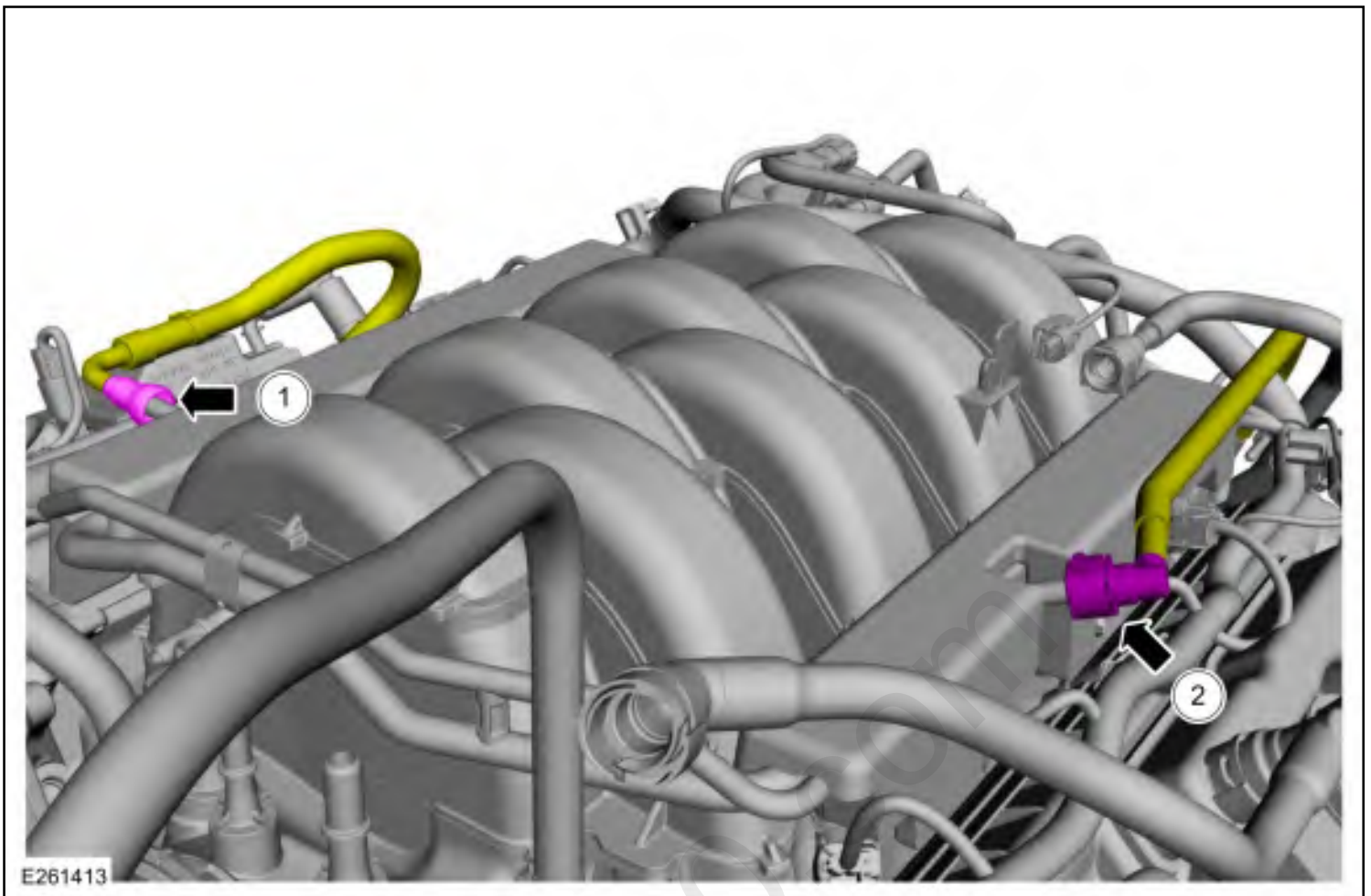


1. Disconnect the EVAP canister purge valve electrical connector.
2. Disconnect the EVAP canister purge valve tube.  
Refer to: [Quick Release Coupling](#) (310-00D Fuel System - General Information - 5.0L 32V Ti-VCT, General Procedures).
3. Disconnect the EVAP canister purge valve tube.  
Refer to: [Quick Release Coupling](#) (310-00D Fuel System - General Information - 5.0L 32V Ti-VCT, General Procedures).
4. Slide the EVAP canister purge valve off of the intake manifold.

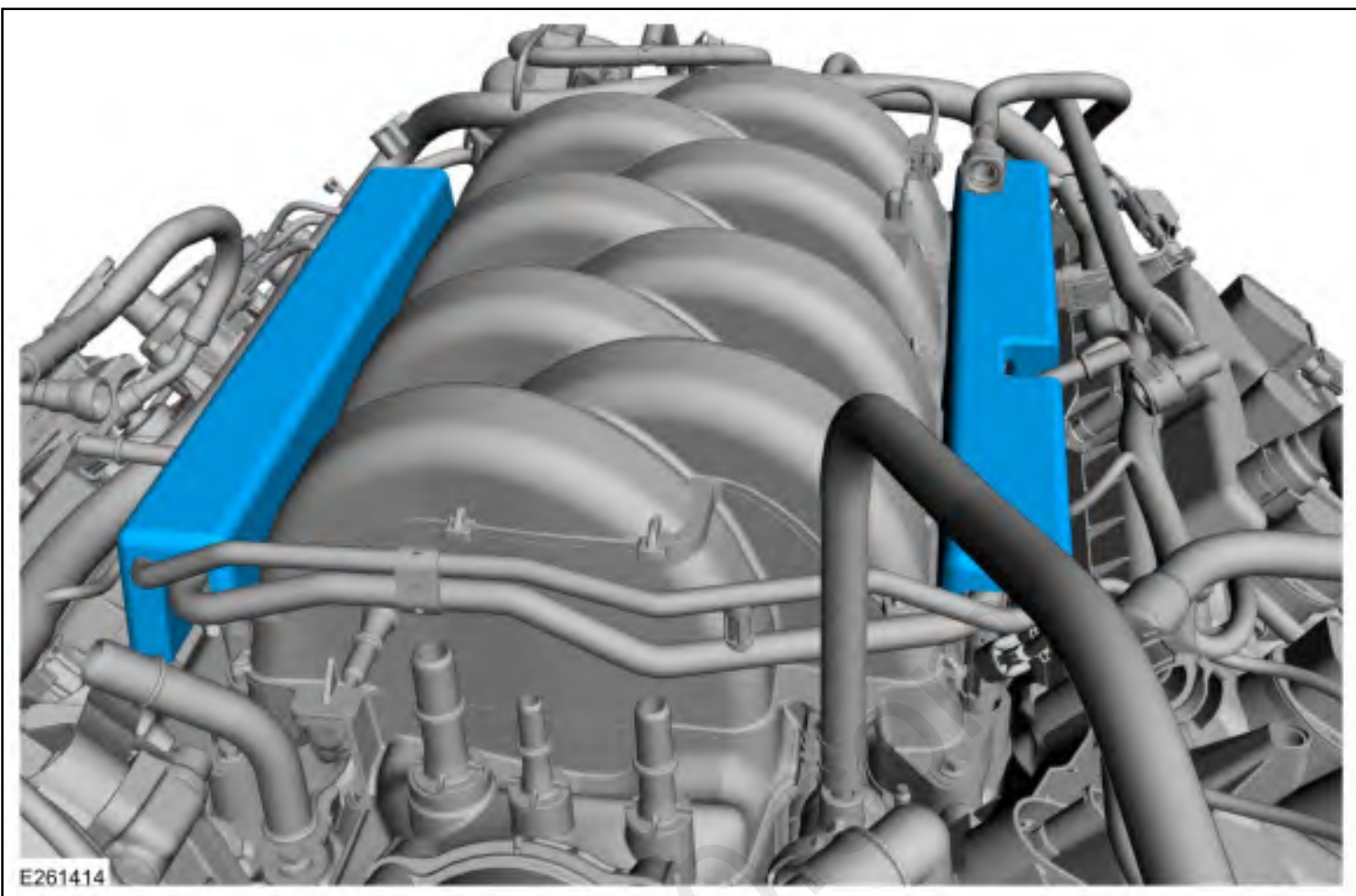


1. Disconnect the fuel tube spring lock coupling.
2. Disconnect the fuel tube quick release coupling.  
Refer to: [Quick Release Coupling](#) (310-00D Fuel System - General Information - 5.0L 32V Ti-VCT, General Procedures).

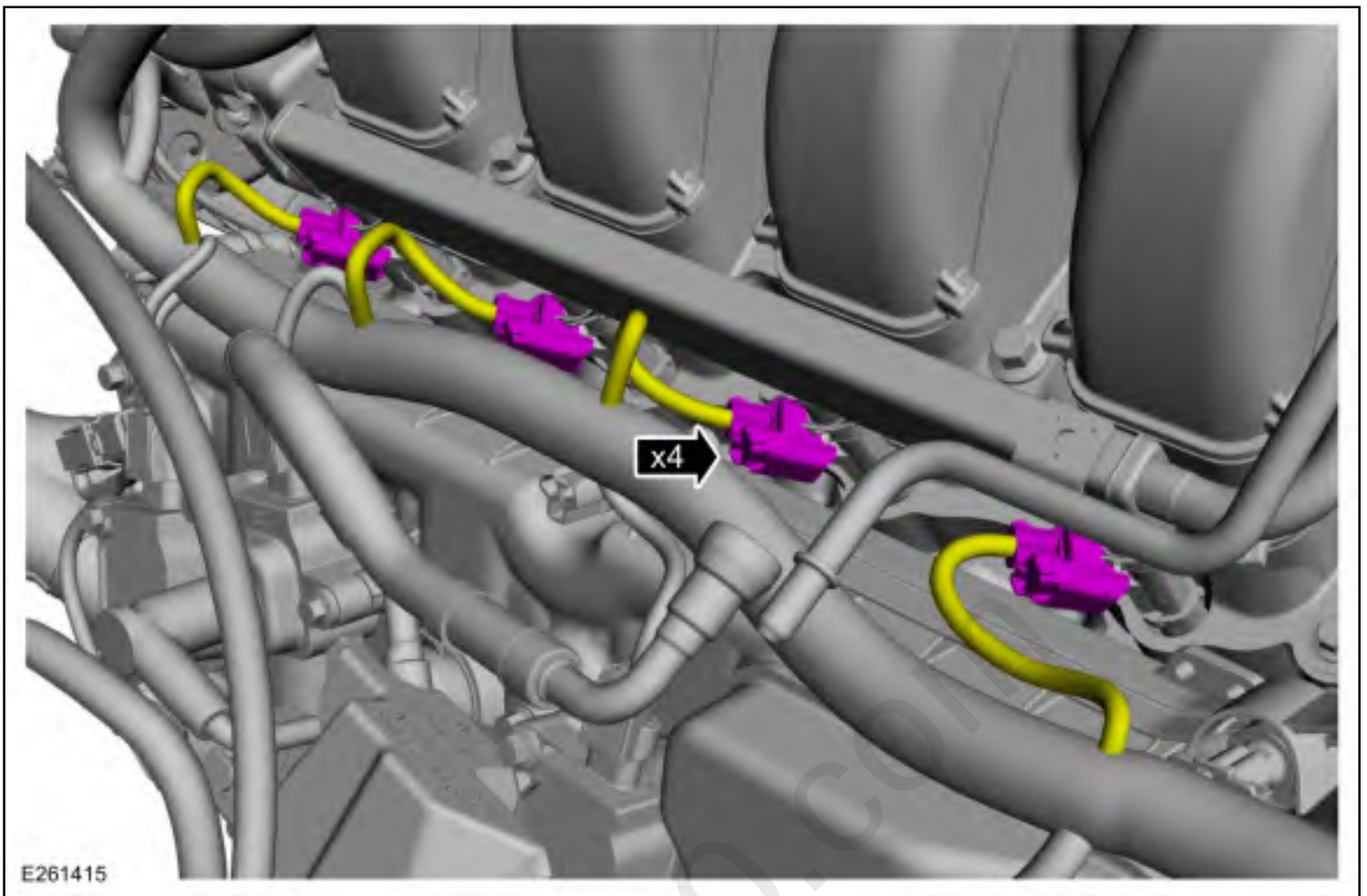




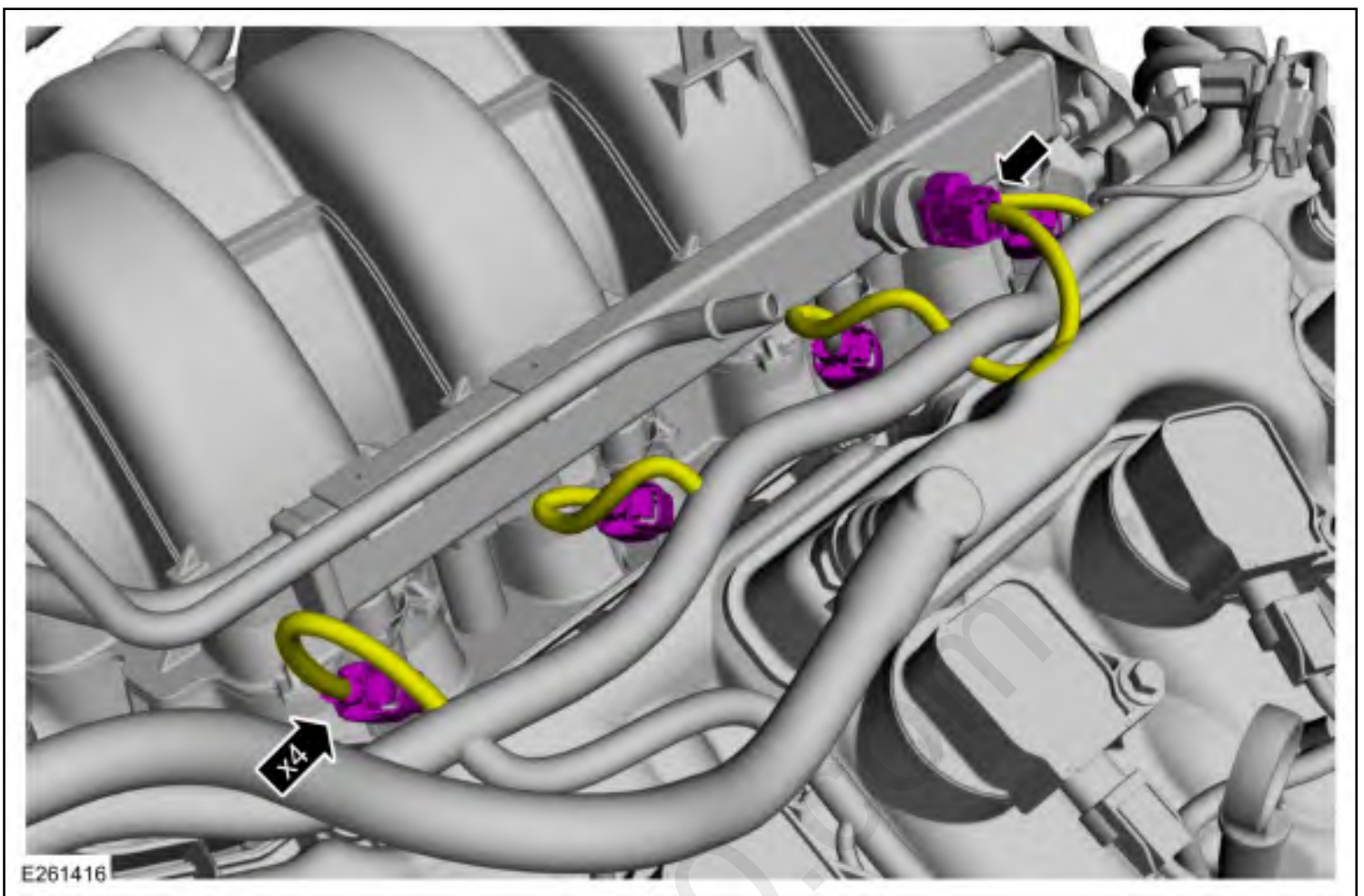
9. Remove the fuel rail insulators.



10. Disconnect the RH fuel injector electrical connectors.



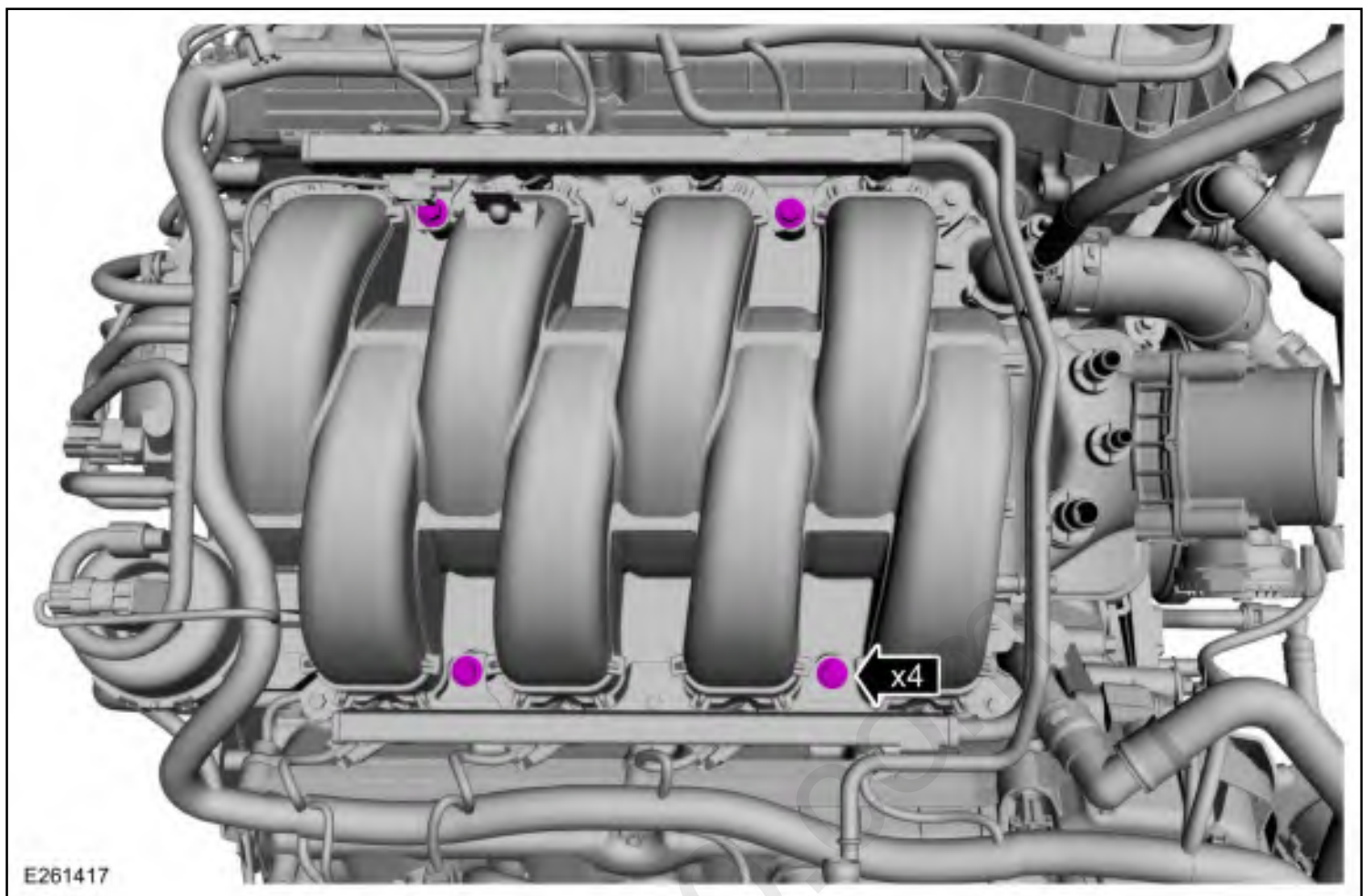
11. Disconnect the LH fuel injector electrical connectors and the fuel sensor electrical connector.



12. **NOTE:** *It is not necessary to remove the fuel rail from the intake manifold assembly.*

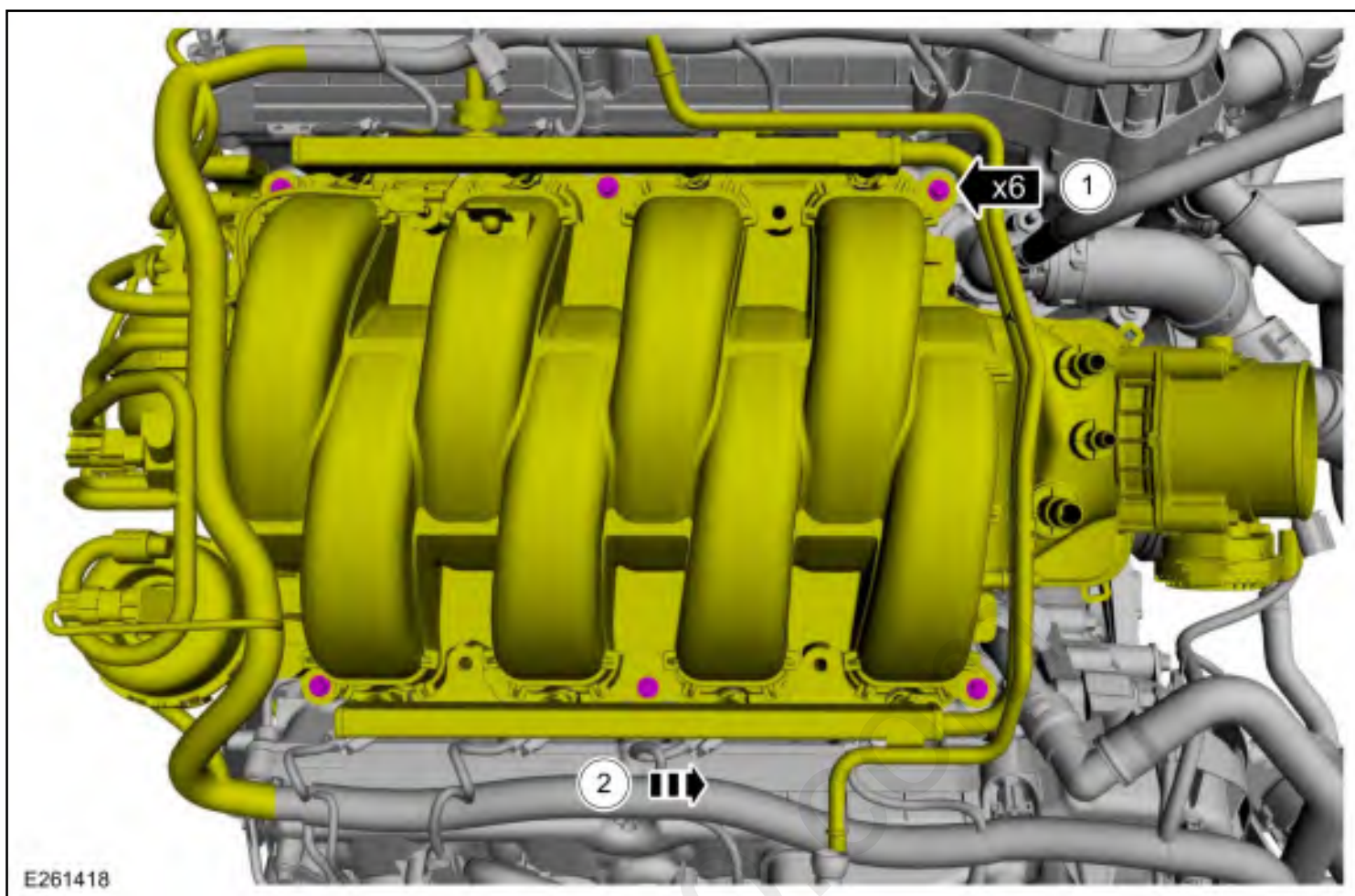
Remove the fuel rail bolts.



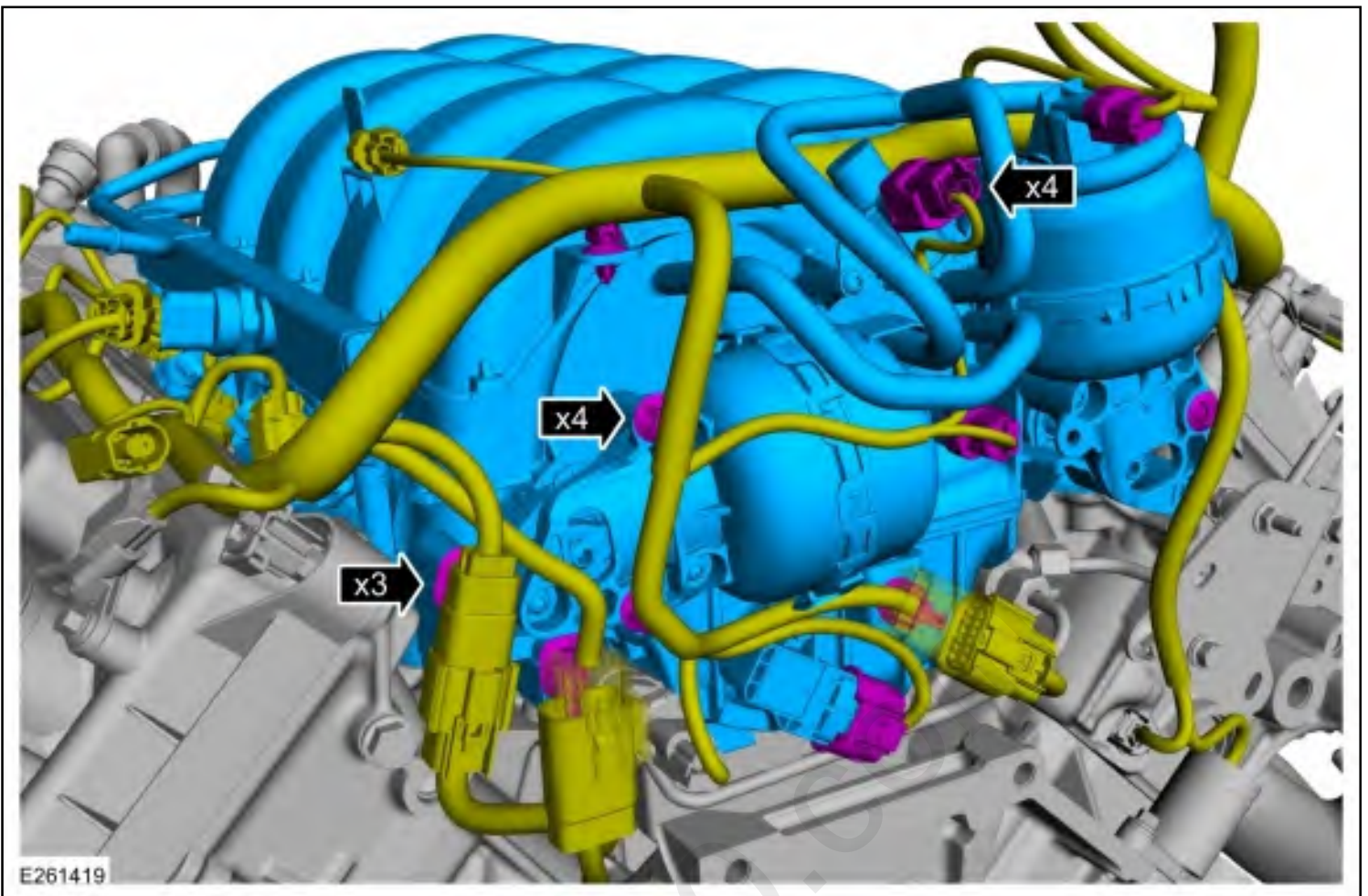


1. Loosen the intake manifold bolts.
2. Position the manifold up and towards the front of the engine to access the rear of the manifold.





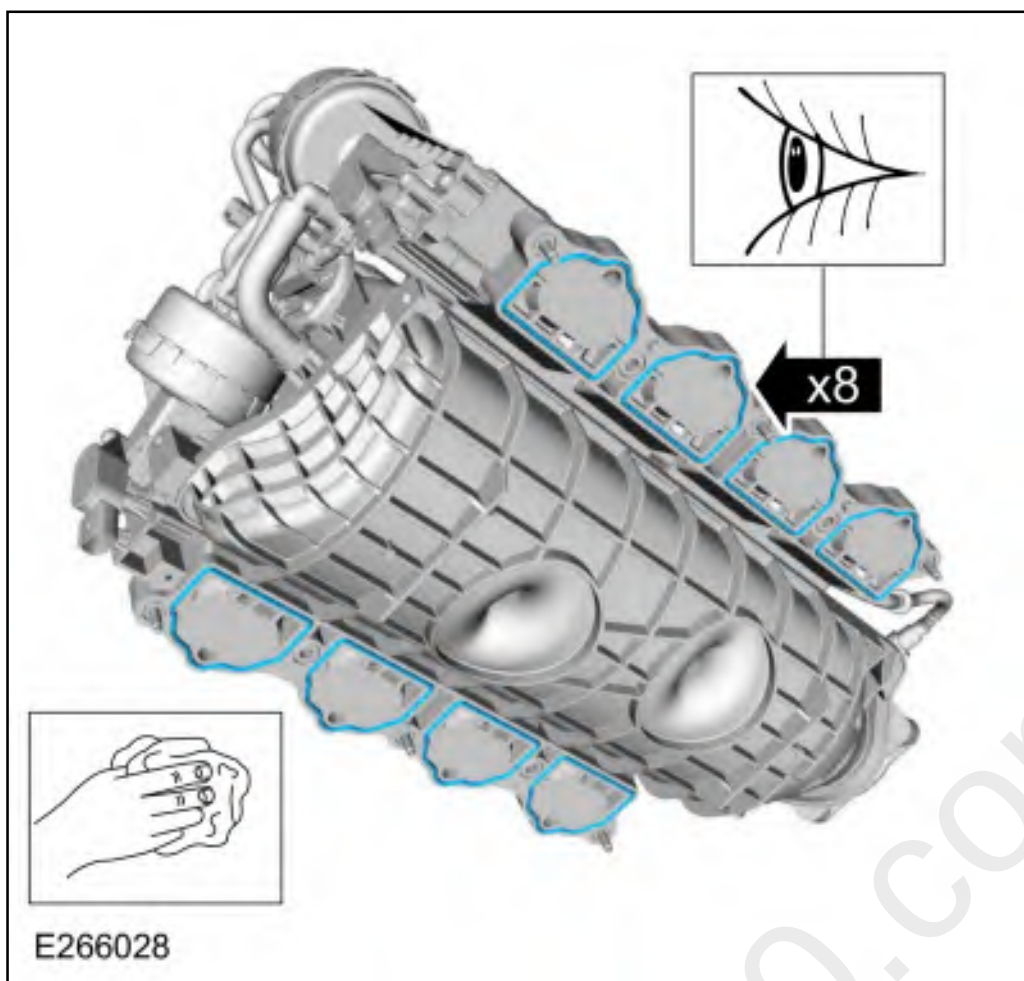
- Disconnect the wiring harness electrical connectors.
- Detach the wiring harness retainers
- Remove the intake manifold.



- **NOTE:** Visually inspect the manifold gaskets for nicks, cuts and abrasions. If these conditions are NOT present, the gaskets may be re-used.

Remove and inspect the gaskets.

- Clean and inspect all sealing surfaces.



## Installation

**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.

**NOTE:** To install, reverse the removal procedure.

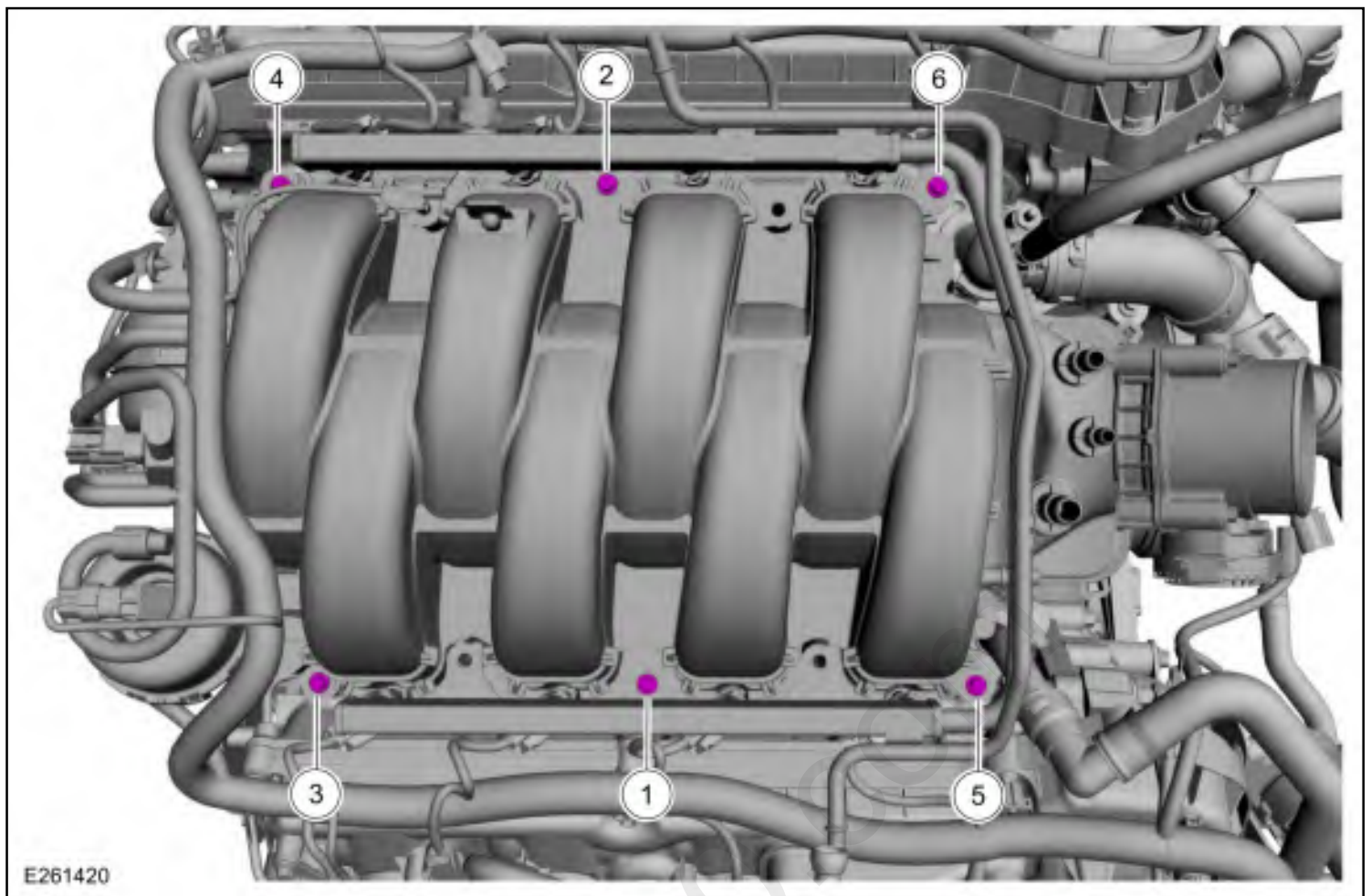
1. Tighten the intake manifold bolts.

*Torque:*

Stage 1: 102 lb.in (11.5 Nm)

Stage 2: 35°



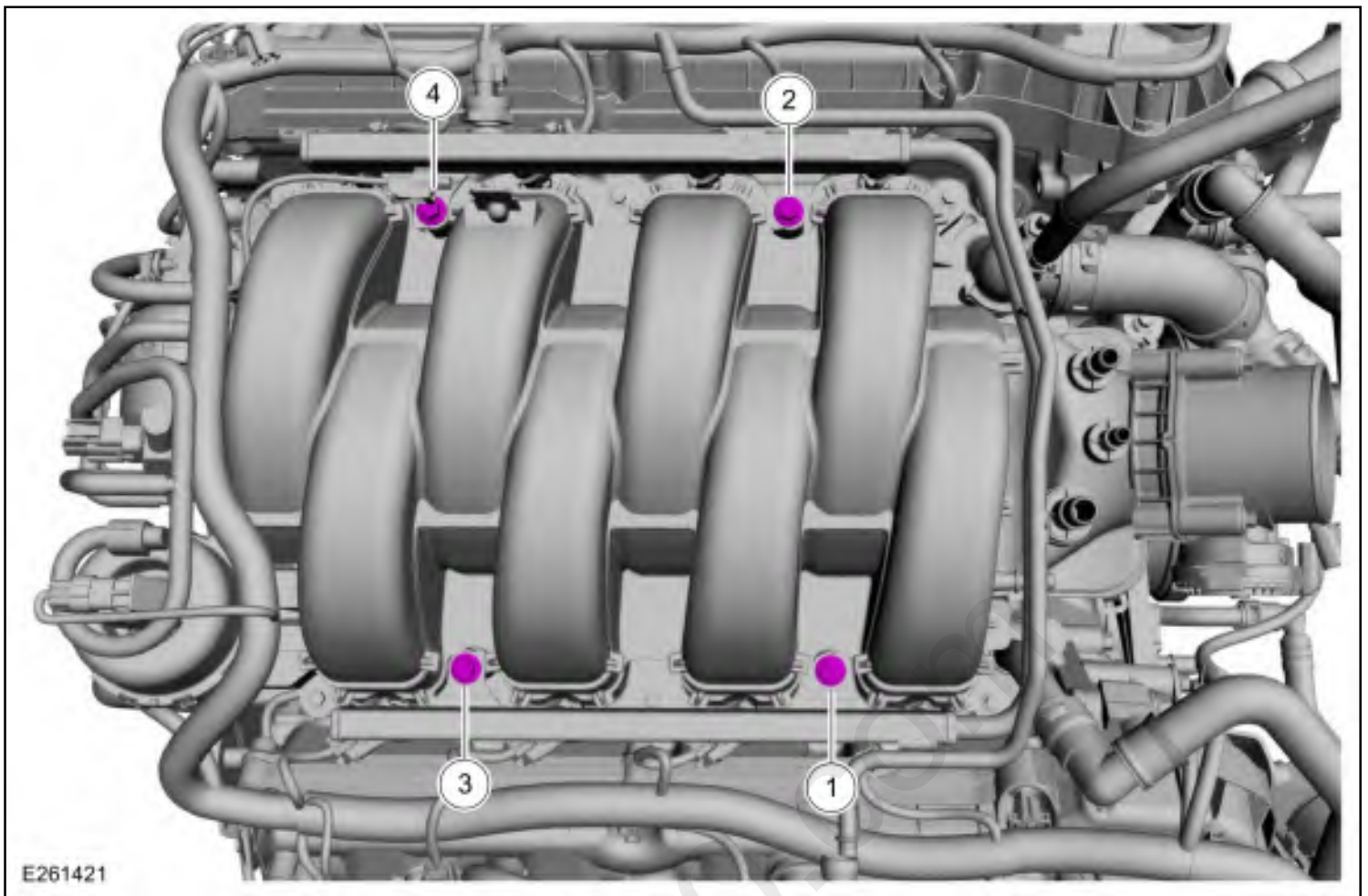


2. Install the fuel rail bolts.

*Torque:*

Stage 1: 89 lb.in (10 Nm)

Stage 2: 90°



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## Timing Chain

### Special Tool(s) / General Equipment

|                                                                                  |                                                                                    |
|----------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
|  | 303-448 (T93P-6303-A)<br>Holding Tool, Crankshaft<br>TKIT-1993-FLM<br>TKIT-1993-LM |
|----------------------------------------------------------------------------------|------------------------------------------------------------------------------------|

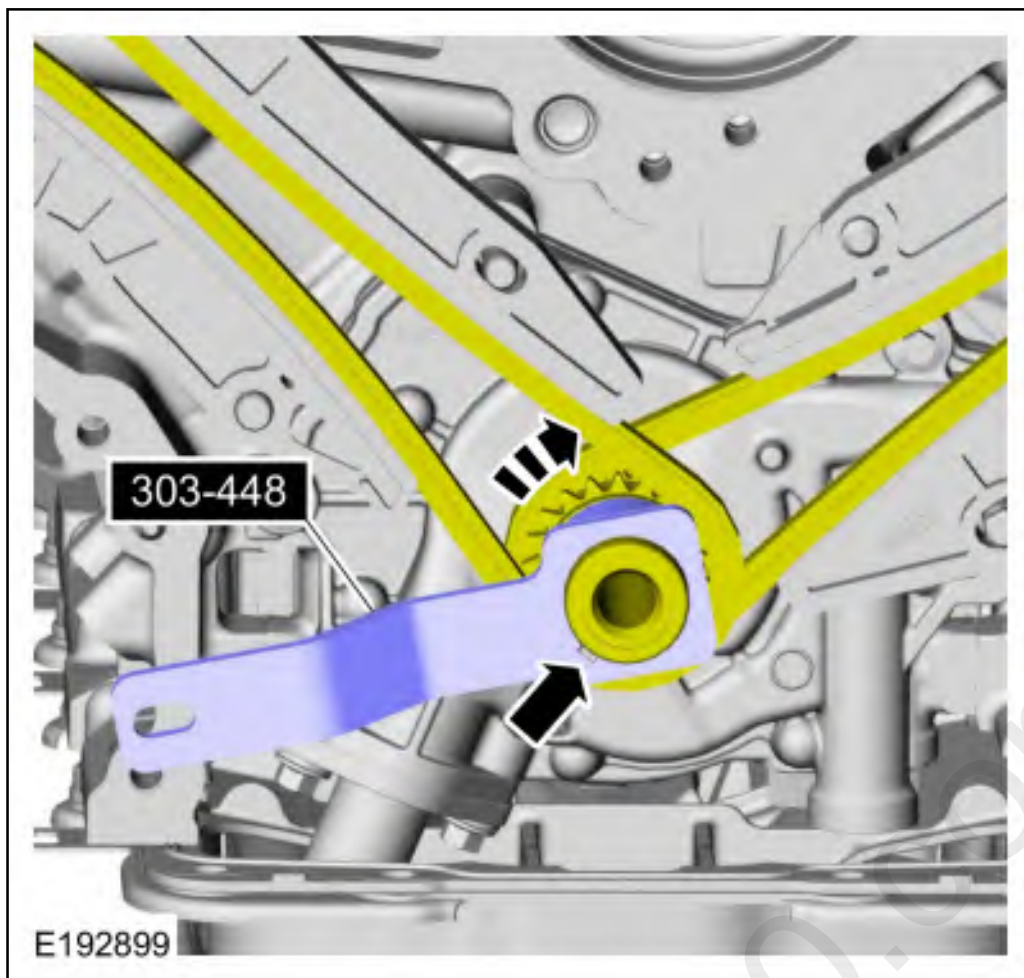
### Removal

**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.

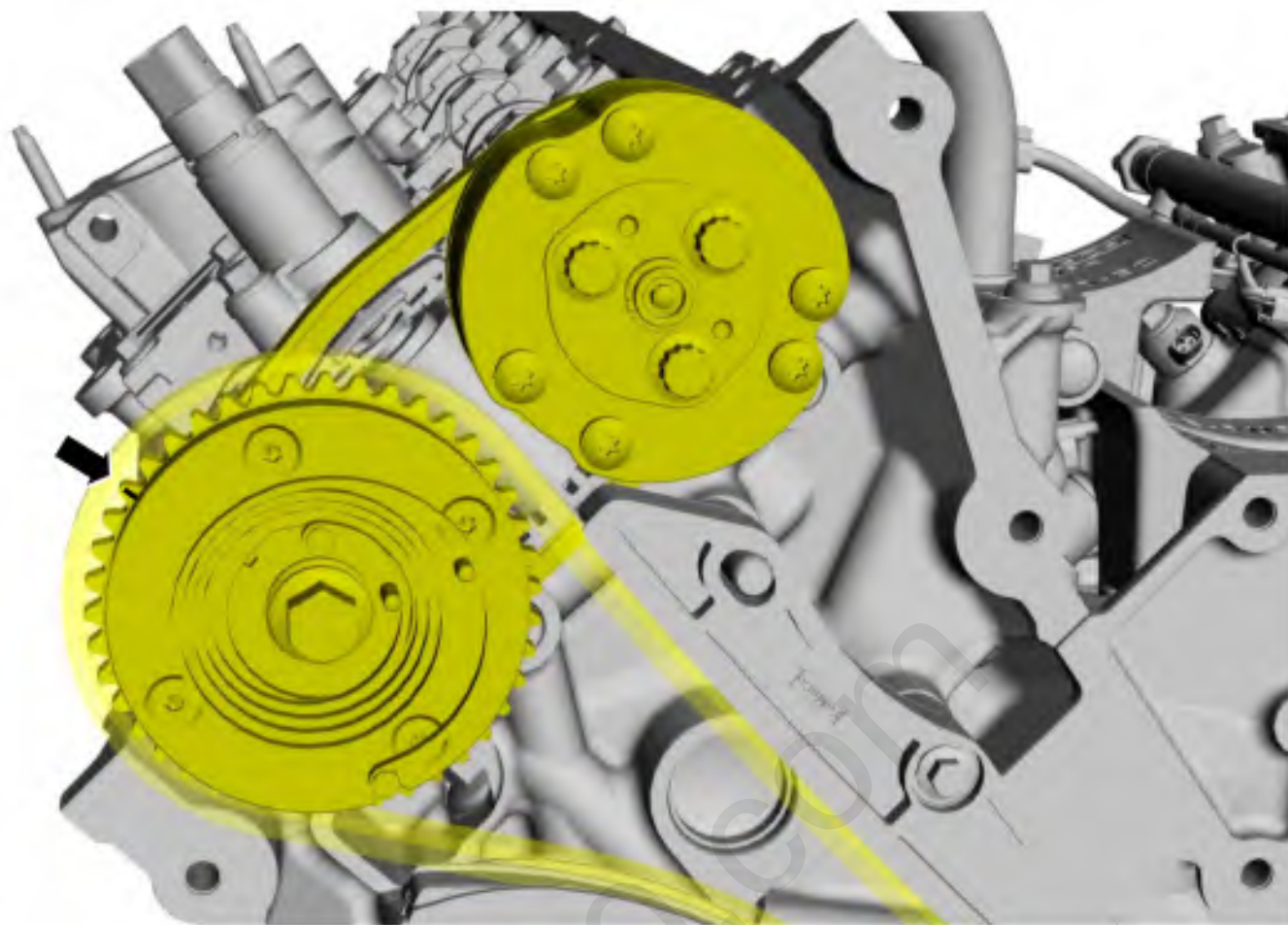
**NOTE:** In order to remove the LH timing chain, the RH timing chain must be removed first.

### RH and LH timing chains

1. Remove the engine front cover.  
Refer to: Engine Front Cover (303-01 Engine - 5.0L 32V Ti-VCT) .
2. 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.



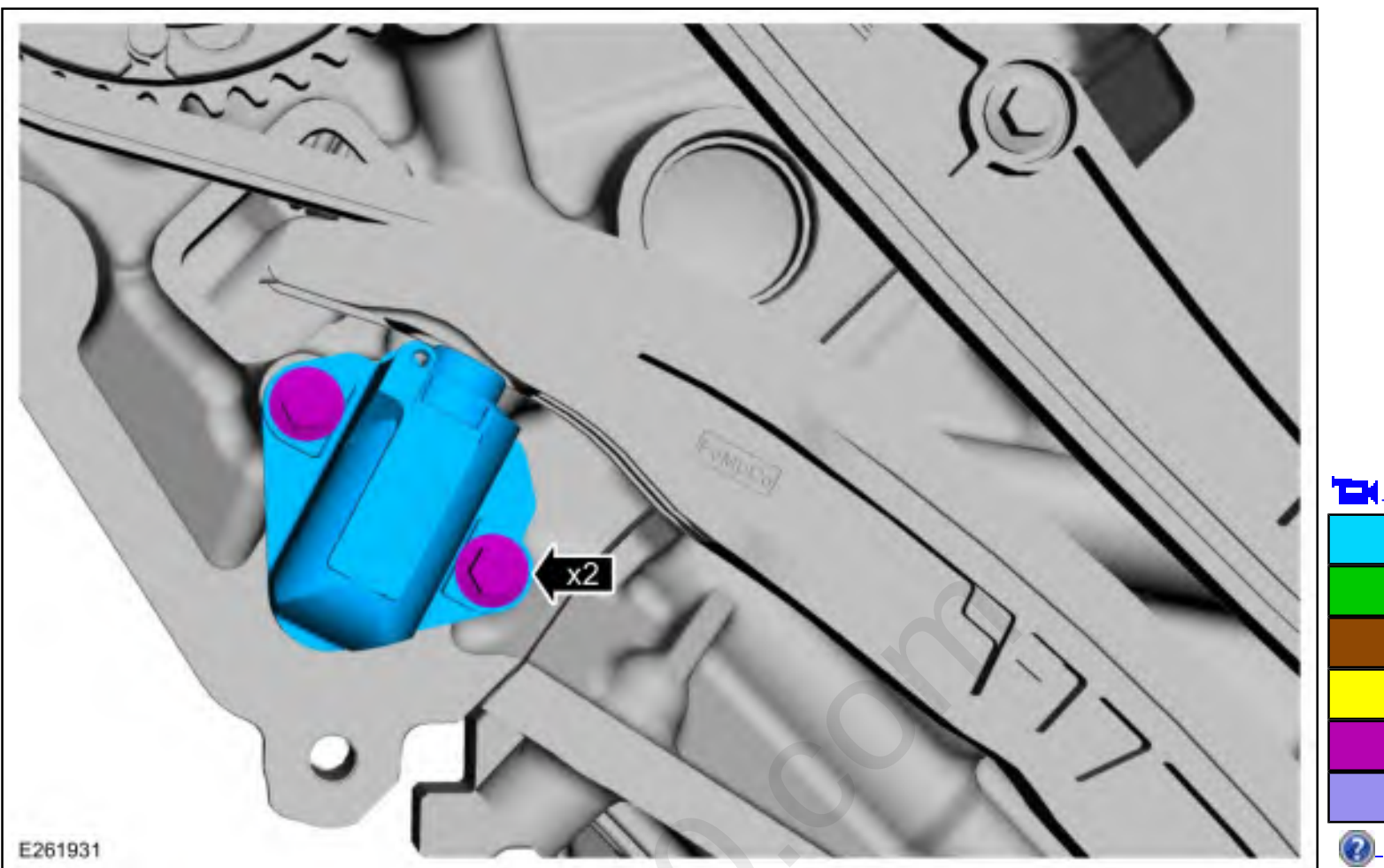
3. Verify the timing mark on the RH VCT unit is on top, if not, rotate the crankshaft clockwise one complete revolution so the keyway is at the 7:30 position.



E261930



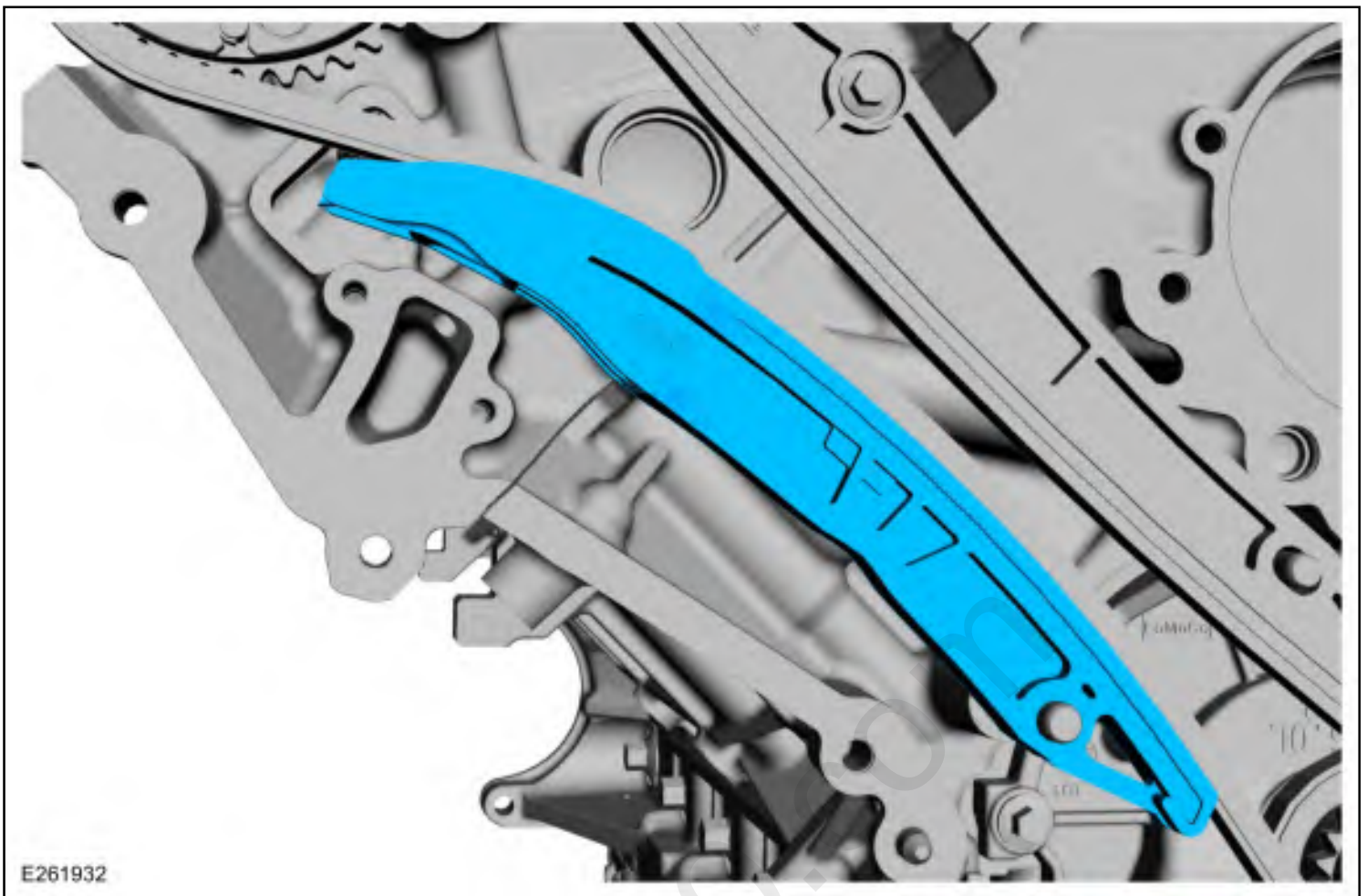
4. Remove the bolts and the RH primary timing chain tensioner.



5. **NOTE:** It may be necessary to rotate the crankshaft slightly to provide enough slack in the chain to remove the RH timing chain tensioner arm. Return the crankshaft keyway to the 7:30 position after removing the RH timing chain tensioner arm.

Remove the RH timing chain tensioner arm.

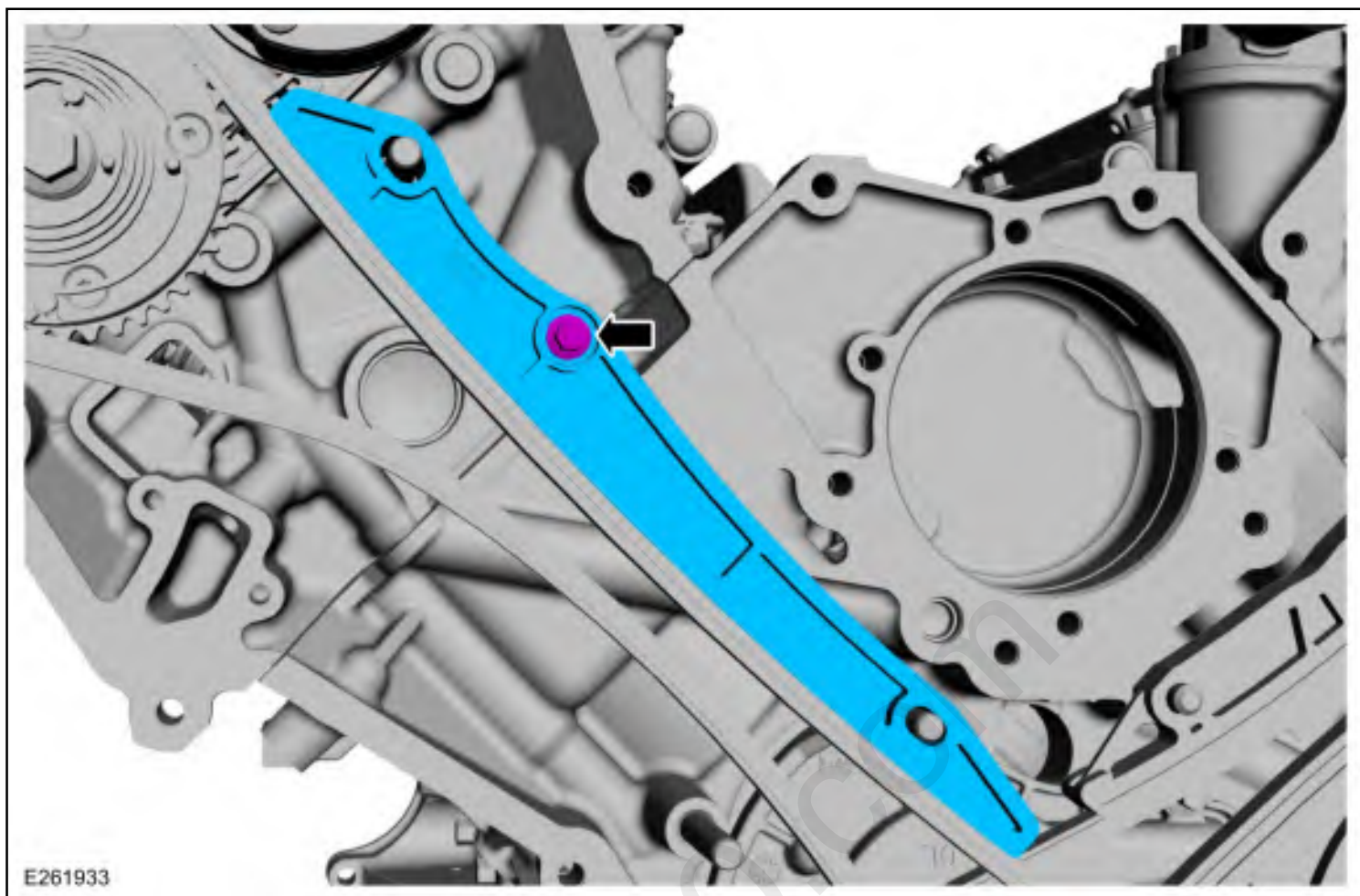




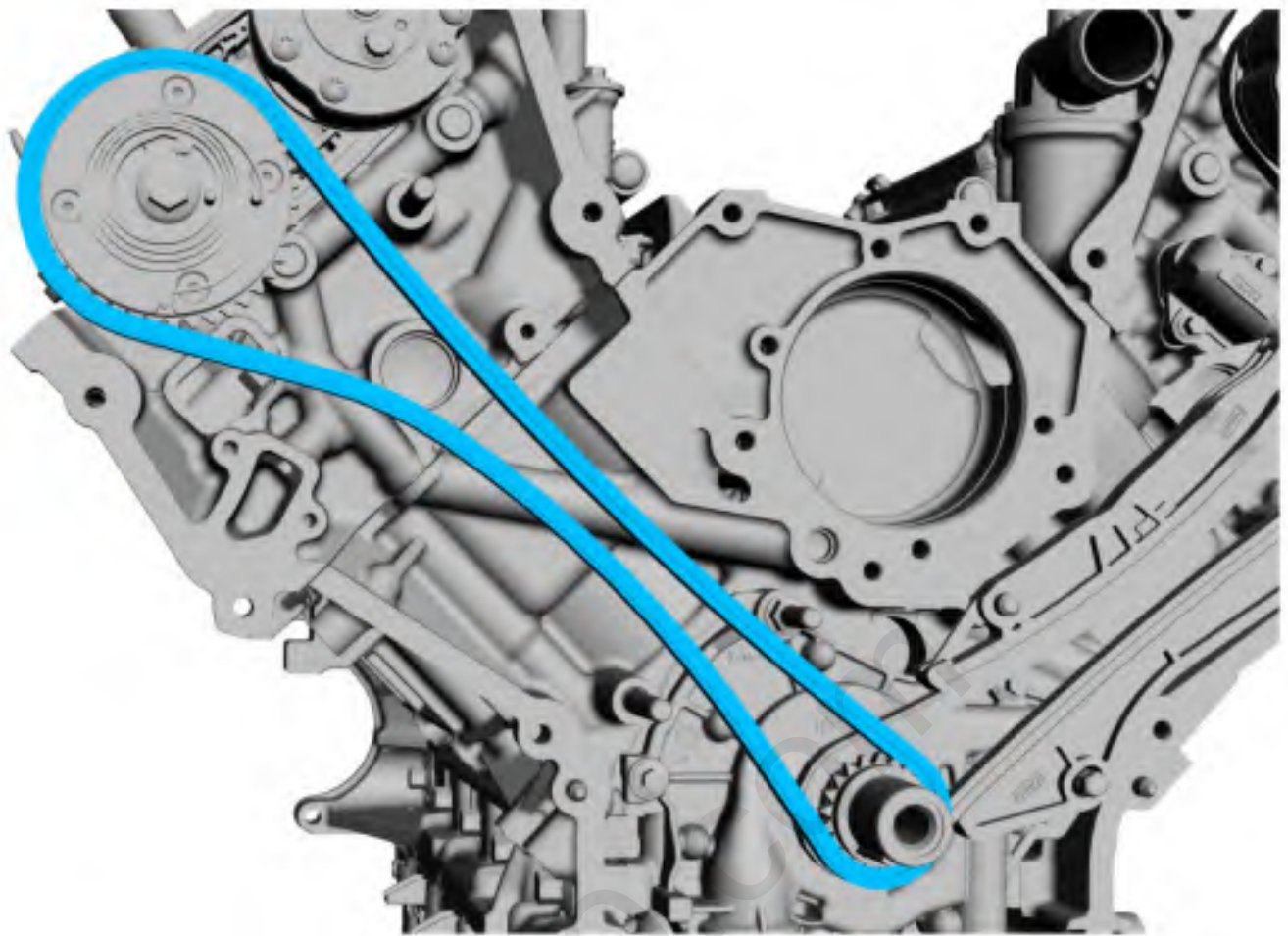
6. **NOTE:** *It may be necessary to rotate the crankshaft slightly to provide enough slack in the chain to remove the RH timing chain guide. Return the crankshaft keyway to the 7:30 position after removing the RH timing chain guide.*

Remove the bolt and the RH timing chain guide.





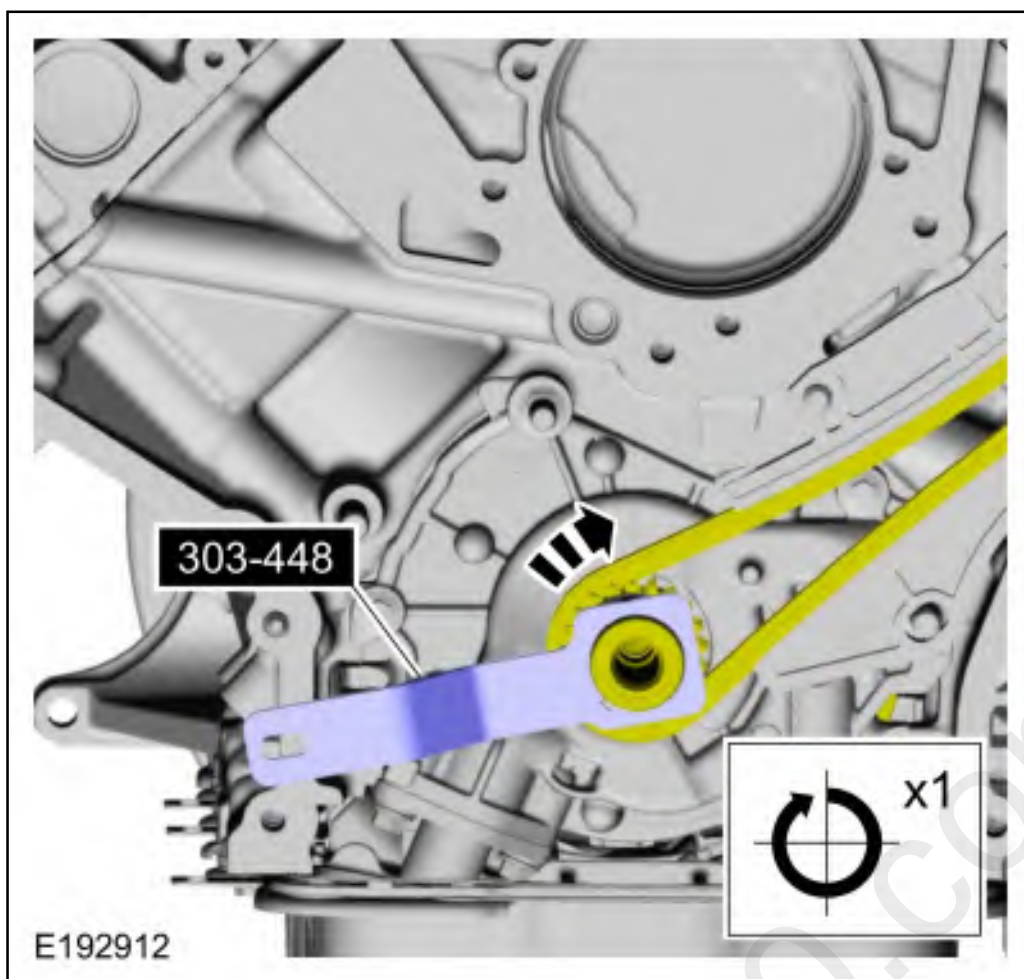
7. Remove the RH timing chain.



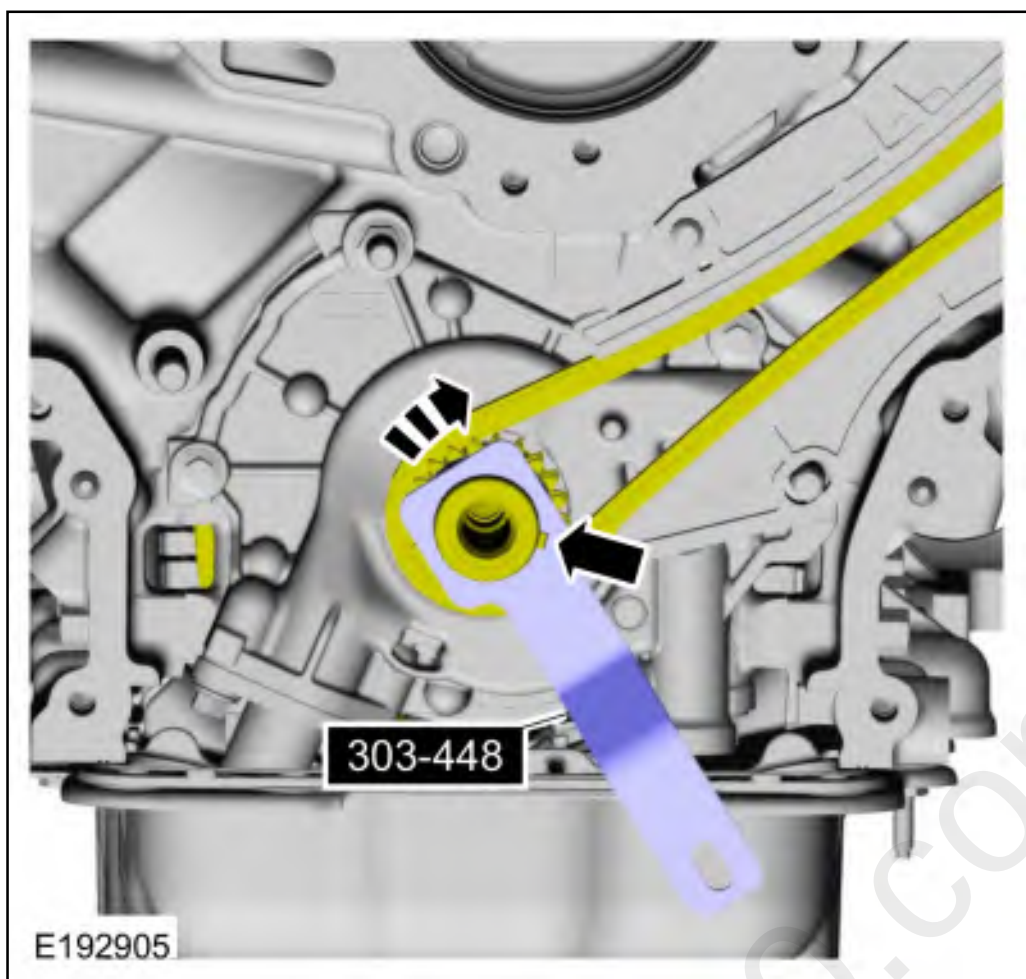
E261934

## LH timing chain

8. Using the special tool, rotate the crankshaft clockwise one complete revolution.  
Use Special Service Tool: 303-448 (T93P-6303-A) Holding Tool, Crankshaft.

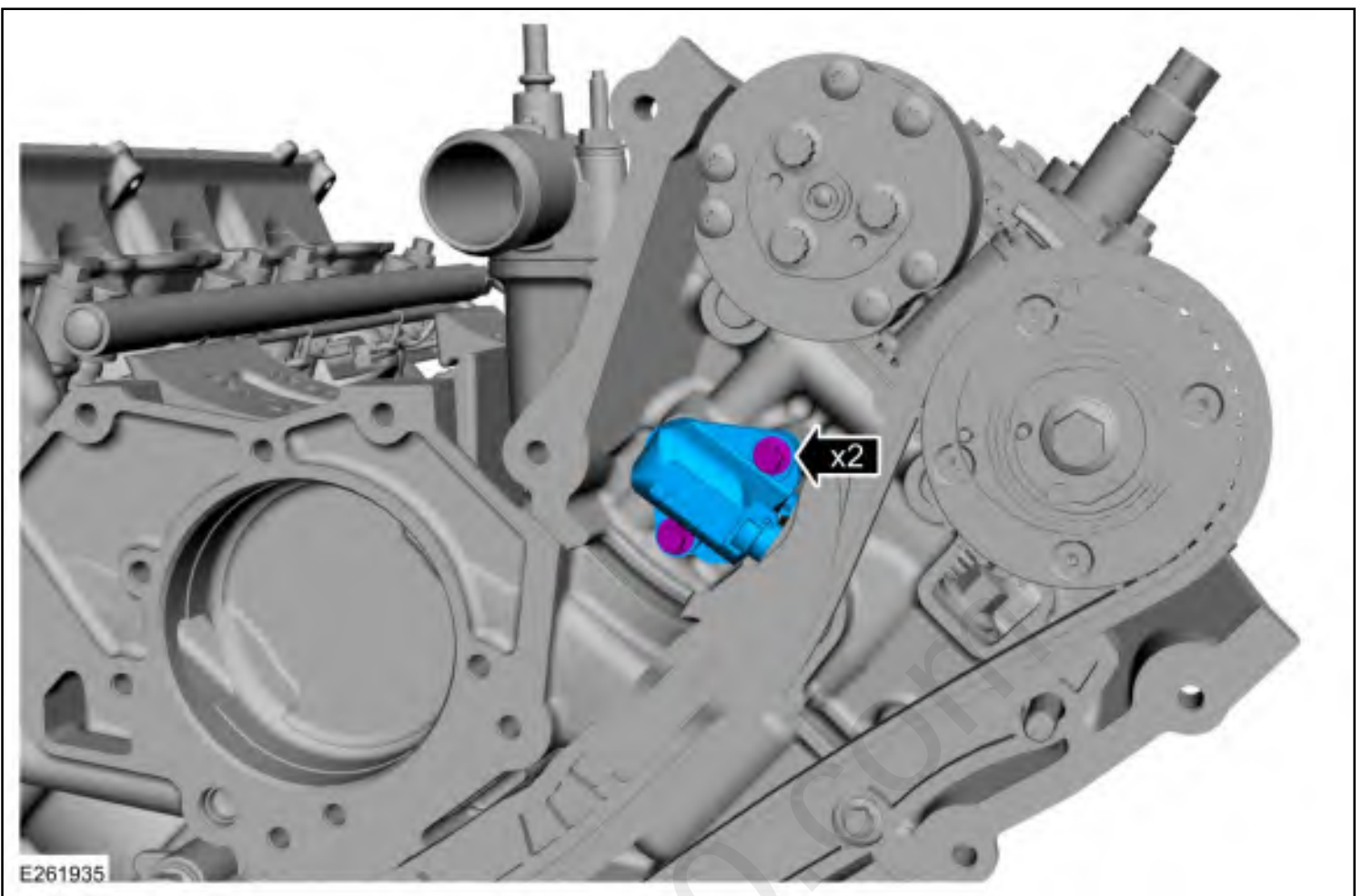


9. Using the special tool, rotate the crankshaft clockwise until the keyway is at the 3:30 position.  
Use Special Service Tool: 303-448 (T93P-6303-A) Holding Tool, Crankshaft.



10. Remove the bolts and the LH primary timing chain tensioner.

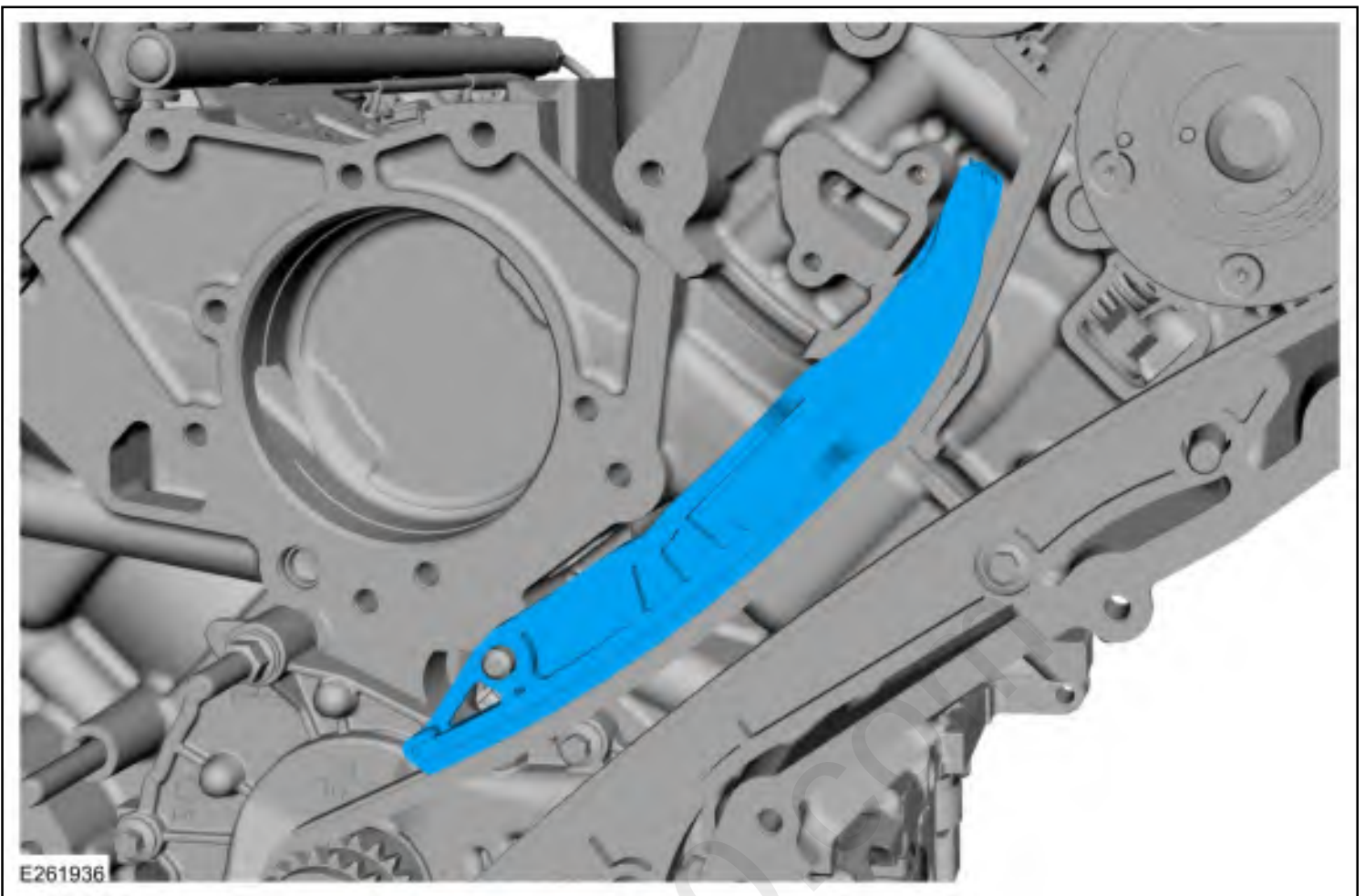




11. **NOTE:** *It may be necessary to rotate the crankshaft slightly to provide enough slack in the chain to remove the LH timing chain tensioner arm. Return the crankshaft keyway to the 3:30 position after removing the LH timing chain tensioner arm.*

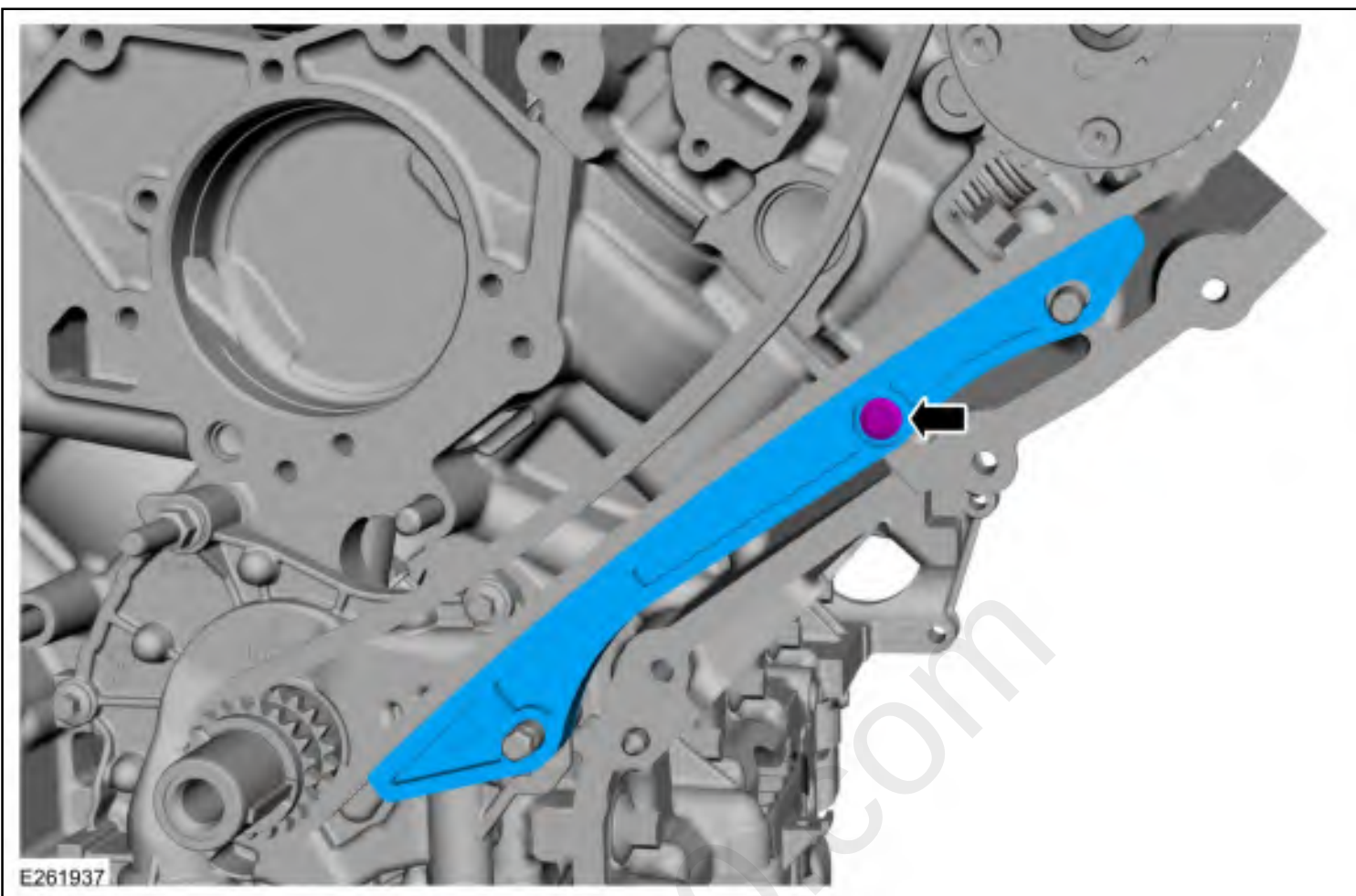
Remove the LH timing chain tensioner arm.



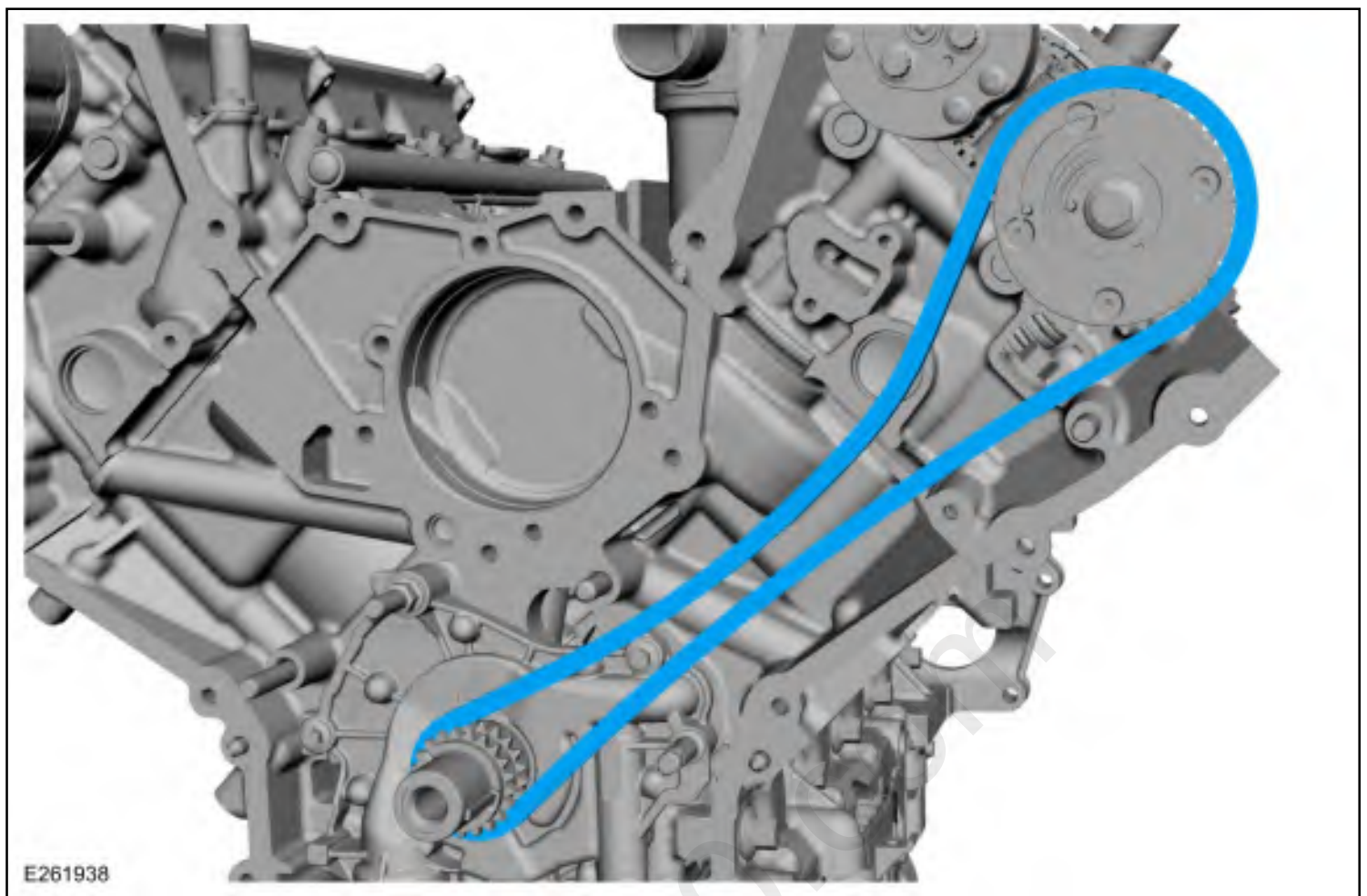


12. **NOTE:** *It may be necessary to rotate the crankshaft slightly to provide enough slack in the chain to remove the LH timing chain guide. Return the crankshaft keyway to the 3:30 position after removing the LH timing chain guide.*

Remove the bolt and the LH timing chain guide.



13. Remove the LH timing chain.

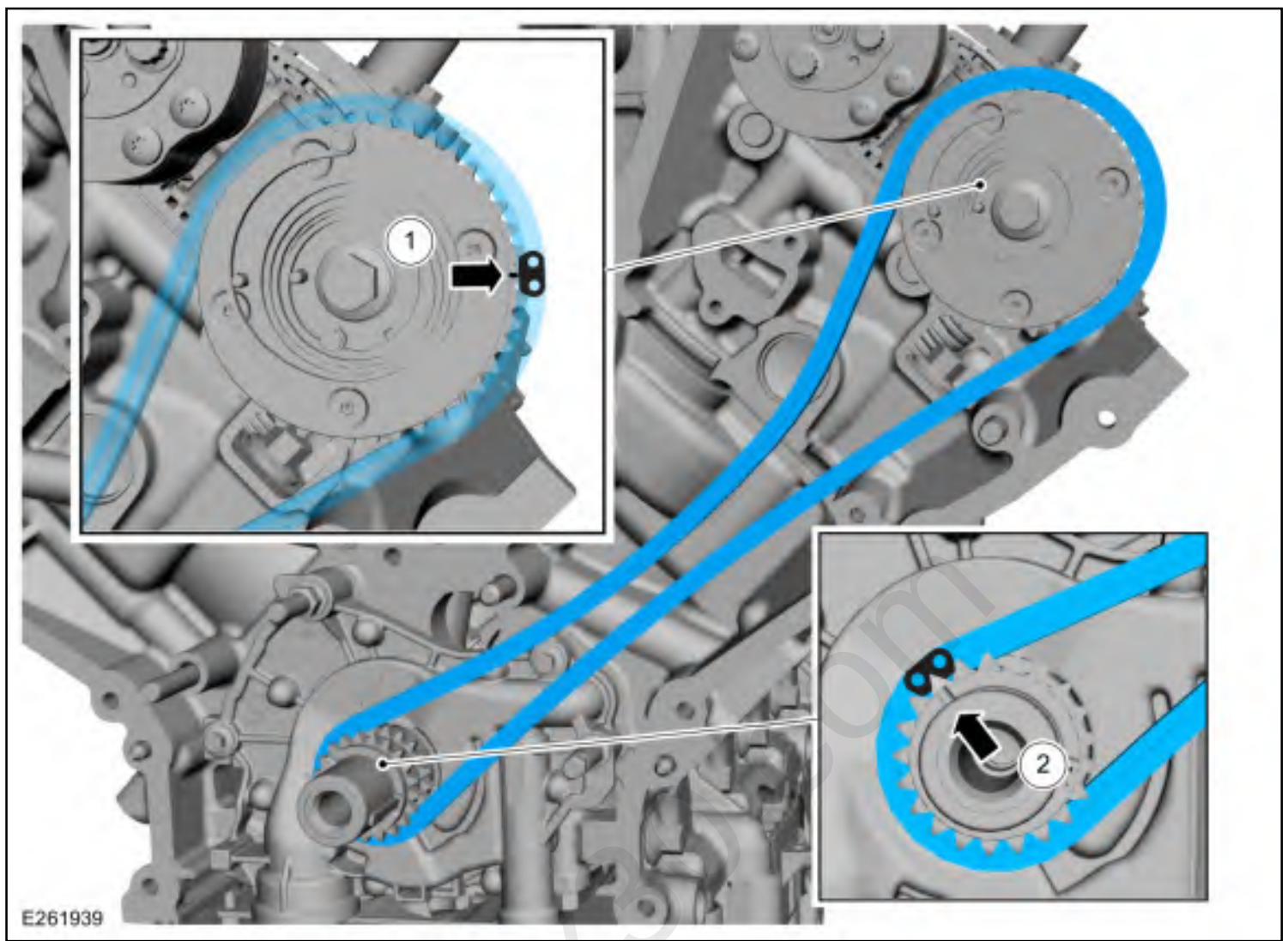


## Installation

### LH timing chain

1. 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.





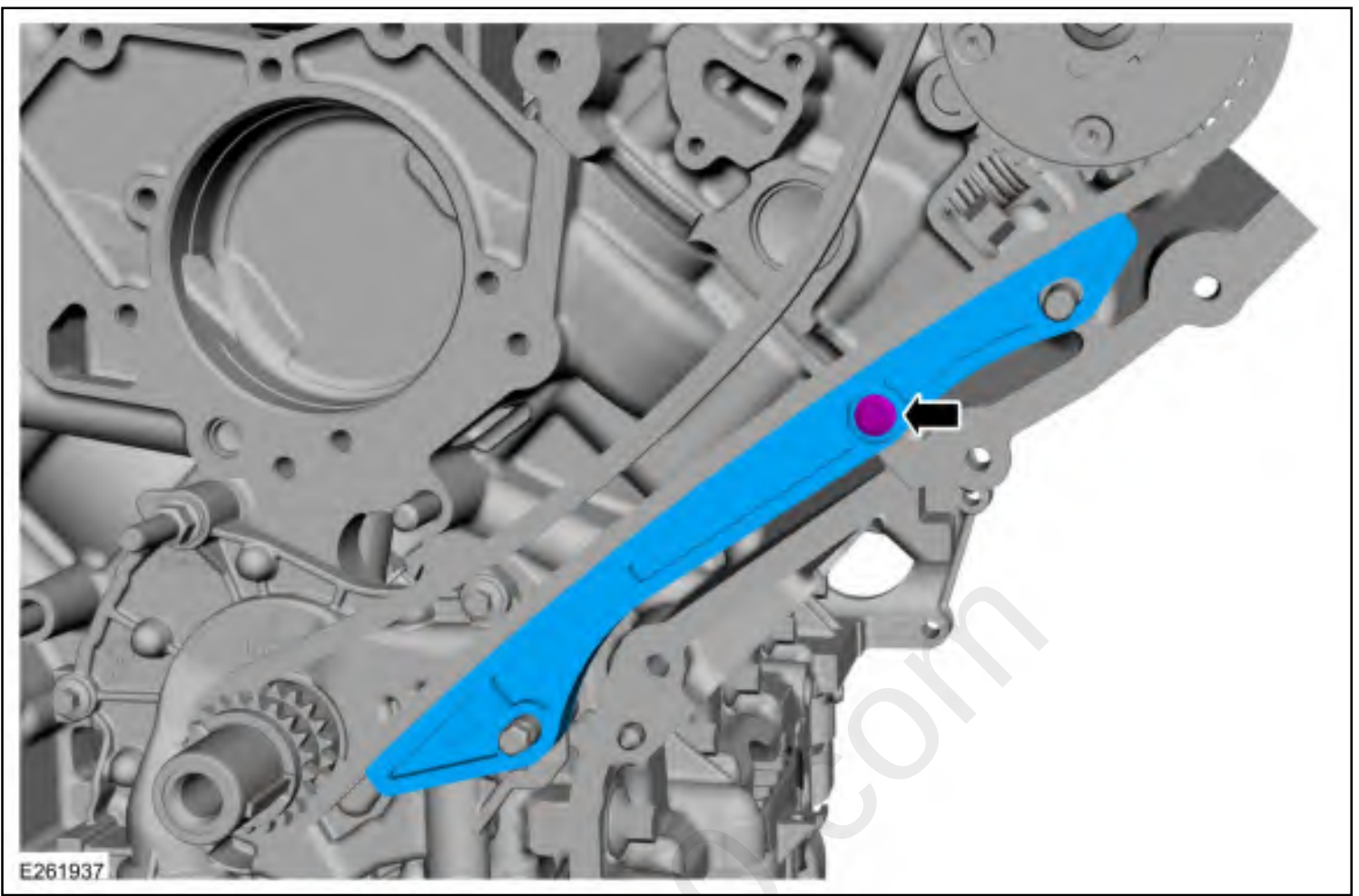
2. **NOTE:** It may be necessary to rotate the crankshaft slightly to provide enough slack in the chain to install the LH timing chain guide. Return the crankshaft keyway to the 3:30 position after installing the LH timing chain guide.

Install the LH timing chain guide and bolt.

*Torque:*

Stage 1: 89 lb.in (10 Nm)

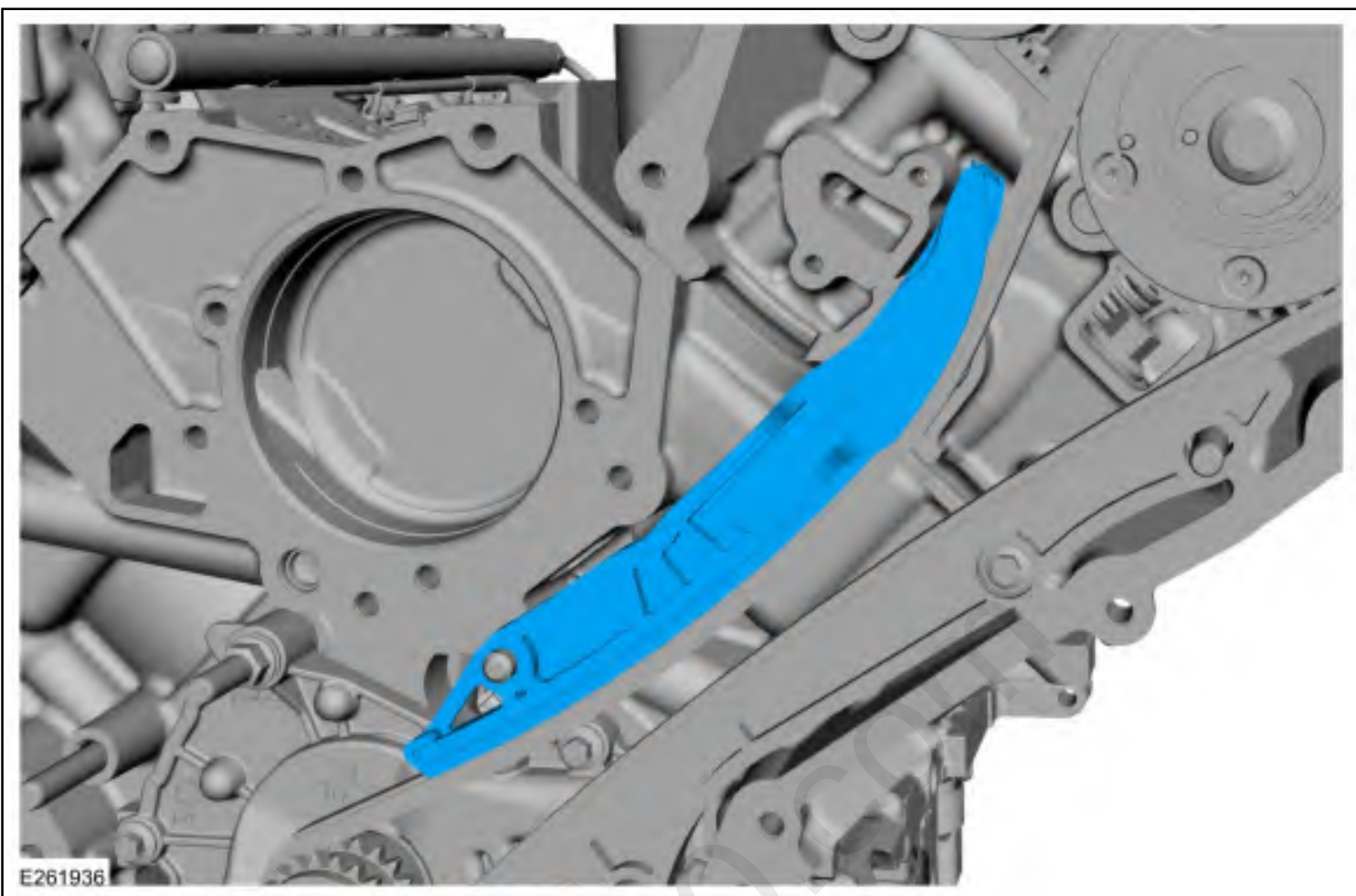
Stage 2: 25°



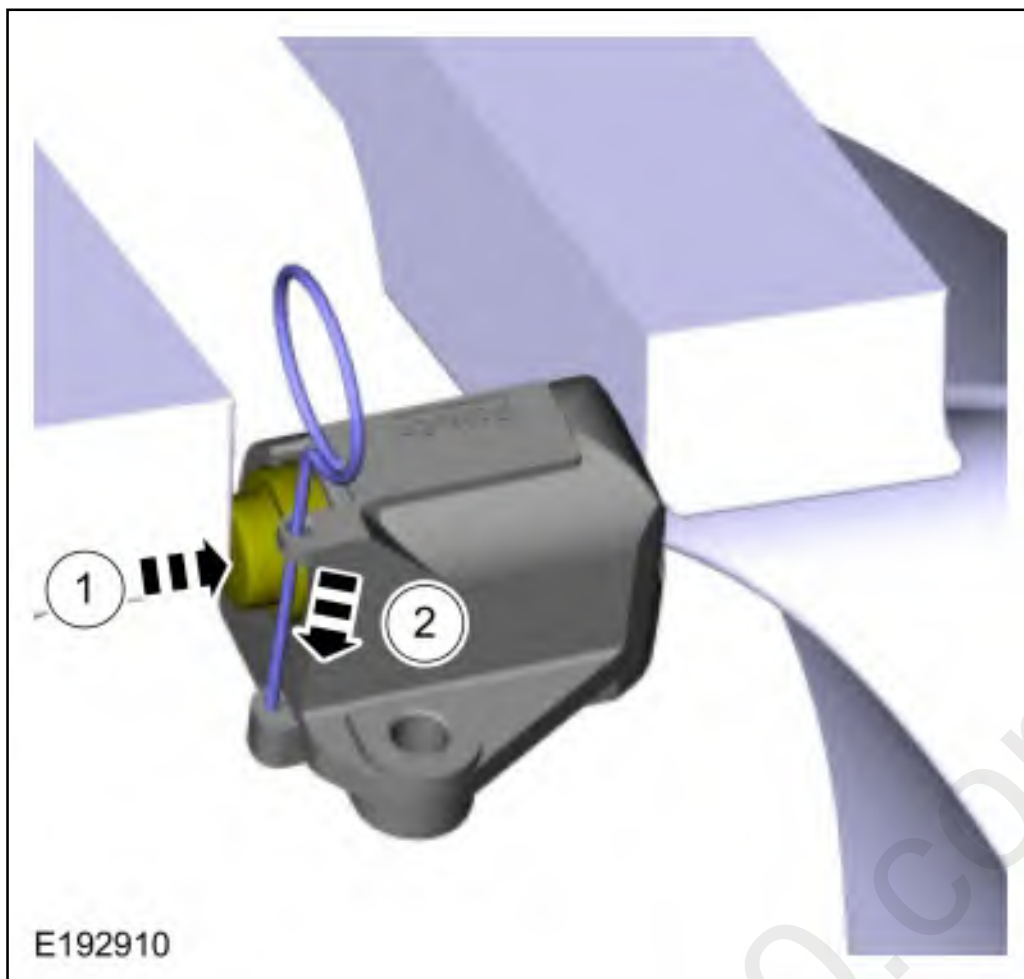
3. **NOTE:** *It may be necessary to rotate the crankshaft slightly to provide enough slack in the chain to install the LH timing chain arm. Return the crankshaft keyway to the 3:30 position after installing the LH timing chain arm.*

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.



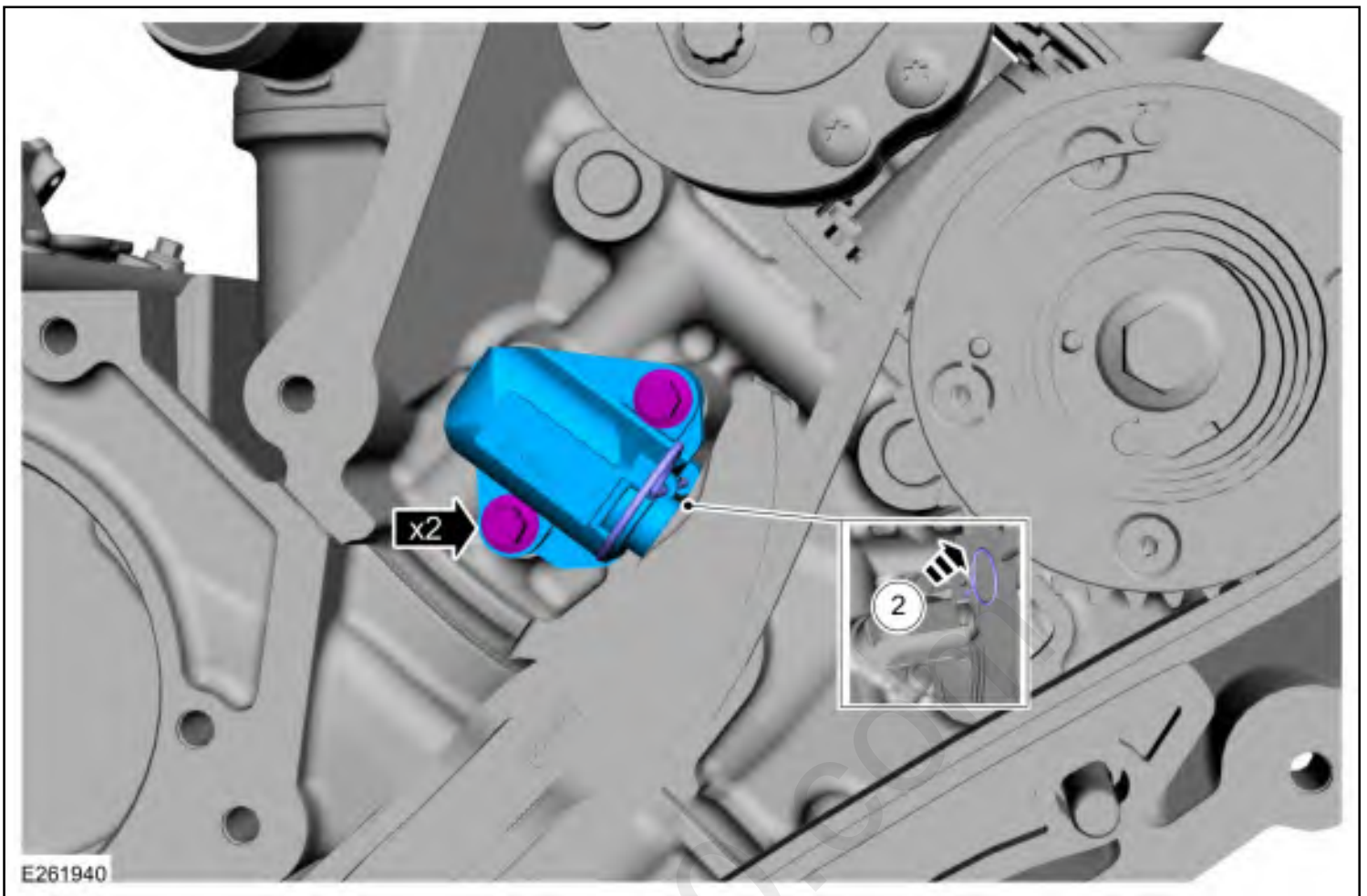
1. Install the LH primary timing chain tensioner and bolts.

*Torque:*

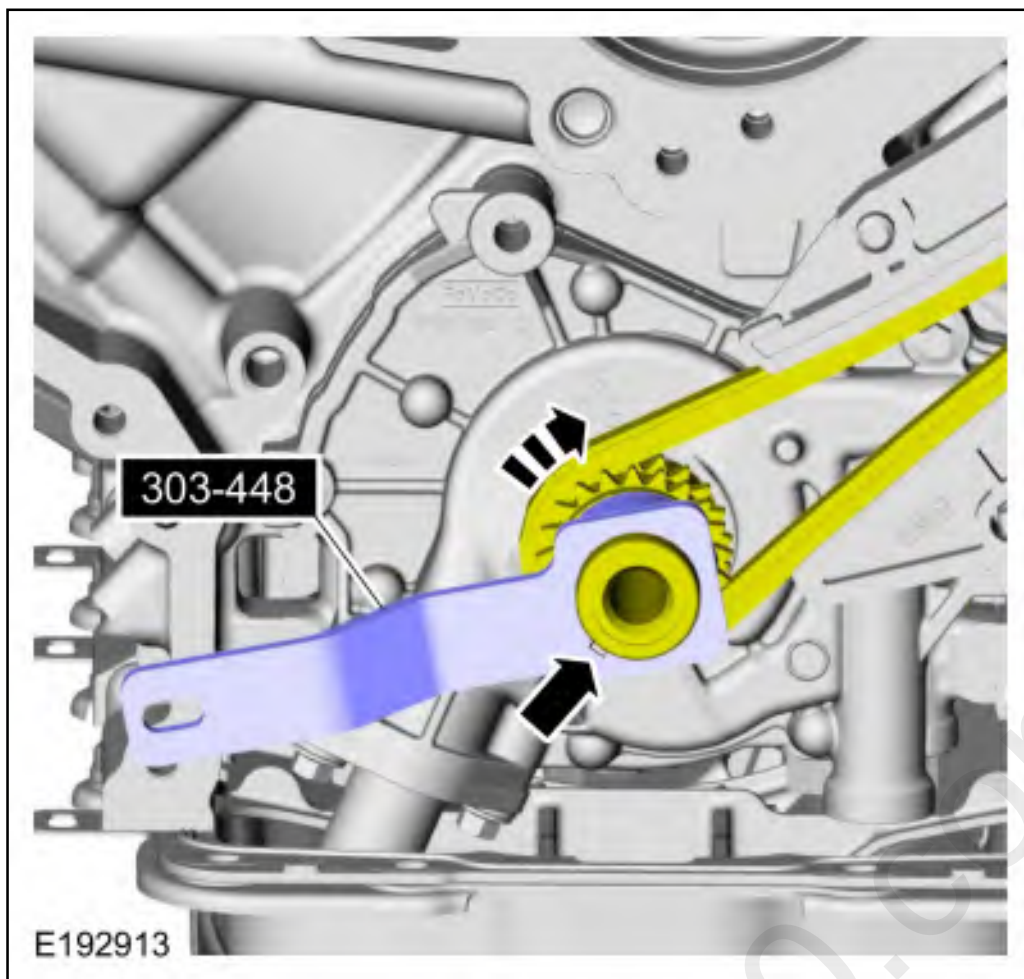
Stage 1: 89 lb.in (10 Nm)

Stage 2: 25°

2. Remove the holding pin from the tensioner.



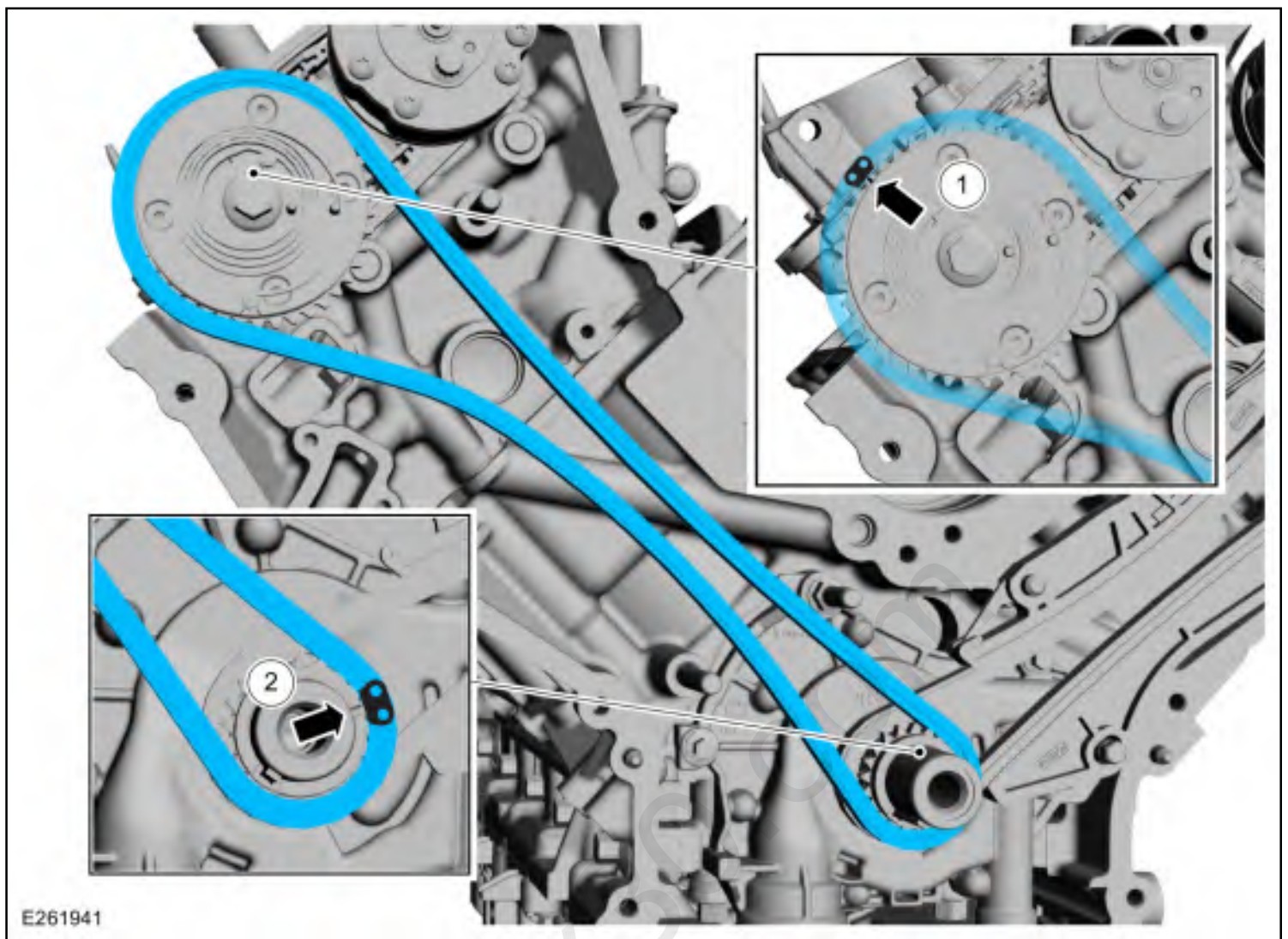
6. Using the special tool, rotate the crankshaft clockwise until the keyway is at the 7:30 position.  
Use Special Service Tool: 303-448 (T93P-6303-A) Holding Tool, Crankshaft.



## RH and LH timing chains

7. 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.





8. **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.

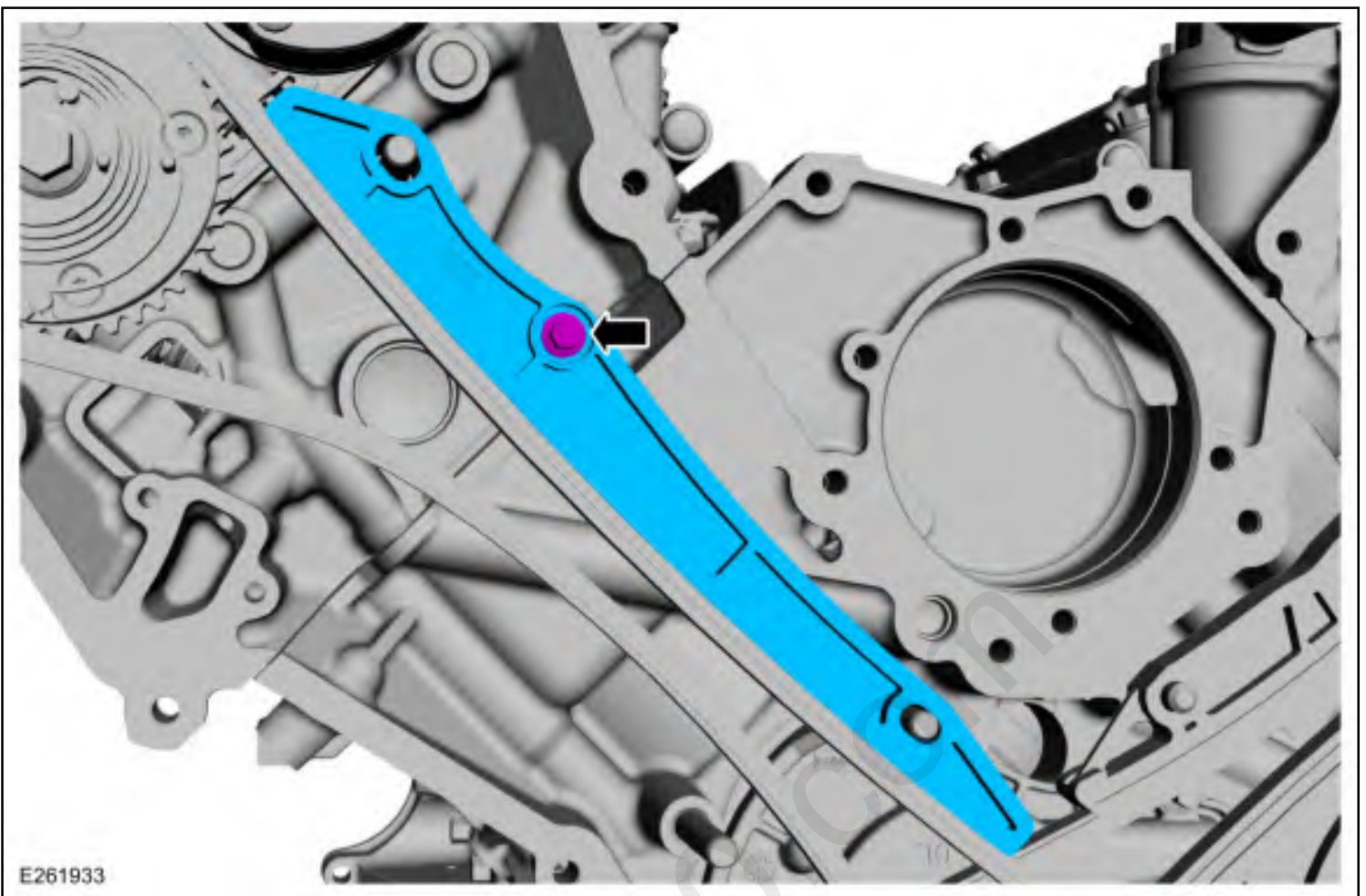
Install the RH timing chain guide and bolt.

*Torque:*

Stage 1: 89 lb.in (10 Nm)

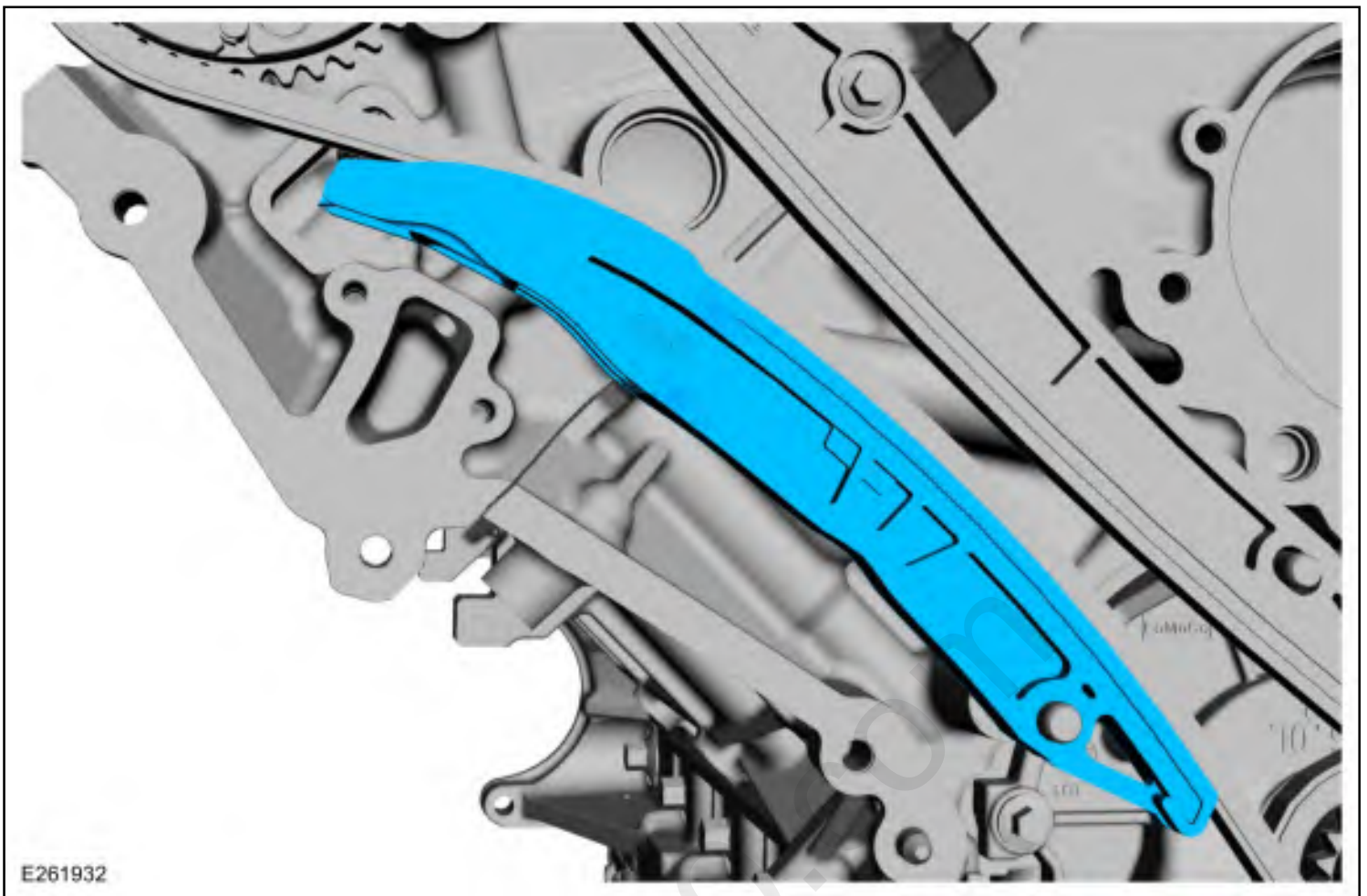
Stage 2: 25°



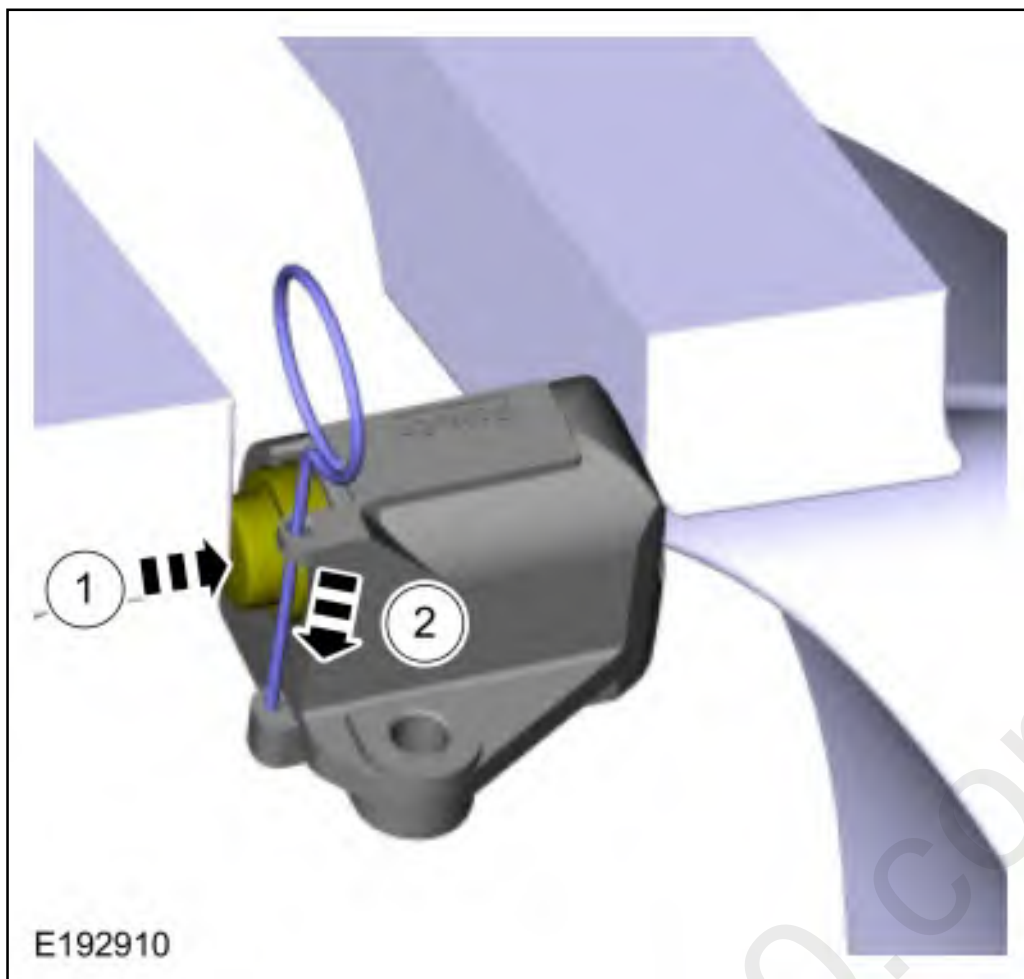


9. **NOTE:** *It may be necessary to rotate the crankshaft slightly to provide enough slack in the chain to install the RH timing chain arm. Return the crankshaft keyway to the 7:30 position after installing the RH timing chain arm.*

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.



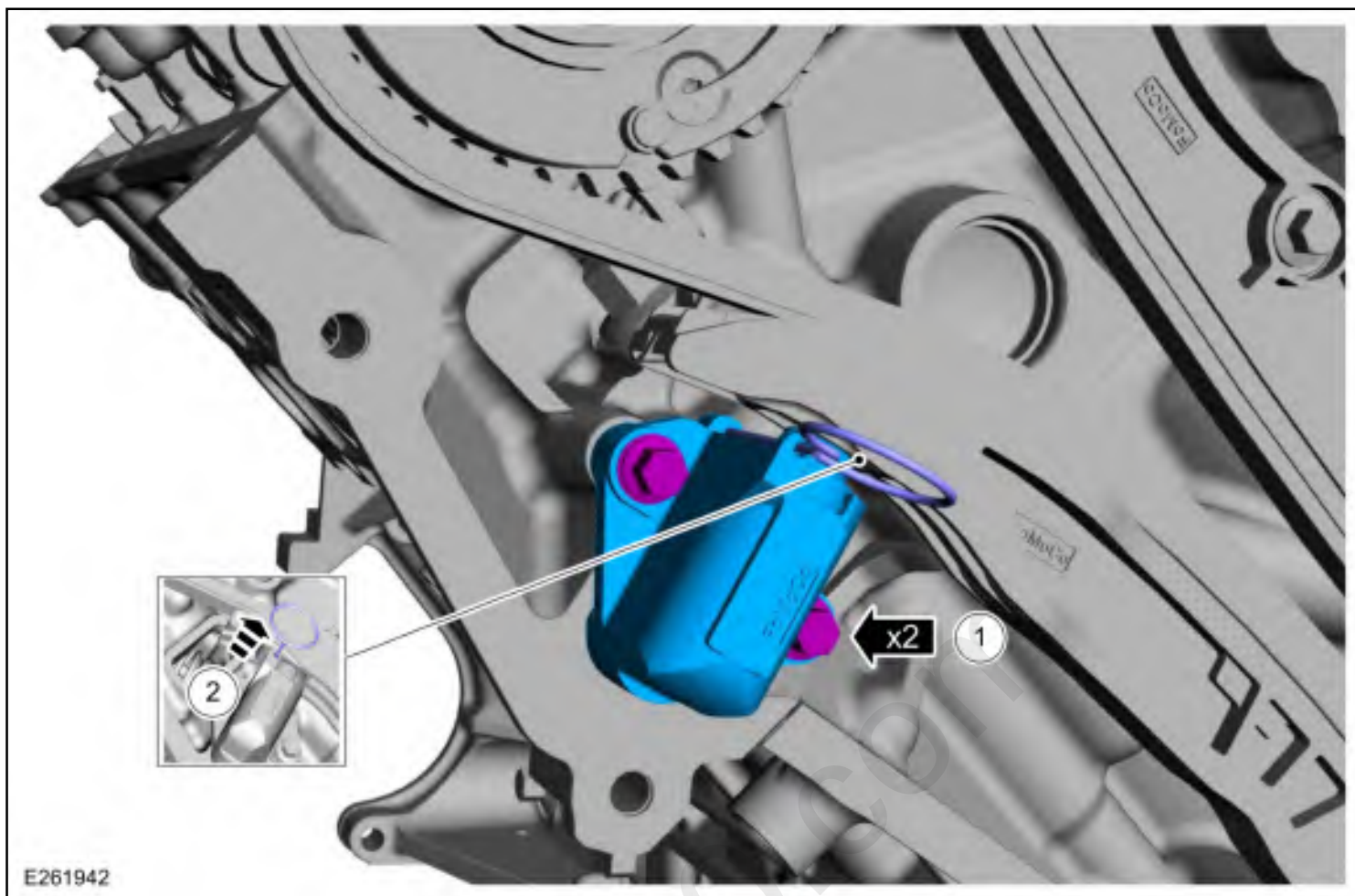
1. Install the RH primary timing chain tensioner and bolts.

*Torque:*

Stage 1: 89 lb.in (10 Nm)

Stage 2: 25°

2. Remove the holding pin from the tensioner.



12. Install the engine front cover.

Refer to: Engine Front Cover (303-01 Engine - 5.0L 32V Ti-VCT) .

# Cylinder Head LH

## Special Tool(s) / General Equipment

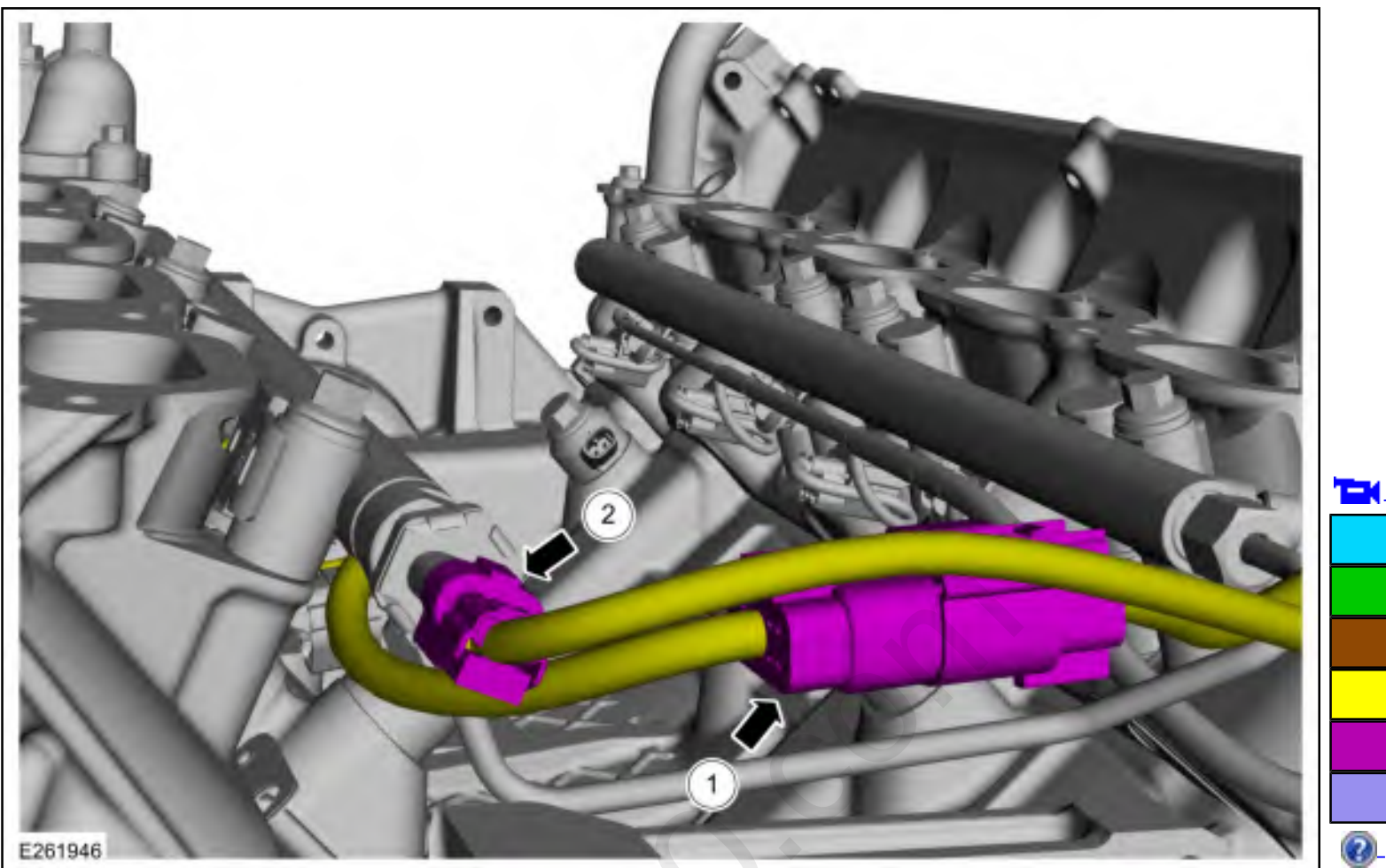
|                     |
|---------------------|
| Oil Drain Equipment |
|---------------------|

## Removal

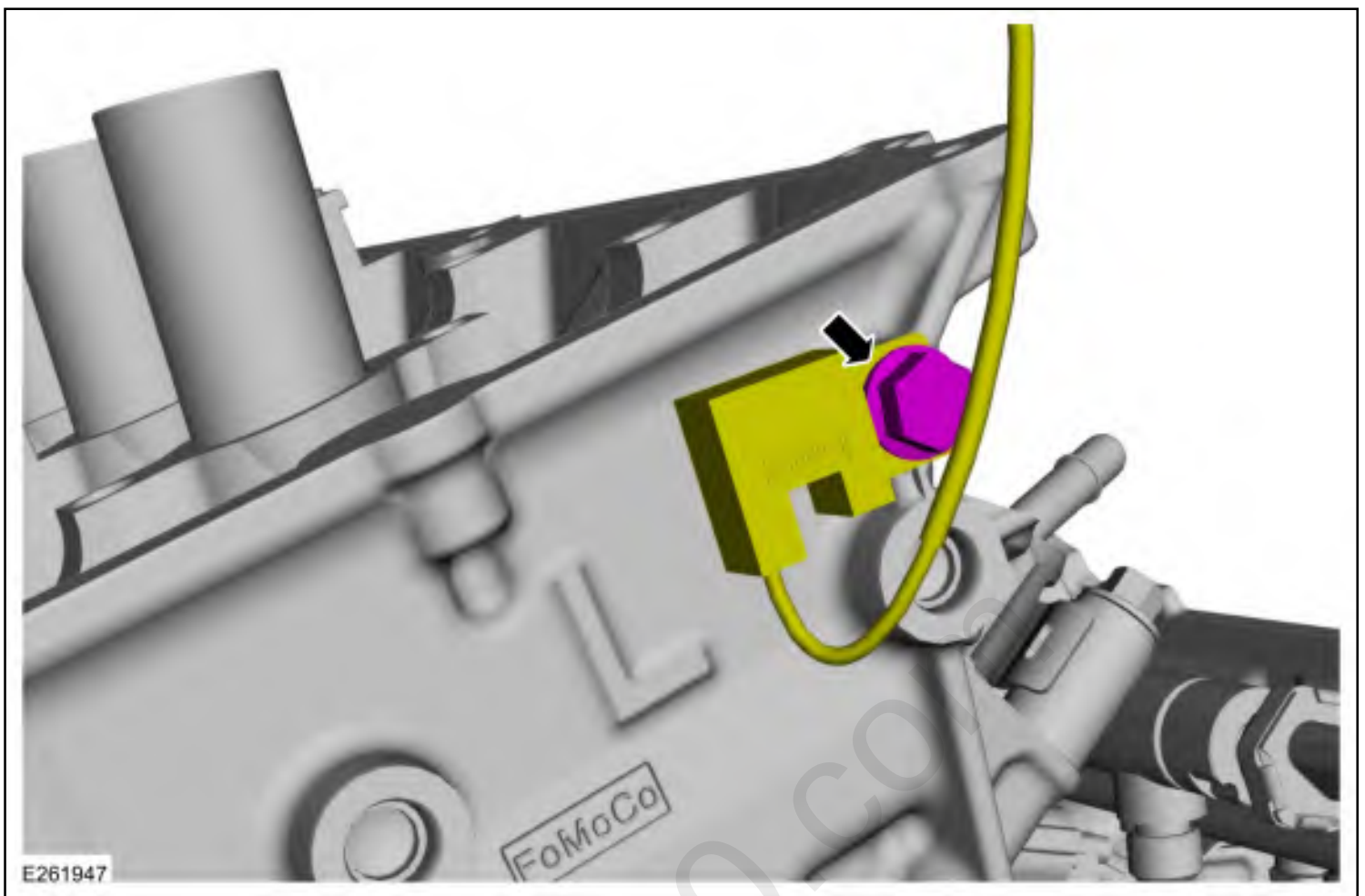
**NOTICE:** During engine repair procedures, cleanliness is extremely important. Any foreign material, including any material created while cleaning gasket surfaces, that enters the oil passages, coolant passages or the oil pan, can cause engine failure.

1. With the vehicle in NEUTRAL, position it on a hoist.  
Refer to: [Jacking and Lifting - Overview](#) (100-02 Jacking and Lifting, Description and Operation).
2. Release the fuel system pressure.  
Refer to: [Fuel System Pressure Release](#) (310-00D Fuel System - General Information - 5.0L 32V Ti-VCT, General Procedures).
3. Disconnect the battery ground cable.  
Refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables) .
4. Drain the engine cooling system.  
Refer to: Cooling System Draining, Vacuum Filling and Bleeding (303-03 Engine Cooling - 5.0L 32V Ti-VCT) .
5. Remove the following items:
  1. Refer to: Camshaft LH (303-01 Engine - 5.0L 32V Ti-VCT) .
  2. Refer to: Exhaust Manifold LH (303-01 Engine - 5.0L 32V Ti-VCT) .
  1. Disconnect the fuel rail electrical connector.
  2. Disconnect the fuel sensor electrical connector.

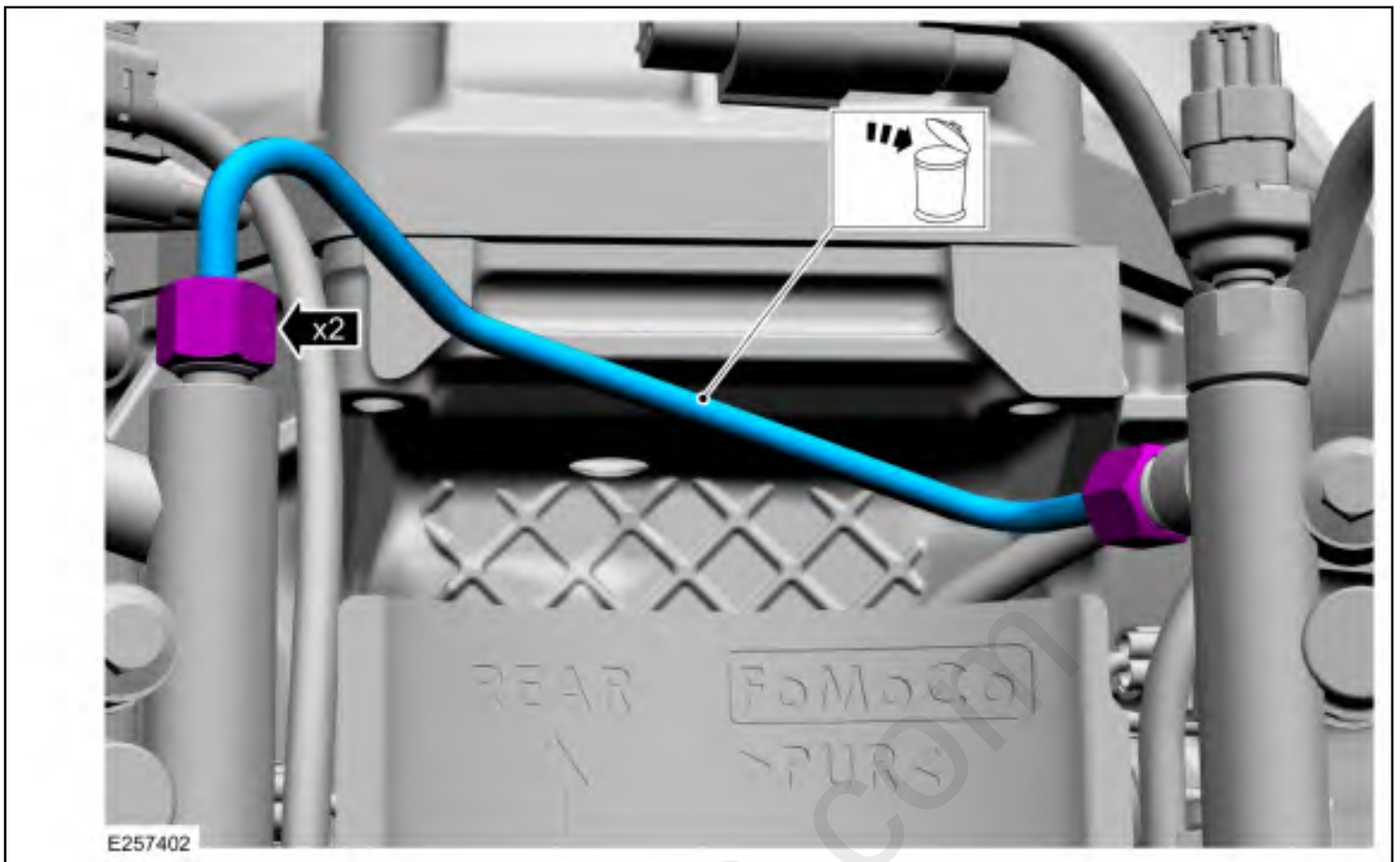




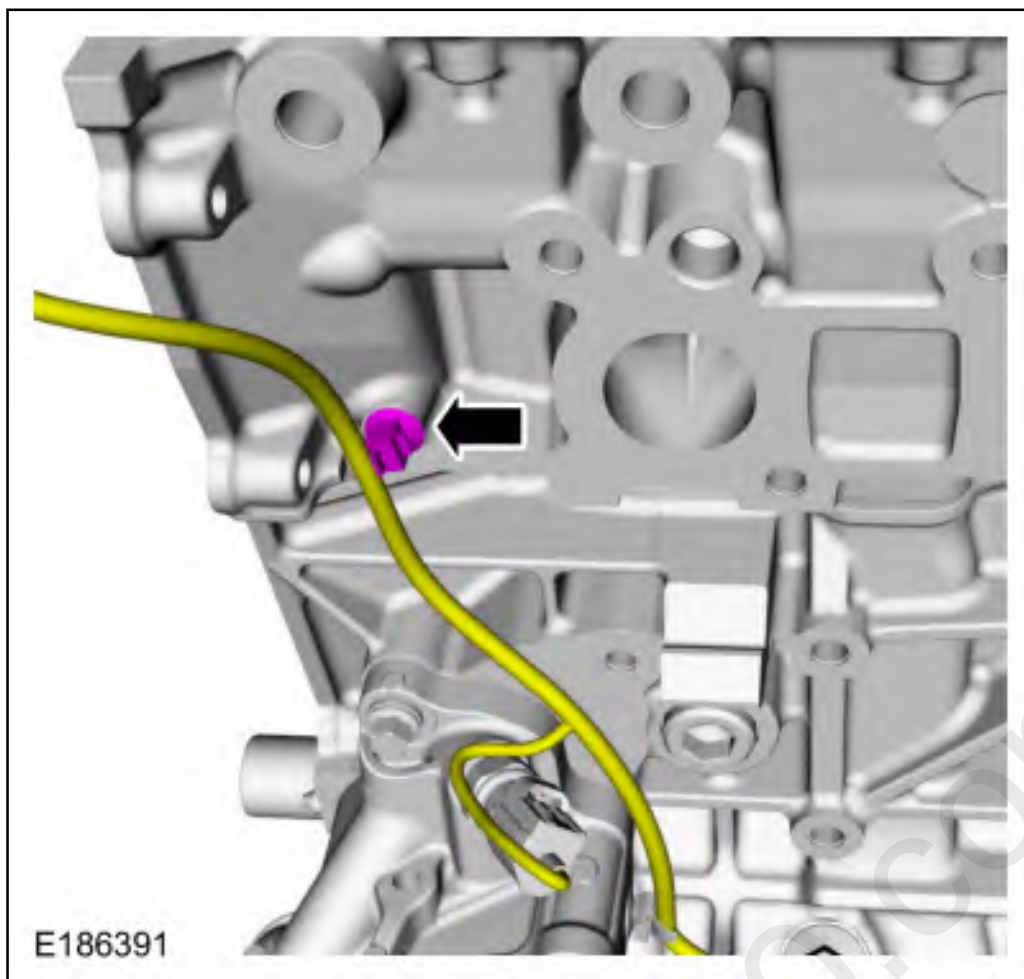
7. Remove the bolt and the capacitor.



8. Disconnect the high-pressure fuel tube flare nuts, then remove and discard the high-pressure fuel tube.

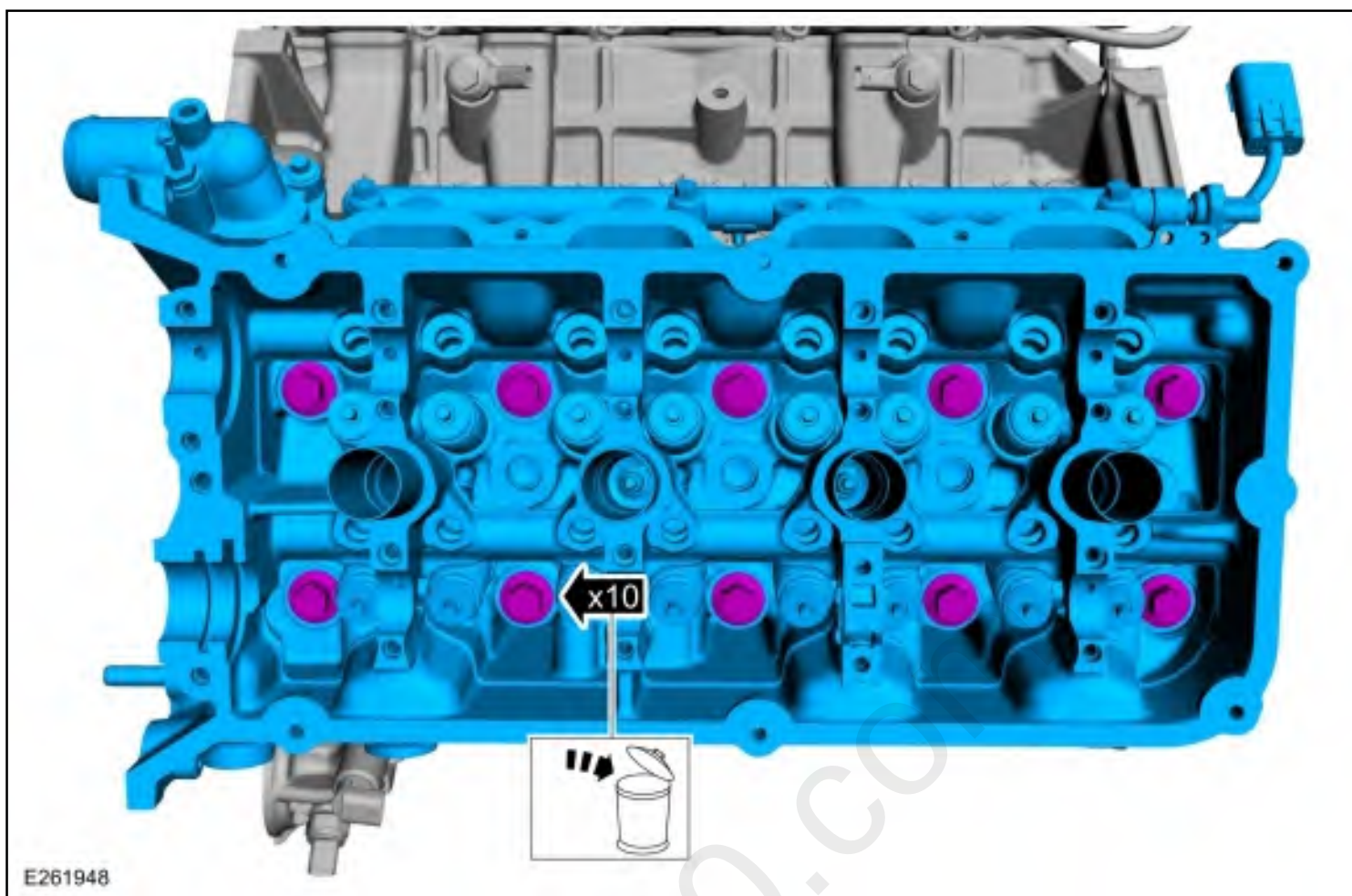


9. Detach the wiring harness retainer from the cylinder head.

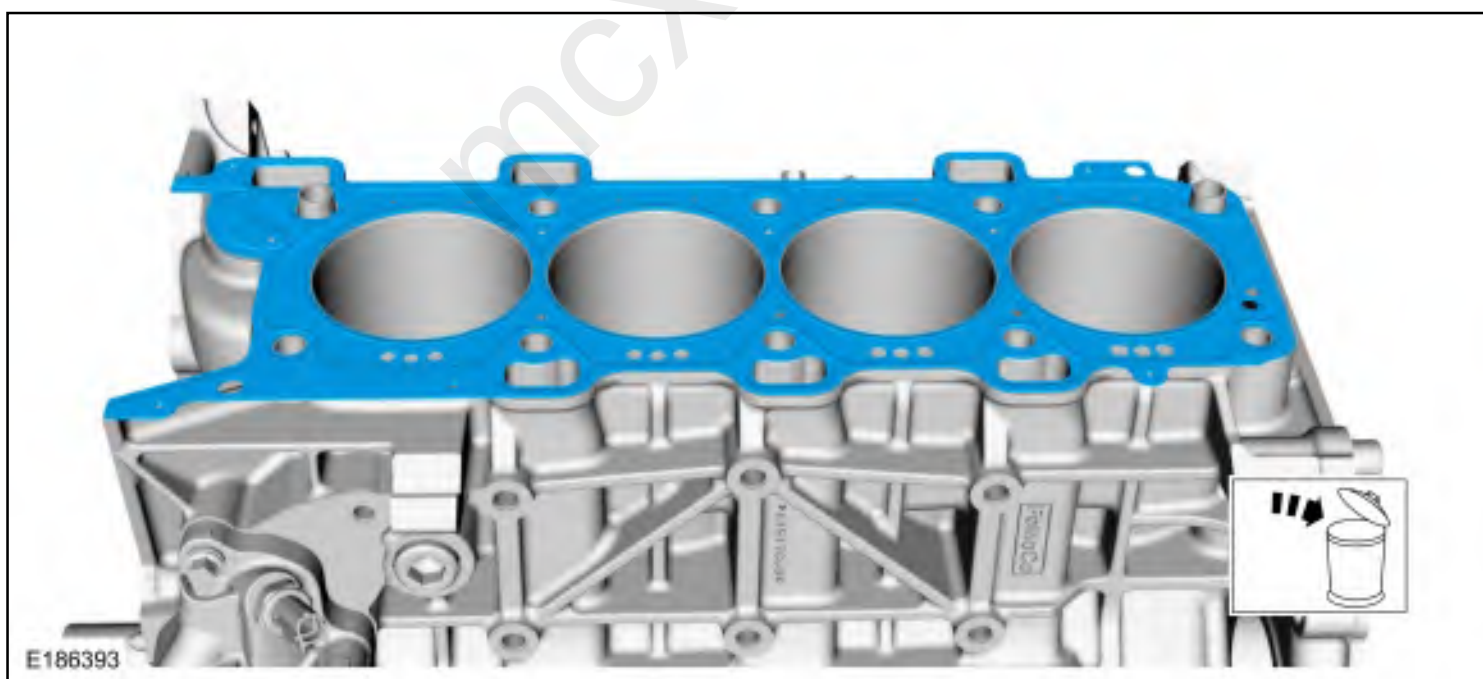


- Remove and discard the bolts.
- Remove the cylinder head.





11. Discard the cylinder head gasket.



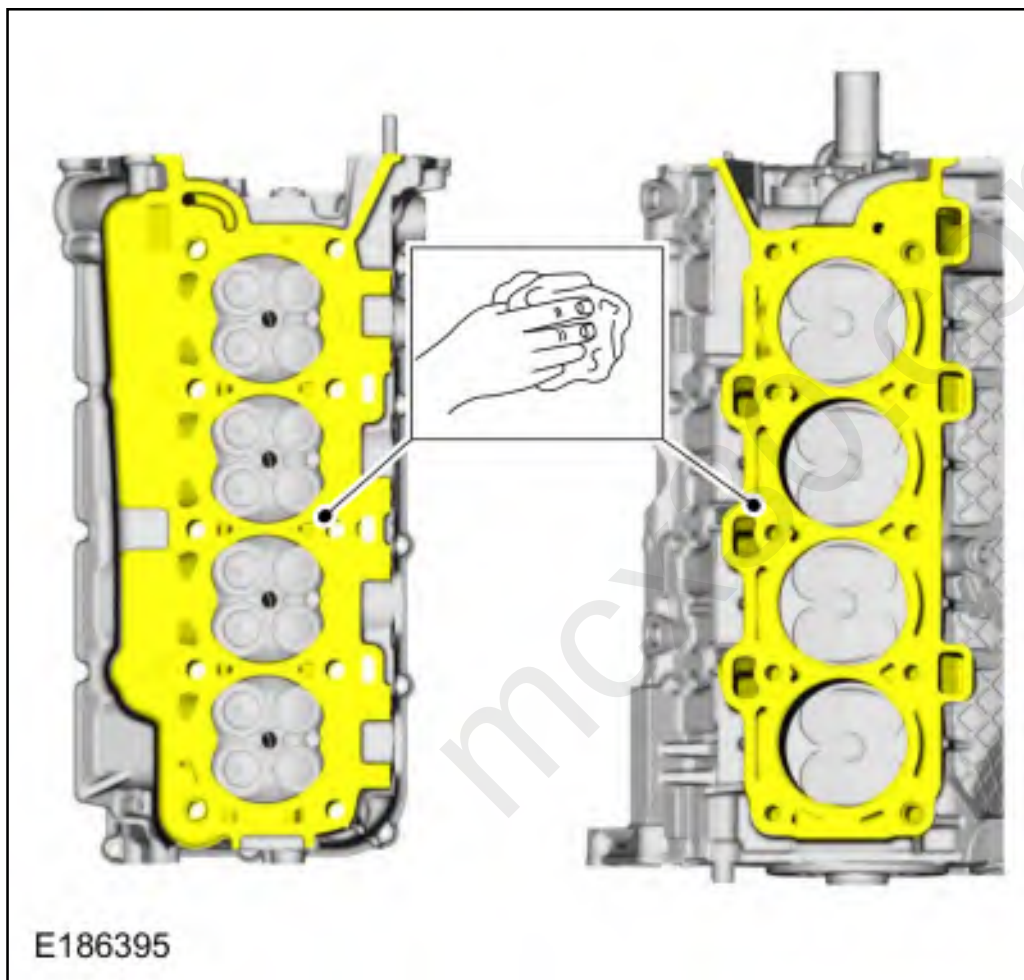
12. **NOTICE:** Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the sealing surfaces. These tools cause scratches and gouges which make leak



paths.

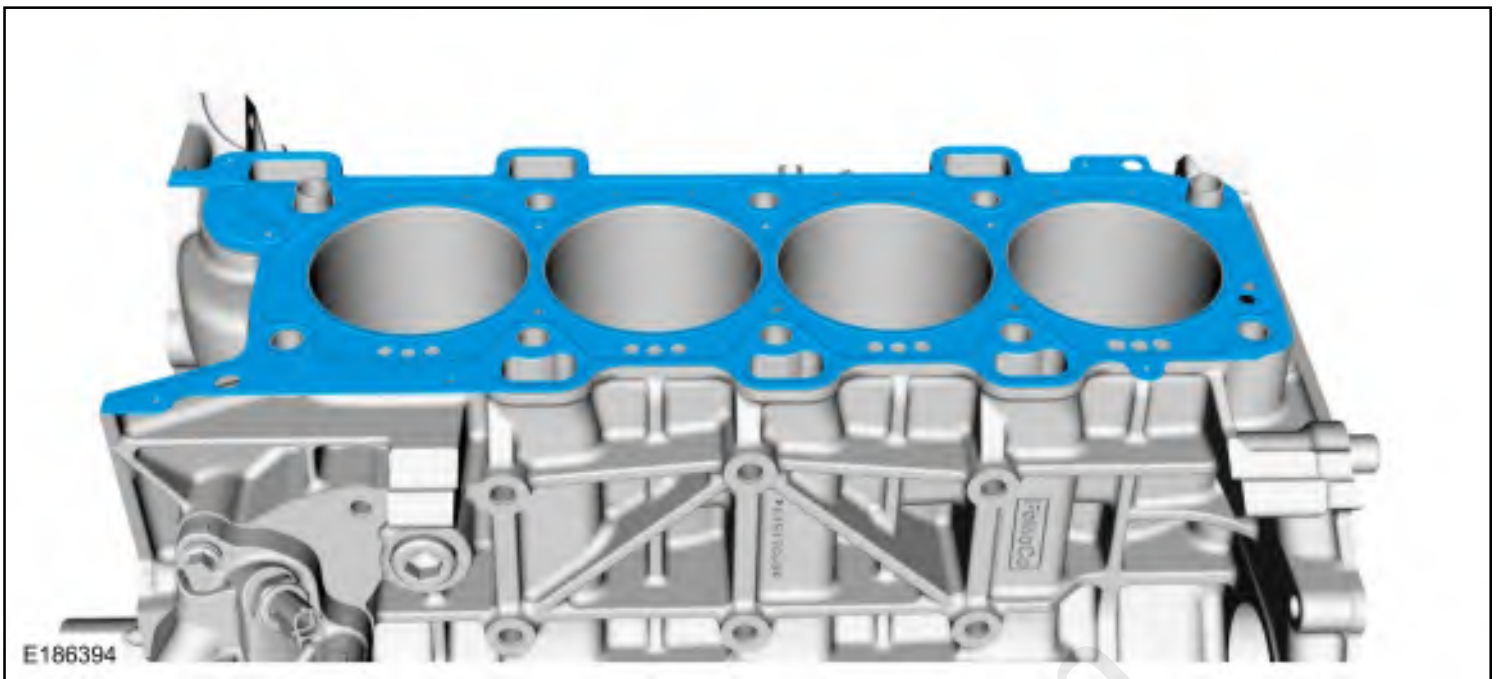
**NOTE:** Clean the cylinder head bolt holes in the cylinder block using compressed air. Make sure all coolant, oil or other foreign material is removed.

- Clean and inspect the cylinder head-to-cylinder block mating surfaces of both the cylinder head and the cylinder block
- Refer to: [Cylinder Head Distortion](#) (303-00 Engine System - General Information, General Procedures).
- Refer to: [Cylinder Block Distortion](#) (303-00 Engine System - General Information, General Procedures).



## Installation

1. Install the cylinder head gasket.



2. **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)

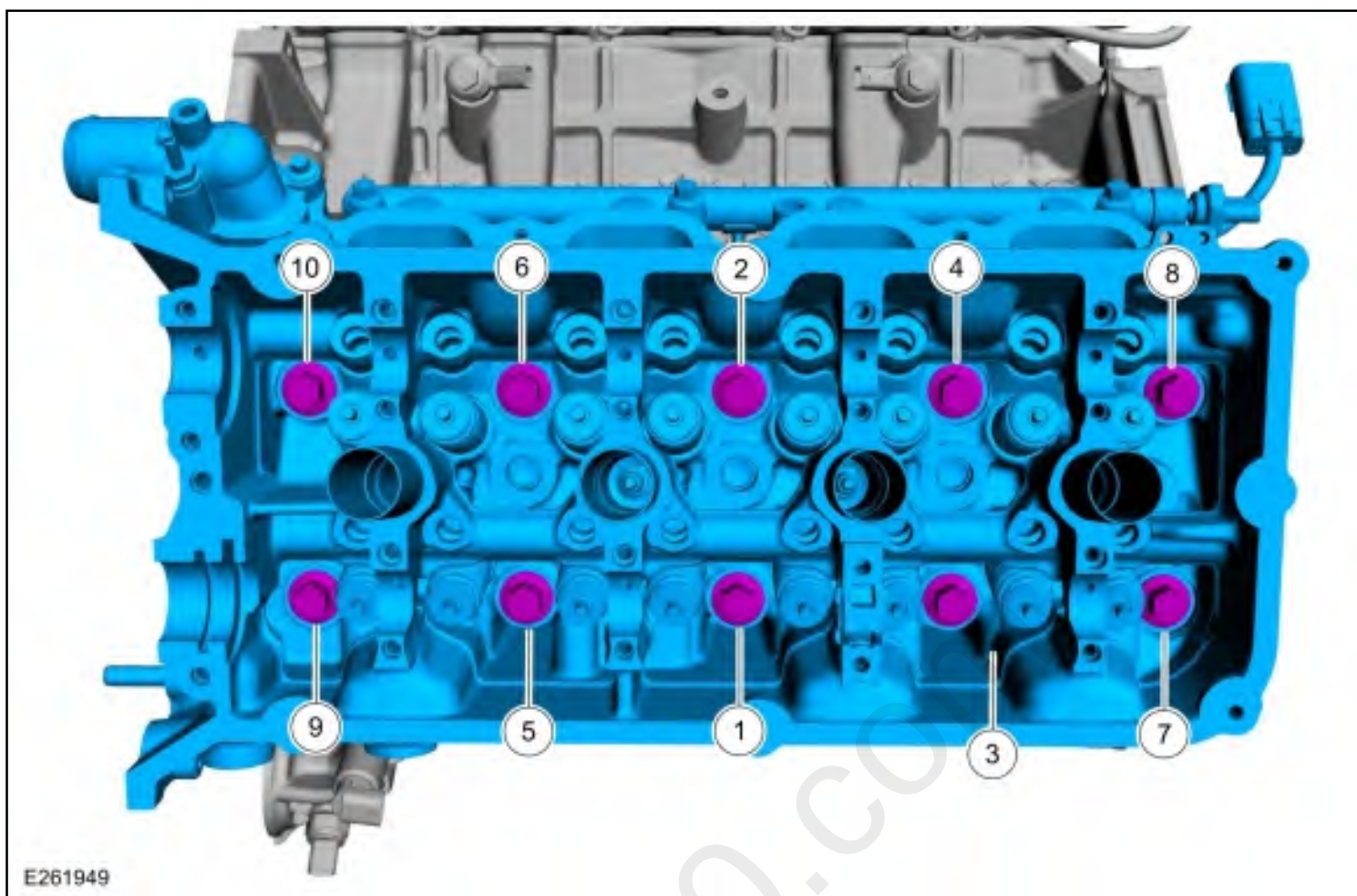
Stage 2: Bolts 1-10 in sequence: 55 lb.ft (75 Nm)

Stage 3: Bolt 1: Loosen: 180°

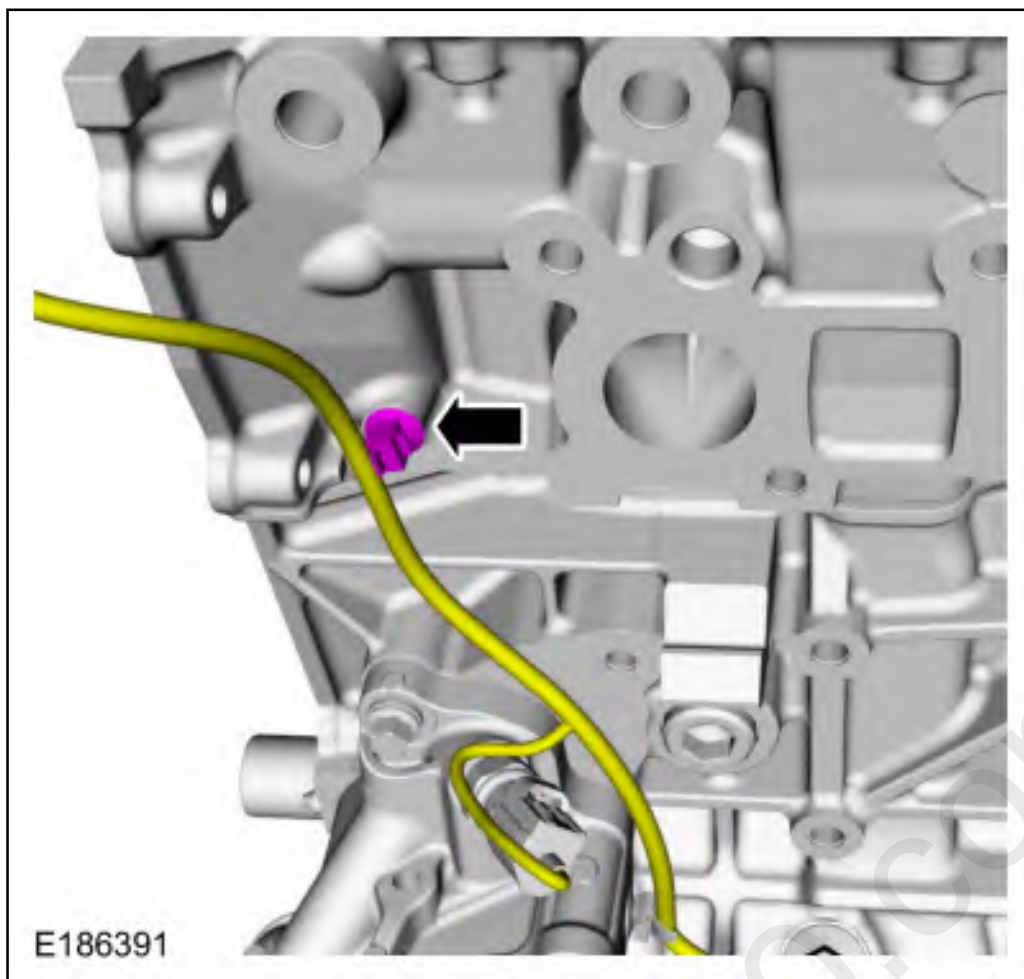
Stage 4: Bolt 1: 37 lb.ft (50 Nm)

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).



3. Attach the wiring harness retainer to the cylinder head.

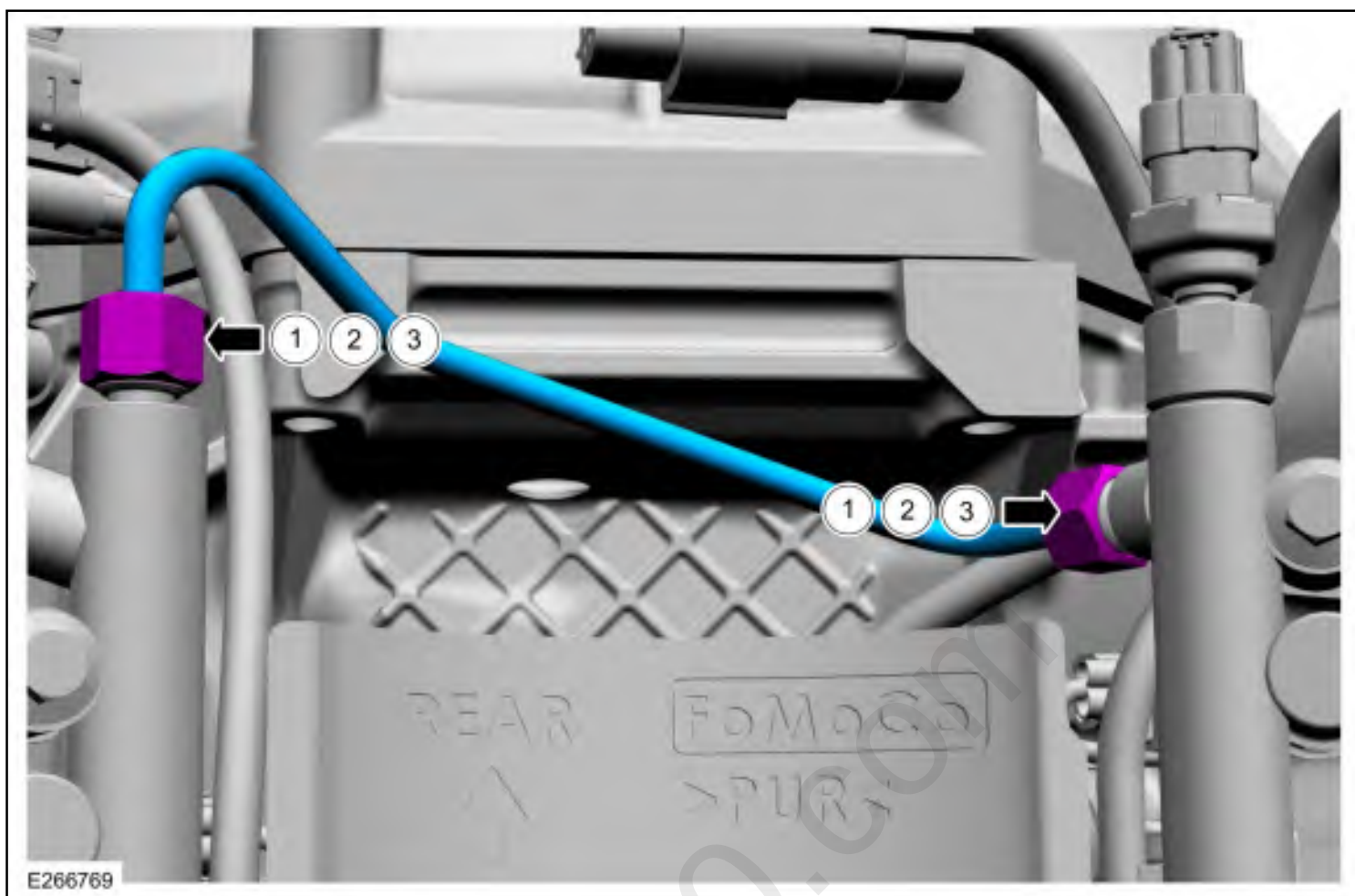


4. **NOTICE:** In stage 3, if the torque required to tighten any flare nut on the new high-pressure fuel tube reaches or exceeds 55 lb.ft (50 Nm), then that high pressure fuel tube must be discarded and replaced with another new high-pressure fuel tube.

*Torque:*

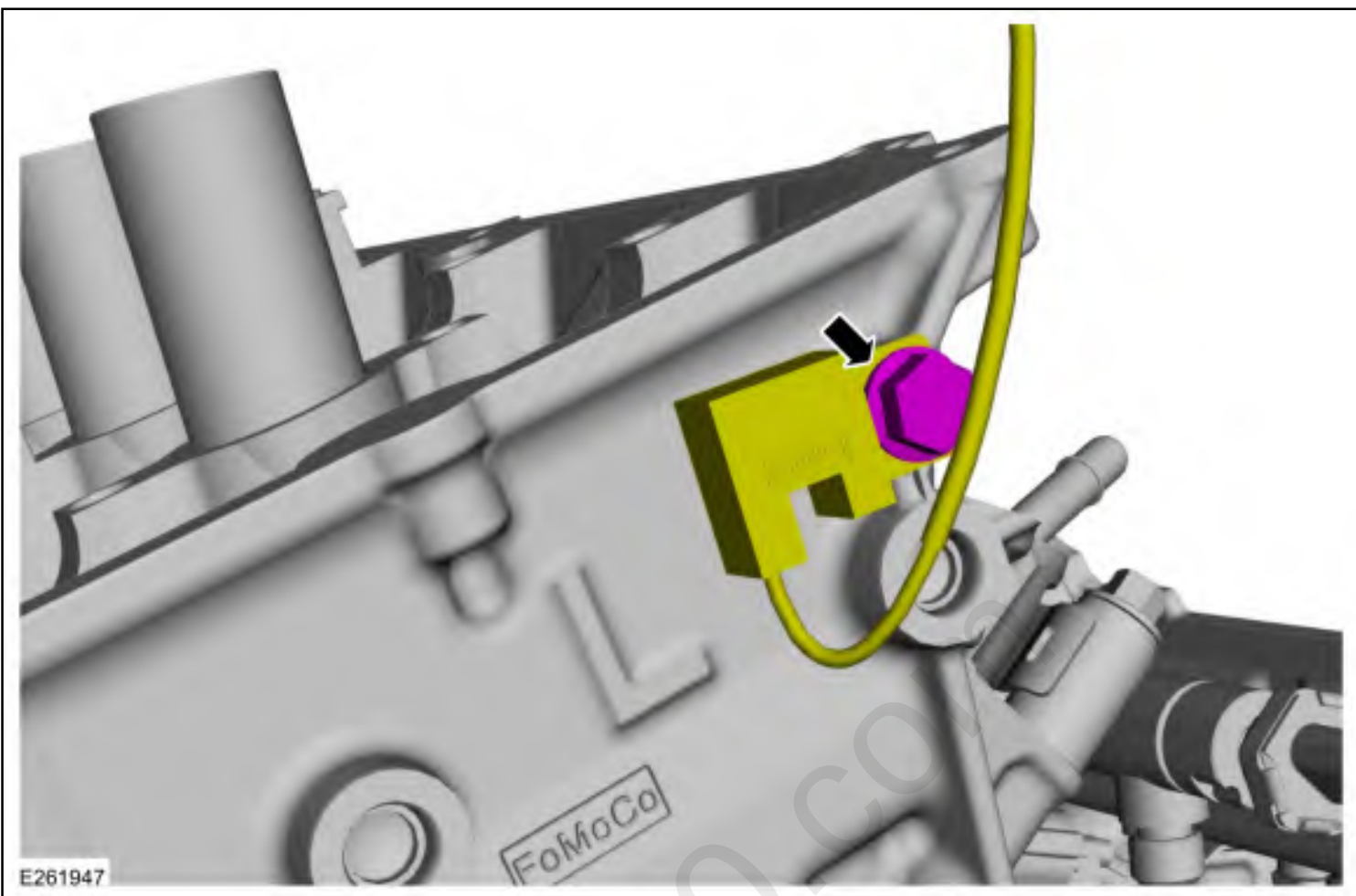
- Stage 1: Tighten the high-pressure fuel tube flare nuts to : 71 lb.in (8 Nm)  
Stage 2: Tighten the high-pressure fuel tube flare nuts to : 89 lb.in (10 Nm)  
Stage 3: Tighten the high-pressure fuel tube flare nuts an additional : 25°



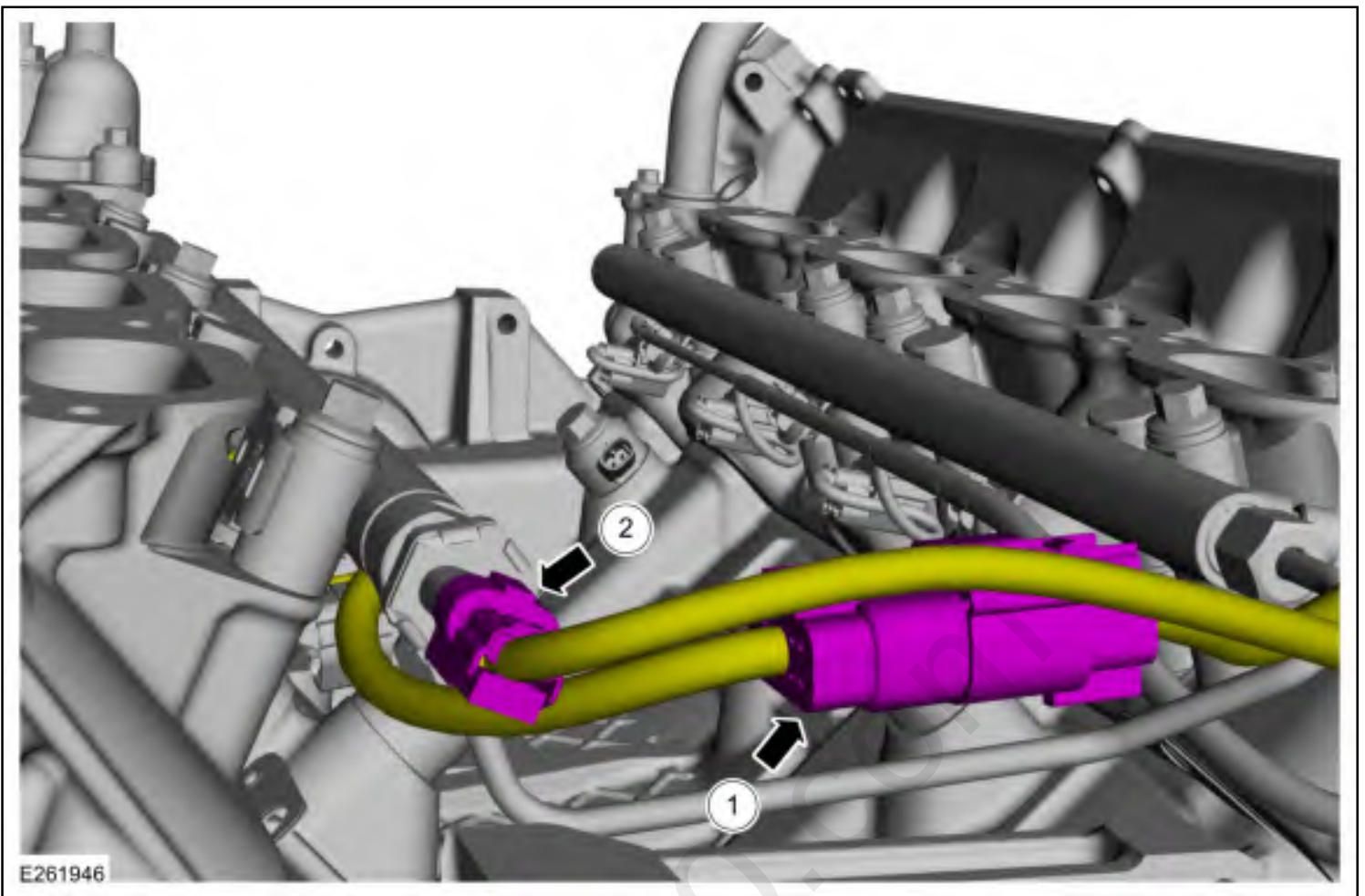


5. Install the capacitor and the bolt.  
*Torque: 89 lb.in (10 Nm)*





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



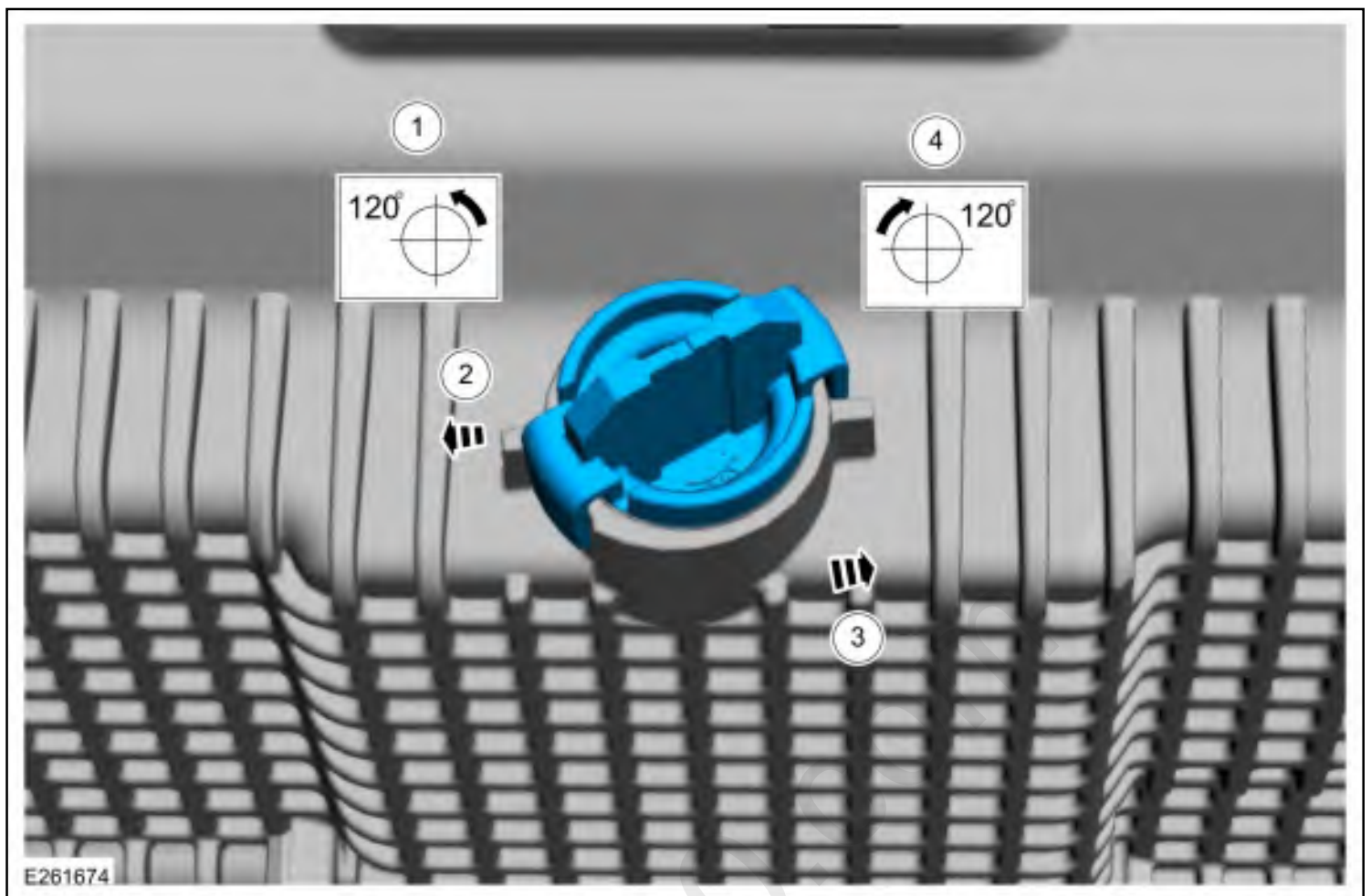
7. Install the following items:

1. Refer to: Exhaust Manifold LH (303-01 Engine - 5.0L 32V Ti-VCT) .
2. Refer to: Camshaft LH (303-01 Engine - 5.0L 32V Ti-VCT) .

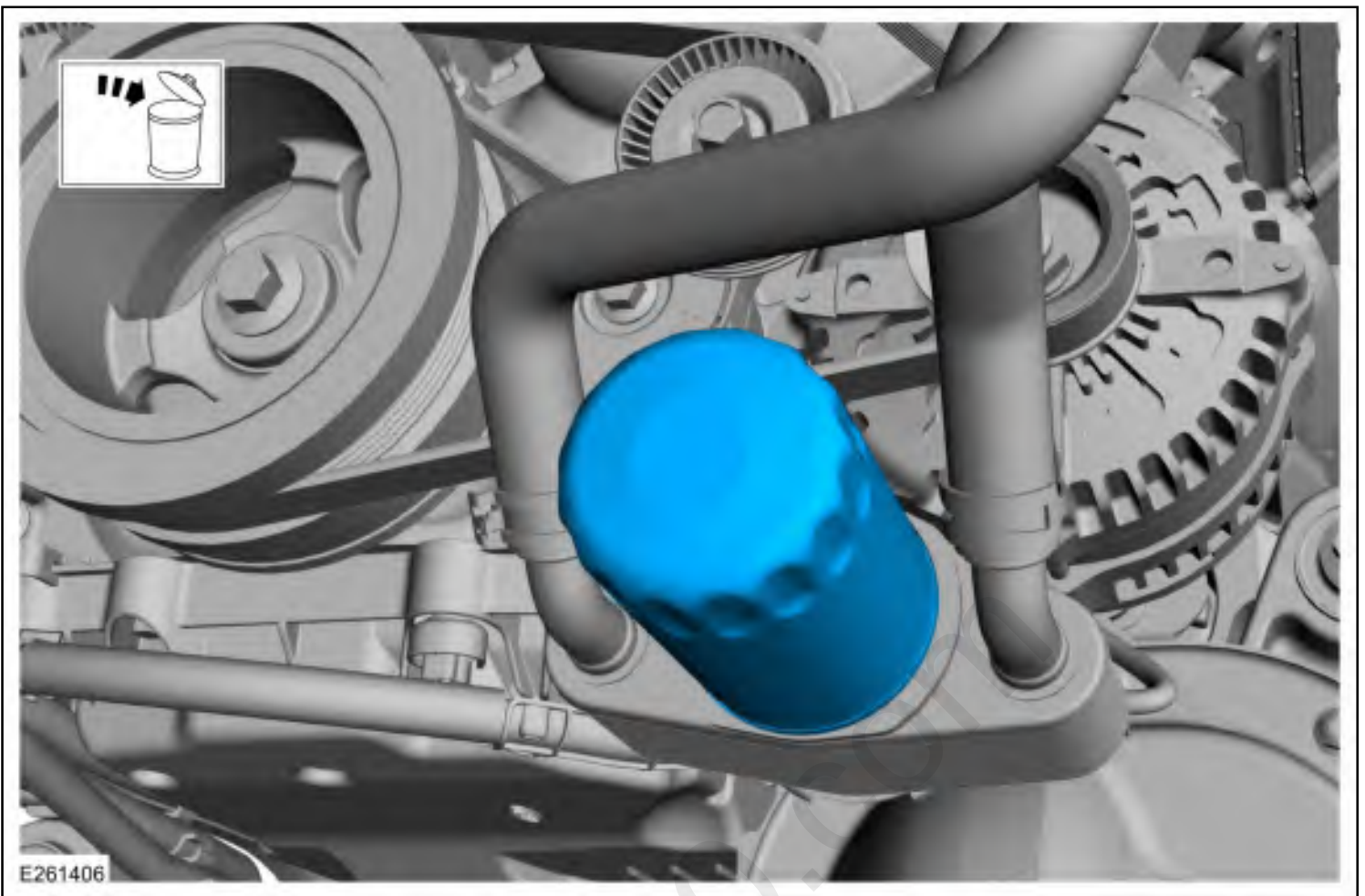
8. **NOTE:** *The drain plug should be removed and installed by hand, do not use tools.*

1. Turn the oil drain plug by hand counterclockwise 120 degrees.  
Use the General Equipment: Oil Drain Equipment
2. Pull the oil drain plug out of the oil pan.
3. After the oil has drained, push the oil drain plug into the oil pan.
4. **NOTICE: Overtightening will damage the oil drain plug and possibly the oil pan.**

Turn the oil drain plug by hand clockwise 120 degrees.



9. Remove and discard the engine oil filter.



10. **NOTE:** *Do not lubricate the O-ring seal.*

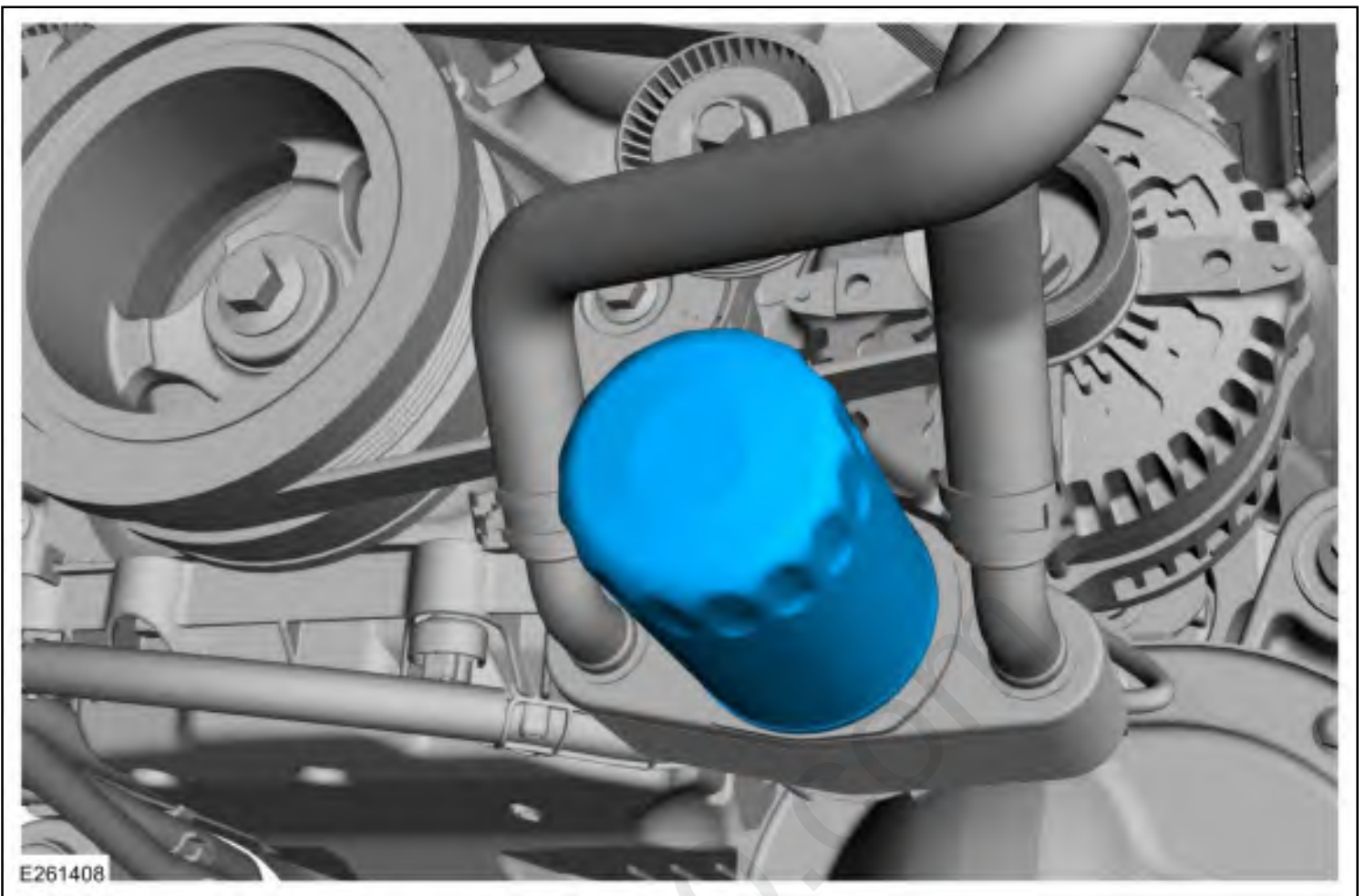
Install a new oil filter.

*Torque:*

Stage 1: 44 lb.in (5 Nm)

Stage 2: 180°

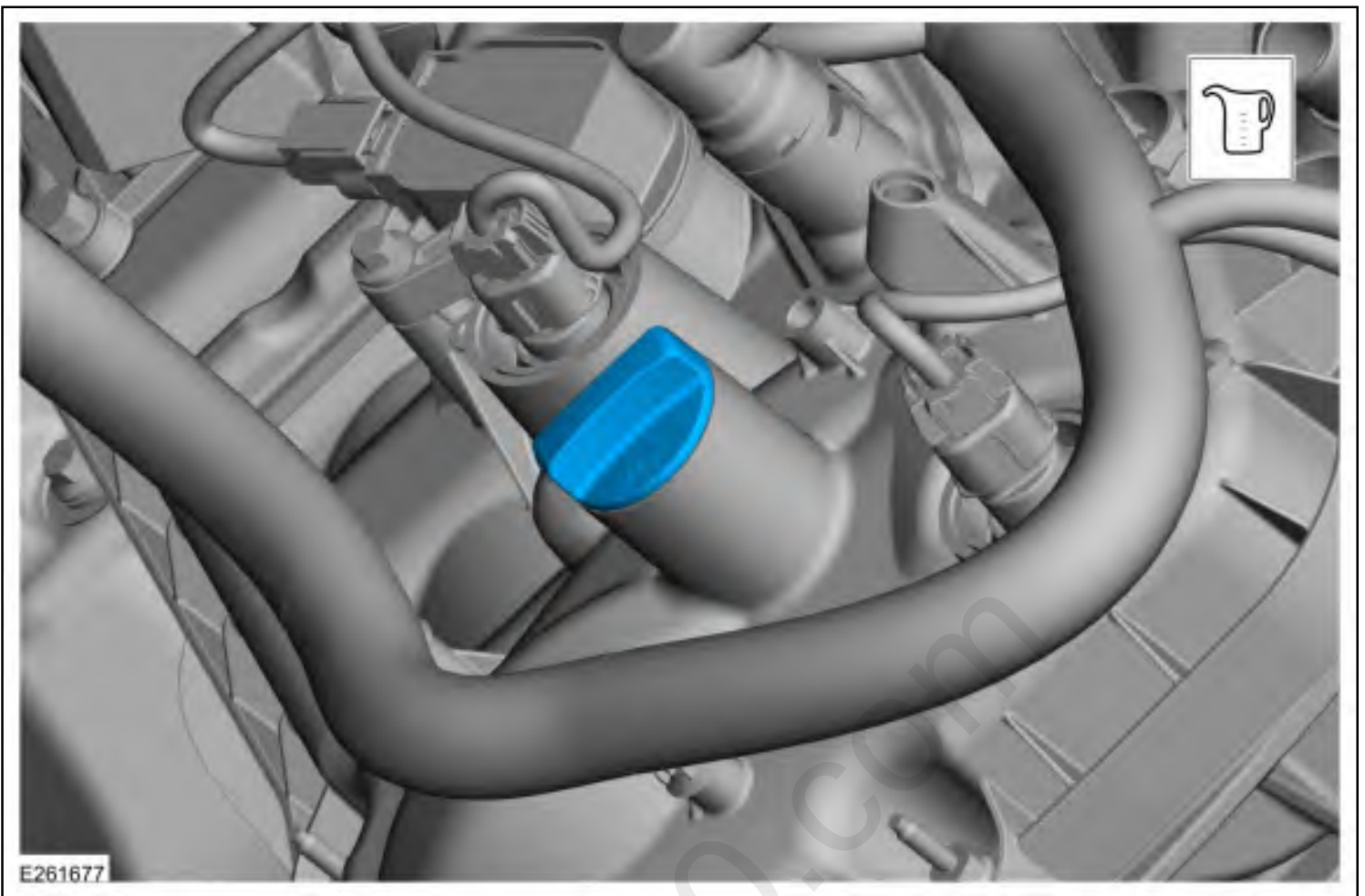




11. Fill the engine with clean engine oil.

Refer to: [Specifications](#) (303-01D Engine - 5.0L 32V Ti-VCT, Specifications).





12. Connect the battery ground cable.  
Refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables) .
13. Fill and bleed the engine cooling system.  
Refer to: Cooling System Draining, Vacuum Filling and Bleeding (303-03 Engine Cooling - 5.0L 32V Ti-VCT) .

## Cylinder Head RH

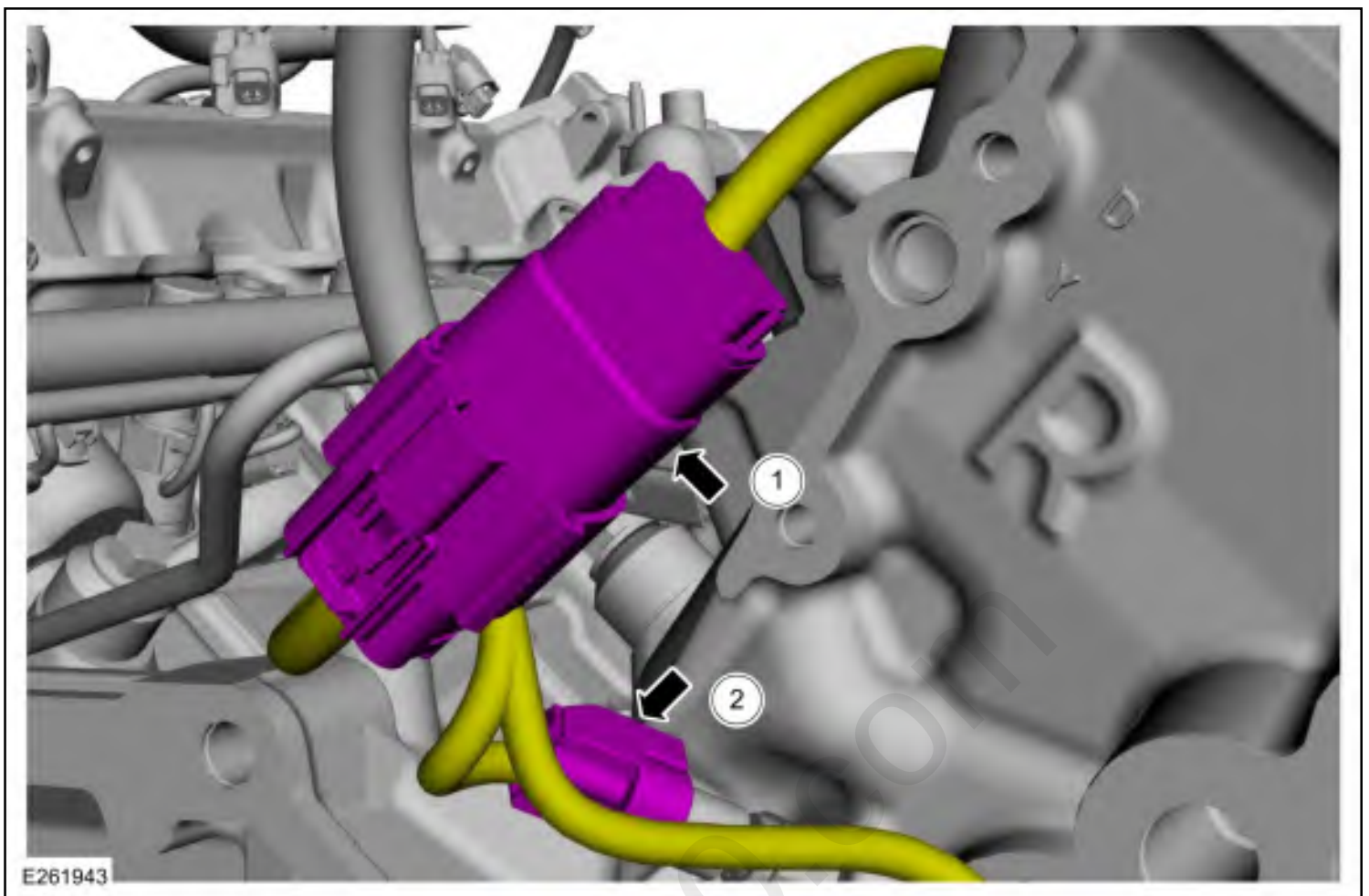
### Special Tool(s) / General Equipment

|                     |
|---------------------|
| Oil Drain Equipment |
|---------------------|

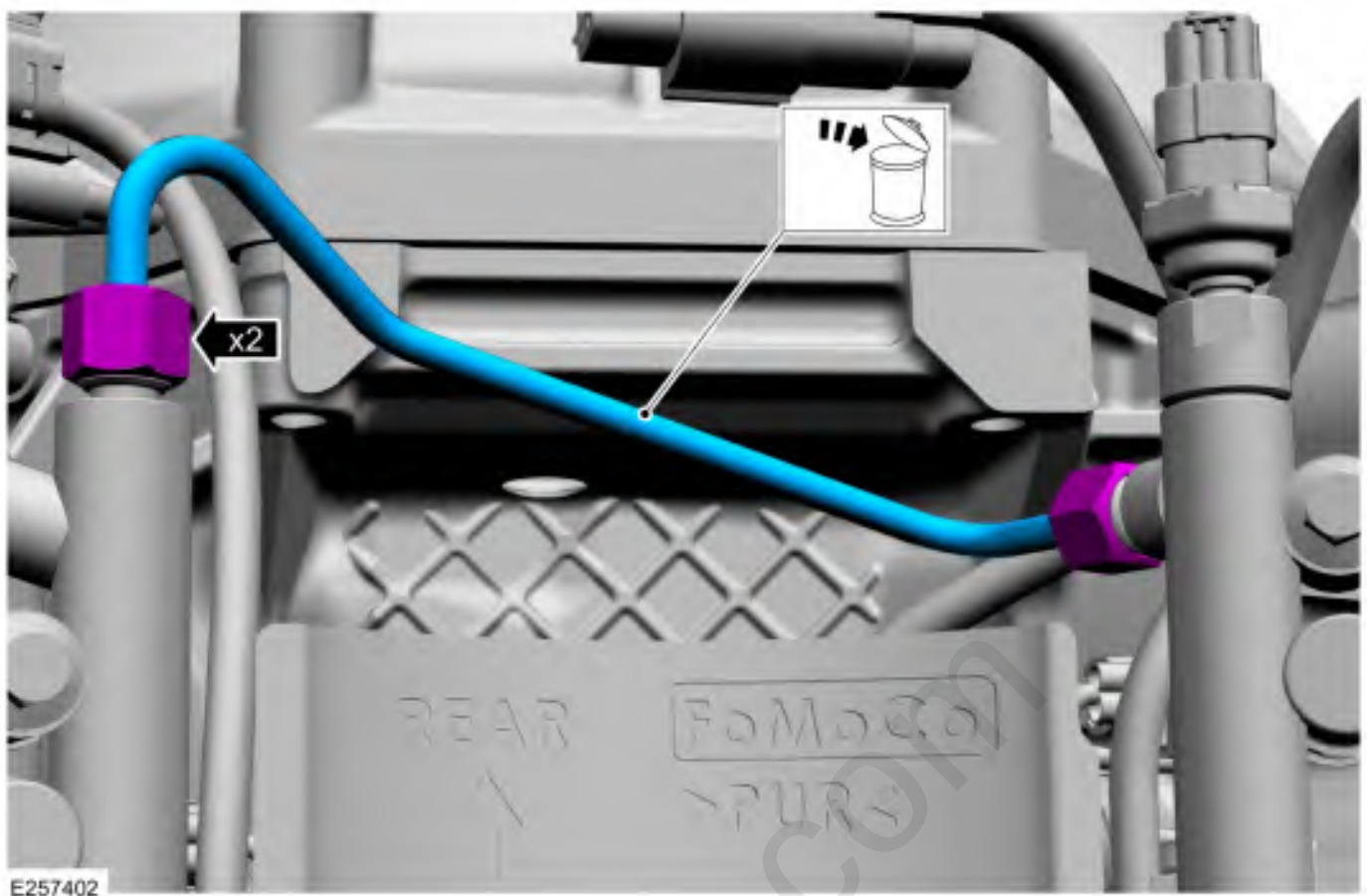
### Removal

**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.

1. With the vehicle in NEUTRAL, position it on a hoist.  
Refer to: [Jacking and Lifting - Overview](#) (100-02 Jacking and Lifting, Description and Operation).
2. Release the fuel system pressure.  
Refer to: [Fuel System Pressure Release](#) (310-00D Fuel System - General Information - 5.0L 32V Ti-VCT, General Procedures).
3. Disconnect the battery ground cable.  
Refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables) .
4. Drain the engine cooling system.  
Refer to: Cooling System Draining, Vacuum Filling and Bleeding (303-03 Engine Cooling - 5.0L 32V Ti-VCT) .
5. Remove the following items:
  1. Refer to: Camshaft RH (303-01 Engine - 5.0L 32V Ti-VCT) .
  2. Refer to: Exhaust Manifold RH (303-01 Engine - 5.0L 32V Ti-VCT) .
  1. Disconnect the fuel rail electrical connector.
  2. Disconnect the CHT sensor electrical connector.



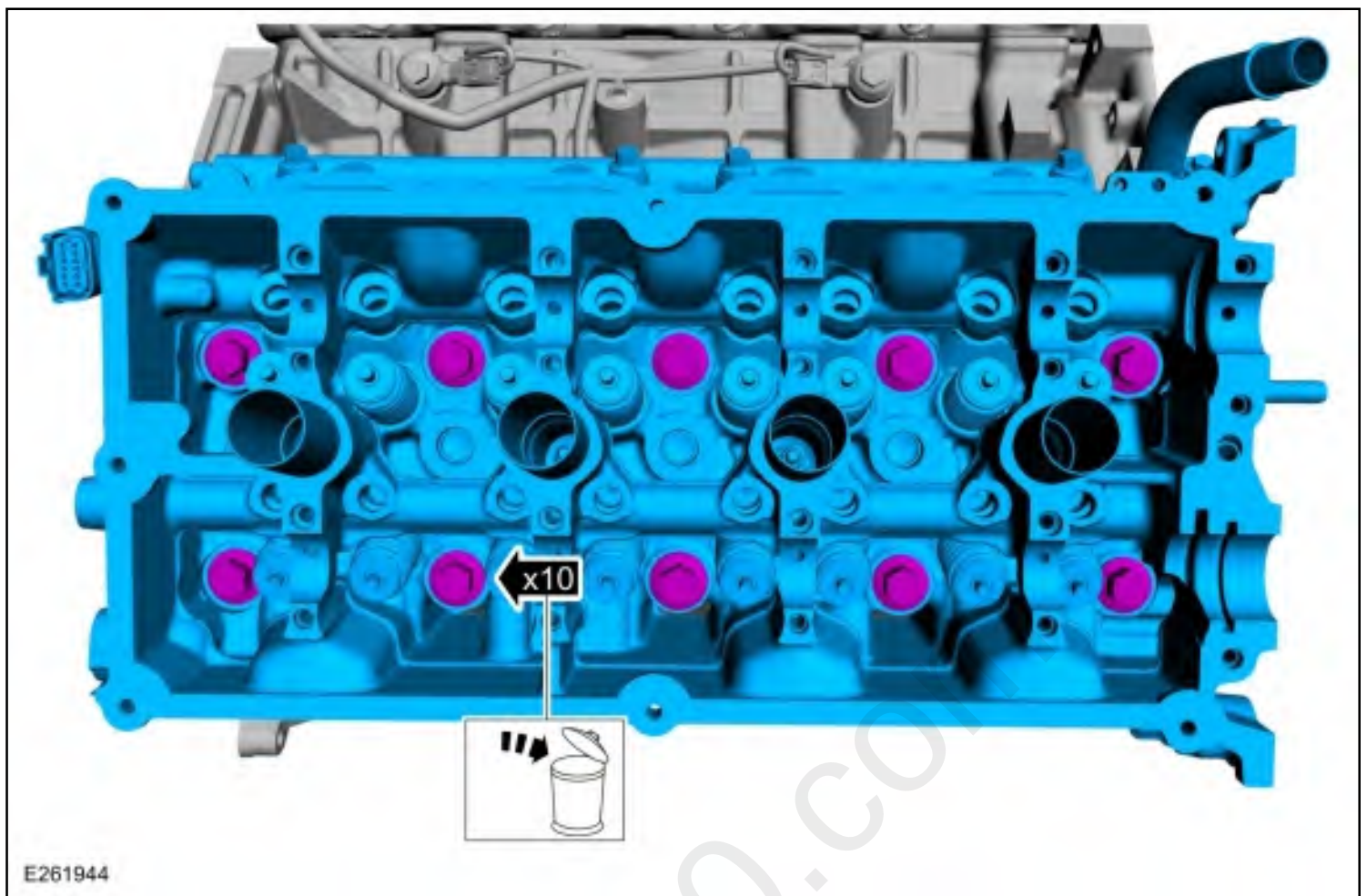
7. Disconnect the high-pressure fuel tube flare nuts, then remove and discard the high-pressure fuel tube.



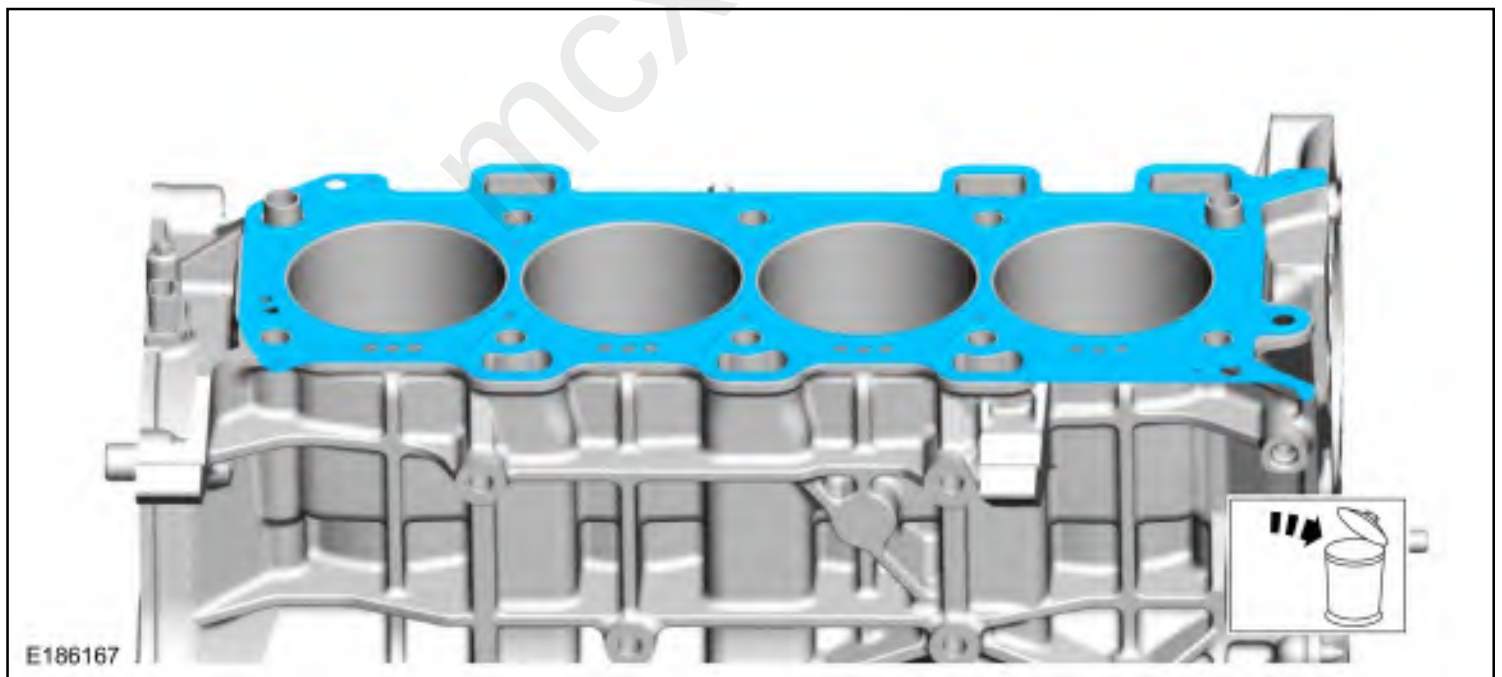
E257402

- Remove and discard the bolts.
- Remove the cylinder head.





9. Remove and discard the cylinder head gasket.



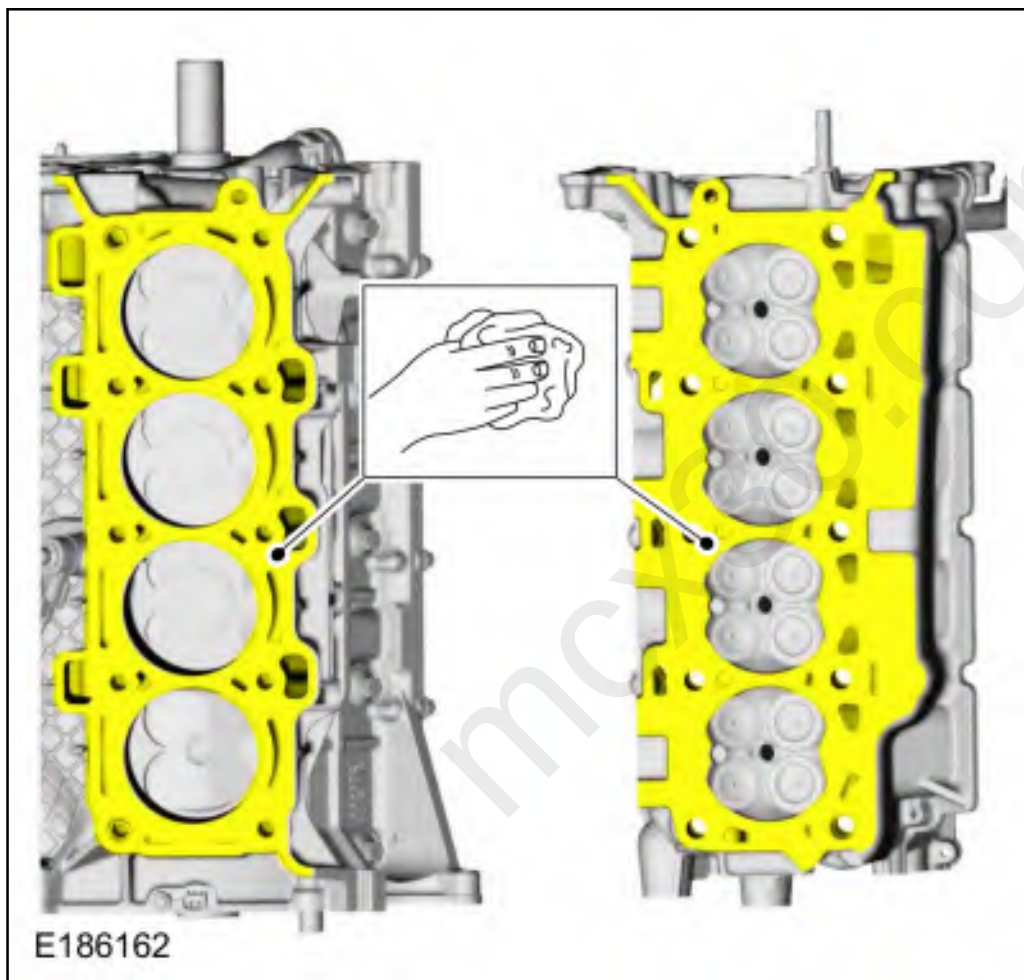
10. **NOTICE:** Do not use metal scrapers, wire brushes, power abrasive discs or other abrasive means to clean the sealing surfaces. These tools cause scratches and gouges which make leak



paths.

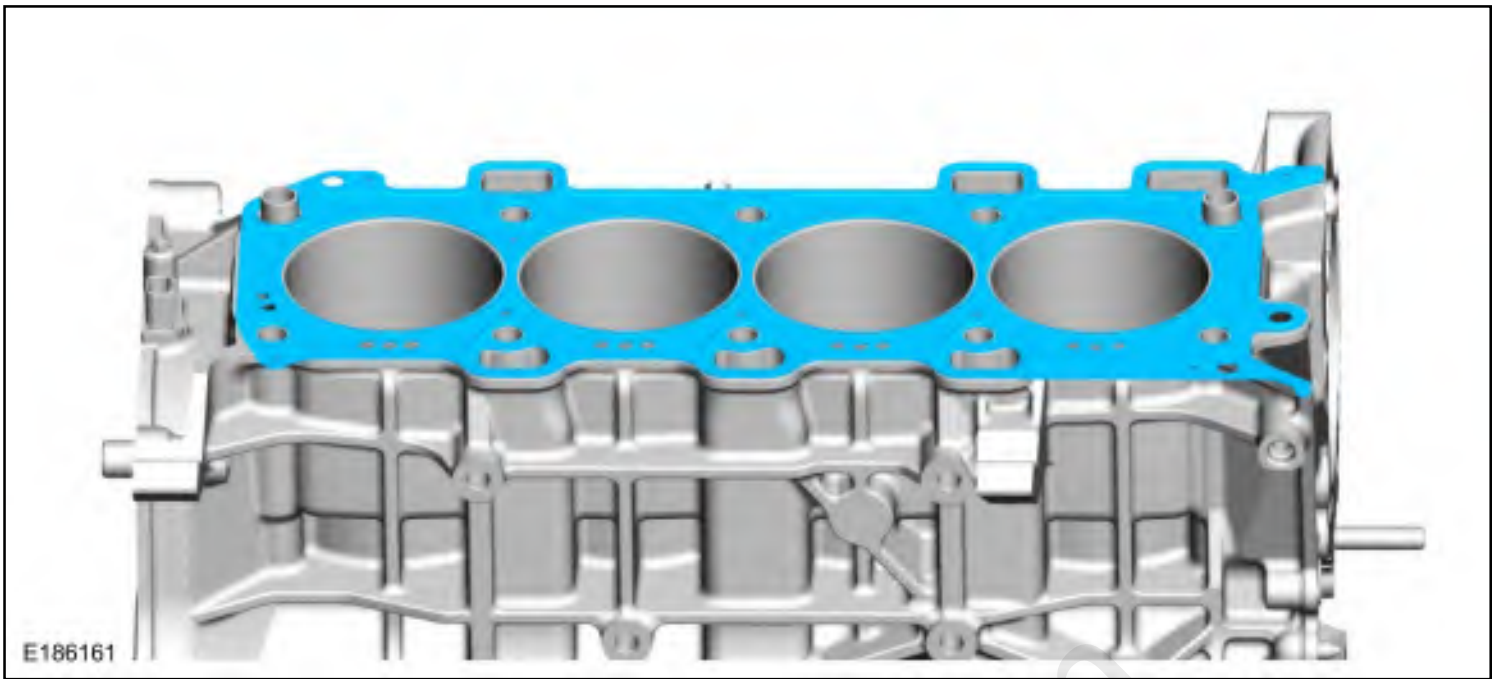
**NOTE:** Clean the cylinder head bolt holes in the cylinder block using compressed air. Make sure all coolant, oil or other foreign material is removed.

- Clean and inspect the cylinder head-to-cylinder block mating surfaces of both the cylinder head and the cylinder block
- Refer to: [Cylinder Head Distortion](#) (303-00 Engine System - General Information, General Procedures).
- Refer to: [Cylinder Block Distortion](#) (303-00 Engine System - General Information, General Procedures).



## Installation

1. Install the new cylinder head gasket.



2. **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)

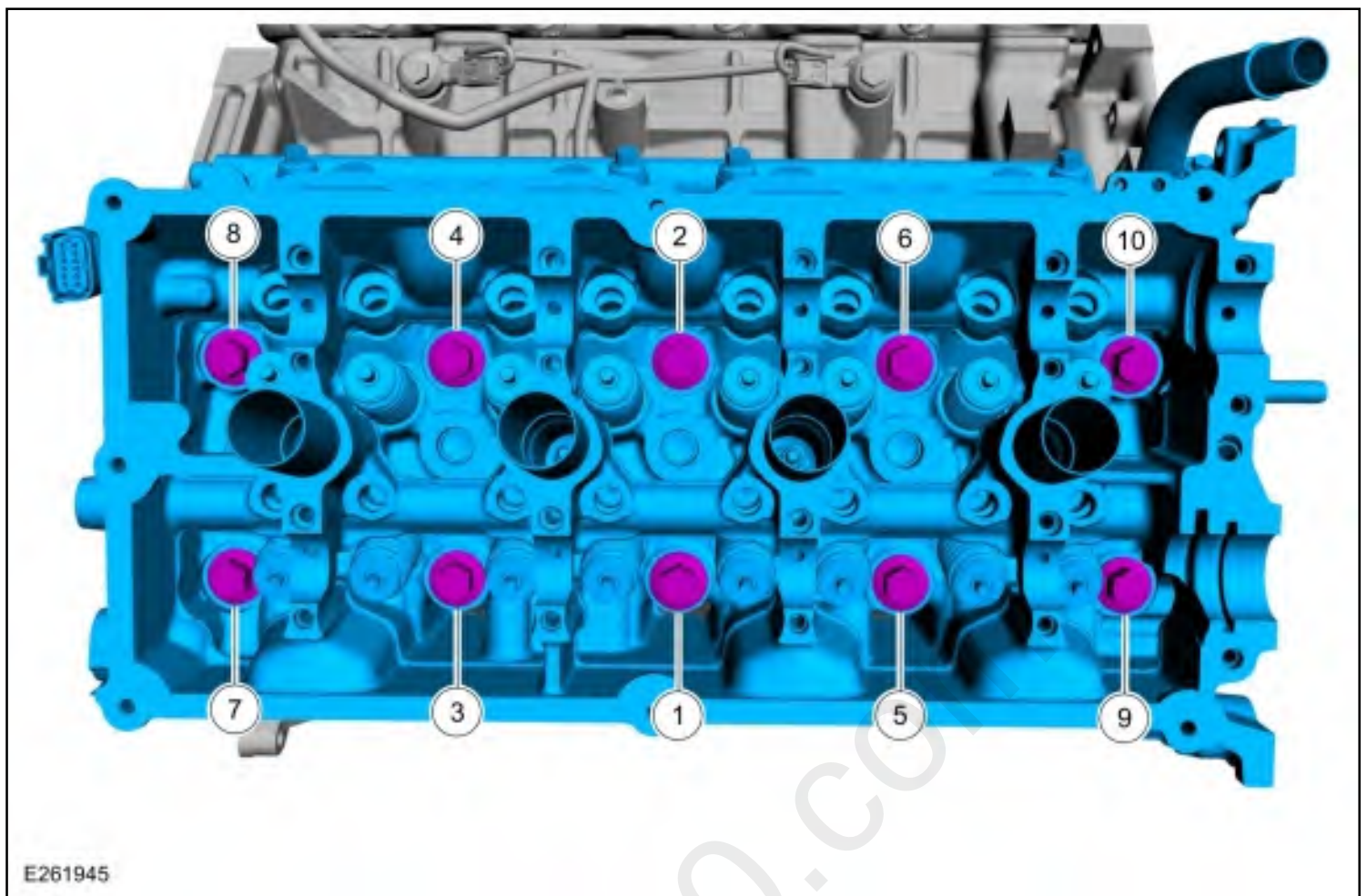
Stage 2: Bolts 1-10 in sequence: 55 lb.ft (75 Nm)

Stage 3: Bolt 1: Loosen: 180°

Stage 4: Bolt 1: 37 lb.ft (50 Nm)

Stage 5: Bolt 1: 240°

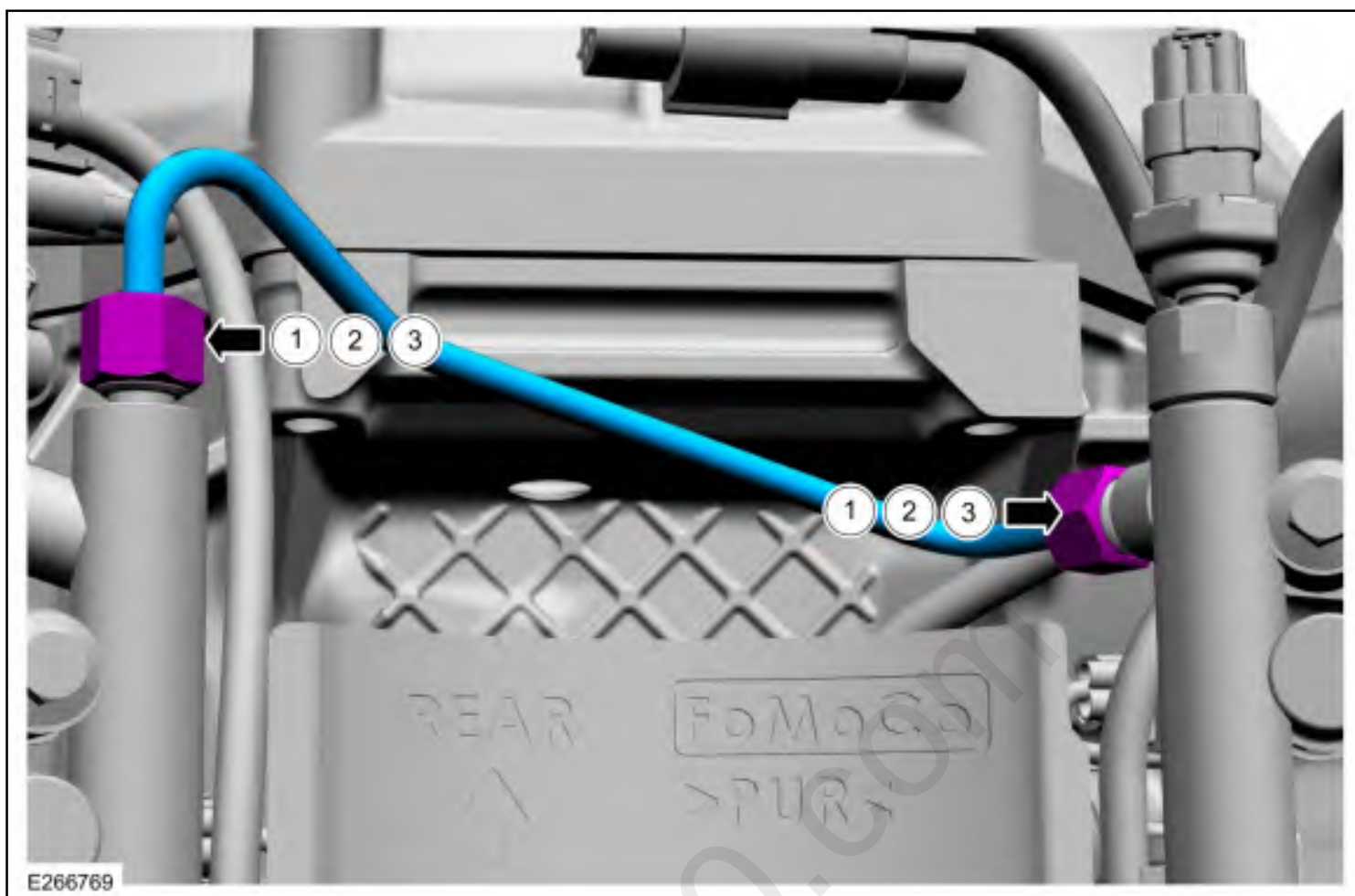
2. Perform stages 3, 4 and 5 on bolts 2 through 10 (complete all three stages to each bolt before moving on to the next bolt in sequence).



3. **NOTICE:** In stage 3, if the torque required to tighten any flare nut on the new high-pressure fuel tube reaches or exceeds 55 lb.ft (50 Nm), then that high pressure fuel tube must be discarded and replaced with another new high-pressure fuel tube.

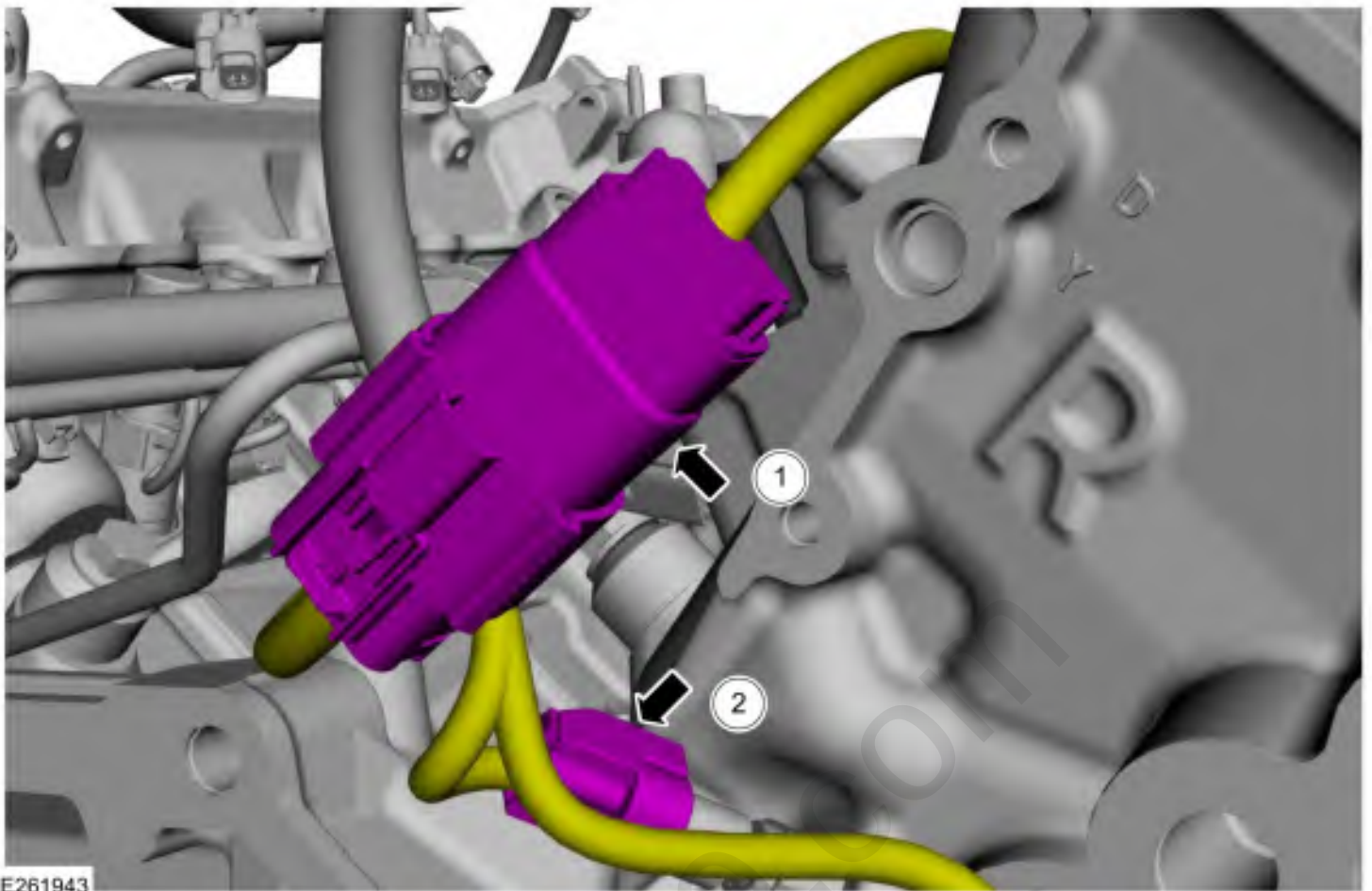
*Torque:*

- Stage 1: Tighten the high-pressure fuel tube flare nuts to : 71 lb.in (8 Nm)
- Stage 2: Tighten the high-pressure fuel tube flare nuts to : 89 lb.in (10 Nm)
- Stage 3: Tighten the high-pressure fuel tube flare nuts an additional : 25°



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





5. Install the following items:

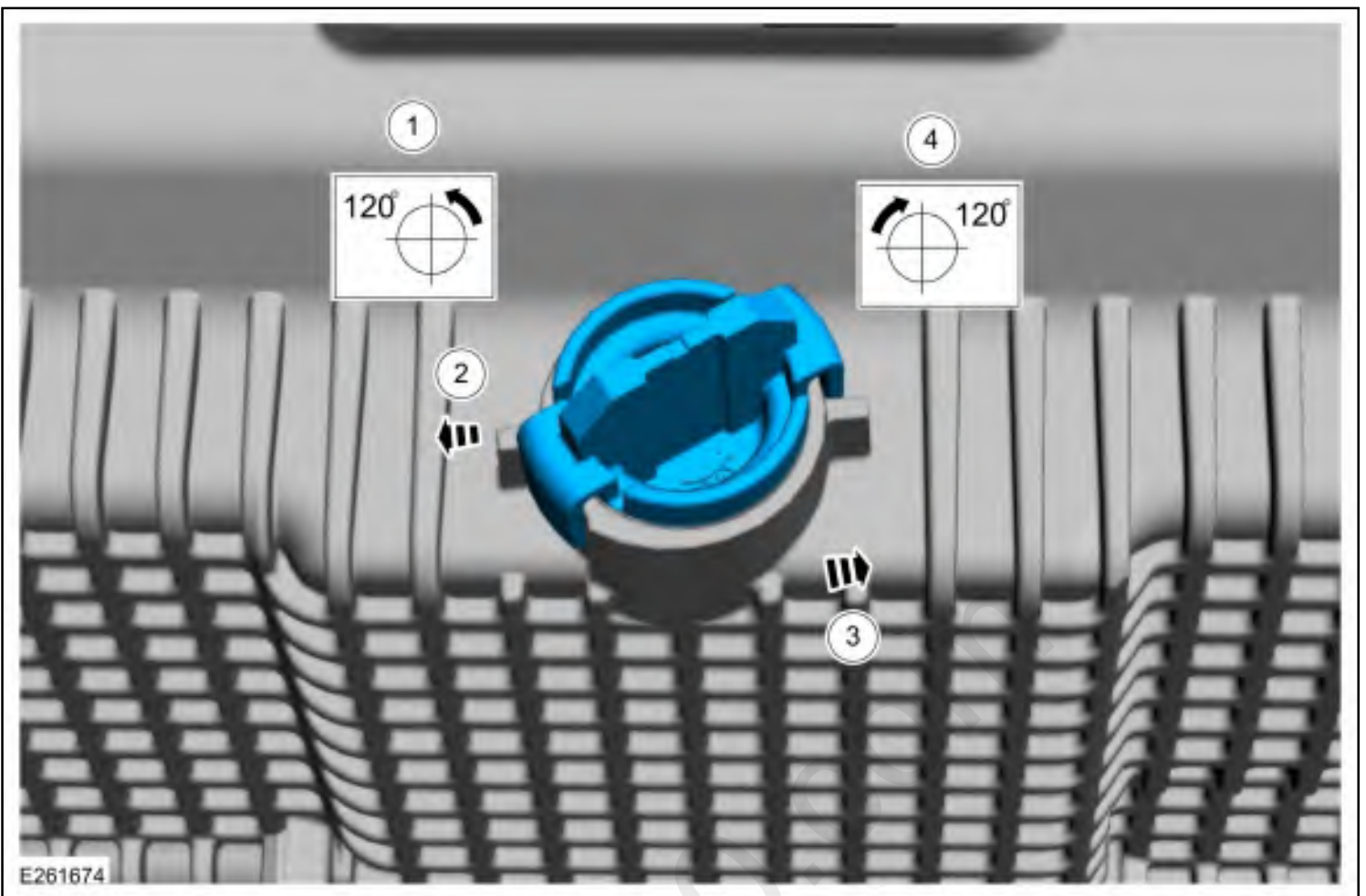
1. Refer to: Exhaust Manifold RH (303-01 Engine - 5.0L 32V Ti-VCT) .
2. Refer to: Camshaft RH (303-01 Engine - 5.0L 32V Ti-VCT) .

