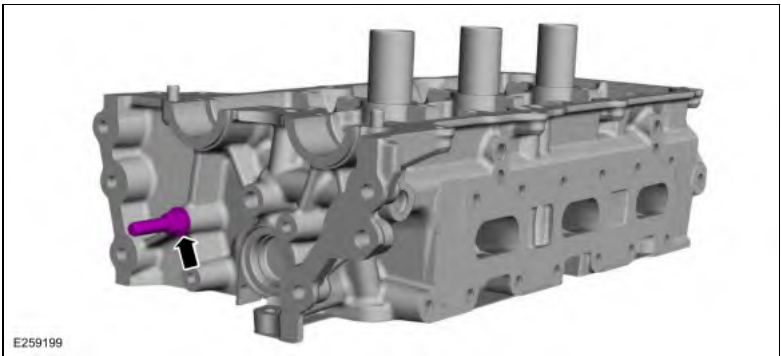


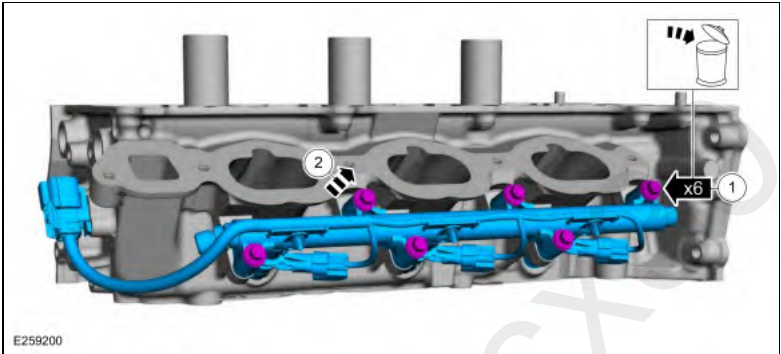


5.

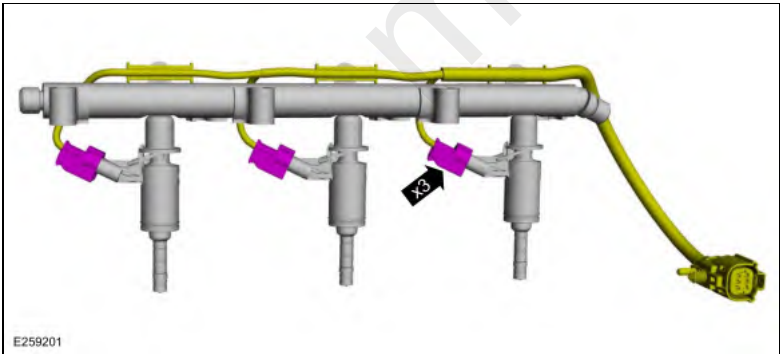
- 1. Remove and discard the direct injection fuel rail mounting bolts.
- 2. **NOTICE:** Pull out the fuel rails in the direction of the fuel injector axis or damage may occur to the fuel injectors.

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.

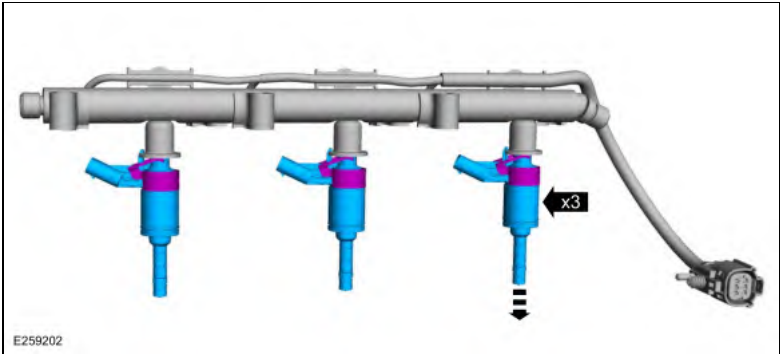
Remove the direct injection fuel rail and the fuel injectors.



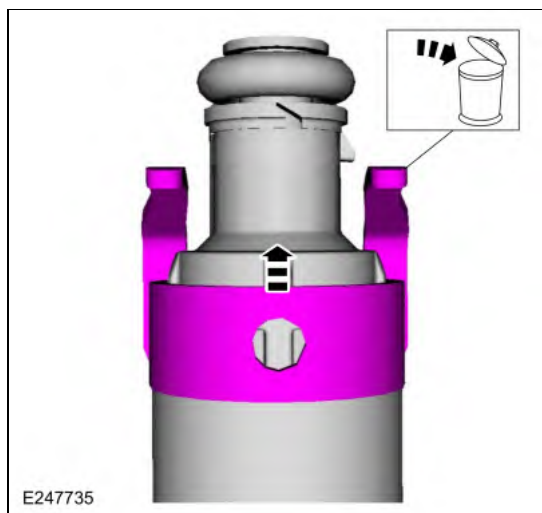
6. Disconnect the fuel injector electrical connectors.



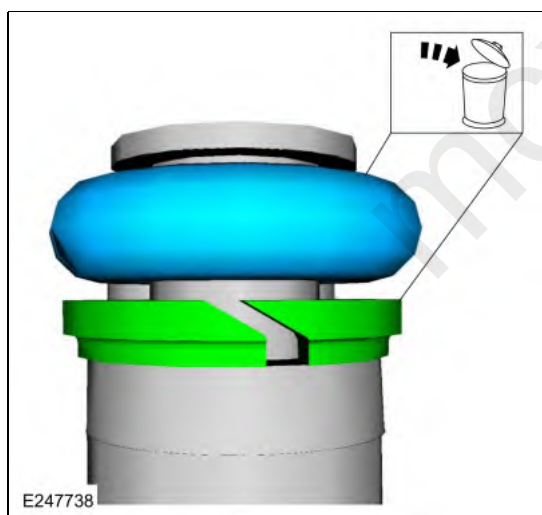
7. Remove the fuel injectors from the fuel rail.



8. Remove and discard the clips from all of the fuel injectors including any injectors that have remained in the cylinder head.



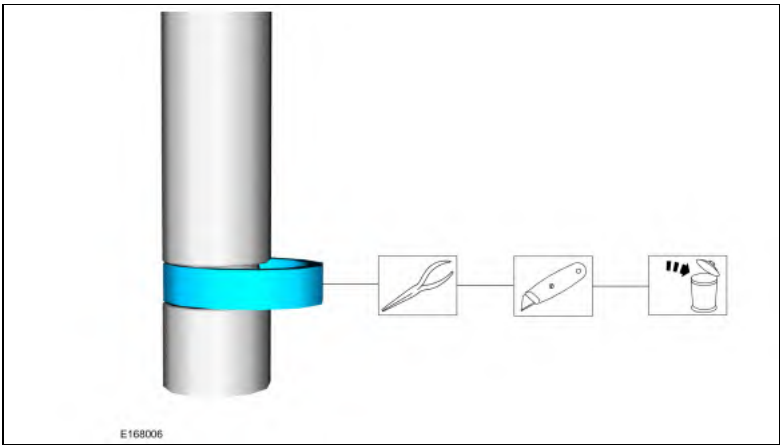
- 9.
- Remove and discard the fuel injector O-ring seals.
 - **NOTE:** Note the correct orientation of the fuel injector support rings for correct installation of the new fuel injector support rings.
- Remove and discard the fuel injector support rings.



