

2021 ENGINE

Engine Mechanical - 3.6L (LGZ) - Repair Instructions - Canyon, Colorado

REPAIR INSTRUCTIONS

DRIVE BELT REPLACEMENT

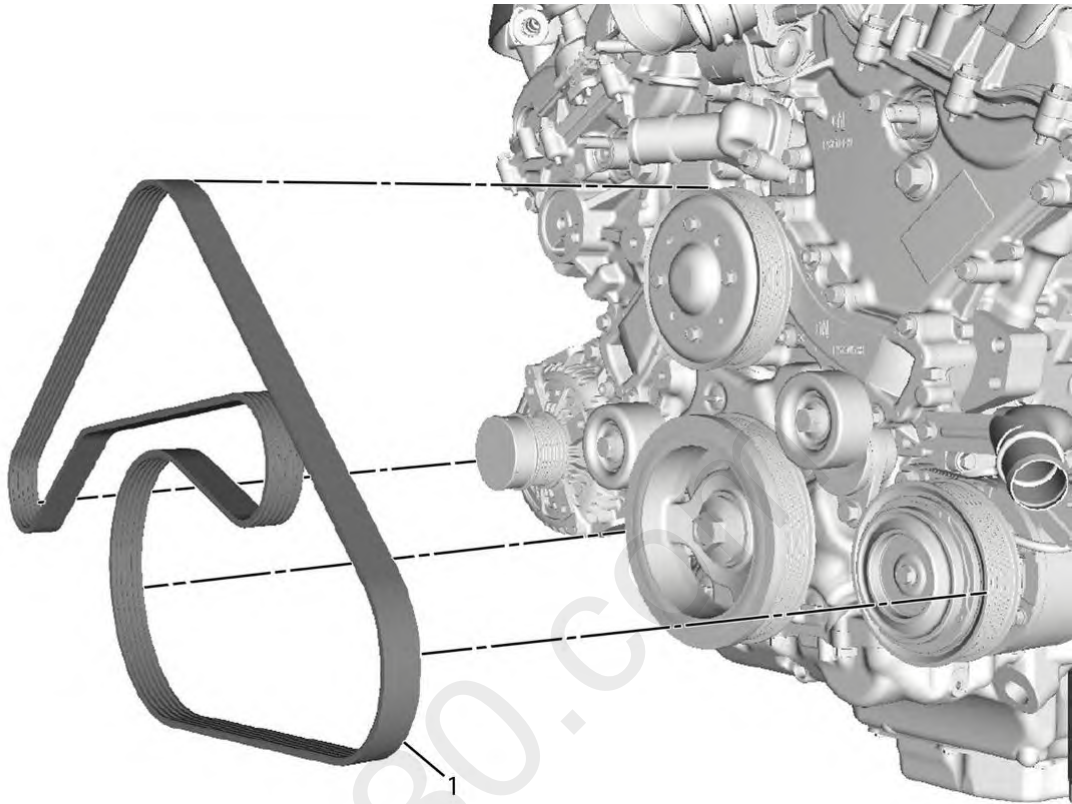


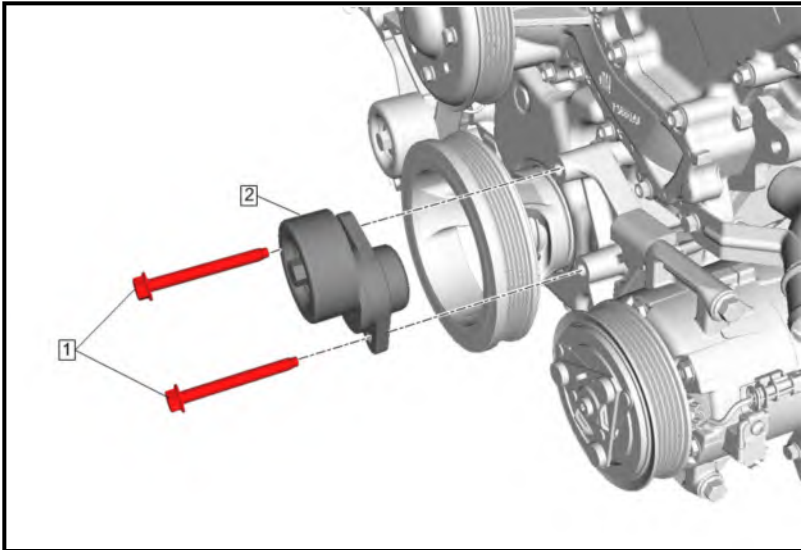
Fig. 1: Drive Belt Routing (LGX)

Courtesy of GENERAL MOTORS COMPANY

NOTE: Callouts in the following chart represent components shown in graphic above.

Callout	Component Name
Preliminary Procedure <u>Air Cleaner Outlet Duct Replacement</u>	
1	Drive Belt Procedure 1. Rotate the drive belt tensioner counterclockwise to release the drive belt tension. 2. Slide the drive belt off of the belt idler pulley. 3. Slowly release the drive belt tensioner.

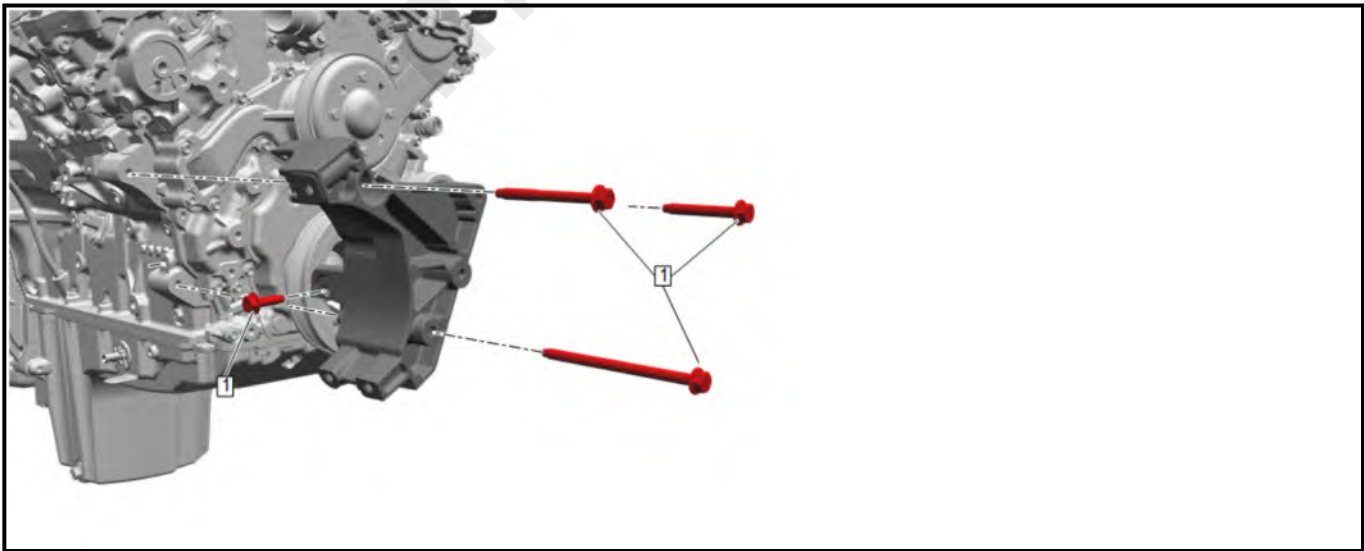
DRIVE BELT TENSIONER REPLACEMENT



NOTE: Callouts in the following chart represent components shown in graphic above.

Callout	Component Name
Preliminary Procedure <u>Drive Belt Replacement</u>	
1	Drive Belt Tensioner Bolt [2x] CAUTION: Refer to <u>Fastener Caution</u> . Tighten 30 N.m (22 lb ft)
2	Drive Belt Tensioner

GENERATOR AND DRIVE BELT TENSIONER BRACKET REPLACEMENT

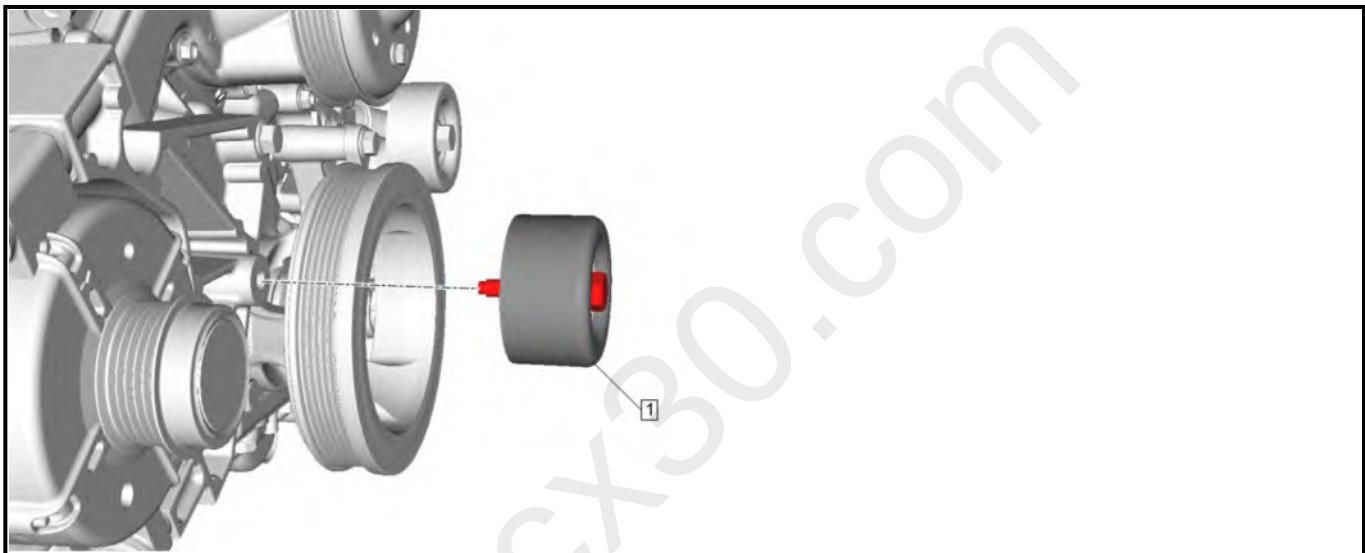


NOTE: Callouts in the following chart represent components shown in graphic above.

Callout	Component Name
Preliminary Procedures	

Callout	Component Name
1. <u>Drive Belt Idler Pulley Replacement</u> 2. <u>Generator Replacement (LGZ)</u>	
1	Generator Bracket Bolt [4X] CAUTION: Refer to <u>Fastener Caution</u> Tighten 22 N.m (16 lb ft)
2	Generator Bracket

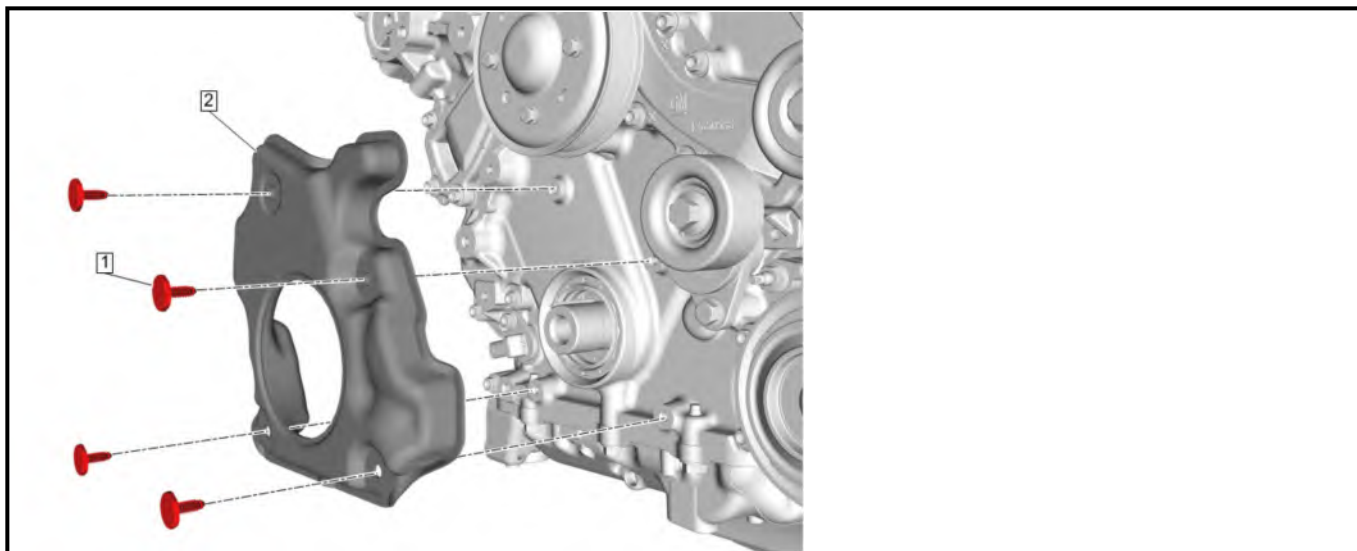
DRIVE BELT IDLER PULLEY REPLACEMENT



NOTE: Callouts in the following chart represent components shown in graphic above.

Callout	Component Name
Preliminary Procedure <u>Drive Belt Replacement</u>	
1	Drive Belt Idler Pulley CAUTION: Refer to <u>Fastener Caution</u> . Tighten 22 N.m (16 lb ft)

ENGINE FRONT COVER INSULATOR REPLACEMENT



NOTE: Callouts in the following chart represent components shown in graphic above.

Callout	Component Name
Preliminary Procedure <u>Crankshaft Balancer Replacement (without Bison)</u> , or <u>Crankshaft Balancer Replacement (with Bison)</u>	
1	Engine Front Cover Retainer [4x]
2	Engine Front Cover WARNING: The noise cancelling foam component MUST be replaced if it has been exposed to engine fluids. Failure to replace the noise cancelling foam component that has been exposed to engine fluids may result in an engine fire resulting in catastrophic engine damage, and possible injury or death.

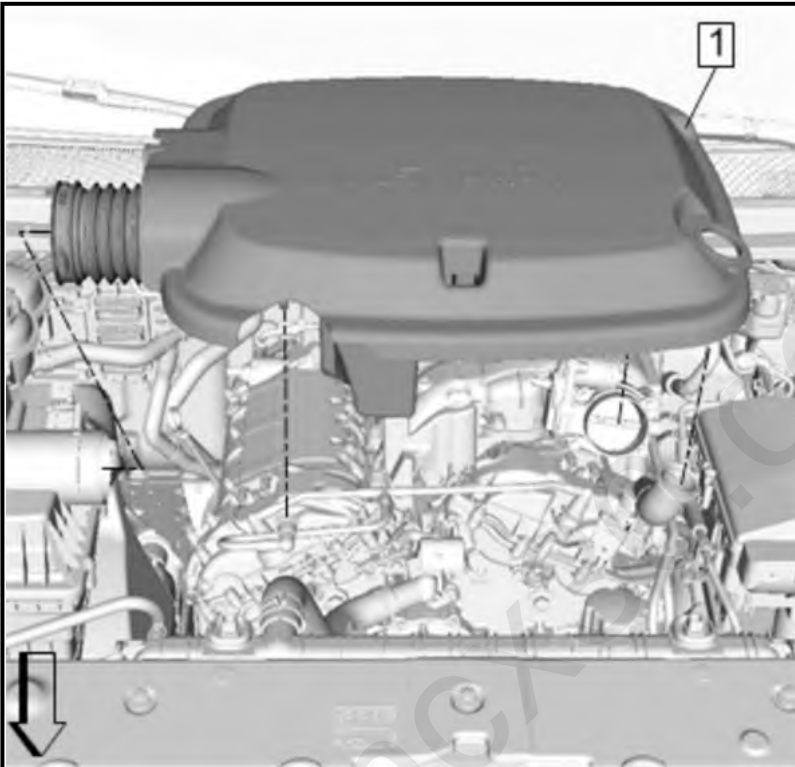
ENGINE SUPPORT FIXTURE

Special Tools

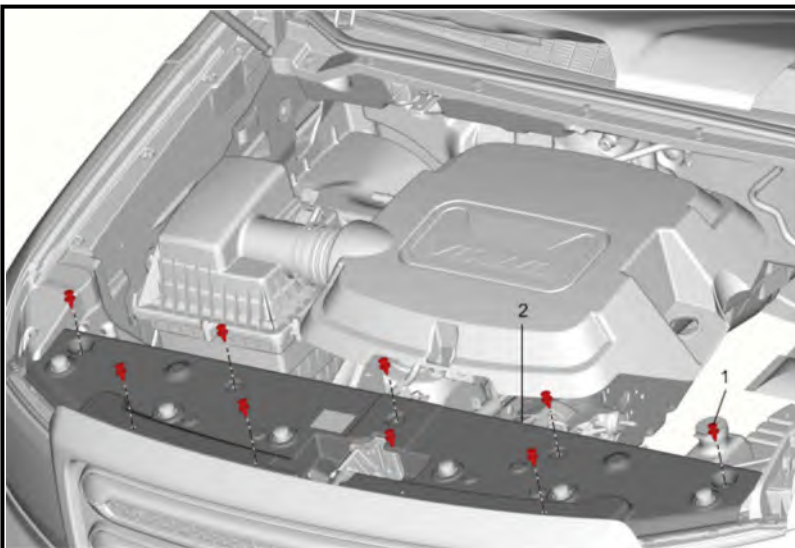
- EN-28467 - 50 Engine Support Hook
- EN-36857 Engine Lift Bracket
- EN-51007 Engine Support Fixture
- EN-52059 Engine Support Fixture Adaptor Bolt - M10

Installation Procedure

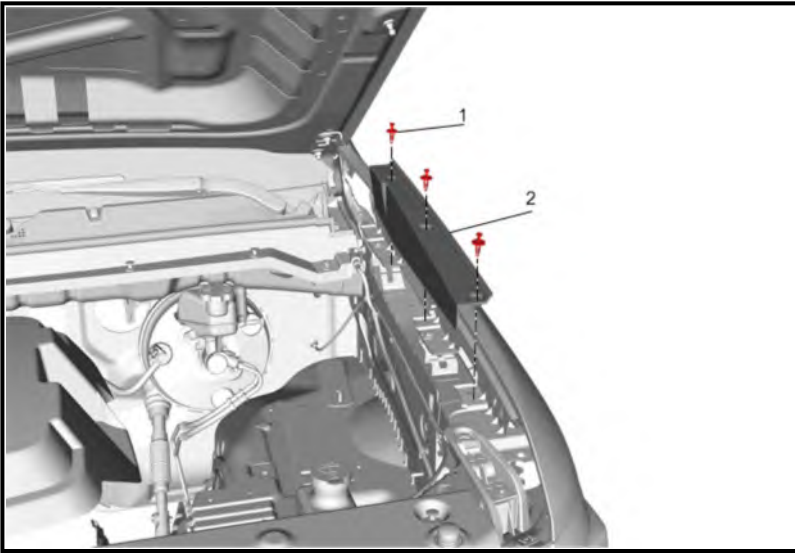
1. Disconnect the negative battery cable. [Battery Negative Cable Disconnection and Connection](#)
2. Air Cleaner Outlet Duct (1) - Remove - [Air Cleaner Outlet Duct Replacement](#)



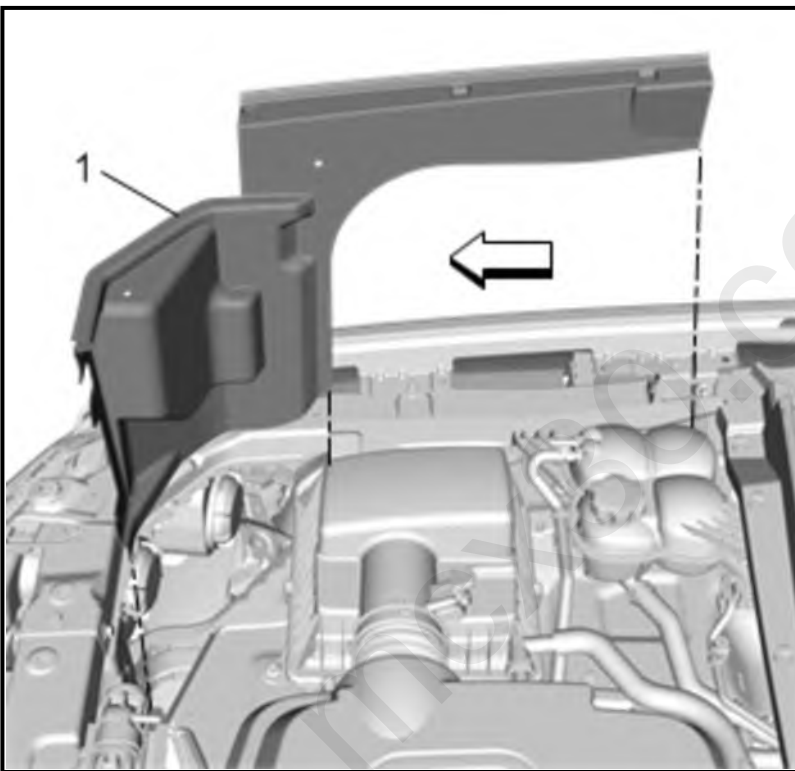
3. {If equipped} Front Compartment Front Sight Shield (2) - Remove - [Front Compartment Front Sight Shield Replacement](#)



4. Front Compartment Side Sight Shield (2) - Remove - [Front Compartment Side Sight Shield Replacement](#)

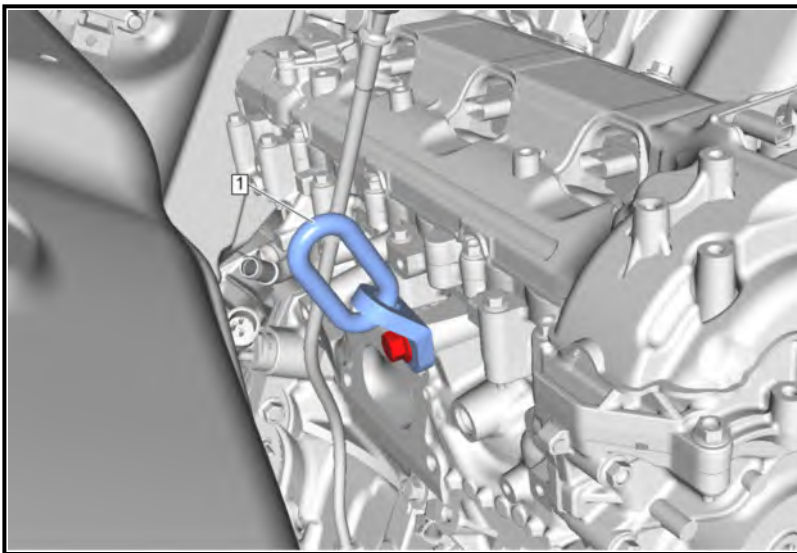


5. Intake Air Splash Shield (1) - Remove - [Intake Air Splash Shield Replacement](#)

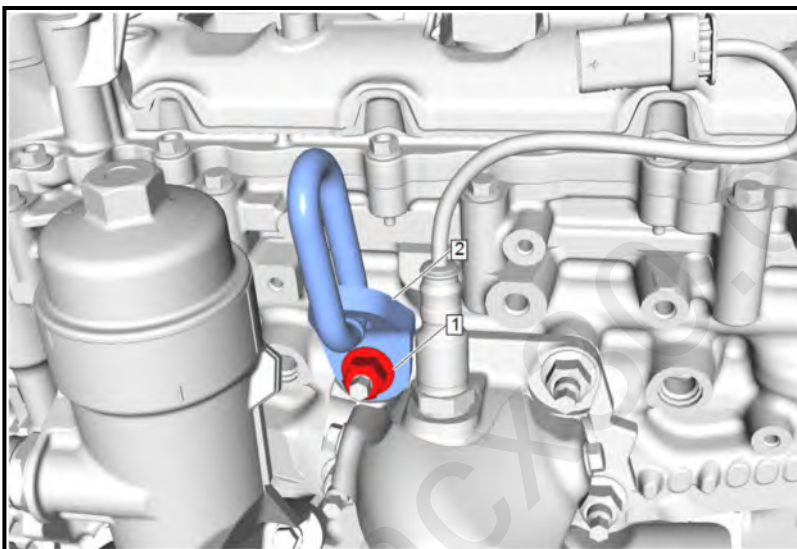


6. Loosen the transmission mount nuts. [Transmission Mount Replacement \(4WD\)](#) , or [Transmission Mount Replacement \(2WD\)](#).

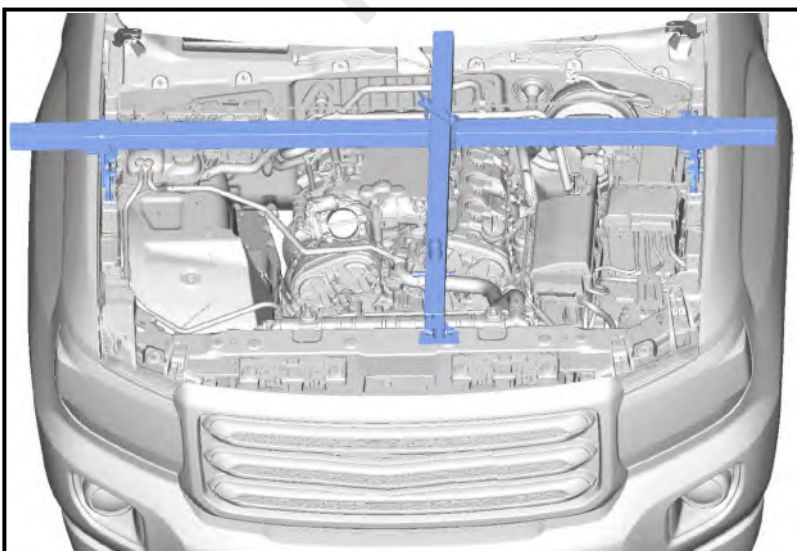
7. If servicing the right side engine mount, install **EN-36857** Engine Lift Bracket (1) to the front of the right side cylinder head as shown using **EN-52059** Engine Support Fixture Adaptor Bolt - M10



8. If servicing the left side engine mount, install **EN-36857** Engine Lift Bracket (2) to the front of the left side cylinder head as shown using the warm up three-way catalytic converter nut (1). [Warm Up Three-Way Catalytic Converter Replacement \(Left Side, LGZ 2WD\)](#) , or [Warm Up Three-Way Catalytic Converter Replacement \(Left Side, LGZ 4WD\)](#).



9. Install the **EN-51007** Engine Support Fixture as shown.

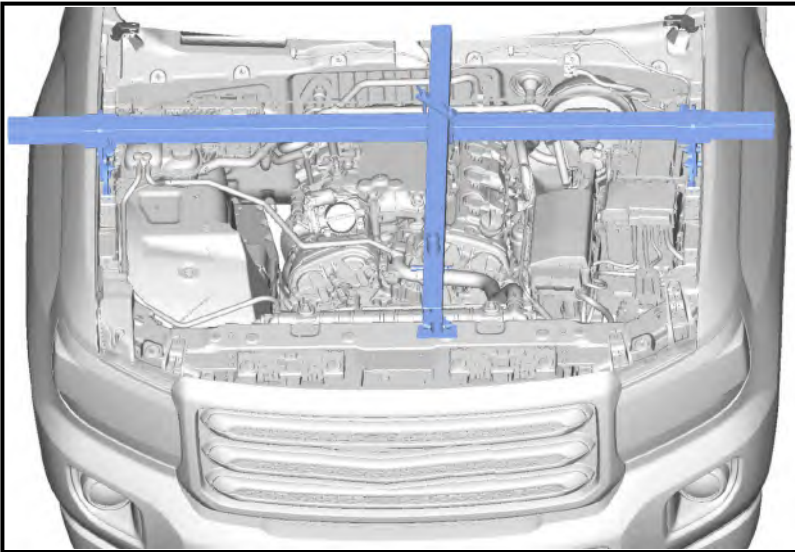


NOTE: Ensure the cross bar is level.

10. Tighten the wing nuts until the engine weight is supported by the engine support fixture and no longer carried by the engine mounts.

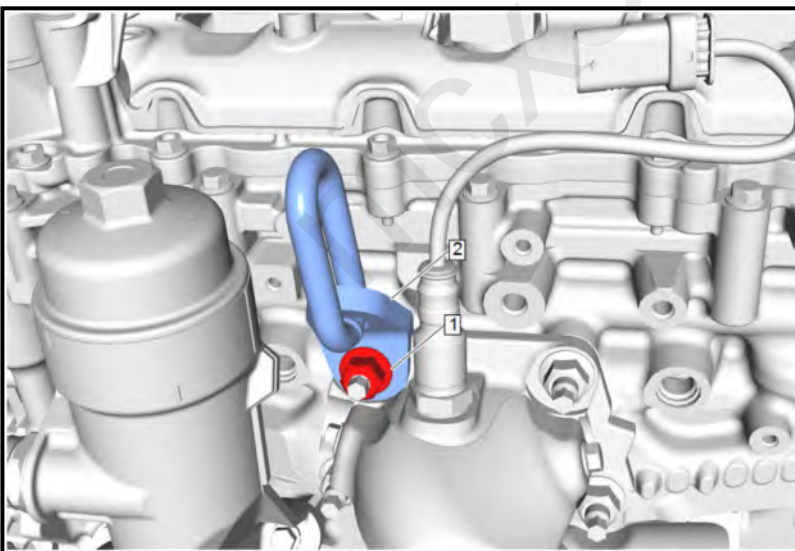
Removal Procedure

1. Loosen the wing nuts.
2. Remove the **EN-51007** Engine Support Fixture.

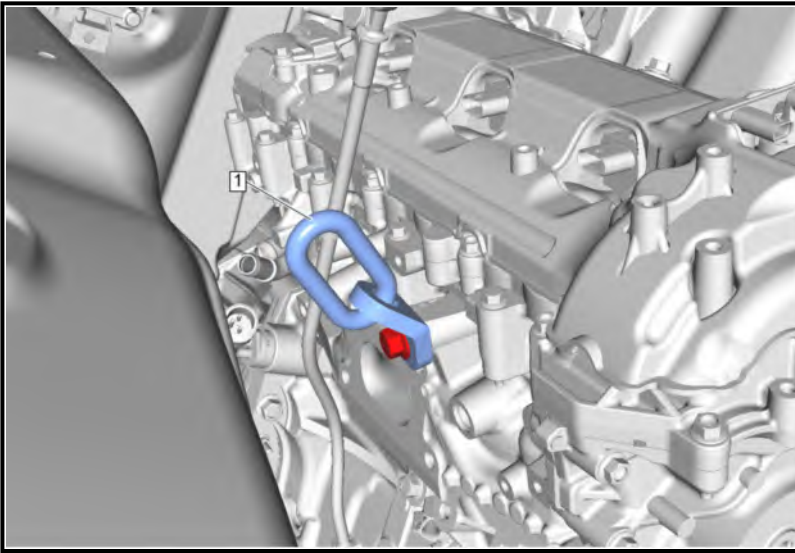


NOTE: Ensure the cross bar is level.

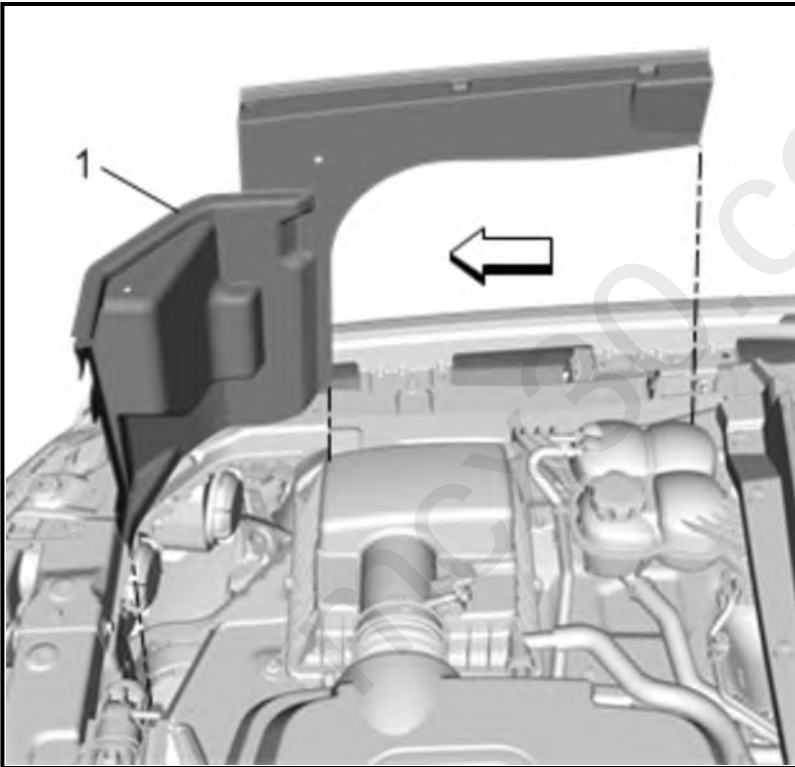
3. Remove the **EN-36857** Engine Lift Bracket (2) from the front of the left side cylinder head and reinstall the warm up three-way catalytic converter nut (1). [Warm Up Three-Way Catalytic Converter Replacement \(Left Side, LGZ 2WD\)](#) , or [Warm Up Three-Way Catalytic Converter Replacement \(Left Side, LGZ 4WD\)](#)



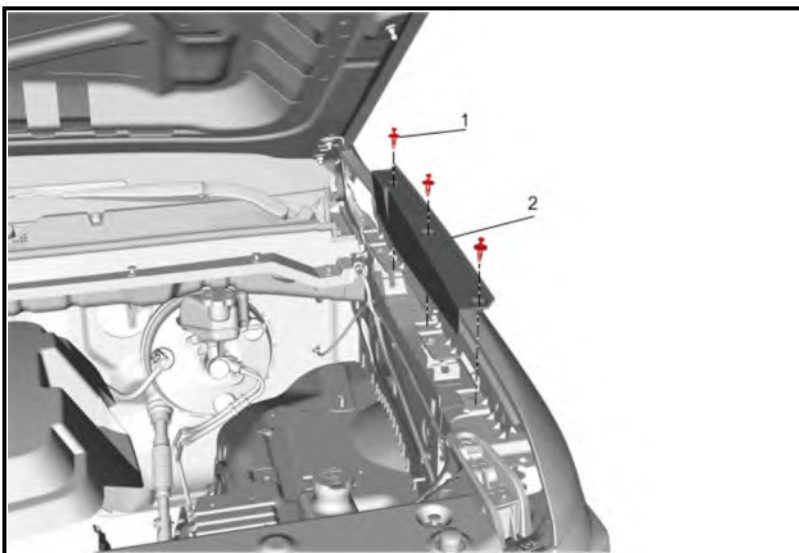
4. Remove the **EN-52059** Engine Support Fixture Adaptor Bolt - M10 and the **EN-36857** Engine Lift Bracket (1) from the front of the right side cylinder head



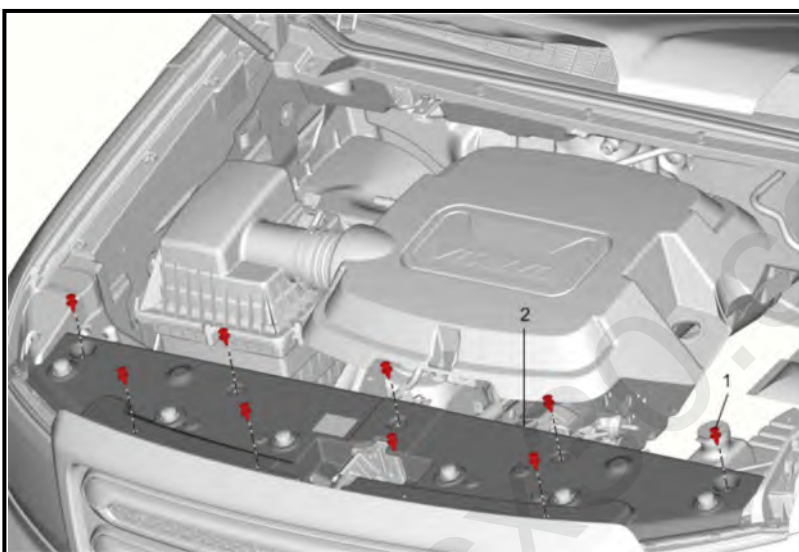
5. Tighten the transmission mount nuts. [Transmission Mount Replacement \(4WD\)](#) , or [Transmission Mount Replacement \(2WD\)](#)
6. Intake Air Splash Shield (1) - Install - [Intake Air Splash Shield Replacement](#)



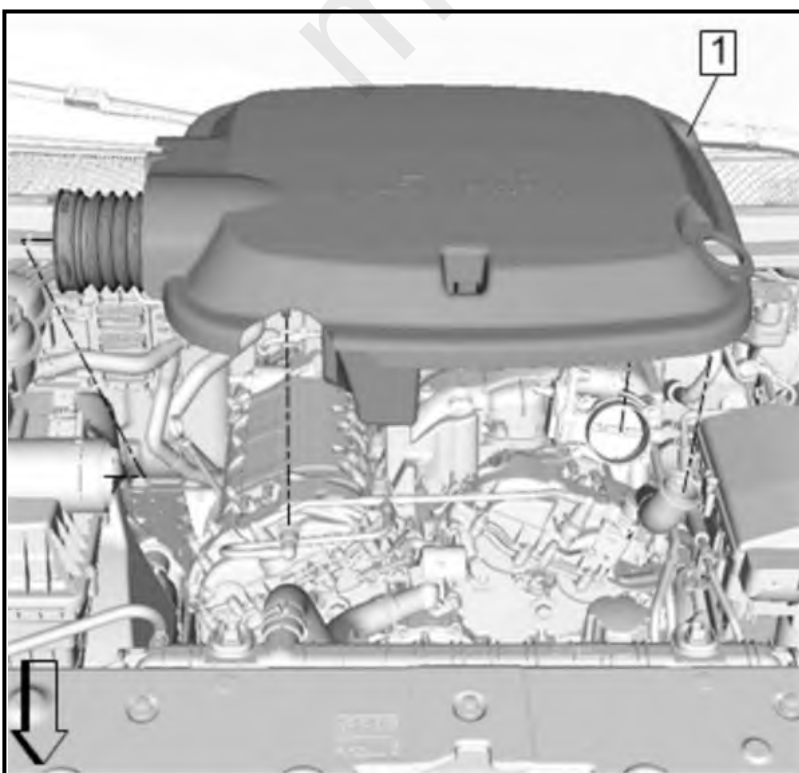
7. Front Compartment Side Sight Shield (2) - Install - [Front Compartment Side Sight Shield Replacement](#)



8. {If equipped} Front Compartment Front Sight Shield (2) - Install - [Front Compartment Front Sight Shield Replacement](#)



9. Air Cleaner Outlet Duct (1) - Install - [Air Cleaner Outlet Duct Replacement](#)



10. Connect the negative battery cable. [Battery Negative Cable Disconnection and Connection](#)

ENGINE MOUNT INSPECTION

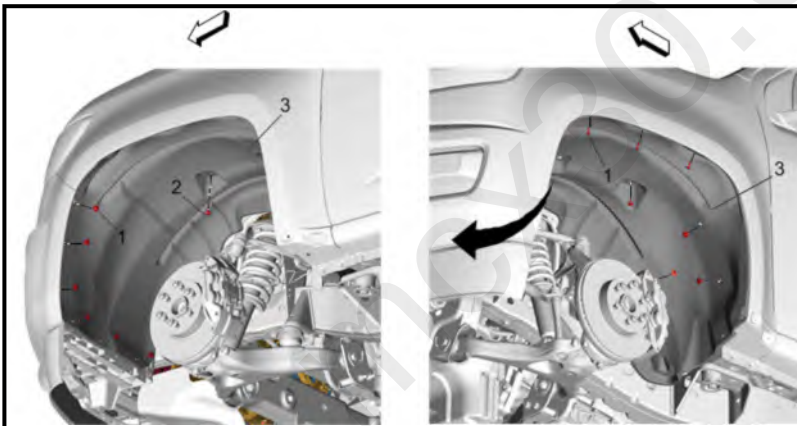
NOTE: Before replacing any engine mount due to suspected fluid loss, verify that the source of the fluid is the engine mount, not the engine or accessories.

1. Install the engine support fixture. Refer to [Engine Support Fixture](#).
2. Observe the engine mount while raising the engine. Raising the engine removes the weight from the engine mount and creates slight tension on the rubber.
3. Replace the engine mount if the engine mount exhibits any of the following conditions:
 - The hard rubber is covered with heat check cracks.
 - The rubber is separated from the metal plate of the engine mount.
 - The rubber is split through the center of the engine mount.
 - The engine mount itself is leaking fluid.
4. For engine mount replacement. Refer to [Engine Mount Replacement - Left Side](#), or [Engine Mount Replacement - Right Side](#).

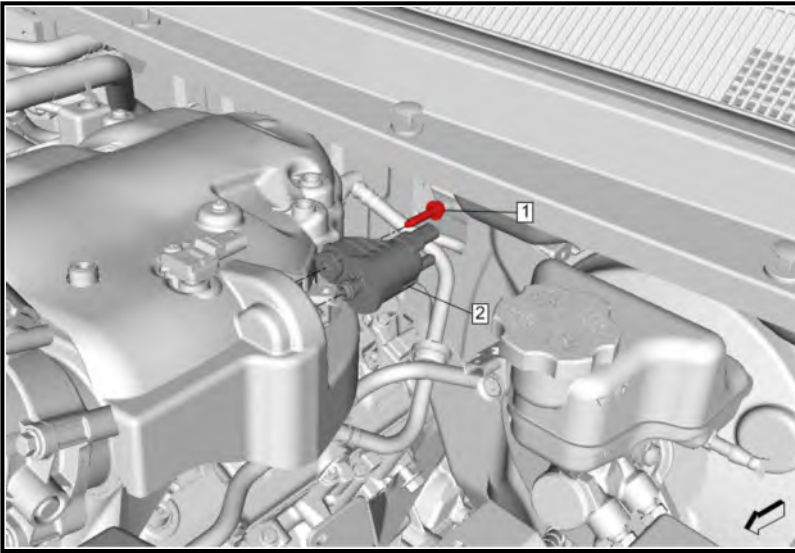
ENGINE MOUNT REPLACEMENT - LEFT SIDE

Removal Procedure

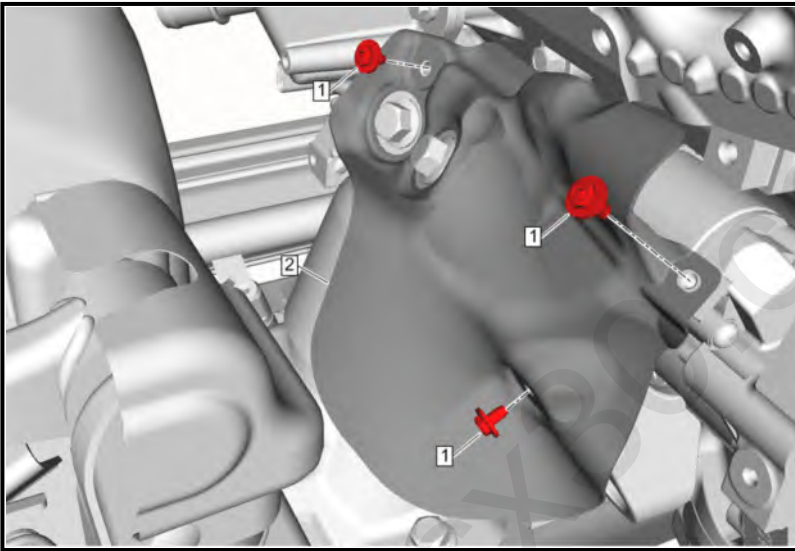
1. Front Wheelhouse Liner-Left Side (3) - Remove - [Front Wheelhouse Liner Replacement \(Without ZR2\)](#), or [Front Wheelhouse Liner Replacement \(With ZR2\)](#), or [Front Wheelhouse Liner Replacement \(Bison\)](#).



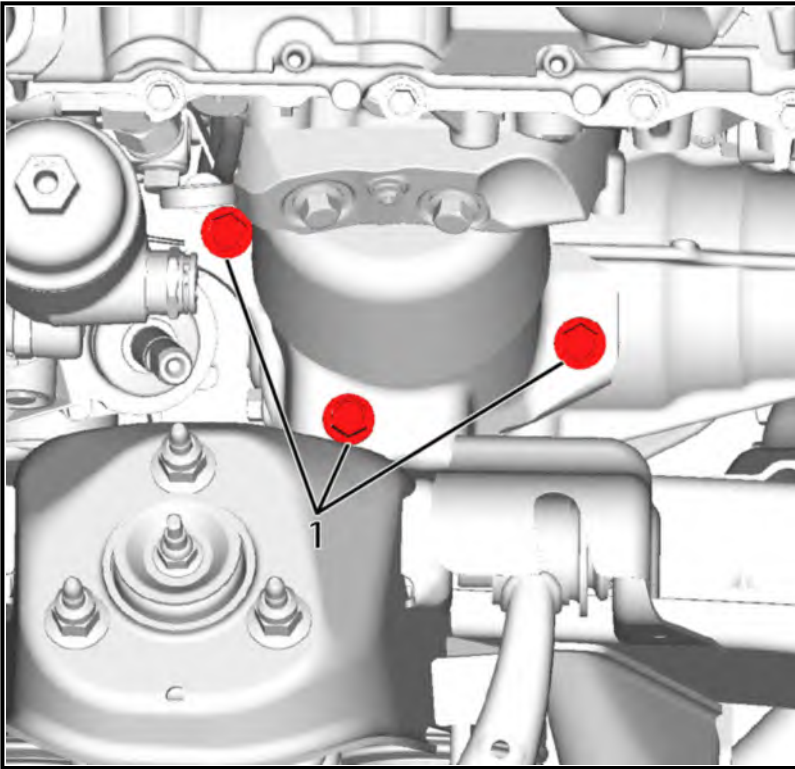
2. Catalytic Converter-Left Side - Remove - [Warm Up Three-Way Catalytic Converter Replacement \(Left Side, LGZ 2WD\)](#), or [Warm Up Three-Way Catalytic Converter Replacement \(Left Side, LGZ 4WD\)](#).
3. Evaporative Emission Canister Purge Valve (2) - Remove - [Evaporative Emission Canister Purge Solenoid Valve Replacement](#)



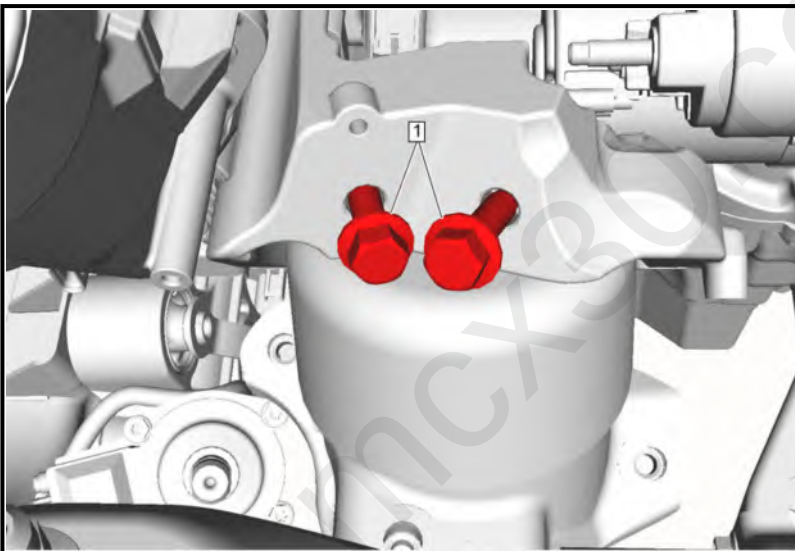
4. Install the engine support fixture. [Engine Support Fixture](#)
5. Remove the engine mount bracket shield bolts (1).



6. Remove the engine mount bracket shield (2).
7. Working through the wheel well, remove the 3 left engine front mount bracket bolts (1).

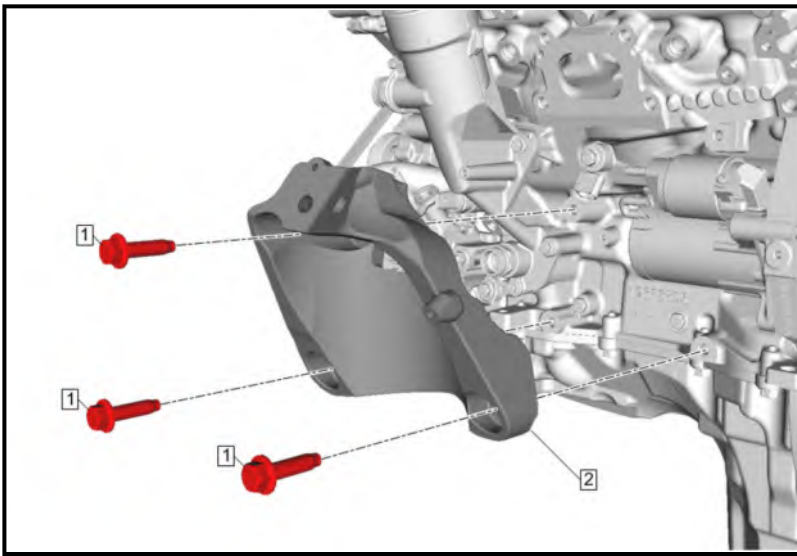


8. Remove and DISCARD the 2 left engine mount to engine mount bracket bolts (1).



9. Adjust the support fixture as necessary to provide clearance to remove the engine mount.

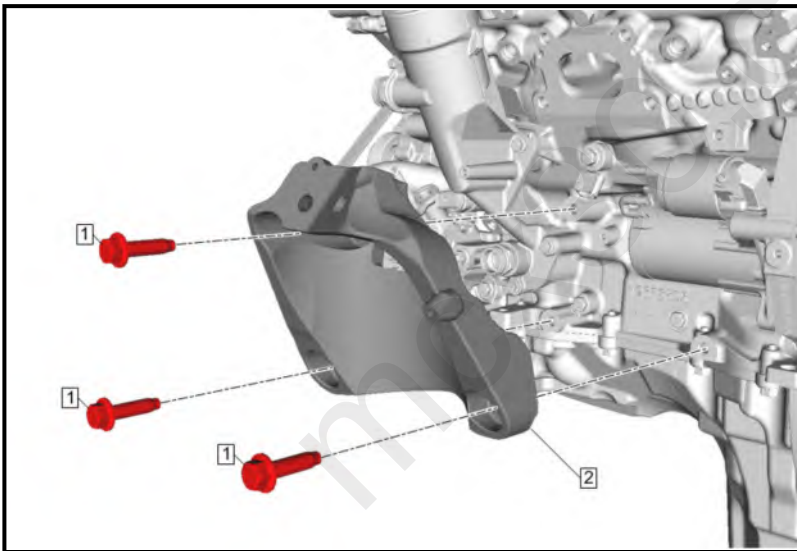
10. Remove and DISCARD the 3 engine mount bracket bolts (1).



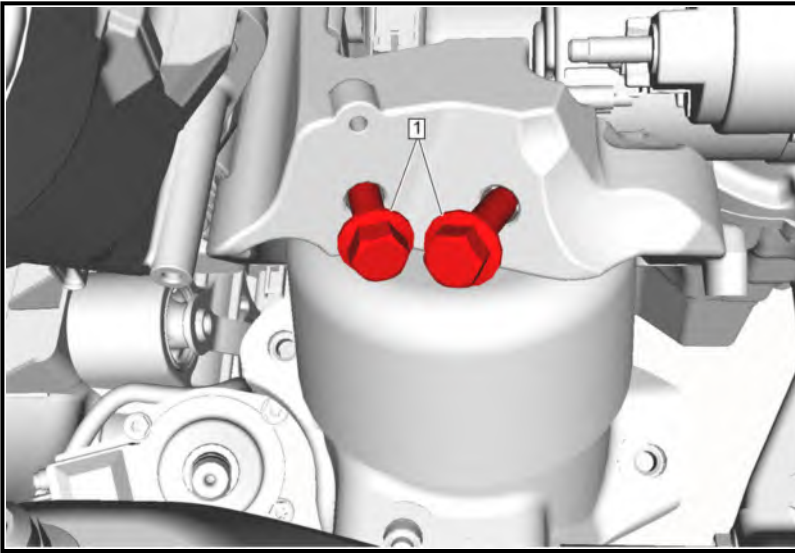
11. Remove engine mount from the bracket.
12. Remove the engine mount bracket (2).
13. Remove engine mount.

Installation Procedure

1. Install engine mount to the vehicle.
2. Install the engine mount bracket (2). [Engine Mount Bracket Replacement - Left Side](#)



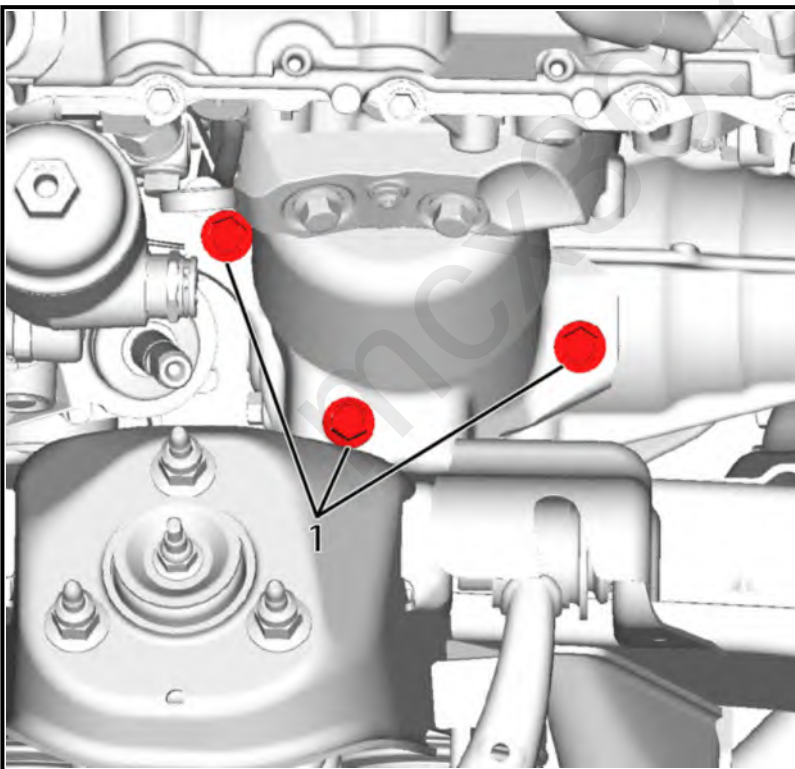
3. Adjust the support fixture as necessary to line up the engine mount to engine mount bracket bolt holes.
4. Install the NEW left engine mount to engine mount bracket bolts (1) and tighten to 58 N.m (43 lb ft)



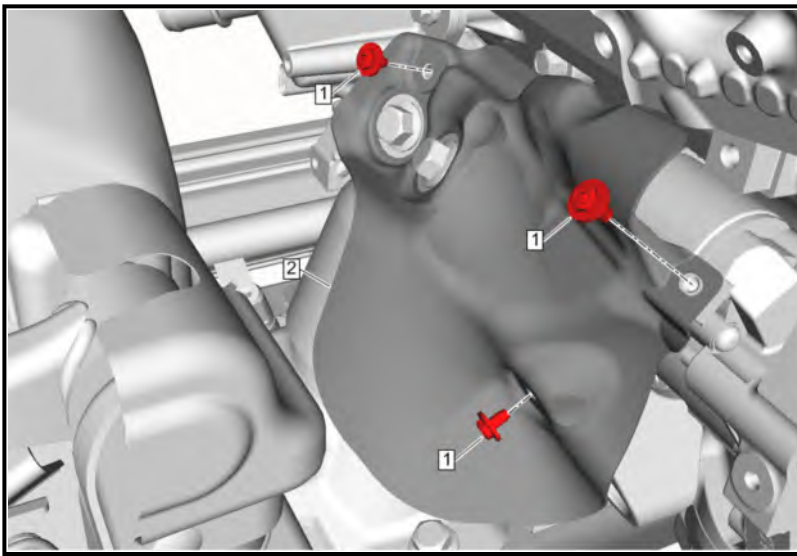
CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a **NEW** torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

CAUTION: Refer to [Fastener Caution](#)

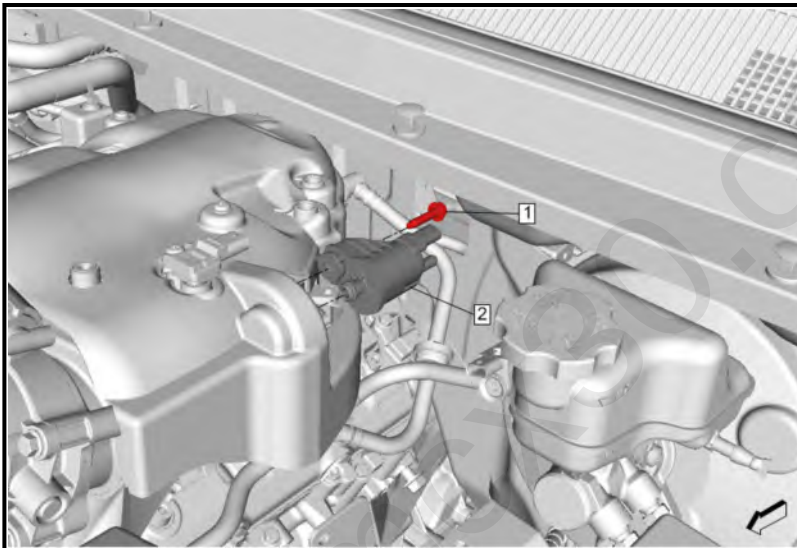
5. Working through the wheel well, install the 3 left engine front mount bracket bolts (1) and tighten to 58 N.m (43 lb ft).



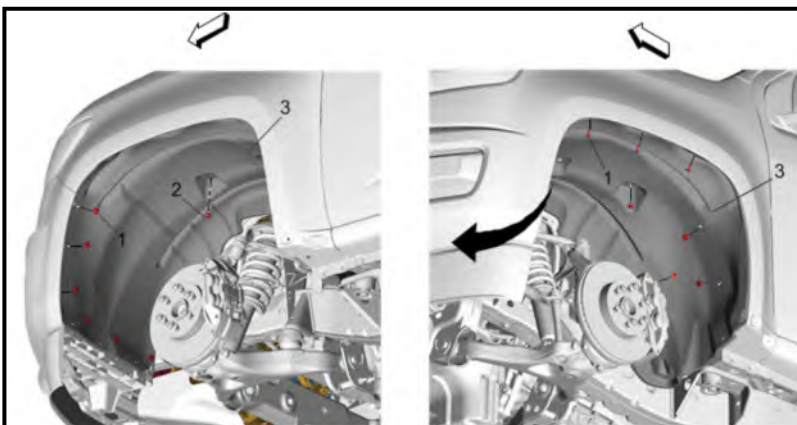
6. Install the engine mount bracket shield (2)



7. Install the engine mount bracket shield bolts (1) and tighten to 5 N.m (44 lb in).
8. Remove the engine support fixture. [Engine Support Fixture](#)
9. Evaporative Emission Canister Purge Valve (2) - Install - [Evaporative Emission Canister Purge Solenoid Valve Replacement](#)



10. Catalytic Converter-Left Side - Install - [Warm Up Three-Way Catalytic Converter Replacement \(Left Side, LGZ 2WD\)](#), or [Warm Up Three-Way Catalytic Converter Replacement \(Left Side, LGZ 4WD\)](#)
11. Front Wheelhouse Liner-Left Side (3) - Install - [Front Wheelhouse Liner Replacement \(Without ZR2\)](#), or [Front Wheelhouse Liner Replacement \(With ZR2\)](#), or [Front Wheelhouse Liner Replacement \(Bison\)](#)



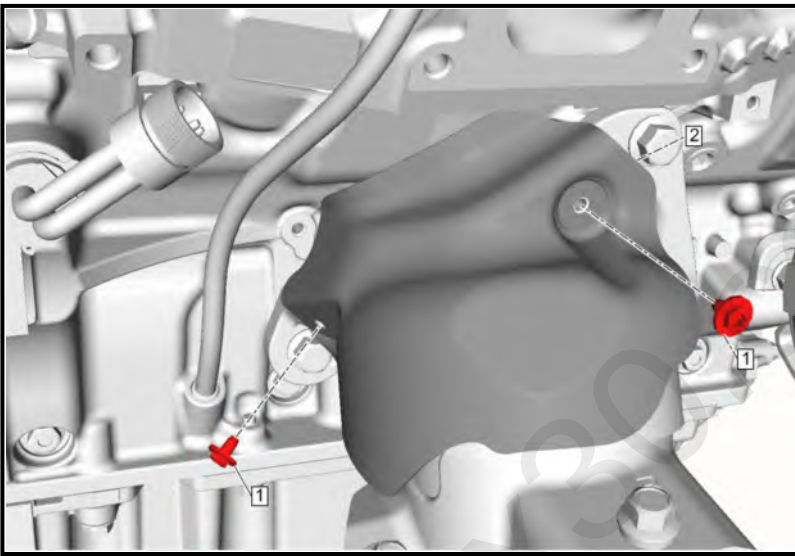
ENGINE MOUNT REPLACEMENT - RIGHT SIDE

Special Tools

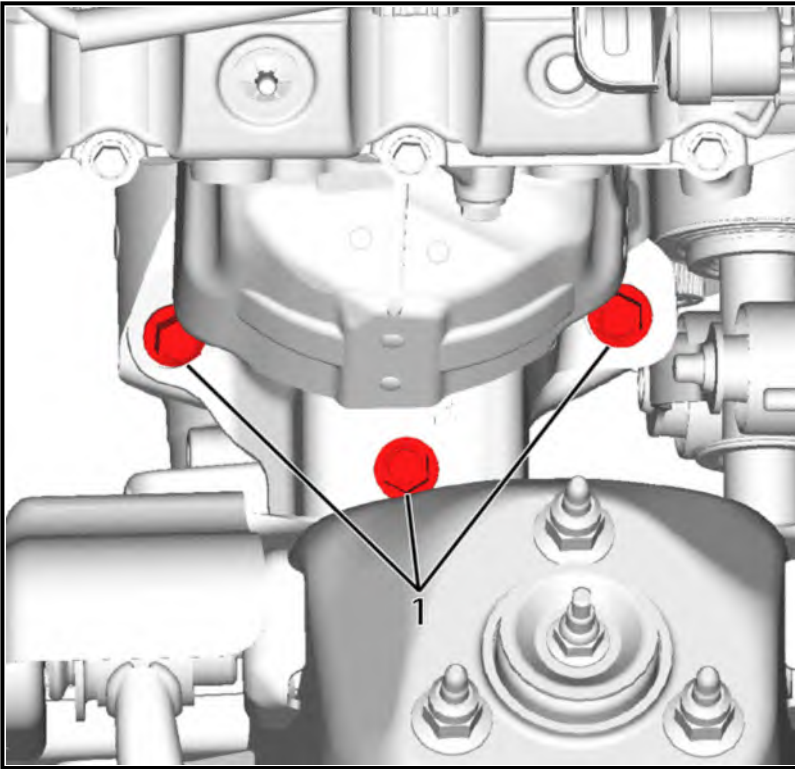
J 39580 Engine Support Stand

Removal Procedure

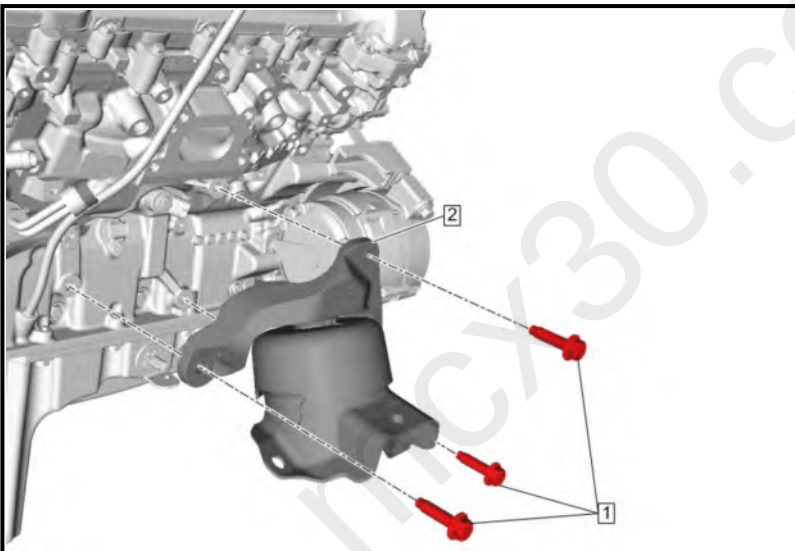
1. Install the engine support fixture. [Engine Support Fixture](#)
2. Remove the right front wheel. [Tire and Wheel Removal and Installation](#)
3. Remove the right front wheelhouse liner. [Front Wheelhouse Liner Replacement \(Without ZR2\)](#) , or [Front Wheelhouse Liner Replacement \(With ZR2\)](#) , or [Front Wheelhouse Liner Replacement \(Bison\)](#)
4. Remove the right side catalytic converter. [Warm Up Three-Way Catalytic Converter Replacement \(Right Side, LGZ\)](#)
5. Remove the 2 engine mount bracket shield bolts (1).



6. Remove the engine mount bracket shield (2).
7. Remove the 3 right engine front mount bracket bolts (1).



8. Remove and DISCARD the 3 right engine mount to engine bolts (1).

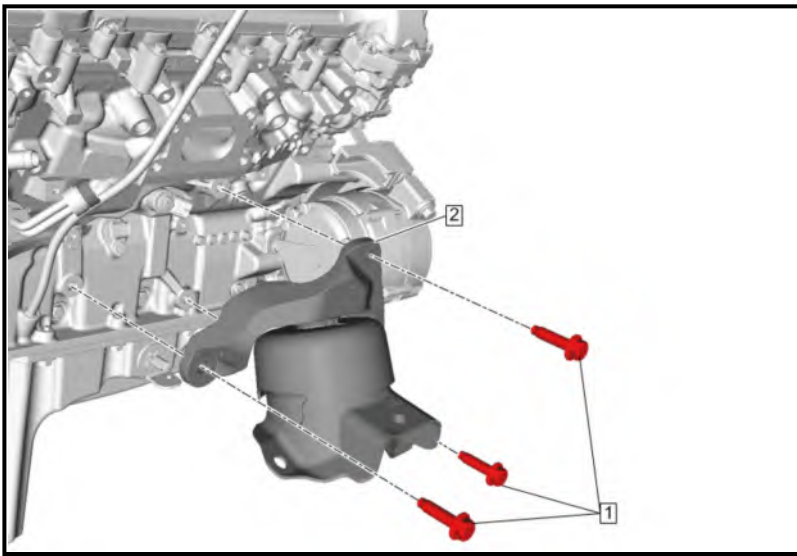


9. Remove engine mount bracket and engine mount as an assembly.

10. Transfer parts as necessary.

Installation Procedure

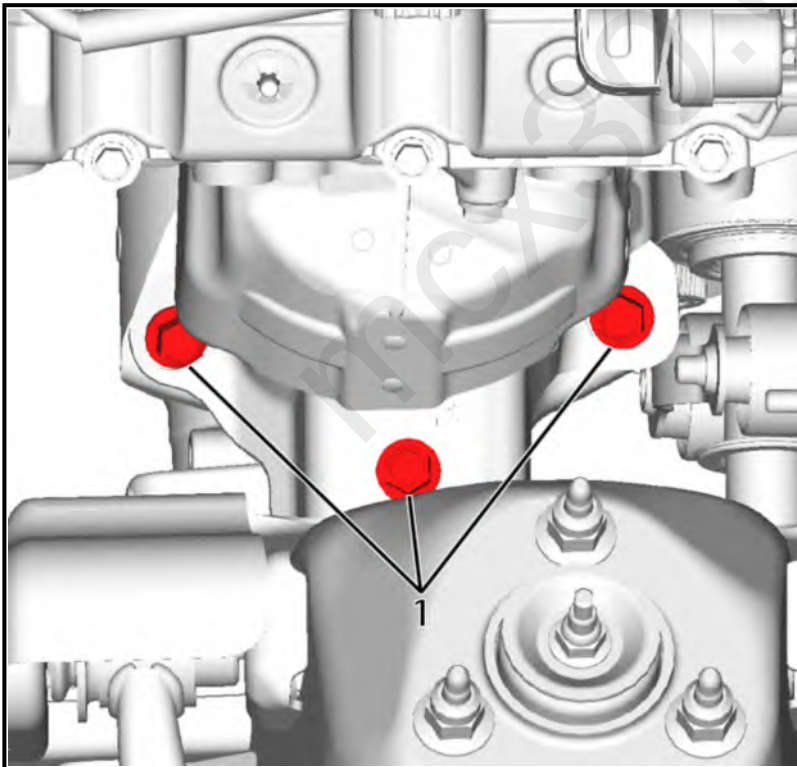
1. Install engine mount bracket and engine mount as an assembly (2).



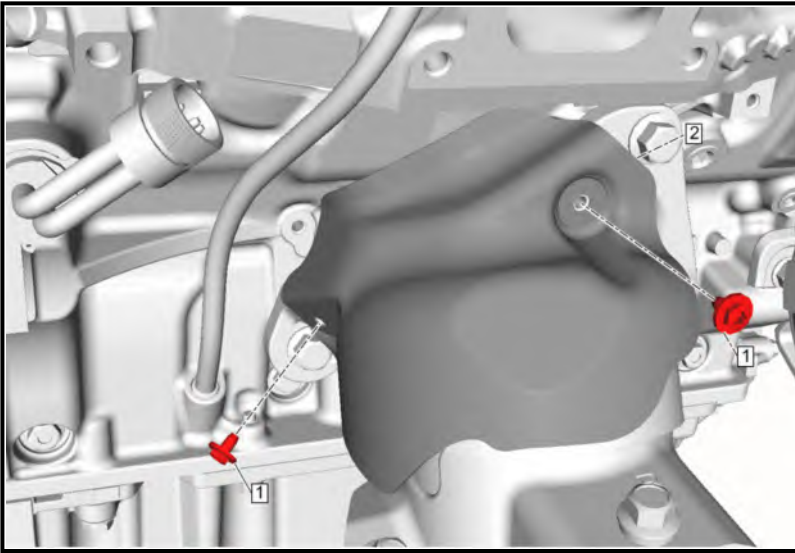
CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a **NEW** torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

CAUTION: Refer to [Fastener Caution](#)

2. Install the 3 NEW right engine mount to engine bolts (1) and tighten to 58 N.m (43 lb ft).
3. Install the 3 left engine front mount bracket bolts (1) and tighten to 58 N.m (43 lb ft).



4. Install the engine mount bracket shield (2)

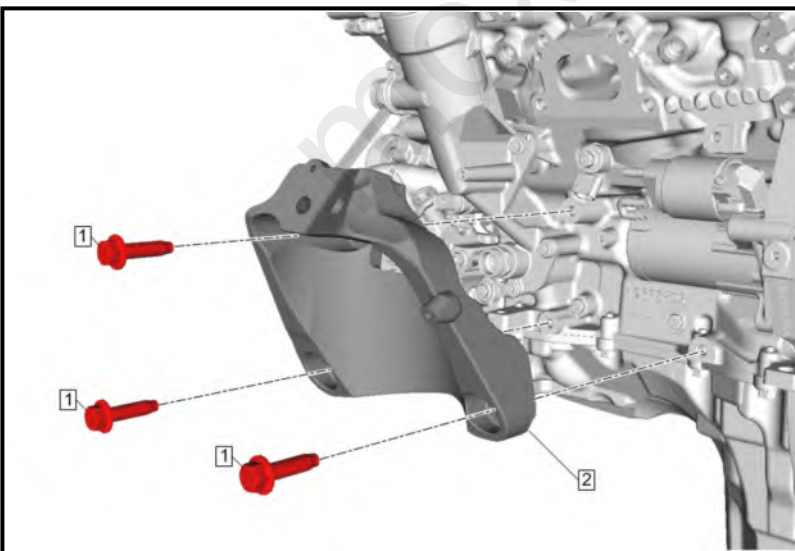


5. Install the 2 engine mount bracket shield bolts (1) and tighten to 5 N.m (44 lb in).
6. Install the right side catalytic converter. [Warm Up Three-Way Catalytic Converter Replacement \(Right Side, LGZ\)](#)
7. Install the right front wheelhouse liner. [Front Wheelhouse Liner Replacement \(Without ZR2\)](#) , or [Front Wheelhouse Liner Replacement \(With ZR2\)](#) , or [Front Wheelhouse Liner Replacement \(Bison\)](#)
8. Install the right front wheel. [Tire and Wheel Removal and Installation](#)
9. Remove the engine support fixture. [Engine Support Fixture](#)

ENGINE MOUNT BRACKET REPLACEMENT - LEFT SIDE

Removal Procedure

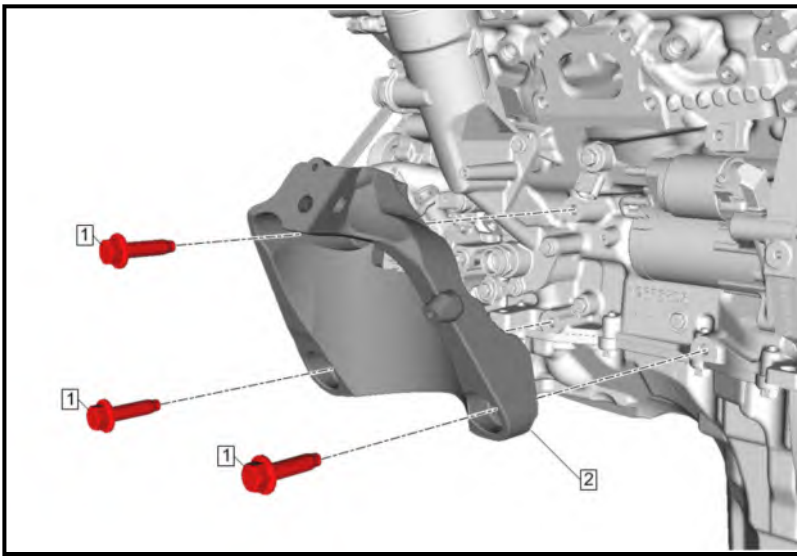
1. Remove the left side engine mount from the engine mount bracket. [Engine Mount Replacement - Left Side](#)
2. Remove and DISCARD the 3 engine mount bracket bolts (1).



3. Remove the engine mount bracket (2).

Installation Procedure

1. Install the engine mount to the vehicle.
2. Install the engine mount bracket (2).



CAUTION: Refer to [Torque-to-Yield Fastener Caution](#) .

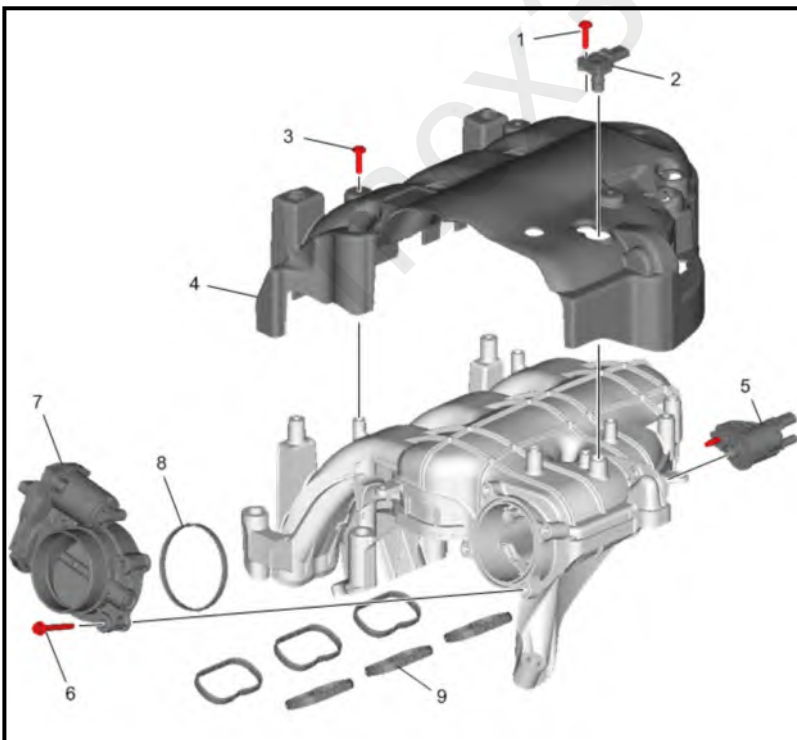
CAUTION: Refer to [Fastener Caution](#) .

3. Install the NEW engine mount bracket bolts (1) and tighten to 50 N.m (37 lb ft) plus 60-75 degrees.
4. Install the left side engine mount to the engine mount bracket. [Engine Mount Replacement - Left Side](#)

INTAKE MANIFOLD INSULATOR REPLACEMENT

Removal Procedure

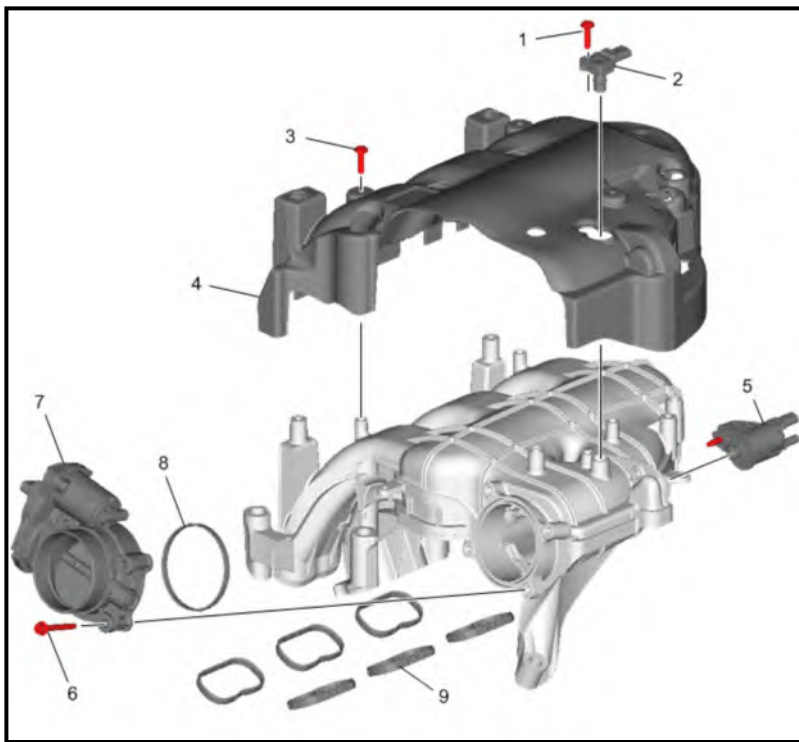
1. Intake Manifold - Remove - [Intake Manifold Replacement](#)
2. Intake Manifold Insulator Bolt (3) - Remove [3x]



3. Intake Manifold Insulator (4) - Remove

Installation Procedure

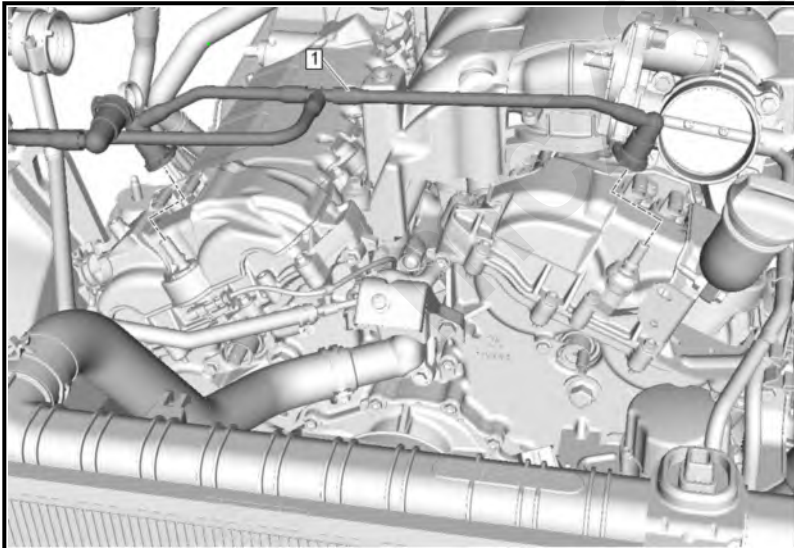
1. Intake Manifold Insulator (4) - Install



CAUTION: Refer to [Fastener Caution](#) .

2. Intake Manifold Insulator Bolt (3) - Install and tighten [3x] 10 N.m (89 lb in)
3. Intake Manifold - Install - [Intake Manifold Replacement](#)

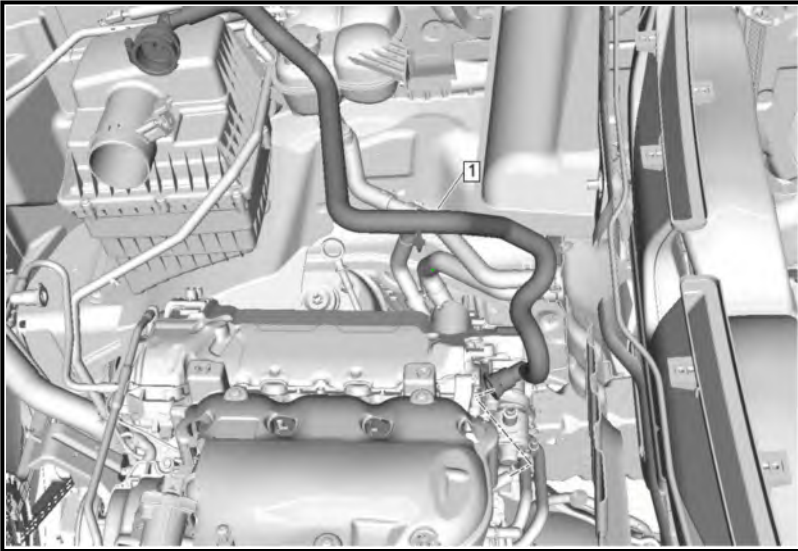
POSITIVE CRANKCASE VENTILATION HOSE/PIPE/TUBE REPLACEMENT (AIR OUTLET DUCT TO CAMSHAFT COVERS)



NOTE: Callouts in the following chart represent components shown in graphic above.

Callout	Component Name
Preliminary Procedure Air Cleaner Outlet Duct Replacement .	
1	Positive Crankcase Ventilation Tube Procedure Disconnect the PCV tube from the camshaft covers. Plastic Collar Quick Connect Fitting Service .

POSITIVE CRANKCASE VENTILATION HOSE/PIPE/TUBE REPLACEMENT (AIR OUTLET DUCT TO PCV OIL SEPARATOR)



NOTE: Callouts in the following chart represent components shown in graphic above.

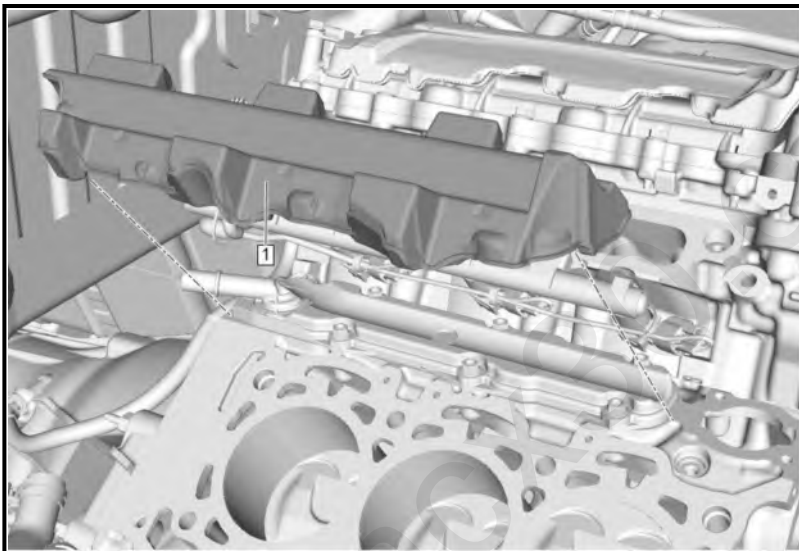
Callout	Component Name
Preliminary Procedures 1. Air Cleaner Outlet Duct Replacement 2. Engine Rear Noise Shield Replacement	
1	Positive Crankcase Ventilation Tube CAUTION: The Positive Crankcase Ventilation (PCV) line is tamper resistant and must always be replaced once it is removed. The fittings connected to the PCV line must also be replaced if they are damaged when the PCV line is removed. To reduce the risk of damage to the fittings, use a suitable

Callout	Component Name
	cutting tool and carefully cut the connections away. Procedure 1. Using a suitable cutting tool, carefully cut the PCV tube away from the PCV oil separator at the rear of the engine. If any damage occurs to the oil separator, it must be replaced. <u>Positive Crankcase Ventilation Oil Separator Replacement</u>

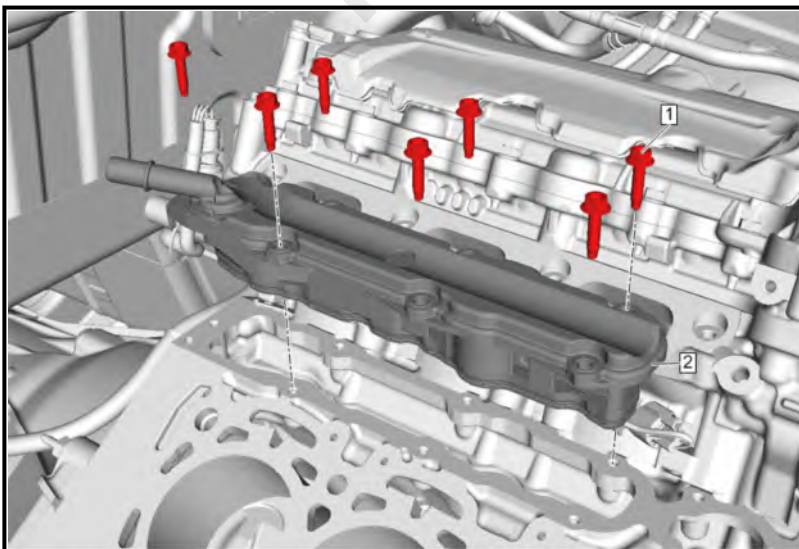
POSITIVE CRANKCASE VENTILATION OIL SEPARATOR REPLACEMENT

Removal Procedure

1. Fuel Injection Fuel Rail Noise Shield (1) - Remove - **Fuel Injection Fuel Rail Noise Shield Replacement (Upper)** , or **Fuel Injection Fuel Rail Noise Shield Replacement (Lower)**.



2. Positive Crankcase Ventilation Oil Separator Bolt (1) - Remove [7x]



3. Positive Crankcase Ventilation Oil Separator (2) - Remove

Installation Procedure

1. Positive Crankcase Ventilation Oil Separator (1) - Install

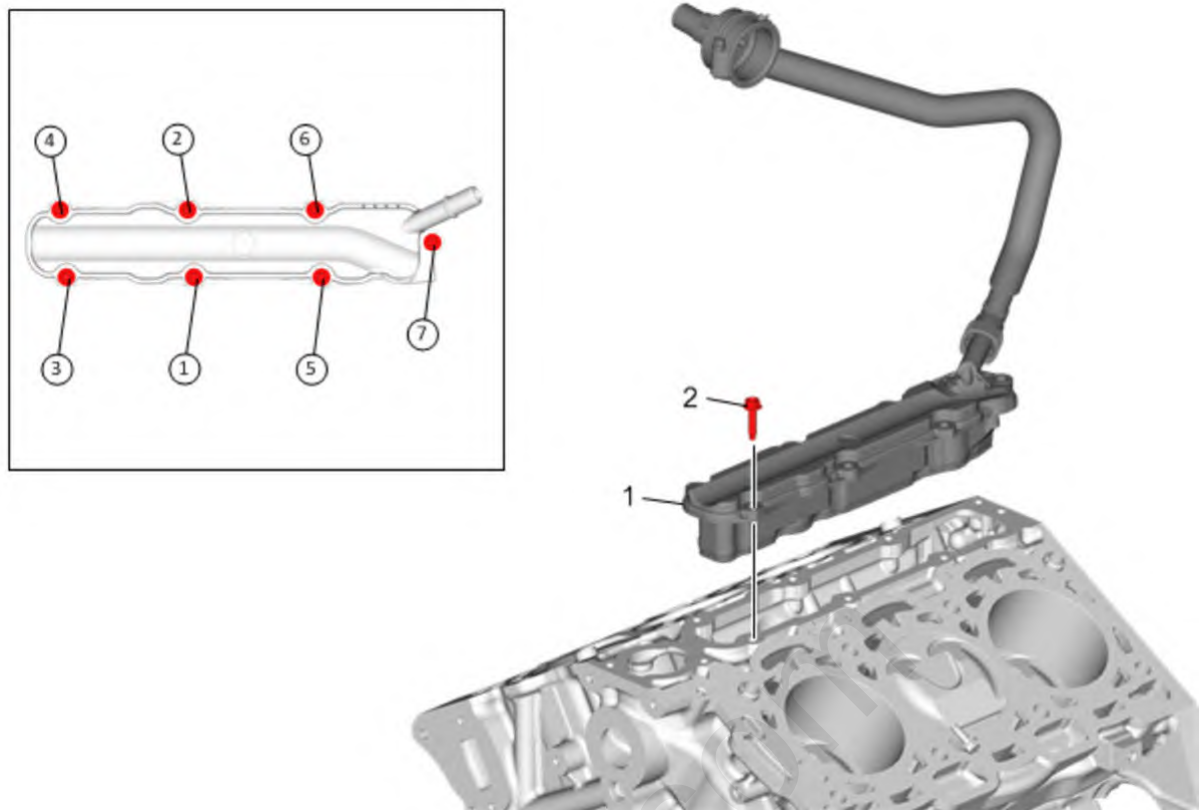
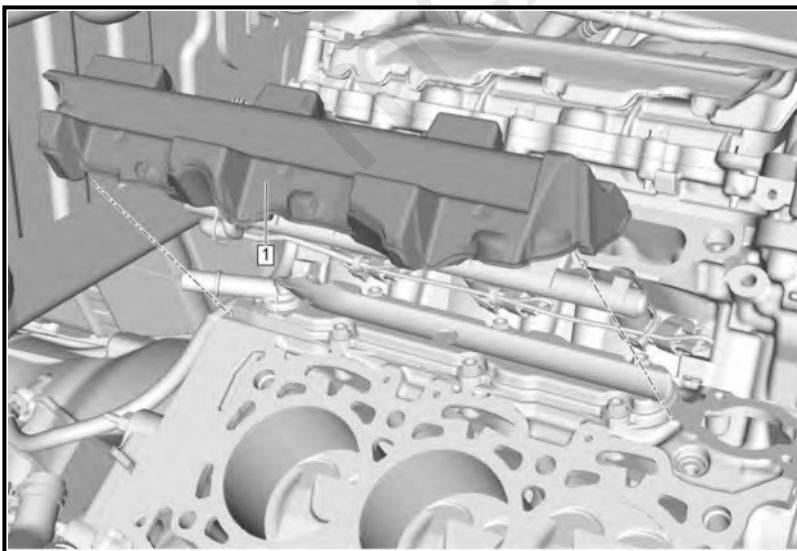


Fig. 2: Positive Crankcase Ventilation Oil Separator Bolt Tightening sequence

Courtesy of GENERAL MOTORS COMPANY

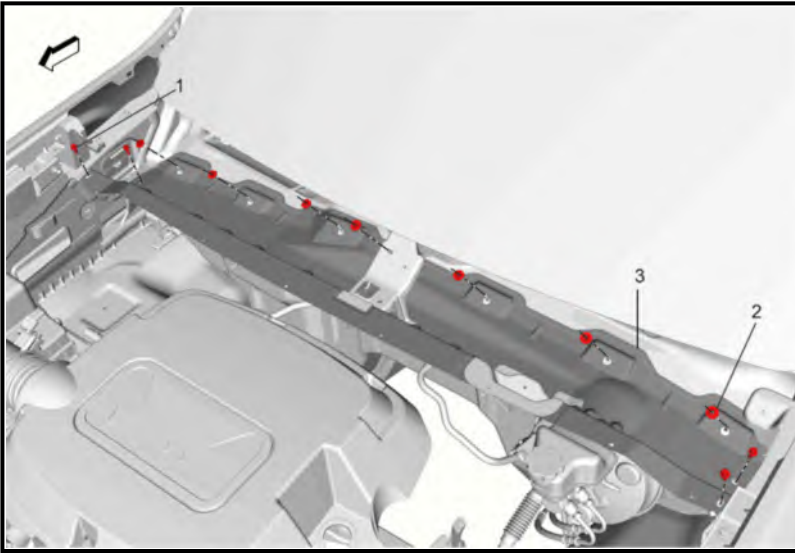
2. Positive Crankcase Ventilation Oil Separator Bolt (2) - Install and tighten in sequence [7x] 10 N.m (89 lb in)
3. Fuel Injection Fuel Rail Noise Shield (1) - Install - [Fuel Injection Fuel Rail Noise Shield Replacement \(Upper\)](#) , or [Fuel Injection Fuel Rail Noise Shield Replacement \(Lower\)](#).



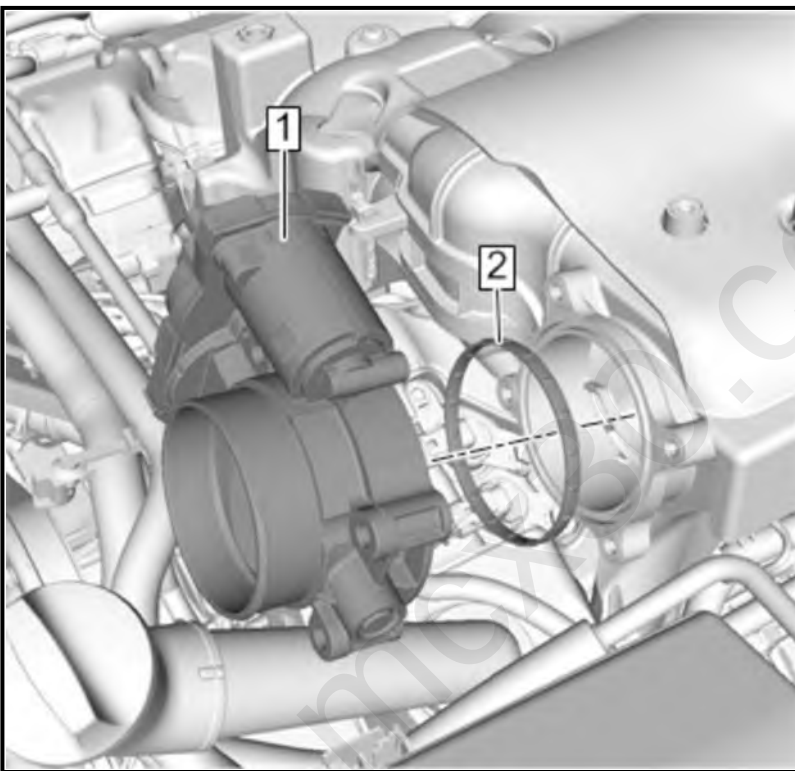
INTAKE MANIFOLD REPLACEMENT

Removal Procedure

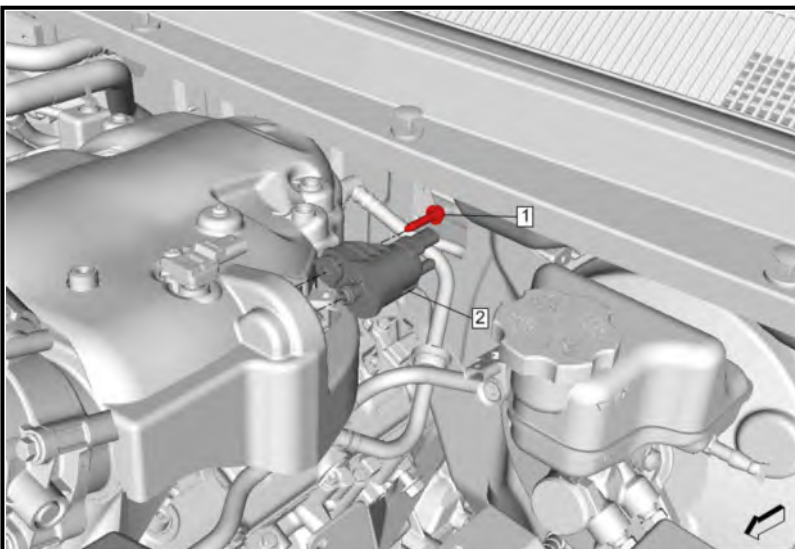
1. Plenum Front Panel (3) - Remove - [Plenum Front Panel Replacement](#)



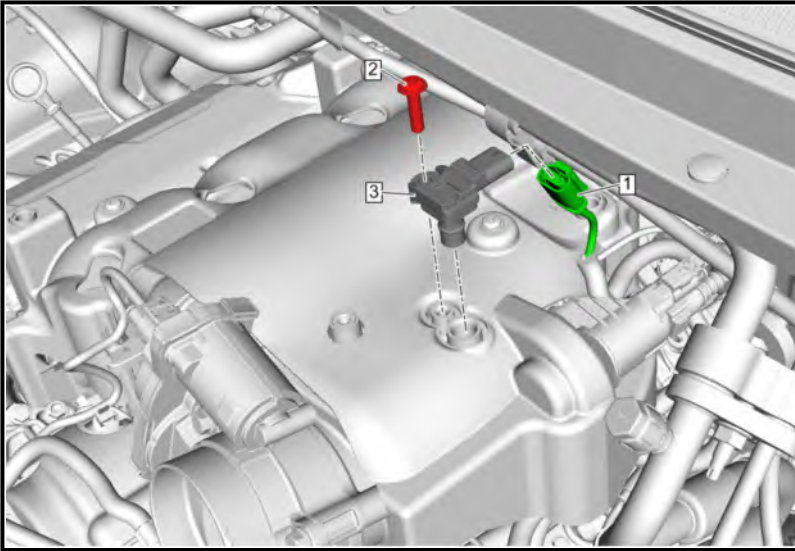
2. Throttle Body Assembly (1) - Remove - [Throttle Body Assembly Replacement](#)



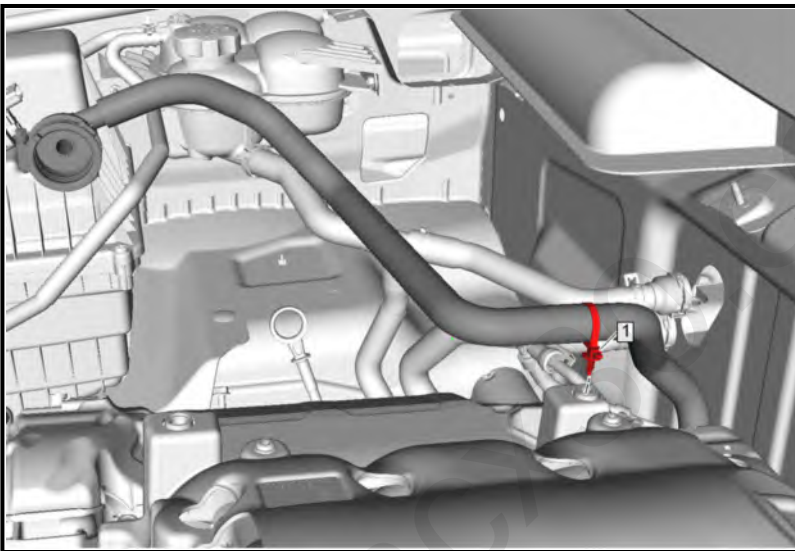
3. Evaporative Emission Canister Purge Solenoid Valve (2) - Remove - [Evaporative Emission Canister Purge Solenoid Valve Replacement](#)



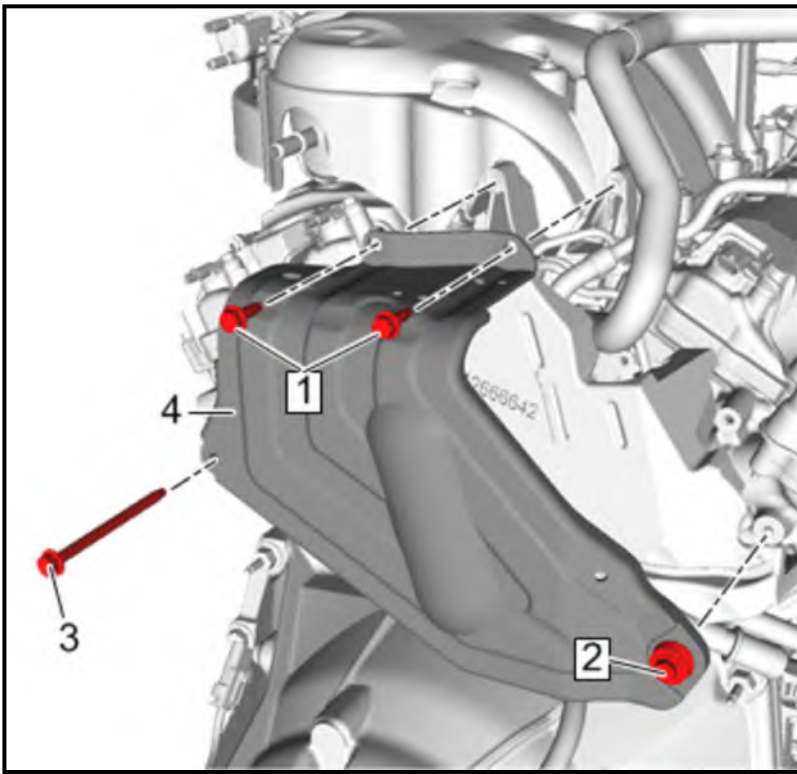
4. Manifold Absolute Pressure Sensor (3) - Remove - [Manifold Absolute Pressure Sensor Replacement](#)



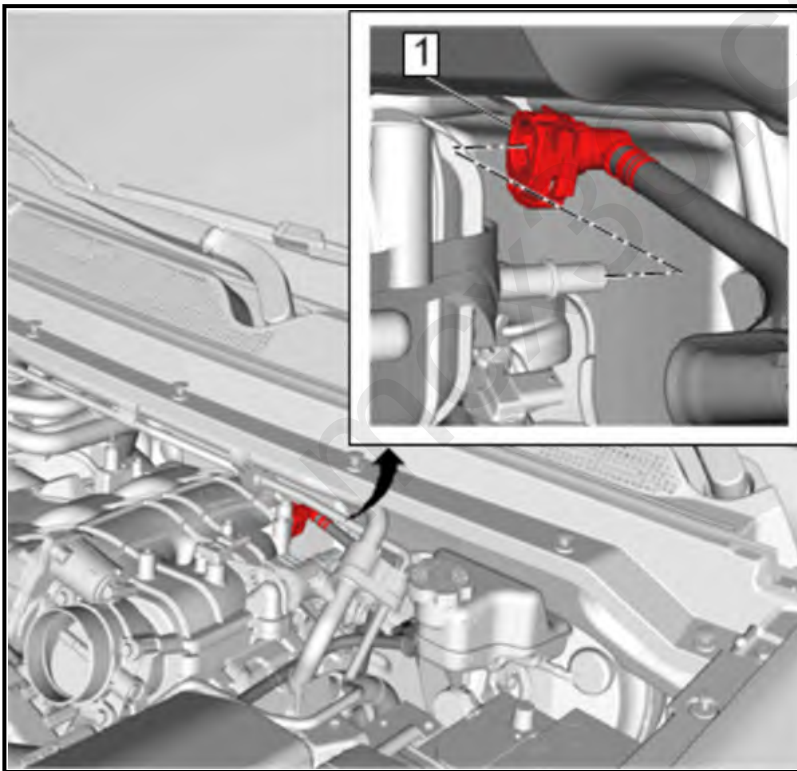
5. Positive Crankcase Ventilation Tube Clip (1) @ Intake Manifold Cover - Disconnect



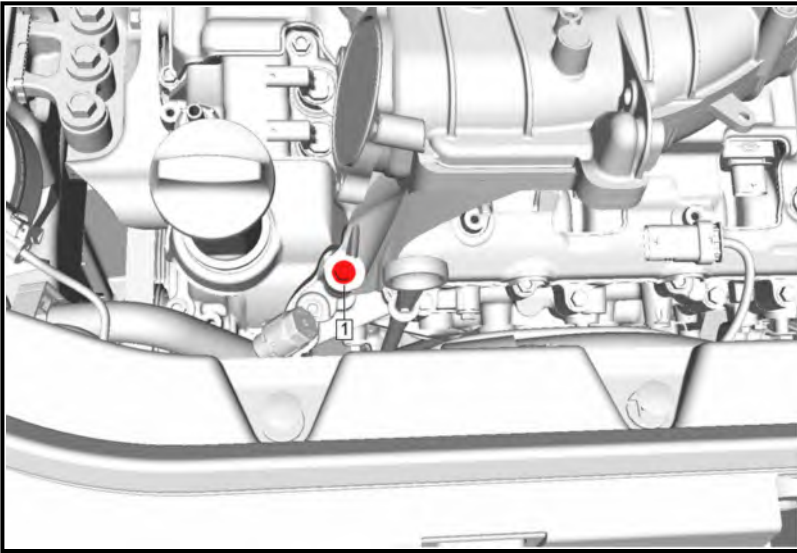
6. Fuel Pipe Shield Bolt (1) @ Intake Manifold - Remove [2x]



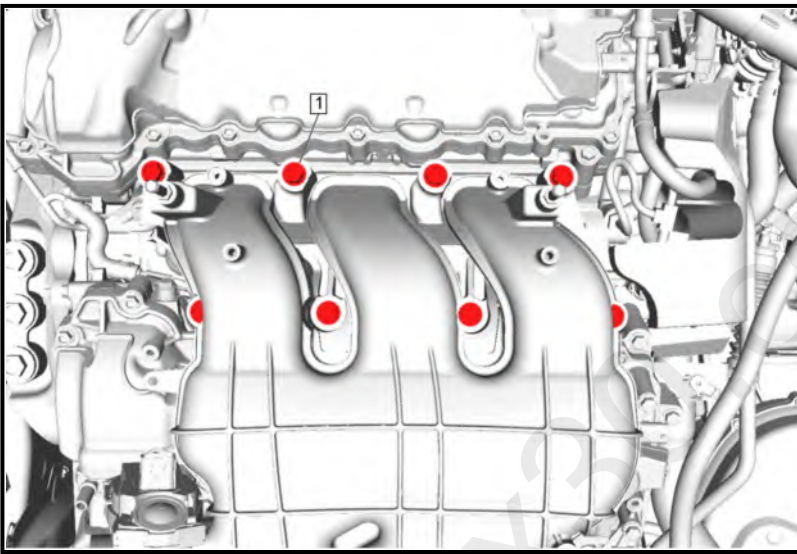
7. Quick Connect Fitting (1) @ Intake Manifold - Disconnect - [Plastic Collar Quick Connect Fitting Service](#)



8. Intake Manifold Bolt (1) - Remove



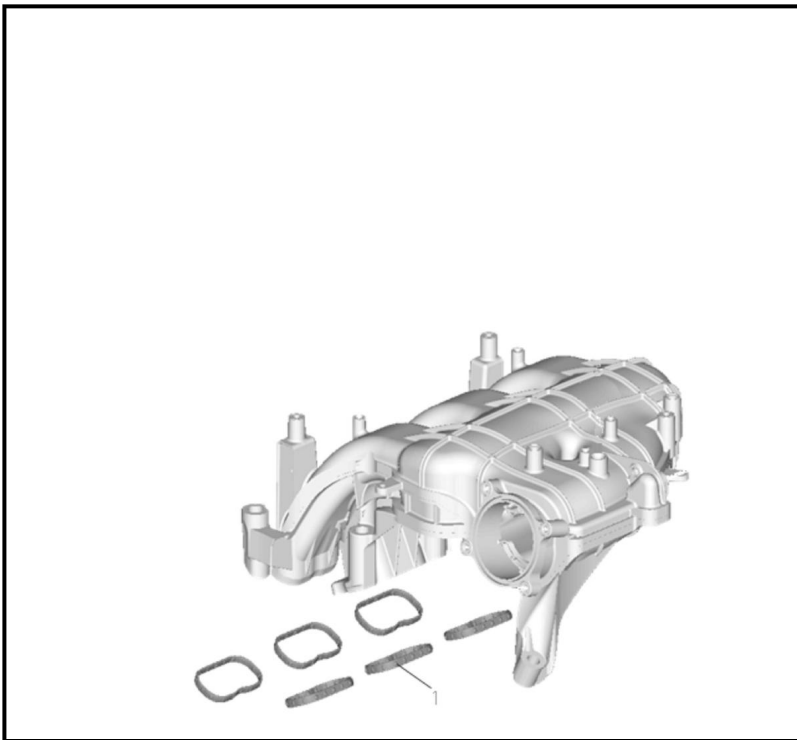
9. Intake Manifold Bolt (1) - Remove [8x]



10. Remove the intake manifold.

11. Cover the cylinder head passages in order to prevent dirt or debris from entering the passages.

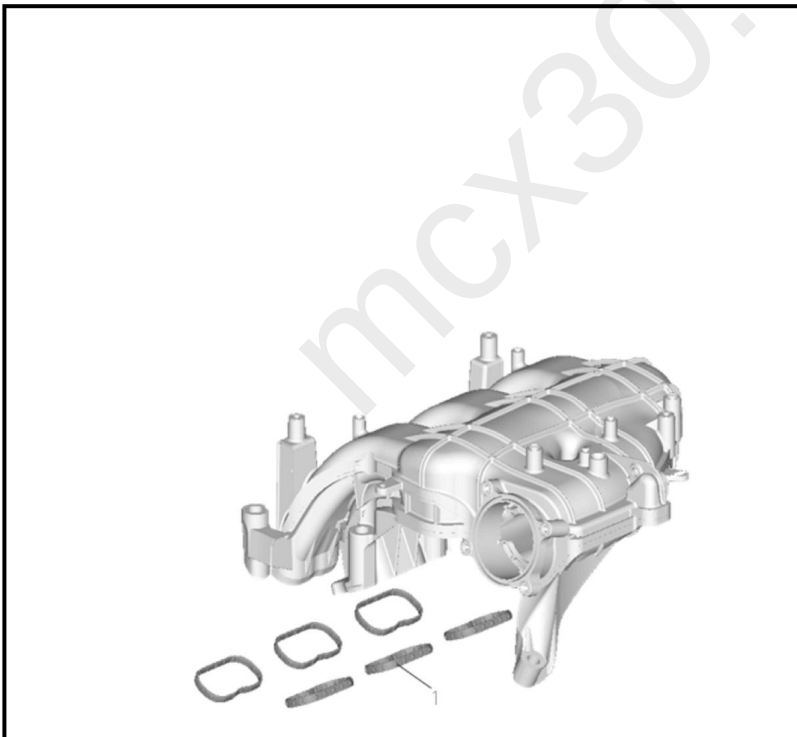
12. Intake Manifold Gasket (1) - Remove and DISCARD



13. Clean, inspect, and overhaul the intake manifold as needed. [Intake Manifold Overhaul](#)

Installation Procedure

1. Transfer components as necessary.
2. Intake Manifold Gasket (1) - Install NEW



3. Apply a 5 mm (0.20 in) band of threadlock to the threads of the intake manifold bolts. [Adhesives, Fluids, Lubricants, and Sealers](#)
4. Remove the covers from the cylinder head passages.
5. Intake Manifold - Install

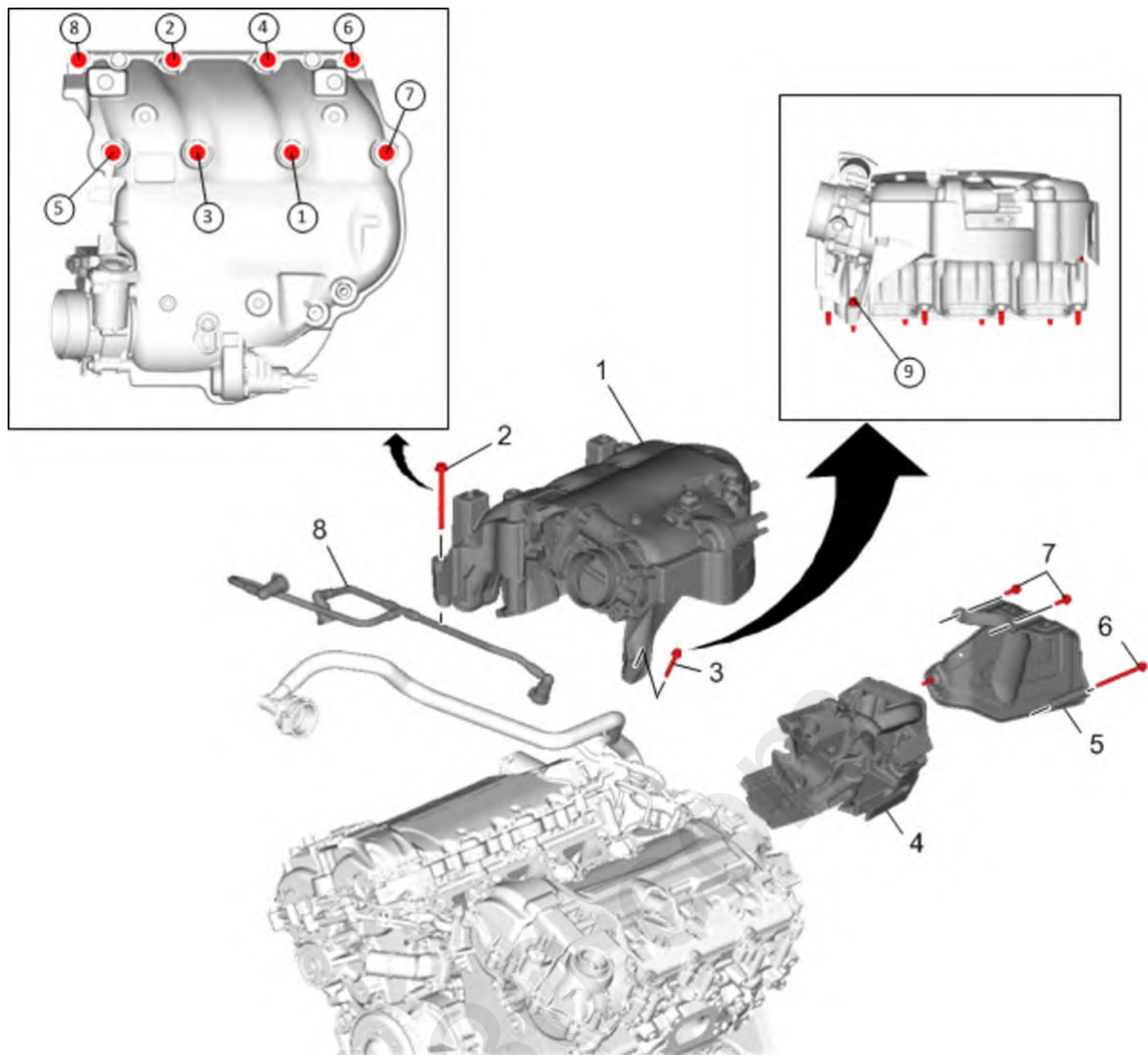
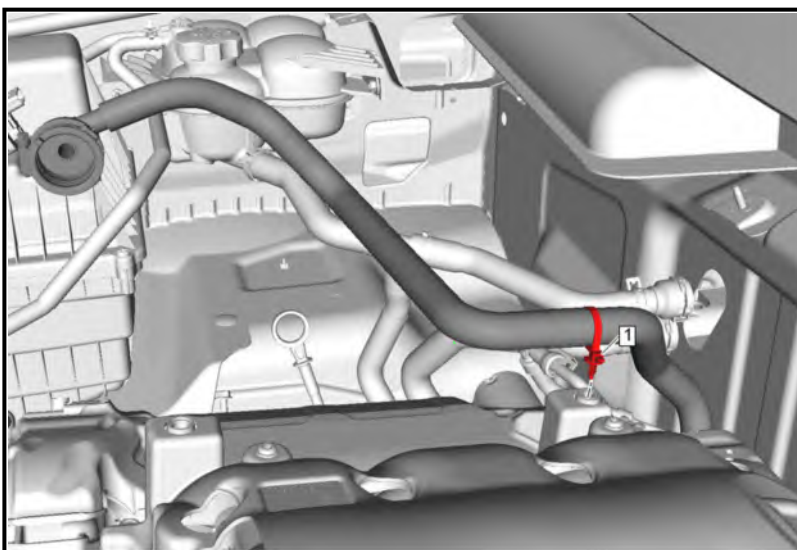


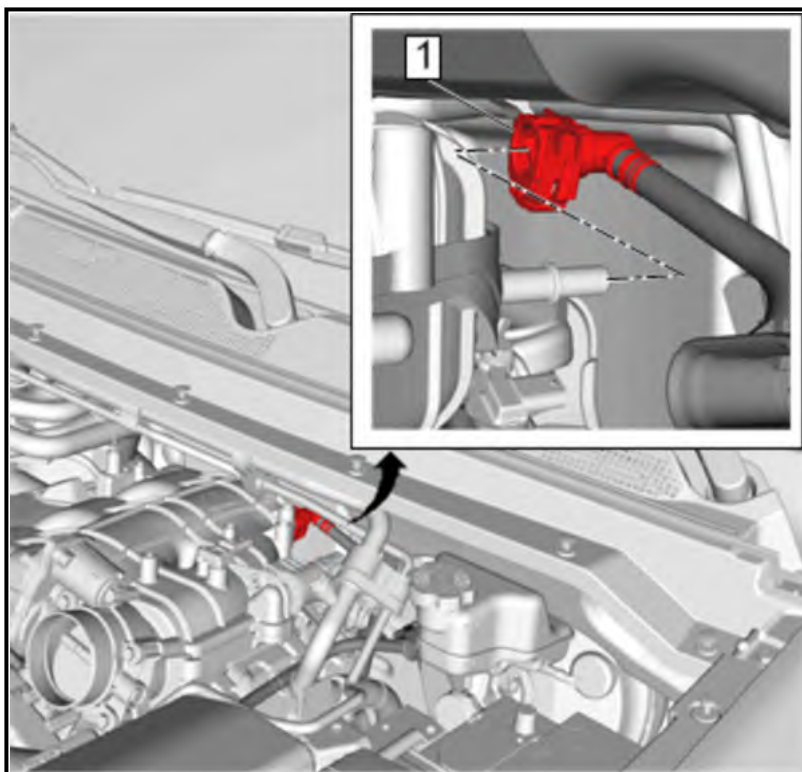
Fig. 3: Exploded View Of Intake Manifold Components And Bolts With Tightening Sequence
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to **Fastener Caution** .

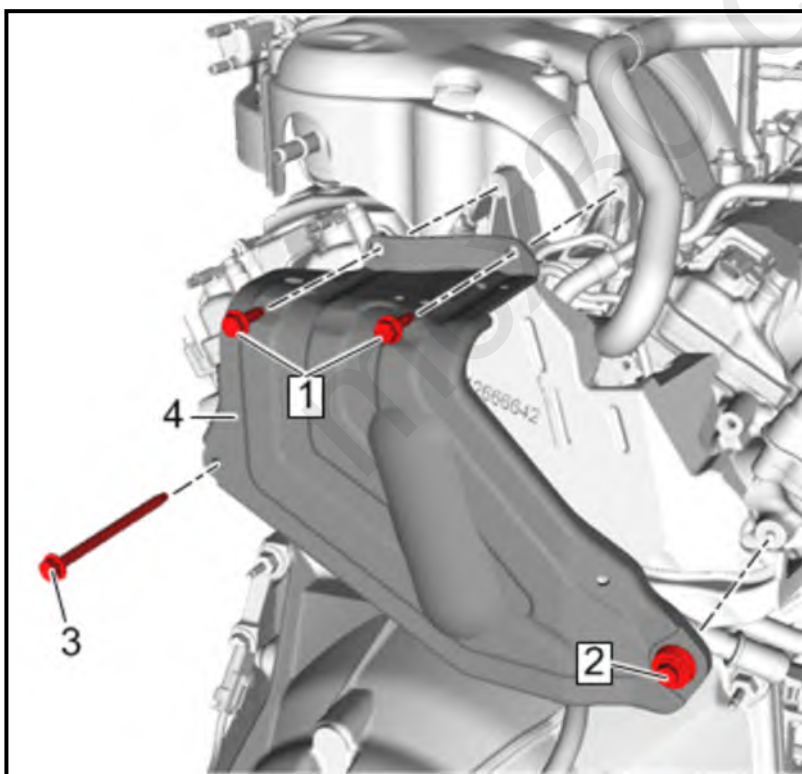
6. Intake Manifold Bolt (2) - Install and tighten in sequence [8x] 25 N.m (18 lb ft)
7. Intake Manifold Bolt (3) - Install and tighten in sequence 10 N.m (89 lb in)
8. Positive Crankcase Ventilation Tube Clip (1) @ Intake Manifold Cover - Connect



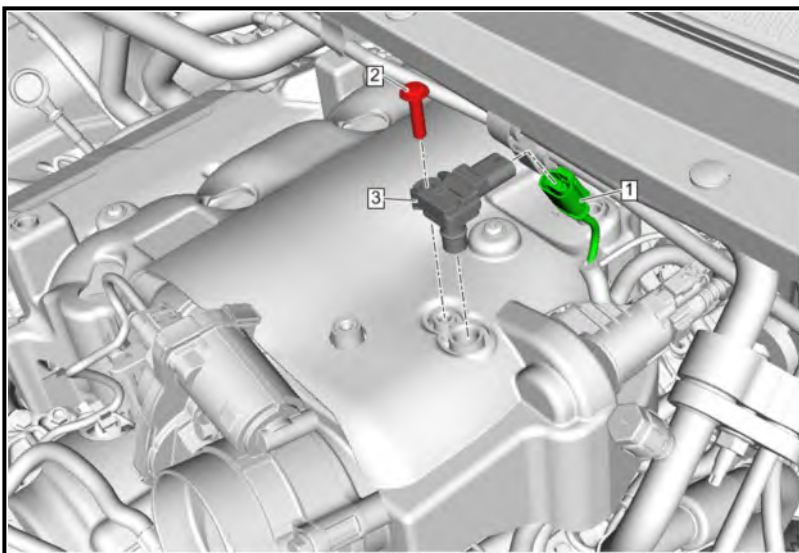
9. Quick Connect Fitting (1) @ Intake Manifold - Connect - [Plastic Collar Quick Connect Fitting Service](#)



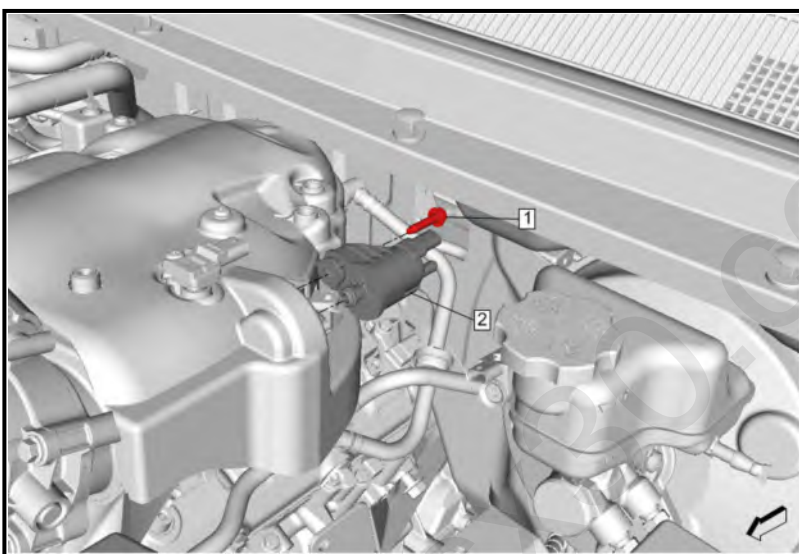
10. Fuel Pipe Shield Bolt (1) @ Intake Manifold - Install [2x] - [Fuel Pipe Shield Replacement](#)



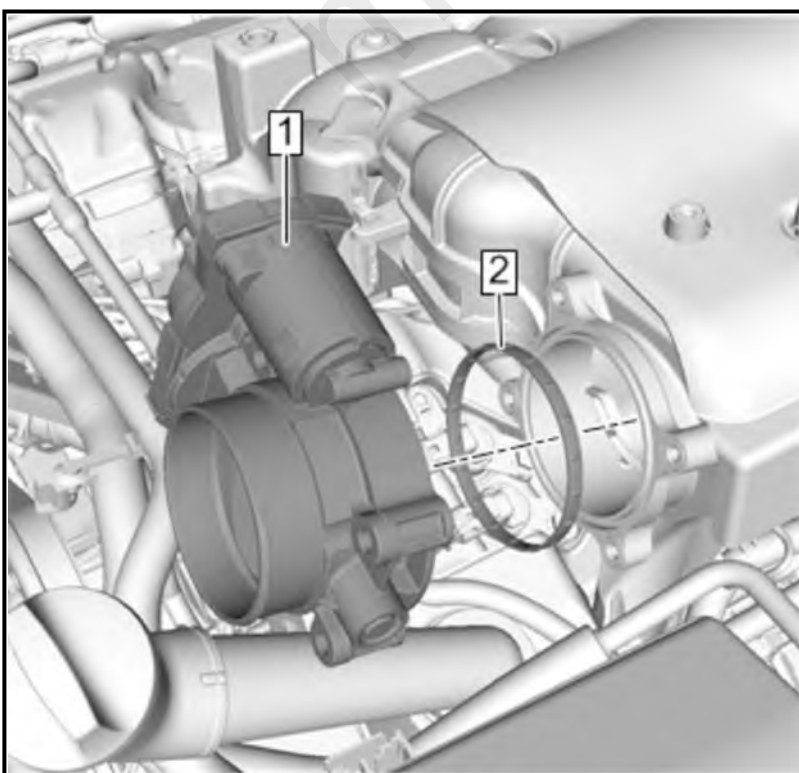
11. Manifold Absolute Pressure Sensor (3) - Install - [Manifold Absolute Pressure Sensor Replacement](#)



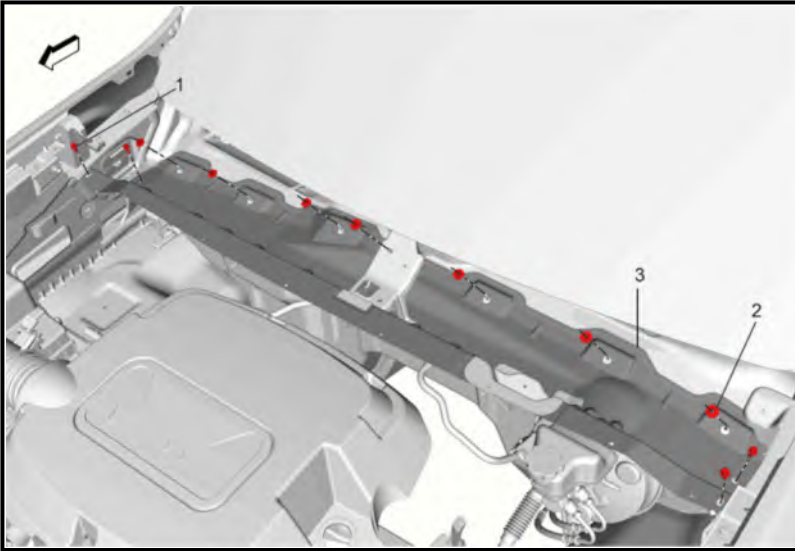
12. Evaporative Emission Canister Purge Solenoid Valve (2) - Install - [Evaporative Emission Canister Purge Solenoid Valve Replacement](#)



13. Throttle Body Assembly (1) - Install - [Throttle Body Assembly Replacement](#)



14. Plenum Front Panel (3) - Install - [Plenum Front Panel Replacement](#)



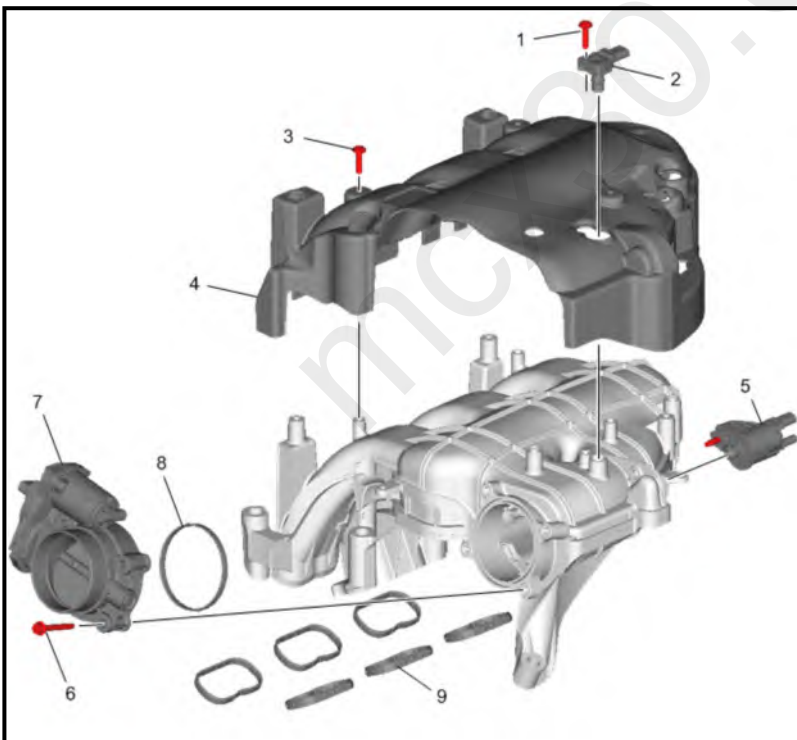
INTAKE MANIFOLD OVERHAUL

Removal Procedure

Intake Manifold - Remove - [Intake Manifold Replacement](#)

Disassemble Procedure

1. Manifold Absolute Pressure Sensor Bolt (1) - Remove



2. Manifold Absolute Pressure Sensor (2) - Remove
3. Intake Manifold Insulator Bolt (3) - Remove [3x]
4. Intake Manifold Insulator (4) - Remove
5. Evaporative Emission Canister Purge Solenoid Valve (5) - Remove
6. Throttle Body Bolt (6) - Remove [4x]
7. Throttle Body (7) - Remove
8. Throttle Body Gasket (8) - Remove and DISCARD

9. Intake Manifold Seal (9) - Remove and DISCARD

Intake Manifold Cleaning Procedure

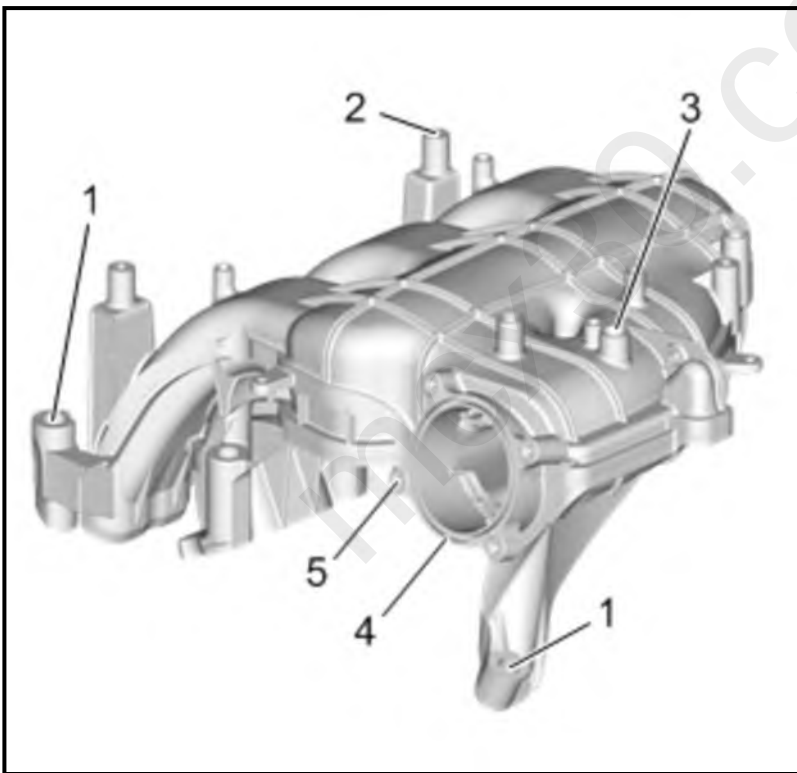
1. Remove any remaining gasket and/or gasket material from the following:
 - Throttle body
 - Intake manifold
2. Clean the following intake manifold areas in solvent.
 - Intake manifold gasket sealing areas
 - Intake manifold passages
 - Brake booster hose passage
 - Evaporative emission (EVAP) solenoid passage
 - Positive crankcase ventilation (PCV) vacuum hose passages

WARNING: Refer to [Safety Glasses Warning](#) .

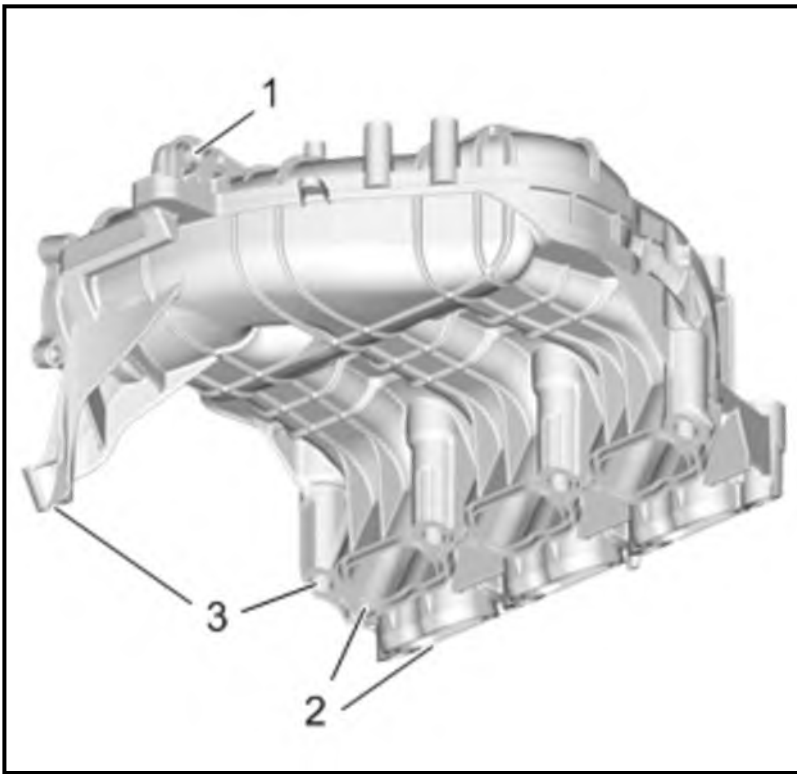
3. Dry the intake manifold and throttle body with compressed air.

Inspection Procedure

1. Inspect the intake manifold for the following conditions:



- Damage to the intake manifold bolt holes (1)
 - Damage to the intake manifold cover bolt holes (2)
 - Damage, debris or restrictions to the MAP sensor hole (3)
 - Damage to the throttle body sealing surface (4)
 - Damage, debris or restrictions to the throttle body hole (5)
2. Inspect the lower intake manifold for the following conditions:



- Damage, debris or restrictions to the (EVAP) (1)
- Gouges or damage to the intake manifold sealing surfaces (2)
- Damage to the intake manifold bolt holes (3)

3. Inspect the lower intake manifold sealing surface for warpage.

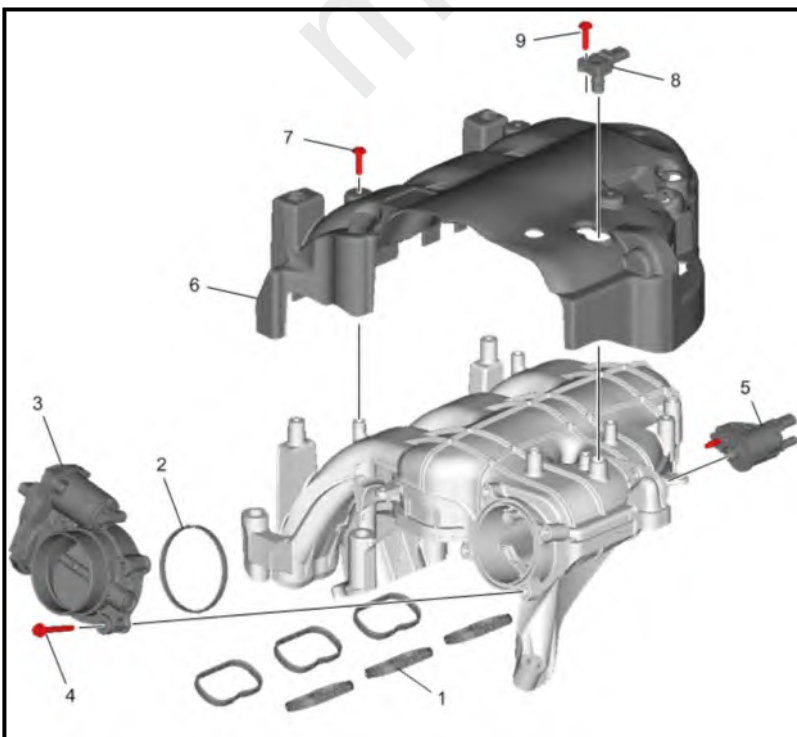
1. Locate a straight edge across the lower intake manifold sealing surface.

2. Insert a feeler gauge between the lower intake manifold and the straight edge. An lower intake manifold with warpage in excess of 0.50 mm (0.020 in) must be replaced.

4. Repair or replace the intake manifold as necessary.

Assemble Procedure

1. Intake Manifold Seal (1) - Install NEW



2. Throttle Body Gasket (2) - Install NEW
3. Throttle Body (3) - Install

CAUTION: Refer to Fastener Caution .

4. Throttle Body Bolt (4) - Install and tighten [4x] 10 N.m (89 lb in)
5. Evaporative Emission Canister Purge Solenoid Valve (5) - Install and tighten 10 N.m (89 lb in)
6. Intake Manifold Insulator (6) - Install
7. Intake Manifold Insulator Bolt (7) - Install and tighten [3x] 10 N.m (89 lb in)
8. Manifold Absolute Pressure Sensor (8) - Install
9. Manifold Absolute Pressure Sensor Bolt (9) - Install and tighten 4 N.m (35 lb in)

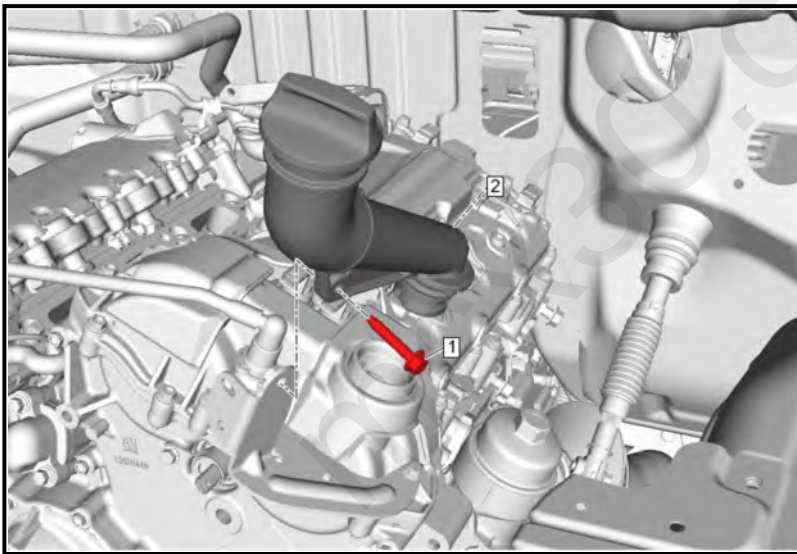
Installation Procedure

Intake Manifold - Install - Intake Manifold Replacement

OIL FILLER TUBE REPLACEMENT

Removal Procedure

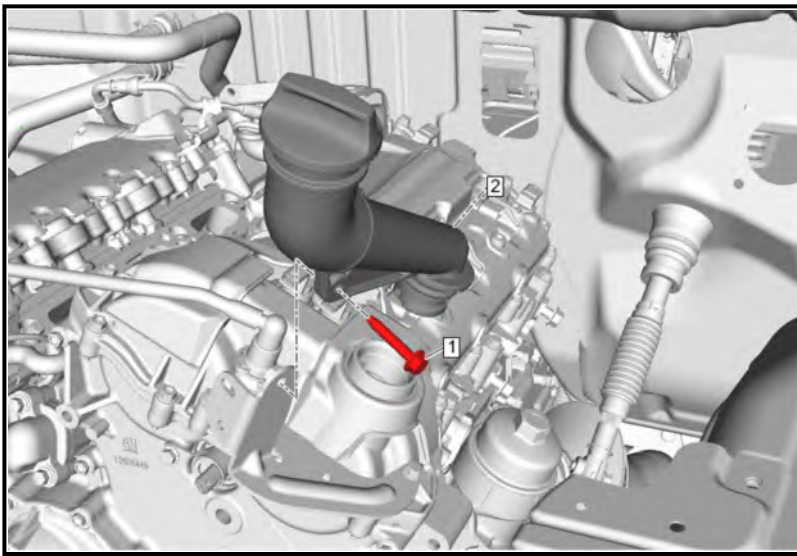
1. Engine Wiring Harness Fuse Block Bracket - Remove - Engine Wiring Harness Fuse Block Bracket Replacement
2. Oil Filler Tube Bracket Bolt (1) - Remove



3. Oil Filler Tube (2) - Remove

Installation procedure

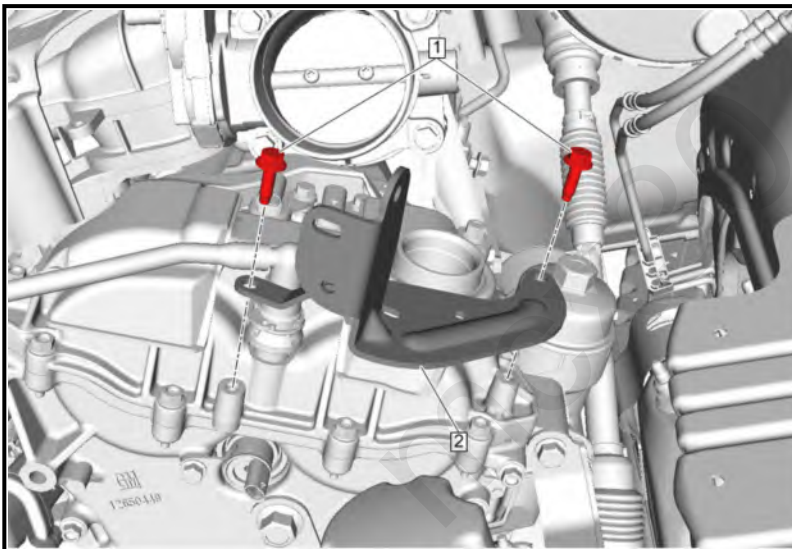
1. Oil Filler Tube (2) - Install



CAUTION: Refer to [Fastener Caution](#) .

2. Oil Filler Tube Bracket Bolt (1) - Install and tighten 12 N.m (9 lb ft)
3. Engine Wiring Harness Fuse Block Bracket - Install - [Engine Wiring Harness Fuse Block Bracket Replacement](#)

OIL FILLER TUBE BRACKET REPLACEMENT



NOTE: Callouts in the following chart represent components shown in graphic above.

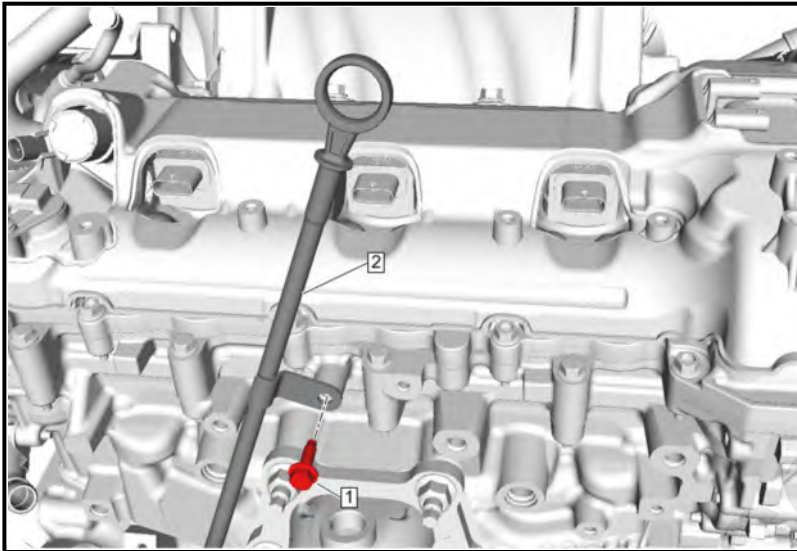
Callout	Component Name
Preliminary Procedure	
Remove the oil filler tube bracket bolt. Oil Filler Tube Replacement	
1	Oil Filler Tube Bracket Bolt [2x] CAUTION: Refer to Fastener Caution . Tighten 9 N.m (80 lb in)

Callout	Component Name
2	Oil Filler Tube Bracket Procedure Detach wiring harness retainers.

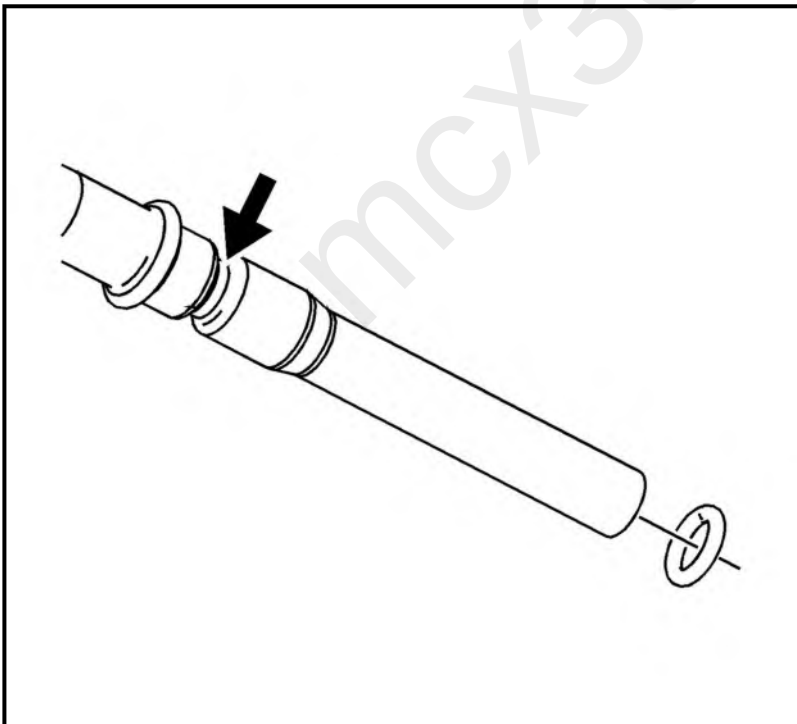
OIL LEVEL INDICATOR TUBE REPLACEMENT

Removal Procedure

1. Oil Level Indicator Tube Bracket Bolt (1) - Remove

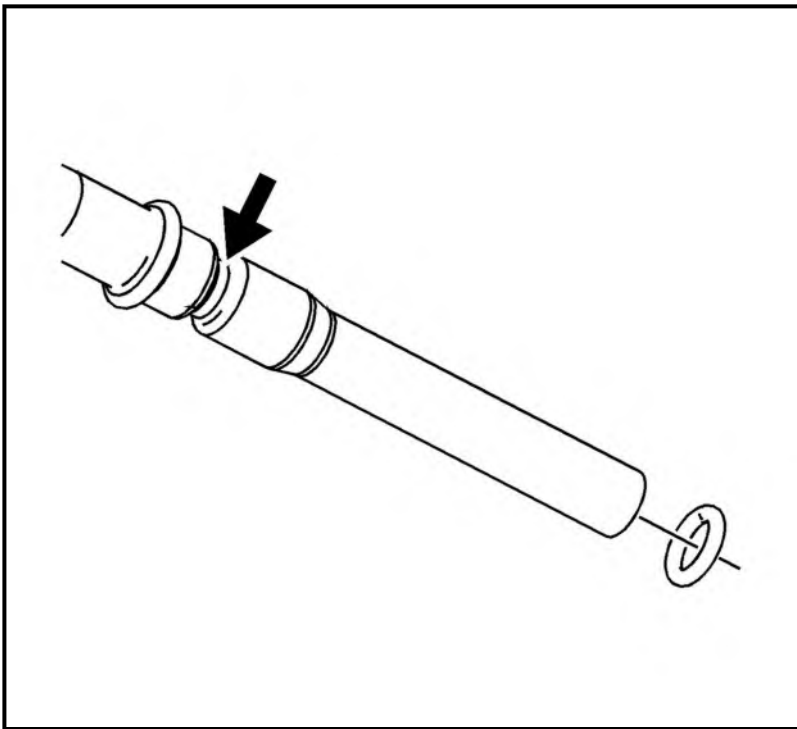


2. Oil Level Indicator and Tube (2) - Remove
3. O-Ring - Remove and DISCARD

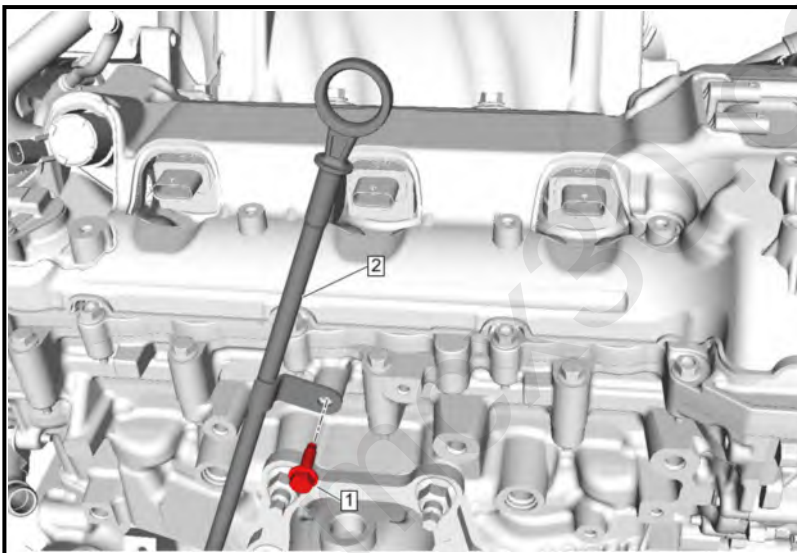


Installation Procedure

1. Install a NEW O-ring seal.



2. Position the oil level indicator and tube (2) by sliding the tube down and in to the approximate location of the lower crankcase hole.



3. Guide the lower portion of the oil level indicator tube into the lower crankcase hole and seat the oil level indicator tube in place

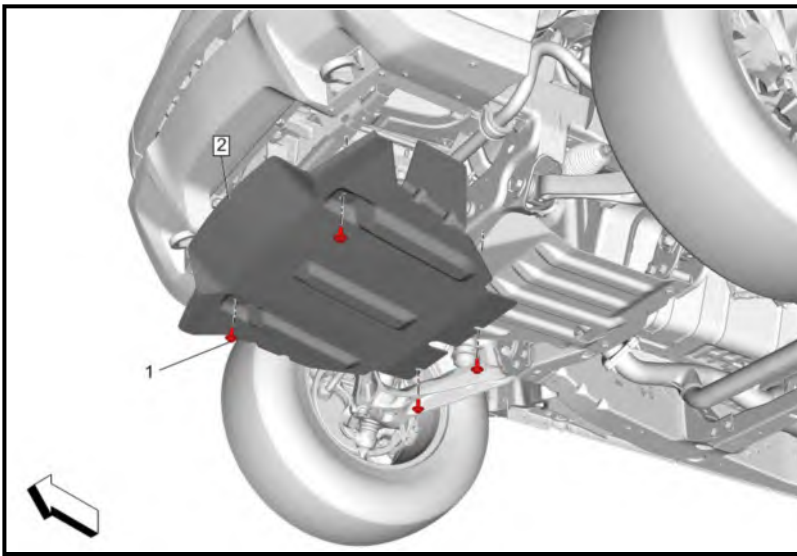
CAUTION: Refer to [Fastener Caution](#) .

4. Install the oil level indicator tube bracket bolt (1) and tighten to 10 N.m (89 lb in).

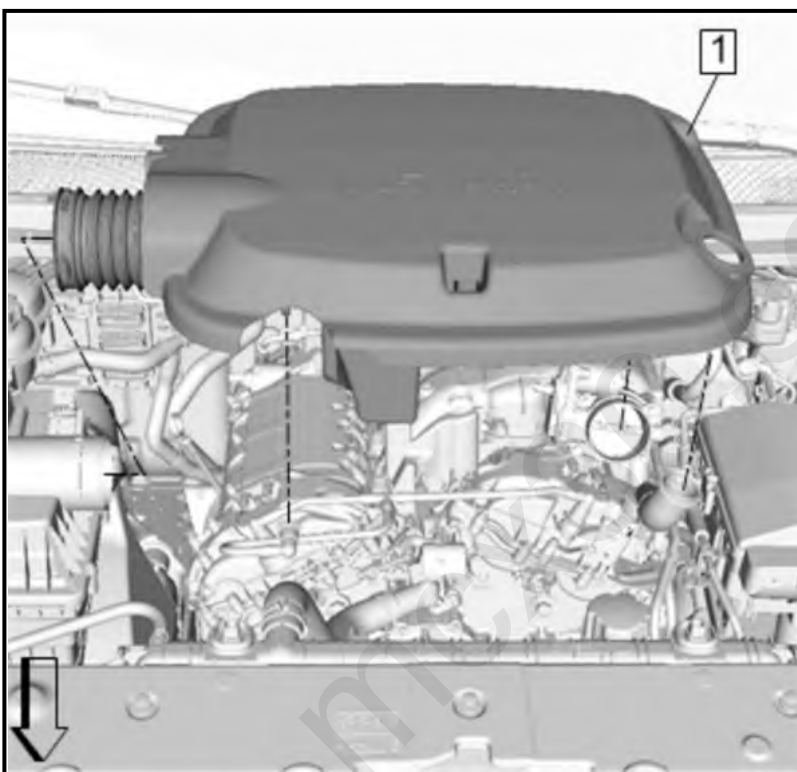
OIL FILTER ADAPTER REPLACEMENT

Removal Procedure

1. Disconnect the battery. [Battery Negative Cable Disconnection and Connection](#)
2. Remove the underbody splash shield (2). [Underbody Splash Shield Replacement \(without ZR2\)](#) , or [Underbody Splash Shield Replacement \(with ZR2\)](#) , or [Underbody Splash Shield Replacement \(Bison\)](#)



3. Remove the air cleaner outlet duct (1). [Air Cleaner Outlet Duct Replacement](#)

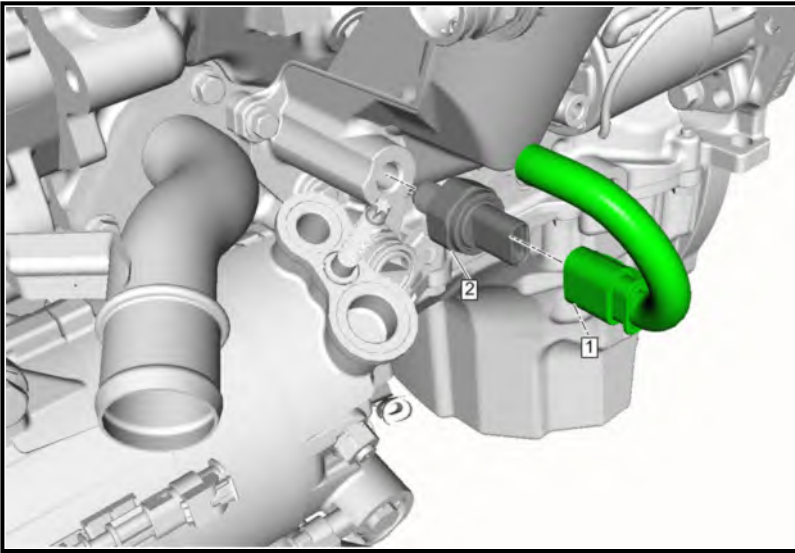


4. Remove the drive belt. [Drive Belt Replacement](#)

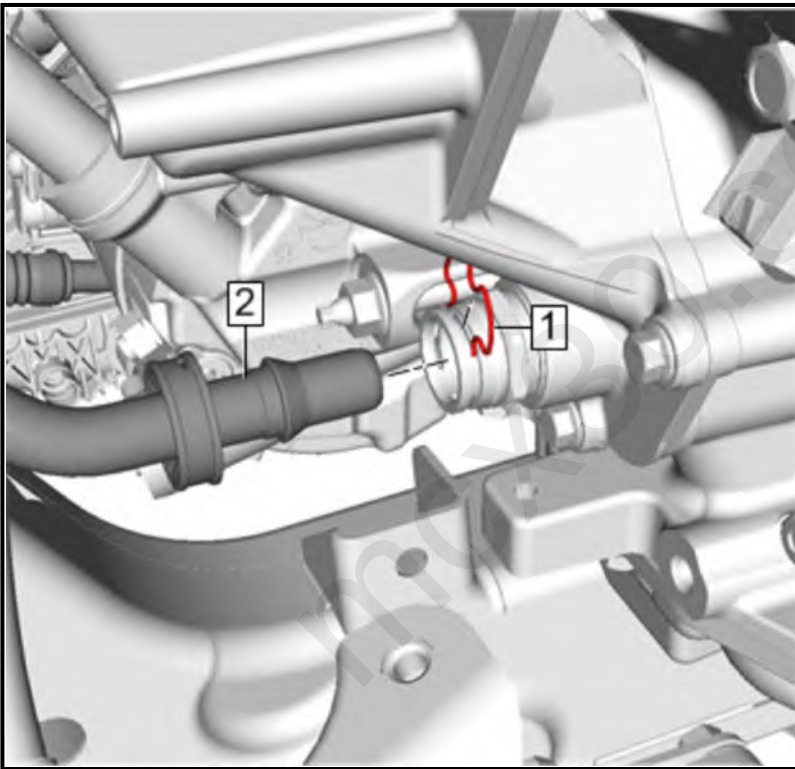
NOTE: Do not disconnect the A/C pipes from the A/C compressor.

5. Remove the A/C compressor bolts. [Air Conditioning Compressor Replacement \(LGZ\)](#)

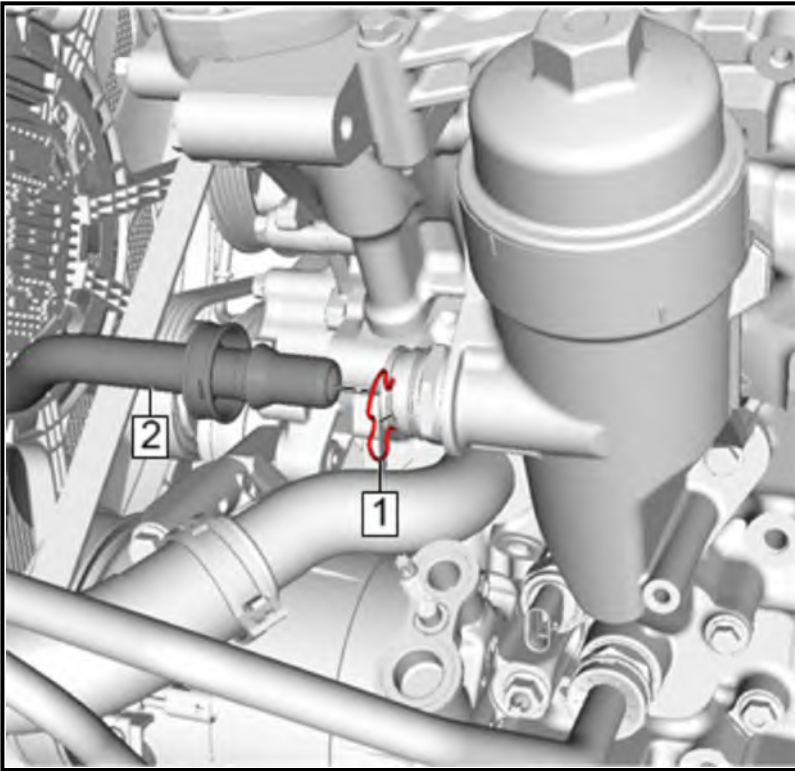
6. Disconnect the oil pressure sensor electrical connector (1).



7. Place a drain pan under the vehicle.
8. Drain engine oil. **Engine Oil and Oil Filter Replacement**
9. Remove the retaining ring (1) from the oil filter adaptor.



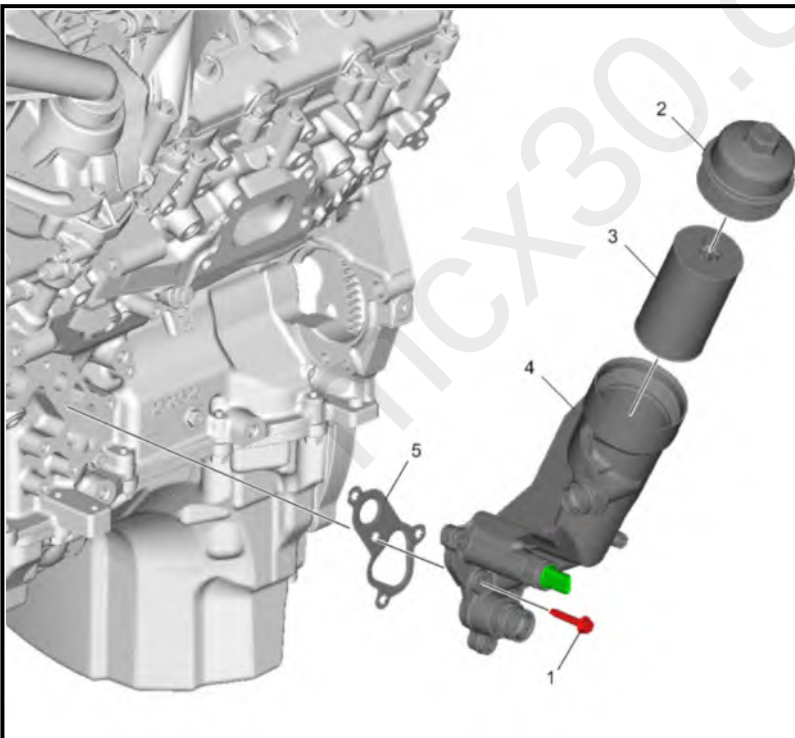
10. Disconnect the engine oil cooler inlet hose (2) from the oil filter adaptor.
11. Remove the retaining ring (1) from the oil filter adaptor.



12. Disconnect the engine oil cooler outlet hose (2) from the oil filter adaptor.

13. Engine Mount Bracket-Left Side - Remove - [Engine Mount Bracket Replacement - Left Side](#)

14. Remove the oil filter adaptor cap (2) and oil filter (3), allow to drain.



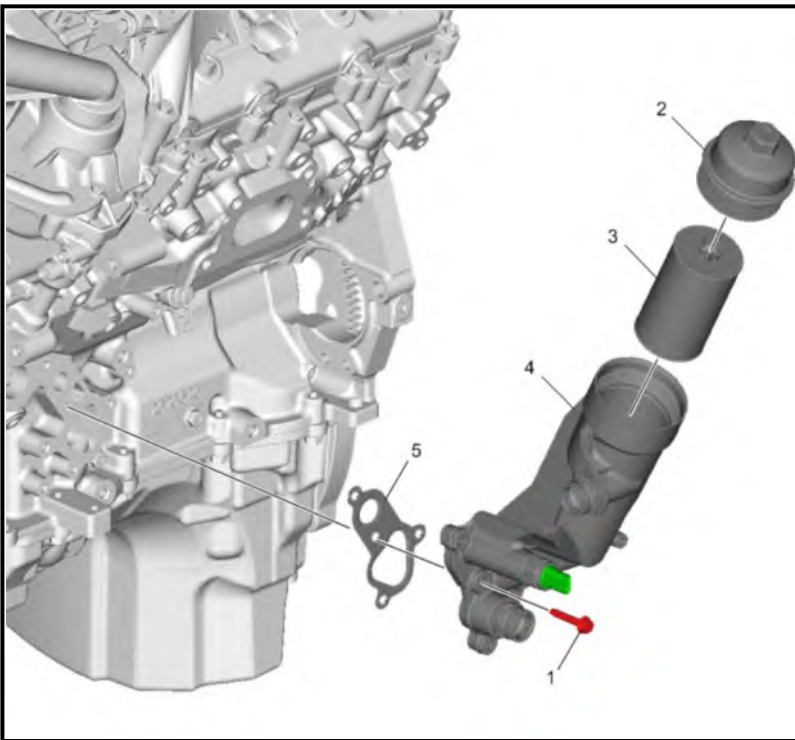
15. Remove the 5 oil filter adapter bolts (1).

16. Remove the oil filter adapter (4).

17. Remove and DISCARD the oil filter adapter gasket (5).

Installation Procedure

1. Install a NEW oil filter adapter gasket (5).



2. Install the oil filter adapter (4).

CAUTION: Refer to [Fastener Caution](#) .

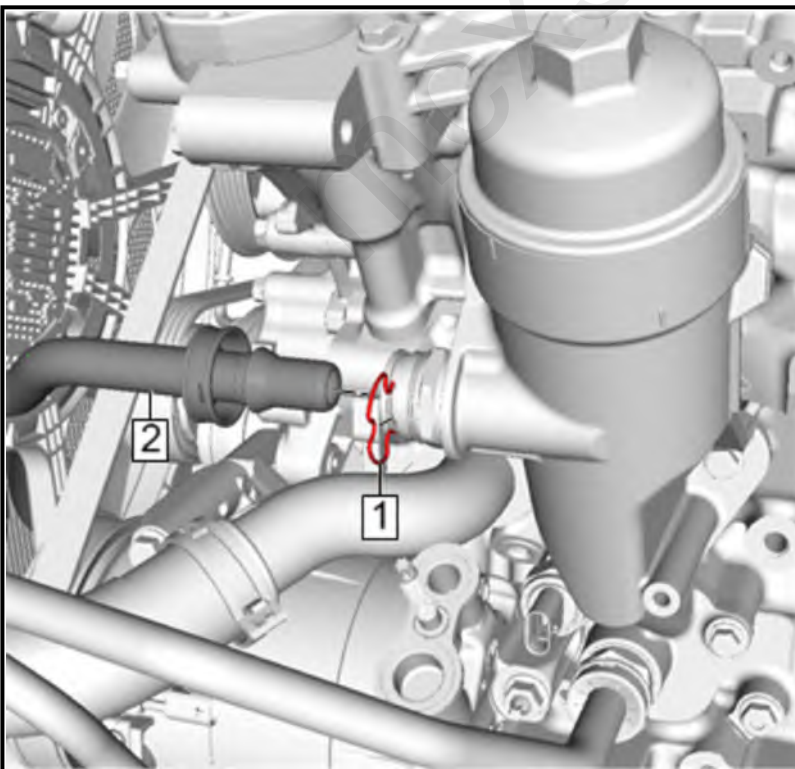
3. Remove the 5 oil filter adapter bolts (1). 10 N.m (89 lb in)

4. Install the NEW oil filter (3).

5. Install the oil filter adaptor cap (2). 25 N.m (18 lb ft)

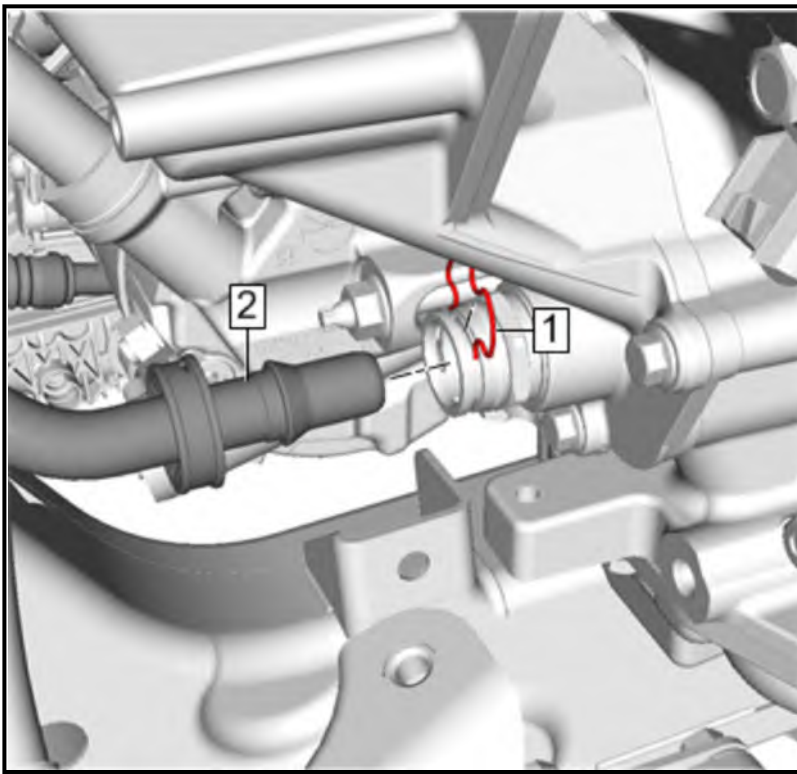
6. Engine Mount Bracket-Left Side - Install - [Engine Mount Bracket Replacement - Left Side](#)

7. Connect the engine oil cooler outlet hose (2) to the oil filter adaptor.

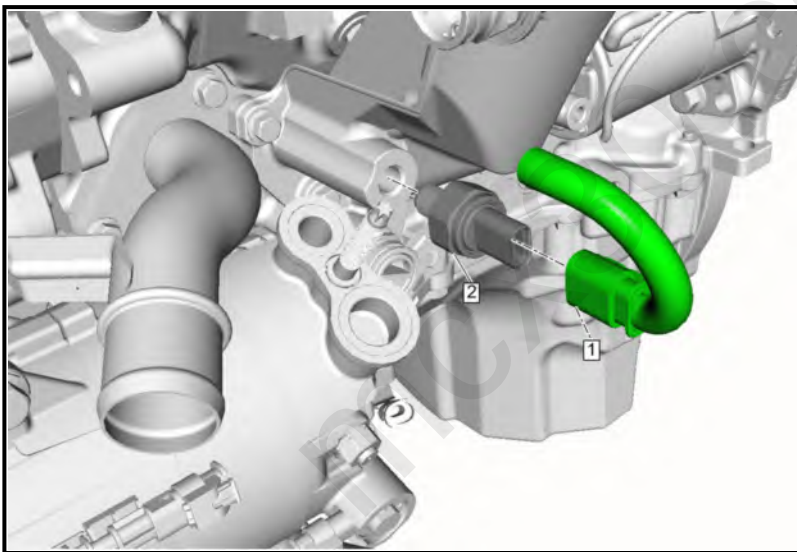


8. Install the retaining ring (1) on the oil filter adaptor.

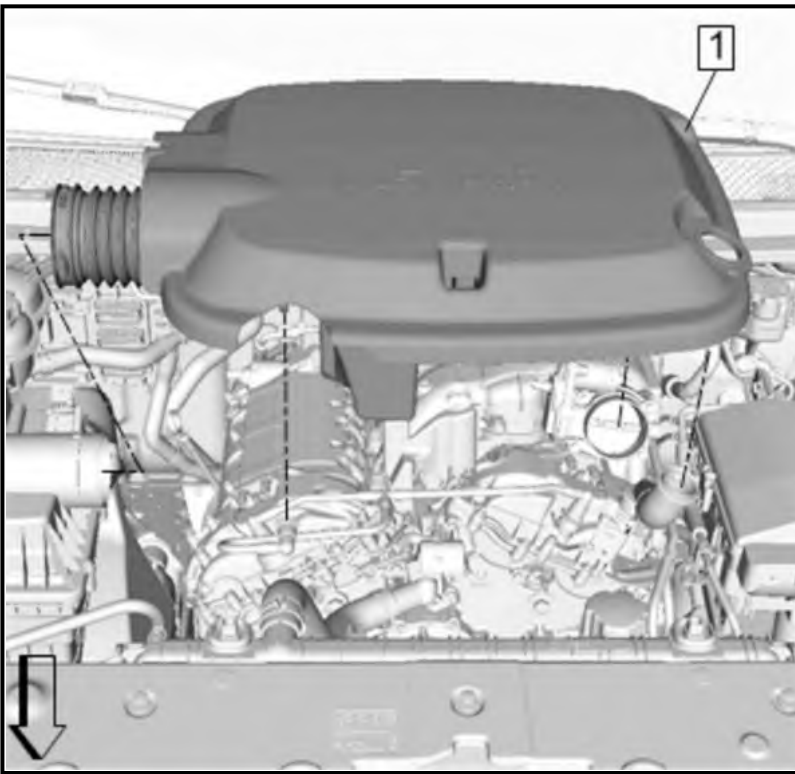
9. Connect the engine oil cooler inlet hose (2) to the oil filter adaptor.



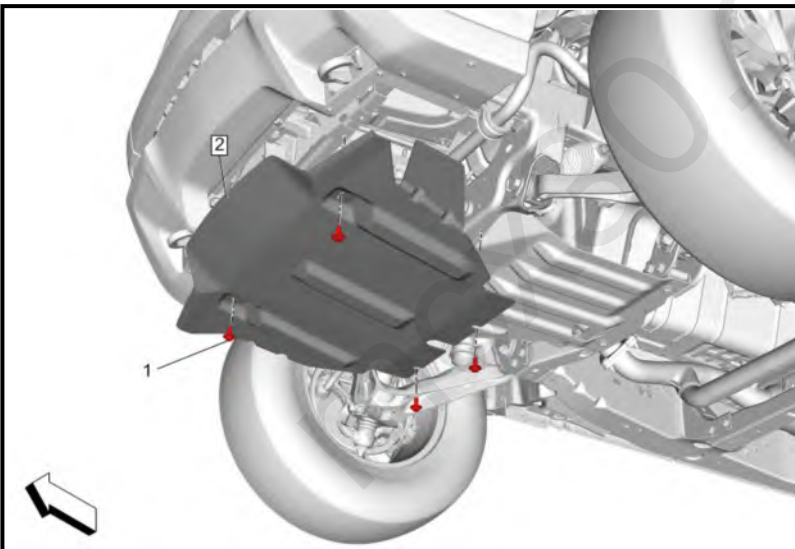
10. Install the retaining ring (1) on the oil filter adaptor.
11. Connect the oil pressure sensor electrical connector (1).



12. Install the A/C compressor with the A/C pipes to the engine. [**Air Conditioning Compressor Replacement \(LGZ\)**](#)
13. Install the drive belt. [**Drive Belt Replacement**](#)
14. Install the air cleaner outlet duct (1). [**Air Cleaner Outlet Duct Replacement**](#)



15. Install the underbody splash shield (2). [Underbody Splash Shield Replacement \(without ZR2\)](#) , or [Underbody Splash Shield Replacement \(with ZR2\)](#) , or [Underbody Splash Shield Replacement \(Bison\)](#)

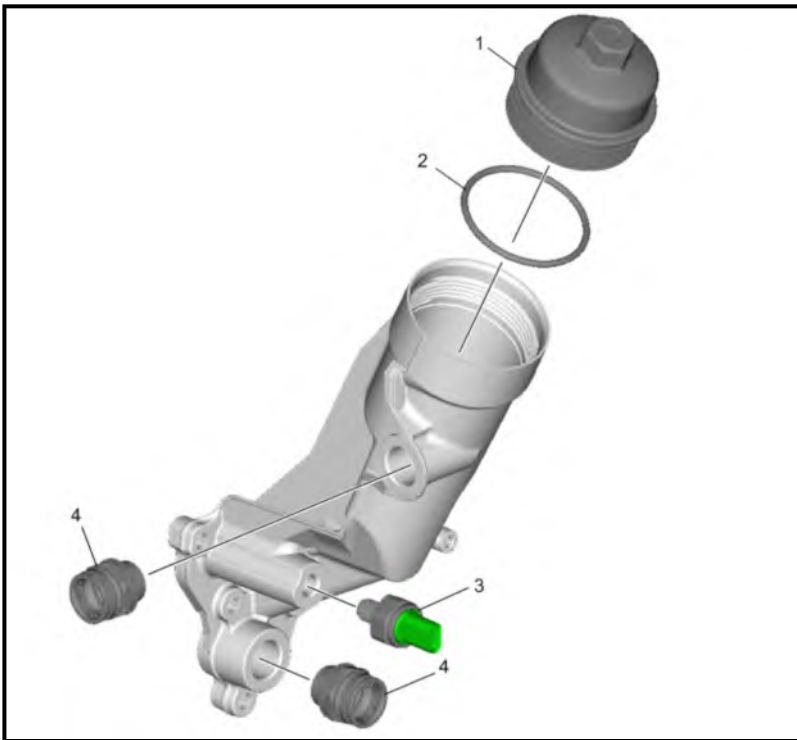


16. Connect the battery. [Battery Negative Cable Disconnection and Connection](#)
 17. Install the oil filter and oil filter adaptor cap and fill engine oil to proper level. [Engine Oil and Oil Filter Replacement](#)

OIL FILTER ADAPTER OVERHAUL

Oil Filter Adapter Disassemble

1. Oil Filter Adapter Cap (1) - Remove



NOTE: Remove and DISCARD the seal.

2. Oil Filter Adapter Seal (2) - Remove and DISCARD
3. Engine Oil Pressure Switch (3) - Remove
4. Engine Oil Cooler Fitting (4) - Remove

Cleaning Procedure

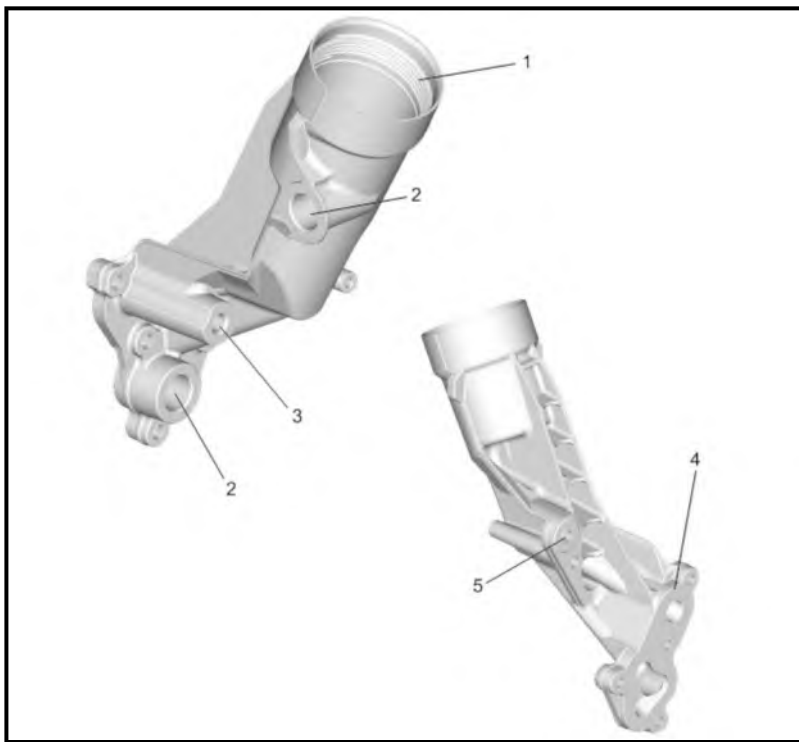
1. Clean the oil filter adapter components with non-corrosive solvent.

WARNING: Refer to Safety Glasses Warning .

2. Dry the oil filter adapter components with compressed air.

Inspection Procedure

1. Inspect the oil filter adapter cap for damage (1).

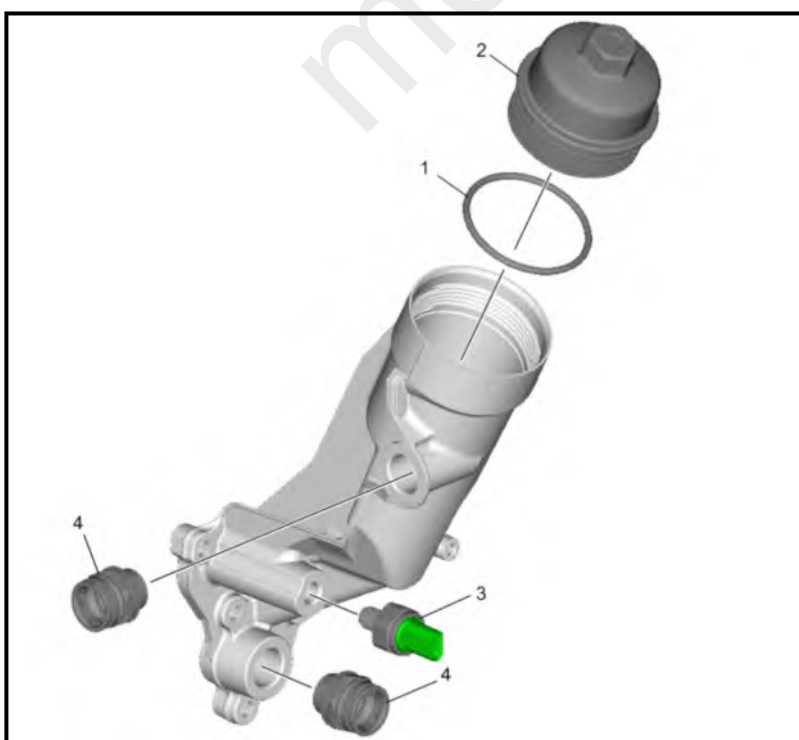


NOTE: The internal parts of the oil filter adapter housing are not serviced separately. If wear or damage is noted, replace the entire oil filter adapter assembly.

2. Inspect the threads for the oil filter fitting (2) for damage.
3. Inspect the mounting sensor and switch holes (3) for damage.
4. Inspect the oil filter adapter housing sealing surface (4) for damage.
5. Inspect the mount hole (5)
6. Repair or replace the oil filter adapter housing as necessary.

Oil Filter Adapter Assemble

1. Oil Filter Adapter Seal (1) - Install NEW



NOTE: Install a **NEW** seal.

CAUTION: Refer to [Fastener Caution](#)

2. Oil Filter Adapter Cap (2) - Install and tighten 25 N.m (18 lb ft)
3. Engine Oil Pressure Switch (3) - Install and tighten 35 N.m (26 lb ft)
4. Engine Oil Cooler Fitting (4) - Install and tighten 20 N.m (15 lb ft)

CRANKSHAFT BALANCER REPLACEMENT (WITHOUT BISON)

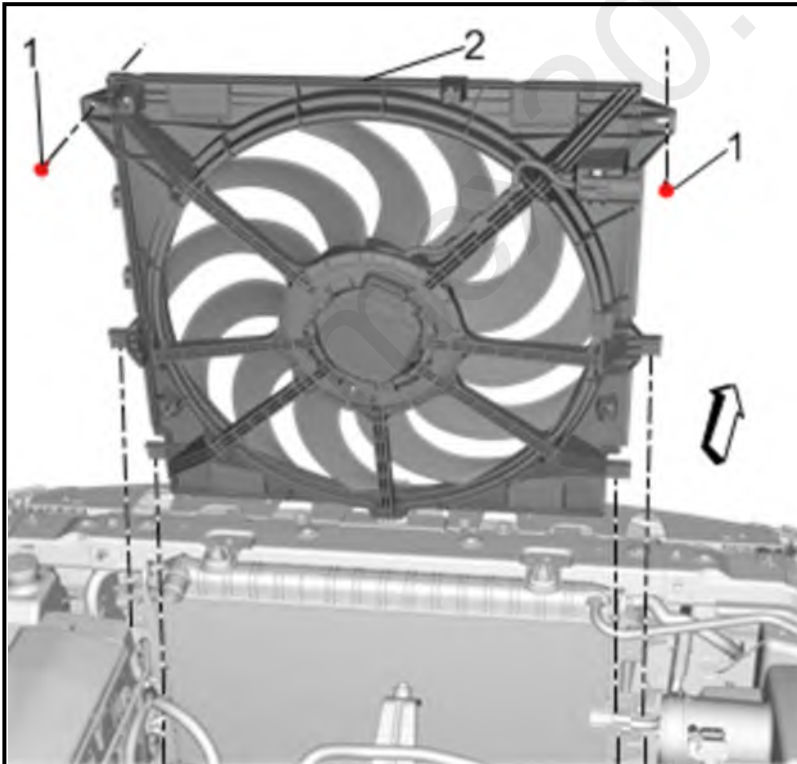
Special Tools

- EN-956 - 1 Extension Bar
- EN-25031 - A Crankshaft Balancer Remover
- EN-41478 - A Crankshaft Front Oil Seal Installer
- EN-41665 - A Crankshaft Balancer and Sprocket Installer
- EN-44226 - 5 Crankshaft Protector
- EN-45059 Angle Meter
- EN-52287 Balancer Holding Kit

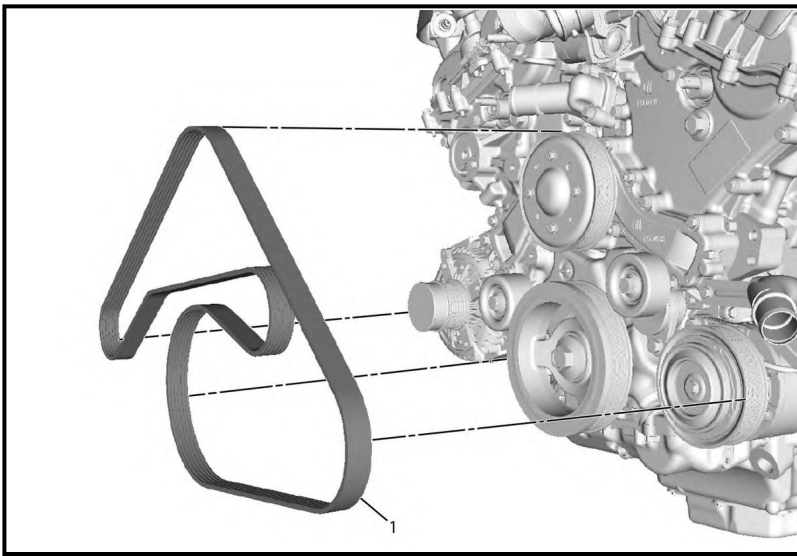
For equivalent regional tools, refer to [Special Tools](#) .

Removal Procedure

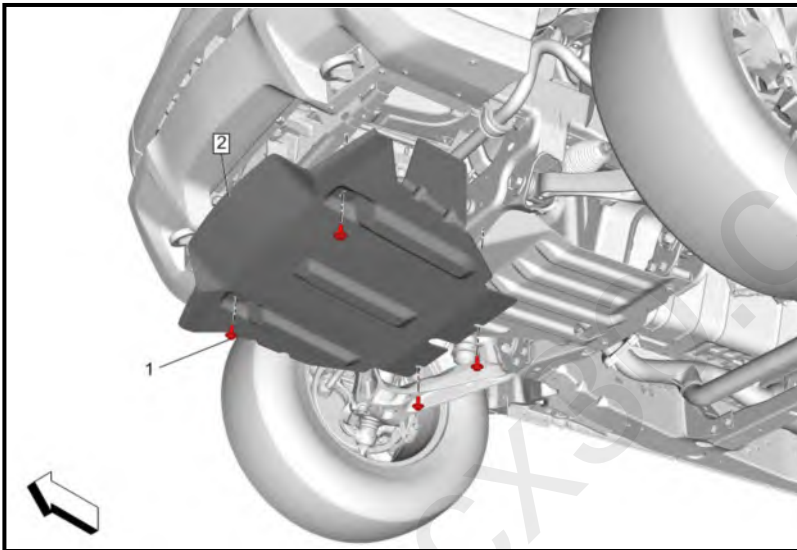
1. Engine Coolant Fan Shroud (2) - Remove - [Engine Coolant Fan Shroud Replacement \(LCV, LGZ\)](#).



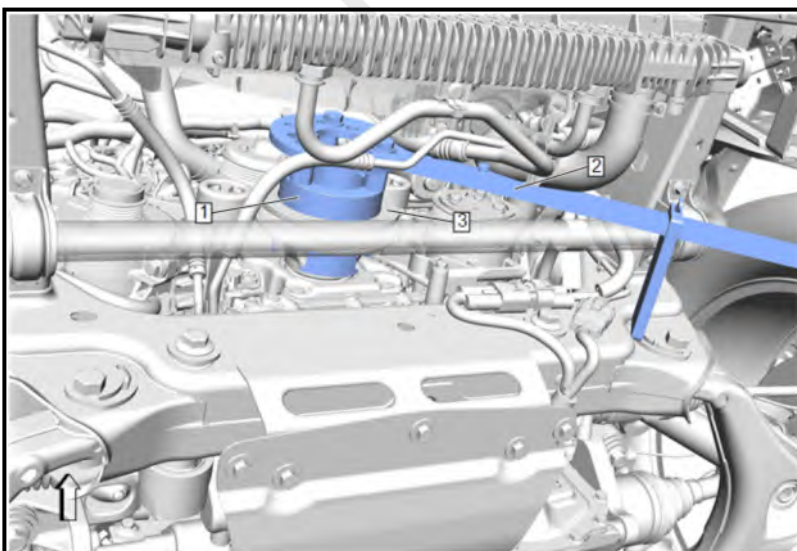
2. Drive Belt (1) - Remove - [Drive Belt Replacement](#)



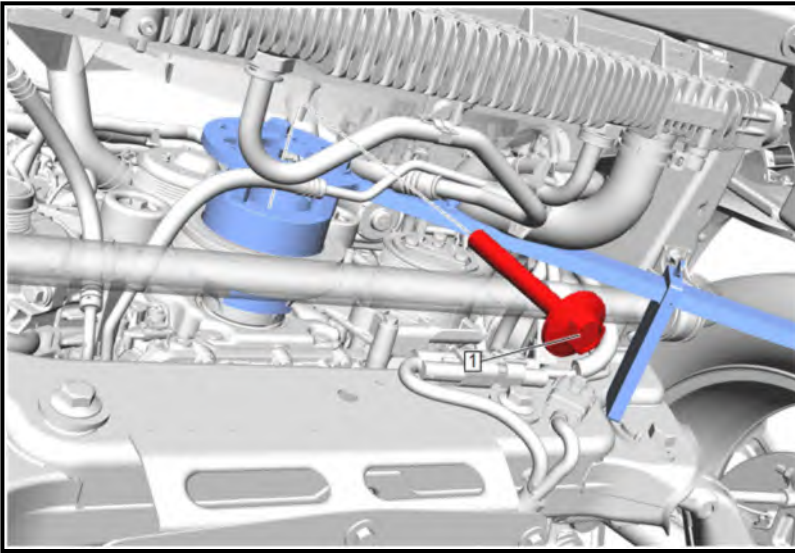
3. Underbody Splash Shield (2) - Remove - [Underbody Splash Shield Replacement \(without ZR2\)](#) , or [Underbody Splash Shield Replacement \(with ZR2\)](#) , or [Underbody Splash Shield Replacement \(Bison\)](#)



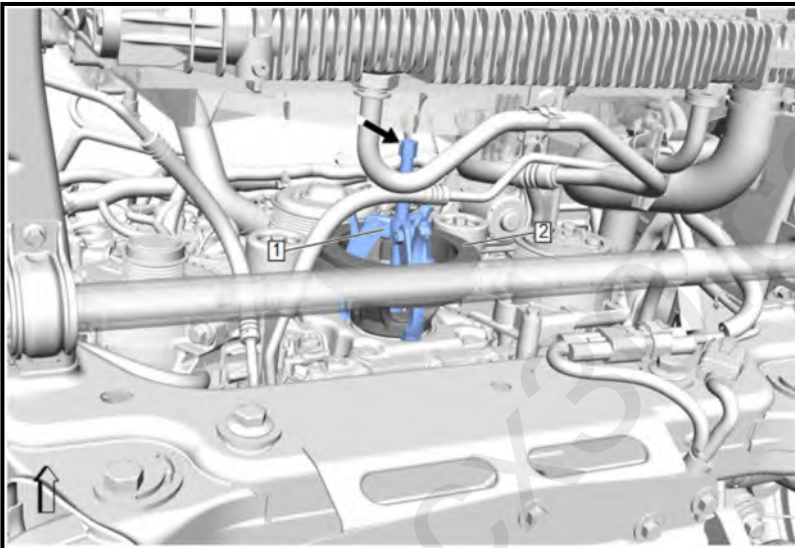
4. Install the **EN-52287** Balancer Holding Kit (1) and the **EN-956 - 1** Extension Bar (2) to the crankshaft balancer (3).