6. **NOTE:** *The drain plug should be removed and installed by hand, do not use tools.*

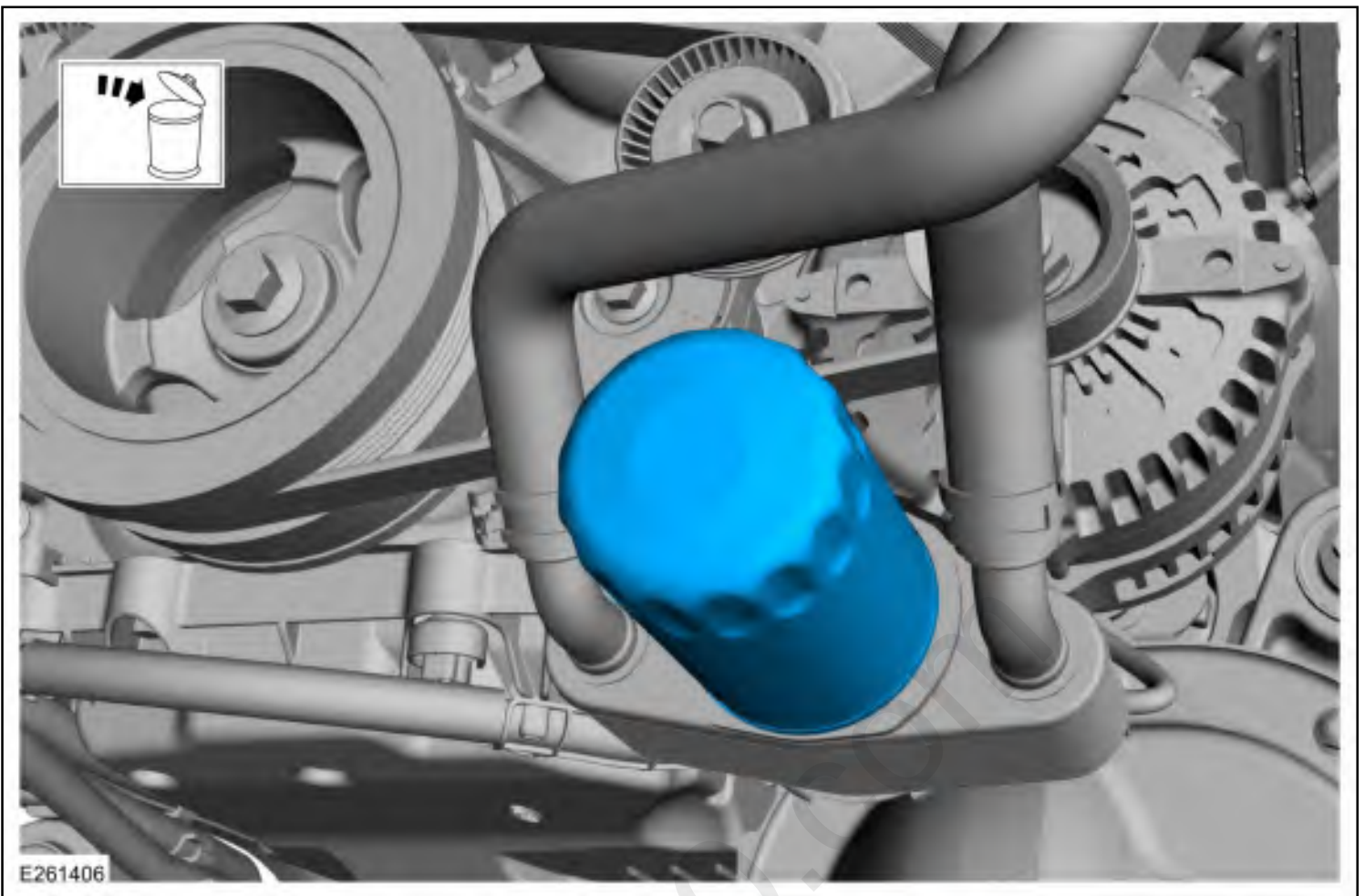
1. Turn the oil drain plug by hand counterclockwise 120 degrees.  
Use the General Equipment: Oil Drain Equipment
2. Pull the oil drain plug out of the oil pan.
3. After the oil has drained, push the oil drain plug into the oil pan.
4. **NOTICE: Overtightening will damage the oil drain plug and possibly the oil pan.**

Turn the oil drain plug by hand clockwise 120 degrees.





7. Remove and discard the engine oil filter.



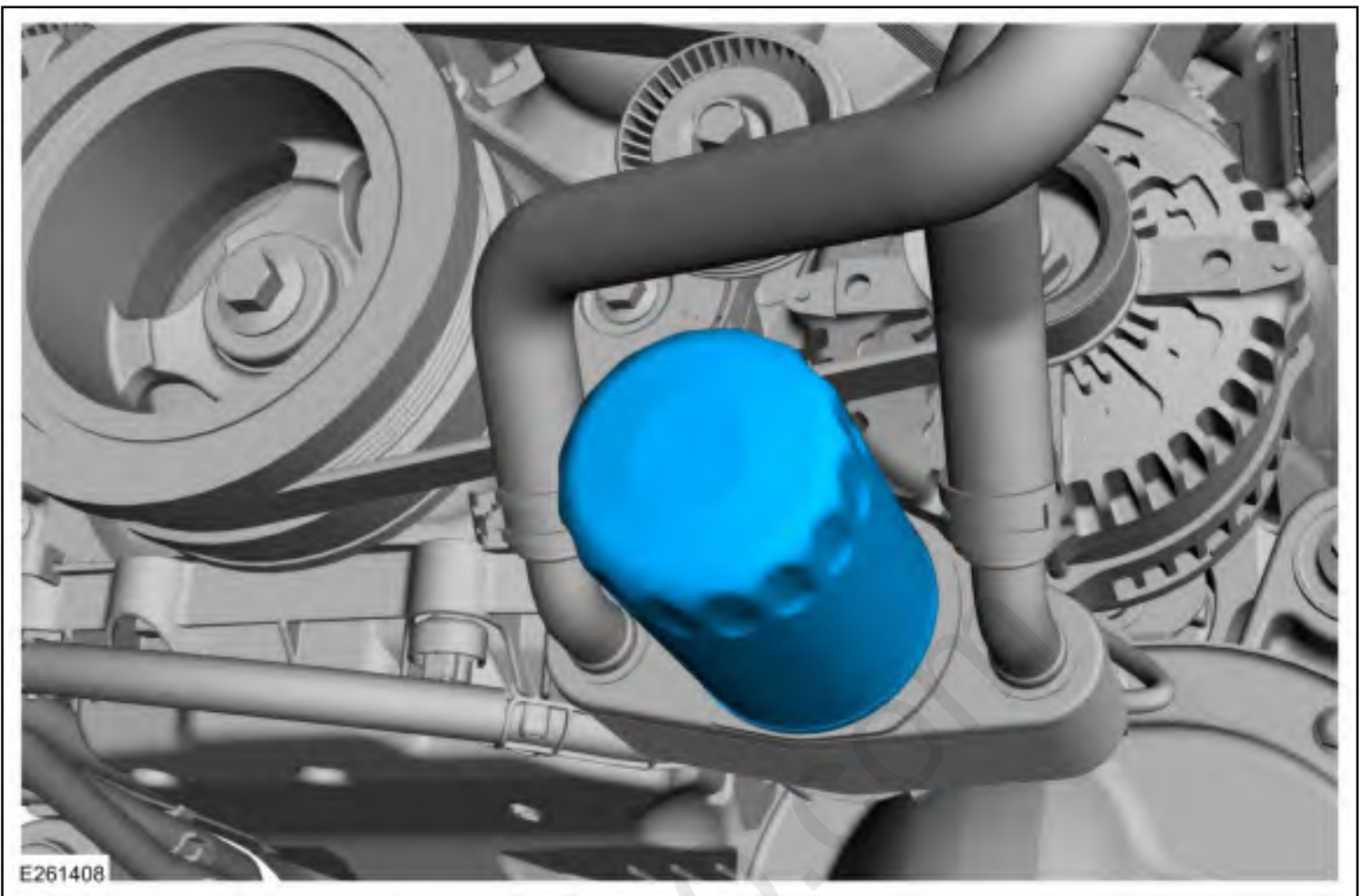
8. **NOTE:** *Do not lubricate the O-ring seal.*

Install a new oil filter.

*Torque:*

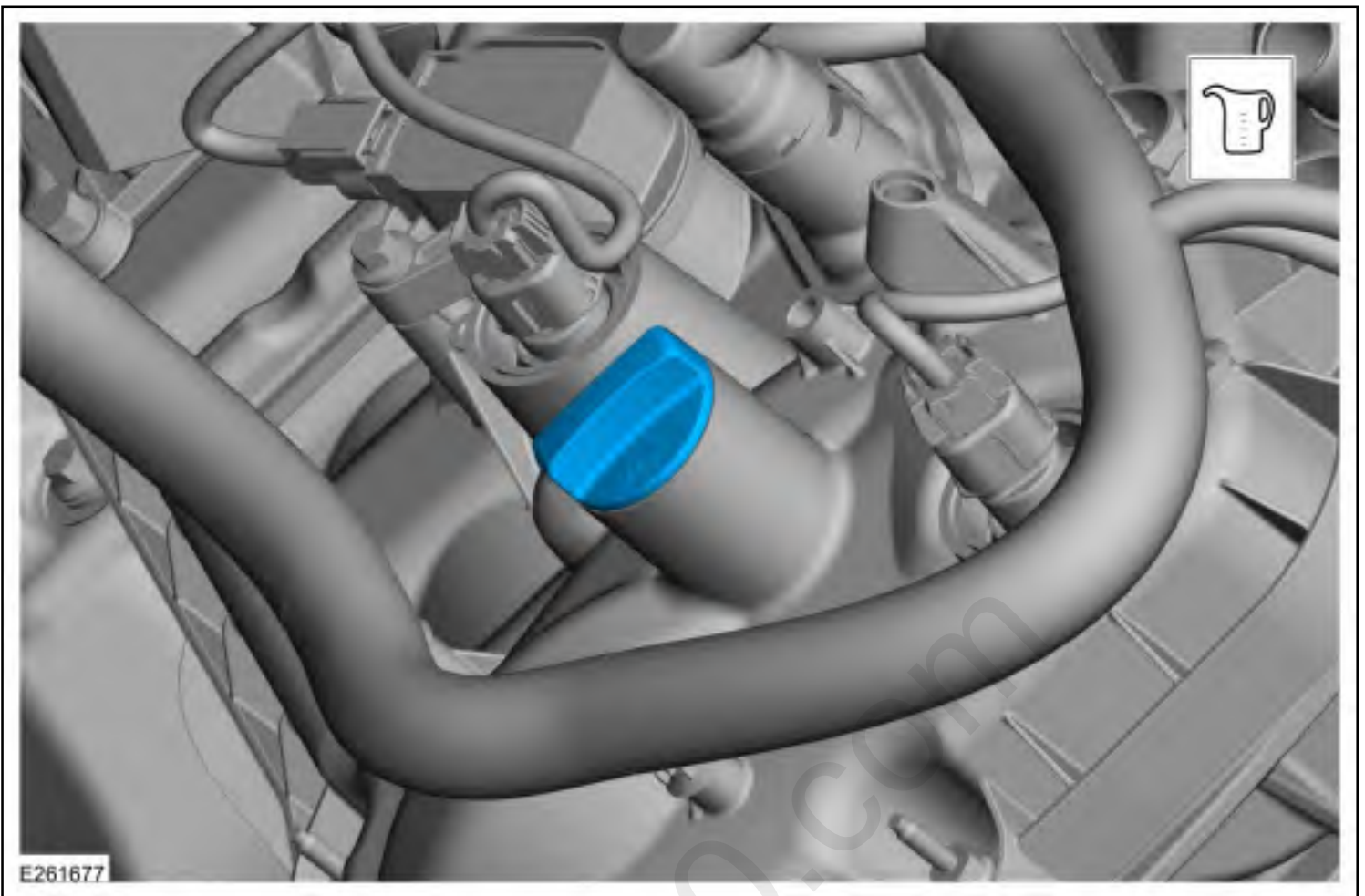
Stage 1: 44 lb.in (5 Nm)

Stage 2: 180°



9. Fill the engine with clean engine oil.

Refer to: [Specifications](#) (303-01D Engine - 5.0L 32V Ti-VCT, Specifications).



10. Connect the battery ground cable.  
Refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables) .
11. Fill and bleed the engine cooling system.  
Refer to: Cooling System Draining, Vacuum Filling and Bleeding (303-03 Engine Cooling - 5.0L 32V Ti-VCT) .

## Variable Camshaft Timing (VCT) Unit

### Removal

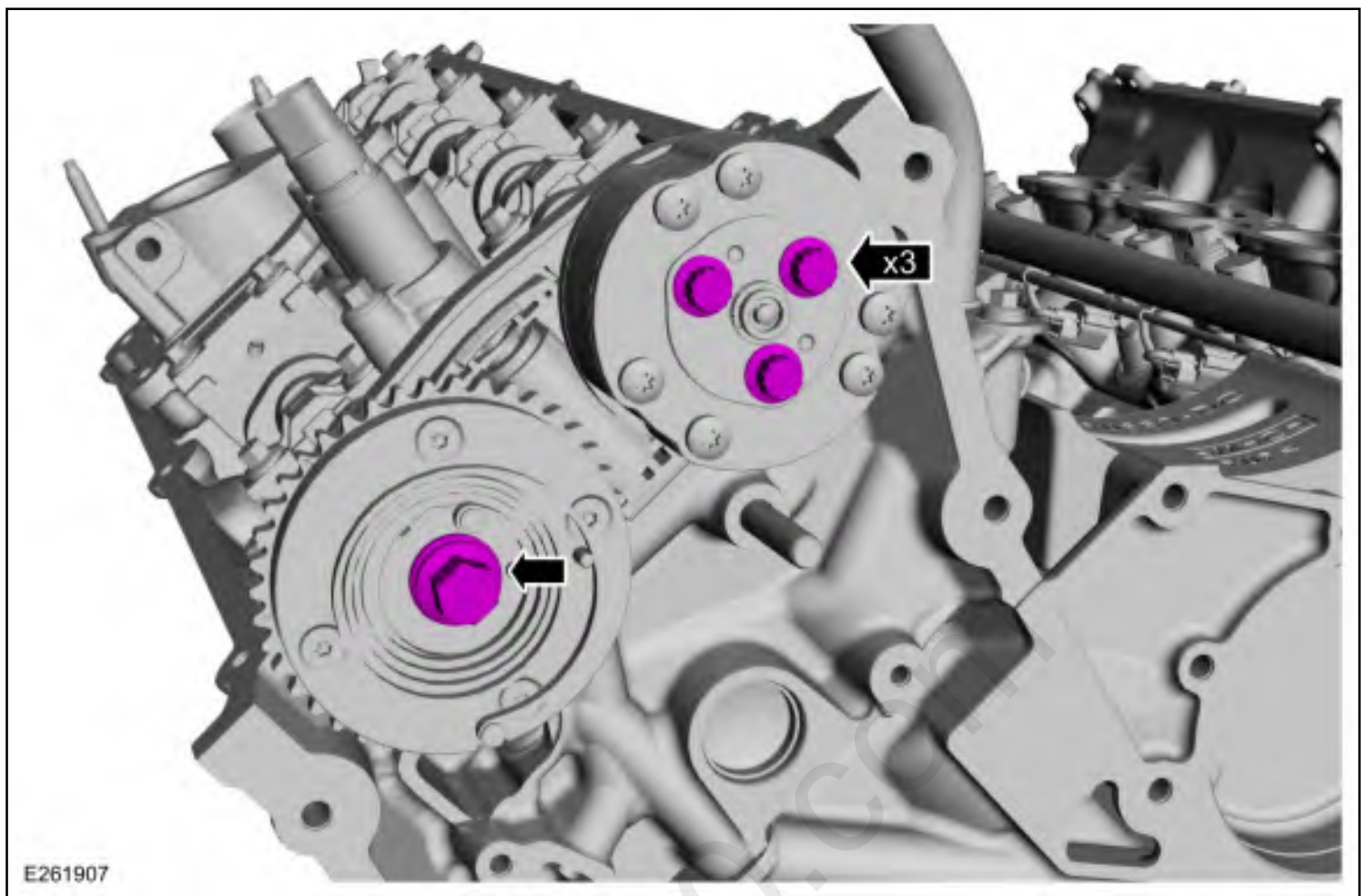
**NOTICE:** During engine repair procedures, cleanliness is extremely important. Any foreign material, including any material created while cleaning gasket surfaces, that enters the oil passages, coolant passages or the oil pan, can cause engine failure.

**NOTE:** If the RH VCT units are being serviced at the same time as the LH VCT units, remove the RH VCT units first.

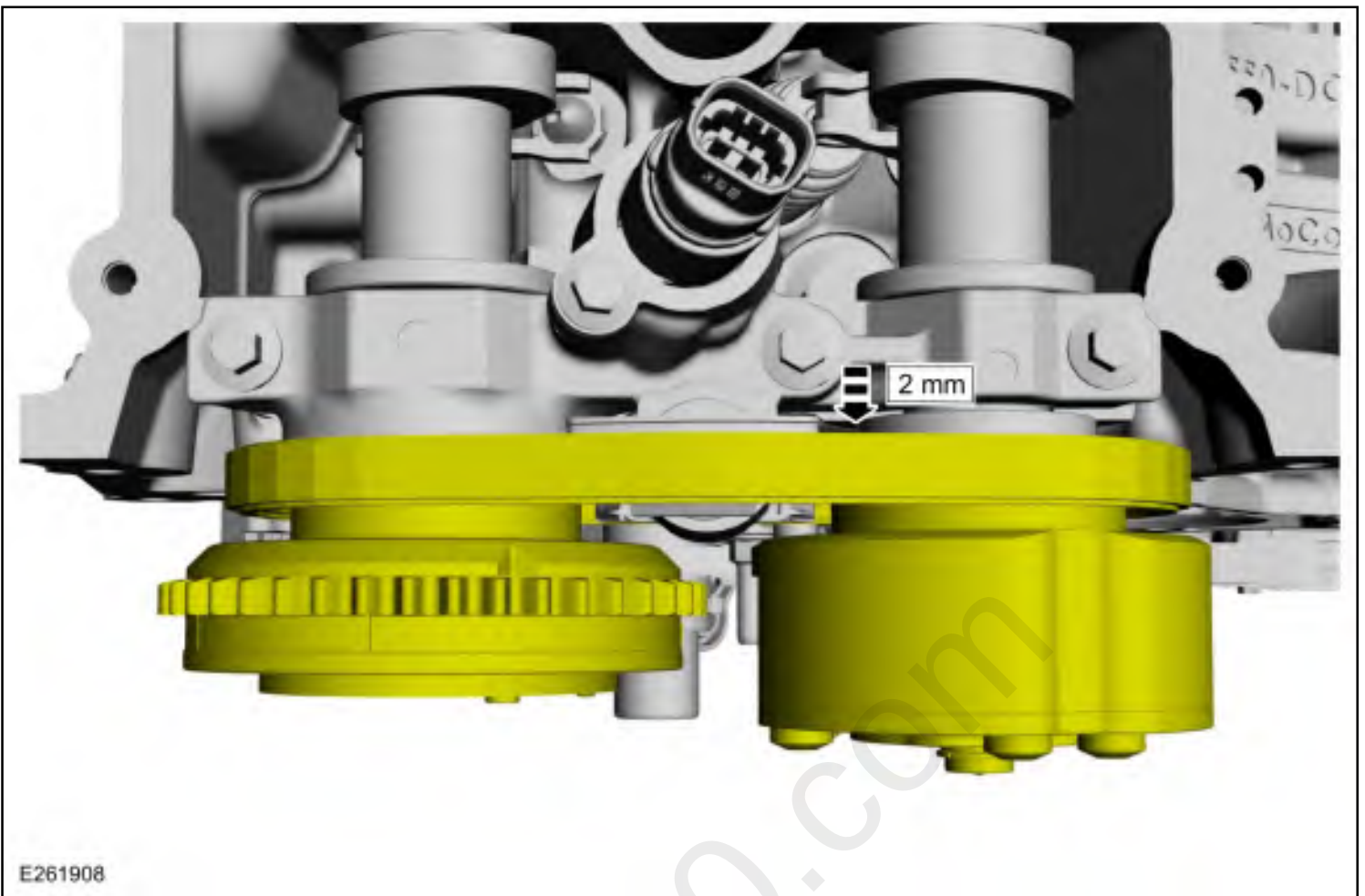
### Right hand units

1. Remove the RH timing chain.  
Refer to: Timing Chain (303-01 Engine - 5.0L 32V Ti-VCT) .
2. Remove the intake and exhaust VCT assembly bolts.

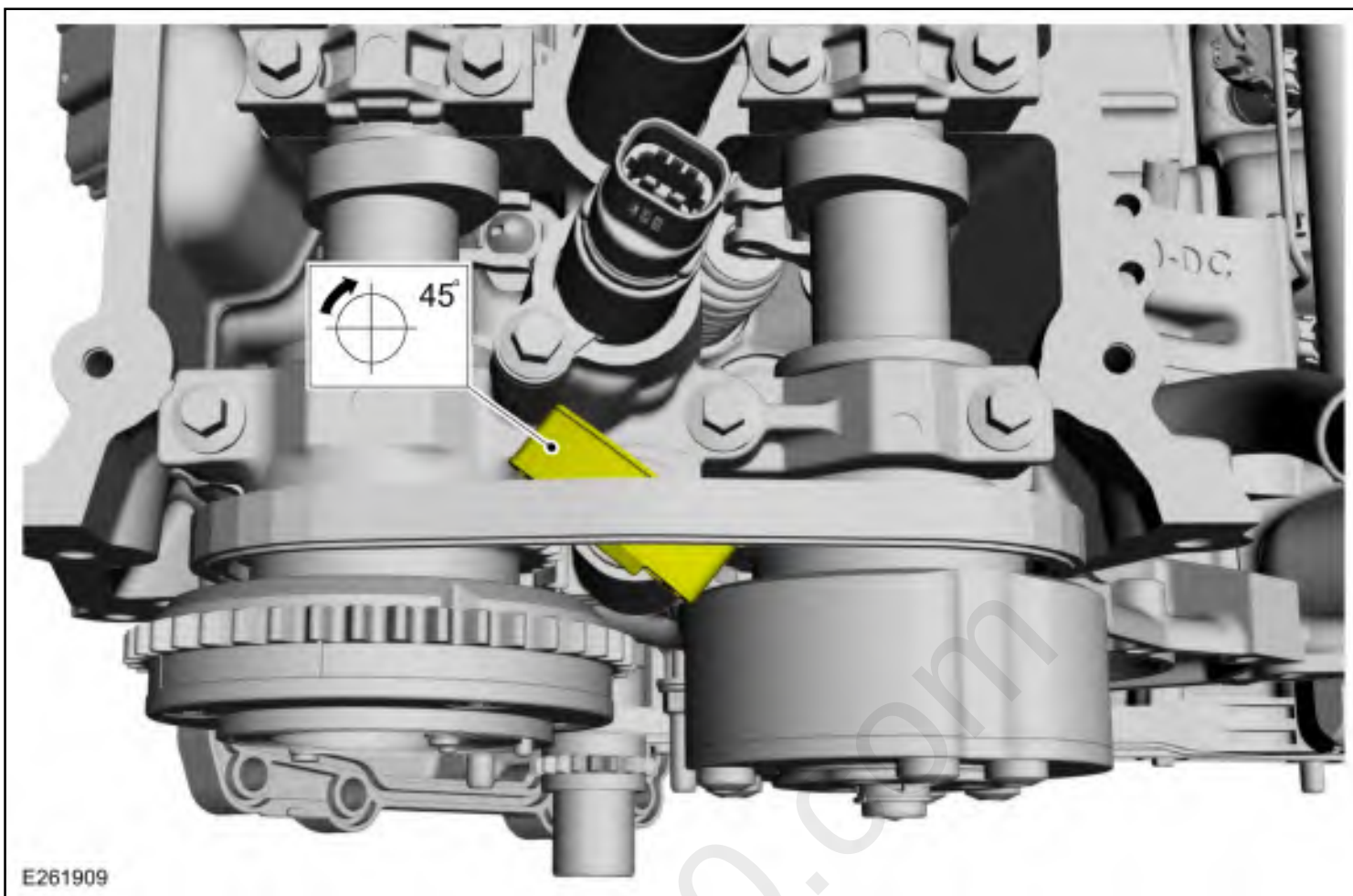




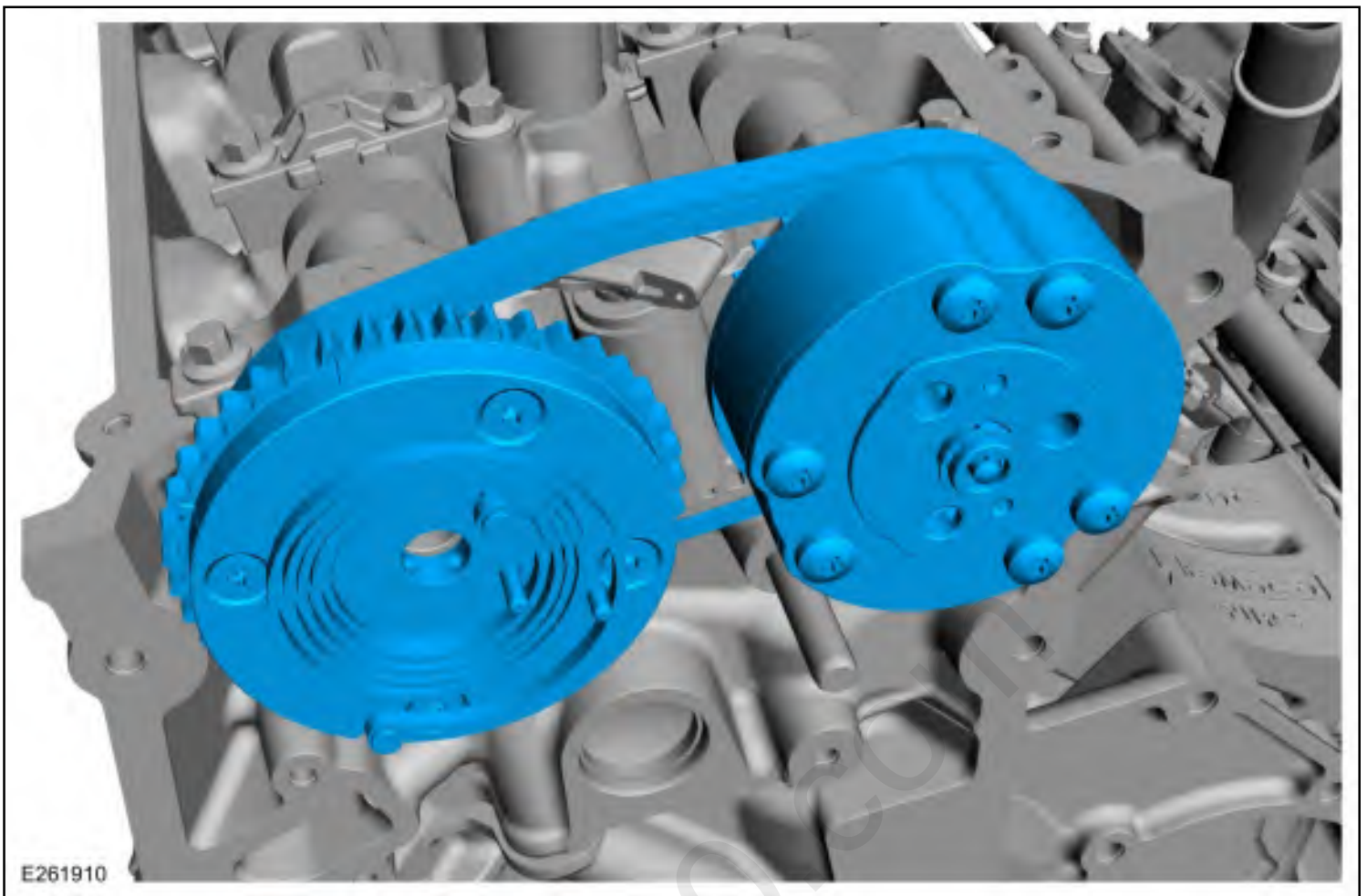
3. Slide the VCT assemblies and secondary timing chain forward 2 mm (0.078 in).



4. Depress and turn the secondary tensioner clockwise 45 degrees.



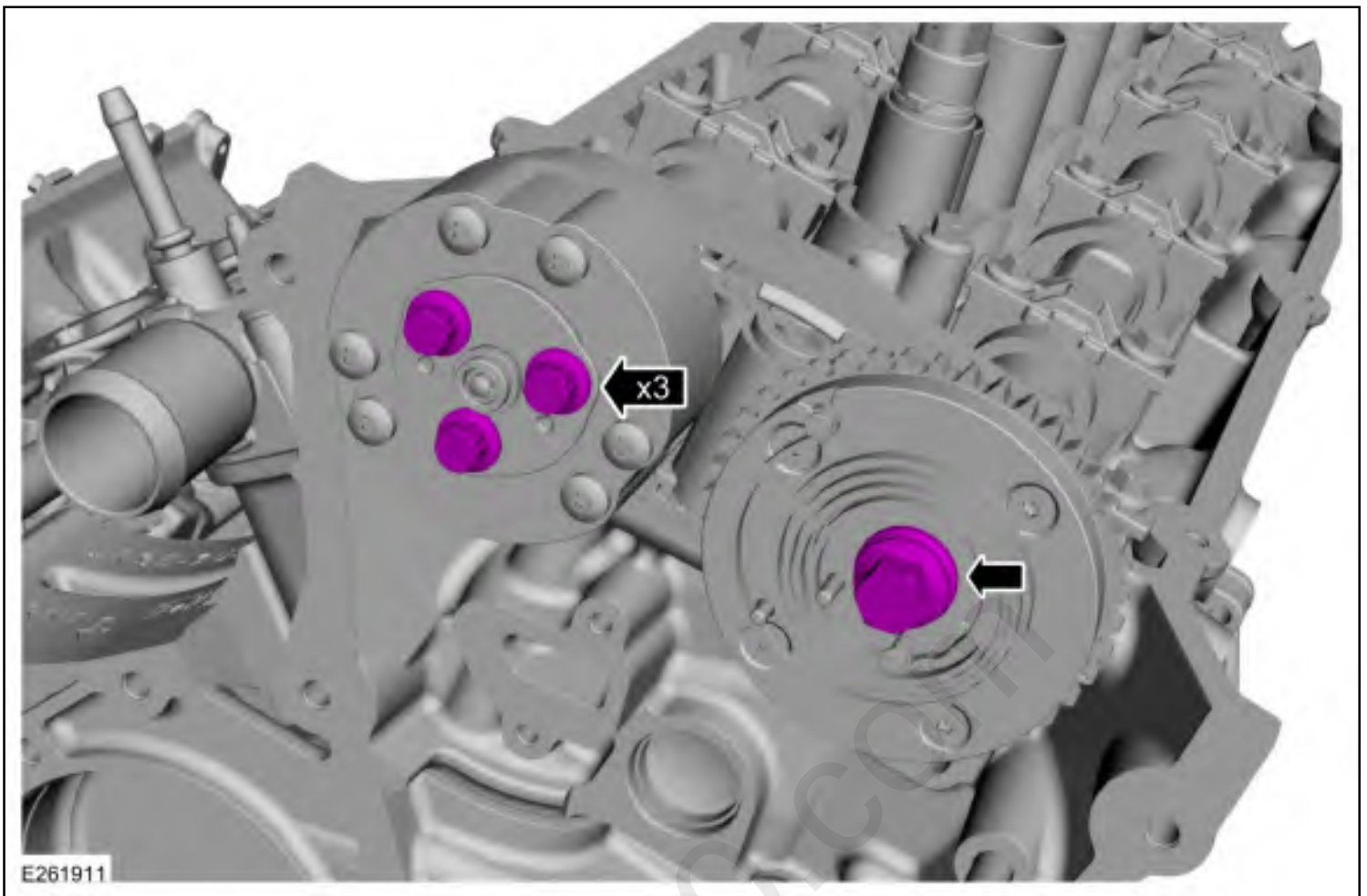
5. Remove the VCT assemblies and the secondary timing chain.



## Left hand units

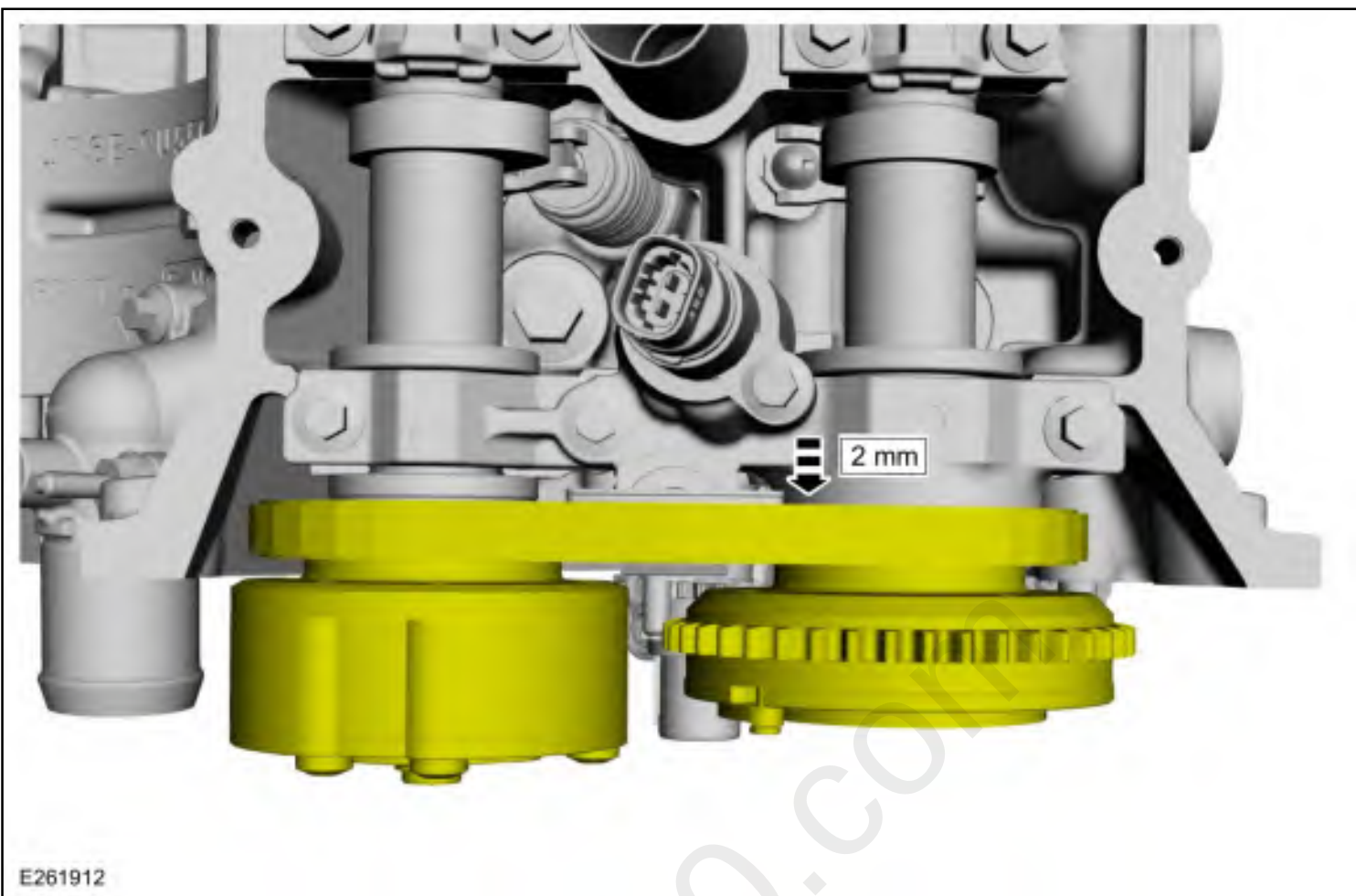
6. Remove the LH timing chain.  
Refer to: Timing Chain (303-01 Engine - 5.0L 32V Ti-VCT) .
7. Remove the intake and exhaust VCT assembly bolts.



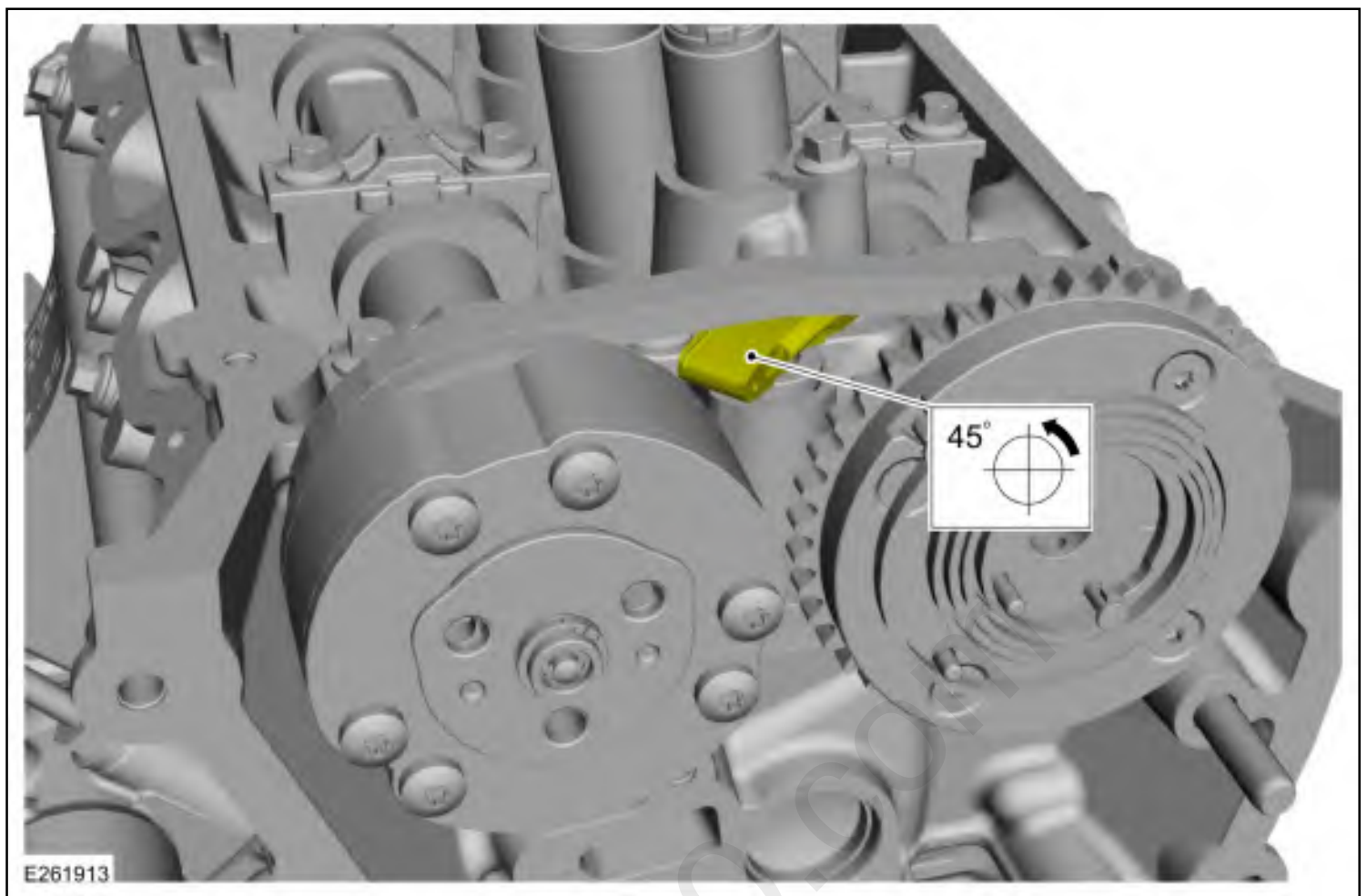


8. Slide the Variable Camshaft Timing VCT assemblies and secondary timing chain forward 2 mm (0.078 in).

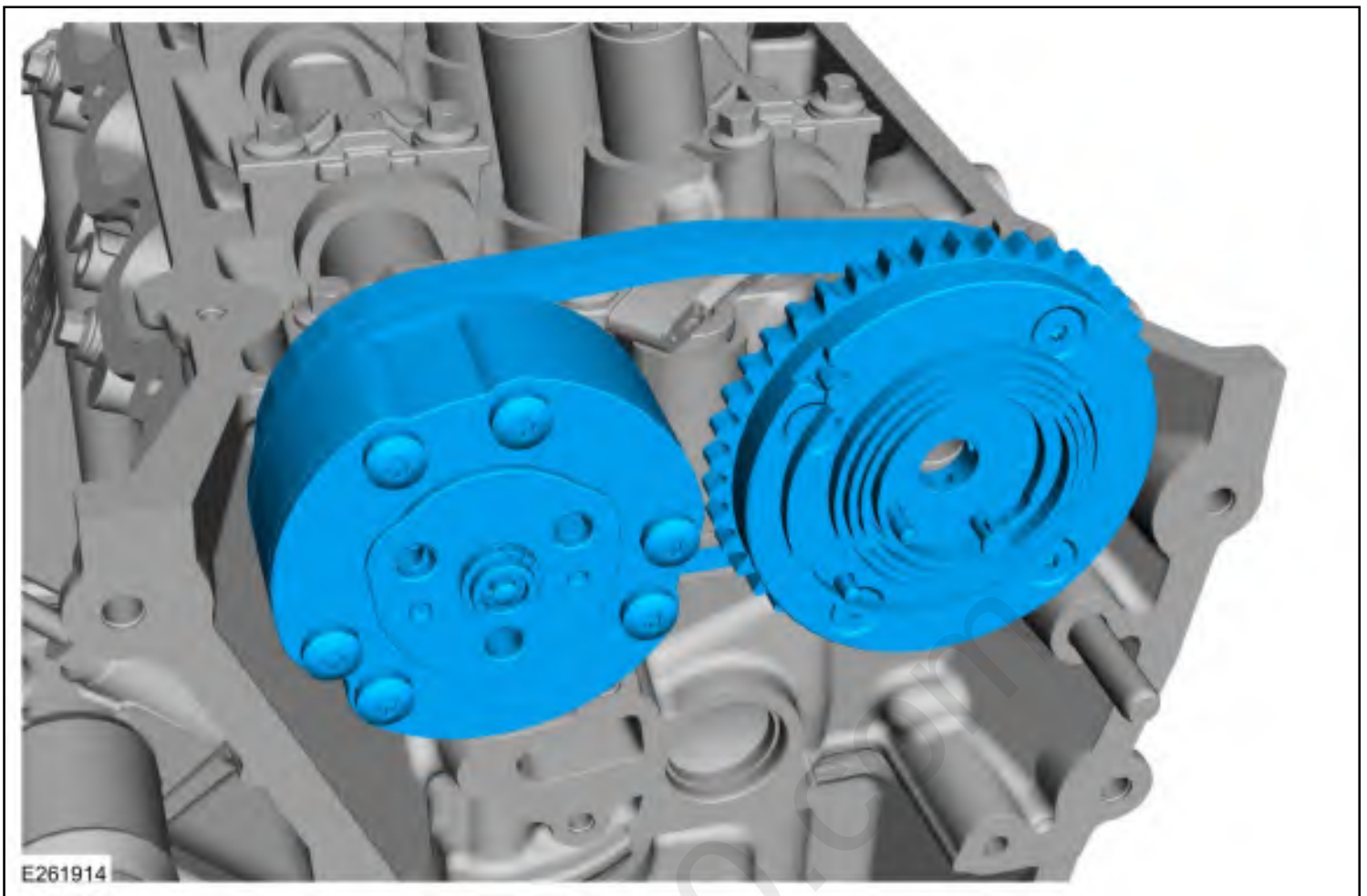




9. Depress and turn the secondary tensioner counterclockwise 45 degrees.



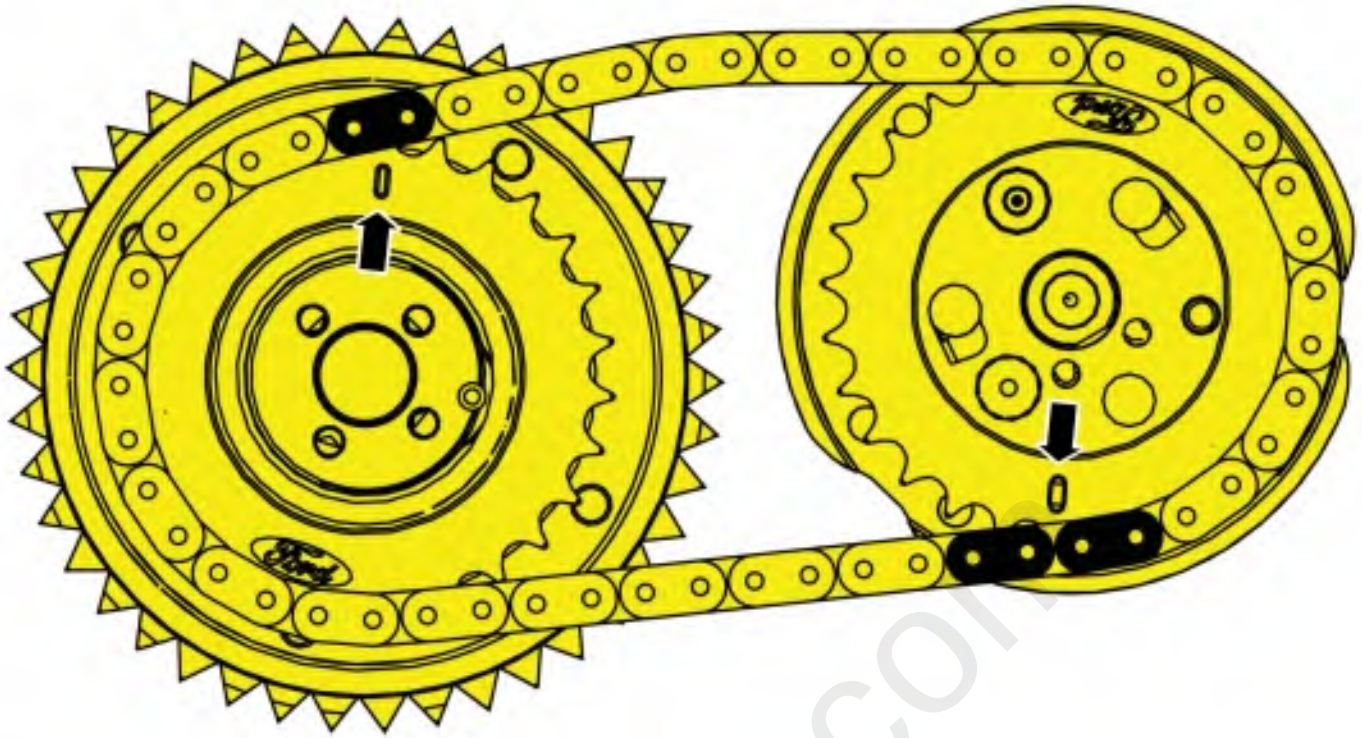
10. Remove the VCT assemblies and the secondary timing chain.



## Installation

### Left hand units

1. 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.

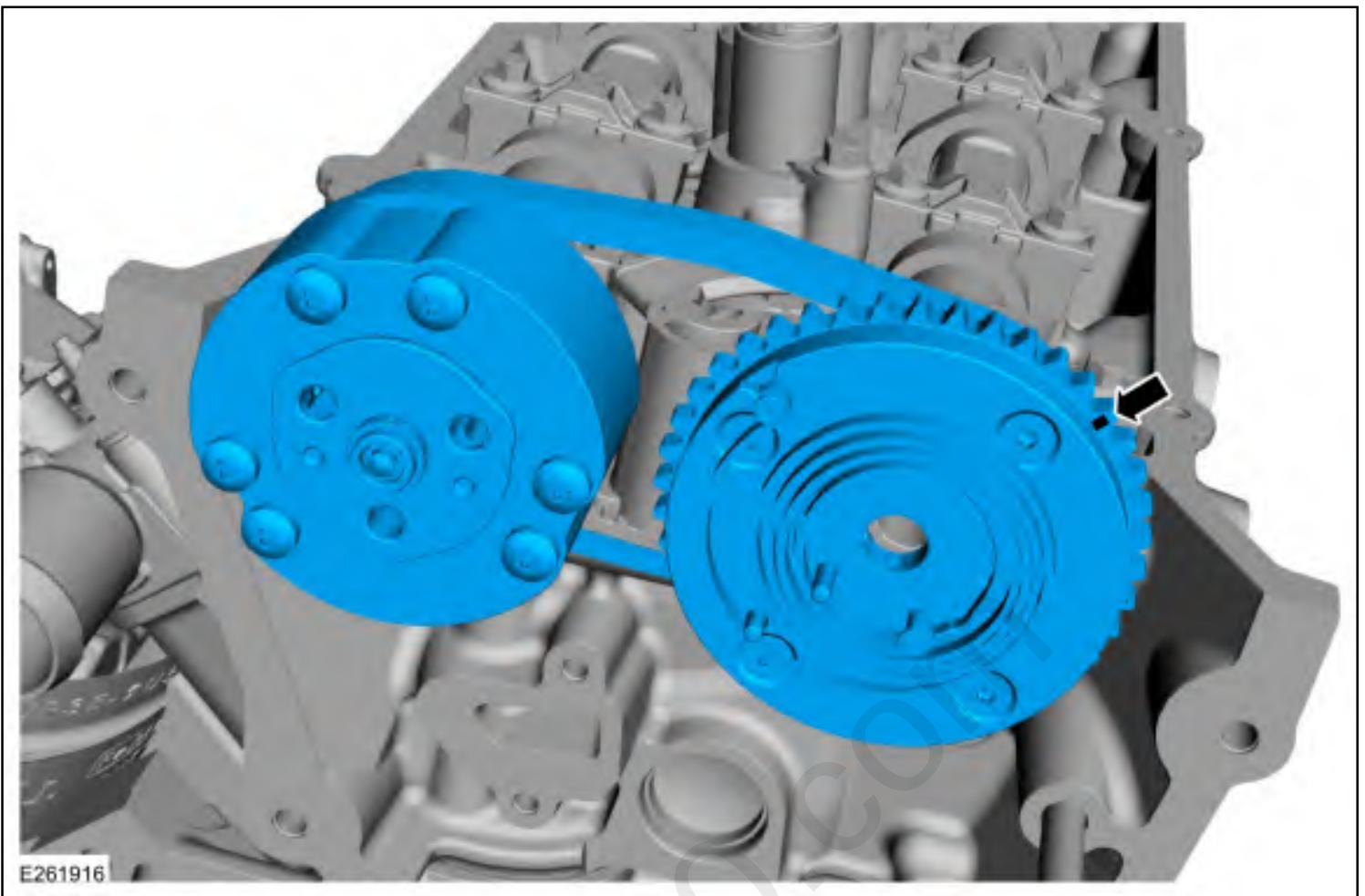


E261915



2. 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.



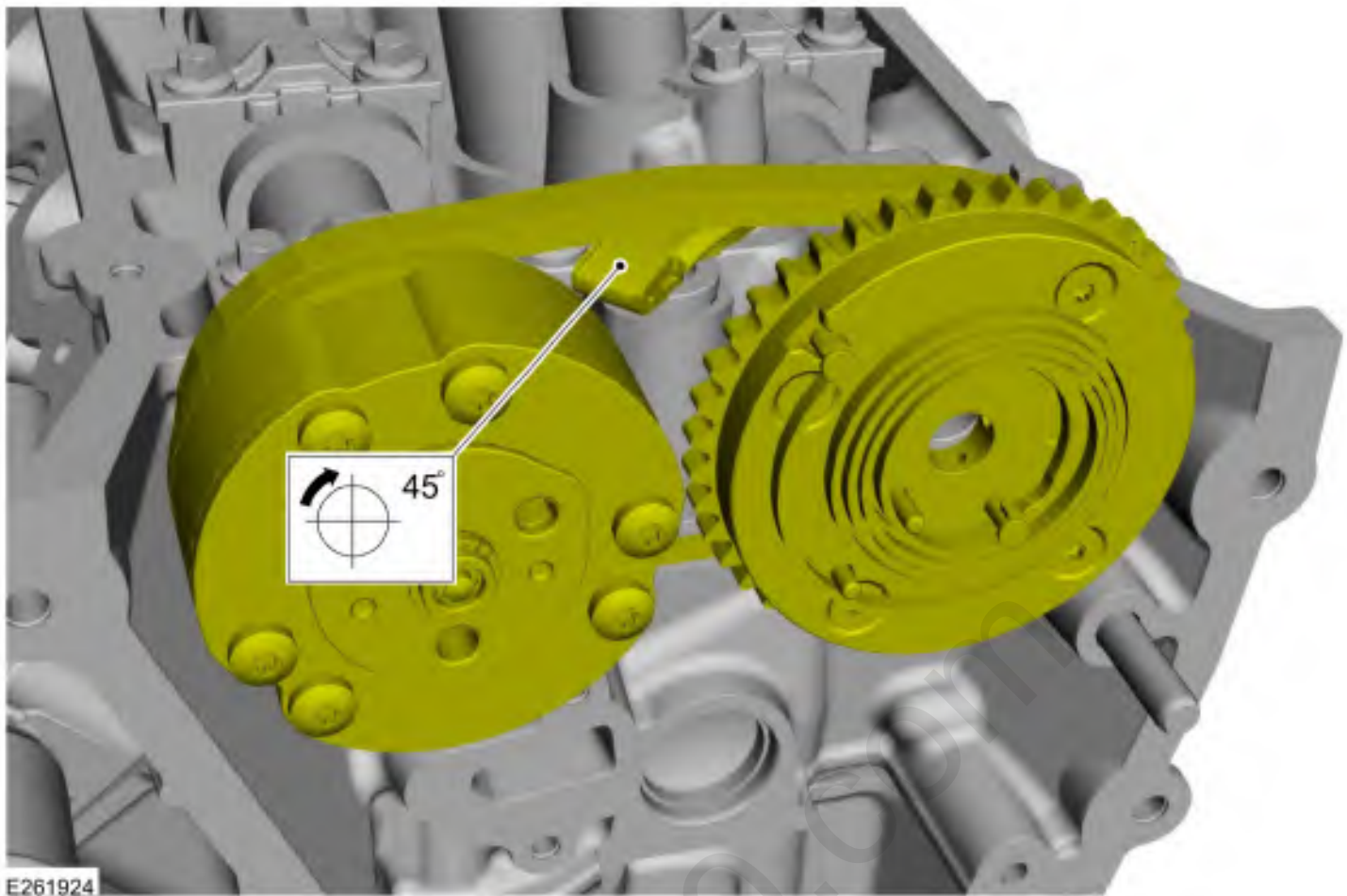


3. **NOTE:** *It may be necessary to rotate the exhaust camshaft slightly (using a wrench on the flats of the camshaft) to seat the VCT assemblies onto the camshafts.*

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.





4. **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.

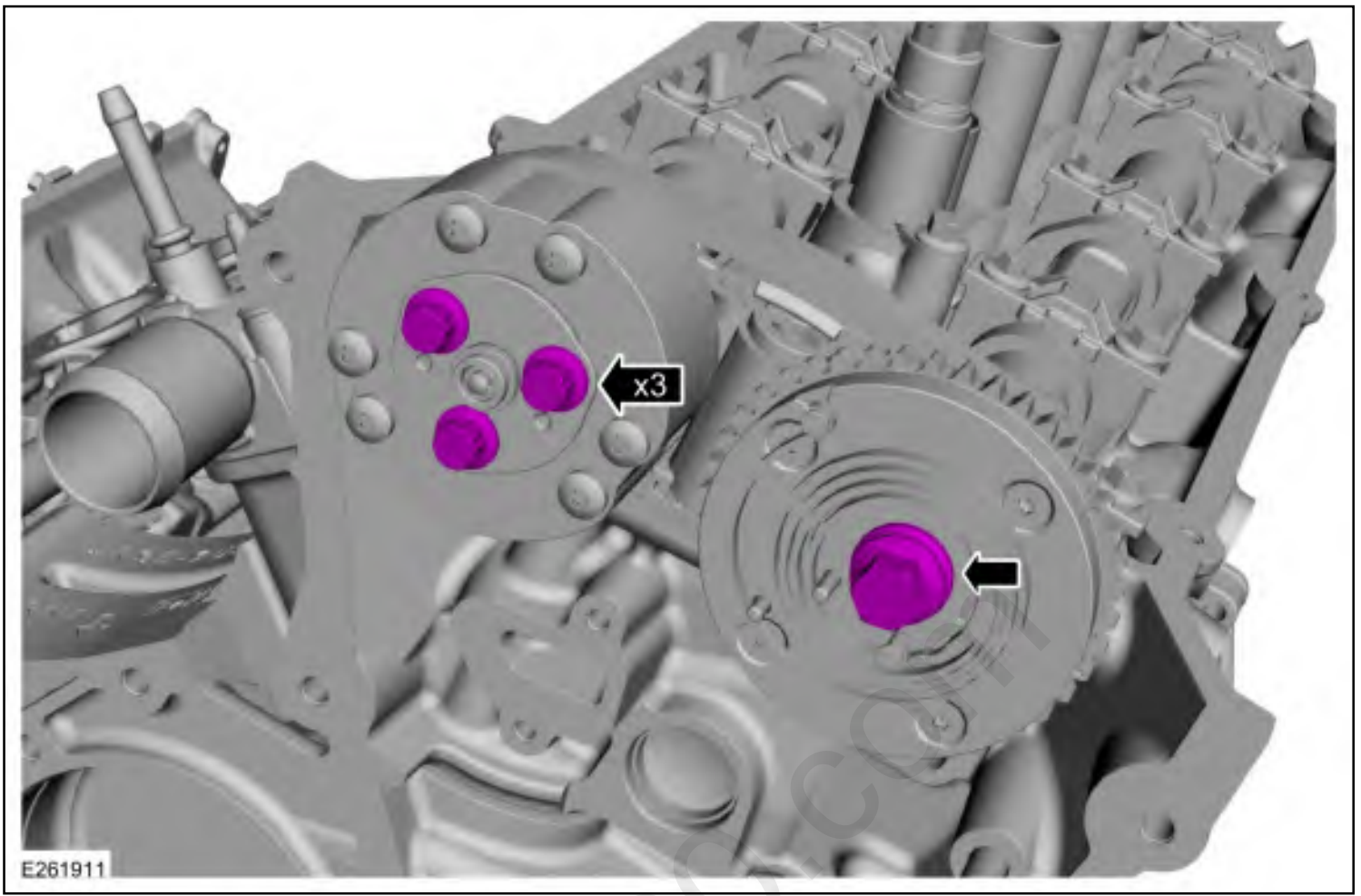
*Torque:*

Stage 1: 30 lb.ft (40 Nm)

Stage 2: Loosen: 360°

Stage 3: 20 lb.ft (27 Nm)

Stage 4: 150°

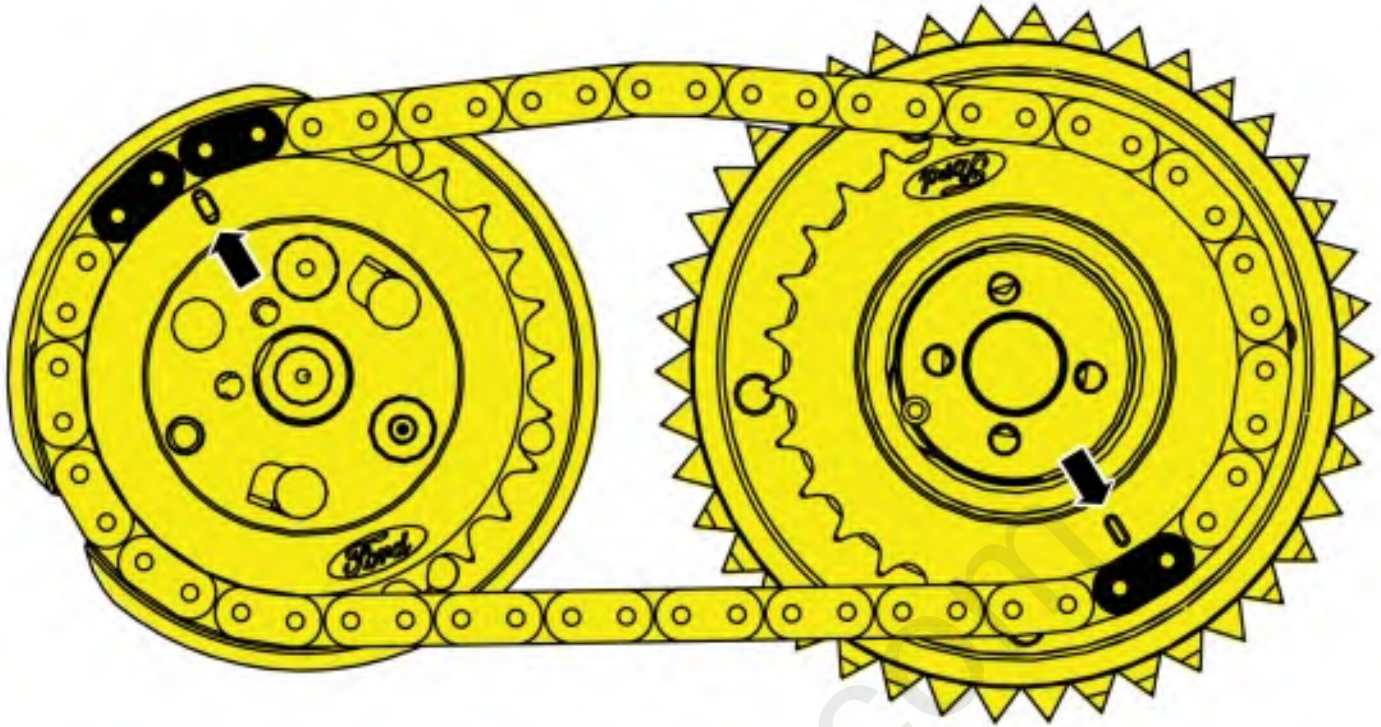


5. Install the LH timing chain.

Refer to: Timing Chain (303-01 Engine - 5.0L 32V Ti-VCT) .

### Right hand units

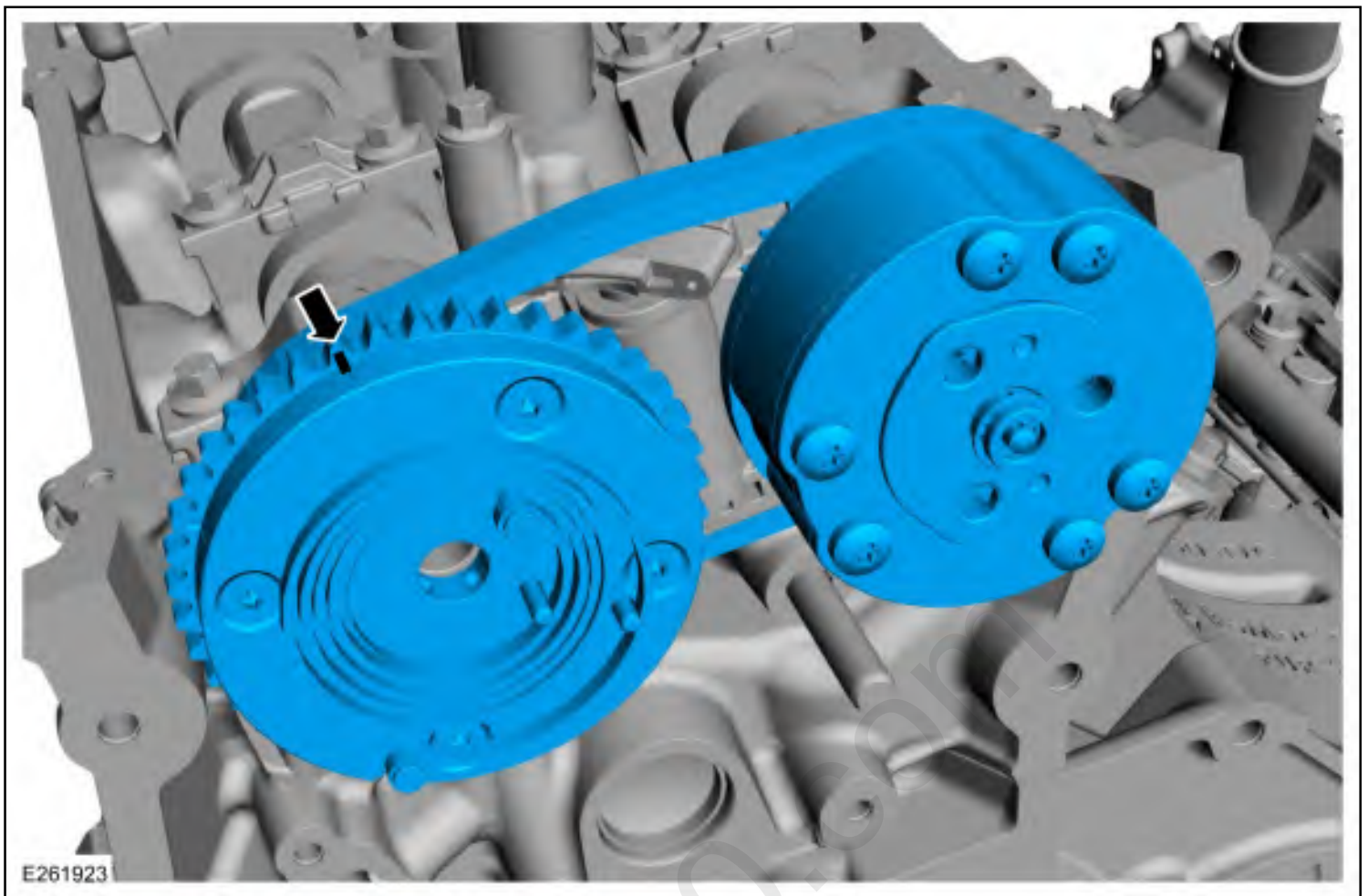
6. Position the secondary timing chain onto the VCT assemblies. Align the colored links on the secondary timing chain with the timing marks on the VCT assemblies as shown in the illustration.
- The timing mark on the intake VCT assembly should align between the 2 consecutive colored links.
  - The timing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



E261922

7. 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.

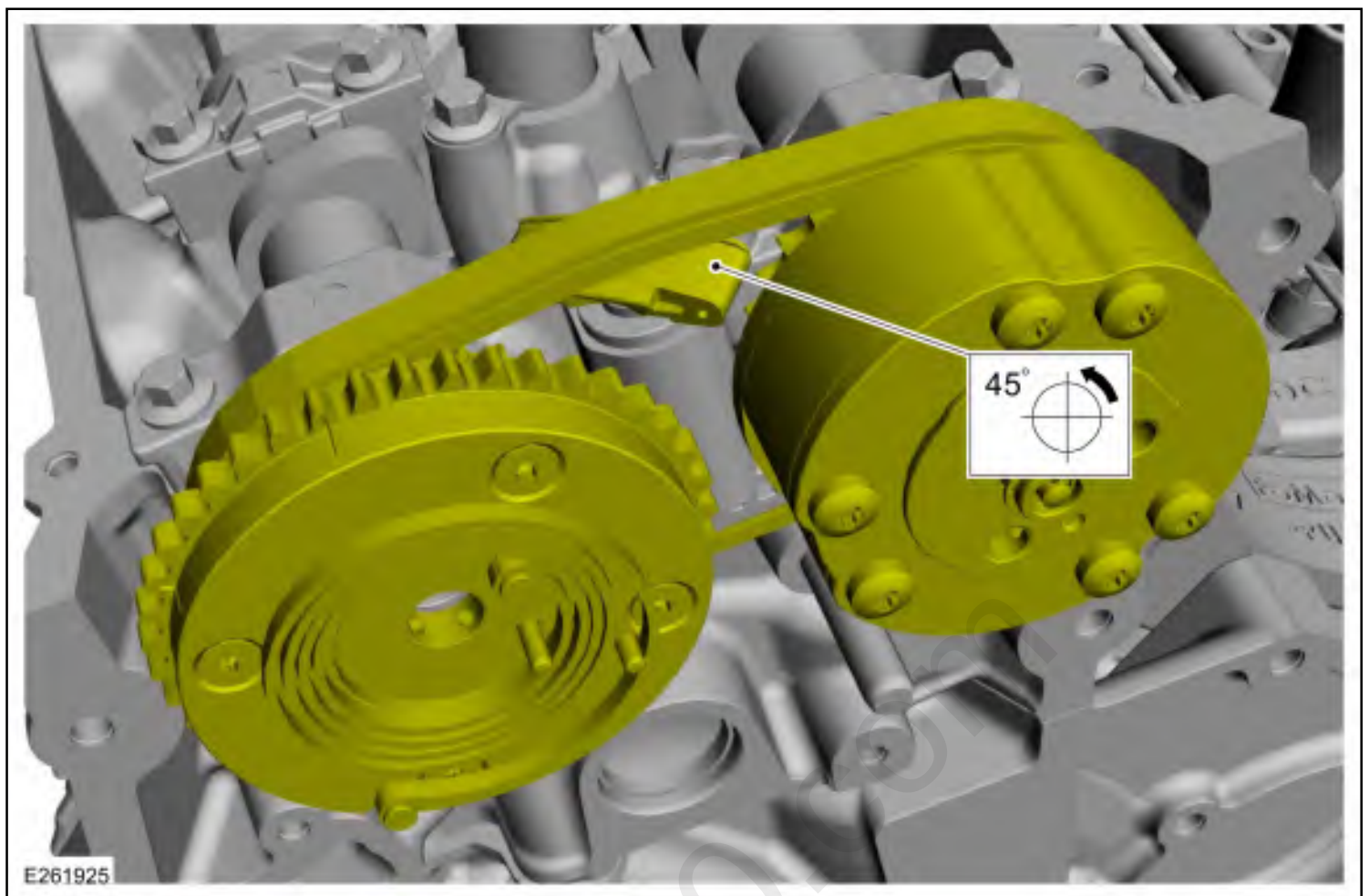




8. **NOTE:** *It may be necessary to rotate the exhaust camshaft slightly (using a wrench on the flats of the camshaft) to seat the VCT assemblies onto the camshafts.*

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.



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

- Install the intake VCT assembly bolts.

*Torque:*

Stage 1: 133 lb.in (15 Nm)

Stage 2: 90°

- Install the exhaust VCT assembly bolt.

*Torque:*

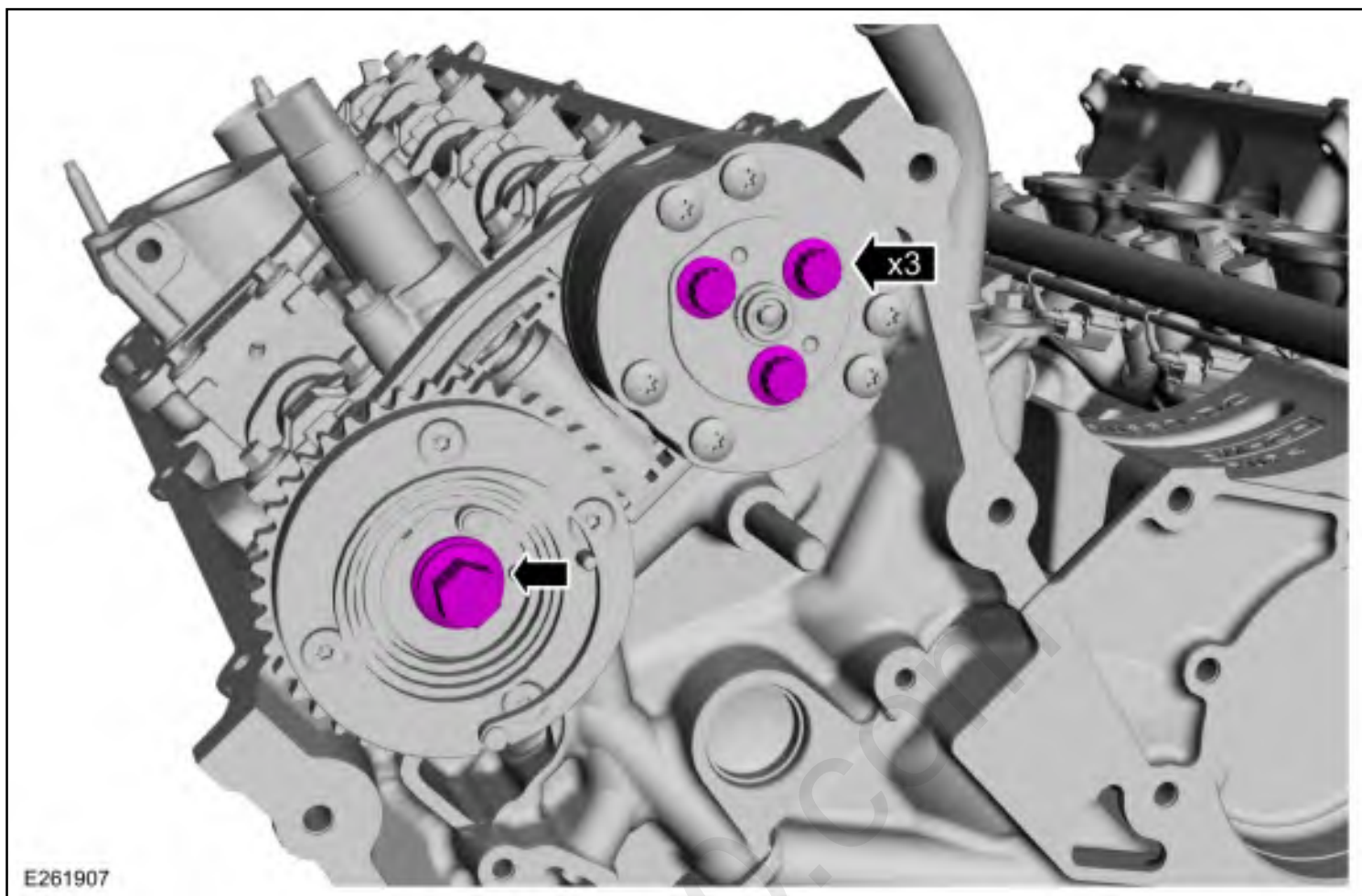
Stage 1: 30 lb.ft (40 Nm)

Stage 2: Loosen: 360°

Stage 3: 20 lb.ft (27 Nm)

Stage 4: 150°





10. Install the RH timing chain.

Refer to: Timing Chain (303-01 Engine - 5.0L 32V Ti-VCT) .

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# Engine

Base Part Number: Base Part Number: 6L084

## Special Tool(s) / General Equipment

|                                                                                  |                                     |
|----------------------------------------------------------------------------------|-------------------------------------|
|  | 303-F047<br>Lifting Bracket, Engine |
| Magnetic Socket                                                                  |                                     |
| Floor Crane                                                                      |                                     |
| Oil Drain Equipment                                                              |                                     |
| Trolley Jack                                                                     |                                     |
| Hose Clamp Remover/Installer                                                     |                                     |
| Wooden Block                                                                     |                                     |

1. With the vehicle in NEUTRAL, position it on a hoist.  
Refer to: [Jacking and Lifting - Overview](#) (100-02 Jacking and Lifting, Description and Operation).
2. Release the fuel system pressure.  
Refer to: [Fuel System Pressure Release](#) (310-00D Fuel System - General Information - 5.0L 32V Ti-VCT, General Procedures).
3. Disconnect the battery ground cable.  
Refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables) .
4. Drain the engine cooling system.  
Refer to: Cooling System Draining, Vacuum Filling and Bleeding (303-03 Engine Cooling - 5.0L 32V Ti-VCT) .
5. Remove the following items:
  1. Refer to: [Hood](#) (501-02 Front End Body Panels, Removal and Installation).

2. **NOTE:** *It is not necessary to clamp off the degas bottle hose with the cooling system drained.*

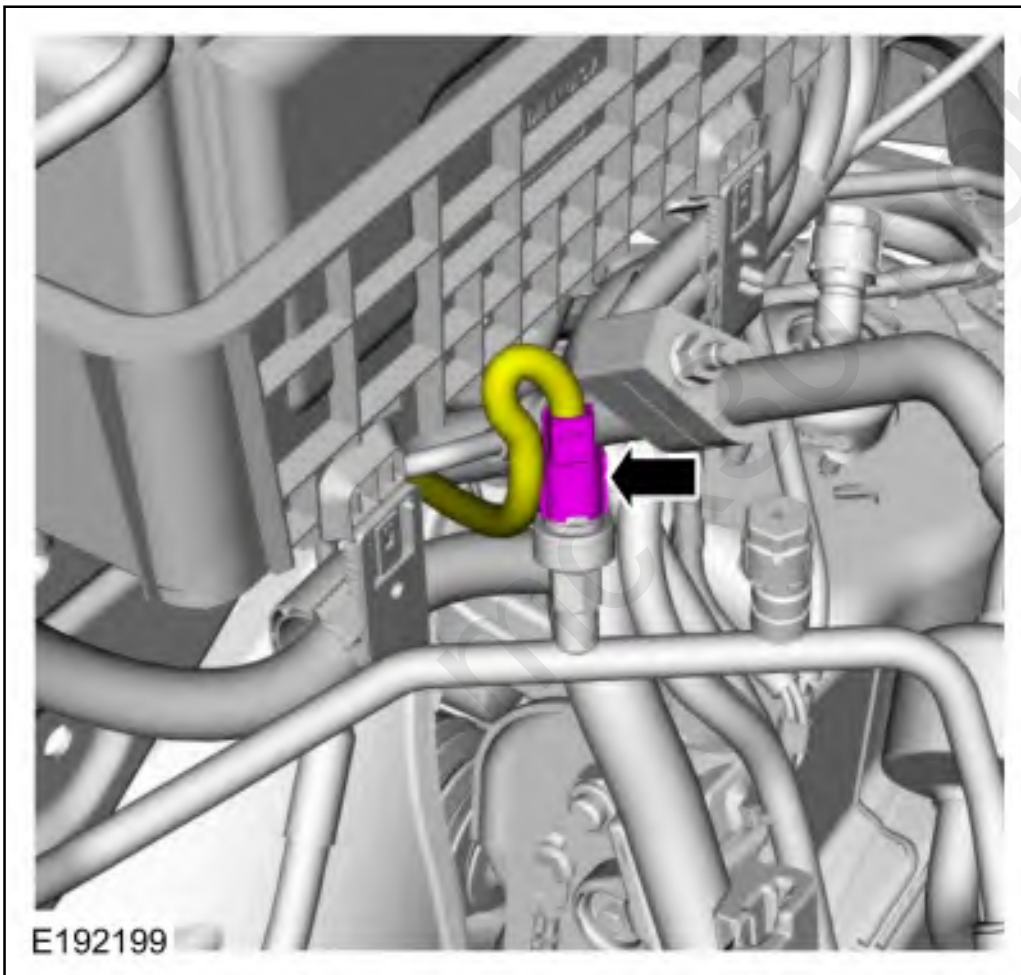
Refer to: [Degas Bottle](#) (303-03D Engine Cooling - 5.0L 32V Ti-VCT, Removal and Installation).

3. Refer to: Cooling Module (303-03 Engine Cooling - 5.0L 32V Ti-VCT) .

4. **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.**

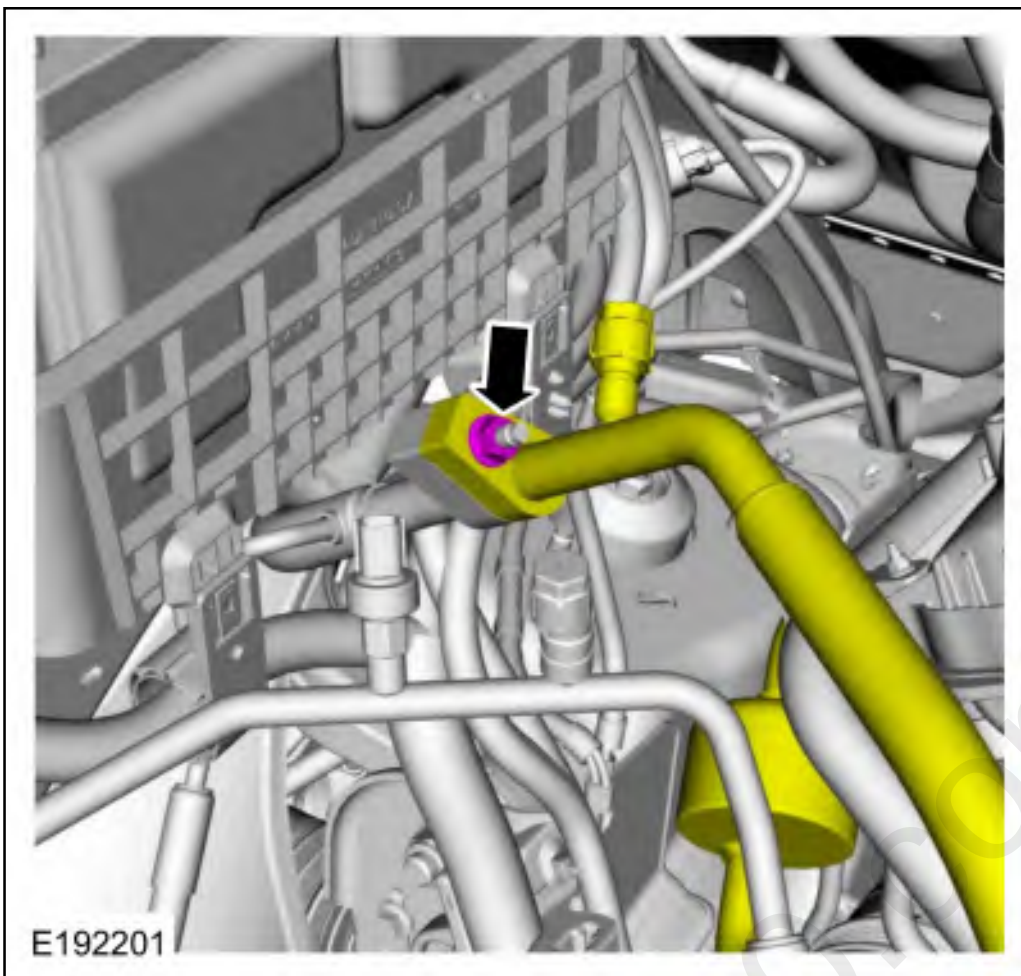
Refer to: Intake Manifold (303-01 Engine - 5.0L 32V Ti-VCT) .

6. Disconnect the A/C pressure transducer electrical connector.



7. Remove the nut and disconnect the A/C tube.

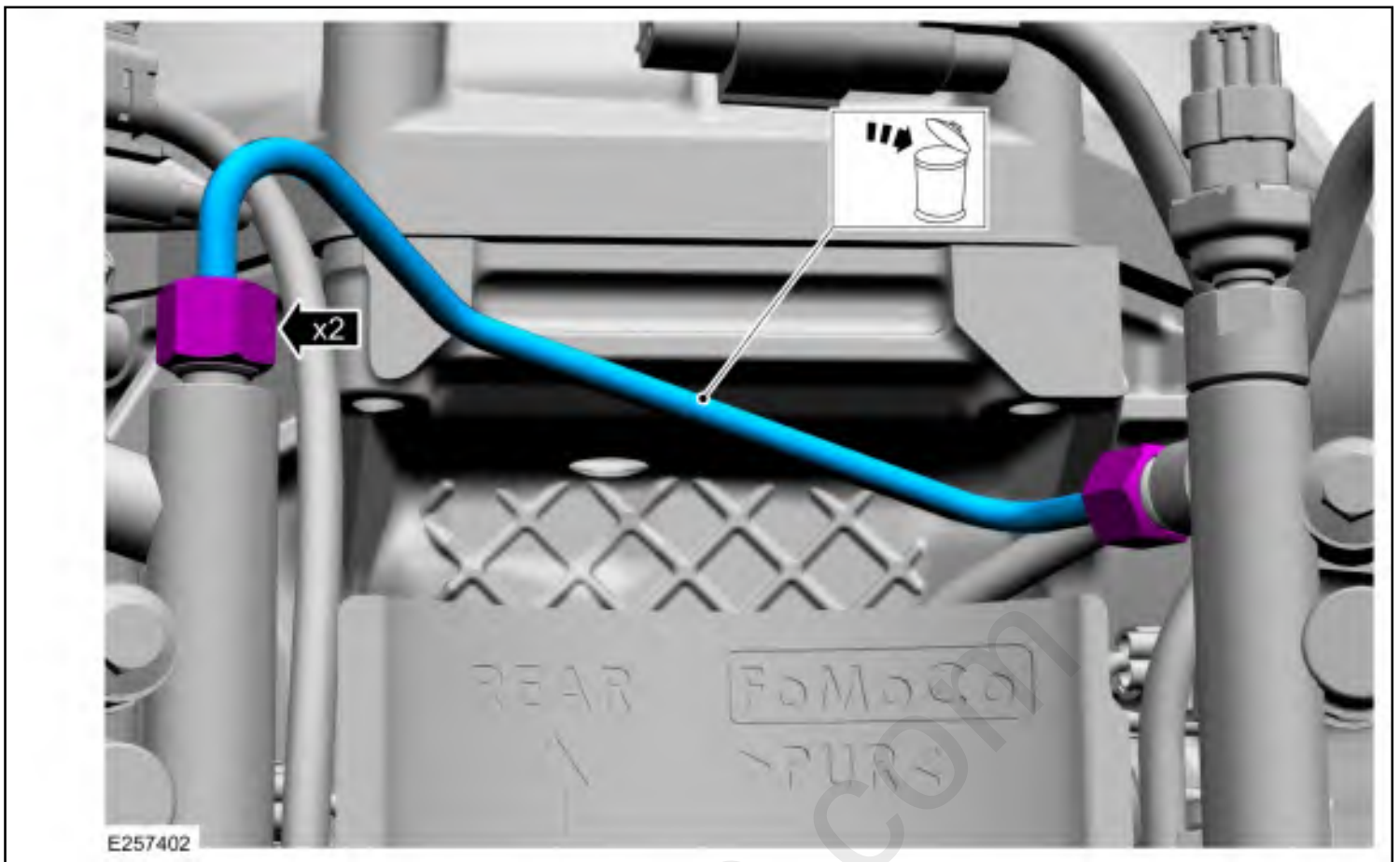
- Discard the O-ring seal and gasket.



8. **NOTICE:** To release the fuel pressure in the high-pressure fuel tube, wrap the high-pressure fuel tube flare nuts with a shop towel to absorb any residual fuel pressure during the loosening of the high-pressure fuel tube flare nuts.

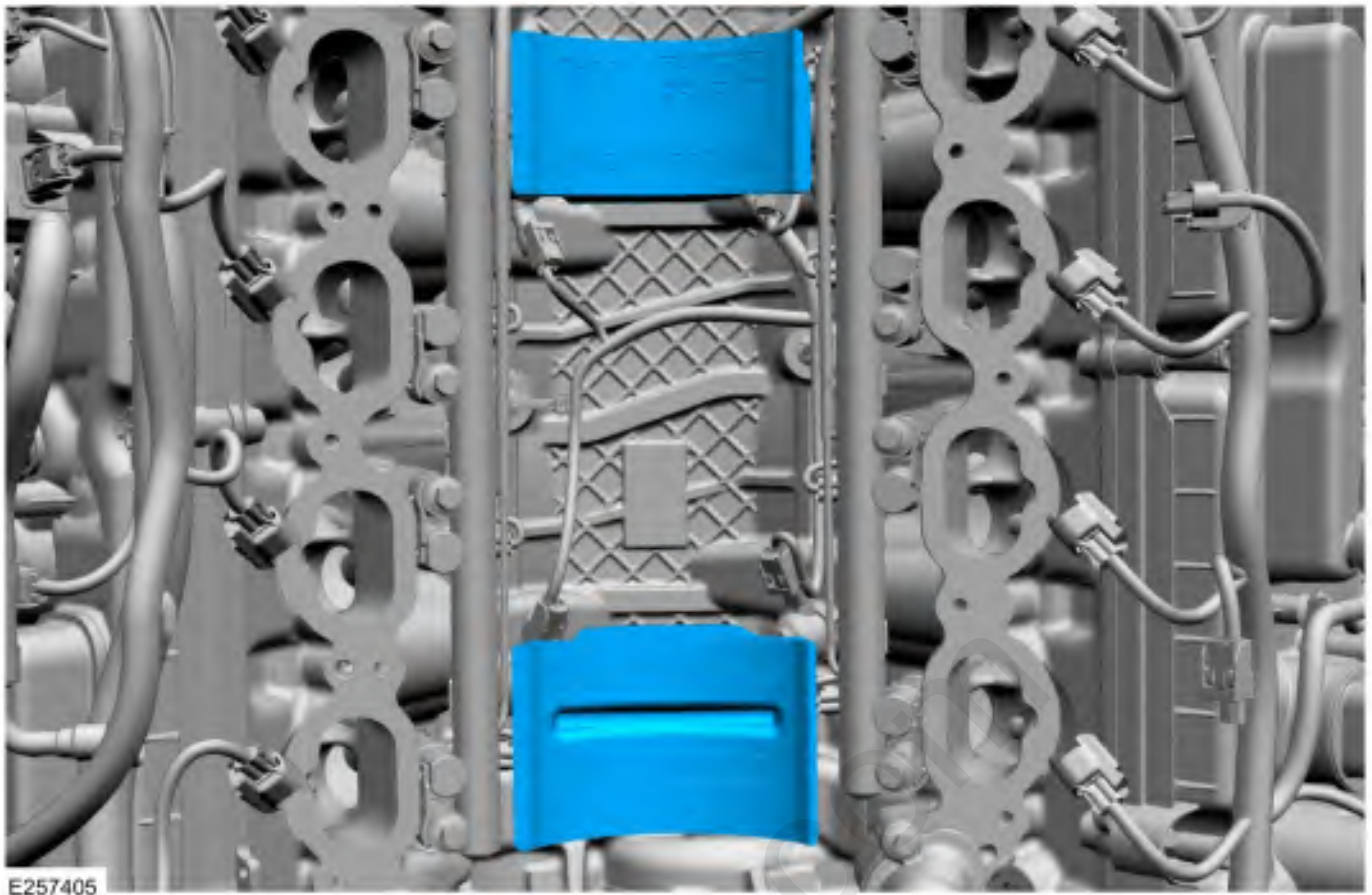
Loosen the nuts and remove the high pressure fuel tube.

- Discard the high pressure fuel tube.

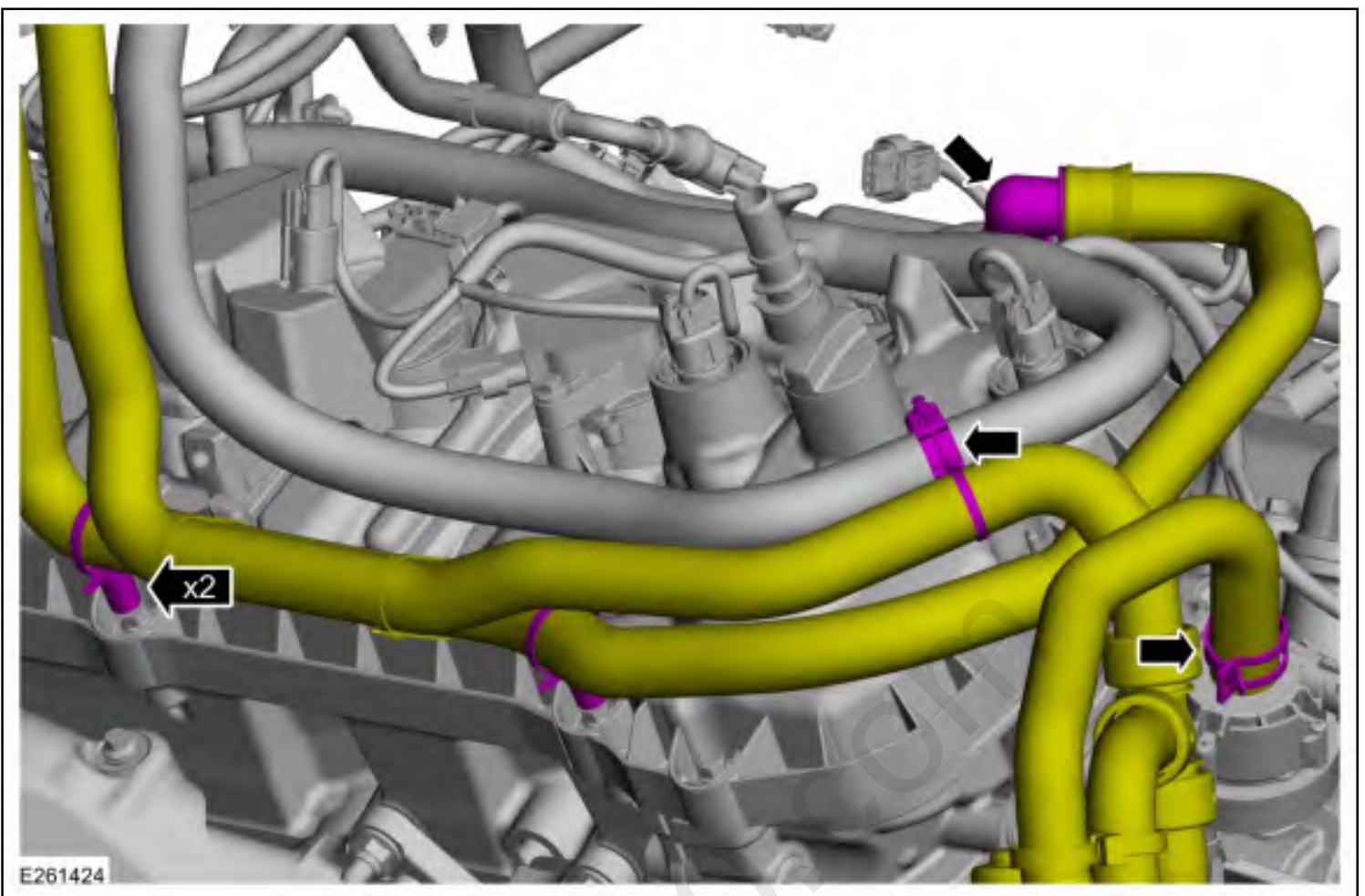


9. Remove the insulators.

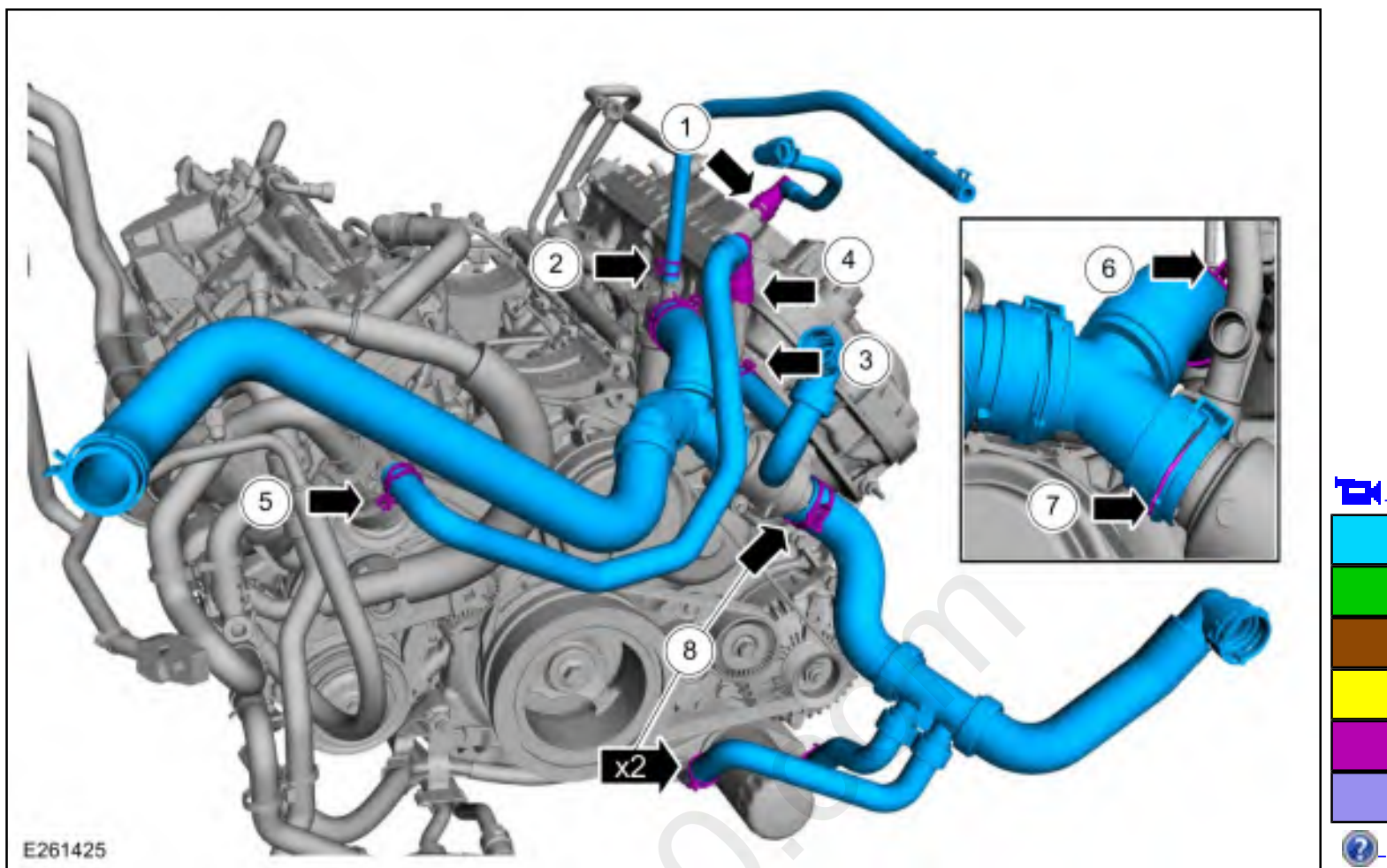




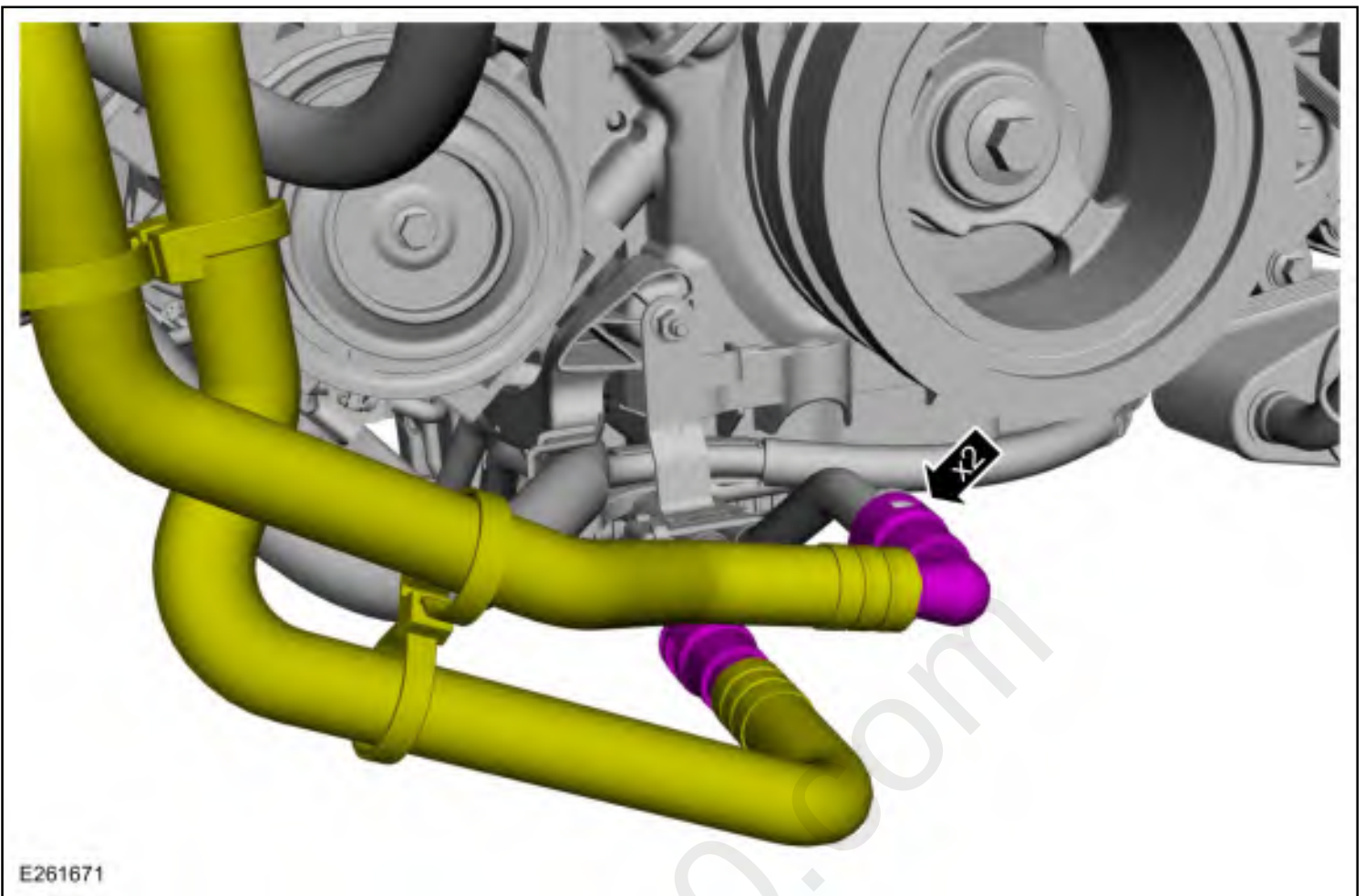
1. Release the clamp and disconnect the coolant hose.  
Use the General Equipment: Hose Clamp Remover/Installer
2. Disconnect the coolant hose quick release coupling.
3. Detach the coolant hose retainer from the wiring harness.
4. Detach the coolant hose retainers from the valve cover stud bolts.



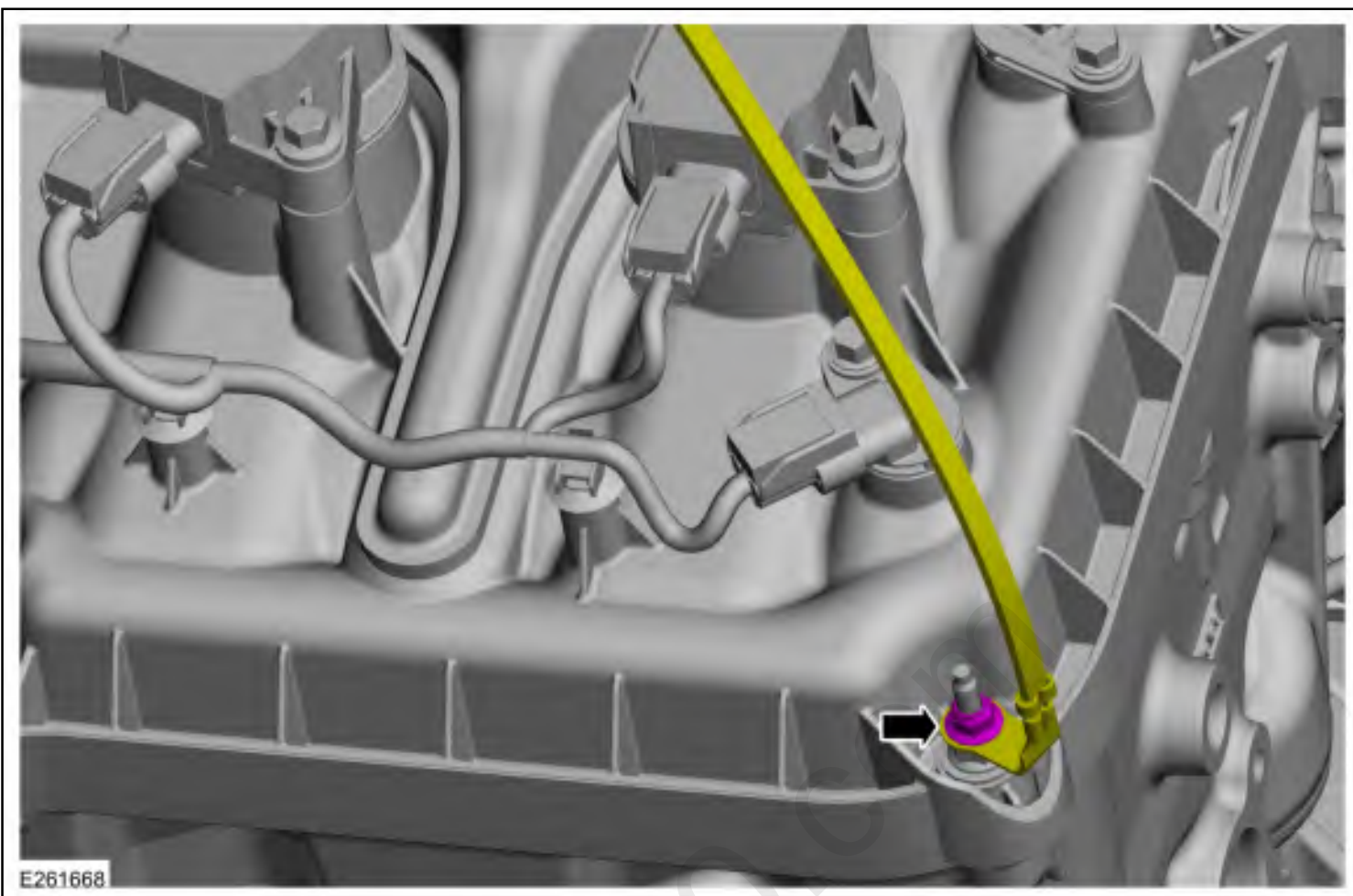
1. Disconnect the quick release coupling and remove the crankcase vent tube.  
Refer to: [Quick Release Coupling](#) (310-00D Fuel System - General Information - 5.0L 32V Ti-VCT, General Procedures).
2. Release the clamp and remove the coolant hose.  
Use the General Equipment: Hose Clamp Remover/Installer
3. Release the clamp and remove the coolant hose.  
Use the General Equipment: Hose Clamp Remover/Installer
4. Disconnect the quick release coupling.
5. Release the clamp and remove the coolant hose.  
Use the General Equipment: Hose Clamp Remover/Installer
6. Release the clamp and remove the coolant hose.  
Use the General Equipment: Hose Clamp Remover/Installer
7. Release the spring clip and remove the coolant bypass T assembly from the engine.
8. Release the clamps and remove the coolant hose assembly.  
Use the General Equipment: Hose Clamp Remover/Installer





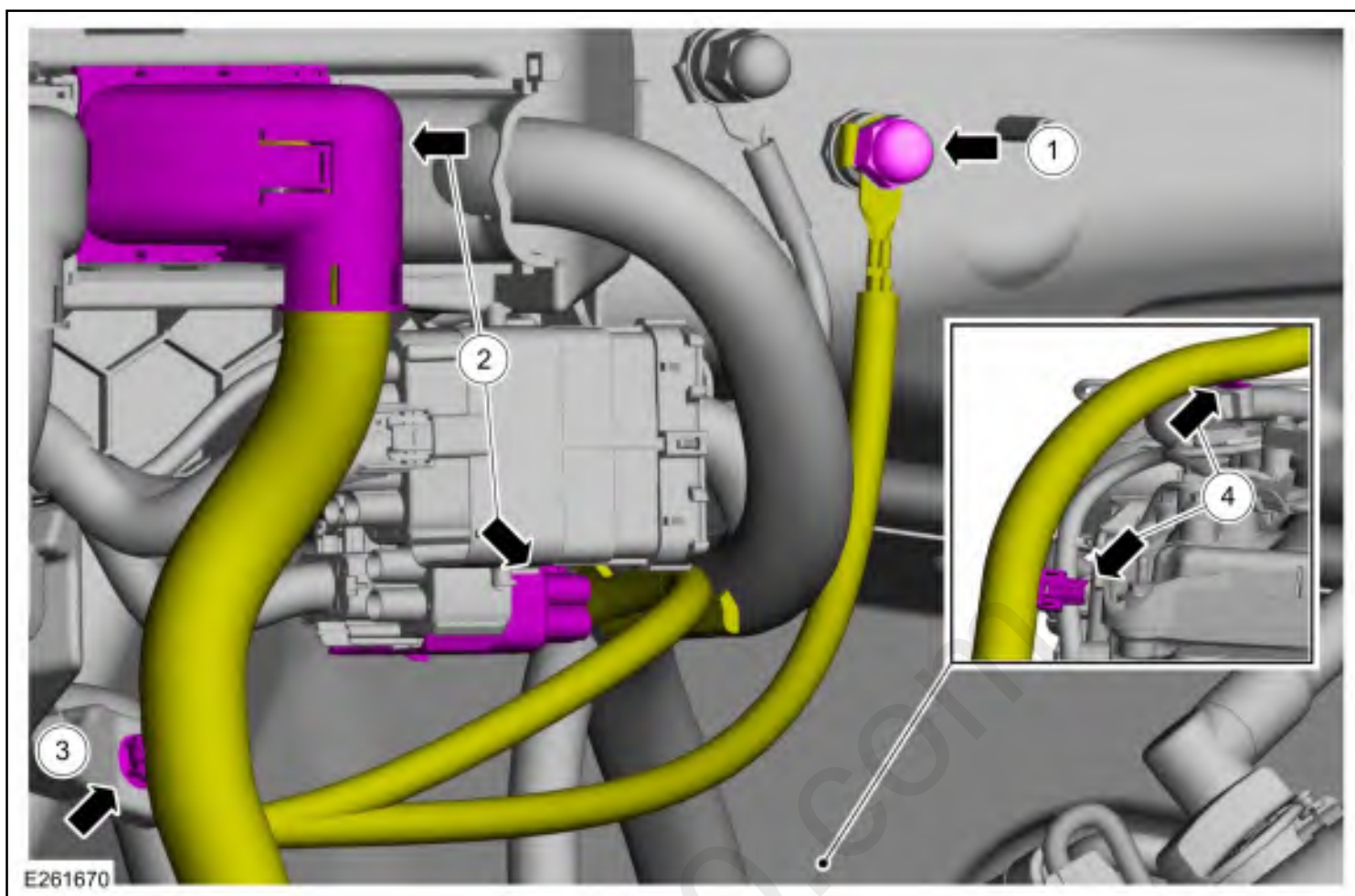


13. Remove the nut and ground strap from the LH valve cover stud bolt.



1. Remove the nut and the ground strap.
2. Disconnect the engine wiring harness connectors.
3. Detach the engine wiring harness retainer.
4. Detach the transmission wiring harness retainers.



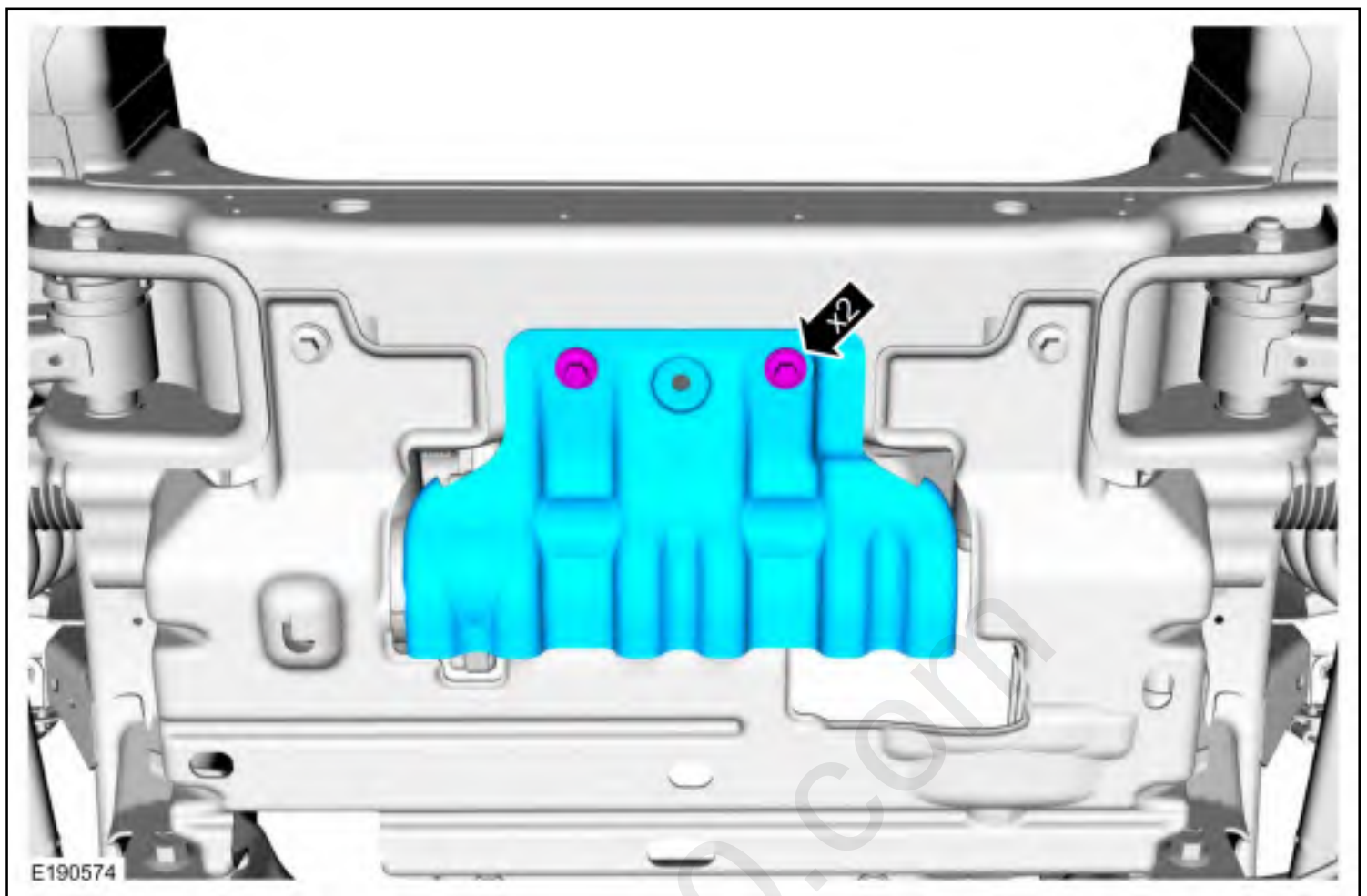


15. Remove the generator.

Refer to: [Generator - 5.0L 32V Ti-VCT](#) (414-02 Generator and Regulator, Removal and Installation).

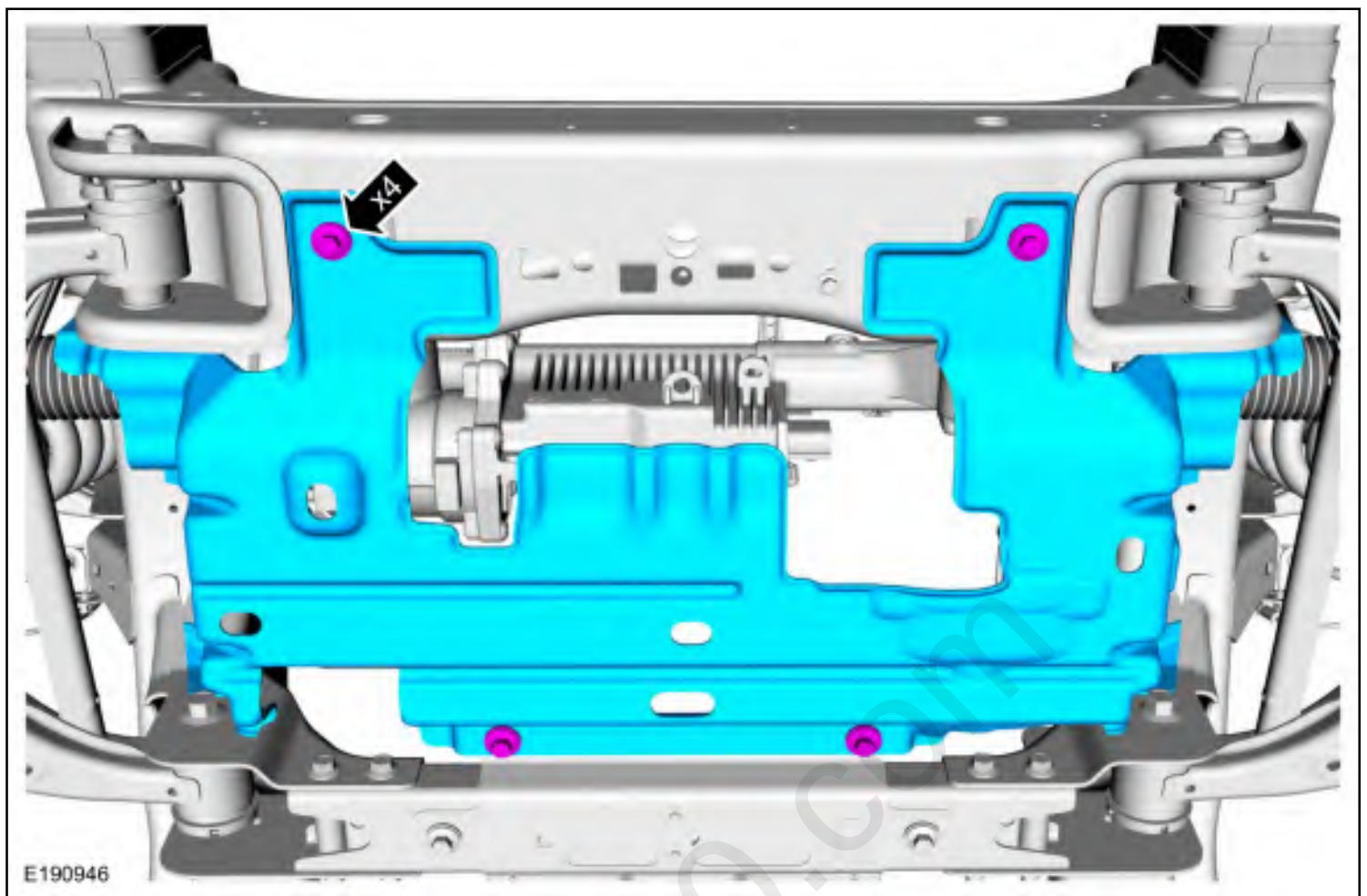
16. **NOTE:** *If equipped.*

Remove the bolts and the skid plate.



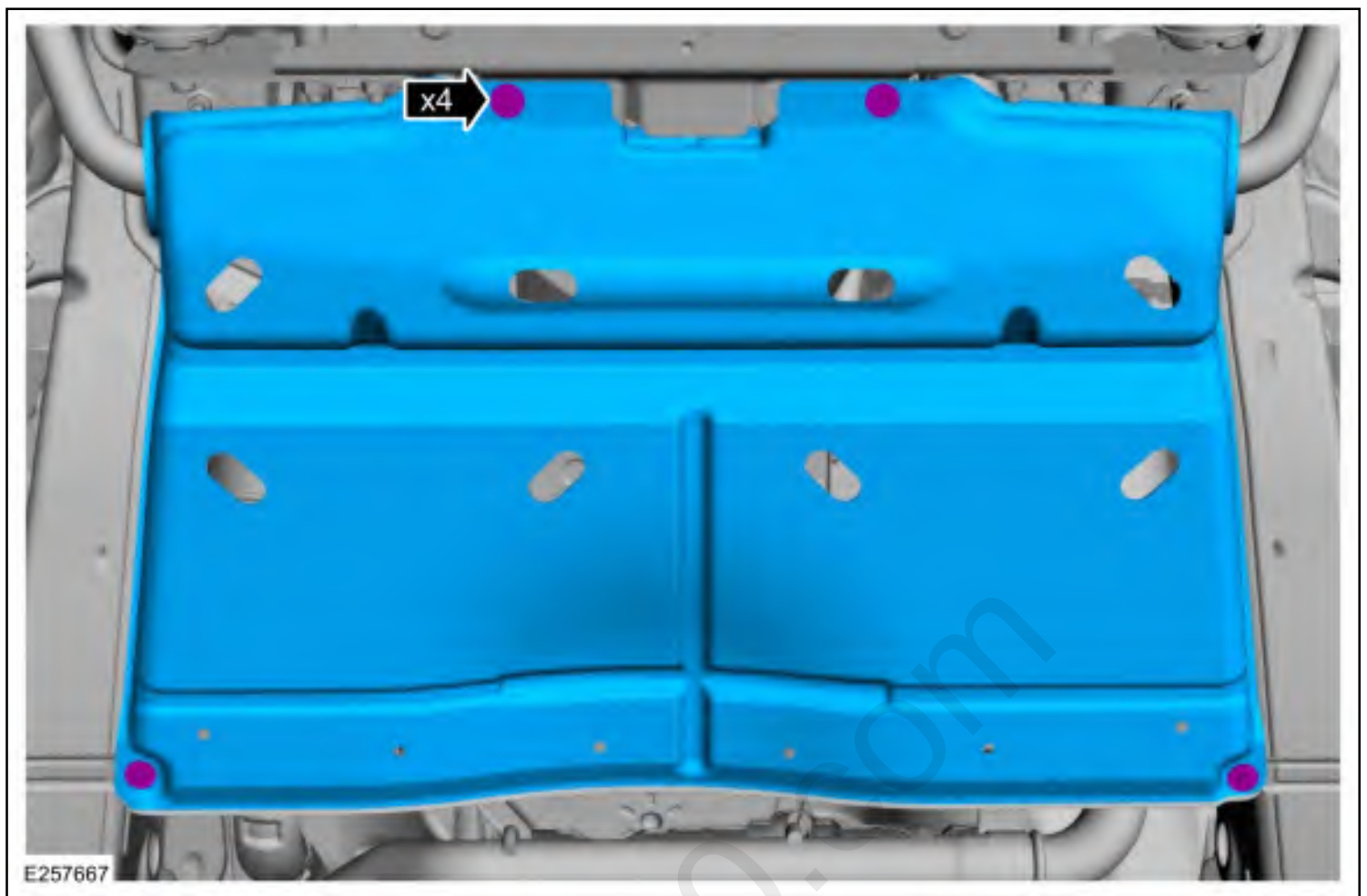
17. **NOTE:** *If equipped.*

Remove the fasteners and the underbody shield.



18. **NOTE:** *If equipped.*

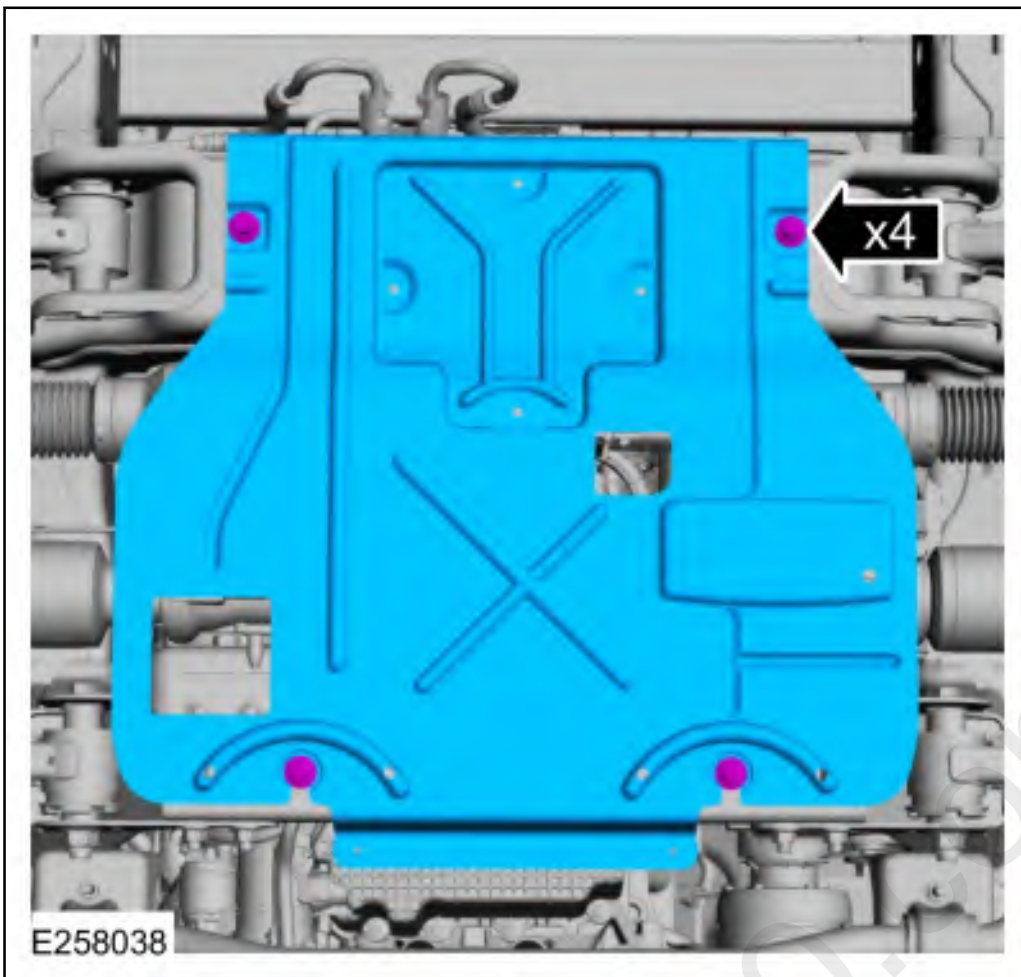
Remove the bolts and the underbody shield.



19. **NOTE:** *If equipped.*

Remove the bolts and the skid plate.





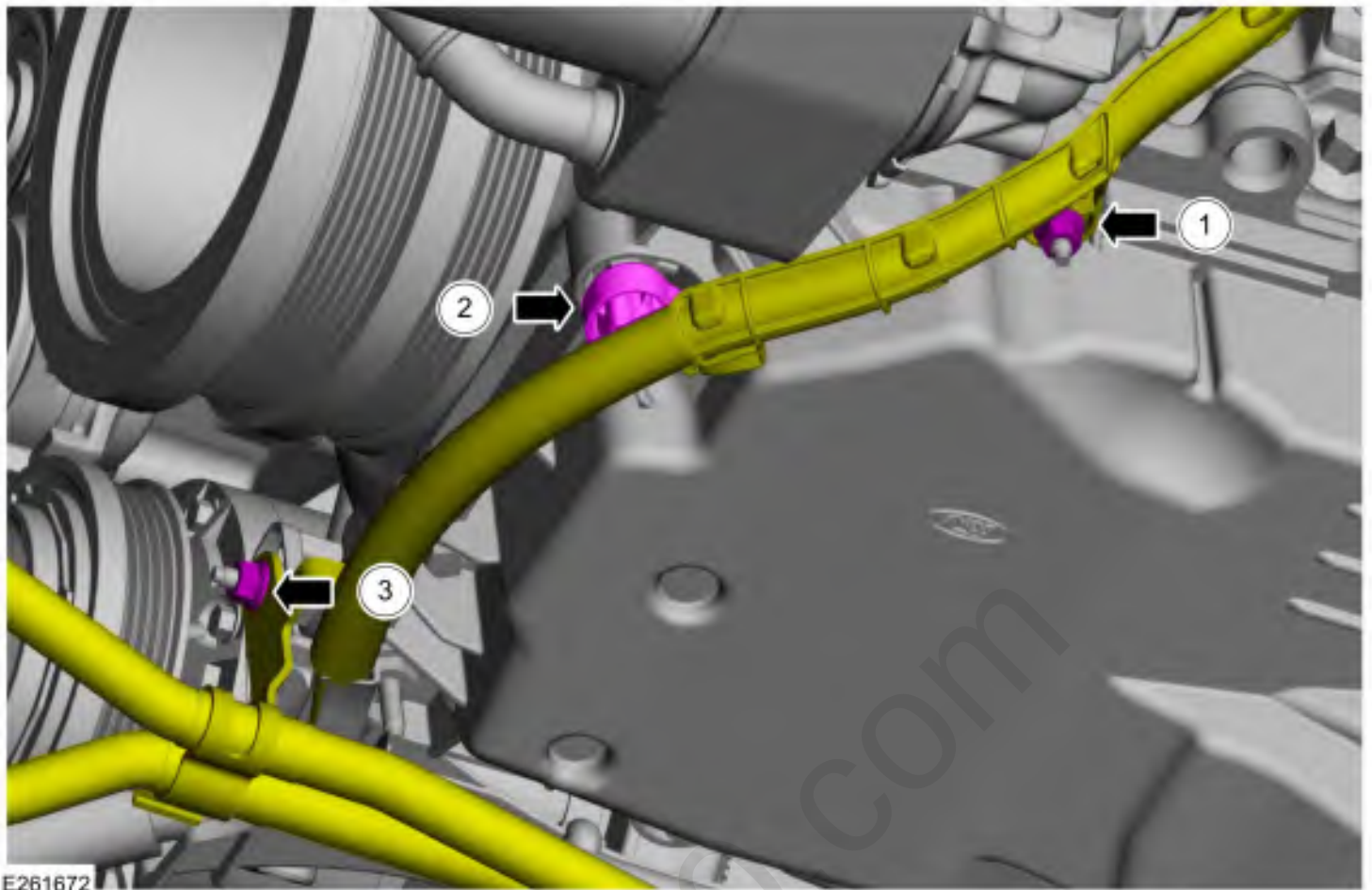
20. Remove the following items:

1. Refer to: Starter Motor (303-06 Starting System - 5.0L 32V Ti-VCT) .
2. **NOTE:** *If equipped.*

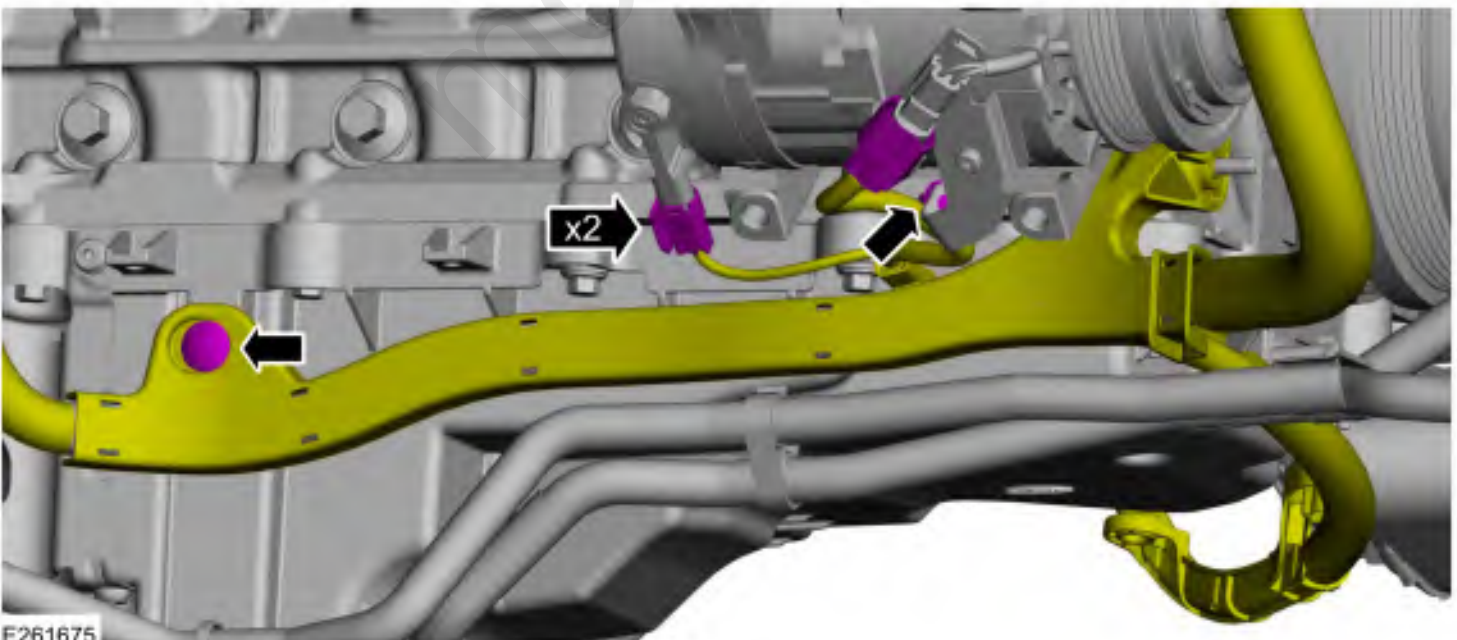
Refer to: [Front Driveshaft](#) (205-01 Driveshaft, Removal and Installation).

1. Remove the nut.
2. Detach the wiring harness retainer.
3. Remove the nut and position the coolant tube and wiring harness brackets aside.





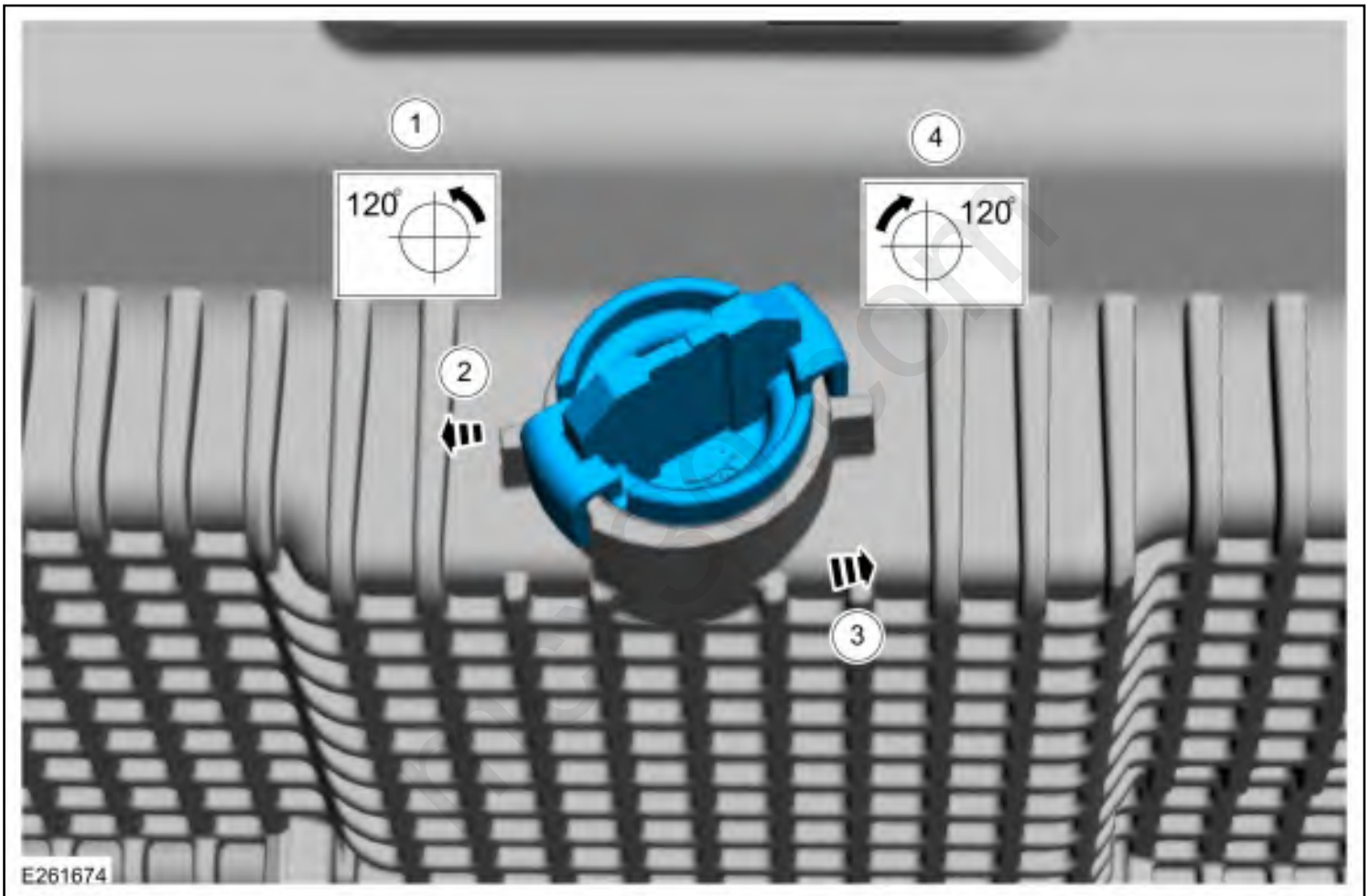
1. Disconnect the A/C compressor electrical connectors.
2. Detach the wiring harness retainers.



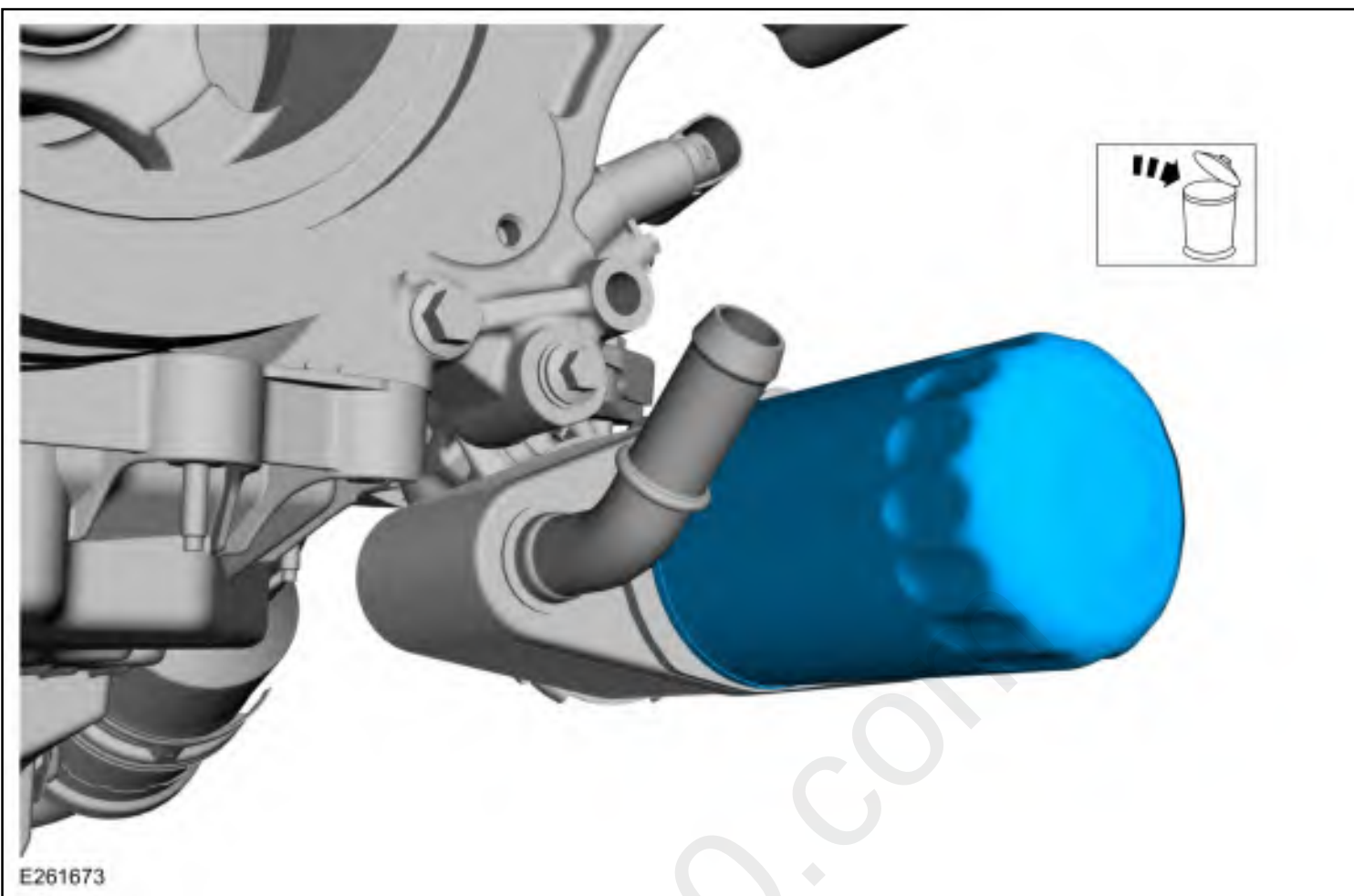
23. **NOTE:** *The drain plug should be removed and installed by hand, do not use tools.*

1. Turn the oil drain plug by hand counterclockwise 120 degrees.  
Use the General Equipment: Oil Drain Equipment
2. Pull the oil drain plug out of the oil pan.
3. After the oil has drained, push the oil drain plug into the oil pan.
4. **NOTICE: Overtightening will damage the oil drain plug and possibly the oil pan.**

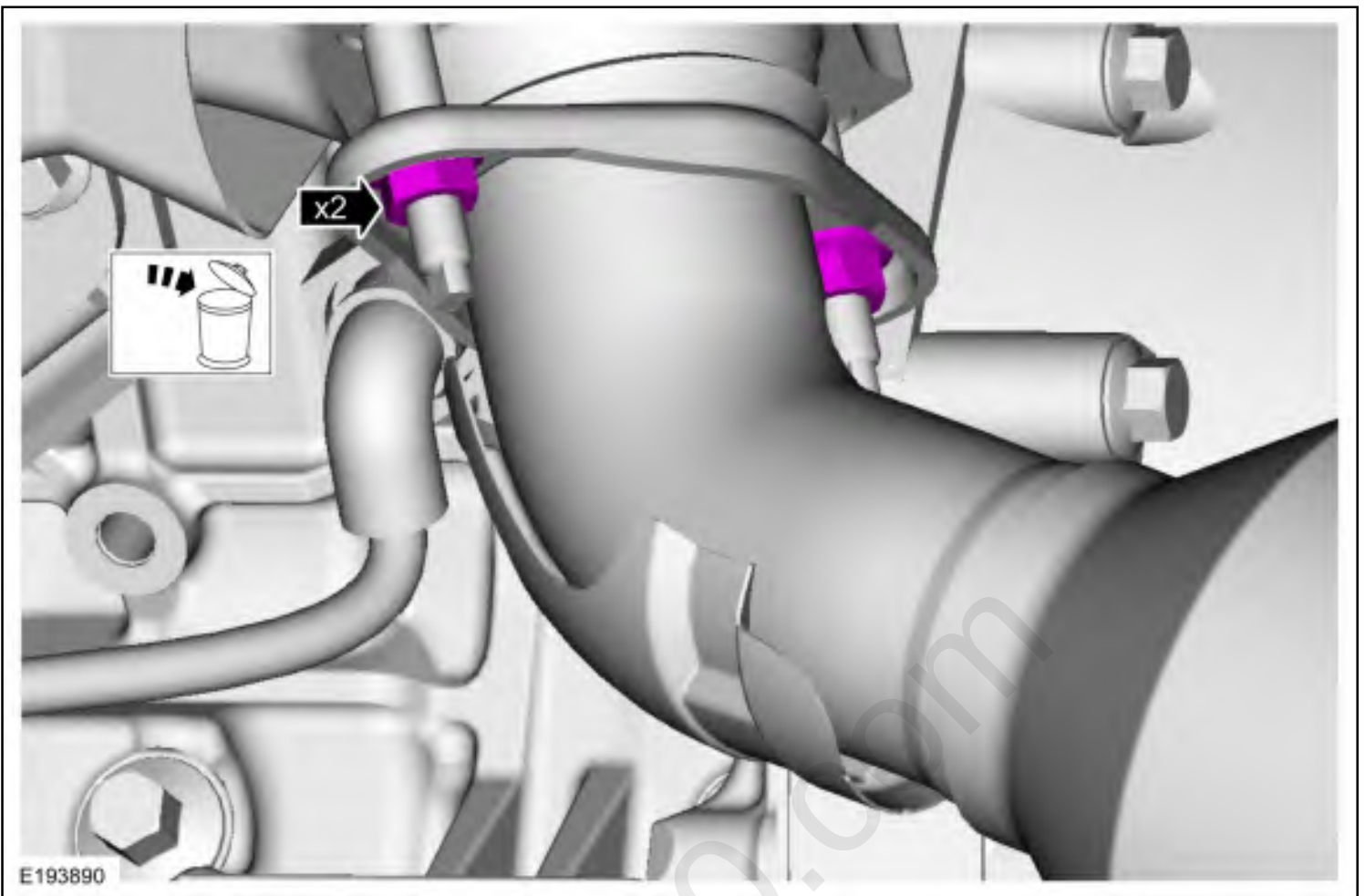
Turn the oil drain plug by hand clockwise 120 degrees.



24. Remove and discard the engine oil filter.

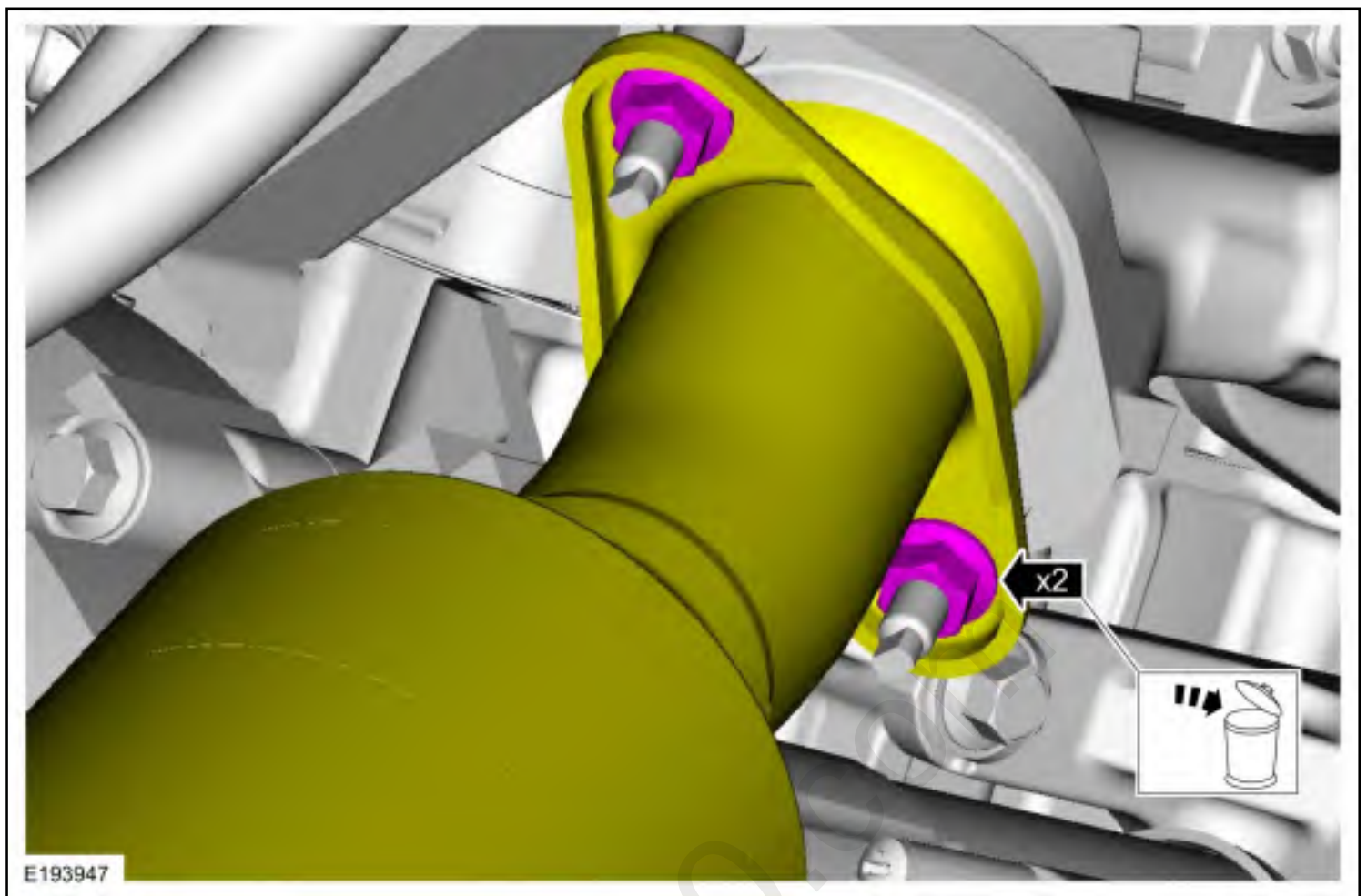


25. Remove and discard the catalytic converter-to-LH exhaust manifold nuts.



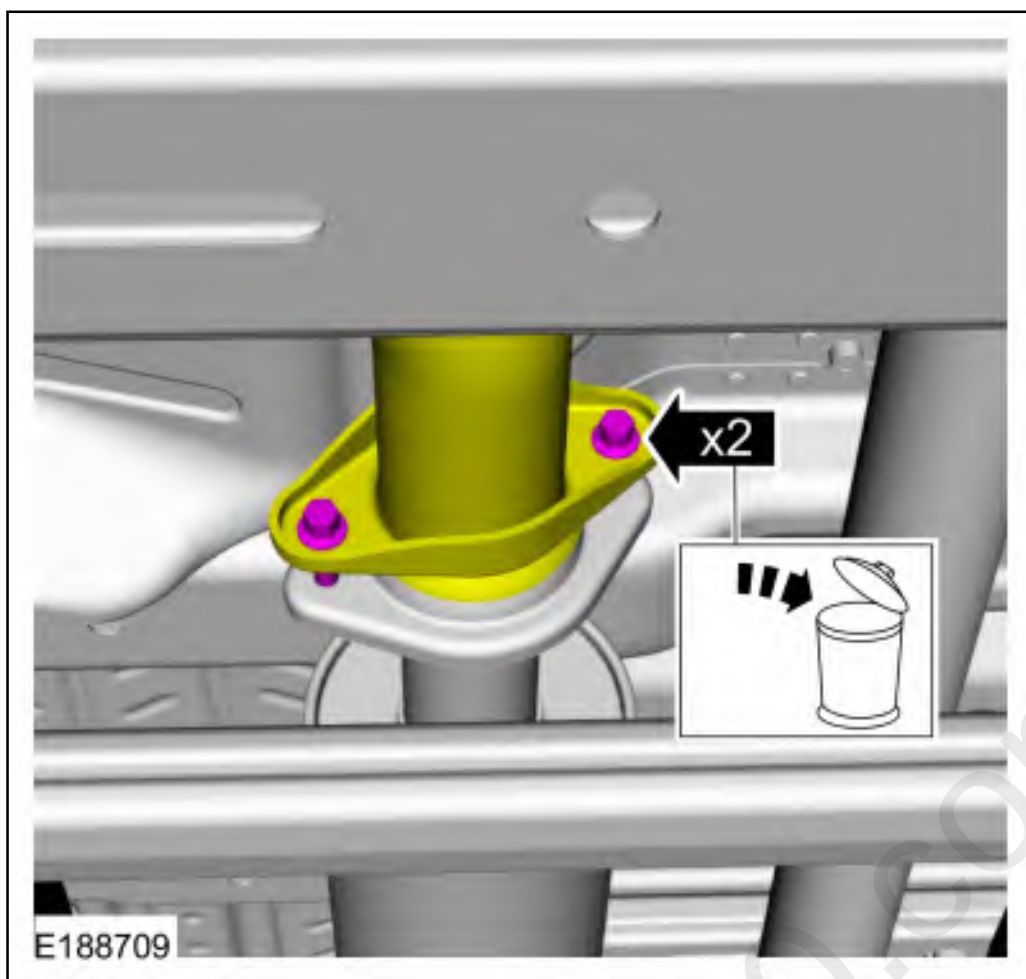
26. Remove and discard the catalytic converter-to-RH exhaust manifold nuts.
- Separate the exhaust Y-pipe dual catalytic converter from the exhaust manifolds.



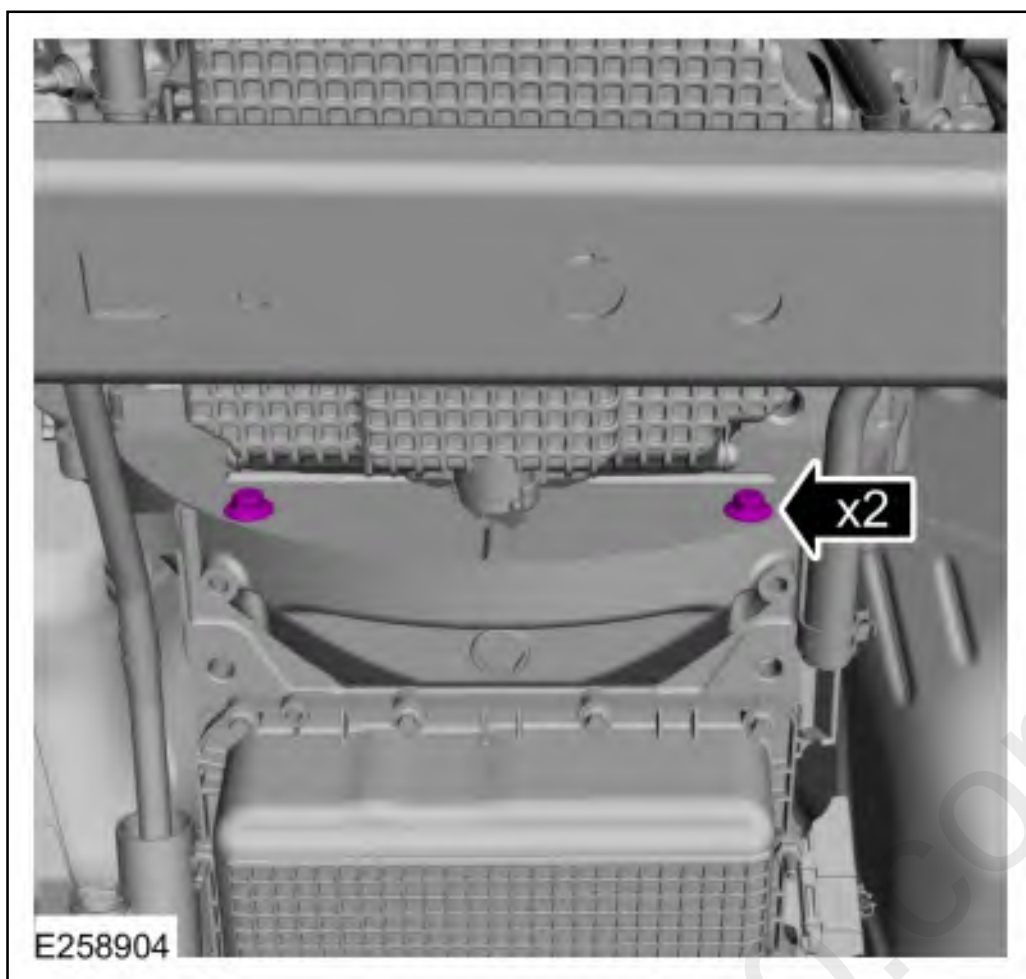


27. Remove and discard the exhaust Y-pipe dual catalytic converter-to-exhaust intermediate pipe bolts and separate.
- Clean all of the exhaust mating surfaces.

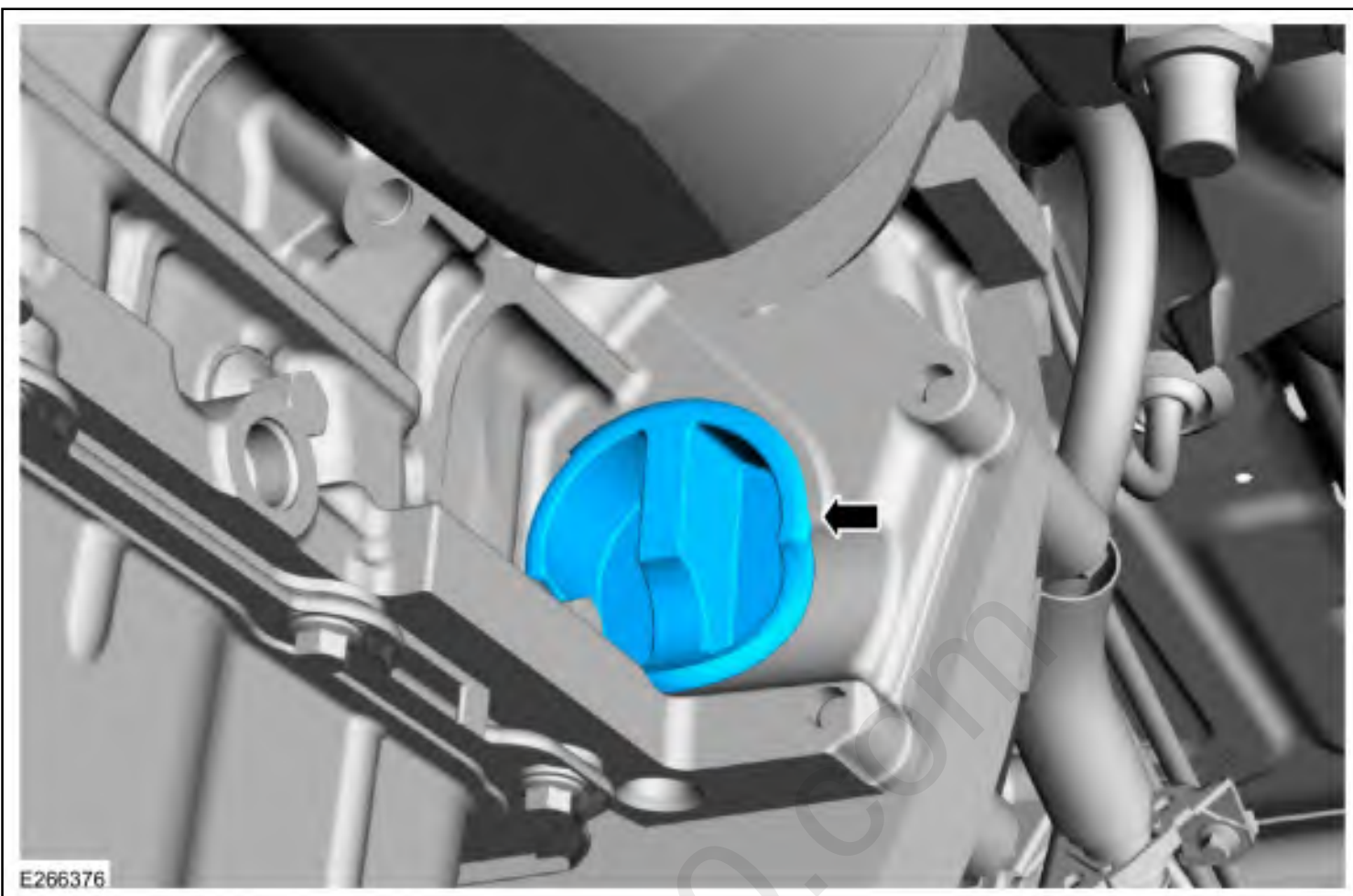




28. Remove the bolts .

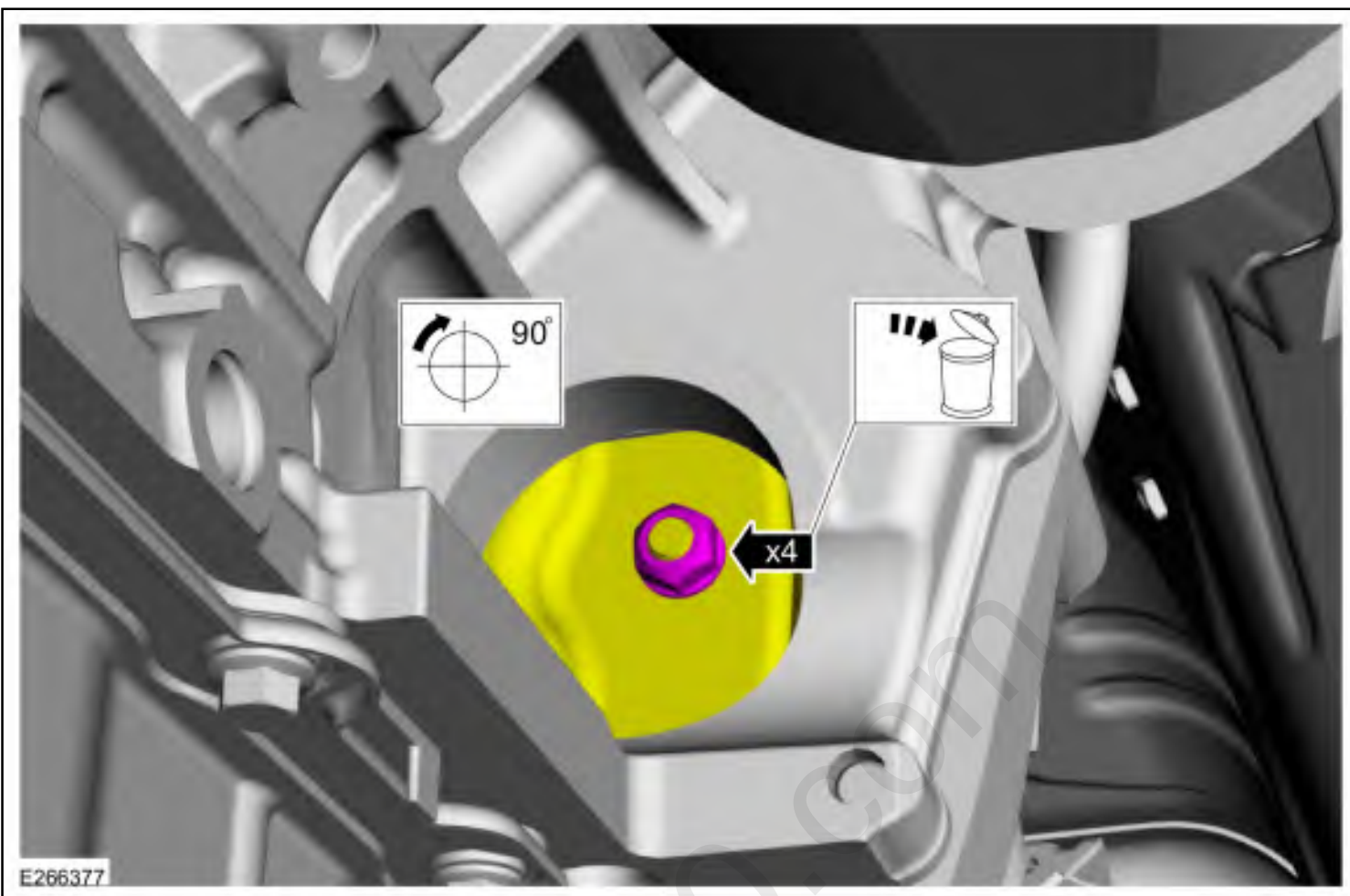


29. Remove the cylinder block opening cover.

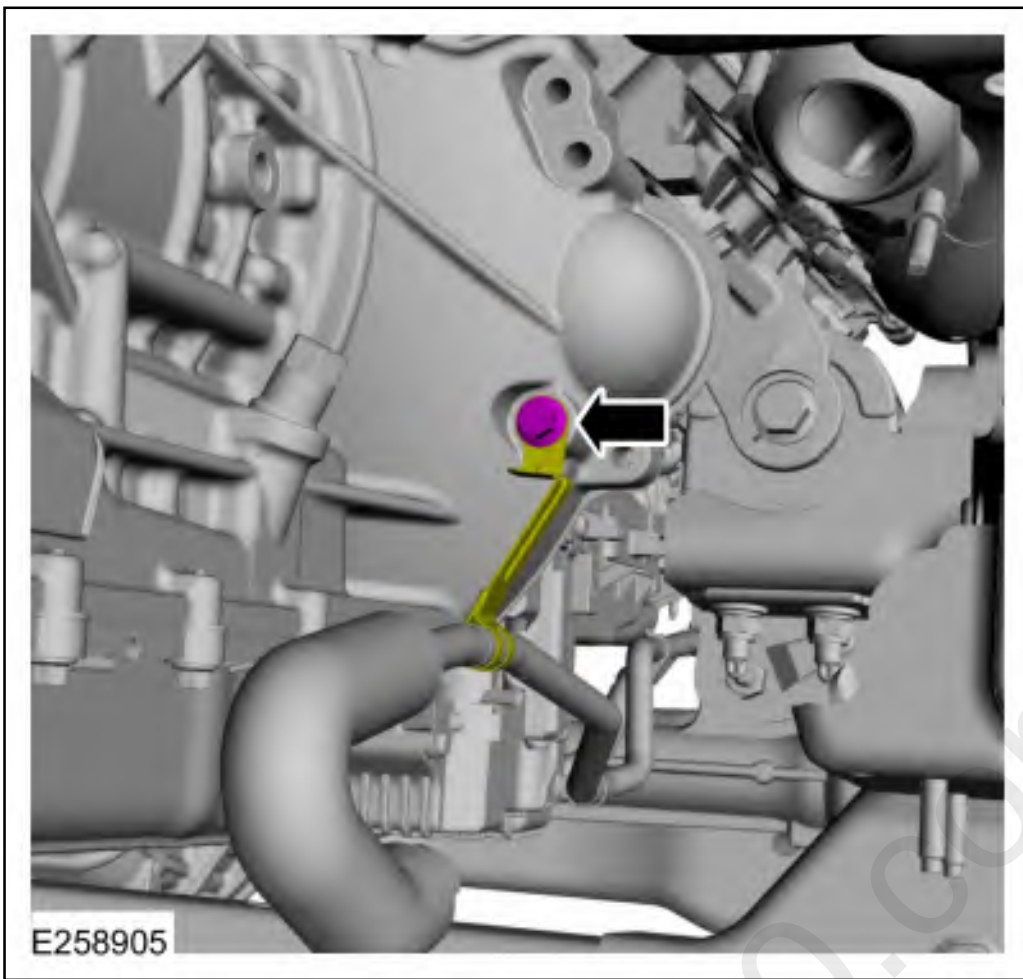


30. **NOTE:** Only rotate the crankshaft in a clockwise direction.

Remove and discard the torque converter-to-flexplate nuts.  
Use the General Equipment: Magnetic Socket

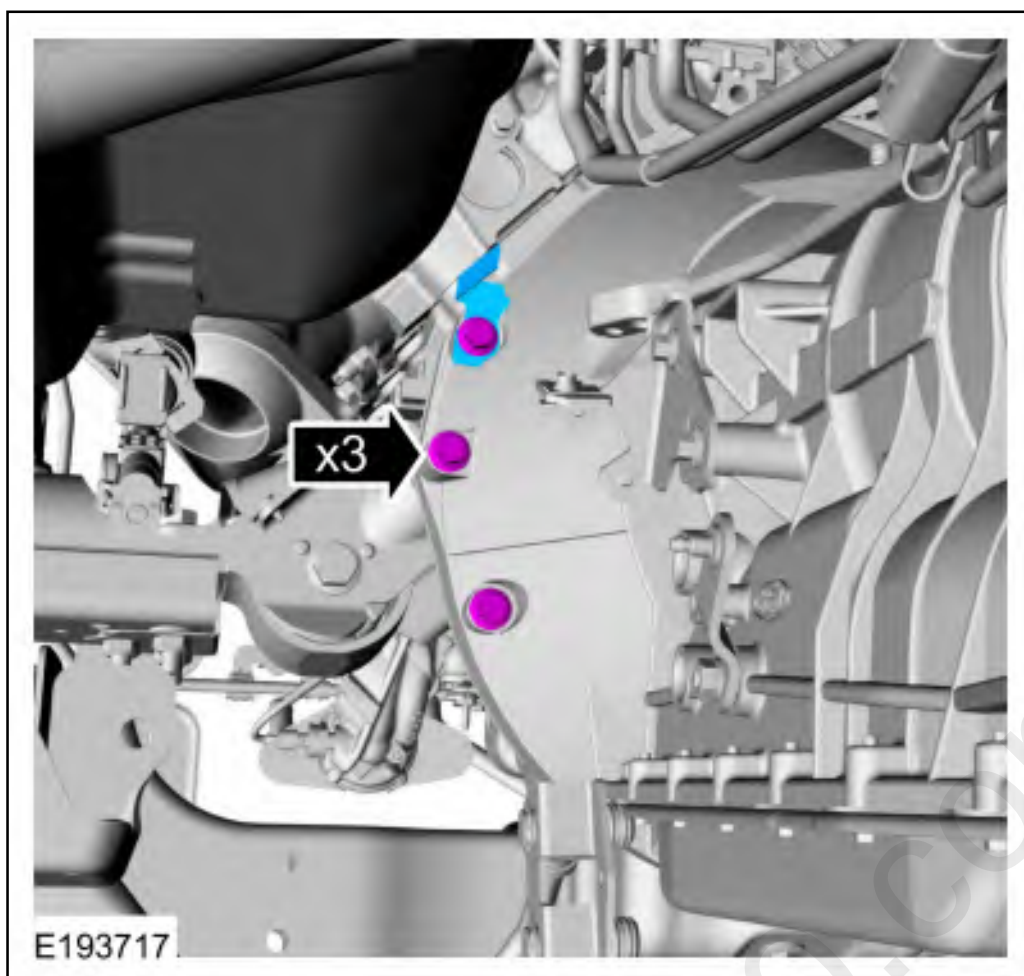


31. Remove the transmission-to-engine bolt and transmission cooler tube support bracket.

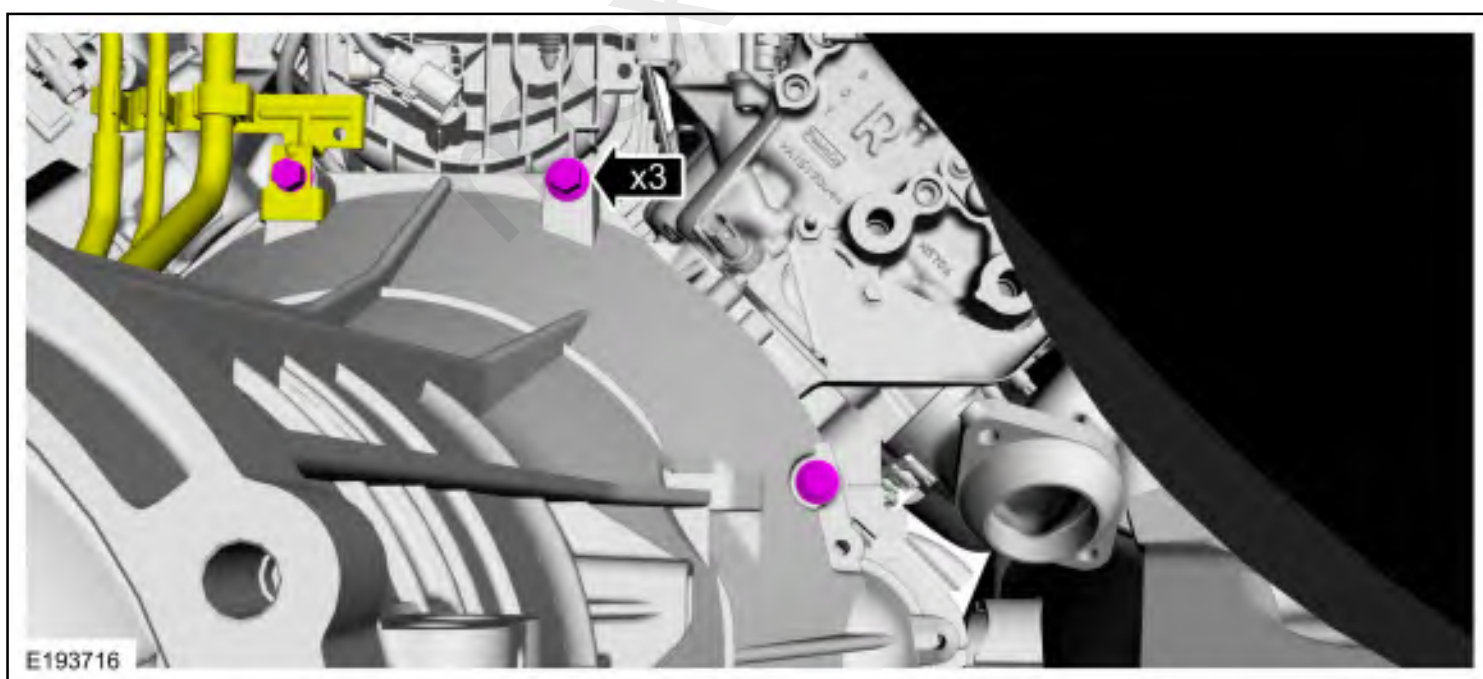


32. Remove the transmission-to-engine bolts.
- Remove the clip.



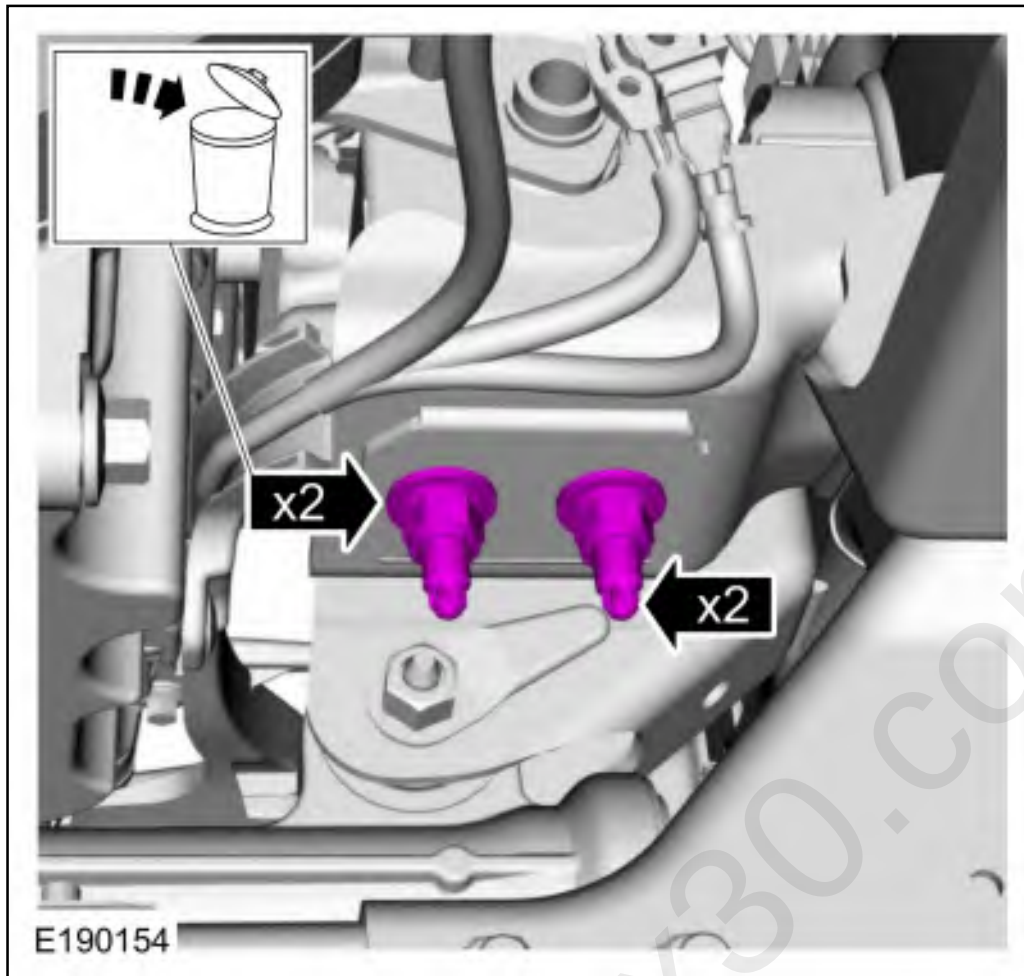


33. Remove the top bellhousing bolts and position the bracket aside.



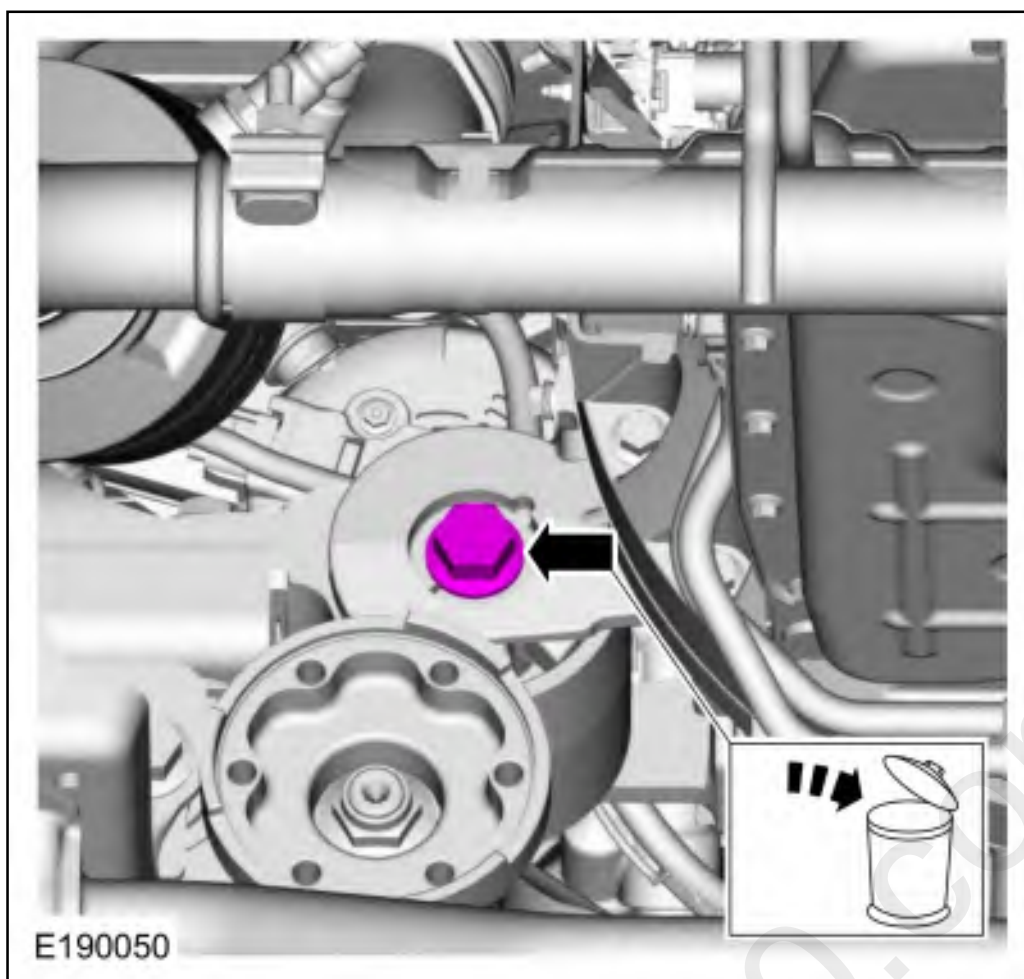
34. **NOTICE:** Only use hand tools when removing the engine mount nuts, stud bolts or damage to the engine mount can occur.

Remove and discard the RH engine mount nuts and stud bolts.



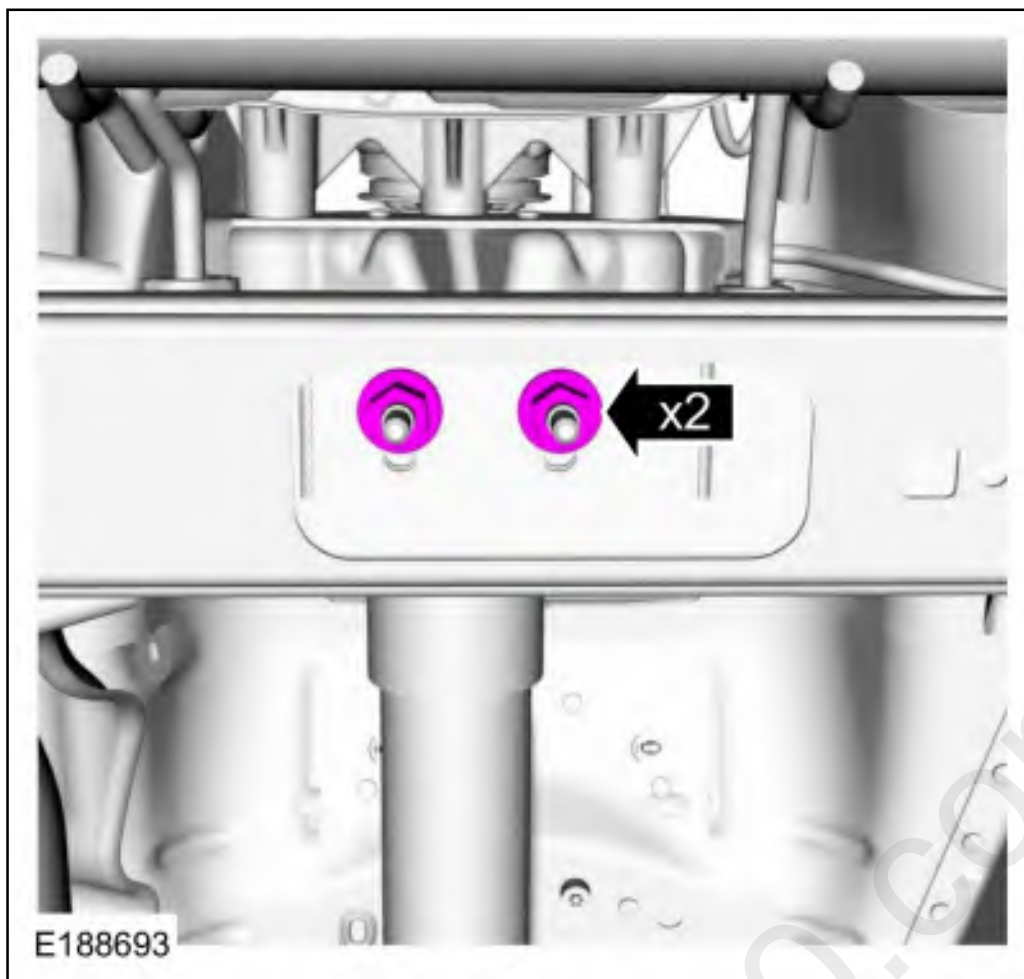
35. **NOTICE:** Only use hand tools when loosening the engine mount through bolts or damage to the engine mount-to-cylinder block bracket can occur.

Remove and discard the LH engine mount through bolt.



36. **NOTICE:** Only use hand tools when removing the transmission mount-to-crossmember nuts or damage to the transmission mount can occur.

Loosen the transmission mount-to-crossmember nuts.



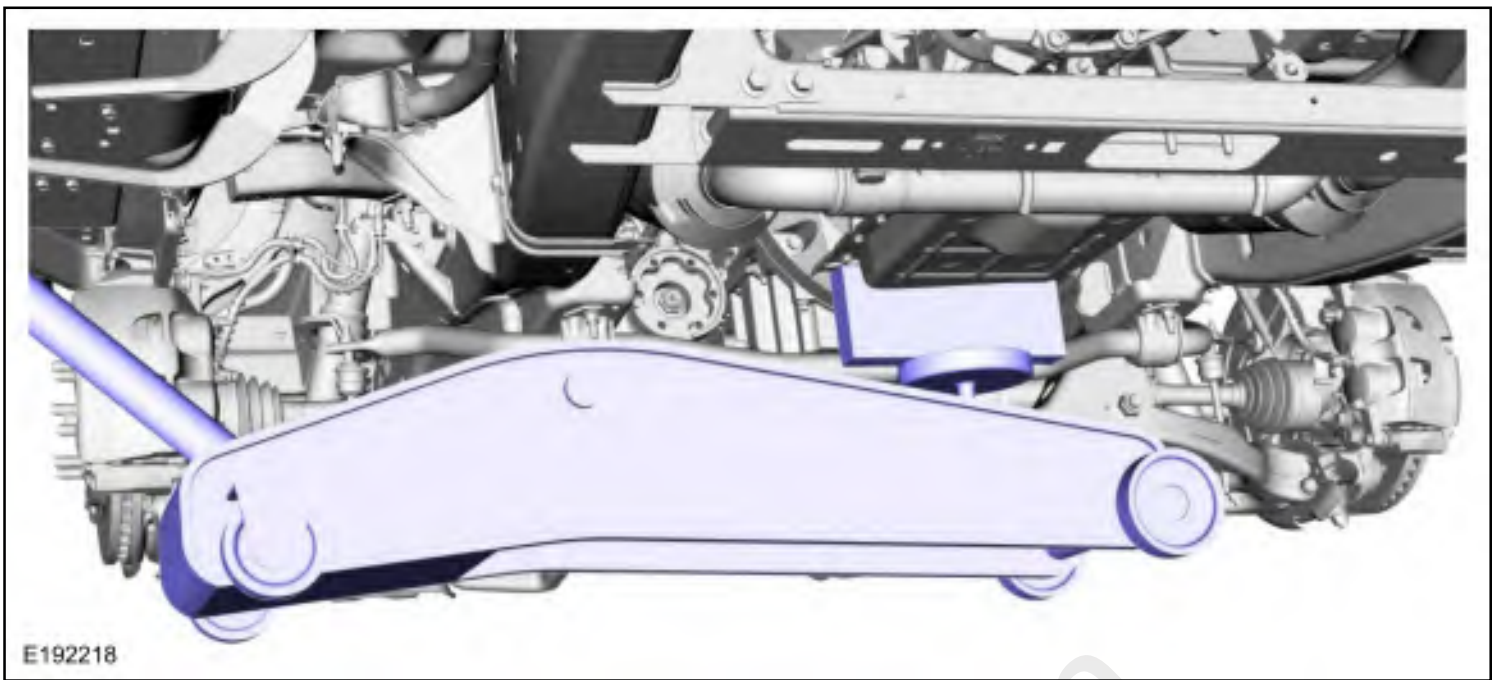
37. **NOTICE: Do not support the transmission by the fluid pan, failure to follow this instruction may result in serious damage to the transmission.**

Support the bellhousing of the transmission with a suitable floor jack and a block of wood.

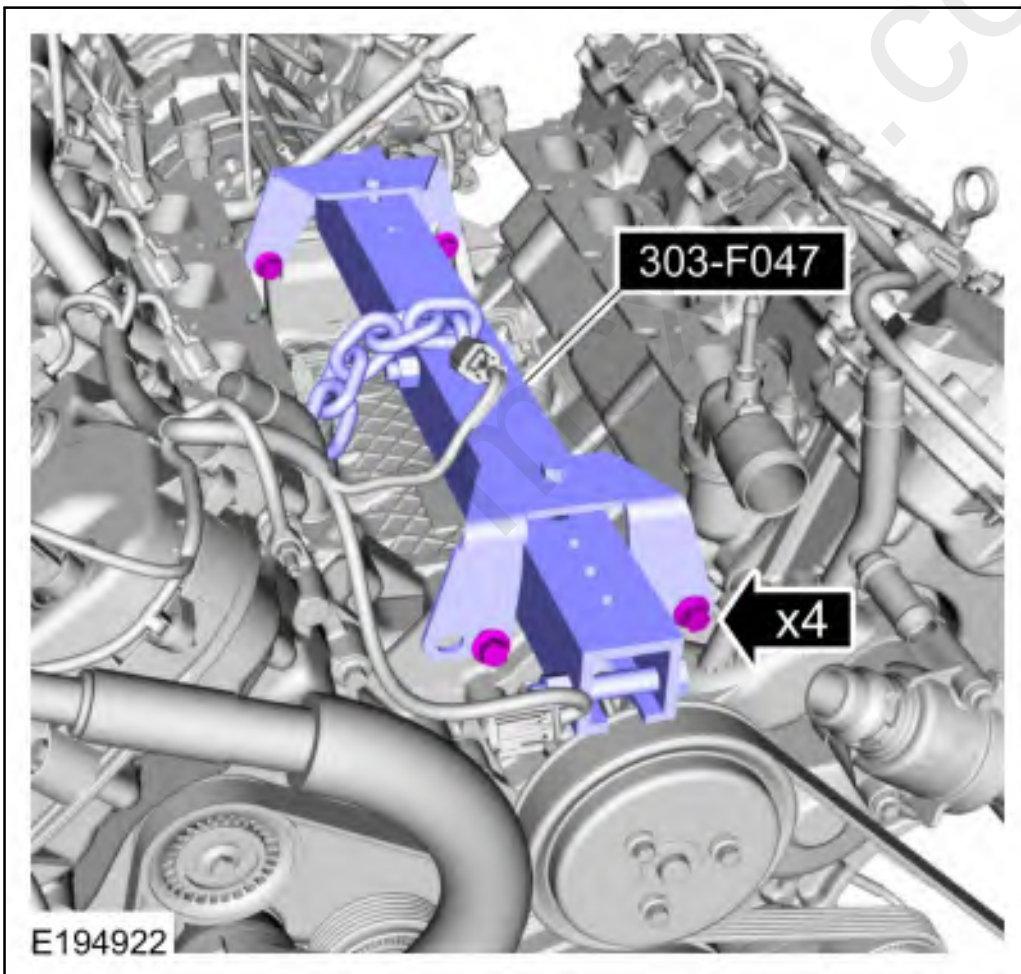
Use the General Equipment: Trolley Jack

Use the General Equipment: Wooden Block





38. Install Special Service Tool: 303-F047 Lifting Bracket, Engine.

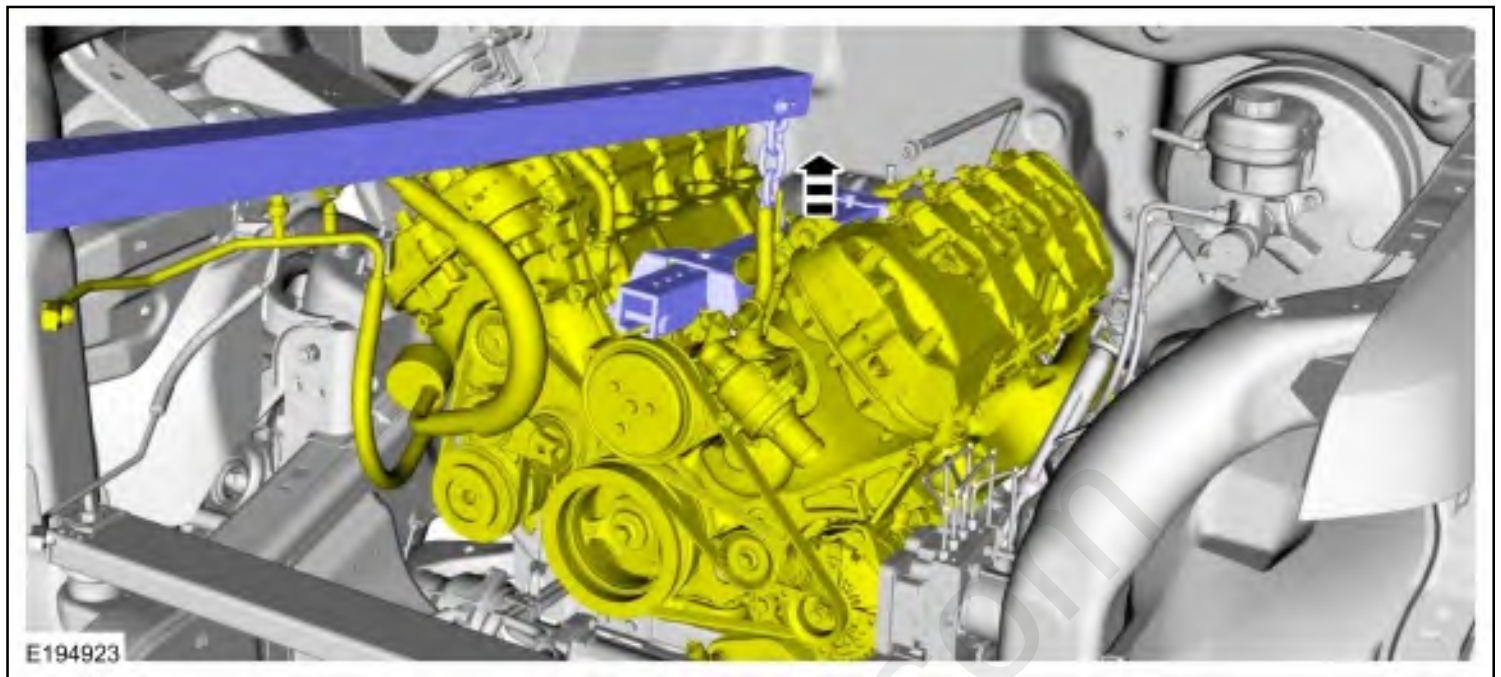


39. **NOTE:** It will be necessary to adjust the height floor jack to support the transmission.



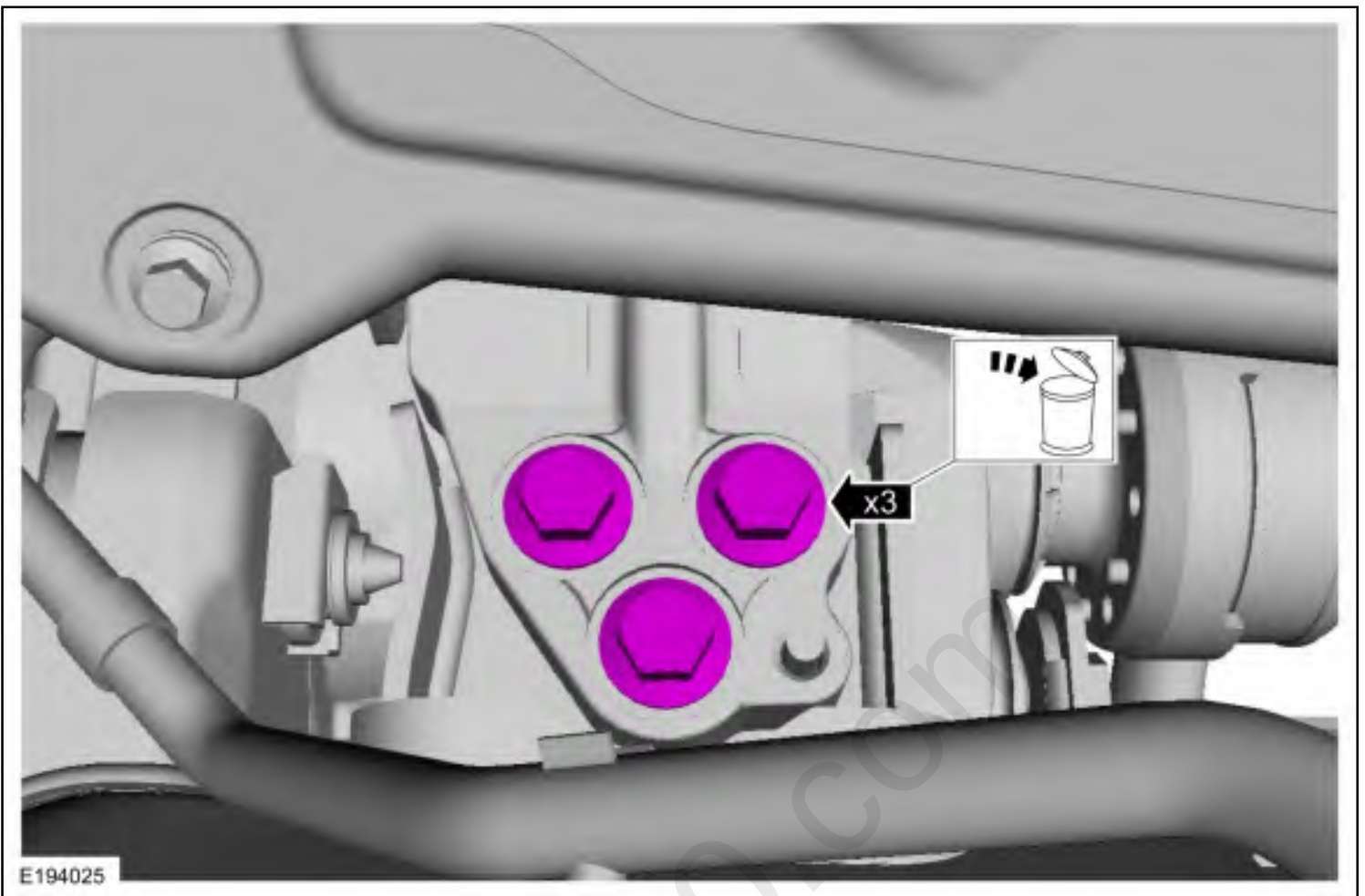
Using the Heavy Duty Floor Crane, raise the engine assembly to gain access to the LH engine mount bolts.

Use the General Equipment: Floor Crane

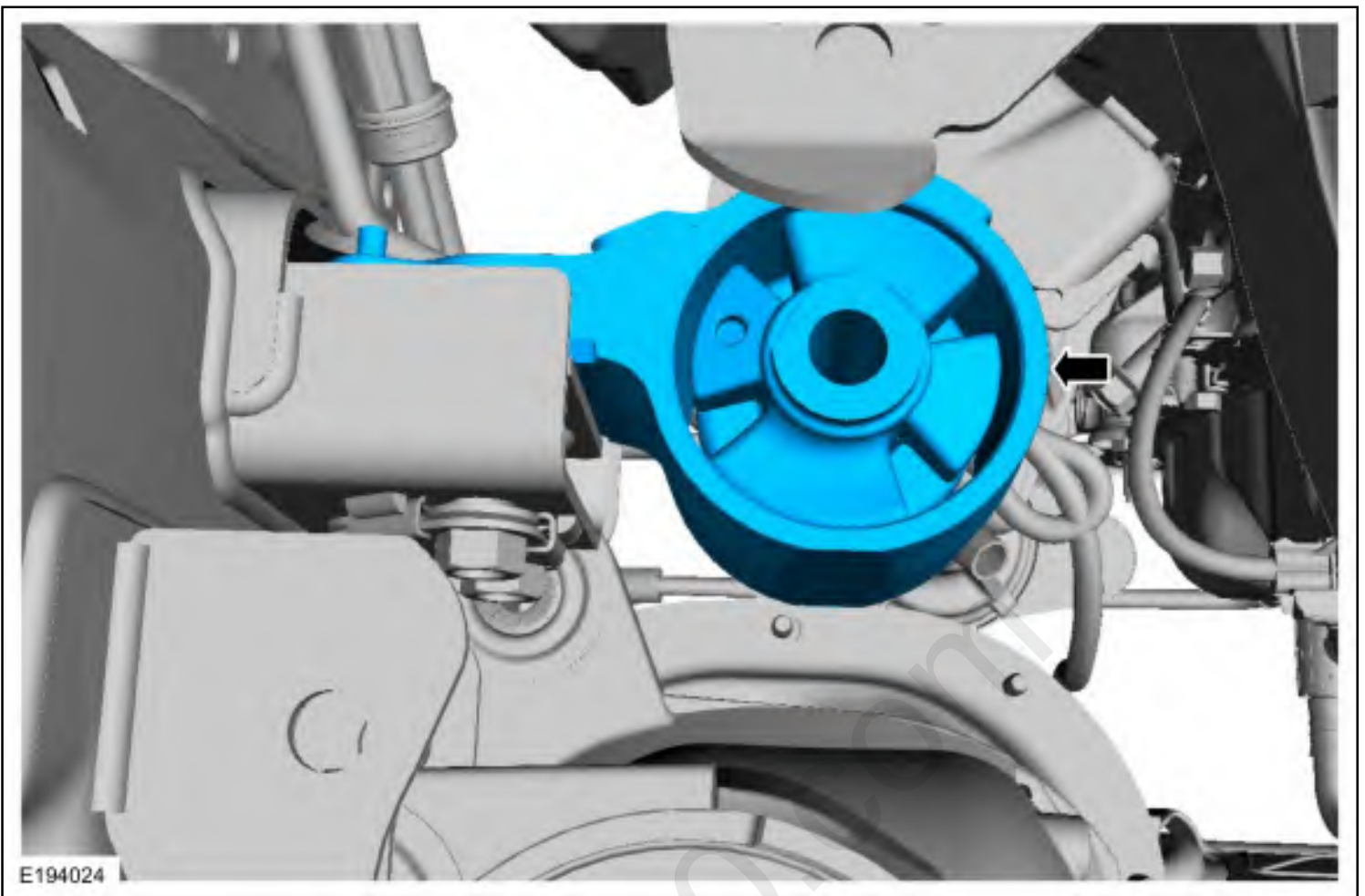


40. **NOTICE:** Only use hand tools when removing or installing the engine mount-to-frame bolts or damage to the engine mount-to-frame nut plate can occur.

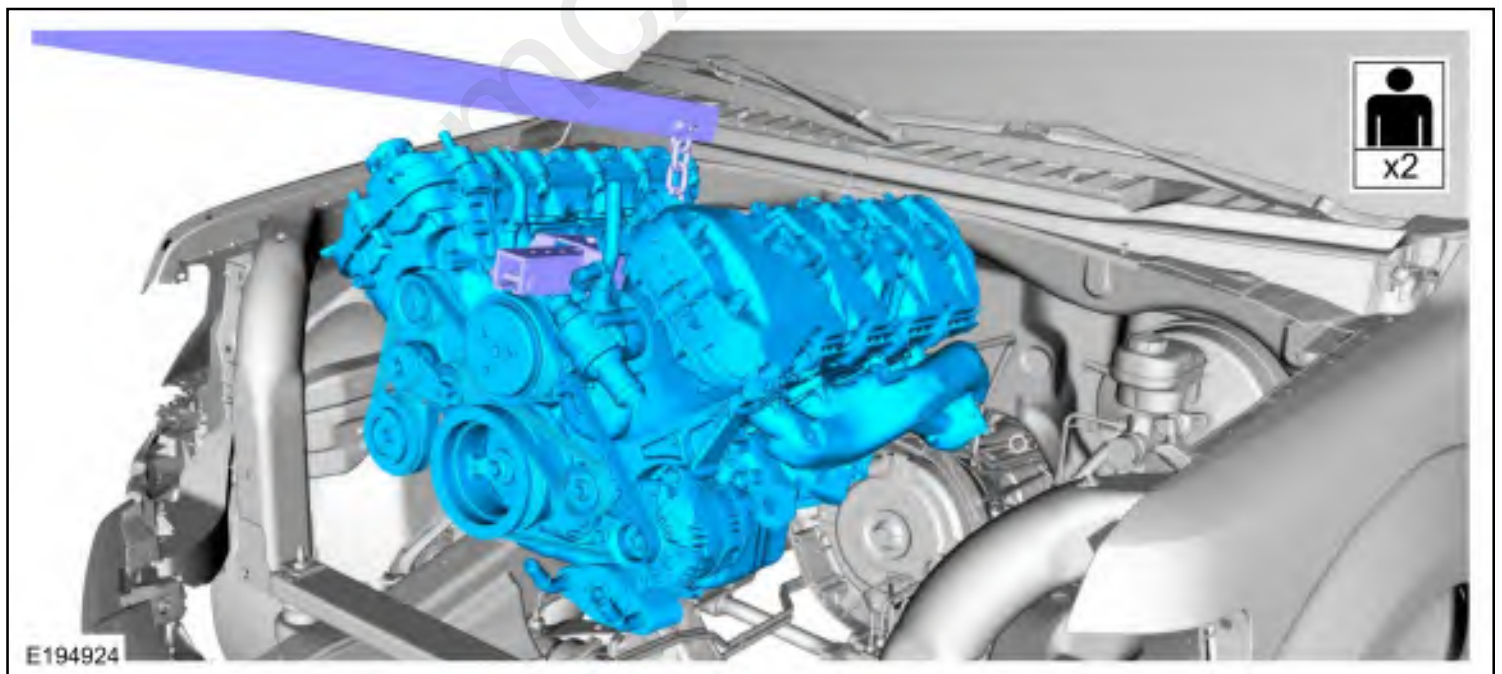
Remove and discard the LH engine mount-to-frame bolts.



41. Remove the LH engine mount.



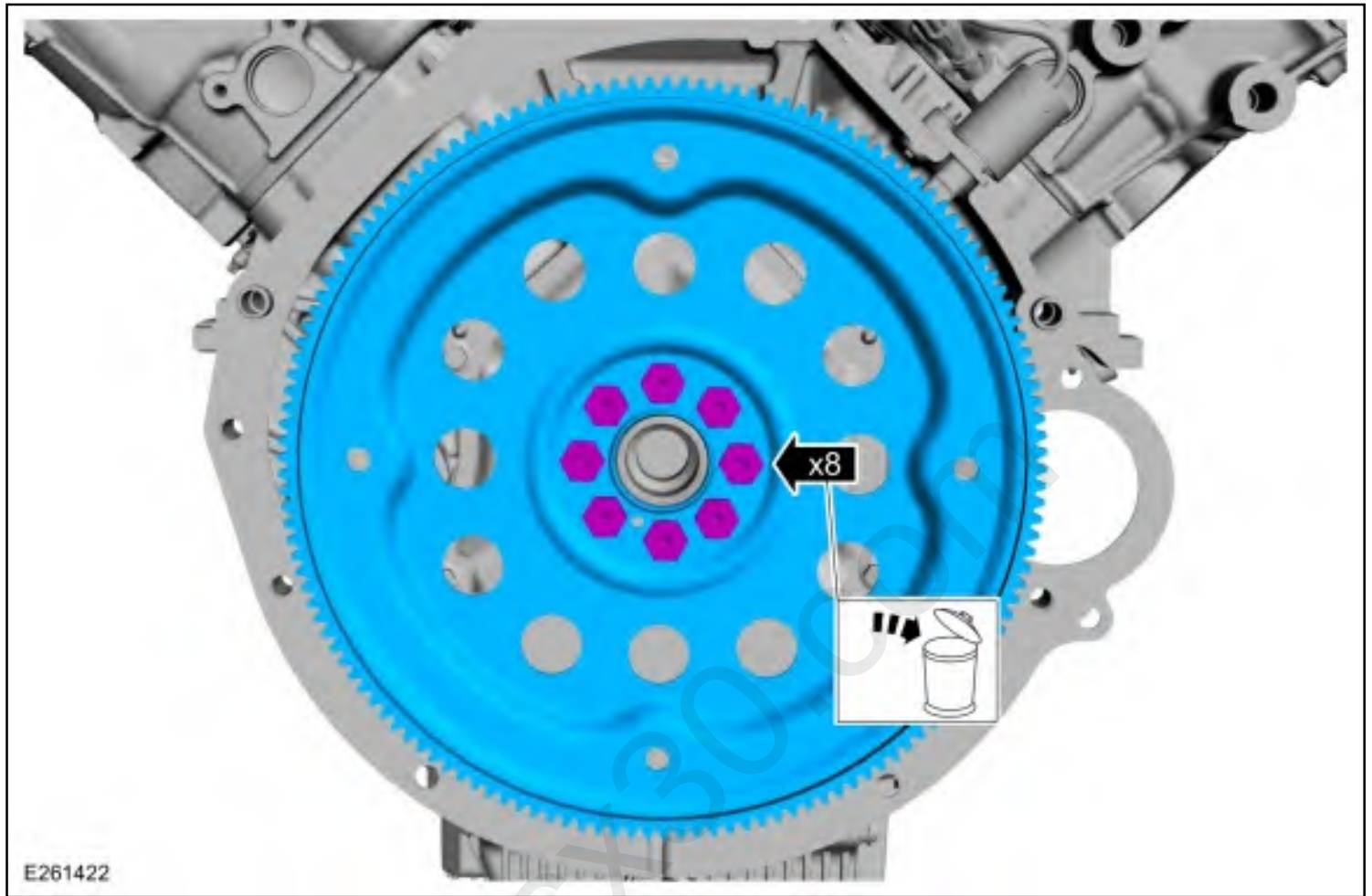
42. Using the Heavy Duty Floor Crane, remove the engine assembly from the vehicle.  
Use the General Equipment: Floor Crane



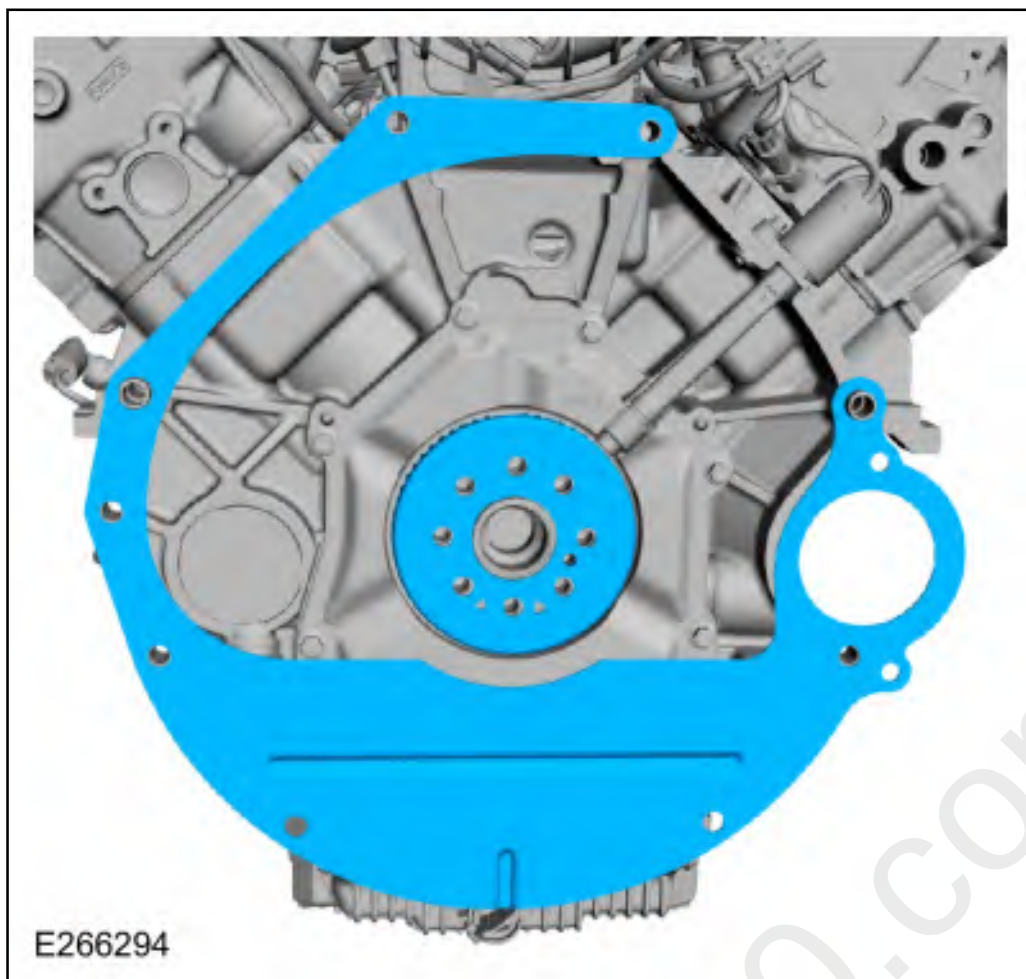
43. **NOTE:** The flexplate bolts are torque-to-yield design and are not reusable.



- Remove and discard the bolts.
- Remove the flexplate.

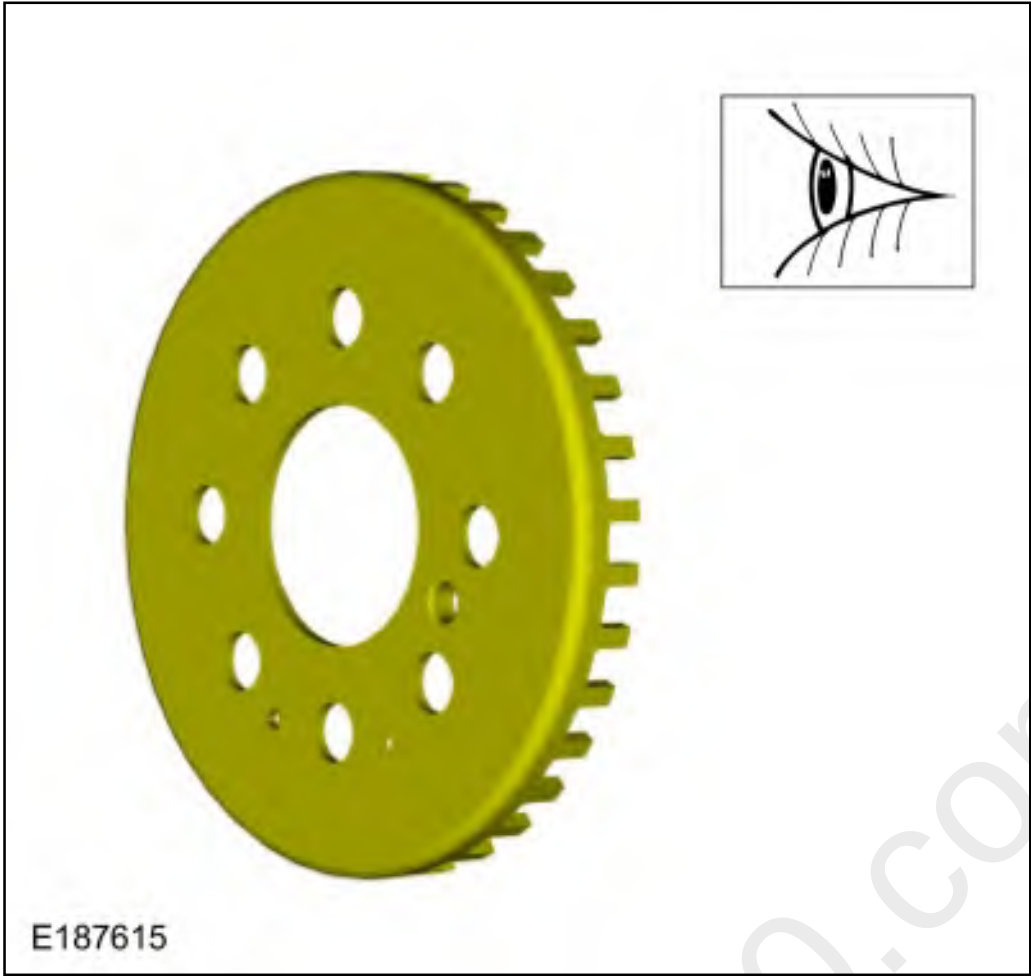


44. Remove the crankshaft sensor ring and the engine-to-transmission spacer plate.



45. Inspect the crankshaft sensor ring for damage. If the crankshaft sensor ring has been dropped or has any visual damage, it must be replaced.





# Engine

Base Part Number: Base Part Number: 6L084

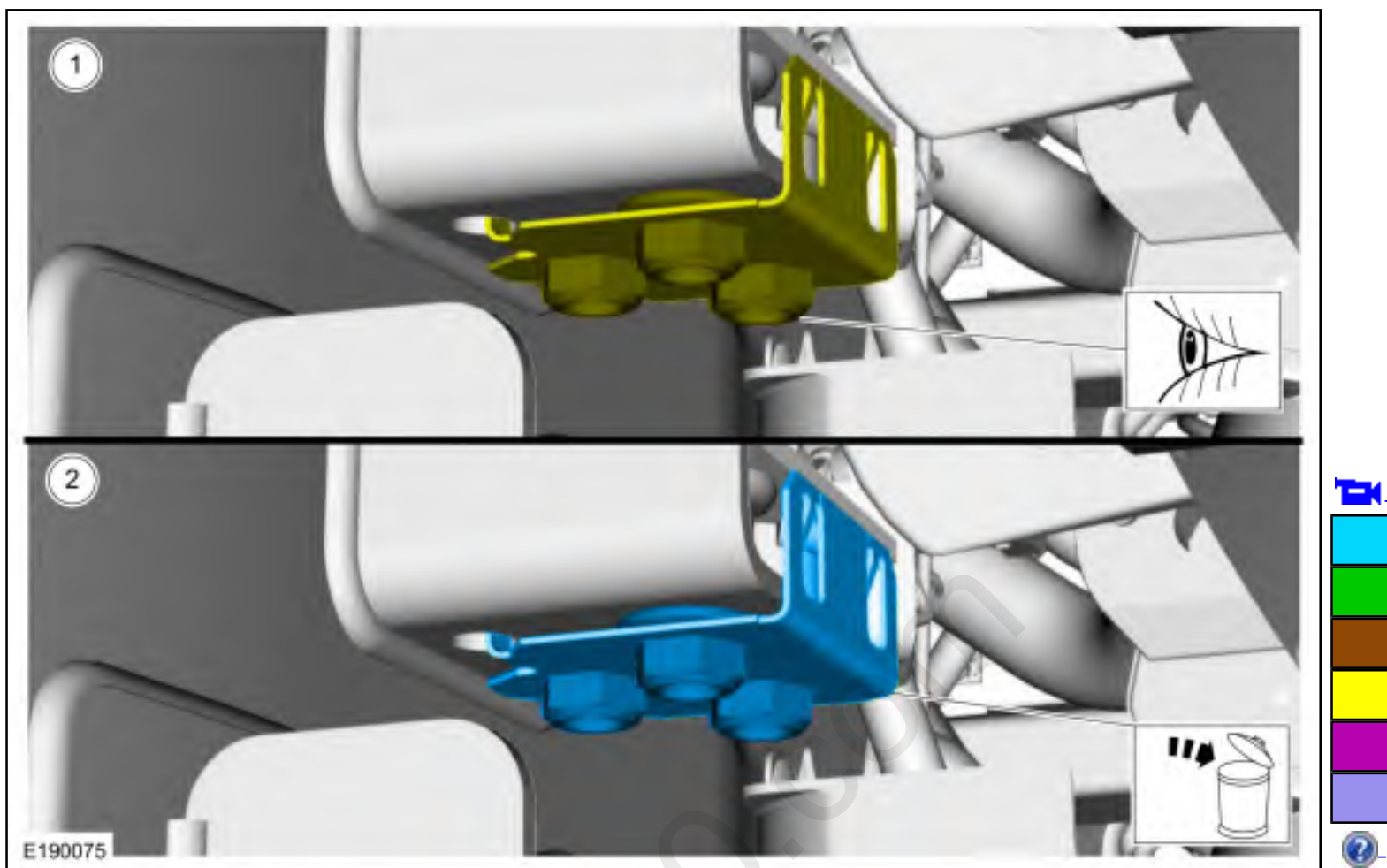
## Special Tool(s) / General Equipment

|                                                                                  |                                     |
|----------------------------------------------------------------------------------|-------------------------------------|
|  | 303-F047<br>Lifting Bracket, Engine |
| Magnetic Socket                                                                  |                                     |
| Floor Crane                                                                      |                                     |
| Trolley Jack                                                                     |                                     |
| Hose Clamp Remover/Installer                                                     |                                     |
| Wooden Block                                                                     |                                     |

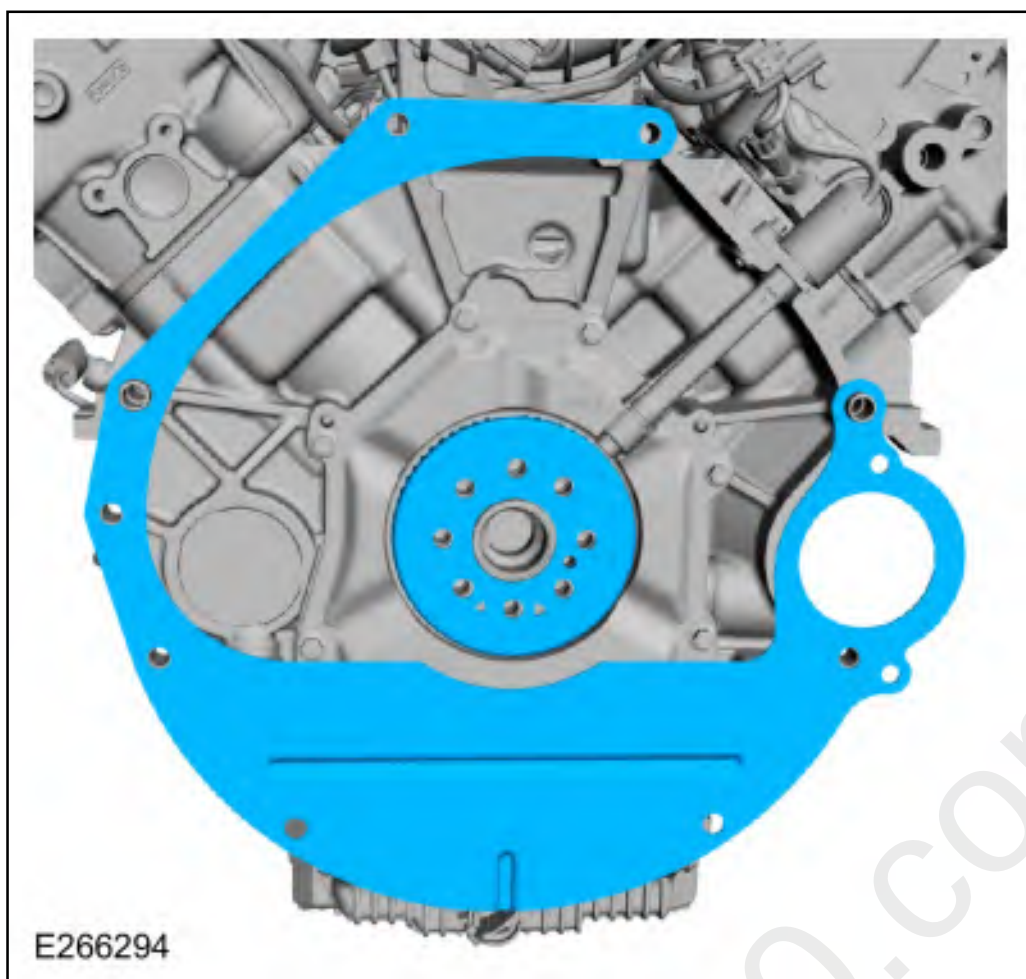
## Materials

| Name                                             | Specification |
|--------------------------------------------------|---------------|
| Motorcraft® Multi-Purpose Grease Spray<br>XL-5-A | ESB-M1C93-B   |

1. Inspect the engine mount-to-frame nut plate for thread damage.
2. If the nut plate is damaged, remove and discard the engine mount-to-frame nut plate.
  - Clean the engine mount-to-frame mating surfaces of any dirt or foreign material prior to installation.



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

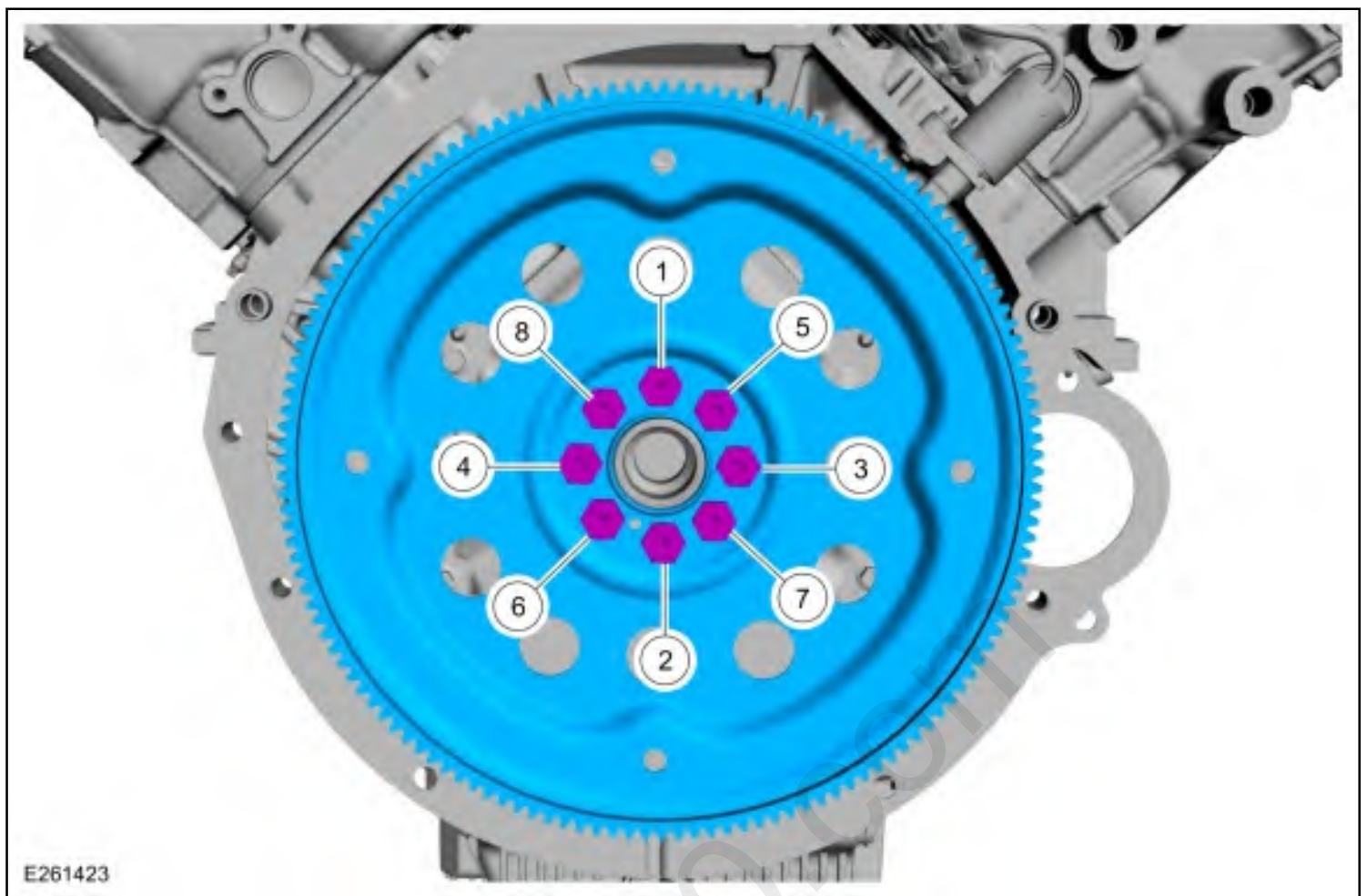


3. Install the flexplate and the bolts.

*Torque:*

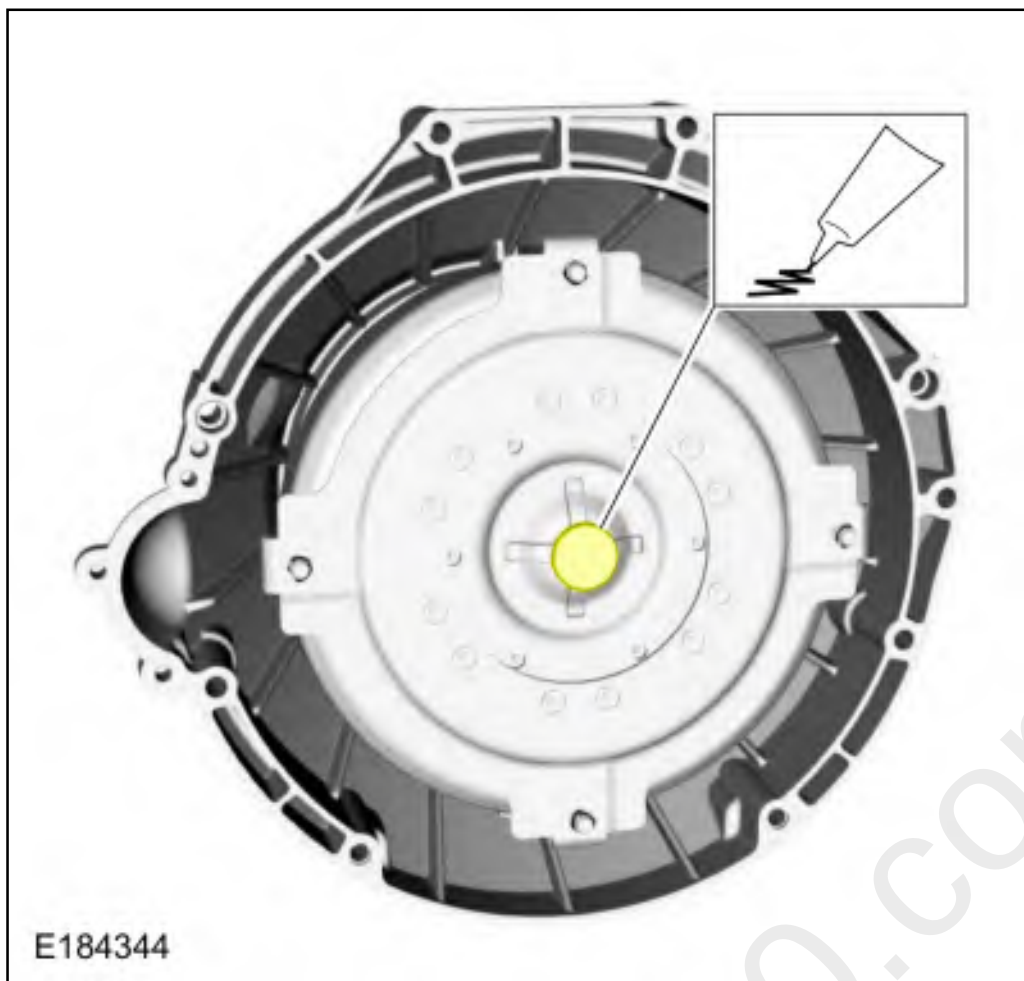
Stage 1: 43 lb.ft (58 Nm)

Stage 2: 45°

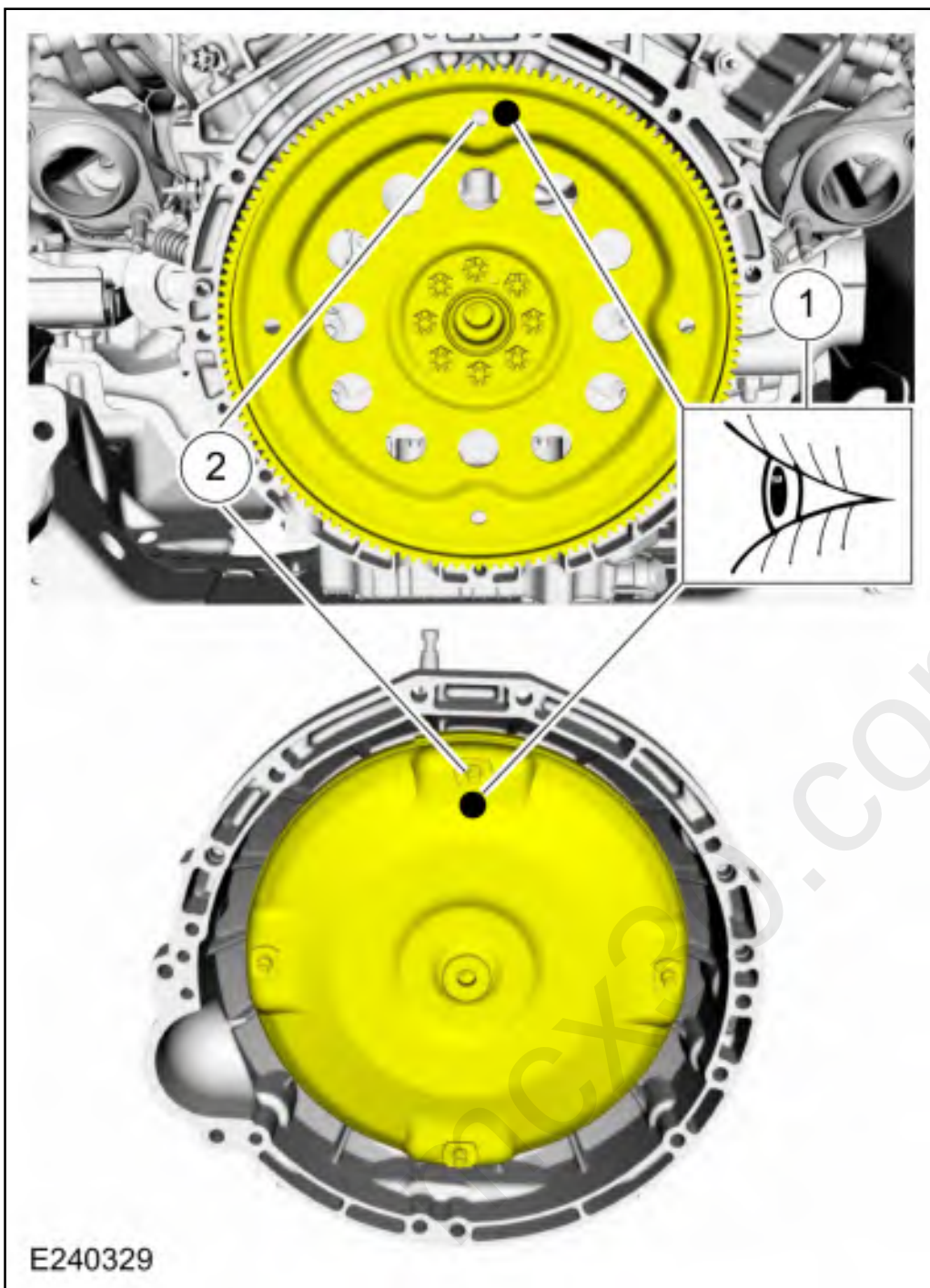


4. Lubricate the torque converter pilot hub with multi-purpose grease.  
*Material: Motorcraft® Multi-Purpose Grease Spray / XL-5-A (ESB-M1C93-B)*

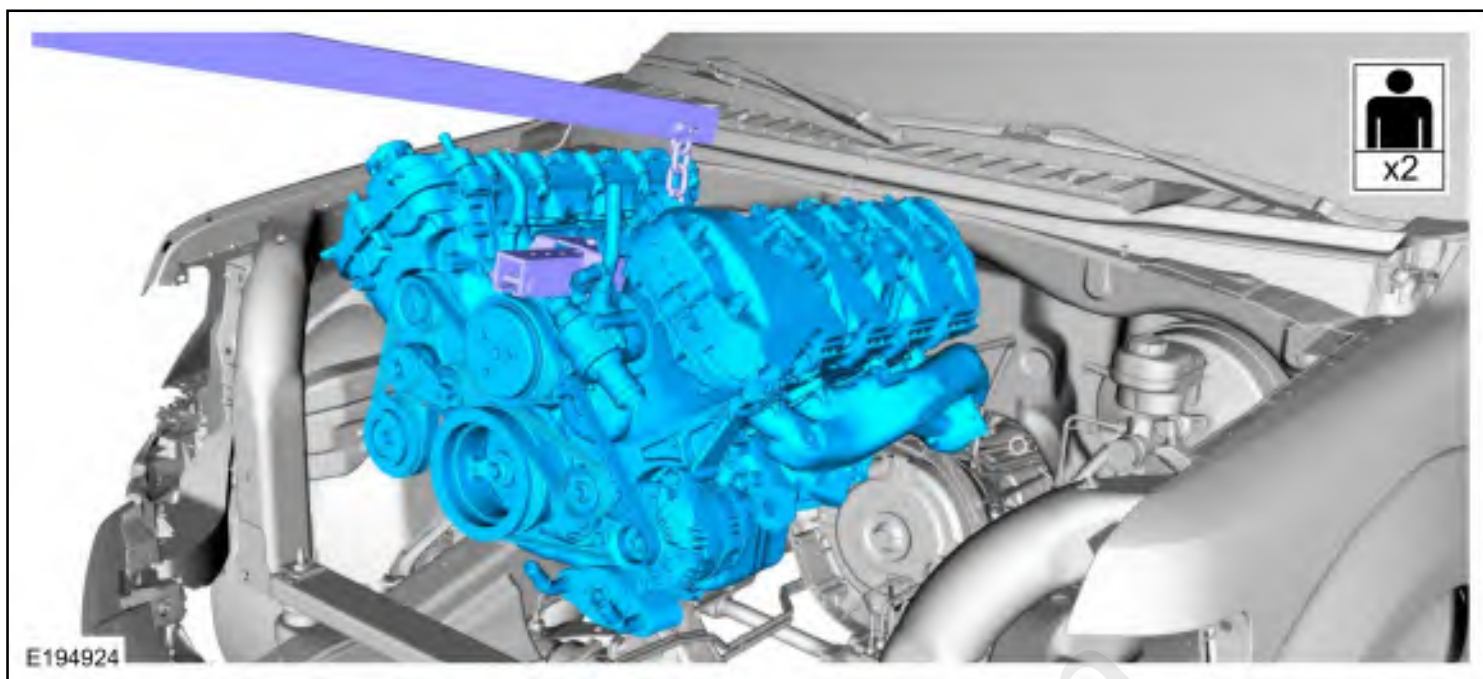




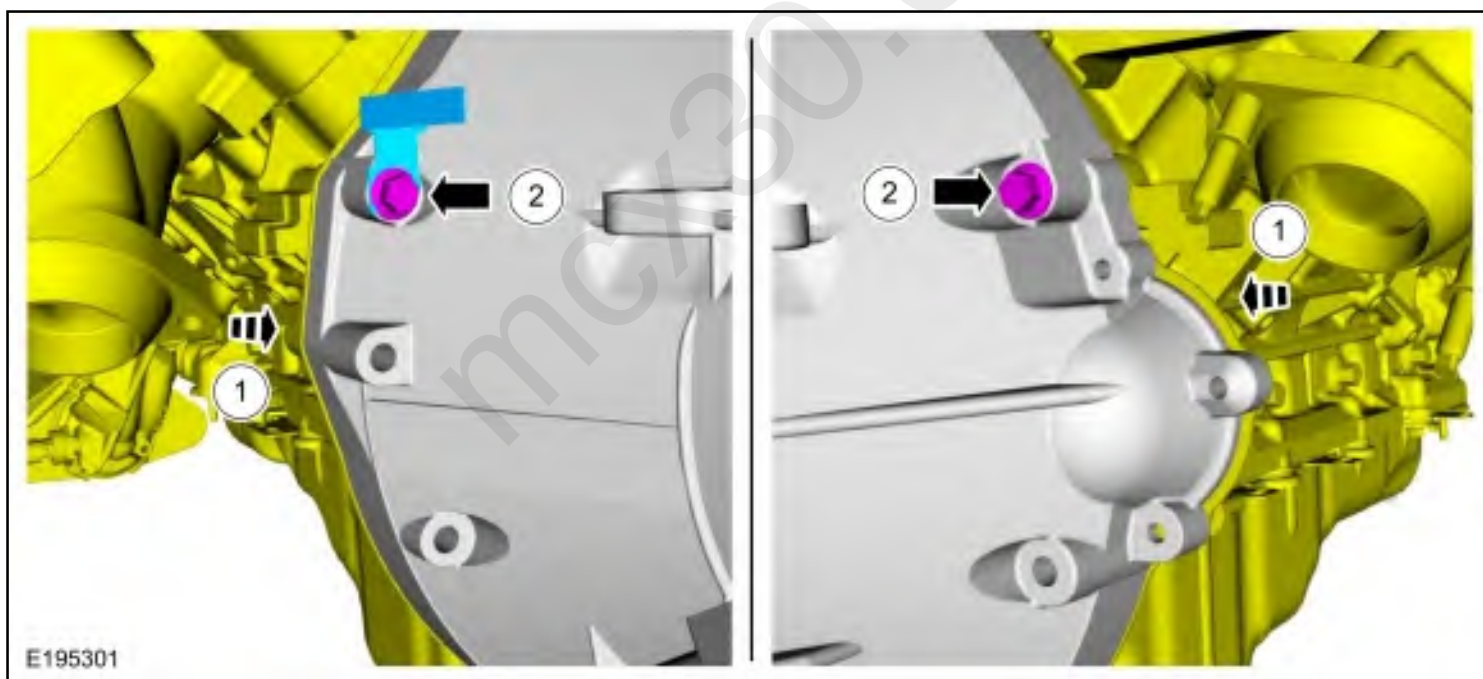
- Inspect the torque converter stud and flexplate for paint marks.
- Align the torque converter stud and flexplate hole near the paint marks to the 12 o'clock position.