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

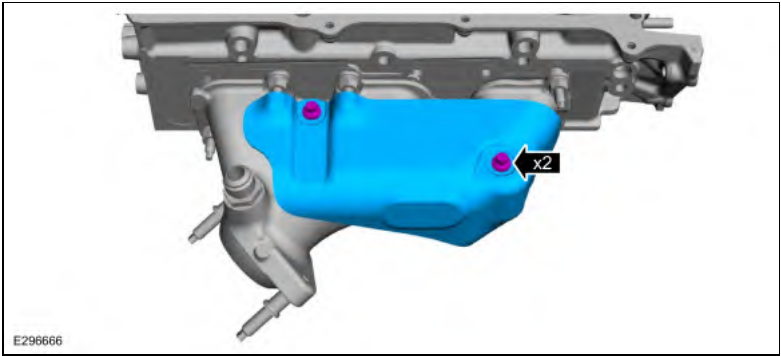
NOTICE: Do not attempt to cut the lower Teflon® seal without first pulling it away from the fuel injector or damage to the injector may occur.

- Pull the lower Teflon® seal away from the injector.
- Carefully cut and discard the lower fuel injector Teflon® seals.

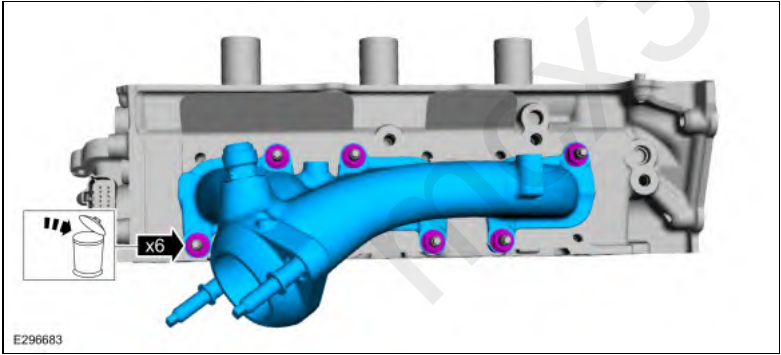


RH cylinder head

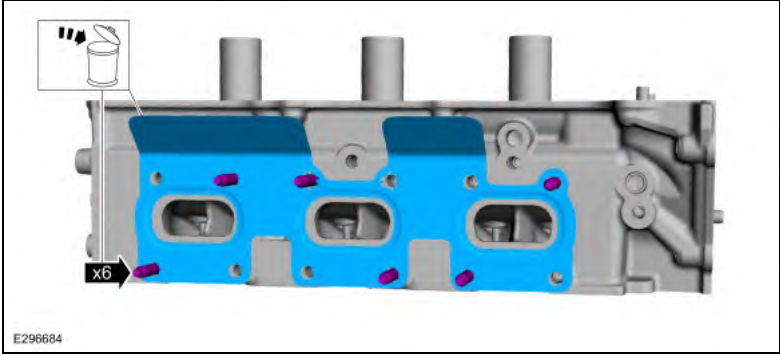
11. Remove the bolts and the exhaust manifold heat shield.



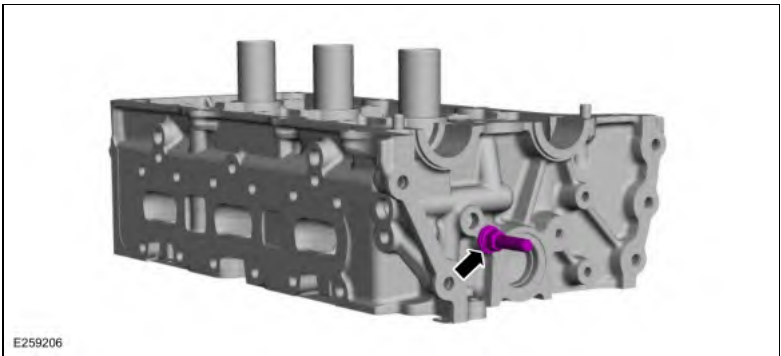
- 12.
- Remove the nuts and the exhaust manifold.
 - Discard the nuts.
 - Clean and inspect the exhaust manifold.
- Refer to: Exhaust Manifold Cleaning and Inspection (303-00 Engine System - General Information, General Procedures).



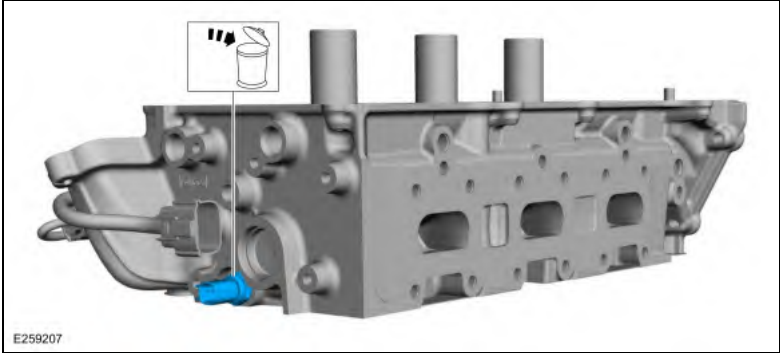
13. Remove and discard the studs and the exhaust manifold gasket.



14. Remove the timing chain tensioner arm guide pin.



15. Remove and discard the CHT sensor.

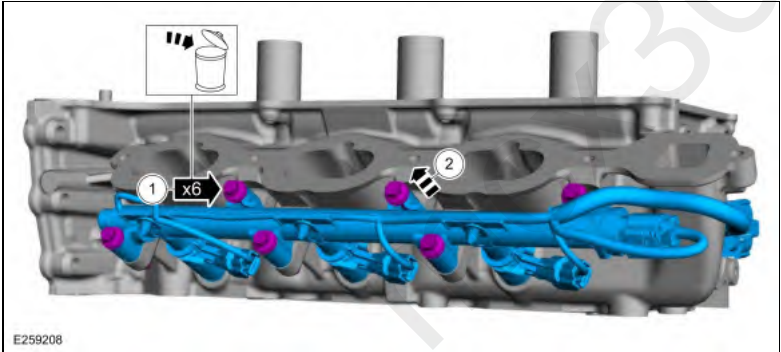


16.

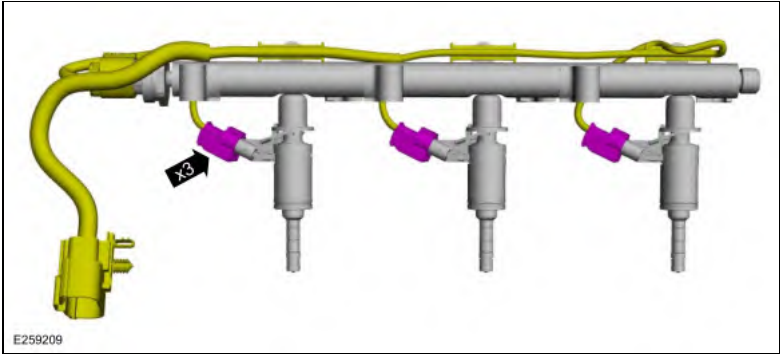
1. Remove and discard the direct injection fuel rail mounting bolts.
2. **NOTICE:** Pull out the fuel rails in the direction of the fuel injector axis or damage may occur to the fuel injectors.

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.

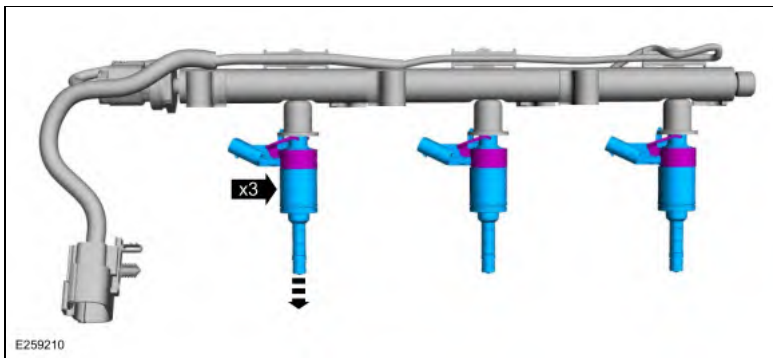
Remove the direct injection fuel rail and the fuel injectors.