5. Crankshaft Balancer Bolt (1) - Remove and DISCARD

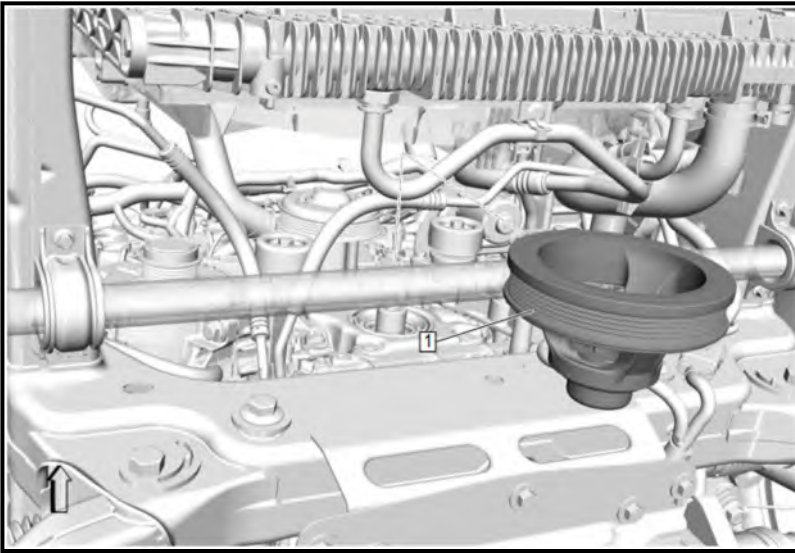


6. Remove the **EN-52287** Balancer Holding Kit and the **EN-956 - 1** Extension Bar.
7. Install the **EN-25031 - A** Crankshaft Balancer Remover (1) and the **EN-44226 - 5** Crankshaft Protector, and use tool adjustment to release the crankshaft balancer (2).



NOTE: Use of the **EN-41816 - A** Crankshaft Balancer Remover with extension arms removed in order to remove the crankshaft balancer as alternate method.

8. Once the crankshaft balancer (2) has released, remove the **EN-41816 - A** Crankshaft Balancer Remover (1) and the **EN-44226 - 5** Crankshaft Protector.
9. Crankshaft Balancer (1) - Remove



Cleaning Procedure

1. Clean the crankshaft balancer in solvent that is compatible with the rubber (1).

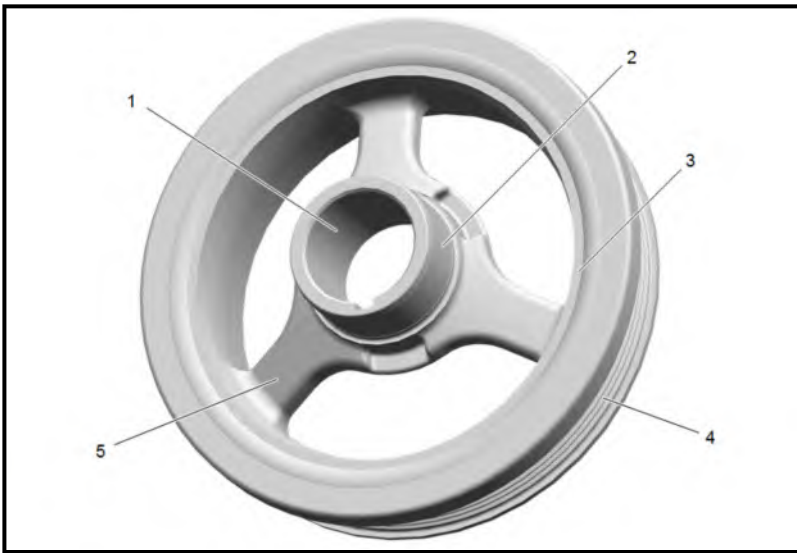


WARNING: Refer to [Safety Glasses Warning](#) .

2. Dry the crankshaft balancer with compressed air.

Inspection Procedure

1. Inspect the crankshaft balancer for the following:



- Worn or damaged hub-to-crankshaft surface (1)
- Worn, grooved or damaged hub seal surface (2)

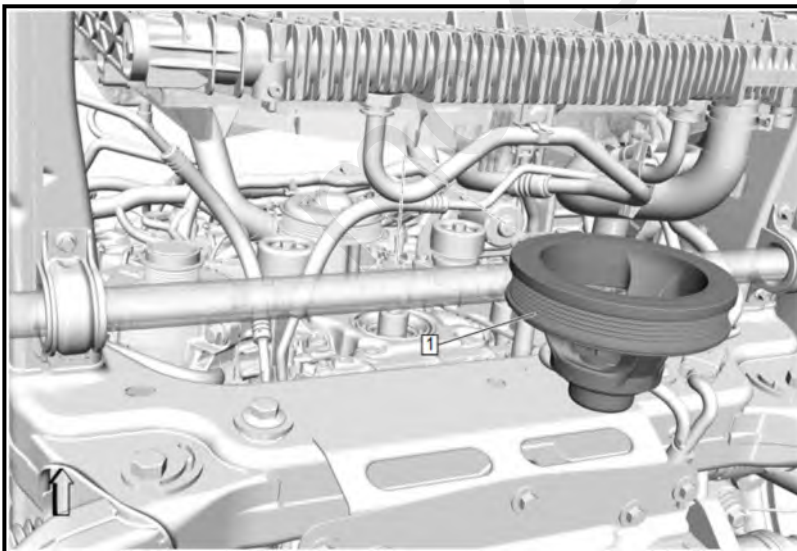
A crankshaft balancer hub seal surface with excessive scoring, grooves, rust or other damage must be replaced.

- Worn, chunking or deteriorated rubber between the hub and pulley (3)
- Damaged drive belt ribs (4)
- Damaged webs (5)

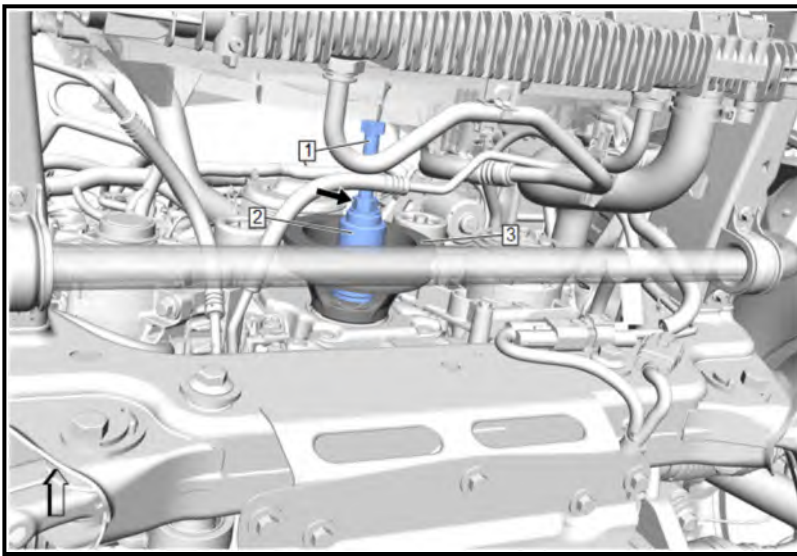
2. Repair or replace the crankshaft balancer as necessary.

Installation Procedure

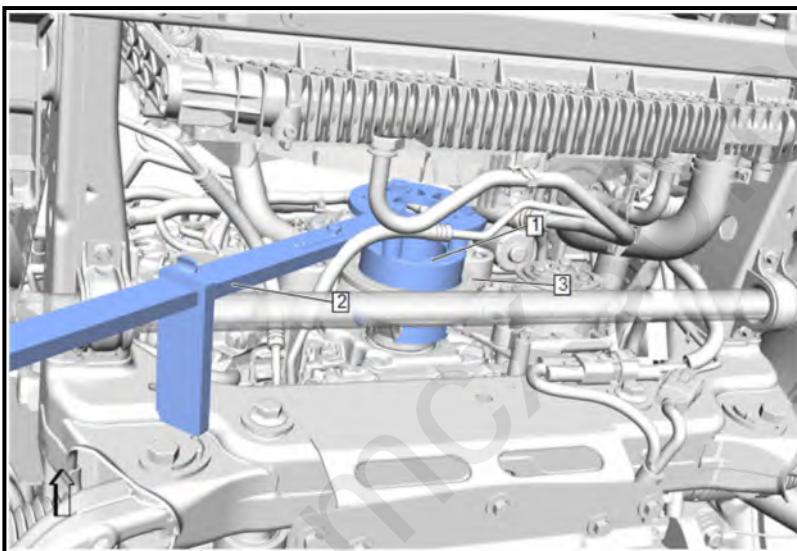
1. Crankshaft Balancer (1) - Loosely install



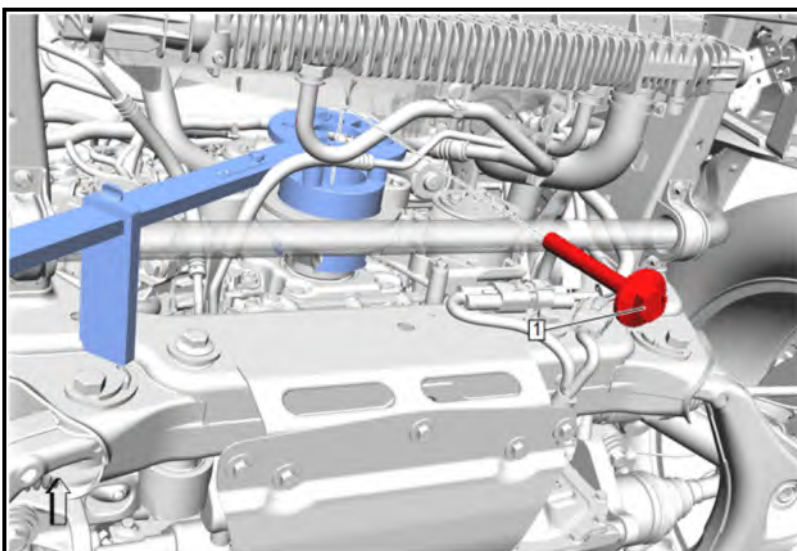
2. Install the **EN-41478 - A Crankshaft Front Oil Seal Installer** (1) and the **EN-41665 - A Crankshaft Balancer and Sprocket Installer** (2) to the crankshaft balancer (3).



3. Use the adjustment nut on the **EN-41478 - A Crankshaft Front Oil Seal Installer (1)** to properly seat the crankshaft balancer (3).
4. Once the crankshaft balancer has been properly seated remove the **EN-41478 - A Crankshaft Front Oil Seal Installer (1)** and the **EN-41665 - A Crankshaft Balancer and Sprocket Installer (2)**.
5. Install the **EN-52287 Balancer Holding Kit (1)** and the **EN-956 - 1 Extension Bar (2)** to the crankshaft balancer (3).



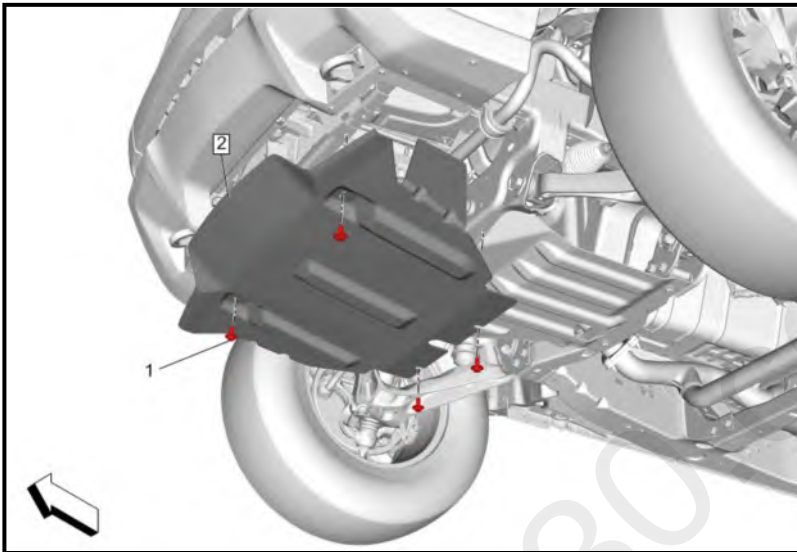
6. Crankshaft Balancer Bolt (1) - Crankshaft Balancer Bolt (1) - Install NEW and tighten



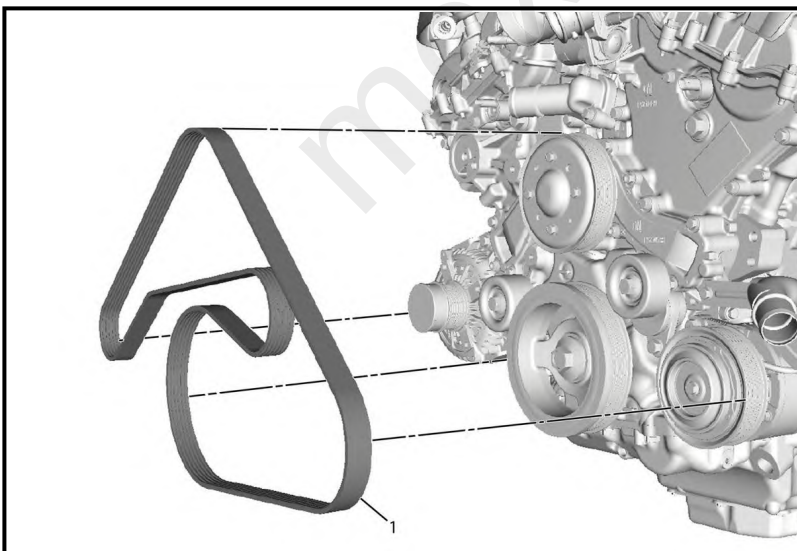
CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

CAUTION: Refer to [Fastener Caution](#) .

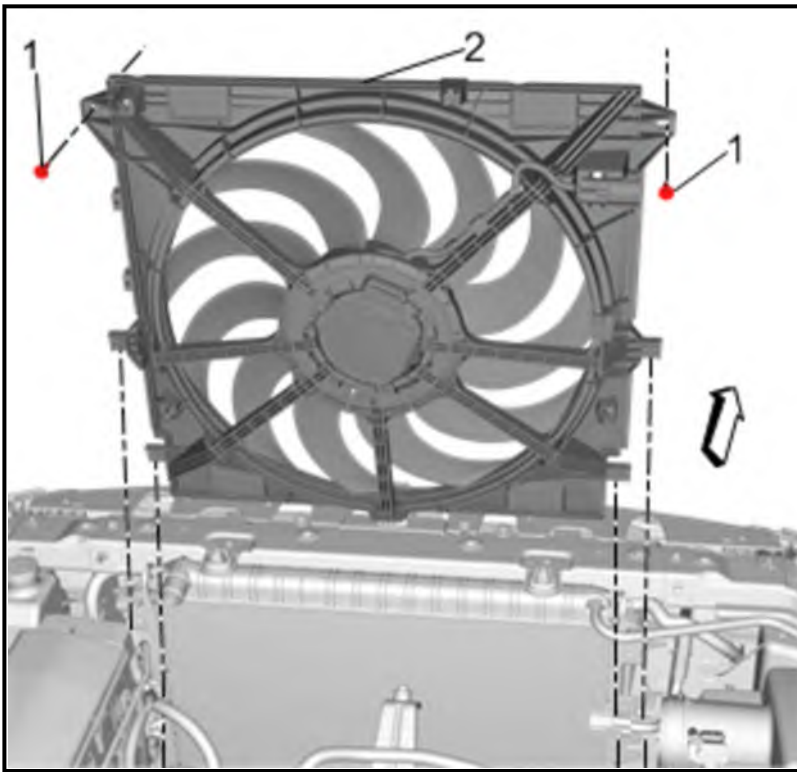
1. First Pass: 80 N.m (59 lb ft)
2. Final Pass: 125 degrees using the EN - 45059 Angle Meter
7. Remove the special tools.
8. Underbody Splash Shield (2) - Install - [Underbody Splash Shield Replacement \(without ZR2\)](#) , or [Underbody Splash Shield Replacement \(with ZR2\)](#) , or [Underbody Splash Shield Replacement \(Bison\)](#)



9. Drive Belt (1) - Install - [Drive Belt Replacement](#)



10. Engine Coolant Fan Shroud (2) - Install - [Engine Coolant Fan Shroud Replacement \(LCV, LGZ\)](#)



11. Perform the crankshaft position variation learn. [Crankshaft Position Variation Learn](#)

CRANKSHAFT BALANCER REPLACEMENT (WITH BISON)

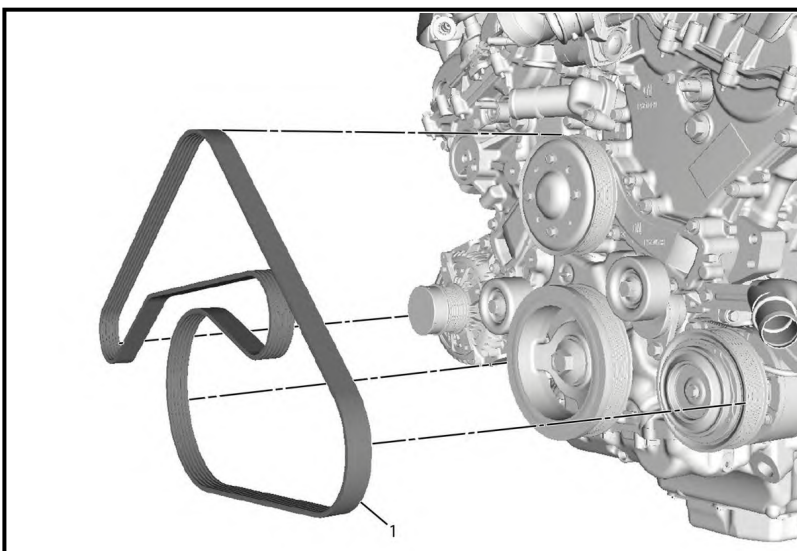
Special Tools

- EN-956 - 1 Extension Bar
- EN-41478 - A Crankshaft Front Oil Seal Installer
- EN-41665 - A Crankshaft Balancer and Sprocket Installer
- EN-41816 - A Crankshaft Balancer Remover
- EN-44226 - 5 Crankshaft Protector
- EN-45059 Angle Meter
- EN-52287 Balancer Holding Kit

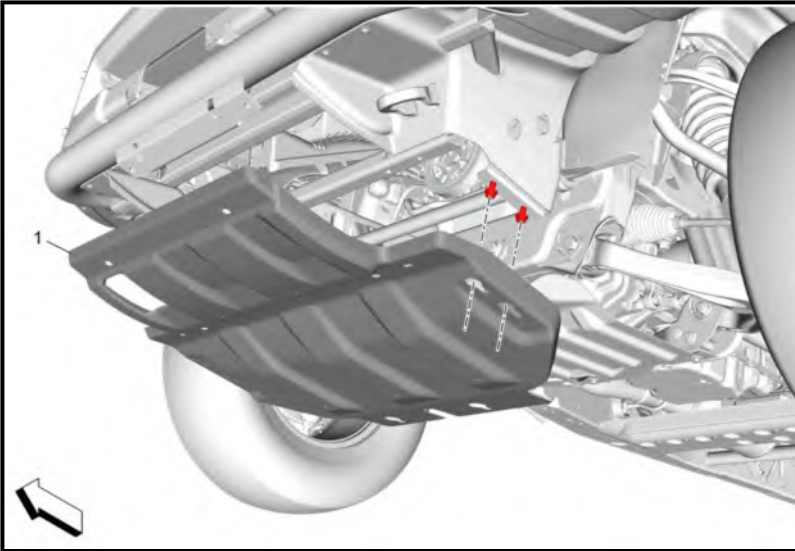
For equivalent regional tools, refer to [Special Tools](#) .

Removal Procedure

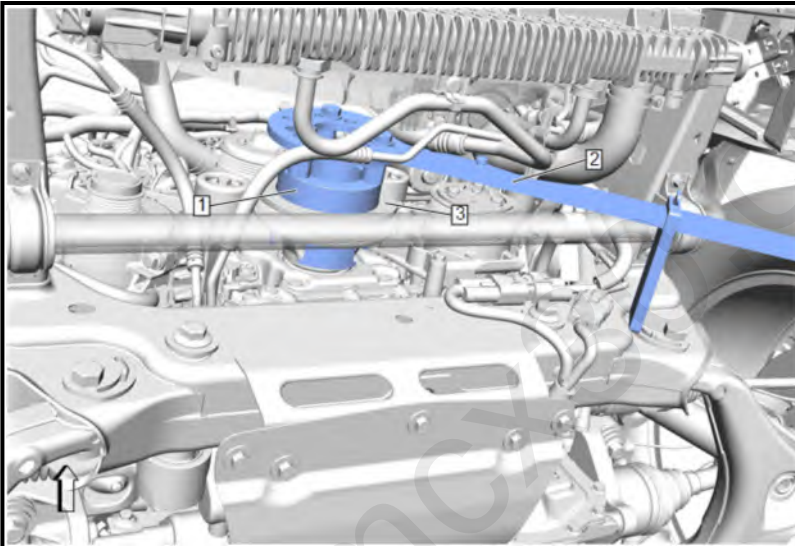
1. Drive Belt (1) - Remove - [Drive Belt Replacement](#)



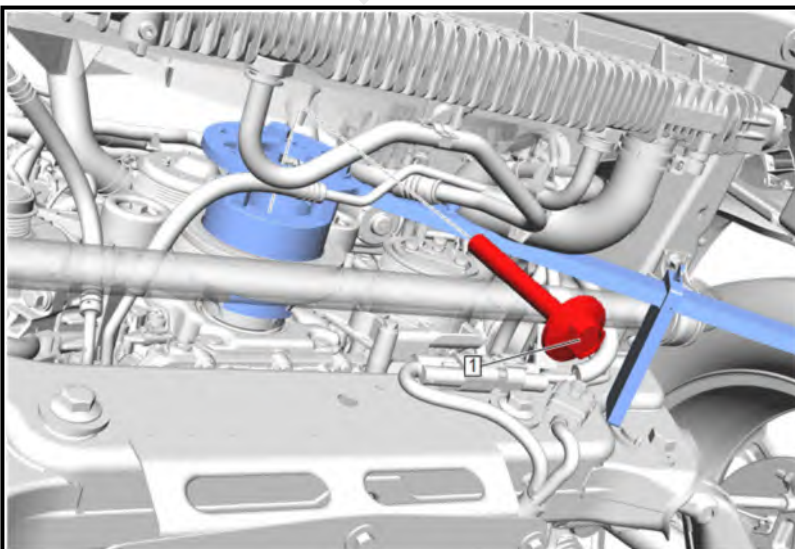
2. Underbody Skid Shield (1) - Remove - [Underbody Skid Shield Replacement \(Bison\)](#)



3. Install the **EN-52287** Balancer Holding Kit (1) and the **EN-956 - 1** Extension Bar (2) to the crankshaft balancer (3).

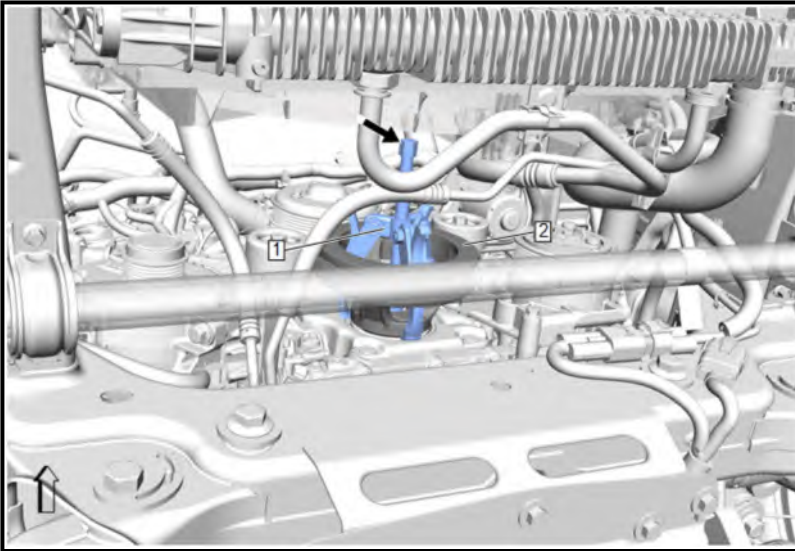


4. Crankshaft Balancer Bolt (1) - Remove and DISCARD

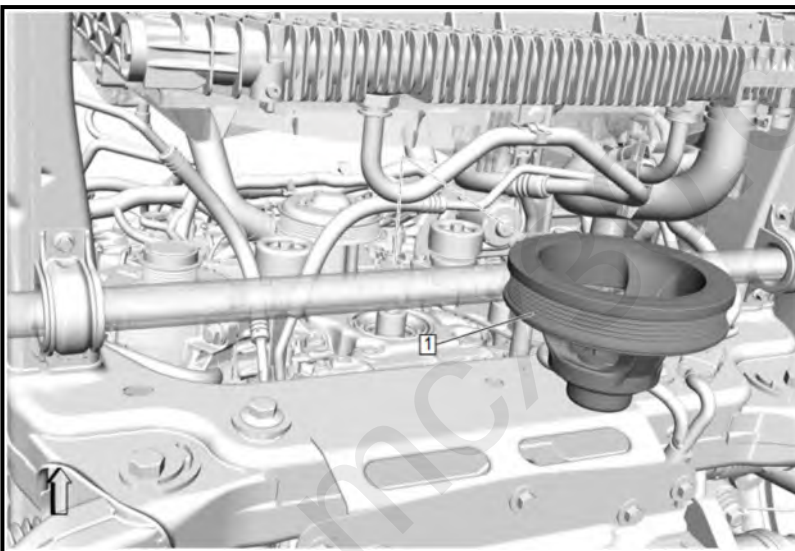


5. Remove the **EN-52287** Balancer Holding Kit and the **EN-956 - 1** Extension Bar.

6. Install the **EN-41816 - A Crankshaft Balancer Remover** (1) and the **EN-44226 - 5 Crankshaft Protector**, and use tool adjustment to release the crankshaft balancer (2).



7. Once the crankshaft balancer (2) has released, remove the **EN-41816 - A Crankshaft Balancer Remover** (1) and the **EN-44226 - 5 Crankshaft Protector**.
8. Crankshaft Balancer (1) - Remove



Cleaning Procedure

1. Clean the crankshaft balancer in solvent that is compatible with the rubber (1).

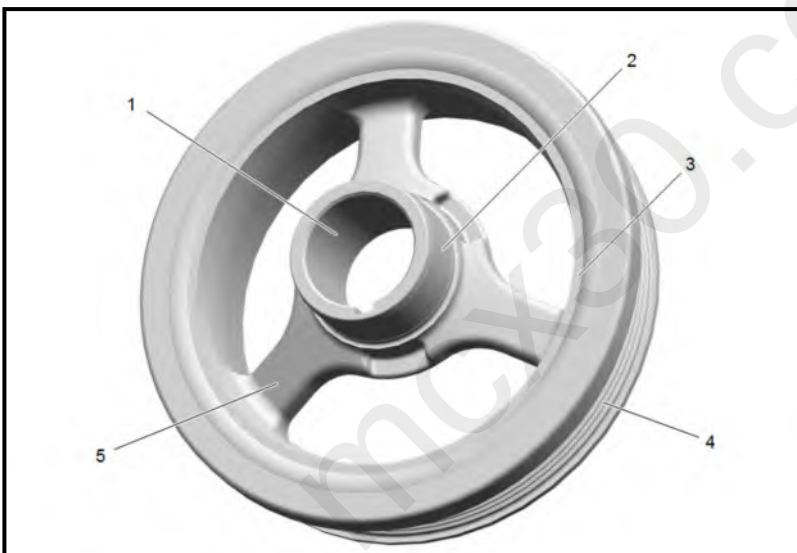


WARNING: Refer to [Safety Glasses Warning](#) .

2. Dry the crankshaft balancer with compressed air.

Inspection Procedure

1. Inspect the crankshaft balancer for the following:



- Worn or damaged hub-to-crankshaft surface (1)
- Worn, grooved or damaged hub seal surface (2)

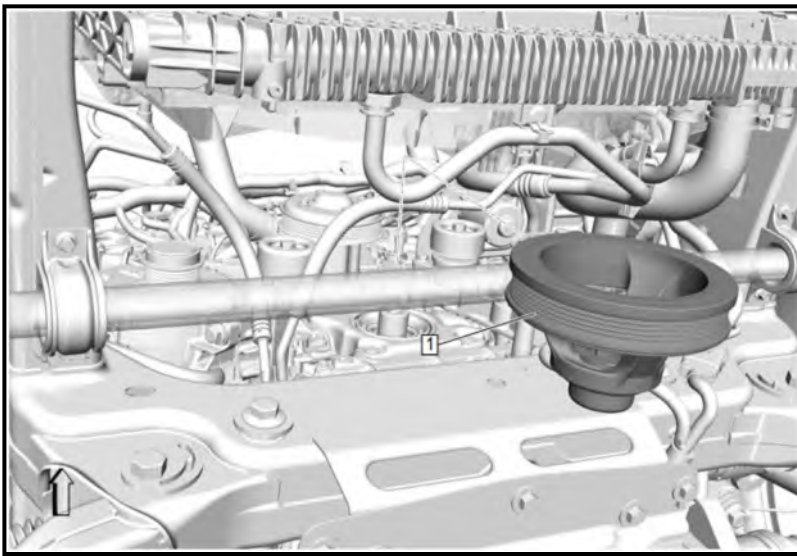
A crankshaft balancer hub seal surface with excessive scoring, grooves, rust or other damage must be replaced.

- Worn, chunking or deteriorated rubber between the hub and pulley (3)
- Damaged drive belt ribs (4)
- Damaged webs (5)

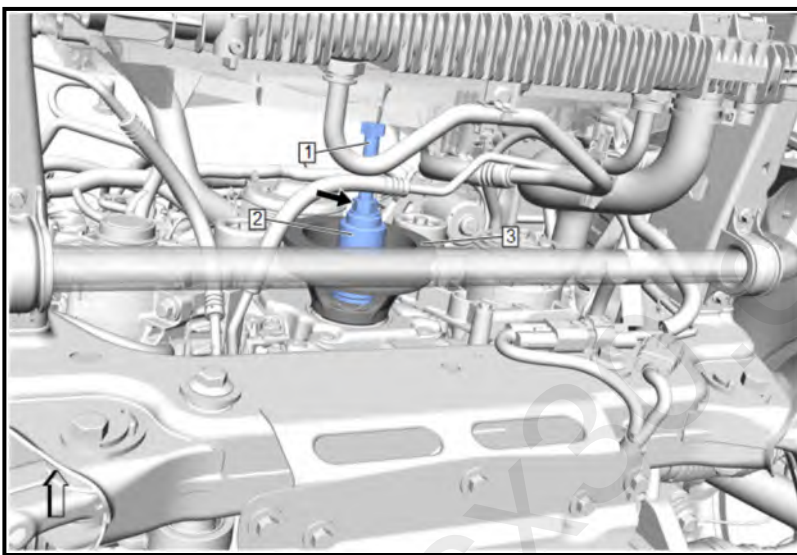
2. Repair or replace the crankshaft balancer as necessary.

Installation Procedure

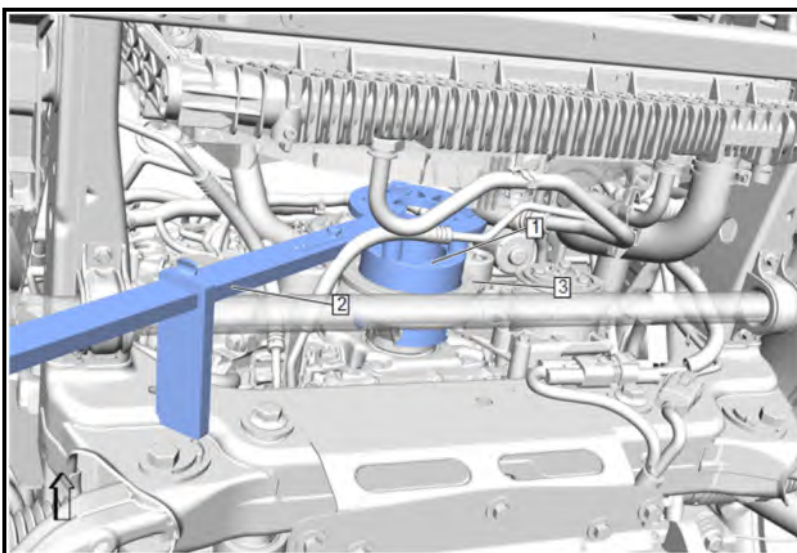
1. Crankshaft Balancer (1) - Loosely install



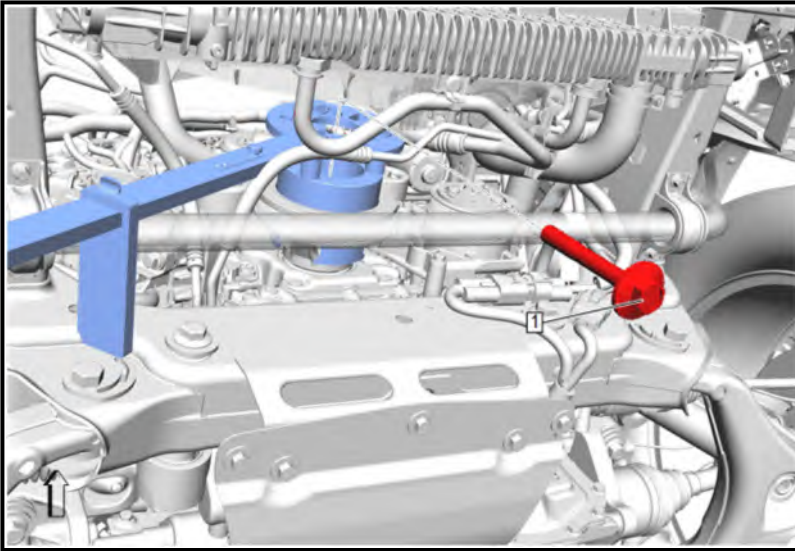
2. Install the **EN-41478 - A Crankshaft Front Oil Seal Installer (1)** and the **EN-41665 - A Crankshaft Balancer and Sprocket Installer (2)** to the crankshaft balancer (3).



3. Use the adjustment nut on the **EN-41478 - A Crankshaft Front Oil Seal Installer (1)** to properly seat the crankshaft balancer (3).
4. Once the crankshaft balancer has been properly seated remove the **EN-41478 - A Crankshaft Front Oil Seal Installer (1)** and the **EN-41665 - A Crankshaft Balancer and Sprocket Installer (2)**.
5. Install the **EN-52287 Balancer Holding Kit (1)** and the **EN-956 - 1 Extension Bar (2)** to the crankshaft balancer (3).



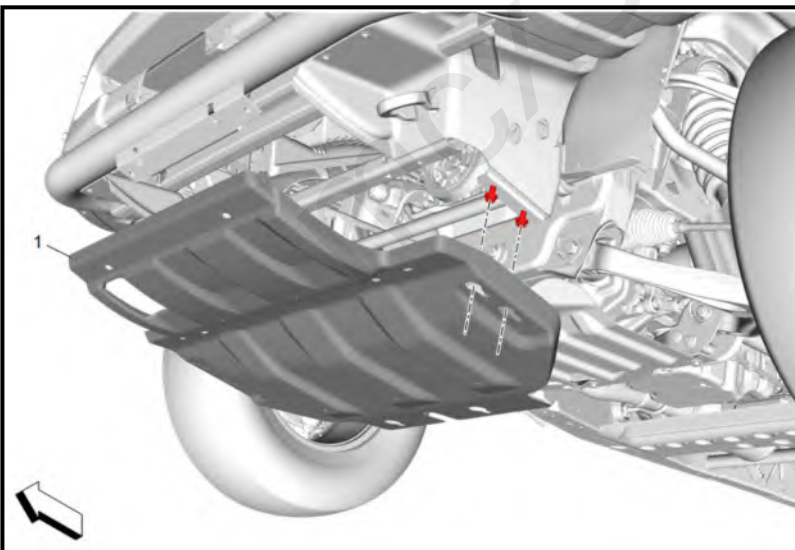
6. Crankshaft Balancer Bolt (1) - Install NEW and tighten



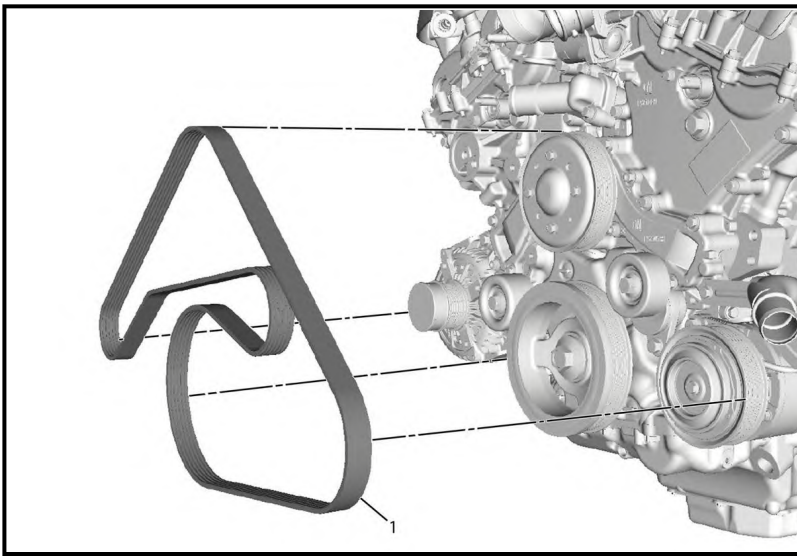
CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

CAUTION: Refer to [Fastener Caution](#) .

1. First Pass: 80 N.m (59 lb ft)
2. Final Pass: 125 degrees using the EN - 45059 Angle Meter
7. Remove the special tools.
8. Underbody Skid Shield (1) - Install - [Underbody Skid Shield Replacement \(Bison\)](#)



9. Drive Belt (1) - Install - [Drive Belt Replacement](#)



10. Perform the crankshaft position variation learn. [Crankshaft Position Variation Learn](#)

CRANKSHAFT FRONT OIL SEAL REPLACEMENT

Special Tools

EN-29184 Oil Seal Installer

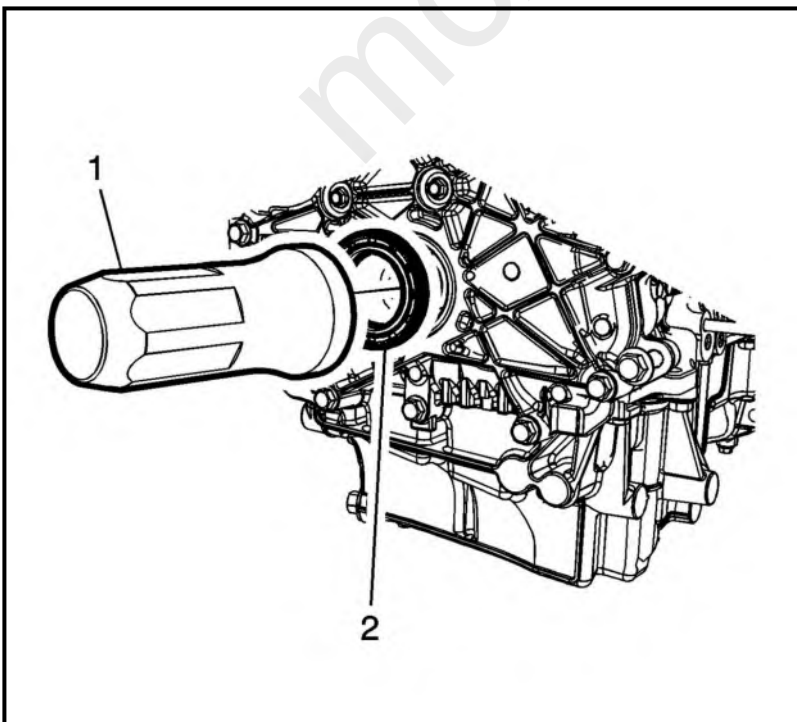
For equivalent regional tools, refer to [Special Tools](#) .

Removal Procedure

1. [Crankshaft Balancer Replacement \(without Bison\)](#), or [Crankshaft Balancer Replacement \(with Bison\)](#) - Remove
2. Remove the crankshaft front cover oil seal with a suitable tool.

Installation Procedure

1. Use the EN-29184 installer (1) or equivalent to install the crankshaft front oil seal (2).



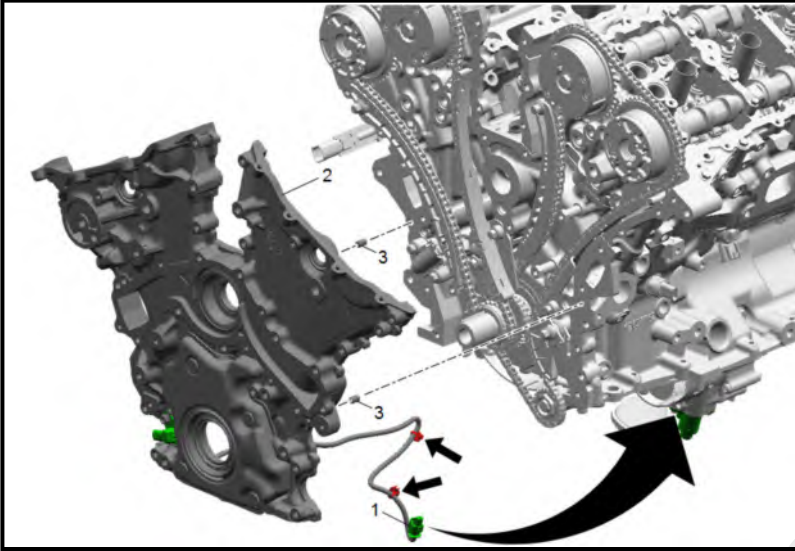
NOTE: Do not lubricate the crankshaft front oil seal or the crankshaft balancer sealing surfaces.

2. Crankshaft Balancer Replacement (without Bison), or Crankshaft Balancer Replacement (with Bison) - Install

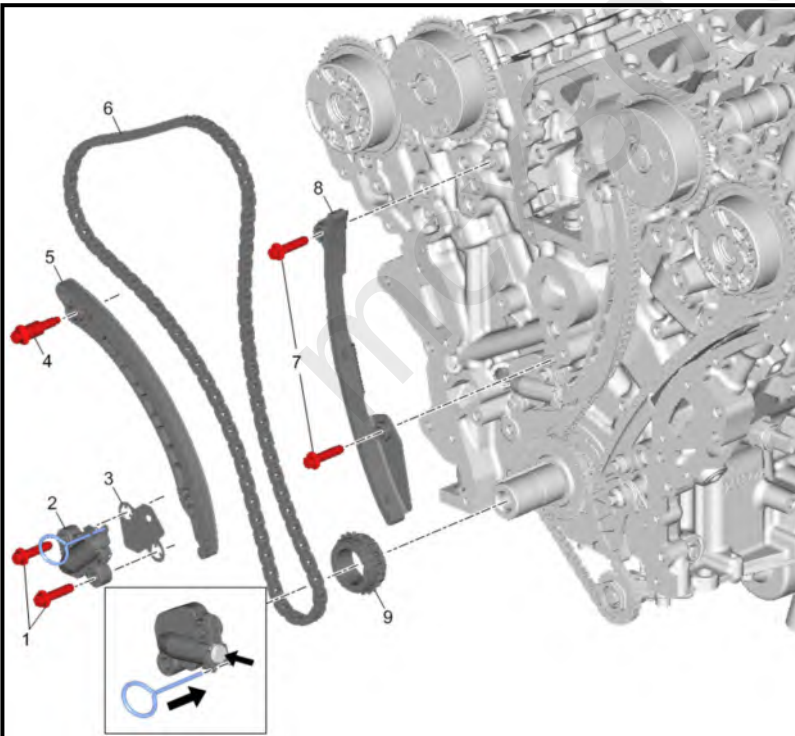
CRANKSHAFT SPROCKET REPLACEMENT - RIGHT SIDE TIMING CHAIN

Removal Procedure

1. Engine Front Cover (2) - Remove - Engine Front Cover Replacement



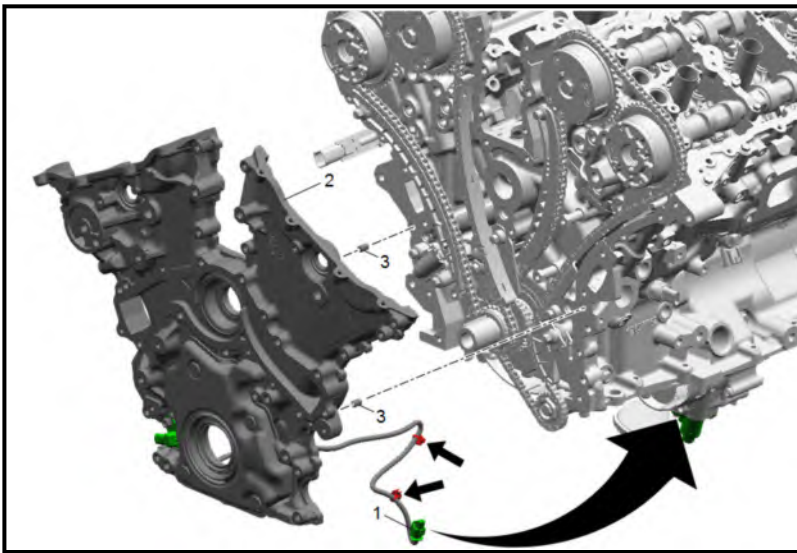
2. Remove the crankshaft sprocket (9) for the right side camshafts. Camshaft Timing Chain Component Removal and Installation



3. Clean and inspect all of the camshaft timing drive components and replace as necessary.

Installation Procedure

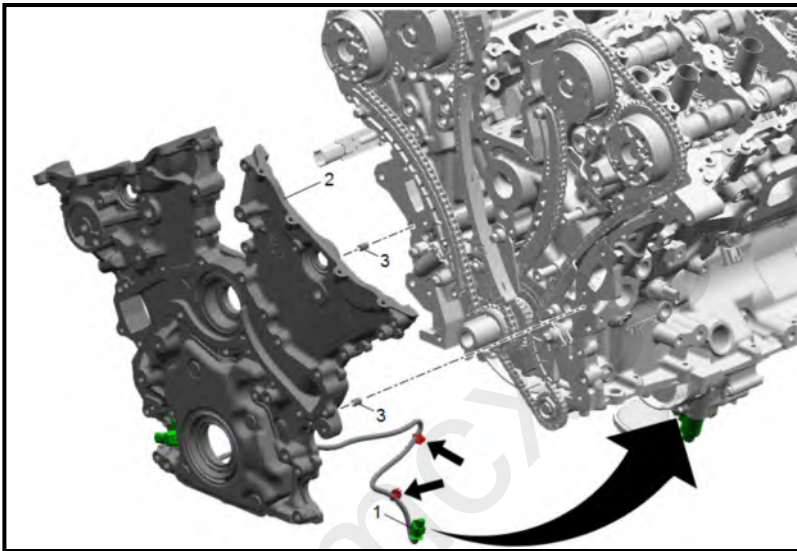
1. Install the camshaft timing chain components. Camshaft Timing Chain Component Removal and Installation
2. Engine Front Cover (2) - Install - Engine Front Cover Replacement



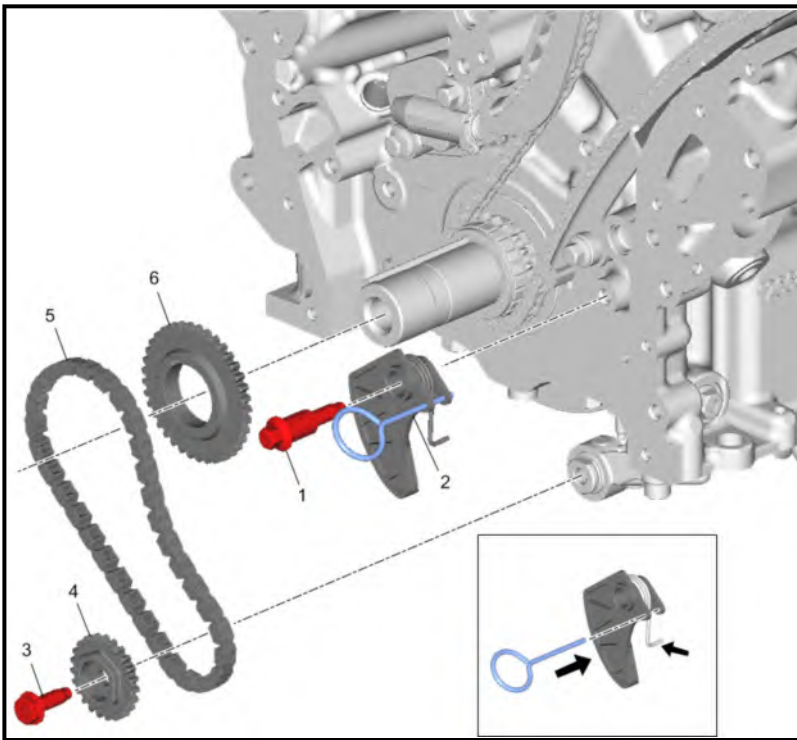
CRANKSHAFT SPROCKET REPLACEMENT - OIL PUMP DRIVE CHAIN

Removal Procedure

1. Engine Front Cover (2) - Remove - [Engine Front Cover Replacement](#)



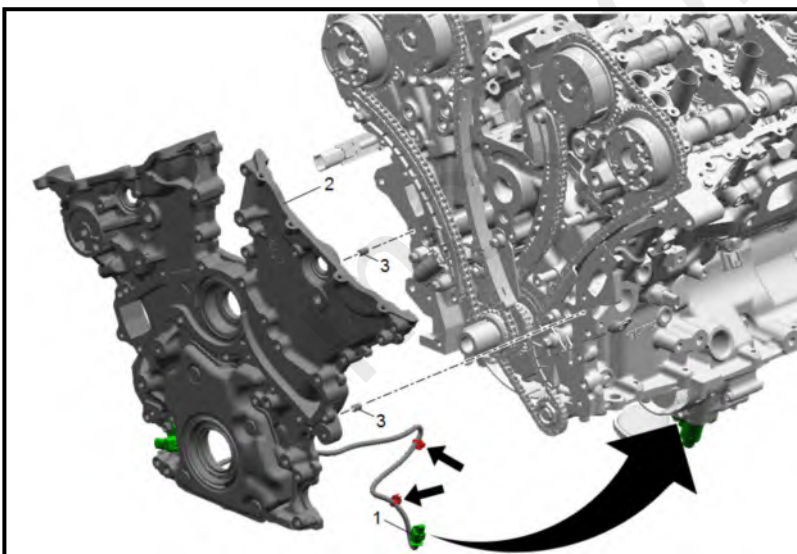
2. Remove the crankshaft sprocket (6) for the oil pump. [Camshaft Timing Chain Component Removal and Installation](#)



3. Clean and inspect all of the camshaft timing drive components and replace as necessary.

Installation Procedure

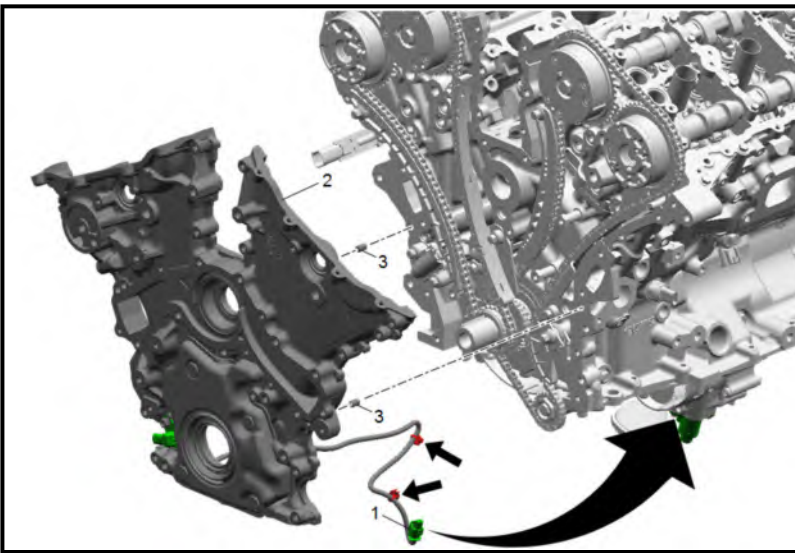
1. Install the camshaft timing chain components. [Camshaft Timing Chain Component Removal and Installation](#)
2. Engine Front Cover (2) - Install - [Engine Front Cover Replacement](#)



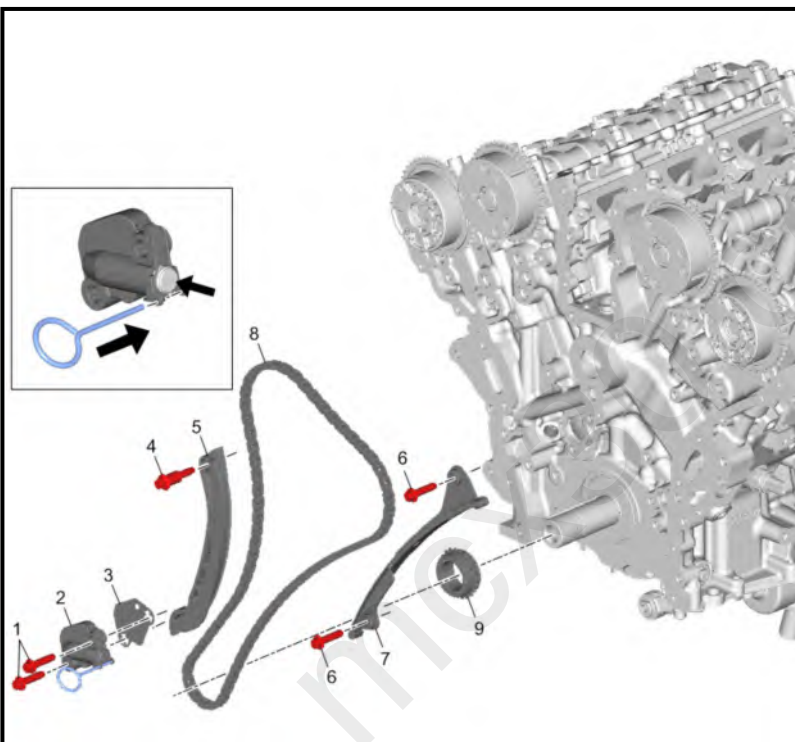
CRANKSHAFT SPROCKET REPLACEMENT - LEFT SIDE TIMING CHAIN

Removal Procedure

1. Engine Front Cover (2) - Remove - [Engine Front Cover Replacement](#)



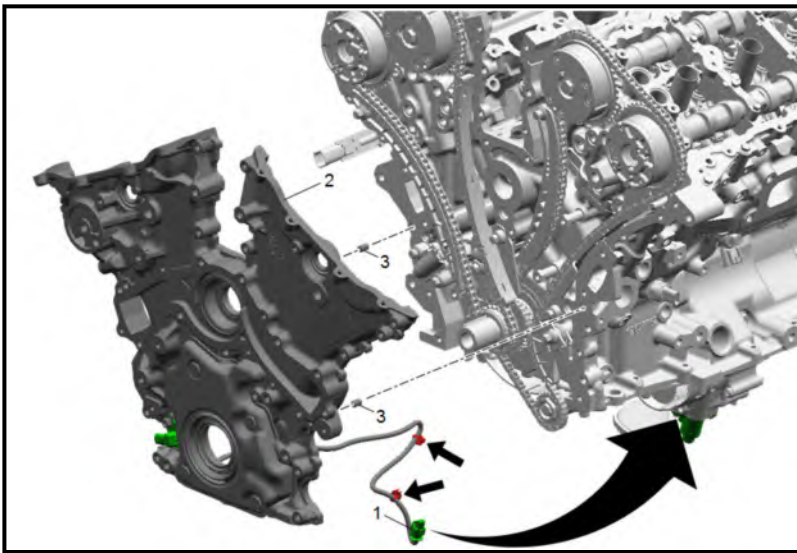
2. Remove the crankshaft sprocket (9) for the left side camshafts. [Camshaft Timing Chain Component Removal and Installation](#)



3. Clean and inspect all of the camshaft timing drive components and replace as necessary.

Installation Procedure

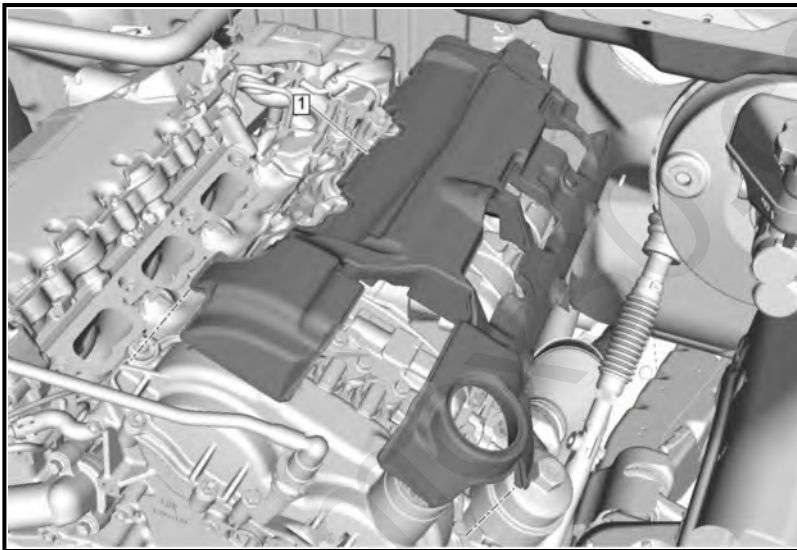
1. Install the camshaft timing chain components. [Camshaft Timing Chain Component Removal and Installation](#)
2. Engine Front Cover (2) - Install - [Engine Front Cover Replacement](#)



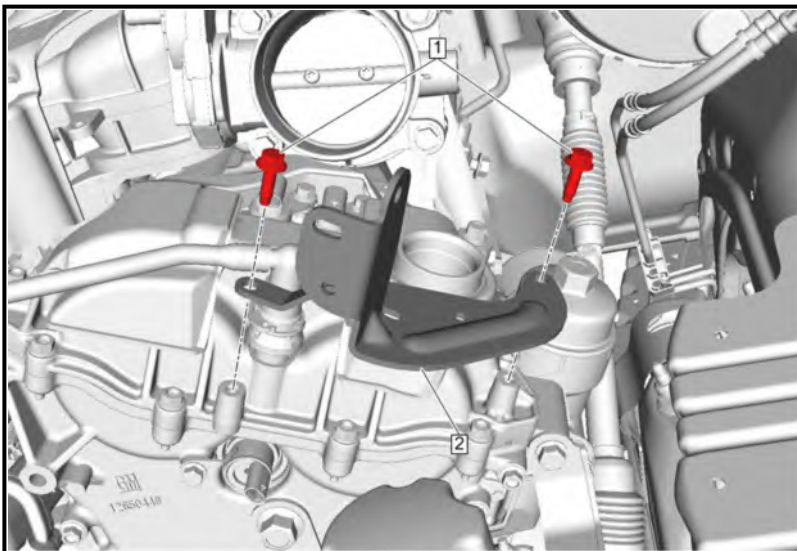
CAMSHAFT COVER REPLACEMENT - LEFT SIDE

Removal Procedure

1. Camshaft Housing Cover Insulator- Left Side (1) - Remove - [Camshaft Housing Cover Insulator Replacement - Left Side](#)

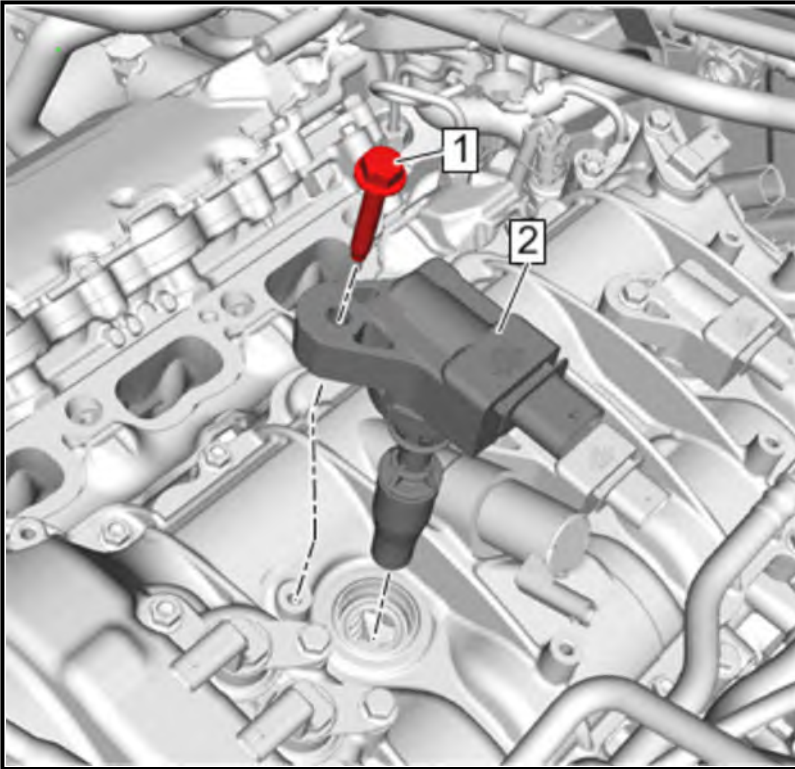


2. Oil Filler Tube Bracket (2) - Remove - [Oil Filler Tube Bracket Replacement](#)

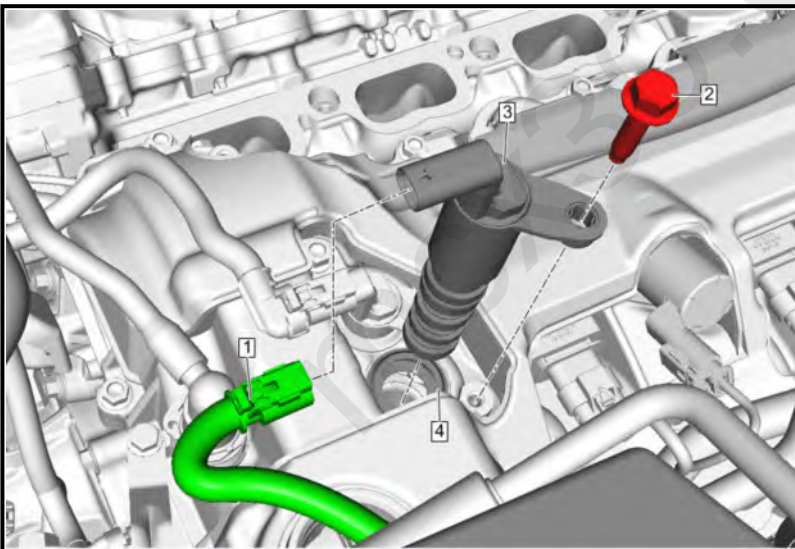


3. Positive Crankcase Ventilation Tube @ Camshaft Cover - Disconnect

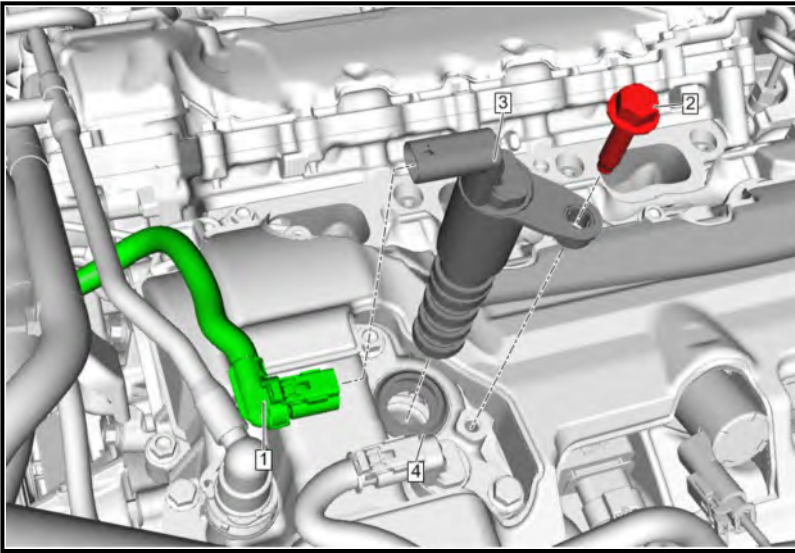
4. Ignition Coil (2) - Remove [3x] - [Ignition Coil Replacement - Bank 2](#)



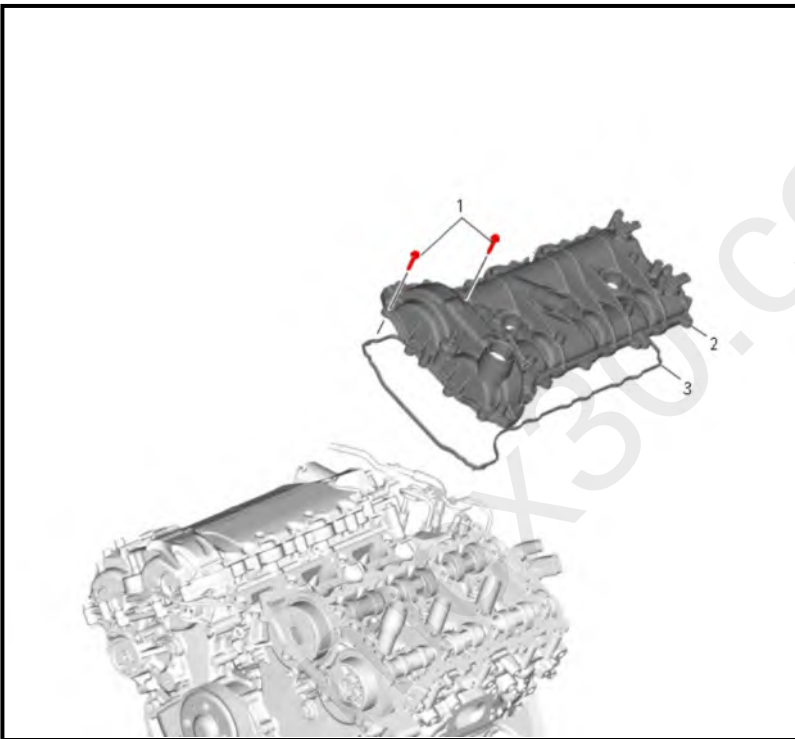
5. Camshaft Position Actuator Valve Solenoid (3) - Remove - [Camshaft Position Actuator Valve Solenoid Replacement - Bank 2 \(Left Side\) Exhaust](#)



6. Camshaft Position Actuator Valve Solenoid (3) - Remove - [Camshaft Position Actuator Valve Solenoid Replacement - Bank 2 \(Left Side\) Intake](#)



7. Disconnect and remove the engine wiring harness from the camshaft cover.
8. Camshaft Cover Bolt (1) - Remove [18x]



9. Camshaft Cover (2) - Remove
10. Camshaft Cover Seal (3) - Remove and DISCARD
11. Clean, inspect, and overhaul the camshaft cover as needed. [Camshaft Cover Overhaul](#)

Installation Procedure

1. Place a bead 8 mm (0.3150 in) in width by 4 mm (0.1575 in) in height of RTV sealant equivalent, on the engine front cover split lines (1). [Adhesives, Fluids, Lubricants, and Sealers](#)

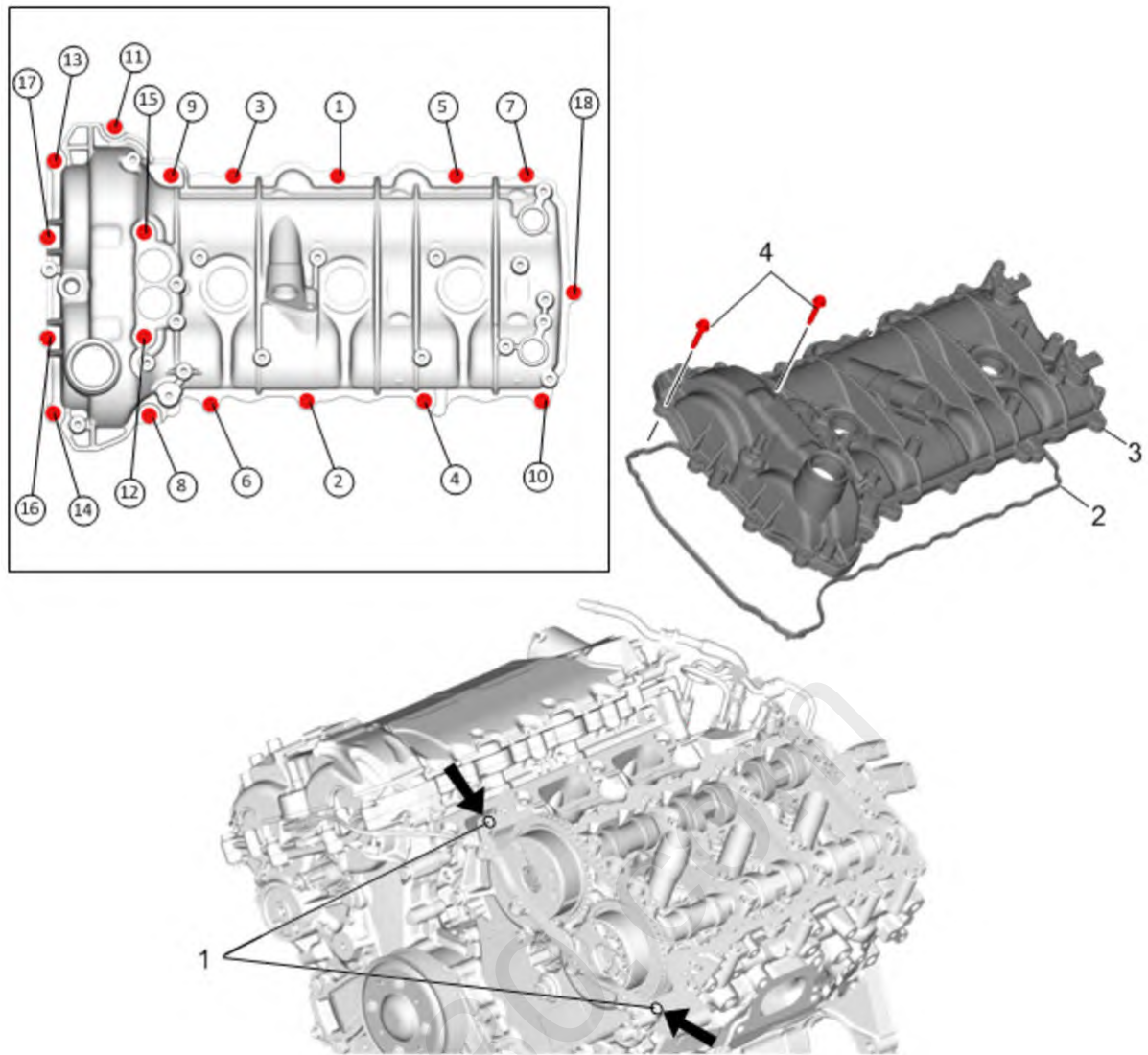
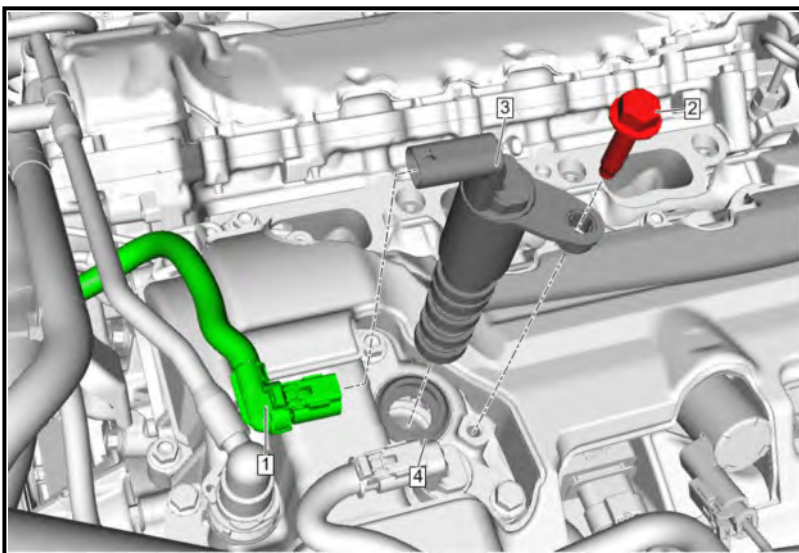


Fig. 4: Identifying Camshaft Cover, Bolts And Seal With Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

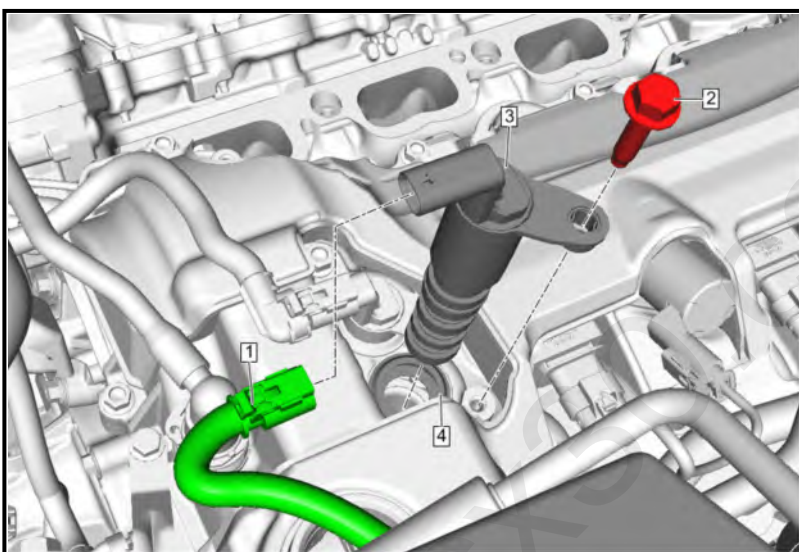
2. Camshaft Cover Seal (2) - Install a NEW seal.
3. Camshaft Cover (3) - Install
4. Camshaft Cover Bolt (4) - Loosely install [18x]

CAUTION: Refer to **Fastener Caution** .

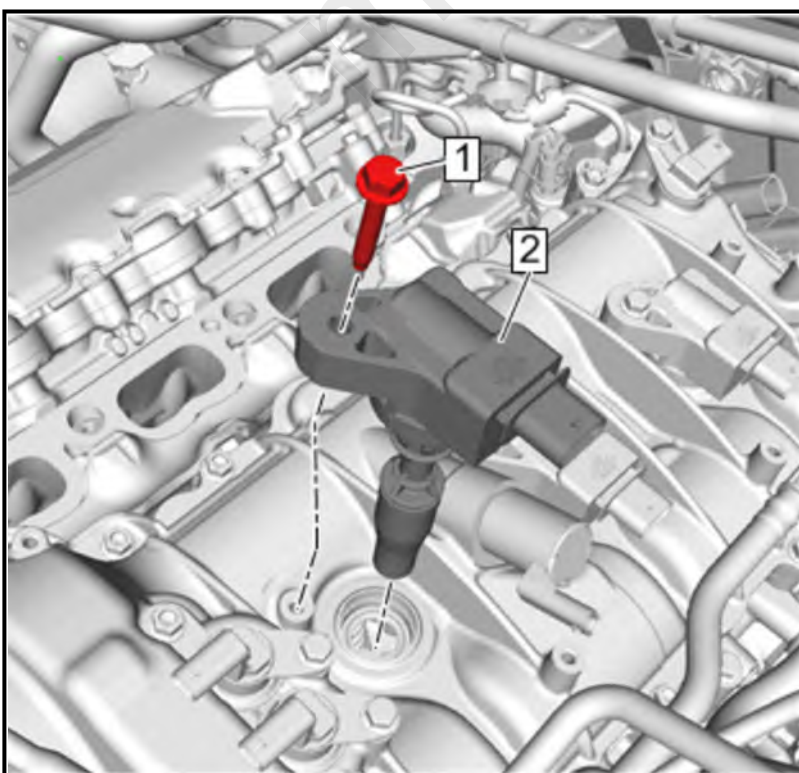
5. Camshaft Cover Bolt (4) - Tighten in the sequence shown. [18x] 15 N.m (11 lb ft)
6. Position and install the engine wiring harness to the camshaft cover.
7. Camshaft Position Actuator Valve Solenoid (3) - Install - **Camshaft Position Actuator Valve Solenoid Replacement - Bank 2 (Left Side) Intake**



8. Camshaft Position Actuator Valve Solenoid (3) - Install - Camshaft Position Actuator Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust

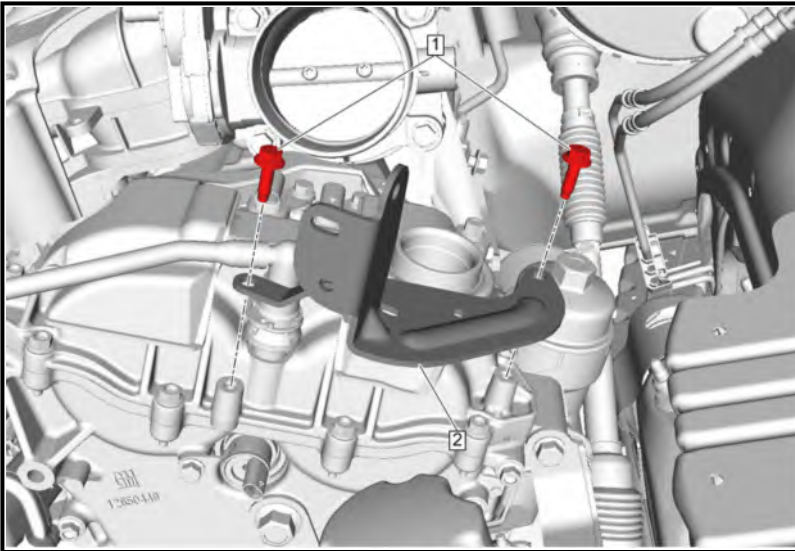


9. Ignition Coil (2) - Install [3x] - Ignition Coil Replacement - Bank 2

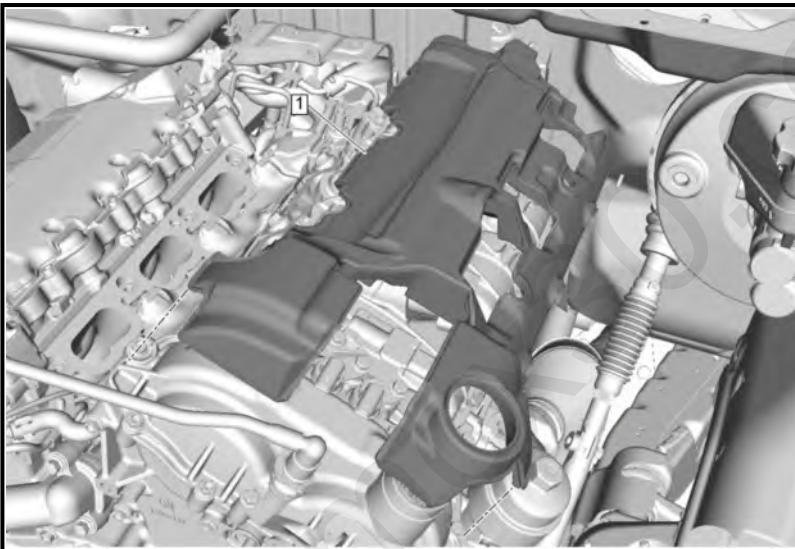


10. Positive Crankcase Ventilation Tube @ Camshaft Cover - Connect

11. Oil Filler Tube Bracket (2) - Install - [Oil Filler Tube Bracket Replacement](#)



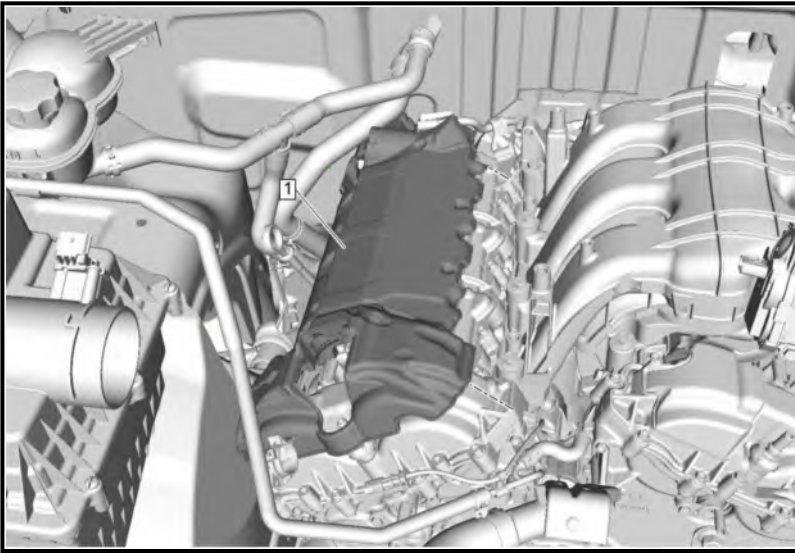
12. Camshaft Housing Cover Insulator- Left Side (1) - Install - [Camshaft Housing Cover Insulator Replacement - Left Side](#)



CAMSHAFT COVER REPLACEMENT - RIGHT SIDE

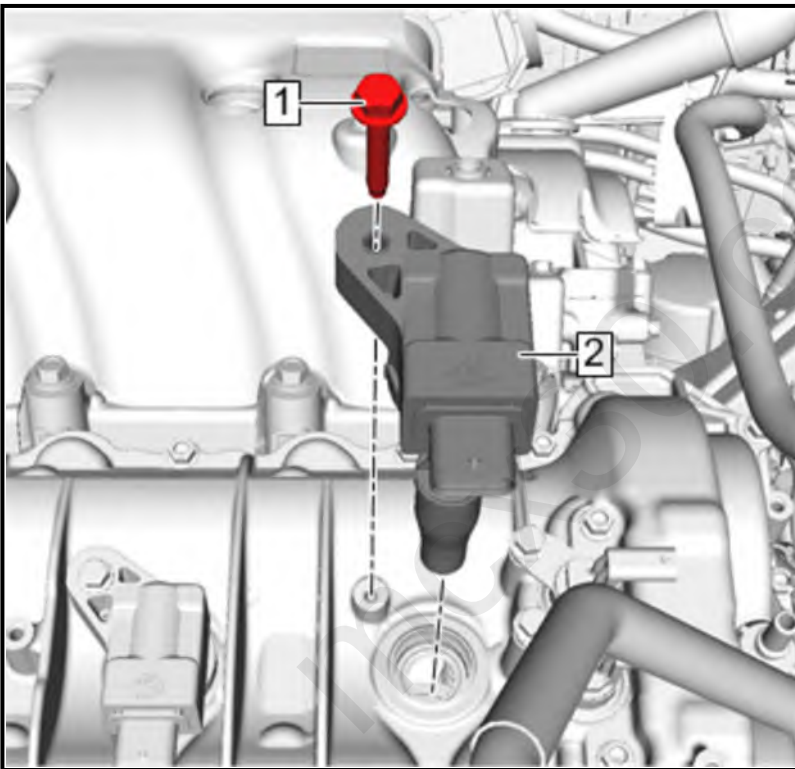
Removal Procedure

1. Camshaft Housing Cover Insulator- Right Side (1) - Remove - [Camshaft Housing Cover Insulator Replacement - Right Side](#)

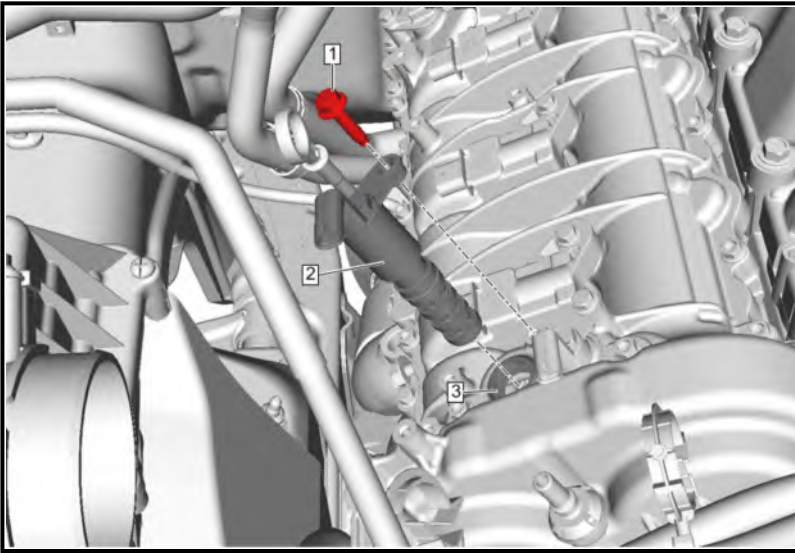


2. Positive Crankcase Ventilation Tube @ Camshaft Cover - Disconnect

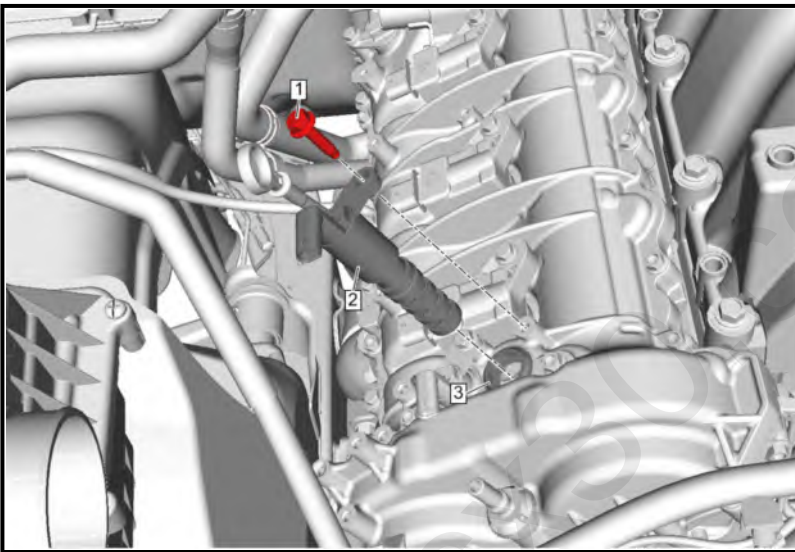
3. Ignition Coil (2) - Remove [3x] - [Ignition Coil Replacement - Bank 1](#)



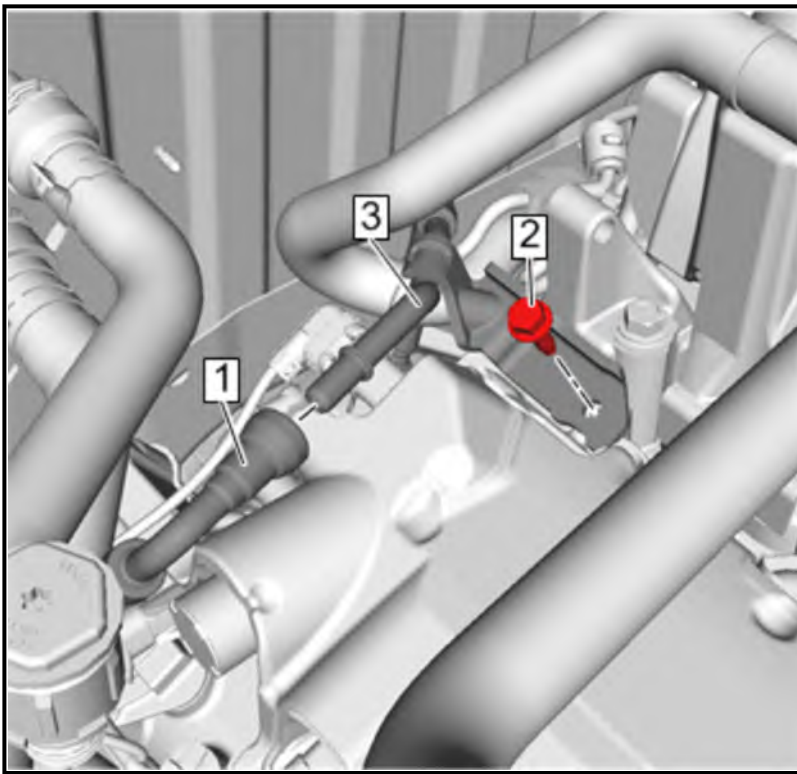
4. Camshaft Position Actuator Valve Solenoid (2) - Remove - [Camshaft Position Actuator Valve Solenoid Replacement - Bank 1 \(Right Side\) Exhaust](#)



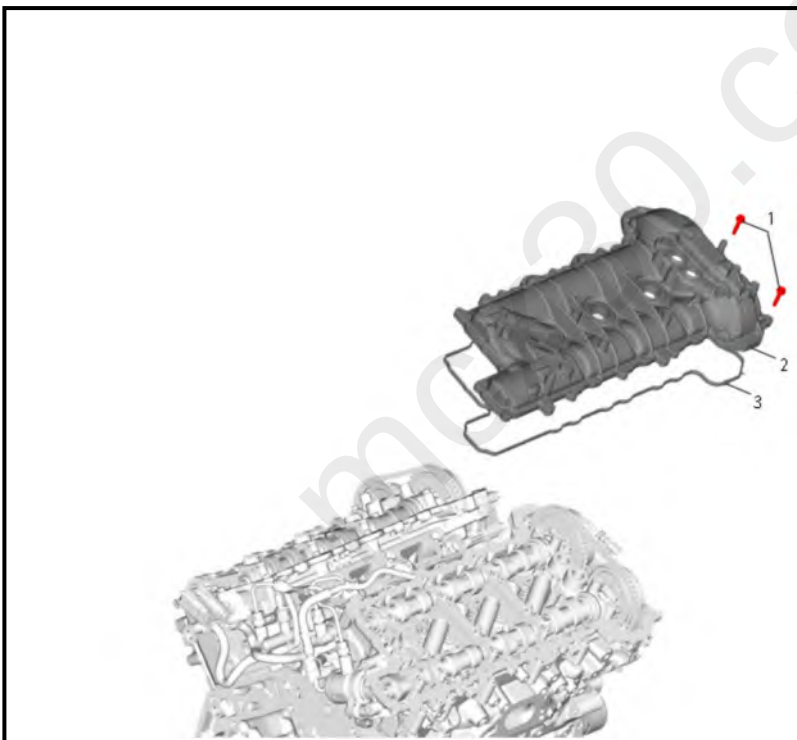
5. Camshaft Position Actuator Valve Solenoid (2) - Remove - [Camshaft Position Actuator Valve Solenoid Replacement - Bank 1 \(Right Side\) Intake](#)



6. Disconnect and remove the engine harness from the camshaft cover.
7. Fuel Feed Pipe Bracket Bolt (2) - Remove - [Fuel Feed Pipe Replacement \(Fuel Tank\)](#) , or [Fuel Feed Pipe Replacement \(Engine\)](#) , or [Fuel Feed Pipe Replacement \(Engine to Tank\)](#).



8. Camshaft Cover Bolt (1) - Remove [18x]



9. Camshaft Cover (2) - Remove

10. Camshaft Cover Seal (3) - Remove and DISCARD

11. Clean, inspect, and overhaul the camshaft cover as needed. [Camshaft Cover Overhaul](#)

Installation Procedure

1. Place a bead 8 mm (0.3150 in) in width by 4 mm (0.1575 in) in height of RTV sealant equivalent, on the engine front cover split lines (1). [Adhesives, Fluids, Lubricants, and Sealers](#)

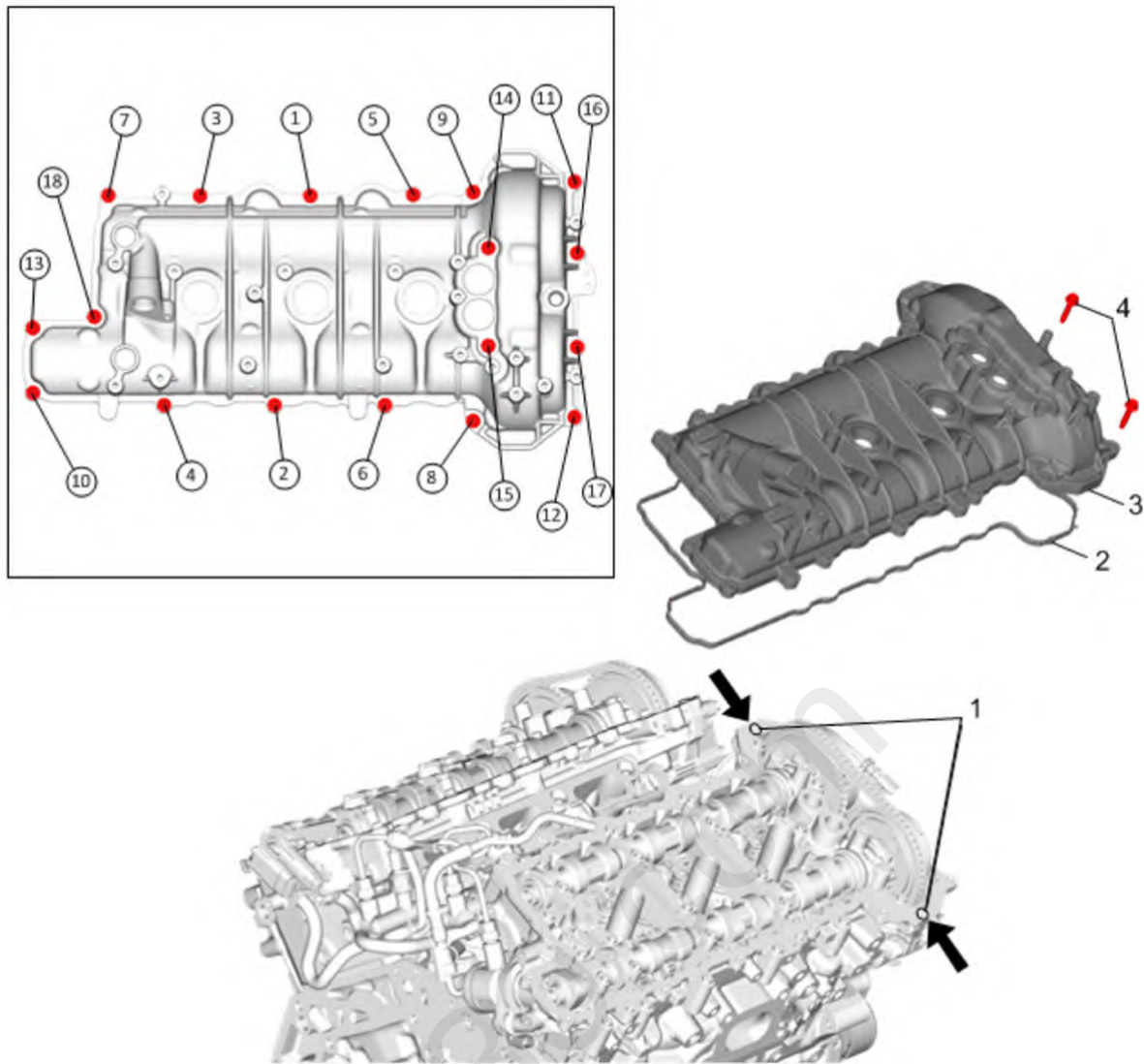
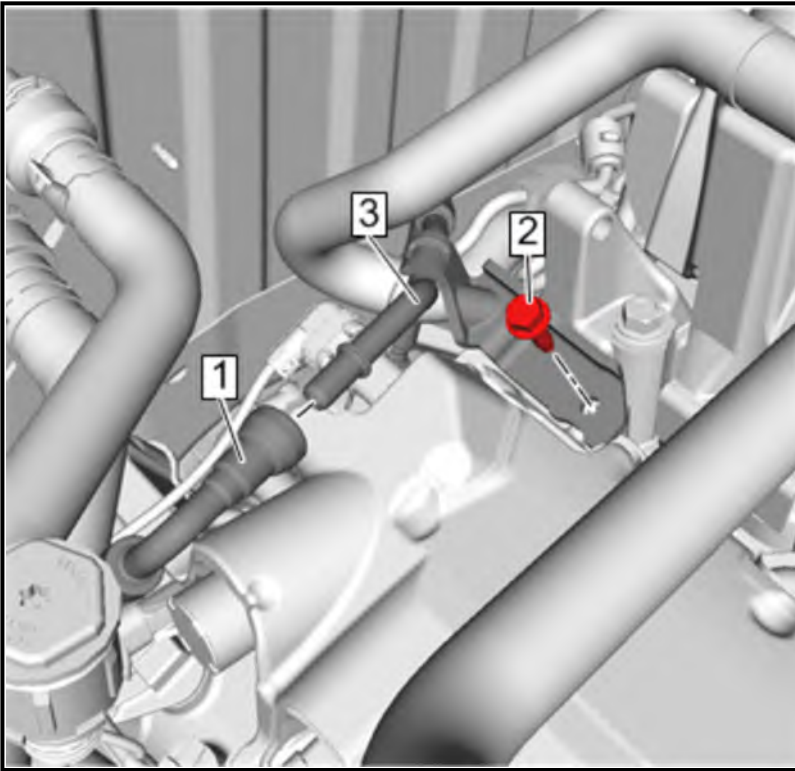


Fig. 5: Camshaft Cover, Bolts And Seal With Tightening Sequence
 Courtesy of GENERAL MOTORS COMPANY

2. Camshaft Cover Seal (2) - Install a NEW seal.
3. Camshaft Cover (3) - Install
4. Camshaft Cover Bolt (4) - Loosely install [18x]

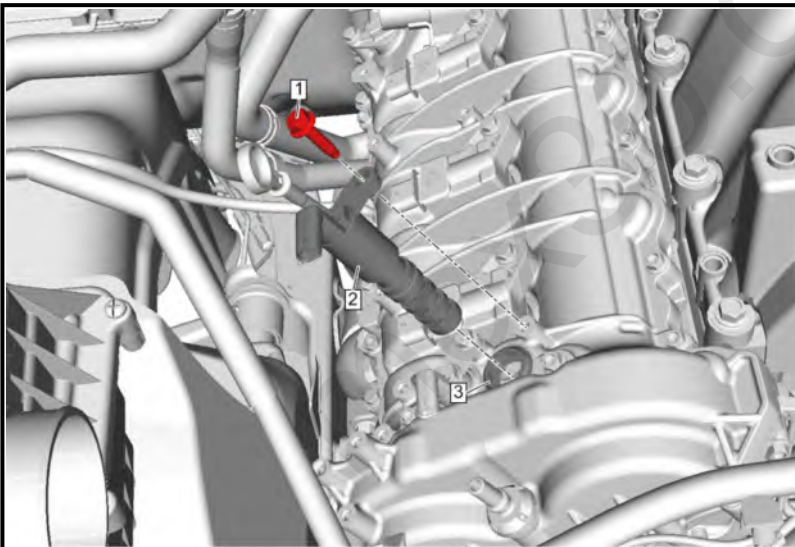
CAUTION: Refer to [Fastener Caution](#) .

5. Tighten in the sequence shown. 15 N.m (11 lb ft).
6. Fuel Feed Pipe Bracket Bolt (2) - Install - [Fuel Feed Pipe Replacement \(Fuel Tank\)](#) , or [Fuel Feed Pipe Replacement \(Engine\)](#) , or [Fuel Feed Pipe Replacement \(Engine to Tank\)](#).

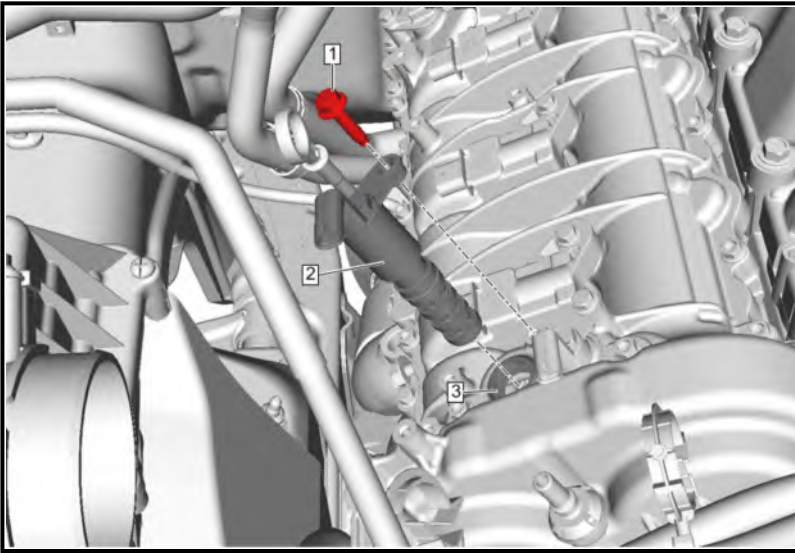


7. Position and install the engine harness to the camshaft cover.

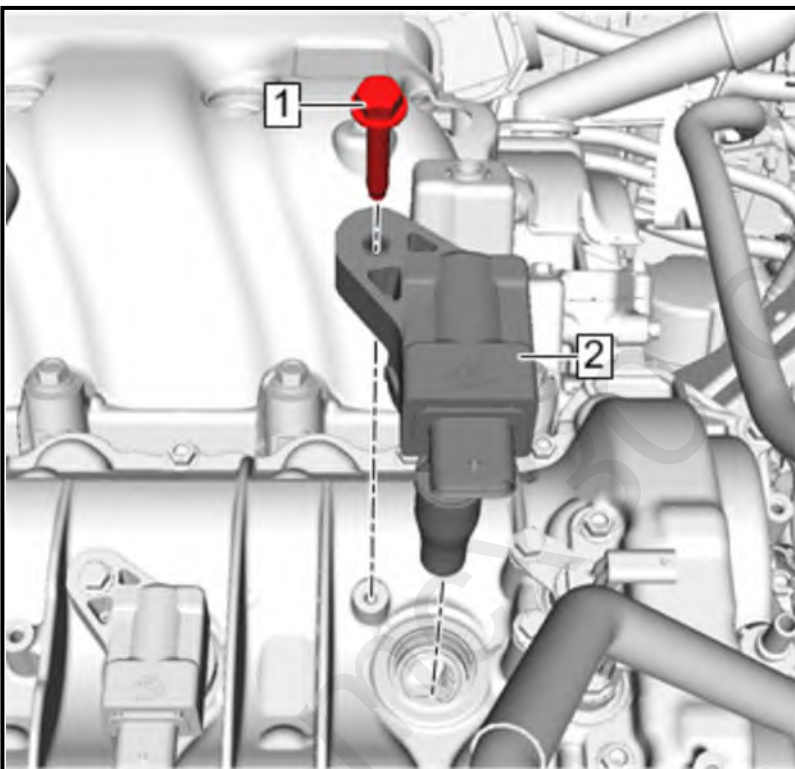
8. Camshaft Position Actuator Valve Solenoid (2) - Install - [Camshaft Position Actuator Valve Solenoid Replacement - Bank 1 \(Right Side\) Intake](#)



9. Camshaft Position Actuator Valve Solenoid (2) - Install - [Camshaft Position Actuator Valve Solenoid Replacement - Bank 1 \(Right Side\) Exhaust](#)

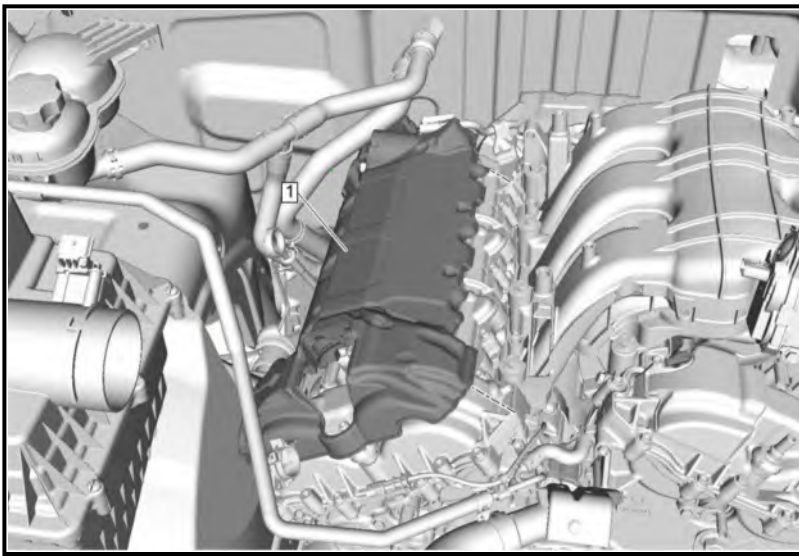


10. Ignition Coil (2) - Install [3x] - [Ignition Coil Replacement - Bank 1](#)



11. Positive Crankcase Ventilation Tube @ Camshaft Cover - Connect

12. Camshaft Housing Cover Insulator- Right Side (1) - Install - [Camshaft Housing Cover Insulator Replacement - Right Side](#)



CAMSHAFT COVER OVERHAUL

Special Tools

J-46103 Camshaft Actuator Valve Seal Installer

Equivalent regional tools: [Special Tools](#)

Removal Procedure

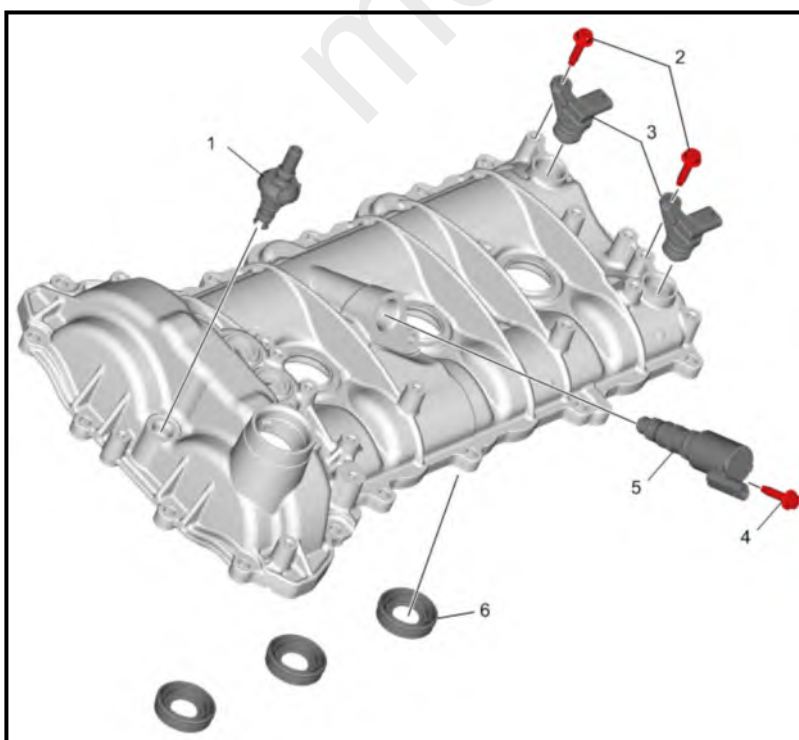
Remove the respective camshaft cover:

- [Camshaft Cover Replacement - Left Side](#)
- [Camshaft Cover Replacement - Right Side](#)

Disassemble Procedure

Camshaft Cover - Left Side

1. Positive Crankcase Ventilation Valve (1) - Remove

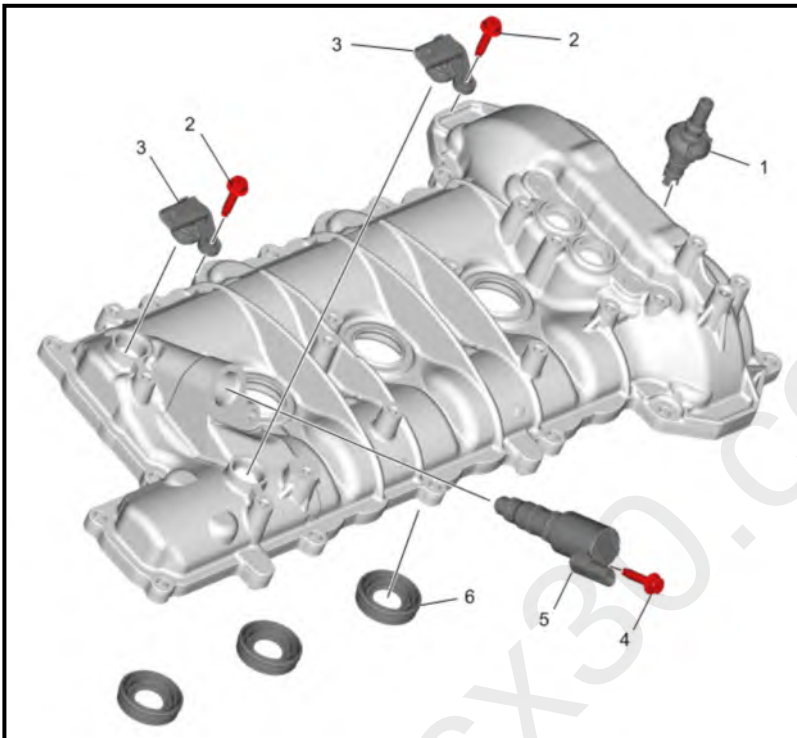


NOTE: These components have tamper-proof connections and cannot be disassembled.

2. Camshaft Position Sensor Bolt (2) - Remove [2x]
3. Camshaft Position Sensor (3) - Remove [2x]
4. Valve Rocker Arm Oil Control Valve Bolt (4) - Remove
5. Valve Rocker Arm Oil Control Valve (5) - Remove
6. Spark Plug Shield Seal (6) - Remove and DISCARD [3x]

Camshaft Cover - Right Side

1. Positive Crankcase Ventilation Valve (1) - Remove



NOTE: These components have tamper-proof connections and cannot be disassembled.

2. Camshaft Position Sensor Bolt (2) - Remove [2x]
3. Camshaft Position Sensor (3) - Remove [2x]
4. Valve Rocker Arm Oil Control Valve Bolt (4) - Remove
5. Valve Rocker Arm Oil Control Valve (5) - Remove
6. Spark Plug Shield Seal (6) - Remove and DISCARD [3x]

Cleaning Procedure

1. Clean the camshaft covers in solvent.

WARNING: Refer to [Safety Glasses Warning](#) .

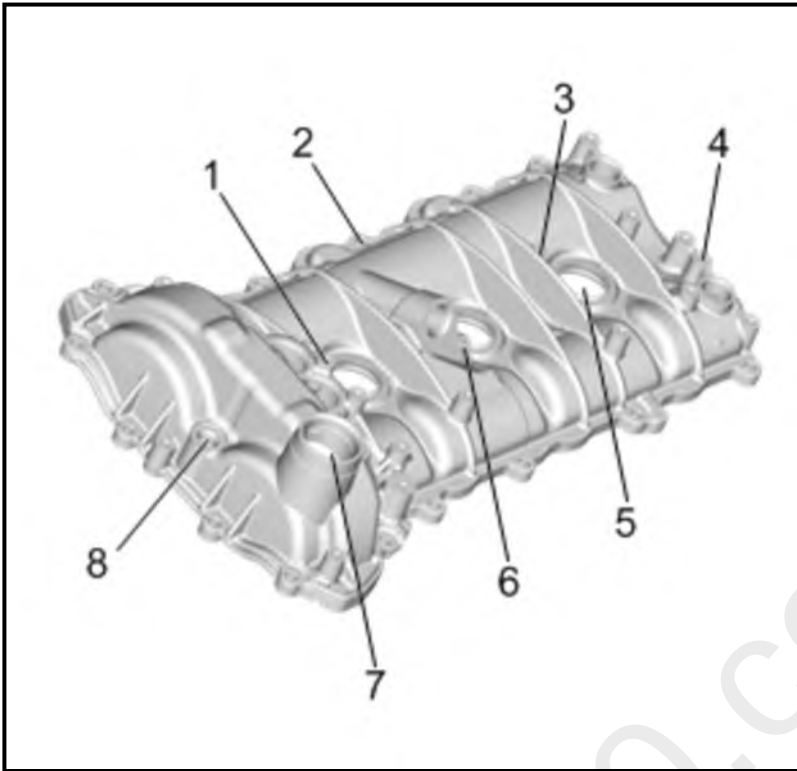
2. Dry the camshaft covers with compressed air.

Inspection Procedure

1. Inspect each camshaft cover for the dents or damage to the exterior. A dented or damaged camshaft cover may:
 - Leak engine oil

- Affect crankcase ventilation
- Interfere with the camshafts
- Interfere with the ignition coil sealing
- Allow water or condensation to enter the engine

2. Inspect the exterior of the right camshaft cover for the following conditions:

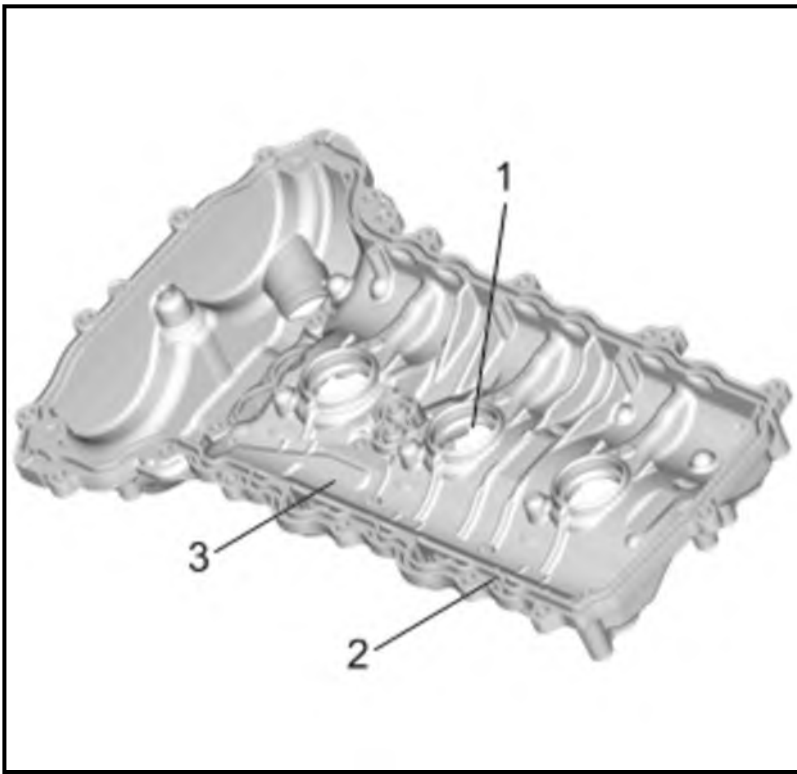


- Damage to the camshaft position actuator solenoid valve bolt hole (1).
- Damage to the camshaft cover bolt holes (2)
- Damage to the mounting holes (3) for the ignition coil assembly and fuel injector sight shield ballstud.
- Damage to the camshaft position sensor bolt hole (4).
- Damage to the spark plug shield seal bore (5)
- Damage to the valve rocker arm oil control valve bolt hole (6).
- Damage to the oil fill hole (7)

NOTE: Not servicable - cam cover must be removed to replace PCV check valve. Can't service check valve alone (tangs will break on removal thus leaving foreign material in engine)

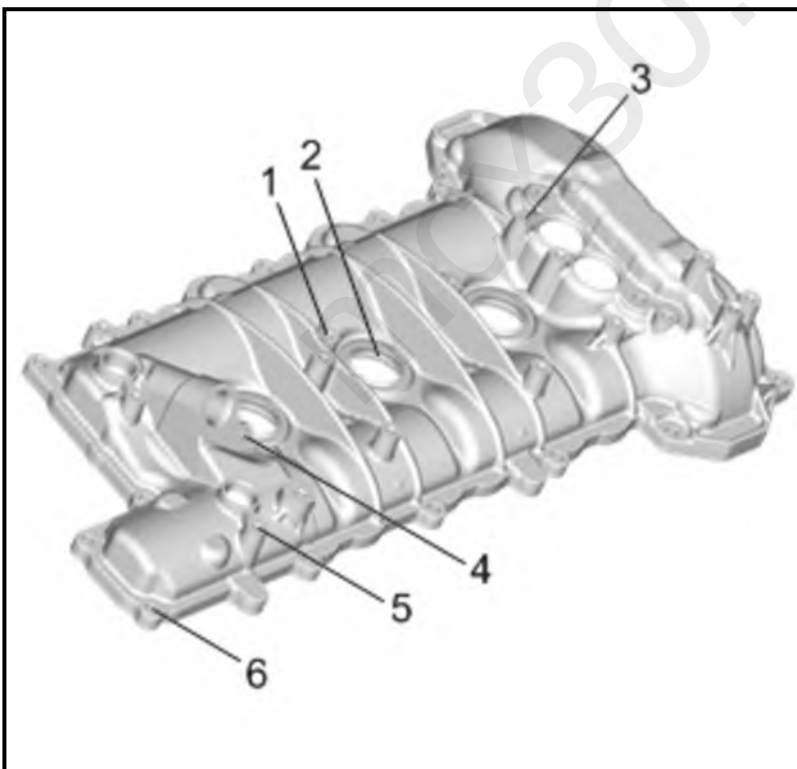
- Damage to the positive crankcase ventilation (PCV) hose connector (8)-A damaged PCV hose connector is not replaceable.

3. Inspect the interior of the right camshaft cover for the following conditions:



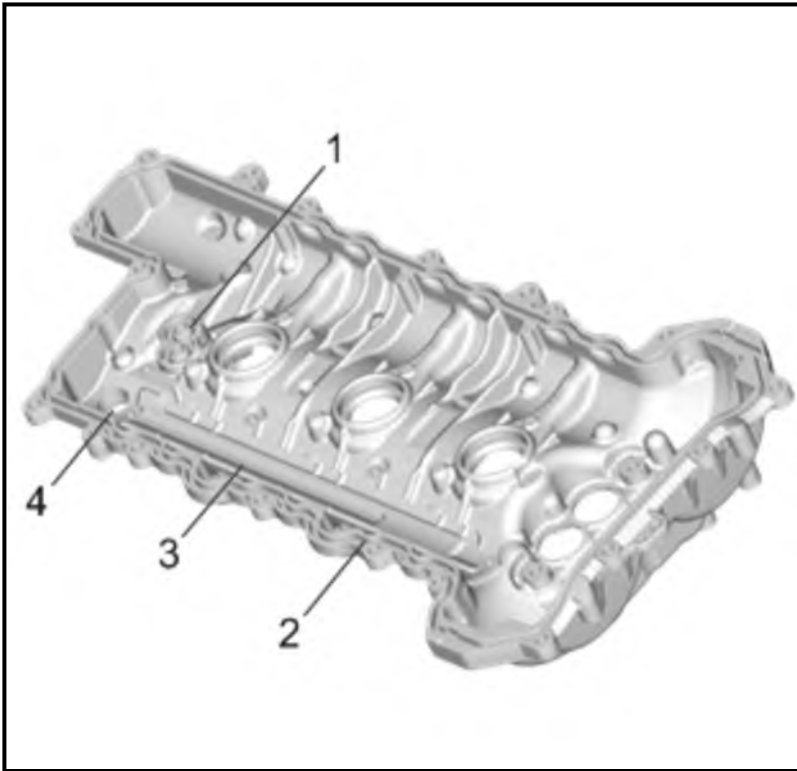
- Gouges or damage to the spark plug shield seal bore (1)
- Gouges or damage to the camshaft cover sealing groove (2)
- Damaged, loose or missing baffle (3)

4. Inspect the exterior of the left camshaft cover for the following conditions:



- Damage to the mounting holes (1) for the ignition coil assembly
- Gouges or damage to the spark plug shield seal bore (2)
- Damage to the camshaft position actuator solenoid valve bolt hole (3).
- Damage to the valve rocker arm oil control valve bolt hole (4).
- Damage to the camshaft position sensor bolt hole (5).
- Damage to the camshaft cover bolt holes (6)

5. Inspect the interior of the left camshaft cover for the following conditions:



- Gouges or damage to the spark plug shield seal bore (1)
- Gouges or damage to the camshaft cover sealing groove (2)
- Damaged, loose or missing baffle (3)

NOTE:

Not servicable - cam cover must be removed to replace PCV check valve. Can't service check valve alone (tangs will break on removal thus leaving foreign material in engine)

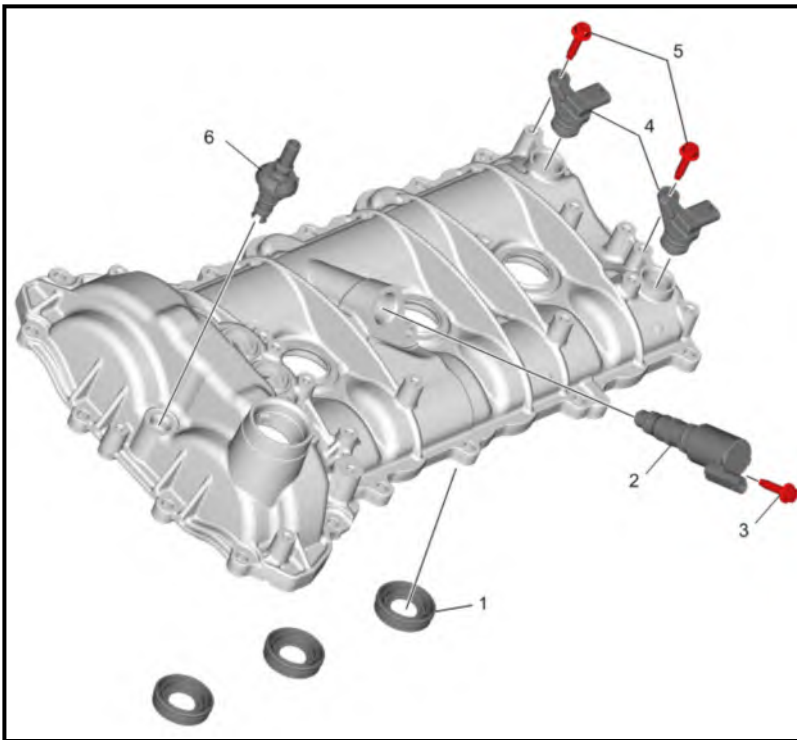
- Damage to the positive crankcase ventilation (PCV) hose connector (8)-A damaged PCV hose connector is not replaceable.

6. Repair or replace the camshaft cover or covers as necessary.

Assemble Procedure

Camshaft Cover - Left Side

1. Spark Plug Shield Seal (1) - Install NEW [3x] - Using **J-46103** Camshaft Actuator Valve Seal Installer



2. Valve Rocker Arm Oil Control Valve (2) - Install

CAUTION: Refer to [Fastener Caution](#) .

3. Valve Rocker Arm Oil Control Valve Bolt (3) - Install - [Valve Rocker Arm Oil Control Valve Replacement - Bank 2](#)

4. Camshaft Position Sensor (4) - Install [2x]

5. Camshaft Position Sensor Bolt (5) - Install [2x]

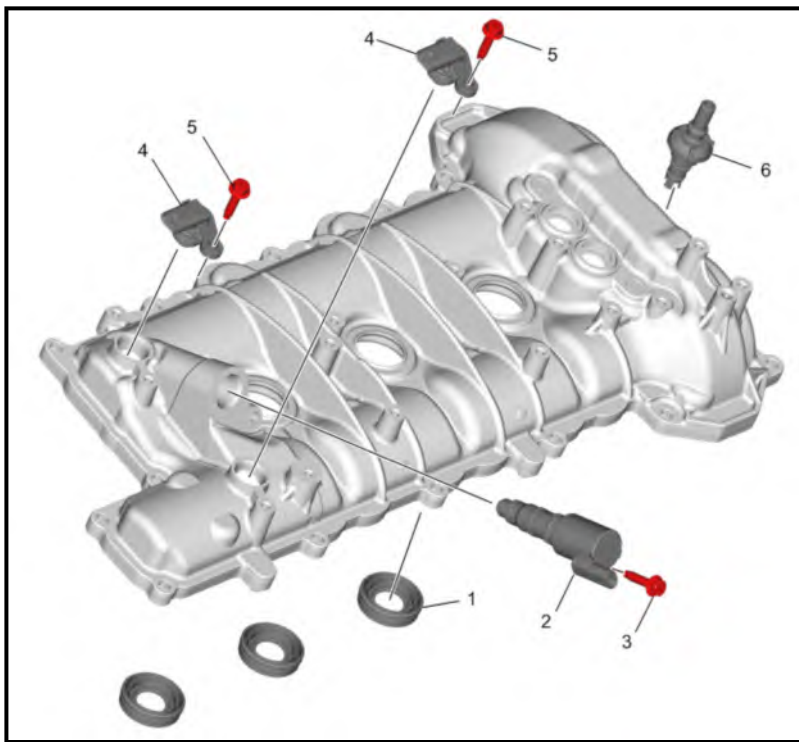
- [Camshaft Position Sensor Replacement - Bank 2 \(Left Side\) Intake](#)
- [Camshaft Position Sensor Replacement - Bank 2 \(Left Side\) Exhaust](#)

NOTE: These components have tamper-proof connections and cannot be disassembled.

6. Positive Crankcase Ventilation Valve (6) - Install

Camshaft Cover - Right Side

1. Spark Plug Shield Seal (1) - Install NEW [3x] - Using **J-46103** Camshaft Actuator Valve Seal Installer



2. Valve Rocker Arm Oil Control Valve (2) - Install
3. Valve Rocker Arm Oil Control Valve Bolt (3) - Install - [Valve Rocker Arm Oil Control Valve Replacement - Bank 1](#)
4. Camshaft Position Sensor (4) - Install [2x]
5. Camshaft Position Sensor Bolt (5) - Install [2x]
 - [Camshaft Position Sensor Replacement - Bank 1 \(Right Side\) Intake](#)
 - [Camshaft Position Sensor Replacement - Bank 1 \(Right Side\) Exhaust](#)

NOTE: These components have tamper-proof connections and cannot be disassembled.

6. Positive Crankcase Ventilation Valve (6) - Install

Installation Procedure

Install the respective camshaft cover:

- [Camshaft Cover Replacement - Left Side](#)
- [Camshaft Cover Replacement - Right Side](#)

ENGINE FRONT COVER REPLACEMENT

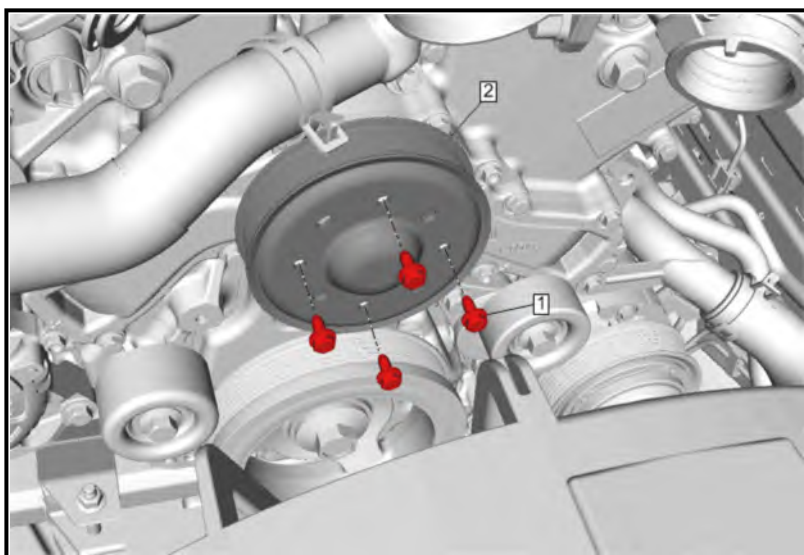
Special Tools

EN-46109 Engine Front Cover Installation Guide Pins

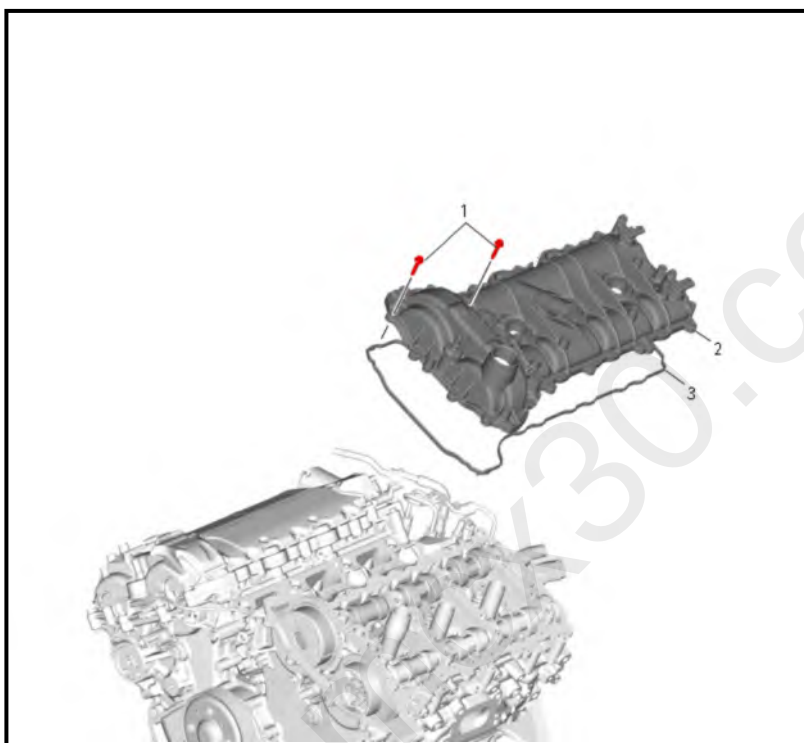
Equivalent regional tools: [Special Tools](#)

Removal Procedure

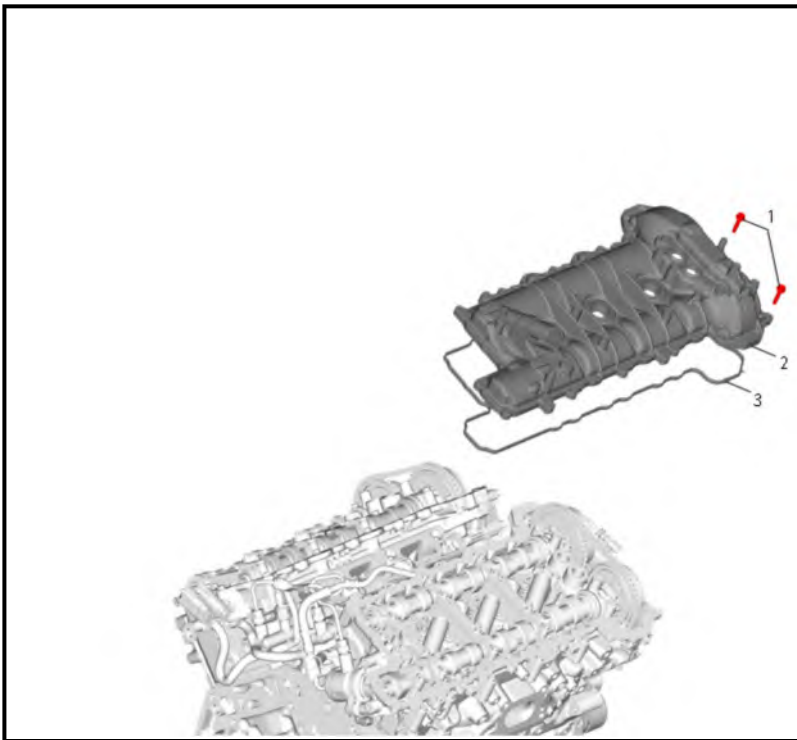
1. Drain the cooling system. [Cooling System Draining and Filling \(Static Fill\)](#) , or [Cooling System Draining and Filling \(Vac n Fill\)](#).
2. Air Cleaner Outlet Duct - Remove - [Air Cleaner Outlet Duct Replacement](#)
3. Power Brake Booster Pump - Remove - [Power Brake Booster Pump Replacement](#)
4. Water Pump Pulley (2) - Remove - [Water Pump Pulley Replacement \(LGZ\)](#)



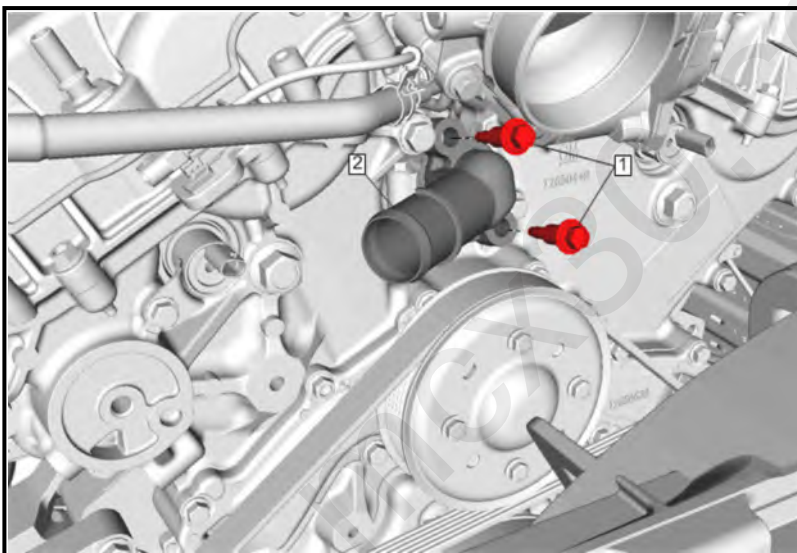
5. Camshaft Cover - Left Side (2) - Remove - [Camshaft Cover Replacement - Left Side](#)



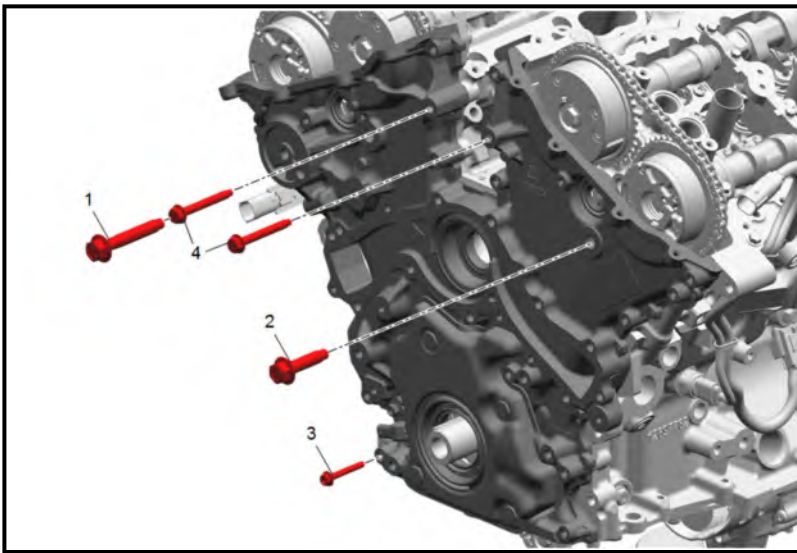
6. Camshaft Cover - Right Side (2) - Remove - [Camshaft Cover Replacement - Right Side](#)



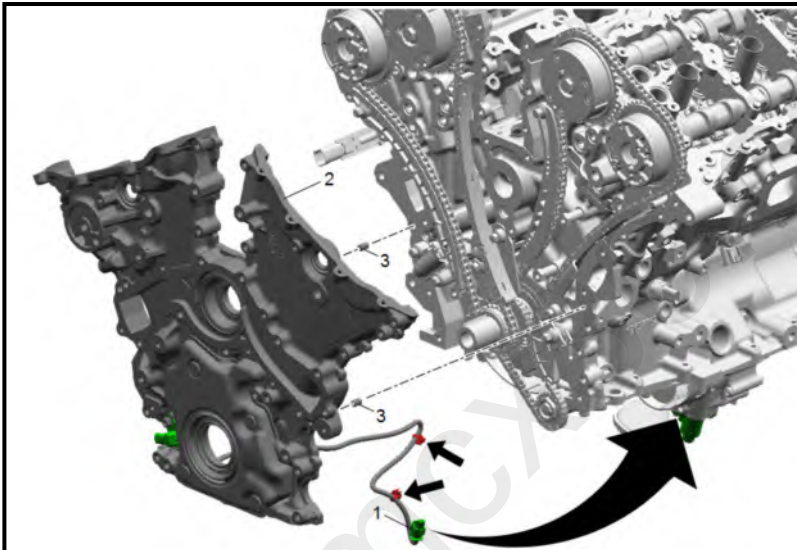
7. Remove the water outlet (2) with the radiator hose and reposition aside. [Water Outlet Replacement \(LGZ\)](#)



8. Crankshaft Balancer - Remove - [Crankshaft Balancer Replacement \(without Bison\)](#), or [Crankshaft Balancer Replacement \(with Bison\)](#)
9. Engine Coolant Air Bleed Pipe - Remove - [Engine Coolant Air Bleed Pipe Replacement \(LGZ\)](#)
10. Remove the engine ground fastener and ground cable attached to the front cover.
11. Detach retainers and position engine harness aside.
12. Water Pump Inlet Pipe - Remove - [Water Pump Inlet Pipe Replacement \(LGZ\)](#)
13. Water Pump - Remove - [Water Pump Replacement \(LGZ\)](#)
14. Oil Pump Flow Control Solenoid Valve Harness - Remove - [Oil Pump Flow Control Solenoid Valve Harness Replacement](#)
15. Camshaft Position Actuator Locating Pin Control Valve-Bank 1 - Remove - [Camshaft Position Actuator Locating Pin Control Valve Replacement - Bank 1](#)
16. Camshaft Position Actuator Locating Pin Control Valve-Bank 2 - Remove - [Camshaft Position Actuator Locating Pin Control Valve Replacement - Bank 2](#)
17. Engine Front Cover Bolt (1) - Remove



18. Engine Front Cover Bolt (2) - Remove
19. Engine Front Cover Bolt (3) - Remove [16x]
20. Engine Front Cover Bolt (4) - Remove [2x]
21. Oil Pump Flow Control Solenoid Valve Electrical Connector (1) - Remove



NOTE: The retaining clips attached to the oil pump flow control solenoid wire are used for production only and should be removed and discarded.

CAUTION: Do not pry against the face of the camshaft position actuators or the position actuator retaining bolts as the position actuators will be damaged.

NOTE: Locate pry points to aid in loosening the cover.

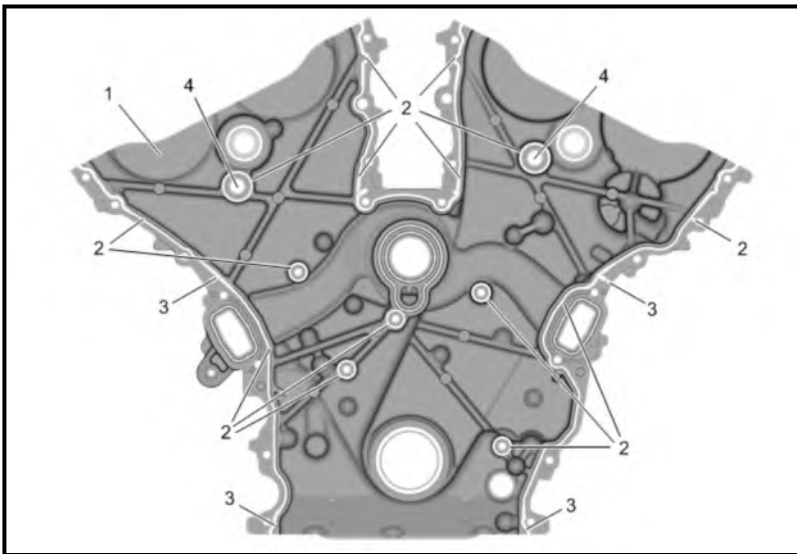
22. Engine Front Cover (2) - Remove
23. Engine Front Cover Locating Pin (3) - Remove [2x]
24. Clean, inspect and overhaul the engine front cover as needed. [Engine Front Cover Overhaul](#)

NOTE: Insert a piece of cardboard between the oil pan front and the oil pump in order to prevent any contaminants from falling into the oil pan.

25. Use compressed air in order to remove any engine coolant from the engine cooling passages and from the top of the oil pan scraper (windage tray).

Installation Procedure

1. Apply the appropriate RTV sealant bead (2, 3) to the areas on the engine front cover (1) as shown in the illustration. [Adhesives, Fluids, Lubricants, and Sealers](#)



NOTE:

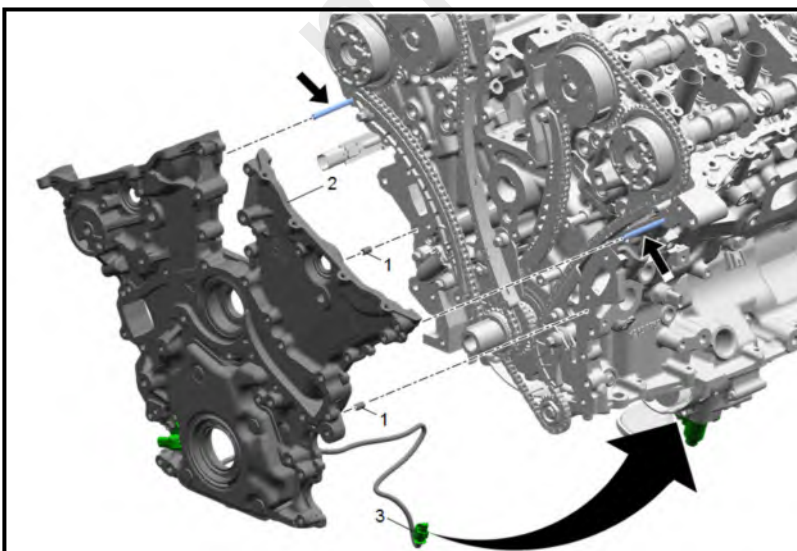
- Ensure proper use of room temperature vulcanizing (RTV) sealant. [Use of Room Temperature Vulcanizing \(RTV\) and Anaerobic Sealant](#)
- Keep the RTV bead path on the outward edge of the t-joints to ensure proper sealant coverage.

1. Apply a 3 mm (0.118 in) bead (2) of RTV sealant to the engine front cover (1).
2. Apply a 5 mm (0.197 in) bead (3) of RTV sealant to the engine front cover (1).

NOTE:

No RTV sealant should be visible in the M12 bolt holes upon final assembly of front cover to engine.

3. Apply a bead of RTV sealant around the M12 Bolt Holes (4).
2. Engine Front Cover Locating Pin (1) - Install [2x]



3. Engine Front Cover (2) - Install - using the **EN-46109** Guide Pins
4. Oil Pump Flow Control Solenoid Valve Electrical Connector (3) - Install
5. Engine Front Cover Bolt (1) - Install and tighten in sequence [2x] 15 N.m (11 lb ft)

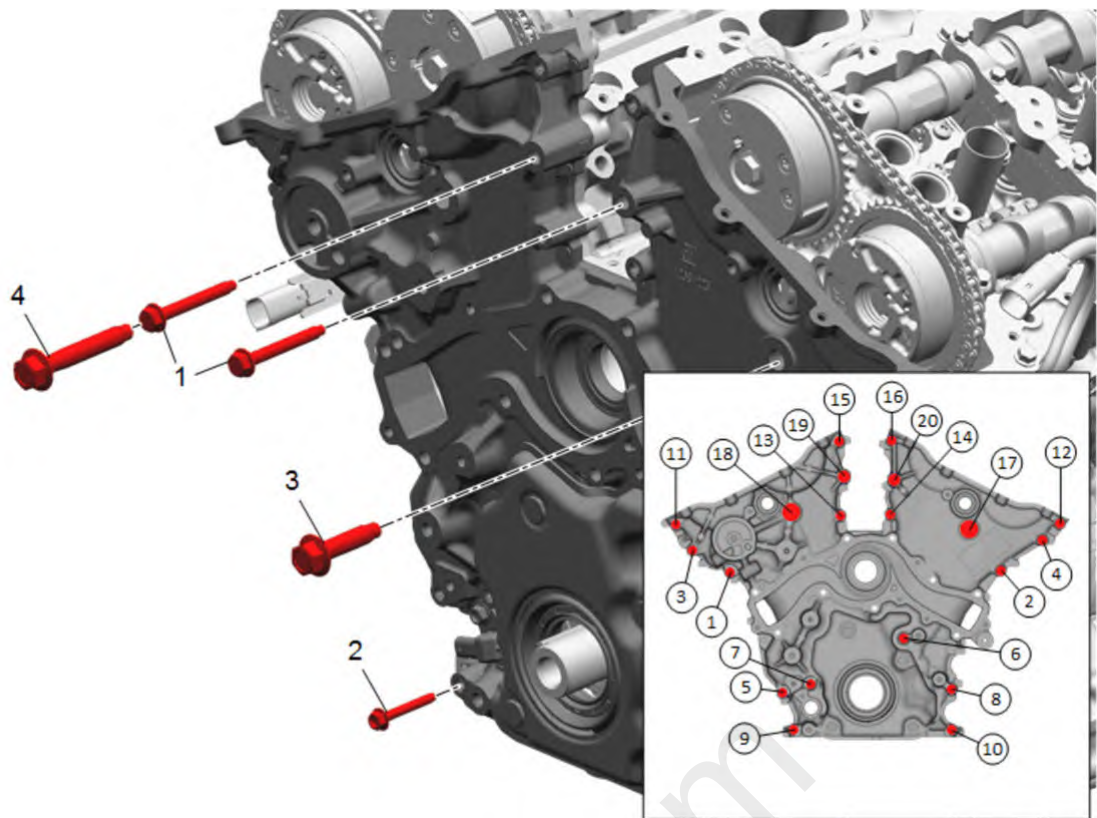
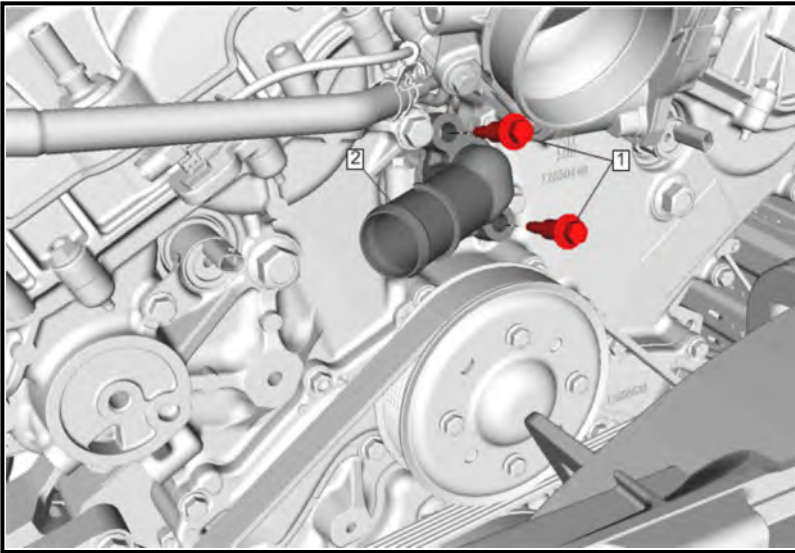


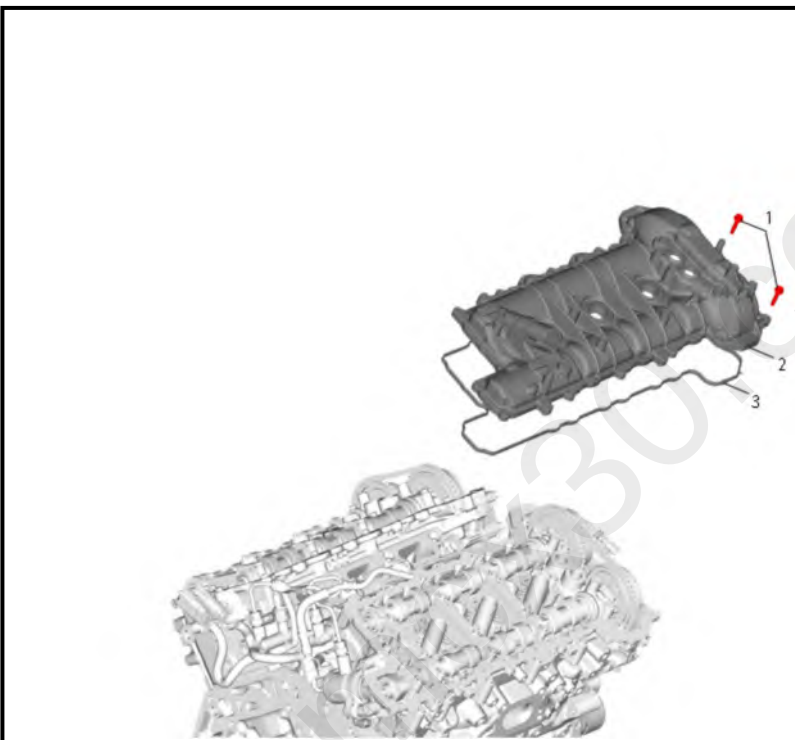
Fig. 6: Identifying Engine Front Cover And Bolts With Tightening Sequence
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to [Fastener Caution](#) .

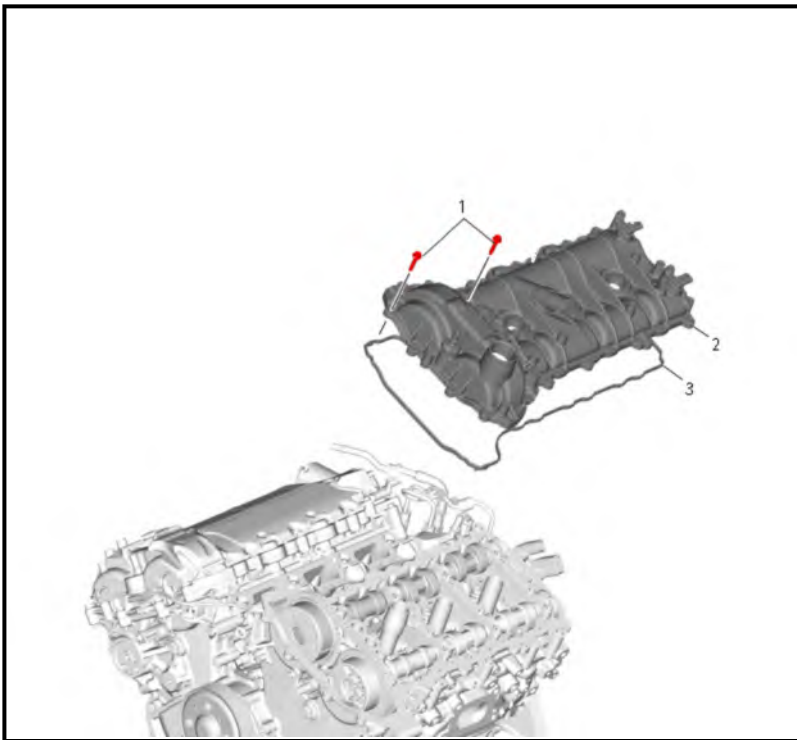
6. Engine Front Cover Bolt (2) - Install and tighten in sequence [16x] 10 N.m (89 lb in)
7. Engine Front Cover Bolt (3) - Install and tighten in sequence 60 N.m (44 lb ft)
8. Engine Front Cover Bolt (4) - Install and tighten in sequence 60 N.m (44 lb ft)
9. Camshaft Position Actuator Locating Pin Control Valve-Bank 2 - Install - [Camshaft Position Actuator Locating Pin Control Valve Replacement - Bank 2](#)
10. Camshaft Position Actuator Locating Pin Control Valve-Bank 1 - Install - [Camshaft Position Actuator Locating Pin Control Valve Replacement - Bank 1](#)
11. Oil Pump Flow Control Solenoid Valve Harness - Install - [Oil Pump Flow Control Solenoid Valve Harness Replacement](#)
12. Water Pump - Install - [Water Pump Replacement \(LGZ\)](#).
13. Water Pump Inlet Pipe - Install - [Water Pump Inlet Pipe Replacement \(LGZ\)](#).
14. Position engine harness and attach harness retainers to engine front cover.
15. Install the ground cable and the fastener to the front engine cover. Tighten fastener to 22 N.m (16 lb ft)
16. Engine Coolant Air Bleed Pipe - Install - [Engine Coolant Air Bleed Pipe Replacement \(LGZ\)](#).
17. Crankshaft Balancer - Install - [Crankshaft Balancer Replacement \(without Bison\)](#), or [Crankshaft Balancer Replacement \(with Bison\)](#).
18. Install the water outlet (2) with radiator hose. [Water Outlet Replacement \(LGZ\)](#).



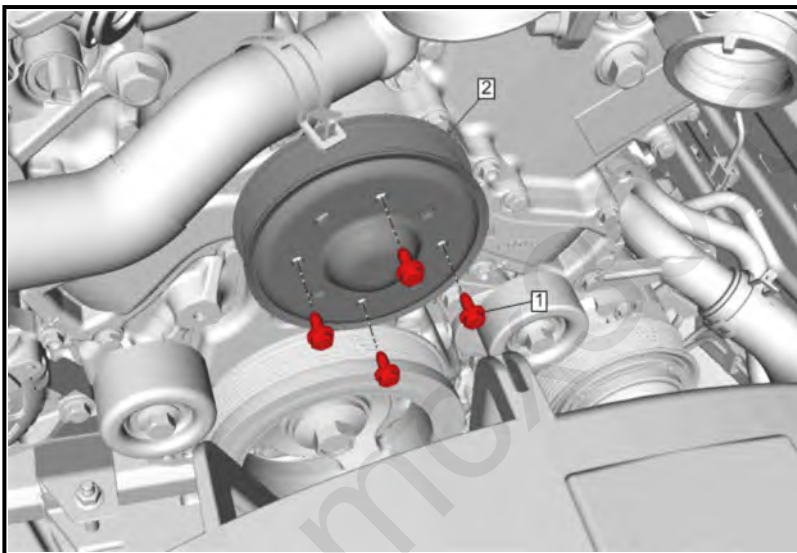
19. Camshaft Cover - Right Side (2) - Install - [Camshaft Cover Replacement - Right Side](#)



20. Camshaft Cover - Left Side (2) - Install - [Camshaft Cover Replacement - Left Side](#)



21. Water Pump Pulley (2) - Install - [Water Pump Pulley Replacement \(LGZ\)](#).



22. Power Brake Booster Pump - Install - [Power Brake Booster Pump Replacement](#)

23. Air Cleaner Outlet Duct - Install - [Air Cleaner Outlet Duct Replacement](#)

24. Fill the cooling system. [Cooling System Draining and Filling \(Static Fill\)](#) , or [Cooling System Draining and Filling \(Vac n Fill\)](#).

ENGINE FRONT COVER OVERHAUL

Special Tools

- EN-28410 Gasket Remover
- EN-29184 Seal Installer
- EN-45000 Seal Remover
- EN-46103 Camshaft Actuator Valve Seal Installer

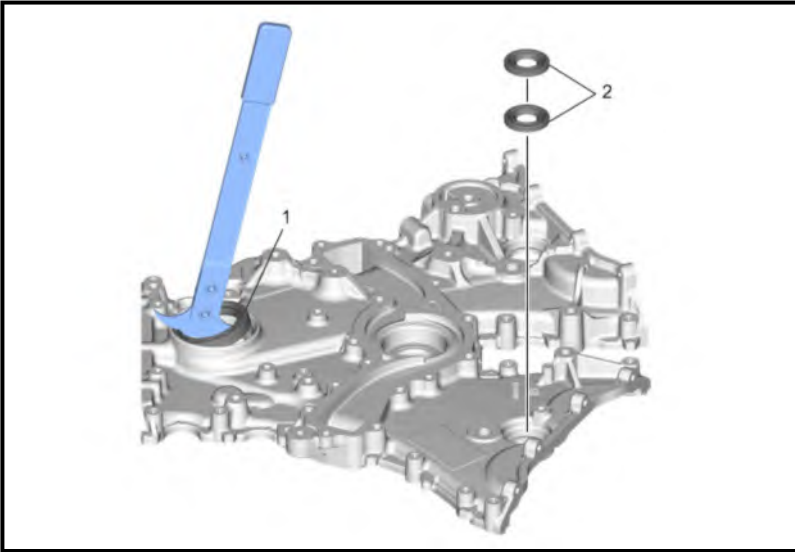
Equivalent regional tools: [Special Tools](#)

Removal Procedure

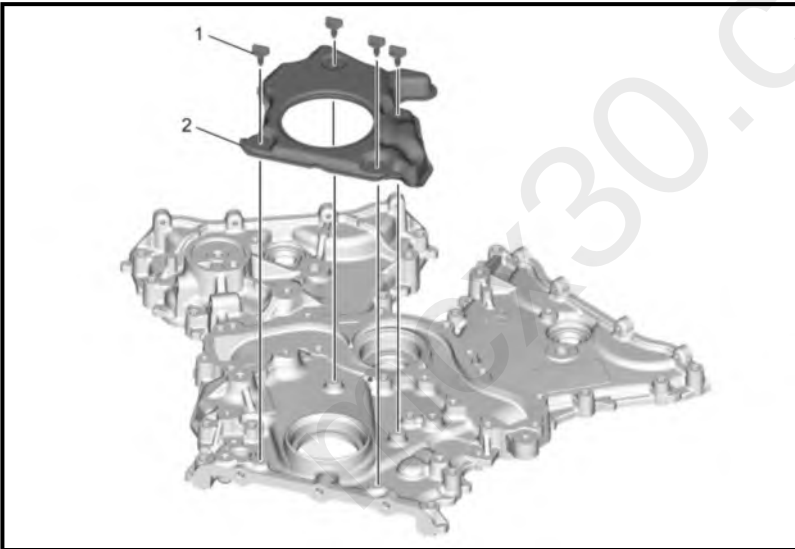
Engine Front Cover - Remove - [Engine Front Cover Replacement](#)

Disassemble Procedure

1. Crankshaft Front Oil Seal (1) - Remove and DISCARD - using the **EN-45000** Seal Remover



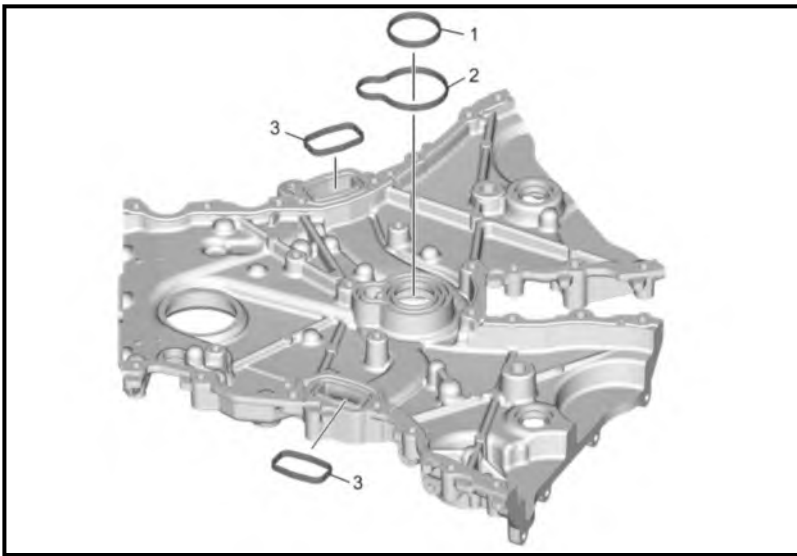
2. Camshaft Position Actuator Control Valve Seal (2) - Remove and DISCARD [2x]
3. Engine Front Cover Retainer (1) - Remove [4x]



WARNING:

The noise cancelling foam component **MUST** be replaced if it has been exposed to engine fluids. Failure to replace the noise cancelling foam component that has been exposed to engine fluids may result in an engine fire resulting in catastrophic engine damage, and possible injury or death.

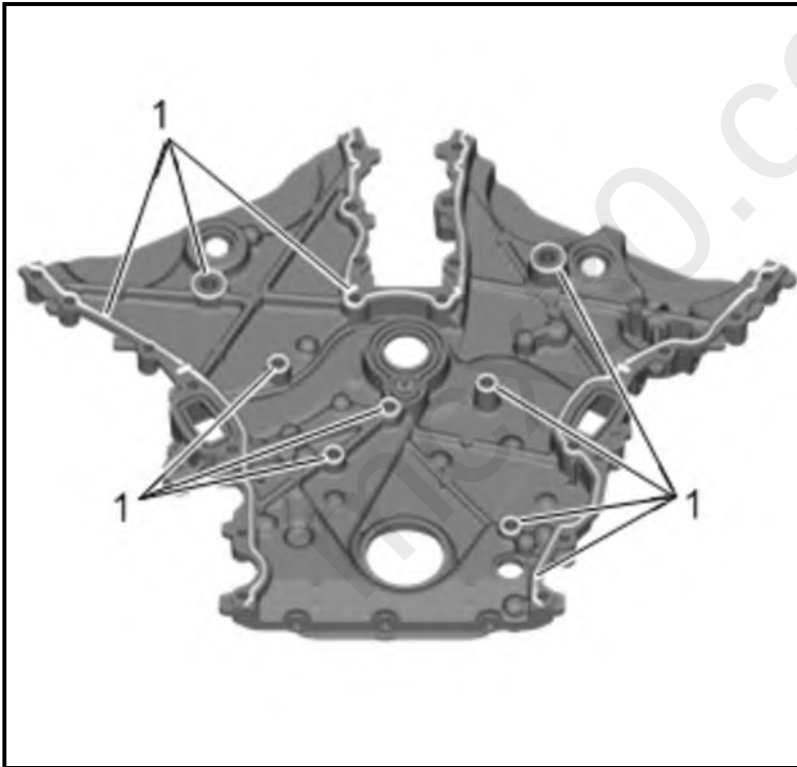
4. Engine Front Cover Insulator (2) - Remove
5. Water Pump Seal (1) - Remove and DISCARD



6. Water Pump Seal (2) - Remove and DISCARD
7. Water Pump Seal (3) - Remove and DISCARD [2x]

Cleaning Procedure

1. Remove any RTV sealant (1) from the engine front cover using **EN-28410** remover.



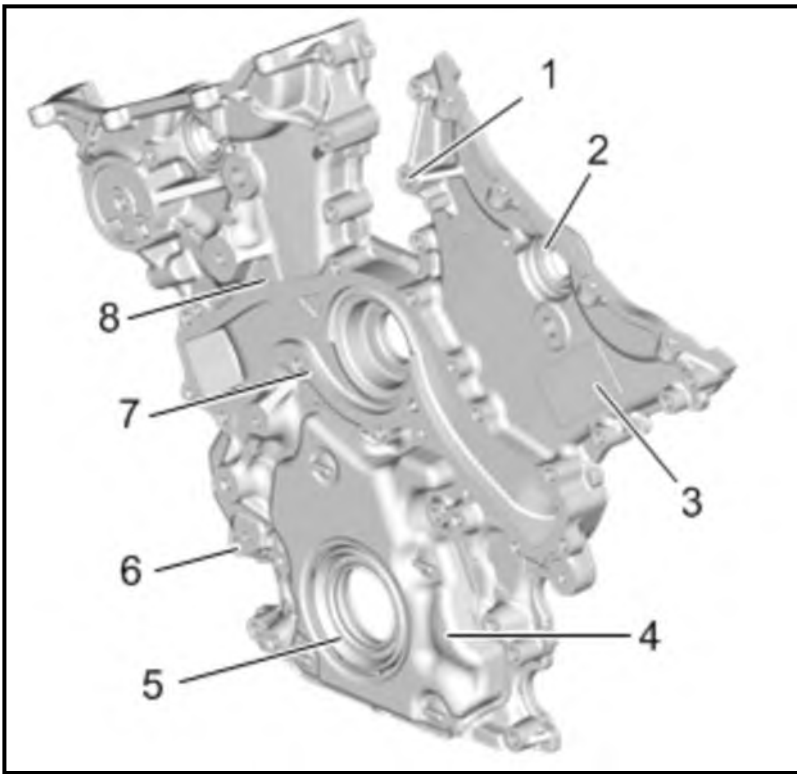
2. Clean out debris from the bolt holes.
3. Clean the engine front cover in solvent.

WARNING: Refer to [Safety Glasses Warning](#) .

4. Dry the engine front cover with compressed air.

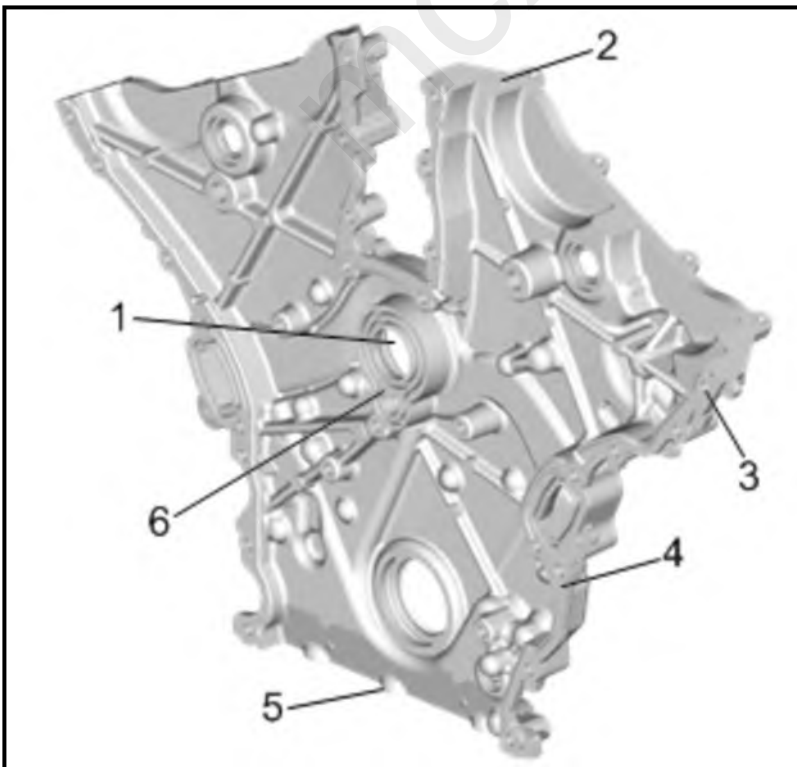
Inspection Procedure

1. Inspect the exterior of the engine front cover for the following conditions:



- Damage to the engine front cover bolt holes (1)
- Damage to the camshaft position actuator valve oil seals and bores (2)
- Damage and/or corrosion to the engine front cover (3)
- Damage to the engine front cover insulator (4)
- Damage to the crankshaft front oil seal bore (5)
- Damage to the oil pump flow control valve wire mounting surface (6)
- Gouges or damage to the water pump sealing surfaces (7)
- Damage to the water pump bolt hole threads (8)

2. Inspect the interior of the engine front cover for the following conditions:

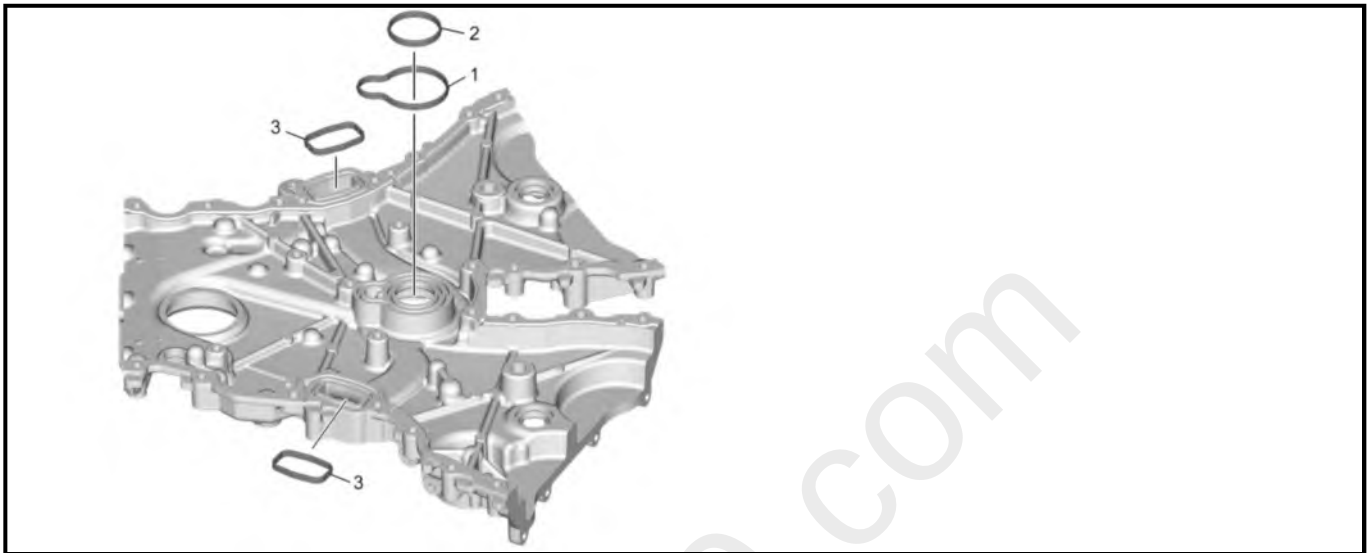


- Damage and/or corrosion to the engine coolant passage (1)

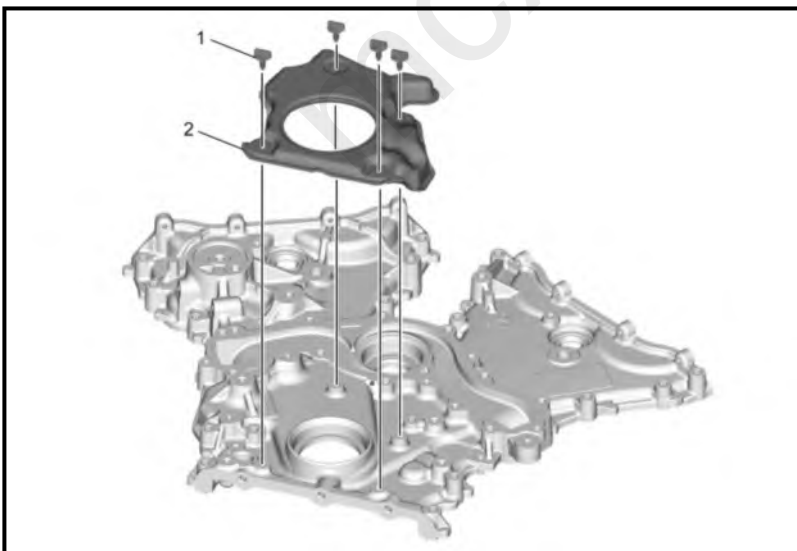
- Gouges or damage to the engine front cover sealing surfaces to the engine block (6), oil pan (4), and/or camshaft covers (2)
- Damage to the engine front cover bolt holes (3)
- Damage to the engine front cover to oil pan mounting bolt holes (5)
- Gouges or damage to the water pump seal area
- Damage to the crankshaft front oil seal bore
- Gouges or damage to the O-ring sealing areas

3. Repair or replace the engine front cover as necessary.

Assemble Procedure



1. Water Pump Seal (1) - Install NEW
2. Water Pump Seal (2) - Install NEW
3. Water Pump Seal (3) - Install NEW [2x]
4. Engine Front Cover Insulator (1) - Install

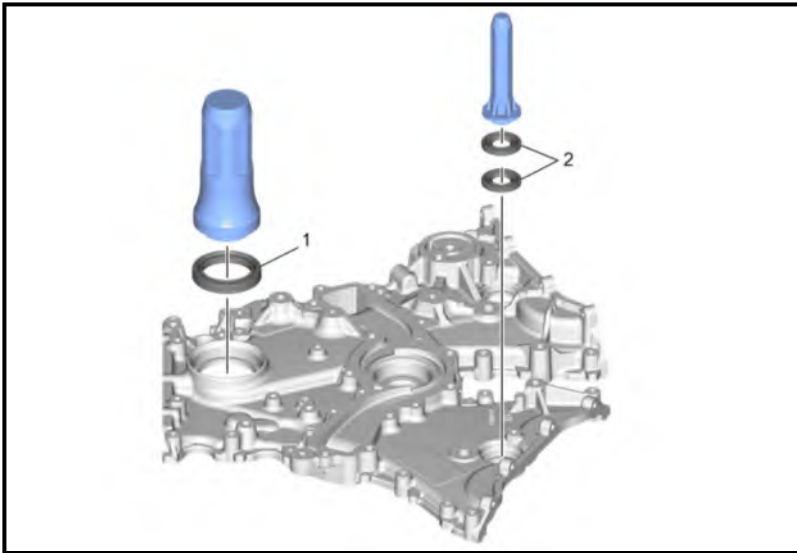


WARNING:

The noise cancelling foam component **MUST** be replaced if it has been exposed to engine fluids. Failure to replace the noise cancelling foam component that has been exposed to engine fluids may result in an engine fire resulting in catastrophic engine damage, and possible injury or death.

5. Engine Front Cover Retainer (2) - Install [4x]

6. Crankshaft Front Oil Seal (1) - Install NEW - using the **EN-29184** Seal Installer



7. Camshaft Position Actuator Control Valve Seal (2) - Install NEW [2x] - using the **EN-46103** Camshaft Actuator Valve Seal Installer

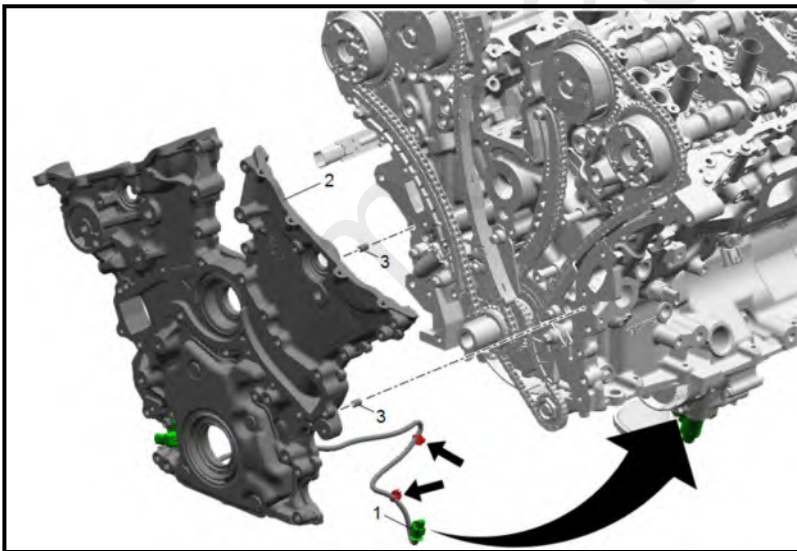
Installation Procedure

Engine Front Cover - Install - [Engine Front Cover Replacement](#)

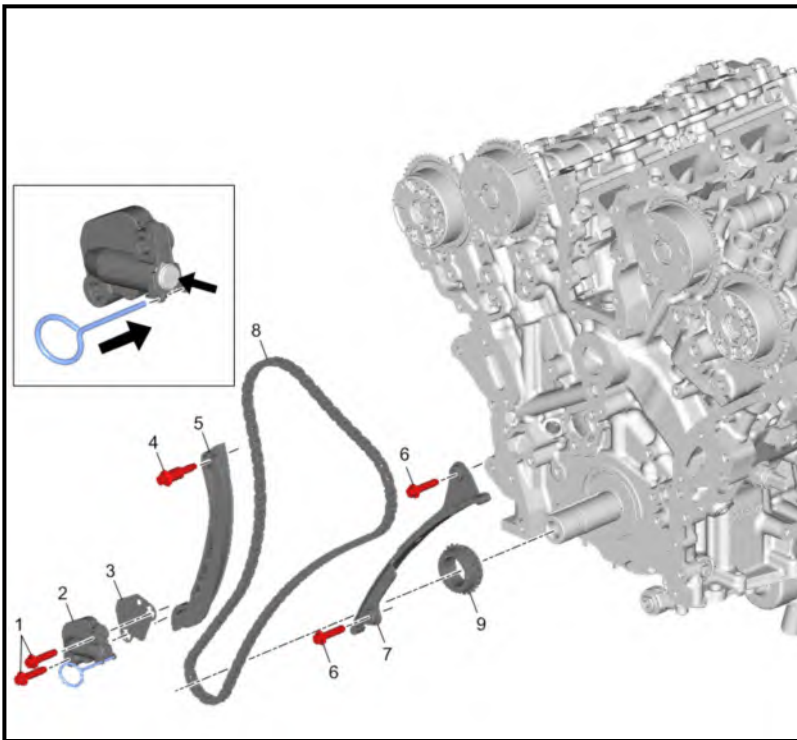
CAMSHAFT TIMING CHAIN ASSEMBLY REPLACEMENT - LEFT SIDE

Removal Procedure

1. Engine Front Cover (2) - Remove - [Engine Front Cover Replacement](#)



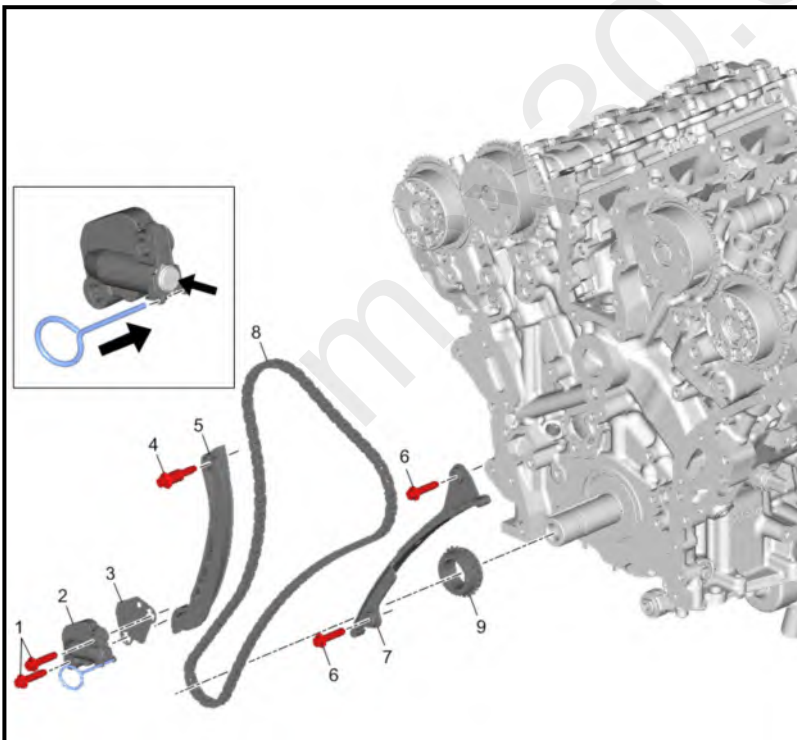
2. Remove the camshaft timing chain (8) and components. [Camshaft Timing Chain Component Removal and Installation](#)



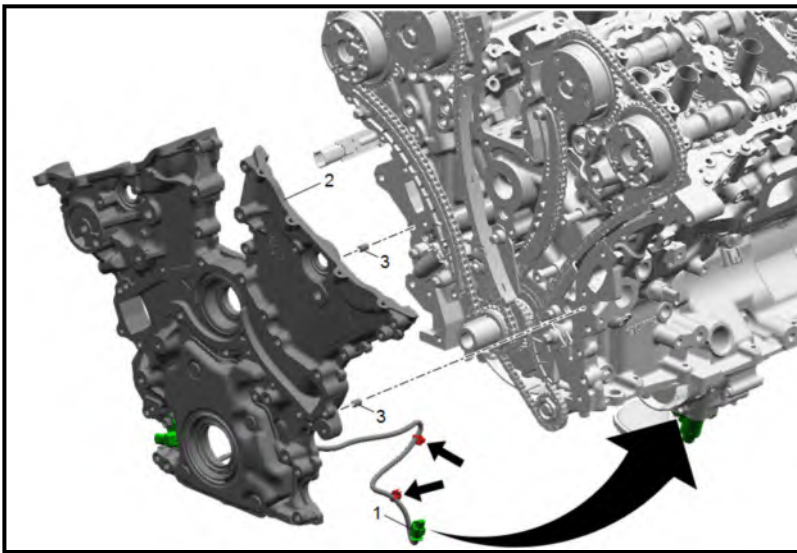
3. Clean and inspect all of the camshaft timing drive components and replace as necessary.

Installation Procedure

1. Install the camshaft timing chain (8) and components. [Camshaft Timing Chain Component Removal and Installation](#)



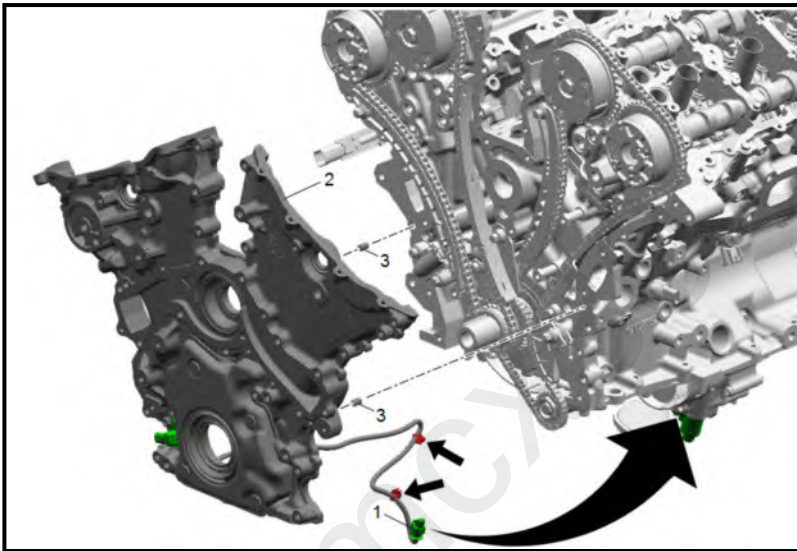
2. Engine Front Cover (2) - Install - [Engine Front Cover Replacement](#)



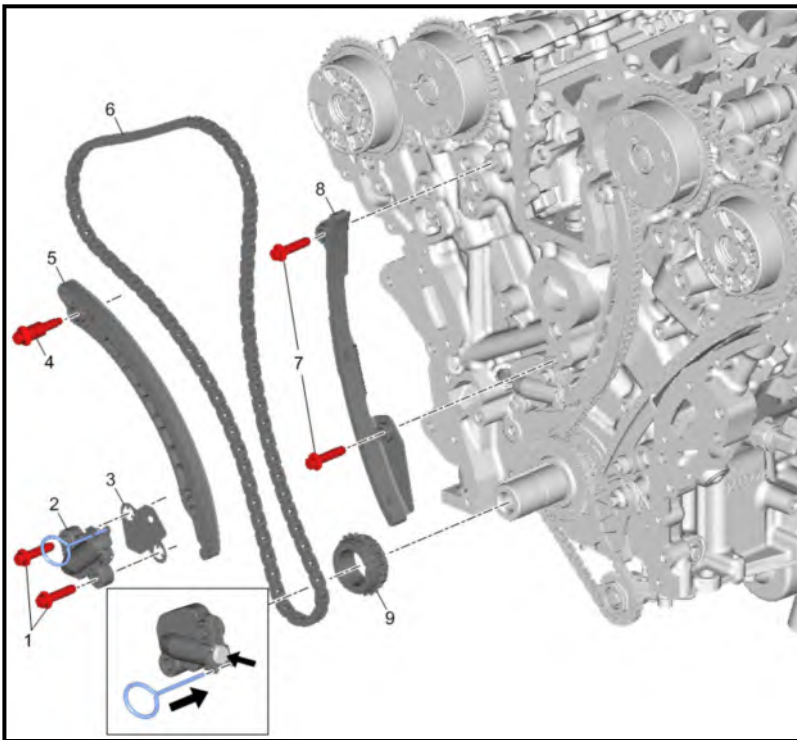
CAMSHAFT TIMING CHAIN ASSEMBLY REPLACEMENT - RIGHT SIDE

Removal Procedure

1. Engine Front Cover (2) - Remove - [Engine Front Cover Replacement](#)



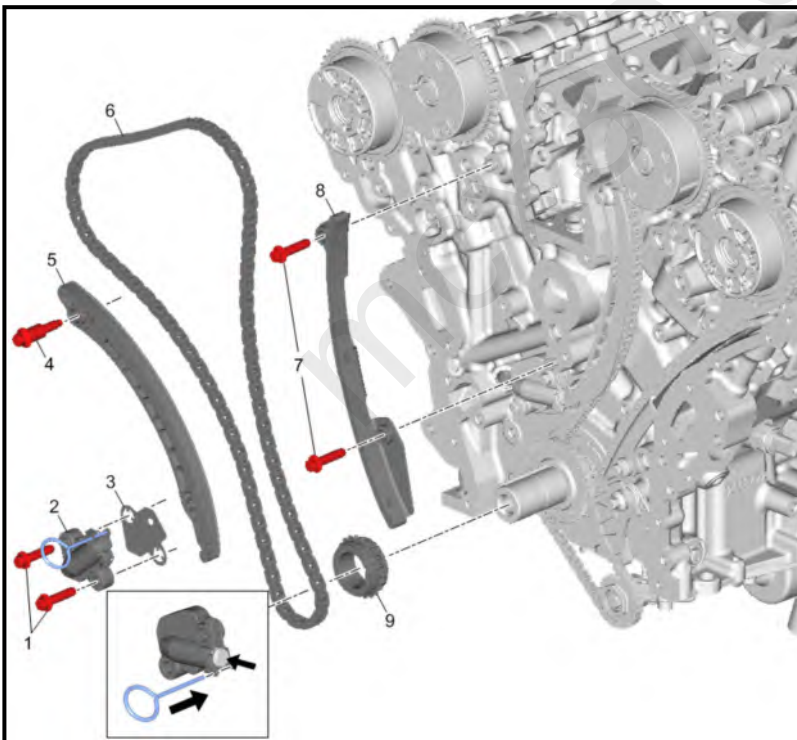
2. Remove the camshaft timing chain (6) and components. [Camshaft Timing Chain Component Removal and Installation](#)



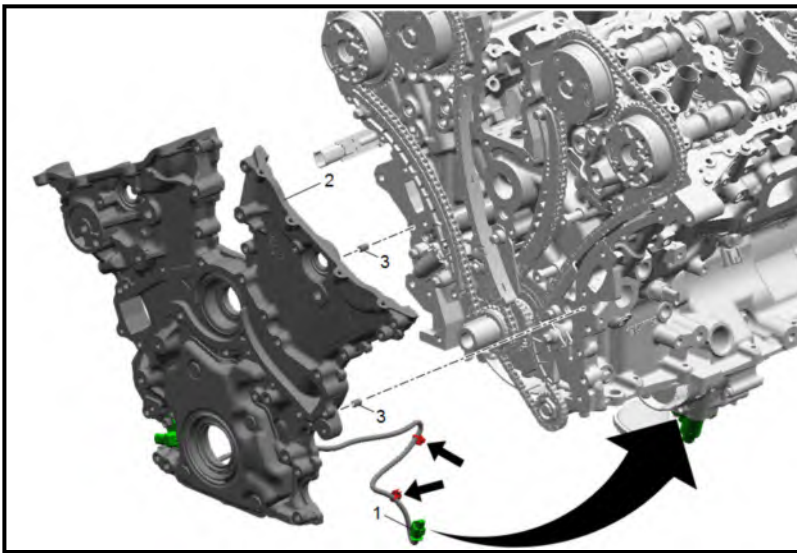
3. Clean and inspect all of the camshaft timing drive components and replace as necessary.