6. Using the Heavy Duty Floor Crane, install the engine assembly into the vehicle.  
Use the General Equipment: Floor Crane

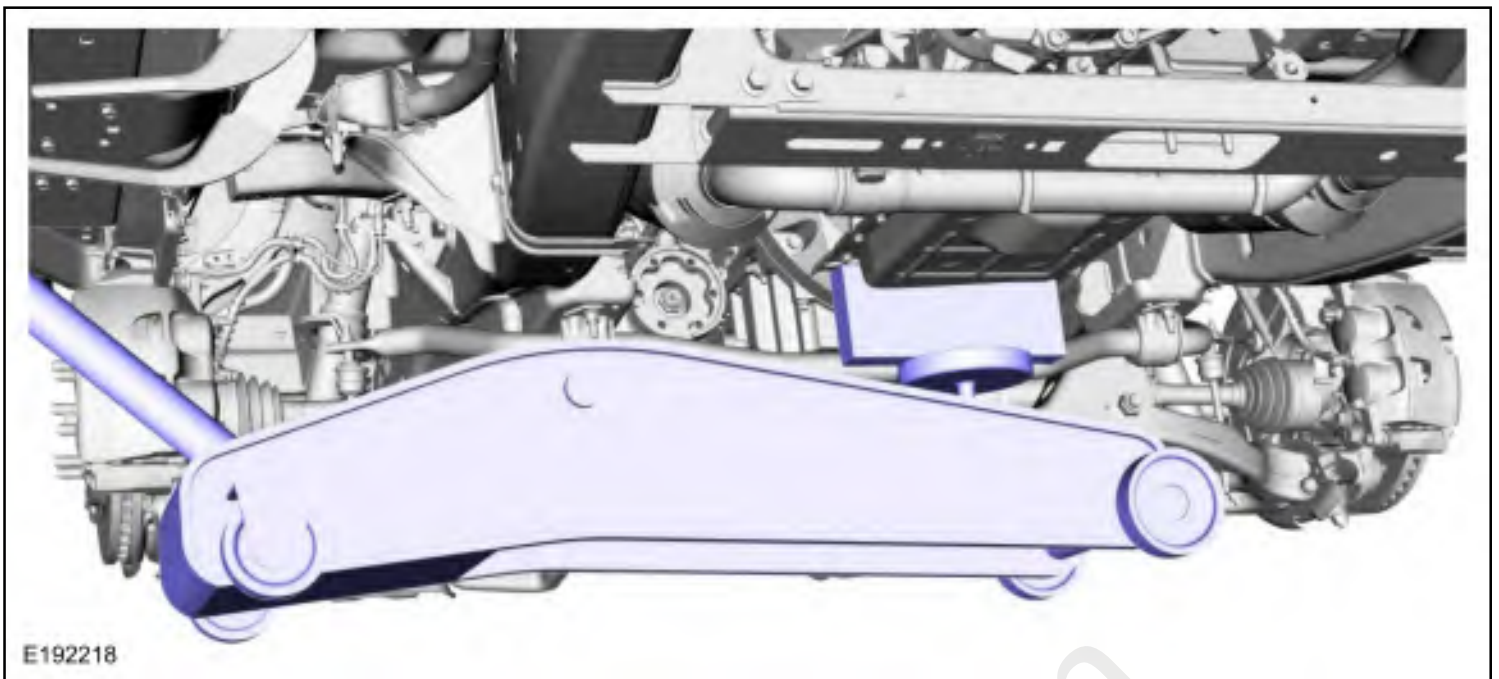


1. Align the engine to the transmission.
  2. Install the clip and draw the engine and transmission together using the bolts.
- Torque: 35 lb.ft (48 Nm)*

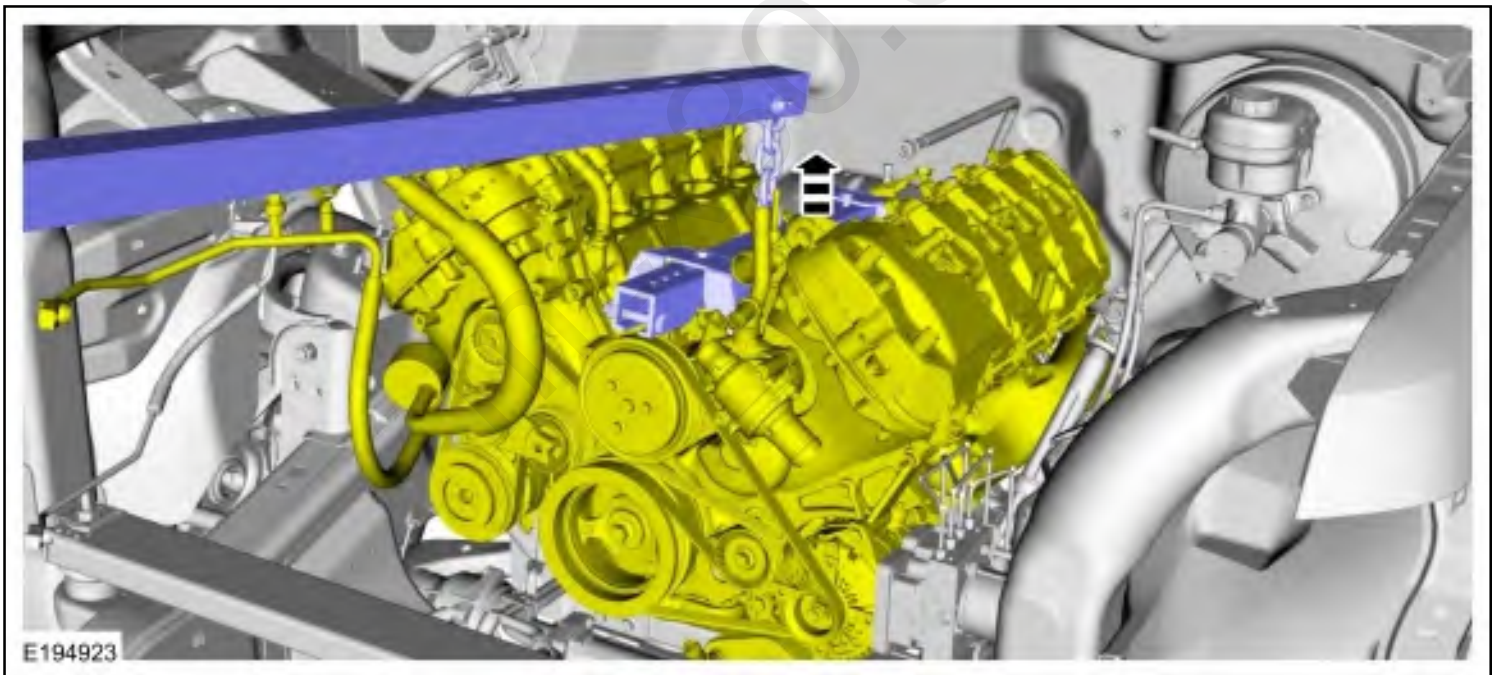


8. Remove the floor jack and a block of wood.  
Use the General Equipment: Trolley Jack  
Use the General Equipment: Wooden Block

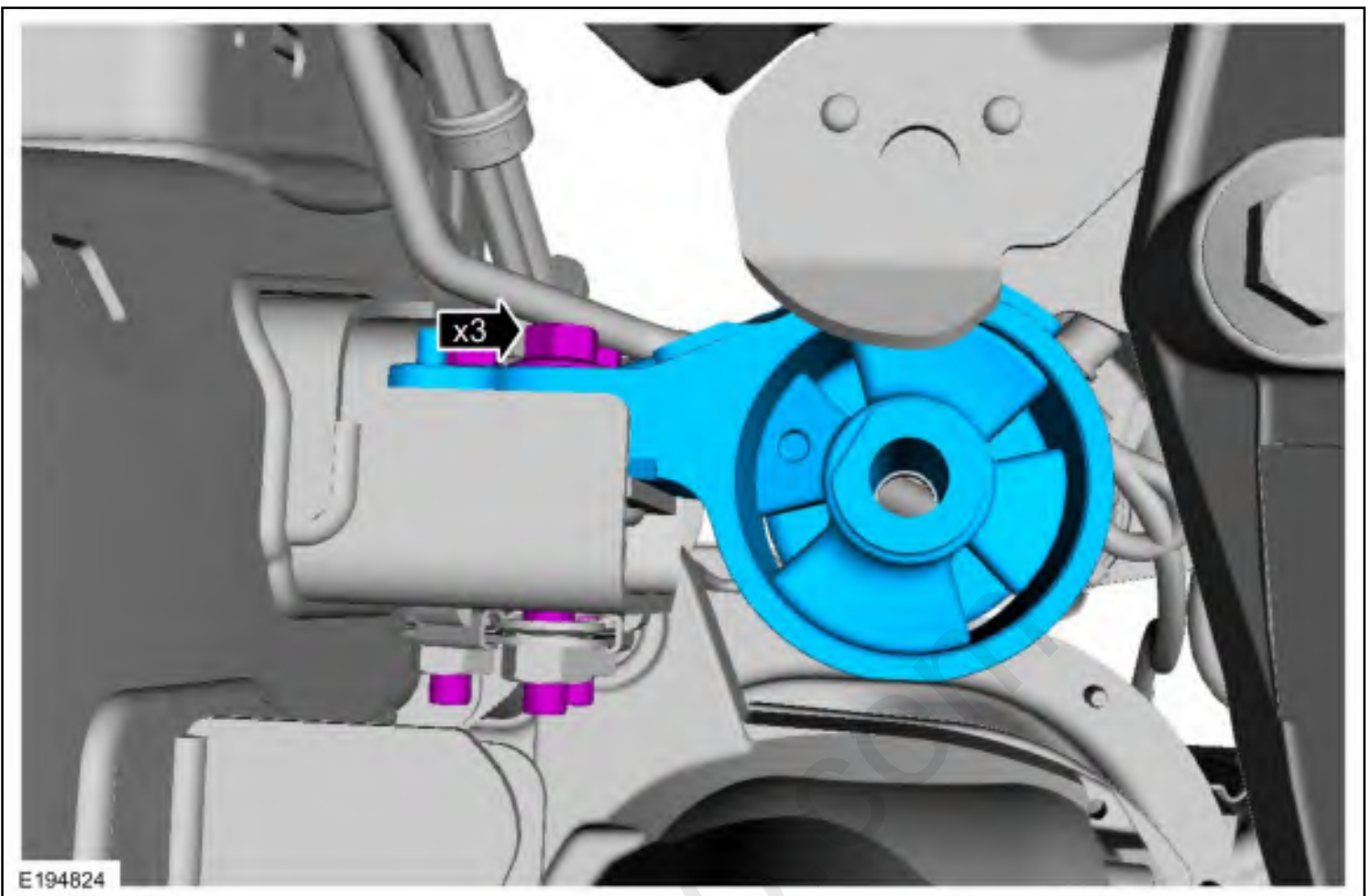




9. Using the Heavy Duty Floor Crane, raise the engine assembly to gain clearance to install the LH engine mount.  
Use the General Equipment: Floor Crane



10. Install the LH engine mount and the new engine mount-to-frame bolts.  
*Torque: 129 lb.ft (175 Nm)*

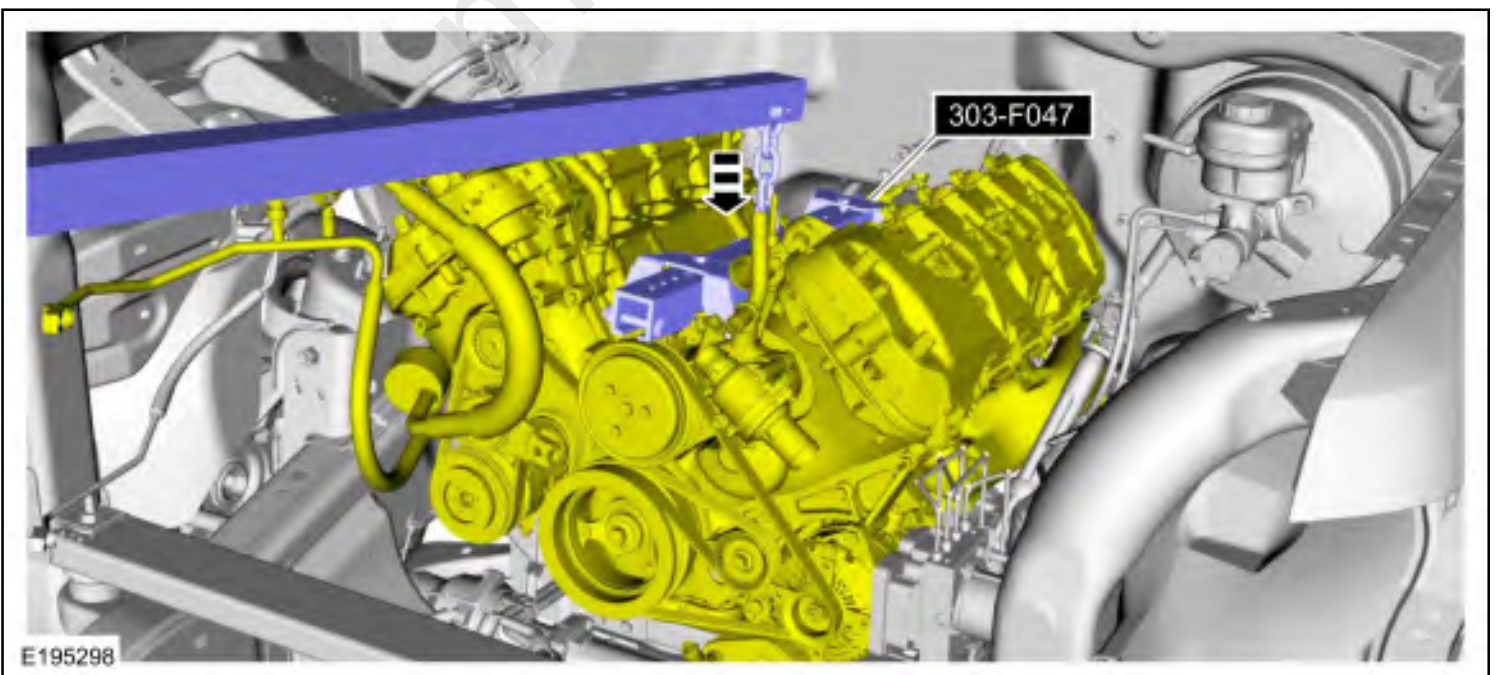


11. Using the Heavy Duty Floor Crane, lower the engine assembly into the installed position.

1. Remove Heavy Duty Floor Crane.

Use the General Equipment: Floor Crane

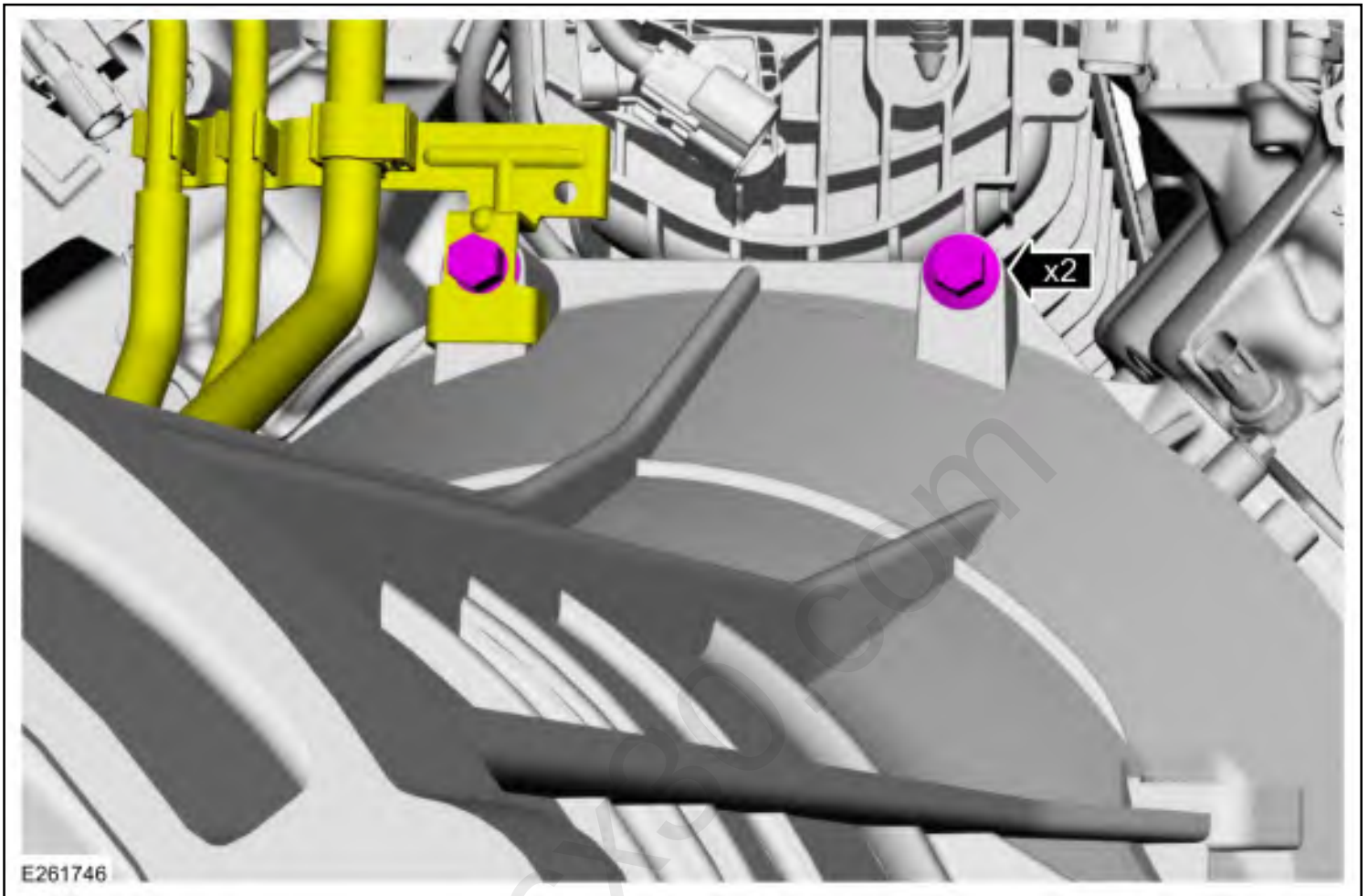
2. Remove Special Service Tool: 303-F047 Lifting Bracket, Engine.





12. Position the bracket and install the upper transmission-to-engine bolts.

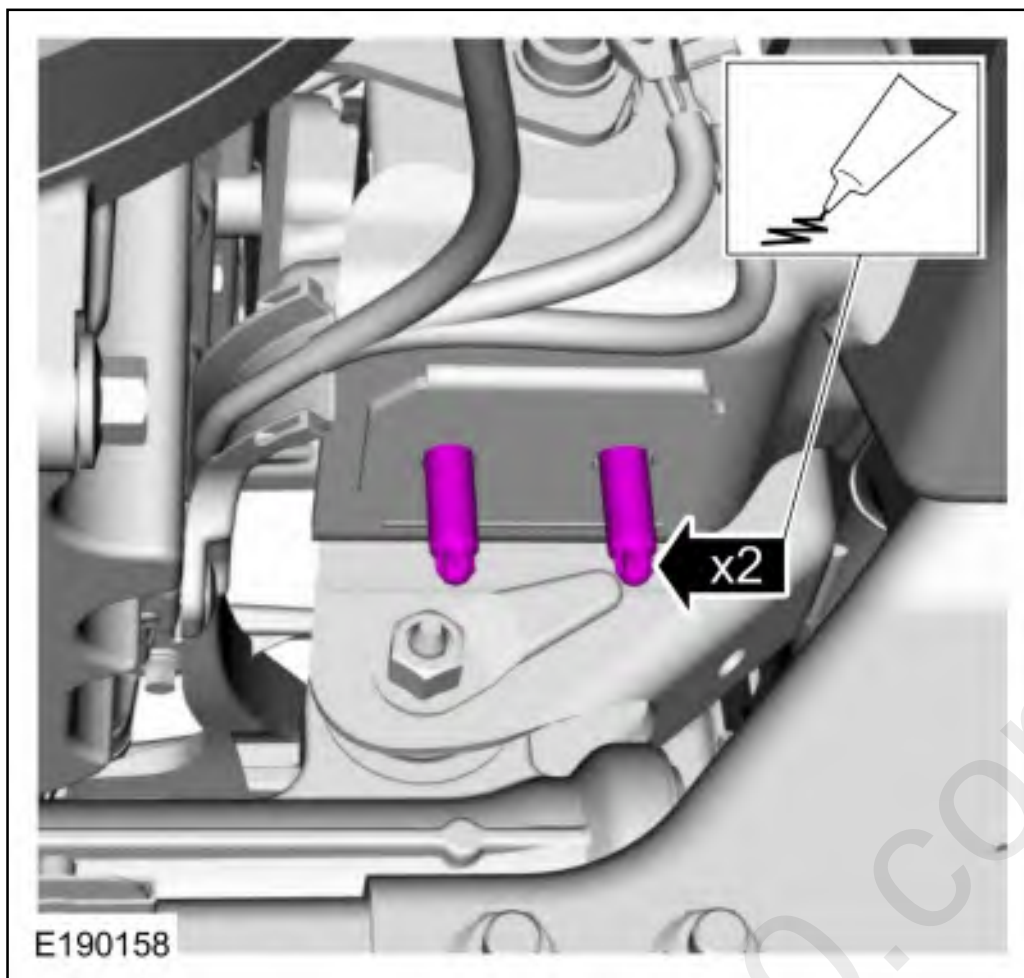
*Torque: 35 lb.ft (48 Nm)*



13. **NOTICE:** Only use hand tools when installing the engine mount stud bolts or damage to the engine mount can occur.

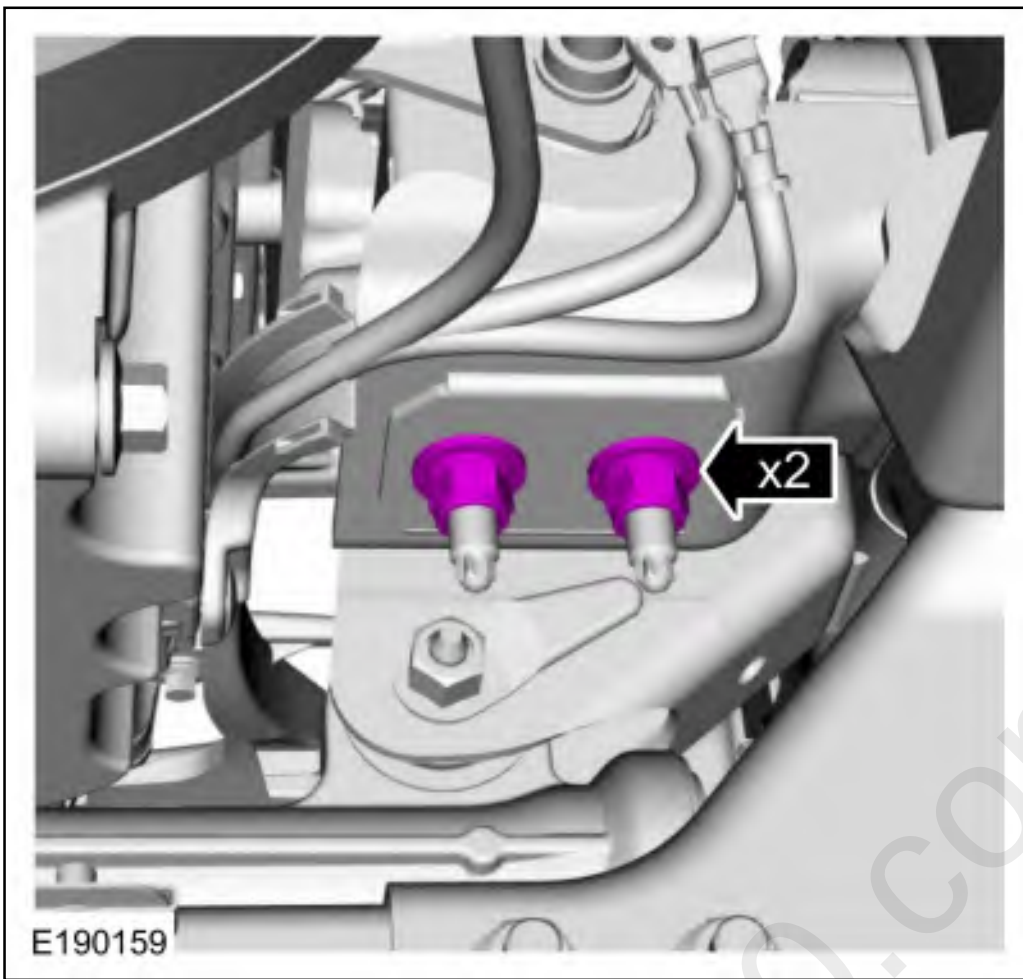
Install the new RH engine mount stud bolts.

*Torque: 22 lb.ft (30 Nm)*



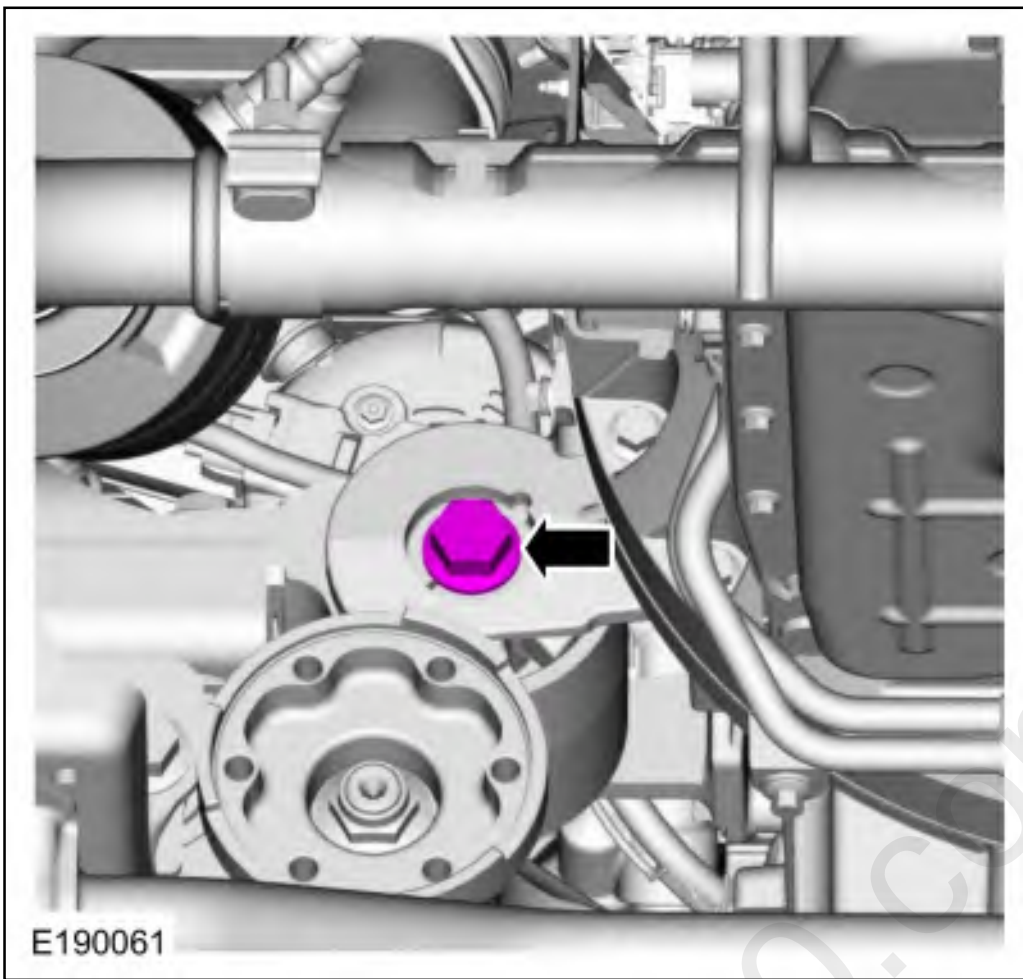
14. **NOTICE:** Only use hand tools when installing the engine mount nuts or damage to the engine mount can occur.

Install the new RH engine mount nuts.  
*Torque:* 111 lb.ft (150 Nm)



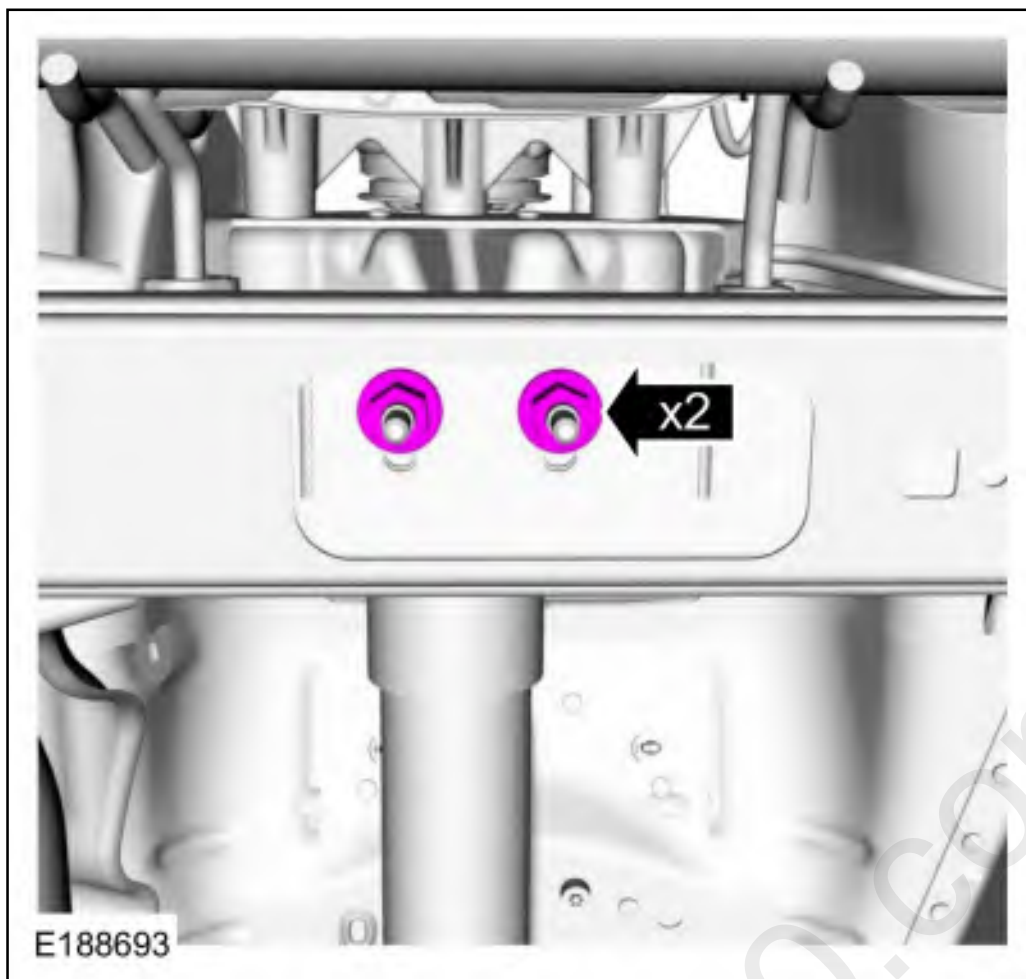
15. **NOTICE:** Only use hand tools when tightening the engine mount through bolts or damage to the engine mount-to-cylinder block bracket can occur.

Install the new LH engine mount through bolt.  
*Torque:* 258 lb.ft (350 Nm)



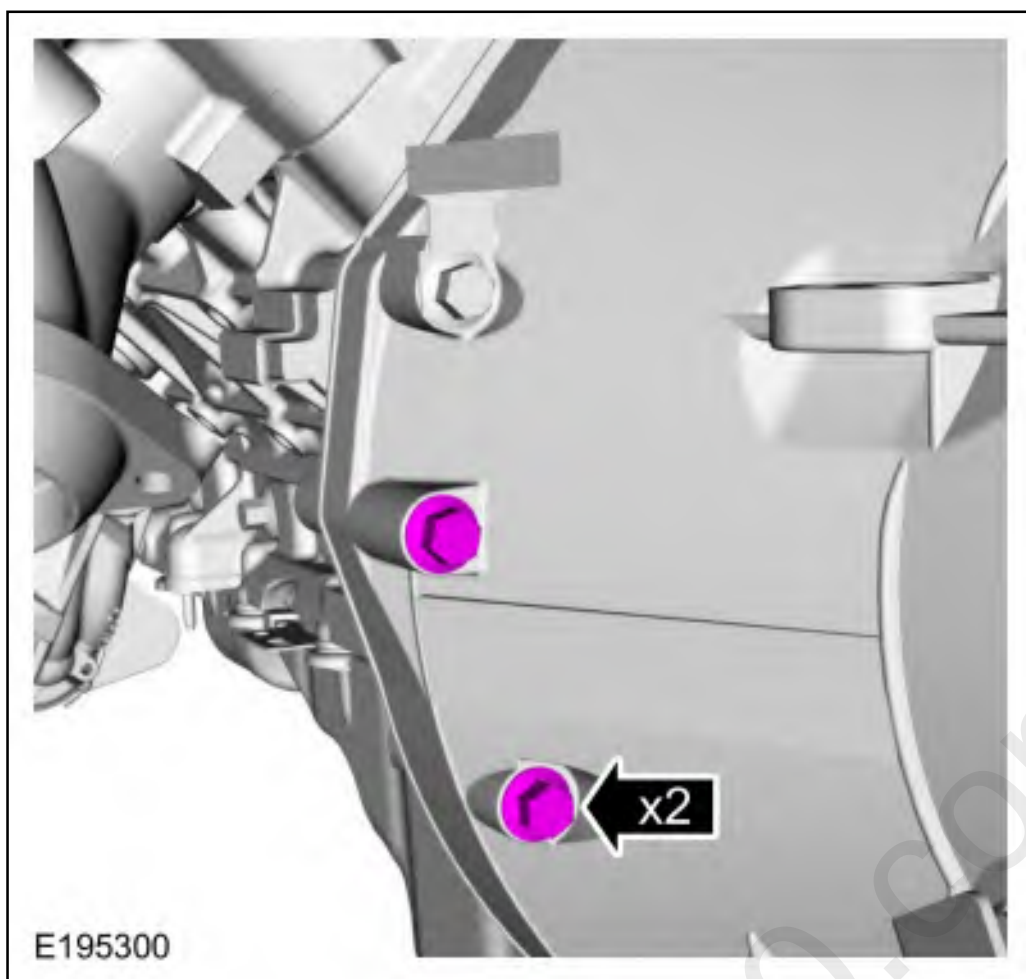
16. **NOTICE:** Only use hand tools when installing the transmission mount-to-crossmember nuts or damage to the transmission mount can occur.

Tighten the transmission mount-to-crossmember nuts.  
*Torque:* 85 lb.ft (115 Nm)

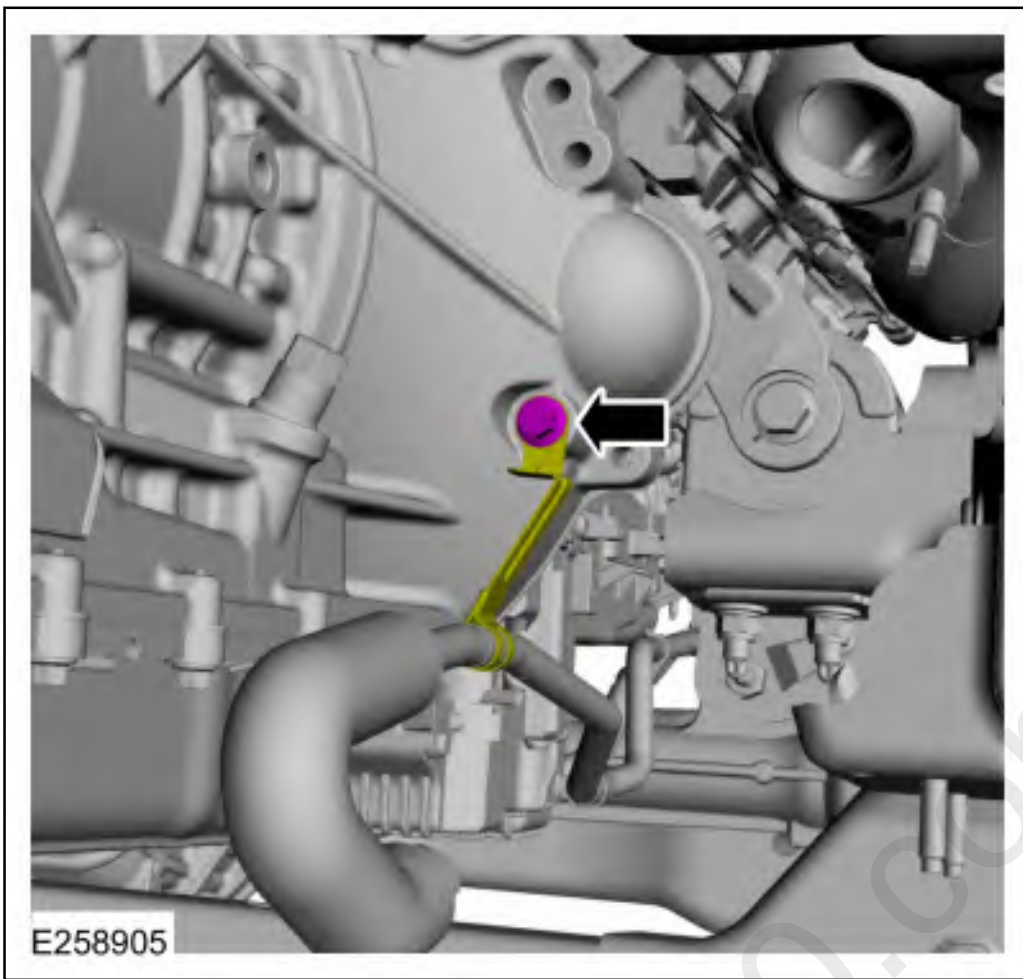


17. Install LH transmission-to-engine bolts.  
*Torque: 35 lb.ft (48 Nm)*

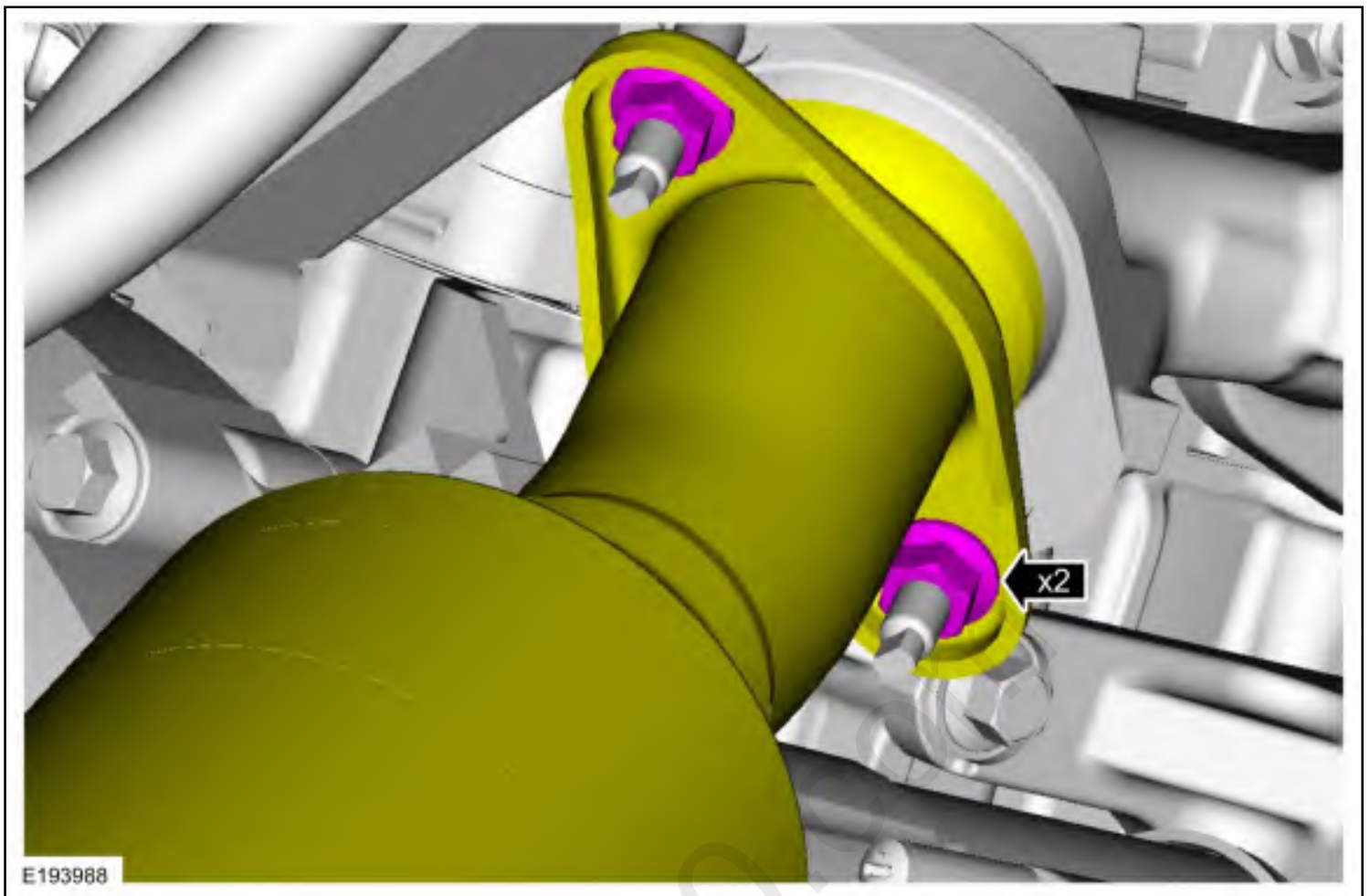




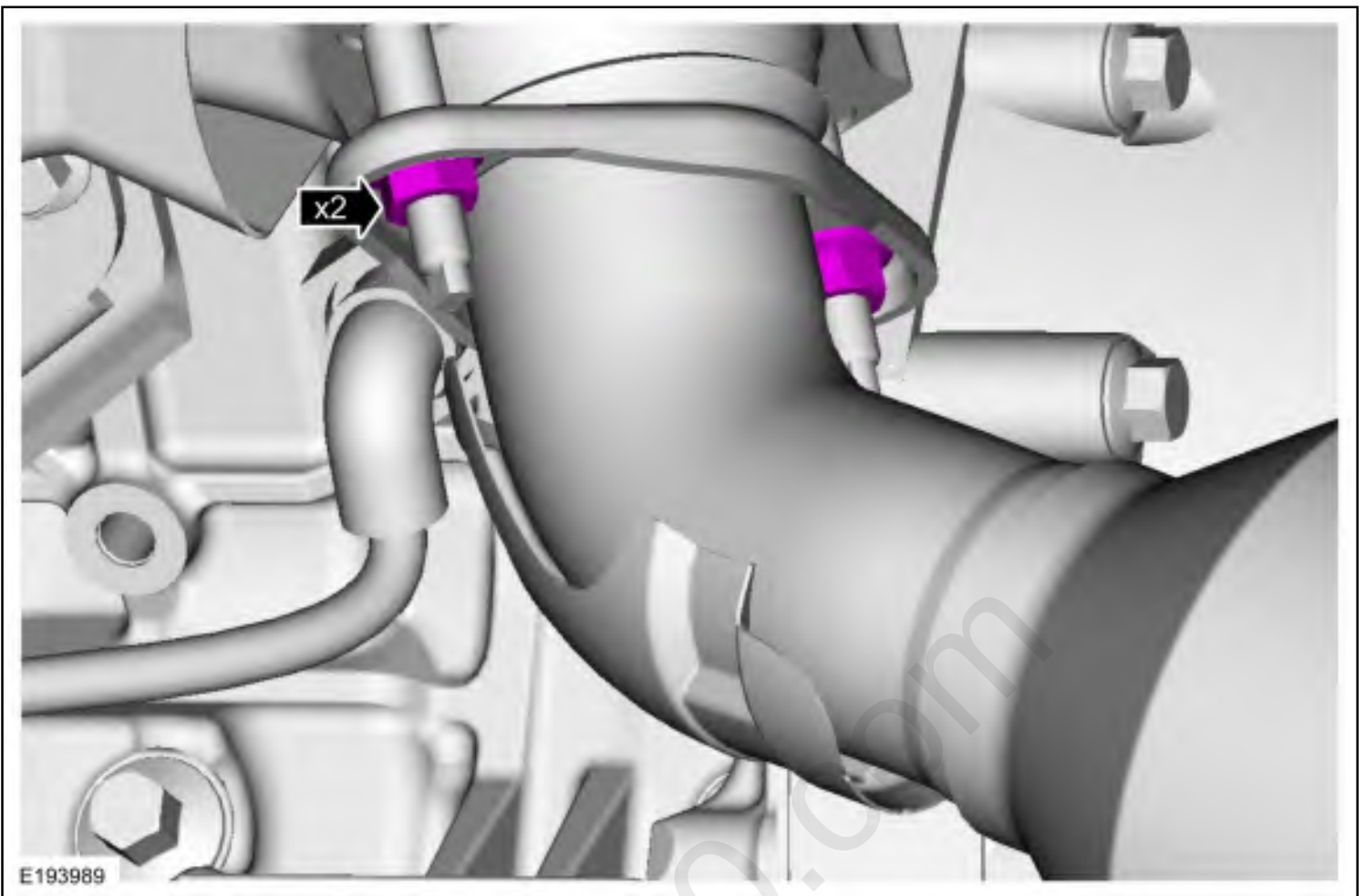
18. Install the transmission cooler tube support bracket and the transmission-to-engine bolt.  
*Torque: 35 lb.ft (48 Nm)*



19. Position the exhaust Y-pipe dual catalytic converter onto the exhaust manifolds and loosely install new RH catalytic converter-to-exhaust manifold nuts.



20. Loosely install new LH catalytic converter-to-exhaust manifold nuts.

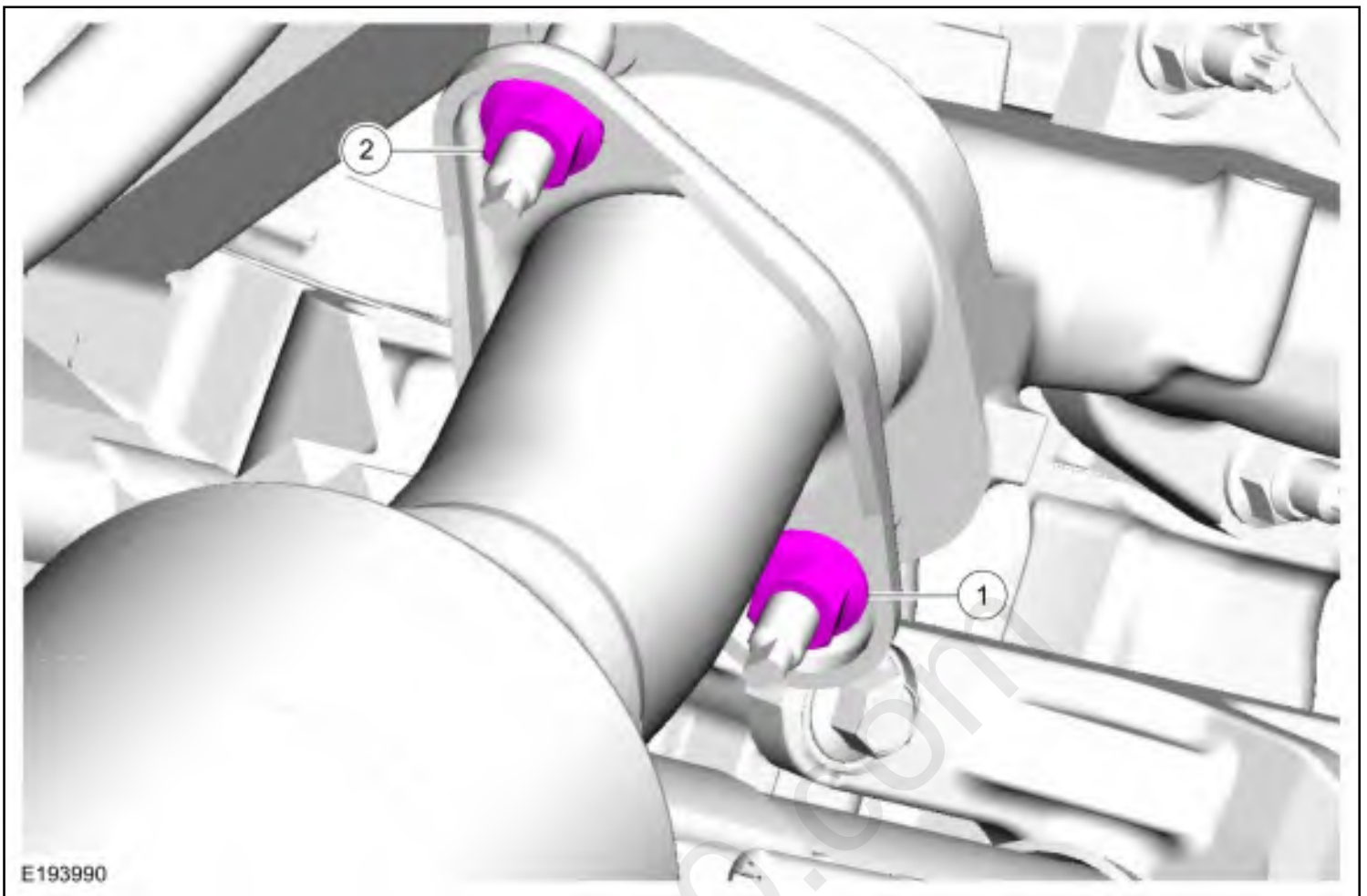


21. Tighten the nuts.

*Torque:*

1: 30 lb.ft (40 Nm)

2: 30 lb.ft (40 Nm)



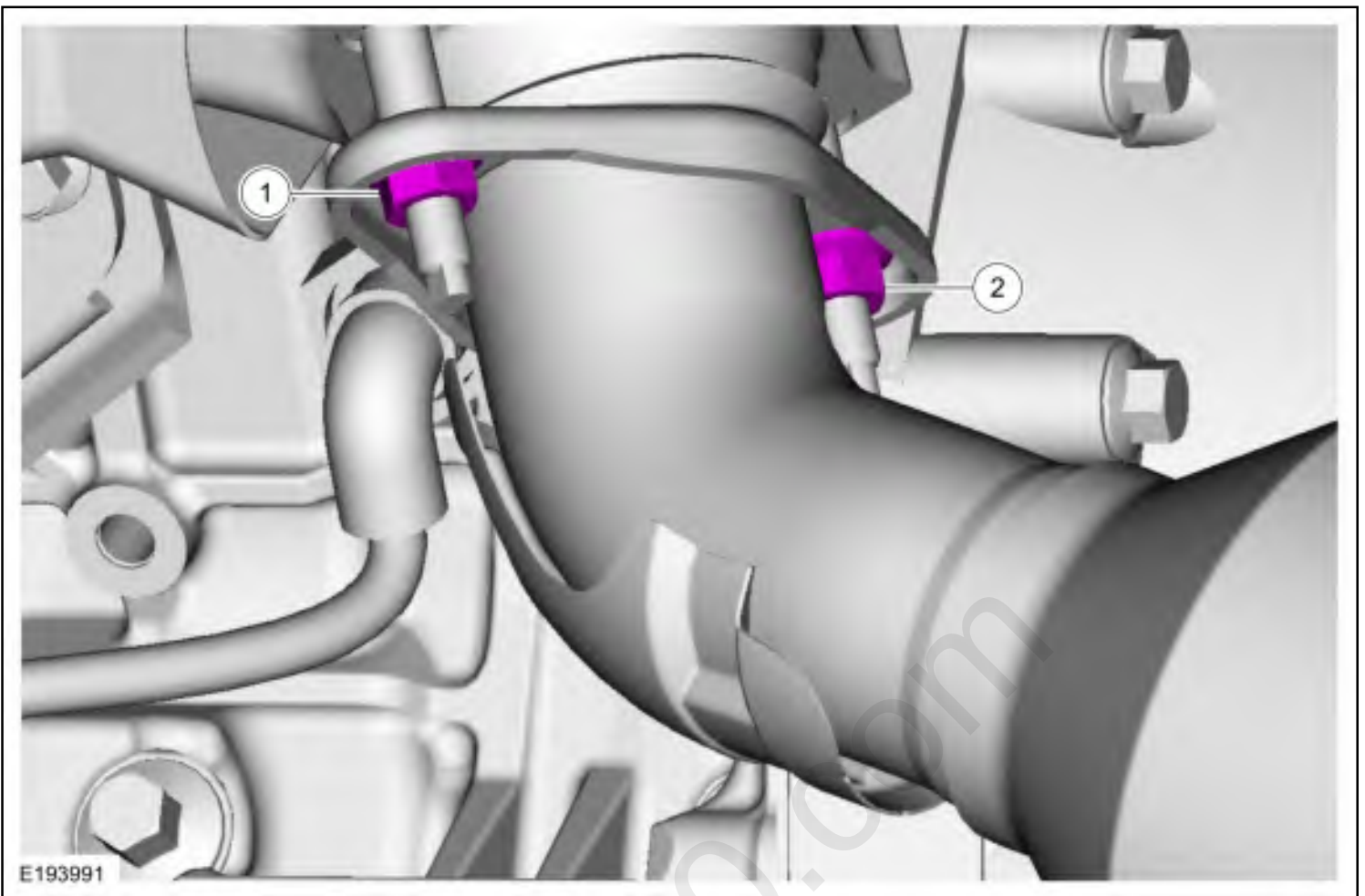
22. Tighten the nuts.

*Torque:*

1: 30 lb.ft (40 Nm)

2: 30 lb.ft (40 Nm)



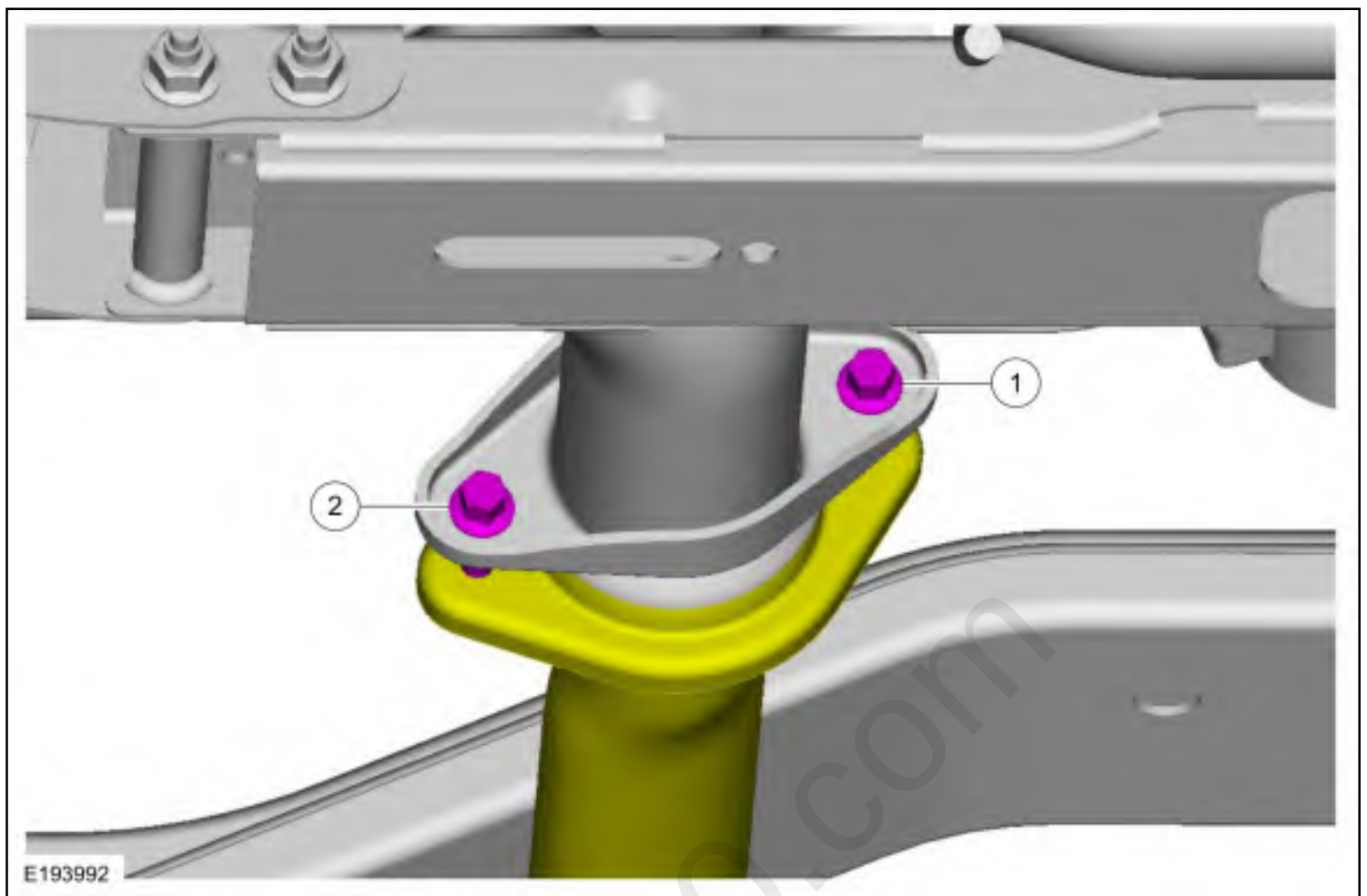


23. Position the exhaust Y-pipe dual catalytic converter-to-exhaust intermediate pipe and install new bolts.

*Torque:*

1: 46 lb.ft (63 Nm)

2: 46 lb.ft (63 Nm)

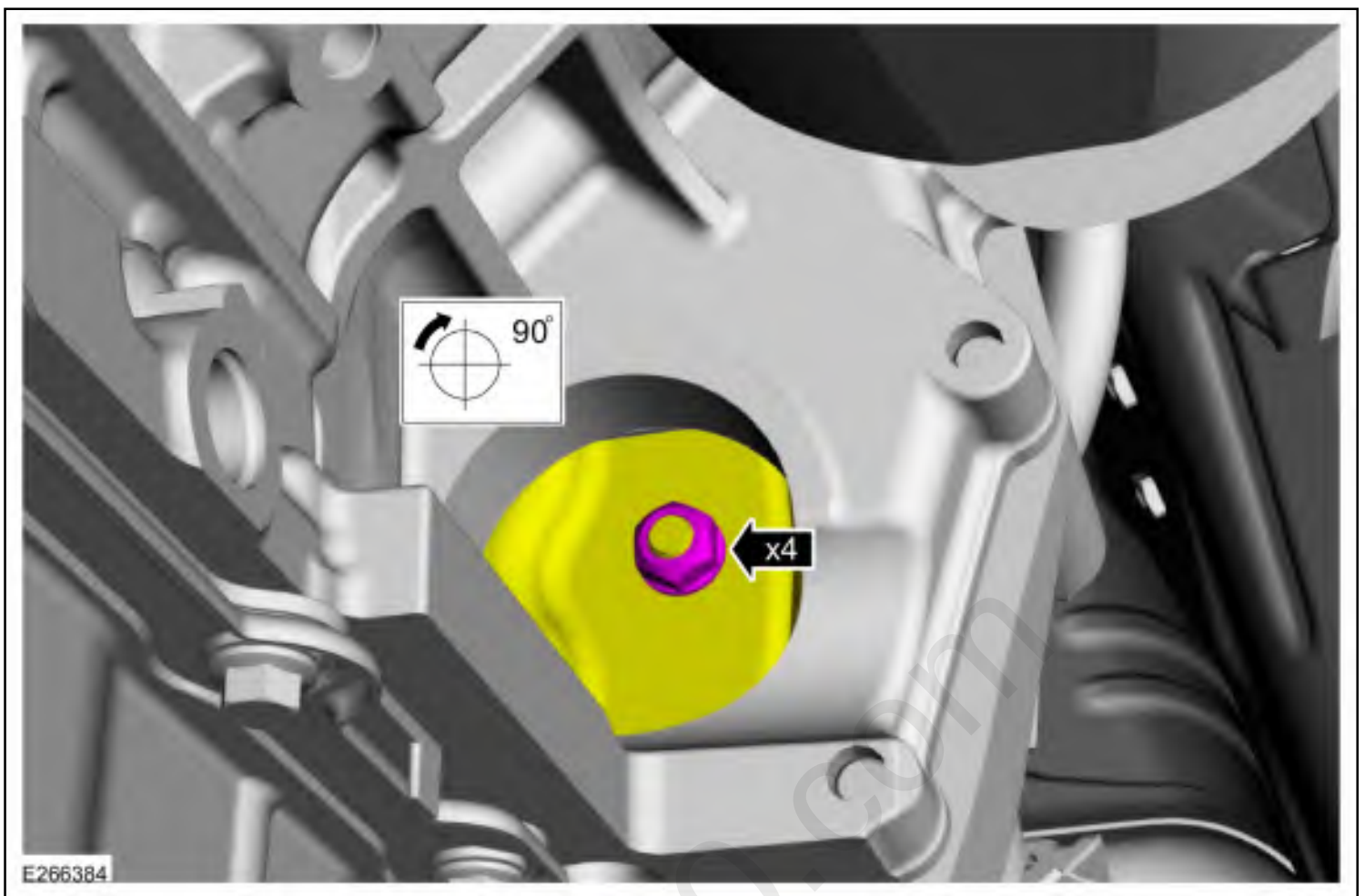


24. **NOTE:** Only rotate the crankshaft in a clockwise direction.

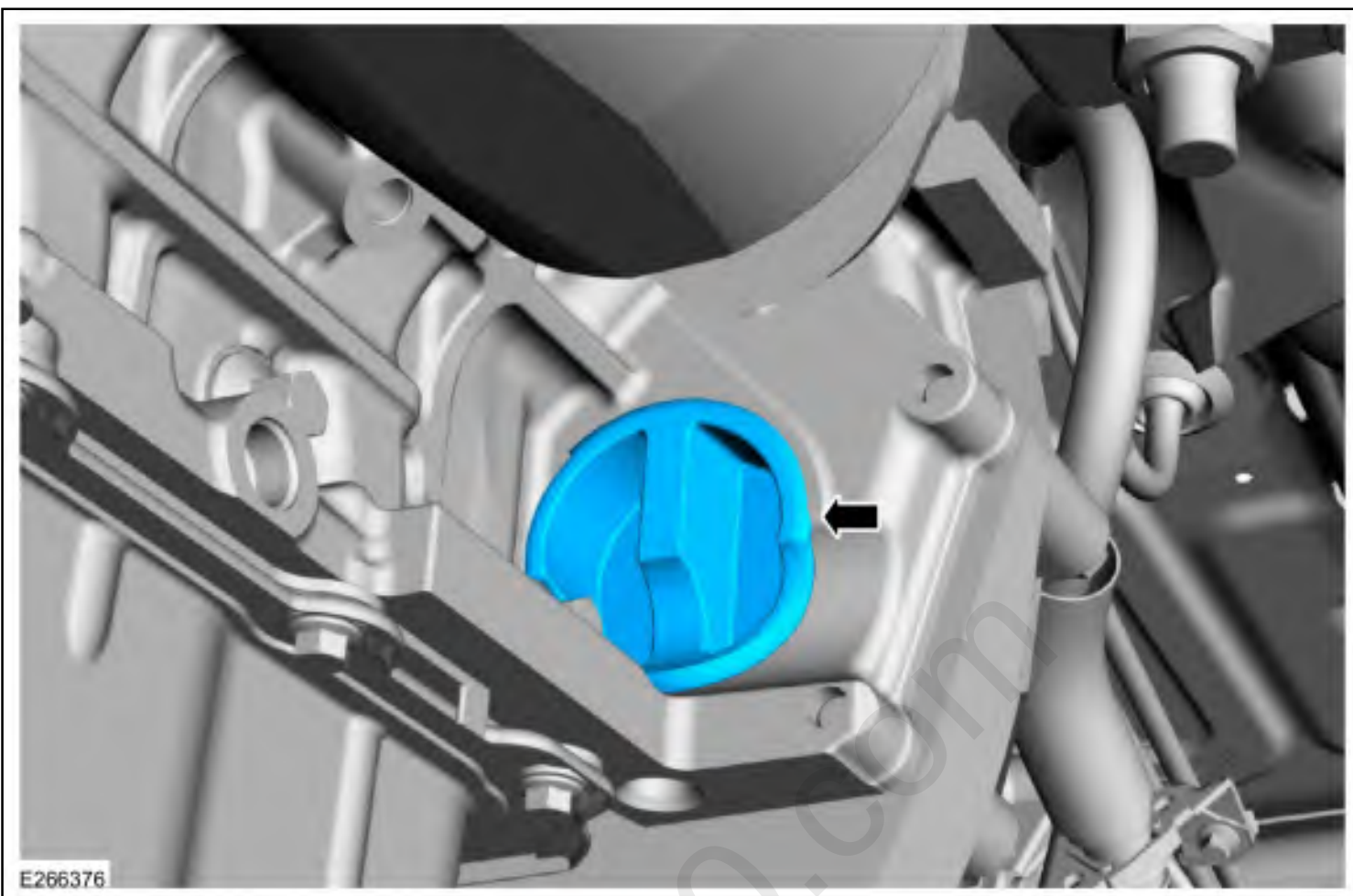
Install the new torque converter-to-flexplate nuts.

Use the General Equipment: Magnetic Socket

Torque: 30 lb.ft (40 Nm)

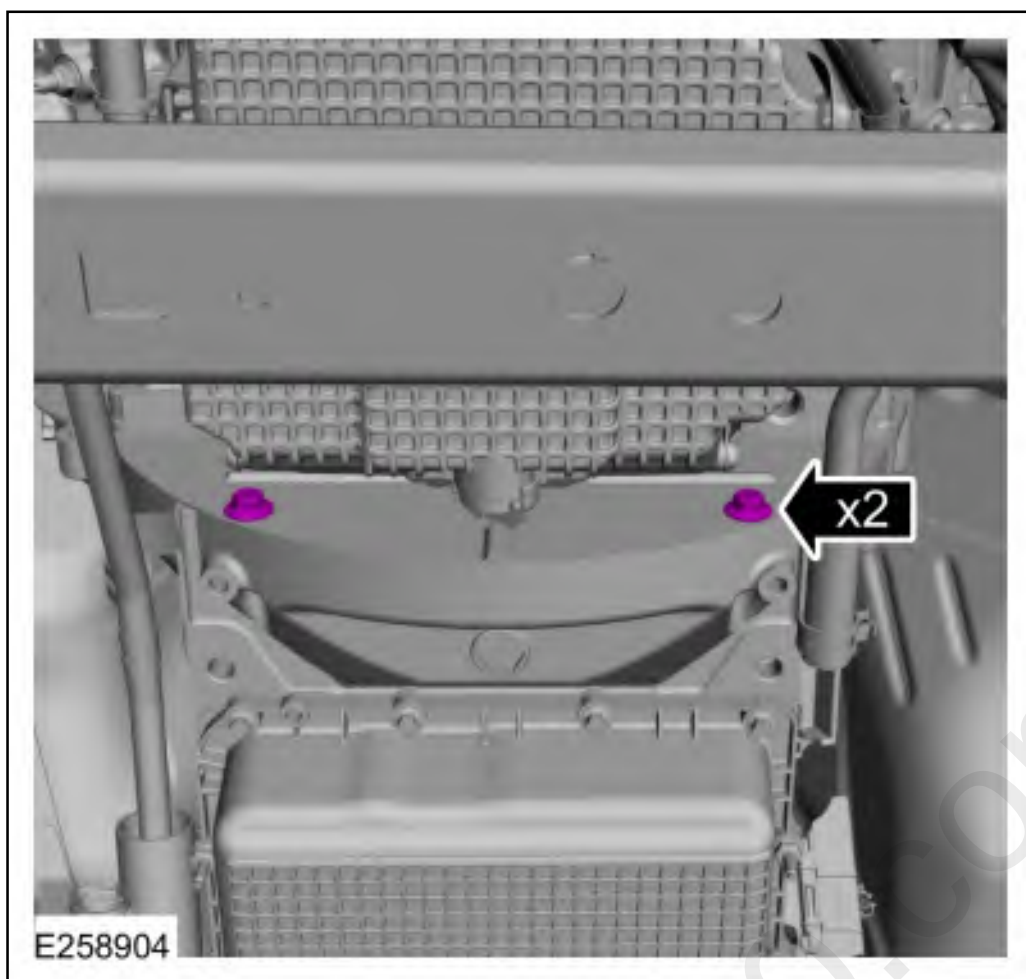


25. Install the cylinder block opening cover.

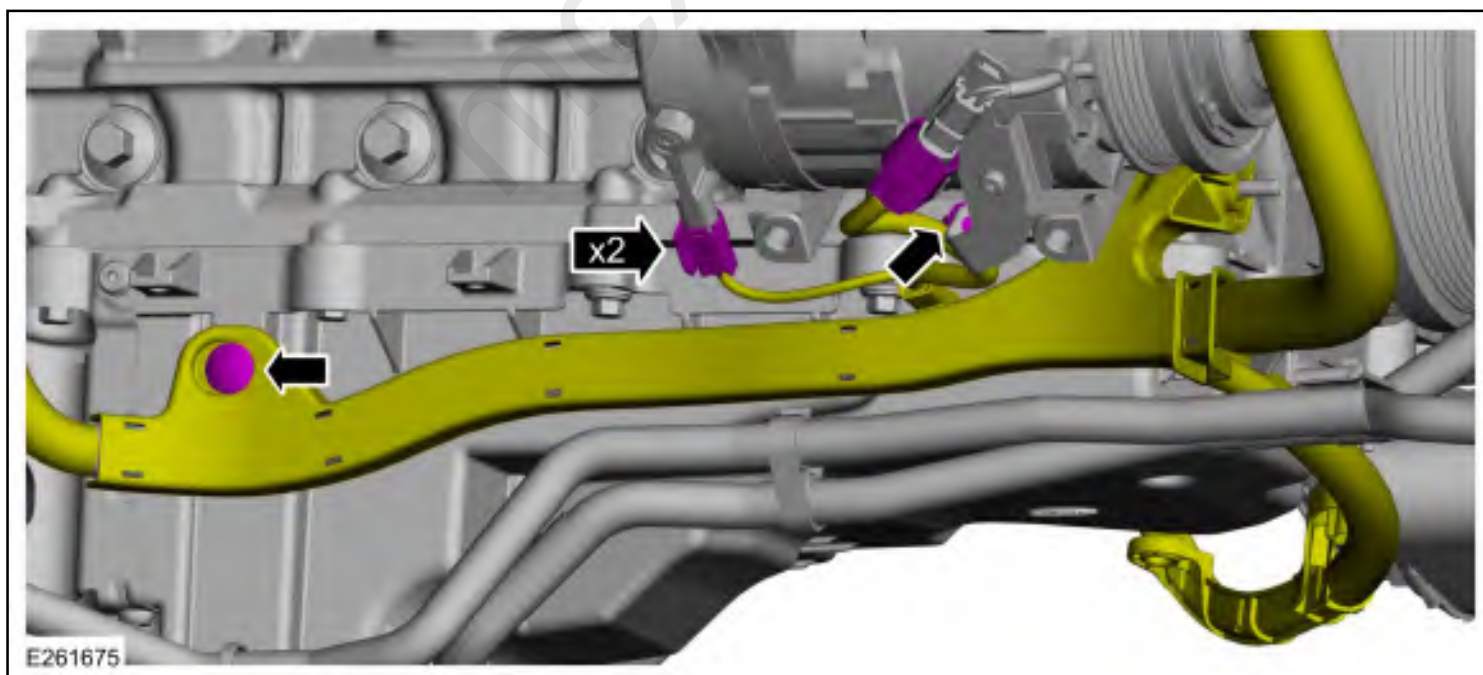


26. Install the flexplate inspection cover and the bolts.  
*Torque: 26 lb.ft (35 Nm)*





1. Connect the A/C compressor electrical connectors.
2. Attach the wiring harness retainers.



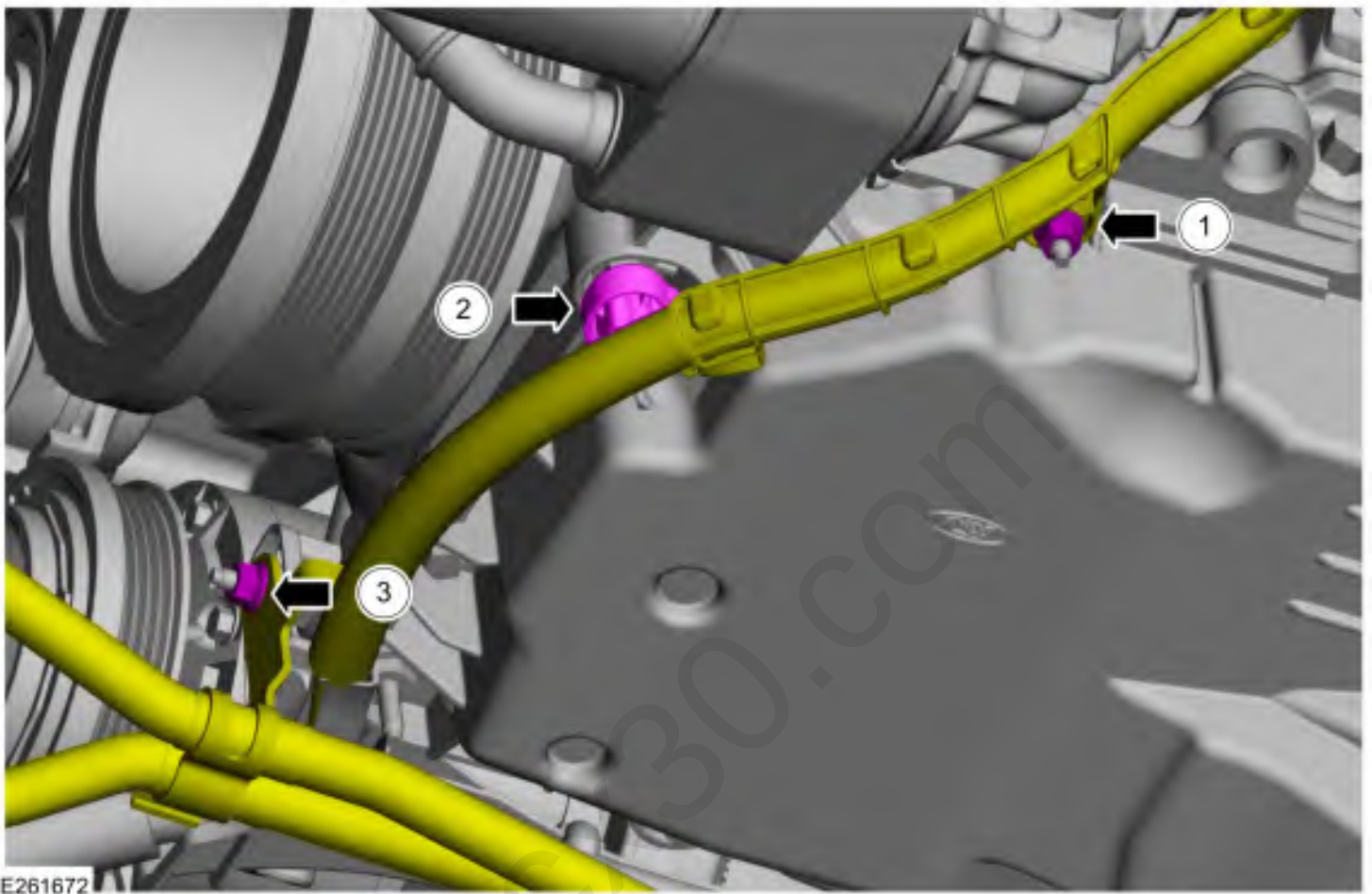
1. Install the nut.



*Torque: 106 lb.in (12 Nm)*

2. Attach the wiring harness retainer.
3. Position the coolant tube and wiring harness brackets and install the nut.

*Torque: 115 lb.in (13 Nm)*



29. Install the following items:

1. Refer to: [Starter Motor](#) (303-06D Starting System - 5.0L 32V Ti-VCT, Removal and Installation).
2. If equipped.  
Refer to: [Front Driveshaft](#) (205-01 Driveshaft, Removal and Installation).

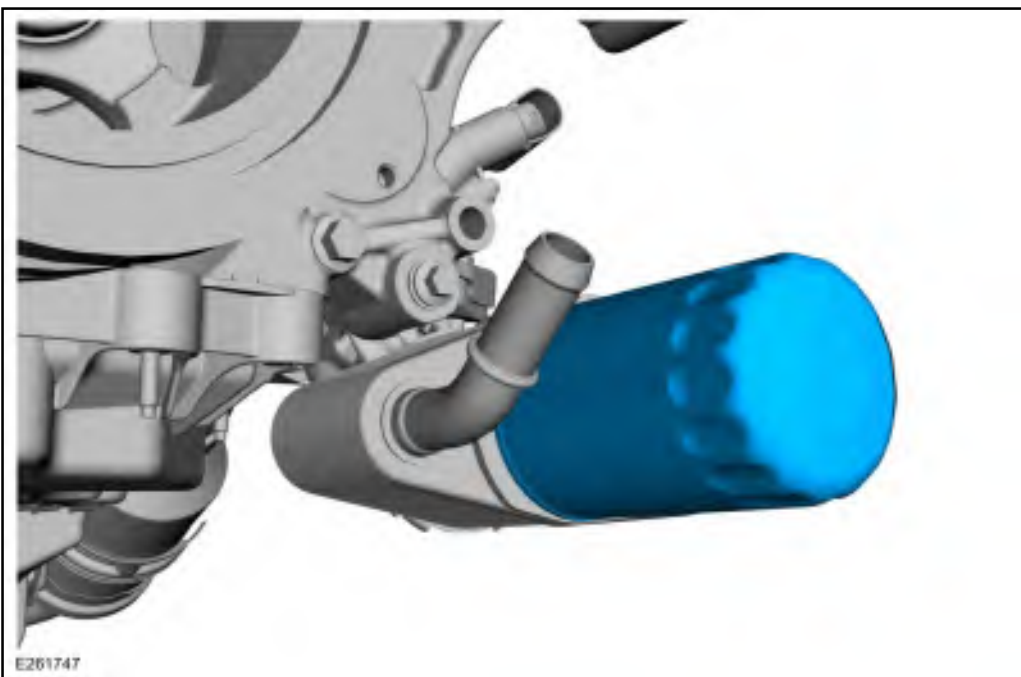
30. **NOTE:** *Do not lubricate the O-ring seal.*

Install a new oil filter.

*Torque:*

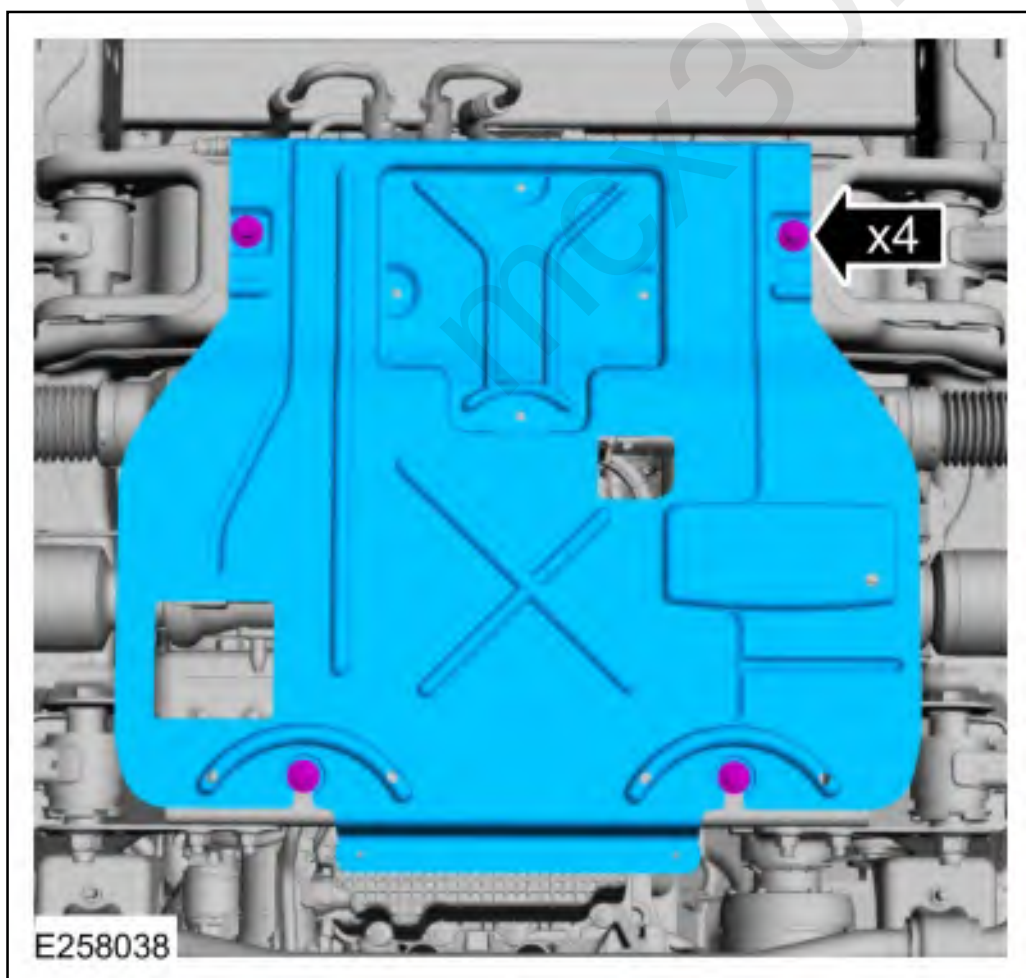
Stage 1: 44 lb.in (5 Nm)

Stage 2: 180°



31. **NOTE:** *If equipped.*

Install the skid plate and bolts.  
*Torque: 30 lb.ft (40 Nm)*



32. **NOTE:** *If equipped.*

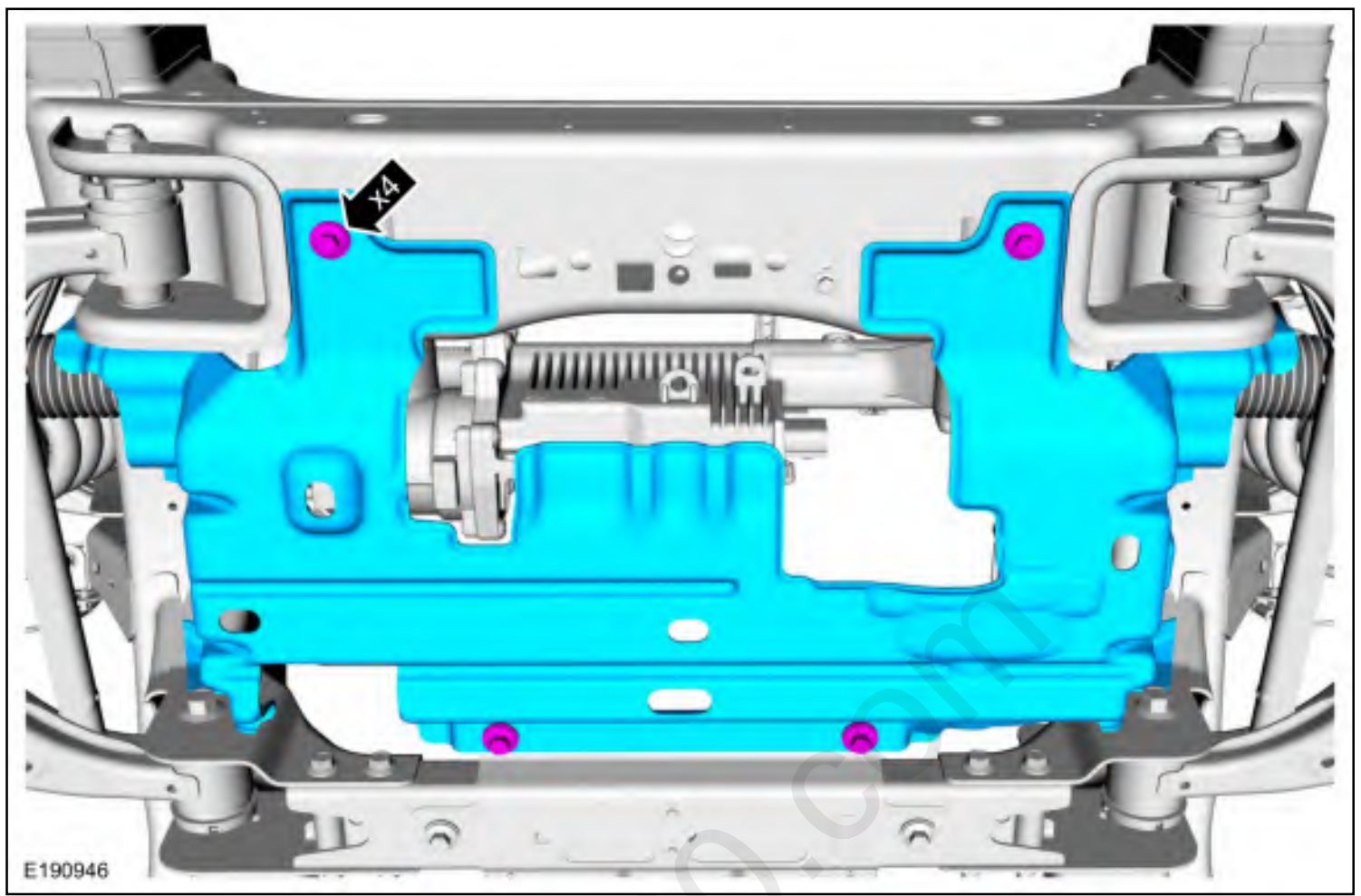
Install the underbody shield and the bolts.

*Torque:* 71 lb.in (8 Nm)



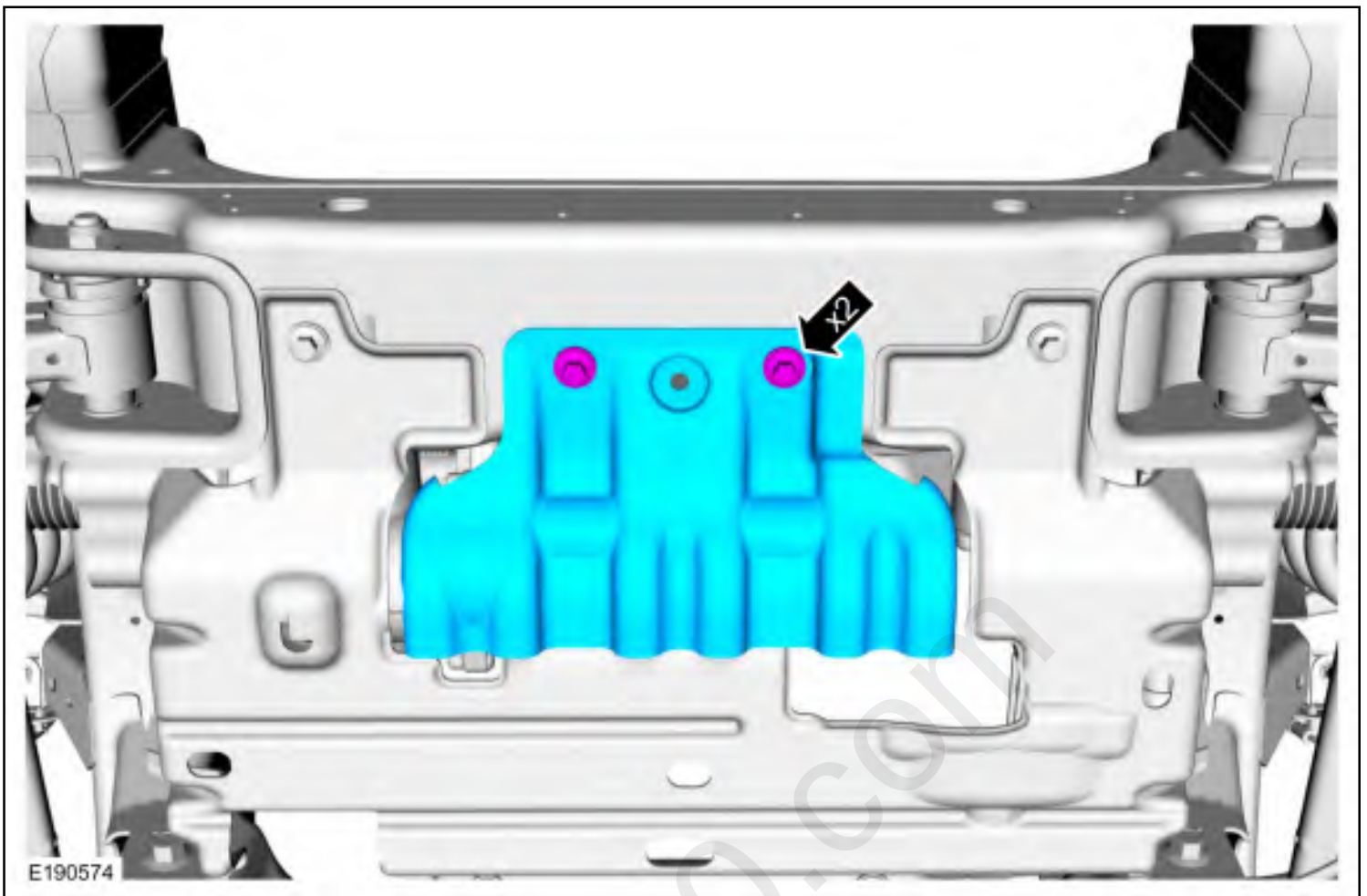
33. If equipped, install the underbody shield and fasteners.

*Torque:* 30 lb.ft (40 Nm)



34. If equipped, install the skid plate and bolts.  
*Torque: 30 lb.ft (40 Nm)*



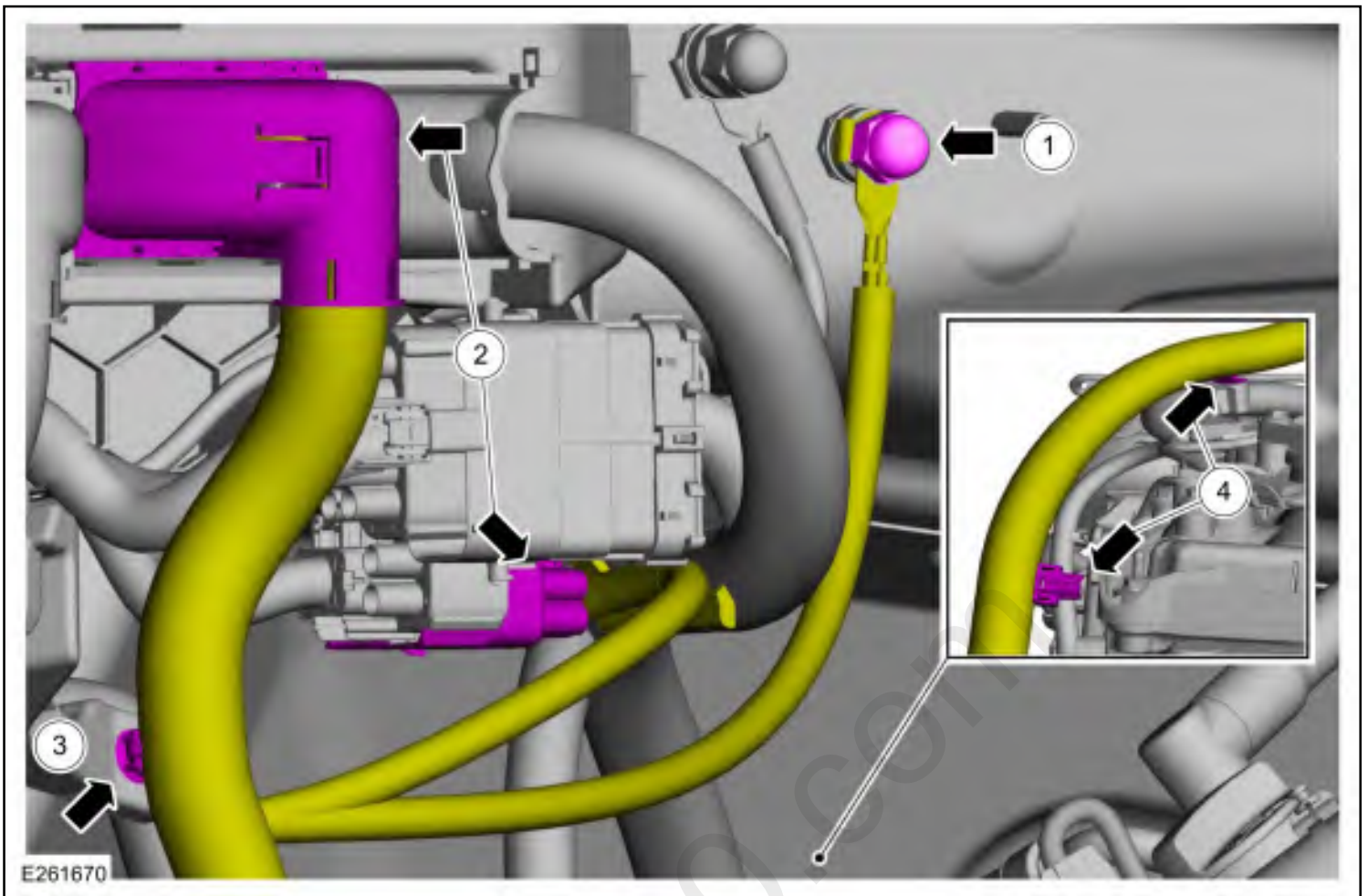


35. Install the generator.

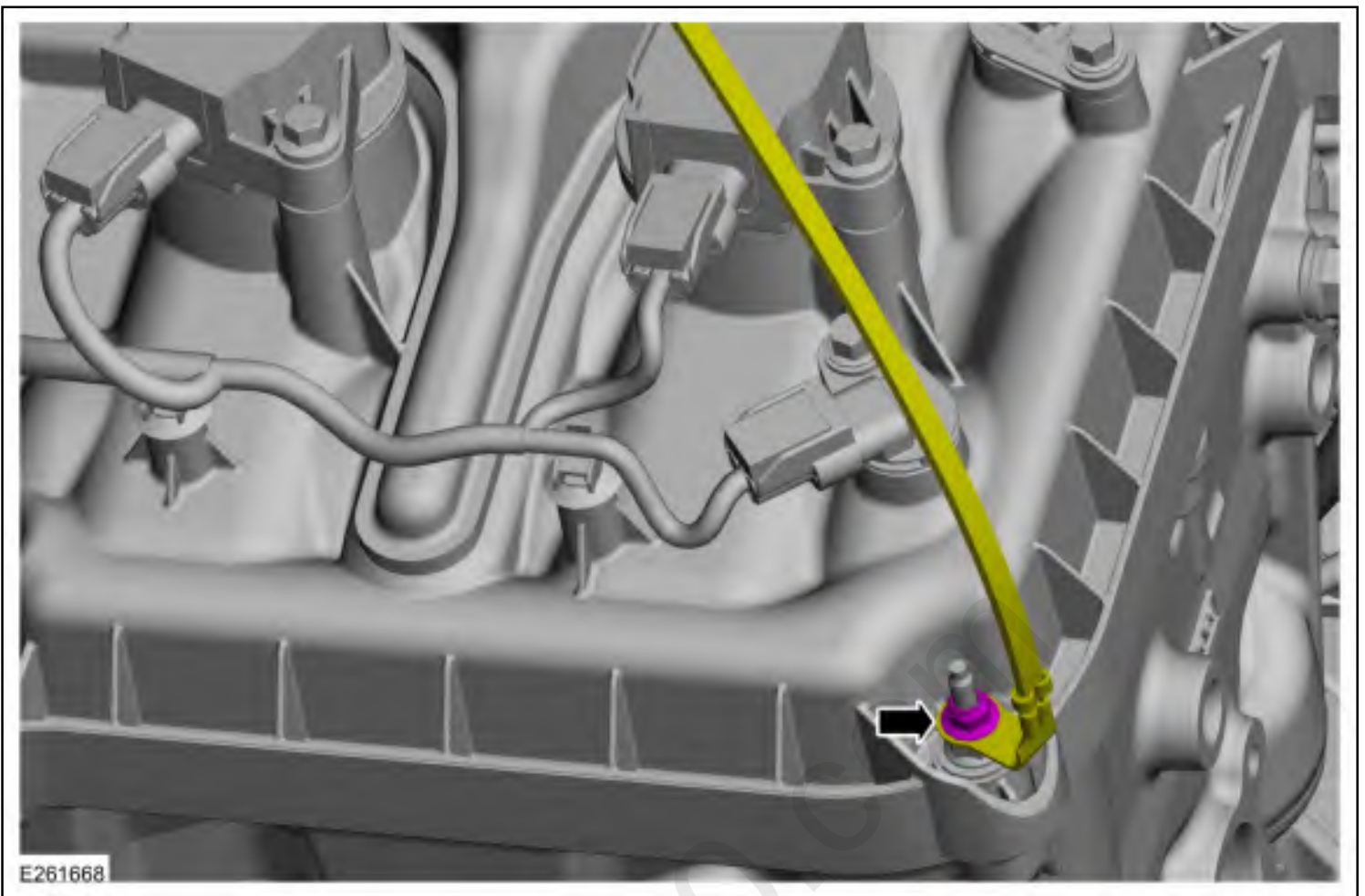
Refer to: [Generator - 5.0L 32V Ti-VCT](#) (414-02 Generator and Regulator, Removal and Installation).

1. Install the ground strap and the nut.  
*Torque: 106 lb.in (12 Nm)*
2. Connect the engine wiring harness connectors.
3. Attach the engine wiring harness retainer.
4. Attach the transmission wiring harness retainers.

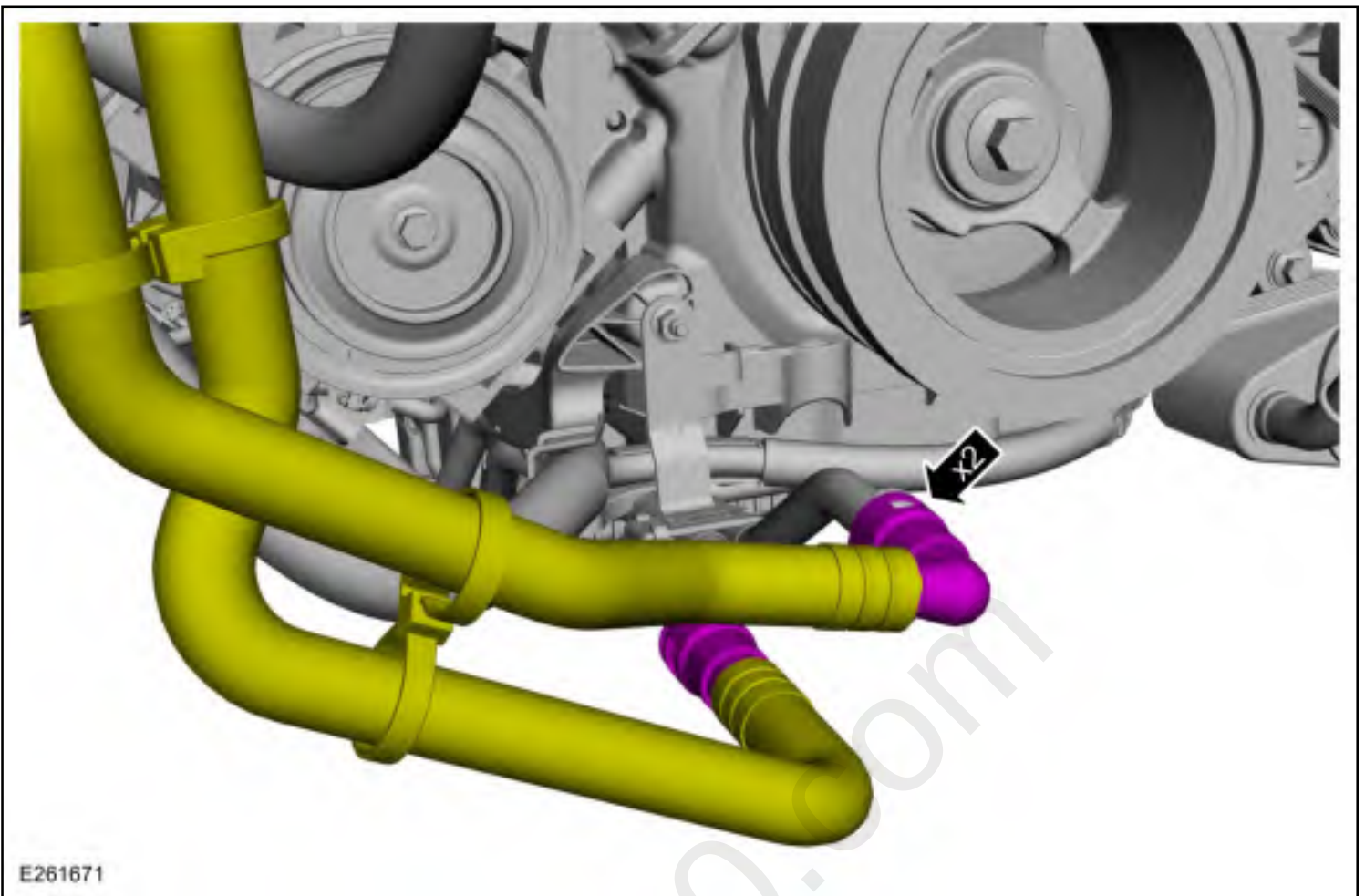




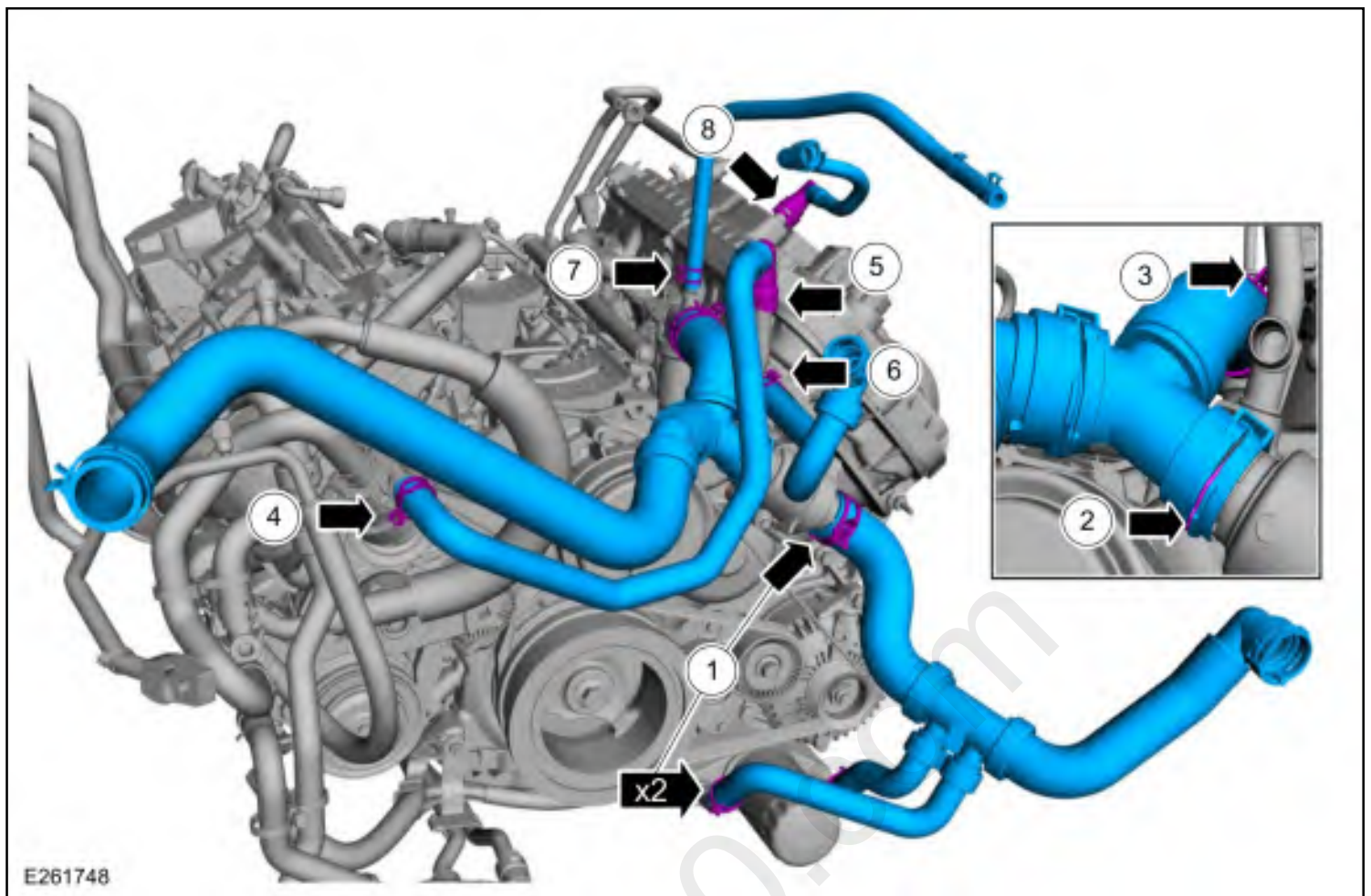
37. Install the ground strap and nut onto the LH valve cover stud bolt.  
*Torque: 53 lb.in (6 Nm)*



38. Connect the coolant hose quick release couplings.

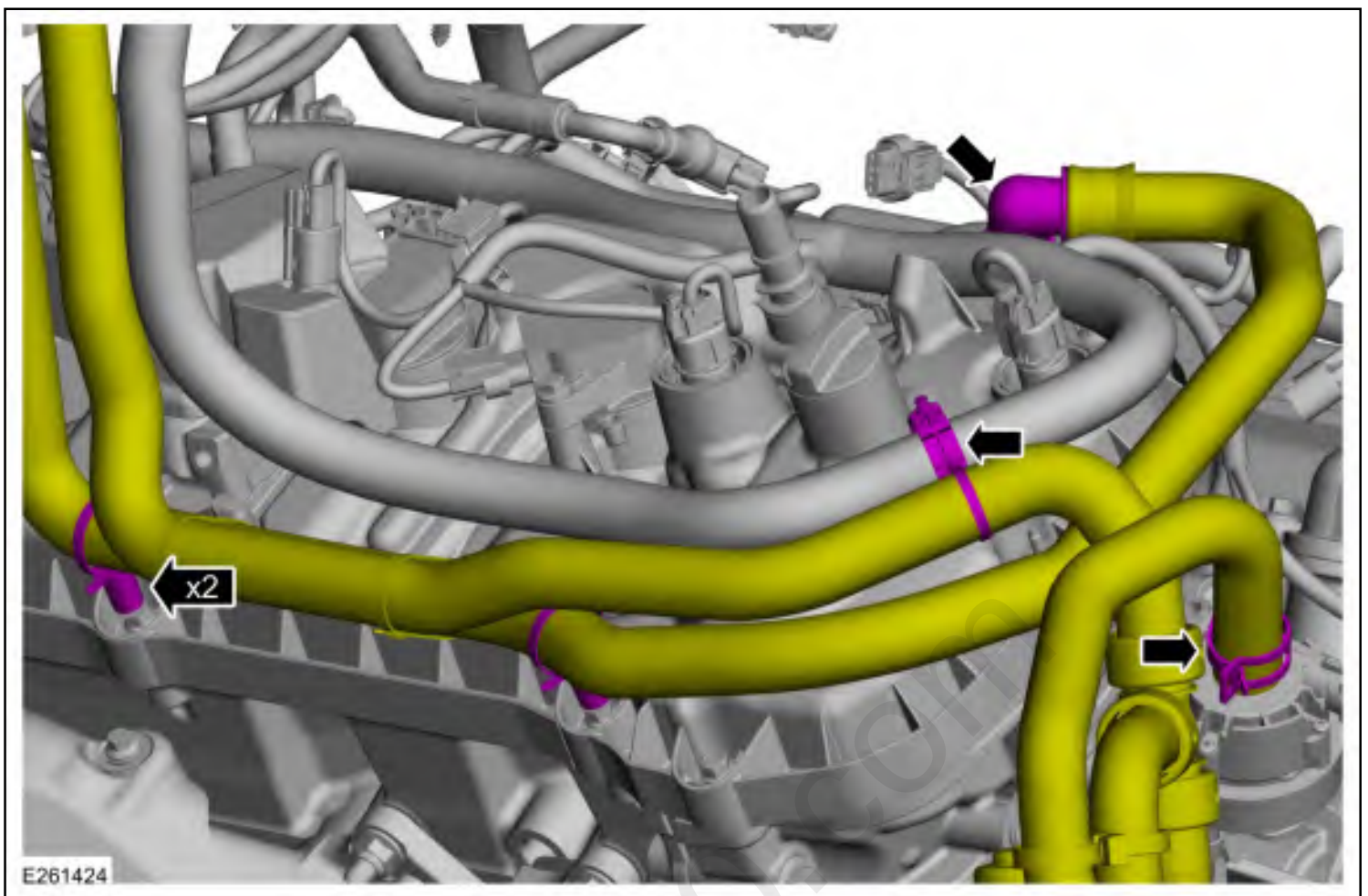


1. Install the coolant hose assembly and the clamps.  
Use the General Equipment: Hose Clamp Remover/Installer
2. Install the coolant bypass T assembly and engage the spring clip.
3. Install the coolant hose and clamp.  
Use the General Equipment: Hose Clamp Remover/Installer
4. Install the coolant hose and clamp.  
Use the General Equipment: Hose Clamp Remover/Installer
5. Connect the quick release coupling.
6. Install the coolant hose and clamp.  
Use the General Equipment: Hose Clamp Remover/Installer
7. Install the coolant hose and clamp.  
Use the General Equipment: Hose Clamp Remover/Installer
8. Install the crankcase vent 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).



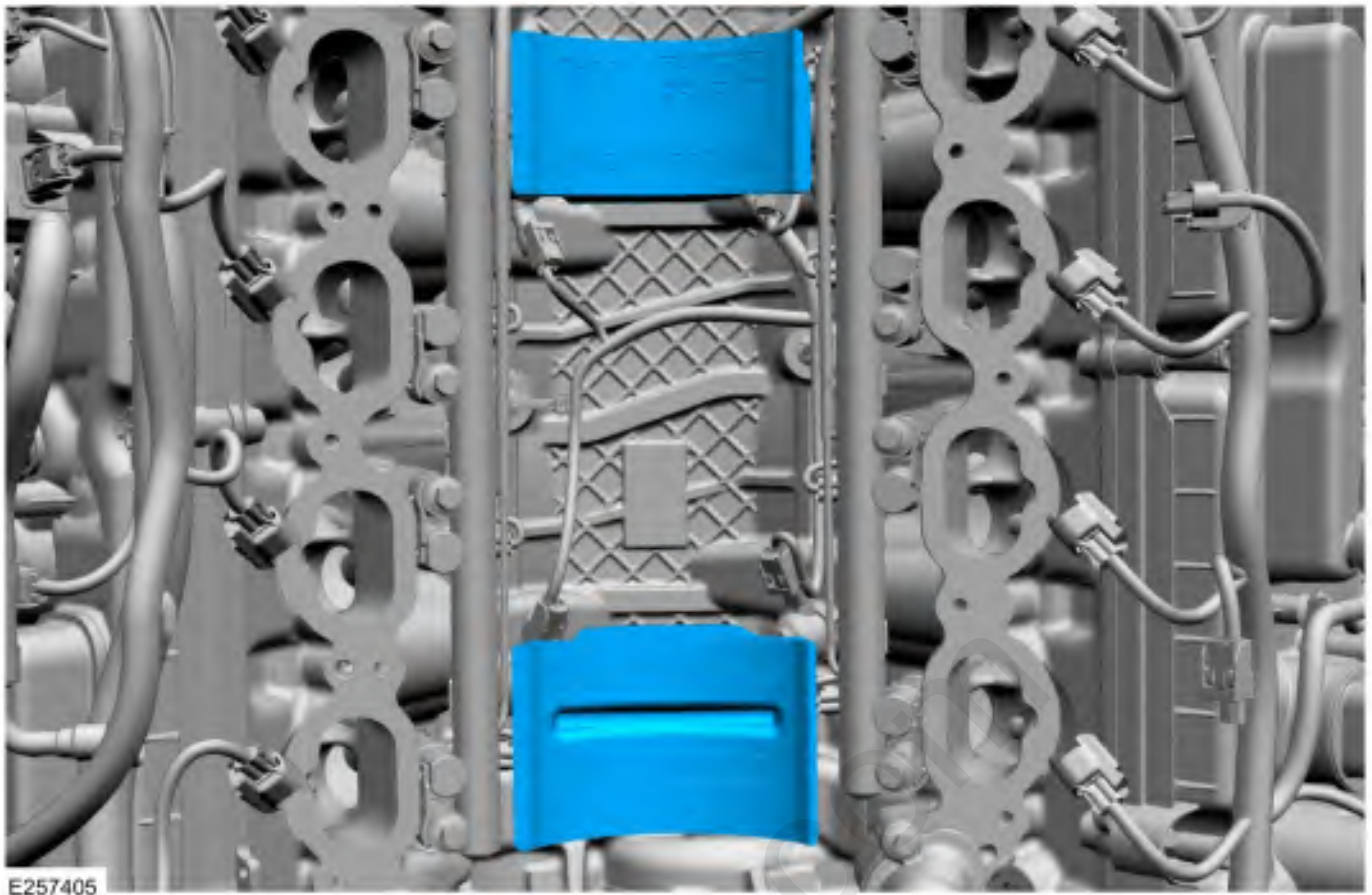
1. Install the coolant hose and clamp.  
Use the General Equipment: Hose Clamp Remover/Installer
2. Connect the coolant hose quick release coupling.
3. Attach the coolant hose retainer to the wiring harness.
4. Attach the coolant hose retainers to the valve cover stud bolts.





41. Install the insulators.

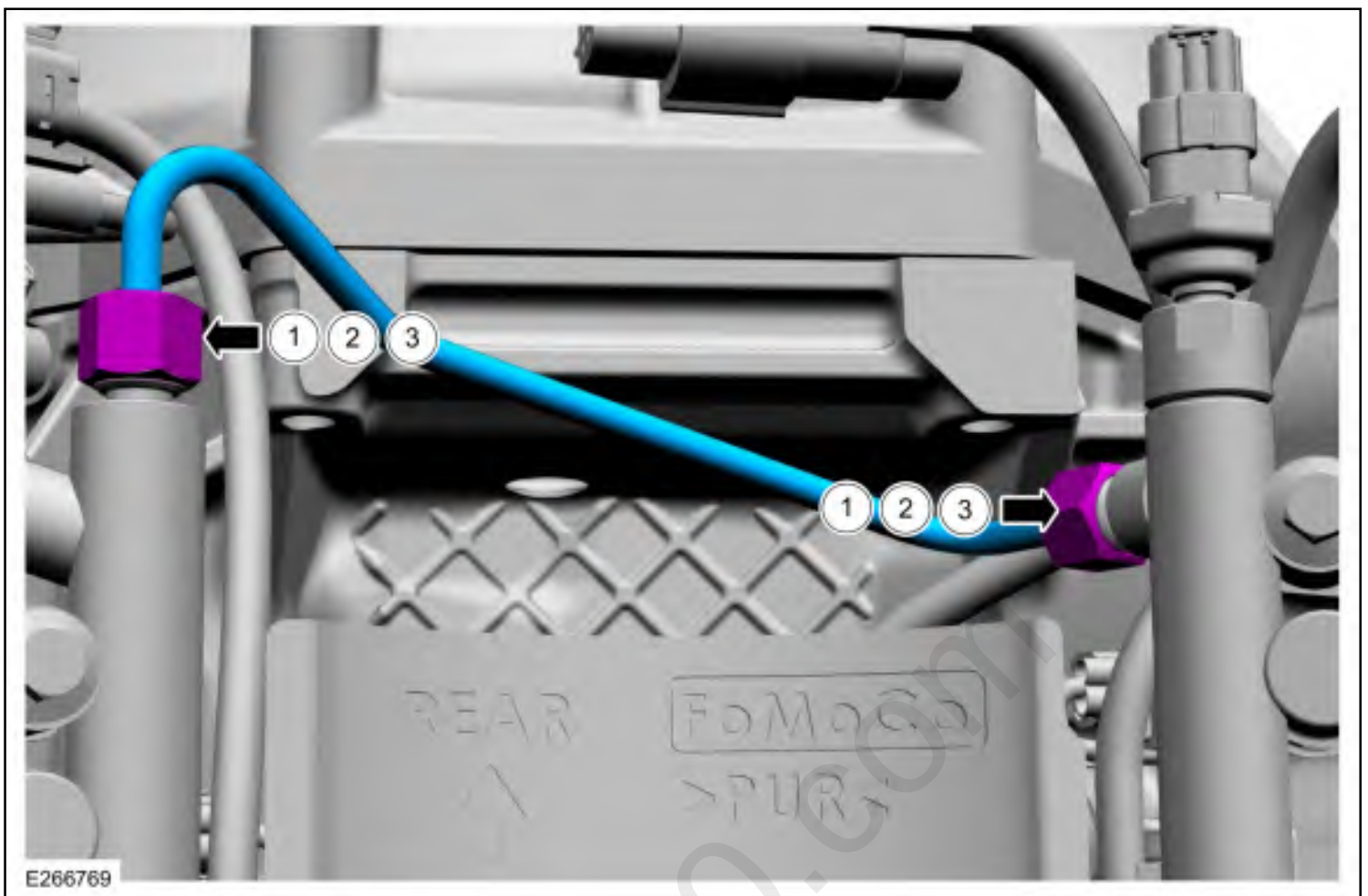




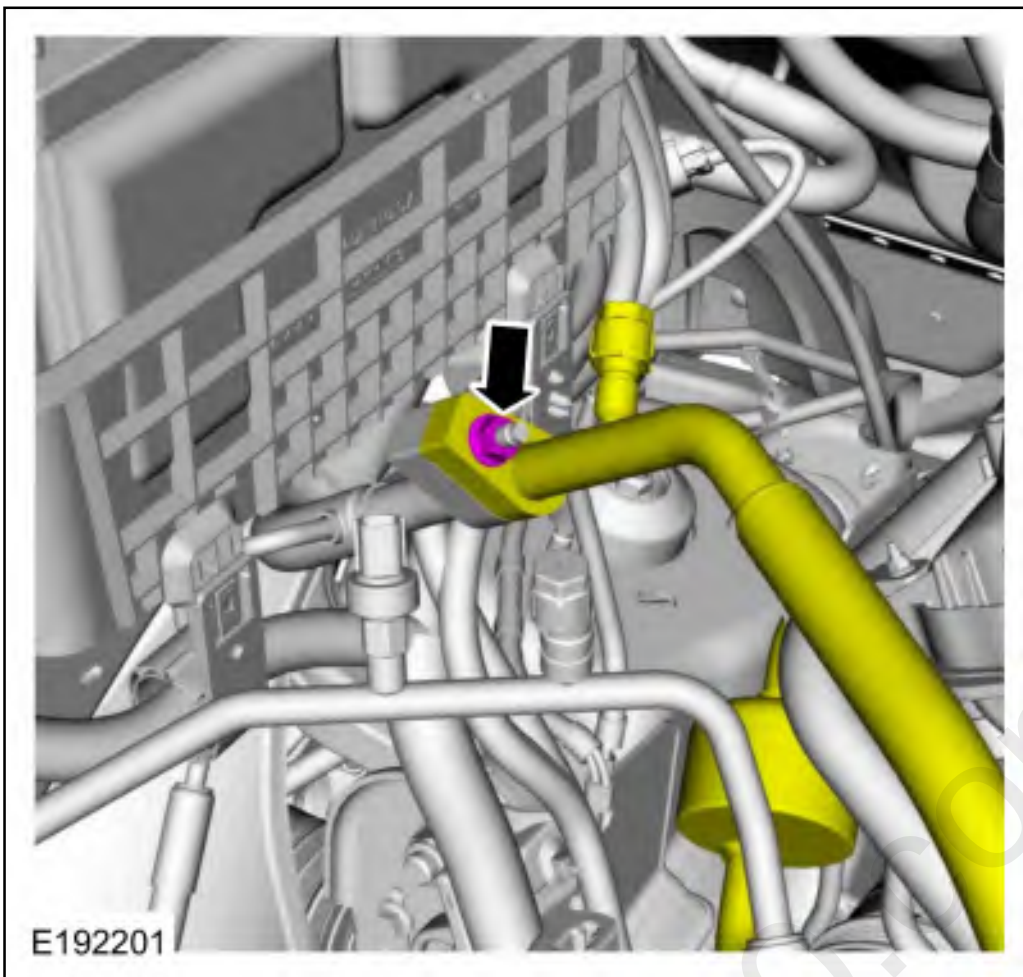
42. **NOTICE:** In stage 3, if the torque required to tighten any flare nut on the new high-pressure fuel tube reaches or exceeds 55 lb.ft (50 Nm), then that high pressure fuel tube must be discarded and replaced with another new high-pressure fuel tube.

*Torque:*

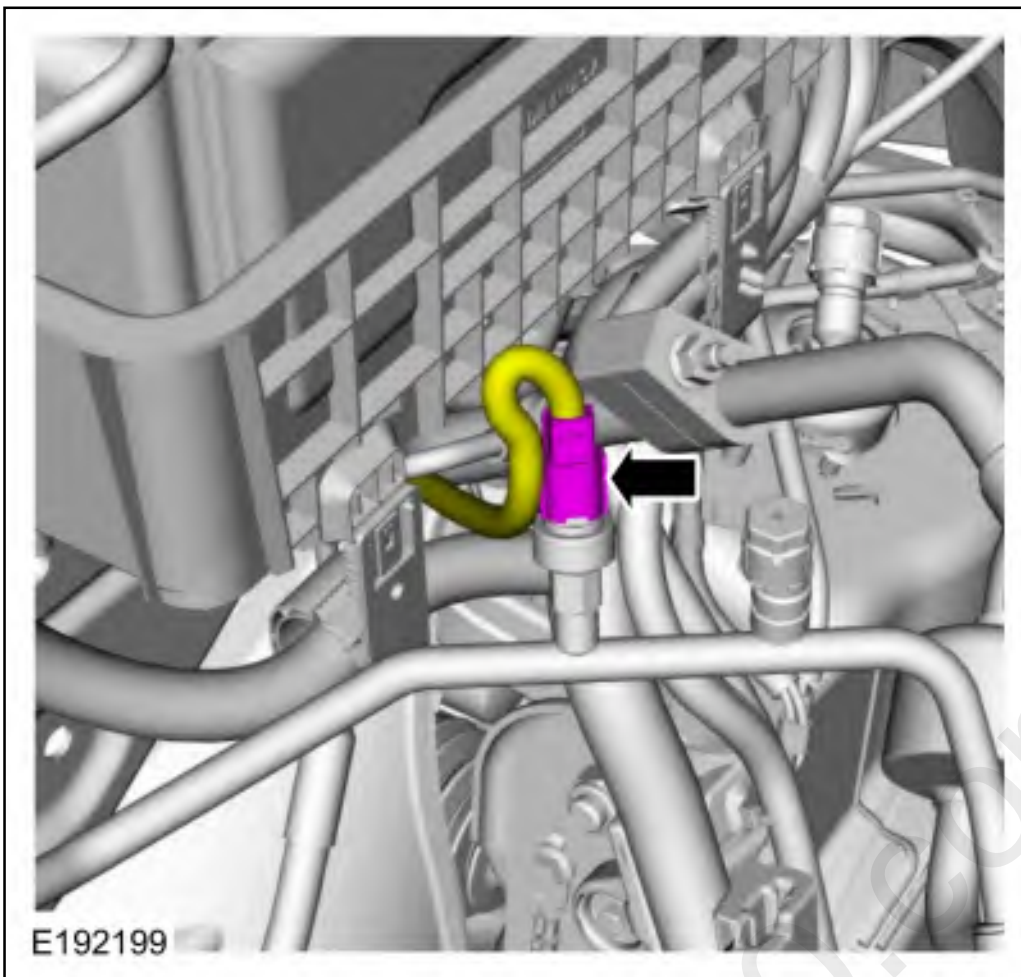
- Stage 1: Tighten the high-pressure fuel tube flare nuts to : 71 lb.in (8 Nm)
- Stage 2: Tighten the high-pressure fuel tube flare nuts to : 89 lb.in (10 Nm)
- Stage 3: Tighten the high-pressure fuel tube flare nuts an additional : 25°



- Install a new O-ring seal and gasket seal.
- Connect the A/C tube and install the nut.  
*Torque: 133 lb.in (15 Nm)*



44. Connect the A/C pressure transducer electrical connector.



45. Install the following items:

1. **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.

Refer to: [Intake Manifold](#) (303-01D Engine - 5.0L 32V Ti-VCT, Removal and Installation).

2. Refer to: [Cooling Module](#) (303-03D Engine Cooling - 5.0L 32V Ti-VCT, Removal and Installation).
3. Refer to: [Degas Bottle](#) (303-03D Engine Cooling - 5.0L 32V Ti-VCT, Removal and Installation).
4. Refer to: [Hood](#) (501-02 Front End Body Panels, Removal and Installation).

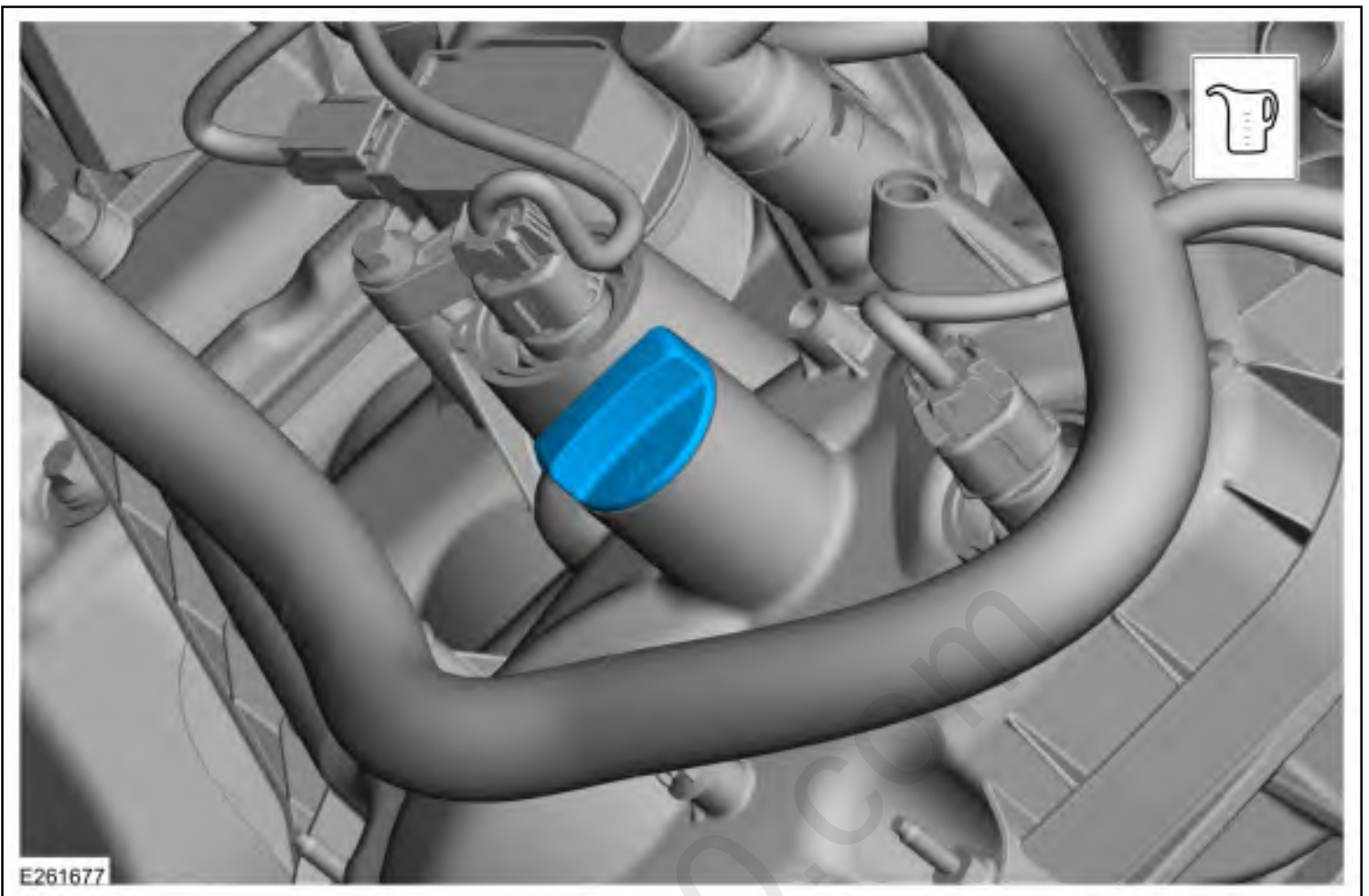
46. Connect the battery ground cable.

Refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables) .

47. Fill the engine with clean engine oil.

Refer to: [Specifications](#) (303-01D Engine - 5.0L 32V Ti-VCT, Specifications).





48. Fill and bleed the engine cooling system.  
Refer to: Cooling System Draining, Vacuum Filling and Bleeding (303-03 Engine Cooling - 5.0L 32V Ti-VCT) .
49. Check and top off the transmission fluid.  
Refer to: [Transmission Fluid Level Check](#) (307-01A Automatic Transmission - 6-Speed Automatic Transmission - 6R80, General Procedures).
50. Start engine and check exhaust system for leaks.
51. Use the Powertrain Control Module (PCM) Misfire Monitor Profile Correction routine in the diagnostic scan tool.



## Specifications

### Lubricants, Fluids, Sealants and Adhesives

| Name                                                       | Specification | Fill Capacity    |
|------------------------------------------------------------|---------------|------------------|
| Motorcraft® Orange Concentrated Antifreeze/Coolant VC-3-B  | WSS-M97B44-D  | 15.6 qt (14.75L) |
| Motorcraft® Orange Prediluted Antifreeze/Coolant VC-3DIL-B | WSS-M97B44-D2 | 15.6 qt (14.75L) |
| Motorcraft® Premium Cooling System Flush VC-1              | ESR-M14P7-A   | -                |

### Cooling System Pressure

|                                                   |                  |
|---------------------------------------------------|------------------|
| Complete cooling system maximum pressure          | 145 kPa (21 psi) |
| Pressure relief cap                               | 145 kPa (21 psi) |
| Radiator pressure test (removed from the vehicle) | 138 kPa (20 psi) |

### Thermostat Opening Temperatures

|                |                               |
|----------------|-------------------------------|
| Starts to open | 85.0 - 88.8°C (185 - 191.8°F) |
| Fully open     | 100.0°C (212°F)               |

# Engine Cooling - System Operation and Component Description

## System Operation

Engine coolant flows primarily from the engine to the radiator circuit and back to the coolant pump. Coolant is sent from the coolant pump through the engine block and cylinder heads. A separate circuit from the engine also feeds the heater core with coolant. The coolant pump, operated by engine rotation through the accessory drive belt, circulates the coolant. The coolant thermostat is a control valve actuated by coolant temperature. When the thermostat is closed, coolant flow bypasses the radiator circuit and returns to the coolant pump. When the thermostat is opened, coolant flows through the radiator circuit to transfer engine-generated heat to the outside air.

The engine uses a cold side thermostat. This means the thermostat is located at the lower radiator hose connection to the engine, where coolant enters the engine after being cooled by the radiator. During initial warm-up, the cooler coolant from the radiator quickly closes the thermostat after the warm coolant in the engine opens the thermostat slightly. The thermostat opens and closes several times before the coolant coming from the radiator is warm enough to allow the thermostat to remain open. The engine must run much longer than a vehicle with a hot side thermostat before the thermostat remains fully opened.

The degas bottle holds surplus coolant and removes air from the cooling system. It also allows for coolant expansion and system pressurization, replenishes coolant to the cooling system and serves as the location for service fill.

The thermostat monitor is a function of the PCM and is designed to verify correct thermostat operation. The monitor executes once per drive cycle and has a monitor run duration of 300-800 seconds. If a malfunction occurs, DTC P0125 or P0128 sets, and the MIL illuminates.

## Fail Safe Cooling

A strategy called Fail Safe Cooling is built into the PCM that will control the engine if it starts to overheat.

Stage 1 of the strategy commences if the engine starts to overheat. The CHT sensor transmits a signal to

the PCM, which moves the temperature gauge pointer into the red zone.

If the engine is not switched off and the temperature continues to rise, the Powertrain Check Lamp is illuminated. This indicates to the driver that the engine is approaching critical limits and should be stopped. At this point DTC P1285 is set in the PCM which can be retrieved using a scan tool.

Stage 2 of the strategy commences if the lamp and temperature gauge are ignored by the driver. The PCM will start to control the engine by cutting out 3 cylinders and restricting engine speed below 3,000 RPM. Simultaneously the MIL illuminates. This indicates that long term engine damage can occur and vehicle emissions will be affected. At this point DTC P1299 is set in the PCM which can be retrieved using a scan tool.

Air is drawn into the deactivated cylinders. This helps to control the temperature of the engine internal components. The deactivated cylinders are alternated to allow even cooling of all the cylinders.

**NOTE:** *If the driver is using a high percentage of throttle travel (for example, an overtaking maneuver) when the PCM starts engine deactivation (Stage 2), the deactivation will be delayed for 10 seconds.*

**NOTE:** *After 4-cylinder operation has begun, the engine will not revert to 8-cylinder operation, even if the temperature should fall, until the ignition is switched off and then on again.*

**NOTE:** *The MIL can only be extinguished by using a scan tool after the fault has been rectified and the DTC cleared.*

Stage 3 of the strategy will commence if the engine temperature continues to rise. This results in the engine being totally disabled before major engine damage or seizure occurs. The Powertrain Check Lamp will begin to flash, indicating to the driver that the engine will be switched off after 30 seconds. This allows the driver time to choose a suitable parking place.

## Component Description

### Cabin Coolant Heater Pump

The cabin heater coolant pump is available on vehicles equipped with Auto Start-Stop feature to assist in flowing coolant through the heater core. For Dual Automatic Temperature Control (DATC), Refer to: [Climate Control System - Vehicles With: Dual Automatic Temperature Control \(DATC\)](#) (412-00 Climate Control System - General Information, Diagnosis and Testing).

For Electronic Manual Temperature control (EMTC), Refer to: [Climate Control System - Vehicles With: Electronic Manual Temperature Control \(EMTC\)](#) (412-00 Climate Control System - General Information, Diagnosis and Testing).

## **Transmission Fluid Heater Coolant Control Valve**

The transmission fluid heater coolant control valve is an electrically controlled solenoid to allow or bypass the flow of engine coolant through the transmission fluid warmer or transmission fluid cooler depending on vehicle application. This electrically controllable valve is normally open when not energized. The valve receives a fused 12V B+ supply when the ignition is in the run or start position and is grounded by the PCM via a low side driver. The PCM monitors the solenoid and circuits for electrical faults and sets an appropriate DTC.

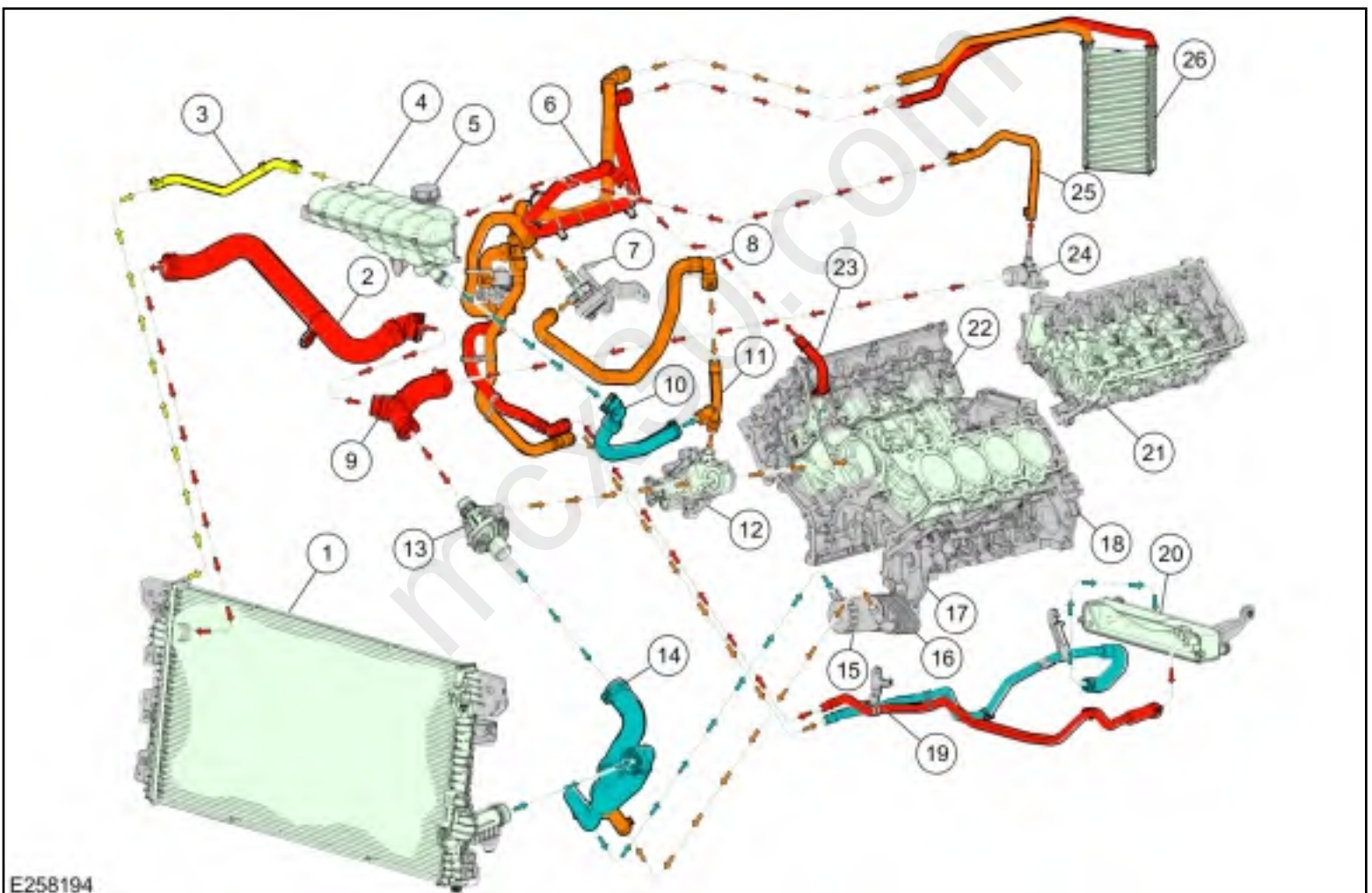
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## Engine Cooling - Component Location

**NOTE:** Coolant temperature will vary with ambient temperature and load. Temperatures shown are for ambient temperature of 38° C (100° F). Red arrows indicate a temperature over 90° C (194° F), Orange arrows indicate a temperature of approximately 90° C (194° F), Blue arrows indicate a temperature below 90° C (194° F).



| Item | Description                            |
|------|----------------------------------------|
| 1    | Radiator                               |
| 2    | Upper radiator hose and clamp assembly |
| 3    | Radiator-to-degas bottle hose          |



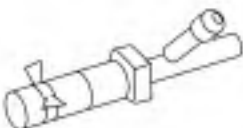
|    |                                       |
|----|---------------------------------------|
| 4  | Degas bottle                          |
| 5  | Pressure relief cap                   |
| 6  | Heater hose assembly                  |
| 7  | Cabin heater coolant pump             |
| 8  | Coolant outlet hose                   |
| 9  | Coolant bypass T assembly             |
| 10 | Degas bottle-to-engine hose           |
| 11 | Heater outlet tube                    |
| 12 | Coolant pump                          |
| 13 | Thermostat housing                    |
| 14 | Lower radiator hose                   |
| 15 | Oil filter                            |
| 16 | Oil cooler                            |
| 17 | Oil filter adapter                    |
| 18 | Cylinder block                        |
| 19 | Transmission fluid cooler outlet tube |
| 20 | Transmission fluid cooler             |
| 21 | Cylinder head LH                      |
| 22 | Cylinder head RH                      |
| 23 | Heater inlet tube                     |
| 24 | Coolant outlet connector              |
| 25 | Degas bottle-to-engine hose           |
| 26 | Heater core                           |

## Engine Cooling

### Materials

| Name                                                       | Specification |
|------------------------------------------------------------|---------------|
| Motorcraft® Orange Prediluted Antifreeze/Coolant VC-3DIL-B | WSS-M97B44-D2 |
| Motorcraft® Orange Concentrated Antifreeze/Coolant VC-3-B  | WSS-M97B44-D  |

### Special Tool(s)

|                                                                                               |                                                                      |
|-----------------------------------------------------------------------------------------------|----------------------------------------------------------------------|
| <br>E144764  | 3-Way HD Antifreeze Coolant Test Kit<br>328-2050-62291 or equivalent |
| <br>E144765 | Coolant/Battery Refractometer<br>ROB75240 or equivalent              |
| <br>E144767 | D-Gas Adapter<br>300-OTC014-R1068 or equivalent                      |
|                                                                                               |                                                                      |

|                                                                                                 |                                              |
|-------------------------------------------------------------------------------------------------|----------------------------------------------|
|  <p>E144766</p>  | Radiator Tester<br>014-R1072 or equivalent   |
|  <p>E145674</p> | UView® Combustion Leak Tester<br>UVU560000-R |

*Material: Motorcraft® Orange Concentrated Antifreeze/Coolant / VC-3-B (WSS-M97B44-D)*

*Material: Motorcraft® Orange Prediluted Antifreeze/Coolant / VC-3DIL-B (WSS-M97B44-D2)*

## DTC Chart

 **WARNING:** Before beginning any service procedure in this section, refer to Safety Warnings in section 100-00 General Information. Failure to follow this instruction may result in serious personal injury.

REFER to: [Engine Cooling System Health and Safety Precautions](#) (100-00 General Information, Description and Operation).

Diagnostics in this manual assume a certain skill level and knowledge of Ford-specific diagnostic practices.

REFER to: [Diagnostic Methods](#) (100-00 General Information, Description and Operation).

## PCM DTC Chart

| DTC | Description | Action |
|-----|-------------|--------|
|     |             |        |

|                                               |                                                                           |                                                                                                                                     |
|-----------------------------------------------|---------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|
| P0125                                         | Insufficient Coolant Temp For Closed Loop Fuel Control                    | <a href="#">GO to Pinpoint Test C</a>                                                                                               |
| P0128                                         | Coolant Thermostat (Coolant Temp Below Thermostat Regulating Temperature) | <a href="#">GO to Pinpoint Test C</a>                                                                                               |
| P0217                                         | Engine Coolant Overtemperature Condition                                  | <a href="#">GO to Pinpoint Test B</a>                                                                                               |
| P0480                                         | Fan 1 Control Circuit                                                     | Refer to Powertrain Control/Emissions Diagnosis (PC/ED) manual.                                                                     |
| P0481                                         | Fan 2 Control Circuit                                                     | Refer to Powertrain Control/Emissions Diagnosis (PC/ED) manual.                                                                     |
| P1285                                         | Cylinder Head Overtemperature Condition                                   | Refer to Powertrain Control/Emissions Diagnosis (PC/ED) manual.                                                                     |
| P1299                                         | Cylinder Head Overtemperature Protection Active                           | <a href="#">GO to Pinpoint Test B</a>                                                                                               |
| P2681                                         | Engine Coolant Bypass Valve "A" Control Circuit/Open                      | REFER to: <a href="#">Transmission Cooling</a> (307-02 Transmission Cooling, Diagnosis and Testing).                                |
| P2683                                         | Engine Coolant Bypass Valve "A" Control Circuit High                      | REFER to: <a href="#">Transmission Cooling</a> (307-02 Transmission Cooling, Diagnosis and Testing).                                |
| All Other PCM Diagnostic Trouble Codes (DTCs) | —                                                                         | REFER to: <a href="#">Electronic Engine Controls</a> (303-14D Electronic Engine Controls - 5.0L 32V Ti-VCT, Diagnosis and Testing). |

## Inspection and Verification

**NOTICE:** The engine cooling system is filled with Motorcraft® Orange Antifreeze/Coolant.

**Always fill the cooling system with the manufacturer's specified coolant. Chemically flush the cooling system if a non-specified coolant has been used. Failure to follow these instructions may damage the engine or cooling system.**

**NOTE:** *During normal vehicle operation, Motorcraft Orange Antifreeze/Coolant may change color from orange to pink or light red. As long as the engine coolant is clear and uncontaminated, this color change does not indicate the engine coolant has degraded nor does it require the engine coolant to be drained, the system to be flushed, or the engine coolant to be replaced.*

1. Verify the customer concern.
2. Visually check the engine coolant level at the degas bottle when the system is cold.
3. Make sure the pressure relief cap is installed correctly.
4. Record any cooling system Diagnostic Trouble Codes (DTCs) retrieved. Refer to the PCM DTC chart in this section for DTC descriptions.
5. **NOTE:** *Take note of any coolant odor or steam coming from cooling system components.*

If the system coolant is filled correctly and no Diagnostic Trouble Codes (DTCs) associated with fail-safe cooling are retrieved, verify the customer concern by operating the engine to duplicate the condition.

6. Visually inspect for obvious signs of any mechanical or electrical damage.

**Visual Inspection Chart**

| Mechanical | Electrical |
|------------|------------|
|            |            |



- Leaks or weeps at:
  - Hoses
  - Tubes
  - Clamp joints
  - Gaskets
  - O-rings
  - Thermostat housing
  - Oil cooler (may leak internally or externally)
  - Transmission fluid cooler (may leak internally or externally)
  - Transmission fluid heater coolant control valve
  - Radiator
  - Pressure relief cap
  - Coolant pump
  - Cabin heater coolant pump
  - Heater core (wet floor or coolant odor in vehicle)
  - Lower intake manifold
  - Degas bottle
  - Cylinder block core plugs
  - Cylinder head core plugs
  - Block heater (if equipped)
- Cracked or damaged:
  - Hoses
  - Tubes
  - Hose clamps
  - Thermostat housing
  - Lower intake manifold
  - Oil cooler (may leak internally or externally)
  - Transmission fluid cooler (may leak internally or externally)
  - Transmission fluid heater coolant control valve
  - Radiator
  - Pressure relief cap
  - Cooling fan
  - Coolant pump
  - Cabin heater coolant pump
  - Degas bottle
  - Cylinder block core plugs

- Inoperative or damaged:
  - Electric cooling fan
  - Wiring, connectors, relays or modules
  - CHT sensor

- Cylinder head core plugs
- Block heater (if equipped)
- Restricted airflow through the A/C condenser/radiator
- Drive belt loose, worn or installed incorrectly
- Broken or weak drive belt tensioner
- Excessive white or light gray exhaust smoke (may have burnt coolant odor)
- Coolant in engine oil
- Coolant in transmission fluid
- Engine oil in coolant
- Transmission fluid in coolant

7. If the inspection reveals an obvious concern that can be readily identified, repair it as necessary.

8. Inspect the coolant condition.

1. Inspect the coolant color.

- Discoloration may indicate that incorrect coolant may have been added to the system. Use of incorrect (green or yellow in color) coolant degrades the corrosion protection of Motorcraft® Orange Antifreeze/Coolant. Addition of Motorcraft® Specialty Green Engine Coolant may cause the color to appear to be a murky green-brown color. The addition of Motorcraft® Gold Antifreeze/Coolant, however, may not change the color or appearance of the orange-colored coolant. Detection of contamination with Motorcraft® Gold Antifreeze/Coolant is determined by the presence of nitrite. If contamination with Motorcraft® Gold Antifreeze/Coolant is suspected, test the coolant with the 3-Way HD Antifreeze Coolant Test Kit. Follow the nitrite testing directions in the kit to determine if nitrite is present in the system. If nitrite is present, flush the system and refill with the correct mixture of distilled water and Motorcraft® Orange Concentrated Antifreeze/Coolant.

REFER to: [Cooling System Draining, Vacuum Filling and Bleeding](#) (303-03D Engine Cooling - 5.0L 32V Ti-VCT, General Procedures).

- A darker orange with the presence of debris could indicate a commercially available stop leak may have been used and could result in loss of coolant flow to critical parts of the engine. If sediment is present, flush the system and refill with the correct mixture of distilled water and Motorcraft® Orange Concentrated Antifreeze/Coolant.

REFER to: [Cooling System Draining, Vacuum Filling and Bleeding](#) (303-03D Engine Cooling - 5.0L 32V Ti-VCT, General Procedures).

- A light or reddish brown color indicates that rust may be present in the cooling

system. Flush the system and refill with the correct mixture of distilled water and Motorcraft® Orange Concentrated Antifreeze/Coolant.

REFER to: [Cooling System Draining, Vacuum Filling and Bleeding](#) (303-03D Engine Cooling - 5.0L 32V Ti-VCT, General Procedures).

- An iridescent sheen on top of the coolant could indicate a trace of oil is entering the system. For engine diagnosis,

REFER to: [Engine](#) (303-00 Engine System - General Information, Diagnosis and Testing).

Flush the system and refill with the correct mixture of distilled water and Motorcraft® Orange Concentrated Antifreeze/Coolant. REFER to: [Cooling System Draining, Vacuum Filling and Bleeding](#) (303-03D Engine Cooling - 5.0L 32V Ti-VCT, General Procedures).

- A milky brown color may indicate that engine oil is entering the cooling system. Pressure test the cooling system. Refer to component tests in this section. If engine oil is suspected, the cause of the leak may be internal to the engine. For engine diagnosis,

REFER to: [Engine](#) (303-00 Engine System - General Information, Diagnosis and Testing).

Flush the system and refill with the correct mixture of distilled water and Motorcraft® Orange Concentrated Antifreeze/Coolant. REFER to: [Cooling System Draining, Vacuum Filling and Bleeding](#) (303-03D Engine Cooling - 5.0L 32V Ti-VCT, General Procedures).

2. If the engine coolant appearance is acceptable, test the engine coolant freezing point range with the Coolant/Battery Refractometer. Maintain the coolant concentration within 48% to 50%, which equates to a freeze point between -34°C and -37°C (-30°F and -34°F). If the vehicle is driven in cold climates less than -37°C (-34°F), it may be necessary to increase the coolant concentration to get adequate freeze protection. Recommended coolant concentration is 48/52 to 50/50 (freeze protection -34°C to -37°C [-30°F to -34°F]) engine coolant to distilled water.

- Maximum coolant concentration is 60/40 for cold weather areas.
- Minimum coolant concentration is 40/60 for warm weather areas.

3. Adjust coolant range and level if necessary:

- If coolant is low, add specified coolant mixture only.
- If the engine coolant tests too weak, remove some of the engine coolant and add Motorcraft® Orange Concentrated Antifreeze/Coolant until the readings are within acceptable levels.
- If the engine coolant tests strong, remove some of the engine coolant and add distilled water until the readings are within acceptable levels.

9. If an obvious cause for an observed or reported concern is found, correct the cause and test the

system for normal operation before proceeding to the next step.

## Symptom Chart

Diagnostics in this manual assume a certain skill level and knowledge of Ford-specific diagnostic practices.

REFER to: [Diagnostic Methods](#) (100-00 General Information, Description and Operation).

| Condition                                                                                    | Possible Sources                                                                                                      | Actions                                                                                                                                                                                                                                                                                                                                                                                                                        |
|----------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Loss of coolant                                                                              | Refer to the Pinpoint Test                                                                                            | <a href="#">GO to Pinpoint Test A</a>                                                                                                                                                                                                                                                                                                                                                                                          |
| The engine overheats.                                                                        | Refer to the Pinpoint Test                                                                                            | <a href="#">GO to Pinpoint Test B</a>                                                                                                                                                                                                                                                                                                                                                                                          |
| The engine does not reach normal operating temperature.                                      | Refer to the Pinpoint Test                                                                                            | <a href="#">GO to Pinpoint Test C</a>                                                                                                                                                                                                                                                                                                                                                                                          |
| The block heater does not operate correctly.                                                 | <ul style="list-style-type: none"><li>• Block heater power cable</li><li>• Block heater</li></ul>                     | <ul style="list-style-type: none"><li>• CHECK continuity in all 3 power cable circuits. If any circuit measures more than 5 ohms, INSTALL a new power cable.</li><li>• CHECK the resistance of the block heater. If the resistance does not measure between 30 and 40 ohms, INSTALL a new block heater.</li></ul> REFER to: <a href="#">Block Heater</a> (303-03D Engine Cooling - 5.0L 32V Ti-VCT, Removal and Installation). |
| The electric cooling fan is inoperative in one or more speeds or does not operate correctly. | <ul style="list-style-type: none"><li>• Wiring</li><li>• Relays</li><li>• Fuses</li><li>• Cooling fan motor</li></ul> | Refer to Powertrain Control/Emissions Diagnosis (PC/ED) manual.                                                                                                                                                                                                                                                                                                                                                                |

|                                                 |                                                                                                         |                                                                                                                                                                                                                                                                                               |
|-------------------------------------------------|---------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| The electric cooling fan stays on all the time. | <ul style="list-style-type: none"> <li>• Wiring</li> <li>• Relays</li> </ul>                            | Refer to Powertrain Control/Emissions Diagnosis (PC/ED) manual.                                                                                                                                                                                                                               |
| Noisy electric cooling fan operation.           | <ul style="list-style-type: none"> <li>• Foreign material contamination</li> <li>• Fan motor</li> </ul> | <ul style="list-style-type: none"> <li>• REMOVE the foreign material from the cooling fan and shroud. TEST the system for normal operation. If still noisy, INSTALL a new cooling fan assembly. REFER to: Cooling Fan Motor and Shroud (303-03 Engine Cooling - 5.0L 32V Ti-VCT) .</li> </ul> |
|                                                 | <ul style="list-style-type: none"> <li>• Fan blade detached from fan motor</li> </ul>                   | <ul style="list-style-type: none"> <li>• INSTALL a new cooling fan assembly. REFER to: Cooling Fan Motor and Shroud (303-03 Engine Cooling - 5.0L 32V Ti-VCT) .</li> </ul>                                                                                                                    |

## Pinpoint Tests

## Loss of Coolant

## Normal operation and Fault Conditions

The engine cooling system is a closed system providing for coolant expansion and contraction as well as changes in pressure as coolant warms and cools with engine operation. Various gaskets, seals, hoses and clamps contain coolant within the cooling system and keep other fluids and contaminants from entering the cooling system.

## Possible Sources

- Coolant hoses or tubes
- Hose clamps
- Thermostat O-ring seal or gasket
- Coolant pump O-ring seal or gasket
- Thermostat housing



- Oil cooler (may leak internally or externally)
- Transmission fluid cooler (may leak internally or externally)
- Transmission fluid heater coolant control valve
- Radiator
- Pressure relief cap
- Coolant pump leaking from weep hole
- Cabin heater coolant pump
- Heater core
- Lower intake manifold
- Engine gaskets (may leak internally or externally)
- Degas bottle
- Cylinder block core plugs
- Cylinder head core plugs
- Block heater (if equipped)

### PINPOINT TEST A : PINPOINT TEST



**WARNING:** Always allow the engine to cool before opening the cooling system. Do not unscrew the coolant pressure relief cap when the engine is operating or the cooling system is hot. The cooling system is under pressure; steam and hot liquid can come out forcefully when the cap is loosened slightly. Failure to follow these instructions may result in serious personal injury.

#### A1 CARRY OUT INSPECTION AND VERIFICATION

- Carry out Inspection and Verification.

Are any concerns present?

|     |                          |
|-----|--------------------------|
| Yes | REPAIR as needed.        |
| No  | GO to <a href="#">A2</a> |

#### A2 CHECK THE ENGINE COOLANT LEVEL AND PRESSURE TEST THE ENGINE COOLING SYSTEM

**NOTE:** Allow the engine to cool before checking the engine coolant level.

- Ignition OFF
- Visually inspect the engine coolant level at the degas bottle and adjust as necessary. Pressure test the engine cooling system. Refer to Component Tests, Cooling System Pressure Test in this section.

**Does the engine cooling system leak externally?**

|            |                                   |
|------------|-----------------------------------|
| <b>Yes</b> | REPAIR or INSTALL new components. |
| <b>No</b>  | GO to <a href="#">A3</a>          |

### **A3 CHECK THE ENGINE COOLANT FOR AN INTERNAL LEAK**

- Inspect the engine coolant in the degas bottle for signs of engine oil.

**Is engine oil evident in the engine coolant?**

|            |                                                                                                       |
|------------|-------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | REFER to: <a href="#">Engine</a> (303-00 Engine System - General Information, Diagnosis and Testing). |
| <b>No</b>  | GO to <a href="#">A4</a>                                                                              |

### **A4 CHECK THE ENGINE OIL FOR COOLANT**

- Remove the oil level indicator from the engine.

#### Is coolant evident in the oil?

|            |                                                                                                       |
|------------|-------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | REFER to: <a href="#">Engine</a> (303-00 Engine System - General Information, Diagnosis and Testing). |
| <b>No</b>  | GO to <a href="#">A5</a>                                                                              |

### A5 CHECK THE ENGINE COOLANT FOR TRANSMISSION FLUID

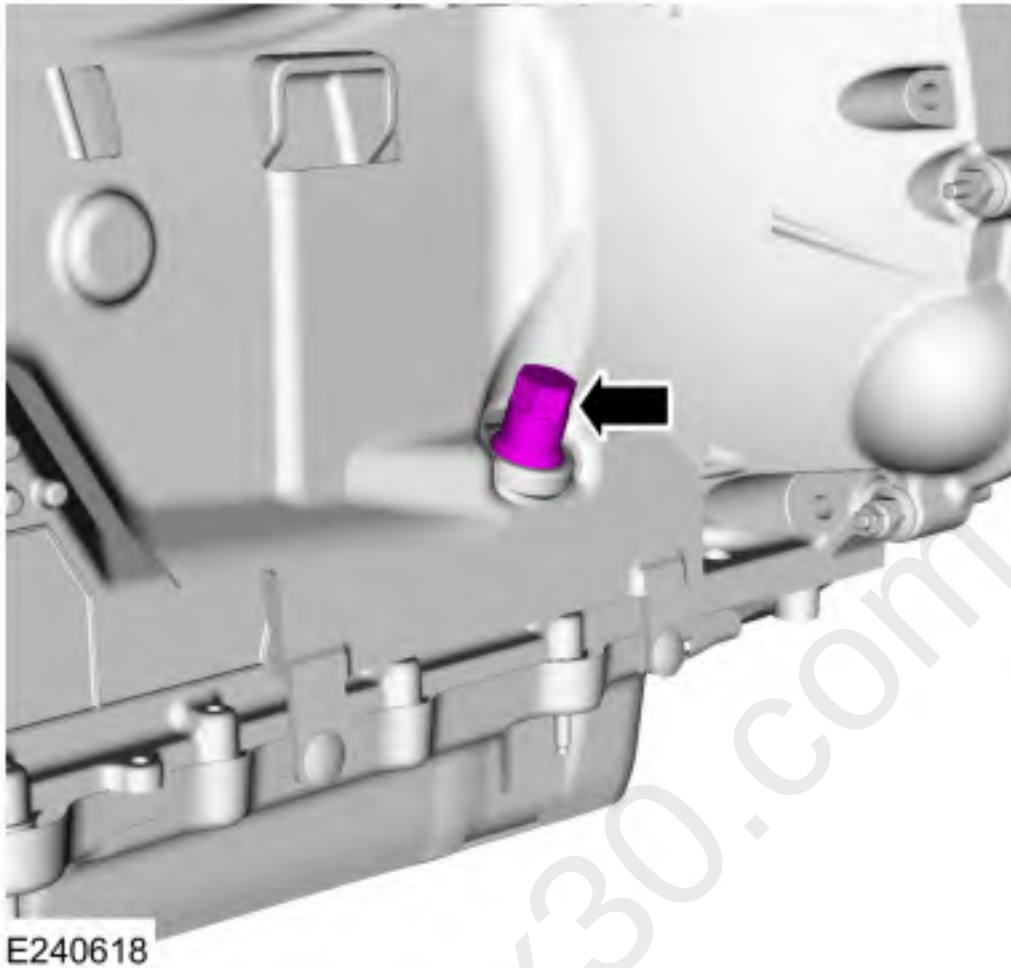
- Check the engine coolant in the degas bottle for signs of transmission fluid.

#### Is transmission fluid evident in the engine coolant?

|            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | <p>INSTALL a new transmission fluid cooler.</p> <p>REFER to: <a href="#">Transmission Fluid Cooler - 2.7L EcoBoost (238kW/324PS)/3.5L EcoBoost (272kW/370PS)/5.0L 32V Ti-VCT</a> (307-02 Transmission Cooling, Removal and Installation).</p> <p>REPAIR the transmission as necessary. REFER to: <a href="#">Diagnosis By Symptom</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing).</p> <p>TEST the system for normal operation.</p> |
| <b>No</b>  | GO to <a href="#">A6</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

### A6 CHECK THE TRANSMISSION FLUID FOR ENGINE COOLANT

- Remove the transmission oil leveling plug.



- Check the transmission fluid for engine coolant.

**Is engine coolant evident in the transmission fluid?**

|            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | <p>INSTALL a new transmission fluid cooler.</p> <p>REFER to: <a href="#">Transmission Fluid Cooler - 2.7L EcoBoost (238kW/324PS)/3.5L EcoBoost (272kW/370PS)/5.0L 32V Ti-VCT</a> (307-02 Transmission Cooling, Removal and Installation).</p> <p>REPAIR the transmission as necessary. REFER to: <a href="#">Diagnosis By Symptom</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing).</p> <p>TEST the system for normal operation.</p> |
| <b>No</b>  | GO to <a href="#">A7</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

## A7 CHECK THE COOLING SYSTEM FOR COMBUSTION GASES

**NOTE:** Use UView® Combustion Leak Tester part number UVU560000-R or equivalent.

- Using a cooling system combustion gas leak tester, following the instructions supplied with the tester, check the coolant for combustion gases.

### Are combustion gases present?

|     |                                                                                                       |
|-----|-------------------------------------------------------------------------------------------------------|
| Yes | REFER to: <a href="#">Engine</a> (303-00 Engine System - General Information, Diagnosis and Testing). |
| No  | The cooling system is operational.                                                                    |

## The Engine Overheats

### Normal operation and Fault Conditions

The engine cooling system maintains the engine temperature during operation. Correct coolant flow through the engine, radiator and remainder of cooling system passages and components is essential to maintaining a correct engine temperature.

Engine coolant flows primarily from the engine to the radiator circuit and back to the coolant pump. Coolant is sent from the coolant pump through the engine block and cylinder head. A separate circuit from the engine also feeds the heater core with coolant. The coolant pump circulates the coolant. The coolant thermostat is a control valve actuated by coolant temperature. When the thermostat is closed, coolant flow bypasses the radiator circuit and returns to the coolant pump. When the thermostat is opened, coolant flows through the radiator circuit to transfer engine-generated heat to the outside air.

Engine overheating generally occurs when there is a disruption in the ability to control either coolant flow at the correct rate, the inability to transfer heat from the engine through the coolant (including low coolant) or an inability to transfer engine-generated heat to the outside air through the radiator.

### Possible Sources

- Low coolant level
- External engine coolant leak
- Airlock in system



- Pressure relief cap installation
- Restricted airflow through A/C condenser/radiator
- Internal engine coolant leak
- Coolant condition/concentration
- Non-OEM engine enhancement components
- Electric cooling fan
- CHT sensor
- Radiator
- Thermostat
- Coolant pump
- Coolant flow restriction
- Active grill shutter assembly

### Diagnostic Trouble Code (DTC) Fault Trigger Conditions

| DTC   | Description                                     | Fault Trigger Conditions                                                        |
|-------|-------------------------------------------------|---------------------------------------------------------------------------------|
| P0217 | Engine Coolant Overtemperature Condition        | Sets in the PCM when an engine overheat condition was sensed by the CHT sensor. |
| P1299 | Cylinder Head Overtemperature Protection Active | Sets in the PCM when an engine overheat condition was sensed by the CHT sensor. |

### PINPOINT TEST B : PINPOINT TEST

#### B1 CARRY OUT INSPECTION AND VERIFICATION

- Carry out the Inspection and Verification procedure in this section.

Are any concerns present?

|     |                          |
|-----|--------------------------|
| Yes | REPAIR as needed.        |
| No  | GO to <a href="#">B2</a> |

#### B2 CHECK FOR PCM (POWERTRAIN CONTROL MODULE) DTCS

- Ignition ON.
- Using a scan tool, perform PCM self-test.

### Is DTC P0217 and/or P1299 present?

|            |                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">B3</a>                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>No</b>  | Actual engine overheating has not been verified. CHECK the engine coolant temperature gauge operation.<br>REFER to: <a href="#">Instrumentation, Message Center and Warning Chimes</a> (413-01 Instrumentation, Message Center and Warning Chimes, Diagnosis and Testing).<br>If any other PCM DTCs are retrieved,<br>REFER to: <a href="#">Electronic Engine Controls</a> (303-14D Electronic Engine Controls - 5.0L 32V Ti-VCT, Diagnosis and Testing). |

### B3 CHECK FOR ACTIVE GRILL SHUDDER DTCS

- Review the PCM DTCs.

### Are any active grill shudder DTCs present?

|            |                                                                                                        |
|------------|--------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | REFER to: <a href="#">Active Grille Shutter</a> (501-02 Front End Body Panels, Diagnosis and Testing). |
| <b>No</b>  | GO to <a href="#">B4</a>                                                                               |

### B4 CHECK FOR AN AIRFLOW OBSTRUCTION AND MISSING AIR DEFLECTORS

**NOTE:** *Verify no vehicle front end damage is present.*

- Check the radiator or A/C condenser for an external obstruction such as leaves or cardboard and verify all air deflectors are present.

**Is an airflow obstruction present or air deflectors missing?**

|            |                          |
|------------|--------------------------|
| <b>Yes</b> | REPAIR as necessary.     |
| <b>No</b>  | GO to <a href="#">B5</a> |

## **B5 CHECK THE ENGINE COOLANT LEVEL AND PRESSURE TEST THE COOLING SYSTEM**

- Ignition OFF.
- Visually check the engine coolant level in the coolant expansion tank and adjust as necessary. Pressure test the cooling system.

**Does the engine cooling system leak externally?**

|            |                                   |
|------------|-----------------------------------|
| <b>Yes</b> | REPAIR or INSTALL new components. |
| <b>No</b>  | GO to <a href="#">B6</a>          |

## **B6 CHECK THE ENGINE COOLANT FOR AN INTERNAL LEAK**

- Inspect the engine coolant in the coolant expansion tank for signs of engine oil.

**Is engine oil evident in the coolant?**

|            |                                                                                                       |
|------------|-------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | REFER to: <a href="#">Engine</a> (303-00 Engine System - General Information, Diagnosis and Testing). |
| <b>No</b>  | GO to <a href="#">B7</a>                                                                              |

## B7 CHECK THE ENGINE OIL FOR COOLANT

- Remove the oil level indicator from the engine.

**Is coolant evident in the oil?**

|            |                                                                                                       |
|------------|-------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | REFER to: <a href="#">Engine</a> (303-00 Engine System - General Information, Diagnosis and Testing). |
| <b>No</b>  | GO to <a href="#">B8</a>                                                                              |

## B8 CHECK THE ENGINE COOLANT FOR TRANSMISSION FLUID

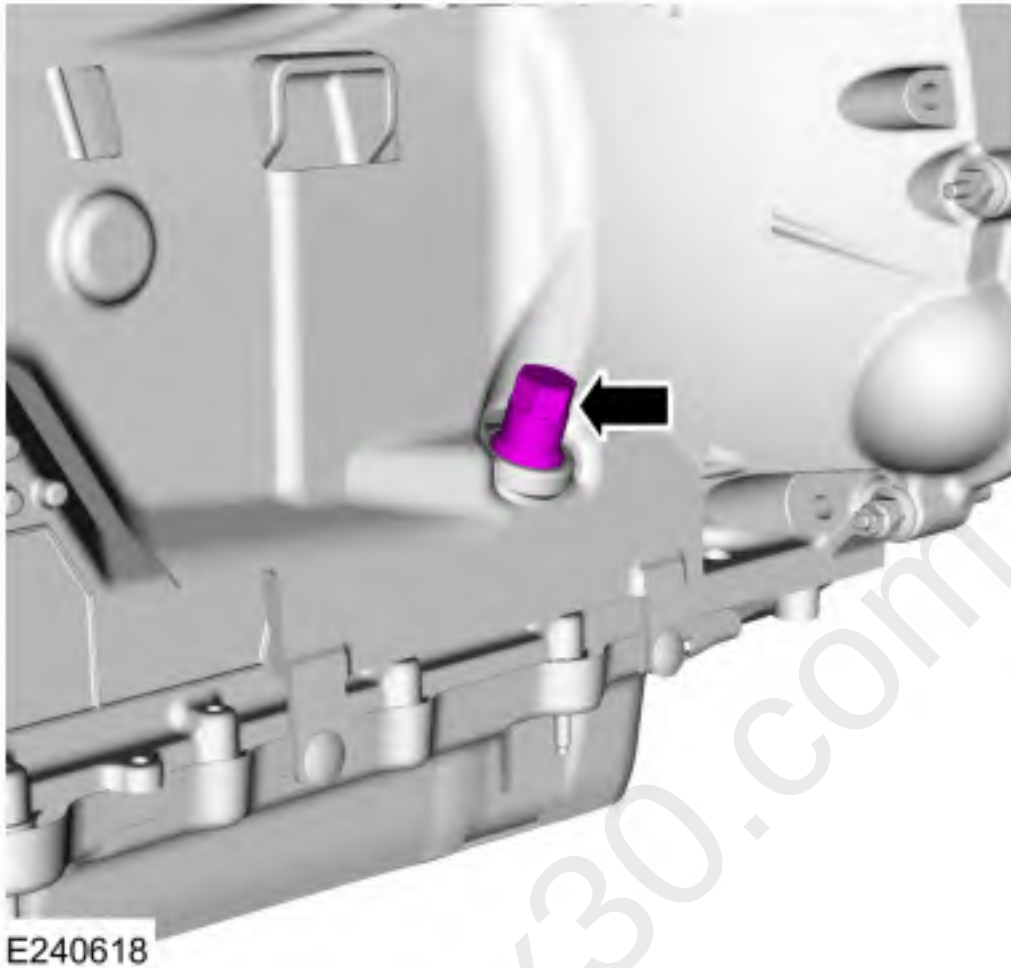
- Check the engine coolant in the degas bottle for signs of transmission fluid.

**Is transmission fluid evident in the engine coolant?**

|            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | INSTALL a new transmission fluid cooler.<br>REFER to: <a href="#">Transmission Fluid Cooler - 2.7L EcoBoost (238kW/324PS)/3.5L EcoBoost (272kW/370PS)/5.0L 32V Ti-VCT</a> (307-02 Transmission Cooling, Removal and Installation).<br>REPAIR the transmission as necessary. REFER to: <a href="#">Diagnosis By Symptom</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing).<br>TEST the system for normal operation. |
| <b>No</b>  | GO to <a href="#">B9</a>                                                                                                                                                                                                                                                                                                                                                                                                                                               |

## B9 CHECK THE TRANSMISSION FLUID FOR ENGINE COOLANT

- Remove the transmission oil leveling plug.



- Check the transmission fluid for engine coolant.

**Is engine coolant evident in the transmission fluid?**

|            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | <p>INSTALL a new transmission fluid cooler.</p> <p>REFER to: <a href="#">Transmission Fluid Cooler - 2.7L EcoBoost (238kW/324PS)/3.5L EcoBoost (272kW/370PS)/5.0L 32V Ti-VCT</a> (307-02 Transmission Cooling, Removal and Installation).</p> <p>REPAIR the transmission as necessary. REFER to: <a href="#">Diagnosis By Symptom</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing).</p> <p>TEST the system for normal operation.</p> |
| <b>No</b>  | GO to <a href="#">B10</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |



## B10 CHECK THE COOLING SYSTEM FOR COMBUSTION GASES

**NOTE:** Use UView® Combustion Leak Tester part number UVU560000-R or equivalent.

- Using a cooling system combustion gas leak tester, following the instructions supplied with the tester, check the coolant for combustion gases.

**Are combustion gases present?**

|            |                                                                                                       |
|------------|-------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | REFER to: <a href="#">Engine</a> (303-00 Engine System - General Information, Diagnosis and Testing). |
| <b>No</b>  | GO to <a href="#">B11</a>                                                                             |

## B11 CHECK COOLANT CONDITION

- Check the coolant for dirt, rust or contamination and check the coolant concentration.

**Is the coolant condition OK?**

|            |                                                                                                                                                       |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">B12</a>                                                                                                                             |
| <b>No</b>  | FLUSH the engine cooling system.<br>REFER to: <a href="#">Cooling System Flushing</a> (303-03D Engine Cooling - 5.0L 32V Ti-VCT, General Procedures). |

## B12 CHECK THE ELECTRIC COOLING FAN OPERATION

- Start the engine.
- Place the climate control function selector in the MAX A/C position and the blower motor switch in the HI position.

**Did the electric cooling fan operate?**

|            |                                                                                                                                        |
|------------|----------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">B13</a>                                                                                                              |
| <b>No</b>  | DIAGNOSE the electric cooling fan operation. Refer to Powertrain Control/Emissions Diagnosis (PC/ED) manual. Section 3 Symptom Charts. |

**B13 CHECK THE COOLANT PUMP OPERATION**

- Start the engine.
- Allow the engine to run for 30 minutes. Place the climate control function selector in the MAX HEAT position. Feel the heater outlet hose.

**Is the heater outlet hose hot?**

|            |                                                                                                                                             |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">B14</a>                                                                                                                   |
| <b>No</b>  | INSTALL a new coolant pump.<br>REFER to: <a href="#">Coolant Pump</a> (303-03D Engine Cooling - 5.0L 32V Ti-VCT, Removal and Installation). |

**B14 CHECK THE THERMOSTAT OPERATION**

**NOTE:** This cooling system uses a cold side thermostat. The coolant in the radiator must reach full operating temperature for the thermostat to remain in an open state.

- Start the engine.
- Allow the engine to run for 30 minutes. Place the climate control function selector in the MAX HEAT position. Feel the lower radiator hose.

**Is the lower radiator hose hot?**

|            |                                                                                                                                                                                                            |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | CHECK the temperature gauge operation.<br>REFER to: <a href="#">Instrumentation, Message Center and Warning Chimes</a> (413-01 Instrumentation, Message Center and Warning Chimes, Diagnosis and Testing). |
| <b>No</b>  | GO to <a href="#">B15</a>                                                                                                                                                                                  |

**B15 VISUALLY INSPECT THE THERMOSTAT**

- Carry out the Thermostat Visual Inspection in the Component Tests portion of this section.

**Is the thermostat damaged?**

|            |                                                                                                                                                                                                                                                                                                            |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | INSTALL a new thermostat.<br>REFER to: <a href="#">Thermostat</a> (303-03D Engine Cooling - 5.0L 32V Ti-VCT, Removal and Installation).                                                                                                                                                                    |
| <b>No</b>  | INSTALL a new thermostat.<br>REFER to: <a href="#">Thermostat</a> (303-03D Engine Cooling - 5.0L 32V Ti-VCT, Removal and Installation).<br>If the engine still overheats, INSTALL a new radiator. REFER to: <a href="#">Radiator</a> (303-03D Engine Cooling - 5.0L 32V Ti-VCT, Removal and Installation). |

**The Engine Does Not Reach Normal Operating Temperature**

**Normal operation and Fault Conditions**

The engine cooling system maintains engine temperature during operation. Correct coolant flow through

the engine, radiator and remainder of cooling system passages and components is essential to maintaining a correct engine temperature.

Engine coolant flows primarily from the engine to the radiator circuit and back to the coolant pump. Coolant is sent from the coolant pump through the engine block and cylinder head. A separate circuit from the engine also feeds the heater core with coolant. The coolant pump circulates the coolant. The coolant thermostat is a control valve actuated by coolant temperature. When the thermostat is closed, coolant flow bypasses the radiator circuit and returns to the coolant pump. When the thermostat is opened, coolant flows through the radiator circuit in order to transfer engine generated heat to the outside air.

Concerns of engine inability to reach normal operating temperature typically occur when the rate of coolant flow through some coolant circuits (radiator, heater core) is more than expected given the conditions. Heat is not allowed to build in the engine because a heat exchanger is removing too much heat, including the radiator, heater core and oil cooler. In addition, perceived concerns that the engine does not reach normal operating temperature can be related to a low coolant level or trapped air which does not allow for hot coolant to be available at the heater core, an inoperative climate control system, or for concerns perceived or related to an incorrect engine temperature gauge indication.

**Possible Sources**

- Low coolant level
- Thermostat
- Temperature gauge
- CHT

**Diagnostic Trouble Code (DTC) Fault Trigger Conditions**

| DTC   | Description                                            | Fault Trigger Conditions                                                                                                                                                                   |
|-------|--------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| P0125 | Insufficient Coolant Temp for Closed Loop Fuel Control | Sets in the PCM when the CHT sensor has not achieved the required temperature level to enter closed loop operating conditions within a specified amount of time after starting the engine. |
|       |                                                        |                                                                                                                                                                                            |

|       |                                                                           |                                                                                                                                                                     |
|-------|---------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| P0128 | Coolant Thermostat (Coolant Temp Below Thermostat Regulating Temperature) | Sets in the PCM when the thermostat monitor has not achieved the required engine operating temperature within a specified amount of time after starting the engine. |
|-------|---------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|

## PINPOINT TEST C : PINPOINT TEST



**WARNING:** Always allow the engine to cool before opening the cooling system. Do not unscrew the coolant pressure relief cap when the engine is operating or the cooling system is hot. The cooling system is under pressure; steam and hot liquid can come out forcefully when the cap is loosened slightly. Failure to follow these instructions may result in serious personal injury.

### C1 CARRY OUT INSPECTION AND VERIFICATION

- Carry out the Inspection and Verification procedure in this section.

**Were any concerns found?**

|            |                          |
|------------|--------------------------|
| <b>Yes</b> | REPAIR as needed.        |
| <b>No</b>  | GO to <a href="#">C2</a> |

### C2 CHECK FOR DTC P0125 OR P0128

- Using a scan tool, perform the PCM self-test.

**Is DTC P0125 or P0128 present?**

|            |                          |
|------------|--------------------------|
| <b>Yes</b> | GO to <a href="#">C3</a> |
|------------|--------------------------|



|           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>No</b> | <p>The cooling system is operational. If an inoperative temperature gauge is suspected, CHECK the temperature gauge operation.</p> <p>REFER to: <a href="#">Instrumentation, Message Center and Warning Chimes</a> (413-01 Instrumentation, Message Center and Warning Chimes, Diagnosis and Testing).</p> <p>If an inoperative climate control system is suspected, CHECK the climate control system operation. For Dual Automatic Temperature Control (DATC), REFER to: <a href="#">Climate Control System - Vehicles With: Dual Automatic Temperature Control (DATC)</a> (412-00 Climate Control System - General Information, Diagnosis and Testing).</p> <p>For Electronic Manual Temperature contro (EMTC), REFER to: <a href="#">Climate Control System - Vehicles With: Electronic Manual Temperature Control (EMTC)</a> (412-00 Climate Control System - General Information, Diagnosis and Testing).</p> <p>If any other Diagnostic Trouble Codes (DTCs) are retrieved, REFER to: <a href="#">Electronic Engine Controls</a> (303-14D Electronic Engine Controls - 5.0L 32V Ti-VCT, Diagnosis and Testing).</p> |
|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

### C3 CHECK THE COOLANT LEVEL

**NOTE:** *Allow the engine to cool before checking the coolant expansion tank.*

- Visually check the engine coolant level in the coolant expansion tank

**Is the engine coolant level within specification?**

|            |                                                                                                                                                                                                                                                             |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | <p>INSTALL a new thermostat.</p> <p>REFER to: <a href="#">Thermostat</a> (303-03D Engine Cooling - 5.0L 32V Ti-VCT, Removal and Installation).</p> <p>CLEAR Diagnostic Trouble Codes (DTCs). If the DTC returns check for correct CHT sensor operation.</p> |
| <b>No</b>  | <a href="#">GO to Pinpoint Test A</a>                                                                                                                                                                                                                       |

### Component Tests

#### Cooling System Pressure Test

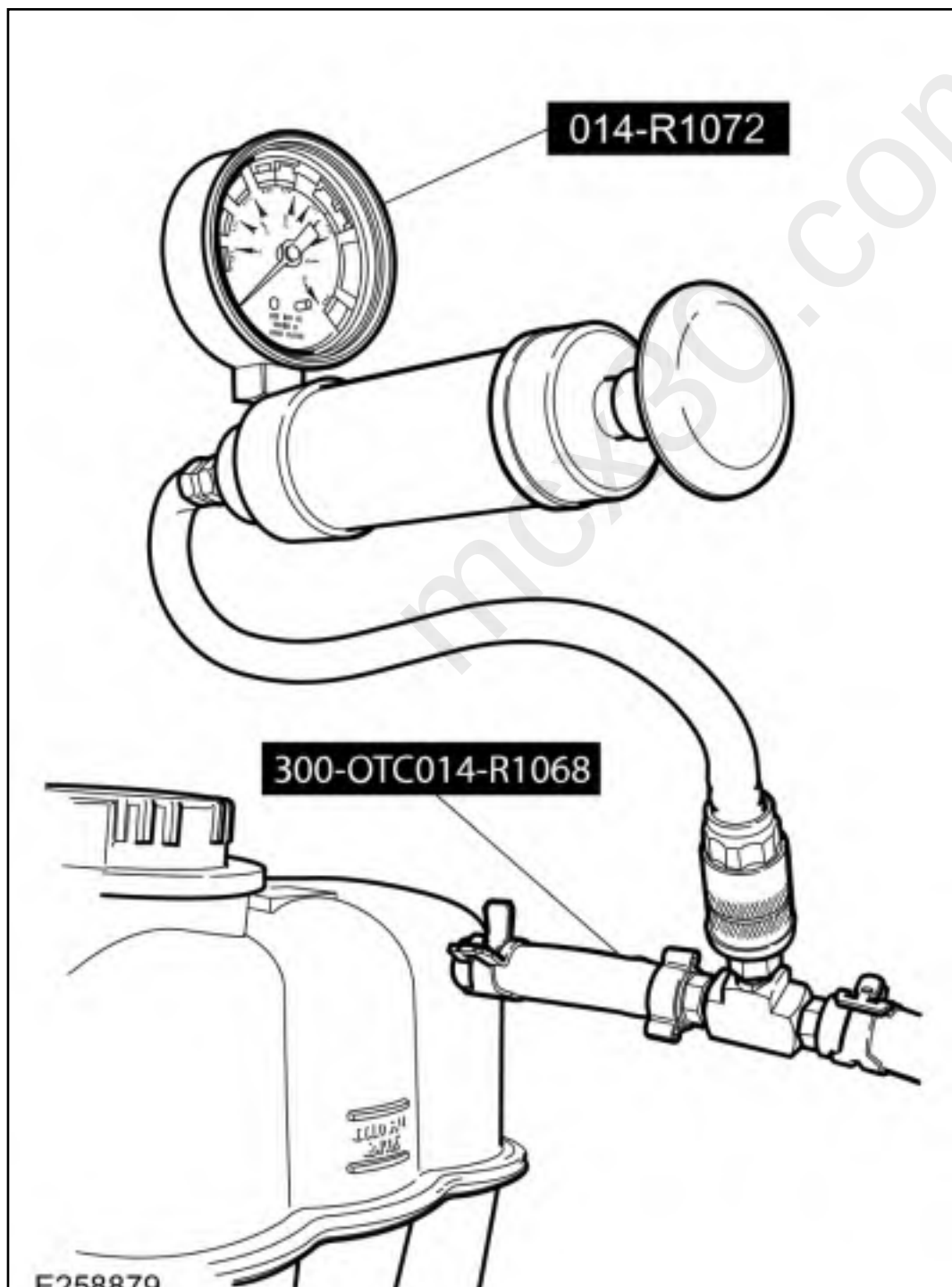


**WARNING:** Always allow the engine to cool before opening the cooling system. Do not

**unscrew the coolant pressure relief cap when the engine is operating or the cooling system is hot. The cooling system is under pressure; steam and hot liquid can come out forcefully when the cap is loosened slightly. Failure to follow these instructions may result in serious personal injury.**

**NOTE:** *Vehicles have a pressure relief cap on the degas bottle and no radiator cap.*

1. Turn the engine OFF.
2. Check the engine coolant level and adjust as necessary.
3. Attach the Pressure Tester to the degas bottle nipple and overflow hose. Install a pressure test pump to the quick connect fitting of the test adapter.





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4. **NOTICE: Do not pressurize the cooling system beyond the maximum pressure listed in the Specifications table in this section or cooling system components may be damaged.**

**NOTE:** *If the plunger of the pressure tester is pressed too fast, an erroneous pressure reading results.*

Slowly press the plunger of the pressure test pump until the pressure gauge reading stops increasing and note the highest pressure reading obtained. If the pressure reading exceeds the maximum cap pressure listed in the Specifications table, install a new pressure relief cap.

5. If the system does not hold pressure, remove the pressure relief cap and wash in clean water to dislodge all the foreign material from the gasket. Check the sealing surface in the filler neck of the degas bottle for nicks or cuts. Install the pressure relief cap.
6. Pressurize the engine cooling system as described in Step 4 above. Observe the gauge reading for approximately 2 minutes. Pressure should not drop during this time. If the pressure drops within this time, inspect for leaks and repair as necessary.
7. If no leaks are found after a new pressure relief cap is installed, and the pressure drops, the leak may be internal to the engine. Inspect the coolant for engine oil and the engine oil for coolant. REFER to: [Engine](#) (303-00 Engine System - General Information, Diagnosis and Testing).
8. Release the system pressure by loosening the pressure relief cap. Check the coolant level and adjust as necessary.

## Thermostat

Install a new thermostat only after at least one of the following tests and checks have been carried out:

- Pinpoint Test B or C
- Thermostat Visual Inspection

## Thermostat Visual Inspection

1. Remove the thermostat.
2. Examine the thermostat for signs of damage including:

- Valve not fully seated (light visible through the valve)
- Foreign material lodged in the main valve
- Bent or broken frame or flange
- Bent or broken spring
- Wax leaking from wax reservoir or a bulge in the reservoir
- Any other damage or distortion

3. **NOTE:** *If no damage is found during the inspection, do not attempt to open the thermostat using hot water or other heat sources. This method is not an accurate means to test the function of the thermostat and may damage the thermostat.*

If damage is found during the inspection, remove any foreign material or broken pieces and install a new thermostat.

### **Radiator Leak Test, Removed From Vehicle**

**NOTICE:** Never leak test an aluminum radiator in the same water that copper/brass radiators are tested in. Flux and caustic cleaners may be present in the cleaning tank and they will damage aluminum radiators.

**NOTE:** *Clean the radiator before leak testing to avoid contamination of tank.*

1. Leak test the radiator in clean water with air pressurized to the maximum pressure listed in the Specifications table.

# Cooling System Draining, Vacuum Filling and Bleeding

## Special Tool(s) / General Equipment

|                                                                                              |                                                        |
|----------------------------------------------------------------------------------------------|--------------------------------------------------------|
| <br>ST1720-A | ROB75240<br>Coolant/Battery Refractometer (Fahrenheit) |
| Fluid Container                                                                              |                                                        |
| Cooling System Vacuum Tester and Refiller                                                    |                                                        |

## Materials

| Name                                                       | Specification |
|------------------------------------------------------------|---------------|
| Motorcraft® Orange Prediluted Antifreeze/Coolant VC-3DIL-B | WSS-M97B44-D2 |
| Motorcraft® Orange Concentrated Antifreeze/Coolant VC-3-B  | WSS-M97B44-D  |

## Draining

**NOTICE:** The coolant must be recovered in a suitable, clean container for reuse. If the coolant is contaminated, it must be recycled or disposed of correctly. Using contaminated coolant may result in damage to the engine or cooling system components.

**NOTICE:** The vehicle cooling system is filled with Motorcraft® Orange Antifreeze/Coolant. Do not mix coolant types. Mixing coolant types degrades the corrosion protection of the coolant. Failure to follow these instructions may damage the engine or cooling system.

**NOTICE:** Always fill the cooling system with the manufacturer's specified coolant. Chemically flush the cooling system if a non-specified coolant has been used. Refer to Cooling System Flushing. Failure



to follow these instructions may damage the engine or cooling system.

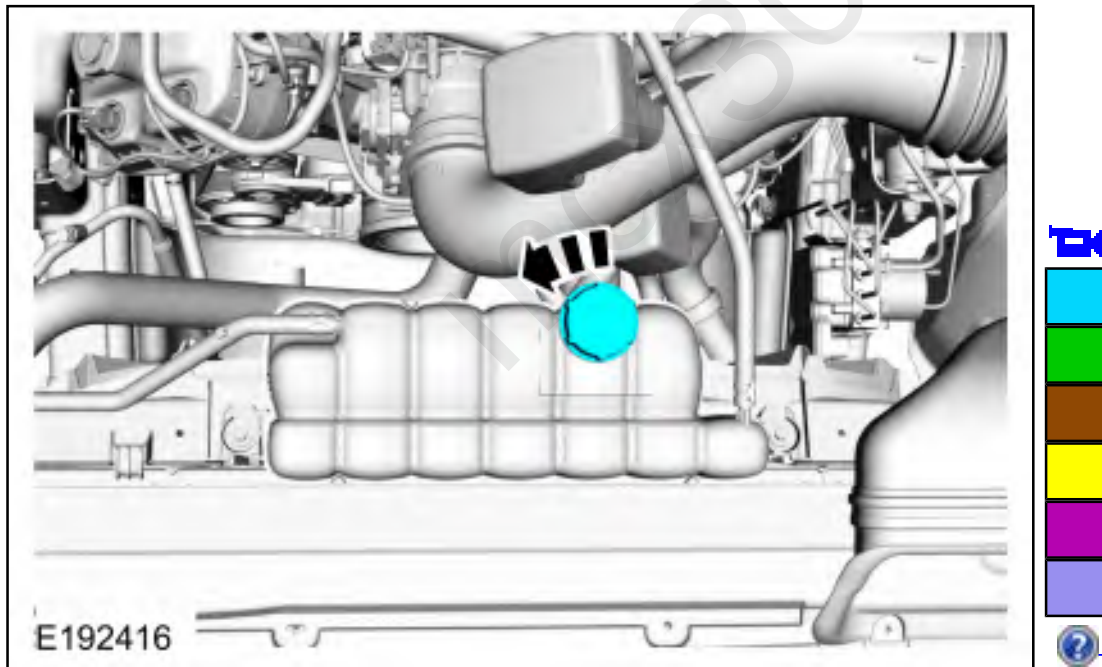
**NOTE:** During normal vehicle operation, Motorcraft® Orange Antifreeze/Coolant may change color from orange to pink or light red. As long as the engine coolant is clear and uncontaminated, this color change does not indicate the engine coolant has degraded nor does it require the engine coolant to be drained, the system to be flushed, or the engine coolant to be replaced.

**NOTE:** Less than 80% of coolant capacity can be recovered with the engine in the vehicle. Dirty, rusty or contaminated coolant requires replacement.



 **WARNING:** When releasing the cooling system pressure, cover the coolant expansion tank cap with a thick cloth.

Remove the pressure relief cap.



2. Refer to: [Jacking and Lifting - Overview](#) (100-02 Jacking and Lifting, Description and Operation).

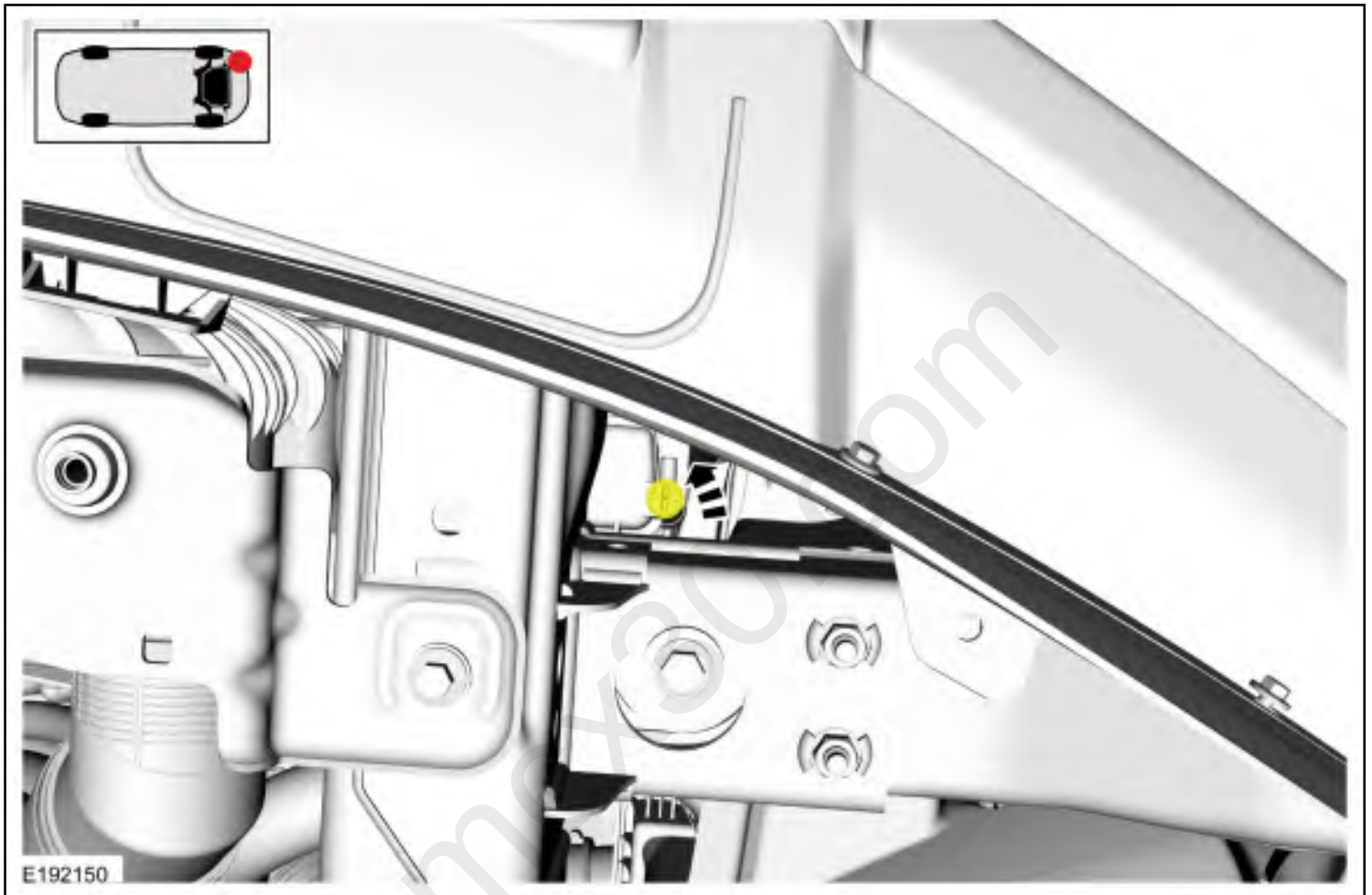




**WARNING: Be prepared to collect escaping fluid.**

Connect a hose to drain the coolant. Open the radiator drain valve and drain the engine coolant in a suitable, clean container.

Use the General Equipment: Fluid Container



## Filling

### Filling and Bleeding with a Vacuum Cooling System Filler

- **NOTICE:** The cooling system is filled with Motorcraft® Orange Antifreeze/Coolant. Do not mix coolant types. Mixing coolant types degrades the corrosion protection of the coolant. Failure to follow these instructions may damage the engine or cooling system.

**NOTICE:** Engine coolant provides boil protection, corrosion protection, freeze protection, and cooling efficiency to the engine and cooling components. In order to obtain these protections, maintain the engine coolant at the correct concentration and fluid level in the degas bottle.

**NOTE:** Add Motorcraft® Orange Antifreeze/Coolant or equivalent.

**NOTE:** Do not add or mix with any other type of engine coolant. Mixing coolants may degrade the coolant's corrosion protection.

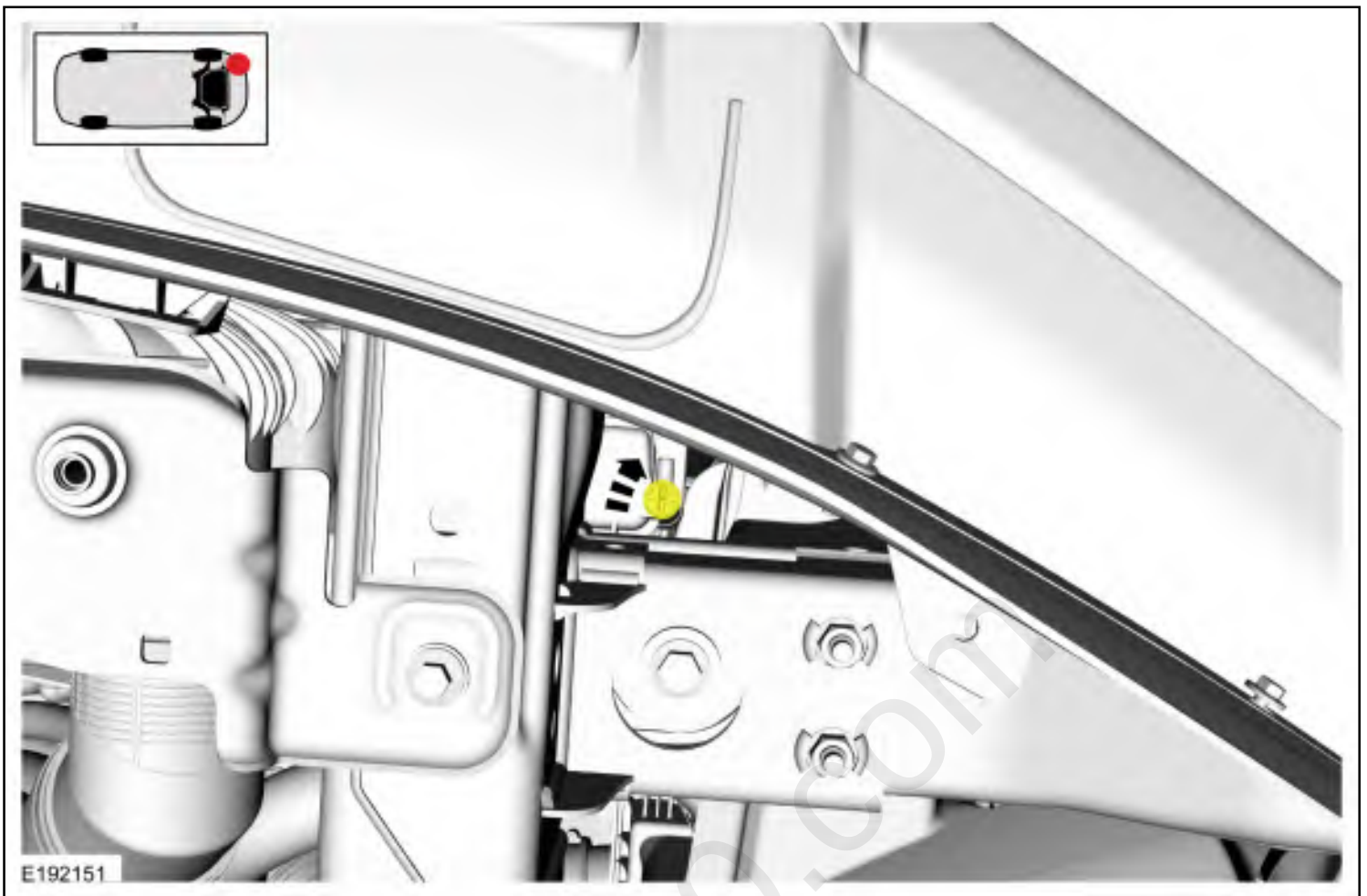
**NOTE:** Do not add alcohol, methanol, or brine, or any engine coolants mixed with alcohol or methanol antifreeze. These can cause engine damage from overheating or freezing.

**NOTE:** Ford Motor Company does NOT recommend the use of recycled engine coolant in vehicles originally equipped with Motorcraft® Orange Antifreeze/Coolant since a Ford-approved recycling process is not yet available.

When adding or topping off the engine coolant:

- Measure the coolant concentration in the vehicle.  
Use Special Service Tool: ROB75240 Coolant/Battery Refractometer (Fahrenheit).
- Determine the concentration desired based on the vehicle duty cycle of extreme hot or cold operating conditions.
- Add, top-off or adjust the coolant as follows:
- For concentrations measured 48/52 to 50/50 (freeze protection -34°C to -37°C [-30°F to -34°F]) use Motorcraft® Orange Prediluted Antifreeze/Coolant to maintain a coolant concentration in this same range.  
*Material:* Motorcraft® Orange Prediluted Antifreeze/Coolant / VC-3DIL-B (WSS-M97B44-D2)
- For all other concentrations, use Motorcraft® Orange Concentrated Antifreeze/Coolant and/or distilled water to get to the desired concentration.  
*Material:* Motorcraft® Orange Concentrated Antifreeze/Coolant / VC-3-B (WSS-M97B44-D)
- When refilling the engine coolant after a flush procedure, use a mixture of Motorcraft® Orange Concentrated Antifreeze/Coolant and distilled water to get to the desired concentration.

2. Close the radiator drain valve.

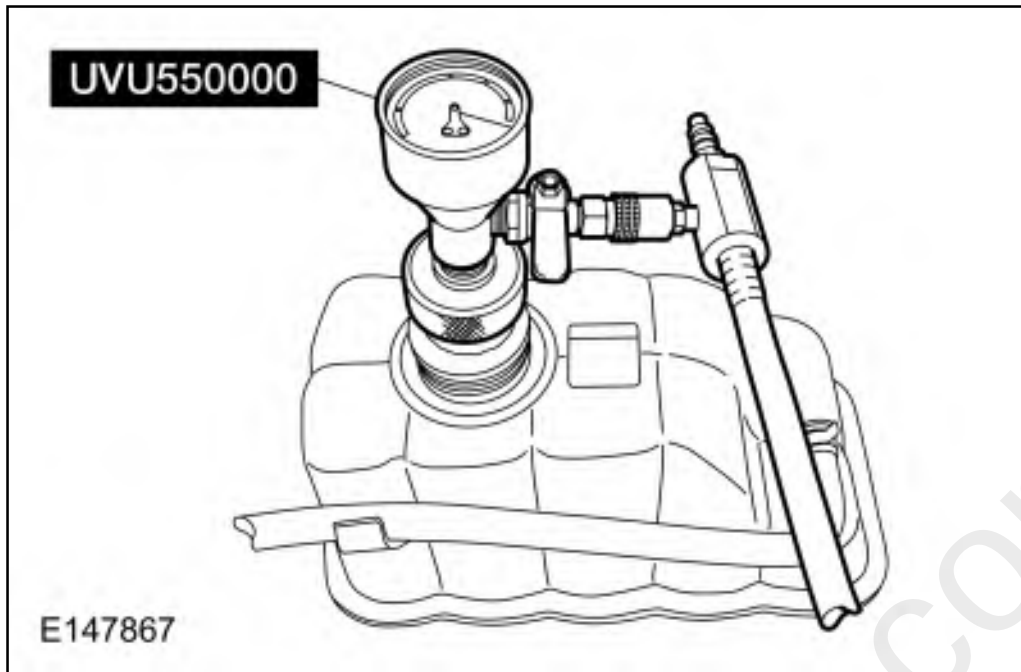


3. Install the vacuum cooling system filler and follow the manufacturer's instructions to fill and bleed the system.

Use the General Equipment: Cooling System Vacuum Tester and Refiller

4. Recommended coolant concentration is 48/52 to 50/50 engine coolant to distilled water (freeze protection  $-34^{\circ}\text{C}$  to  $-37^{\circ}\text{C}$  [ $-30^{\circ}\text{F}$  to  $-34^{\circ}\text{F}$ ]).
  - For extremely cold climates (less than  $-37^{\circ}\text{C}$  [ $-34^{\circ}\text{F}$ ]):
    - It may be necessary to increase the coolant concentration above 50%.
    - NEVER increase the coolant concentration above 60%.
    - Maximum coolant concentration is 60/40 for cold weather areas.
    - A coolant concentration of 60% provides freeze protection down to  $-50^{\circ}\text{C}$  ( $-58^{\circ}\text{F}$ )
    - Engine coolant concentrations above 60% will decrease the overheat protection characteristics of the engine coolant and may damage the engine.
  - For extremely hot climates:
    - It is still necessary to maintain the coolant concentration above 40%.
    - NEVER decrease the coolant concentration below 40%.
    - Minimum coolant concentration is 40/60 for warm weather areas.
    - Engine coolant concentrations below 40% will decrease the freeze and corrosion protection characteristics of the engine coolant and may damage the engine.

7. Vehicles driven year-round in non-extreme climates should use a 48/52 to 50/50 (freeze protection - 34°C to -37°C [-30°F to -34°F]) mixture of engine coolant and distilled water for optimum cooling system and engine protection.



8. Fill the degas bottle to the MAX FILL line.
9. Install the degas bottle cap until it contacts the hard stop.
10. Turn the climate control system off.
11. Start the engine and increase the engine speed to 3,500 rpm and hold for 30 seconds.
12. Turn the engine off and wait for 1 minute to purge any large air pockets from the cooling system.

13. **⚠ WARNING: Always allow the engine to cool before opening the cooling system. Do not unscrew the coolant pressure relief cap when the engine is operating or the cooling system is hot. The cooling system is under pressure; steam and hot liquid can come out forcefully when the cap is loosened slightly. Failure to follow these instructions may result in serious personal injury.**

Check the engine coolant level in degas bottle and if necessary fill to the top of the MAX FILL line on the degas bottle if the engine is warm or to the top of the MIN FILL LEVEL if the engine is cold.

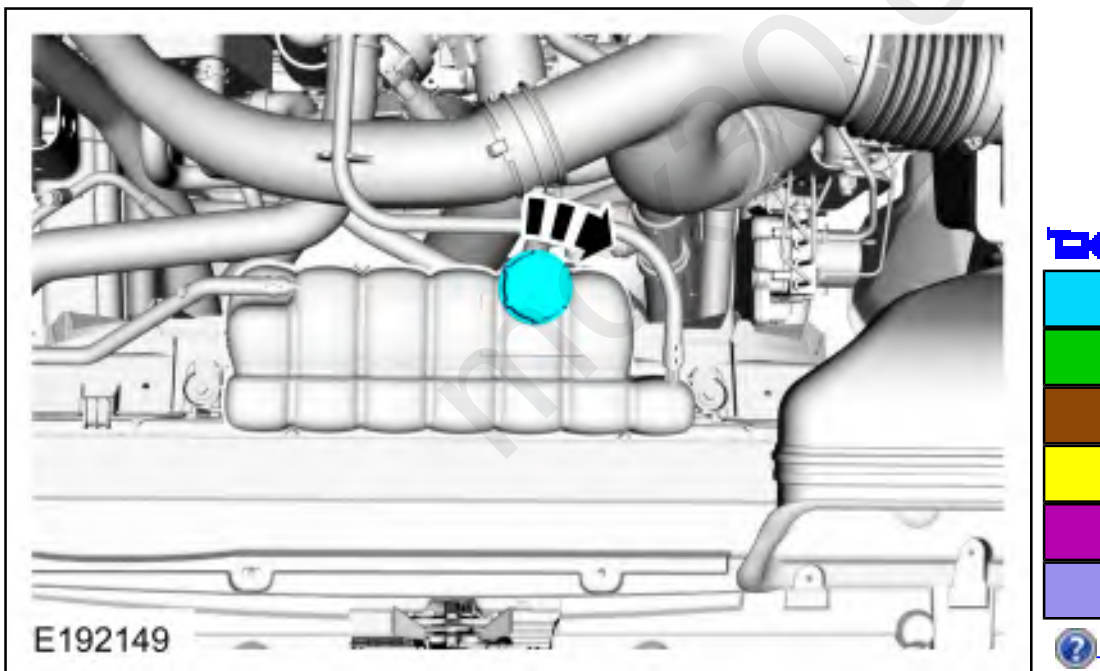
14. Start the engine and let it idle until the engine reaches normal operating temperature and the thermostat is fully open. A fully open thermostat is verified by the cooling fan cycling on at least once.



15. Increase the engine speed to 3,500 rpm and hold for 30 seconds.
16. Allow the engine to idle for 30 seconds.
17. Turn the engine off for 1 minute.
18. Repeat steps 15 through 17 a total of 10 times to remove any remaining air trapped in the system.
19.  **WARNING: Always allow the engine to cool before opening the cooling system. Do not unscrew the coolant pressure relief cap when the engine is operating or the cooling system is hot. The cooling system is under pressure; steam and hot liquid can come out forcefully when the cap is loosened slightly. Failure to follow these instructions may result in serious personal injury.**

Check the engine coolant level in degas bottle and if necessary fill to the top of the MAX FILL line on the degas bottle.

20. Install the pressure relief cap until it contacts the hard stop.



### Filling and Bleeding without a Vacuum Cooling System Filler

- **NOTICE: The cooling system is filled with Motorcraft® Orange Antifreeze/Coolant. Do not mix coolant types. Mixing coolant types degrades the corrosion protection of the coolant. Failure to follow these instructions may damage the engine or cooling system.**

**NOTICE: Engine coolant provides boil protection, corrosion protection, freeze**

**protection, and cooling efficiency to the engine and cooling components. In order to obtain these protections, maintain the engine coolant at the correct concentration and fluid level in the degas bottle.**

**NOTE:** *Add Motorcraft® Orange Antifreeze/Coolant or equivalent.*

**NOTE:** *Do not add or mix with any other type of engine coolant. Mixing coolants may degrade the coolant's corrosion protection.*

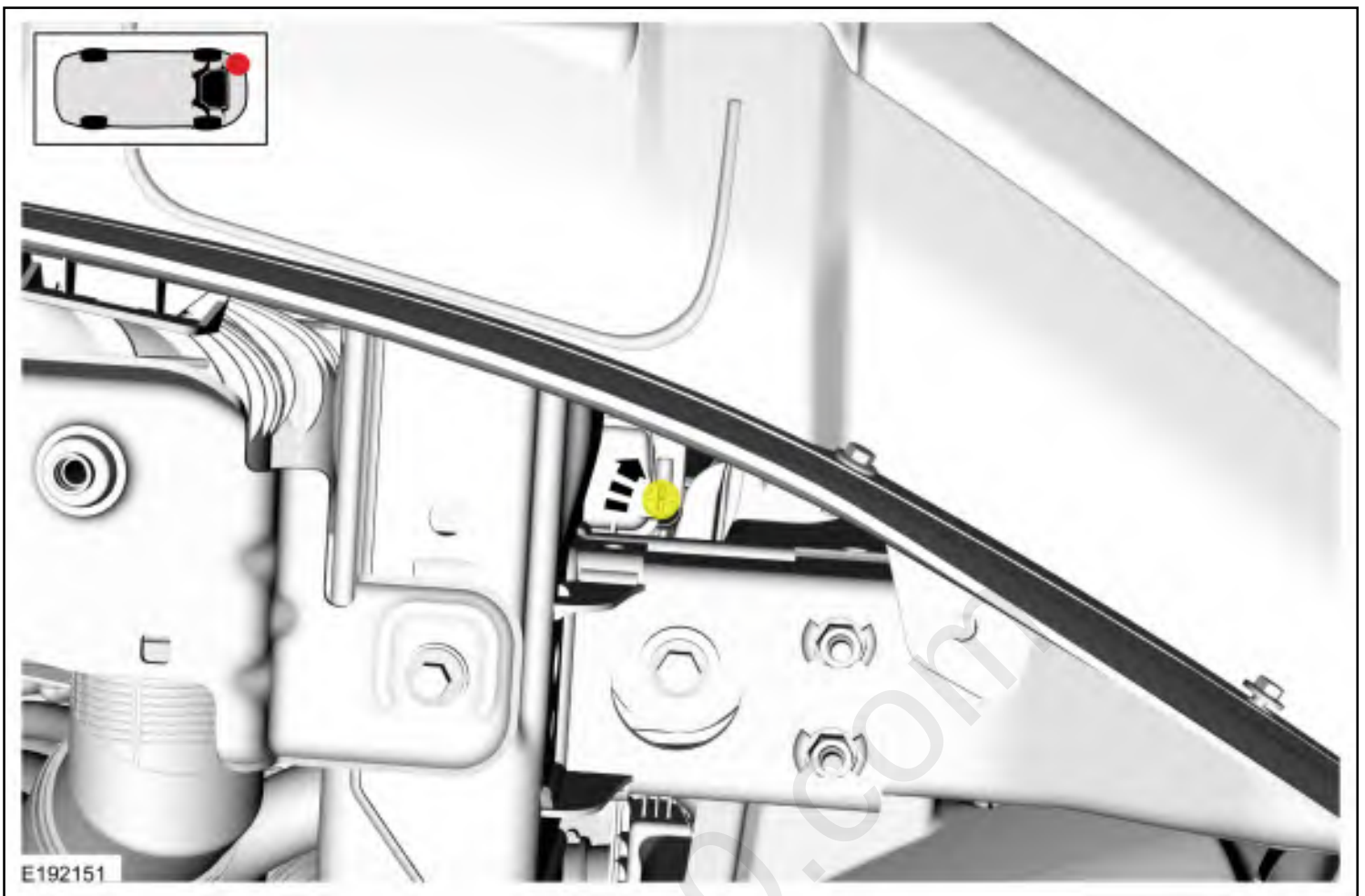
**NOTE:** *Do not add alcohol, methanol, or brine, or any engine coolants mixed with alcohol or methanol antifreeze. These can cause engine damage from overheating or freezing.*

**NOTE:** *Ford Motor Company does NOT recommend the use of recycled engine coolant in vehicles originally equipped with Motorcraft® Orange Antifreeze/Coolant since a Ford-approved recycling process is not yet available.*

When adding or topping off the engine coolant:

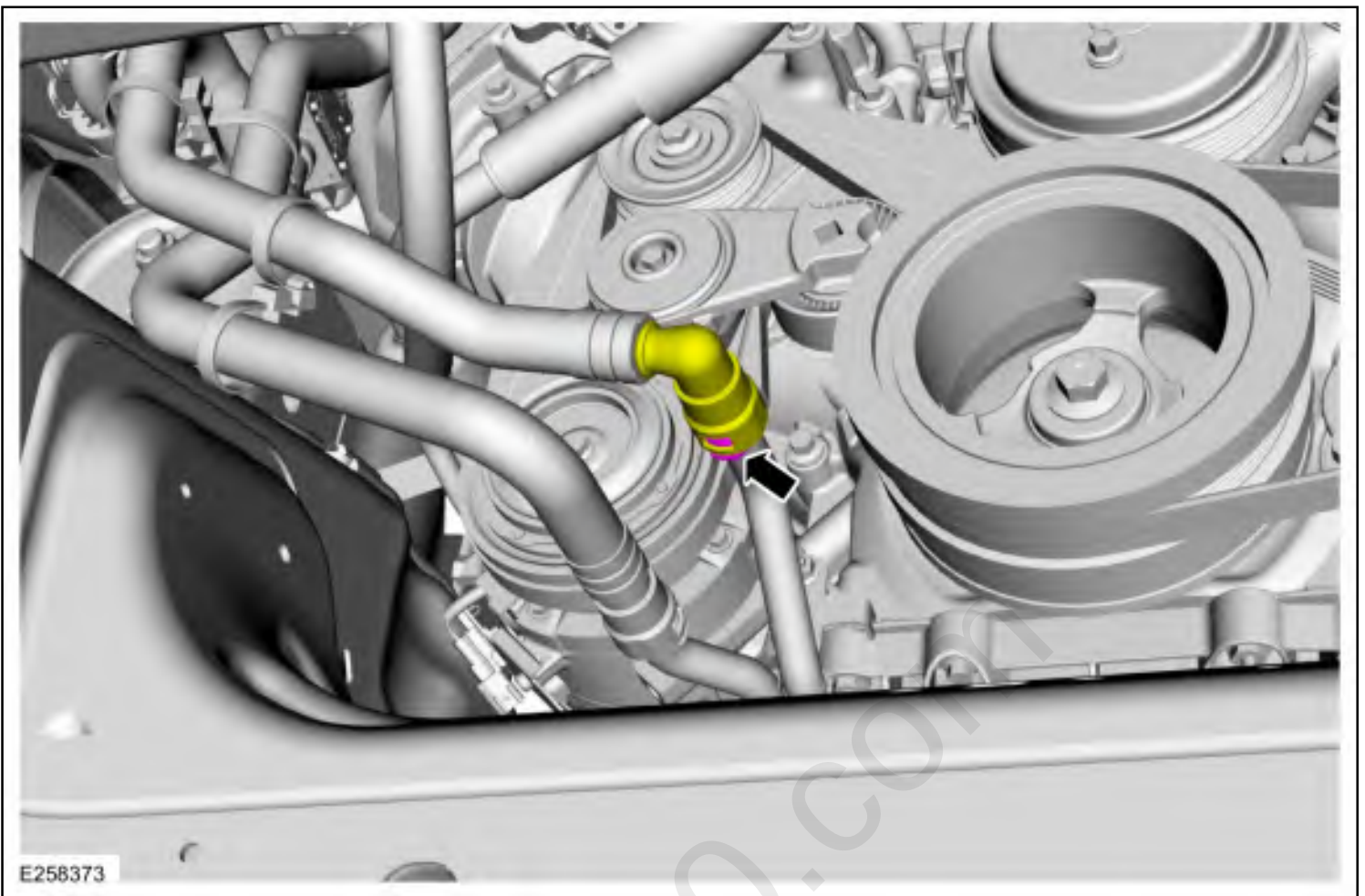
- Measure the coolant concentration in the vehicle.  
Use Special Service Tool: ROB75240 Coolant/Battery Refractometer (Fahrenheit).
- Determine the concentration desired based on the vehicle duty cycle of extreme hot or cold operating conditions.
- Add, top-off or adjust the coolant as follows:
- For concentrations measured 48/52 to 50/50 (freeze protection -34°C to -37°C [-30°F to -34°F]) use Motorcraft® Orange Prediluted Antifreeze/Coolant to maintain a coolant concentration in this same range.  
*Material:* Motorcraft® Orange Prediluted Antifreeze/Coolant / VC-3DIL-B (WSS-M97B44-D2)
- For all other concentrations, use Motorcraft® Orange Concentrated Antifreeze/Coolant and/or distilled water to get to the desired concentration.  
*Material:* Motorcraft® Orange Concentrated Antifreeze/Coolant / VC-3-B (WSS-M97B44-D)
- When refilling the engine coolant after a flush procedure, use a mixture of Motorcraft® Orange Concentrated Antifreeze/Coolant and distilled water to get to the desired concentration.

22. Close the radiator drain valve.



23.  **WARNING: Be prepared to collect escaping fluid.**

Disconnect the transmission fluid cooler coolant inlet hose.

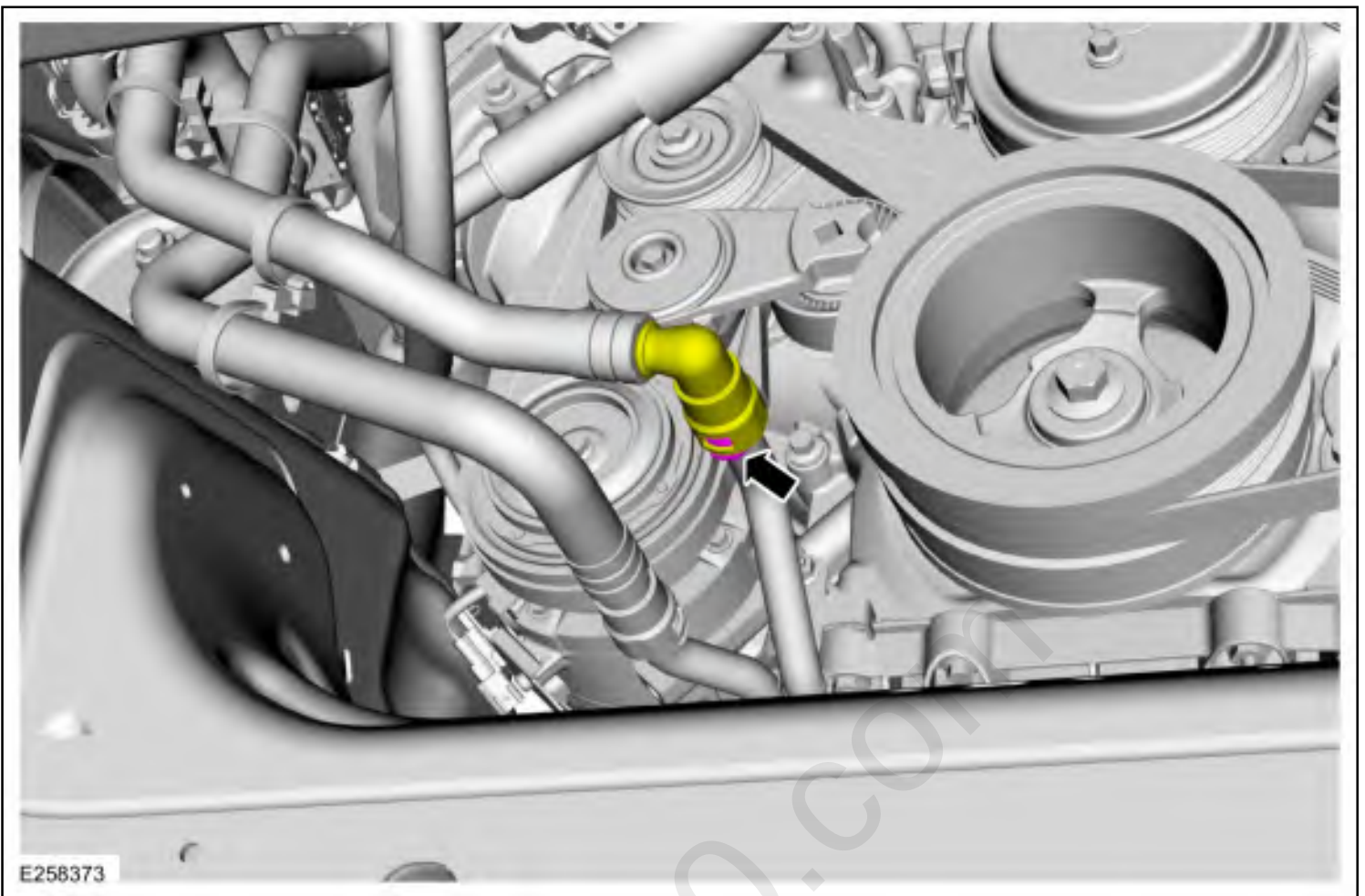


24. Fill the degas bottle to the indicated level.



25. Connect the transmission fluid cooler coolant inlet hose after coolant begins to flow out of the hose.





26. Recommended coolant concentration is 48/52 to 50/50 engine coolant to distilled water (freeze protection  $-34^{\circ}\text{C}$  to  $-37^{\circ}\text{C}$  [ $-30^{\circ}\text{F}$  to  $-34^{\circ}\text{F}$ ]).

- For extremely cold climates (less than  $-37^{\circ}\text{C}$  [ $-34^{\circ}\text{F}$ ]):
- It may be necessary to increase the coolant concentration above 50%.
- NEVER increase the coolant concentration above 60%.
- Maximum coolant concentration is 60/40 for cold weather areas.
- A coolant concentration of 60% provides freeze protection down to  $-50^{\circ}\text{C}$  ( $-58^{\circ}\text{F}$ )
- Engine coolant concentrations above 60% will decrease the overheat protection characteristics of the engine coolant and may damage the engine.
- For extremely hot climates:
- It is still necessary to maintain the coolant concentration above 40%.
- NEVER decrease the coolant concentration below 40%.
- Minimum coolant concentration is 40/60 for warm weather areas.
- Engine coolant concentrations below 40% will decrease the freeze and corrosion protection characteristics of the engine coolant and may damage the engine.

29. Vehicles driven year-round in non-extreme climates should use a 48/52 to 50/50 (freeze protection  $-34^{\circ}\text{C}$  to  $-37^{\circ}\text{C}$  [ $-30^{\circ}\text{F}$  to  $-34^{\circ}\text{F}$ ]) mixture of engine coolant and distilled water for optimum cooling system and engine protection.

30. Install the degas bottle cap until it contacts the hard stop.
31. Turn the climate control system off.
32. Start the engine and increase the engine speed to 3,500 rpm and hold for 30 seconds.
33. Turn the engine off and wait for 1 minute to purge any large air pockets from the cooling system.
34.  **WARNING: Always allow the engine to cool before opening the cooling system. Do not unscrew the coolant pressure relief cap when the engine is operating or the cooling system is hot. The cooling system is under pressure; steam and hot liquid can come out forcefully when the cap is loosened slightly. Failure to follow these instructions may result in serious personal injury.**

Check the engine coolant level in degas bottle and if necessary fill to the indicated level.

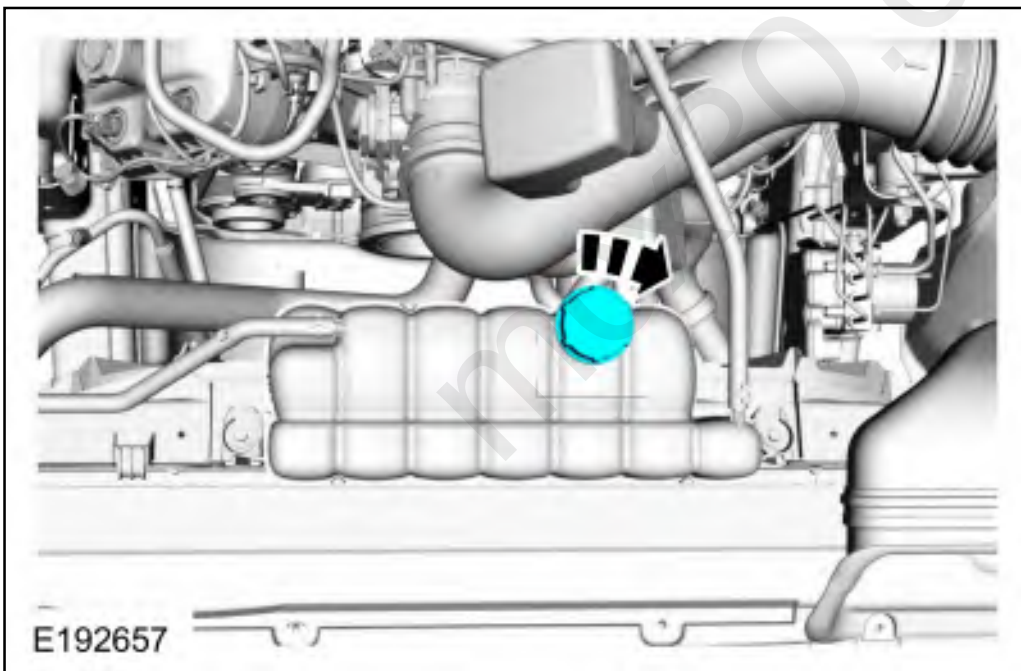


35. Start the engine and let it idle until the engine reaches normal operating temperature and the thermostat is fully open. A fully open thermostat is verified by the cooling fan cycling on at least once.