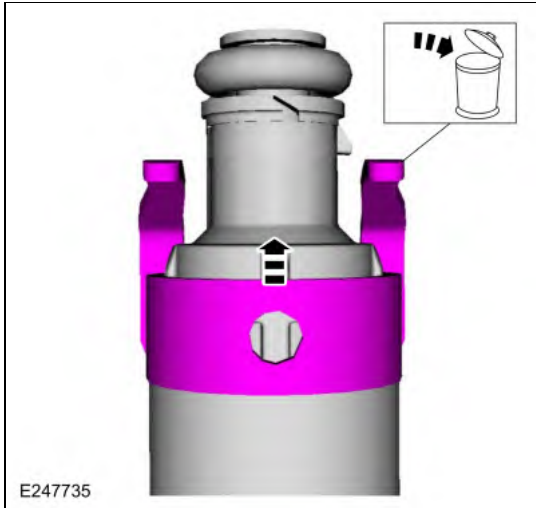
17. Disconnect the fuel injector electrical connectors.



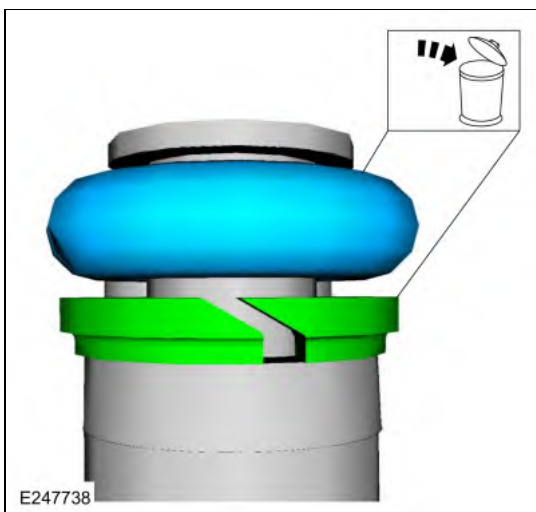
18. Remove the fuel injectors from the fuel rail.



19. Remove and discard the clips from all of the fuel injectors including any injectors that have remained in the cylinder head.



- 20.
- Remove and discard the fuel injector O-ring seals.
 - **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.

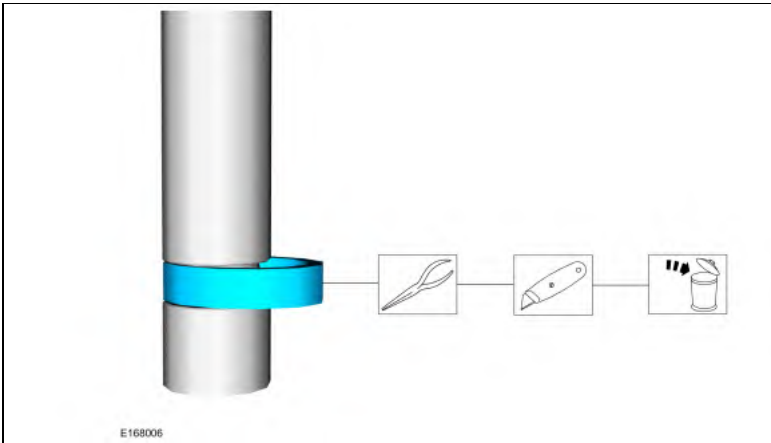


21. **NOTICE:** Use care when removing the lower Teflon® seals, not to scratch, nick or gouge the fuel injectors.

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.

- Pull the lower Teflon® seal away from the injector.

- Carefully cut and discard the lower fuel injector Teflon® seals.



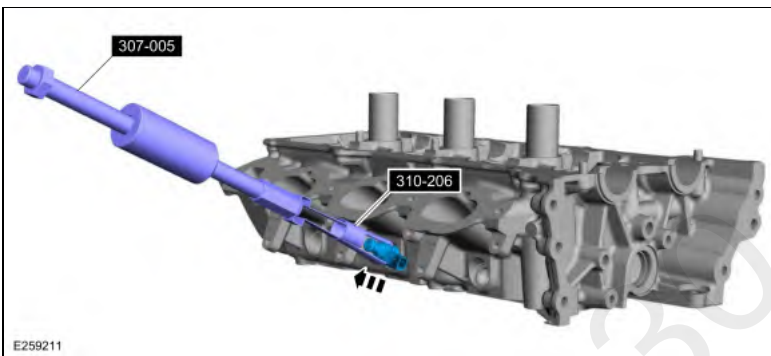
All cylinder heads

NOTE: LH shown, RH similar.

22. **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.

Using the special tools, remove 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.



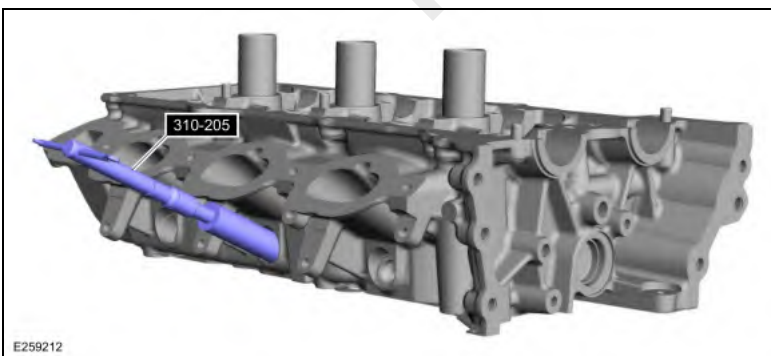
23. **NOTICE:** Make sure to thoroughly clean any residual fuel or foreign material from the cylinder head, block and the general surrounding area of the fuel rails and injectors.

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.

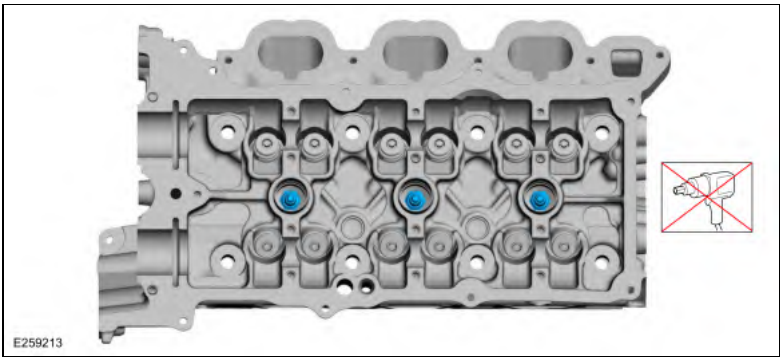


24. **NOTICE:** Do not remove the spark plugs when the engine is hot or cold soaked. Spark plug thread or cylinder head damage can occur. Make sure that the engine is warm (hand touch after cooling down) prior to spark plug removal.