Installation Procedure

1. Install the camshaft timing chain (6) and components. [Camshaft Timing Chain Component Removal and Installation](#)



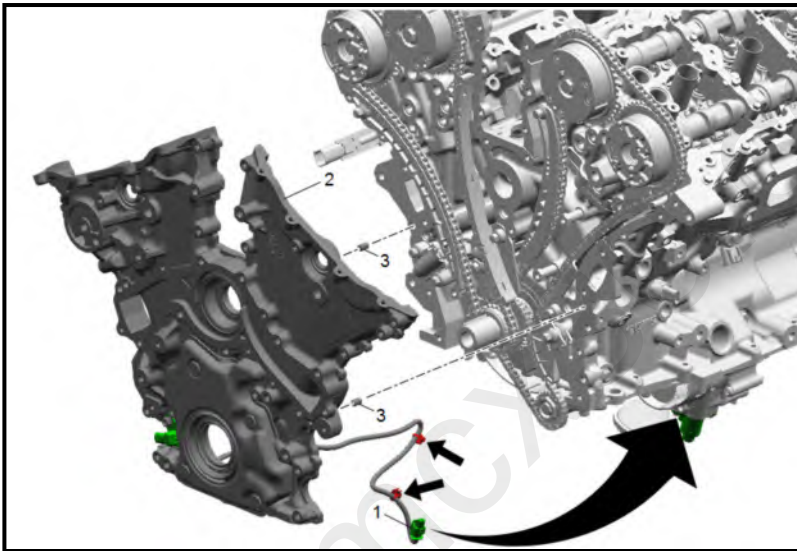
2. Engine Front Cover (2) - Install - [Engine Front Cover Replacement](#)



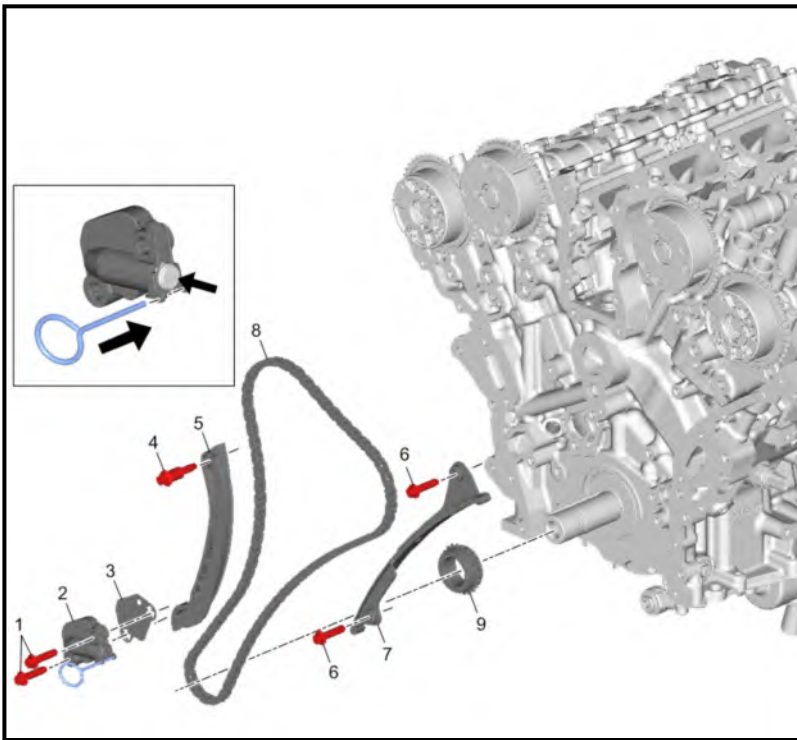
TIMING CHAIN TENSIONER ASSEMBLY REPLACEMENT - LEFT SIDE

Removal Procedure

1. Engine Front Cover (2) - Remove - [Engine Front Cover Replacement](#)



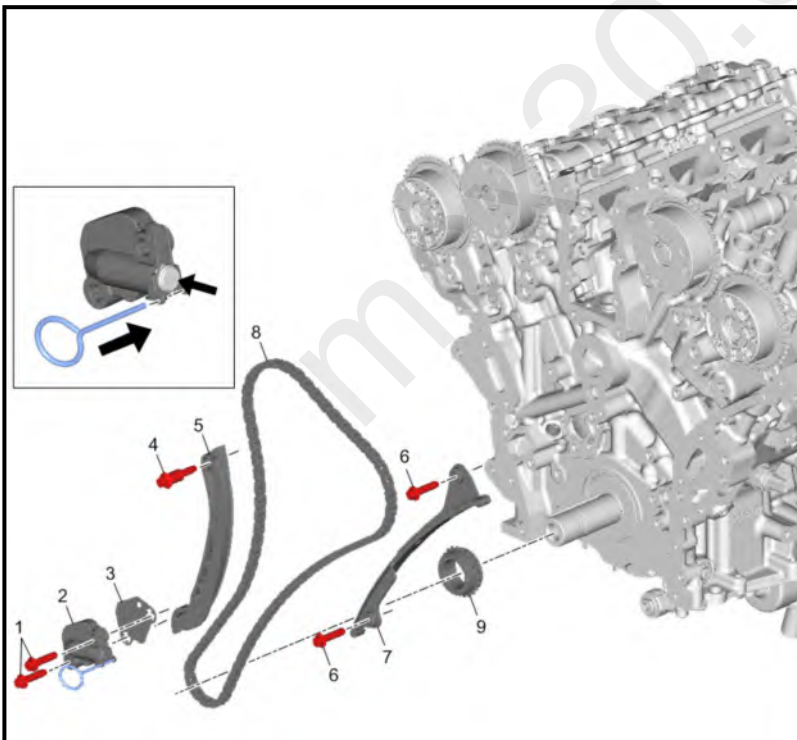
2. Remove the timing chain tensioner (2) and components. [Camshaft Timing Chain Component Removal and Installation](#)



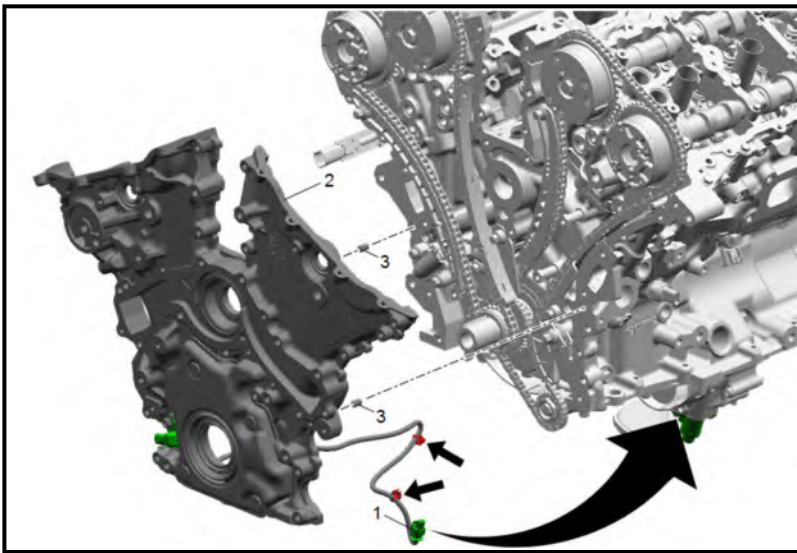
3. Clean and inspect all of the camshaft timing drive components and replace as necessary.

Installation Procedure

1. Install the timing chain tensioner (2) and components. [Camshaft Timing Chain Component Removal and Installation](#)



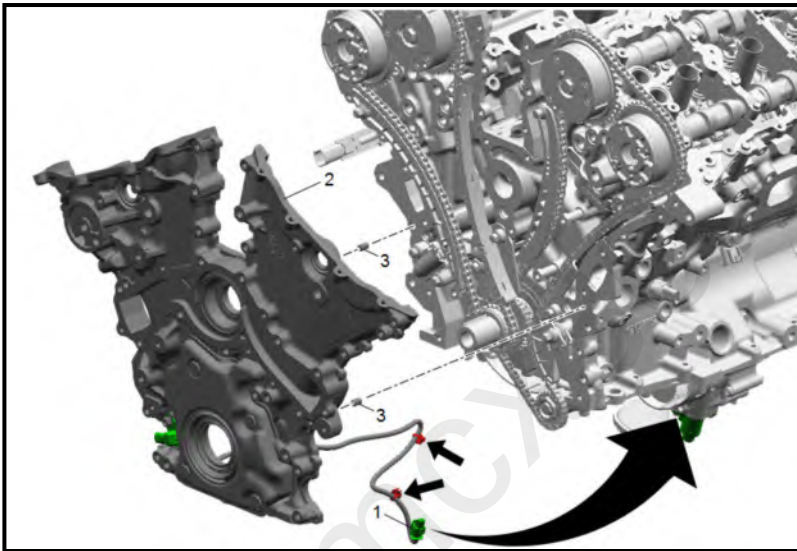
2. Engine Front Cover (2) - Install - [Engine Front Cover Replacement](#)



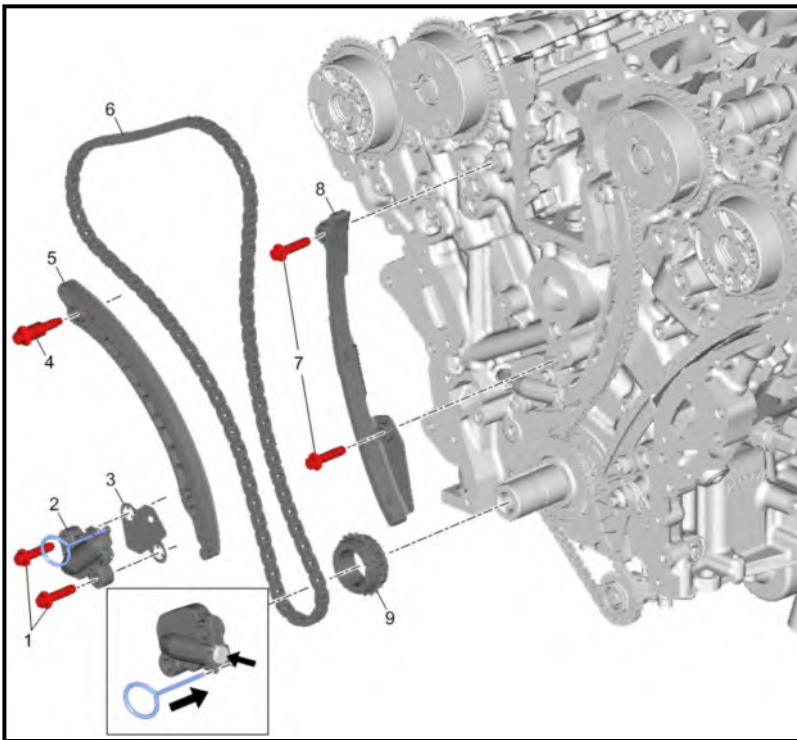
TIMING CHAIN TENSIONER ASSEMBLY REPLACEMENT - RIGHT SIDE

Removal Procedure

1. Engine Front Cover (2) - Remove - [Engine Front Cover Replacement](#)



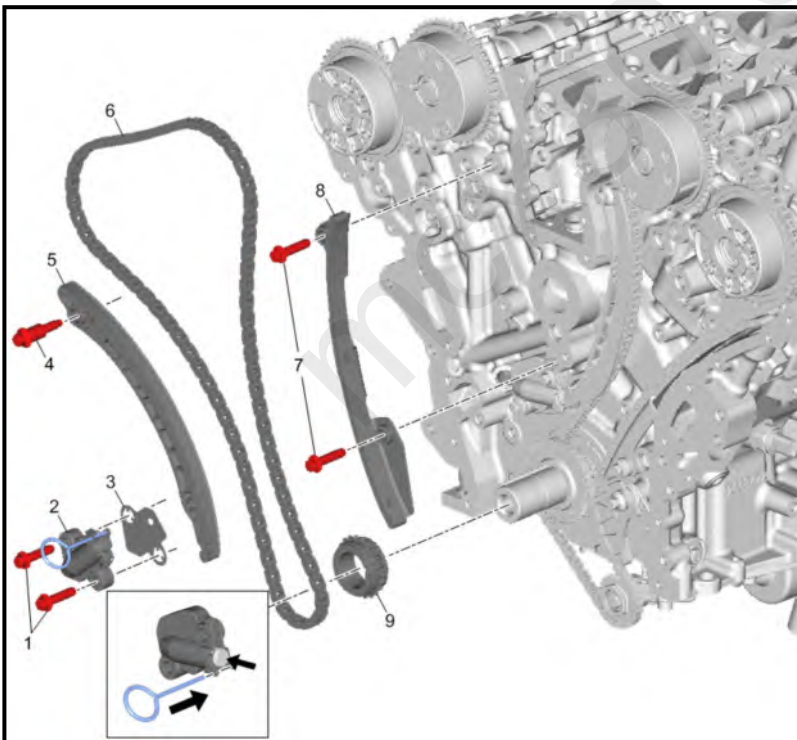
2. Remove the timing chain tensioner (2) and components. [Camshaft Timing Chain Component Removal and Installation](#)



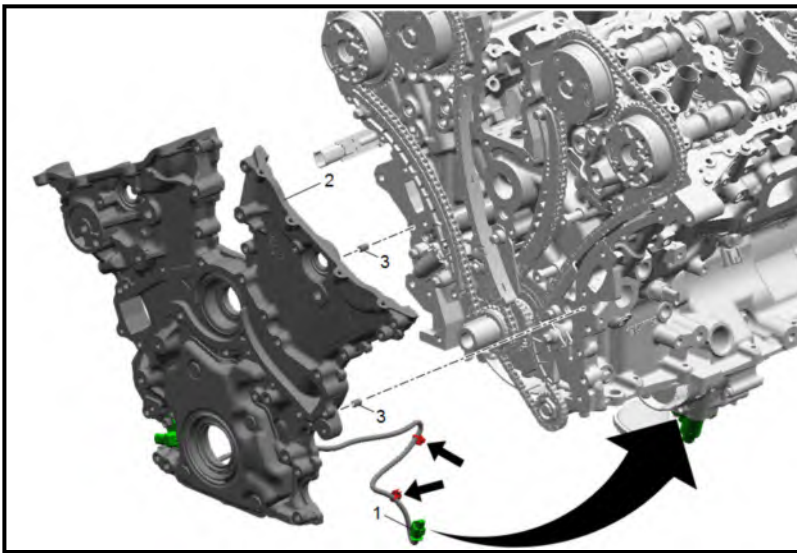
3. Clean and inspect all of the camshaft timing drive components and replace as necessary.

Installation Procedure

1. Install the timing chain tensioner (2) and components. [Camshaft Timing Chain Component Removal and Installation](#)



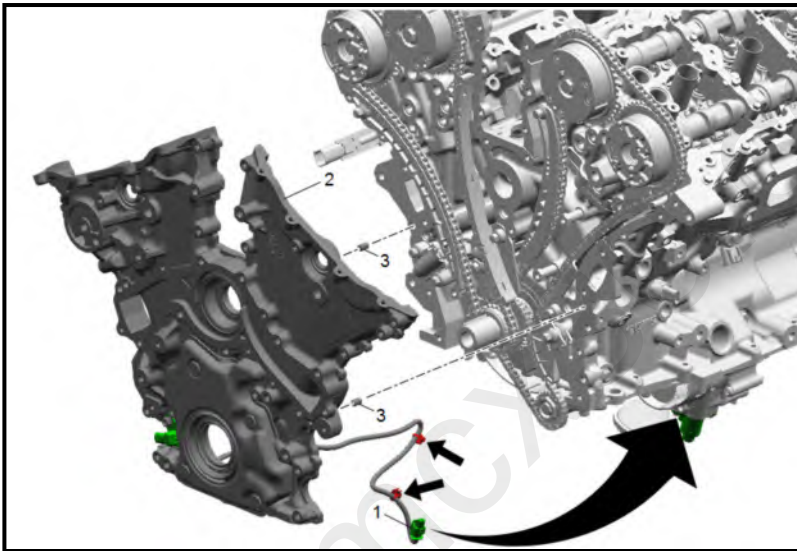
2. Engine Front Cover (2) - Install - [Engine Front Cover Replacement](#)



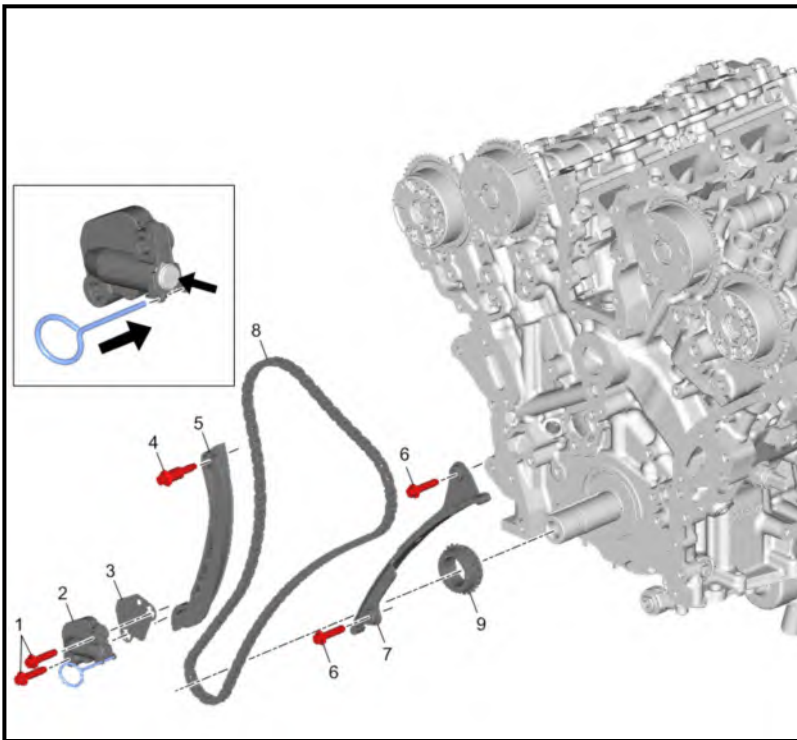
TIMING CHAIN ASSEMBLY GUIDE REPLACEMENT - LEFT SIDE

Removal Procedure

1. Engine Front Cover (2) - Remove - [Engine Front Cover Replacement](#)



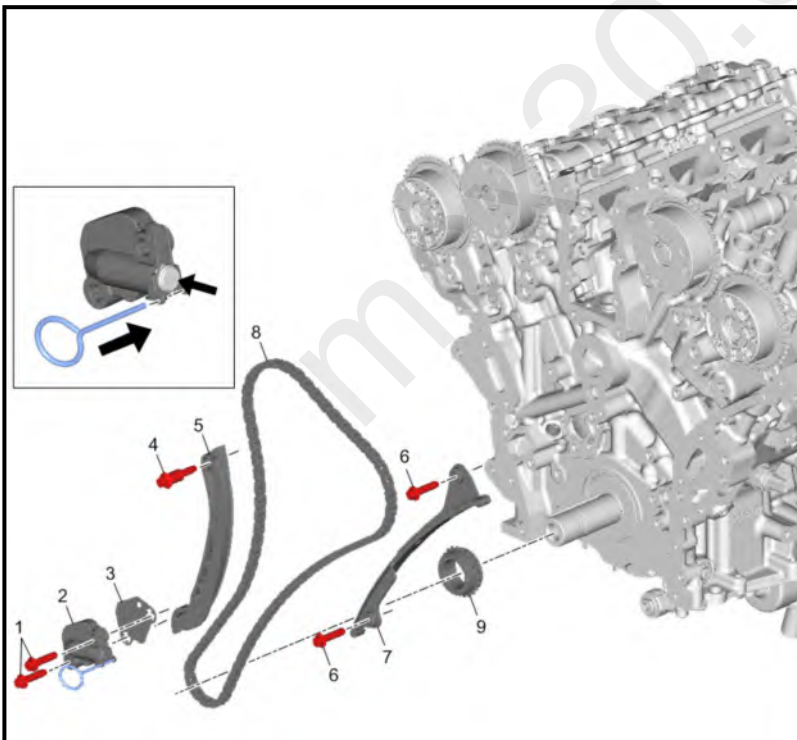
2. Remove the timing chain guides (5, 7) and components. [Camshaft Timing Chain Component Removal and Installation](#)



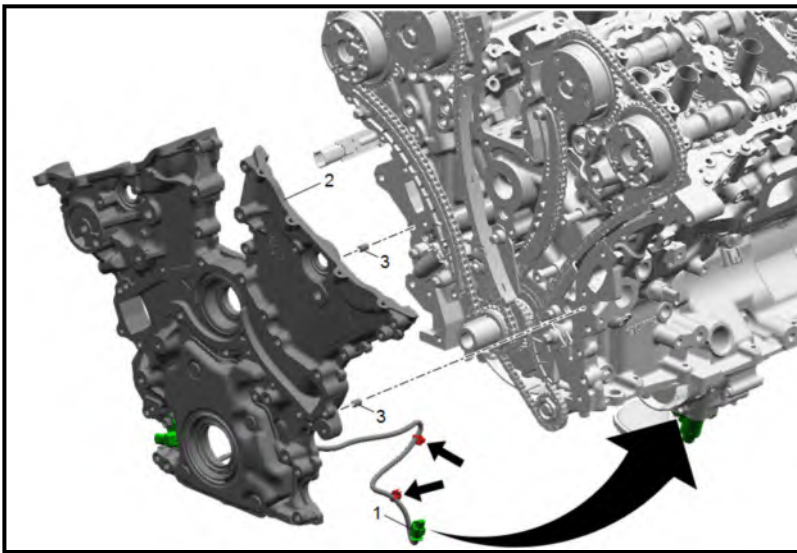
3. Clean and inspect all of the camshaft timing drive components and replace as necessary.

Installation Procedure

1. Install the timing chain guides (5, 7) and components. [Camshaft Timing Chain Component Removal and Installation](#)



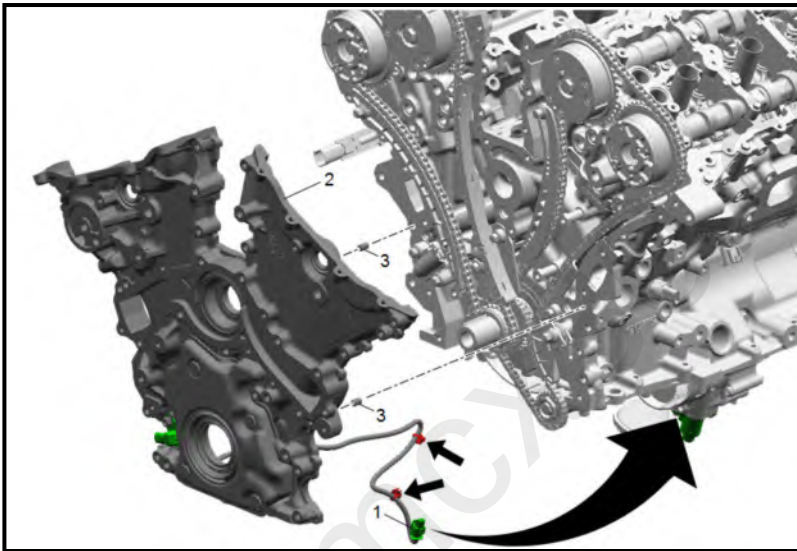
2. Engine Front Cover (2) - Install - [Engine Front Cover Replacement](#)



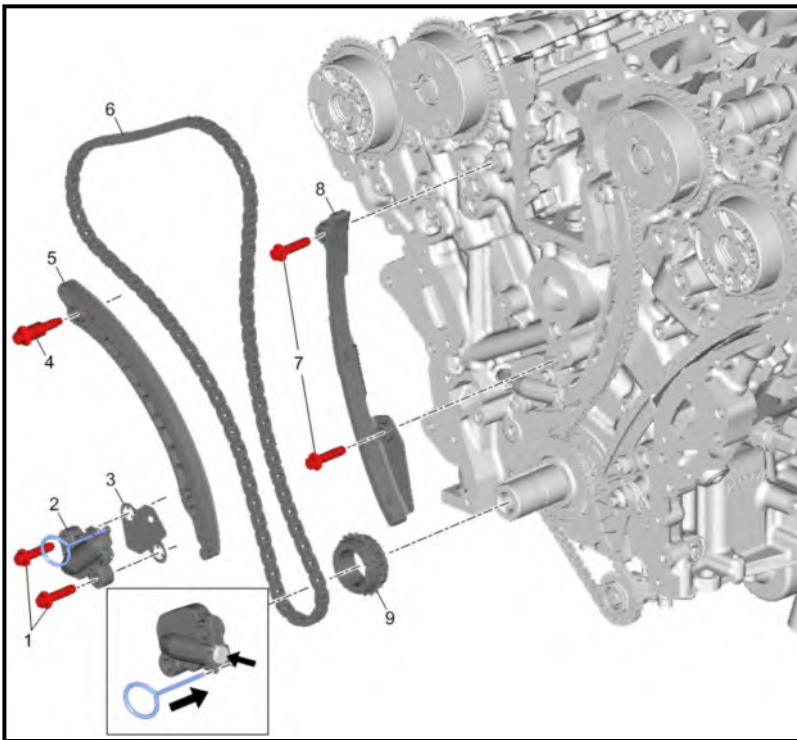
TIMING CHAIN ASSEMBLY GUIDE REPLACEMENT - RIGHT SIDE

Removal Procedure

1. Engine Front Cover (2) - Remove - [Engine Front Cover Replacement](#)



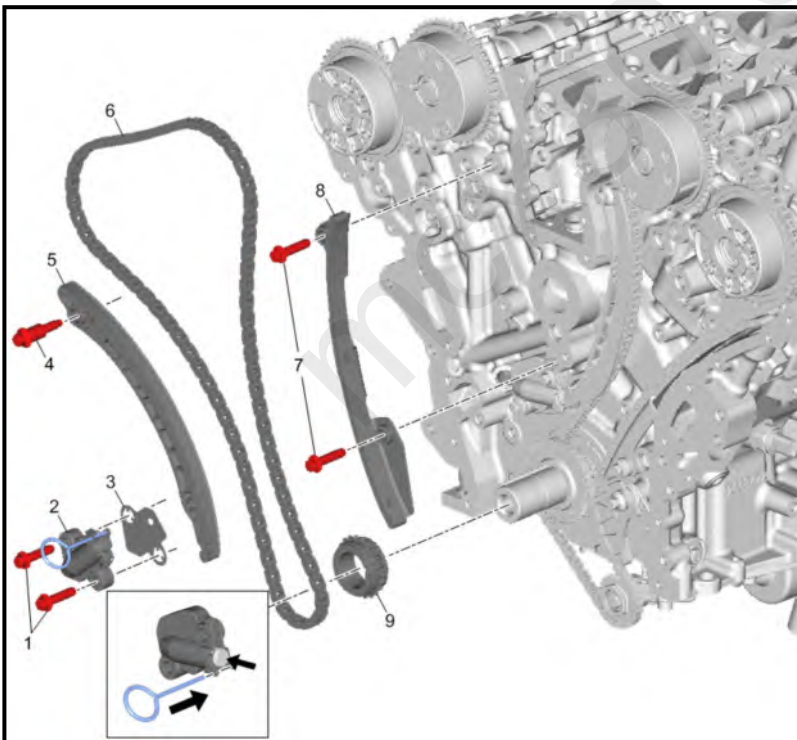
2. Remove the timing chain guides (5, 8) and components. [Camshaft Timing Chain Component Removal and Installation](#)



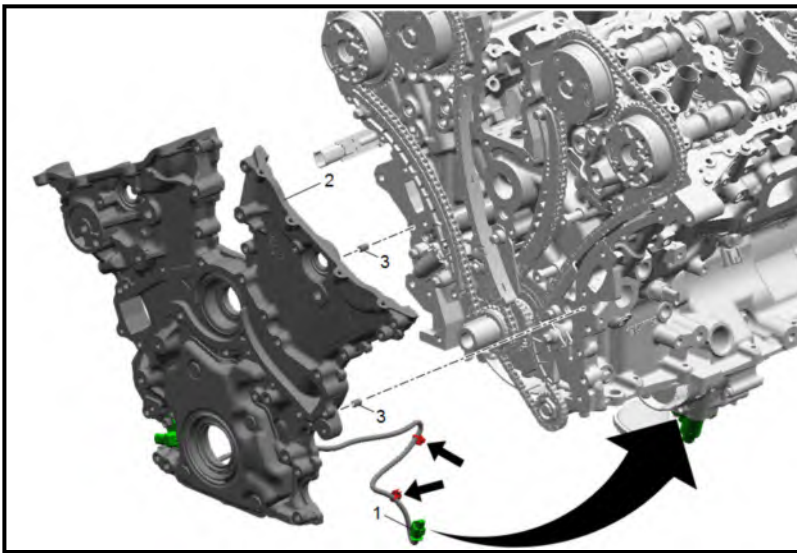
3. Clean and inspect all of the camshaft timing drive components and replace as necessary.

Installation Procedure

1. Install the timing chain guides (5, 8) and components. [Camshaft Timing Chain Component Removal and Installation](#)



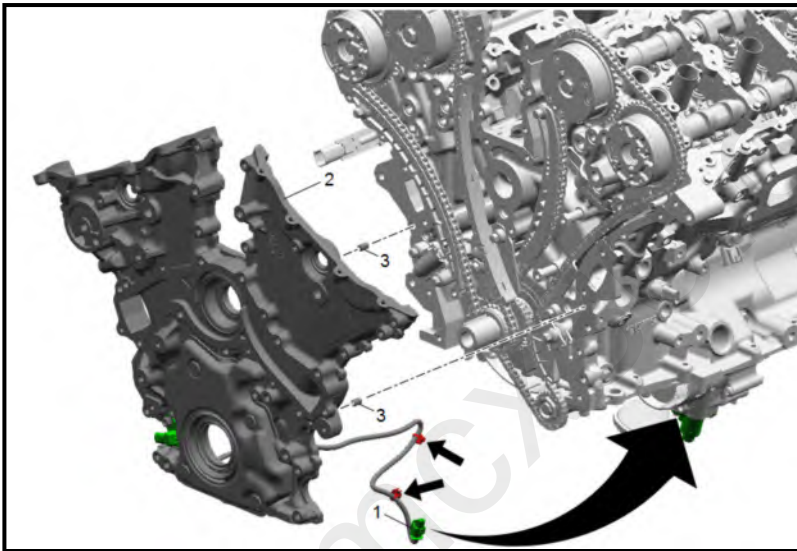
2. Engine Front Cover (2) - Install - [Engine Front Cover Replacement](#)



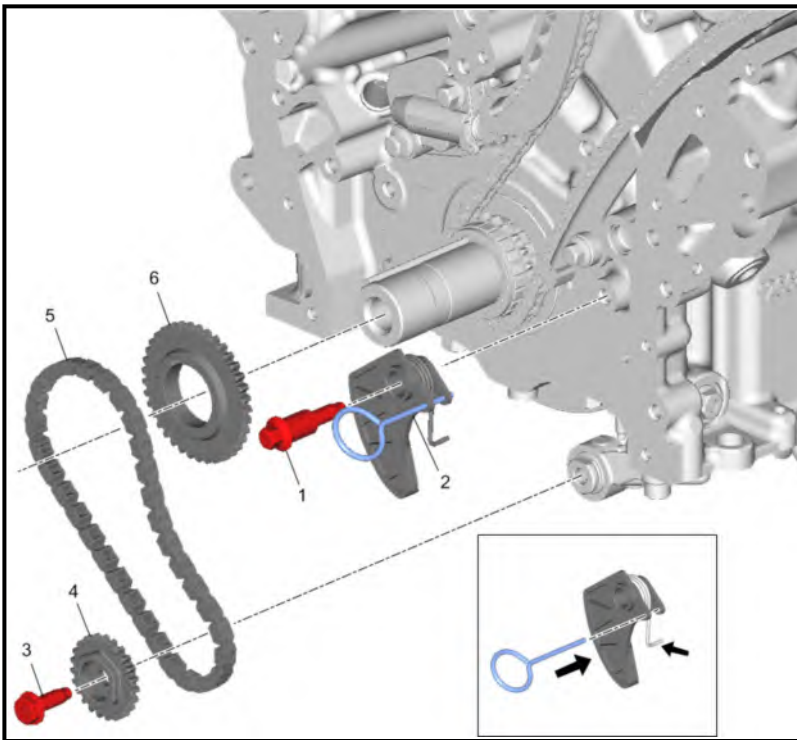
OIL PUMP CHAIN REPLACEMENT

Removal Procedure

1. Engine Front Cover (2) - Remove - [Engine Front Cover Replacement](#)



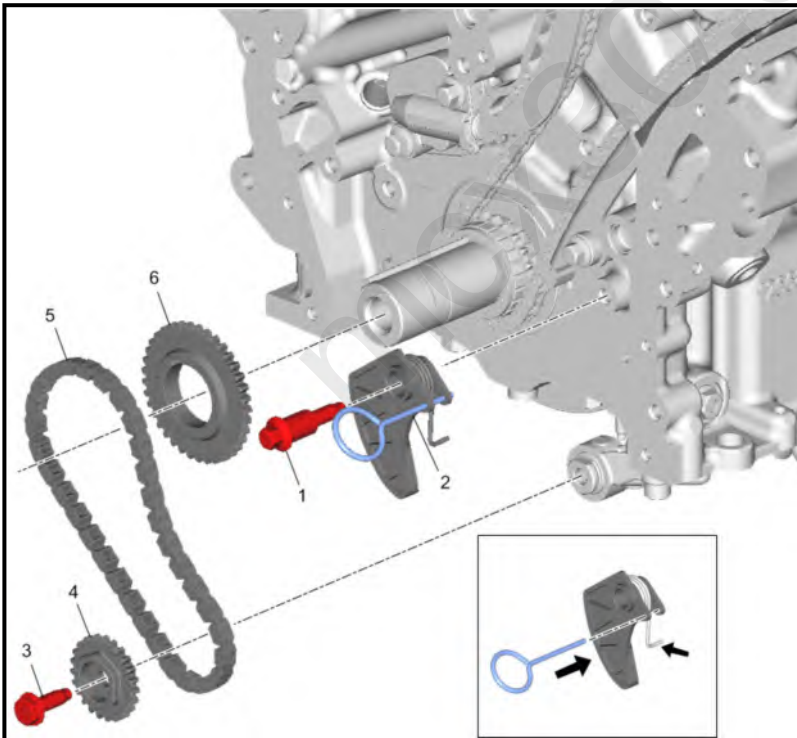
2. Remove the oil pump timing chain (5) and components. [Camshaft Timing Chain Component Removal and Installation](#)



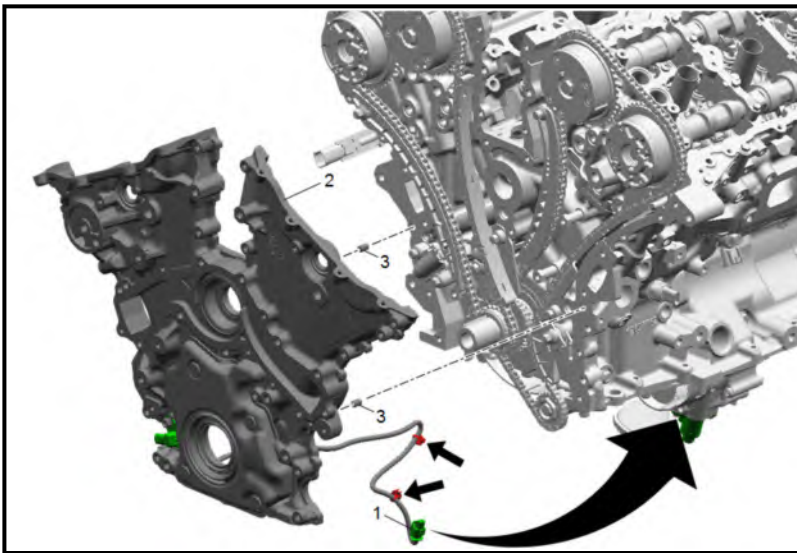
3. Clean and inspect all of the camshaft timing drive components and replace as necessary.

Installation Procedure

1. Install the oil pump timing chain (5) and components. [Camshaft Timing Chain Component Removal and Installation](#)



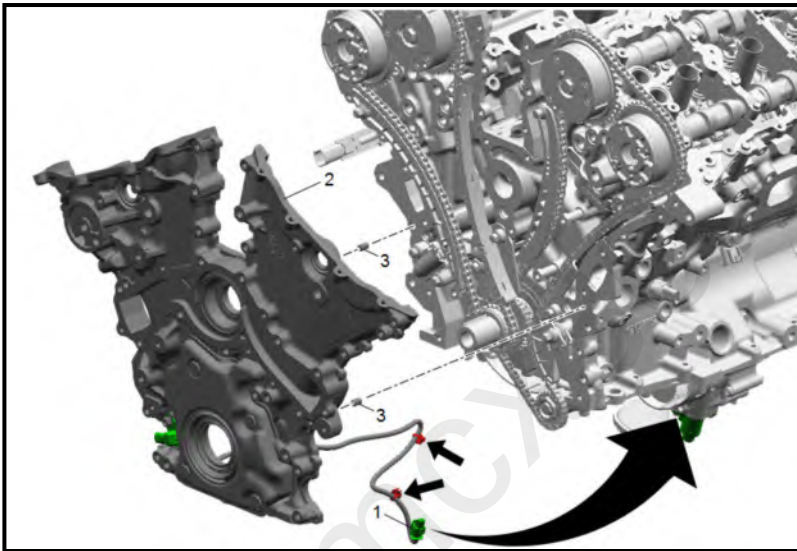
2. Engine Front Cover (2) - Install - [Engine Front Cover Replacement](#)



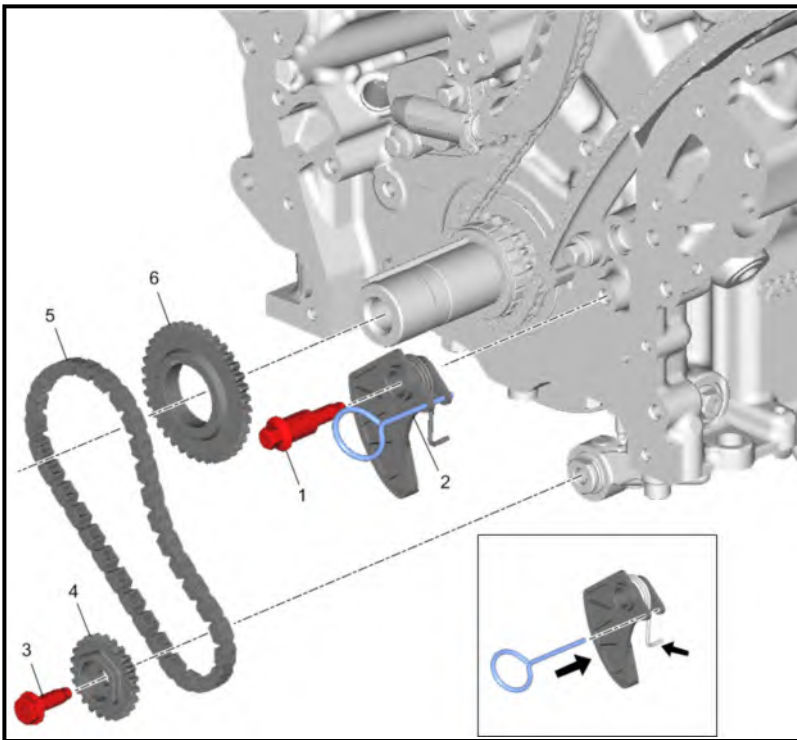
OIL PUMP CHAIN TENSIONER REPLACEMENT

Removal Procedure

1. Engine Front Cover (2) - Remove - [Engine Front Cover Replacement](#)



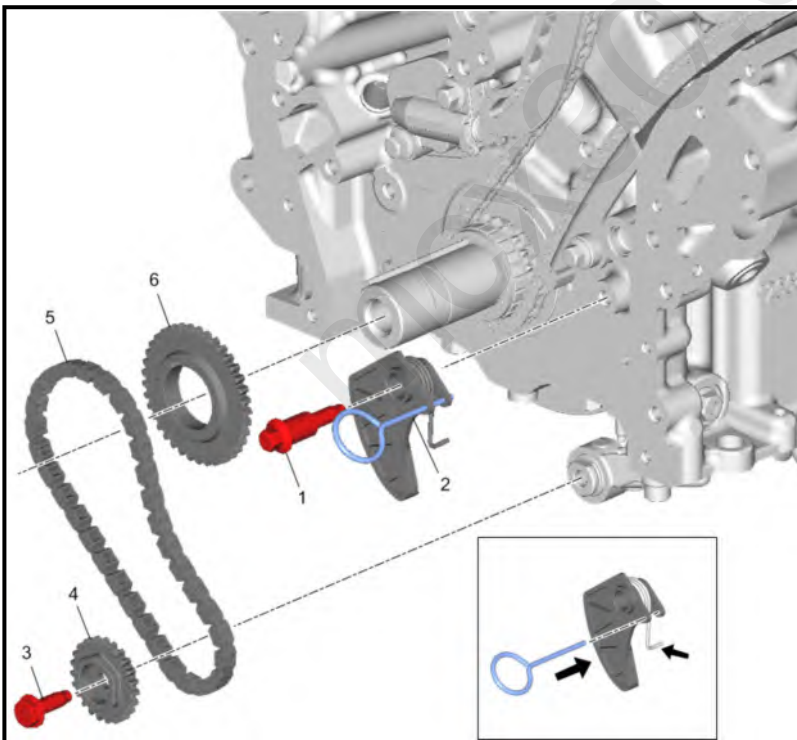
2. Remove the oil pump timing chain tensioner (2) and components. [Camshaft Timing Chain Component Removal and Installation](#)



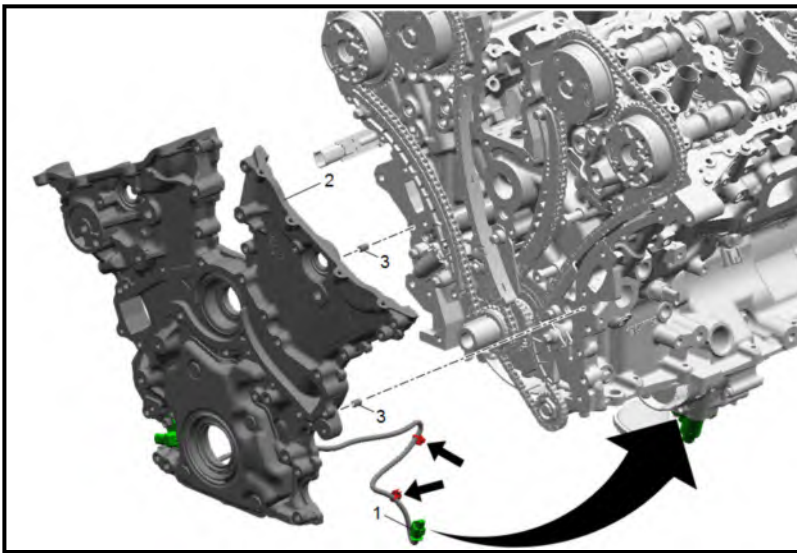
3. Clean and inspect all of the camshaft timing drive components and replace as necessary.

Installation Procedure

1. Install the oil pump timing chain tensioner (2) and components. [Camshaft Timing Chain Component Removal and Installation](#)



2. Engine Front Cover (2) - Install - [Engine Front Cover Replacement](#)



CAMSHAFT POSITION ACTUATOR REPLACEMENT - BANK 1

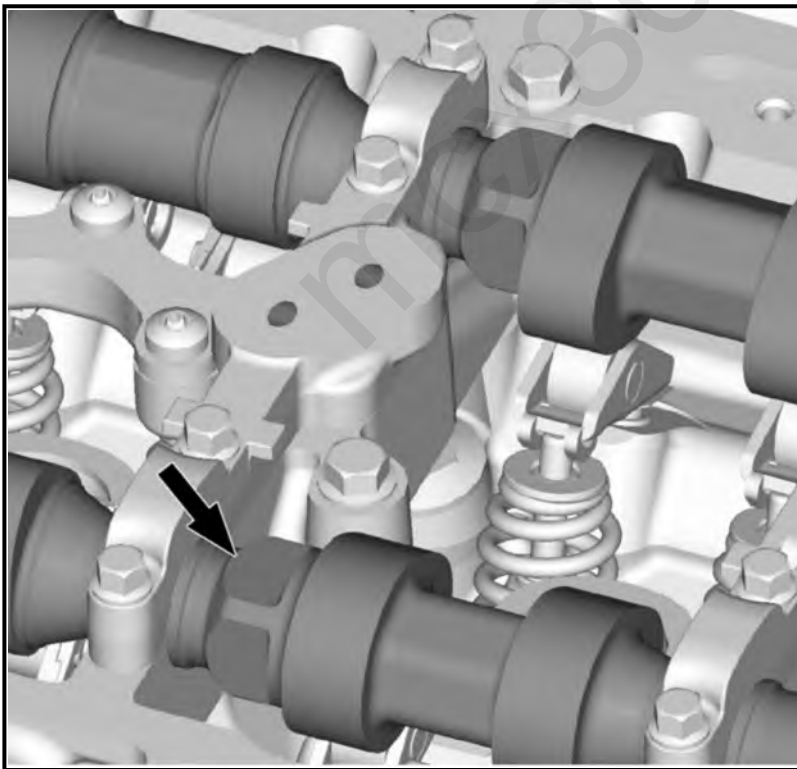
Special Tools

EN-51333 Timing Chain Retainer Set

Equivalent regional tools: [Special Tools](#)

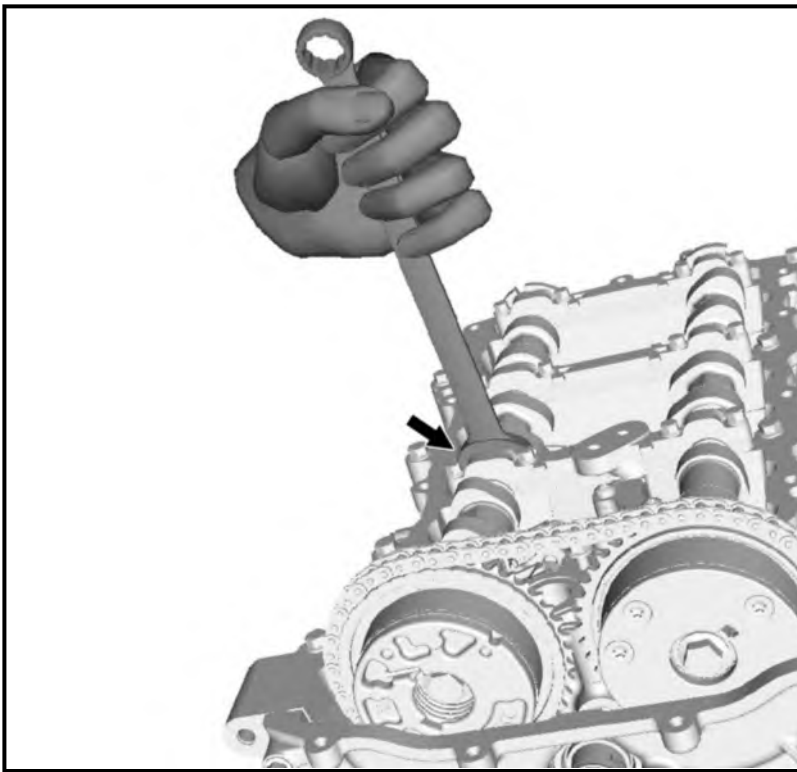
Removal Procedure

1. Camshaft Cover-Right Side - Remove - [Camshaft Cover Replacement - Right Side](#)
2. Rotate the engine clockwise using the crankshaft dampener retaining bolt until laser etched flats on both camshafts are facing up.



NOTE: This will put the camshafts in a rested position and aid in removal

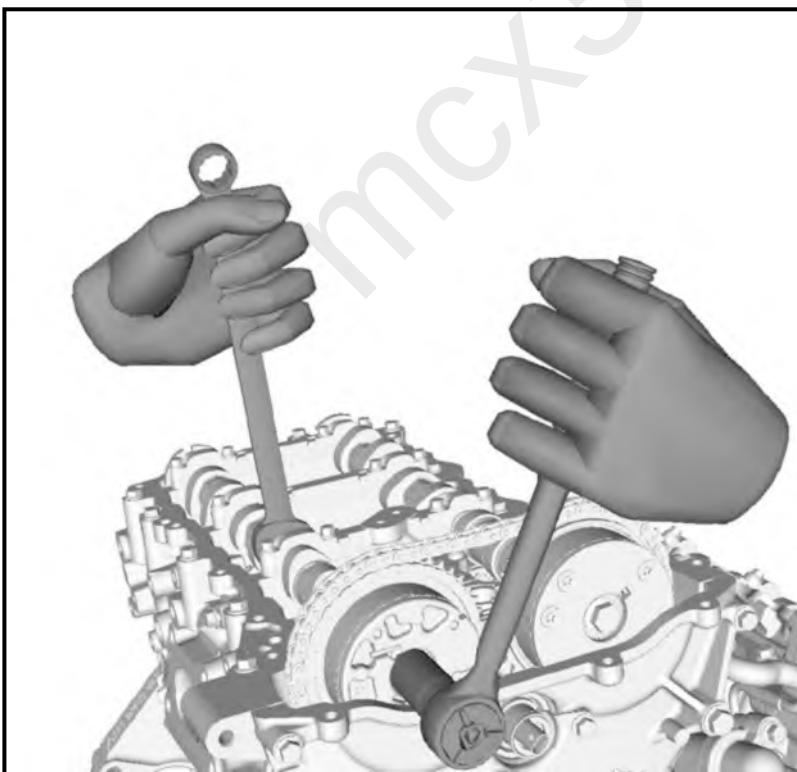
3. Use an opened end wrench on the cast hexagonal portion of the camshafts to hold them in place while breaking the actuator fasteners loose to prevent camshaft rotation.



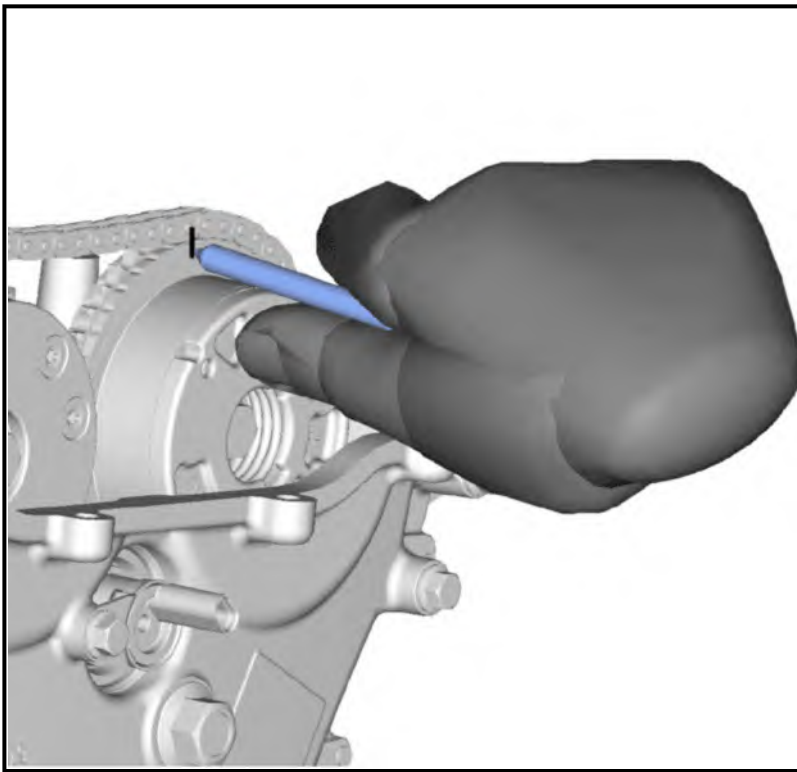
CAUTION: Refer to [Torque Reaction Against Timing Drive Chain Caution](#) .

NOTE: Do NOT remove or back out the camshaft position actuator bolt(s). Simply break them loose from their fully-torqued position. The position actuators must stay firmly attached until the retaining tools are in place, but they should be broken loose while the chain is still tight and in position.

4. Loosen the intake and exhaust camshaft position actuator retaining bolt but DO NOT remove.



5. Clean off any oil residue on camshaft position actuators.
6. Mark the position of the chain to the camshaft position actuator - intake.



NOTE: Marking the relationship of the timing chain to actuators is critical for timing alignment.

7. Mark the position of the chain to the camshaft position actuator - exhaust.
8. Remove camshaft front cap bolts (1) [5x].

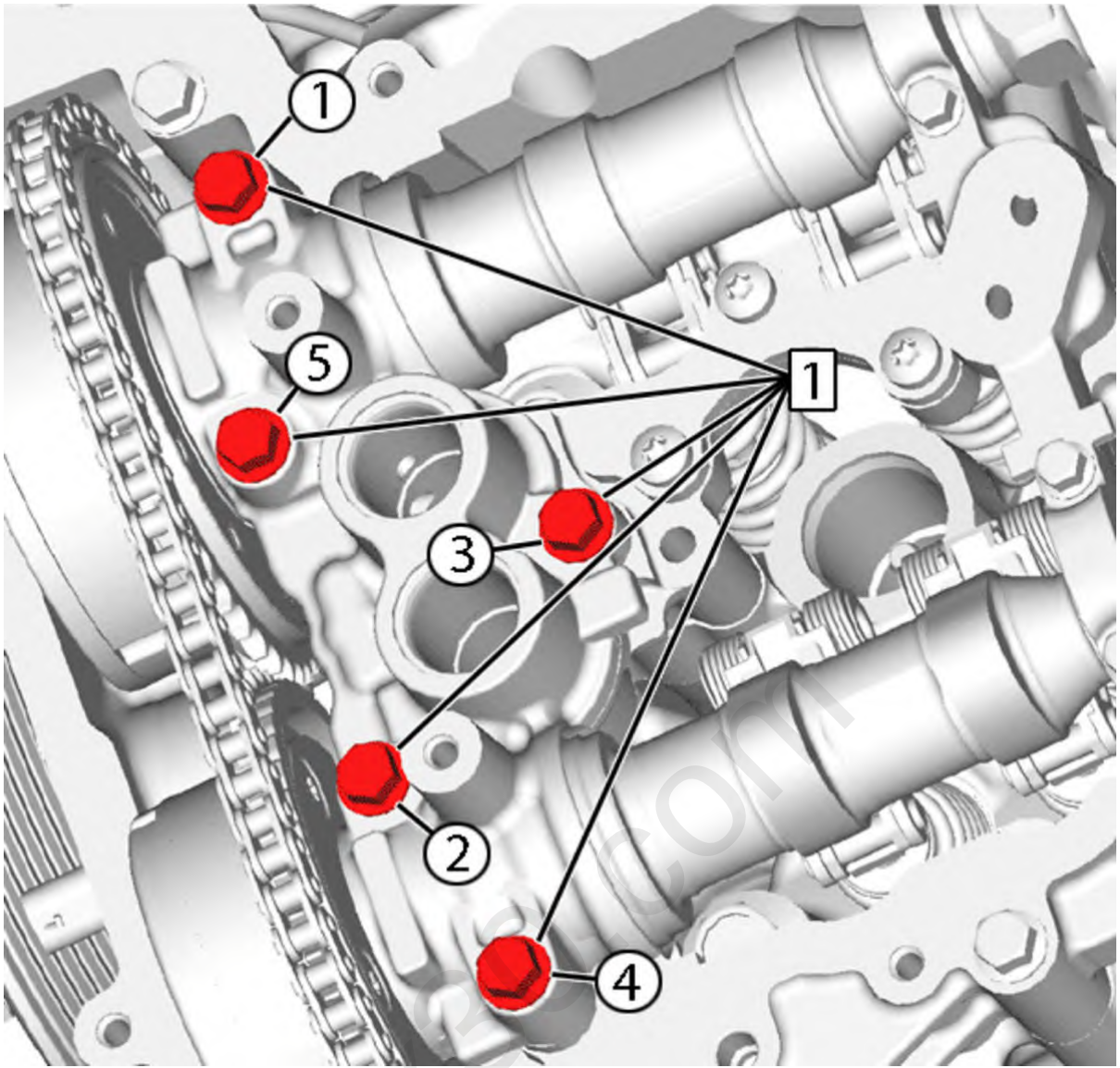
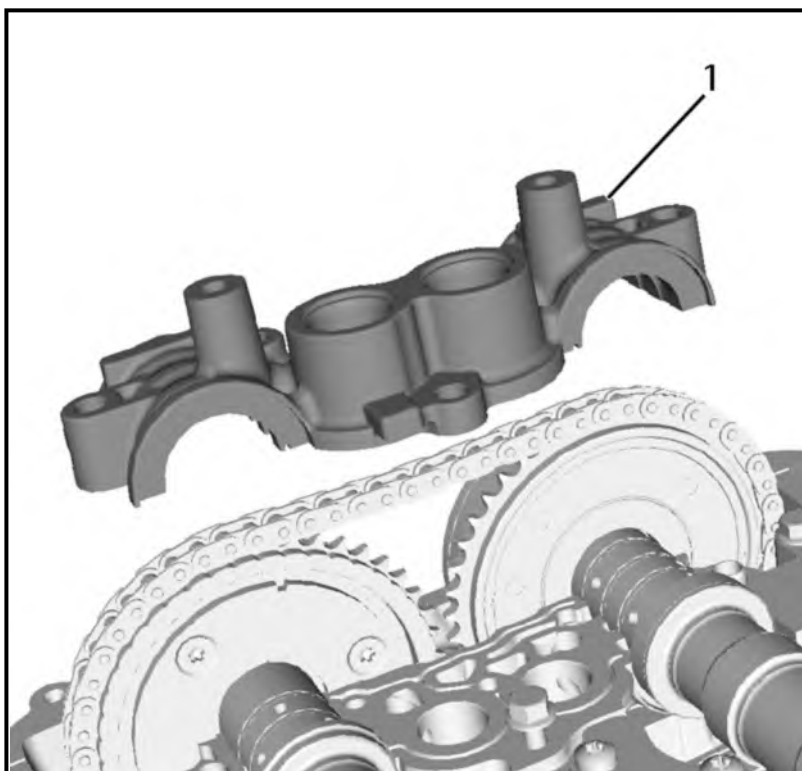


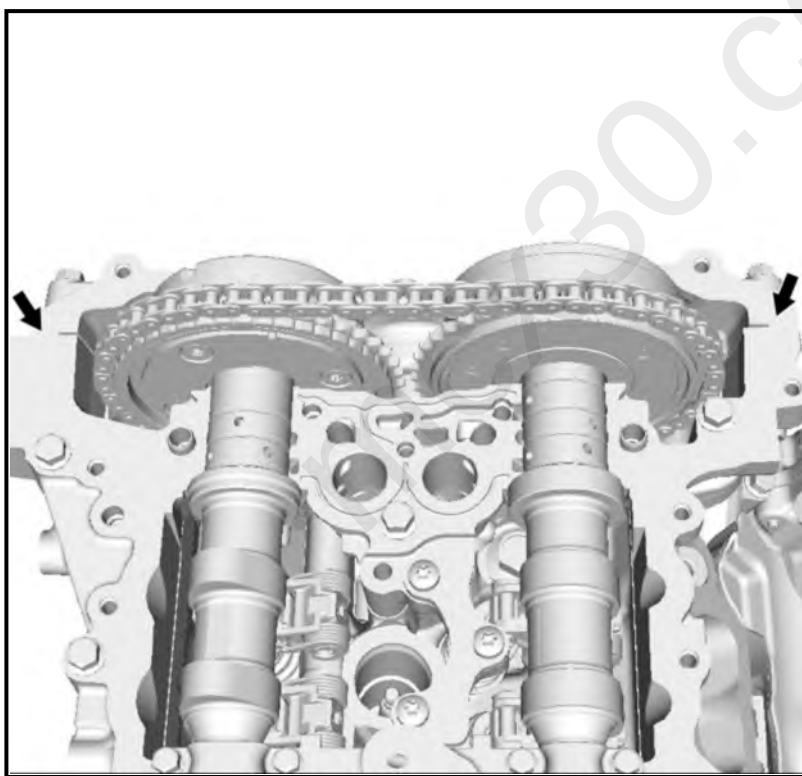
Fig. 7: Camshaft Front Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do NOT remove or loosen any other camshaft bearing caps at this time, even if you intend to remove the camshaft.

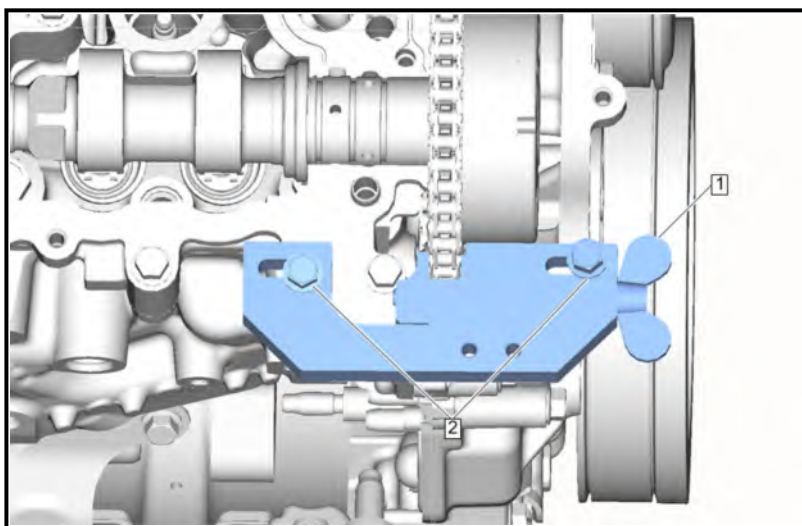
9. Remove the camshaft front cap (1).



10. Clean RTV from front cover and cylinder head surface at the indicated locations prior to timing retainer tool installation.

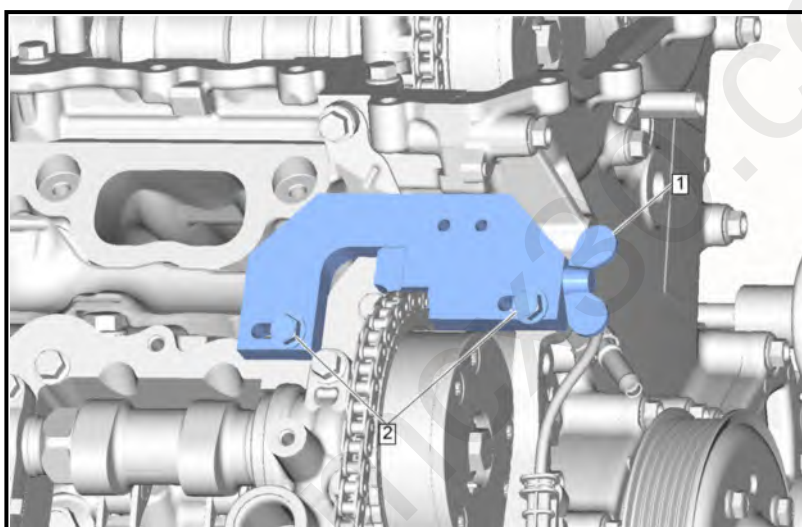


11. Loosen the wingnut (1) to open the clamping area of **EN-51333-1** retainer.



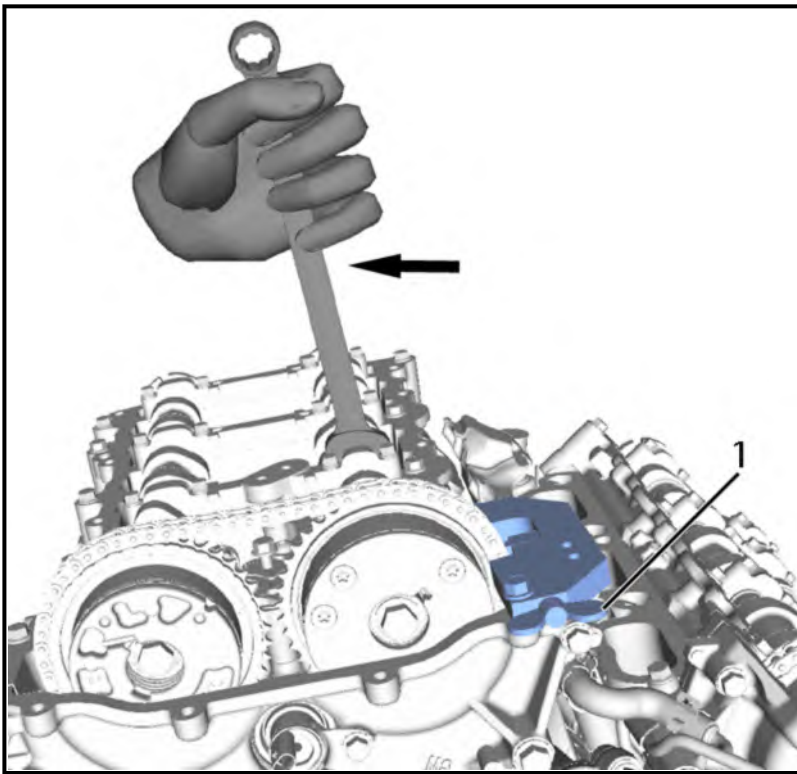
NOTE: Do NOT overtighten the retainer bolts. The EN-51333-1 retainer should be able to slide via the retaining bolt slots. This fore/aft movement will allow easier removal and installation of the timing chain.

12. Install the **EN-51333-1** retainer on the exhaust side front cover and cylinder head by screwing in the bolts (2) on the **EN-51333-1** retainer finger-tight.
13. Loosen the wingnut (1) to open the clamping area of **EN-51333-2** retainer.



NOTE: Do NOT overtighten the retainer bolts. The EN-51333-2 retainer should be able to slide via the retaining bolt slots. This fore/aft movement will allow easier removal and installation of the timing chain.

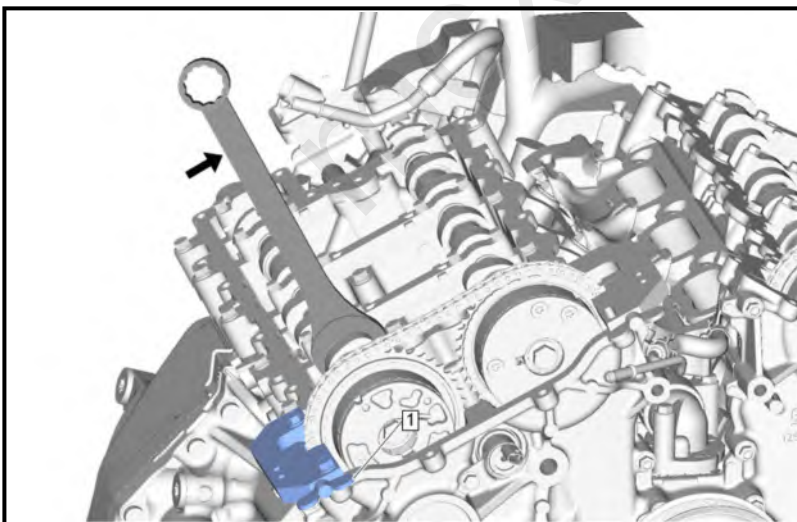
14. Install the **EN-51333-2** retainer on the intake side front cover and cylinder head by screwing in the bolts (2) on the **EN-51333-2** retainer finger-tight.
15. Using a wrench on the cast hexagonal portion of the intake camshaft, rotate the camshaft toward the exhaust camshaft and then release. Repeat this action three times to fully drain the tensioners of oil.



16. Rotate the intake camshaft toward the exhaust camshaft and hold in order to create slack in the chain between the actuators.

NOTE: Do NOT tighten the wingnut with a tool of any kind. Firm finger-tightening is sufficient.

17. Tighten wingnut (1) so EN-51333-2 retainer closes and firmly grasps timing chain.
 18. Tighten the EN-51333-2 retainer bolts.
 19. Using a wrench on the cast hexagonal portion of the exhaust camshaft, rotate the camshaft toward the intake camshaft and then release. Repeat this action three times to fully drain the tensioners of oil.

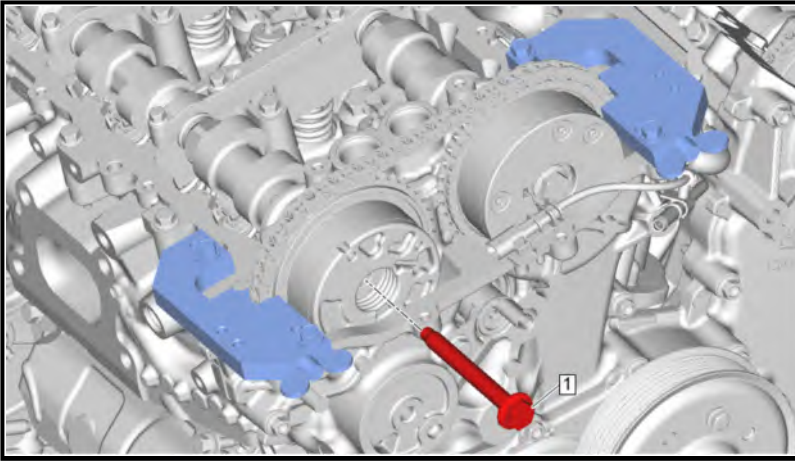


20. Rotate the exhaust camshaft toward the intake camshaft and hold in order to create slack in the chain between the actuators.

NOTE: Do NOT tighten the wingnut with a tool of any kind. Firm finger-tightening is sufficient.

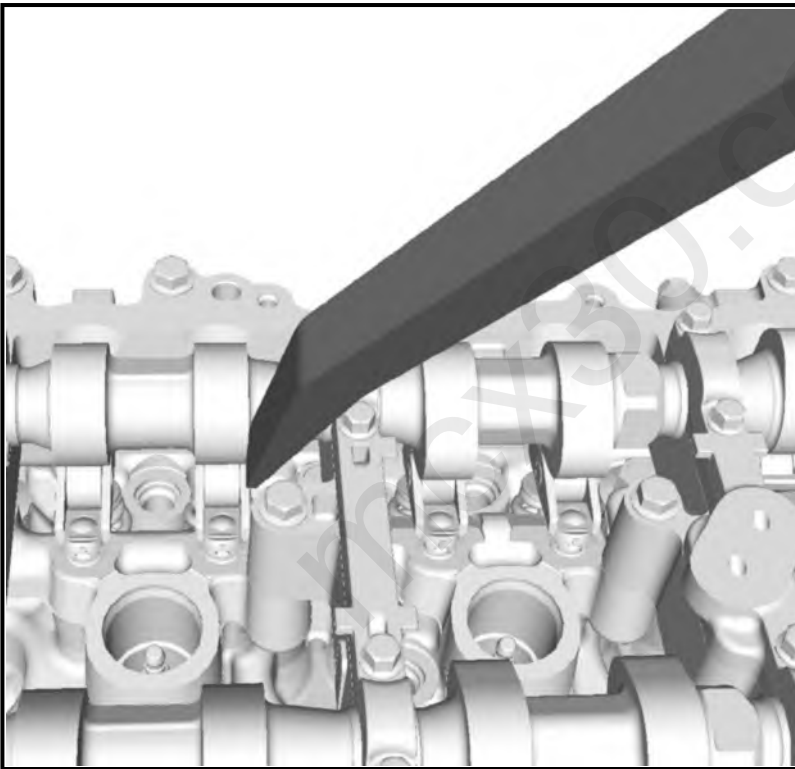
21. Tighten wingnut (1) so EN-51333-1 retainer closes and firmly grasps timing chain.
 22. Tighten the EN-51333-1 retainer bolts.

23. Fully remove the camshaft actuator bolt (1) for the exhaust camshaft position actuator.



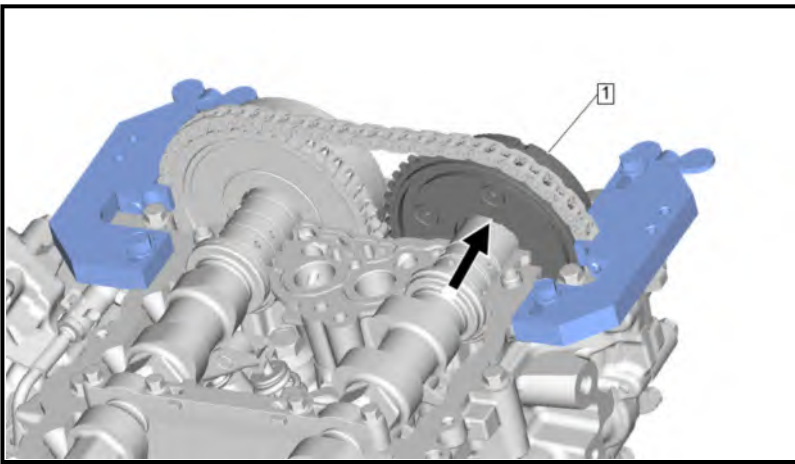
NOTE: The Exhaust camshaft position actuator must be removed first to provide enough chain slack to remove the intake Position Actuator.

24. Position a screwdriver or small pry bar between a camshaft cap and camshaft lobe. Carefully pry the camshafts to move as far as possible toward the rear/flywheel end of the engine.

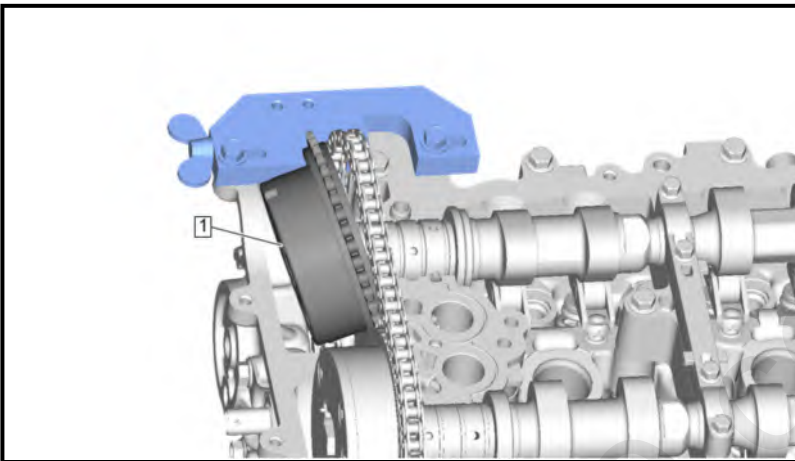


CAUTION: Do not pry against the face of the camshaft position actuators or the position actuator retaining bolts as the position actuators will be damaged.

25. Slide the camshaft position actuator (1) forward and off the end of the exhaust camshaft.



26. Tilt the camshaft position actuator forward and out/away from the engine.

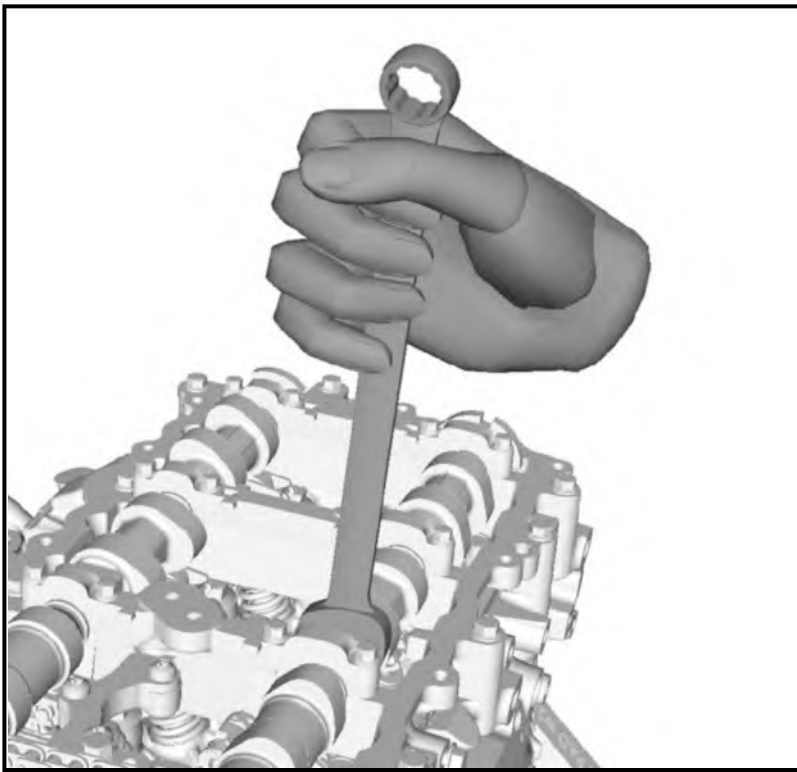


NOTE: DO NOT remove the EN-51333 Timing Chain Retainer Set, they are holding the cam chain to maintain the proper timed position.

27. Repeat steps 11-26 to remove the intake camshaft position actuator.

Installation Procedure

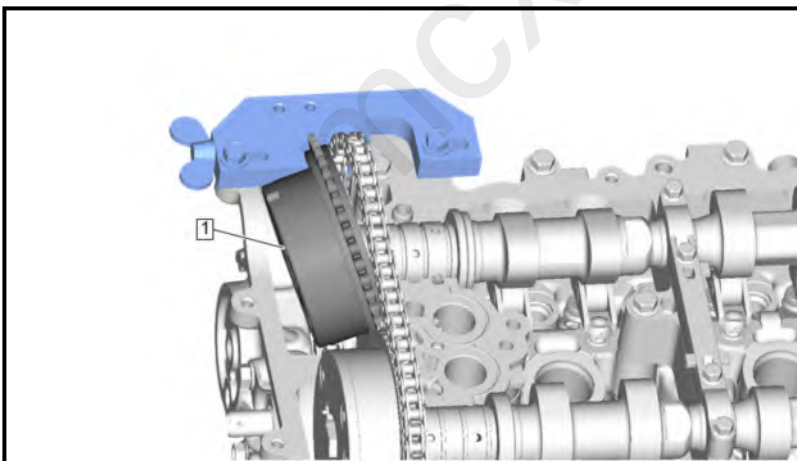
1. Use an open ended wrench on the cast hexagonal portion of the intake camshaft to aid in alignment of the timing chain marks.



CAUTION: Refer to [Torque Reaction Against Timing Drive Chain Caution](#) .

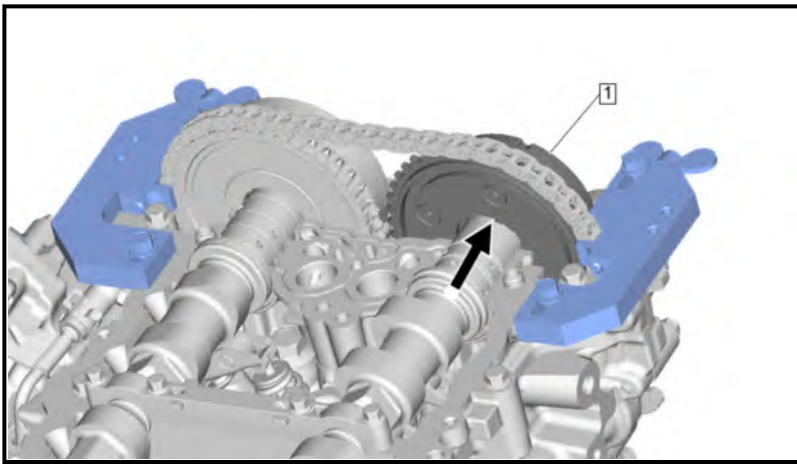
NOTE: The intake camshaft position actuator must be installed first to provide enough chain slack to install the exhaust position actuator.

2. Apply lubricant to the back of the camshaft position actuator and front of the camshaft bearing cap.
[Adhesives, Fluids, Lubricants, and Sealers](#)
3. Install the intake camshaft position actuator (1) first by inserting the actuator between the timing chain and front cover. While pushing the actuator into the tensioned side of the chain, tilt the actuator while engaging the chain, aligning the marks on the chain and place the actuator in the fully seated position.

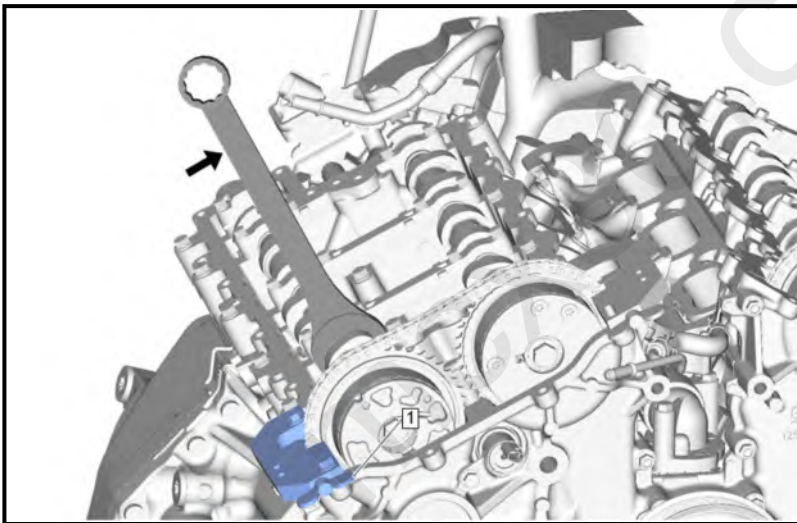


NOTE: Ensure the proper camshaft position actuator is installed in the correct position. The dowel pin on the camshaft position actuator must be aligned with the slot in the camshaft nose for reassembly. Failure to install the proper camshaft position actuator can effect engine performance and set an engine code.

4. Once actuator is in position, carefully pry the camshaft forward and move the **EN-51333** retainers backward via the slot to reengage the position actuator to the camshaft. The dowel pin on the camshaft position actuator must be aligned with the slot in the camshaft nose for reassembly.
5. Ensure the camshaft position actuator is seated properly on the end of the camshaft.



6. Repeat steps 4 and 5 to install the exhaust camshaft position actuator.
7. Install the intake camshaft position actuator retaining bolt, and lightly tighten the bolt to hold the camshaft actuator in place. DO NOT torque at this time.
8. Install the exhaust camshaft position actuator retaining bolt, and lightly tighten the bolt to hold the camshaft actuator in place. DO NOT torque at this time.
9. Check the marks on both the intake and exhaust camshaft position actuators to ensure that they are aligned with their respective paint marks on the chain.
10. Using an open ended wrench on the cast hexagonal portion of the exhaust camshaft, hold the camshaft in place while loosening the wing nut on the **EN-51333-1** retainer after fully loosed, let the camshaft rotate back into tension.



CAUTION: Refer to [Torque Reaction Against Timing Drive Chain Caution](#) .

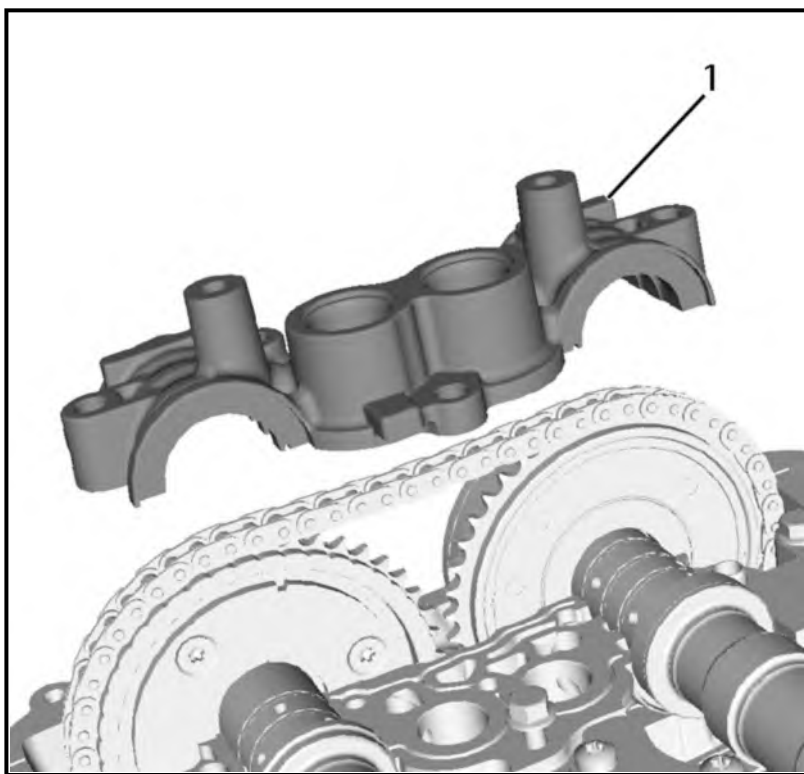
11. Repeat step 10 for the intake camshaft and **EN-51333-2** retainer

CAUTION: Refer to [Fastener Caution](#) .

12. Using an open ended wrench on the cast hexagonal portion of the exhaust camshaft, tighten both camshaft position actuator retaining bolts.

Tighten

1. First Pass: 20 N.m (15 lb ft)
2. Final Pass: 45 degrees
13. Remove the **EN-51333** retainers.
14. Install the camshaft front cap (1).



15. Install and tighten the camshaft front cap bolts in sequence.

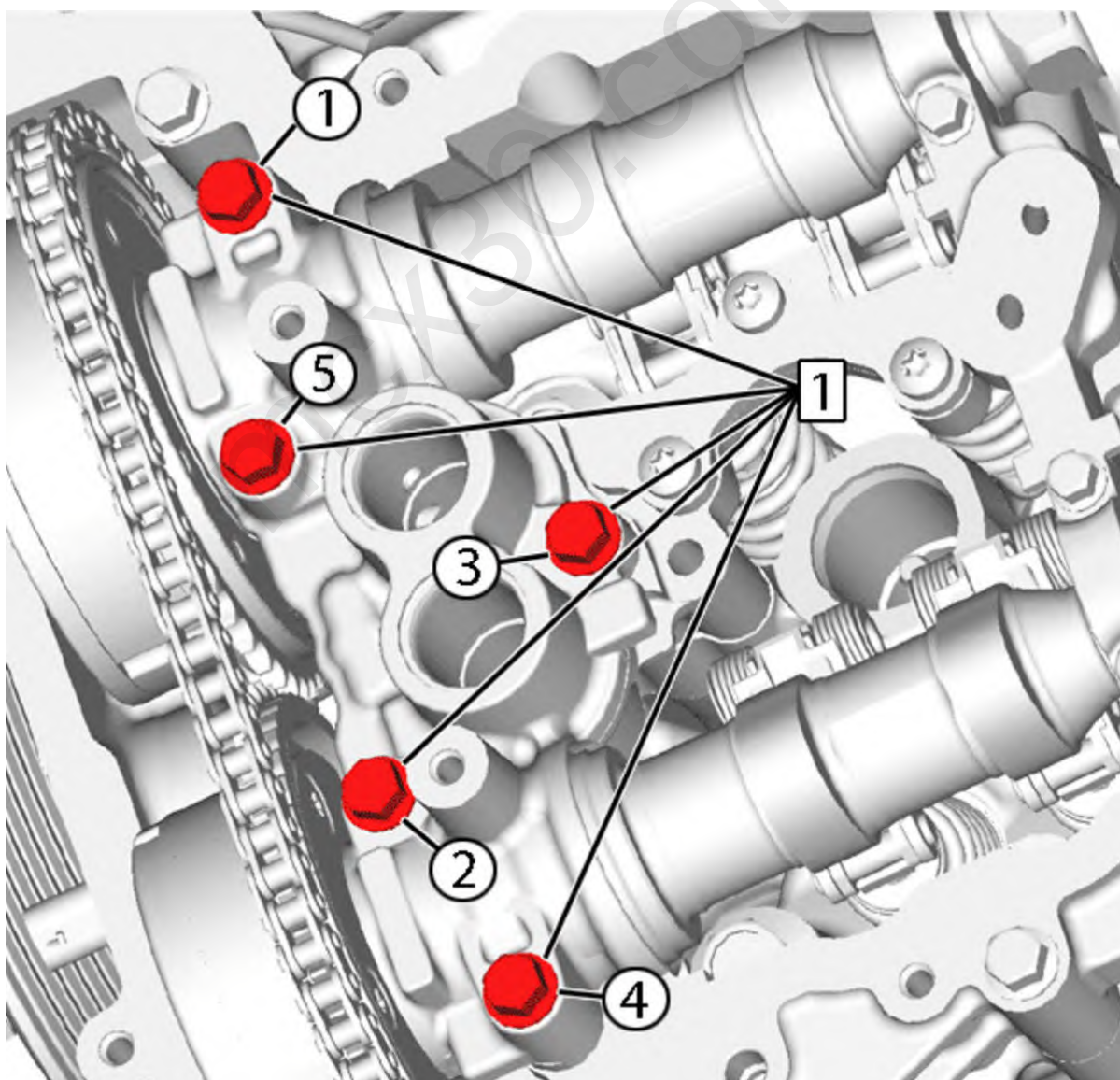


Fig. 8: Camshaft Front Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

Tighten

1. First Pass: 6 N.m (53 lb in)
2. Final Pass: 45 degrees
16. Camshaft Cover-Right Side - Install - [Camshaft Cover Replacement - Right Side](#)

CAMSHAFT POSITION ACTUATOR REPLACEMENT - BANK 2

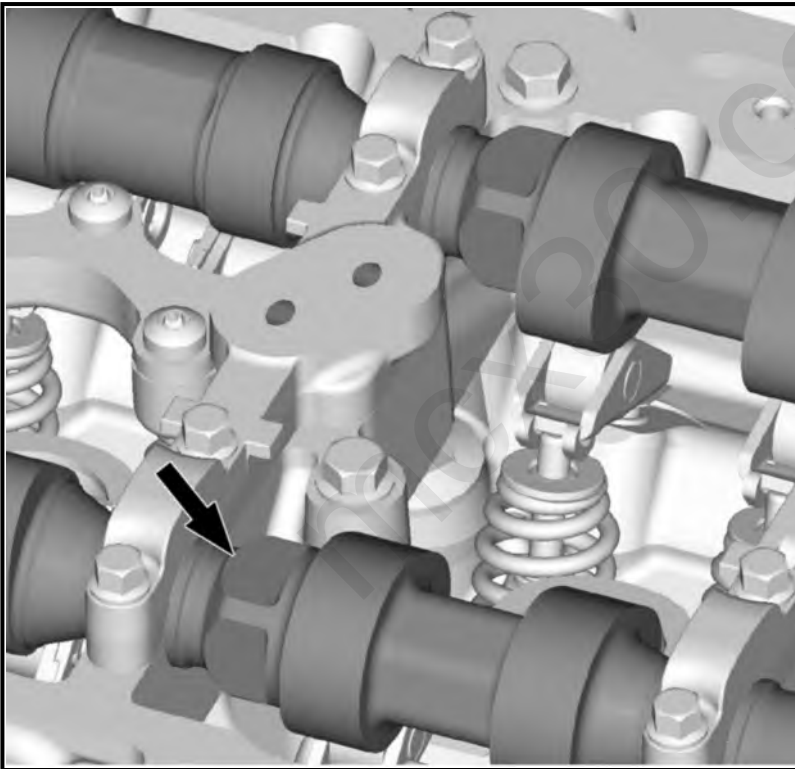
Special Tools

EN-51333 Timing Chain Retainer Set

Equivalent regional tools: [Special Tools](#) .

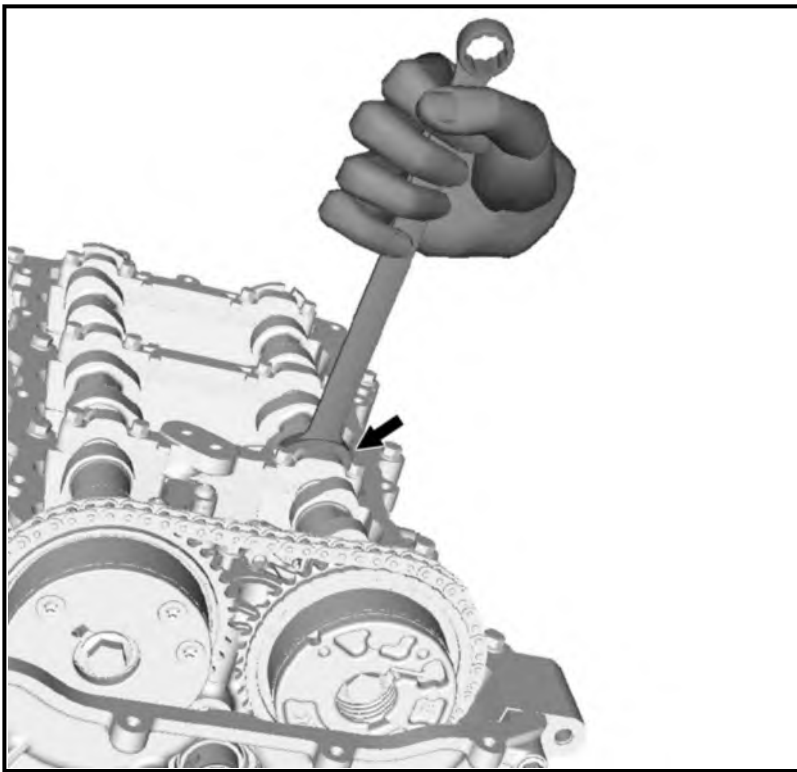
Removal Procedure

1. [Camshaft Cover Replacement - Left Side](#) - Remove
2. Rotate the engine clockwise using the crankshaft dampener retaining bolt until laser etched flats on both camshafts are facing up.



NOTE: This will put the camshafts in a rested position and aid in removal

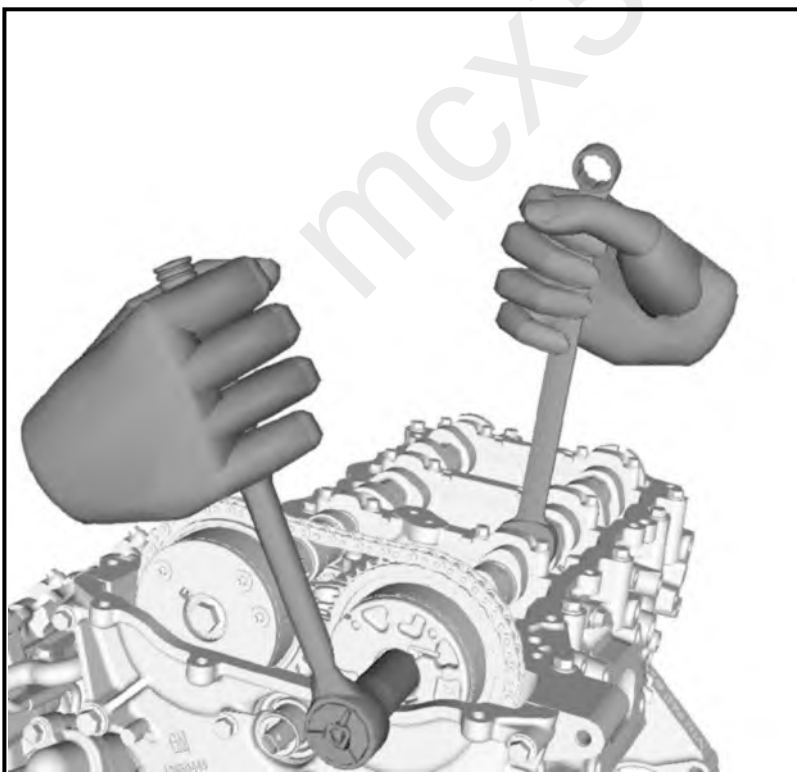
3. Use an opened end wrench on the cast hexagonal portion of the camshafts to hold them in place while breaking the actuator fasteners loose to prevent camshaft rotation.



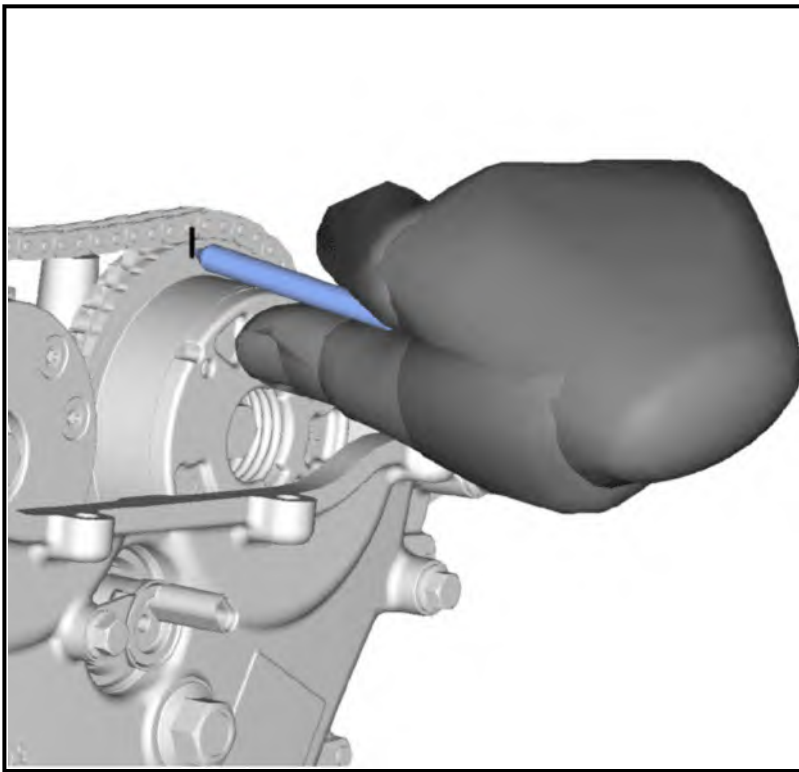
CAUTION: Refer to [Torque Reaction Against Timing Drive Chain Caution](#) .

NOTE: Do NOT remove or back out the camshaft position actuator bolt(s). Simply break them loose from their fully-torqued position. The position actuators must stay firmly attached until the retaining tools are in place, but they should be broken loose while the chain is still tight and in position.

4. Loosen both intake and exhaust camshaft position actuator retaining bolts but DO NOT remove.

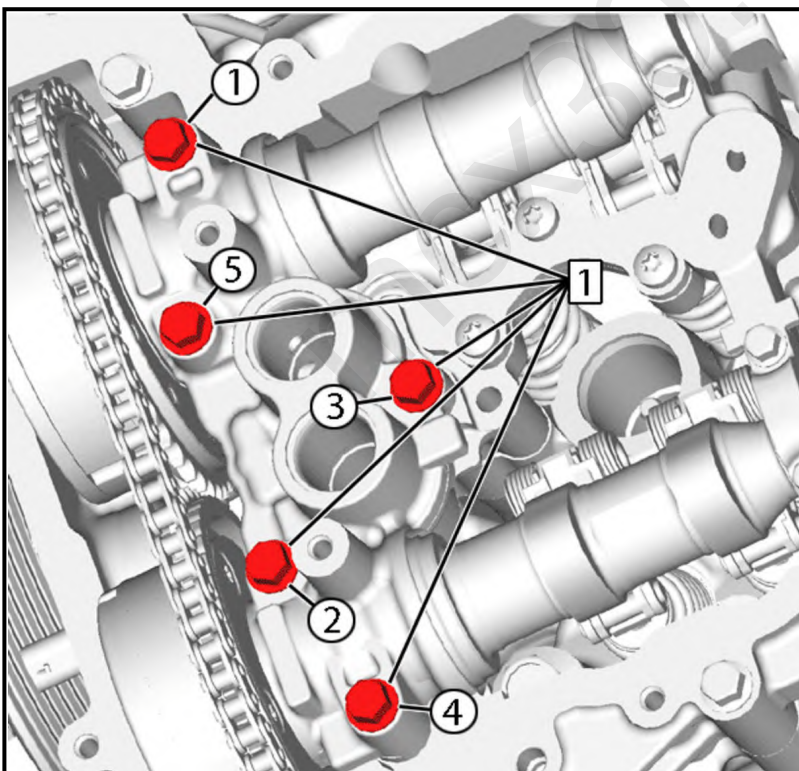


5. Clean off any oil residue on camshaft position actuators.
6. Mark the position of the chain to the camshaft position actuator - intake.



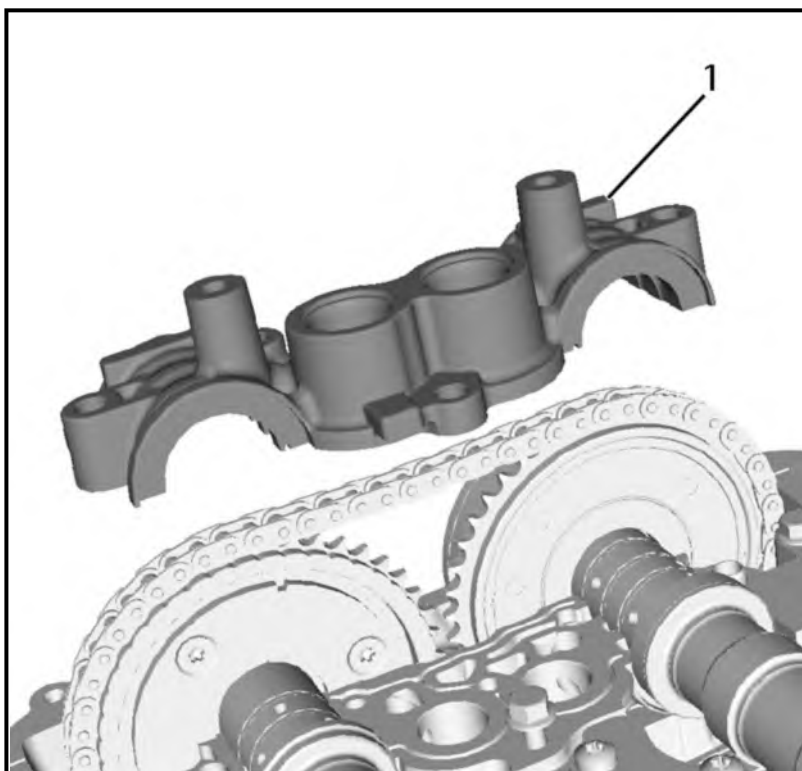
NOTE: Marking the relationship of the timing chain to actuators is critical for timing alignment.

7. Mark the position of the chain to the camshaft position actuator - exhaust.
8. Remove camshaft front cap bolts (1) [5x].

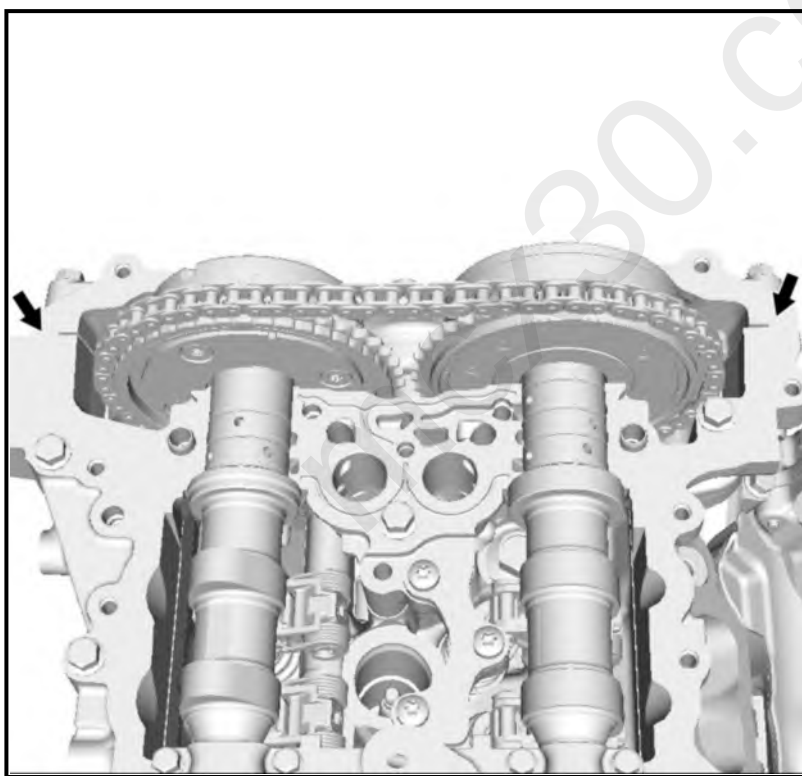


NOTE: Do NOT remove or loosen any other camshaft bearing caps at this time, even if you intend to remove the camshaft.

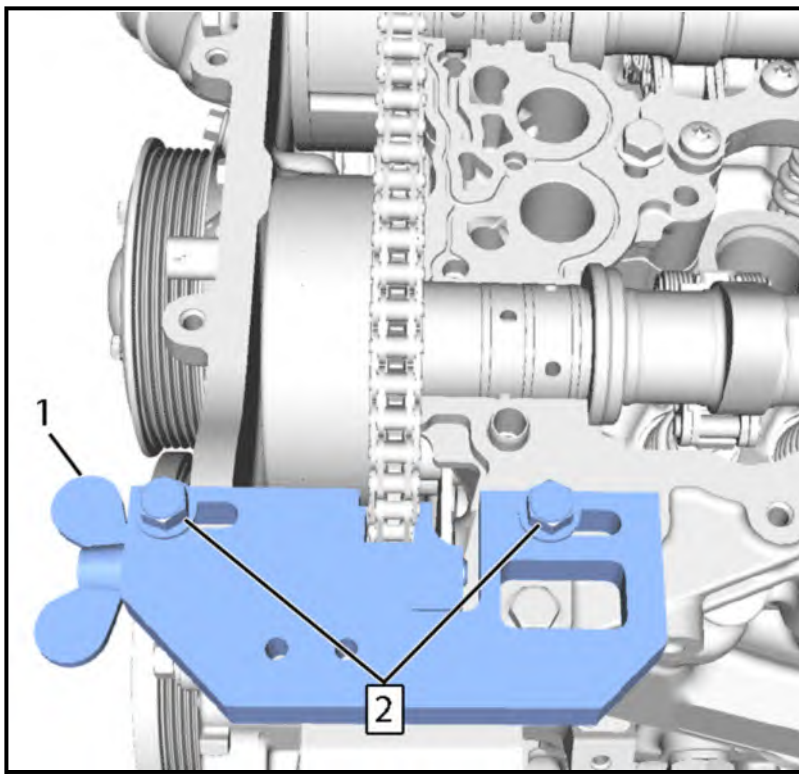
9. Remove the camshaft front cap (1).



10. Clean RTV from front cover and cylinder head surface at the indicated locations prior to timing retainer tool installation.

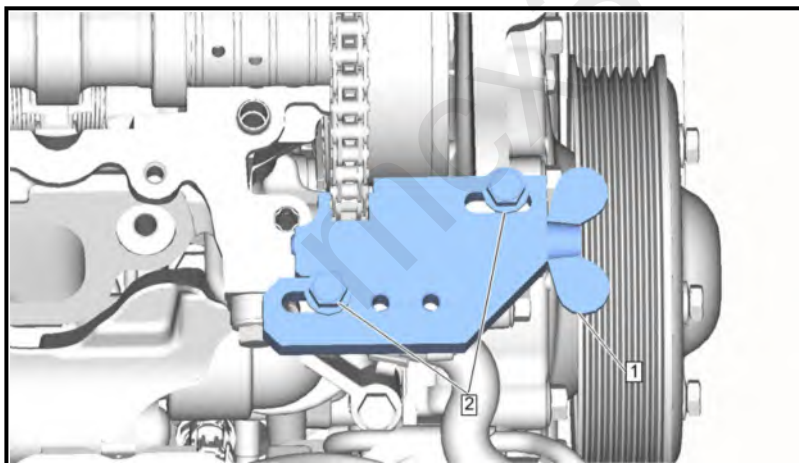


11. Loosen the wingnut (1) to open the clamping area of **EN-51333-4** retainer.



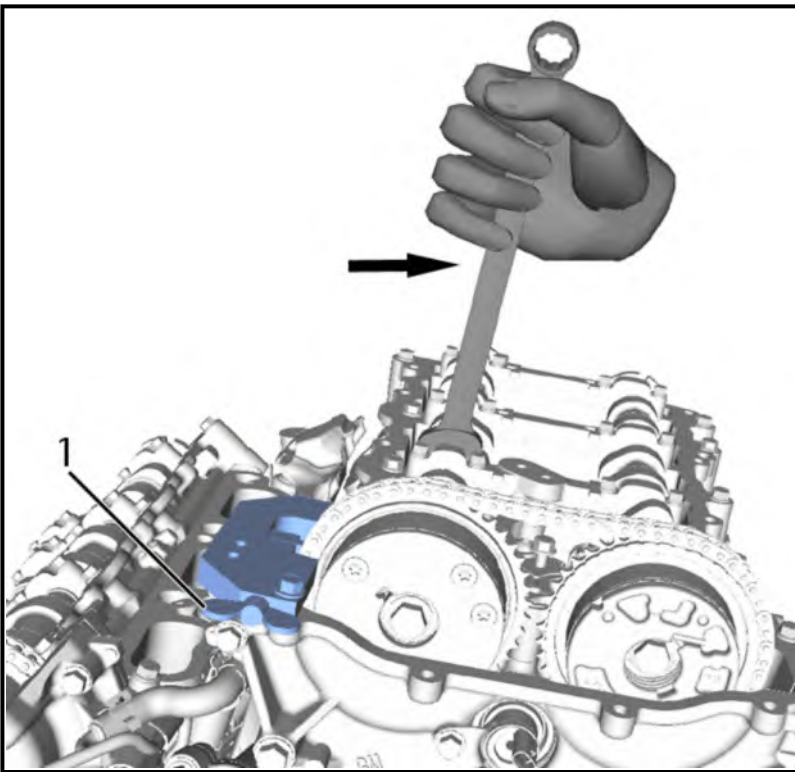
NOTE: Do NOT overtighten the retainer bolts. The EN-51333-4 retainer should be able to slide via the retaining bolt slots. This fore/aft movement will allow easier removal and installation of the timing chain.

12. Install the **EN-51333-4** retainer on the exhaust side front cover and cylinder head by screwing in the bolts (2) on the **EN-51333-1** retainer finger-tight.
13. Loosen the wingnut (1) to open the clamping area of **EN-51333-3** retainer.



NOTE: Do NOT overtighten the retainer bolts. The EN-51333-3 retainer should be able to slide via the retaining bolt slots. This fore/aft movement will allow easier removal and installation of the timing chain.

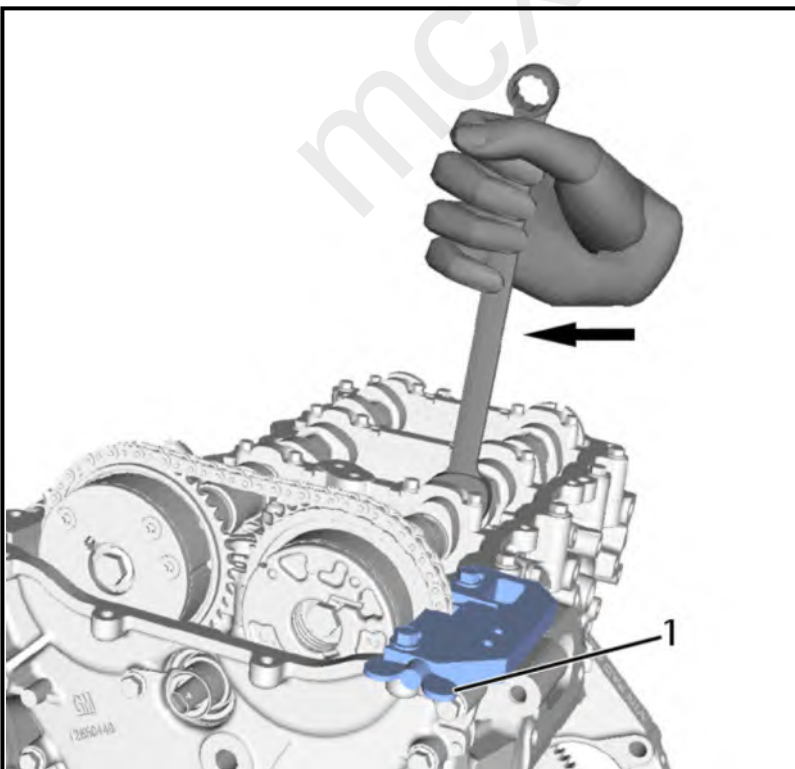
14. Install the **EN-51333-3** retainer on the intake side front cover and cylinder head by screwing in the bolts (2) on the **EN-51333-3** retainer finger-tight.
15. Using a wrench on the cast hexagonal portion of the intake camshaft, rotate the camshaft toward the exhaust camshaft and then release. Repeat this action three times to fully drain the tensioners of oil.



16. Rotate the intake camshaft toward the exhaust camshaft and hold in order to create slack in the chain between the actuators.

NOTE: Do NOT tighten the wingnut with a tool of any kind. Firm finger-tightening is sufficient.

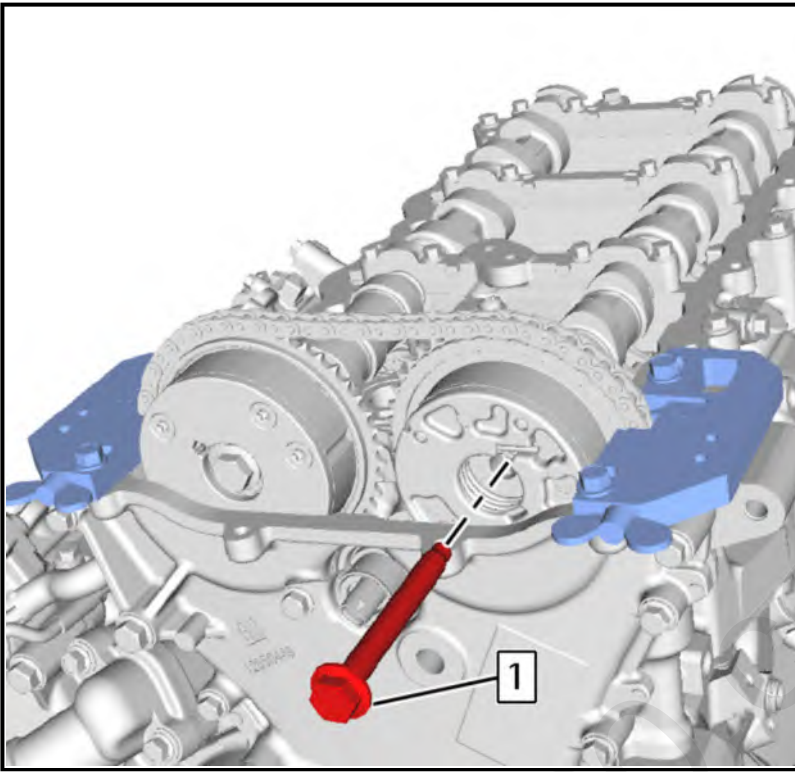
17. Tighten wingnut (1) so EN-51333-3 retainer closes and firmly grasps timing chain.
 18. Tighten the EN-51333-3 retainer bolts.
 19. Using a wrench on the cast hexagonal portion of the exhaust camshaft, rotate the camshaft toward the intake camshaft and then release. Repeat this action three times to fully drain the tensioners of oil.



20. Rotate the exhaust camshaft toward the intake camshaft and hold in order to create slack in the chain between the actuators.

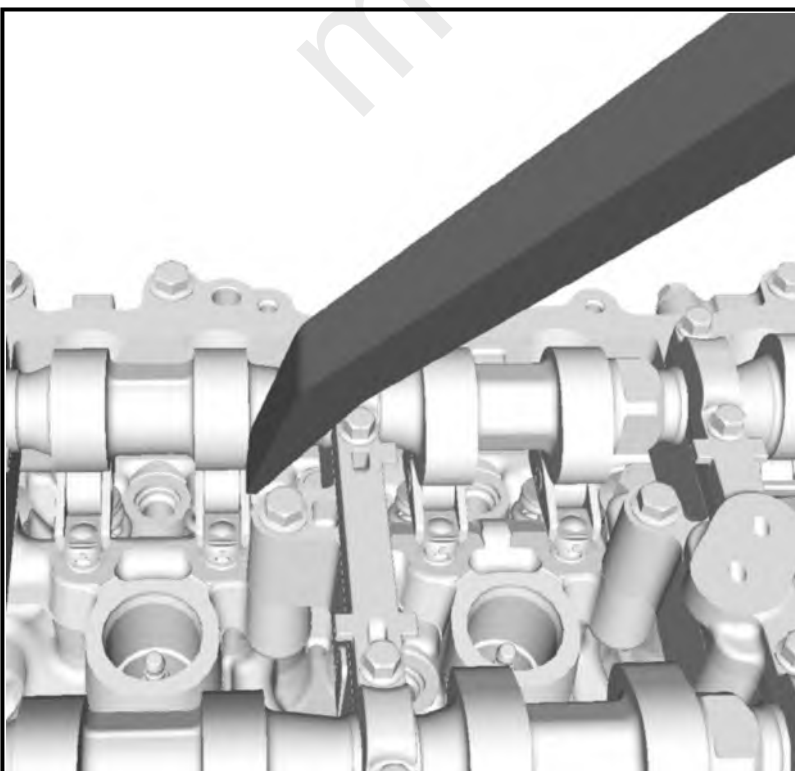
NOTE: Do NOT tighten the wingnut with a tool of any kind. Firm finger-tightening is sufficient.

21. Tighten wingnut (1) so EN-51333-4 retainer closes and firmly grasps timing chain.
22. Tighten the EN-51333-4 retainer bolts.
23. Fully remove the camshaft actuator bolt (1) for the exhaust camshaft position actuator.



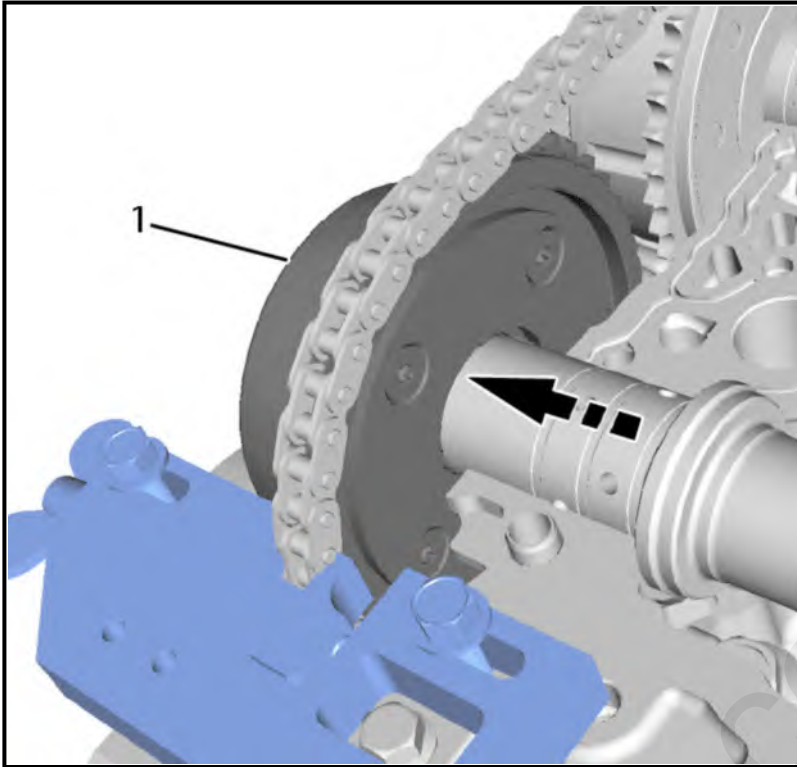
NOTE: The Exhaust camshaft position actuator must be removed first to provide enough chain slack to remove the intake Position Actuator.

24. Position a screwdriver or small pry bar between a camshaft cap and camshaft lobe. Carefully pry the camshafts to move as far as possible toward the rear/flywheel end of the engine.

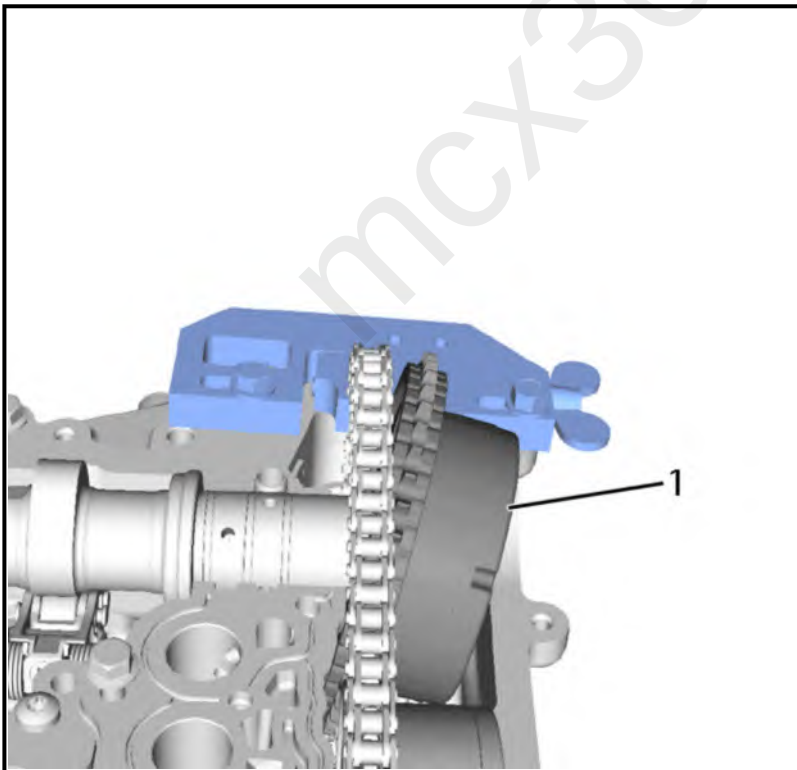


CAUTION: Do not pry against the face of the camshaft position actuators or the position actuator retaining bolts as the position actuators will be damaged.

25. Slide the camshaft position actuator (1) forward and off the end of the exhaust camshaft.



26. Tilt the camshaft position actuator forward and out/away from the engine.

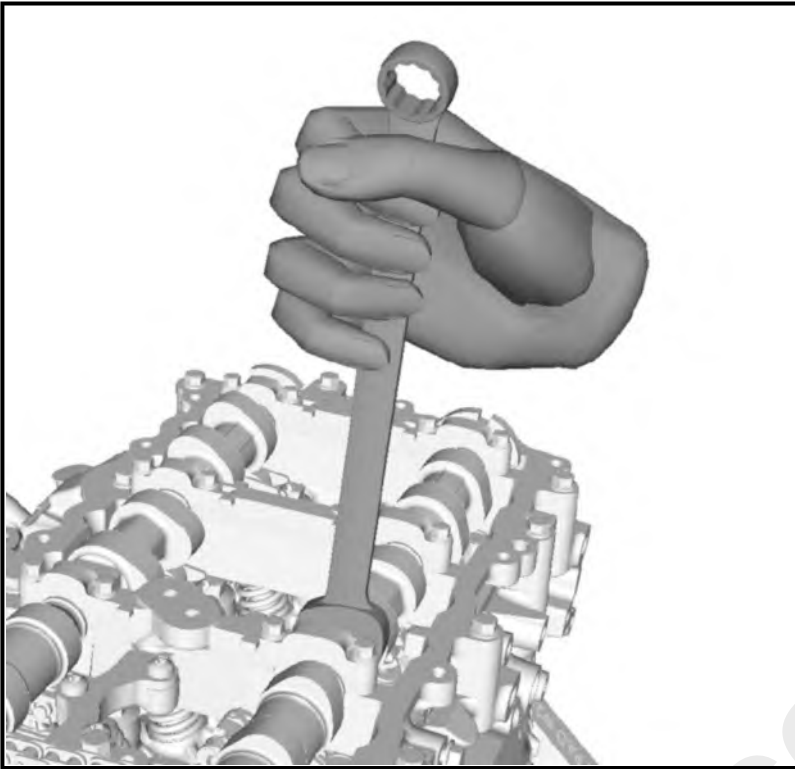


NOTE: DO NOT remove the EN-51333 Timing Chain Retainer Set, they are holding the cam chain to maintain the proper timed position.

27. Repeat steps 11-26 to remove the intake camshaft position actuator.

Installation Procedure

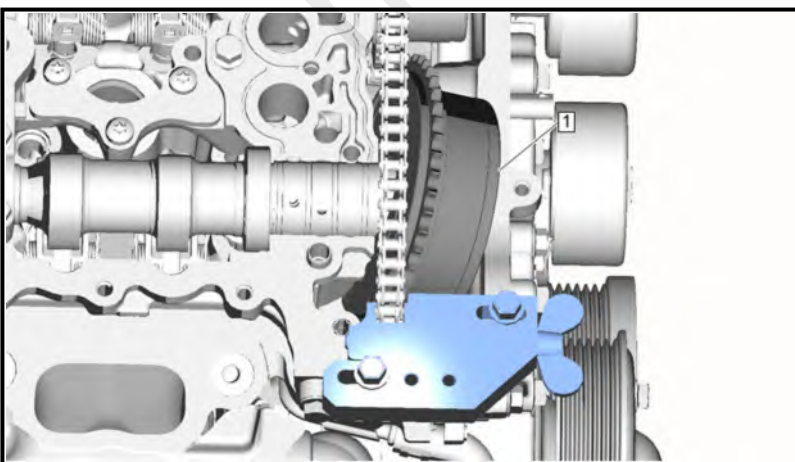
1. Use an open ended wrench on the cast hexagonal portion of the intake camshaft to aid in alignment of the timing chain marks.



CAUTION: Refer to [Torque Reaction Against Timing Drive Chain Caution](#) .

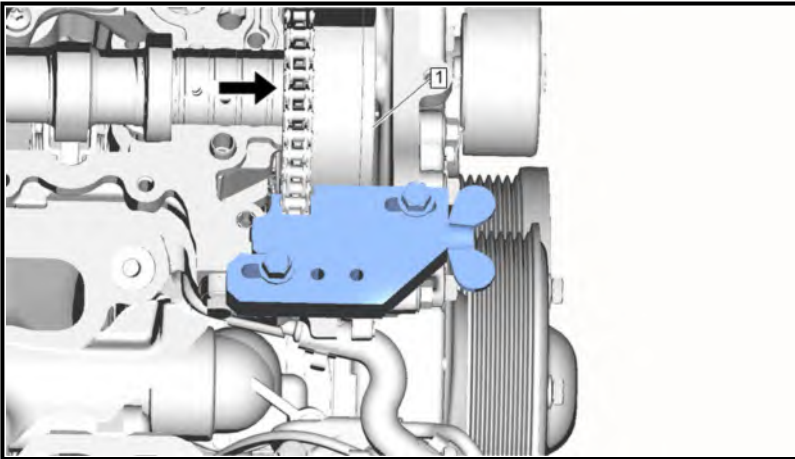
NOTE: The intake camshaft position actuator must be installed first to provide enough chain slack to install the exhaust position actuator.

2. Apply lubricant to the back of the camshaft position actuator and front of the camshaft bearing cap.
[Adhesives, Fluids, Lubricants, and Sealers](#)
3. Install the intake camshaft position actuator (1) first by inserting the actuator between the timing chain and front cover. While pushing the actuator into the tensioned side of the chain, tilt the actuator while engaging the chain, aligning the marks on the chain and place the actuator in the fully seated position.

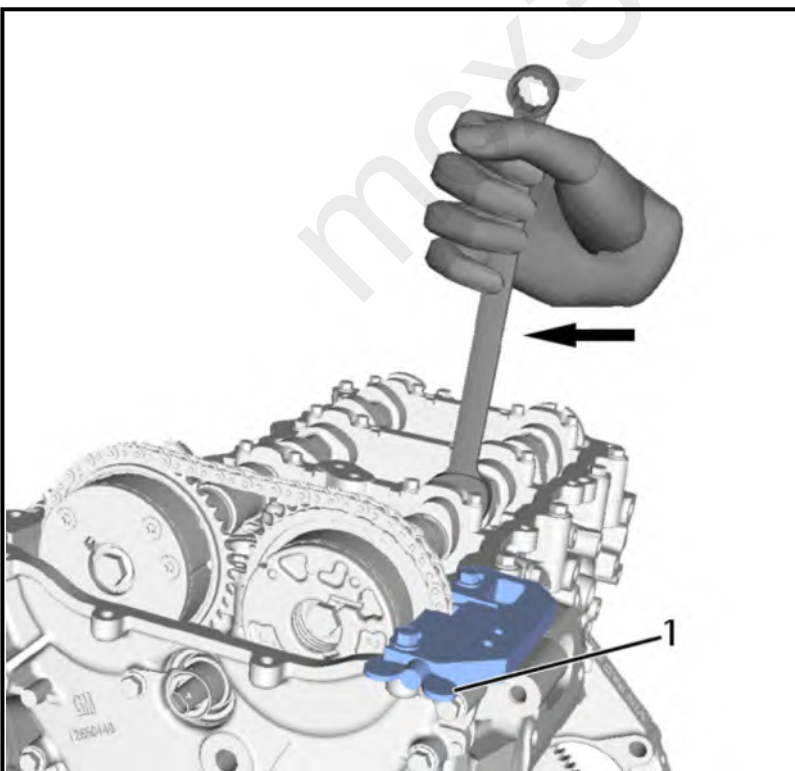


NOTE: Ensure the proper camshaft position actuator is installed in the correct position. The dowel pin on the camshaft position actuator must be aligned with the slot in the camshaft nose for reassembly. Failure to install the proper camshaft position actuator can effect engine performance and set an engine code.

4. Once actuator is in position, carefully pry the camshaft forward and move the **EN-51333** retainers backward via the slot to reengage the position actuator to the camshaft. The dowel pin on the camshaft position actuator must be aligned with the slot in the camshaft nose for reassembly.
5. Ensure the camshaft position actuator is seated properly on the end of the camshaft.



6. Repeat steps 4 and 5 to install the exhaust camshaft position actuator.
7. Install the intake camshaft position actuator retaining bolt, and lightly tighten the bolt to hold the camshaft actuator in place. DO NOT torque at this time.
8. Install the exhaust camshaft position actuator retaining bolt, and lightly tighten the bolt to hold the camshaft actuator in place. DO NOT torque at this time.
9. Check the marks on both the intake and exhaust camshaft position actuators to ensure that they are aligned with their respective paint marks on the chain.
10. Using an open ended wrench on the cast hexagonal portion of the exhaust camshaft, hold the camshaft in place while loosening the wing nut on the **EN-51333-4** retainer after fully loosed, let the camshaft rotate back into tension.



CAUTION: Refer to [Torque Reaction Against Timing Drive Chain Caution](#) .

11. Repeat step 10 for the intake camshaft and **EN-51333-3** retainer

CAUTION: Refer to [Fastener Caution](#) .

12. Using an open ended wrench on the cast hexagonal portion of the exhaust camshaft, tighten both camshaft position actuator retaining bolts.

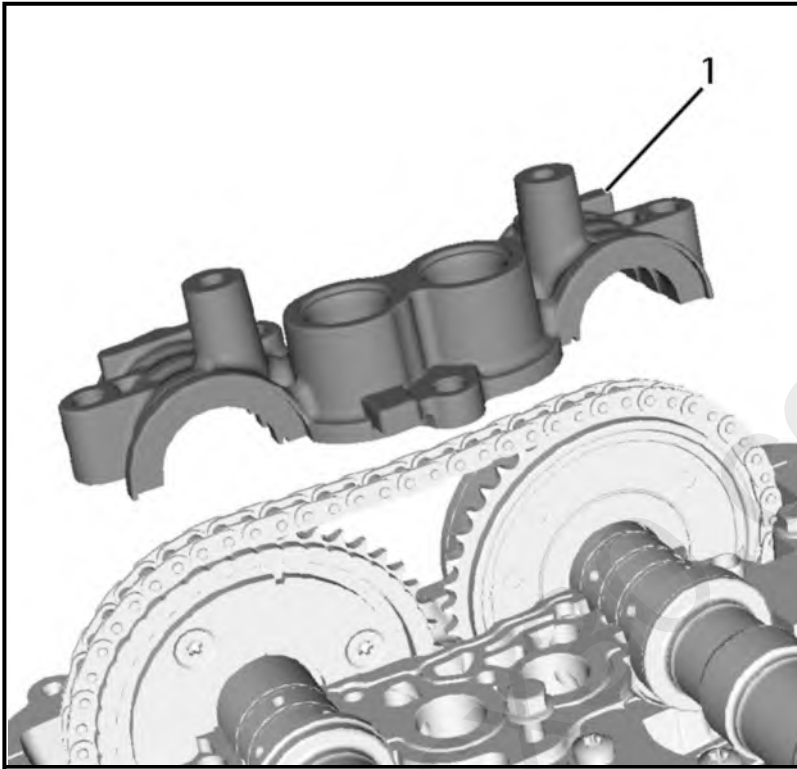
Tighten

1. First Pass: 20 N.m (15 lb ft)

2. Final Pass: 45 degrees

13. Remove the **EN-51333** retainers.

14. Install the camshaft front cap (1).



15. Install and tighten the camshaft front cap bolts in sequence.

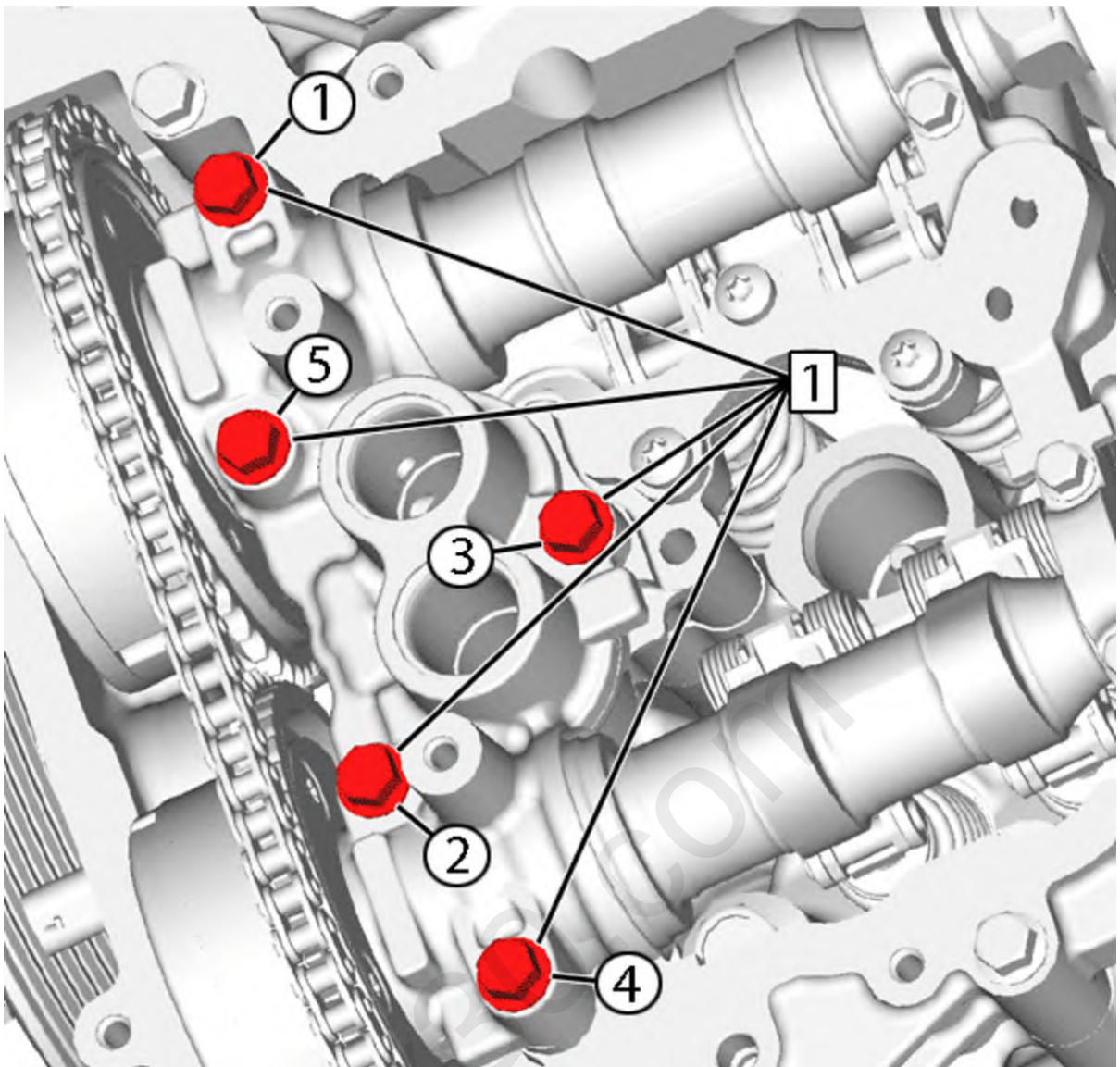


Fig. 9: Camshaft Front Cap Bolt Tightening Sequence

Courtesy of GENERAL MOTORS COMPANY

Tighten

1. First Pass: 6 N.m (53 lb in)
2. Final Pass: 45 degrees

16. Camshaft Cover-Left Side - Install - [Camshaft Cover Replacement - Left Side](#)

CAMSHAFT TIMING CHAIN COMPONENT REMOVAL AND INSTALLATION

Special Tools

EN-52234 Timing Chain Tensioner Retaining Pins

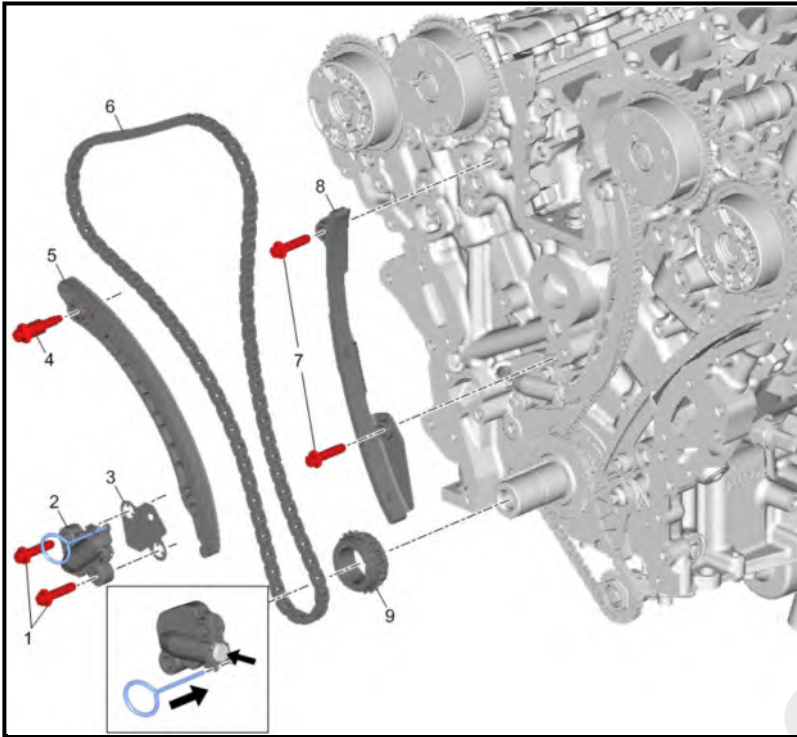
Equivalent regional tools: [Special Tools](#) .

Camshaft Timing Chain Component Removal - Right Side

WARNING:

The timing chain tensioner plunger is under high tension and must be retained by using the tensioner retraction pin during removal or installation of the timing chain tensioner. Failure to retain the timing chain tensioner plunger may cause it to be ejected with intense force and cause personal injury.

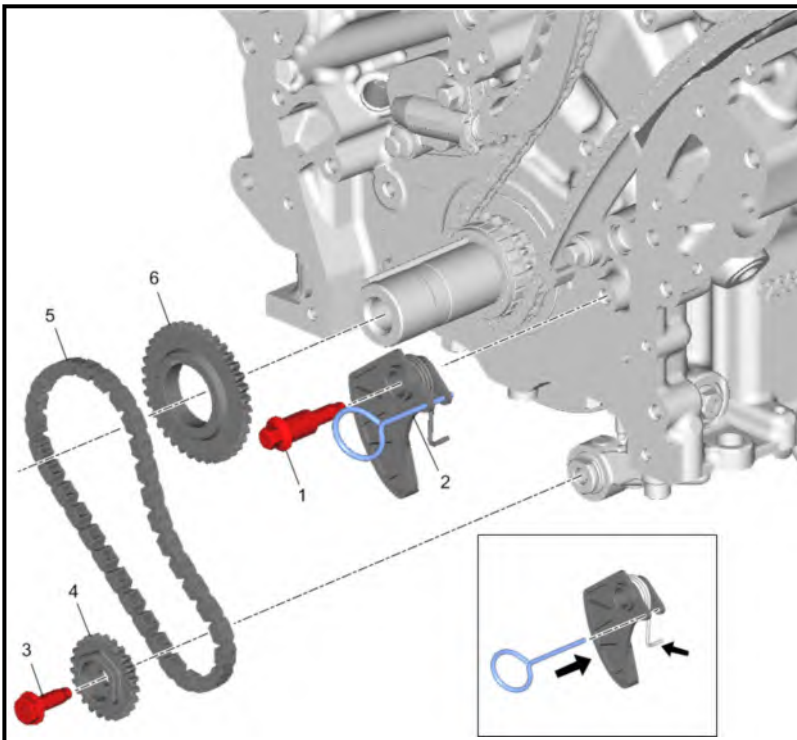
1. Rotate the engine clockwise until the right hand bank camshaft flats with laser etched markings are straight up in relation to the cylinder head. The crankshaft key way will be at approximately the 3 o'clock position.



2. Reset the timing chain tensioner plunger using your thumb and **EN-52234** Timing Chain Tensioner Retaining Pins or a 1/8" drill bit to retain the plunger.
3. Compress the plunger into the body and lock the right timing chain tensioner by inserting **EN-52234** Timing Chain Tensioner Retaining Pins or 1/8" drill bit into the access hole in the side of the right timing chain tensioner body.
4. Slowly release pressure on the right timing chain tensioner. The right timing chain tensioner should remain compressed.
5. Timing Chain Tensioner Bolt (1) - Remove [2x]
6. Timing Chain Tensioner- Right Side (2) - Remove
7. Timing Chain Tensioner Gasket (3) - Remove and DISCARD
8. Timing Chain Guide Bolt (4) - Remove
9. Timing Chain Guide- Right Side (5) - Remove
10. Timing Chain- Right Side (6) - Remove
11. Timing Chain Guide Bolt (7) - Remove [2x]
12. Timing Chain Guide- Right Side (8) - Remove
13. Crankshaft Sprocket (9) - Remove

Oil Pump Timing Chain Components Removal

1. Collapse the oil pump timing tensioner by hand and install **EN-52234** Timing Chain Tensioner Retaining Pins or a 1/8" drill bit to hold it in place.

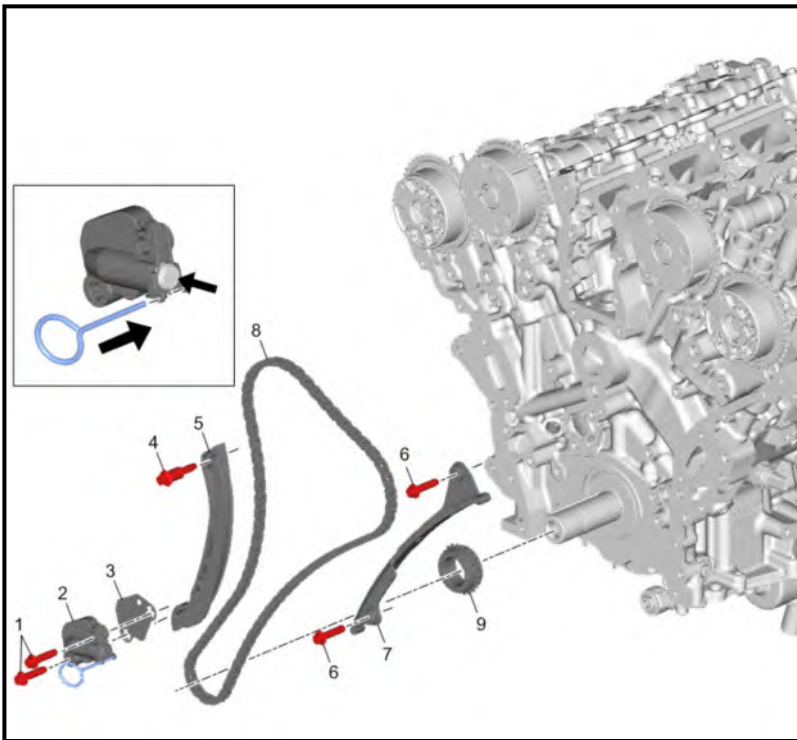


2. Timing Chain Tensioner Bolt (1) - Remove
3. Timing Chain Tensioner (2) - Remove
4. Oil Pump Drive Bolt (3) - Remove and DISCARD
5. Oil Pump Sprocket (4) - Remove
6. Oil Pump Timing Chain (5) - Remove
7. Crankshaft Sprocket (6) - Remove

Camshaft Timing Chain Component Removal - Left Side

WARNING: The timing chain tensioner plunger is under high tension and must be retained by using the tensioner retraction pin during removal or installation of the timing chain tensioner. Failure to retain the timing chain tensioner plunger may cause it to be ejected with intense force and cause personal injury.

1. Rotate the engine counter clockwise until the left hand bank camshaft flats with laser etched markings are straight up in relation to the cylinder head. The crankshaft key way will be at approximately the 11 o'clock position.



2. Reset the timing chain tensioner plunger using your thumb and **EN-52234** Timing Chain Tensioner Retaining Pins or a 1/8" drill bit to retain the plunger.
3. Compress the plunger into the body and lock the left timing chain tensioner by inserting **EN-52234** Timing Chain Tensioner Retaining Pins or 1/8" drill bit into the access hole in the side of the left timing chain tensioner body.
4. Slowly release pressure on the left timing chain tensioner. The left timing chain tensioner should remain compressed.
5. Timing Chain Tensioner Bolt (1) - Remove [2x]
6. Timing Chain Tensioner- Left Side (2) - Remove
7. Timing Chain Tensioner Gasket (3) - Remove and DISCARD
8. Timing Chain Guide Bolt (4) - Remove [2x]
9. Timing Chain Guide- Left Side (5) - Remove
10. Timing Chain Guide Bolt (6) - Remove [2x]
11. Timing Chain Guide- Left Side (7) - Remove
12. Timing Chain- Left Side (8) - Remove
13. Crankshaft Sprocket (9) - Remove

Cleaning Procedure

1. Clean all the following components with solvent:
 - Crankshaft sprocket
 - Timing drive chains
 - Right timing drive chain guides
 - Right timing drive chain tensioner
 - Left timing drive chain guides
 - Left timing drive chain tensioners
 - Timing component fastening bolts
2. Clean each camshaft position actuator's exterior with solvent.

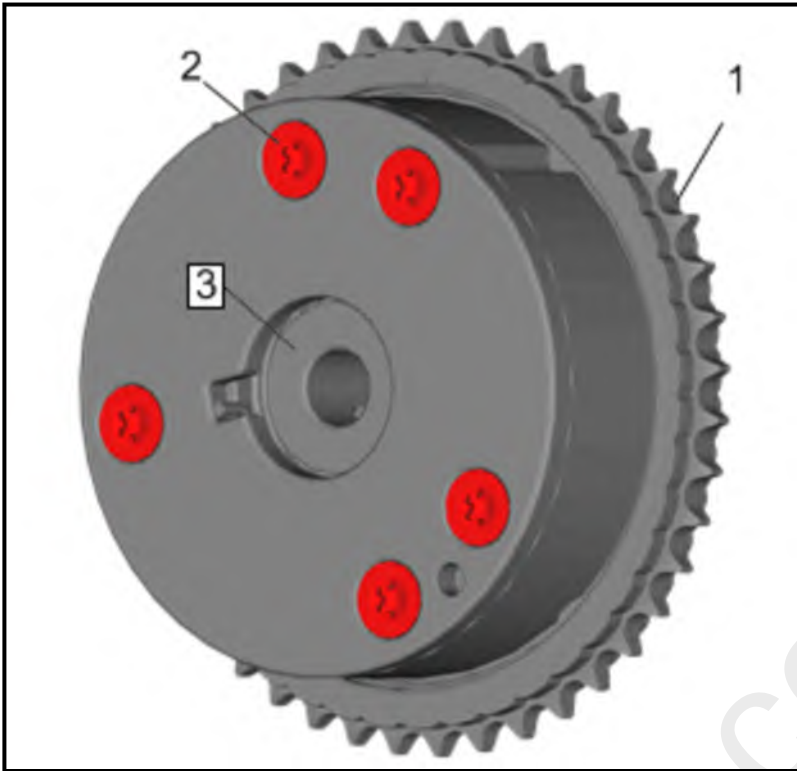
WARNING: Refer to Safety Glasses Warning .

3. Dry the timing components with compressed air.

Visual Inspection

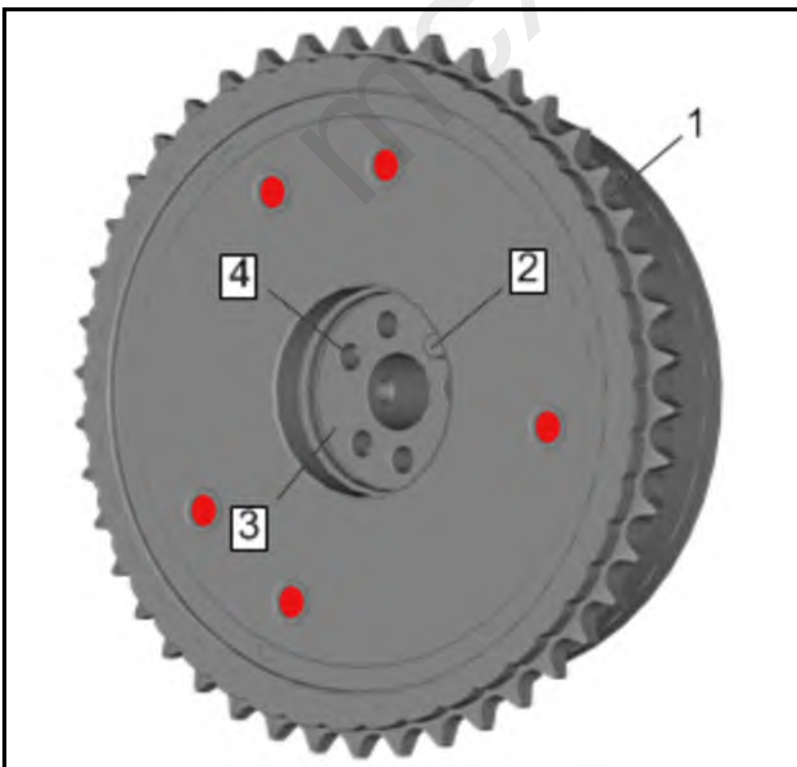
Camshaft Position Actuator

1. Inspect the front of the right exhaust camshaft position actuators for the following:



- Sprocket damage (1)
- Loose or missing housing bolts (2)
- Camshaft position actuator bolt seating/sealing inner hub flange damage (3)

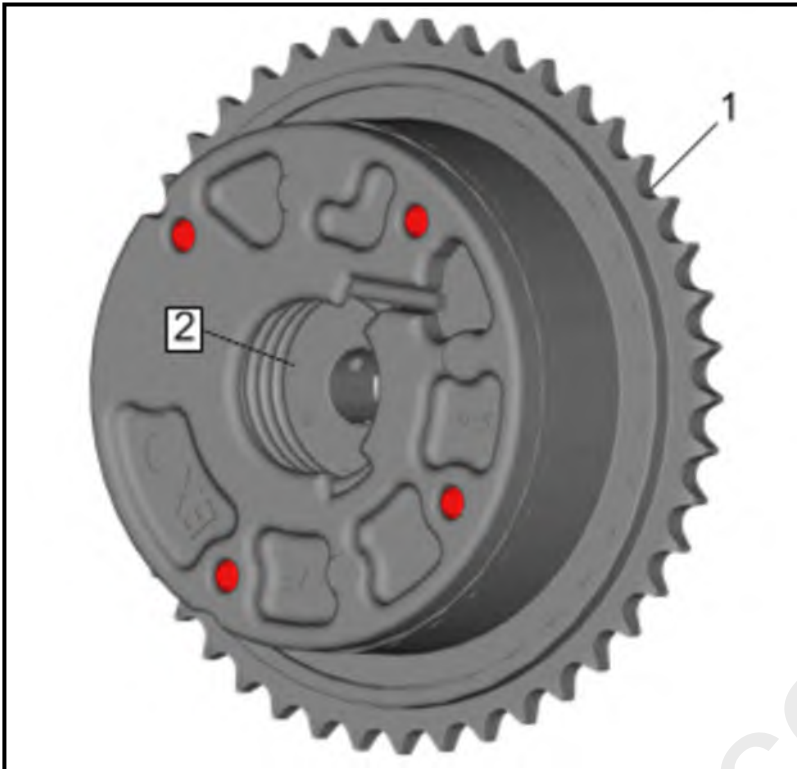
2. Inspect the back of the right exhaust camshaft position actuators for the following:



- Sprocket damage (1)
- Camshaft locating pin damage (2)

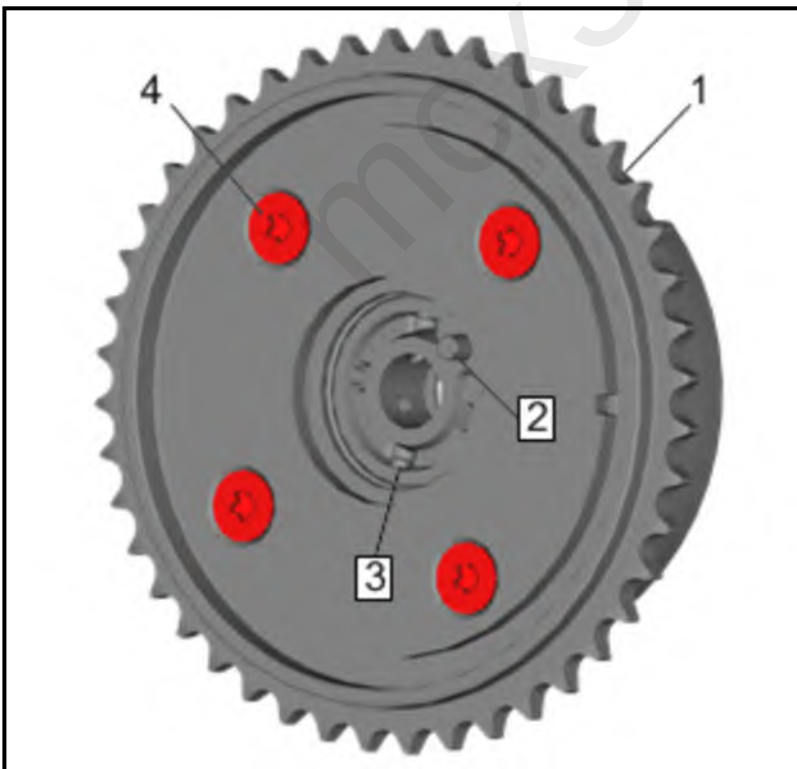
- Camshaft seating/sealing inner hub flange damage (3)
- Blockage to the oil passages (4)

3. Inspect the front of the right intake camshaft position actuators for the following:



- Sprocket damage (1)
- Camshaft position actuator oil control valve bolt seating/sealing inner hub flange damage (2)

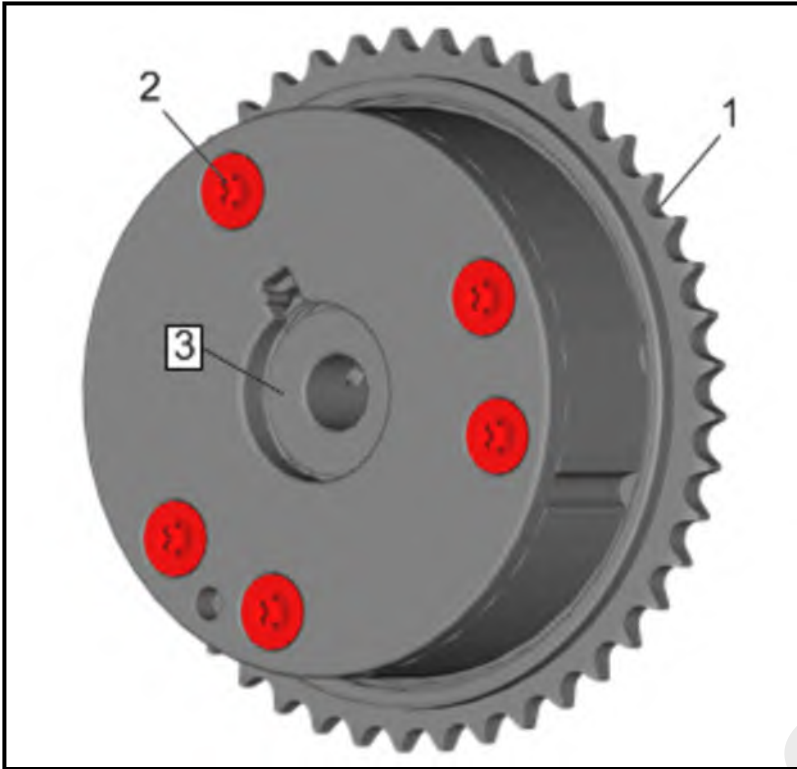
4. Inspect the back of the right intake camshaft position actuators for the following:



- Sprocket damage (1)
- Camshaft locating pin damage (2)
- Blockage to the oil passages (3)

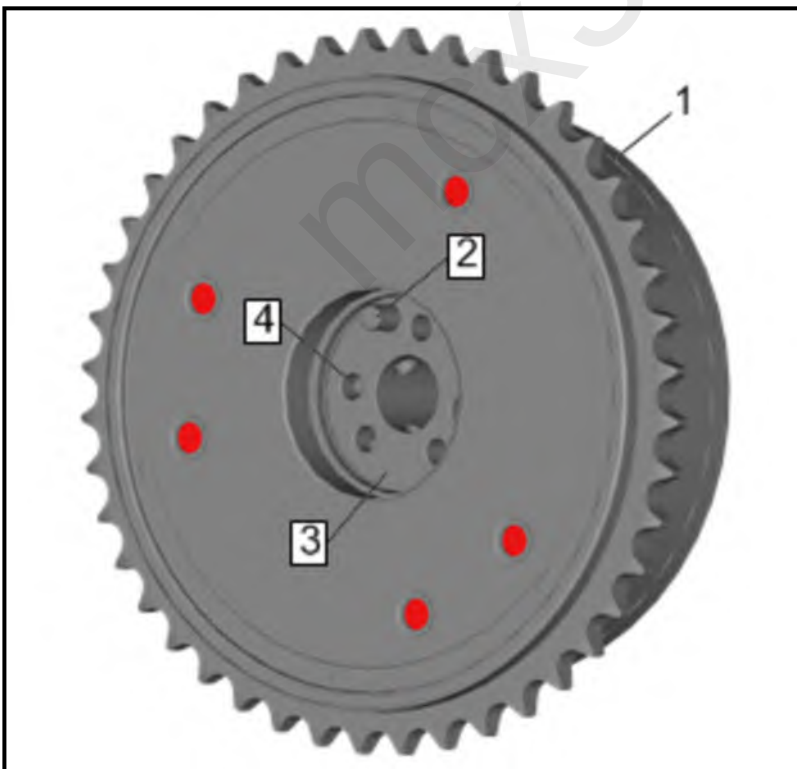
- Loose or missing housing bolts (4)

5. Inspect the front of the left exhaust camshaft position actuators for the following:



- Sprocket damage (1)
- Loose or missing housing bolts (2)
- Camshaft position actuator bolt seating/sealing inner hub flange damage (3)

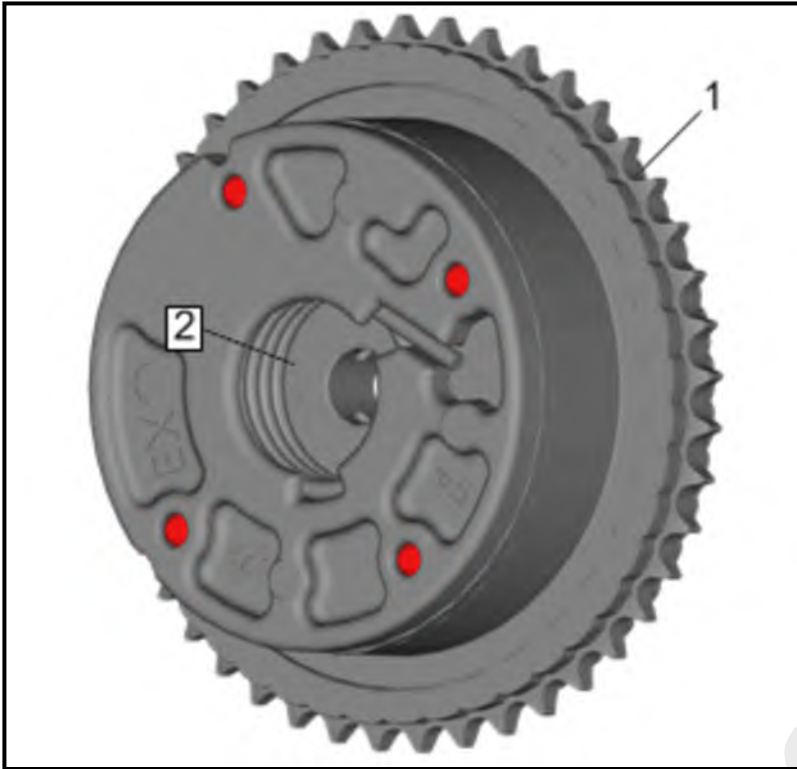
6. Inspect the back of the left exhaust camshaft position actuators for the following:



- Sprocket damage (1)
- Camshaft locating pin damage (2)
- Camshaft seating/sealing inner hub flange damage (3)

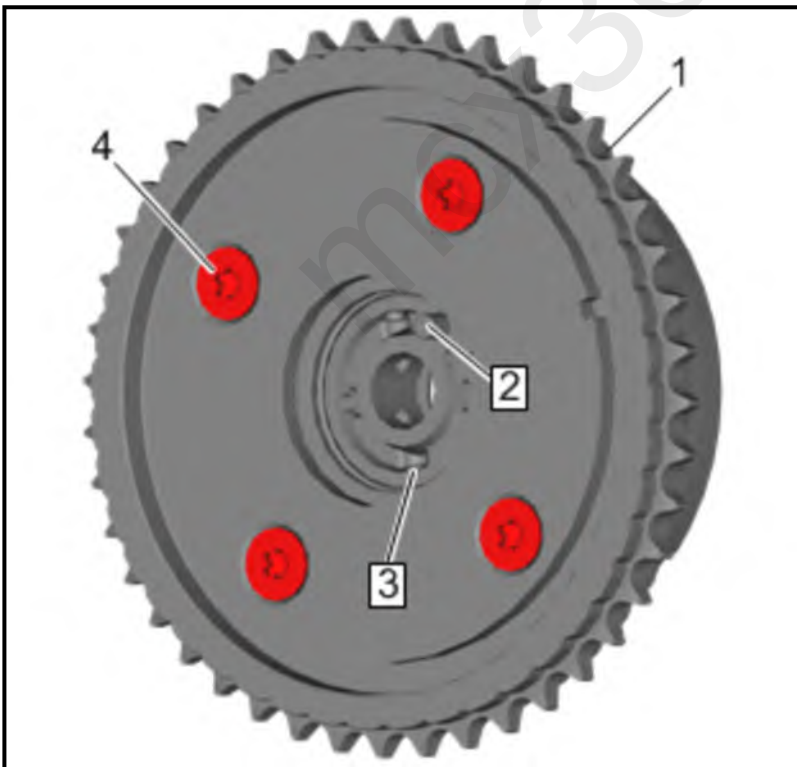
- Blockage to the oil passages (4)

7. Inspect the front of the left intake camshaft position actuators for the following:



- Sprocket damage (1)
- Camshaft position actuator oil control valve bolt seating/sealing inner hub flange damage (2)

8. Inspect the back of the left intake camshaft position actuators for the following:

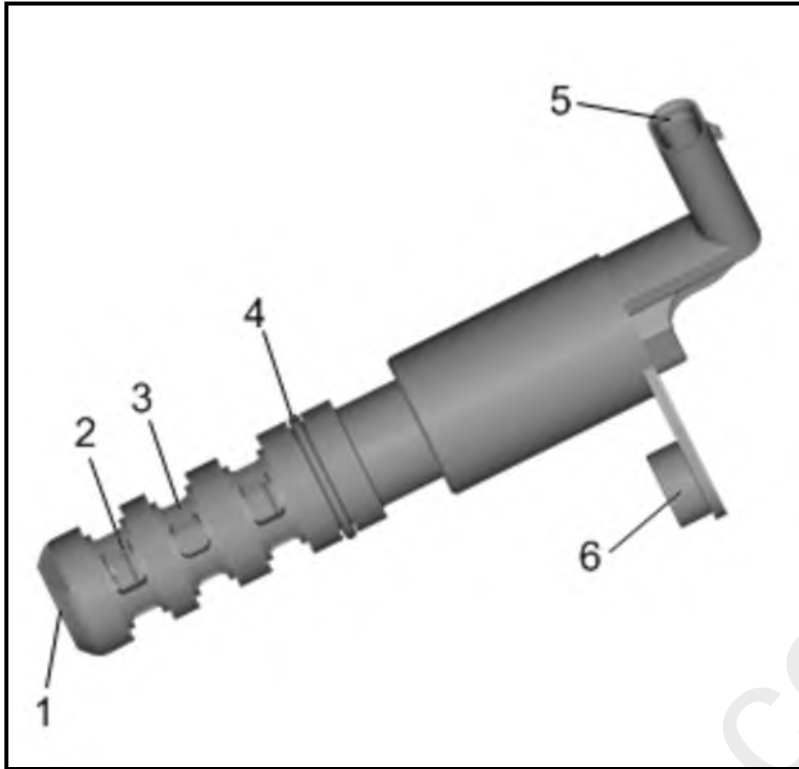


- Sprocket damage (1)
- Camshaft locating pin damage (2)
- Blockage to the oil passages (3)
- Loose or missing housing bolts (4)

9. Replace a damaged camshaft position actuator.

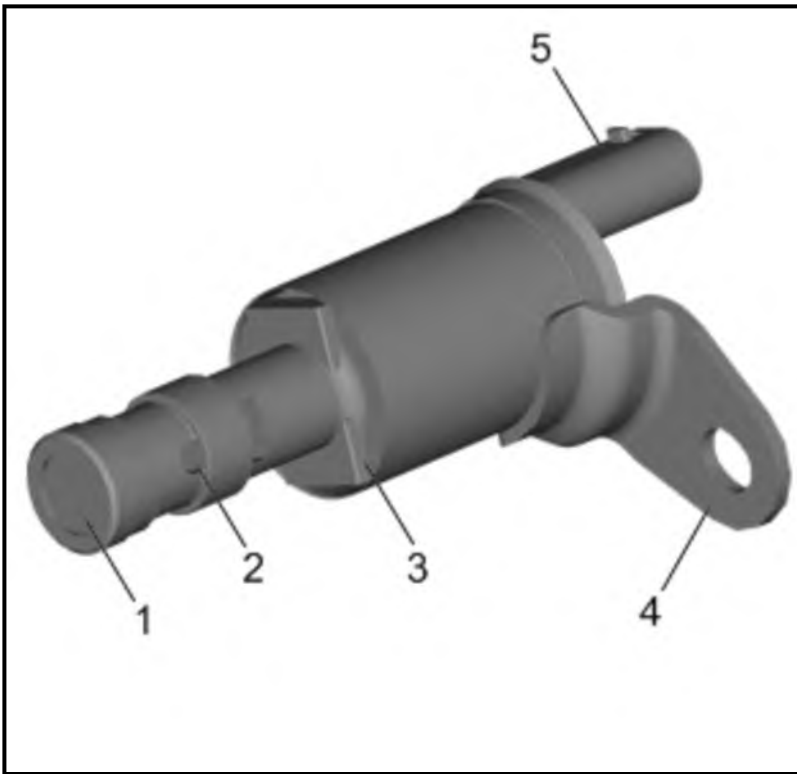
Camshaft Position Actuator Solenoid Valve

1. Inspect the camshaft position actuator solenoid valves for the following:



- Blockage to the oil passage (1)
- Missing or damaged oil screen clip (2)
- Blockage or damage to the oil screen (3)
- Damage to the sealing surface for the camshaft position actuator solenoid valve solenoid oil seal (4)
- Damage to the wiring harness connection and/or terminals (5)
- Damage to the bracket (6)

2. Inspect the camshaft position actuator solenoid valves for the following:

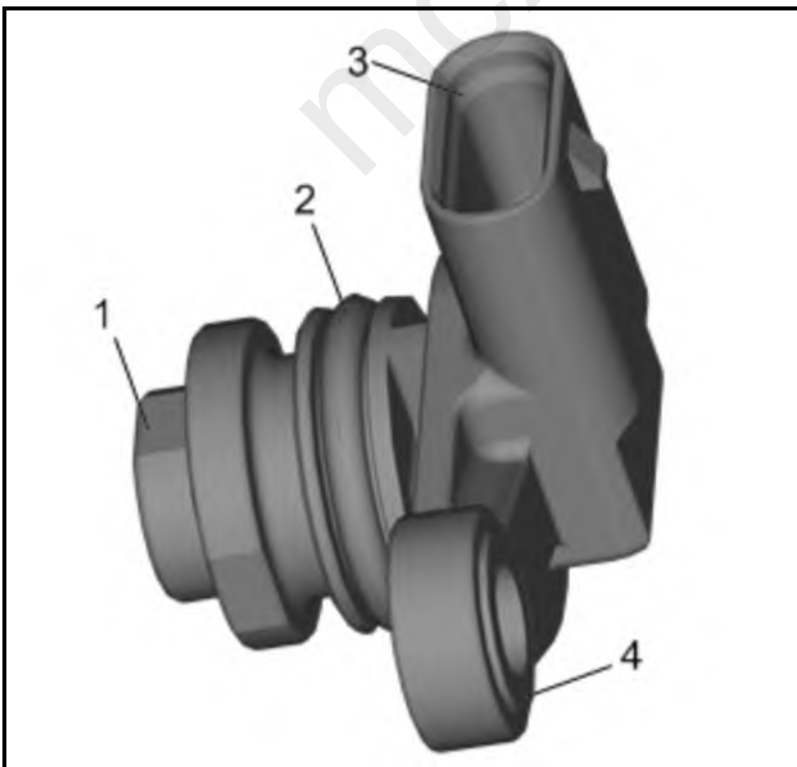


- Blockage to the oil passage (1)
- Missing or damaged oil screen clip (2)
- Blockage or damage to the oil screen (3)
- Damage to the bracket (4)
- Damage to the wiring harness connection and/or terminals (5)

3. Replace a damaged camshaft position actuator solenoid valve.

Camshaft Position Sensor

1. Inspect the camshaft position sensor for the following:



- Damage to the camshaft position sensor (1)

- Damage to the sealing surface for the camshaft position sensor (2)
- Damage to the wiring harness connection and/or terminals (3)
- Damage to the bracket (4)

2. Replace a damaged camshaft position sensor.

Crankshaft Sprocket

1. Inspect the crankshaft sprocket for the following:

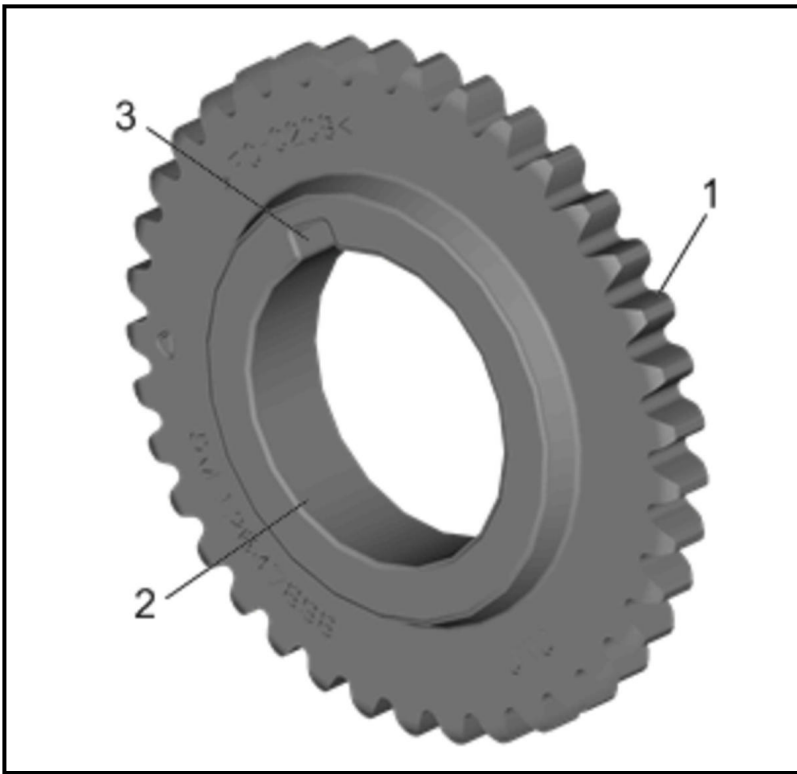


- Sprocket damage (1)
- Bore damage (2)
- Keyway damage (3)

2. Replace a damaged crankshaft sprocket.

Crankshaft Sprocket

1. Inspect the crankshaft sprocket for the following:

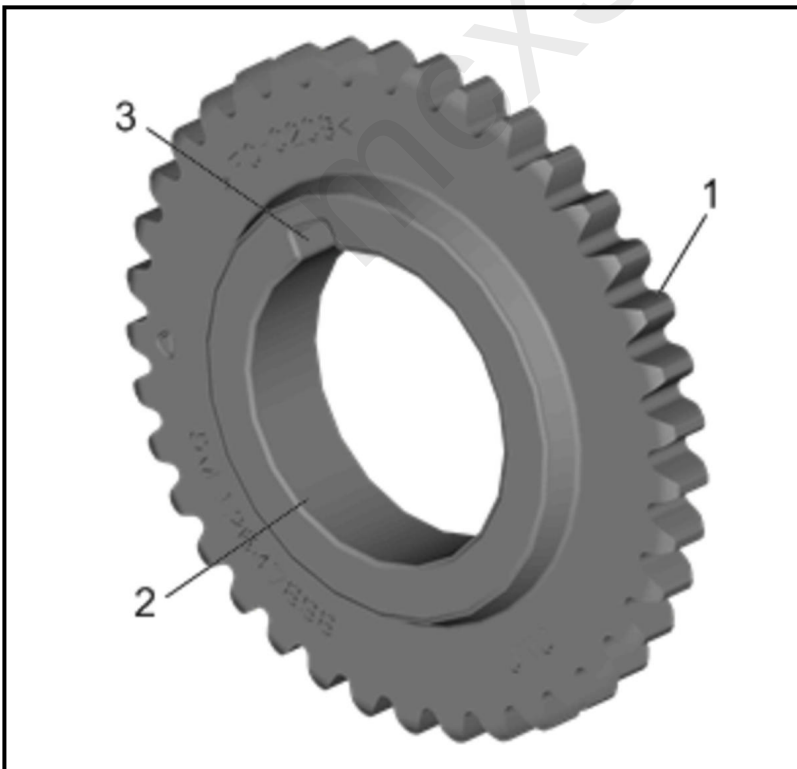


- Sprocket damage (1)
- Bore damage (2)
- Keyway damage (3)

2. Replace a damaged crankshaft sprocket.

Oil Pump Sprocket

1. Inspect the crankshaft sprocket for the following:



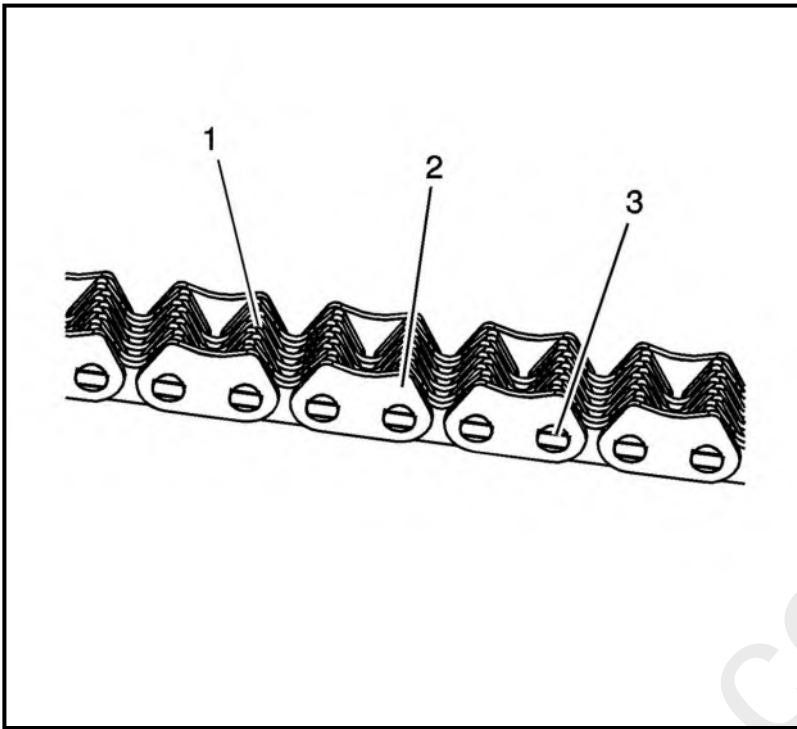
- Sprocket damage (1)
- Bore damage (2)
- Bore damage (3)

- Keyway damage (4)

2. Replace a damaged crankshaft sprocket.

Timing Chains with Inverted Tooth (IT) Chain

1. Inspect the timing chain for the following:

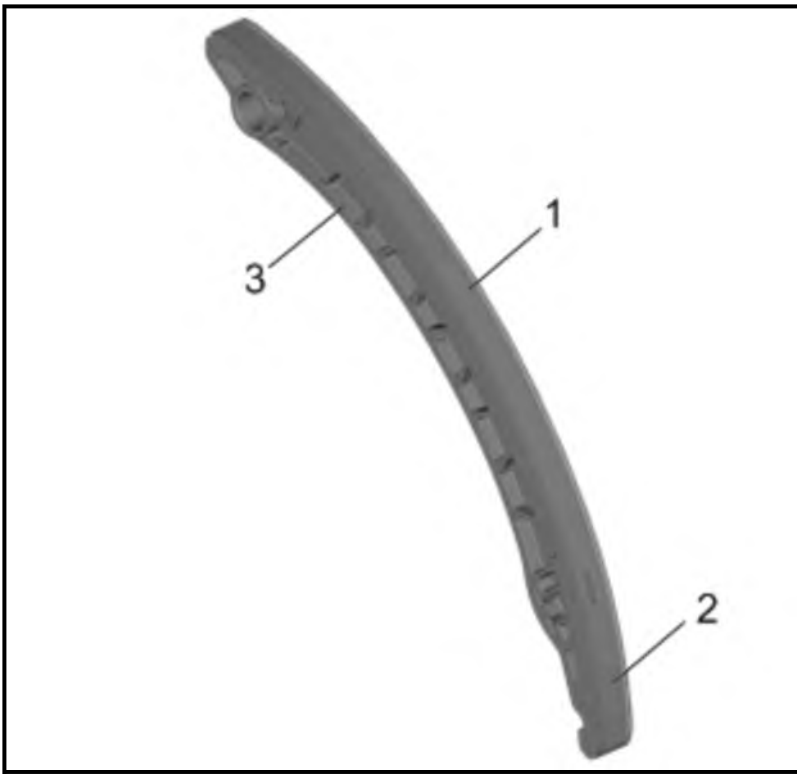


- Binding or worn links (1)
- Loose links (2)
- Loose pins (3)

2. Replace a damaged timing chain.

Timing Chain Guide

1. Inspect the timing chain guide for the following:

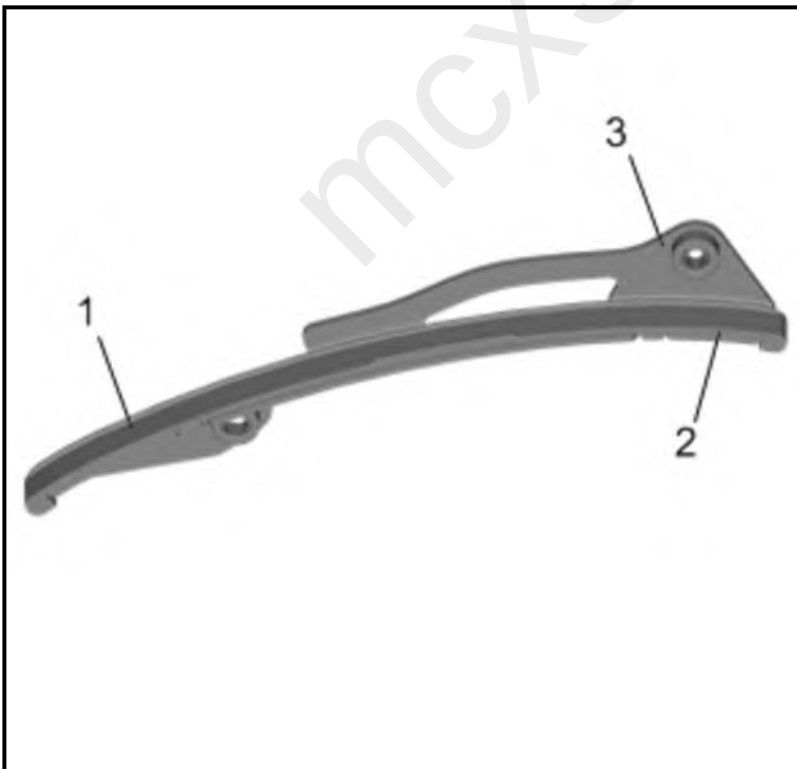


- Worn guide surface (1)
- Cracked or broken guide surface (2)
- Cracked or damaged guide base (3)

2. Replace a damaged primary timing chain upper guide.

Timing Chain Guide

1. Inspect the timing chain guide for the following:

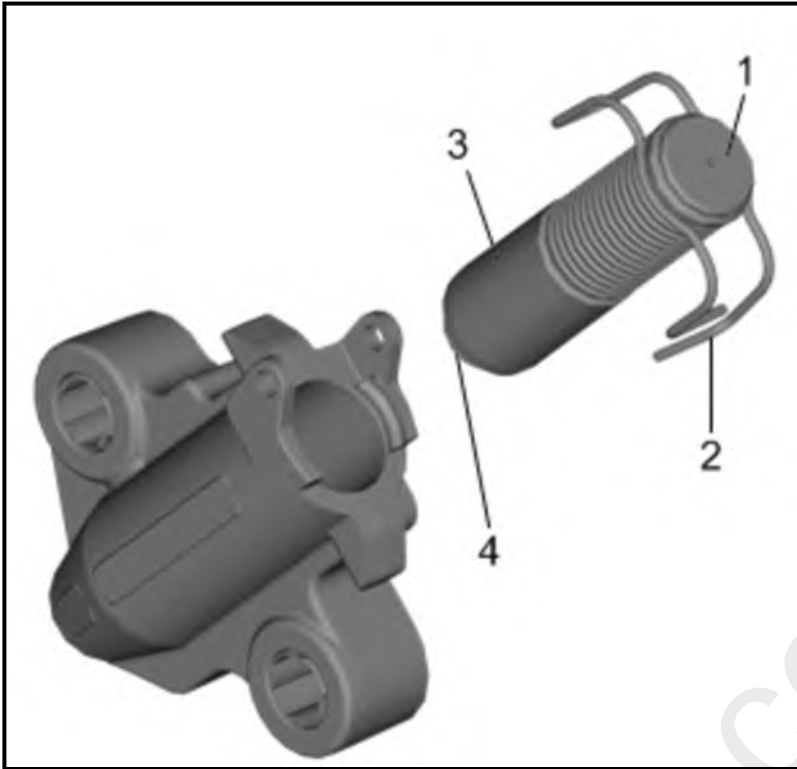


- Worn guide surface (1)
- Cracked or broken guide surface (2)
- Cracked or damaged guide base (3)

2. Replace a damaged primary timing chain upper guide.

Timing Chain Tensioner

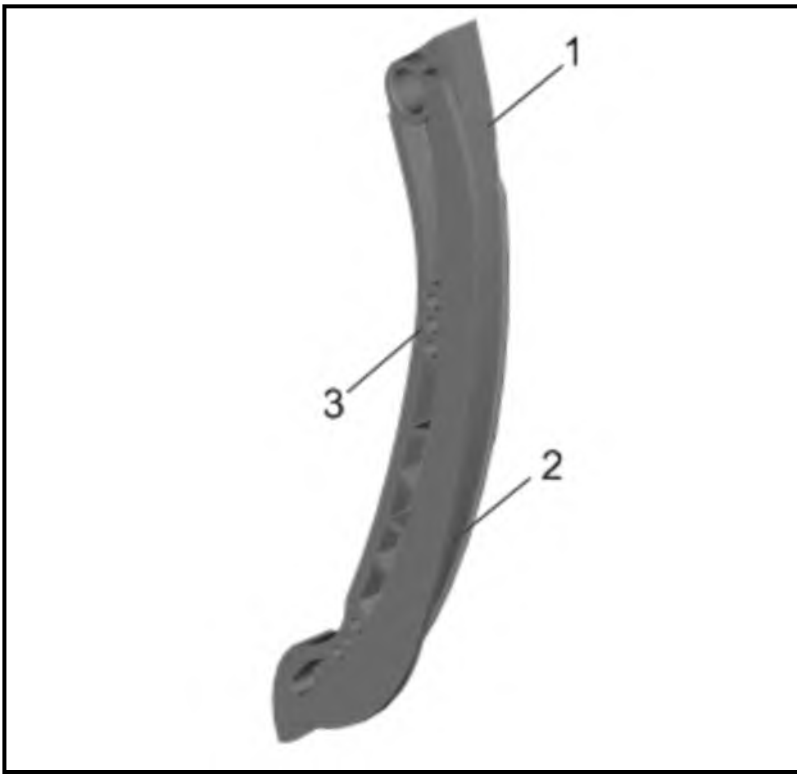
1. Inspect the timing chain tensioner for worn timing chain tensioner surface (1).



2. Inspect the timing chain tensioner for worn timing chain tensioner spring (2).
3. Inspect the timing chain tensioner for locked or binding timing chain tensioner. Reset the plunger (4) and ensure the plunger moves freely (3) in and out of the body of the tensioner.
4. Replace a damaged primary timing chain tensioner.

Timing Chain Guide

1. Inspect the timing chain guide for the following:

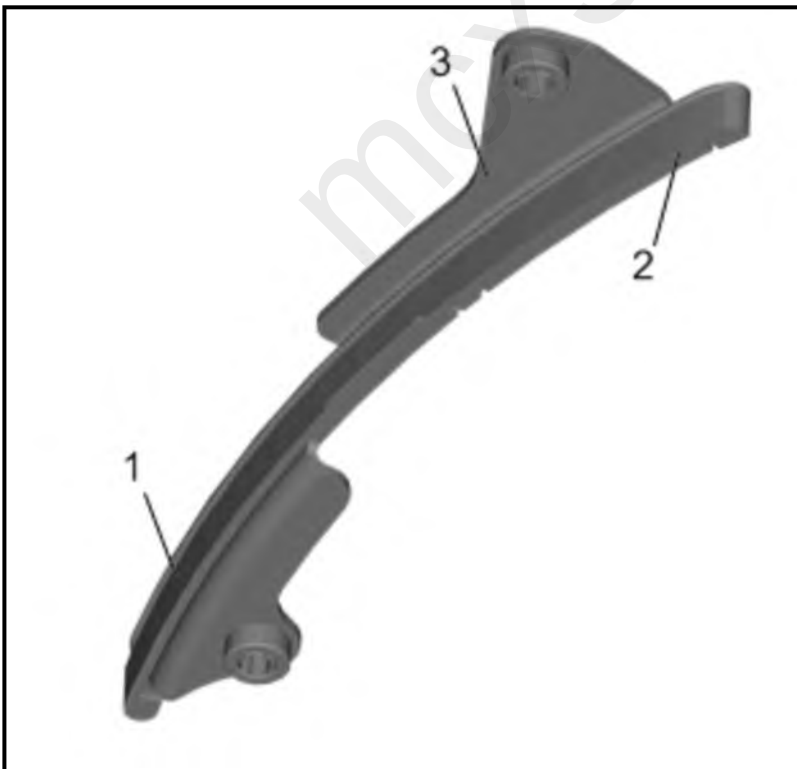


- Worn guide surface (1)
- Cracked or broken guide surface (2)
- Cracked or damaged guide base (3)

2. Replace a damaged primary timing chain upper guide.

Timing Chain Guide

1. Inspect the timing chain guide for the following:

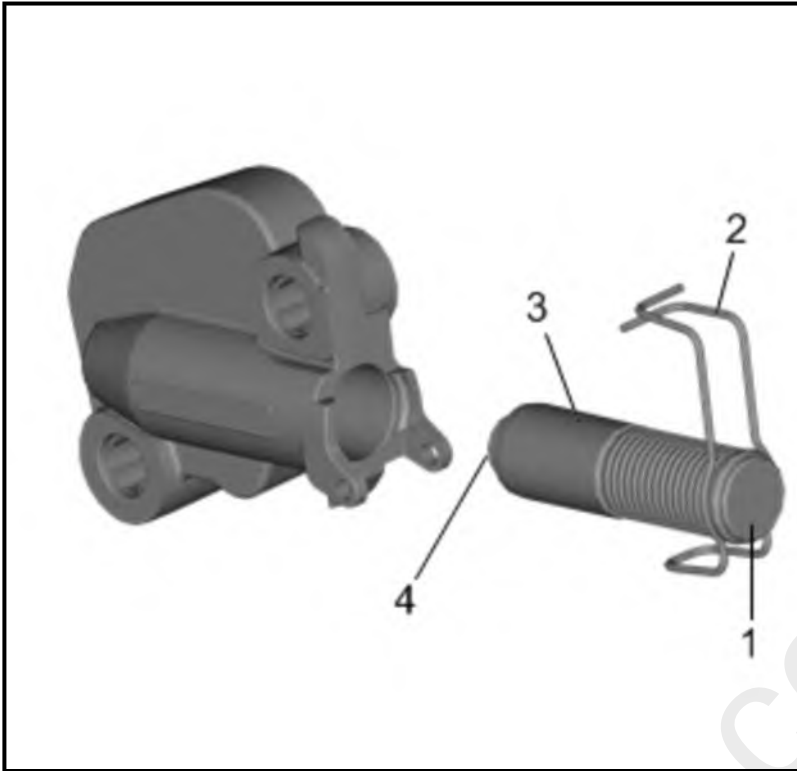


- Worn guide surface (1)
- Cracked or broken guide surface (2)
- Cracked or damaged guide base (3)

2. Replace a damaged primary timing chain upper guide.

Timing Chain Tensioner

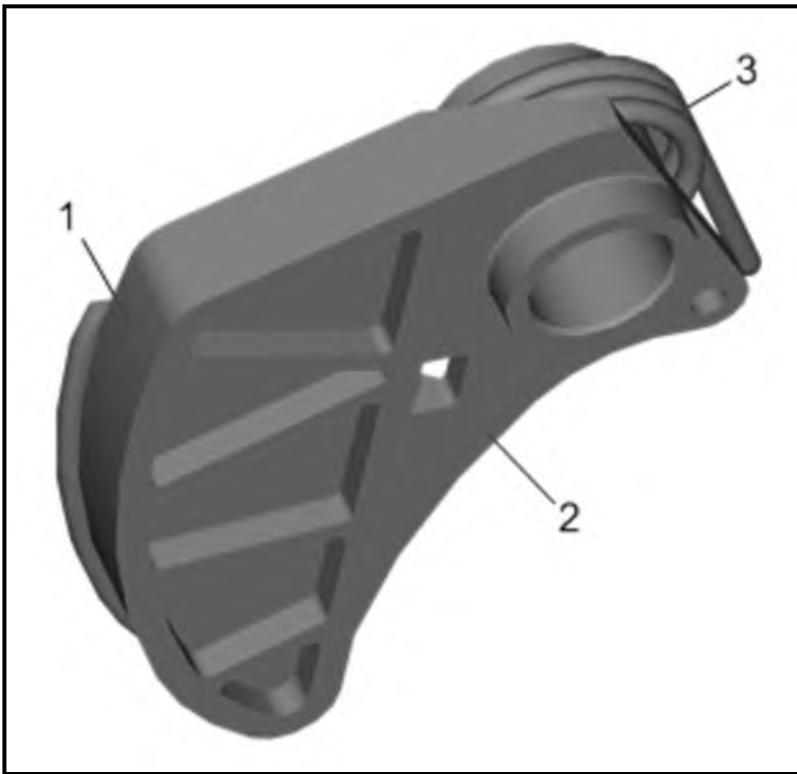
1. Inspect the timing chain tensioner for worn timing chain tensioner surface (1).



2. Inspect the timing chain tensioner for worn timing chain tensioner spring (2).
3. Inspect the timing chain tensioner for locked or binding timing chain tensioner. Reset the plunger (4) and ensure the plunger moves freely (3) in and out of the body of the tensioner.
4. Replace a damaged primary timing chain tensioner.