36. Increase the engine speed to 3,500 rpm and hold for 30 seconds.
37. Allow the engine to idle for 30 seconds.
38. Turn the engine off for 1 minute.
39. Repeat steps 34 through 36 a total of 10 times to remove any remaining air trapped in the system.
40.  **WARNING: Always allow the engine to cool before opening the cooling system. Do not unscrew the coolant pressure relief cap when the engine is operating or the cooling system is hot. The cooling system is under pressure; steam and hot liquid can come out forcefully when the cap is loosened slightly. Failure to follow these instructions may result in serious personal injury.**

Check the engine coolant level in degas bottle and if necessary fill to the top of the MAX FILL line on the degas bottle.

41. Install the pressure relief cap until it contacts the hard stop.



# Cooling System Flushing

## Materials

| Name                                          | Specification |
|-----------------------------------------------|---------------|
| Motorcraft® Premium Cooling System Flush VC-1 | ESR-M14P7-A   |

## Flushing

 **WARNING:** Always allow the engine to cool before opening the cooling system. Do not unscrew the coolant pressure relief cap when the engine is operating or the cooling system is hot. The cooling system is under pressure; steam and hot liquid can come out forcefully when the cap is loosened slightly. Failure to follow these instructions may result in serious personal injury.

**NOTE:** To remove rust, sludge and other foreign material from the cooling system, use cooling system flush that is safe for use with aluminum radiators. This cleaning restores cooling system efficiency and helps prevent overheating. A pulsating or reversed direction of flushing water will loosen sediment more quickly than a steady flow in the normal coolant flow direction. In severe cases where cleaning solvents will not clean the cooling system efficiently, it will be necessary to use the pressure flushing method using cooling system flusher. Dispose of old coolant and flushing water contaminated with antifreeze and cleaning chemicals in accordance with local, state or federal laws.

1. Add Motorcraft® Premium Cooling System Flush to the cooling system and follow the directions on the package.

*Material:* Motorcraft® Premium Cooling System Flush / VC-1 (ESR-M14P7-A)

2. Drain the cooling system.

Refer to: [Cooling System Draining, Vacuum Filling and Bleeding](#) (303-03D Engine Cooling - 5.0L 32V Ti-VCT, General Procedures).

3. Remove the radiator.

Refer to: [Radiator](#) (303-03D Engine Cooling - 5.0L 32V Ti-VCT, Removal and Installation).

4. **NOTICE: Radiator internal pressure must not exceed 138 kPa (20 psi). Damage to the radiator can result.**

Position the radiator upside down and with a high pressure hose in the lower radiator hose opening, backflush the the radiator.

5. Remove the thermostat.

Refer to: [Thermostat](#) (303-03D Engine Cooling - 5.0L 32V Ti-VCT, Removal and Installation).

6. Install the coolant inlet connection without the thermostat.

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

7. Backflush the engine. Position the high-pressure water hose into the engine through the upper radiator hose and backflush the engine.

8. Install the thermostat.

Refer to: [Thermostat](#) (303-03D Engine Cooling - 5.0L 32V Ti-VCT, Removal and Installation).

9. Install the radiator.

Refer to: [Radiator](#) (303-03D Engine Cooling - 5.0L 32V Ti-VCT, Removal and Installation).

10. Fill and bleed the cooling system.

Refer to: [Cooling System Draining, Vacuum Filling and Bleeding](#) (303-03D Engine Cooling - 5.0L 32V Ti-VCT, General Procedures).



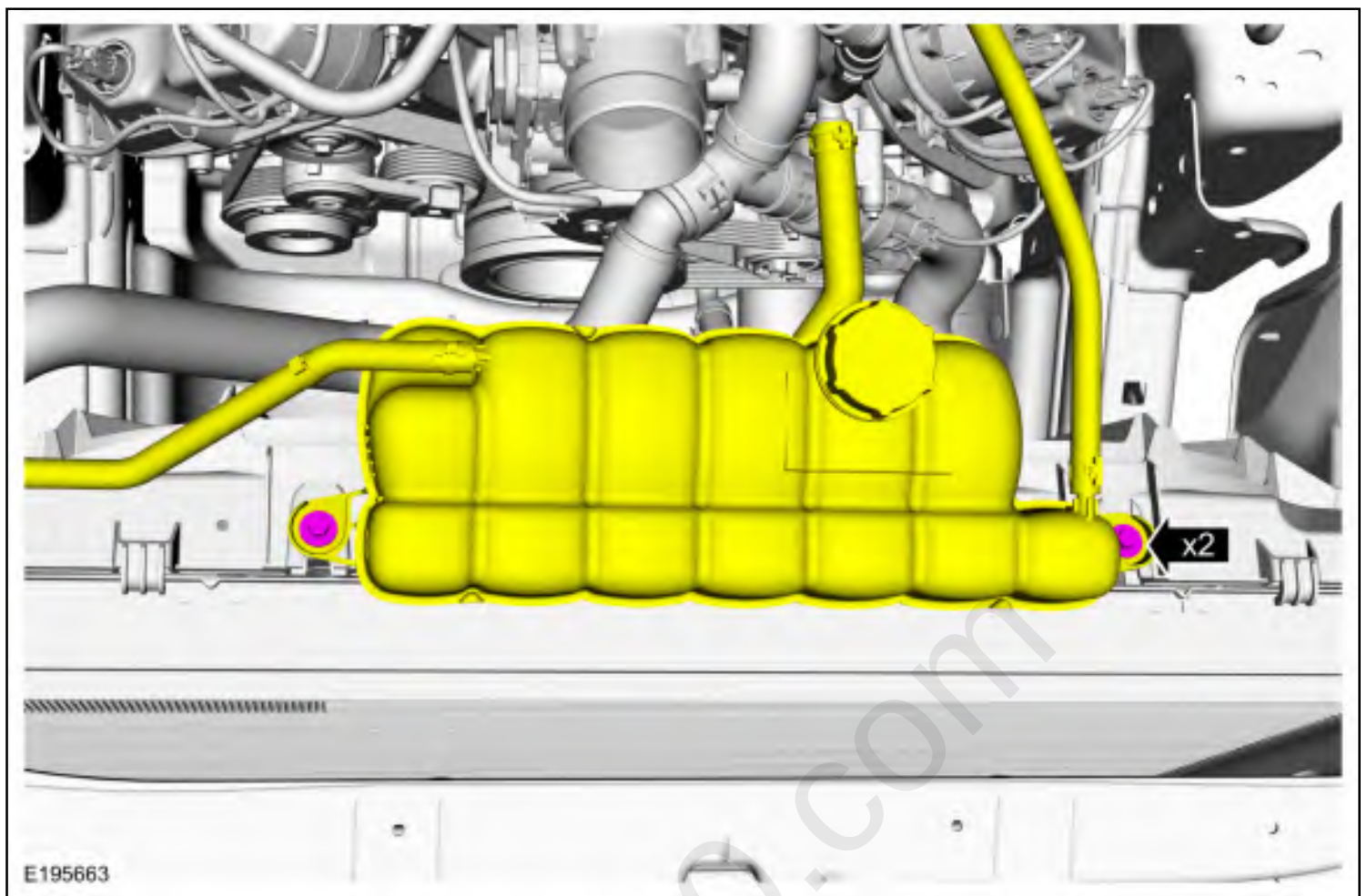
## Coolant Pump

### Materials

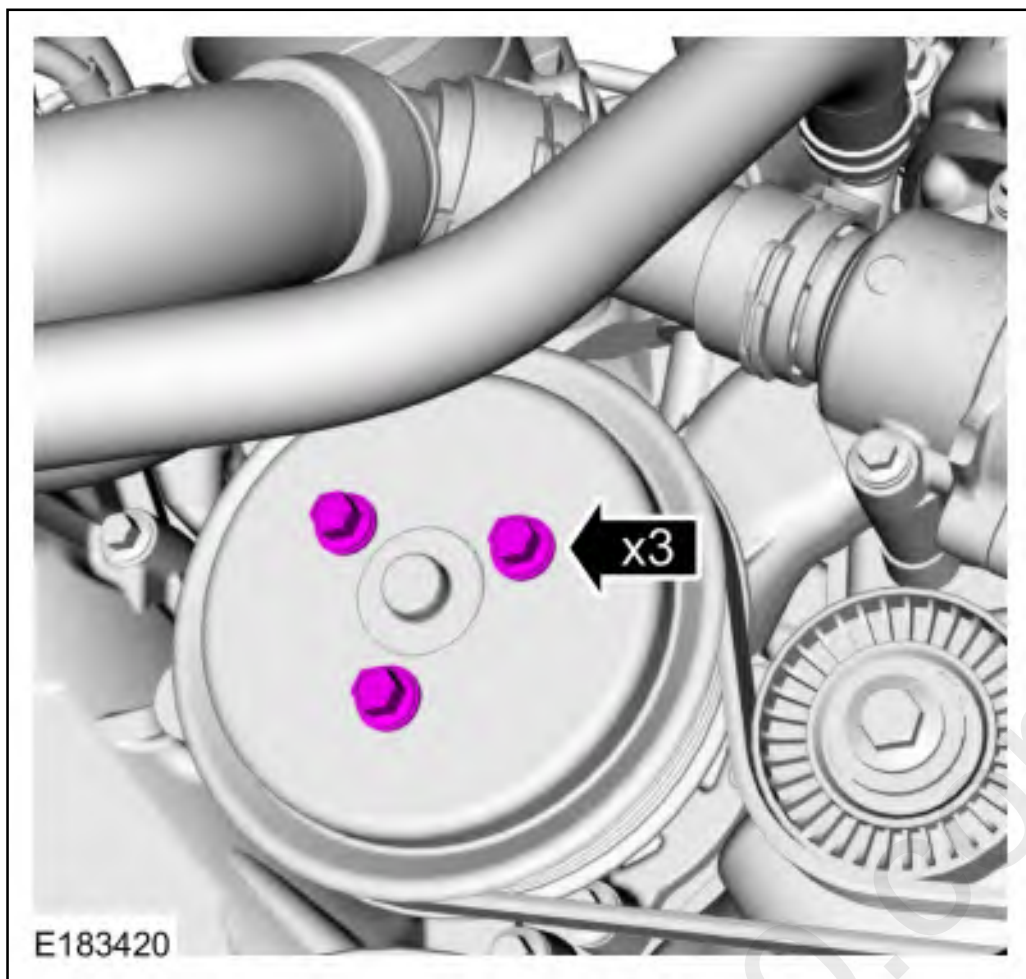
| Name                                                         | Specification |
|--------------------------------------------------------------|---------------|
| Motorcraft® Metal Surface Prep Wipes<br>ZC-31-B              | -             |
| Motorcraft® Orange Concentrated Antifreeze/Coolant<br>VC-3-B | WSS-M97B44-D  |

### Removal

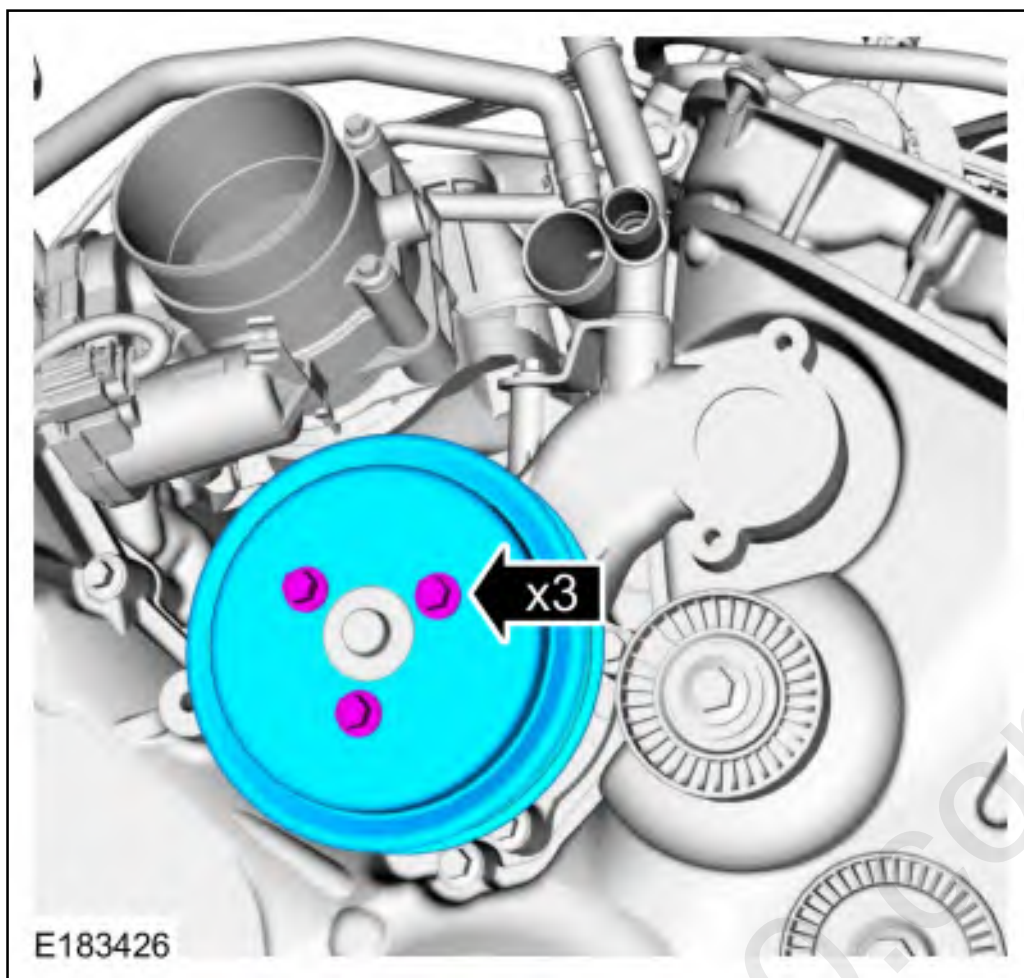
1. Drain the cooling system.  
Refer to: [Cooling System Draining, Vacuum Filling and Bleeding](#) (303-03D Engine Cooling - 5.0L 32V Ti-VCT, General Procedures).
2. Remove the air cleaner outlet pipe.  
Refer to: [Air Cleaner Outlet Pipe](#) (303-12D Intake Air Distribution and Filtering - 5.0L 32V Ti-VCT, Removal and Installation).
3. Remove the bolts and position the degas bottle aside.



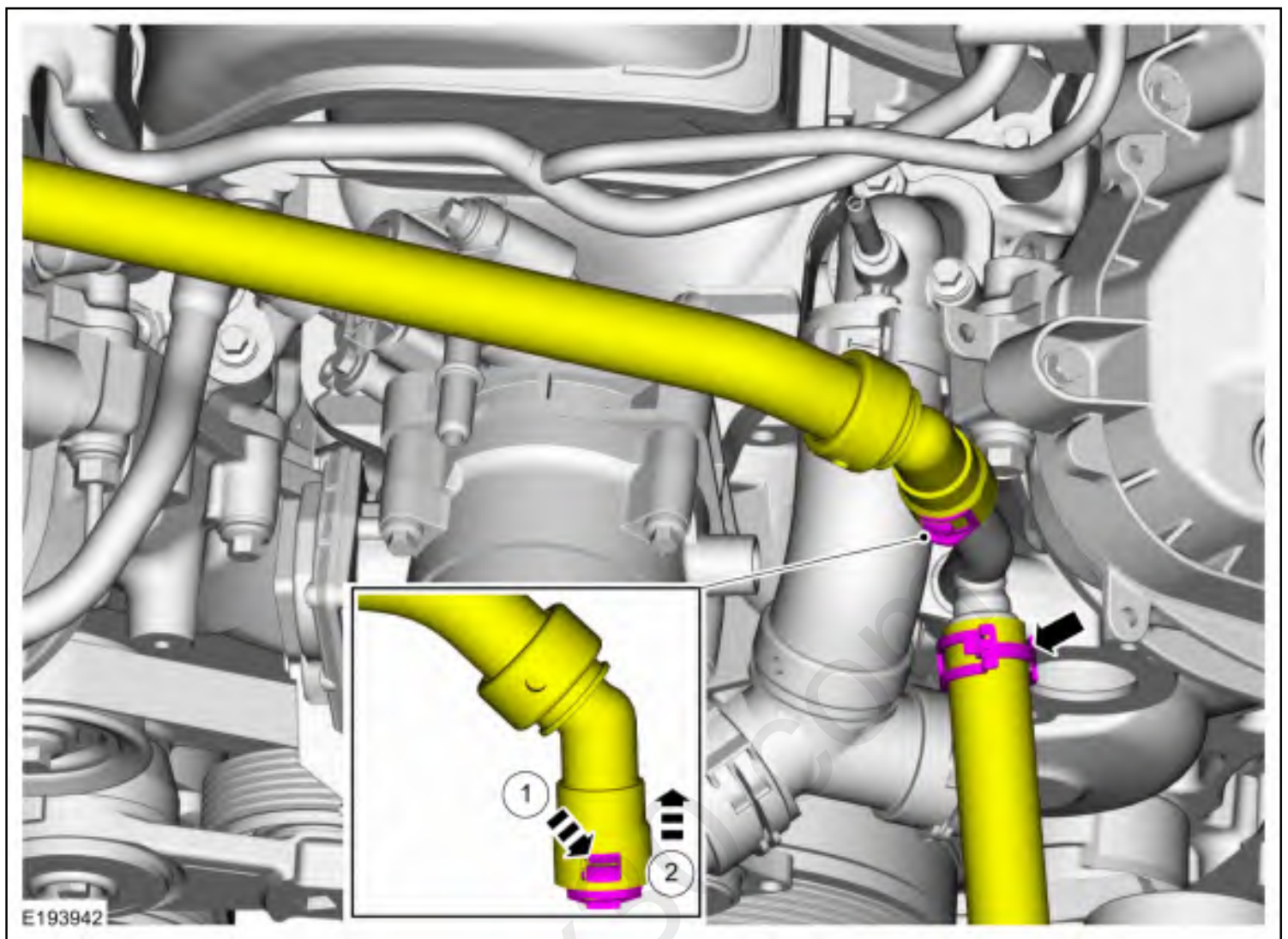
4. Loosen the coolant pump pulley bolts.



5. Remove the accessory drive belt.  
Refer to: [Accessory Drive Belt](#) (303-05D Accessory Drive - 5.0L 32V Ti-VCT, Removal and Installation).
6. **NOTICE: Cover the A/C compressor belt to prevent coolant contamination of the belt.**  
  
Completely cover the A/C compressor belt with waterproof plastic.
7. Remove the thermostat housing.  
Refer to: [Thermostat Housing](#) (303-03D Engine Cooling - 5.0L 32V Ti-VCT, Removal and Installation).
8. Remove the bolts and the coolant pump pulley.

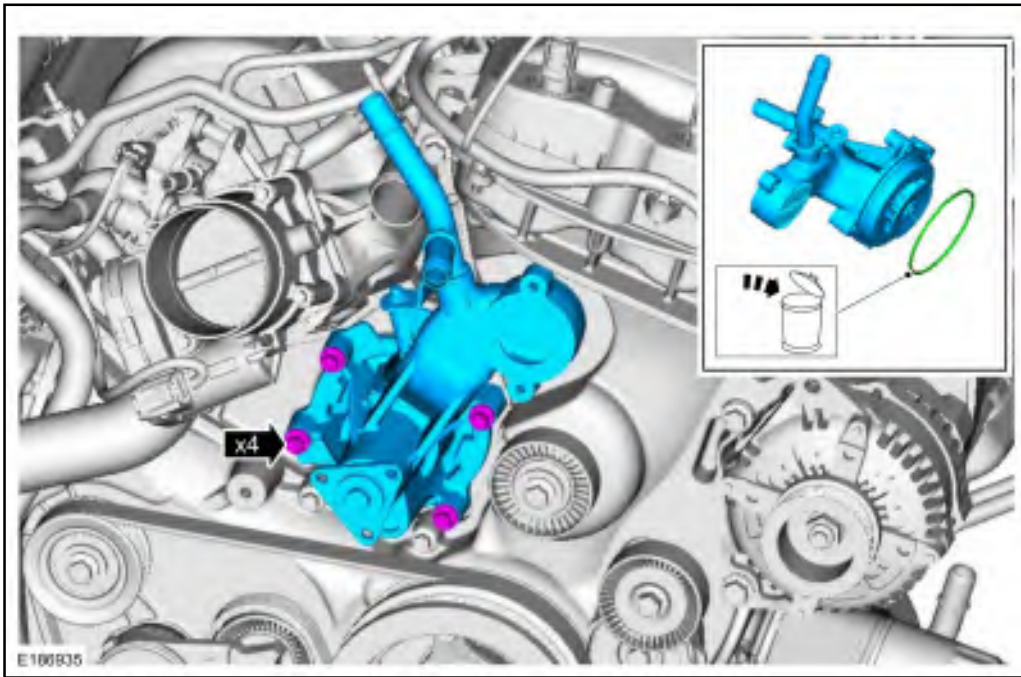


- Disconnect the heater outlet hose from the heater outlet tube.
- Release the clamp and disconnect the lower degas bottle hose from the heater outlet tube.



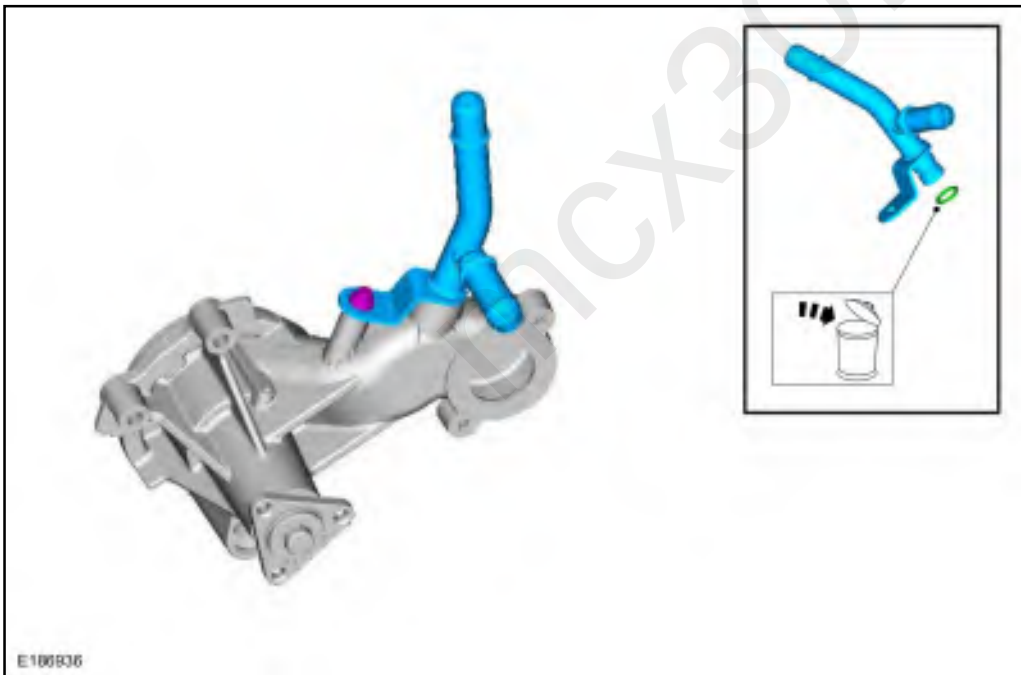
- Remove the bolts and the coolant pump.
- Remove and discard the O-ring seal.





11. **NOTE:** *This step is only necessary when installing a new component.*

- Remove the bolt and the heater outlet tube.
- Remove and discard the O-ring seal.



## Installation

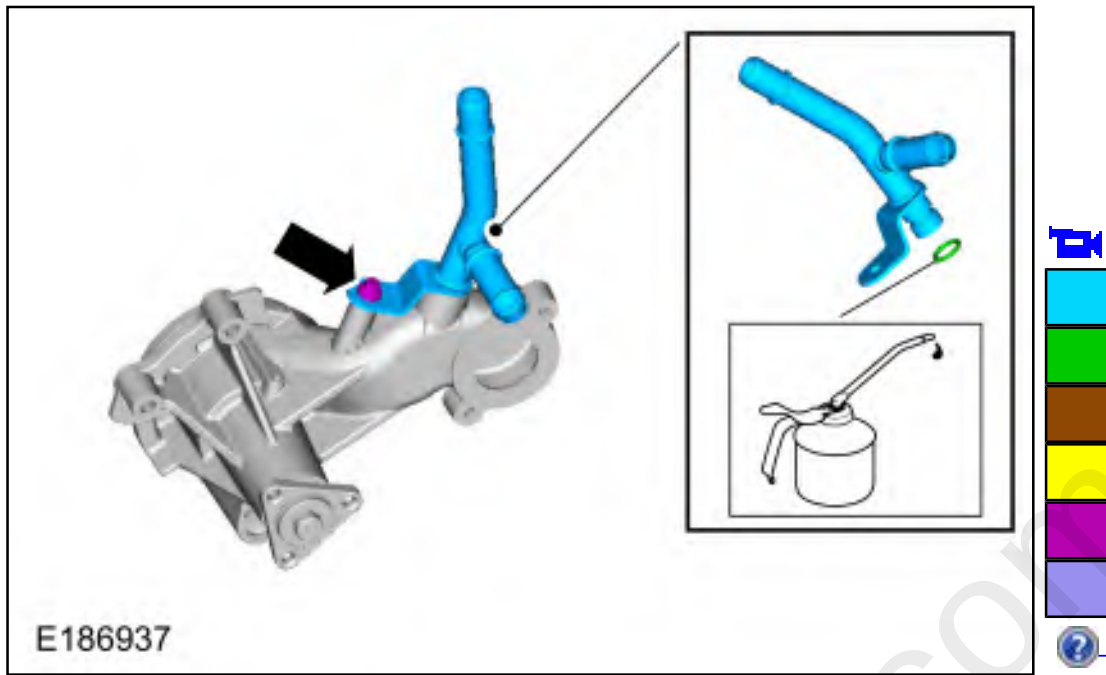
1. **NOTE:** *This step is only necessary when installing a new component.*

- Install a new O-ring seal on the heater outlet tube and lubricate it with clean engine coolant.

*Material:* Motorcraft® Orange Concentrated Antifreeze/Coolant / VC-3-B (WSS-M97B44-D)

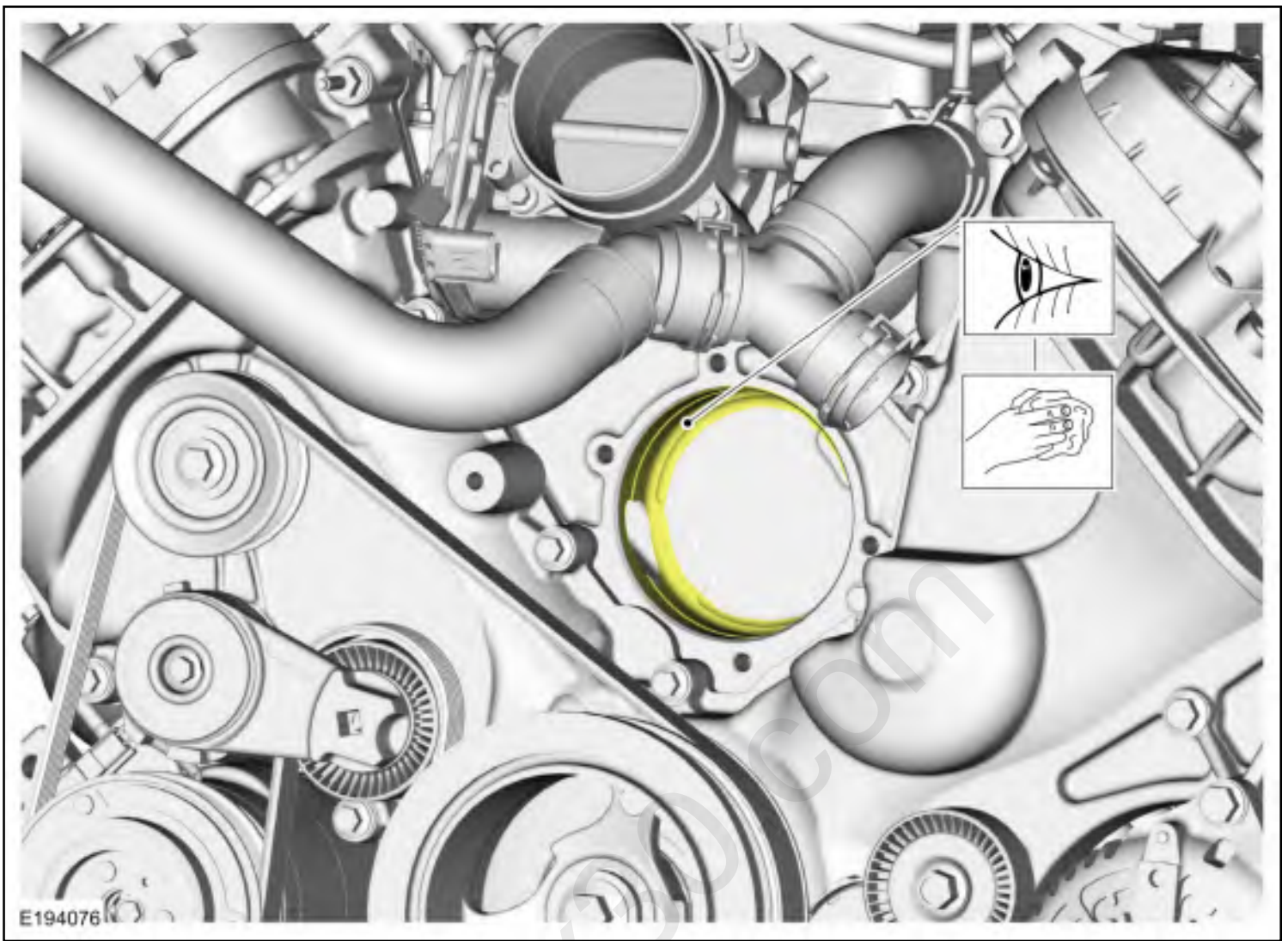
- Install the heater outlet tube and the bolt.

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



2. Inspect the sealing surfaces and clean with metal surface prep wipes.

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



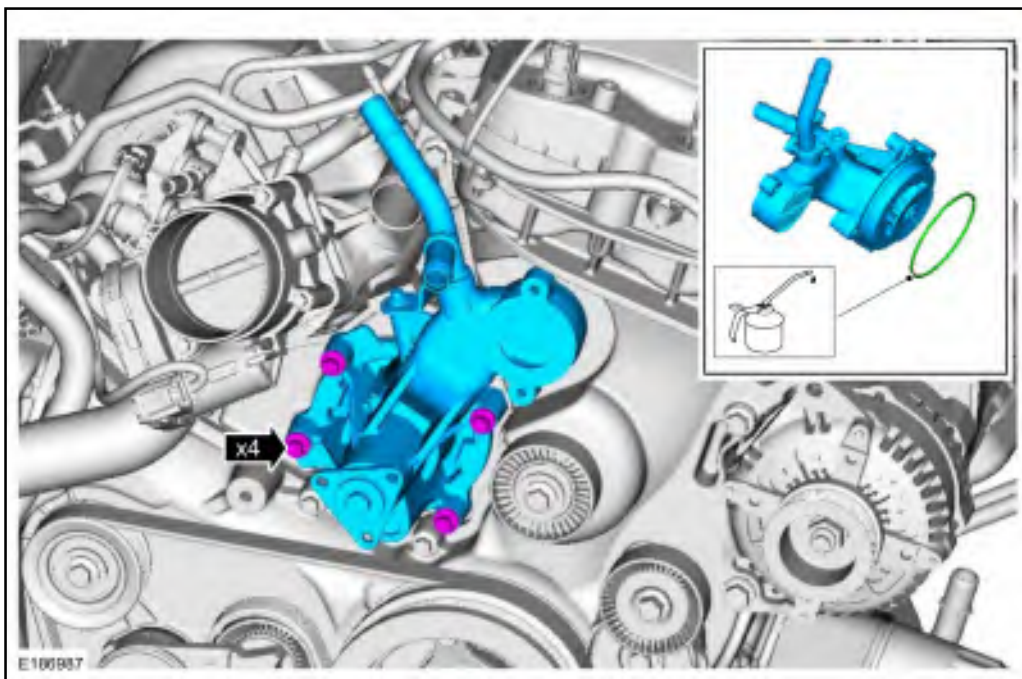
3. **NOTICE:** Align the bolt holes with the bosses prior to insertion of the coolant pump and insert the pump straight into the coolant pump cavity. Do not rotate the coolant pump once installed into the coolant pump cavity or the O-ring seal can be damaged, causing the coolant pump to leak.

- Install a new O-ring seal and lubricate it with clean engine coolant.  
*Material:* Motorcraft® Orange Concentrated Antifreeze/Coolant / VC-3-B (WSS-M97B44-D)
- Install the coolant pump and tighten the bolts in 2 stages.

*Torque:*

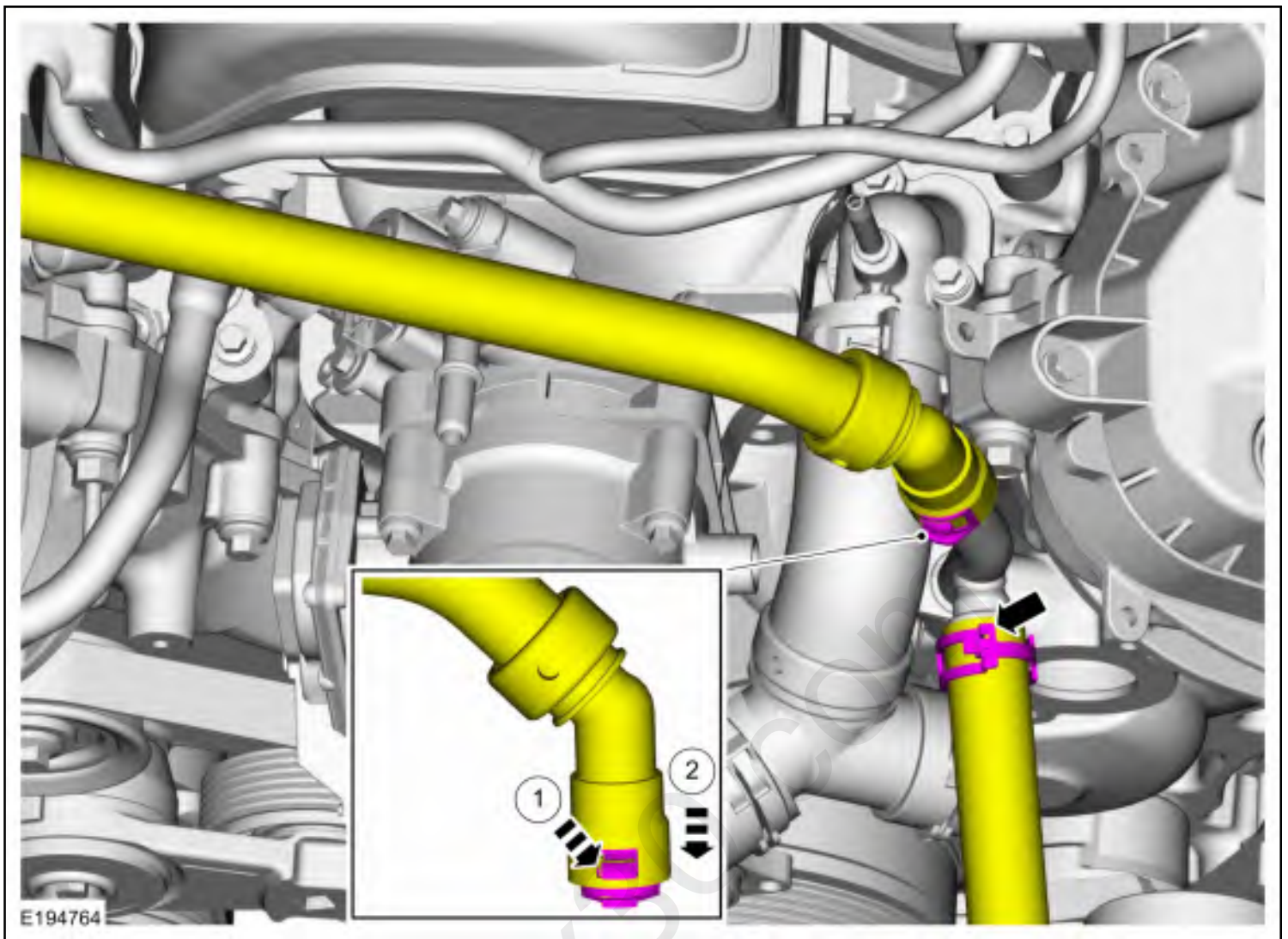
Stage 1: 177 lb.in (20 Nm)

Stage 2: 60°



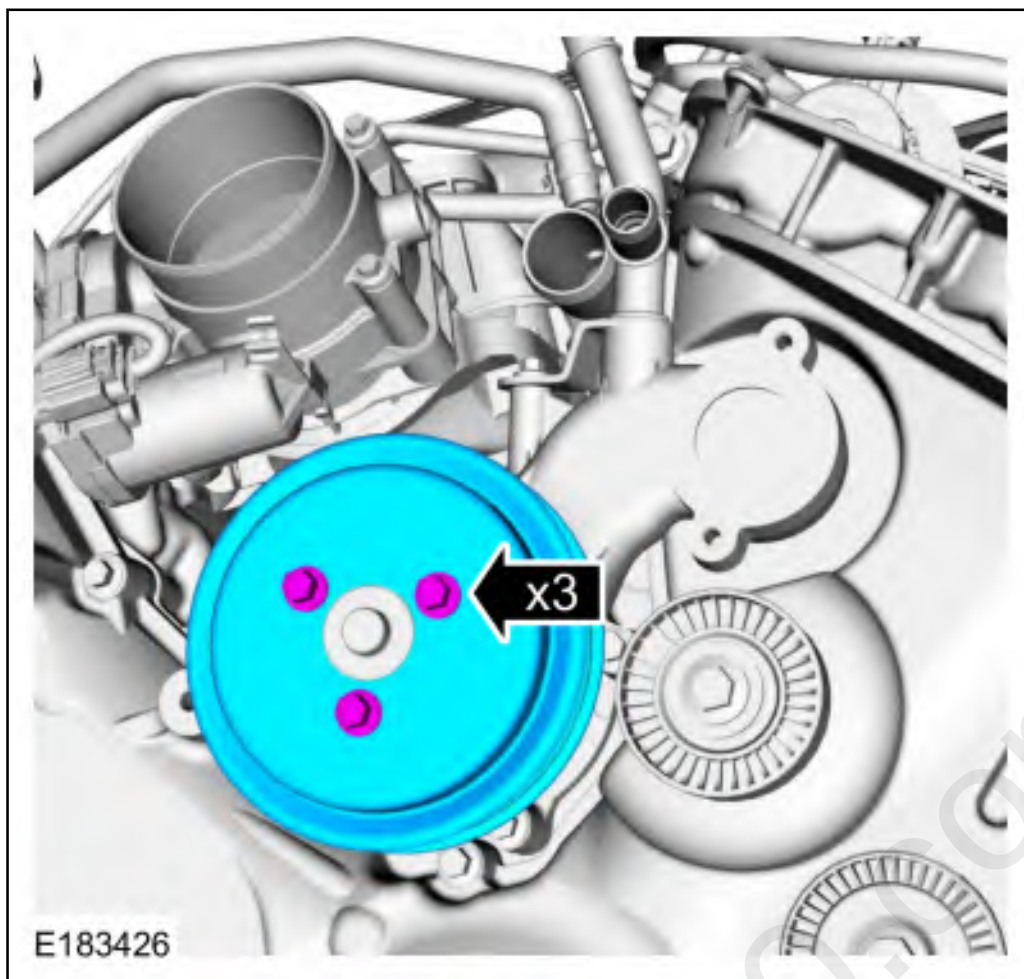
- Connect the lower degas bottle hose to the heater outlet tube and position the clamp.
- Connect the heater outlet hose to the heater outlet tube.



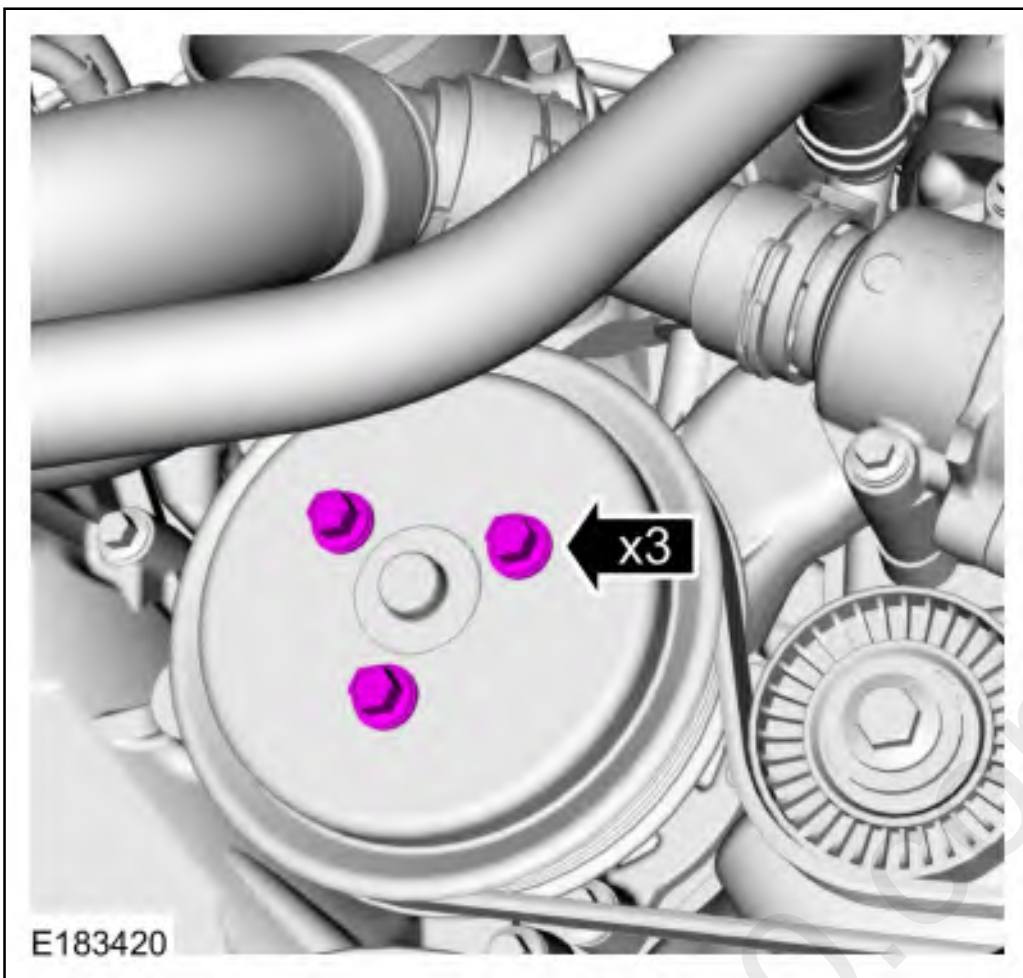


5. Position the coolant pump pulley and install the bolts finger tight.

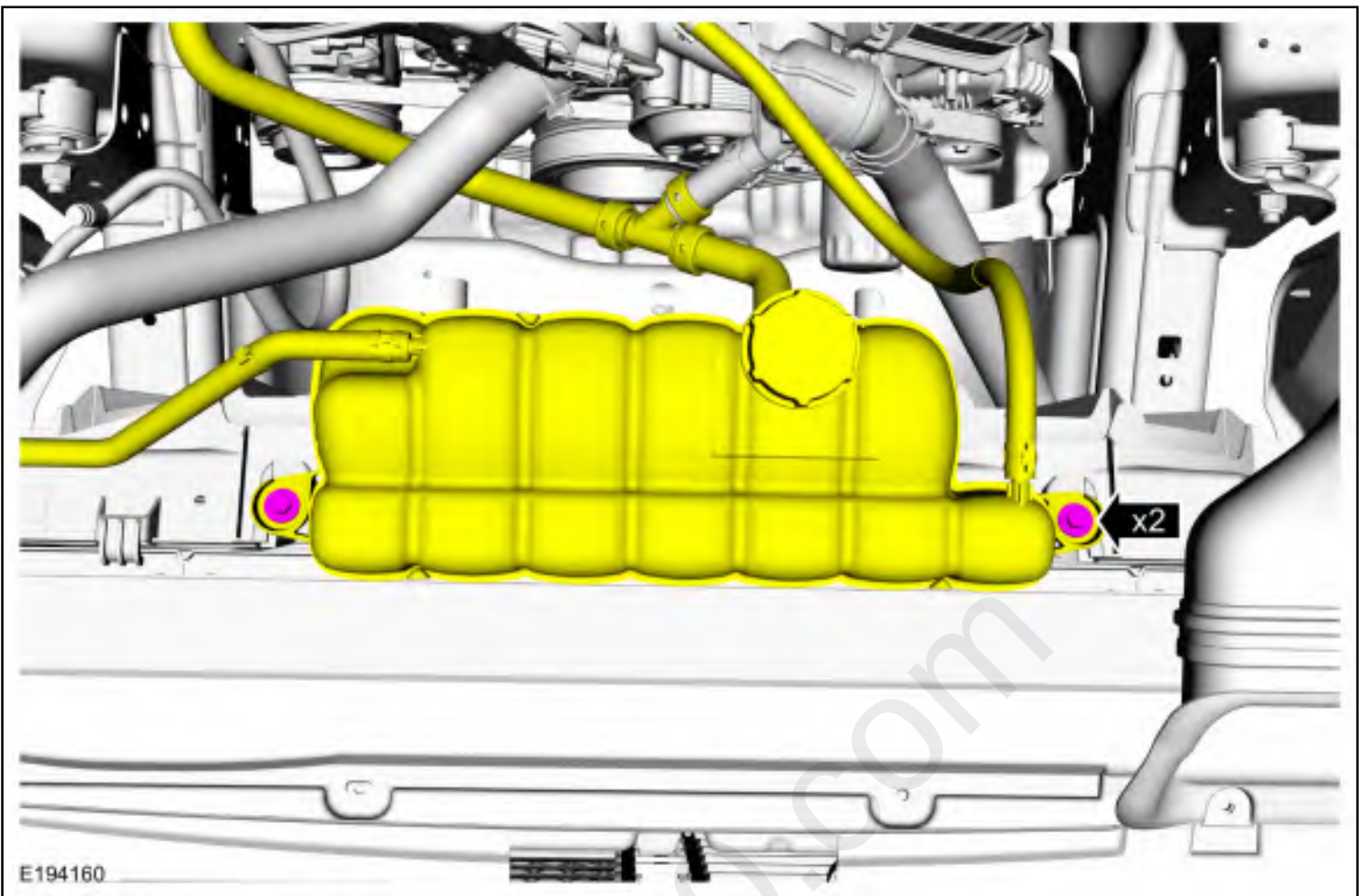




6. Install the thermostat housing.  
Refer to: [Thermostat Housing](#) (303-03D Engine Cooling - 5.0L 32V Ti-VCT, Removal and Installation).
7. Remove the plastic from the A/C compressor belt.
8. Install the accessory drive belt.  
Refer to: [Accessory Drive Belt](#) (303-05D Accessory Drive - 5.0L 32V Ti-VCT, Removal and Installation).
9. Tighten the coolant pump pulley bolts.  
*Torque: 18 lb.ft (25 Nm)*



10. Position the degas bottle back and tighten the bolts.  
*Torque: 62 lb.in (7 Nm)*



11. Install the air cleaner outlet pipe.  
Refer to: [Air Cleaner Outlet Pipe](#) (303-12D Intake Air Distribution and Filtering - 5.0L 32V Ti-VCT, Removal and Installation).
12. Fill and bleed the cooling system.  
Refer to: [Cooling System Draining, Vacuum Filling and Bleeding](#) (303-03D Engine Cooling - 5.0L 32V Ti-VCT, General Procedures).

## Cooling Module

### Special Tool(s) / General Equipment

|                              |
|------------------------------|
| Hose Clamp Remover/Installer |
|------------------------------|

### Materials

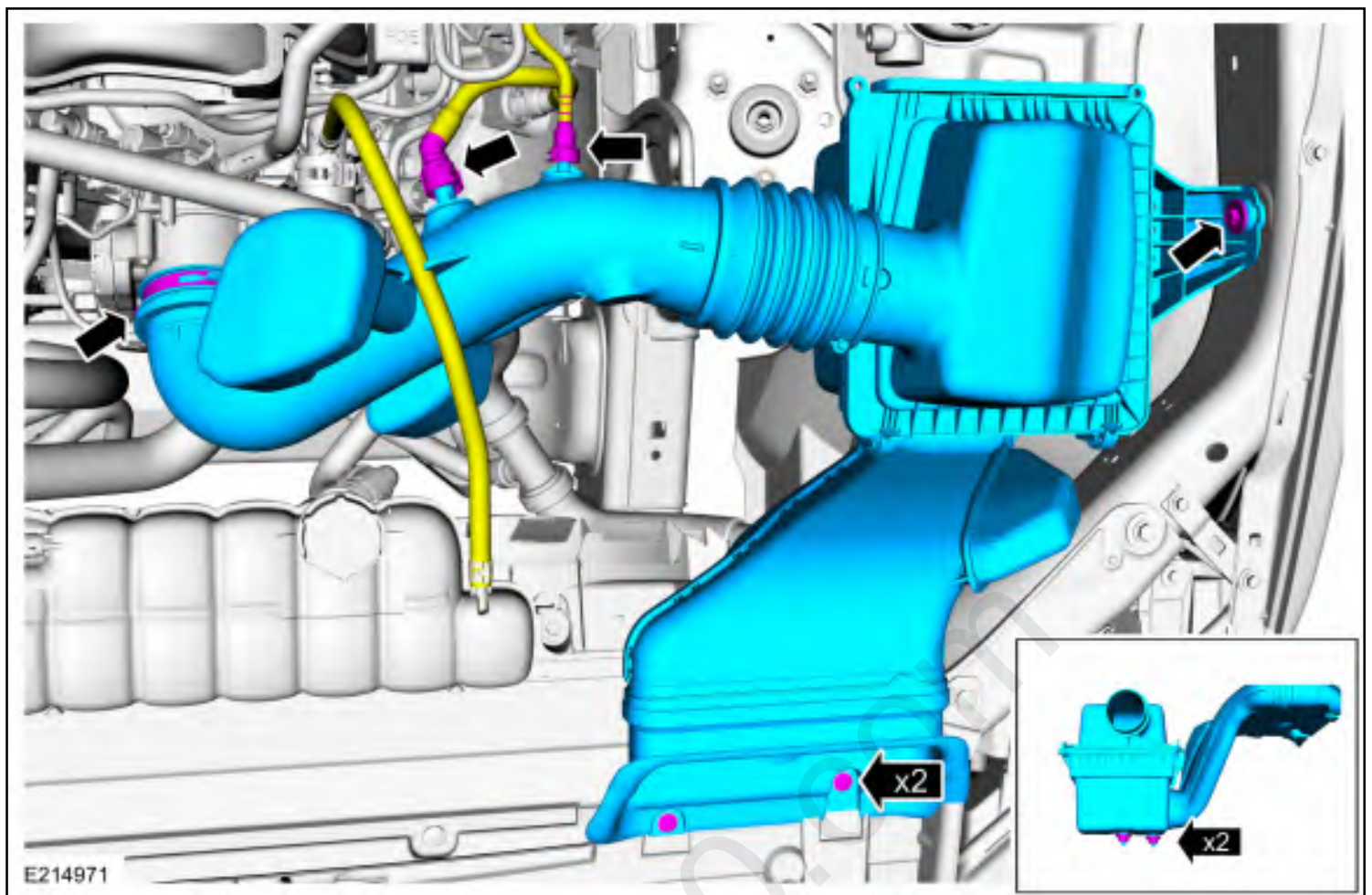
| Name                                           | Specification |
|------------------------------------------------|---------------|
| Motorcraft® R-1234yf Refrigerant PAG Oil YN-35 | WSS-M2C300-A2 |

### Removal

**NOTE:** Removal steps in this procedure may contain installation details.

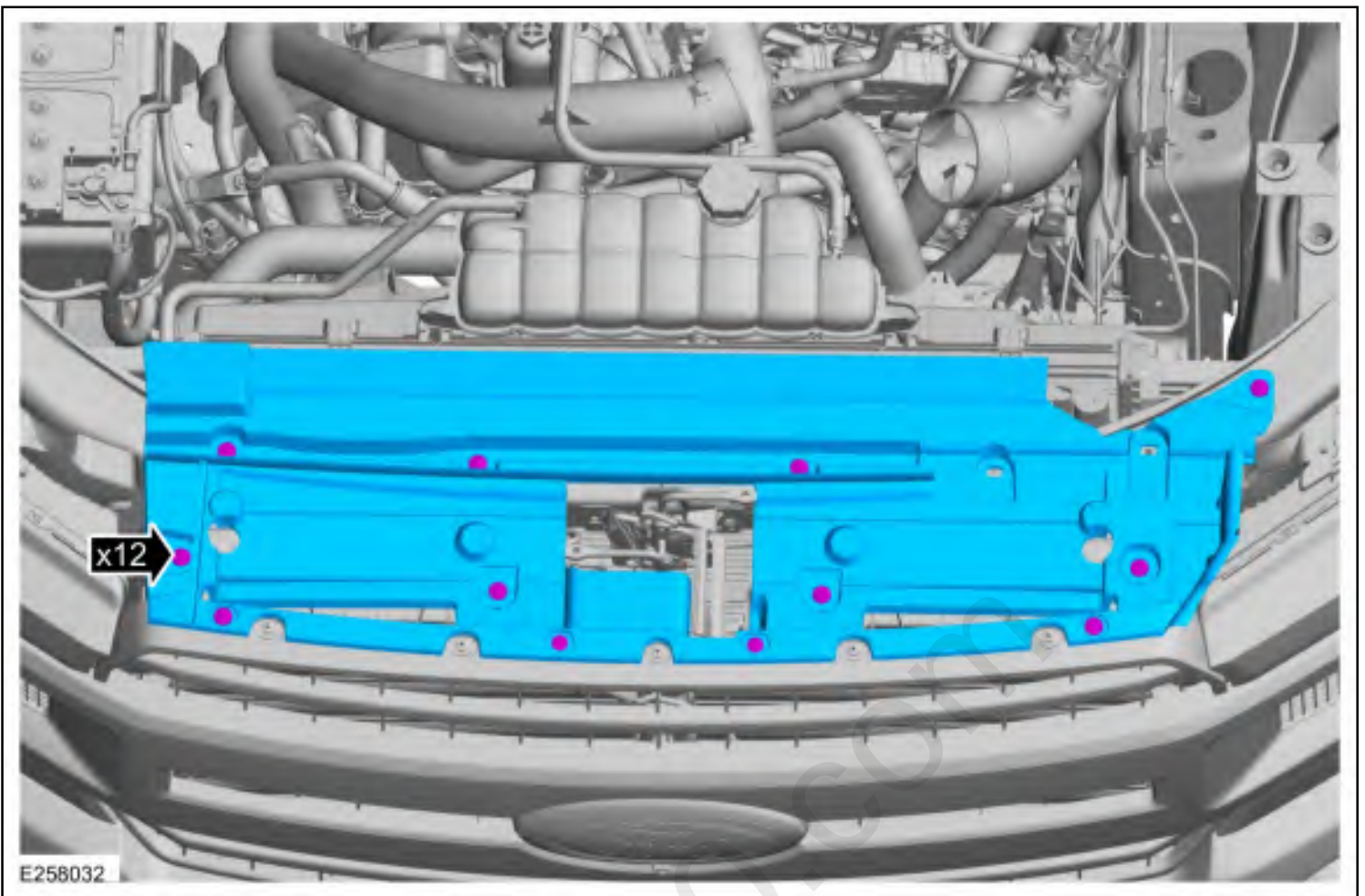
1. With the vehicle in NEUTRAL, position it on a hoist.  
Refer to: [Jacking and Lifting - Overview](#) (100-02 Jacking and Lifting, Description and Operation).
2. Drain the cooling system.  
Refer to: [Cooling System Draining, Vacuum Filling and Bleeding](#) (303-03D Engine Cooling - 5.0L 32V Ti-VCT, General Procedures).
3. Evacuate the A/C system.  
Refer to: [Air Conditioning \(A/C\) System Recovery, Evacuation and Charging - Vehicles With: R1234YF Refrigerant](#) (412-00 Climate Control System - General Information, General Procedures).
4. Position aside the coolant tube. Disconnect and position aside the brake booster and the crankcase ventilation tubes. Loosen the clamp and remove the retainers and the air cleaner and outlet pipe assembly.  
*Torque:*  
Clamp: 35 lb.in (4 Nm)  
Bolt: 150 lb.in (17 Nm)



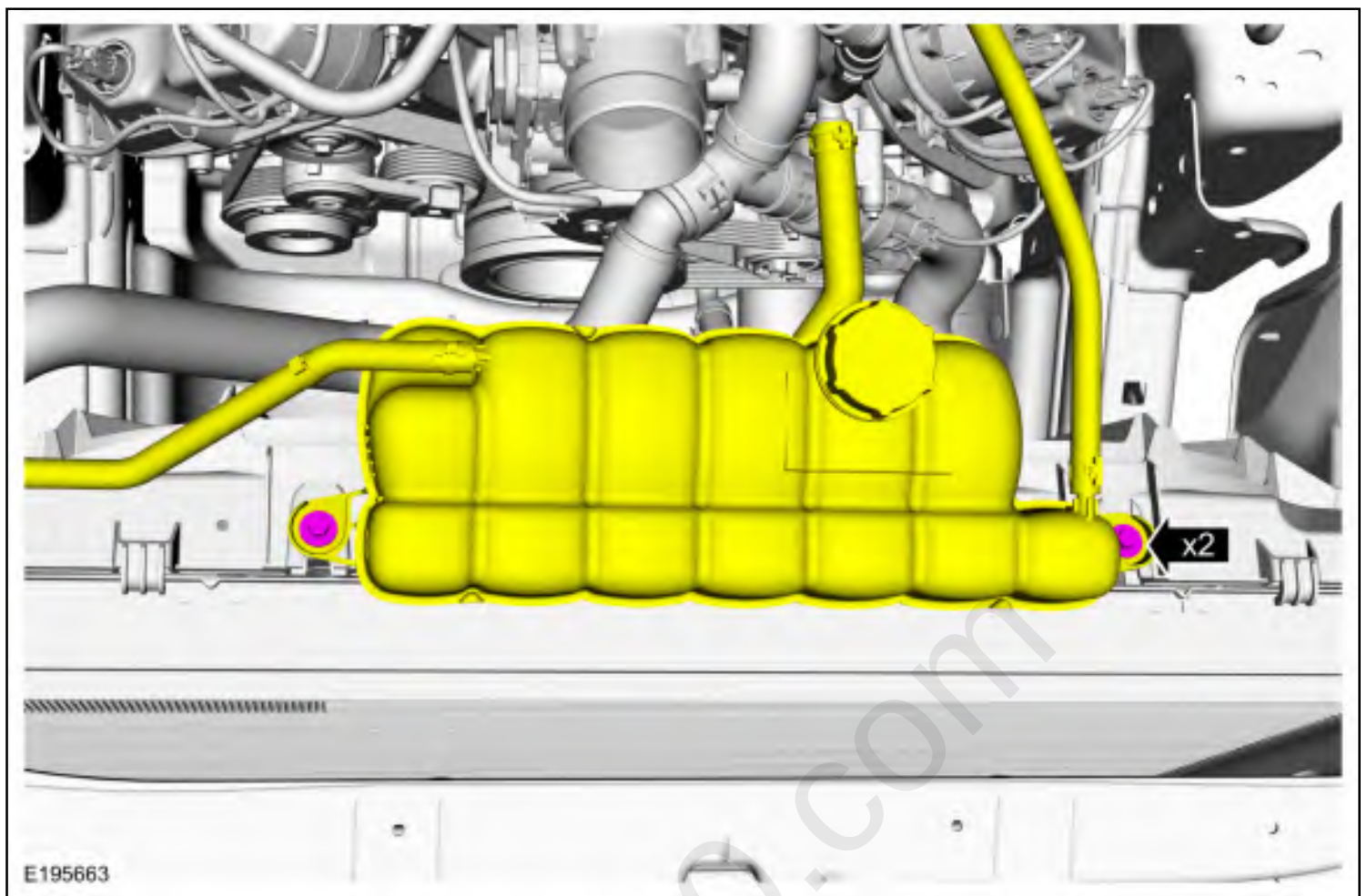


5. Remove the pin-type retainers and the upper radiator air deflector.

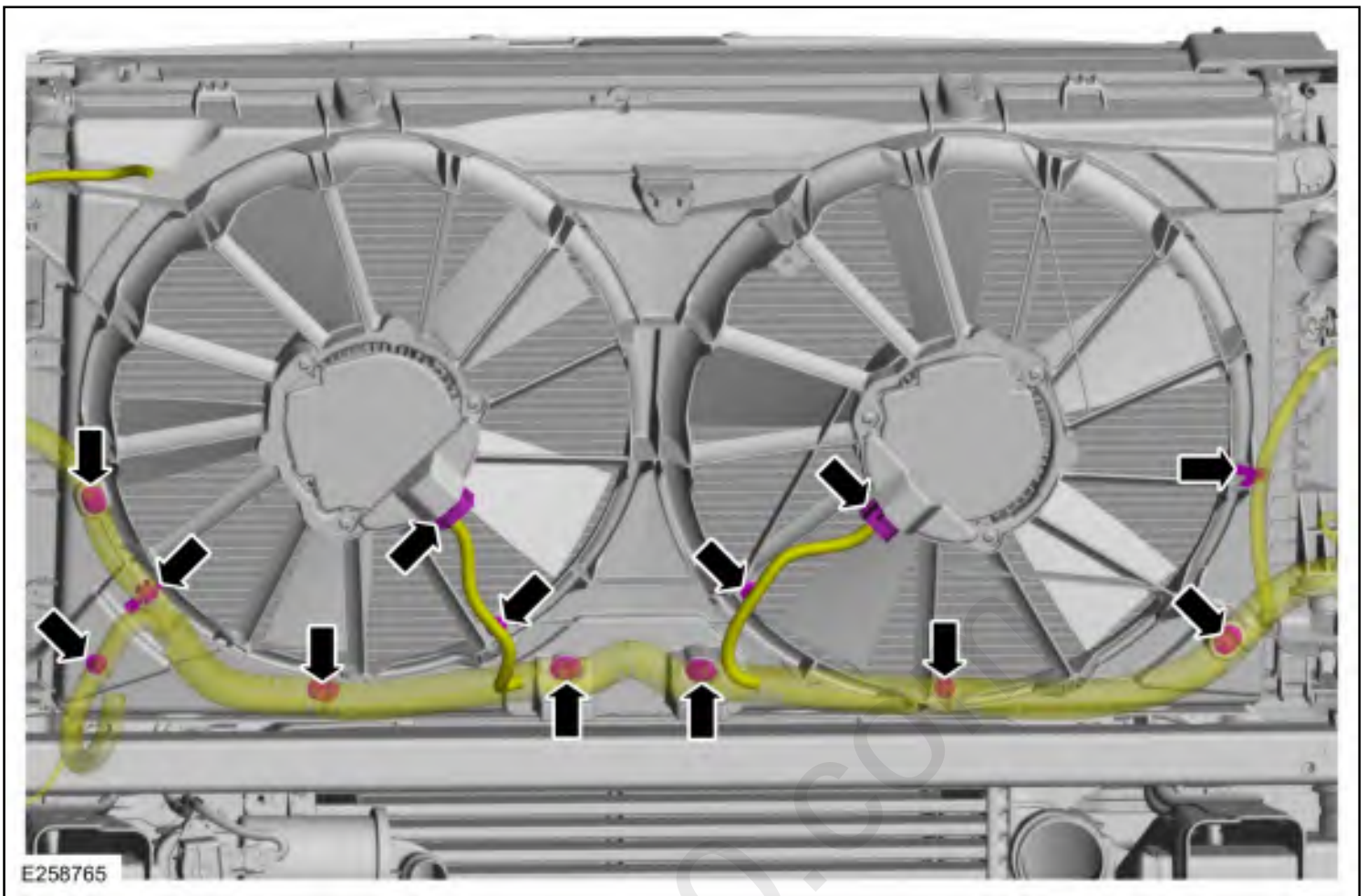




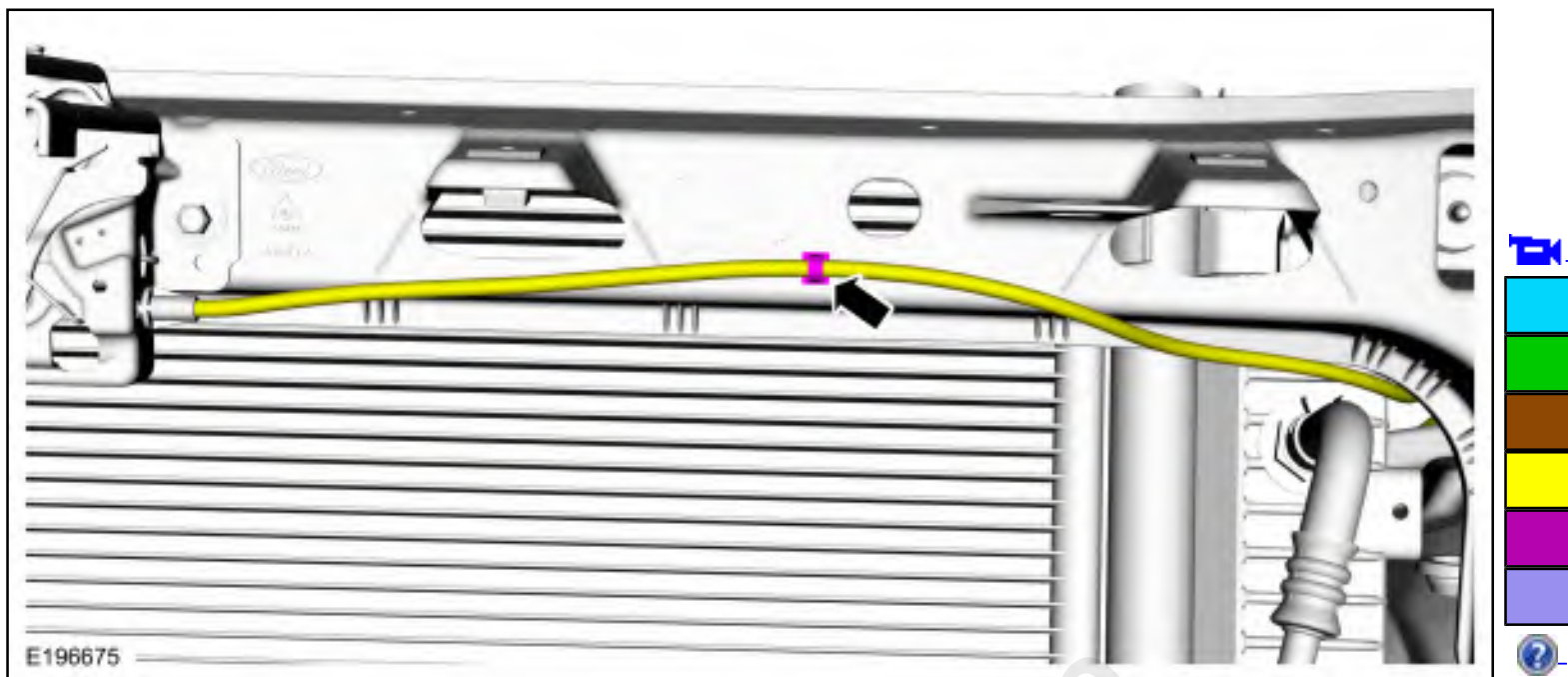
6. Remove the bolts and position the degas bottle aside.  
*Torque: 62 lb.in (7 Nm)*



7. Disconnect the electrical connectors, detach the pin-type retainers and position the wiring harness aside.



8. Remove both headlamp assemblies.  
Refer to: [Headlamp Assembly](#) (417-01 Exterior Lighting, Removal and Installation).
9. Remove the radiator grille.  
Refer to: [Radiator Grille](#) (501-08 Exterior Trim and Ornamentation, Removal and Installation).
10. Detach the hood latch cable retainer.



11. Remove the hood latch assembly.

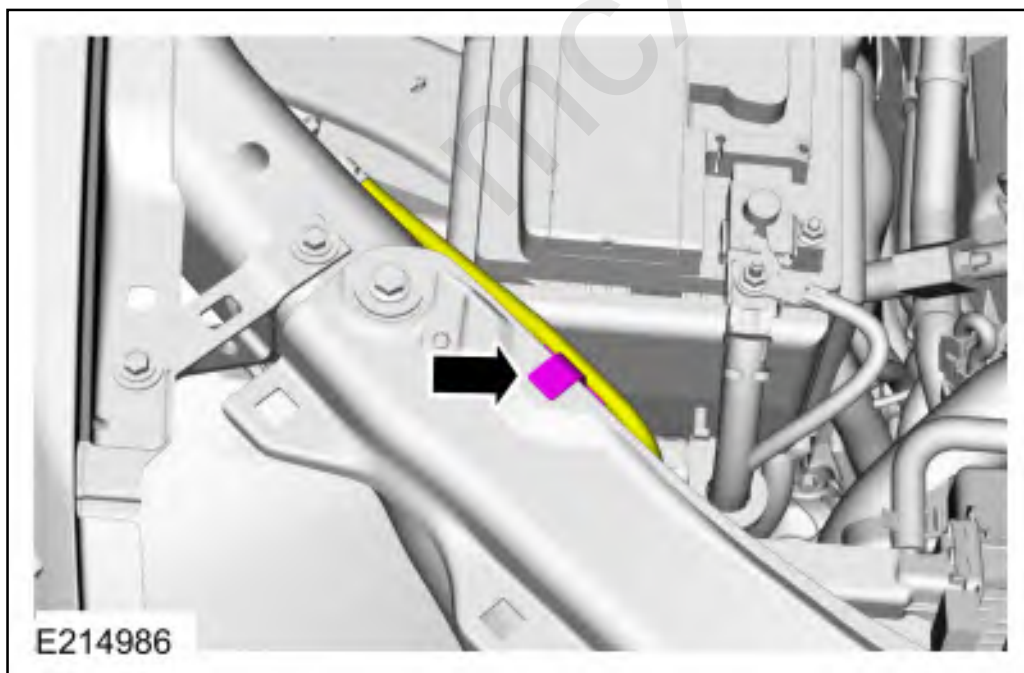
Refer to: [Hood Latch](#) (501-14 Handles, Locks, Latches and Entry Systems, Removal and Installation).

12. Remove the pin-type retainers and position the air deflector aside.





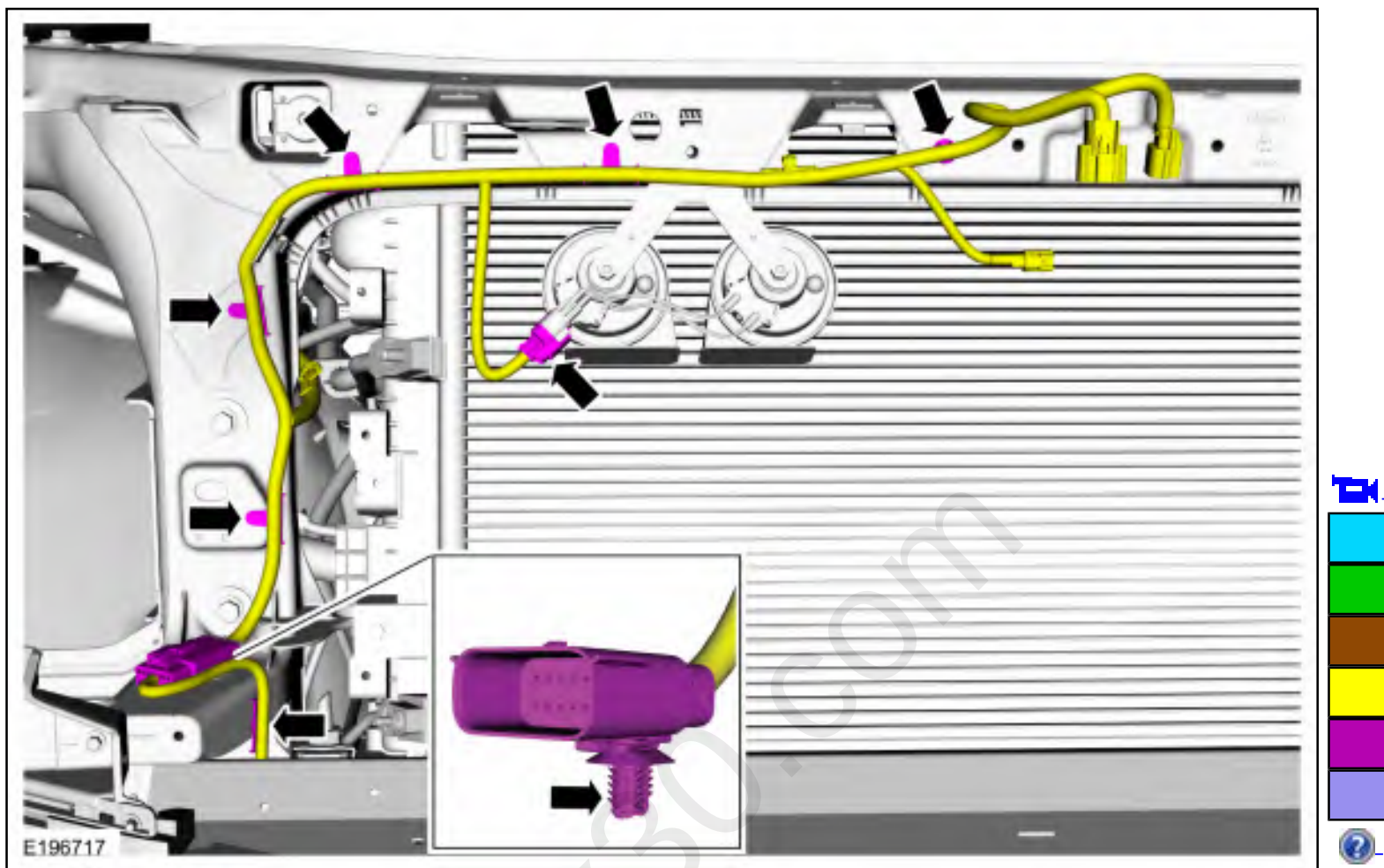
13. Detach the battery cable pin-type retainer.



14. Disconnect the electrical connectors. Detach the electrical connector and wiring harness retainers.



Position the wiring harness between the radiator and the radiator grille support.



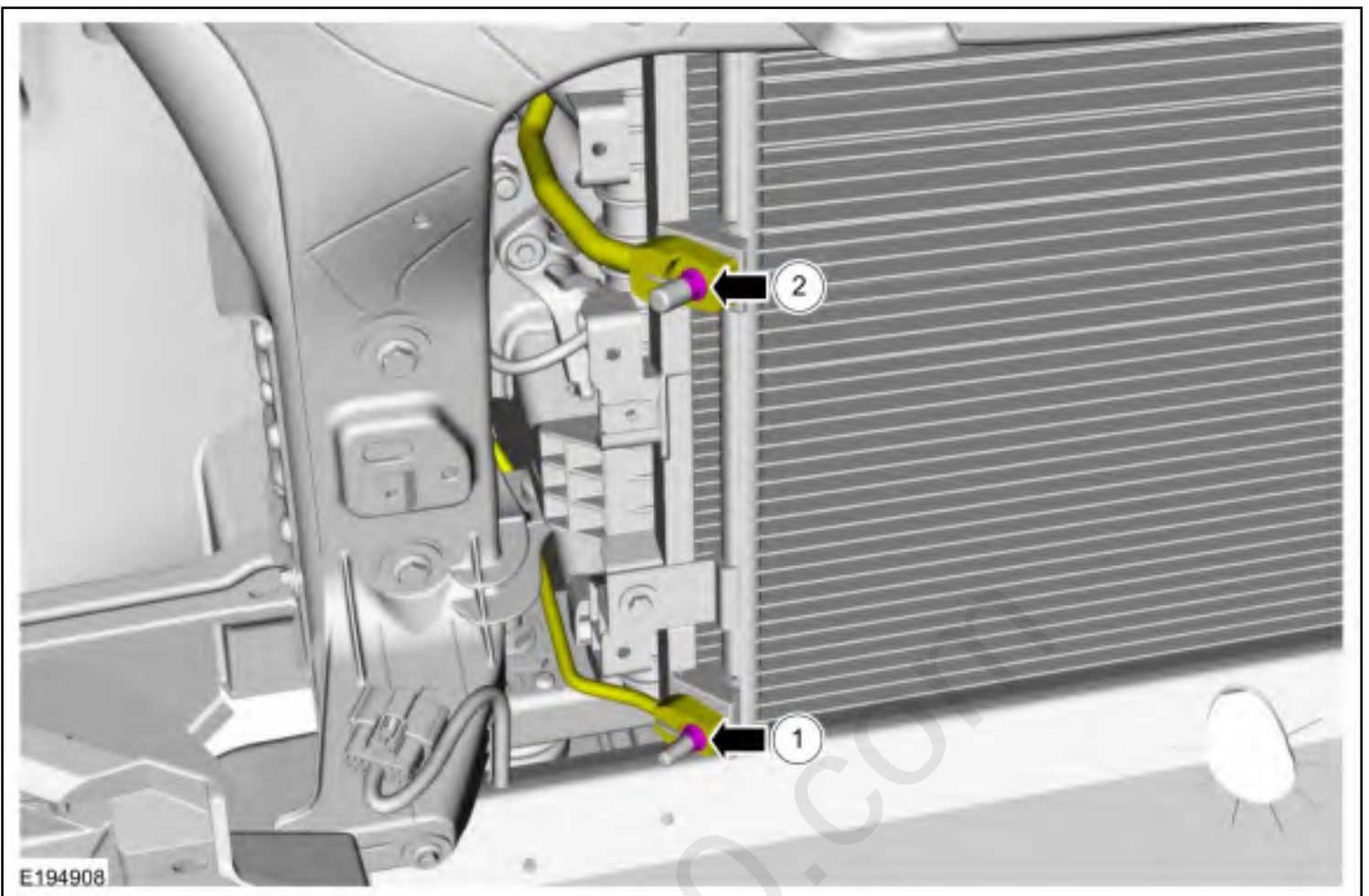
15. **NOTICE: Make sure that all openings are sealed.**

Remove the condenser inlet and outlet nuts and disconnect the fittings.

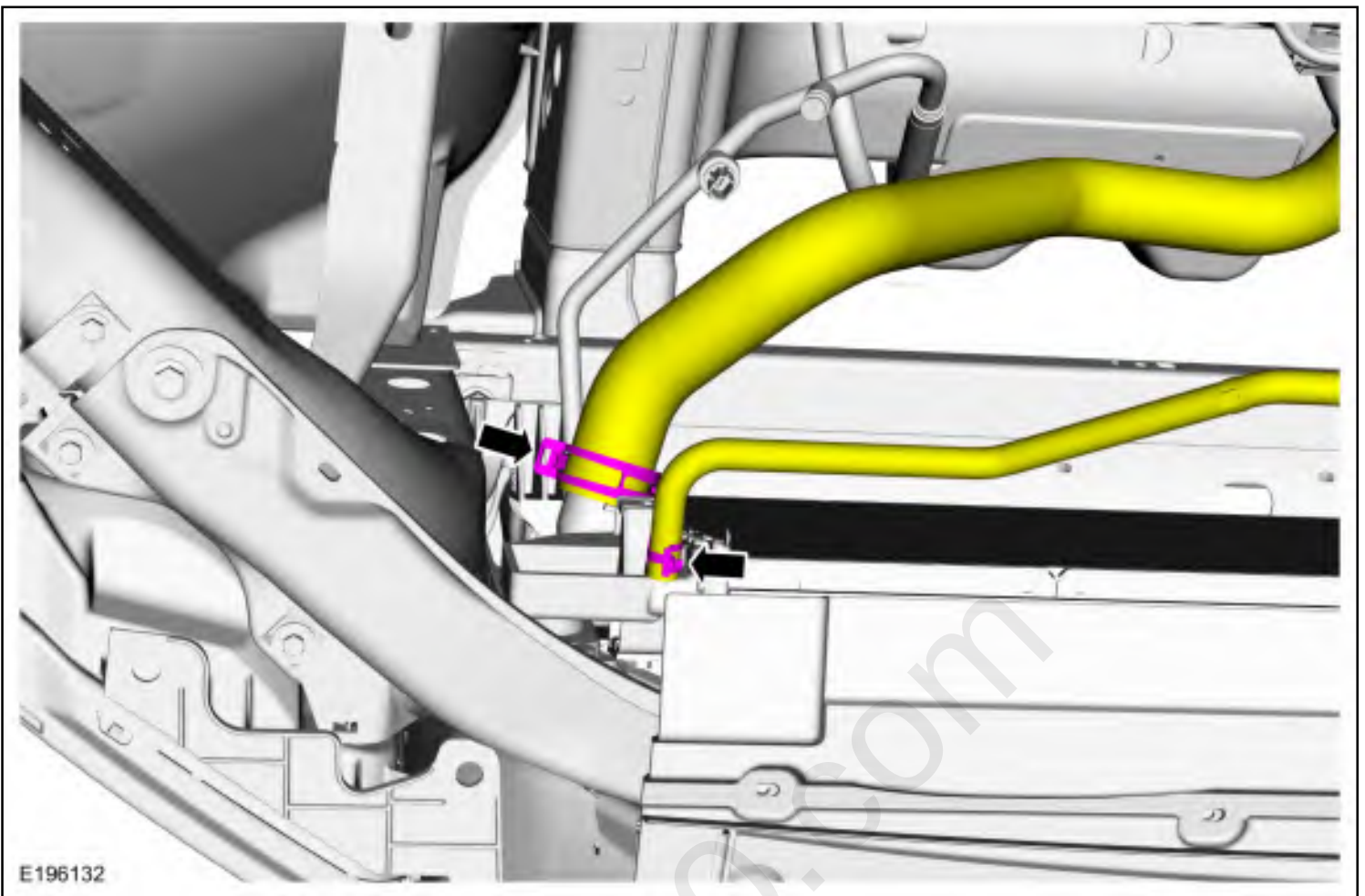
*Torque:*

Stage 1: 71 lb.in (8 Nm)

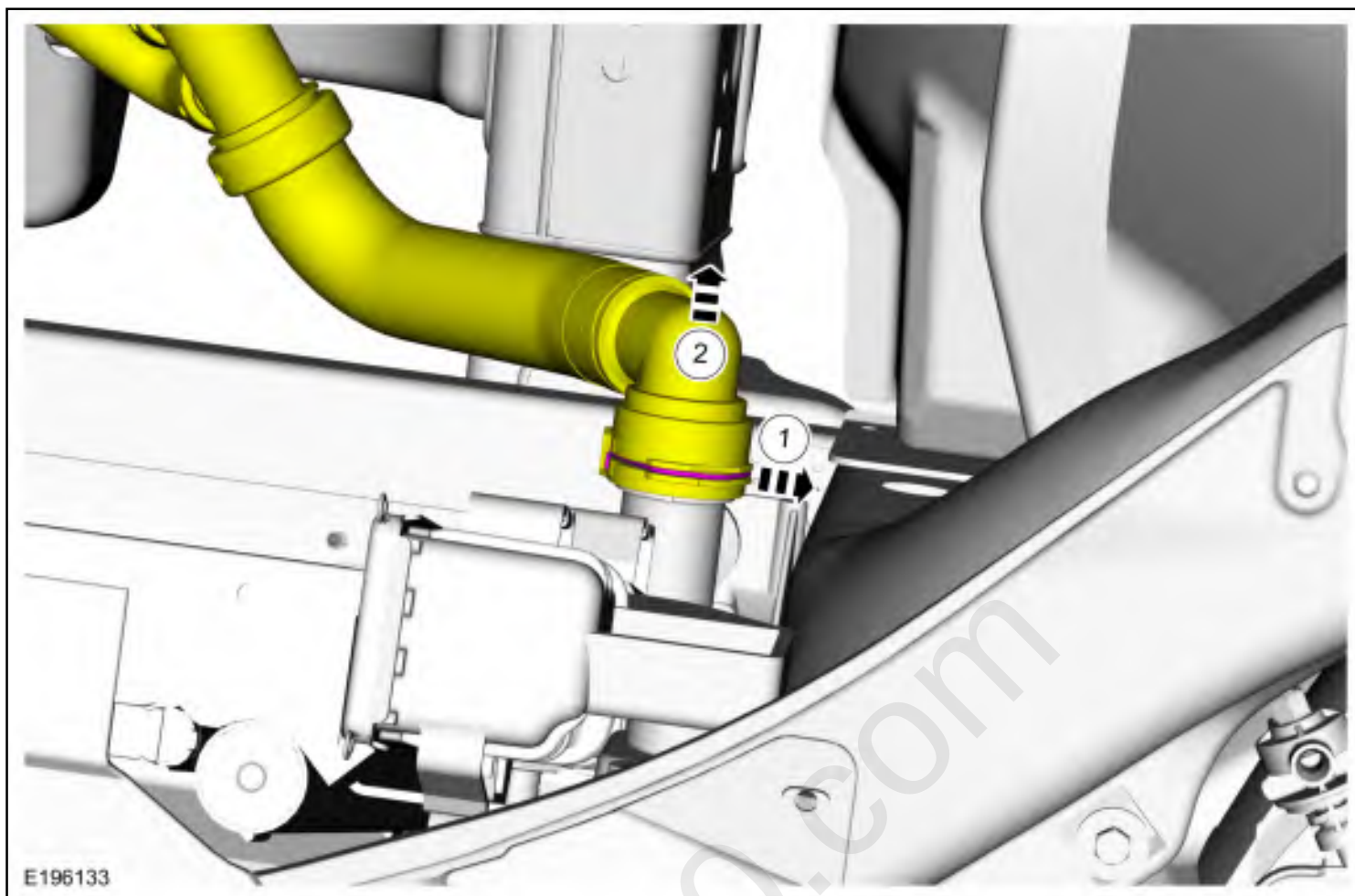
Stage 2: 133 lb.in (15 Nm)



16. Release the clamps and disconnect the upper radiator hose and the radiator to degas bottle hose.  
Use the General Equipment: Hose Clamp Remover/Installer



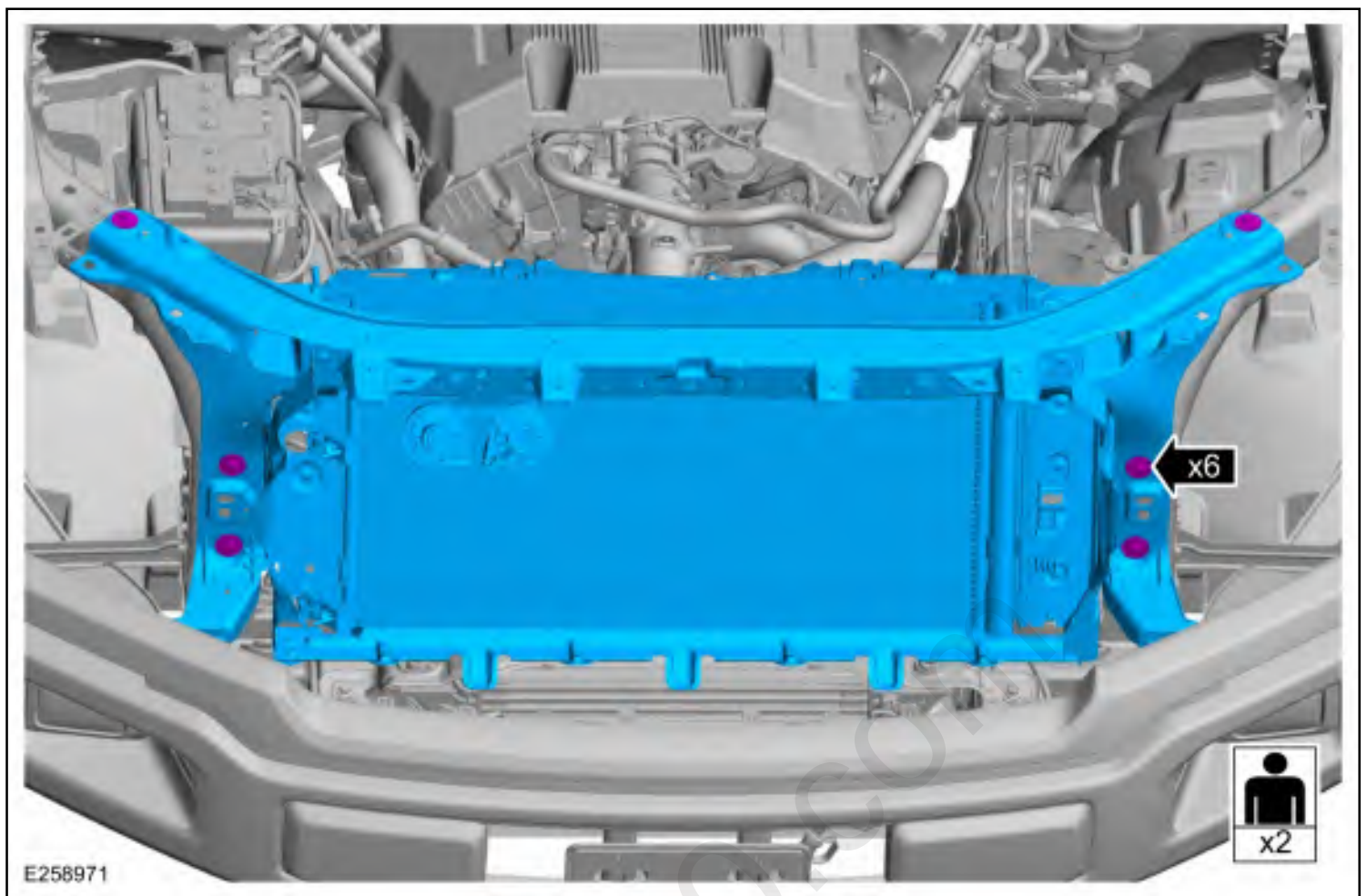
17. Pull the lower radiator hose spring clip until the end of the clip is in the detent on the quick connect coupling and disconnect the lower radiator hose.



18. Remove the retainers and the cooling module.  
*Torque: 22 lb.ft (30 Nm)*







## Installation

1. To install, reverse the removal procedure.
2. **NOTICE: Only use the specified material to lubricate the seals.**

Install new condenser fitting O-ring seals.

*Material:* Motorcraft® R-1234yf Refrigerant PAG Oil / YN-35 (WSS-M2C300-A2)

3. Fill and bleed the cooling system.  
Refer to: [Cooling System Draining, Vacuum Filling and Bleeding](#) (303-03D Engine Cooling - 5.0L 32V Ti-VCT, General Procedures).



# Thermostat

## Materials

| Name                                                      | Specification |
|-----------------------------------------------------------|---------------|
| Motorcraft® Orange Concentrated Antifreeze/Coolant VC-3-B | WSS-M97B44-D  |

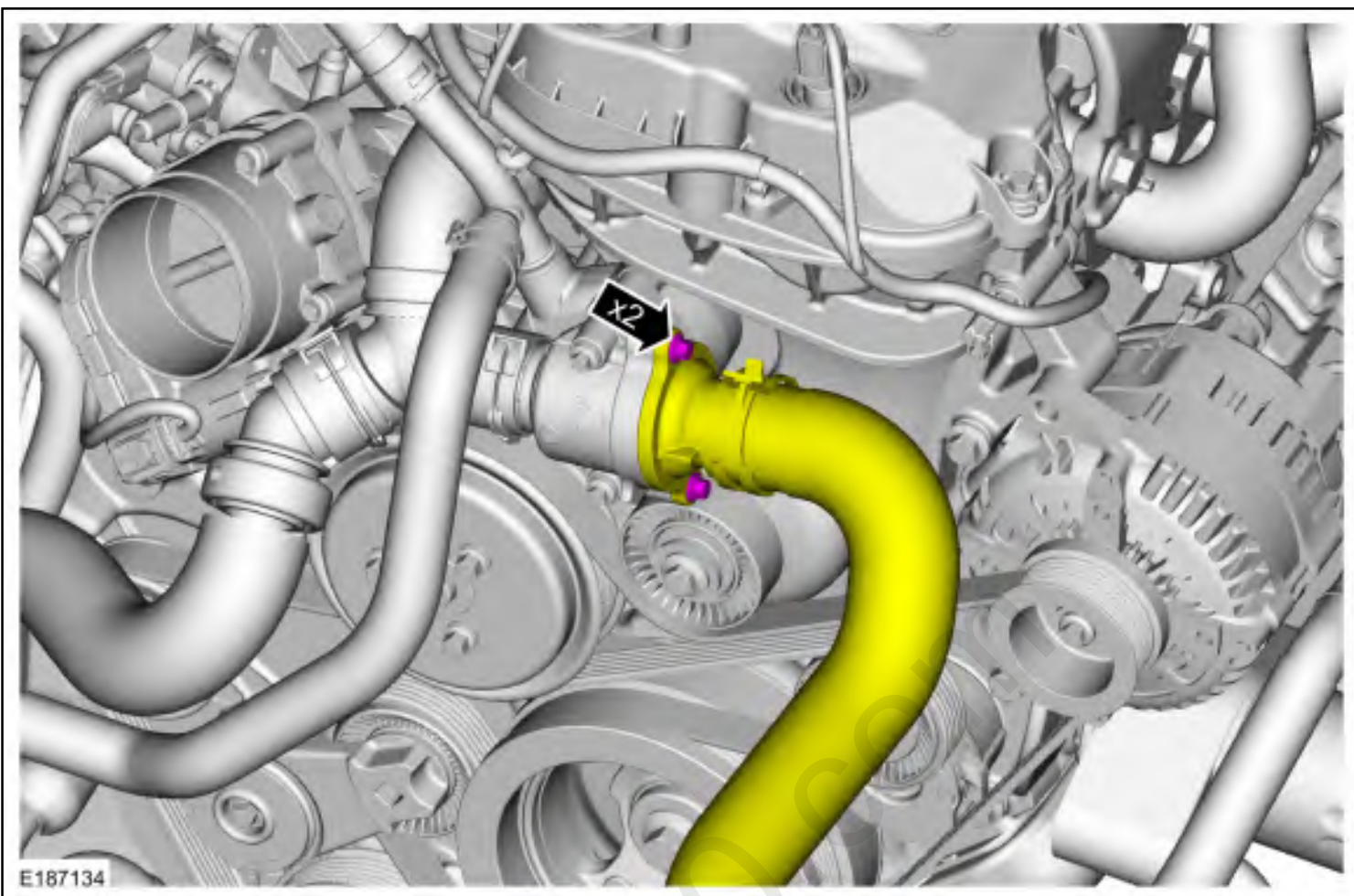
## Removal

**NOTE:** Removal steps in this procedure may contain installation details.

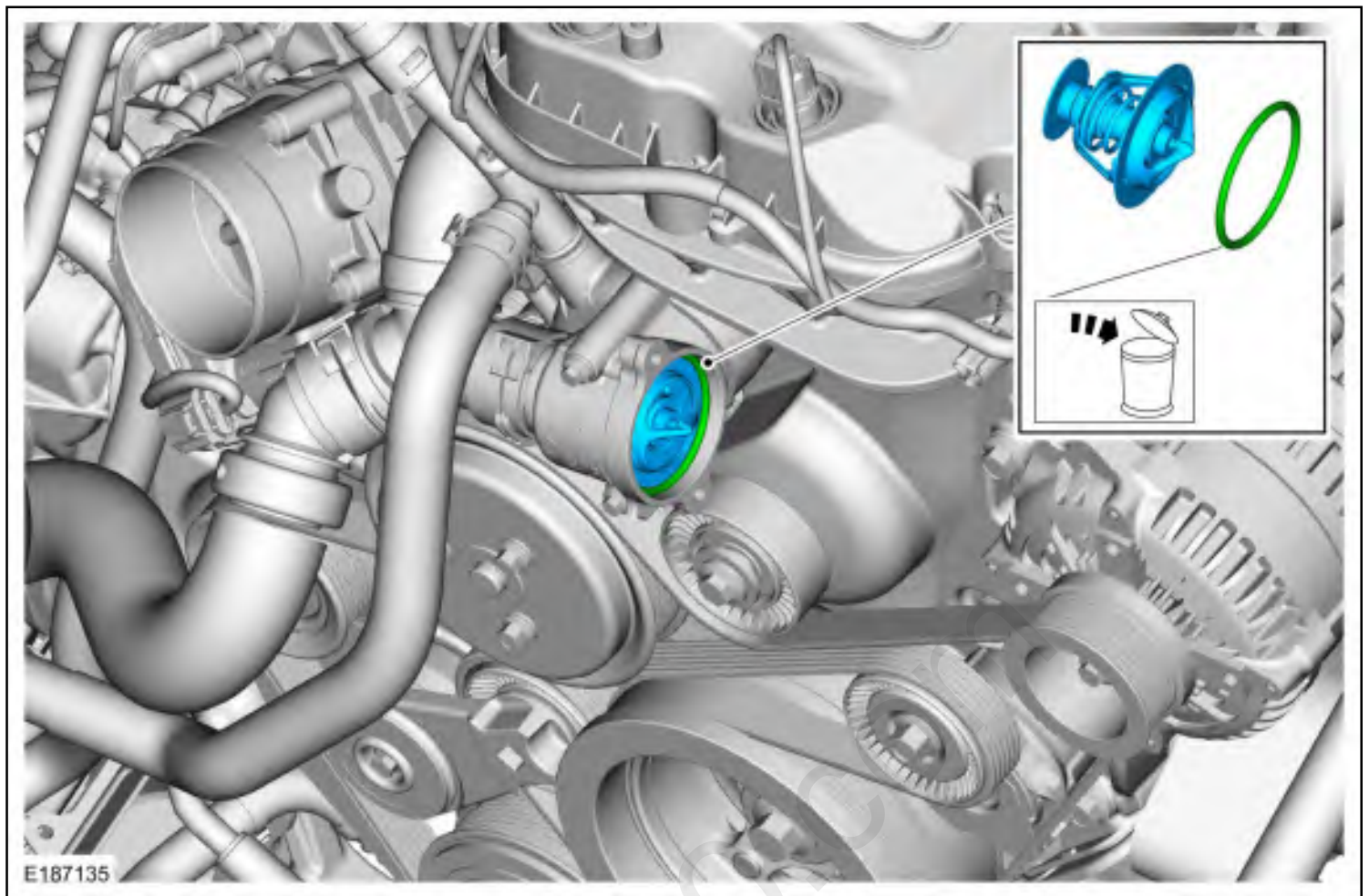
1. Drain the cooling system.  
Refer to: [Cooling System Draining, Vacuum Filling and Bleeding](#) (303-03D Engine Cooling - 5.0L 32V Ti-VCT, General Procedures).
2. Remove the air cleaner outlet pipe.  
Refer to: [Air Cleaner Outlet Pipe](#) (303-12D Intake Air Distribution and Filtering - 5.0L 32V Ti-VCT, Removal and Installation).
3. **NOTICE: Cover the accessory drive belts to prevent coolant contamination of the belts.**  
  
Completely cover the accessory drive belts with waterproof plastic.
4. **NOTE:** During installation, make sure the coolant inlet connection is fully seated on the thermostat housing before tightening the bolts.

Remove the bolts and detach the coolant inlet connector.

Torque: 89 lb.in (10 Nm)



5. Remove the thermostat and discard the O-ring seal.



## Installation

1. Install a new O-ring seal and lubricate it with clean engine coolant.  
*Material:* Motorcraft® Orange Concentrated Antifreeze/Coolant / VC-3-B (WSS-M97B44-D)
2. To install, reverse the removal procedure.

2. Fill and bleed the cooling system.

Refer to: [Cooling System Draining, Vacuum Filling and Bleeding](#) (303-03D Engine Cooling - 5.0L 32V Ti-VCT, General Procedures).

3. Install the air cleaner outlet pipe.

Refer to: [Air Cleaner Outlet Pipe](#) (303-12D Intake Air Distribution and Filtering - 5.0L 32V Ti-VCT, Removal and Installation).

## Thermostat Housing

### Removal

**NOTE:** *Removal steps in this procedure may contain installation details.*

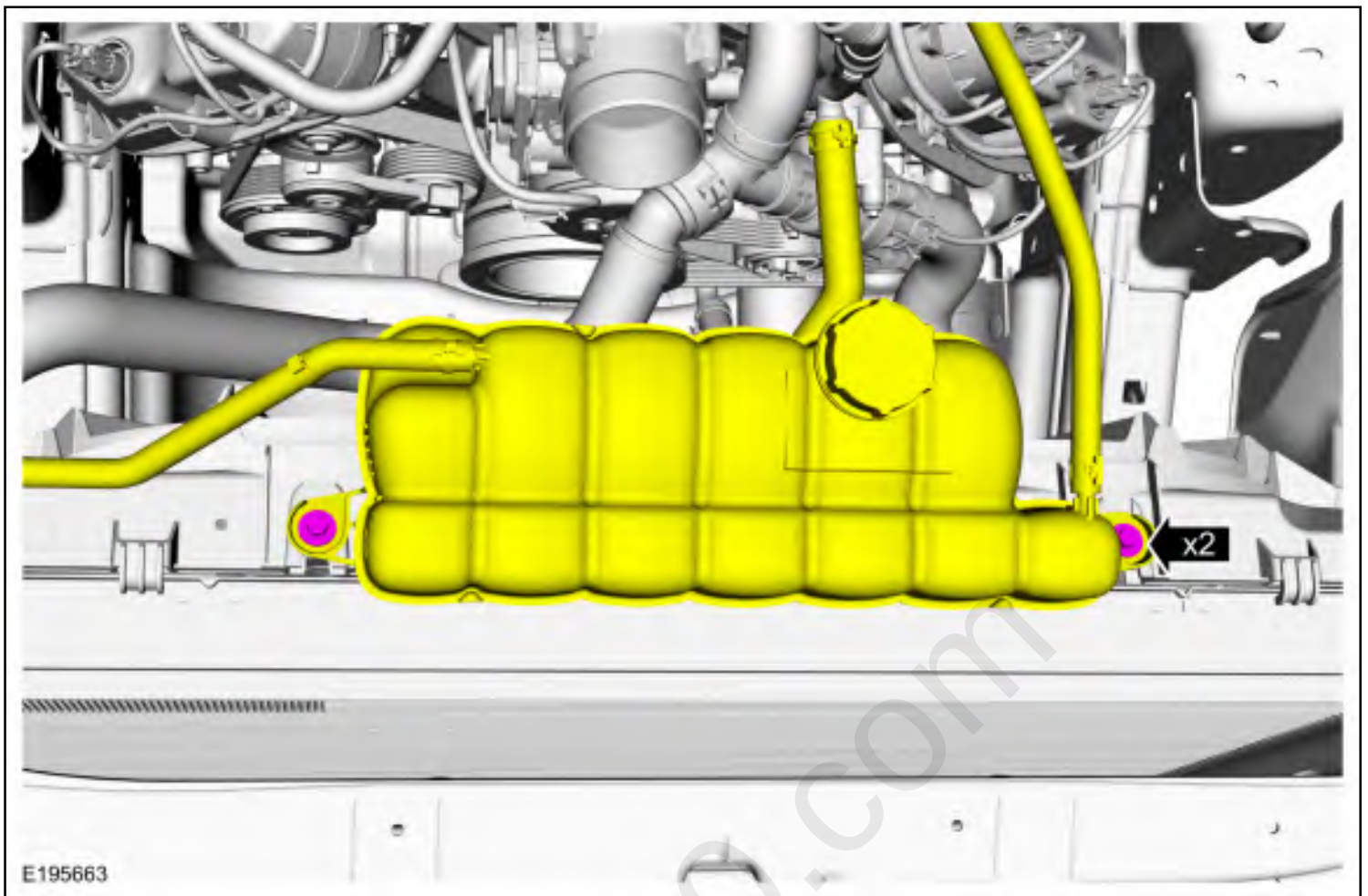
1. Drain the cooling system.

Refer to: [Cooling System Draining, Vacuum Filling and Bleeding](#) (303-03D Engine Cooling - 5.0L 32V Ti-VCT, General Procedures).

2. Remove the air cleaner outlet pipe.

Refer to: [Air Cleaner Outlet Pipe](#) (303-12D Intake Air Distribution and Filtering - 5.0L 32V Ti-VCT, Removal and Installation).

3. Remove the bolts and position the degas bottle aside.

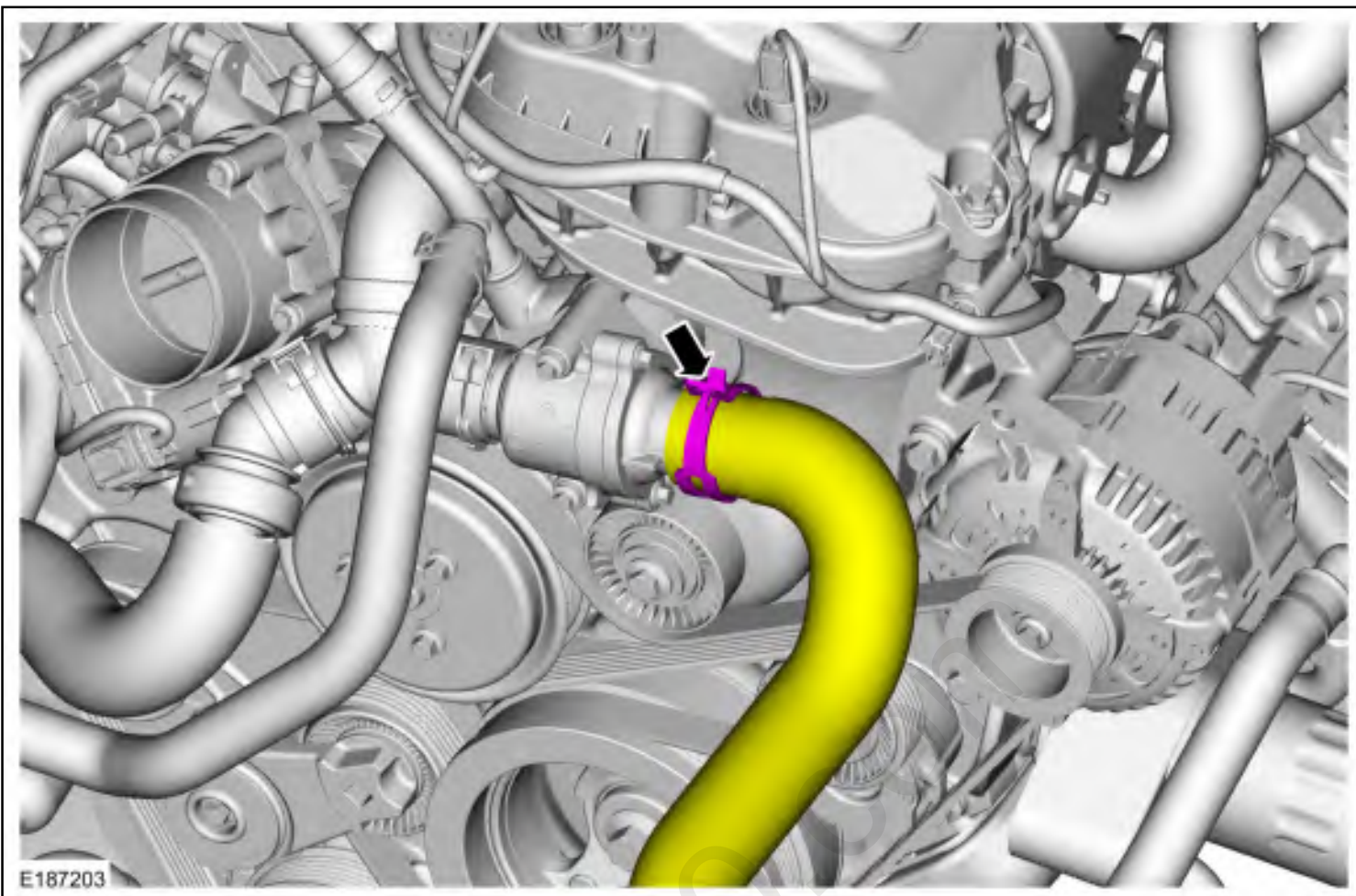


4. **NOTICE: Cover the accessory drive belts to prevent coolant contamination of the belts.**

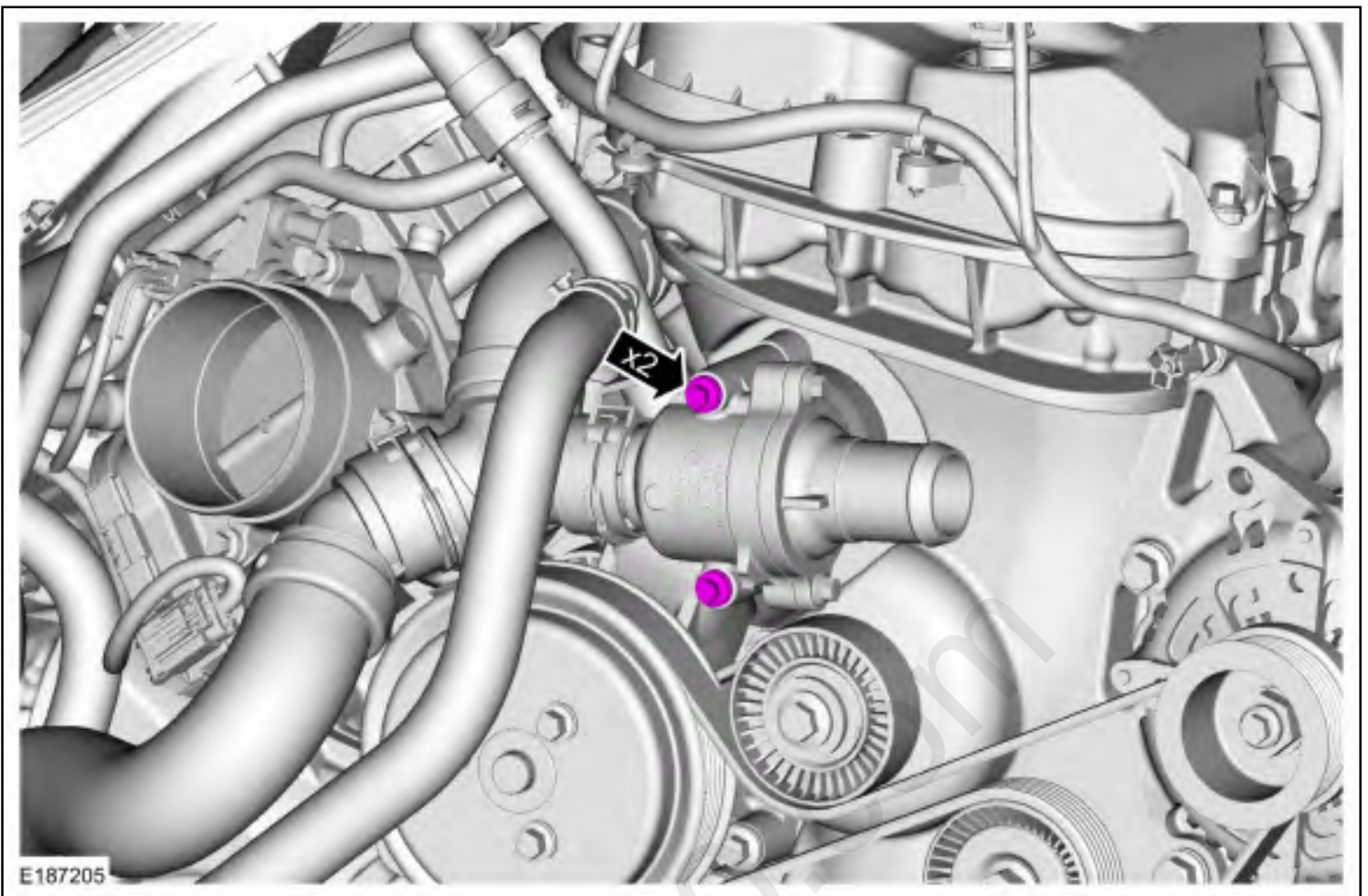
Completely cover the accessory drive belts with waterproof plastic.

5. Release the clamp and disconnect the lower radiator hose from the coolant inlet connection.

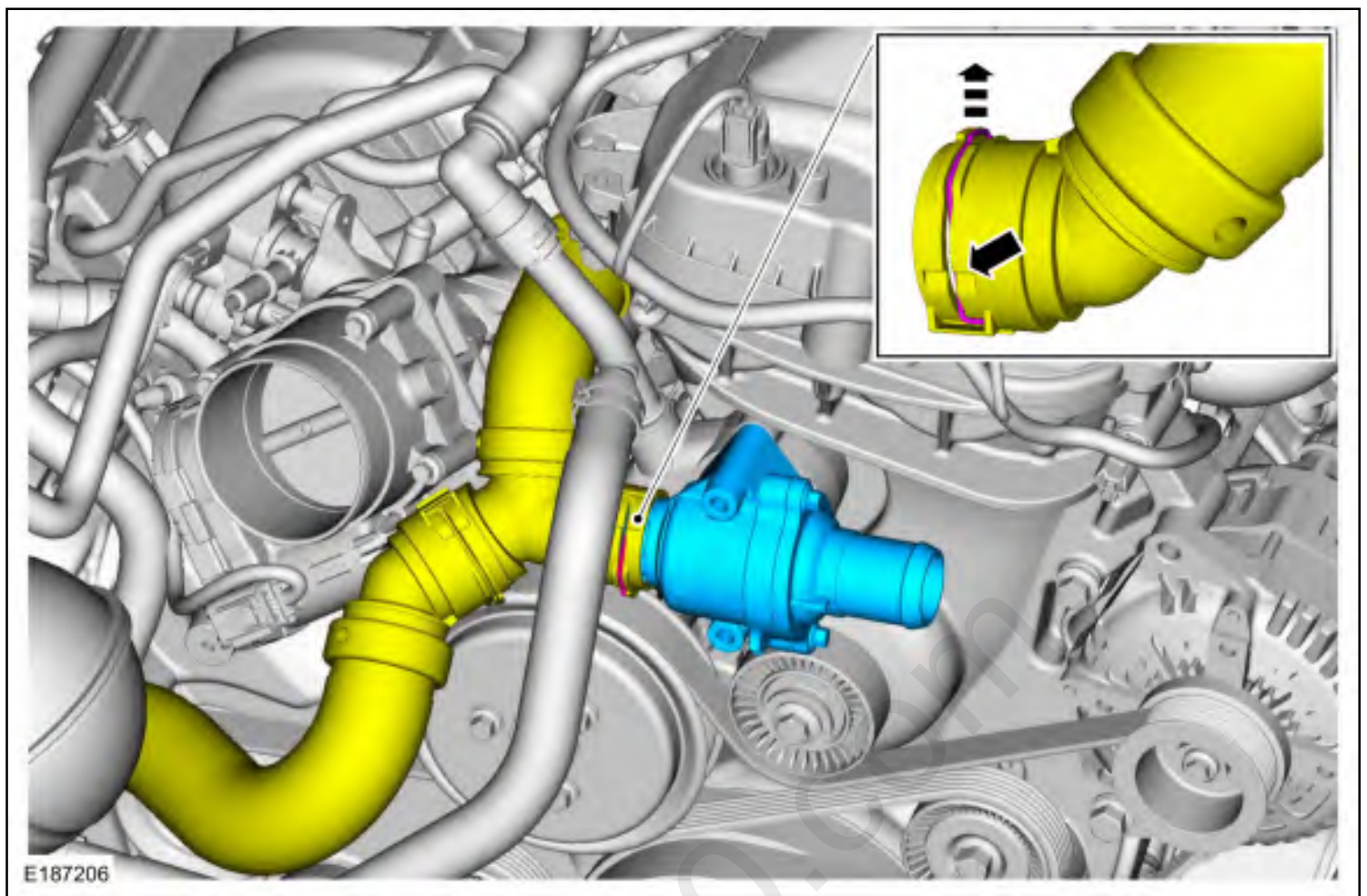




6. Remove the thermostat housing bolts.  
*Torque: 89 lb.in (10 Nm)*



7. Pull the upper radiator hose T-connector spring clip up until the end of the clip is in the detent on the quick connect coupling and remove the thermostat housing from the upper radiator hose T-connector.



8. Remove and discard the thermostat housing gasket.



## Installation

- Install a new thermostat housing gasket.
- To install, reverse the removal procedure.

2. Fill and bleed the cooling system.

Refer to: [Cooling System Draining, Vacuum Filling and Bleeding](#) (303-03D Engine Cooling - 5.0L 32V Ti-VCT, General Procedures).

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# Transmission Fluid Heater Coolant Control Valve

## Special Tool(s) / General Equipment

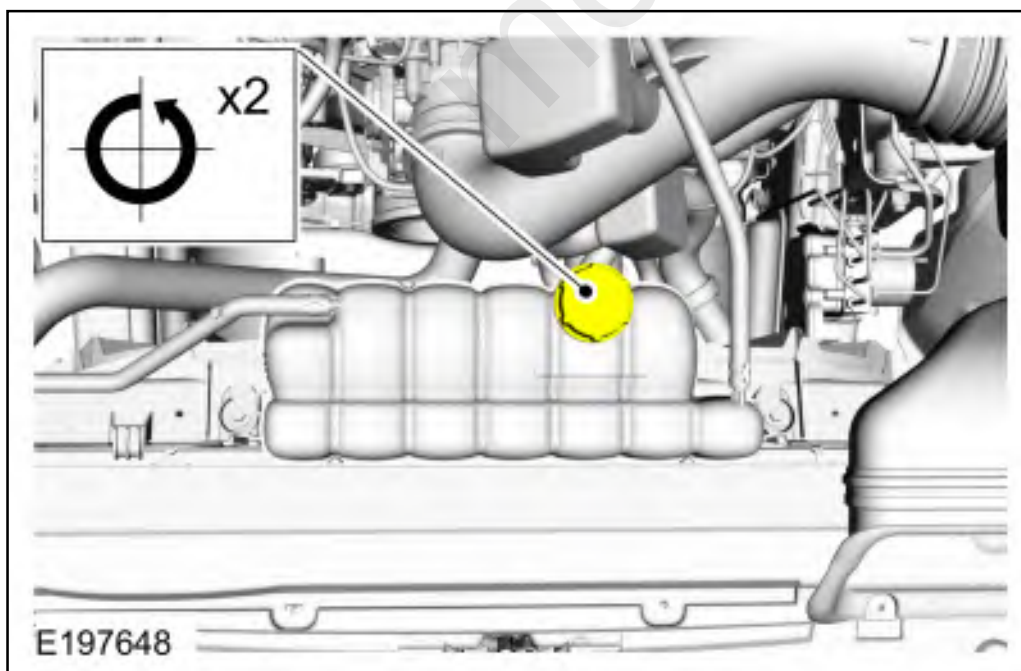
Hose Clamp Remover/Installer

## Removal



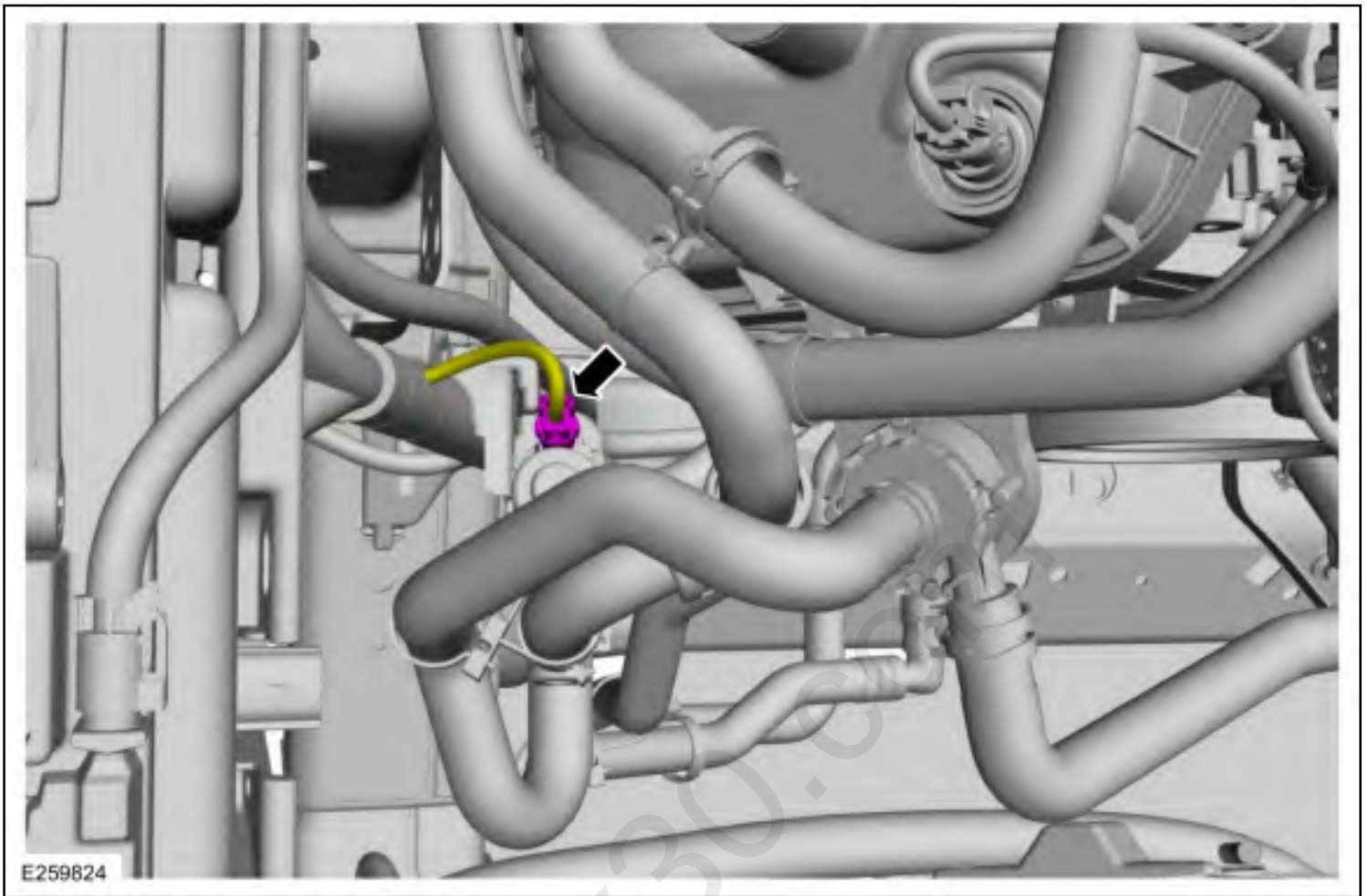
 **WARNING:** When releasing the cooling system pressure, cover the coolant expansion tank cap with a thick cloth.

Loosen the pressure relief cap.

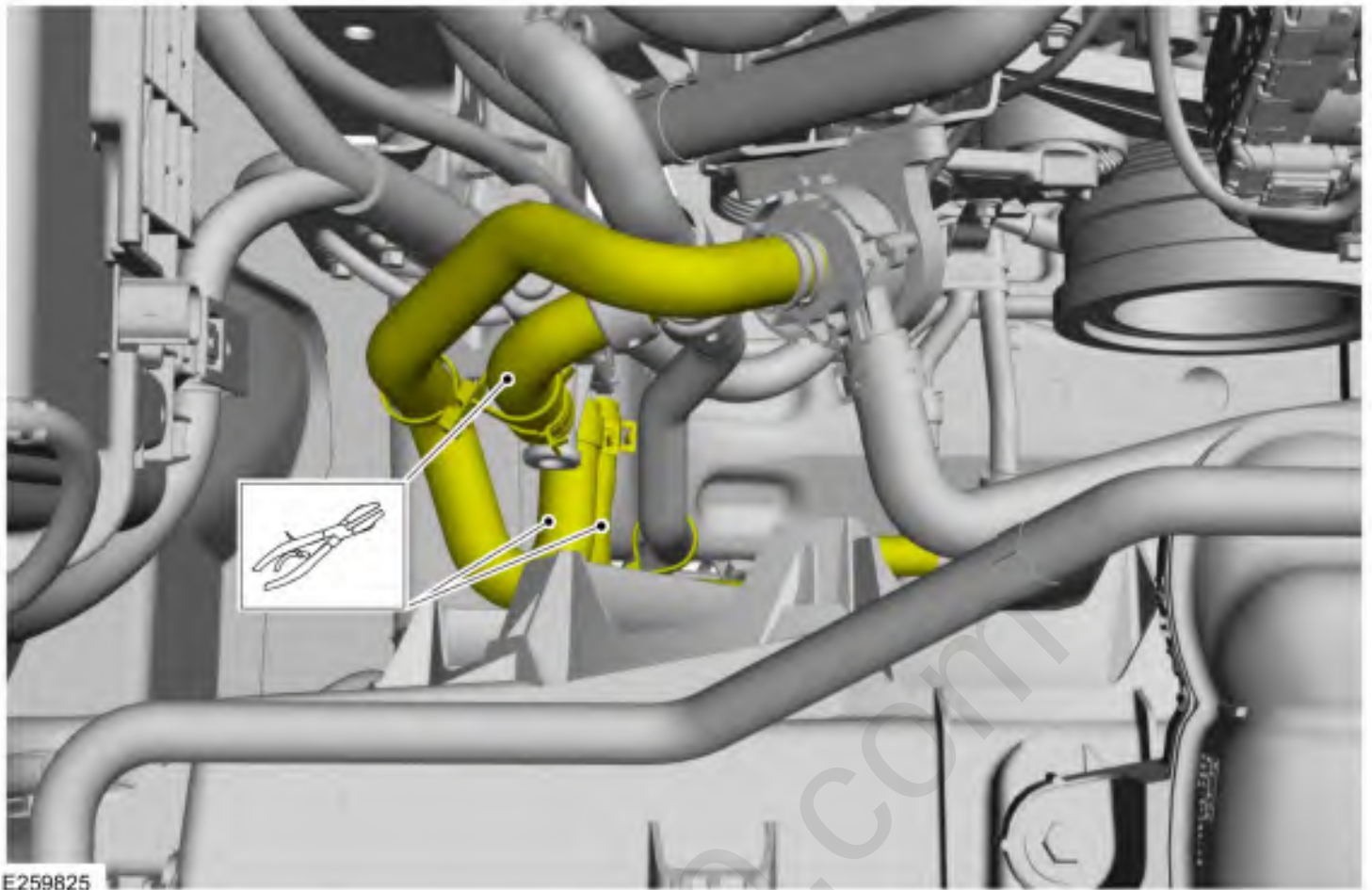




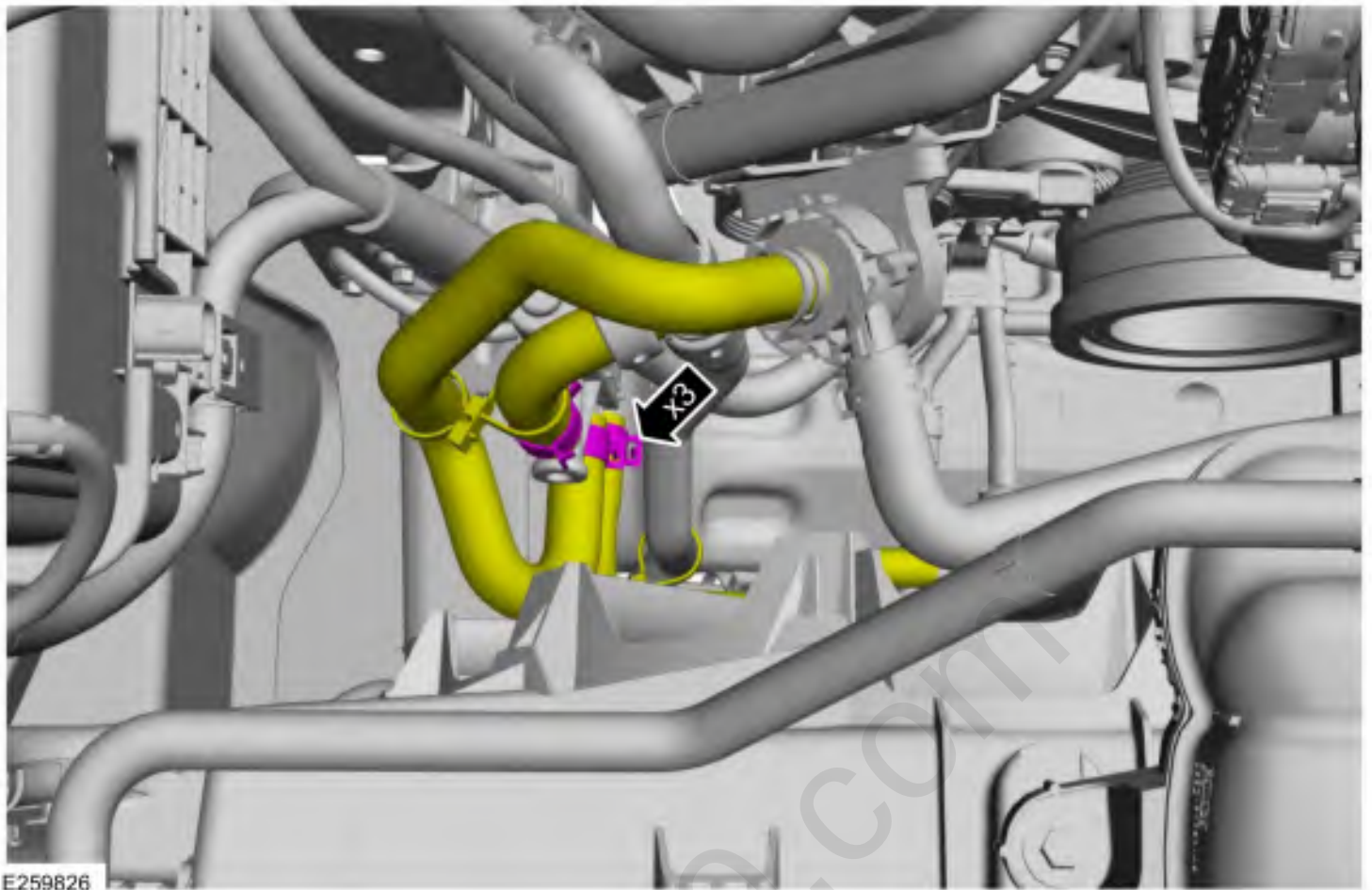
2. Disconnect the coolant control valve electrical connector.



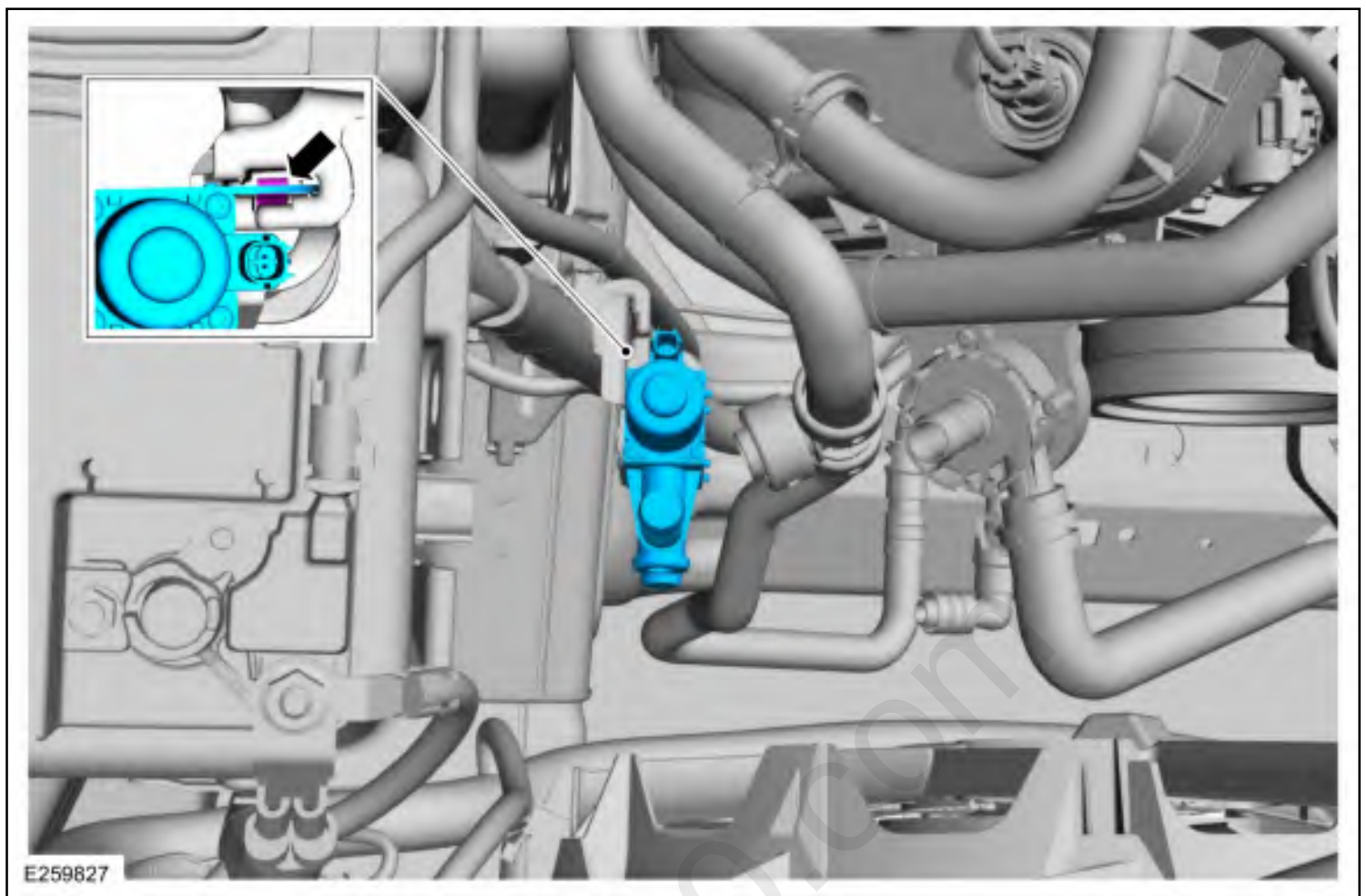
3. Clamp off the coolant control valve hoses.



4. Release the clamps and disconnect the coolant hoses.  
Use the General Equipment: Hose Clamp Remover/Installer



5. Release the tab and remove the transmission fluid heater coolant control valve.



## Installation

1. To install, reverse the removal procedure.
2. Fill and bleed the cooling system without using a vacuum cooling system filler.  
Refer to: [Cooling System Draining, Vacuum Filling and Bleeding](#) (303-03D Engine Cooling - 5.0L 32V Ti-VCT, General Procedures).

# Cooling Fan Motor and Shroud

Base Part Number: Base Part Number: 8C607

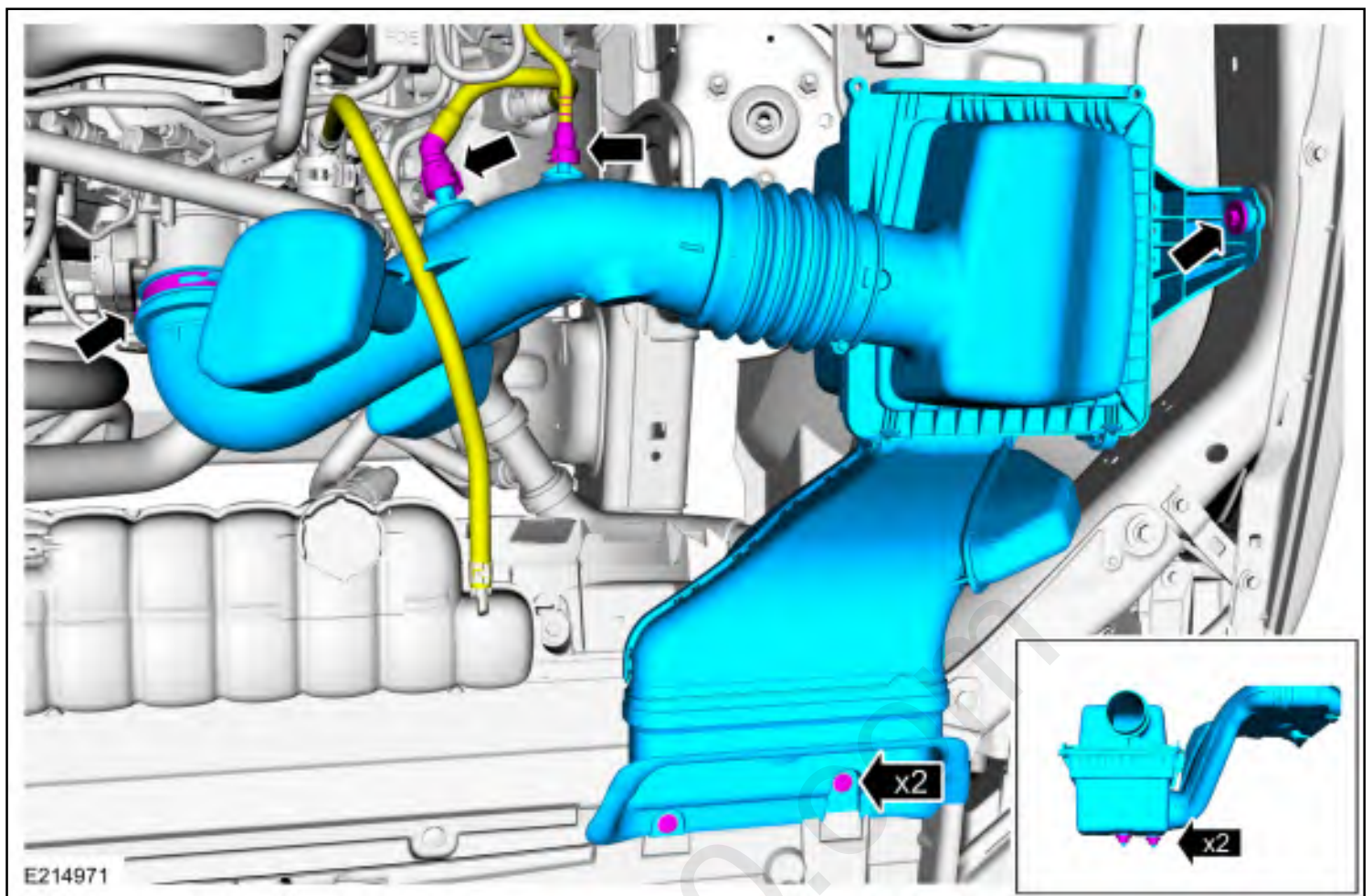
## Special Tool(s) / General Equipment

|              |
|--------------|
| Wooden Block |
|--------------|

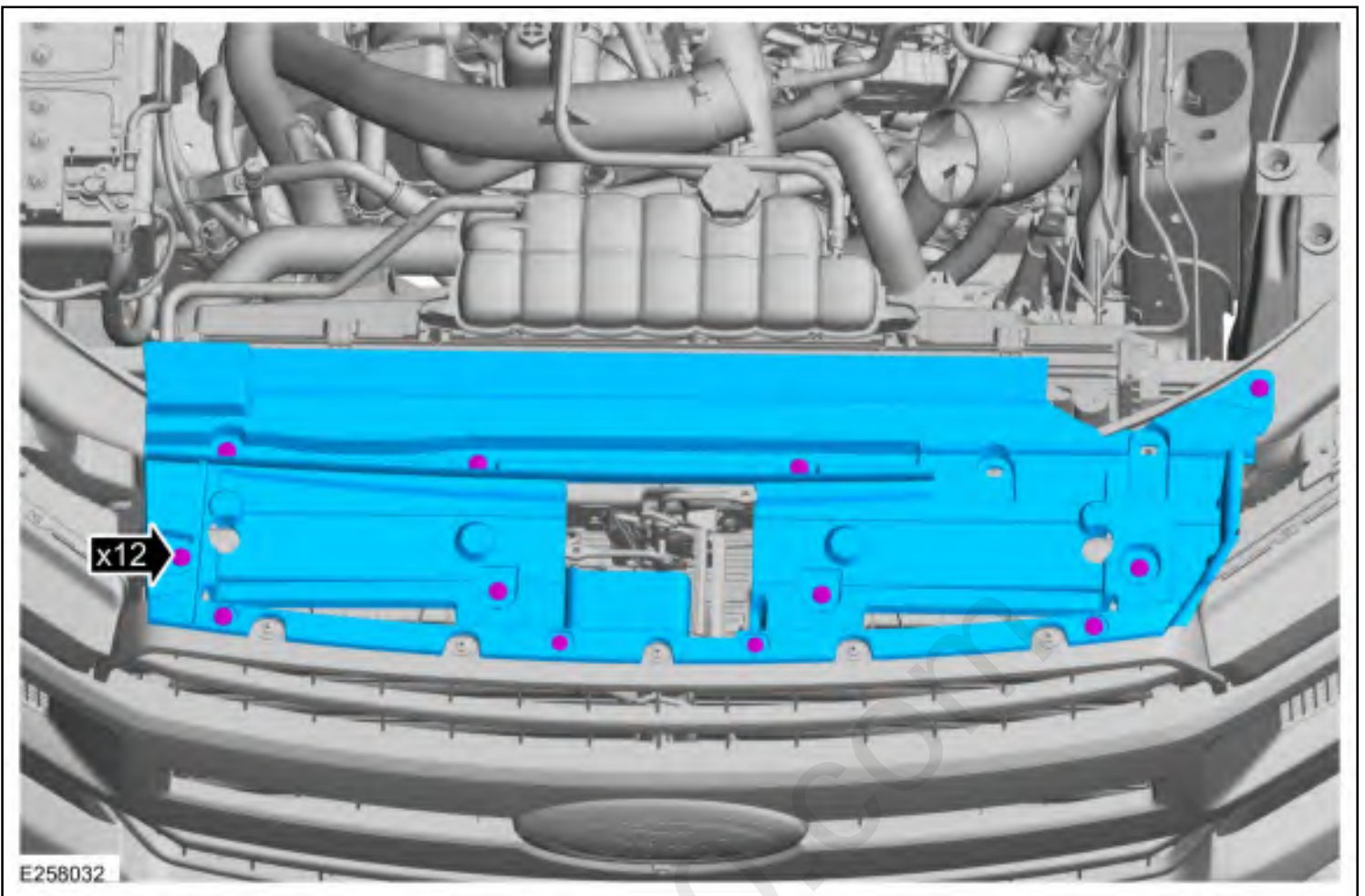
## Removal

1. With the vehicle in NEUTRAL, position it on a hoist.  
Refer to: [Jacking and Lifting - Overview](#) (100-02 Jacking and Lifting, Description and Operation).
2. Position aside the coolant tube. Disconnect and position aside the brake booster and the crankcase ventilation tubes. Loosen the clamp and remove the retainers and the air cleaner and outlet pipe assembly.  
*Torque:*  
Clamp: 35 lb.in (4 Nm)  
Bolt: 150 lb.in (17 Nm)

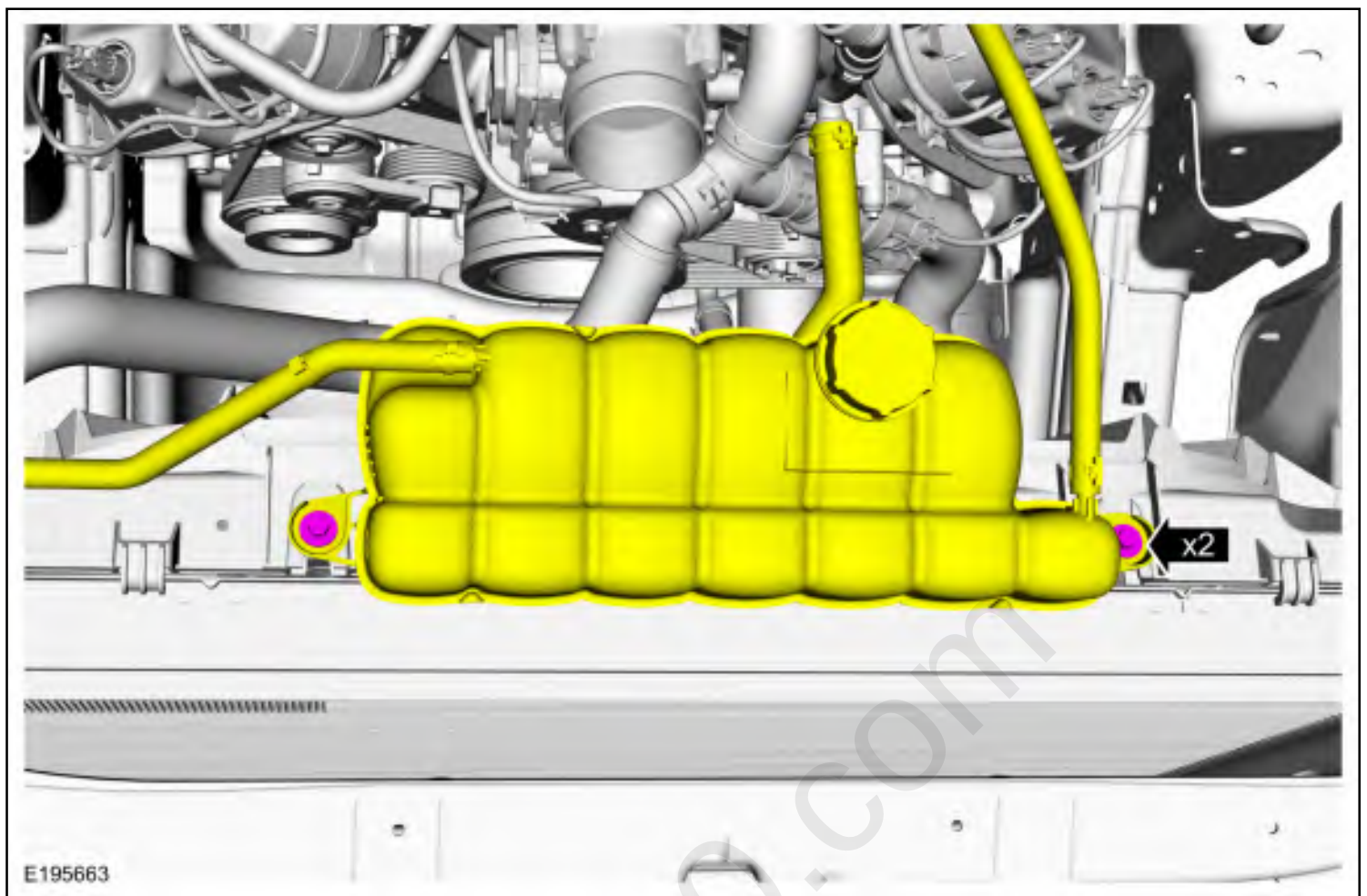




3. Remove the pin-type retainers and the upper radiator air deflector.

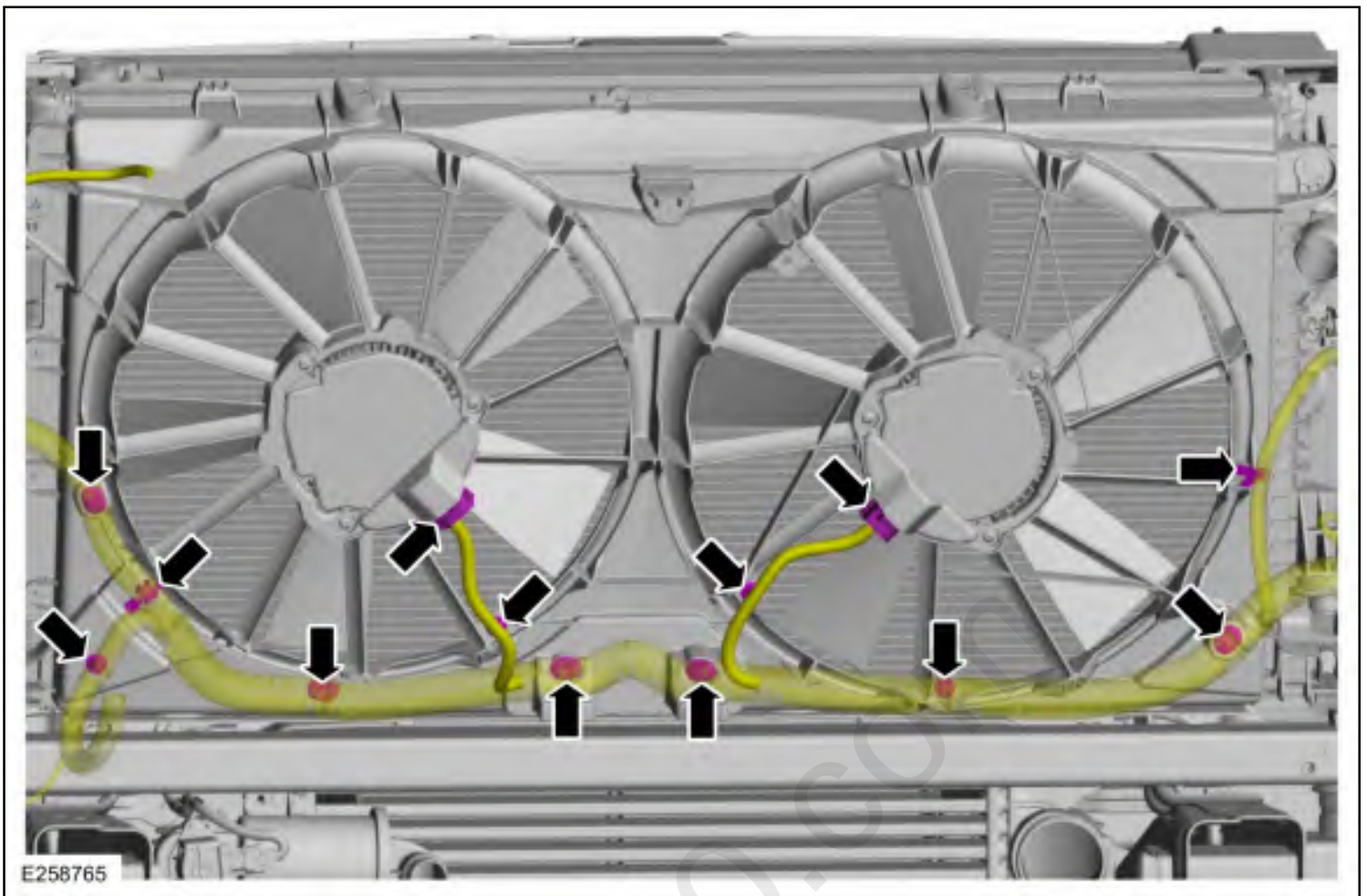


4. Remove the bolts and position the degas bottle aside.  
*Torque: 62 lb.in (7 Nm)*



5. Disconnect the electrical connectors, detach the pin-type retainers and position the wiring harness aside.



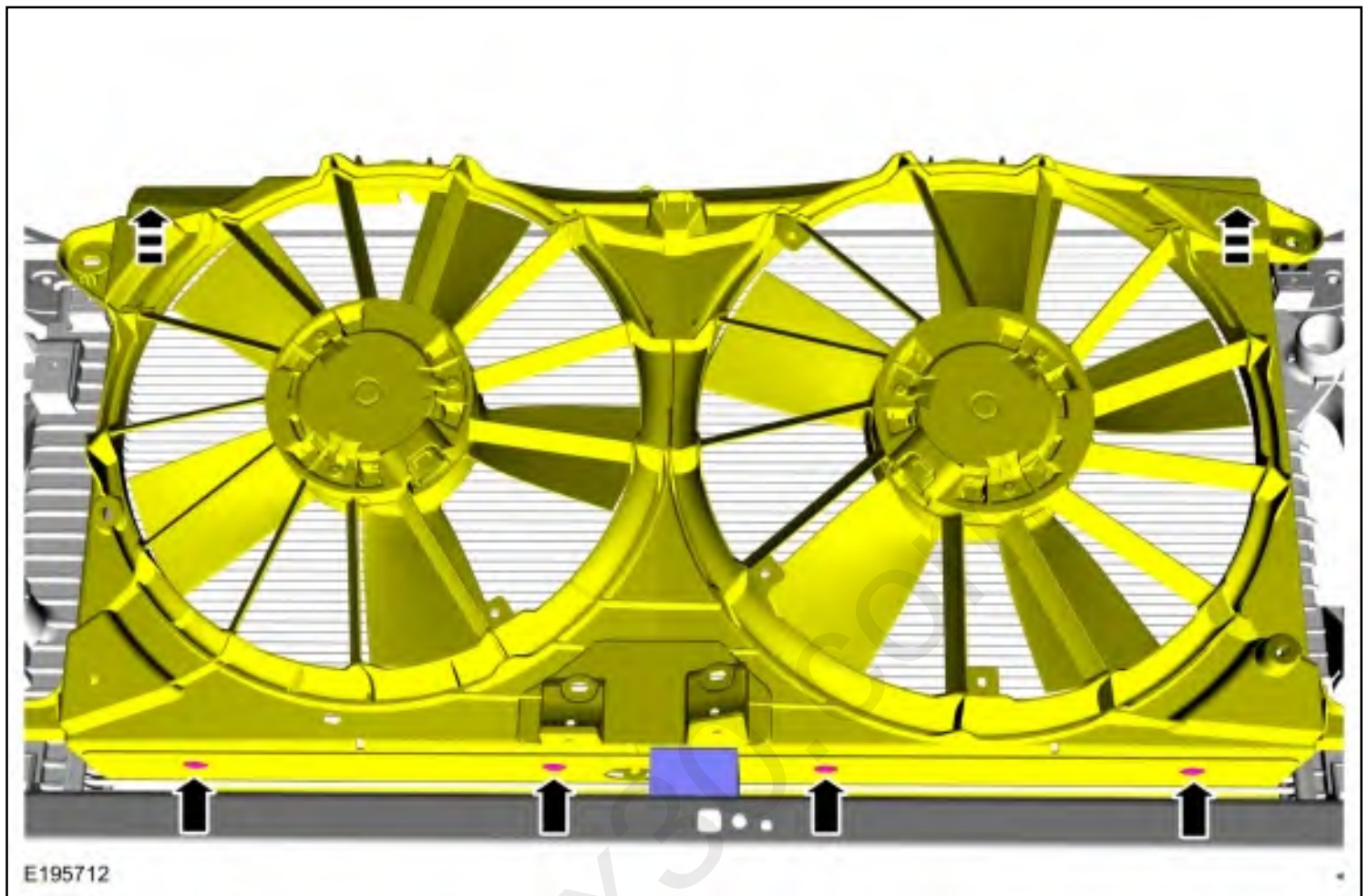


6. Remove the bolts that secure the cooling fan motor and shroud.  
*Torque: 62 lb.in (7 Nm)*



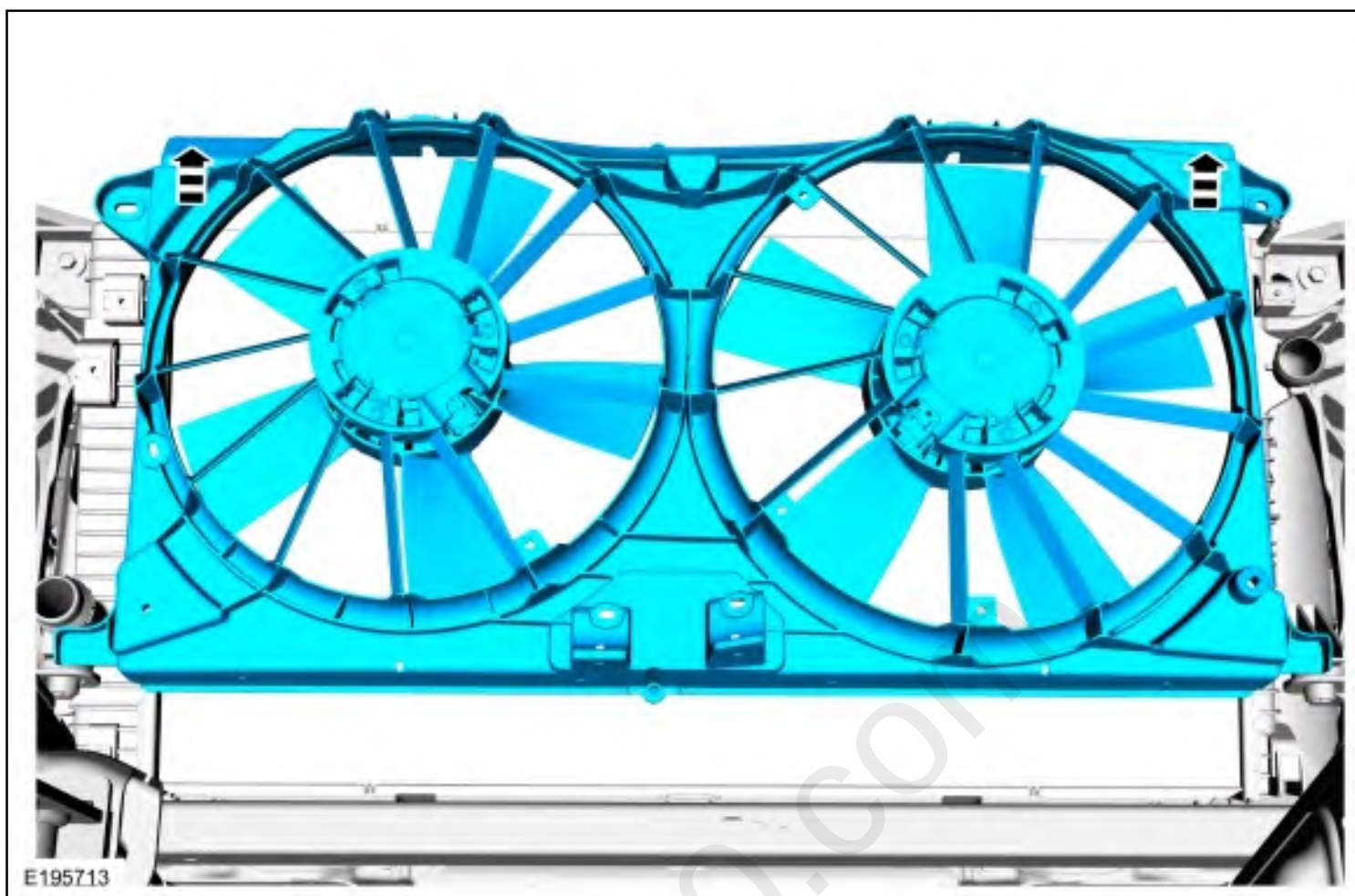
7. Lift the cooling fan motor and shroud upward and place wooden block to support it. Detach the pin-

type retainers that secure the lower radiator shield to the cooling fan shroud.  
Use the General Equipment: Wooden Block



8. Remove the cooling fan motor and shroud.





## Installation

1. To install, reverse the removal procedure.

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## Degas Bottle

Base Part Number: Base Part Number: 8A080

### Special Tool(s) / General Equipment

|                              |
|------------------------------|
| Fluid Suction Gun            |
| Hose Clamp Remover/Installer |
| Locking Pliers               |

### Materials

| Name                                                       | Specification |
|------------------------------------------------------------|---------------|
| Motorcraft® Orange Prediluted Antifreeze/Coolant VC-3DIL-B | WSS-M97B44-D2 |

### Removal



**WARNING:** Always allow the engine to cool before opening the cooling system. Do not unscrew the coolant pressure relief cap when the engine is operating or the cooling system is hot. The cooling system is under pressure; steam and hot liquid can come out forcefully when the cap is loosened slightly. Failure to follow these instructions may result in serious personal injury.

**NOTE:** Removal steps in this procedure may contain installation details.

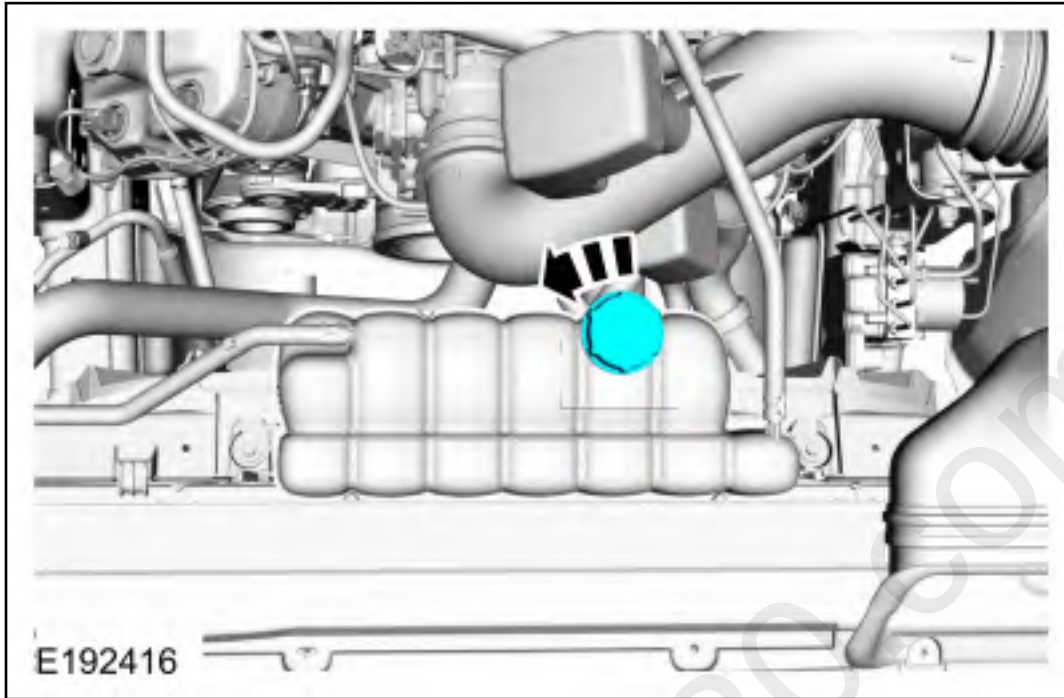
1.





**WARNING:** When releasing the cooling system pressure, cover the coolant expansion tank cap with a thick cloth.

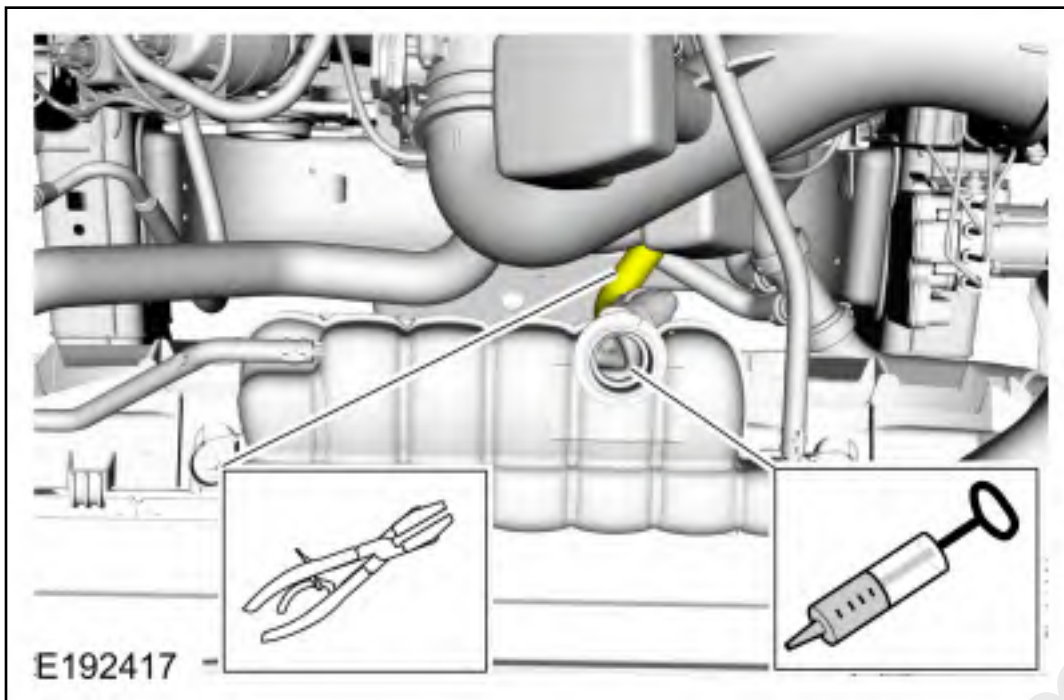
Release the cooling system pressure by slowly turning the degas bottle cap between 2 and 3 turns and remove the degas bottle cap.



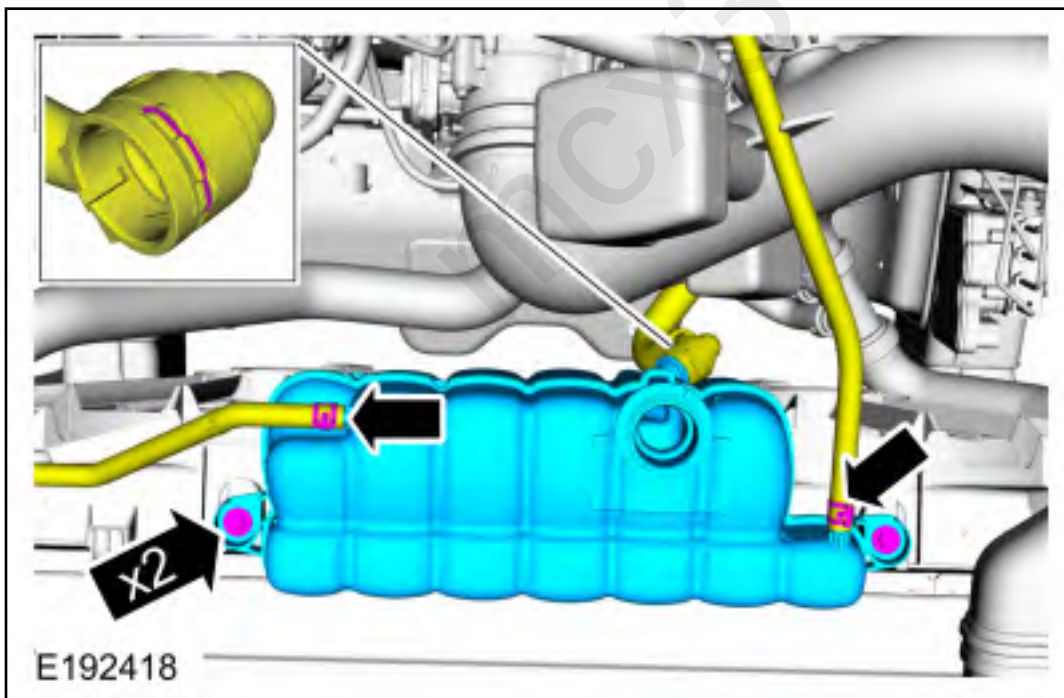
2. Using general tools, clamp the lower expansion tank hose and syphon the engine coolant from the expansion tank.

Use the General Equipment: Fluid Suction Gun

Use the General Equipment: Locking Pliers



- Release the clamps, disconnect the 2 upper coolant hoses.  
Use the General Equipment: Hose Clamp Remover/Installer
- Remove the spring clip and disconnect the lower coolant hose.
- Remove the 2 fasteners and remove the degas bottle.  
*Torque: 62 lb.in (7 Nm)*



## Installation

1. To install, reverse the removal procedure.

2. Fill the degas bottle with the recommended coolant mixture and fill level.

*Material:* Motorcraft® Orange Prediluted Antifreeze/Coolant / VC-3DIL-B (WSS-M97B44-D2)

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# Block Heater

## Removal

**NOTE:** Removal steps in this procedure may contain installation details.

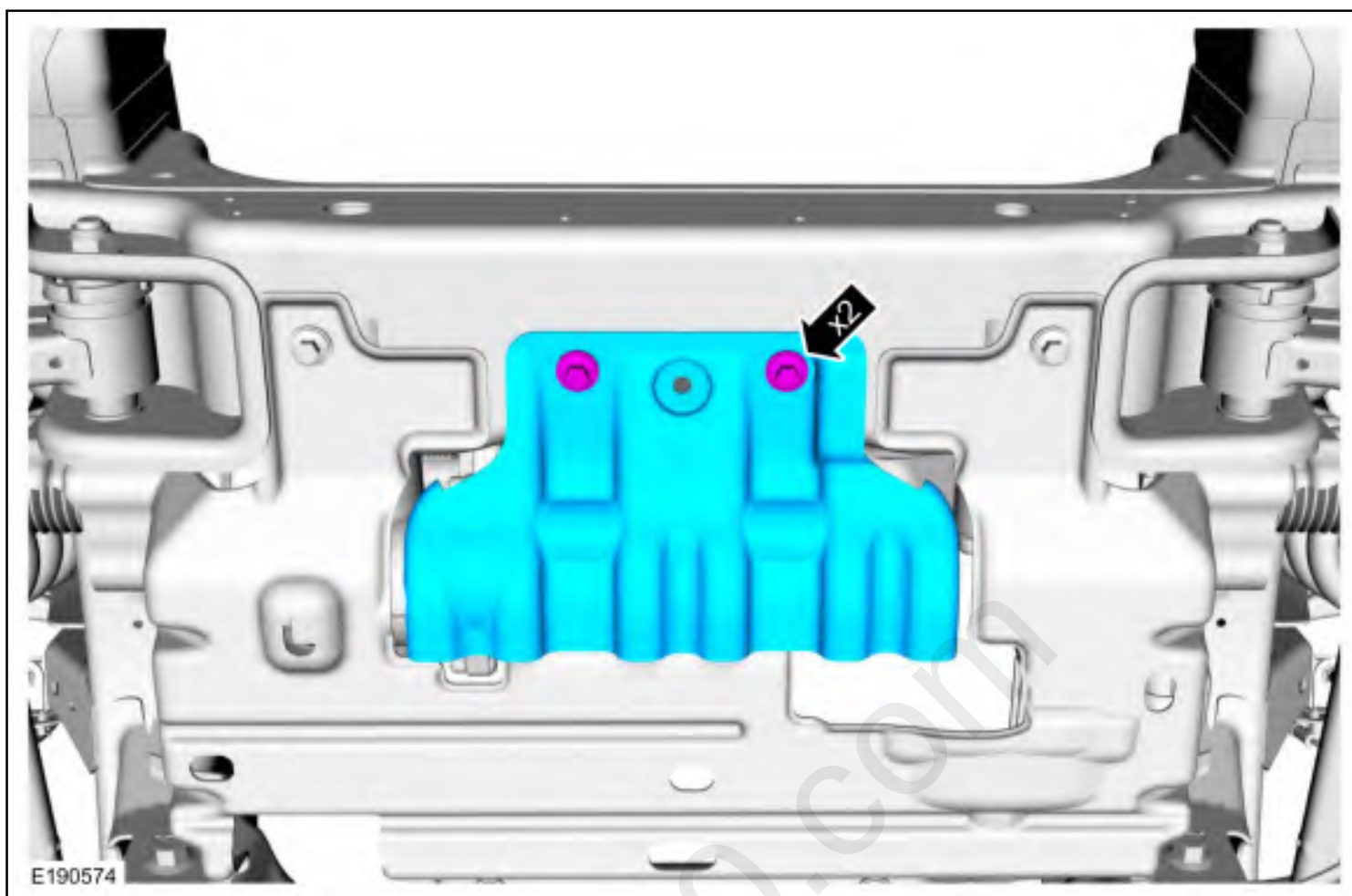
## All Vehicles

1. Drain the cooling system.

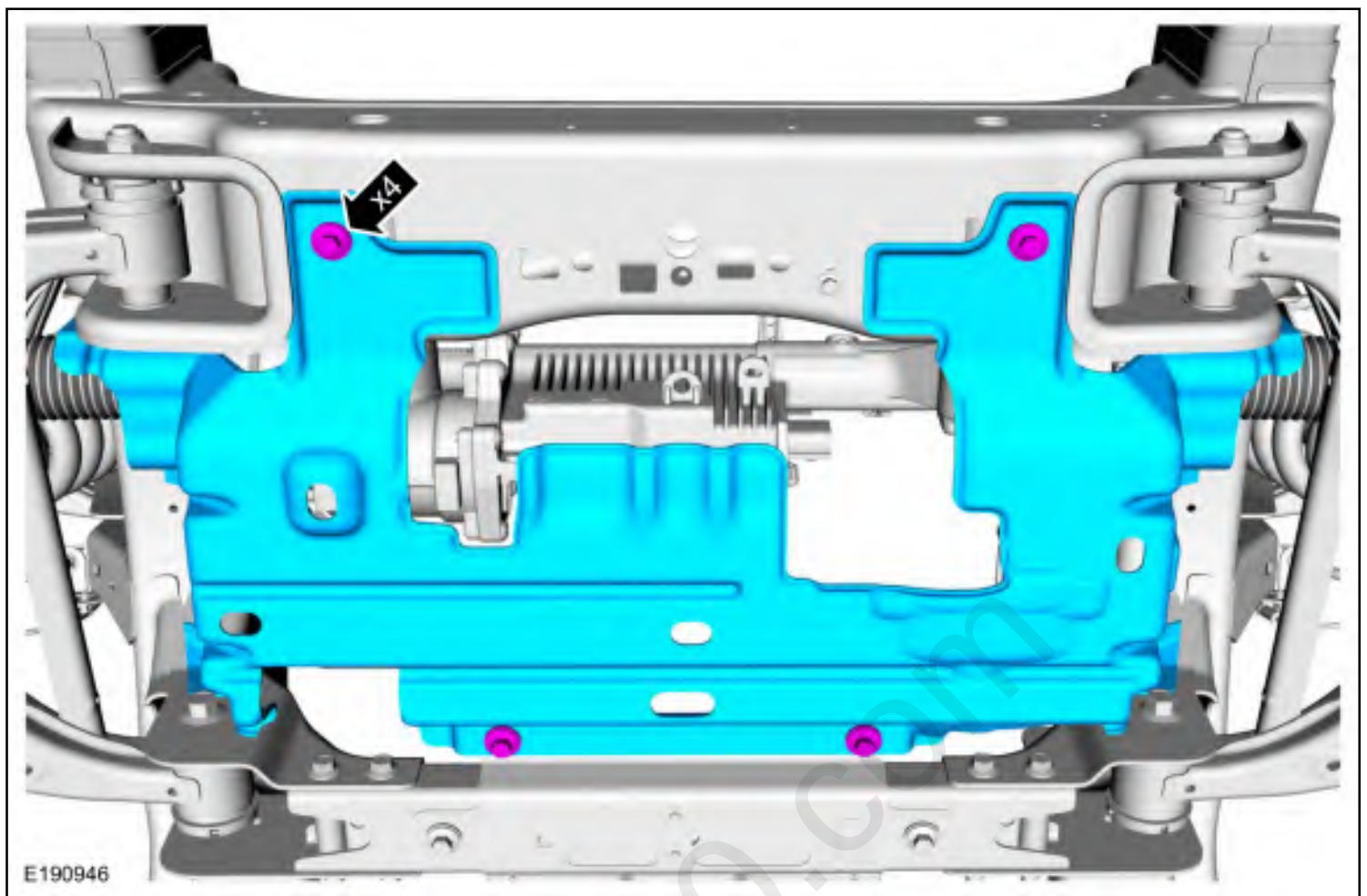
Refer to: [Cooling System Draining, Vacuum Filling and Bleeding](#) (303-03D Engine Cooling - 5.0L 32V Ti-VCT, General Procedures).

## 4X2 Vehicles

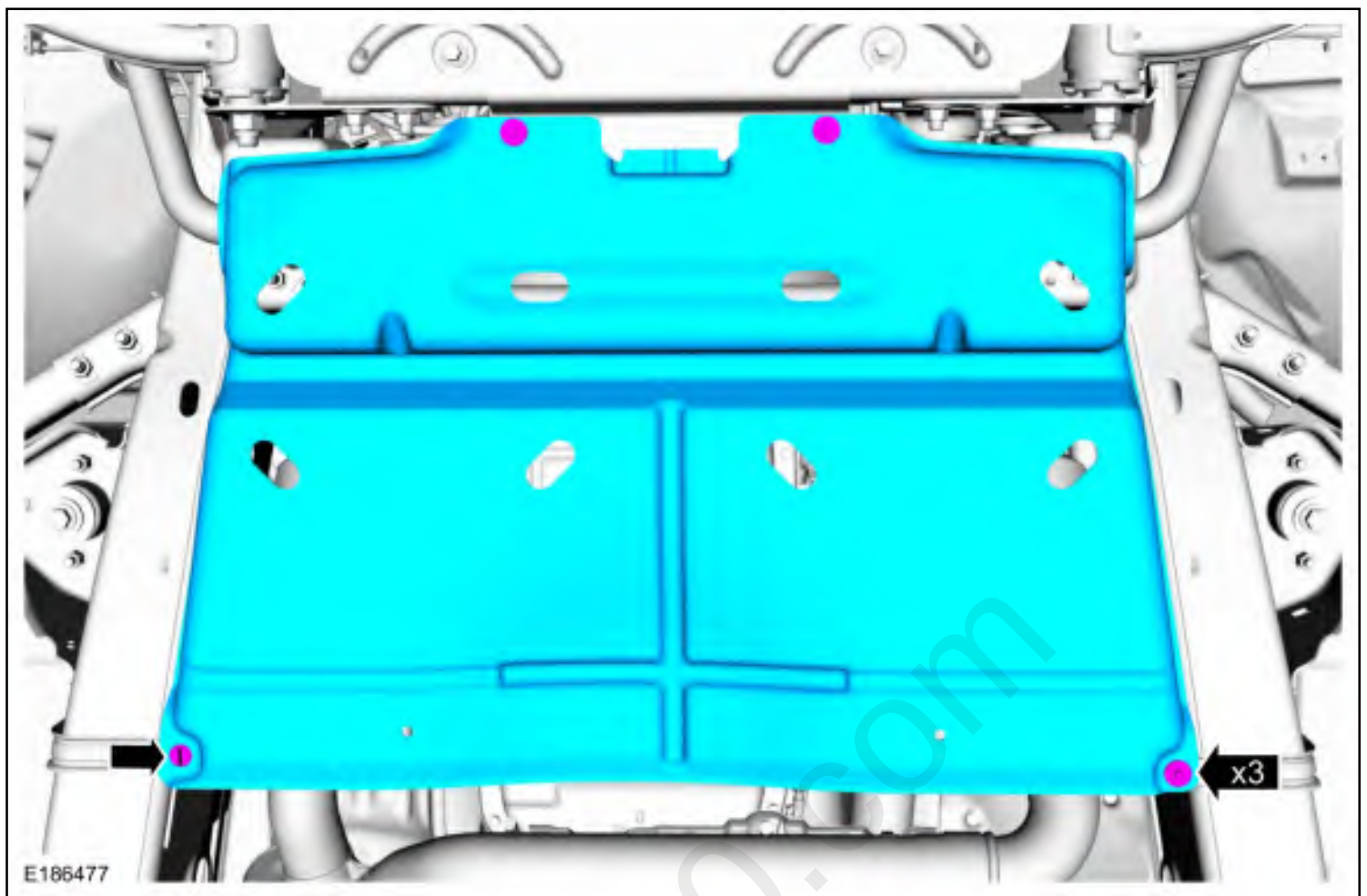
2. If equipped, remove the bolts and the skid plate.



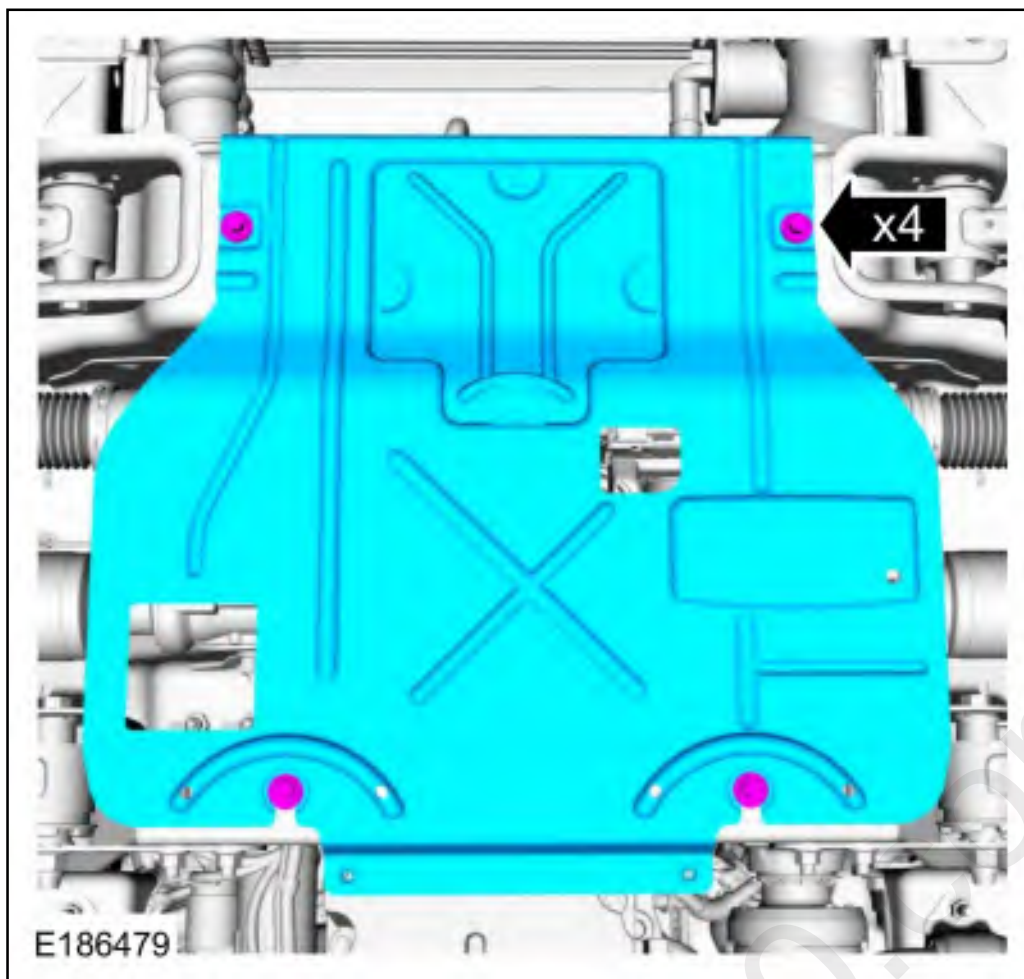
3. If equipped, remove the fasteners and the underbody shield.



4. If equipped, remove the fasteners and the underbody shield.



5. If equipped, remove the bolts and the skid plate.



## 4X4 Vehicles

6. Remove the generator.

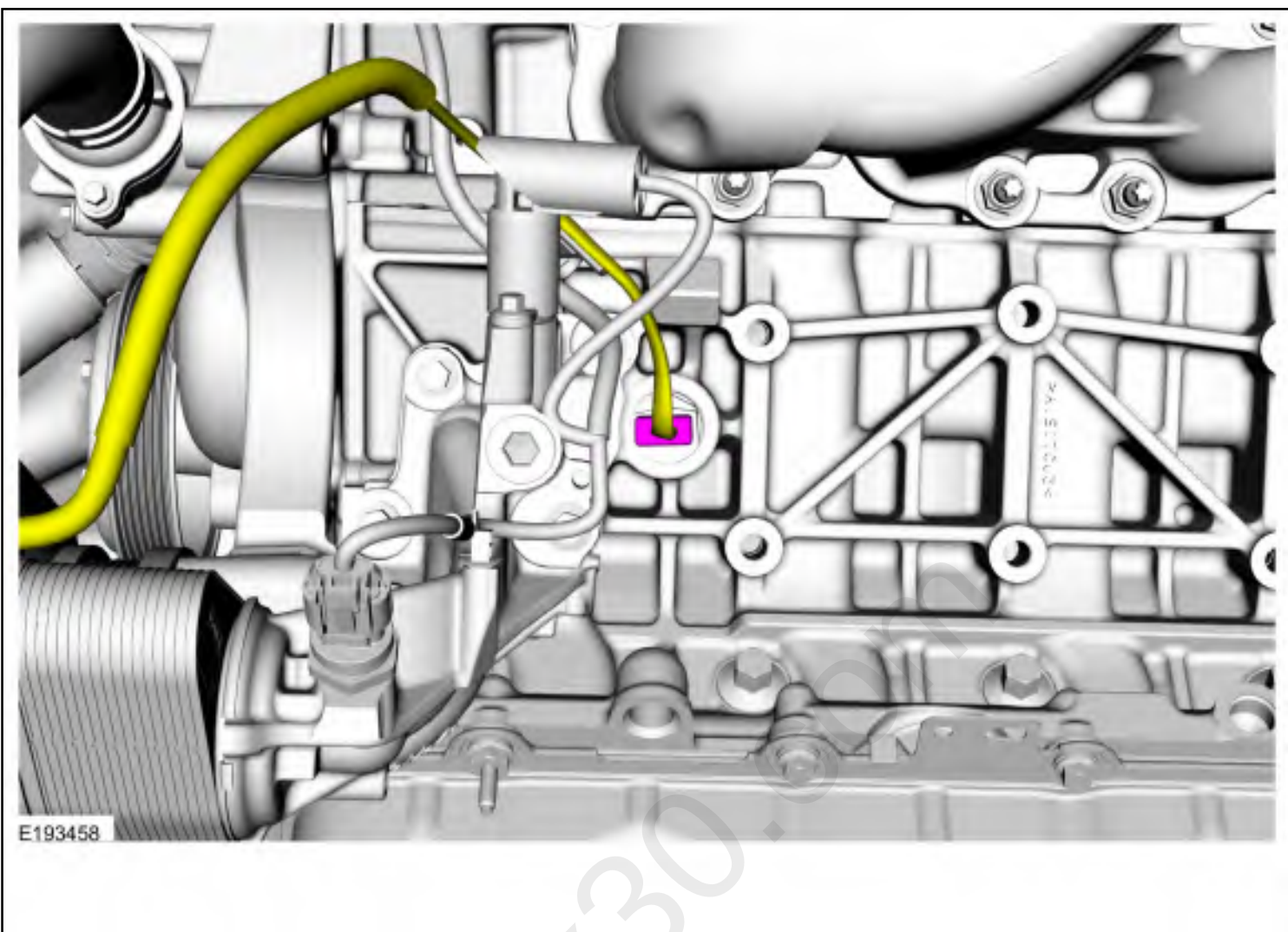
Refer to: [Generator - 5.0L 32V Ti-VCT](#) (414-02 Generator and Regulator, Removal and Installation).

## All Vehicles

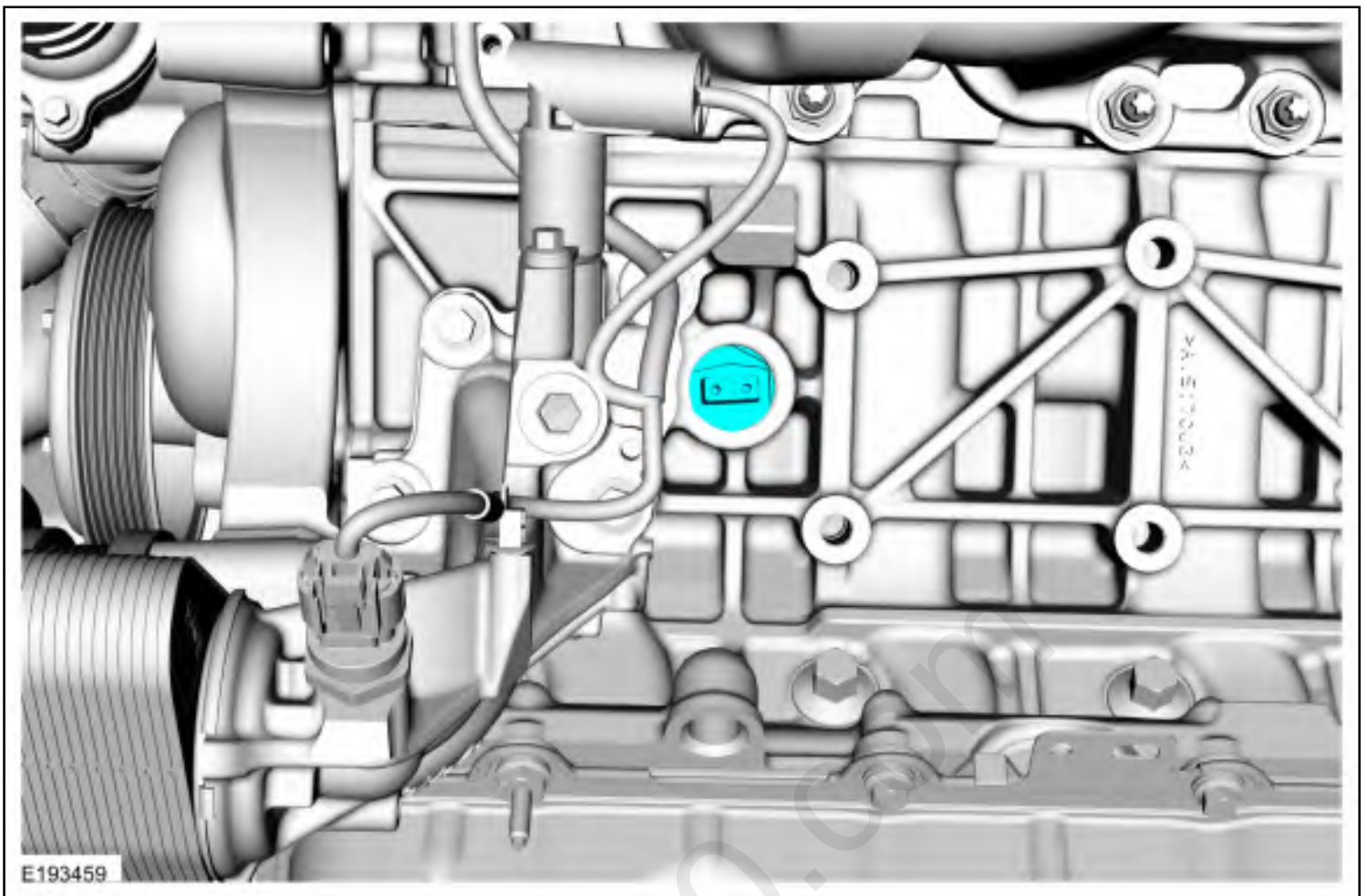
7. **NOTE:** Make sure the block heater wiring is routed and secured away from rotating or hot components.

Disconnect the block heater electrical connector.





8. Remove the block heater.  
*Torque: 30 lb.ft (40 Nm)*



## Installation

1. To install, reverse the removal procedure.
2. Fill and bleed the cooling system.  
Refer to: [Cooling System Draining, Vacuum Filling and Bleeding](#) (303-03D Engine Cooling - 5.0L 32V Ti-VCT, General Procedures).

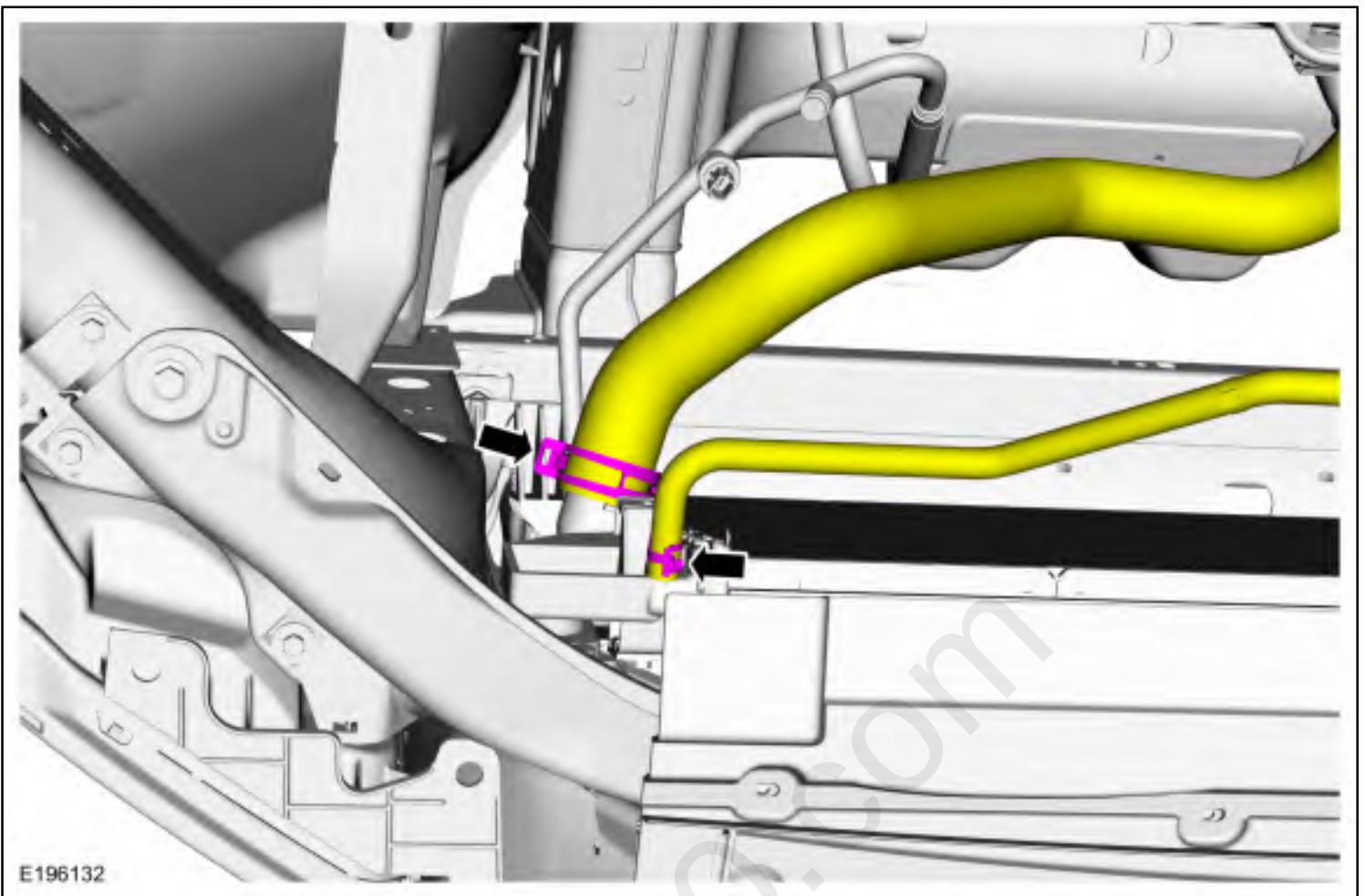
# Radiator

Base Part Number: Base Part Number: 8005

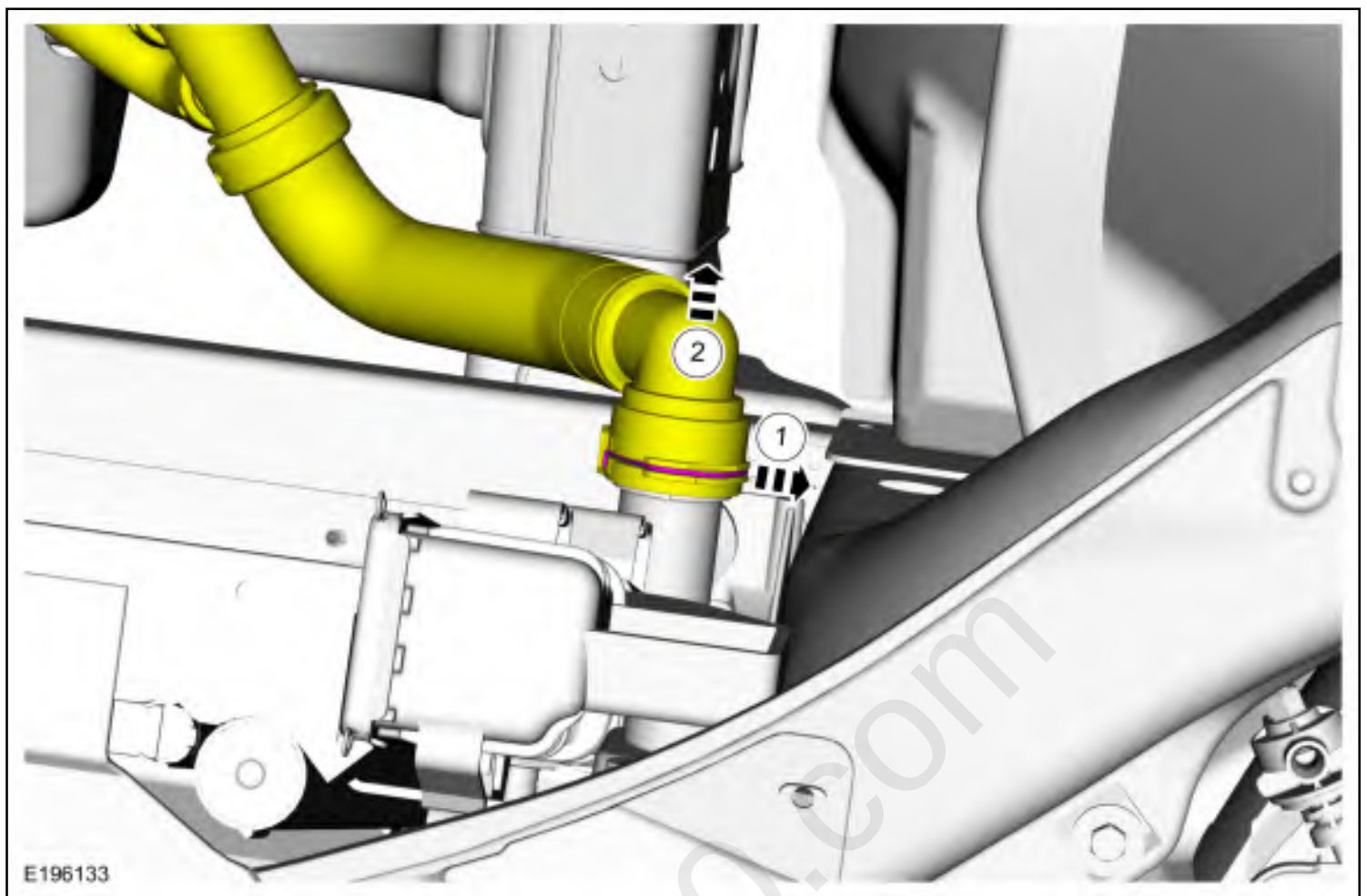
## Removal

**NOTE:** *Removal steps in this procedure may contain installation details.*

1. Drain the cooling system.  
Refer to: [Cooling System Draining, Vacuum Filling and Bleeding](#) (303-03D Engine Cooling - 5.0L 32V Ti-VCT, General Procedures).
2. Remove the cooling fan motor and shroud.  
Refer to: [Cooling Fan Motor and Shroud](#) (303-03D Engine Cooling - 5.0L 32V Ti-VCT, Removal and Installation).
3. Release the clamps and disconnect the upper radiator hose and the radiator to degas bottle hose.



4. Pull the lower radiator hose spring clip until the end of the clip is in the detent on the quick connect coupling and disconnect the lower radiator hose.

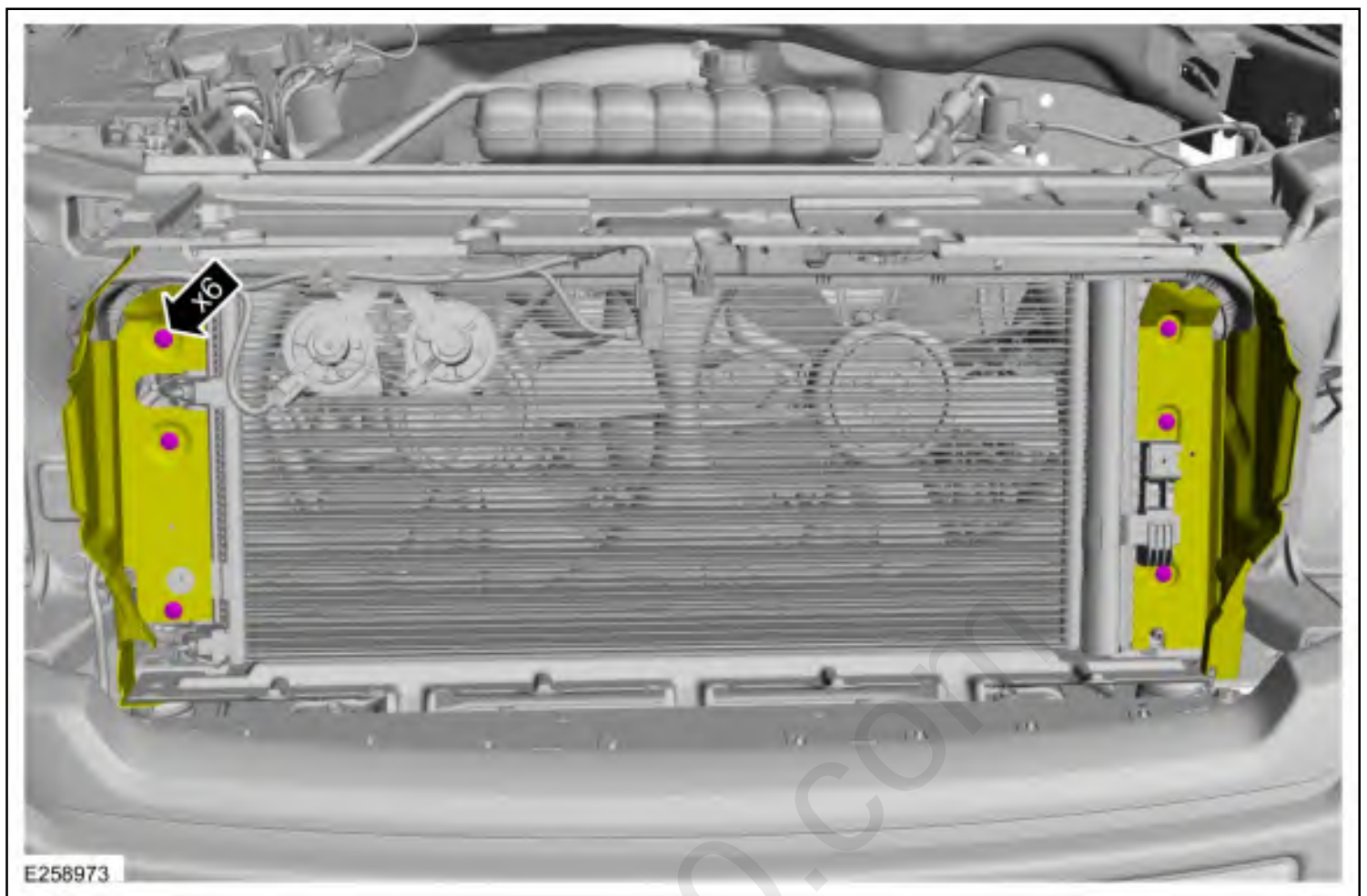


5. Remove the radiator grille.

Refer to: [Radiator Grille](#) (501-08 Exterior Trim and Ornamentation, Removal and Installation).

6. Remove the pin-type retainers.

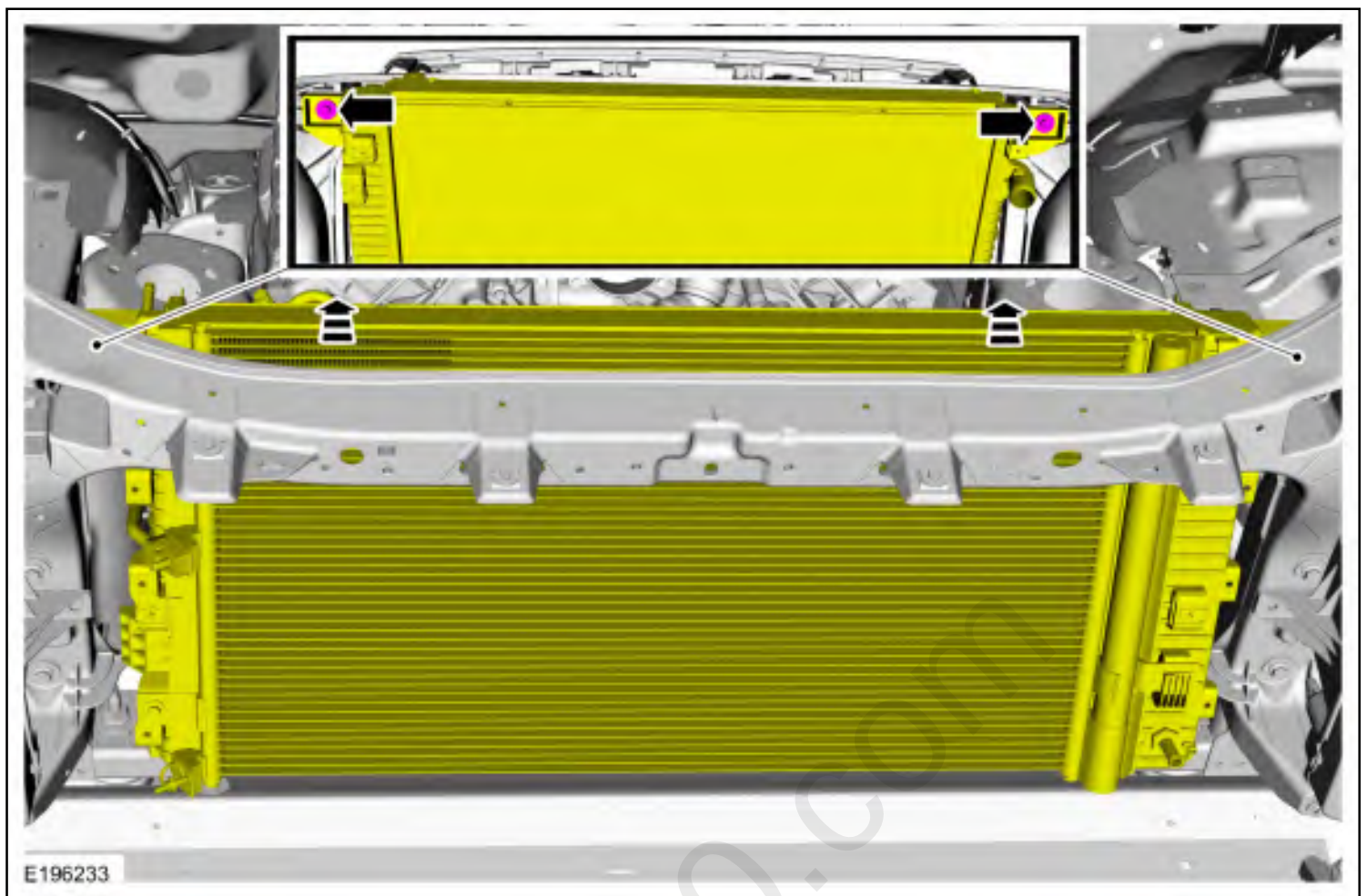




7. **NOTE:** *Components not shown for clarity.*

Remove the radiator retainers and tilt cooling module backwards.

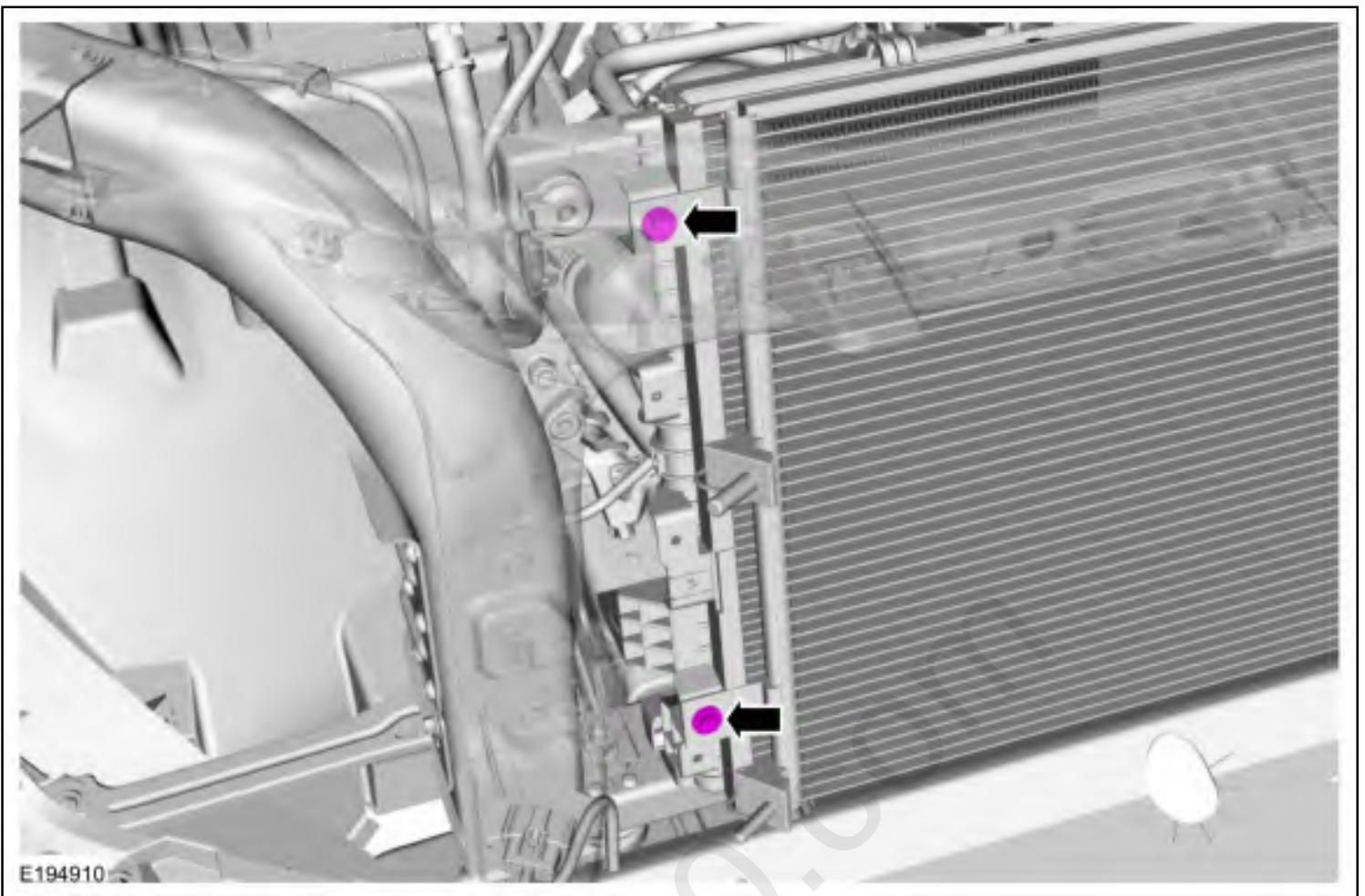
*Torque: 133 lb.in (15 Nm)*



8. **NOTE:** *Components not shown for clarity.*

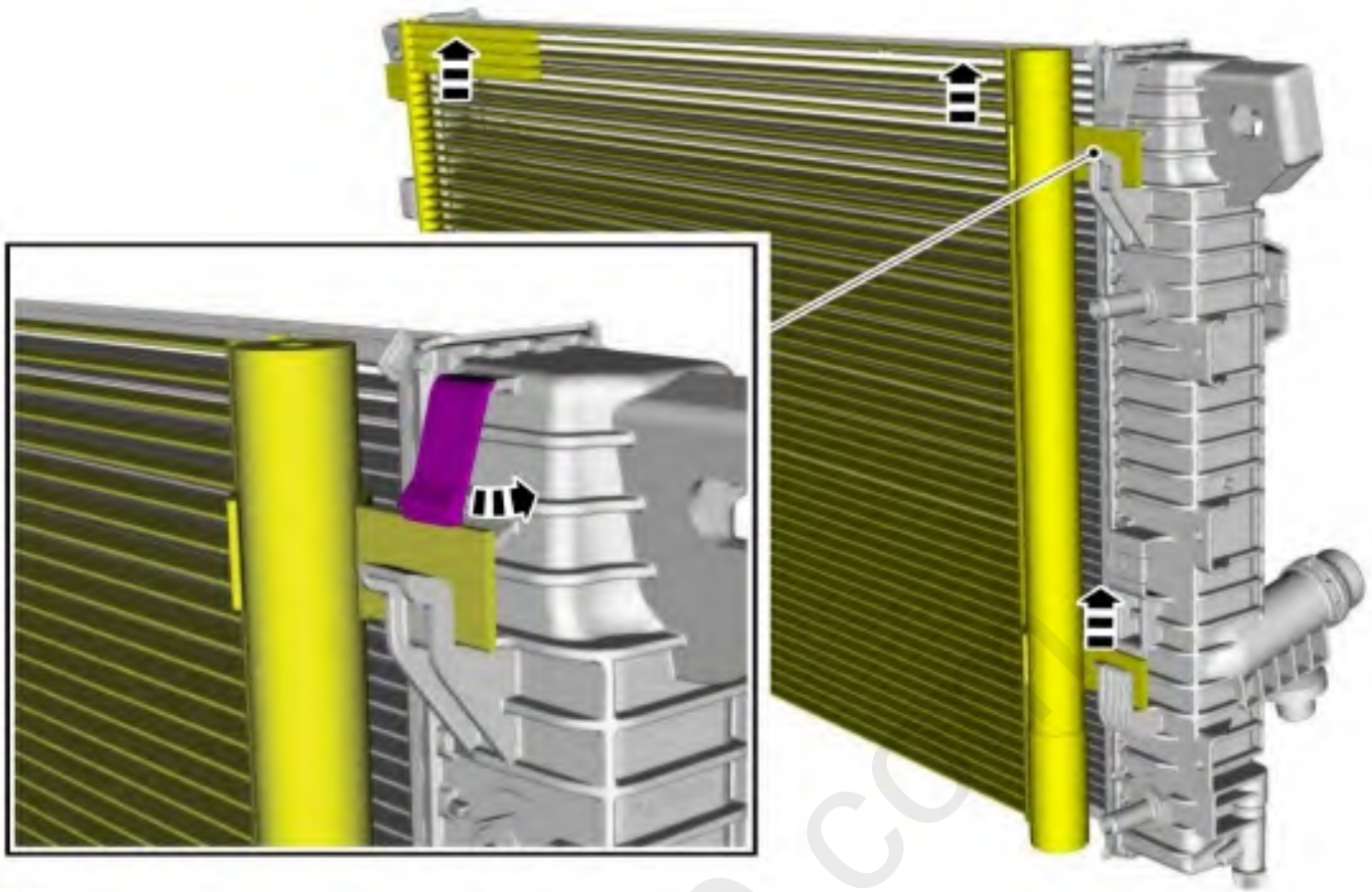
Remove the condenser retainers.

*Torque:* 62 lb.in (7 Nm)



9. **NOTE:** *Components not shown for clarity.*

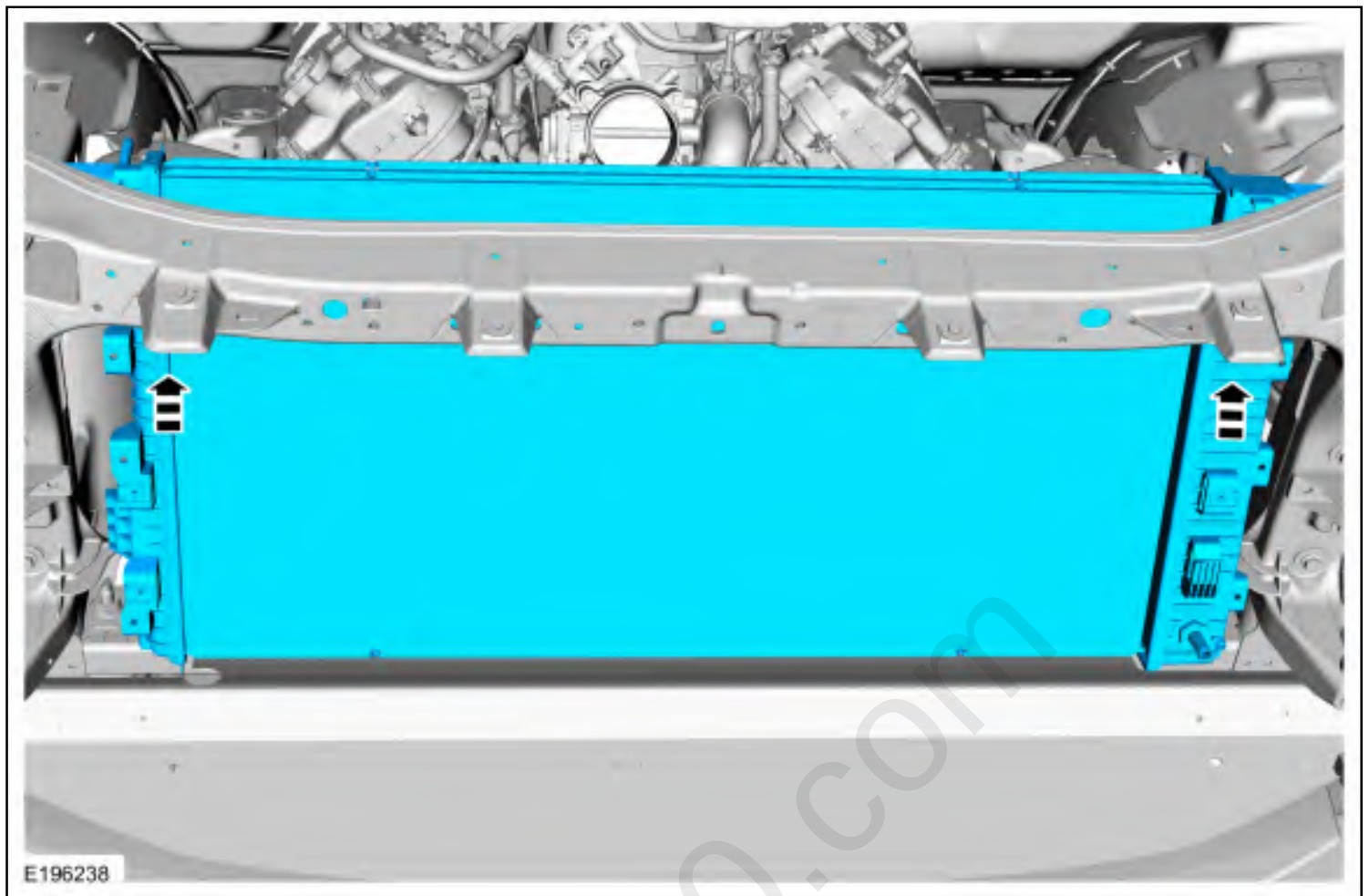
Release the tab and position the condenser upward to separate the condenser from the radiator.



E194912

10. Remove the radiator.





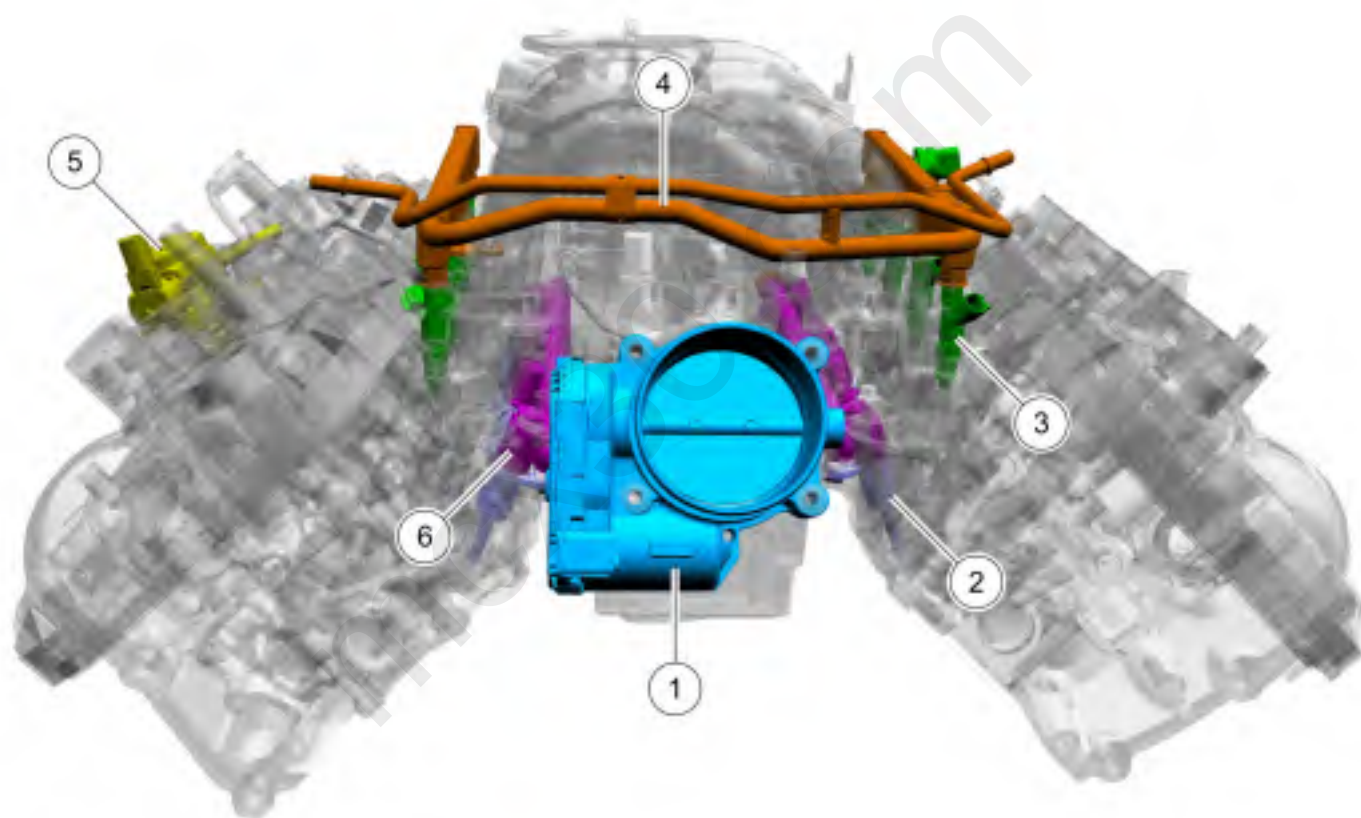
## Installation

1. To install, reverse the removal procedure.
2. Fill and bleed the cooling system.  
Refer to: [Cooling System Draining, Vacuum Filling and Bleeding](#) (303-03D Engine Cooling - 5.0L 32V Ti-VCT, General Procedures).



## Fuel Charging and Controls - Component Location

### 5.0L 32V Ti-VCT

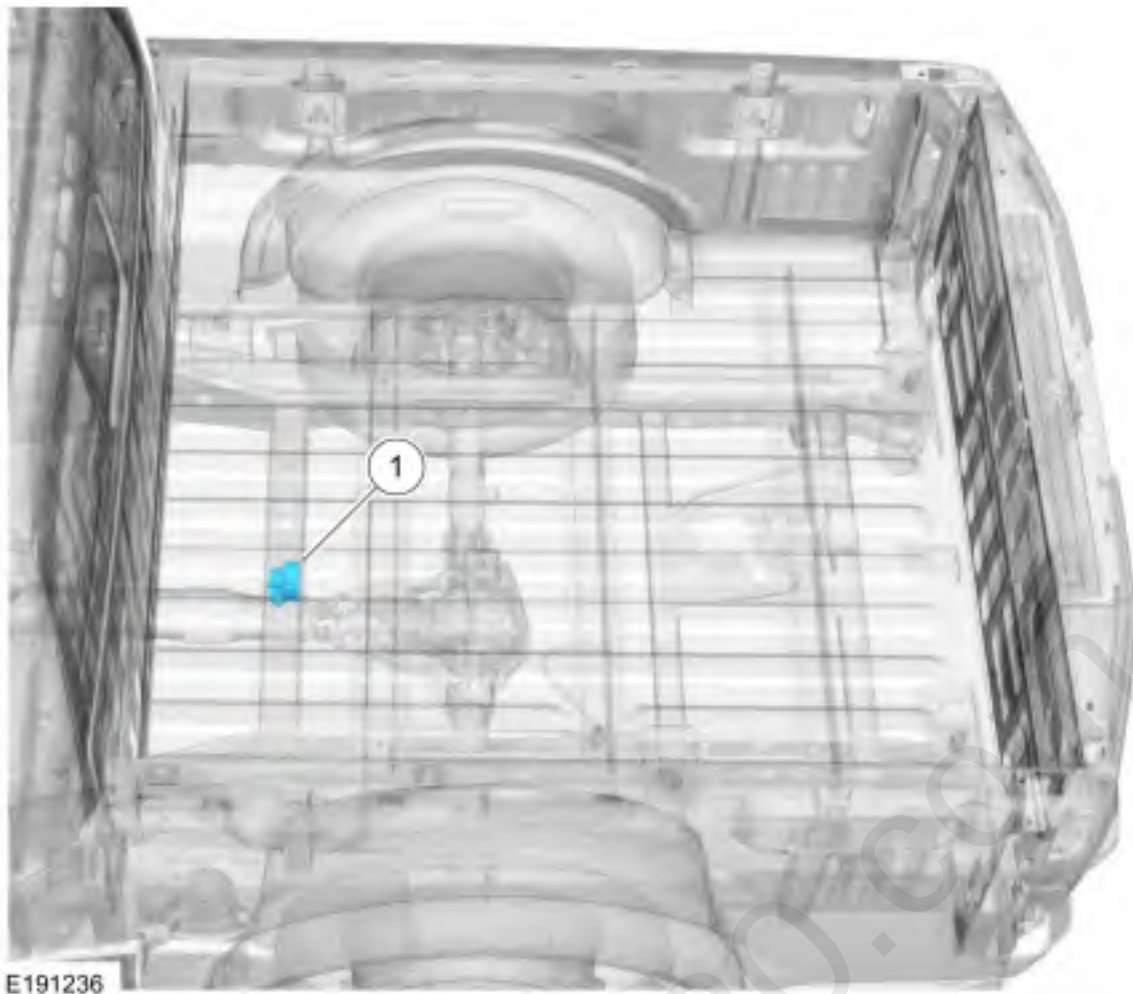


E258585

| Item | Description                                                                                                                                                  |
|------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | Throttle body<br>Refer to: <a href="#">Throttle Body</a> (303-04D Fuel Charging and Controls - 5.0L 32V Ti-VCT, Removal and Installation).                   |
| 2    | Direct injection fuel injector<br>Refer to: <a href="#">Fuel Injectors</a> (303-04D Fuel Charging and Controls - 5.0L 32V Ti-VCT, Removal and Installation). |

|   |                                                                                                                                                                                                                                                                                                                      |
|---|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3 | Port injection fuel injector<br>Refer to: <a href="#">Fuel Injectors</a> (303-04D Fuel Charging and Controls - 5.0L 32V Ti-VCT, Removal and Installation).                                                                                                                                                           |
| 4 | Port injection fuel rail assembly<br>Refer to: <a href="#">Port Injection Fuel Rail</a> (303-04D Fuel Charging and Controls - 5.0L 32V Ti-VCT, Removal and Installation).                                                                                                                                            |
| 5 | High-pressure fuel pump<br>Refer to: <a href="#">High-Pressure Fuel Pump</a> (303-04D Fuel Charging and Controls - 5.0L 32V Ti-VCT, Removal and Installation).                                                                                                                                                       |
| 6 | Direct injection fuel rail<br>Refer to: <a href="#">Direct Injection Fuel Rail LH</a> (303-04D Fuel Charging and Controls - 5.0L 32V Ti-VCT, Removal and Installation).<br>Refer to: <a href="#">Direct Injection Fuel Rail RH</a> (303-04D Fuel Charging and Controls - 5.0L 32V Ti-VCT, Removal and Installation). |

## Fuel Pump Driver Module



| Item | Description                                                                                                                                                                                                                                                                           |
|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | <p>Fuel pump driver module.<br/>Refer to: <a href="#">Fuel Pump Driver Module (FPDM)</a> (303-04D Fuel Charging and Controls - 5.0L 32V Ti-VCT, Removal and Installation).</p> <p><b>Comments:</b><br/>The fuel pump driver module is located on top of a rear frame crossmember.</p> |

## Fuel Charging and Controls

Diagnostics in this manual assume a certain skill level and knowledge of Ford-specific diagnostic practices. For information about these,

REFER to: [Diagnostic Methods](#) (100-00 General Information, Description and Operation).

For a PCM DTC,

REFER to: [Electronic Engine Controls](#) (303-14D Electronic Engine Controls - 5.0L 32V Ti-VCT, Diagnosis and Testing).

For driveability symptoms without a DTC, Refer to Powertrain Control/Emissions Diagnosis (PC/ED) manual. See Section 3, Symptom Charts.

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# Fuel Injectors

## Removal and Installation

1. The fuel injectors are removed with the fuel rails.

Refer to: [Direct Injection Fuel Rail LH](#) (303-04D Fuel Charging and Controls - 5.0L 32V Ti-VCT, Removal and Installation).

Refer to: [Direct Injection Fuel Rail RH](#) (303-04D Fuel Charging and Controls - 5.0L 32V Ti-VCT, Removal and Installation).

Refer to: [Port Injection Fuel Rail](#) (303-04D Fuel Charging and Controls - 5.0L 32V Ti-VCT, Removal and Installation).