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

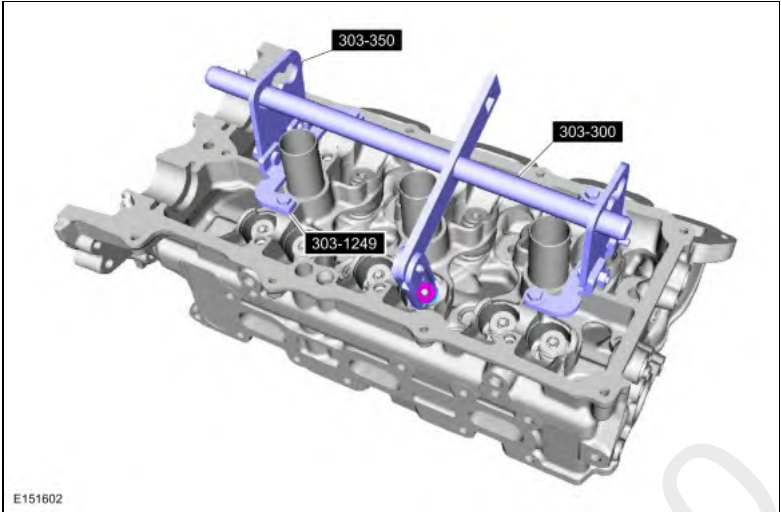
NOTE: Use compressed air to remove any foreign material in the spark plug well before removing the spark plugs.

Remove the spark plugs.

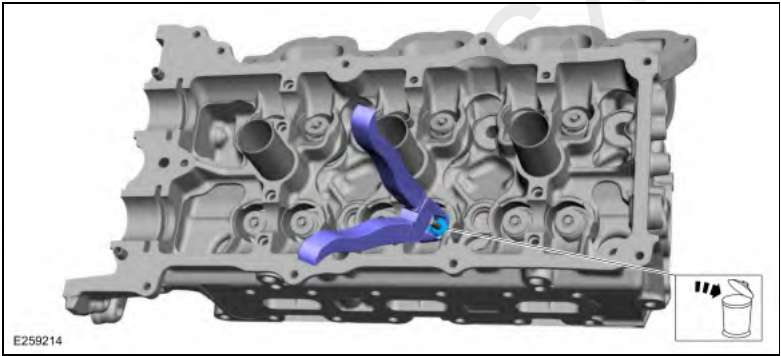


25. **NOTE:** If the components are to be reinstalled, they must be installed in the same positions. Mark the components for installation into their original locations.

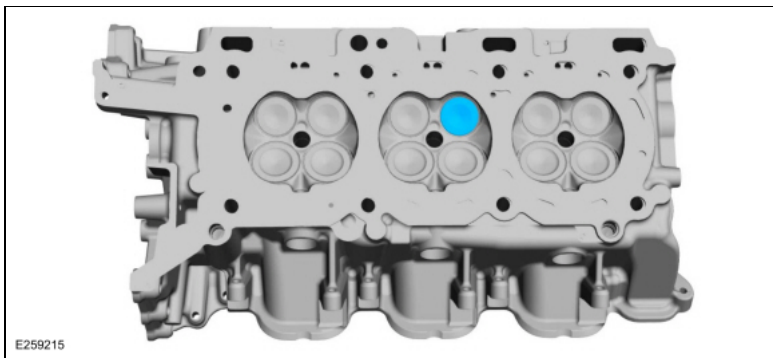
Using the special tools, remove the valve collet, valve spring retainer and the valve spring.
 Use Special Service Tool: 303-300 (T87C-6565-A) Set, Valve Spring Compressor. , 303-350 (T89P-6565-A) Compressor, Valve Spring. , 303-1249 Valve Spring Compressor.



26. **NOTE:** Use valve stem seal pliers (such as BeTooll HW0107 or equivalent).
- Use commercially available valve stem seal pliers to remove the valve stem seal.
 - Discard the valve stem seal.



27. Remove the valve.



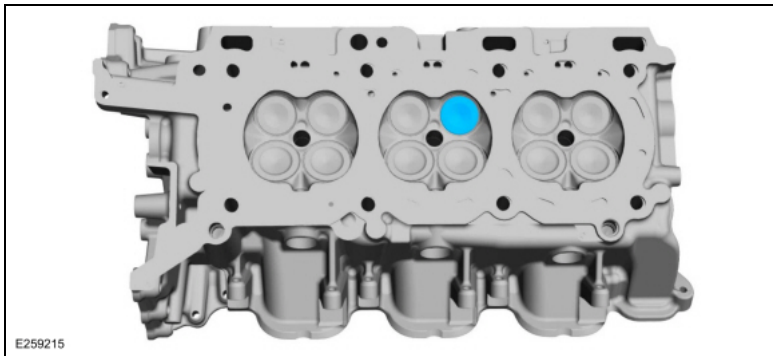
28. Repeat the previous 3 steps for each valve.

ASSEMBLY

All cylinder heads

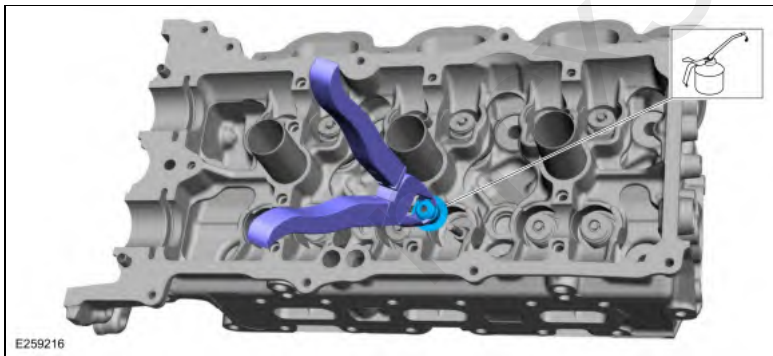
NOTE: LH shown, RH similar.

1. Install the valve.



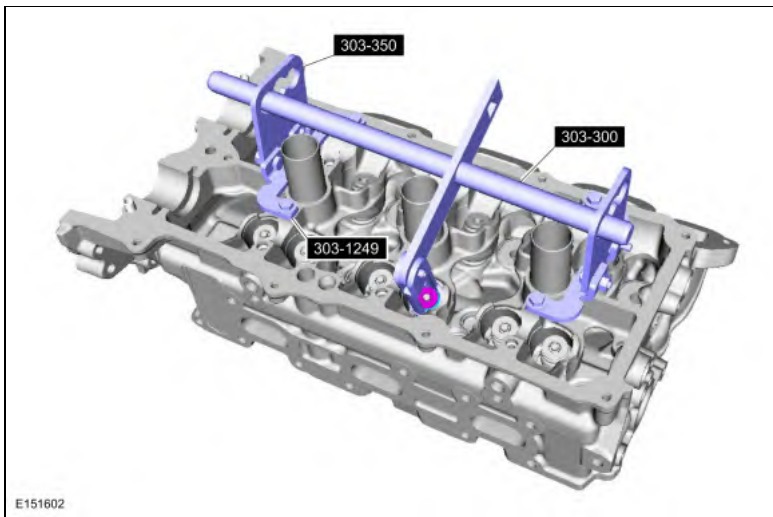
2. **NOTE:** Use valve stem seal pliers (such as BeTooll HW0107 or equivalent).

- Lubricate the valve stem seal with clean engine oil.
- Use commercially available valve stem seal pliers to install the valve stem seal.



3. Using the special tools, install the valve spring, valve spring retainer and the valve collet.

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.

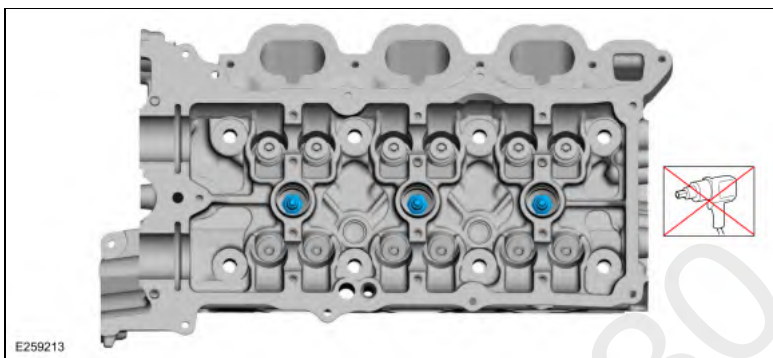


4. Repeat the previous 3 steps for each valve.

5. **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**

Install the spark plugs.