Timing Chain Tensioner

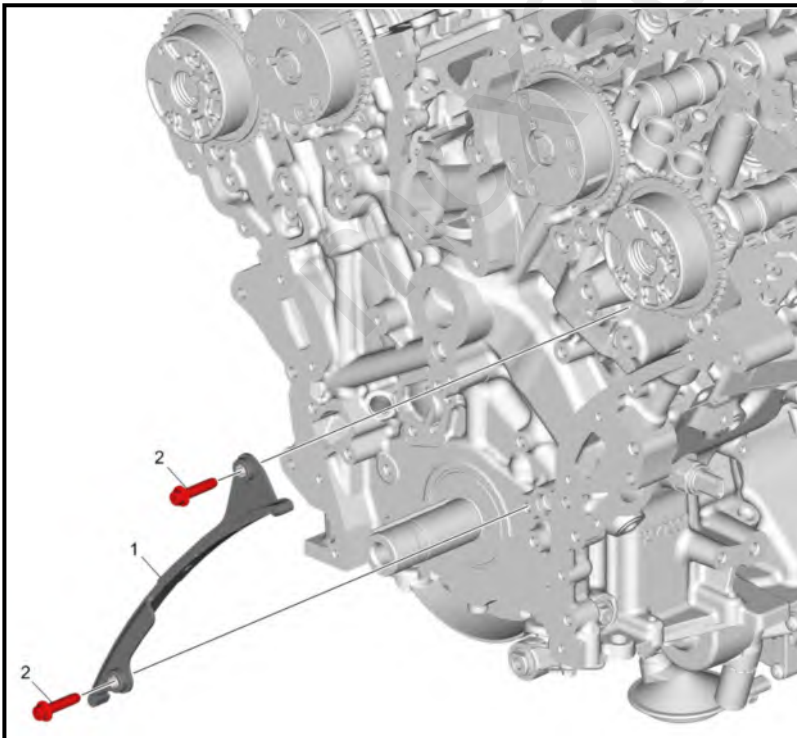
1. Inspect the timing chain tensioner for worn timing chain tensioner surface (1).



2. Cracked or broken tensioner surface (2)
3. Inspect the timing chain tensioner for worn timing chain tensioner spring (3).
4. Replace a damaged primary timing chain tensioner.

Camshaft Timing Chain Guide Installation - Left Side

1. Timing Chain Guide- Left Side (1) - Install



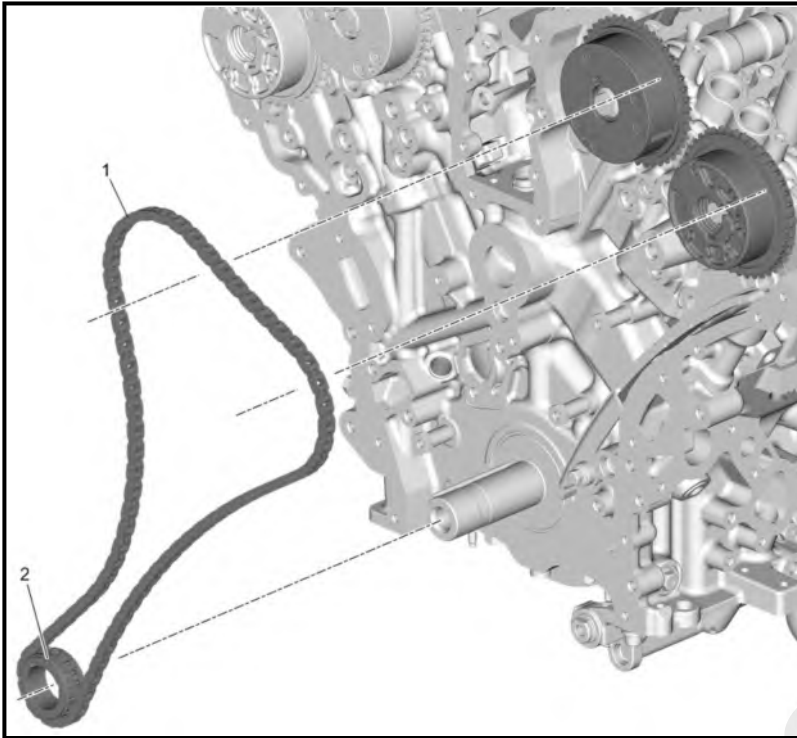
NOTE: Check that the specific Intake and exhaust actuators are in there proper position. There are specific Right and Left actuators.

CAUTION: Refer to [Fastener Caution](#) .

2. Timing Chain Guide Bolt (2) - Install and tighten [2x] 25 N.m (18 lb ft)

Camshaft Timing Chain Installation - Left Side

1. Timing Chain- Left Side (1) - Install

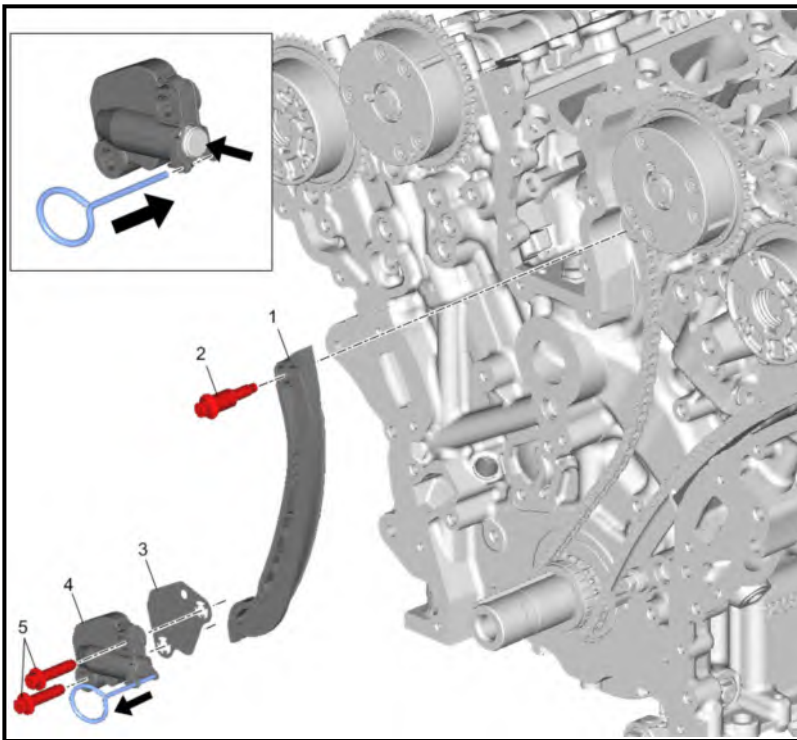


1. Make sure the camshaft flats with laser etched markings are straight up in relation to the cylinder head and that the crankshaft is in the stage 1 position. The crankshaft key way will be at approximately the 11 o'clock position. [Timing Chain Alignment Diagram](#)
2. Preassemble the crank sprocket (2) to the left timing chain (1).
3. Install the crank sprocket on the crankshaft while holding up the timing chain.
4. Guide timing chain onto the guide, and not resting on the plastic side ribs.
5. Use an open ended wrench on the cast hexagonal portion of the camshaft to rotate the camshafts, which will aid in the aligning of the timing marks.
6. There may be more than one marking on the camshaft actuator sprocket area. Locate the (L) on the face of the actuator body. The correct timing mark can be a circle or triangle located straight inboard on the sprocket tooth in line with the (L) identifier.
7. Align the left (L) exhaust camshaft position actuator sprocket alignment circle or triangle mark with the camshaft drive chain timing link.
8. Align the left (L) intake camshaft position actuator sprocket alignment circle or triangle mark with the camshaft drive chain timing link.

2. Crankshaft Sprocket (2) - Install

Camshaft Timing Chain Guide and Timing Chain Tensioner Installation - Left Side

1. Timing Chain Guide- Left Side (1) - Install



2. Timing Chain Guide Bolt (2) - Install and tighten [2x] 25 N.m (18 lb ft)

NOTE: Ensure the left timing chain tensioner mounting surface on the left cylinder head does not have any burrs or defects that would degrade the sealing of the NEW left timing chain tensioner gasket.

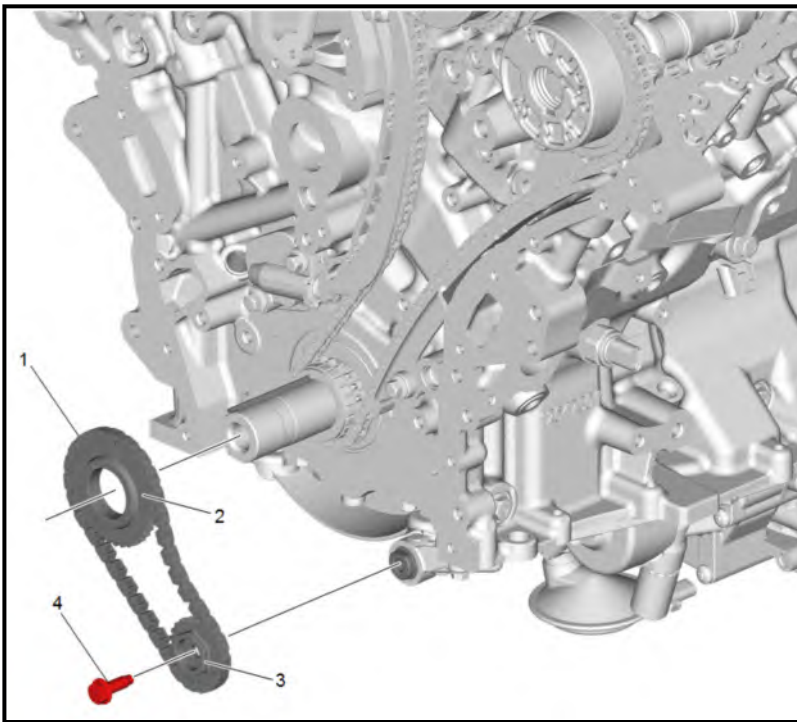
3. Timing Chain Tensioner Gasket (3) - Install NEW

WARNING: The timing chain tensioner plunger is under high tension and must be retained by using the tensioner retraction pin during removal or installation of the timing chain tensioner. Failure to retain the timing chain tensioner plunger may cause it to be ejected with intense force and cause personal injury.

4. Reset the timing chain tensioner plunger using your thumb and **EN-52234** Timing Chain Tensioner Retaining Pin or a 1/8" drill bit to retain the plunger.
5. Compress the plunger into the body and lock the left timing chain tensioner by inserting **EN-52234** Timing Chain Tensioner Retaining Pin or 1/8" drill bit into the access hole in the side of the left timing chain tensioner body.
6. Slowly release pressure on the right timing chain tensioner. The right timing chain tensioner should remain compressed.
7. Timing Chain Tensioner- Left Side (4) - Install
8. Place the chain tensioner into position and loosely install the bolts to the block.
9. Timing Chain Tensioner Bolt (5) - Install and tighten [2x] 25 N.m (18 lb ft)
10. Verify the timing marks are in the correct position before releasing the drive chain tensioner.
11. Release the timing chain tensioner plunger by pulling out the suitable tool.
12. Verify the left timing chain timing mark alignments by referring to [Timing Chain Alignment Diagram](#) - Stage One.

Oil Pump Timing Chain Installation

1. Oil Pump Timing Chain (1) - Install



NOTE: Timing of the oil pump to the engine is not required. The colored links on the oil pump drive chain and timing mark on the oil pump drive sprocket are for production use only.

2. Crankshaft Sprocket (2) - Install

NOTE: Use a suitable wrench to hold the sprocket to torque the bolt.

3. Oil Pump Sprocket (3) - Install

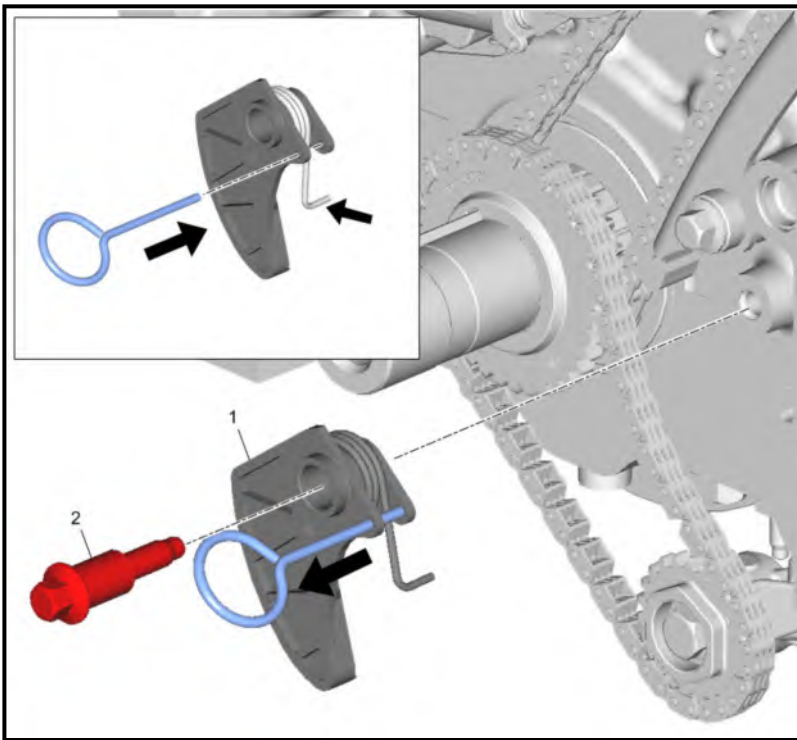
4. Oil Pump Drive Bolt (4) - Install NEW and tighten

1. First Pass: 15 N.m (11 lb ft)

2. Final Pass: 110 degrees

Oil Pump Timing Chain Tensioner Installation

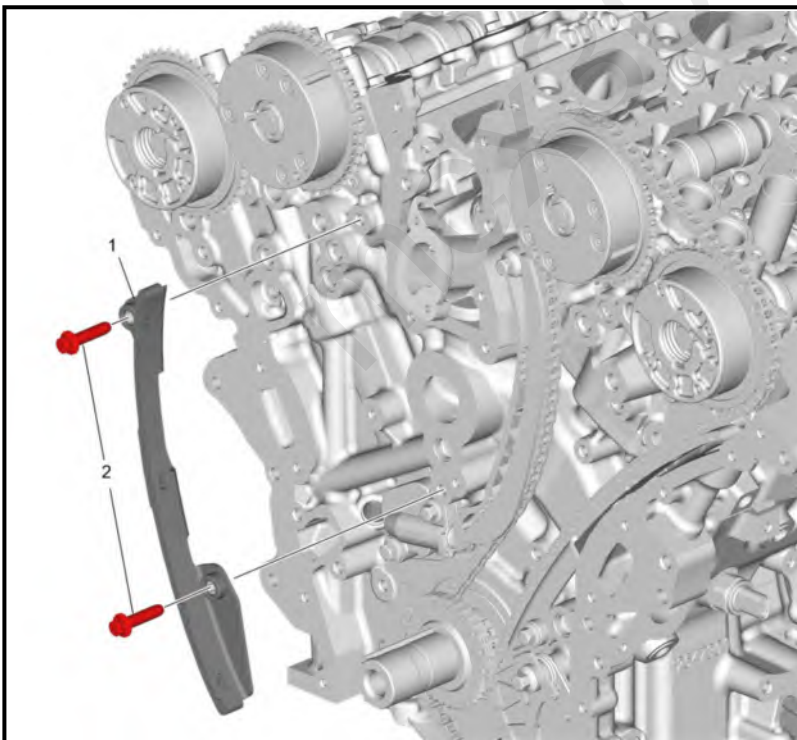
1. Collapse the oil pump timing tensioner by hand and install **EN-52234** Timing Chain Tensioner Retaining Pin or a 1/8" drill bit to hold it in place.



2. Timing Chain Tensioner (1) - Install
3. Place the chain tensioner into position and loosely install the bolt to the block
4. Timing Chain Tensioner Bolt (2) - Install and tighten 25 N.m (18 lb ft)

Camshaft Timing Chain Guide Installation - Right Side

1. Timing Chain Guide- Right Side (1) - Install

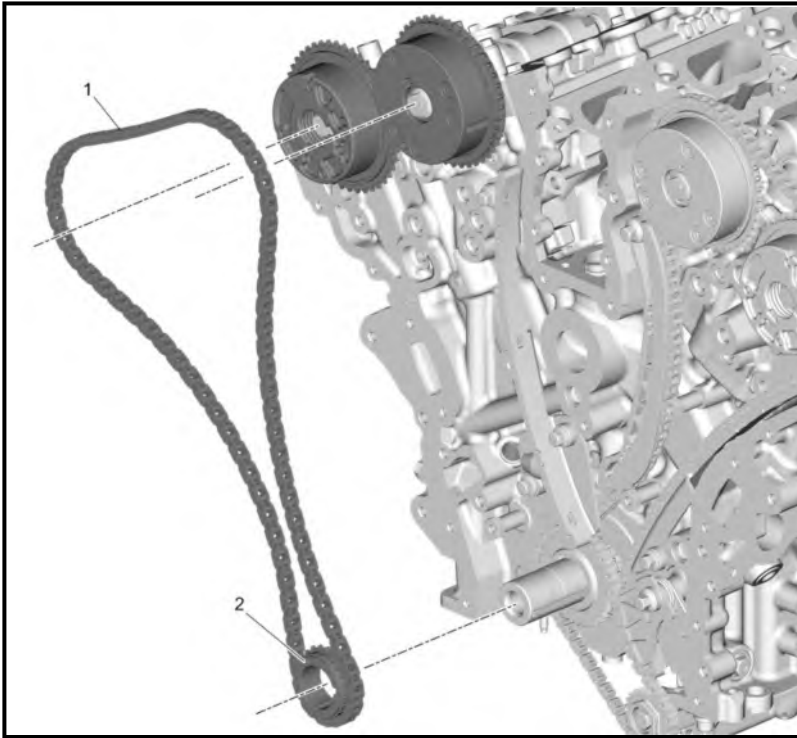


NOTE: Check that the specific Intake and exhaust actuators are in there proper position. There are specific Right and Left actuators.

2. Timing Chain Guide Bolt (2) - Install and tighten 25 N.m (18 lb ft)

Camshaft Timing Chain Installation - Right Side

1. Timing Chain- Right Side (1) - Install

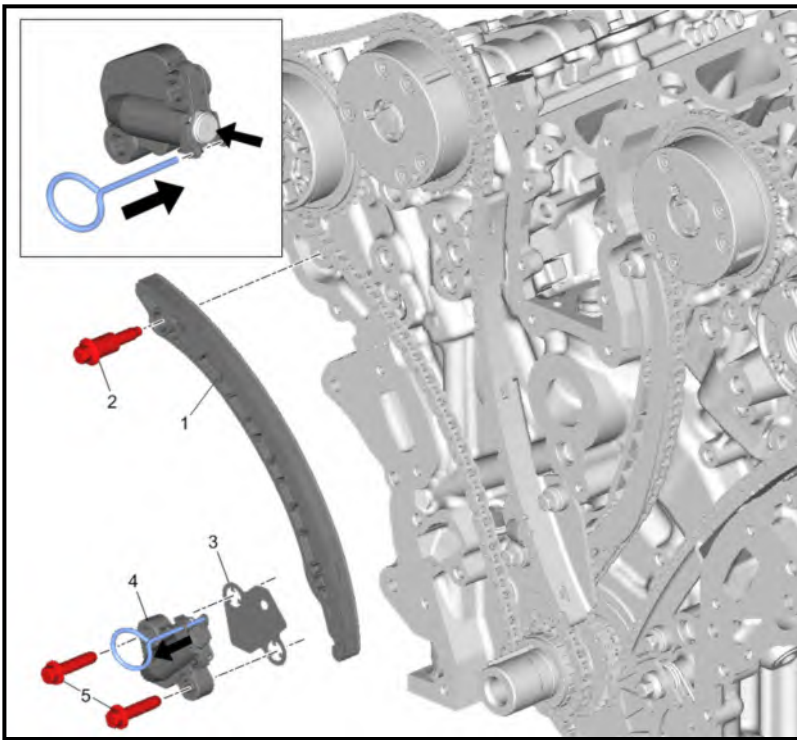


1. Make sure the camshaft flats with laser etched markings are straight up in relation to the cylinder head and that the crankshaft is in the stage 2 position. The crankshaft key way will be at approximately the 3 o'clock position. **Timing Chain Alignment Diagram**
2. Preassemble the crank sprocket (2) to the right timing chain (1).
3. Install the crank sprocket on the crankshaft while holding up the timing chain.
4. Guide timing chain onto the guide, and not resting on the plastic side ribs.
5. Use an open ended wrench on the cast hexagonal portion of the camshaft to rotate the camshafts, which will aid in the aligning of the timing marks.
6. There may be more than one marking on the camshaft actuator sprocket area. Locate the (R) on the face of the actuator body. The correct timing mark can be a circle or triangle located straight inboard on the sprocket tooth in line with the (R) identifier.
7. Align the right (R) exhaust camshaft position actuator sprocket alignment circle or triangle mark with the camshaft drive chain timing link.
8. Align the right (R) intake camshaft position actuator sprocket alignment circle or triangle mark with the camshaft drive chain timing link.

2. Crankshaft Sprocket (2) - Install

Camshaft Timing Chain Guide and Timing Chain Tensioner Installation - Right Side

1. Timing Chain Guide- Right Side (1) - Install



2. Timing Chain Guide Bolt (2) - Install and tighten 25 N.m (18 lb ft)

NOTE: Ensure the right timing chain tensioner mounting surface on the right cylinder head does not have any burrs or defects that would degrade the sealing of the NEW right timing chain tensioner gasket.

3. Timing Chain Tensioner Gasket (3) - Install NEW

WARNING: The timing chain tensioner plunger is under high tension and must be retained by using the tensioner retraction pin during removal or installation of the timing chain tensioner. Failure to retain the timing chain tensioner plunger may cause it to be ejected with intense force and cause personal injury.

4. Reset the timing chain tensioner plunger using your thumb and **EN-52234** Timing Chain Tensioner Retaining Pin or a 1/8" drill bit to retain the plunger.
5. Compress the plunger into the body and lock the right timing chain tensioner by inserting **EN-52234** Timing Chain Tensioner Retaining Pin or 1/8" drill bit into the access hole in the side of the right timing chain tensioner body.
6. Slowly release pressure on the right timing chain tensioner. The right timing chain tensioner should remain compressed.
7. Timing Chain Tensioner- Right Side (4) - Install
8. Place the chain tensioner into position and loosely install the bolts to the block.
9. Timing Chain Tensioner Bolt (5) - Install and tighten 25 N.m (18 lb ft)
10. Verify the timing marks are in the correct position before releasing the drive chain tensioner.
11. Release the timing chain tensioner plunger by pulling out the suitable tool.
12. Verify the left timing chain timing mark alignments by referring to [Timing Chain Alignment Diagram - Stage Two](#).

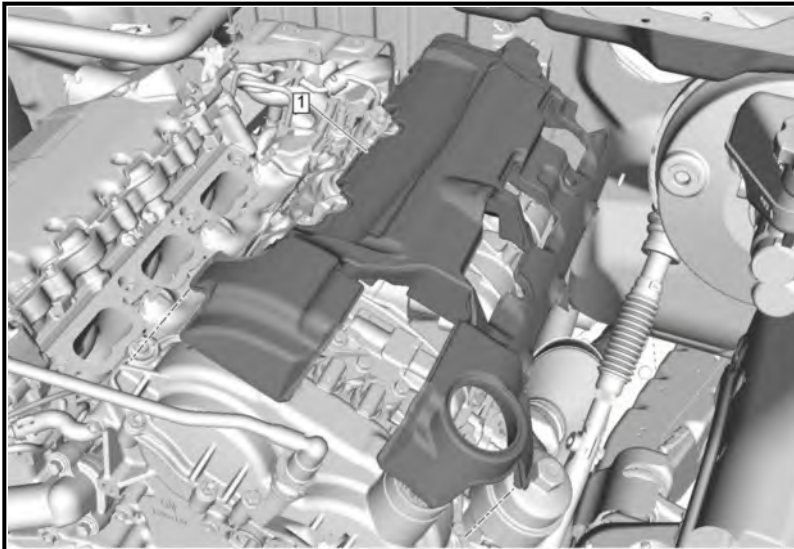
SETTING CAMSHAFT TIMING

IMPORTANT: Setting the camshaft timing is necessary whenever the camshaft drive system has been disturbed such that the relationship between any chain and sprocket has been lost. Even when

only one sprocket is involved, multiple crankshaft rotations will not produce conditions where correct timing can be confirmed.

Follow the left camshaft timing chain assembly replacement procedure to reset the camshaft timing. [Camshaft Timing Chain Assembly Replacement - Left Side](#)

CAMSHAFT HOUSING COVER INSULATOR REPLACEMENT - LEFT SIDE

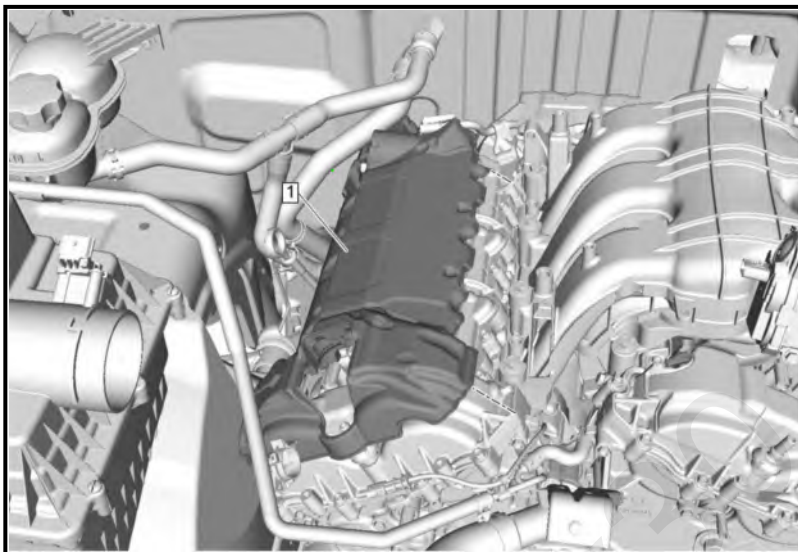


NOTE: Callouts in the following chart represent components shown in graphic above.

Callout	Component Name
Preliminary Procedures 1. Intake Manifold Replacement 2. Remove the oil filler cap. 3. Remove the oil filler tube bracket bolt. Oil Filler Tube Replacement 4. Disconnect electrical connectors and remove the engine harness from the camshaft housing cover insulator.	
1	Camshaft Housing Cover Insulator WARNING: The noise cancelling foam component MUST be replaced if it has been exposed to engine fluids. Failure to replace the noise cancelling foam component that has been

Callout	Component Name
	exposed to engine fluids may result in an engine fire resulting in catastrophic engine damage, and possible injury or death.

CAMSHAFT HOUSING COVER INSULATOR REPLACEMENT - RIGHT SIDE



NOTE: Callouts in the following chart represent components shown in graphic above.

Callout	Component Name
Preliminary Procedures <u>Air Cleaner Outlet Duct Replacement</u> - Disconnect the positive crankcase ventilation tube from the right camshaft cover. <u>Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Air Outlet Duct to Camshaft Covers)</u>, or <u>Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Air Outlet Duct to PCV Oil Separator)</u> - Disconnect electrical connectors and detach harness retainers as needed.	
1	Camshaft Housing Cover Insulator WARNING: The noise cancelling foam component MUST be replaced if it has been exposed to engine

Callout	Component Name
	fluids. Failure to replace the noise cancelling foam component that has been exposed to engine fluids may result in an engine fire resulting in catastrophic engine damage, and possible injury or death.

CAMSHAFT REPLACEMENT - LEFT SIDE

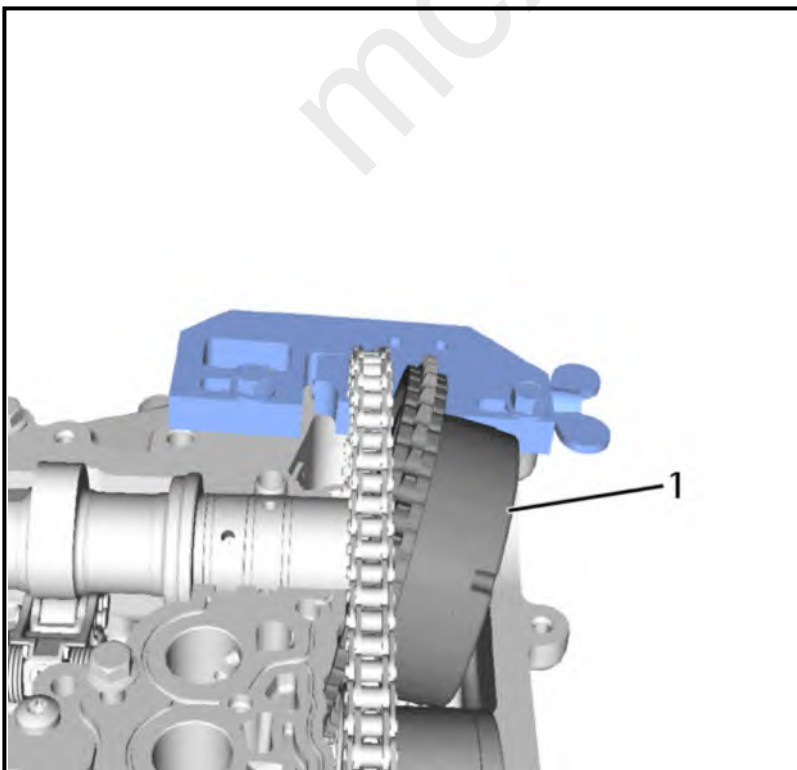
Special Tools

GE-7872 Magnetic Base Dial Indicator

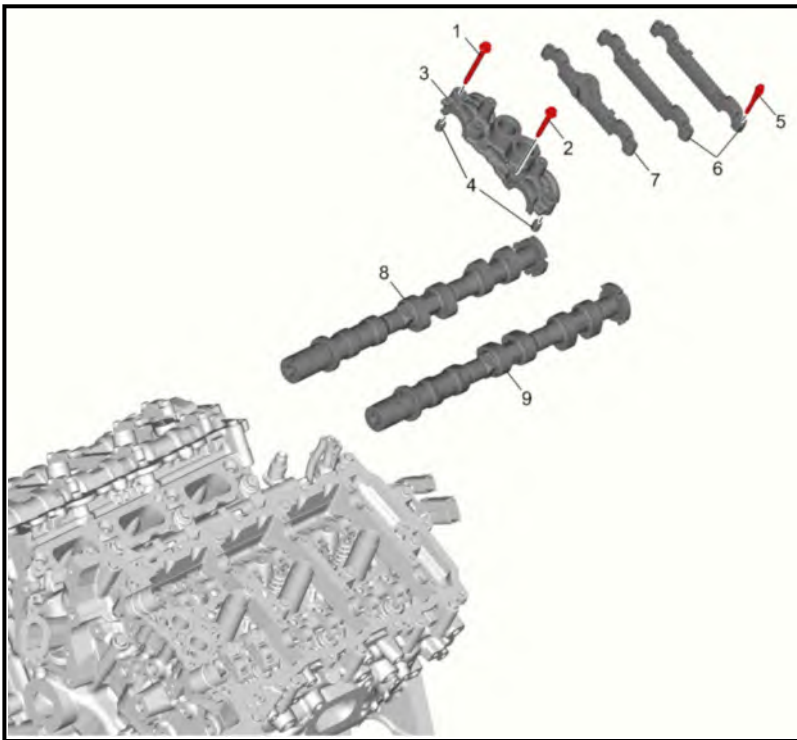
Equivalent regional tools: [Special Tools](#)

Removal Procedure

1. Camshaft Position Actuator (1) - Remove [2x] - [Camshaft Position Actuator Replacement - Bank 2](#)



2. Camshaft Carrier Bolt (1) - Remove [4x]



- 3. Camshaft Bearing Cap Bolt (2) - Remove [4x]
- 4. Camshaft Bearing Cap (3) - Remove
- 5. Dowel Pin (4) - Remove
- 6. Camshaft Bearing Cap Bolt (5) - Remove [12x]
- 7. Camshaft Bearing Cap (6) - Remove
- 8. Camshaft Bearing Cap (7) - Remove

NOTE: Laser Etched or ID flats- Correct Camshaft Location - Bank 2 (C)

- 9. Intake Camshaft - Left Side (8) - Remove

NOTE: Laser Etched or ID flats- Correct Camshaft Location - Bank 2 (D)

- 10. Exhaust Camshaft - Left Side (9) - Remove

Cleaning Procedure

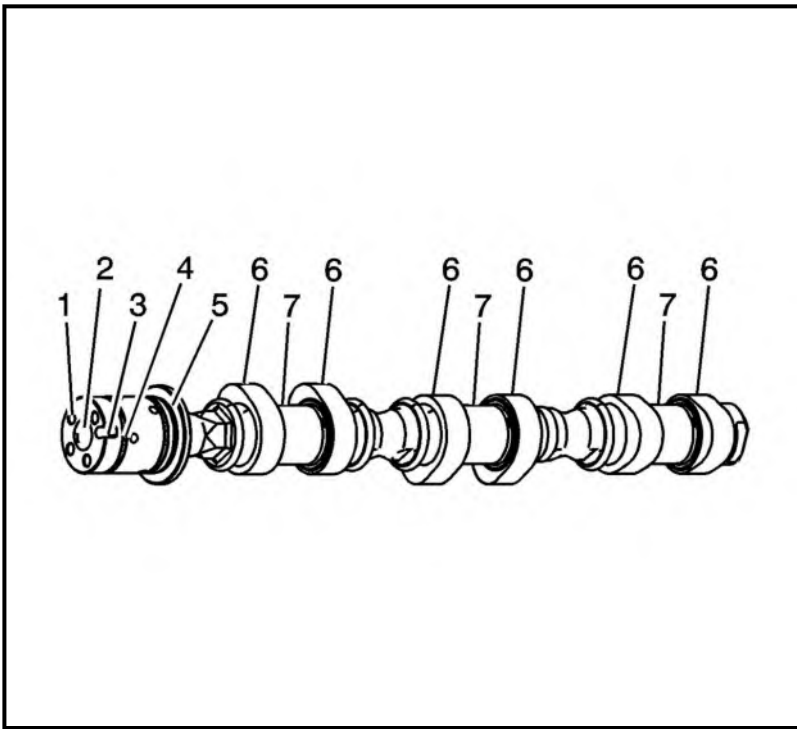
- 1. Clean the camshaft in solvent.

WARNING: Refer to Safety Glasses Warning .

- 2. Dry the camshaft with compressed air.

Visual Inspection

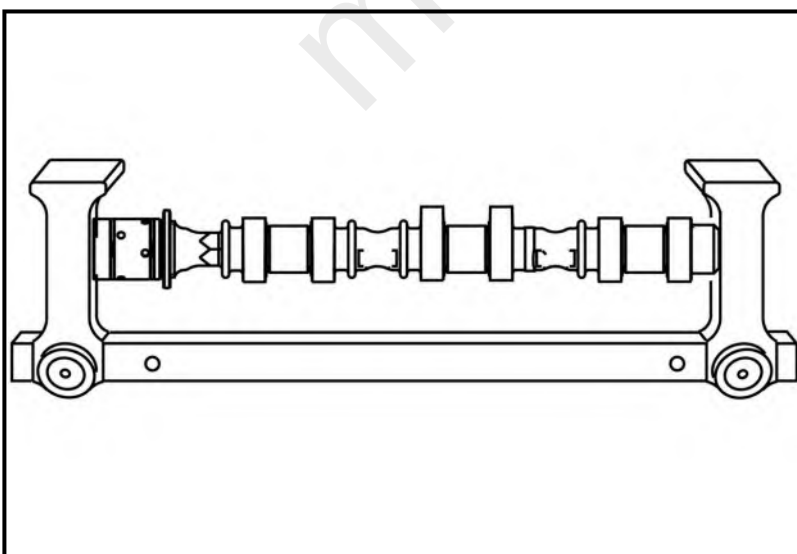
- 1. Inspect the camshaft oil feed holes (1) to the camshaft position actuator for dirt, debris or blockage.



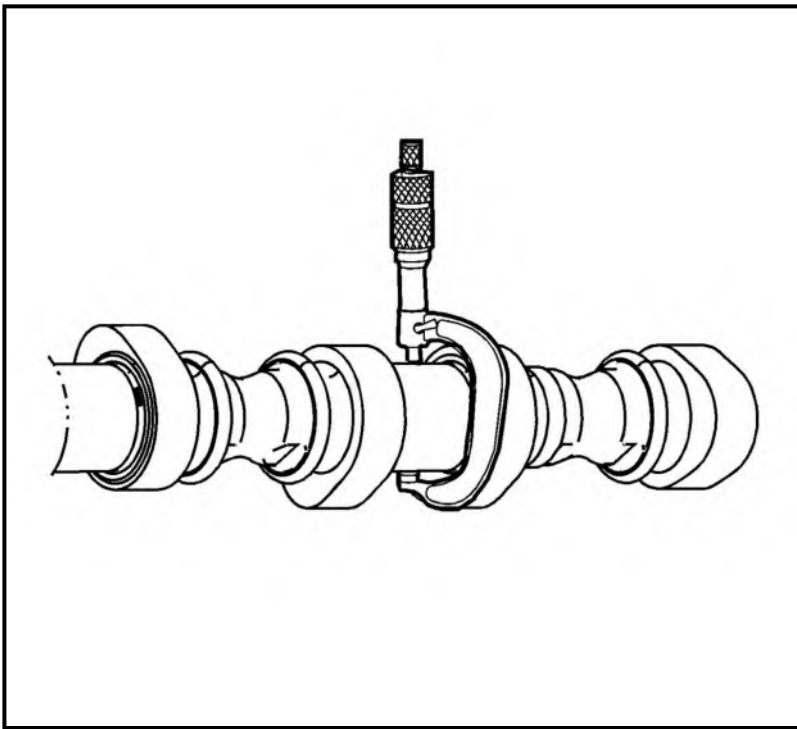
2. Inspect the threaded hole (2) for damage.
3. Inspect the camshaft position actuator locating notch (3) for damage or wear.
4. Inspect the camshaft sealing grooves (4) for damage.
5. Inspect the camshaft thrust surface (5) for damage.
6. Inspect the camshaft lobes (6) and journals (7) for the following conditions:
 - Excessive scoring or pitting
 - Discoloration from overheating
 - Deformation from excessive wear, especially the camshaft lobes
7. If any of the above conditions exist on the camshaft, replace the camshaft.

Camshaft Measurement

1. With the camshaft in a suitable fixture, measure the camshaft for wear.

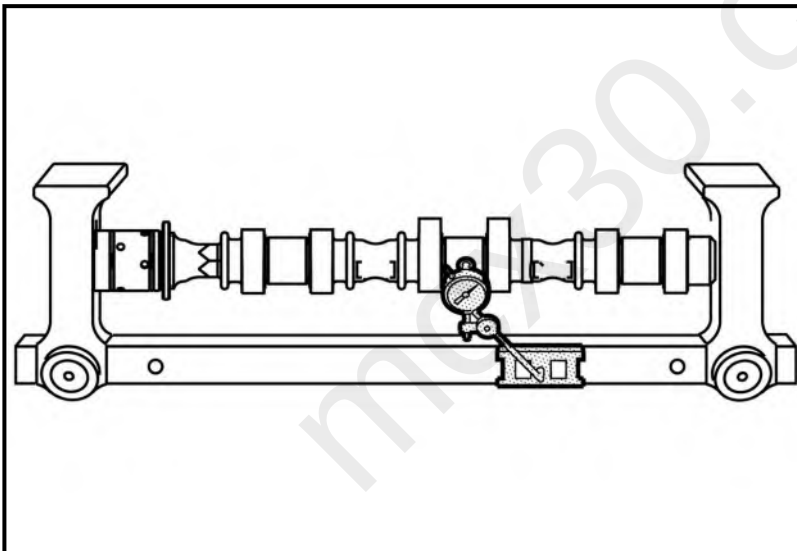


2. Measure the camshaft journals for diameter and out-of-round using an outside micrometer. **Engine Mechanical Specifications**

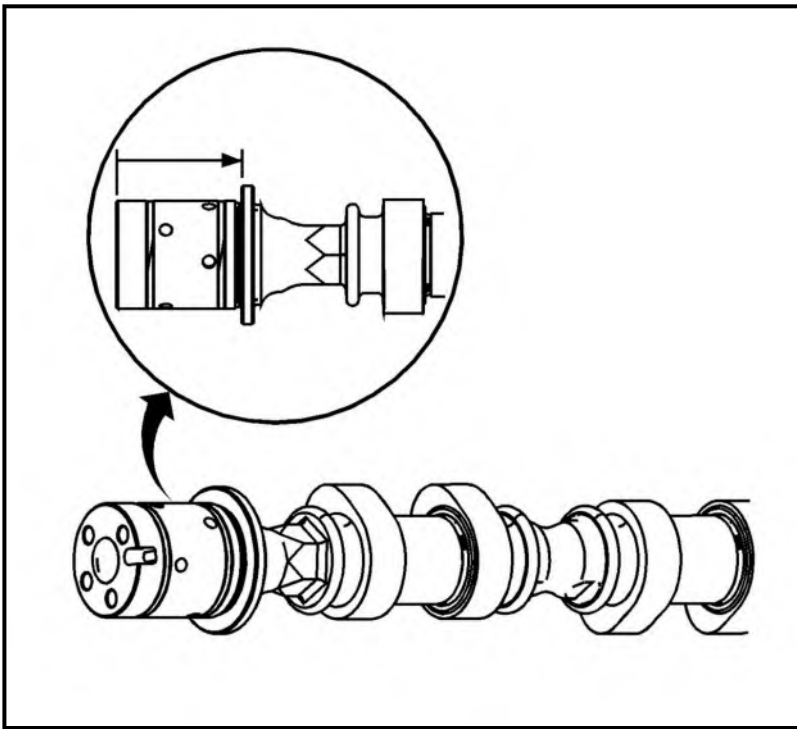


- If the diameter is smaller than specifications, replace the camshaft.
- If the out-of-round exceeds specifications, replace the camshaft.

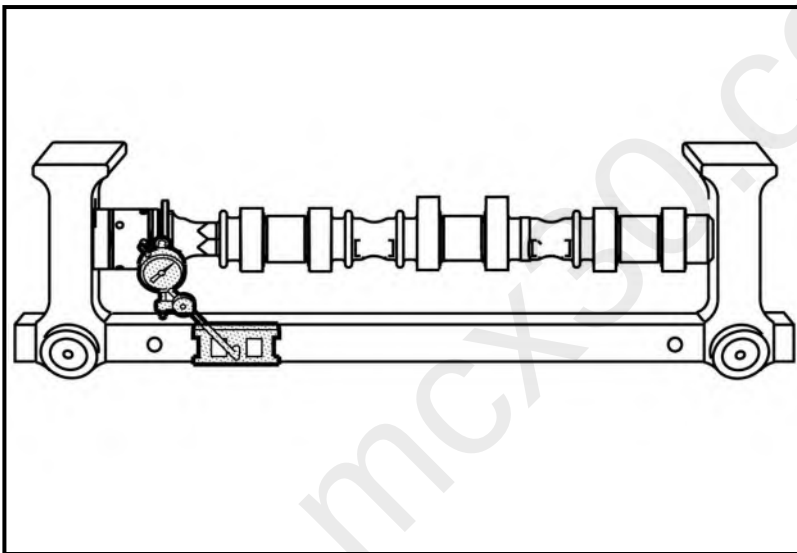
3. Measure the camshaft runout using the **GE-7872** indicator. [Engine Mechanical Specifications](#)



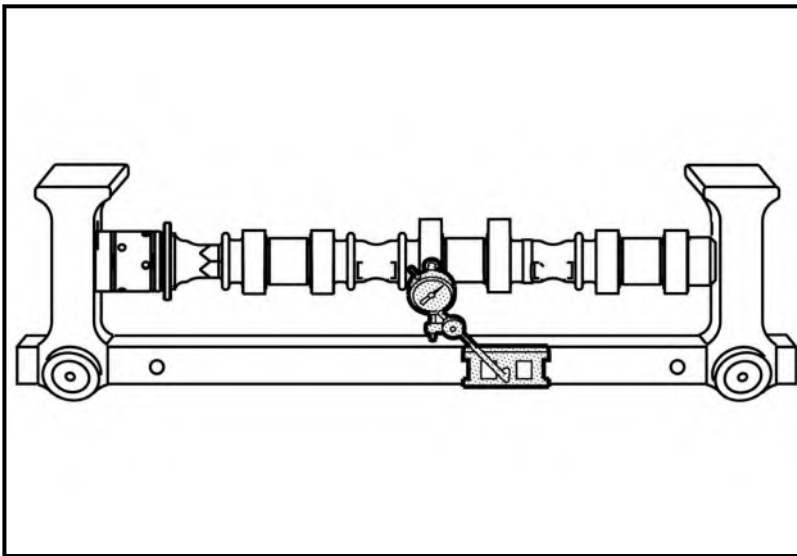
4. Measure the camshaft thrust width for wear using a depth micrometer. [Engine Mechanical Specifications](#)



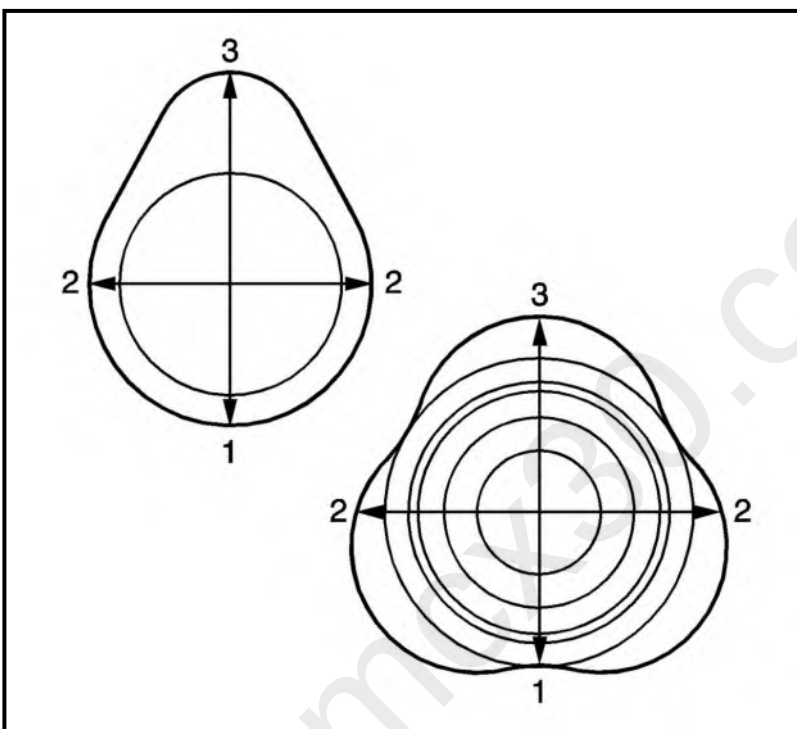
5. Measure the camshaft thrust wall surface for runout using **GE-7872** indicator. [Engine Mechanical Specifications](#)



6. If the camshaft is damaged or worn beyond specifications, replace the camshaft. No machining of the camshaft is allowed.
7. Measure the camshaft lobes for wear using the **GE-7872** indicator.



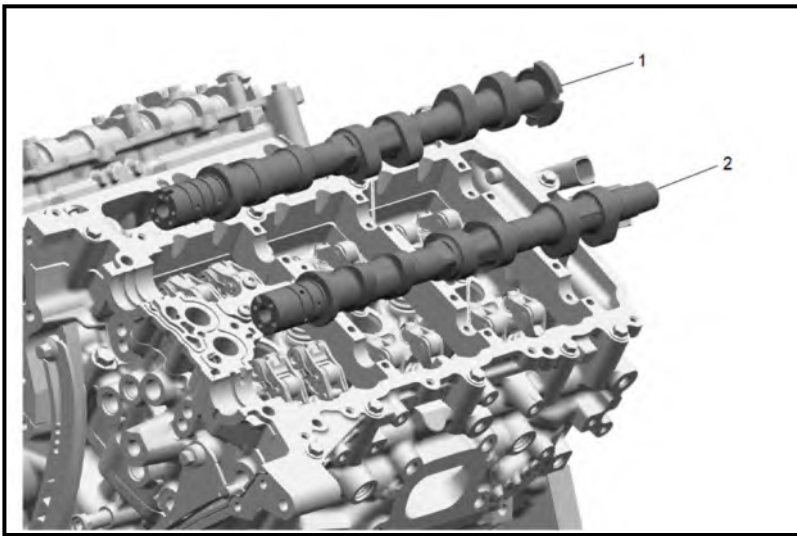
8. Place the **GE-7872** indicator with the indicator tip on the base circle (1) of the camshaft lobe.



1. Place the **GE-7872** indicator at zero.
2. Rotate the camshaft until the indicator tip is at the highest point (3) on the lobe. This reading is the lift of the camshaft lobe. **Engine Mechanical Specifications**
3. If the indicated measurement is significantly lower than these specifications, replace the camshaft or engine performance will be reduced.

Installation Procedure

1. Intake Camshaft - Left Side (1) - Install



NOTE: Laser Etched or ID flats- Correct Camshaft Location - Bank 2 (C)

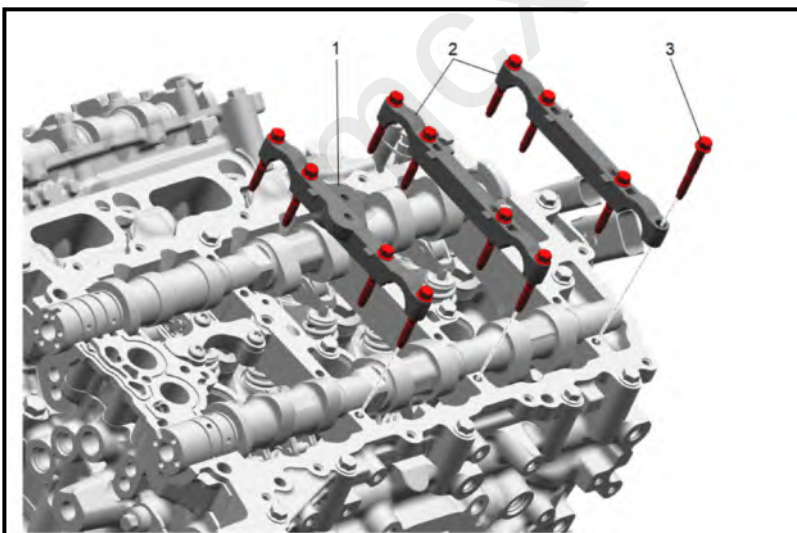
1. Make sure the camshaft flats with laser etched markings are straight up in relation to the cylinder head and that the crankshaft is in the stage 1 position. The crankshaft key way will be at approximately the 11 o'clock position. [Timing Chain Alignment Diagram](#)
2. Ensure the flat is facing upward when installed to help when installing timing chains.

NOTE: Laser Etched or ID flats- Correct Camshaft Location - Bank 2 (D)

2. Exhaust Camshaft - Left Side (2) - Install

1. Make sure the camshaft flats with laser etched markings are straight up in relation to the cylinder head and that the crankshaft is in the stage 1 position. The crankshaft key way will be at approximately the 11 o'clock position. [Timing Chain Alignment Diagram](#)
2. Ensure the flat is facing upward when installed to help when installing timing chains.

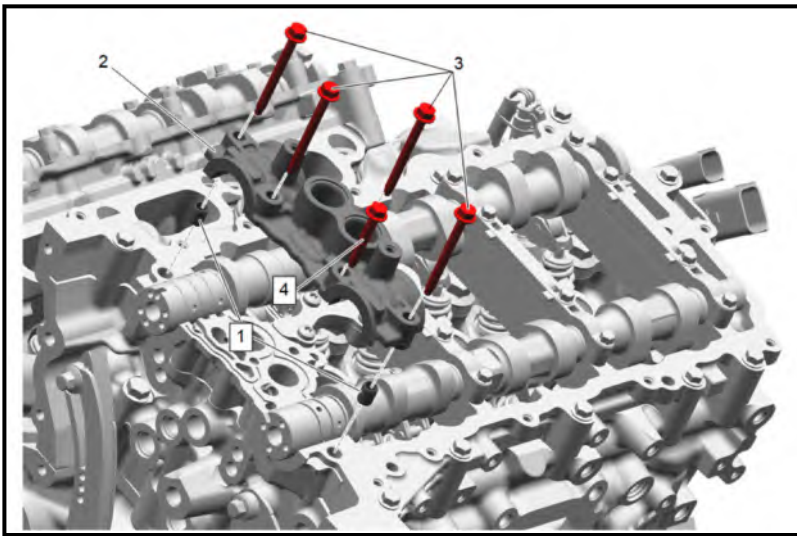
3. Camshaft Bearing Cap (1) - Install



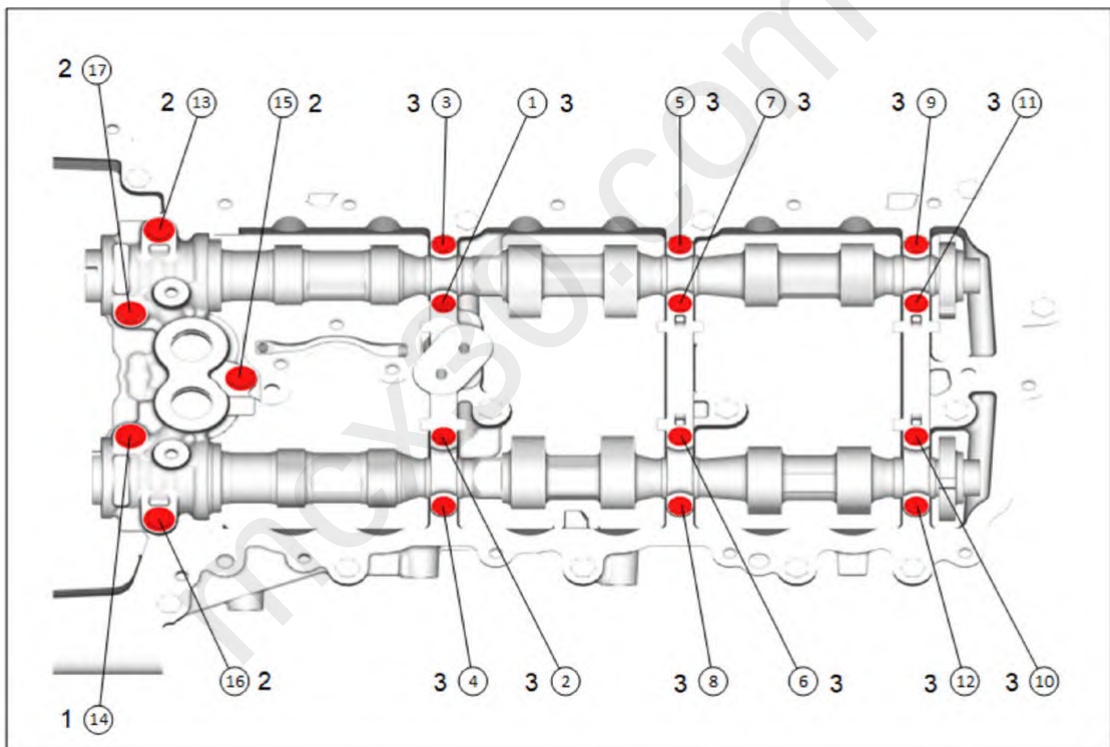
4. Camshaft Bearing Cap (2) - Install [2x]

5. Camshaft Bearing Cap Bolt (3) - Install and hand tighten [12x]

6. Dowel Pin (1) - Install [2x]

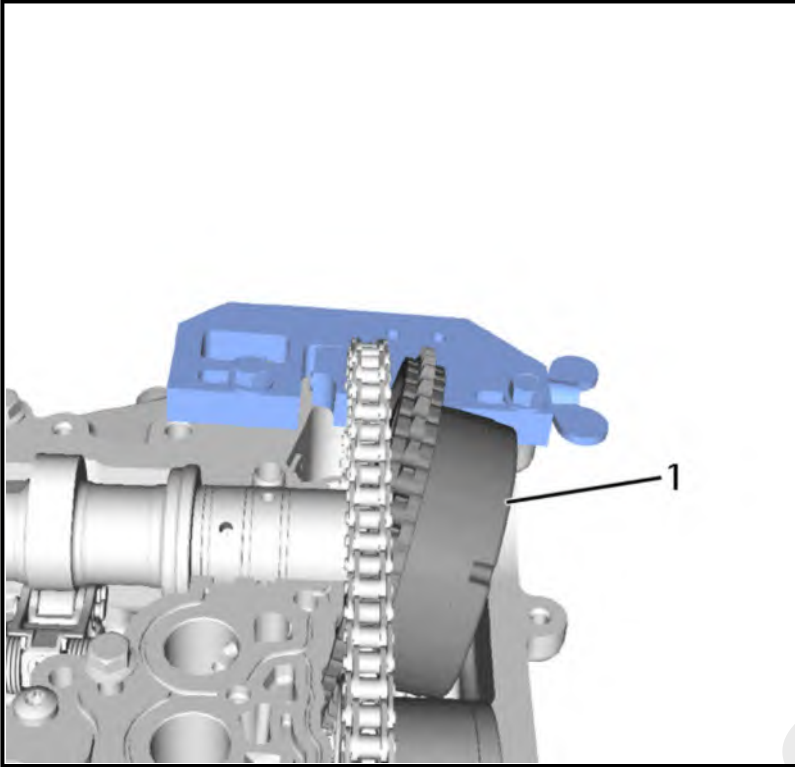


7. Camshaft Bearing Cap (2) - Install
8. Camshaft Carrier Bolt (3) - Install and hand tighten [4x]
9. Camshaft Bearing Cap Bolt (4) - Install and hand tighten
10. Camshaft Bearing Cap Bolt (1) - Tighten in sequence



2. Final Pass: 60 degrees

13. Camshaft Position Actuator (1) - Install [2x] - [Camshaft Position Actuator Replacement - Bank 2](#)



CAMSHAFT REPLACEMENT - RIGHT SIDE

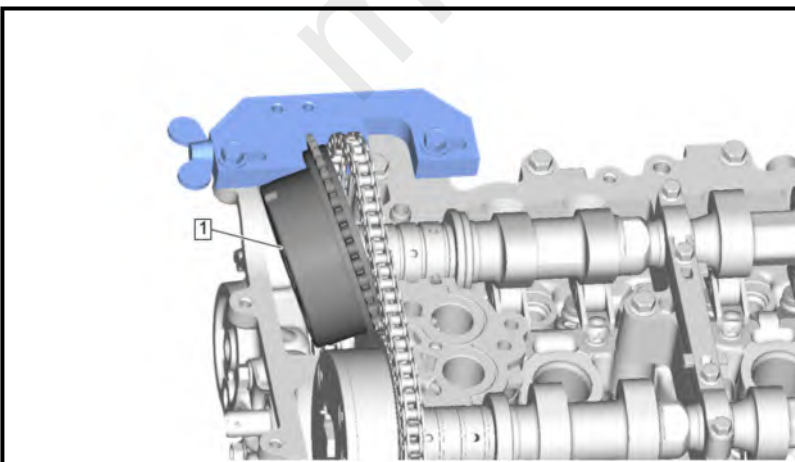
Special Tools

GE-7872 Magnetic Base Dial Indicator

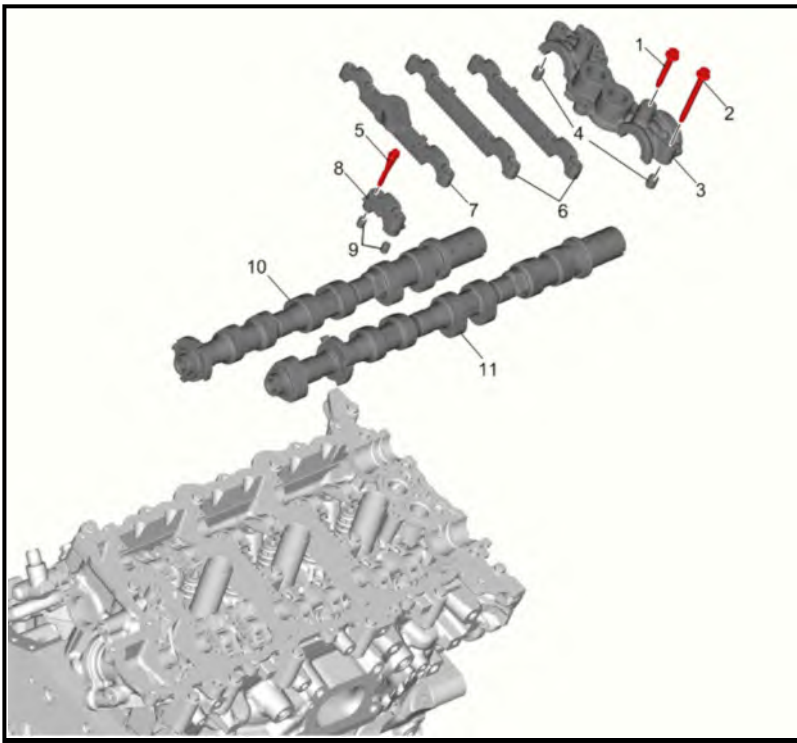
Equivalent regional tools: [Special Tools](#)

Removal Procedure

1. Camshaft Position Actuator (1) - Remove [2x] - [Camshaft Position Actuator Replacement - Bank 1](#)



2. Camshaft Bearing Cap Bolt (1) - Remove



3. Camshaft Bearing Cap Bolt (2) - Remove [4x]
4. Camshaft Bearing Cap (3) - Remove
5. Dowel Pin (4) - Remove
6. Camshaft Bearing Cap Bolt (5) - Remove [14x]
7. Camshaft Bearing Cap (6) - Remove
8. Camshaft Bearing Cap (7) - Remove
9. Camshaft Bearing Cap - Intermediate (8) - Remove
10. Dowel Pin (9) - Remove

NOTE: Laser Etched or ID flats- Correct Camshaft Location - Bank 1 (B)

11. Intake Camshaft - Right Side (10) - Remove

NOTE: Laser Etched or ID flats- Correct Camshaft Location - Bank 1 (A)

12. Exhaust Camshaft - Right Side (11) - Remove

Cleaning Procedure

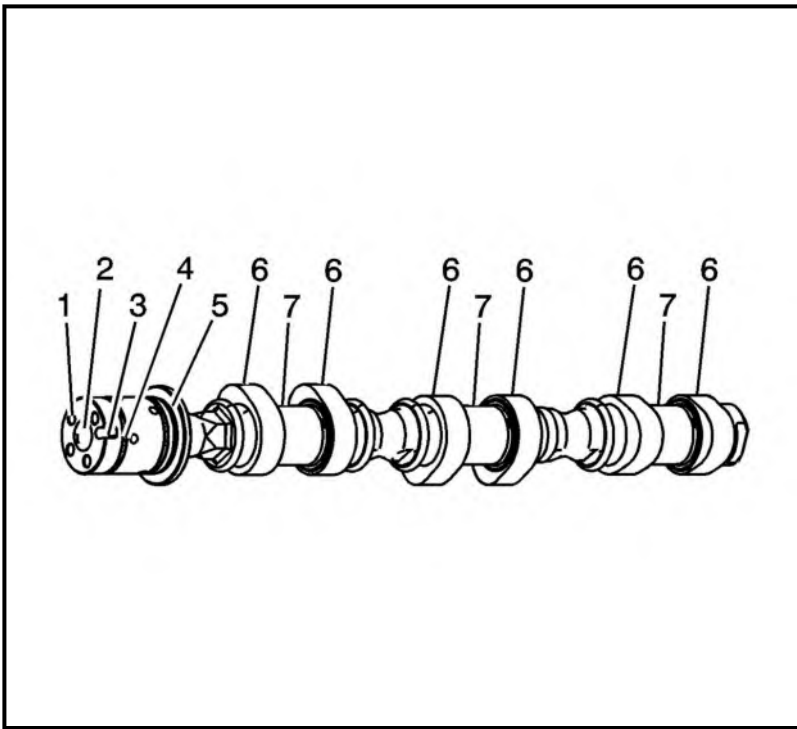
1. Clean the camshaft in solvent.

WARNING: Refer to [Safety Glasses Warning](#) .

2. Dry the camshaft with compressed air.

Visual Inspection

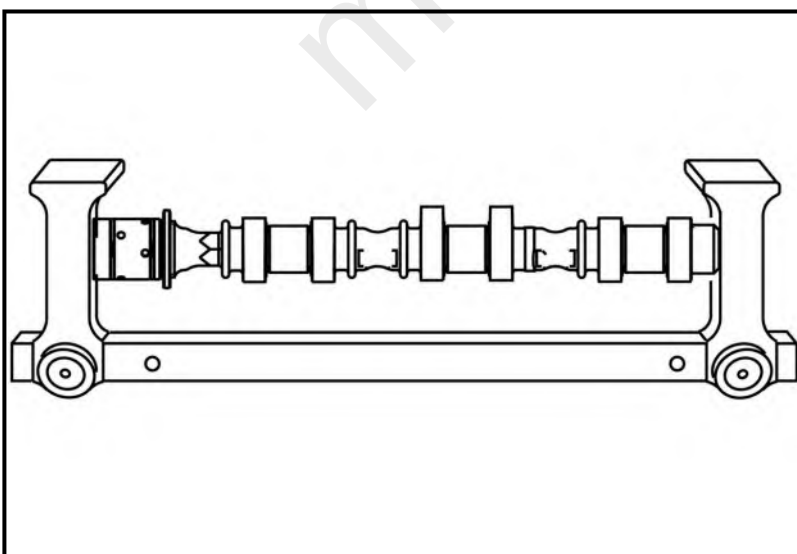
1. Inspect the camshaft oil feed holes (1) to the camshaft position actuator for dirt, debris or blockage.



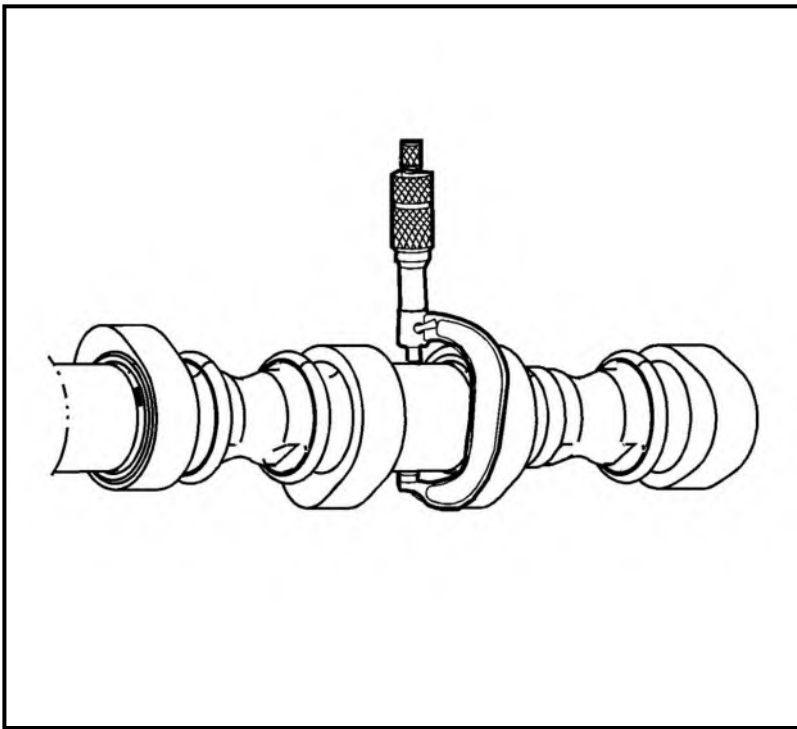
2. Inspect the threaded hole (2) for damage.
3. Inspect the camshaft position actuator locating notch (3) for damage or wear.
4. Inspect the camshaft sealing grooves (4) for damage.
5. Inspect the camshaft thrust surface (5) for damage.
6. Inspect the camshaft lobes (6) and journals (7) for the following conditions:
 - Excessive scoring or pitting
 - Discoloration from overheating
 - Deformation from excessive wear, especially the camshaft lobes
7. If any of the above conditions exist on the camshaft, replace the camshaft.

Camshaft Measurement

1. With the camshaft in a suitable fixture, measure the camshaft for wear.

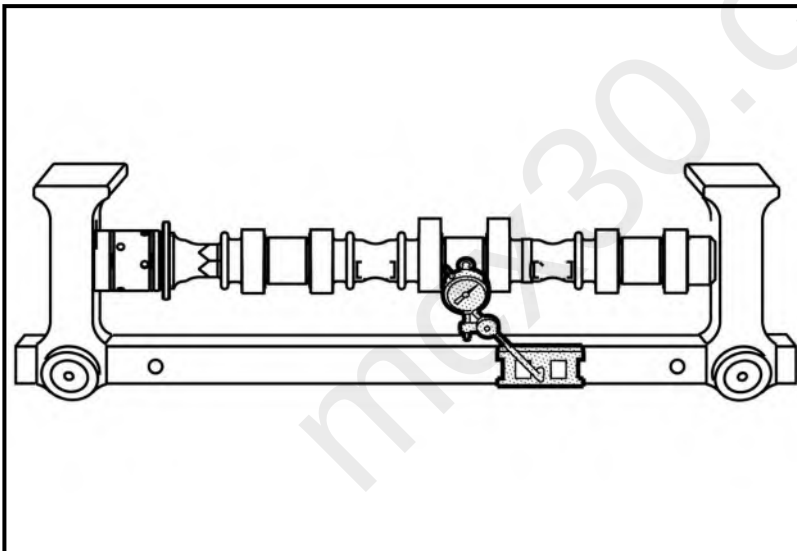


2. Measure the camshaft journals for diameter and out-of-round using an outside micrometer. [Engine Mechanical Specifications](#)

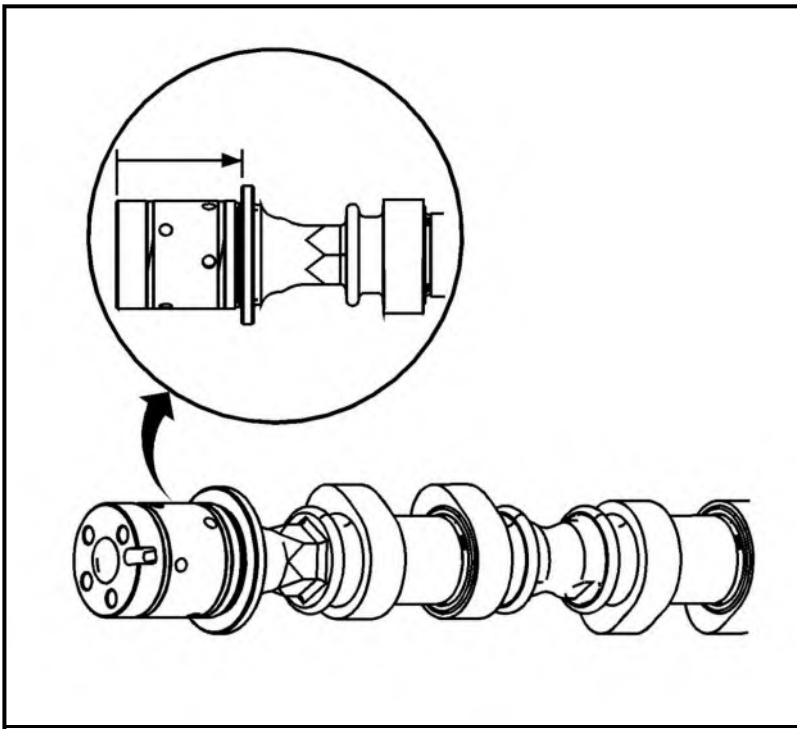


- If the diameter is smaller than specifications, replace the camshaft.
- If the out-of-round exceeds specifications, replace the camshaft.

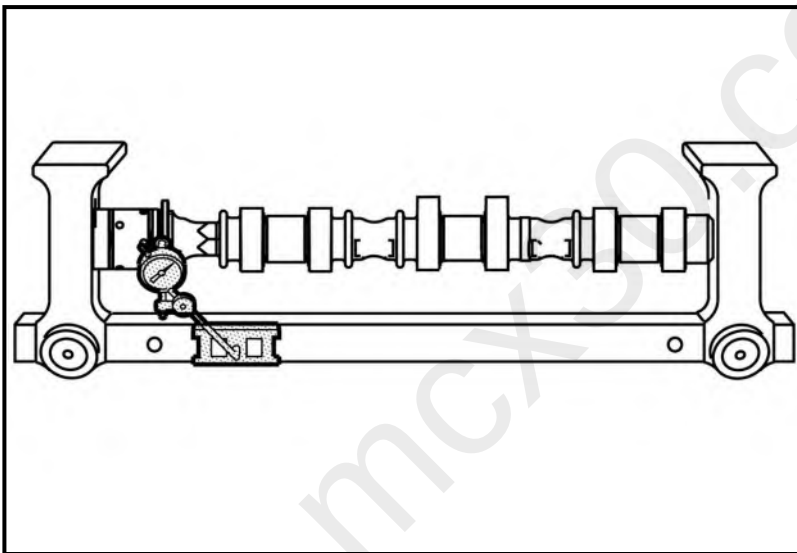
3. Measure the camshaft runout using the **GE-7872** indicator. [Engine Mechanical Specifications](#)



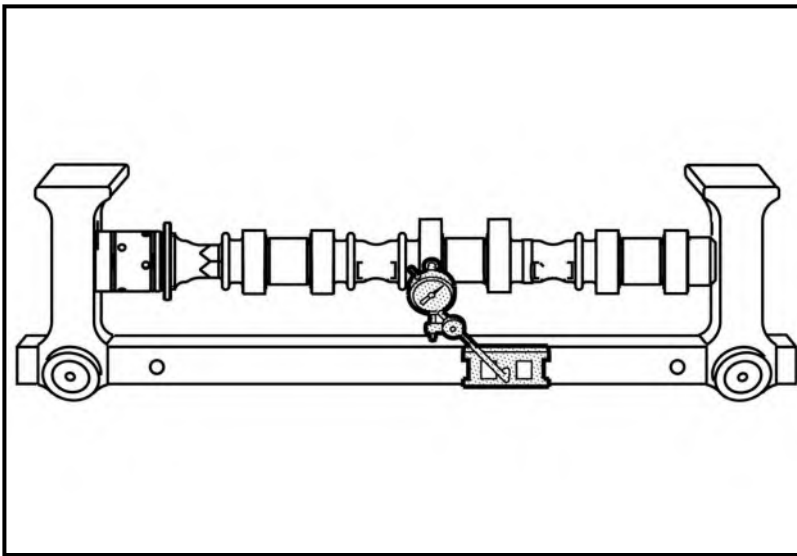
4. Measure the camshaft thrust width for wear using a depth micrometer. [Engine Mechanical Specifications](#)



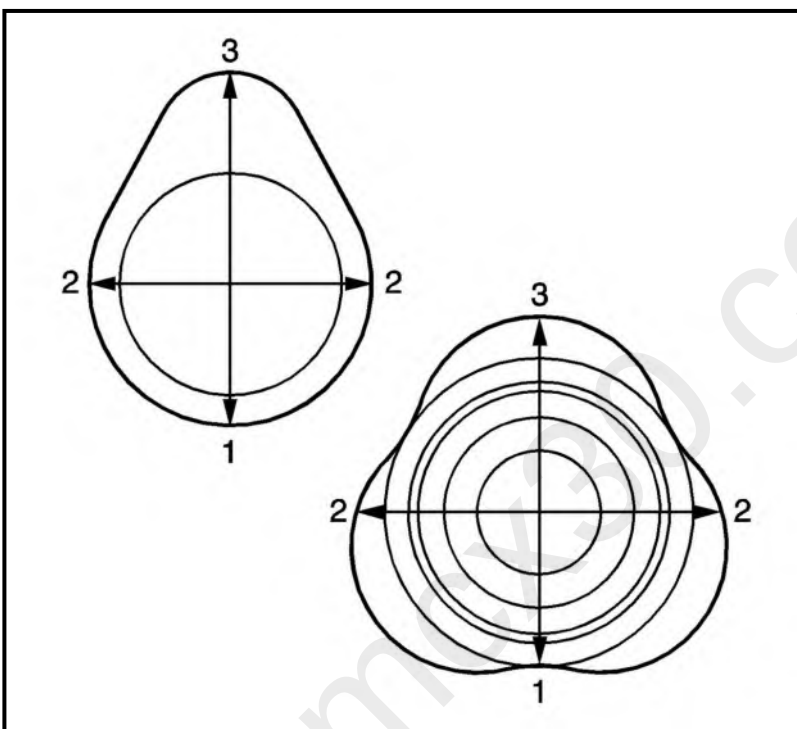
5. Measure the camshaft thrust wall surface for runout using **GE-7872** indicator. **Engine Mechanical Specifications**



6. If the camshaft is damaged or worn beyond specifications, replace the camshaft. No machining of the camshaft is allowed.
7. Measure the camshaft lobes for wear using the **GE-7872** indicator.



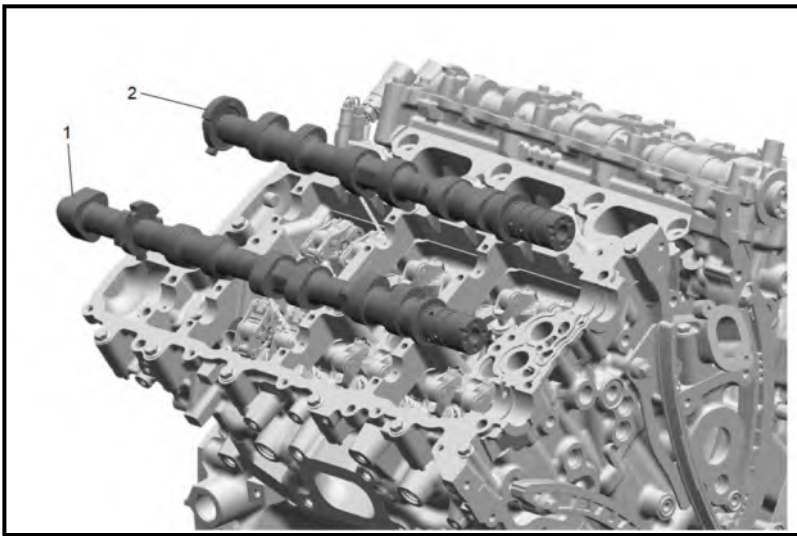
8. Place the **GE-7872** indicator with the indicator tip on the base circle (1) of the camshaft lobe.



1. Place the **GE-7872** indicator at zero.
2. Rotate the camshaft until the indicator tip is at the highest point (3) on the lobe. This reading is the lift of the camshaft lobe. **Engine Mechanical Specifications**
3. If the indicated measurement is significantly lower than these specifications, replace the camshaft or engine performance will be reduced.

Installation Procedure

1. Exhaust Camshaft - Right Side (1) - Install



NOTE: Laser Etched or ID flats- Correct Camshaft Location - Bank 1 (A)

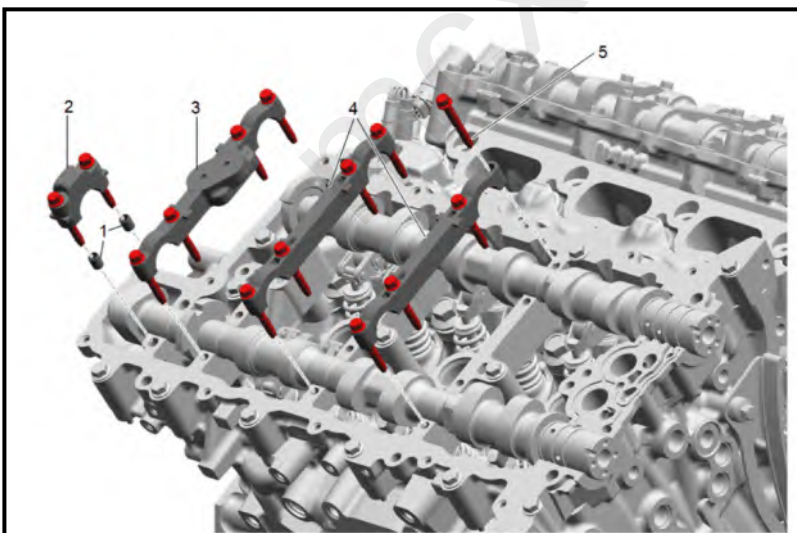
1. Make sure the camshaft flats with laser etched markings are straight up in relation to the cylinder head and that the crankshaft is in the stage 2 position. The crankshaft key way will be at approximately the 3 o'clock position. [Timing Chain Alignment Diagram](#)
2. Ensure the flat is facing upward when installed to help when installing timing chains.

NOTE: Laser Etched or ID flats- Correct Camshaft Location - Bank 1 (B)

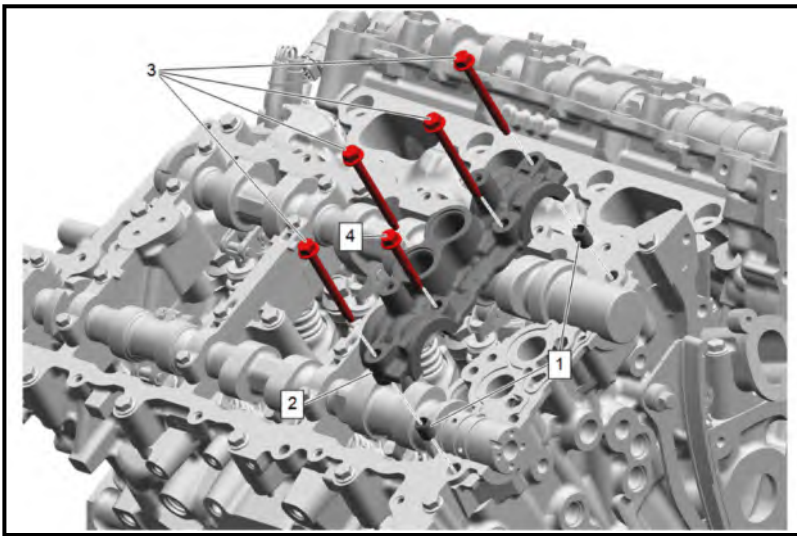
2. Intake Camshaft - Right Side (2) - Install

1. Make sure the camshaft flats with laser etched markings are straight up in relation to the cylinder head and that the crankshaft is in the stage 2 position. The crankshaft key way will be at approximately the 3 o'clock position. [Timing Chain Alignment Diagram](#)
2. Ensure the flat is facing upward when installed to help when installing timing chains.

3. Dowel Pin (1) - Install [2x]



4. Camshaft Bearing Cap - Intermediate (2) - Install
5. Camshaft Bearing Cap (3) - Install
6. Camshaft Bearing Cap (4) - Install [2x]
7. Camshaft Bearing Cap Bolt (5) - Install and hand tighten [14x]
8. Dowel Pin (1) - Install [2x]



9. Camshaft Bearing Cap (2) - Install
10. Camshaft Carrier Bolt (3) - Install and hand tighten [4x]
11. Camshaft Bearing Cap Bolt (4) - Install and hand tighten
12. Camshaft Bearing Cap Bolt (1) - Tighten in sequence [14x]

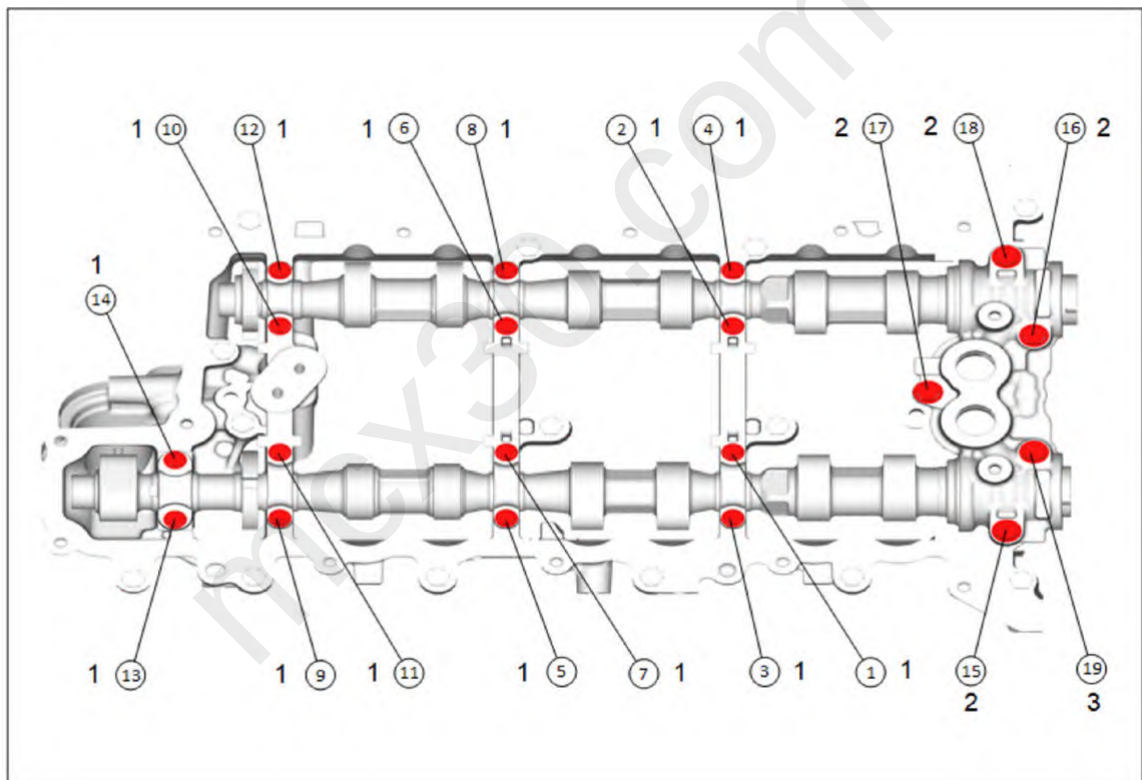


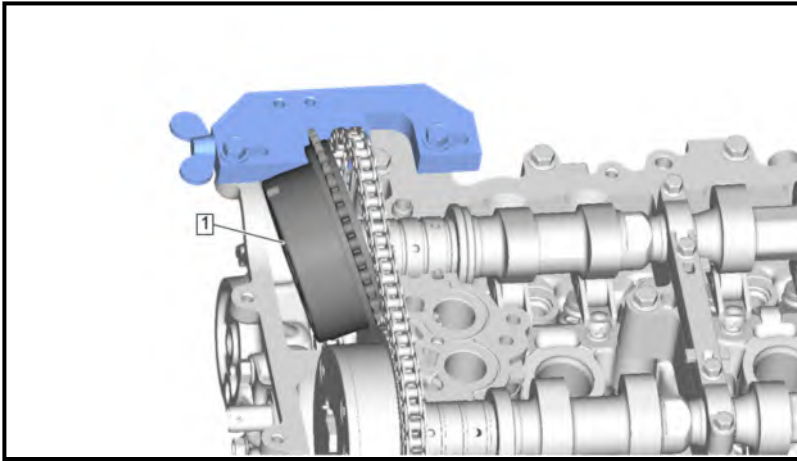
Fig. 11: Identifying Camshaft Bearing Cap Bolts With Tightening Sequence - Right Side
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to **Fastener Caution** .

1. First Pass: 6 N.m (53 lb in)
2. Final Pass: 60 degrees
13. Camshaft Carrier Bolt (2) - Tighten in sequence [4x]
 1. First Pass: 6 N.m (53 lb in)
 2. Final Pass: 45 degrees
14. Camshaft Bearing Cap Bolt (3) - Tighten in sequence
 1. First Pass: 6 N.m (53 lb in)

2. Final Pass: 45 degrees

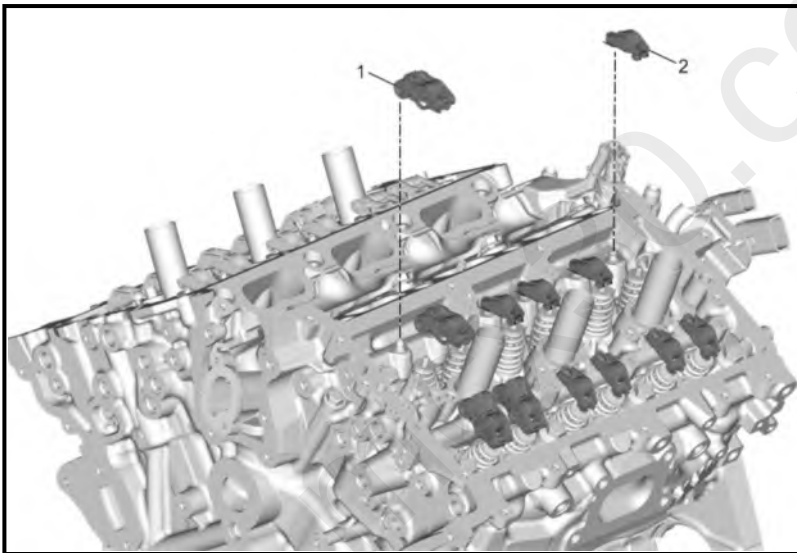
15. Camshaft Position Actuator (1) - Install [2x] - [Camshaft Position Actuator Replacement - Bank 1](#)



VALVE ROCKER ARM REPLACEMENT - LEFT SIDE

Removal Procedure

1. Camshaft-Left Side - Remove - [Camshaft Replacement - Left Side](#)
2. Valve Rocker Switching Arm (1) - Remove [4x]



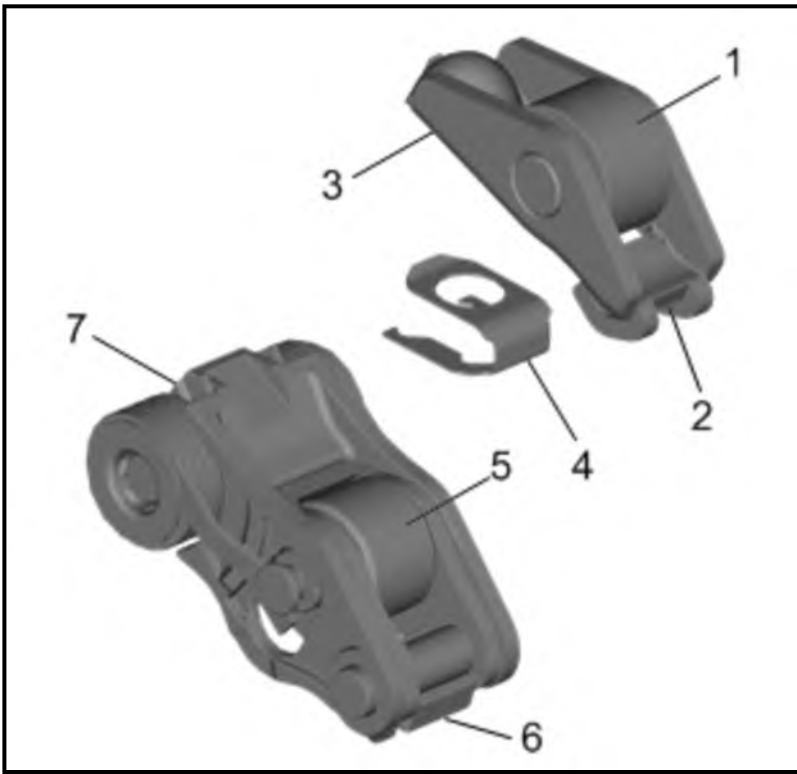
NOTE: If the rocker arms are to be reused, keep in order so they can be reinstalled in the same position.

NOTE: If the rocker arms are to be reused, keep in order so they can be reinstalled in the same position.

3. Valve Rocker Arm (2) - Remove [8x]

Inspection Procedure

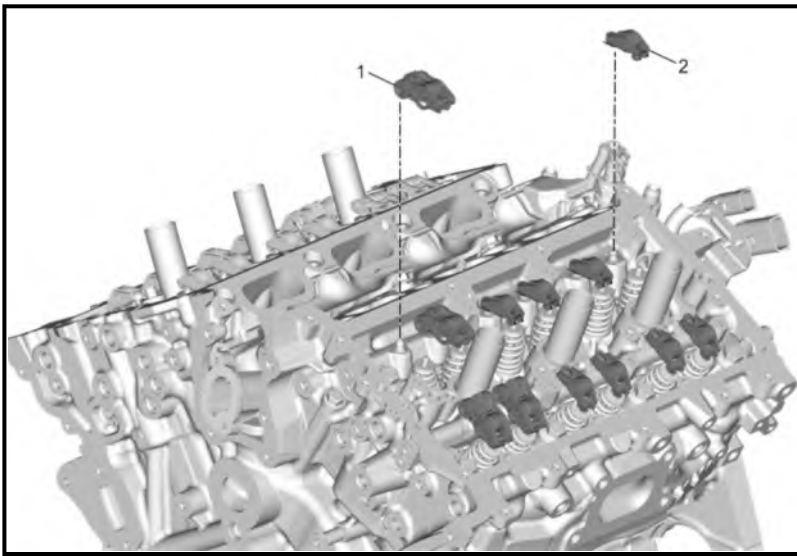
1. Inspect the valve rocker arm roller (1) for the following:



- Flat spots
 - Excessive scoring and pitting
 - Ensure the roller spins freely
2. Inspect the valve rocker arm tip area (2).
 3. Inspect the valve rocker arm hydraulic lash adjuster (HLA) pivot area (3).
 4. Inspect the valve rocker arm retaining clip (4).
 5. Inspect the valve rocker switching arm roller (5) for the following:
 - Flat spots
 - Excessive scoring and pitting
 - Ensure the roller spins freely
 6. Inspect the valve rocker switching arm tip area (6).
 7. Inspect the valve rocker switching arm dual feed hydraulic lash adjuster (DFHLA) pivot area (7).
 8. Replace the valve rocker switching arm or followers as necessary.

Installation Procedure

1. Apply a liberal amount of lubricant to the pivot pocket, roller and valve slot areas of the camshaft followers. Adhesives, Fluids, Lubricants, and Sealers



NOTE:

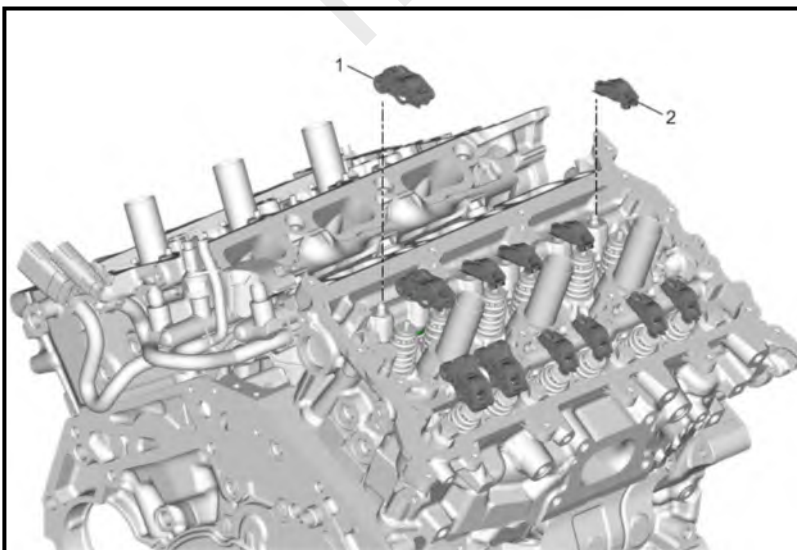
- The follower must be positioned squarely on the valve tip so that the full width of the roller will completely contact the camshaft lobe. If the followers are being reused you must put them back in their original location.
- The rounded head end of the follower goes on the adjuster while the flat end goes on the valve tip.

2. Place the camshaft followers in position on the valve tip and adjuster.
3. Clean the camshaft journals and carriers with a clean, lint-free cloth.
4. Valve Rocker Switching Arm (1) - Install [4x]
5. Valve Rocker Arm (2) - Install [8x]
6. Camshaft-Left Side - Install - [Camshaft Replacement - Left Side](#)

VALVE ROCKER ARM REPLACEMENT - RIGHT SIDE

Removal Procedure

1. Camshaft-Right Side - Remove - [Camshaft Replacement - Right Side](#)
2. Valve Rocker Switching Arm (1) - Remove [4x]



NOTE:

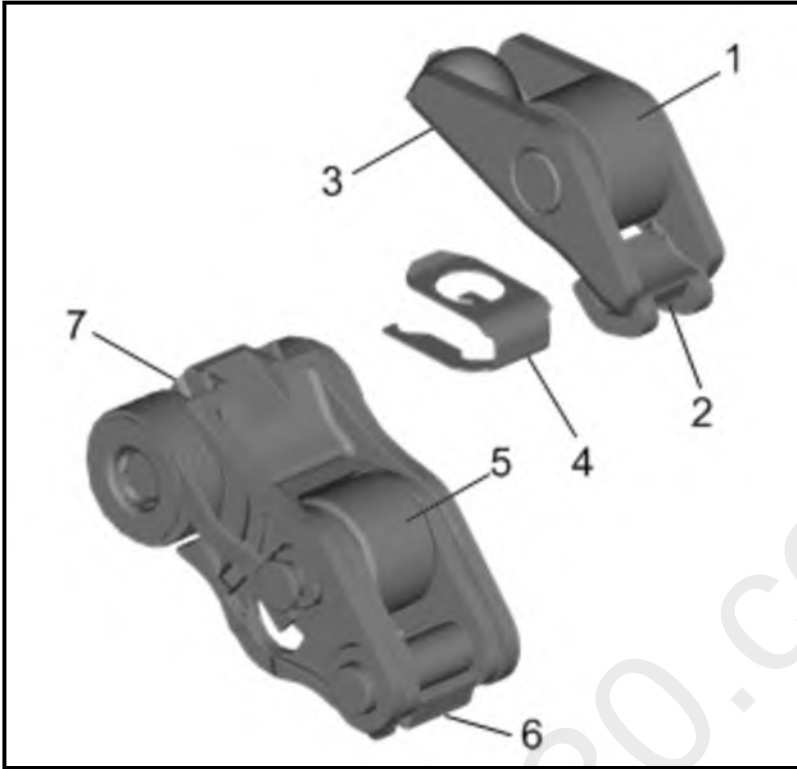
If the rocker arms are to be reused, keep in order so they can be reinstalled in the same position.

NOTE: If the rocker arms are to be reused, keep in order so they can be reinstalled in the same position.

3. Valve Rocker Arm (2) - Remove [8x]

Inspection Procedure

1. Inspect the valve rocker arm roller (1) for the following:



- Flat spots
- Excessive scoring and pitting
- Ensure the roller spins freely

2. Inspect the valve rocker arm tip area (2).

3. Inspect the valve rocker arm hydraulic lash adjuster (HLA) pivot area (3).

4. Inspect the valve rocker arm retaining clip (4).

5. Inspect the valve rocker switching arm roller (5) for the following:

- Flat spots
- Excessive scoring and pitting
- Ensure the roller spins freely

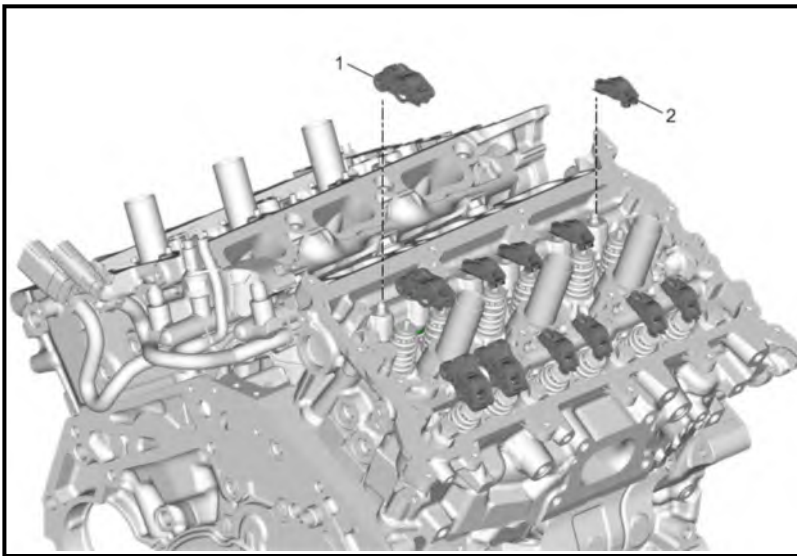
6. Inspect the valve rocker switching arm tip area (6).

7. Inspect the valve rocker switching arm dual feed hydraulic lash adjuster (DFHLA) pivot area (7).

8. Replace the valve rocker switching arm or followers as necessary.

Installation Procedure

1. Apply a liberal amount of lubricant to the pivot pocket, roller and valve slot areas of the camshaft followers. **Adhesives, Fluids, Lubricants, and Sealers**



NOTE:

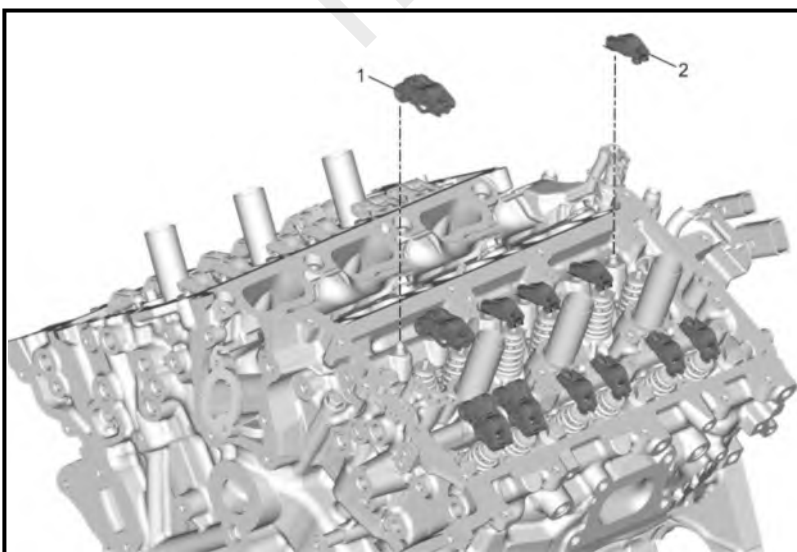
- The follower must be positioned squarely on the valve tip so that the full width of the roller will completely contact the camshaft lobe. If the followers are being reused you must put them back in their original location.
- The rounded head end of the follower goes on the adjuster while the flat end goes on the valve tip.

2. Place the camshaft followers in position on the valve tip and adjuster.
3. Clean the camshaft journals and carriers with a clean, lint-free cloth.
4. Valve Rocker Switching Arm (1) - Install [4x]
5. Valve Rocker Arm (2) - Install [8x]
6. Camshaft-Right Side - Install - [Camshaft Replacement - Right Side](#)

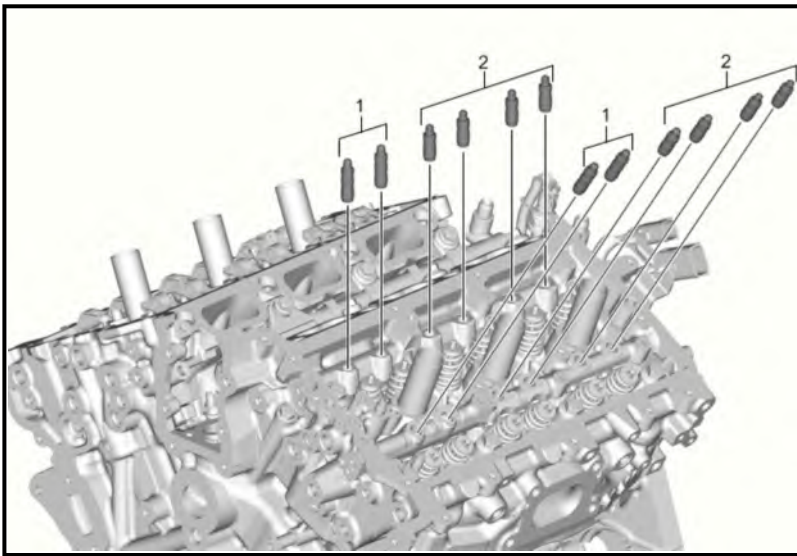
VALVE LIFTER REPLACEMENT - LEFT SIDE

Removal Procedure

1. Camshaft-Left Side - Remove [Camshaft Replacement - Left Side](#)
2. Valve Rocker Arm (1, 2) - Remove [12x] - [Valve Rocker Arm Replacement - Left Side](#)



3. Dual Feed Hydraulic Valve Lash Adjuster (1) - Remove [4x]



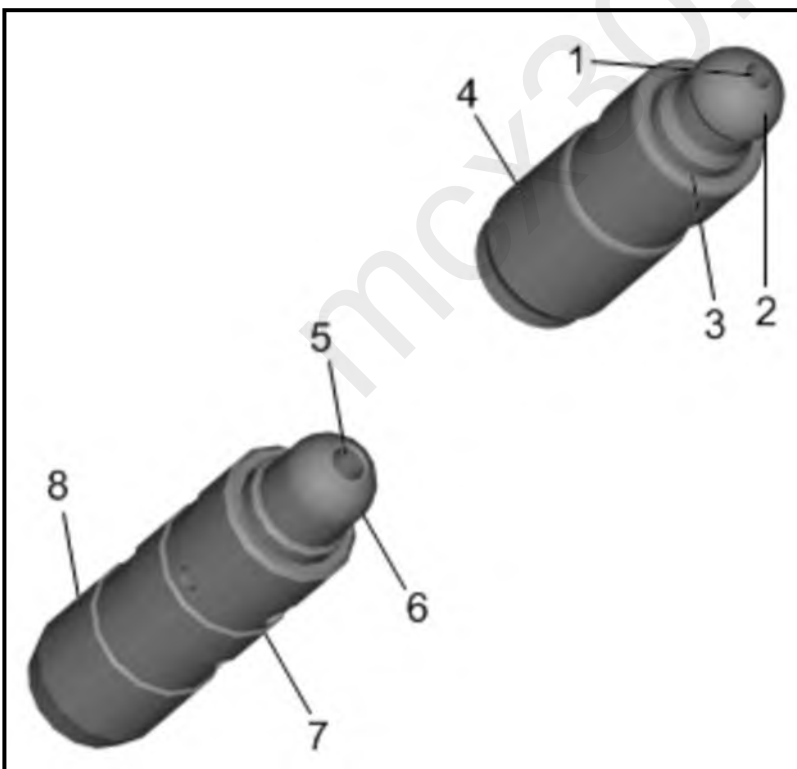
NOTE: If the lifters are to be reused, keep in order so they can be reinstalled in the same position.

NOTE: If the lifters are to be reused, keep in order so they can be reinstalled in the same position.

4. Hydraulic Valve Lash Adjuster (2) - Remove [8x]

Inspection Procedure

1. Inspect the hydraulic lash adjuster (HLA) in the following areas:



CAUTION: Refer to [Valve Lifter Priming Caution](#) .

- A plugged oil passage (1)
- A scored or worn camshaft follower pivot area (2)
- A damaged or broken retainer (3), some applications
- A severely scuffed or worn HLA body (4)

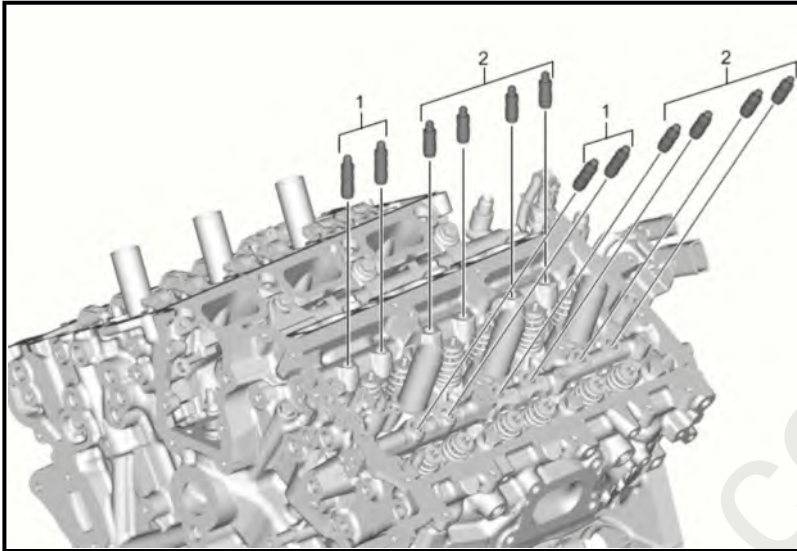
2. Inspect the dual feed hydraulic lash adjuster (DFHLA) in the following areas:

- A plugged oil passage (5)
- A scored or worn camshaft follower pivot area (6)
- A damaged or broken retainer (7), some applications
- A severely scuffed or worn DFHLA body (8)

3. Replace the HLA or DFHLAs as necessary.

Installation Procedure

1. Fill the adjusters with clean engine oil. [Adhesives, Fluids, Lubricants, and Sealers](#)



NOTE:

- Do not stroke/cycle the adjusters without oil in the lower pressure chamber.
- Do not allow the adjusters to tip over, plunger down, after the oil fill.

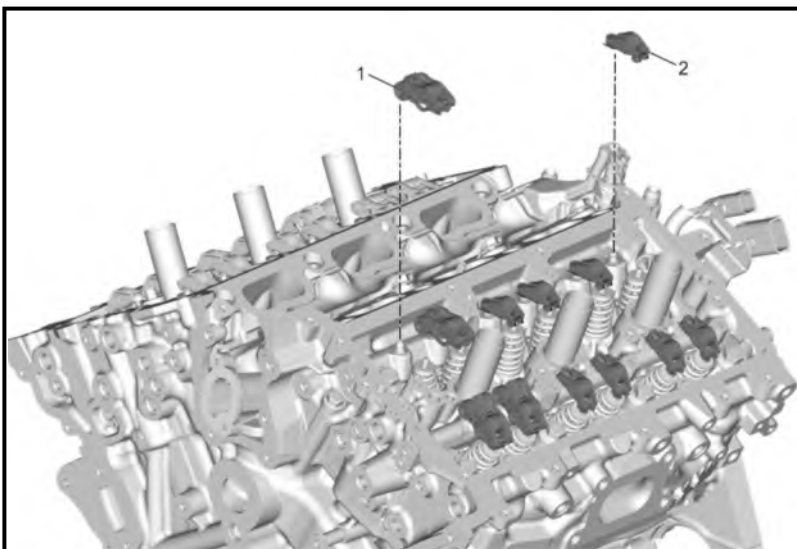
2. Lubricate the adjusters bores in the cylinder head with clean engine oil.

3. Hydraulic Valve Lash Adjuster (2) - Install [8x]

4. Dual Feed Hydraulic Valve Lash Adjuster (1) - Install [4x]

5. Apply a liberal amount of lubricant to the pivot spheres on the adjusters.

6. Valve Rocker Arm (1, 2) - Install [12x] - [Valve Rocker Arm Replacement - Left Side](#)

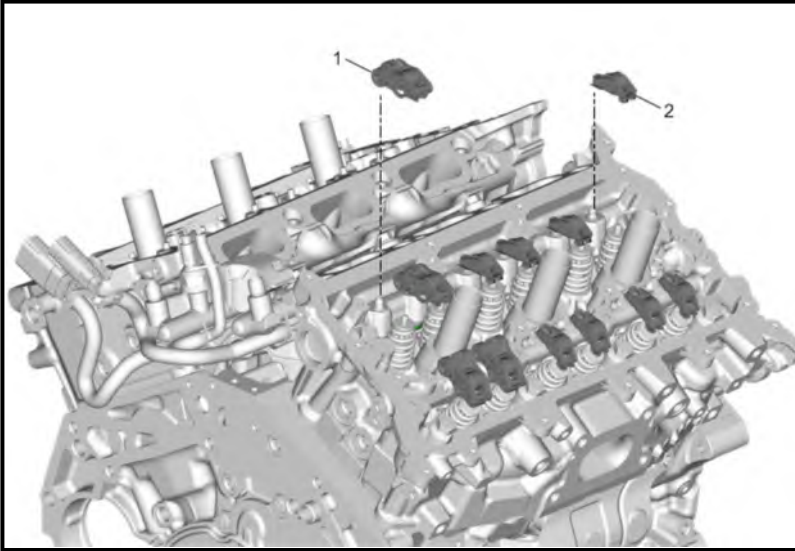


7. Camshaft-Left Side - Install - [Camshaft Replacement - Left Side](#)

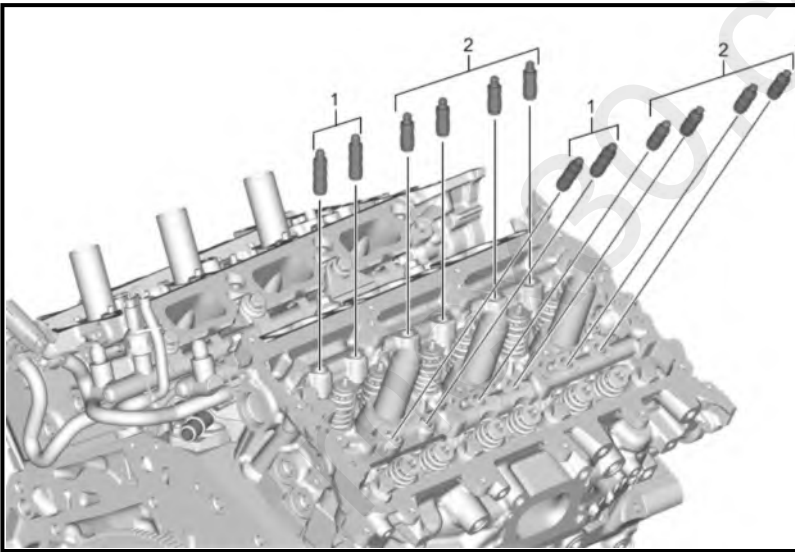
VALVE LIFTER REPLACEMENT - RIGHT SIDE

Removal Procedure

1. Camshaft-Right Side - Remove - [Camshaft Replacement - Right Side](#)
2. Valve Rocker Arm-Right Side (1, 2) - Remove [12x] - [Valve Rocker Arm Replacement - Right Side](#)



3. Dual Feed Hydraulic Valve Lash Adjuster (1) - Remove [4x]



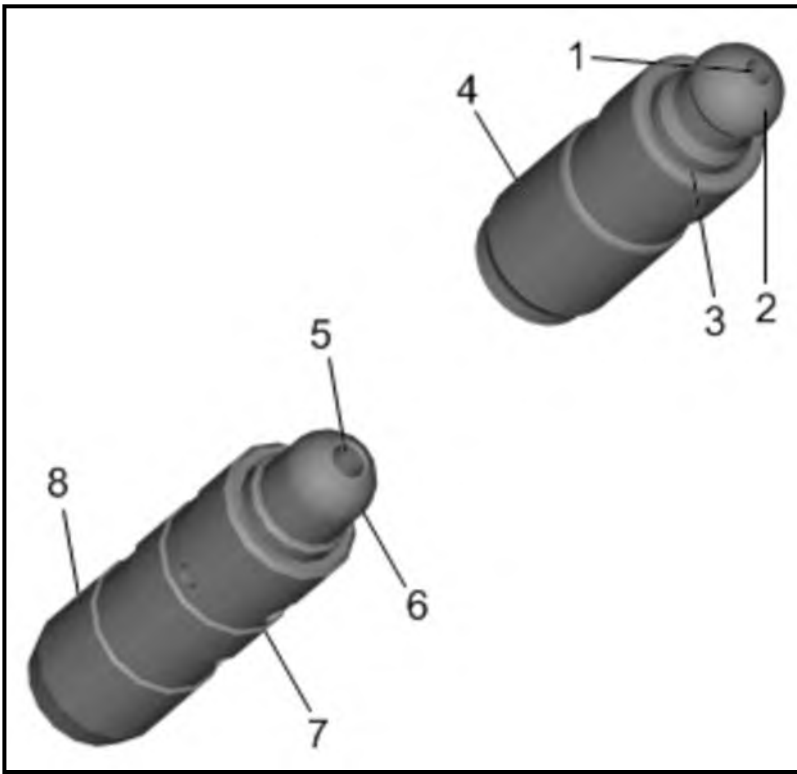
NOTE: If the lifters are to be reused, keep in order so they can be reinstalled in the same position.

NOTE: If the lifters are to be reused, keep in order so they can be reinstalled in the same position.

4. Hydraulic Valve Lash Adjuster (2) - Remove [8x]

Inspection Procedure

1. Inspect the hydraulic lash adjuster (HLA) in the following areas:



CAUTION: Refer to [Valve Lifter Priming Caution](#) .

- A plugged oil passage (1)
- A scored or worn camshaft follower pivot area (2)
- A damaged or broken retainer (3), some applications
- A severely scuffed or worn HLA body (4)

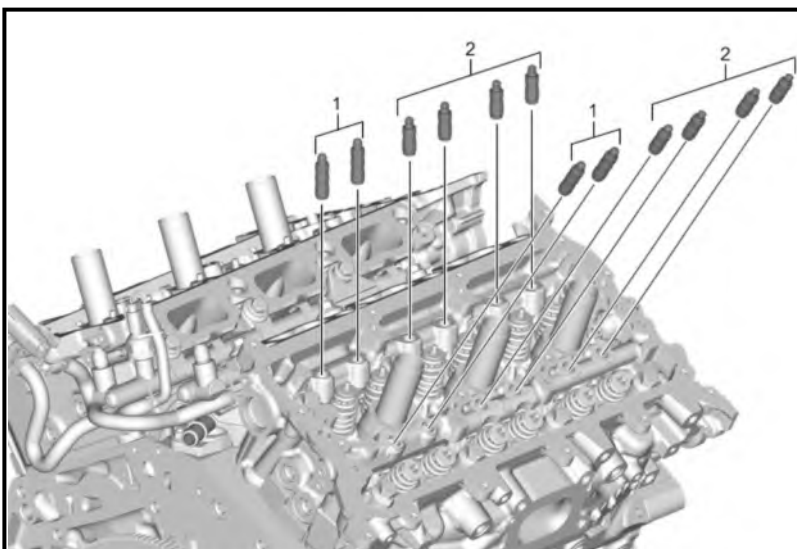
2. Inspect the dual feed hydraulic lash adjuster (DFHLA) in the following areas:

- A plugged oil passage (5)
- A scored or worn camshaft follower pivot area (6)
- A damaged or broken retainer (7), some applications
- A severely scuffed or worn DFHLA body (8)

3. Replace the HLA or DFHLAs as necessary.

Installation Procedure

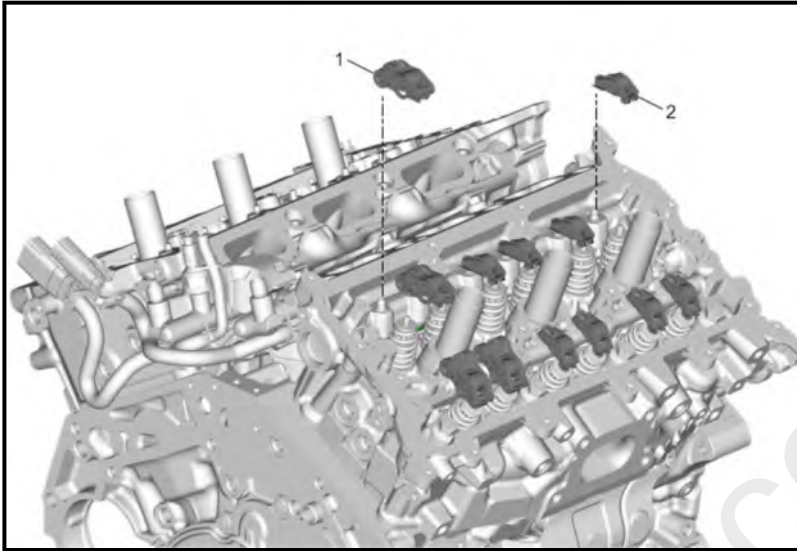
1. Fill the adjusters with clean engine oil. [Adhesives, Fluids, Lubricants, and Sealers](#)



NOTE:

- Do not stroke/cycle the adjusters without oil in the lower pressure chamber.
- Do not allow the adjusters to tip over, plunger down, after the oil fill.

2. Lubricate the adjusters bores in the cylinder head with clean engine oil.
3. Hydraulic Valve Lash Adjuster (2) - Install [8x]
4. Dual Feed Hydraulic Valve Lash Adjuster (1) - Install [4x]
5. Apply a liberal amount of lubricant to the pivot spheres on the adjusters.
6. Valve Rocker Arm-Right Side (1, 2) - Install [12x] - [Valve Rocker Arm Replacement - Right Side](#)



7. Camshaft-Right Side - Install [Camshaft Replacement - Right Side](#)

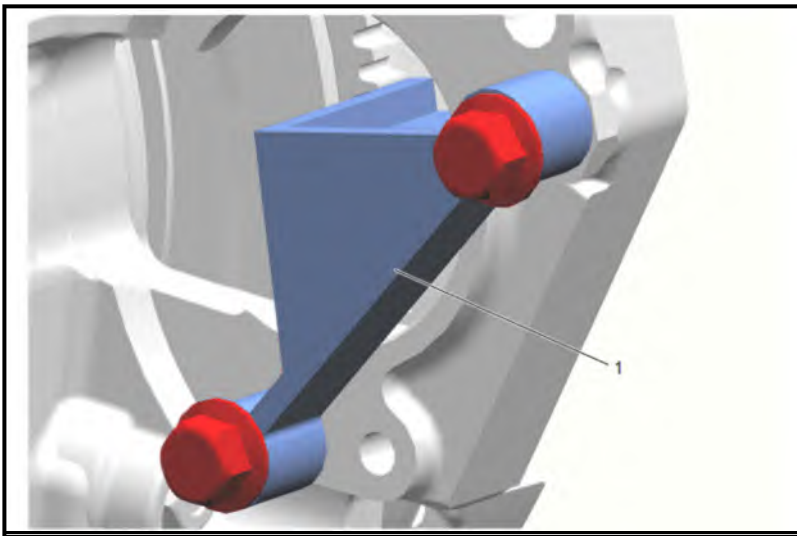
VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT - LEFT SIDE**Special Tools**

- EN-51749 Spark Plug Port Adapter
- EN-46106 Flywheel Holding Tool
- EN-46335-A On-Vehicle Valve Spring Compressor
- EN-46116 Valve Stem Seal Remover/Installer

Equivalent regional tools: [Special Tools](#)

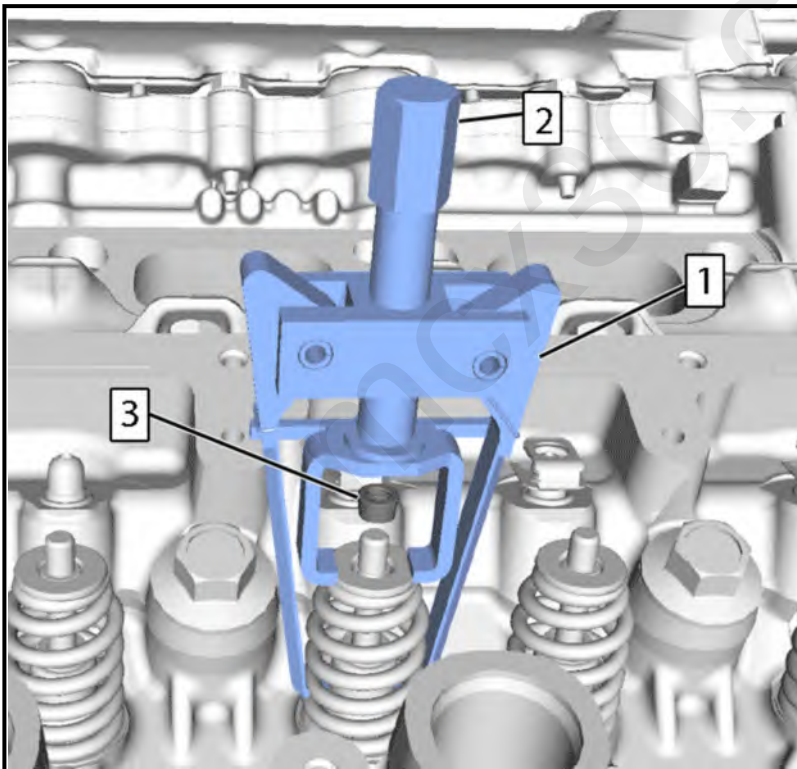
Removal Procedure

1. Remove the valve rocker arms. [Valve Rocker Arm Replacement - Left Side](#)
2. Remove the starter. [Starter Replacement \(LGZ\)](#)
3. Install the EN-46106 tool (1) to prevent crankshaft rotation.

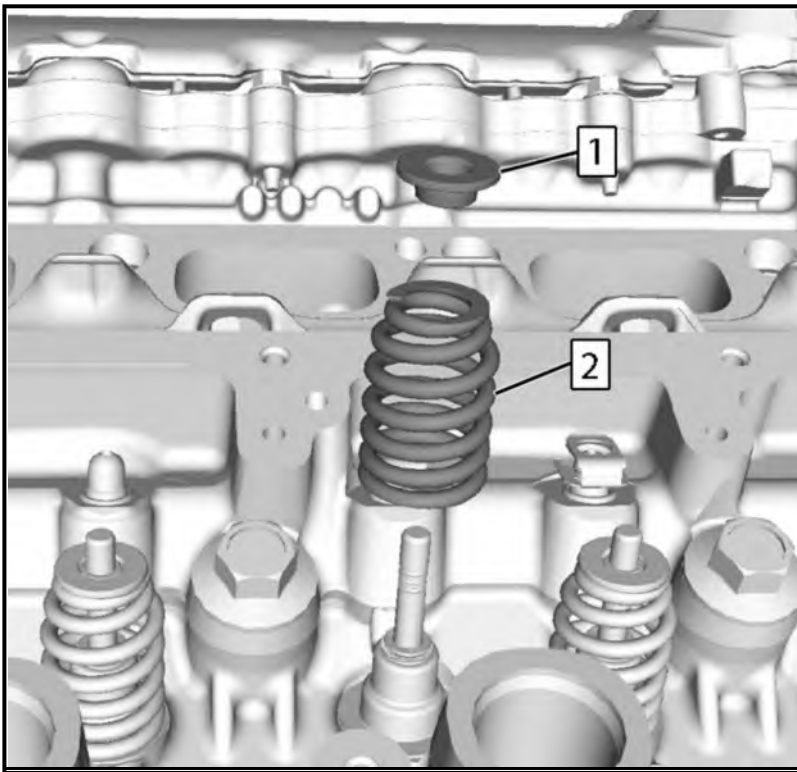


NOTE: If the EN-46106 tool is not installed, the crankshaft may rotate. If the crankshaft rotates, disassembly and reassembly of the entire camshaft timing system may be required.

4. Remove the spark plug from the applicable cylinder. [Gas Engine Ignition Spark Plug Replacement](#)
5. Install the **EN-51749** adapter to the applicable cylinder.
6. Connect the **EN-51749** adapter to a compressed air source.
7. Install the **EN-46335-A** compressor (1) above the applicable cylinder as shown.

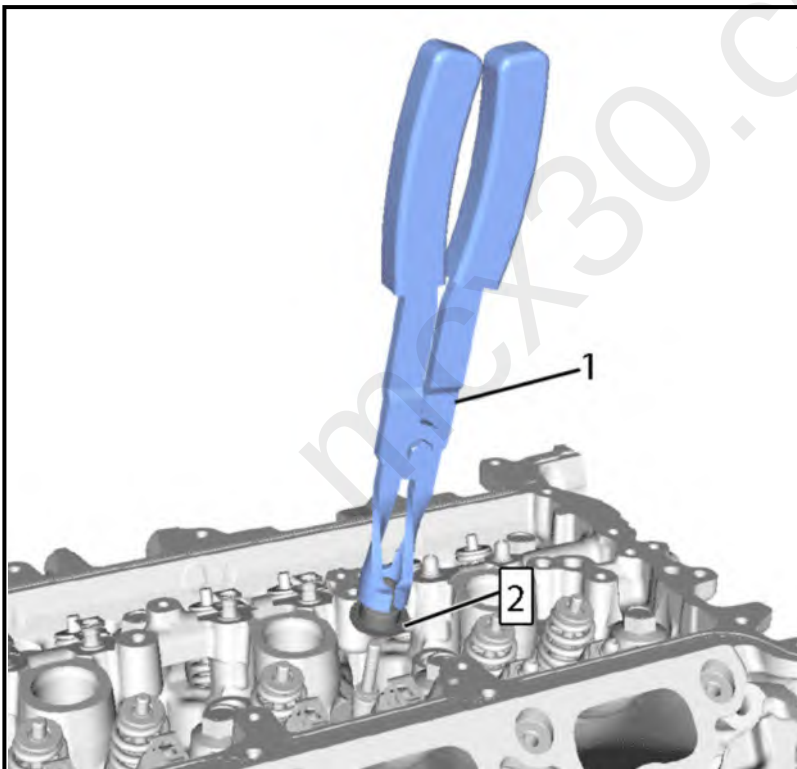


8. Tighten the **EN-46335-A** compressor bolt (2).
9. Remove the valve keepers (3).
10. Loosen the **EN-46335-A** compressor bolt and remove the compressor.
11. Valve Spring Retainer (1) - Remove



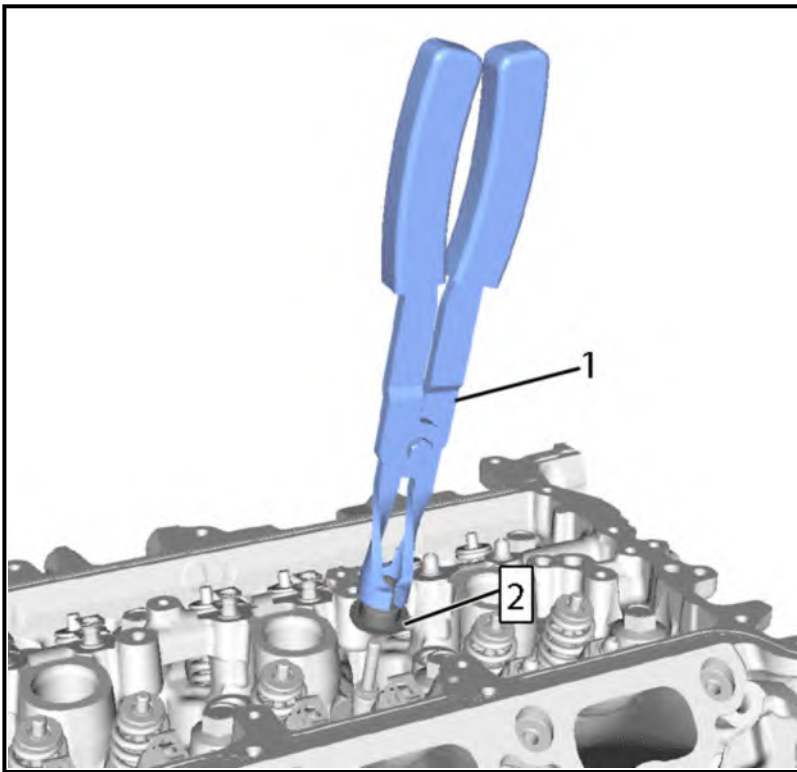
12. Valve Spring (2) - Remove

13. Use the **EN-46116** remover/installer (1) to remove the valve stem seal (2).

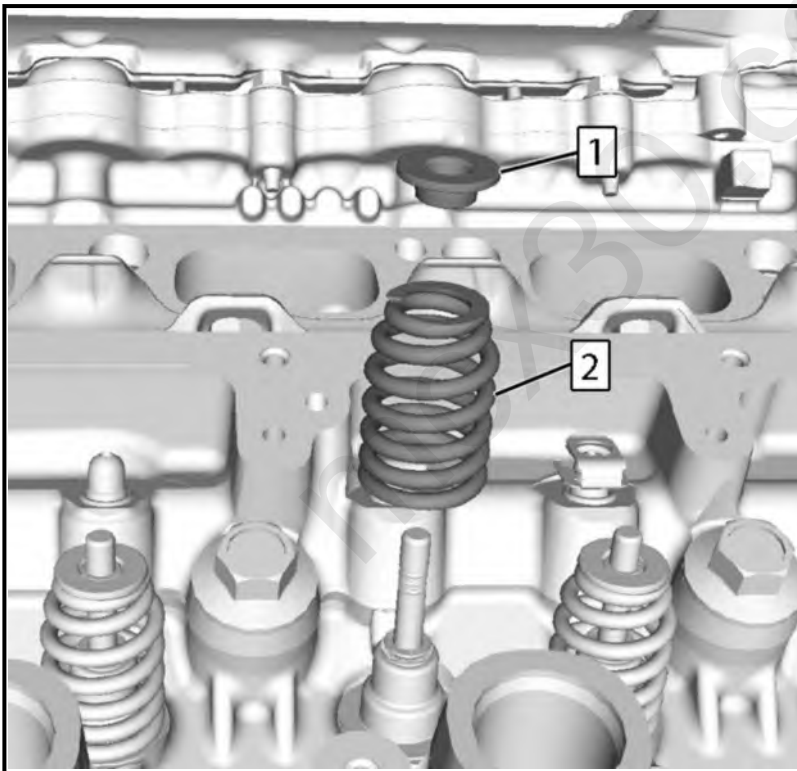


Installation Procedure

1. Use the **EN-46116** remover/installer (1) to install the valve stem seal (2).

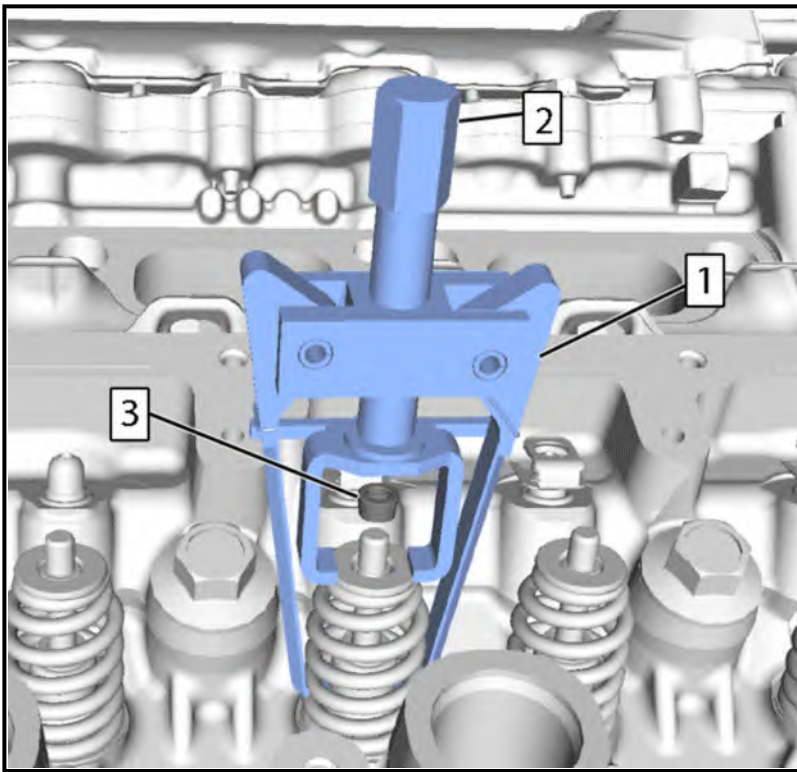


2. Valve Spring (2) - Install

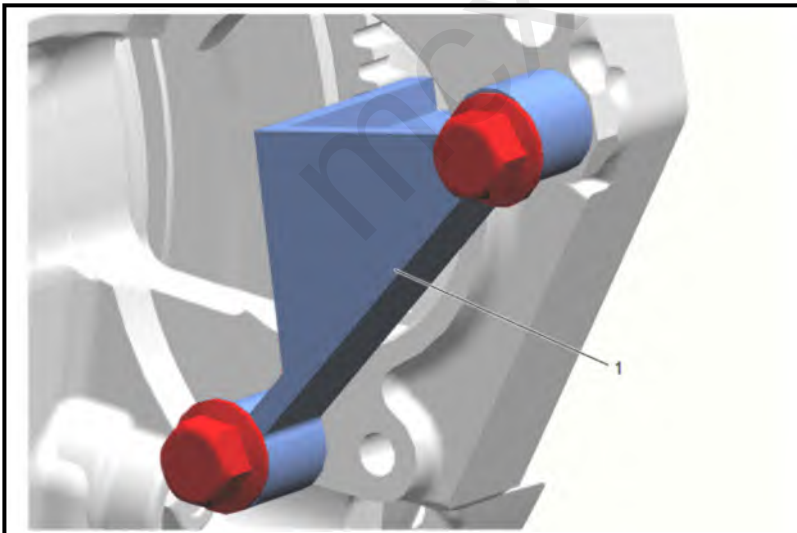


3. Valve Spring Retainer (1) - Install

4. Install the **EN-46335-A** compressor (1) above the applicable cylinder as shown.



5. Tighten the **EN-46335-A** compressor bolt (2).
6. Install the valve spring keepers (3).
7. **EN-46335-A** compressor - Remove
8. Disconnect the **EN-51749** adapter from the compressed air source.
9. **EN-51749** adapter - Remove
10. Spark Plug - Install - [Gas Engine Ignition Spark Plug Replacement](#)
11. Install the rocker arms. [Valve Rocker Arm Replacement - Left Side](#)
12. **EN-46106** tool (1) - Remove



13. Install the starter. [Starter Replacement \(LGZ\)](#)

VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT - RIGHT SIDE

Special Tools

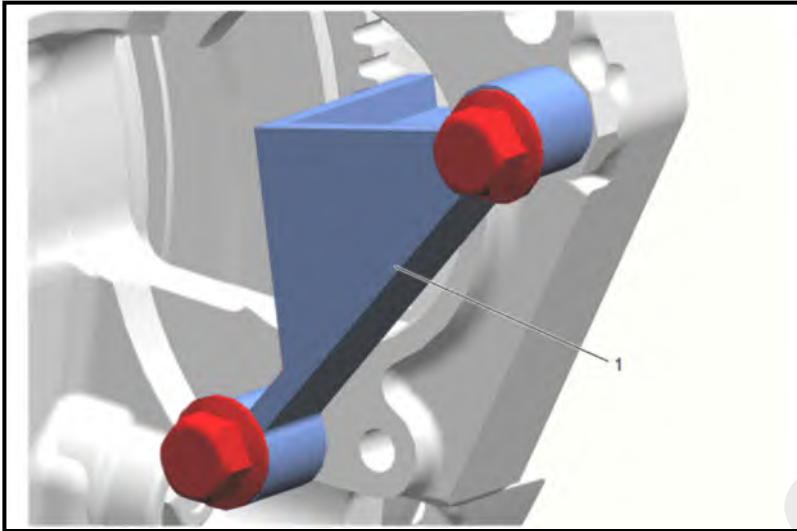
- **EN-51749** Spark Plug Port Adapter
- **EN-46106** Flywheel Holding Tool
- **EN-46335-A** On-Vehicle Valve Spring Compressor

- **EN-46116** Valve Stem Seal Remover/Installer

Equivalent regional tools: [Special Tools](#)

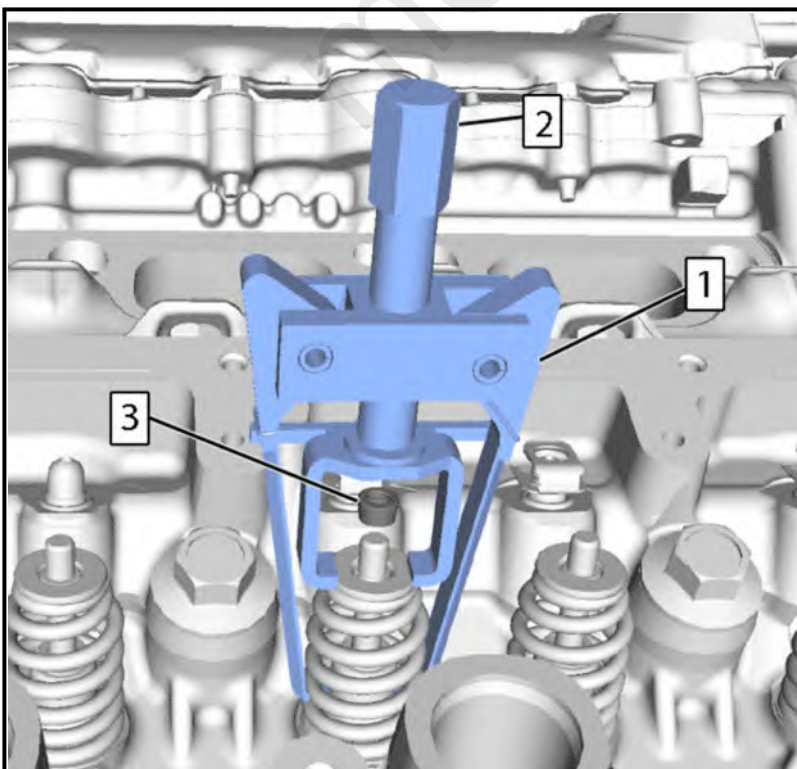
Removal Procedure

1. Remove the valve rocker arms. [Valve Rocker Arm Replacement - Right Side](#)
2. Remove the starter. [Starter Replacement \(LGZ\)](#)
3. Install the **EN-46106** tool (1) to prevent crankshaft rotation.

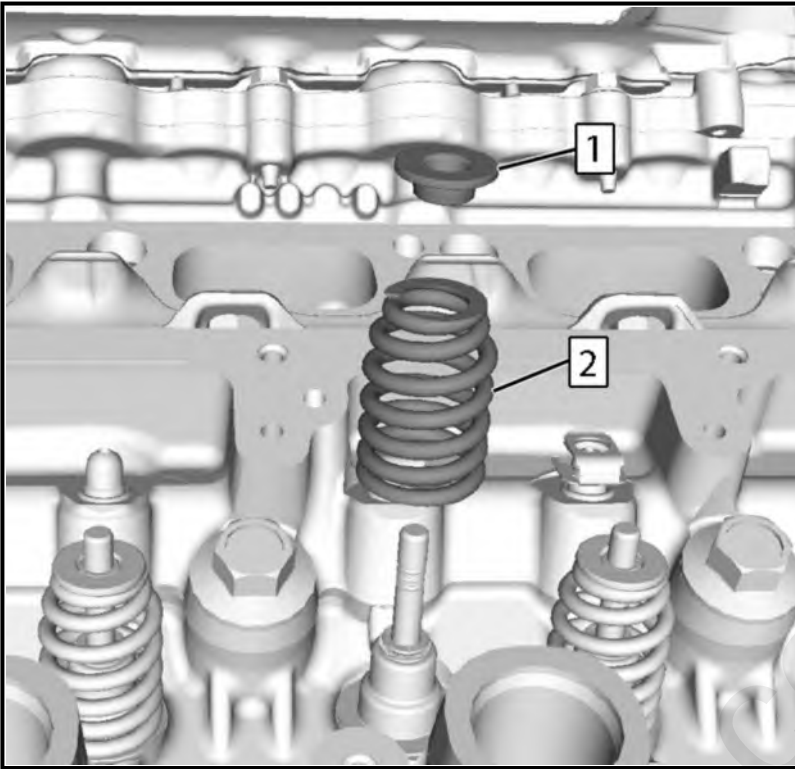


NOTE: If the EN-46106 tool is not installed, the crankshaft may rotate. If the crankshaft rotates, disassembly and reassembly of the entire camshaft timing system may be required.

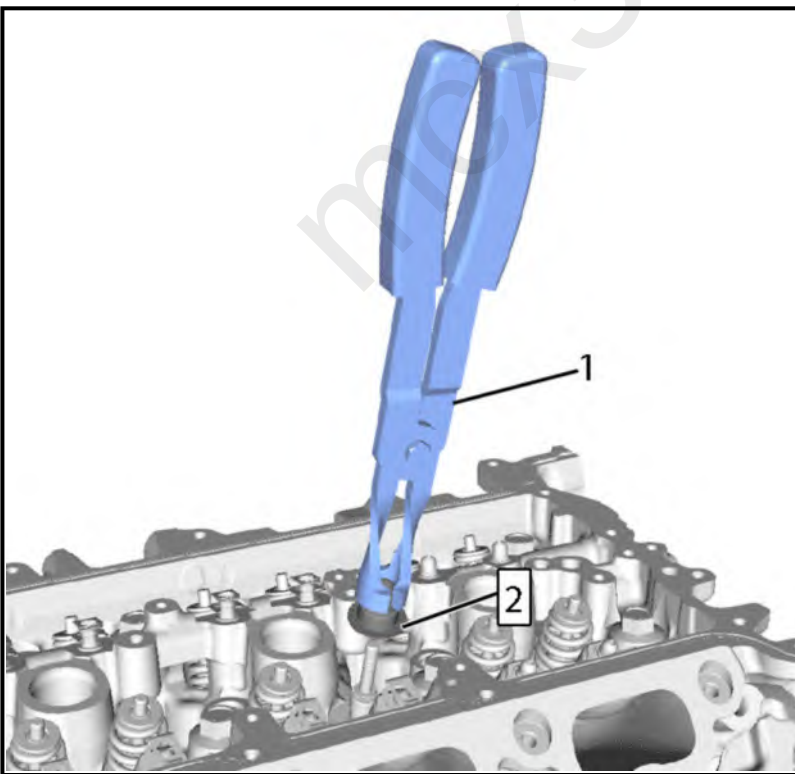
4. Remove the spark plug from the applicable cylinder. [Gas Engine Ignition Spark Plug Replacement](#)
5. Install the **EN-51749** adapter to the applicable cylinder.
6. Connect the **EN-51749** adapter to a compressed air source.
7. Install the **EN-46335-A** compressor (1) above the applicable cylinder as shown.



8. Tighten the **EN-46335-A** compressor bolt (2).
9. Remove the valve keepers (3).
10. Loosen the **EN-46335-A** compressor bolt and remove the compressor.
11. Valve Spring Retainer (1) - Remove

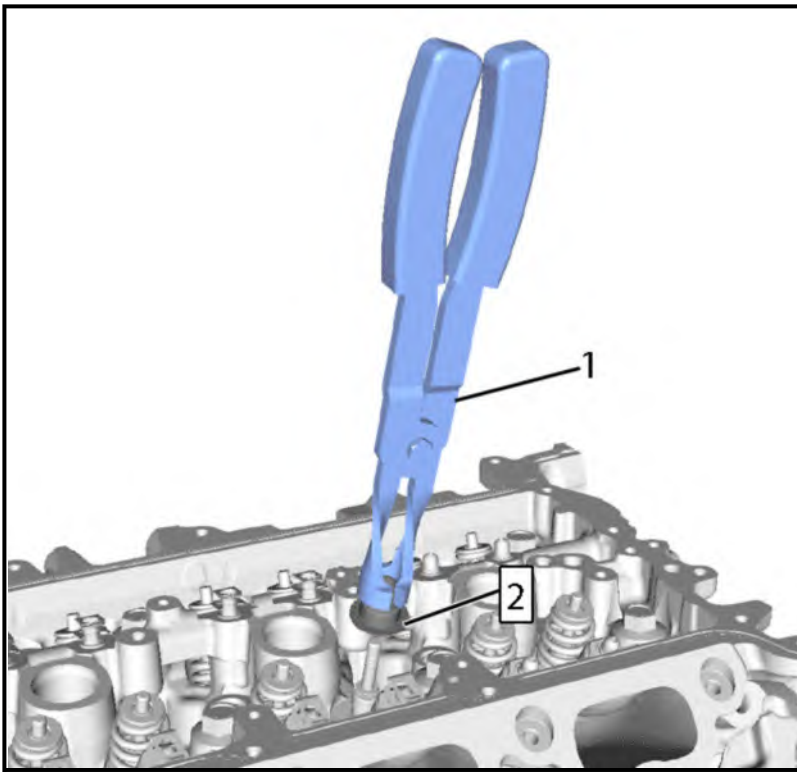


12. Valve Spring (2) - Remove
13. Use the **EN-46116** remover/installer (1) to remove the valve stem seal (2).

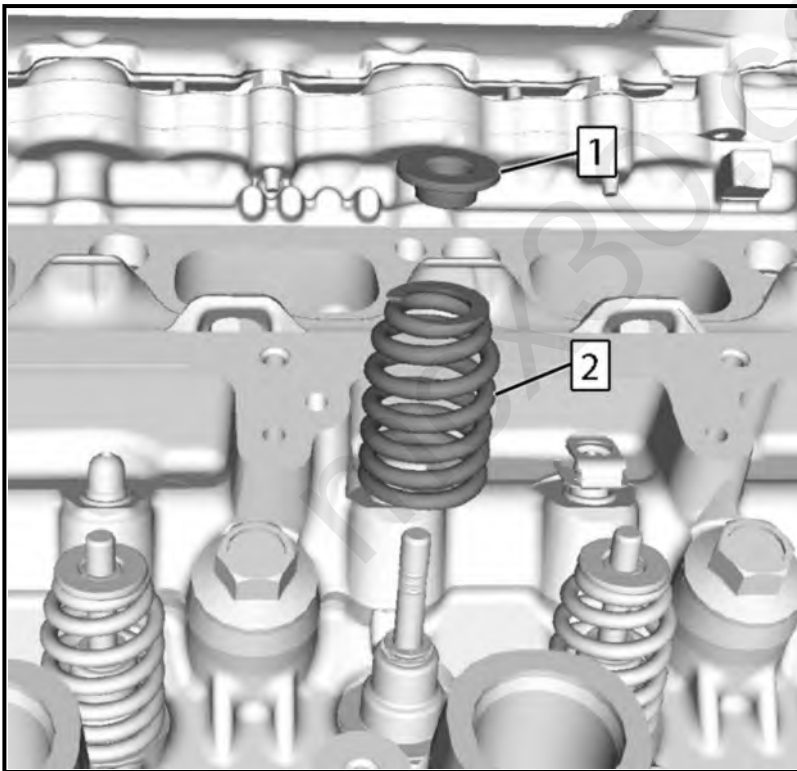


Installation Procedure

1. Use the **EN-46116** remover/installer (1) to install the valve stem seal (2).

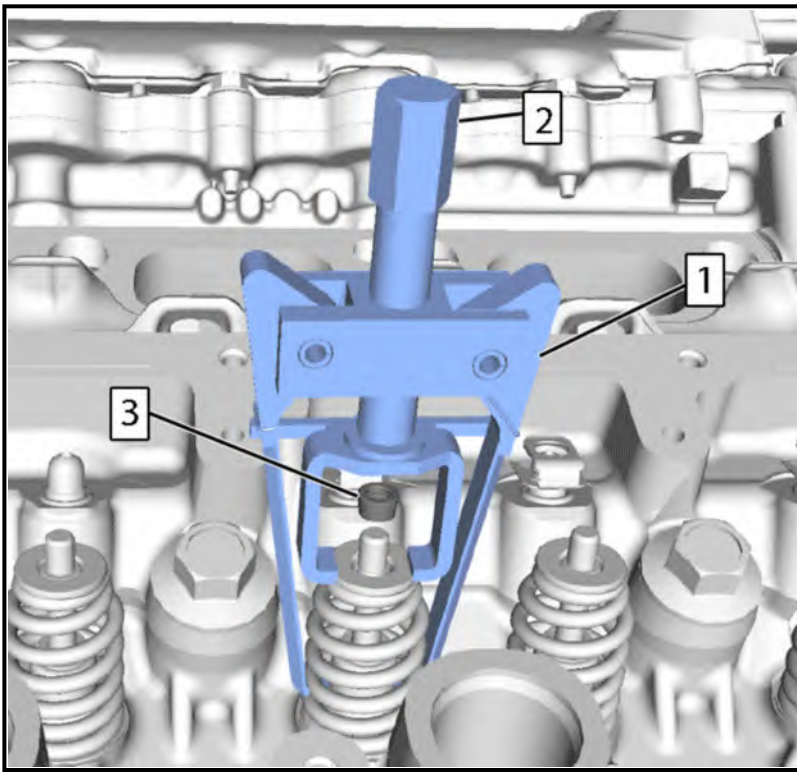


2. Valve Spring (2) - Install

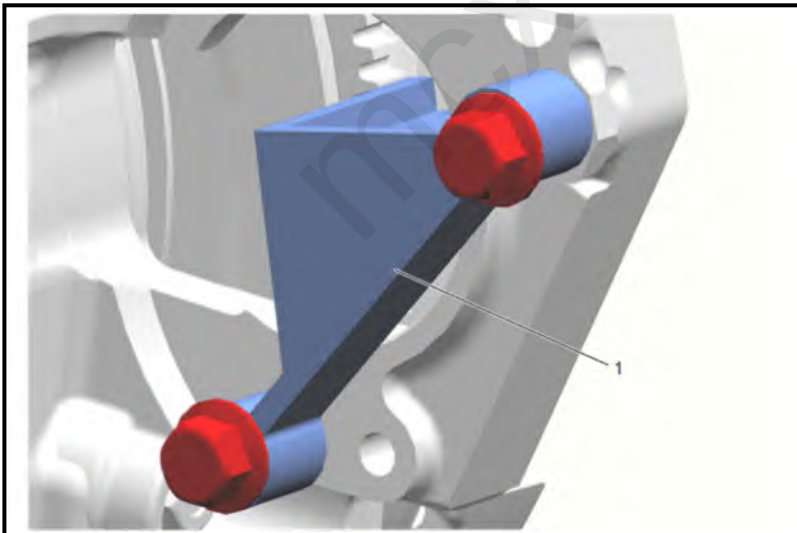


3. Valve Spring Retainer (1) - Install

4. Install the **EN-46335-A** compressor (1) above the applicable cylinder as shown.



5. Tighten the **EN-46335-A** compressor bolt (2).
6. Install the valve spring keepers (3).
7. **EN-46335-A** compressor - Remove
8. Disconnect the **EN-51749** adapter from the compressed air source.
9. **EN-51749** adapter - Remove
10. Spark Plug - Install - [Gas Engine Ignition Spark Plug Replacement](#)
11. Install the rocker arms. [Valve Rocker Arm Replacement - Right Side](#)
12. **EN-46106** tool (1) - Remove



13. Install the starter. [Starter Replacement \(LGZ\)](#)

CAMSHAFT CARRIER RESEALING - LEFT SIDE

Special Tools

- **EN-28410** Gasket Remover
- **EN - 45059** Angle Meter
- **EN-46122** Camshaft Position Actuator Check-Ball Valve Remover/Installer

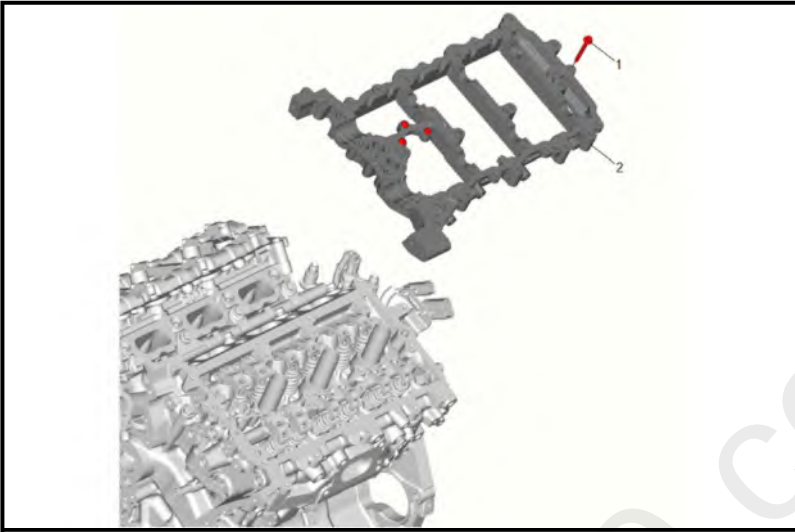
Equivalent regional tools: [Special Tools](#)

Removal Procedure

1. Camshaft Timing Chain-Left Side - Remove - [Camshaft Timing Chain Assembly Replacement - Left Side](#)

NOTE: It is not necessary to remove the camshaft position actuators from the camshafts unless visual damage is present.

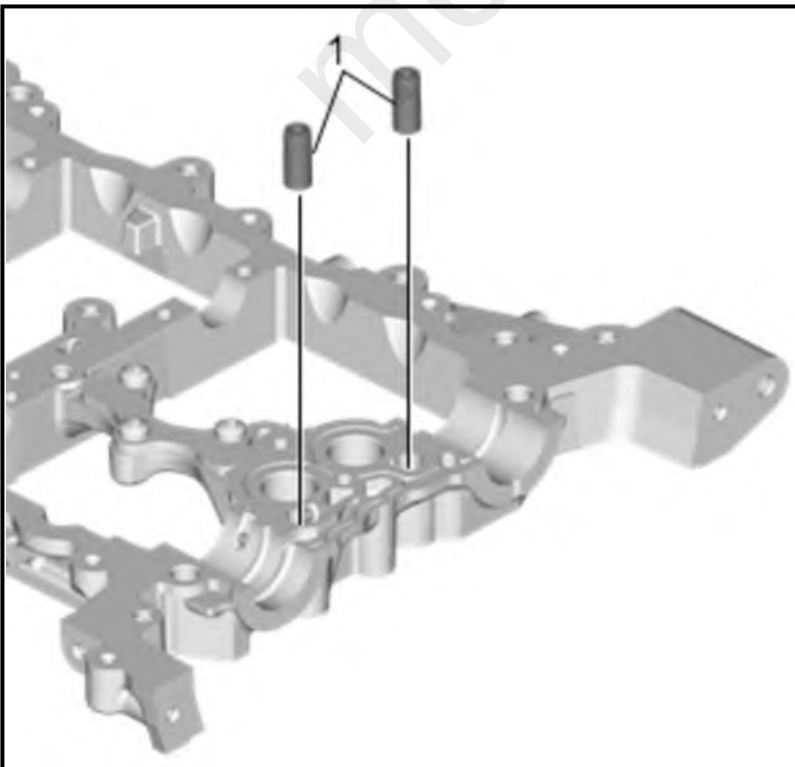
2. Camshaft-Left Side - Remove - [Camshaft Replacement - Left Side](#)
3. Camshaft Carrier Bolt (1) - Remove [13x]



4. Camshaft Carrier (2) - Remove

Camshaft Carrier Disassemble

1. Inspect the engine oil manifold check valves (1). Damaged, restricted or clogged check valves must be replaced. If the check valves require replacement, proceed to step 2.



2. Push out the engine oil manifold check valves (1) from the bottom side of the camshaft carrier.
3. Clean the check valve bore and related passages thoroughly to remove any debris.

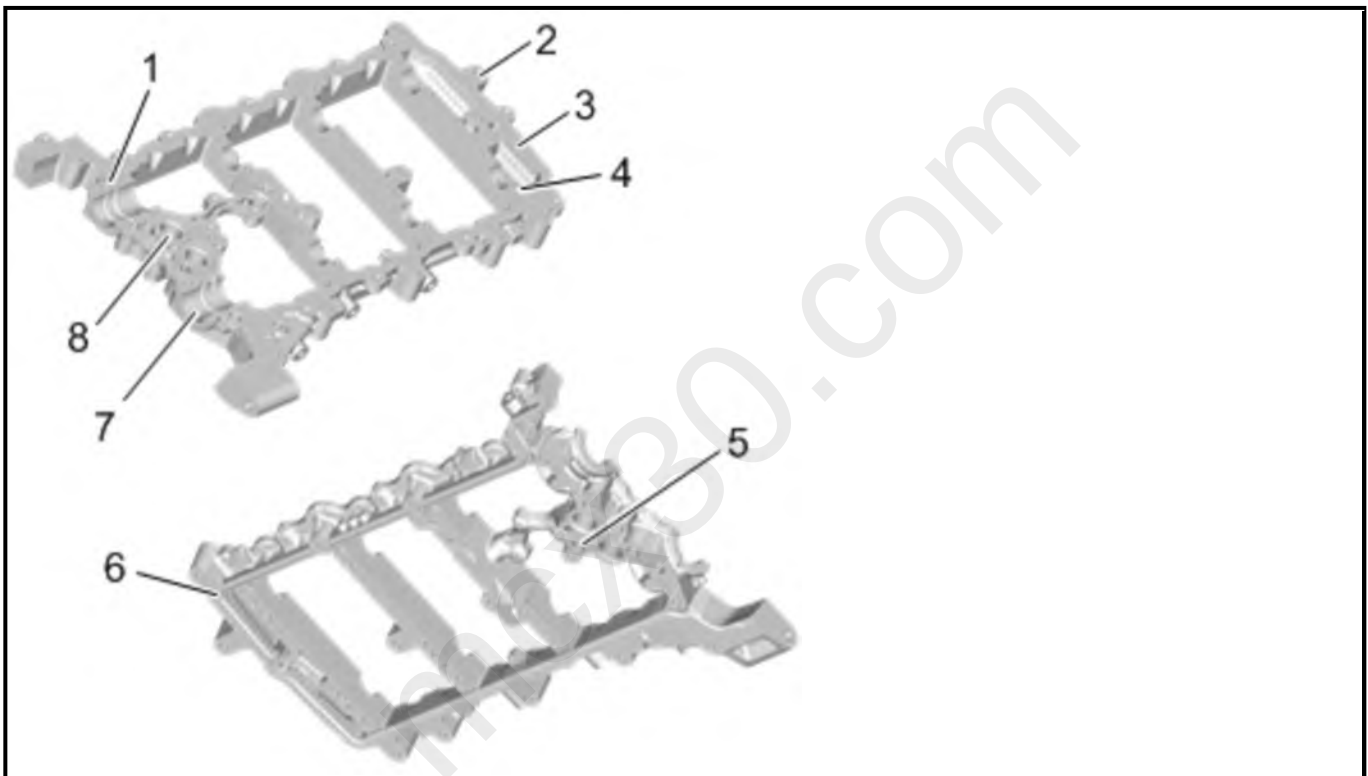
Cleaning Procedure

1. Remove old thread sealant, gasket material or RTV sealant using the **EN-28410** Gasket Remover.
2. Ensure proper use of room temperature vulcanizing (RTV) sealant. [Use of Room Temperature Vulcanizing \(RTV\) and Anaerobic Sealant](#)
3. Clean the camshaft carriers using a non corrosive solvent.
4. Clean out debris from the bolt holes.

WARNING: Refer to [Safety Glasses Warning](#) .

5. Dry the camshaft carriers with compressed air.

Inspection Procedure Left Camshaft Carrier

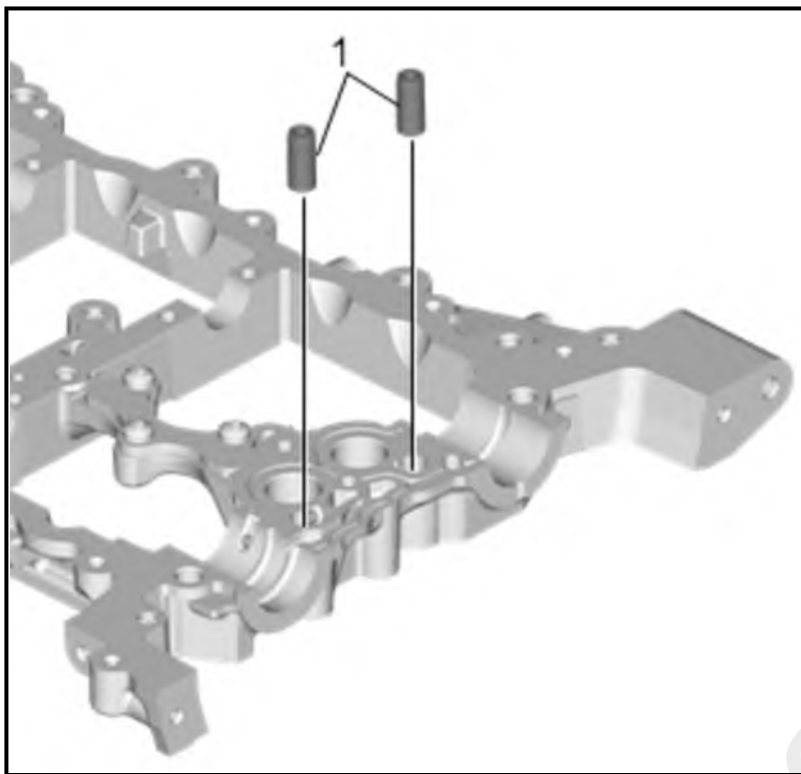


NOTE: The camshaft carrier is not a serviceable component if damaged replacement of the cylinder head is required.

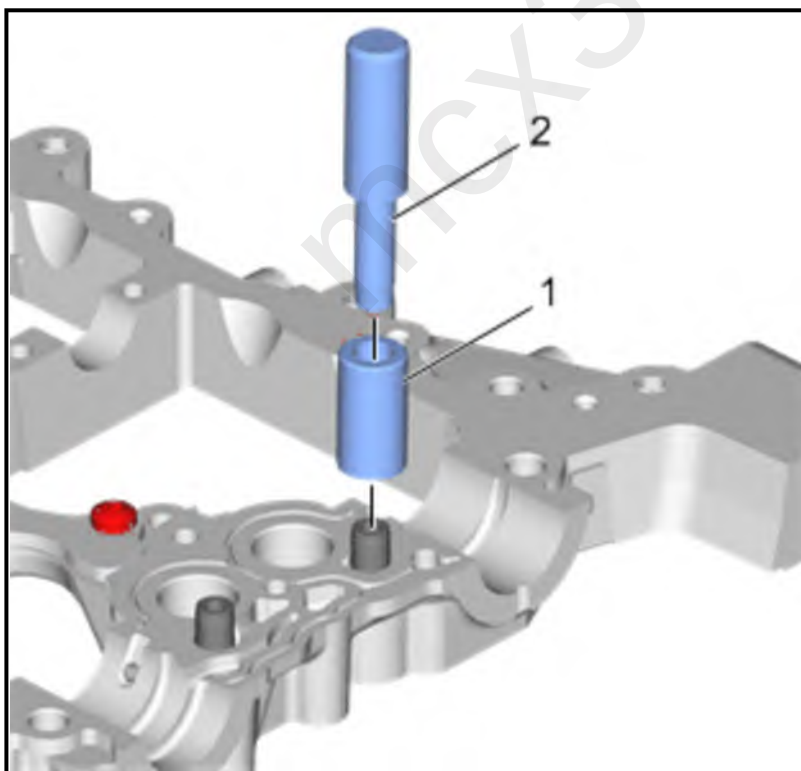
1. Inspect the camshaft carrier for the following conditions:
 - Damage to the camshaft bearing cap bolt holes (1)
 - Damage to the camshaft carrier bolt holes (2)
 - Damage to the top sealing surface (3)
 - Damage to the camshaft bearing cap bolt holes (4)
 - Damage to the engine oil manifold check valve mounting areas (5)
 - Damage to the bottom sealing surface (6)
 - Damage to the camshafts mounting surface areas (7)
 - Damage to the camshaft position actuator solenoid valve holes (8)
2. Replace the camshaft carrier and cylinder head as necessary.

Camshaft Carrier Assemble

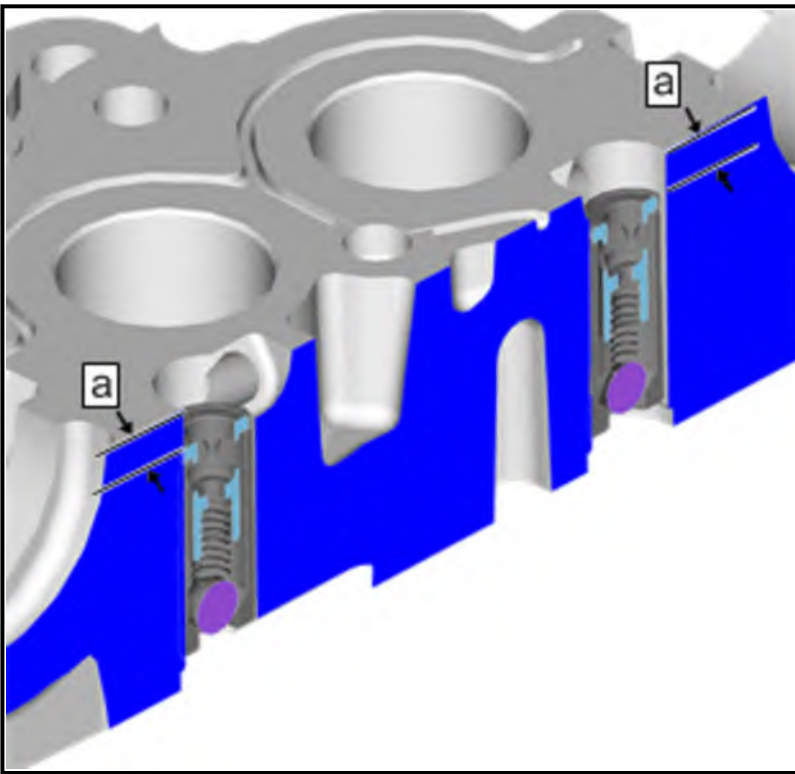
1. Use lubricant included with the **EN-46122** Camshaft Position Actuator Check-Ball Valve Remover/Installer to lubricate outside of NEW engine oil manifold check valve (1).



2. With the check ball end of the check valve facing UP, away from the head, insert the NEW engine oil manifold check valve into the check valve bore in the camshaft carrier.
3. Place collar **EN-46122 - 2** (1) over the NEW engine oil manifold check valve with the slightly-larger inside diameter of the collar DOWN toward the camshaft carrier.



4. Using the driver **EN-46122 - 1** (2), lightly tap the NEW engine oil manifold check valve into place until the driver stops against the top of the collar.
5. Inspect the engine oil manifold check valves in order to ensure they are properly installed in the camshaft carrier. The engine oil manifold check valves should be flush to 0.75 mm (0.0295 in) below the camshaft carrier deck surface (a).



Installation Procedure

1. Place a 3 mm (0.118 in) bead of RTV sealant (1) on the bottom of the camshaft carrier, following the specific bead path.

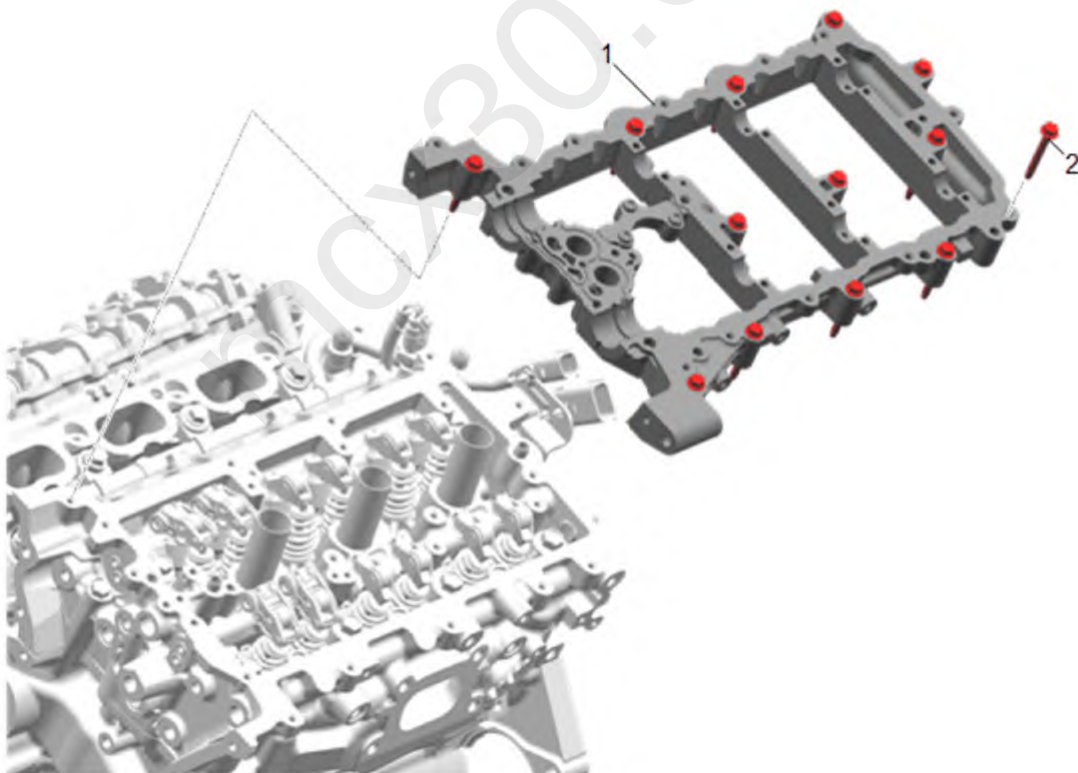


Fig. 12: Identifying Camshaft Carrier Components - Left Side With Tightening Sequence
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Do not apply more room temperature vulcanization (RTV) silicone than specified. Excess RTV silicone could plug up oil passage holes in the camshaft carrier and lead to engine damage.

NOTE: Camshaft carrier surfaces should be free and clean of oil and foreign substances.

NOTE: Ensure proper use of room temperature vulcanizing (RTV) sealant. Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant

2. Place a 5 mm (0.197 in) bead of RTV sealant (1) on the bottom of the camshaft carrier as arrows show. Refer to Adhesives, Fluids, Lubricants, and Sealers for recommended sealant.
3. Camshaft Carrier (2) - Install

CAUTION: Refer to Fastener Caution .

4. Camshaft Carrier Bolt (1) - Install and tighten in sequence [13x]
 1. First Pass: 6 N.m (53 lb in)
 2. Final Pass: 60 degrees using the EN - 45059 Angle Meter
5. Camshaft-Left Side - Install - Camshaft Replacement - Left Side
6. Camshaft Timing Chain-Left Side - Install - Camshaft Timing Chain Assembly Replacement - Left Side

CAMSHAFT CARRIER RESEALING - RIGHT SIDE

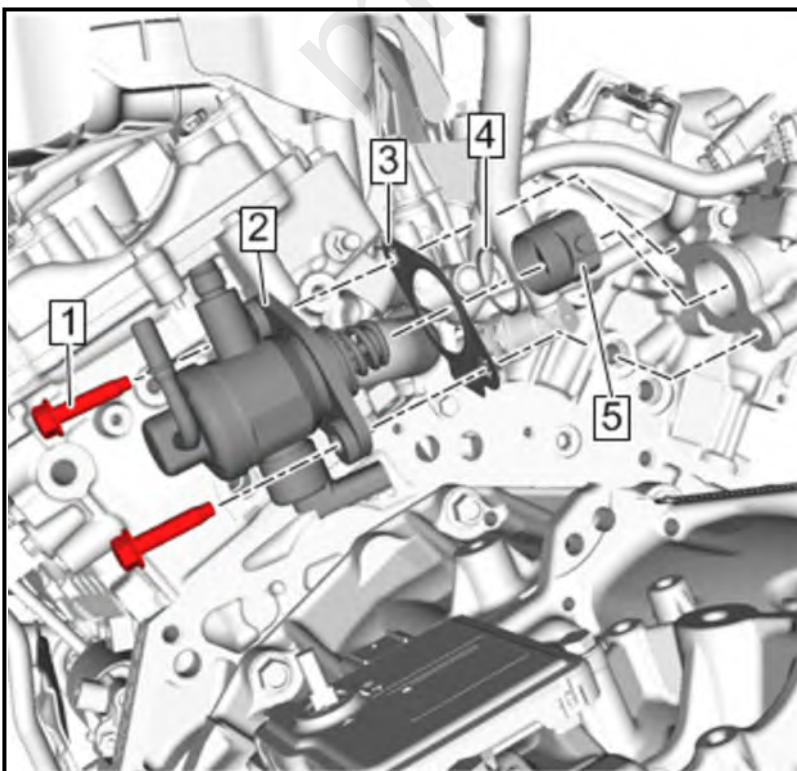
Special Tools

- EN-28410 Gasket Remover
- EN - 45059 Angle Meter
- EN-46122 Camshaft Position Actuator Check-Ball Valve Remover/Installer

Equivalent regional tools: Special Tools

Removal Procedure

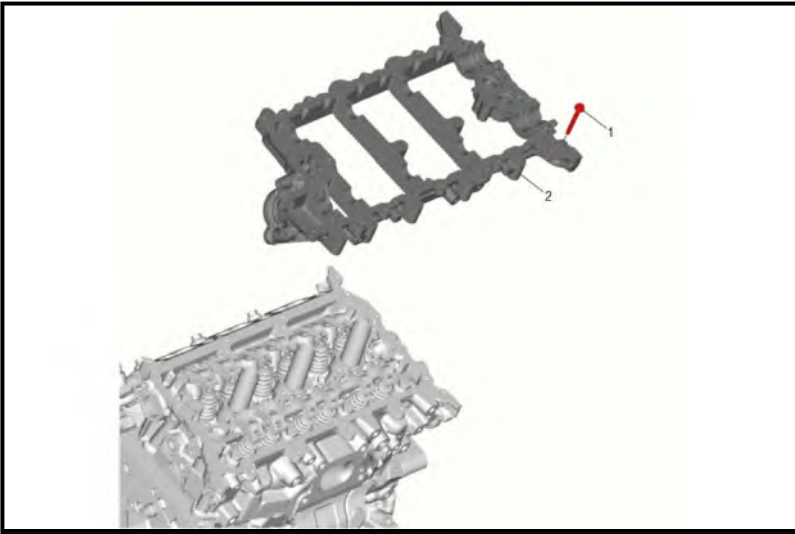
1. Camshaft Timing Chain-Right Side - Remove - Camshaft Timing Chain Assembly Replacement - Right Side
2. Fuel Pump (2) - Remove - Fuel Pump Replacement



NOTE:

It is not necessary to remove the camshaft position actuators from the camshafts unless visual damage is present.

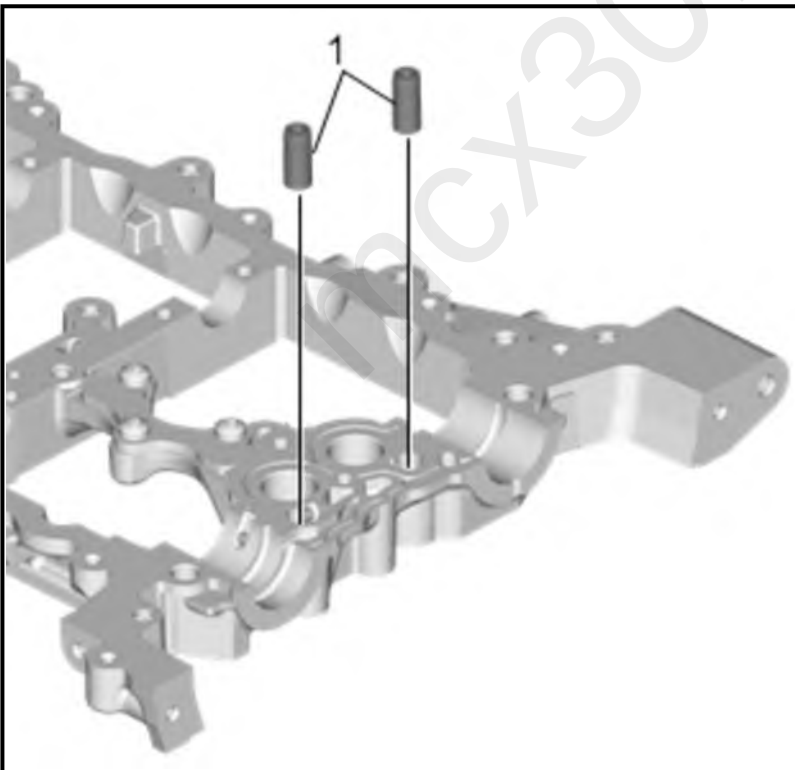
3. Camshaft-Right Side - Remove - [Camshaft Replacement - Right Side](#)
4. Camshaft Carrier Bolt (1) - Remove [14x]



5. Camshaft Carrier (2) - Remove

Camshaft Carrier Disassemble

1. Inspect the engine oil manifold check valves (1). Damaged, restricted or clogged check valves must be replaced. If the check valves require replacement, proceed to step 2.



2. Push out the engine oil manifold check valves (1) from the bottom side of the camshaft carrier.
3. Clean the check valve bore and related passages thoroughly to remove any debris.

Cleaning Procedure

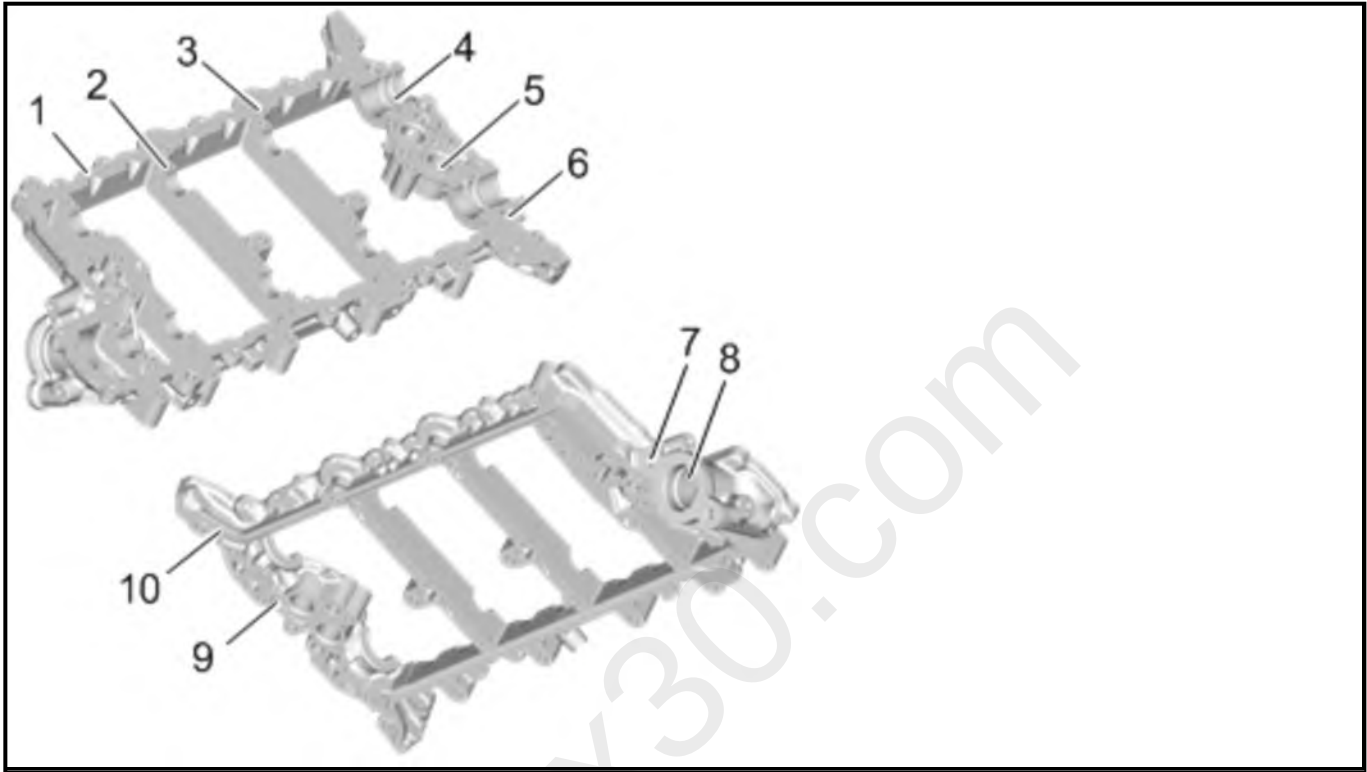
1. Remove old thread sealant, gasket material or RTV sealant using the **EN-28410** Gasket Remover.

2. Ensure proper use of room temperature vulcanizing (RTV) sealant. [Use of Room Temperature Vulcanizing \(RTV\) and Anaerobic Sealant](#)
3. Clean the camshaft carriers using a non corrosive solvent.
4. Clean out debris from the bolt holes.

WARNING: Refer to [Safety Glasses Warning](#) .

5. Dry the camshaft carriers with compressed air.

Inspection Procedure Right Camshaft Carrier

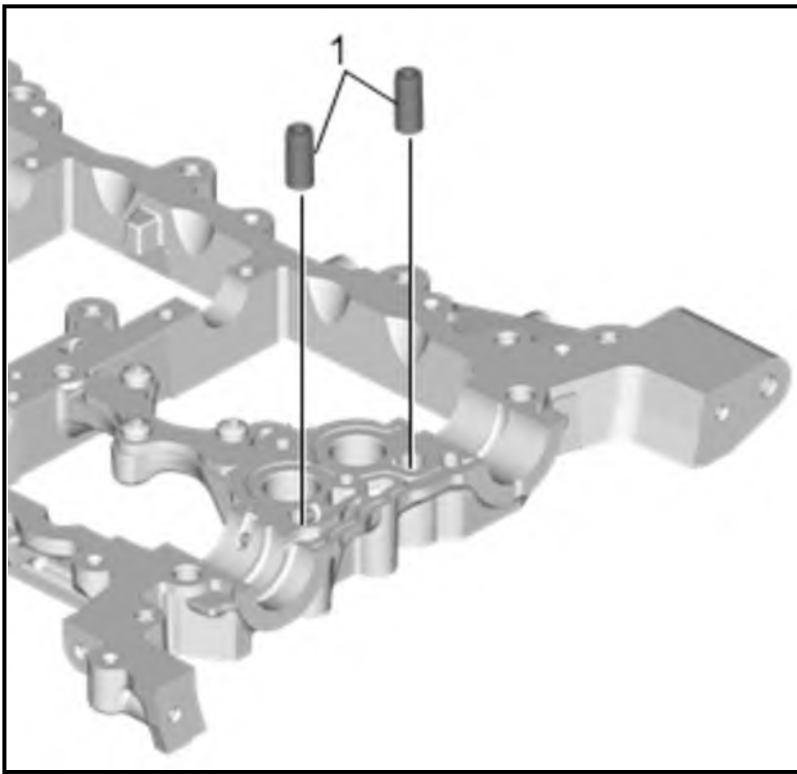


NOTE: The camshaft carrier is not a serviceable component if damaged replacement of the cylinder head is required.

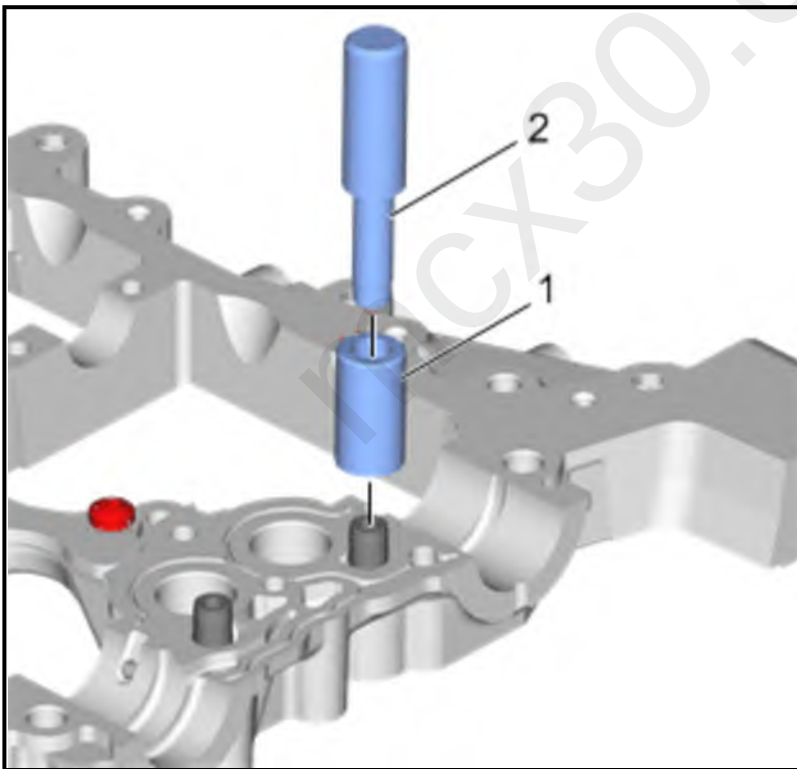
1. Inspect the camshaft carrier for the following conditions:
 - Damage to the top sealing surface (1)
 - Damage to the camshaft bearing cap bolt holes (2)
 - Damage to the camshaft carrier bolt holes (3)
 - Damage to the camshafts mounting surface areas (4)
 - Damage to the camshaft position actuator solenoid valve holes (5)
 - Damage to the camshaft bearing cap bolt holes (6)
 - Damage to the fuel pump bolt holes (7)
 - Damage to the fuel pump mounting surface and the valve lifter follower area (8)
 - Damage to the engine oil manifold check valve mounting areas (9)
 - Damage to the bottom sealing surface (10)
2. Replace the camshaft carrier and cylinder head as necessary.

Camshaft Carrier Assemble

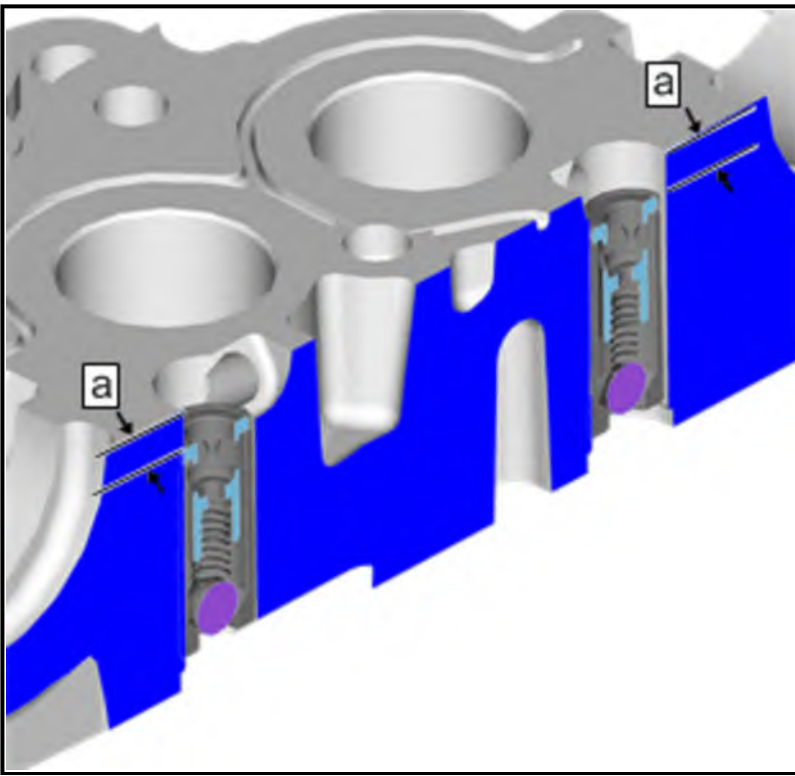
1. Use lubricant included with the **EN-46122** Camshaft Position Actuator Check-Ball Valve Remover/Installer to lubricate outside of NEW engine oil manifold check valve (1).



2. With the check ball end of the check valve facing UP, away from the head, insert the NEW engine oil manifold check valve into the check valve bore in the camshaft carrier.
3. Place collar **EN-46122 - 2** (1) over the NEW engine oil manifold check valve with the slightly-larger inside diameter of the collar DOWN toward the camshaft carrier.



4. Using the driver **EN-46122 - 1** (2), lightly tap the NEW engine oil manifold check valve into place until the driver stops against the top of the collar.
5. Inspect the engine oil manifold check valves in order to ensure they are properly installed in the camshaft carrier. The engine oil manifold check valves should be flush to 0.75 mm (0.0295 in) below the camshaft carrier deck surface (a).



Installation Procedure

1. Place a 3 mm (0.118 in) bead of RTV sealant (1) on the bottom of the camshaft carrier, following the specific bead path.