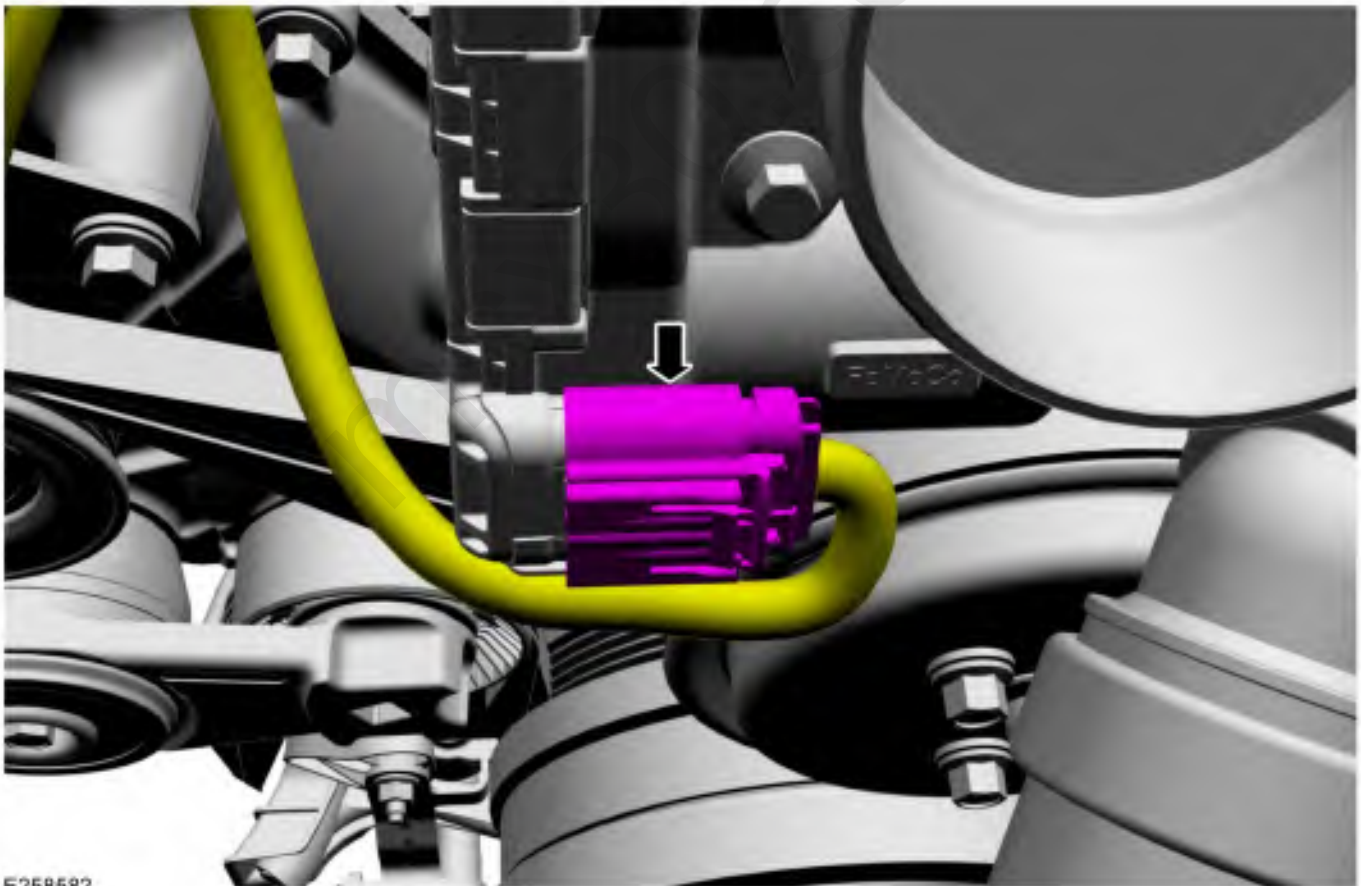


## Throttle Body

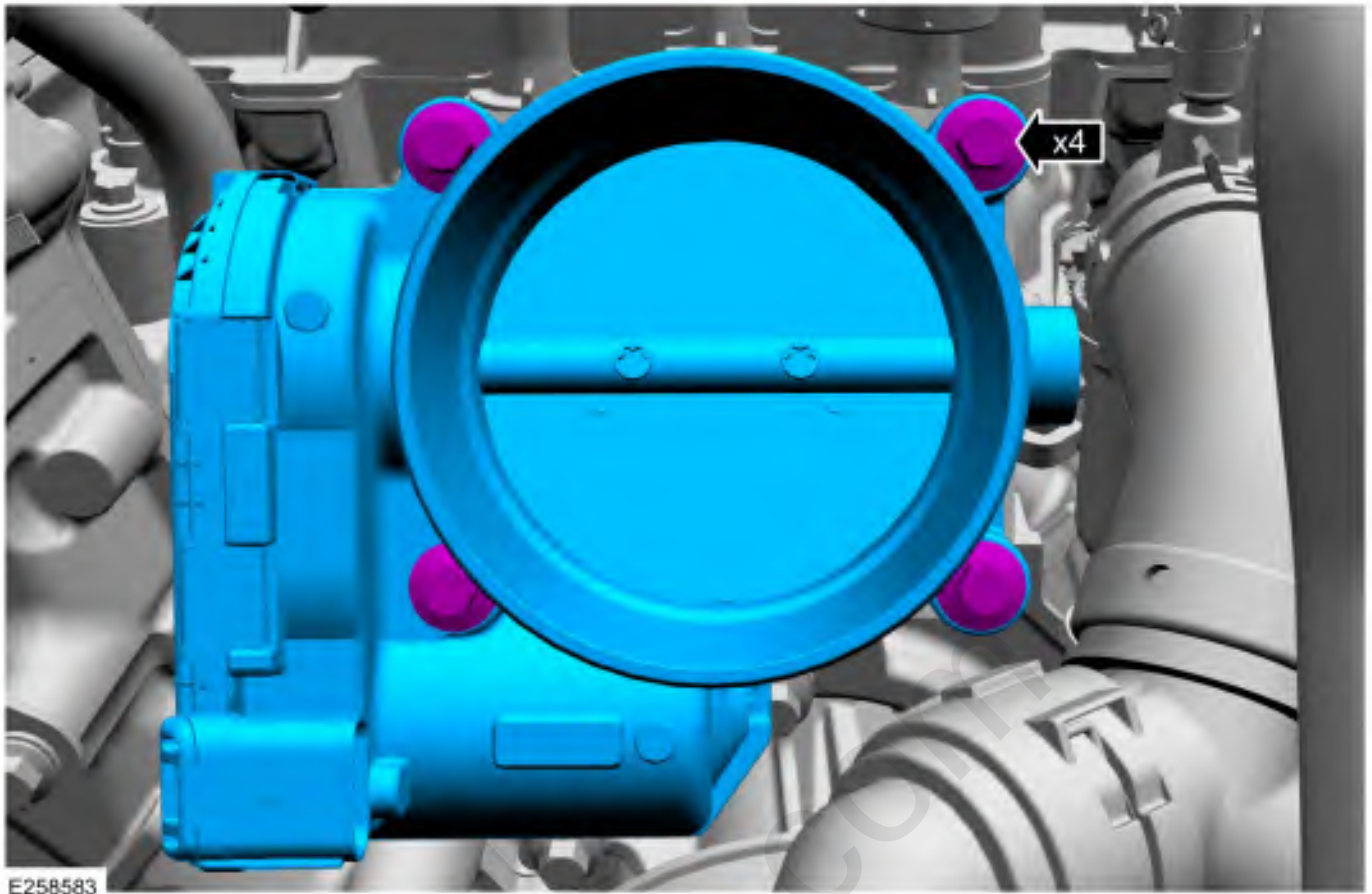
Base Part Number: Base Part Number: 9F991

### Removal

1. Remove the air cleaner outlet pipe.  
Refer to: [Air Cleaner Outlet Pipe](#) (303-12D Intake Air Distribution and Filtering - 5.0L 32V Ti-VCT, Removal and Installation).
2. Disconnect the throttle body electrical connector.



3. Remove the throttle body retaining bolts, then remove the throttle body.



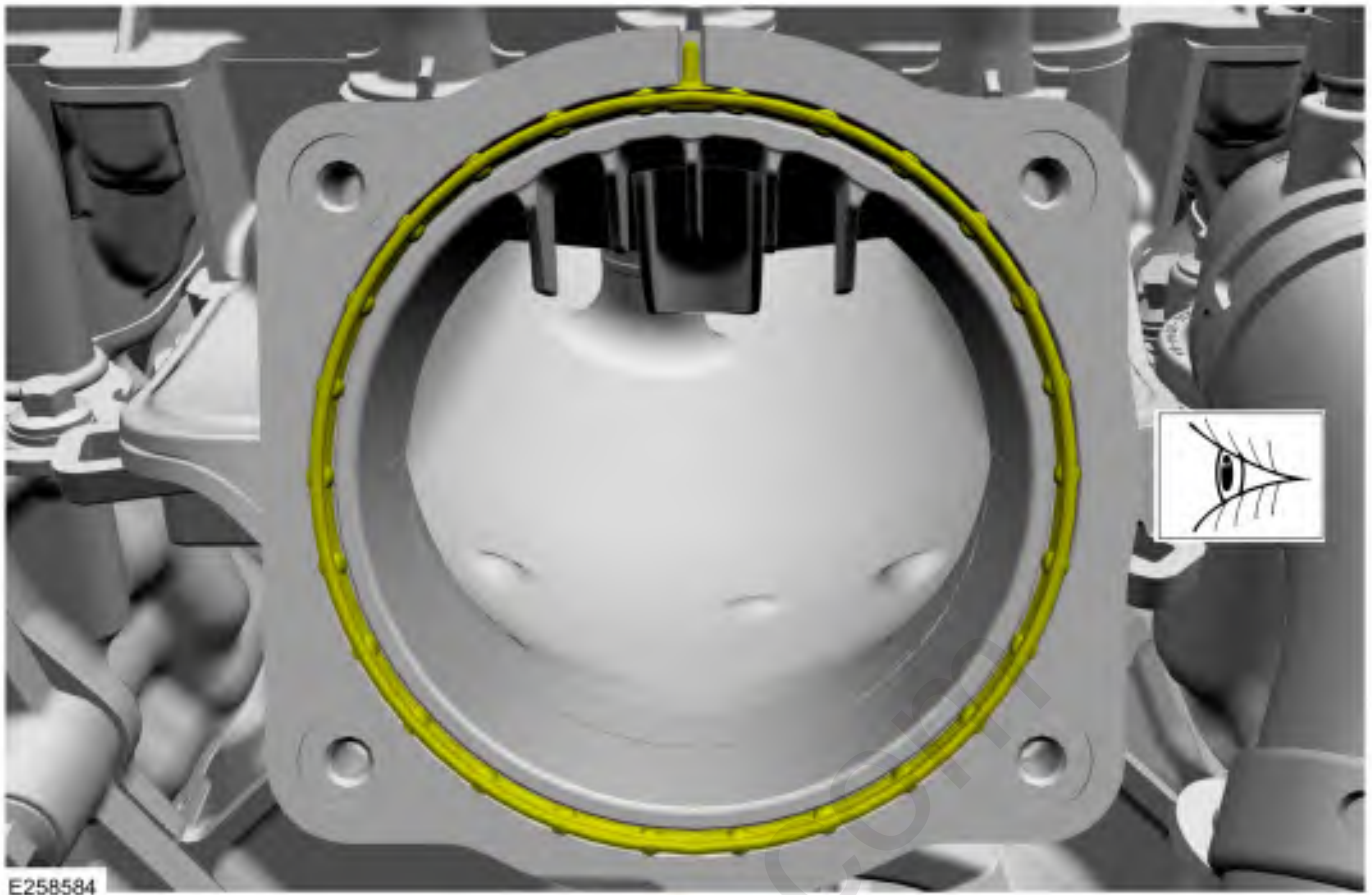
E258583



## Installation

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

1. Inspect the throttle body gasket, clean and replace the throttle body gasket as needed.

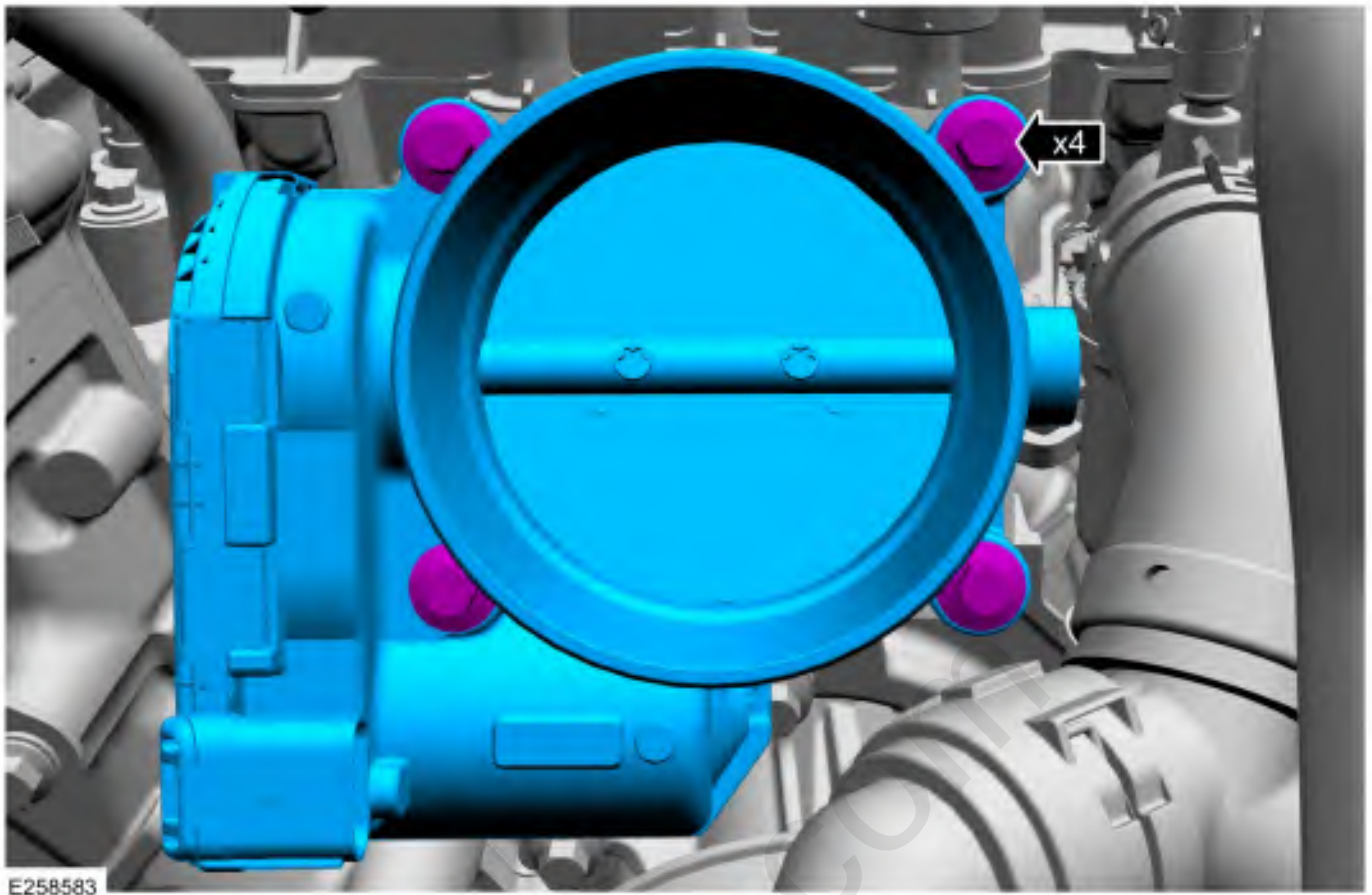


2. Install the throttle body, then install and tighten the throttle body retaining bolts in the following 2 stages.

*Torque:*

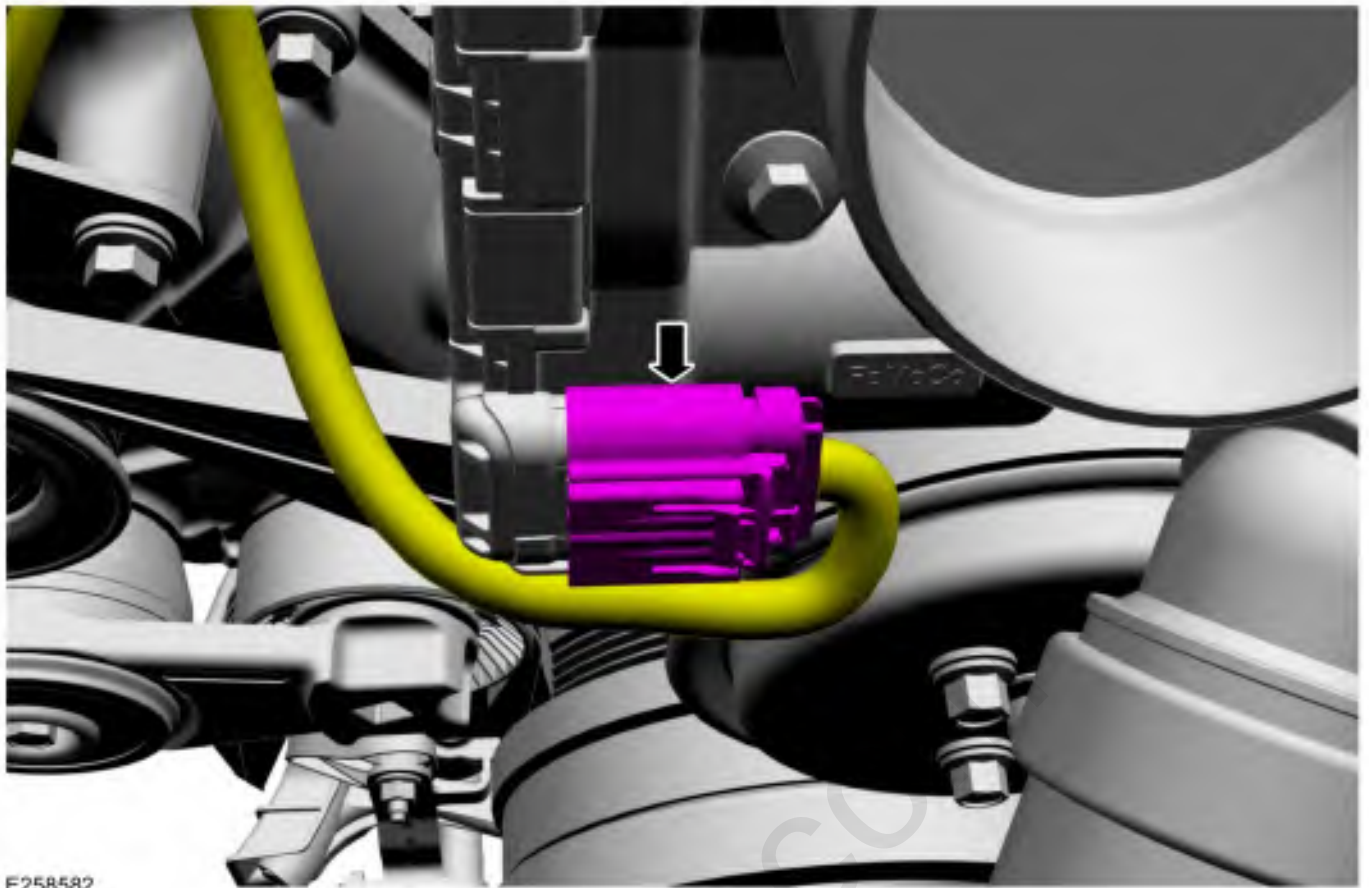
Stage 1: 62 lb.in (7 Nm)

Stage 2: 60°



3. Connect the throttle body electrical connector.





E258582

4. Install the air cleaner outlet pipe.

Refer to: [Air Cleaner Outlet Pipe](#) (303-12D Intake Air Distribution and Filtering - 5.0L 32V Ti-VCT, Removal and Installation).



# High-Pressure Fuel Pump Drive Unit

## Removal and Installation

1. The high-pressure fuel pump drive unit is part of the right cylinder head.  
Refer to: [Cylinder Head RH](#) (303-01D Engine - 5.0L 32V Ti-VCT, Removal and Installation).

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## Port Injection Fuel Rail

### Removal

1. Release the fuel system pressure.

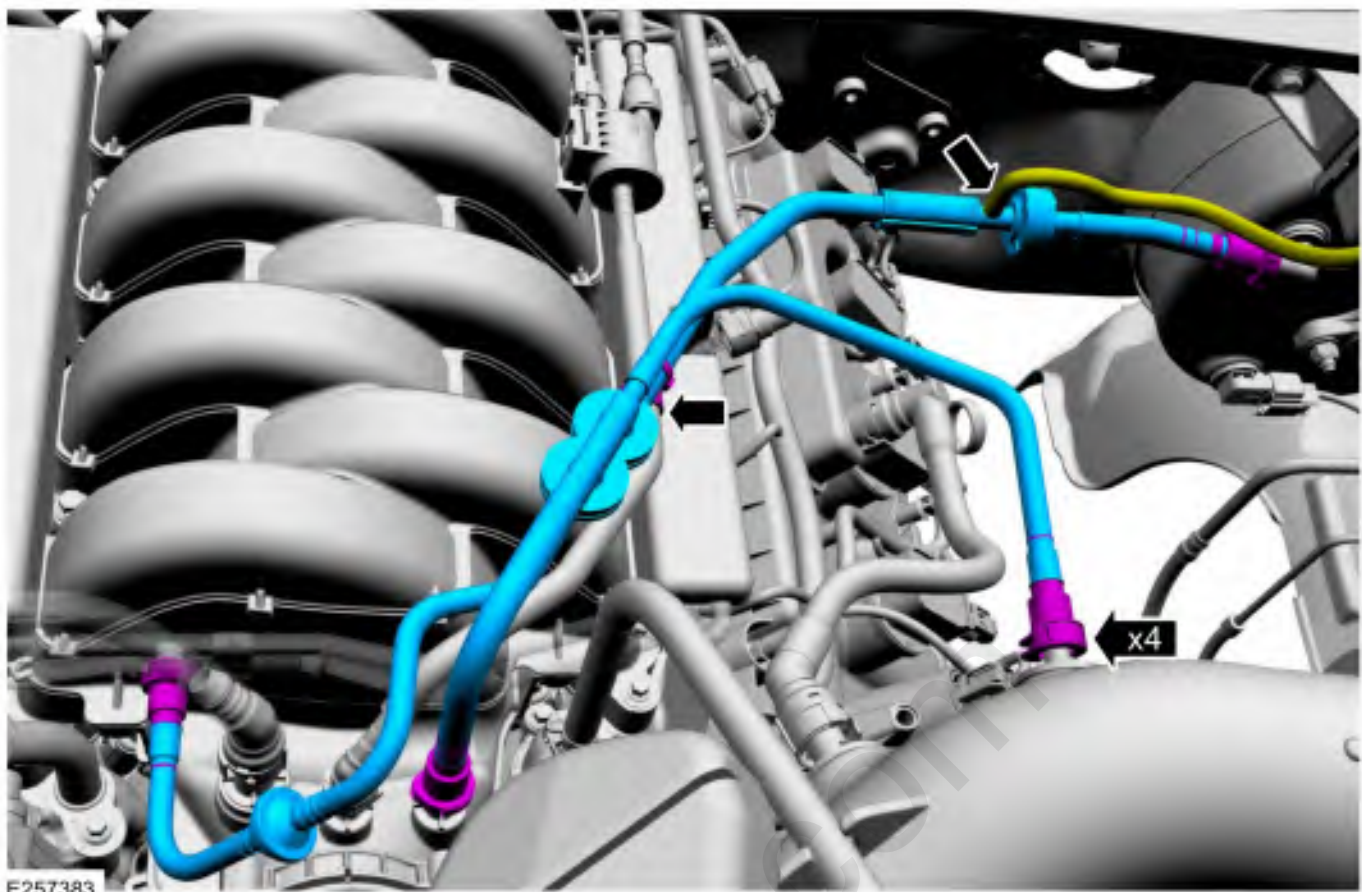
Refer to: [Fuel System Pressure Release](#) (310-00D Fuel System - General Information - 5.0L 32V Ti-VCT, General Procedures).

2. Disconnect the battery negative cable.

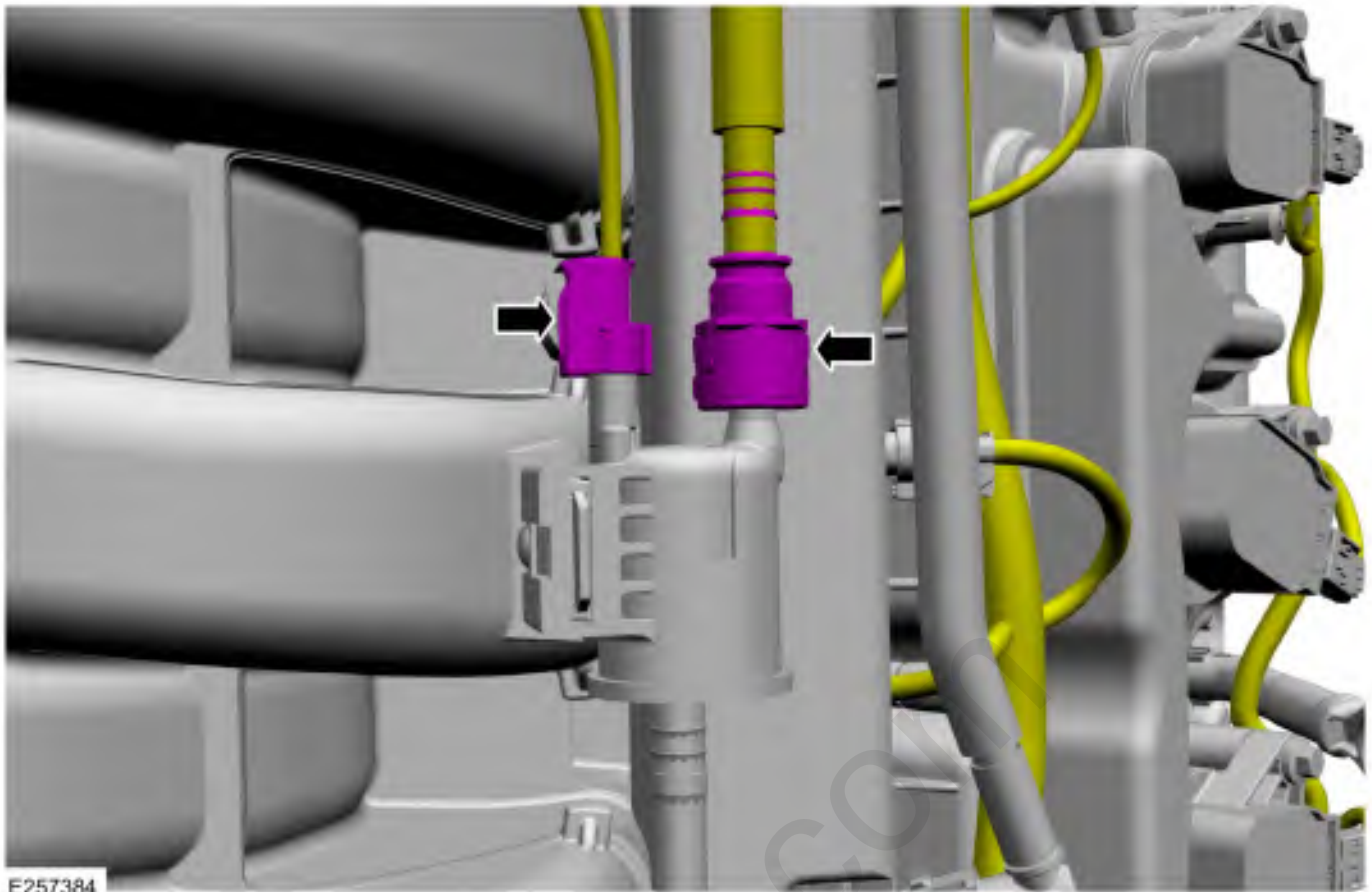
Refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables) .

- Disconnect the hose.
- Detach the hose retainer.
- Disconnect the quick release couplings.

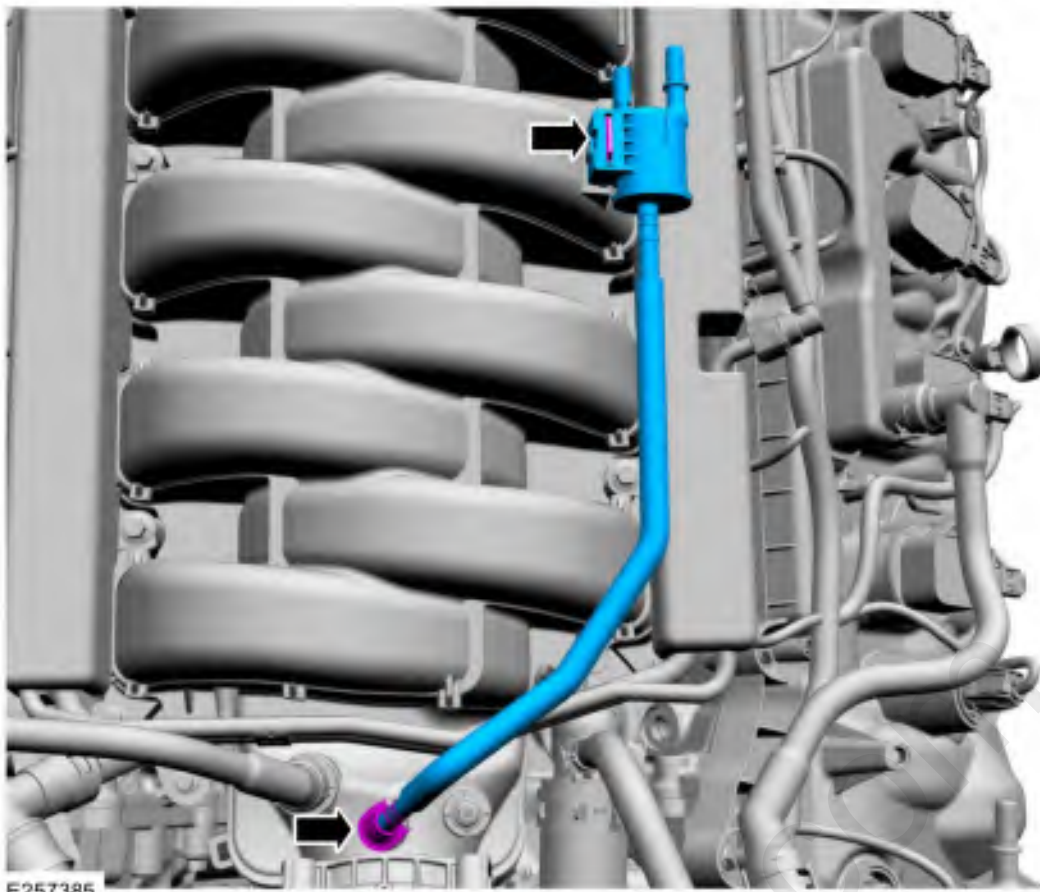
Refer to: [Quick Release Coupling](#) (310-00D Fuel System - General Information - 5.0L 32V Ti-VCT, General Procedures).



- Disconnect the quick release coupling.  
Refer to: [Quick Release Coupling](#) (310-00D Fuel System - General Information - 5.0L 32V Ti-VCT, General Procedures).
- Disconnect the electrical connector.

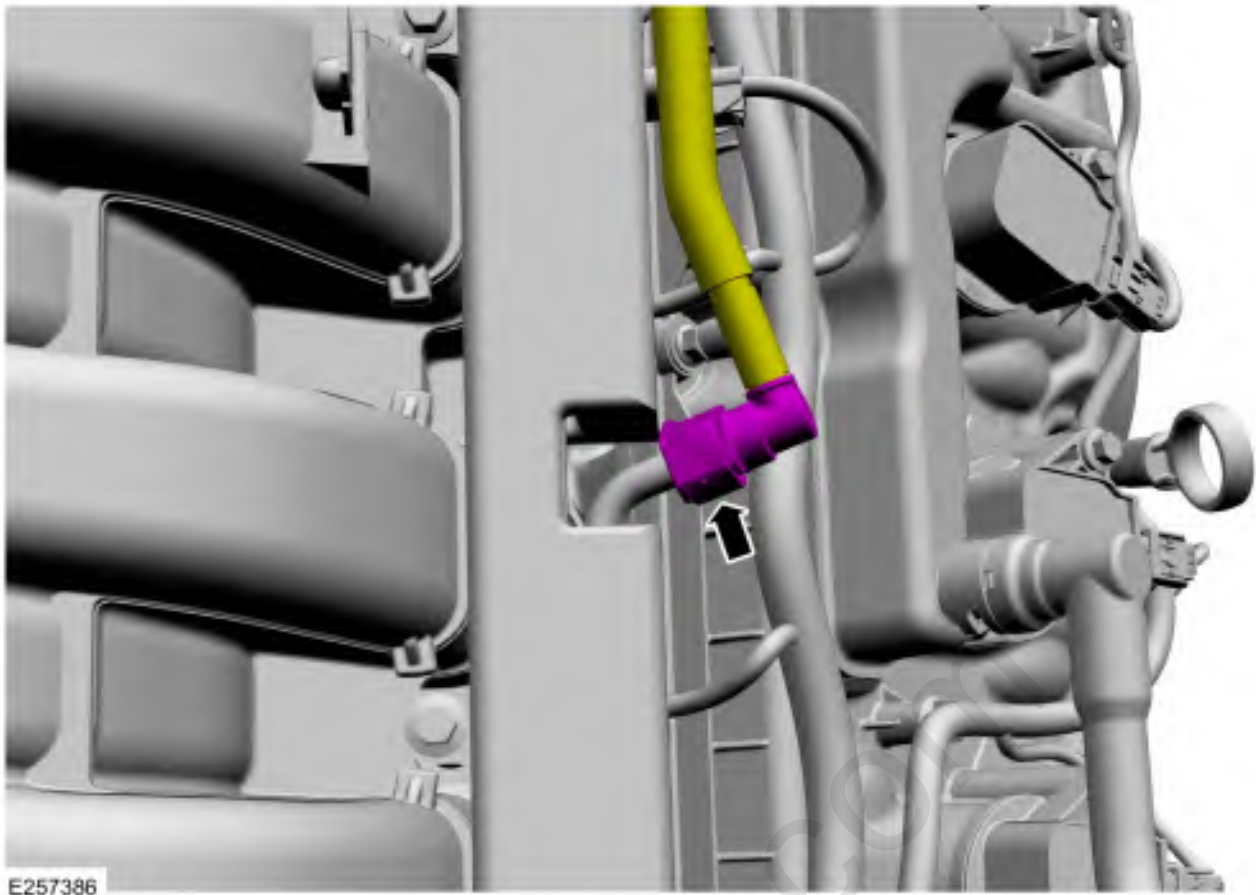


- Disconnect the quick release coupling.  
Refer to: [Quick Release Coupling](#) (310-00D Fuel System - General Information - 5.0L 32V Ti-VCT, General Procedures).
- Release the valve from the bracket, then remove the valve assembly.

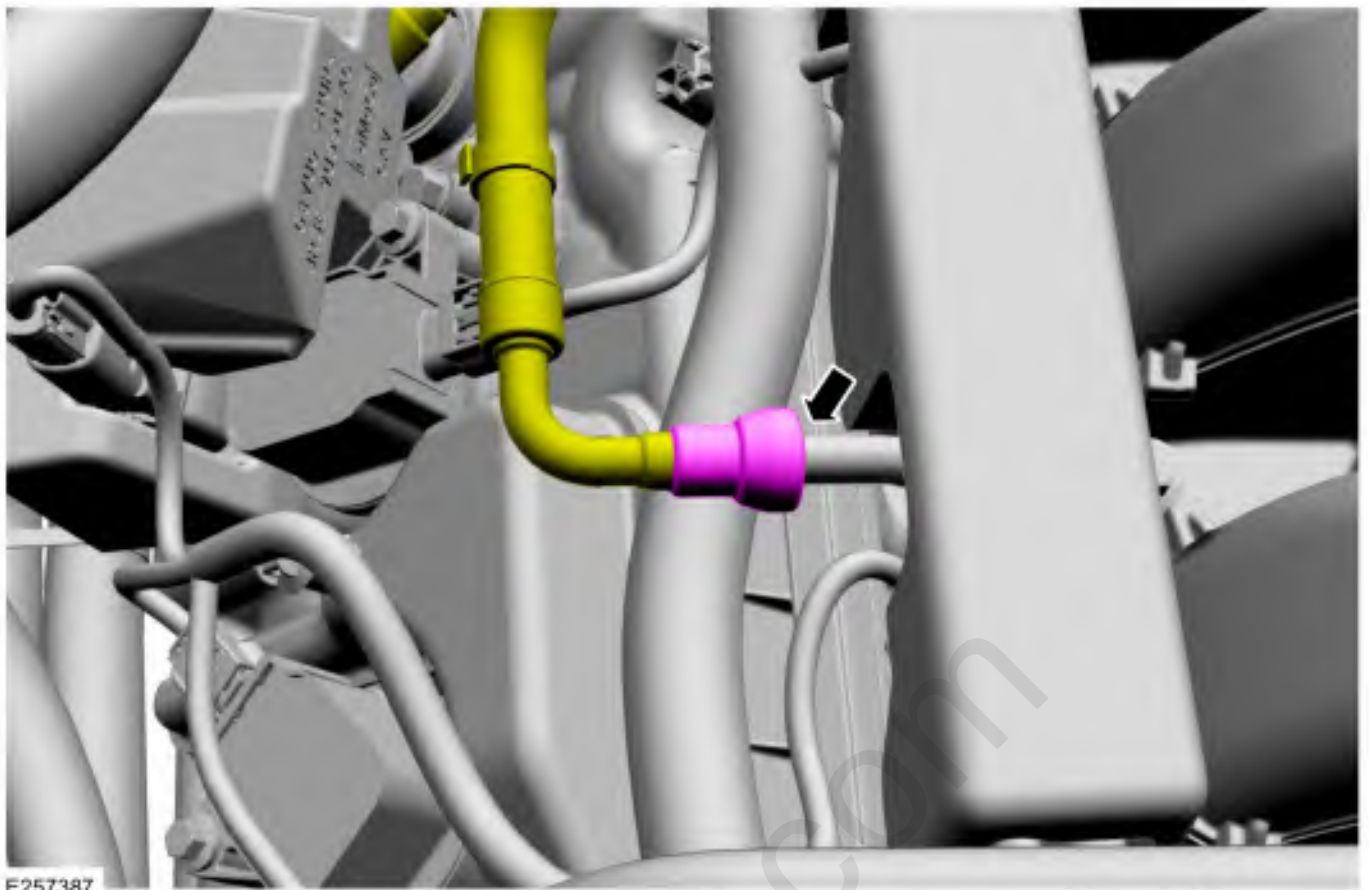


6. Disconnect the fuel supply tube quick release coupling.  
Refer to: [Quick Release Coupling](#) (310-00D Fuel System - General Information - 5.0L 32V Ti-VCT, General Procedures).

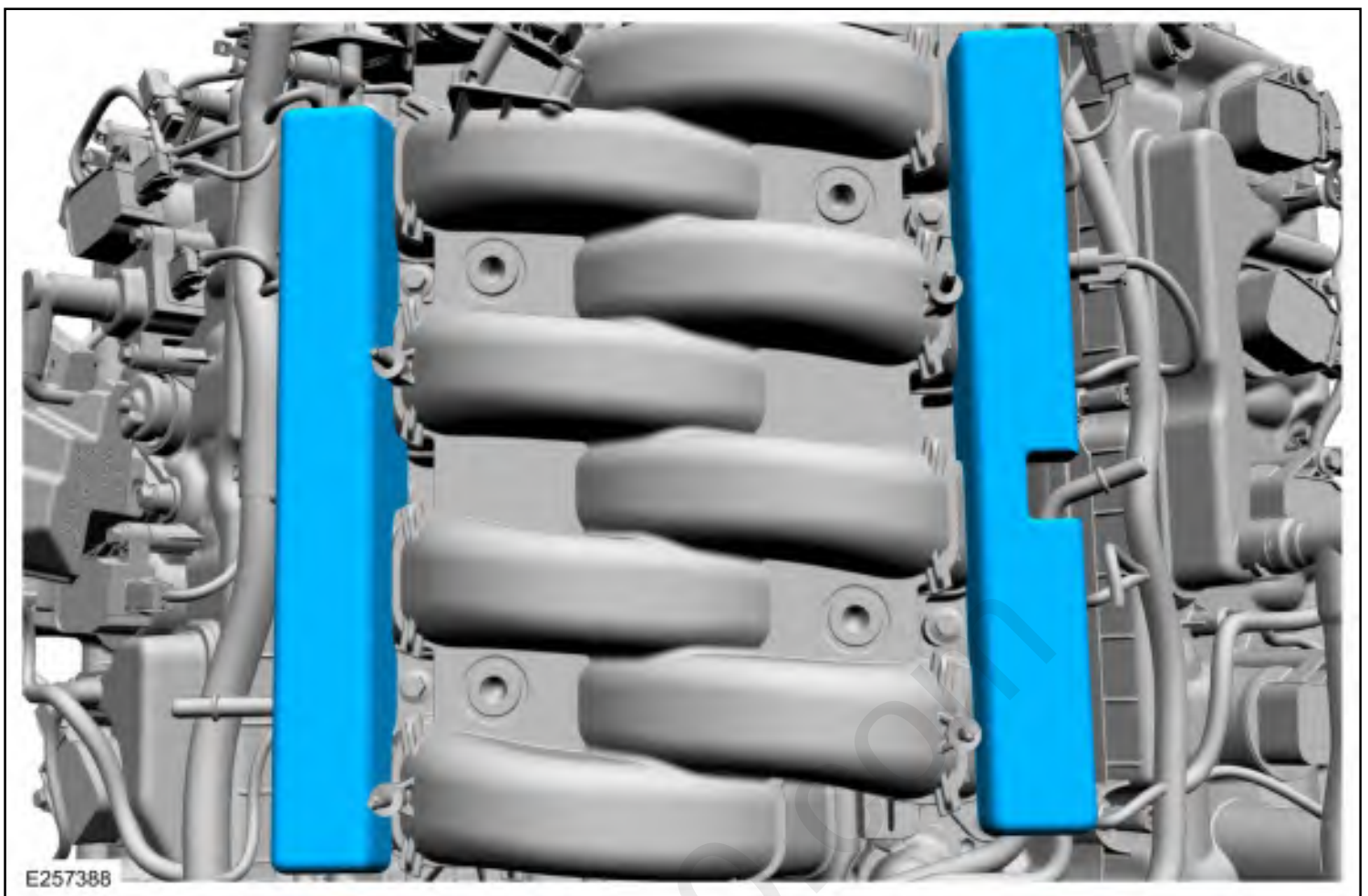




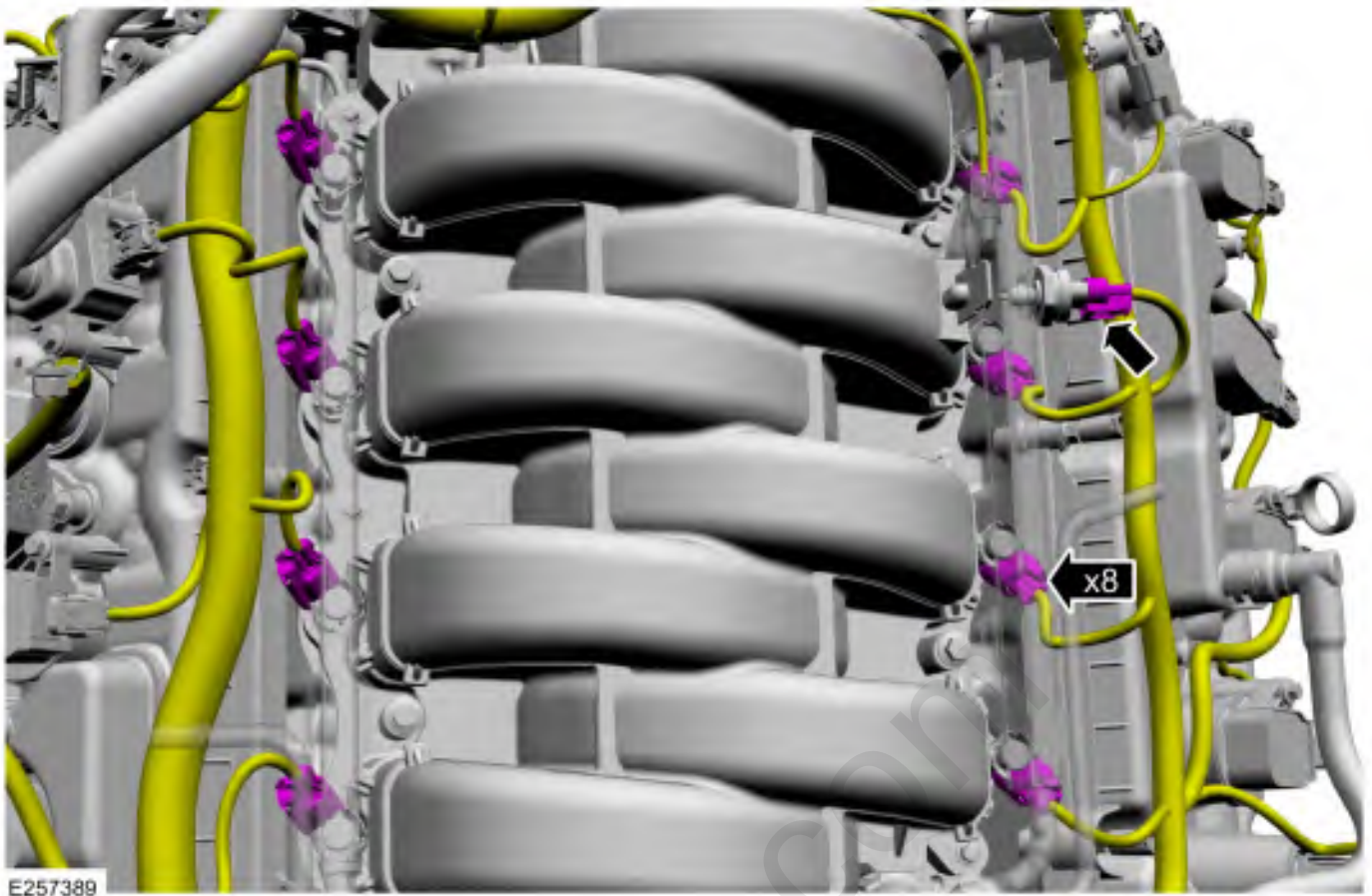
7. Disconnect the fuel high-pressure fuel pump supply tube spring lock coupling.  
Refer to: [Spring Lock Couplings](#) (310-00D Fuel System - General Information - 5.0L 32V Ti-VCT, General Procedures).



8. Remove the left and the right fuel rail insulators.

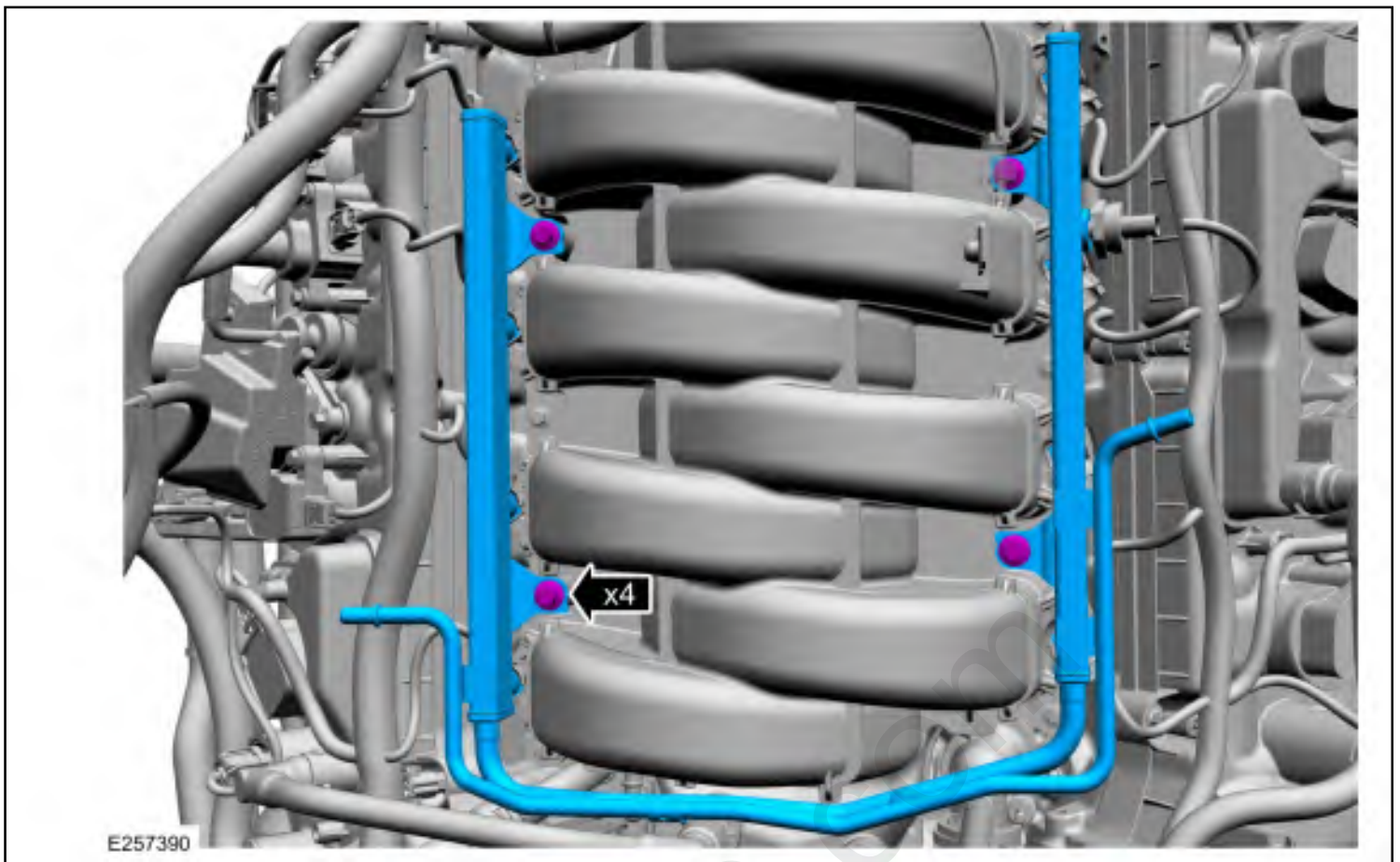


9. Disconnect the fuel injector electrical connectors and the fuel sensor electrical connector.



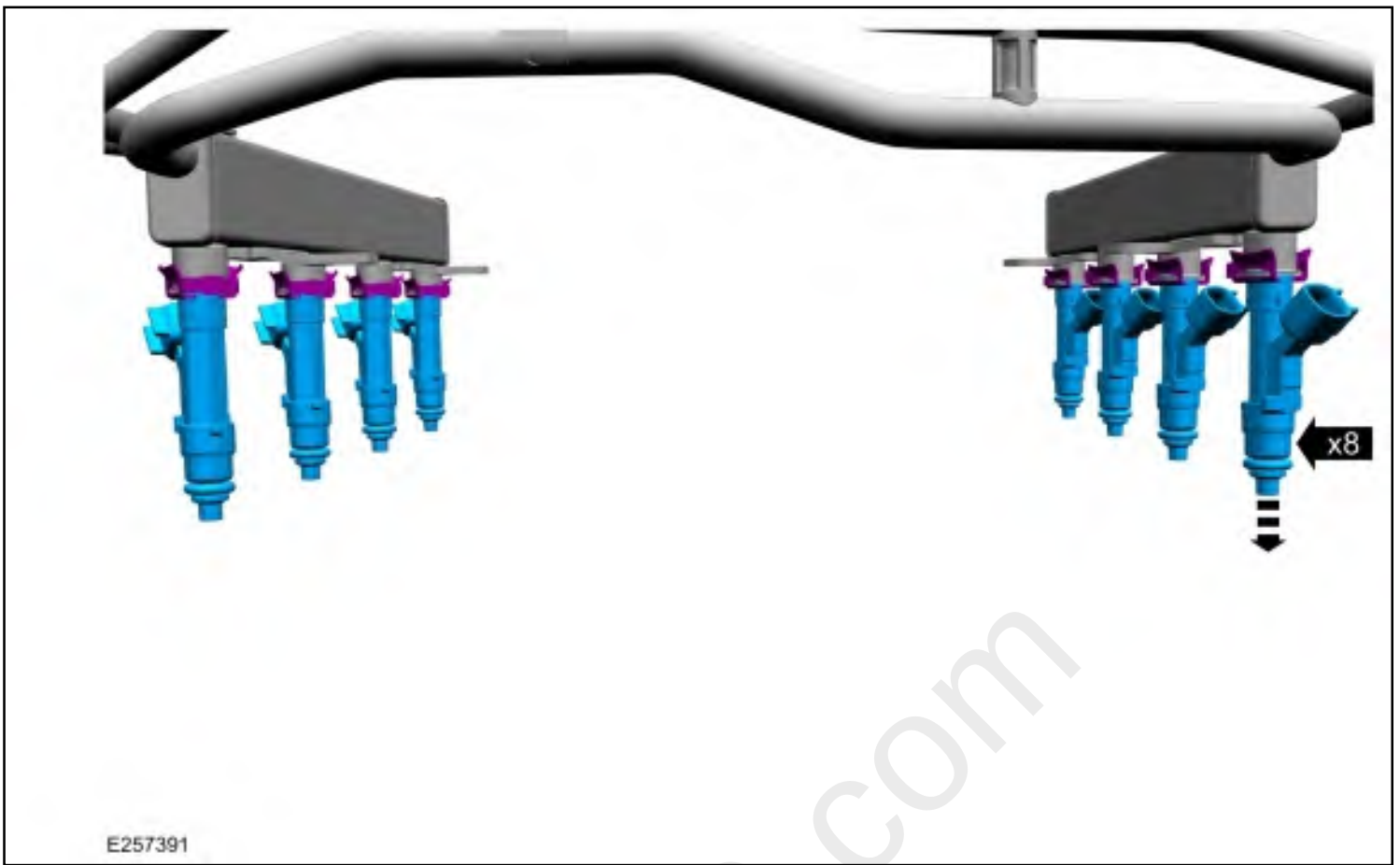
10. Remove the fuel rail retaining bolts, then remove the fuel rail.



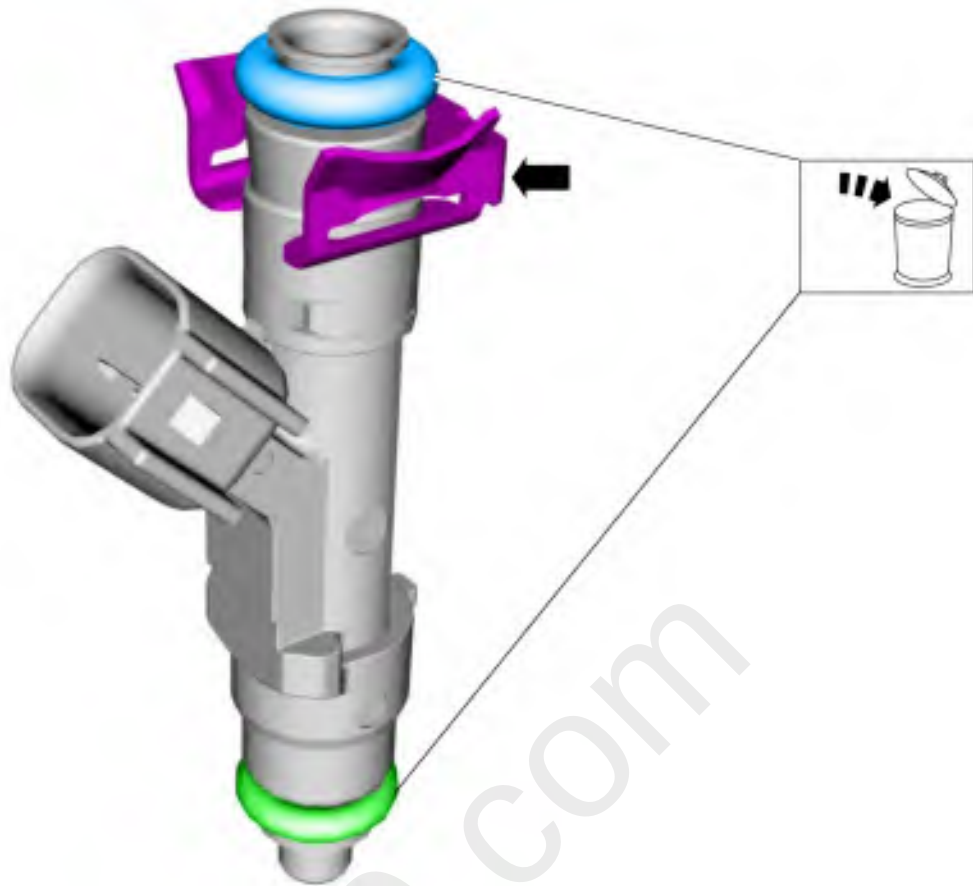


11. Remove the fuel injectors from the fuel rail.





12. Remove and discard all of the fuel injector O-ring seals. Remove the fuel injector retaining clips.



E191249



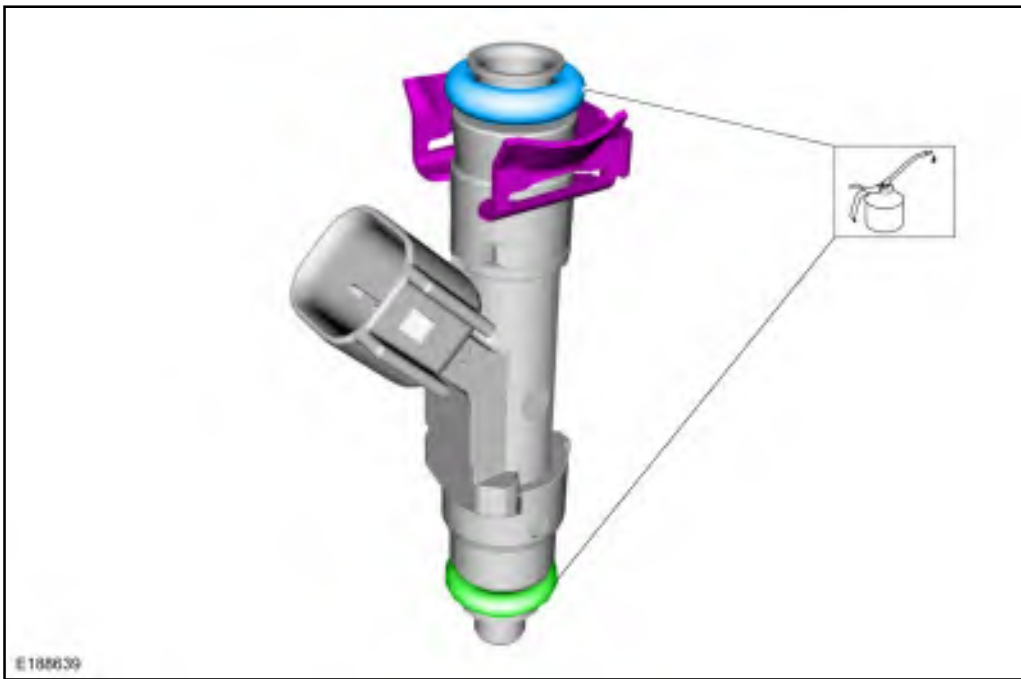
## Installation

1. **NOTE:** Make sure that NEW fuel injector O-ring seals are installed.

**NOTE:** The fuel injector clip can be reused if it is not damaged during removal. If the clip is reused, the 2 sides of the clip should be squeezed back into shape by placing it between index finger and thumb.

Install the NEW fuel injector O-ring seals and the fuel injector retaining clips onto the fuel injectors. Lubricate the NEW fuel injector O-ring seals with clean engine oil.

Refer to: [Specifications](#) (303-01D Engine - 5.0L 32V Ti-VCT, Specifications).

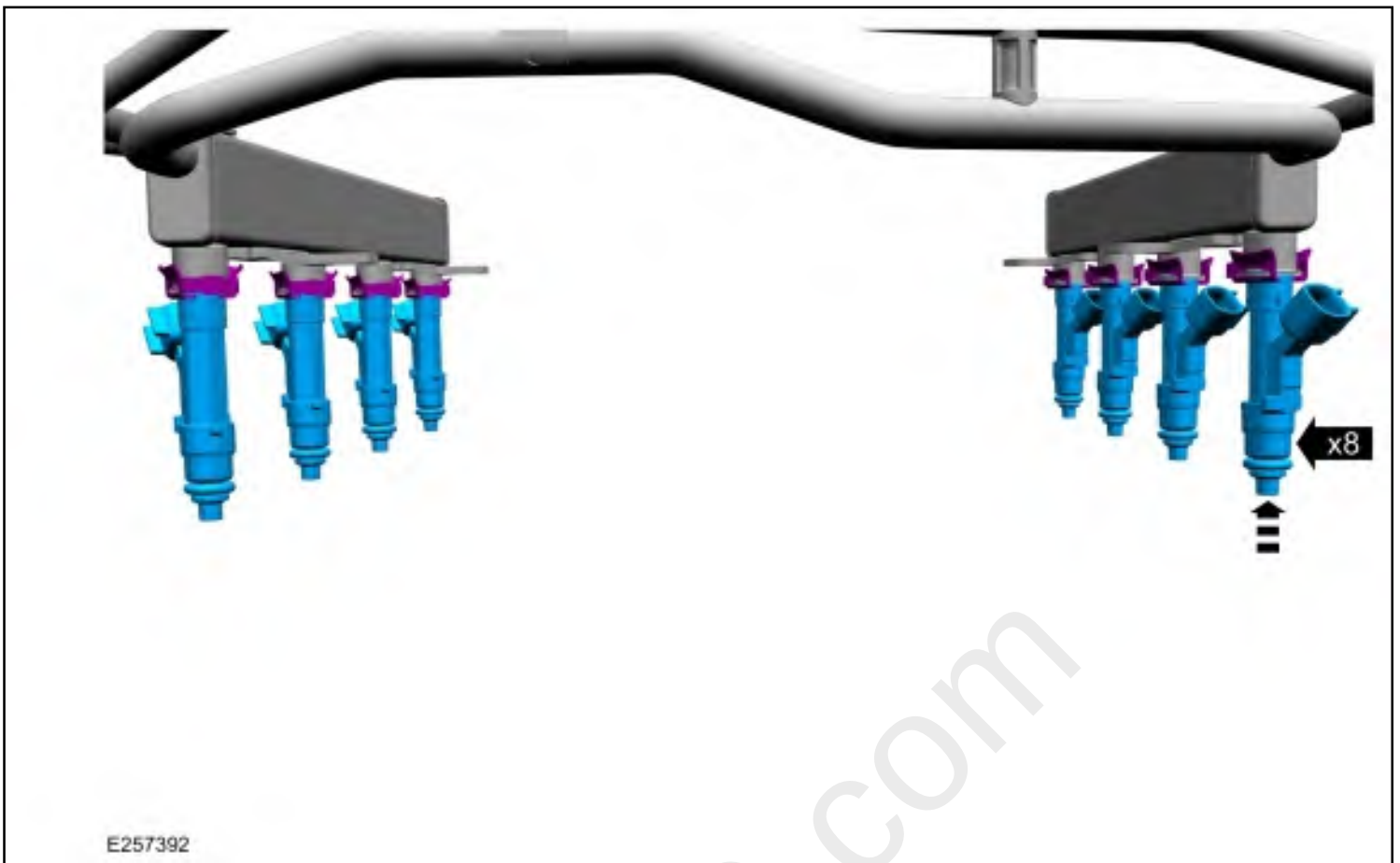


2. **NOTICE:** The fuel rail pressure and temperature sensor must be replaced if it is removed from the fuel rail.

**NOTE:** Position the fuel injector's so that the flat sides of the fuel rail injector cup is aligned with the flat side of the fuel injector retainer.

Install the fuel injectors into the fuel rail.

Refer to: [Fuel Rail Pressure and Temperature Sensor](#) (303-14D Electronic Engine Controls - 5.0L 32V Ti-VCT, Removal and Installation).

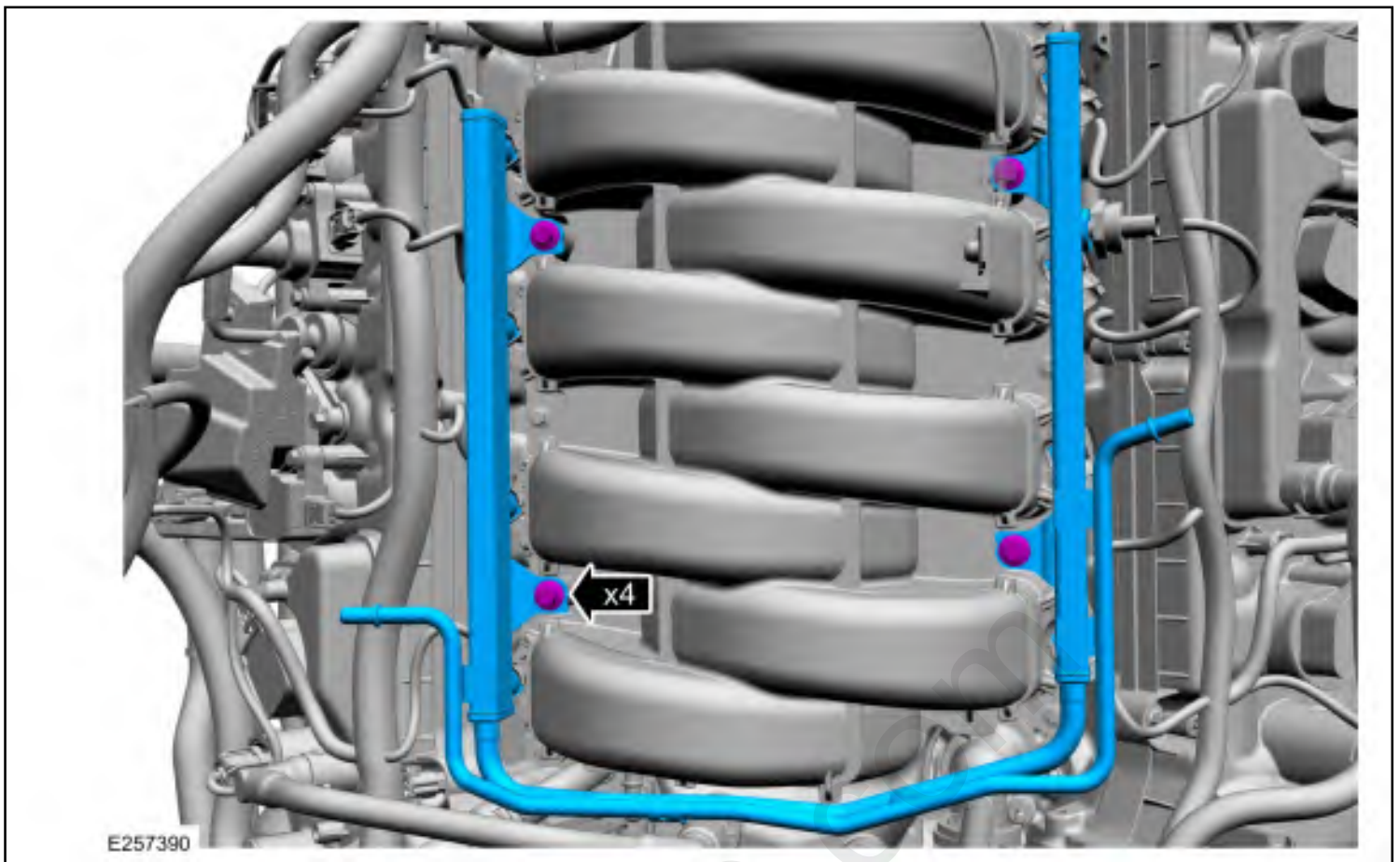


3. Install the fuel rail, then install and tighten the fuel rail retaining bolts in the following 2 stages.

*Torque:*

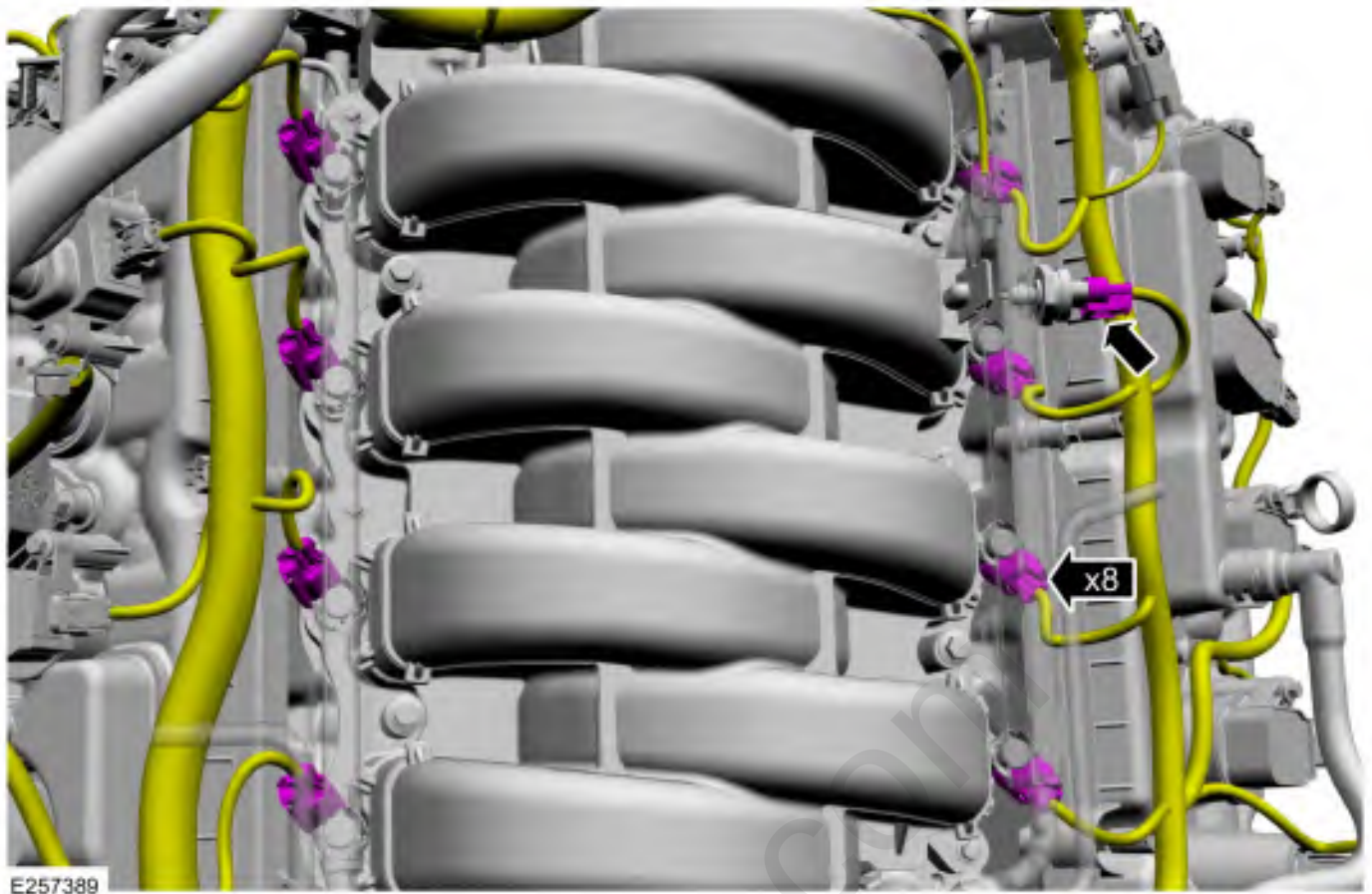
Stage 1: 89 lb.in (10 Nm)

Stage 2: 90°

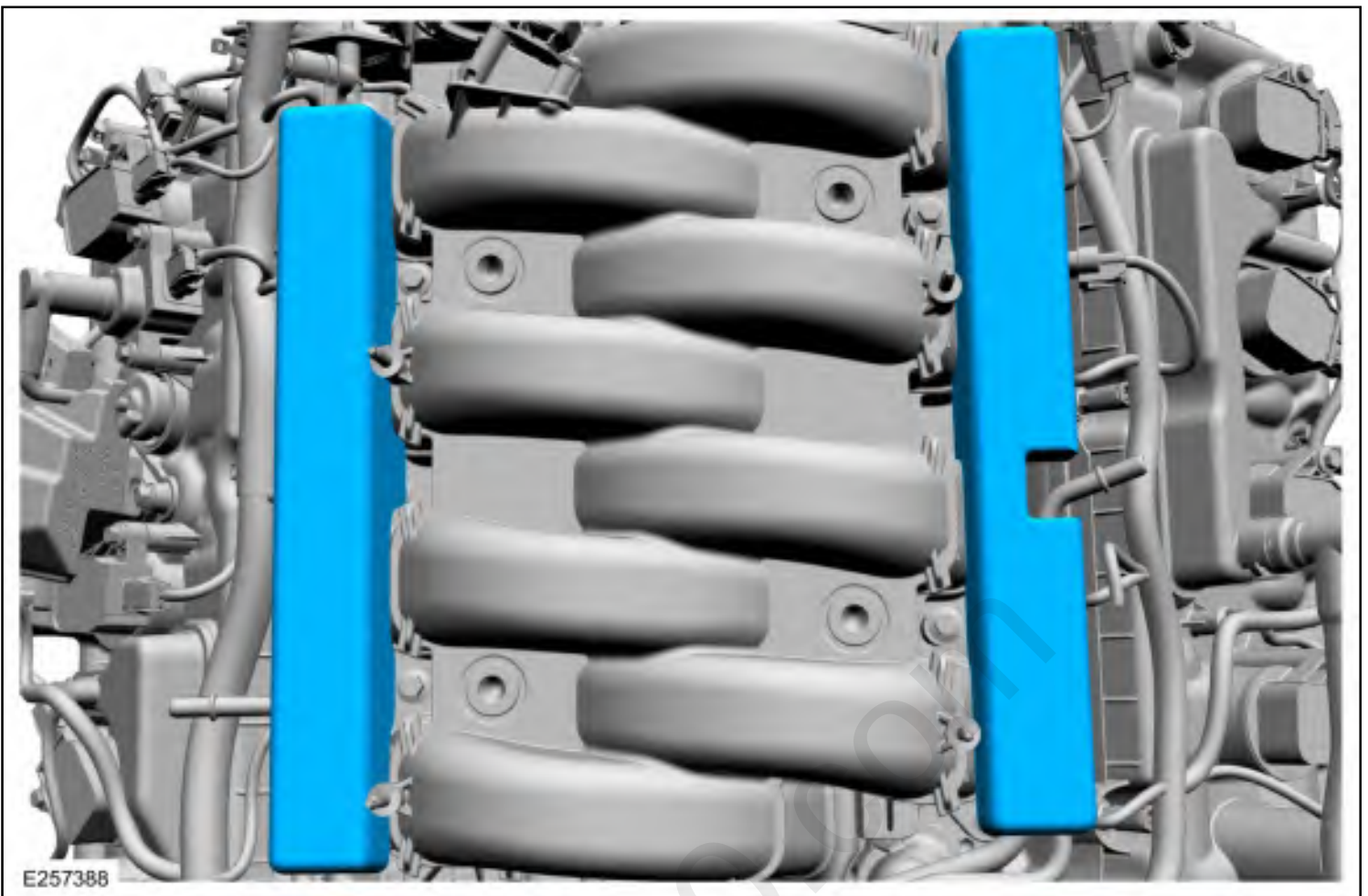


4. Connect the fuel injector electrical connectors and the fuel sensor electrical connector.





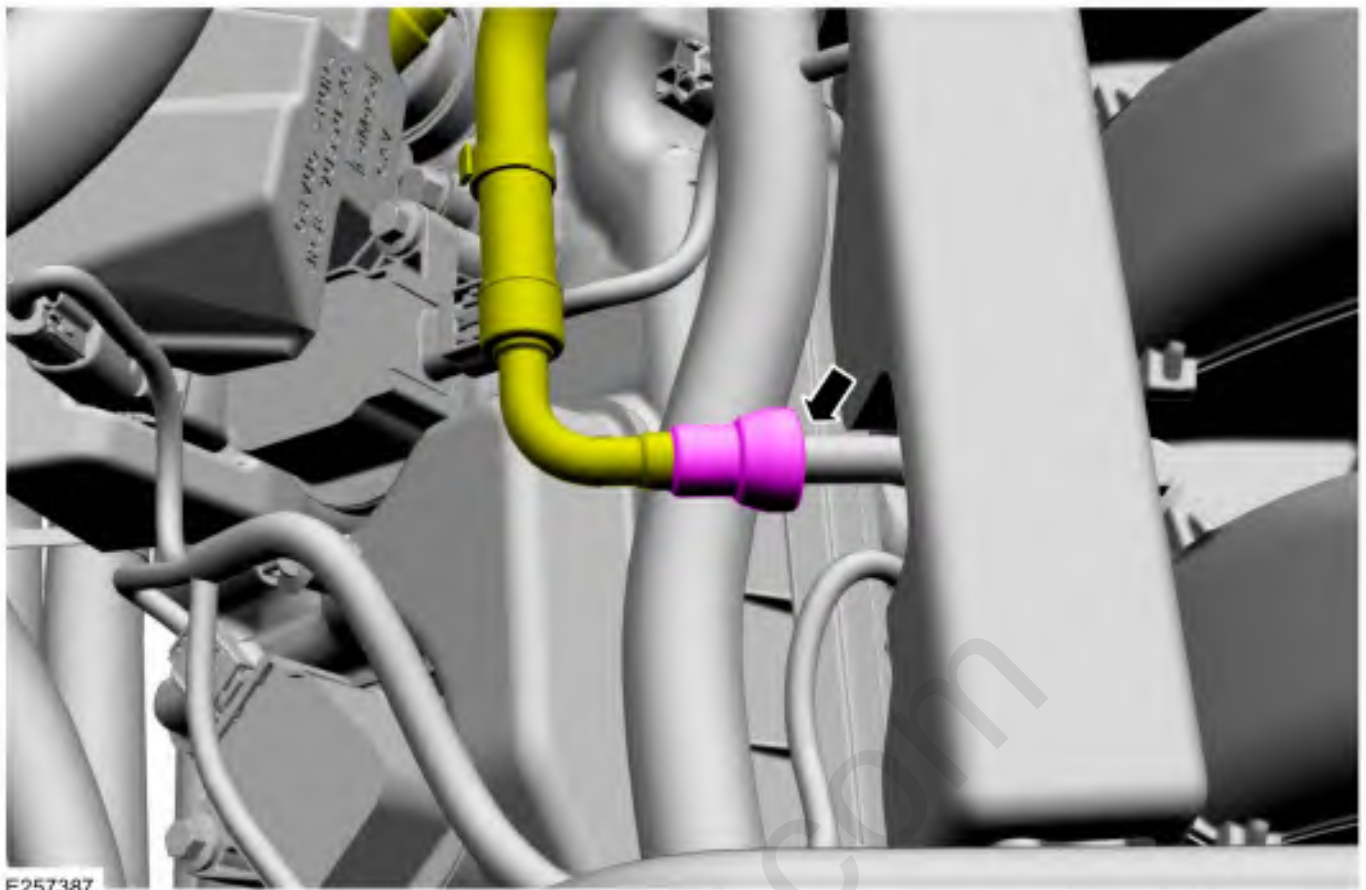
5. Install the left and the right fuel rail insulators.



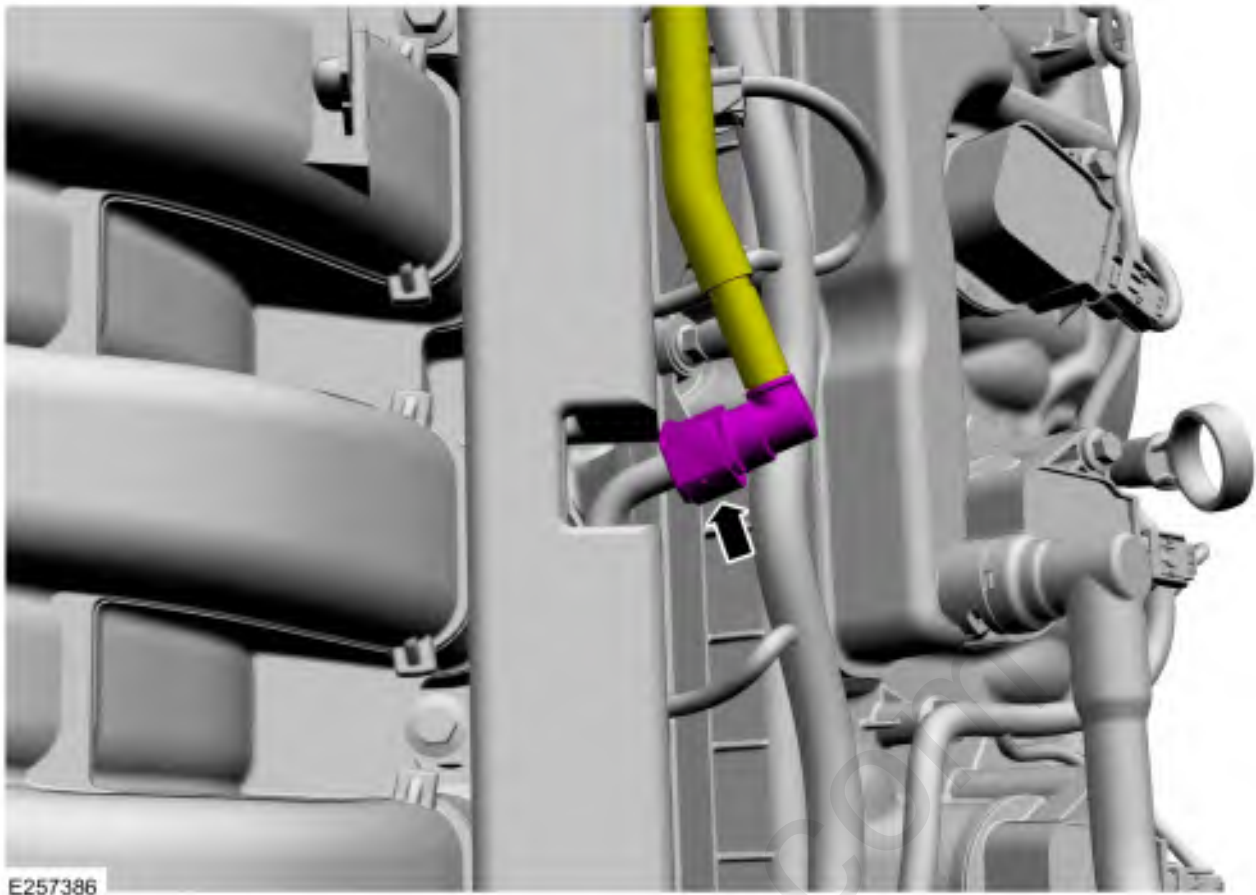
6. **NOTICE:** The fuel high-pressure fuel pump supply tube must be installed with the 90 degree spring lock end installed to the port fuel rail; if it is installed backwards a check valve will prevent the engine from running properly.

Connect fuel high-pressure fuel pump supply tube spring lock coupling.

Refer to: [Spring Lock Couplings](#) (310-00D Fuel System - General Information - 5.0L 32V Ti-VCT, General Procedures).

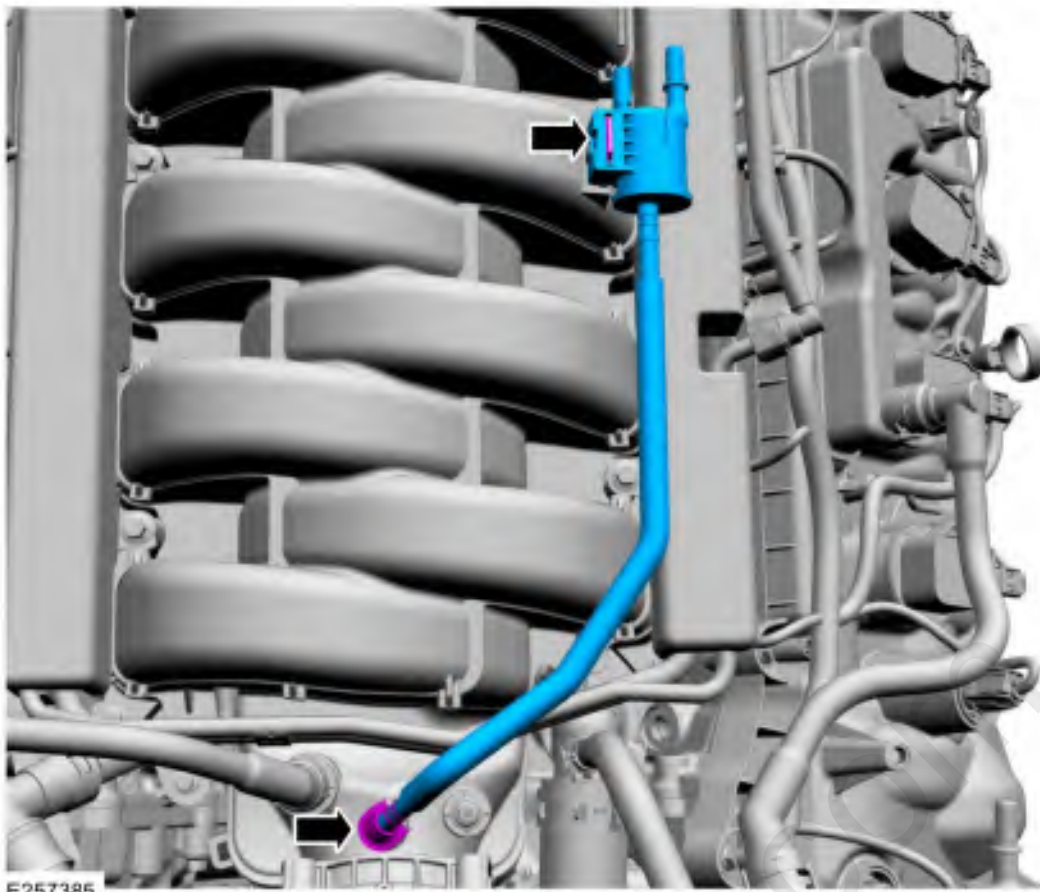


7. Connect the fuel supply tube quick release coupling.  
Refer to: [Quick Release Coupling](#) (310-00D Fuel System - General Information - 5.0L 32V Ti-VCT, General Procedures).



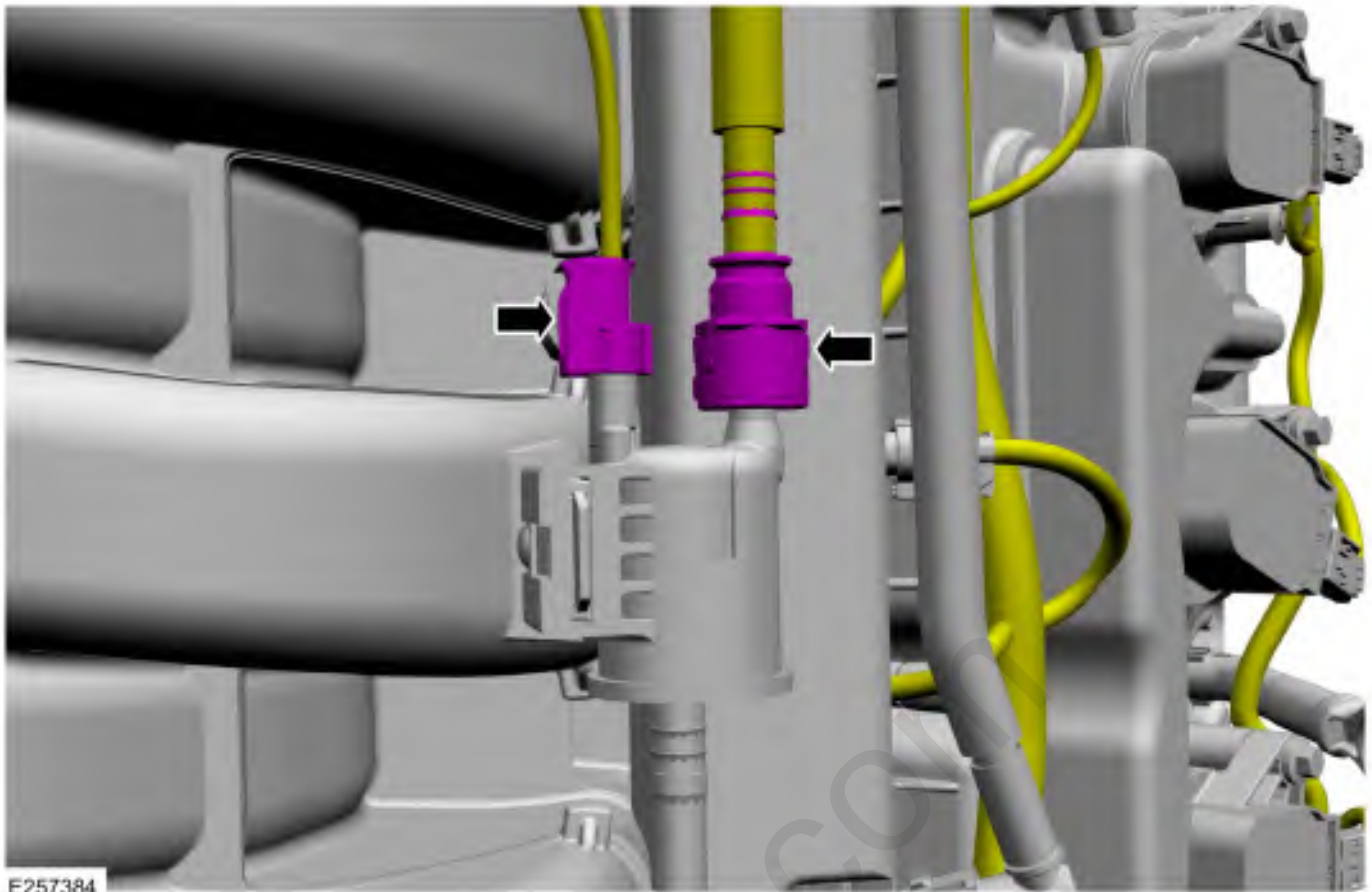
- Connect the quick release coupling.  
Refer to: [Quick Release Coupling](#) (310-00D Fuel System - General Information - 5.0L 32V Ti-VCT, General Procedures).
- Install the valve assembly to the bracket.



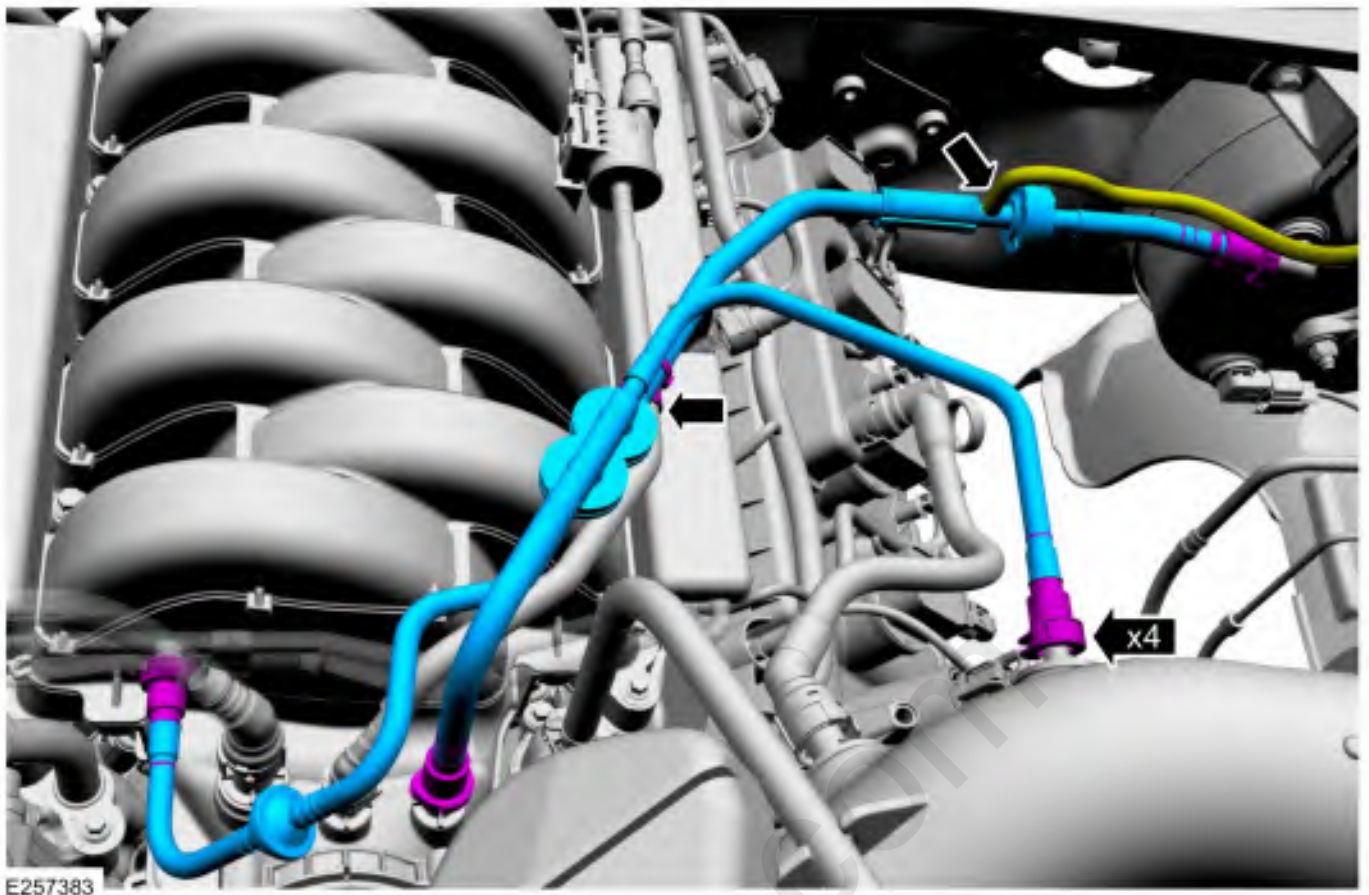


- Connect the quick release coupling.  
Refer to: [Quick Release Coupling](#) (310-00D Fuel System - General Information - 5.0L 32V Ti-VCT, General Procedures).
- Connect the electrical connector.





- Connect the quick release couplings.  
Refer to: [Quick Release Coupling](#) (310-00D Fuel System - General Information - 5.0L 32V Ti-VCT, General Procedures).
- Attach the hose retainer.
- Connect the hose.



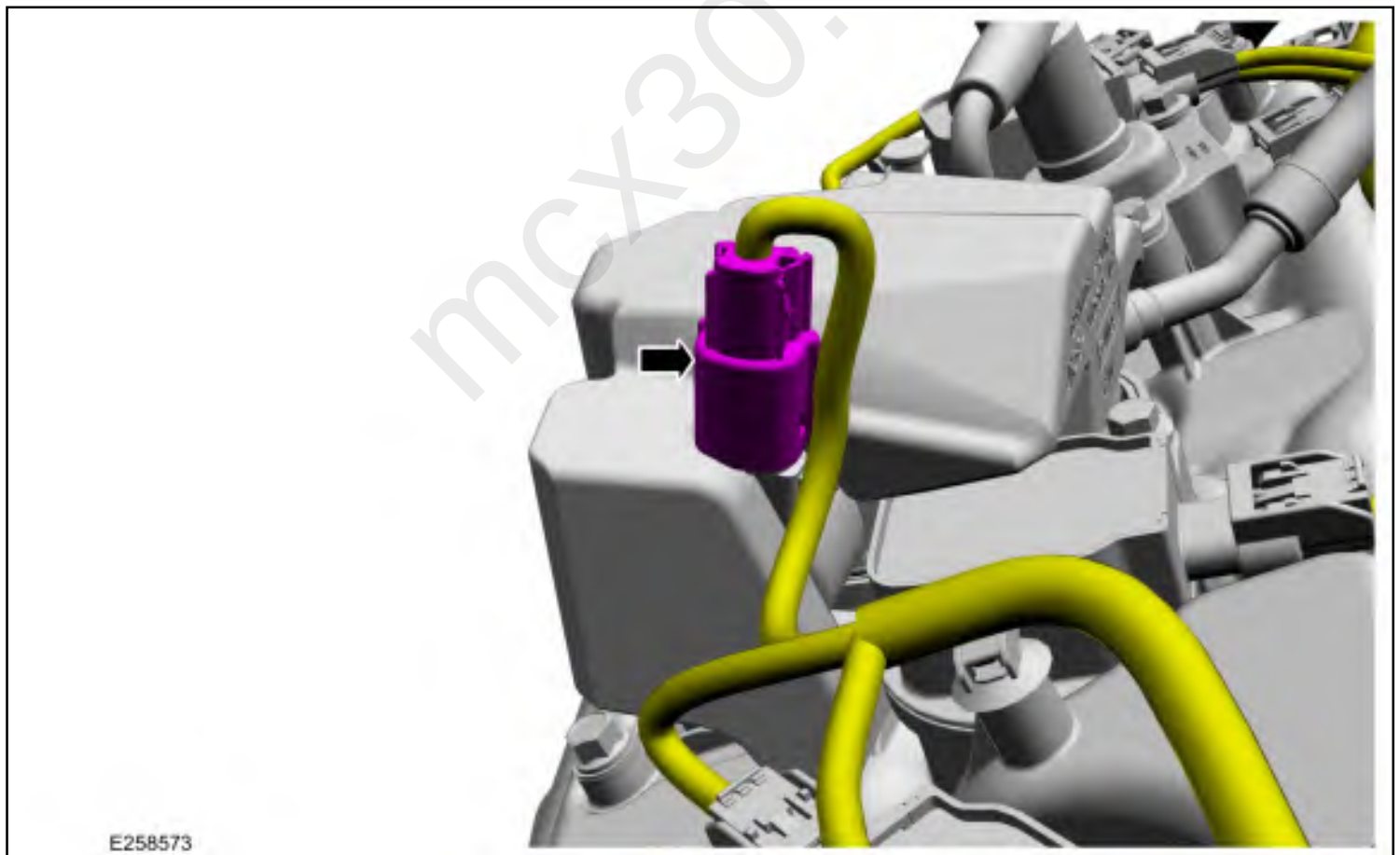
11. Connect the battery negative cable.  
Refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables) .
12. Pressurize the fuel system.  
Refer to: [Fuel System Pressure Release](#) (310-00D Fuel System - General Information - 5.0L 32V Ti-VCT, General Procedures).

# High-Pressure Fuel Pump

## Removal

**NOTICE:** Do not loosen any fittings or plugs on the high-pressure fuel pump.

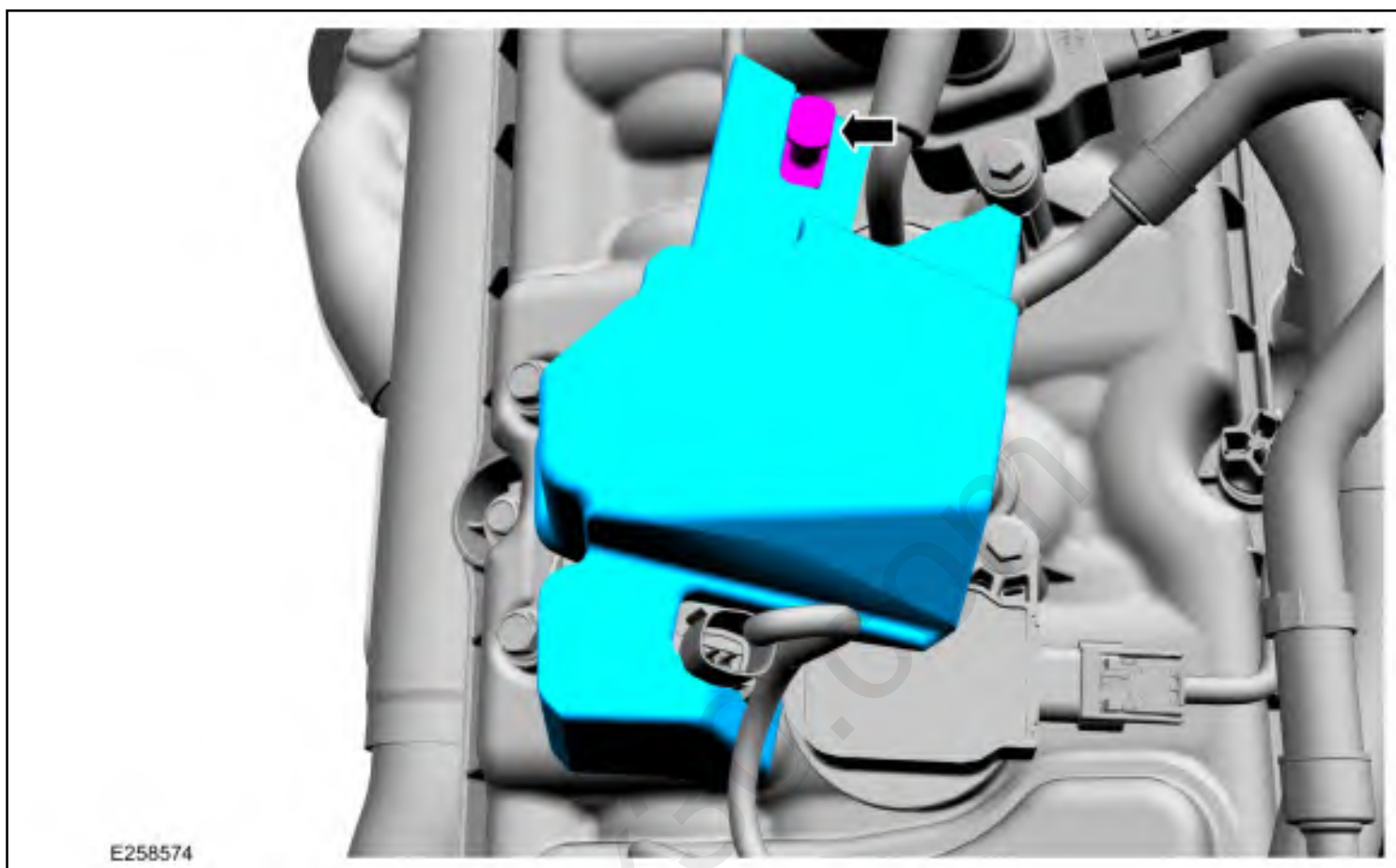
1. With the vehicle in NEUTRAL, position it on a hoist.  
Refer to: [Jacking and Lifting - Overview](#) (100-02 Jacking and Lifting, Description and Operation).
2. Remove the intake manifold.  
Refer to: [Intake Manifold](#) (303-01D Engine - 5.0L 32V Ti-VCT, Removal and Installation).
3. Disconnect the high-pressure fuel pump electrical connector.



4. **NOTE:** When removing or installing the fuel injection pump noise insulator, spreading the openings

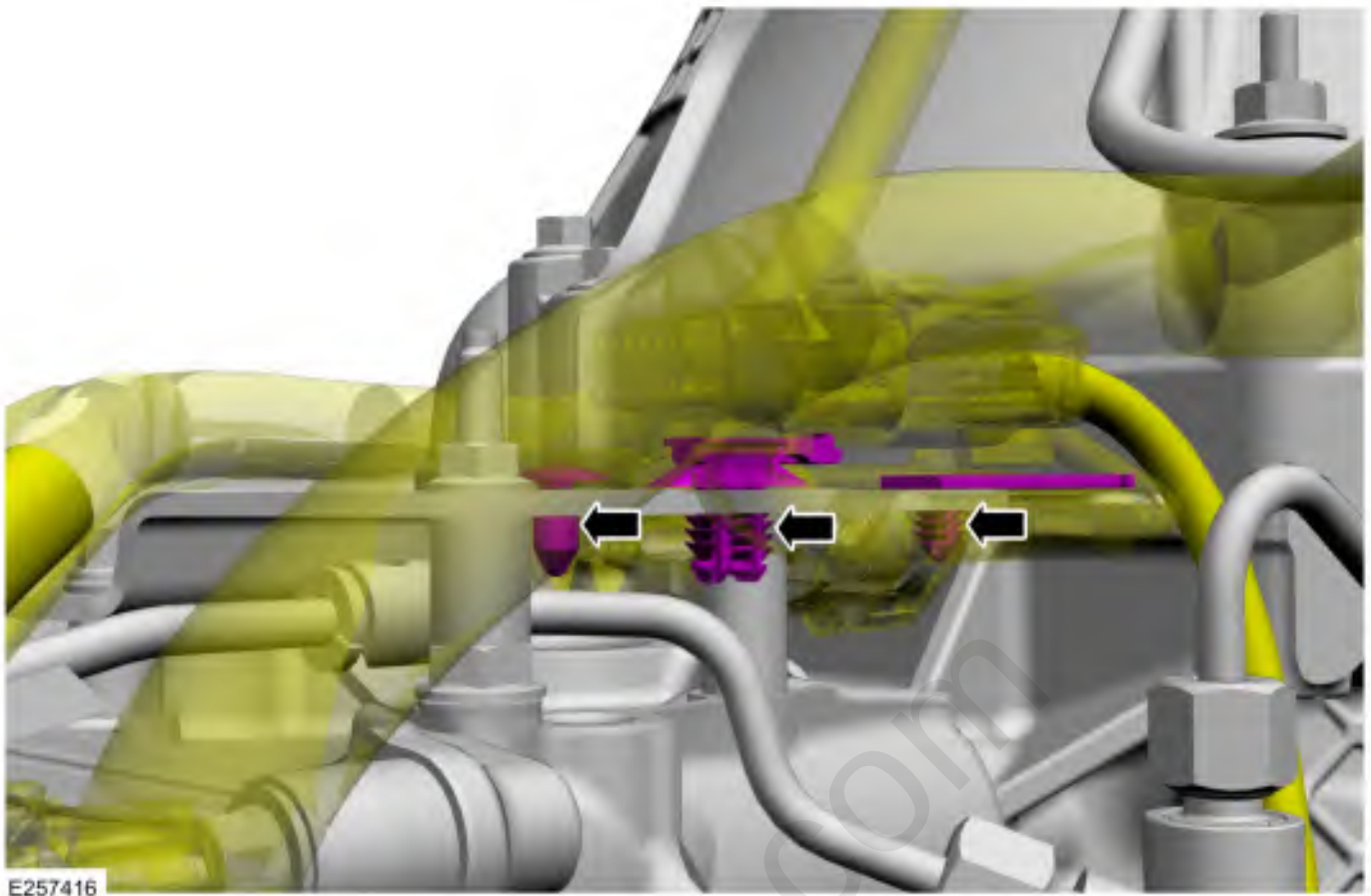
*will reduce the risk of damage.*

Release the retainer, then remove the fuel injection pump noise insulator.



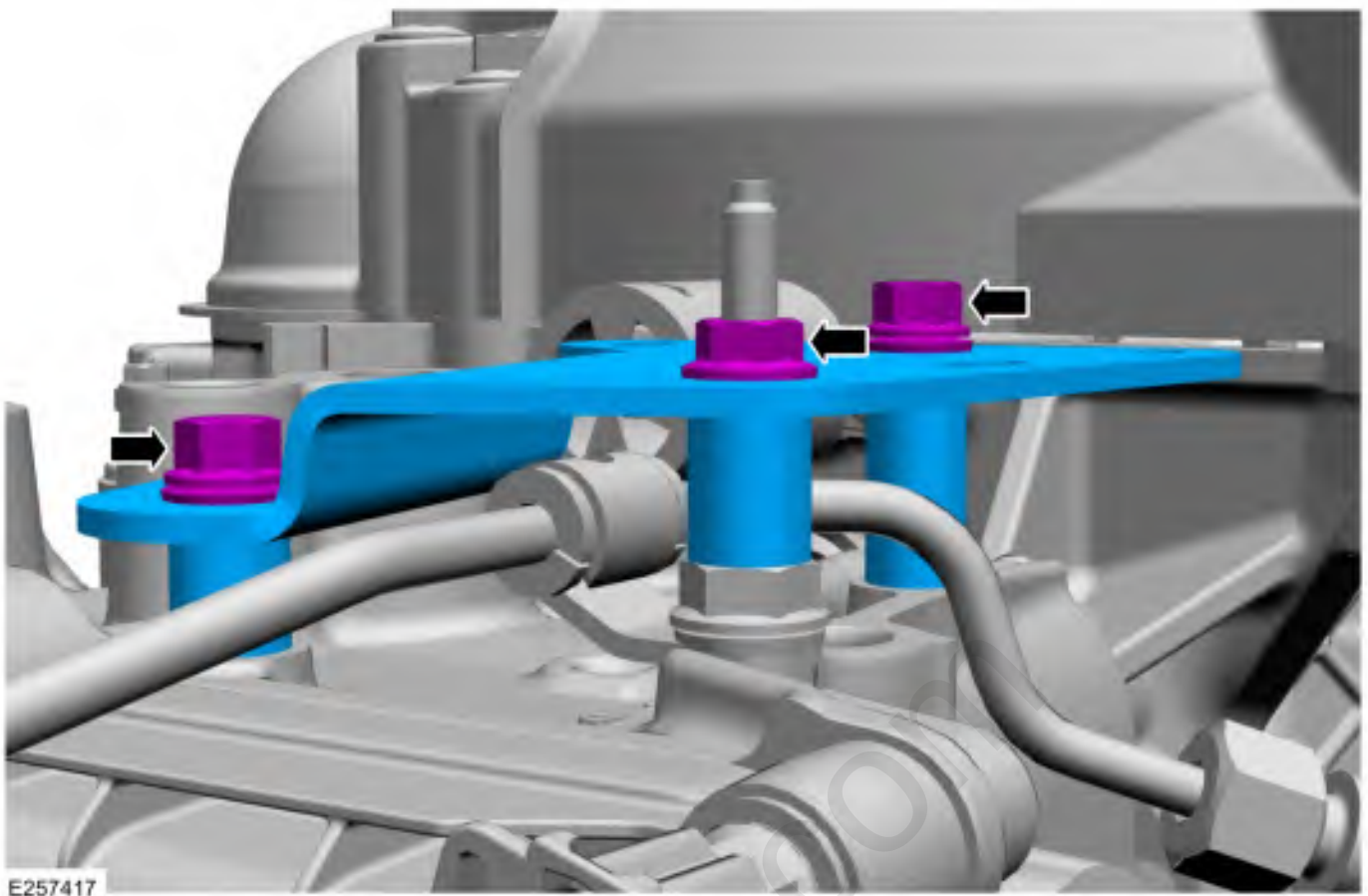
5. Detach the wiring harness retainers from high-pressure fuel line shield.





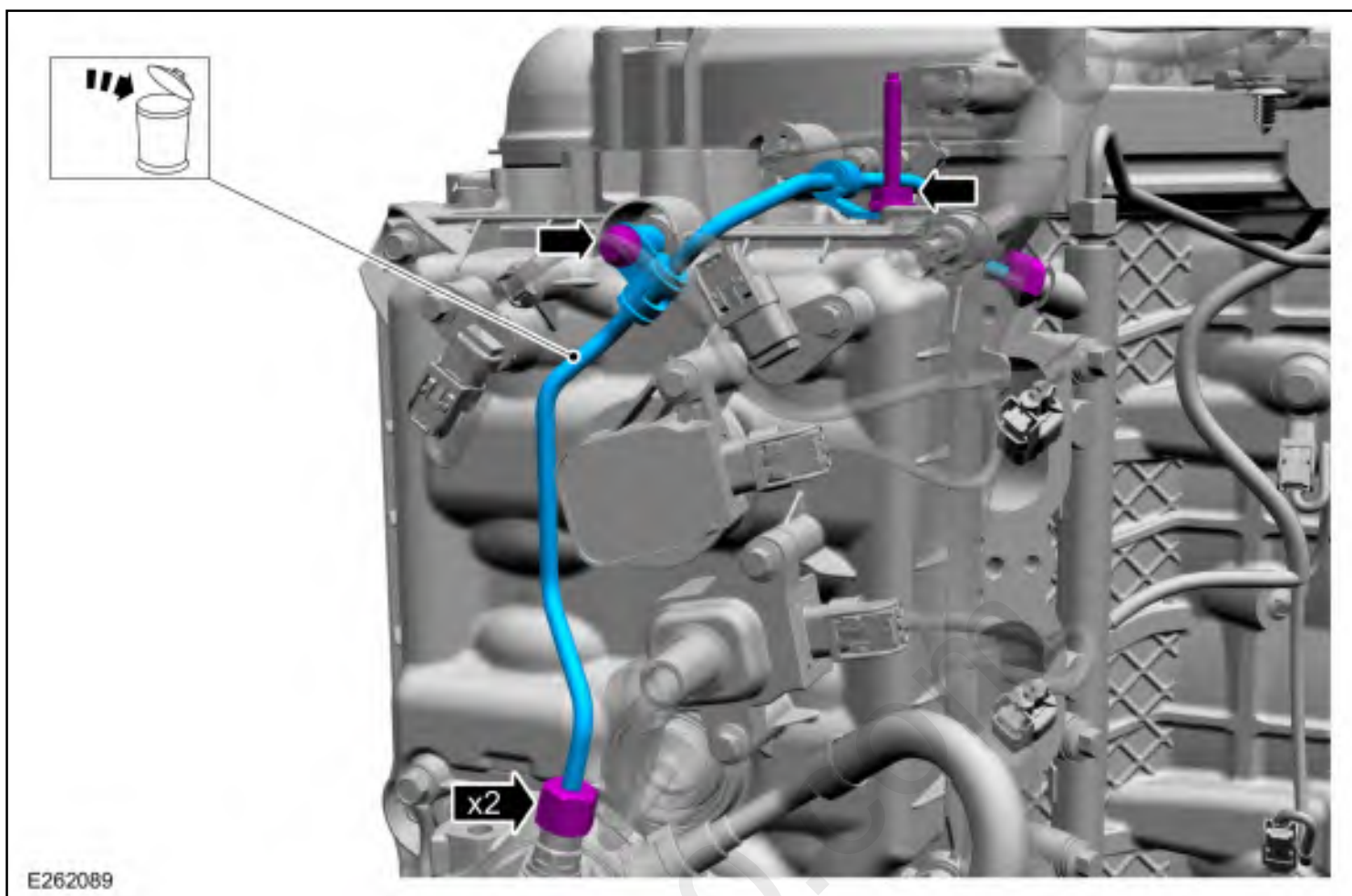
6. Remove the high-pressure fuel line shield retainers, then remove high-pressure fuel line shield.



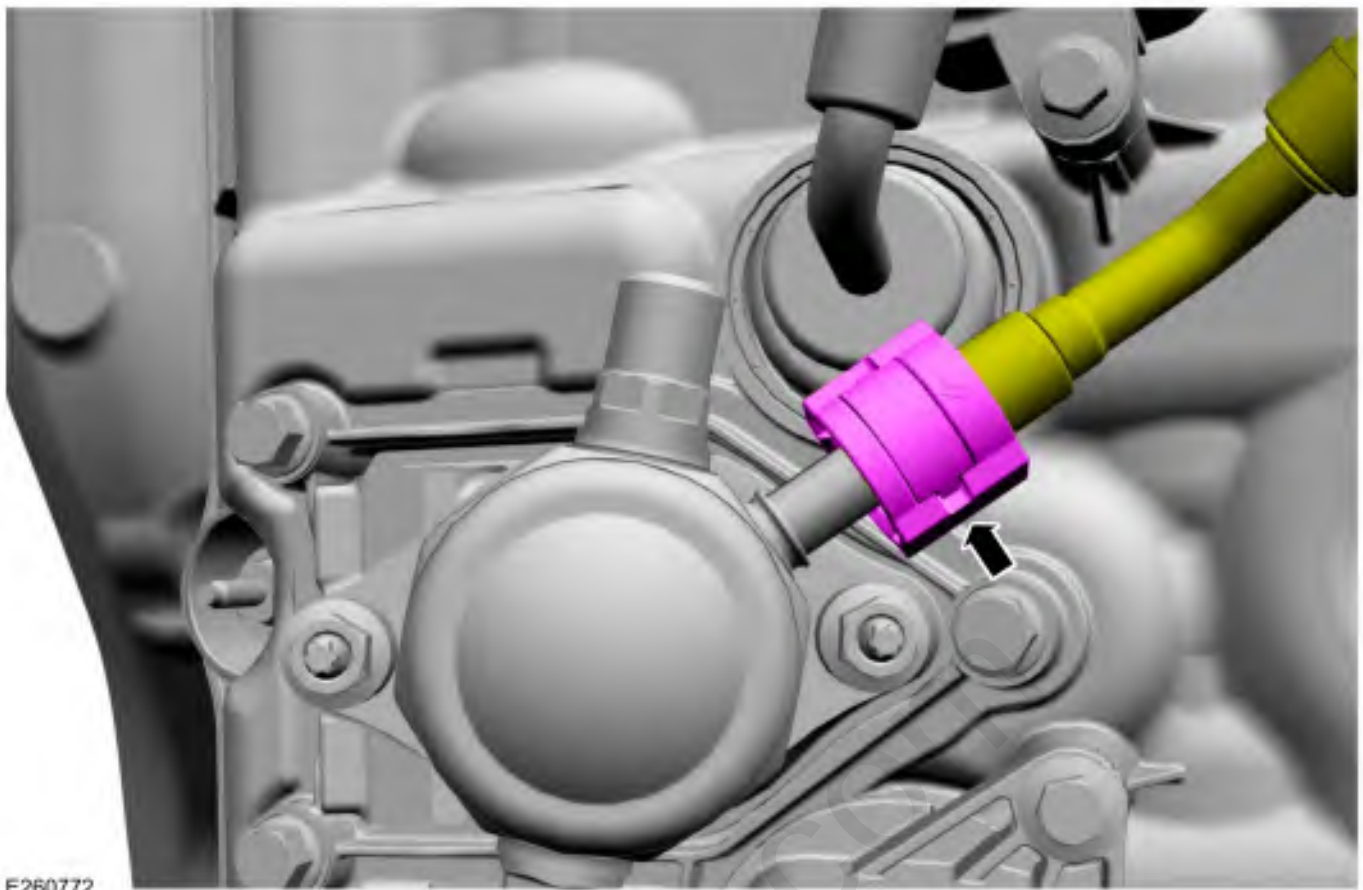


7. **NOTICE:** To release the fuel pressure in the high-pressure fuel tube, wrap the high-pressure fuel tube flare nuts with a shop towel to absorb any residual fuel pressure during the loosening of the high-pressure fuel tube flare nuts.

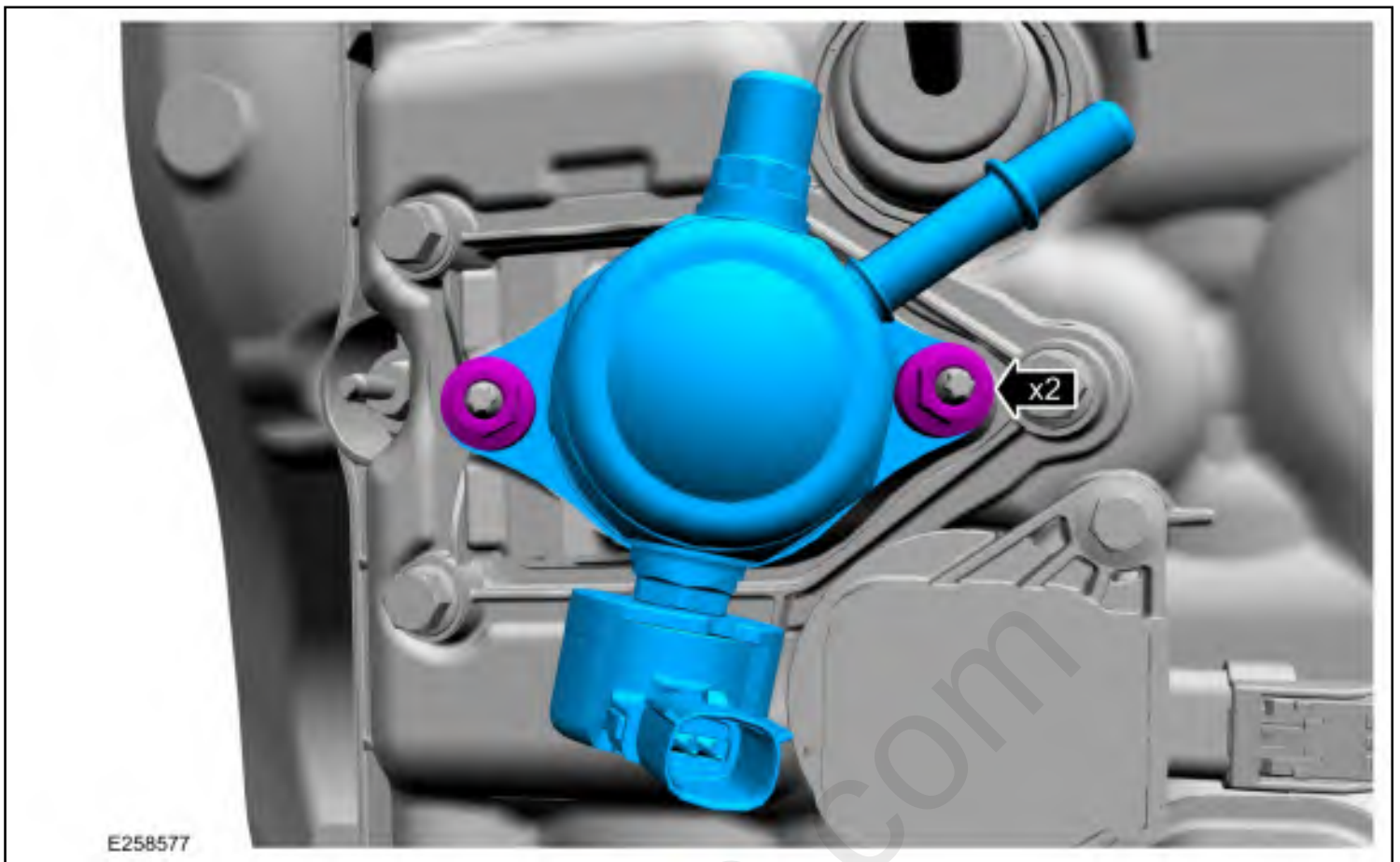
Remove the high-pressure fuel tube retainers. Disconnect the high-pressure fuel tube flare nuts, then remove and discard the high-pressure fuel tube.



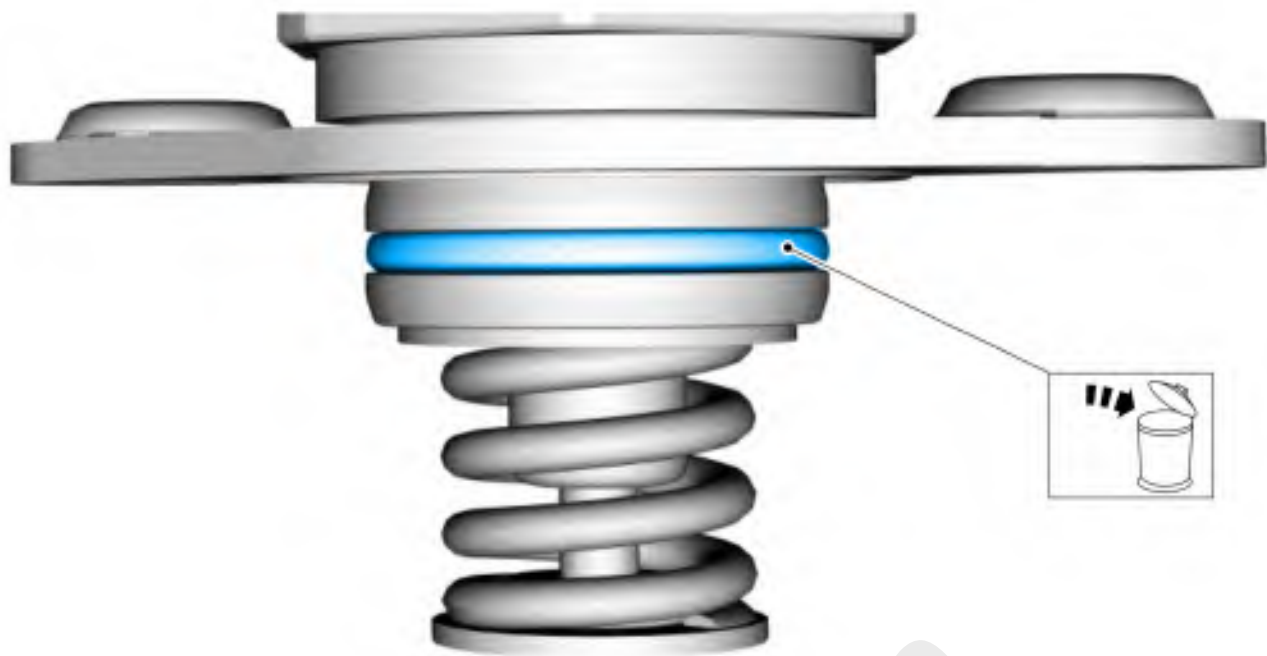
8. Disconnect the high-pressure fuel pump fuel feed quick release coupling.  
Refer to: [Quick Release Coupling](#) (310-00D Fuel System - General Information - 5.0L 32V Ti-VCT, General Procedures).



9. Alternately loosen the high-pressure fuel pump nuts one complete revolution at a time and remove, then remove the high-pressure fuel pump.



10. Remove and discard the high-pressure fuel pump O-ring seal.



E242552

11. Remove the high-pressure fuel pump roller tappet.





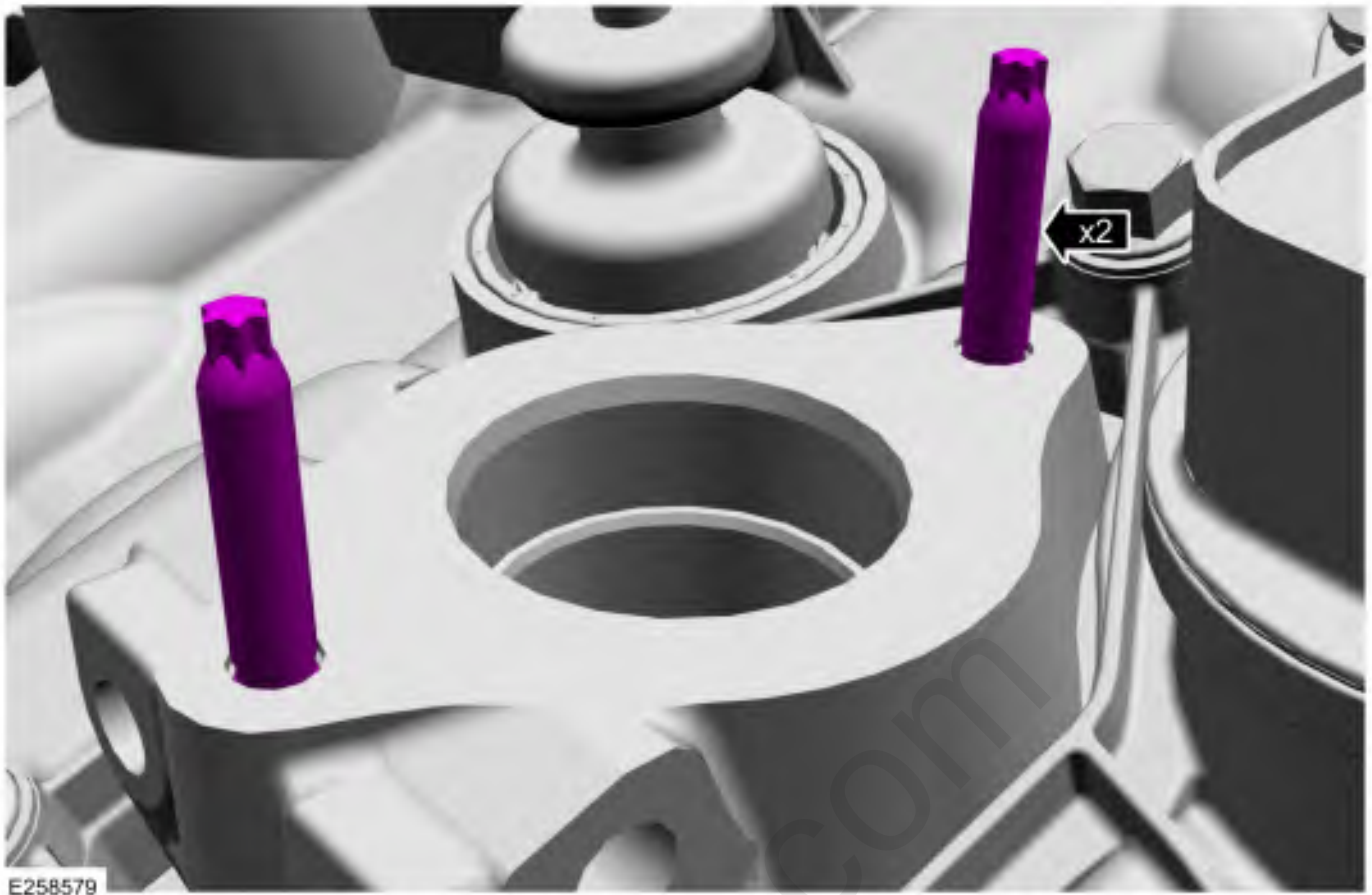
12. Inspect the high-pressure fuel pump roller tappet. If any flat spots or scoring are found, especially in the indicated areas, then inspect the high-pressure fuel pump and the high-pressure fuel pump roller tappet drive lobe. Install new components as needed.



E175709



13. If needed, remove the high-pressure fuel pump mounting studs.

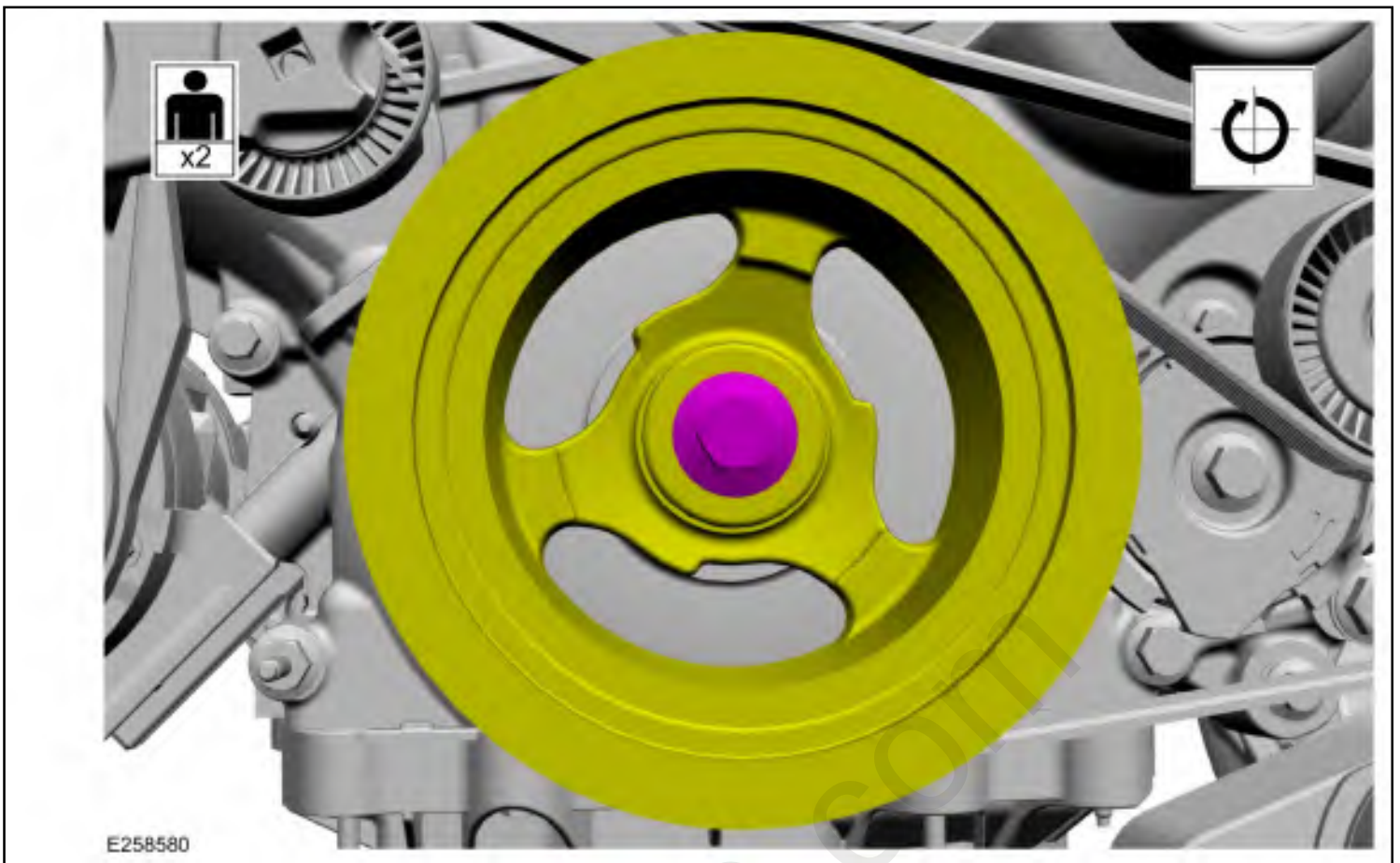


## Installation

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

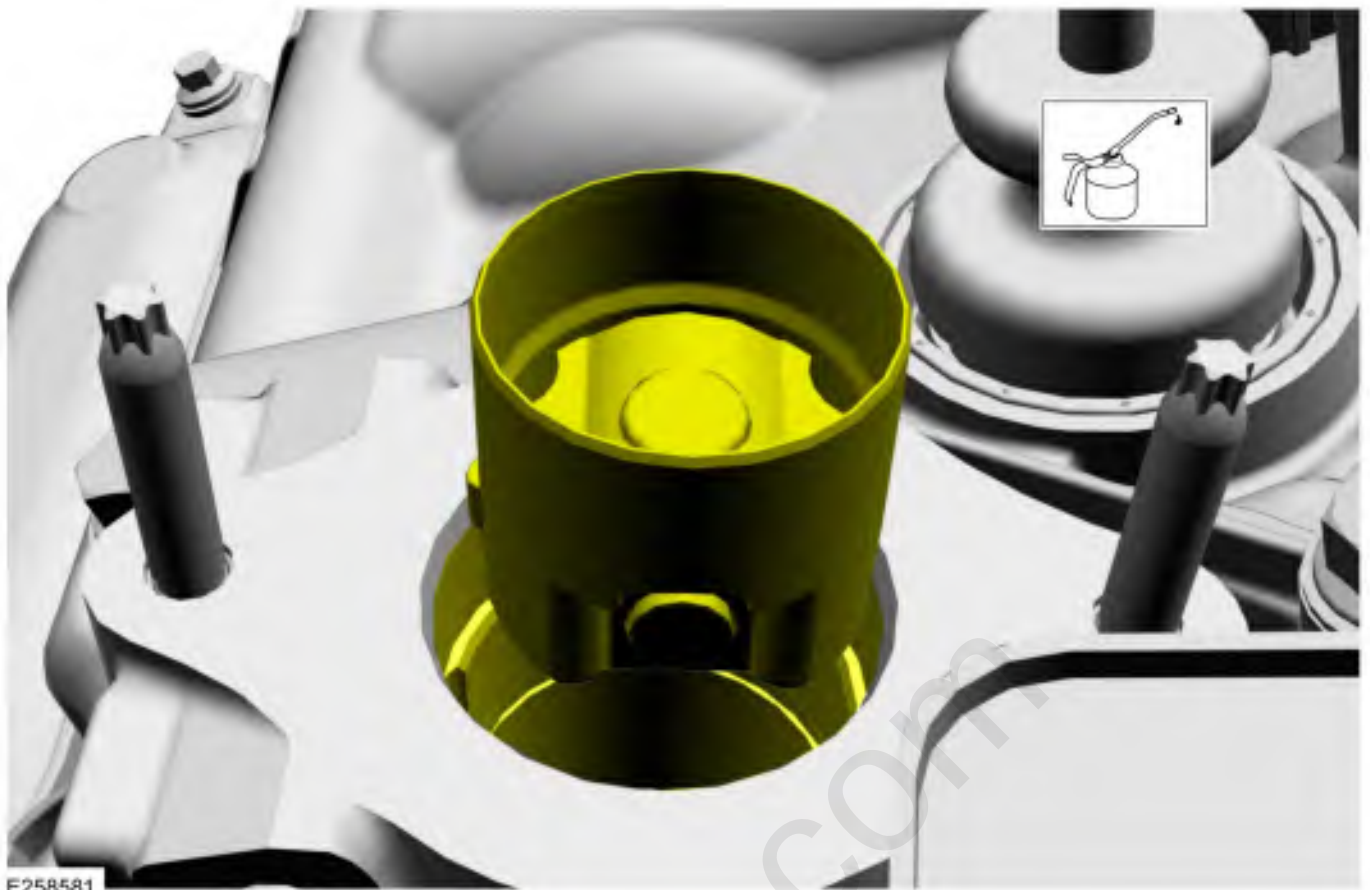
**NOTICE:** The drive lobe for the high-pressure fuel pump must be at BDC (bottom dead center) for the high-pressure fuel pump installation.

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.



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

Refer to: [Specifications](#) (303-01D Engine - 5.0L 32V Ti-VCT, Specifications).

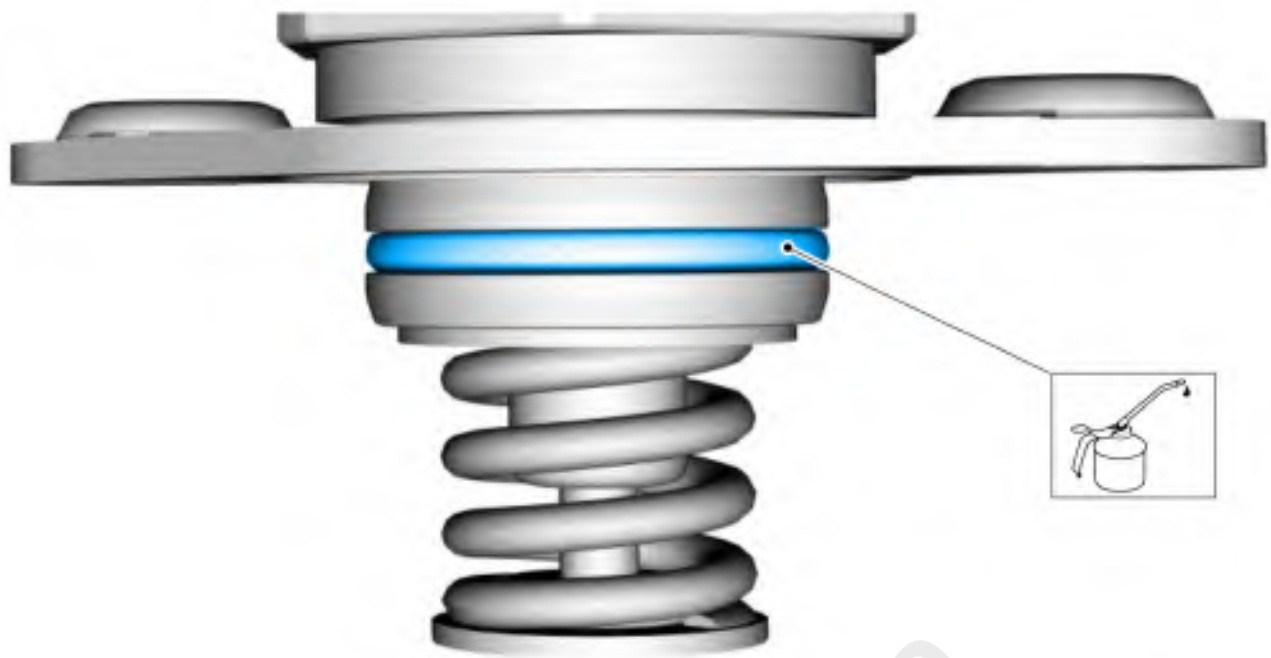


3. Install the high-pressure fuel pump roller tappet.



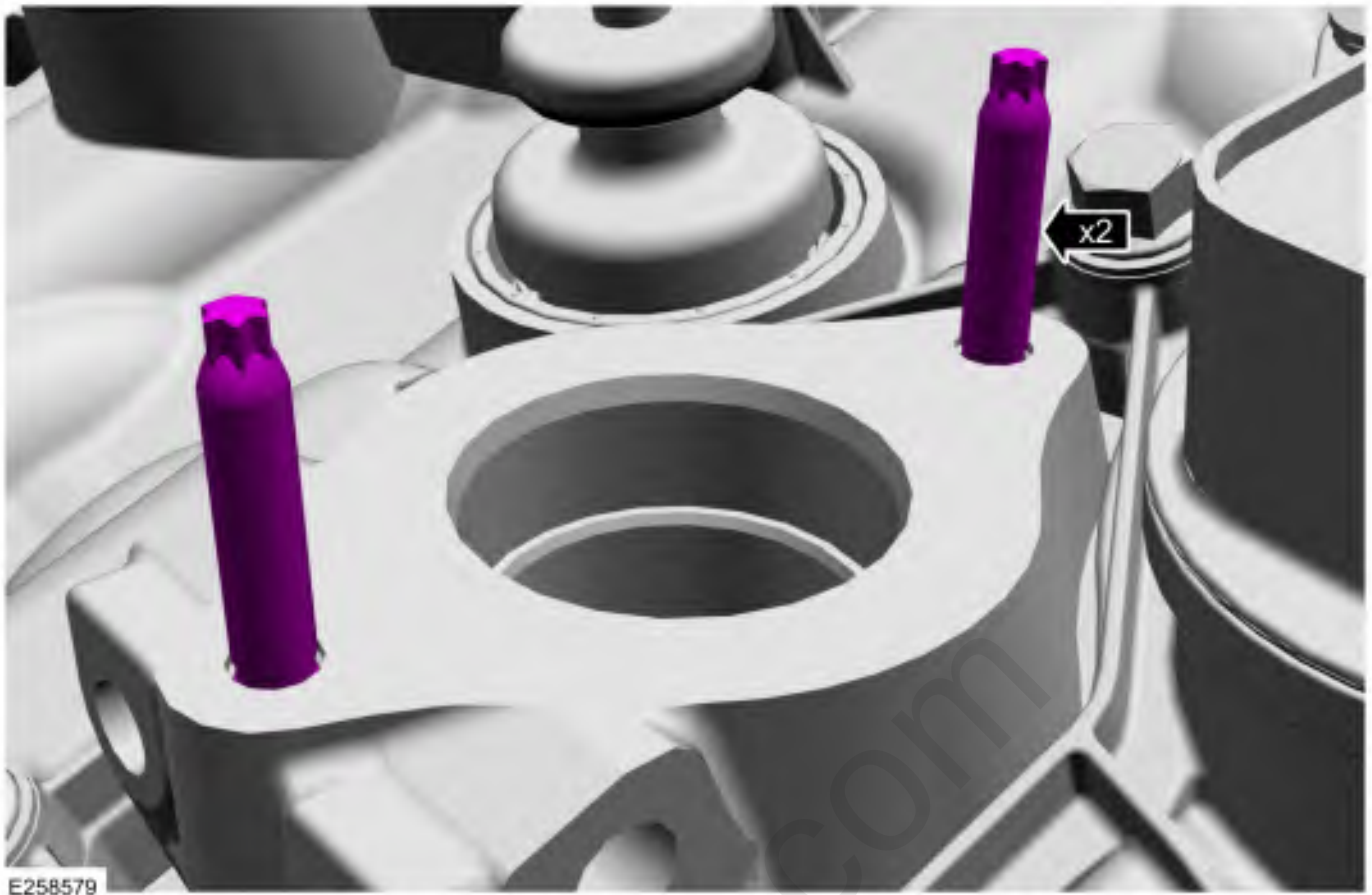


4. Install a new high-pressure fuel pump O-ring seal. Lubricate with clean engine oil.  
Refer to: [Specifications](#) (303-01D Engine - 5.0L 32V Ti-VCT, Specifications).



E242553

5. If removed, install and tighten the high-pressure fuel pump mounting studs.  
*Torque: 53 lb.in (6 Nm)*

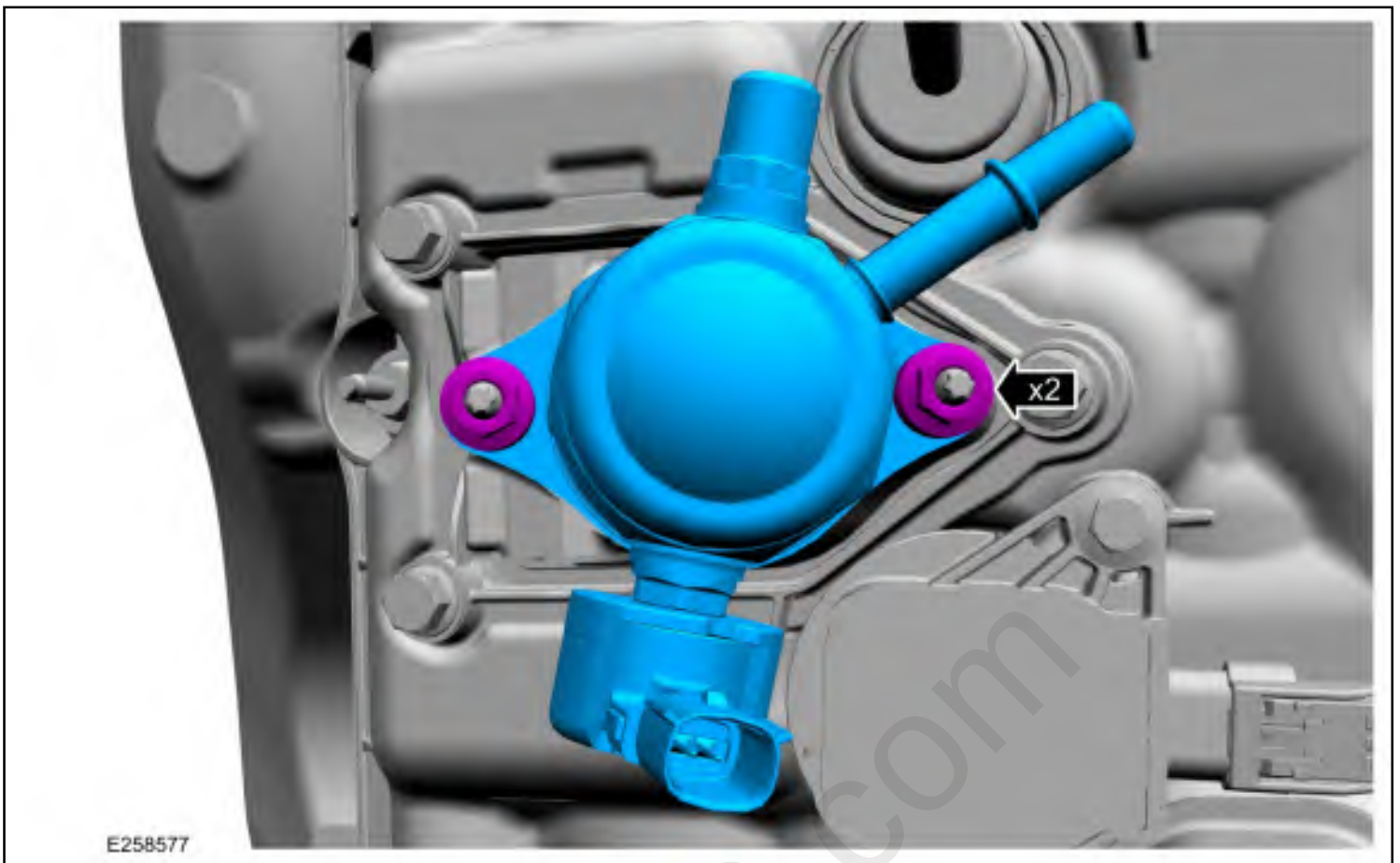


6. Install the high-pressure fuel pump, then install the mounting nuts finger tight. Alternately tighten each high-pressure fuel pump nut one complete revolution until seated. Tighten the fuel high-pressure fuel pump nuts in the following 2 stages.

*Torque:*

Stage 1: 89 lb.in (10 Nm)

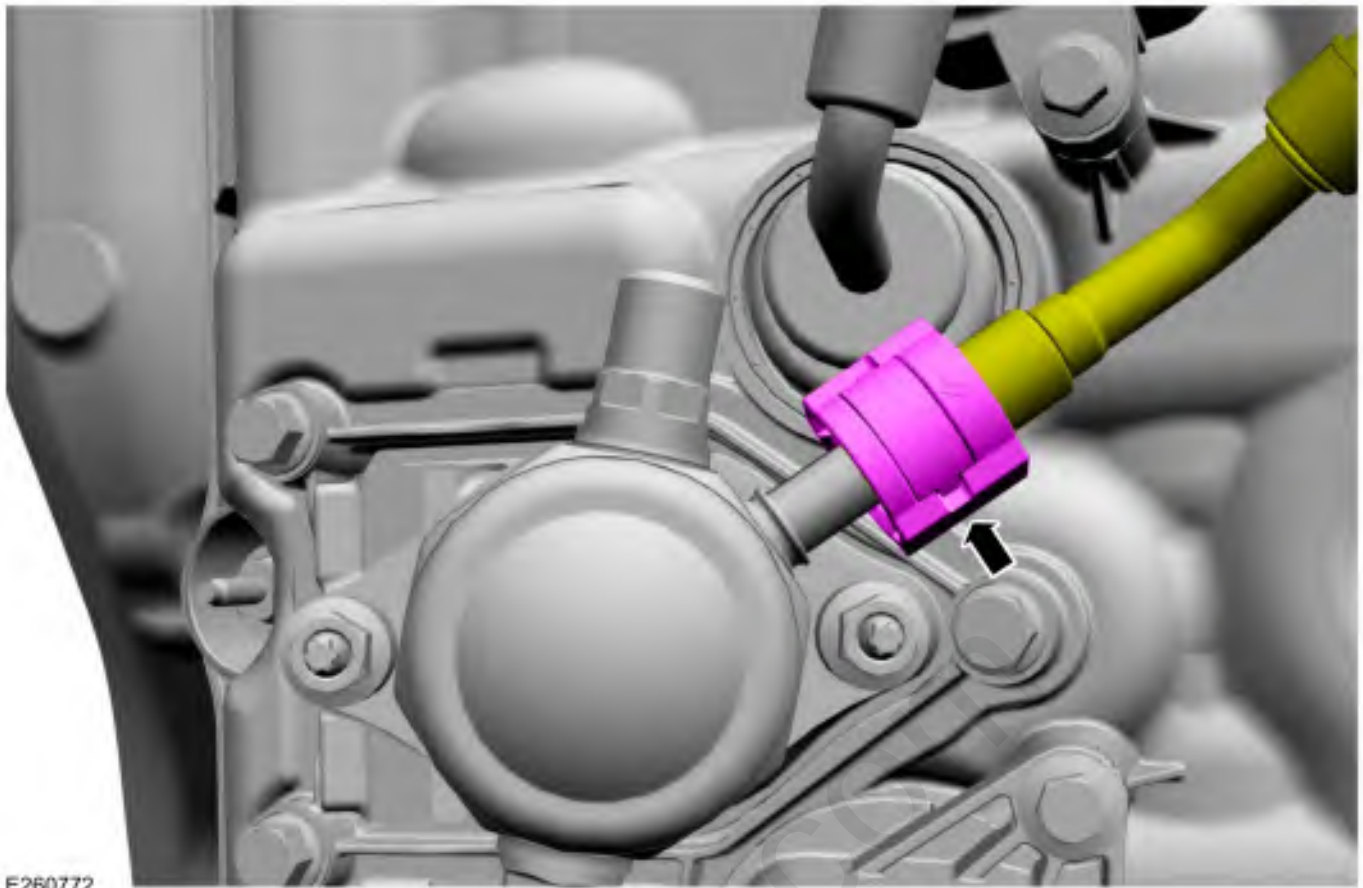
Stage 2: 30°



7. **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.

Connect the high-pressure fuel pump fuel feed quick release coupling.

Refer to: [Quick Release Coupling](#) (310-00D Fuel System - General Information - 5.0L 32V Ti-VCT, General Procedures).



8. **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.

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

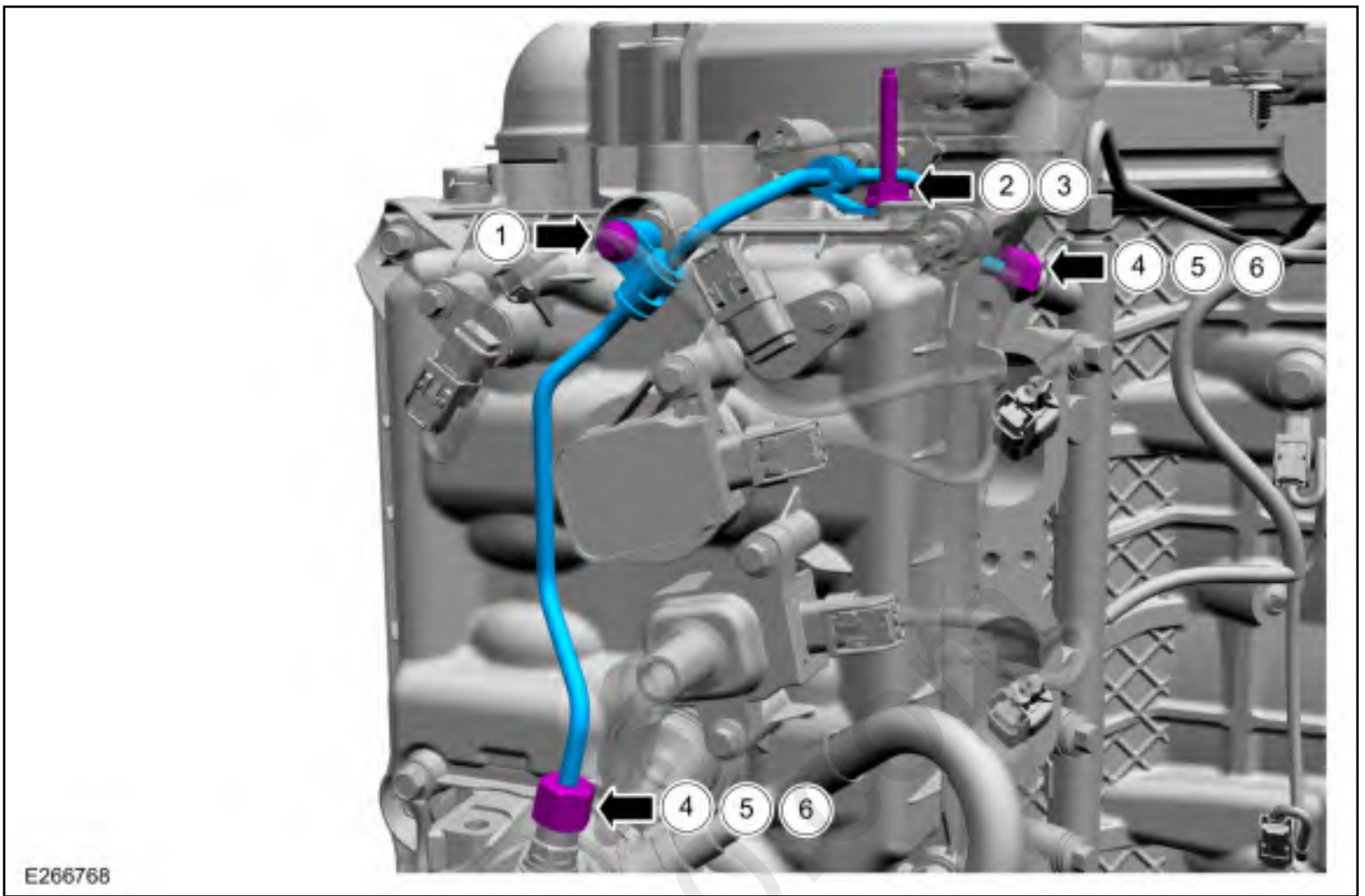
**NOTE:** Make sure that a new high-pressure fuel tube is installed.

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

*Torque:*

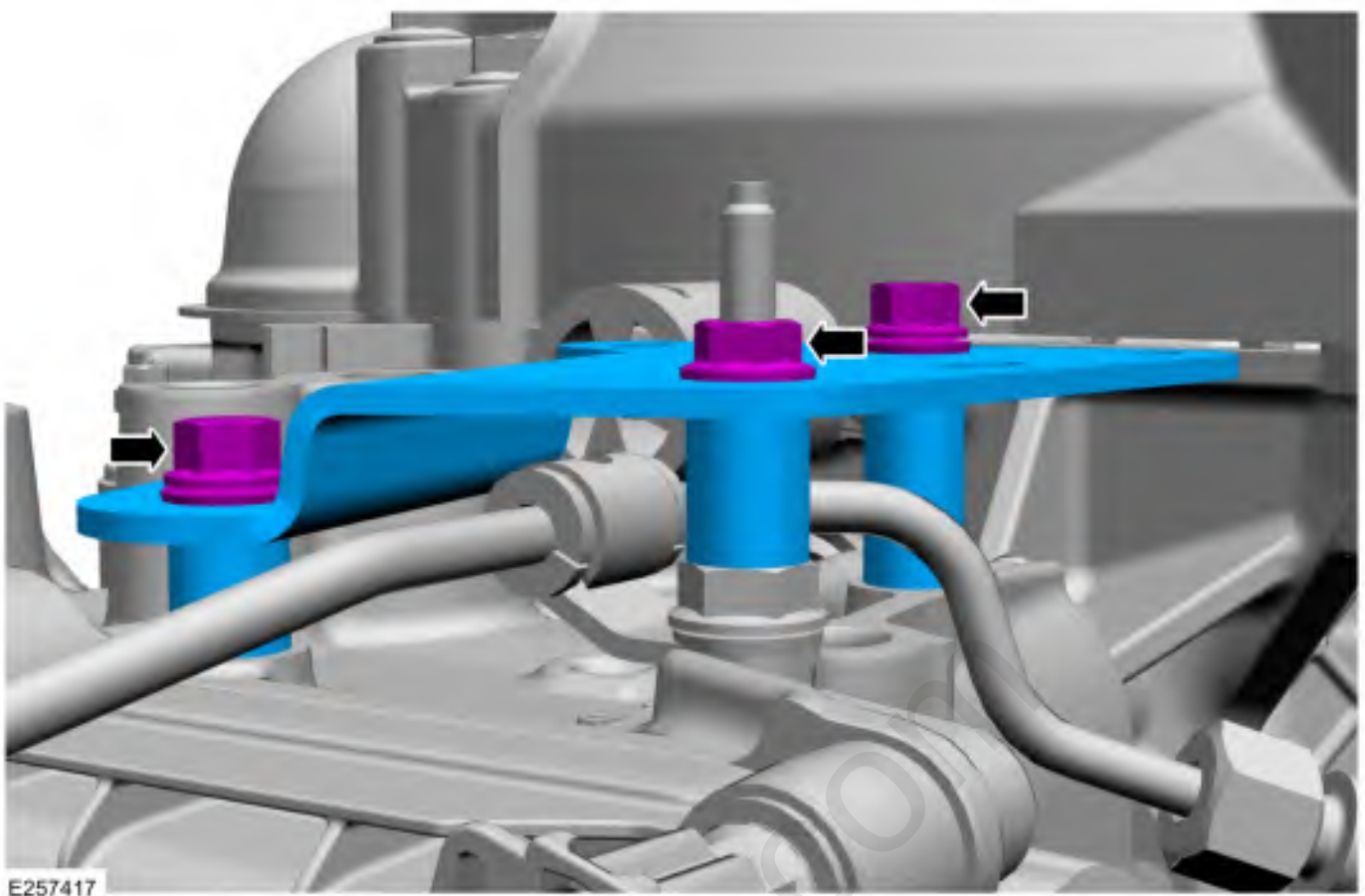
- Stage 1: Tighten the high-pressure fuel tube bolt to : 89 lb.in (10 Nm)
- Stage 2: Tighten the high-pressure fuel tube stud-bolt to : 89 lb.in (10 Nm)
- Stage 3: Tighten the high-pressure fuel tube stud-bolt an additional : 30°
- Stage 4: Tighten the high-pressure fuel tube flare nuts to : 71 lb.in (8 Nm)
- Stage 5: Tighten the high-pressure fuel tube flare nuts to : 89 lb.in (10 Nm)
- Stage 6: Tighten the high-pressure fuel tube flare nuts an additional : 25°



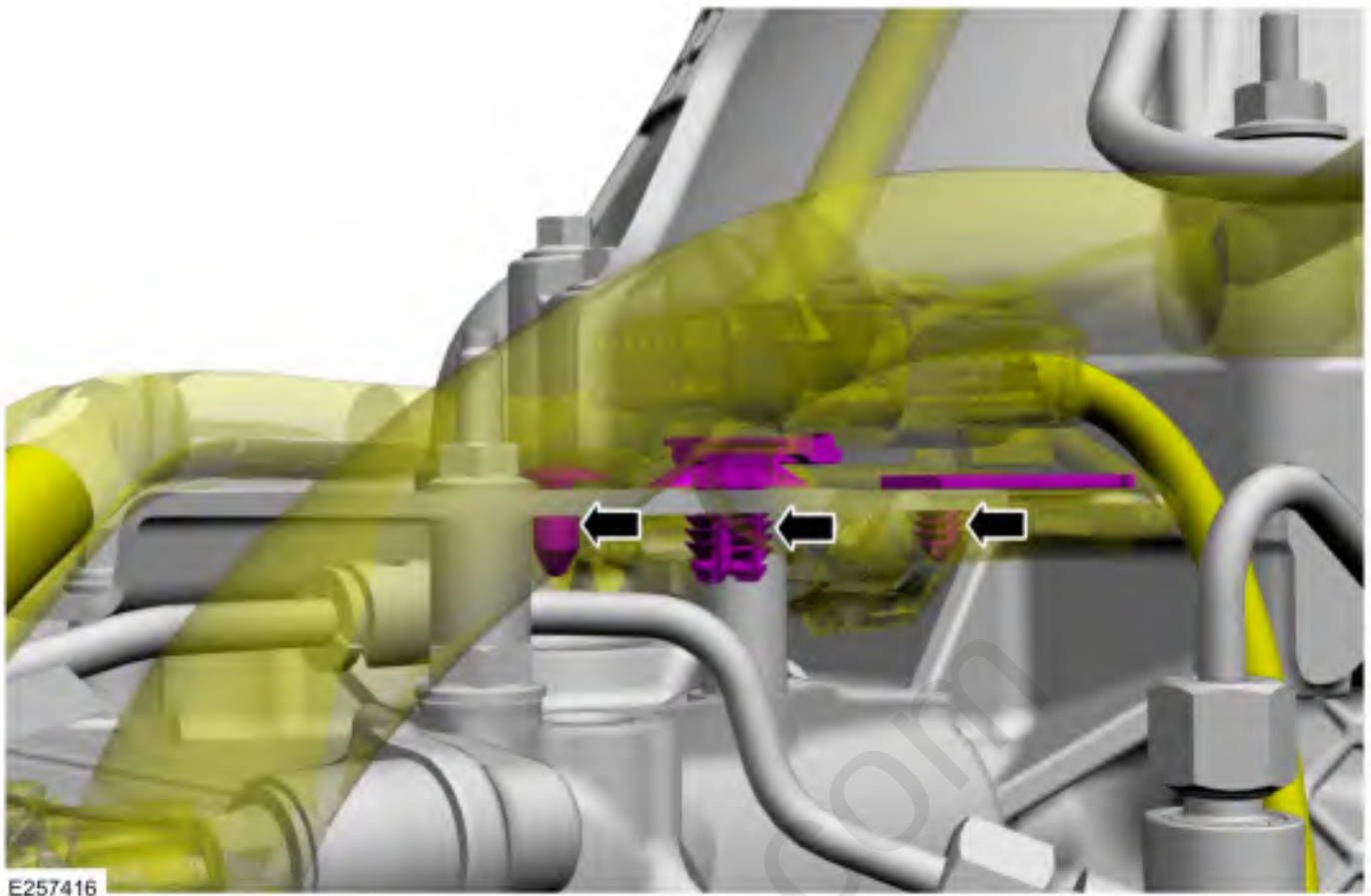


9. Install the high-pressure fuel line shield, then install and tighten the high-pressure fuel line shield retainers.

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

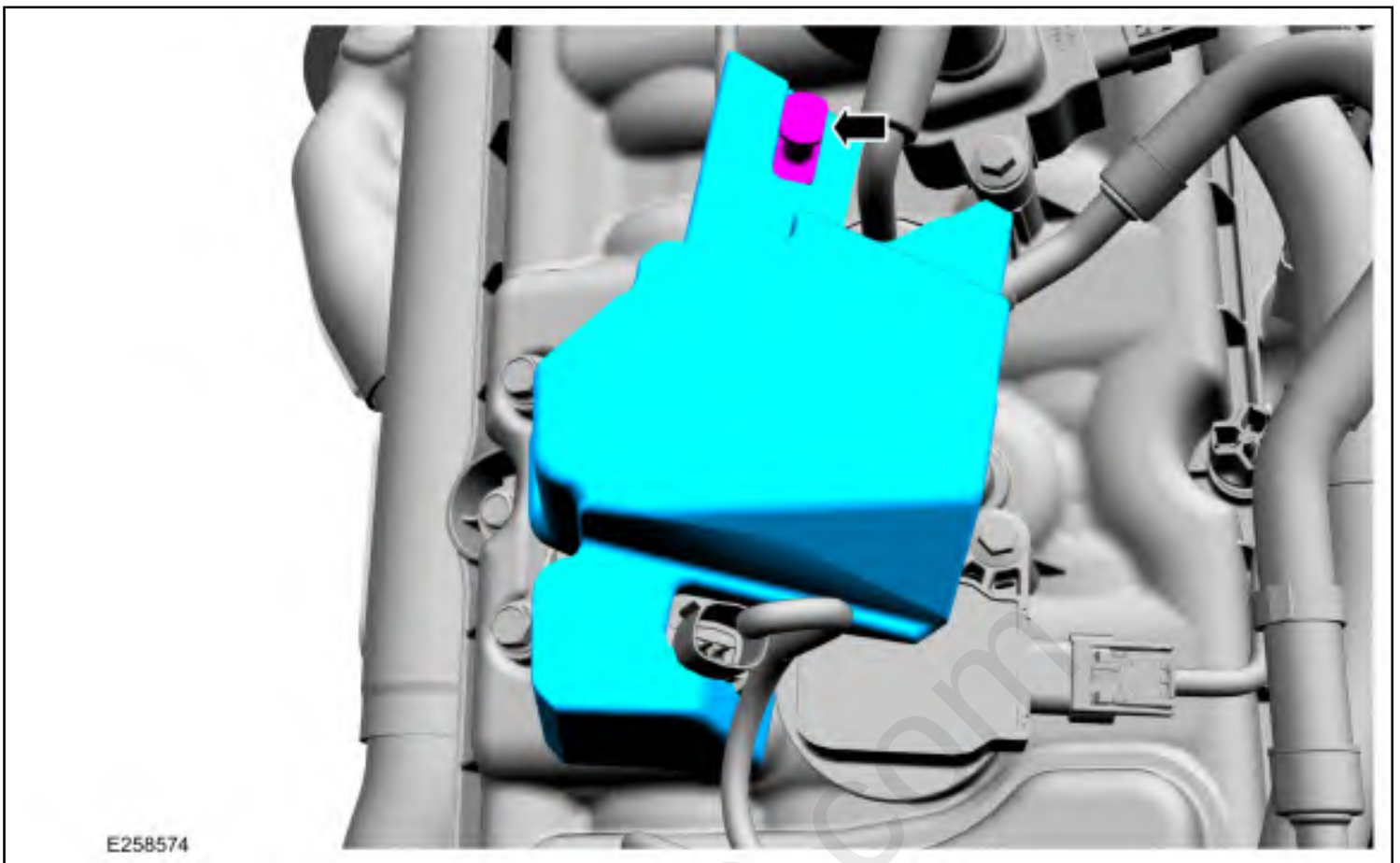


10. Attach the wiring harness retainers to high-pressure fuel line shield.

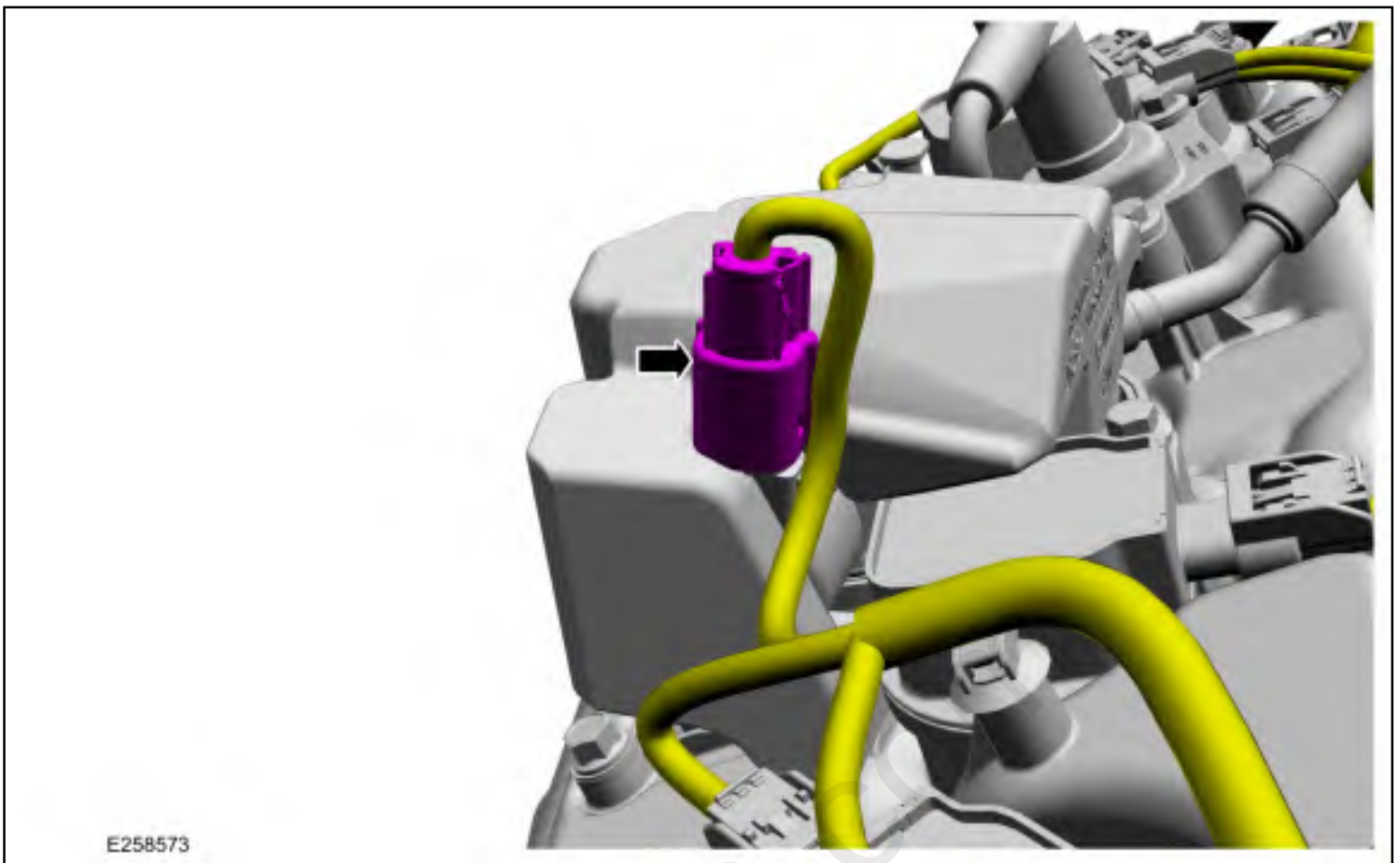


11. **NOTE:** *When removing or installing the fuel injection pump noise insulator, spreading the openings will reduce the risk of damage.*

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



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



13. Install the intake manifold.

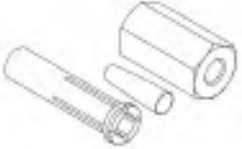
Refer to: [Intake Manifold](#) (303-01D Engine - 5.0L 32V Ti-VCT, Removal and Installation).

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## Direct Injection Fuel Rail LH

### Special Tool(s) / General Equipment

|                                                                                               |                                                                     |
|-----------------------------------------------------------------------------------------------|---------------------------------------------------------------------|
| <br>E222987   | 303-1567<br>Sizer, Teflon Seal<br>TKIT-2010C-FLM                    |
| <br>E222982  | 307-005 (T59L-100-B)<br>Slide Hammer                                |
| <br>E223046 | 310-205<br>Fuel Injector Brush                                      |
| <br>E168032 | 310-206<br>Remover, Fuel Injector<br>TKIT-2009A-FLM                 |
| <br>E223047 | 310-207<br>Installer, Fuel Injector Seal Assembly<br>TKIT-2009A-FLM |

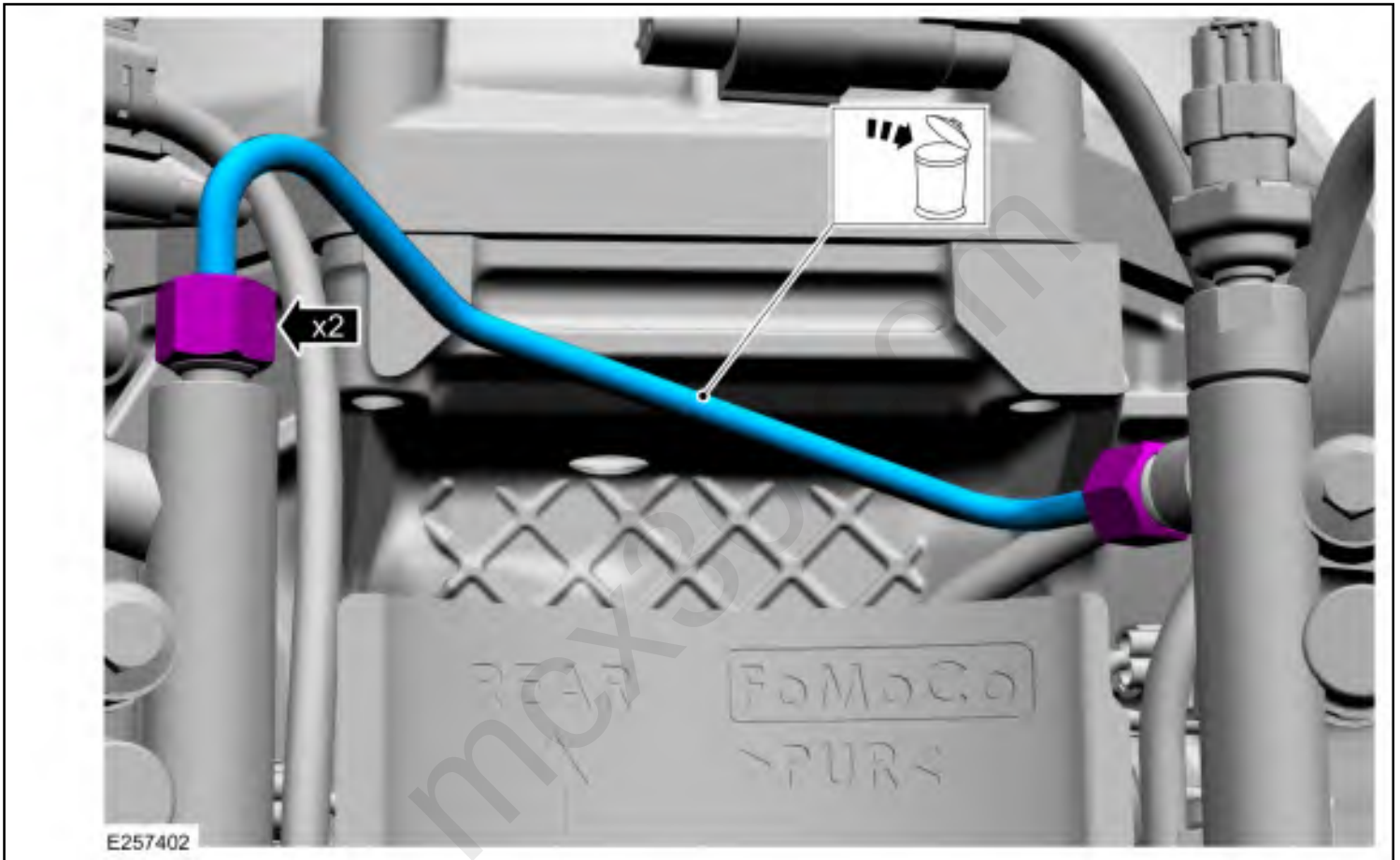
### Removal

1. Remove the intake manifold.

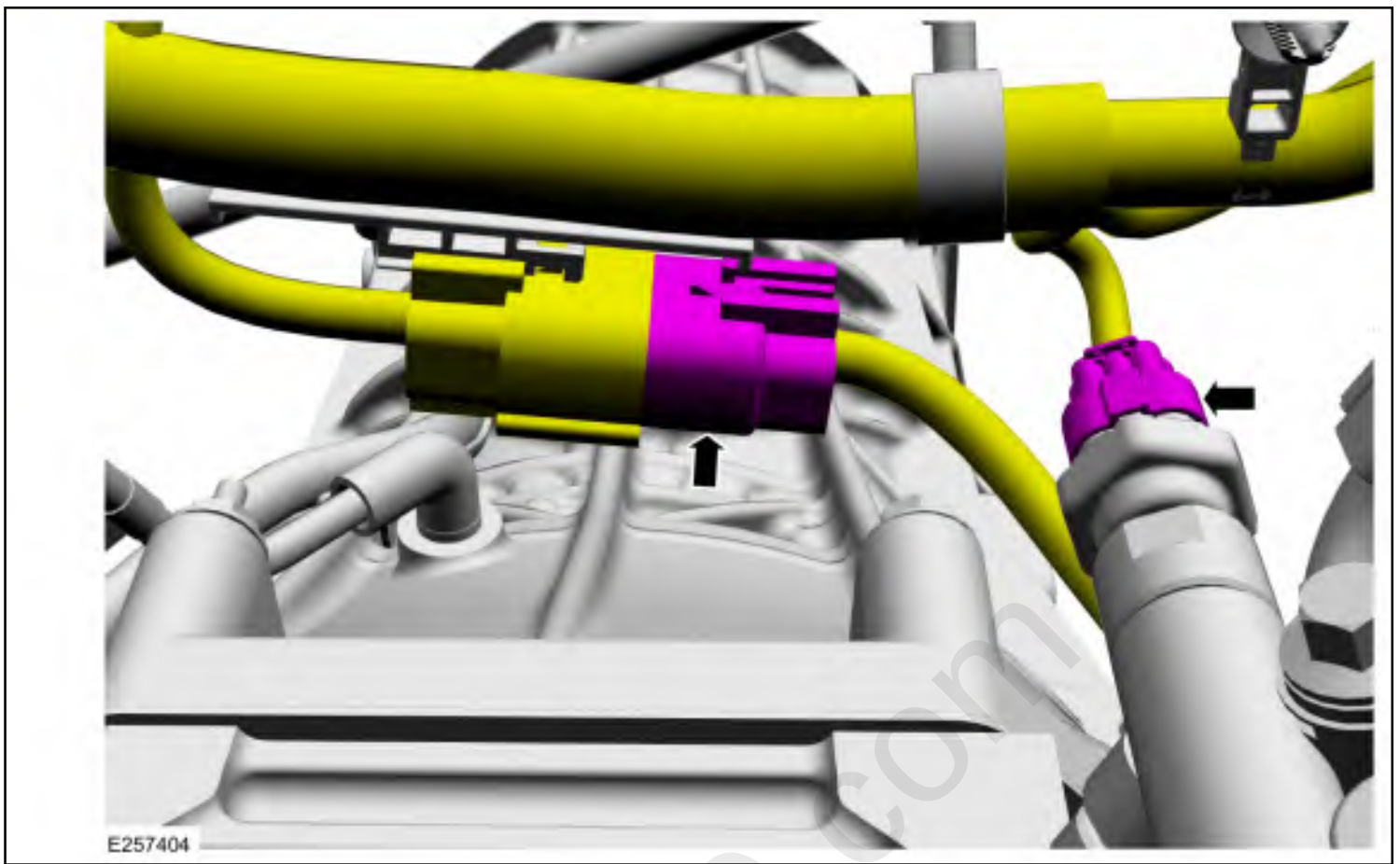
Refer to: [Intake Manifold](#) (303-01D Engine - 5.0L 32V Ti-VCT, Removal and Installation).

2. **NOTICE:** To release the fuel pressure in the high-pressure fuel tube, wrap the high-pressure fuel tube flare nuts with a shop towel to absorb any residual fuel pressure during the loosening of the high-pressure fuel tube flare nuts.

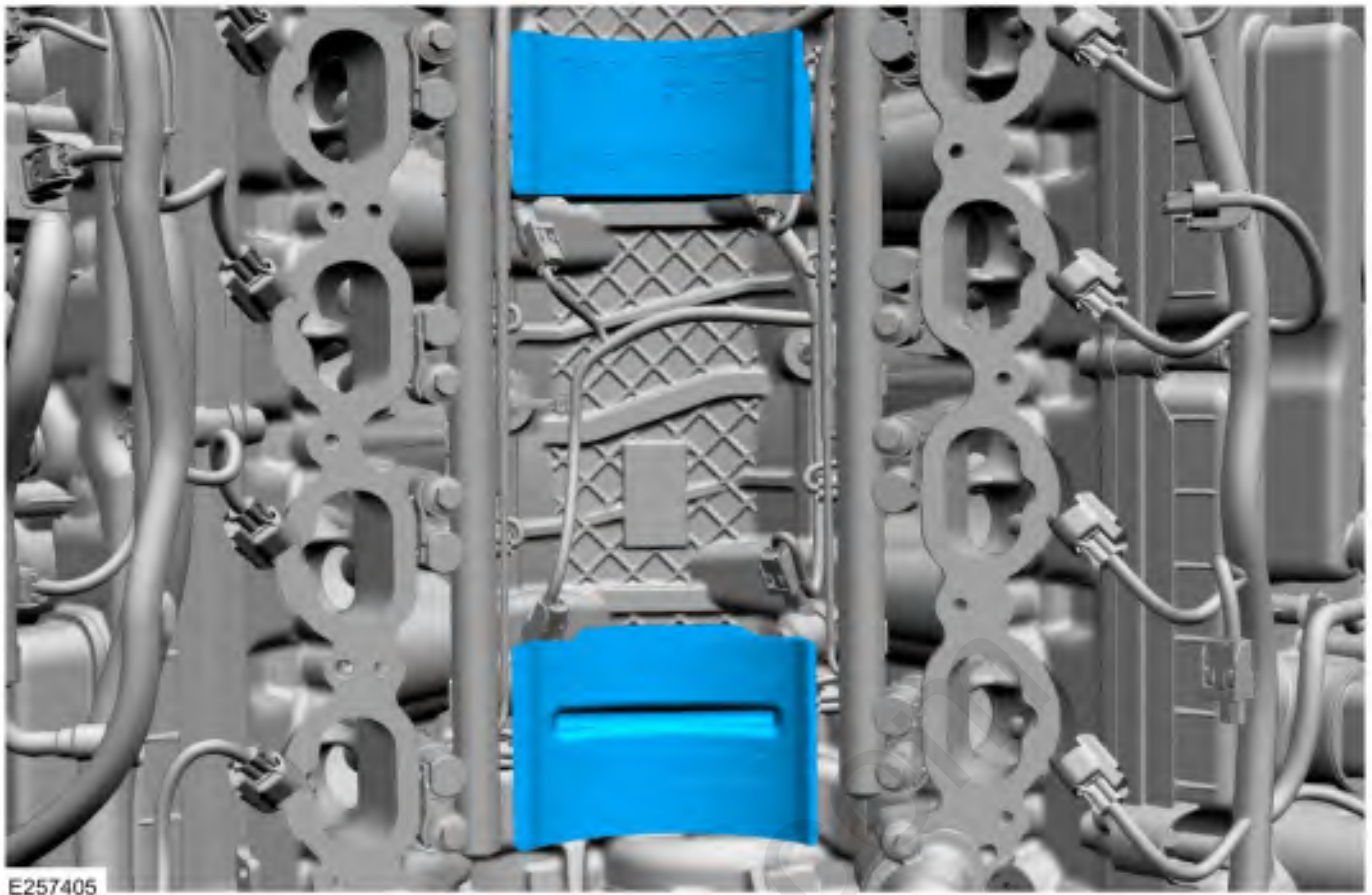
Disconnect the high-pressure fuel tube flare nuts, then remove and discard the high-pressure fuel tube.



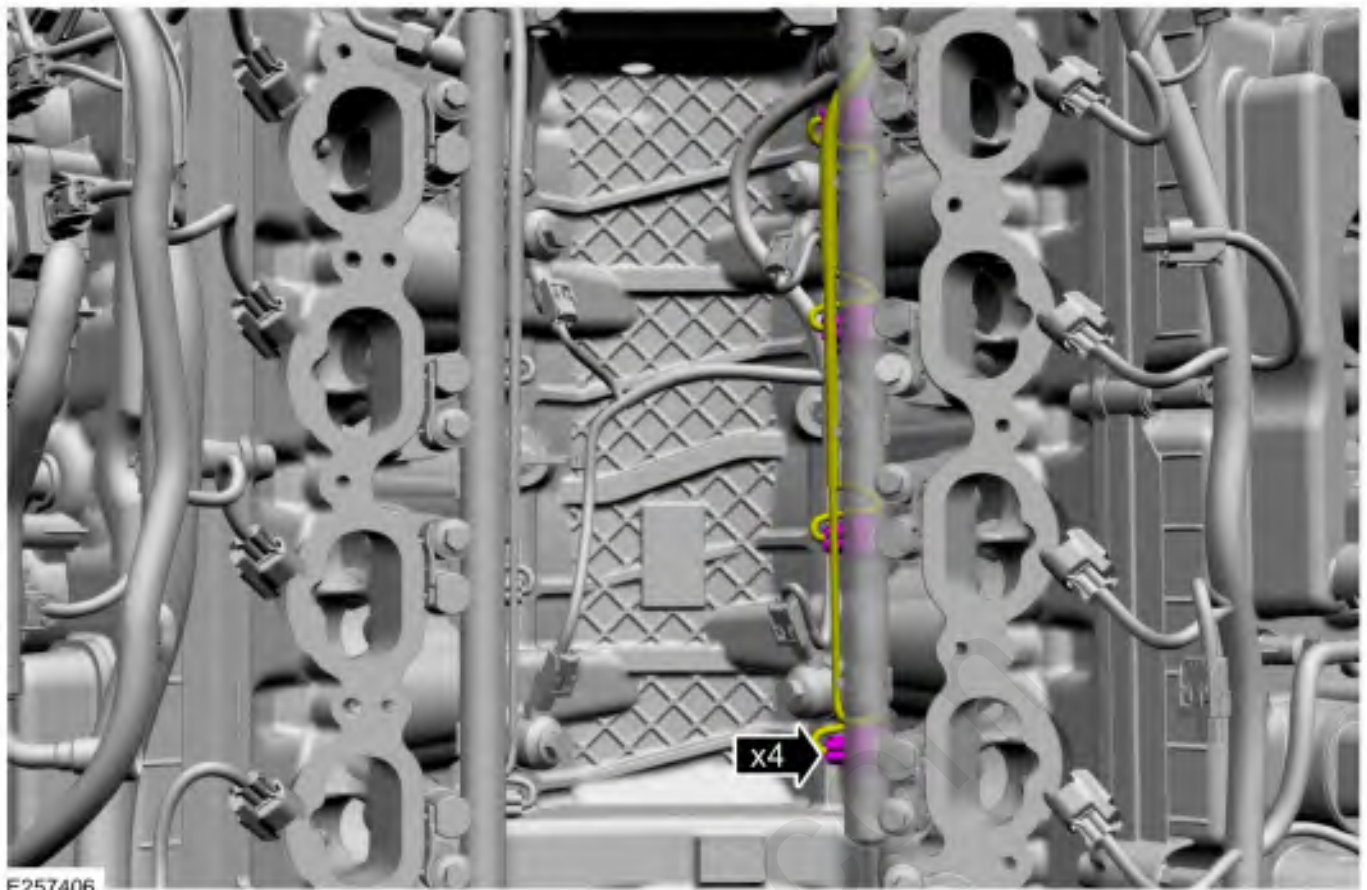
3. Disconnect the electrical connectors.



4. Remove the insulators.



5. Disconnect the fuel injector electrical connectors.



6. **NOTICE:** Pull out the fuel rails in the direction of the fuel injector axis or damage may occur to the fuel injectors.

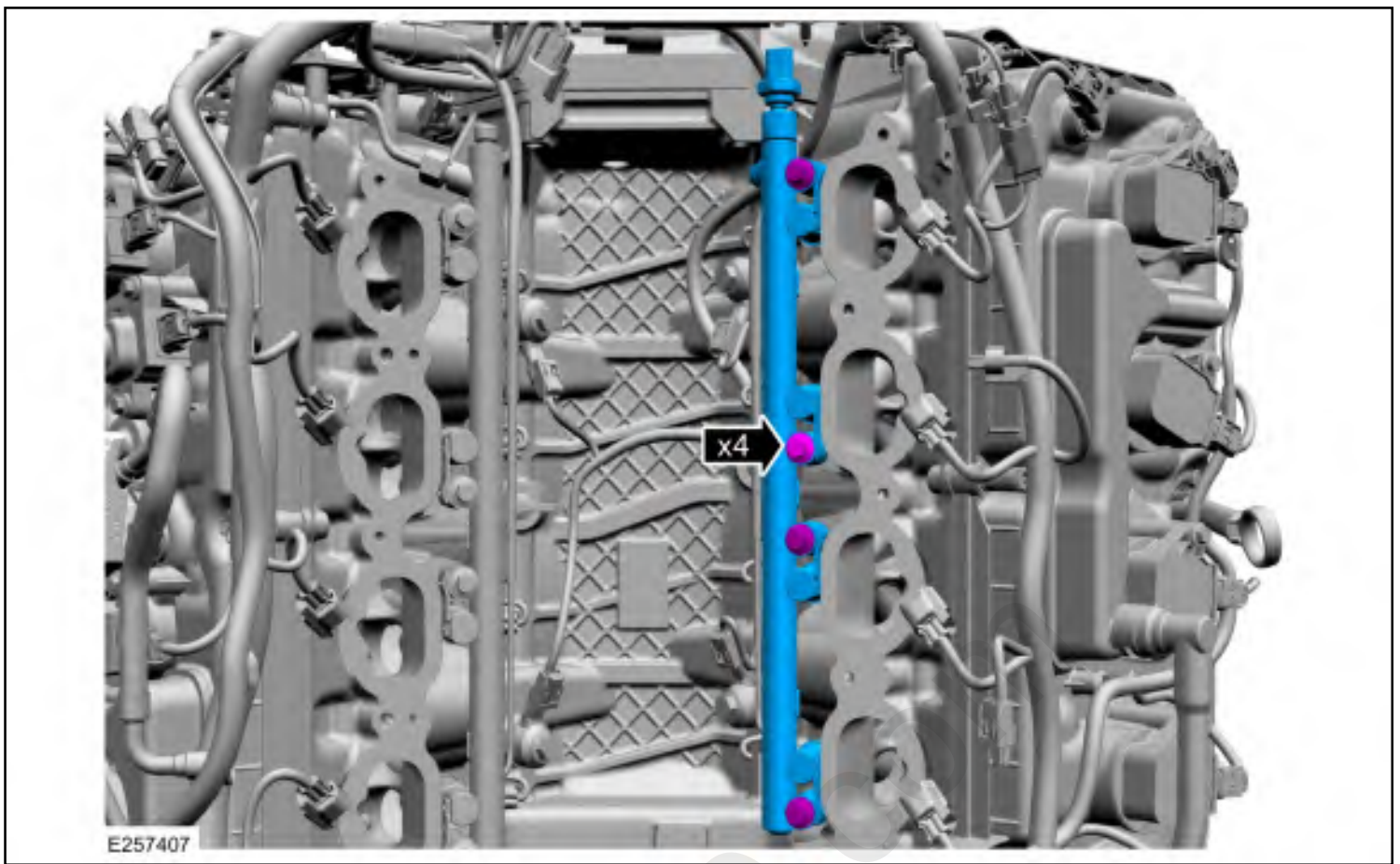
**NOTE:** Use compressed air and remove any dirt or foreign material from the cylinder head, block and general surrounding area of the fuel rail and injectors.

**NOTE:** When removing the fuel rails, the fuel injectors may remain in the cylinder heads and require the use of a Fuel Injector Remover tool to extract. Wiggling the injector by hand to break it loose may allow the injector to be removed by hand.

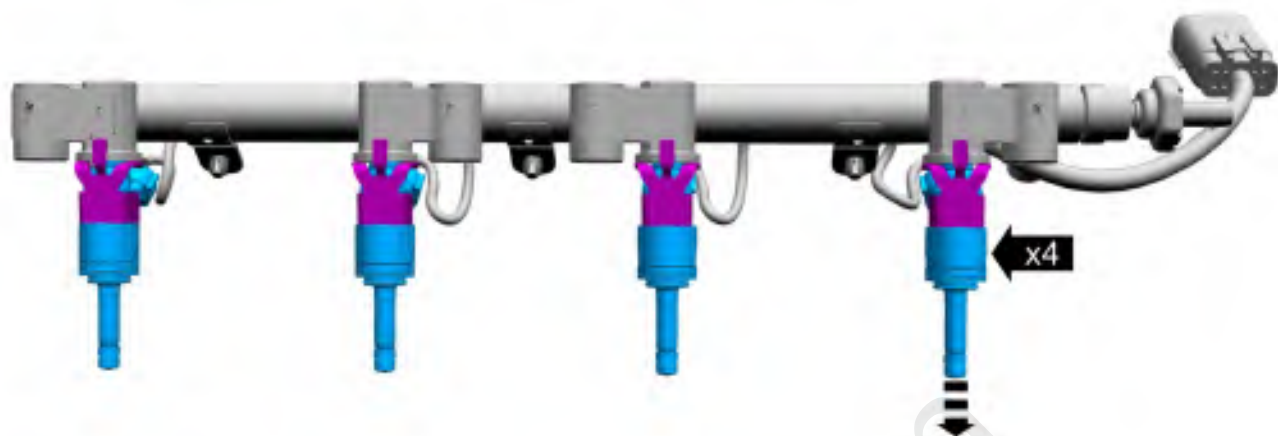
**NOTE:** Should any of the fuel injectors remain in the head, then the fuel injector electrical connectors will need to be disconnected as the fuel rail is being removed.

Remove the fuel rail bolts, then remove the fuel rail.



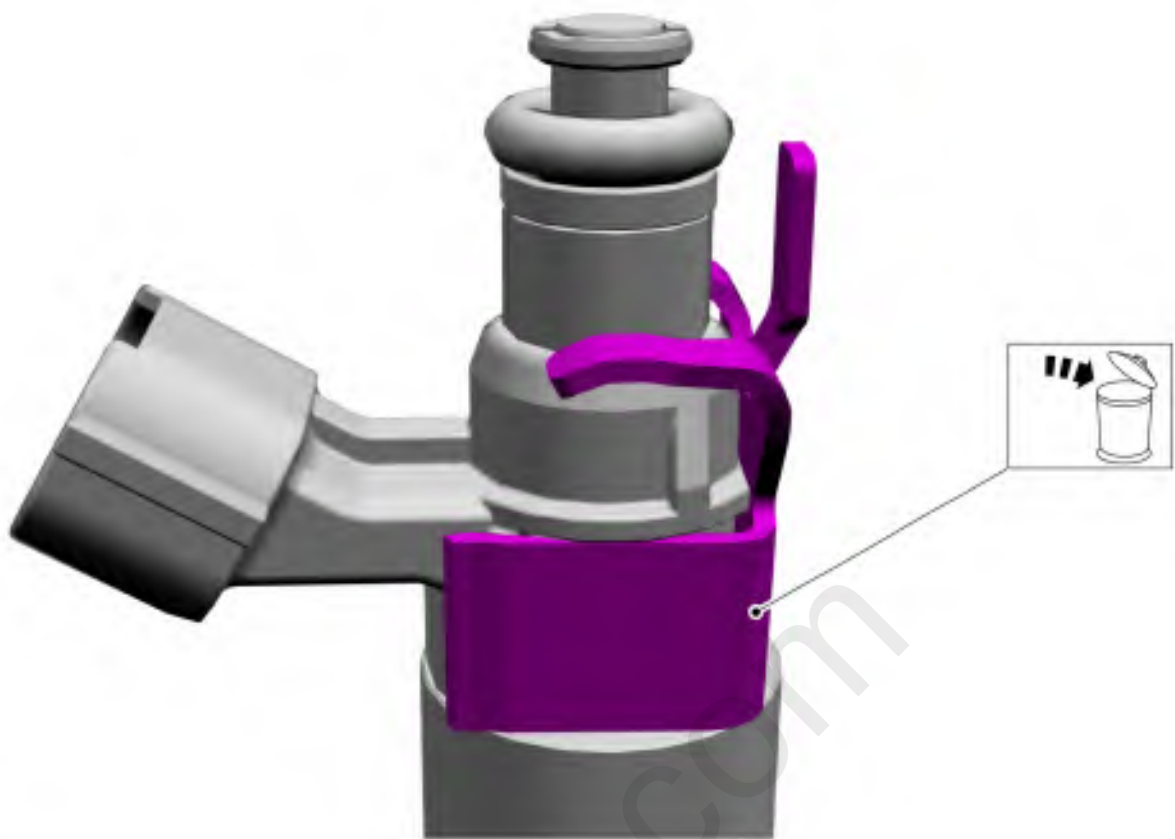


7. Remove the fuel injectors from the fuel rail.



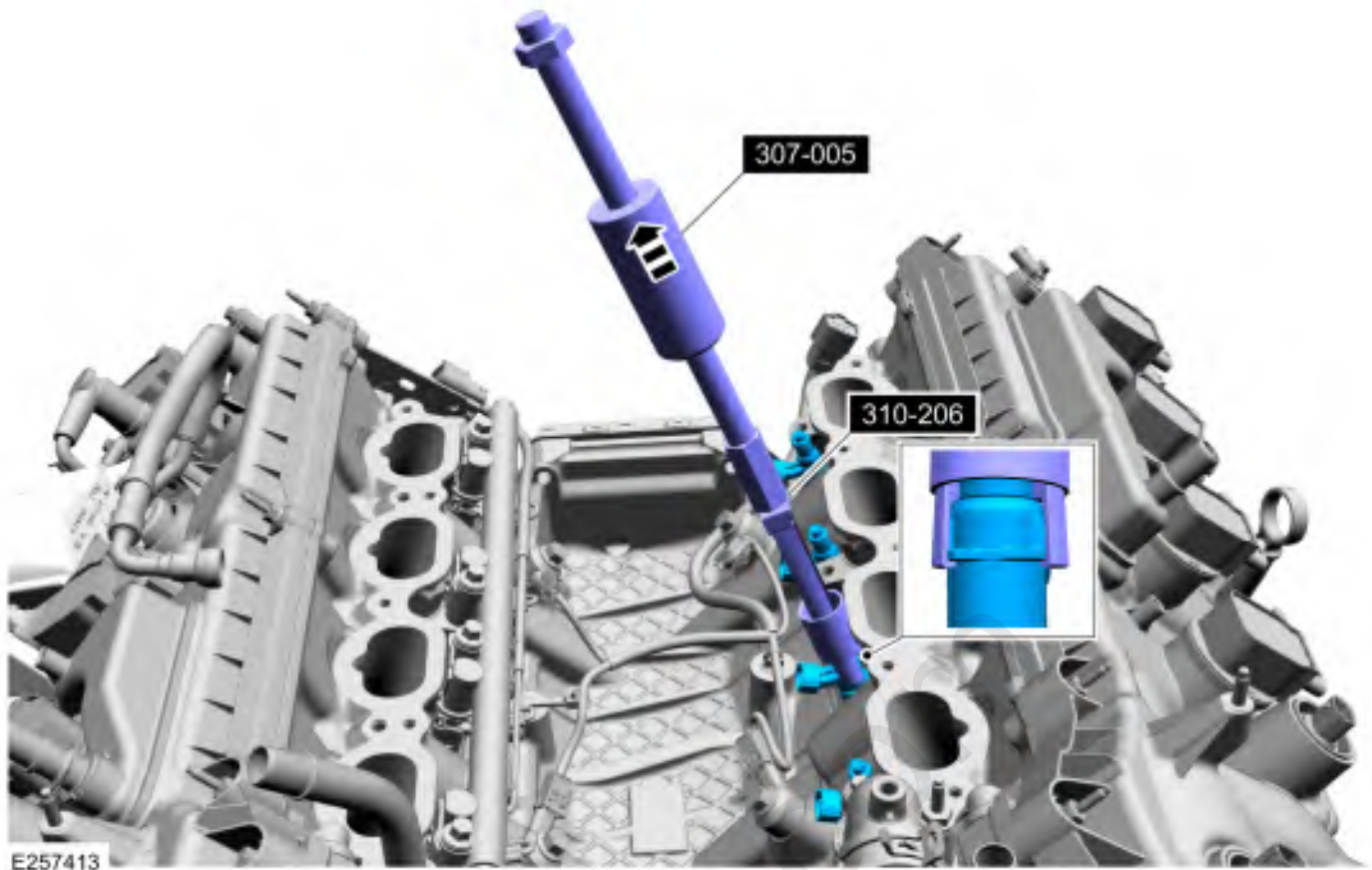
E257409

8. Remove and discard the fuel injector clips.



9. **NOTICE:** Use minimal force to remove the fuel injectors that remained in the cylinder head with the Fuel Injector Remover tool or damage to the fuel injector assembly may occur. Wiggling the injector by hand to break it loose may allow the injector to be removed by hand.

Using the special tools, remove any of the fuel injectors that remained in the cylinder head.  
Use Special Service Tool: 307-005 (T59L-100-B) Slide Hammer. , 310-206 Remover, Fuel Injector.

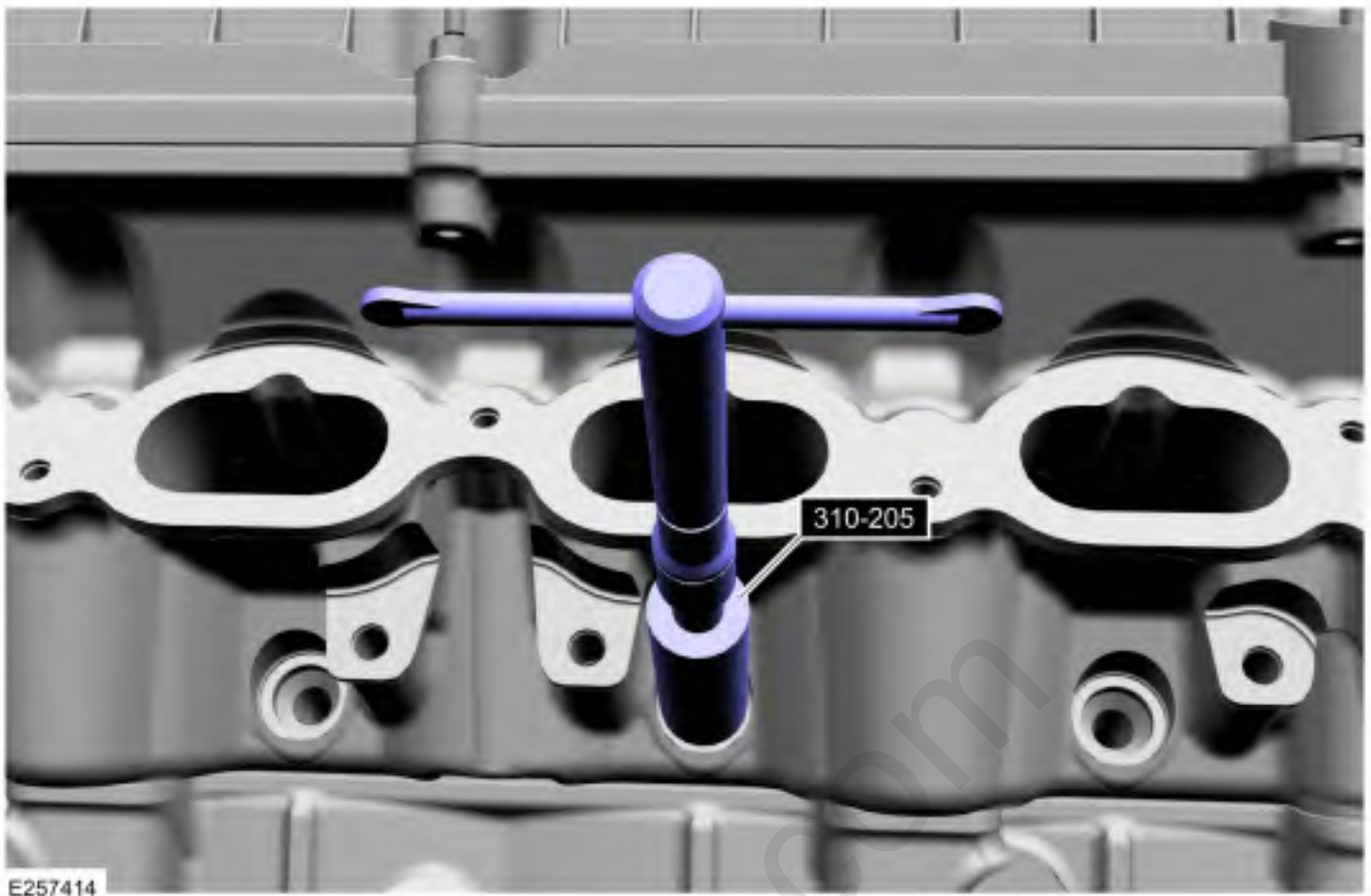


10. **NOTICE:** Make sure to thoroughly clean any residual fuel or foreign material from the cylinder head, block and the general surrounding area of the fuel rails and injectors.

**NOTICE:** Do not use compressed air to clean the tip of the fuel injector.

**NOTICE:** Do not use a brush to clean the tip of the fuel injector.

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



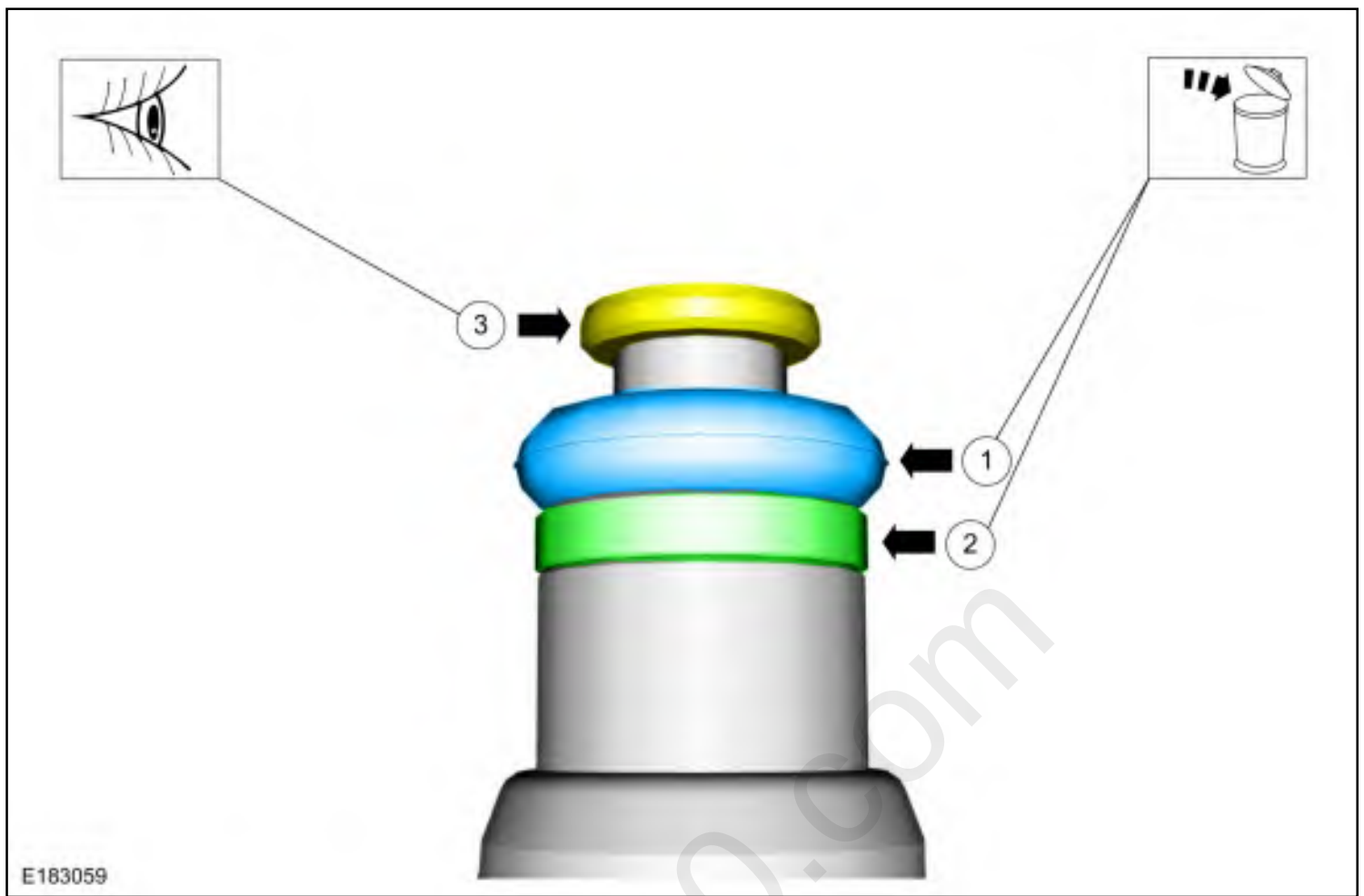
## Installation

1. Remove and discard the fuel injector O-ring seals.
2. **NOTE:** *Note the correct orientation of the fuel injector support rings for correct installation of the NEW fuel injector support rings.*

Remove and discard the fuel injector support rings.

3. Inspect the inlet stopper, if it is damaged or comes off then discard the inlet stopper. The inlet stopper is not needed for proper function. Ensure that any debris from the inlet stopper are removed. If the inlet stopper is intact and undamaged do not remove the inlet stopper from the fuel injector.

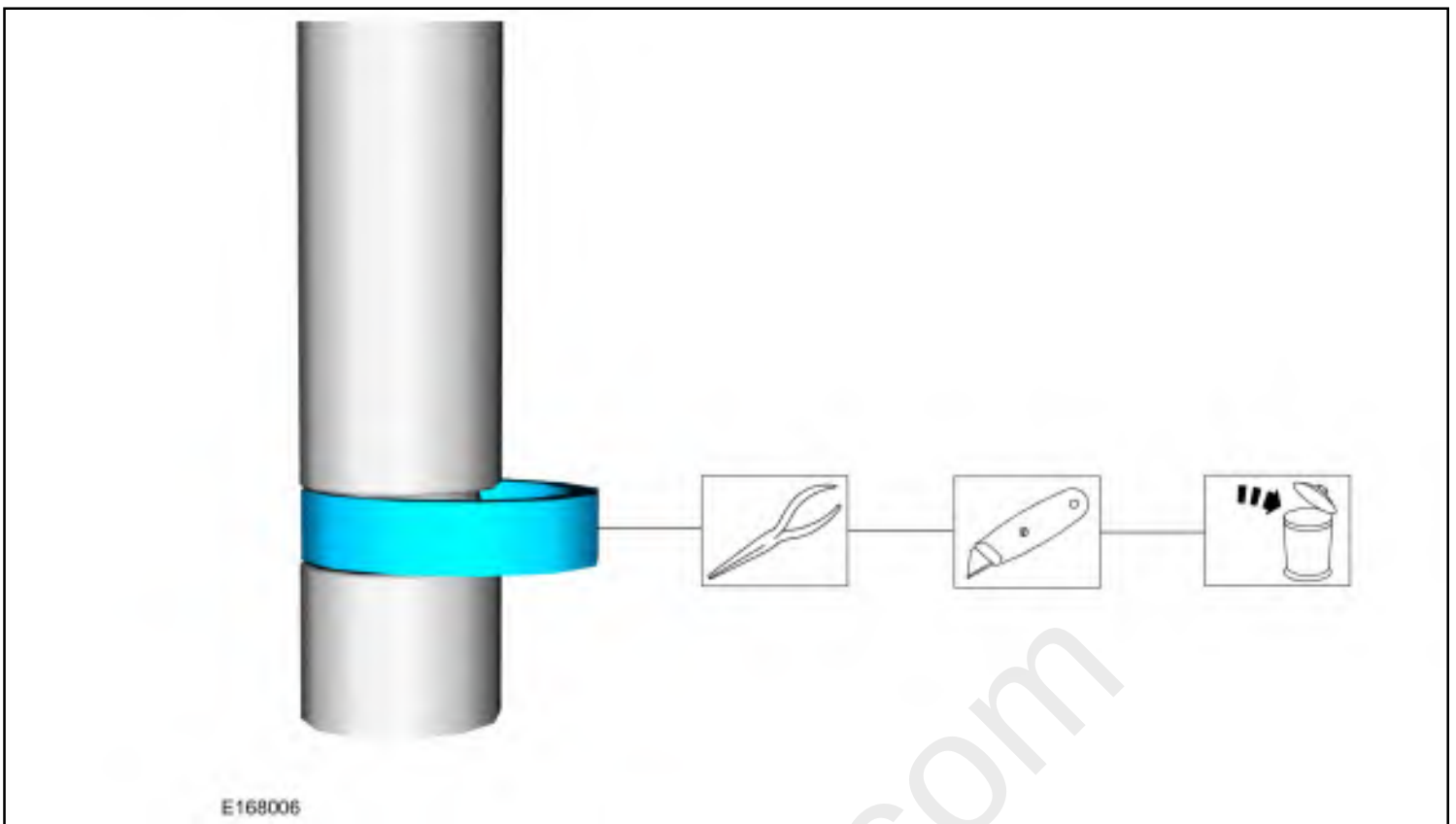




2. **NOTICE:** Use care when removing the lower Teflon® seals, not to scratch, nick or gouge the fuel injector.

**NOTICE:** Do not attempt to cut the lower Teflon® seal without first pulling it away from the fuel injector or damage to the injector may occur.

1. Pull the lower Teflon® seal away from the injector.
2. Carefully cut and discard the lower fuel injector Teflon® seal.



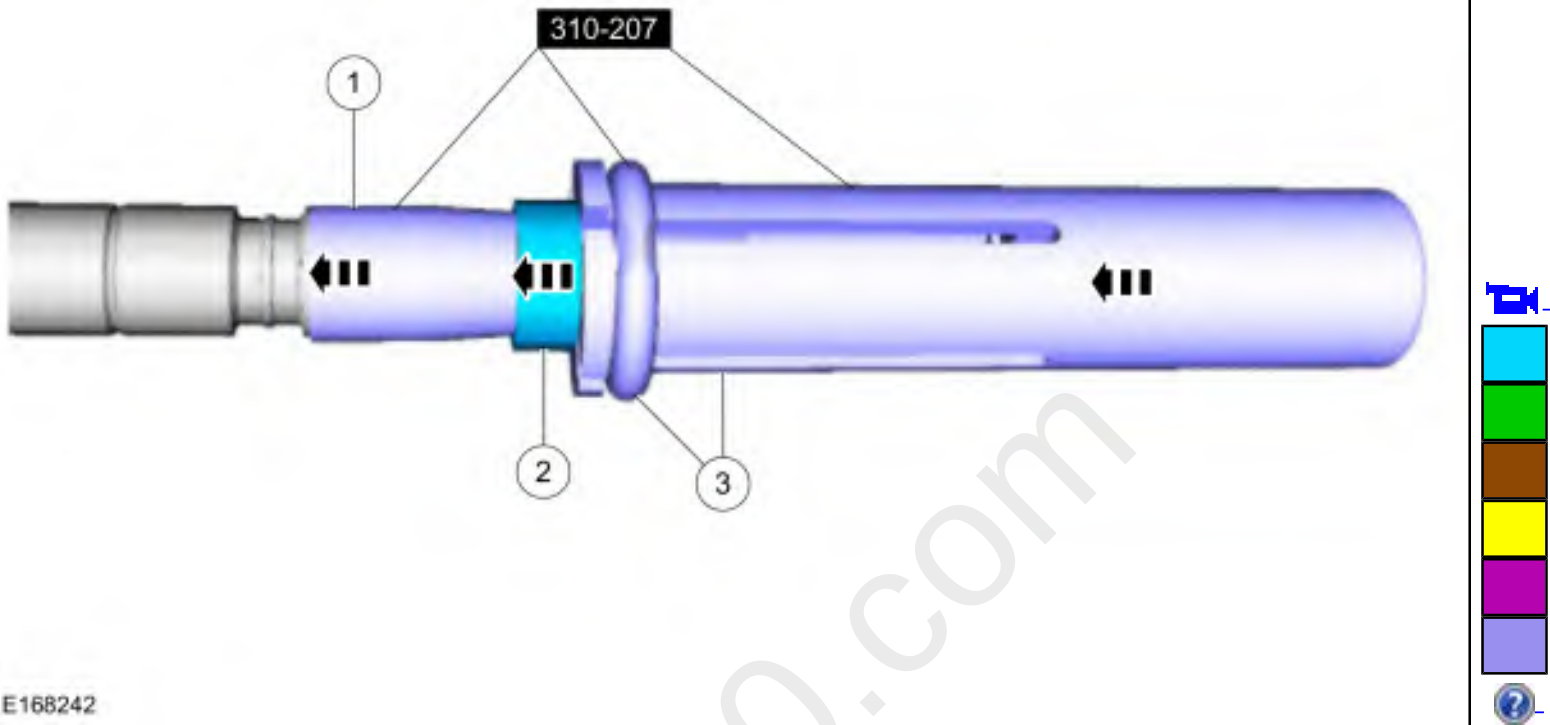
3. **NOTICE: Do not lubricate the NEW lower Teflon® fuel injector seals.**

1. Install the Teflon® Seal Guide onto the fuel injector tip.  
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.**

**NOTE:** *Make sure that NEW lower fuel injector Teflon® seals are installed.*

Install the NEW Teflon® seals onto the Teflon® Seal Guide, using the Pusher Tool, slide the Teflon® seals along the Teflon® Seal Guide.

3. Using the Pusher Tool, slide the Teflon® seals off of the Teflon® Seal Guide and into the groove on the fuel injectors.  
Use Special Service Tool: 310-207 Installer, Fuel Injector Seal Assembly.
4. Remove the special tools.



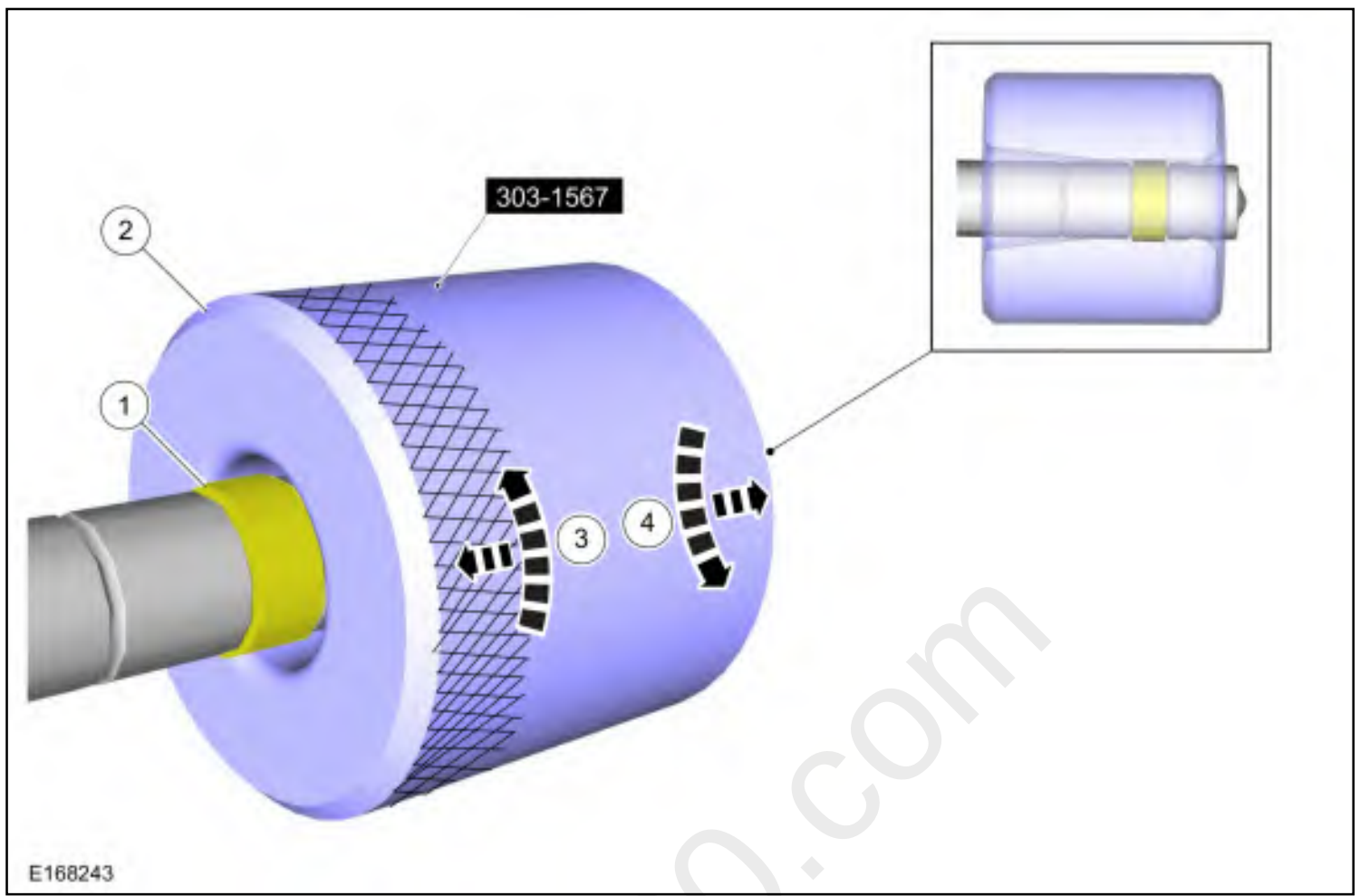
4. **NOTE:** Make sure the Teflon® seal is fully seated in the groove on the fuel injector before sizing the Teflon® seal.

1. Massage and warm the Teflon® seal with your fingers before the Teflon® seal sizer tool is installed. This will aid in installing the Teflon® seal sizer tool.
2. **NOTE:** The beveled opening of the Teflon® seal sizer tool goes away from the seal.

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 Teflon® seal sizer tool is installed, check and make sure the Teflon® seal is in the sizing portion of the Teflon® seal sizer tool.
4. After one minute, turn the Teflon® seal sizer tool back 180 degrees and remove.

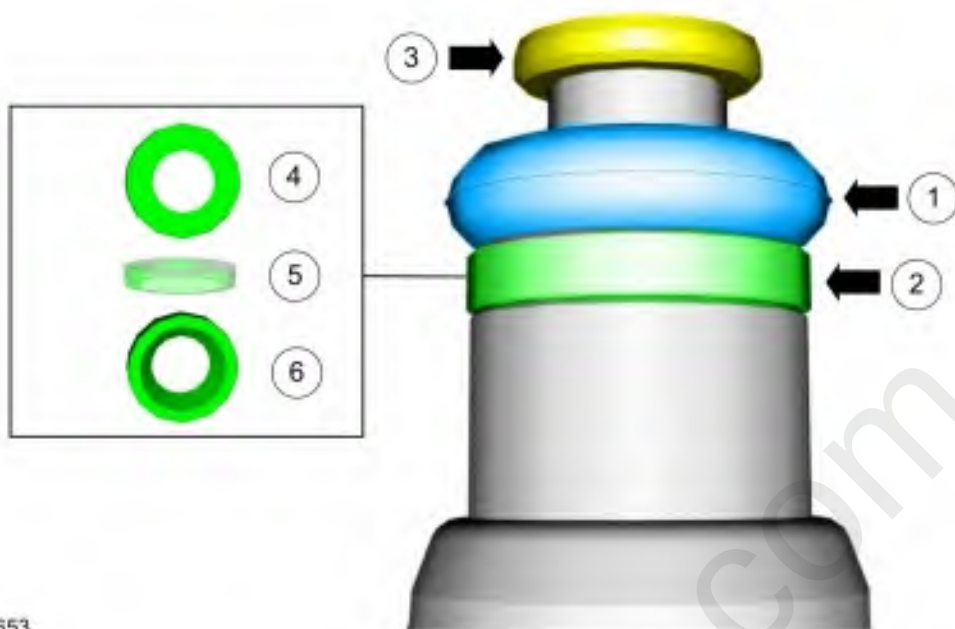


5. **NOTE:** Make sure that *NEW* fuel injector support rings and *NEW* fuel injector O-ring seals are installed.

1. Install the new fuel injector O-rings. The O-rings are pre-lubricated, NO ADDITIONAL lubricant is required.
2. **NOTICE:** The *NEW* the fuel injector support rings must be installed in the correct orientation with the wide surface area facing up against the fuel injector O-ring seals. Improperly installed support rings may cause the fuel system to leak.

Install the *NEW* the fuel injector support rings.

3. Inspect the inlet stopper, if it is damaged or comes off then discard the inlet stopper. The inlet stopper is not needed for proper function. Ensure that any debris from the inlet stopper are removed. If the inlet stopper is intact and undamaged do not remove the inlet stopper from the fuel injector.
4. The upper side of the support ring has the wide surface area.
5. Fuel injector support ring.
6. The lower side of the support ring has the narrow surface area.



E199653

6. Install the NEW fuel injector clips.





E257412

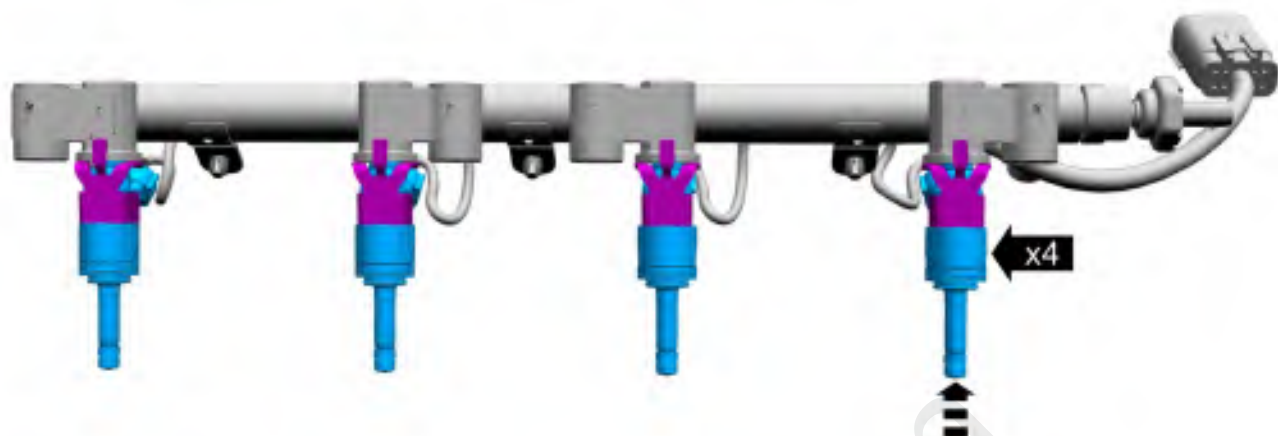


7. **NOTICE:** The fuel rail pressure sensor must be replaced if it is removed from the fuel rail.

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

Install the fuel injectors to the fuel rail and then connect the fuel injector electrical connectors.

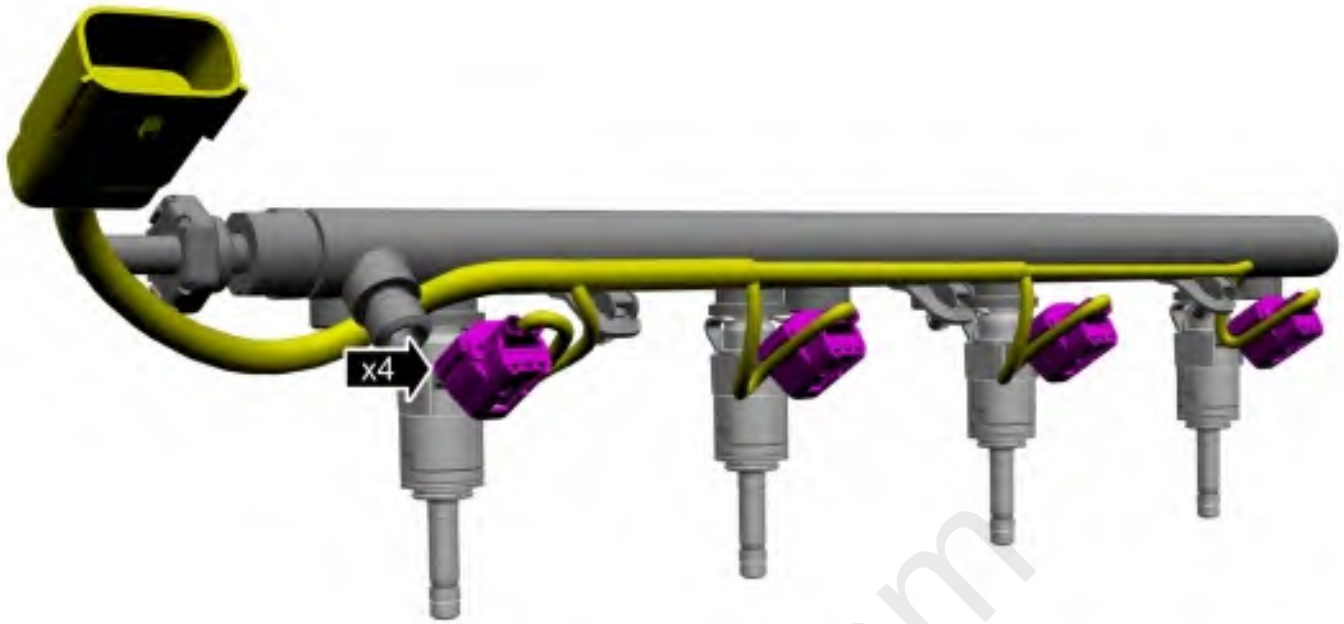
Refer to: [Fuel Rail Pressure \(FRP\) Sensor](#) (303-14D Electronic Engine Controls - 5.0L 32V Ti-VCT, Removal and Installation).



E257410



8. Connect the fuel injector electrical connectors.



E257411

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

Install the fuel rail, push down on the fuel rail above the injectors.

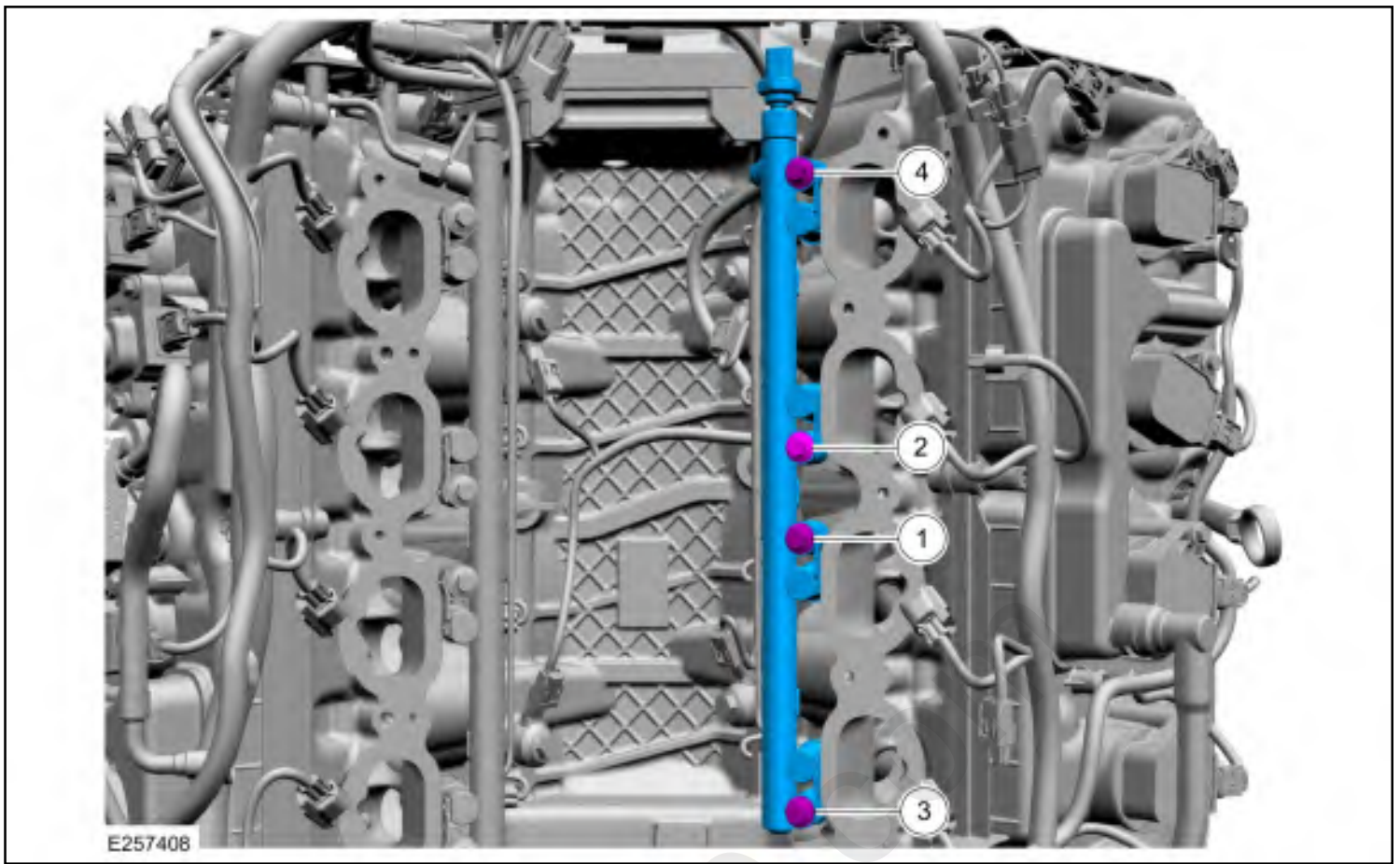
- Hand start all of the fuel rail bolts and finger tighten the fuel rail bolts so they are uniformly in light contact with fuel rail bosses.
- Tighten the fuel rail bolts approximately 90 degrees, in the sequence shown. Repeat to evenly draw down the fuel rail, until the fuel rail bosses are in contact with the cylinder head.