Torque: 133 lb.in (15 Nm)



RH cylinder head

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

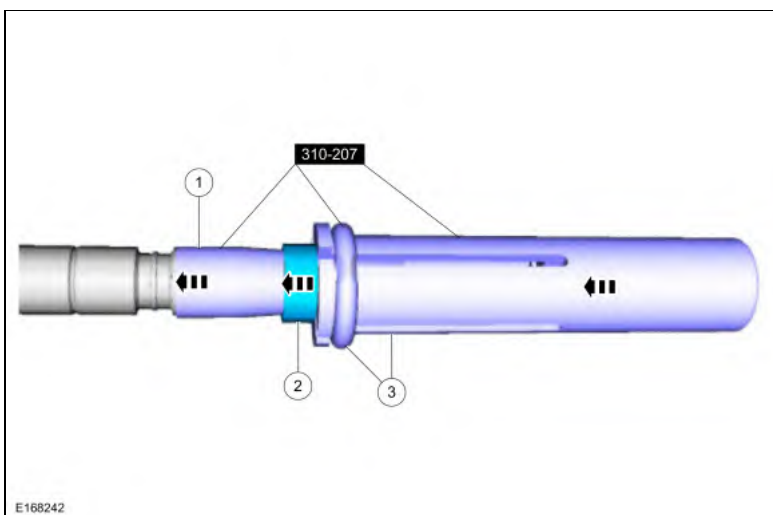
1. Install the Arbor on the fuel injector tips.
Use Special Service Tool: 310-207 Installer, Fuel Injector Seal Assembly.

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 Arbor, using the Pusher Tool (part of the Fuel Injector Seal Installer), slide the Teflon® seals along the Arbor.

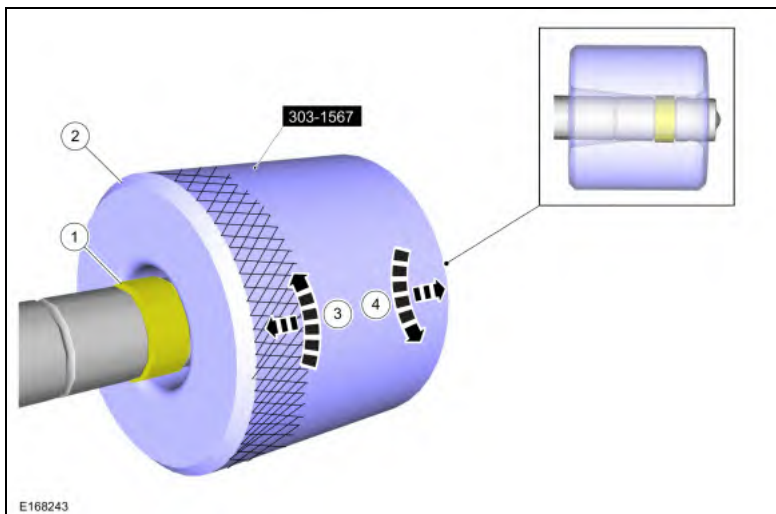
3. Using the Pusher Tool, slide the Teflon® seals off of the Teflon® Seal Guide and into the groove on the fuel injectors.
Use Special Service Tool: 310-207 Installer, Fuel Injector Seal Assembly.



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

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

1. Some Teflon® seal massaging with your fingers before the Teflon® seal sizer tool is installed 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. After one minute, turn the Teflon® Seal Sizer tool back 180 degrees and remove.
4. After one minute, turn the Teflon® seal sizer tool back 180 degrees and remove.



8.

1. **NOTICE:** The large diameter step of the backup ring must go up towards the new O-ring seal. Improperly installed backup rings may cause the fuel system to leak.

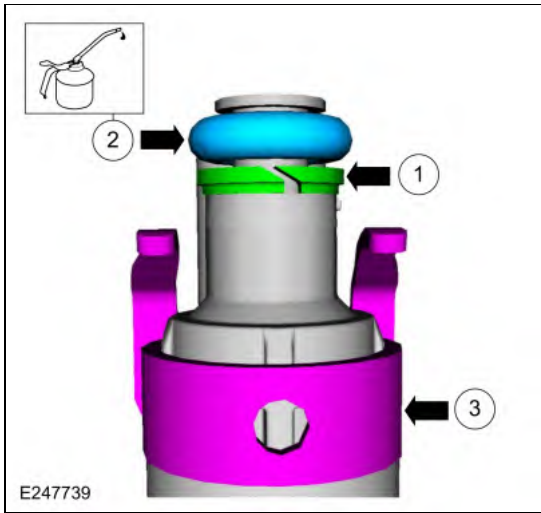
Install the fuel injector backup ring.

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

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

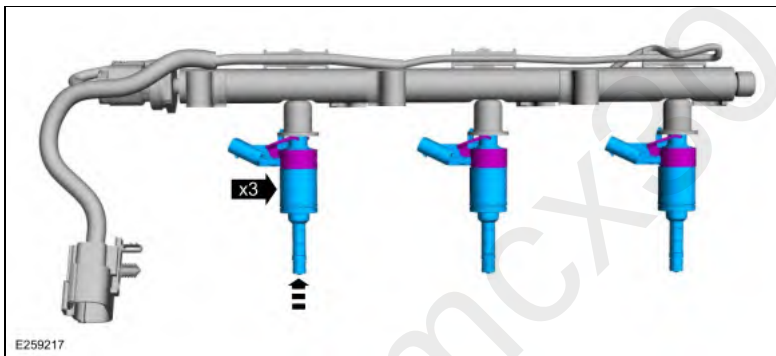
Install the new fuel injector O-ring seals. Lubricate the new fuel injector O-ring seals with clean engine oil.

3. Install the new the fuel injector clip.

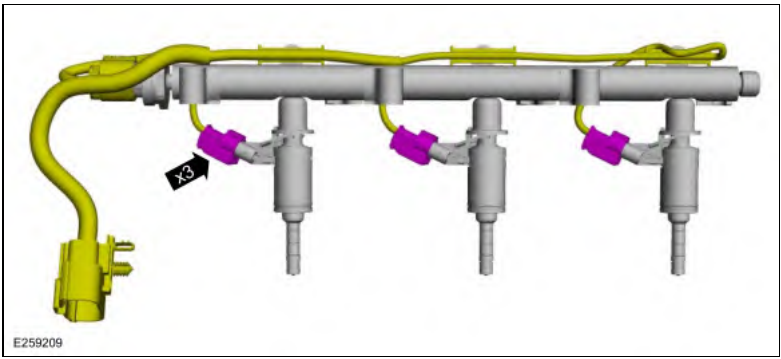


9. **NOTE:** The fuel injectors are held in by the O-ring seal only.

Install the fuel injectors into the fuel rail.



10. Connect the fuel injector electrical connectors.

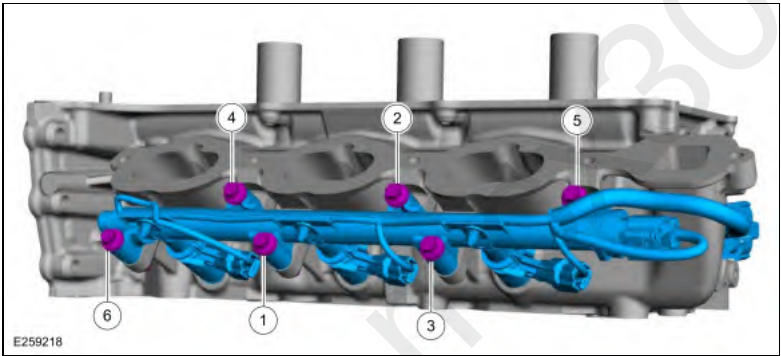


11. **NOTE:** Do not lubricate the new lower Teflon® fuel injector seals.