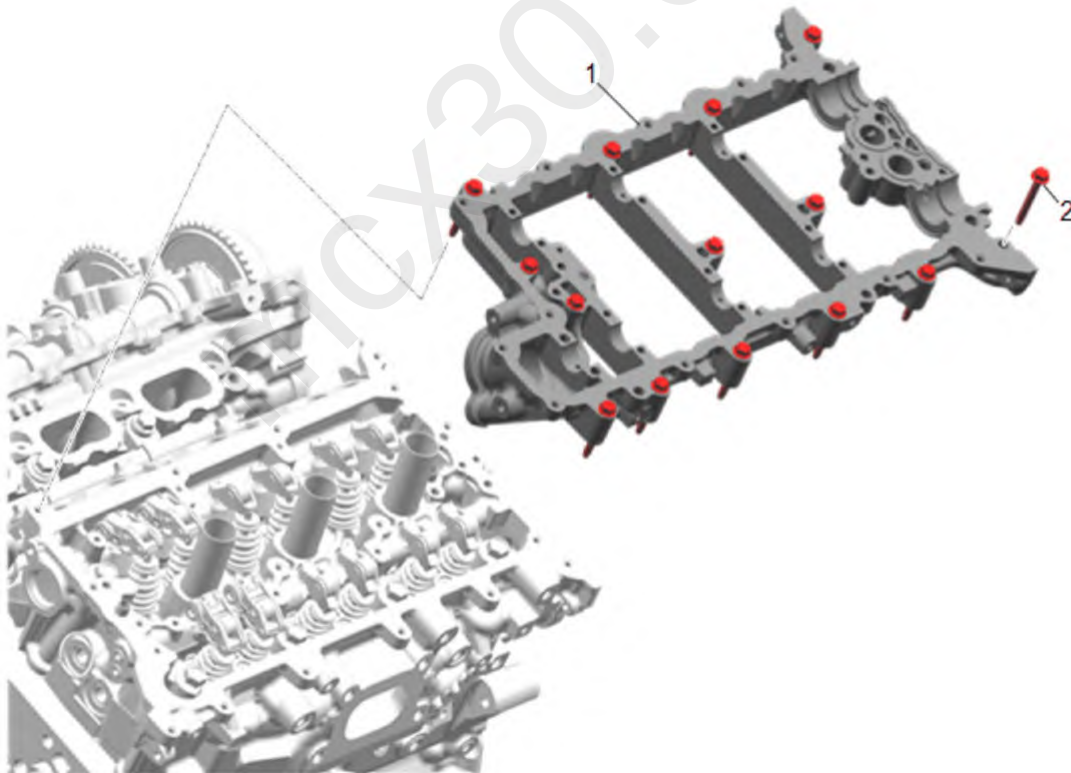


Fig. 13: Identifying Camshaft Carrier Components - Right Side With Tightening Sequence
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Do not apply more room temperature vulcanization (RTV) silicone than specified. Excess RTV silicone could plug up oil passage holes in the camshaft carrier and lead to engine damage.

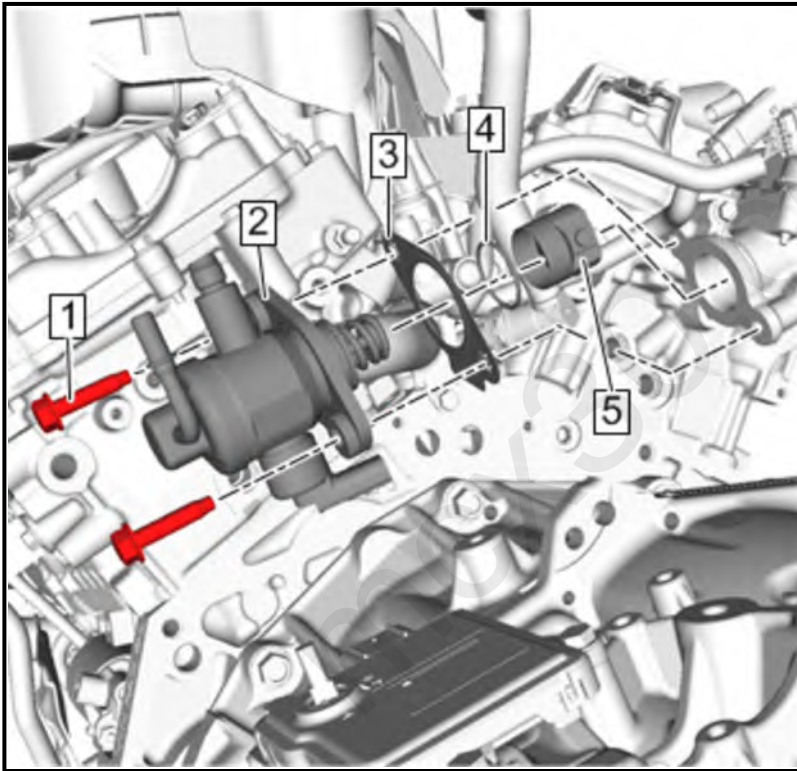
NOTE: Camshaft carrier surfaces should be free and clean of oil and foreign substances.

NOTE: Ensure proper use of room temperature vulcanizing (RTV) sealant. Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant

2. Place a 5 mm (0.197 in) bead of RTV sealant (1) on the bottom of the camshaft carrier as arrows show. Refer to Adhesives, Fluids, Lubricants, and Sealers for recommended sealant.
3. Camshaft Carrier (2) - Install

CAUTION: Refer to Fastener Caution .

4. Camshaft Carrier Bolt (1) - Install and tighten in sequence [14x]
 1. First Pass: 6 N.m (53 lb in)
 2. Final Pass: 60 degrees using the EN - 45059 Angle Meter
5. Camshaft-Right Side - Install - Camshaft Replacement - Right Side
6. Fuel Pump (2) - Install - Fuel Pump Replacement



7. Camshaft Timing Chain-Right Side - Install - Camshaft Timing Chain Assembly Replacement - Right Side

CYLINDER HEAD REPLACEMENT - LEFT SIDE

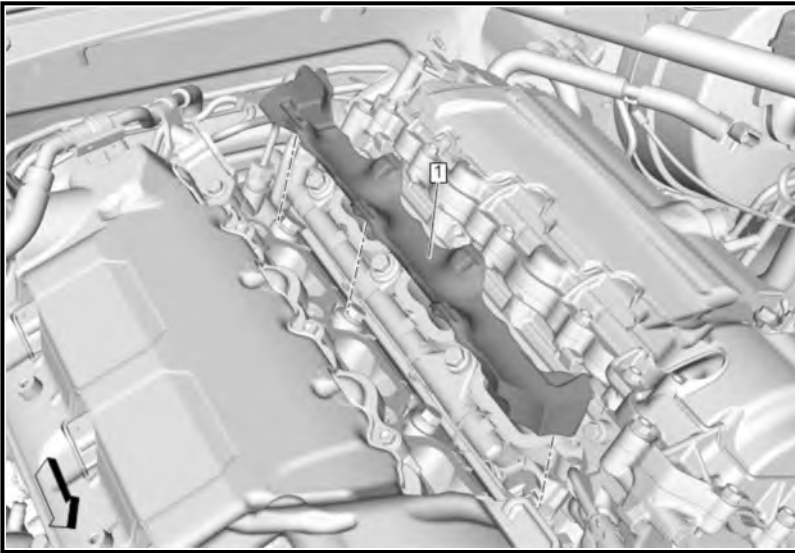
Special Tools

EN - 45059 Angle Meter

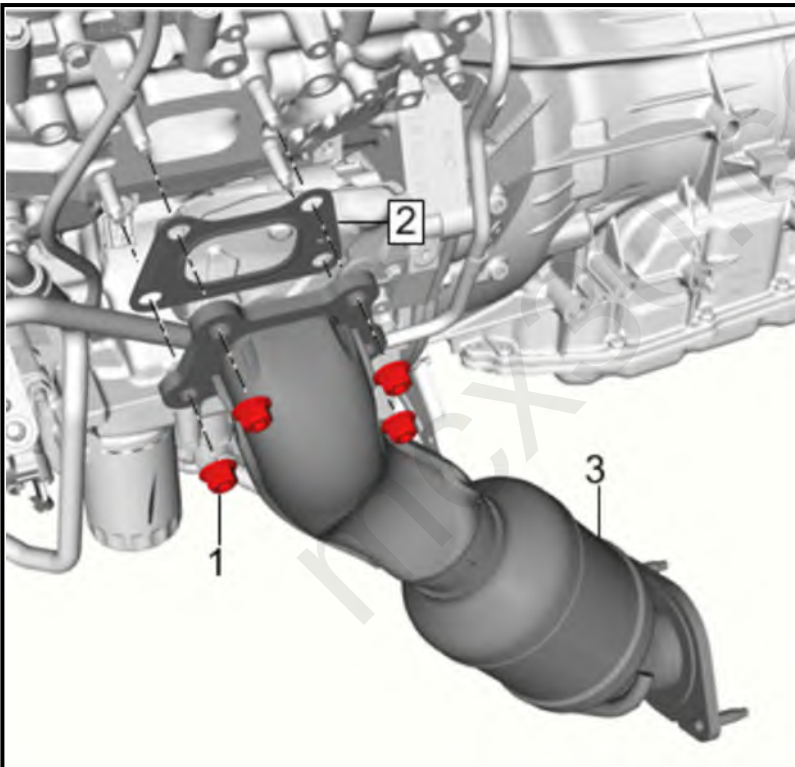
Equivalent regional tools: Special Tools .

Removal Procedure

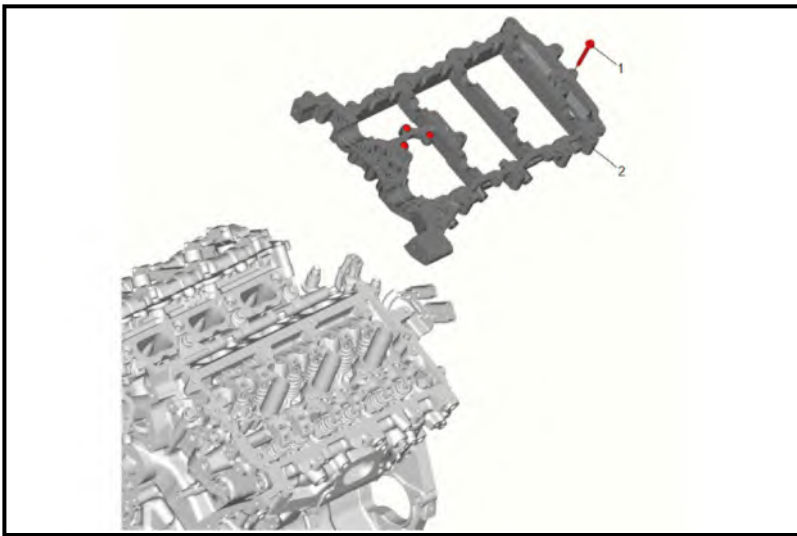
1. Camshaft Timing Chain-Left Side - Remove - Camshaft Timing Chain Assembly Replacement - Left Side
2. Fuel Injection Fuel Rail Noise Shield (1) - Remove - Fuel Injection Fuel Rail Noise Shield Replacement (Upper) , or Fuel Injection Fuel Rail Noise Shield Replacement (Lower).



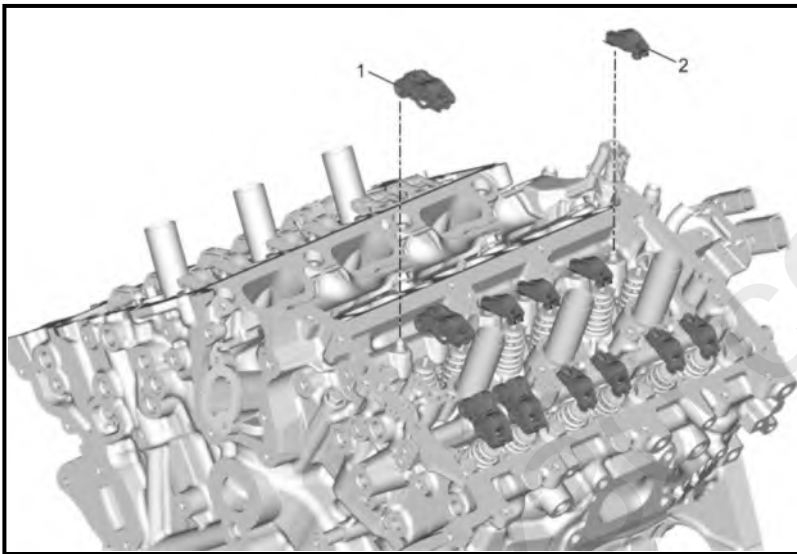
3. Fuel Feed Intermediate Pipe - Remove - [Fuel Feed Intermediate Pipe Replacement](#)
4. Warm Up Three-Way Catalytic Converter (3) @ Bank 2 - Remove - [Warm Up Three-Way Catalytic Converter Replacement \(Right Side, LGZ\)](#) , or [Warm Up Three-Way Catalytic Converter Replacement \(Left Side, LGZ 2WD\)](#) , or [Warm Up Three-Way Catalytic Converter Replacement \(Left Side, LGZ 4WD\)](#)



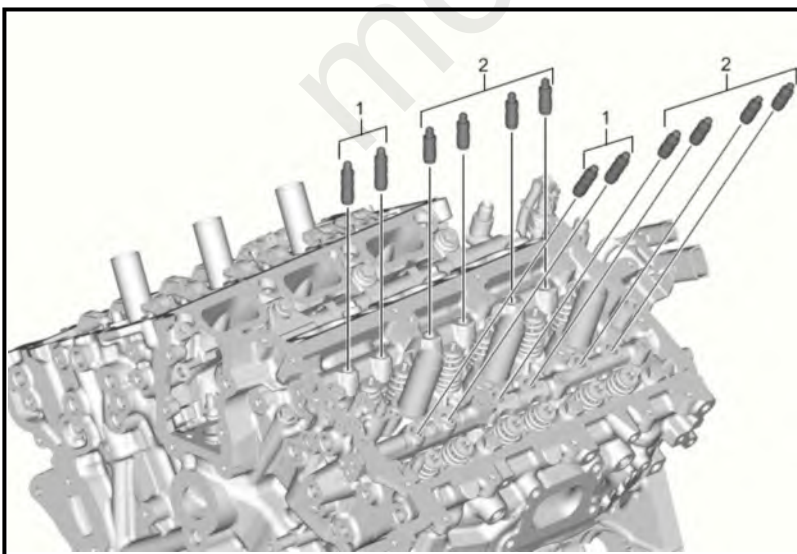
5. Camshaft-Left Side - Remove - [Camshaft Replacement - Left Side](#)
6. Camshaft Carrier-Left Side (2) - Remove - [Camshaft Carrier Resealing - Left Side](#)



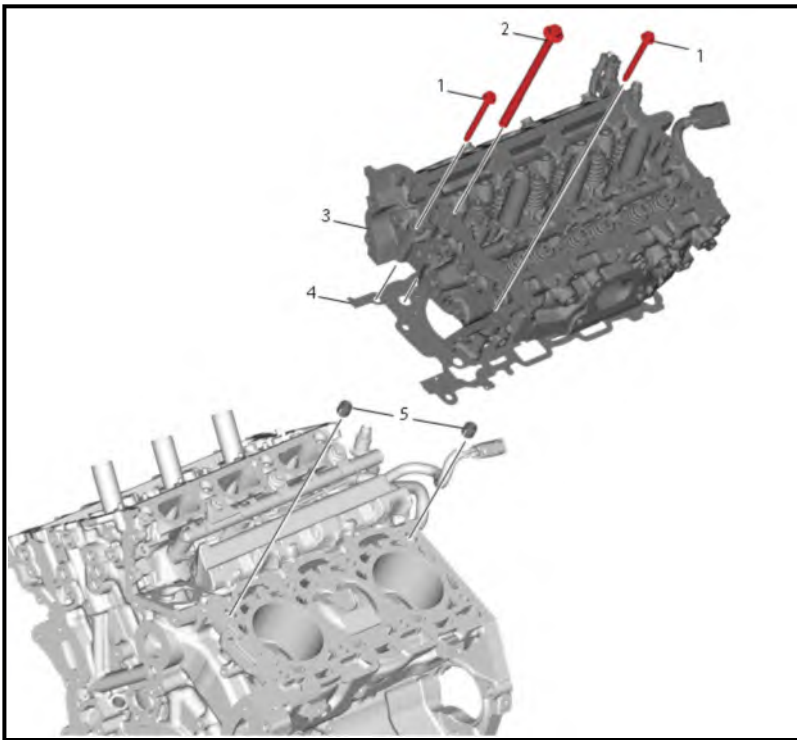
7. Valve Rocker Arm-Left Side - Remove - [Valve Rocker Arm Replacement - Left Side](#)



8. Valve Lifter-Left Side - Remove - [Valve Lifter Replacement - Left Side](#)

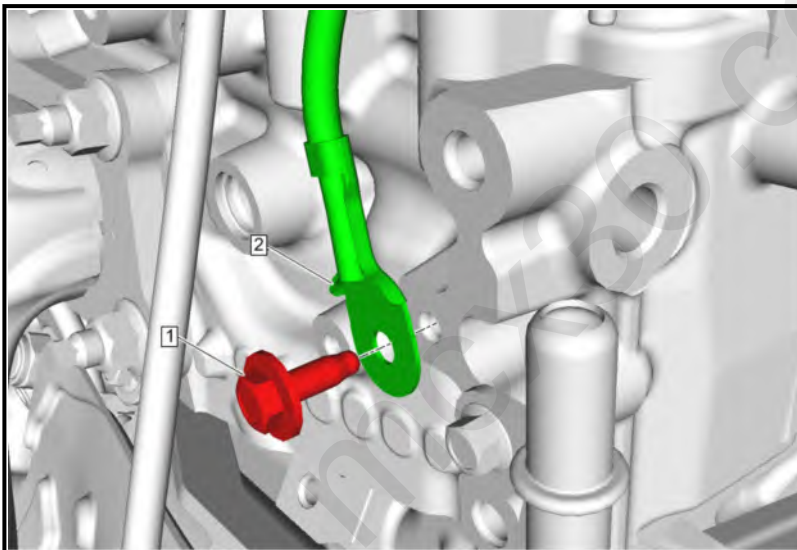


9. Cylinder Head BoltM8 x 80.8 (1) - Remove and DISCARD [2x]

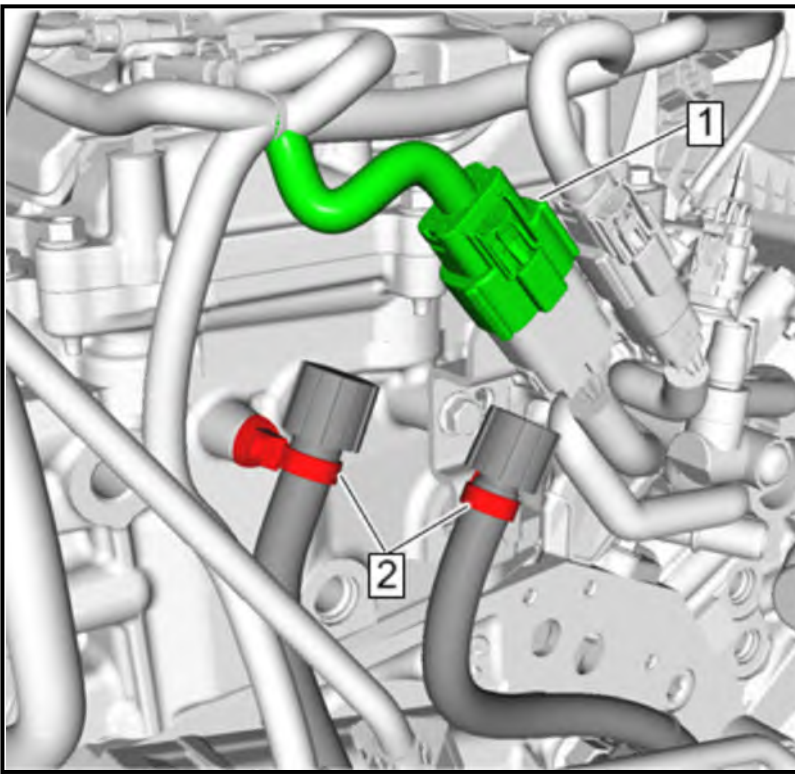


10. Cylinder Head Bolt M11 x 178 (2) - Remove and DISCARD [8x]

11. Remove the ground wire bolt (1) and ground wire (2).



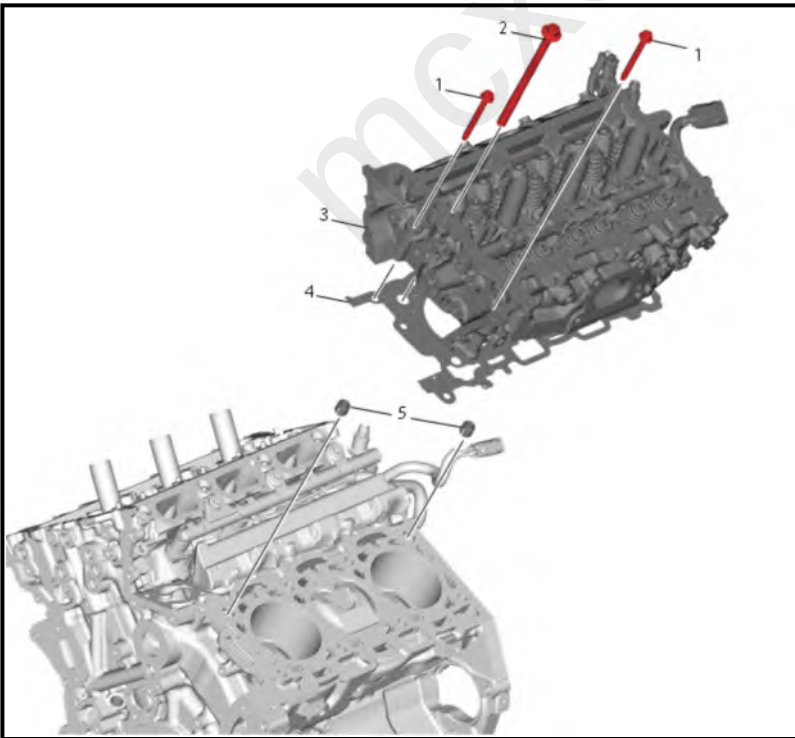
12. Disconnect fuel rail connector (1).



13. Detach vent hose retainers (2) from cylinder head.
14. Disconnect and reposition harness as necessary.
15. Cylinder Head (3) - Remove
16. Cylinder Head Gasket (4) - Remove and DISCARD
17. Clean, inspect and overhaul the cylinder head as needed. [Cylinder Head Overhaul](#)

Installation Procedure

1. Ensure the cylinder head locating pins (5) are securely mounted in the engine block deck face.



2. Install a NEW cylinder head gasket (4) using the deck face locating pins for retention.
3. Cylinder Head (3) - Install
4. Cylinder Head Bolt M8 x 80.8 (3) - Install NEW and tighten in sequence [2x]

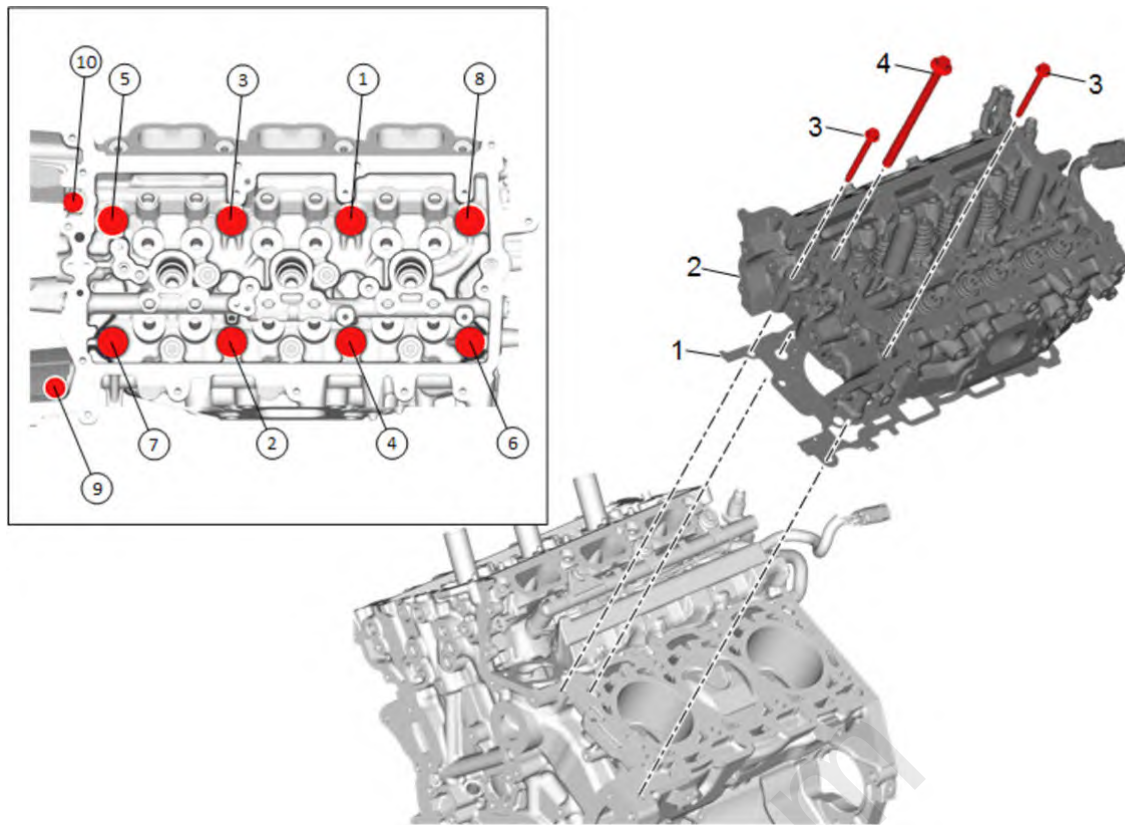
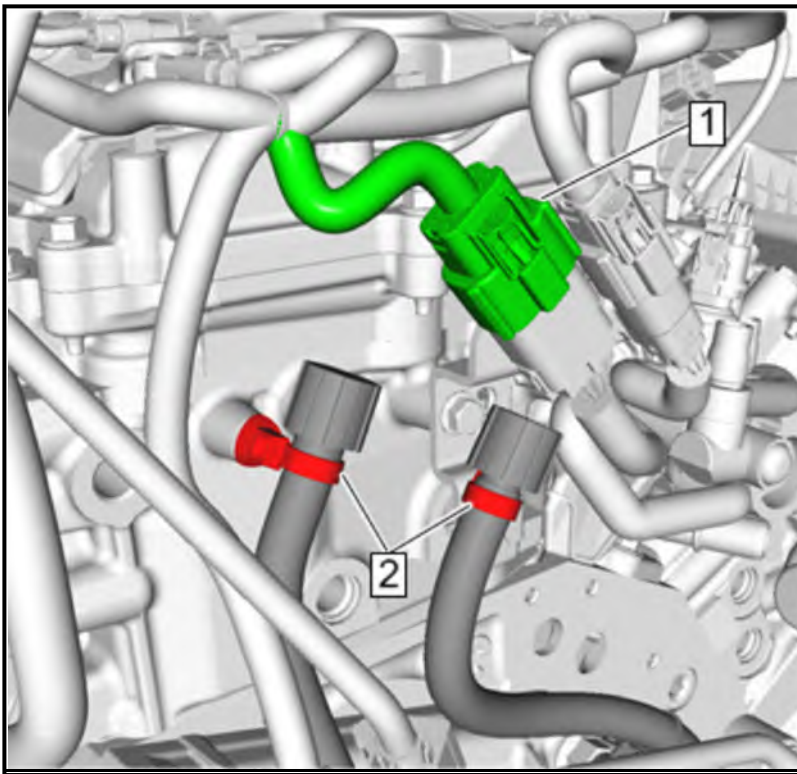


Fig. 14: Exploded View Of Cylinder Head Components - Left Side With Tightening Sequence
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to **Fastener Caution** .

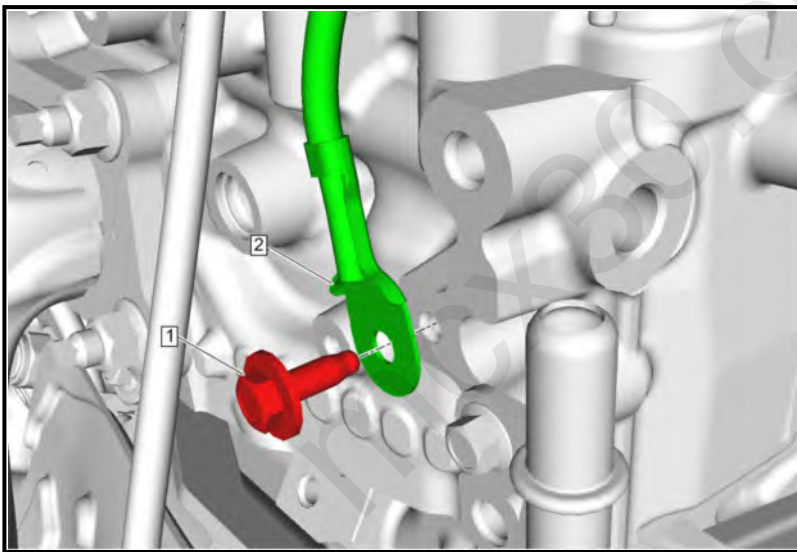
CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a **NEW** torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

1. First Pass: 15 N.m (11 lb ft)
2. Final Pass: 75 degrees
5. Cylinder Head Bolt M11 x 178 (4) - Install NEW and tighten in sequence [8x]
 1. First Pass: 60 N.m (44 lb ft)
 2. Final Pass: 185 degrees
6. Position and connect harness as necessary.
7. Attach vent hose retainers (2) from cylinder head.

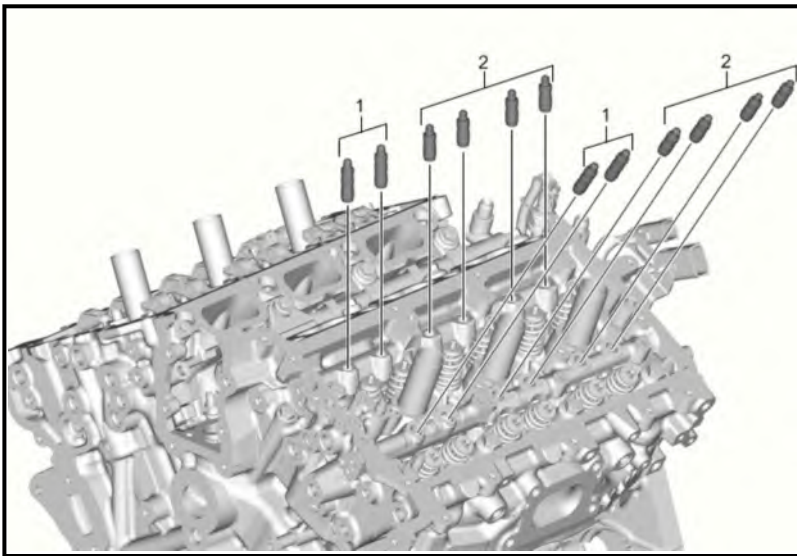


8. Connect fuel rail connector (1).

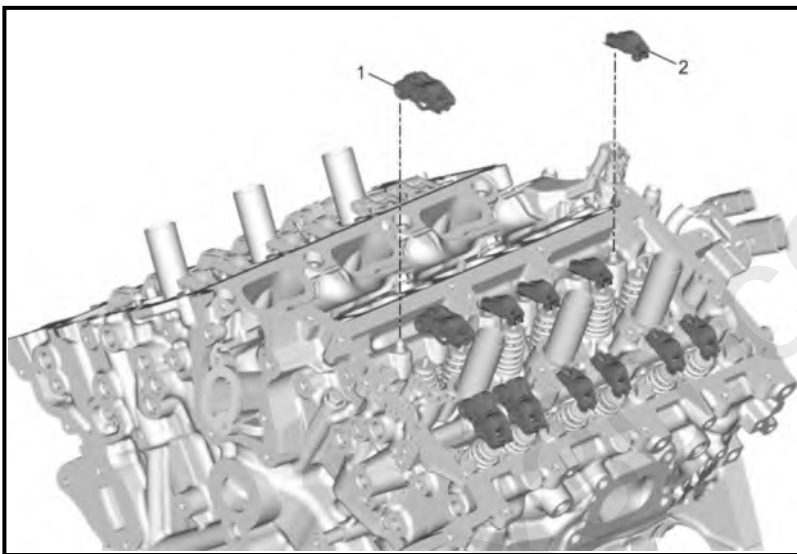
9. Install ground wire (2) and ground wire bolt (1). Tighten bolt to 9 N.m (80 lb in).



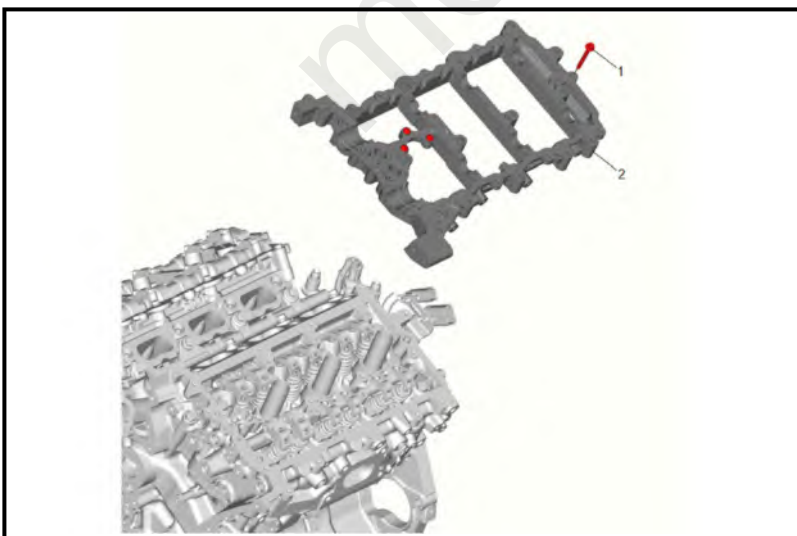
10. Valve Lifter-Left Side - Install - [Valve Lifter Replacement - Left Side](#)



11. Valve Rocker Arm-Left Side - Install - [Valve Rocker Arm Replacement - Left Side](#)

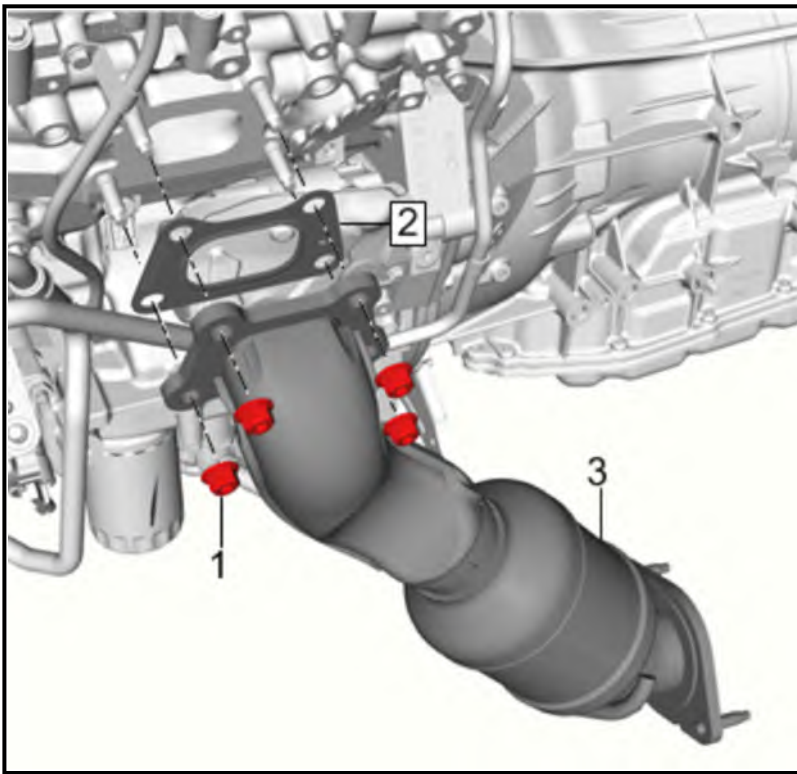


12. Camshaft Carrier-Left Side (2) - Install - [Camshaft Carrier Resealing - Left Side](#)



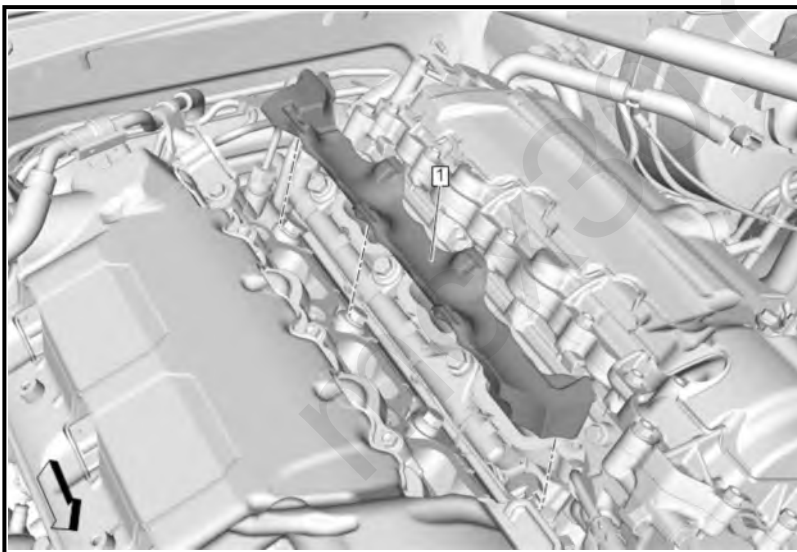
13. Camshaft-Left Side - Install - [Camshaft Replacement - Left Side](#)

14. Warm Up Three-Way Catalytic Converter (3) @ Bank 2 - Install - [Warm Up Three-Way Catalytic Converter Replacement \(Right Side, LGZ\)](#) , or [Warm Up Three-Way Catalytic Converter Replacement \(Left Side, LGZ 2WD\)](#) , or [Warm Up Three-Way Catalytic Converter Replacement \(Left Side, LGZ 4WD\)](#)



15. Fuel Feed Intermediate Pipe - Install - [Fuel Feed Intermediate Pipe Replacement](#)

16. Fuel Injection Fuel Rail Noise Shield (1) - Install - [Fuel Injection Fuel Rail Noise Shield Replacement \(Upper\)](#) , or [Fuel Injection Fuel Rail Noise Shield Replacement \(Lower\)](#).



17. Camshaft Timing Chain-Left Side - Install - [Camshaft Timing Chain Assembly Replacement - Left Side](#)

CYLINDER HEAD REPLACEMENT - RIGHT SIDE

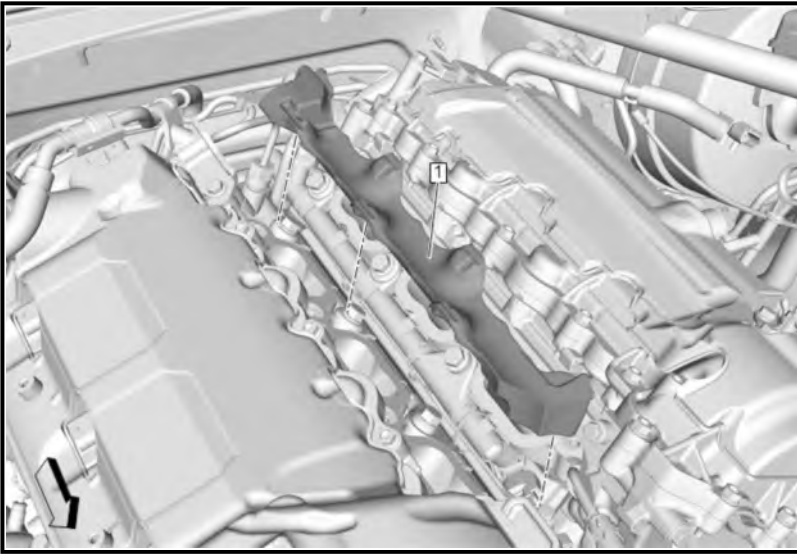
Special Tools

EN - 45059 Angle Meter

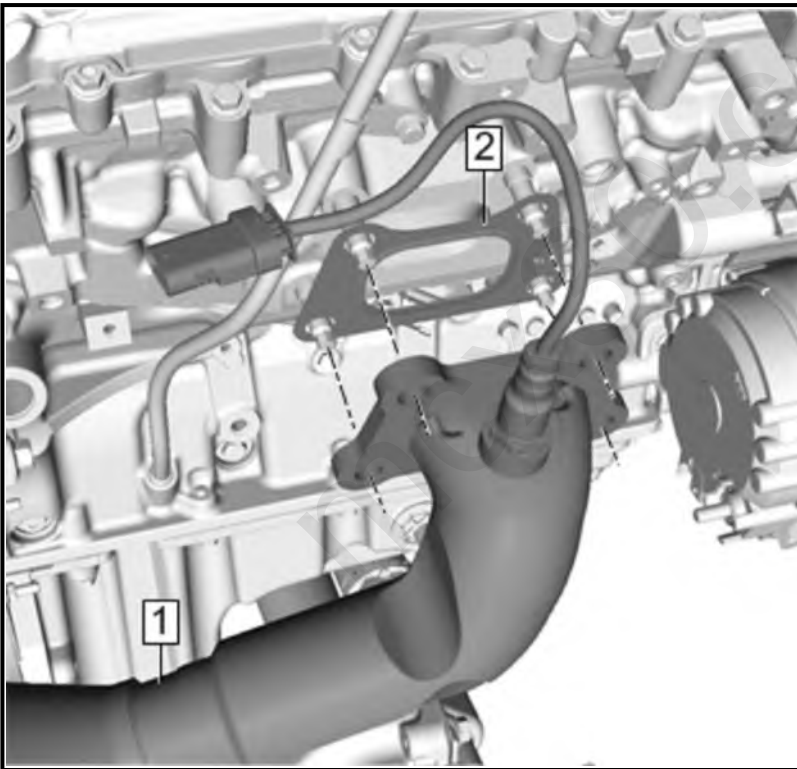
Equivalent regional tools: [Special Tools](#) .

Removal Procedure

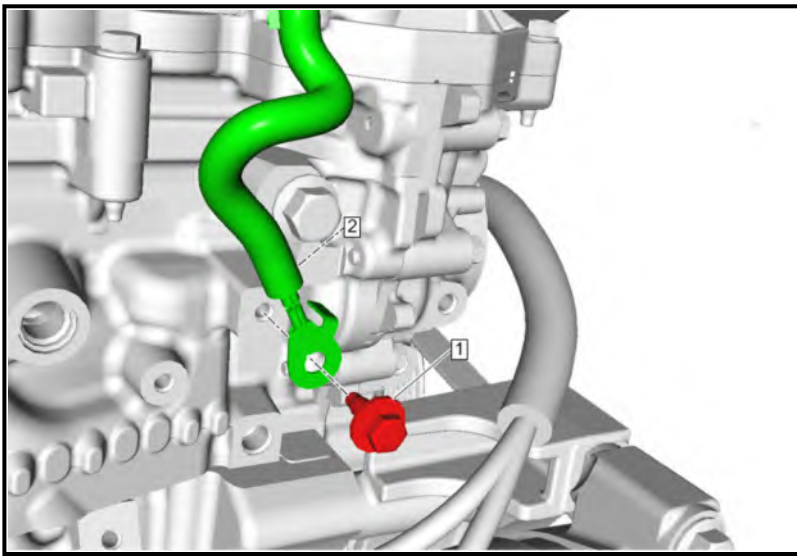
1. Fuel Injection Fuel Rail Noise Shield (1) - Remove - [Fuel Injection Fuel Rail Noise Shield Replacement \(Upper\)](#) , or [Fuel Injection Fuel Rail Noise Shield Replacement \(Lower\)](#).



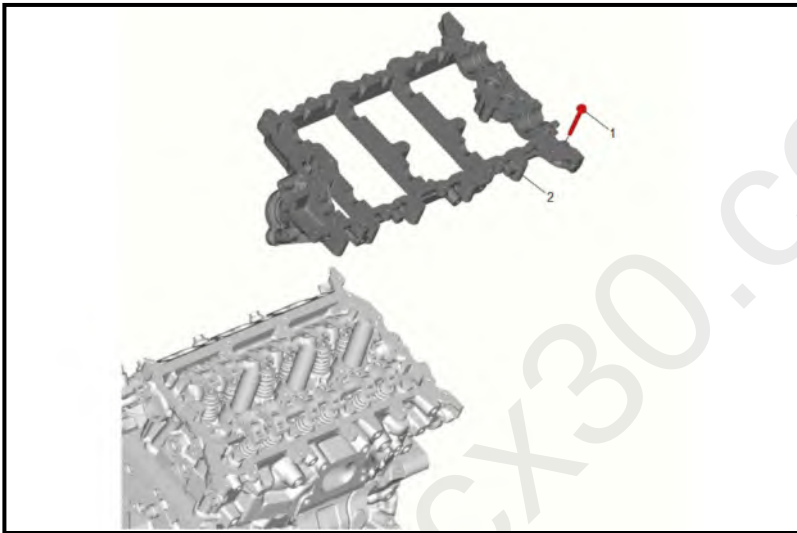
2. Camshaft Timing Chain-Right Side - Remove - [Camshaft Timing Chain Assembly Replacement - Right Side](#)
3. Warm Up Three-Way Catalytic Converter (1) @ Bank 1 - Remove - [Warm Up Three-Way Catalytic Converter Replacement \(Right Side, LGZ\)](#) , or [Warm Up Three-Way Catalytic Converter Replacement \(Left Side, LGZ 2WD\)](#) , or [Warm Up Three-Way Catalytic Converter Replacement \(Left Side, LGZ 4WD\)](#)



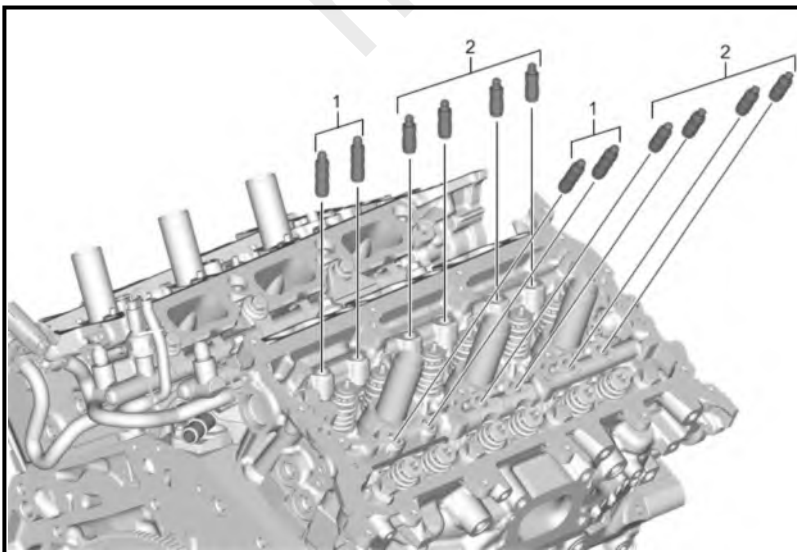
4. Fuel Pump - Remove - [Fuel Pump Replacement](#)
5. Remove the ground wire bolt (1) and ground wire (2).



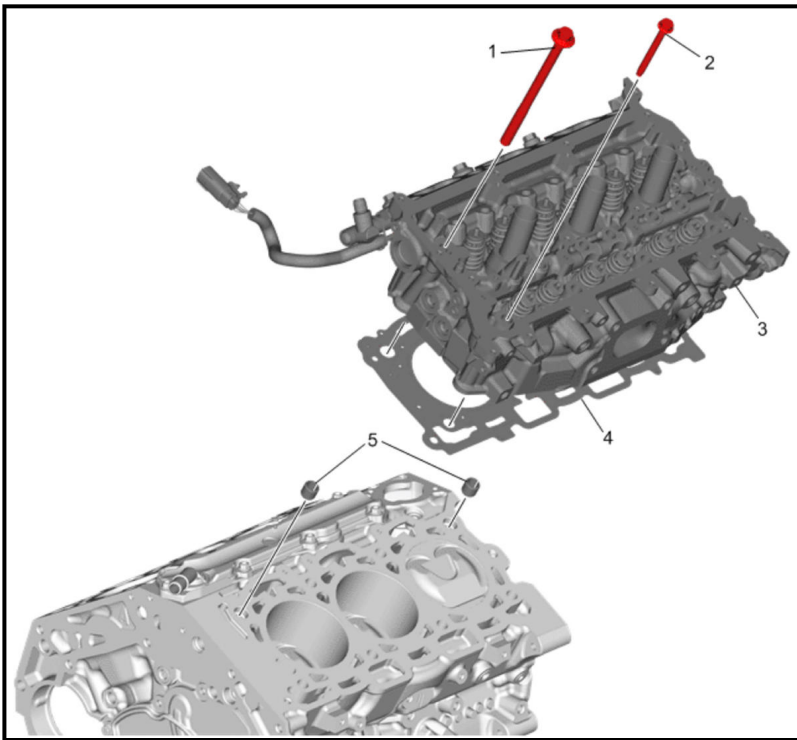
6. Disconnect and reposition harness as necessary.
7. Camshaft-Right Side - Remove - [Camshaft Replacement - Right Side](#)
8. Camshaft Carrier-Right Side (2) - Remove - [Camshaft Carrier Resealing - Right Side](#)



9. Valve Lifter-Right Side (1, 2) - Remove - [Valve Lifter Replacement - Right Side](#)



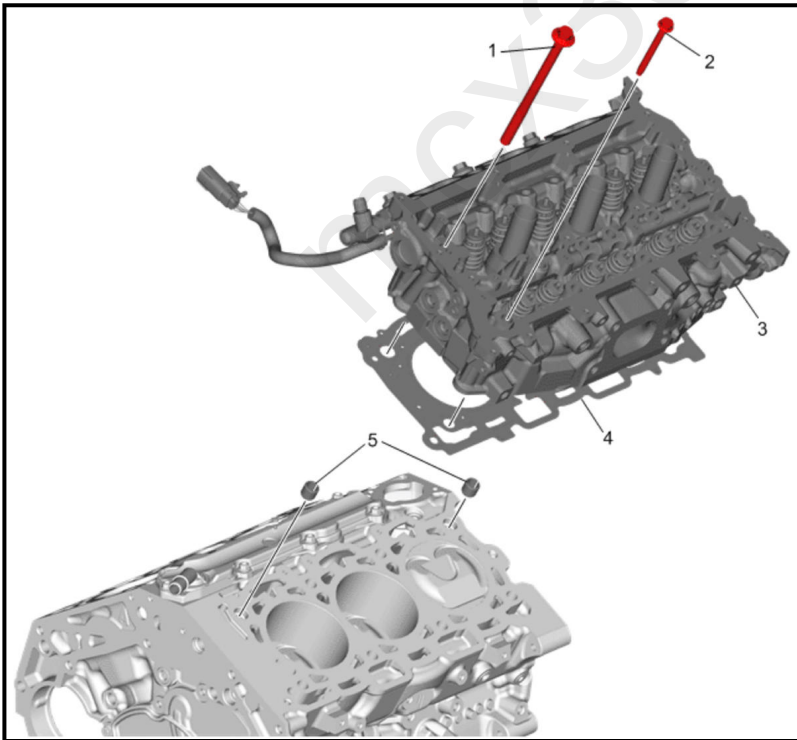
10. Cylinder Head Bolt (1) - Remove and DISCARD [8x]



11. Remove and DISCARD the rear M8 right cylinder head bolt (2).
12. Cylinder Head (3) - Remove
13. Cylinder Head Gasket (4) - Remove and DISCARD
14. Clean, inspect and overhaul the cylinder head as needed. [Cylinder Head Overhaul](#)

Installation Procedure

1. Ensure the cylinder head locating pins (5) are securely mounted in the engine block deck face.



2. Install a NEW cylinder head gasket (4) using the deck face locating pins for retention.
3. Cylinder Head (3) - Install
4. Inspect the fuel injection fuel rail noise shield (1) and replace if it has been exposed to engine fluids.

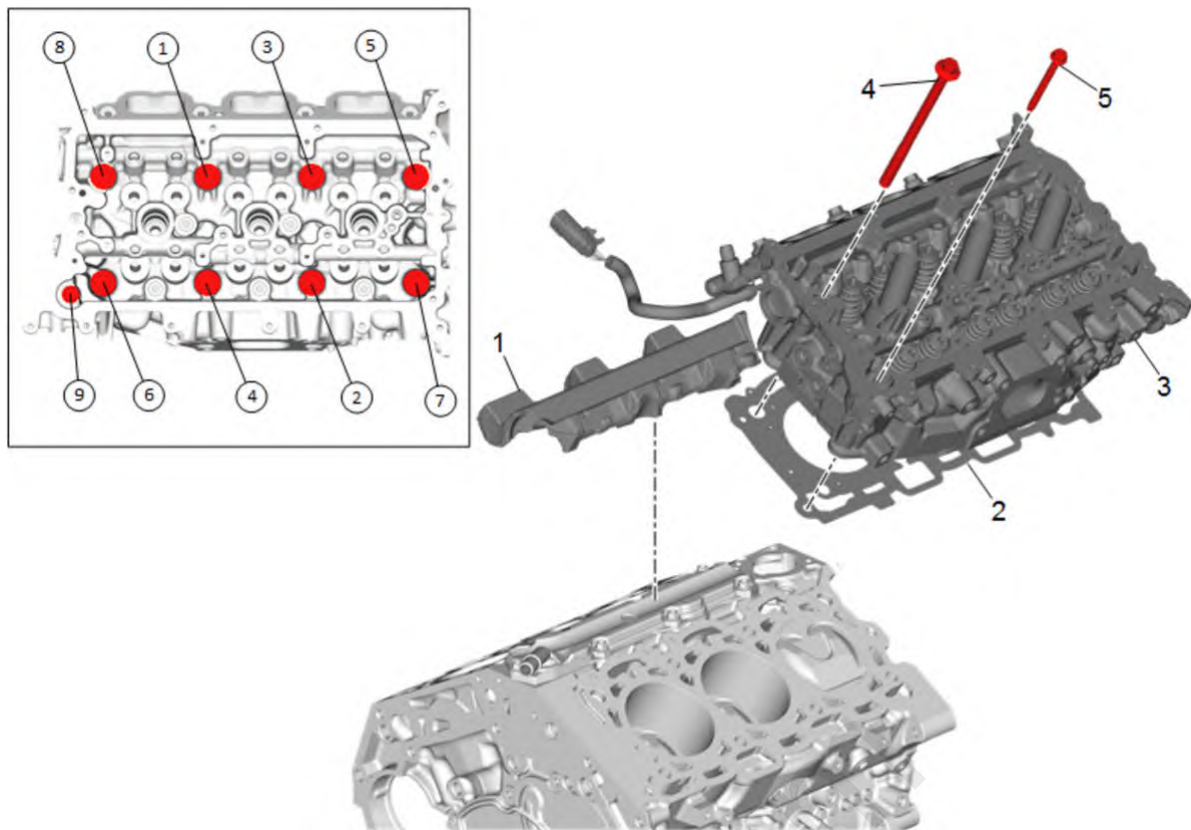


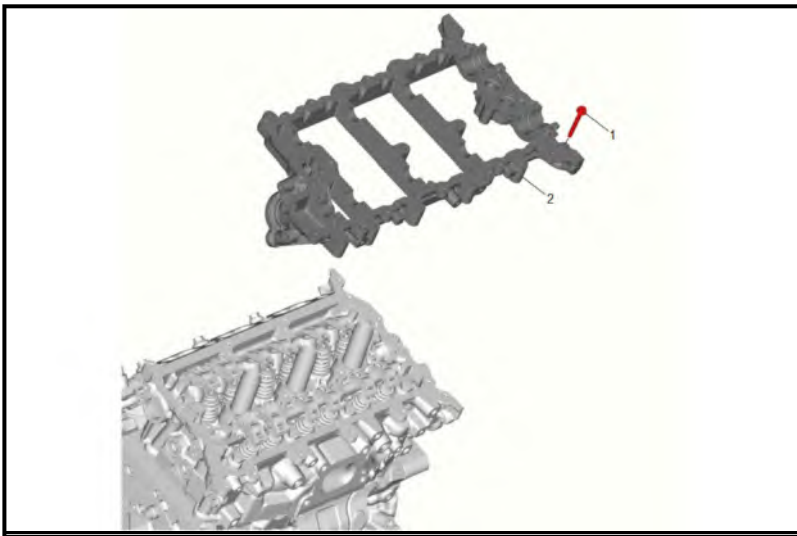
Fig. 15: Exploded View Of Cylinder Head Components - Right Side With Tightening Sequence
 Courtesy of GENERAL MOTORS COMPANY

WARNING: The noise cancelling foam component **MUST** be replaced if it has been exposed to engine fluids. Failure to replace the noise cancelling foam component that has been exposed to engine fluids may result in an engine fire resulting in catastrophic engine damage, and possible injury or death.

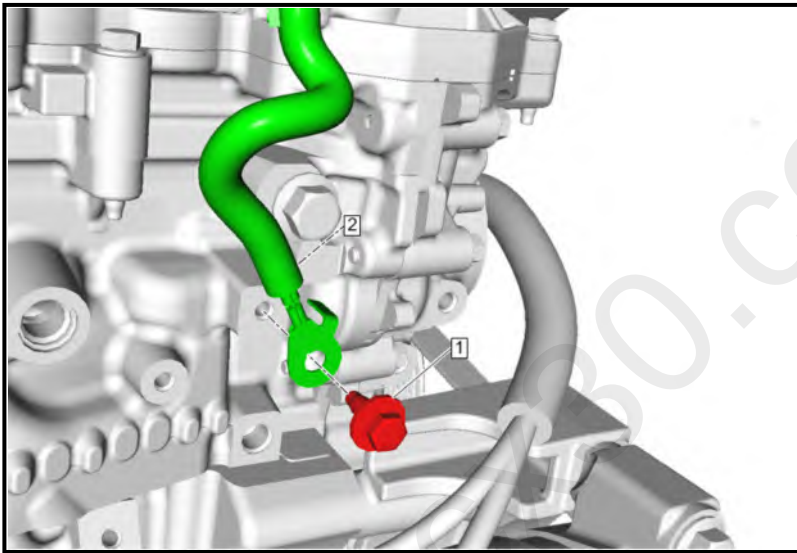
CAUTION: Refer to [Fastener Caution](#) .

CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a **NEW** torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

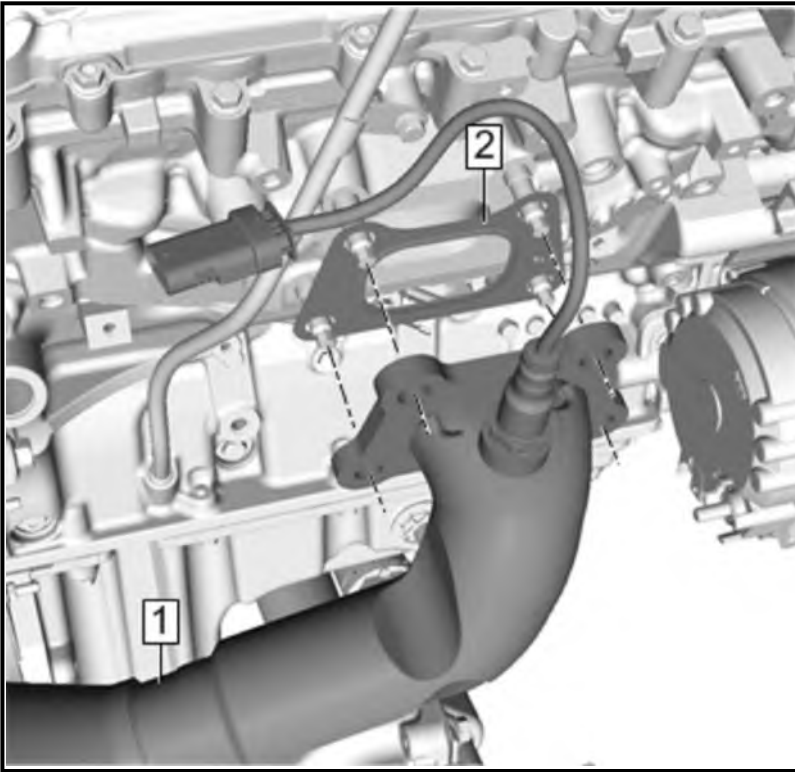
5. Cylinder Head Bolt M11 x 178 (4) - Install NEW and tighten in sequence [8x]
 1. First Pass: 60 N.m (44 lb ft)
 2. Final Pass: 185 degrees
6. Cylinder Head Bolt M8 x 80.8 (5) - Install NEW and tighten in sequence
 1. First Pass: 15 N.m (11 lb ft)
 2. Final Pass: 75 degrees
7. Camshaft Carrier-Right Side (2) - Install - [Camshaft Carrier Resealing - Right Side](#)



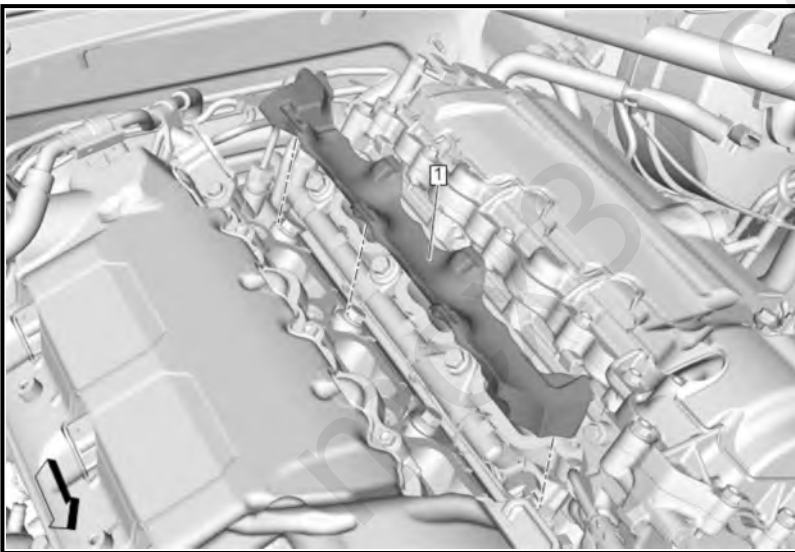
8. Camshaft-Right Side - Install - [Camshaft Replacement - Right Side](#)
9. Position wire harness and connect as necessary.
10. Install ground wire (2) and ground wire bolt (1). Tighten bolt to 9 N.m (80 lb in).



11. Fuel Pump - Install - [Fuel Pump Replacement](#)
12. Warm Up Three-Way Catalytic Converter (1) @ Bank 1 - Install - [Warm Up Three-Way Catalytic Converter Replacement \(Right Side, LGZ\)](#) , or [Warm Up Three-Way Catalytic Converter Replacement \(Left Side, LGZ 2WD\)](#) , or [Warm Up Three-Way Catalytic Converter Replacement \(Left Side, LGZ 4WD\)](#)



13. Fuel Injection Fuel Rail Noise Shield (1) - Install - [Fuel Injection Fuel Rail Noise Shield Replacement \(Upper\)](#) , or [Fuel Injection Fuel Rail Noise Shield Replacement \(Lower\)](#).



14. Camshaft Timing Chain-Right Side - Install - [Camshaft Timing Chain Assembly Replacement - Right Side](#)

CYLINDER HEAD OVERHAUL

Special Tools

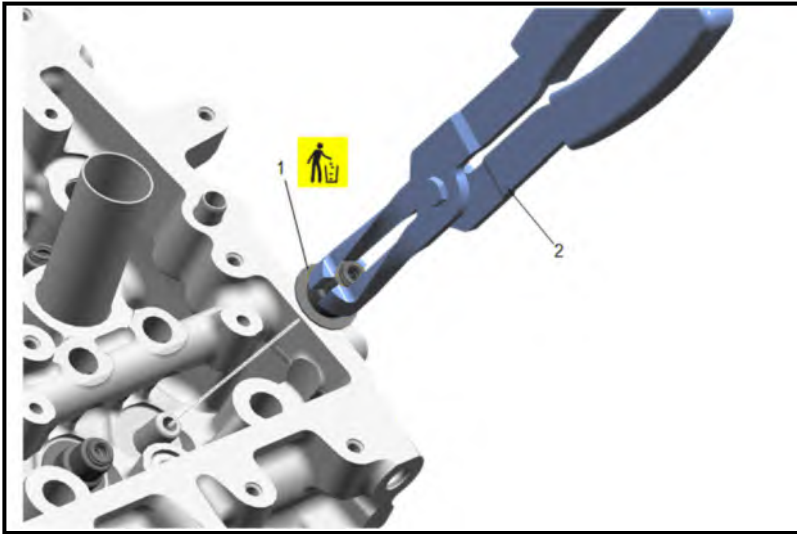
- **GE - 8001** Dial Indicator Set
- **GE - 8358** Carbon Removal Brush
- **EN - 28410** Gasket Remover
- **EN - 42096** Valve Guide Reamer
- **EN - 47909** Injector Bore and Sleeve Cleaning Kit
- **EN-8062** Valve Spring Compressor - Head Off
- **EN-46116** Valve Stem Seal Remover/Installer
- **EN-46117** Valve Stem Key Remover/Installer

- **EN-46119** Off-Vehicle Valve Spring Compressor Adapter

Equivalent regional tools: [Special Tools](#)

Cylinder Head Disassemble

1. Place the valve stem oil seals (1) onto the guides.

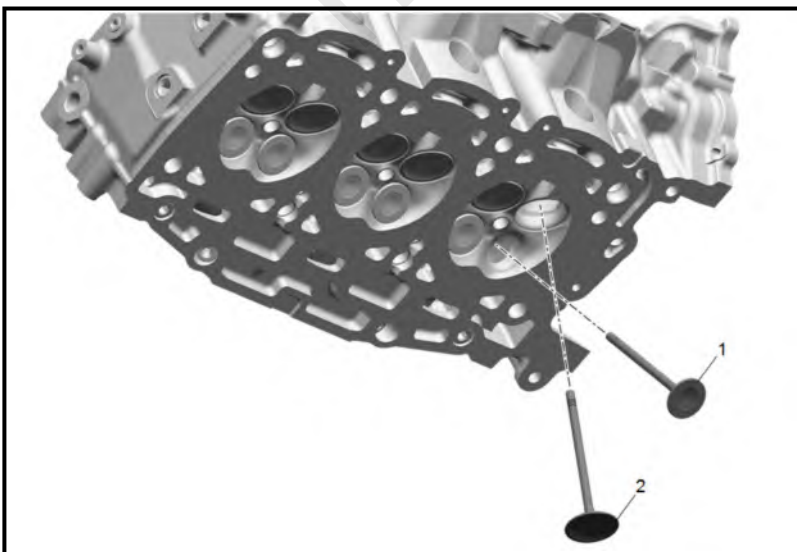


NOTE: NEVER reuse a valve stem oil seal. Always use new seals when assembling the cylinder head.

2. Mount a NEW valve stem oil seal (1) using the **EN - 46116** Valve Stem Seal Remover/Installer.

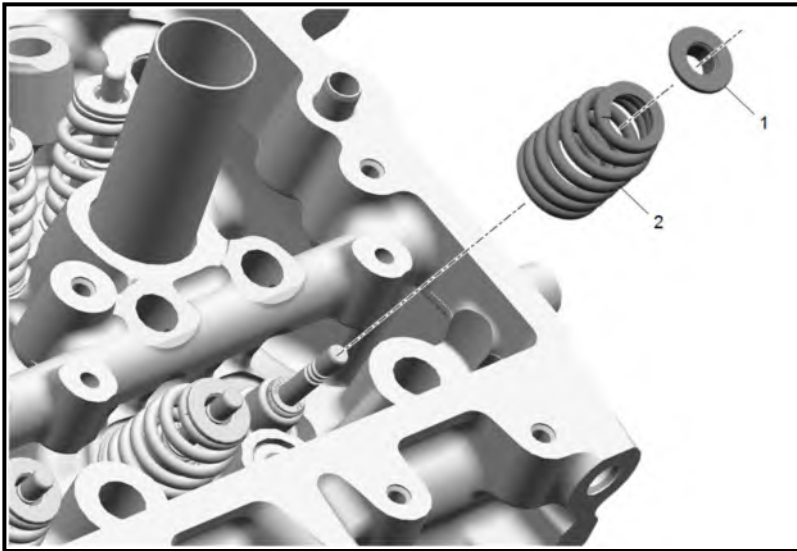
NOTE: Force should only be applied to the valve spring contact area of the new valve stem oil seal during installation.

3. Push and twist the valve stem oil seal (1) into position on the valve guide until the seal positively locks on the guide using the **EN - 46116** Valve Stem Seal Remover/Installer.
4. Lubricate the valve stem and valve guide ID with clean engine oil. [Adhesives, Fluids, Lubricants, and Sealers](#)
5. Insert the valves (1 and 2) into the valve guide until it bottoms on the valve seat.



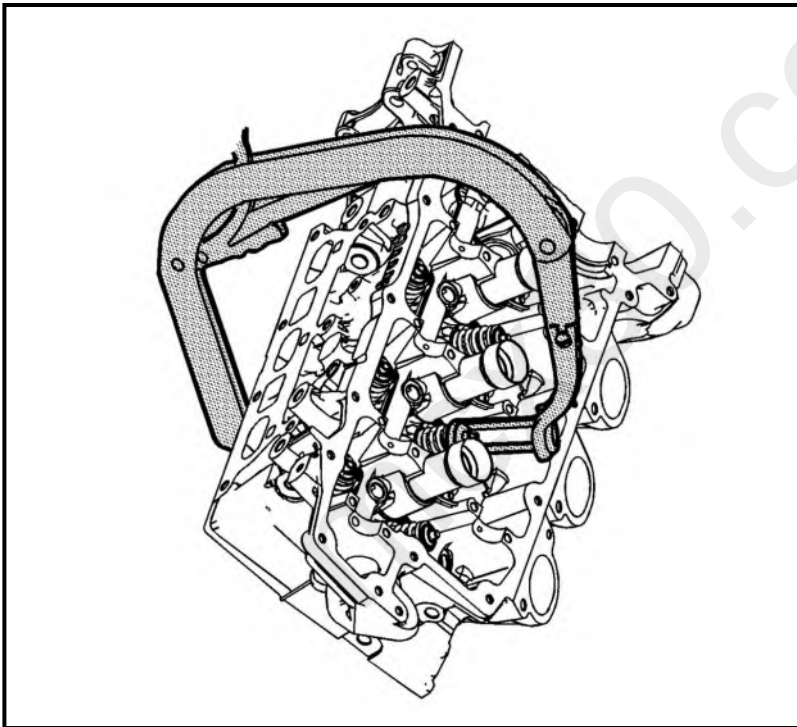
NOTE: The valve stem oil seal must not come loose from the valve guide when the valve is installed.

6. Position the valve spring on the spring seat.



7. Place the valve spring retainers onto the valve spring.

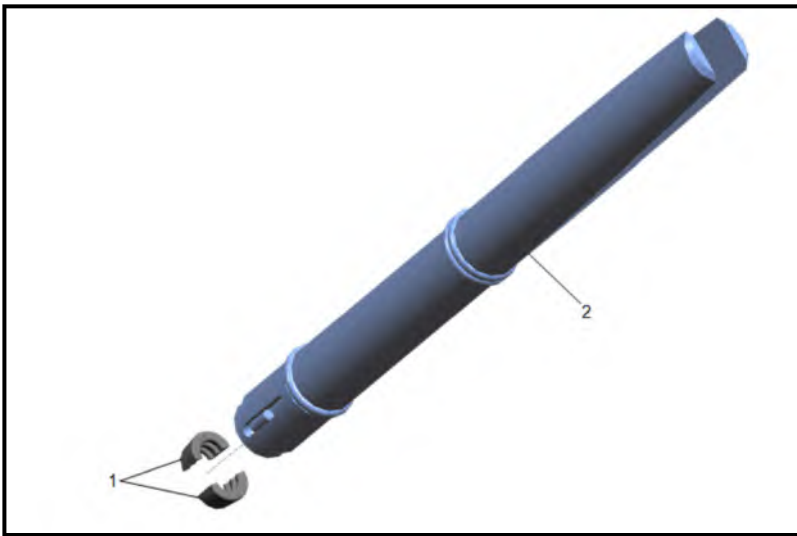
8. Compress the valve spring using the **EN - 8062** Valve Spring Compressor - Head Off and the **EN - 46119** Off-Vehicle Valve Spring Compressor Adapter.



WARNING: Compressed valve springs have high tension against the valve spring compressor. Valve springs that are not properly compressed by or released from the valve spring compressor can be ejected from the valve spring compressor with intense force. Use care when compressing or releasing the valve spring with the valve spring compressor and when removing or installing the valve stem keys. Failing to use care may cause personal injury.

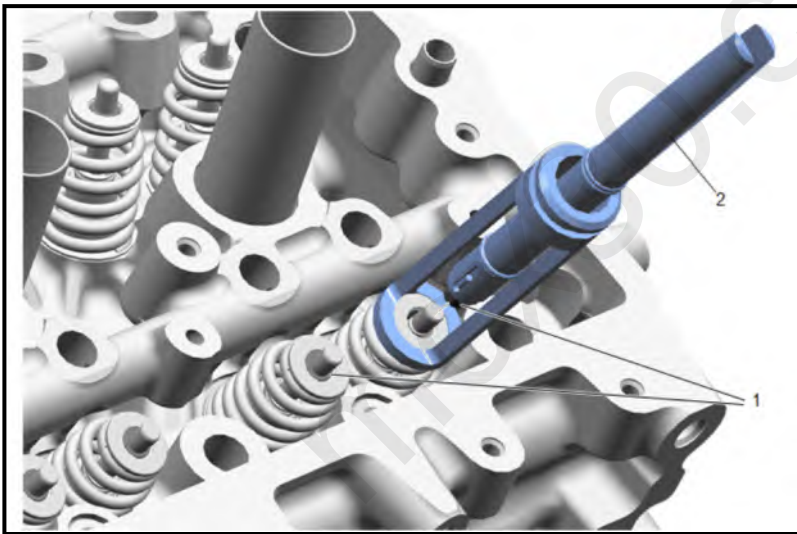
CAUTION: Do not compress the valve springs to less than 24.0 mm (0.943 in). Contact between the valve spring retainer and the valve stem oil seal can cause potential valve stem oil seal damage.

9. With the spring compressed, install the valve keepers (1) into the **EN - 46117** Valve Stem Key Remover/Installer.



NOTE: Ensure proper directional placement of valve keepers in the EN - 46117 Valve Stem Key Remover/Installer. The valve keepers must be installed with the tapered end towards the valve stem seal.

10. Place the keepers (1) into position by pushing the tool downward. While holding the tool lightly together in the area between the O-rings, using the thumb and forefinger, release tension on the EN - 46119 Off-Vehicle Valve Spring Compressor Adapter and the EN - 8062 Valve Spring Compressor - Head Off. This will slowly push the EN - 46117 Valve Stem Key Remover/Installer off the valve stem, leaving the keepers in place.



11. Verify that the valve keepers are installed by placing a rag over the valve tip and tapping with a dead-blow hammer.

Cleaning Procedure

1. Ensure proper use of room temperature vulcanizing (RTV) sealant. [Use of Room Temperature Vulcanizing \(RTV\) and Anaerobic Sealant](#)
2. Remove any old thread sealant, gasket material or sealant using EN - 28410 Gasket Remover.
3. Clean all cylinder head surfaces with non-corrosive solvent.

WARNING: Refer to [Safety Glasses Warning](#) .

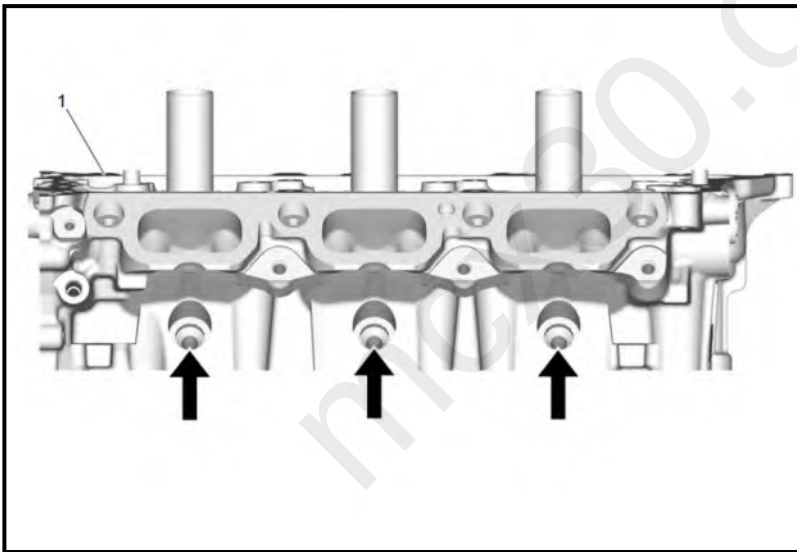
4. Blow out all the oil galleries using compressed air.
5. Remove any carbon deposits from the combustion chambers using the GE - 8358 Carbon Removal Brush.
6. Clean any debris or build-up from the lifter pockets.

Visual Inspection

1. Inspect the cylinder head for the following:

- Cracks, damage or pitting in the combustion chambers
- Debris in the oil galleries - Continue to clean the galleries until all debris is removed.
- Coolant leaks or damage to the deck face sealing surface - If coolant leaks are present, measure the surface warpage as described under Cylinder Head Measurement - Deck Flatness Inspection.
- Burrs or any defects that would degrade the sealing of the NEW secondary camshaft drive chain tensioner gasket
- Damage to any gasket surfaces
- Damage to any threaded bolt holes
- Burnt or eroded areas in the combustion chamber
- Cracks in the exhaust ports and combustion chambers
- External cracks in the water passages
- Restrictions in the intake or exhaust passages
- Restrictions in the cooling system passages
- Rusted, damaged or leaking core plugs

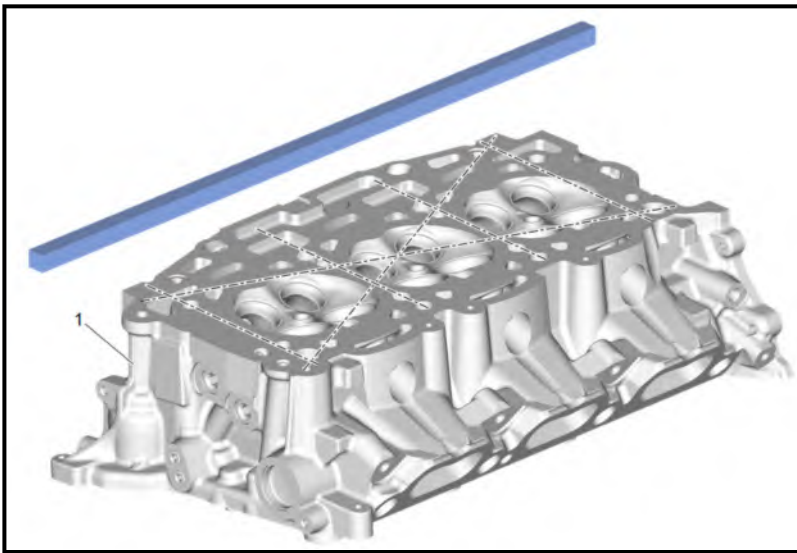
2. If the cylinder head is cracked or damaged, it must be replaced. No welding or patching of the cylinder head is recommended.
3. Inspect the fuel rail injector bores and clean with EN - 47909 Injector Bore and Sleeve Cleaning Kit, if required.



Cylinder Head Measurement

Deck Flatness Inspection

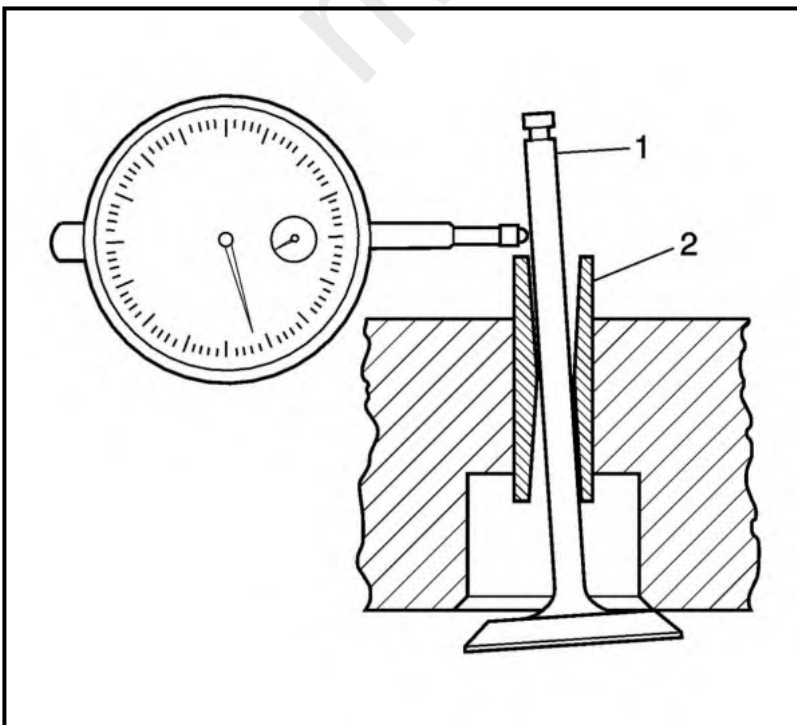
1. Ensure the cylinder head decks are clean and free of gasket material.



2. Inspect the surface for any imperfections or scratches that could inhibit proper cylinder head gasket sealing.
3. Place a straight-edge diagonally across the cylinder head deck face surface.
4. Measure the clearance between the straight-edge and the cylinder head deck face using a feeler gauge at 4 points along the straight-edge.
5. If the warpage is less than 0.05 mm (0.002 in), the cylinder head deck surface does not require resurfacing.
6. If the warpage is between 0.05 - 0.20 mm (0.002 - 0.008 in) or any imperfections or scratches that could inhibit proper cylinder head gasket sealing are present, the cylinder head deck surface requires resurfacing.
7. If resurfacing is required the maximum amount that can be removed is 0.25 mm (0.010 in).
8. If the cylinder head deck surface requires more than 0.25 mm (0.010 in) material removal the head must be replaced.

Valve Guide Measurement

1. Measure the valve stem (1)-to-guide (2) clearance. Excessive valve stem-to-guide clearance may cause an excessive oil consumption and may also cause a valve to break. Insufficient clearance will result in noisy and sticky functioning of the valve and will disturb the engine assembly smoothness.



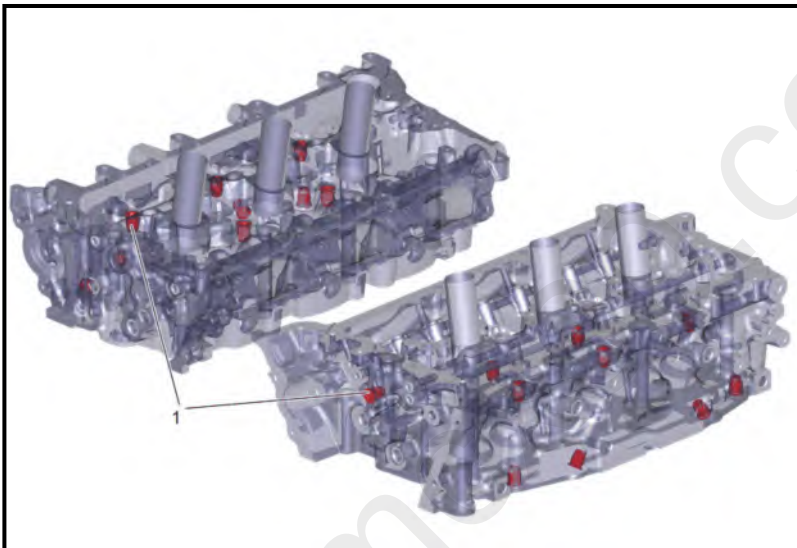
2. Clamp the **GE - 8001** Dial Indicator Set to the cylinder head at the camshaft cover rail.
3. Locate the dial indicator so that the movement of the valve stem from side to side, crossways to the cylinder head, will cause a direct movement of the indicator stem. The dial indicator stem must contact the side of the valve stem just above the valve guide.
4. Drop the valve head about 0.064 mm (0.0025 in) off the valve seat.
5. Use light pressure when moving the valve stem from side to side in order to obtain a clearance reading.

Engine Mechanical Specifications

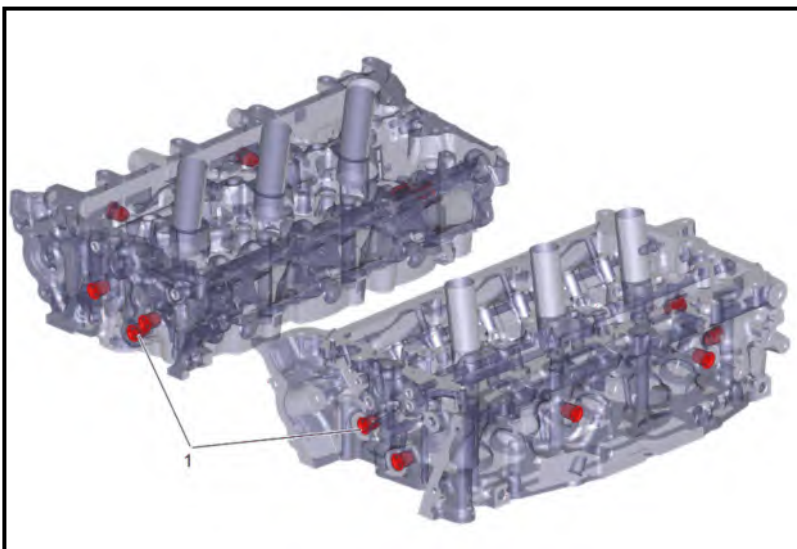
- If the clearance for the valve is greater than specifications and a new standard diameter valve stem will not bring the clearance within specifications, the valve guide may be oversized by 0.075 mm (0.003 in) using the **EN - 42096** Valve Guide Reamer. There is 1 size of oversized valve stem available for service.
- Valve guide wear at the bottom 10 mm (0.390 in) of the valve guide is not significant to normal operation.
- If oversizing the guide does not bring the clearance within specifications, replace the cylinder head.

Plug Inspection

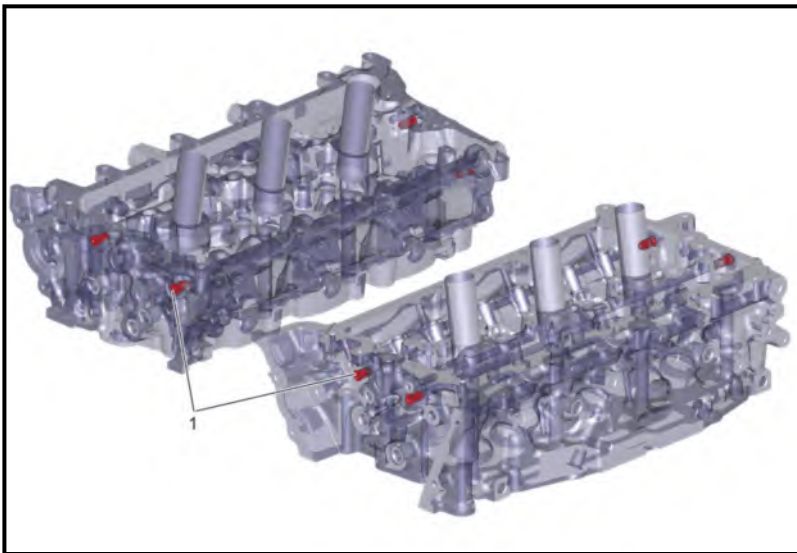
1. Inspect the cylinder head oil galley and core plug (1).



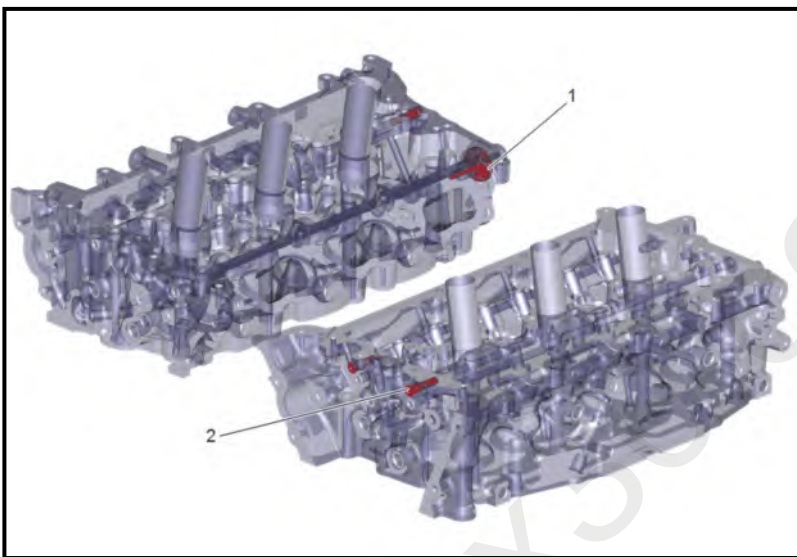
2. Inspect the cylinder head oil galley and core plug (1).



3. Inspect the cylinder head oil galley plug (1).

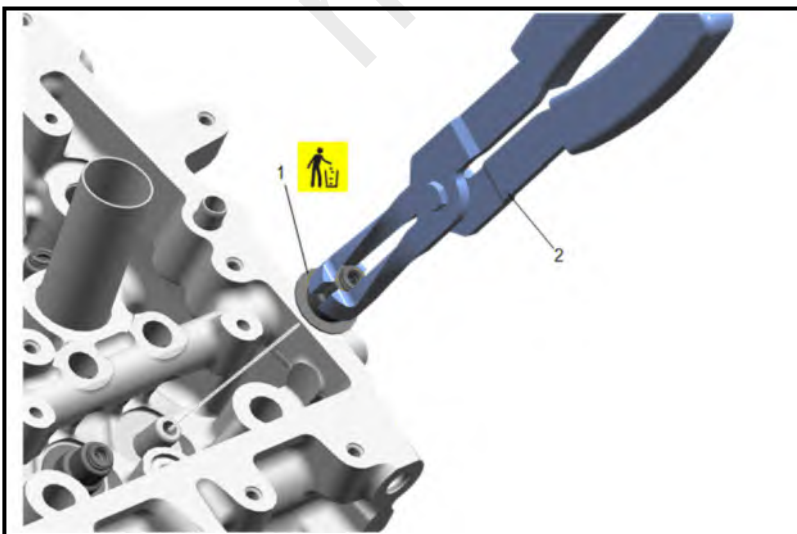


4. Inspect the cylinder head cup plug (1) and oil galley plug (2).



Cylinder Head Assemble

1. Mount a NEW valve stem oil seal (1) using the **EN - 46116** Valve Stem Seal Remover/Installer.

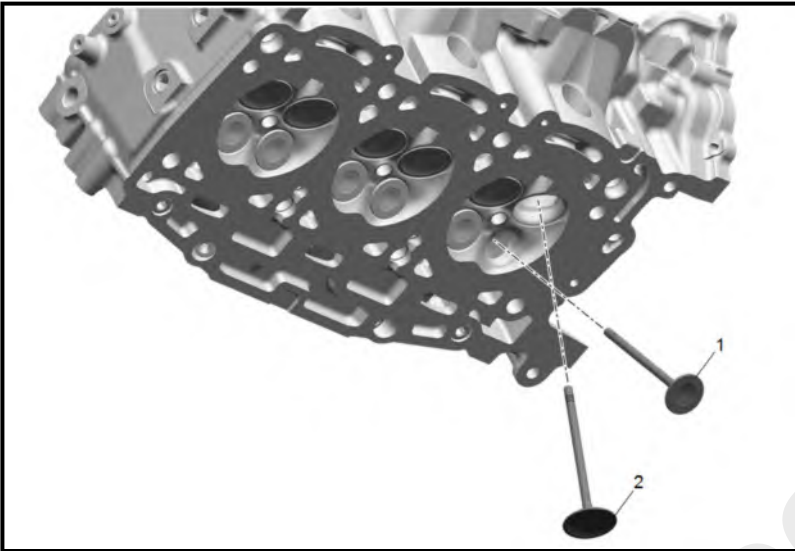


Place the valve stem oil seals (1) onto the guides.

NOTE: **NEVER** reuse a valve stem oil seal. Always use new seals when assembling the cylinder head.

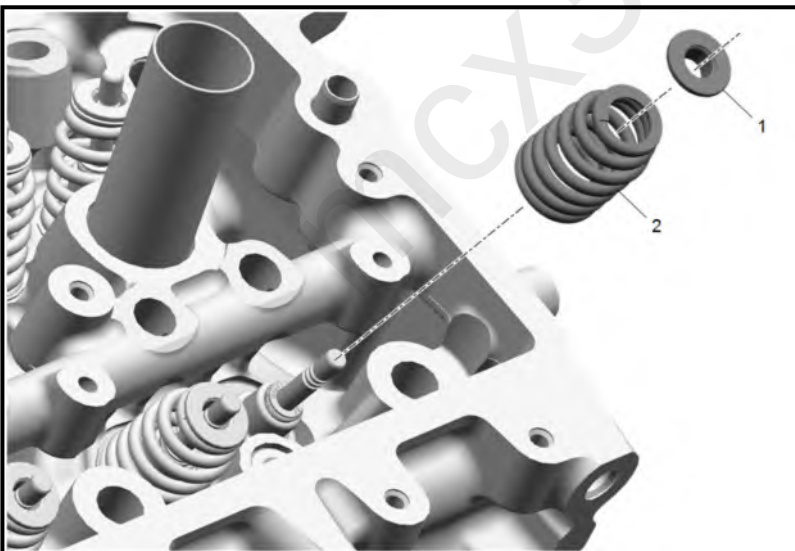
NOTE: Force should only be applied to the valve spring contact area of the new valve stem oil seal during installation.

2. Push and twist the valve stem oil seal (1) into position on the valve guide until the seal positively locks on the guide using the **EN - 46116** Valve Stem Seal Remover/Installer.
3. Lubricate the valve stem and valve guide ID with clean engine oil. [Adhesives, Fluids, Lubricants, and Sealers](#)
4. Insert the valves (1 and 2) into the valve guide until it bottoms on the valve seat.

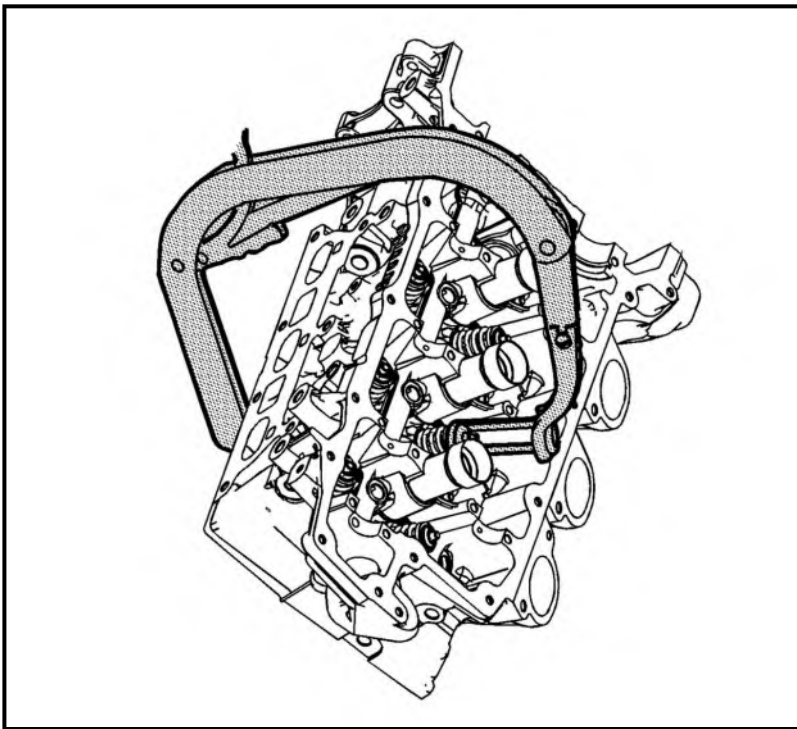


NOTE: The valve stem oil seal must not come loose from the valve guide when the valve is installed.

5. Position the valve spring on the spring seat.



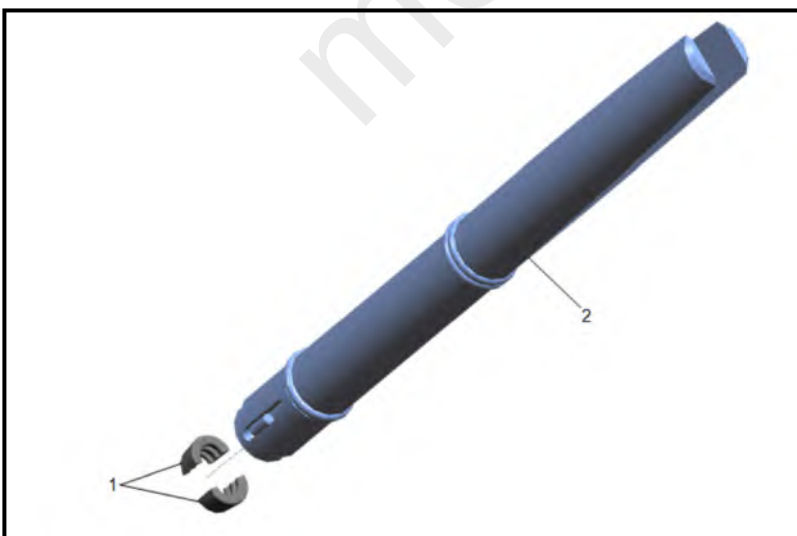
6. Place the valve spring retainer onto the valve spring.
7. Compress the valve spring using the **EN - 8062** Valve Spring Compressor - Head Off and the **EN - 46119** Off-Vehicle Valve Spring Compressor Adapter.



WARNING: Compressed valve springs have high tension against the valve spring compressor. Valve springs that are not properly compressed by or released from the valve spring compressor can be ejected from the valve spring compressor with intense force. Use care when compressing or releasing the valve spring with the valve spring compressor and when removing or installing the valve stem keys. Failing to use care may cause personal injury.

CAUTION: Do not compress the valve springs to less than 24.0 mm (0.943 in). Contact between the valve spring retainer and the valve stem oil seal can cause potential valve stem oil seal damage.

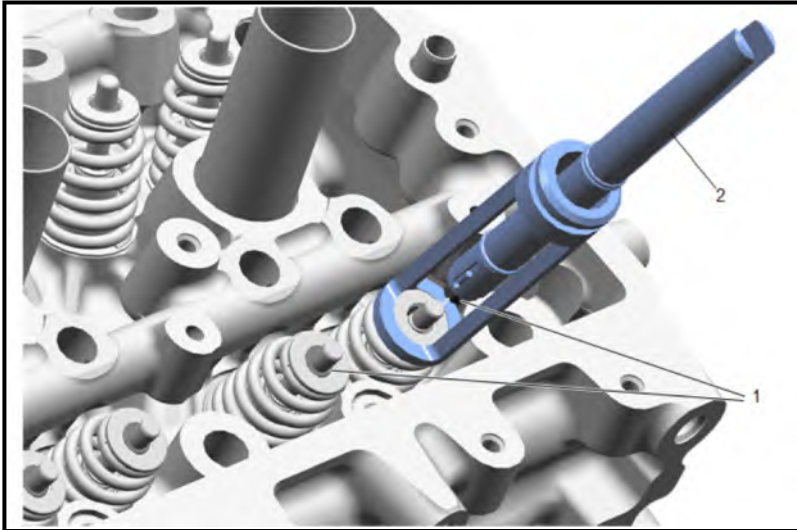
8. With the spring compressed, install the valve keepers (1) into the EN - 46117 Valve Stem Key Remover/Installer.



NOTE: Ensure proper directional placement of valve keepers in the EN - 46117 Valve Stem Key Remover/Installer. The valve keepers must be installed with the tapered end towards the valve stem seal.

9. Place the keepers (1) into position by pushing the tool downward. While holding the tool lightly together in the area between the O-rings, using the thumb and forefinger, release tension on the EN - 46119 Off-

Vehicle Valve Spring Compressor Adapter and the **EN - 8062** Valve Spring Compressor - Head Off. This will slowly push the **EN - 46117** Valve Stem Key Remover/Installer off the valve stem, leaving the keepers in place.



10. Verify that the valve keepers are installed by placing a rag over the valve tip and tapping with a dead-blow hammer.

AUTOMATIC TRANSMISSION FLEX PLATE REPLACEMENT

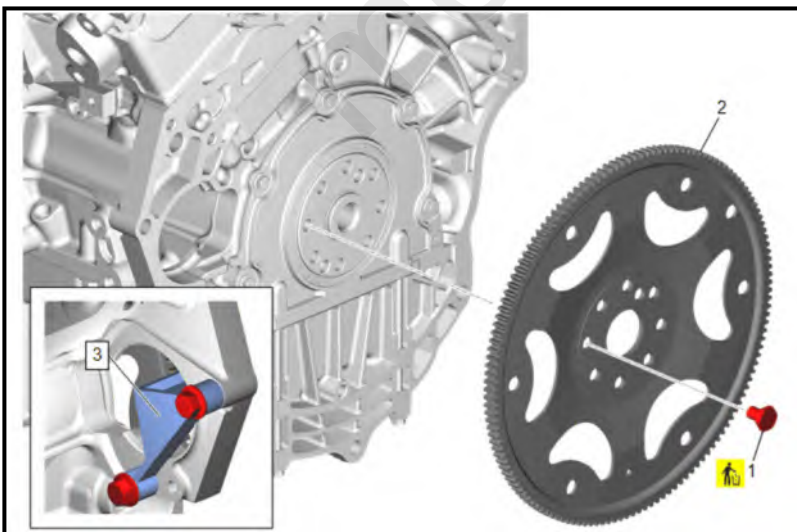
Special Tools

- **EN-45059** Angle Meter
- **EN-46106** Flywheel Holding Tool

Equivalent regional tools: **Special Tools**

Removal Procedure

1. Transmission - Remove - **Transmission Replacement (2WD)** , or **Transmission Replacement (4WD)**.
2. Install the **EN-46106** Flywheel Holding Tool through the starter mounting hole.



3. Automatic Transmission Flex Plate Bolt (1) - Remove and DISCARD [8x]
4. Automatic Transmission Flex Plate (2) - Remove

Cleaning Procedure

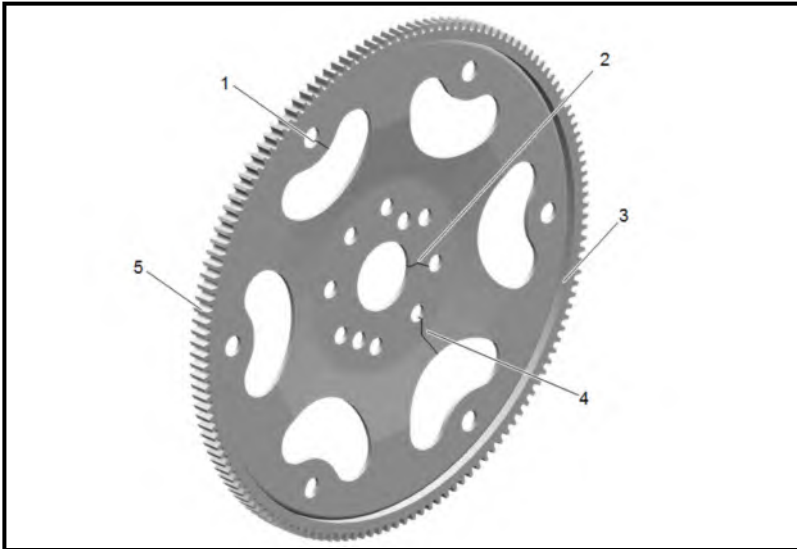
1. Clean the flex plate in solvent.

WARNING: Refer to [Safety Glasses Warning](#) .

2. Dry the flex plate with compressed air.

Inspection Procedure

1. Inspect the flex plate for the following conditions:



- Stress cracks around the flex plate-to-torque converter mounting bolt hole locations (1) and/or flex plate-to-crankshaft (2, 4)

NOTE: Do not attempt to repair the welded areas that retain the ring gear to the flex plate. Install a NEW flex plate.

- Cracks at welded areas that retain the ring gear onto the flex plate (3)
- Damaged or missing ring gear teeth (5)

2. Replace the flex plate as necessary.

Installation Procedure

1. Automatic Transmission Flex Plate (1) - Install

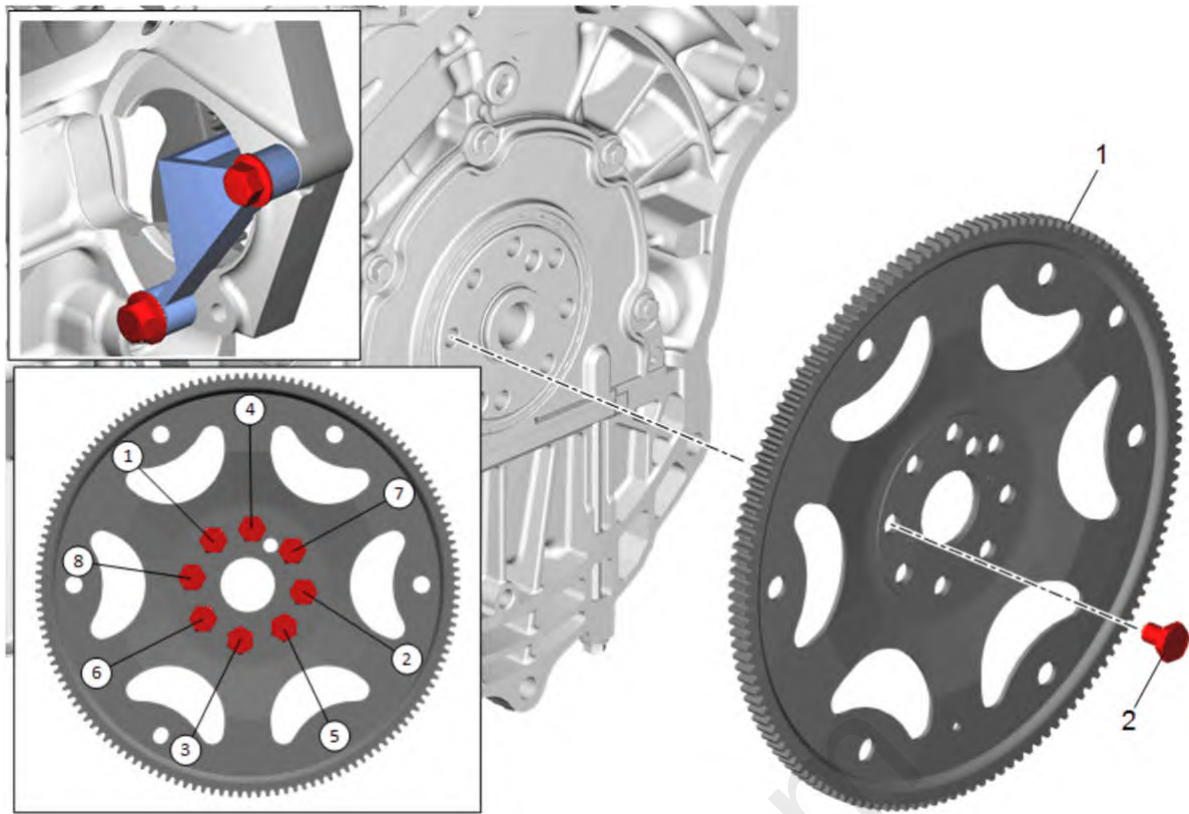


Fig. 16: Automatic Transmission Flex Plate Bolts Tightening Sequence

Courtesy of GENERAL MOTORS COMPANY

2. Install 2 NEW bolts (2) in location at the top and bottom of the flex plate bolt pattern allowing the flex plate (1) to hang in position.

CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

CAUTION: Refer to [Fastener Caution](#) .

3. Install the remaining NEW flex plate bolts (2) and tighten in sequence.
 1. First Pass: 30 N.m (22 lb ft)
 2. Final Pass: 45 degrees using the EN - 45059 Angle Meter
4. Transmission - Install - [Transmission Replacement \(2WD\)](#) , or [Transmission Replacement \(4WD\)](#).

CRANKSHAFT REAR OIL SEAL AND HOUSING REPLACEMENT

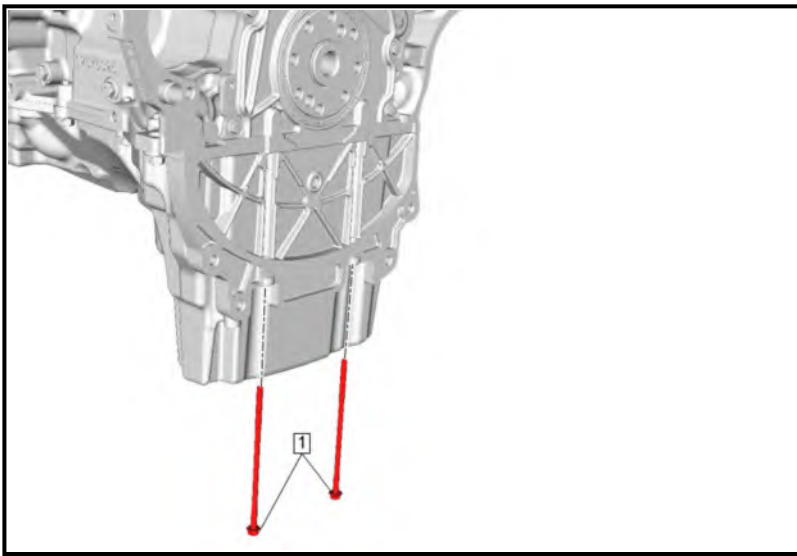
Special Tools

EN-51766 Crankshaft Rear Oil Seal Installation Tool

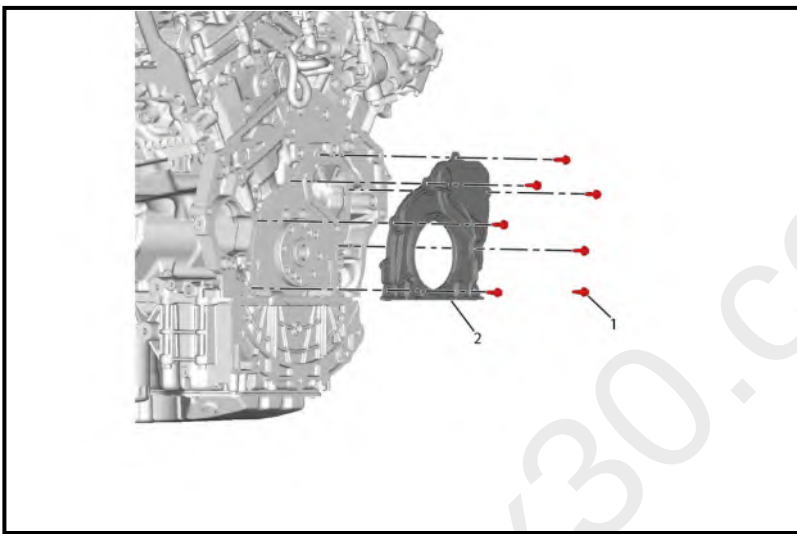
Equivalent regional tools: [Special Tools](#)

Removal Procedure

1. Automatic Transmission Flex Plate - Remove - [Automatic Transmission Flex Plate Replacement](#)
2. Remove the oil pan to crankshaft rear oil seal and housing bolts (1).



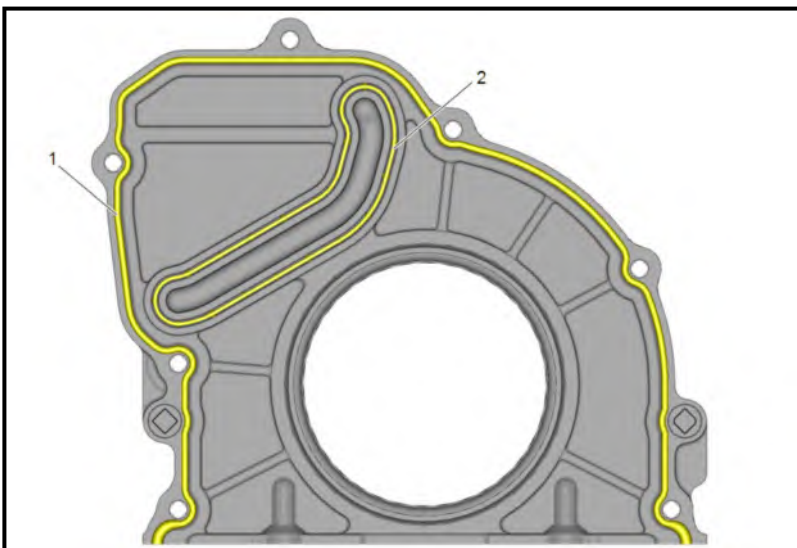
3. Remove the crankshaft rear oil seal housing bolts. (1) [7x]



4. Remove and DISCARD the crankshaft rear oil seal housing. (2)

Installation Procedure

1. Apply a 3 mm (0.118 in) bead of RTV sealant around the perimeter of the NEW crankshaft rear oil seal housing (1). Adhesives, Fluids, Lubricants, and Sealers



NOTE: Ensure proper use of room temperature vulcanizing (RTV) sealant. Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant

NOTE: DO NOT allow any engine oil on the area where the crankshaft rear oil seal housing is to be installed.

2. Apply a 3 mm (0.118 in) bead of RTV sealant to the positive crankcase ventilation tube seal area on the NEW crankshaft rear oil seal housing (2). [Adhesives, Fluids, Lubricants, and Sealers](#)
3. Install the **EN-51766** tool onto the rear of the crankshaft flange.

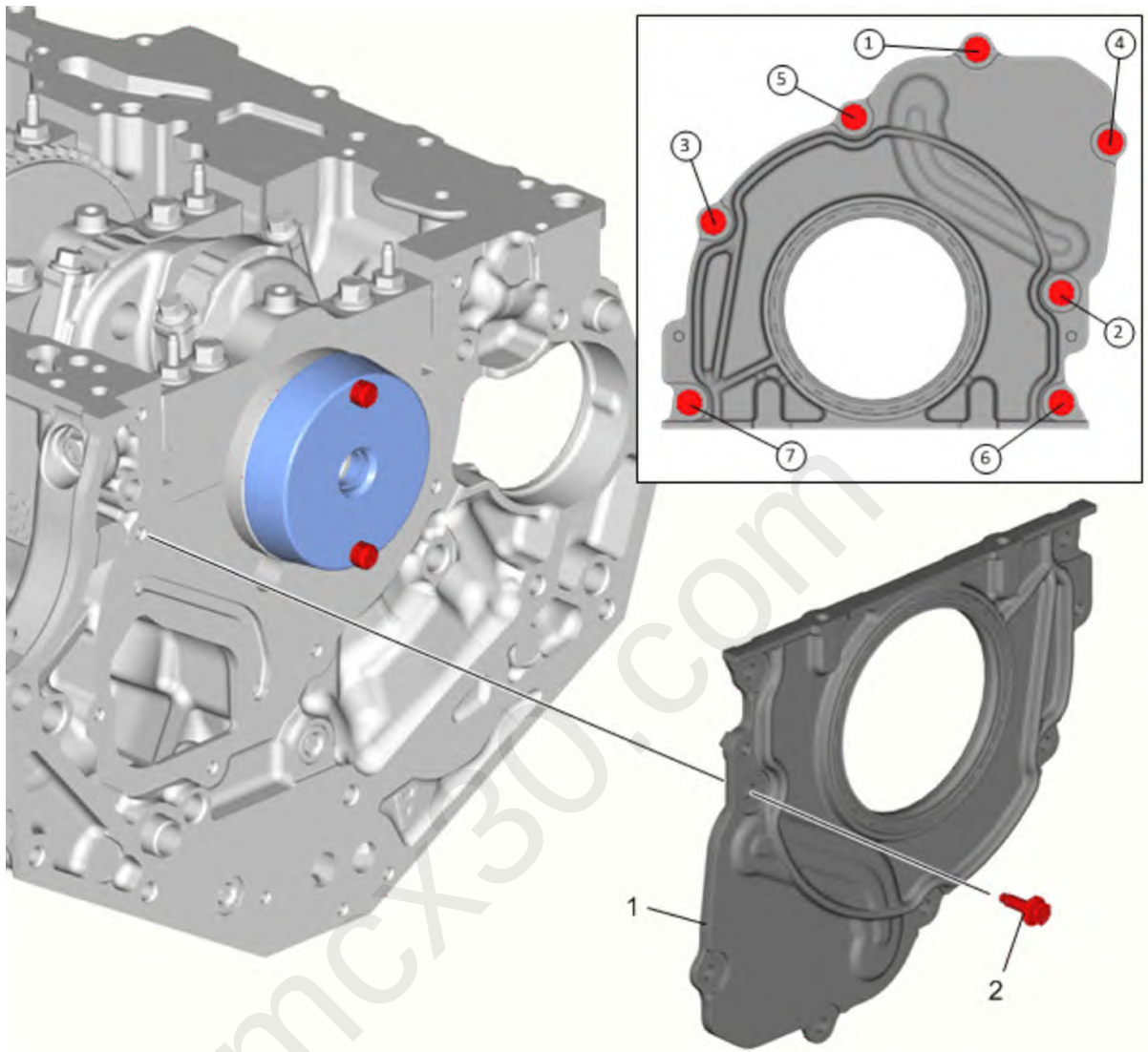


Fig. 17: Crankshaft Rear Oil Seal Housing Bolts Tightening Sequence (3.6L)

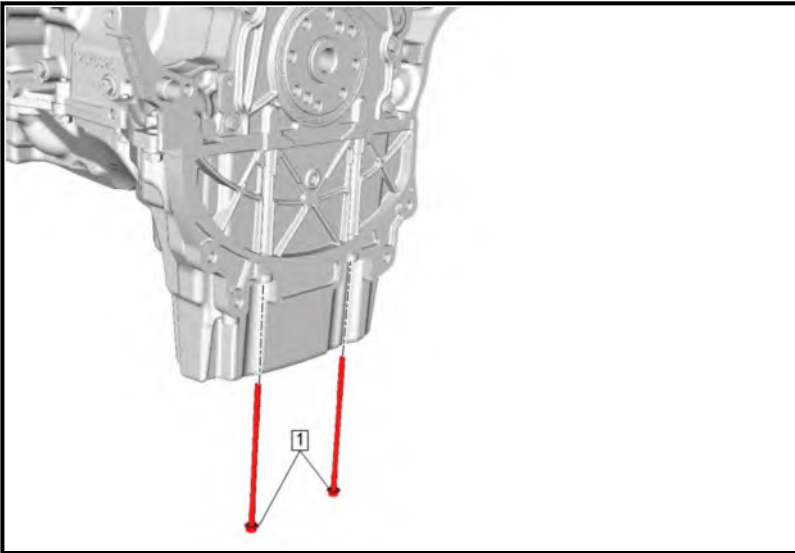
Courtesy of GENERAL MOTORS COMPANY

NOTE: The crankshaft rear oil seal is a dry seal do not lubricate.

4. Install the NEW crankshaft rear oil seal housing (1) to the engine block.
5. Install the crankshaft rear oil seal housing bolts (2) and hand tighten.
6. Remove the **EN-51766** tool from the crankshaft flange.

CAUTION: Refer to [Fastener Caution](#) .

7. Crankshaft Rear Oil Seal Housing Bolt - Tighten in sequence [7x] 10 N.m (89 lb in)
8. Install the oil pan to crankshaft rear oil seal and housing bolts (1).

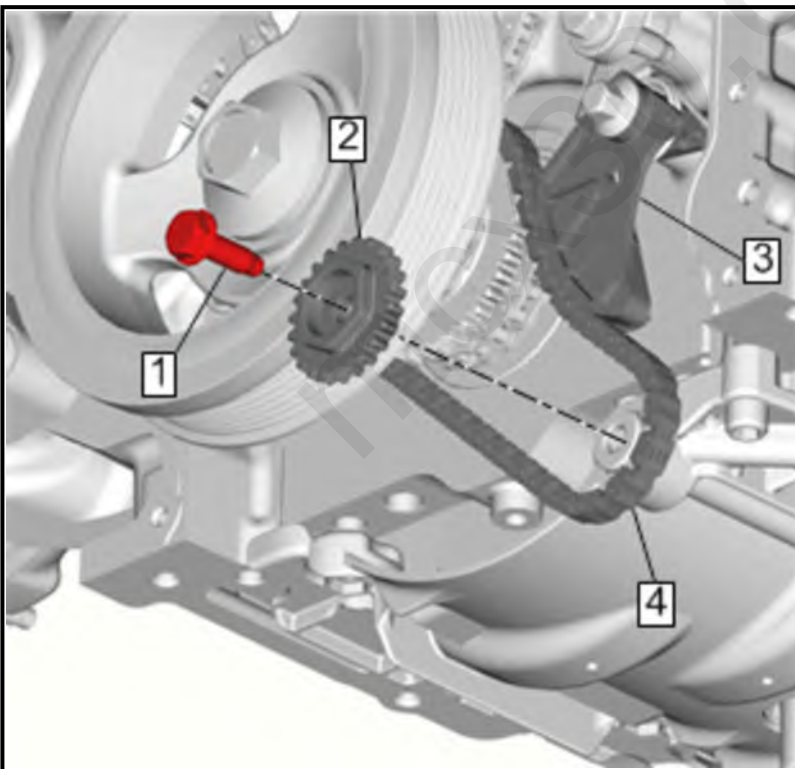


9. Tighten the oil pan to crankshaft rear oil seal and housing bolts to 15 N.m (11 lb ft).
10. Automatic Transmission Flex Plate - Install - [Automatic Transmission Flex Plate Replacement](#)

OIL PUMP SPROCKET REPLACEMENT

Removal Procedure

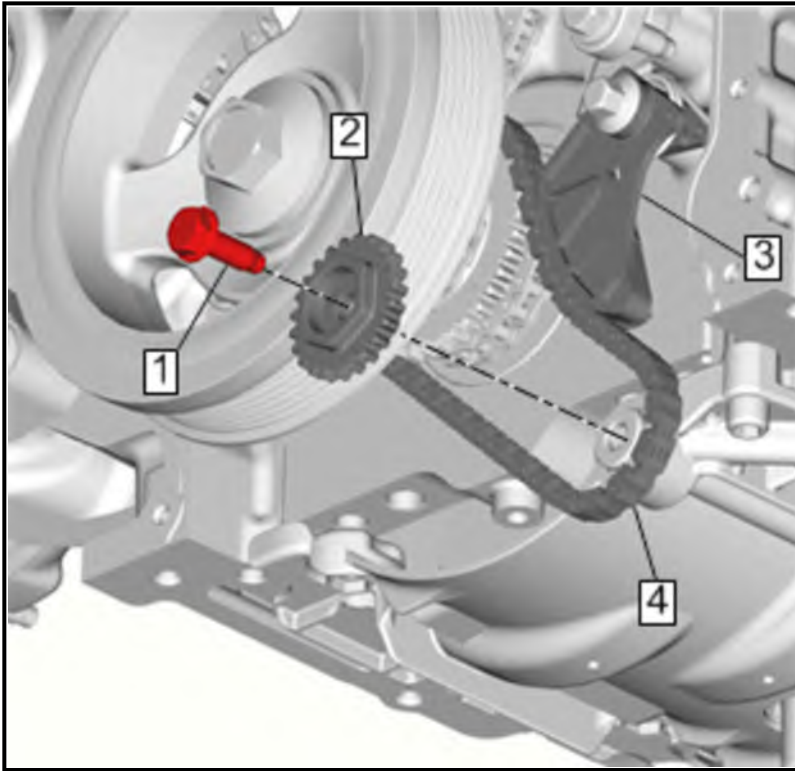
1. Oil Pan - Remove - [Oil Pan Replacement \(4WD\)](#), or [Oil Pan Replacement \(2WD\)](#).
2. Using a suitable wrench to hold the oil pump sprocket (2), remove and DISCARD the oil pump sprocket bolt (1).



NOTE: Engine front cover not shown for clarity.

3. Remove the oil pump sprocket (2) from the oil pump drive shaft leaving the oil pump timing chain (4) on the crankshaft sprocket.
4. Clean and inspect all of the oil pump drive components.

Installation Procedure



NOTE: Engine front cover not shown for clarity.

1. Collapse the oil pump timing chain tensioner (3) by hand.

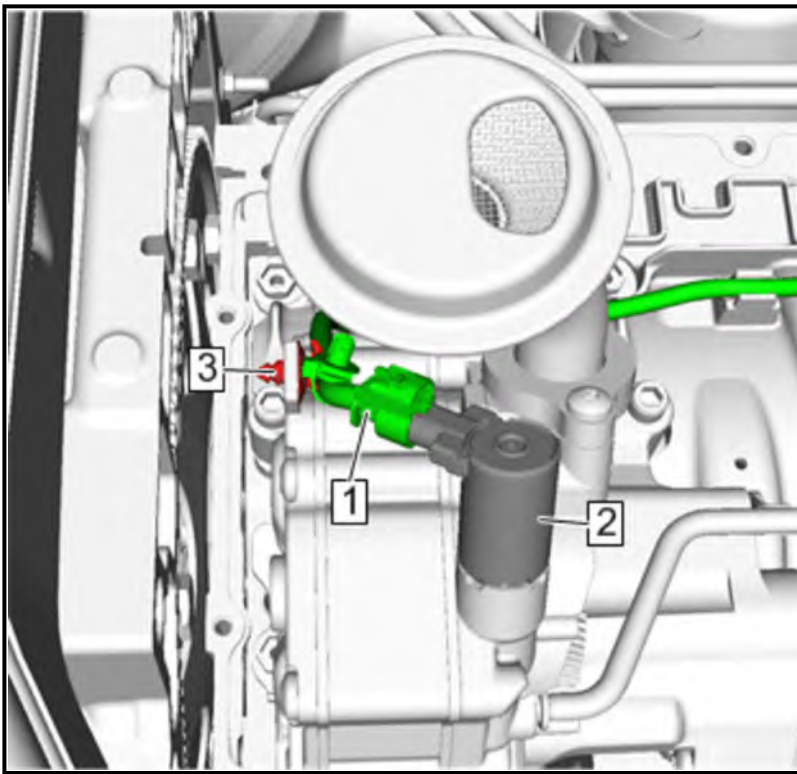
NOTE: Align the flat on the sprocket with the flat on the oil pump drive shaft.

2. Install the oil pump sprocket (2) and oil pump timing chain (4) onto the oil pump shaft.
3. Oil Pump Drive Bolt (1) - Install NEW and tighten
 1. First Pass: 15 N.m (11 lb ft)
 2. Final Pass: 110 degrees
4. Oil Pan - Install - [Oil Pan Replacement \(4WD\)](#), or [Oil Pan Replacement \(2WD\)](#).

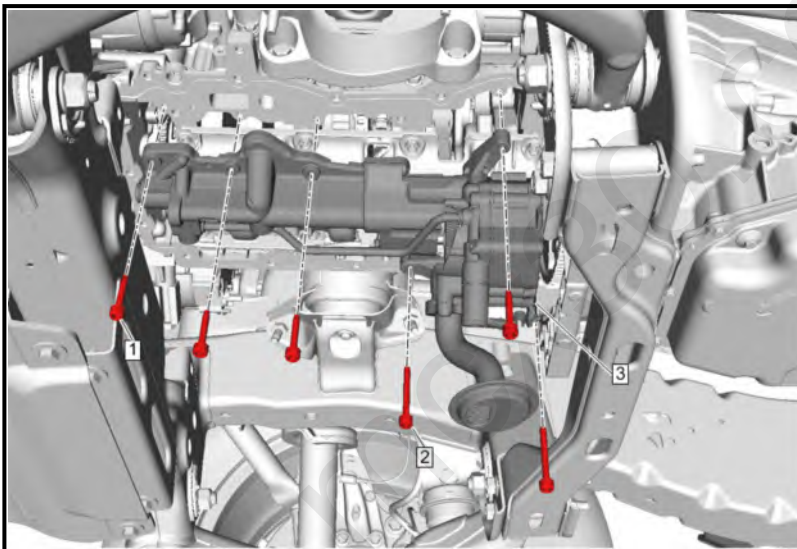
OIL PUMP REPLACEMENT

Removal Procedure

1. Oil Pan - Remove - [Oil Pan Replacement \(4WD\)](#), or [Oil Pan Replacement \(2WD\)](#).
2. Oil Pump Sprocket - Remove - [Oil Pump Sprocket Replacement](#)
3. Disconnect harness (1), harness retainer (3), and position harness aside.



4. Oil Pump Bolt (1, 2) - Remove [6x]



5. Oil Pump (3) - Remove

Installation Procedure

1. Oil Pump (3) - Install

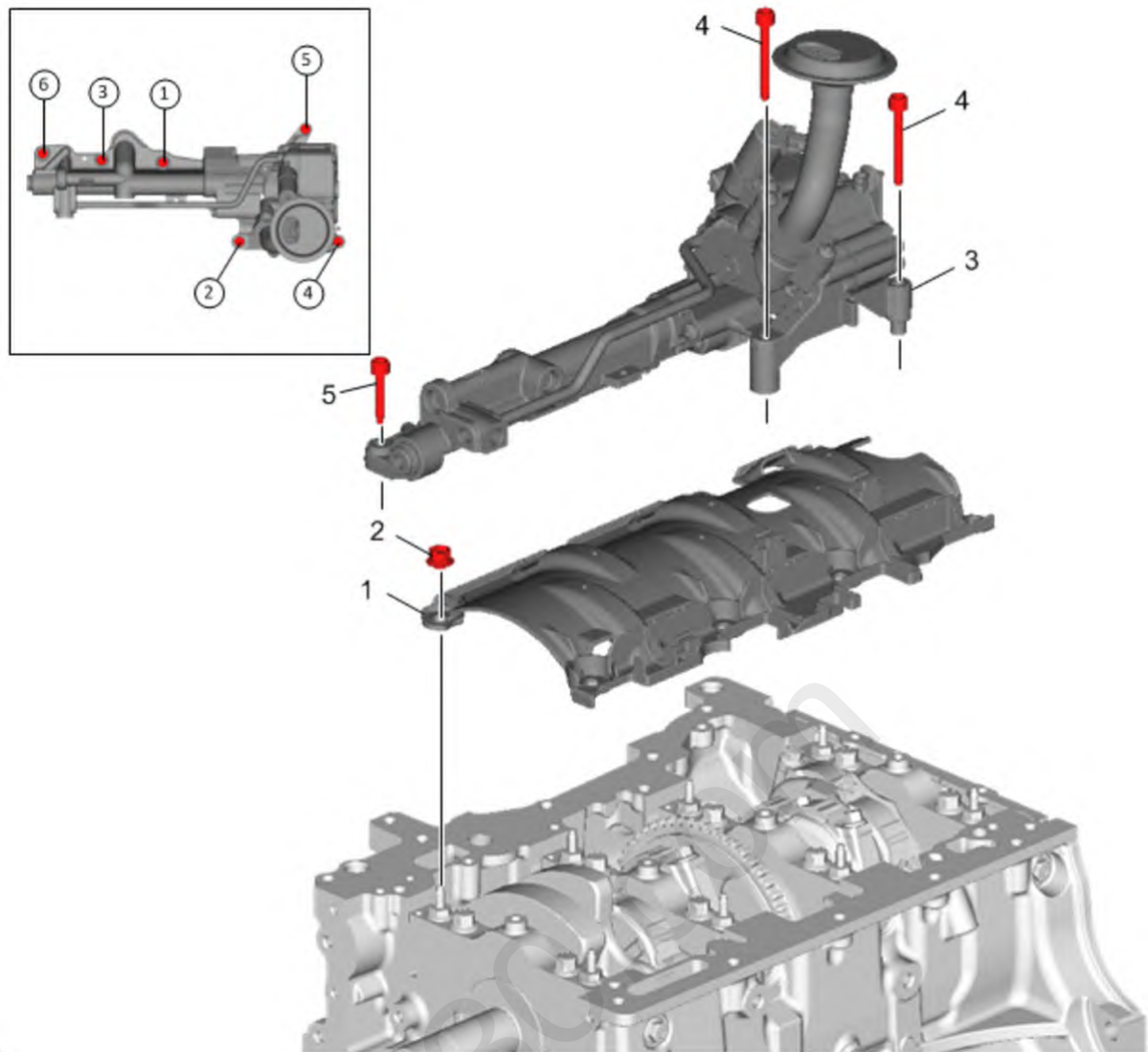
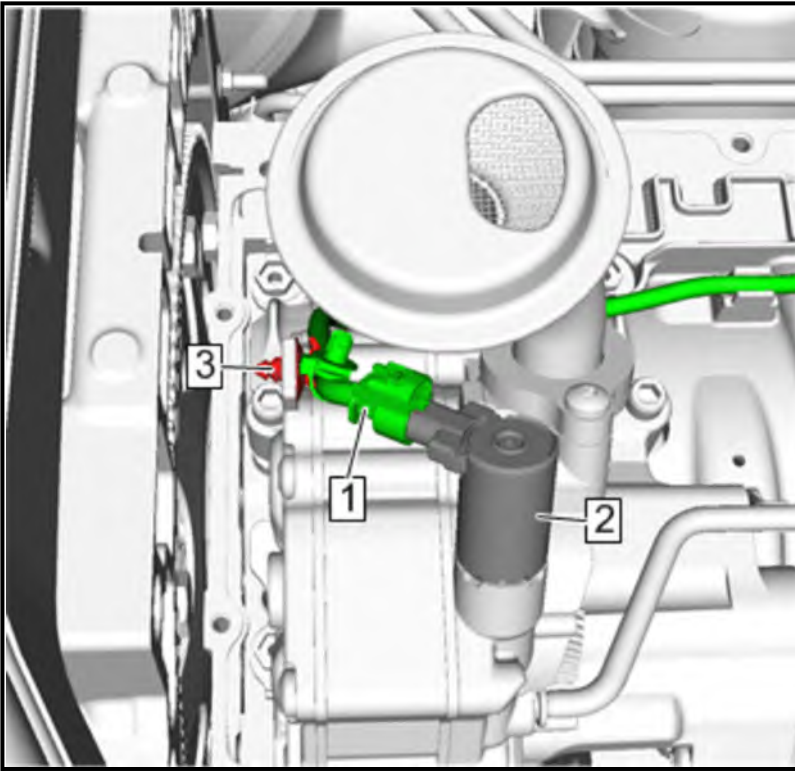


Fig. 18: Oil Pump Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to [Fastener Caution](#) .

2. Oil Pump Bolt (4, 5) - Install and tighten in sequence [6x] 10 N.m (89 lb in)
3. Position harness, attach harness retainer (3), and connect harness (1).



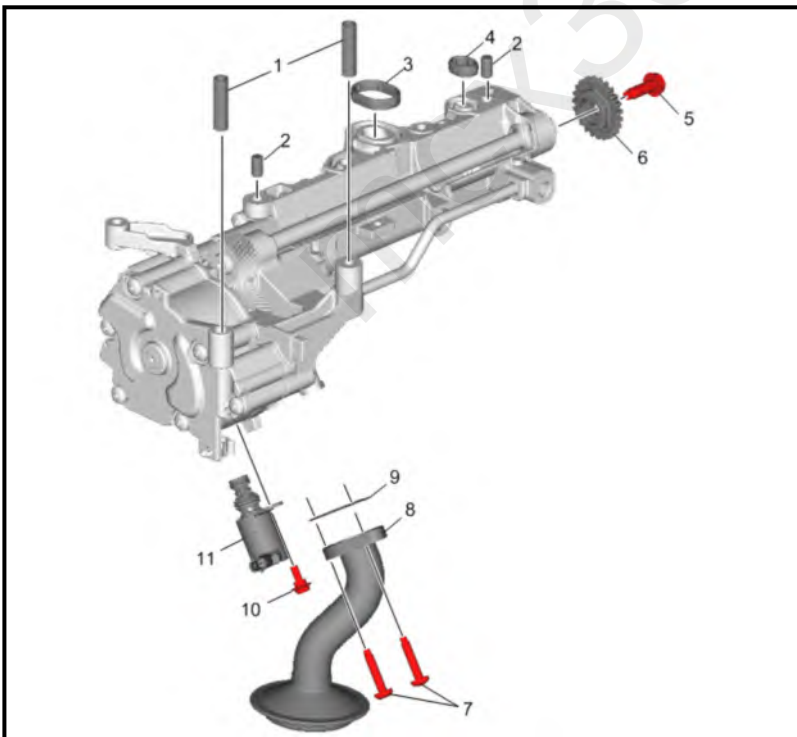
4. Oil Pump Sprocket - Install - [Oil Pump Sprocket Replacement](#)

5. Oil Pan - Install - [Oil Pan Replacement \(4WD\)](#), or [Oil Pan Replacement \(2WD\)](#).

OIL PUMP OVERHAUL

Oil Pump Disassemble

1. Spacer (1) - Remove



NOTE: This is press fit and not serviceable.

2. Dowel Pin (2) - Remove

3. Oil Pump Housing Passage Seal (3) - Remove and DISCARD

4. Oil Pump Housing Passage Seal (4) - Remove and DISCARD

5. Oil Pump Drive Bolt (5) - Remove and DISCARD
6. Oil Pump Sprocket (6) - Remove and DISCARD
7. Oil Pump Suction Pipe Bolt [2x] (7) - Remove and DISCARD
8. Oil Pump Suction Pipe (8) - Remove and DISCARD
9. Oil Pump Suction Pipe Gasket (9) - Remove and DISCARD
10. Oil Pump Flow Control Valve Bolt (10) - Remove and DISCARD

CAUTION: After removing the oil pump flow control valve, ensure the entire valve has been removed and there is no debris left in the oil pump bore. Failure to ensure the oil pump bore is free from debris may result in engine damage.

11. Oil Pump Flow Control Valve (11) - Remove and DISCARD

Cleaning Procedure

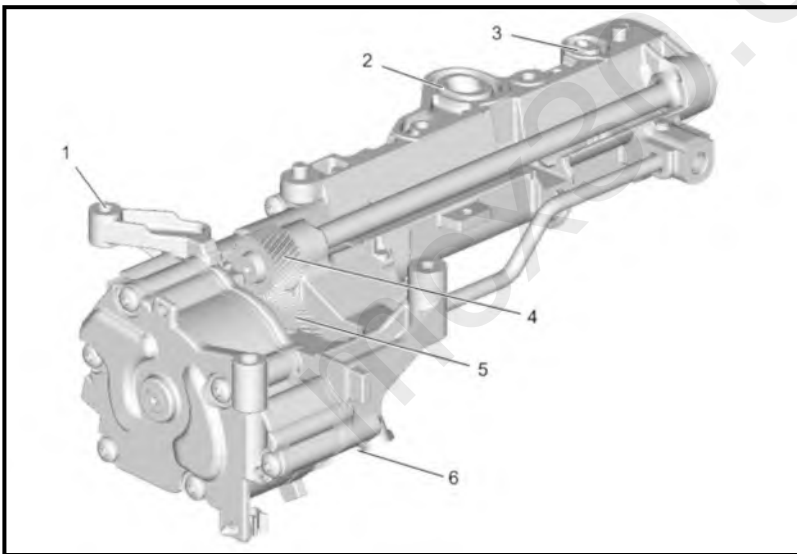
1. Clean the oil pump components with non-corrosive solvent.

WARNING: Refer to [Safety Glasses Warning](#) .

2. Dry the oil pump components with compressed air.

Inspection Procedure

1. Inspect the oil pump housing for the following:

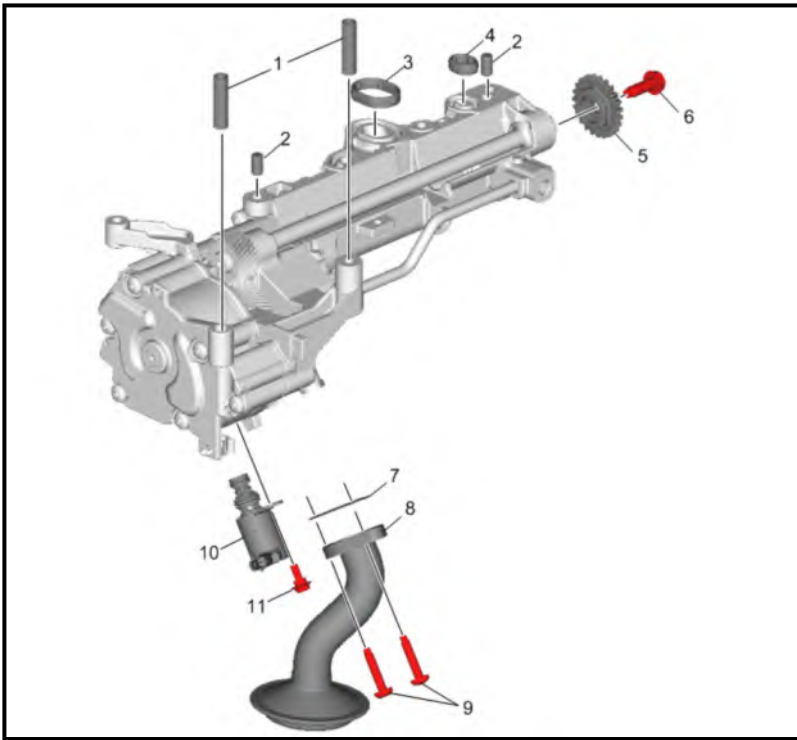


NOTE: There are no serviceable components within the oil pump. Disassemble the pump only to diagnose an oiling concern. A disassembled oil pump must not be reused. A disassembled oil pump must be replaced.

- Damage to the oil pump mounting bosses (1)
- Damage to the oil pump housing seal surface (2)
- Damage to the oil pump housing seal surface (3)
- Damage to the gear (4)
- Damage to the gear (5)
- Damage to the mounting surface for the suction pipe (6)

Oil Pump Assemble

1. Spacer (1) - Install NEW



NOTE: This is press fit and not serviceable.

2. Dowel Pin (2) - Install
3. Oil Pump Housing Passage Seal (3) - Install NEW
4. Oil Pump Housing Passage Seal (4) - Install NEW
5. Oil Pump Sprocket (5) - Install

CAUTION: Refer to [Fastener Caution](#) .

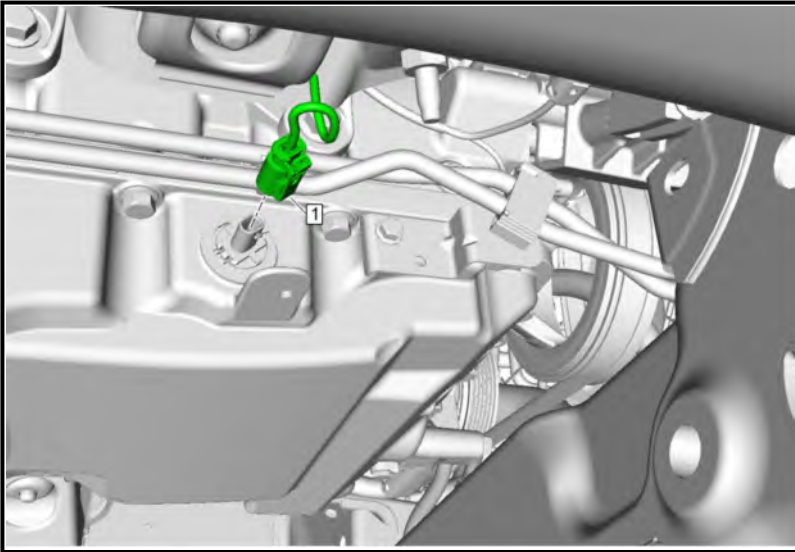
6. Oil Pump Drive Bolt (6) - Install NEW and tighten
 1. First Pass: 15 N.m (11 lb ft)
 2. Final Pass: 110 degrees
7. Oil Pump Suction Pipe Gasket (7) - Install NEW
8. Oil Pump Suction Pipe (8) - Install
9. Oil Pump Suction Pipe Bolt [2x] (9) - Install and tighten 10 N.m (89 lb in)
10. Oil Pump Flow Control Valve (10) - Install
11. Oil Pump Flow Control Valve Bolt (11) - Install and tighten 10 N.m (89 lb in)

OIL PAN REPLACEMENT (4WD)

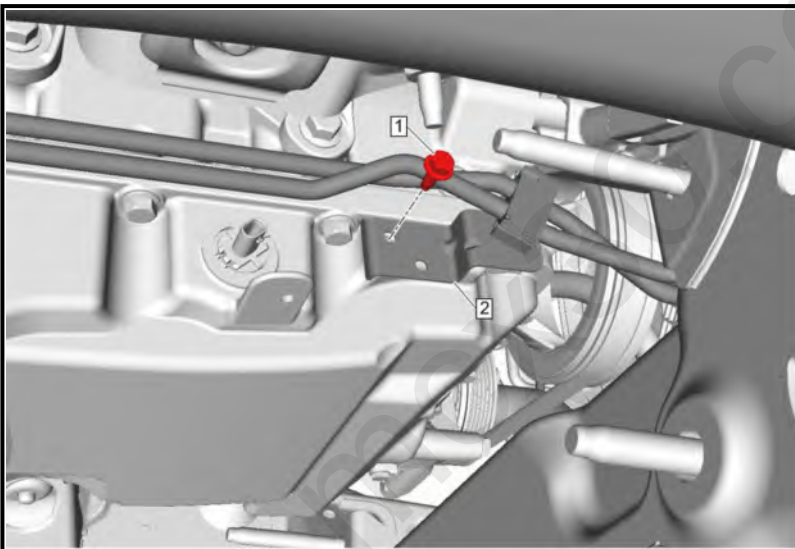
Removal Procedure

1. Engine Support Fixture - Install - [Engine Support Fixture](#)
2. Drain the engine oil. [Engine Oil and Oil Filter Replacement](#)
3. Remove the steering gear skid plate. [Steering Gear Skid Shield Replacement \(without ZR2\)](#) , or [Steering Gear Skid Shield Replacement \(with ZR2\)](#) , or [Steering Gear Skid Shield Replacement \(Bison\)](#)
4. Drivetrain and Front Suspension Frame Front Crossmember - Remove - [Drivetrain and Front Suspension Frame Front Crossmember Replacement \(4 Wheel Drive\)](#)

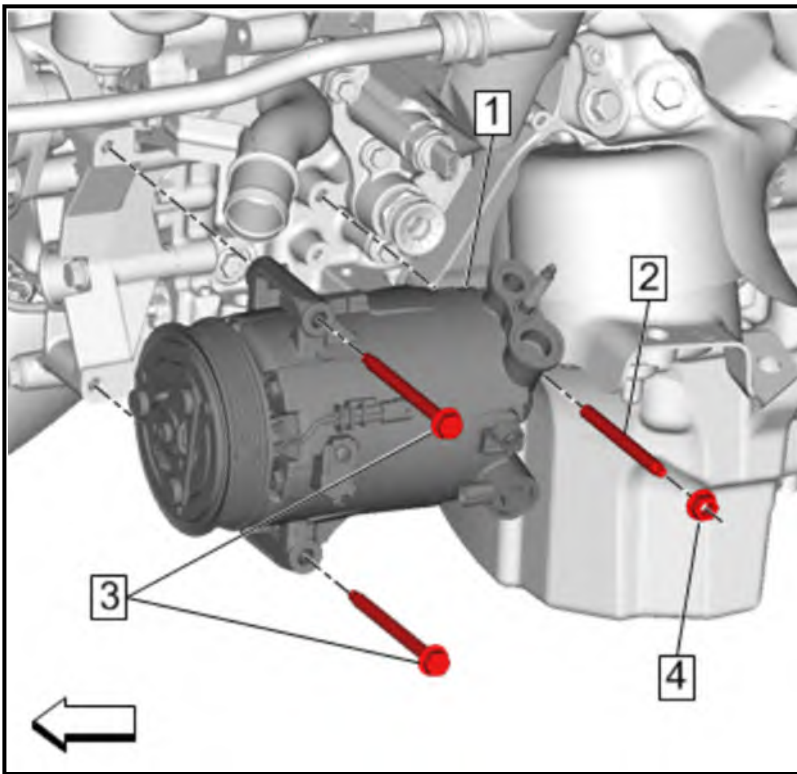
5. Remove the front axle. [Front Axle Replacement \(without ZR2\)](#) , or [Front Axle Replacement \(with ZR2\)](#).
6. Remove the steering gear. [Electric Belt Drive Rack and Pinion Steering Gear Replacement \(4WD\)](#).
7. Disconnect the oil level indicator electrical connector (1).



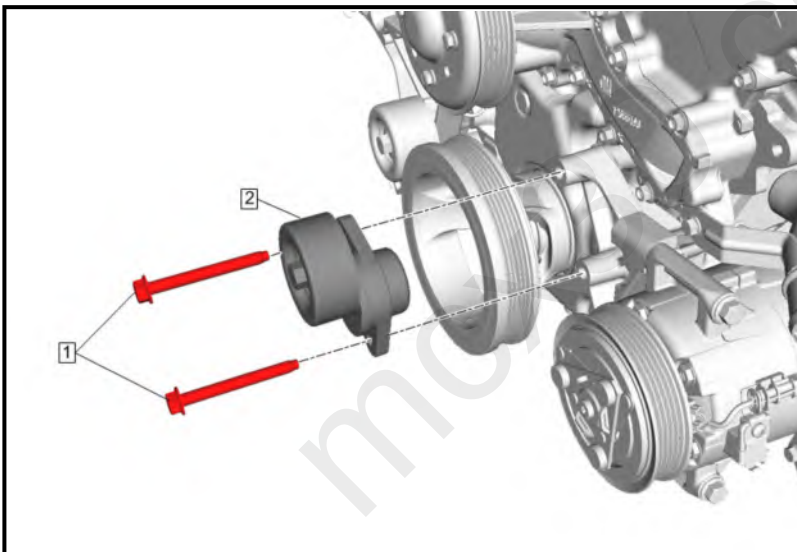
8. Remove the fastener (1) retaining the transmission lines (2) to the oil pan.



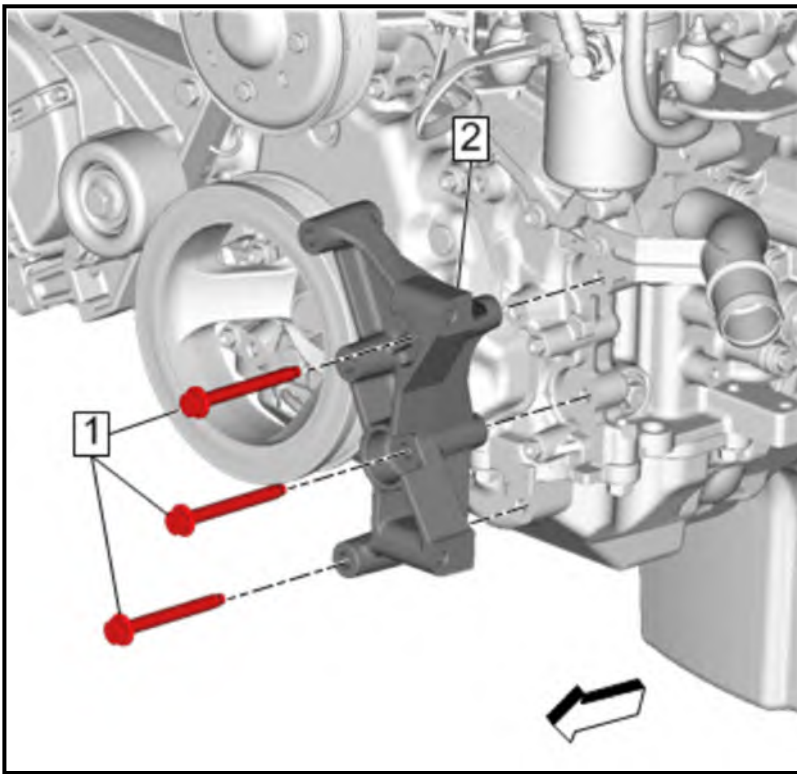
9. Drive Belt @ Air Conditioning Compressor - Remove - [Drive Belt Replacement](#)
10. Air Conditioning Compressor Nut (4) - Remove



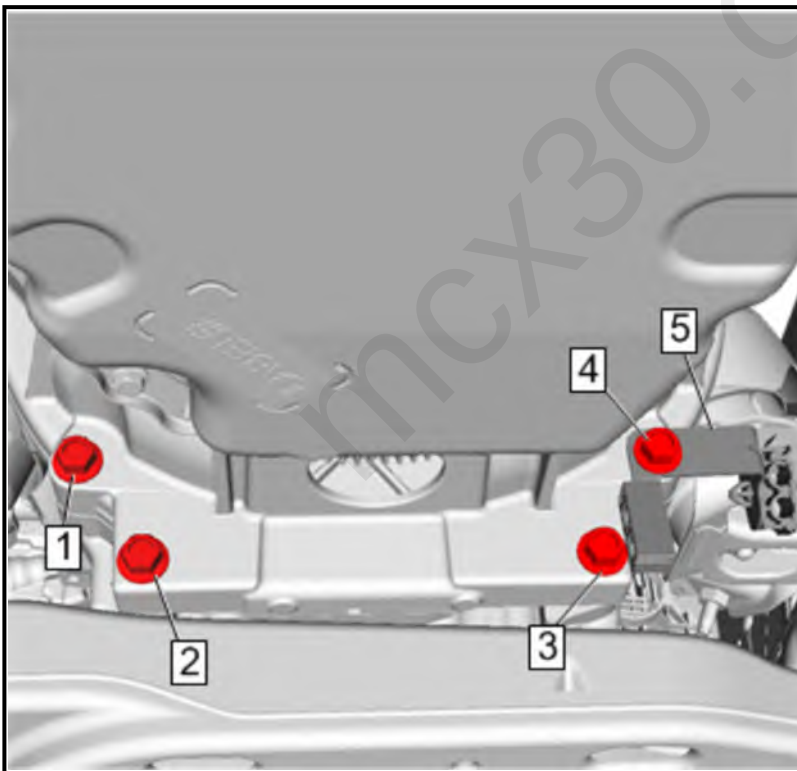
11. Air Conditioning Compressor Stud (2) - Remove
12. Loosen the 2 drive belt tensioner bolts (1).



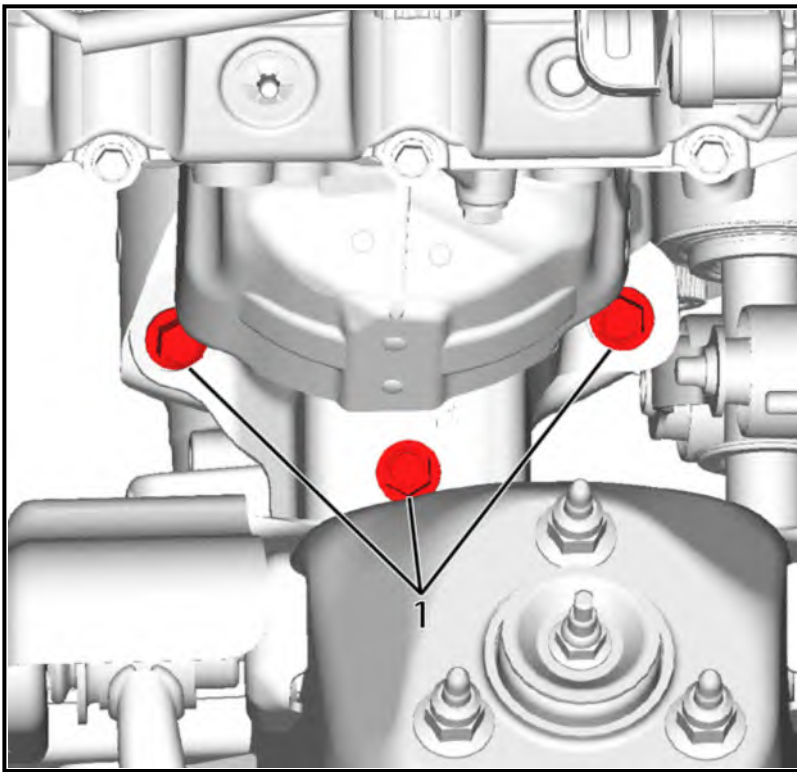
13. Remove the lower air conditioning compressor bracket bolt (1).



14. Loosen the upper 2 air conditioning compressor bracket bolts (1) and position the air conditioning compressor bracket away from the oil pan.
15. Remove the lower transmission to engine bolts (1, 2, 3, 4). [Transmission Replacement \(4WD\)](#)

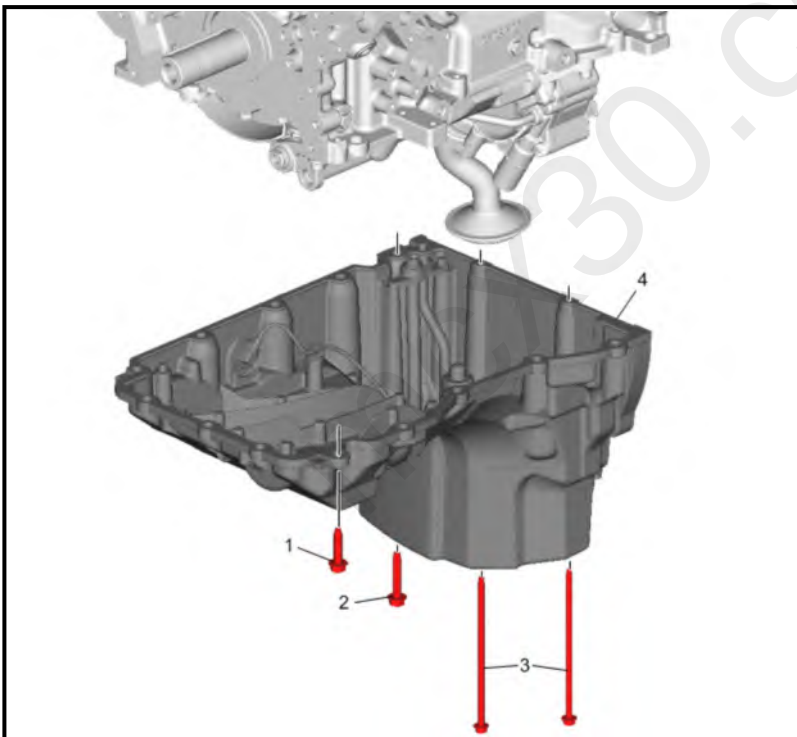


16. Remove and DISCARD the 3 right side engine mount to frame bolts (1). [Engine Mount Replacement - Right Side](#)



17. Adjust the support fixture as necessary to provide clearance for oil pan removal.

18. Oil Pan Bolt (1) - Remove [12x]



NOTE: The two rear oil pan bolts will be captured in the oil pan until oil pan is removed.

19. Oil Pan Bolt (2) - Remove

20. Oil Pan Bolt (3) - Remove and DISCARD [2x]

21. Oil Pan - Remove

22. Clean, inspect, and overhaul the oil pan as needed. [Oil Pan Overhaul](#)

Installation Procedure

1. Place a 3 mm (0.118 in) bead of RTV sealant on the block pan rail and the crankshaft rear oil seal housing (1). [Adhesives, Fluids, Lubricants, and Sealers](#)

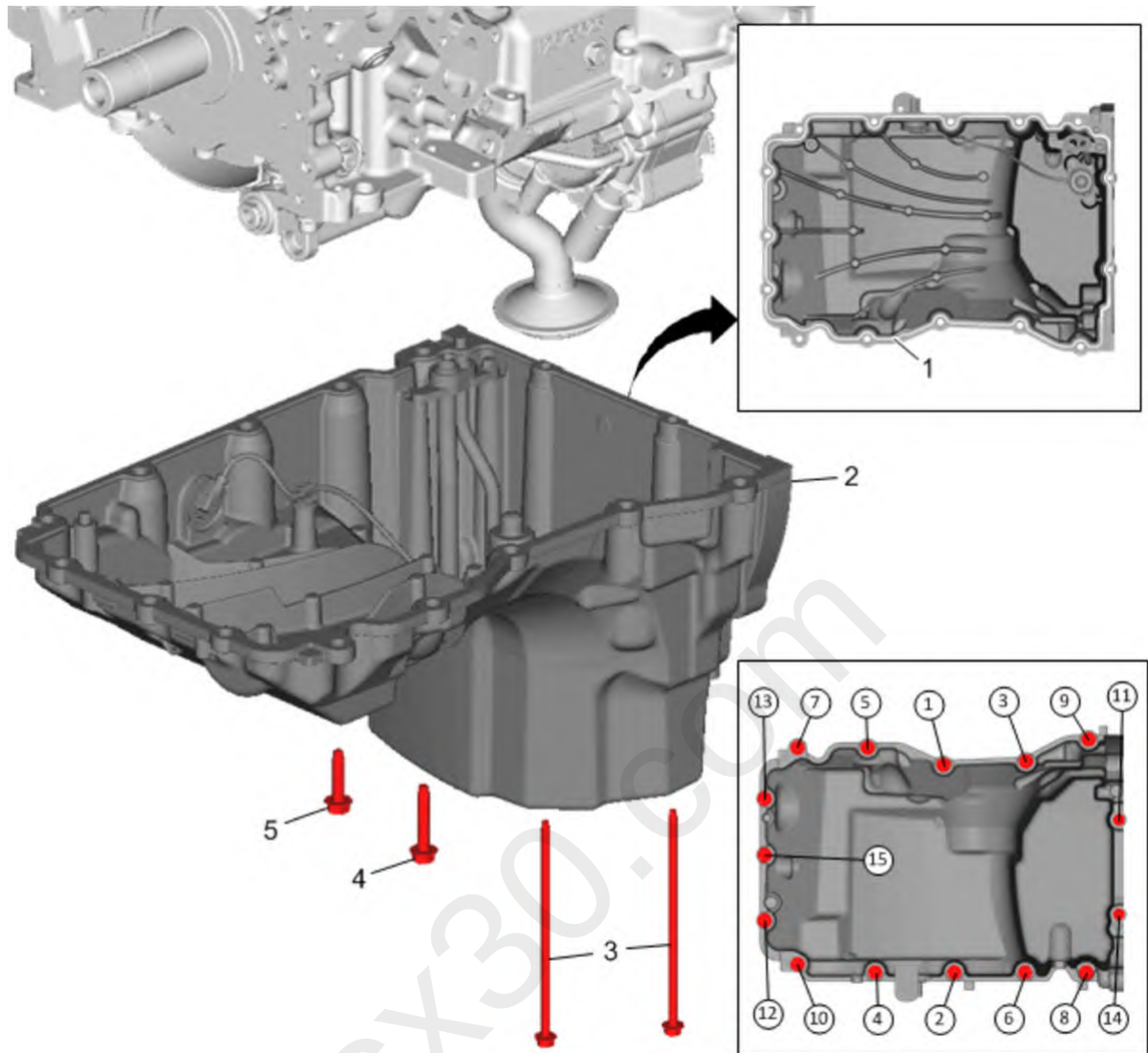


Fig. 19: Oil Pan Bolt Tightening Sequence

Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure proper use of room temperature vulcanizing (RTV) sealant. [Use of Room Temperature Vulcanizing \(RTV\) and Anaerobic Sealant](#)

NOTE: Install the 2 rear oil pan bolts to the oil pan prior to positioning the oil pan to the engine.

2. Oil Pan (2) - Install

CAUTION: Refer to [Fastener Caution](#) .

3. Oil Pan Bolt (3) - Install NEW and tighten in sequence [2x]

1. First Pass: 7 N.m (62 lb in)

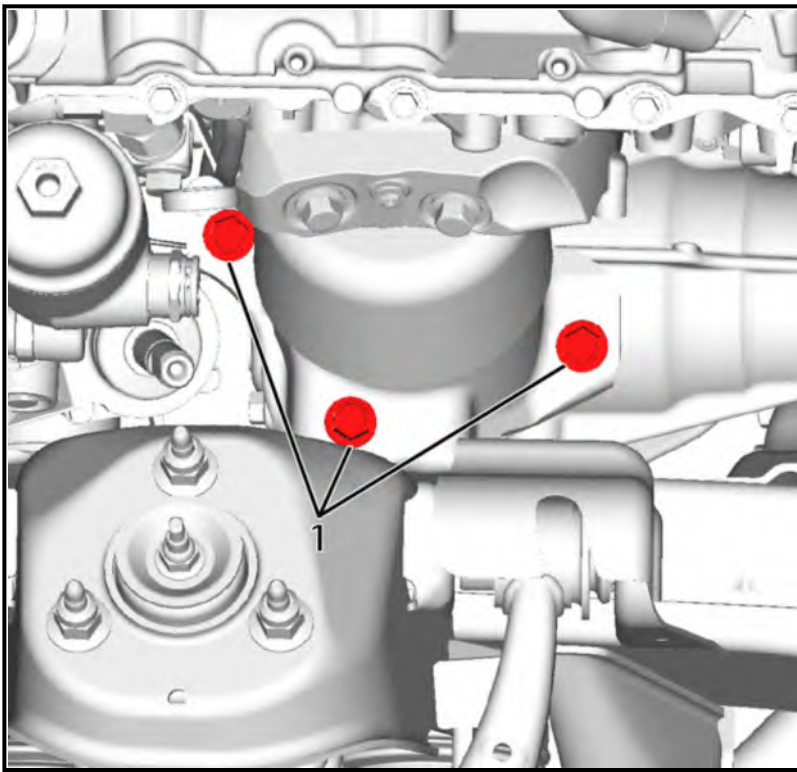
2. Final Pass: 180 degrees

4. Oil Pan Bolt (4) - Tighten in sequence 25 N.m (18 lb ft)

5. Oil Pan Bolt (5) - Tighten in sequence [12x] 25 N.m (18 lb ft)

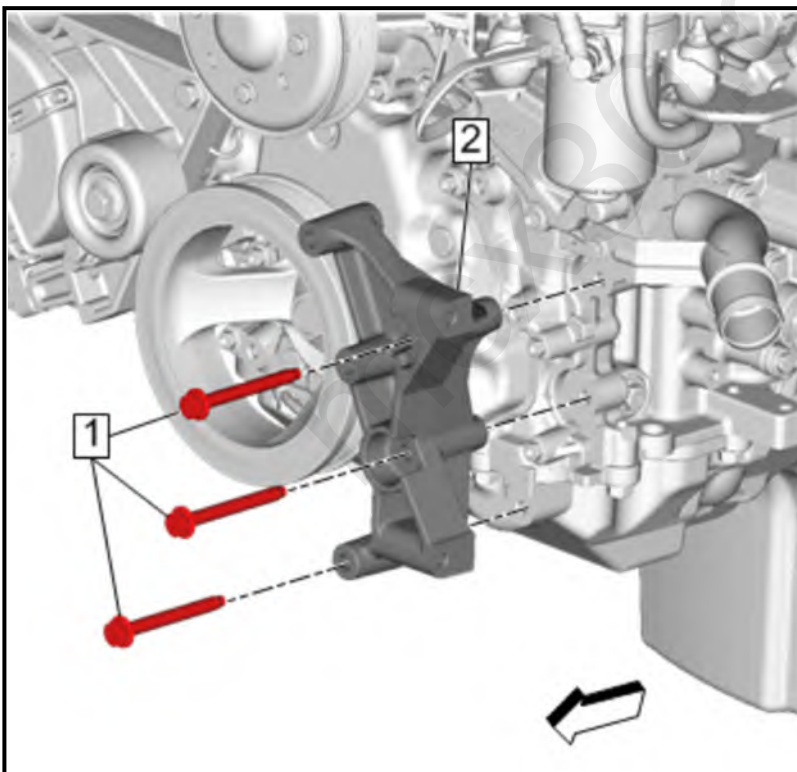
6. Engine Support Fixture - Remove - [Engine Support Fixture](#)

7. Install 3 NEW right side engine mount to frame bolts (1). [Engine Mount Replacement - Right Side](#)



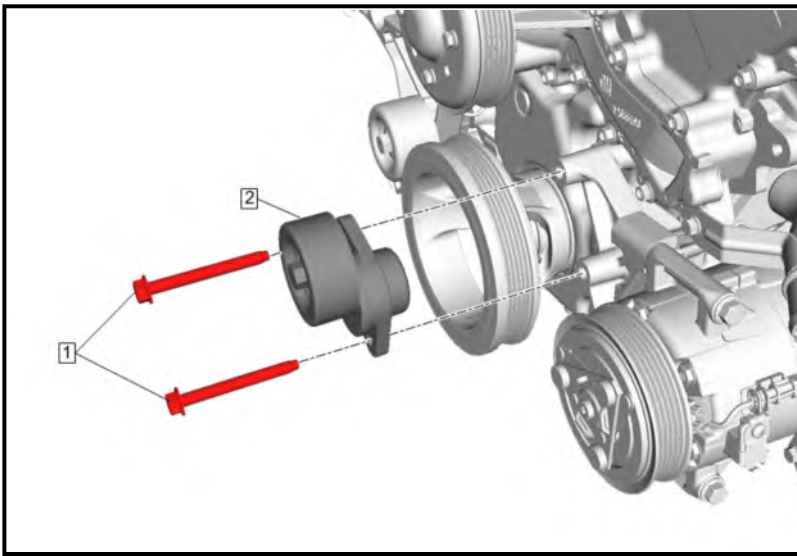
NOTE: Refer to the procedure link for torque specification.

8. Install the lower air conditioning compressor bracket bolt (1).



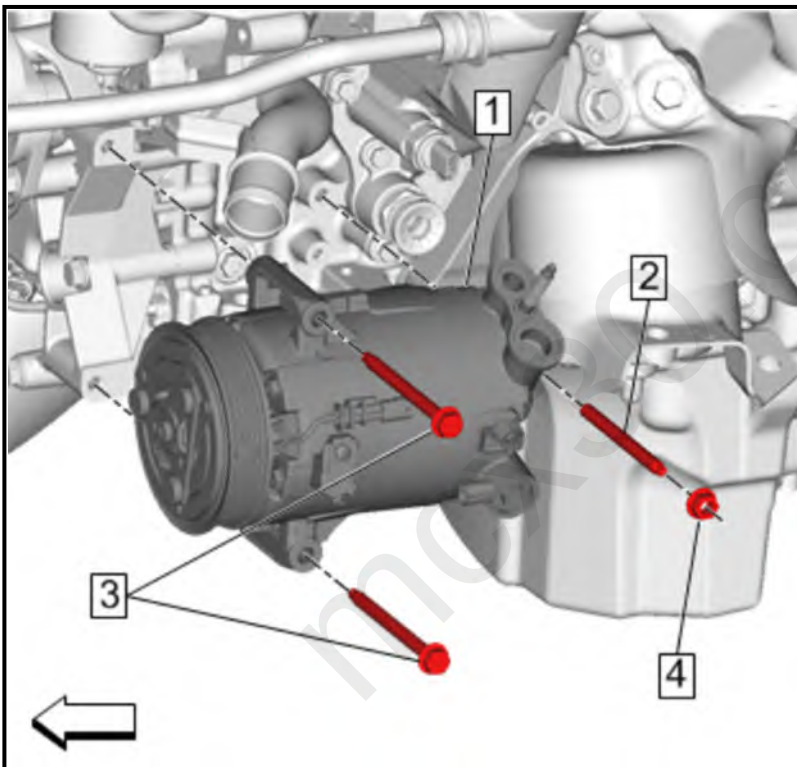
NOTE: Refer to the procedure link for torque specification.

9. Tighten the 3 air conditioning compressor bracket bolts (1). [Air Conditioning Compressor Bracket Replacement \(LGZ\)](#)
10. Tighten the 2 drive belt tensioner bolts (1). [Drive Belt Tensioner Replacement](#)



NOTE: Refer to the procedure link for torque specification.

11. Air Conditioning Compressor Stud (2) - Install - [Air Conditioning Compressor Replacement \(LGZ\)](#)



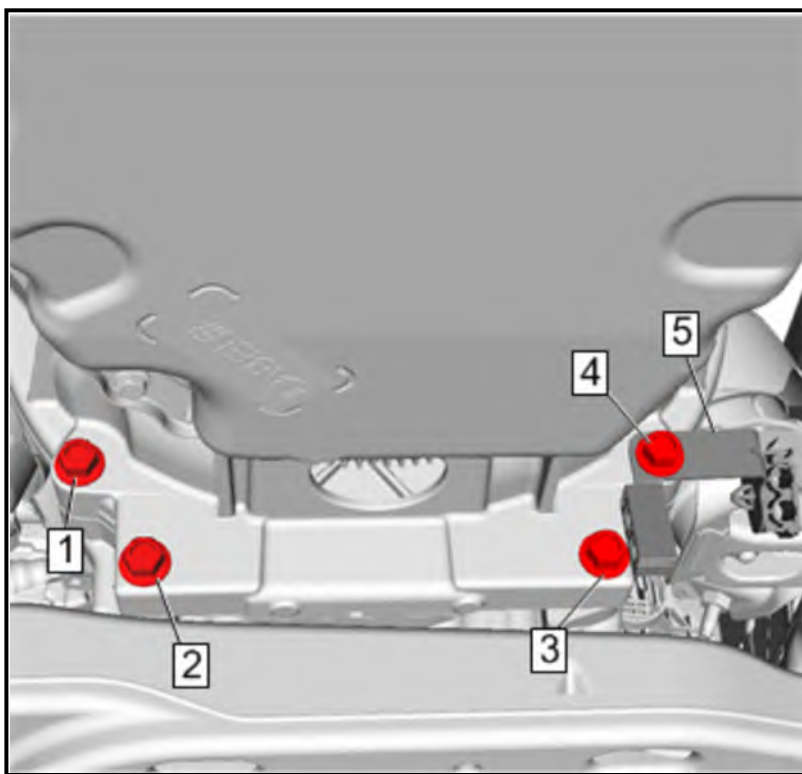
NOTE: Refer to the procedure link for torque specification.

NOTE: Refer to the procedure link for torque specification.

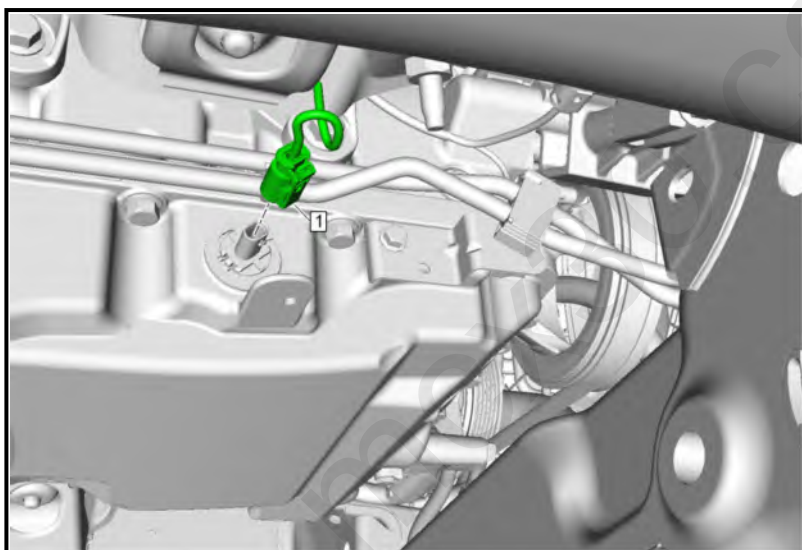
12. Air Conditioning Compressor Nut (4) - Install - [Air Conditioning Compressor Replacement \(LGZ\)](#)

13. Drive Belt @ Air Conditioning Compressor - Install - [Drive Belt Replacement](#)

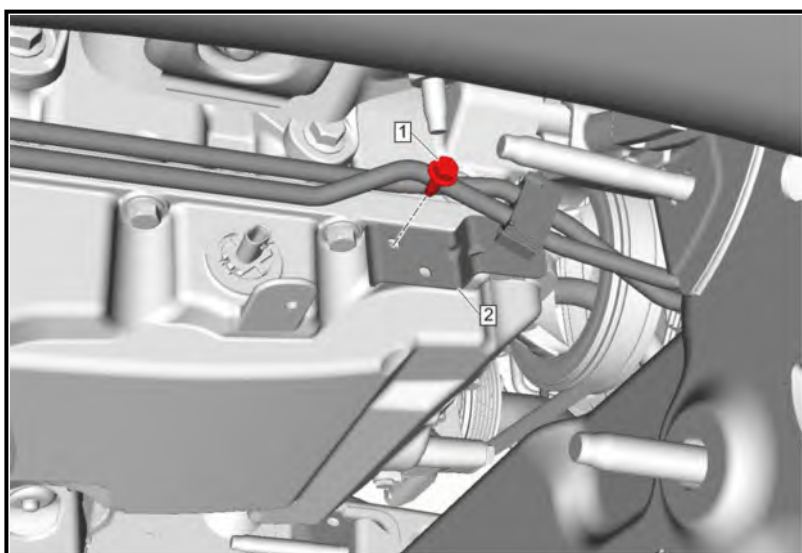
14. Install the lower transmission to engine bolts (1, 2, 3, 4). [Transmission Replacement \(4WD\)](#)



15. Connect the oil level indicator electrical connector (1).



16. Reposition the transmission lines (2) to the oil pan.

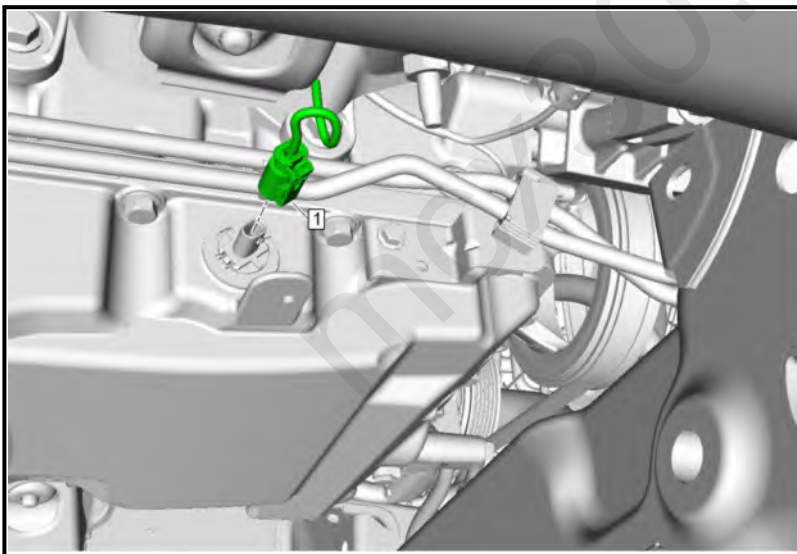


17. Transmission Fluid Cooler Pipe Clip Bolt (1) - Install and tighten - [Transmission Fluid Cooler Inlet and Outlet Pipe Replacement \(LGZ With M5T and 4WD\)](#) ,
18. Drivetrain and Front Suspension Frame Front Crossmember - Install - [Drivetrain and Front Suspension Frame Front Crossmember Replacement \(4 Wheel Drive\)](#)
19. Install the front axle. [Front Axle Replacement \(without ZR2\)](#) , or [Front Axle Replacement \(with ZR2\)](#).
20. Install the steering gear. [Electric Belt Drive Rack and Pinion Steering Gear Replacement \(4WD\)](#).
21. Install the steering gear skid plate. [Steering Gear Skid Shield Replacement \(without ZR2\)](#) , or [Steering Gear Skid Shield Replacement \(with ZR2\)](#) , or [Steering Gear Skid Shield Replacement \(Bison\)](#)
22. Fill the engine oil. [Engine Oil and Oil Filter Replacement](#)

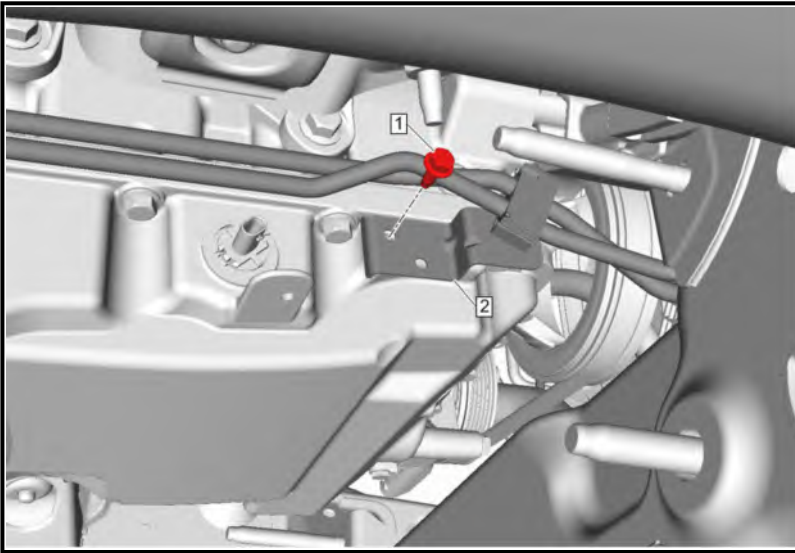
OIL PAN REPLACEMENT (2WD)

Removal Procedure

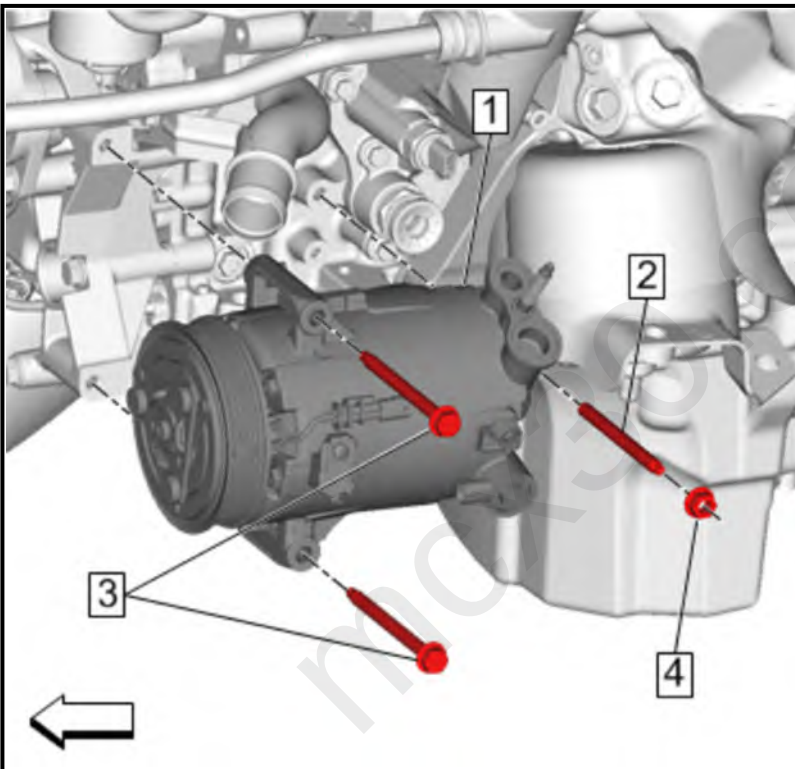
1. Engine Support Fixture - Install - [Engine Support Fixture](#)
2. Drain the engine oil. [Engine Oil and Oil Filter Replacement](#)
3. Remove the steering gear skid plate. [Steering Gear Skid Shield Replacement \(without ZR2\)](#) , or [Steering Gear Skid Shield Replacement \(with ZR2\)](#) , or [Steering Gear Skid Shield Replacement \(Bison\)](#)
4. Remove the steering gear. [Electric Belt Drive Rack and Pinion Steering Gear Replacement \(2WD\)](#).
5. Drivetrain and Front Suspension Frame Front Crossmember - Remove - [Drivetrain and Front Suspension Frame Front Crossmember Replacement \(2 Wheel Drive\)](#).
6. Disconnect the oil level indicator electrical connector (1).



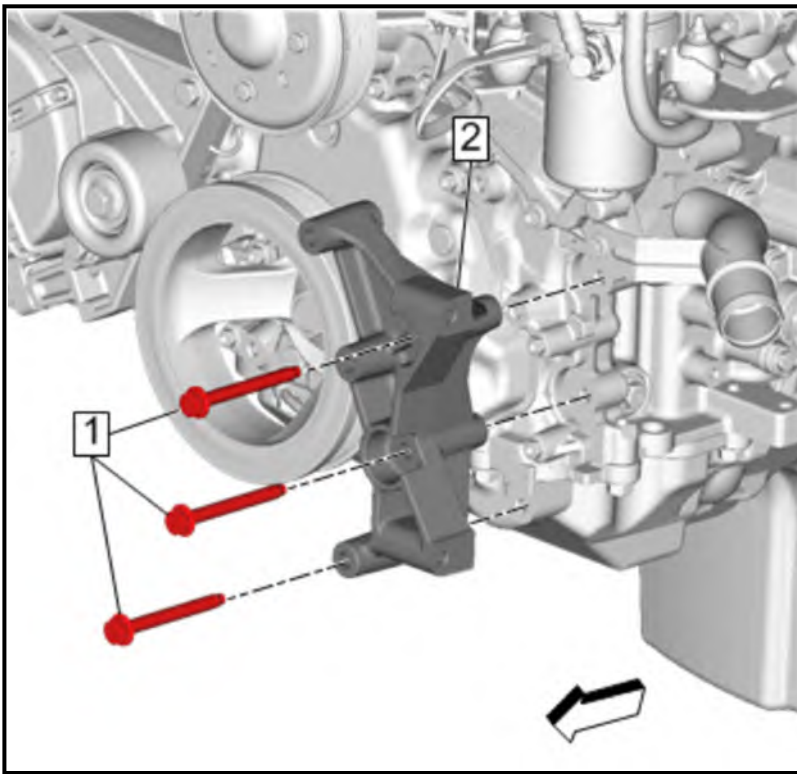
7. Remove the fastener (1) retaining the transmission lines (2) to the oil pan.



8. Position the transmission lines (2) out of the way.
9. Air Conditioning Compressor Nut (4) - Remove

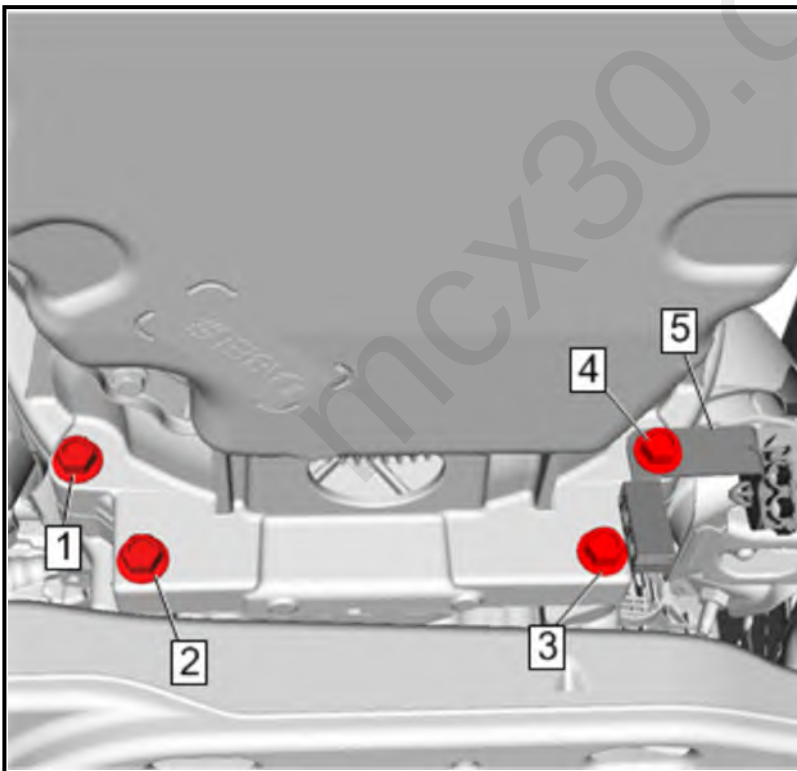


10. Air Conditioning Compressor Stud (2) - Remove
11. Air Conditioning Compressor Bracket Bolt (1) - Remove [3x] - [Air Conditioning Compressor Bracket Replacement \(LGZ\)](#)

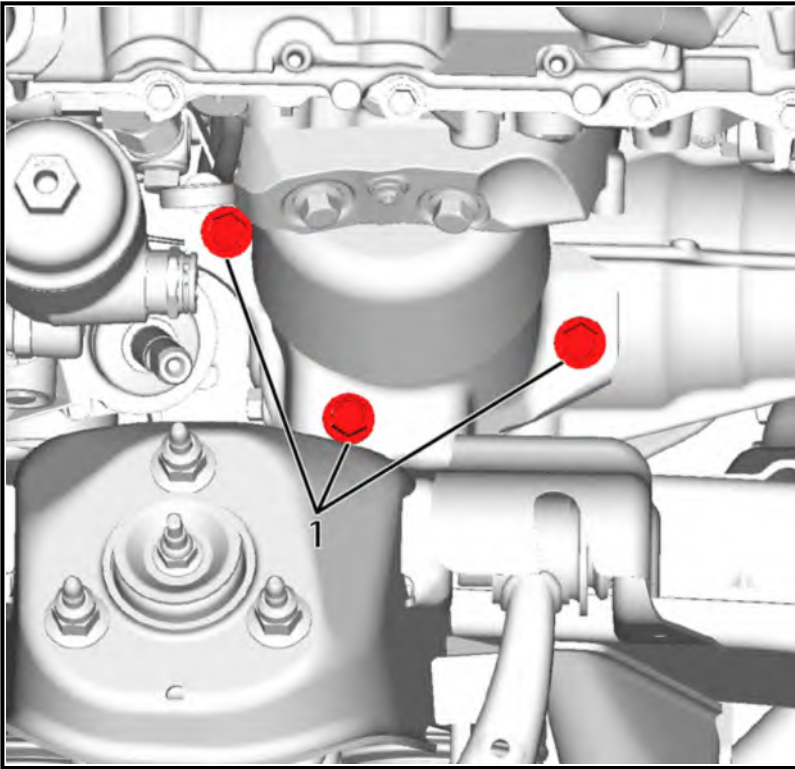


NOTE: Reposition the air conditioning bracket and compressor as an assembly.

12. Remove the lower transmission to engine bolts (1, 2, 3, 4). [Transmission Replacement \(2WD\)](#)

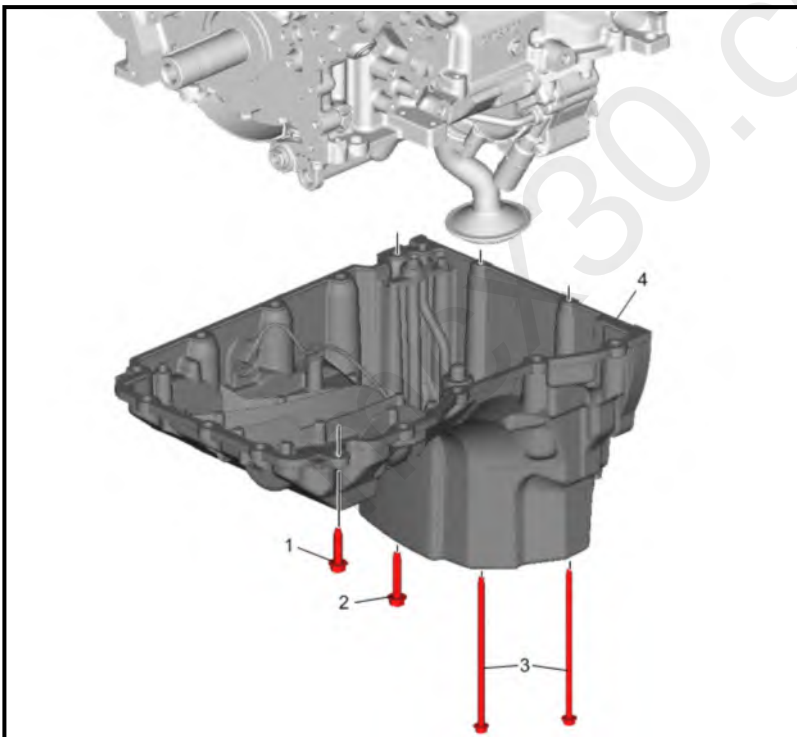


13. Remove and DISCARD the left side engine mount to frame bolts (1). [Engine Mount Replacement - Left Side](#)



14. Adjust the support fixture as necessary to provide clearance for oil pan removal.

15. Oil Pan Bolt (1) - Remove [12x]



NOTE: The two rear oil pan bolts will be captured in the oil pan until oil pan is removed.