*Torque:*

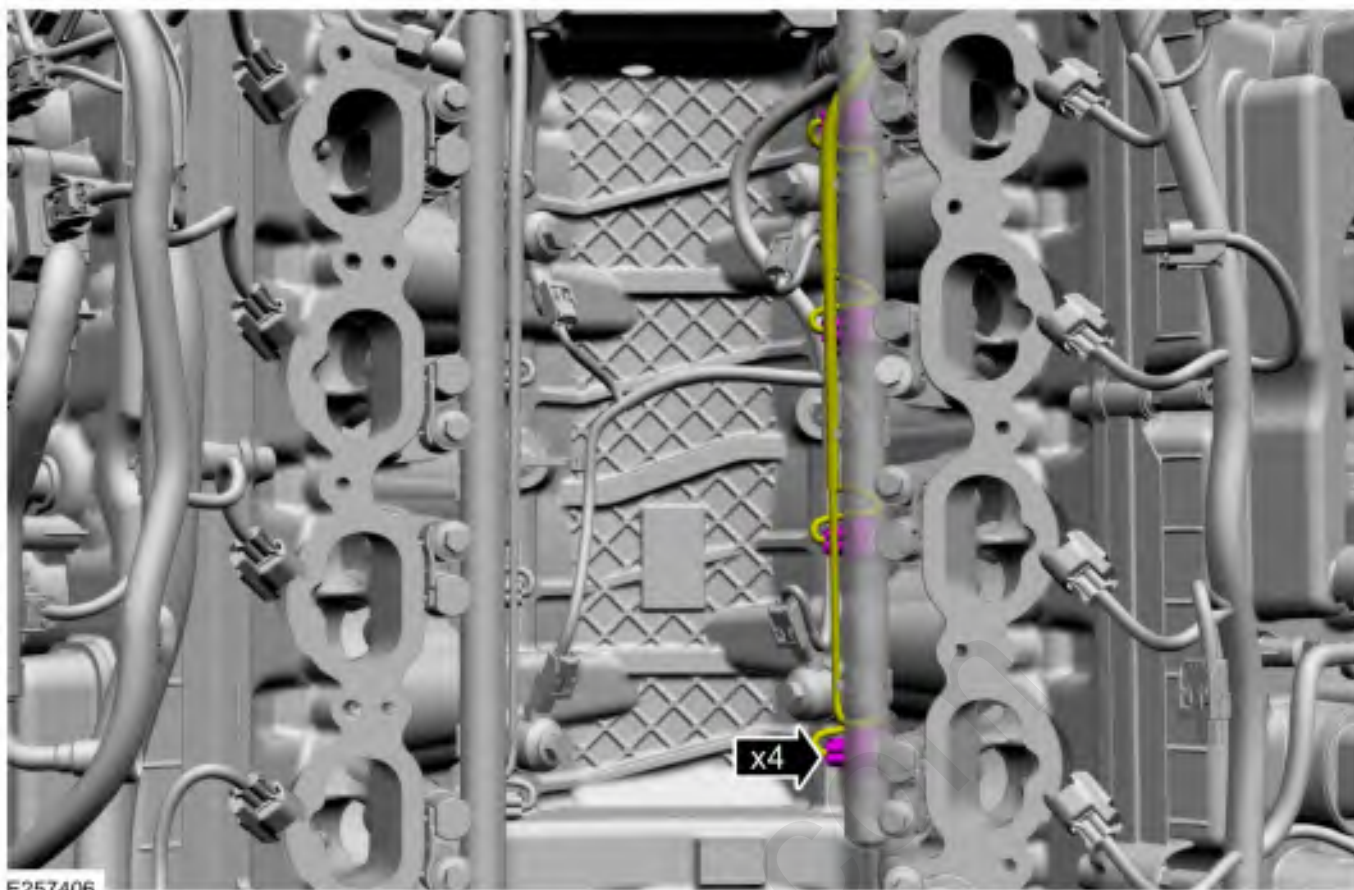
Stage 1: Tighten the fuel rail bolts in the sequence shown to : 89 lb.in (10 Nm)

Stage 2: Tighten the fuel rail bolts in the sequence shown to : 21 lb.ft (28 Nm)

Stage 3: Tighten the fuel rail bolts in the sequence shown an additional : 25°



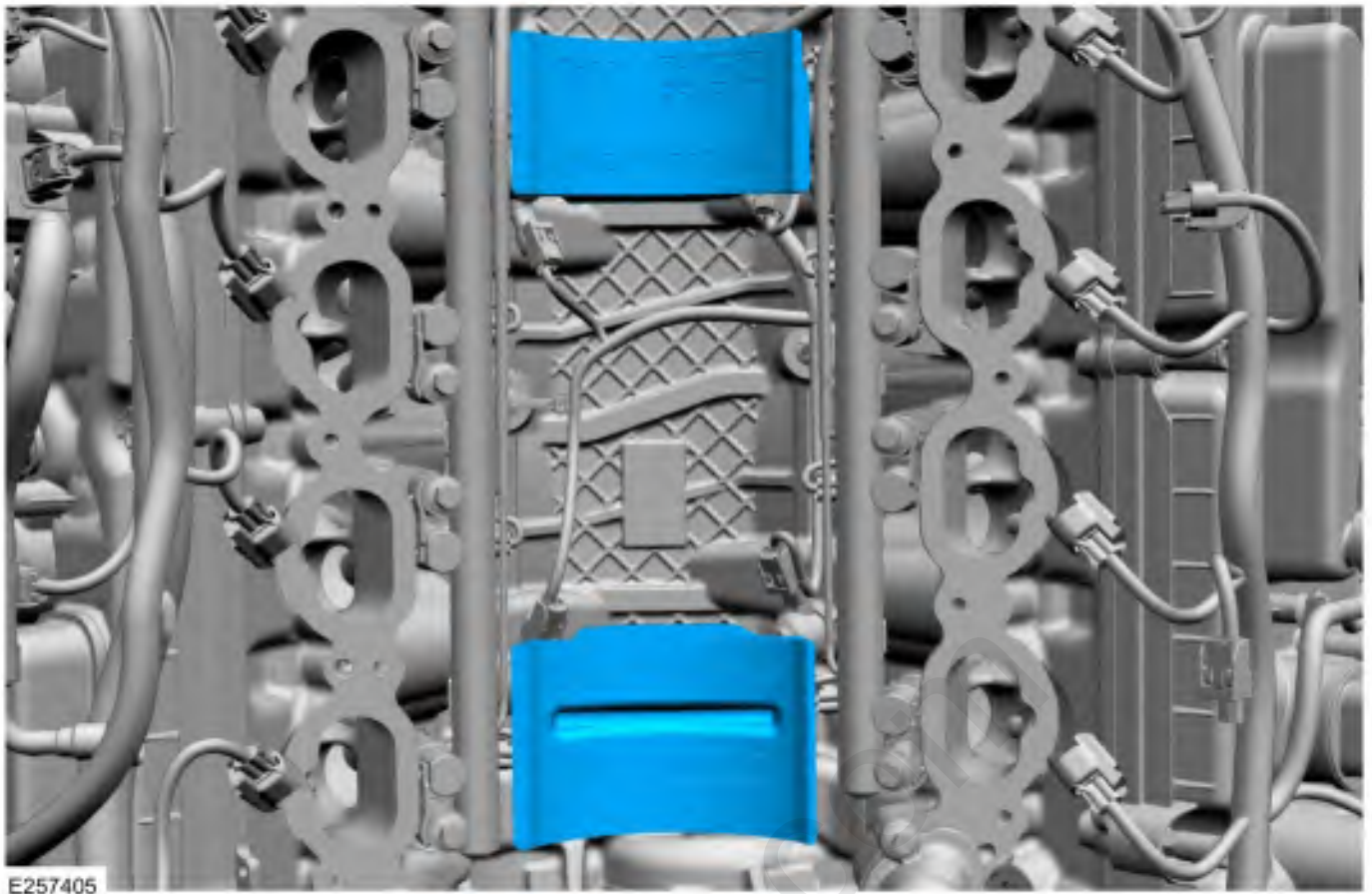
10. Connect the fuel injector electrical connectors.



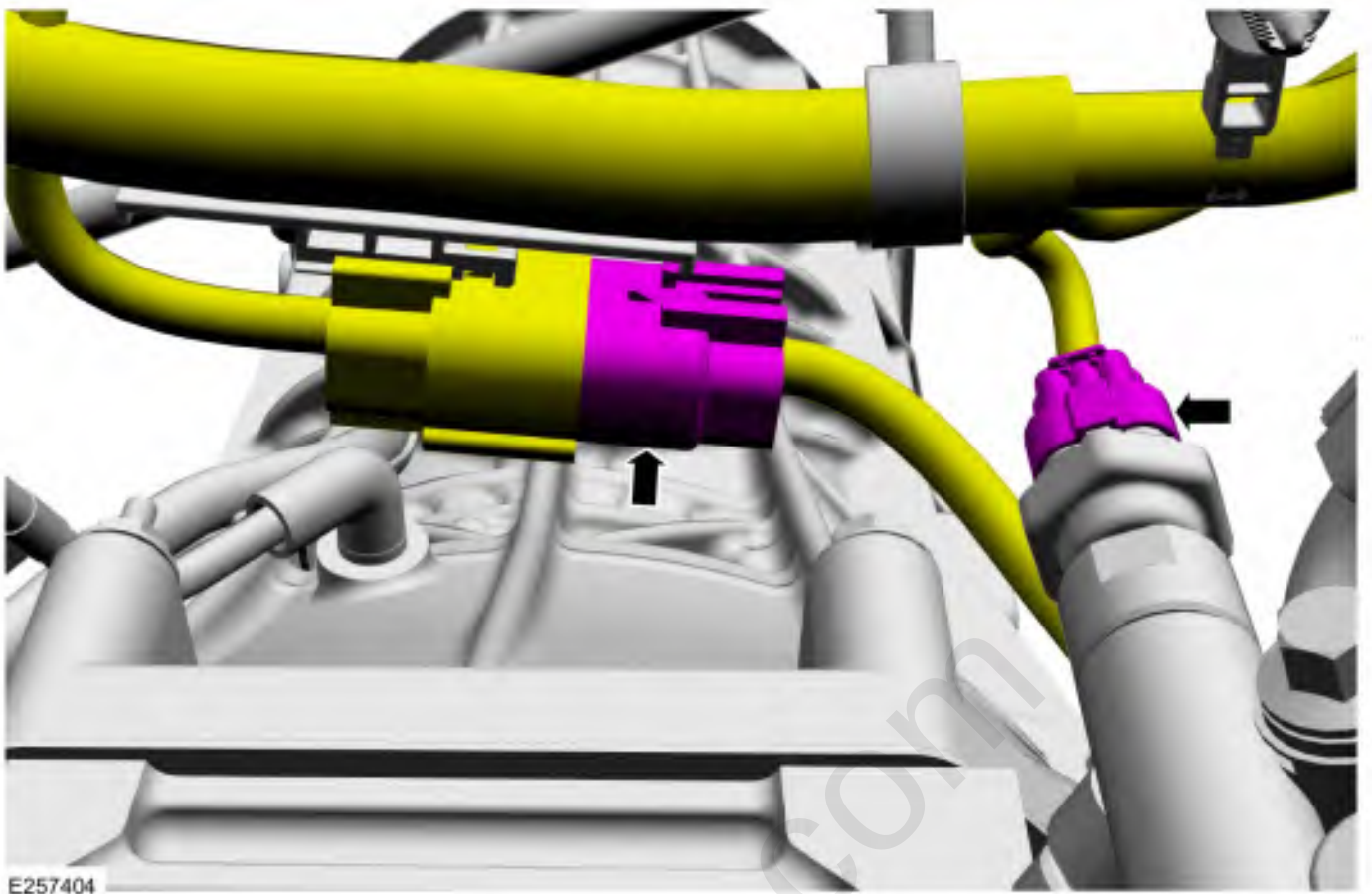
E257406

11. Install the insulators.





12. Connect the electrical connectors.



13. **NOTICE:** In stage 3, if the torque required to tighten any flare nut on the new high-pressure fuel tube reaches or exceeds 55 lb.ft (50 Nm), then that high pressure fuel tube must be discarded and replaced with another new high-pressure fuel tube.

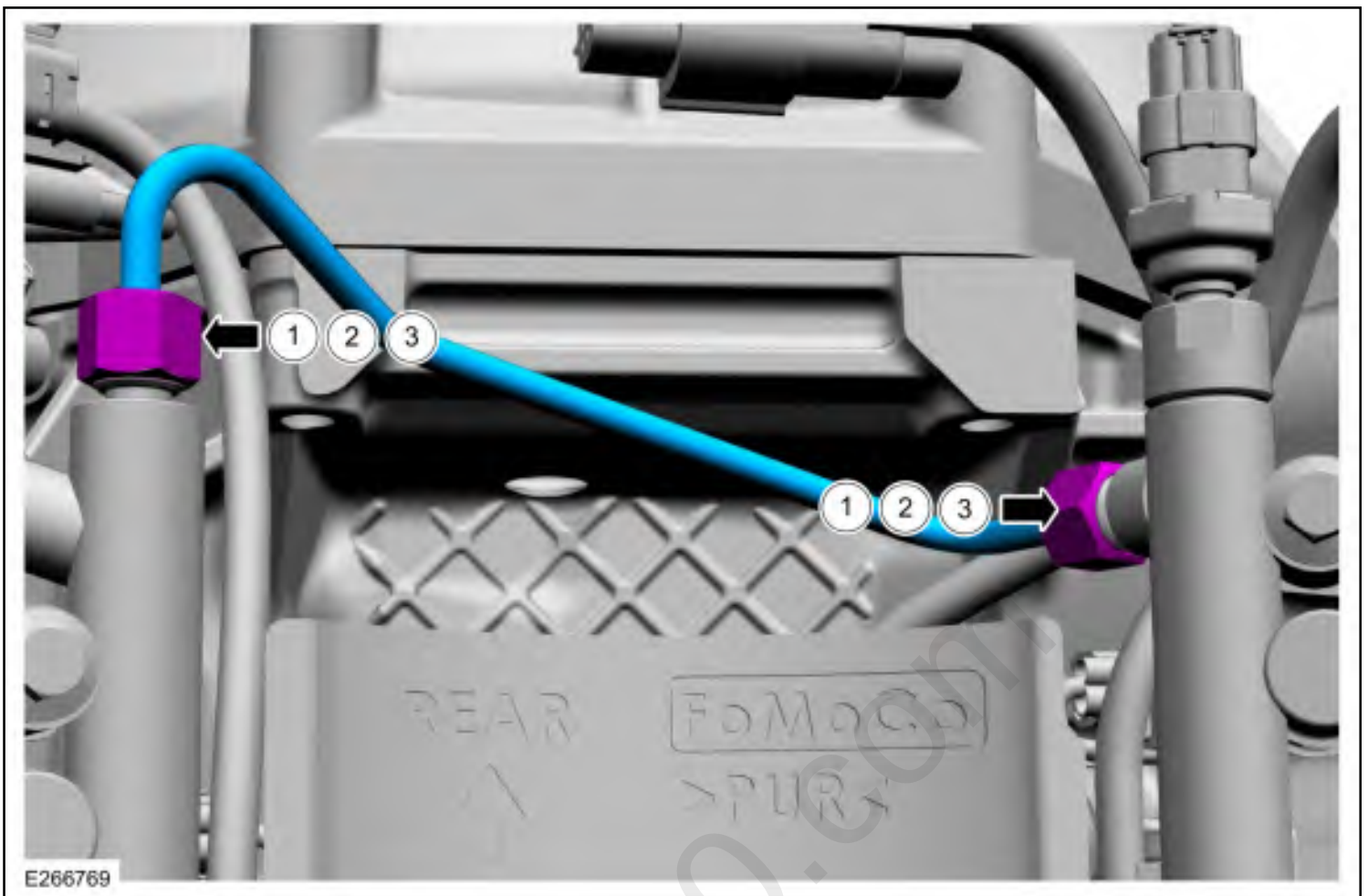
**NOTE:** Make sure that a new high-pressure fuel tube is installed.

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

Install the high-pressure fuel tube and tighten the flare nuts finger tight, then tighten the flare nuts in the following 3 stages.

*Torque:*

- Stage 1: Tighten the high-pressure fuel tube flare nuts to : 71 lb.in (8 Nm)
- Stage 2: Tighten the high-pressure fuel tube flare nuts to : 89 lb.in (10 Nm)
- Stage 3: Tighten the high-pressure fuel tube flare nuts an additional : 25°

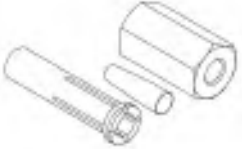


14. Install the intake manifold.

Refer to: [Intake Manifold](#) (303-01D Engine - 5.0L 32V Ti-VCT, Removal and Installation).

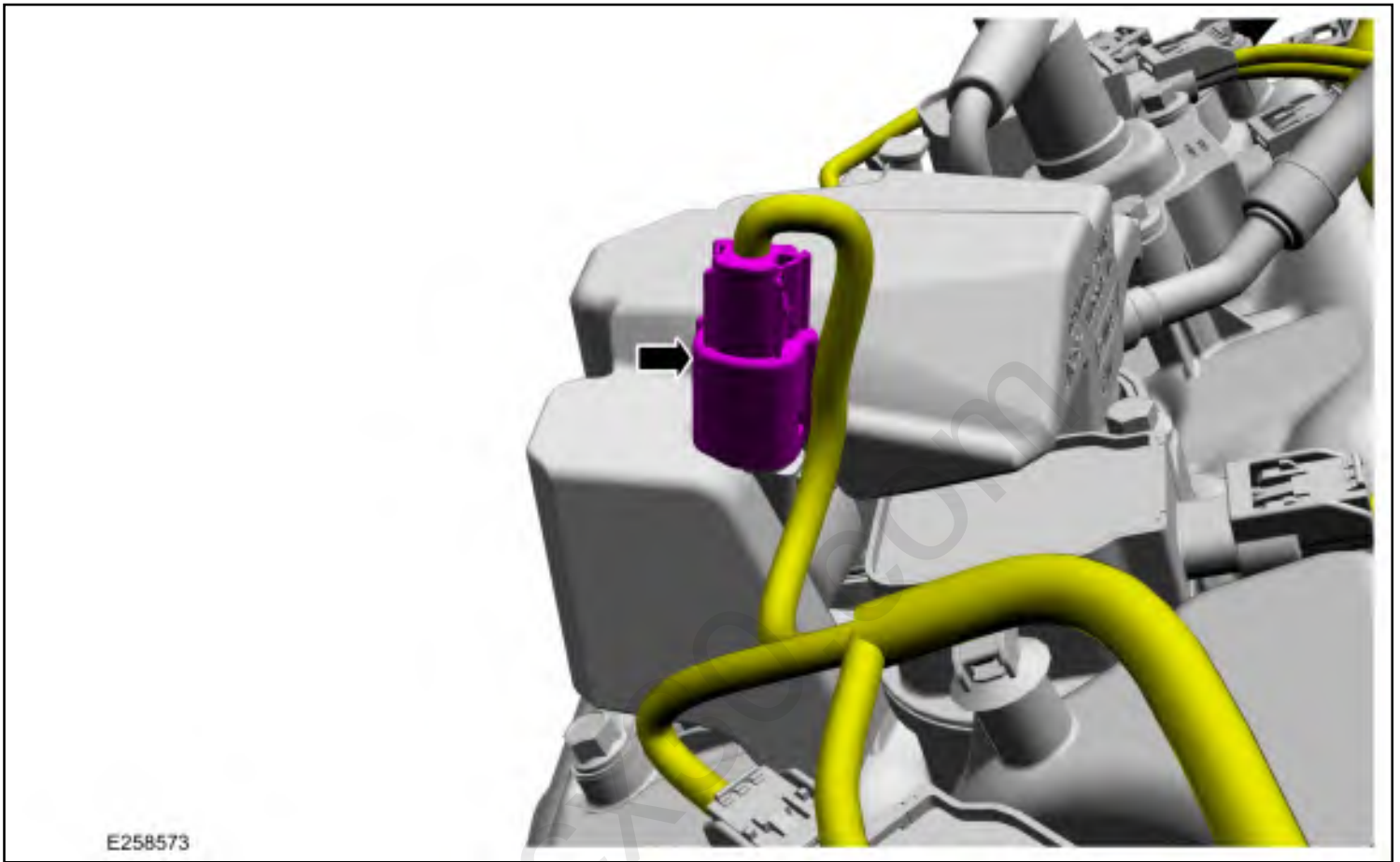
## Direct Injection Fuel Rail RH

### Special Tool(s) / General Equipment

|                                                                                               |                                                                     |
|-----------------------------------------------------------------------------------------------|---------------------------------------------------------------------|
| <br>E222987   | 303-1567<br>Sizer, Teflon Seal<br>TKIT-2010C-FLM                    |
| <br>E222982  | 307-005 (T59L-100-B)<br>Slide Hammer                                |
| <br>E223046 | 310-205<br>Fuel Injector Brush                                      |
| <br>E168032 | 310-206<br>Remover, Fuel Injector<br>TKIT-2009A-FLM                 |
| <br>E223047 | 310-207<br>Installer, Fuel Injector Seal Assembly<br>TKIT-2009A-FLM |

### Removal

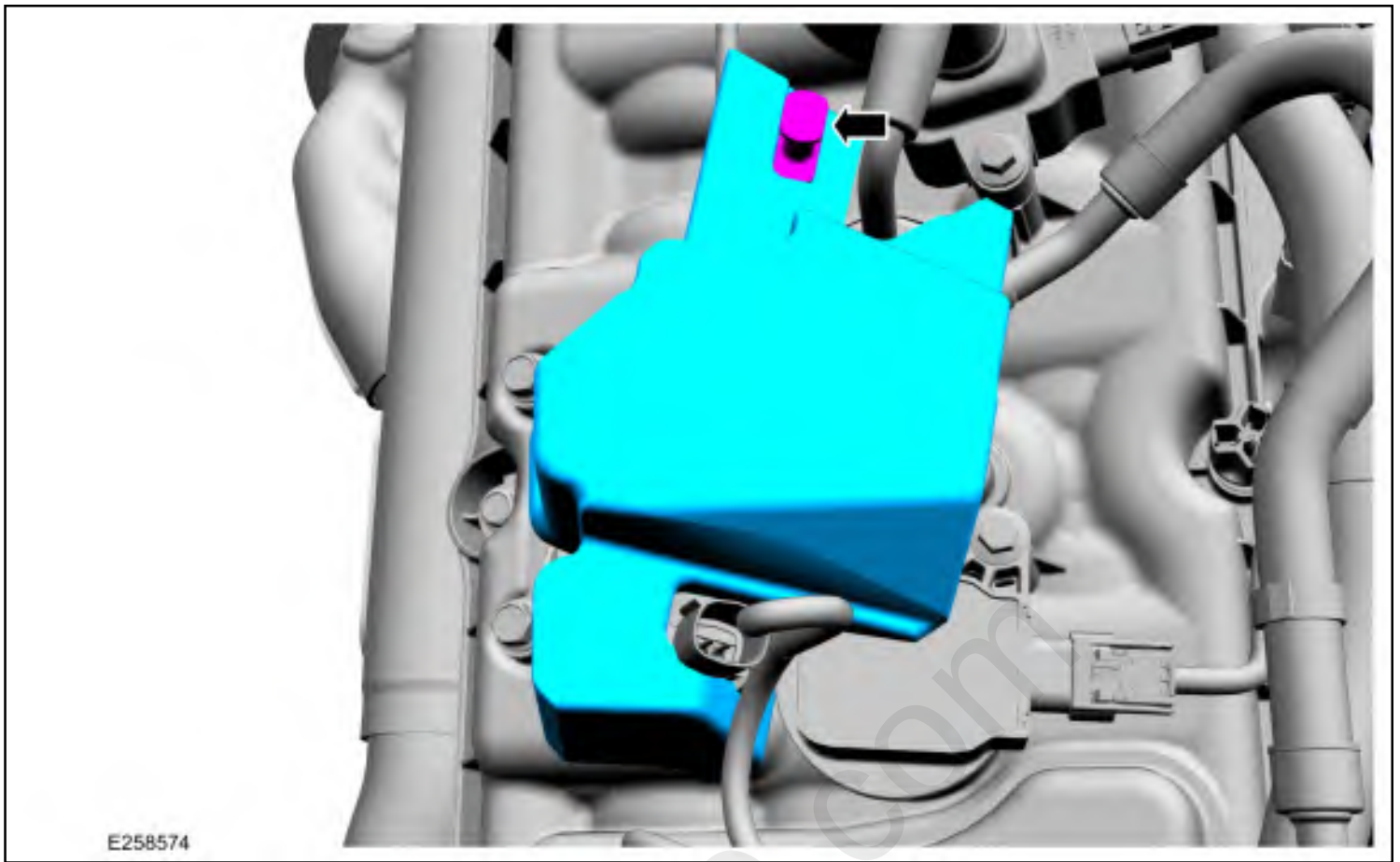
1. Remove the intake manifold.  
Refer to: [Intake Manifold](#) (303-01D Engine - 5.0L 32V Ti-VCT, Removal and Installation).
2. Disconnect the high-pressure fuel pump electrical connector.



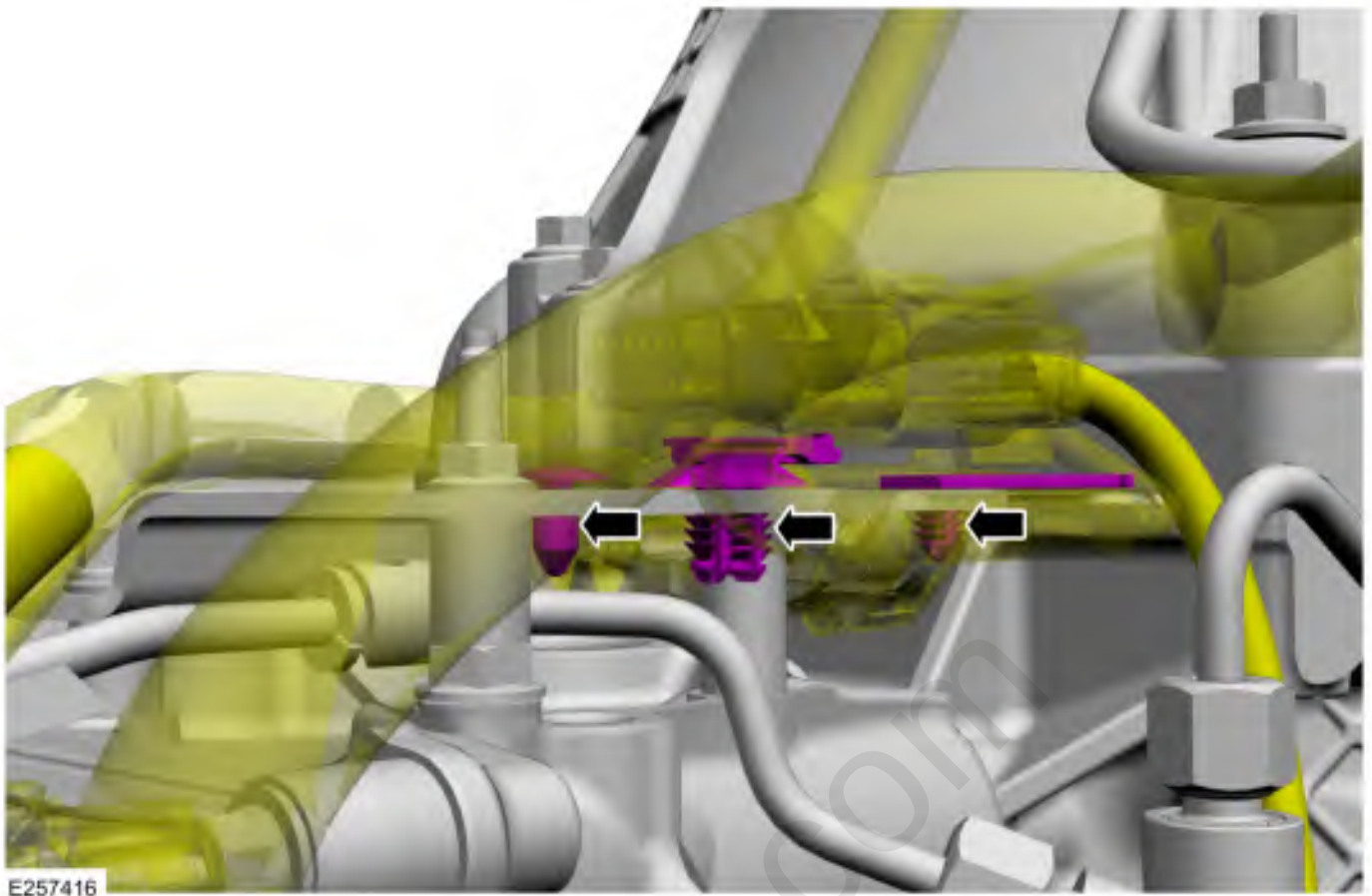
3. **NOTE:** *When removing or installing the fuel injection pump noise insulator, spreading the openings will reduce the risk of damage.*

Release the retainer, then remove the fuel injection pump noise insulator.

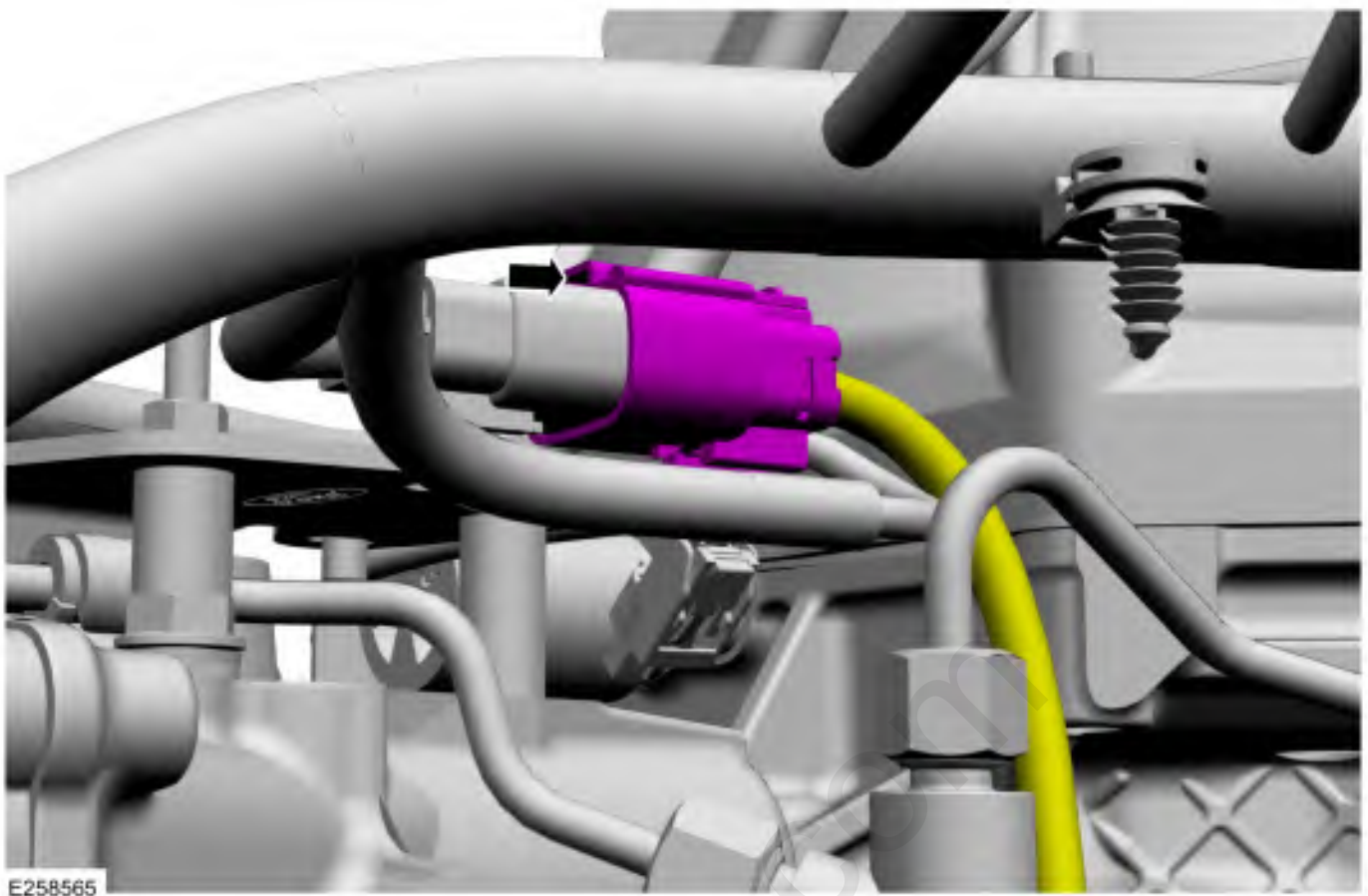




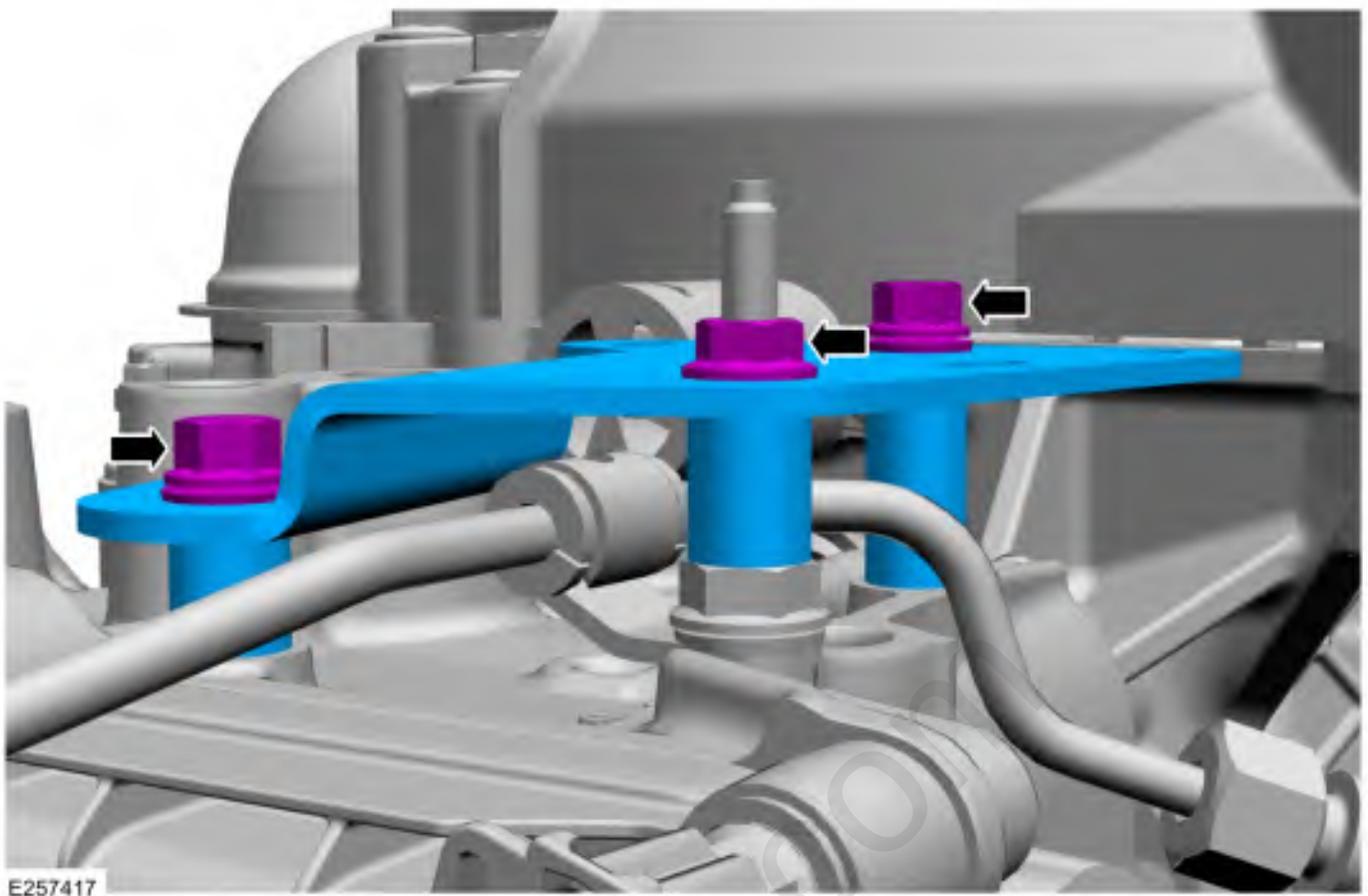
4. Detach the wiring harness retainers from high-pressure fuel line shield.



5. Disconnect the fuel injector main harness electrical connector.

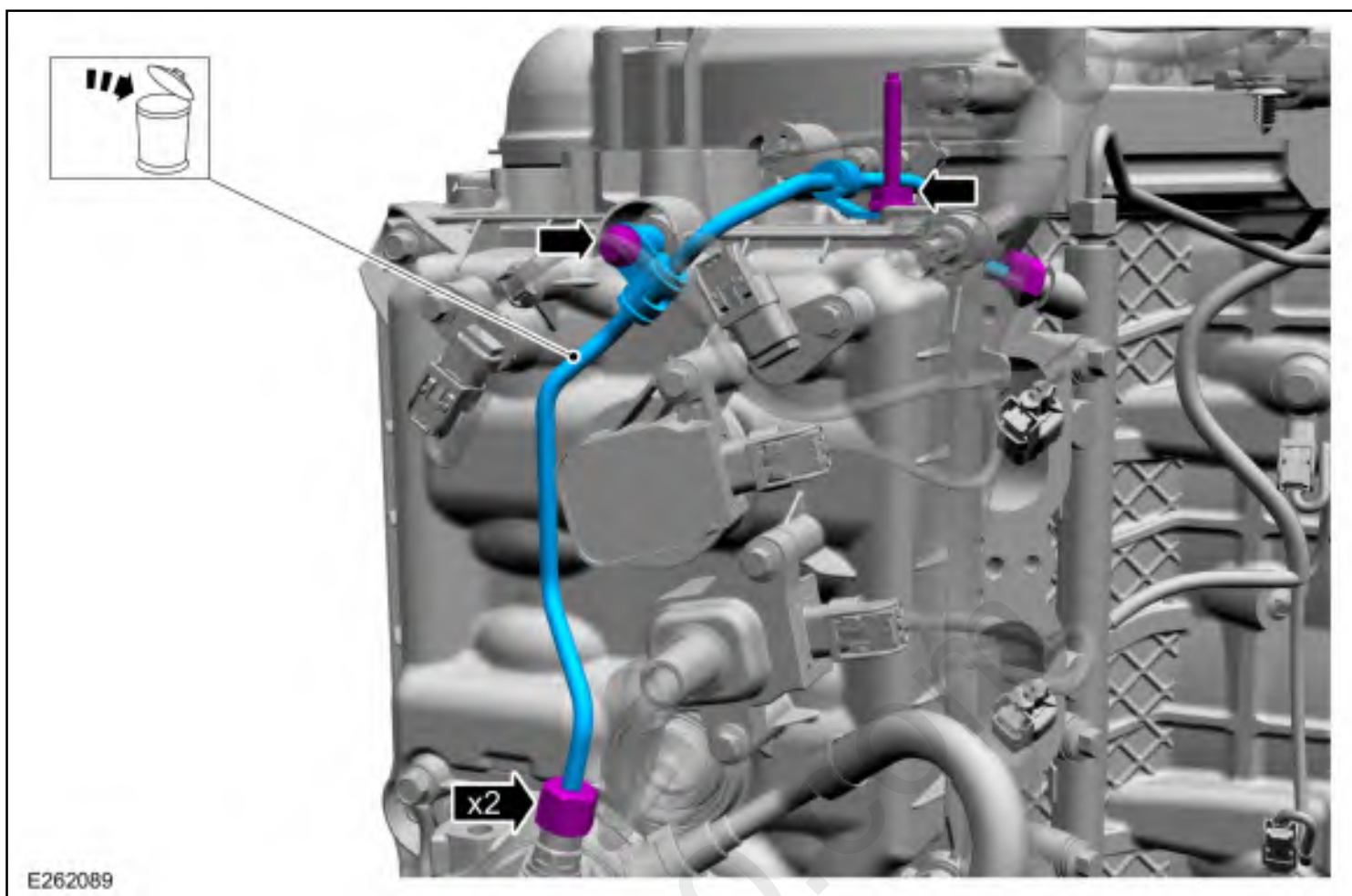


6. Remove the high-pressure fuel line shield retainers, then remove high-pressure fuel line shield.



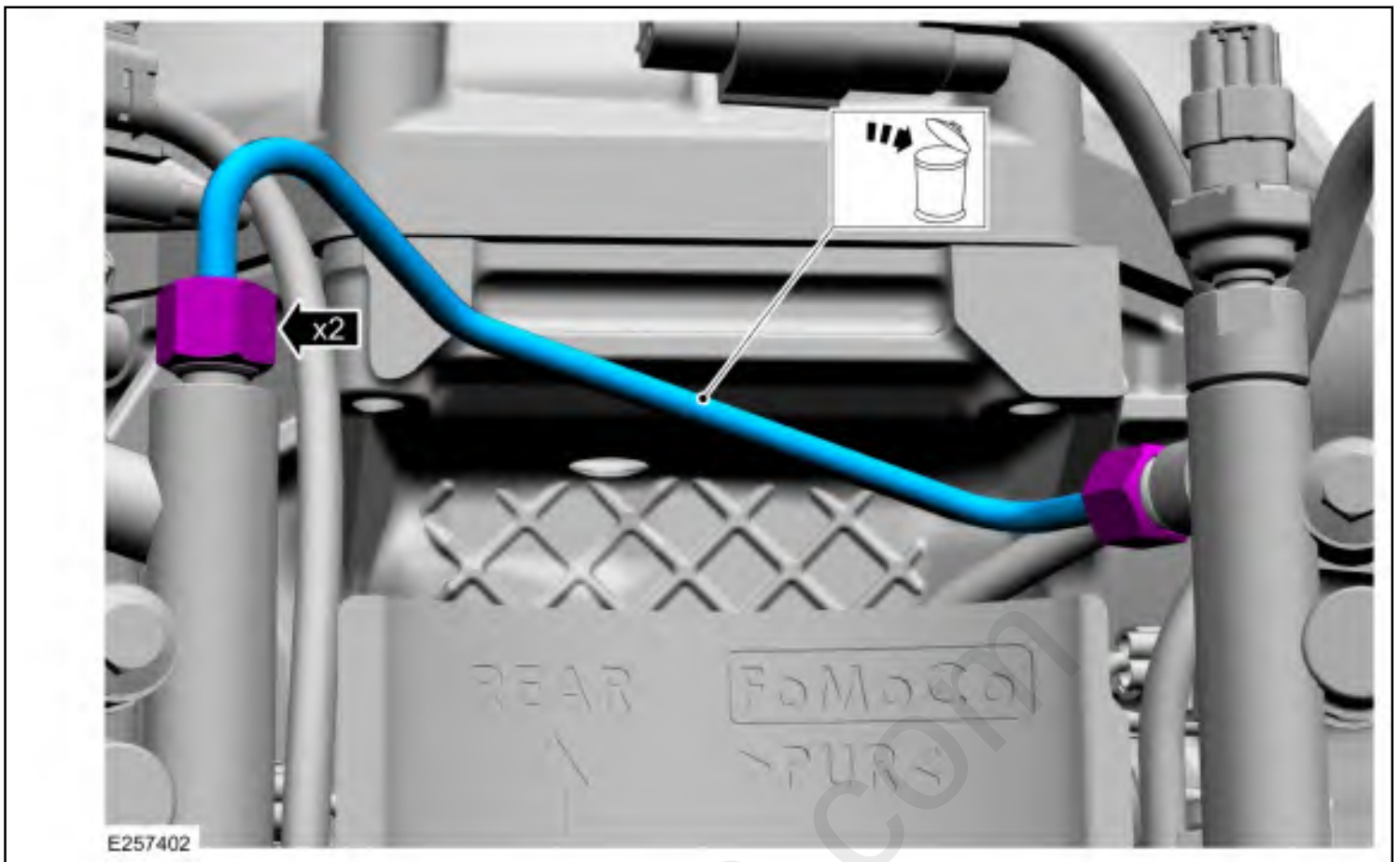
7. **NOTICE:** To release the fuel pressure in the high-pressure fuel tube, wrap the high-pressure fuel tube flare nuts with a shop towel to absorb any residual fuel pressure during the loosening of the high-pressure fuel tube flare nuts.

Remove the high-pressure fuel tube retainers. Disconnect the high-pressure fuel tube flare nuts, then remove and discard the high-pressure fuel tube.

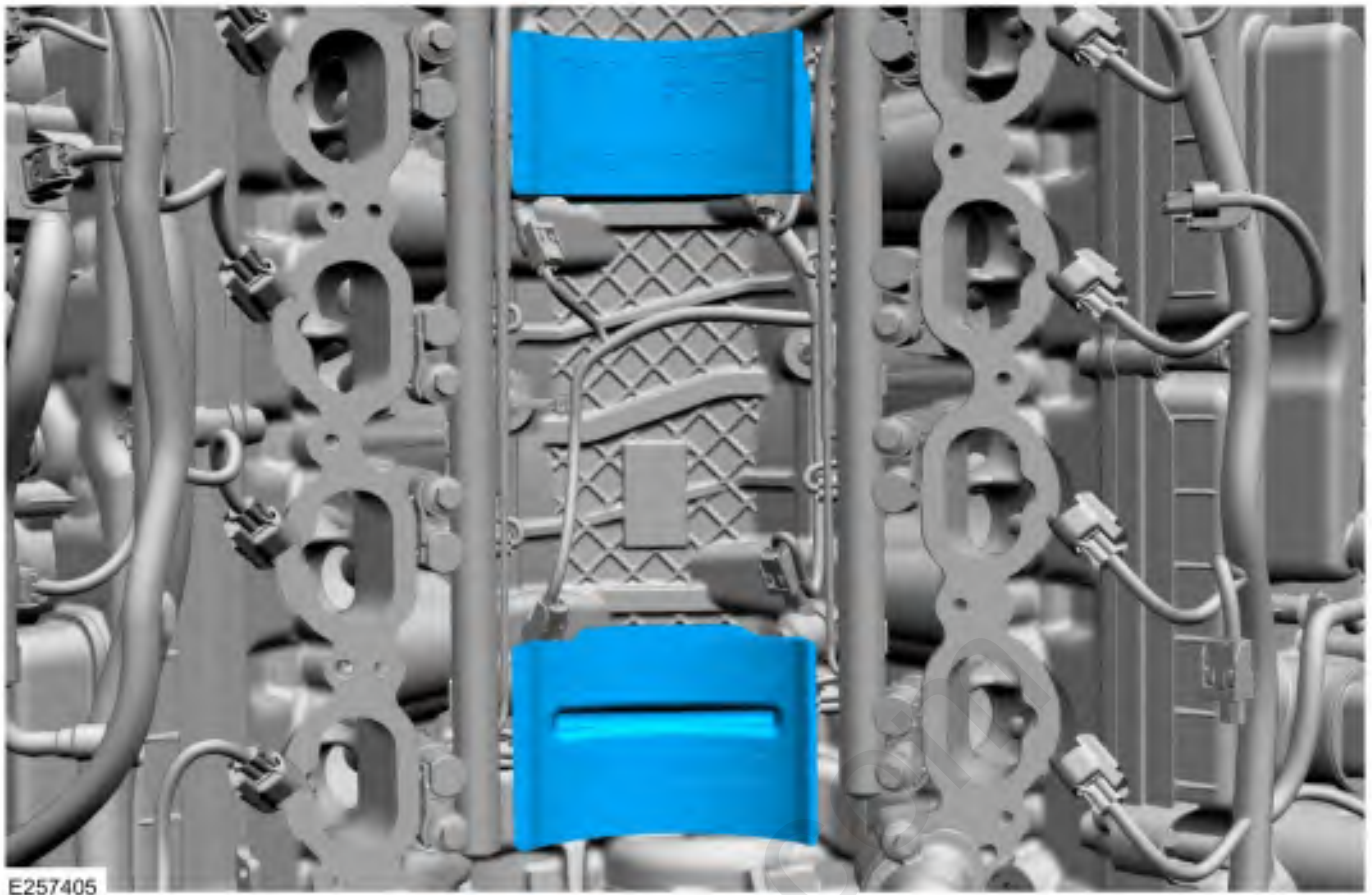


8. Disconnect the high-pressure fuel tube flare nuts, then remove and discard the high-pressure fuel tube.

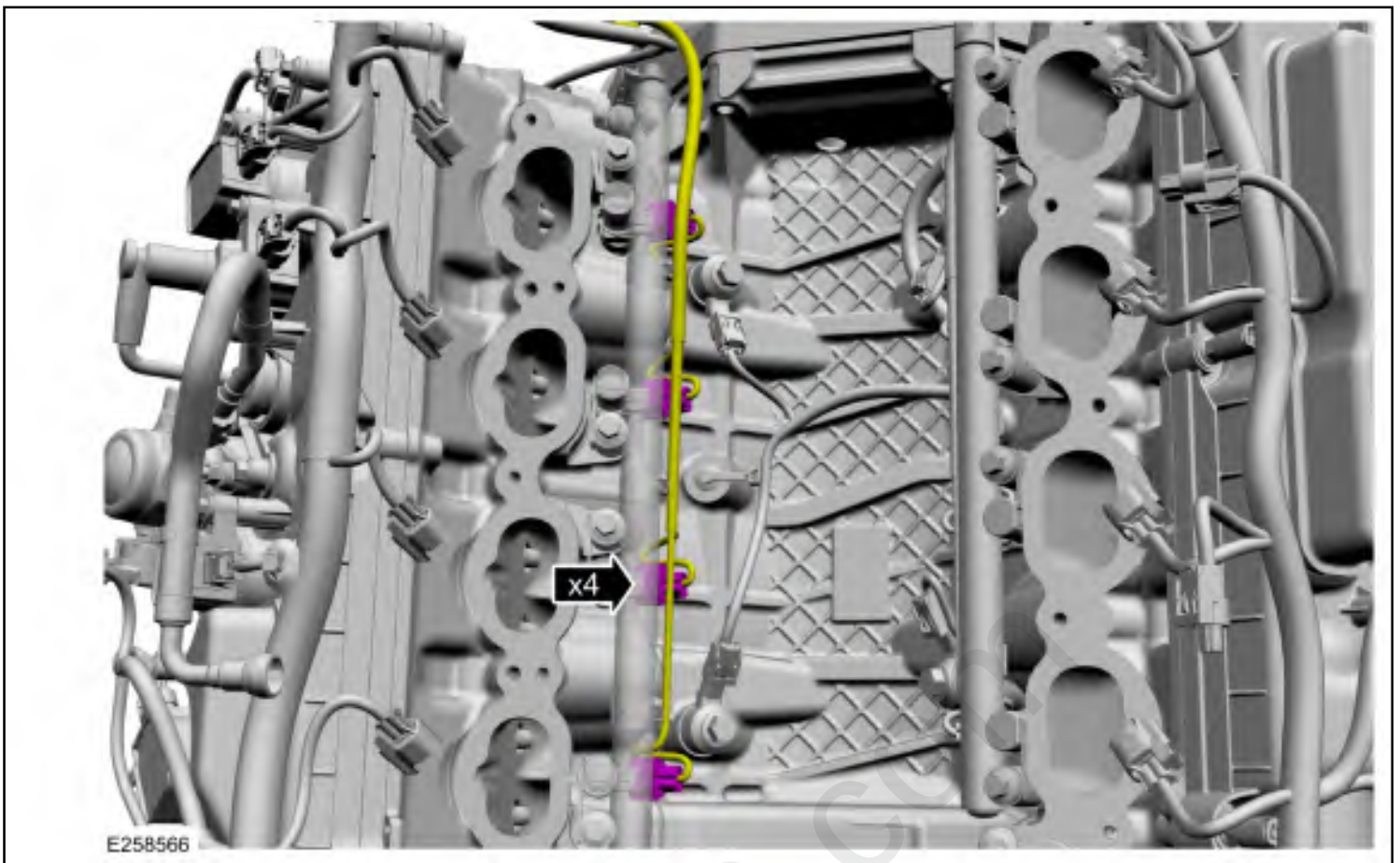




9. Remove the insulators.



10. Disconnect the fuel injector electrical connectors.



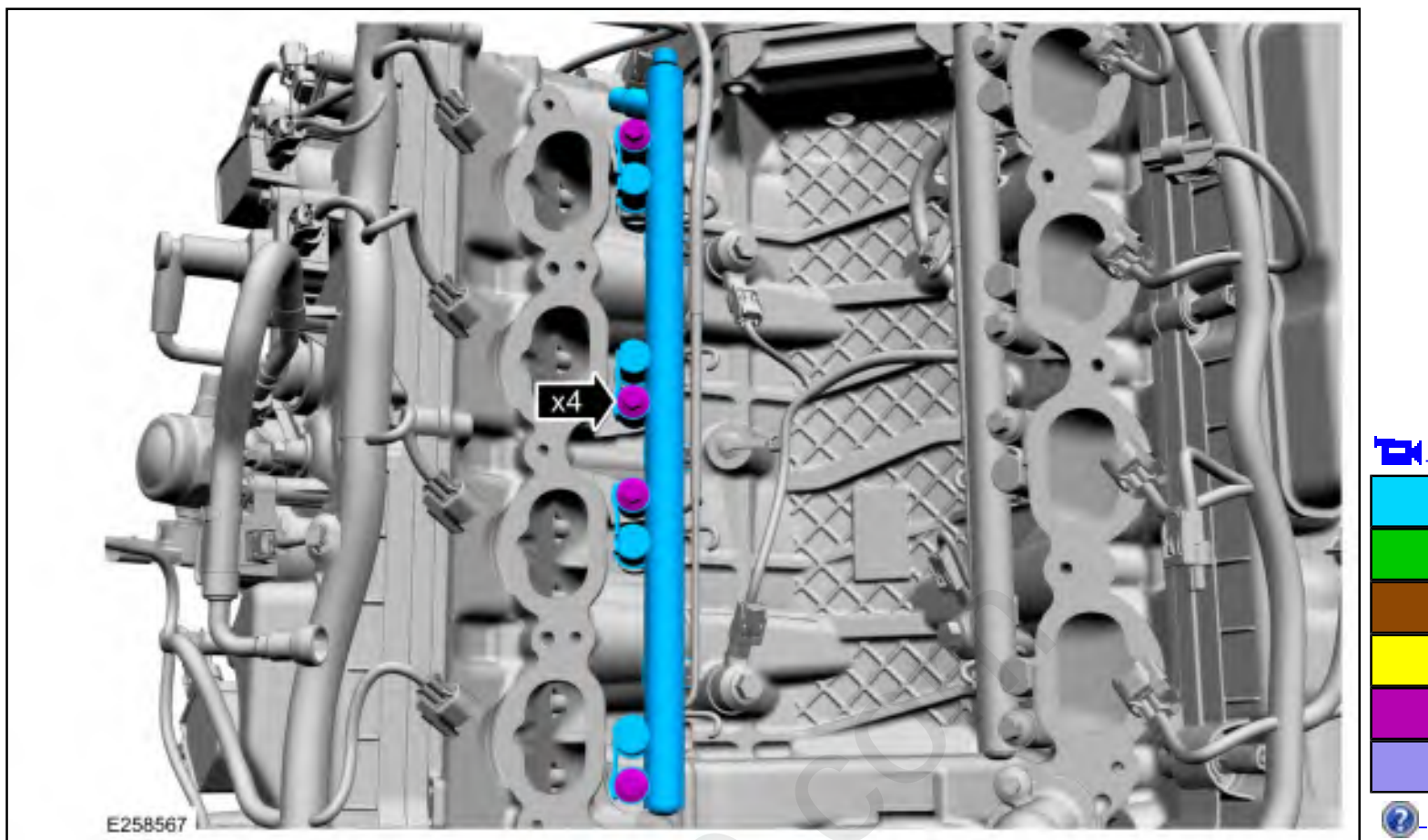
11. **NOTICE:** Pull out the fuel rails in the direction of the fuel injector axis or damage may occur to the fuel injectors.

**NOTE:** Use compressed air and remove any dirt or foreign material from the cylinder head, block and general surrounding area of the fuel rail and injectors.

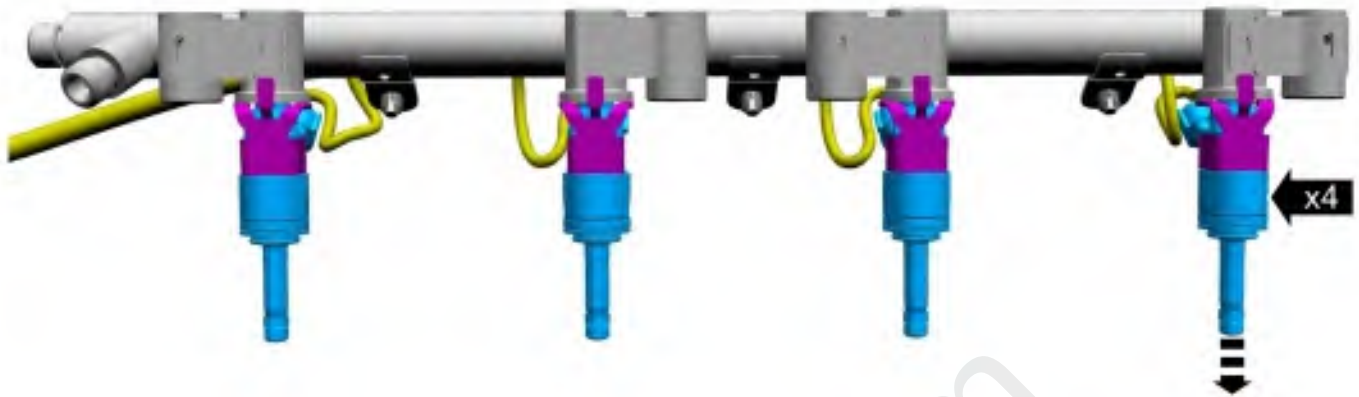
**NOTE:** When removing the fuel rails, the fuel injectors may remain in the cylinder heads and require the use of a Fuel Injector Remover tool to extract. Wiggling the injector by hand to break it loose may allow the injector to be removed by hand.

**NOTE:** Should any of the fuel injectors remain in the head, then the fuel injector electrical connectors will need to be disconnected as the fuel rail is being removed.

Remove the fuel rail bolts, then remove the fuel rail.



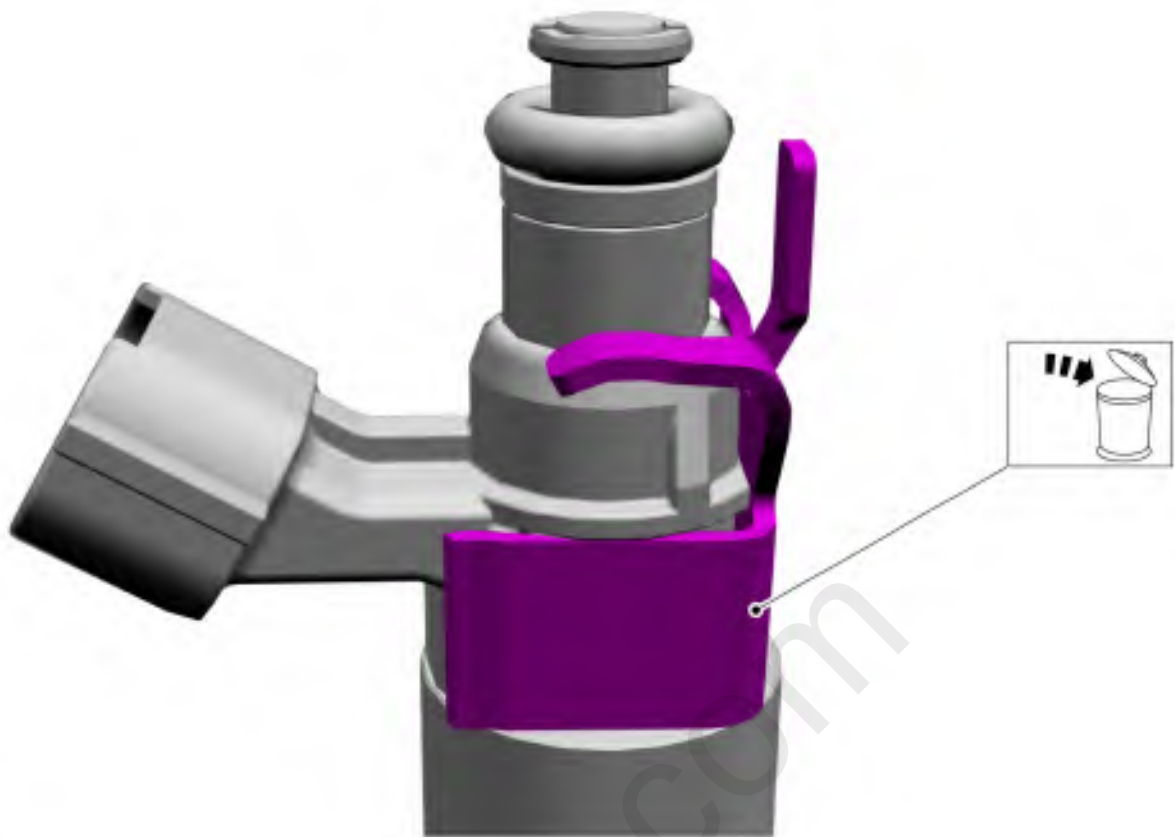
12. Remove the fuel injectors from the fuel rail.



E258569

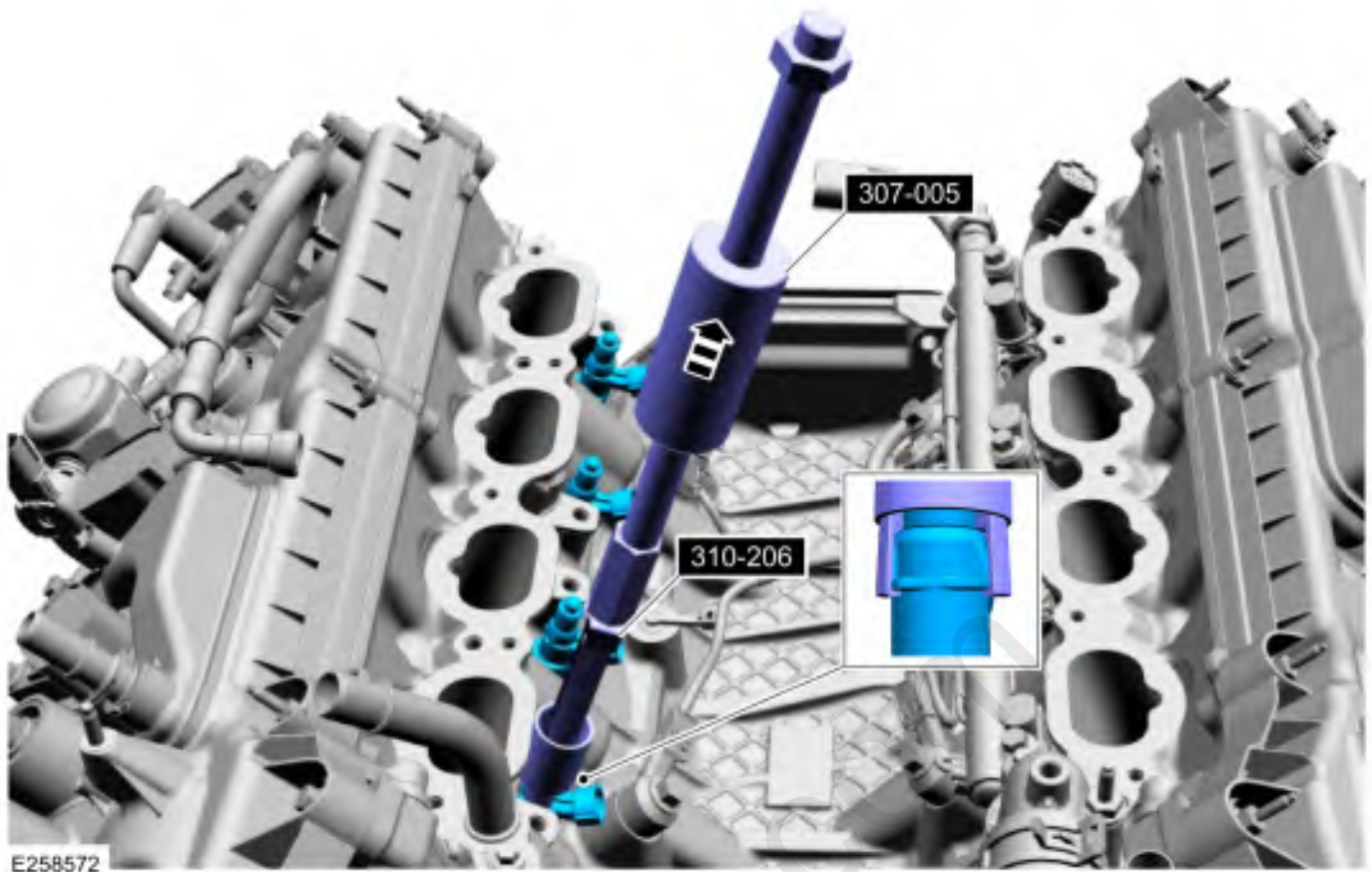
13. Remove and discard the fuel injector clips.





14. **NOTICE:** Use minimal force to remove the fuel injectors that remained in the cylinder head with the Fuel Injector Remover tool or damage to the fuel injector assembly may occur. Wiggling the injector by hand to break it loose may allow the injector to be removed by hand.

Using the special tools, remove any of the fuel injectors that remained in the cylinder head.  
Use Special Service Tool: 307-005 (T59L-100-B) Slide Hammer. , 310-206 Remover, Fuel Injector.

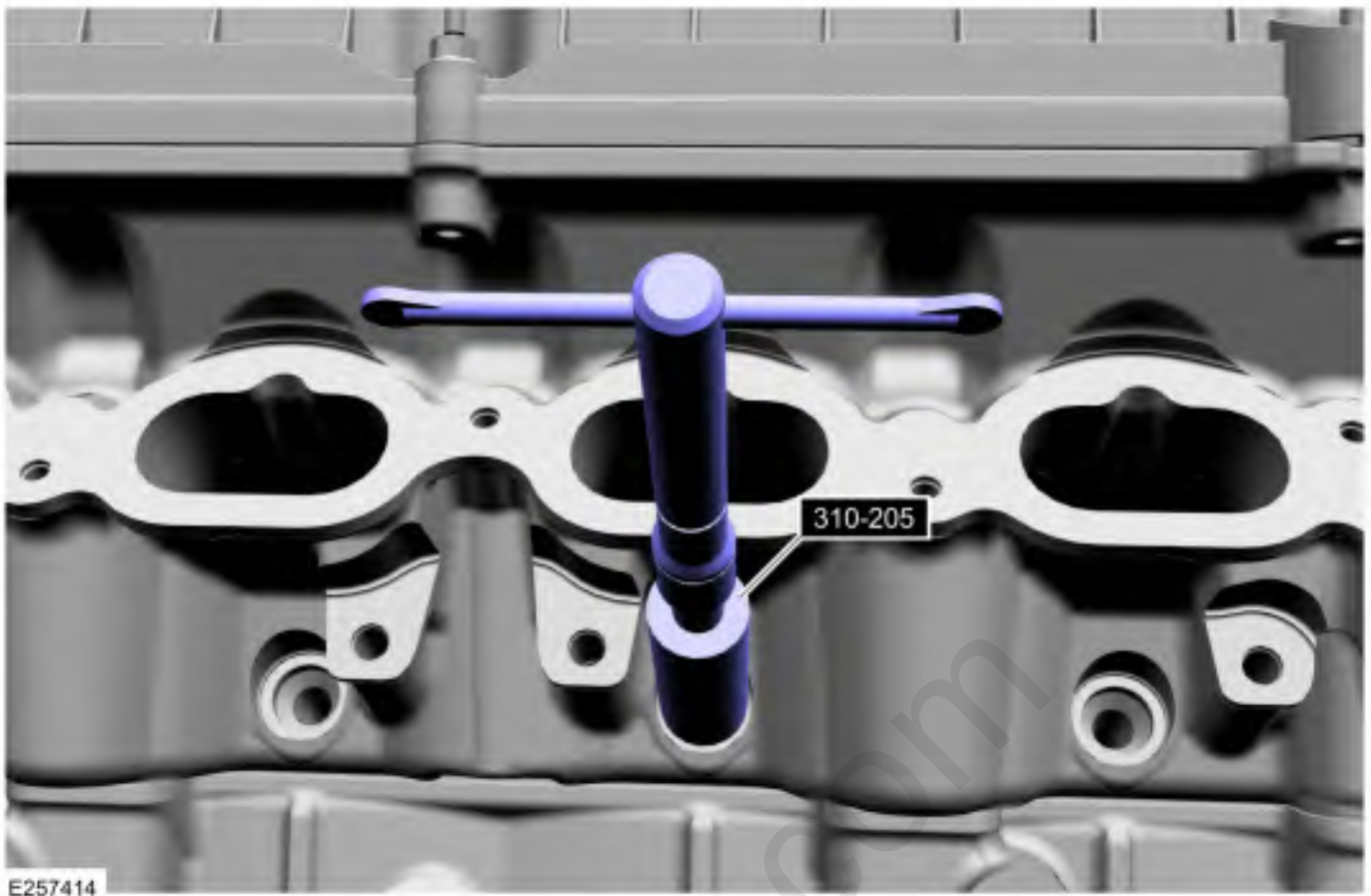


15. **NOTICE:** Make sure to thoroughly clean any residual fuel or foreign material from the cylinder head, block and the general surrounding area of the fuel rails and injectors.

**NOTICE:** Do not use compressed air to clean the tip of the fuel injector.

**NOTICE:** Do not use a brush to clean the tip of the fuel injector.

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

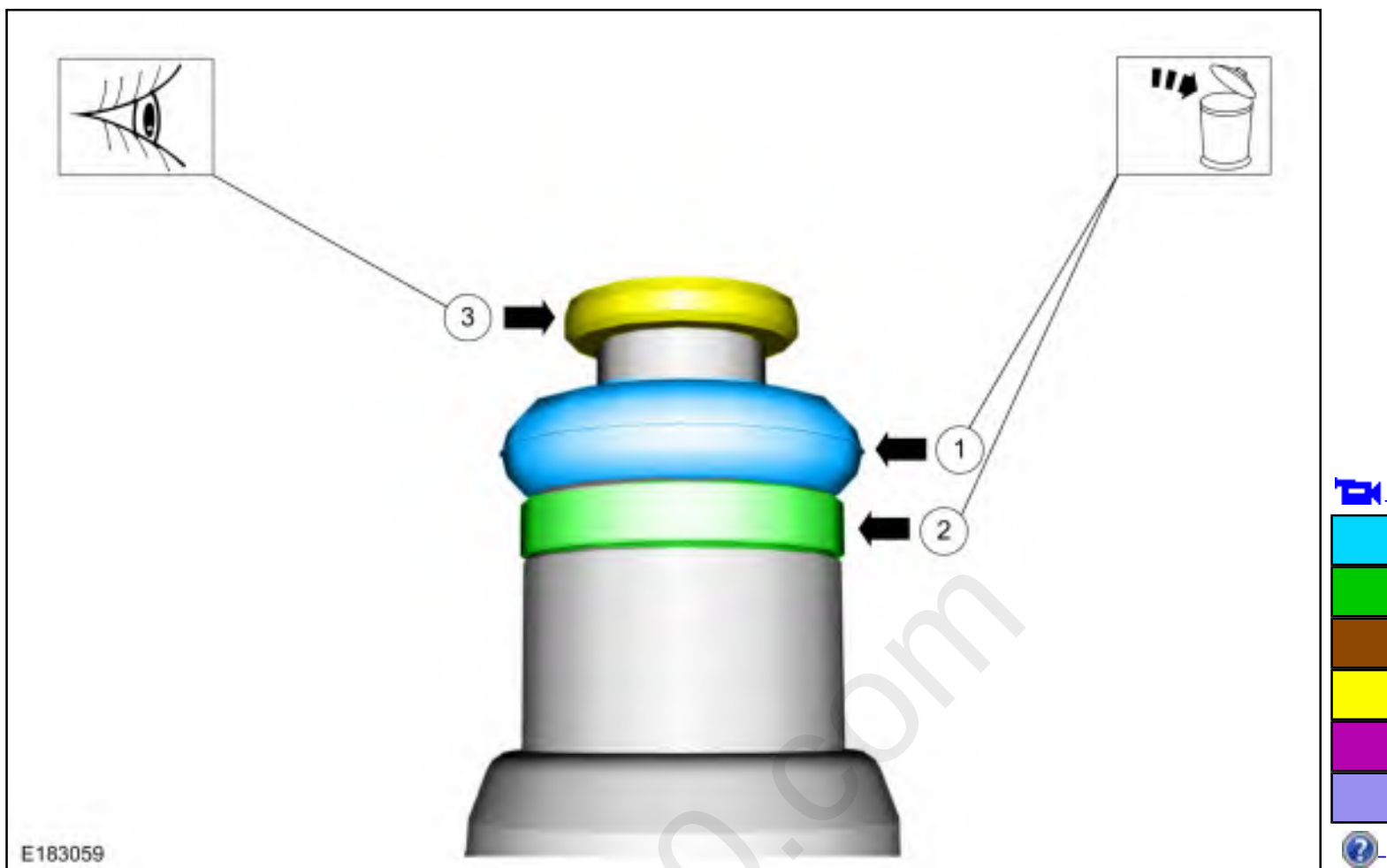


## Installation

1. Remove and discard the fuel injector O-ring seals.
2. **NOTE:** *Note the correct orientation of the fuel injector support rings for correct installation of the NEW fuel injector support rings.*

Remove and discard the fuel injector support rings.

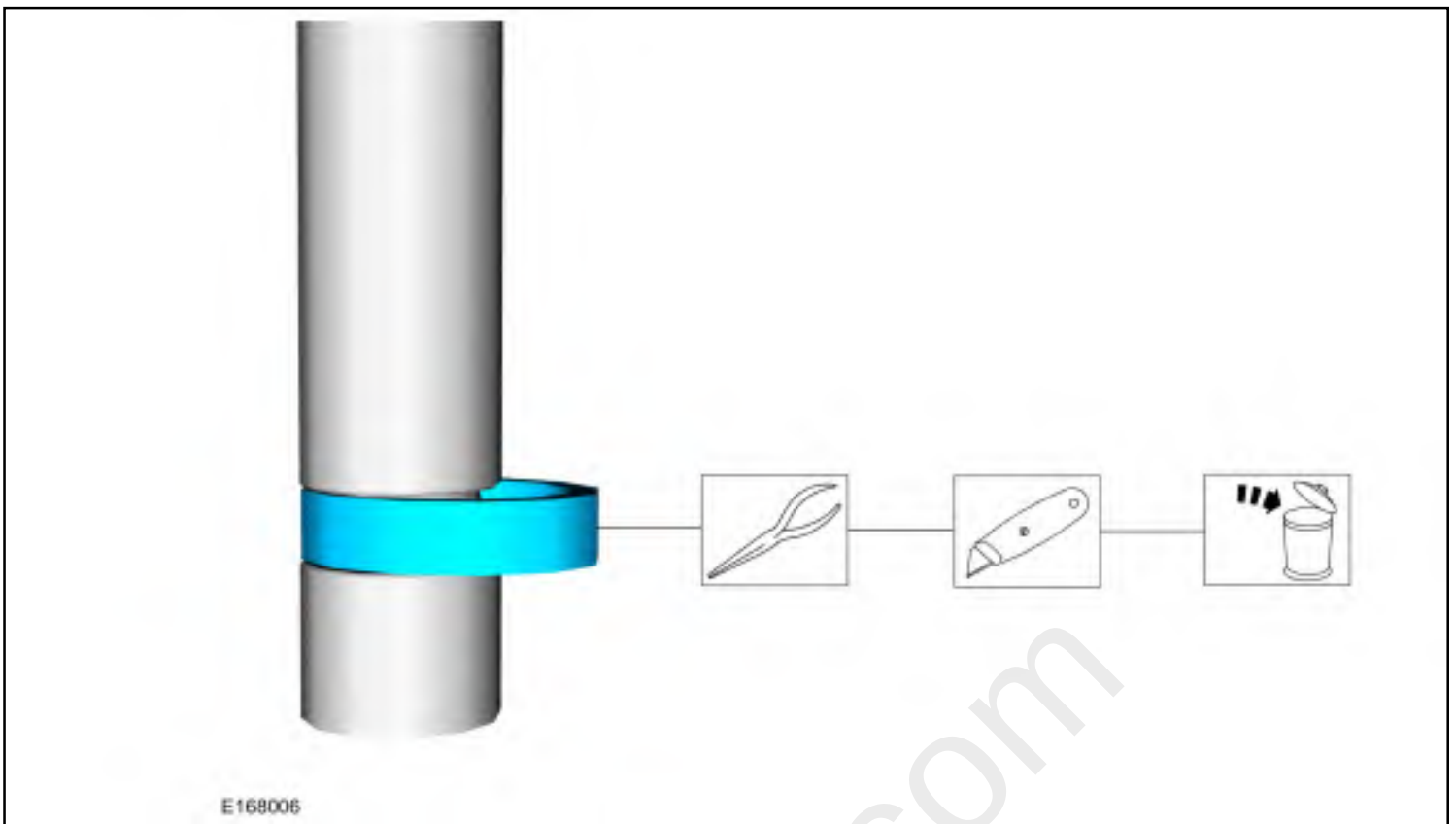
3. Inspect the inlet stopper, if it is damaged or comes off then discard the inlet stopper. The inlet stopper is not needed for proper function. Ensure that any debris from the inlet stopper are removed. If the inlet stopper is intact and undamaged do not remove the inlet stopper from the fuel injector.



2. **NOTICE:** Use care when removing the lower Teflon® seals, not to scratch, nick or gouge the fuel injector.

**NOTICE:** Do not attempt to cut the lower Teflon® seal without first pulling it away from the fuel injector or damage to the injector may occur.

1. Pull the lower Teflon® seal away from the injector.
2. Carefully cut and discard the lower fuel injector Teflon® seal.



3. **NOTICE: Do not lubricate the NEW lower Teflon® fuel injector seals.**

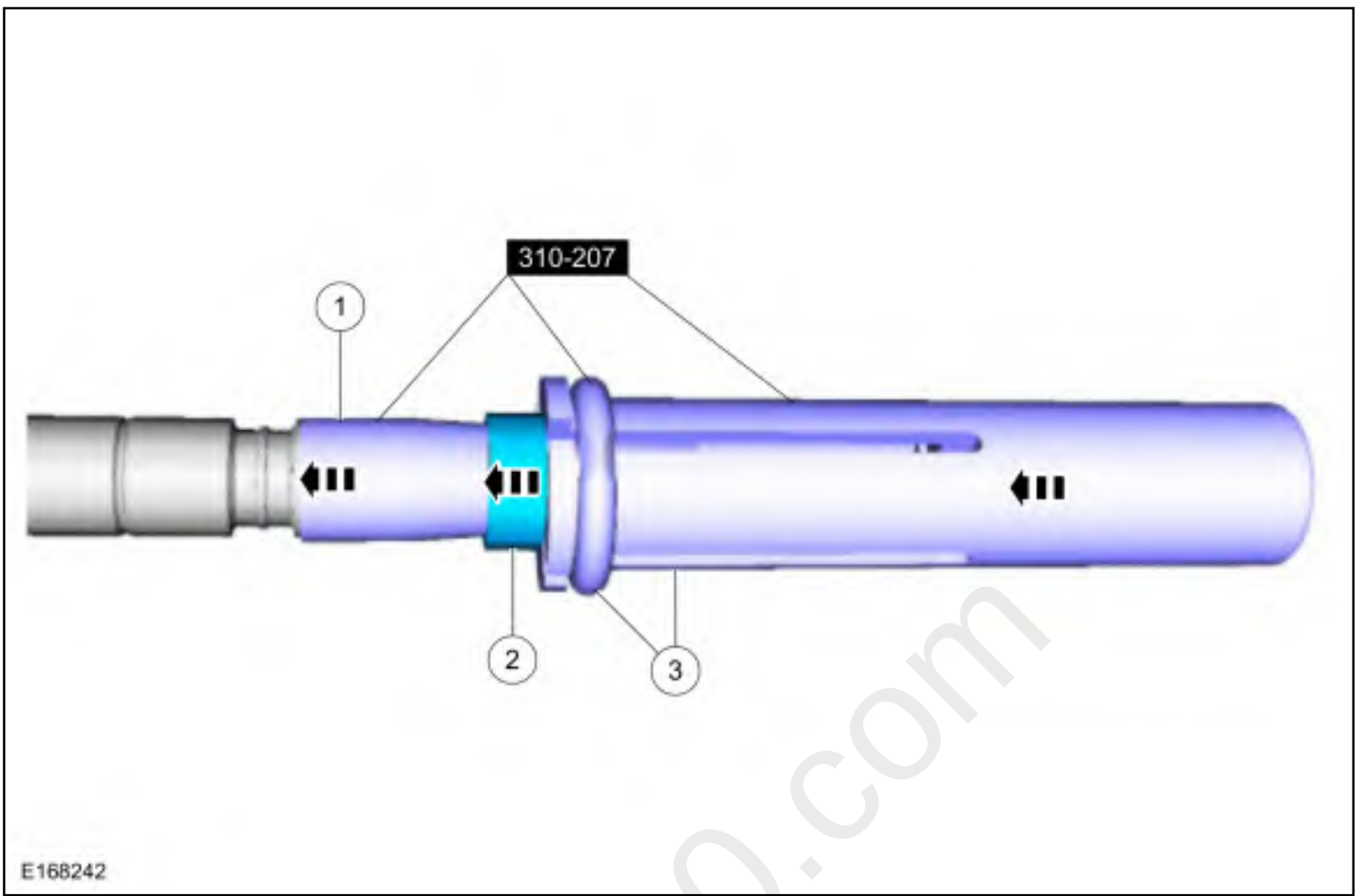
1. Install the Teflon® Seal Guide onto the fuel injector tip.  
Use Special Service Tool: 310-207 Installer, Fuel Injector Seal Assembly.
2. **NOTICE: Once the Teflon® seal is installed on the Teflon® Seal Guide, it should immediately be installed onto the fuel injector to avoid excessive expansion of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

**NOTE:** Make sure that NEW lower fuel injector Teflon® seals are installed.

Install the NEW Teflon® seals onto the Teflon® Seal Guide, using the Pusher Tool, slide the Teflon® seals along the Teflon® Seal Guide.

3. Using the Pusher Tool, slide the Teflon® seals off of the Teflon® Seal Guide and into the groove on the fuel injectors.  
Use Special Service Tool: 310-207 Installer, Fuel Injector Seal Assembly.
4. Remove the special tools.





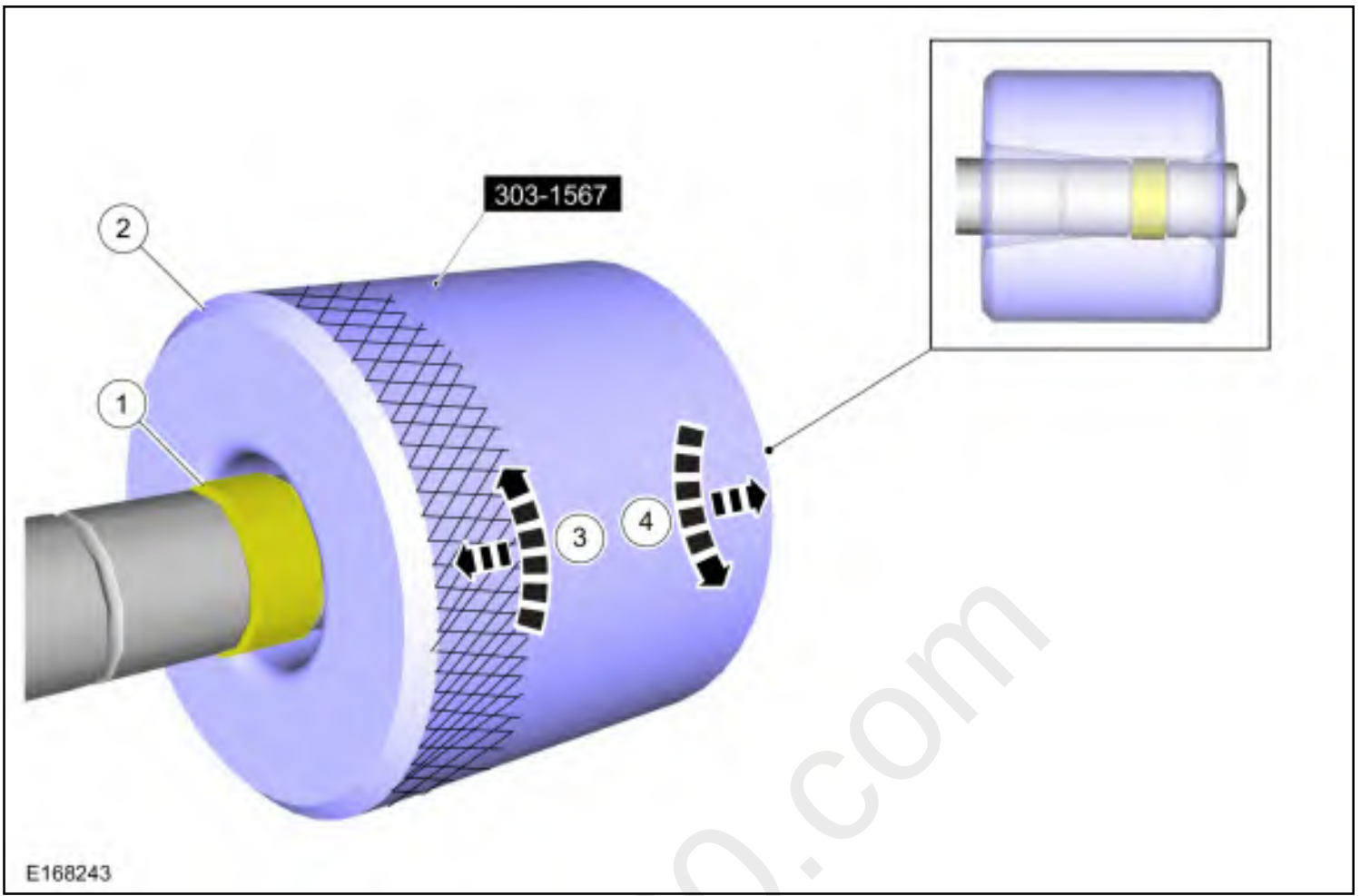
4. **NOTE:** Make sure the Teflon® seal is fully seated in the groove on the fuel injector before sizing the Teflon® seal.

1. Massage and warm the Teflon® seal with your fingers before the Teflon® seal sizer tool is installed. This will aid in installing the Teflon® seal sizer tool.
2. **NOTE:** The beveled opening of the Teflon® seal sizer tool goes away from the seal.

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 Teflon® seal sizer tool is installed, check and make sure the Teflon® seal is in the sizing portion of the Teflon® seal sizer tool.
4. After one minute, turn the Teflon® seal sizer tool back 180 degrees and remove.

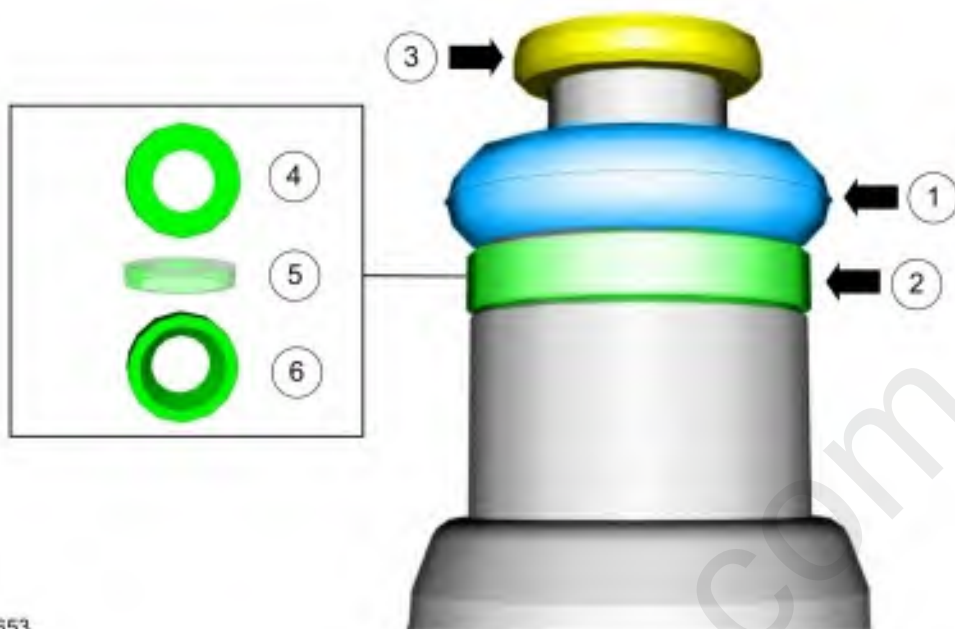


5. **NOTE:** Make sure that *NEW* fuel injector support rings and *NEW* fuel injector O-ring seals are installed.

1. Install the new fuel injector O-rings. The O-rings are pre-lubricated, NO ADDITIONAL lubricant is required.
2. **NOTICE:** The *NEW* the fuel injector support rings must be installed in the correct orientation with the wide surface area facing up against the fuel injector O-ring seals. Improperly installed support rings may cause the fuel system to leak.

Install the *NEW* the fuel injector support rings.

3. Inspect the inlet stopper, if it is damaged or comes off then discard the inlet stopper. The inlet stopper is not needed for proper function. Ensure that any debris from the inlet stopper are removed. If the inlet stopper is intact and undamaged do not remove the inlet stopper from the fuel injector.
4. The upper side of the support ring has the wide surface area.
5. Fuel injector support ring.
6. The lower side of the support ring has the narrow surface area.

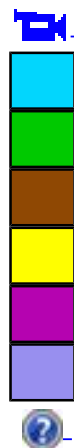


E199653

6. Install the NEW fuel injector clips.

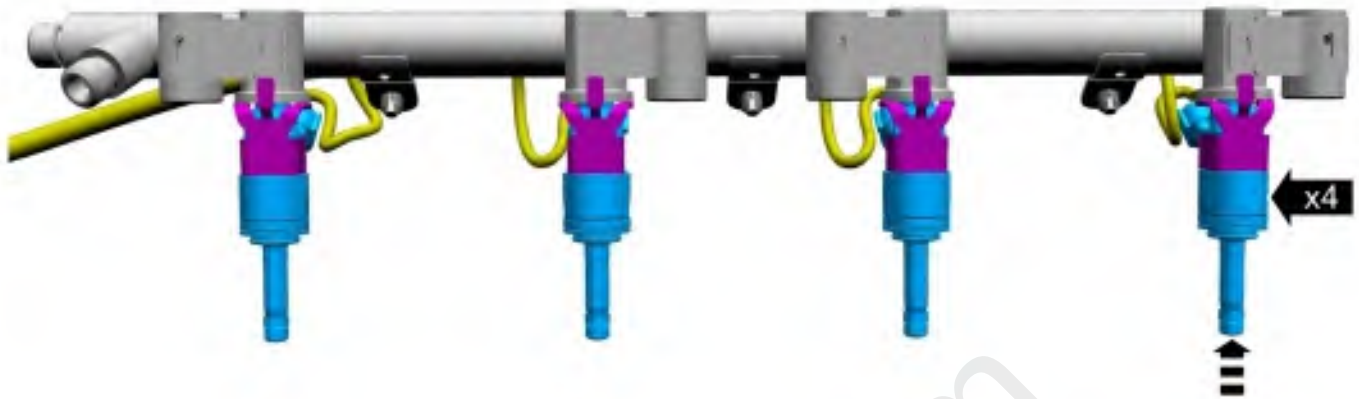


E257412



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

Install the fuel injectors to the fuel rail and then connect the fuel injector electrical connectors.

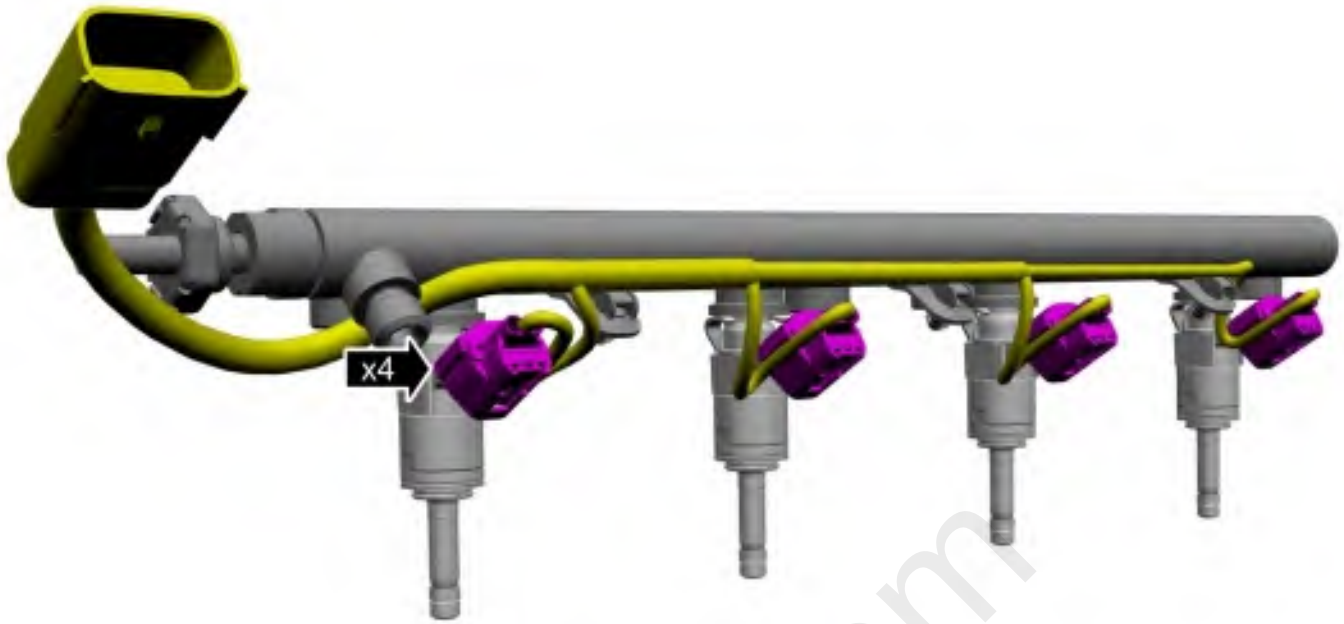


E258570



8. Connect the fuel injector electrical connectors.





E257411

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

Install the fuel rail, push down on the fuel rail above the injectors.

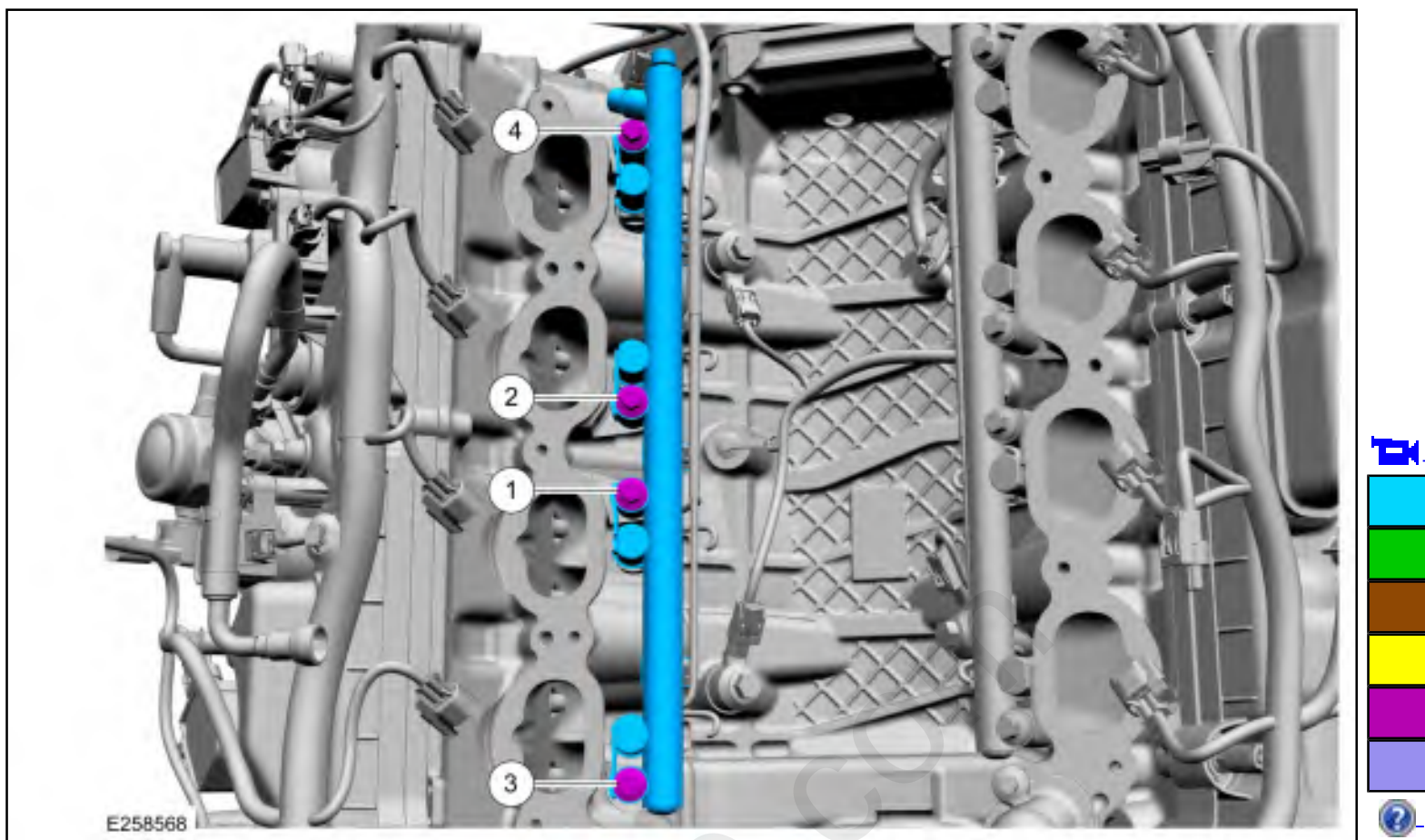
- Hand start all of the fuel rail bolts and finger tighten the fuel rail bolts so they are uniformly in light contact with fuel rail bosses.
- Tighten the fuel rail bolts approximately 90 degrees, in the sequence shown. Repeat to evenly draw down the fuel rail, until the fuel rail bosses are in contact with the cylinder head.

*Torque:*

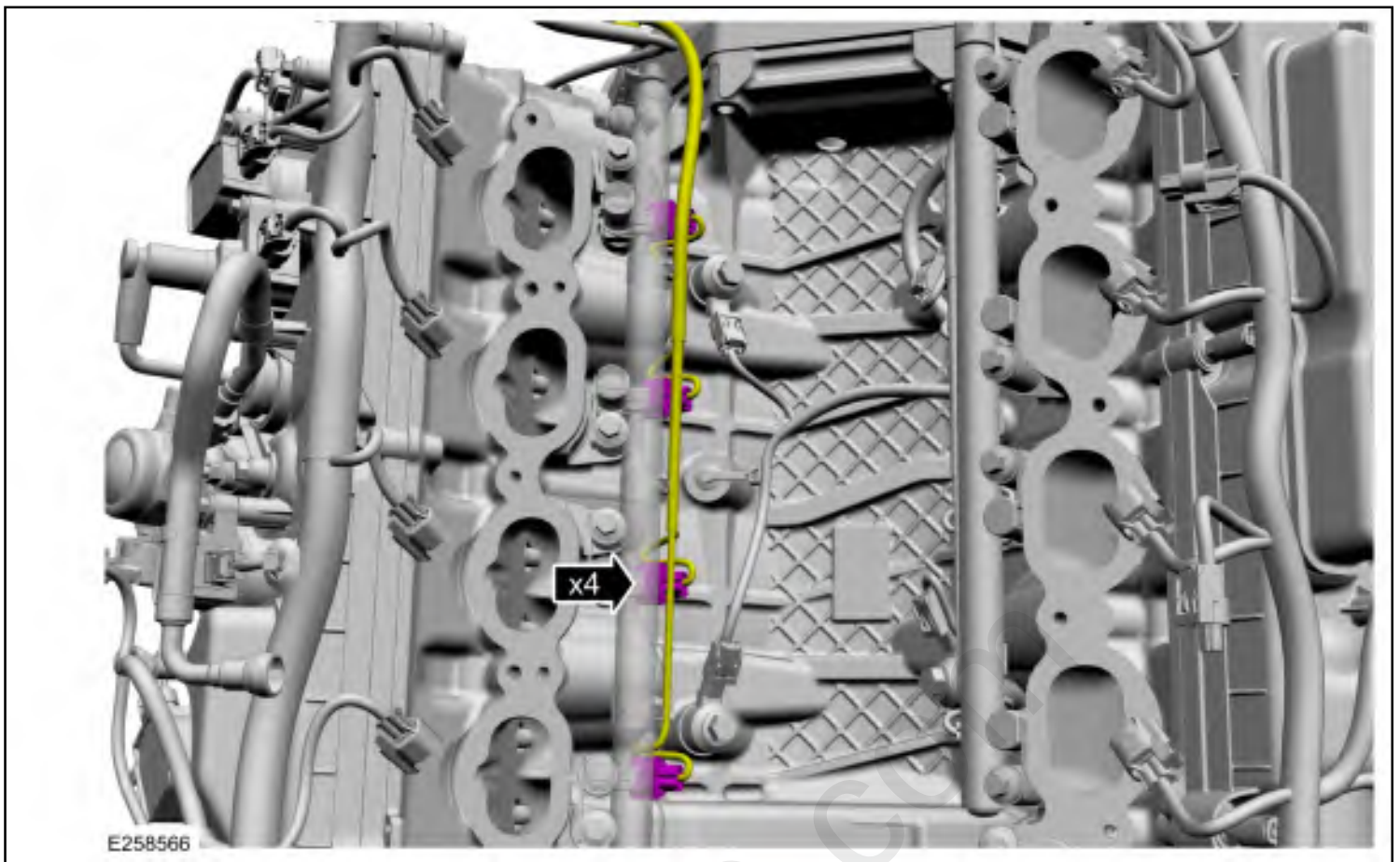
Stage 1: Tighten the fuel rail bolts in the sequence shown to : 89 lb.in (10 Nm)

Stage 2: Tighten the fuel rail bolts in the sequence shown to : 21 lb.ft (28 Nm)

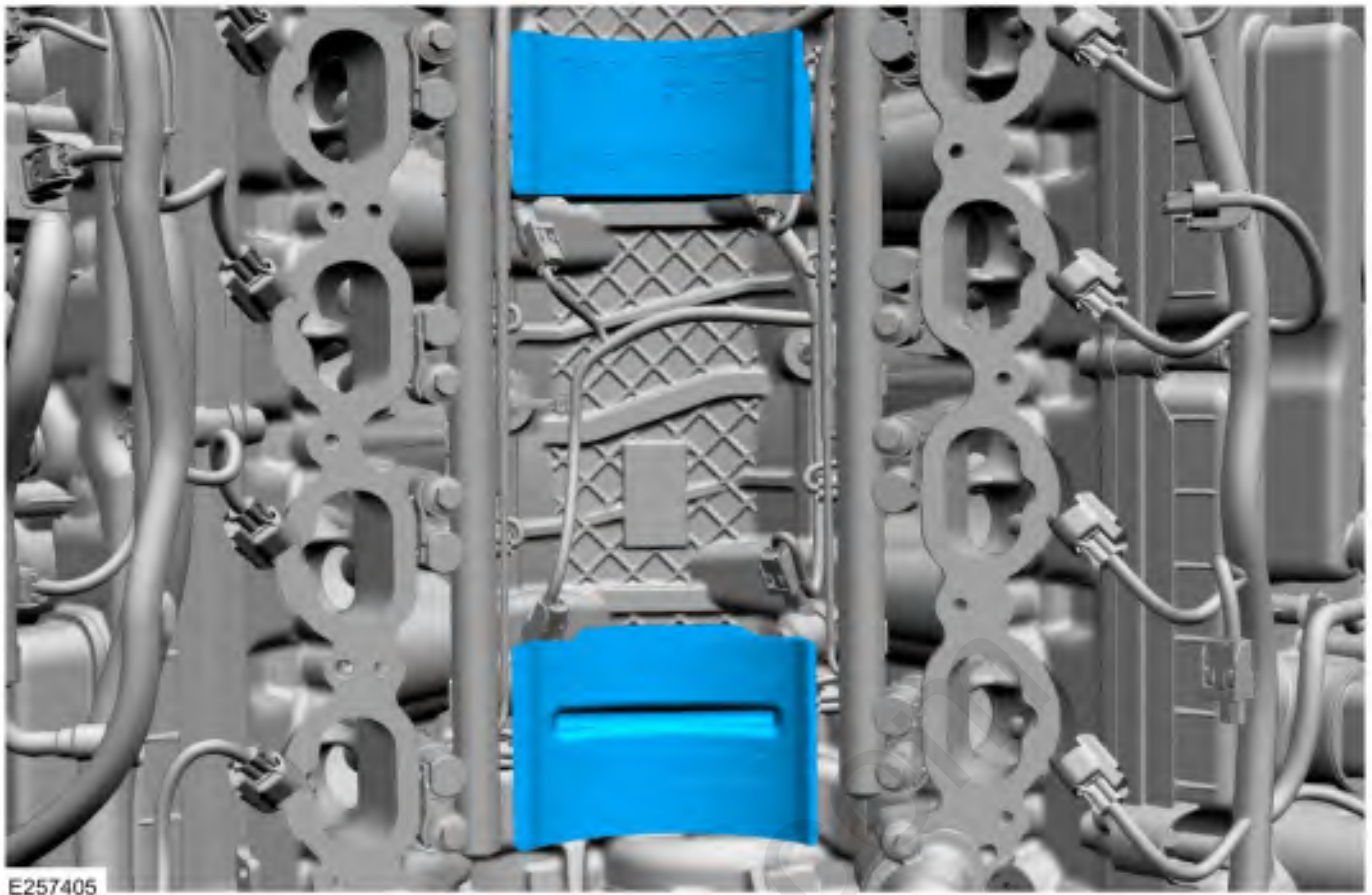
Stage 3: Tighten the fuel rail bolts in the sequence shown an additional : 25°



10. Connect the fuel injector electrical connectors.



11. Install the insulators.



12. **NOTICE:** In stage 3, if the torque required to tighten any flare nut on the new high-pressure fuel tube reaches or exceeds 55 lb.ft (50 Nm), then that high pressure fuel tube must be discarded and replaced with another new high-pressure fuel tube.

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

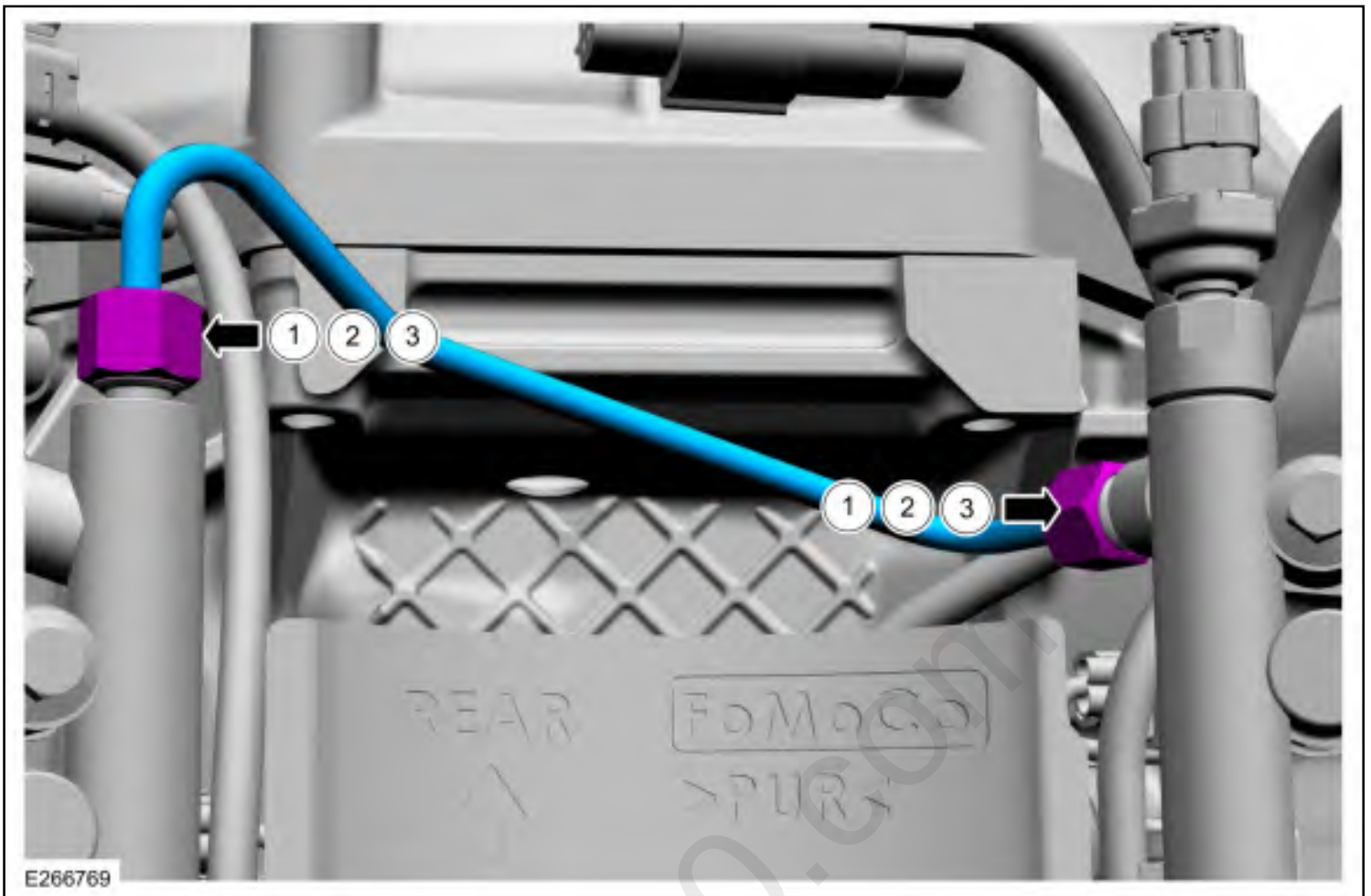
**NOTE:** Calculate the correct torque wrench setting for the following torque using the Torque Wrench Adapter Formulas.

Install the high-pressure fuel tube and tighten the flare nuts finger tight, then tighten the flare nuts in the following 3 stages.

*Torque:*

- Stage 1: Tighten the high-pressure fuel tube flare nuts to : 71 lb.in (8 Nm)
- Stage 2: Tighten the high-pressure fuel tube flare nuts to : 89 lb.in (10 Nm)
- Stage 3: Tighten the high-pressure fuel tube flare nuts an additional : 25°





13. **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.

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

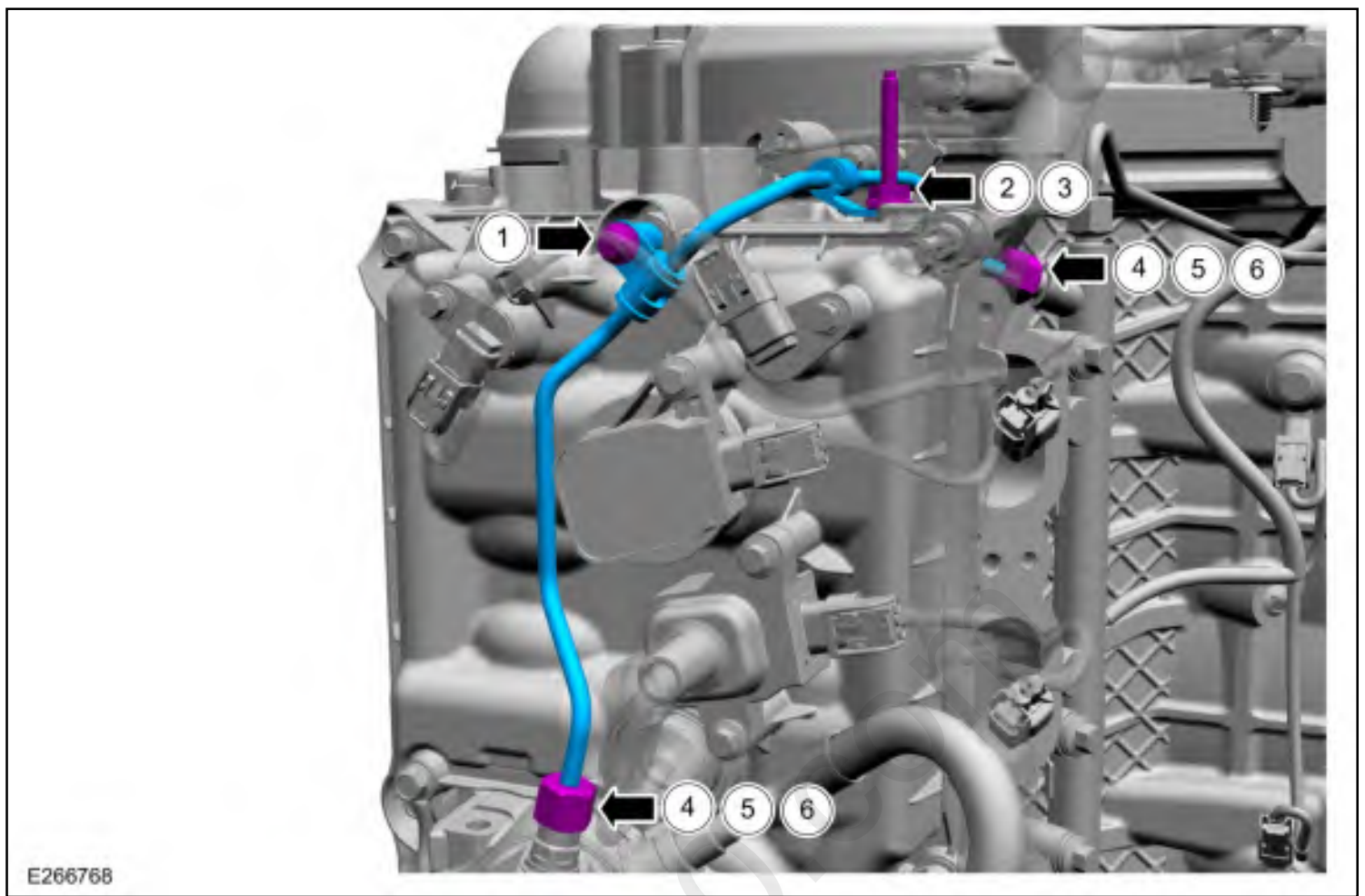
**NOTE:** Make sure that a new high-pressure fuel tube is installed.

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

**Torque:**

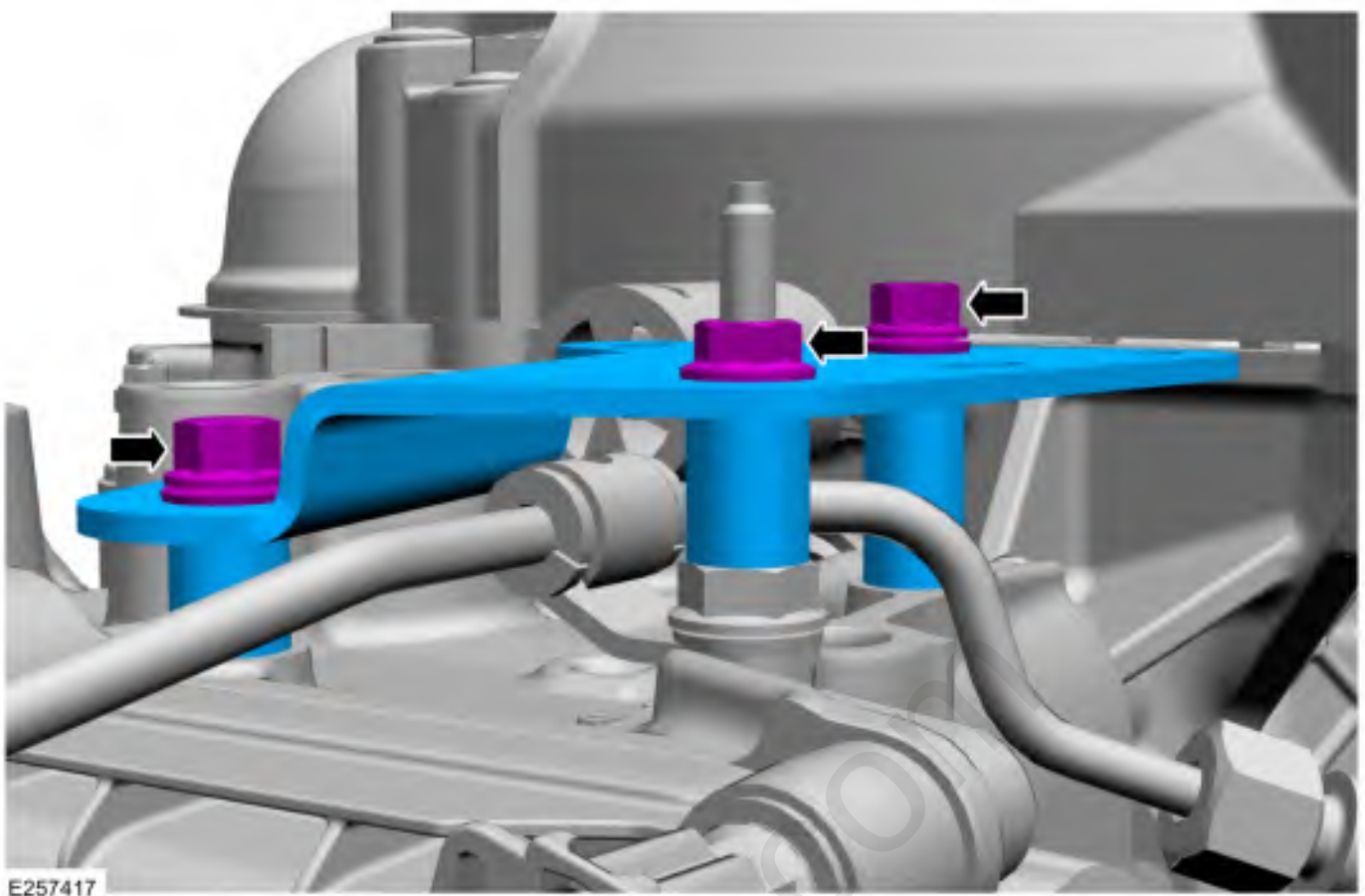
- Stage 1: Tighten the high-pressure fuel tube bolt to : 89 lb.in (10 Nm)
- Stage 2: Tighten the high-pressure fuel tube stud-bolt to : 89 lb.in (10 Nm)
- Stage 3: Tighten the high-pressure fuel tube stud-bolt an additional : 30°
- Stage 4: Tighten the high-pressure fuel tube flare nuts to : 71 lb.in (8 Nm)
- Stage 5: Tighten the high-pressure fuel tube flare nuts to : 89 lb.in (10 Nm)
- Stage 6: Tighten the high-pressure fuel tube flare nuts an additional : 25°



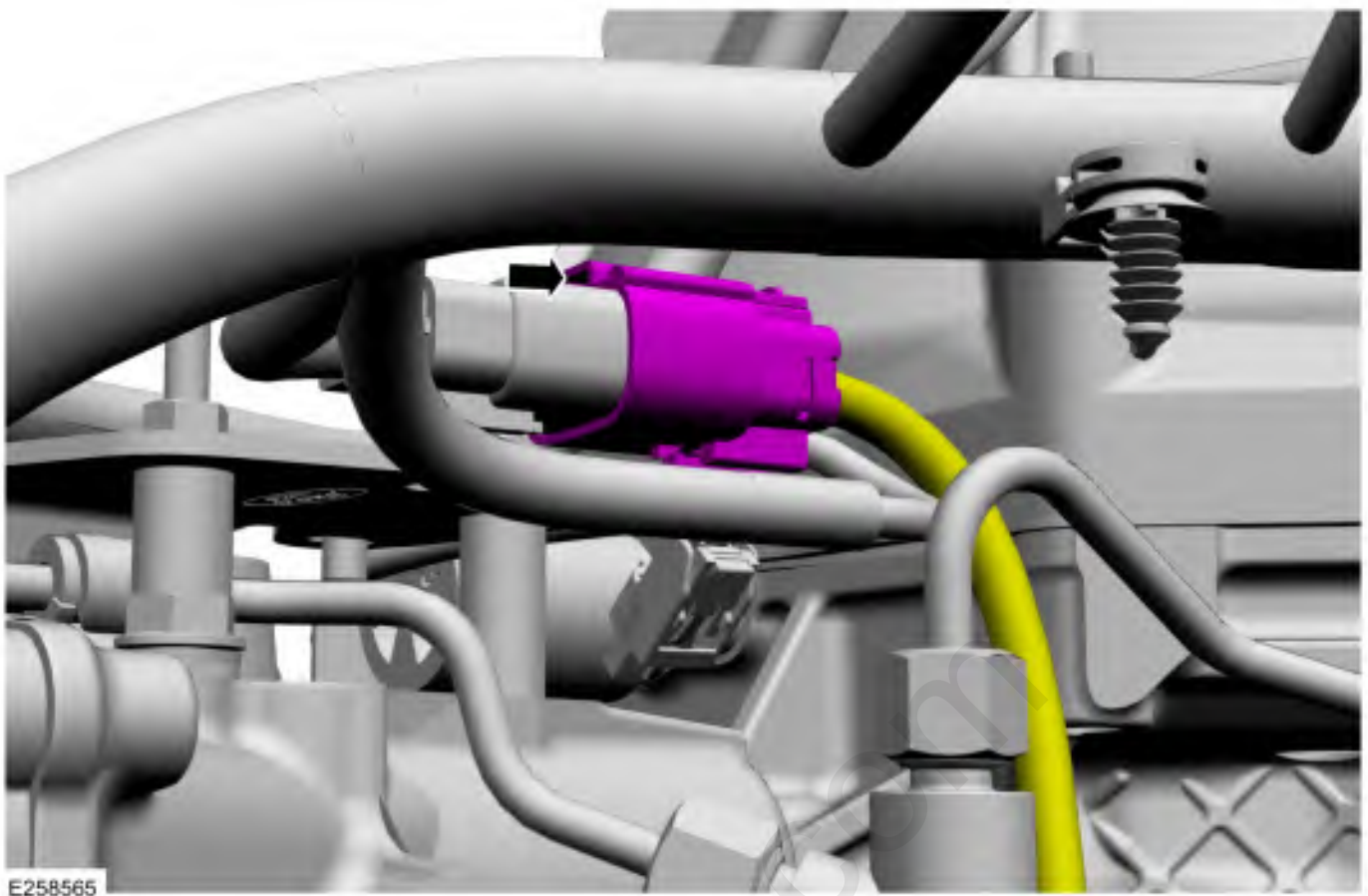


14. Install the high-pressure fuel line shield, then install and tighten the high-pressure fuel line shield retainers.

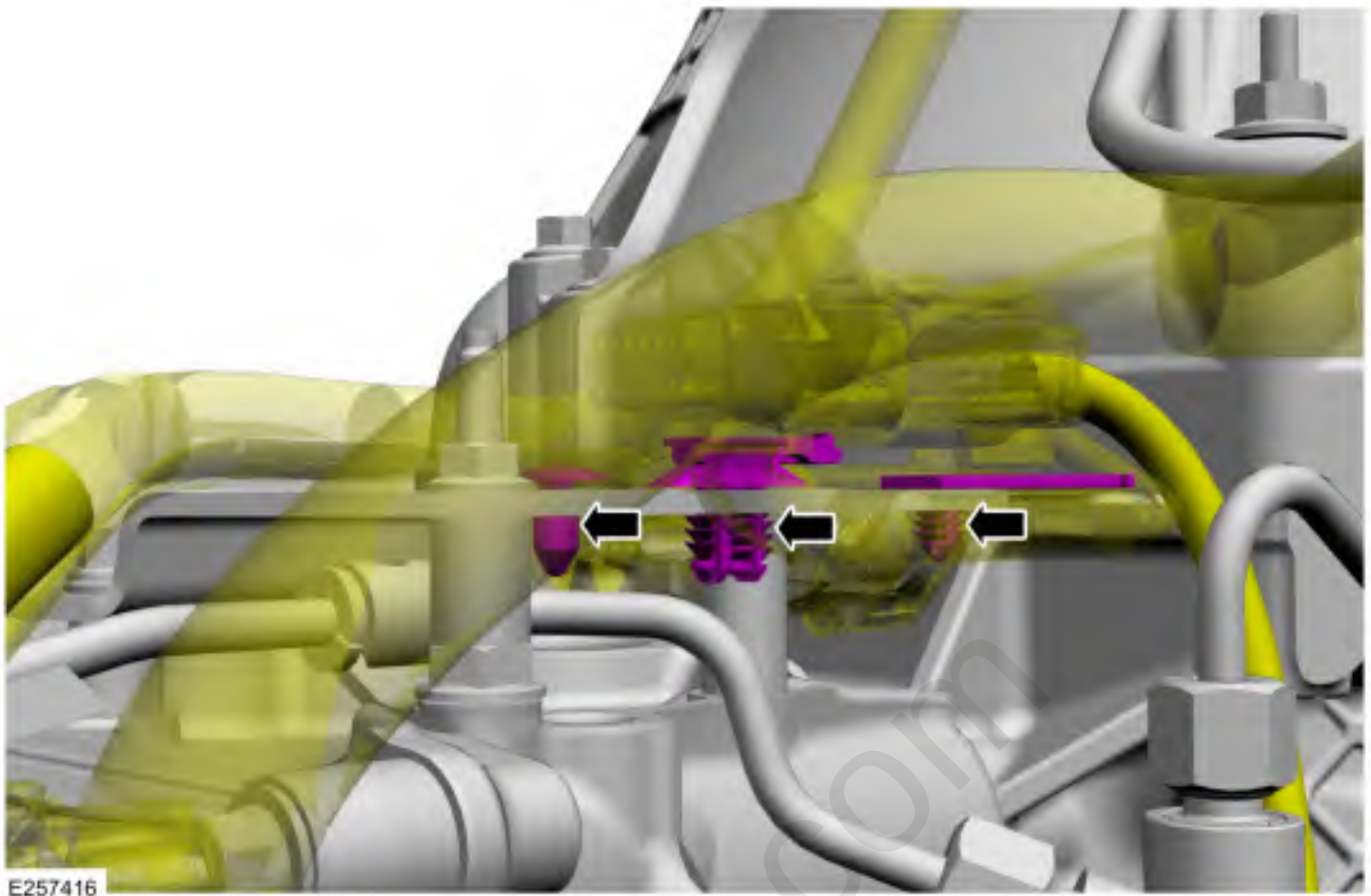
*Torque:* 89 lb.in (10 Nm)



15. Connect the fuel injector main harness electrical connector.

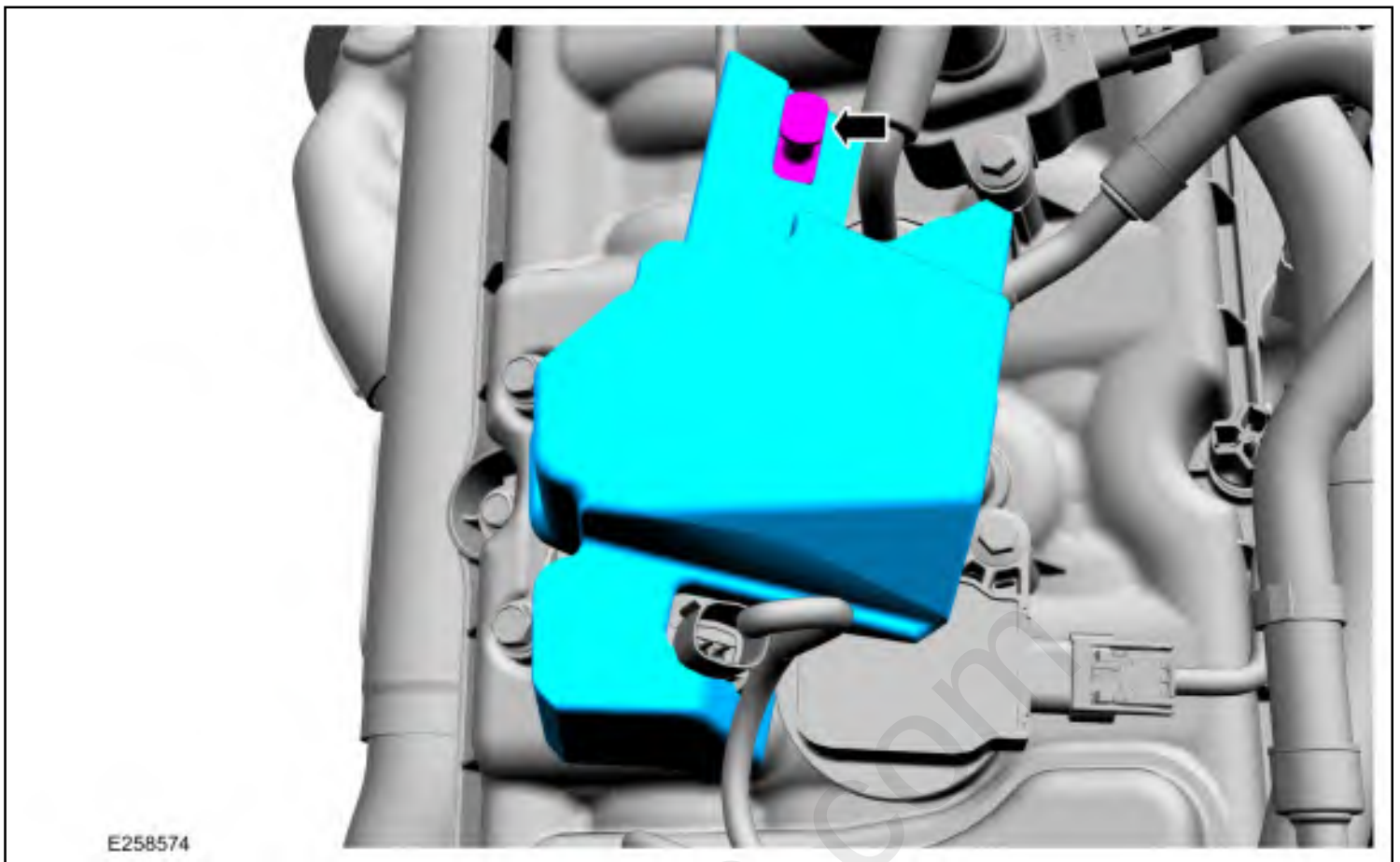


16. Attach the wiring harness retainers to high-pressure fuel line shield.



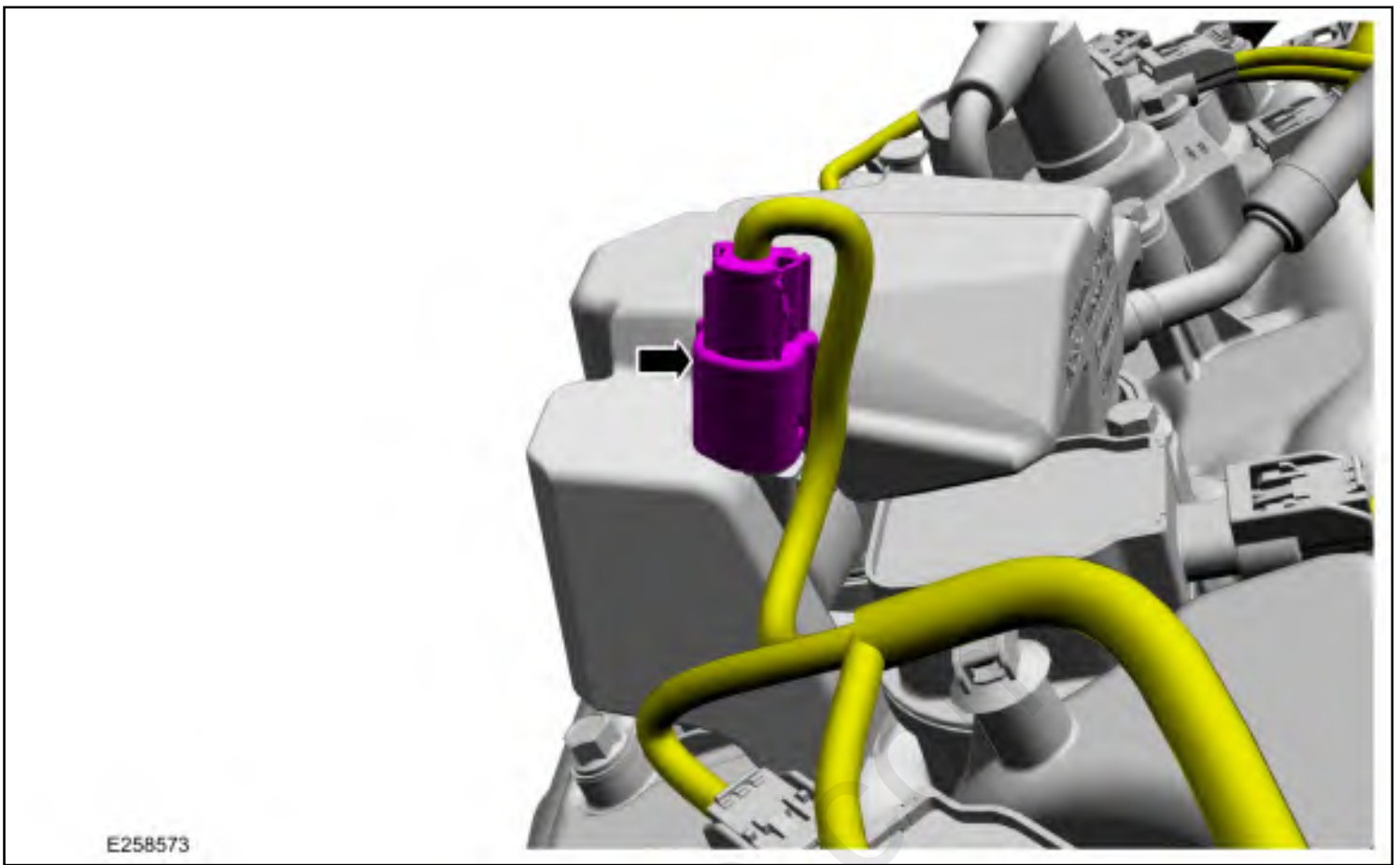
17. **NOTE:** When removing or installing the fuel injection pump noise insulator, spreading the openings will reduce the risk of damage.

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



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

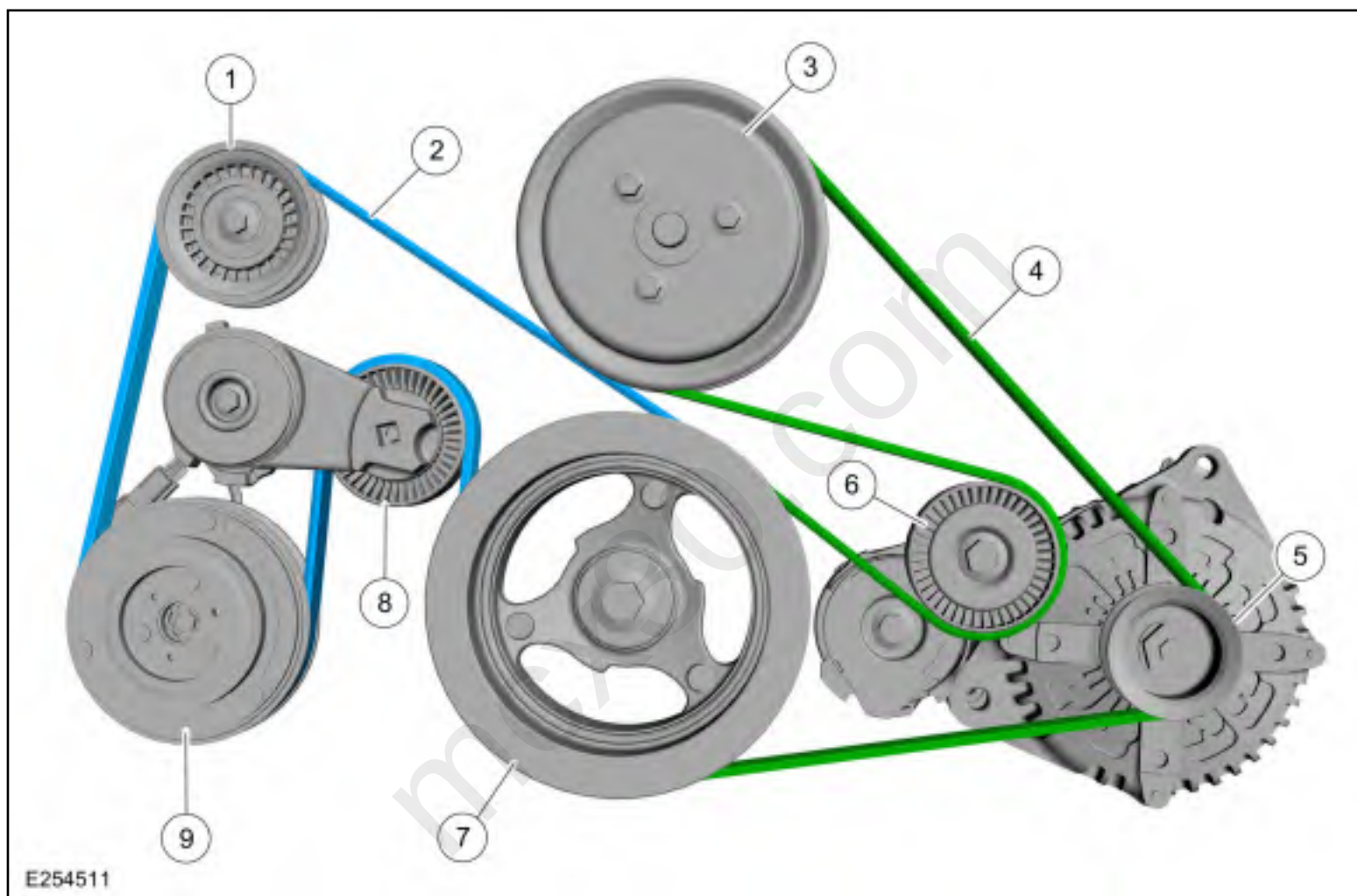




19. Install the intake manifold.

Refer to: [Intake Manifold](#) (303-01D Engine - 5.0L 32V Ti-VCT, Removal and Installation).

## Accessory Drive - Component Location



| Item | Description                      |
|------|----------------------------------|
| 1    | A/C compressor belt idler pulley |
| 2    | Belt - A/C compressor            |
| 3    | Coolant pump pulley              |
| 4    | Accessory drive belt             |
| 5    | Generator pulley                 |
| 6    | Accessory drive belt tensioner   |

|   |                               |
|---|-------------------------------|
| 7 | Crankshaft belt pulley        |
| 8 | A/C compressor belt tensioner |
| 9 | Pulley - A/C compressor       |

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# Accessory Drive

## Inspection and Verification

1. Verify the customer concern.
2. Visually inspect for obvious signs of mechanical damage.

## Visual Inspection Chart

| Mechanical                                                                                                                                                                                                                                                                                                                                               |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"><li>• Damaged or contaminated accessory drive belt</li><li>• Damaged or contaminated pulley(s)</li><li>• Incorrect accessory drive belt</li><li>• Incorrect fitment of the accessory drive belt</li><li>• Generator</li><li>• Air conditioning (A/C) compressor</li><li>• Pulley(s)</li><li>• Loose hardware</li></ul> |

3. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding to the next step.

## Accessory Drive Belt Concerns

**NOTICE:** Do not lubricate the accessory drive belt as potential damage to the accessory drive belt material construction may occur.

## Cracking

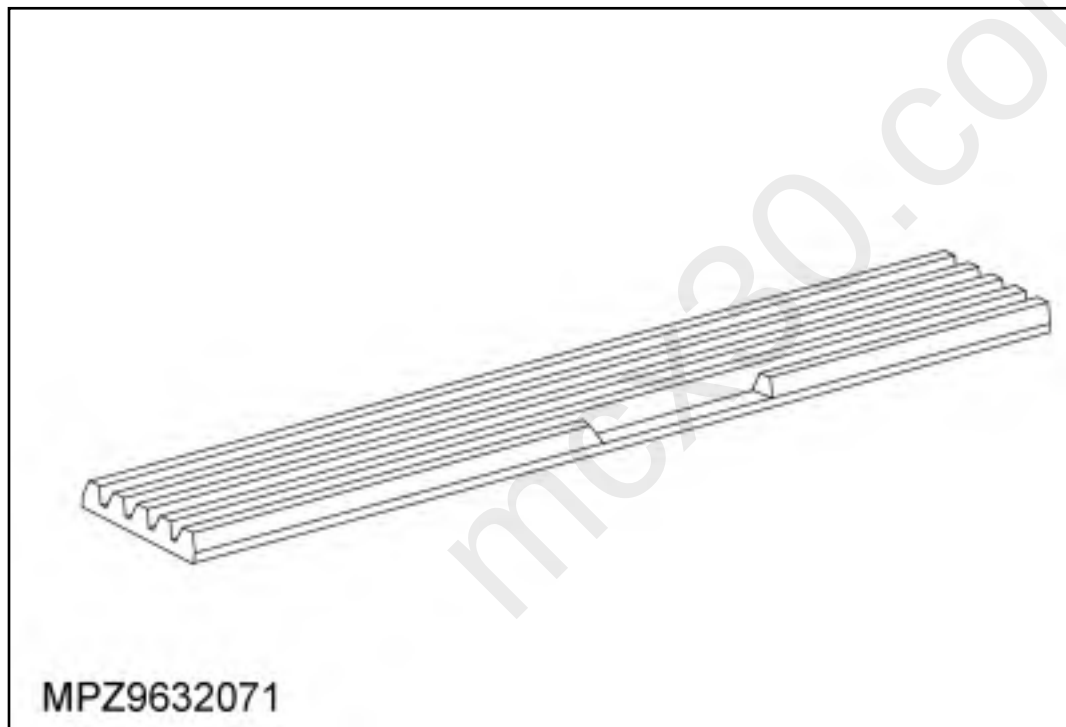
Accessory drive belts are made from rubber which hardens with time and can develop cracks. As the accessory drive belt runs on the back of some of the pulleys, the cracks are opened up. Small cracks are not considered to be a failure of the accessory drive belt. Only if the crack is deep enough to reach the bottom of the groove to expose the cord or any chunks are found to be missing from the accessory drive belt, is the accessory drive belt condition considered to be unacceptable.

1. Check the accessory drive belt for cracks. If the damage exceeds the acceptable limit, install a new accessory drive belt.

REFER to: [Accessory Drive Belt](#) (303-05D Accessory Drive - 5.0L 32V Ti-VCT, Removal and Installation).

## Chunking

Chunking describes the condition where long lengths of rubber become detached from the ribs of the accessory drive belt. This is considered to be a failure of the accessory drive belt.



2. Check the accessory drive belt for damage. If any chunks are found to be missing, install a new accessory drive belt.

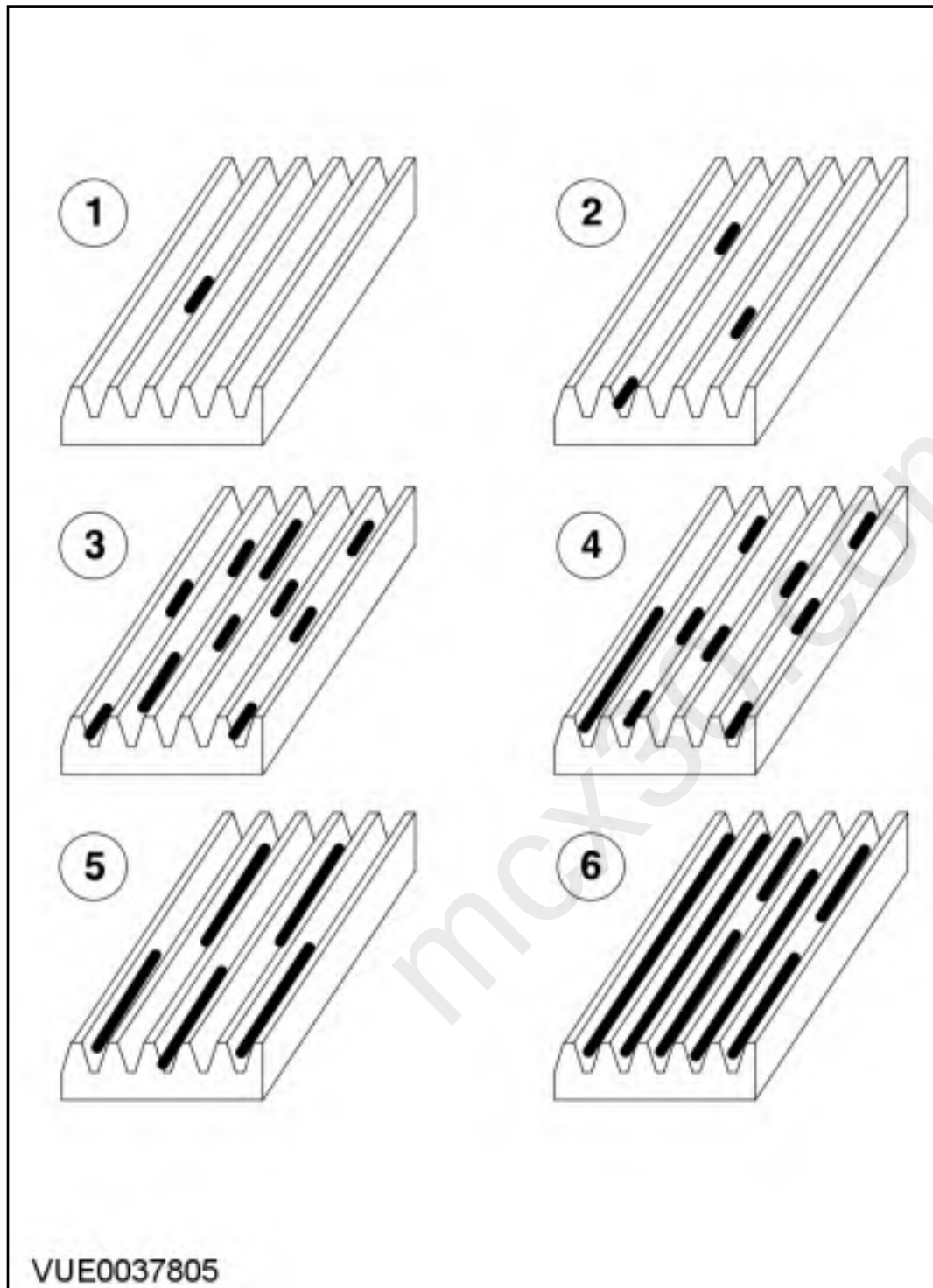
REFER to: [Accessory Drive Belt](#) (303-05D Accessory Drive - 5.0L 32V Ti-VCT, Removal and Installation).

## Pilling

Pilling is dust that forms in between the ribs of the accessory drive belt from rubber that is worn off the accessory drive belt when it is new. There may also be loose particles left on the accessory drive belt



during the manufacturing process. These are worn off and form into small balls of rubber that then get trapped in the grooves of the accessory drive belt. This condition will usually clear itself within 4800 km - 8000 km (3000 miles - 5000 miles) of normal driving.



3. Check the accessory drive belt for pilling. The condition of the accessory drive belt should be compared against the illustration.

1. Small scattered pills. Not considered a concern. No action required.
2. Small scattered pills. Not considered a concern. No action required.
3. Longer pills up to 50% of the rib height. Possible noise concern. **INSTALL** a new

accessory drive belt if noise is apparent.

REFER to: [Accessory Drive Belt](#) (303-05D Accessory Drive - 5.0L 32V Ti-VCT, Removal and Installation).

4. Longer pills up to 50% of the rib height. Possible noise concern. INSTALL a new accessory drive belt if noise is apparent.

REFER to: [Accessory Drive Belt](#) (303-05D Accessory Drive - 5.0L 32V Ti-VCT, Removal and Installation).

5. Heavy deposits in the grooves. Possible noise and stability concern. INSTALL a new accessory drive belt.

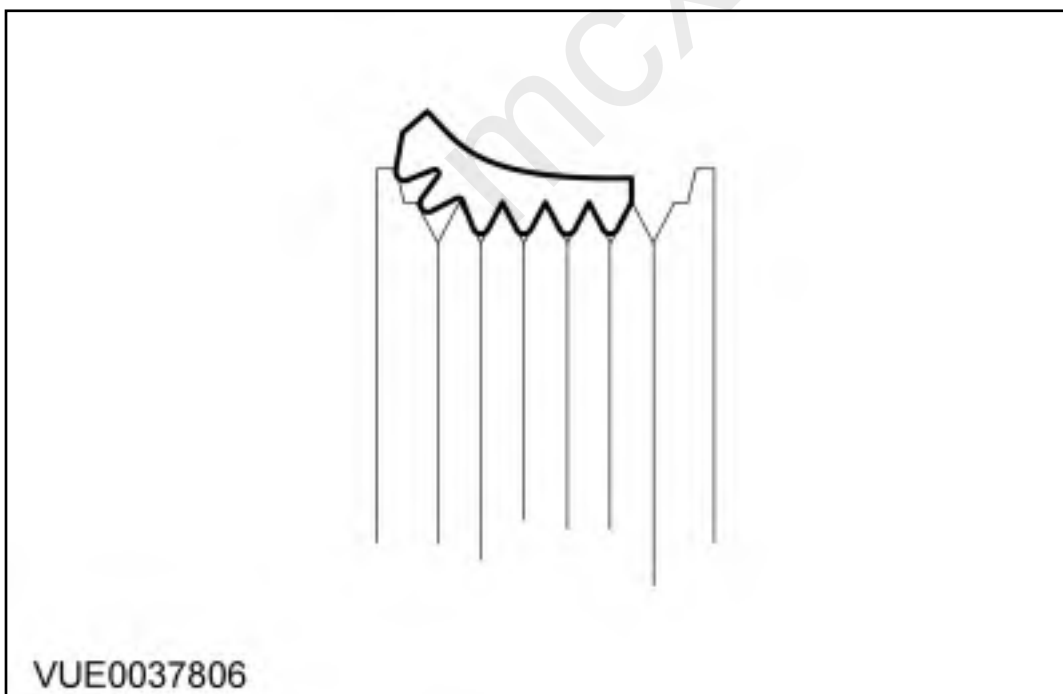
REFER to: [Accessory Drive Belt](#) (303-05D Accessory Drive - 5.0L 32V Ti-VCT, Removal and Installation).

6. Heavy deposits in the grooves. Possible noise and stability concern. INSTALL a new accessory drive belt.

REFER to: [Accessory Drive Belt](#) (303-05D Accessory Drive - 5.0L 32V Ti-VCT, Removal and Installation).

## Incorrect fitment

Accessory drive belt noise can be generated by the accessory drive belt being incorrectly fitted on the pulley as shown in the following illustration. Make sure that all the V grooves on the accessory drive belt contact correctly with the pulley.



4. If the cause is not visually evident, verify the symptom and refer to the Symptom Chart.

## Symptom Chart

| Symptom                                                                      | Possible Sources                                                                              | Action                                                                                                                                                                                                                                                                                                |
|------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>Accessory drive belt noise</li> </ul> | <ul style="list-style-type: none"> <li>Accessory drive system</li> </ul>                      | <ul style="list-style-type: none"> <li>Use a stethoscope or other listening device to determine the source of the noise. INSTALL new components as necessary.</li> </ul>                                                                                                                              |
|                                                                              | <ul style="list-style-type: none"> <li>Accessory drive belt incorrectly installed.</li> </ul> | <ul style="list-style-type: none"> <li>CHECK the accessory drive belt is correctly installed in the pulley grooves. INSTALL a new accessory drive belt as necessary. REFER to: <a href="#">Accessory Drive Belt</a> (303-05D Accessory Drive - 5.0L 32V Ti-VCT, Removal and Installation).</li> </ul> |
|                                                                              | <ul style="list-style-type: none"> <li>Pulley(s).</li> </ul>                                  | <ul style="list-style-type: none"> <li>CHECK the pulley(s) for damage, freedom of rotation, stone entrapment and alignment. INSTALL new components as necessary.</li> </ul>                                                                                                                           |

|                                                                                                                                                                          |                                                                                                    |                                                                                                                                                                                                                                                                                                                                                  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                                                                                          | <ul style="list-style-type: none"> <li>• Lubricant or other contamination.</li> </ul>              | <ul style="list-style-type: none"> <li>• CHECK the accessory drive belt for contamination or damage. RECTIFY the source of the leak and INSTALL a new accessory drive belt. REFER to: <a href="#">Accessory Drive Belt</a> (303-05D Accessory Drive - 5.0L 32V Ti-VCT, Removal and Installation).</li> </ul>                                     |
| <ul style="list-style-type: none"> <li>• <b>NOTE:</b> <i>Chirp is defined as a twittering noise, often intermittent</i></li> <li>• Accessory drive belt chirp</li> </ul> | <ul style="list-style-type: none"> <li>• Pulley misalignment (usually evident at idle).</li> </ul> | <ul style="list-style-type: none"> <li>• CHECK that the accessory drive belt is running centrally on the flat pulleys.</li> <li>• CHECK the pulleys for excessive end float and bent flanges.</li> <li>• With the engine running at idle, use a stethoscope to identify the source of the noise. INSTALL new components as necessary.</li> </ul> |
| <ul style="list-style-type: none"> <li>• <b>NOTE:</b> <i>Rattle is defined as a metallic knocking noise</i></li> <li>• Accessory drive belt rattle</li> </ul>            | <ul style="list-style-type: none"> <li>• Loose components or hardware.</li> </ul>                  | <ul style="list-style-type: none"> <li>• CHECK the components or hardware for correct installation and tighten as necessary.</li> </ul>                                                                                                                                                                                                          |

## Component Tests

### Accessory Drive Belt Tensioner - Static Check

The accessory drive belt tensioner may be checked statically as follows:

1. Inspect the area surrounding the accessory drive belt tensioner for lubricant or other contamination. Rectify any leaks before installing a new accessory drive belt tensioner. If the accessory drive belt tensioner is contaminated, do not attempt to clean it as the damping mechanism inside may be damaged. INSTALL a new accessory drive belt tensioner as necessary. REFER to: [Accessory Drive Belt Tensioner](#) (303-05D Accessory Drive - 5.0L 32V Ti-VCT, Removal and Installation).
2. Detach the accessory drive belt in the area of the accessory drive belt tensioner.
3. **NOTE:** *The accessory drive belt tensioner has a damping feature, which is usually a friction device, therefore some friction within the system is normal.*

Using the correct tool, move the accessory drive belt tensioner from its relaxed position through its full stroke and back to the relaxed position to make sure there is no excessive stick, grab or bind, and to make sure there is tension on the accessory drive belt tensioner spring.

4. Rotate the accessory drive belt tensioner pulley and check for damage, freedom of rotation and alignment. INSTALL a new accessory drive belt tensioner as necessary. REFER to: [Accessory Drive Belt Tensioner](#) (303-05D Accessory Drive - 5.0L 32V Ti-VCT, Removal and Installation).
5. If the accessory drive belt tensioner meets the above criteria, proceed to test the accessory drive belt tensioner dynamically. If the accessory drive belt tensioner does not meet the above criteria, INSTALL a new accessory drive belt tensioner. REFER to: [Accessory Drive Belt Tensioner](#) (303-05D Accessory Drive - 5.0L 32V Ti-VCT, Removal and Installation).

### Accessory Drive Belt Tensioner - Dynamic Check

The accessory drive belt tensioner may be checked dynamically as follows:

1. With the engine running, observe the accessory drive belt tensioner movement. The accessory drive belt tensioner should move (respond) when the engine is accelerated rapidly or when the A/C clutch cycles ON and OFF (the degree of movement can be up to 4 mm). If the accessory drive belt tensioner movement is not constant without engine acceleration or A/C clutch cycling, a



pulley or shaft is possibly bent, out of round, or the damping mechanism inside the accessory drive belt tensioner may be damaged. INSTALL a new accessory drive belt tensioner as necessary.

REFER to: [Accessory Drive Belt Tensioner](#) (303-05D Accessory Drive - 5.0L 32V Ti-VCT, Removal and Installation).

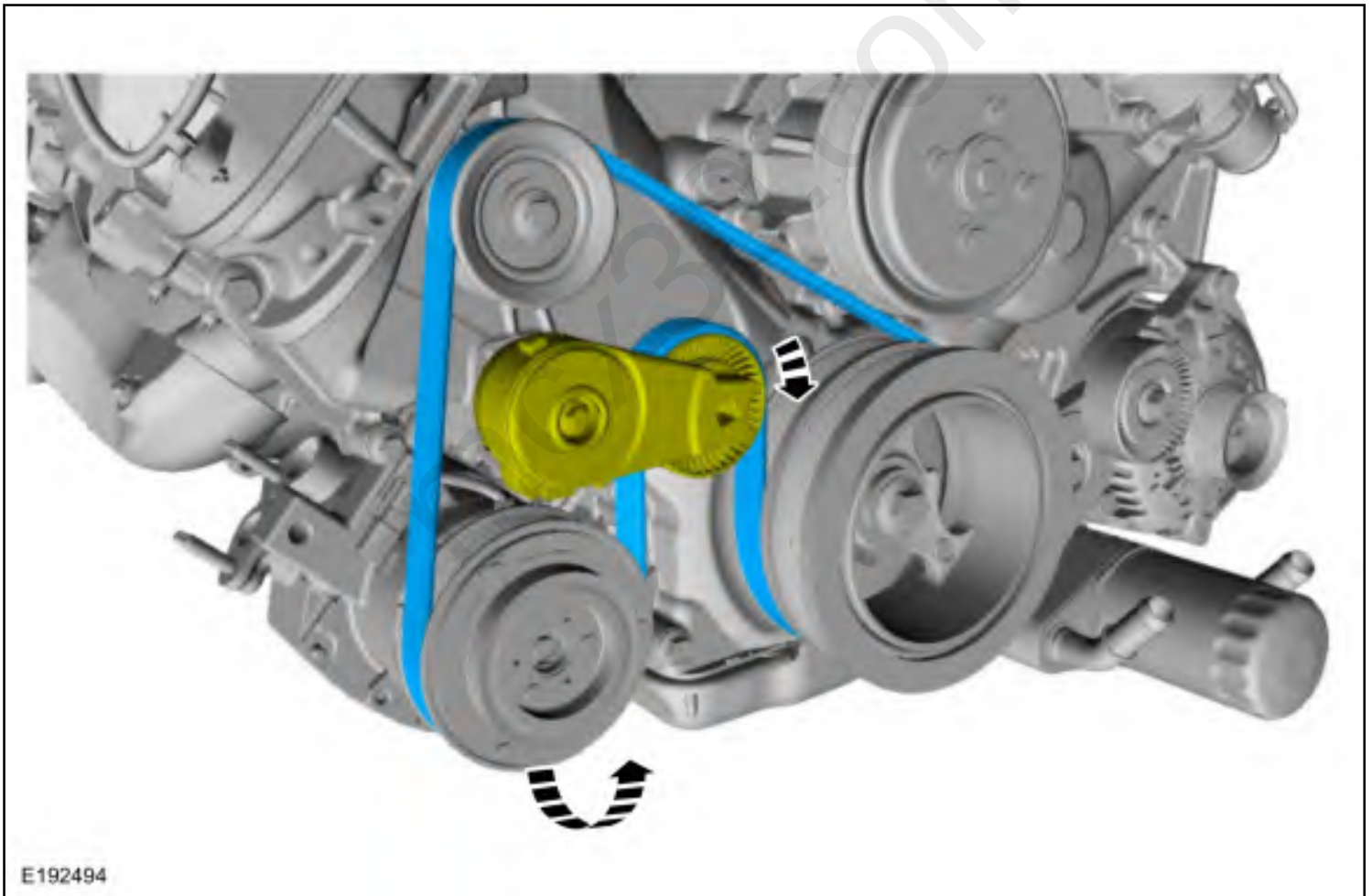
2. Excessive accessory drive belt rideout (uneven depth of grooves in the accessory drive belt) may cause excessive accessory drive belt tensioner movement. Check the condition by installing a new accessory drive belt.

REFER to: [Accessory Drive Belt](#) (303-05D Accessory Drive - 5.0L 32V Ti-VCT, Removal and Installation).

## Air Conditioning (A/C) Compressor Belt

### Removal

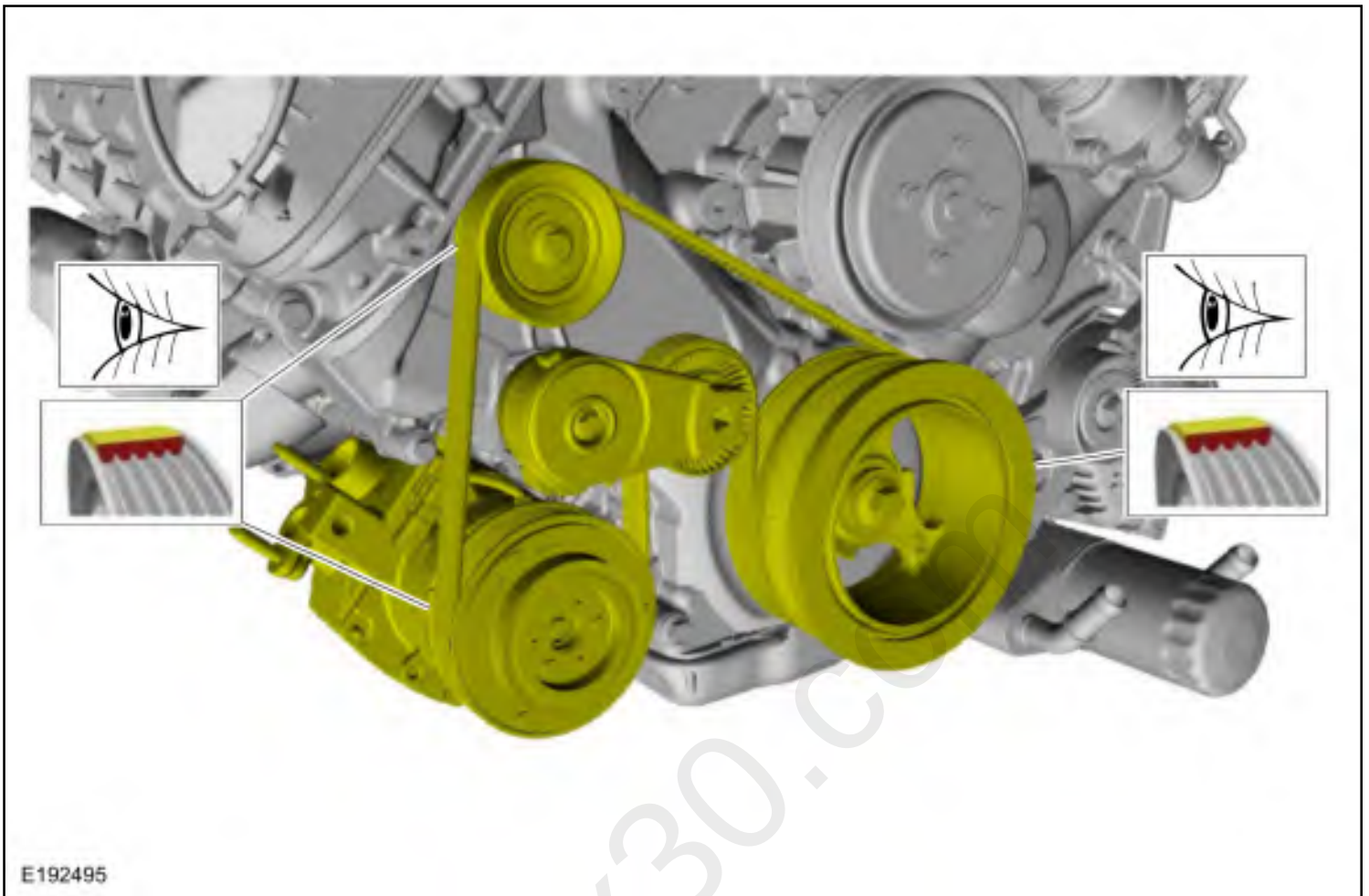
1. Remove the accessory drive belt tensioner.  
Refer to: [Accessory Drive Belt Tensioner](#) (303-05D Accessory Drive - 5.0L 32V Ti-VCT, Removal and Installation).
2. Rotate the A/C compressor belt tensioner clockwise and remove the A/C compressor belt.



### Installation

1. To install, reverse the removal procedure.

2. After installation, make sure the A/C compressor belt is correctly seated on all pulleys.



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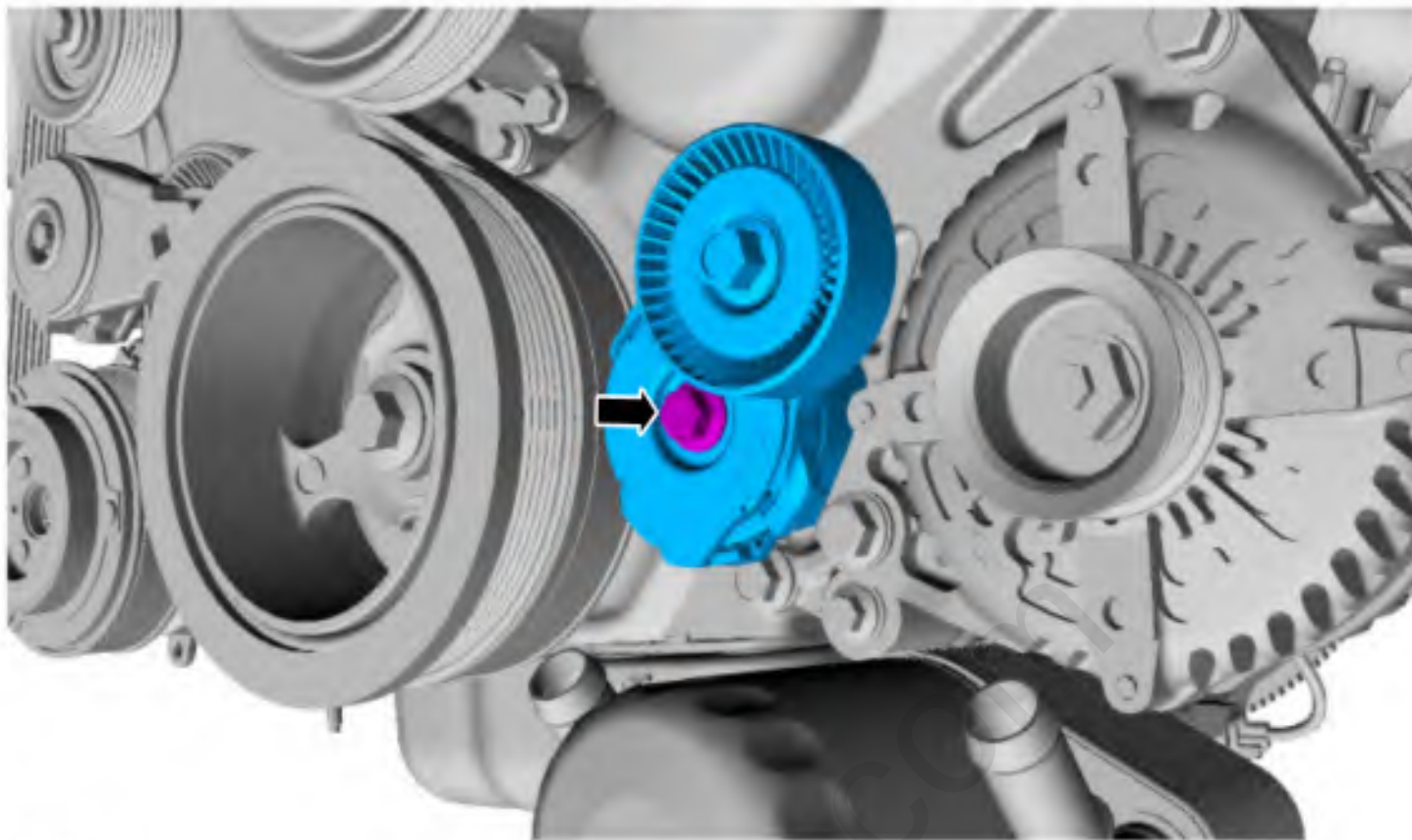
# Accessory Drive Belt Tensioner

Base Part Number: Base Part Number: 6B209

## Removal

**NOTE:** Removal steps in this procedure may contain installation details.

1. Remove the accessory drive belt.  
Refer to: [Accessory Drive Belt](#) (303-05D Accessory Drive - 5.0L 32V Ti-VCT, Removal and Installation).
2. Remove the bolt and the accessory drive belt tensioner.  
*Torque:* 35 lb.ft (47 Nm)



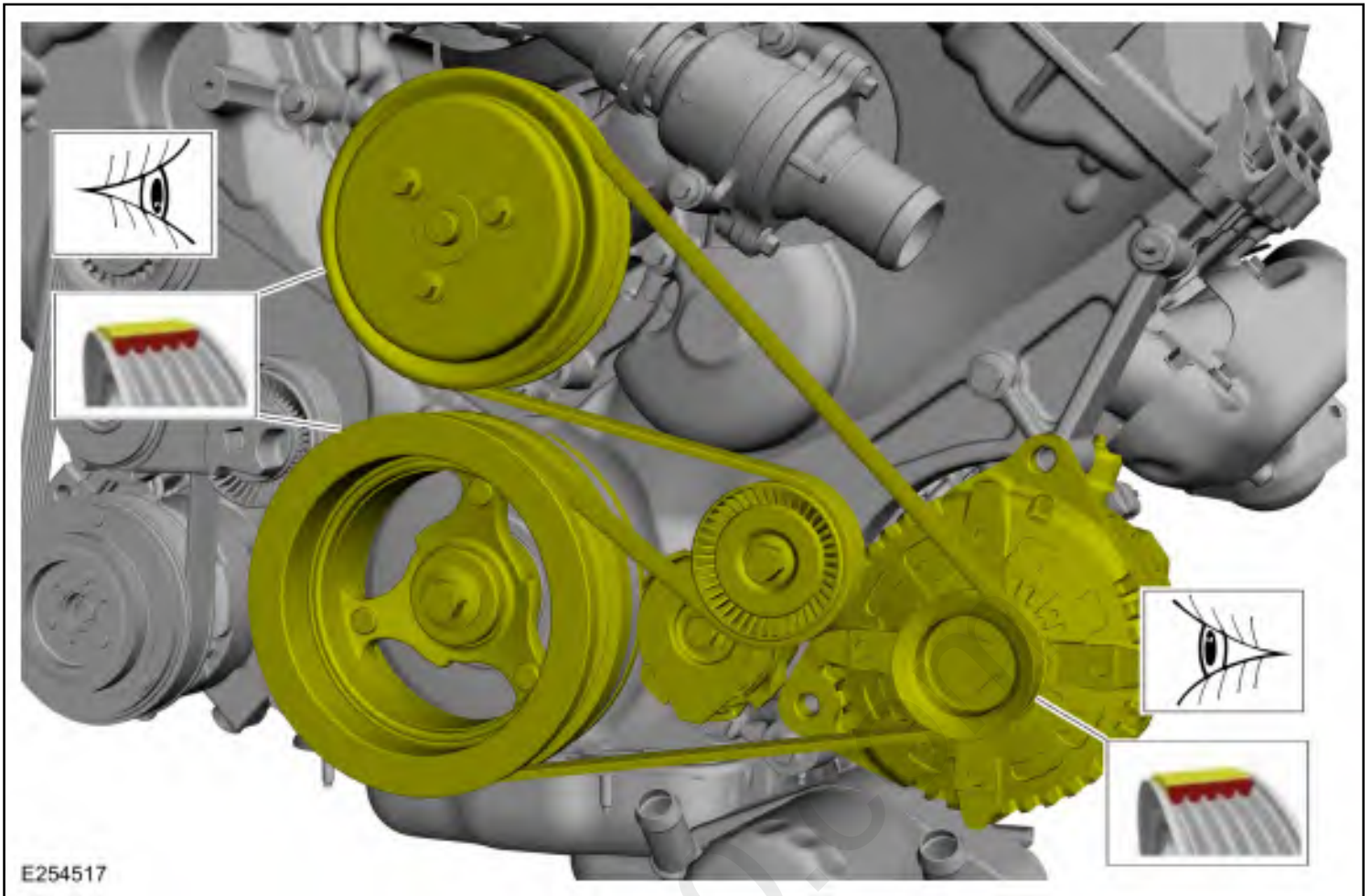
E192486



## Installation

1. To install, reverse the removal procedure.
2. After installation, make sure the accessory drive belt is correctly seated on all pulleys.





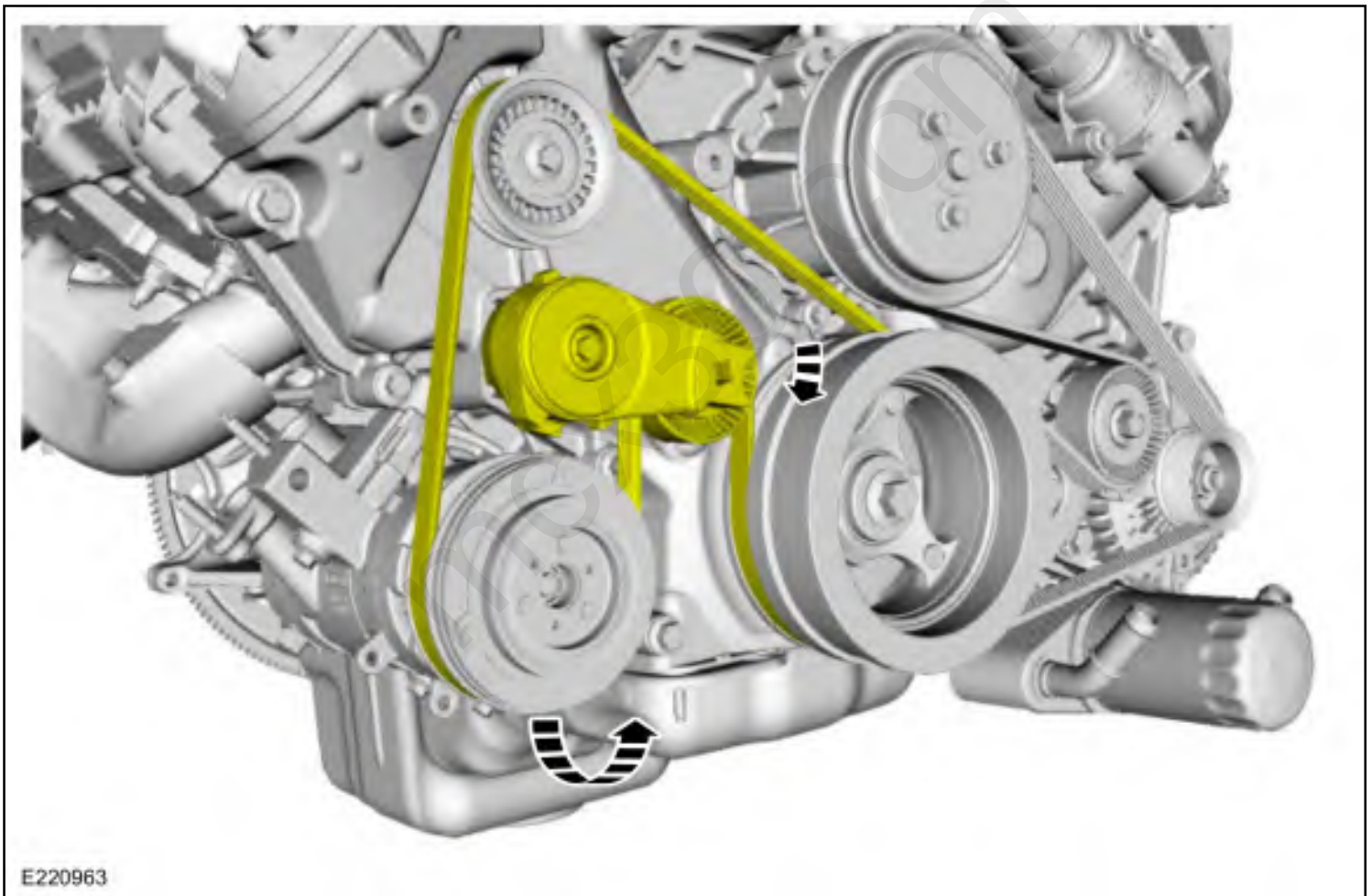
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# Air Conditioning (A/C) Compressor Belt Tensioner

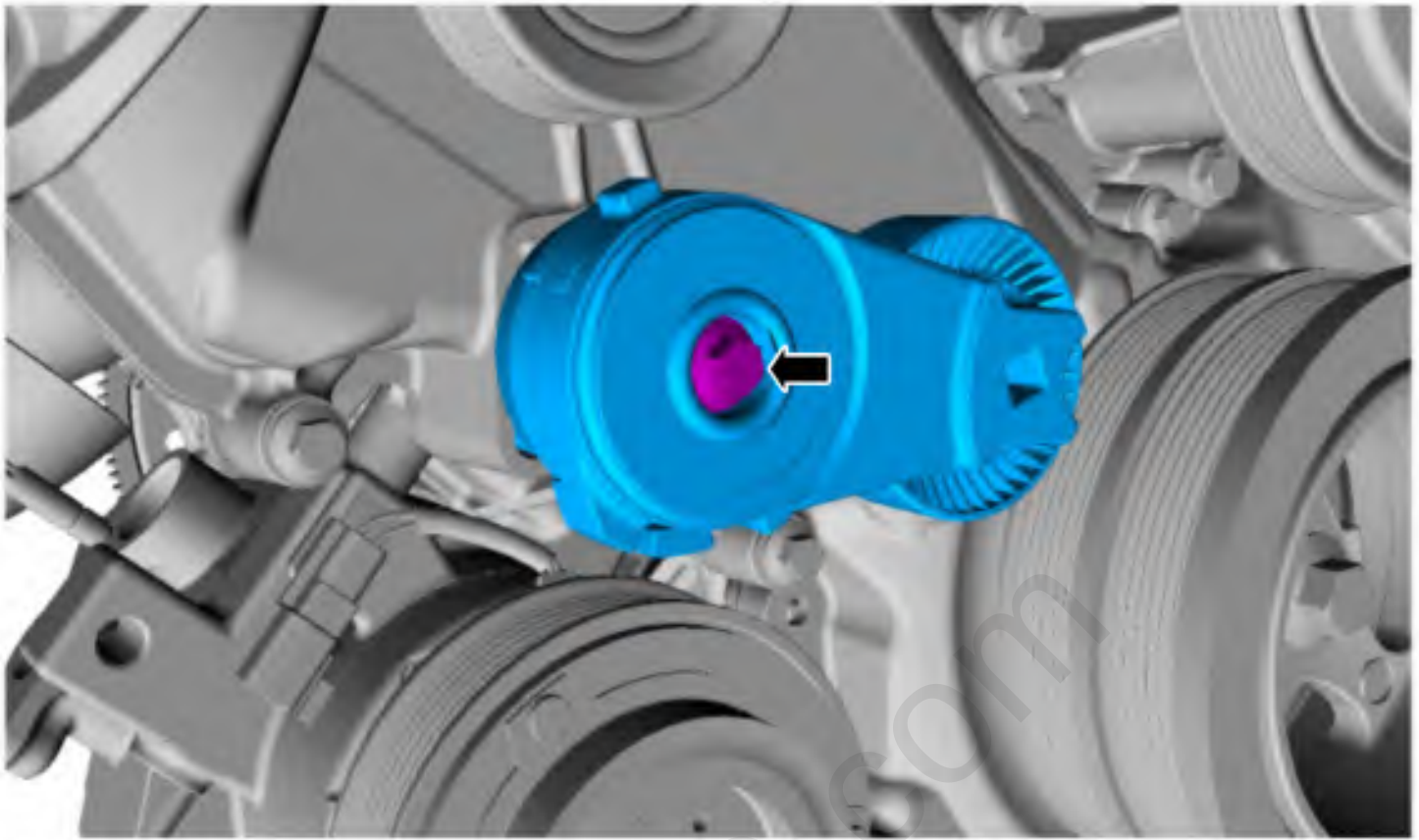
## Removal

**NOTE:** Removal steps in this procedure may contain installation details.

1. Rotate the A/C compressor belt tensioner clockwise and position the belt aside.



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

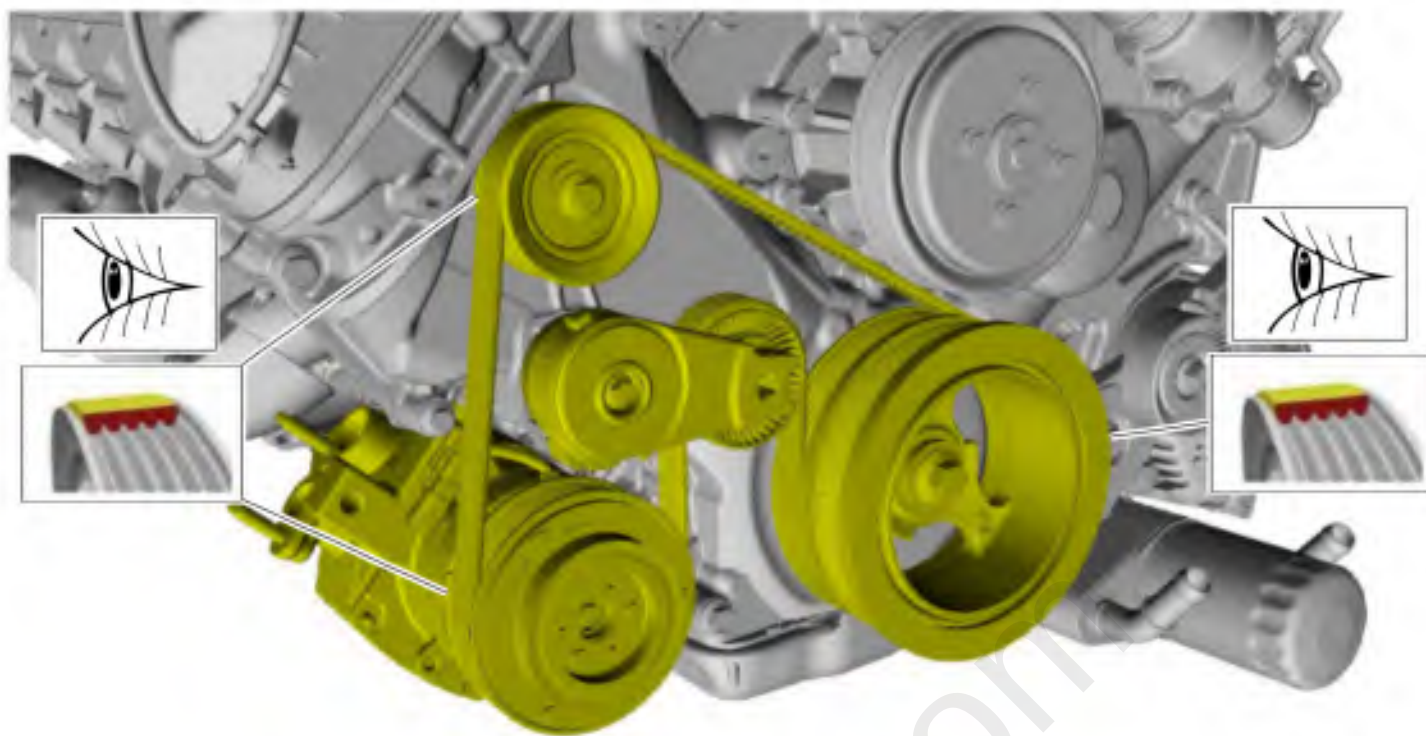


E192520

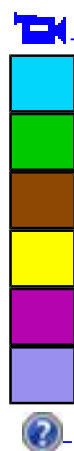


## Installation

1. To install, reverse the removal procedure.
2. After installation, make sure the A/C compressor belt is correctly seated on all pulleys.



E192495



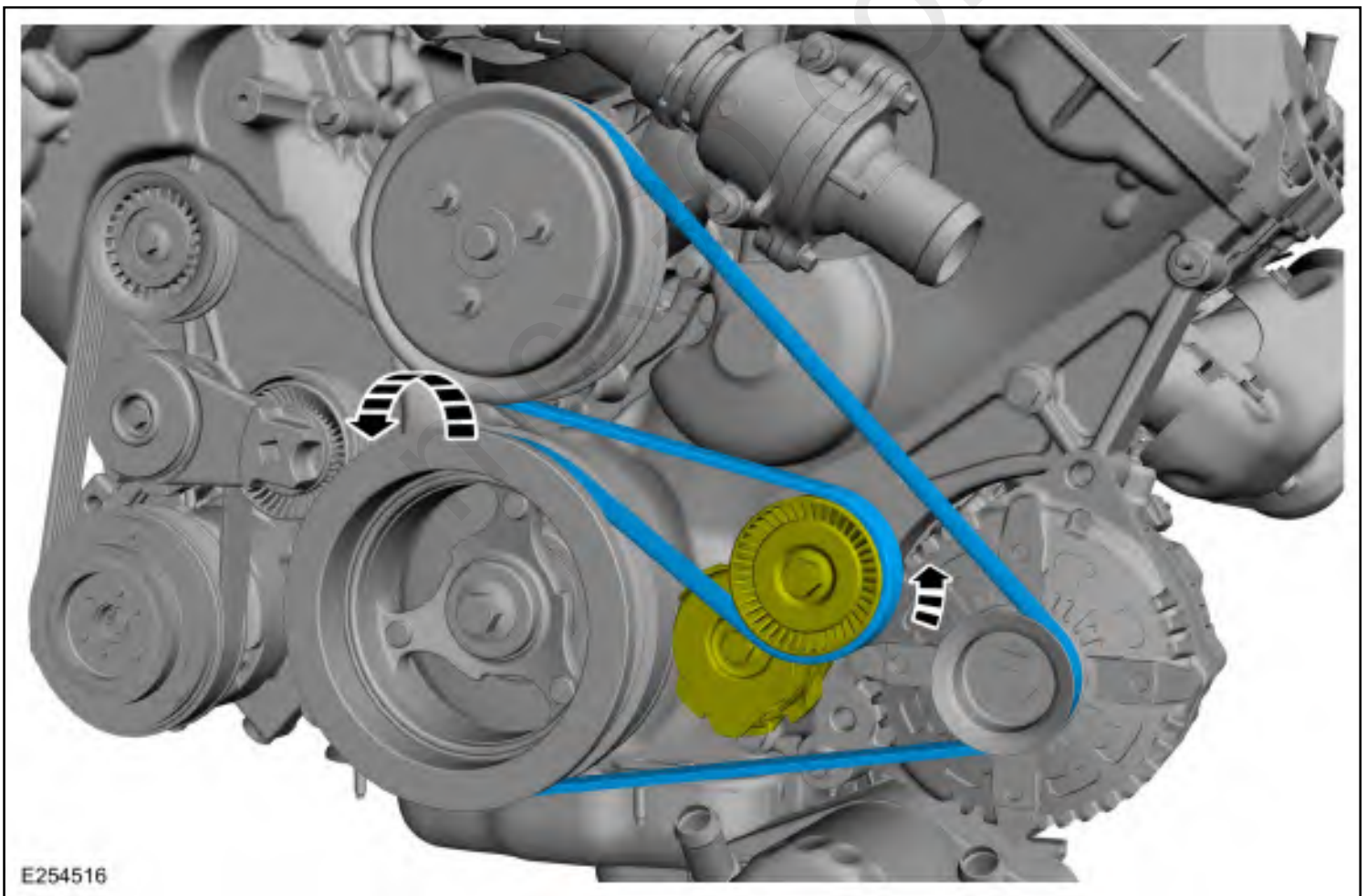


# Accessory Drive Belt

Base Part Number: Base Part Number: 8620

## Removal

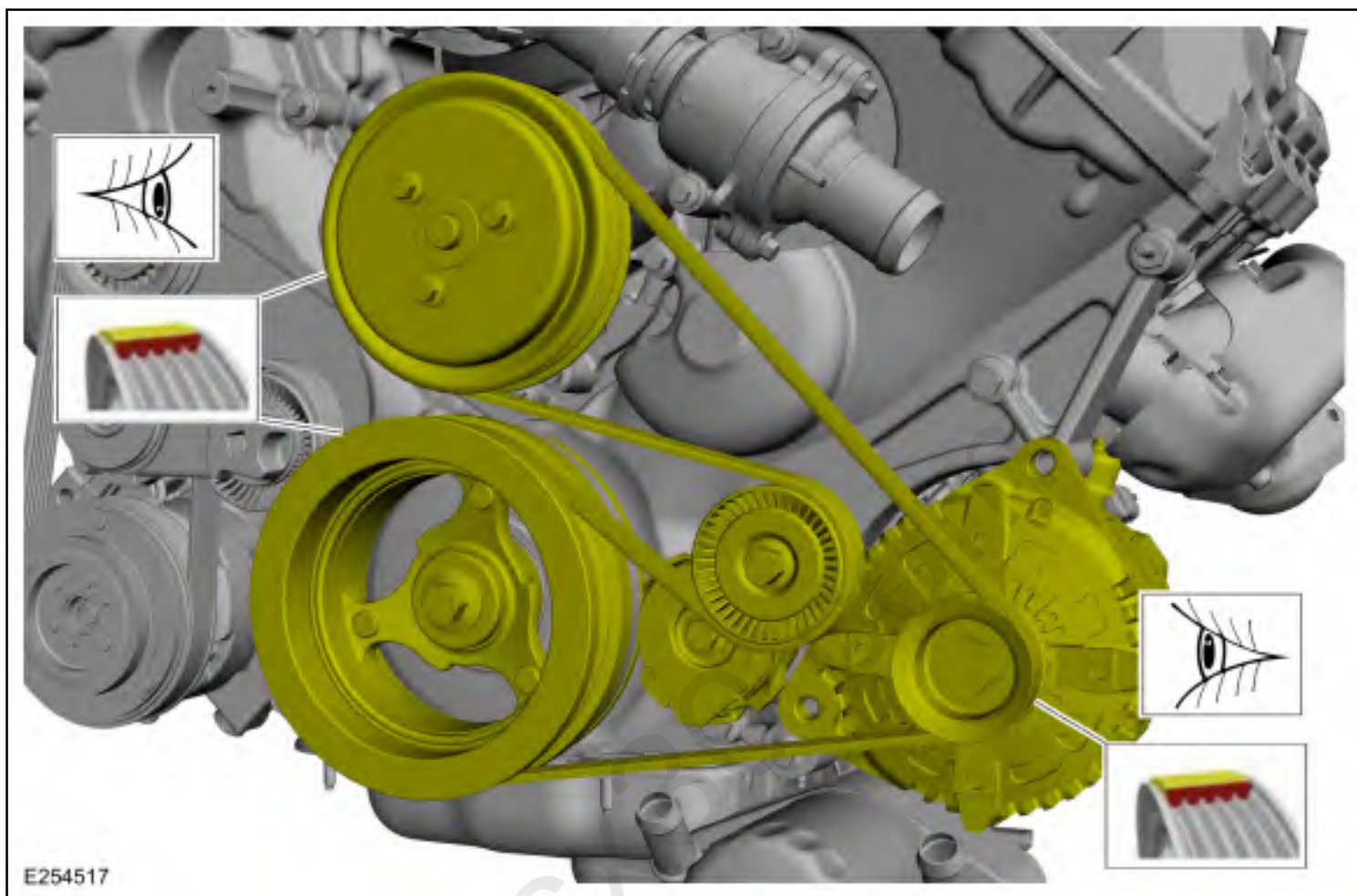
1. With the vehicle in NEUTRAL, position it on a hoist.  
Refer to: [Jacking and Lifting - Overview](#) (100-02 Jacking and Lifting, Description and Operation).
2. Rotate the accessory drive belt tensioner counter clockwise and remove the accessory drive belt.



## Installation



1. To install, reverse the removal procedure.
2. After installation, make sure the accessory drive belt is correctly seated on all pulleys.

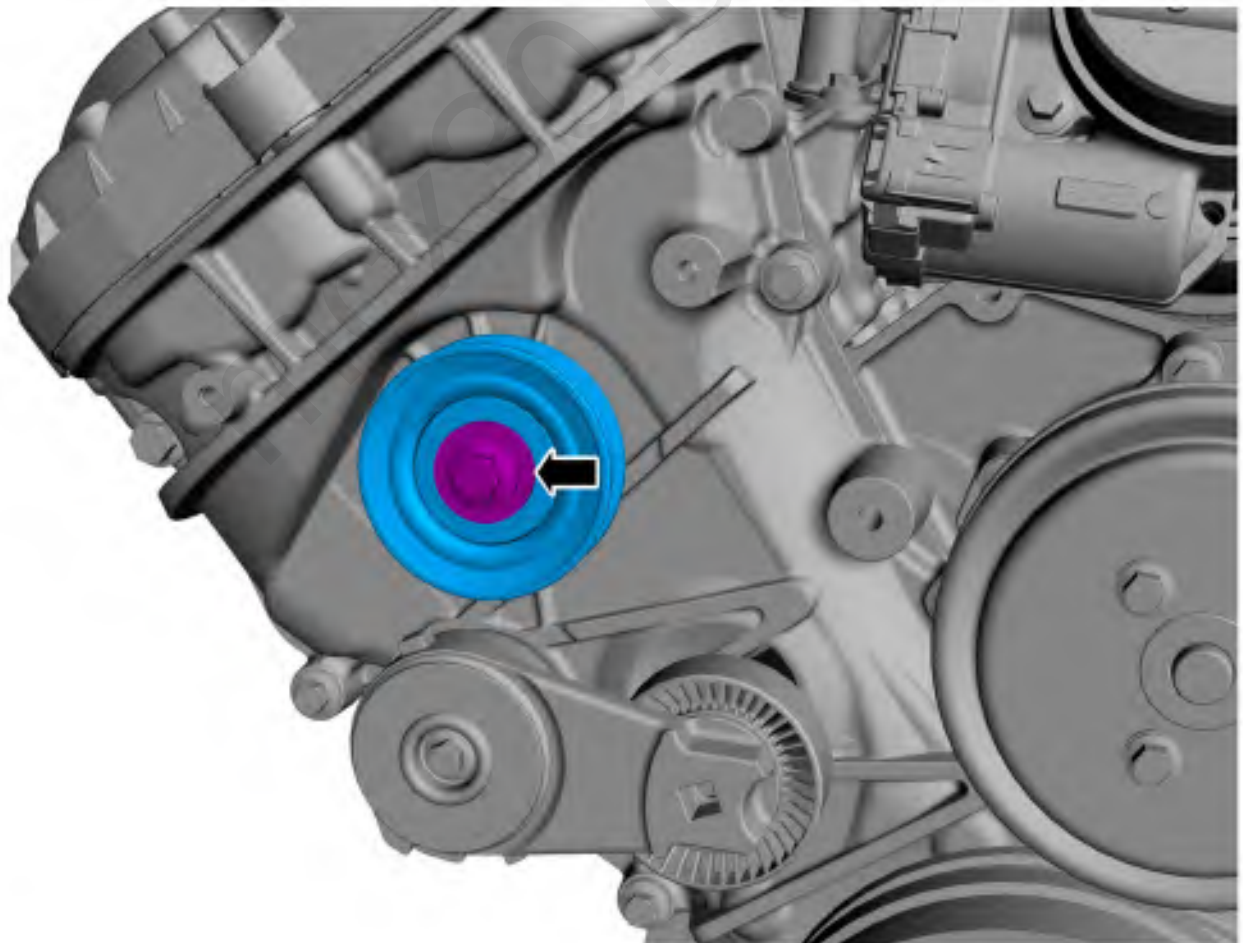


## Accessory Drive Belt Idler Pulley

### Removal

**NOTE:** Removal steps in this procedure may contain installation details.

1. Remove the accessory drive belt.  
Refer to: [Air Conditioning \(A/C\) Compressor Belt](#) (303-05D Accessory Drive - 5.0L 32V Ti-VCT, Removal and Installation).
2. Remove the bolts and the accessory drive belt idler pulleys.  
*Torque: 18 lb.ft (25 Nm)*



E255311



## Installation

1. To install, reverse the removal procedure.

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## Specifications

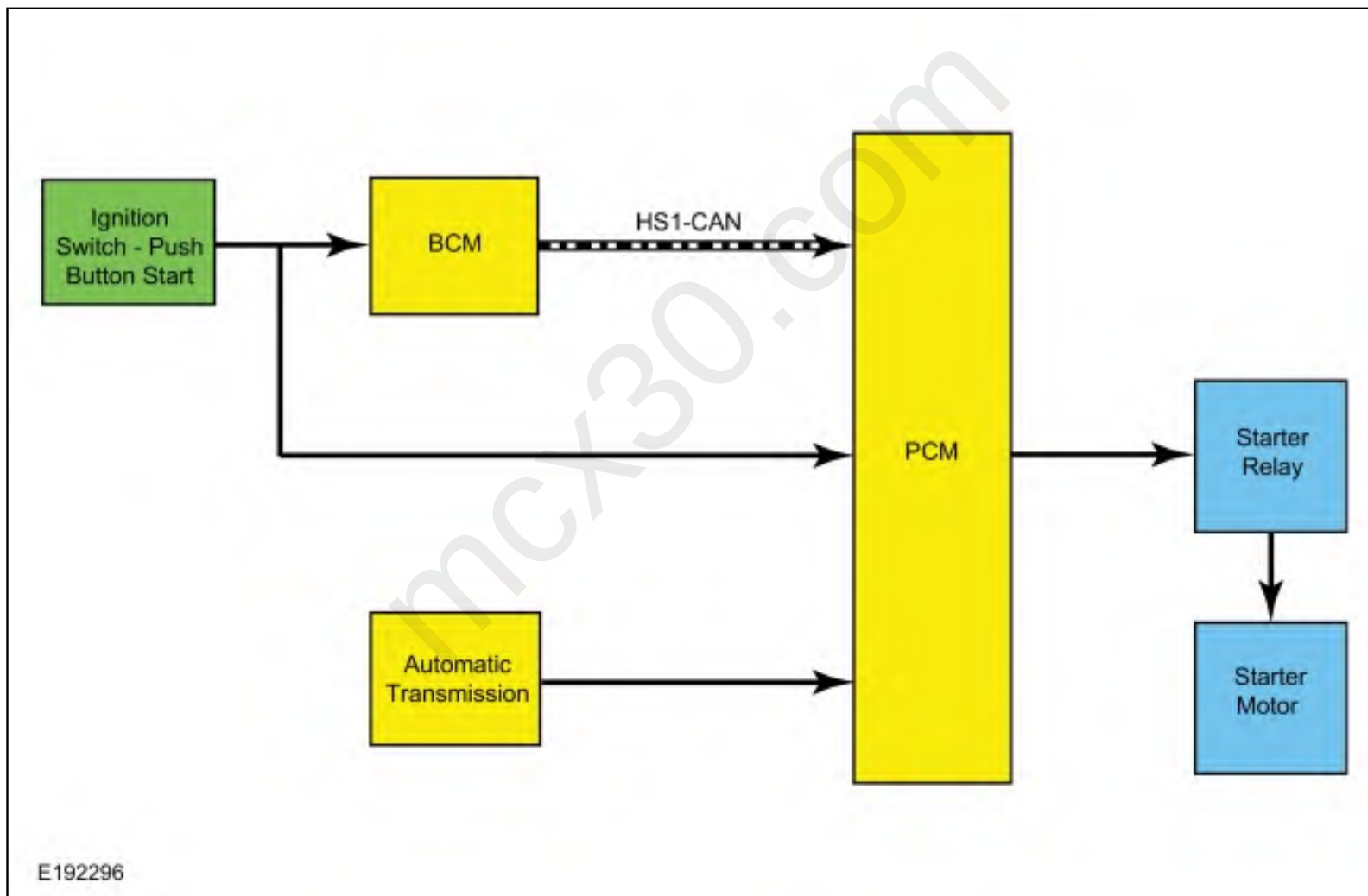
### General Specifications

| Item                                                                                     | Specification |
|------------------------------------------------------------------------------------------|---------------|
| Normal engine cranking speed (Average)                                                   | 200-250 RPM   |
| Starting circuit maximum voltage drop (Engine at normal operating temperature) (Average) | 0.5 volt      |
| Starter motor maximum load current draw                                                  | 800 amps      |
| Starter motor no-load current draw (Average)                                             | 60-80 amps    |
| Starter motor normal load current draw (Average)                                         | 130-190 amps  |

# Starting System - System Operation and Component Description

## System Operation

## System Diagram



## Network Message Chart

### Module Network Input Messages Powertrain Control Module (PCM)



| Broadcast Message     | Originating Module | Message Purpose                                                                                                            |
|-----------------------|--------------------|----------------------------------------------------------------------------------------------------------------------------|
| Starter crank request | BCM                | Provides the PCM with ignition, hood input status and a request to crank and start the engine during a remote start event. |
| Remote start request  | BCM                | Provides the PCM with a remote start request.                                                                              |

## Starting System

The BCM controls the ignition modes and, in conjunction with the PCM, the starting system.

During a start event, when the ignition switch is turned to Start (without push button start) or the engine start/stop switch and the brake pedal are pressed simultaneously (with push-button start), the PCM and BCM receive a request to start the engine. The PCM recognizes the correct inputs from the BCM and TR sensor and provides voltage and ground to energize the starter relay coil and close the starter relay contacts. The starter relay contacts close, providing voltage to the starter solenoid, allowing the starter motor to crank the engine. The PCM disengages the starter motor once an engine RPM threshold is reached, a set crank time is exceeded or the ignition switch is turned off (without push button start) or the start/stop button is pressed (with push-button start).

## Passive Anti-theft System (PATS)

This vehicle is equipped with a PATS. PATS disables the engine from starting if an unprogrammed PATS key is used or an invalid PCM ID is received. The PATS is controlled by the BCM. If there is a PATS concern that disables the engine, the IPC displays a corresponding message in the message center.

Refer to: [Passive Anti-Theft System \(PATS\) - System Operation and Component Description](#) (419-01B Passive Anti-Theft System (PATS), Description and Operation).

## Remote Start

The remote start system is controlled by the RKE system. For more information,

Refer to: [Handles, Locks, Latches and Entry Systems - System Operation and Component Description](#) (501-14 Handles, Locks, Latches and Entry Systems, Description and Operation).

## Component Description

### Body Control Module (BCM)

Refer to: [Module Controlled Functions - System Operation and Component Description](#) (419-10 Multifunction Electronic Modules, Description and Operation).

## Gateway Module

The GWM translates messages between HS-CAN and MS-CAN. This allows a message to be distributed throughout the networks.

Refer to: [Communications Network - System Operation and Component Description](#) (418-00 Module Communications Network, Description and Operation).

### **Ignition Switch (without Push Button Start)**

Refer to: [Steering Wheel and Column Electrical Components - System Operation and Component Description](#) (211-05 Steering Wheel and Column Electrical Components, Description and Operation).

### **Ignition Switch - Push Button Start (with Push Button Start)**

The ignition switch - push button start (engine start/stop button) is a momentary contact switch that is hardwired to the BCM and the PCM. The ignition switch - push button start is used to obtain the OFF, ON or START ignition modes. For more information,

Refer to: [Steering Wheel and Column Electrical Components - System Operation and Component Description](#) (211-05 Steering Wheel and Column Electrical Components, Description and Operation).

### **Integrated Keyhead Transmitter (IKT)**

Refer to: [Passive Anti-Theft System \(PATS\) - System Operation and Component Description](#) (419-01B Passive Anti-Theft System (PATS), Description and Operation).

### **Passive Key**

Refer to: [Passive Anti-Theft System \(PATS\) - System Operation and Component Description](#) (419-01B Passive Anti-Theft System (PATS), Description and Operation).

### **Powertrain Control Module (PCM)**

The PCM provides power and ground to the starter relay to initiate cranking of the engine.

### **RTM**

Refer to: [Handles, Locks, Latches and Entry Systems - System Operation and Component Description](#) (501-14 Handles, Locks, Latches and Entry Systems, Description and Operation).

**Information not available at this time.**

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# Starting System - Overview

## Starting System

The starting system controls the cranking of the engine. The PCM energizes the starter relay when it receives inputs from the ignition switch, automatic transmission, and the BCM. When the starter relay is energized it applies power to the starter motor which cranks the engine.

## Starting System - with Remote Start

If equipped, the remote start system allows the vehicle to be started from up to 20 meters (65 feet) away. For more information on the remote start system, refer to the owners literature and Refer to: [Handles, Locks, Latches and Entry Systems - System Operation and Component Description](#) (501-14 Handles, Locks, Latches and Entry Systems, Description and Operation).

## Starting System - with Auto-Start-Stop

The Auto-Start-Stop system helps reduce fuel consumption by automatically shutting off the vehicle's engine while the vehicle is at a complete stop and restarting the engine when the brake pedal is released. The Auto-Start-Stop system is automatically enabled whenever the ignition is turned on. The vehicle may restart automatically in order to maintain interior comfort or to recharge the battery.

Refer to the Owner's Literature for additional information.

## Starting System

### Inspection and Verification

Diagnostics in this manual assume a certain skill level and knowledge of Ford-specific diagnostic practices.  
REFER to: [Diagnostic Methods](#) (100-00 General Information, Description and Operation).

1. Verify the customer concern.
2. Check the battery for loose, damaged or corroded connections.
3. Check the starter for loose, damaged or corroded connections.
4. Check the battery condition and state of charge.  
REFER to: [Battery](#) (414-01 Battery, Mounting and Cables, Diagnosis and Testing).
5. Remove the accessory drive belt.  
REFER to: [Accessory Drive Belt](#) (303-05D Accessory Drive - 5.0L 32V Ti-VCT, Removal and Installation).  
Verify the crankshaft and each of the components driven by the accessory drive belt rotate and are not seized or damaged.
6. If any aftermarket accessories have been added to the vehicle, make sure they are properly wired.
7. If an obvious cause for an observed or reported concern is found, correct the cause (if possible) before proceeding.

### DTC Charts

Diagnostics in this manual assume a certain skill level and knowledge of Ford-specific diagnostic practices.  
REFER to: [Diagnostic Methods](#) (100-00 General Information, Description and Operation).

### PCM DTC Chart

| DTC | Description | Action |
|-----|-------------|--------|
|     |             |        |



|                |                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|----------------|-----------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| P06E4          | Control Module Wake-up Circuit Performance          | RETRIEVE and RECORD all CMDTCs. If BCM DTC C113A:11 or C113A:15 is found, <a href="#">GO to Pinpoint Test D</a> Clear all Diagnostic Trouble Codes (DTCs). RERUN the PCM self-test. If the DTC returns, CHECK OASIS for any applicable Technical Service Bulletins (TSBs). If no Technical Service Bulletins (TSBs) address this concern, INSTALL a new PCM.<br>REFER to: <a href="#">Powertrain Control Module (PCM)</a> (303-14D Electronic Engine Controls - 5.0L 32V Ti-VCT, Removal and Installation). |
| P06E9          | Engine Starter Performance                          | If the engine cranks, Refer to Powertrain Control/Emissions Diagnosis (PC/ED) manual. If the engine does not crank, for vehicles without push button start, <a href="#">GO to Pinpoint Test A</a> For vehicles with push button start, <a href="#">GO to Pinpoint Test B</a>                                                                                                                                                                                                                                |
| P162F          | Starter Motor Disabled - Engine Crank Time Too Long | This DTC sets in the PCM when the engine has been cranked for more than a total of 60 seconds without allowing sufficient time for the starter to cool. Diagnose all other DTCs and symptoms. Check the charging system voltage and correct as necessary. Clear the DTC.                                                                                                                                                                                                                                    |
| P2535          | Ignition Switch Run/Start Position Circuit High     | For vehicles without Push button start, <a href="#">GO to Pinpoint Test E</a> For vehicles with Push button start, <a href="#">GO to Pinpoint Test F</a>                                                                                                                                                                                                                                                                                                                                                    |
| All Other DTCs | -                                                   | REFER to: <a href="#">Electronic Engine Controls</a> (303-14D Electronic Engine Controls - 5.0L 32V Ti-VCT, Diagnosis and Testing).                                                                                                                                                                                                                                                                                                                                                                         |

#### BCM DTC Chart

| DTC            | Description                                          | Action                                                                                                                                                                                                                       |
|----------------|------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| C113A:11       | PCM Wake-up Signal: Circuit Short to Ground          | Without push-button start,<br>REFER to: <a href="#">Passive Anti-Theft System (PATS)</a> (419-01B Passive Anti-Theft System (PATS), Diagnosis and Testing).<br>With push-button start, <a href="#">GO to Pinpoint Test D</a> |
| C113A:15       | PCM Wake-up Signal: Circuit Short to Battery or Open | Without push-button start,<br>REFER to: <a href="#">Passive Anti-Theft System (PATS)</a> (419-01B Passive Anti-Theft System (PATS), Diagnosis and Testing).<br>With push-button start, <a href="#">GO to Pinpoint Test D</a> |
| All Other DTCs | -                                                    | REFER to: <a href="#">Body Control Module (BCM)</a> (419-10 Multifunction Electronic Modules, Diagnosis and Testing).                                                                                                        |

#### RTM DTC Chart

| DTC      | Description | Action                                                                                                                                    |
|----------|-------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| All DTCs | -           | REFER to: <a href="#">Tire Pressure Monitoring System (TPMS)</a> (204-04B Tire Pressure Monitoring System (TPMS), Diagnosis and Testing). |

## Symptom Chart(s)

### Symptom Chart: Starting System

Diagnostics in this manual assume a certain skill level and knowledge of Ford-specific diagnostic practices.  
REFER to: [Diagnostic Methods](#) (100-00 General Information, Description and Operation).

### Symptom Chart

| Condition                                             | Possible Sources                                                                                                                                                           | Actions                                                                                                                                                             |
|-------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| The engine does not crank — without Push-button Start | Refer to the Pinpoint Test.                                                                                                                                                | <a href="#">GO to Pinpoint Test A</a>                                                                                                                               |
| The engine does not crank — with Push-button Start    | Refer to the Pinpoint Test.                                                                                                                                                | <a href="#">GO to Pinpoint Test B</a>                                                                                                                               |
| The engine cranks slowly                              | Refer to the Pinpoint Test.                                                                                                                                                | PERFORM the starter system component test. REFER to Starter Motor - Positive Circuit Test in this section.                                                          |
| The engine cranks but will not start                  | <ul style="list-style-type: none"> <li>Fuses</li> <li>PCM</li> <li>Fuel pump</li> <li>Fuel pump relay</li> <li>Run/start relay</li> <li>Starter</li> <li>Wiring</li> </ul> | Refer to Powertrain Control/Emissions Diagnosis (PC/ED) manual.                                                                                                     |
| Unusual starter noise                                 | Refer to the Pinpoint Test.                                                                                                                                                | <a href="#">GO to Pinpoint Test C</a>                                                                                                                               |
| The starter spins but the engine does not crank       | Starter motor                                                                                                                                                              | INSPECT the starter motor mounting and engagement. REPAIR as necessary.                                                                                             |
|                                                       | Damaged flexplate                                                                                                                                                          | INSPECT the flexplate for damaged, missing or worn teeth. REPAIR as necessary.                                                                                      |
| The starter does not disengage from the flexplate     | <ul style="list-style-type: none"> <li>Starter relay</li> <li>Wiring, terminals or connectors</li> </ul>                                                                   | REMOVE the starter relay. If the engine stops cranking, INSTALL a new relay. If the engine continues to crank, REPAIR circuit CDC35 (BU/WH) for a short to voltage. |
|                                                       |                                                                                                                                                                            |                                                                                                                                                                     |

|                                             |                                                                                                                                                                                                    |                                                                                                                                                                                                |
|---------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| The remote start is inoperative             | <ul style="list-style-type: none"> <li>• Remote start feature not enabled</li> <li>• Passive Key</li> <li>• Hood switch input</li> <li>• PCM</li> <li>• Wiring, terminals or connectors</li> </ul> | REFER to: <a href="#">Locks, Latches and Entry Systems</a> (501-14 Handles, Locks, Latches and Entry Systems, Diagnosis and Testing).                                                          |
| The remote start has poor range performance | <ul style="list-style-type: none"> <li>• Passive Key or battery</li> <li>• After market systems</li> <li>• High power devices</li> <li>• TV/radio transmission towers</li> <li>• RTM</li> </ul>    | Diagnose The RKE Transmitter Has Poor Range Performance, REFER to: <a href="#">Locks, Latches and Entry Systems</a> (501-14 Handles, Locks, Latches and Entry Systems, Diagnosis and Testing). |

### Symptom Chart: Auto-Start-Stop System

Diagnostics in this manual assume a certain skill level and knowledge of Ford-specific diagnostic practices.  
REFER to: [Diagnostic Methods](#) (100-00 General Information, Description and Operation).

#### Symptom Chart

| Condition                                                           | Possible Sources                                                                                                                              | Actions                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|---------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Auto-Start-Stop System is inoperative or does not operate correctly | One or more required criteria required for Auto-start-stop operation has not been met.                                                        | REFER to owners manual Refer to Powertrain Control/Emissions Diagnosis (PC/ED) manual. for proper system operation.                                                                                                                                                                                                                                                                                                                                                                   |
|                                                                     | Electronic Control Modules                                                                                                                    | <ul style="list-style-type: none"> <li>• RETRIEVE all Continuous Memory Diagnostic Trouble Codes (CMDTCs).</li> <li>• For PCM Diagnostic Trouble Codes (DTCs), REFER to PCM DTC Chart in this section.</li> <li>• For BCM Diagnostic Trouble Codes (DTCs), REFER to BCM DTC Chart in this section.</li> <li>• For all other Diagnostic Trouble Codes (DTCs), REFER to: <a href="#">Diagnostic Trouble Code Charts</a> (100-00 General Information, Diagnosis and Testing).</li> </ul> |
|                                                                     | Vehicle Battery                                                                                                                               | Refer to Powertrain Control/Emissions Diagnosis (PC/ED) manual. Section 3 Symptom Charts.                                                                                                                                                                                                                                                                                                                                                                                             |
| Auto-Start-Stop System cannot be disabled by driver                 | <ul style="list-style-type: none"> <li>• Wiring, terminals or connectors</li> <li>• Auto-start-stop disable switch</li> <li>• FCIM</li> </ul> | Refer to the appropriate section in Group 415 for the procedure.                                                                                                                                                                                                                                                                                                                                                                                                                      |

Pinpoint Test(s)

Engine Does Not Crank - without Push-button Start

Refer to Wiring Diagrams Cell 20 for schematic and connector information.

Normal Operation and Fault Conditions

REFER to: [Starting System - System Operation and Component Description](#) (303-06D Starting System - 5.0L 32V Ti-VCT, Description and Operation).

DTC Fault Trigger Conditions

| DTC   | Description                | Fault Trigger Conditions                        |
|-------|----------------------------|-------------------------------------------------|
| P06E9 | Engine Starter Performance | No engine rotation detected during crank event. |

Possible Sources

- Battery
- Battery cables
- Starter motor
- BJB starter relay

Visual Inspection and Diagnostic Pre-checks

- Inspect the Run/start relay.
- Inspect the high current BJB connections.
- Verify the BJB fuse 5 (30A).
- Verify the BCM fuse 18 (5A).
- Inspect the Integrated Keyhead Transmitter (IKT).

PINPOINT TEST A : ENGINE DOES NOT CRANK - WITHOUT PUSH-BUTTON START

|                                                                                                           |
|-----------------------------------------------------------------------------------------------------------|
| <b>NOTE:</b> Make sure battery voltage is greater than 12.2 volts prior to and during this pinpoint test. |
| <b>NOTE:</b> Do not have a battery charger attached during vehicle testing.                               |
| <b>A1 PERFORM INSPECTION AND VERIFICATION</b>                                                             |
|                                                                                                           |

- Perform Inspection and Verification procedure in this section.

**Was an obvious cause for an observed or reported concern found?**

|            |                                 |
|------------|---------------------------------|
| <b>Yes</b> | Correct the cause as necessary. |
| <b>No</b>  | GO to <a href="#">A2</a>        |

## **A2 VERIFY THE BCM (BODY CONTROL MODULE) AND PCM (POWERTRAIN CONTROL MODULE) PASS THE NETWORK TEST**

- Ignition ON.
- Using a diagnostic scan tool, perform the Network Test.

**Did the BCM and PCM pass the Network Test?**

|            |                                                                                                                 |
|------------|-----------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">A3</a>                                                                                        |
| <b>No</b>  | REFER to: <a href="#">Communications Network</a> (418-00 Module Communications Network, Diagnosis and Testing). |

## **A3 RETRIEVE DIAGNOSTIC TROUBLE CODES (DTCS)**

- Using a diagnostic scan tool, perform BCM and PCM self-tests.

**Are any Diagnostic Trouble Codes (DTCs) present?**

|            |                                                                                                                                                                                                                                                                                                                                      |
|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | For all BCM Diagnostic Trouble Codes (DTCs), refer to the BCM DTC Chart in this section.<br>For PCM DTC P06E9, GO to <a href="#">A4</a><br>For all other PCM Diagnostic Trouble Codes (DTCs),<br>REFER to: <a href="#">Electronic Engine Controls</a> (303-14D Electronic Engine Controls - 5.0L 32V Ti-VCT, Diagnosis and Testing). |
| <b>No</b>  | GO to <a href="#">A4</a>                                                                                                                                                                                                                                                                                                             |

## **A4 CHECK BCM (BODY CONTROL MODULE) IGN\_SW\_STATE PID (PARAMETER IDENTIFICATION)**



- Using a diagnostic scan tool, view the BCM Parameter Identifications (PIDs).
- Monitor the BCM PID IGN\_SW\_STATE while turning the ignition switch from OFF to START.

**Does the PID change from Off to Start when the ignition switch is turned from OFF to START?**

|            |                                                                                                                                                                                           |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">A5</a>                                                                                                                                                                  |
| <b>No</b>  | DIAGNOSE No power in Start.<br>REFER to: <a href="#">Steering Wheel and Column Electrical Components</a> (211-05 Steering Wheel and Column Electrical Components, Diagnosis and Testing). |

#### **A5 CHECK THE PCM (POWERTRAIN CONTROL MODULE) IN GEAR-TRANSMISSION IS APPLYING A LOAD TO ENGINE (IN\_GEAR) PID (PARAMETER IDENTIFICATION)**

- Using a diagnostic scan tool, view the PCM Parameter Identifications (PIDs).
- Monitor the PCM PID IN\_GEAR, while placing the gear selector in PARK and then NEUTRAL.

**Does the PID read No in both positions?**

|            |                                                                                                                                                                                                        |
|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">A6</a>                                                                                                                                                                               |
| <b>No</b>  | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |

#### **A6 CHECK THE PCM (POWERTRAIN CONTROL MODULE) ENGINE CRANKING (ENG\_CRANK) PID (PARAMETER IDENTIFICATION)**

- Make sure the transmission is in PARK or NEUTRAL.
- Using a diagnostic scan tool, view the PCM Parameter Identifications (PIDs).
- Monitor the PCM PID ENG\_CRANK while turning the ignition switch to the START position.

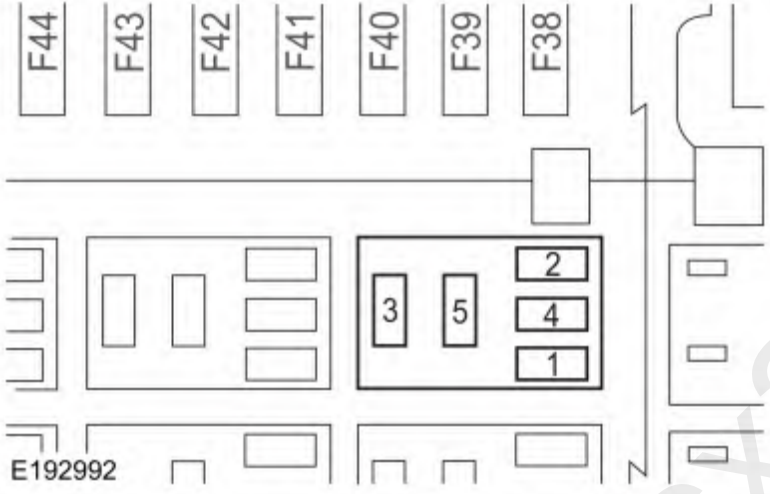
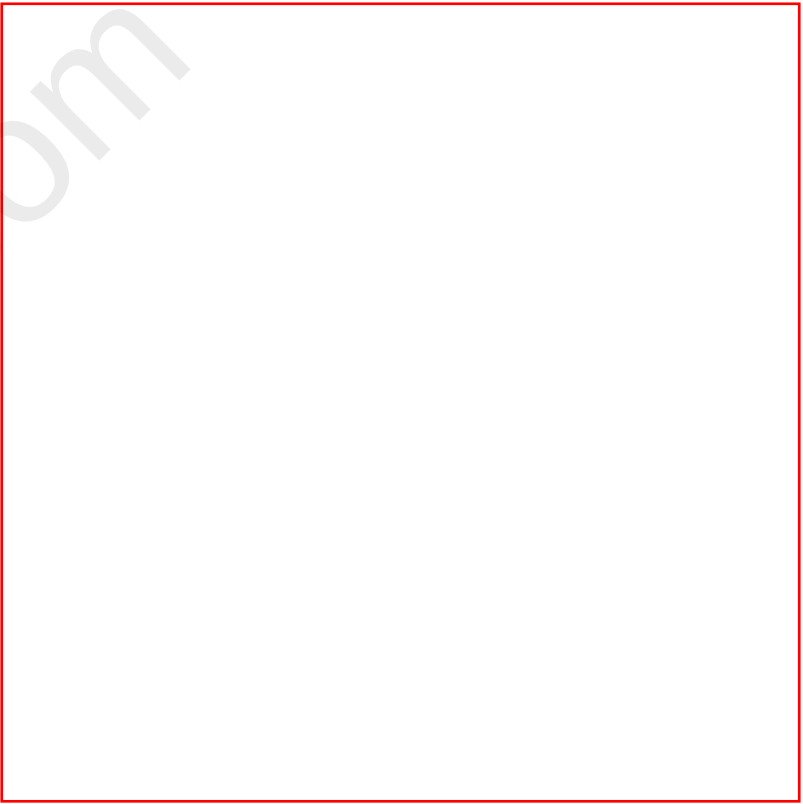
**Does the PID change from Inactive to Active?**

|            |                           |
|------------|---------------------------|
| <b>Yes</b> | GO to <a href="#">A7</a>  |
| <b>No</b>  | GO to <a href="#">A17</a> |

A7 CHECK THE STARTER RELAY CONTROL OPERATION

**NOTICE:** The following step uses a test light to simulate normal circuit loads. Use only the test light recommended in the Special Tools table at the beginning of this section. To avoid connector terminal damage, use the Flex Probe Kit for the test light probe connection to the vehicle. Do not use the test light probe directly on any connector.

- Remove the BJB starter relay.
- Measure:

| Positive Lead                                                                                                    | Measurement / Action                                                                | Negative Lead                                                                                                       |
|------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|
|  <p>BJB starter relay pin 1</p> |  |  <p>BJB starter relay pin 2</p> |

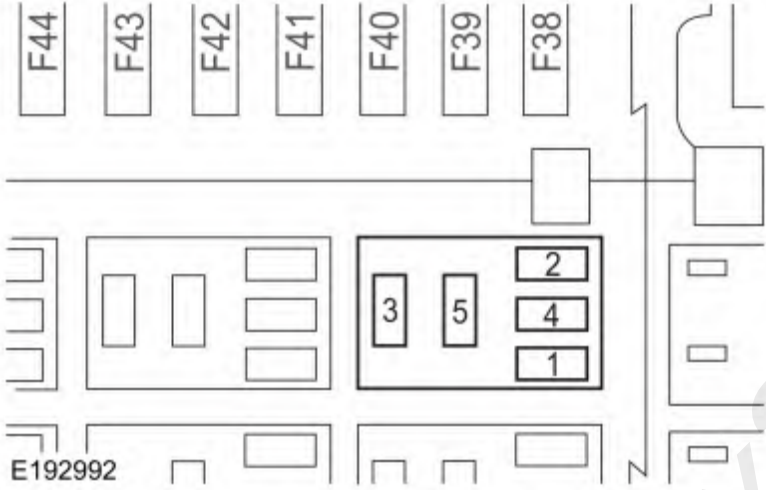
- Make sure the transmission is in PARK or NEUTRAL.
- While holding the key in the START position, observe the test light.

**Does the test light illuminate when the key is in the START position?**

|            |                           |
|------------|---------------------------|
| <b>Yes</b> | GO to <a href="#">A8</a>  |
| <b>No</b>  | GO to <a href="#">A15</a> |

#### A8 CHECK THE VOLTAGE TO THE STARTER RELAY

- Measure:

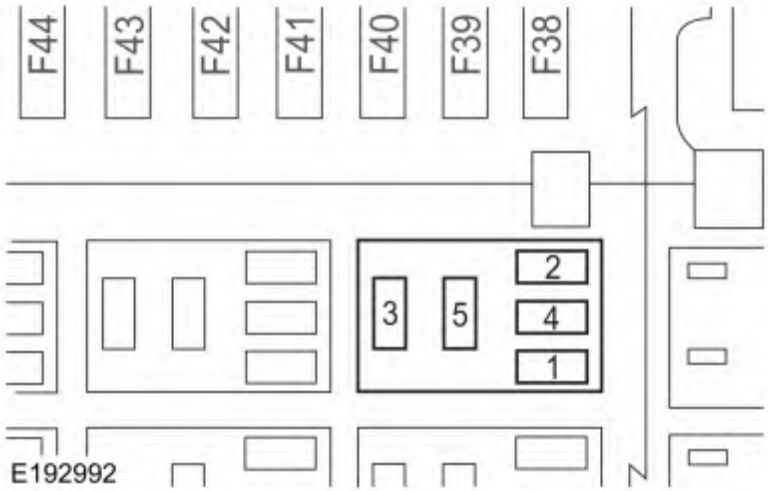
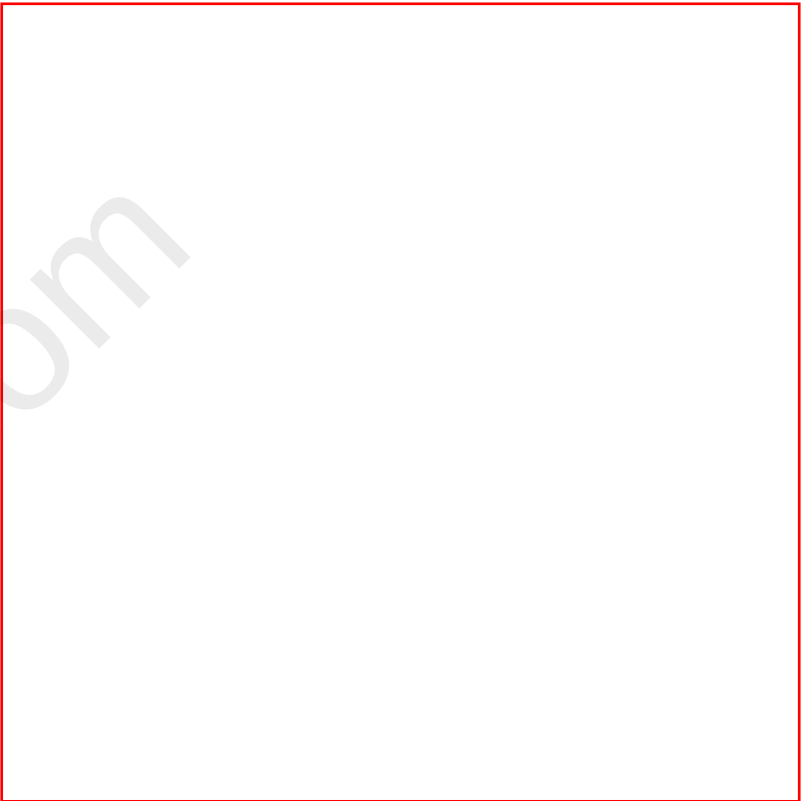
| Positive Lead                                                                                                    | Measurement / Action                                                                | Negative Lead |
|------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|---------------|
|  <p>BJB starter relay pin 3</p> |  | Ground        |

Is the voltage greater than 11 volts?

|            |                                                                                                                                                                                |
|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">A9</a>                                                                                                                                                       |
| <b>No</b>  | VERIFY the BJB fuse 5 (30A) is OK. If OK, REPAIR the circuit for an open. If not OK, REFER to the Wiring Diagrams manual to identify the possible causes of the circuit short. |

#### A9 CHECK THE STARTER MOTOR OPERATION AT THE STARTER RELAY

- Ignition OFF.
- With the transmission in PARK or NEUTRAL, momentarily connect a fused jumper wire:

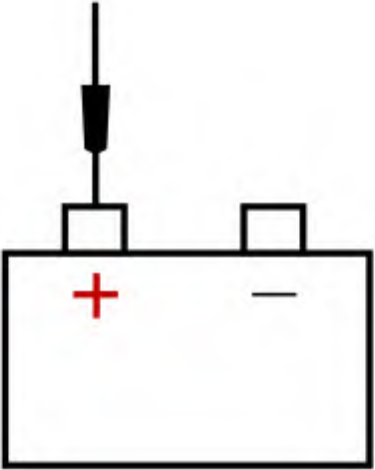
| Positive Lead                                                                                                    | Measurement / Action                                                               | Negative Lead                                                                                                       |
|------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|
|  <p>BJB starter relay pin 3</p> |  |  <p>BJB starter relay pin 5</p> |

Did the starter engage and the engine crank?

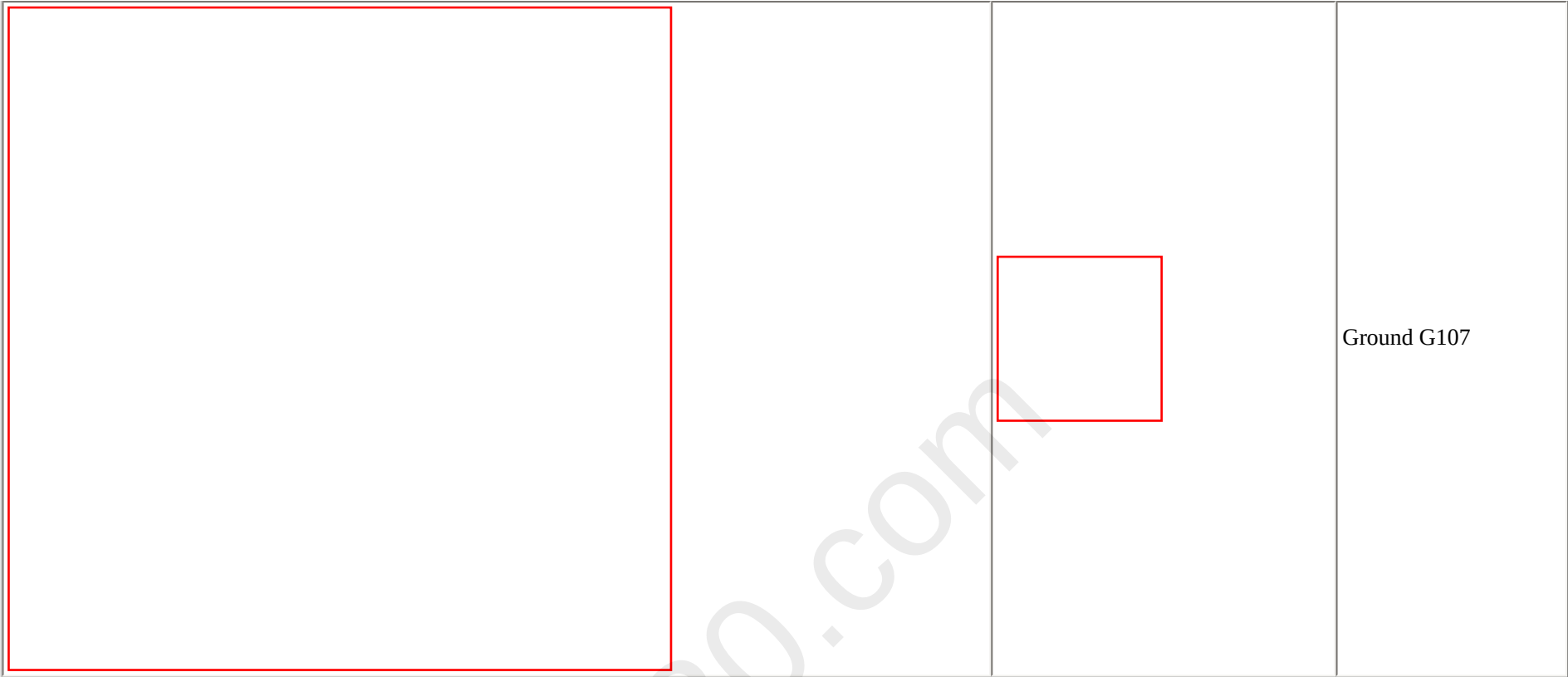
|     |                              |
|-----|------------------------------|
| Yes | INSTALL a new starter relay. |
| No  | GO to <a href="#">A10</a>    |

A10 CHECK THE BATTERY GROUND CABLES

- Measure:

| Positive Lead                                                                                              | Measurement / Action | Negative Lead |
|------------------------------------------------------------------------------------------------------------|----------------------|---------------|
| <div><p>E148840</p></div> | <div></div>          | Ground G105   |
| <div></div>                                                                                                | <div></div>          | Ground G106   |



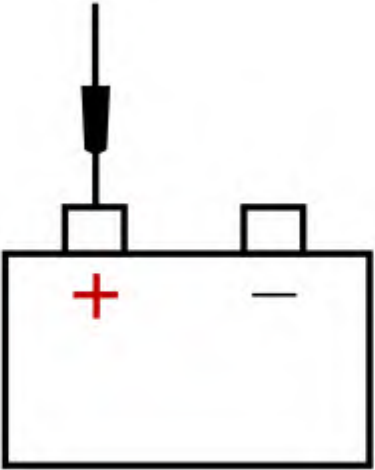
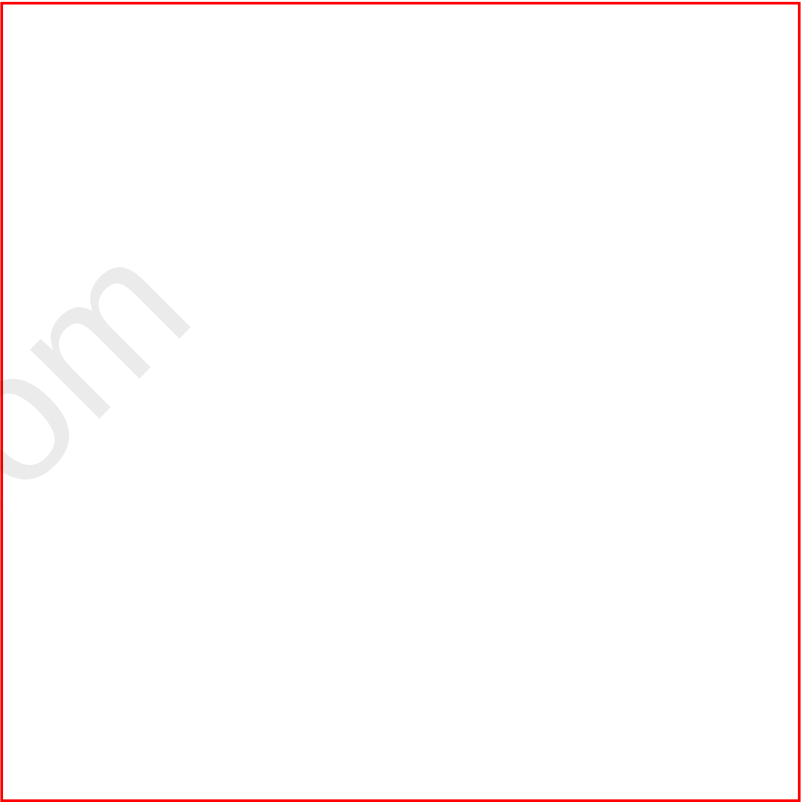


Are the voltages greater than 11 volts?

|     |                                                                                                                                                                                           |
|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Yes | GO to <a href="#">A11</a>                                                                                                                                                                 |
| No  | CLEAN or INSTALL new negative battery cables as necessary.<br>REFER to: <a href="#">Battery Cables - 5.0L 32V Ti-VCT</a> (414-01 Battery, Mounting and Cables, Removal and Installation). |

**A11 CHECK THE STARTER MOTOR GROUND**

- Measure:

| Positive Lead                                                                                              | Measurement / Action                                                                          | Negative Lead                                                                                                            |
|------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| <div><p>E148840</p></div> | <div></div> | <div><p>Starter motor case</p></div> |

Is the voltage greater than 11 volts?

|     |                                                                                               |
|-----|-----------------------------------------------------------------------------------------------|
| Yes | GO to <a href="#">A12</a>                                                                     |
| No  | CLEAN the starter motor mounting flange and MAKE SURE the starter motor is correctly mounted. |

**A12 CHECK THE VOLTAGE TO THE STARTER MOTOR**

**Is the voltage greater than 11 volts?**

|            |                                                                                                                                                                      |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">A13</a>                                                                                                                                            |
| <b>No</b>  | INSTALL a new positive battery cable.<br>REFER to: <a href="#">Battery Cables - 5.0L 32V Ti-VCT</a> (414-01 Battery, Mounting and Cables, Removal and Installation). |

#### **A13 CHECK THE STARTER MOTOR FOR CORRECT OPERATION**

- Perform Starter Motor - Positive Circuit Test in this section.