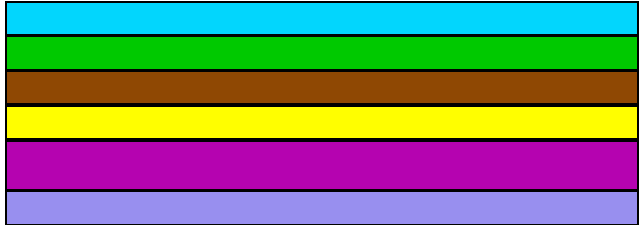
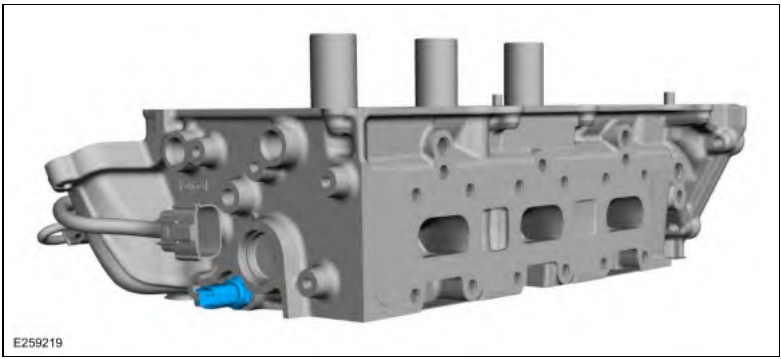
NOTE: Make sure that new fuel rail mounting bolts are installed.

NOTE: Push down on the fuel rail above the injectors.

- Install the fuel injectors and direct injection fuel rail assembly into the cylinder head. Tighten the bolts in sequence shown in 2 stages.
Torque:
Stage 1: 89 lb.in (10 Nm)
Stage 2: 45°
- Connect the fuel injector electrical connectors.

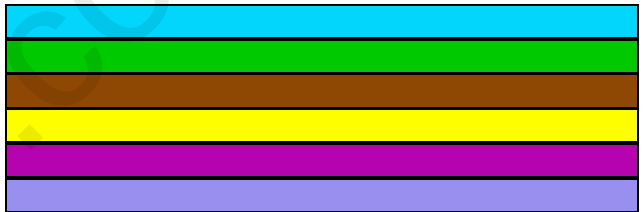
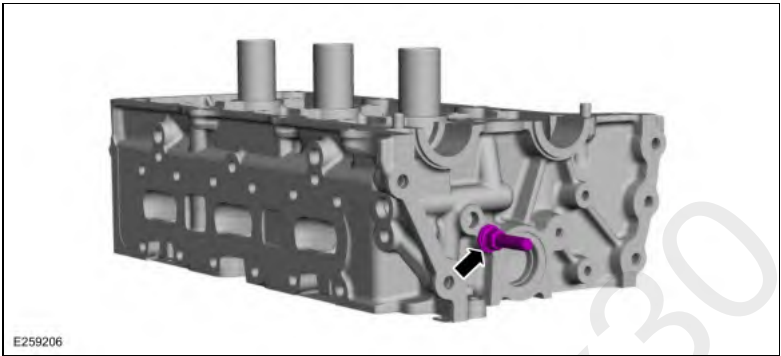


12. Install a new CHT sensor.
Torque: 89 lb.in (10 Nm)

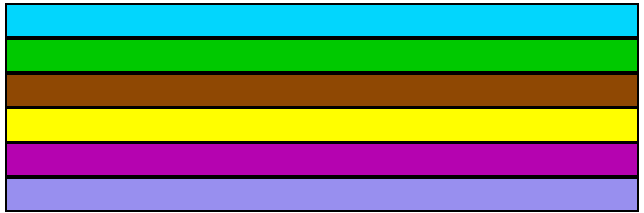
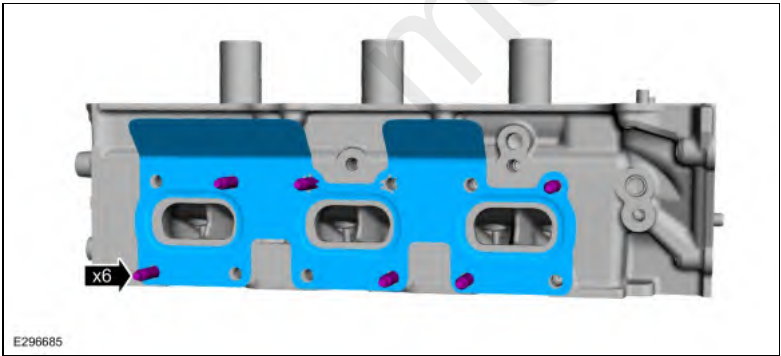


13. Install the timing chain tensioner arm guide pin.

Torque:
Stage 1: 177 lb.in (20 Nm)
Stage 2: 60°

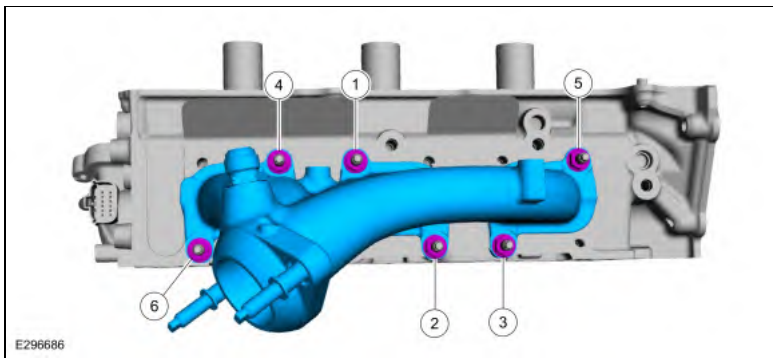


- 14.
- Install the new the exhaust manifold studs.
Torque: 106 lb.in (12 Nm)
 - Install a new exhaust manifold gasket.

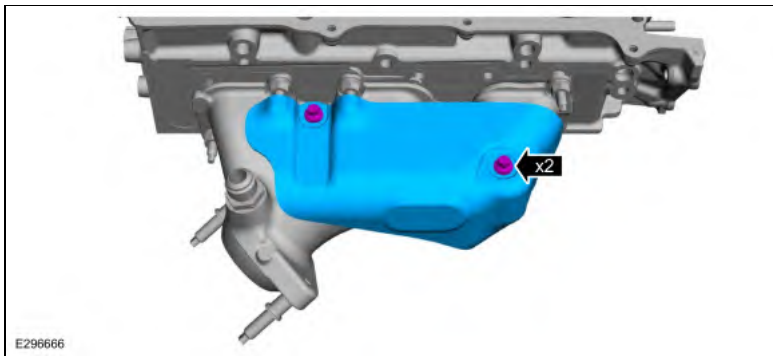


15. Install the exhaust manifold and the new nuts.

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



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



LH cylinder head

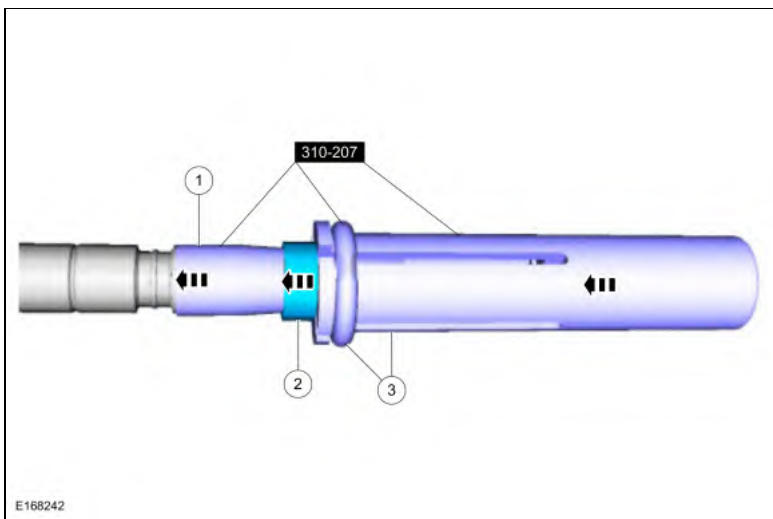
17. **NOTICE: Do not lubricate the new lower Teflon® fuel injector seals.**