16. Oil Pan Bolt (2) - Remove

17. Oil Pan Bolt (3) - Remove and DISCARD [2x]

18. Oil Pan - Remove

19. Clean, inspect, and overhaul the oil pan as needed. [Oil Pan Overhaul](#)

Installation Procedure

1. Place a 3 mm (0.118 in) bead of RTV sealant on the block pan rail and the crankshaft rear oil seal housing (1). [Adhesives, Fluids, Lubricants, and Sealers](#)

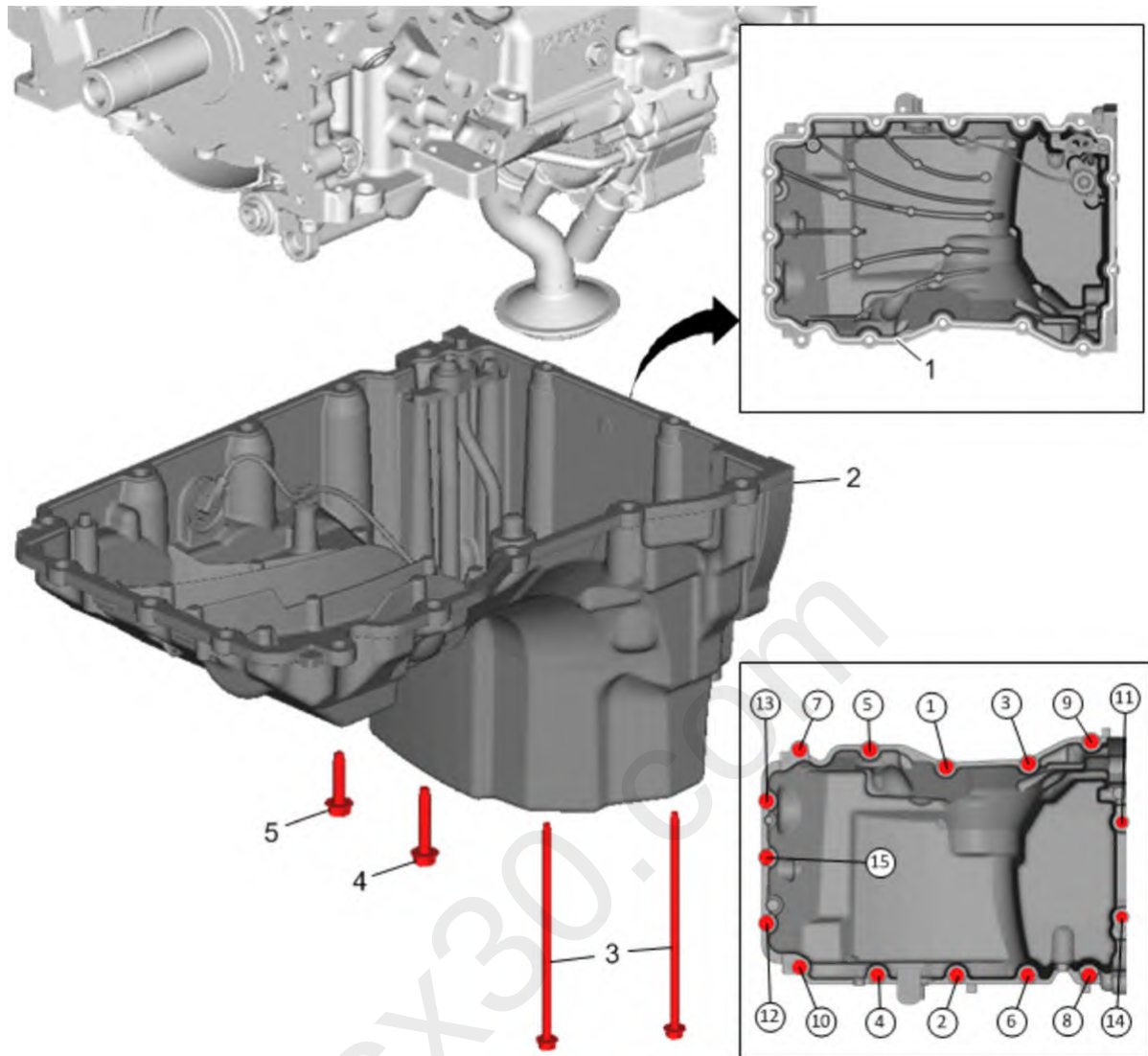


Fig. 20: Oil Pan Bolt Tightening Sequence

Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure proper use of room temperature vulcanizing (RTV) sealant. [Use of Room Temperature Vulcanizing \(RTV\) and Anaerobic Sealant](#)

NOTE: Install the 2 rear oil pan bolts to the oil pan prior to positioning the oil pan to the engine.

2. Oil Pan (2) - Install

CAUTION: Refer to [Fastener Caution](#) .

3. Oil Pan Bolt (3) - Install NEW and tighten in sequence [2x]

1. First Pass: 7 N.m (62 lb in)

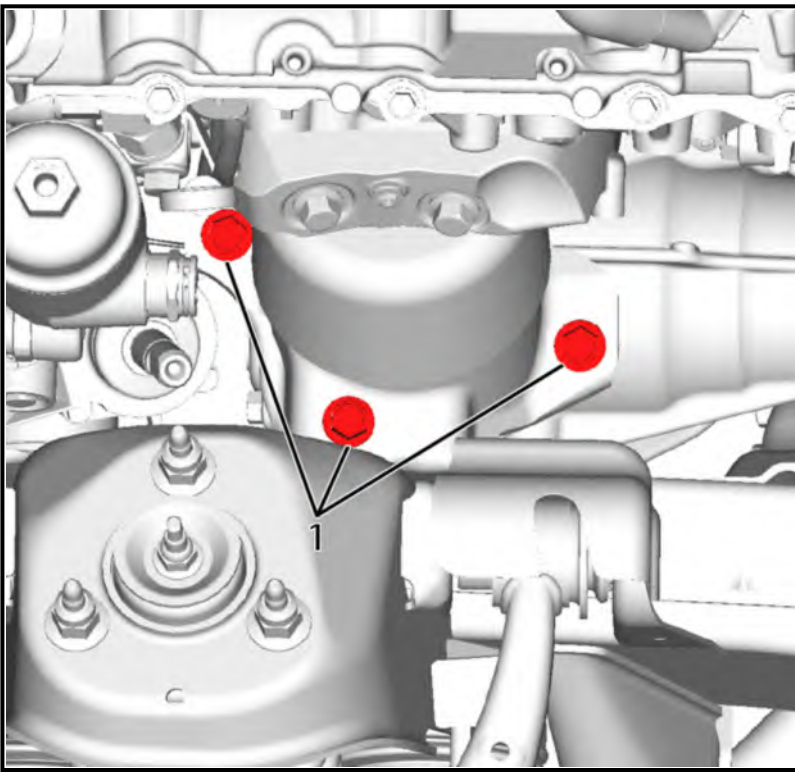
2. Final Pass: 180 degrees

4. Oil Pan Bolt (4) - Tighten in sequence 25 N.m (18 lb ft)

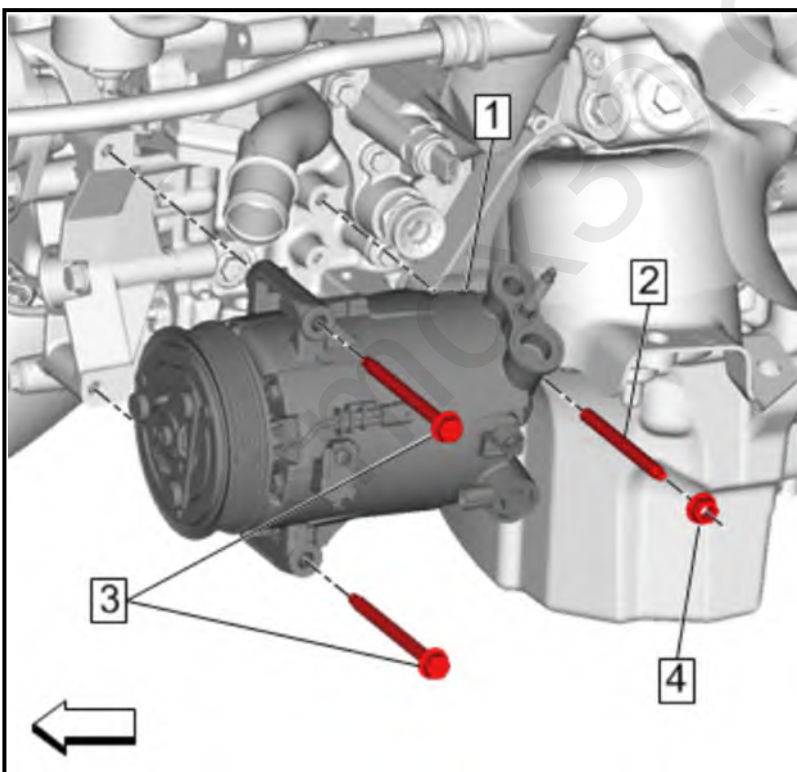
5. Oil Pan Bolt (5) - Tighten in sequence [12x] 25 N.m (18 lb ft)

6. Engine Support Fixture - Remove - [Engine Support Fixture](#)

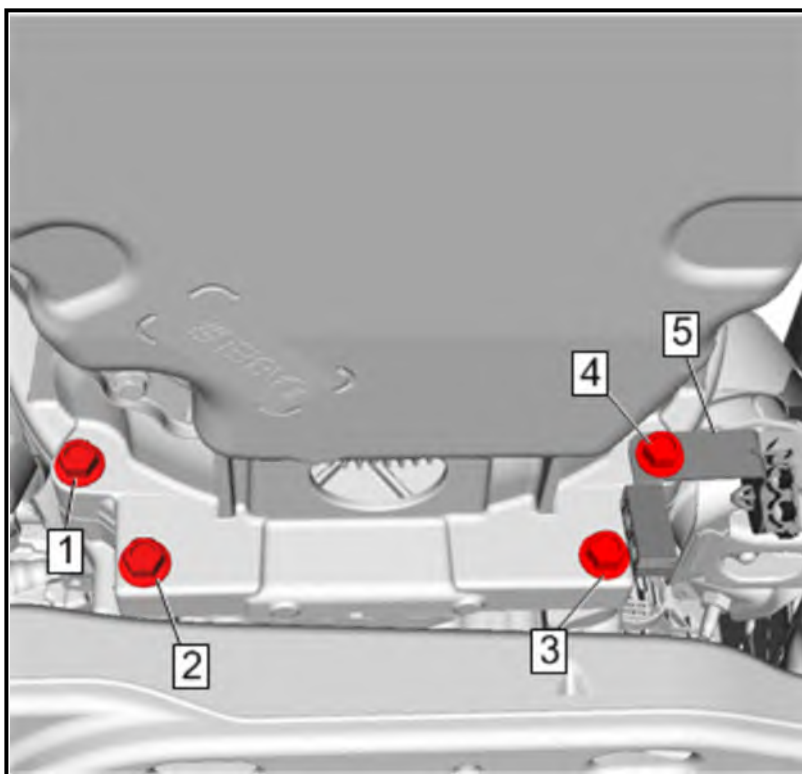
7. Install NEW left side engine mount to frame bolts (1). [Engine Mount Replacement - Left Side](#)



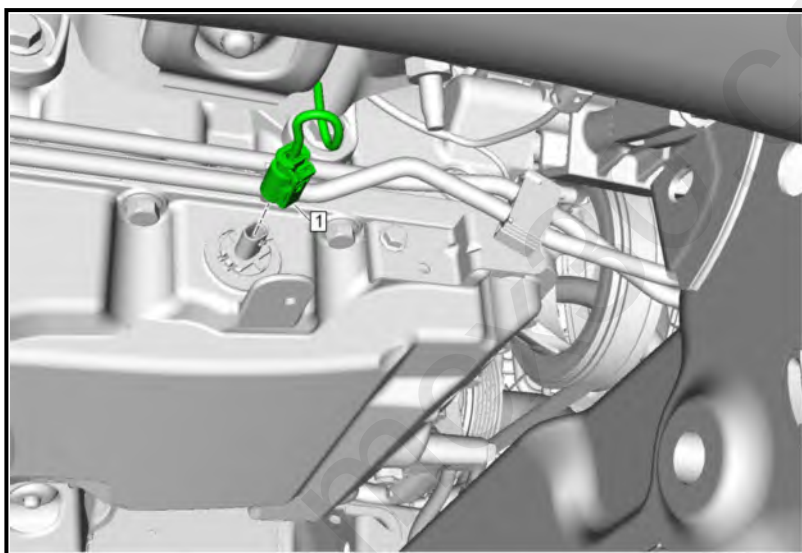
8. Air Conditioning Compressor Bracket - Install - [Air Conditioning Compressor Bracket Replacement \(LGZ\)](#)
9. Air Conditioning Compressor Stud (2) - Install - [Air Conditioning Compressor Replacement \(LGZ\)](#)



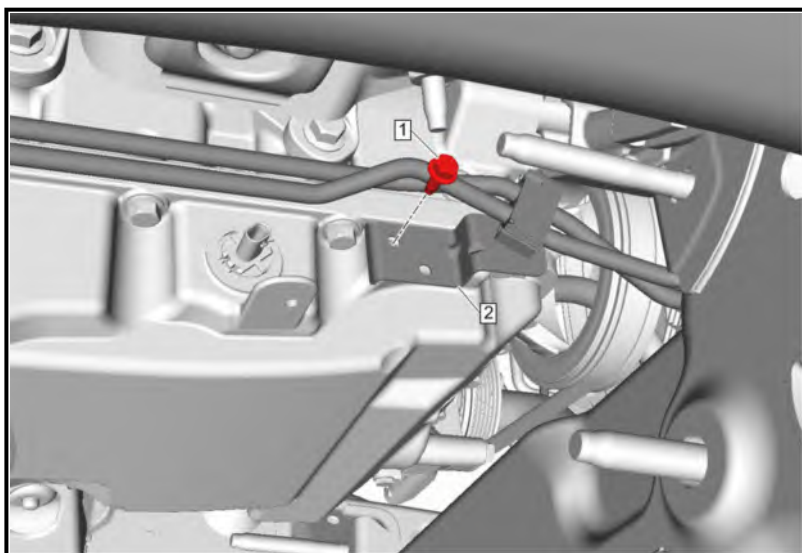
10. Air Conditioning Compressor Nut (4) - Install - [Air Conditioning Compressor Replacement \(LGZ\)](#)
11. Drivetrain and Front Suspension Frame Front Crossmember - Install - [Drivetrain and Front Suspension Frame Front Crossmember Replacement \(2 Wheel Drive\)](#)
12. Install the lower transmission to engine bolts (1, 2, 3, 4). [Transmission Replacement \(2WD\)](#)



13. Connect the oil level indicator electrical connector (1).



14. Reposition the transmission lines (2) to the oil pan.



15. Transmission Fluid Cooler Pipe Clip Bolt (1) - Install and tighten - [Transmission Fluid Cooler Inlet and Outlet Pipe Replacement \(LGZ With M5T and 2WD\)](#).
16. Install the steering gear. [Electric Belt Drive Rack and Pinion Steering Gear Replacement \(2WD\)](#).
17. Install the steering gear skid plate. [Steering Gear Skid Shield Replacement \(without ZR2\)](#) , or [Steering Gear Skid Shield Replacement \(with ZR2\)](#) , or [Steering Gear Skid Shield Replacement \(Bison\)](#).
18. Fill the engine oil. [Engine Oil and Oil Filter Replacement](#)

OIL PAN OVERHAUL

Special Tools

EN-28410 Gasket Remover

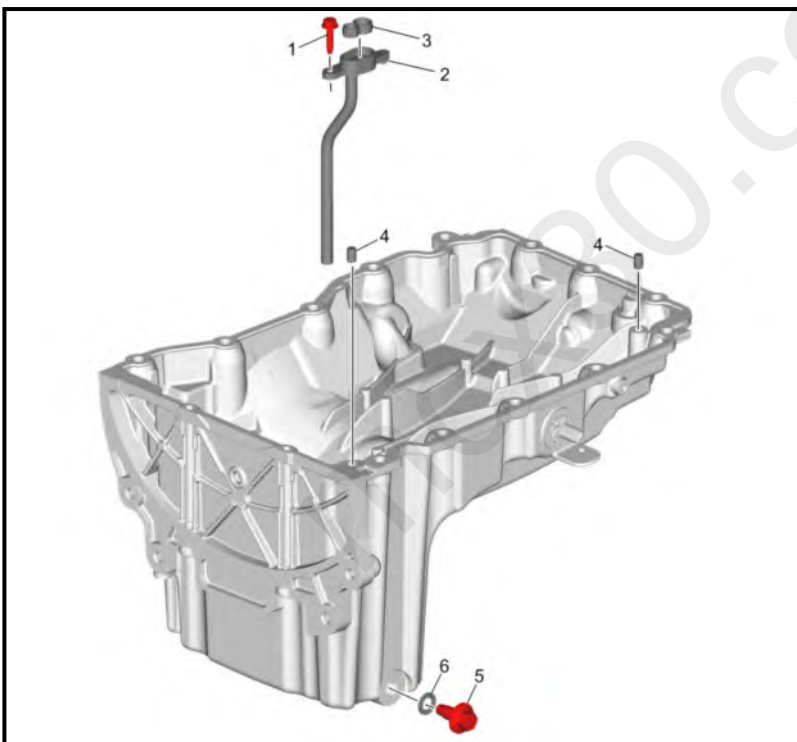
Equivalent regional tools: [Special Tools](#)

Removal Procedure

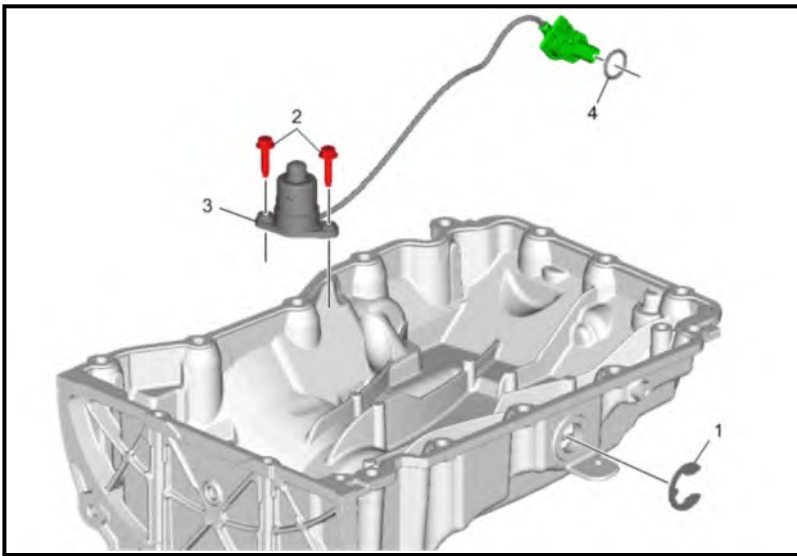
Remove the oil pan. [Oil Pan Replacement \(4WD\)](#), or [Oil Pan Replacement \(2WD\)](#).

Disassemble Procedure

1. Positive Crankcase Ventilation Oil Separator Drain Pipe Bolt (1) - Remove



2. Positive Crankcase Ventilation Oil Separator Drain Pipe (2) - Remove
3. Oil Pan High Pressure Port Seal (3) - Remove and DISCARD
4. Dowel Pin (4) - Remove [2x]
5. Oil Pan Drain Plug (5) - Remove
6. Oil Pan Drain Plug Seal (6) - Remove and DISCARD
7. Engine Oil Level Switch Clip (1) - Remove



8. Engine Oil Level Indicator Switch Bolt (2) - Remove [2x]
9. Engine Oil Level Indicator Switch (3) - Remove
10. Engine Oil Level Indicator Switch O-Ring Seal (4) - Remove and DISCARD

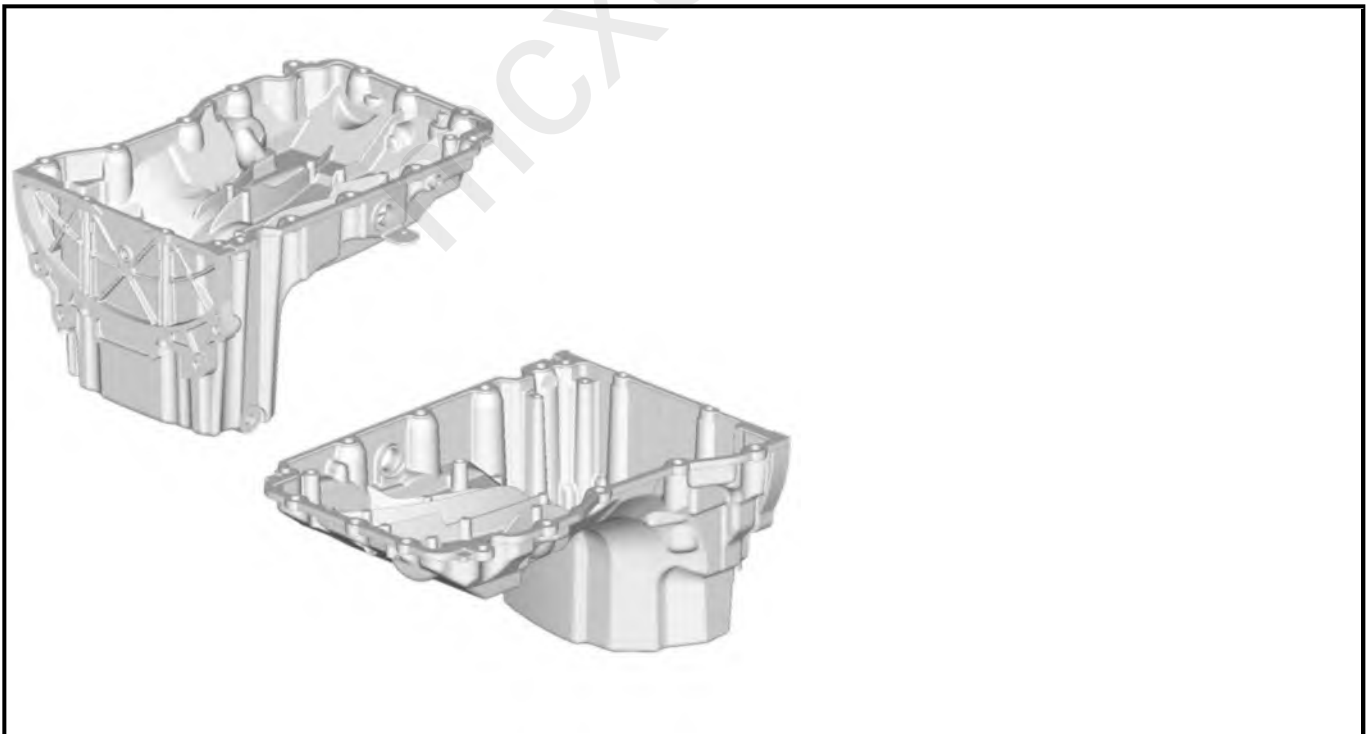
Cleaning Procedure

1. Remove any old thread sealant, gasket material or sealant using **EN-28410** remover.
2. Clean the oil pan and oil pan components in solvent.
3. Clean out debris from the bolt holes.

WARNING: Refer to [Safety Glasses Warning](#) .

4. Dry the oil pan and oil pan components with compressed air.

Inspection Procedure Oil Pan



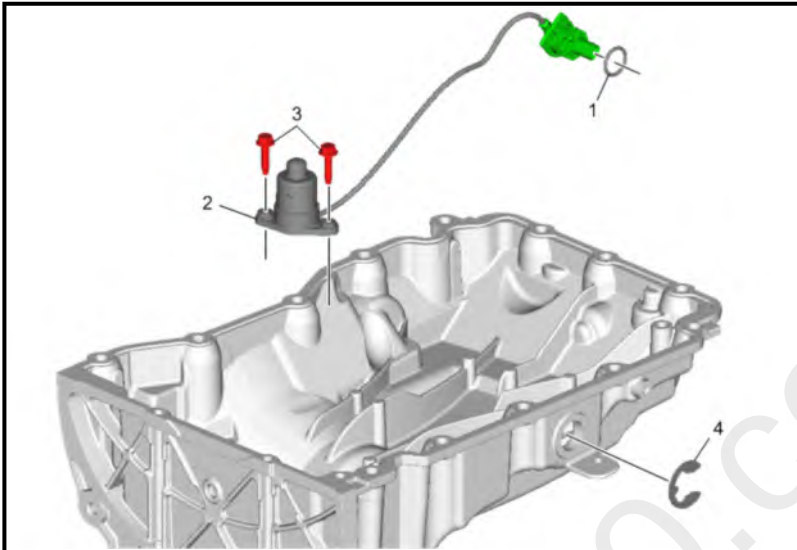
1. Inspect the oil pan for the following conditions:
 - Damage to the brace mounting bosses (1)
 - Damage to the engine oil level switch hole (2)

- Damage to the positive crankcase ventilation separator drain bolt hole (3)
- Damage to the high pressure part seal area (4)
- Damage to the engine oil level switch mounting holes (5)
- Gouges or damage to the oil pan sealing surfaces (6)
- Damage to the lower oil pan mounting holes (7)
- Gouges or damage to the lower oil pan sealing surfaces (8)

2. Repair or replace the oil pan and/or oil pan components as necessary.

Assemble Procedure

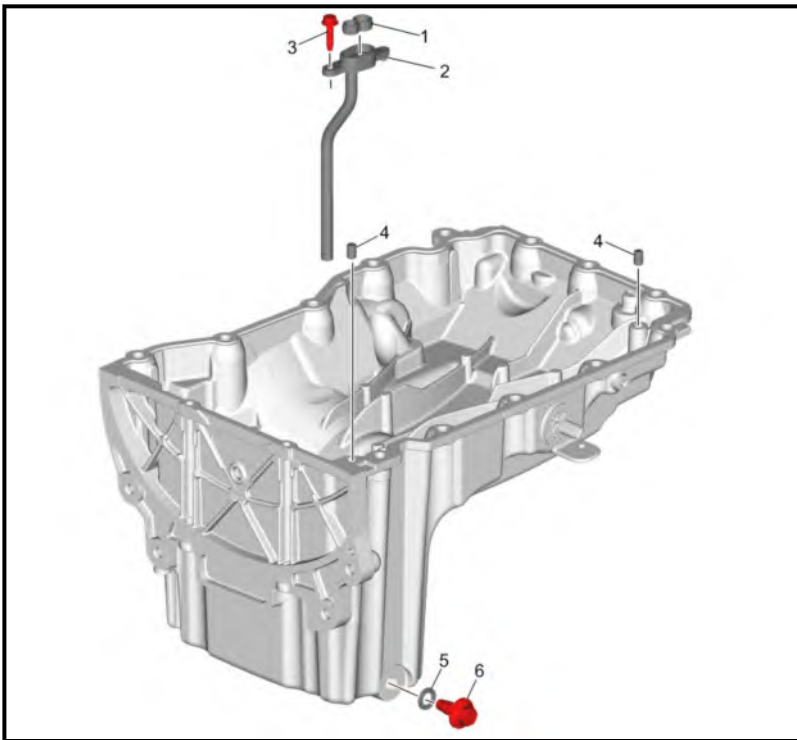
1. Engine Oil Level Indicator Switch O-Ring Seal (1) - Install NEW



2. Engine Oil Level Indicator Switch (2) - Install

CAUTION: Refer to [Fastener Caution](#) .

3. Engine Oil Level Indicator Switch Bolt (3) - Install [2x] - [Engine Oil Level Indicator Switch Replacement](#)
4. Engine Oil Level Switch Clip (4) - Install
5. Oil Pan High Pressure Port Seal (1) - Install NEW



6. Positive Crankcase Ventilation Oil Separator Drain Pipe (2) - Install
7. Positive Crankcase Ventilation Oil Separator Drain Pipe Bolt (3) - Install and tighten 15 N.m (11 lb ft)
8. Dowel Pin (4) - Install [2x]
9. Oil Pan Drain Plug Seal (5) - Install NEW
10. Oil Pan Drain Plug (6) - Install and tighten 25 N.m (18 lb ft)

Installation Procedure

Install the oil pan. [Oil Pan Replacement \(4WD\)](#), or [Oil Pan Replacement \(2WD\)](#).

PISTON AND CONNECTING ROD REMOVAL AND INSTALLATION

Special Tools

- EN-43690-A Rod Bearing Clearance Checking Tool
- EN-43690-100 Rod Bearing Clearance Checking Tool - Adapter Kit
- EN-45059 Angle Meter
- EN-46121 Connecting Rod Guide Pin Set
- EN-48589 Crankshaft Rotation Socket

Equivalent regional tools: [Special Tools](#)

Removal Procedure

1. Engine - Remove - [Engine Replacement](#)
2. Remove the appropriate cylinder head.
 - [Cylinder Head Replacement - Left Side](#)
 - [Cylinder Head Replacement - Right Side](#)
3. Oil Pan - Remove - [Oil Pan Replacement \(4WD\)](#), or [Oil Pan Replacement \(2WD\)](#).

NOTE:

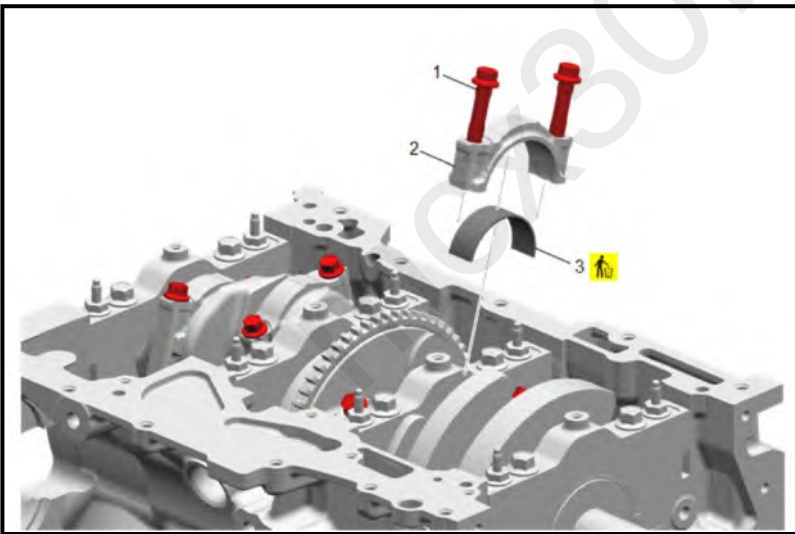
- An arrow/dot showing proper piston orientation is located on the top of the piston.
- If the connecting rod bearings have been used in a running engine, you must replace them with NEW connecting rod bearings for

reassembly.

4. Before removing the connecting rods, check the connecting rod side clearance using the following procedure:
 1. Tap the connecting rod to one end of the crankshaft journal with a dead-blow or wooden hammer.
 2. Using feeler gauges, measure the clearance between the crankshaft counterweight and the connecting rod.
 3. The connecting rod side clearance should not exceed specifications. [Engine Mechanical Specifications](#)
 4. If the end play exceeds the specified limits, measure the width of the crankpin end of the connecting rod. [Piston and Connecting Rod Overhaul](#)
 5. If the connecting rod width is significantly smaller than specified and severe wear is present on the side of the connecting rod, replace the connecting rod.
 6. If the connecting rod width is within specification and excessive scoring is present on the crankshaft journals, replace the crankshaft.
5. Using a marker, number each piston face. Draw an arrow along the centerline of the piston pointing toward the front of the engine.

CAUTION: Do not use a stamp, punch or any other method that may distort or stress the connecting rod or connecting rod cap. Extensive engine damage may result from a connecting rod that is distorted or stressed.

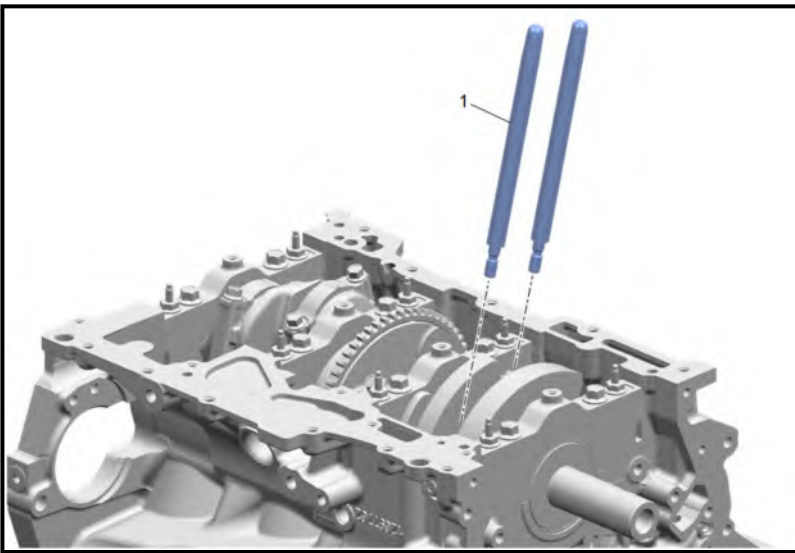
6. Mark the cylinder number on the connecting rod and the connecting rod cap with a scribe, paint stick or permanent marker.
7. Remove the connecting rod bolts (1).



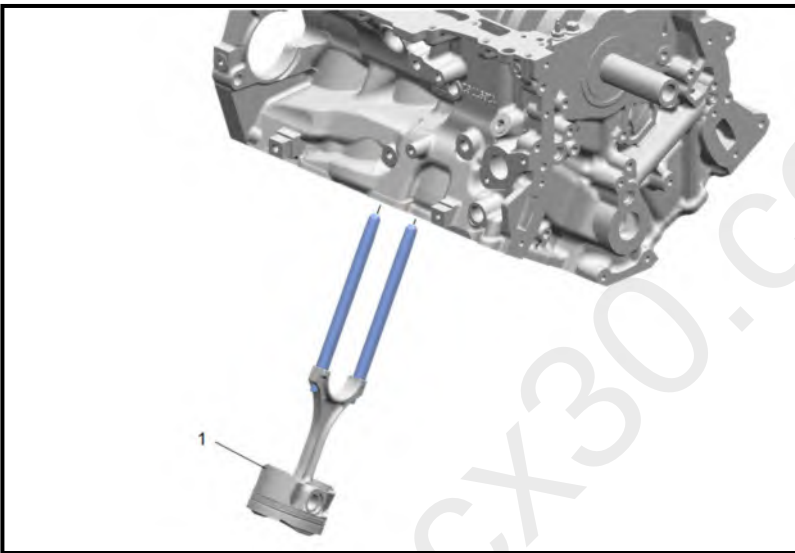
CAUTION: Powdered metal connecting rods have rod bolts which yield when torqued. If the rod bolts are loosened or removed the rod bolts must be replaced. Rod bolts that are not replaced will not torque to the correct clamp load and can lead to serious engine damage.

NOTE: The connecting rod caps must remain with the original connecting rod.

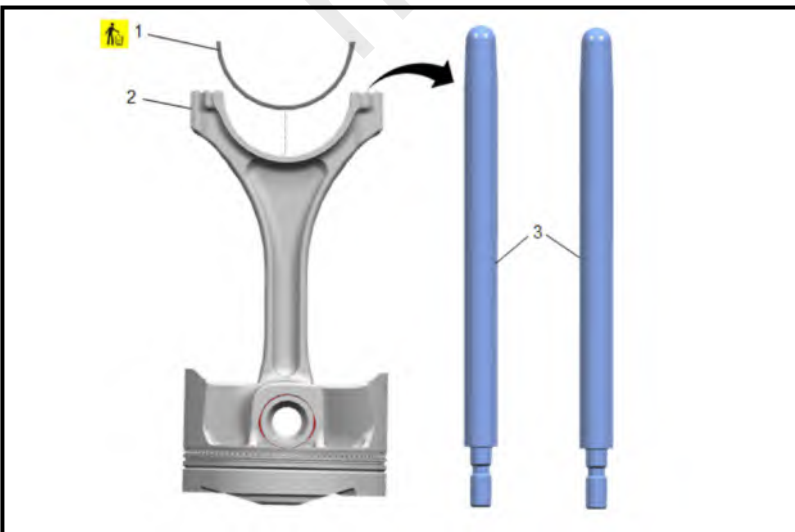
8. Remove the connecting rod cap (2).
9. Install the **EN-46121** Connecting Rod Guide Pin Set (1) into the connecting rod bolt holes.



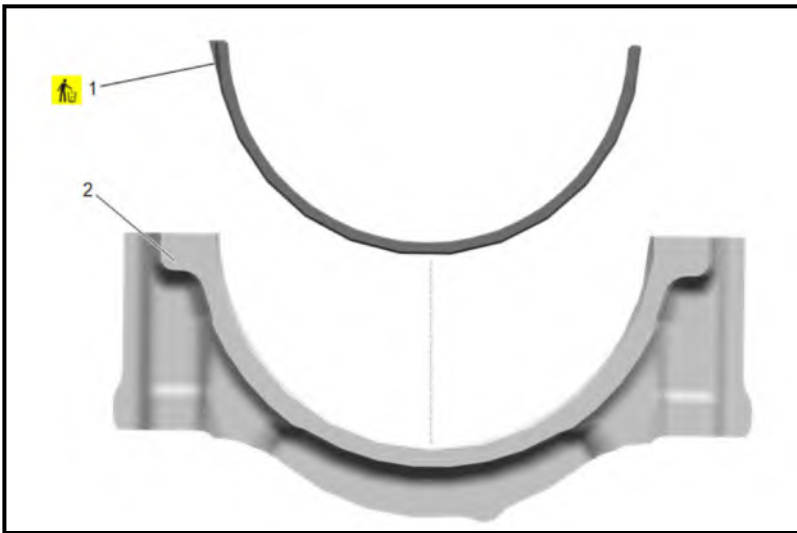
10. Using the **EN-46121** Connecting Rod Guide Pin Set, push the connecting rod and piston assembly (1) through the top of the cylinder. **DO NOT** scratch the crankshaft journal or cylinder wall and **DO NOT** damage the oil jets when removing the connecting rod and piston assembly.



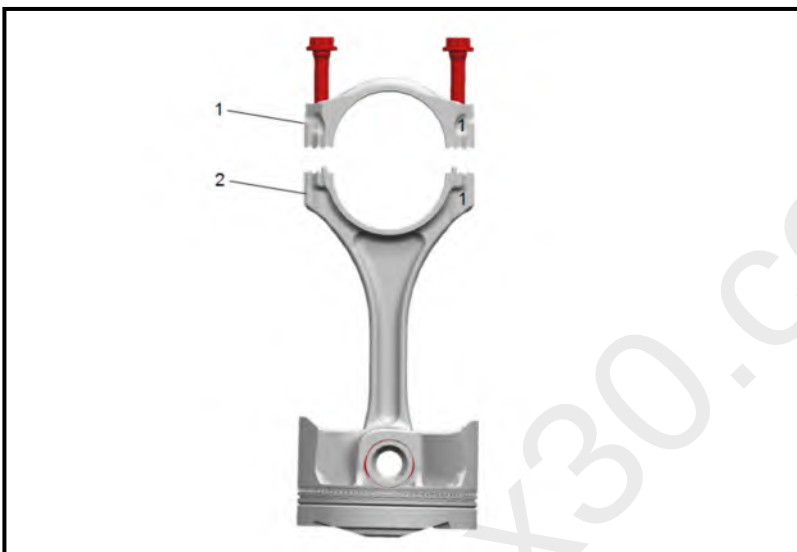
11. Remove the **EN-46121** Connecting Rod Guide Pin Set (3) from the connecting rod bolt holes.



12. Remove and **DISCARD** the upper connecting rod bearing (1) from the connecting rod (2).
 13. Remove and **DISCARD** the lower connecting rod bearing (1) from the connecting rod cap (2).

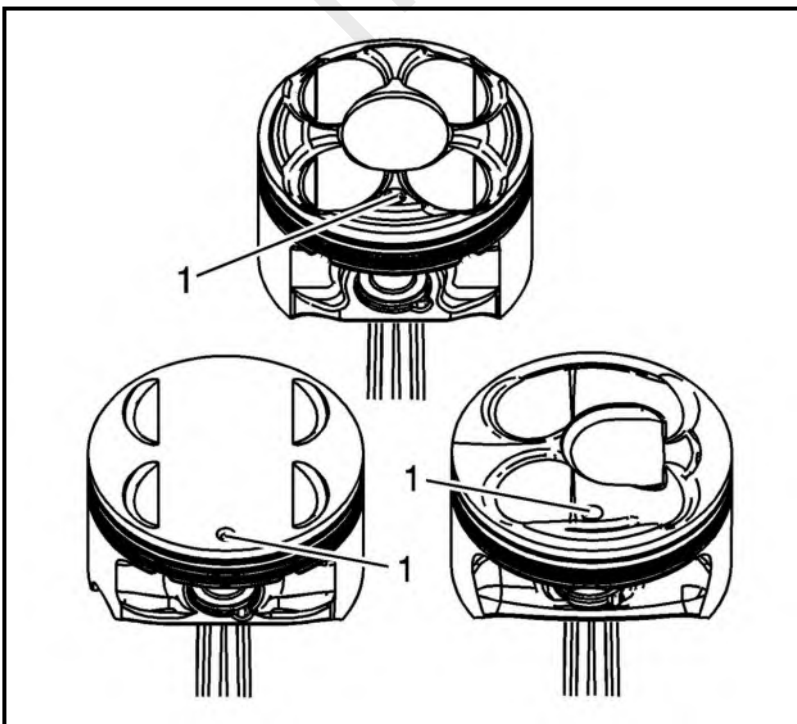


14. Reattach the connecting rod cap (1) to the connecting rod (2) to prevent damage to their mating surfaces. The cap (1) and connecting rod (2) are a matched set and must be kept together.



Piston and Connecting Rod Assembly Procedure

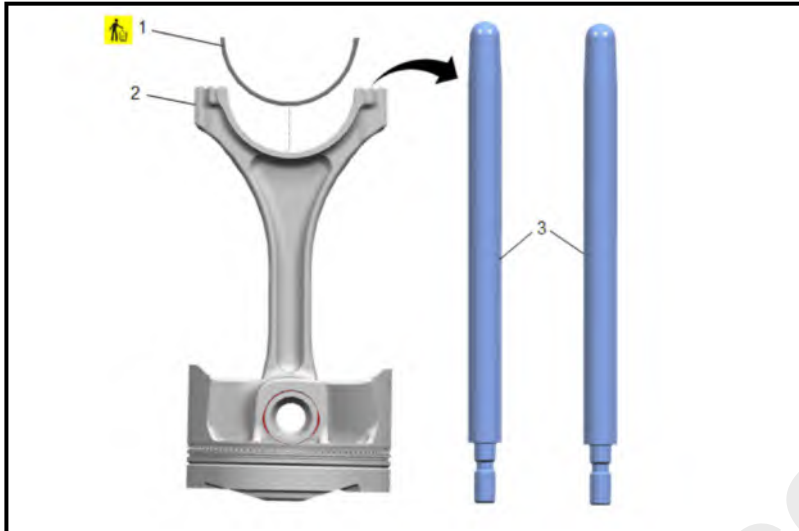
1. Liberally lubricate the cylinder walls, piston rings and piston skirts with engine oil.



NOTE:

- The piston is directional and must be installed in the engine block in the proper direction. The dot on the top of the piston must face the front of the engine.
- Ensure the bowl of the piston faces the intake.

2. Select the correctly numbered piston/connecting rod assembly for the cylinder. A dot (1) showing proper piston orientation is located on the top of the piston. Piston is model dependent.
3. Install a NEW connecting rod bearing (1) into the connecting rod (2).



NOTE:

If the connecting rod bearings have been used in a running engine, you must replace them with **NEW** connecting rod bearings for reassembly.

4. Install the **EN-46121** Connecting Rod Guide Pin Set (3) into the connecting rod bolt holes.
5. Compress the piston rings using the a ring compressor sleeve or equivalent.

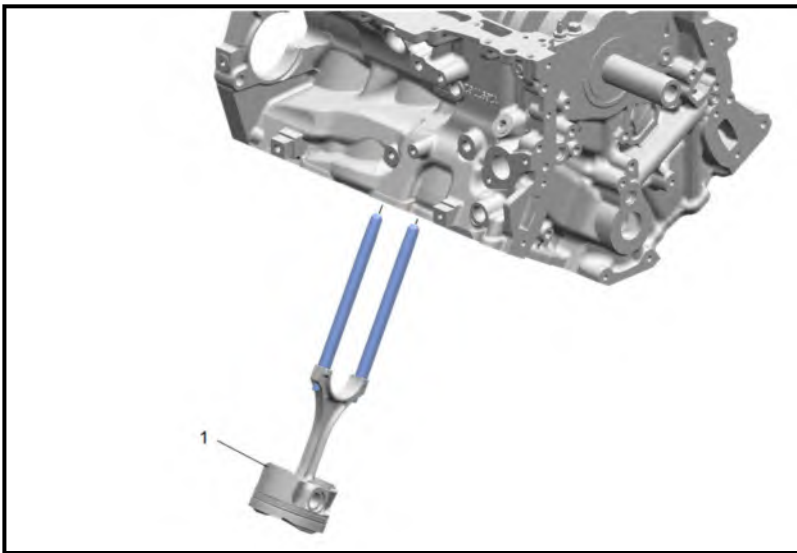
NOTE:

When installing a piston into a cylinder, use a ring compressor sleeve or equivalent for best results. The following features should be looked for when selecting a ring compressor sleeve.

1. Hard anodized and Teflon coated for low friction and prolonged wear resistance.
2. Smooth radius that tapers down to the specific bore size.
3. Sleeve should compress the piston rings smoothly and evenly.
4. Using a ring compressor sleeve greatly reduces the difficulty with installing thin high-performance oil rings.

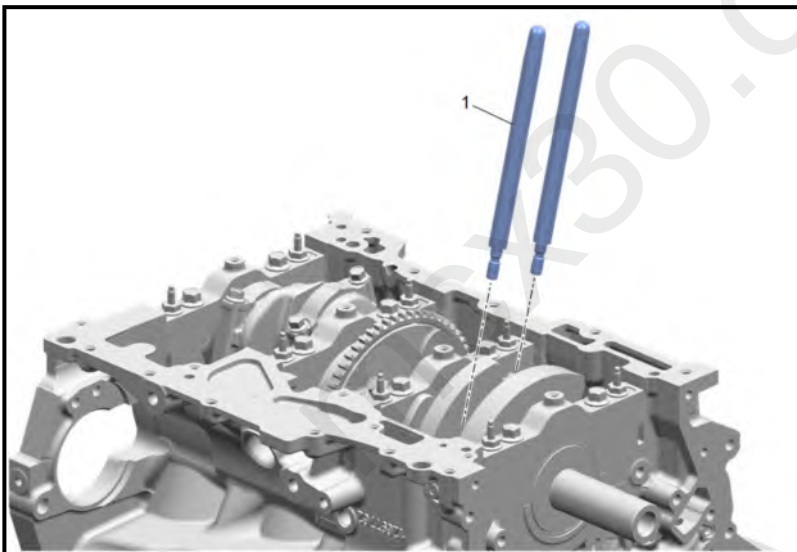
If a ring compressor sleeve is unavailable, a universal ring compressor will work but is more difficult to use.

6. Using both hands, slowly guide the piston and connecting rod assembly (1) into the cylinder from the top and bottom of the cylinder. **DO NOT** allow the connecting rod to contact the cylinder wall.



NOTE: Extreme care must be used when installing the piston and connecting rod to ensure the rod does not scrape or nick the cylinder bore, the oil jets, or the crankshaft surfaces.

7. Tap the piston into its bore with a hammer handle. Guide the connecting rod to the connecting rod journal using the **EN-46121** Connecting Rod Guide Pin Set while gently tapping the piston into place. Hold the ring compressor sleeve or equivalent against the engine block until all the rings have entered the cylinder bore.
8. Remove the **EN-46121** Connecting Rod Guide Pin Set (1) from the connecting rod bolt holes.



Connecting Rod Bearing Clearance Measurement Procedure - Using Plastic Gaging

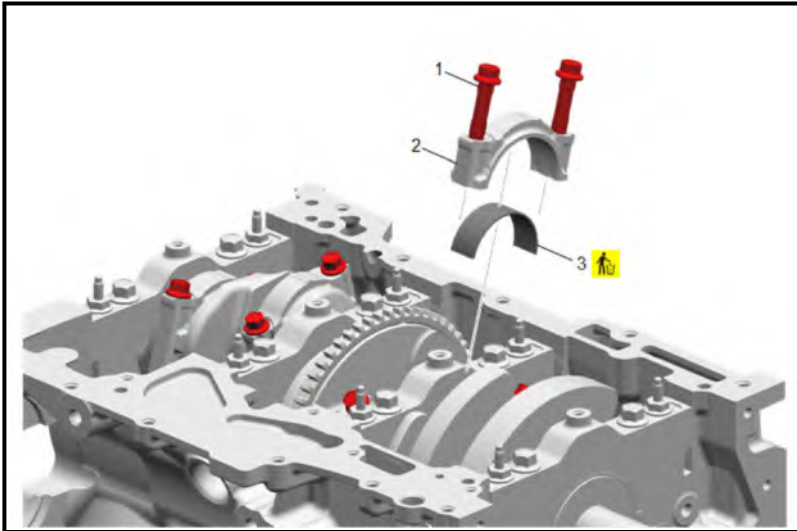
NOTE: Connecting rod bearings that have been run in an engine should **NEVER** be reused.

Before final assembly it is important to check the clearance of the new connecting rod bearings.

1. Place a length of fresh, room temperature plastic gaging material all the way across the connecting rod bearing journal.
2. Install the connecting rod bearing into the connecting rod cap.

NOTE: The connecting rod is non-directional therefore the connecting rod bearing lock tangs can face inboard or outboard.

3. Install the connecting rod end cap on its original connecting rod and ensure the bearing lock tangs are aligned on the same side of the rod.
4. Install NEW connecting rod bearing (3) into the connecting rod cap (2).

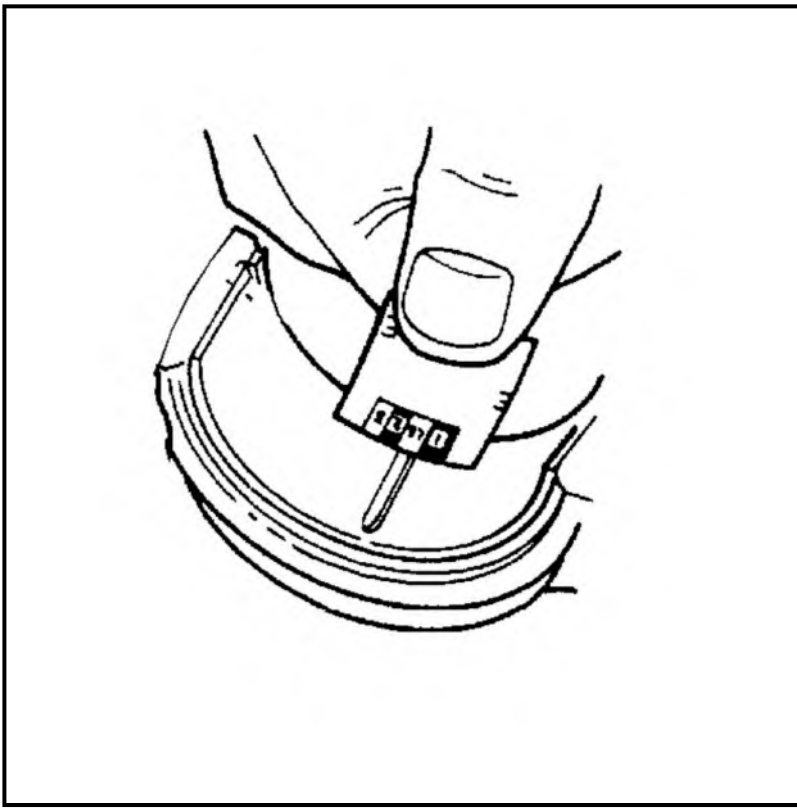


CAUTION: Refer to [Fastener Caution](#) .

CAUTION: Do not lubricate the NEW connecting rod bolts. The NEW bolts have a pre-applied graphite lubricant. Applying lubricant to the connecting rod bolts will effect the clamp load when the connecting rod bolts are torqued. Improper clamp load can lead to component failure and extensive engine damage.

NOTE: Reuse the old connecting rod bolts ONLY for measuring the connecting rod bearing clearance.

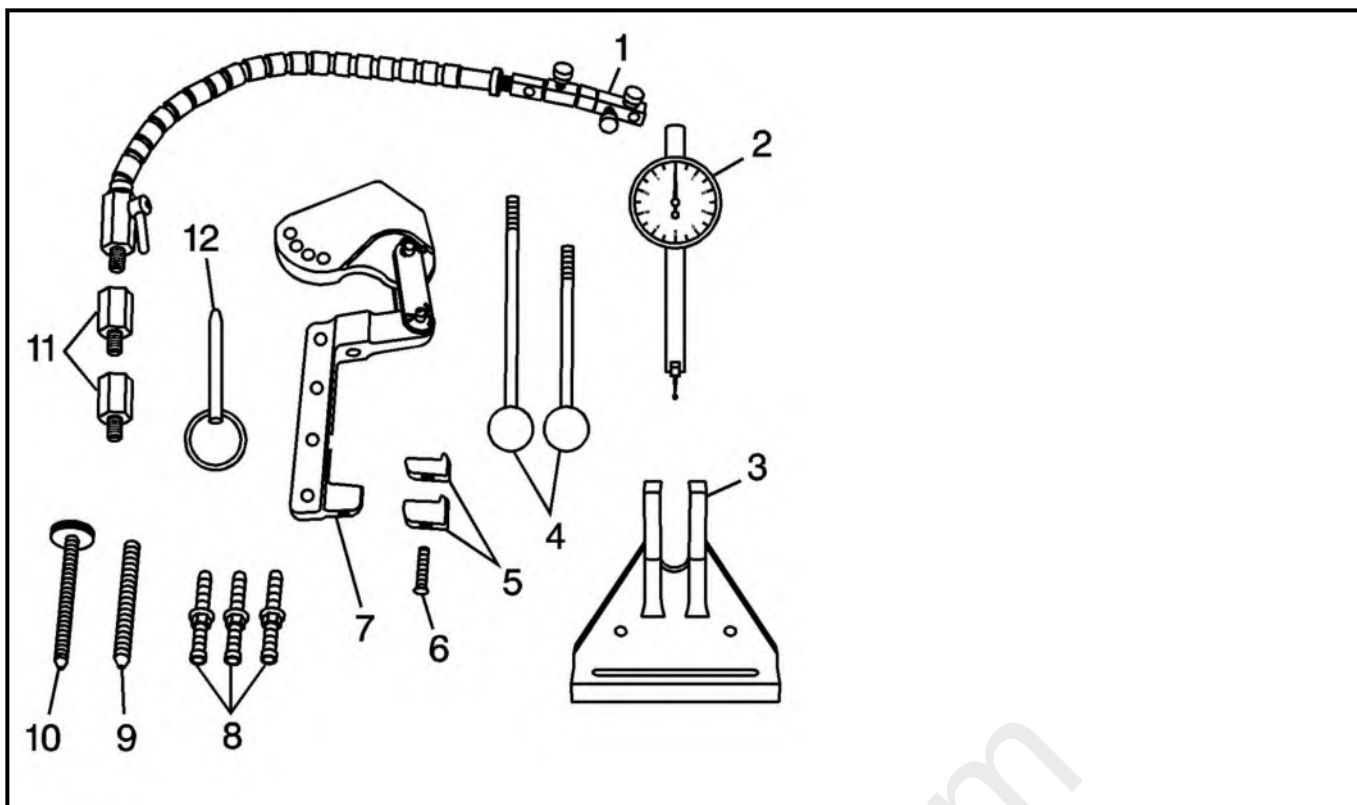
5. Install the connecting rod bolts (1) into the connecting rod cap (2).
6. Tighten the connecting rod bolts (1).
 - First Pass: 25 N.m (18 lb ft)
 - Final Pass: 110 degrees - **EN-45059** Angle Meter
7. Allow the assembly to sit for at least 2 minutes.
8. Remove the connecting rod cap bolts (1).
9. Remove the connecting rod cap (2).
10. Determine the connecting rod bearing clearance by comparing the width of the flattened plastic gaging material at its widest point with the graduation on the gaging material container.



11. Compare your measurements with the engine mechanical specifications. If the new bearings do not provide the proper crankshaft to connecting rod bearing clearance, inspect the following:
 1. Re-measure the crankshaft connecting rod journals for the correct specified size and ensure the proper new bearings are being installed. If the crankshaft connecting rod journals are incorrectly sized, replace or regrind the crankshaft. Crankshaft machining is permitted and undersized bearings are available.
 2. Re-measure the connecting rod bearing bore diameter to ensure proper size. The connecting rod is not machinable and the connecting rod must be replaced if out of specification.
12. Clean the plastic gaging material from the connecting rod bearing journals using a soft lint-free cloth.

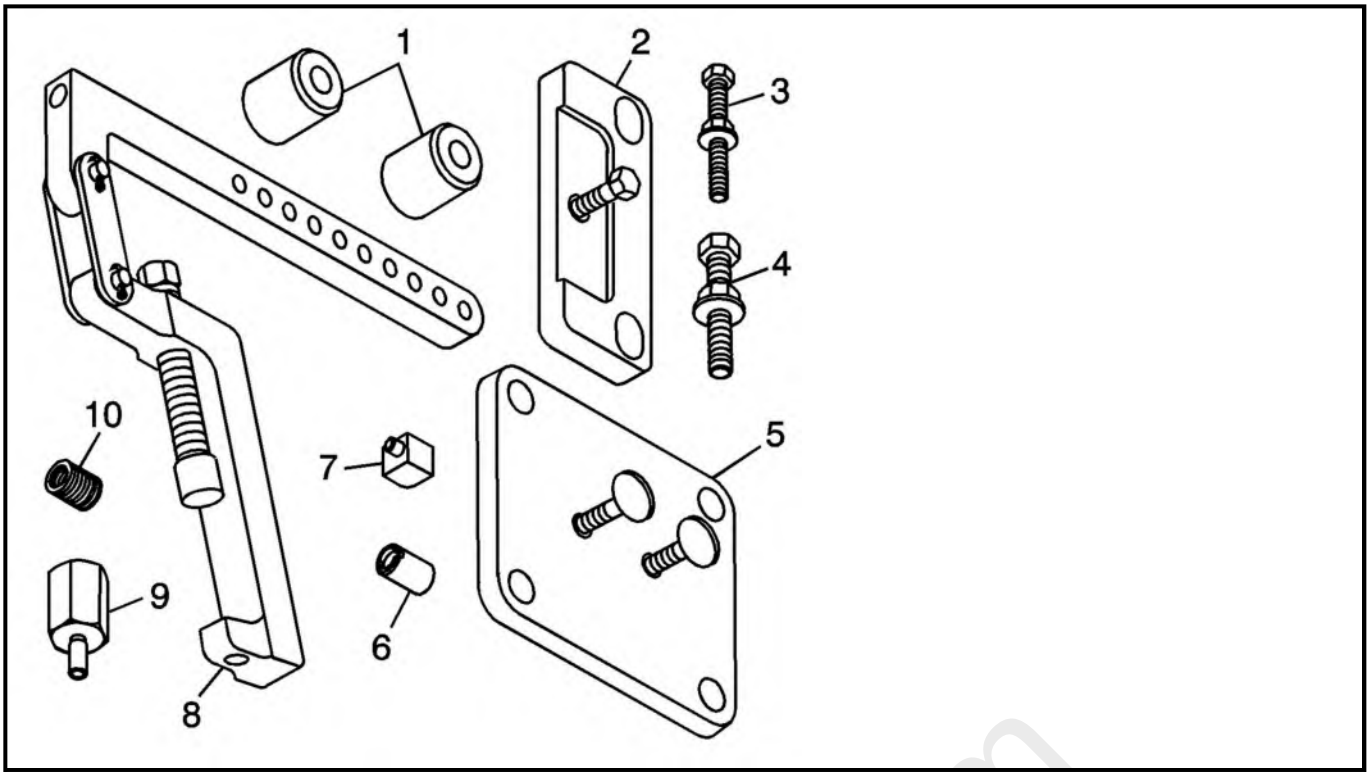
Connecting Rod Bearing Clearance Measurement Procedure - Using EN-43690-A and EN-43690-100

The **EN-43690-A** Rod Bearing Clearance Checking Tool and the **EN-43690-100** Rod Bearing Clearance Checking Tool - Adapter Kit have been developed as a more accurate method to measure connecting rod bearing clearances. The instructions below provide an overview of tool set-up and usage. For more detailed information, refer to the tool instruction sheets as supplied by the tool manufacturer.



EN-43690-A Rod Bearing Clearance Checking Tool

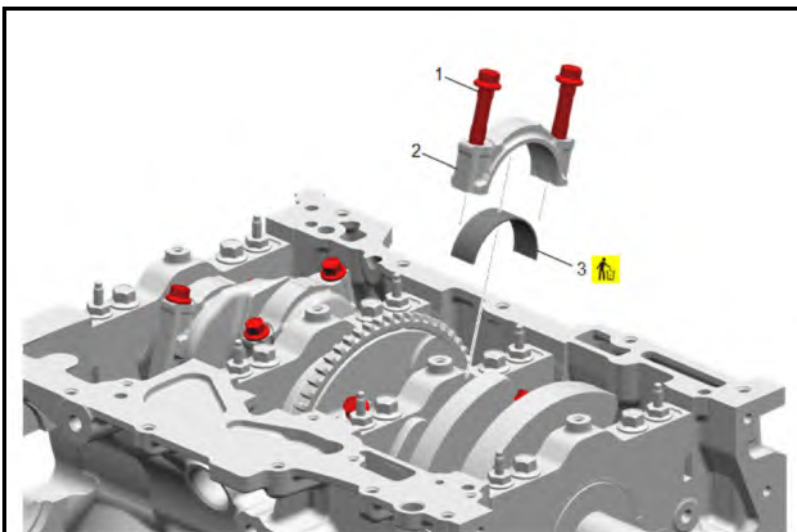
- EN - 43690-20 Swivel Base (1)
- EN - 43690-19 Dial Indicator (2)
- EN - 43690-2 Base (3)
- EN - 43690-5, -6 Handle (4)
- EN - 43690-10, -11 Foot (5)
- 280307 Screw (6)
- EN - 43690-1 Pivot Arm Assembly (7)
- EN - 43690-3, -7, -8 Screws (8)
- 280319 Screw (9)
- 280311 Screw (10)
- EN - 43690-17, -18 Adapter (11)
- 280310 Pin (12)



EN-43690-100 Rod Bearing Clearance Checking Tool - Adapter Kit

- EN - 43690-104 Spacer (1)
- EN - 43690-105 Retainer Plate (2)
- 505478 Bolt (3)
- 511341 Bolt (4)
- EN - 43690-106 Retainer Plate (5)
- EN - 43690-107 Cap (6)
- EN - 43690-102 Foot (7)
- EN - 43690-101 Pivot Arm Assembly (8)
- EN - 43690-103 Adapter (9)
- 505439 Adapter (10)

1. Before final assembly it is important to check the clearance of the new connecting rod bearings.



NOTE: Connecting rod bearings that have been run in an engine should **NEVER** be reused.

Install NEW connecting rod bearing (3) into the connecting rod cap (2).

NOTE: The connecting rod is non-directional therefore the connecting rod bearing lock tangs can face inboard or outboard.

2. Install the connecting rod end cap (2) on its original connecting rod and ensure the bearing lock tangs are aligned on the same side of the rod.

CAUTION: Refer to [Fastener Caution](#) .

CAUTION: Do not lubricate the NEW connecting rod bolts. The NEW bolts have a pre-applied graphite lubricant. Applying lubricant to the connecting rod bolts will effect the clamp load when the connecting rod bolts are torqued. Improper clamp load can lead to component failure and extensive engine damage.

NOTE: Reuse the old connecting rod bolts ONLY for measuring the connecting rod bearing clearance.

3. Install the connecting rod bolts (1) into the connecting rod cap (2).
4. Tighten the connecting rod bolts (1).
 - First Pass: 25 N.m (18 lb ft)
 - Final Pass: 110 degrees - EN-45059 Angle Meter
5. Rotate the crankshaft until the crankshaft journal and the connecting rod to be measured is in the 12 o'clock position.

NOTE: The crankshaft must be secure with no movement or rotation to obtain an accurate reading.

6. Remove the crankshaft main bolts required to install the retainer plate EN - 43690-105 .

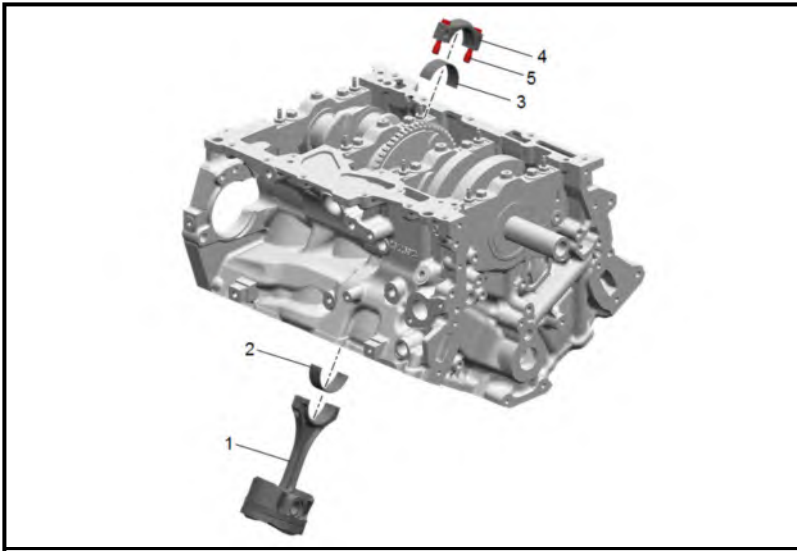
NOTE: Do not allow the EN - 43690-105 retainer plate screw to contact the reluctor ring.

7. Install the EN - 43690-105 and crankshaft main bolts.
8. Loosen the connecting rod bolts until the torque reading is zero.
9. Tighten the connecting rod bolts.
 - First Pass: 25 N.m (18 lb ft)
 - Final Pass: 110 degrees - EN-45059 Angle Meter
10. During and after installation, ensure each piston is positioned properly in the correct cylinder. The locating arrow on the top of each piston must be pointing toward the front of the engine.
11. Repeat these procedures for the remaining piston/connecting rod assemblies using the EN-48589 Crankshaft Rotation Socket to rotate the crankshaft.

Connecting Rod Final Assembly Procedure

1. Guide the connecting rod away from the crankshaft connecting rod journal to lubricate the crankshaft connecting rod bearing journal.
2. Apply a liberal amount of crankshaft prelube to the crankshaft connecting rod bearing journal.
[Adhesives, Fluids, Lubricants, and Sealers](#)
3. Guide the connecting rod to the crankshaft connecting rod journal.
4. Install the connecting rod end cap (4) on its original connecting rod (1) and ensure the bearing lock tangs are aligned on the same side of the rod.

5. Install the NEW connecting rod bolts (5) into the connecting rod cap (4).



CAUTION: Do not lubricate the NEW connecting rod bolts. The NEW bolts have a pre-applied graphite lubricant. Applying lubricant to the connecting rod bolts will effect the clamp load when the connecting rod bolts are torqued. Improper clamp load can lead to component failure and extensive engine damage.

CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

6. Tighten the connecting rod bolts (5).

1. First Pass: 25 N.m (18 lb ft)

2. Final Pass: 110 degrees - EN-45059 Angle Meter

7. During and after installation, ensure each piston is positioned properly in the correct cylinder. The locating arrow on the top of each piston must be pointing toward the front of the engine.

8. Repeat these procedures for the remaining piston/connecting rod assemblies using the EN-48589 Crankshaft Rotation Socket to rotate the crankshaft.

9. Oil Pan - Install - [Oil Pan Replacement \(4WD\)](#), or [Oil Pan Replacement \(2WD\)](#).

10. Install the appropriate cylinder head.

- [Cylinder Head Replacement - Left Side](#)
- [Cylinder Head Replacement - Right Side](#)

11. Engine - Install - [Engine Replacement](#)

PISTON AND CONNECTING ROD OVERHAUL

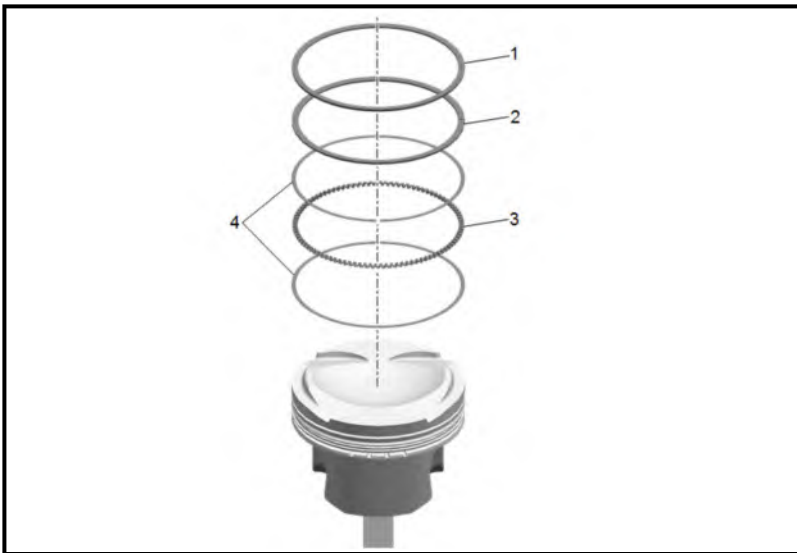
Special Tools

- EN-46121 Connecting Rod Guide Pin Set
- EN-46745 Piston Pin Clip Remover/Installer

Equivalent regional tools: [Special Tools](#)

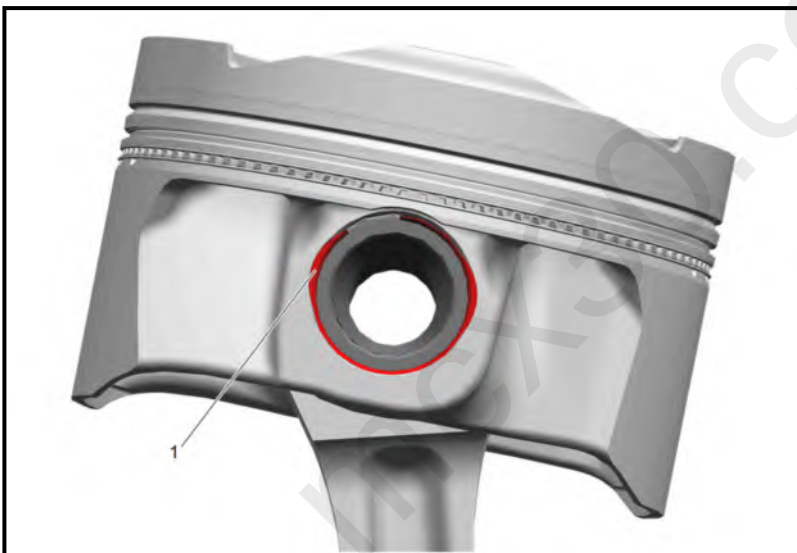
Piston and Connecting Rod Disassemble

1. Remove the piston rings (1, 2, 3, and 4) using a piston ring expander. Place each ring in a clean shop towel for storage.

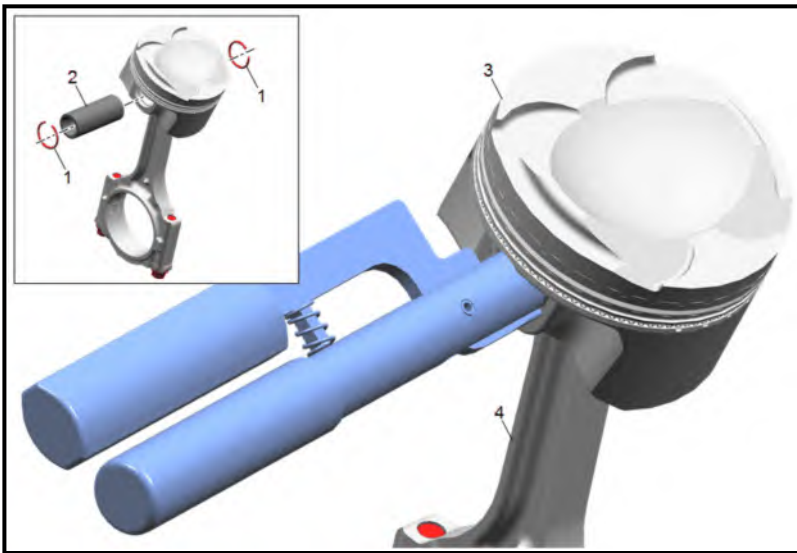


CAUTION: You must use a piston ring expander to remove and install the piston rings. Only expand the rings far enough to fit over the piston lands. If the rings are overexpanded, the top ring will shatter and the others will distort.

2. Using the **EN-46745** Piston Pin Clip Remover/Installer, remove the piston pin retainers by using the removal access notch (1) in the side of the piston (3). Discard the piston pin retainers (1).



- NOTE:**
- The connecting rod is non-directional and may be assembled/reassembled to the piston in either direction.
 - **DO NOT** reuse the piston pin retainers.



3. Slide the piston pin (2) out of the piston (3). The piston will disconnect from the connecting rod (4).

Cleaning Procedure

NOTE: DO NOT wire brush any part of the piston.

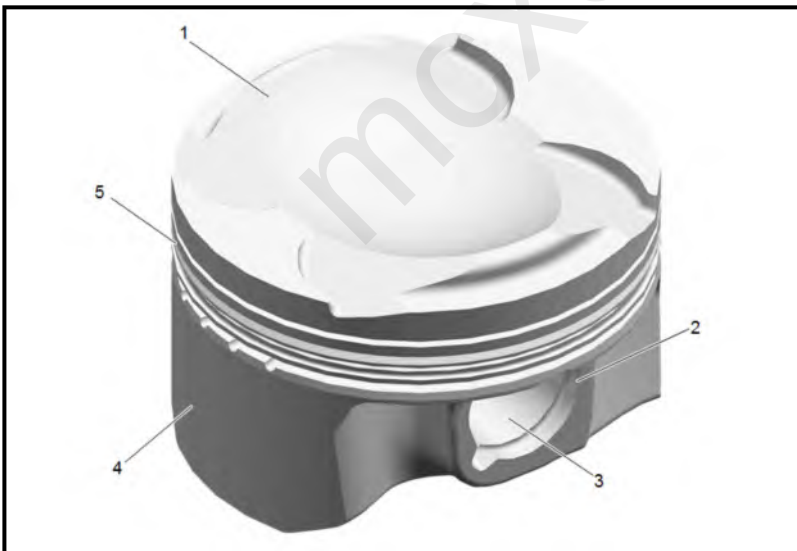
1. Clean the piston skirts and the pins with a cleaning solvent.
2. Clean the piston ring grooves with a groove cleaner. Ensure that the oil ring holes and slots are clean.

WARNING: Refer to [Safety Glasses Warning](#).

3. Dry the piston with compressed air.

Piston Inspection Procedure

1. Inspect the pistons for the following conditions:

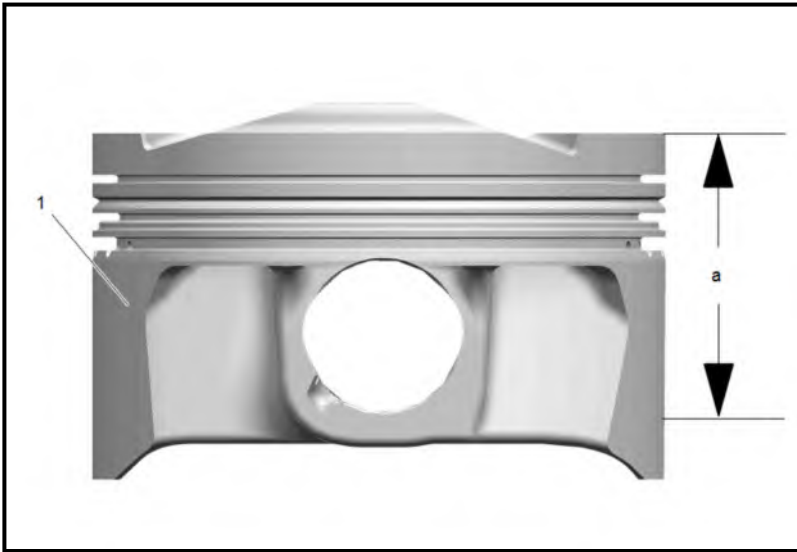


- Cracked ring lands, skirts or pin bosses
- Ring grooves for nicks, burrs that may cause binding (5)
- Warped or worn ring lands (5)
- Piston pin retainer grooves for burrs (2)
- Eroded areas at the top of the piston (1)
- Scuffed or damaged skirt coating (4)
- Worn piston pin bores or worn piston pins (3)

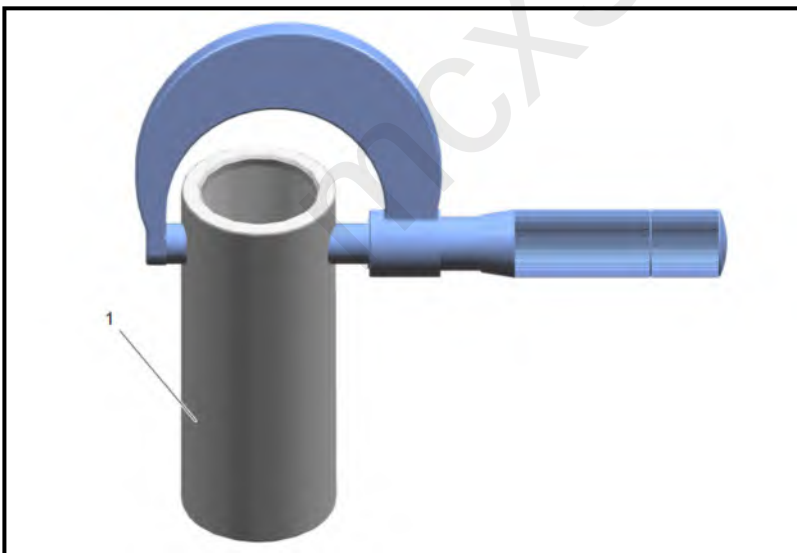
2. Replace pistons that show any signs of damage or excessive wear.

Piston Measurement Procedure

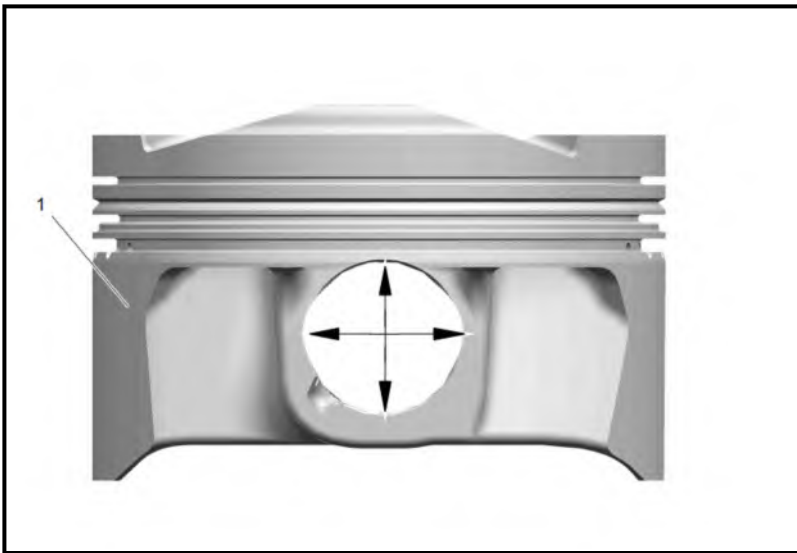
1. Measure piston width using the following procedure:



1. Using an outside micrometer, measure the width of the piston at 30 mm (1.181 in) below the crown, top, (1) at the thrust surfaces of the piston, perpendicular to the piston pin centerline.
 2. Compare the measurement of the piston to its original cylinder by subtracting the piston width from the cylinder diameter.
 3. Check your measurements with the [Engine Mechanical Specifications](#).
 4. If the clearance obtained through measurement is greater than the provided specifications and the cylinder bores are within specification, replace the piston.
2. Measure the piston pin bore to piston pin clearances using the following procedure:



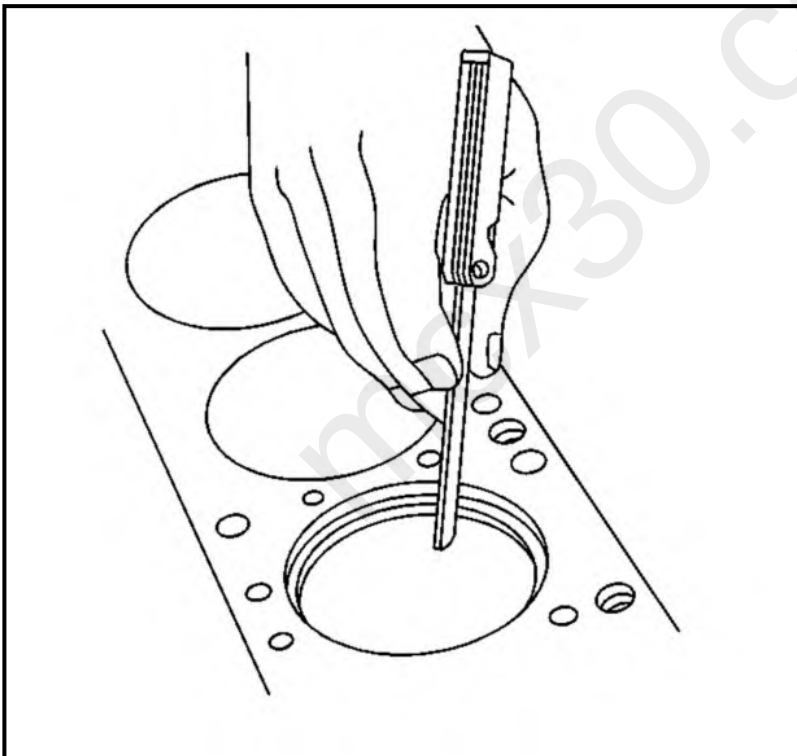
1. Piston pin bores and pins must be free of varnish or scuffing.
2. Use an outside micrometer to measure the piston pin in the piston contact areas.
3. Using an inside micrometer, measure the piston pin bore. Compare your result with the piston pin diameter and piston pin to piston pin bore clearance listed in the [Engine Mechanical Specifications](#).



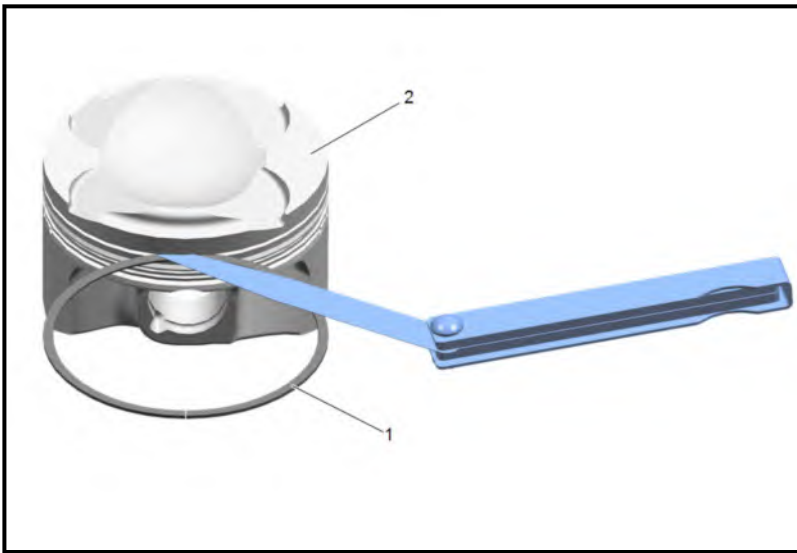
4. If the clearance is excessive, determine which piece is out of specification and replace as necessary.
5. You must replace the piston if any of its dimensions are out of specification.
6. If the new piston does not meet clearance specifications, the cylinder block may need to be oversized to 0.25 mm (0.010 in). There is only one size of oversized pistons and rings available for service.

Piston Ring Measurement Procedure

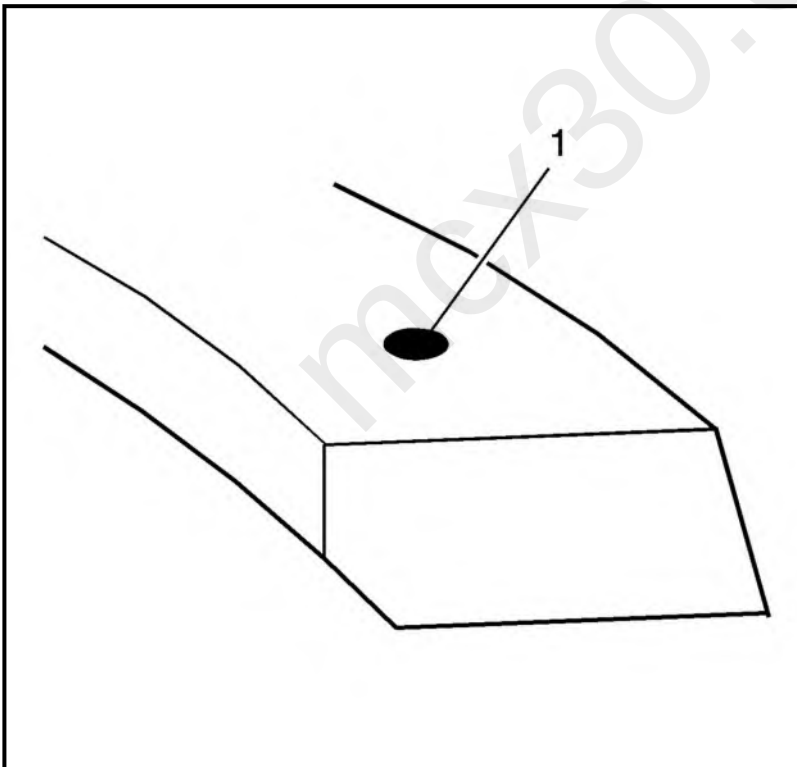
1. Measure the piston ring end gap using the following procedure:



1. Place the piston ring in the area of the bore where the piston ring will travel approximately 25 mm (1 in) down from the deck surface. Ensure that the ring is square with the cylinder bore by positioning the ring with the piston head.
 2. Measure the end gap of the piston ring with feeler gauges. Refer to [Engine Mechanical Specifications](#).
 3. If the clearance exceeds the provided specifications, the piston rings must be replaced.
 4. Repeat the procedure for all the piston rings.
2. Measure the piston ring side clearance using the following procedure:



1. Roll the piston ring entirely around the piston ring groove. If any binding is caused by the ring groove, dress the groove with a fine file. If any binding is caused by a distorted piston ring, replace the ring.
 2. With the piston ring on the piston, use feeler gauges to check clearance at multiple locations.
 3. Compare the measurements with piston ring side clearance listed in the [Engine Mechanical Specifications](#).
 4. If the clearance is greater than specifications, replace the piston rings.
3. There is a locating dimple (1) on the compression rings near the end for identification. Install the compression rings with the dimple facing up.



4. If the new ring does not reduce the clearance to the proper specification, install a new piston.
5. If the new piston does not meet clearance specifications, the cylinder block may need to be oversized to 0.25 mm (0.010 in). There is only 1 size of oversized pistons and rings available for service.

Connecting Rod Cleaning Procedure

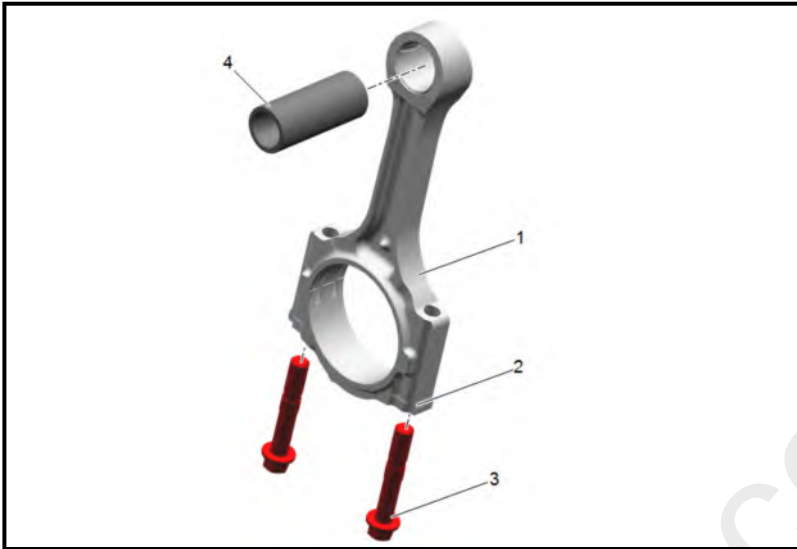
1. Clean the connecting rods in solvent.

WARNING: Refer to [Safety Glasses Warning](#) .

2. Dry the connecting rod using compressed air.
3. Remove the connecting rod cap and clean the threads.
4. Remove the connecting rod bearing and discard. Never reuse a connecting rod bearing used in a running engine.

Connecting Rod Visual Inspection Procedure

1. Inspect the piston pin bushing (4) for scoring or damage.



2. Inspect the connecting rod beam (1) for twisting or bending.
3. Inspect the rod cap (2) for any nicks or damage caused by possible interference.
4. Inspect for scratches or abrasion on the rod bearing seating surface.

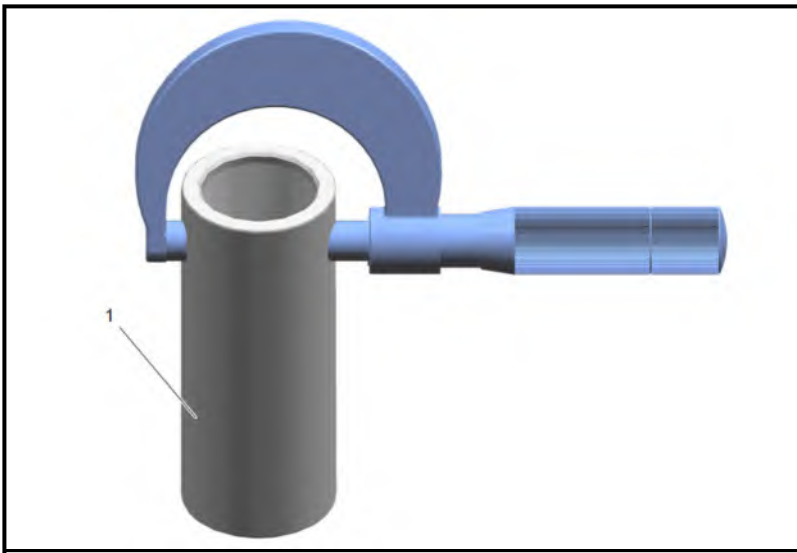
NOTE: DO NOT scrape the rod or rod cap.

5. If the connecting rod bores contain minor scratches or abrasions, clean the bores in a circular direction with a light emery paper.

Connecting Rod Measurement Procedure

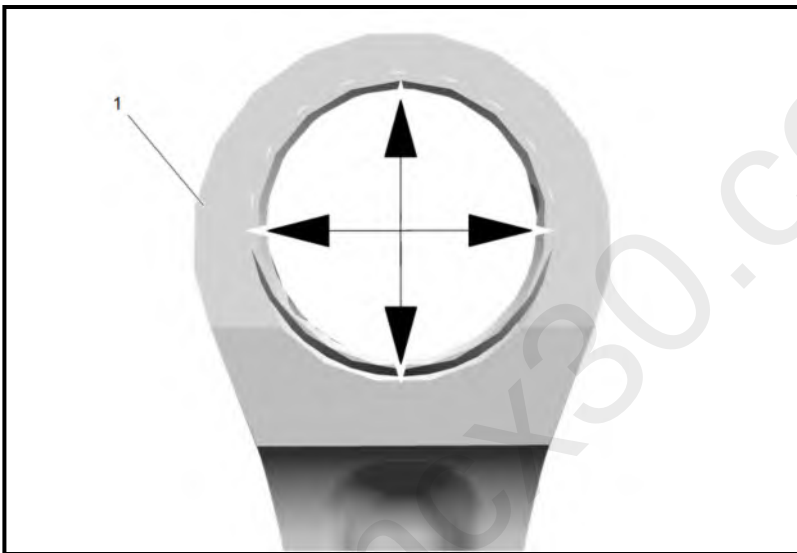
Piston Pin End

1. Using an outside micrometer, take 2 measurements of the piston pin in the area of the connecting rod contact.



NOTE: Measurements of all components should be taken with the components at normal room temperature.

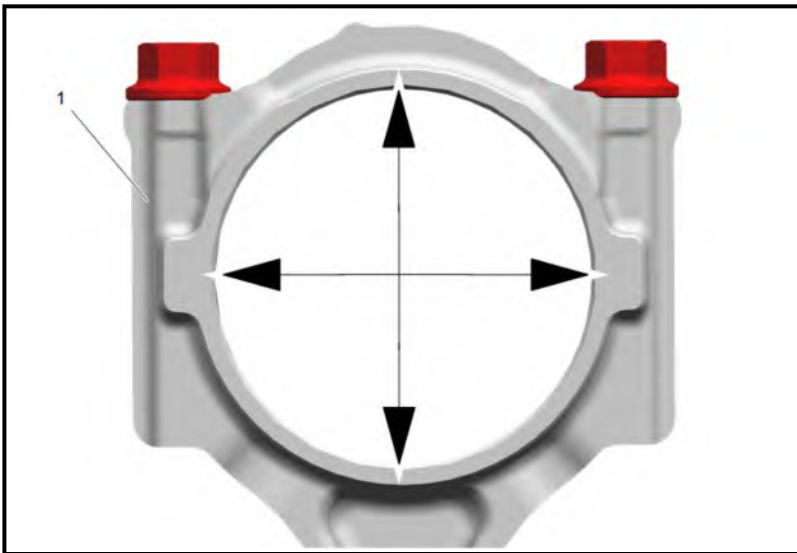
2. Using an inside micrometer, measure the connecting rod piston pin bore.



3. Subtract the piston pin diameter from the piston pin bore.
4. Compare the clearance measurements with the [Engine Mechanical Specifications](#) .
5. If the clearance is excessive, replace the piston pin. If a new pin does not resolve the clearance problem, replace the connecting rod.

Connecting Rod Crankshaft Bearing End

1. Using an inside micrometer, measure the connecting rod crankshaft bearing bore.

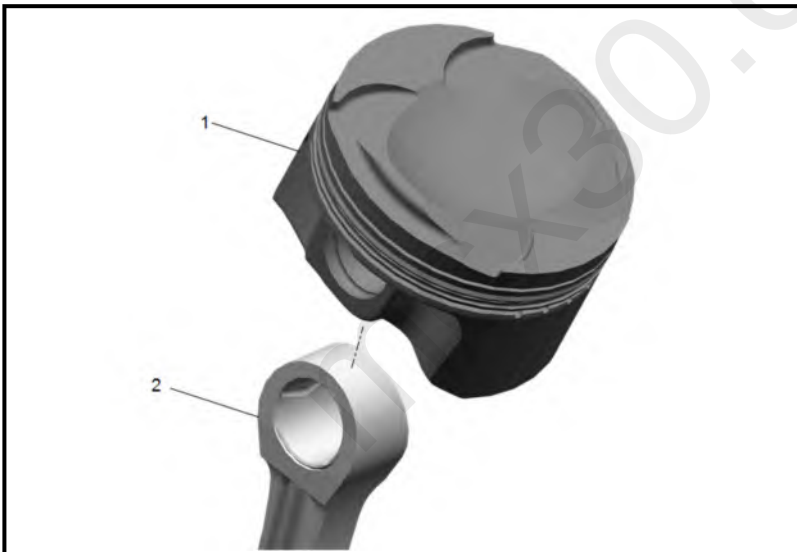


NOTE: Measurements of all components should be taken with the components at normal room temperature.

2. Compare the bore measurements with the [Engine Mechanical Specifications](#).
3. Replace the connecting rod if the bore is out of specifications. DO NOT recondition the connecting rod.

Piston and Piston Pin Installation Procedure

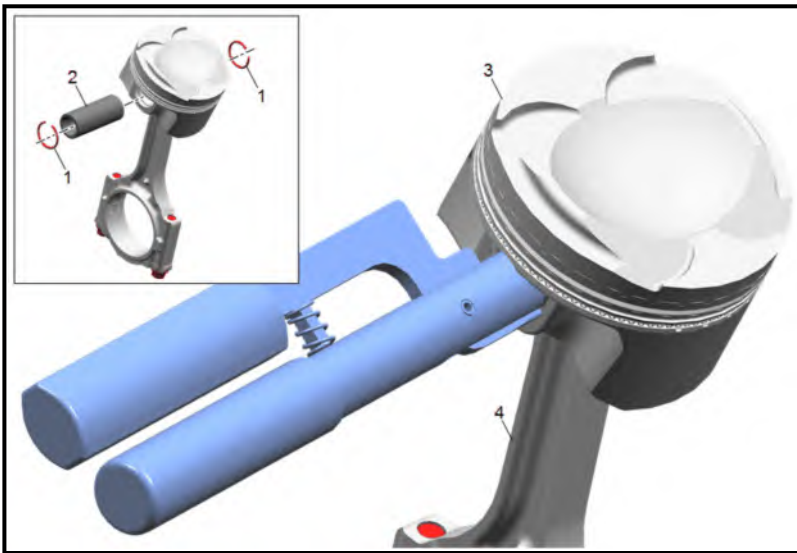
1. Lubricate the piston pin bores in the piston (1) and the connecting rod (2) with prelube lubricant.
[Adhesives, Fluids, Lubricants, and Sealers](#)



NOTE:

- The piston is directional and must be installed in the engine block in the proper direction. The dot on the top of the piston must face the front of the engine.
- The piston is model dependent and may not appear exactly as shown.

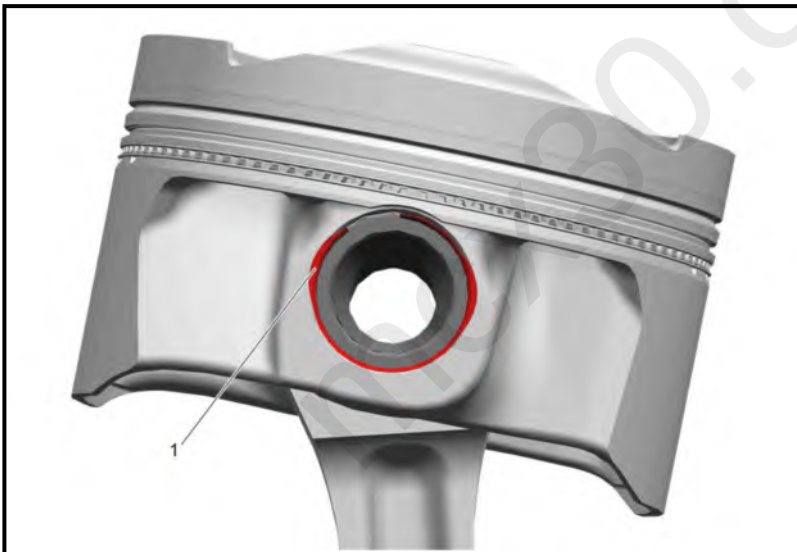
2. Assemble the piston (3) and piston pin (2) to the connecting rod (4). Properly orient the piston when reusing a marked connecting rod.



3. Align the piston pin bore with the connecting rod pin bore.
4. Slide the piston pin (2) into the piston (3) and the connecting rod (4).

NOTE: New piston pin retainers must be used. Never reuse the piston pin retainers.

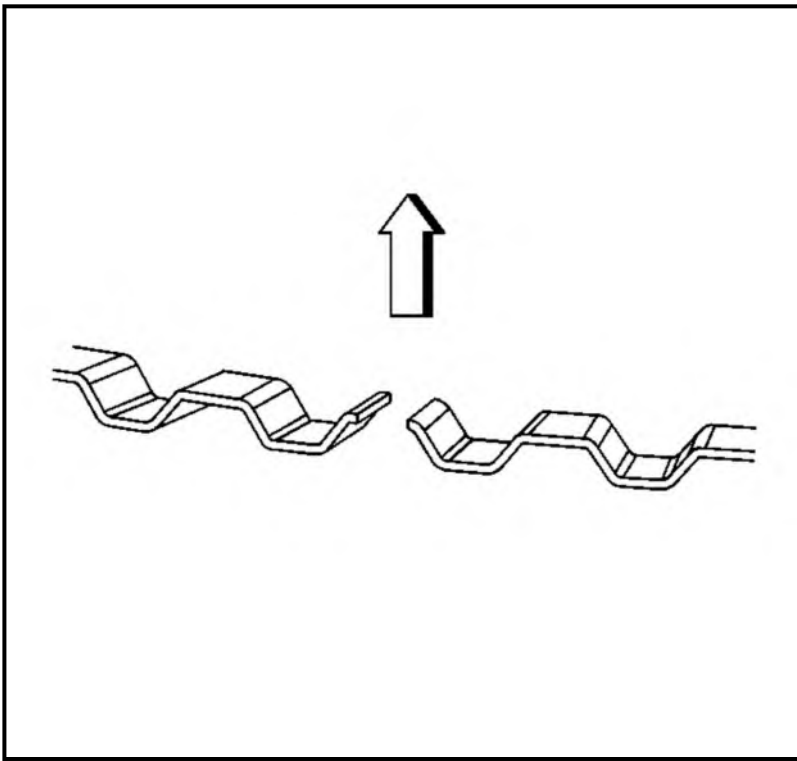
5. Install NEW piston pin retainers (1) using the **EN-46745** Piston Pin Clip Remover/Installer. Align the **EN-46745** Piston Pin Clip Remover/Installer to the notch in the piston.
6. Ensure that the piston pin retainers (1) are fully seated in their grooves.



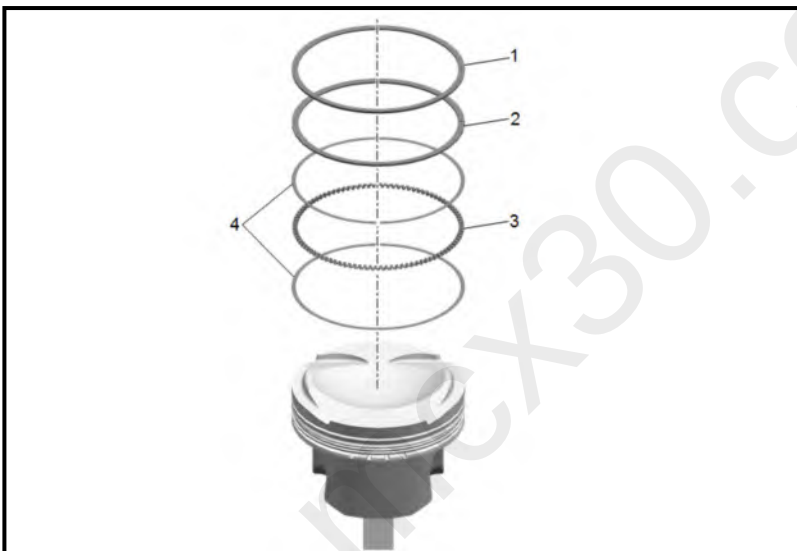
7. Repeat these procedures for the remaining pistons.

Piston Ring Installation Procedure

1. Properly orient the oil control ring expander as shown before installation. The ends of the expander must be facing toward the top of the piston.



2. Using a piston ring expander, install the oil control ring assembly using the following procedure:

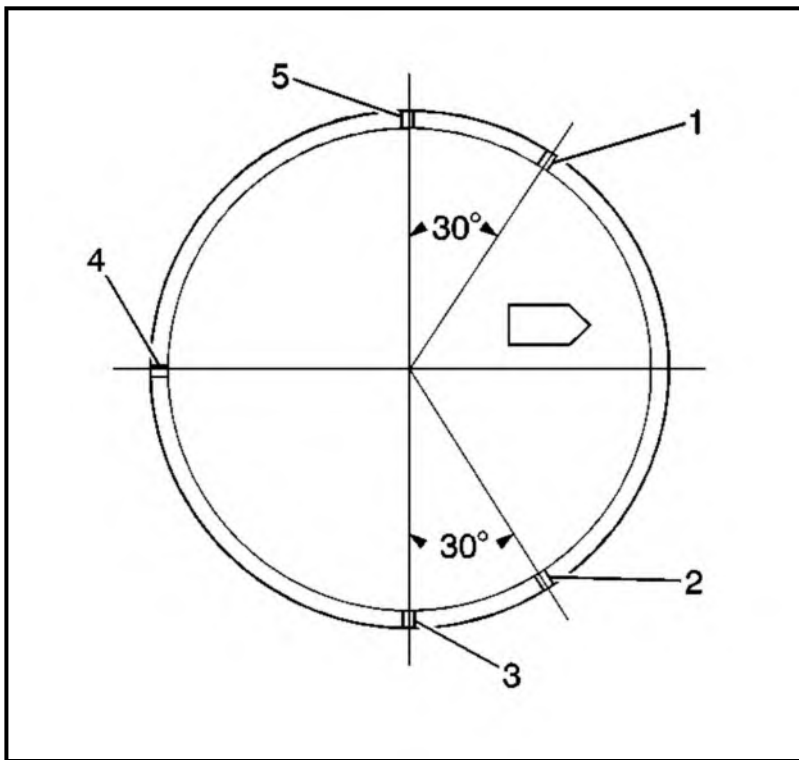


1. Install the expander ring (3).
2. Install the 2 oil scraper rings (4). Expand the rings only enough to clear the piston diameter. Overexpanding the piston rings will distort or crack the rings.

NOTE: The lower compression piston ring (2) is thicker and will not fit in the upper compression rings (1) position.

NOTE: For the LY7, the upper compression ring is symmetrical and may be installed either side up. For all other RPO's, the mark on the piston ring should face the top of the piston.

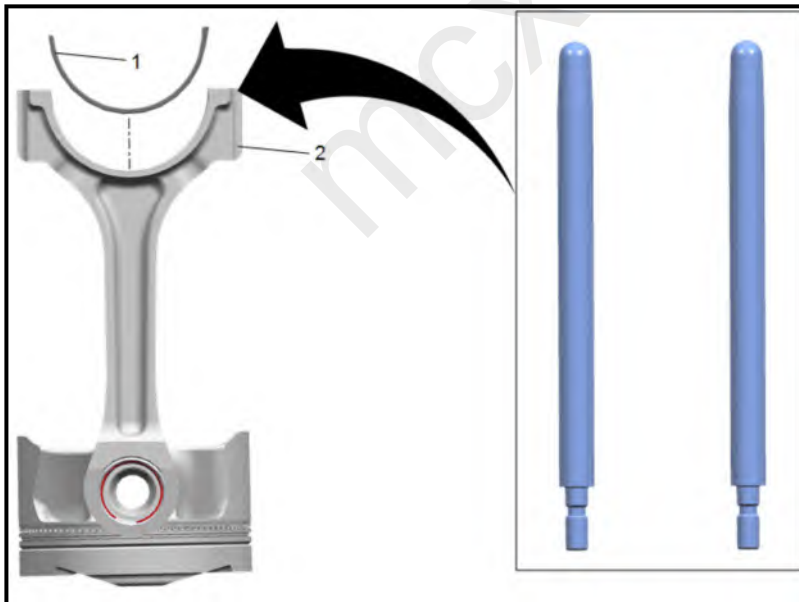
3. Install the lower compression piston ring (2) onto the piston with the mark facing the top of the piston.
4. Install the upper compression piston ring (1) onto the piston with the mark facing the top of the piston, if required.
5. Once the rings are installed, set the ring gaps for the oil control, second and top ring as follows. Use the piston location arrow for reference.



1. Lower oil control ring - position 1
2. Upper oil control ring - position 2
3. Top Ring - position 3
4. Oil control ring expander - position 4
5. Second ring - position 5

Connecting Rod Bearing Installation Procedure

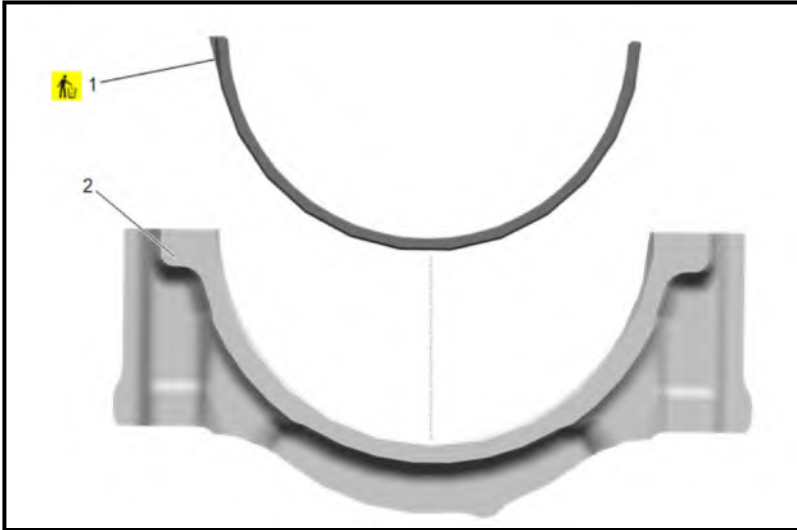
1. Clean the connecting rod (2) and the connecting rod cap bearing bore with a lint-free cloth.



NOTE: If the connecting rod bearings have been used in a running engine, you must replace them with **NEW** connecting rod bearings for reassembly.

2. Clean all the oil from behind the connecting rod bearing halves.
3. Install **NEW** upper connecting rod bearing (1) into position. Roll the bearing into position so that the lock tang engages the alignment slot. The bearing must fit flush in the connecting rod.
4. Install the **EN-46121** Connecting Rod Guide Pin Set into the connecting rod bolt holes.

5. Install NEW lower connecting rod bearing (1) into position in the connecting rod cap (2). Roll the bearing into position so that the lock tang engages the alignment slot. The bearings must fit flush with the connecting rod cap.



CRANKSHAFT AND BEARING REMOVAL AND INSTALLATION

Special Tools

- EN-6125-1B Slide Hammer Adapter
- EN-7872 Magnetic Base Dial Indicator
- EN-45059 Angle Meter
- EN-49102 Crankshaft Bearing Cap Remover

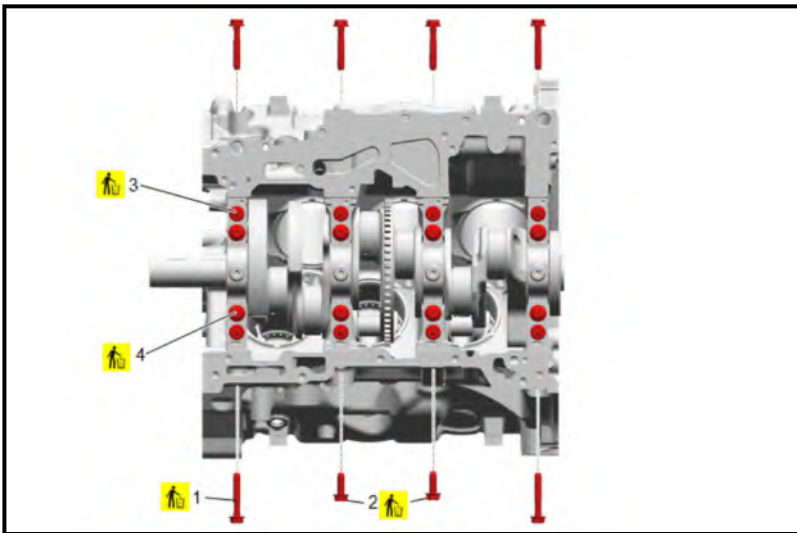
Equivalent regional tools: [Special Tools](#)

Crankshaft End Play Measurement

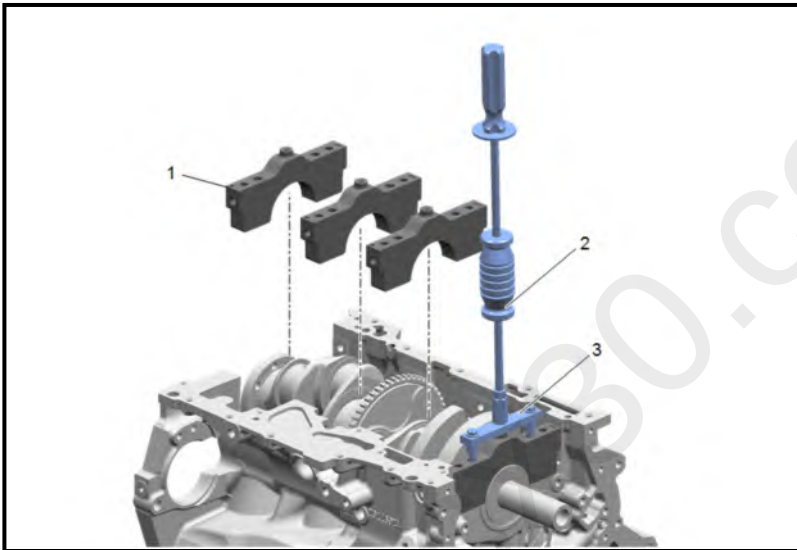
1. Place a dial indicator at the crankshaft nose.
2. Gently force the crankshaft to the extreme front and rear positions with a pry tool while monitoring the movement of the dial indicator.
3. The crankshaft end play should not exceed specifications. [Engine Mechanical Specifications](#)
4. If the specifications are exceeded inspect the thrust bearing thrust OD and the crankshaft thrust wall for wear and/or excessive runout. [Engine Mechanical Specifications](#)
5. Replace the thrust bearing or crankshaft as necessary.

Crankshaft Removal

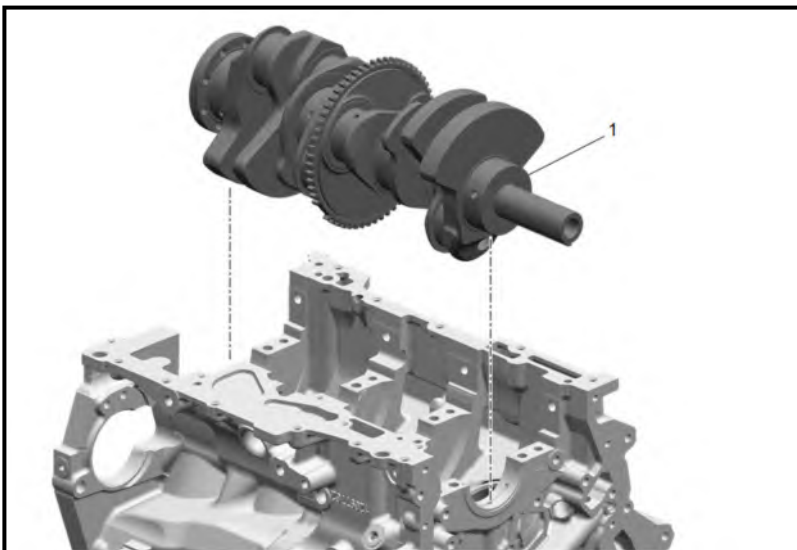
1. Remove the crankshaft bearing cap side bolts (1 and 2).



2. Remove the crankshaft bearing cap outer bolts (3).
3. Remove the crankshaft bearing cap inner bolts (4).
4. Mark the crankshaft bearing caps (1) to ensure they go back into same location.

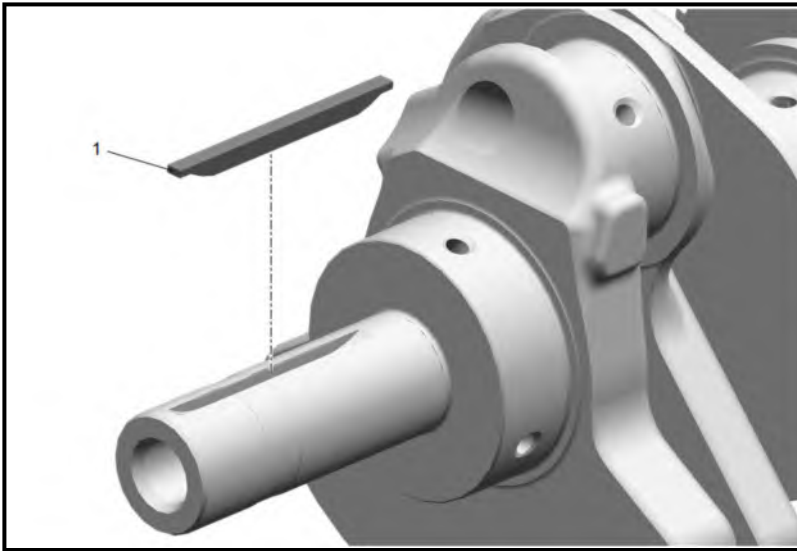


5. Remove the crankshaft bearing caps (1) using the **EN-6125-1B** Slide Hammer Adapter (2) and **EN-49102** Crankshaft Bearing Cap Remover (3).
6. Using two hands, lift the crankshaft (1) straight up from the engine block.



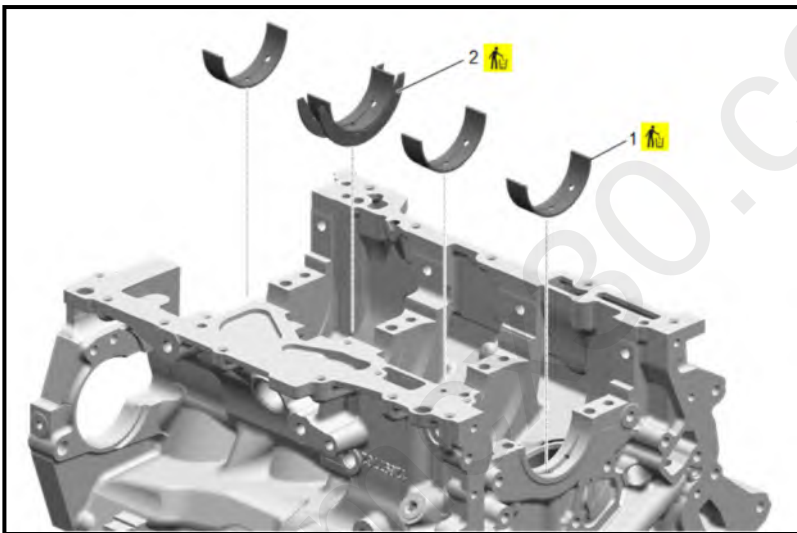
7. Place the crankshaft in a secure place.

8. Remove the crankshaft key (1) from the nose of the crankshaft, if damaged.

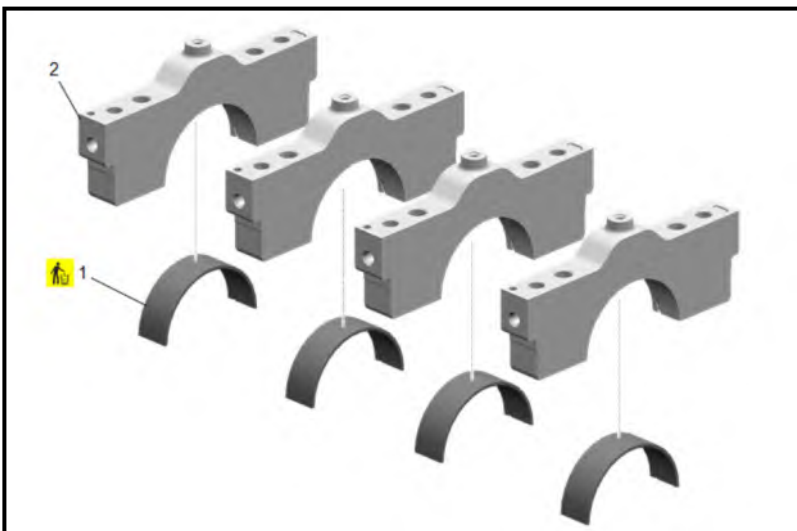


Crankshaft Bearing Removal

1. Remove and DISCARD the crankshaft upper bearing halves from the engine block. Note the position of the thrust bearing (1) at the number 3 journal (2).



2. Remove and DISCARD the crankshaft lower bearing halves (1) from the crankshaft bearing caps (2).



Cleaning Procedure

1. Clean the following components in solvent:

- Crankshaft bearings
- Connecting rod bearings
- Crankshaft journals
- Crankpin journals
- Crankshaft oil passages
- Crankshaft threaded holes

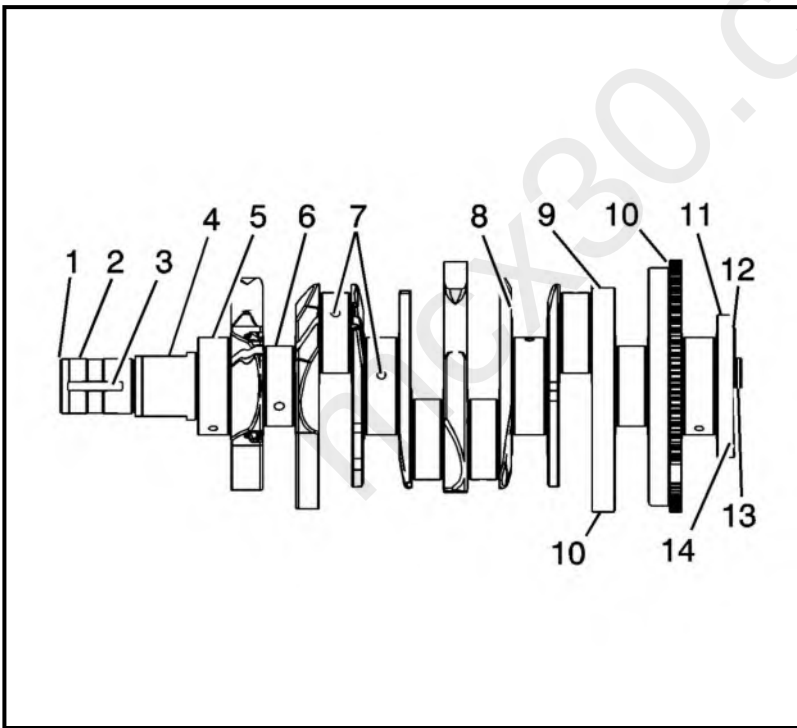
WARNING: Refer to [Safety Glasses Warning](#)

2. Dry the following components with compressed air:

- Crankshaft bearings
- Connecting rod bearings
- Crankshaft journals
- Crankpin journals
- Crankshaft oil passages
- Crankshaft threaded holes

Visual Inspection

1. Perform the following visual inspections:



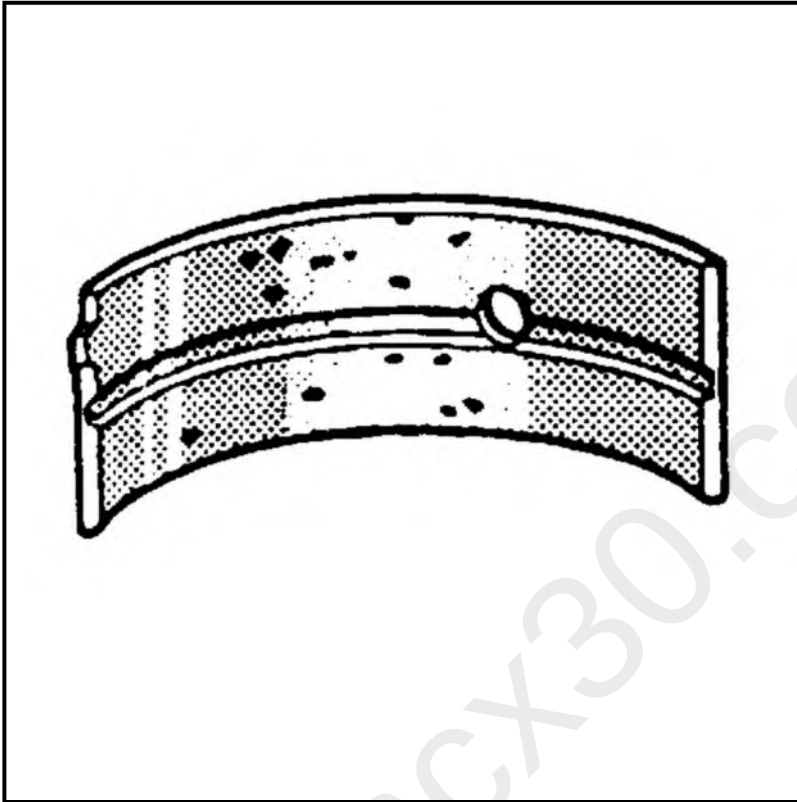
- Inspect the crankshaft balancer bolt hole (1) for thread damage.
- Inspect the crankshaft balancer mounting area (2) for damage.
- Inspect the crankshaft keyway (3) for damage.
- Inspect the oil pump drive flats (4) for damage.
- Inspect the crankshaft main journals (5) for damage.
- Inspect the crankshaft connecting rod journals (6) for damage.
- Inspect the crankshaft oil passages (7) for obstructions.
- Inspect the crankshaft main bearing thrust wall surfaces (8) for damage.
- Inspect the crankshaft counterweights (9) for damage.

- Inspect the crankshaft reluctor ring teeth (10) for damage.
- Inspect the crankshaft rear main oil seal surface (11) for damage.
- Inspect the crankshaft engine flex plate mounting surface (12) for damage.
- Inspect the crankshaft pilot hole (13) for damage.
- Inspect the crankshaft engine flex plate bolt holes (14) for thread damage.

2. Repair or replace the crankshaft as necessary.

Crankshaft Bearing Inspection

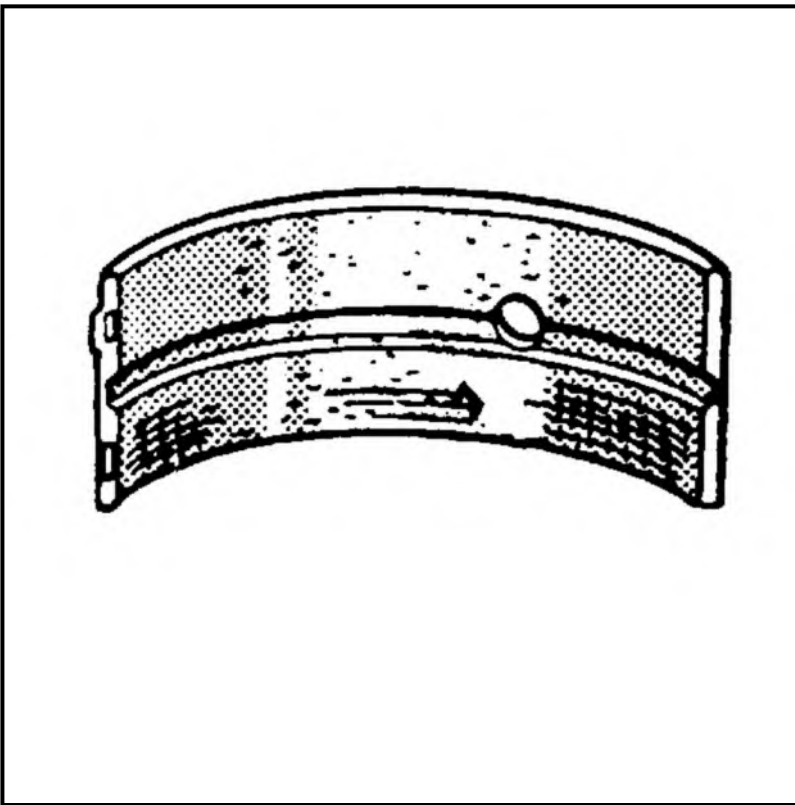
1. Inspect for fatigue indicated by craters or pockets. Flattened sections on the bearing halves also indicate fatigue.



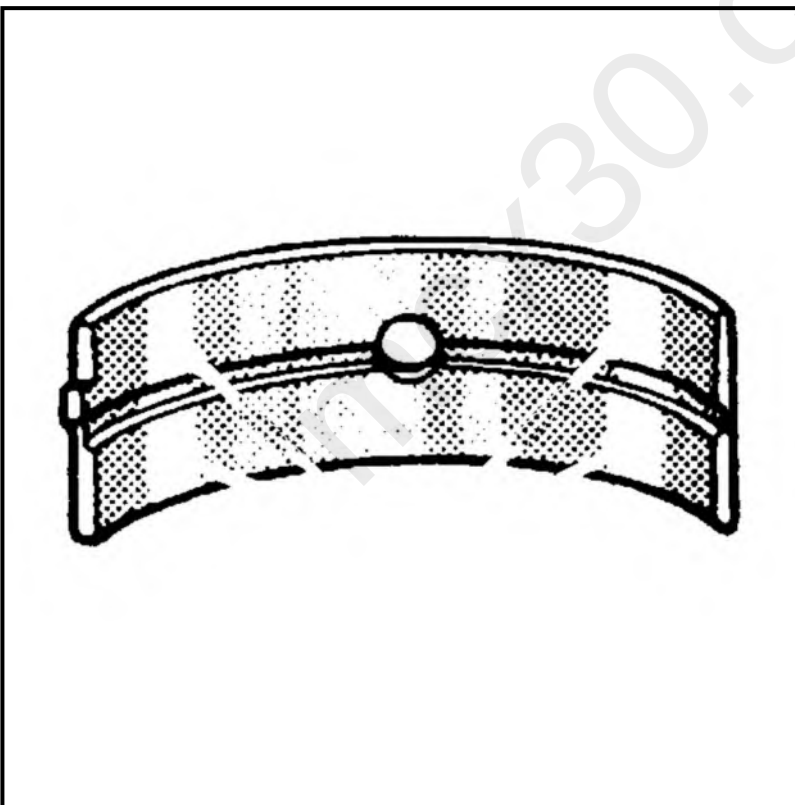
NOTE:

- All connecting rod and main journal bearings that have been used in a running engine must be replaced. Never re-use the crankshaft or connecting rod bearings.
- The following bearing wear conditions should be used to diagnose engine operating conditions or root cause of a condition.

2. Inspect for excessive scoring or discoloration on both front and back of the bearing halves.

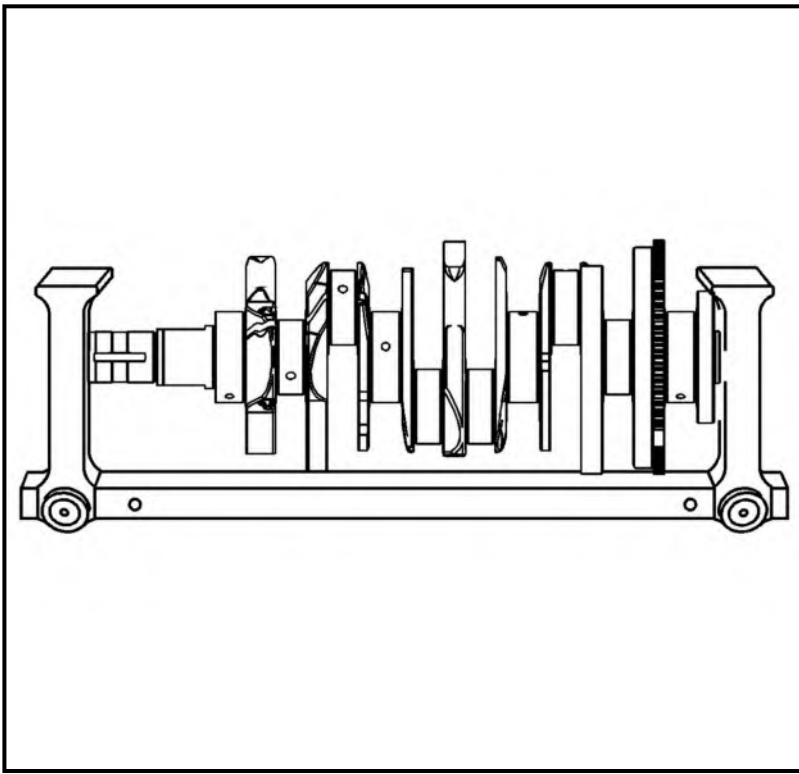


3. Inspect the main bearings for dirt embedded into the bearing material.
4. Inspect for improper seating indicated by bright, polished sections.

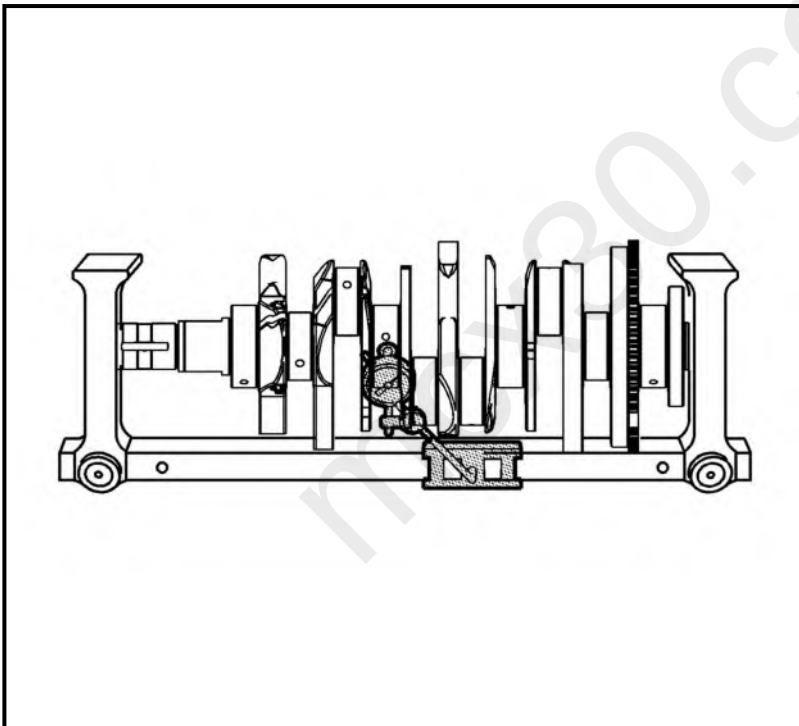


Crankshaft Measurement

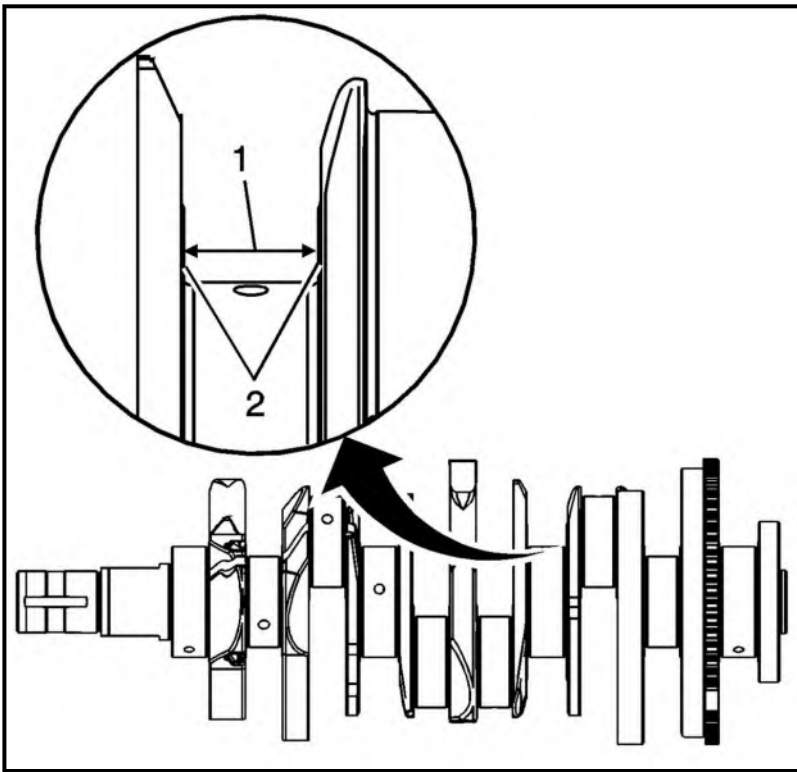
1. Using a suitable fixture, support the crankshaft.



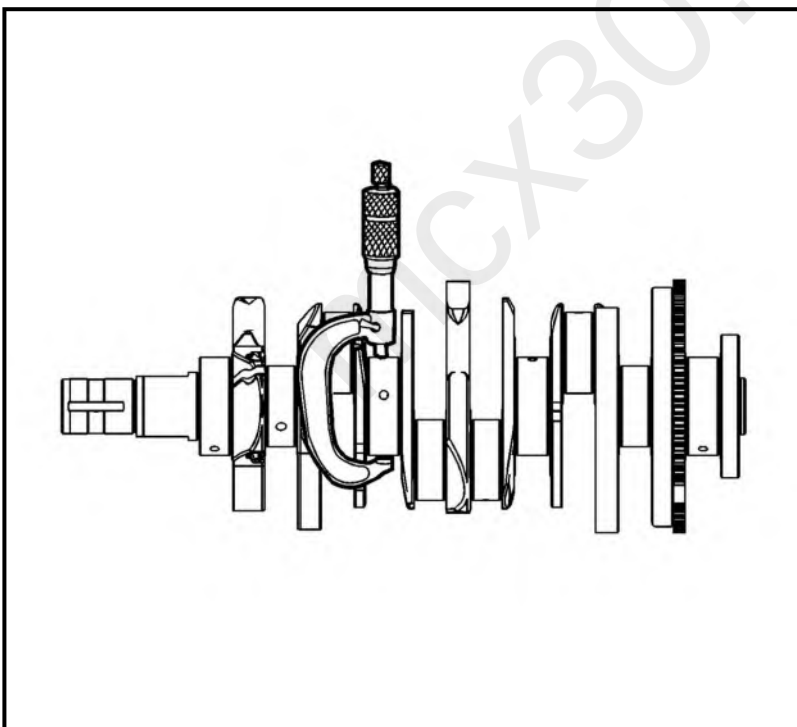
2. Install the **EN-7872** indicator.



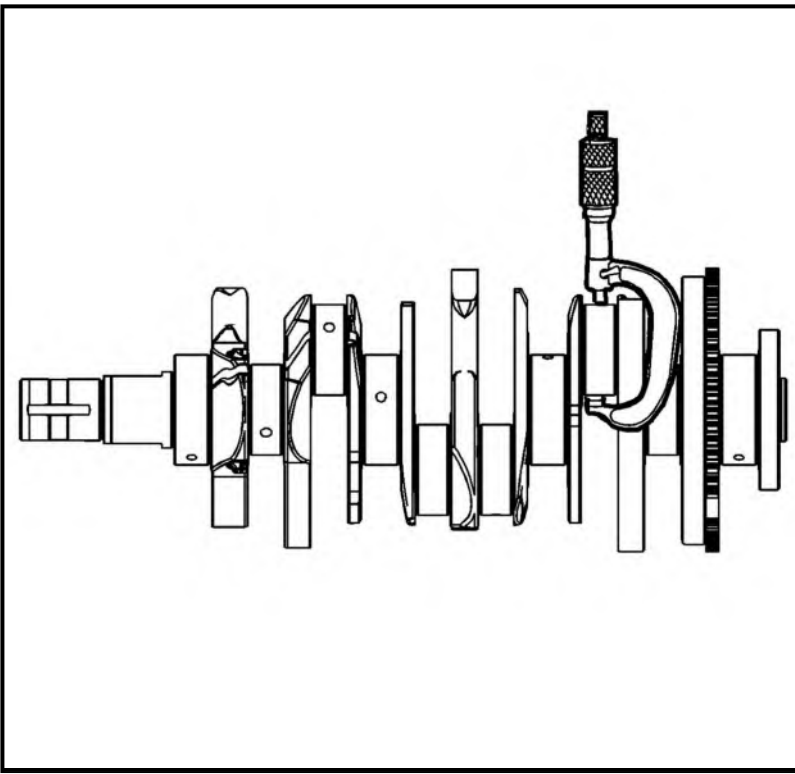
3. Measure the crankshaft runout using the **EN-7872** indicator. [Engine Mechanical Specifications](#)
4. Measure the crankshaft thrust wall width (1) for wear using an inside micrometer. [Engine Mechanical Specifications](#)



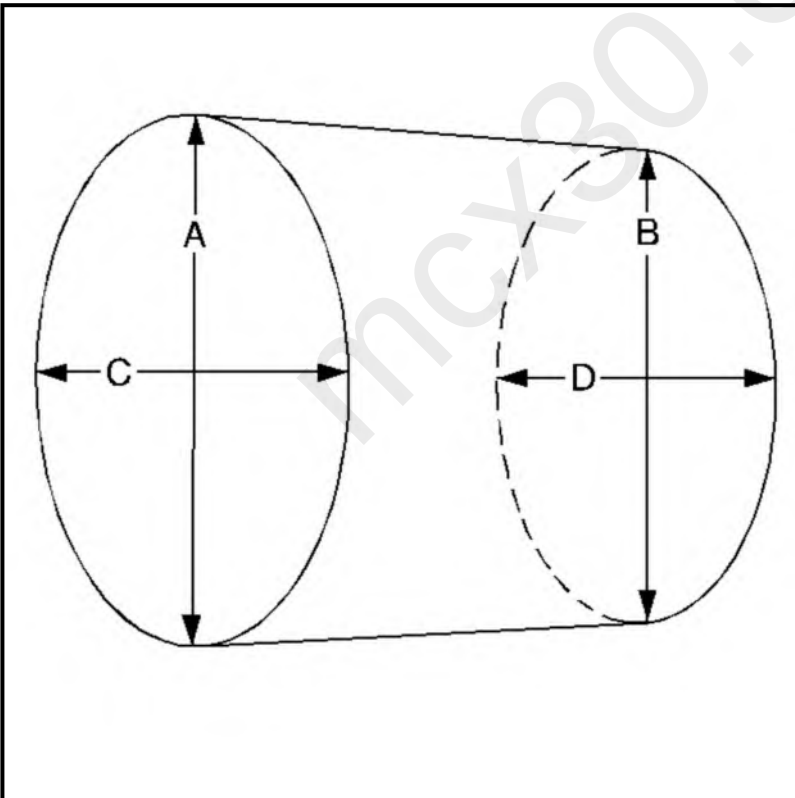
5. Measure the crankshaft thrust wall surface (2) for runout using the EN-7872 indicator. **Engine Mechanical Specifications**
6. If the crankshaft journals are damaged or worn beyond specifications, the crankshaft may be ground 0.25 mm (0.010 in). There is only 1 size of oversized main bearings available for service.
7. Inspect the crankshaft main journals for undersize, using an outside micrometer.



8. Inspect the crankpins for undersize using an outside micrometer.



9. Compare your measurements with those listed in the [Engine Mechanical Specifications](#) . If the crankpin journals are worn beyond the specifications, the crankshaft may be ground 0.25 mm (0.010 in). There is only 1 size of oversized connecting rod bearings available for service.
10. Measure the main bearing and crankpin journals for out-of-round using the following procedure:



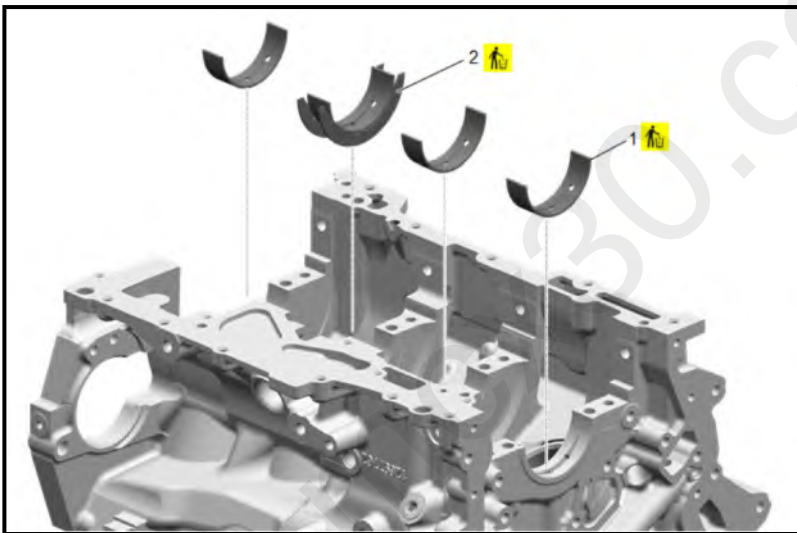
1. Using an outside micrometer, measure the journal at the extreme front and rear locations on the journal. Call these points A and B.
2. Measure the journal in 2 new locations exactly 90 degrees from the first points. Call these points C and D.
3. Subtract A from C and B from D. The differences will indicate journal out-of-round.
4. The out-of-round should not exceed 0.004 mm (0.00016 in) maximum.

5. If the journals are worn beyond the specifications, the crankshaft may be ground 0.25 mm (0.010 in). There is only 1 size of oversized crankshaft and connecting rod bearings available for service.
11. Measure the main bearing and crankpin journals for taper using the following procedure:
 1. Using an outside micrometer, measure the journal at the extreme front (A) and rear (B) of the journal parallel to the crankshaft centerline.
 2. Subtract the smallest from the largest measurement. The result will be the journal taper.
 3. If the main bearing journal taper exceeds 0.004 mm (0.00016 in), replace the crankshaft.
 4. If the journals are worn beyond the specifications, the crankshaft may be ground 0.25 mm (0.010 in). There is only 1 size of oversized crankshaft and connecting rod bearings available for service.

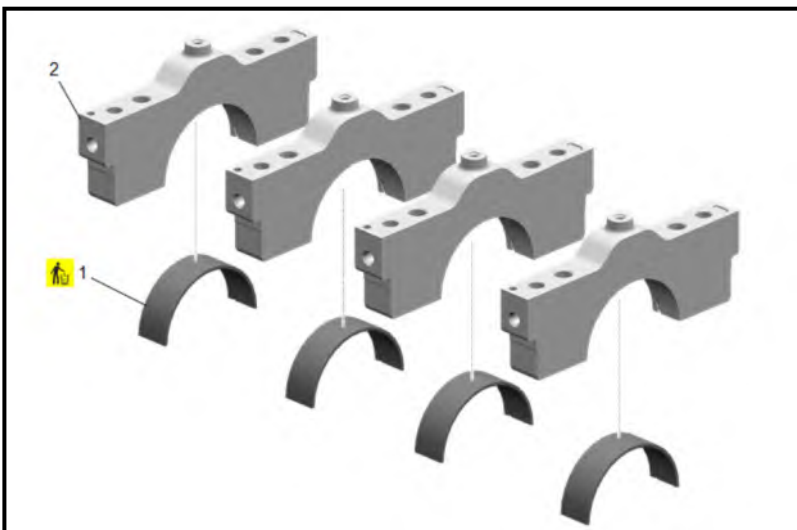
Crankshaft Bearing Installation Procedure

NOTE: If the crankshaft bearings have been used in a running engine, you must replace them with **NEW** crankshaft bearings for reassembly.

1. Clean the crankcase crank bore with a lint-free cloth.
2. Clean all the oil from the backside of new bearing halves.
3. Install the NEW upper crankshaft bearings (1) into position. The thrust bearing belongs in the number 3 journal (2). Ensure that the upper bearing insert contains the oil transfer hole and groove. Roll the bearing into position so that the lock tang engages the crank slot. The bearing must fit flush with the upper crankcase.

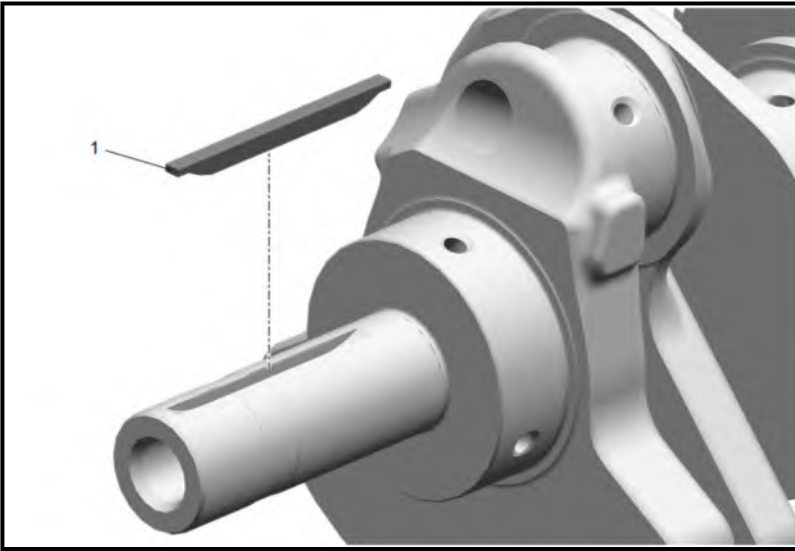


4. Install the NEW lower crankshaft bearings (1) into position in the main bearing caps (2). The lower crankshaft bearings are identified by NO grooves or holes. The bearings (1) must fit flush with the crankshaft bearing caps (2).

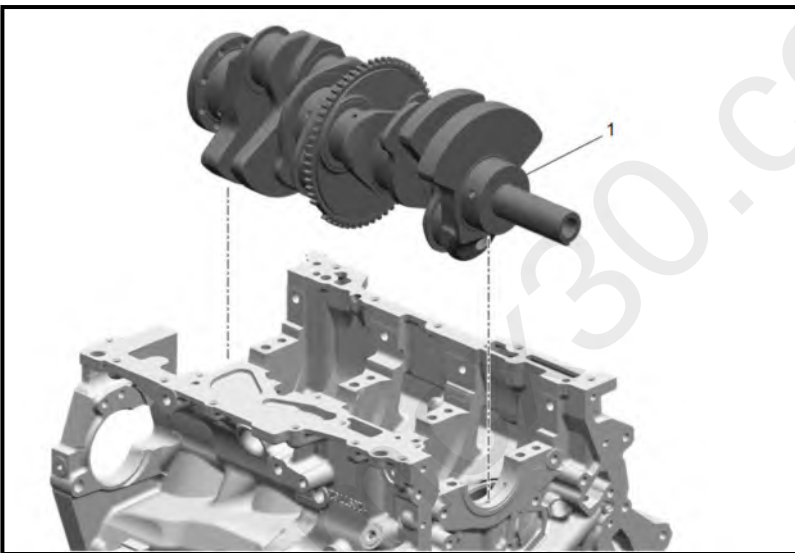


Crankshaft Installation Procedure

1. If removed, install the crankshaft key (1). Lightly tap the key in place with a small soft face, bronze/plastic, hammer until it bottoms in the keyway.

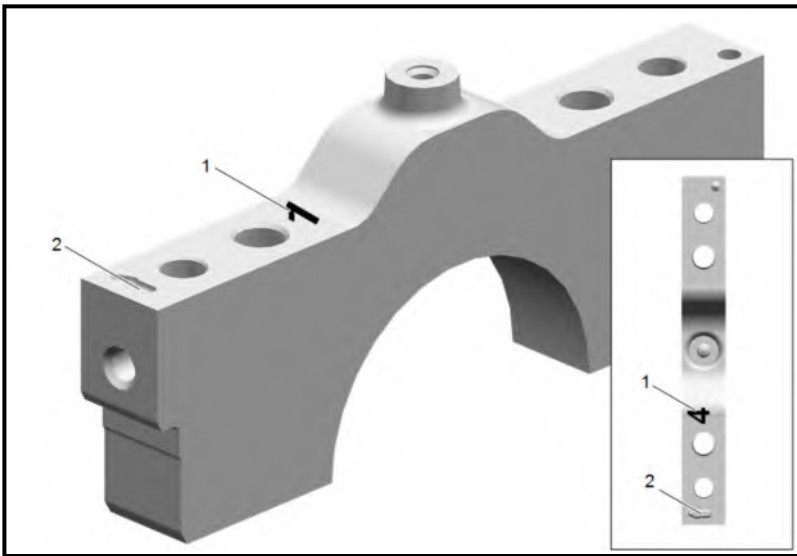


2. Gently lower the crankshaft (1) into position in the engine block.

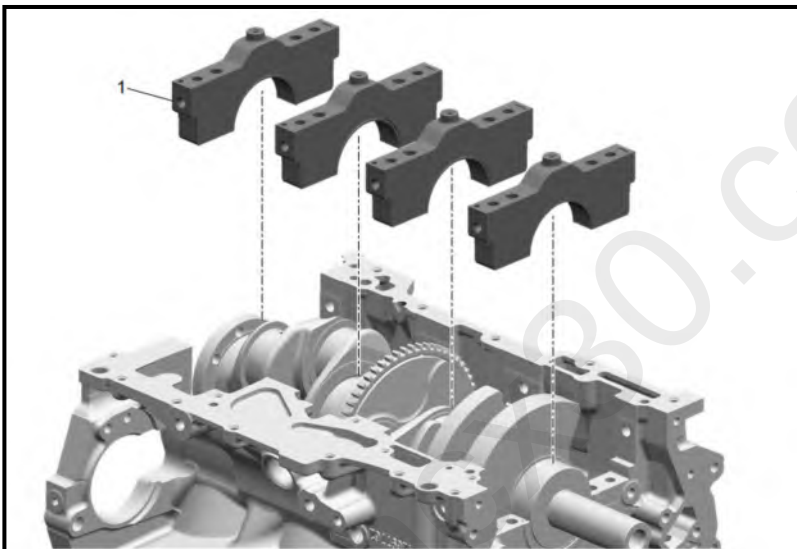


Crankshaft Bearing Clearance Measurement Procedure

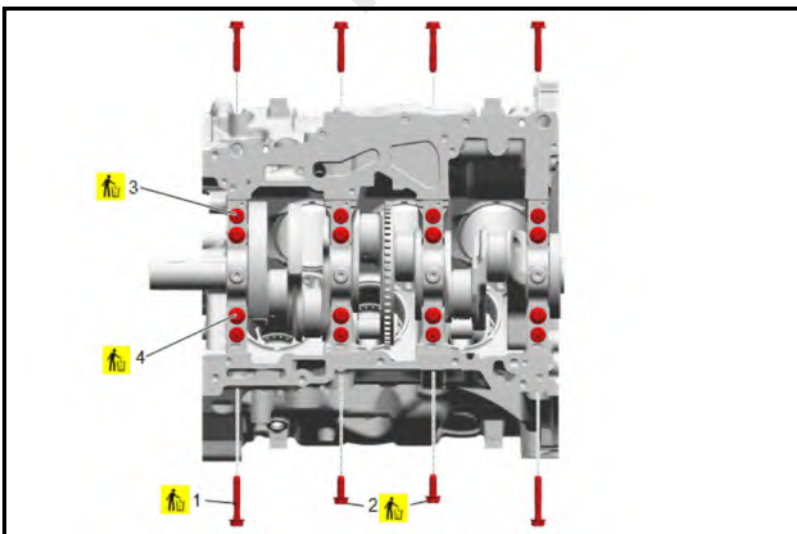
1. Place a length of fresh, room temperature plastic gaging material all the way across all the crankshaft bearing journals.



2. Identify the proper order of the main bearing caps. The main bearing caps are numbered 1 (1) through 4, with the front main bearing cap marked with the number 1. The arrow (2) is to be oriented to the front of the engine.
3. Install the crankshaft main bearing caps.



4. Loosely install the original short/inner side main cap bolts (2).



5. Loosely install the original long/outer side main cap bolts (1).
6. Loosely install the original inner main cap bolts (4).
7. Loosely install the original outer main cap bolts (3).

8. Tap the crankshaft main bearing caps with a soft-faced hammer.
9. Tighten the main caps bolts using the **EN-45059** Angle Meter in the following sequence:

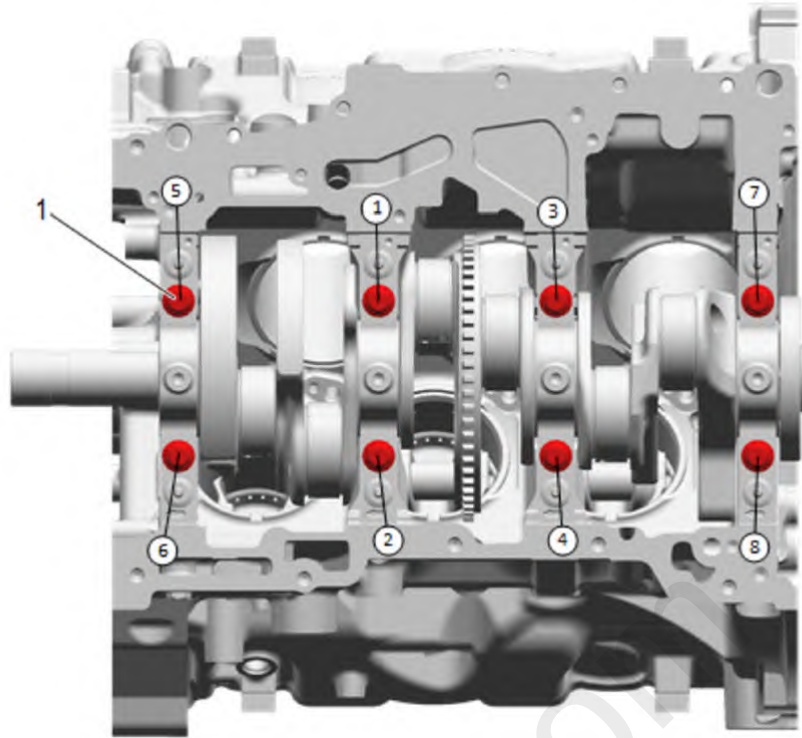


Fig. 21: Crankshaft Main Bearing Inboard Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to **Fastener Caution** .

10. Tighten the inboard bolts (1 - 8) first, in two passes.
 1. Tighten the inboard bolts to 20 N.m (15 lb ft) on the first pass.
 2. Tighten the inboard bolts (1 - 8) an additional 120 degrees on the second pass.
11. Tighten the outboard bolts (9 - 16) second, in two passes.

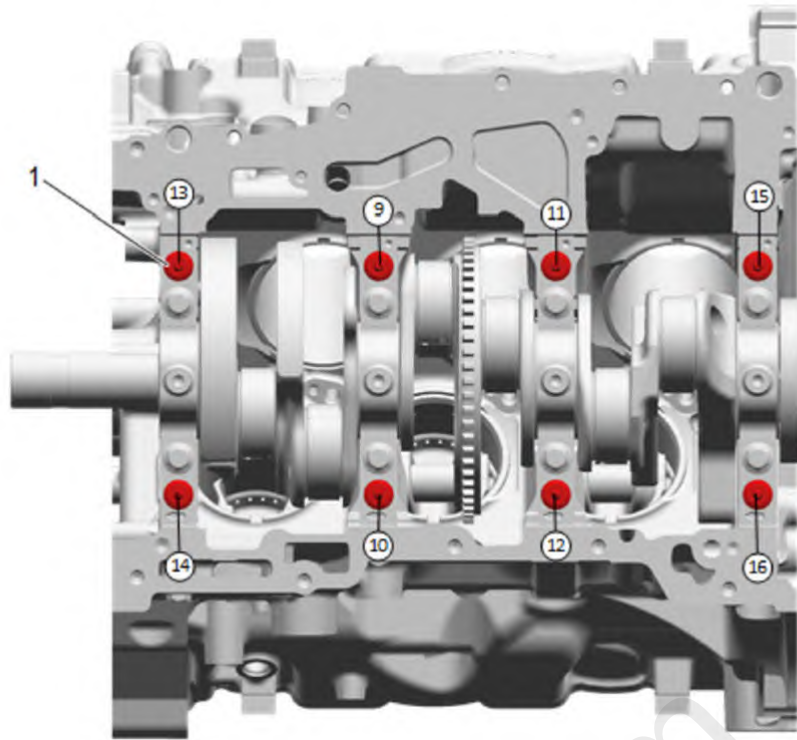


Fig. 22: Outboard Crankshaft Main Bearing Bolt Tightening Sequence
 Courtesy of GENERAL MOTORS COMPANY

1. Tighten the outboard bolts to 20 N.m (15 lb ft) on the first pass.
2. Tighten the outboard bolts (9 - 16) an additional 80 degrees on the second pass.
12. Tighten the short/inner bolts (17 - 20) third, in two passes.

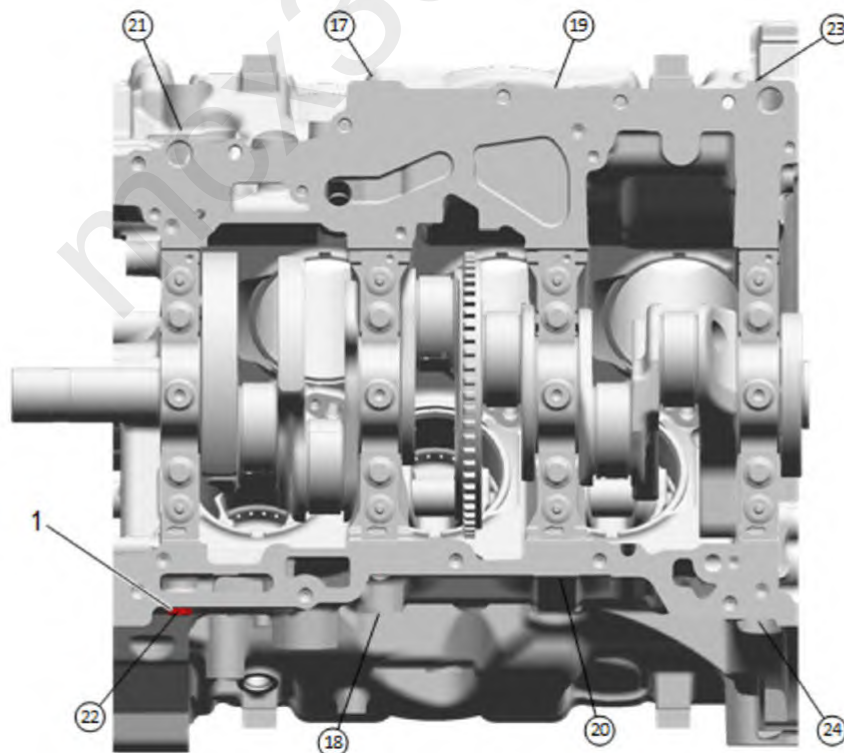


Fig. 23: Identifying Short/Inner Crankshaft Main Bearing (Bolt Tightening Sequence)
 Courtesy of GENERAL MOTORS COMPANY

1. Tighten the short/inner bolts to 30 N.m (22 lb ft) on the first pass.
2. Tighten the short/inner bolts (17 - 20) an additional 60 degrees on the second pass.

13. Tighten the long/outer bolts (21 - 24) fourth, in two passes.

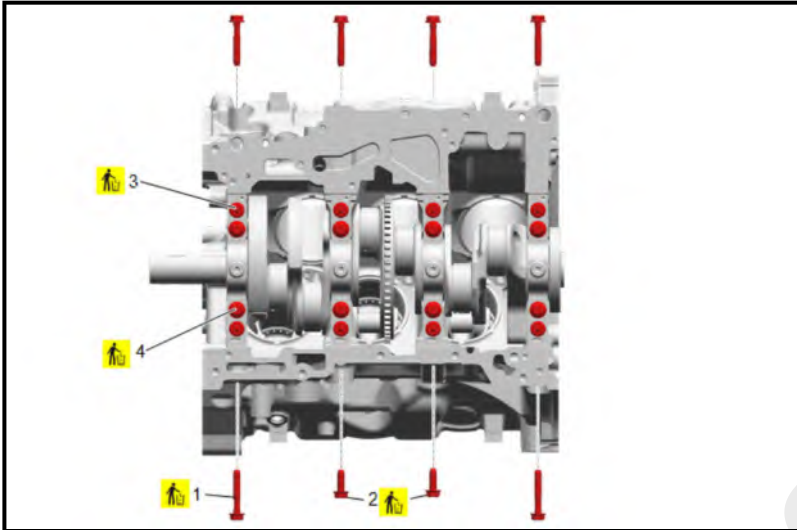
1. Tighten the long/outer bolts to 30 N.m (22 lb ft) on the first pass.

2. Tighten the long/outer bolts (21 - 24) an additional 60 degrees on the second pass.

NOTE: Do not rotate the crankshaft.

14. After reaching final torque, allow the assembly to sit for 2 minutes.

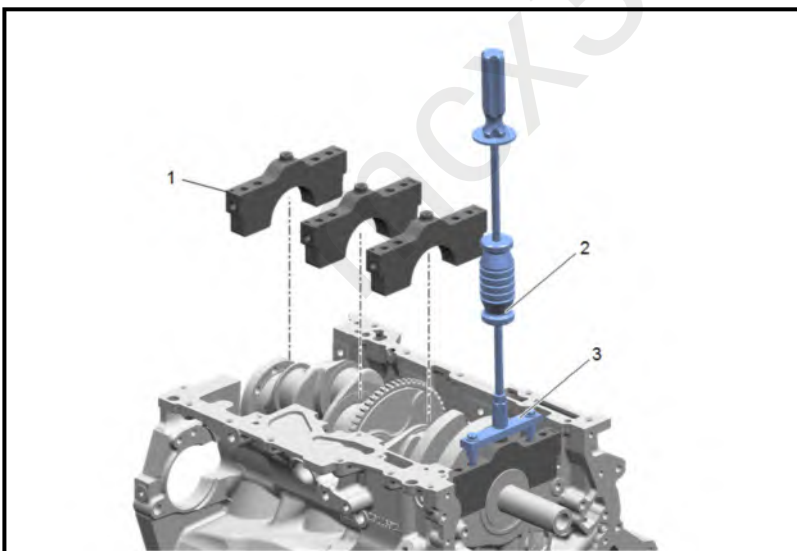
15. Remove the crankshaft bearing cap side bolts (1 and 2).



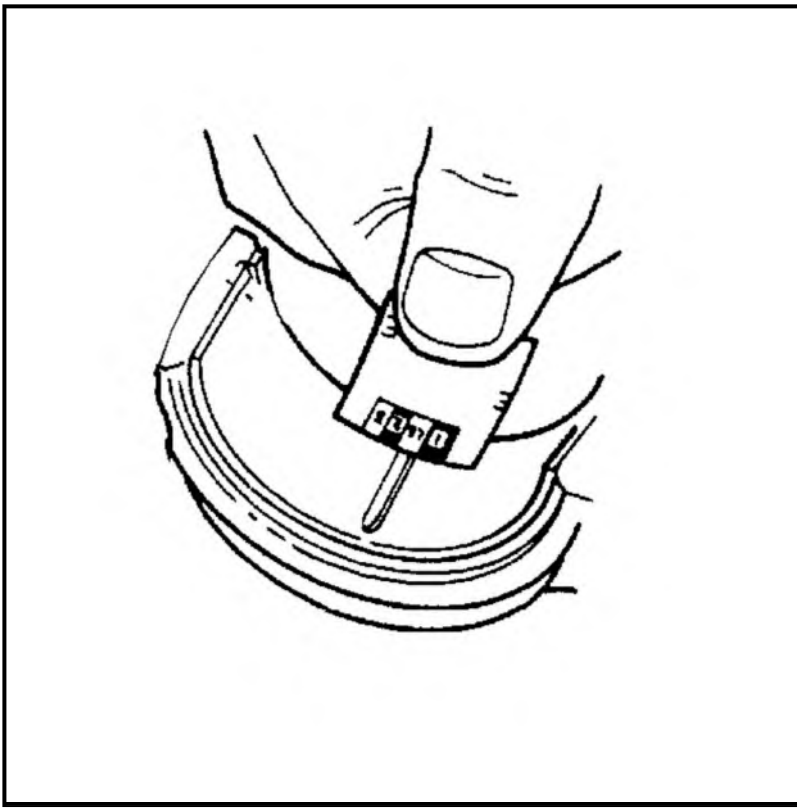
16. Remove the crankshaft bearing cap outer bolts (3).

17. Remove the crankshaft bearing cap inner bolts (4).

18. Remove the crankshaft bearing caps (1) using the **GE-6125-1B** Slide Hammer Adapter (2) and **EN-49102** Crankshaft Bearing Cap Remover (3).

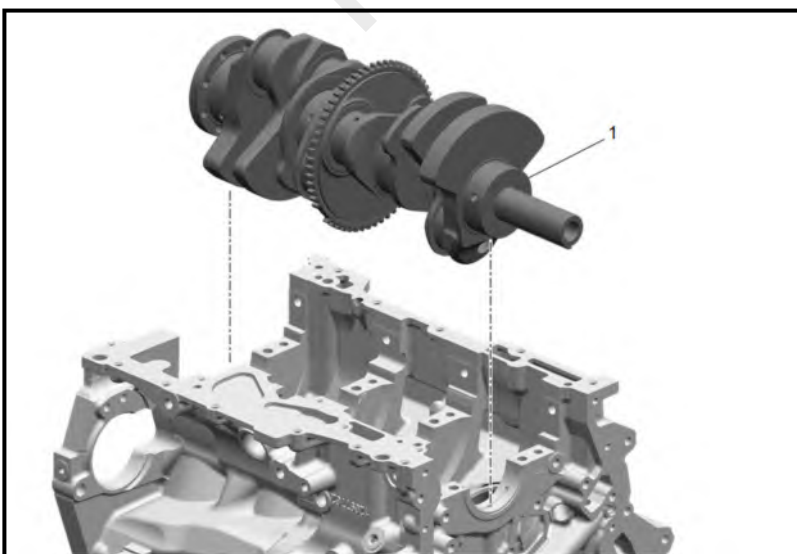


19. Determine the crankshaft bearing clearance by comparing the width of the flattened plastic gaging material at its widest point with the graduation on the gaging material container.

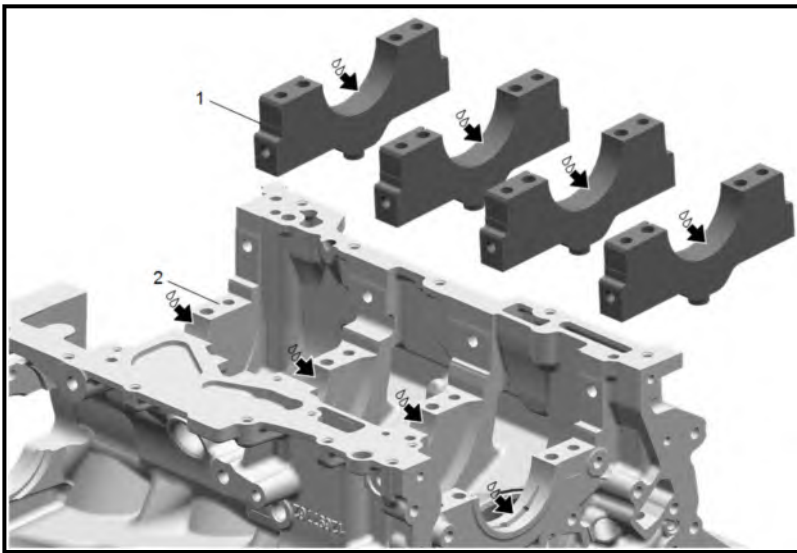


NOTE: The crankshaft bearings **CAN** be reused after checking the clearance if the bearings have never been used in a running engine.

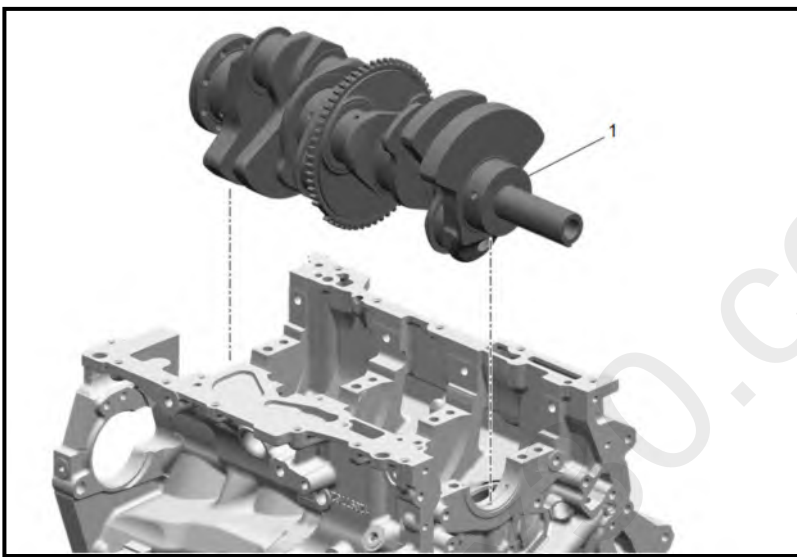
20. Compare your measurements with the [Engine Mechanical Specifications](#) . If the new bearings do not provide the proper crankshaft to bearing clearance, inspect the following:
 1. Re-measure the crankshaft journals for the correct specified size and ensure the proper new bearings are being installed. If the crankshaft journals are incorrectly sized, replace or regrind the crankshaft. Crankshaft machining is permitted and undersized bearings are available.
 2. Re-measure the engine block crankshaft bearing bore diameter to ensure proper size. The engine block crankshaft bearing bore is not machinable and the block must be replaced if out of specification.
21. Clean the plastic gaging material from the crankshaft bearing journals with a soft, lint-free cloth.
22. Lift the crankshaft (1) out of the engine block.



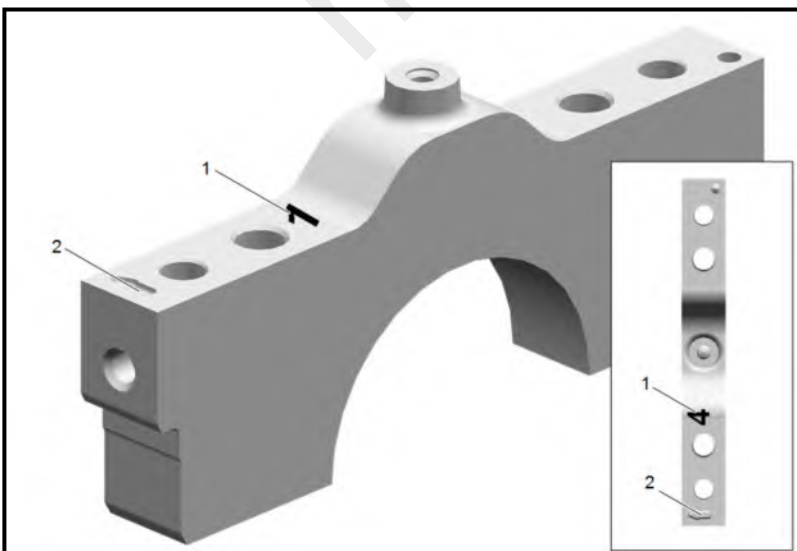
23. Apply a liberal amount of crankshaft prelube or clean engine oil to the upper (1) and lower (2) bearing surfaces. [Adhesives, Fluids, Lubricants, and Sealers](#)



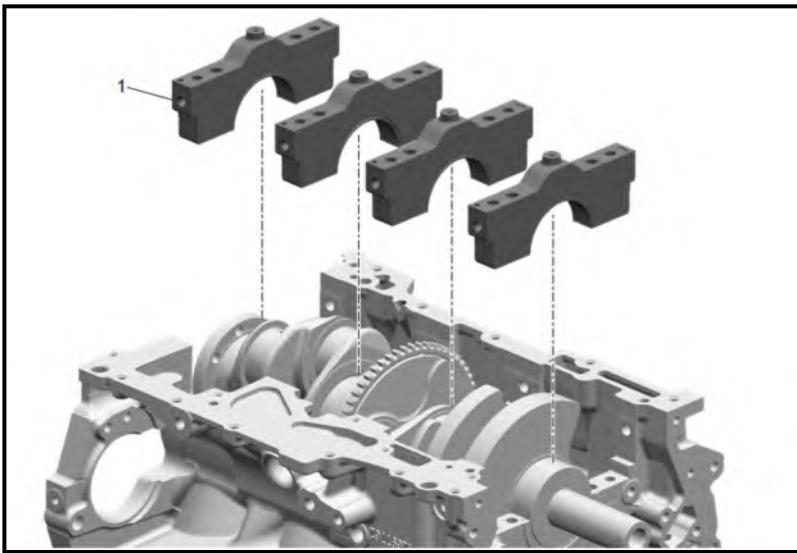
24. Gently lower the crankshaft (1) into position in the engine block.



25. Identify the proper order of the main bearing caps. The main bearing caps are numbered 1 (1) through 4, with the front main bearing cap marked with the number 1. The arrow (2) is to be oriented to the front of the engine.

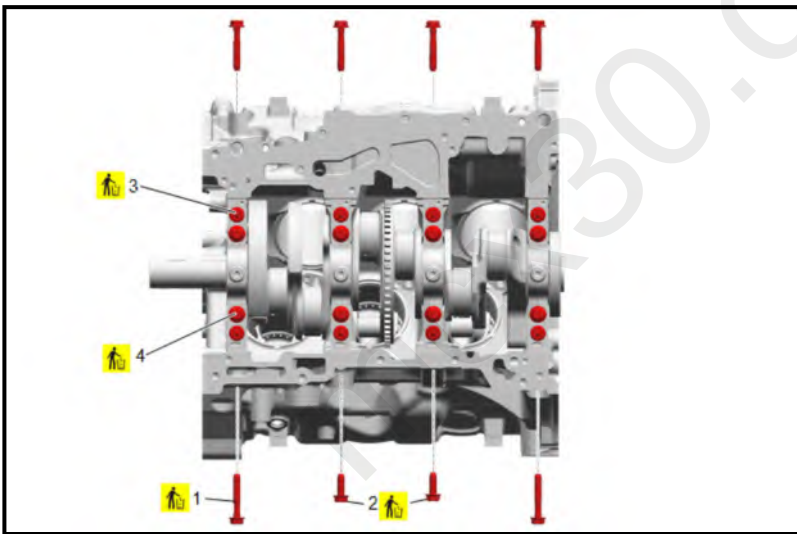


26. Install the crankshaft main bearing caps (1).

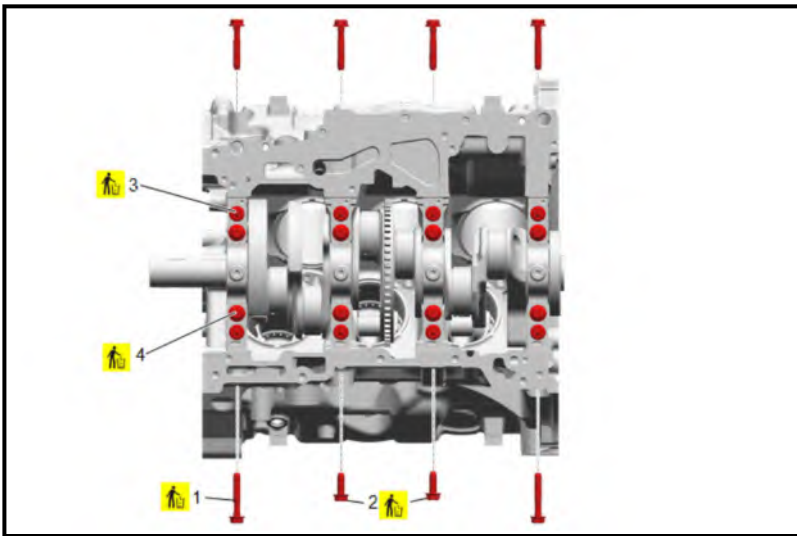


CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a **NEW** torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

- 27. Loosely install the NEW inner main cap bolts (4).
- 28. Loosely install the NEW outer main cap bolts (3).
- 29. Tap the crankshaft main bearing caps with a soft-faced hammer.



- 30. Loosely install the NEW short/inner side main cap bolts (2).



31. Loosely install the NEW long/outer side main cap bolts (1).
32. Tighten the main cap bolts using the **EN-45059** Angle Meter in the following sequence:

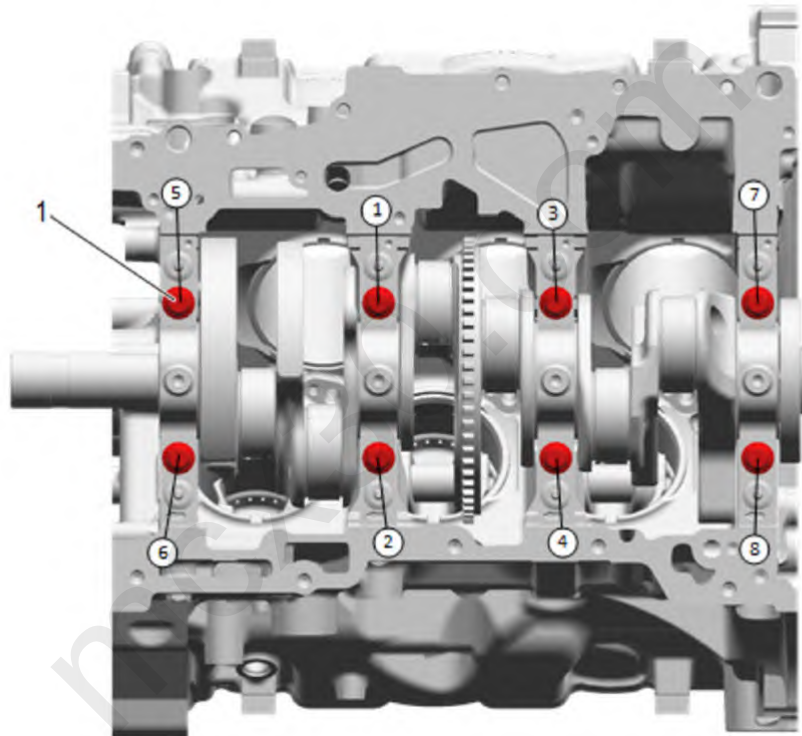


Fig. 24: Identifying Crankshaft Main Bearing Inboard Bolt Tightening Sequence
 Courtesy of GENERAL MOTORS COMPANY

33. Tighten the inboard bolts (1 - 8) first, in two passes.
 1. Tighten the inboard bolts to 20 N.m (15 lb ft) on the first pass.
 2. Tighten the inboard bolts (1 - 8) an additional 120 degrees on the second pass.
34. Tighten the outboard bolts (9 - 16) second, in two passes.

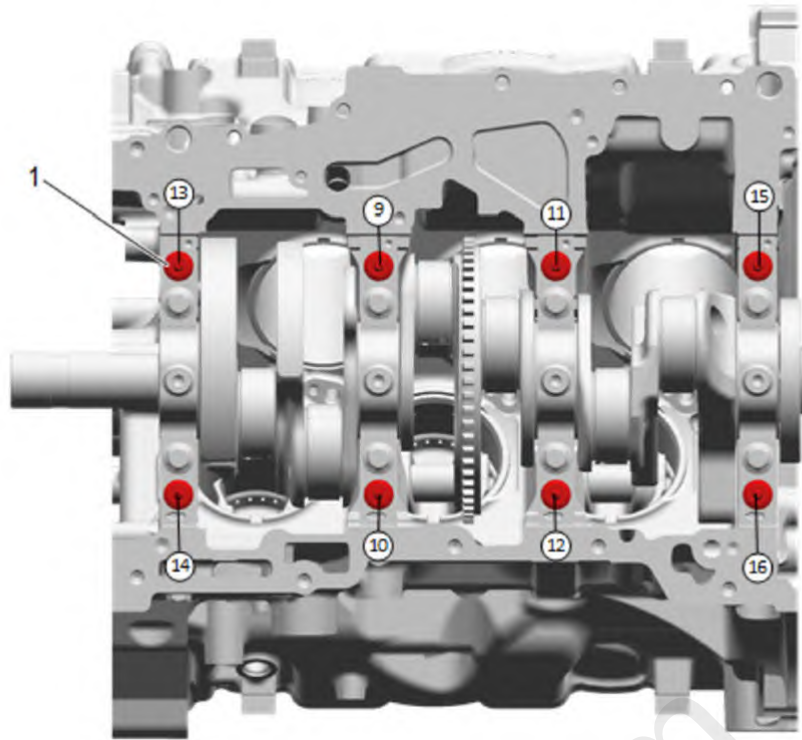


Fig. 25: Identifying Outboard Crankshaft Main Bearing Bolt Tightening Sequence
 Courtesy of GENERAL MOTORS COMPANY

1. Tighten the outboard bolts to 20 N.m (15 lb ft) on the first pass.
2. Tighten the outboard bolts (9 - 16) an additional 80 degrees on the 2nd pass.
35. Tighten the short/inner bolts (17 - 20) third, in two passes.

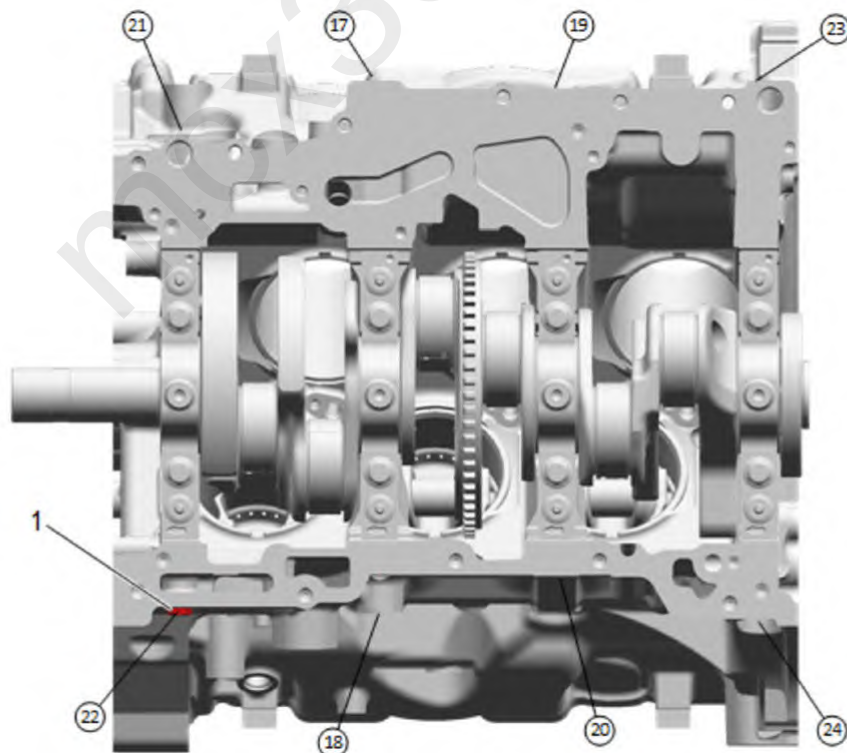
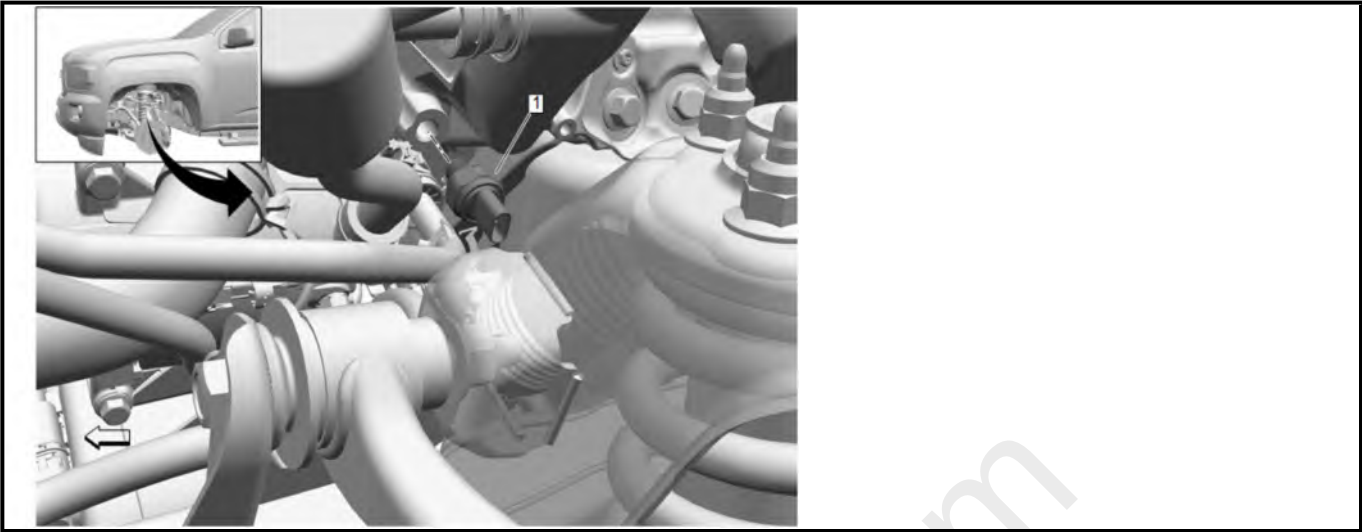


Fig. 26: Identifying Short/Inner Crankshaft Main Bearing (Bolt Tightening Sequence)
 Courtesy of GENERAL MOTORS COMPANY

1. Tighten the short/inner bolts to 30 N.m (22 lb ft) on the first pass.
2. Tighten the short/inner bolts (17 - 20) an additional 60 degrees on the second pass.

36. Tighten the long/outer bolts (21 - 24) fourth, in two passes.
 1. Tighten the long/outer bolts to 30 N.m (22 lb ft) on the first pass.
 2. Tighten the long/outer bolts (21 - 24) an additional 60 degrees on the second pass.
37. Ensure that the crankshaft turns without binding or noise.

ENGINE OIL PRESSURE SENSOR AND/OR SWITCH REPLACEMENT



NOTE: Callouts in the following chart represent components shown in graphic above.