**Was an obvious cause found?**

|            |                                 |
|------------|---------------------------------|
| <b>Yes</b> | Correct the cause as necessary. |
| <b>No</b>  | GO to <a href="#">A14</a>       |

#### **A14 CHECK FOR START INPUT AT THE STARTER**

- Connect BJB starter relay.
- Disconnect Starter solenoid C1100B.

**Is the voltage greater than 11 volts?**

|            |                                                                                                                                                        |
|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | CLEAN the starter solenoid "S" terminal and starter solenoid connector. CHECK the wiring and the starter motor for a loose or intermittent connection. |
| <b>No</b>  | REPAIR the circuit for an open.                                                                                                                        |

#### **A15 CHECK THE PCM (POWERTRAIN CONTROL MODULE) STARTER RELAY CONTROL CIRCUITS FOR A SHORT TO GROUND**

- Ignition OFF.
- Disconnect PCM C1381B.

**Are the resistances greater than 10,000 ohms?**

|            |                              |
|------------|------------------------------|
| <b>Yes</b> | GO to <a href="#">A16</a>    |
| <b>No</b>  | REPAIR the affected circuit. |

#### **A16 CHECK THE PCM (POWERTRAIN CONTROL MODULE) STARTER RELAY CONTROL CIRCUITS FOR AN OPEN**

**Are the resistances less than 3 ohms?**

|            |                              |
|------------|------------------------------|
| <b>Yes</b> | GO to <a href="#">A17</a>    |
| <b>No</b>  | REPAIR the affected circuit. |

#### **A17 CHECK FOR CORRECT PCM (POWERTRAIN CONTROL MODULE) OPERATION**

- Ignition OFF.
- Disconnect and inspect all PCM connectors.
- Repair:
  - corrosion (install new connectors or terminals - clean module pins)
  - damaged or bent pins - install new terminals/pins
  - pushed-out pins - install new pins as necessary
- Reconnect the PCM connectors. Make sure they seat and latch correctly.
- Operate the system and determine if the concern is still present.

**Is the concern still present?**

|            |                                                                                                                                                                                                                                                                                                                                                                                              |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | CHECK OASIS for any applicable Technical Service Bulletins (TSBs). If a TSB exists for this concern, DISCONTINUE this test and FOLLOW the TSB instructions. If no Technical Service Bulletins (TSBs) address this concern, INSTALL a new PCM.<br>REFER to: <a href="#">Powertrain Control Module (PCM)</a> (303-14D Electronic Engine Controls - 5.0L 32V Ti-VCT, Removal and Installation). |
| <b>No</b>  | The system is operating correctly at this time. The concern may have been caused by module connections. ADDRESS the root cause of any connector or pin issues.                                                                                                                                                                                                                               |

Engine Does Not Crank - with Push-Button Start

Refer to Wiring Diagrams Cell 20 for schematic and connector information.

Normal Operation and Fault Conditions

REFER to: [Starting System - System Operation and Component Description](#) (303-06D Starting System - 5.0L 32V Ti-VCT, Description and Operation).

DTC Fault Trigger Conditions

| DTC   | Description                | Fault Trigger Conditions                       |
|-------|----------------------------|------------------------------------------------|
| P06E9 | Engine Starter Performance | No engine rotation detected during crank event |

Possible Sources

- Battery
- Battery cables
- IPC
- Starter motor
- BJB starter relay

Visual Inspection and Diagnostic Pre-checks

- Inspect the Run/start relay.
- Inspect the high current BJB connections.
- Verify the BJB fuse 5 (30A).
- Verify the BCM fuse 18 (5A).
- Inspect the Integrated Keyhead Transmitter (IKT).

PINPOINT TEST B : ENGINE DOES NOT CRANK - WITH PUSH-BUTTON START

|                                               |
|-----------------------------------------------|
| <b>B1 PERFORM INSPECTION AND VERIFICATION</b> |
|                                               |



- Perform Inspection and Verification procedure in this section.

**Was an obvious cause for an observed or reported concern found?**

|            |                                 |
|------------|---------------------------------|
| <b>Yes</b> | Correct the cause as necessary. |
| <b>No</b>  | GO to <a href="#">B2</a>        |

**B2 CHECK FOR NO KEY DETECTED MESSAGE IN THE MESSAGE CENTER**

- **NOTE:** *There are certain areas inside the vehicle where the IA key may not be detected and the message center displays NO KEY DETECTED. If the IA key is in the far outside edges of the interior (like in a door map pocket or above a sun visor) it might not be detected. Move the IA key to a different location and try to start the vehicle again.*

Check the message displayed in the message center while pressing the ignition switch - push button start.

**Is NO KEY DETECTED displayed?**

|            |                                                                                                                                                                        |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | Diagnose the NO KEY DETECTED concern.<br>REFER to: <a href="#">Passive Anti-Theft System (PATS)</a> (419-01B Passive Anti-Theft System (PATS), Diagnosis and Testing). |
| <b>No</b>  | GO to <a href="#">B3</a>                                                                                                                                               |

**B3 VERIFY THE BCM (BODY CONTROL MODULE) AND PCM (POWERTRAIN CONTROL MODULE) PASS THE NETWORK TEST**

- Ignition ON.
- Using a diagnostic scan tool, perform the Network Test.

**Did the BCM and PCM pass the Network Test?**

|            |                                                                                                                 |
|------------|-----------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">B4</a>                                                                                        |
| <b>No</b>  | REFER to: <a href="#">Communications Network</a> (418-00 Module Communications Network, Diagnosis and Testing). |

**B4 RETRIEVE DIAGNOSTIC TROUBLE CODES (DTCS)**

- Using a diagnostic scan tool, perform BCM and PCM self-tests.

**Are any Diagnostic Trouble Codes (DTCs) present?**

|            |                                                                                                                                                                                                                                                                                                                                     |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | For all BCM Diagnostic Trouble Codes (DTCs), refer to the BCM DTC Chart in this section.<br>For PCM DTC P06E9 GO to <a href="#">B5</a><br>For all other PCM Diagnostic Trouble Codes (DTCs),<br>REFER to: <a href="#">Electronic Engine Controls</a> (303-14D Electronic Engine Controls - 5.0L 32V Ti-VCT, Diagnosis and Testing). |
| <b>No</b>  | GO to <a href="#">B5</a>                                                                                                                                                                                                                                                                                                            |

**B5 CHECK THE OPERATION OF THE STOPLAMPS**

- While observing the stoplamps, apply the brake pedal.

**Do the stoplamps illuminate?**

|            |                                                                               |
|------------|-------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">B6</a>                                                      |
| <b>No</b>  | Diagnose All the Stoplamps are inoperative.<br>REFER to: Stoplamps (417-01) . |

**B6 CHECK THE BRAKE PEDAL POSITION (BOO1) PID (PARAMETER IDENTIFICATION)**

- Using a diagnostic scan tool, view PCM Parameter Identifications (PIDs)
- Monitor the PCM B001 PID while applying the brake pedal.

**Does the PID read On?**

|            |                          |
|------------|--------------------------|
| <b>Yes</b> | GO to <a href="#">B8</a> |
| <b>No</b>  | GO to <a href="#">B7</a> |

**B7 CHECK THE BPP (BRAKE PEDAL POSITION) SWITCH CIRCUIT FOR VOLTAGE AT THE PCM (POWERTRAIN CONTROL MODULE)**

- Ignition OFF.
- Disconnect PCM C1381B.

**Is the voltage greater than 11 volts?**

|            |                           |
|------------|---------------------------|
| <b>Yes</b> | GO to <a href="#">B21</a> |
| <b>No</b>  | REPAIR the circuit.       |

#### **B8 CHECK BCM (BODY CONTROL MODULE) IGN\_SW\_STATE PID (PARAMETER IDENTIFICATION)**

- Using a diagnostic scan tool, view the BCM Parameter Identifications (PIDs).
- Make sure the transmission is in PARK or NEUTRAL.
- Monitor the BCM PID IGN\_SW\_STATE while pressing the ignition switch - push button start and the brake pedal.

**Does the PID change from Off to Start when the ignition switch - push button start and the brake pedal are pressed?**

|            |                                                                                                                                                                                           |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">B9</a>                                                                                                                                                                  |
| <b>No</b>  | DIAGNOSE No power in Start.<br>REFER to: <a href="#">Steering Wheel and Column Electrical Components</a> (211-05 Steering Wheel and Column Electrical Components, Diagnosis and Testing). |

#### **B9 CHECK THE PCM (POWERTRAIN CONTROL MODULE) IN GEAR-TRANSMISSION IS APPLYING A LOAD TO ENGINE (IN\_GEAR) PID (PARAMETER IDENTIFICATION)**

- Using a diagnostic scan tool, view the PCM Parameter Identifications (PIDs).
- Monitor the PCM PID IN\_GEAR, while placing the gear selector in PARK and then NEUTRAL.

**Does the PID read No in both positions?**

|            |                                                                                                                                                                                                        |
|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">B10</a>                                                                                                                                                                              |
| <b>No</b>  | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |

**B10 CHECK THE PCM (POWERTRAIN CONTROL MODULE) ENGINE CRANKING (ENG\_CRANK) PID (PARAMETER IDENTIFICATION)**

- Make sure the transmission is in PARK or NEUTRAL.
- Using a diagnostic scan tool, view the PCM Parameter Identifications (PIDs).
- Monitor the PCM PID ENG\_CRANK while pressing the ignition switch - push button start and the brake pedal.

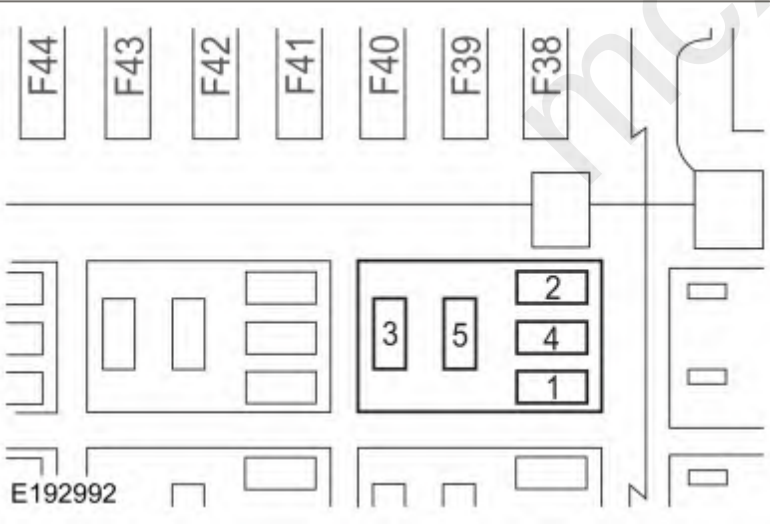
Does the PID change from Inactive to Active?

|     |                           |
|-----|---------------------------|
| Yes | GO to <a href="#">B11</a> |
| No  | GO to <a href="#">B21</a> |

**B11 CHECK THE STARTER RELAY CONTROL OPERATION**

**NOTICE:** The following step uses a test light to simulate normal circuit loads. Use only the test light recommended in the Special Tools table at the beginning of this section. To avoid connector terminal damage, use the Flex Probe Kit for the test light probe connection to the vehicle. Do not use the test light probe directly on any connector.

- Remove the BJB starter relay.
- Measure:

| Positive Lead                                                                                                 | Measurement / Action | Negative Lead |
|---------------------------------------------------------------------------------------------------------------|----------------------|---------------|
| <br>BJB starter relay pin 1 | <div></div>          |               |

BJB starter relay pin 2

- Make sure the transmission is in PARK or NEUTRAL.
- While pressing the ignition switch - push button start and the brake pedal, observe the test light.

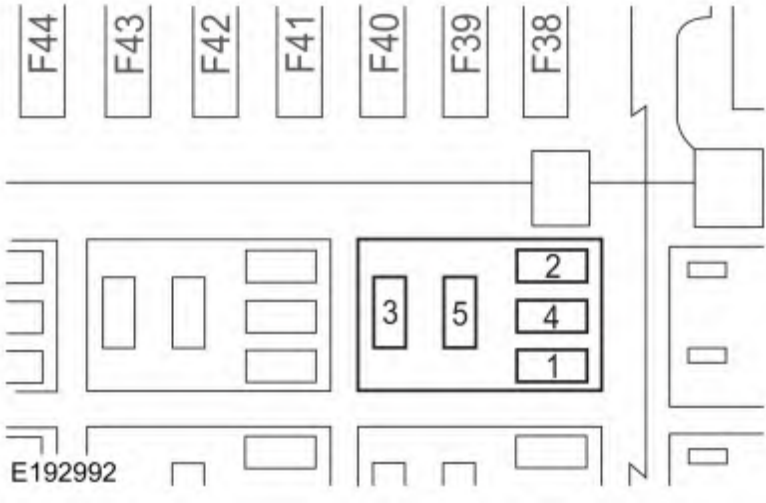
**Does the test light illuminate when the ignition switch - push button start is pressed?**

|            |                           |
|------------|---------------------------|
| <b>Yes</b> | GO to <a href="#">B12</a> |
| <b>No</b>  | GO to <a href="#">B19</a> |

## **B12 CHECK THE VOLTAGE TO THE STARTER RELAY**



- Measure:

| Positive Lead                                                                                                    | Measurement / Action                                                                | Negative Lead |
|------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|---------------|
|  <p>BJB starter relay pin 3</p> |  | Ground        |

Is the voltage greater than 11 volts?

|     |                                                                                                                                                                            |
|-----|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Yes | GO to <a href="#">B13</a>                                                                                                                                                  |
| No  | VERIFY BJB fuse 5 (30A) is OK. If OK, REPAIR the circuit for an open. If not OK, REFER to the Wiring Diagrams manual to identify the possible causes of the circuit short. |

**B13 CHECK THE STARTER MOTOR OPERATION AT THE STARTER RELAY**

- Ignition OFF.
- With the transmission in PARK or NEUTRAL, momentarily connect a fused jumper wire:

| Positive Lead | Measurement / Action | Negative Lead |
|---------------|----------------------|---------------|
|               |                      |               |

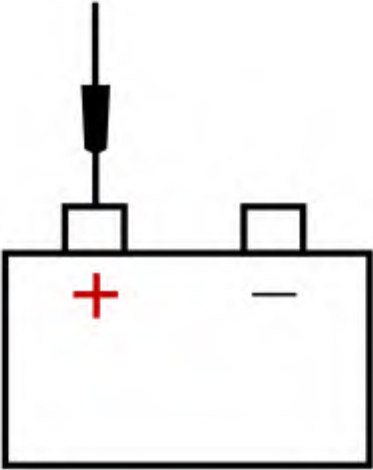


om

|            |                              |
|------------|------------------------------|
| <b>Yes</b> | INSTALL a new starter relay. |
| <b>No</b>  | GO to <a href="#">B14</a>    |

## B14 CHECK THE BATTERY GROUND CABLES

- Measure:

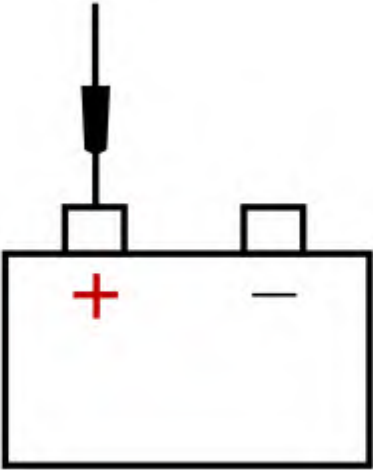
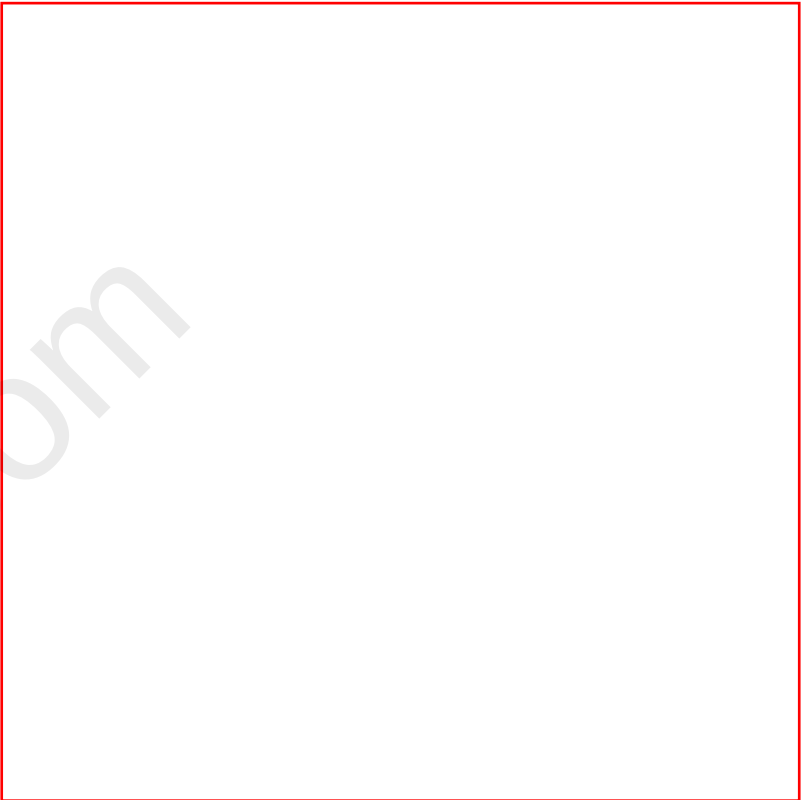
| Positive Lead                                                                                              | Measurement / Action | Negative Lead |
|------------------------------------------------------------------------------------------------------------|----------------------|---------------|
| <div><p>E148840</p></div> | <div></div>          | Ground G105   |
| <div></div>                                                                                                | <div></div>          | Ground G106   |

Are the voltages greater than 11 volts?

|     |                                                                                                                                                                                           |
|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Yes | GO to <a href="#">B15</a>                                                                                                                                                                 |
| No  | CLEAN or INSTALL new negative battery cables as necessary.<br>REFER to: <a href="#">Battery Cables - 5.0L 32V Ti-VCT</a> (414-01 Battery, Mounting and Cables, Removal and Installation). |

**B15 CHECK THE STARTER MOTOR GROUND**

- Measure:

| Positive Lead                                                                                        | Measurement / Action                                                               | Negative Lead                                                                                                      |
|------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|
| <div>E148840</div>  |  |  <div>Starter motor case</div> |

Is the voltage greater than 11 volts?

|     |                                                                                                                                                                                                                 |
|-----|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Yes | GO to <a href="#">B16</a>                                                                                                                                                                                       |
| No  | CLEAN the starter motor mounting flange and MAKE SURE the starter motor is correctly mounted.<br>REFER to: <a href="#">Starter Motor</a> (303-06D Starting System - 5.0L 32V Ti-VCT, Removal and Installation). |

**B16 CHECK THE VOLTAGE TO THE STARTER MOTOR**



**Is the voltage greater than 11 volts?**

|            |                                                                                                                                                                      |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">B17</a>                                                                                                                                            |
| <b>No</b>  | INSTALL a new positive battery cable.<br>REFER to: <a href="#">Battery Cables - 5.0L 32V Ti-VCT</a> (414-01 Battery, Mounting and Cables, Removal and Installation). |

#### **B17 CHECK THE STARTER MOTOR FOR CORRECT OPERATION**

- Perform Starter Motor - Positive Circuit Test in this section.

**Was an obvious cause found?**

|            |                                 |
|------------|---------------------------------|
| <b>Yes</b> | Correct the cause as necessary. |
| <b>No</b>  | GO to <a href="#">B18</a>       |

#### **B18 CHECK FOR START INPUT AT THE STARTER**

- Connect BJB starter relay.
- Disconnect Starter solenoid C1100B.

**Is the voltage greater than 11 volts?**

|            |                                                                                                                                                        |
|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | CLEAN the starter solenoid "S" terminal and starter solenoid connector. CHECK the wiring and the starter motor for a loose or intermittent connection. |
| <b>No</b>  | REPAIR the circuit for an open.                                                                                                                        |

#### **B19 CHECK THE PCM (POWERTRAIN CONTROL MODULE) STARTER RELAY CONTROL CIRCUITS FOR A SHORT TO GROUND**

- Ignition OFF.
- Disconnect PCM C1381B.

**Are the resistances greater than 10,000 ohms?**

|            |                              |
|------------|------------------------------|
| <b>Yes</b> | GO to <a href="#">B20</a>    |
| <b>No</b>  | REPAIR the affected circuit. |

## **B20 CHECK THE PCM (POWERTRAIN CONTROL MODULE) STARTER RELAY CIRCUITS FOR AN OPEN**

**Are the resistances less than 3 ohms?**

|            |                              |
|------------|------------------------------|
| <b>Yes</b> | GO to <a href="#">B21</a>    |
| <b>No</b>  | REPAIR the affected circuit. |

## **B21 CHECK FOR CORRECT PCM (POWERTRAIN CONTROL MODULE) OPERATION**

- Ignition OFF.
- Disconnect and inspect all PCM connectors.
- Repair:
  - corrosion (install new connectors or terminals - clean module pins)
  - damaged or bent pins - install new terminals/pins
  - pushed-out pins - install new pins as necessary
- Reconnect the PCM connectors. Make sure they seat and latch correctly.
- Operate the system and determine if the concern is still present.

**Is the concern still present?**

|            |                                                                                                                                                                                                                                                                                                                                                                                              |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | CHECK OASIS for any applicable Technical Service Bulletins (TSBs). If a TSB exists for this concern, DISCONTINUE this test and FOLLOW the TSB instructions. If no Technical Service Bulletins (TSBs) address this concern, INSTALL a new PCM.<br>REFER to: <a href="#">Powertrain Control Module (PCM)</a> (303-14D Electronic Engine Controls - 5.0L 32V Ti-VCT, Removal and Installation). |
| <b>No</b>  | The system is operating correctly at this time. The concern may have been caused by module connections. ADDRESS the root cause of any connector or pin issues.                                                                                                                                                                                                                               |

Unusual Starter Noise

Normal Operation and Fault Conditions

Correct starter operation relies on correct mounting of the starter to the engine, alignment of the starter ring gear to the flexplate and correct functioning of the starter assembly (internal gears, bearings).

Possible Sources

- Engine
- Starter motor
- Starter motor mounting

Visual Inspection and Diagnostic Pre-checks

- Inspect the starter motor.
- Inspect the starter motor mounting.

PINPOINT TEST C : UNUSUAL STARTER NOISE

|                                                                                                     |                                                                                                                                                        |
|-----------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| C1 CHECK THE STARTER MOUNTING                                                                       |                                                                                                                                                        |
| <ul style="list-style-type: none"><li>• Inspect the starter mounting bolts for looseness.</li></ul> |                                                                                                                                                        |
| Is the starter motor mounted correctly?                                                             |                                                                                                                                                        |
| Yes                                                                                                 | GO to <a href="#">C2</a>                                                                                                                               |
| No                                                                                                  | INSTALL the starter motor correctly.<br>REFER to: <a href="#">Starter Motor</a> (303-06D Starting System - 5.0L 32V Ti-VCT, Removal and Installation). |
| C2 CHECK FOR STARTER NOISE                                                                          |                                                                                                                                                        |
|                                                                                                     |                                                                                                                                                        |

- Ignition OFF.
- Connect a remote starter switch between the starter solenoid C1100A-1 ("B" terminal) and C1100B-1 ("S" terminal).
- Engage the starter and verify the noise is due to starter operation.

#### Is the noise due to the starter engagement?

|     |                                                                                                                                                       |
|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| Yes | REFER to: <a href="#">Starter Motor Drive Gear and Flywheel Ring Gear Inspection</a> (303-06D Starting System - 5.0L 32V Ti-VCT, General Procedures). |
| No  | REFER to: <a href="#">Engine</a> (303-00 Engine System - General Information, Diagnosis and Testing).<br>to continue diagnosis.                       |

#### C113A:11 or C113A:15

Refer to Wiring Diagrams Cell 23 for schematic and connector information.

#### Normal Operation and Fault Conditions

The wake-up control circuit wakes up the PCM prior to the engine cranking. The PCM needs to wake up prior to a crank request so it has time to go through its initialization. The wake-up control circuit is controlled by the BCM. The BCM activates the wake-up control circuit when the driver door is opened, a key is inserted into the ignition, or when the ignition is in the ON or START position.

#### DTC Fault Trigger Conditions

| DTC      | Description                                          | Fault Trigger Conditions                                                                      |
|----------|------------------------------------------------------|-----------------------------------------------------------------------------------------------|
| C113A:11 | PCM Wake-up Signal: Circuit Short to Ground          | Set by the BCM when a short to ground is detected on the wake-up control circuit.             |
| C113A:15 | PCM Wake-up Signal: Circuit Short to Battery or Open | Set by the BCM when a short to voltage or an open is detected on the wake-up control circuit. |

#### Possible Sources

- BCM
- PCM
- Wiring, terminals or connectors

## PINPOINT TEST D : C113A:11 OR C113A:15

### D1 CHECK FOR BCM (BODY CONTROL MODULE) DTCS

- Ignition ON.
- Using a diagnostic scan tool, perform the BCM self-test.

#### Is DTC C113A:11 present?

|     |                                                                                                                                                                                                                                     |
|-----|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Yes | GO to <a href="#">D2</a>                                                                                                                                                                                                            |
| No  | If DTC C113A:15 is present, GO to <a href="#">D4</a><br>For all other BCM Diagnostic Trouble Codes (DTCs),<br>REFER to: <a href="#">Body Control Module (BCM)</a> (419-10 Multifunction Electronic Modules, Diagnosis and Testing). |

### D2 CHECK THE PCM (POWERTRAIN CONTROL MODULE) FOR A SHORT TO GROUND

- Ignition OFF.
- Disconnect PCM C1381B.
- Ignition ON.
- Using a diagnostic scan tool, clear the BCM Diagnostic Trouble Codes (DTCs).
- Using a diagnostic scan tool, perform the BCM self-test.

#### Is BCM DTC C113A:11 present?

|     |                          |
|-----|--------------------------|
| Yes | GO to <a href="#">D3</a> |
| No  | GO to <a href="#">D7</a> |

### D3 CHECK THE PCM (POWERTRAIN CONTROL MODULE) WAKE-UP SIGNAL CIRCUIT FOR A SHORT TO GROUND



- Ignition OFF.

**Is the resistance greater than 10,000 ohms?**

|            |                          |
|------------|--------------------------|
| <b>Yes</b> | GO to <a href="#">D7</a> |
| <b>No</b>  | REPAIR the circuit.      |

#### **D4 CHECK THE PCM (POWERTRAIN CONTROL MODULE) WAKE-UP SIGNAL CIRCUIT FOR A SHORT TO VOLTAGE**

- Ignition OFF.
- Disconnect PCM C1381B if necessary.
- Disconnect BCM C2280F.
- Ignition ON.

**Is any voltage present?**

|            |                          |
|------------|--------------------------|
| <b>Yes</b> | REPAIR the circuit.      |
| <b>No</b>  | GO to <a href="#">D5</a> |

#### **D5 CHECK THE PCM (POWERTRAIN CONTROL MODULE) WAKE-UP SIGNAL CIRCUIT FOR AN OPEN**

- Ignition OFF.

**Is the resistance less than 3 ohms?**

|            |                          |
|------------|--------------------------|
| <b>Yes</b> | GO to <a href="#">D6</a> |
| <b>No</b>  | REPAIR the circuit.      |

#### **D6 CHECK FOR CORRECT BCM (BODY CONTROL MODULE) OPERATION**

- Ignition OFF.
- Disconnect and inspect all BCM connectors.
- Repair:
  - corrosion (install new connectors or terminals - clean module pins)
  - damaged or bent pins - install new terminals/pins
  - pushed-out pins - install new pins as necessary
- Reconnect the BCM connectors. Make sure they seat and latch correctly.
- Operate the system and determine if the concern is still present.

#### Is the concern still present?

|            |                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | CHECK OASIS for any applicable Technical Service Bulletins (TSBs). If a TSB exists for this concern, DISCONTINUE this test and FOLLOW the TSB instructions. If no Technical Service Bulletins (TSBs) address this concern,   <a href="#">Click here to access Guided Routine (BCM).</a> |
| <b>No</b>  | The system is operating correctly at this time. The concern may have been caused by module connections. ADDRESS the root cause of any connector or pin issues.                                                                                                                                                                                                                                                                                                |

### D7 CHECK FOR CORRECT PCM (POWERTRAIN CONTROL MODULE) OPERATION

- Ignition OFF.
- Disconnect and inspect all PCM connectors.
- Repair:
  - corrosion (install new connectors or terminals - clean module pins)
  - damaged or bent pins - install new terminals/pins
  - pushed-out pins - install new pins as necessary
- Reconnect the PCM connectors. Make sure they seat and latch correctly.
- Operate the system and determine if the concern is still present.

#### Is the concern still present?

|            |                                                                                                                                                                                                                                                                                                                                                                                              |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | CHECK OASIS for any applicable Technical Service Bulletins (TSBs). If a TSB exists for this concern, DISCONTINUE this test and FOLLOW the TSB instructions. If no Technical Service Bulletins (TSBs) address this concern, INSTALL a new PCM.<br>REFER to: <a href="#">Powertrain Control Module (PCM)</a> (303-14D Electronic Engine Controls - 5.0L 32V Ti-VCT, Removal and Installation). |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

|    |                                                                                                                                                                |
|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| No | The system is operating correctly at this time. The concern may have been caused by module connections. ADDRESS the root cause of any connector or pin issues. |
|----|----------------------------------------------------------------------------------------------------------------------------------------------------------------|

**P2535 (without Push Button Start)**

Refer to Wiring Diagrams Cell 20 for schematic and connector information.

**Normal Operation and Fault Conditions**

When the ignition is turned to the START position the PCM receives a voltage signal on the crank detect circuit. The PCM then supplies voltage and ground to the starter relay coil when the required inputs have been received.

**DTC Fault Trigger Conditions**

| DTC   | Description                                     | Fault Trigger Conditions                                                                            |
|-------|-------------------------------------------------|-----------------------------------------------------------------------------------------------------|
| P2535 | Ignition Switch Run/Start Position Circuit High | This DTC sets when the PCM detects voltage on the crank detect circuit while the engine is running. |

**Possible Sources**

- BCM
- Ignition switch
- PCM
- Wiring, terminals or connectors

**PINPOINT TEST E : DTC P2535 (WITHOUT PUSH BUTTON START)**

|                                                    |
|----------------------------------------------------|
| <b>E1 RETRIEVE DIAGNOSTIC TROUBLE CODES (DTCS)</b> |
|                                                    |

- Ignition ON.
- Using a diagnostic scan tool, perform PCM self-tests.

**Is DTC P2535 recorded?**

|            |                                                                                          |
|------------|------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">E2</a>                                                                 |
| <b>No</b>  | For all PCM Diagnostic Trouble Codes (DTCs), refer to the PCM DTC Chart in this section. |

**E2 CHECK THE CRANK DETECT CIRCUIT FOR A SHORT TO VOLTAGE WITH PCM (POWERTRAIN CONTROL MODULE) DISCONNECTED**

- Ignition OFF.
- Disconnect PCM C1381B.
- Ignition ON.

**Is any voltage present?**

|            |                          |
|------------|--------------------------|
| <b>Yes</b> | GO to <a href="#">E3</a> |
| <b>No</b>  | GO to <a href="#">E5</a> |

**E3 CHECK THE CRANK DETECT CIRCUIT FOR A SHORT TO VOLTAGE WITH IGNITION SWITCH DISCONNECTED**

- Ignition OFF.
- Disconnect Ignition switch C250.

**Is any voltage present?**

|            |                                                                                                                                                                 |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">E4</a>                                                                                                                                        |
| <b>No</b>  | INSTALL a new ignition switch.<br>REFER to: <a href="#">Ignition Switch</a> (211-05 Steering Wheel and Column Electrical Components, Removal and Installation). |

**E4 CHECK THE CRANK DETECT CIRCUIT FOR A SHORT TO VOLTAGE WITH BCM (BODY CONTROL MODULE) DISCONNECTED**

- Ignition OFF.
- Disconnect BCM C2280A.

**Is any voltage present?**

|            |                          |
|------------|--------------------------|
| <b>Yes</b> | REPAIR the circuit.      |
| <b>No</b>  | GO to <a href="#">E6</a> |

## **E5 CHECK FOR CORRECT PCM (POWERTRAIN CONTROL MODULE) OPERATION**

- Disconnect and inspect all PCM connectors.
- Repair:
  - corrosion (install new connectors or terminals - clean module pins)
  - damaged or bent pins - install new terminals/pins
  - pushed-out pins - install new pins as necessary
- Reconnect all connectors. Make sure they seat and latch correctly.
- Operate the system and determine if the concern is still present.

**Is the concern still present?**

|            |                                                                                                                                                                                                                                                                                                                                                                                              |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | CHECK OASIS for any applicable Technical Service Bulletins (TSBs). If a TSB exists for this concern, DISCONTINUE this test and FOLLOW the TSB instructions. If no Technical Service Bulletins (TSBs) address this concern, INSTALL a new PCM.<br>REFER to: <a href="#">Powertrain Control Module (PCM)</a> (303-14D Electronic Engine Controls - 5.0L 32V Ti-VCT, Removal and Installation). |
| <b>No</b>  | The system is operating correctly at this time. The concern may have been caused by module connections. ADDRESS the root cause of any connector or pin issues.                                                                                                                                                                                                                               |

## **E6 CHECK FOR CORRECT BCM (BODY CONTROL MODULE) OPERATION**



- Disconnect and inspect all BCM connectors.
- Repair:
  - corrosion (install new connectors or terminals - clean module pins)
  - damaged or bent pins - install new terminals/pins
  - pushed-out pins - install new pins as necessary
- Reconnect all connectors. Make sure they seat and latch correctly.
- Operate the system and determine if the concern is still present.

#### Is the concern still present?

|            |                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | CHECK OASIS for any applicable Technical Service Bulletins (TSBs). If a TSB exists for this concern, DISCONTINUE this test and FOLLOW the TSB instructions. If no Technical Service Bulletins (TSBs) address this concern,   <a href="#">Click here to access Guided Routine (BCM).</a> |
| <b>No</b>  | The system is operating correctly at this time. The concern may have been caused by module connections. ADDRESS the root cause of any connector or pin issues.                                                                                                                                                                                                                                                                                                |

#### P2535 (with Push Button Start)

Refer to Wiring Diagrams Cell 25 for schematic and connector information.

#### Normal Operation and Fault Conditions

When the engine start/stop switch has been pressed, the PCM receives a voltage signal on the crank detect circuit. The PCM then supplies voltage and ground to the starter relay coil when the required inputs have been received.

#### DTC Fault Trigger Conditions

| DTC   | Description                                     | Fault Trigger Conditions                                                                            |
|-------|-------------------------------------------------|-----------------------------------------------------------------------------------------------------|
| P2535 | Ignition Switch Run/Start Position Circuit High | This DTC sets when the PCM detects voltage on the crank detect circuit while the engine is running. |

#### Possible Sources

- BCM

- Ignition switch - Push Button Start
- PCM
- Wiring, terminals or connectors

## PINPOINT TEST F : DTC P2535 (WITH PUSH BUTTON START)

### F1 RETRIEVE DIAGNOSTIC TROUBLE CODES (DTCS)

- Ignition ON.
- Using a diagnostic scan tool, perform PCM self-tests.

#### Is DTC P2535 recorded?

|     |                                                                                          |
|-----|------------------------------------------------------------------------------------------|
| Yes | GO to <a href="#">F2</a>                                                                 |
| No  | For all PCM Diagnostic Trouble Codes (DTCs), refer to the PCM DTC Chart in this section. |

### F2 CHECK THE CRANK DETECT CIRCUIT FOR A SHORT TO VOLTAGE WITH PCM (POWERTRAIN CONTROL MODULE) DISCONNECTED

- Ignition OFF.
- Disconnect PCM C1381B.
- Ignition ON.

#### Is any voltage present?

|     |                          |
|-----|--------------------------|
| Yes | GO to <a href="#">F3</a> |
| No  | GO to <a href="#">F5</a> |

### F3 CHECK THE CRANK DETECT CIRCUIT FOR A SHORT TO VOLTAGE WITH IGNITION SWITCH - PUSH BUTTON START DISCONNECTED

- Ignition OFF.
- Disconnect Ignition switch - Push Button Start C2195.

**Is any voltage present?**

|            |                                                                                                                                                                                                                             |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">F4</a>                                                                                                                                                                                                    |
| <b>No</b>  | INSTALL a new ignition switch - push button start.<br>REFER to: <a href="#">Ignition Switch - Vehicles With: Keyless Vehicle System</a> (211-05 Steering Wheel and Column Electrical Components, Removal and Installation). |

#### **F4 CHECK THE CRANK DETECT CIRCUIT FOR A SHORT TO VOLTAGE WITH BCM (BODY CONTROL MODULE) DISCONNECTED**

- Ignition OFF.
- Disconnect BCM C2280B.

**Is any voltage present?**

|            |                          |
|------------|--------------------------|
| <b>Yes</b> | REPAIR the circuit.      |
| <b>No</b>  | GO to <a href="#">F6</a> |

#### **F5 CHECK FOR CORRECT PCM (POWERTRAIN CONTROL MODULE) OPERATION**

- Disconnect and inspect all PCM connectors.
- Repair:
  - corrosion (install new connectors or terminals - clean module pins)
  - damaged or bent pins - install new terminals/pins
  - pushed-out pins - install new pins as necessary
- Reconnect all connectors. Make sure they seat and latch correctly.
- Operate the system and determine if the concern is still present.

**Is the concern still present?**

|            |                                                                                                                                                                                                                                                                                                                                                                                              |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | CHECK OASIS for any applicable Technical Service Bulletins (TSBs). If a TSB exists for this concern, DISCONTINUE this test and FOLLOW the TSB instructions. If no Technical Service Bulletins (TSBs) address this concern, INSTALL a new PCM.<br>REFER to: <a href="#">Powertrain Control Module (PCM)</a> (303-14D Electronic Engine Controls - 5.0L 32V Ti-VCT, Removal and Installation). |
| <b>No</b>  | The system is operating correctly at this time. The concern may have been caused by module connections. ADDRESS the root cause of any connector or pin issues.                                                                                                                                                                                                                               |

## F6 CHECK FOR CORRECT BCM (BODY CONTROL MODULE) OPERATION

- Disconnect and inspect all BCM connectors.
- Repair:
  - corrosion (install new connectors or terminals - clean module pins)
  - damaged or bent pins - install new terminals/pins
  - pushed-out pins - install new pins as necessary
- Reconnect all connectors. Make sure they seat and latch correctly.
- Operate the system and determine if the concern is still present.

### Is the concern still present?

|            |                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | CHECK OASIS for any applicable Technical Service Bulletins (TSBs). If a TSB exists for this concern, DISCONTINUE this test and FOLLOW the TSB instructions. If no Technical Service Bulletins (TSBs) address this concern,   <a href="#">Click here to access Guided Routine (BCM).</a> |
| <b>No</b>  | The system is operating correctly at this time. The concern may have been caused by module connections. ADDRESS the root cause of any connector or pin issues.                                                                                                                                                                                                                                                                                                |

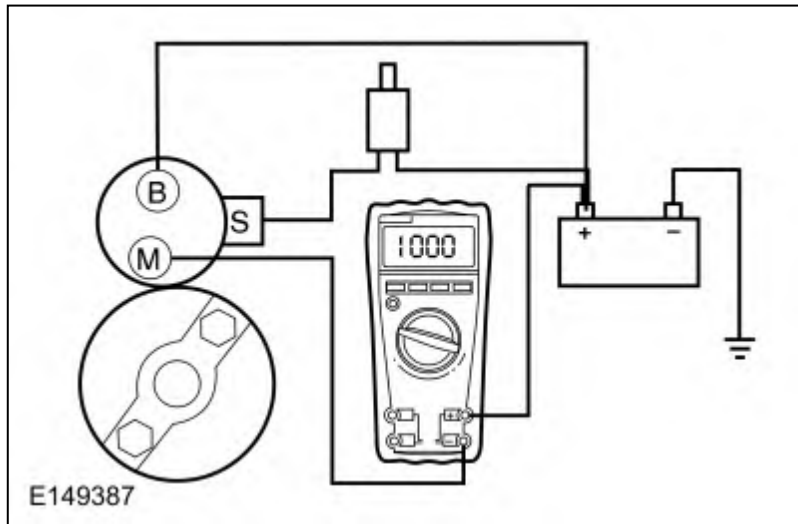
## Component Test(s)

### Starter Motor - Positive Circuit Test

**NOTE:** Always make the multimeter connection at the component terminal rather than at the wiring end of the connector. Making a connection at the wiring end of the connector could result in false readings because the meter will not pick up a high resistance between the wiring connector and component.

1. Make sure the battery is fully charged.  
REFER to: [Battery](#) (414-01 Battery, Mounting and Cables, Diagnosis and Testing).
2. Perform a battery drain test.  
REFER to: [Battery Drain Check](#) (414-01 Battery, Mounting and Cables, General Procedures).

3. Connect a remote starter switch between starter solenoid “S” terminal and the battery positive terminal.
4. Connect the multimeter positive lead to the battery positive post. Connect the negative lead to the starter solenoid "M" terminal.



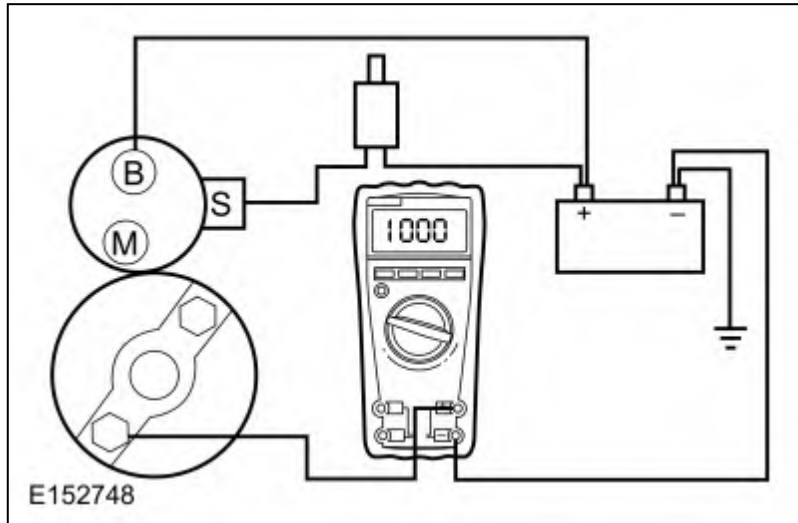
5. Place gear selector lever in Park or Neutral.
6. Engage the remote starter switch. Read and record the voltage. The voltage reading should be 0.5 volt or less.
7. If the voltage reading is 0.5 volt or less, perform Starter Motor - Ground Circuit Test in this section.
8. A voltage reading greater than 0.5 volt is an indication of excessive resistance in the connections, the positive battery cable or in the starter solenoid. Remove the cables from the solenoid "B", "S" and "M" terminals. Clean the cables and connections and reinstall the cables to the correct terminals. Repeat Steps 3 through 6.
9. If the voltage reading is still greater than 0.5 volt when checked at the "M" terminal, move the multimeter negative lead to the starter solenoid “B” terminal.
10. With the gear selector lever in Park or Neutral, engage the remote starter switch. Read and record the voltage.
11. If the voltage reading at the "B" terminal is lower than 0.5 volt, the concern is in the connections at the starter solenoid or in the solenoid contacts. Install a new starter motor.  
REFER to: [Starter Motor](#) (303-06D Starting System - 5.0L 32V Ti-VCT, Removal and Installation).
12. If the voltage reading taken at the solenoid "B" terminal is greater than 0.5 volt after cleaning the cables and connections at the solenoid, the concern is in the positive battery cable connection or in the positive battery cable itself. Clean the positive battery cable connection. If this does not resolve the concern, install a new positive battery cable.  
REFER to: [Battery Cables - 5.0L 32V Ti-VCT](#) (414-01 Battery, Mounting and Cables, Removal and Installation).

### **Starter Motor - Ground Circuit Test**



A slow cranking condition can be caused by resistance in the ground or return portion of the cranking circuit. This procedure checks the voltage drop in the ground circuit.

1. Connect a remote starter switch between starter solenoid "S" terminal and the battery positive terminal.
2. Connect the multimeter positive lead to the starter motor housing (the connection must be clean and free of rust or grease). Connect the negative lead to the negative battery terminal.
3. Place gear selector lever in Park or Neutral.
4. Engage the remote starter switch and crank the engine. Read and record the voltage reading. The reading should be 0.5 volt or less.



5. If the voltage reading is greater than 0.5 volt, clean the negative cable connections at the battery, the body ground connections and the starter ground connection. Retest.
6. If the voltage reading is greater than 0.5 volt, install a new negative battery cable.  
REFER to: [Battery Cables - 5.0L 32V Ti-VCT](#) (414-01 Battery, Mounting and Cables, Removal and Installation).
7. If the voltage reading is less than 0.5 volt and the engine still cranks slowly, install a new starter motor.  
REFER to: [Starter Motor](#) (303-06D Starting System - 5.0L 32V Ti-VCT, Removal and Installation).

# Starter Motor Drive Gear and Flywheel Ring Gear Inspection

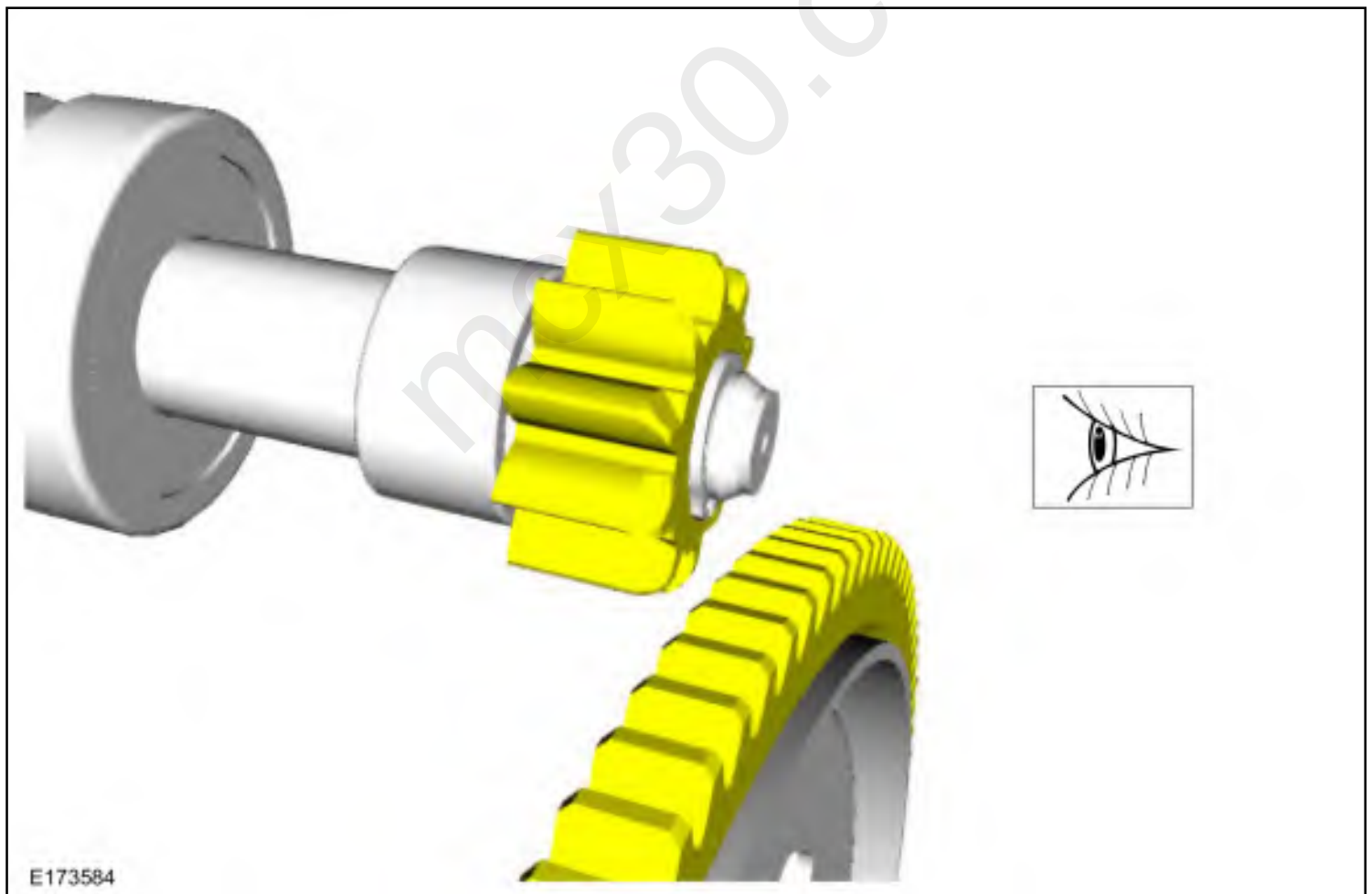
## Inspection

1. Remove the starter motor.

Refer to: [Starter Motor](#) (303-06D Starting System - 5.0L 32V Ti-VCT, Removal and Installation).

2. Check the wear patterns on the starter motor drive gear and the flywheel or flexplate ring gear. If the wear pattern is normal, then install the starter motor.

Refer to: [Starter Motor](#) (303-06D Starting System - 5.0L 32V Ti-VCT, Removal and Installation).



3. If the starter motor drive gear and the flywheel or flexplate ring gear are not fully engaging and the

starter motor drive gear is scored or damaged, then install a new starter motor.

Refer to: [Starter Motor](#) (303-06D Starting System - 5.0L 32V Ti-VCT, Removal and Installation).

4. If the teeth on the flywheel or flexplate ring gear are scored or damaged, then install a new flywheel or flexplate.

Refer to: [Flexplate](#) (303-01D Engine - 5.0L 32V Ti-VCT, Removal and Installation).

# Starter Motor

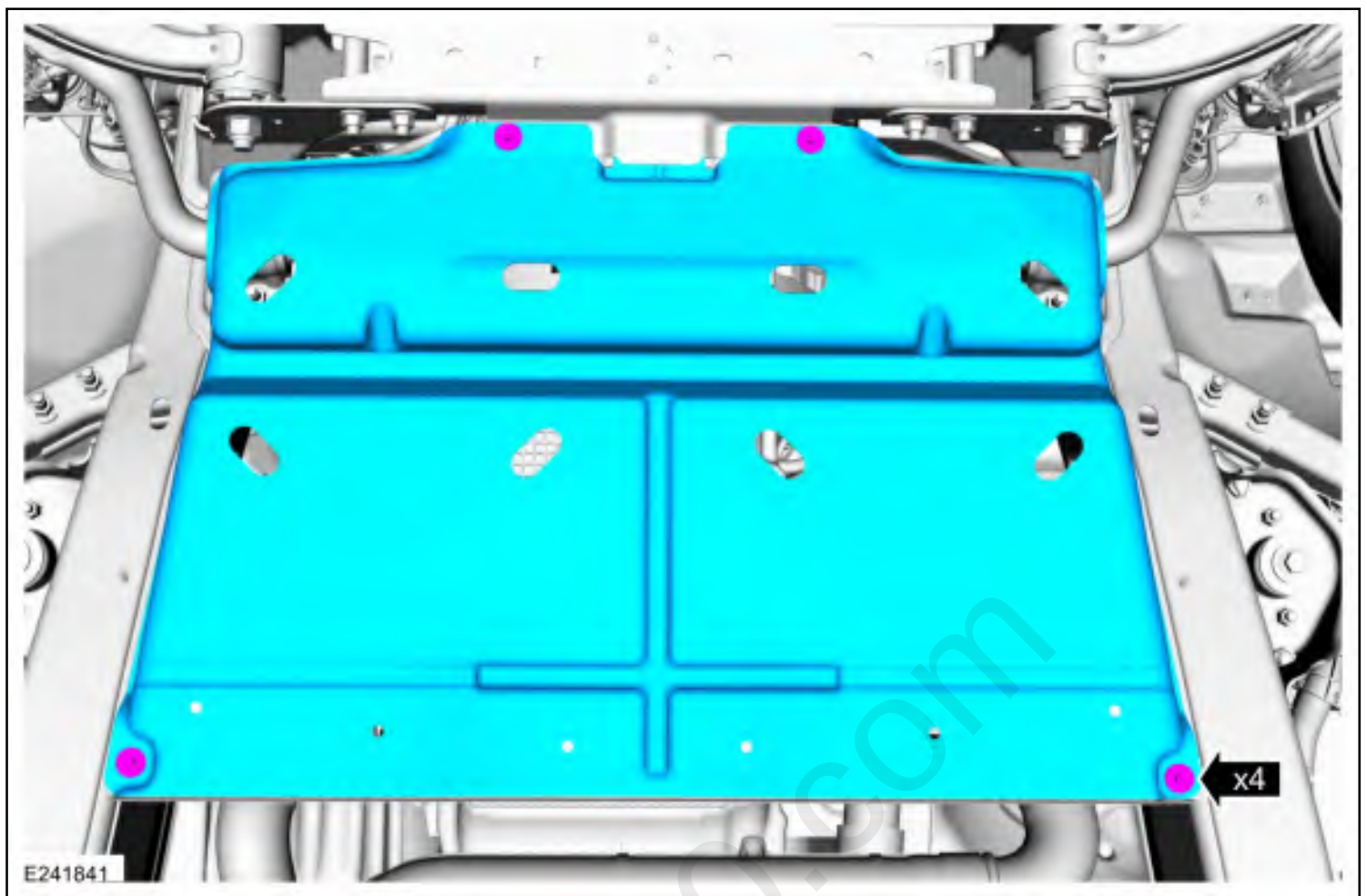
Base Part Number: Base Part Number: 11000

## Removal

 **WARNING:** Always disconnect the battery ground cable at the battery before disconnecting the starter motor battery terminal lead. If a tool is shorted at the starter motor battery terminal, the tool can quickly heat enough to cause a skin burn. Failure to follow this instruction may result in serious personal injury.

**NOTE:** Removal steps in this procedure may contain installation details.

1. With the vehicle in NEUTRAL, position it on a hoist.  
Refer to: [Jacking and Lifting - Overview](#) (100-02 Jacking and Lifting, Description and Operation).
2. Disconnect the battery.  
Refer to: Battery Disconnect and Connect (414-01 Battery, Mounting and Cables) .
3. Release the bolts and remove the transmission housing cover.  
*Torque:* 71 lb.in (8 Nm)

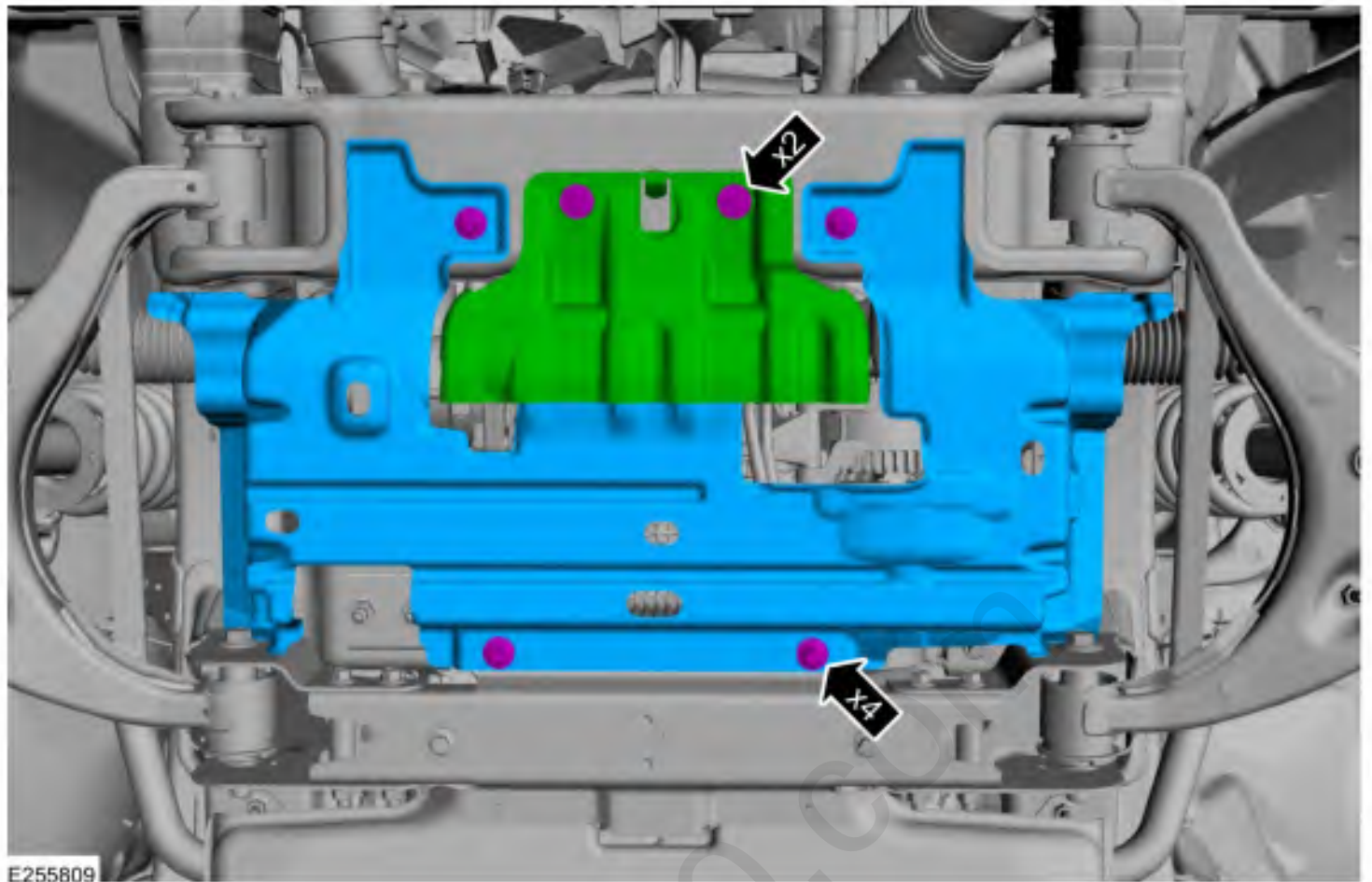


4. **NOTE:** Vehicles come with an underbody shield or a skid plate.

Remove the bolts and the underbody shield.

Torque: 30 lb.ft (40 Nm)

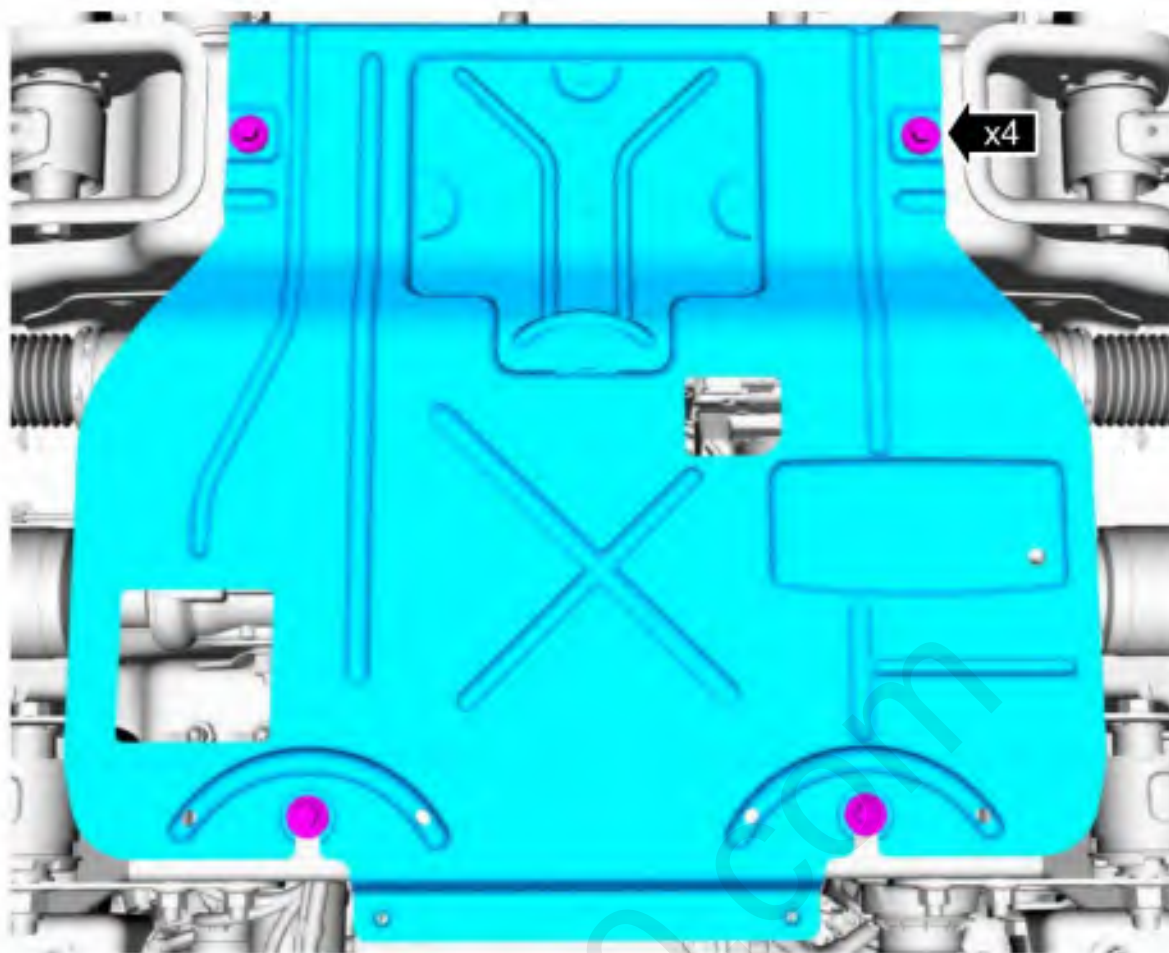




5. **NOTE:** Vehicles come with an underbody shield or a skid plate.

If equipped, remove the bolts and the skid plate.

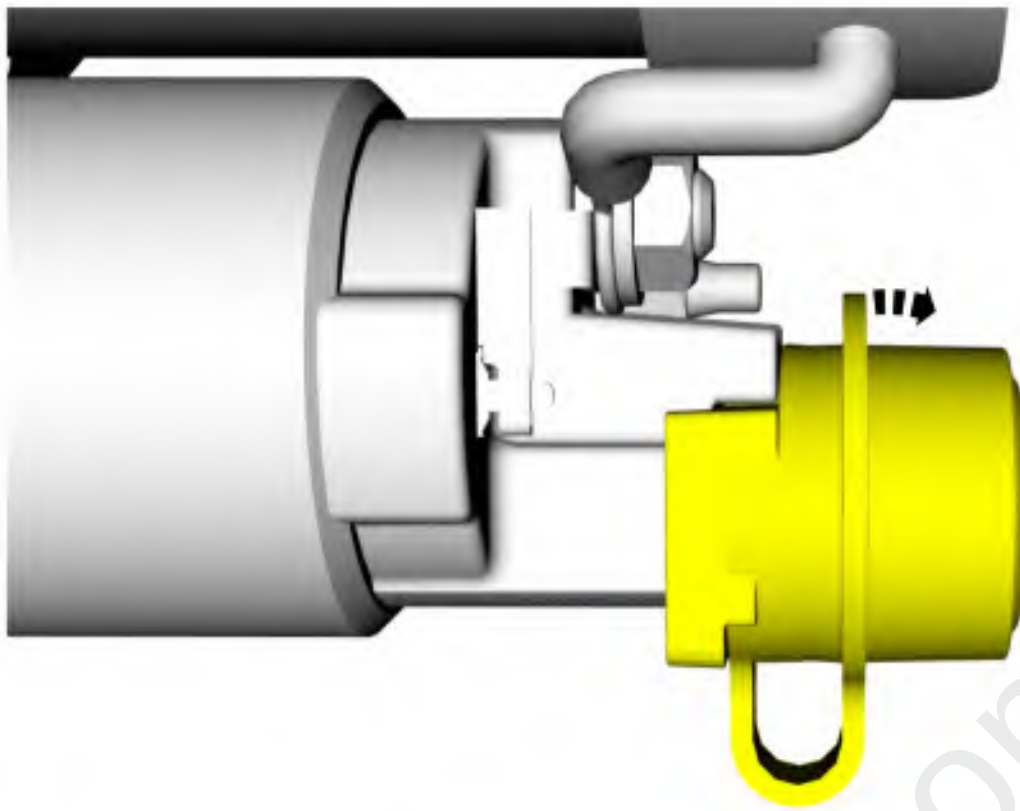
Torque: 30 lb.ft (40 Nm)



E193607



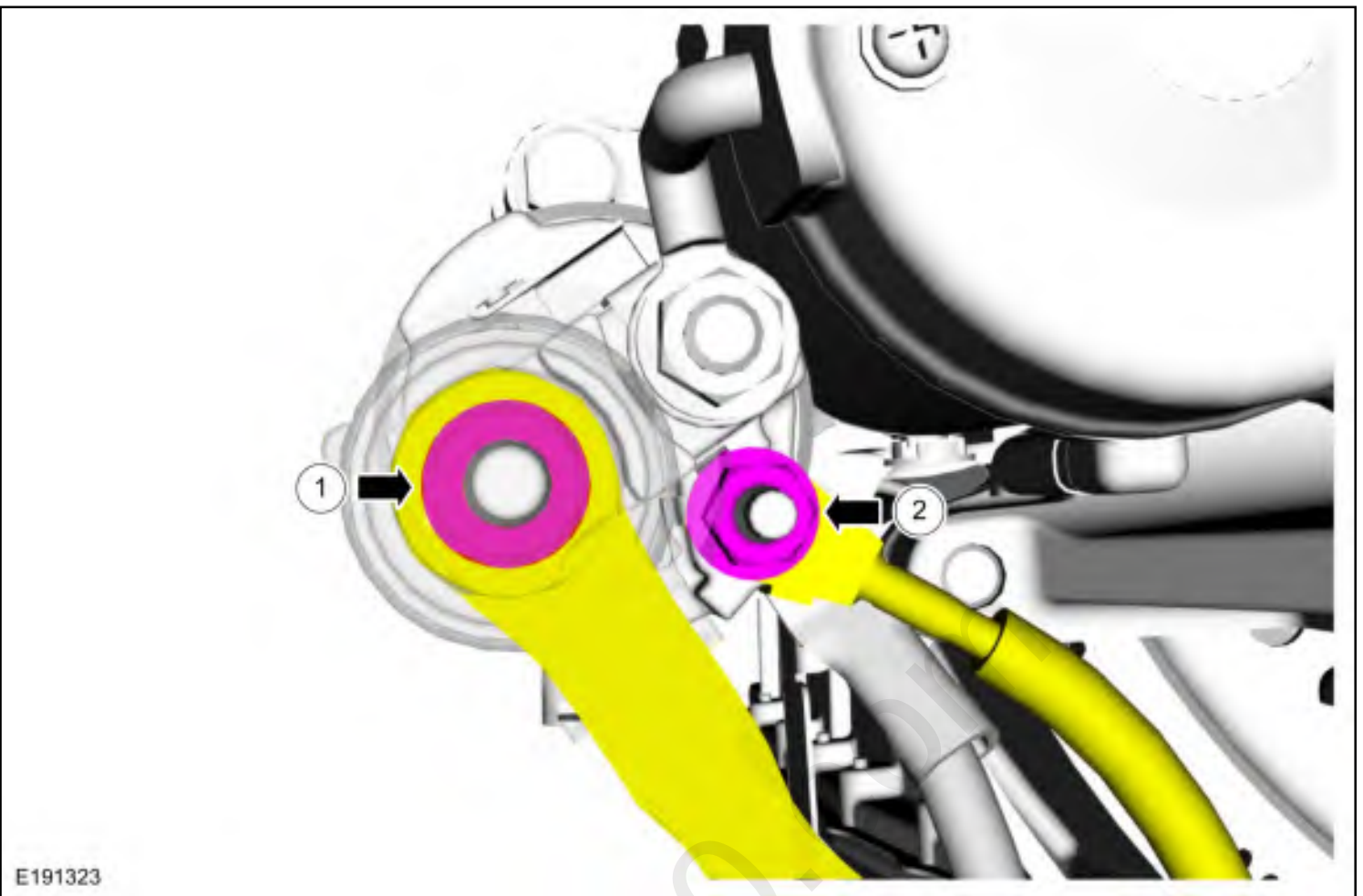
6. Open the starter motor solenoid battery cable cover.



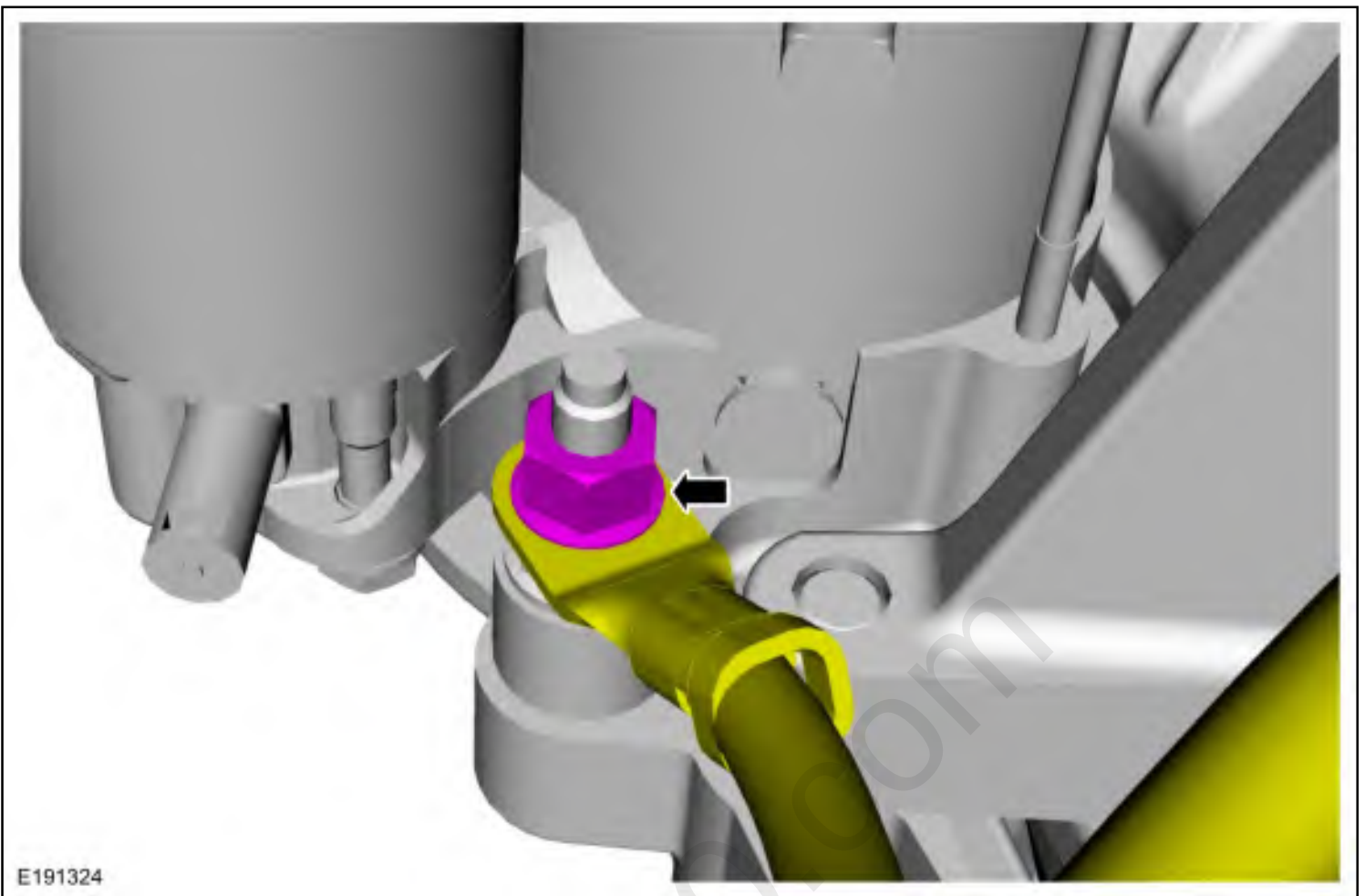
E191322



1. Remove the starter motor solenoid battery cable nut and then disconnect the starter motor solenoid battery cable.  
*Torque:* 106 lb.in (12 Nm)
2. Remove the starter motor solenoid control wire nut and then disconnect the starter motor solenoid control wire.  
*Torque:* 53 lb.in (6 Nm)



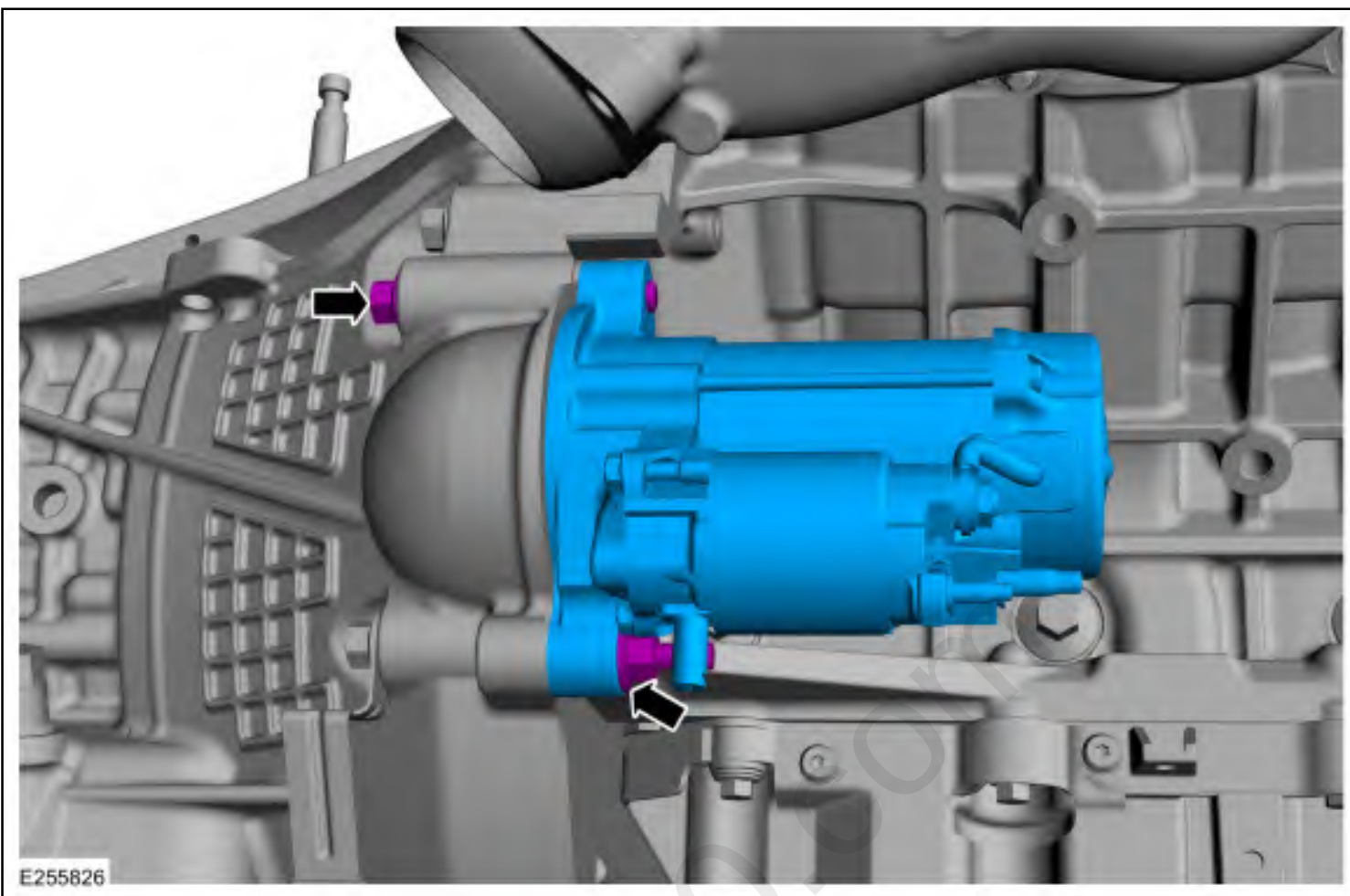
8. Remove the starter motor ground cable nut and position the cable aside.  
*Torque: 18 lb.ft (25 Nm)*



9. Remove the starter motor retaining bolts and the starter motor retaining studbolt, then remove the starter motor.

*Torque: 35 lb.ft (48 Nm)*





10. Inspect the starter motor drive gear and flywheel ring gear.

Refer to: [Starter Motor Drive Gear and Flywheel Ring Gear Inspection](#) (303-06D Starting System - 5.0L 32V Ti-VCT, General Procedures).

## Installation

1. To install, reverse the removal procedure.

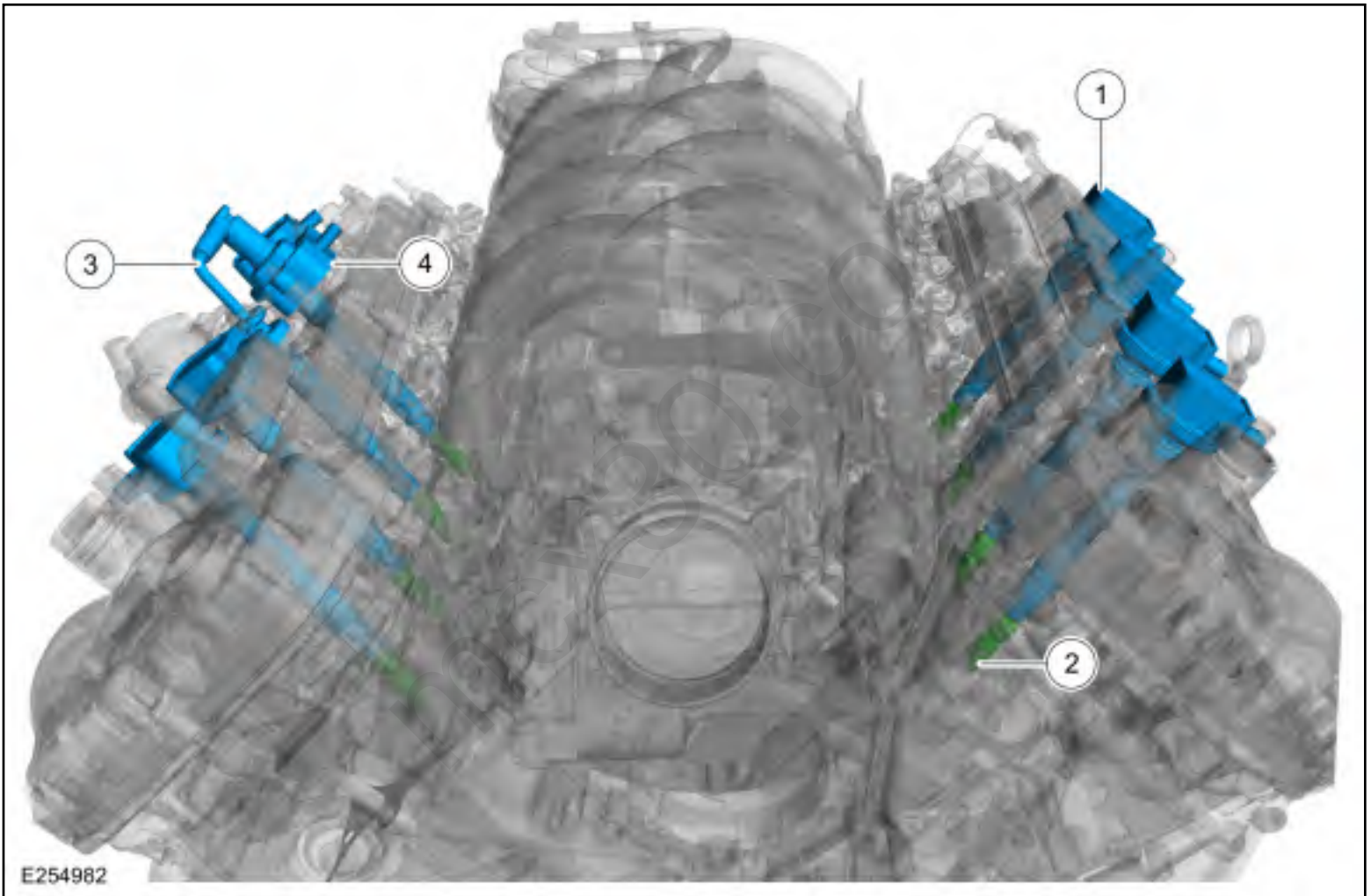
# Specifications

## General Specifications

| Item           | Specification                 |
|----------------|-------------------------------|
| Spark plug     | 12405                         |
| Spark plug gap | 0.049–0.053 in (1.25–1.35 mm) |

## Engine Ignition - Component Location

### 5.0L 32V Ti-VCT



| Item | Description              |
|------|--------------------------|
| 1    | Ignition coil-on-plug(s) |
| 2    | Spark plug(s)            |
| 3    | Spark plug wire          |
| 3    | Ignition coil-near-plug  |

mcx30.com

## Engine Ignition

Diagnostics in this manual assume a certain skill level and knowledge of Ford-specific diagnostic practices. For information about these,

REFER to: [Diagnostic Methods](#) (100-00 General Information, Description and Operation).

For PCM DTC,

REFER to: [Electronic Engine Controls](#) (303-14D Electronic Engine Controls - 5.0L 32V Ti-VCT, Diagnosis and Testing).

For driveability symptoms without DTC, Refer to Powertrain Control/Emissions Diagnosis (PC/ED) manual. See Section 3, Symptom Charts.

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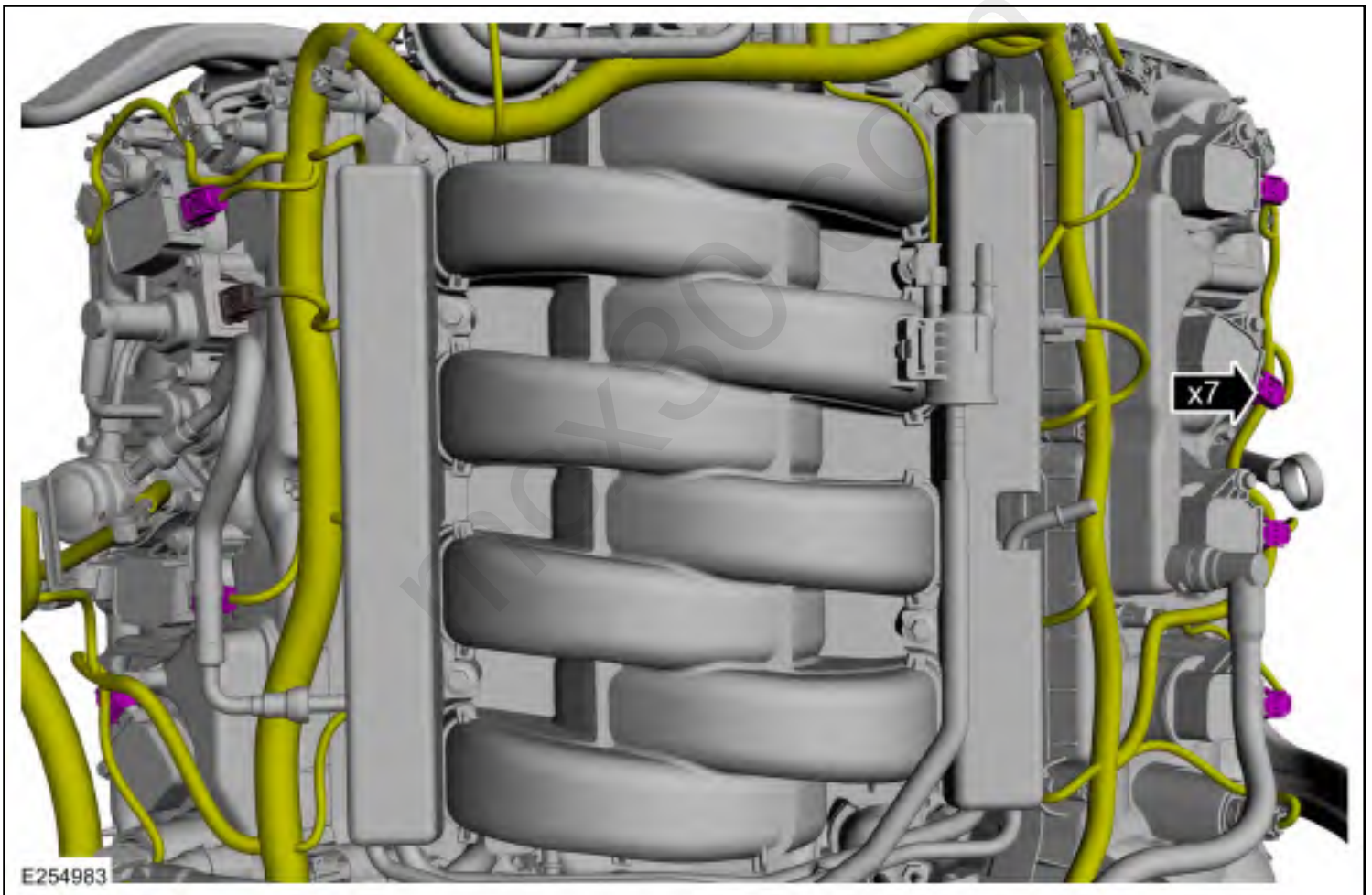


# Ignition Coil-On-Plug

Base Part Number: Base Part Number: 12A366

## Removal

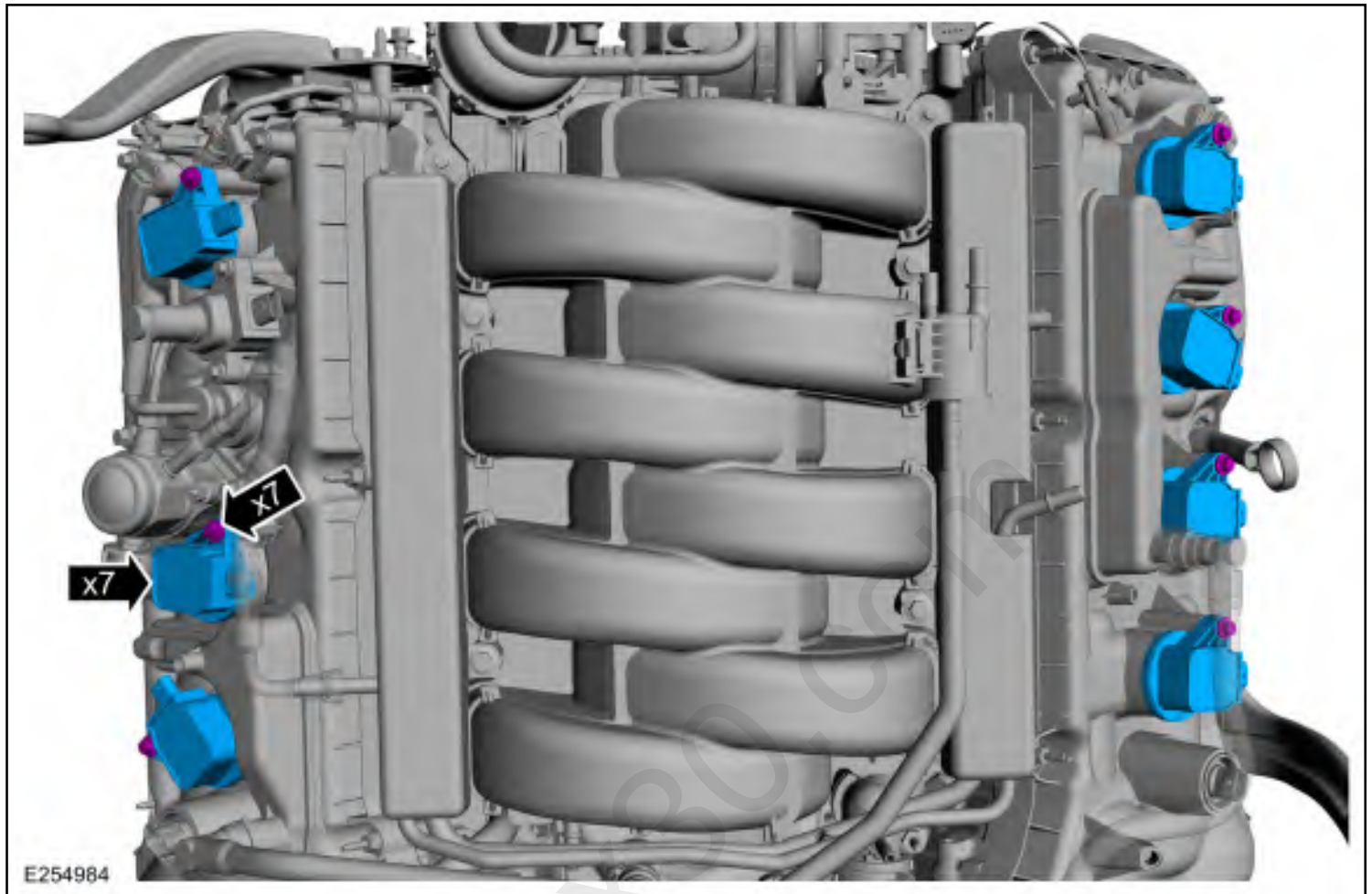
1. Disconnect the ignition coil-on-plug electrical connectors.



2. **NOTE:** Use compressed air to remove any foreign material from the ignition coil-on-plugs and surrounding area before removing the ignition coil-on-plugs.

**NOTE:** When removing the ignition coil-on-plugs, a slight twisting motion will break the seal and ease removal.

1. Remove the ignition coil-on-plug retaining bolts.
2. Remove the ignition coil-on-plugs.



## Installation

1. Inspect the ignition coil-on-plug assembly for cracks, rips, or tears. Replace any damaged coil-on-plug assemblies.



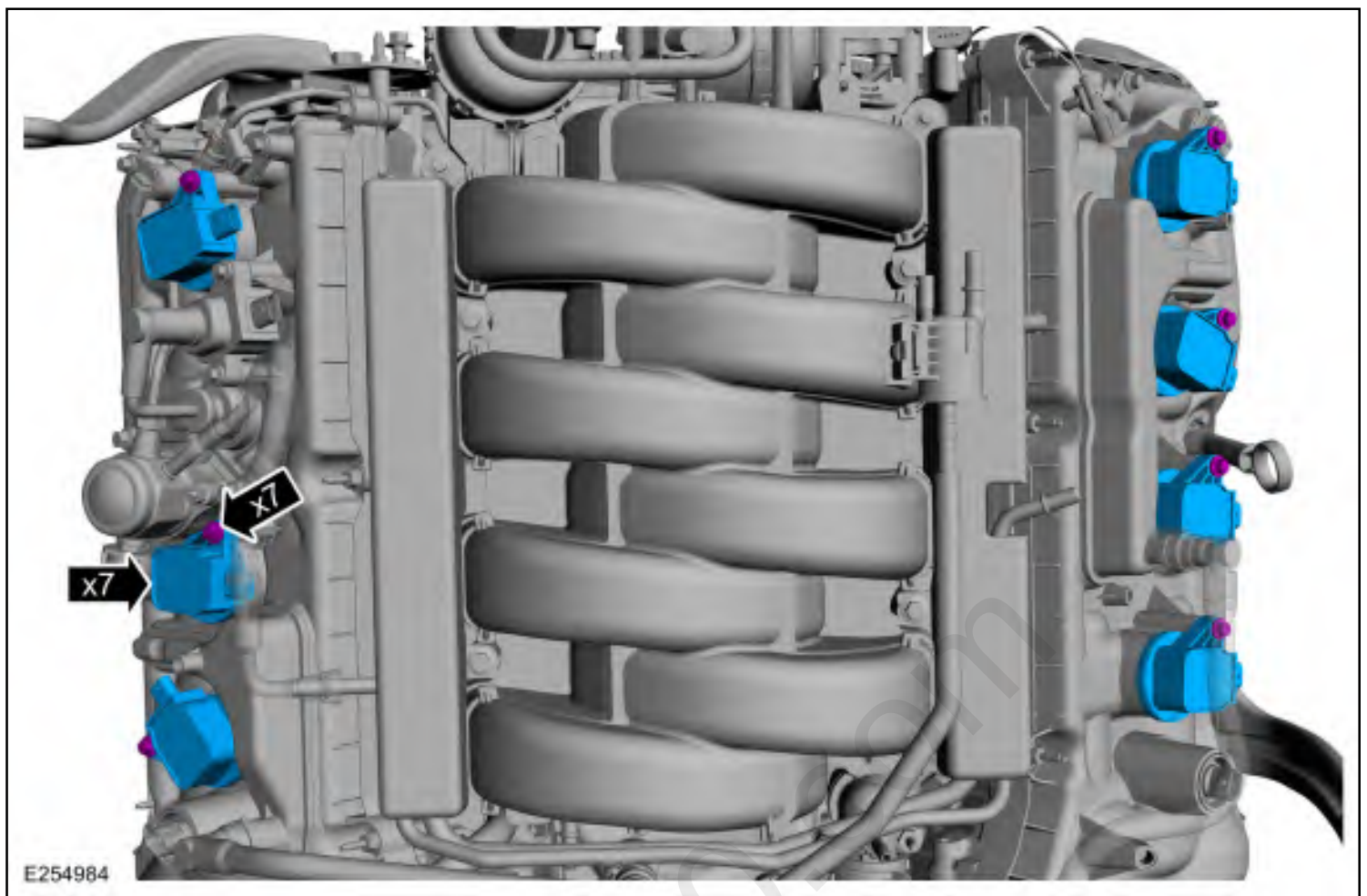
E254986

1. Install the ignition coil-on-plugs
2. Install and tighten the ignition coil-on-plug retaining bolts in the following 2 stages.

*Torque:*

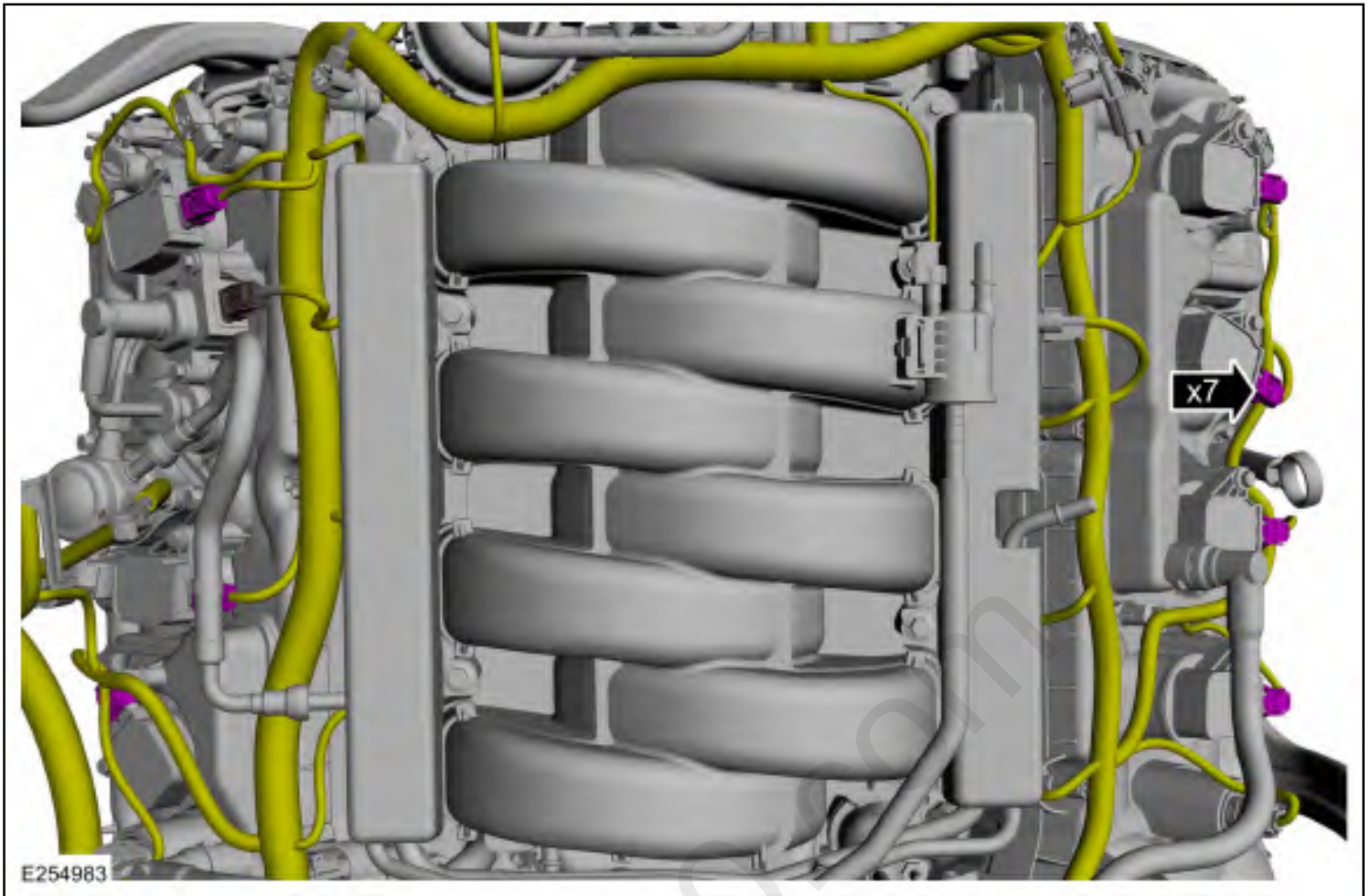
Stage 1: 62 lb.in (7 Nm)

Stage 2: 45°



3. Connect the ignition coil-on-plug electrical connectors.





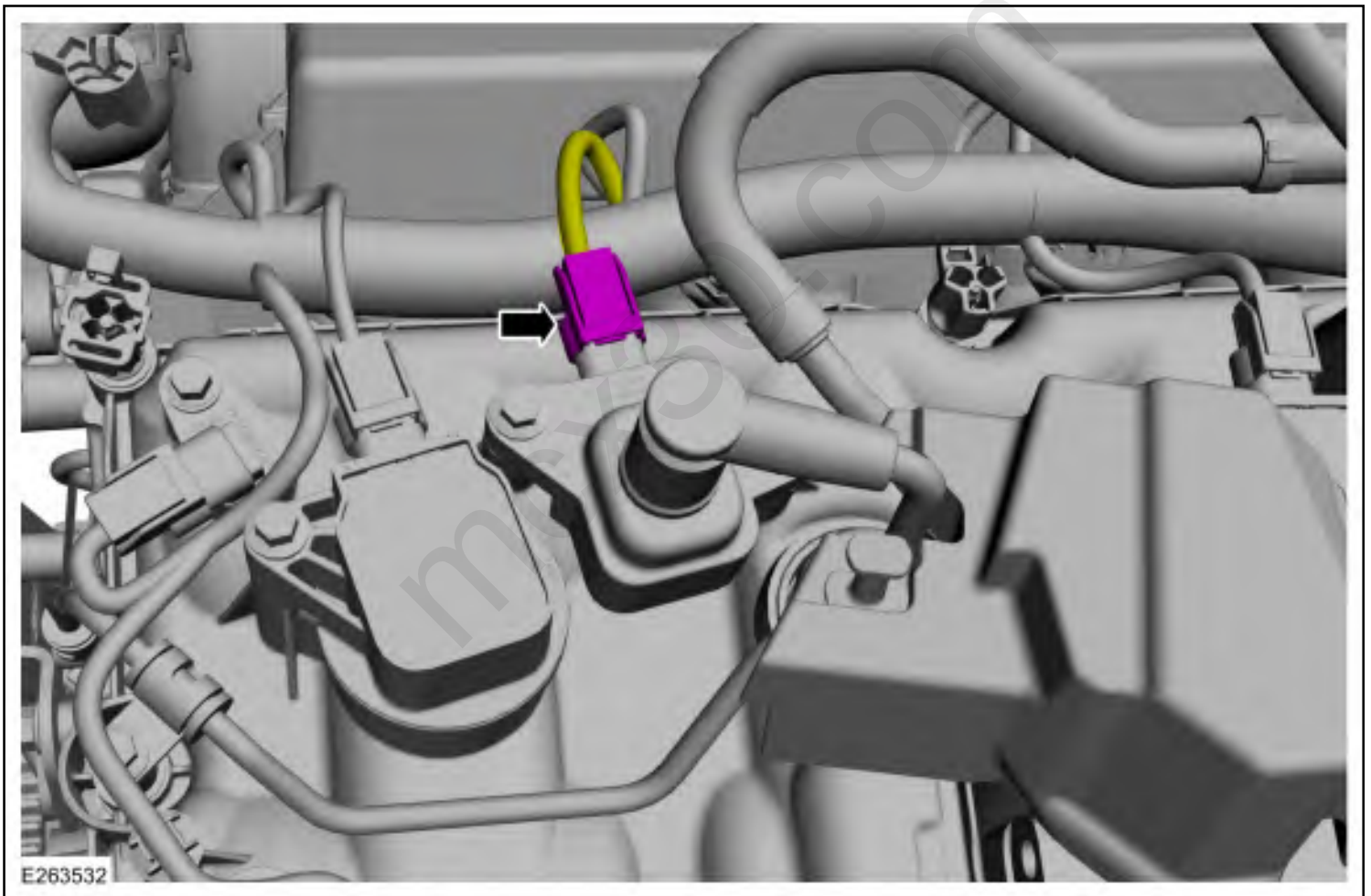


## Remote Mount Ignition Coil

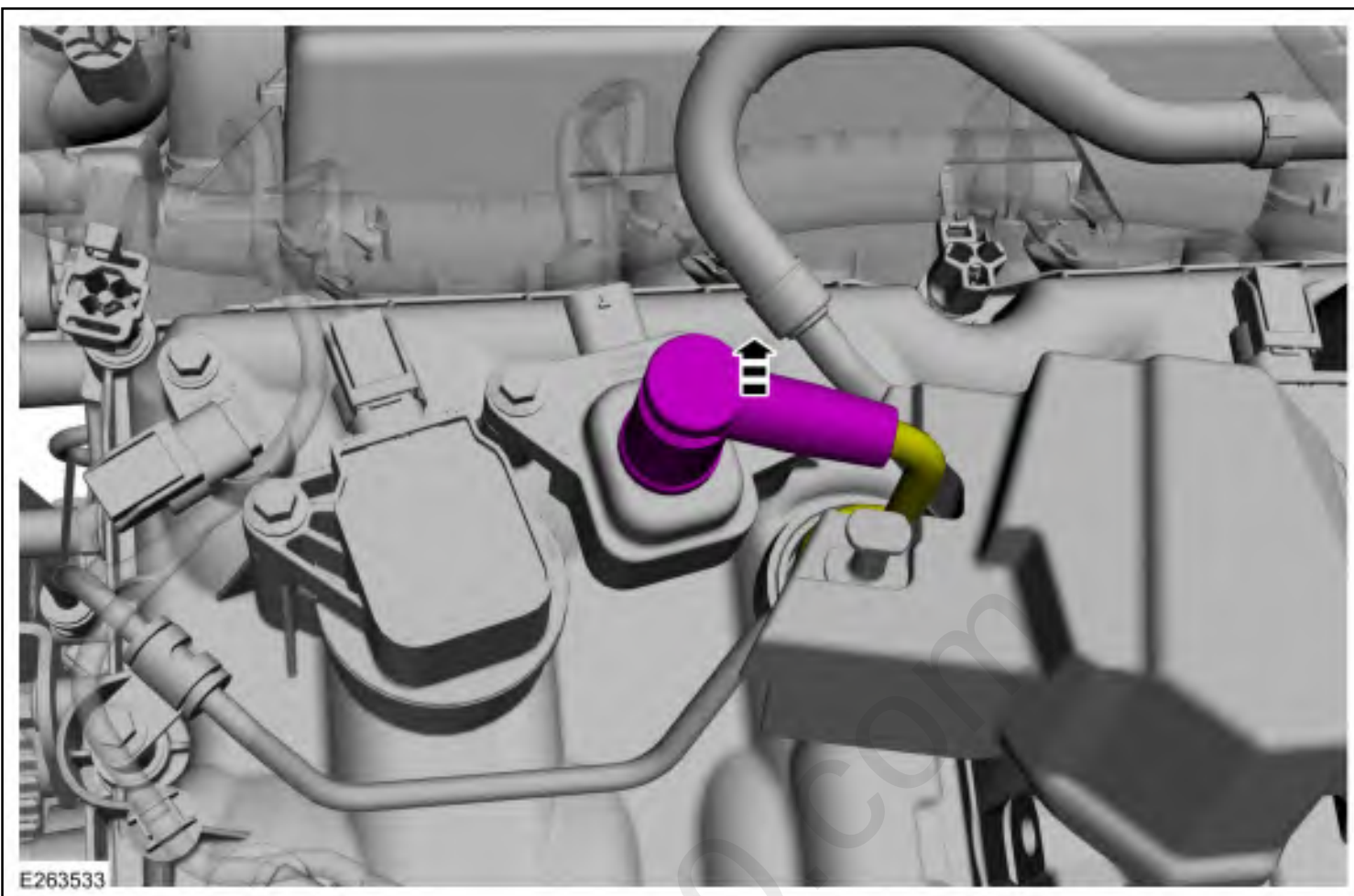
### Removal

**NOTE:** Removal steps in this procedure may contain installation details.

1. Disconnect the electrical connector.



2. Disconnect the spark plug wire connector and position it aside.

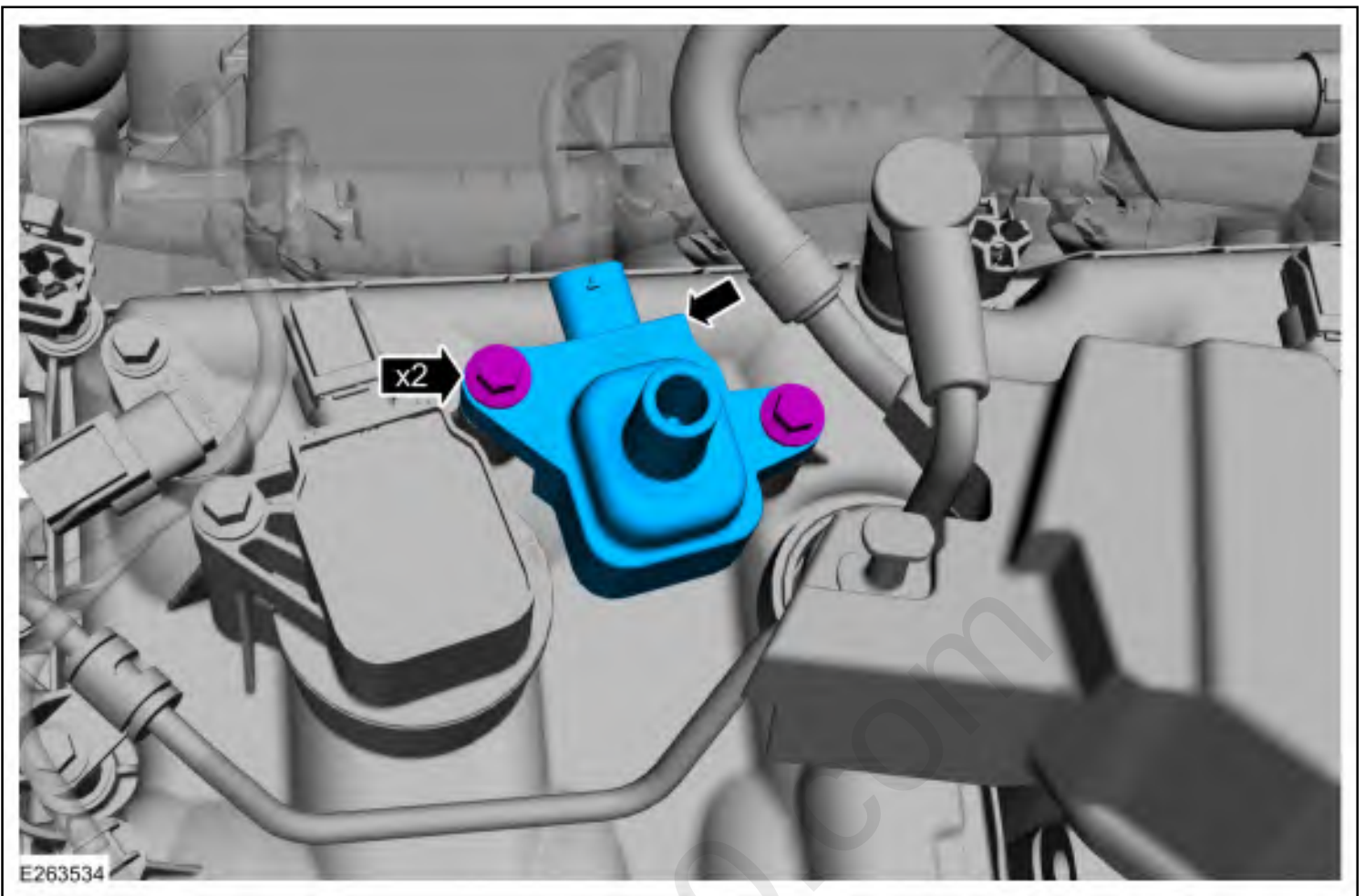


3. Remove the bolts and the remote mount ignition coil.

*Torque:*

Stage 1: 62 lb.in (7 Nm)

Stage 2: 45°



## Installation

1. To install, reverse the removal procedure.

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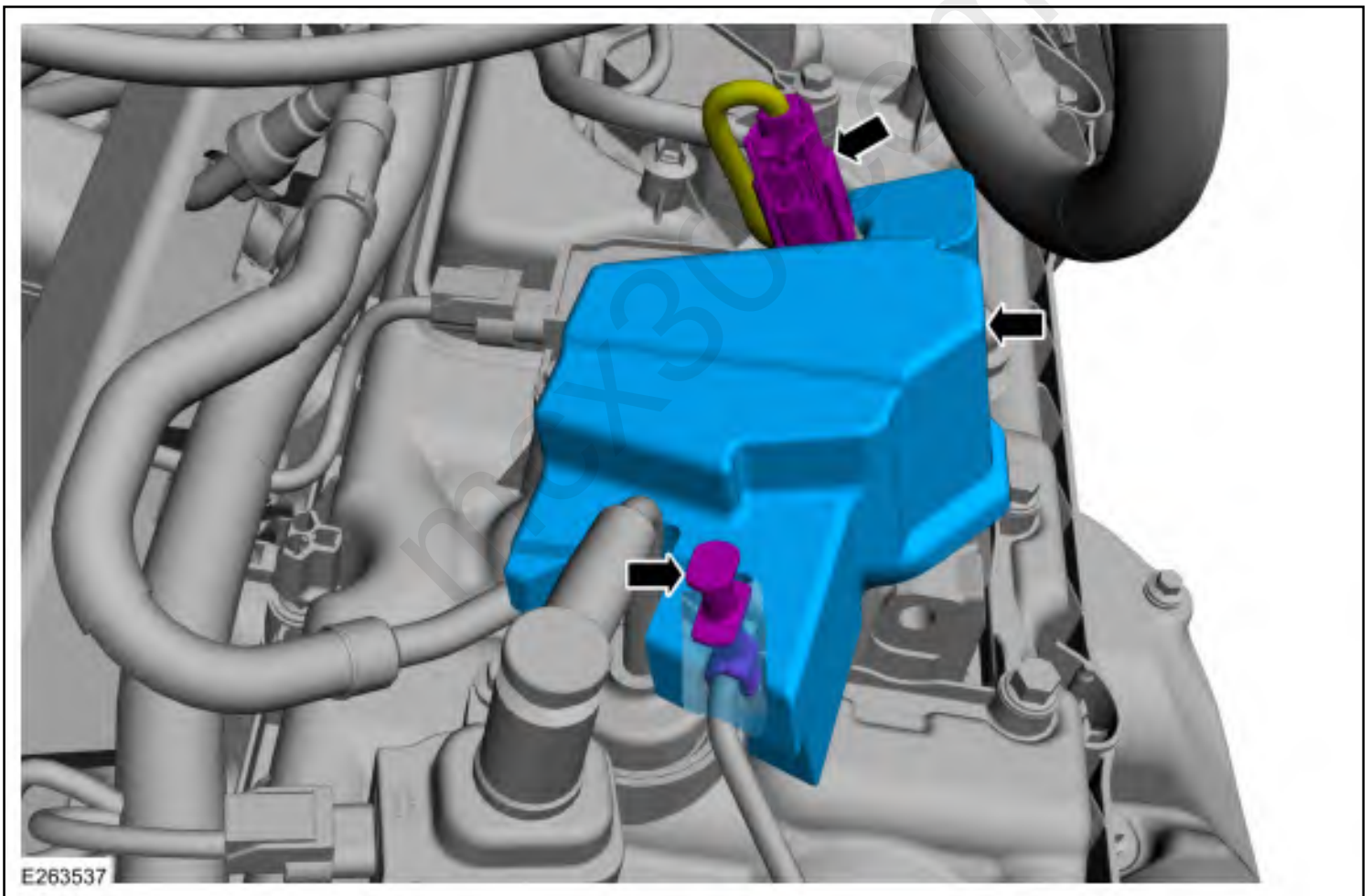
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## Spark Plug Wire

### Removal

**NOTE:** Removal steps in this procedure may contain installation details.

- Disconnect the fuel pump electrical connector.
- Detach the retainer and remove the fuel pump cover.

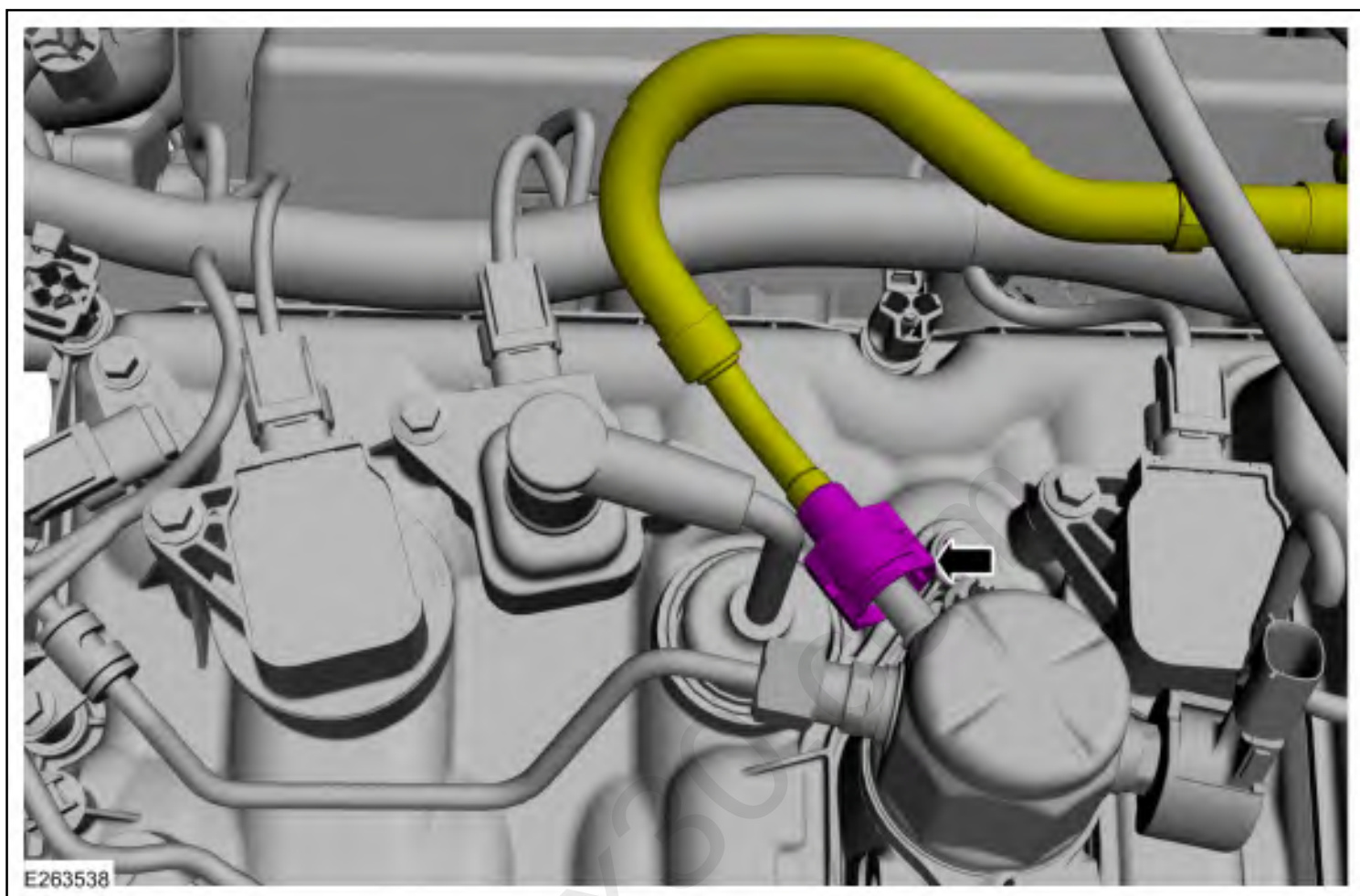


2. **NOTE:** When disconnecting or removing any fuel tubes, carefully drain any residual fuel into a suitable container.

Disconnect the quick release coupling and position the fuel tube aside.

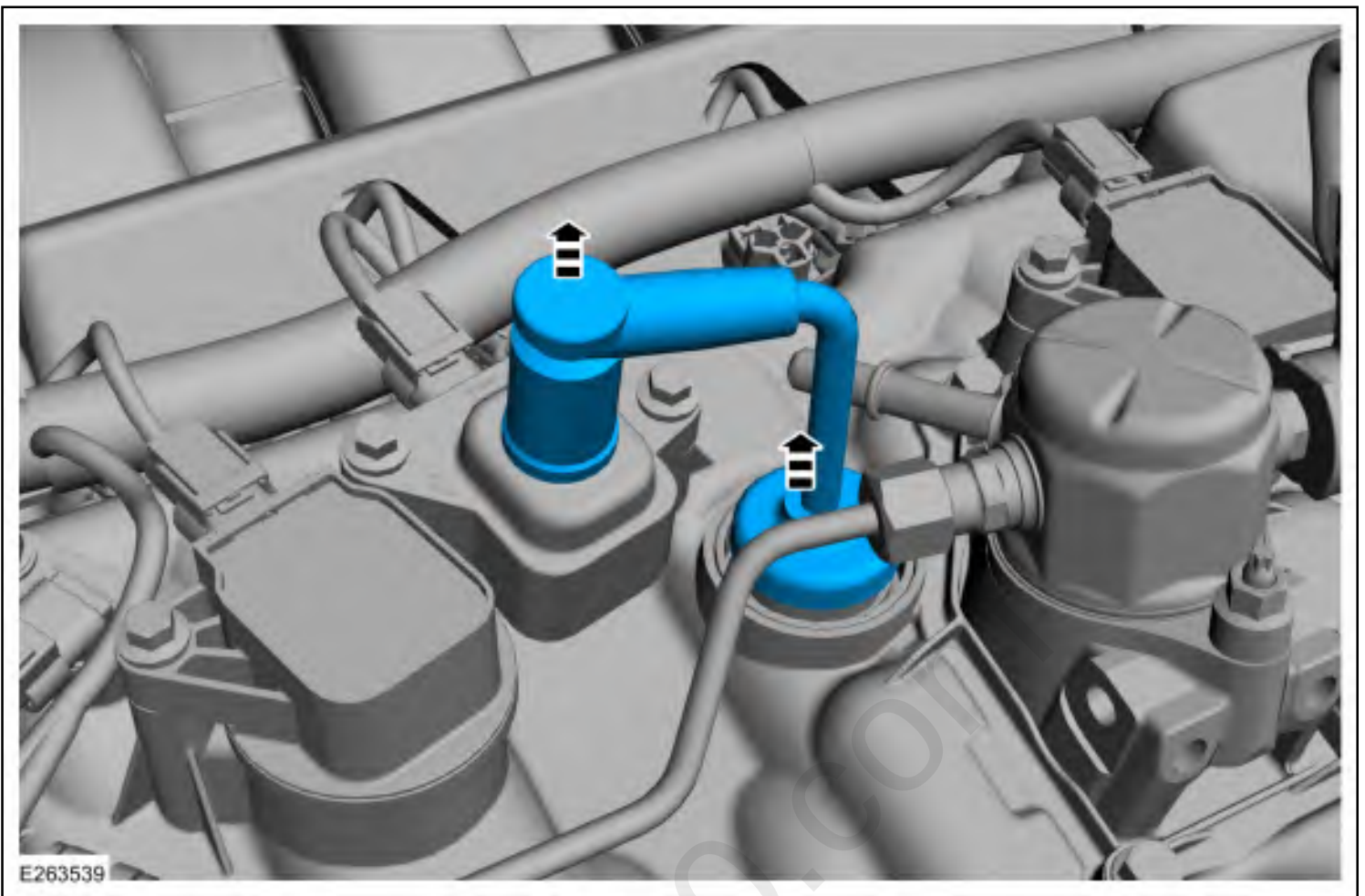


Refer to: [Quick Release Coupling](#) (310-00D Fuel System - General Information - 5.0L 32V Ti-VCT, General Procedures).



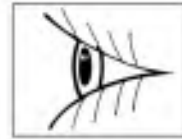
3. Disconnect and remove the spark plug wire.





## Installation

1. Inspect the spark plug wire for cracks, rips, or tears. Replace any damaged spark plug wire.



E263540



2. To install, reverse the removal procedure.

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# Spark Plugs

Base Part Number: Base Part Number: 12405

## Removal

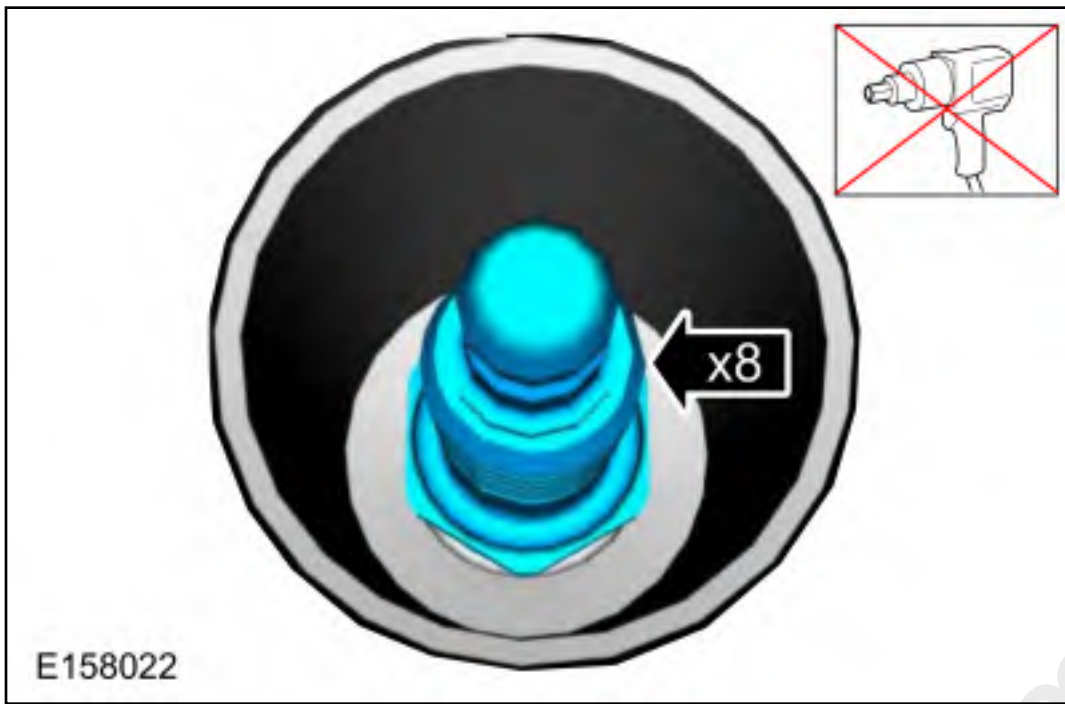
**NOTE:** Removal steps in this procedure may contain installation details.

1. Remove the spark plug wire.  
Refer to: [Spark Plug Wire](#) (303-07D Engine Ignition - 5.0L 32V Ti-VCT, Removal and Installation).
2. Remove the ignition coil-on-plugs.  
Refer to: Ignition Coil-On-Plug (303-07 Engine Ignition - 5.0L 32V Ti-VCT) .
3. **NOTICE: Do not remove the spark plugs when the engine is hot or cold soaked. Spark plug thread or cylinder head damage can occur. Make sure the engine is warm (hand touch after cooling down) prior to spark plug removal.**

**NOTICE: If a spark plug is dropped, internal damage may result and the spark plug must be discarded. The use of a damaged spark plug may cause cylinder misfire resulting in engine damage.**

**NOTE:** Use compressed air to remove any foreign material in the spark plug well before removing the spark plugs.

Remove the spark plugs.  
*Torque:* 128 lb.in (14.5 Nm)



## Installation

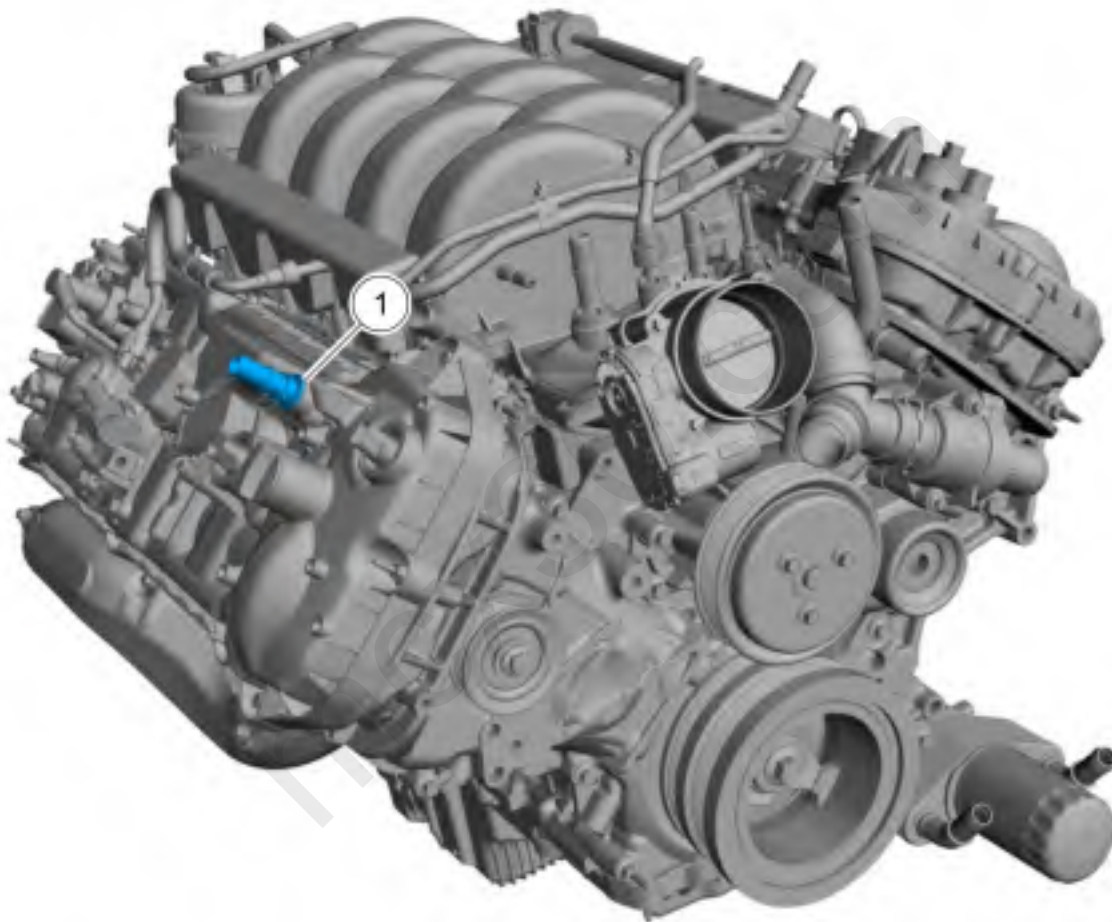
1. To install, reverse the removal procedure.

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# Engine Emission Control - Component Location

## 5.0L 32V Ti-VCT



E260883

| Item | Description |
|------|-------------|
| 1    | PCV valve   |



## Engine Emission Control

Diagnostics in this manual assume a certain skill level and knowledge of Ford-specific diagnostic practices. For information about these,

REFER to: [Diagnostic Methods](#) (100-00 General Information, Description and Operation).

For PCM DTC,

REFER to: [Electronic Engine Controls](#) (303-14D Electronic Engine Controls - 5.0L 32V Ti-VCT, Diagnosis and Testing).

For driveability symptoms without DTC, Refer to Powertrain Control/Emissions Diagnosis (PC/ED) manual. See Section 3, Symptom Charts.

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## Positive Crankcase Ventilation (PCV) Valve

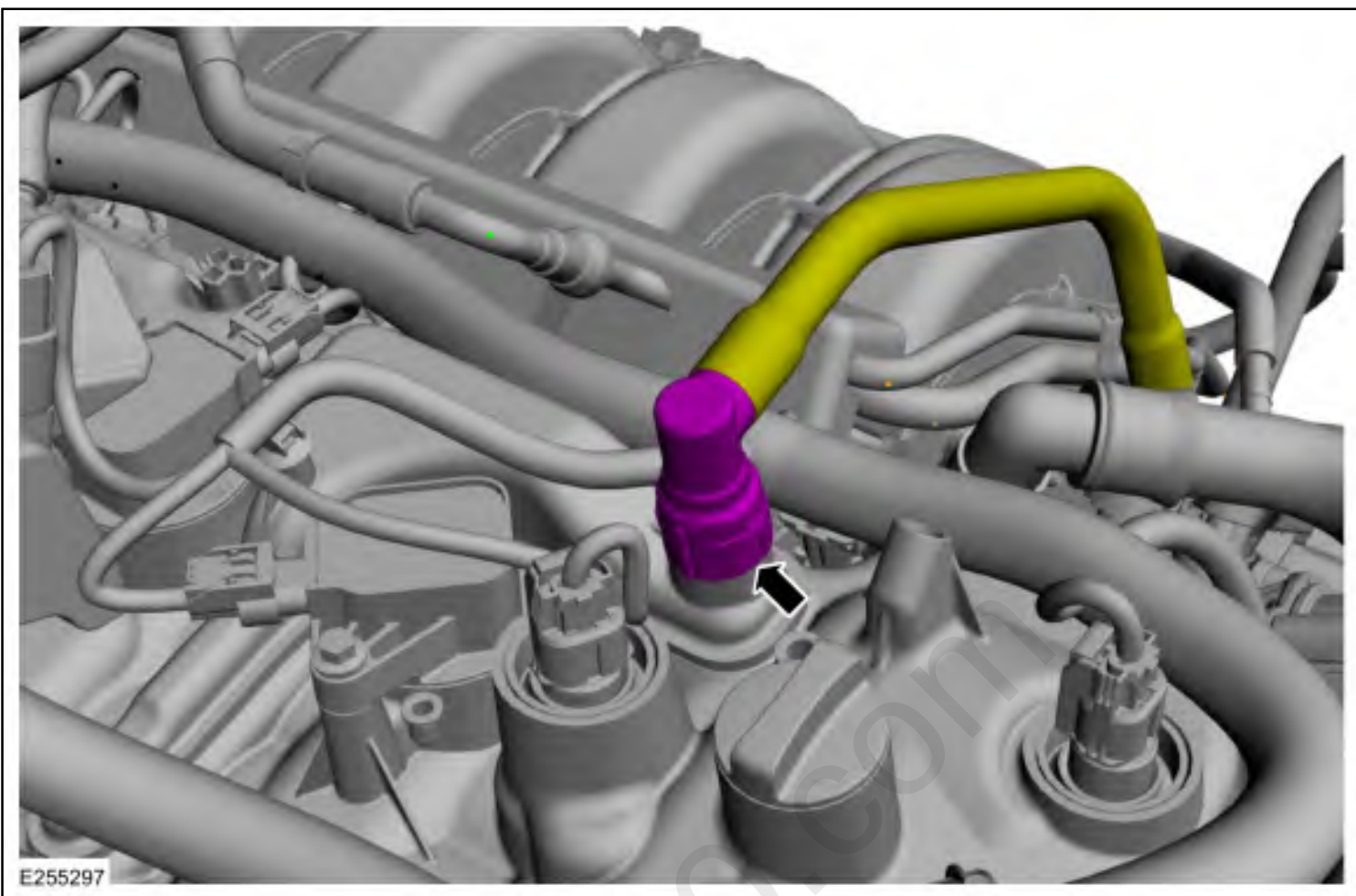
### Materials

| Name                                                           | Specification |
|----------------------------------------------------------------|---------------|
| Motorcraft® SAE 5W-20 Synthetic Blend Motor Oil<br>XO-5W20-QSP | WSS-M2C945-A  |

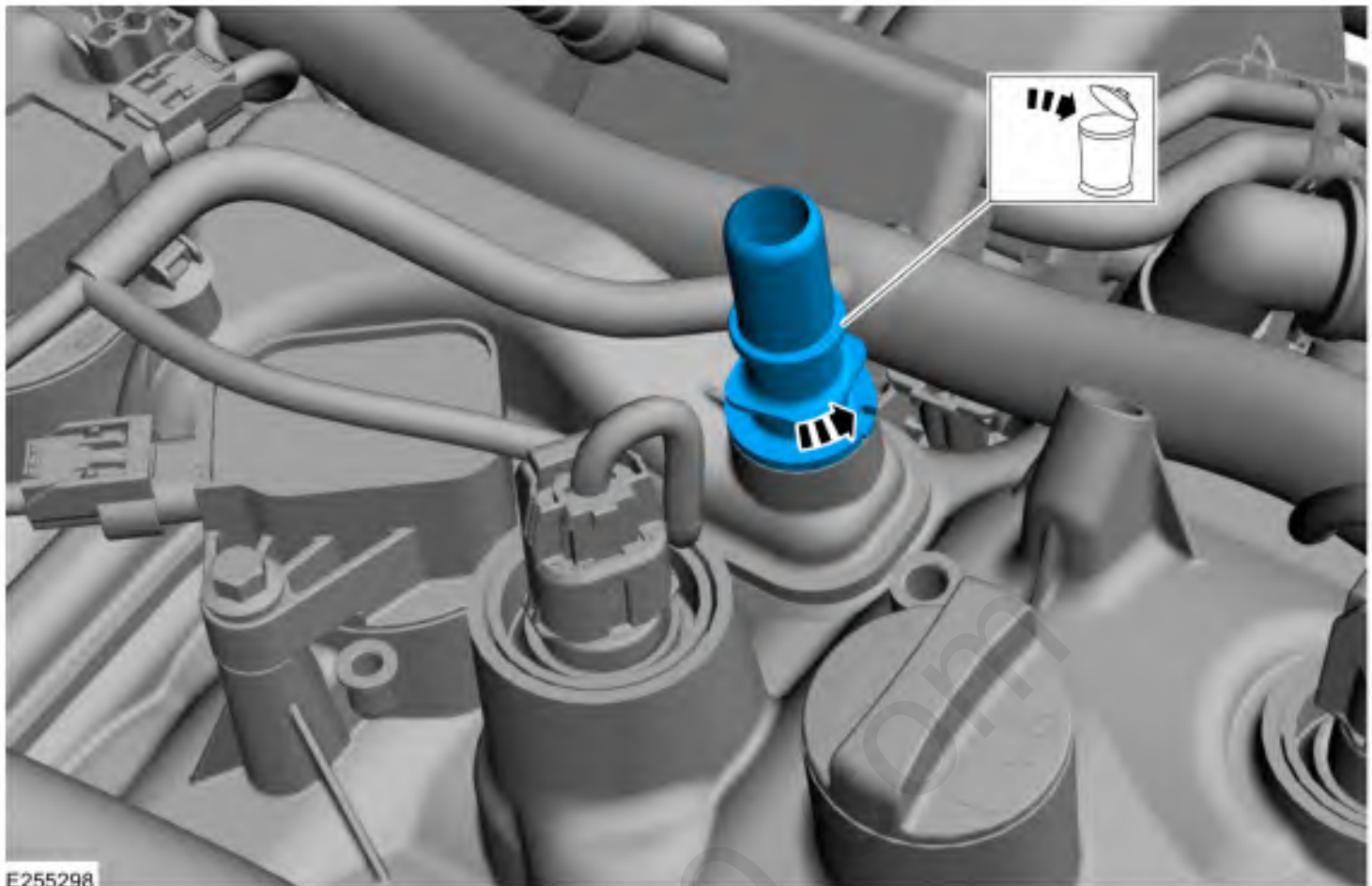
### Removal

**NOTE:** Removal steps in this procedure may contain installation details.

1. Disconnect the crankcase ventilation tube-to-PCV valve quick connect coupling.  
Refer to: [Quick Release Coupling](#) (310-00D Fuel System - General Information - 5.0L 32V Ti-VCT, General Procedures).



2. Rotate the PCV valve counterclockwise, then remove and discard the PCV valve.



## Installation

**NOTICE:** A new PCV valve must be installed if removed. Damage will occur to the locking mechanism on the PCV valve.

1. Lubricate the O-ring seal of the new PCV valve with clean engine oil.  
*Material:* Motorcraft® SAE 5W-20 Synthetic Blend Motor Oil / XO-5W20-QSP (WSS-M2C945-A)



E180567

2. To install, reverse the removal procedure.

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# Intake Air Distribution and Filtering - Overview

## Overview

The air intake system cleans intake air with a replaceable, dry-type engine Air Cleaner (ACL) element made of treated, pleated paper. A new Air Cleaner (ACL) element must be installed periodically as scheduled. Engine performance and fuel economy are adversely affected when maximum restriction of the Air Cleaner (ACL) element is reached.

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# Intake Air Distribution and Filtering

Diagnostics in this manual assume a certain skill level and knowledge of Ford-specific diagnostic practices. For information about these,

REFER to: [Diagnostic Methods](#) (100-00 General Information, Description and Operation).

For PCM DTC,

REFER to: [Electronic Engine Controls - Component Location](#) (303-14D Electronic Engine Controls - 5.0L 32V Ti-VCT, Description and Operation).

For driveability symptoms without DTC, Refer to Powertrain Control/Emissions Diagnosis (PC/ED) manual. See Section 3, Symptom Charts.

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Removal and Installation

Procedure revision date:  
05/29/2015

## Air Cleaner

### Removal

**NOTE:** Removal steps in this procedure may contain installation details.

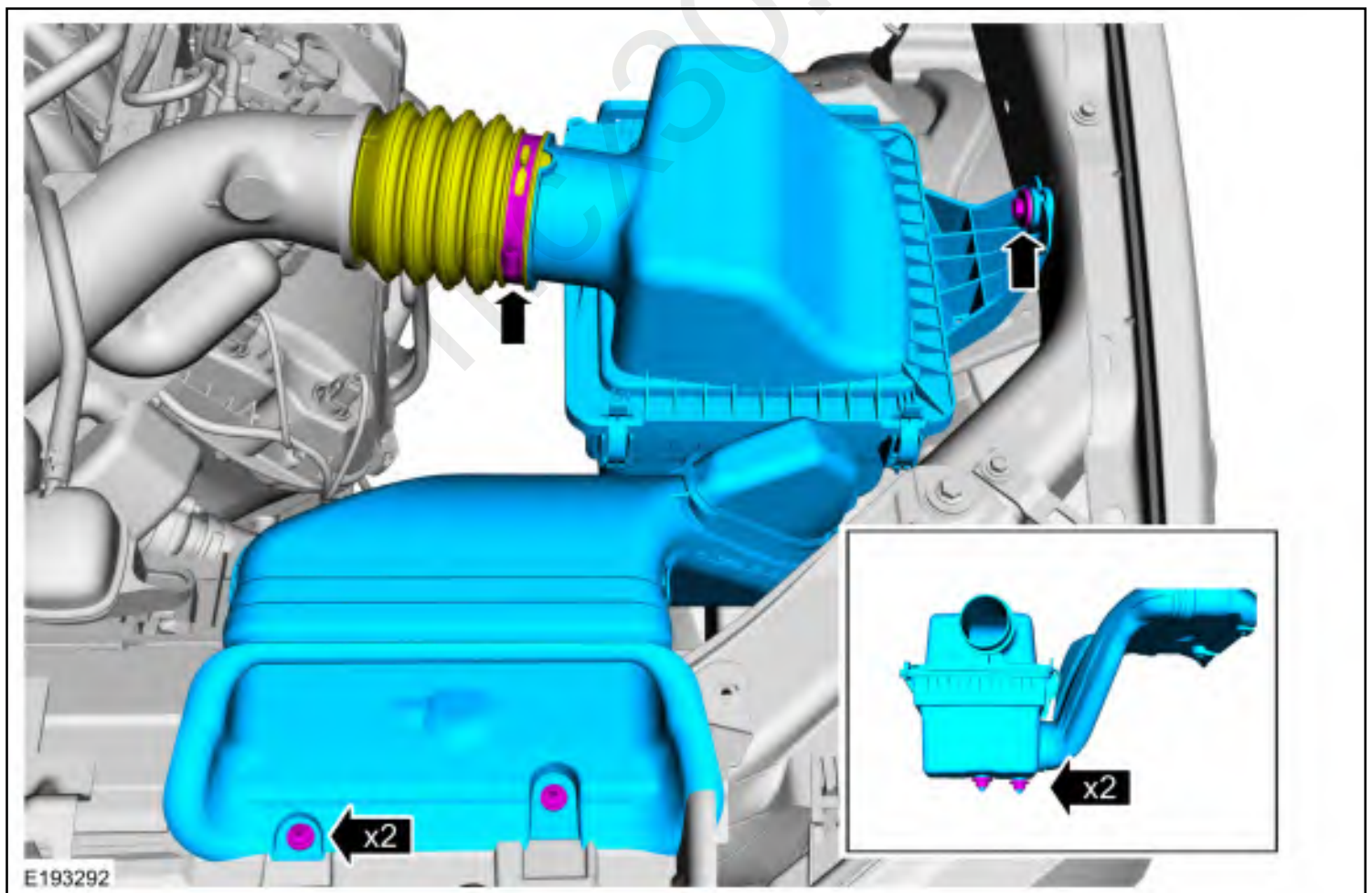
- Loosen the clamp and position aside the air cleaner outlet pipe. Remove the bolt and the push pin retainers from the air cleaner assembly.

*Torque:*

Clamp.: 36 lb.in (4.1 Nm)

Bolt.: 155 lb.in (17.5 Nm)

- Remove the air cleaner assembly.



## Installation

1. To install, reverse the removal procedure.

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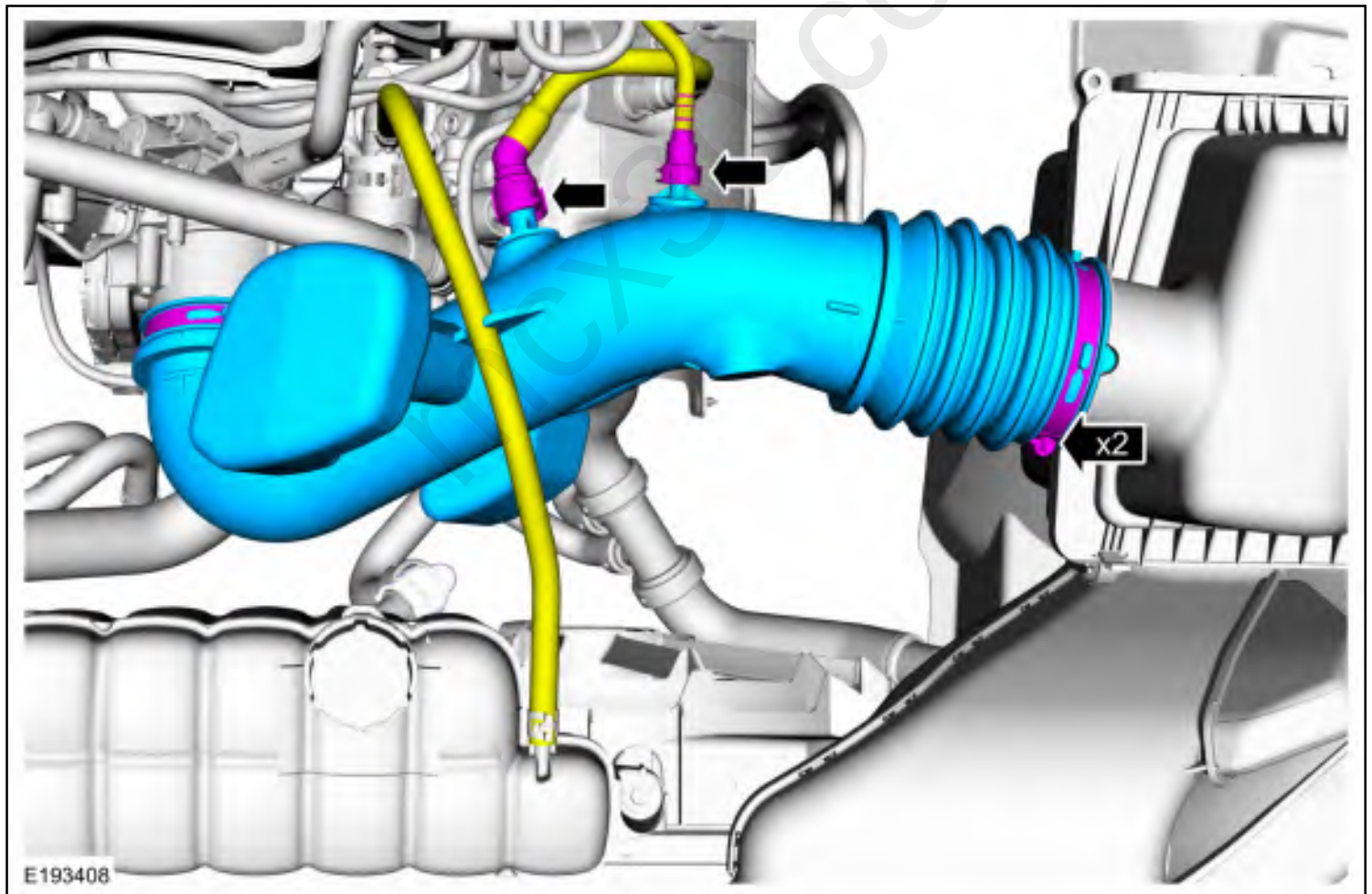
mcx30.com

## Air Cleaner Outlet Pipe

### Removal

**NOTE:** Removal steps in this procedure may contain installation details.

1. Position aside the coolant tube. Disconnect and position aside the brake booster tube and the crankcase ventilation tube. Loosen the 2 clamps and remove the air cleaner outlet pipe.  
Torque: 36 lb.in (4.1 Nm)



### Installation



1. To install, reverse the removal procedure.

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# Evaporative Emissions

## Engine Diagnostic Information

For PCM DTC,  
REFER to: [Electronic Engine Controls](#) (303-14D Electronic Engine Controls - 5.0L 32V Ti-VCT, Diagnosis and Testing).

For driveability symptoms without DTC, Refer to Powertrain Control/Emissions Diagnosis (PC/ED) manual. See Section 3, Symptom Charts.

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# Evaporative Emission System Leak Test

## Activation

### Phase 1 - Leak Verification

1. Run the EVAP Test with the scan tool.
2. **NOTE:** *Some small leaks may not be detected using the EVAP Test. If the system has passed the test but a leak is still suspected, then proceed to Phase 2.*

If the EVAP system failed the EVAP Test, then proceed to Phase 2.

### Phase 2 - System Leak Check

3. Disconnect the fuel vapor tube-to-EVAP canister purge valve quick connect coupling.  
Refer to: [Quick Release Coupling](#) (310-00D Fuel System - General Information - 5.0L 32V Ti-VCT, General Procedures).
4. Connect the VACUTEC Smoke Machine Fuel EVAP Emissions System Tester to the fuel vapor tube quick connect coupling. Refer to the manufacturer's instructions.
5. **NOTE:** *The battery ground cable was previously disconnected in the fuel vapor tube quick connect coupling procedure.*

Connect the battery ground cable.

Refer to: [Battery Disconnect and Connect](#) (414-01 Battery, Mounting and Cables, General Procedures).

6. Close the canister vent solenoid with the scan tool.
7. **NOTE:** *The supplemental refueling adapter is located in the jack storage compartment.*

Install the supplemental refueling adapter into the Easy Fuel™ (capless) fuel tank filler pipe assembly.

8. **NOTE:** *If smoke does not exit the fuel tank filler pipe neck area after the system is pressurized, open the canister vent solenoid with the scan tool to allow the air to purge. Once smoke is seen at the canister vent solenoid, close the canister vent solenoid with the scan tool.*

Introduce smoke from the VACUTEC Smoke Machine Fuel EVAP Emissions System Tester into the EVAP system and verify that smoke is exiting the fuel tank filler pipe neck area. For additional information, refer to the manufacturer's instructions.

9. Remove the supplemental refueling adapter once smoke is observed exiting the fuel tank filler pipe neck area.
10. Continue to enter smoke into the system for 60 seconds to obtain pressure.
11. Press and release the remote start button in intervals of 15 seconds ON and 15 seconds OFF while checking for exiting smoke.
12. Use the halogen light provided with the VACUTEC Smoke Machine Fuel EVAP Emissions System Tester to follow the EVAP system path and look for smoke exiting at the source of the leak(s).
13. Repair any leaks as necessary.
14. Repeat the leak test until the system passes.

# Evaporative Emission Canister Purge Valve

Base Part Number: Base Part Number: 9D289

## Removal

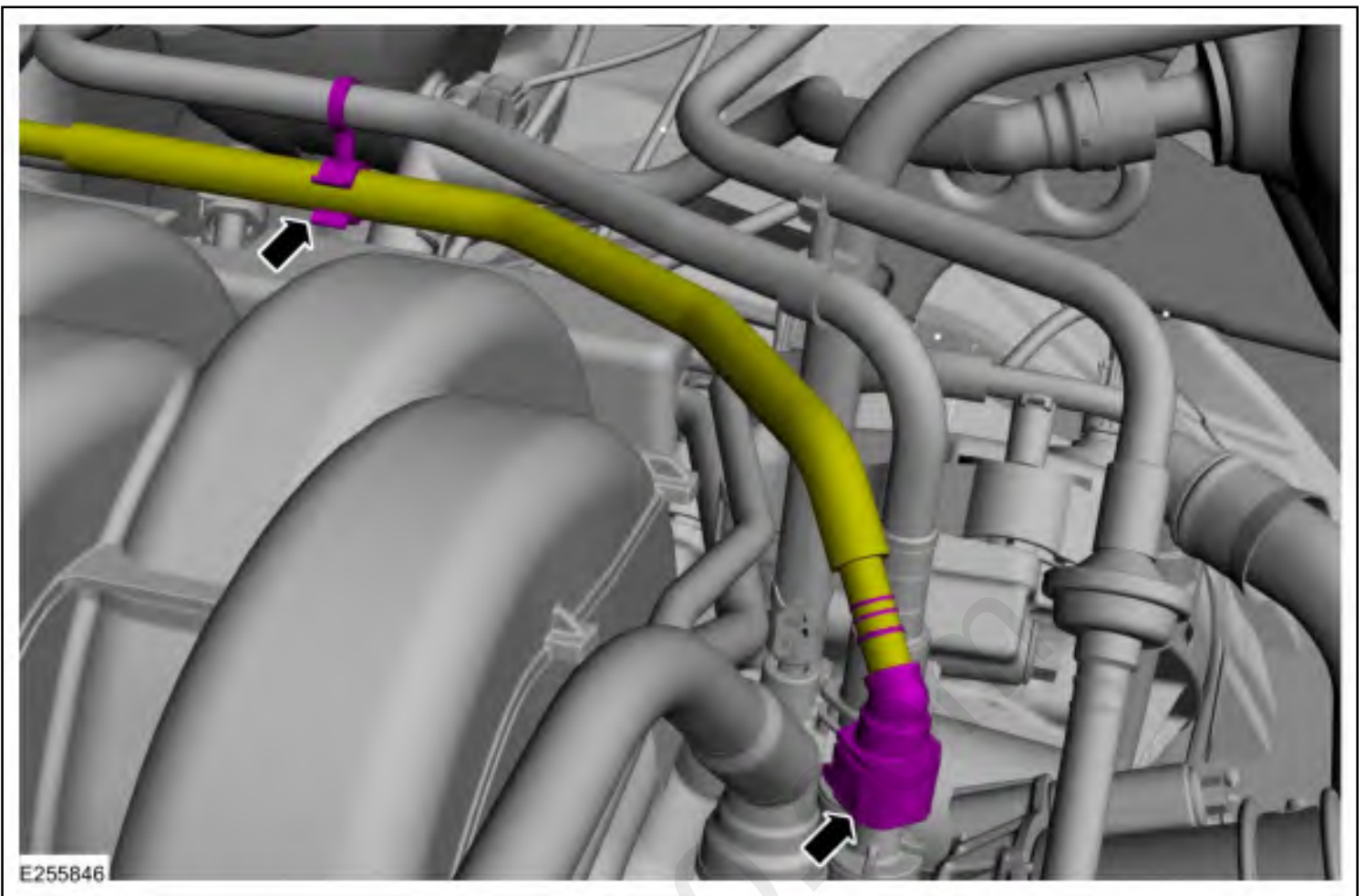
 **WARNING:** Do not smoke, carry lighted tobacco or have an open flame of any type when working on or near any fuel-related component. Highly flammable mixtures may be present and may be ignited. Failure to follow these instructions may result in serious personal injury.

 **WARNING:** Do not carry personal electronic devices such as cell phones, pagers or audio equipment of any type when working on or near any fuel-related component. Highly flammable mixtures may be present and may be ignited. Failure to follow these instructions may result in serious personal injury.

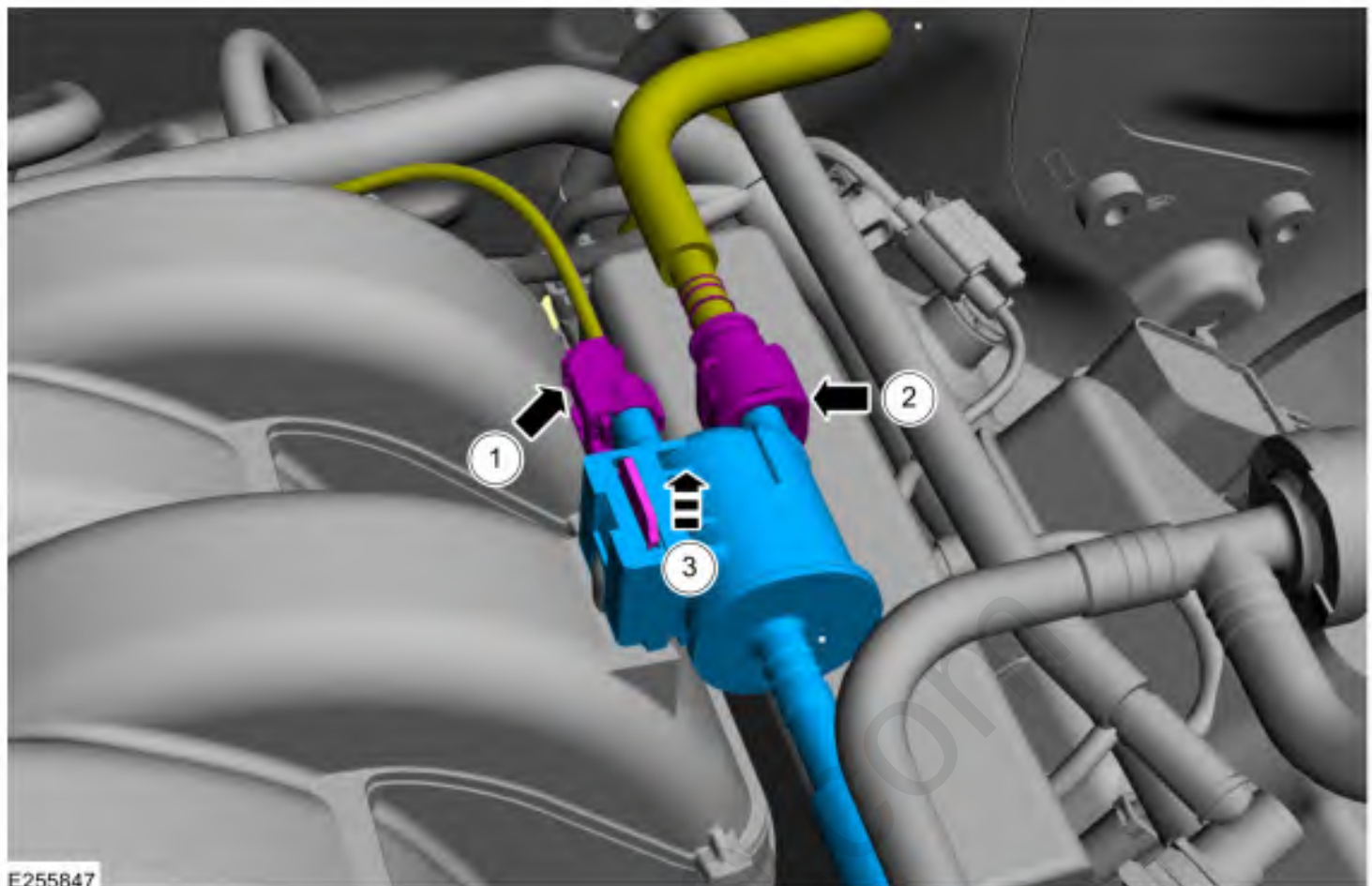
**NOTE:** Removal steps in this procedure may contain installation details.

1. Disconnect the EVAP canister purge valve quick connect coupling.  
Refer to: [Quick Release Coupling](#) (310-00D Fuel System - General Information - 5.0L 32V Ti-VCT, General Procedures).
2. Detach the retainer and position aside the EVAP canister purge valve hose.





1. Disconnect the EVAP canister purge valve electrical connector.
2. Disconnect the EVAP canister purge valve quick connect coupling.  
Refer to: [Quick Release Coupling](#) (310-00D Fuel System - General Information - 5.0L 32V Ti-VCT, General Procedures).
3. Lift and remove the EVAP canister purge valve.  
*Torque: 89 lb.in (10 Nm)*



## Installation

1. To install, reverse the removal procedure.

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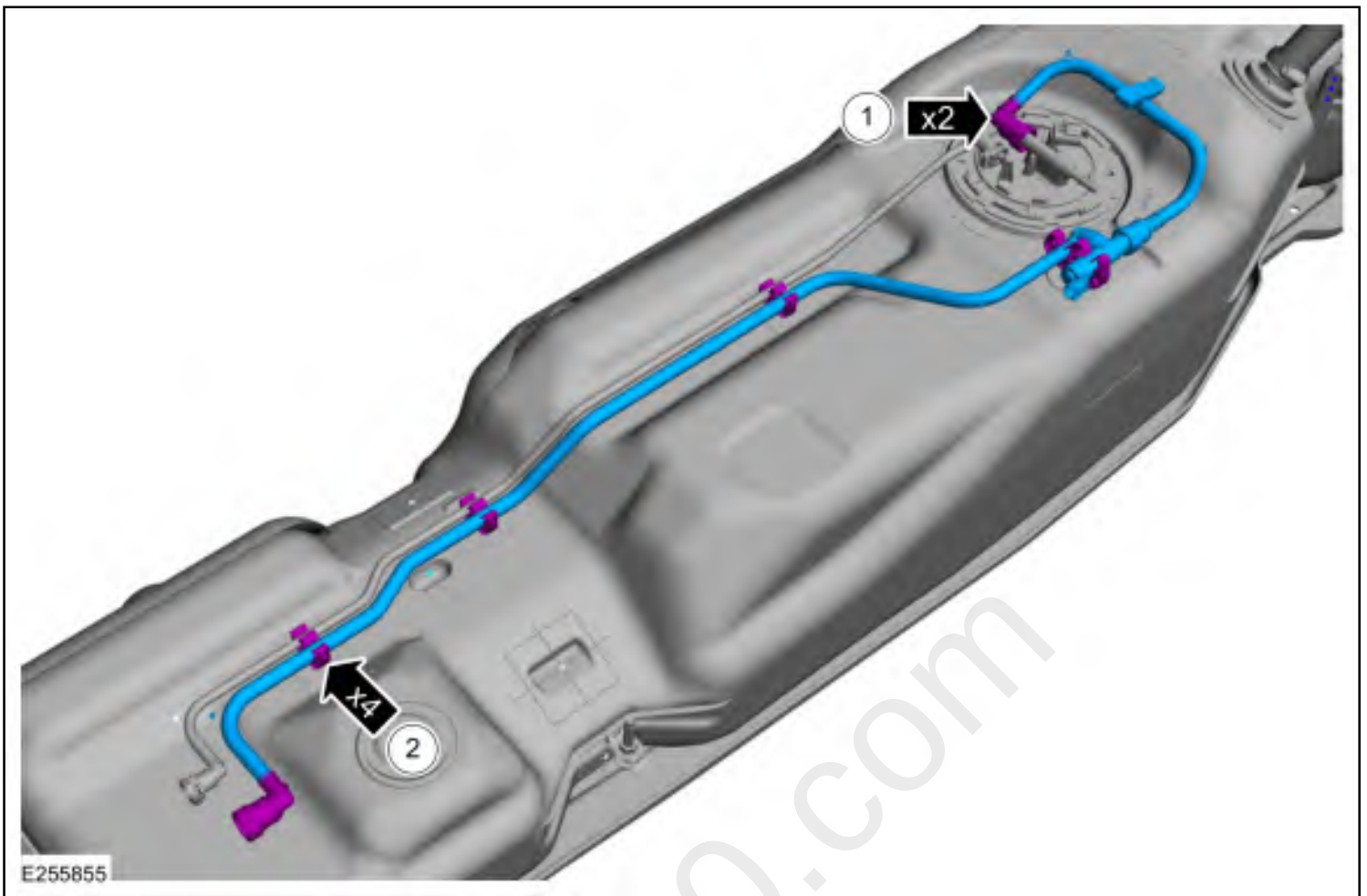
# Fuel Tank Pressure Sensor and Tube

Base Part Number: Base Part Number: 9D683

## Removal

**NOTE:** Removal steps in this procedure may contain installation details.

1. With the vehicle in NEUTRAL, position it on a hoist.  
Refer to: [Jacking and Lifting - Overview](#) (100-02 Jacking and Lifting, Description and Operation).
2. Remove the fuel tank.  
Refer to: [Fuel Tank](#) (310-01D Fuel Tank and Lines - 5.0L 32V Ti-VCT, Removal and Installation).
3. **NOTE:** Typical application shown.
  1. Disconnect the EVAP quick connect couplings.  
Refer to: [Quick Release Coupling](#) (310-00D Fuel System - General Information - 5.0L 32V Ti-VCT, General Procedures).
  2. Release the hose routing clips and remove the EVAP fuel tank pressure sensor and tube.



## Installation

1. To install, reverse the removal procedure.

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# Evaporative Emission Blocking Valve

## Removal

**NOTE:** *The evaporative emission blocking valve is serviced with the fuel tank pressure sensor and tube.*

1. Remove the fuel tank pressure sensor and tube.  
Refer to: [Fuel Tank Pressure Sensor and Tube](#) (303-13D Evaporative Emissions - 5.0L 32V Ti-VCT, Removal and Installation).

## Installation

1. To install, reverse the removal procedure.

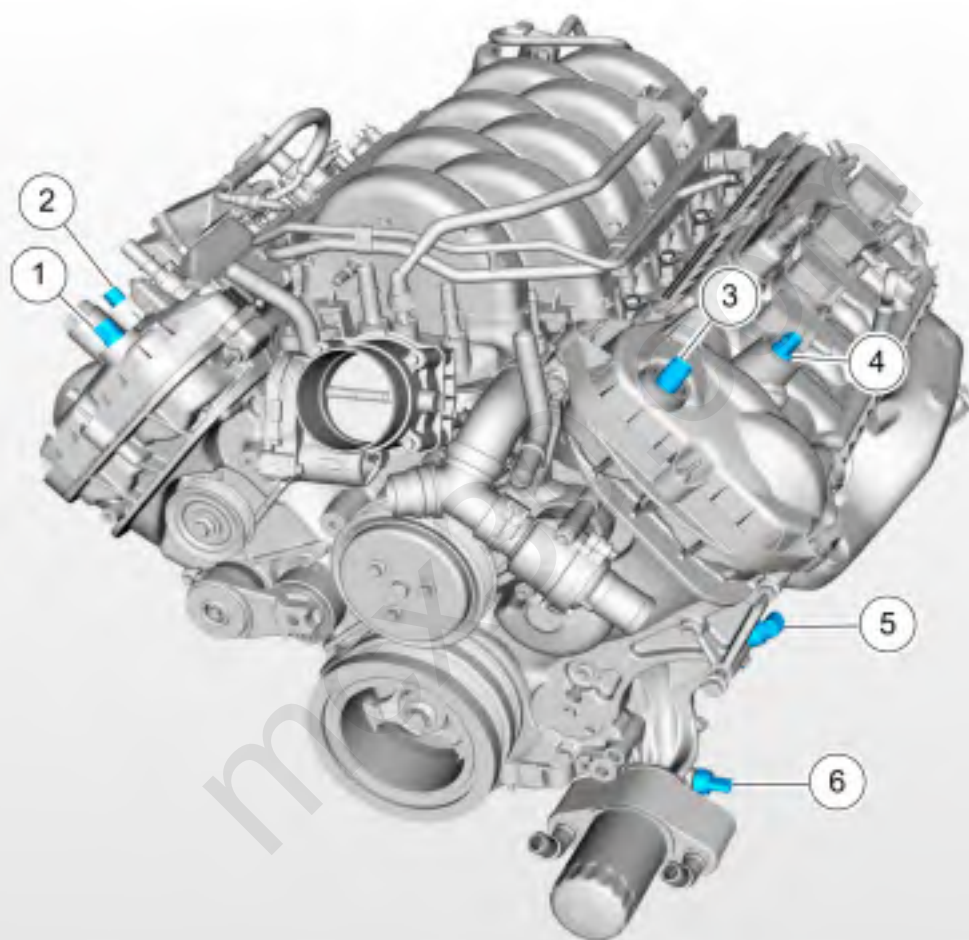
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# Electronic Engine Controls - Component Location

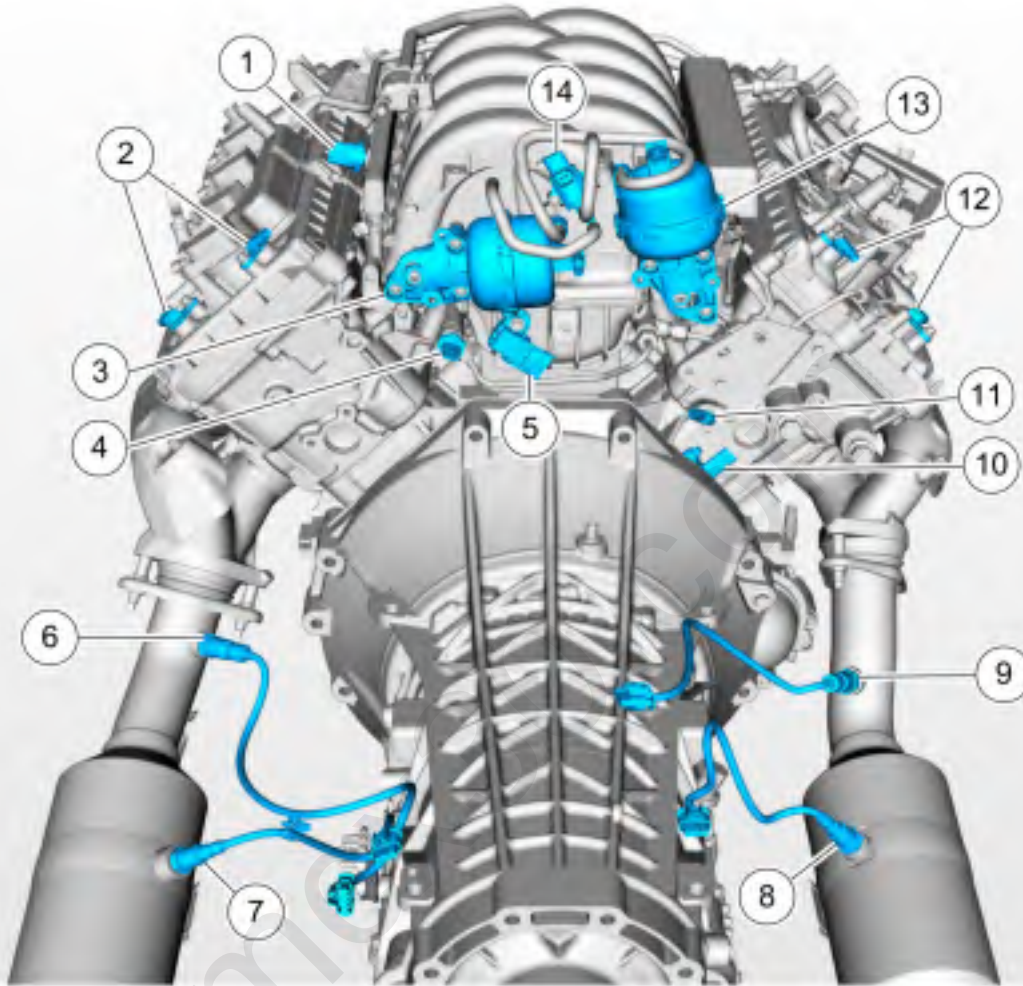
## Electronic Engine Controls- Front



E257723

| Item | Description                         |
|------|-------------------------------------|
| 1    | RH Intake VCT Oil Control Solenoid  |
| 2    | RH Exhaust VCT Oil Control Solenoid |
| 3    | LH Intake VCT Oil Control Solenoid  |
| 4    | LH Exhaust VCT Oil Control Solenoid |
| 5    | Oil Pressure Control Solenoid       |

## Electronic Engine Controls - Rear

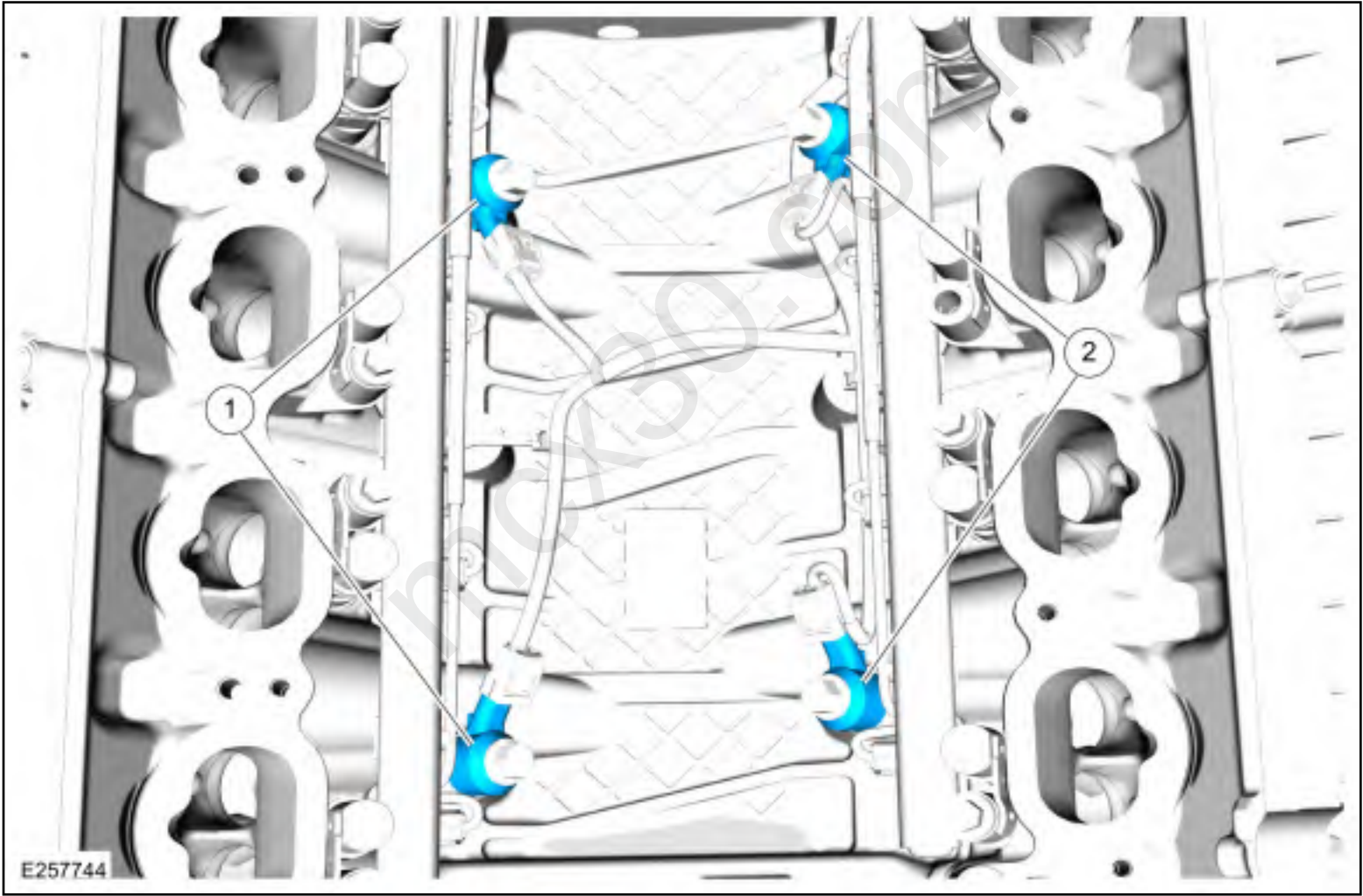


E257738

| Item | Description                |
|------|----------------------------|
| 1    | FRP and temperature sensor |
| 2    | LH CMP sensors             |
| 3    | LH IMRC Actuator           |
| 4    | FRP sensor                 |
| 5    | MAPT sensor                |
| 6    | LH HO2S                    |
| 7    | LH Catalyst Monitor sensor |
| 8    | RH Catalyst Monitor sensor |

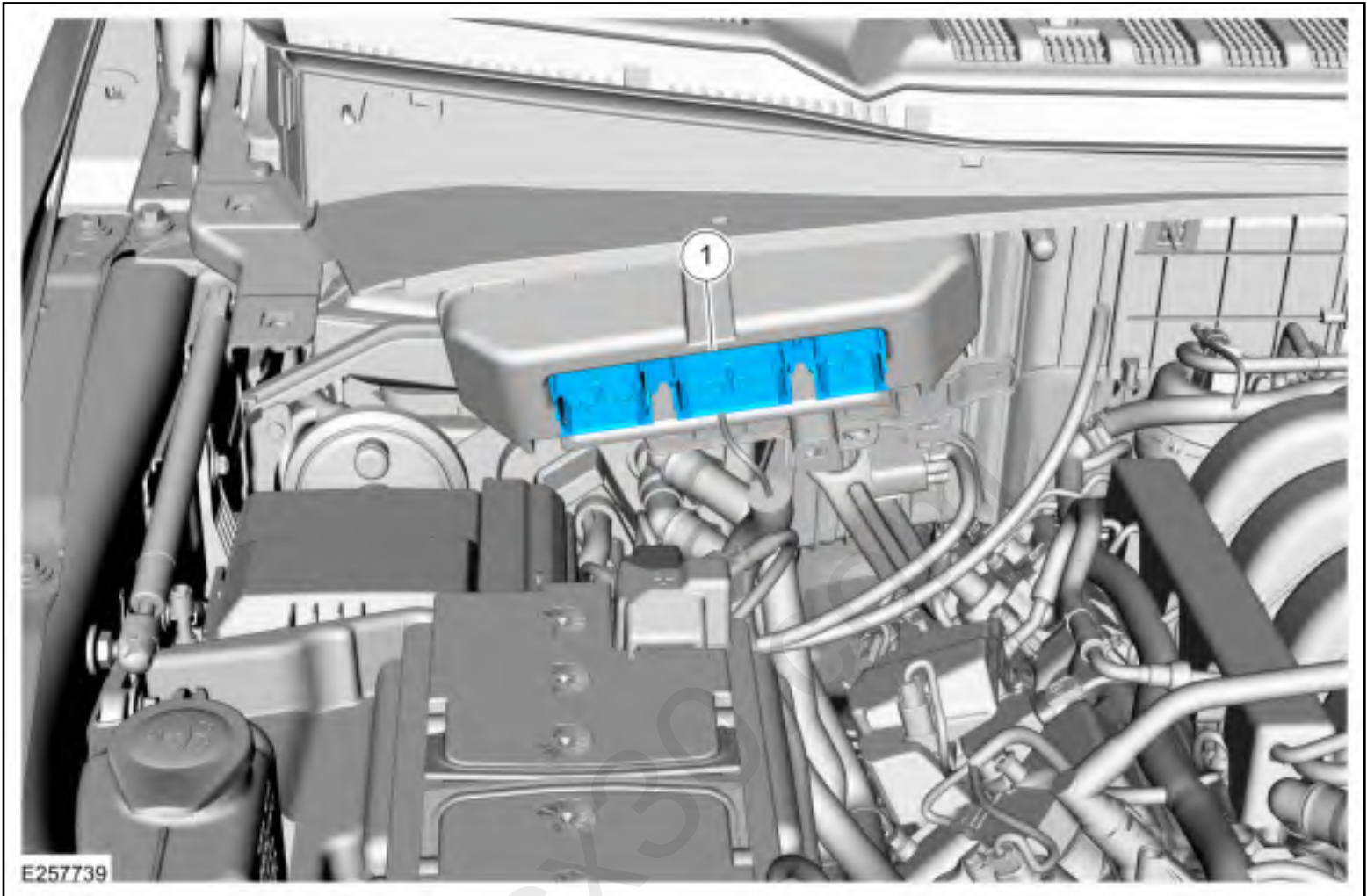
|    |                  |
|----|------------------|
| 9  | RH HO2S          |
| 10 | CKP sensor       |
| 11 | CHT sensor       |
| 12 | RH CMP sensors   |
| 13 | RH IMRC Actuator |
| 14 | IMRC Solenoid    |

KS



| Item | Description |
|------|-------------|
| 1    | KS          |
| 2    | KS          |

**Powertrain Control Module (PCM)**



| Item | Description |
|------|-------------|
| 1    | PCM         |



# Electronic Engine Controls

## DTC Chart: Powertrain Control Module (PCM)

Diagnostics in this manual assume a certain skill level and knowledge of Ford-specific diagnostic practices.

REFER to: [Diagnostic Methods](#) (100-00 General Information, Description and Operation).

### Powertrain Control Module (PCM) DTC Chart

| DTC   | Description                                                               | Action                                                                                                                                                                                                 |
|-------|---------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| P0125 | Insufficient Coolant Temp For Closed Loop Fuel Control                    | REFER to: <a href="#">Engine Cooling</a> (303-03D Engine Cooling - 5.0L 32V Ti-VCT, Diagnosis and Testing).                                                                                            |
| P0128 | Coolant Thermostat (Coolant Temp Below Thermostat Regulating Temperature) | REFER to: <a href="#">Engine Cooling</a> (303-03D Engine Cooling - 5.0L 32V Ti-VCT, Diagnosis and Testing).                                                                                            |
| P0217 | Engine Coolant Overtemperature Condition                                  | REFER to: <a href="#">Engine Cooling</a> (303-03D Engine Cooling - 5.0L 32V Ti-VCT, Diagnosis and Testing).                                                                                            |
| P0218 | Transmission Fluid Temperature Sensor "A" Over Temperature Condition      | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |



|       |                                                         |                                                                                                                                                                                                                                                                                                 |
|-------|---------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| P025A | Fuel Pump Module A Control Circuit/<br>Open             | First, Refer to Powertrain Control/<br>Emissions Diagnosis (PC/ED) manual. If<br>sent here from the PC/ED manual,<br> <a href="#">Click here to access</a><br><a href="#">Guided Routine (BCM).</a>           |
| P025B | Fuel Pump Module A Control Circuit<br>Range/Performance | First, Refer to Powertrain Control/<br>Emissions Diagnosis (PC/ED) manual. If<br>sent here from the PC/ED manual,<br> <a href="#">Click here to access</a><br><a href="#">Guided Routine (BCM).</a>           |
| P025C | Fuel Pump Module A Control Circuit<br>Low               | First, Refer to Powertrain Control/<br>Emissions Diagnosis (PC/ED) manual. If<br>sent here from the PC/ED manual,<br> <a href="#">Click here to access</a><br><a href="#">Guided Routine (BCM).</a>           |
| P025D | Fuel Pump Module A Control Circuit<br>High              | First, Refer to Powertrain Control/<br>Emissions Diagnosis (PC/ED) manual. If<br>sent here from the PC/ED manual,<br> <a href="#">Click here to access</a><br><a href="#">Guided Routine (BCM).</a>         |
| P027B | Fuel Pump Module B Control Circuit<br>Range/Performance | First, Refer to Powertrain Control/<br>Emissions Diagnosis (PC/ED) manual. If<br>sent here from the PC/ED manual,<br> <a href="#">Click here to access</a><br><a href="#">Guided Routine (BCM).</a>         |
| P0461 | Fuel Level Sensor A Circuit Range/<br>Performance       | First, Refer to Powertrain Control/<br>Emissions Diagnosis (PC/ED) manual. If<br>sent here from the PC/ED manual,<br>REFER to: <a href="#">Instrumentation, Message<br/>Center and Warning Chimes</a> (413-01<br>Instrumentation, Message Center and<br>Warning Chimes, Diagnosis and Testing). |

|       |                                                                 |                                                                                                                                                                                                                                                                                             |
|-------|-----------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| P0462 | Fuel Level Sensor A Circuit Low                                 | First, Refer to Powertrain Control/ Emissions Diagnosis (PC/ED) manual. If sent here from the PC/ED manual, REFER to: <a href="#">Instrumentation, Message Center and Warning Chimes</a> (413-01 Instrumentation, Message Center and Warning Chimes, Diagnosis and Testing).                |
| P0504 | Brake Switch A / B Correlation                                  | Without adaptive cruise control, REFER to: <a href="#">Cruise Control</a> (419-03A Cruise Control, Diagnosis and Testing). With adaptive cruise control, REFER to: <a href="#">Cruise Control</a> (419-03B Cruise Control - Vehicles With: Adaptive Cruise Control, Diagnosis and Testing). |
| P050F | Brake Assist Vacuum Too Low                                     | REFER to: Anti-Lock Brake System (ABS) and Stability Control (206-09 Anti-Lock Brake System (ABS) and Stability Control) .                                                                                                                                                                  |
| P0521 | Engine Oil Pressure Sensor/Switch "A" Circuit Range/Performance | REFER to: <a href="#">Instrumentation, Message Center and Warning Chimes</a> (413-01 Instrumentation, Message Center and Warning Chimes, Diagnosis and Testing).                                                                                                                            |
| P0522 | Engine Oil Pressure Sensor/Switch "A" Circuit Low               | REFER to: <a href="#">Instrumentation, Message Center and Warning Chimes</a> (413-01 Instrumentation, Message Center and Warning Chimes, Diagnosis and Testing).                                                                                                                            |
| P0523 | Engine Oil Pressure Sensor/Switch "A" Circuit High              | REFER to: <a href="#">Instrumentation, Message Center and Warning Chimes</a> (413-01 Instrumentation, Message Center and Warning Chimes, Diagnosis and Testing).                                                                                                                            |

|       |                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-------|---------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| P0524 | Engine Oil Pressure Too Low                             | REFER to: <a href="#">Instrumentation, Message Center and Warning Chimes</a> (413-01 Instrumentation, Message Center and Warning Chimes, Diagnosis and Testing).                                                                                                                                                                                                                                                     |
| P0532 | A/C Refrigerant Pressure Sensor “A” Circuit Low         | With DATC<br>REFER to: <a href="#">Climate Control System - Vehicles With: Dual Automatic Temperature Control (DATC)</a> (412-00 Climate Control System - General Information, Diagnosis and Testing).<br>With EMTC,<br>REFER to: <a href="#">Climate Control System - Vehicles With: Electronic Manual Temperature Control (EMTC)</a> (412-00 Climate Control System - General Information, Diagnosis and Testing). |
| P0533 | A/C Refrigerant Pressure Sensor “A” Circuit High        | With DATC<br>REFER to: <a href="#">Climate Control System - Vehicles With: Dual Automatic Temperature Control (DATC)</a> (412-00 Climate Control System - General Information, Diagnosis and Testing).<br>With EMTC,<br>REFER to: <a href="#">Climate Control System - Vehicles With: Electronic Manual Temperature Control (EMTC)</a> (412-00 Climate Control System - General Information, Diagnosis and Testing). |
| P0555 | Brake Booster Pressure Sensor Circuit                   | REFER to: Anti-Lock Brake System (ABS) and Stability Control (206-09 Anti-Lock Brake System (ABS) and Stability Control) .                                                                                                                                                                                                                                                                                           |
| P0556 | Brake Booster Pressure Sensor Circuit Range/Performance | REFER to: Anti-Lock Brake System (ABS) and Stability Control (206-09 Anti-Lock Brake System (ABS) and Stability Control) .                                                                                                                                                                                                                                                                                           |

|       |                                                    |                                                                                                                                                                                                                                                                                                |
|-------|----------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| P0557 | Brake Booster Pressure Sensor Circuit Low          | REFER to: Anti-Lock Brake System (ABS) and Stability Control (206-09 Anti-Lock Brake System (ABS) and Stability Control) .                                                                                                                                                                     |
| P0558 | Brake Booster Pressure Sensor Circuit High         | REFER to: Anti-Lock Brake System (ABS) and Stability Control (206-09 Anti-Lock Brake System (ABS) and Stability Control) .                                                                                                                                                                     |
| P0559 | Brake Booster Pressure Sensor Circuit Intermittent | REFER to: Anti-Lock Brake System (ABS) and Stability Control (206-09 Anti-Lock Brake System (ABS) and Stability Control) .                                                                                                                                                                     |
| P055F | Engine Oil Pressure Out of Range                   | REFER to: <a href="#">Instrumentation, Message Center and Warning Chimes</a> (413-01 Instrumentation, Message Center and Warning Chimes, Diagnosis and Testing).                                                                                                                               |
| P0562 | System Voltage Low                                 | REFER to: <a href="#">Charging System - 3.3L Duratec - V6/5.0L 32V Ti-VCT</a> (414-00 Charging System - General Information, Diagnosis and Testing).                                                                                                                                           |
| P0563 | System Voltage High                                | REFER to: <a href="#">Charging System - 3.3L Duratec - V6/5.0L 32V Ti-VCT</a> (414-00 Charging System - General Information, Diagnosis and Testing).                                                                                                                                           |
| P0572 | Brake Switch A Circuit Low                         | Without adaptive cruise control, REFER to: <a href="#">Cruise Control</a> (419-03A Cruise Control, Diagnosis and Testing).<br>With adaptive cruise control, REFER to: <a href="#">Cruise Control</a> (419-03B Cruise Control - Vehicles With: Adaptive Cruise Control, Diagnosis and Testing). |

|       |                                                                                  |                                                                                                                                                                                                                                                                                                |
|-------|----------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| P0573 | Brake Switch A Circuit High                                                      | Without adaptive cruise control, REFER to: <a href="#">Cruise Control</a> (419-03A Cruise Control, Diagnosis and Testing).<br>With adaptive cruise control, REFER to: <a href="#">Cruise Control</a> (419-03B Cruise Control - Vehicles With: Adaptive Cruise Control, Diagnosis and Testing). |
| P05A1 | Active Grille Air Shutter "A" Position Sensor Minimum / Maximum Stop Performance | REFER to: <a href="#">Active Grille Shutter</a> (501-02 Front End Body Panels, Diagnosis and Testing).                                                                                                                                                                                         |
| P05A2 | Active Grille Air Shutter "A" Control Circuit / Open                             | REFER to: <a href="#">Active Grille Shutter</a> (501-02 Front End Body Panels, Diagnosis and Testing).                                                                                                                                                                                         |
| P05A7 | Active Grille Air Shutter Control Module "A" Supply Voltage Circuit Low          | REFER to: <a href="#">Active Grille Shutter</a> (501-02 Front End Body Panels, Diagnosis and Testing).                                                                                                                                                                                         |
| P05C0 | Active Grille Air Shutter Module "A" Over Temperature                            | REFER to: <a href="#">Active Grille Shutter</a> (501-02 Front End Body Panels, Diagnosis and Testing).                                                                                                                                                                                         |
| P05FF | Brake Pressure Sensor / Brake Pedal Position Sensor Correlation                  | REFER to: Anti-Lock Brake System (ABS) and Stability Control (206-09 Anti-Lock Brake System (ABS) and Stability Control) .                                                                                                                                                                     |
| P0620 | Generator Control Circuit                                                        | REFER to: <a href="#">Charging System - 3.3L Duratec - V6/5.0L 32V Ti-VCT</a> (414-00 Charging System - General Information, Diagnosis and Testing).                                                                                                                                           |
| P0625 | Generator Field Terminal Circuit Low                                             | REFER to: <a href="#">Charging System - 3.3L Duratec - V6/5.0L 32V Ti-VCT</a> (414-00 Charging System - General Information, Diagnosis and Testing).                                                                                                                                           |



|       |                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-------|-------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| P0626 | Generator Field Terminal Circuit High           | REFER to: <a href="#">Charging System - 3.3L Duratec - V6/5.0L 32V Ti-VCT</a> (414-00 Charging System - General Information, Diagnosis and Testing).                                                                                                                                                                                                                                                                 |
| P0645 | A/C Clutch Relay Control Circuit                | With DATC<br>REFER to: <a href="#">Climate Control System - Vehicles With: Dual Automatic Temperature Control (DATC)</a> (412-00 Climate Control System - General Information, Diagnosis and Testing).<br>With EMTC,<br>REFER to: <a href="#">Climate Control System - Vehicles With: Electronic Manual Temperature Control (EMTC)</a> (412-00 Climate Control System - General Information, Diagnosis and Testing). |
| P0657 | Actuator Supply Voltage "A" Circuit/<br>Open    | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing).                                                                                                                                                                                                               |
| P065B | Generator Control Circuit Range/<br>Performance | REFER to: <a href="#">Charging System - 3.3L Duratec - V6/5.0L 32V Ti-VCT</a> (414-00 Charging System - General Information, Diagnosis and Testing).                                                                                                                                                                                                                                                                 |

|       |                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-------|-----------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| P06A0 | Variable A/C Compressor Control Circuit                   | <p>With DATC<br/>REFER to: <a href="#">Climate Control System - Vehicles With: Dual Automatic Temperature Control (DATC)</a> (412-00 Climate Control System - General Information, Diagnosis and Testing).</p> <p>With EMTC,<br/>REFER to: <a href="#">Climate Control System - Vehicles With: Electronic Manual Temperature Control (EMTC)</a> (412-00 Climate Control System - General Information, Diagnosis and Testing).</p> |
| P06DA | Engine Oil Pressure Control Circuit/ Open                 | <a href="#">GO to Pinpoint Test L</a>                                                                                                                                                                                                                                                                                                                                                                                             |
| P06DB | Engine Oil Pressure Control Circuit Low                   | <a href="#">GO to Pinpoint Test L</a>                                                                                                                                                                                                                                                                                                                                                                                             |
| P06DC | Engine Oil Pressure Control Circuit High                  | <a href="#">GO to Pinpoint Test L</a>                                                                                                                                                                                                                                                                                                                                                                                             |
| P06DD | Engine Oil Pressure Control Circuit Performance/Stuck Off | <a href="#">GO to Pinpoint Test L</a>                                                                                                                                                                                                                                                                                                                                                                                             |
| P06E4 | Control Module Wake-up Circuit Performance                | REFER to: <a href="#">Starting System</a> (303-06D Starting System - 5.0L 32V Ti-VCT, Diagnosis and Testing).                                                                                                                                                                                                                                                                                                                     |
| P06E9 | No engine rotation detected during crank event            | REFER to: <a href="#">Starting System</a> (303-06D Starting System - 5.0L 32V Ti-VCT, Diagnosis and Testing).                                                                                                                                                                                                                                                                                                                     |
| P0702 | Transmission Control System Electrical                    | <p>REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing).</p>                                                                                                                                                                                                                     |
|       |                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                   |

|       |                                                            |                                                                                                                                                                                                        |
|-------|------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| P0706 | Transmission Range Sensor "A"<br>Circuit Range/Performance | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0707 | Transmission Range Sensor "A"<br>Circuit Low               | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0708 | Transmission Range Sensor "A"<br>Circuit High              | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0709 | Transmission Range Sensor "A"<br>Circuit Intermittent      | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0710 | Transmission Fluid Temperature<br>Sensor "A" Circuit       | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |

|       |                                                                     |                                                                                                                                                                                                        |
|-------|---------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| P0711 | Transmission Fluid Temperature Sensor "A" Circuit Range/Performance | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0712 | Transmission Fluid Temperature Sensor "A" Circuit Low               | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0713 | Transmission Fluid Temperature Sensor "A" Circuit High              | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0715 | Turbine/Input Shaft Speed Sensor "A" Circuit                        | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0716 | Turbine/Input Shaft Speed Sensor "A" Circuit Range/Performance      | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |

|       |                                                              |                                                                                                                                                                                                        |
|-------|--------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| P0717 | Turbine/Input Shaft Speed Sensor "A"<br>Circuit No Signal    | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0718 | Turbine/Input Shaft Speed Sensor "A"<br>Circuit Intermittent | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0720 | Output Shaft Speed Sensor Circuit                            | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0721 | Output Shaft Speed Sensor Circuit<br>Range/Performance       | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0722 | Output Shaft Speed Sensor Circuit No<br>Signal               | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |



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| P0729 | Gear 6 Incorrect Ratio | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0731 | Gear 1 Incorrect Ratio | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0732 | Gear 2 Incorrect Ratio | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0733 | Gear 3 Incorrect Ratio | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0734 | Gear 4 Incorrect Ratio | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |

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| P0735 | Gear 5 Incorrect Ratio                                         | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0736 | Reverse Incorrect Ratio                                        | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0740 | Torque Converter Clutch Solenoid Circuit/Open                  | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0741 | Torque Converter Clutch Solenoid Circuit Performance/Stuck Off | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0743 | Torque Converter Clutch Solenoid Circuit Electrical            | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |

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| P0748 | Pressure Control Solenoid "A"<br>Electrical | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0751 | Shift Solenoid "A" Performance/Stuck Off    | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0752 | Shift Solenoid "A" Stuck On                 | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0753 | Shift Solenoid "A" Electrical               | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0754 | Shift Solenoid "A" Intermittent             | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |

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| P0756 | Shift Solenoid "B" Performance/Stuck Off | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0757 | Shift Solenoid "B" Stuck On              | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0758 | Shift Solenoid "B" Electrical            | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0759 | Shift Solenoid "B" Intermittent          | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0761 | Shift Solenoid "C" Performance/Stuck Off | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |

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| P0762 | Shift Solenoid "C" Stuck On              | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0763 | Shift Solenoid "C" Electrical            | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0764 | Shift Solenoid "C" Intermittent          | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0766 | Shift Solenoid "D" Performance/Stuck Off | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0767 | Shift Solenoid "D" Stuck On              | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |



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| P0768 | Shift Solenoid "D" Electrical            | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0769 | Shift Solenoid "D" Intermittent          | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P076F | Gear 7 Ratio Incorrect                   | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0771 | Shift Solenoid "E" Performance/Stuck Off | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0772 | Shift Solenoid "E" Stuck On              | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |

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| P0773 | Shift Solenoid "E" Electrical                                 | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0774 | Shift Solenoid "E" Intermittent                               | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P077D | Output Shaft Speed Sensor Circuit High                        | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0791 | Intermediate Shaft Speed Sensor "A" Circuit                   | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0792 | Intermediate Shaft Speed Sensor "A" Circuit Range/Performance | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |

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| P0793 | Intermediate Shaft Speed Sensor "A"<br>Circuit No Signal    | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0794 | Intermediate Shaft Speed Sensor "A"<br>Circuit Intermittent | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P07C0 | Input/Turbine Shaft Speed Sensor "A"<br>Circuit High        | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P07C6 | Intermediate Shaft Speed Sensor "A"<br>Circuit High         | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P07C8 | Intermediate Shaft Speed Sensor "B"<br>Circuit High         | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |

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| P07D9 | Gear 8 Incorrect Ratio          | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P07F6 | Gear 9 Incoret Ratio            | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P07F7 | Gear 10 Incorrect Ratio         | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0868 | Transmission Fluid Pressure Low | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0882 | TCM Power Input Signal Low      | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |

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| P0883 | TCM Power Input Signal High                        | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0960 | Line Pressure Control (LPC) A Control Circuit/Open | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0961 | Pressure Control Solenoid "A" Control Circuit/Open | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0962 | Pressure Control Solenoid "A" Control Circuit Low  | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0963 | Pressure Control Solenoid "A" Control Circuit High | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |



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| P0973 | Shift Solenoid "A" Control Circuit Low  | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0974 | Shift Solenoid "A" Control Circuit High | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0976 | Shift Solenoid "B" Control Circuit Low  | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0977 | Shift Solenoid "B" Control Circuit High | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0979 | Shift Solenoid "C" Control Circuit Low  | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |

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| P097A | Shift Solenoid "A" Control Circuit / Open | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P097B | Shift Solenoid "B" Control Circuit / Open | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P097C | Shift Solenoid "C" Control Circuit / Open | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P097D | Shift Solenoid "D" Control Circuit / Open | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P097E | Shift Solenoid "E" Control Circuit / Open | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |

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| P097F | Shift Solenoid "F" Control Circuit / Open | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0980 | Shift Solenoid "C" Control Circuit High   | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0982 | Shift Solenoid "D" Control Circuit Low    | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0983 | Shift Solenoid "D" Control Circuit High   | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0985 | Shift Solenoid "E" Control Circuit Low    | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |

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| P0986 | Shift Solenoid "E" Control Circuit High            | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0998 | Shift Solenoid "F" Control Circuit Low             | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0999 | Shift Solenoid "F" Control Circuit High            | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0A5A | Generator Current Sensor Circuit Range/Performance | REFER to: <a href="#">Charging System - 3.3L Duratec - V6/5.0L 32V Ti-VCT</a> (414-00 Charging System - General Information, Diagnosis and Testing).                                                   |
| P0A5B | Generator Current Sensor Circuit Low               | REFER to: <a href="#">Charging System - 3.3L Duratec - V6/5.0L 32V Ti-VCT</a> (414-00 Charging System - General Information, Diagnosis and Testing).                                                   |
| P0A5C | Generator Current Sensor Circuit High              | REFER to: <a href="#">Charging System - 3.3L Duratec - V6/5.0L 32V Ti-VCT</a> (414-00 Charging System - General Information, Diagnosis and Testing).                                                   |

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| P0B0D | Electric/Auxiliary Transmission Fluid Pump Motor Control Module           | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0C27 | Electric/Auxiliary Transmission Fluid Pump "A" Motor Current Low          | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0C28 | Electric/Auxiliary Transmission Fluid Pump "A" Motor Current High         | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0C29 | Electric/Auxiliary Transmission Fluid Pump "A" Driver Circuit Performance | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P0C2A | Electric/Auxiliary Transmission Fluid Pump "A" Motor Stalled              | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |



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| P0C2C | Electric Transmission Fluid Pump Control Module Feedback Signal Range/Performance | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing).                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| P0C2D | Electric Transmission Fluid Pump Control Module Feedback Signal Low               | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing).                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| P0C2E | Electric Transmission Fluid Pump Control Module Feedback Signal High              | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing).                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| P1001 | KOER Not Able to Complete, KOER Aborted                                           | <p>RETRIEVE and RECORD all Diagnostic Trouble Codes (DTCs). REPAIR any self-test or Continuous Memory Diagnostic Trouble Codes (CMDTCs) first. CLEAR the DTC. RERUN the KOER self-test. If the DTC returns, REPROGRAM the PCM with the latest software.</p> <p>REFER to: <a href="#">Module Programming</a> (418-01 Module Configuration, General Procedures).</p> <p>RERUN the KOER self-test. If the DTC returns, INSTALL a new PCM, REFER to: <a href="#">Powertrain Control Module (PCM)</a> (303-14D Electronic Engine Controls - 5.0L 32V Ti-VCT, Removal and Installation).</p> <p>After installing the new PCM PROGRAM it with the latest software.</p> |

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| P1299 | Cylinder Head Overtemperature Protection Active                                    | REFER to: <a href="#">Engine Cooling</a> (303-03D Engine Cooling - 5.0L 32V Ti-VCT, Diagnosis and Testing).                                                                                                                                                                                                                                                                                                          |
| P1397 | System Voltage Out Of Self Test Range                                              | REFER to: <a href="#">Charging System - 3.3L Duratec - V6/5.0L 32V Ti-VCT</a> (414-00 Charging System - General Information, Diagnosis and Testing).                                                                                                                                                                                                                                                                 |
| P1464 | A/C Demand Out Of Self Test Range                                                  | With DATC<br>REFER to: <a href="#">Climate Control System - Vehicles With: Dual Automatic Temperature Control (DATC)</a> (412-00 Climate Control System - General Information, Diagnosis and Testing).<br>With EMTC,<br>REFER to: <a href="#">Climate Control System - Vehicles With: Electronic Manual Temperature Control (EMTC)</a> (412-00 Climate Control System - General Information, Diagnosis and Testing). |
| P1501 | Vehicle Speed Sensor Out Of Self Test Range                                        | REFER to: Anti-Lock Brake System (ABS) and Stability Control (206-09 Anti-Lock Brake System (ABS) and Stability Control) .                                                                                                                                                                                                                                                                                           |
| P1595 | Forced engine shutdown – remote start system fault, transmission range not in park | REFER to: <a href="#">Locks, Latches and Entry Systems</a> (501-14 Handles, Locks, Latches and Entry Systems, Diagnosis and Testing).                                                                                                                                                                                                                                                                                |

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| P161A | Incorrect Response from Immobilizer Control Module | Without keyless vehicle system, REFER to: <a href="#">Passive Anti-Theft System (PATS)</a> (419-01B Passive Anti-Theft System (PATS), Diagnosis and Testing). With keyless vehicle system, REFER to: <a href="#">Passive Anti-Theft System (PATS)</a> (419-01C Passive Anti-Theft System (PATS) - Vehicles With: Keyless Vehicle System, Diagnosis and Testing). |
| P1636 | Inductive Signature Chip Communication Error       | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing).                                                                                                                                                           |
| P163E | Transmission Control Module Programming Error      | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing).                                                                                                                                                           |
| P163F | Transmission ID Block Corrupted, Not Programmed    | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing).                                                                                                                                                           |
| P166A | Restraints Deployment Communication Circuit        | First, Refer to Powertrain Control/ Emissions Diagnosis (PC/ED) manual. If sent here from the PC/ED manual,   <a href="#">Click here to access Guided Routine (BCM).</a>                |

|       |                                          |                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-------|------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| P1703 | Brake Switch Out Of Self-Test Range      | Without adaptive cruise control, REFER to: <a href="#">Cruise Control</a> (419-03A Cruise Control, Diagnosis and Testing). With adaptive cruise control, REFER to: <a href="#">Cruise Control</a> (419-03B Cruise Control - Vehicles With: Adaptive Cruise Control, Diagnosis and Testing).                                                                                                                          |
| P1744 | Torque Converter Clutch Solenoid Circuit | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing).                                                                                                                                                                                                               |
| P1783 | Transmission Overtemperature Condition   | REFER to: <a href="#">Transmission Cooling</a> (307-02 Transmission Cooling, Diagnosis and Testing).                                                                                                                                                                                                                                                                                                                 |
| P1935 | Brake Switch/Sensor Signal               | Without adaptive cruise control, REFER to: <a href="#">Cruise Control</a> (419-03A Cruise Control, Diagnosis and Testing). With adaptive cruise control, REFER to: <a href="#">Cruise Control</a> (419-03B Cruise Control - Vehicles With: Adaptive Cruise Control, Diagnosis and Testing).                                                                                                                          |
| P193E | A/C Clutch Request Signal                | With DATC<br>REFER to: <a href="#">Climate Control System - Vehicles With: Dual Automatic Temperature Control (DATC)</a> (412-00 Climate Control System - General Information, Diagnosis and Testing).<br>With EMTC,<br>REFER to: <a href="#">Climate Control System - Vehicles With: Electronic Manual Temperature Control (EMTC)</a> (412-00 Climate Control System - General Information, Diagnosis and Testing). |

|       |                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                      |
|-------|--------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| P1A02 | Transmission One Way Clutch Performance                | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing).                                                                                                                                                                                                               |
| P2535 | Ignition Switch Run/Start Position Circuit High        | REFER to: <a href="#">Starting System</a> (303-06D Starting System - 5.0L 32V Ti-VCT, Diagnosis and Testing).                                                                                                                                                                                                                                                                                                        |
| P25B0 | Fuel Level Sensor "A" Stuck                            | REFER to: <a href="#">Instrumentation, Message Center and Warning Chimes</a> (413-01 Instrumentation, Message Center and Warning Chimes, Diagnosis and Testing).                                                                                                                                                                                                                                                     |
| P2601 | Coolant Pump "A" Control Circuit Performance/Stuck Off | With DATC<br>REFER to: <a href="#">Climate Control System - Vehicles With: Dual Automatic Temperature Control (DATC)</a> (412-00 Climate Control System - General Information, Diagnosis and Testing).<br>With EMTC,<br>REFER to: <a href="#">Climate Control System - Vehicles With: Electronic Manual Temperature Control (EMTC)</a> (412-00 Climate Control System - General Information, Diagnosis and Testing). |
| P2602 | Coolant Pump "A" Control Circuit Low                   | With DATC<br>REFER to: <a href="#">Climate Control System - Vehicles With: Dual Automatic Temperature Control (DATC)</a> (412-00 Climate Control System - General Information, Diagnosis and Testing).<br>With EMTC,<br>REFER to: <a href="#">Climate Control System - Vehicles With: Electronic Manual Temperature Control (EMTC)</a> (412-00 Climate Control System - General                                      |



|       |                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-------|----------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|       |                                                                | Information, Diagnosis and Testing).                                                                                                                                                                                                                                                                                                                                                                                                |
| P2603 | Coolant Pump "A" Control Circuit High                          | <p>With DATC<br/> REFER to: <a href="#">Climate Control System - Vehicles With: Dual Automatic Temperature Control (DATC)</a> (412-00 Climate Control System - General Information, Diagnosis and Testing).</p> <p>With EMTC,<br/> REFER to: <a href="#">Climate Control System - Vehicles With: Electronic Manual Temperature Control (EMTC)</a> (412-00 Climate Control System - General Information, Diagnosis and Testing).</p> |
| P2669 | Actuator Supply Voltage "B" Circuit/Open                       | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing).                                                                                                                                                                                                                              |
| P2681 | Engine Coolant Bypass Valve "A" Control Circuit/Open           | REFER to: <a href="#">Transmission Cooling</a> (307-02 Transmission Cooling, Diagnosis and Testing).                                                                                                                                                                                                                                                                                                                                |
| P2683 | Engine Coolant Bypass Valve "A" Control Circuit High           | REFER to: <a href="#">Transmission Cooling</a> (307-02 Transmission Cooling, Diagnosis and Testing).                                                                                                                                                                                                                                                                                                                                |
| P2700 | Transmission Friction Element "A" Apply Time Range/Performance | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing).                                                                                                                                                                                                                              |

|       |                                                                   |                                                                                                                                                                                                        |
|-------|-------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| P2701 | Transmission Friction Element "B"<br>Apply Time Range/Performance | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P2702 | Transmission Friction Element "C"<br>Apply Time Range/Performance | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P2703 | Transmission Friction Element "D"<br>Apply Time Range/Performance | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P2704 | Transmission Friction Element "E"<br>Apply Time Range/Performance | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P2705 | Transmission Friction Element "F"<br>Apply Time Range/Performance | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |

|       |                                             |                                                                                                                                                                                                        |
|-------|---------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| P2707 | Shift Solenoid "F" Performance/Stuck Off    | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P2708 | Shift Solenoid "F" Stuck On                 | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P2709 | Shift Solenoid "F" Electrical               | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P2710 | Shift Solenoid "F" Intermittent             | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P2745 | Intermediate Shaft Speed Sensor "B" Circuit | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |

|       |                                                                   |                                                                                                                                                                                                        |
|-------|-------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| P2746 | Intermediate Shaft Speed Sensor "B"<br>Circuit Range/Performance  | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P2747 | Intermediate Shaft Speed Sensor "B"<br>Circuit No Signal          | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P2748 | Intermediate Shaft Speed Sensor "B"<br>Circuit Intermittent       | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P2758 | Torque Converter Clutch Pressure<br>Control Solenoid Stuck On     | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P2760 | Torque Converter Clutch Pressure<br>Control Solenoid Intermittent | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |

|       |                                                         |                                                                                                                                                                                                        |
|-------|---------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| P2769 | Torque Converter Clutch Circuit Low                     | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P2770 | Torque Converter Clutch Circuit High                    | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P2783 | Torque Converter Temperature Too High                   | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P2796 | Electric Transmission Fluid Pump Control Circuit        | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P2801 | Transmission Range Sensor "B" Circuit Range/Performance | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |



|       |                                                                     |                                                                                                                                                                                                        |
|-------|---------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| P2802 | Transmission Range Sensor "B"<br>Circuit Low                        | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P2803 | Transmission Range Sensor "B"<br>Circuit High                       | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P2804 | Transmission Range Sensor "B"<br>Circuit Intermittant               | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| P2805 | Transmission Range Sensor "A"/"B"<br>Correlation                    | REFER to: <a href="#">Diagnostic Trouble Code (DTC) Charts and Pinpoint Tests - 5.0L 32V Ti-VCT</a> (307-01B Automatic Transmission - 10-Speed Automatic Transmission - 10R80, Diagnosis and Testing). |
| U0104 | Lost Communication With Cruise Control Module                       | REFER to: <a href="#">Cruise Control</a> (419-03B Cruise Control - Vehicles With: Adaptive Cruise Control, Diagnosis and Testing).                                                                     |
| U0121 | Lost Communication With Anti-Lock Brake System (ABS) Control Module | <a href="#">GO to Pinpoint Test A</a>                                                                                                                                                                  |
| U0131 | Lost Communication with Power Steering Control Module               | <a href="#">GO to Pinpoint Test C</a>                                                                                                                                                                  |
| U0137 | Lost Communication With Trailer Brake Control Module                | <a href="#">GO to Pinpoint Test D</a>                                                                                                                                                                  |

|       |                                                               |                                                                                                                            |
|-------|---------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|
| U0159 | Lost Communication With Parking Assist Control Module "A"     | <a href="#">GO to Pinpoint Test E</a>                                                                                      |
| U0164 | Lost Communication With HVAC Control Module                   | <a href="#">GO to Pinpoint Test F</a>                                                                                      |
| U0199 | Lost Communication With "Door Control Module A"               | <a href="#">GO to Pinpoint Test G</a>                                                                                      |
| U0200 | Lost Communication With "Door Control Module B"               | <a href="#">GO to Pinpoint Test H</a>                                                                                      |
| U0212 | Lost Communication With Steering Column Control Module        | <a href="#">GO to Pinpoint Test B</a>                                                                                      |
| U023A | Lost Communication With Image Processing Module A             | <a href="#">GO to Pinpoint Test I</a>                                                                                      |
| U0252 | Lost Communication With Lighting Control Module- Rear "B"     | REFER to: <a href="#">Trailer Lamps</a> (417-01 Exterior Lighting, Diagnosis and Testing).                                 |
| U0256 | Lost Communication With Front Controls Interface Module "A"   | <a href="#">GO to Pinpoint Test J</a>                                                                                      |
| U0284 | Lost Communication with Active Grille Air Shutter Module "A"  | REFER to: <a href="#">Active Grille Shutter</a> (501-02 Front End Body Panels, Diagnosis and Testing).                     |
| U0298 | Lost Communication With DC to DC Converter Control Module "A" | <a href="#">GO to Pinpoint Test K</a>                                                                                      |
| U034B | Software Incompatibility with Brake Booster Control           | REFER to: Anti-Lock Brake System (ABS) and Stability Control (206-09 Anti-Lock Brake System (ABS) and Stability Control) . |

|                |                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                         |
|----------------|--------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| U0405          | Invalid Data Received From Cruise Control Module | This DTC sets when the PCM receives invalid network data from the CCM. RETRIEVE and REPAIR all non-network Diagnostic Trouble Codes (DTCs) in the PCM, CCM, and other modules on the network. For PCM Diagnostic Trouble Codes (DTCs) refer to this chart. For all other Diagnostic Trouble Codes (DTCs), REFER to: <a href="#">Diagnostic Trouble Code Charts</a> (100-00 General Information, Diagnosis and Testing). |
| U2200          | Control Module Configuration Memory Corrupt      | INSTALL As-Built data from Professional Technician Society (PTS) following diagnostic scan tool instructions under Module Programming>As-Built. CLEAR the Diagnostic Trouble Codes (DTCs). REPEAT the self-test. If PCM DTC U2200 is retrieved again, INSTALL a new PCM. REFER to: <a href="#">Powertrain Control Module (PCM)</a> (303-14D Electronic Engine Controls - 5.0L 32V Ti-VCT, Removal and Installation).    |
| All Other DTCs | —                                                | Refer to Powertrain Control/Emissions Diagnosis (PC/ED) manual. Section 3 Symptom Charts.                                                                                                                                                                                                                                                                                                                               |

## Pinpoint Tests

### U0121

#### DTC Fault Trigger Condition-PCM

| DTC   | Description                                                         | Fault Trigger Conditions                                                                |
|-------|---------------------------------------------------------------------|-----------------------------------------------------------------------------------------|
| U0121 | Lost Communication With Anti-Lock Brake System (ABS) Control Module | The PCM sets this DTC if data messages from the ABS module through the GWM are missing. |

Normal Operation and Fault Conditions

REFER to: [Communications Network - System Operation and Component Description](#) (418-00 Module Communications Network, Description and Operation).

Possible Sources

- Communications network concern
- ABS module
- GWM
- PCM

PINPOINT TEST A : U0121

|                                                                                                                         |                                                                                                                                          |
|-------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| A1 VERIFY THE CUSTOMER CONCERN                                                                                          |                                                                                                                                          |
| <ul style="list-style-type: none"><li>• Ignition ON.</li><li>• Verify there is an observable symptom present.</li></ul> |                                                                                                                                          |
| Is an observable symptom present?                                                                                       |                                                                                                                                          |
| Yes                                                                                                                     | GO to <a href="#">A2</a>                                                                                                                 |
| No                                                                                                                      | The system is operating normally at this time. The DTC may have been set due to high network traffic or an intermittent fault condition. |
| A2 CHECK THE COMMUNICATION NETWORK                                                                                      |                                                                                                                                          |
|                                                                                                                         |                                                                                                                                          |

- Using a diagnostic scan tool, perform a network test.

**Did the ABS module pass the network test?**

|            |                                                                                                                 |
|------------|-----------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">A3</a>                                                                                        |
| <b>No</b>  | REFER to: <a href="#">Communications Network</a> (418-00 Module Communications Network, Diagnosis and Testing). |

**A3 PERFORM ABS (ANTI-LOCK BRAKE SYSTEM) CONTROL MODULE SELF-TEST**

- Using a diagnostic scan tool, perform a ABS control module self-test.

**Are any Diagnostic Trouble Codes (DTCs) recorded?**

|            |                                                                                                                            |
|------------|----------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | REFER to: Anti-Lock Brake System (ABS) and Stability Control (206-09 Anti-Lock Brake System (ABS) and Stability Control) . |
| <b>No</b>  | GO to <a href="#">A4</a>                                                                                                   |

**A4 CHECK THE BCM (BODY CONTROL MODULE) DIAGNOSTIC TROUBLE CODES (DTCS)**

- Using a diagnostic scan tool, retrieve the BCM Diagnostic Trouble Codes (DTCs).

**Are any Diagnostic Trouble Codes (DTCs) recorded?**

|            |                                                                                                                       |
|------------|-----------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | REFER to: <a href="#">Body Control Module (BCM)</a> (419-10 Multifunction Electronic Modules, Diagnosis and Testing). |
| <b>No</b>  | GO to <a href="#">A5</a>                                                                                              |

**A5 PERFORM THE PCM (POWERTRAIN CONTROL MODULE) SELF-TEST**



- Using a diagnostic scan tool, perform the PCM self-test.

**Is DTC P0562 or DTC P0563 recorded?**

|            |                                         |
|------------|-----------------------------------------|
| <b>Yes</b> | REFER to PCM DTC Chart in this section. |
| <b>No</b>  | GO to <a href="#">A6</a>                |

**A6 RECHECK THE PCM (POWERTRAIN CONTROL MODULE) DIAGNOSTIC TROUBLE CODES (DTCS)**

**NOTE:** *If new modules were installed prior to the DTC being set, the module configuration may be incorrectly set during the PMI, or the PMI may not have been carried out.*

- Using a diagnostic scan tool, clear the Diagnostic Trouble Codes (DTCs).
- Wait 10 seconds.
- Repeat the PCM self-test.

**Is DTC U0121 still present?**

|            |                                                                                                                                           |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">A7</a>                                                                                                                  |
| <b>No</b>  | The system is operating correctly at this time. The DTC may have been set due to high network traffic or an intermittent fault condition. |

**A7 CHECK FOR DTC (DIAGNOSTIC TROUBLE CODE) U0121 SET IN OTHER MODULES**

- Using a diagnostic scan tool, clear all Diagnostic Trouble Codes (DTCs).
- Ignition OFF.
- Ignition ON.
- Wait 10 seconds.
- Using a diagnostic scan tool, retrieve all Continuous Memory Diagnostic Trouble Codes (CMDTCs) from all modules.

**Is DTC U0121:00 set in any other module?**

|            |                          |
|------------|--------------------------|
| <b>Yes</b> | GO to <a href="#">A8</a> |
| <b>No</b>  | GO to <a href="#">A9</a> |

## **A8 CHECK FOR CORRECT ABS (ANTI-LOCK BRAKE SYSTEM) MODULE OPERATION**

- Ignition OFF.
- Disconnect and inspect the ABS control module connectors.
- Repair:
  - corrosion (install new connector or terminals – clean module pins)
  - damaged or bent pins – install new terminals/pins
  - pushed-out pins – install new pins as necessary
- Reconnect the ABS control module connectors. Make sure they seat and latch correctly.
- Operate the system and determine if the concern is still present.

**Is the concern still present?**

|            |                                                                                                                                                                                                                                                                                                                                                                                                          |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | CHECK OASIS for any applicable Technical Service Bulletins (TSBs). If a TSB exists for this concern, DISCONTINUE this test and FOLLOW TSB instructions. If no Technical Service Bulletins (TSBs) address this concern, INSTALL a new ABS module.<br>REFER to: <a href="#">Anti-Lock Brake System (ABS) Module</a> (206-09 Anti-Lock Brake System (ABS) and Stability Control, Removal and Installation). |
| <b>No</b>  | The system is operating correctly at this time. The concern may have been caused by module connections. ADDRESS the root cause of any connector or pin issues.                                                                                                                                                                                                                                           |

## A9 CHECK FOR CORRECT PCM (POWERTRAIN CONTROL MODULE) OPERATION

- Ignition OFF.
- Disconnect and inspect the PCM connectors.
- Repair:
  - corrosion (install new connector or terminals – clean module pins)
  - damaged or bent pins – install new terminals/pins
  - pushed-out pins – install new pins as necessary
- Reconnect the PCM connectors. Make sure they seat and latch correctly.
- Operate the system and determine if the concern is still present.

### Is the concern still present?

|            |                                                                                                                                                                                                                                                                                                                                                                                          |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | CHECK OASIS for any applicable Technical Service Bulletins (TSBs). If a TSB exists for this concern, DISCONTINUE this test and FOLLOW TSB instructions. If no Technical Service Bulletins (TSBs) address this concern, INSTALL a new PCM.<br>REFER to: <a href="#">Powertrain Control Module (PCM)</a> (303-14D Electronic Engine Controls - 5.0L 32V Ti-VCT, Removal and Installation). |
| <b>No</b>  | The system is operating correctly at this time. The concern may have been caused by module connections. ADDRESS the root cause of any connector or pin issues.                                                                                                                                                                                                                           |

DTC Fault Trigger Condition-PCM

| DTC   | Description                                            | Fault Trigger Conditions                                                          |
|-------|--------------------------------------------------------|-----------------------------------------------------------------------------------|
| U0212 | Lost Communication With Steering Column Control Module | The PCM sets this DTC if data messages from the SCCM through the GWM are missing. |

Normal Operation and Fault Conditions

REFER to: [Communications Network - System Operation and Component Description](#) (418-00 Module Communications Network, Description and Operation).

Possible Sources

- Communications network concern
- SCCM
- GWM
- PCM

PINPOINT TEST B : U0212

| B1 VERIFY THE CUSTOMER CONCERN                                                                                          |                                                                                                                                          |
|-------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"><li>• Ignition ON.</li><li>• Verify there is an observable symptom present.</li></ul> |                                                                                                                                          |
| Is an observable symptom present?                                                                                       |                                                                                                                                          |
| Yes                                                                                                                     | GO to <a href="#">B2</a>                                                                                                                 |
| No                                                                                                                      | The system is operating normally at this time. The DTC may have been set due to high network traffic or an intermittent fault condition. |

## B2 CHECK THE COMMUNICATION NETWORK

- Using a diagnostic scan tool, perform a network test.

**Did the SCCM module pass the network test?**

|            |                                                                                                                 |
|------------|-----------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">B3</a>                                                                                        |
| <b>No</b>  | REFER to: <a href="#">Communications Network</a> (418-00 Module Communications Network, Diagnosis and Testing). |

## B3 PERFORM SCCM (STEERING COLUMN CONTROL MODULE) SELF-TEST

- Using a diagnostic scan tool, perform a SCCM self-test.

**Are any Diagnostic Trouble Codes (DTCs) recorded?**

|            |                                                                                                                                                            |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | REFER to: <a href="#">Steering Wheel and Column Electrical Components</a> (211-05 Steering Wheel and Column Electrical Components, Diagnosis and Testing). |
| <b>No</b>  | GO to <a href="#">B4</a>                                                                                                                                   |

## B4 CHECK THE BCM (BODY CONTROL MODULE) DIAGNOSTIC TROUBLE CODES (DTCS)

- Using a diagnostic scan tool, retrieve the BCM Diagnostic Trouble Codes (DTCs).

**Are any Diagnostic Trouble Codes (DTCs) recorded?**

|            |                                                                                                                       |
|------------|-----------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | REFER to: <a href="#">Body Control Module (BCM)</a> (419-10 Multifunction Electronic Modules, Diagnosis and Testing). |
| <b>No</b>  | GO to <a href="#">B5</a>                                                                                              |



## B5 PERFORM THE PCM (POWERTRAIN CONTROL MODULE) SELF-TEST

- Using a diagnostic scan tool, perform the PCM self-test.

**Is DTC P0562 or P0563 recorded?**

|            |                                         |
|------------|-----------------------------------------|
| <b>Yes</b> | REFER to PCM DTC Chart in this section. |
| <b>No</b>  | GO to <a href="#">B6</a>                |

## B6 RECHECK THE PCM (POWERTRAIN CONTROL MODULE) DIAGNOSTIC TROUBLE CODES (DTCS)

**NOTE:** *If new modules were installed prior to the DTC being set, the module configuration may be incorrectly set during the PMI, or the PMI may not have been carried out.*

- Using a diagnostic scan tool, clear the Diagnostic Trouble Codes (DTCs).
- Wait 10 seconds.
- Repeat the PCM self-test.

**Is DTC U0212 still present?**

|            |                                                                                                                                           |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">B7</a>                                                                                                                  |
| <b>No</b>  | The system is operating correctly at this time. The DTC may have been set due to high network traffic or an intermittent fault condition. |

## B7 CHECK FOR DTC (DIAGNOSTIC TROUBLE CODE) U0212 SET IN OTHER MODULES

- Using a diagnostic scan tool, clear all Diagnostic Trouble Codes (DTCs).
- Ignition OFF.
- Ignition ON.
- Wait 10 seconds.
- Using a diagnostic scan tool, retrieve all Continuous Memory Diagnostic Trouble Codes (CMDTCs) from all modules.

**Is DTC U0212 set in any other module?**

|            |                          |
|------------|--------------------------|
| <b>Yes</b> | GO to <a href="#">B8</a> |
| <b>No</b>  | GO to <a href="#">B9</a> |

## **B8 CHECK FOR CORRECT SCCM (STEERING COLUMN CONTROL MODULE) OPERATION**

- Ignition OFF.
- Disconnect and inspect the SCCM connector.
- Repair:
  - corrosion (install new connector or terminals – clean module pins)
  - damaged or bent pins – install new terminals/pins
  - pushed-out pins – install new pins as necessary
- Reconnect the SCCM connector. Make sure it seats and latches correctly.
- Operate the system and determine if the concern is still present.

**Is the concern still present?**

|            |                                                                                                                                                                                                                                                                                                                                                                                                   |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | CHECK OASIS for any applicable Technical Service Bulletins (TSBs). If a TSB exists for this concern, DISCONTINUE this test and FOLLOW TSB instructions. If no Technical Service Bulletins (TSBs) address this concern, INSTALL a new SCCM.<br>REFER to: <a href="#">Steering Column Control Module (SCCM)</a> (211-05 Steering Wheel and Column Electrical Components, Removal and Installation). |
| <b>No</b>  | The system is operating correctly at this time. The concern may have been caused by module connections. ADDRESS the root cause of any connector or pin issues.                                                                                                                                                                                                                                    |

## **B9 CHECK FOR CORRECT PCM (POWERTRAIN CONTROL MODULE) OPERATION**

- Ignition OFF.
- Disconnect and inspect the PCM connectors.
- Repair:
  - corrosion (install new connector or terminals – clean module pins)
  - damaged or bent pins – install new terminals/pins
  - pushed-out pins – install new pins as necessary
- Reconnect the PCM connectors. Make sure they seat and latch correctly.
- Operate the system and determine if the concern is still present.

### **Is the concern still present?**

|            |                                                                                                                                                                                                                                                                                                                                                                                          |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | CHECK OASIS for any applicable Technical Service Bulletins (TSBs). If a TSB exists for this concern, DISCONTINUE this test and FOLLOW TSB instructions. If no Technical Service Bulletins (TSBs) address this concern, INSTALL a new PCM.<br>REFER to: <a href="#">Powertrain Control Module (PCM)</a> (303-14D Electronic Engine Controls - 5.0L 32V Ti-VCT, Removal and Installation). |
| <b>No</b>  | The system is operating correctly at this time. The concern may have been caused by module connections. ADDRESS the root cause of any connector or pin issues.                                                                                                                                                                                                                           |

U0131

Normal Operation and Fault Conditions

REFER to: [Communications Network - System Operation and Component Description](#) (418-00 Module Communications Network, Description and Operation).

DTC Fault Trigger Conditions

| DTC   | Description                                                            | Fault Trigger Conditions                                                                            |
|-------|------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|
| U0131 | Lost Communication With Power Steering Control Module: Missing Message | A continuous memory DTC that sets in the PCM if messages from the PSCM through the GWM are missing. |

Possible Sources

- Communication network concern
- Battery voltage concern
- GWM
- PSCM
- PCM

PINPOINT TEST C : U0131

|                                |
|--------------------------------|
| C1 VERIFY THE CUSTOMER CONCERN |
|                                |

- Ignition ON.
- Verify there is an observable symptom present.

**Is an observable symptom present?**

|            |                                                                                                                                                         |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">C2</a>                                                                                                                                |
| <b>No</b>  | The system is operating normally at this time. The DTC may have been set due to high network traffic or an intermittent fault condition. CLEAR the DTC. |

## **C2 CHECK THE COMMUNICATION NETWORK**

- Using a diagnostic scan tool, perform a network test.

**Does the PSCM pass the network test?**

|            |                                                                                                                                                             |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">C3</a>                                                                                                                                    |
| <b>No</b>  | DIAGNOSE no communication with the PSCM.<br>REFER to: <a href="#">Communications Network</a> (418-00 Module Communications Network, Diagnosis and Testing). |

## **C3 PERFORM THE PSCM (POWER STEERING CONTROL MODULE) SELF-TEST**

- Using a diagnostic scan tool, perform aPSCM self-test.