1. Install the Arbor on the fuel injector tips
 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 Arbor, using the Pusher Tool (part of the Fuel Injector Seal Installer), slide the Teflon® seals along the Arbor.

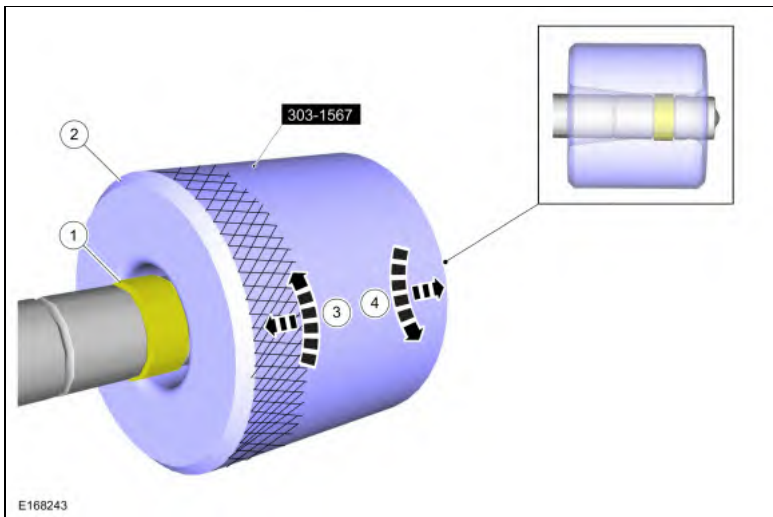
3. Using the Pusher Tool, slide the Teflon® seals off of the Teflon® Seal Guide and into the groove on the fuel injectors.
 Use Special Service Tool: 310-207 Installer, Fuel Injector Seal Assembly.



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

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

1. Some Teflon® seal massaging with your fingers before the Teflon® seal sizer tool is installed 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. After one minute, turn the Teflon® Seal Sizer tool back 180 degrees and remove.
4. After one minute, turn the Teflon® seal sizer tool back 180 degrees and remove.



19.

1. **NOTICE:** The large diameter step of the backup ring must go up towards the new O-ring seal. Improperly installed backup rings may cause the fuel system to leak.

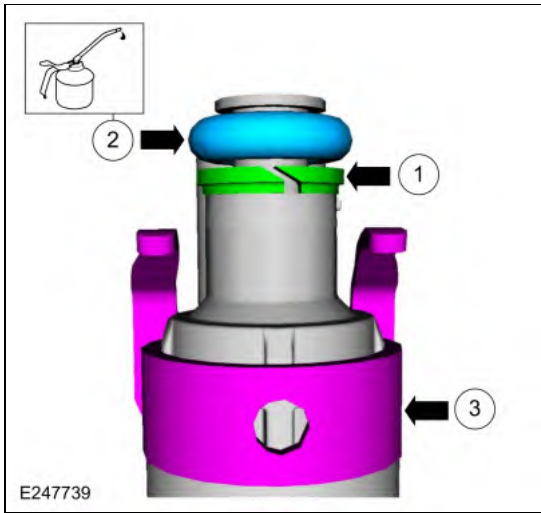
Install the fuel injector backup ring.

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

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

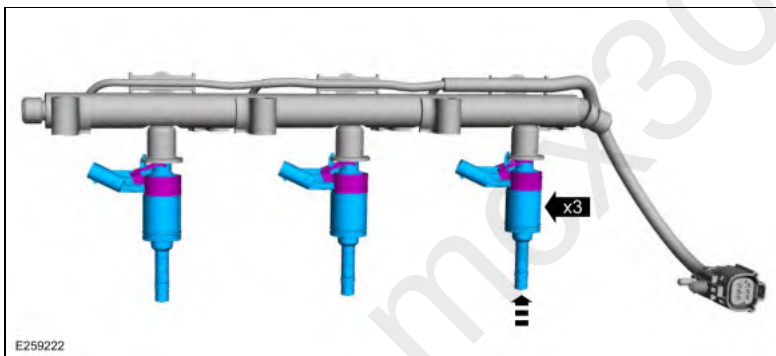
Install the new fuel injector O-ring seals. Lubricate the new fuel injector O-ring seals with clean engine oil.

3. Install the new the fuel injector clip.

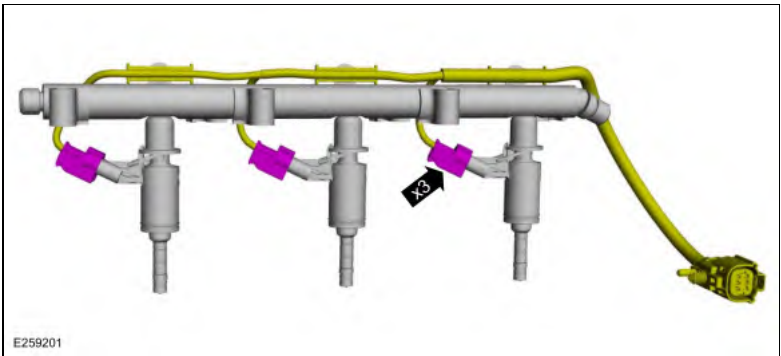


20. **NOTE:** *The fuel injectors are held in by the O-ring seal only.*

Install the fuel injectors into the fuel rail.



21. Connect the fuel injector electrical connectors.

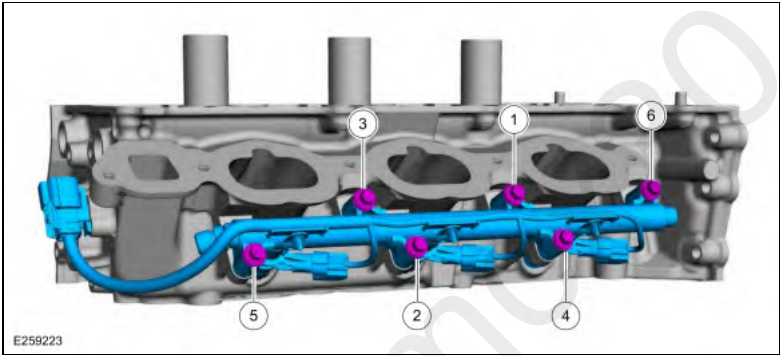


22. **NOTE:** Do not lubricate the new lower Teflon® fuel injector seals.

NOTE: Make sure that new fuel rail mounting bolts are installed.