Callout	Component Name
Preliminary Procedure Front Wheelhouse Liner-Left Side - Remove - Front Wheelhouse Liner Replacement (Without ZR2) , or Front Wheelhouse Liner Replacement (With ZR2) , or Front Wheelhouse Liner Replacement (Bison)	
1	Engine Oil Pressure Sensor and/or Switch CAUTION: Refer to Component Fastener Tightening Caution . Procedure Disconnect the electrical connector. Tighten 20 N.m (15 lb ft)

ENGINE OIL LEVEL INDICATOR SWITCH REPLACEMENT

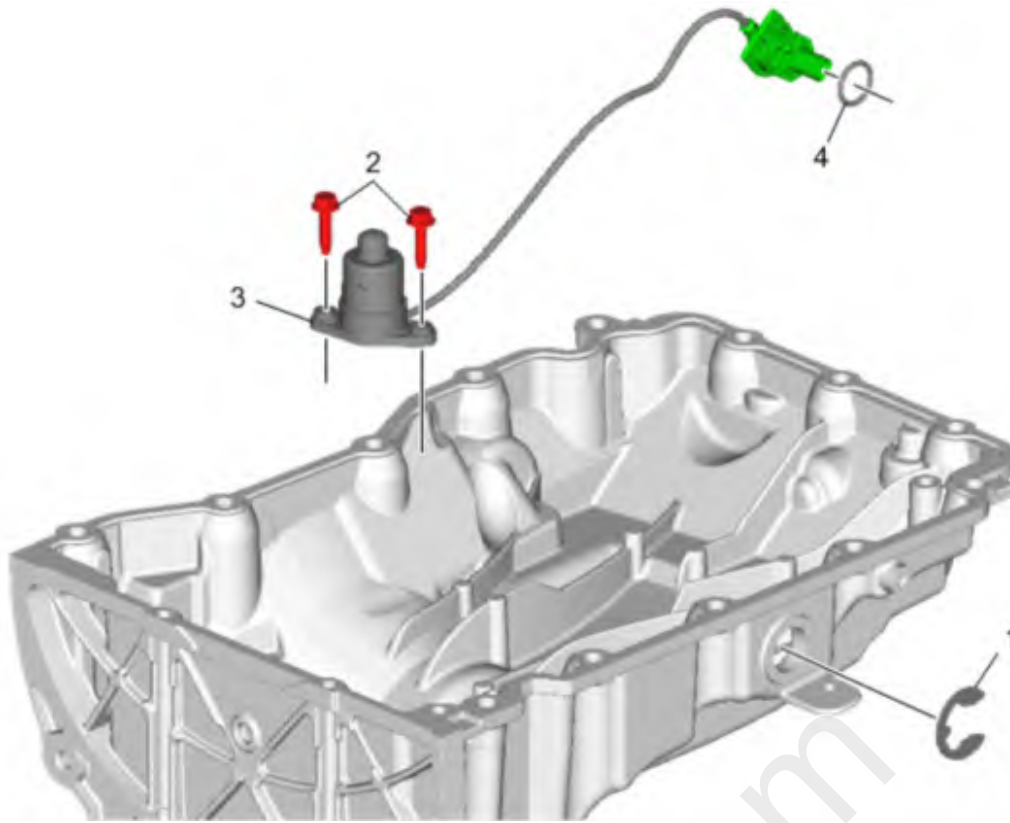


Fig. 27: Engine Oil Level Indicator Switch Components Location

Courtesy of GENERAL MOTORS COMPANY

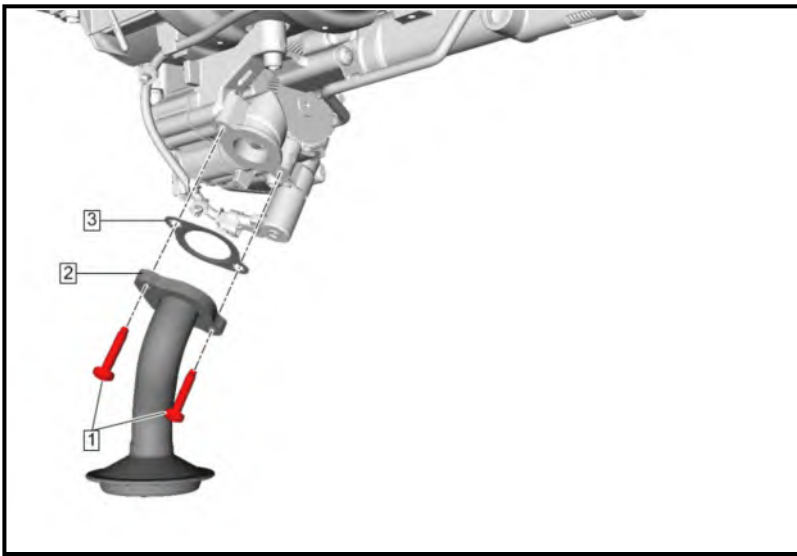
NOTE: Callouts in the following chart represent components shown in graphic above.

Callout	Component Name
Preliminary Procedure <u>Oil Pan Replacement (4WD)</u> , or <u>Oil Pan Replacement (2WD)</u>	
1	Engine Oil Level Switch Clip
2	Engine Oil Level Indicator Switch Bolt [2x] CAUTION: Refer to <u>Fastener Caution</u> . Tighten 10 N.m (89 lb in)
3	Engine Oil Level Indicator Switch
4	Engine Oil Level Indicator Switch O-Ring Seal NOTE: Install a NEW seal.

OIL PUMP SUCTION PIPE AND SCREEN ASSEMBLY REPLACEMENT

Removal Procedure

1. Oil Pan - Remove - Oil Pan Replacement (4WD), or Oil Pan Replacement (2WD)
2. Oil Pump Suction Pipe Bolt (1) - Remove [2x]



3. Oil Pump Suction Pipe and Screen Assembly (2) - Remove
4. Oil Pump Suction Pipe Gasket (3) - Remove and DISCARD

Cleaning Procedure

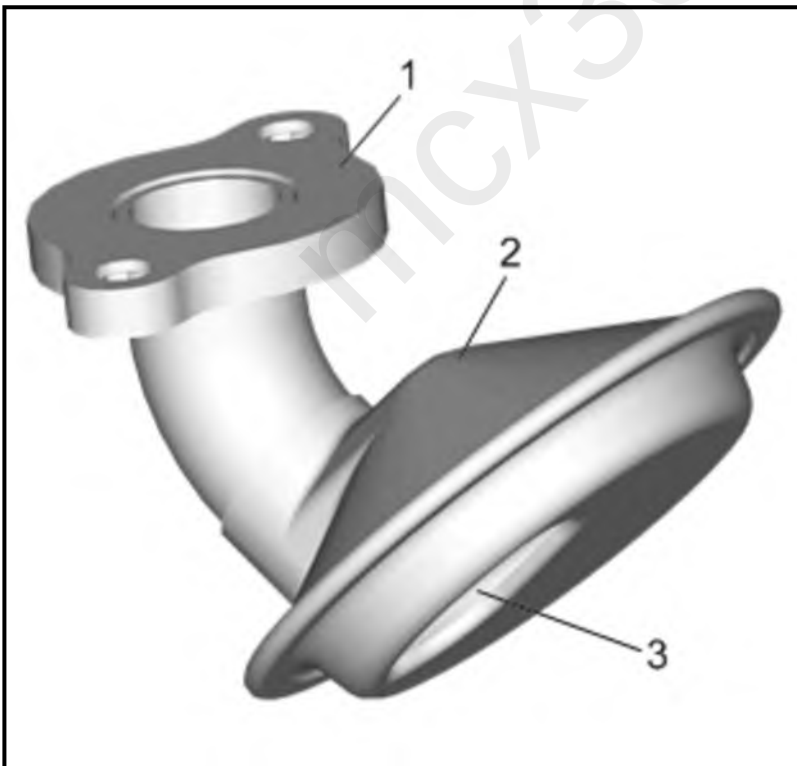
1. Clean the oil pump pipe and screen with solvent.

WARNING: Refer to [Safety Glasses Warning](#) .

2. Dry the oil pump pipe and screen with compressed air.

Inspection Procedure

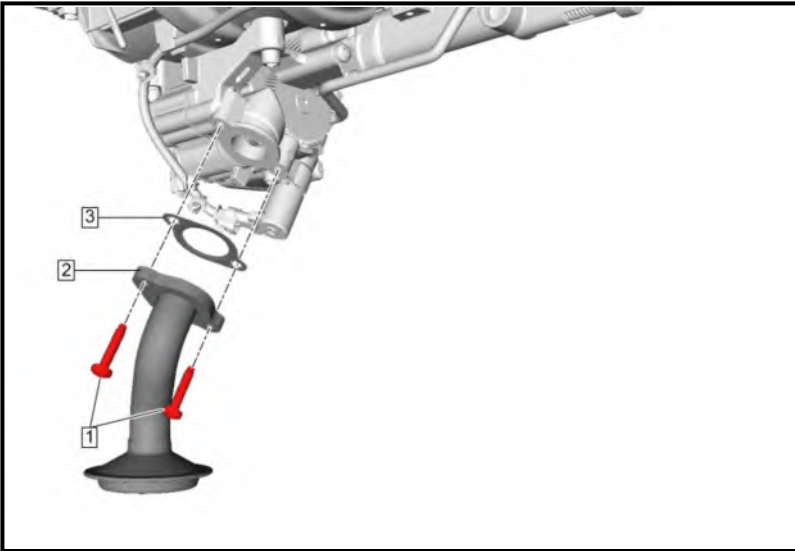
1. Inspect the mounting surface (1) for possible leakage paths.



2. Inspect the oil pump pipe tube (2) for cracks, imperfections and/or damage.
3. Inspect the oil pump screen (3) for blockage, foreign material, tears, cracks and/or damage.

Installation Procedure

1. Oil Pump Suction Pipe Gasket (3) - Install NEW



2. Oil Pump Suction Pipe and Screen Assembly (2) - Install

CAUTION: Refer to [Fastener Caution](#) .

3. Oil Pump Suction Pipe Bolt (1) - Install and tighten [2x] 10 N.m (89 lb in)

4. Oil Pan - Install - [Oil Pan Replacement \(4WD\)](#), or [Oil Pan Replacement \(2WD\)](#).

ENGINE REPLACEMENT

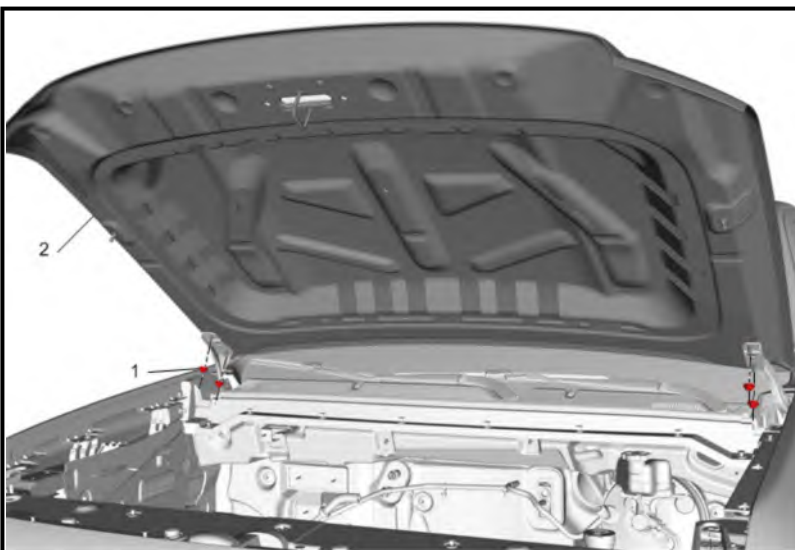
Special Tools

- EN-36857 Engine Lift Hook
- DT-21366 Converter Holding Strap
- EN-52059 Engine Support Fixture Adapter Bolt - M10

Equivalent regional tools: [Special Tools](#)

Removal Procedure

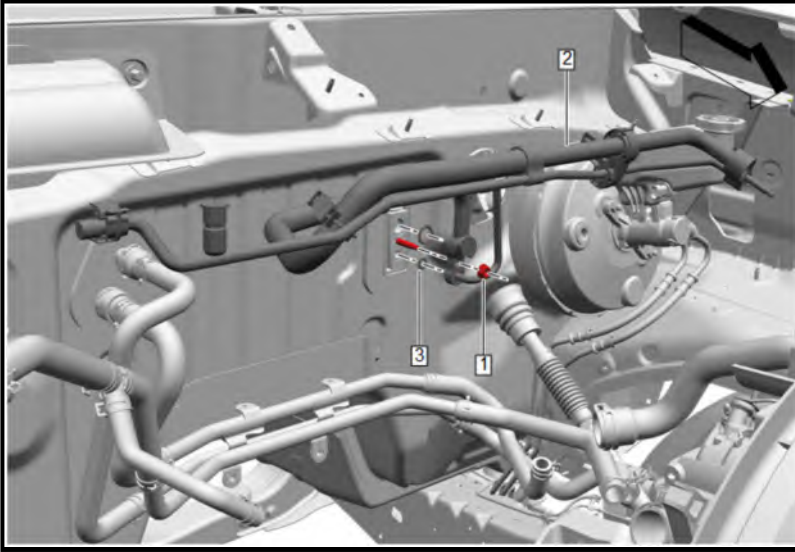
1. Hood (2) - Remove - [Hood Replacement](#)



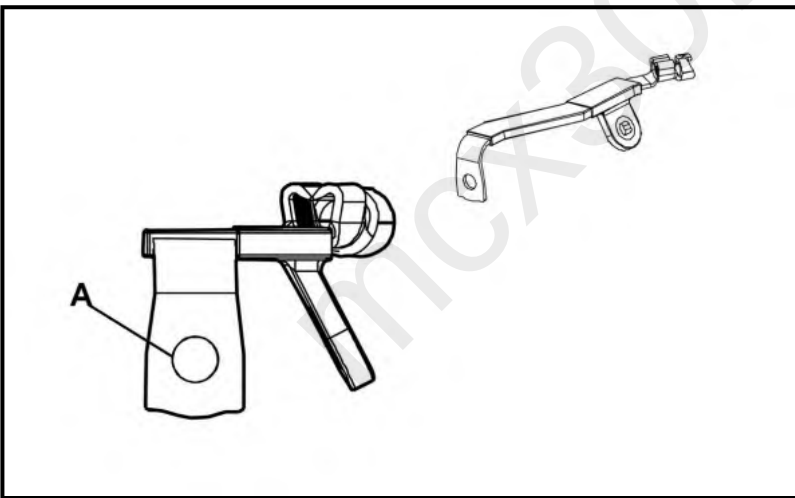
2. Relieve the fuel system pressure. [Fuel Pressure Relief](#)

3. Disconnect the negative battery cable. [Battery Negative Cable Disconnection and Connection](#)

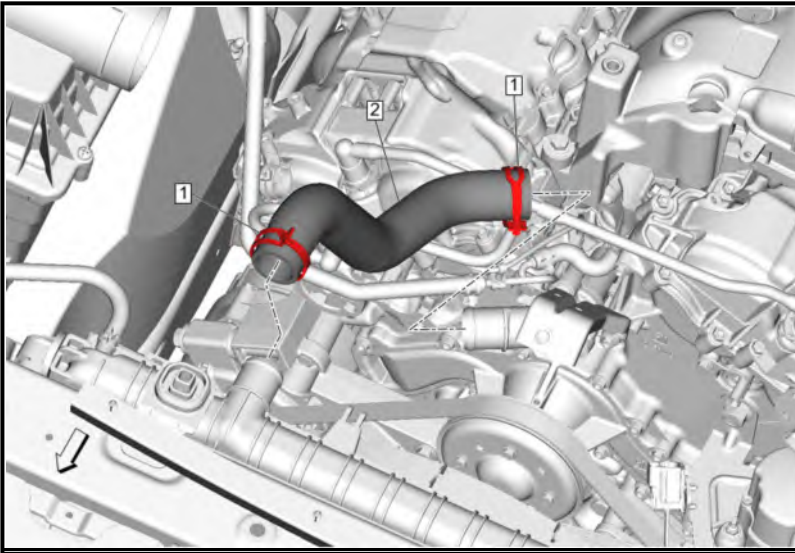
4. Recover the refrigerant. [Refrigerant Recovery and Recharging \(R-1234yf\)](#)
5. Air Conditioning Evaporator Hose Assembly (3) - Remove - [Air Conditioning Evaporator Hose Replacement \(LGZ\)](#)



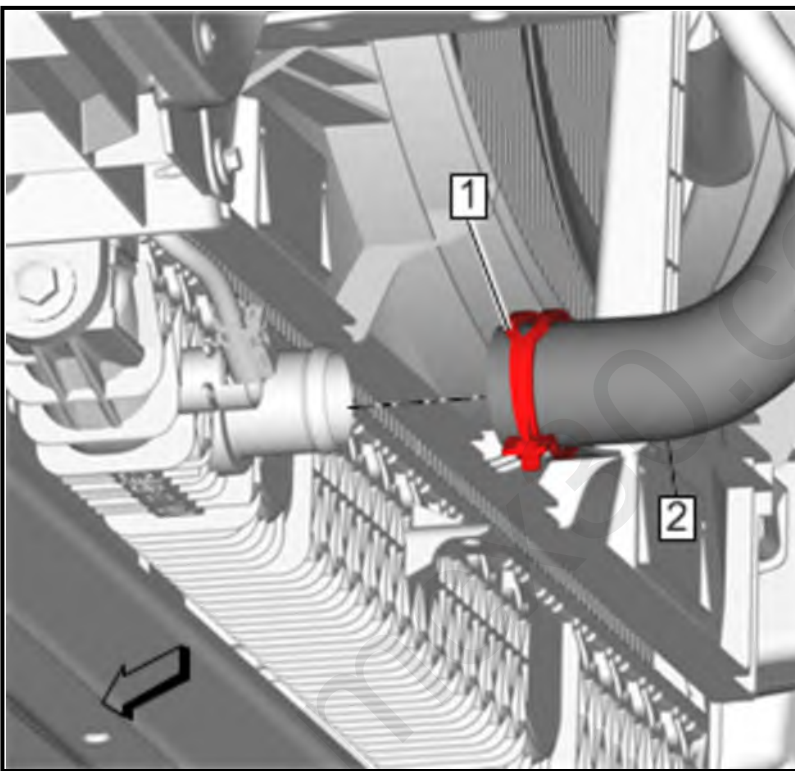
6. Drain the cooling system. [Cooling System Draining and Filling \(Static Fill\)](#) , or [Cooling System Draining and Filling \(Vac n Fill\)](#)
7. Drain the engine oil. [Engine Oil and Oil Filter Replacement](#)
8. Remove the front wheel and tire assemblies. [Tire and Wheel Removal and Installation](#)
9. Intake Manifold - Remove - [Intake Manifold Replacement](#)
10. Generator (3) - Remove - [Generator Replacement \(LGZ\)](#)



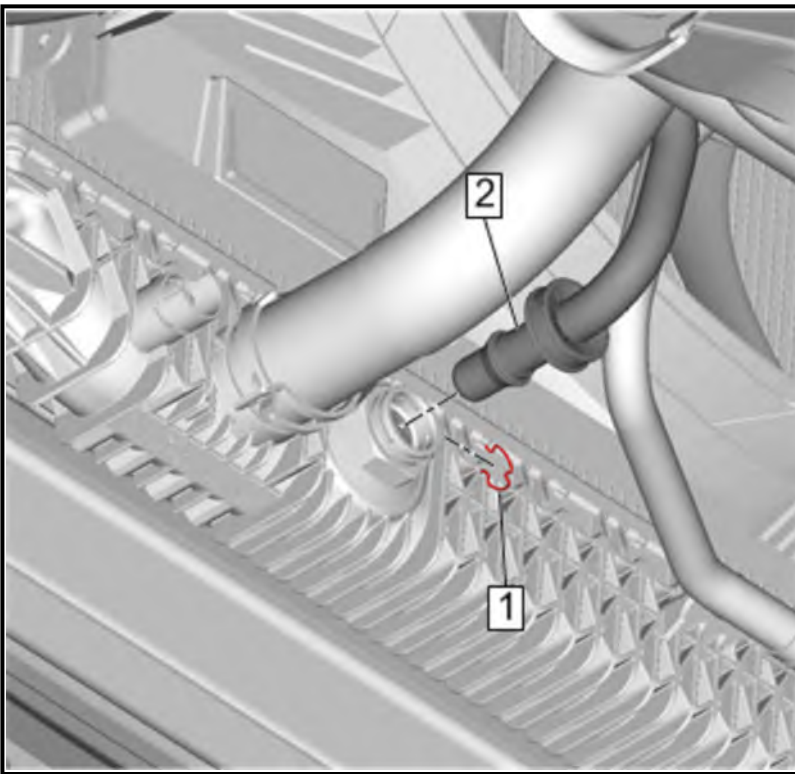
11. Radiator Inlet Hose (2) - Remove - [Radiator Inlet Hose Replacement \(LGZ\)](#)



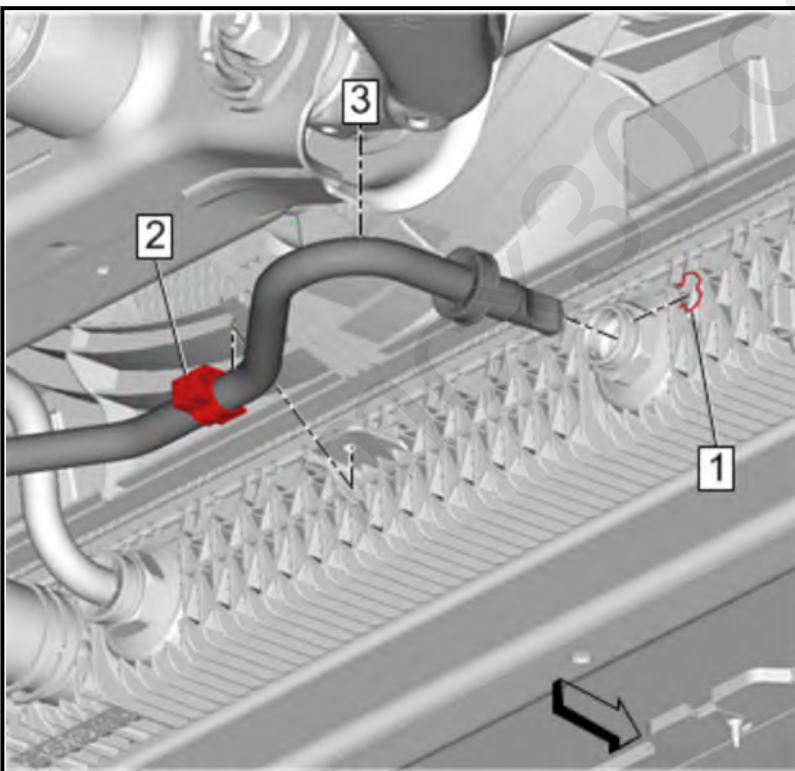
12. Radiator Outlet Hose (2) @ Radiator - Remove - [Radiator Outlet Hose Replacement \(LGZ\)](#).



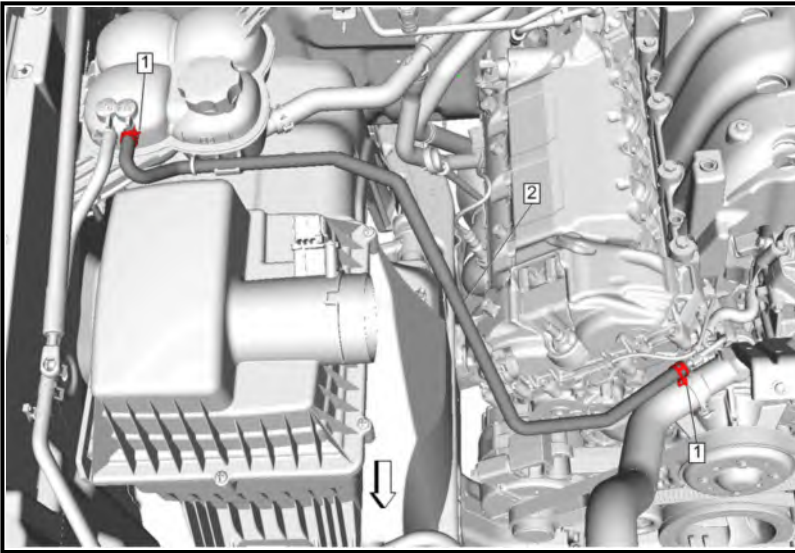
13. Engine Oil Cooler Inlet Pipe (2) @ Radiator Disconnect - [Engine Oil Cooler Inlet Pipe Replacement \(LGZ, 2WD\)](#), or [Engine Oil Cooler Inlet Pipe Replacement \(LGZ, 4WD\)](#).



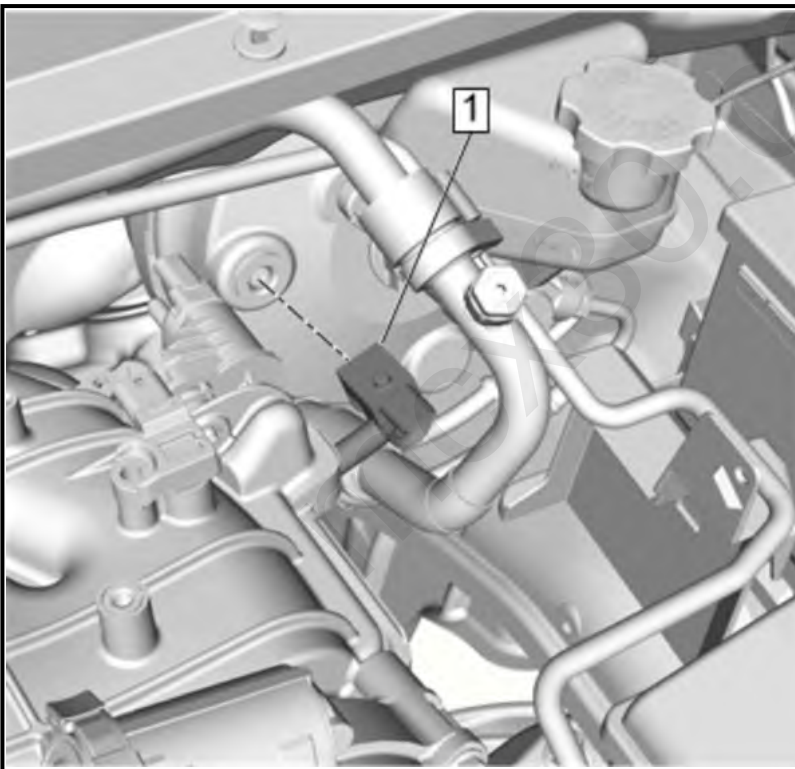
14. Engine Oil Cooler Outlet Pipe (3) @ Radiator Disconnect - [Engine Oil Cooler Outlet Pipe Replacement \(LGZ\)](#)



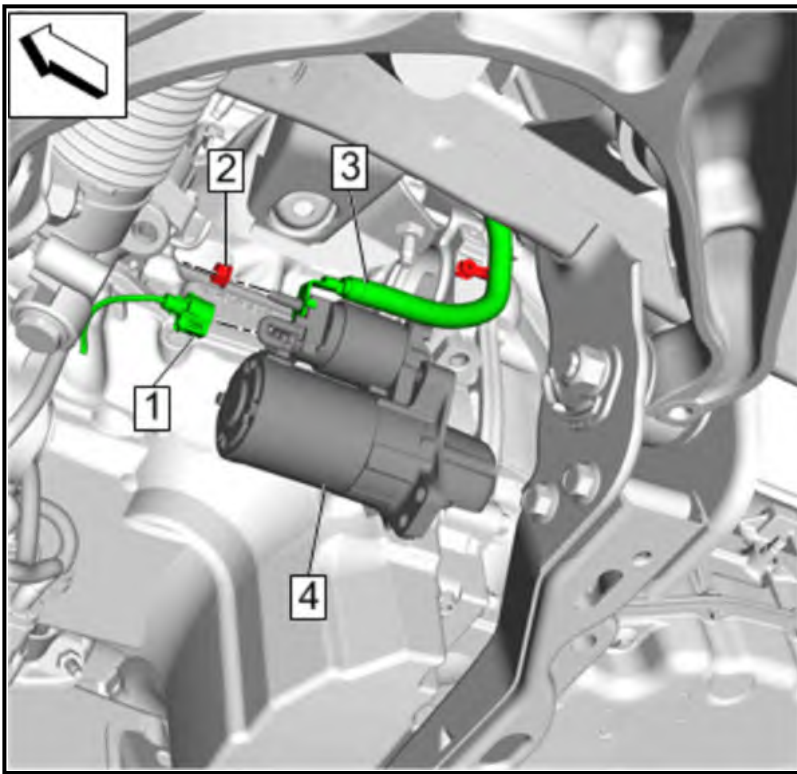
15. Warm Up Three-Way Catalytic Converter - Right Side - Remove - [Warm Up Three-Way Catalytic Converter Replacement \(Right Side, LGZ\)](#) , or [Warm Up Three-Way Catalytic Converter Replacement \(Left Side, LGZ 2WD\)](#)
16. Disconnect the heater inlet hose from the heater core tube. [Heater Inlet Hose Replacement \(LGZ\)](#)
17. Disconnect the heater outlet hose from the heater core tube. [Heater Outlet Hose Replacement \(LGZ Surge Tank to Connection\)](#) , or [Heater Outlet Hose Replacement \(Heater Outlet Hose Connector to Heater Core Tube LGZ\)](#)
18. Coolant Recovery Reservoir Hose (2) @ Water Outlet - Disconnect



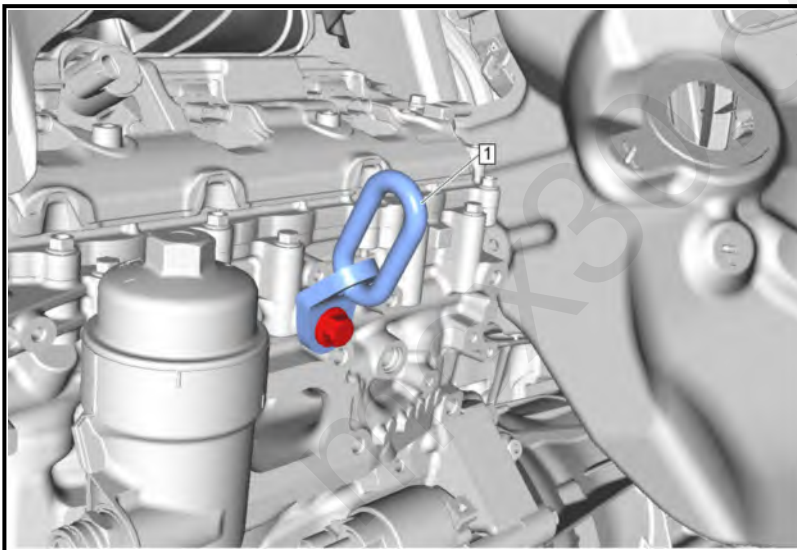
19. Disconnect the heater outlet pipe to surge tank hose. [Heater Outlet Hose Replacement \(LGZ Surge Tank to Connection\)](#) , or [Heater Outlet Hose Replacement \(Heater Outlet Hose Connector to Heater Core Tube LGZ\)](#) , or [Heater Outlet Hose Replacement \(Heater Outlet Hose Connector to Heater Inlet Outlet Pipe LGZ\)](#)
20. Disconnect the fuel feed pipe from the fuel pump. [Metal Collar Quick Connect Fitting Service](#)
21. Disconnect electrical connector from the vacuum booster check valve (1).



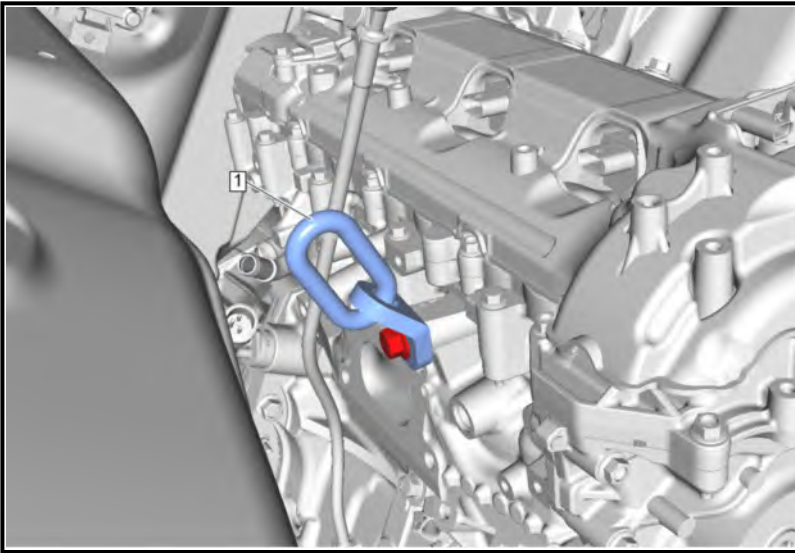
22. Disconnect the vacuum booster check valve (1) from the vacuum booster.
23. Disconnect the A/C lines from the compressor and position the lines aside. [Air Conditioning Compressor Hose Replacement \(LCV\)](#) , or [Air Conditioning Compressor Hose Replacement \(LWN\)](#) , or [Air Conditioning Compressor Hose Replacement \(LGZ\)](#)
24. Starter (4) - Remove - [Starter Replacement \(LGZ\)](#)



25. Using **EN-52059** Engine Support Fixture Adapter Bolt - M10, install **EN-36857** Engine Lift Hook (1) to the left cylinder head as shown.

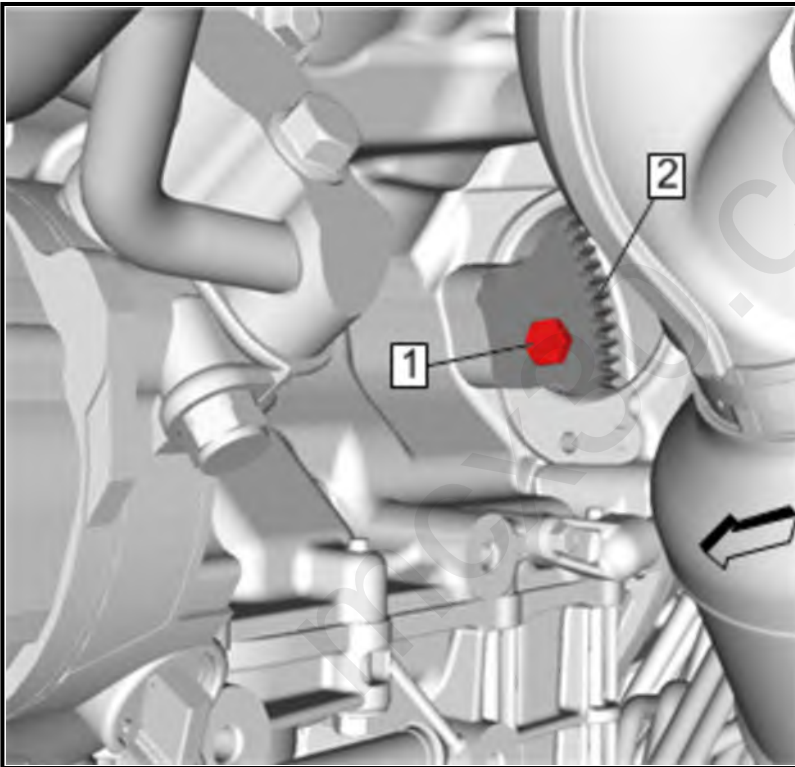


26. Using **EN-52059** Engine Support Fixture Adapter Bolt - M10, install **EN-36857** Engine Lift Hook (1) to the right cylinder head as shown.

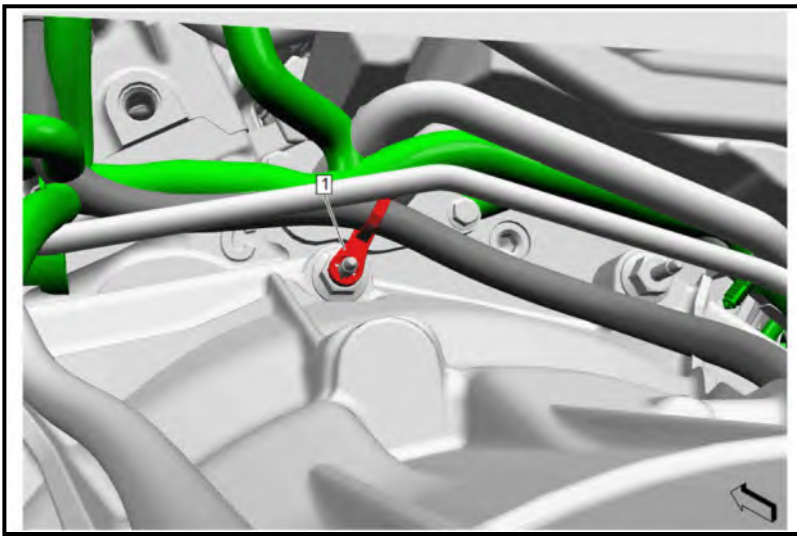


27. Mark the torque converter to flexplate orientation to ensure proper realignment.

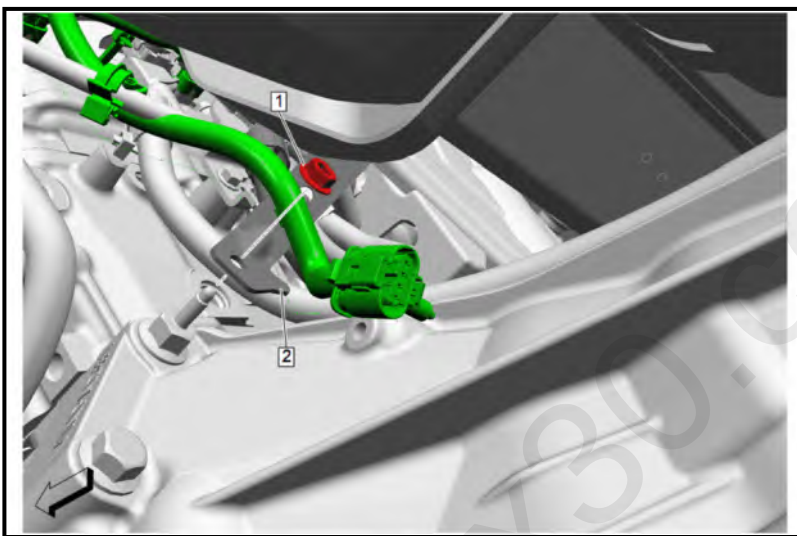
28. Torque Converter Bolt (1) - Remove [6x] - [Transmission Replacement \(2WD\)](#) , or [Transmission Replacement \(4WD\)](#).



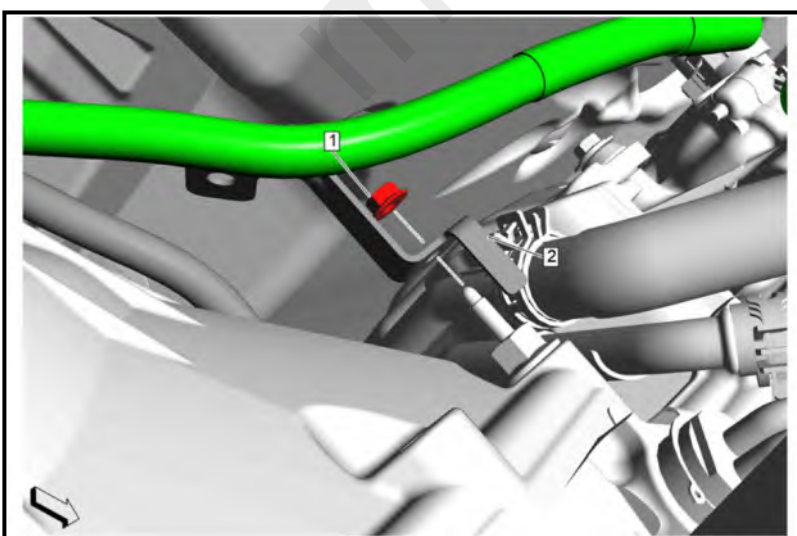
29. Disconnect the transmission vent hose retainer (1) from the transmission to engine bolt.



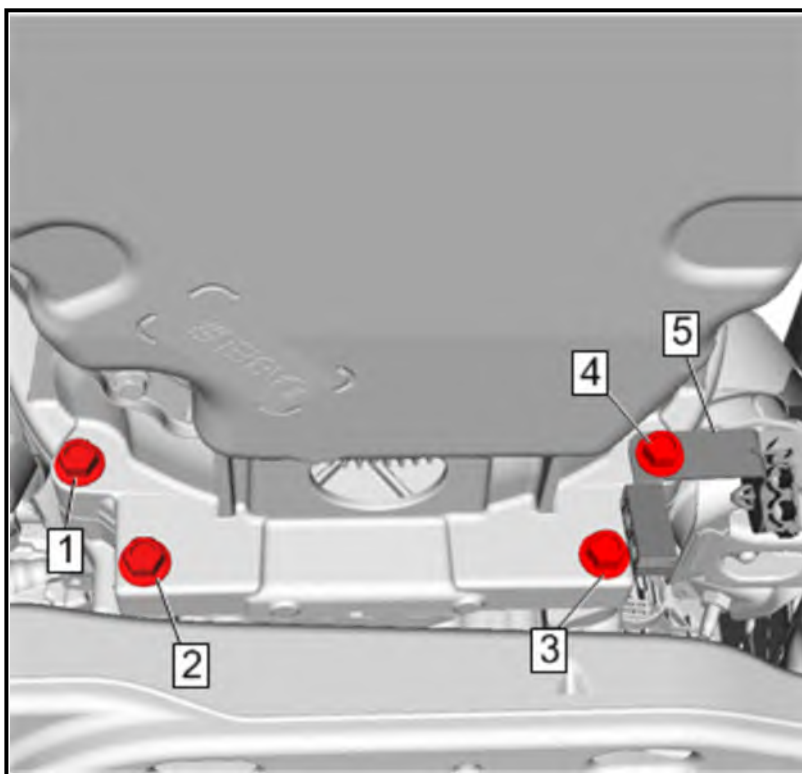
30. Remove the fuel feed and return pipe clip bracket nut (1) from the transmission to engine stud, and reposition the fuel feed and return pipe clip bracket (2).



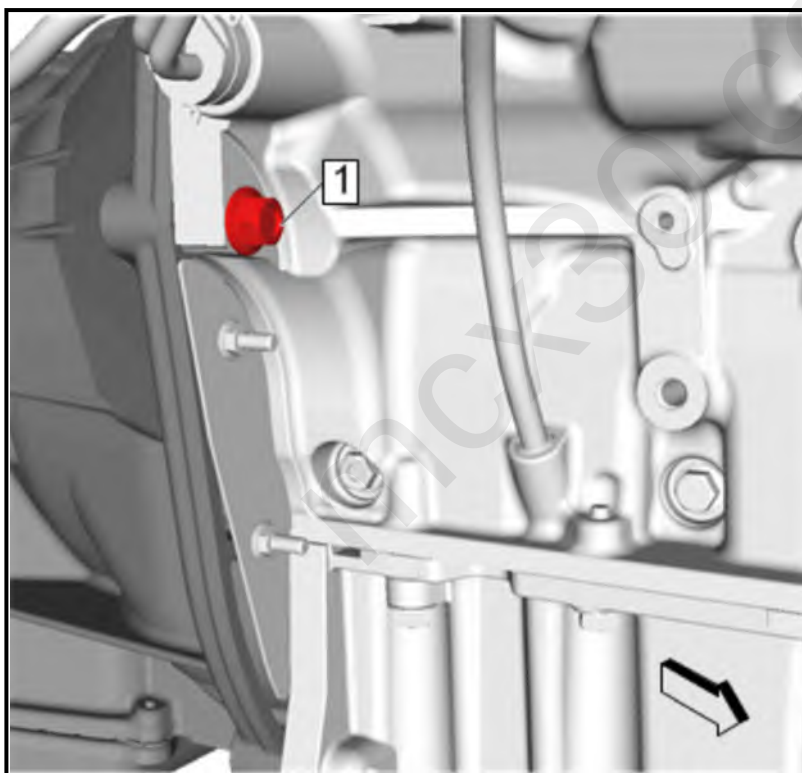
31. Remove the fuel feed and return pipe clip bracket nut (1) from the transmission to engine stud, and reposition the fuel feed and return pipe clip bracket (2).



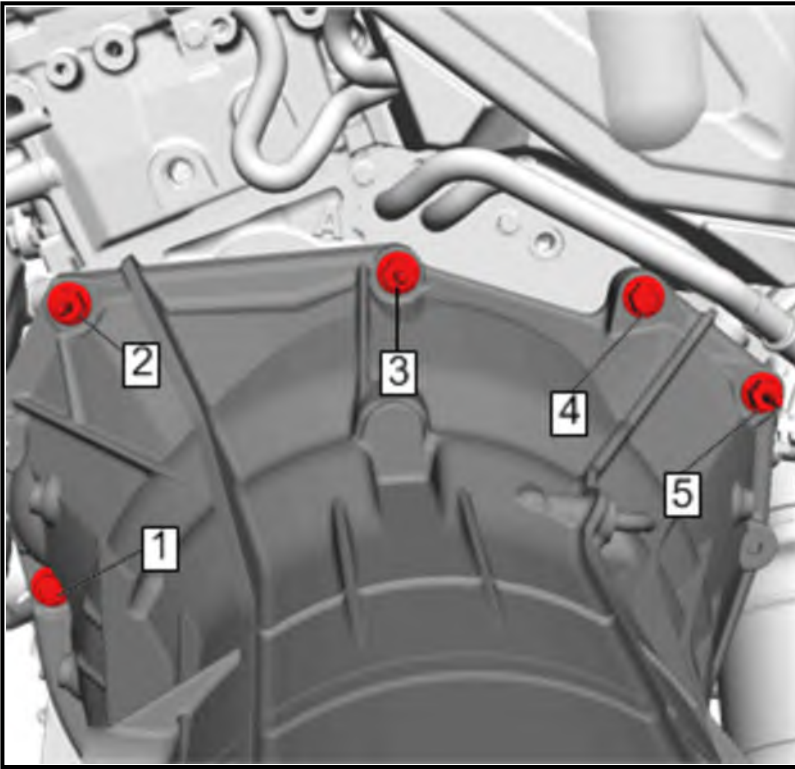
32. Remove the lower transmission to engine bolts (1, 2, 3, 4).



33. Remove the right side engine to transmission bolt (1).



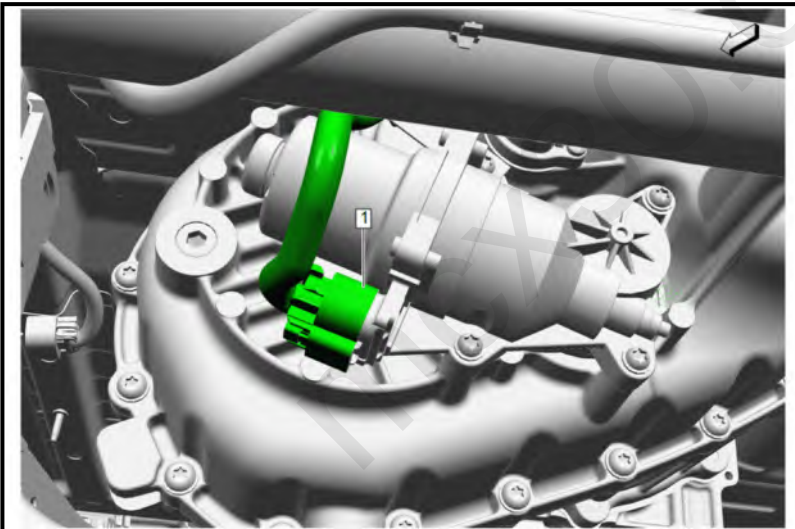
34. Remove the transmission to engine bolts (1, 3, 4).



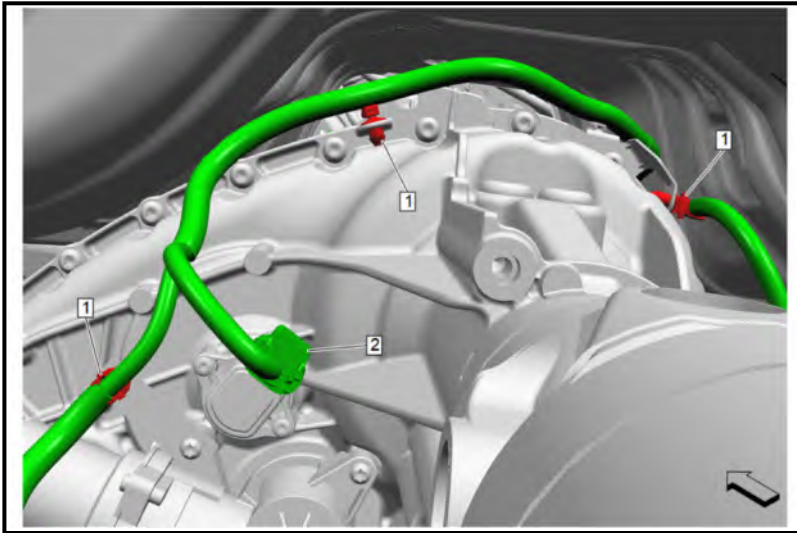
35. Disconnect the 3 electrical wiring harness retainers from the transmission case.

36. Disconnect the main transmission electrical connector.

37. {If equipped} Electrical Connector (1) @ Transfer Case Four Wheel Drive Actuator - Disconnect

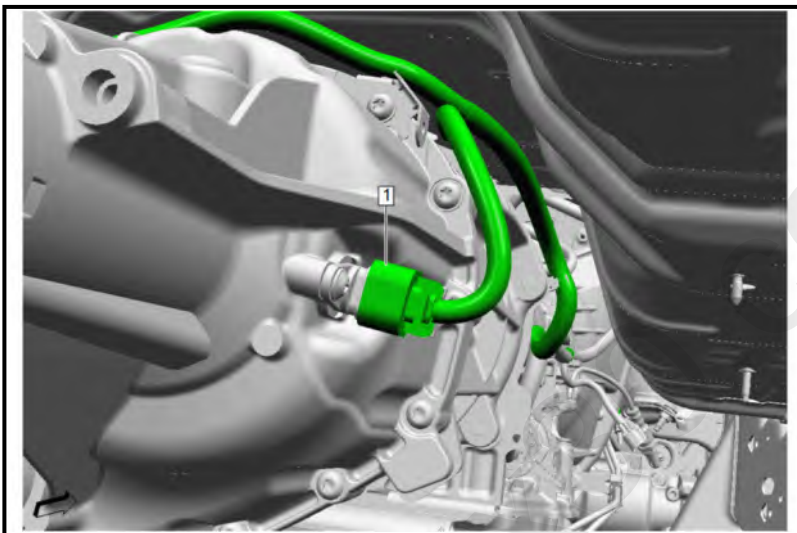


38. {If equipped} Electrical Connector (2) @ Transfer Case Two/Four Wheel Drive Actuator Position Sensor - Disconnect



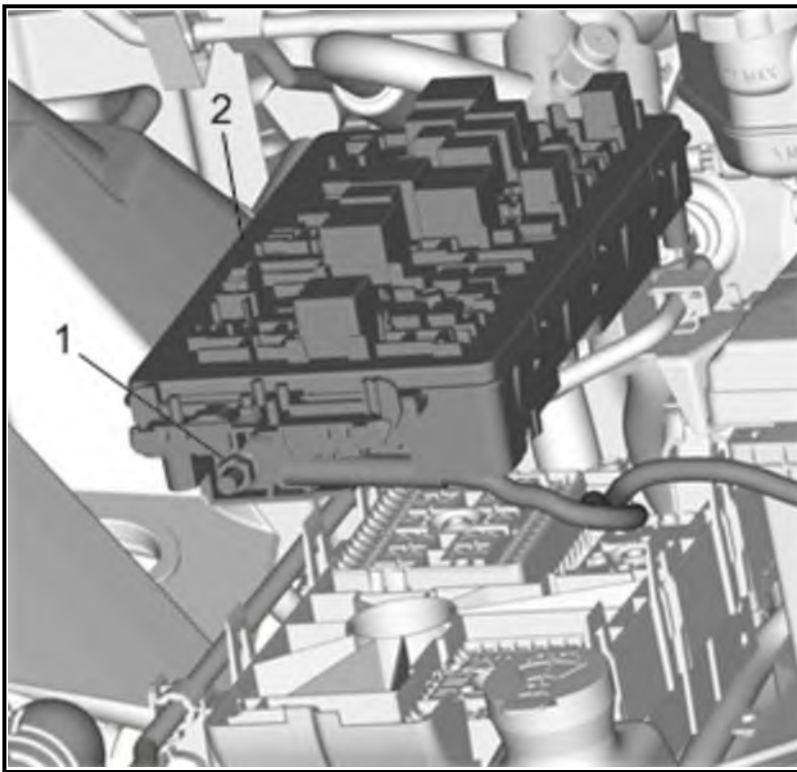
39. {If equipped} Wiring Harness Retainer (1) - Disconnect [3x]

40. Electrical Connector (1) @ Transfer Case Rear Output Shaft Speed Sensor - Disconnect



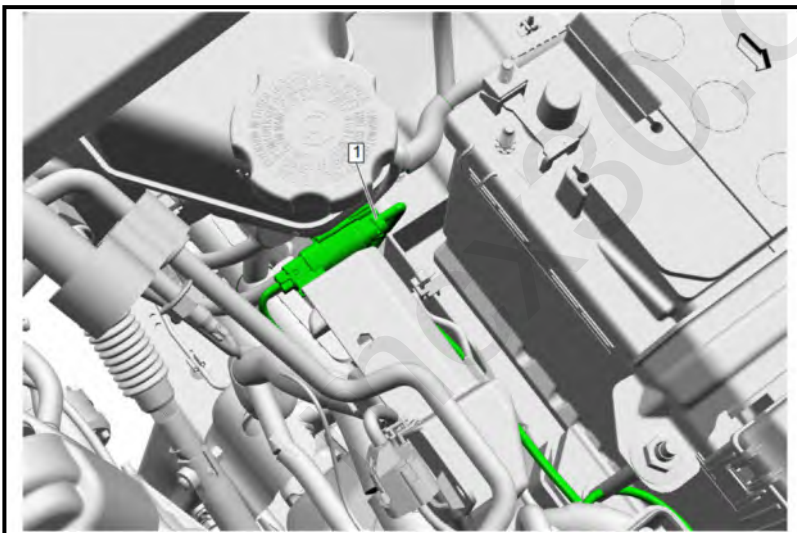
41. Lower Vehicle.

42. Engine Wiring Harness Junction Block - Remove - [Engine Wiring Harness Junction Block Replacement](#)

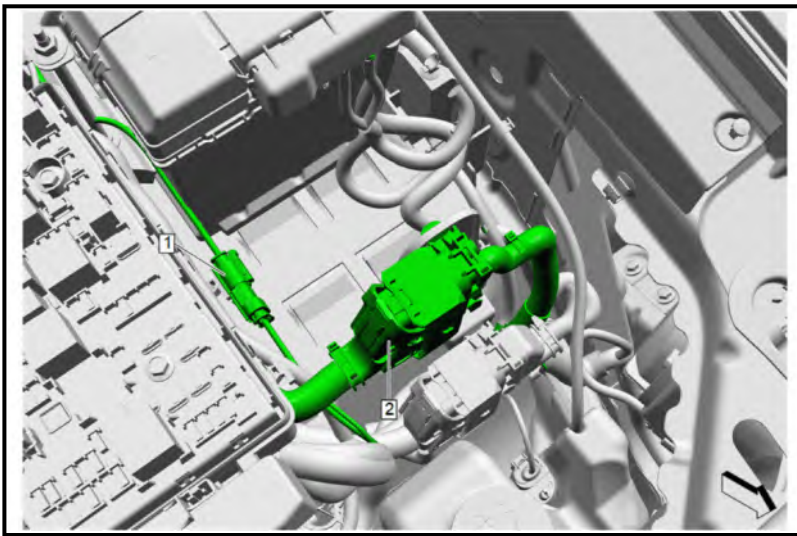


43. Remove the engine wiring harness junction block connector from the engine wiring harness fuse block bracket.

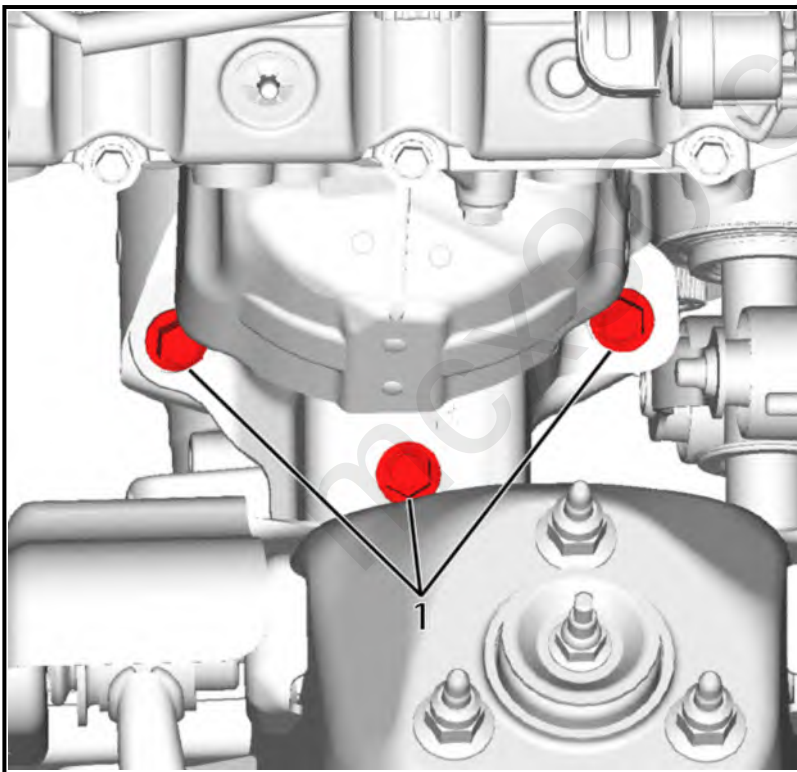
44. Disconnect the electrical connector (1).



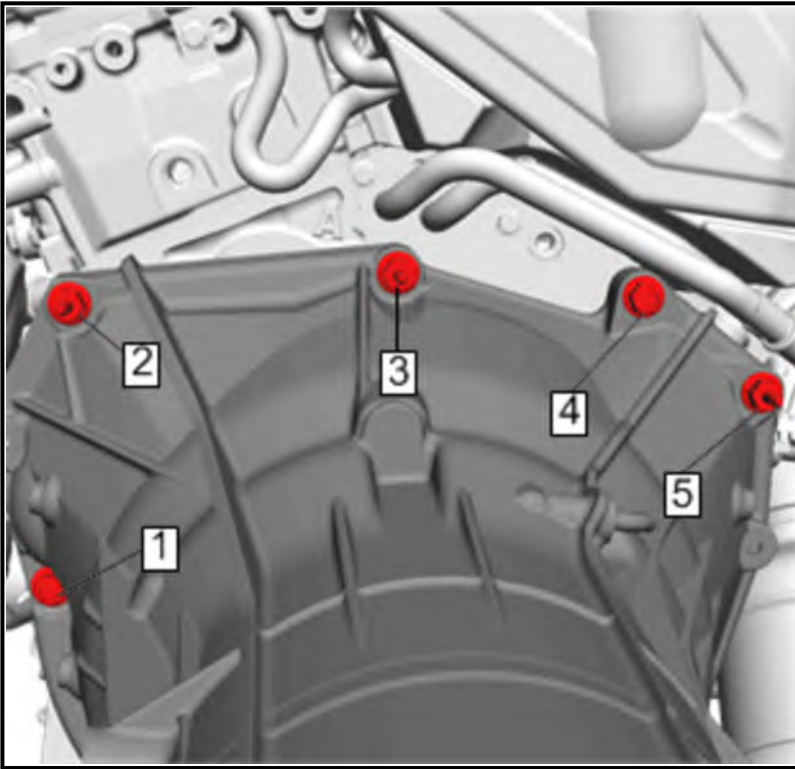
45. Disconnect the electrical connector (1).



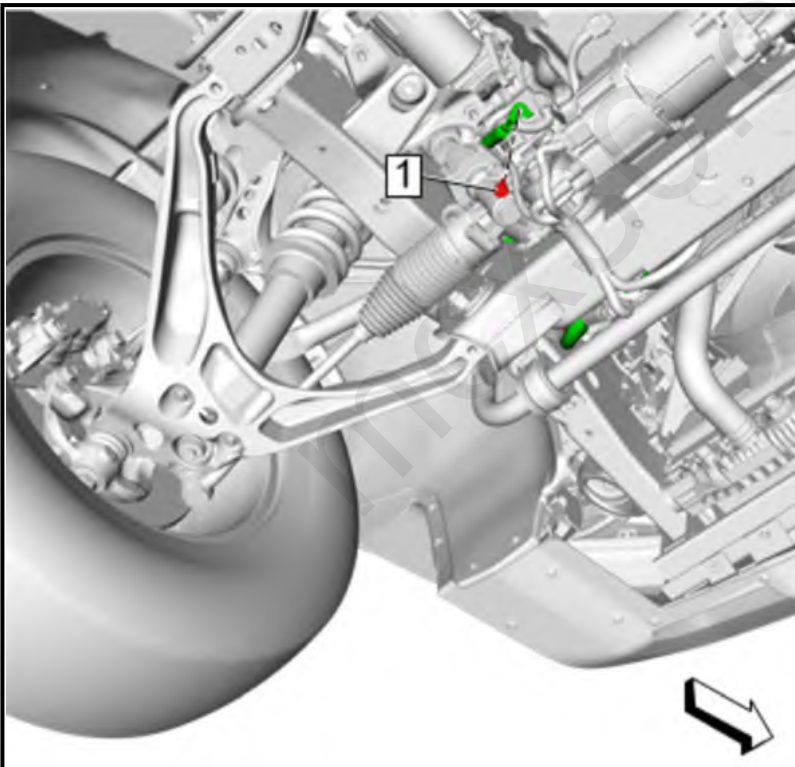
46. Disconnect the electrical connector (2).
47. Disconnect the 3 ECM connectors.
48. Disconnect the connector at the transmission control module.
49. If equipped remove the 4 engine block heater wiring harness retainers.
50. Mass air flow sensor electrical connector and retainer.
51. Remove and DISCARD the right upper engine mount bolts (1).



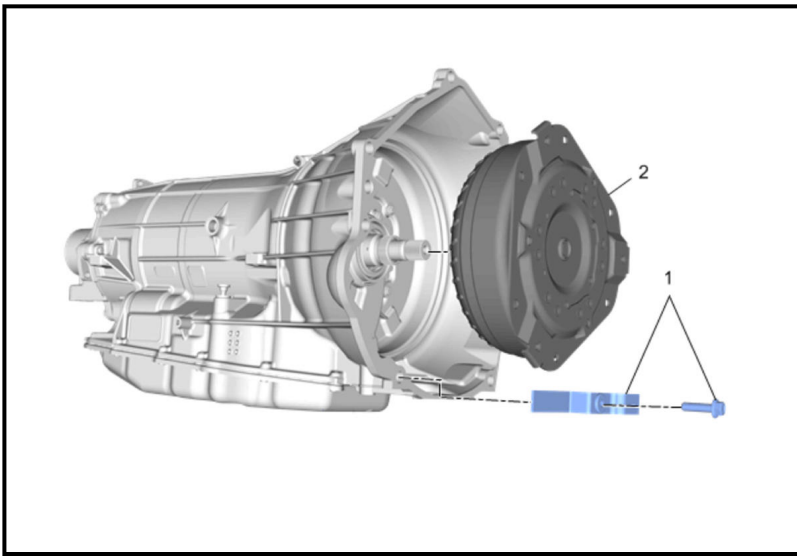
52. Ensure the following items are clear from the frame:
 - Vacuum lines
 - Steering knuckles
 - Electrical wiring harnesses
 - Transmission cooler lines
53. Install engine lift chain.
54. Apply tension to the chain with a lifting device.
55. Support transmission with a floor jack and a suitable piece of wood.
56. Remove the transmission to engine bolts (2, 5).



57. With the aid of an assistant, use a suitable engine lifting device to remove the engine from the vehicle.
58. Engine Wiring Harness Ground Bolt (1) - Remove



59. Battery Negative Cable @ Engine Block - Remove
60. Install the converter holding strap (1) **DT-21366** Converter Holding Strap to the transmission.



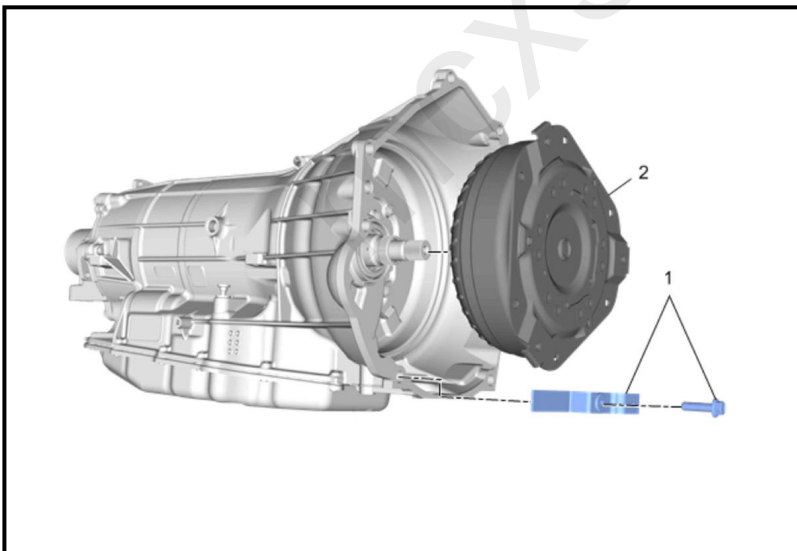
WARNING: The torque converter must be held to the torque converter housing by a retaining device such as shipping brackets. Without the retaining device, the torque converter may slide forward, disengaging the oil pump, or may fall completely out of the transmission causing personal injury and/or property damage.

61. Transfer components as necessary.

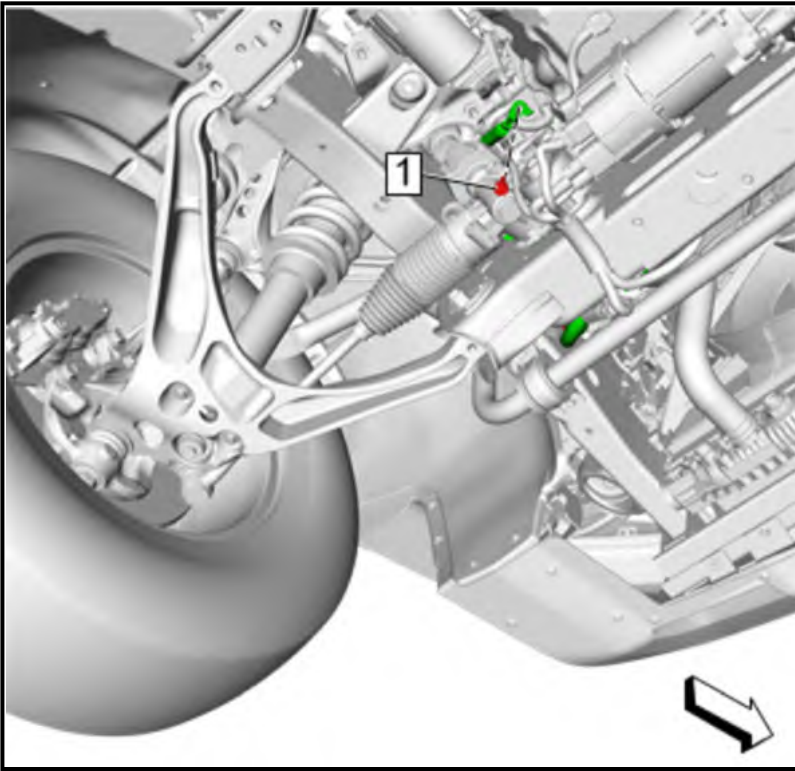
Installation Procedure

NOTE: Prelube is necessary if the engine is replaced or overhauled.

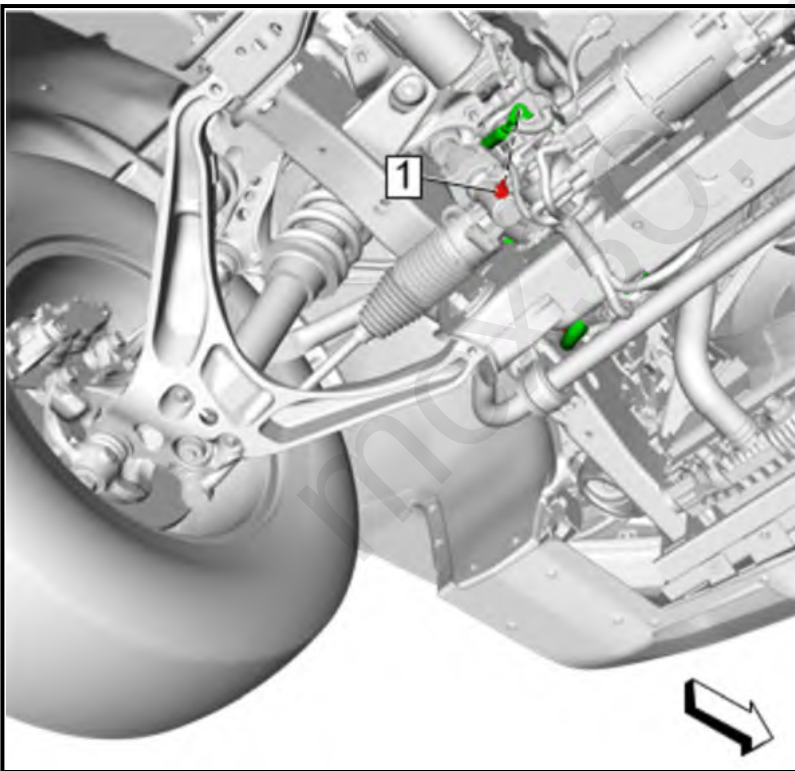
1. If the engine is replaced with a new engine or has been overhauled, perform the engine pre-lube procedure. [Engine Prelubing](#)
2. Remove the converter holding strap (1) **DT-21366** Converter Holding Strap from the transmission.



3. With the aid of an assistant, carefully lower the engine into the vehicle.
4. Battery Negative Cable @ Engine Block - Install



5. Engine Wiring Harness Ground Bolt (1) - Install - [Battery Negative Cable Replacement \(LGZ\)](#).



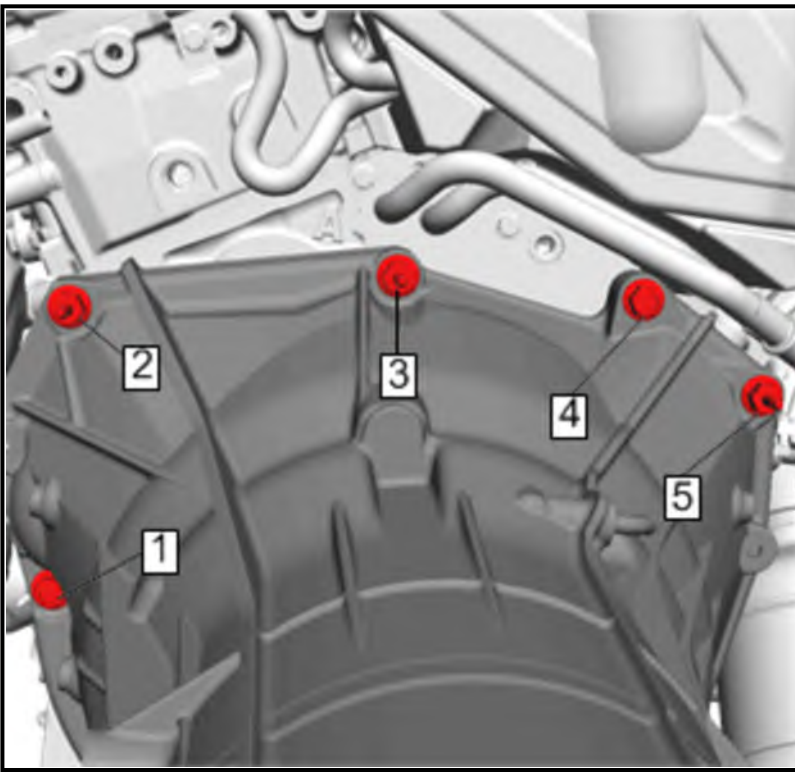
NOTE: Refer to the procedure link for torque specification.

6. Ensure when lowering the engine the following items are clear from the frame:

- Vacuum lines
- Steering knuckles
- Electrical wiring harnesses
- Transmission cooler lines

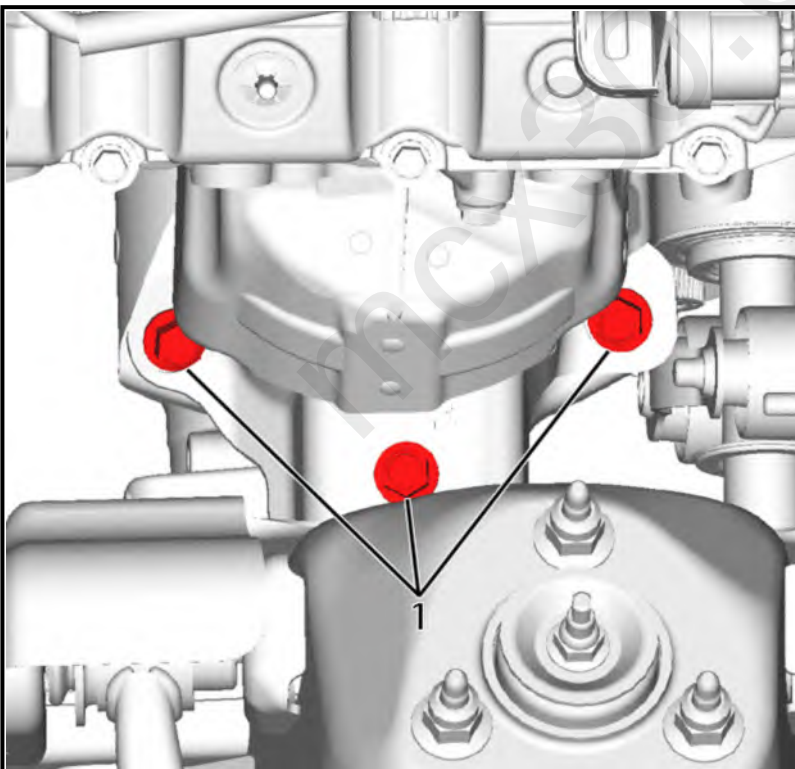
7. Align engine to the transmission dole pins.

8. Install the transmission to engine bolts (2, 5). [Transmission Replacement \(2WD\)](#), or [Transmission Replacement \(4WD\)](#).

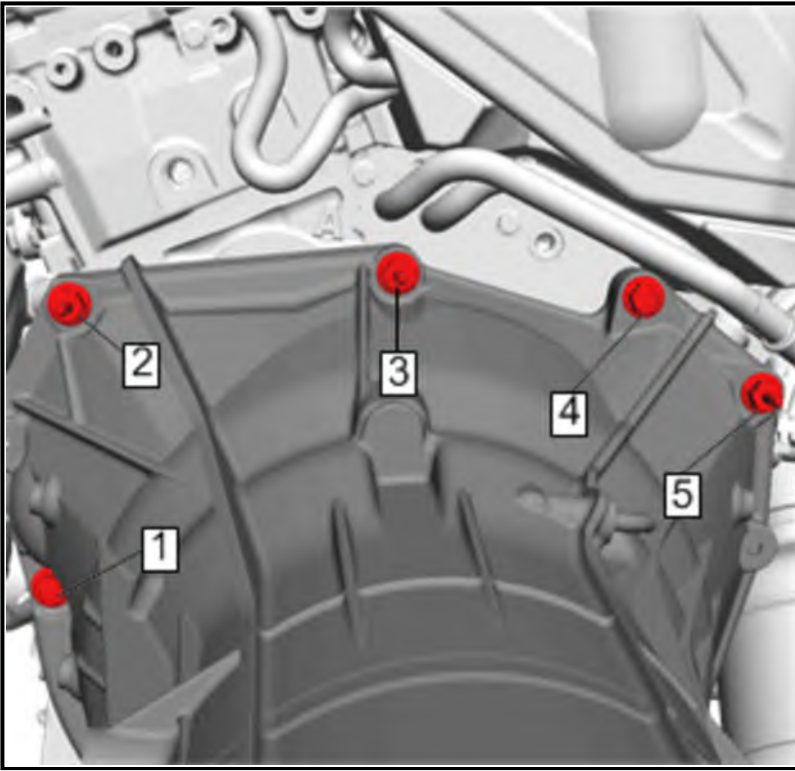


NOTE: Refer to the procedure link for torque specification.

9. Lower engine until the right motor mount holes align with the holes on the frame.
10. Install NEW right upper engine mount bolts (1). [Engine Mount Replacement - Right Side](#)

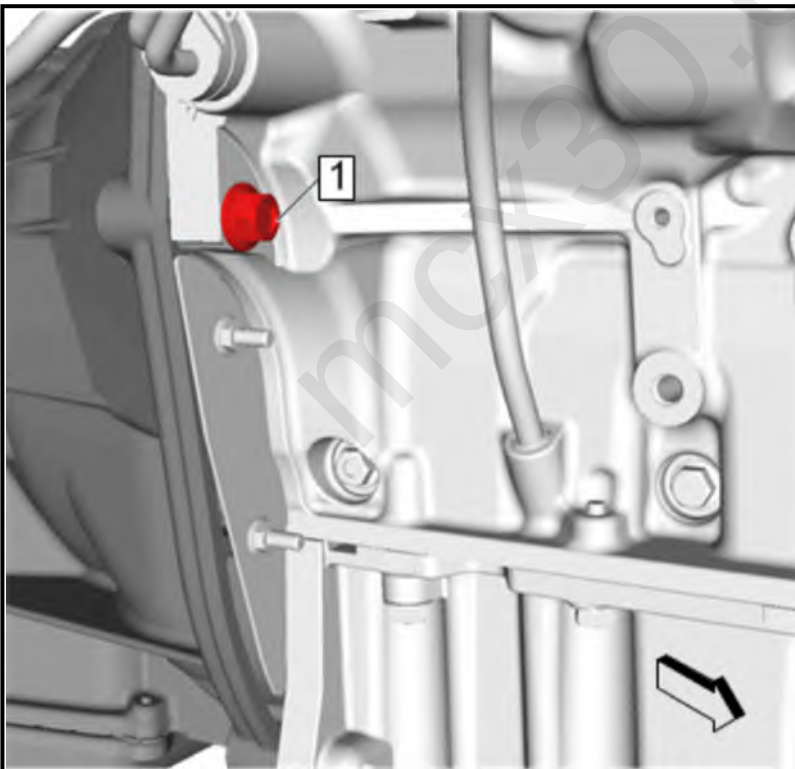


11. Remove the lifting device.
12. Remove lifting chain.
13. Remove the floor jack from the transmission.
14. Install the transmission to engine bolts (1, 3, 4). [Transmission Replacement \(2WD\)](#), or [Transmission Replacement \(4WD\)](#)



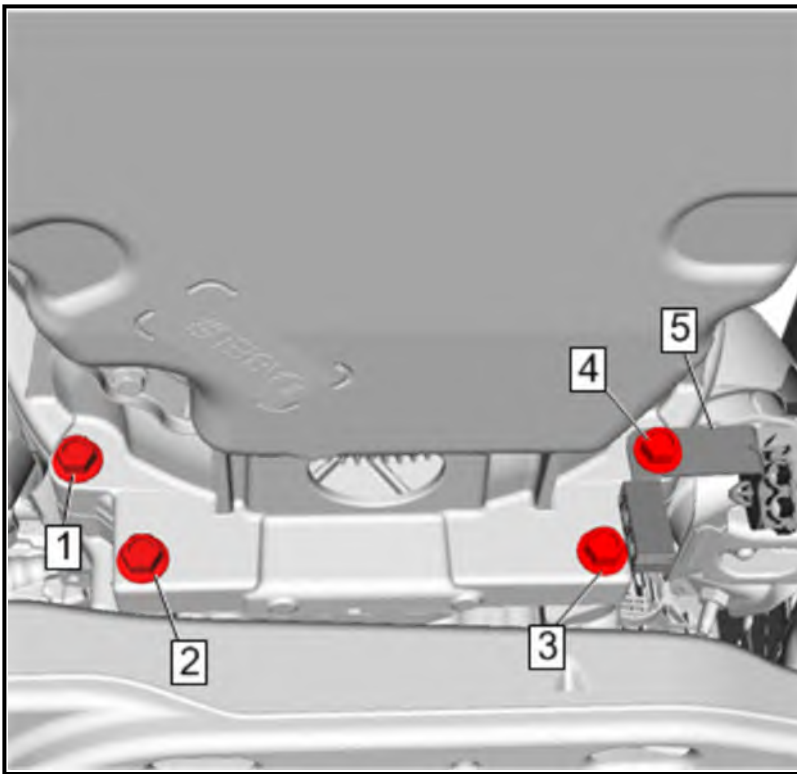
NOTE: Refer to the procedure link for torque specification.

15. Install the right side engine to transmission bolt (1). [Transmission Replacement \(2WD\)](#) , or [Transmission Replacement \(4WD\)](#).



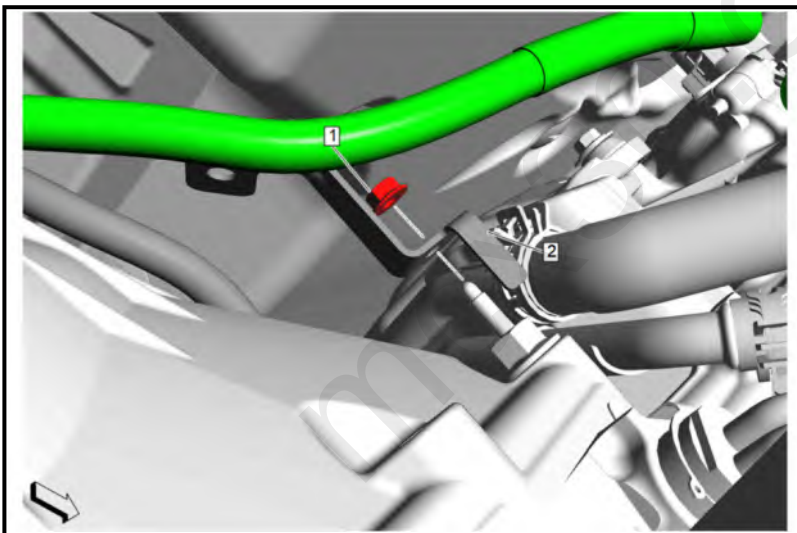
NOTE: Refer to the procedure link for torque specification.

16. Install the lower transmission to engine bolts (1, 2, 3, 4). [Transmission Replacement \(2WD\)](#) , or [Transmission Replacement \(4WD\)](#).

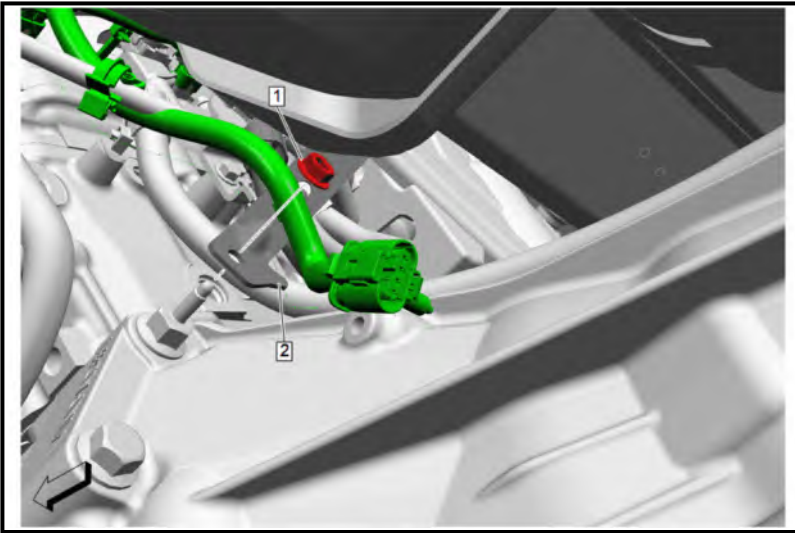


NOTE: Refer to the procedure link for torque specification.

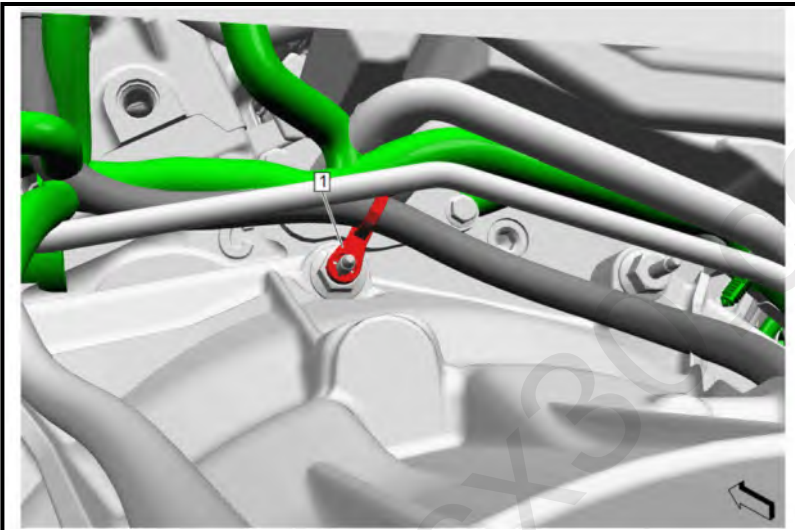
17. Install the fuel feed and return pipe clip bracket (2) to the transmission to engine stud.



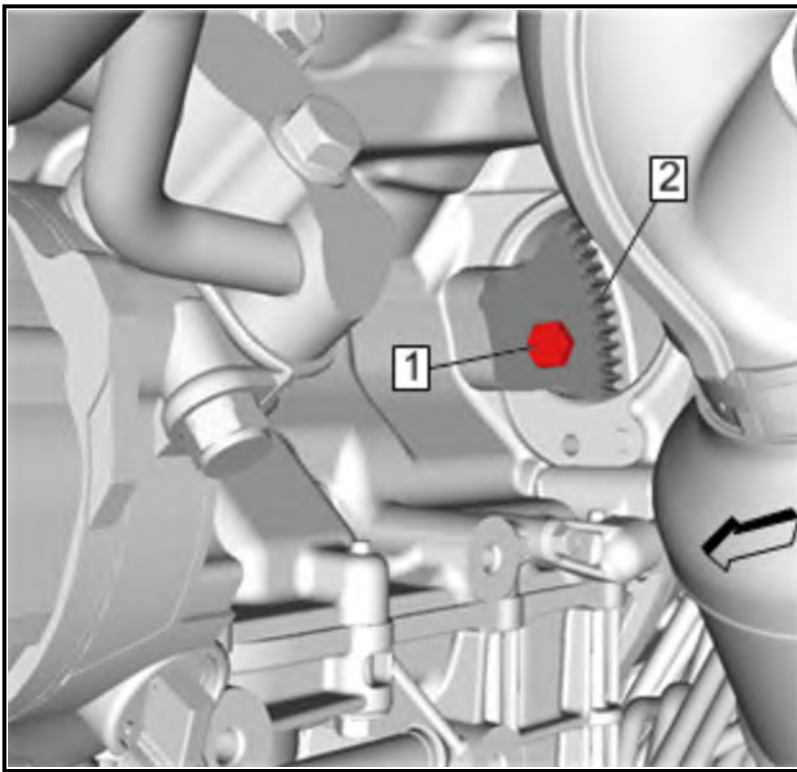
18. Install and tighten the fuel feed and return pipe clip bracket nut (1). [Transmission Replacement \(2WD\)](#) , or [Transmission Replacement \(4WD\)](#).
19. Install the fuel feed and return pipe clip bracket (2) from the transmission to engine stud.



20. Install and tighten the fuel feed and return pipe clip bracket nut (1). [Transmission Replacement \(2WD\)](#) , or [Transmission Replacement \(4WD\)](#).
21. Connect the transmission vent hose retainer (1) to the transmission to engine bolt.

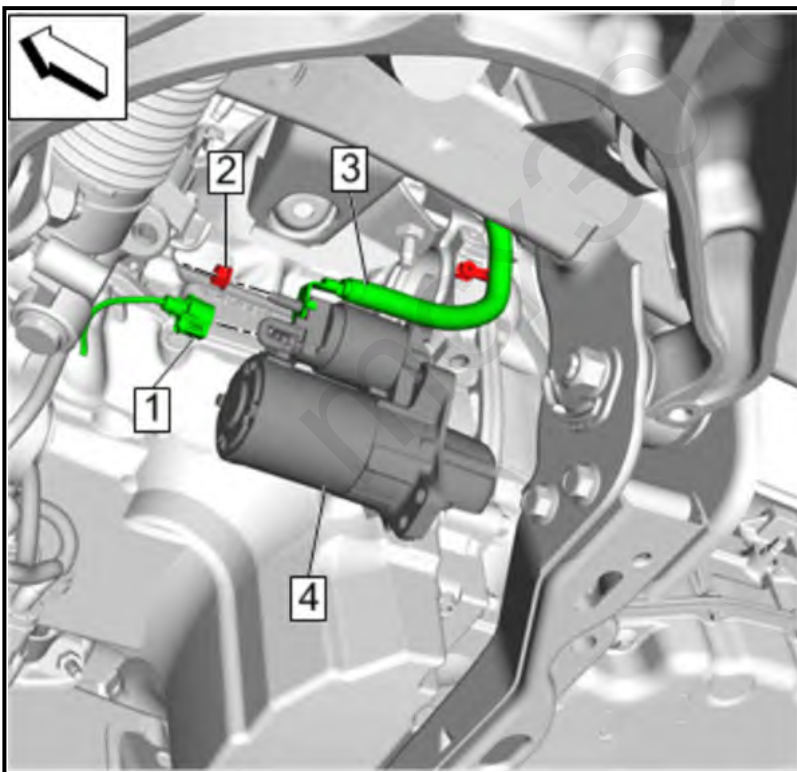


22. Torque Converter Bolt (1) - Install [6x] - [Transmission Replacement \(2WD\)](#) , or [Transmission Replacement \(4WD\)](#).

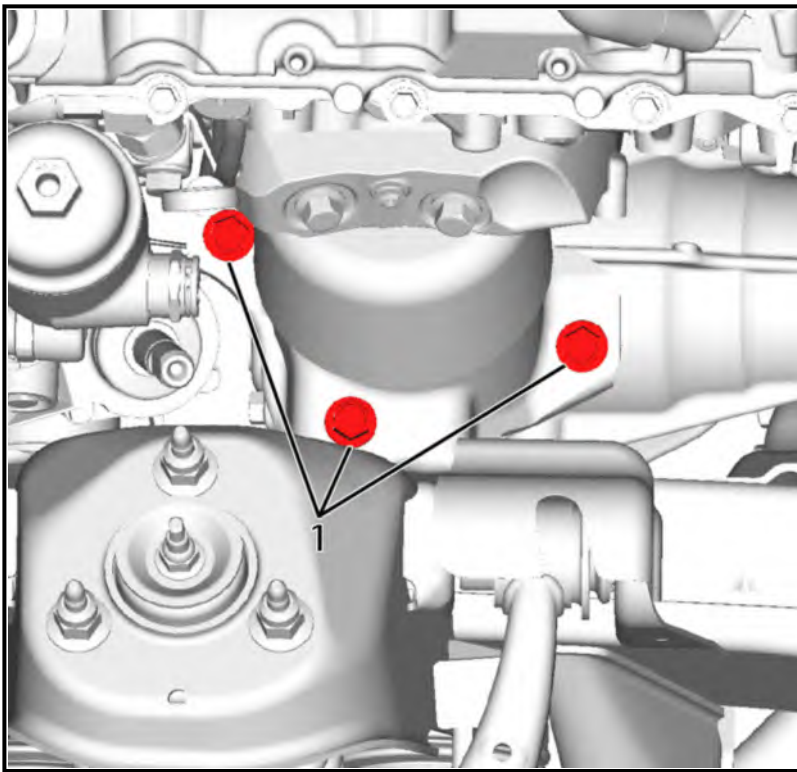


NOTE: Refer to the procedure link for torque specification.

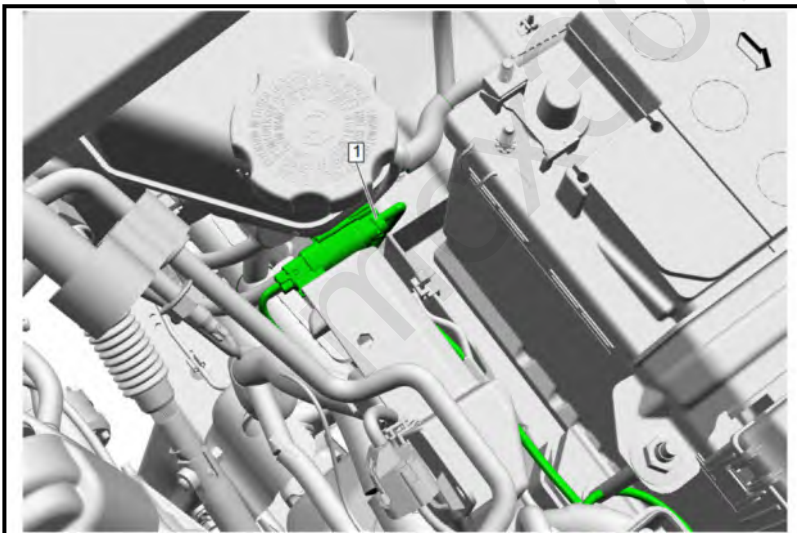
23. Starter (4) - Install - [Starter Replacement \(LGZ\)](#).



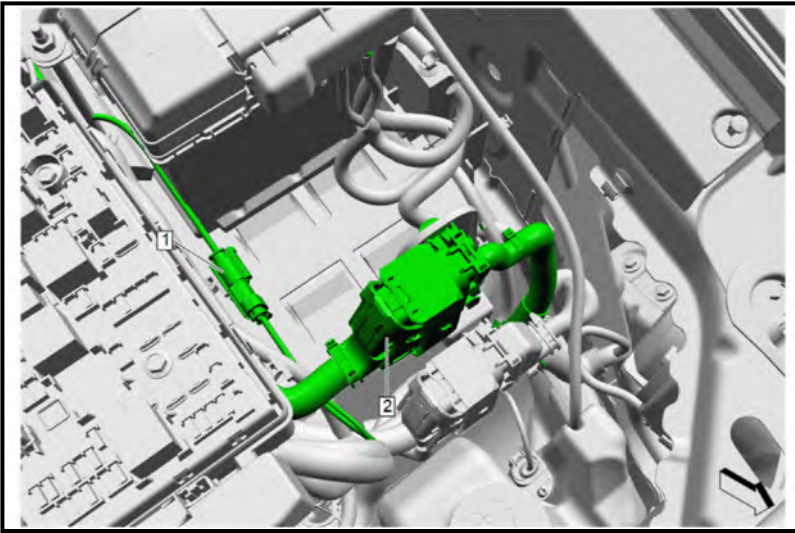
24. Install NEW left upper engine mount bolts (1). [Engine Mount Replacement - Left Side](#)



25. Connect mass air flow sensor electrical connector and retainer.
26. If equipped install the 4 engine block heater wiring harness retainers.
27. Connect the connector at the transmission control module.
28. Connect the 3 ECM connectors.
29. Connect the electrical connector (2).

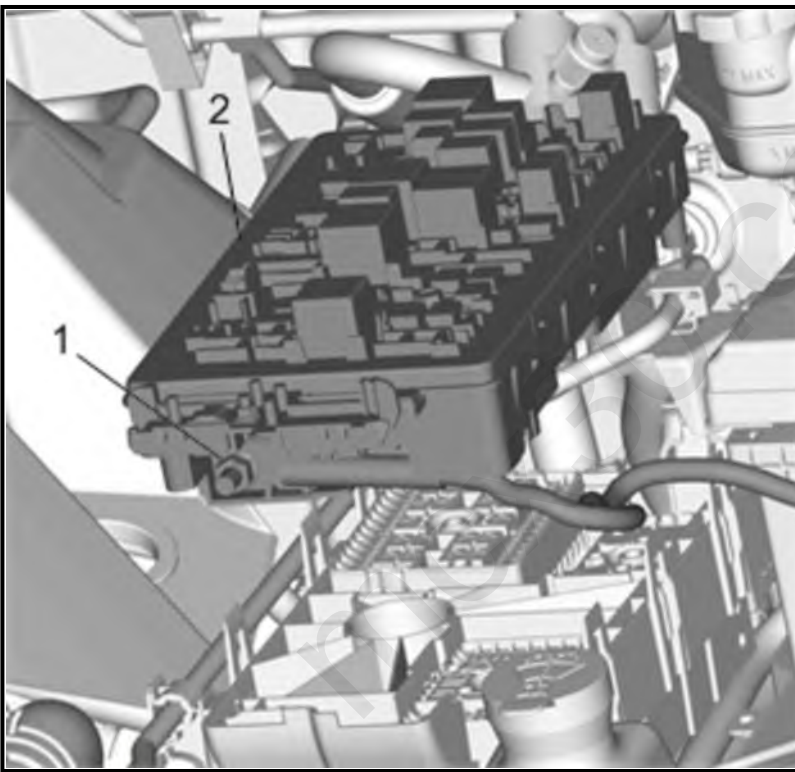


30. Connect the electrical connector (1).
31. Connect the electrical connector (1).

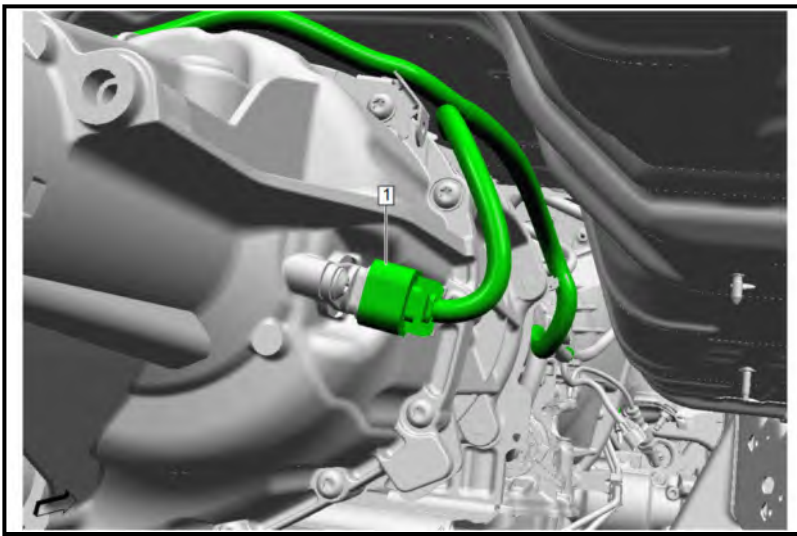


32. Install the engine wiring harness junction block connector to the engine wiring harness fuse block bracket.

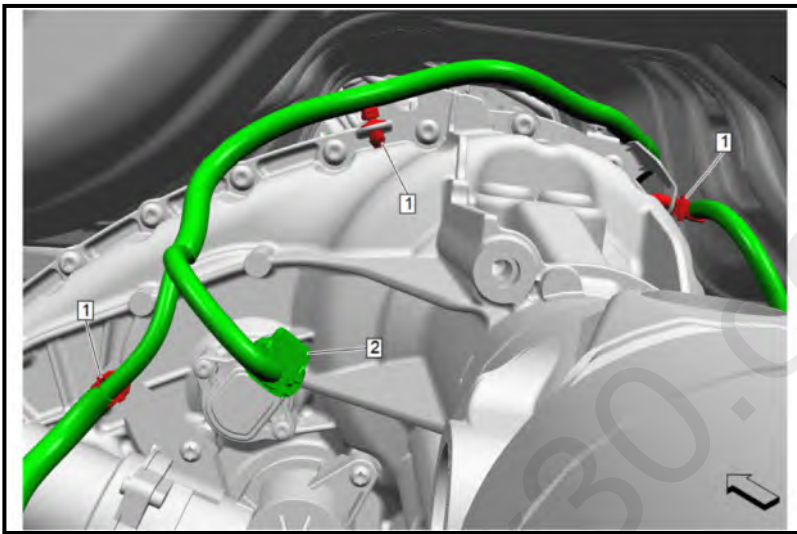
33. Engine Wiring Harness Junction Block - Install - [Engine Wiring Harness Junction Block Replacement](#)



34. Electrical Connector (1) @ Transfer Case Rear Output Shaft Speed Sensor - Connect

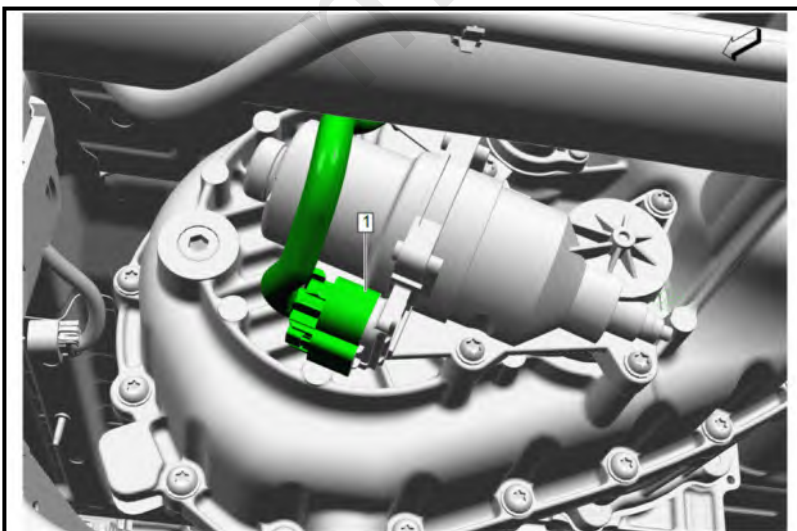


35. {If equipped} Wiring Harness Retainer (1) - Connect [3x]



36. {If equipped} Electrical Connector (2) @ Transfer Case Two/Four Wheel Drive Actuator Position Sensor - Connect

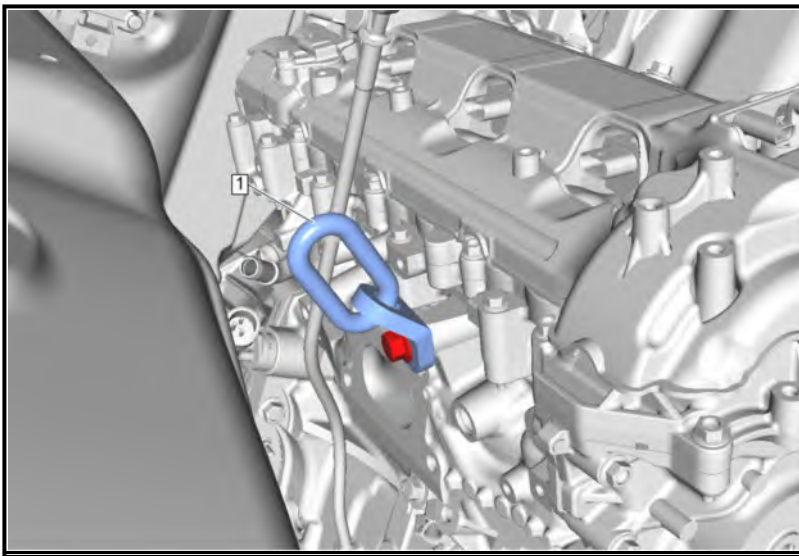
37. {If equipped} Electrical Connector (1) @ Transfer Case Four Wheel Drive Actuator - Connect



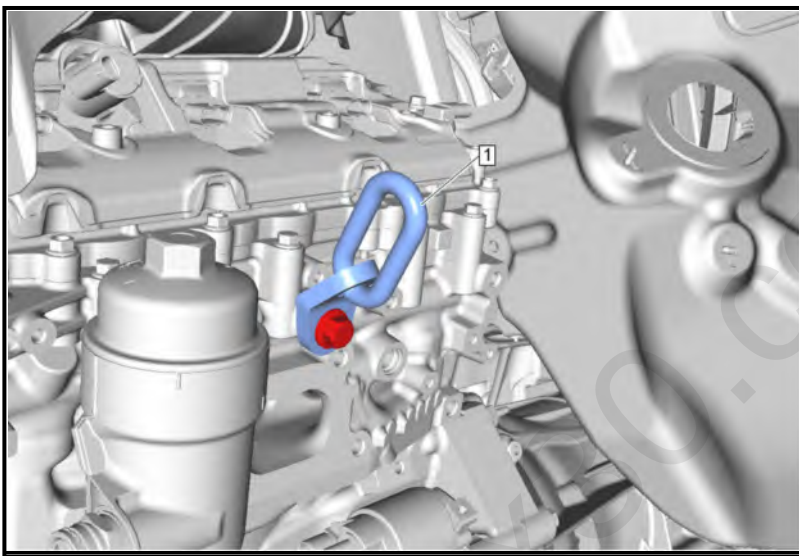
38. Connect the electrical wiring harness retainers from the transmission case.

39. Connect the main transmission electrical connector.

40. Remove **EN-36857** Engine Lift Hook (1) to the right cylinder head heavy duty bolt.

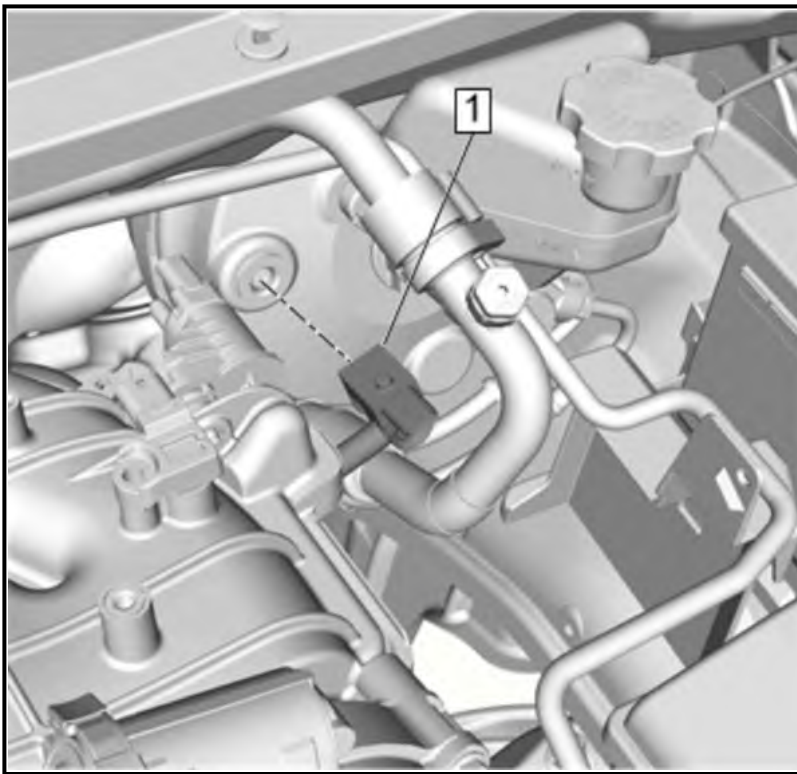


41. Remove **EN-36857** Engine Lift Hook (1) to the left cylinder head heavy duty bolt.

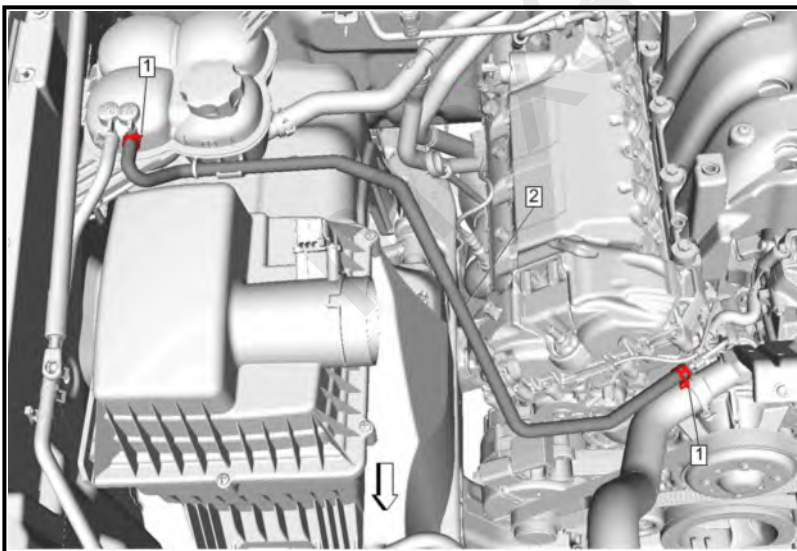


42. Connect the A/C lines to the compressor. [**Air Conditioning Compressor Hose Replacement \(LGZ\)**](#)

43. Connect the vacuum booster check valve (1) to the vacuum booster.

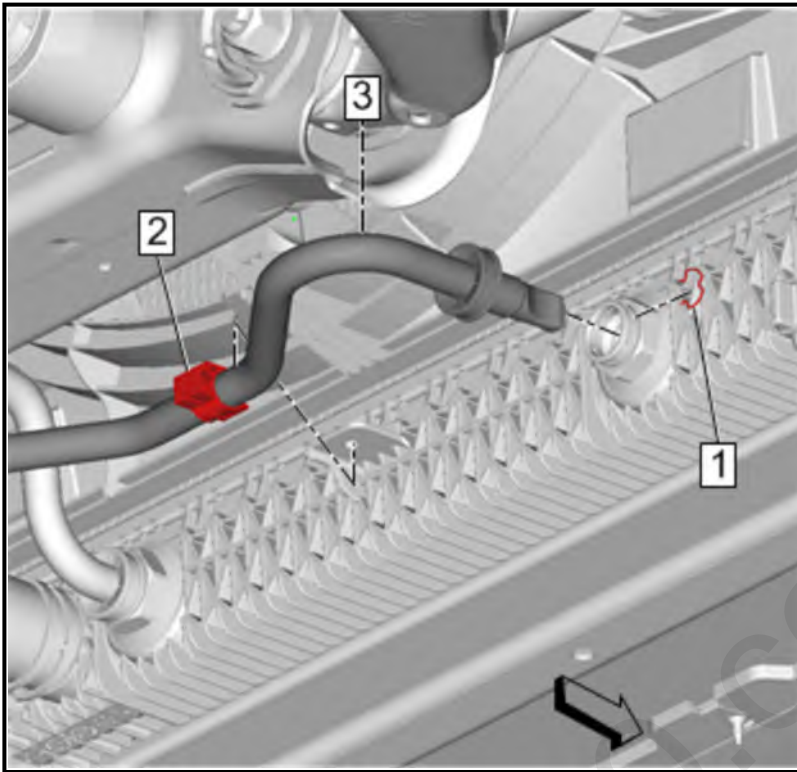


44. Connect the electrical connector the vacuum booster check valve.
45. Connect the fuel feed pipe to the fuel pump. [Metal Collar Quick Connect Fitting Service](#)
46. Connect the heater outlet pipe to surge tank hose. [Heater Outlet Hose Replacement \(LGZ Surge Tank to Connection\)](#) , or [Heater Outlet Hose Replacement \(Heater Outlet Hose Connector to Heater Core Tube LGZ\)](#) , or [Heater Outlet Hose Replacement \(Heater Outlet Hose Connector to Heater Inlet Outlet Pipe LGZ\)](#)
47. Coolant Recovery Reservoir Hose (2) @ Water Outlet - Connect

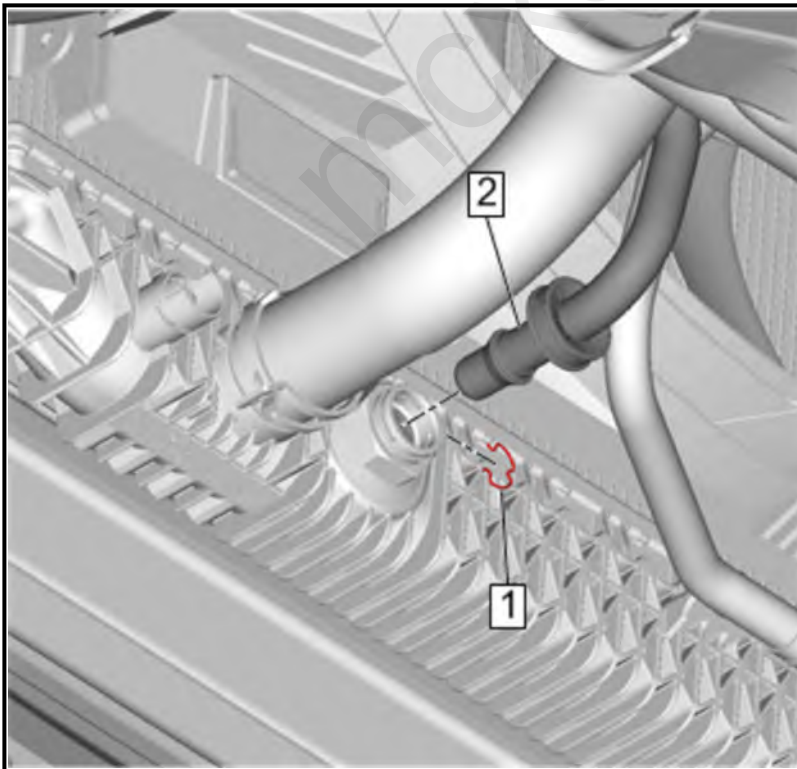


48. Connect the heater outlet hose to the heater core tube. [Heater Outlet Hose Replacement \(LGZ Surge Tank to Connection\)](#) , or [Heater Outlet Hose Replacement \(Heater Outlet Hose Connector to Heater Core Tube LGZ\)](#) , or [Heater Outlet Hose Replacement \(Heater Outlet Hose Connector to Heater Inlet Outlet Pipe LGZ\)](#)
49. Connect the heater inlet hose to the heater core tube. [Heater Inlet Hose Replacement \(LGZ\)](#)
50. Warm Up Three-Way Catalytic Converter - Left Side - Install - [Warm Up Three-Way Catalytic Converter Replacement \(Right Side, LGZ\)](#) , or [Warm Up Three-Way Catalytic Converter Replacement \(Left Side, LGZ 2WD\)](#) , or [Warm Up Three-Way Catalytic Converter Replacement \(Left Side, LGZ 4WD\)](#)

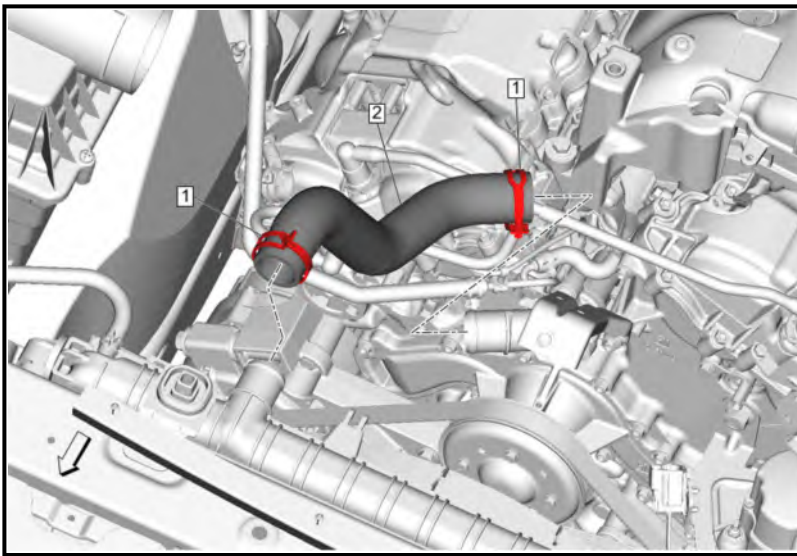
51. Warm Up Three-Way Catalytic Converter - Right Side - Install - [Warm Up Three-Way Catalytic Converter Replacement \(Right Side, LGZ\)](#) , or [Warm Up Three-Way Catalytic Converter Replacement \(Left Side, LGZ 2WD\)](#) , or [Warm Up Three-Way Catalytic Converter Replacement \(Left Side, LGZ 4WD\)](#)
52. Engine Oil Cooler Outlet Pipe (3) @ Radiator Connect - [Engine Oil Cooler Outlet Pipe Replacement \(LGZ\)](#)



53. Engine Oil Cooler Inlet Pipe (2) @ Radiator Connect - [Engine Oil Cooler Inlet Pipe Replacement \(LGZ, 2WD\)](#) , or [Engine Oil Cooler Inlet Pipe Replacement \(LGZ, 4WD\)](#)

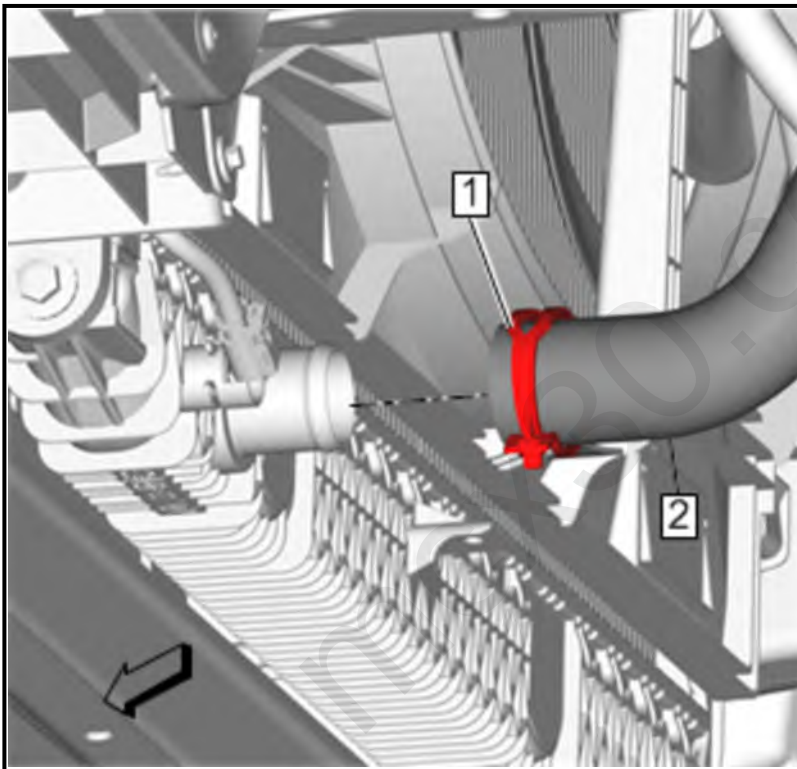


54. Radiator Inlet Hose (2) - Install - [Radiator Inlet Hose Replacement \(LGZ\)](#)

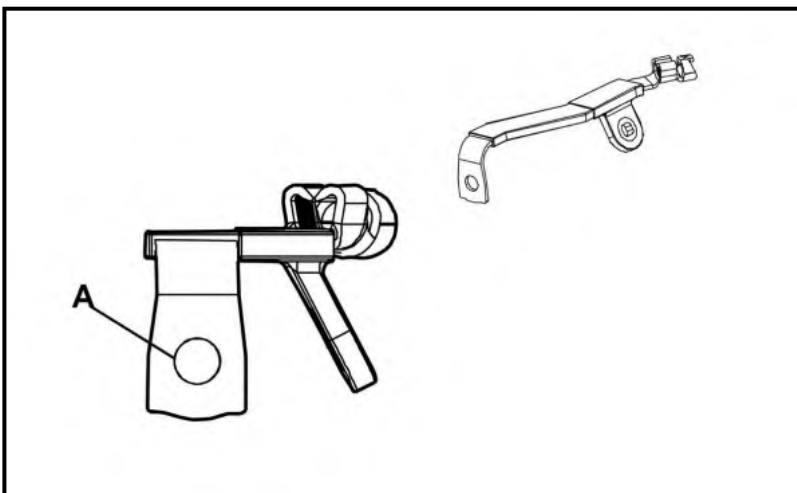


55. Intake Manifold - Install - [Intake Manifold Replacement](#)

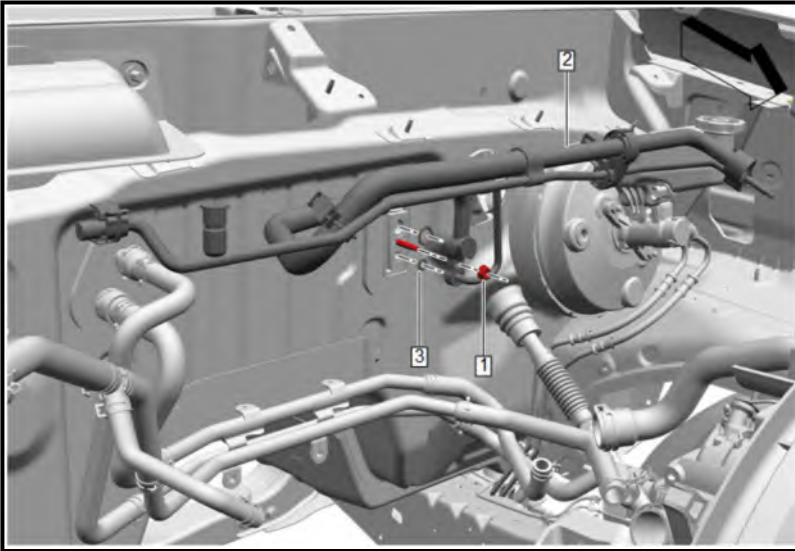
56. Radiator Outlet Hose (2) @ Radiator - Install - [Radiator Outlet Hose Replacement \(LGZ\)](#)



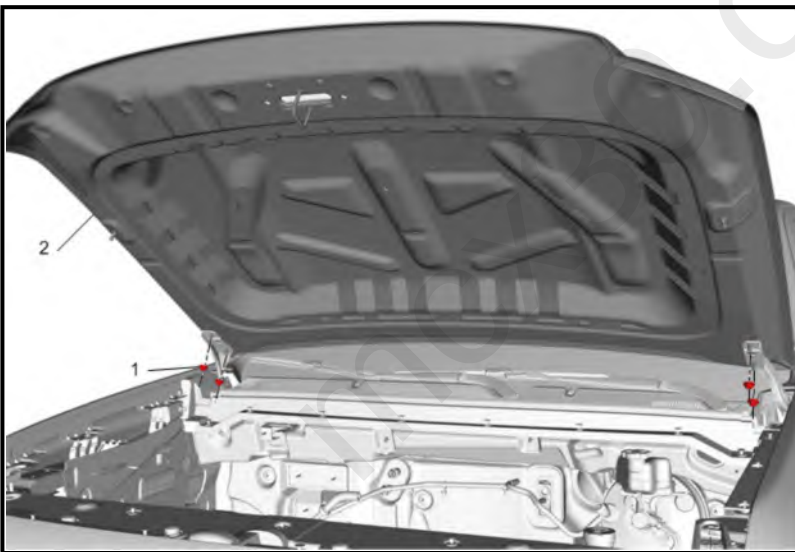
57. Generator (3) - Install - [Generator Replacement \(LGZ\)](#)



58. Air Conditioning Evaporator Hose Assembly (3) - Install - [Air Conditioning Evaporator Hose Replacement \(LGZ\)](#)



59. Fill the cooling system. [Cooling System Draining and Filling \(Static Fill\)](#) , or [Cooling System Draining and Filling \(Vac n Fill\)](#)
60. Charge the A/C system. [Refrigerant Recovery and Recharging \(R-1234yf\)](#)
61. Connect the negative battery cable. [Battery Negative Cable Disconnection and Connection](#)
62. Hood (2) - Install - [Hood Replacement](#)



63. Fill the crankcase with the proper quantity and grade of engine oil. [Approximate Fluid Capacities](#) , and [Fluid and Lubricant Recommendations](#)
64. Disable the fuel system.
65. Crank the engine several times. Listen for any unusual noises or evidence that parts are binding.
66. Enable the fuel system.
67. Start the engine and run the engine speed at about 1, 000 RPM until the engine has reached normal operating temperature.
68. Check the vehicle oil pressure gauge and confirm that the engine has acceptable oil pressure.

If necessary, install an oil pressure gauge and measure the engine oil pressure.

69. Listen for sticking lifters and other unusual noises.
70. Inspect for fuel, oil, and/or other coolant leaks while the engine is running.
71. Install the front wheel and tire assemblies. [Tire and Wheel Removal and Installation](#)

72. Perform a final inspection for the proper engine oil and coolant levels.

73. Perform the throttle body idle air flow compensation reset procedure. [Throttle Body Idle Air Flow Compensation Reset](#)

74. Perform the crankshaft position variation learn. [Crankshaft Position Variation Learn](#)

ENGINE BLOCK OVERHAUL

Special Tools

- EN - 8087 Cylinder Bore Gauge
- EN - 28410 Gasket Remover

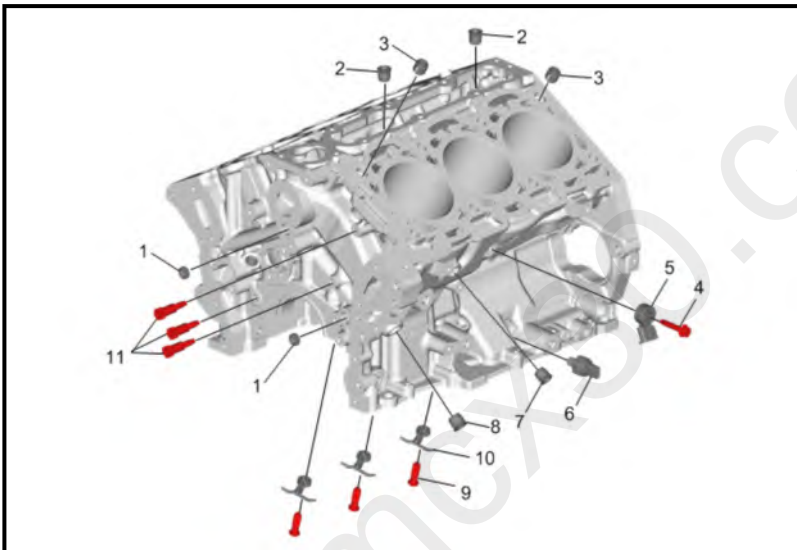
Equivalent regional tools: [Special Tools](#)

Removal Procedure

Remove the engine. [Engine Replacement](#)

Disassemble Procedure

1. Engine Block Oil Gallery Plug Cap (1) - Remove [2x]



2. Engine Block Oil Gallery PlugM16 (2) - Remove [2x]

3. Cylinder Head Locating Pin (3) - Remove [2x]

4. Knock Sensor Bolt (4) - Remove

5. Knock Sensor (5) - Remove

6. Engine Oil Pressure Sensor (6) - Remove

7. Engine Block Core Hole Plug (7) - Remove

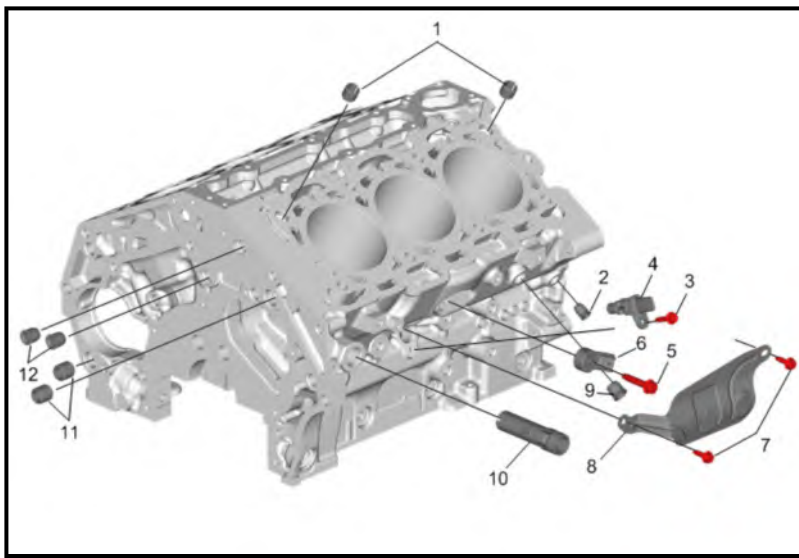
8. Engine Block Oil Gallery PlugM16 (8) - Remove

9. Piston Oil Nozzle Bolt (9) - Remove [3x]

10. Piston Oil Nozzle (10) - Remove [3x]

11. Engine Front Cover Stud (11) - Remove [3x]

12. Cylinder Head Locating Pin (1) - Remove [2x]



13. Engine Block Core Hole Plug (2) - Remove
14. Crankshaft Position Sensor Bolt (3) - Remove
15. Crankshaft Position Sensor (4) - Remove
16. Knock Sensor Bolt (5) - Remove
17. Knock Sensor (6) - Remove
18. Knock Sensor Heat Shield Bolt (7) - Remove [2x]
19. Knock Sensor Heat Shield (8) - Remove
20. Engine Block Oil Gallery PlugM16 (9) - Remove
21. Engine Coolant Temperature Sensor (10) - Remove
22. Crankshaft Rear Oil Seal Housing Locating Pin (11) - Remove [2x]
23. Engine Block Oil Gallery PlugM16 (12) - Remove [2x]

Cleaning Procedure

NOTE: Ensure proper use of room temperature vulcanizing (RTV) sealant. Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant

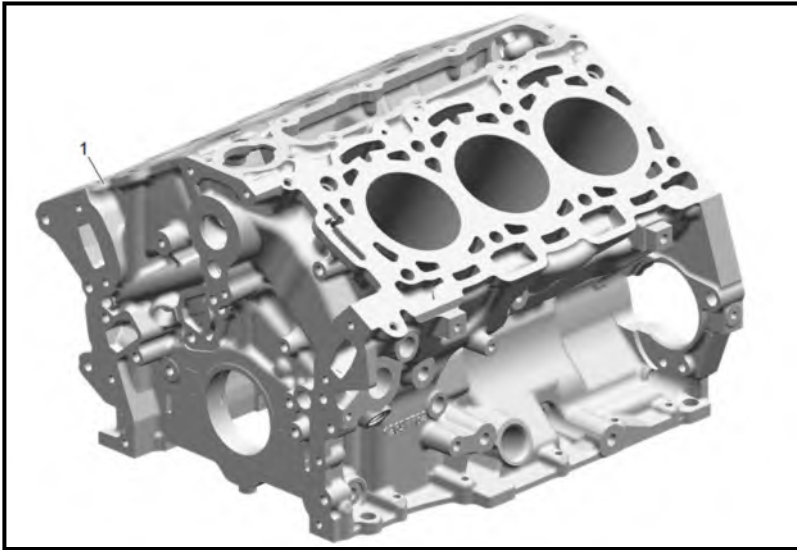
1. Remove any old thread sealant, gasket material or sealant using EN - 28410 Gasket Remover.
2. Clean all the following areas with solvent:
 - Sealing surfaces
 - Cooling passages
 - Oil passages
 - Bearing journals
3. Clean all threaded and through holes with solvent.

WARNING: Refer to Safety Glasses Warning .

4. Dry the engine block with compressed air.

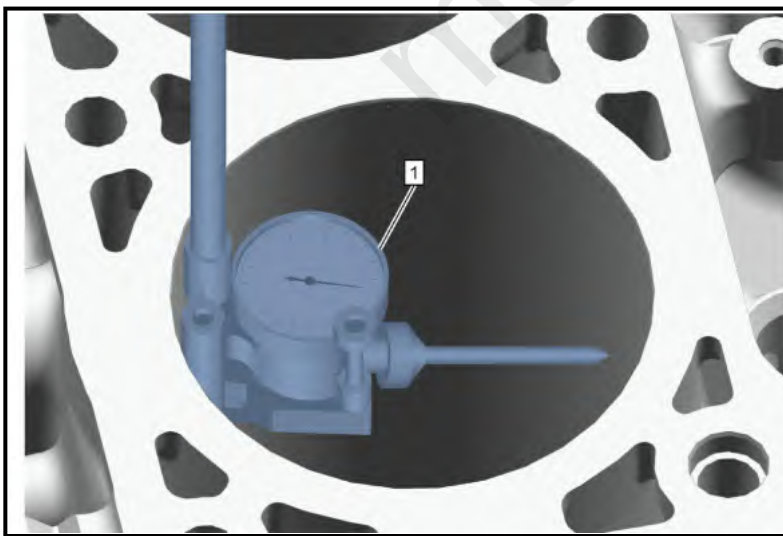
Visual Inspection

1. Inspect the crankshaft bearings journals for damage or spun bearings. The crankshaft bearing journals are not repairable, if the crankshaft bearing journals are damaged the engine block must be replaced.



2. Inspect the primary camshaft drive chain tensioner mounting surface on the engine block for burrs or any defects that would degrade the sealing of the NEW primary camshaft drive chain tensioner gasket.
3. Inspect all sealing and mating surfaces for damage, repair or replace the engine block if necessary.
4. Inspect all threaded and through holes for damage or excessive debris.
5. Inspect all bolts for damage, if damaged replace with NEW bolts only.
6. Check the cylinder condition. Some light vertical marks may be visible on the cylinder wall. In these areas, check that the honing marks are still visible in this marked area. If they are, the cylinder surface has not been compromised and the engine block can be used.
7. Inspect the cylinder walls for cracks or damage. The cylinder sleeves are not serviced separately, if the cylinders are damaged the engine block must be replaced.
8. Inspect the engine block for cracks. Do not repair any cracks. If cracks are found, the engine block must be replaced.
9. Repair any damaged threaded holes.
 - [Thread Repair Specifications](#)
 - [Thread Repair](#)

Measuring Cylinder Bore Diameter



Measure the cylinder bore diameter 37 mm (1.457 in) from the deck face using the **EN - 8087** gauge.

Compare your results with the [Engine Mechanical Specifications](#) . If the cylinder diameter exceeds the specifications, the engine block may be oversized to 0.25 mm (0.010 in). There is only one size of oversized pistons and rings available for service.

Measuring Cylinder Bore Taper

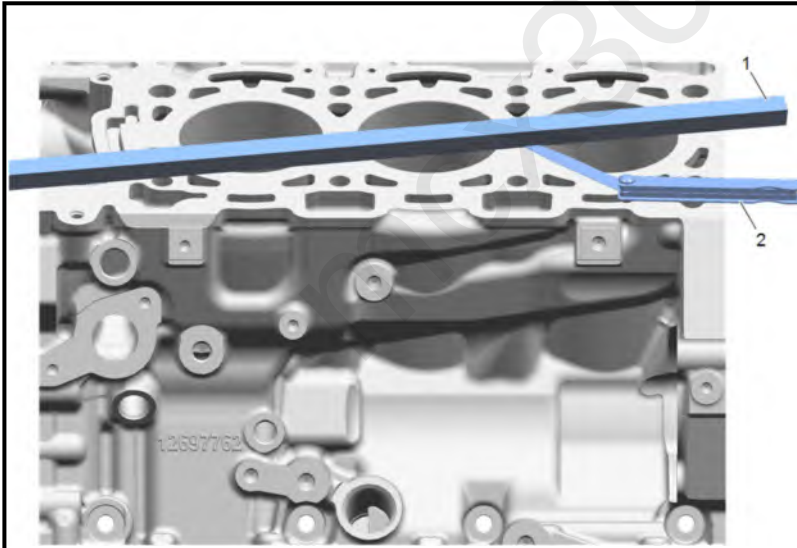
1. Measure the cylinder bore along the thrust surfaces, perpendicular to the crankshaft centerline, at 10 mm (0.397 in) below the deck surface and record your measurement.
2. Measure the cylinder bore along the thrust surfaces, perpendicular to the crankshaft centerline, at 100 mm (3.976 in) below the deck surface and record your measurement.
3. Calculate the difference between the 2 measurements. The result will be the cylinder taper.
4. Compare your results with the **Engine Mechanical Specifications**. If the cylinders exceed the specifications, the engine block may be oversized to 0.25 mm (0.010 in). There is only one size of oversized pistons and rings available for service.

Measuring Cylinder Bore Out-of-Round

1. Measure both the thrust and non-thrust cylinder diameter at 10 mm (0.397 in) below the deck. Record your measurements.
2. Calculate the difference between the 2 measurements. The result will indicate out-of-round at the upper end of the cylinder.
3. Measure both the thrust and non-thrust cylinder diameter at 100 mm (3.976 in) below the deck surface. Record your measurements.
4. Calculate the difference between the 2 measurements. The result will indicate out-of-round at the lower end of the cylinder.
5. Compare your results with the **Engine Mechanical Specifications**. If the cylinders exceed these specifications, the engine block may be oversized to 0.25 mm (0.010 in). There is only one size of oversized pistons and rings available for service.

Deck Flatness Inspection

1. Ensure the engine block decks are clean and free of gasket material.

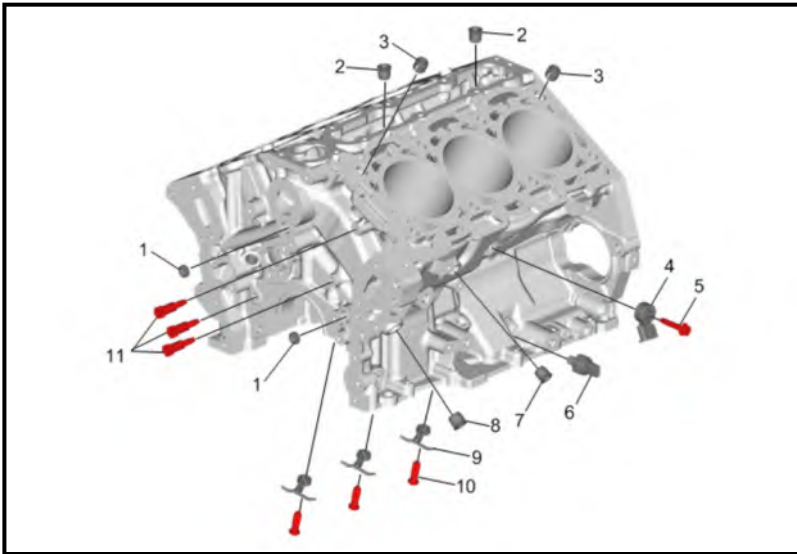


2. Inspect the surface for any imperfections or scratches that could inhibit proper cylinder head gasket sealing.
3. Place a straight-edge diagonally across the engine block deck face surface.
4. Measure the clearance between the straight-edge and the engine block deck face using a feeler gauge at 4 points along the straight-edge.
5. If the warpage is less than 0.05 mm (0.002 in), the engine block deck surface does not require resurfacing.
6. If the warpage is between 0.05 - 0.20 mm (0.002 - 0.008 in) or any imperfections or scratches that could inhibit proper cylinder head gasket sealing are present, the engine block deck surface requires resurfacing.
7. If resurfacing is required the maximum amount that can be removed is 0.25 mm (0.010 in).

8. If the engine block deck surface requires more than 0.25 mm (0.010 in) material removal the block must be replaced.

Assemble Procedure

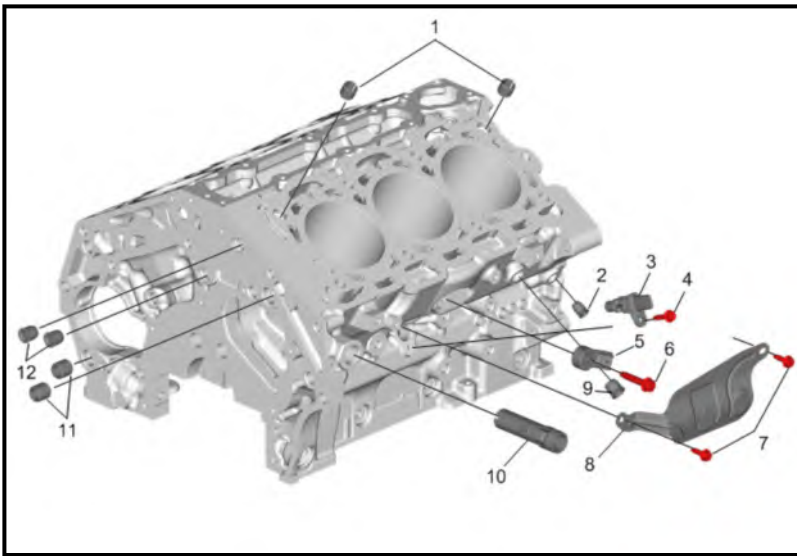
1. Engine Block Oil Gallery Plug Cap (1) - Install [2x]



CAUTION: Refer to [Fastener Caution](#) .

NOTE: Ensure proper use of room temperature vulcanizing (RTV) sealant. [Use of Room Temperature Vulcanizing \(RTV\) and Anaerobic Sealant](#)

2. Engine Block Oil Gallery PlugM16 (2) - Install and tighten [2x] 40 N.m (30 lb ft)
3. Cylinder Head Locating Pin (3) - Install [2x]
4. Knock Sensor (4) - Install
5. Knock Sensor Bolt (5) - Install - [Knock Sensor Replacement - Bank 2](#)
6. Engine Oil Pressure Sensor (6) - Install - [Engine Oil Pressure Sensor and/or Switch Replacement](#)
7. Engine Block Core Hole Plug (7) - Install and tighten 45 N.m (33 lb ft)
8. Engine Block Oil Gallery PlugM16 (8) - Install and tighten 40 N.m (30 lb ft)
9. Piston Oil Nozzle (9) - Install [3x]
10. Piston Oil Nozzle Bolt (10) - Install and tighten [3x] 10 N.m (89 lb in)
11. Engine Front Cover Stud (11) - Install and tighten [3x] 15 N.m (11 lb ft)
12. Cylinder Head Locating Pin (1) - Install [2x]



13. Engine Block Core Hole Plug (2) - Install and tighten [2x] 40 N.m (30 lb ft)
14. Crankshaft Position Sensor (3) - Install
15. Crankshaft Position Sensor Bolt (4) - Install - [Crankshaft Position Sensor Replacement](#)
16. Knock Sensor (5) - Install
17. Knock Sensor Bolt (6) - Install - [Knock Sensor Replacement - Bank 1](#)
18. Knock Sensor Heat Shield (8) - Install
19. Knock Sensor Heat Shield Bolt (7) - Install and tighten [2x] 10 N.m (89 lb in)
20. Engine Block Oil Gallery PlugM16 (9) - Install and tighten [2x] 40 N.m (30 lb ft)
21. Engine Coolant Heater (10) - Install and tighten [2x] 9 N.m (80 lb in)
22. Crankshaft Rear Oil Seal Housing Locating Pin (11) - Install [2x]
23. Engine Block Oil Gallery PlugM16 (12) - Install and tighten [2x] 40 N.m (30 lb ft)

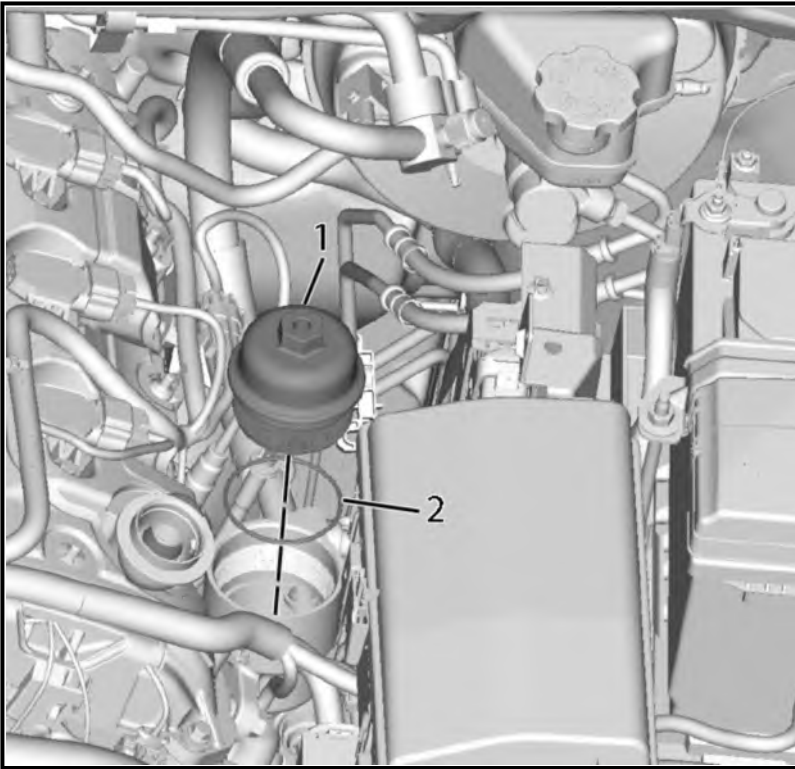
Installation Procedure

Install the engine. [Engine Replacement](#)

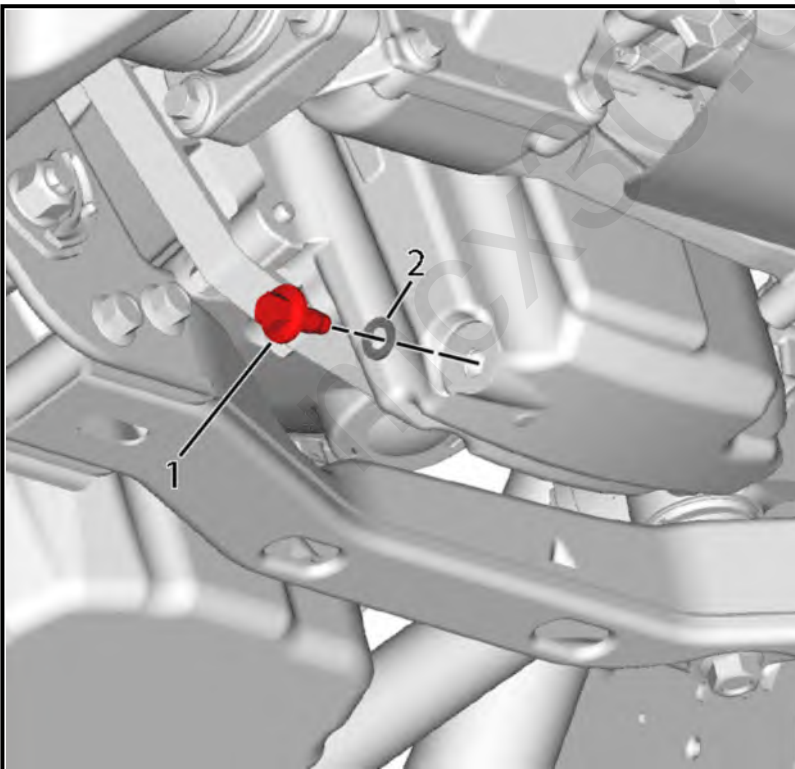
ENGINE OIL AND OIL FILTER REPLACEMENT

Removal Procedure

1. Remove the oil filter cap (1) and seal (2).



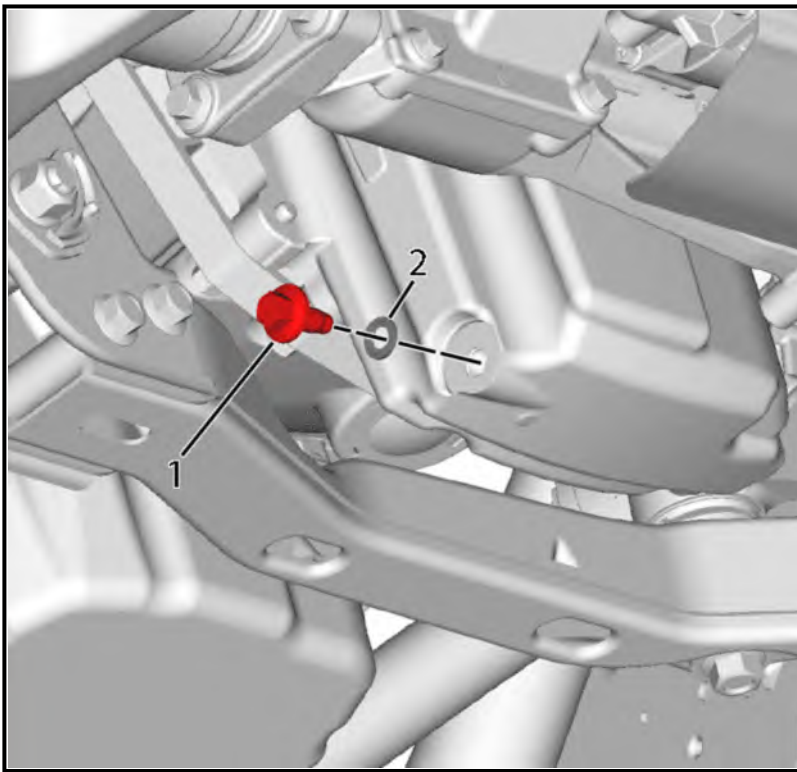
2. Remove and properly dispose of the oil filter.
3. Raise and support the vehicle. [Lifting and Jacking the Vehicle](#) .
4. Place a suitable drain pan below the oil pan drain plug.



5. Remove the oil pan drain plug (1) and seal (2).
6. Allow the oil to drain completely.

Installation Procedure

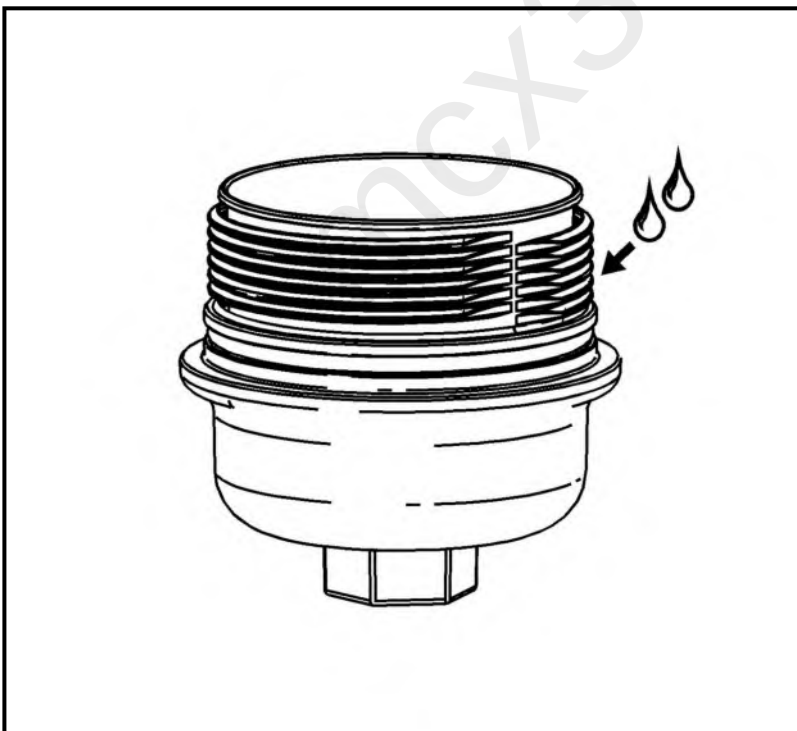
1. Install seal (2) and oil pan drain plug (1) and tighten to 25 N.m (18 lb ft).



CAUTION: Refer to [Component Fastener Tightening Caution](#) .

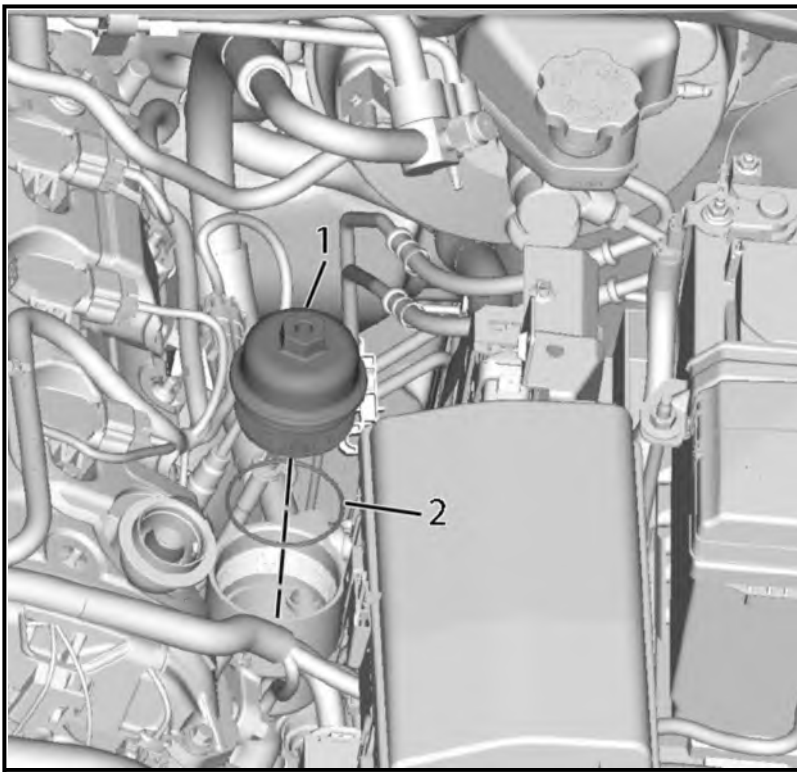
NOTE: Inspect the oil drain plug seal for damage, replace if necessary.

2. Remove the drain pan.
3. Lower the vehicle.
4. Lubricate the oil filter cap threads with clean engine oil.



CAUTION: Lubrication must be applied to the threads of the oil filter cap prior to installation. Failure to lubricate the oil filter cap threads can hinder later removal and cause possible oil filter cap damage.

5. Install a NEW oil filter (3).



CAUTION: Proper oil filter cap tightening is mandatory. Failure to tighten the oil filter cap to the proper specification can hinder later removal and cause possible oil filter cap damage.

NOTE: Inspect the oil filter seal for damage, replace if necessary.

6. Install seal (2) and tighten the oil filter cap (1) to 30 N.m (22 lb ft).
7. Fill the engine with the appropriate oil type and quantity. [Approximate Fluid Capacities](#) , and [Adhesives, Fluids, Lubricants, and Sealers](#)
8. Reset the oil life. [GM Oil Life System Resetting](#) , or [GM Oil Life System Resetting \(With Scan Tool\)](#).

FLYWHEEL CLEANING AND INSPECTION

Cleaning Procedure

NOTE: In order to maintain the proper component balance, contact surface taper and heat transfer, manual transmission flywheels are NOT to be machined.

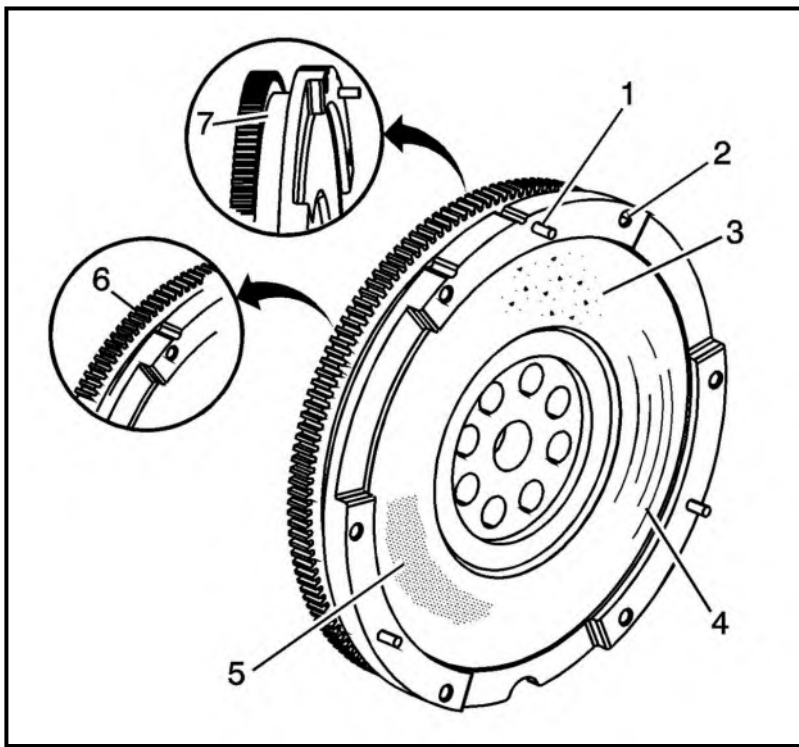
1. Clean the engine flywheel in solvent.

WARNING: Refer to [Safety Glasses Warning](#) .

2. Dry the engine flywheel with compressed air.

Inspection Procedure

1. Inspect the manual transmission engine flywheel for the following conditions:



- Missing and/or damaged alignment pins (1)
- Damaged threaded holes (2)
- Pitted surface (3)
- Scoring or grooves (4)
- Rust or other surface damaged (5)
- Damaged ring gear teeth (6)
- Loose or improperly positioned ring gear

The ring gear has an interference fit onto the engine flywheel and should be positioned completely against the flange of the engine flywheel (7).

2. Replace the engine flywheel as necessary.

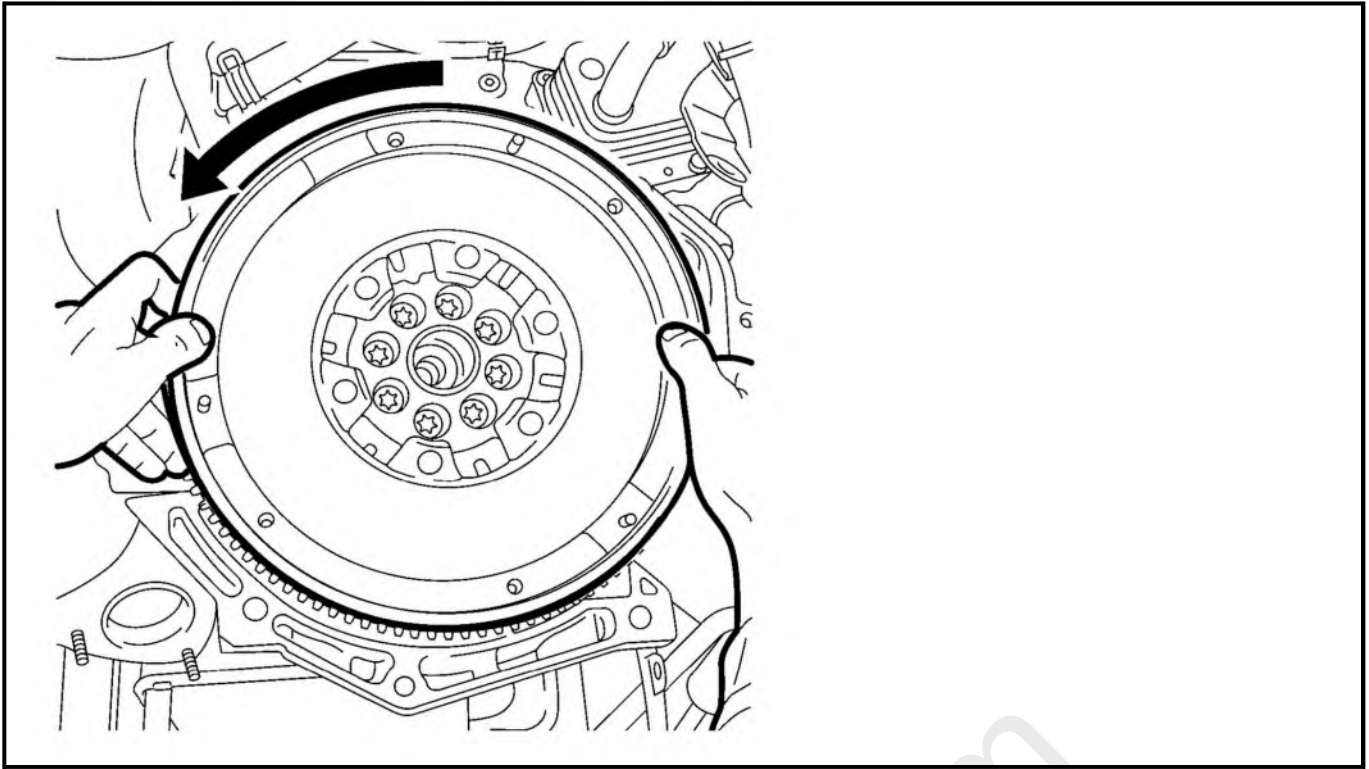
Clearance Angle Inspection

NOTE: If the vehicle is equipped with a dual mass flywheel, perform the following inspection.

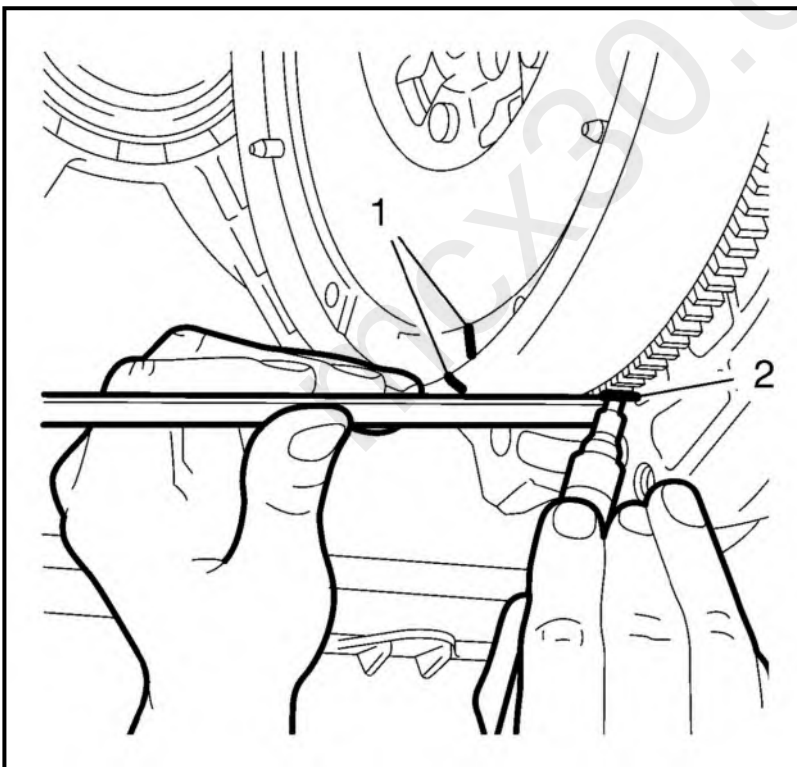
The clearance inspection is to check if the secondary flywheel exhibits a normal amount of movement in relation to the primary flywheel, in both directions, as the internal flange contacts the ARC springs.

NOTE: Before the inspection of the clearance angle, the dual mass flywheel should be rotated several times in a clockwise and counter clockwise direction. There may be light scrubbing, clicking or metallic noises as the flywheel is rotated in each direction.

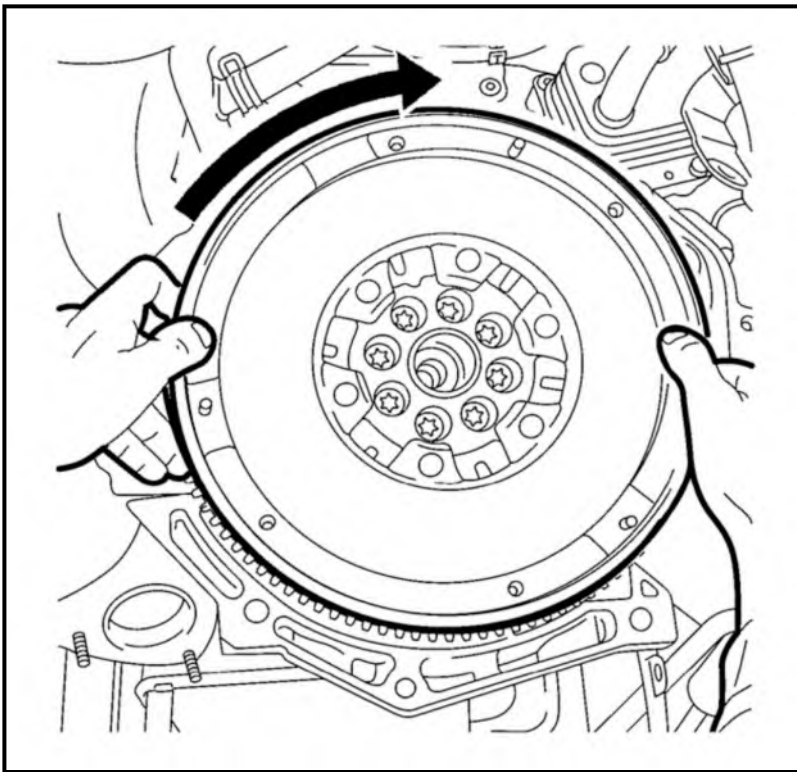
If the flywheel cannot be moved in either direction or exhibits a binding condition, the flywheel is defective and must be replaced.



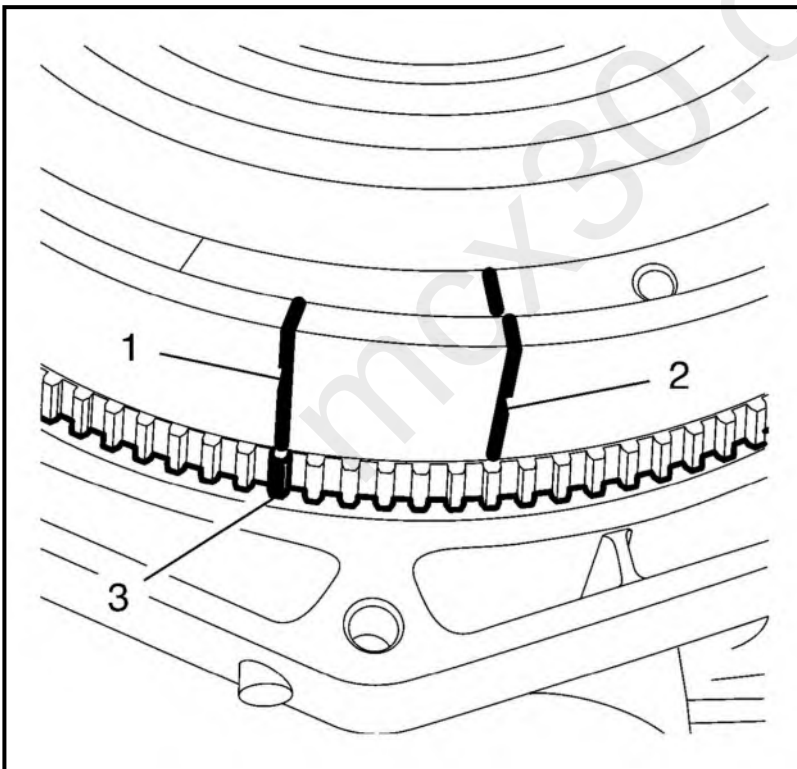
1. Rotate secondary flywheel counter clockwise until the counterforce (spring force) is clearly noticeable
2. Release secondary flywheel slowly until there is no spring force on the flywheel.
3. Mark position with a vertical line on secondary flywheel (1) and on toothed ring (2).



4. Rotate secondary flywheel clockwise until the counterforce (spring force) is clearly noticeable.



5. Release secondary flywheel slowly until there is no spring force on the flywheel.
6. Apply a new marking on secondary flywheel (1) on the height of the marking on the toothed ring for starter (3).



7. Count the number of teeth from marked tooth up to the height of the first marking on secondary flywheel (2).
8. For the functional movement of the secondary flywheel, up to 6 teeth are allowed.
9. If the movement exceeds 6 teeth, the flywheel must be replaced.

VALVE SPRING INSPECTION AND MEASUREMENT

Special Tools

EN-22738-B Valve Spring Tester

Equivalent regional tools: [Special Tools](#)

Inspection Procedure

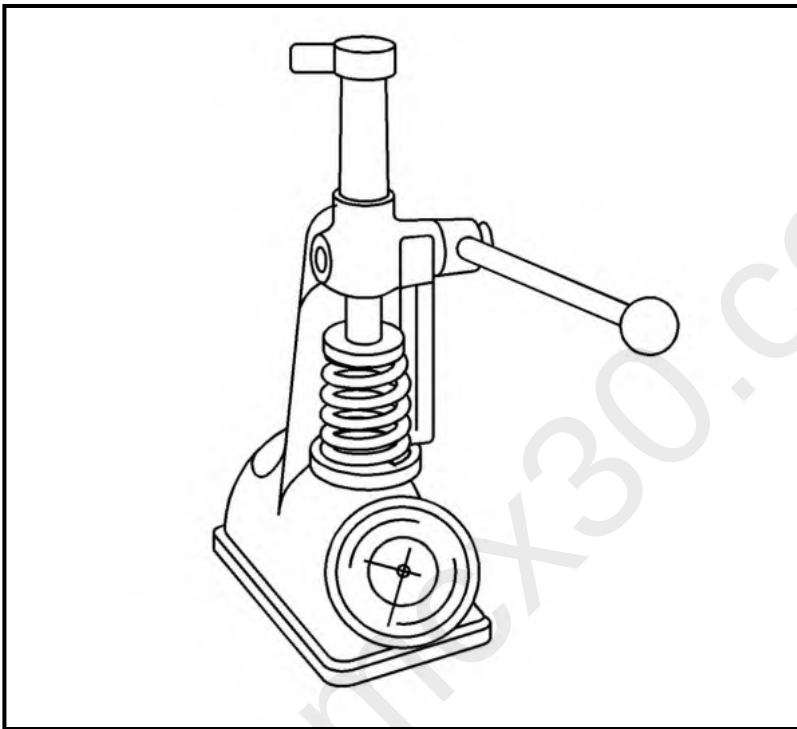
1. Clean the valve springs in solvent.

WARNING: Refer to [Safety Glasses Warning](#) .

2. Dry the valve springs with compressed air.
3. Inspect the valve springs for broken coils or coil ends.

Measurement Procedure

1. Measure the valve spring tension using the EN-22738-B Valve Spring Tester. [Engine Mechanical Specifications](#)



2. If low valve spring load is found, replace the valve springs. DO NOT use shims to increase spring load. The use of shims can cause the valve spring to bottom out before the camshaft lobe is at peak lift.

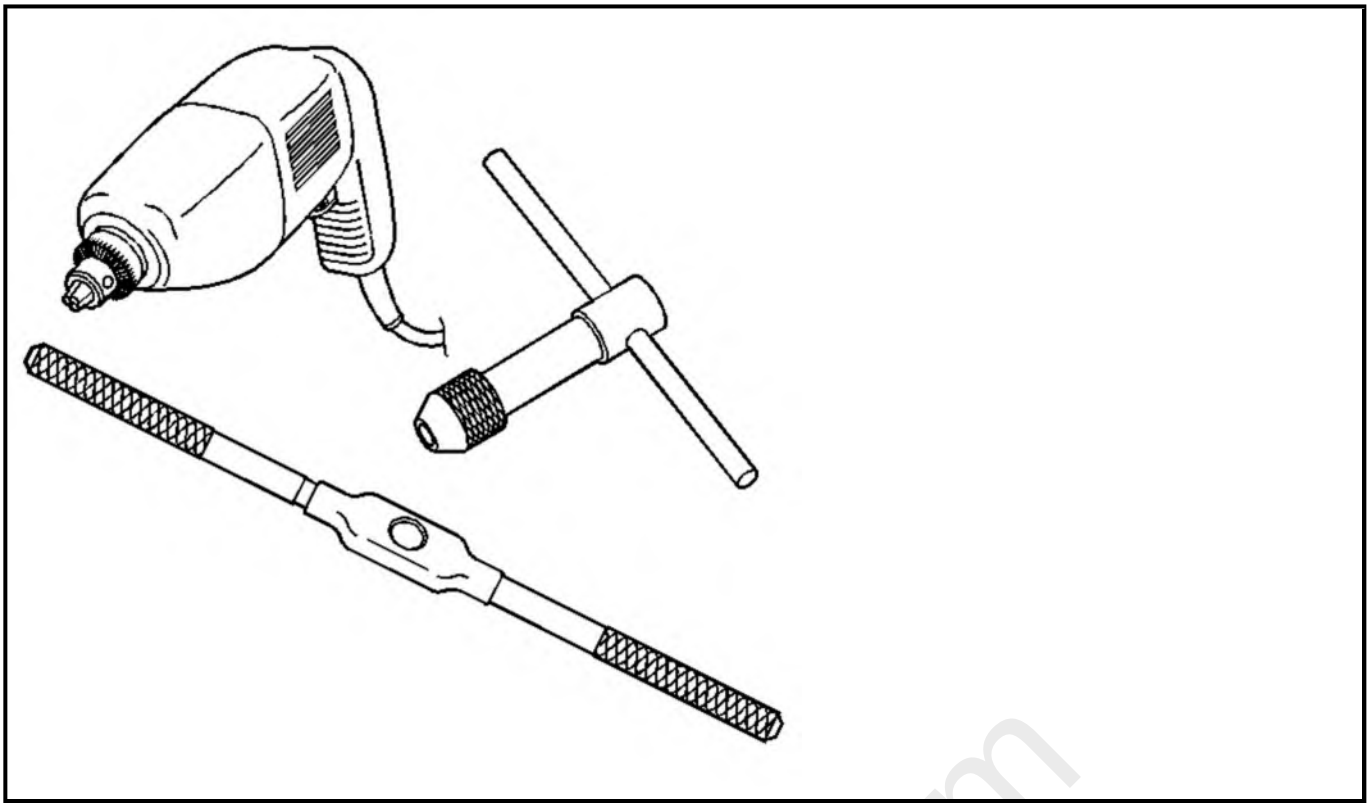
THREAD REPAIR

Special Tools

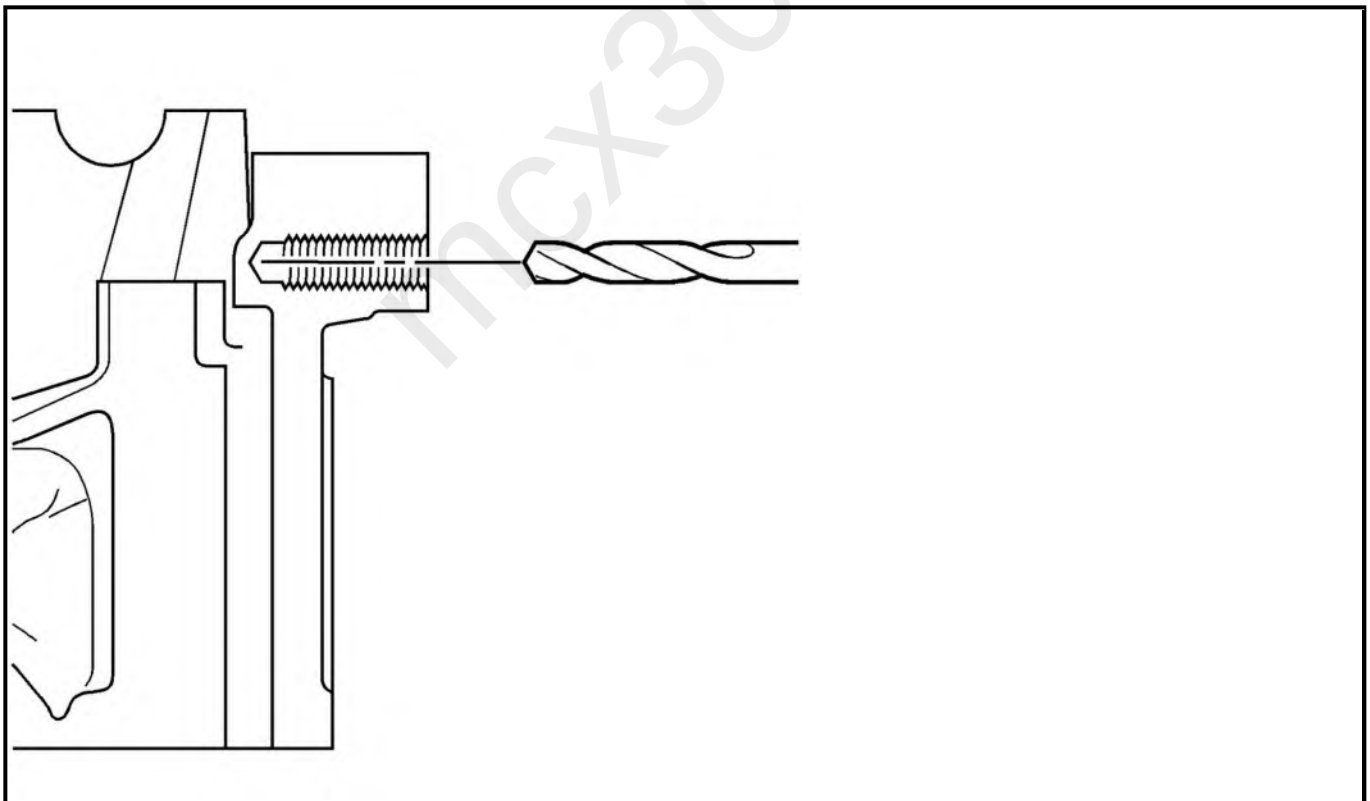
- EN - 42385-70 Head Bolt Thread Repair Fixture
- EN - 42385-700 High Feature Thread Repair Kit
- EN - 42385-2000 Thread Insert Kit
- EN - 43965 Thread Repair Extension Kit

For equivalent regional tools, refer to [Special Tools](#) .

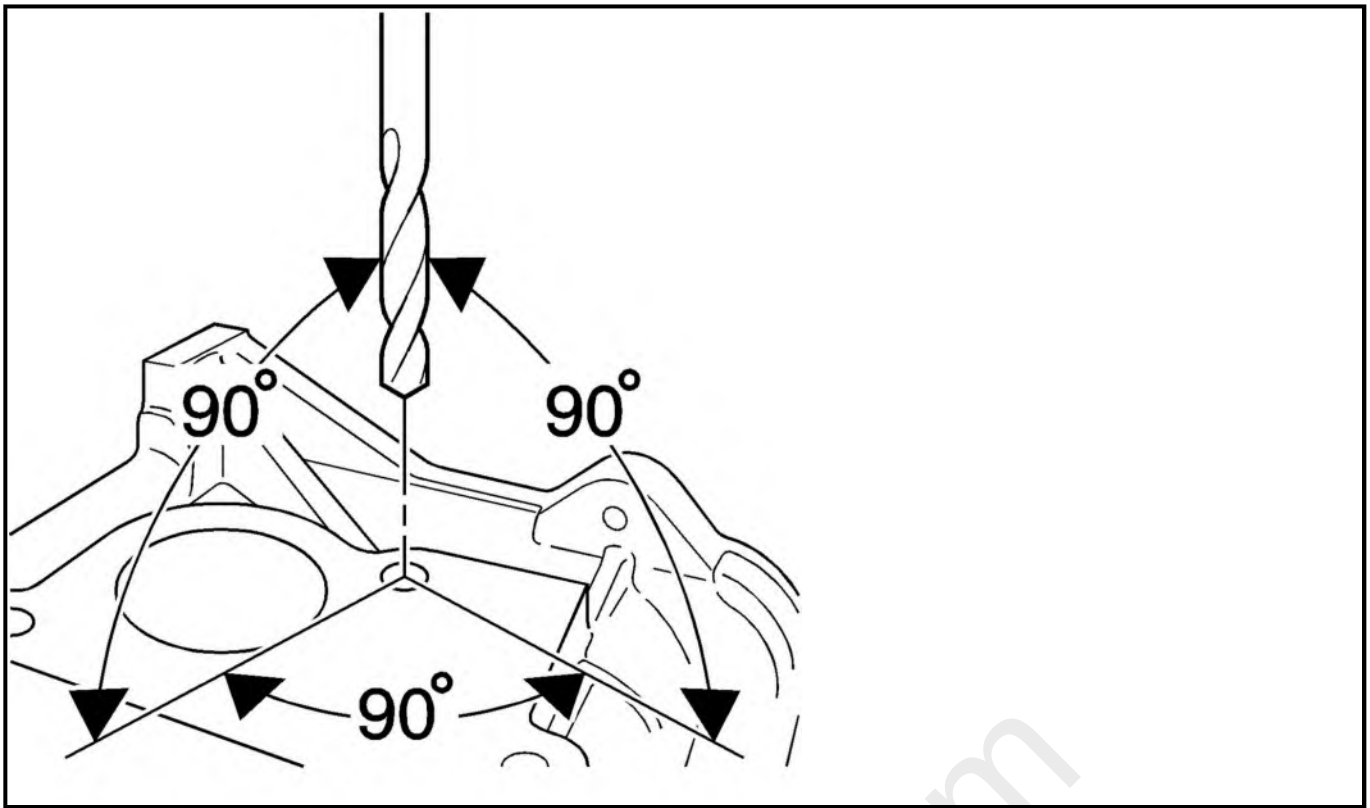
The thread repair process involves a solid, thin walled, self-locking, carbon steel, bushing type insert. During the insert installation process, the installation driver tool cold-rolls the bottom internal threads and expands the bottom external threads of the insert into the base material. This action mechanically locks the insert into place.



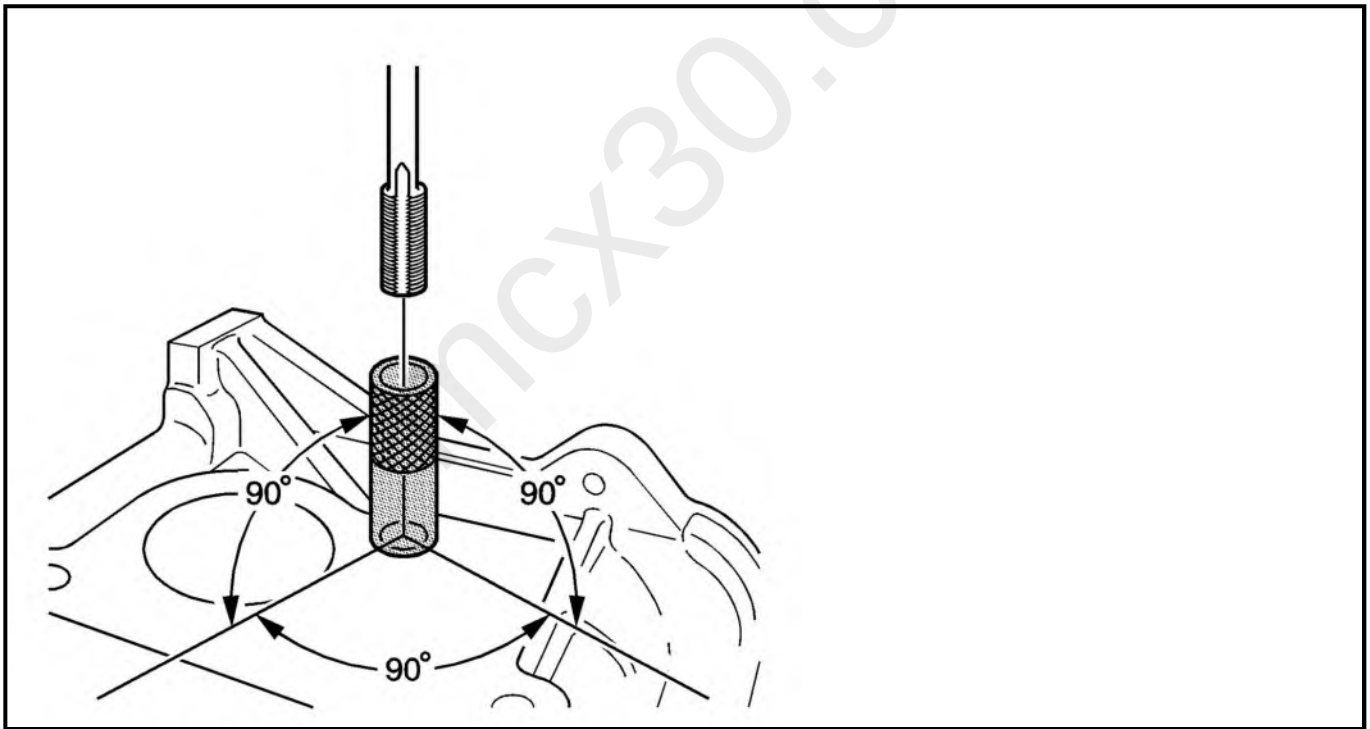
The drill bit and counter bore tool from the tool kit **EN - 42385-700** kit and **EN - 42385-2000** insert kit is designed for use with either a suitable tap wrench or drill motor. Limited access and larger hole repair may process better using a tap wrench. An extension from kit **EN - 43965** extension kit may also be necessary to drive the thread repair tooling dependent on access to the hole being repaired. Use only a tap wrench when tapping the hole and during installation of the insert.



It is critical that the drilling, counterboring and tapping of the hole to be repaired follows the same centerline as the original hole.



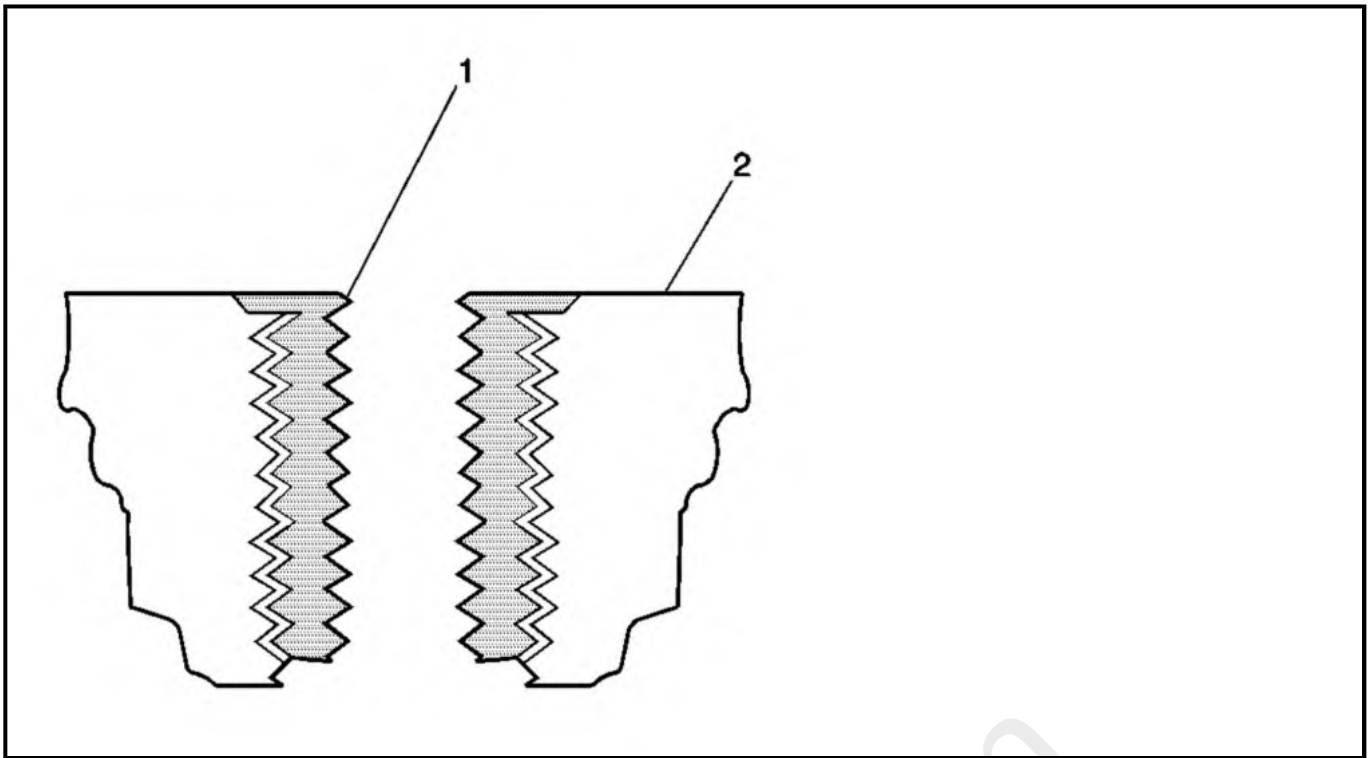
During the drilling and tapping of the hole being repaired ensure the tooling is consistently machining perpendicular to the surface of the base material.



If the threaded hole being repaired has a base surface perpendicular to the hole centerline, tapping guides are available to aid in tapping the hole.

Tap Size	Tap Guide	Tap Size	Tap Guide	Tap Size	Tap Guide
-	EN 42385-	-	EN 42385-	-	EN 42385-
6 x 1.0	729	10 x 1.5	731	14 x 1.5	736
8 x 1.25	730	12 x 1.5	732	20 x 1.5	737

Standard Thread Repair - Flush Hole

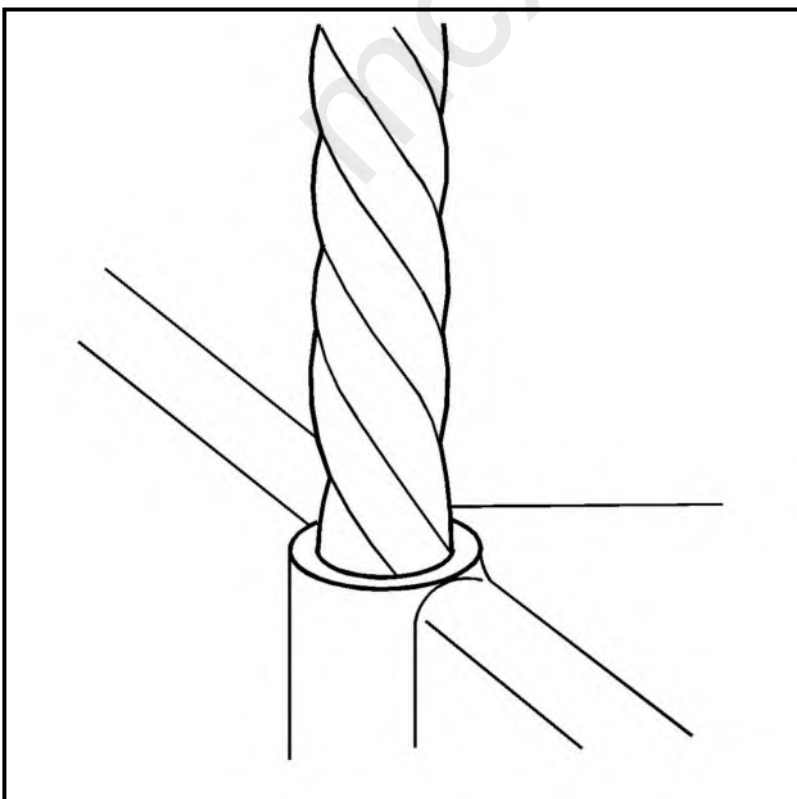


WARNING: Refer to [Safety Glasses Warning](#) .

NOTE: The use of a cutting type fluid is recommended when performing the drilling, counterboring and tapping procedures. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended cutting fluid.

When installed to the proper depth, the flange (1) of the insert will be seated against the counterbore of the drilled/tapped hole and just below the surface (2) of the base material.

1. Drill out the threads of the damaged hole.



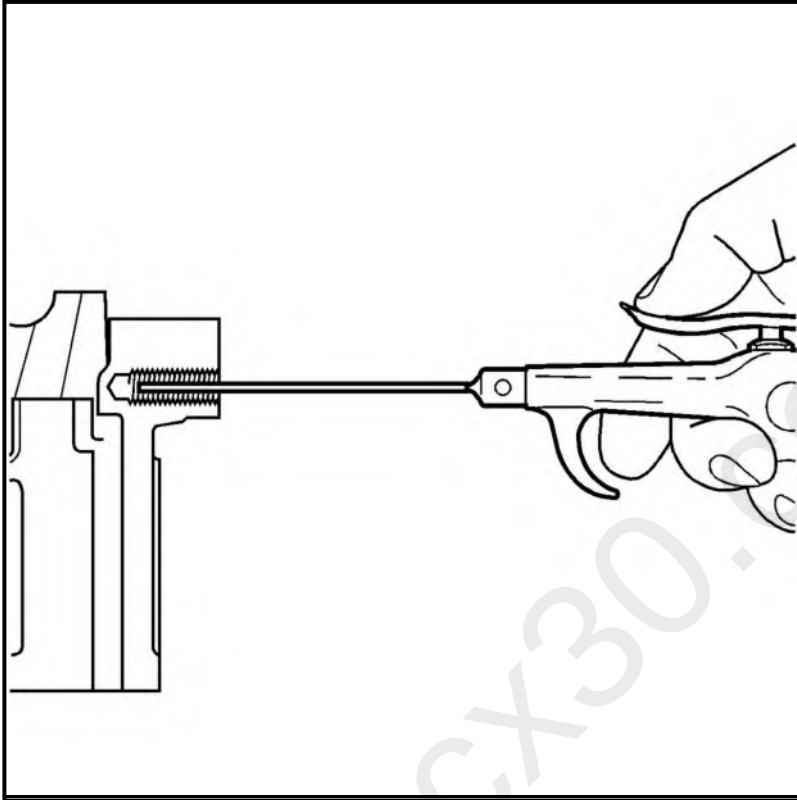
NOTE:

- During the drilling process, it is necessary to repeatedly remove the drill and clean chips from the hole and the flutes of the drill.
- Do NOT drill any further than the original hole depth.