**Are any Diagnostic Trouble Codes (DTCs) recorded?**

|            |                                                                                          |
|------------|------------------------------------------------------------------------------------------|
| <b>Yes</b> | REFER to: <a href="#">Power Steering</a> (211-02 Power Steering, Diagnosis and Testing). |
| <b>No</b>  | GO to <a href="#">C4</a>                                                                 |

## **C4 CHECK THE BCM (BODY CONTROL MODULE) DIAGNOSTIC TROUBLE CODES (DTCS)**



- Using a diagnostic scan tool, retrieve the BCM Diagnostic Trouble Codes (DTCs).

#### Are any Diagnostic Trouble Codes (DTCs) recorded?

|            |                                                                                                                       |
|------------|-----------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | REFER to: <a href="#">Body Control Module (BCM)</a> (419-10 Multifunction Electronic Modules, Diagnosis and Testing). |
| <b>No</b>  | GO to <a href="#">C5</a>                                                                                              |

### C5 PERFORM THE PCM (POWERTRAIN CONTROL MODULE) SELF-TEST

- Using a diagnostic scan tool, perform the PCM self-test.

#### Is DTC P0562 or P0563 recorded?

|            |                                         |
|------------|-----------------------------------------|
| <b>Yes</b> | REFER to PCM DTC Chart in this section. |
| <b>No</b>  | GO to <a href="#">C6</a>                |

### C6 RECHECK THE PCM (POWERTRAIN CONTROL MODULE) DIAGNOSTIC TROUBLE CODES (DTCS)

**NOTE:** *If new modules were installed prior to the DTC being set, the module configuration may be incorrectly set during the PMI, or the PMI may not have been carried out.*

- Using a diagnostic scan tool, clear the Diagnostic Trouble Codes (DTCs).
- Wait 10 seconds.
- Repeat the PCM self-test.

#### Is DTC U0131 still present?

|            |                                                                                                                                           |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">C7</a>                                                                                                                  |
| <b>No</b>  | The system is operating correctly at this time. The DTC may have been set due to high network traffic or an intermittent fault condition. |

## C7 CHECK FOR DTC (DIAGNOSTIC TROUBLE CODE) U0131 SET IN OTHER MODULES

- Using a diagnostic scan tool, clear all Diagnostic Trouble Codes (DTCs).
- Ignition OFF.
- Ignition ON.
- Wait 10 seconds.
- Using a diagnostic scan tool, retrieve all Continuous Memory Diagnostic Trouble Codes (CMDTCs) from all modules.

**Is DTC U0131:87 set in any other module?**

|     |                          |
|-----|--------------------------|
| Yes | GO to <a href="#">C8</a> |
| No  | GO to <a href="#">C9</a> |

## C8 CHECK FOR CORRECT PSCM (POWER STEERING CONTROL MODULE) OPERATION

- Disconnect and inspect the PSCM connectors.
- Repair:
  - corrosion (install new connector or terminals - clean module pins)
  - damaged or bent pins - install new terminals/pins
  - pushed-out pins - install new pins as necessary
- Reconnect the PSCM connectors. Make sure they seat and latch correctly.
- Operate the system and determine if the concern is still present.

**Is the concern still present?**

|            |                                                                                                                                                                                                                                                                                                                                                                         |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | CHECK OASIS for any applicable Technical Service Bulletins (TSBs). If a TSB exists for this concern, DISCONTINUE this test and FOLLOW TSB instructions. If no Technical Service Bulletins (TSBs) address this concern,<br> <a href="#">Click here to access Guided Routine (EPAS).</a> |
| <b>No</b>  | The system is operating correctly at this time. The concern may have been caused by module connections. ADDRESS the root cause of any connector or pin issues.                                                                                                                                                                                                          |

## C9 CHECK FOR CORRECT PCM (POWERTRAIN CONTROL MODULE) OPERATION

- Ignition OFF.
- Disconnect and inspect the PCM connectors.
- Repair:
  - corrosion (install new connector or terminals – clean module pins)
  - damaged or bent pins – install new terminals/pins
  - pushed-out pins – install new pins as necessary
- Reconnect the PCM connectors. Make sure they seat and latch correctly.
- Operate the system and determine if the concern is still present.

### Is the concern still present?

|            |                                                                                                                                                                                                                                                                                                                                                                                          |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | CHECK OASIS for any applicable Technical Service Bulletins (TSBs). If a TSB exists for this concern, DISCONTINUE this test and FOLLOW TSB instructions. If no Technical Service Bulletins (TSBs) address this concern, INSTALL a new PCM.<br>REFER to: <a href="#">Powertrain Control Module (PCM)</a> (303-14D Electronic Engine Controls - 5.0L 32V Ti-VCT, Removal and Installation). |
| <b>No</b>  | The system is operating correctly at this time. The concern may have been caused by module connections. ADDRESS the root cause of any connector or pin issues.                                                                                                                                                                                                                           |

## DTC Fault Trigger Condition-PCM

| DTC   | Description                                          | Fault Trigger Conditions                                                         |
|-------|------------------------------------------------------|----------------------------------------------------------------------------------|
| U0137 | Lost Communication With Trailer Brake Control Module | The PCM sets this DTC if data messages from the TBM through the GWM are missing. |

### Normal Operation and Fault Conditions

REFER to: [Communications Network - System Operation and Component Description](#) (418-00 Module Communications Network, Description and Operation).

### Possible Sources

- Communications network concern
- TBM
- GWM
- PCM

### PINPOINT TEST D : U0137

#### D1 VERIFY THE CUSTOMER CONCERN

- Ignition ON.
- Verify there is an observable symptom present.

**Is an observable symptom present?**

|            |                                                                                                                                          |
|------------|------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">D2</a>                                                                                                                 |
| <b>No</b>  | The system is operating normally at this time. The DTC may have been set due to high network traffic or an intermittent fault condition. |

#### D2 CHECK THE COMMUNICATION NETWORK

- Using a diagnostic scan tool, perform a network test.

**Did the TBM pass the network test?**

|            |                                                                                                                 |
|------------|-----------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">D3</a>                                                                                        |
| <b>No</b>  | REFER to: <a href="#">Communications Network</a> (418-00 Module Communications Network, Diagnosis and Testing). |

**D3 PERFORM TBM (TRAILER BRAKE CONTROL MODULE) SELF-TEST**

- Using a diagnostic scan tool, perform a TBM self-test.

**Are any Diagnostic Trouble Codes (DTCs) recorded?**

|            |                                                                                                                                                 |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | REFER to: <a href="#">Auxiliary Brake System - Vehicles With: Trailer Brake Control</a> (206-10 Auxiliary Brake System, Diagnosis and Testing). |
| <b>No</b>  | GO to <a href="#">D4</a>                                                                                                                        |

**D4 CHECK THE BCM (BODY CONTROL MODULE) DIAGNOSTIC TROUBLE CODES (DTCS)**

- Using a diagnostic scan tool, retrieve the BCM Diagnostic Trouble Codes (DTCs).

**Are any Diagnostic Trouble Codes (DTCs) recorded?**

|            |                                                                                                                       |
|------------|-----------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | REFER to: <a href="#">Body Control Module (BCM)</a> (419-10 Multifunction Electronic Modules, Diagnosis and Testing). |
| <b>No</b>  | GO to <a href="#">D5</a>                                                                                              |

**D5 PERFORM THE PCM (POWERTRAIN CONTROL MODULE) SELF-TEST**



- Using a diagnostic scan tool, perform the PCM self-test.

**Is DTC P0562 or P0563 recorded?**

|            |                                         |
|------------|-----------------------------------------|
| <b>Yes</b> | REFER to PCM DTC Chart in this section. |
| <b>No</b>  | GO to <a href="#">D6</a>                |

**D6 RECHECK THE PCM (POWERTRAIN CONTROL MODULE) DIAGNOSTIC TROUBLE CODES (DTCS)**

**NOTE:** *If new modules were installed prior to the DTC being set, the module configuration may be incorrectly set during the PMI, or the PMI may not have been carried out.*

- Using a diagnostic scan tool, clear the Diagnostic Trouble Codes (DTCs).
- Wait 10 seconds.
- Repeat the PCM self-test.

**Is DTC U0137 still present?**

|            |                                                                                                                                           |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">D7</a>                                                                                                                  |
| <b>No</b>  | The system is operating correctly at this time. The DTC may have been set due to high network traffic or an intermittent fault condition. |

**D7 CHECK FOR DTC (DIAGNOSTIC TROUBLE CODE) U0137 SET IN OTHER MODULES**

- Using a diagnostic scan tool, clear all Diagnostic Trouble Codes (DTCs).
- Ignition OFF.
- Ignition ON.
- Wait 10 seconds.
- Using a diagnostic scan tool, retrieve all Continuous Memory Diagnostic Trouble Codes (CMDTCs) from all modules.

**Is DTC U0137:00 set in any other module?**

|            |                          |
|------------|--------------------------|
| <b>Yes</b> | GO to <a href="#">D8</a> |
| <b>No</b>  | GO to <a href="#">D9</a> |

## **D8 CHECK FOR CORRECT TBM (TRAILER BRAKE CONTROL MODULE) OPERATION**

- Ignition OFF.
- Disconnect and inspect the TBM connector.
- Repair:
  - corrosion (install new connector or terminals – clean module pins)
  - damaged or bent pins – install new terminals/pins
  - pushed-out pins – install new pins as necessary
- Reconnect the TBM connector. Make sure it seats and latches correctly.
- Operate the system and determine if the concern is still present.

**Is the concern still present?**

|            |                                                                                                                                                                                                                                                                                                                                                                      |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | CHECK OASIS for any applicable Technical Service Bulletins (TSBs). If a TSB exists for this concern, DISCONTINUE this test and FOLLOW TSB instructions. If no Technical Service Bulletins (TSBs) address this concern, INSTALL a new TBM.<br>REFER to: <a href="#">Trailer Brake Control Module (TBM)</a> (206-10 Auxiliary Brake System, Removal and Installation). |
| <b>No</b>  | The system is operating correctly at this time. The concern may have been caused by module connections. ADDRESS the root cause of any connector or pin issues.                                                                                                                                                                                                       |

## D9 CHECK FOR CORRECT PCM (POWERTRAIN CONTROL MODULE) OPERATION

- Ignition OFF.
- Disconnect and inspect the PCM connectors.
- Repair:
  - corrosion (install new connector or terminals – clean module pins)
  - damaged or bent pins – install new terminals/pins
  - pushed-out pins – install new pins as necessary
- Reconnect the PCM connectors. Make sure they seat and latch correctly.
- Operate the system and determine if the concern is still present.

### Is the concern still present?

|            |                                                                                                                                                                                                                                                                                                                                                                                          |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | CHECK OASIS for any applicable Technical Service Bulletins (TSBs). If a TSB exists for this concern, DISCONTINUE this test and FOLLOW TSB instructions. If no Technical Service Bulletins (TSBs) address this concern, INSTALL a new PCM.<br>REFER to: <a href="#">Powertrain Control Module (PCM)</a> (303-14D Electronic Engine Controls - 5.0L 32V Ti-VCT, Removal and Installation). |
| <b>No</b>  | The system is operating correctly at this time. The concern may have been caused by module connections. ADDRESS the root cause of any connector or pin issues.                                                                                                                                                                                                                           |

DTC Fault Trigger Condition-PCM

| DTC   | Description                                               | Fault Trigger Conditions                                                          |
|-------|-----------------------------------------------------------|-----------------------------------------------------------------------------------|
| U0159 | Lost Communication With Parking Assist Control Module "A" | The PCM sets this DTC if data messages from the PAM over the HS-CAN1 are missing. |

Normal Operation and Fault Conditions

REFER to: [Communications Network - System Operation and Component Description](#) (418-00 Module Communications Network, Description and Operation).

Possible Sources

- Communications network concern
- PAM
- BCM
- PCM

PINPOINT TEST E : U0159

| E1 VERIFY THE CUSTOMER CONCERN                                                                                          |                                                                                                                                          |
|-------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"><li>• Ignition ON.</li><li>• Verify there is an observable symptom present.</li></ul> |                                                                                                                                          |
| Is an observable symptom present?                                                                                       |                                                                                                                                          |
| Yes                                                                                                                     | GO to <a href="#">E2</a>                                                                                                                 |
| No                                                                                                                      | The system is operating normally at this time. The DTC may have been set due to high network traffic or an intermittent fault condition. |

## E2 CHECK THE COMMUNICATION NETWORK

- Using a diagnostic scan tool, perform a network test.

**Did the PAM module pass the network test?**

|            |                                                                                                                 |
|------------|-----------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">E3</a>                                                                                        |
| <b>No</b>  | REFER to: <a href="#">Communications Network</a> (418-00 Module Communications Network, Diagnosis and Testing). |

## E3 PERFORM PAM (PARKING ASSIST CONTROL MODULE) SELF-TEST

- Using a diagnostic scan tool, perform a PAM self-test.

**Are any Diagnostic Trouble Codes (DTCs) recorded?**

|            |                                                                                                                                                                                                                                                         |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | Without park assist,<br>REFER to: Parking Aid (413-13 Parking Aid - Vehicles With: Parking Aid Camera) .<br>, With park assist, REFER to: <a href="#">Parking Aid</a> (413-13C Parking Aid - Vehicles With: Active Park Assist, Diagnosis and Testing). |
| <b>No</b>  | GO to <a href="#">E4</a>                                                                                                                                                                                                                                |

## E4 CHECK THE BCM (BODY CONTROL MODULE) DIAGNOSTIC TROUBLE CODES (DTCS)



- Using a diagnostic scan tool, retrieve the BCM Diagnostic Trouble Codes (DTCs).

**Are any Diagnostic Trouble Codes (DTCs) recorded?**

|            |                                                                                                                       |
|------------|-----------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | REFER to: <a href="#">Body Control Module (BCM)</a> (419-10 Multifunction Electronic Modules, Diagnosis and Testing). |
| <b>No</b>  | GO to <a href="#">E5</a>                                                                                              |

**E5 PERFORM THE PCM (POWERTRAIN CONTROL MODULE) SELF-TEST**

- Using a diagnostic scan tool, perform the PCM self-test.

**Is DTC P0562 or P0563 recorded?**

|            |                                         |
|------------|-----------------------------------------|
| <b>Yes</b> | REFER to PCM DTC Chart in this section. |
| <b>No</b>  | GO to <a href="#">E6</a>                |

**E6 RECHECK THE PCM (POWERTRAIN CONTROL MODULE) DIAGNOSTIC TROUBLE CODES (DTCs)**

**NOTE:** *If new modules were installed prior to the DTC being set, the module configuration may be incorrectly set during the PMI, or the PMI may not have been carried out.*

- Using a diagnostic scan tool, clear the Diagnostic Trouble Codes (DTCs).
- Wait 10 seconds.
- Repeat the PCM self-test.

**Is DTC U0159 still present?**

|            |                                                                                                                                           |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">E7</a>                                                                                                                  |
| <b>No</b>  | The system is operating correctly at this time. The DTC may have been set due to high network traffic or an intermittent fault condition. |

## E7 CHECK FOR DTC (DIAGNOSTIC TROUBLE CODE) U0159 SET IN OTHER MODULES

- Using a diagnostic scan tool, clear all Diagnostic Trouble Codes (DTCs).
- Ignition OFF.
- Ignition ON.
- Wait 10 seconds.
- Using a diagnostic scan tool, retrieve all Continuous Memory Diagnostic Trouble Codes (CMDTCs) from all modules.

**Is DTC U0159:00 set in any other module?**

|            |                          |
|------------|--------------------------|
| <b>Yes</b> | GO to <a href="#">E8</a> |
| <b>No</b>  | GO to <a href="#">E9</a> |

## E8 CHECK FOR CORRECT PAM (PARKING ASSIST CONTROL MODULE) OPERATION

- Ignition OFF.
- Disconnect and inspect the BCM module connectors.
- Repair:
  - corrosion (install new connector or terminals – clean module pins)
  - damaged or bent pins – install new terminals/pins
  - pushed-out pins – install new pins as necessary
- Reconnect the BCM connectors. Make sure they seat and latch correctly.
- Operate the system and determine if the concern is still present.

**Is the concern still present?**

|            |                                                                                                                                                                                                                                                                                                                                                                      |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | CHECK OASIS for any applicable Technical Service Bulletins (TSBs). If a TSB exists for this concern, DISCONTINUE this test and FOLLOW TSB instructions. If no Technical Service Bulletins (TSBs) address this concern, INSTALL a new BCM<br>REFER to: <a href="#">Body Control Module (BCM)</a> (419-10 Multifunction Electronic Modules, Removal and Installation). |
| <b>No</b>  | The system is operating correctly at this time. The concern may have been caused by module connections. ADDRESS the root cause of any connector or pin issues.                                                                                                                                                                                                       |

## E9 CHECK FOR CORRECT PCM (POWERTRAIN CONTROL MODULE) OPERATION

- Ignition OFF.
- Disconnect and inspect the PCM connectors.
- Repair:
  - corrosion (install new connector or terminals – clean module pins)
  - damaged or bent pins – install new terminals/pins
  - pushed-out pins – install new pins as necessary
- Reconnect the PCM connectors. Make sure they seat and latch correctly.
- Operate the system and determine if the concern is still present.

### Is the concern still present?

|            |                                                                                                                                                                                                                                                                                                                                                                                          |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | CHECK OASIS for any applicable Technical Service Bulletins (TSBs). If a TSB exists for this concern, DISCONTINUE this test and FOLLOW TSB instructions. If no Technical Service Bulletins (TSBs) address this concern, INSTALL a new PCM.<br>REFER to: <a href="#">Powertrain Control Module (PCM)</a> (303-14D Electronic Engine Controls - 5.0L 32V Ti-VCT, Removal and Installation). |
| <b>No</b>  | The system is operating correctly at this time. The concern may have been caused by module connections. ADDRESS the root cause of any connector or pin issues.                                                                                                                                                                                                                           |

U0164

DTC Fault Trigger Condition-PCM

| DTC   | Description                                 | Fault Trigger Conditions                                                                                                                              |
|-------|---------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| U0164 | Lost Communication With HVAC Control Module | The FCIM controls the HVAC control module functions. The PCM sets this DTC if data messages from the HVAC control module through the GWM are missing. |

Normal Operation and Fault Conditions

The HVAC control module functions are performed by the FCIM.  
REFER to: [Communications Network - System Operation and Component Description](#) (418-00 Module Communications Network, Description and Operation).

Possible Sources

- Communications network concern
- FCIM
- GWM
- PCM

PINPOINT TEST F : U0164

|                                   |
|-----------------------------------|
| F1    VERIFY THE CUSTOMER CONCERN |
|                                   |

- Ignition ON.
- Verify there is an observable symptom present.

**Is an observable symptom present?**

|            |                                                                                                                                          |
|------------|------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">F2</a>                                                                                                                 |
| <b>No</b>  | The system is operating normally at this time. The DTC may have been set due to high network traffic or an intermittent fault condition. |

## **F2 CHECK THE COMMUNICATION NETWORK**

- Using a diagnostic scan tool, perform a network test.

**Did the FCIM control module pass the network test?**

|            |                                                                                                                 |
|------------|-----------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">F3</a>                                                                                        |
| <b>No</b>  | REFER to: <a href="#">Communications Network</a> (418-00 Module Communications Network, Diagnosis and Testing). |

## **F3 PERFORM FCIM (FRONT CONTROLS INTERFACE MODULE) CONTROL MODULE SELF-TEST**

- Using a diagnostic scan tool, perform a FCIM control module self-test.

**Are any Diagnostic Trouble Codes (DTCs) recorded?**



|            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | <p>Without touchscreen,<br/>REFER to: <a href="#">Information and Entertainment System</a> (415-00C Information and Entertainment System - General Information - Vehicles With: Touchscreen Display, Diagnosis and Testing).</p> <p>With touchscreen and without Sync®, REFER to: <a href="#">Information and Entertainment System</a> (415-00B Information and Entertainment System - General Information - Vehicles With: SYNC Without Touchscreen, Diagnosis and Testing).</p> <p>Without Sync® REFER to: <a href="#">Information and Entertainment System</a> (415-00A Information and Entertainment System - General Information - Vehicles Without: SYNC, Diagnosis and Testing).</p> <p>With Bang &amp; Olufsen sound system, REFER to: <a href="#">Information and Entertainment System</a> (415-00D Information and Entertainment System - General Information - Vehicles With: Bang and Olufsen Audio System, Diagnosis and Testing).</p> |
| <b>No</b>  | GO to <a href="#">F4</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

#### **F4 CHECK THE BCM (BODY CONTROL MODULE) DIAGNOSTIC TROUBLE CODES (DTCS)**

- Using a diagnostic scan tool, retrieve the BCM Diagnostic Trouble Codes (DTCs).

#### **Are any Diagnostic Trouble Codes (DTCs) recorded?**

|            |                                                                                                                       |
|------------|-----------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | REFER to: <a href="#">Body Control Module (BCM)</a> (419-10 Multifunction Electronic Modules, Diagnosis and Testing). |
| <b>No</b>  | GO to <a href="#">F5</a>                                                                                              |

#### **F5 PERFORM THE PCM (POWERTRAIN CONTROL MODULE) SELF-TEST**

- Using a diagnostic scan tool, perform the PCM self-test.

**Is DTC P0562 or P0563 recorded?**

|            |                                         |
|------------|-----------------------------------------|
| <b>Yes</b> | REFER to PCM DTC Chart in this section. |
| <b>No</b>  | GO to <a href="#">F6</a>                |

**F6 RECHECK THE PCM (POWERTRAIN CONTROL MODULE) DIAGNOSTIC TROUBLE CODES (DTCS)**

**NOTE:** *If new modules were installed prior to the DTC being set, the module configuration may be incorrectly set during the PMI, or the PMI may not have been carried out.*

- Using a diagnostic scan tool, clear the Diagnostic Trouble Codes (DTCs).
- Wait 10 seconds.
- Repeat the PCM self-test.

**Is DTC U0164 still present?**

|            |                                                                                                                                           |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">F7</a>                                                                                                                  |
| <b>No</b>  | The system is operating correctly at this time. The DTC may have been set due to high network traffic or an intermittent fault condition. |

**F7 CHECK FOR DTC (DIAGNOSTIC TROUBLE CODE) U0164 SET IN OTHER MODULES**

- Using a diagnostic scan tool, clear all Diagnostic Trouble Codes (DTCs).
- Ignition OFF.
- Ignition ON.
- Wait 10 seconds.
- Using a diagnostic scan tool, retrieve all Continuous Memory Diagnostic Trouble Codes (CMDTCs) from all modules.

**Is DTC U0164:00 set in any other module?**

|            |                          |
|------------|--------------------------|
| <b>Yes</b> | GO to <a href="#">F8</a> |
| <b>No</b>  | GO to <a href="#">F9</a> |

## **F8 CHECK FOR CORRECT FCIM (FRONT CONTROLS INTERFACE MODULE) CONTROL MODULE OPERATION**

- Ignition OFF.
- Disconnect and inspect the FCIM control module connectors.
- Repair:
  - corrosion (install new connector or terminals – clean module pins)
  - damaged or bent pins – install new terminals/pins
  - pushed-out pins – install new pins as necessary
- Reconnect the FCIM control module connectors. Make sure they seat and latch correctly.
- Operate the system and determine if the concern is still present.

**Is the concern still present?**

|            |                                                                                                                                                                                                                                                                                                                                                                         |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | CHECK OASIS for any applicable Technical Service Bulletins (TSBs). If a TSB exists for this concern, DISCONTINUE this test and FOLLOW TSB instructions. If no Technical Service Bulletins (TSBs) address this concern,<br> <a href="#">Click here to access Guided Routine (FCIM).</a> |
| <b>No</b>  | The system is operating correctly at this time. The concern may have been caused by module connections. ADDRESS the root cause of any connector or pin issues.                                                                                                                                                                                                          |

## F9 CHECK FOR CORRECT PCM (POWERTRAIN CONTROL MODULE) OPERATION

- Ignition OFF.
- Disconnect and inspect the PCM connectors.
- Repair:
  - corrosion (install new connector or terminals – clean module pins)
  - damaged or bent pins – install new terminals/pins
  - pushed-out pins – install new pins as necessary
- Reconnect the PCM connectors. Make sure they seat and latch correctly.
- Operate the system and determine if the concern is still present.

### Is the concern still present?

|            |                                                                                                                                                                                                                                                                                                                                                                                          |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | CHECK OASIS for any applicable Technical Service Bulletins (TSBs). If a TSB exists for this concern, DISCONTINUE this test and FOLLOW TSB instructions. If no Technical Service Bulletins (TSBs) address this concern, INSTALL a new PCM.<br>REFER to: <a href="#">Powertrain Control Module (PCM)</a> (303-14D Electronic Engine Controls - 5.0L 32V Ti-VCT, Removal and Installation). |
| <b>No</b>  | The system is operating correctly at this time. The concern may have been caused by module connections. ADDRESS the root cause of any connector or pin issues.                                                                                                                                                                                                                           |

## DTC Fault Trigger Condition-PCM

| DTC   | Description                                     | Fault Trigger Conditions                                                         |
|-------|-------------------------------------------------|----------------------------------------------------------------------------------|
| U0199 | Lost Communication With "Door Control Module A" | The PCM sets this DTC if data messages from the DDM through the GWM are missing. |

### Normal Operation and Fault Conditions

REFER to: [Communications Network - System Operation and Component Description](#) (418-00 Module Communications Network, Description and Operation).

### Possible Sources

- Communications network concern
- DDM
- GWM
- PCM

### PINPOINT TEST G : U0199

#### G1 VERIFY THE CUSTOMER CONCERN

- Ignition ON.
- Verify there is an observable symptom present.

**Is an observable symptom present?**

|            |                                                                                                                                          |
|------------|------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">G2</a>                                                                                                                 |
| <b>No</b>  | The system is operating normally at this time. The DTC may have been set due to high network traffic or an intermittent fault condition. |

#### G2 CHECK THE COMMUNICATION NETWORK



- Using a diagnostic scan tool, perform a network test.

**Did the DDM pass the network test?**

|            |                                                                                                                 |
|------------|-----------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">G3</a>                                                                                        |
| <b>No</b>  | REFER to: <a href="#">Communications Network</a> (418-00 Module Communications Network, Diagnosis and Testing). |

**G3 PERFORM DDM (DRIVER DOOR MODULE) SELF-TEST**

- Using a diagnostic scan tool, perform a DDM self-test.

**Are any Diagnostic Trouble Codes (DTCs) recorded?**

|            |                                                                                                                                       |
|------------|---------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | REFER to: <a href="#">Locks, Latches and Entry Systems</a> (501-14 Handles, Locks, Latches and Entry Systems, Diagnosis and Testing). |
| <b>No</b>  | GO to <a href="#">G4</a>                                                                                                              |

**G4 CHECK THE BCM (BODY CONTROL MODULE) DIAGNOSTIC TROUBLE CODES (DTCS)**

- Using a diagnostic scan tool, retrieve the BCM Diagnostic Trouble Codes (DTCs).

**Are any Diagnostic Trouble Codes (DTCs) recorded?**

|            |                                                                                                                       |
|------------|-----------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | REFER to: <a href="#">Body Control Module (BCM)</a> (419-10 Multifunction Electronic Modules, Diagnosis and Testing). |
| <b>No</b>  | GO to <a href="#">G5</a>                                                                                              |

**G5 PERFORM THE PCM (POWERTRAIN CONTROL MODULE) SELF-TEST**

- Using a diagnostic scan tool, perform the PCM self-test.

**Is DTC P0562 or P0563 recorded?**

|            |                                         |
|------------|-----------------------------------------|
| <b>Yes</b> | REFER to PCM DTC Chart in this section. |
| <b>No</b>  | GO to <a href="#">G6</a>                |

**G6 RECHECK THE PCM (POWERTRAIN CONTROL MODULE) DIAGNOSTIC TROUBLE CODES (DTCS)**

**NOTE:** *If new modules were installed prior to the DTC being set, the module configuration may be incorrectly set during the PMI, or the PMI may not have been carried out.*

- Using a diagnostic scan tool, clear the Diagnostic Trouble Codes (DTCs).
- Wait 10 seconds.
- Repeat the PCM self-test.

**Is DTC U0199 still present?**

|            |                                                                                                                                           |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">G7</a>                                                                                                                  |
| <b>No</b>  | The system is operating correctly at this time. The DTC may have been set due to high network traffic or an intermittent fault condition. |

**G7 CHECK FOR DTC (DIAGNOSTIC TROUBLE CODE) U0199 SET IN OTHER MODULES**

- Using a diagnostic scan tool, clear all Diagnostic Trouble Codes (DTCs).
- Ignition OFF.
- Ignition ON.
- Wait 10 seconds.
- Using a diagnostic scan tool, retrieve all Continuous Memory Diagnostic Trouble Codes (CMDTCs) from all modules.

**Is DTC U0199:87 set in any other module?**

|            |                          |
|------------|--------------------------|
| <b>Yes</b> | GO to <a href="#">G8</a> |
| <b>No</b>  | GO to <a href="#">G9</a> |

## **G8 CHECK FOR CORRECT DDM (DRIVER DOOR MODULE) MODULE OPERATION**

- Ignition OFF.
- Disconnect and inspect the DDM connectors.
- Repair:
  - corrosion (install new connector or terminals – clean module pins)
  - damaged or bent pins – install new terminals/pins
  - pushed-out pins – install new pins as necessary
- Reconnect the DDM module connectors. Make sure they seat and latch correctly.
- Operate the system and determine if the concern is still present.

**Is the concern still present?**

|            |                                                                                                                                                                                                                                                                                                                                                                      |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | CHECK OASIS for any applicable Technical Service Bulletins (TSBs). If a TSB exists for this concern, DISCONTINUE this test and FOLLOW TSB instructions. If no Technical Service Bulletins (TSBs) address this concern, INSTALL a new DDM.<br>REFER to: <a href="#">Driver Door Module (DDM)</a> (419-10 Multifunction Electronic Modules, Removal and Installation). |
| <b>No</b>  | The system is operating correctly at this time. The concern may have been caused by module connections. ADDRESS the root cause of any connector or pin issues.                                                                                                                                                                                                       |

## **G9 CHECK FOR CORRECT PCM (POWERTRAIN CONTROL MODULE) OPERATION**

- Ignition OFF.
- Disconnect and inspect the PCM connectors.
- Repair:
  - corrosion (install new connector or terminals – clean module pins)
  - damaged or bent pins – install new terminals/pins
  - pushed-out pins – install new pins as necessary
- Reconnect the PCM connectors. Make sure they seat and latch correctly.
- Operate the system and determine if the concern is still present.

### **Is the concern still present?**

|            |                                                                                                                                                                                                                                                                                                                                                                                          |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | CHECK OASIS for any applicable Technical Service Bulletins (TSBs). If a TSB exists for this concern, DISCONTINUE this test and FOLLOW TSB instructions. If no Technical Service Bulletins (TSBs) address this concern, INSTALL a new PCM.<br>REFER to: <a href="#">Powertrain Control Module (PCM)</a> (303-14D Electronic Engine Controls - 5.0L 32V Ti-VCT, Removal and Installation). |
| <b>No</b>  | The system is operating correctly at this time. The concern may have been caused by module connections. ADDRESS the root cause of any connector or pin issues.                                                                                                                                                                                                                           |

DTC Fault Trigger Condition-PCM

| DTC   | Description                                     | Fault Trigger Conditions                                                         |
|-------|-------------------------------------------------|----------------------------------------------------------------------------------|
| U0200 | Lost Communication With "Door Control Module B" | The PCM sets this DTC if data messages from the PDM through the GWM are missing. |

Normal Operation and Fault Conditions

REFER to: [Communications Network - System Operation and Component Description](#) (418-00 Module Communications Network, Description and Operation).

Possible Sources

- Communications network concern
- PDM
- GWM
- PCM

PINPOINT TEST H : U0200

| H1 VERIFY THE CUSTOMER CONCERN                                                                                          |                                                                                                                                          |
|-------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"><li>• Ignition ON.</li><li>• Verify there is an observable symptom present.</li></ul> |                                                                                                                                          |
| Is an observable symptom present?                                                                                       |                                                                                                                                          |
| Yes                                                                                                                     | GO to <a href="#">H2</a>                                                                                                                 |
| No                                                                                                                      | The system is operating normally at this time. The DTC may have been set due to high network traffic or an intermittent fault condition. |



## H2 CHECK THE COMMUNICATION NETWORK

- Using a diagnostic scan tool, perform a network test.

**Did the PDM pass the network test?**

|            |                                                                                                                 |
|------------|-----------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">H3</a>                                                                                        |
| <b>No</b>  | REFER to: <a href="#">Communications Network</a> (418-00 Module Communications Network, Diagnosis and Testing). |

## H3 PERFORM PDM (PASSENGER DOOR MODULE) SELF-TEST

- Using a diagnostic scan tool, perform a PDM self-test.

**Are any Diagnostic Trouble Codes (DTCs) recorded?**

|            |                                                                                                                                       |
|------------|---------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | REFER to: <a href="#">Locks, Latches and Entry Systems</a> (501-14 Handles, Locks, Latches and Entry Systems, Diagnosis and Testing). |
| <b>No</b>  | GO to <a href="#">H4</a>                                                                                                              |

## H4 CHECK THE BCM (BODY CONTROL MODULE) DIAGNOSTIC TROUBLE CODES (DTCS)

- Using a diagnostic scan tool, retrieve the BCM Diagnostic Trouble Codes (DTCs).

**Are any Diagnostic Trouble Codes (DTCs) recorded?**

|            |                                                                                                                       |
|------------|-----------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | REFER to: <a href="#">Body Control Module (BCM)</a> (419-10 Multifunction Electronic Modules, Diagnosis and Testing). |
| <b>No</b>  | GO to <a href="#">H5</a>                                                                                              |

## H5 PERFORM THE PCM (POWERTRAIN CONTROL MODULE) SELF-TEST

- Using a diagnostic scan tool, perform the PCM self-test.

**Is DTC P0562 or P0563 recorded?**

|            |                                         |
|------------|-----------------------------------------|
| <b>Yes</b> | REFER to PCM DTC Chart in this section. |
| <b>No</b>  | GO to <a href="#">H6</a>                |

## H6 RECHECK THE PCM (POWERTRAIN CONTROL MODULE) DIAGNOSTIC TROUBLE CODES (DTCS)

**NOTE:** *If new modules were installed prior to the DTC being set, the module configuration may be incorrectly set during the PMI, or the PMI may not have been carried out.*

- Using a diagnostic scan tool, clear the Diagnostic Trouble Codes (DTCs).
- Wait 10 seconds.
- Repeat the PCM self-test.

**Is DTC U0200 still present?**

|            |                                                                                                                                           |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">H7</a>                                                                                                                  |
| <b>No</b>  | The system is operating correctly at this time. The DTC may have been set due to high network traffic or an intermittent fault condition. |

## H7 CHECK FOR DTC (DIAGNOSTIC TROUBLE CODE) U0200 SET IN OTHER MODULES

- Using a diagnostic scan tool, clear all Diagnostic Trouble Codes (DTCs).
- Ignition OFF.
- Ignition ON.
- Wait 10 seconds.
- Using a diagnostic scan tool, retrieve all Continuous Memory Diagnostic Trouble Codes (CMDTCs) from all modules.

**Is DTC U0200:87 set in any other module?**

|            |                          |
|------------|--------------------------|
| <b>Yes</b> | GO to <a href="#">H8</a> |
| <b>No</b>  | GO to <a href="#">H9</a> |

## **H8 CHECK FOR CORRECT PDM (PASSENGER DOOR MODULE) OPERATION**

- Ignition OFF.
- Disconnect and inspect the PDM connectors.
- Repair:
  - corrosion (install new connector or terminals – clean module pins)
  - damaged or bent pins – install new terminals/pins
  - pushed-out pins – install new pins as necessary
- Reconnect the PDM connectors. Make sure they seat and latch correctly.
- Operate the system and determine if the concern is still present.

**Is the concern still present?**

|            |                                                                                                                                                                                                                                                                                                                                                                                |
|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | CHECK OASIS for any applicable Technical Service Bulletins (TSBs). If a TSB exists for this concern, DISCONTINUE this test and FOLLOW TSB instructions. If no Technical Service Bulletins (TSBs) address this concern, INSTALL a new PDM module.<br>REFER to: <a href="#">Passenger Door Module (PDM)</a> (419-10 Multifunction Electronic Modules, Removal and Installation). |
| <b>No</b>  | The system is operating correctly at this time. The concern may have been caused by module connections. ADDRESS the root cause of any connector or pin issues.                                                                                                                                                                                                                 |

## H9 CHECK FOR CORRECT PCM (POWERTRAIN CONTROL MODULE) OPERATION

- Ignition OFF.
- Disconnect and inspect the PCM connectors.
- Repair:
  - corrosion (install new connector or terminals – clean module pins)
  - damaged or bent pins – install new terminals/pins
  - pushed-out pins – install new pins as necessary
- Reconnect the PCM connectors. Make sure they seat and latch correctly.
- Operate the system and determine if the concern is still present.

### Is the concern still present?

|            |                                                                                                                                                                                                                                                                                                                                                                                          |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | CHECK OASIS for any applicable Technical Service Bulletins (TSBs). If a TSB exists for this concern, DISCONTINUE this test and FOLLOW TSB instructions. If no Technical Service Bulletins (TSBs) address this concern, INSTALL a new PCM.<br>REFER to: <a href="#">Powertrain Control Module (PCM)</a> (303-14D Electronic Engine Controls - 5.0L 32V Ti-VCT, Removal and Installation). |
| <b>No</b>  | The system is operating correctly at this time. The concern may have been caused by module connections. ADDRESS the root cause of any connector or pin issues.                                                                                                                                                                                                                           |

U023A

DTC Fault Trigger Condition-PCM

| DTC   | Description                                       | Fault Trigger Conditions                                                          |
|-------|---------------------------------------------------|-----------------------------------------------------------------------------------|
| U023A | Lost Communication With Image Processing Module A | The PCM sets this DTC if data messages from the IPMA through the GWM are missing. |

Normal Operation and Fault Conditions

REFER to: [Communications Network - System Operation and Component Description](#) (418-00 Module Communications Network, Description and Operation).

Possible Sources

- Communications network concern
- IPMA
- GWM
- PCM

PINPOINT TEST I : U023A

| I1 VERIFY THE CUSTOMER CONCERN                                                                                          |                                                                                                                                          |
|-------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"><li>• Ignition ON.</li><li>• Verify there is an observable symptom present.</li></ul> |                                                                                                                                          |
| Is an observable symptom present?                                                                                       |                                                                                                                                          |
| Yes                                                                                                                     | GO to <a href="#">I2</a>                                                                                                                 |
| No                                                                                                                      | The system is operating normally at this time. The DTC may have been set due to high network traffic or an intermittent fault condition. |



## I2 CHECK THE COMMUNICATION NETWORK

- Using a diagnostic scan tool, perform a network test.

**Did the IPMA pass the network test?**

|            |                                                                                                                 |
|------------|-----------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">I3</a>                                                                                        |
| <b>No</b>  | REFER to: <a href="#">Communications Network</a> (418-00 Module Communications Network, Diagnosis and Testing). |

## I3 PERFORM IPMA (IMAGE PROCESSING MODULE A) SELF-TEST

- Using a diagnostic scan tool, perform a IPMA module self-test.

**Are any Diagnostic Trouble Codes (DTCs) recorded?**

|            |                                                                                                    |
|------------|----------------------------------------------------------------------------------------------------|
| <b>Yes</b> | REFER to: <a href="#">Lane Keeping System</a> (419-07 Lane Keeping System, Diagnosis and Testing). |
| <b>No</b>  | GO to <a href="#">I4</a>                                                                           |

## I4 CHECK THE BCM (BODY CONTROL MODULE) DIAGNOSTIC TROUBLE CODES (DTCS)

- Using a diagnostic scan tool, retrieve the BCM Diagnostic Trouble Codes (DTCs).

**Are any Diagnostic Trouble Codes (DTCs) recorded?**

|            |                                                                                                                       |
|------------|-----------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | REFER to: <a href="#">Body Control Module (BCM)</a> (419-10 Multifunction Electronic Modules, Diagnosis and Testing). |
| <b>No</b>  | GO to <a href="#">I5</a>                                                                                              |

## I5 PERFORM THE PCM (POWERTRAIN CONTROL MODULE) SELF-TEST

- Using a diagnostic scan tool, perform the PCM self-test.

**Is DTC P0562 or P0563 recorded?**

|            |                                         |
|------------|-----------------------------------------|
| <b>Yes</b> | REFER to PCM DTC Chart in this section. |
| <b>No</b>  | GO to <a href="#">I6</a>                |

## I6 RECHECK THE PCM (POWERTRAIN CONTROL MODULE) DIAGNOSTIC TROUBLE CODES (DTCS)

**NOTE:** *If new modules were installed prior to the DTC being set, the module configuration may be incorrectly set during the PMI, or the PMI may not have been carried out.*

- Using a diagnostic scan tool, clear the Diagnostic Trouble Codes (DTCs).
- Wait 10 seconds.
- Repeat the PCM self-test.

**Is DTC U023A still present?**

|            |                                                                                                                                           |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">I7</a>                                                                                                                  |
| <b>No</b>  | The system is operating correctly at this time. The DTC may have been set due to high network traffic or an intermittent fault condition. |

## I7 CHECK FOR DTC (DIAGNOSTIC TROUBLE CODE) U023A SET IN OTHER MODULES

- Using a diagnostic scan tool, clear all Diagnostic Trouble Codes (DTCs).
- Ignition OFF.
- Ignition ON.
- Wait 10 seconds.
- Using a diagnostic scan tool, retrieve all Continuous Memory Diagnostic Trouble Codes (CMDTCs) from all modules.

**Is DTC U023A:00 set in any other module?**

|            |                          |
|------------|--------------------------|
| <b>Yes</b> | GO to <a href="#">18</a> |
| <b>No</b>  | GO to <a href="#">19</a> |

## **18 CHECK FOR CORRECT IPMA (IMAGE PROCESSING MODULE A) OPERATION**

- Ignition OFF.
- Disconnect and inspect the IPMA connector.
- Repair:
  - corrosion (install new connector or terminals – clean module pins)
  - damaged or bent pins – install new terminals/pins
  - pushed-out pins – install new pins as necessary
- Reconnect the IPMA connector. Make sure it seats and latches correctly.
- Operate the system and determine if the concern is still present.

**Is the concern still present?**

|            |                                                                                                                                                                                                                                                                                                                                                         |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | CHECK OASIS for any applicable Technical Service Bulletins (TSBs). If a TSB exists for this concern, DISCONTINUE this test and FOLLOW TSB instructions. If no Technical Service Bulletins (TSBs) address this concern, INSTALL a new IPMA.<br>REFER to: <a href="#">Interior Rear View Mirror</a> (501-09 Rear View Mirrors, Removal and Installation). |
| <b>No</b>  | The system is operating correctly at this time. The concern may have been caused by module connections. ADDRESS the root cause of any connector or pin issues.                                                                                                                                                                                          |

## **I9 CHECK FOR CORRECT PCM (POWERTRAIN CONTROL MODULE) OPERATION**

- Ignition OFF.
- Disconnect and inspect the PCM connectors.
- Repair:
  - corrosion (install new connector or terminals – clean module pins)
  - damaged or bent pins – install new terminals/pins
  - pushed-out pins – install new pins as necessary
- Reconnect the PCM connectors. Make sure they seat and latch correctly.
- Operate the system and determine if the concern is still present.

### **Is the concern still present?**

|            |                                                                                                                                                                                                                                                                                                                                                                                          |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | CHECK OASIS for any applicable Technical Service Bulletins (TSBs). If a TSB exists for this concern, DISCONTINUE this test and FOLLOW TSB instructions. If no Technical Service Bulletins (TSBs) address this concern, INSTALL a new PCM.<br>REFER to: <a href="#">Powertrain Control Module (PCM)</a> (303-14D Electronic Engine Controls - 5.0L 32V Ti-VCT, Removal and Installation). |
| <b>No</b>  | The system is operating correctly at this time. The concern may have been caused by module connections. ADDRESS the root cause of any connector or pin issues.                                                                                                                                                                                                                           |

DTC Fault Trigger Condition-PCM

| DTC   | Description                                                 | Fault Trigger Conditions                                                          |
|-------|-------------------------------------------------------------|-----------------------------------------------------------------------------------|
| U0256 | Lost Communication With Front Controls Interface Module "A" | The PCM sets this DTC if data messages from the FCIM through the GWM are missing. |

Normal Operation and Fault Conditions

REFER to: [Communications Network - System Operation and Component Description](#) (418-00 Module Communications Network, Description and Operation).

Possible Sources

- Communications network concern
- FCIM
- GWM
- PCM

PINPOINT TEST J : U0256

| J1 VERIFY THE CUSTOMER CONCERN                                                                                          |                                                                                                                                          |
|-------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"><li>• Ignition ON.</li><li>• Verify there is an observable symptom present.</li></ul> |                                                                                                                                          |
| Is an observable symptom present?                                                                                       |                                                                                                                                          |
| Yes                                                                                                                     | GO to <a href="#">J2</a>                                                                                                                 |
| No                                                                                                                      | The system is operating normally at this time. The DTC may have been set due to high network traffic or an intermittent fault condition. |



## J2 CHECK THE COMMUNICATION NETWORK

- Using a diagnostic scan tool, perform a network test.

**Did the FCIM pass the network test?**

|            |                                                                                                                 |
|------------|-----------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">J3</a>                                                                                        |
| <b>No</b>  | REFER to: <a href="#">Communications Network</a> (418-00 Module Communications Network, Diagnosis and Testing). |

## J3 PERFORM FCIM (FRONT CONTROLS INTERFACE MODULE) SELF-TEST

- Using a diagnostic scan tool, perform a FCIM self-test.

**Are any Diagnostic Trouble Codes (DTCs) recorded?**

|            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | Without touchscreen,<br>REFER to: <a href="#">Information and Entertainment System</a> (415-00C Information and Entertainment System - General Information - Vehicles With: Touchscreen Display, Diagnosis and Testing).<br>With touchscreen and without Sync®, REFER to: <a href="#">Information and Entertainment System</a> (415-00B Information and Entertainment System - General Information - Vehicles With: SYNC Without Touchscreen, Diagnosis and Testing).<br>Without Sync® REFER to: <a href="#">Information and Entertainment System</a> (415-00A Information and Entertainment System - General Information - Vehicles Without: SYNC, Diagnosis and Testing).<br>With Bang & Olufsen sound system, REFER to: <a href="#">Information and Entertainment System</a> (415-00D Information and Entertainment System - General Information - Vehicles With: Bang and Olufsen Audio System, Diagnosis and Testing). |
| <b>No</b>  | GO to <a href="#">J4</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

## J4 CHECK THE BCM (BODY CONTROL MODULE) DIAGNOSTIC TROUBLE CODES (DTCS)

- Using a diagnostic scan tool, retrieve the BCM Diagnostic Trouble Codes (DTCs).

#### Are any Diagnostic Trouble Codes (DTCs) recorded?

|            |                                                                                                                       |
|------------|-----------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | REFER to: <a href="#">Body Control Module (BCM)</a> (419-10 Multifunction Electronic Modules, Diagnosis and Testing). |
| <b>No</b>  | GO to <a href="#">J5</a>                                                                                              |

#### J5 PERFORM THE PCM (POWERTRAIN CONTROL MODULE) SELF-TEST

- Using a diagnostic scan tool, perform the PCM self-test.

#### Is DTC P0562 or P0563 recorded?

|            |                                         |
|------------|-----------------------------------------|
| <b>Yes</b> | REFER to PCM DTC Chart in this section. |
| <b>No</b>  | GO to <a href="#">J6</a>                |

#### J6 RECHECK THE PCM (POWERTRAIN CONTROL MODULE) DIAGNOSTIC TROUBLE CODES (DTCs)

**NOTE:** *If new modules were installed prior to the DTC being set, the module configuration may be incorrectly set during the PMI, or the PMI may not have been carried out.*

- Using a diagnostic scan tool, clear the Diagnostic Trouble Codes (DTCs).
- Wait 10 seconds.
- Repeat the PCM self-test.

#### Is DTC U0256 still present?

|            |                                                                                                                                           |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">J7</a>                                                                                                                  |
| <b>No</b>  | The system is operating correctly at this time. The DTC may have been set due to high network traffic or an intermittent fault condition. |

## **J7 CHECK FOR DTC (DIAGNOSTIC TROUBLE CODE) U0256 SET IN OTHER MODULES**

- Using a diagnostic scan tool, clear all Diagnostic Trouble Codes (DTCs).
- Ignition OFF.
- Ignition ON.
- Wait 10 seconds.
- Using a diagnostic scan tool, retrieve all Continuous Memory Diagnostic Trouble Codes (CMDTCs) from all modules.

**Is DTC U0256:87 set in any other module?**

|            |                          |
|------------|--------------------------|
| <b>Yes</b> | GO to <a href="#">J8</a> |
| <b>No</b>  | GO to <a href="#">J9</a> |

## **J8 CHECK FOR CORRECT FCIM (FRONT CONTROLS INTERFACE MODULE) OPERATION**

- Ignition OFF.
- Disconnect and inspect the FCIM connectors.
- Repair:
  - corrosion (install new connector or terminals – clean module pins)
  - damaged or bent pins – install new terminals/pins
  - pushed-out pins – install new pins as necessary
- Reconnect the FCIM connectors. Make sure they seat and latch correctly.
- Operate the system and determine if the concern is still present.

**Is the concern still present?**

|            |                                                                                                                                                                                                                                                                                                                                                                         |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | CHECK OASIS for any applicable Technical Service Bulletins (TSBs). If a TSB exists for this concern, DISCONTINUE this test and FOLLOW TSB instructions. If no Technical Service Bulletins (TSBs) address this concern,<br> <a href="#">Click here to access Guided Routine (FCIM).</a> |
| <b>No</b>  | The system is operating correctly at this time. The concern may have been caused by module connections. ADDRESS the root cause of any connector or pin issues.                                                                                                                                                                                                          |

## J9 CHECK FOR CORRECT PCM (POWERTRAIN CONTROL MODULE) OPERATION

- Ignition OFF.
- Disconnect and inspect the PCM connectors.
- Repair:
  - corrosion (install new connector or terminals – clean module pins)
  - damaged or bent pins – install new terminals/pins
  - pushed-out pins – install new pins as necessary
- Reconnect the PCM connectors. Make sure they seat and latch correctly.
- Operate the system and determine if the concern is still present.

### Is the concern still present?

|            |                                                                                                                                                                                                                                                                                                                                                                                          |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | CHECK OASIS for any applicable Technical Service Bulletins (TSBs). If a TSB exists for this concern, DISCONTINUE this test and FOLLOW TSB instructions. If no Technical Service Bulletins (TSBs) address this concern, INSTALL a new PCM.<br>REFER to: <a href="#">Powertrain Control Module (PCM)</a> (303-14D Electronic Engine Controls - 5.0L 32V Ti-VCT, Removal and Installation). |
| <b>No</b>  | The system is operating correctly at this time. The concern may have been caused by module connections. ADDRESS the root cause of any connector or pin issues.                                                                                                                                                                                                                           |

## DTC Fault Trigger Condition-PCM

| DTC   | Description                                                   | Fault Trigger Conditions                                                                                     |
|-------|---------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|
| U0298 | Lost Communication With DC to DC Converter Control Module "A" | The PCM sets this DTC if data messages from the DC/DC Converter Control Module over the HS-CAN1 are missing. |

### Normal Operation and Fault Conditions

REFER to: [Communications Network - System Operation and Component Description](#) (418-00 Module Communications Network, Description and Operation).

### Possible Sources

- Communications network concern
- DC/DC Converter Control Module
- PCM

### PINPOINT TEST K : U0298

#### K1 VERIFY THE CUSTOMER CONCERN

- Ignition ON.
- Verify there is an observable symptom present.

Is an observable symptom present?

|     |                                                                                                                                          |
|-----|------------------------------------------------------------------------------------------------------------------------------------------|
| Yes | GO to <a href="#">K2</a>                                                                                                                 |
| No  | The system is operating normally at this time. The DTC may have been set due to high network traffic or an intermittent fault condition. |

#### K2 CHECK THE COMMUNICATION NETWORK



- Using a diagnostic scan tool, perform a network test.

**Did the DC/DC Converter Control Module pass the network test?**

|            |                                                                                                                 |
|------------|-----------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">K3</a>                                                                                        |
| <b>No</b>  | REFER to: <a href="#">Communications Network</a> (418-00 Module Communications Network, Diagnosis and Testing). |

**K3 PERFORM THE DC/DC CONVERTER CONTROL MODULE SELF-TEST**

- Using a diagnostic scan tool, perform a DC/DC Converter Control Module self-test.

**Are any Diagnostic Trouble Codes (DTCs) recorded?**

|            |                                                                                                                                                      |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | REFER to: <a href="#">Direct Current/Direct Current (DC/DC) Converter Control Module</a> (414-05 Voltage Converter/Inverter, Diagnosis and Testing). |
| <b>No</b>  | GO to <a href="#">K4</a>                                                                                                                             |

**K4 CHECK THE BCM (BODY CONTROL MODULE) DIAGNOSTIC TROUBLE CODES (DTCS)**

- Using a diagnostic scan tool, retrieve the BCM Diagnostic Trouble Codes (DTCs).

**Are any Diagnostic Trouble Codes (DTCs) recorded?**

|            |                                                                                                                       |
|------------|-----------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | REFER to: <a href="#">Body Control Module (BCM)</a> (419-10 Multifunction Electronic Modules, Diagnosis and Testing). |
| <b>No</b>  | GO to <a href="#">K5</a>                                                                                              |

**K5 PERFORM THE PCM (POWERTRAIN CONTROL MODULE) SELF-TEST**

- Using a diagnostic scan tool, perform the PCM self-test.

**Is DTC P0562 or P0563 recorded?**

|            |                                         |
|------------|-----------------------------------------|
| <b>Yes</b> | REFER to PCM DTC Chart in this section. |
| <b>No</b>  | GO to <a href="#">K6</a>                |

**K6 RECHECK THE PCM (POWERTRAIN CONTROL MODULE) DIAGNOSTIC TROUBLE CODES (DTCS)**

**NOTE:** *If new modules were installed prior to the DTC being set, the module configuration may be incorrectly set during the PMI, or the PMI may not have been carried out.*

- Using a diagnostic scan tool, clear the Diagnostic Trouble Codes (DTCs).
- Wait 10 seconds.
- Repeat the PCM self-test.

**Is DTC U0298 still present?**

|            |                                                                                                                                           |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">K7</a>                                                                                                                  |
| <b>No</b>  | The system is operating correctly at this time. The DTC may have been set due to high network traffic or an intermittent fault condition. |

**K7 CHECK FOR DTC (DIAGNOSTIC TROUBLE CODE) U0298 SET IN OTHER MODULES**

- Using a diagnostic scan tool, clear all Diagnostic Trouble Codes (DTCs).
- Ignition OFF.
- Ignition ON.
- Wait 10 seconds.
- Using a diagnostic scan tool, retrieve all Continuous Memory Diagnostic Trouble Codes (CMDTCs) from all modules.

**Is DTC U0298:00 or U0298:87 set in any other module?**

|            |                          |
|------------|--------------------------|
| <b>Yes</b> | GO to <a href="#">K8</a> |
| <b>No</b>  | GO to <a href="#">K9</a> |

## **K8 CHECK FOR CORRECT DC/DC CONVERTER CONTROL MODULE OPERATION**

- Ignition OFF.
- Disconnect and inspect the DC/DC converter control module connector.
- Repair:
  - corrosion (install new connector or terminals – clean module pins)
  - damaged or bent pins – install new terminals/pins
  - pushed-out pins – install new pins as necessary
- Reconnect the DC/DC Converter Control module connector. Make sure it seats and latches correctly.
- Operate the system and determine if the concern is still present.

**Is the concern still present?**

|            |                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | CHECK OASIS for any applicable Technical Service Bulletins (TSBs). If a TSB exists for this concern, DISCONTINUE this test and FOLLOW TSB instructions. If no Technical Service Bulletins (TSBs) address this concern, INSTALL a new DC/DC Converter Control Module.<br>REFER to: <a href="#">Direct Current/Direct Current (DC/DC) Converter Control Module</a> (414-05 Voltage Converter/Inverter, Removal and Installation). |
| <b>No</b>  | The system is operating correctly at this time. The concern may have been caused by module connections. ADDRESS the root cause of any connector or pin issues.                                                                                                                                                                                                                                                                  |

## K9 CHECK FOR CORRECT PCM (POWERTRAIN CONTROL MODULE) OPERATION

- Ignition OFF.
- Disconnect and inspect the PCM connectors.
- Repair:
  - corrosion (install new connector or terminals – clean module pins)
  - damaged or bent pins – install new terminals/pins
  - pushed-out pins – install new pins as necessary
- Reconnect the PCM connectors. Make sure they seat and latch correctly.
- Operate the system and determine if the concern is still present.

### Is the concern still present?

|            |                                                                                                                                                                                                                                                                                                                                                                                          |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | CHECK OASIS for any applicable Technical Service Bulletins (TSBs). If a TSB exists for this concern, DISCONTINUE this test and FOLLOW TSB instructions. If no Technical Service Bulletins (TSBs) address this concern, INSTALL a new PCM.<br>REFER to: <a href="#">Powertrain Control Module (PCM)</a> (303-14D Electronic Engine Controls - 5.0L 32V Ti-VCT, Removal and Installation). |
| <b>No</b>  | The system is operating correctly at this time. The concern may have been caused by module connections. ADDRESS the root cause of any connector or pin issues.                                                                                                                                                                                                                           |

**Oil Pressure Control Solenoid Faults**

Refer to Wiring Diagrams Cell 26 for schematic and connector information.

**Normal Operation and Fault Conditions**

303-01 DO overview

**DTC Fault Trigger Condition-PCM**

| DTC   | Description                                               | Fault Trigger Conditions                                                                                |
|-------|-----------------------------------------------------------|---------------------------------------------------------------------------------------------------------|
| P06DA | Engine Oil Pressure Control Circuit/Open                  | Sets when the PCM detects an open on the engine oil pressure control solenoid valve circuit.            |
| P06DB | Engine Oil Pressure Control Circuit Low                   | Sets when the PCM detects a short to ground on the engine oil pressure control solenoid valve circuit.  |
| P06DC | Engine Oil Pressure Control Circuit High                  | Sets when the PCM detects a short to voltage on the engine oil pressure control solenoid valve circuit. |
| P06DD | Engine Oil Pressure Control Circuit Performance/Stuck Off | Sets when the PCM detects the engine oil pressure control solenoid valve is stuck.                      |

**Possible Sources**

- Engine oil pressure control solenoid valve
- PCM
- Wiring, terminals or connectors

**PINPOINT TEST L : OIL PRESSURE CONTROL SOLENOID FAULTS**

|                                                                               |
|-------------------------------------------------------------------------------|
| <b>L1 CHECK THE ENGINE OIL PRESSURE CONTROL SOLENOID VALVE SUPPLY VOLTAGE</b> |
|                                                                               |



- Ignition OFF.
- Disconnect Engine oil pressure control solenoid valve C1924.
- Ignition ON.

**Is the voltage greater than 11 volts?**

|            |                                                                                                                                                                       |
|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">L2</a>                                                                                                                                              |
| <b>No</b>  | VERIFY BJB fuse F97 (10A) is OK. If OK, REPAIR the open circuit. If not OK, REFER to the Wiring Diagrams manual to identify the possible causes of the circuit short. |

## **L2 CHECK THE ENGINE OIL PRESSURE CONTROL SOLENOID VALVE CIRCUIT FOR A SHORT TO VOLTAGE**

- Ignition OFF.
- Disconnect PCM C1381E.
- Ignition ON.

**Is any voltage present?**

|            |                          |
|------------|--------------------------|
| <b>Yes</b> | REPAIR the circuit.      |
| <b>No</b>  | GO to <a href="#">L3</a> |

## **L3 CHECK THE ENGINE OIL PRESSURE CONTROL SOLENOID VALVE CIRCUIT FOR AN OPEN**

- Ignition OFF.

**Is the resistance less than 3 ohms?**

|            |                          |
|------------|--------------------------|
| <b>Yes</b> | GO to <a href="#">L4</a> |
| <b>No</b>  | REPAIR the circuit.      |

#### **L4 CHECK THE ENGINE OIL PRESSURE CONTROL SOLENOID VALVE CIRCUIT FOR A SHORT TO GROUND**

**Is the resistance greater than 10,000 ohms?**

|            |                          |
|------------|--------------------------|
| <b>Yes</b> | GO to <a href="#">L5</a> |
| <b>No</b>  | REPAIR the circuit.      |

#### **L5 CHECK THE ENGINE OIL PRESSURE CONTROL SOLENOID VALVE OPERATION**

- **NOTE:** *Engine oil level and contamination can affect the oil pressure reading.*  
  
Check the engine oil level and correct as necessary.
- Connect PCM C1381E.
- Connect Engine oil pressure control solenoid valve C1924.
- Connect an EOP gauge to the oil pressure sender oil galley port. For more information, REFER to: [Engine](#) (303-00 Engine System - General Information, Diagnosis and Testing).  
**Oil Pressure Test.**
- Start the engine.
- **NOTE:** *The PCM PID EOPDC\_CMD may or may not be available in the diagnostic scan tool.*

If the active command PCM PID EOPDC\_CMD is available in the diagnostic scan tool, enable the engine oil pressure control solenoid valve using the PCM PID EOPDC\_CMD.

- If the active command PCM PID EOPDC\_CMD is **not** available in the diagnostic scan tool, with the engine running, wait for approximately 20 to 30 seconds, the PCM commands the pump state transition from high pressure mode to low pressure mode.
- A pressure drop of **8 psi** or greater is anticipated. If the engine coolant temperature is less than 100°F (38°C), a pressure drop of **15 psi** or greater is anticipated.

#### Is the expected engine oil pressure drop present?

|            |                                                                                                                                                                                                 |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Yes</b> | GO to <a href="#">L6</a>                                                                                                                                                                        |
| <b>No</b>  | INSTALL a new oil pressure control solenoid valve.<br>REFER to: <a href="#">Oil Pressure Control Solenoid</a> (303-14D Electronic Engine Controls - 5.0L 32V Ti-VCT, Removal and Installation). |

#### L6 VERIFY ENGINE OIL PRESSURE CONTROL SOLENOID VALVE CONNECTION AND WIRING

- Ignition OFF.
- Disconnect Engine oil pressure control solenoid valve C1924.
- Disconnect PCM connectors.
- Inspect connectors and wiring:
  - corrosion (install new connector or terminals – clean module pins)
  - damaged or bent pins - install new terminals/pins
  - pushed-out pins - install new pins as necessary
- Reconnect **all** connectors. Make sure they seat and latch correctly.
- Operate the system and determine if the concern is still present.

#### Is the concern still present?

|            |                                            |
|------------|--------------------------------------------|
| <b>Yes</b> | REPAIR the circuit or connector as needed. |
|------------|--------------------------------------------|

|           |                                                                                                                      |
|-----------|----------------------------------------------------------------------------------------------------------------------|
| <b>No</b> | The system is operating correctly at this time. The intermittent concern may have been caused by a loose connection. |
|-----------|----------------------------------------------------------------------------------------------------------------------|

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# Catalyst Monitor Sensor

Base Part Number: Base Part Number: 9G444

## Special Tool(s) / General Equipment

|                                                                                              |                                                                                                                 |
|----------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|
| <br>E172696 | 303-476 (T94P-9472-A)<br>Socket, Exhaust Gas Oxygen Sensor<br>TKIT-1994-F<br>TKIT-1994-FLM/FM<br>TKIT-1994-LM/M |
|----------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|

## Materials

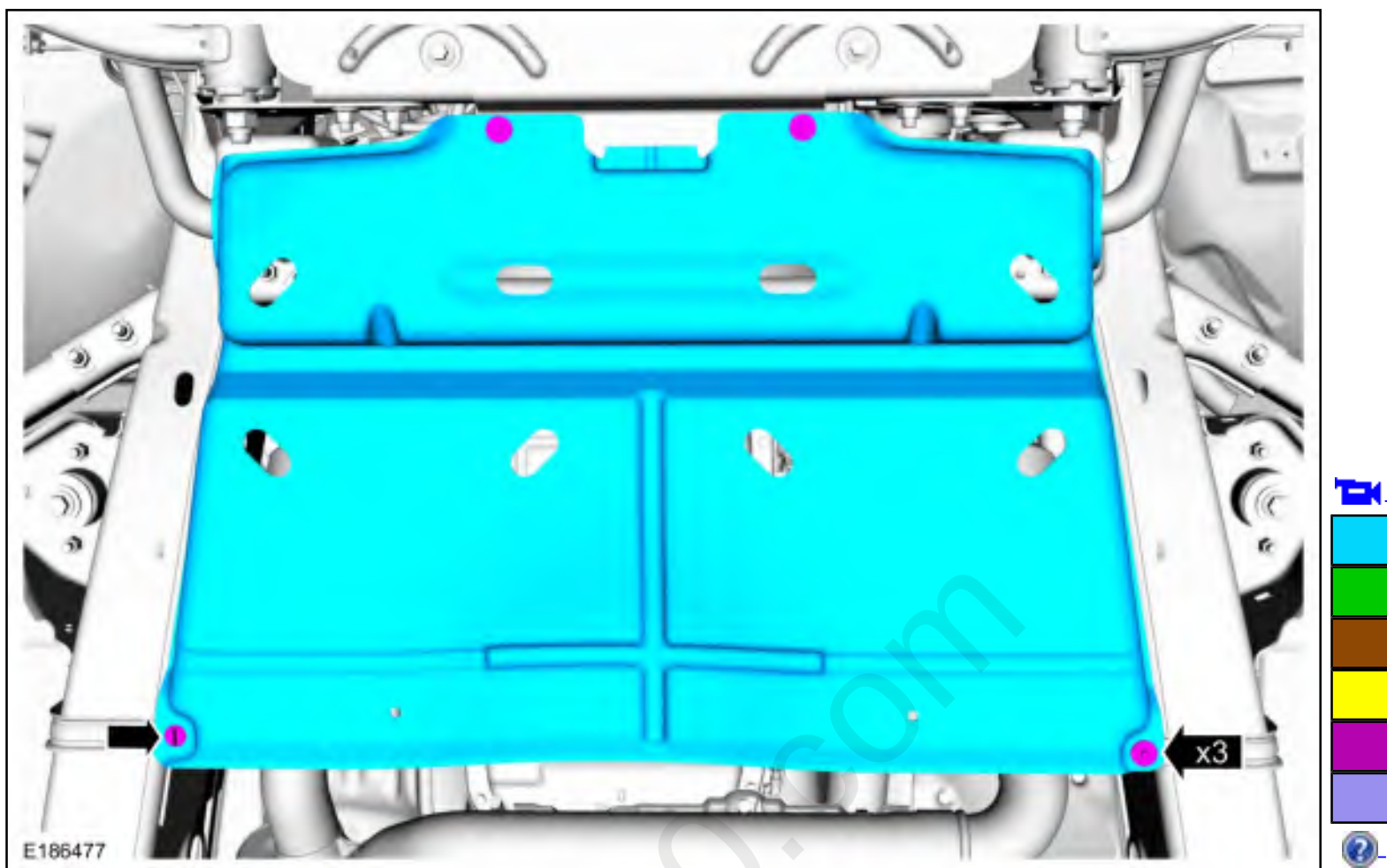
| Name                                                          | Specification |
|---------------------------------------------------------------|---------------|
| Motorcraft® High Temperature Nickel Anti-Seize Lubricant XL-2 | -             |
| Motorcraft® Penetrating and Lock Lubricant XL-1               | -             |

## Removal

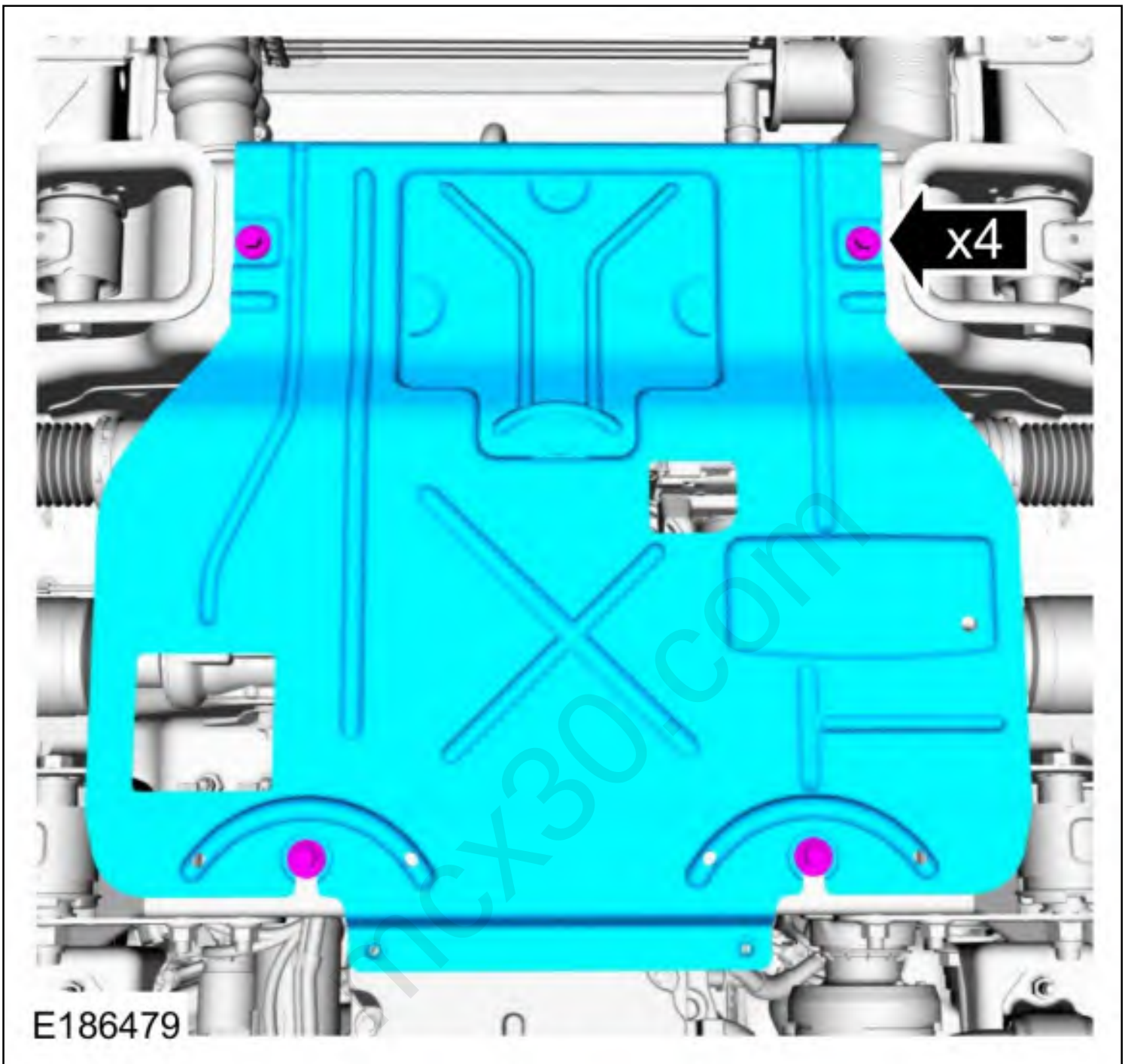
### All sensors

1. With the vehicle in NEUTRAL, position it on a hoist.  
Refer to: [Jacking and Lifting - Overview](#) (100-02 Jacking and Lifting, Description and Operation).
2. If equipped, remove the fasteners and the underbody shield.



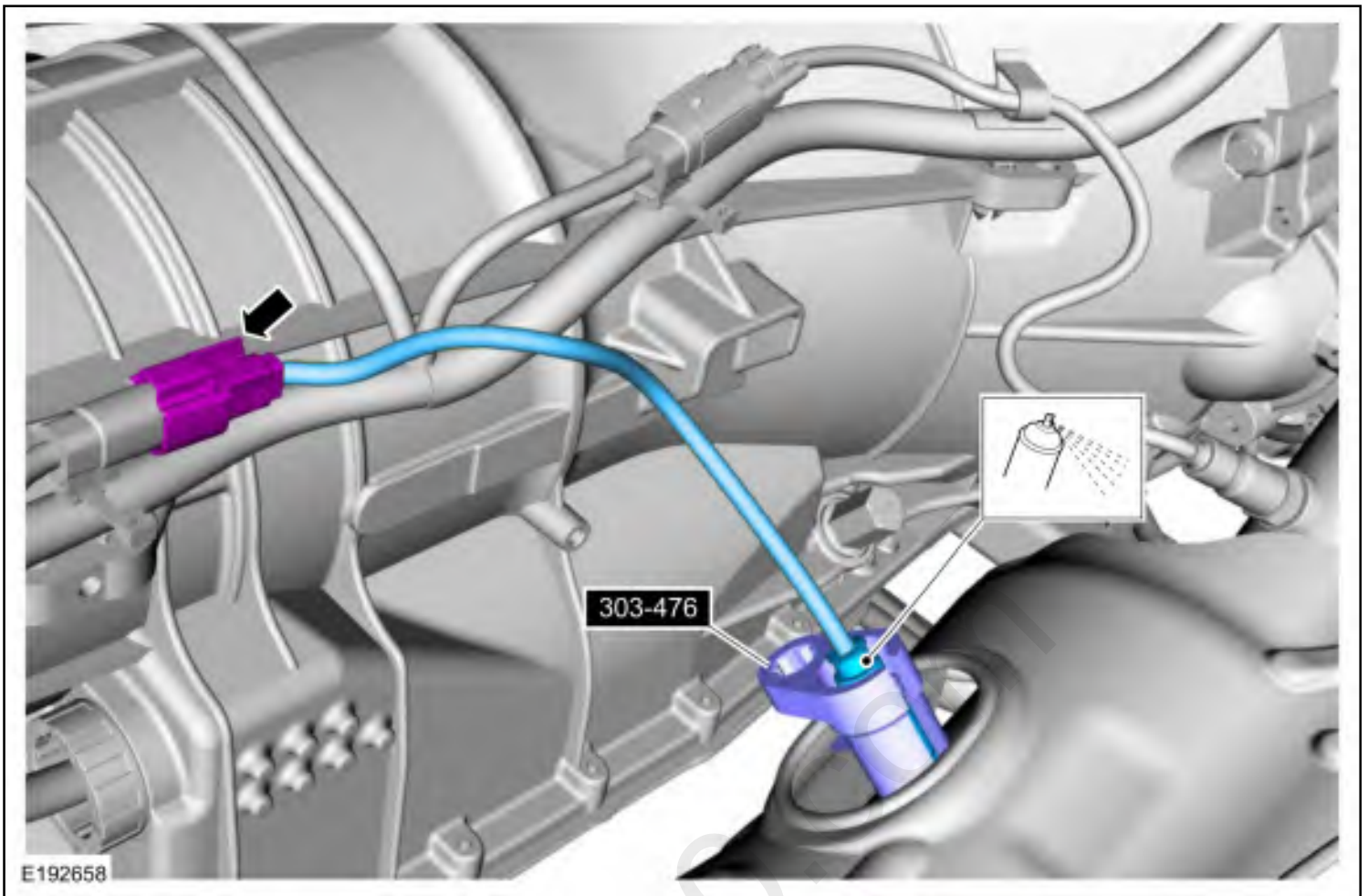


3. If equipped, remove the bolts and the skid plate.



### Right hand (RH) Catalyst monitor sensor

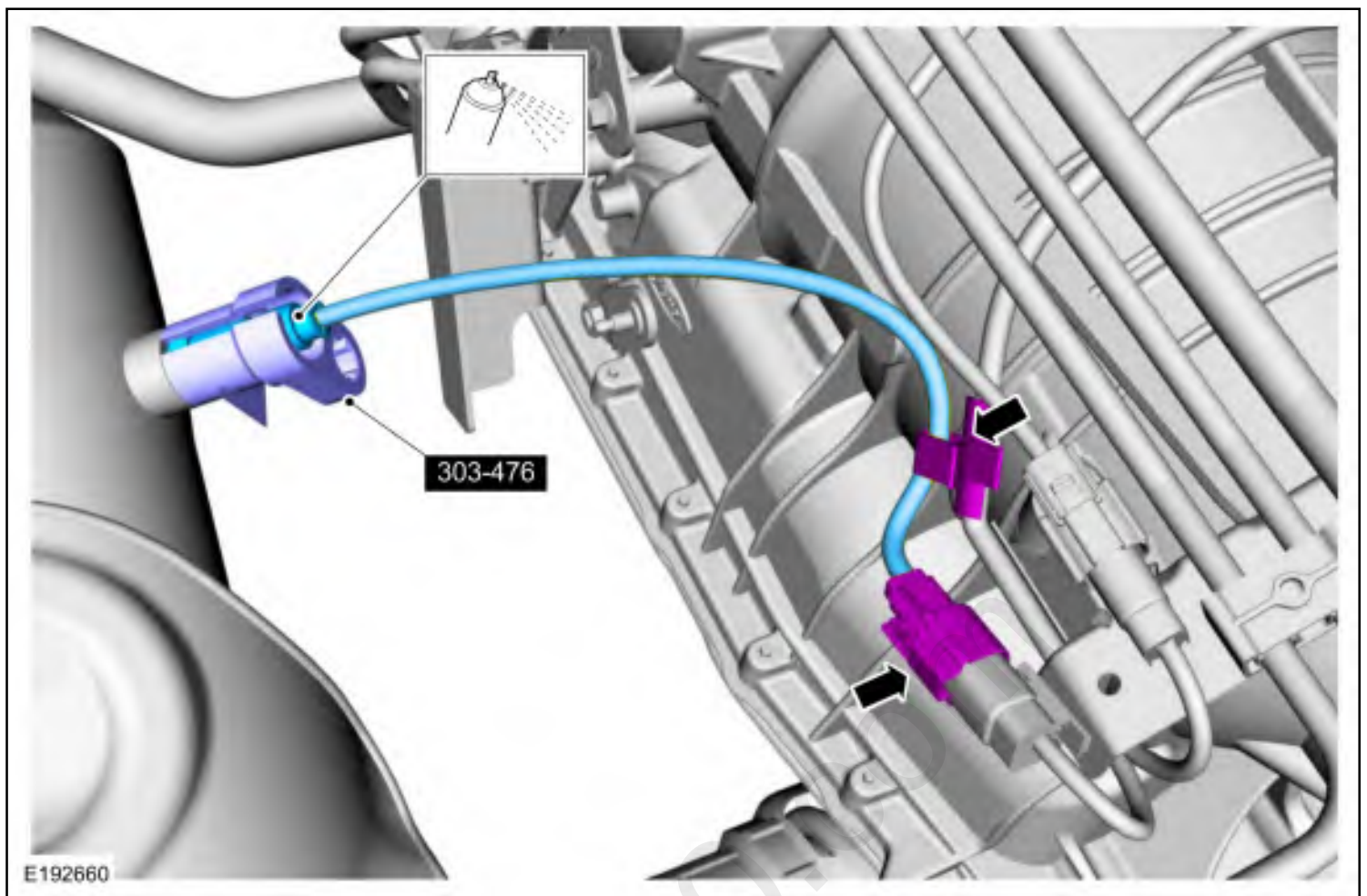
- Disconnect the electrical connector.
- Apply penetrating oil to sensor, using the special tool remove the Catalyst monitor sensor. Use Special Service Tool: 303-476 (T94P-9472-A) Socket, Exhaust Gas Oxygen Sensor. *Material: Motorcraft® Penetrating and Lock Lubricant / XL-1*



### Left hand (LH) Catalyst monitor sensor

- Disconnect the electrical connector and remove the harness retainer.
- Apply penetrating oil to sensor, using the special tool remove the Catalyst monitor sensor. Use Special Service Tool: 303-476 (T94P-9472-A) Socket, Exhaust Gas Oxygen Sensor. *Material: Motorcraft® Penetrating and Lock Lubricant / XL-1*

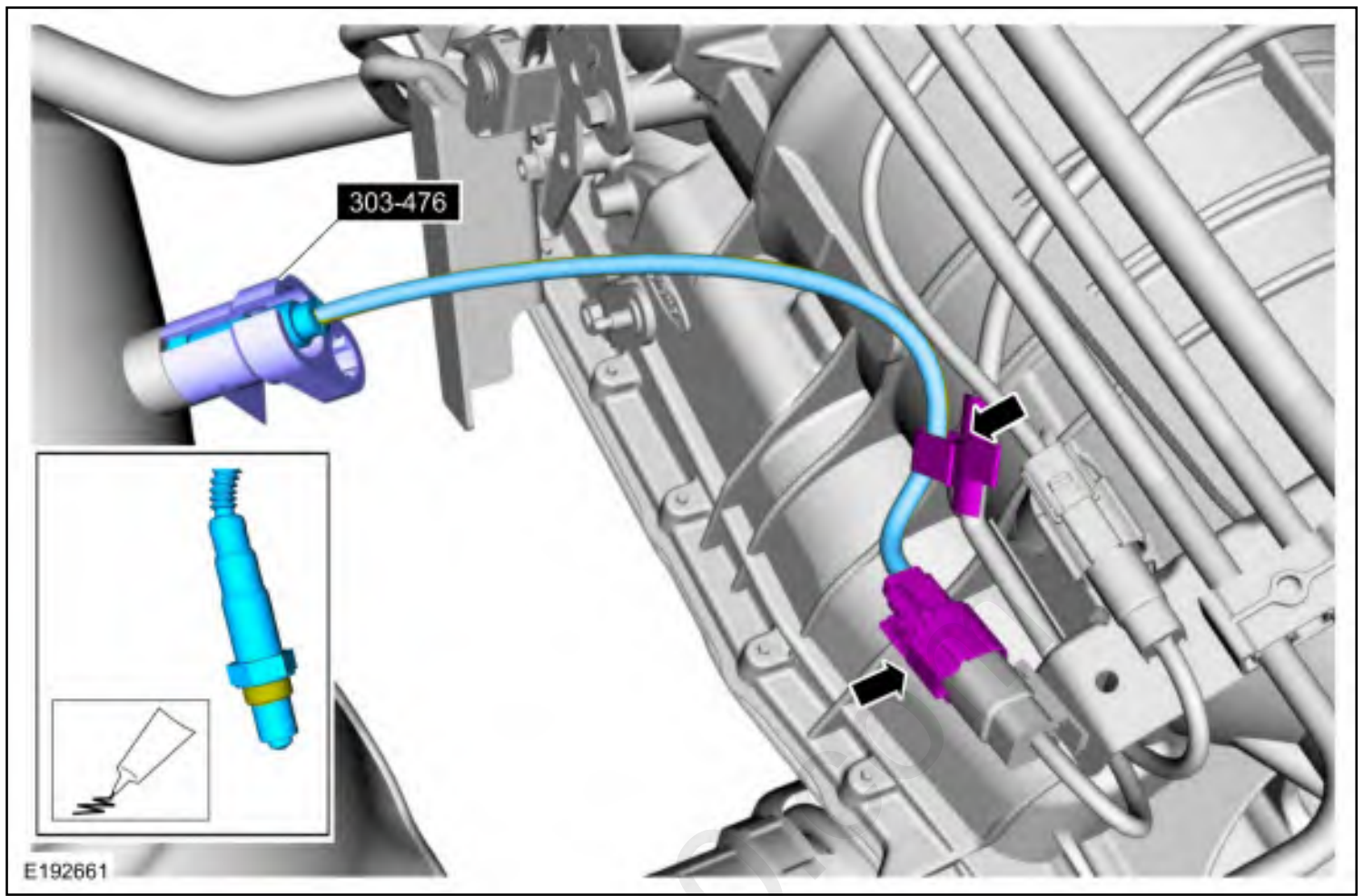




## Installation

### Left hand (LH) Catalyst monitor sensor

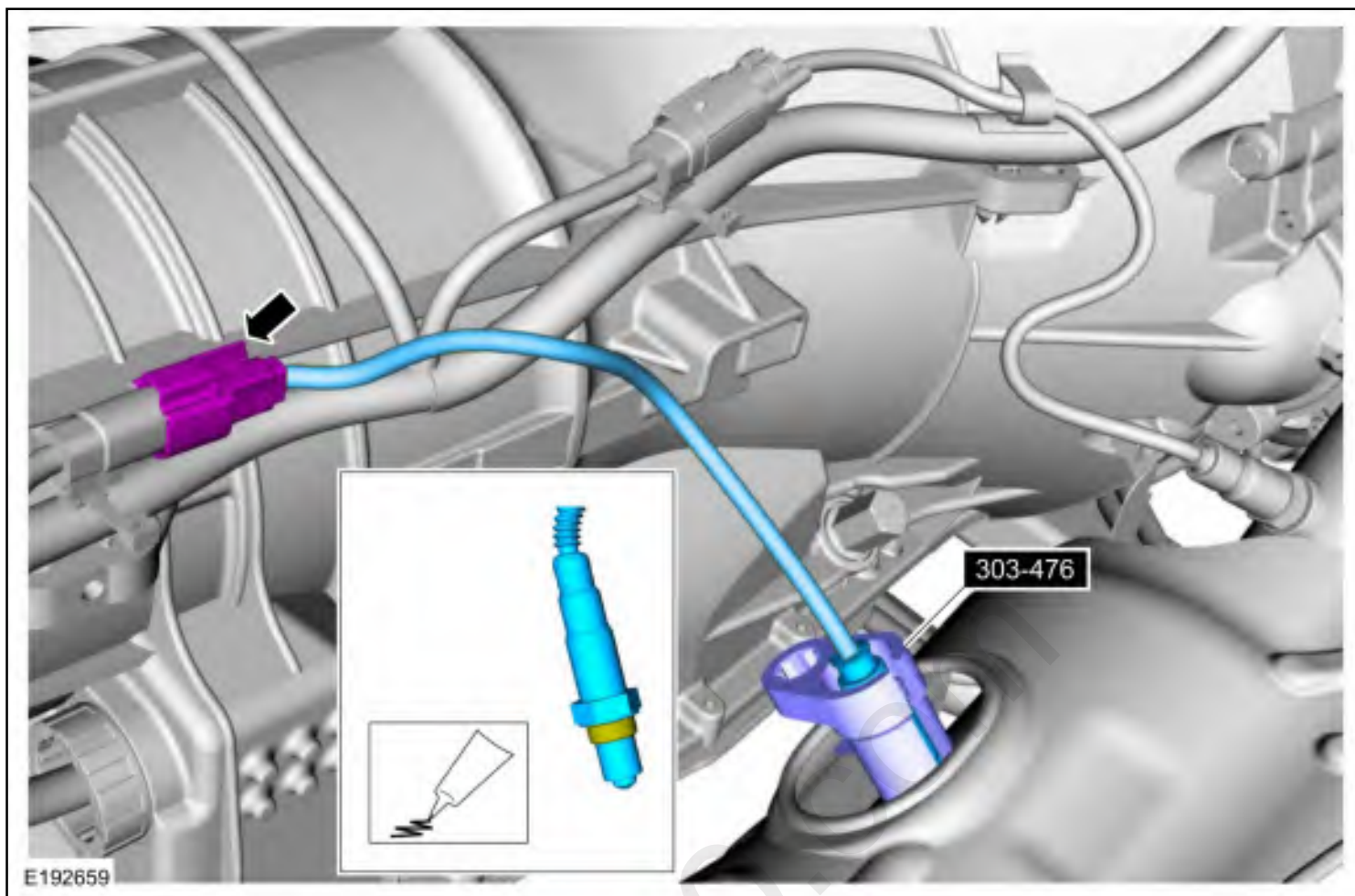
- Apply anti-seize to thread of sensor, Using special tool install the Catalyst monitor sensor. Use Special Service Tool: 303-476 (T94P-9472-A) Socket, Exhaust Gas Oxygen Sensor. *Material:* Motorcraft® High Temperature Nickel Anti-Seize Lubricant / XL-2  
*Torque:* 35 lb.ft (48 Nm)
- Install the harness retainer and connect the electrical connector.



### Right hand (RH) Catalyst monitor sensor

- Apply anti-seize to thread of sensor, Using special tool install the Catalyst monitor sensor. Use Special Service Tool: 303-476 (T94P-9472-A) Socket, Exhaust Gas Oxygen Sensor.  
*Material:* Motorcraft® High Temperature Nickel Anti-Seize Lubricant / XL-2  
*Torque:* 35 lb.ft (48 Nm)
- Connect the electrical connector.





## All sensors

3. To install, reverse the removal procedure.

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# Camshaft Position (CMP) Sensor

Base Part Number: Base Part Number: 12K073

## Materials

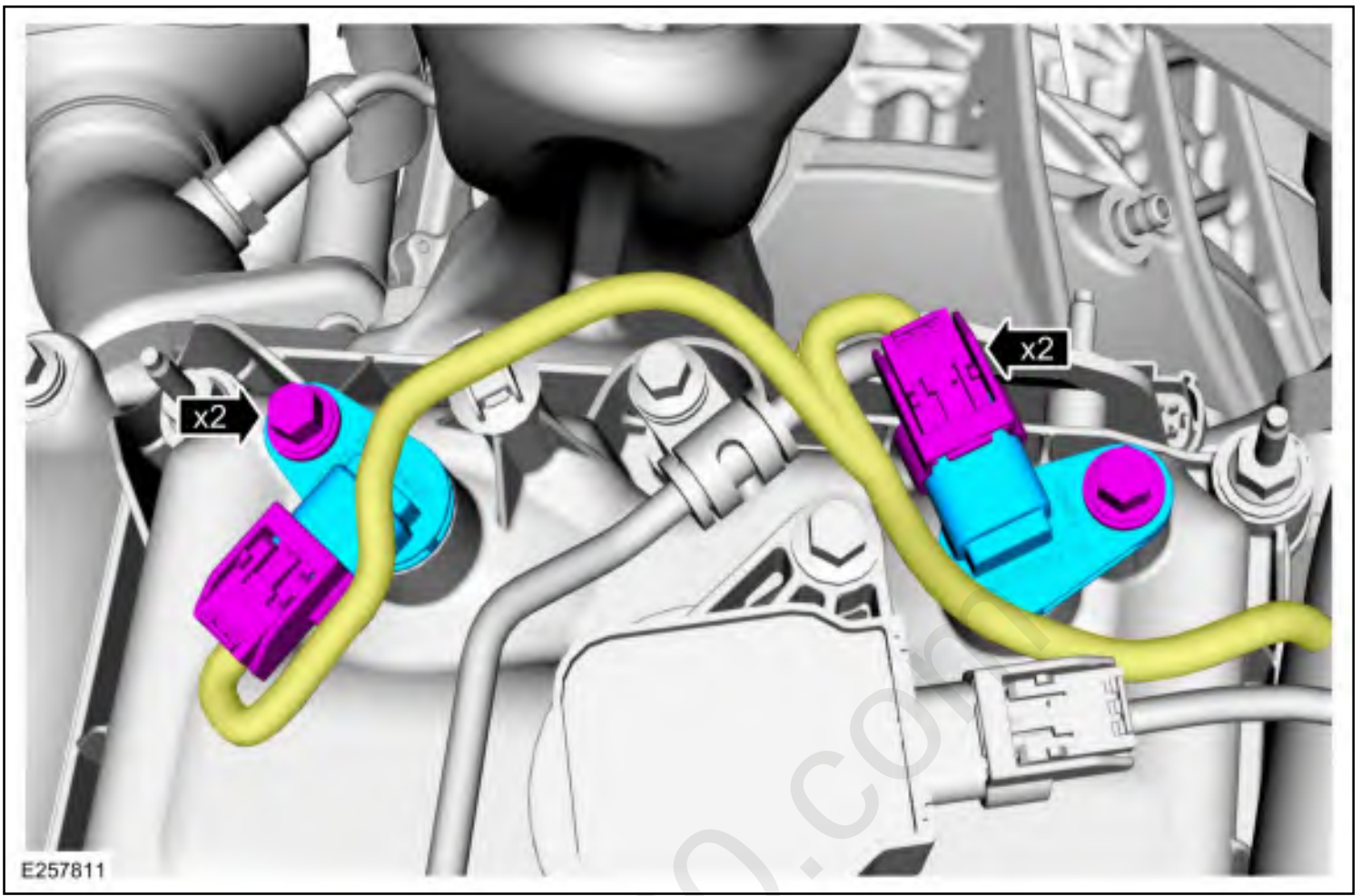
| Name                                                           | Specification |
|----------------------------------------------------------------|---------------|
| Motorcraft® SAE 5W-20 Synthetic Blend Motor Oil<br>XO-5W20-QSP | WSS-M2C945-A  |

## Removal

**NOTE:** Removal steps in this procedure may contain installation details.

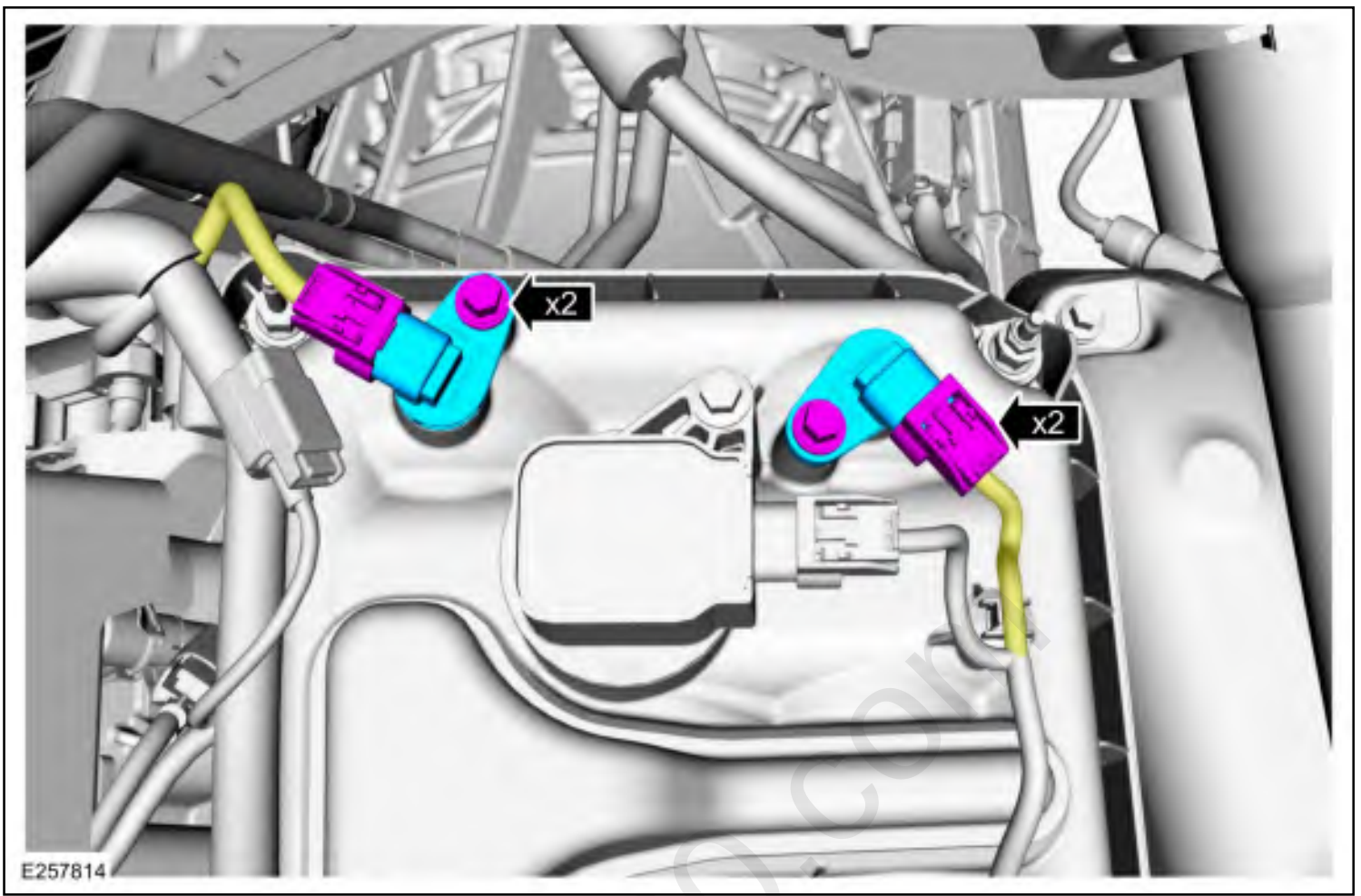
## RH (right-hand) Camshaft Position (CMP) Sensors

- Disconnect the exhaust CMP sensor electrical connector and remove the retainer and the CMP sensor.  
*Material:* Motorcraft® SAE 5W-20 Synthetic Blend Motor Oil / XO-5W20-QSP (WSS-M2C945-A)  
*Torque:* 66 lb.in (7.5 Nm)
- Disconnect the intake CMP sensor electrical connector and remove the retainer and the CMP sensor.  
*Material:* Motorcraft® SAE 5W-20 Synthetic Blend Motor Oil / XO-5W20-QSP (WSS-M2C945-A)  
*Torque:* 66 lb.in (7.5 Nm)



## LH (left-hand) Camshaft Position (CMP) Sensors

- Disconnect the exhaust CMP sensor electrical connector and remove the retainer and the CMP sensor.  
*Material:* Motorcraft® SAE 5W-20 Synthetic Blend Motor Oil / XO-5W20-QSP (WSS-M2C945-A)  
*Torque:* 66 lb.in (7.5 Nm)
- Disconnect the intake CMP sensor electrical connector and remove the retainer and the CMP sensor.  
*Material:* Motorcraft® SAE 5W-20 Synthetic Blend Motor Oil / XO-5W20-QSP (WSS-M2C945-A)  
*Torque:* 66 lb.in (7.5 Nm)



## Installation

**NOTE:** Before installation, lubricate the CMP sensor O-ring seal with clean engine oil.

1. To install, reverse the removal procedure.

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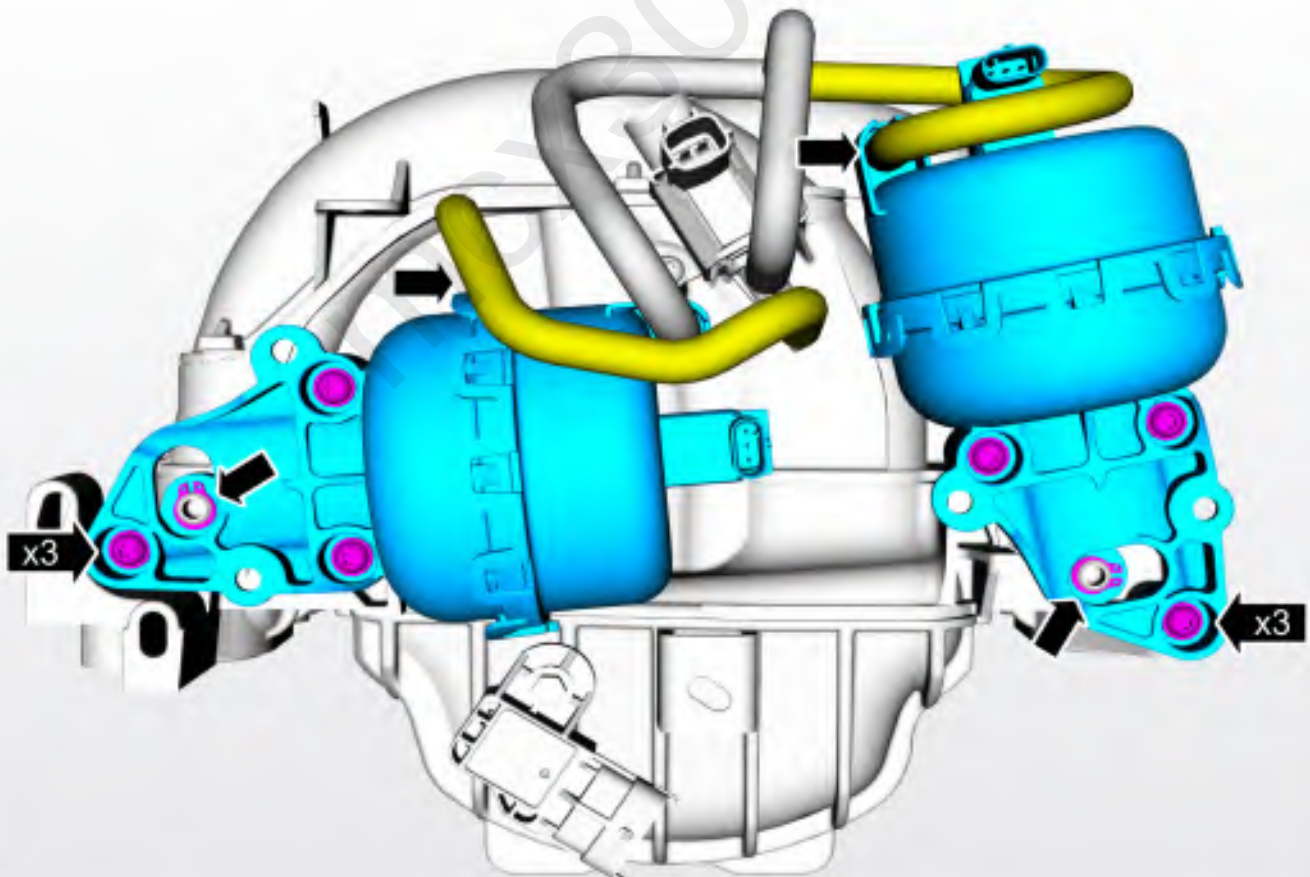
# Intake Manifold Runner Control (IMRC) Actuator

Base Part Number: Base Part Number: 9J559

## Removal

**NOTE:** Removal steps in this procedure may contain installation details.

1. Remove the intake manifold.  
Refer to: [Intake Manifold](#) (303-01D Engine - 5.0L 32V Ti-VCT, Removal and Installation).
2. Remove the hoses, retainers and the IMRC actuators.  
Torque: 35 lb.in (4 Nm)



E258190





## Installation

1. To install, reverse the removal procedure.

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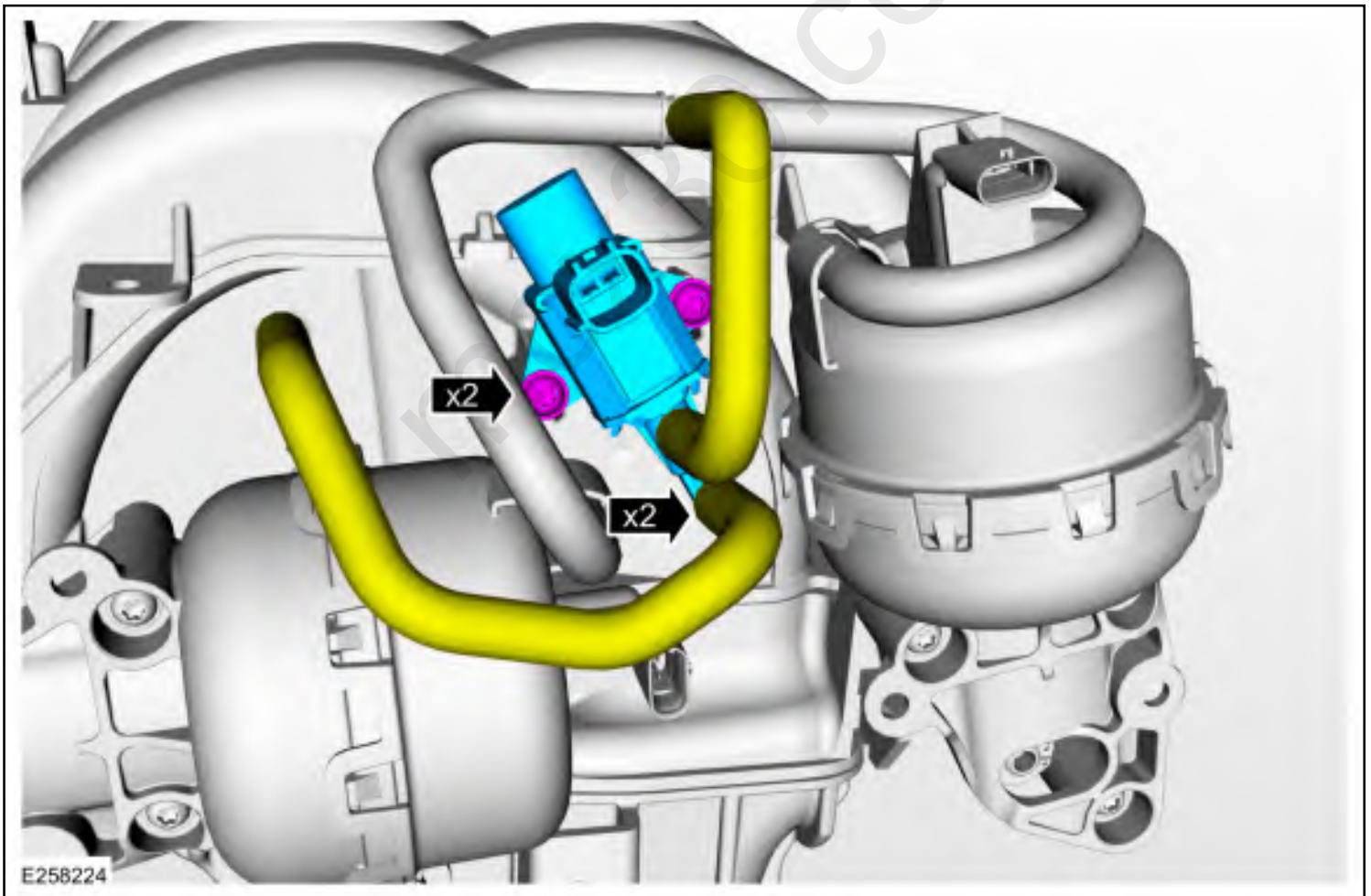
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# Intake Manifold Runner Control (IMRC) Solenoid

## Removal

**NOTE:** Removal steps in this procedure may contain installation details.

1. Remove the intake manifold.  
Refer to: [Intake Manifold](#) (303-01D Engine - 5.0L 32V Ti-VCT, Removal and Installation).
2. Disconnect the hoses and remove the IMRC solenoid.  
Torque: 35 lb.in (4 Nm)



## Installation

1. To install, reverse the removal procedure.

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## Heated Oxygen Sensor (HO2S)

Base Part Number: Base Part Number: 9F472

### Special Tool(s) / General Equipment

|                                                                                              |                                                                                                                 |
|----------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|
| <br>E172696 | 303-476 (T94P-9472-A)<br>Socket, Exhaust Gas Oxygen Sensor<br>TKIT-1994-F<br>TKIT-1994-FLM/FM<br>TKIT-1994-LM/M |
|----------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|

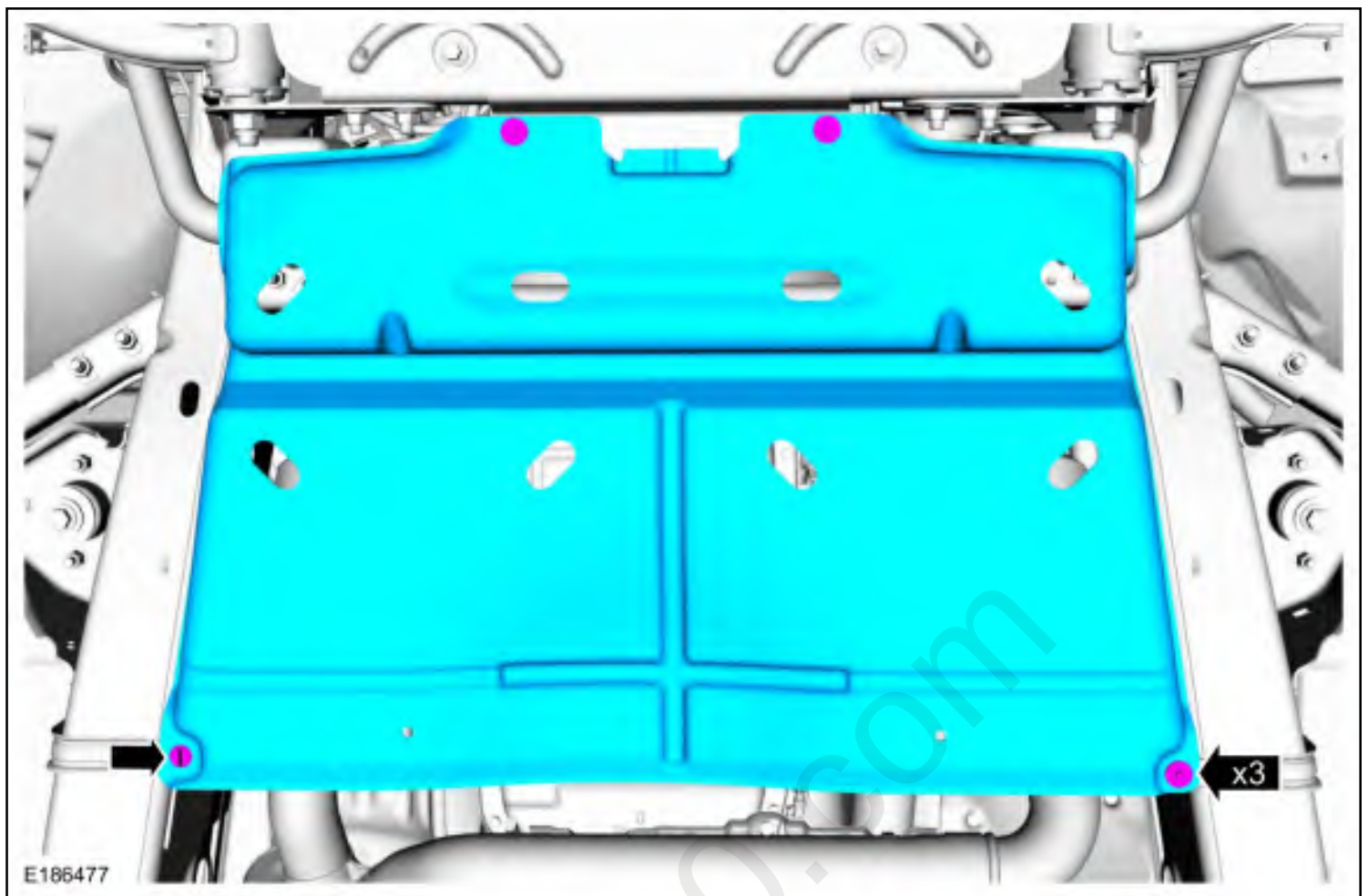
### Materials

| Name                                                          | Specification |
|---------------------------------------------------------------|---------------|
| Motorcraft® High Temperature Nickel Anti-Seize Lubricant XL-2 | -             |
| Motorcraft® Penetrating and Lock Lubricant XL-1               | -             |

### Removal

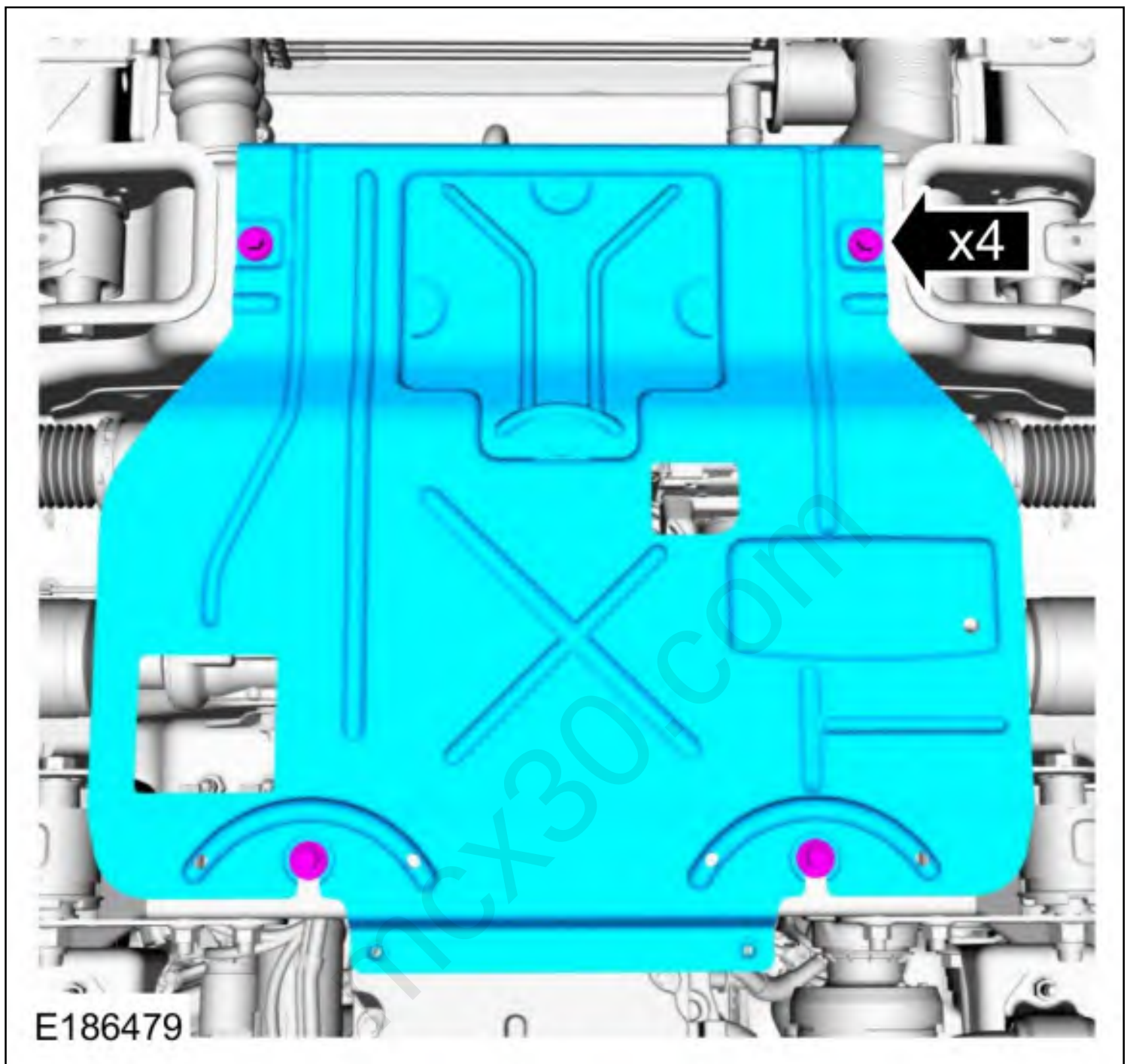
#### All sensors

1. With the vehicle in NEUTRAL, position it on a hoist.  
Refer to: [Jacking and Lifting - Overview](#) (100-02 Jacking and Lifting, Description and Operation).
2. If equipped, remove the fasteners and the underbody shield.  
*Torque:* 71 lb.in (8 Nm)



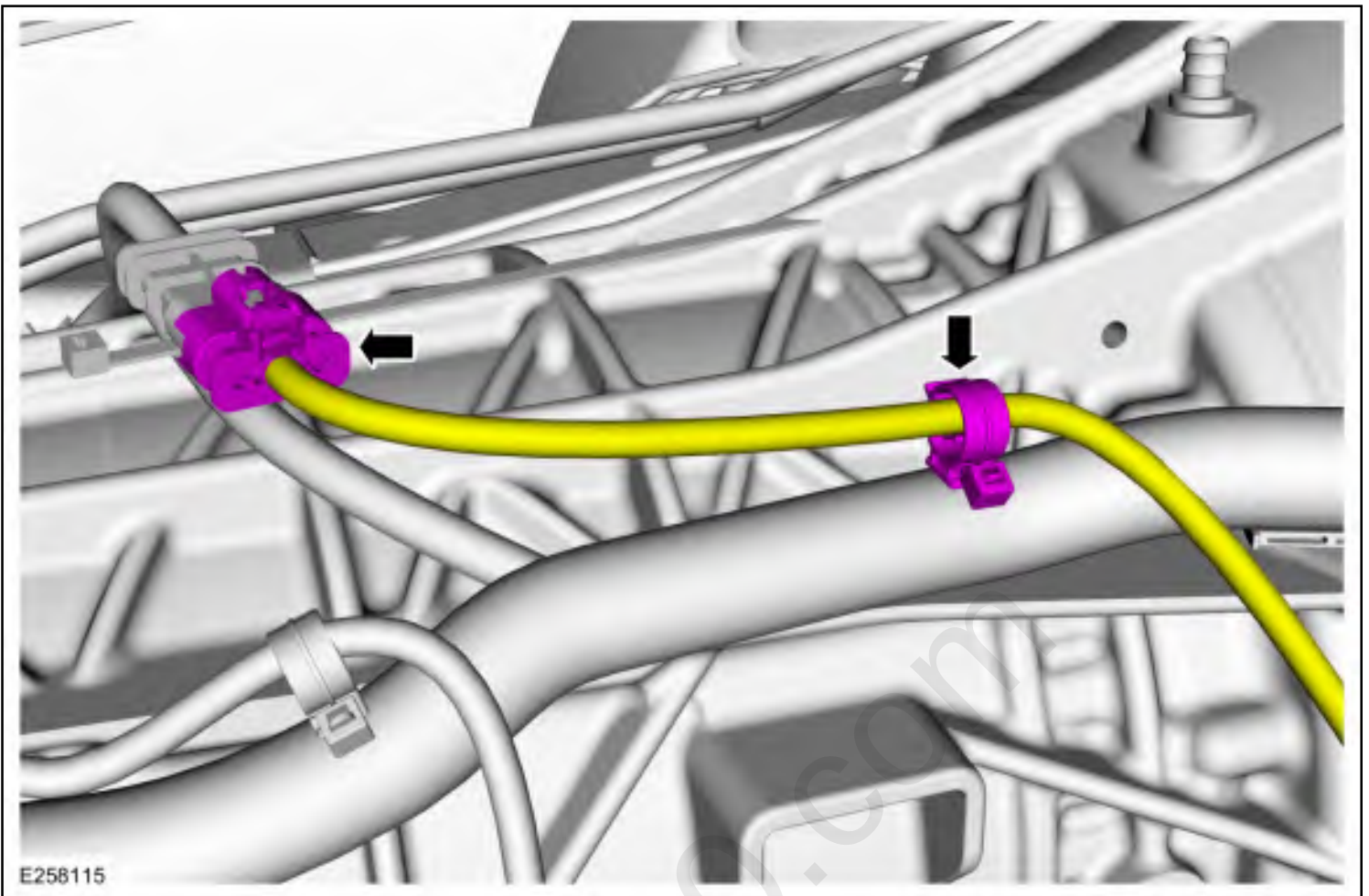
3. If equipped, remove the bolts and the skid plate.  
*Torque: 30 lb.ft (40 Nm)*



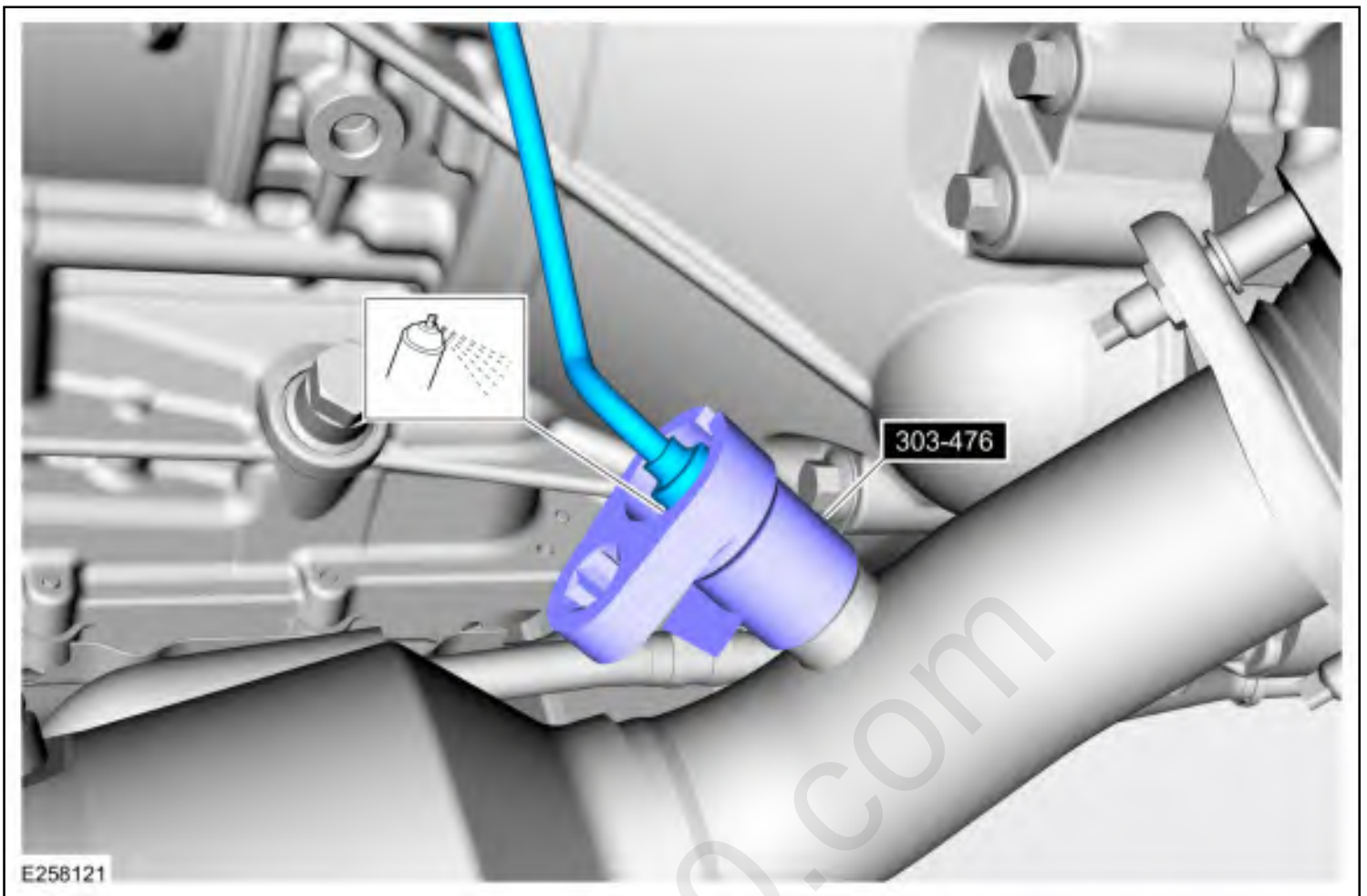


### Right hand (RH) Heated oxygen sensor

4. Disconnect the electrical connector and unclip the wire from the retainer.



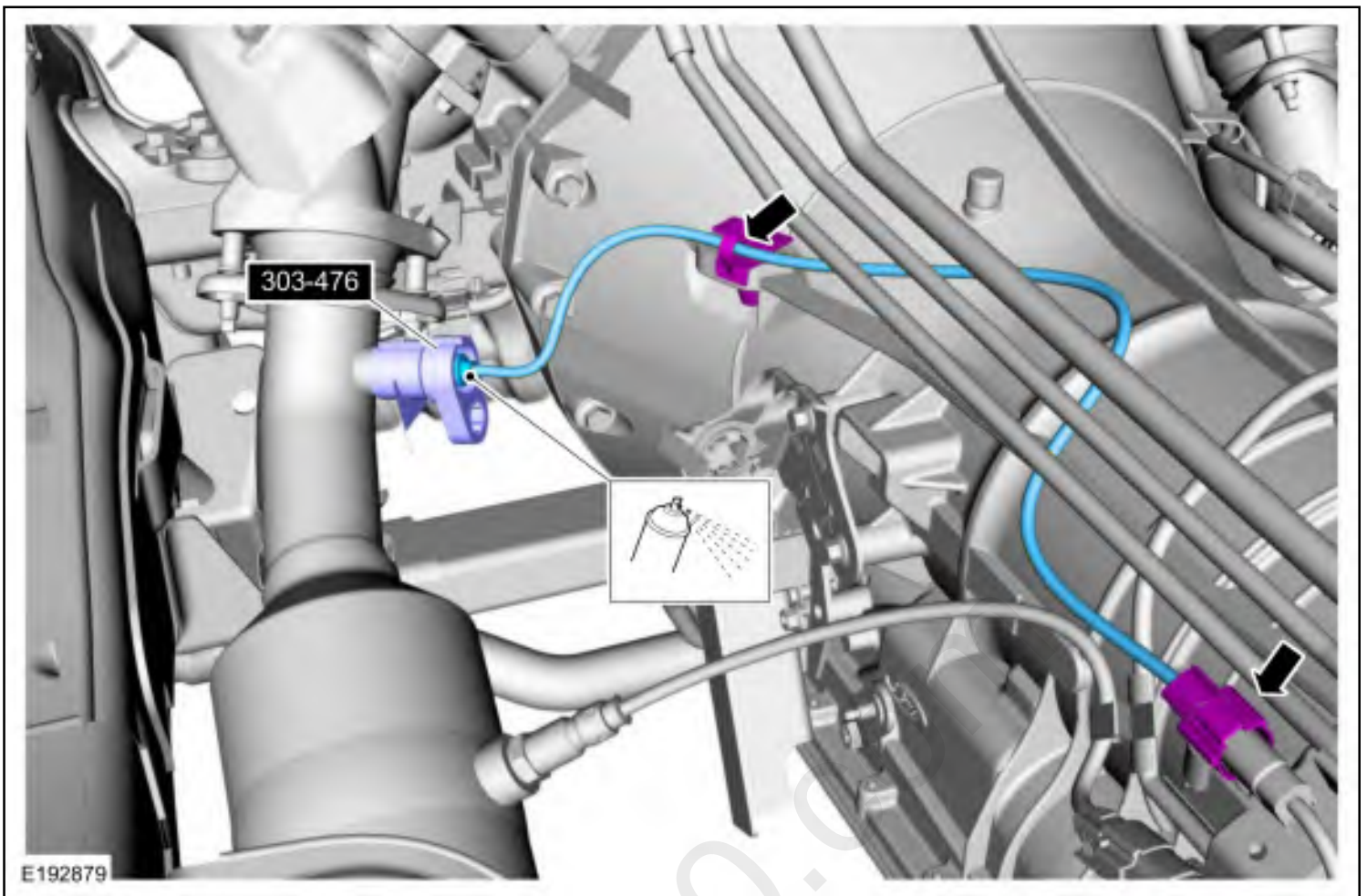
5. Apply penetrating oil to sensor, using the special tool remove the HO2S.  
Use Special Service Tool: 303-476 (T94P-9472-A) Socket, Exhaust Gas Oxygen Sensor.  
*Material:* Motorcraft® Penetrating and Lock Lubricant / XL-1



### Left hand (LH) Heated oxygen sensor

- Disconnect the electrical connector and unclip the wire from the retainer.
- Apply penetrating oil to sensor, using the special tool remove the HO2S.  
Use Special Service Tool: 303-476 (T94P-9472-A) Socket, Exhaust Gas Oxygen Sensor.  
*Material: Motorcraft® Penetrating and Lock Lubricant / XL-1*

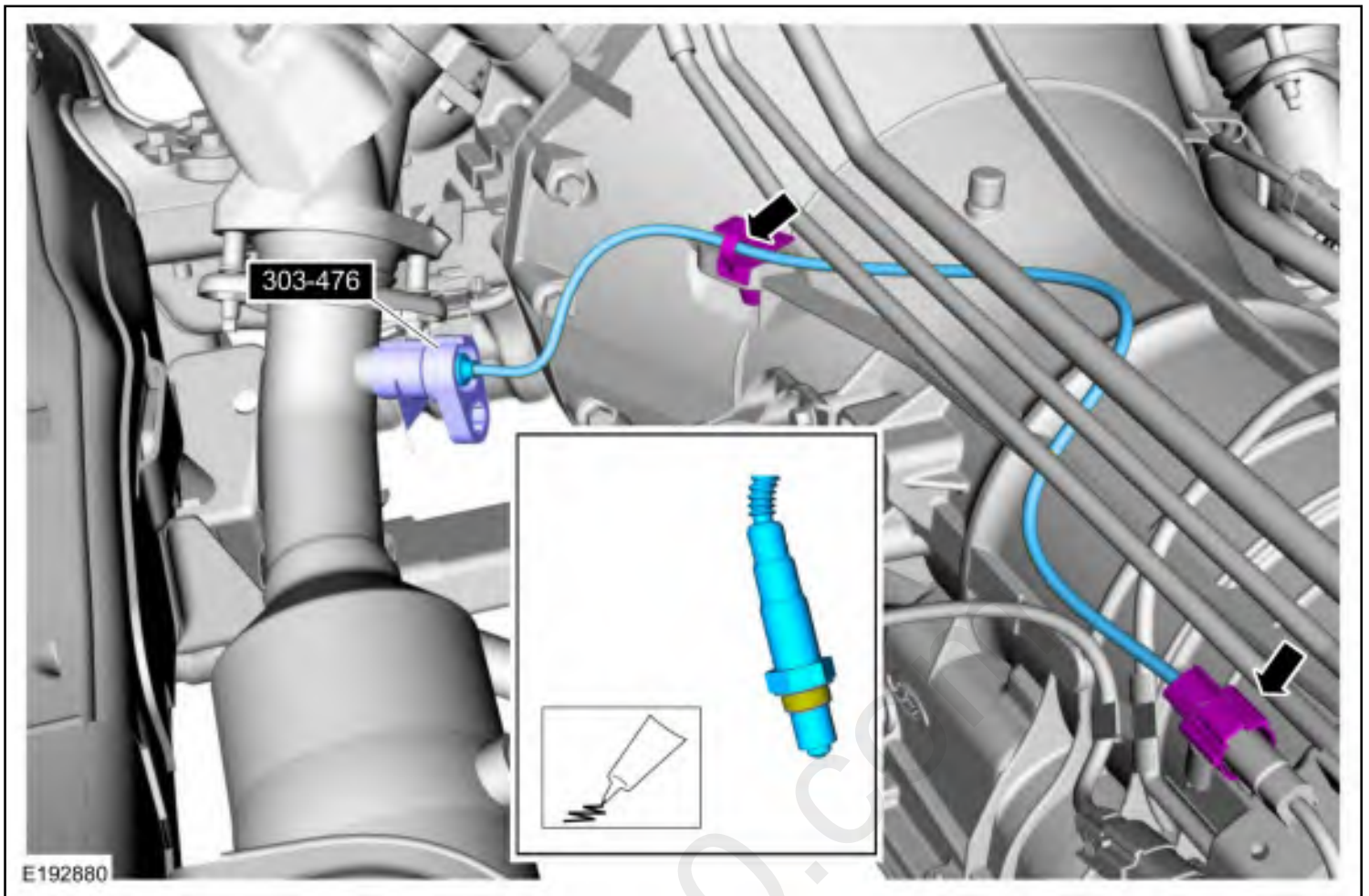




## Installation

### Left hand (LH) Heated oxygen sensor

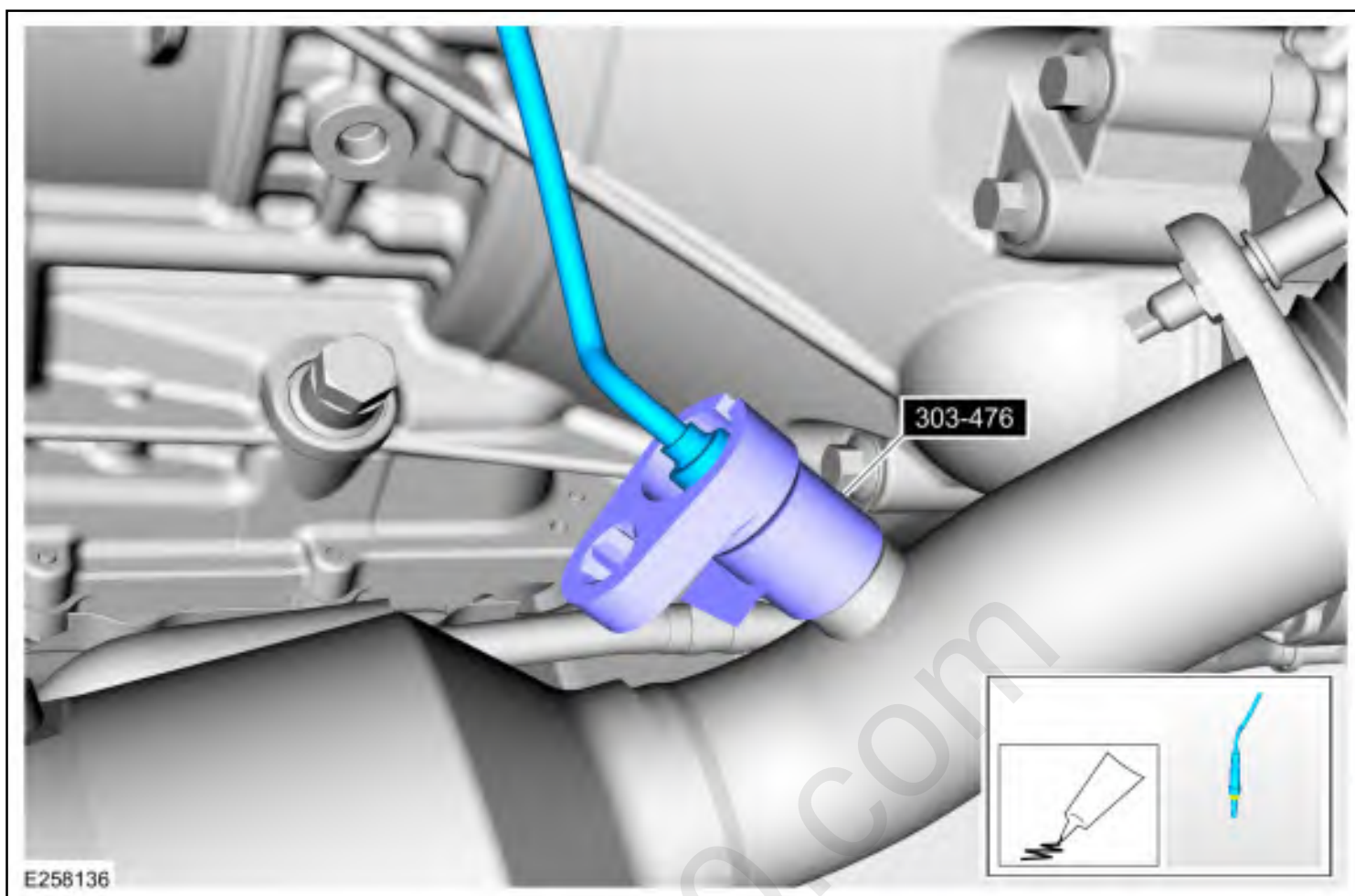
- Apply anti-seize to thread of sensor, Using special tool install the HO2S.  
Use Special Service Tool: 303-476 (T94P-9472-A) Socket, Exhaust Gas Oxygen Sensor.  
*Material:* Motorcraft® High Temperature Nickel Anti-Seize Lubricant / XL-2  
*Torque:* 35 lb.ft (48 Nm)
- Install the wire into the retainer and connect the electrical connector.



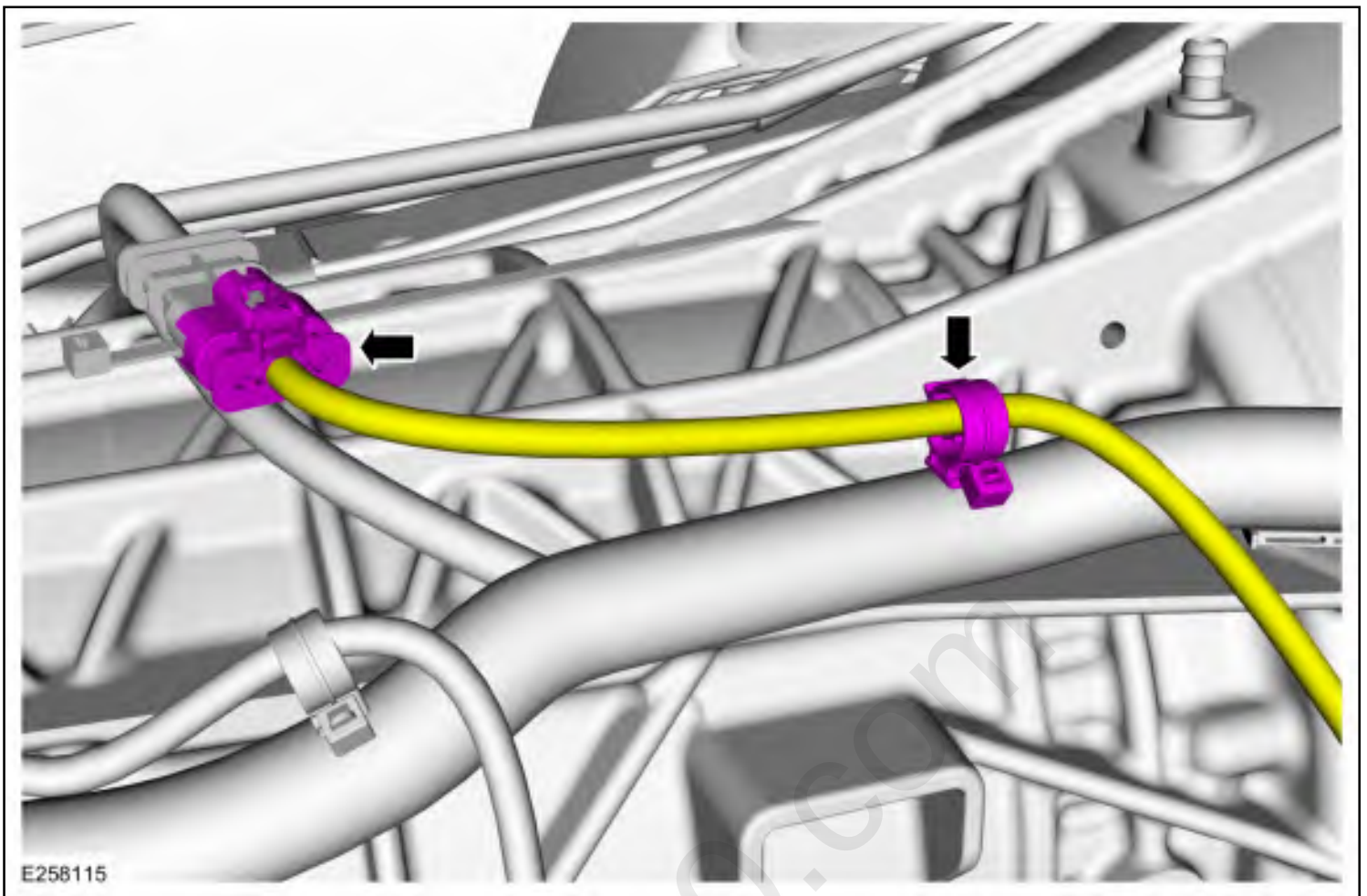
### Right hand (RH) Heated oxygen sensor

- Apply anti-seize to thread of sensor, Using special tool install the HO2S.  
Use Special Service Tool: 303-476 (T94P-9472-A) Socket, Exhaust Gas Oxygen Sensor.  
*Material:* Motorcraft® High Temperature Nickel Anti-Seize Lubricant / XL-2  
*Torque:* 35 lb.ft (48 Nm)





3. Install the wire into the retainer and connect the electrical connector.



## All sensors

4. To install, reverse the removal procedure.

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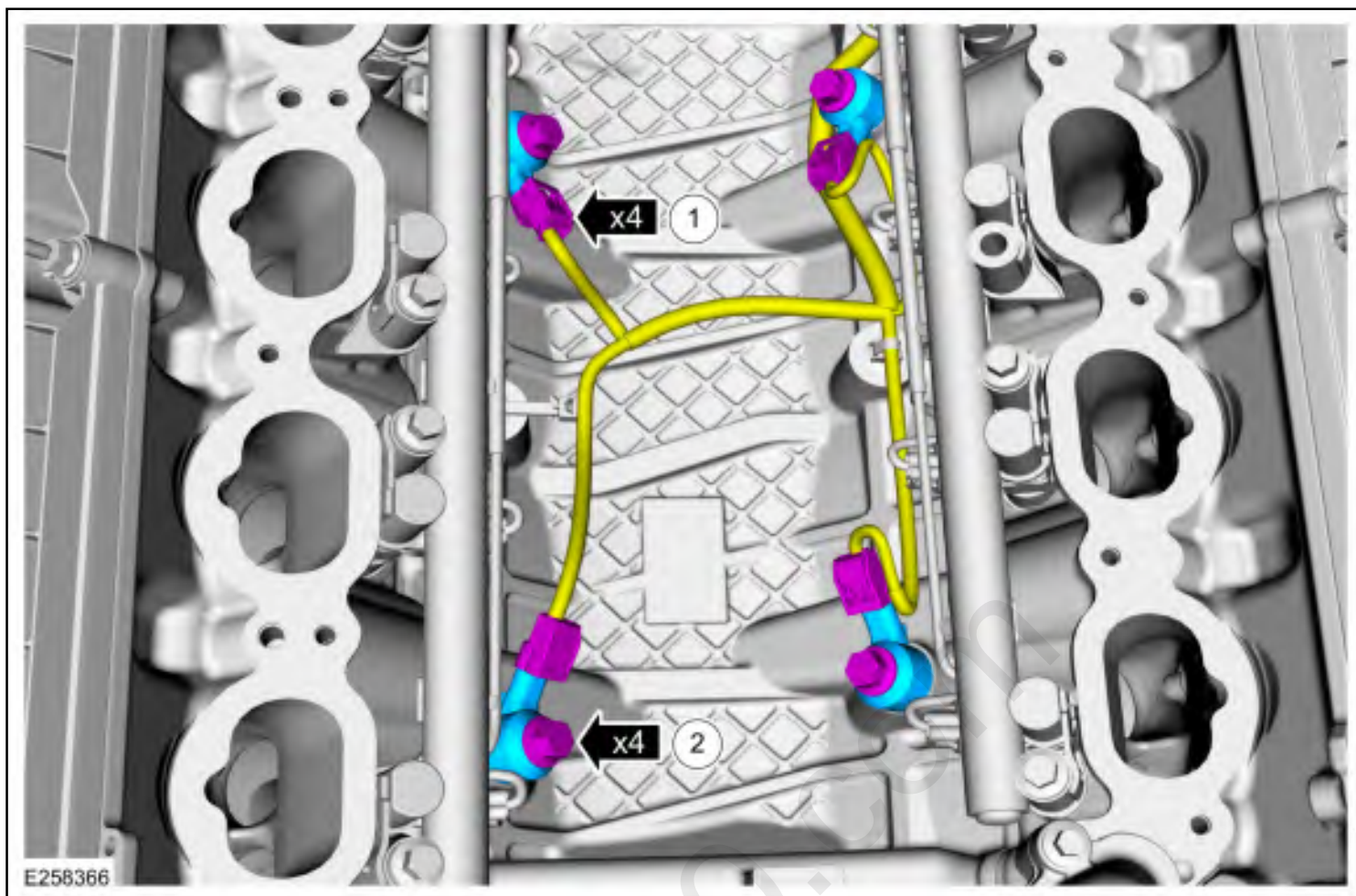
## Knock Sensor (KS)

Base Part Number: Base Part Number: 12A699

### Removal

**NOTE:** Removal steps in this procedure may contain installation details.

1. Remove the intake manifold.  
Refer to: [Intake Manifold](#) (303-01D Engine - 5.0L 32V Ti-VCT, Removal and Installation).
2. **NOTE:** Note the position of the components before removal.
  - Disconnect the KS electrical connectors.
  - Remove the bolts and the KS.  
Torque: 177 lb.in (20 Nm)



## Installation

**NOTE:** Make sure that the components are installed to the position noted before removal.

1. To install, reverse the removal procedure.

# Cylinder Head Temperature (CHT) Sensor

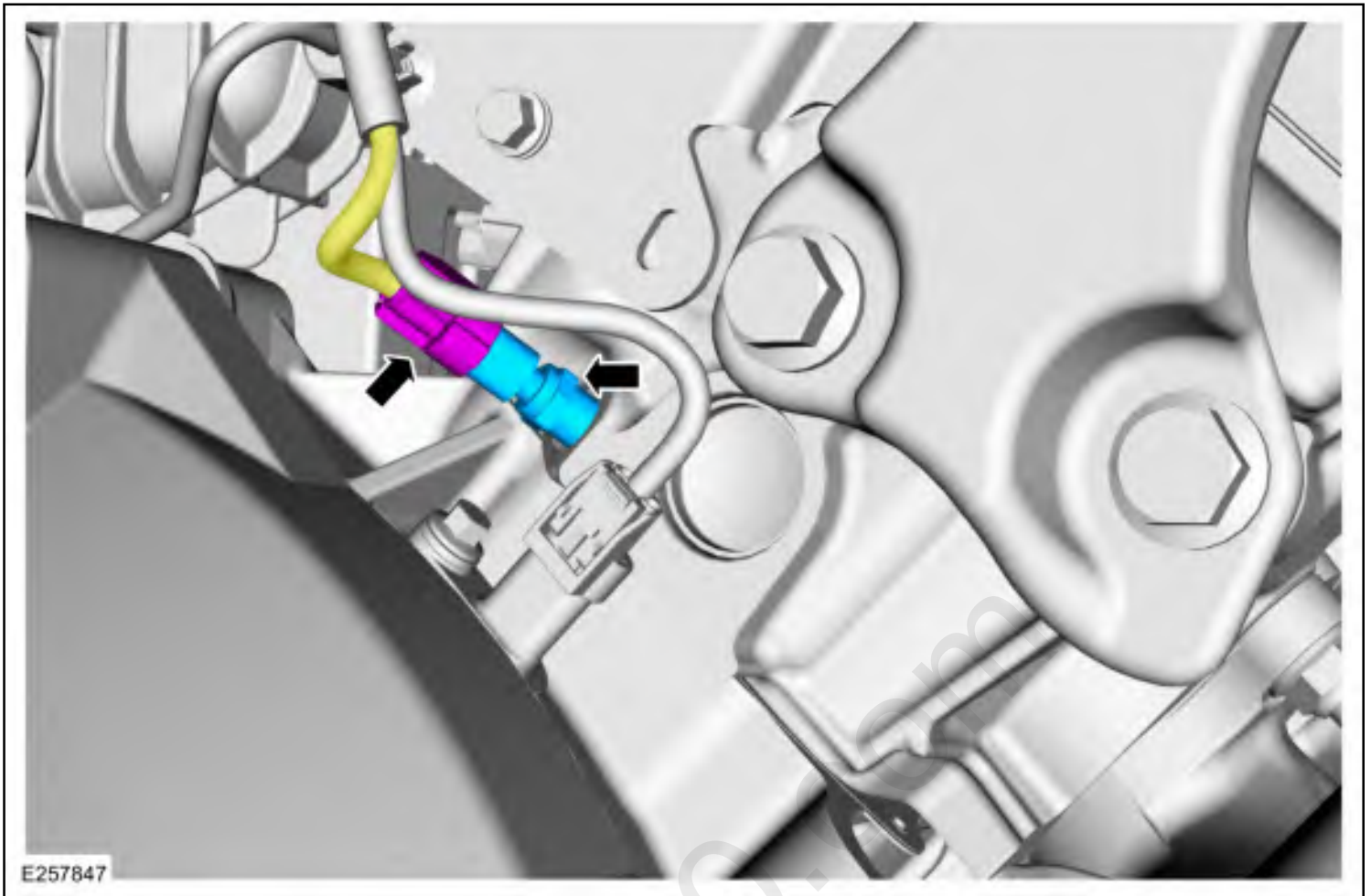
Base Part Number: Base Part Number: 6G004

## Removal

**NOTE:** Removal steps in this procedure may contain installation details.

1. Remove the RH fender splash shield.  
Refer to: [Fender Splash Shield](#) (501-02 Front End Body Panels, Removal and Installation).
2. **NOTE:** Do not reuse the CHT sensor, install a new sensor.
  - Disconnect the CHT sensor electrical connector.
  - Remove and discard the CHT sensor.  
Torque: 97 lb.in (11 Nm)





## Installation

1. To install, reverse the removal procedure.

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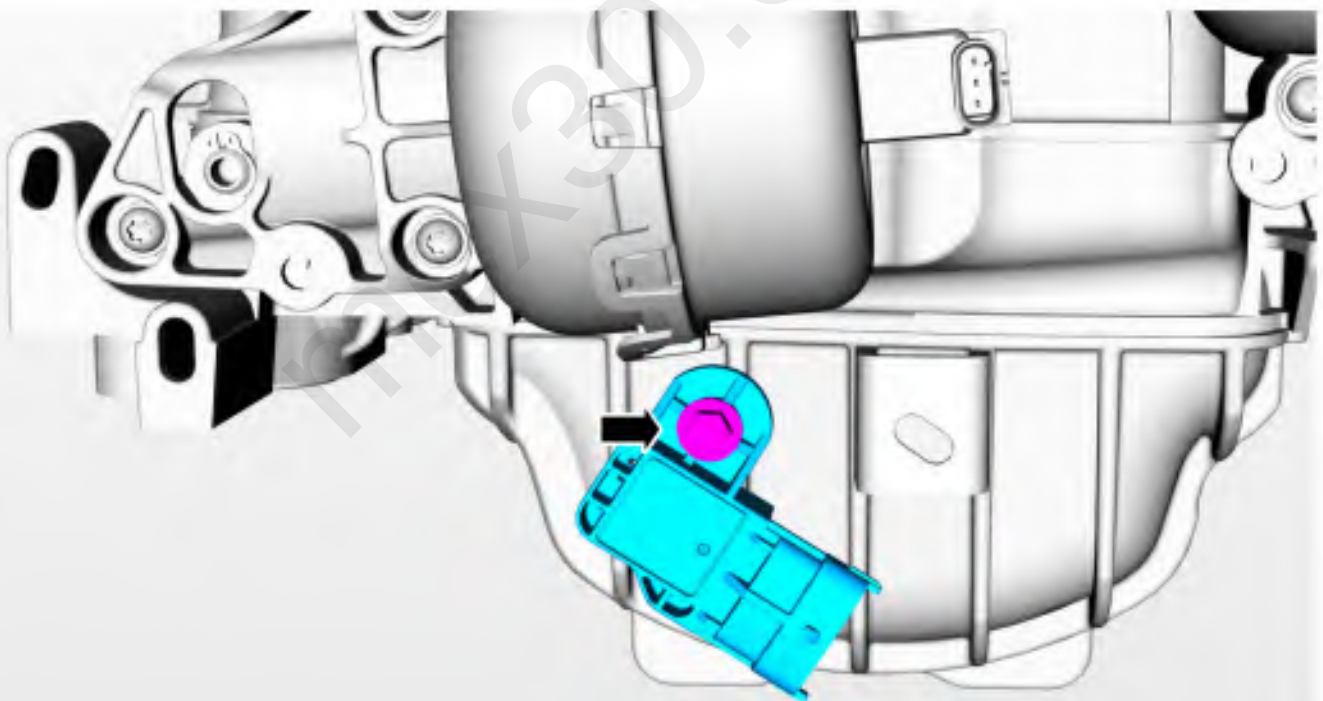
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# Manifold Absolute Pressure and Temperature (MAPT) Sensor

## Removal

**NOTE:** Removal steps in this procedure may contain installation details.

1. Remove the intake manifold.  
Refer to: [Intake Manifold](#) (303-01D Engine - 5.0L 32V Ti-VCT, Removal and Installation).
2. Remove the retainer and MAPT sensor.  
Torque: 71 lb.in (8 Nm)



## Installation

1. To install, reverse the removal procedure.

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## Engine Oil Pressure (EOP) Sensor

### Materials

| Name                                            | Specification |
|-------------------------------------------------|---------------|
| Motorcraft® Thread Sealant with PTFE<br>TA-24-B | WSK-M2G350-A2 |

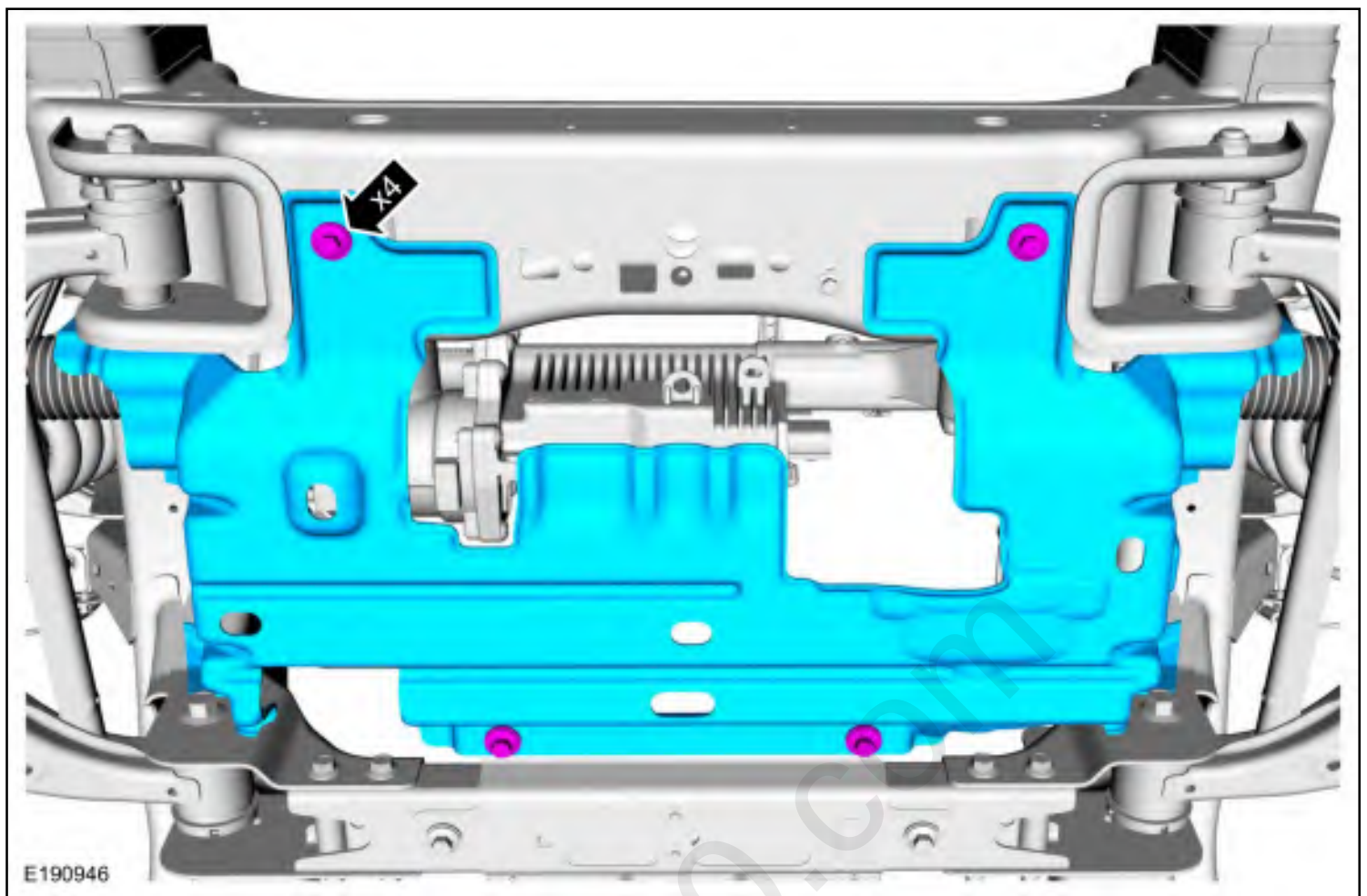
### Removal

**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:** Removal steps in this procedure may contain installation details.

1. With the vehicle in NEUTRAL, position it on a hoist.  
Refer to: [Jacking and Lifting - Overview](#) (100-02 Jacking and Lifting, Description and Operation).
2. **NOTE:** Vehicles come with an underbody shield or a skid plate.

If equipped, remove the bolts and the underbody shield.  
Torque: 30 lb.ft (40 Nm)

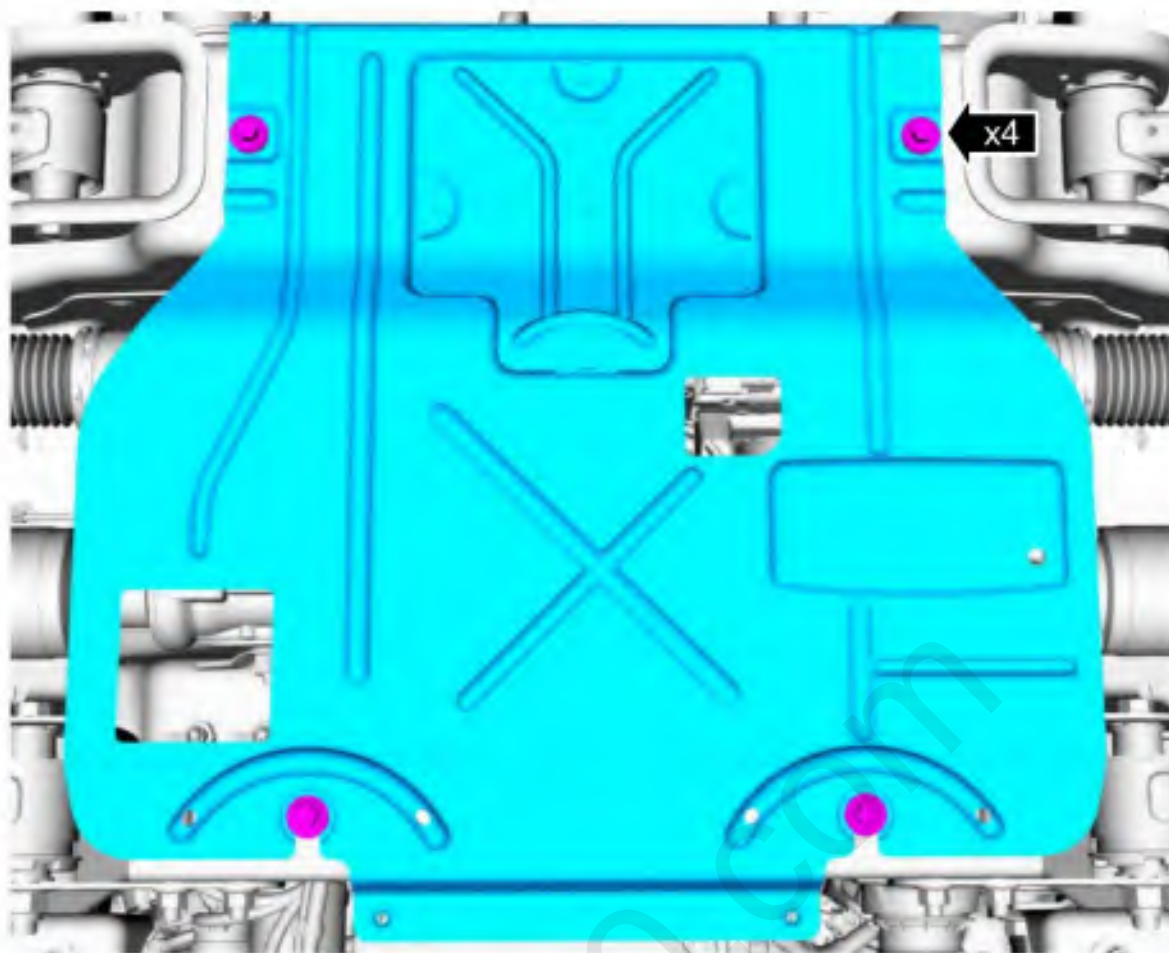


3. **NOTE:** Vehicles come with an underbody shield or a skid plate.

If equipped, remove the bolts and the skid plate.

Torque: 30 lb.ft (40 Nm)

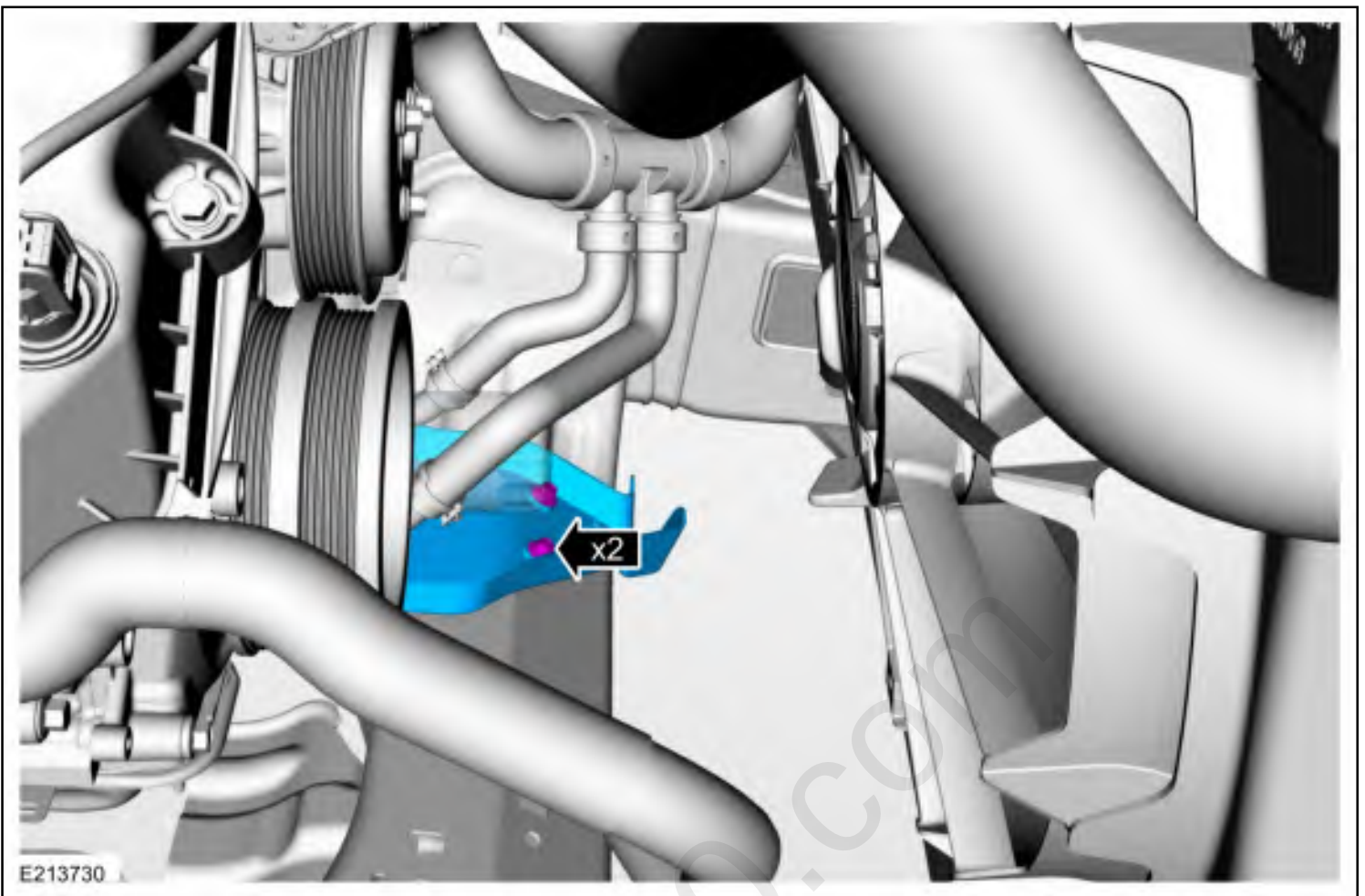




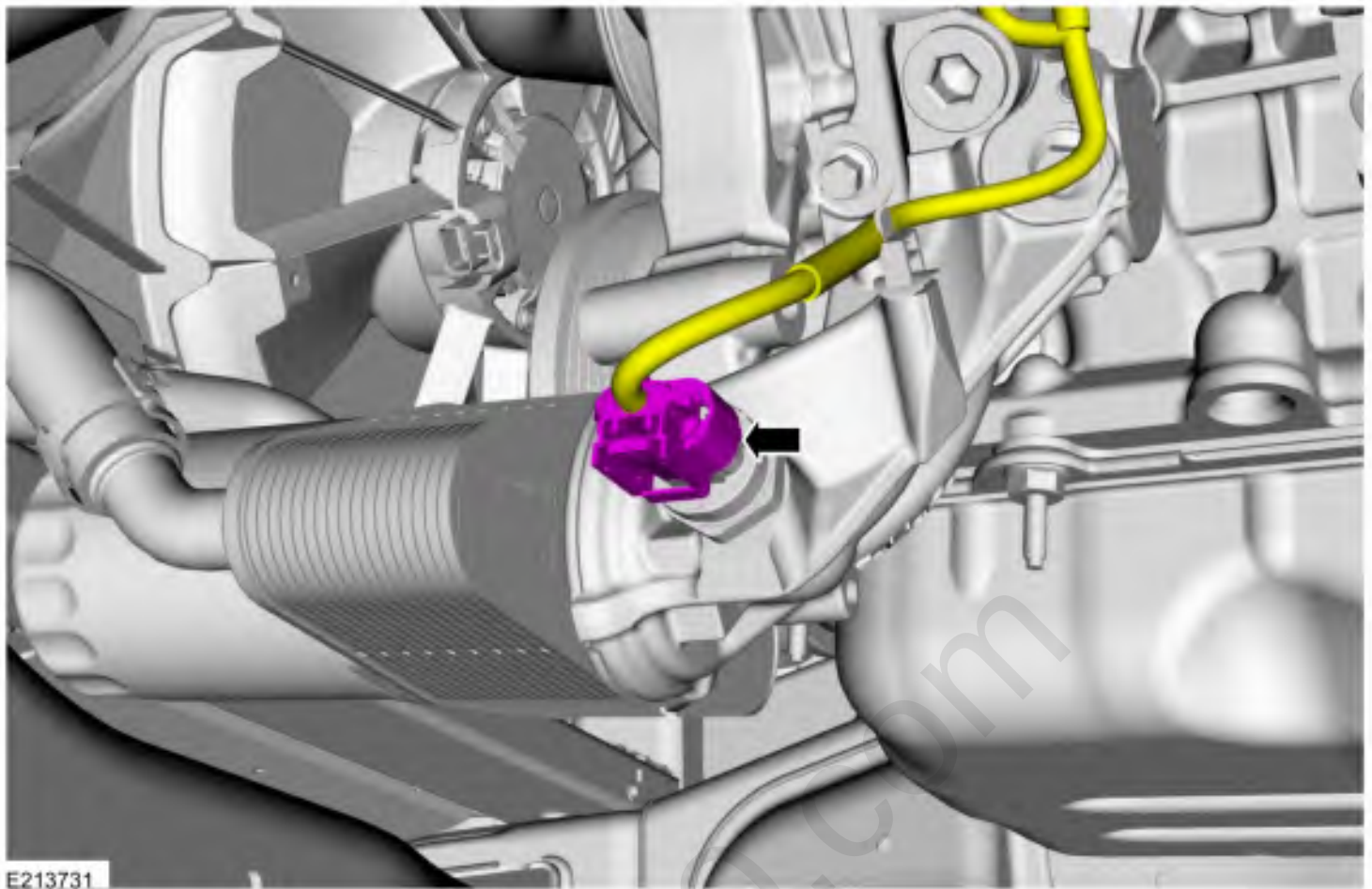
E193607



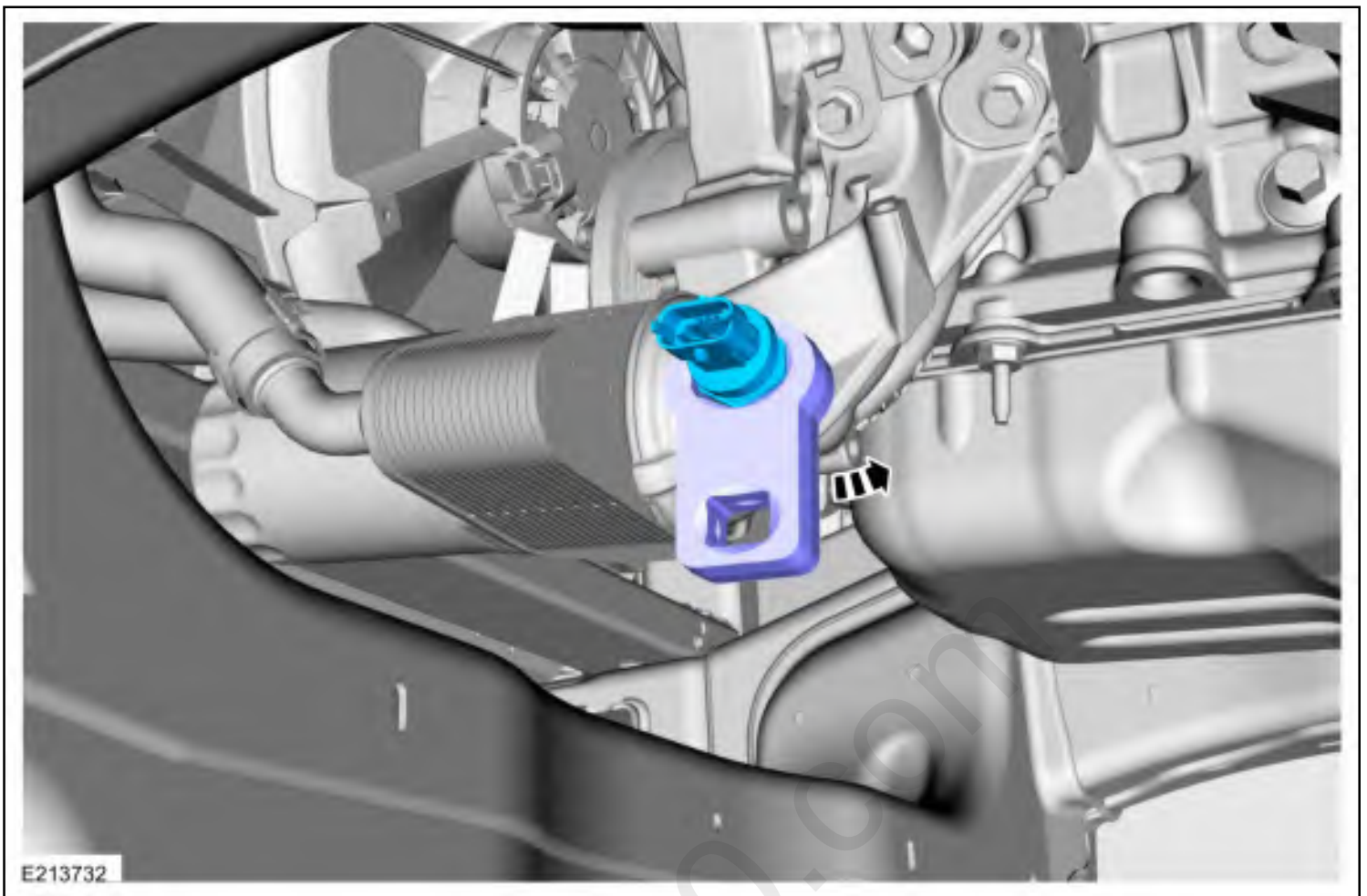
4. If equipped, remove the bolts and the oil drain gutter.  
*Torque: 62 lb.in (7 Nm)*



5. Disconnect the EOP sensor electrical connector.



6. Using a crowfoot, remove the EOP sensor.  
*Torque: 133 lb.in (15 Nm)*



## Installation

**NOTE:** *If the EOP sensor is to be reused, apply thread sealant.*

1. To install, reverse the removal procedure.

*Material:* Motorcraft® Thread Sealant with PTFE / TA-24-B (WSK-M2G350-A2)

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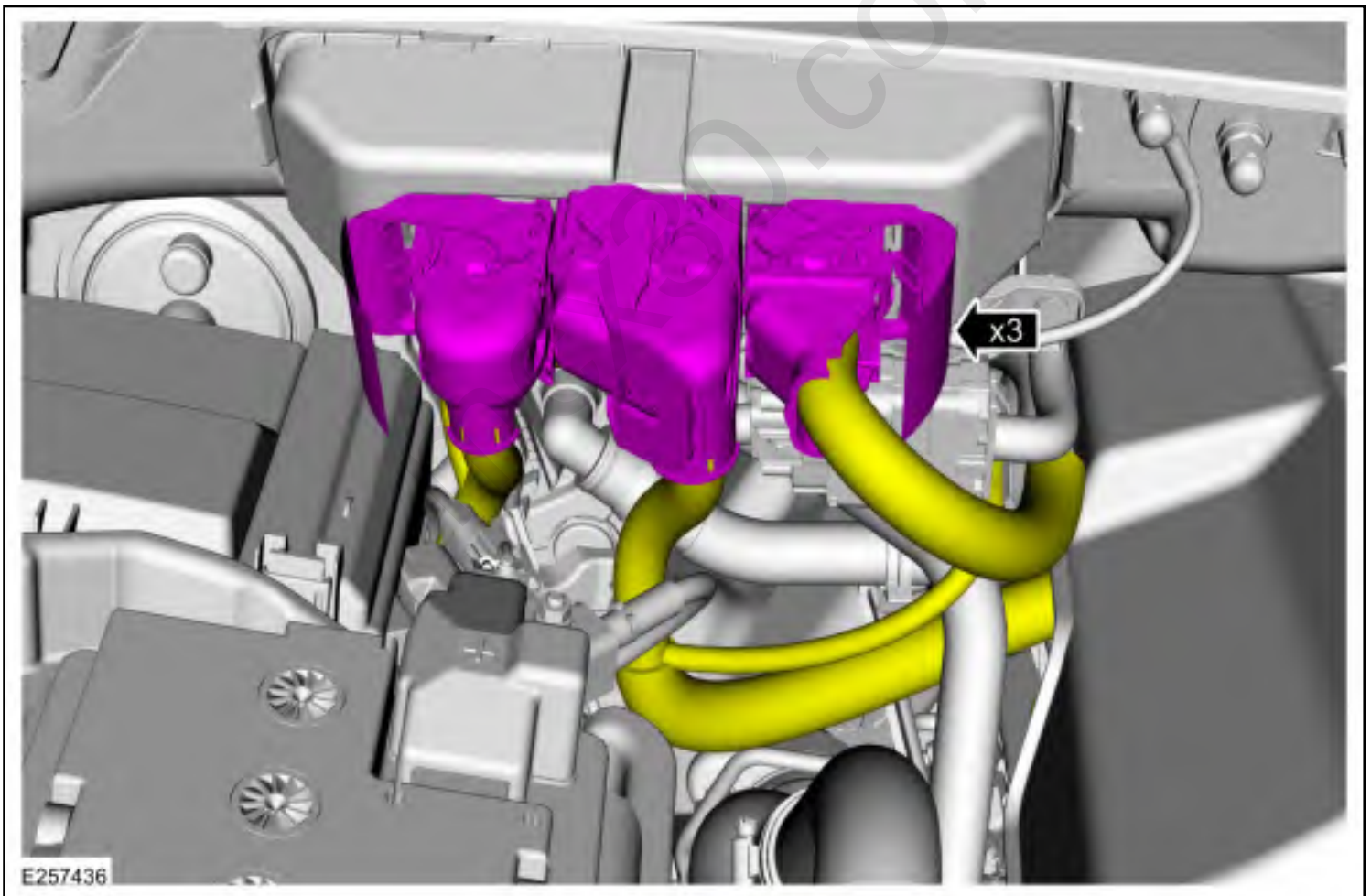
## Powertrain Control Module (PCM)

Base Part Number: Base Part Number: 12A650

### Removal

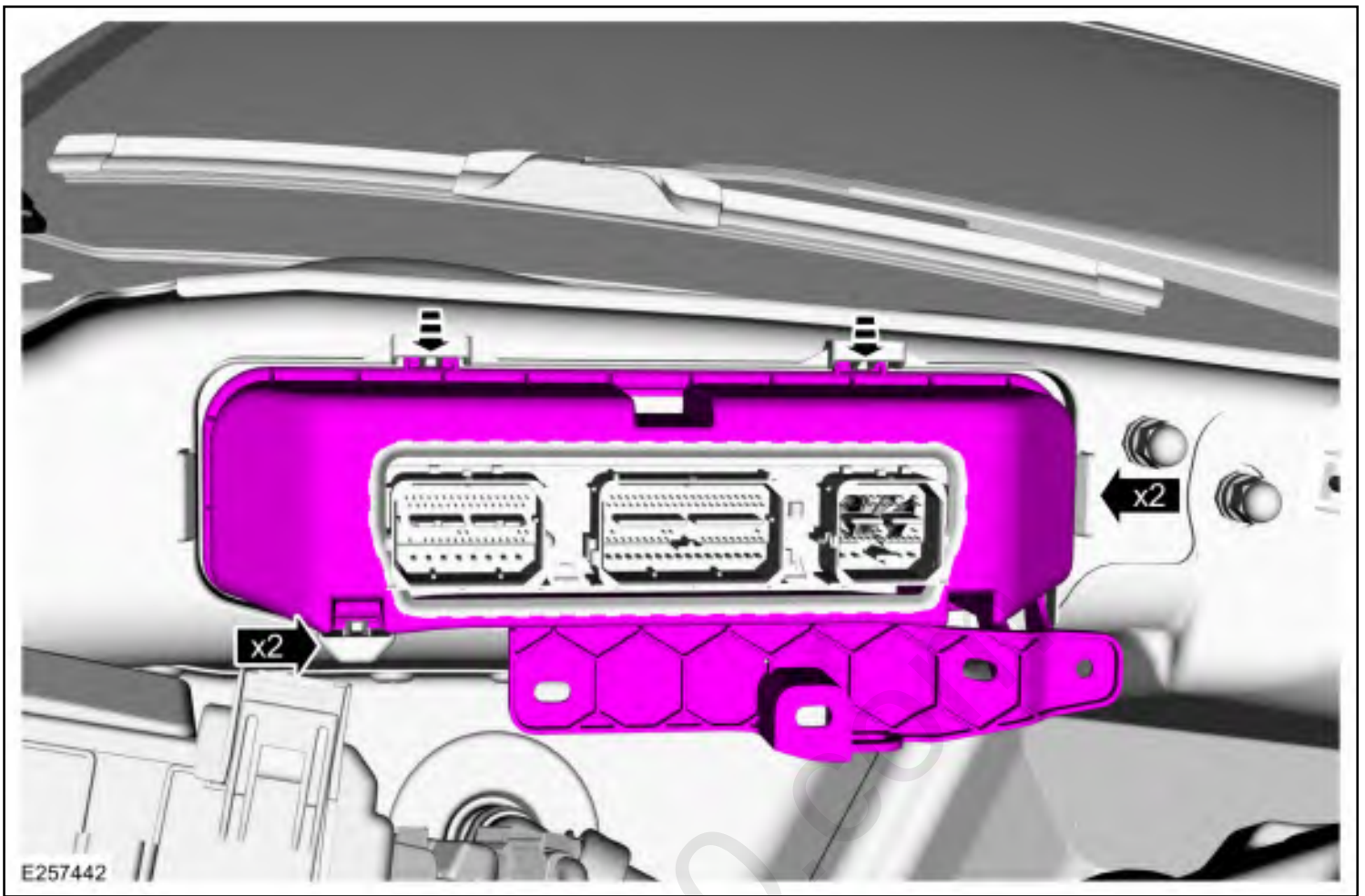
**NOTE:** Removal steps in this procedure may contain installation details.

1. Disconnect the PCM electrical connectors. Release the harness retainers from the lower PCM cover to position aside the harnesses.

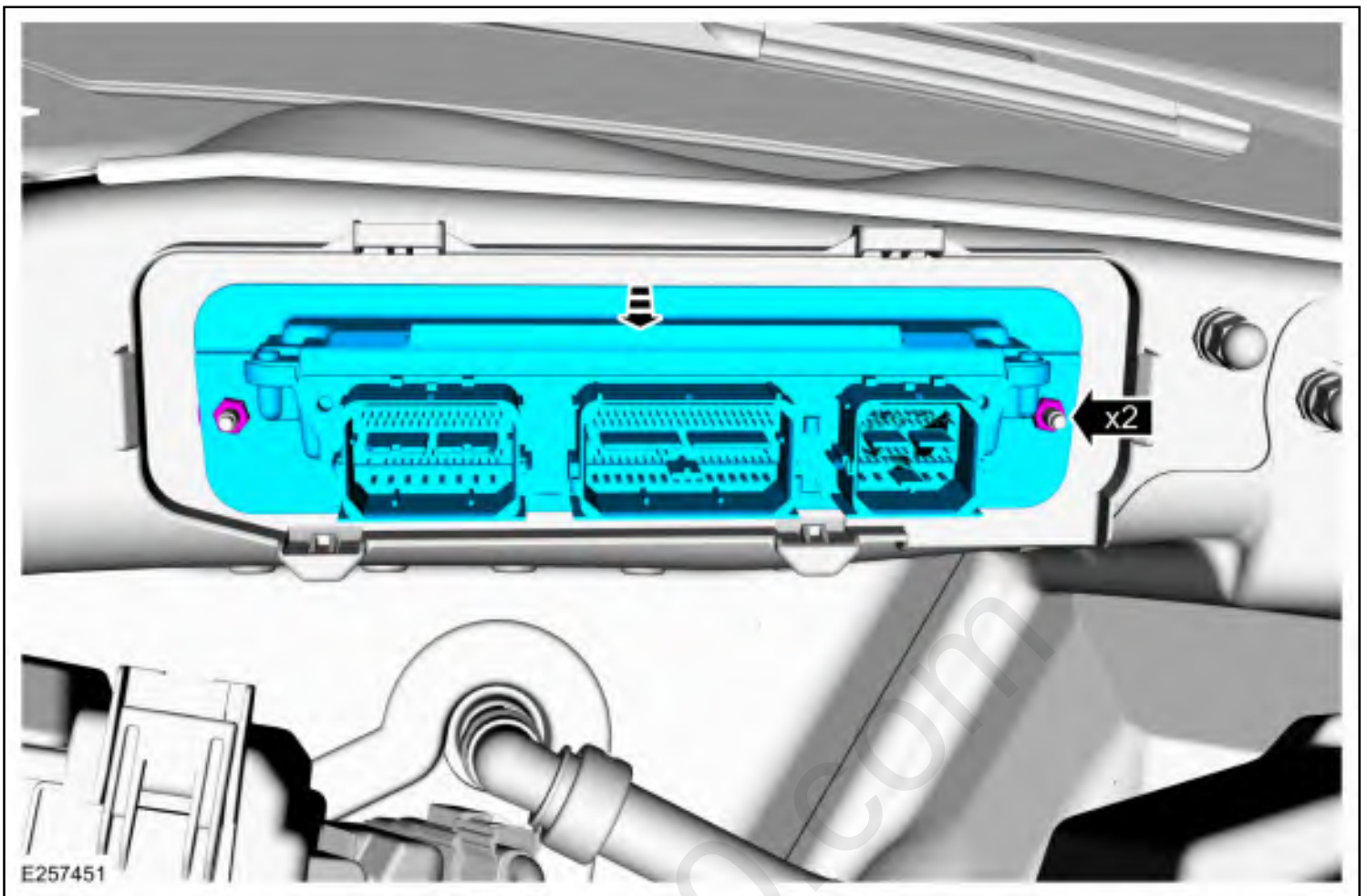


2. Release the retaining clips and remove the PCM cover.





3. Remove the nuts and the PCM.  
*Torque: 62 lb.in (7 Nm)*



## Installation

1. To install, reverse the removal procedure.
2. **NOTE:** *This step is only necessary when installing a new component.*

Upload the module information from the diagnostic tool using the Programmable Modules Installation routine.

Refer to: [Module Configuration - System Operation and Component Description](#) (418-01 Module Configuration, Description and Operation).

3. Carry out the Parameter Reset procedure.  
Refer to: [Anti-Theft Security Access and Key Programming - Scan Tool](#) (419-01C Passive Anti-Theft System (PATS) - Vehicles With: Keyless Vehicle System, General Procedures).
4. Using the scan tool, perform the Misfire Monitor Neutral Profile Correction procedure, following the on-screen instructions.

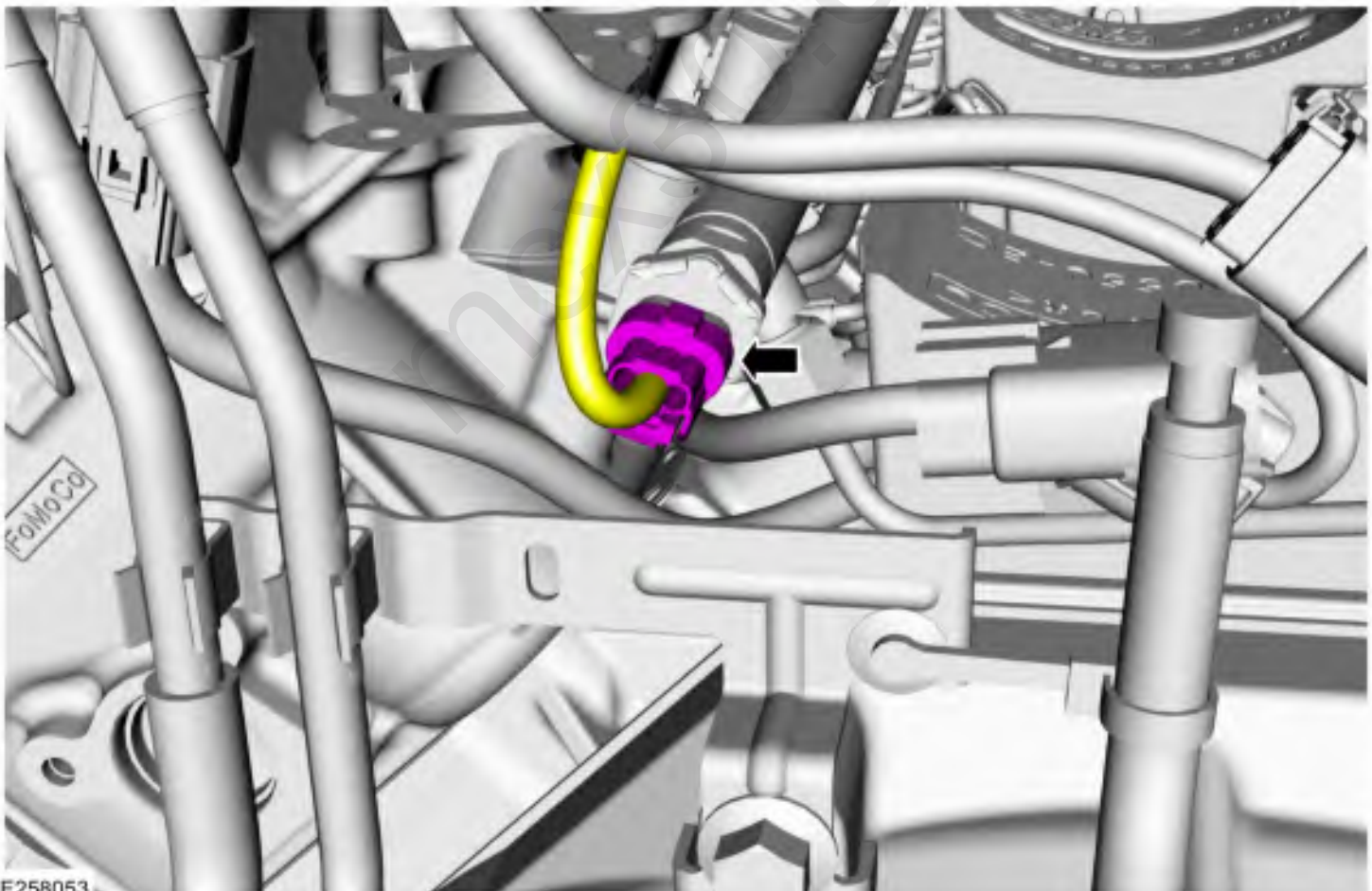
## Fuel Rail Pressure (FRP) Sensor

Base Part Number: Base Part Number: 9F972

### Removal

**NOTE:** Removal steps in this procedure may contain installation details.

1. Remove the intake manifold.  
Refer to: [Intake Manifold](#) (303-01D Engine - 5.0L 32V Ti-VCT, Removal and Installation).
2. Disconnect the FRP temperature sensor.



3. **NOTE:** Torque cannot exceed 40 Nm or there is a potential to damage the FRP sensor.

Remove the FRP temperature sensor.

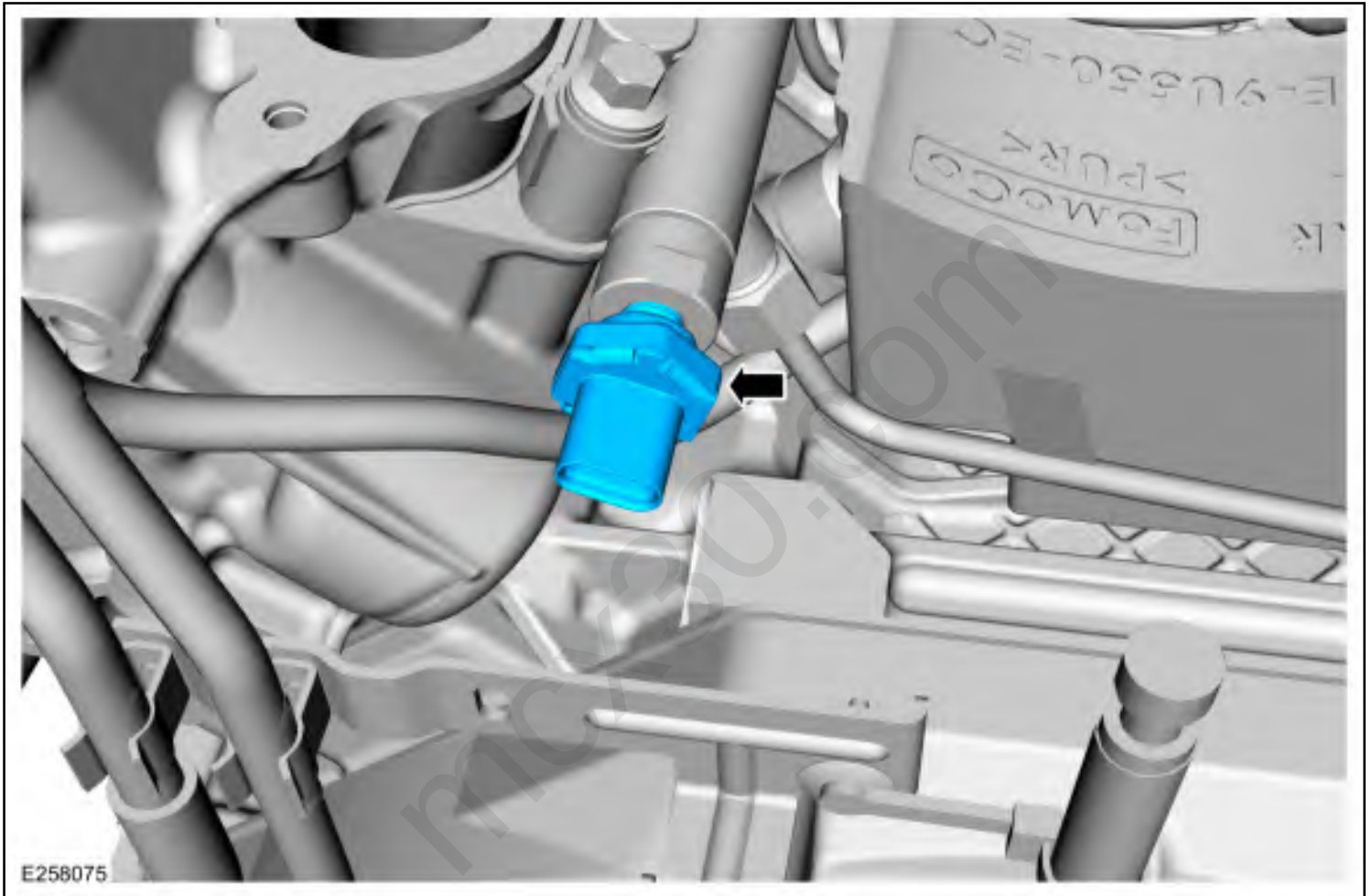
Torque:

Stage 1: 44 lb.in (5 Nm)

Stage 2: Loosen: 1 turn(s)

Stage 3: 44 lb.in (5 Nm)

Stage 4: 19°



## Installation

**NOTE:** Lubricate the threaded area of the new FRP temperature sensor with clean engine oil prior to installation.

1. To install, reverse the removal procedure.



# Variable Camshaft Timing (VCT) Oil Control Solenoid

Base Part Number: Base Part Number: 6B297/6M280

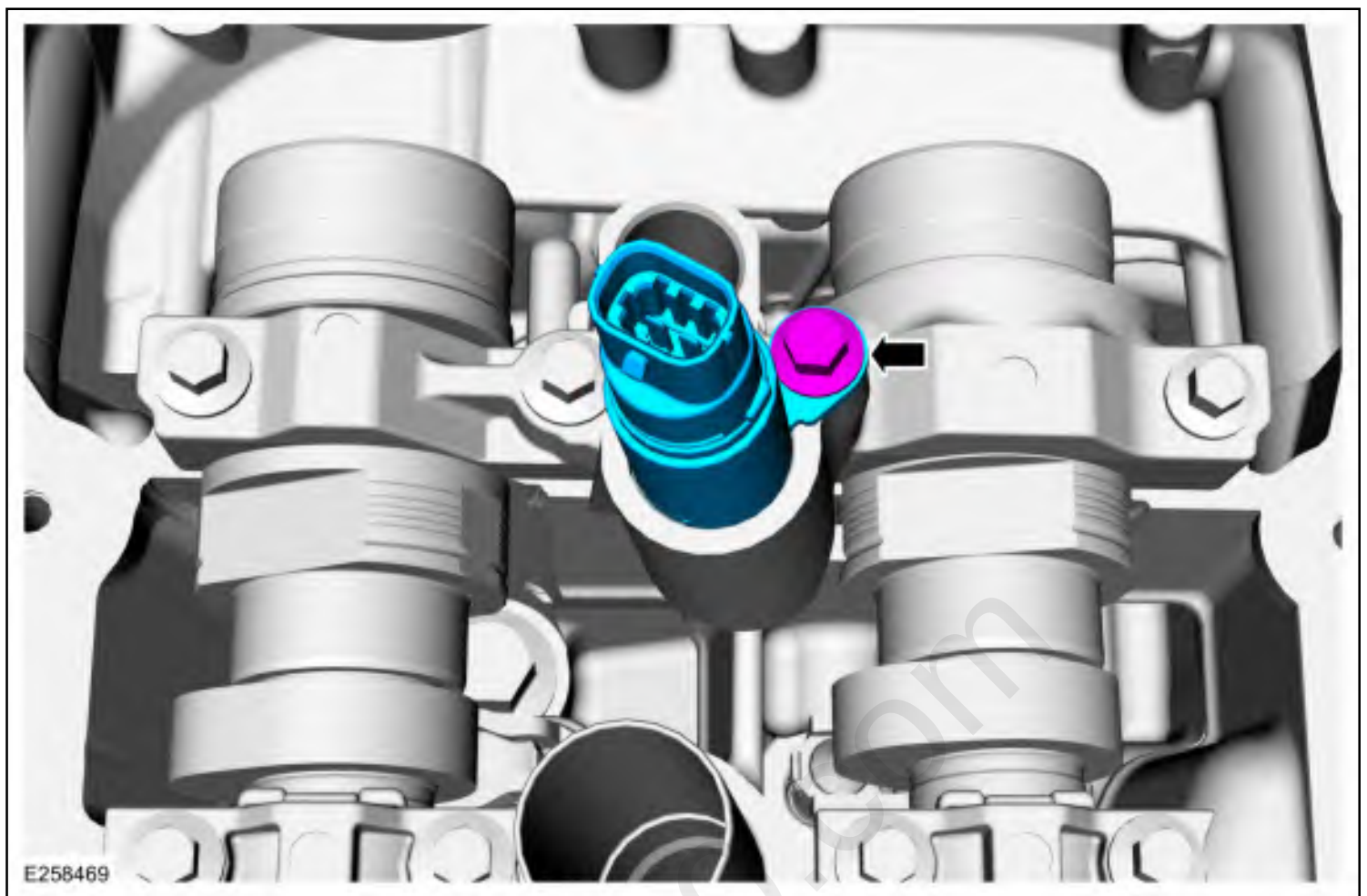
## Removal

**NOTE:** Removal steps in this procedure may contain installation details.

### RH (right-hand) Variable Camshaft Timing (VCT) Oil Control Solenoids

1. Remove the RH valve cover.  
Refer to: [Valve Cover RH](#) (303-01D Engine - 5.0L 32V Ti-VCT, Removal and Installation).
2. Remove the bolt and the exhaust VCT oil control solenoid.  
Torque: 89 lb.in (10 Nm)



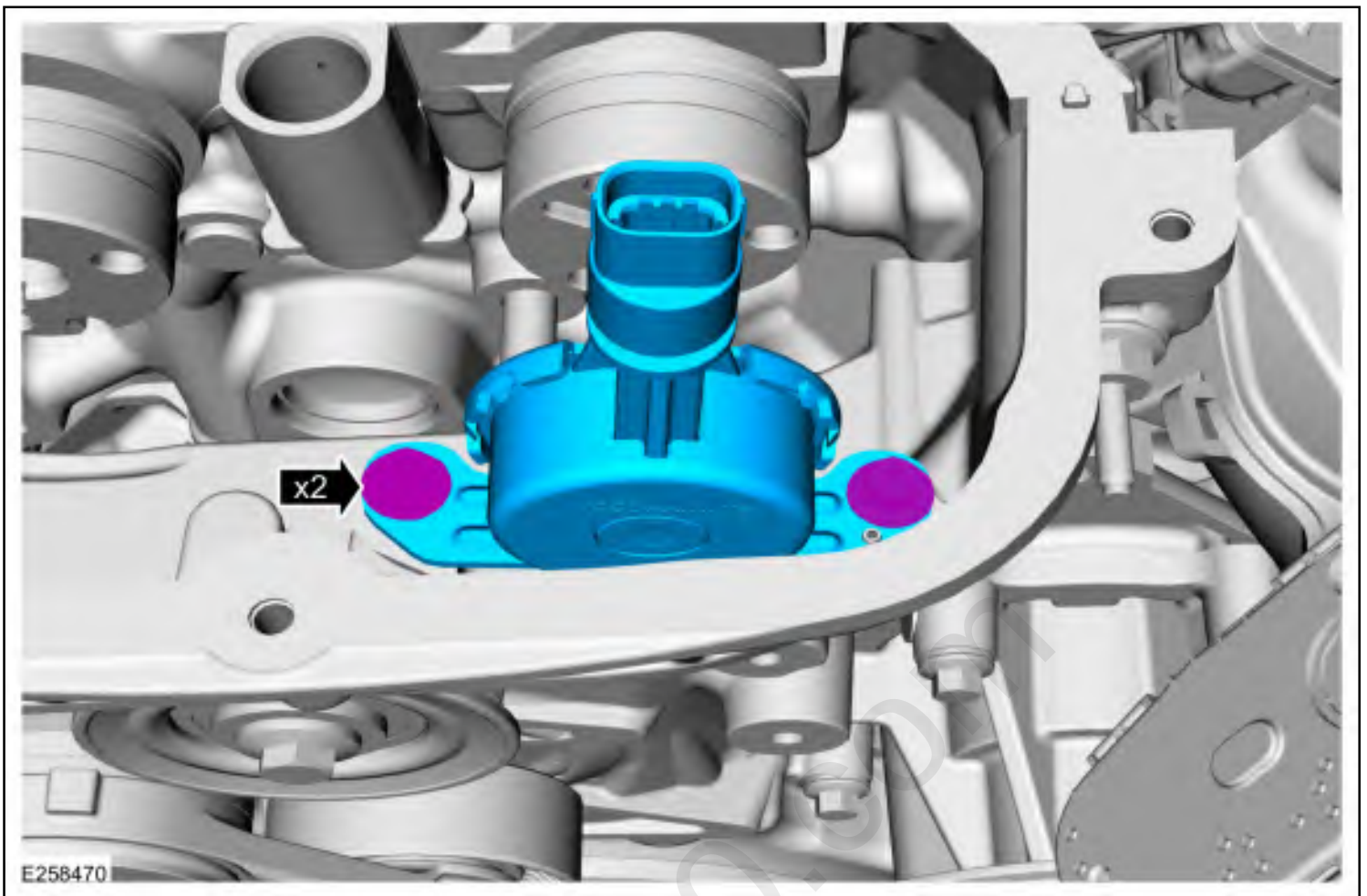


3. Remove the bolts and the intake VCT oil control solenoid.

*Torque:*

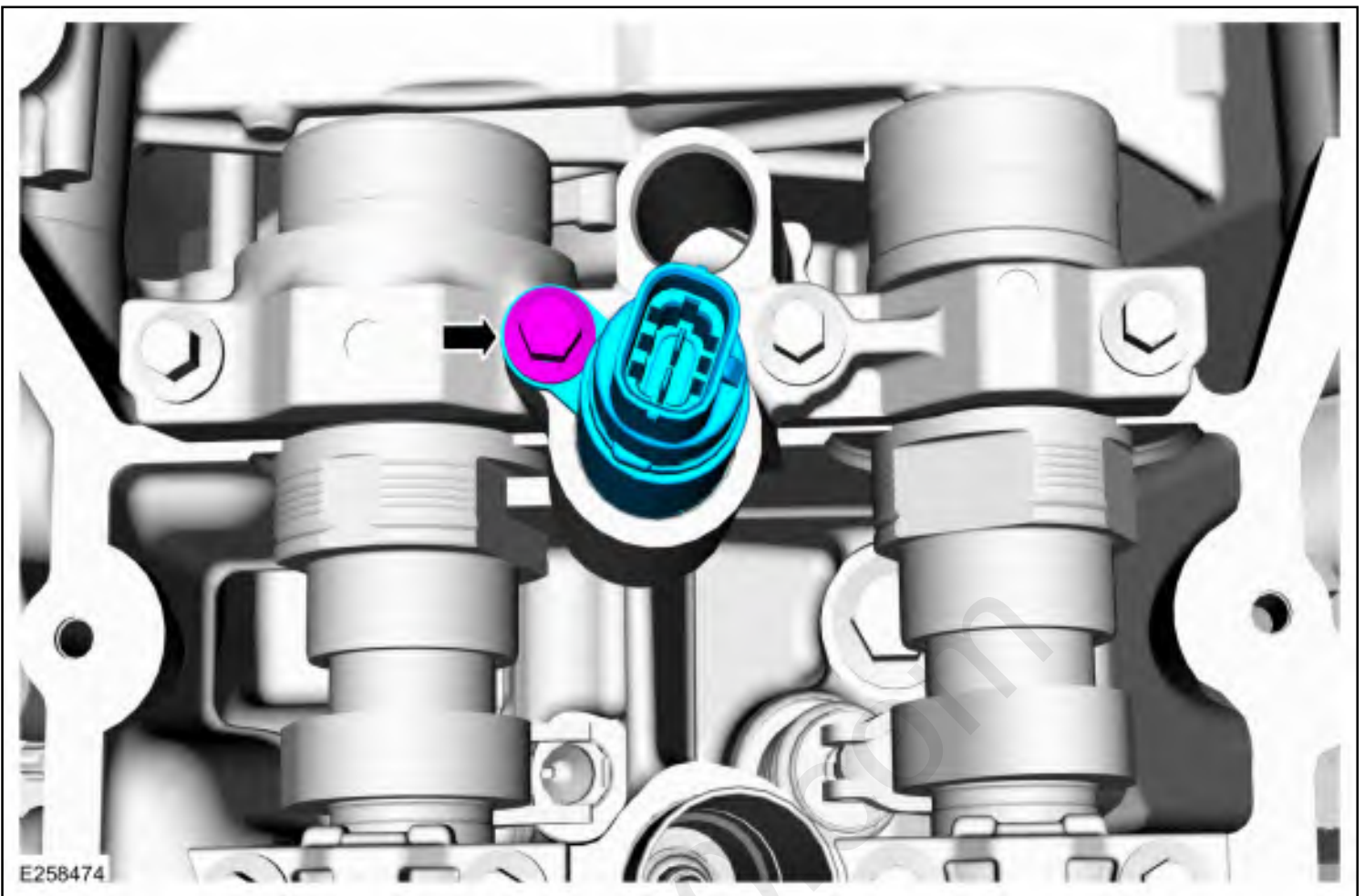
Stage 1: 71 lb.in (8 Nm)

Stage 2: 30°



### LH (left-hand) Variable Camshaft Timing (VCT) Oil Control Solenoids

4. Remove the LH valve cover.  
Refer to: [Valve Cover LH](#) (303-01D Engine - 5.0L 32V Ti-VCT, Removal and Installation).
5. Remove the bolt and the exhaust VCT oil control solenoid.  
*Torque: 89 lb.in (10 Nm)*

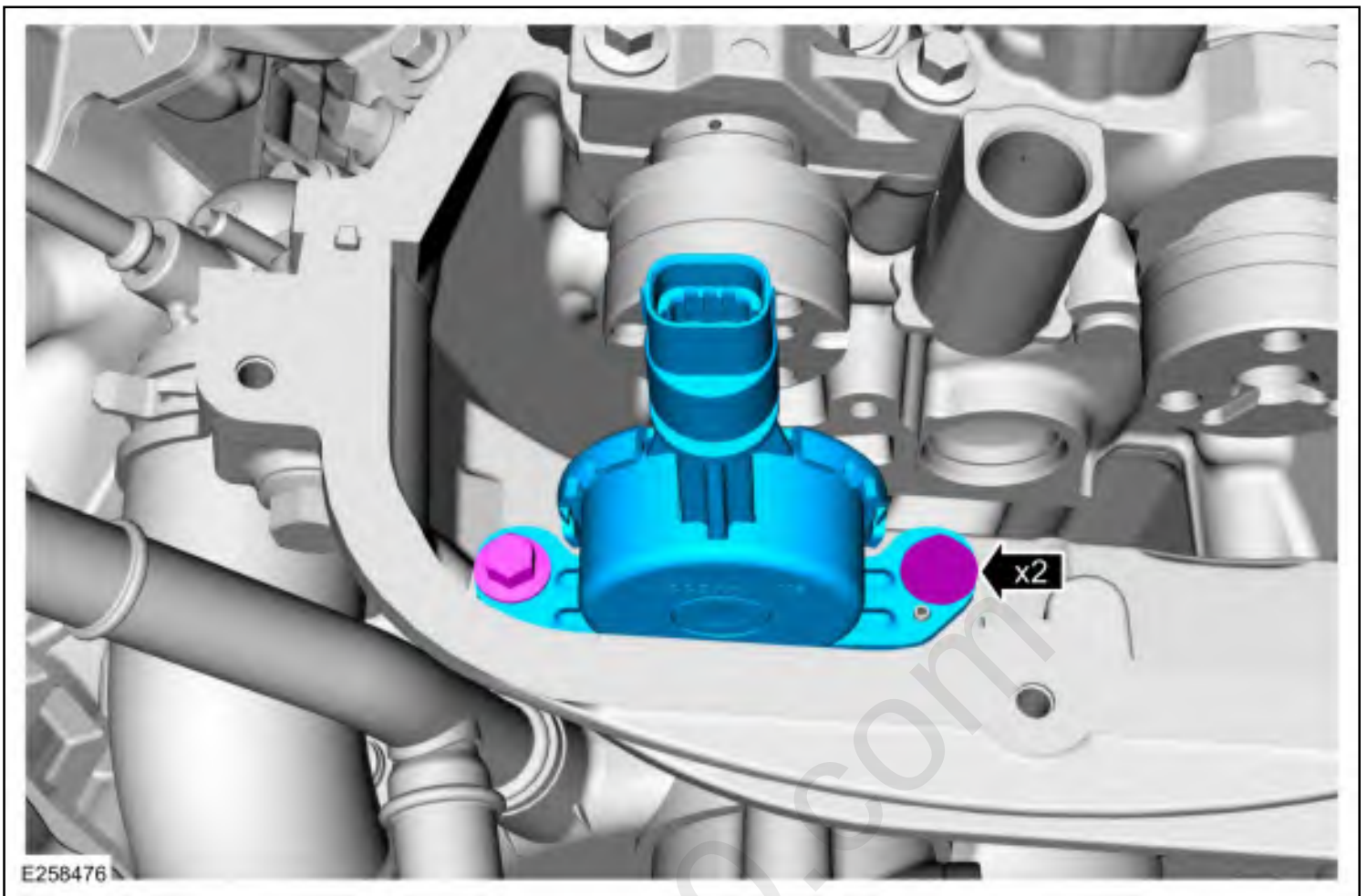


6. Remove the bolts and the intake VCT oil control solenoid.

*Torque:*

Stage 1: 71 lb.in (8 Nm)

Stage 2: 30°



## Installation

1. To install, reverse the removal procedure.

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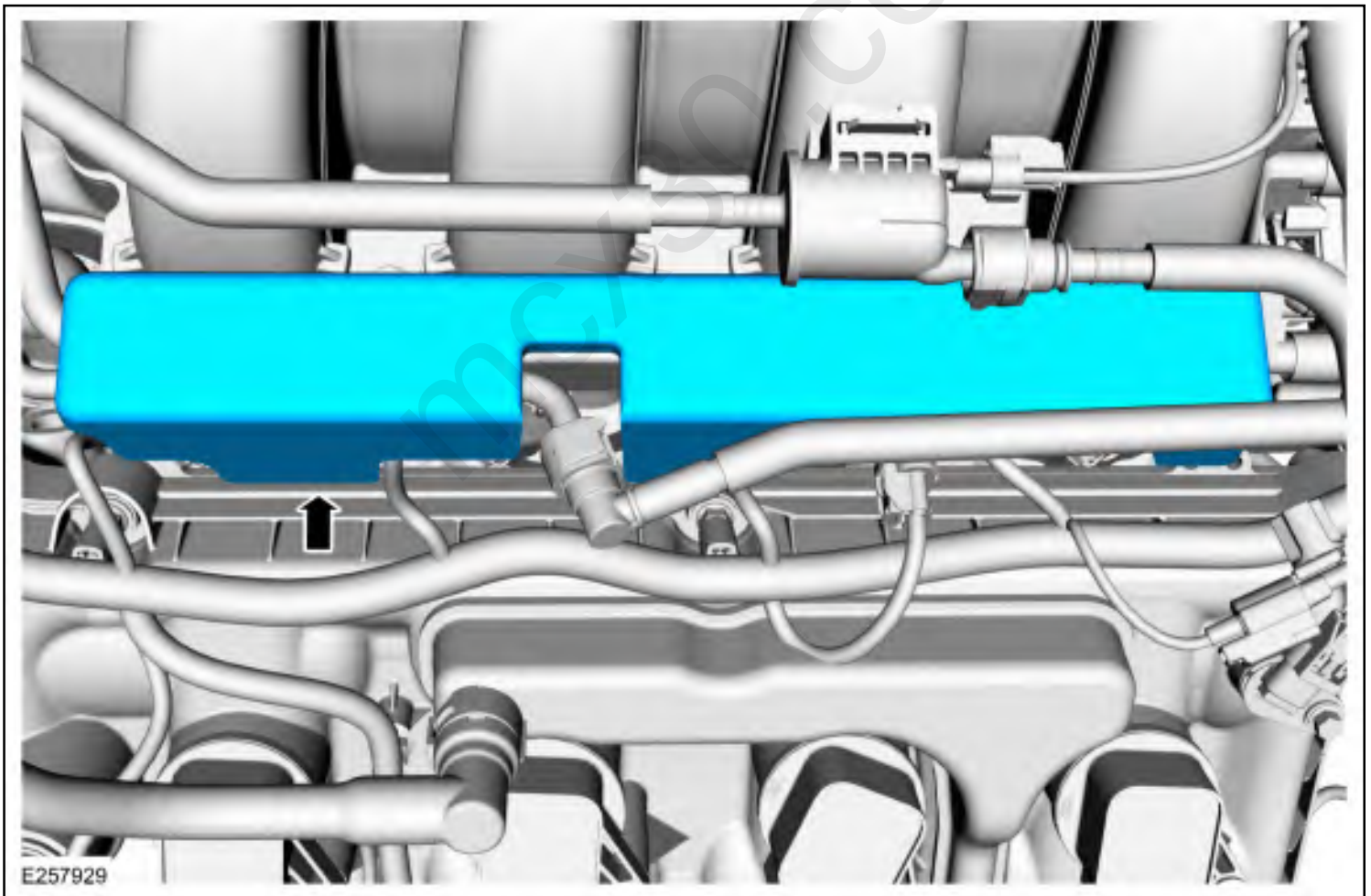


# Fuel Rail Pressure and Temperature Sensor

## Removal

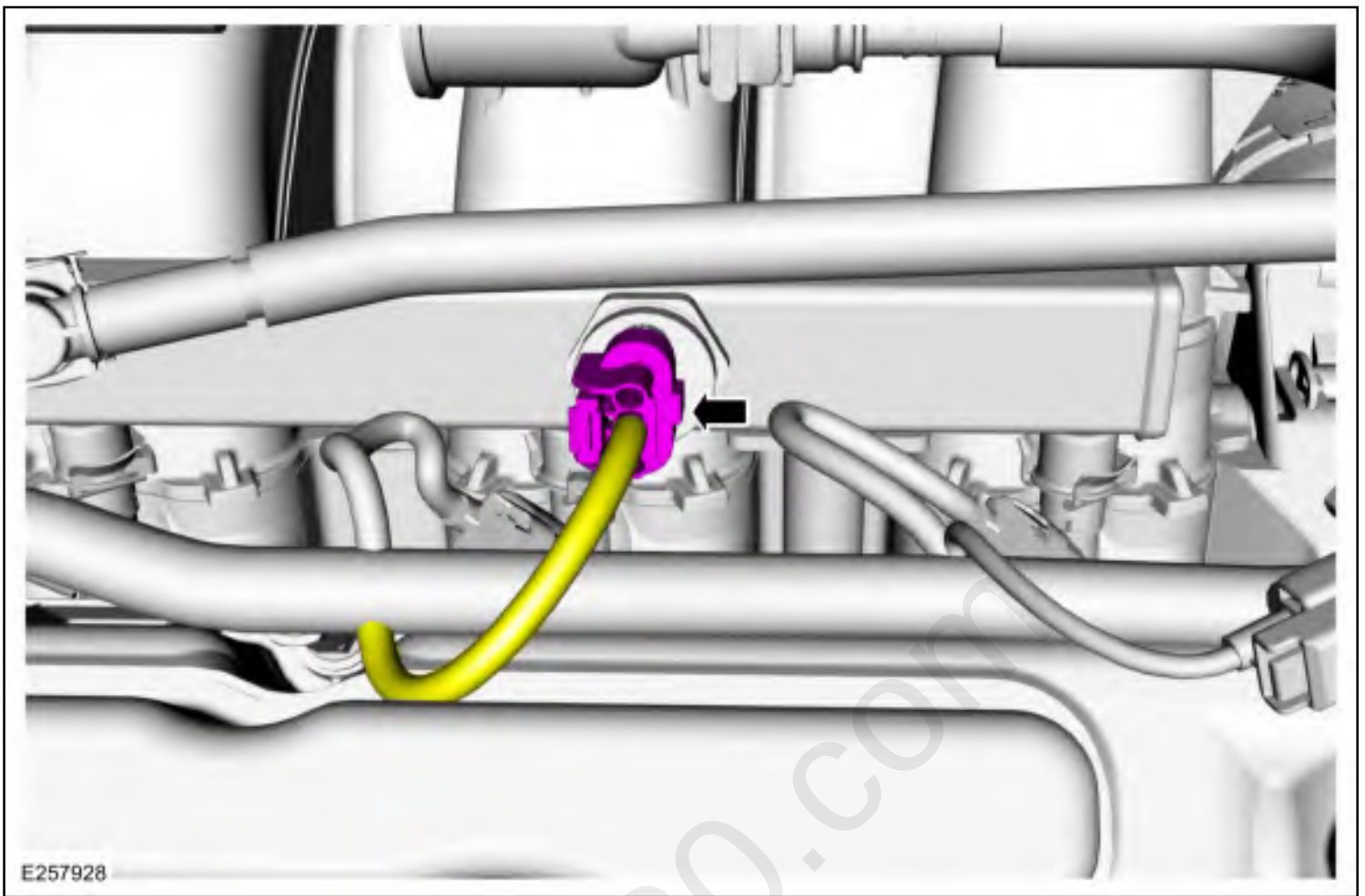
**NOTE:** Removal steps in this procedure may contain installation details.

1. Release the fuel system pressure.  
Refer to: [Fuel System Pressure Release](#) (310-00D Fuel System - General Information - 5.0L 32V Ti-VCT, General Procedures).
2. Remove the fuel rail insulator.



3. Disconnect the FRP sensor electrical connector.



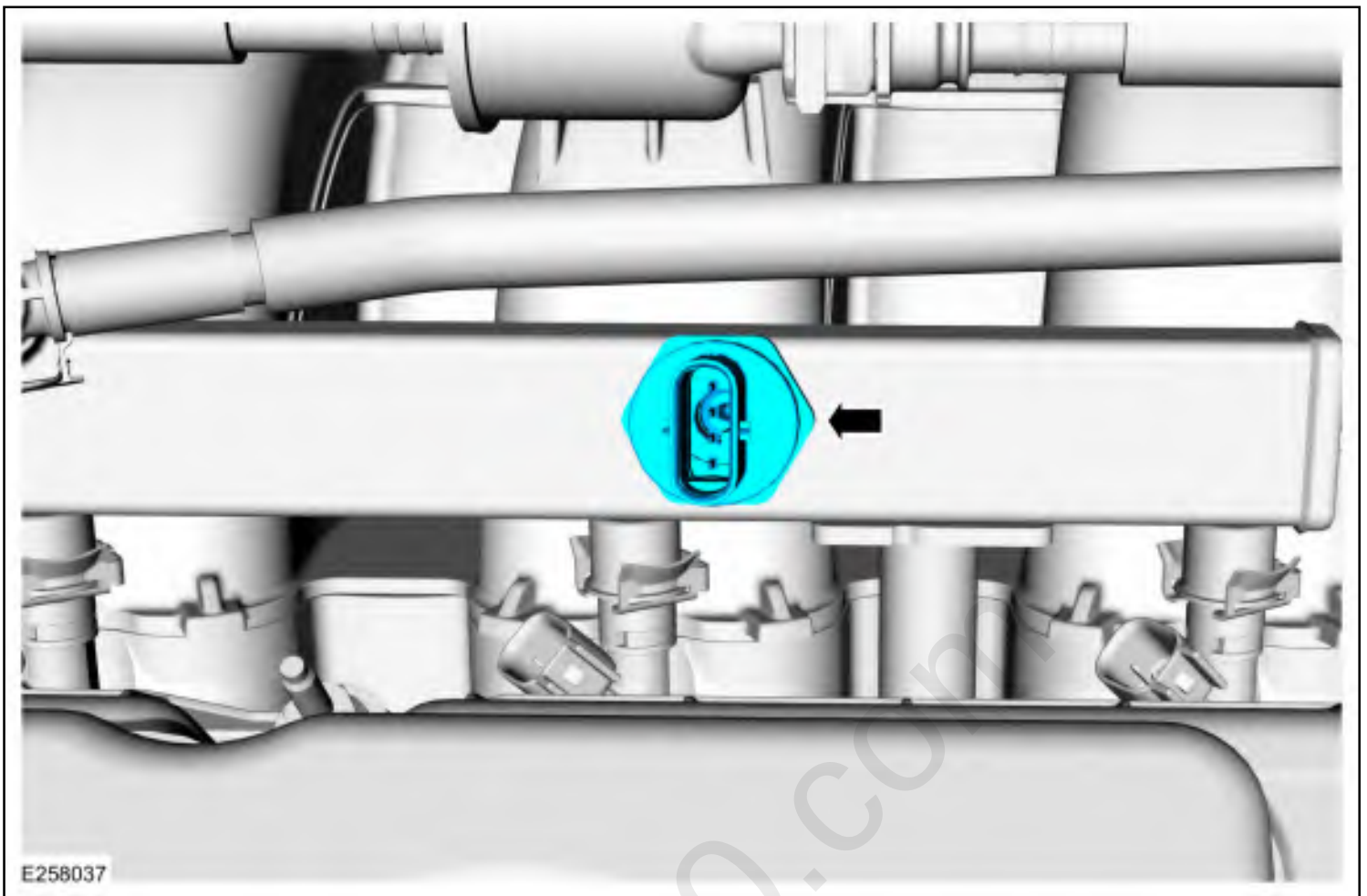


4. Remove the FRP sensor.

*Torque:*

Stage 1: 53 lb.in (6 Nm)

Stage 2: 25°



## Installation

**NOTE:** Lubricate the threaded area of the new FRP temperature sensor with clean engine oil prior to installation.

1. To install, reverse the removal procedure.

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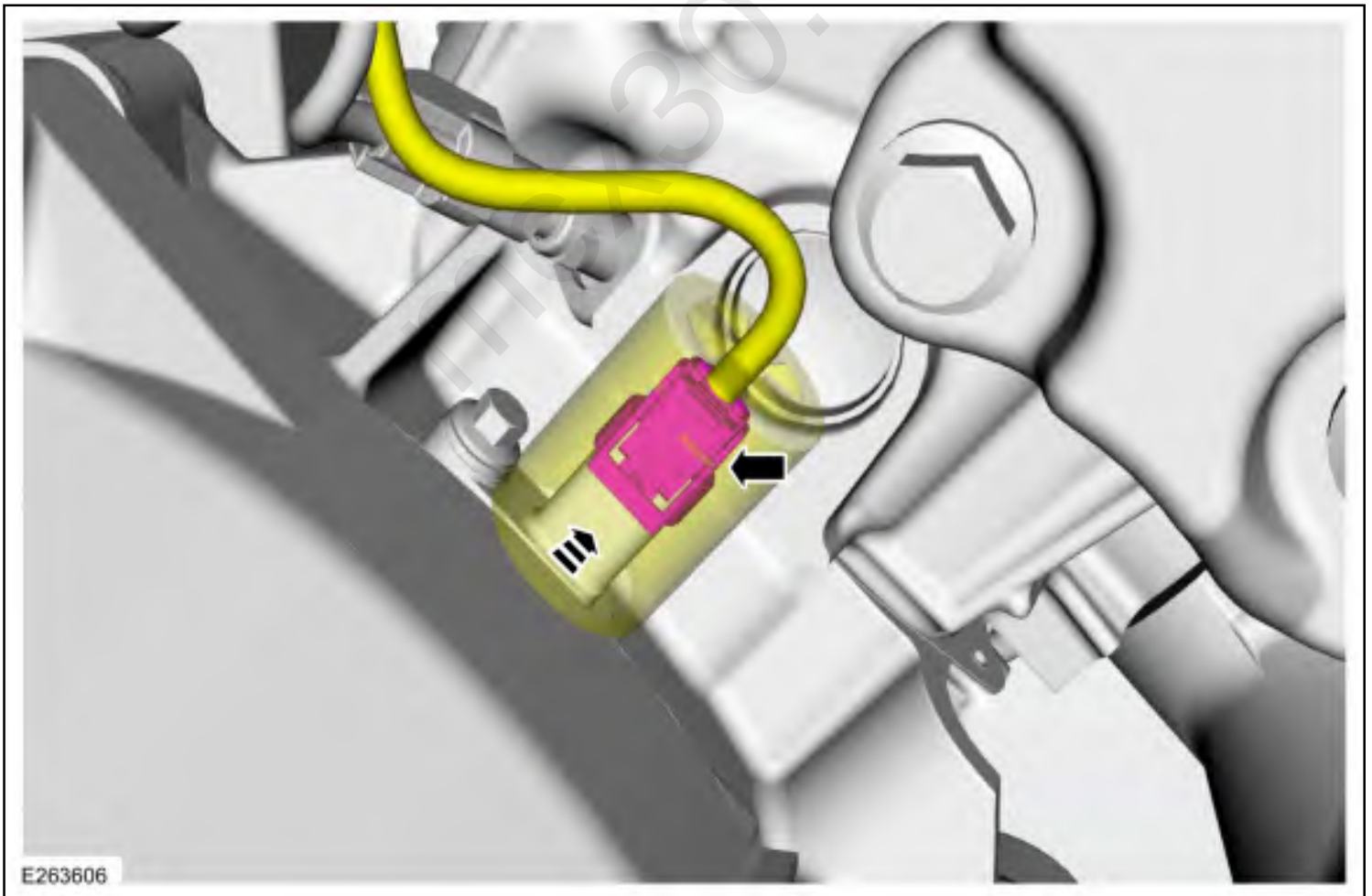
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## Crankshaft Position (CKP) Sensor

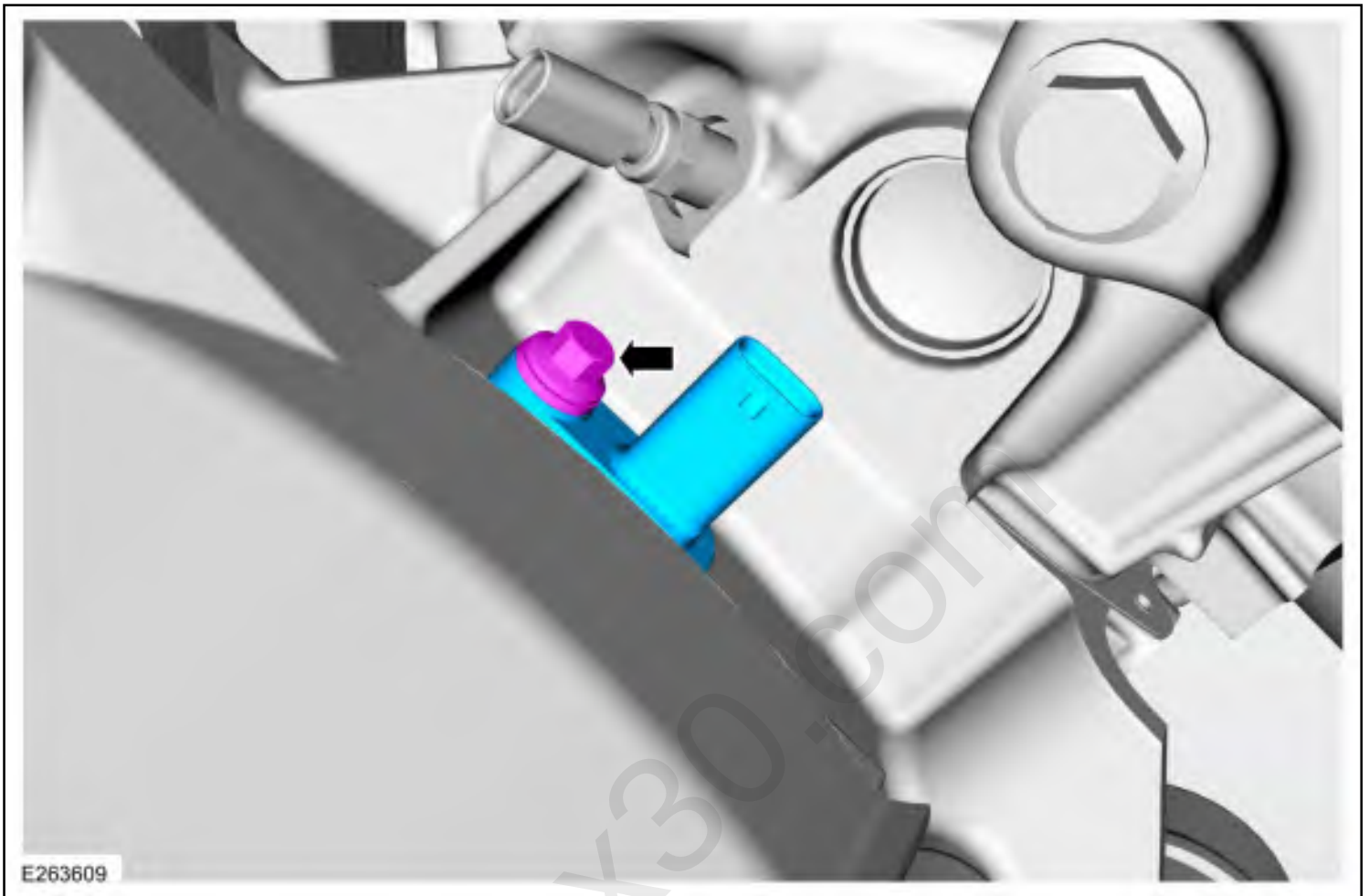
### Removal

**NOTE:** Removal steps in this procedure may contain installation details.

1. Remove the RHF wheel and tire.  
Refer to: [Wheel and Tire](#) (204-04A Wheels and Tires, Removal and Installation).
2. Remove the RH fender splash shield.  
Refer to: [Fender Splash Shield](#) (501-02 Front End Body Panels, Removal and Installation).
3. Position the cover and disconnect the CKP sensor electrical connector.



4. Remove the bolt and the CKP sensor.  
*Torque: 89 lb.in (10 Nm)*



## Installation

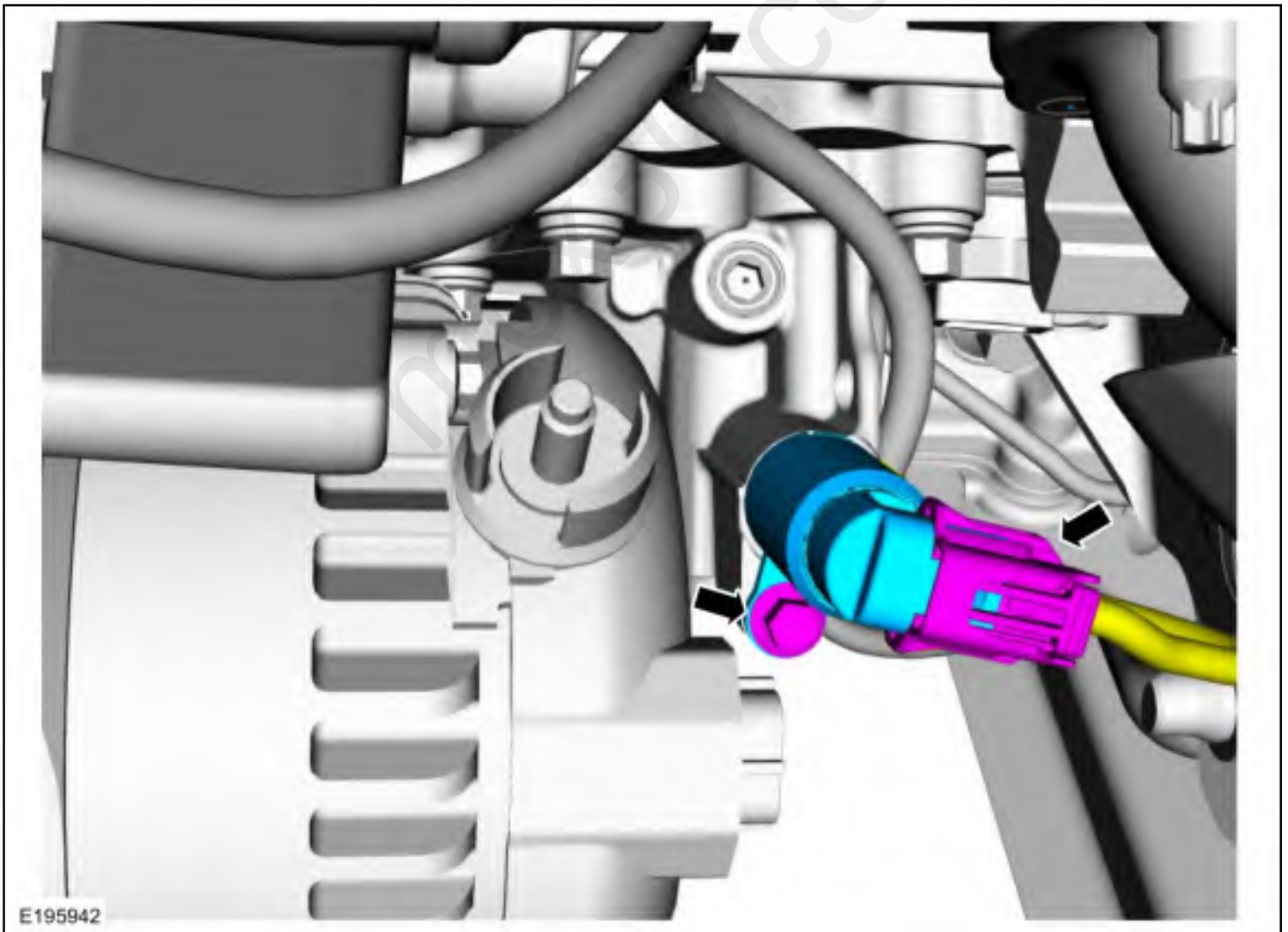
1. To install, reverse the removal procedure.
2. Using the scan tool, perform the Misfire Monitor Neutral Profile Correction procedure, following the on-screen instructions.

## Oil Pressure Control Solenoid

### Removal

**NOTE:** Removal steps in this procedure may contain installation details.

1. Remove the LH fender splash shield.  
Refer to: [Fender Splash Shield](#) (501-02 Front End Body Panels, Removal and Installation).
2. Disconnect the electrical connector, remove the bolt and the oil pressure control solenoid.  
Torque: 97 lb.in (11 Nm)





## Installation

1. To install, reverse the removal procedure.

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