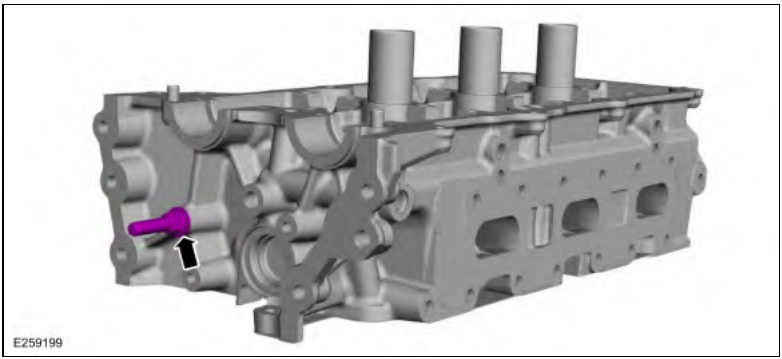
NOTE: Push down on the fuel rail above the injectors.

- Install the fuel injectors and direct injection fuel rail assembly into the cylinder head. Tighten the bolts in sequence shown in 2 stages.
Torque:
Stage 1: 89 lb.in (10 Nm)
Stage 2: 45°
- Connect the fuel injector electrical connectors.

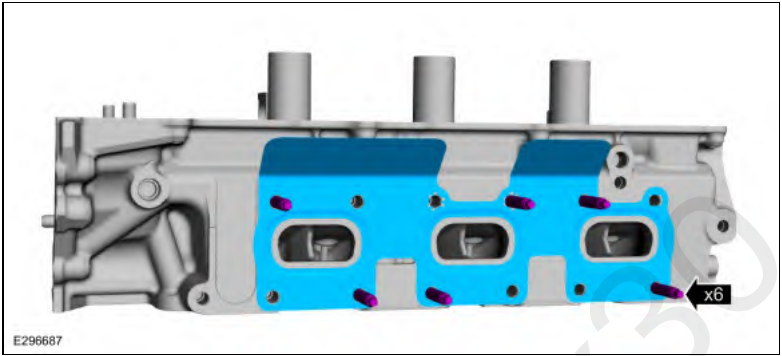


23. Install the timing chain guide pin.

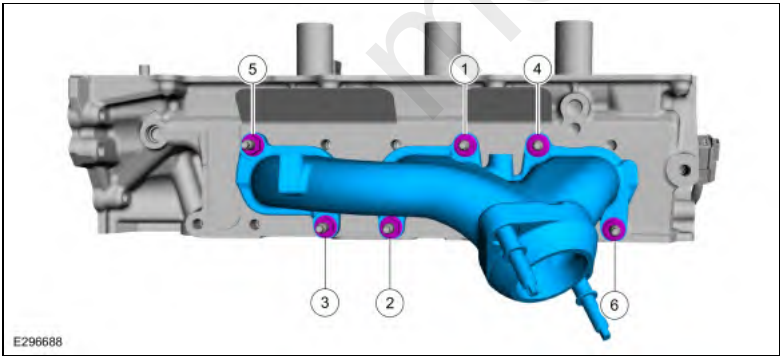
Torque:
Stage 1: 177 lb.in (20 Nm)
Stage 2: 60°



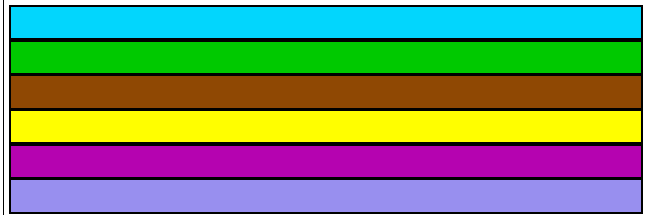
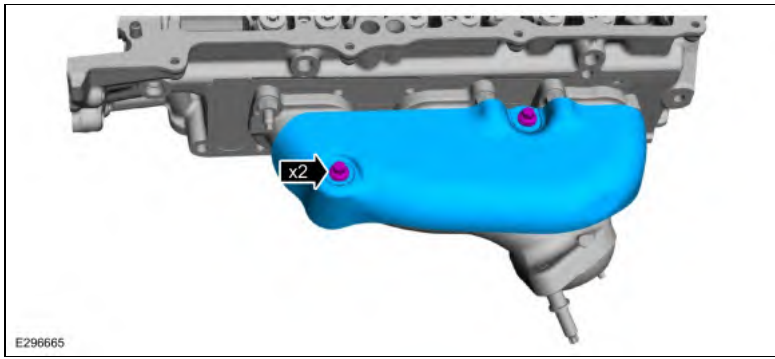
- 24.
- Install the new the exhaust manifold studs.
Torque: 106 lb.in (12 Nm)
 - Install a new exhaust manifold gasket.



25. Install the exhaust manifold and the new nuts.
- Torque:*
Stage 1: 168 lb.in (19 Nm)
Stage 2: 18 lb.ft (25 Nm)



26. Install the exhaust manifold heat shield and the bolts.
- Torque: 106 lb.in (12 Nm)*



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Piston

DISASSEMBLY

1. Remove the piston rings and discard.

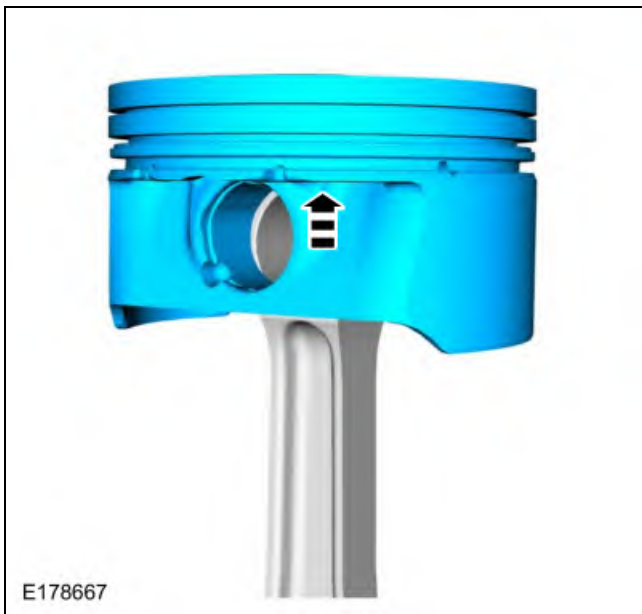


2.
 - Remove the piston pin retainers and discard.
 - Remove the piston pin.

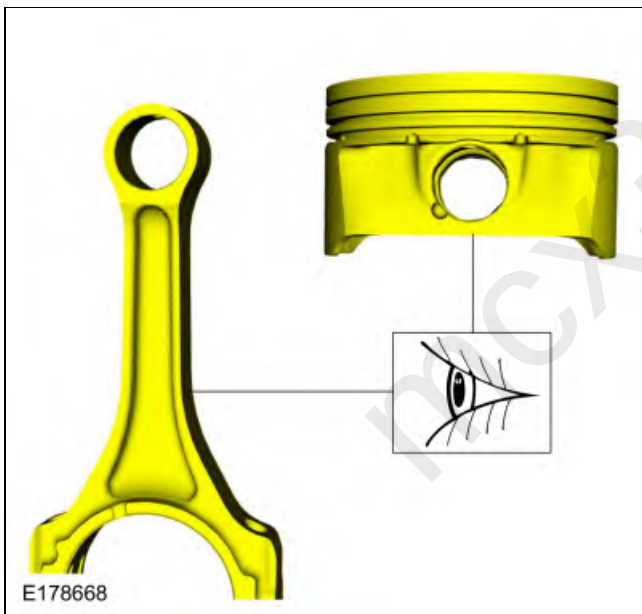


3. **NOTE:** If the piston and connecting rod are to be reinstalled, they must be assembled in the same orientation. Mark the piston orientation to the connecting rod for reassembly.

Remove the piston from the connecting rod.



4. 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 piston rod orientation marks and the arrow on the top of the dome of the piston should be facing toward the front of the engine block.