Specifications

- M6 inserts require a minimum drill depth of 15 mm (0.59 in).
- M8 inserts require a minimum drill depth of 20 mm (0.79 in).
- M10 inserts require a minimum drill depth of 23.5 mm (0.93 in).

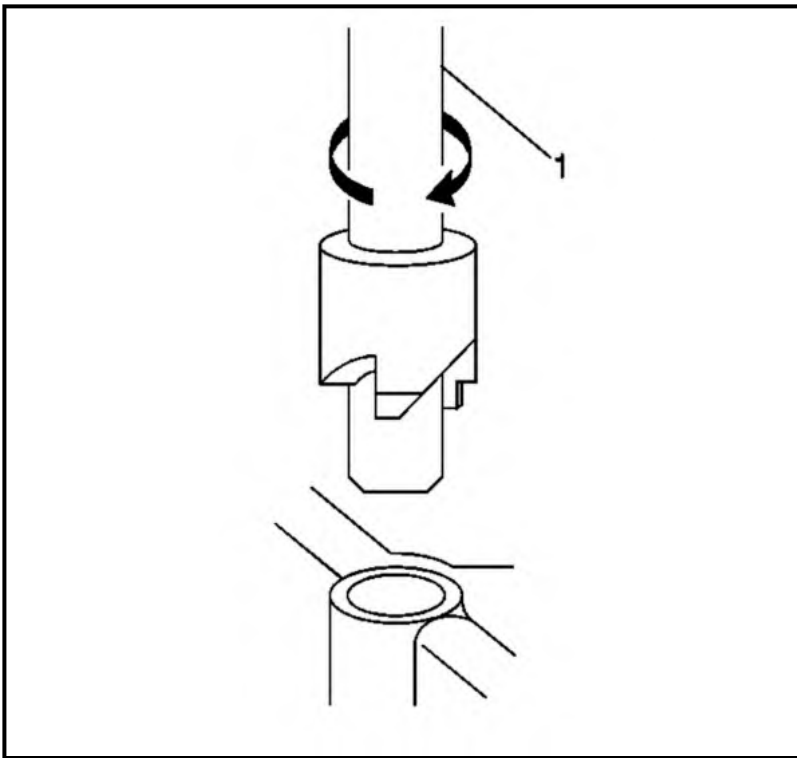
2. Using compressed air, clean out any chips.



NOTE:

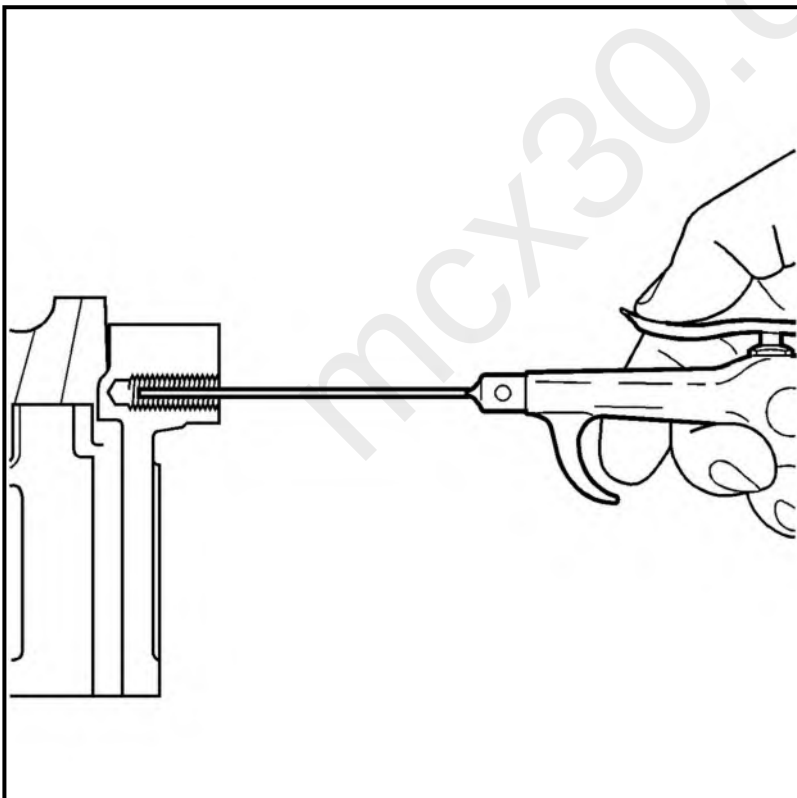
All chips must be removed from the drilled hole prior to tapping.

3. Counterbore the drilled hole to the full depth permitted by the tool (1).



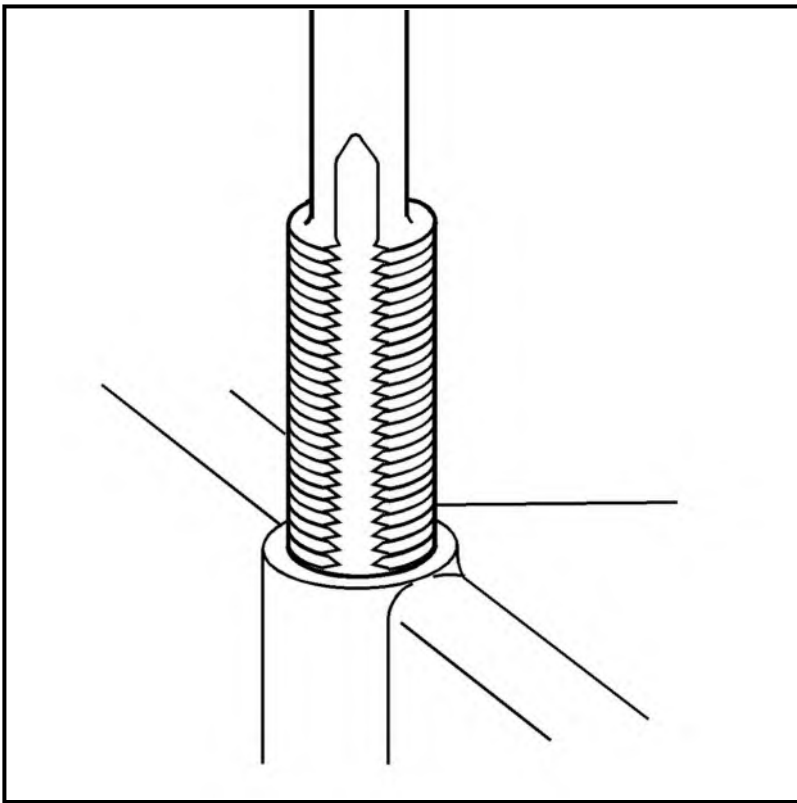
NOTE: A properly counterbored hole will show a slight burnishing on the surface of the base material for 360 degrees around the drilled hole.

4. Using compressed air, clean out any chips.



NOTE: All chips must be removed from the drilled hole prior to tapping.

5. Using a suitable tapping wrench, tap the threads of the drilled hole by hand only.



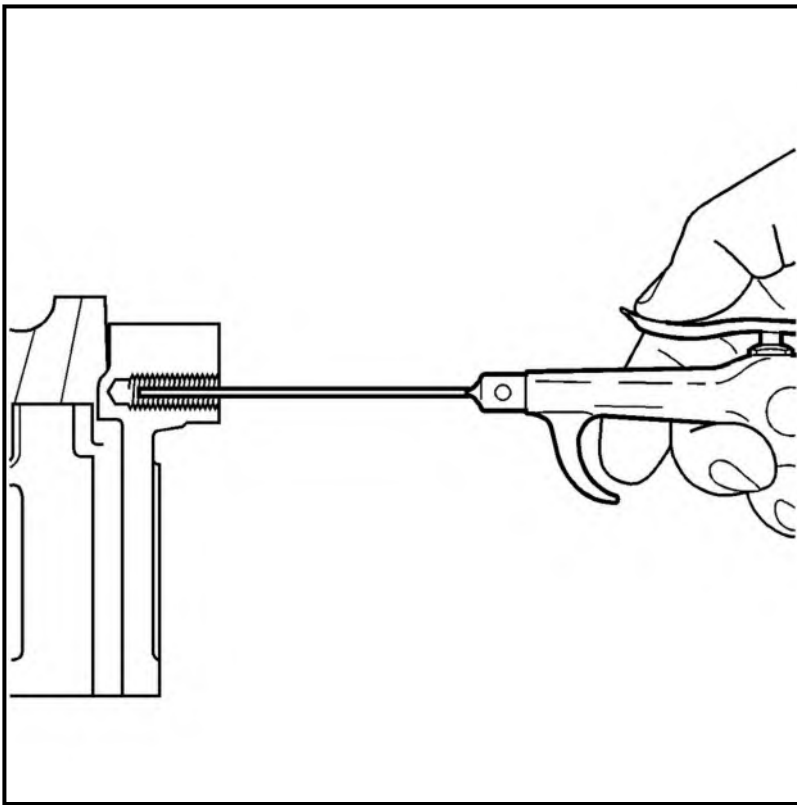
NOTE:

- During the tapping process, it is necessary to repeatedly remove the tap and clean chips from the hole and the flutes of the tap.
- Ensure the tap has created full threads at least to the depth equal to the insert length.

Specifications

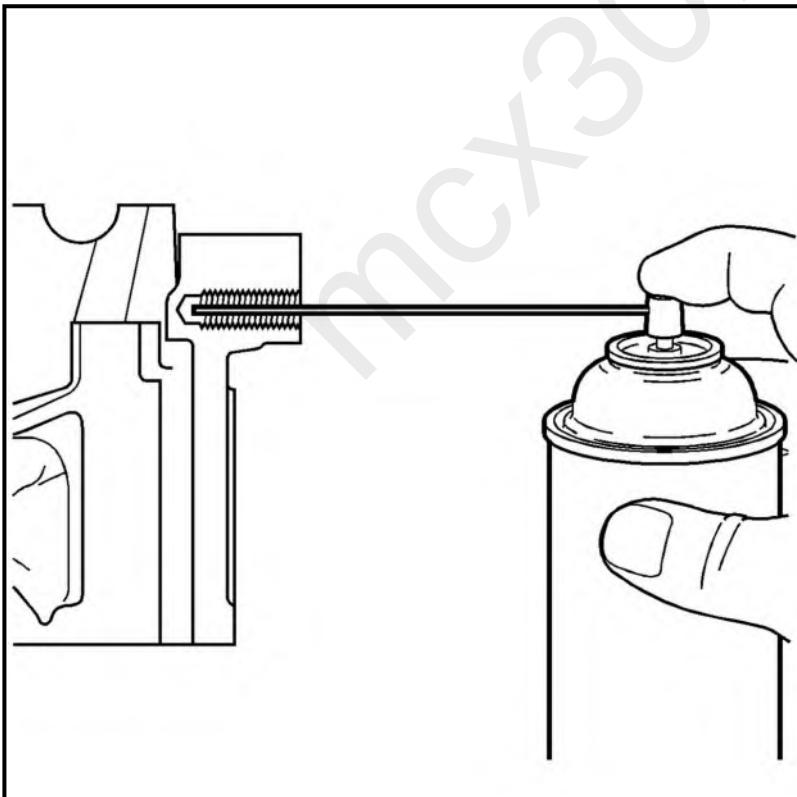
- M6 inserts require a minimum tap depth of 15 mm (0.59 in).
- M8 inserts require a minimum tap depth of 20 mm (0.79 in).
- M10 inserts require a minimum tap depth of 23.5 mm (0.93 in).

6. Using compressed air, clean out any chips.

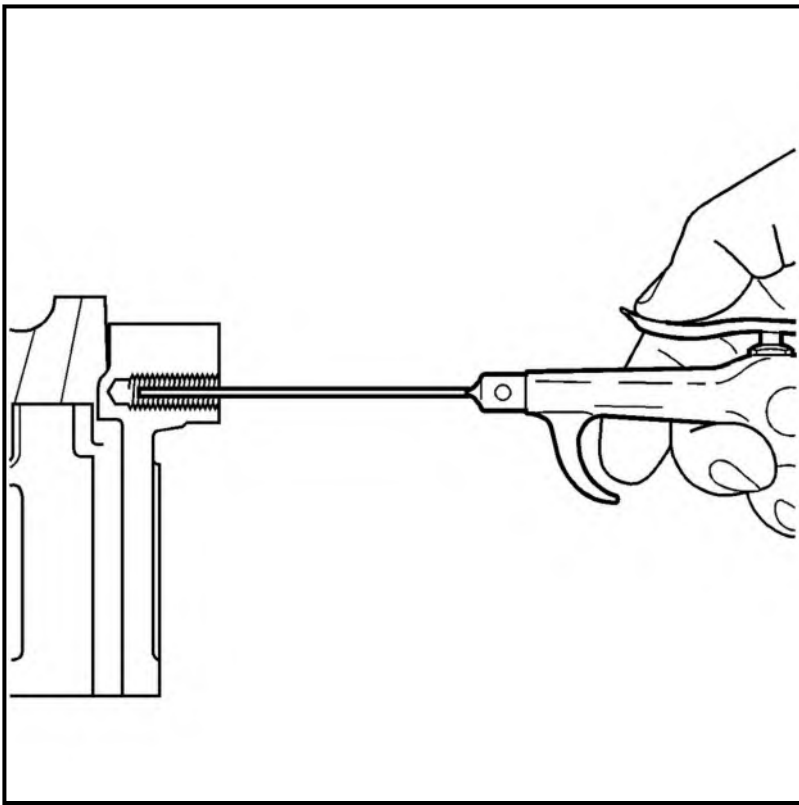


NOTE: All chips must be removed from the tapped hole prior to insert installation.

7. Spray cleaner into the tapped hole. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended cleaner.

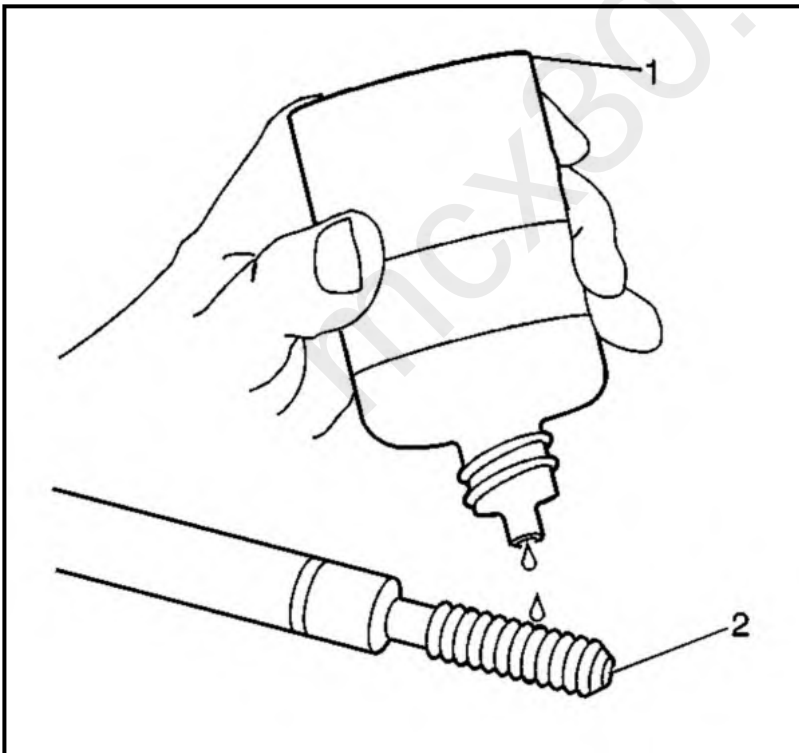


8. Using compressed air, clean out any chips.



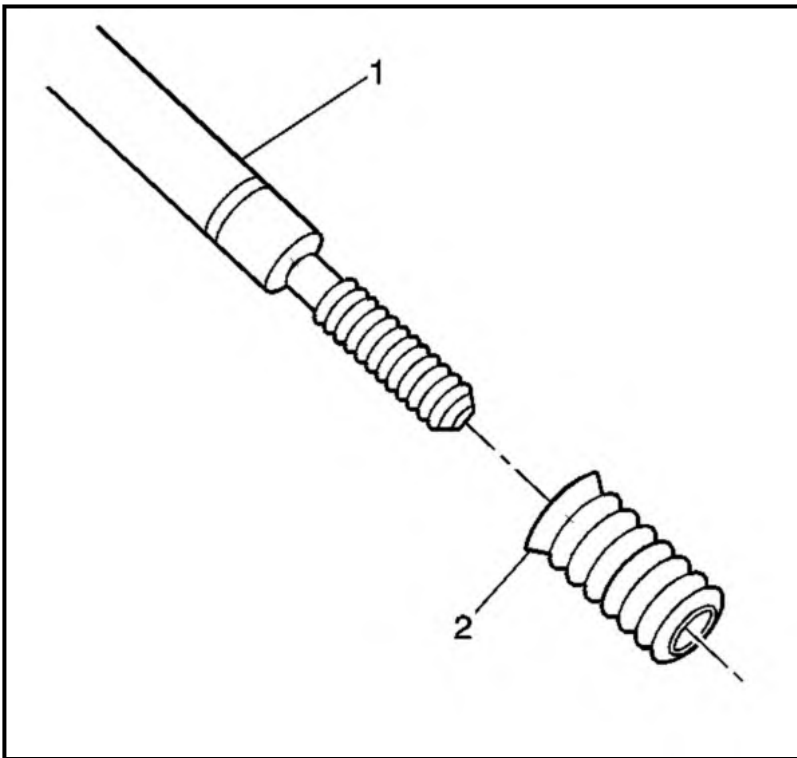
NOTE: All chips must be removed from the tapped hole prior to insert installation.

9. Lubricate the threads of the driver installation tool (2) with the EN - 42385-110 (1).

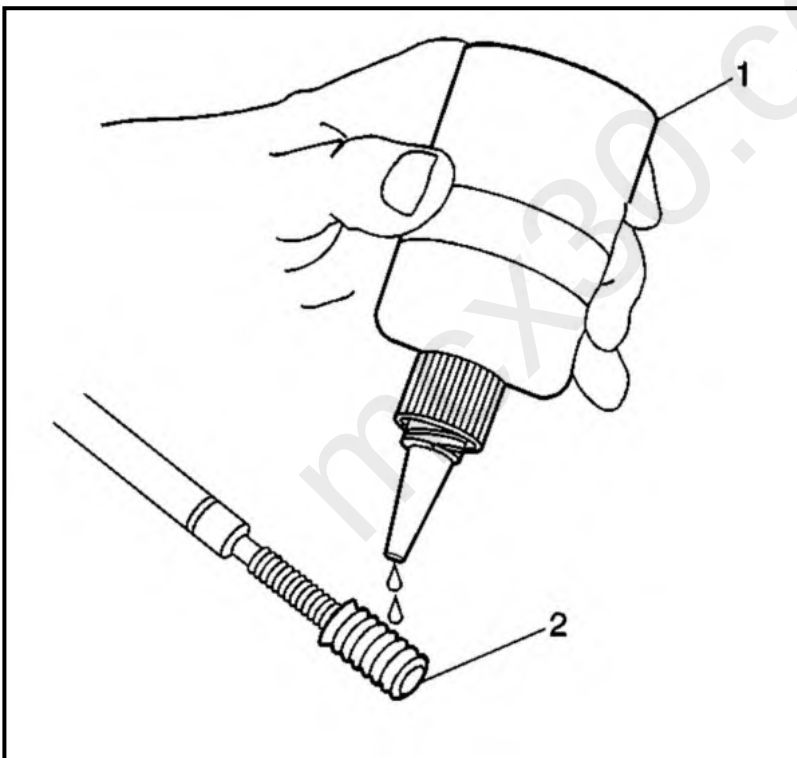


NOTE: Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.

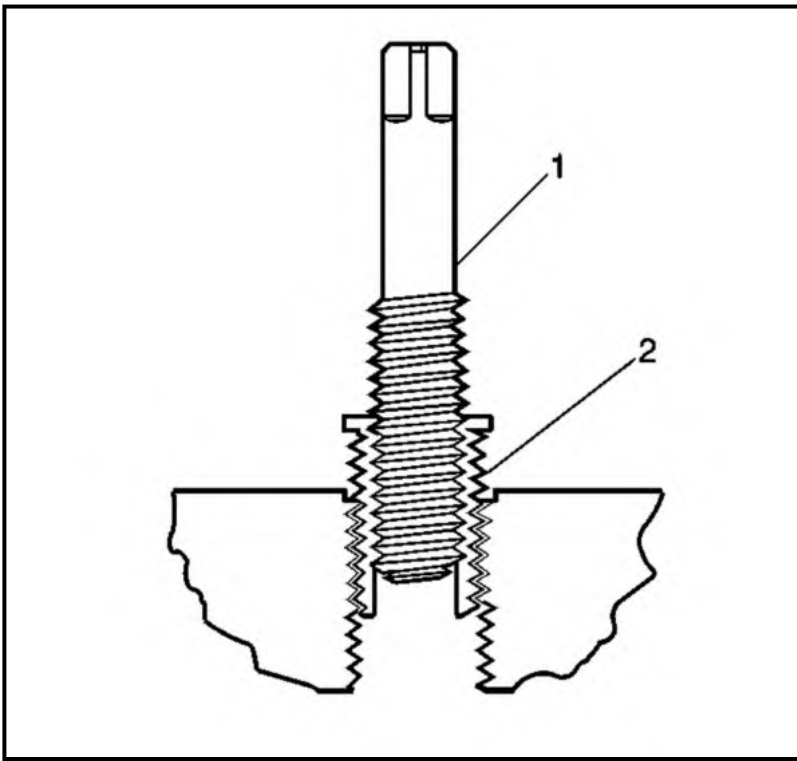
10. Install the insert (2) onto the driver installation tool (1).



11. Apply threadlock sealant, **EN - 42385-109** , LOCTITE 277Â® or equivalent (1) to the insert OD threads (2). Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended sealant.

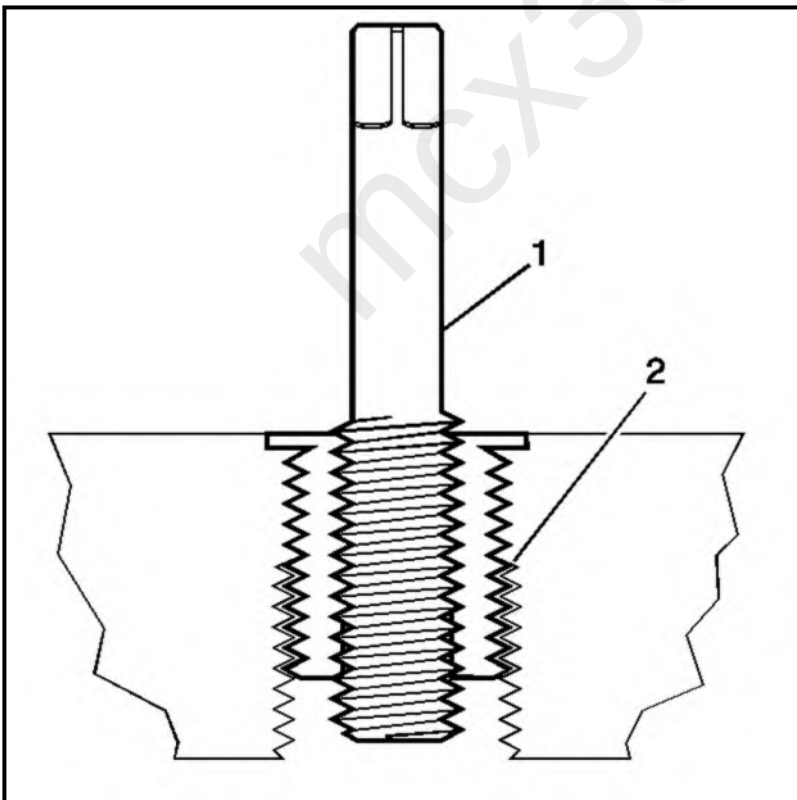


12. Install the insert (2) into the tapped hole by hand only.



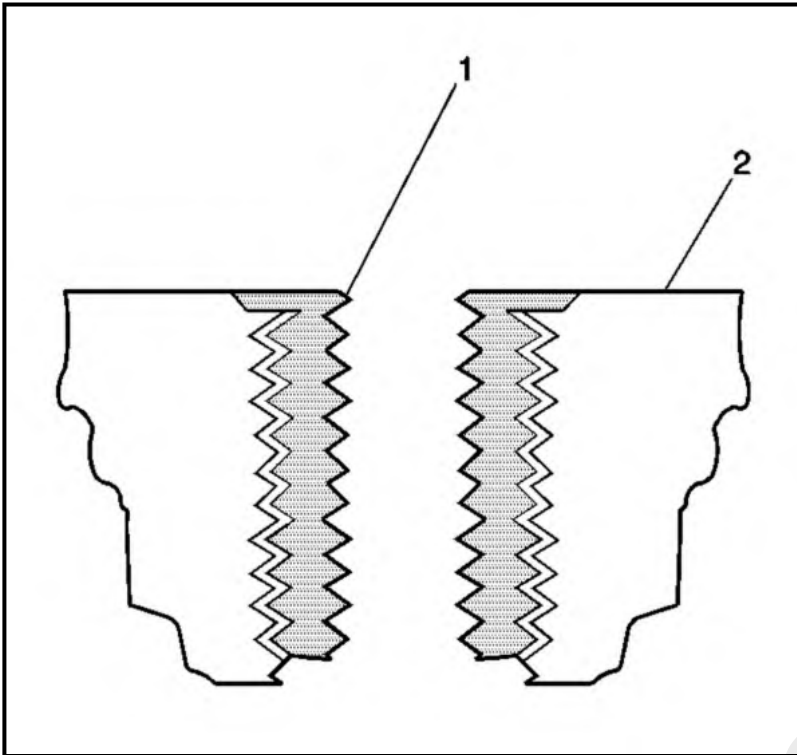
NOTE: If the insert will not thread down until the flange contacts the counterbored surface, remove the insert immediately with a screw extracting tool and inspect the tapped hole for any remaining chips and/or improper tapping.

13. Install the insert until the flange (2) of the insert contacts the counterbored surface.
14. Continue to rotate the driver installation tool (1) through the insert (2).

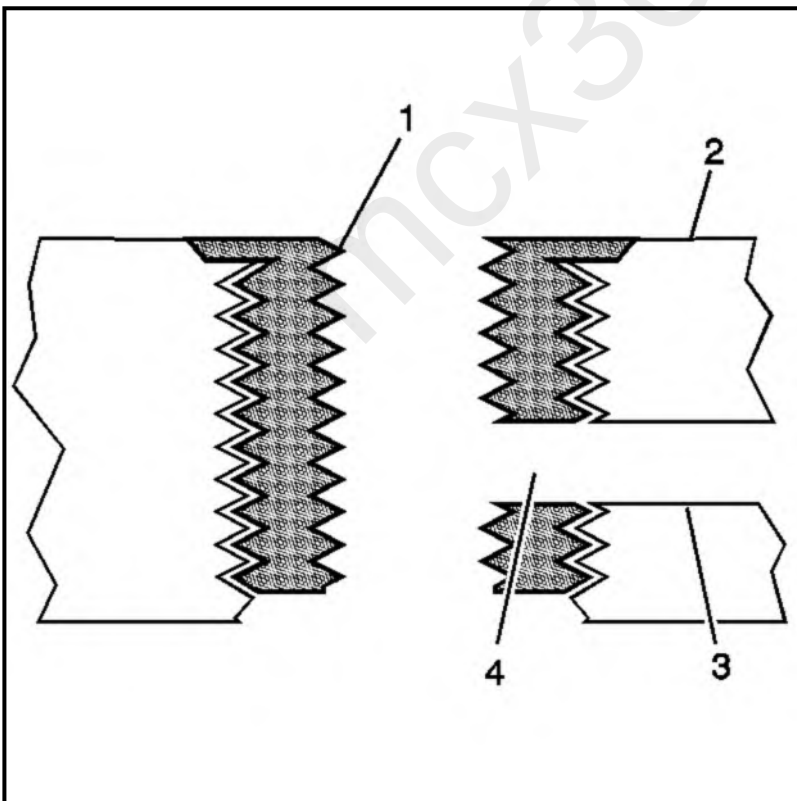


NOTE: The driver installation tool will tighten up before screwing completely through the insert. This is acceptable. The threads at the bottom of the insert are being formed and the insert is mechanically locking the insert into the base material threads.

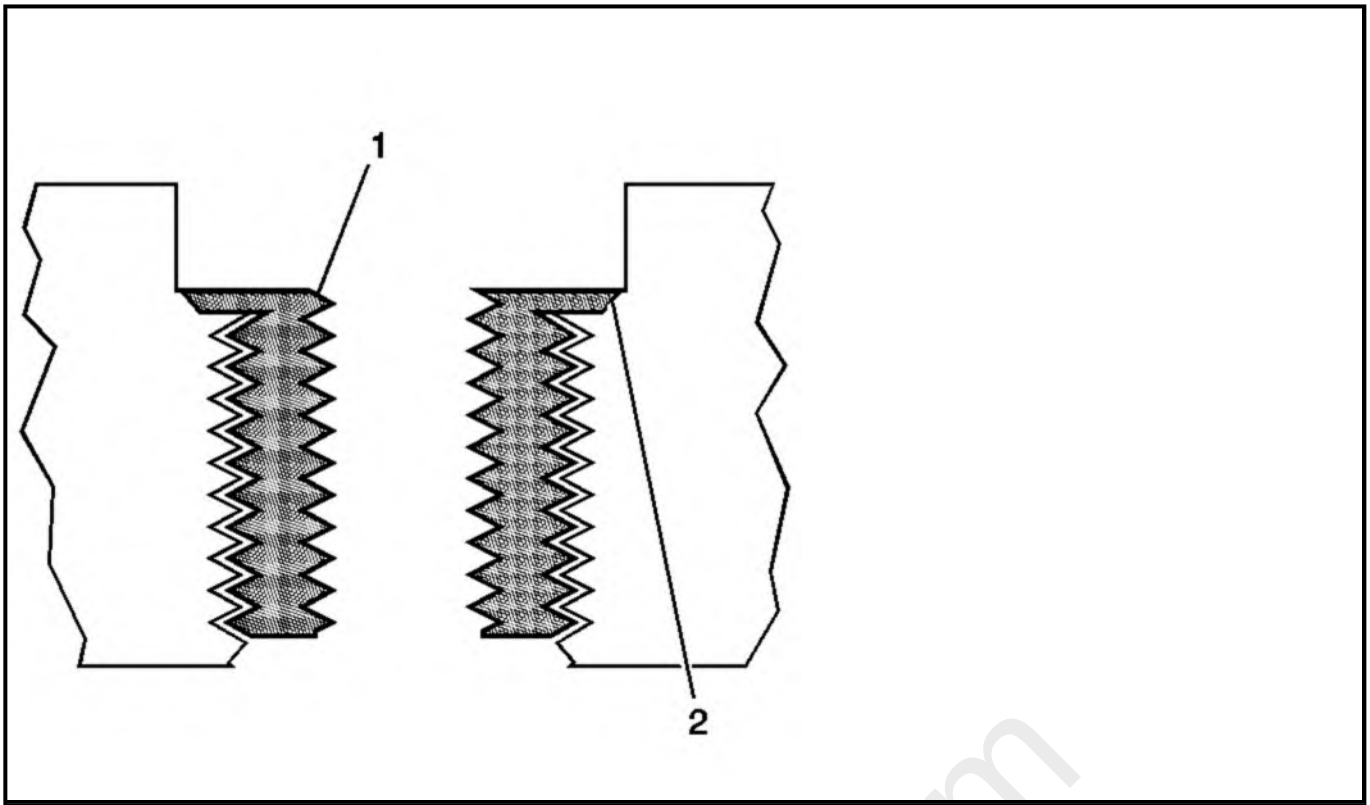
15. Inspect the insert for proper installation into the tapped hole. A properly installed insert (1) will be either flush or slightly below flush with the surface of the base material (2).



16. Any installed insert that restricts or blocks an oil or engine coolant passage (3) will need to have the oil or engine coolant passage drilled out (4) to the original size of the oil or engine coolant passage. After drilling the restriction or blockage, clean out any chips and thread the installation driver tool through the insert again to remove any burrs caused by the drilling of the oil or engine coolant passage.



Recessed Thread Repair



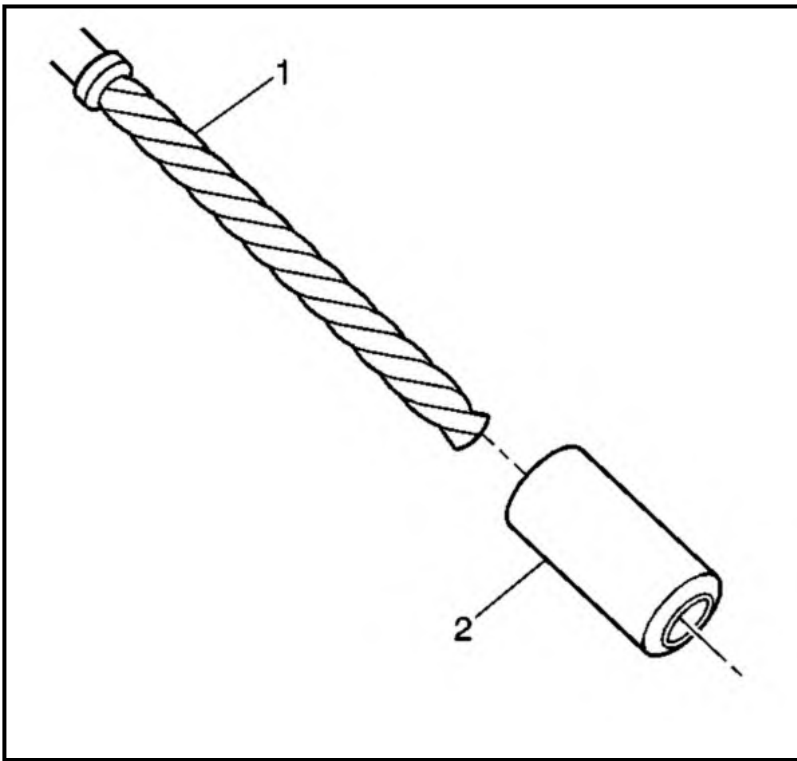
WARNING: Refer to [Safety Glasses Warning](#) .

NOTE:

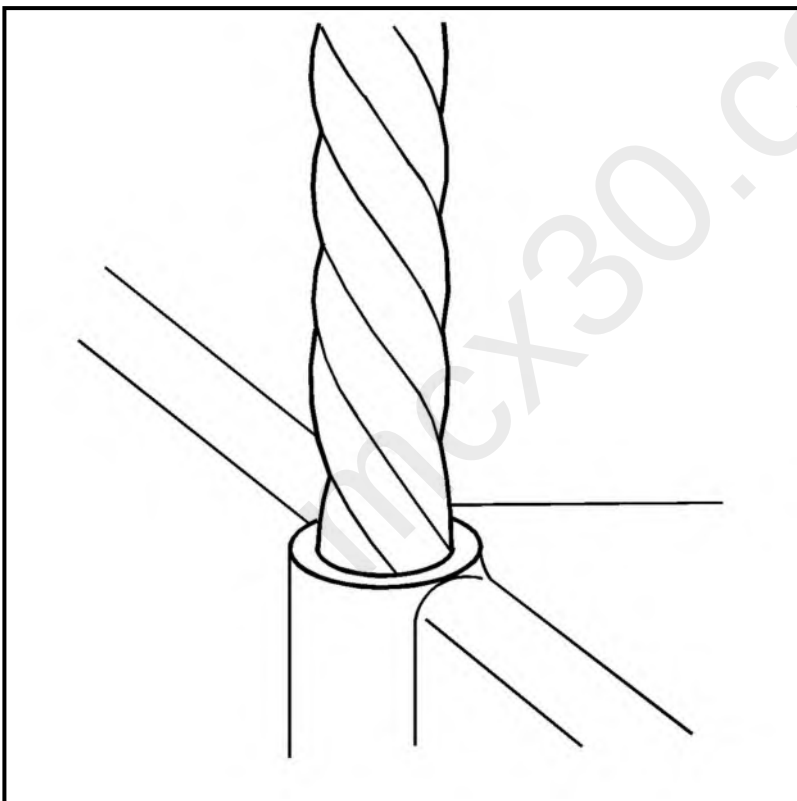
- The use of a cutting type fluid, WD 40® or equivalent is recommended when performing the drilling, counterboring and tapping procedures. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended cutting fluid.
- Do NOT remove the original stop collar from a counterbore drill.

When installed to the proper depth, the flange of the insert (1) will be seated against the counterbore (2) of the drilled/tapped hole.

1. Install a stop collar (2) on the counterbore drill (1), if required.



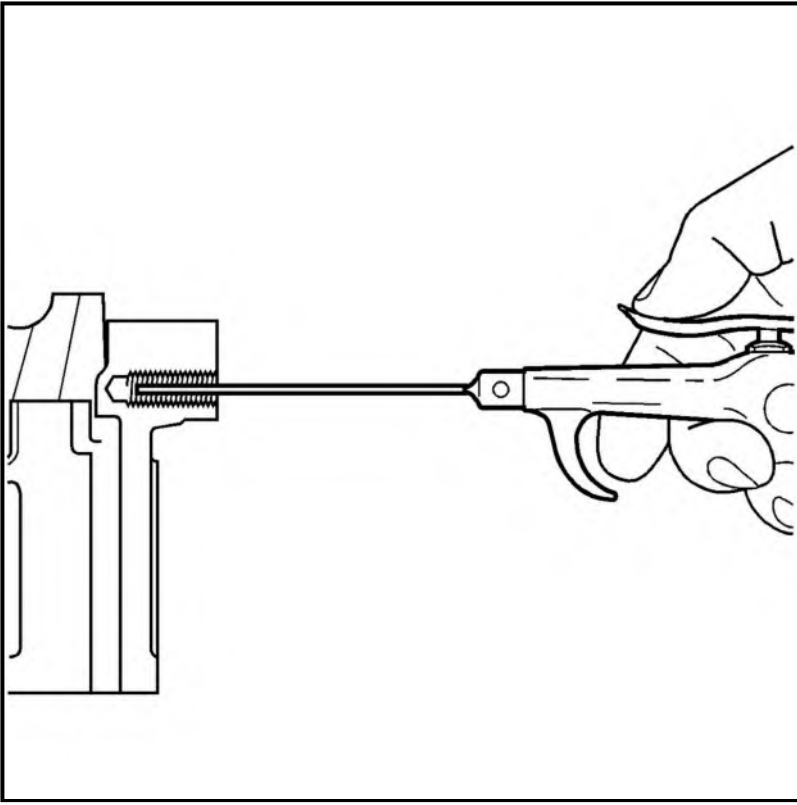
2. Drill out the threads of the damaged hole.



NOTE:

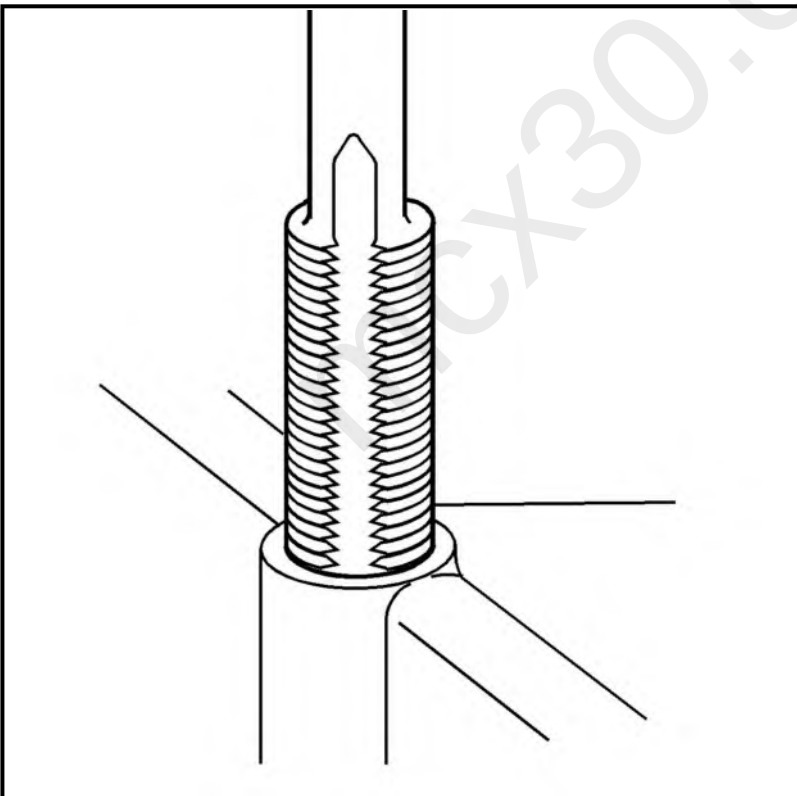
- During the drilling process, it is necessary to repeatedly remove the drill and clean chips from the hole and the flutes of the drill.
- Drill the hole until the stop collar contacts the surface of the base material.

3. Using compressed air, clean out any chips.



NOTE: All chips must be removed from the drilled hole prior to tapping.

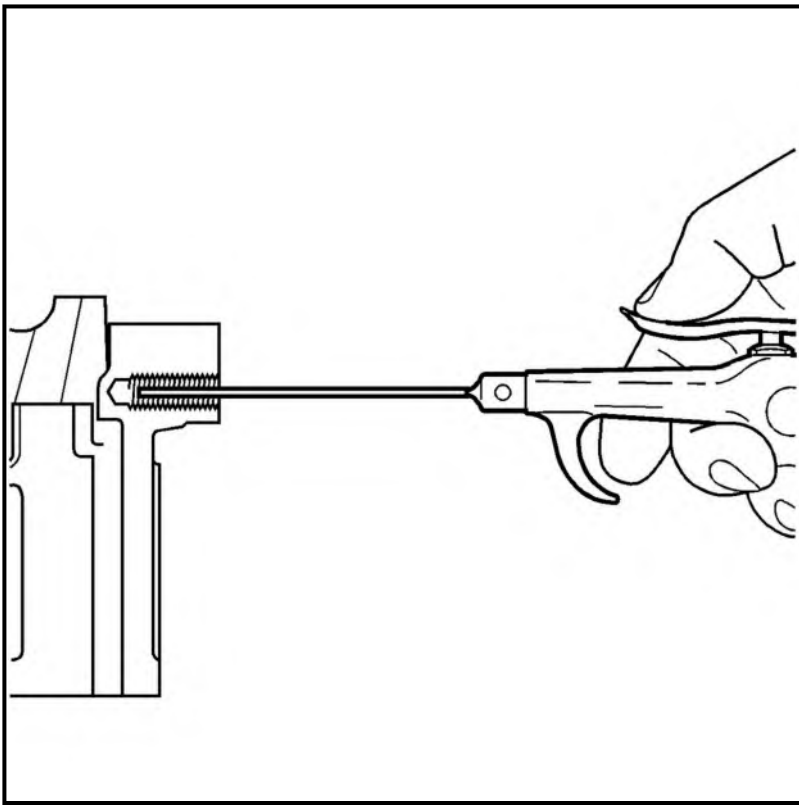
4. Using a suitable tapping wrench, tap the threads of the drilled hole by hand only.



NOTE:

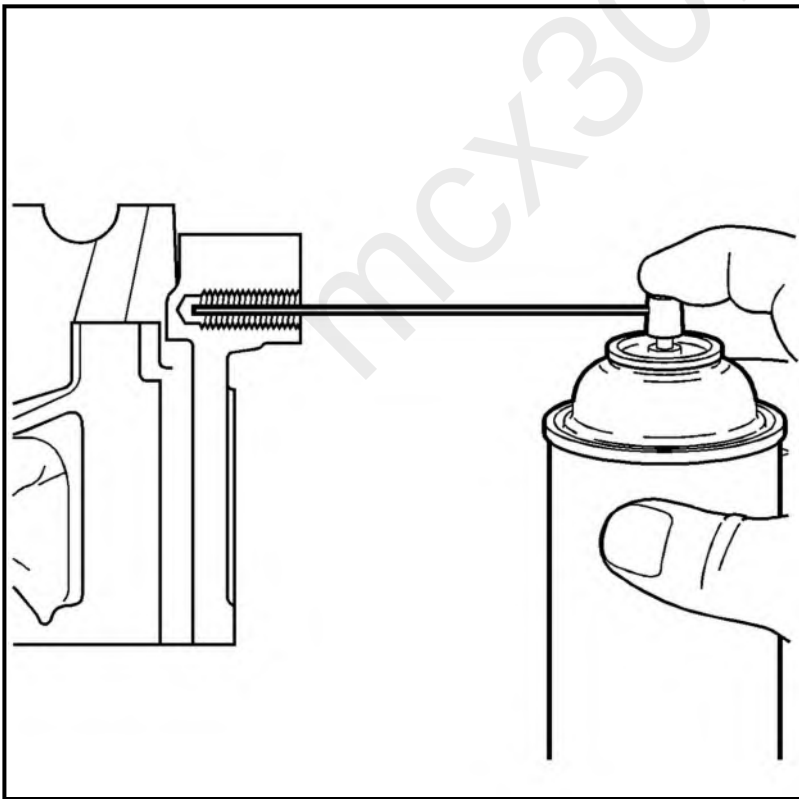
- During the tapping process, it is necessary to repeatedly remove the tap and clean chips from the hole and the flutes of the tap.
- Ensure the tap has created full threads at least to the depth equal to the insert length.

5. Using compressed air, clean out any chips.

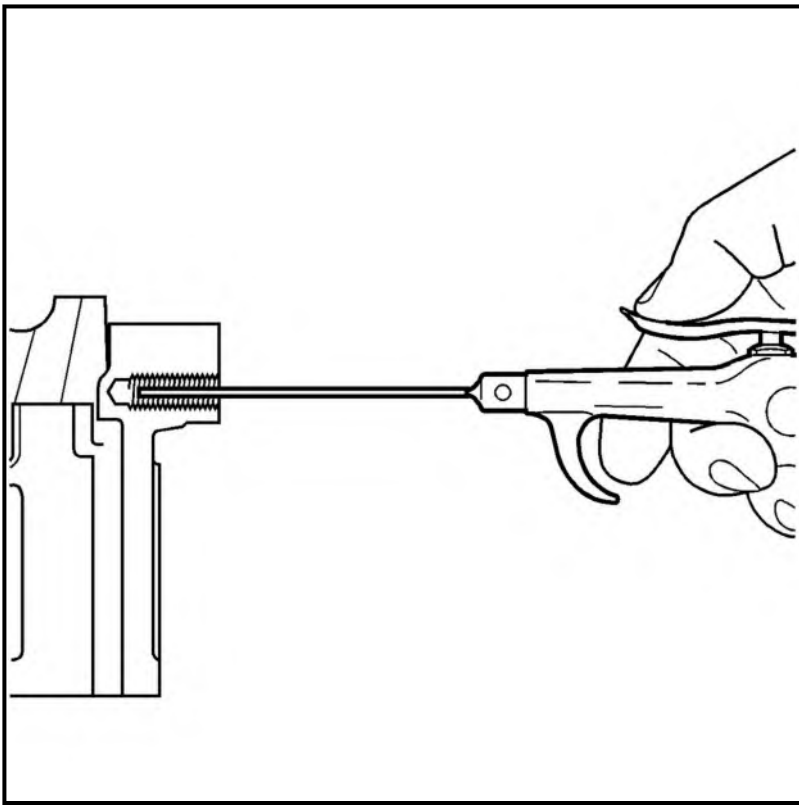


NOTE: All chips must be removed from the tapped hole prior to insert installation.

6. Spray cleaner into the tapped hole. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended cleaner.

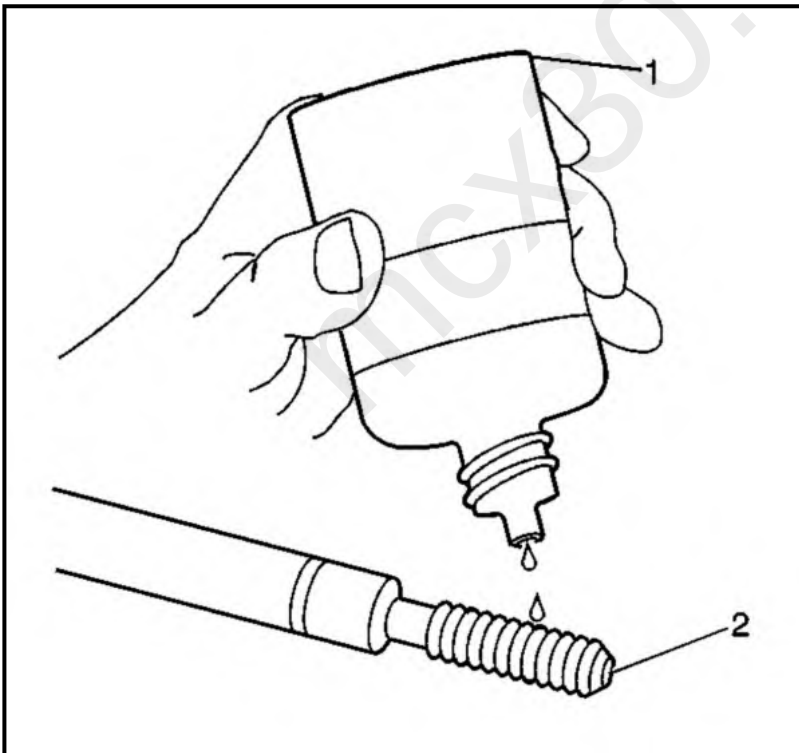


7. Using compressed air, clean out any chips.



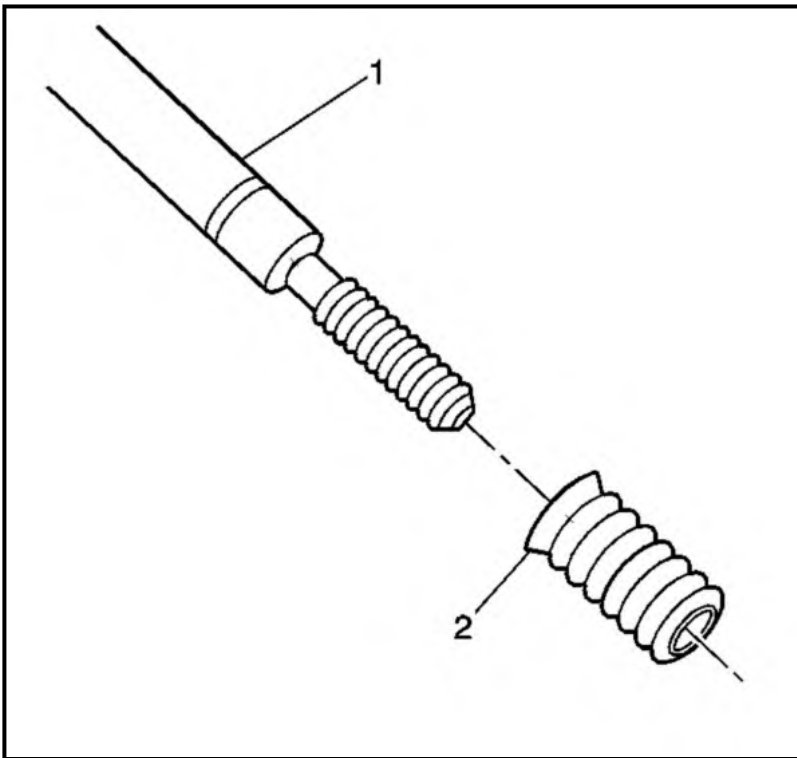
NOTE: All chips must be removed from the tapped hole prior to insert installation.

8. Lubricate the threads of the driver installation tool (2) with the EN 42385-110 (1).

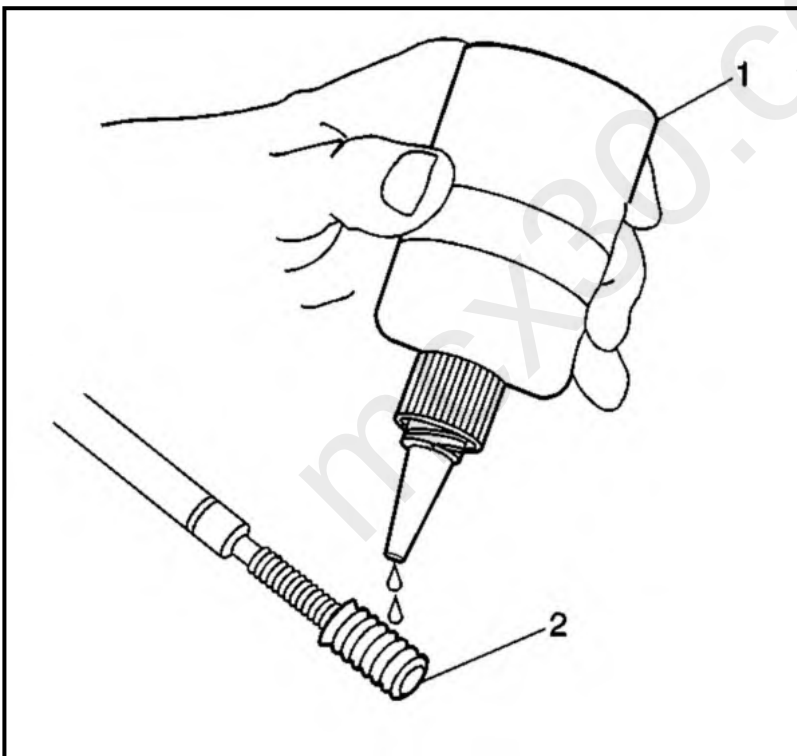


NOTE: Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.

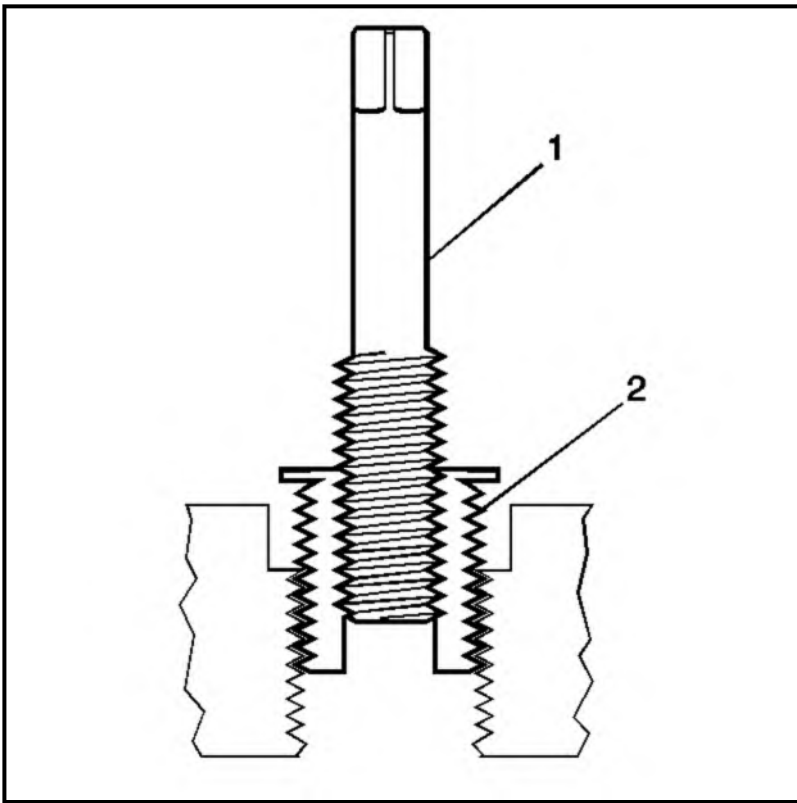
9. Install the insert (2) onto the driver installation tool (1).



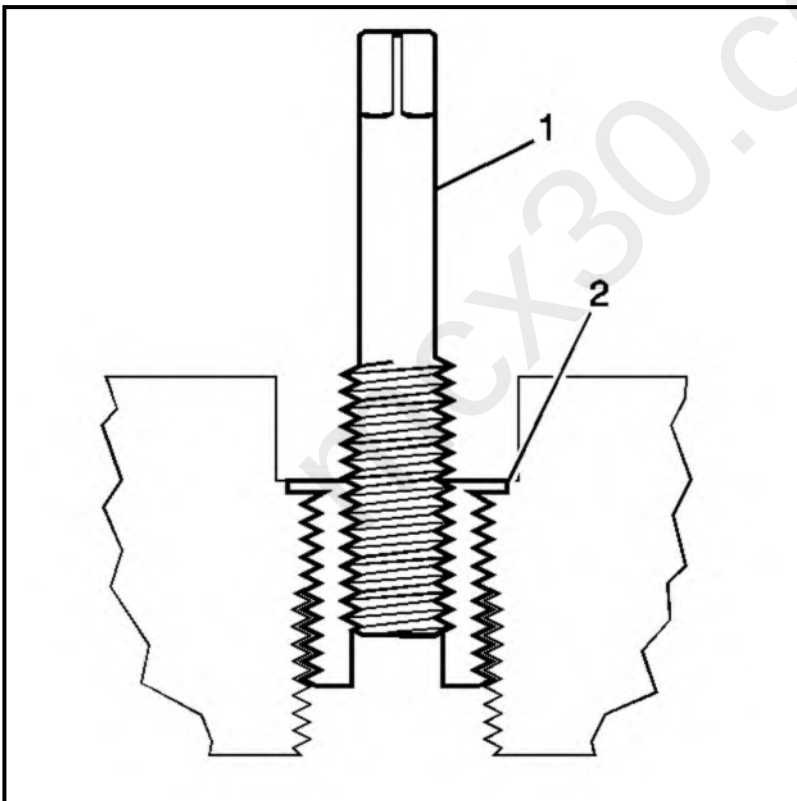
10. Apply threadlock sealant, **EN - 42385-109** , LOCTITE 277Â® or equivalent (1) to the insert OD threads (2). Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended sealant.



11. Install the insert (2) into the tapped hole by hand only.

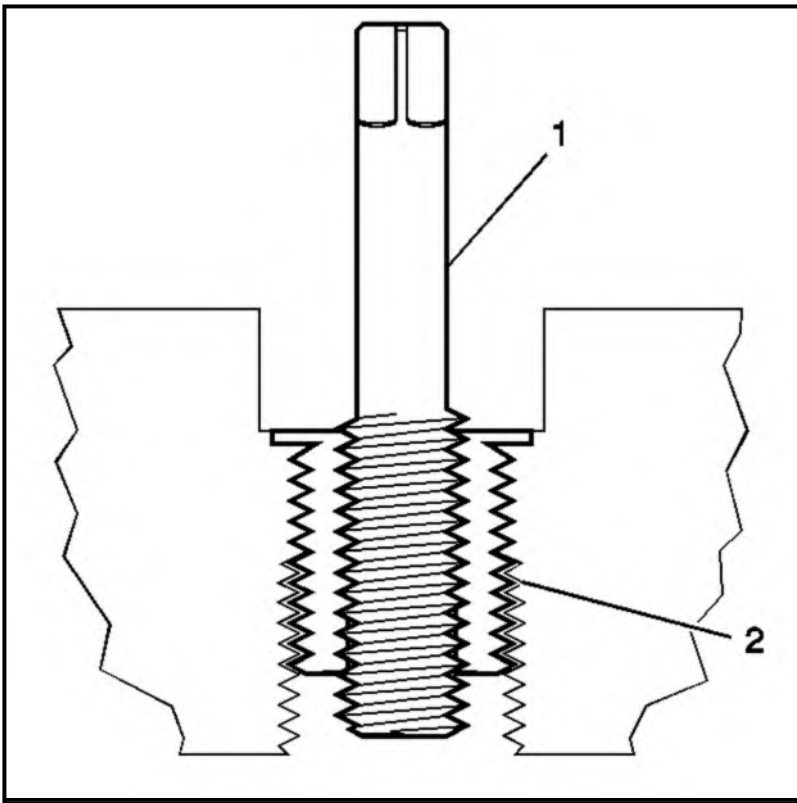


12. Install the insert until the flange (2) of the insert contacts the counterbored surface.



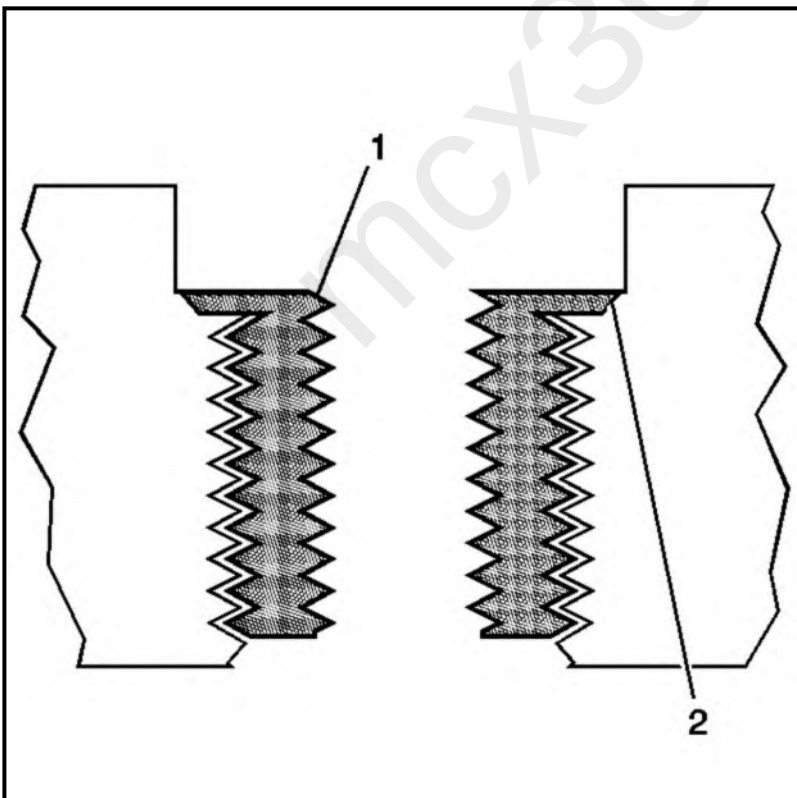
NOTE: If the insert will not thread down until the flange contacts the counterbored surface remove the insert immediately with a screw extracting tool and inspect the tapped hole for any remaining chips and/or improper tapping.

13. Continue to rotate the driver installation tool (1) through the insert (2).

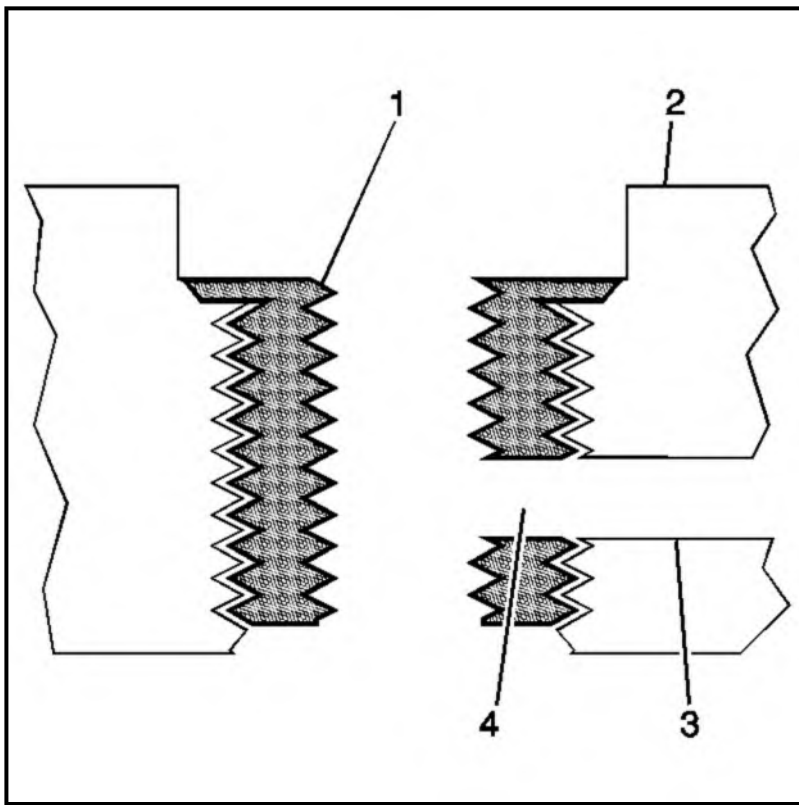


NOTE: The driver installation tool will tighten up before screwing completely through the insert. This is acceptable. The threads at the bottom of the insert are being formed and the insert is mechanically locking the insert into the base material threads.

14. Inspect the insert (1) for proper installation (2) into the tapped hole.

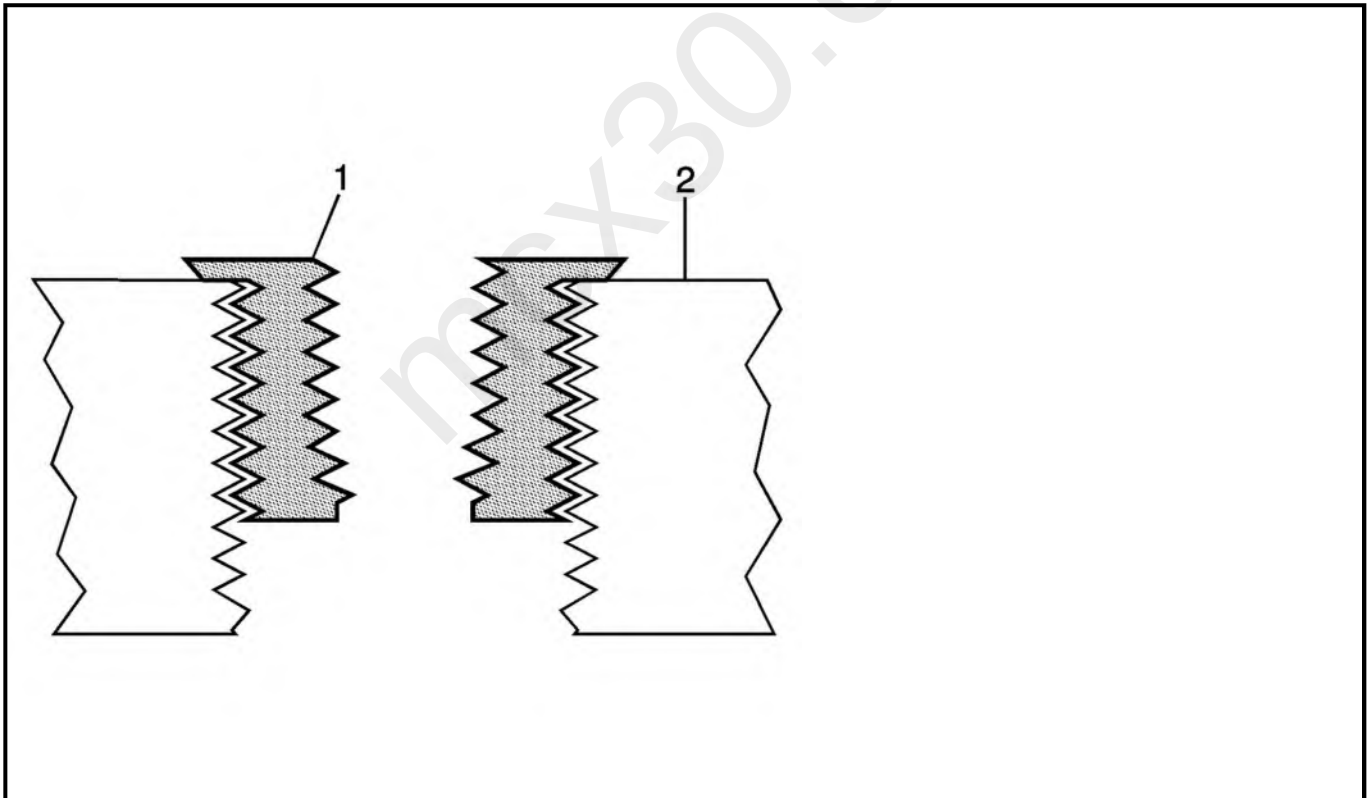


15. Any installed insert that restricts or blocks an oil or engine coolant passage (3) will need to have the oil or engine coolant passage drilled out (4) to the original size of the oil or engine coolant passage. After drilling the restriction or blockage, clean out any chips and thread the installation driver tool through the insert again to remove any burrs caused by the drilling of the oil or engine coolant passage.



Tapered Pipe Thread Repair

The thread repair insert for tapered pipe threads is coated with a clear silver zinc coating.

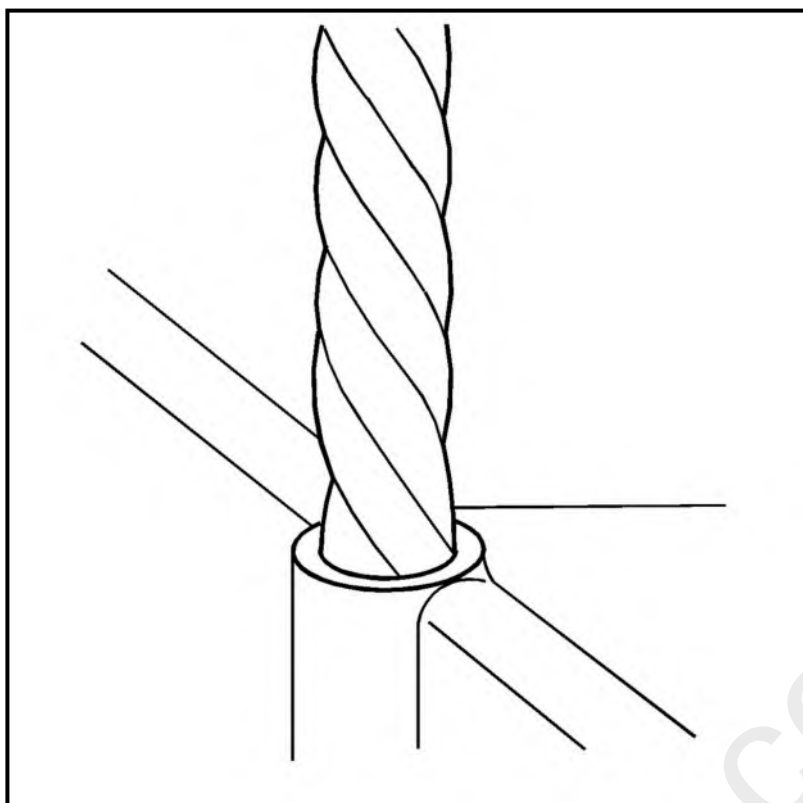


WARNING: Refer to [Safety Glasses Warning](#) .

NOTE: The use of a cutting type fluid, WD 40® or equivalent is recommended when performing the drilling, counterboring and tapping procedures. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended cutting fluid.

When installed to the proper depth, the flange (1) of the insert will be seated against surface (2) of the base material of the drilled/tapped hole.

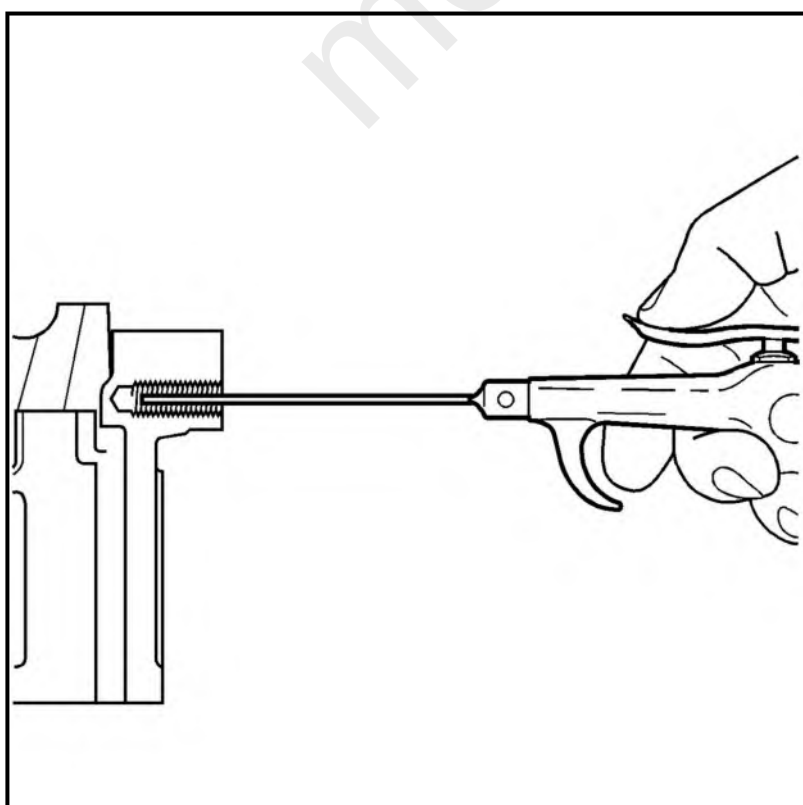
1. Drill out the threads of the damaged hole.



NOTE:

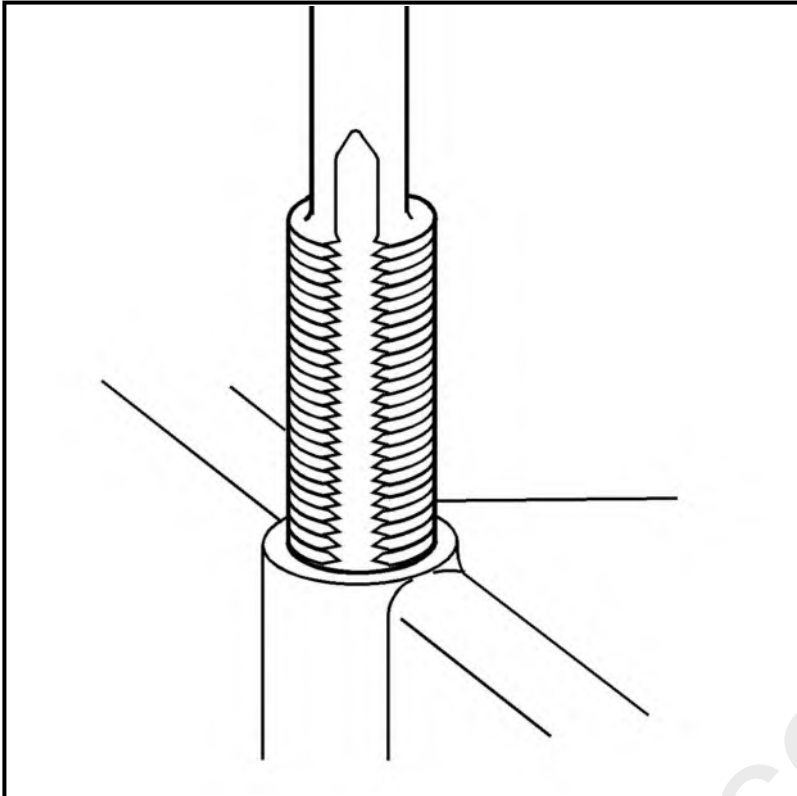
- During the drilling process, it is necessary to repeatedly remove the drill and clean chips from the hole and the flutes of the drill.
- Drill the hole until the stop collar contacts the surface of the base material.

2. Using compressed air, clean out any chips.



NOTE: All chips must be removed from the drilled hole prior to tapping.

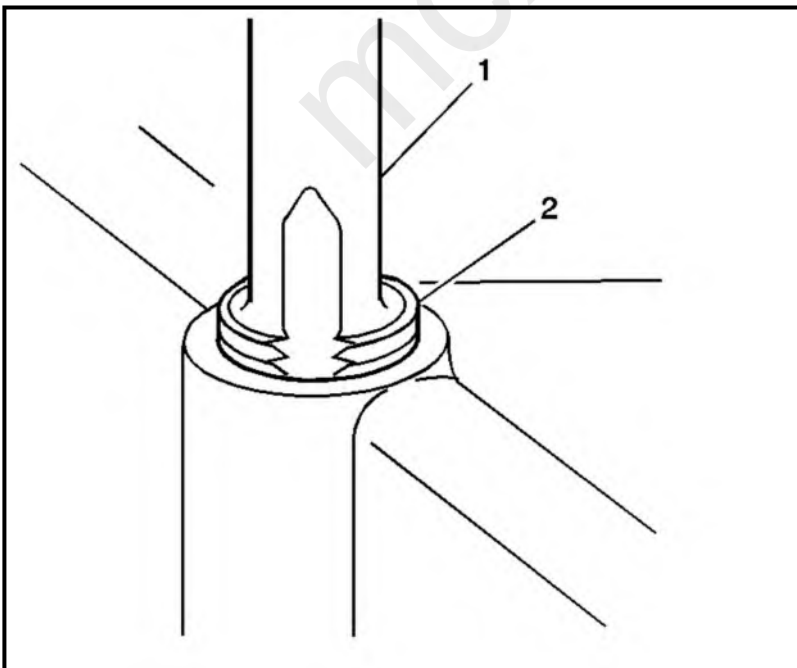
3. Using a suitable tapping wrench, tap the threads of the drilled hole by hand only.



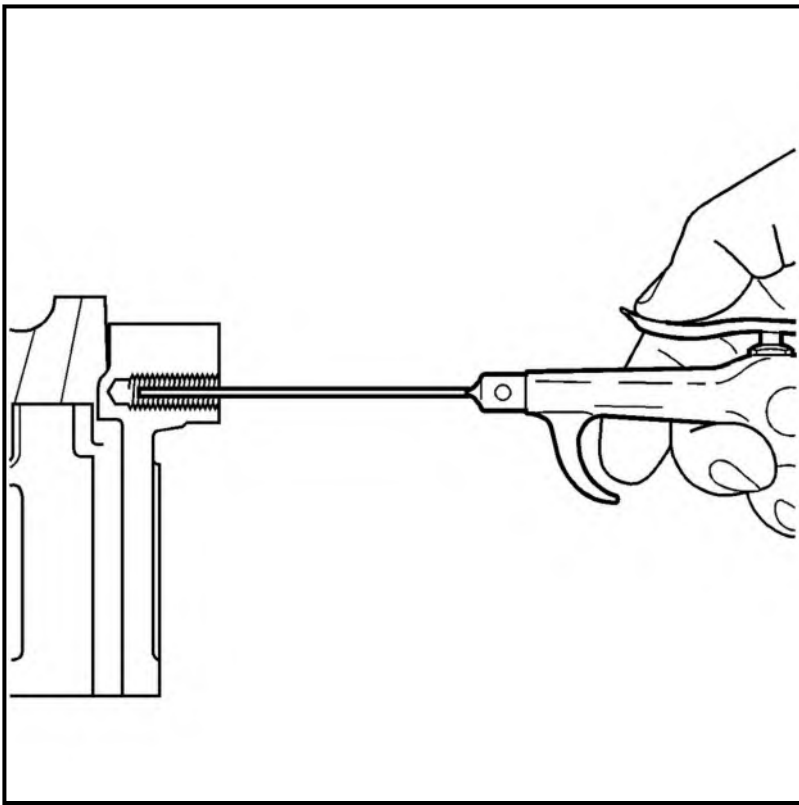
NOTE:

- During the tapping process, it is necessary to repeatedly remove the tap and clean chips from the hole and the flutes of the tap.
- Ensure the tap has created full threads at least to the depth equal to the insert length.

4. Tap the drilled hole until the threads at the top of the tap (2) are down to the surface of the base material.

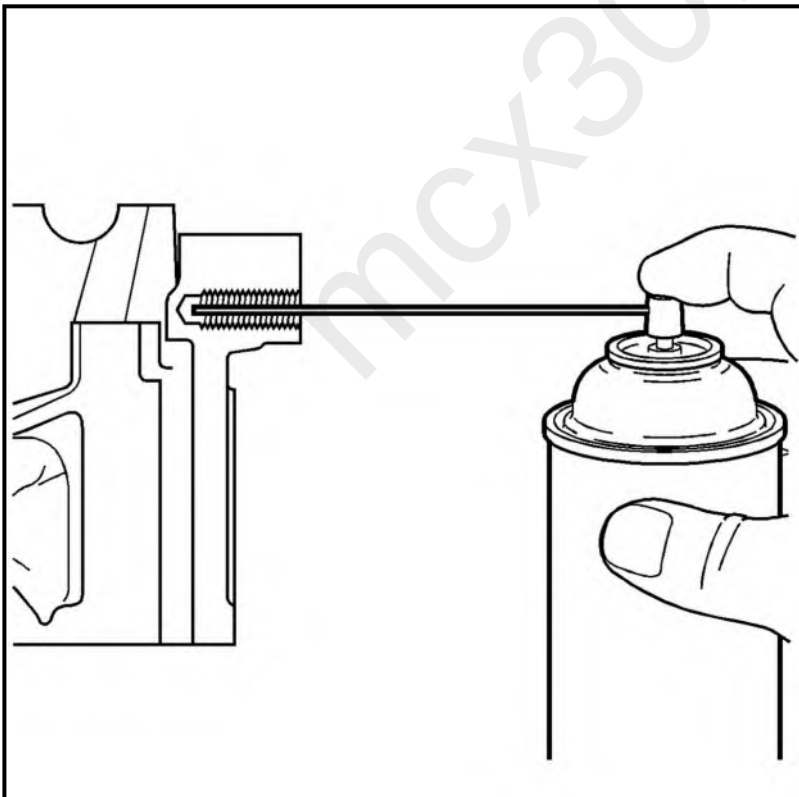


5. Using compressed air, clean out any chips.

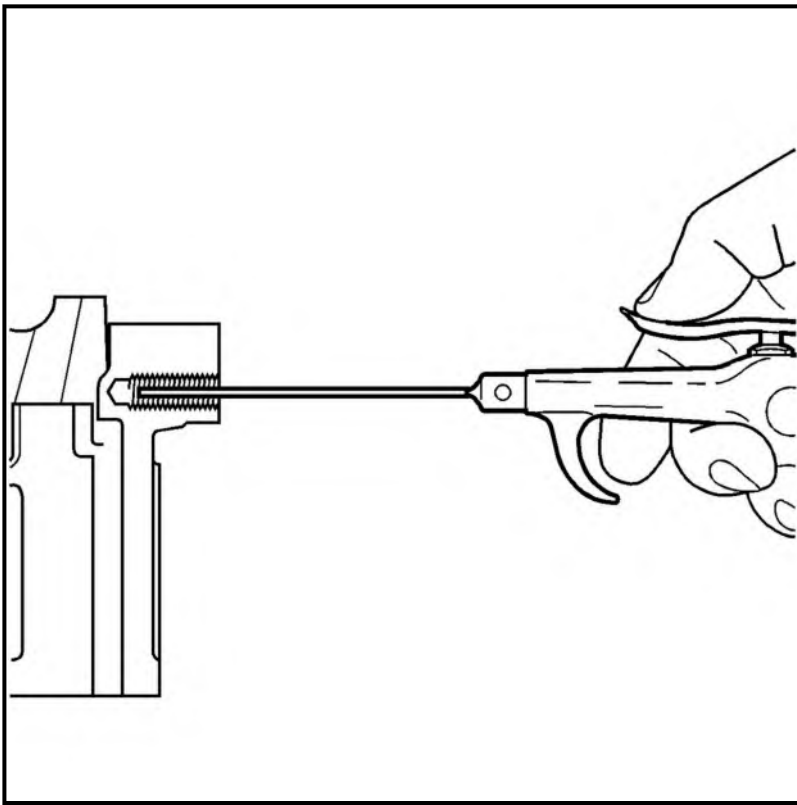


NOTE: All chips must be removed from the tapped hole prior to insert installation.

6. Spray cleaner into the tapped hole. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended cleaner.

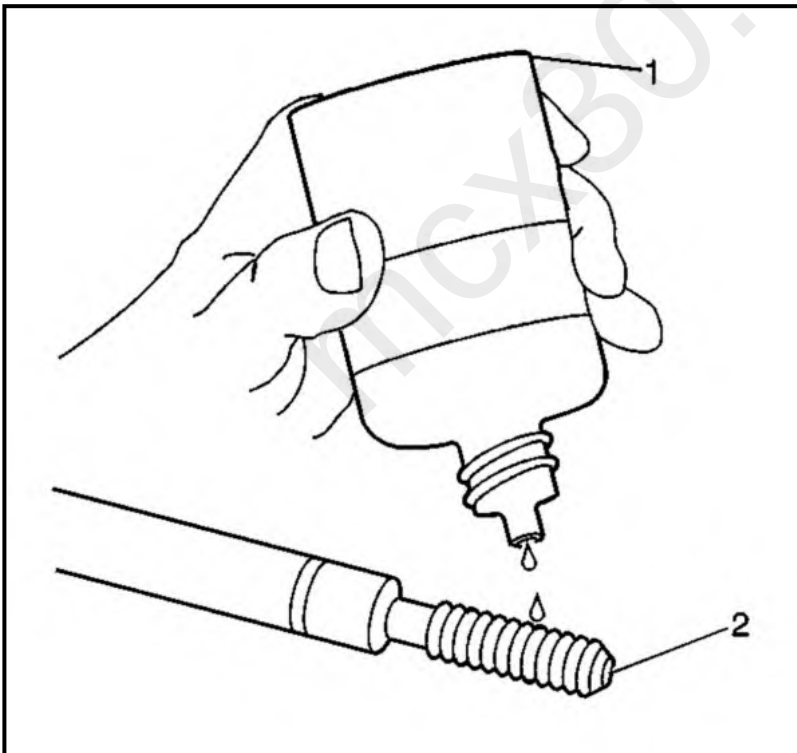


7. Using compressed air, clean out any chips.



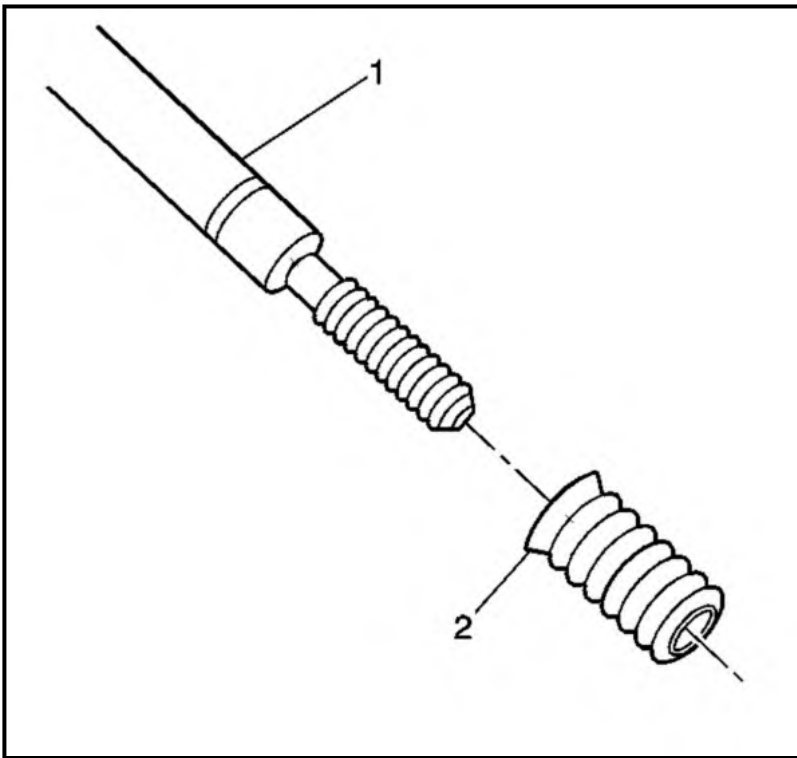
NOTE: All chips must be removed from the tapped hole prior to insert installation.

8. Lubricate the threads of the driver installation tool (2) with the EN 42385-110 (1).

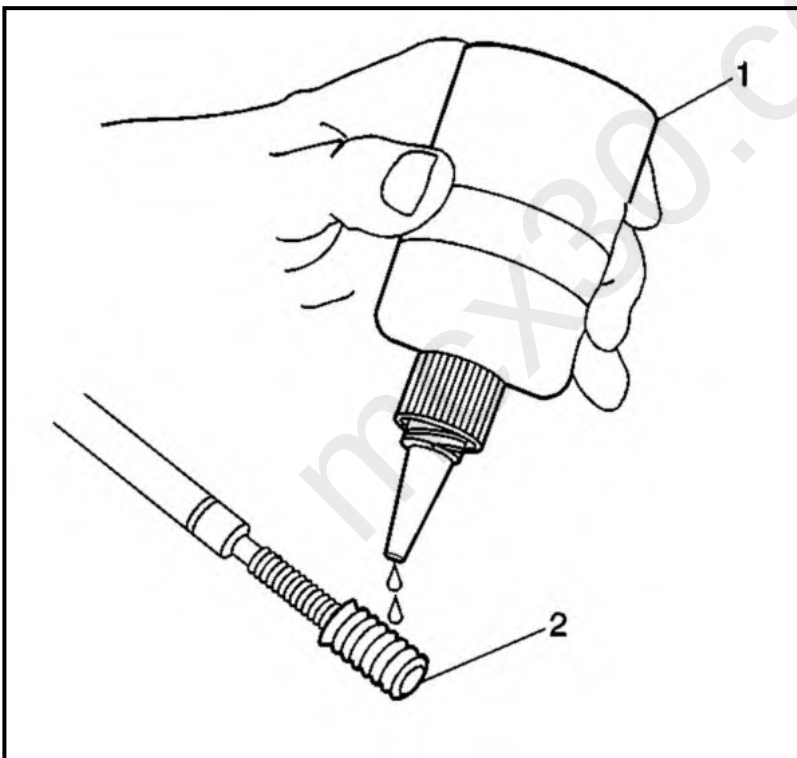


NOTE: Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.

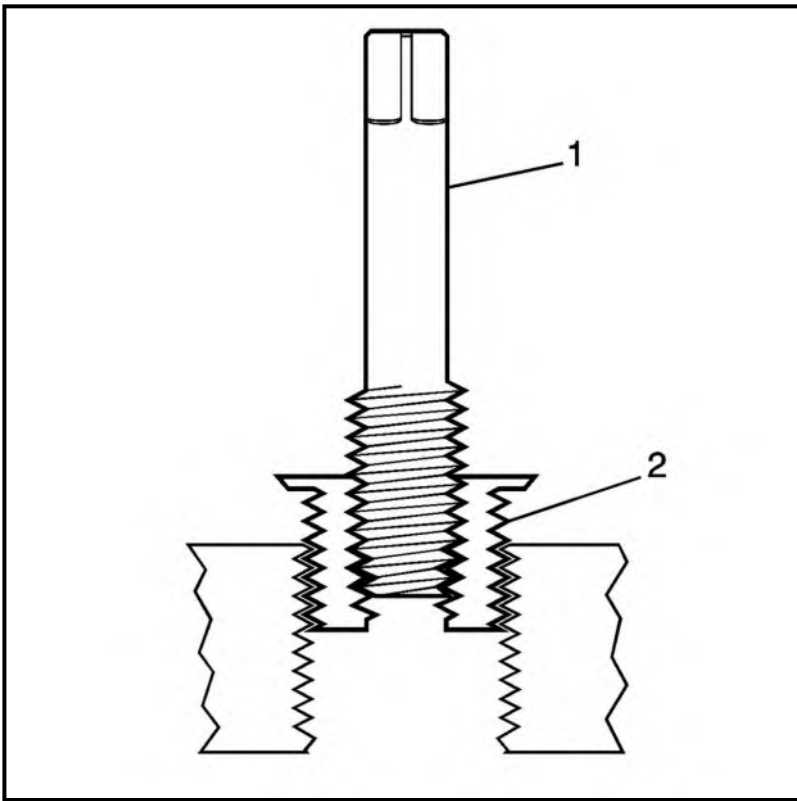
9. Install the insert (2) onto the driver installation tool (1).



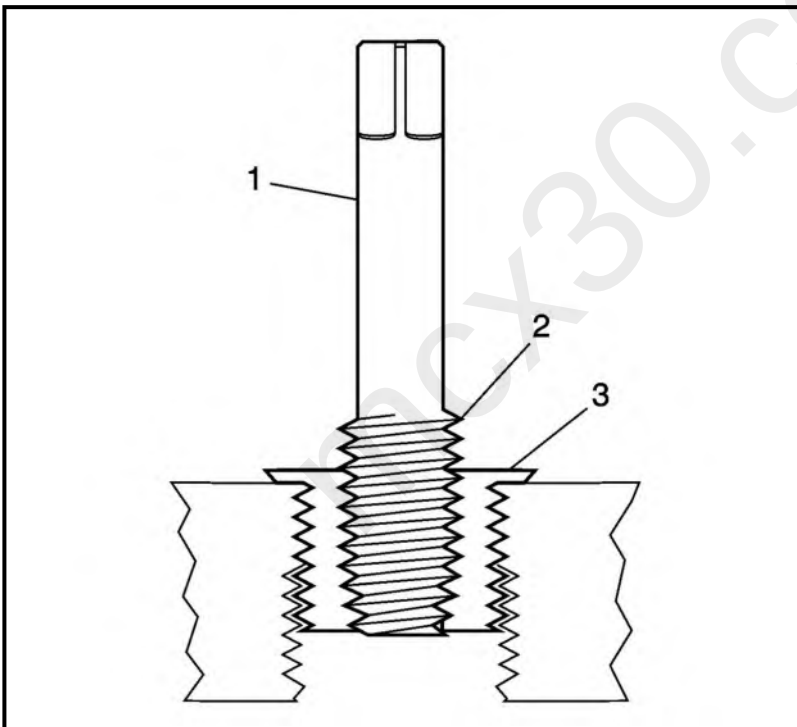
10. Apply threadlock sealant, **EN - 42385-109** , LOCTITE 277Â® or equivalent (1) to the insert OD threads (2). Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended sealant.



11. Install the insert (2) into the tapped hole by hand only.



12. Install the insert until the flange of the insert (3) contacts the surface of the base material.

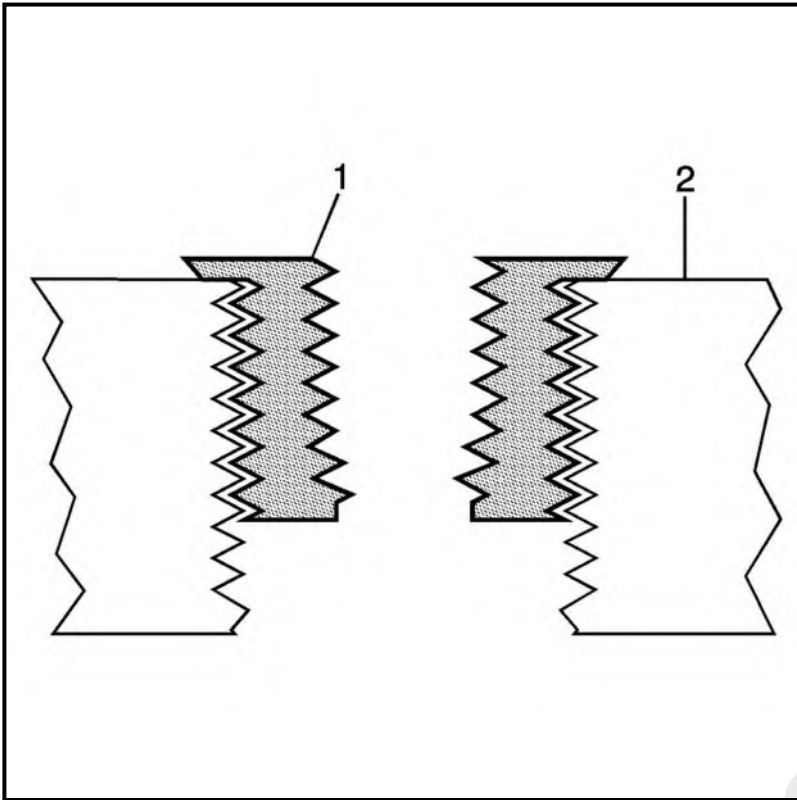


NOTE: If the insert will not thread down until the flange contacts the surface of the base material remove the insert immediately with a screw extracting tool and inspect the tapped hole for any remaining chips and/or improper tapping.

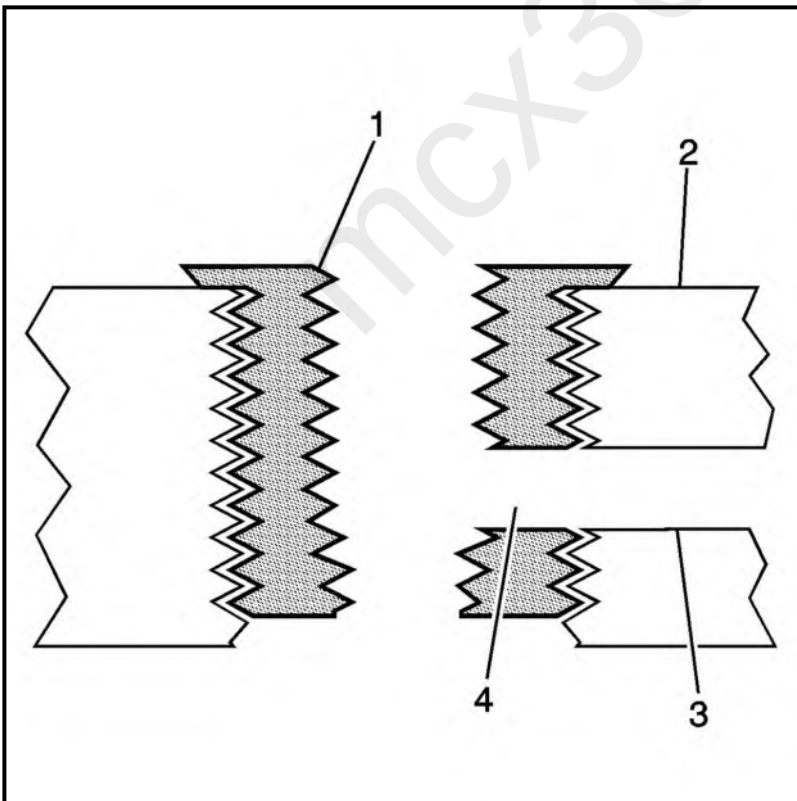
NOTE: The driver installation tool will tighten up before screwing completely through the insert. This is acceptable. The threads at the bottom of the insert are being formed and the insert is mechanically locking the insert into the base material threads.

13. Continue to rotate the driver installation tool (1) until the top of the threaded section (2) is level with the top of the insert (3).

14. Inspect the insert (1) for proper installation (2) into the tapped hole.



15. Any installed insert that restricts or blocks an oil or engine coolant passage (3) will need to have the oil or engine coolant passage drilled out (4) to the original size of the oil or engine coolant passage. After drilling the restriction or blockage, clean out any chips and thread the installation driver tool through the insert again to remove any burrs caused by the drilling of the oil or engine coolant passage.



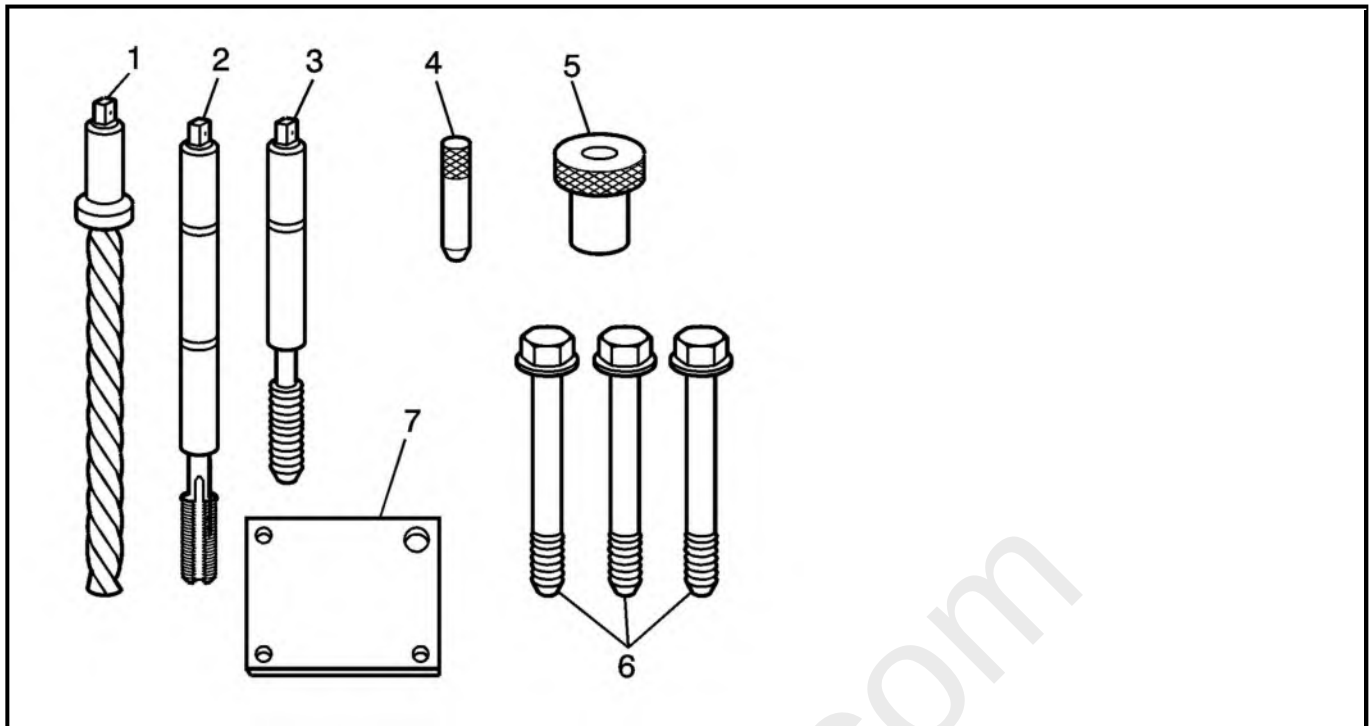
Cylinder Head Bolt Hole Thread Repair

Special Tools

- EN - 42385-70 Head Bolt Thread Repair Fixture

- EN - 42385-700 High Feature Thread Repair Kit
- EN - 42385-2000 Thread Insert Kit

For equivalent regional tools, refer to [Special Tools](#) .



The cylinder head bolt hole thread repair tooling are in the kits EN - 42385-2000 insert kit and EN - 42385-700 kit. The cylinder head bolt hole thread repair components consist of the following:

- EN - 42385-723 Drill (1)
- EN - 42385-724 Tap (2)
- EN - 42385-725 Installation driver (3)
- EN - 42385-303 Alignment pin (4)
- EN - 42385-70 Bushing (5)
- EN - 42385-733 Bolts (6)
- EN - 42385-70 Fixture plate (7)

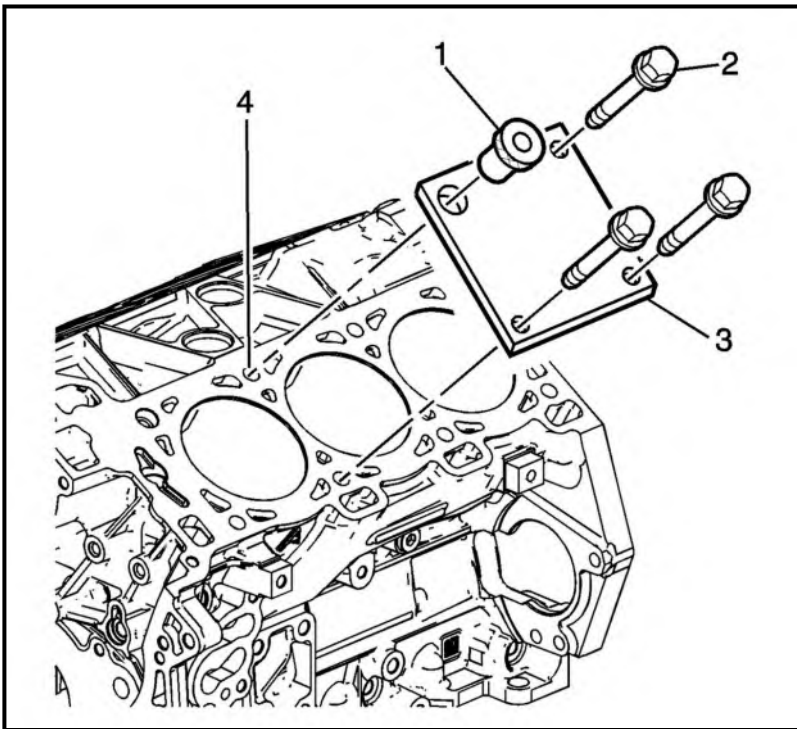
WARNING: Refer to [Safety Glasses Warning](#) .

NOTE:

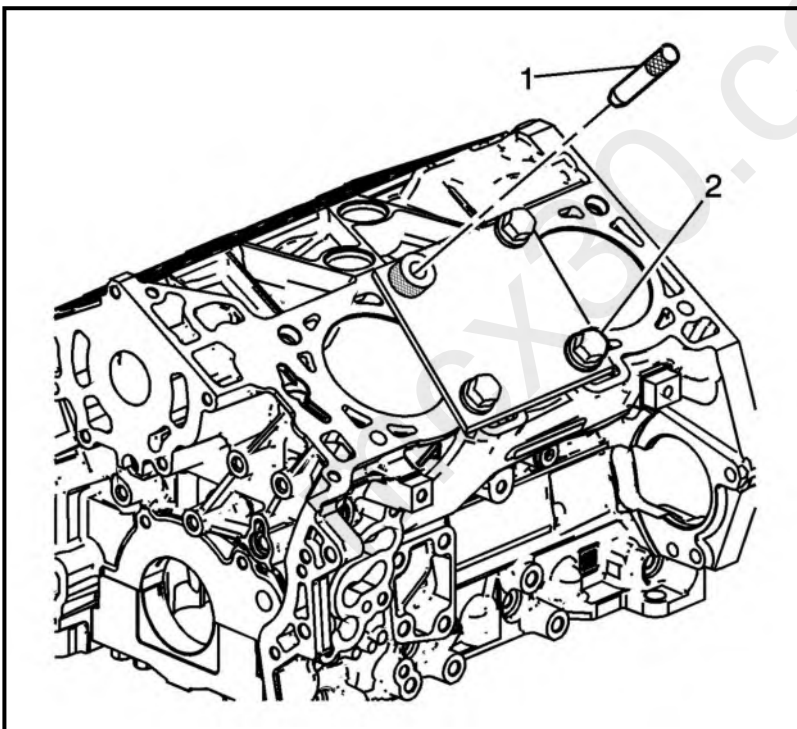
- Remove the fixture plate prior to installing the insert with the installer tool.
- The use of a cutting type fluid, WD 40®; or equivalent is recommended when performing the drilling, counterboring and tapping procedures. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended cutting fluid.

When installed to the proper depth, the flange of the insert will be seated against the counterbore of the drilled/tapped hole.

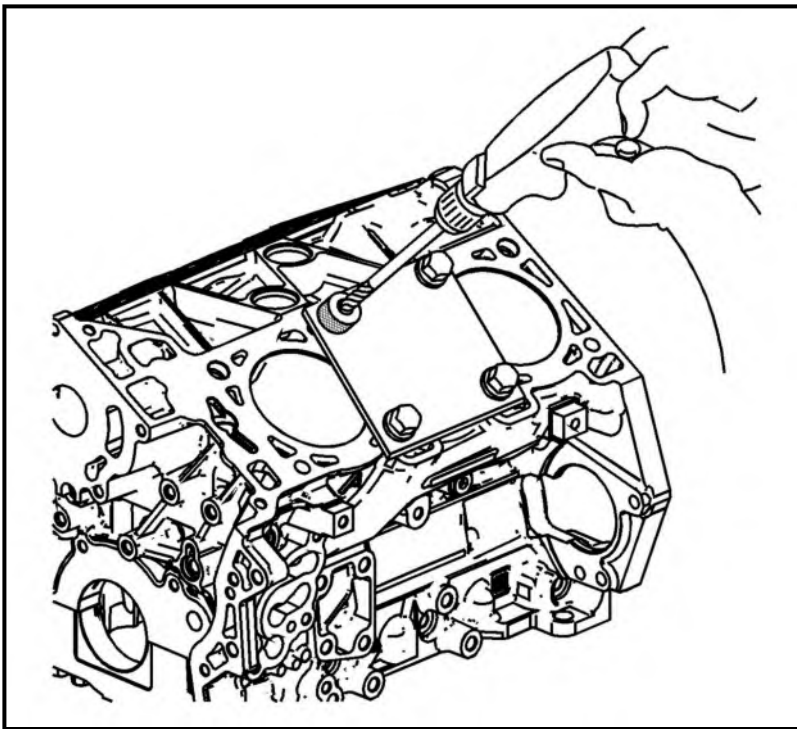
1. Position the fixture plate (3) with the bushing (1) installed over the cylinder head bolt hole to be repaired (4).



2. Loosely install the fixture plate bolts (2) into the remaining cylinder head bolt holes.
3. Position the alignment pin (1) through the bushing and into the cylinder head bolt hole.



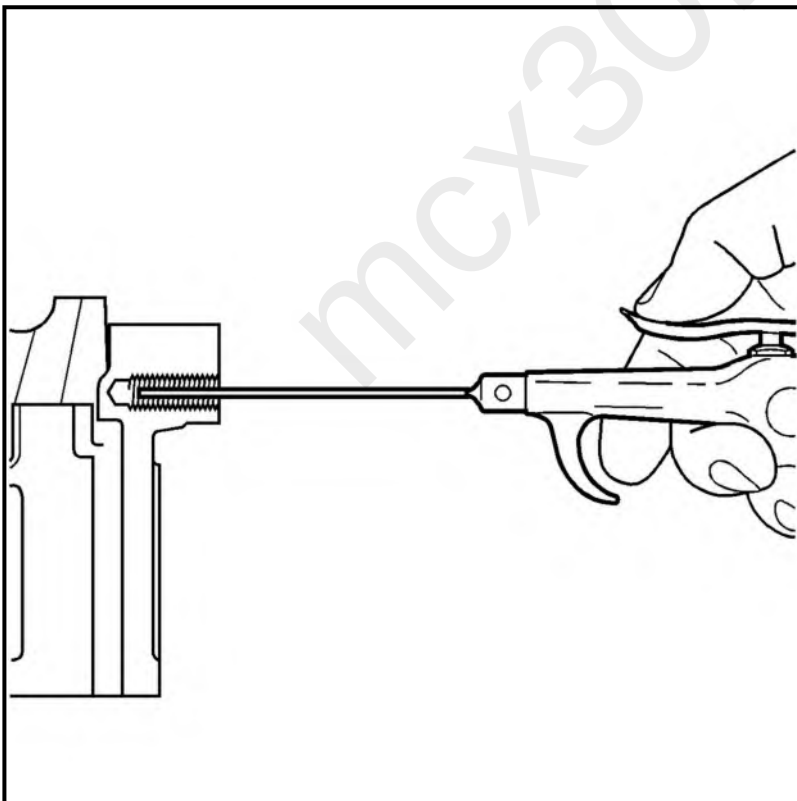
4. With the alignment pin in the desired cylinder head bolt hole, tighten the fixture retaining bolts (2).
5. Remove the alignment pin (1) from the cylinder head bolt hole.
6. Drill out the threads of the damaged hole.



NOTE:

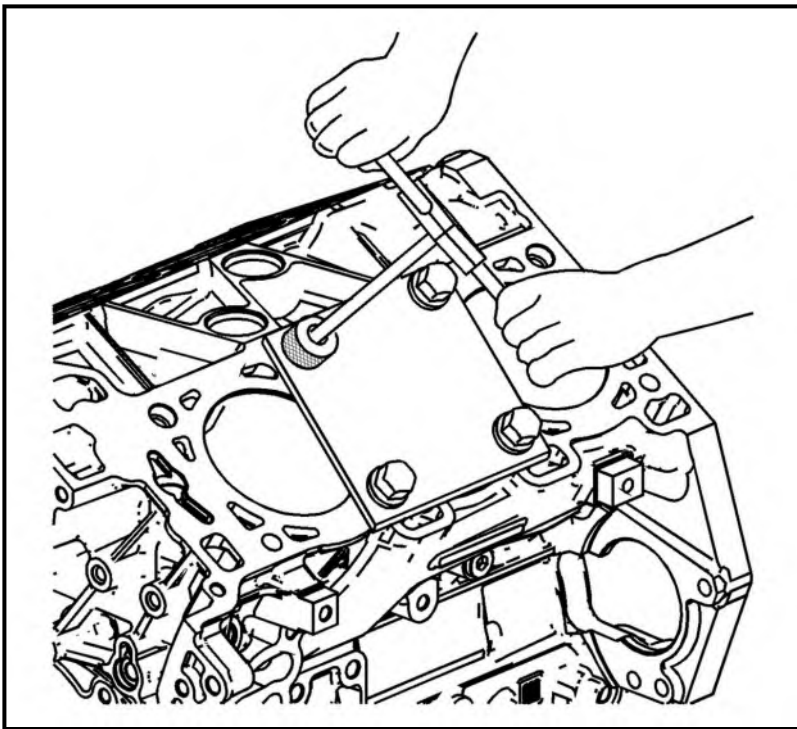
- During the drilling process, it is necessary to repeatedly remove the drill and clean chips from the hole and the flutes of the drill.
- Drill the hole until the stop collar contacts the top of the drill bushing.

7. Using compressed air, clean out any chips.



NOTE: All chips must be removed from the drilled hole prior to tapping.

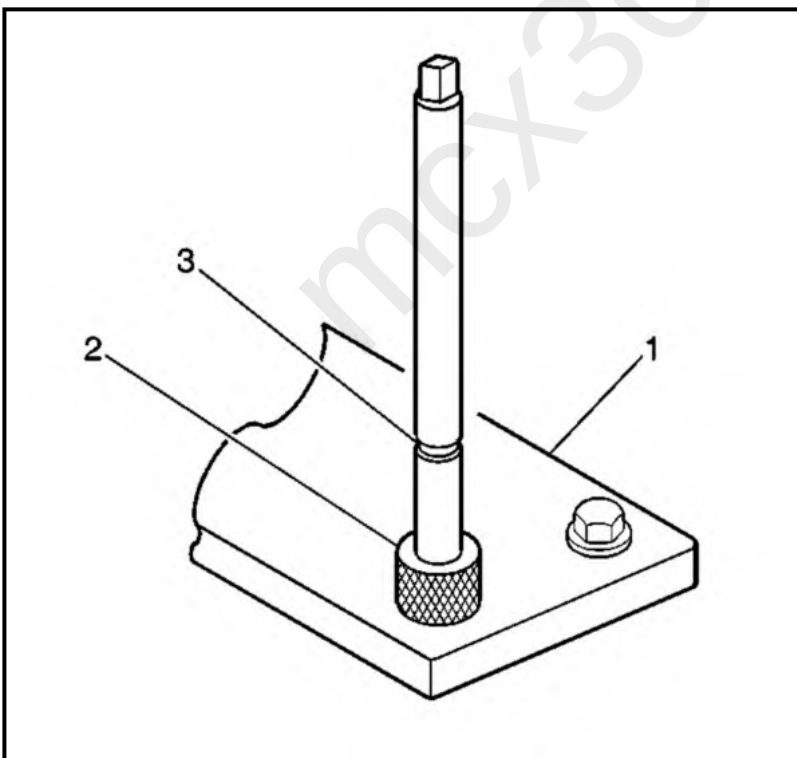
8. Using a suitable tapping wrench, tap the threads of the drilled hole by hand only.



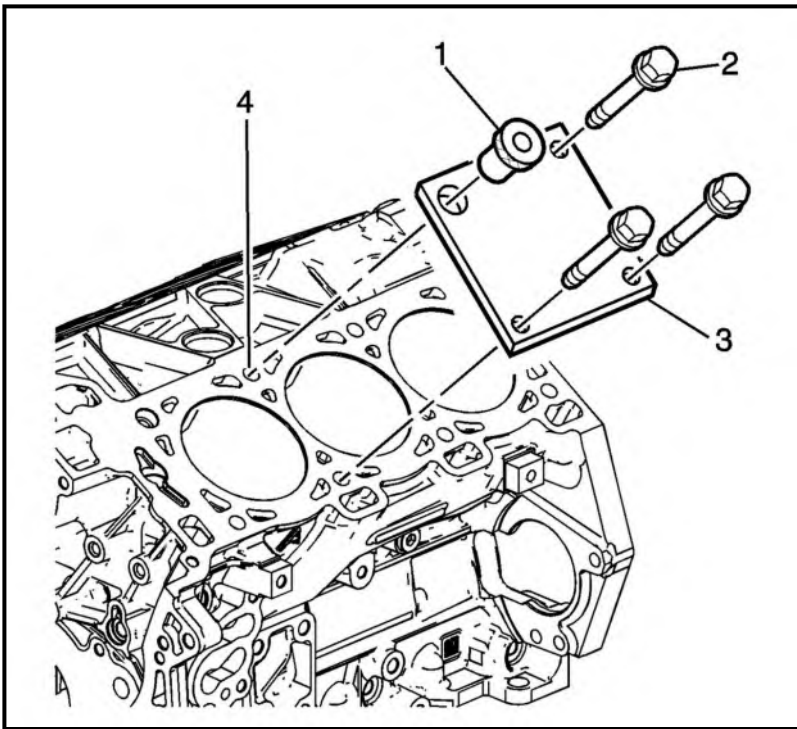
NOTE:

- During the tapping process, it is necessary to repeatedly remove the tap and clean chips from the hole and the flutes of the tap.
- Ensure the tap has created full threads at least to the depth equal to the insert length.

9. In order to tap the new threads for the insert to the proper depth, rotate the tap into the cylinder head bolt hole until the mark (3) on the tap aligns with the top of the drill bushing (2).

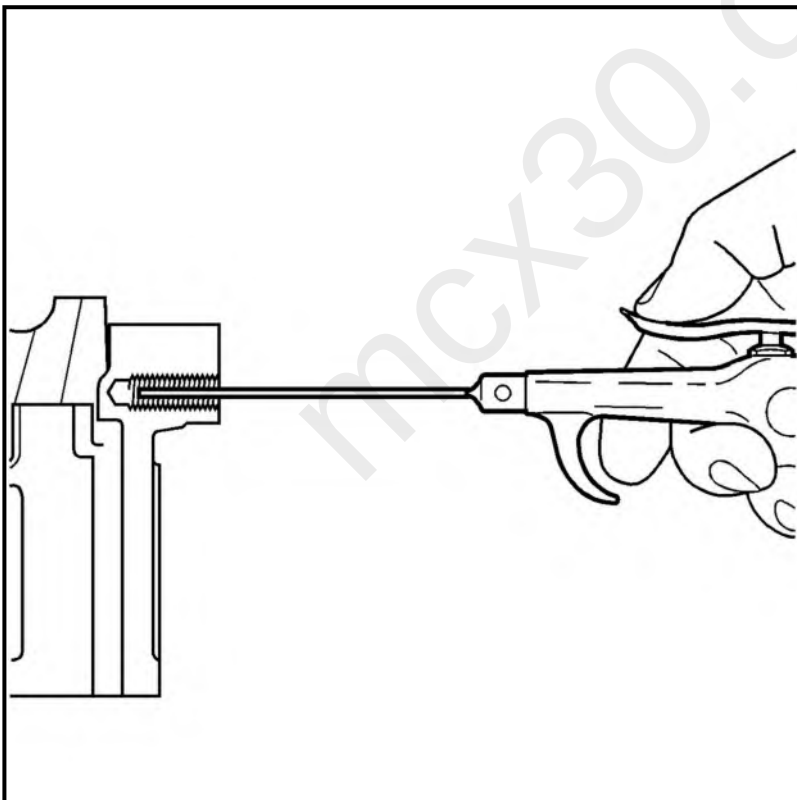


10. Remove the fixture plate bolts (2).



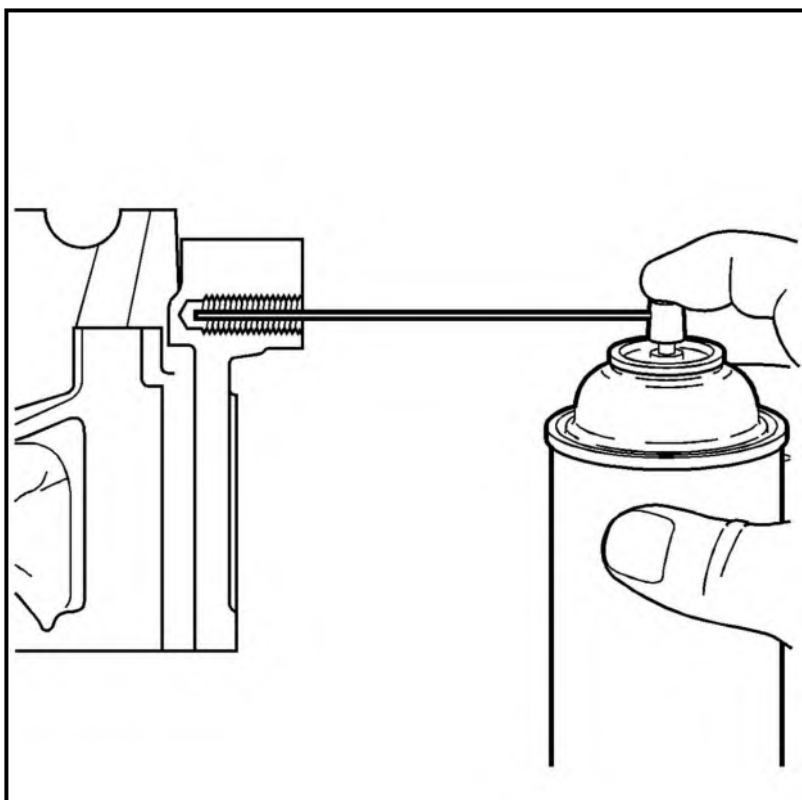
NOTE: Remove the fixture plate prior to installing the insert with the installer tool.

11. Remove the fixture plate (3) and bushing (1).
12. Using compressed air, clean out any chips.

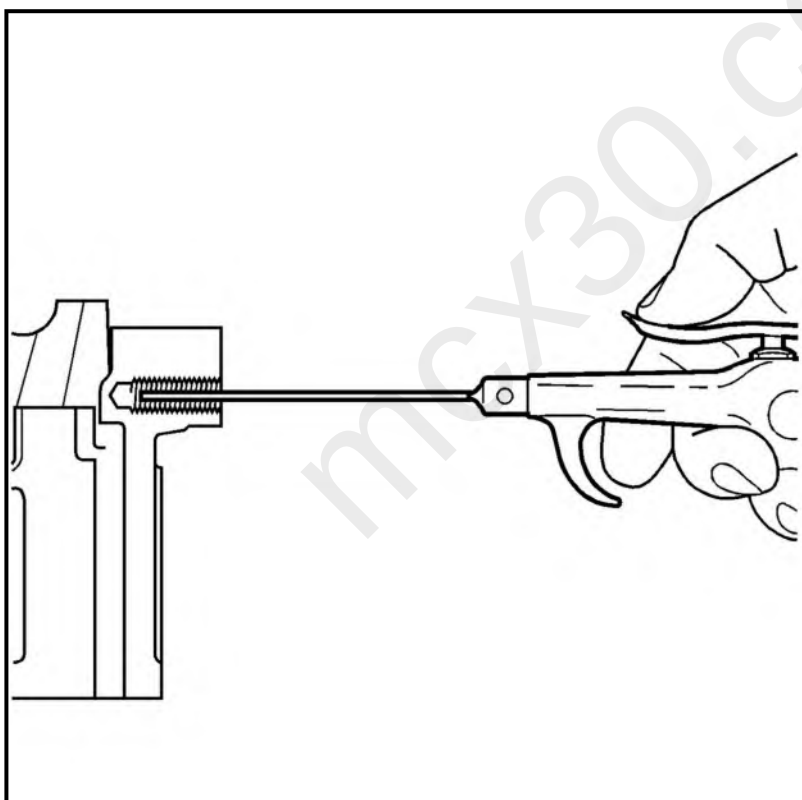


NOTE: All chips must be removed from the tapped hole prior to insert installation.

13. Spray cleaner into the tapped hole. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended cleaner.

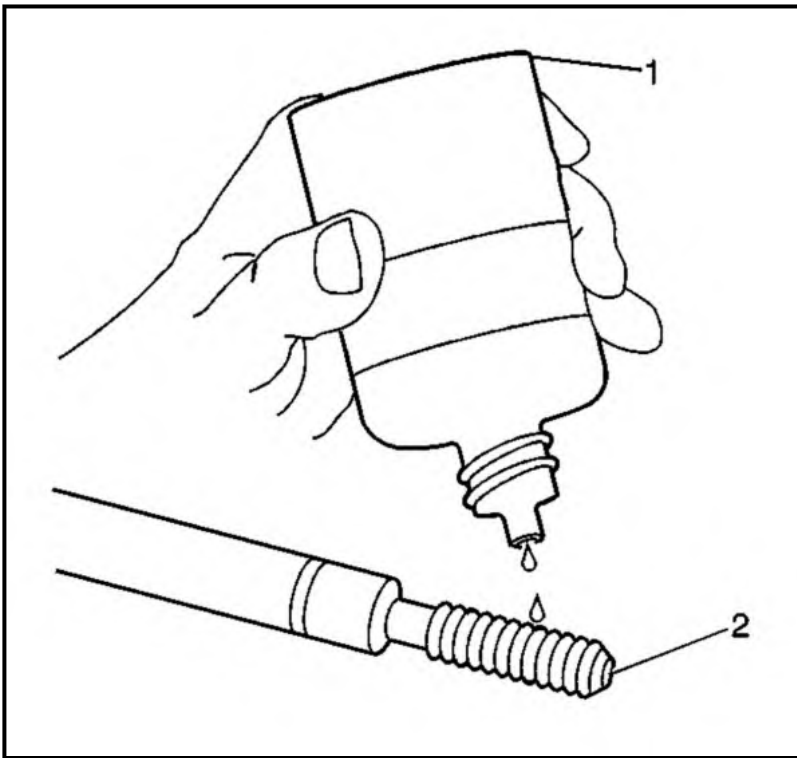


14. Using compressed air, clean out any chips.



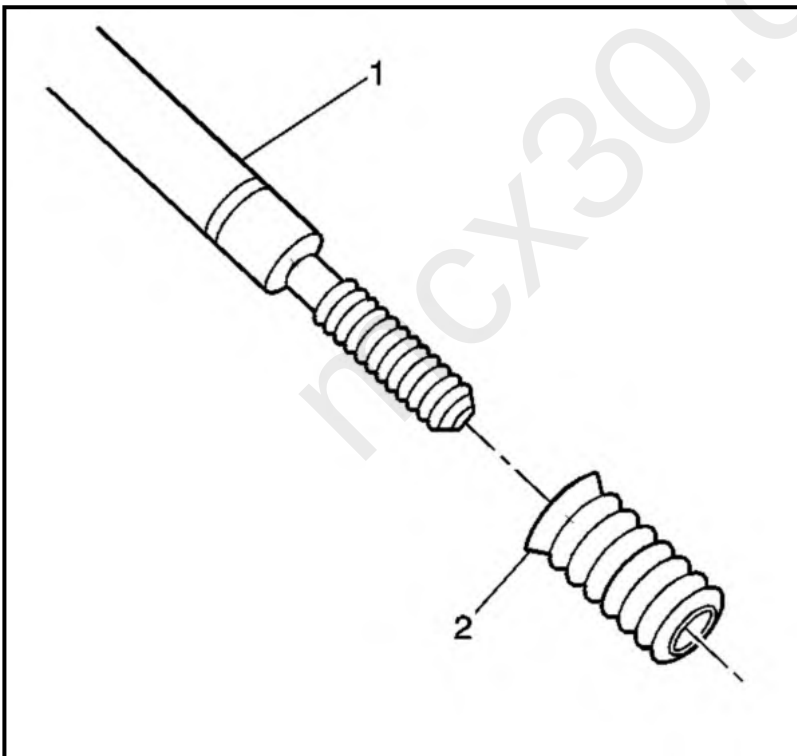
NOTE: All chips must be removed from the tapped hole prior to insert installation.

15. Lubricate the threads of the driver installation tool (2) with the EN - 42385-110 (1).

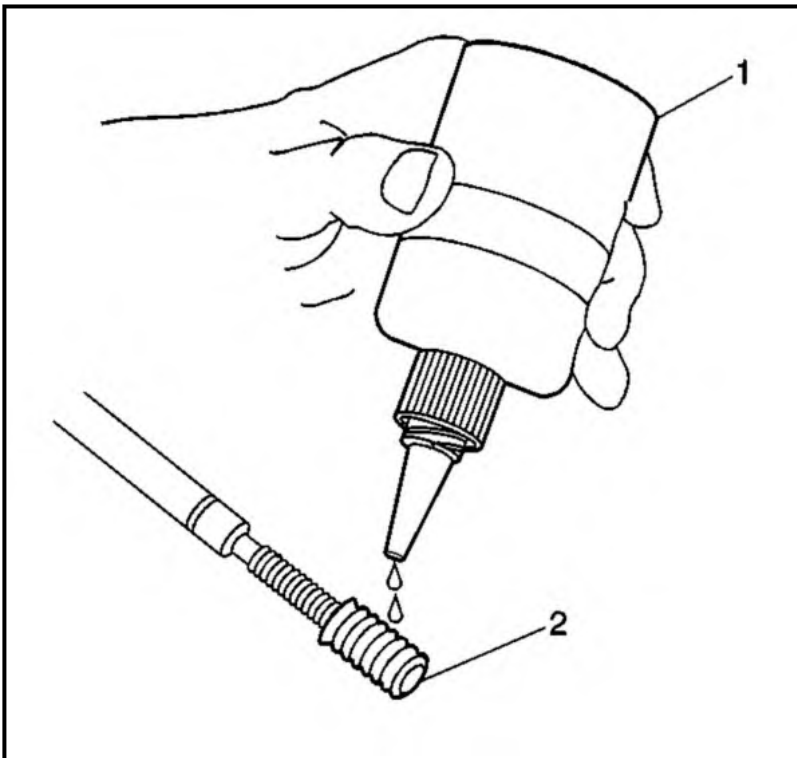


NOTE: Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.

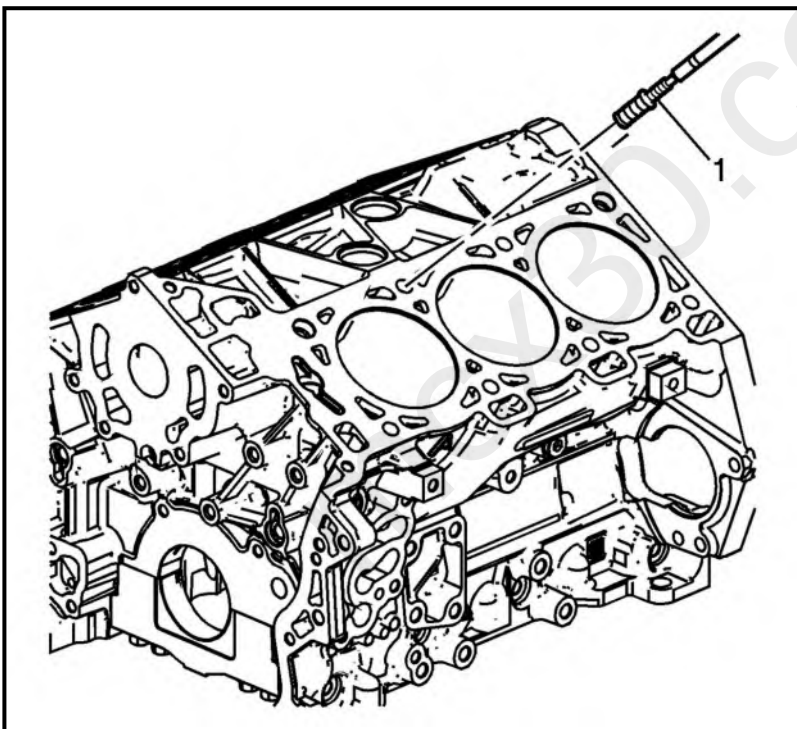
16. Install the insert (2) onto the driver installation tool (1).



17. Apply threadlock sealant, EN - 42385-109 , LOCTITE 277Â®; or equivalent (1) to the insert OD threads (2). Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended sealant.



18. Install the insert and installation driver (1) into the tapped hole by hand only.



19. Start the insert into the threaded hole.

NOTE:

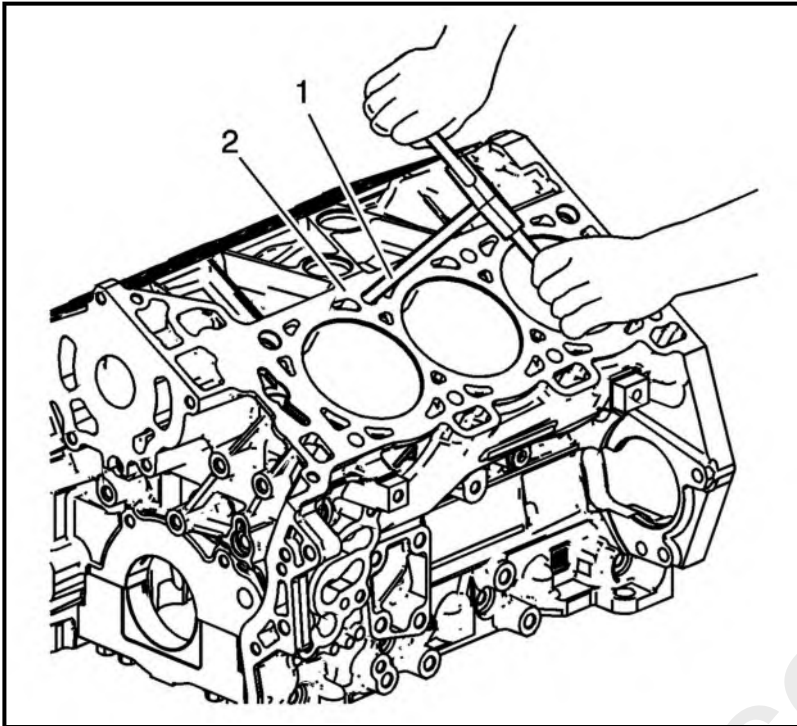
If the insert will not thread down until the flange contacts the counterbored surface remove the insert immediately with a screw extracting tool and inspect the tapped hole for any remaining chips and/or improper tapping.

20. Install the insert until the flange of the insert contacts the counterbored surface.

NOTE:

The driver installation tool will tighten up before screwing completely through the insert. This is acceptable. The threads at the bottom of the insert are being formed and the insert is mechanically locking the insert into the base material threads.

21. Continue to rotate the driver installation tool through the insert.
22. In order to completely form the new threads in the insert, rotate the driver installation tool through the insert until the mark (1) on the driver installation tool aligns with the surface of the engine block deck (2).



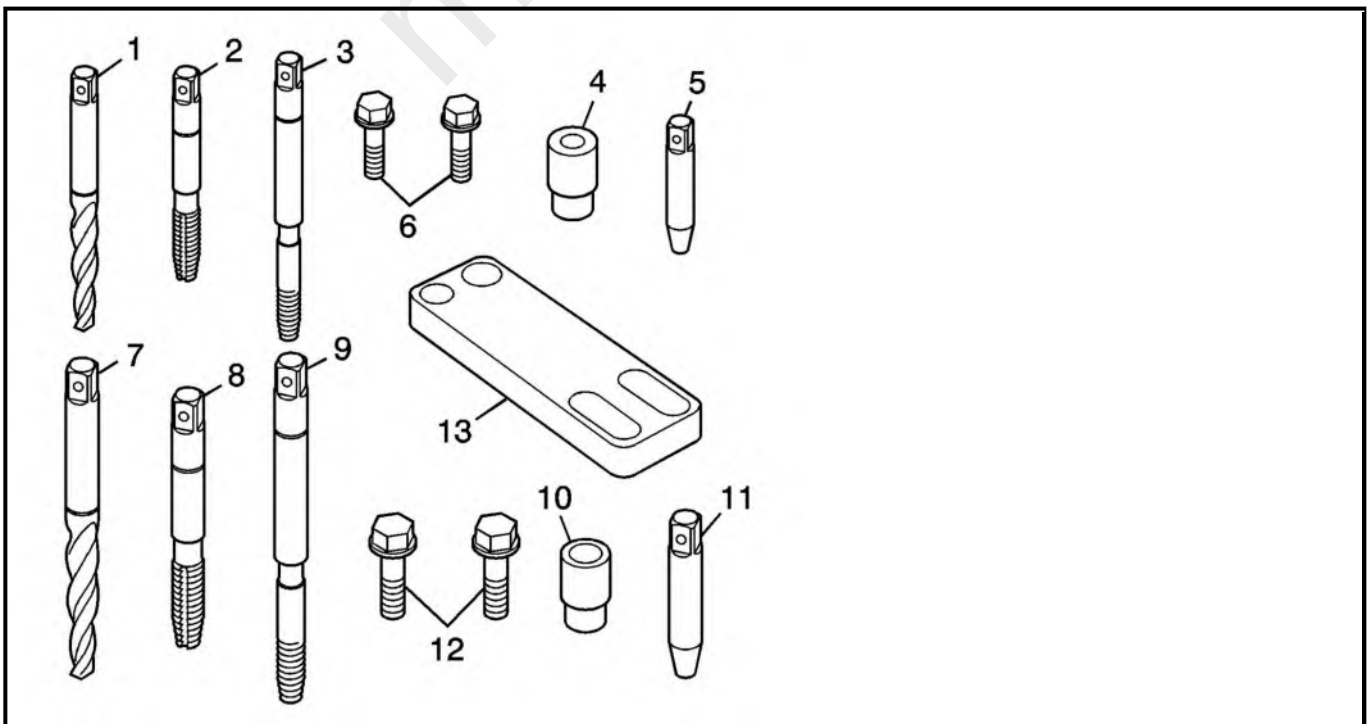
23. Inspect the insert for proper installation into the tapped hole.

Crankshaft Main Bolt Hole Thread Repair

Special Tools

- EN - 42385-700 High Feature Thread Repair Kit
- EN - 42385-2000 Thread Insert Kit

For equivalent regional tools, refer to [Special Tools](#) .



NOTE:

- In order to repair some crankshaft main bolt holes it will be necessary to mount the fixture plate upside down.
- Do NOT remove the fixture plate prior to installing the insert with the installation driver. The fixture plate remains in position throughout the thread repair process.

The crankshaft main bearing bolt hole thread repair tooling are in the kits **EN - 42385-2000** insert kit and **EN - 42385-700** kit. The crankshaft main bearing bolt hole thread repair components consist of the following:

- EN - 42385-702 Drill (1) for outboard holes
- EN - 42385-703 Tap (2) for outboard holes
- EN - 42385-704 Installation driver (3) for outboard holes
- EN - 42385-726 Bushing (4) for outboard holes
- EN - 42385-727 Alignment pin (5) for outboard holes
- EN - 42385-728 Bolts (6) for outboard holes
- EN - 42385-720 Drill (7) for inboard holes
- EN - 42385-721 Tap (8) for inboard holes
- EN - 42385-722 Installation driver (9) for inboard holes
- EN - 42385-713 Bushing (10)
- EN - 42385-308 Alignment pin (11)
- EN - 42385-734 Bolts (12)
- EN - 42385-712 Fixture plate (13)

Outboard Bolt Holes

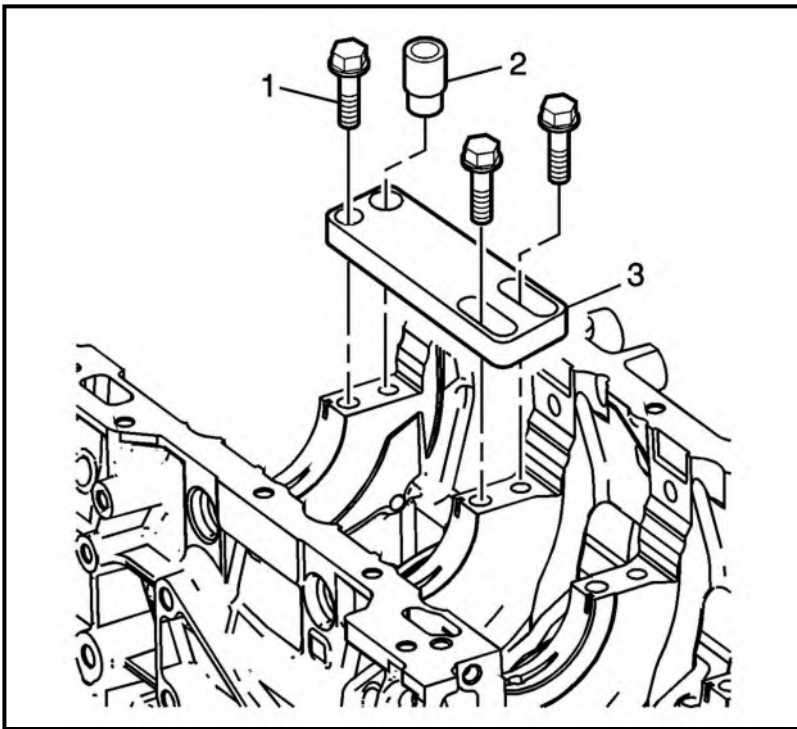
WARNING: Refer to [Safety Glasses Warning](#) .

NOTE:

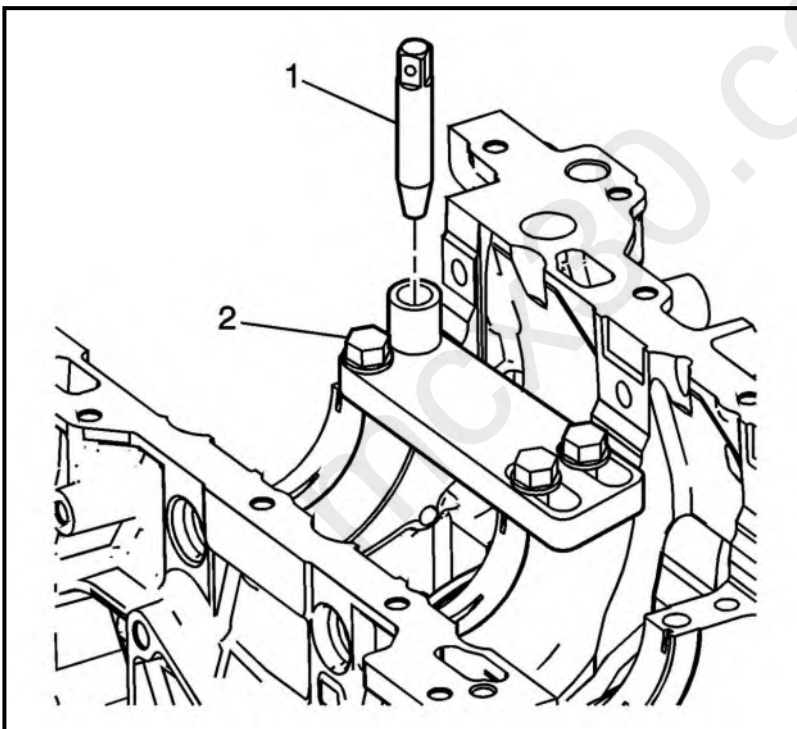
- Ensure the fixture plate is installed during the machining and installation processes of the insert.
- The use of a cutting type fluid, WD 40® or equivalent is recommended when performing the drilling, counterboring and tapping procedures. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended cutting fluid.

When installed to the proper depth, the flange of the insert will be seated against the counterbore of the drilled/tapped hole.

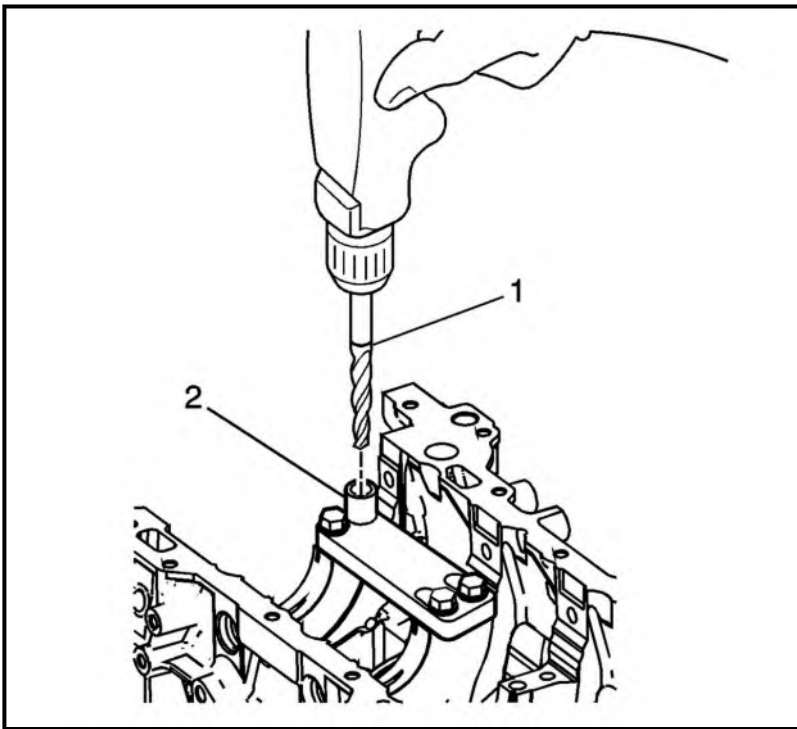
1. Position the fixture plate (3) with the bushing (2) installed over the crankshaft main cap bolt hole to be repaired.



2. Loosely install the fixture plate bolts (1) into the remaining crankshaft main cap bolt holes.
3. Position the alignment pin (1) through the bushing and into the crankshaft main cap bolt hole.



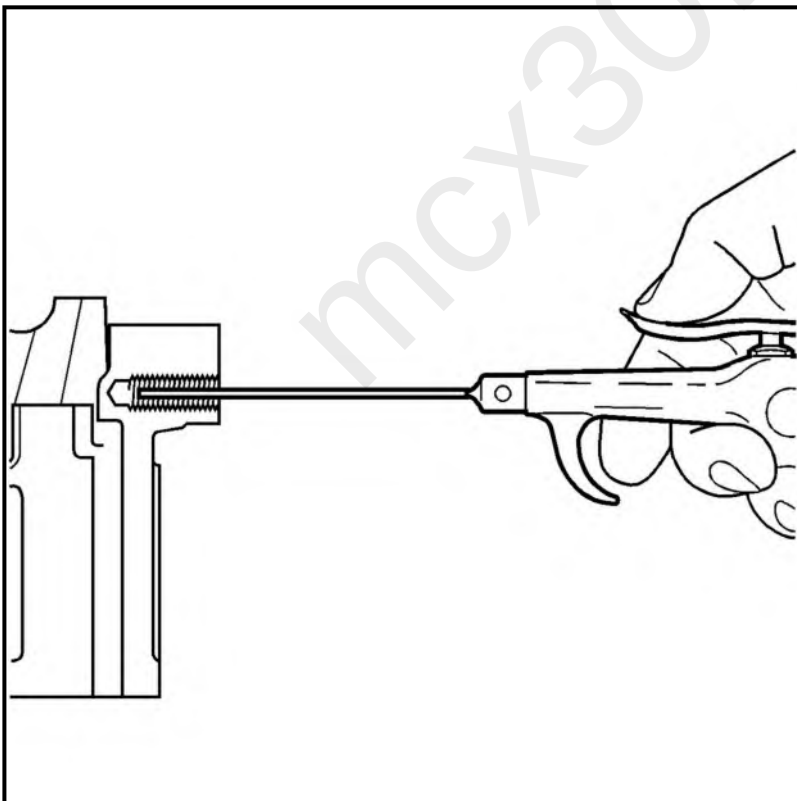
4. With the alignment pin in the desired crankshaft main cap bolt hole, tighten the fixture retaining bolts (2).
5. Remove the alignment pin (1) from the crankshaft main cap bolt hole.
6. Drill out the threads of the damaged hole.



NOTE:

- During the drilling process, it is necessary to repeatedly remove the drill and clean chips from the hole and the flutes of the drill.
- Drill the crankshaft main bolt hole until the mark (1) on the drill aligns with the top of the drill bushing (2).

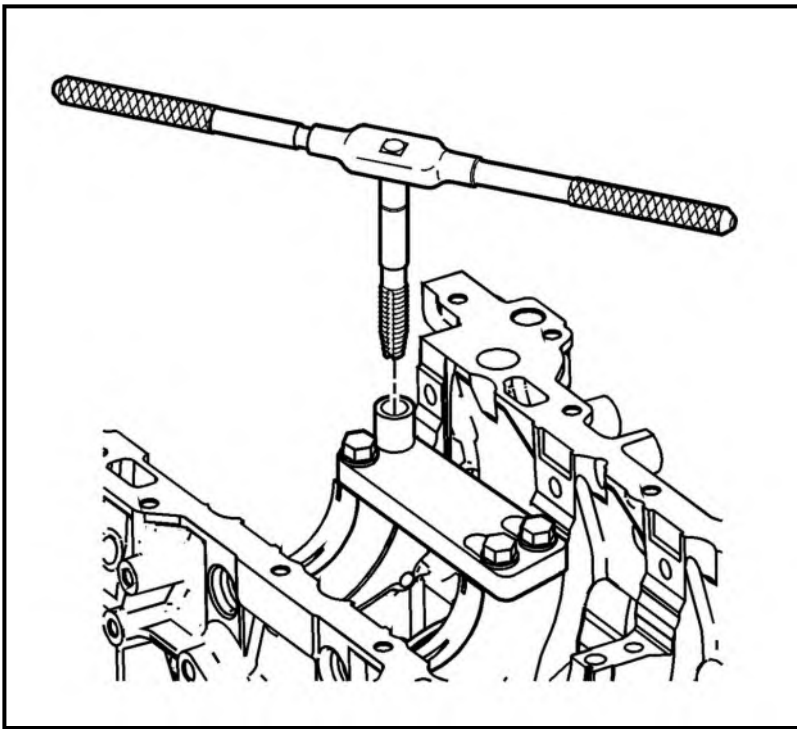
7. Using compressed air, clean out any chips.



NOTE:

All chips must be removed from the drilled hole prior to tapping.

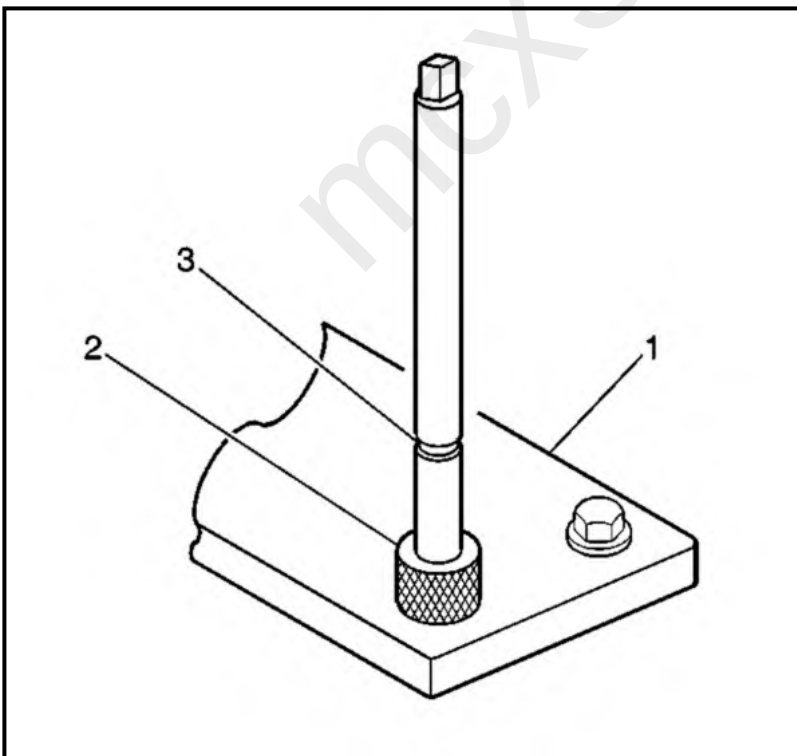
8. Using a suitable tapping wrench, tap the threads of the drilled hole by hand only.



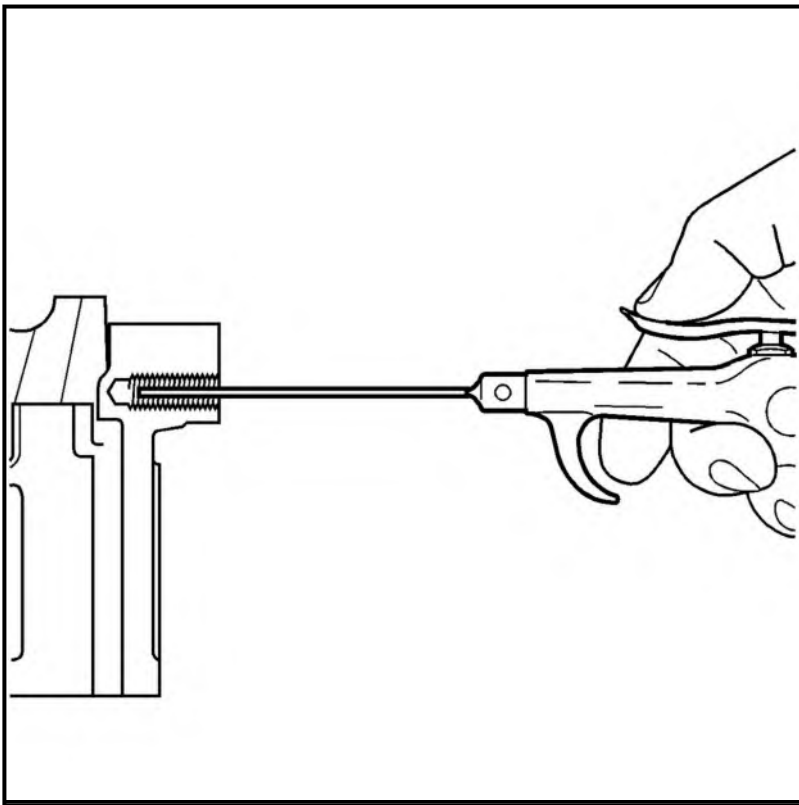
NOTE:

- Do not remove the fixture plate, ensure the fixture plate is installed during the machining and installation processes of the insert.
- During the tapping process, it is necessary to repeatedly remove the tap and clean chips from the hole and the flutes of the tap.
- Ensure the tap has created full threads at least to the depth equal to the insert length.

9. In order to tap the new threads for the insert to the proper depth, rotate the tap into the crankshaft main cap bolt hole until the mark (3) on the tap aligns with the top of the drill bushing (2).

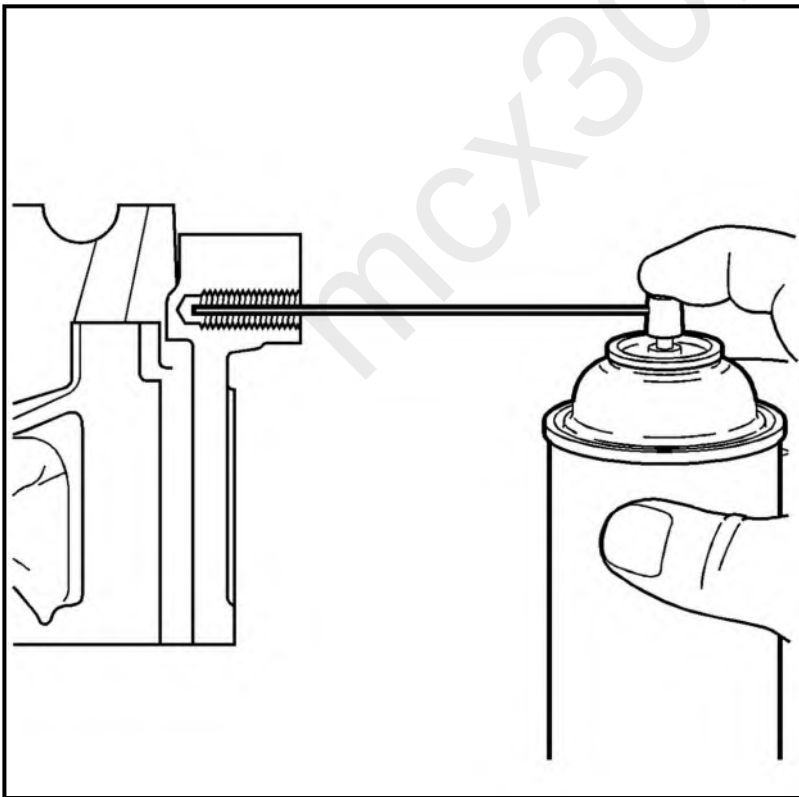


10. Using compressed air, clean out any chips.

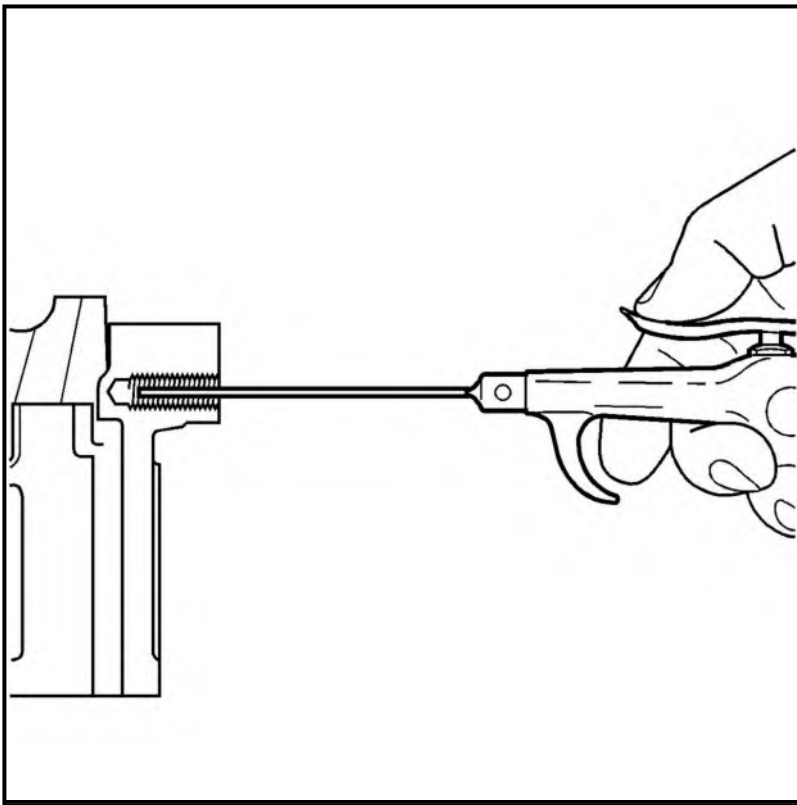


NOTE: All chips must be removed from the tapped hole prior to insert installation.

11. Spray cleaner into the tapped hole. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended cleaner.

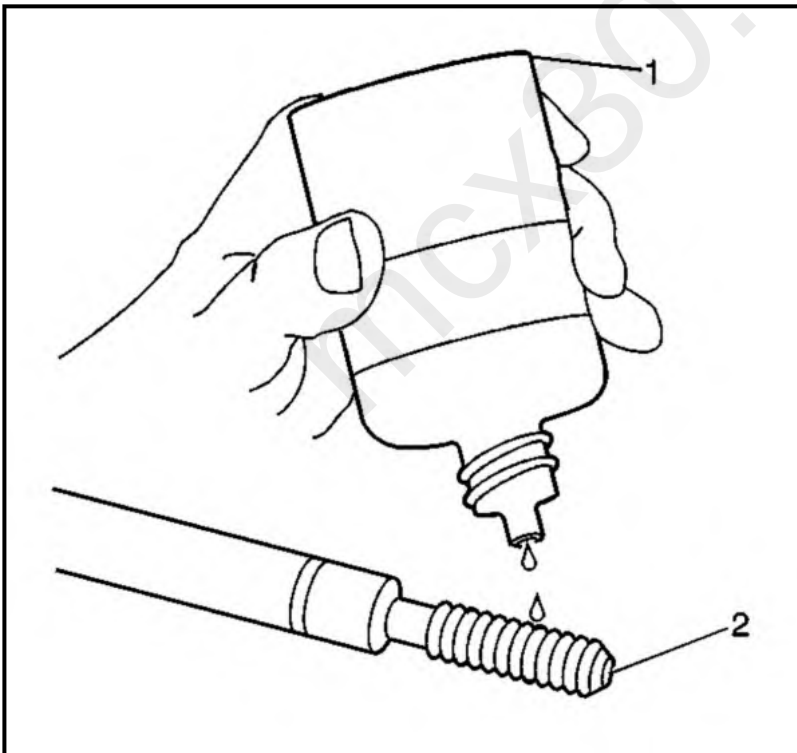


12. Using compressed air, clean out any chips.



NOTE: All chips must be removed from the tapped hole prior to insert installation.

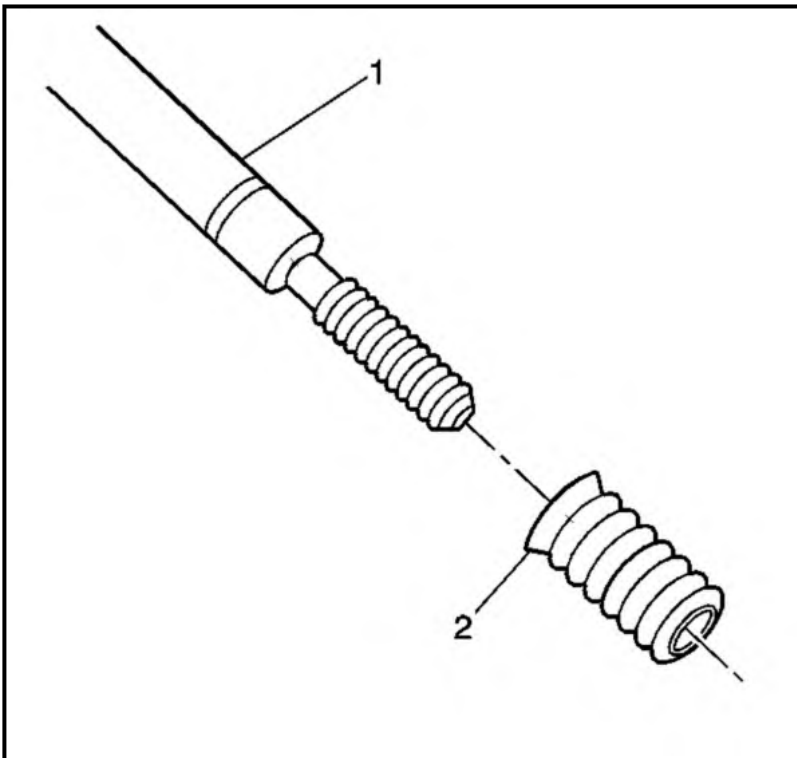
13. Lubricate the threads of the driver installation tool (2) with the EN - 42385-110 (1).



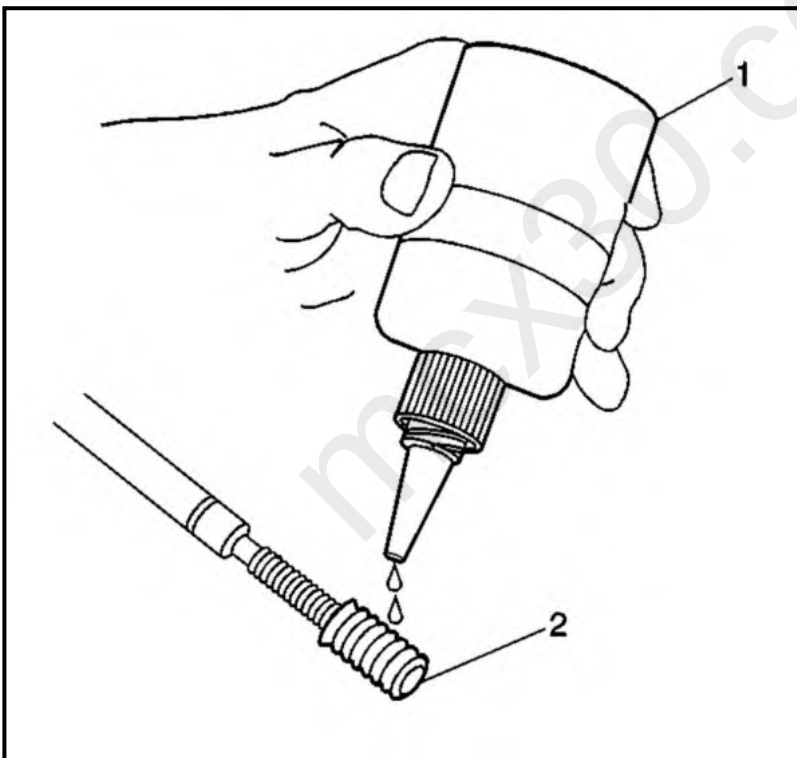
NOTE:

- Do not remove the fixture plate, ensure the fixture plate is installed during the installation process of the insert.
- Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.

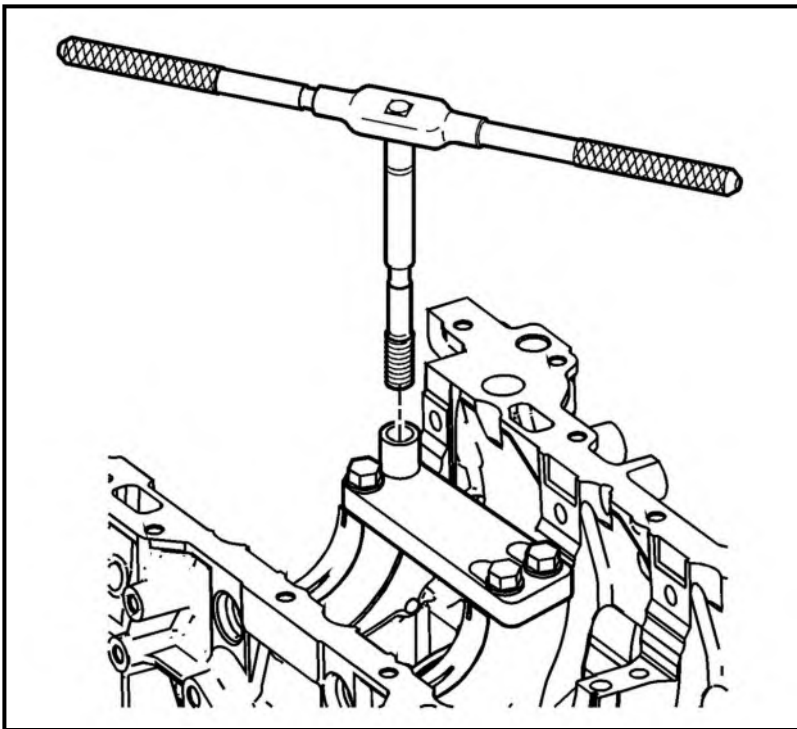
14. Install the insert (2) onto the driver installation tool (1).



15. Apply threadlock sealant, **EN - 42385-109** , LOCTITE 277Â®, or equivalent (1) to the insert OD threads (2). Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended sealant.



16. Install the insert and installation driver into the tapped hole by hand only.



17. Start the insert into the threaded hole.

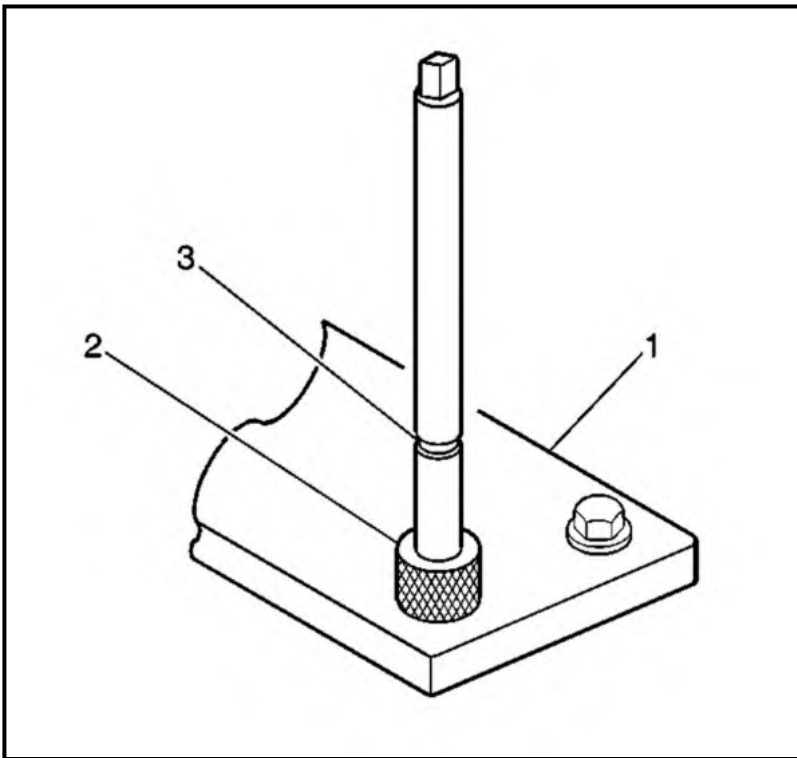
NOTE: If the insert will not thread down until the flange contacts the counterbored surface remove the insert immediately with a screw extracting tool and inspect the tapped hole for any remaining chips and/or improper tapping.

18. Install the insert until the flange of the insert contacts the counterbored surface.

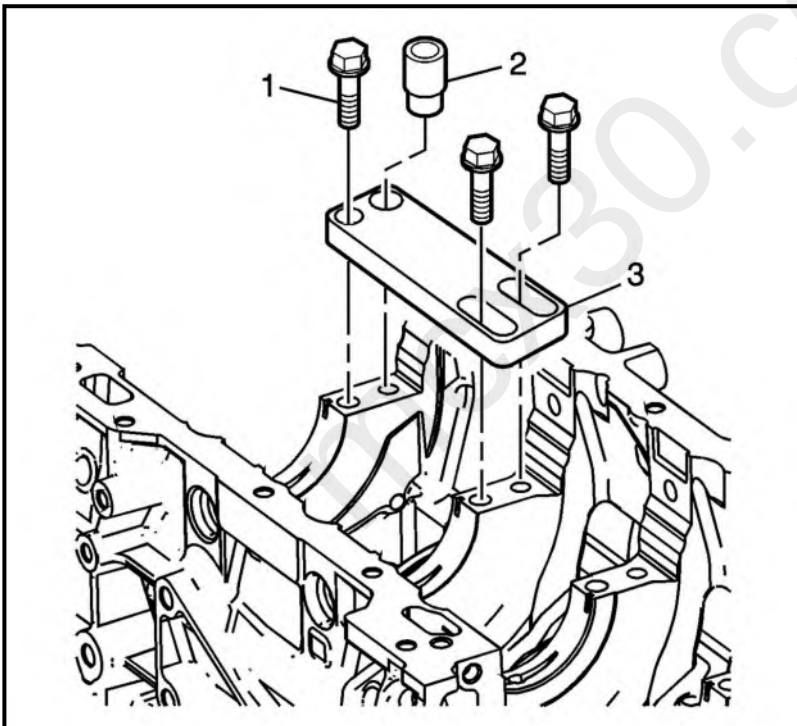
NOTE: The driver installation tool will tighten up before screwing completely through the insert. This is acceptable. The threads at the bottom of the insert are being formed and the insert is mechanically locking the insert into the base material threads.

19. Continue to rotate the driver installation tool through the insert.

20. Rotate the driver installation tool until the mark (3) on the driver installation tool aligns with the top of the drill bushing (2).



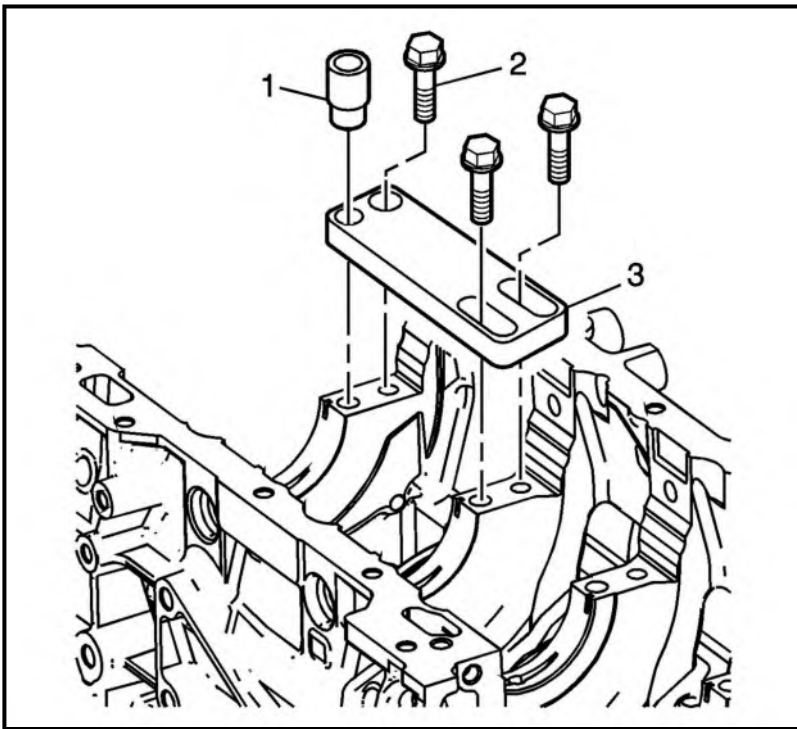
21. Inspect the insert for proper installation into the tapped hole.
22. Remove the fixture plate bolts (1).



23. Remove the fixture plate (3) and bushing (2).

Inboard Bolt Holes

1. Position the fixture plate (3) with the bushing (1) installed over the crankshaft main cap bolt hole to be repaired.



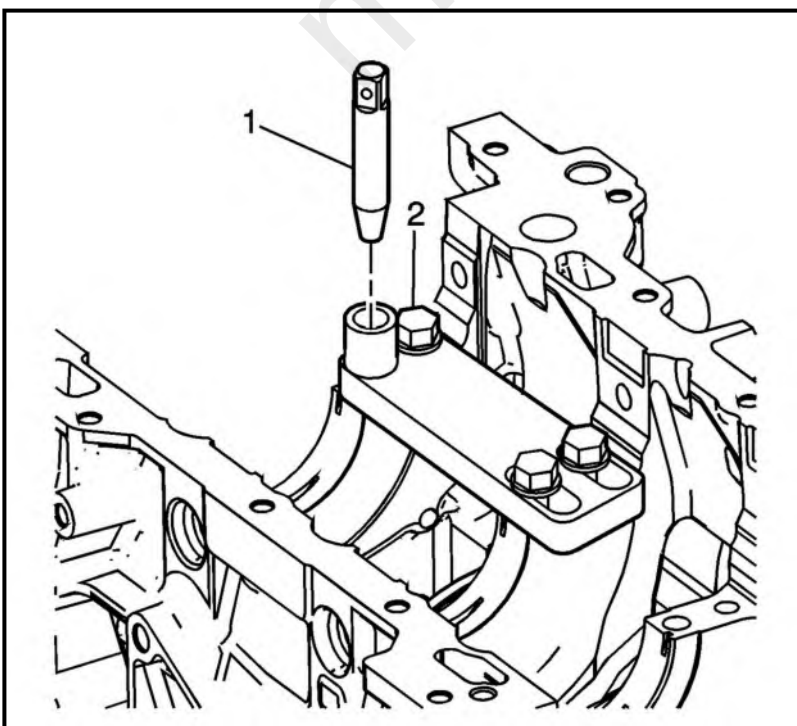
WARNING: Refer to [Safety Glasses Warning](#) .

NOTE:

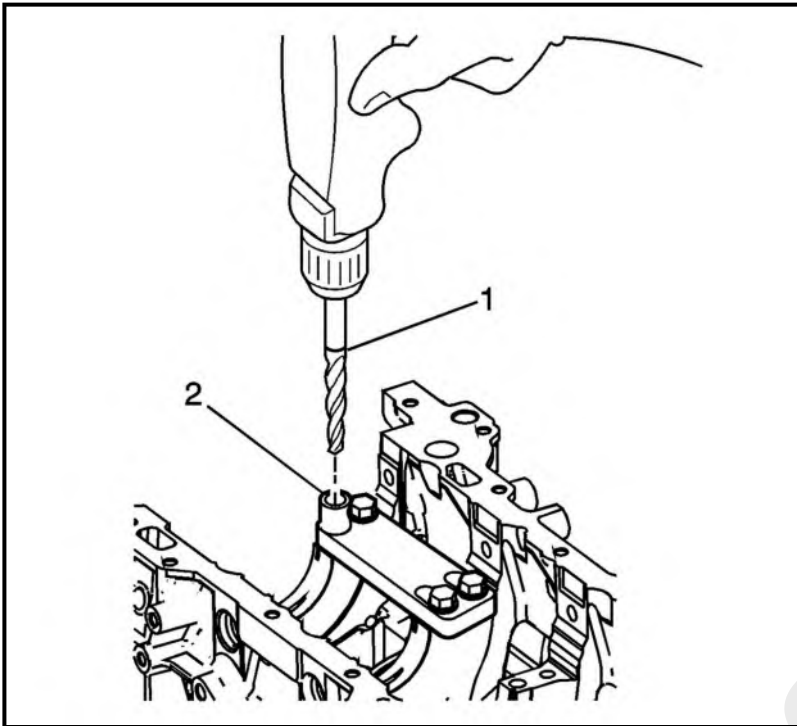
- Ensure the fixture plate is installed during the machining and installation processes of the insert.
- The use of a cutting type fluid, WD 40® or equivalent is recommended when performing the drilling, counterboring and tapping procedures. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended cutting fluid.

When installed to the proper depth, the flange of the insert will be seated against the counterbore of the drilled/tapped hole.

2. Loosely install the fixture plate bolts (2) into the remaining crankshaft main cap bolt holes.
3. Position the alignment pin (1) through the bushing and into the crankshaft main cap bolt hole.



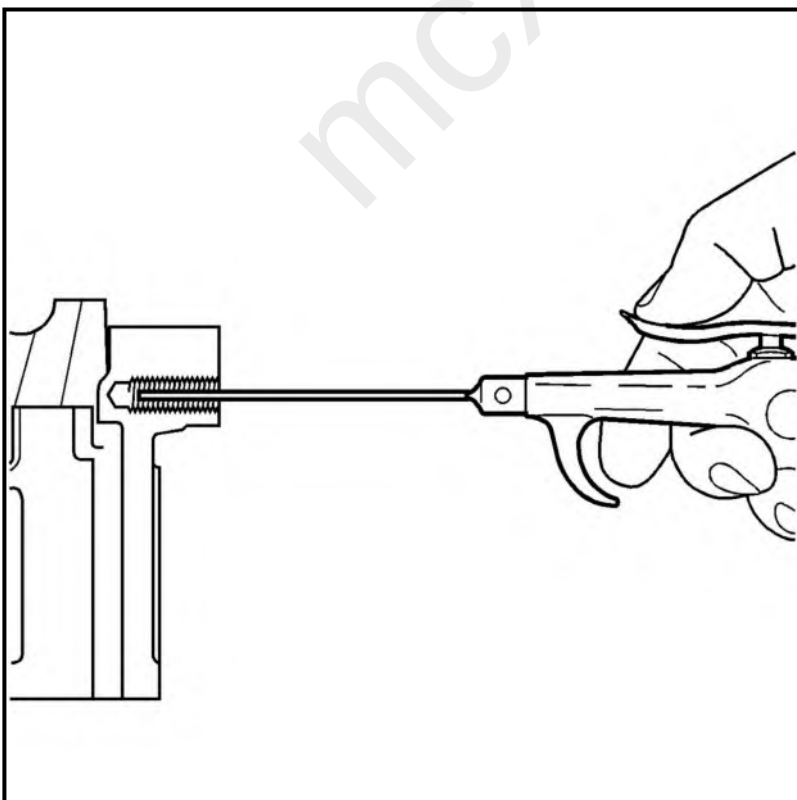
4. With the alignment pin in the desired crankshaft main cap bolt hole, tighten the fixture retaining bolts (2).
5. Remove the alignment pin (1) from the crankshaft main cap bolt hole.
6. Drill out the threads of the damaged hole.



NOTE:

- During the drilling process, it is necessary to repeatedly remove the drill and clean chips from the hole and the flutes of the drill.
- Drill the crankshaft main bolt hole until the mark (1) on the drill aligns with the top of the drill bushing (2).

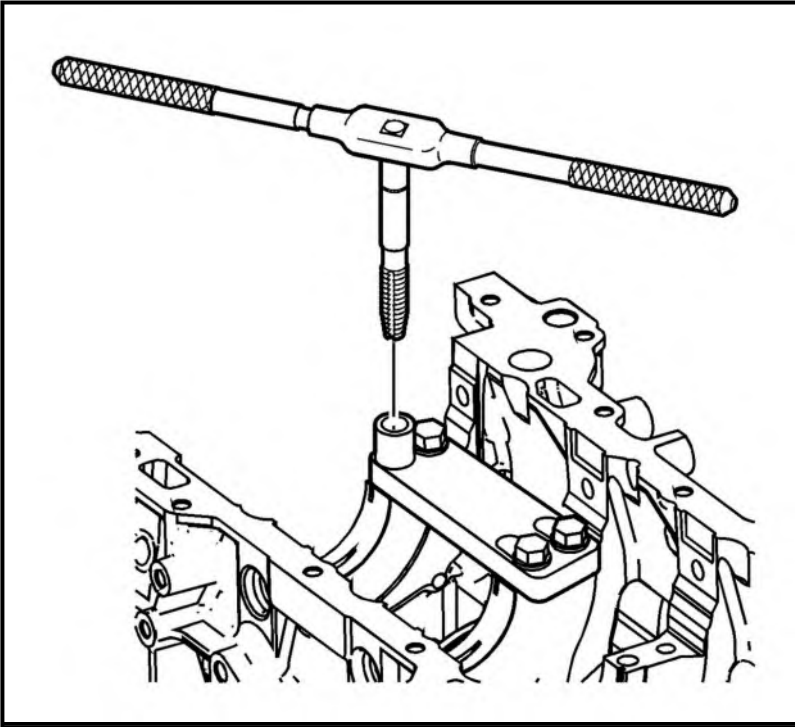
7. Using compressed air, clean out any chips.



NOTE:

All chips must be removed from the drilled hole prior to tapping.

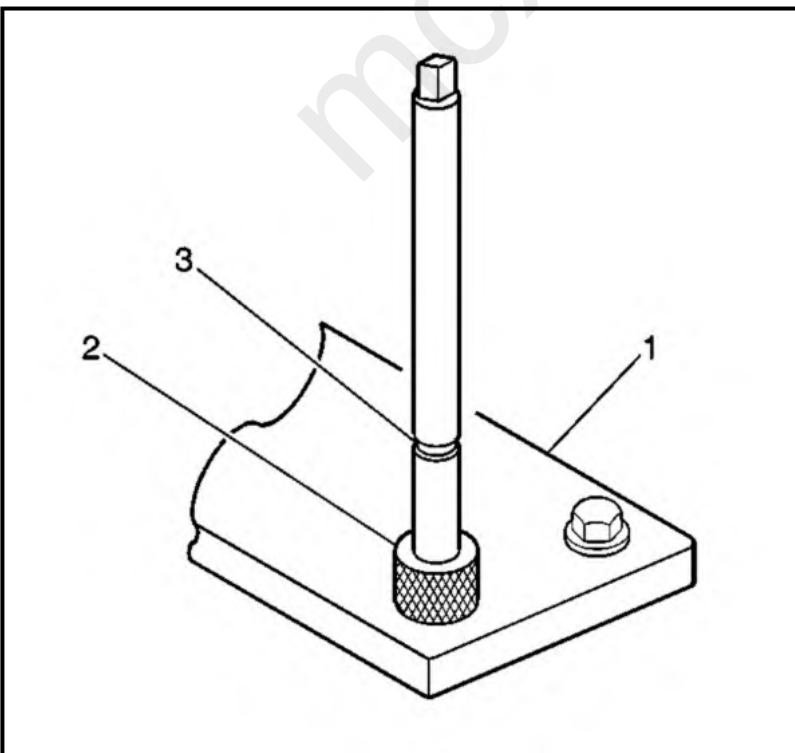
8. Using a suitable tapping wrench, tap the threads of the drilled hole by hand only.



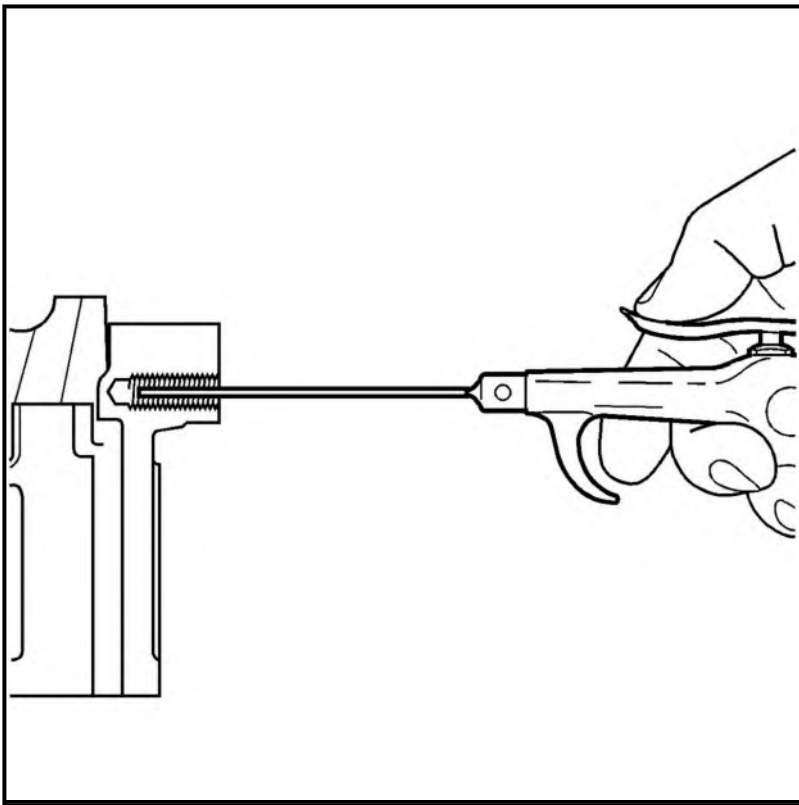
NOTE:

- Do not remove the fixture plate, ensure the fixture plate is installed during the machining and installation processes of the insert.
- During the tapping process, it is necessary to repeatedly remove the tap and clean chips from the hole and the flutes of the tap.
- Ensure the tap has created full threads at least to the depth equal to the insert length.

9. In order to tap the new threads for the insert to the proper depth, rotate the tap into the crankshaft main cap bolt hole until the mark (3) on the tap aligns with the top of the drill bushing (2).

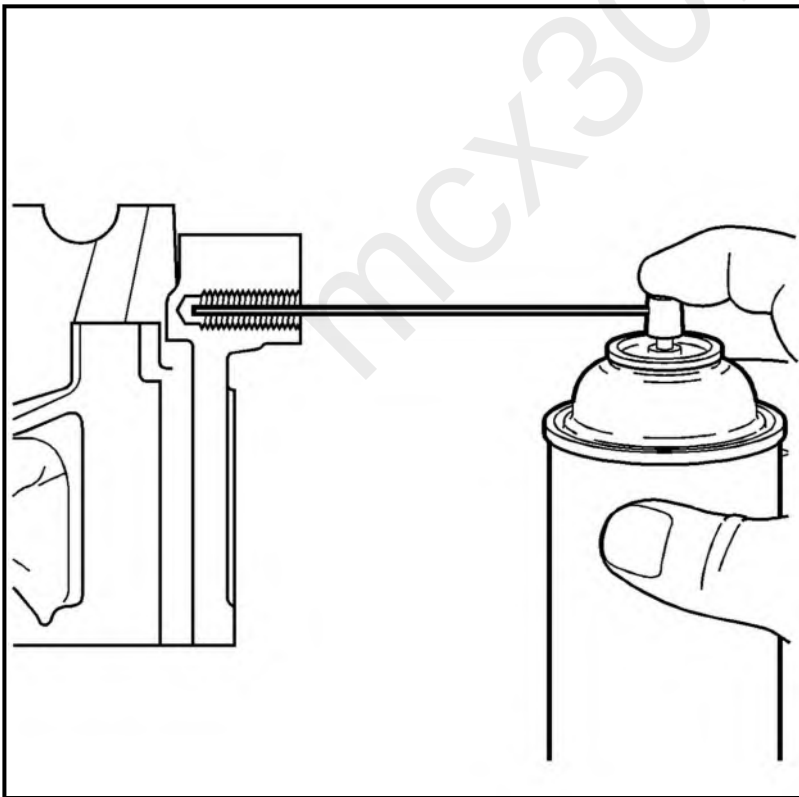


10. Using compressed air, clean out any chips.

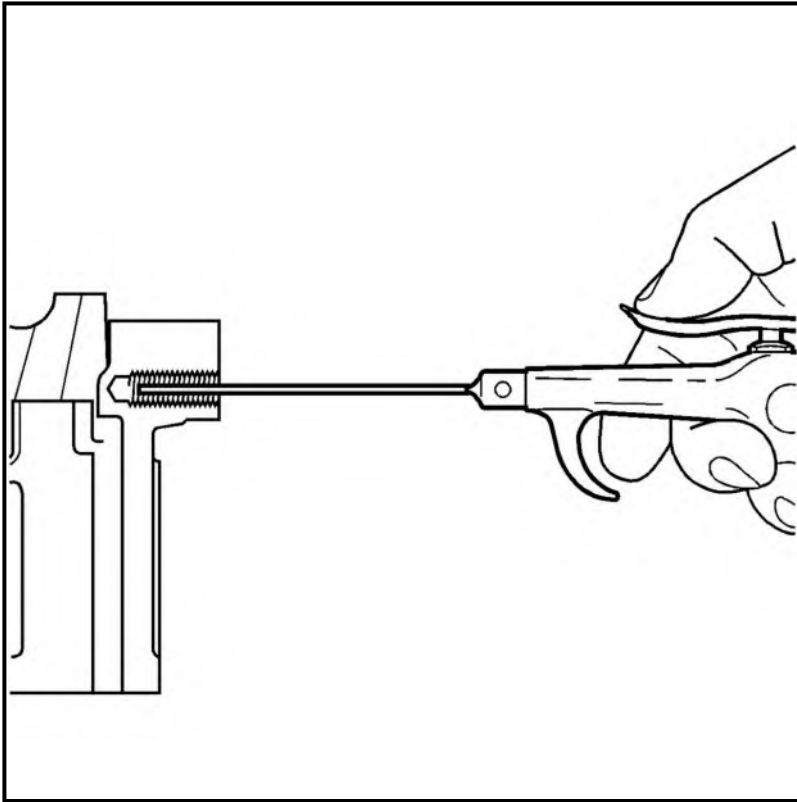


NOTE: All chips must be removed from the tapped hole prior to insert installation.

11. Spray cleaner into the tapped hole. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended cleaner.

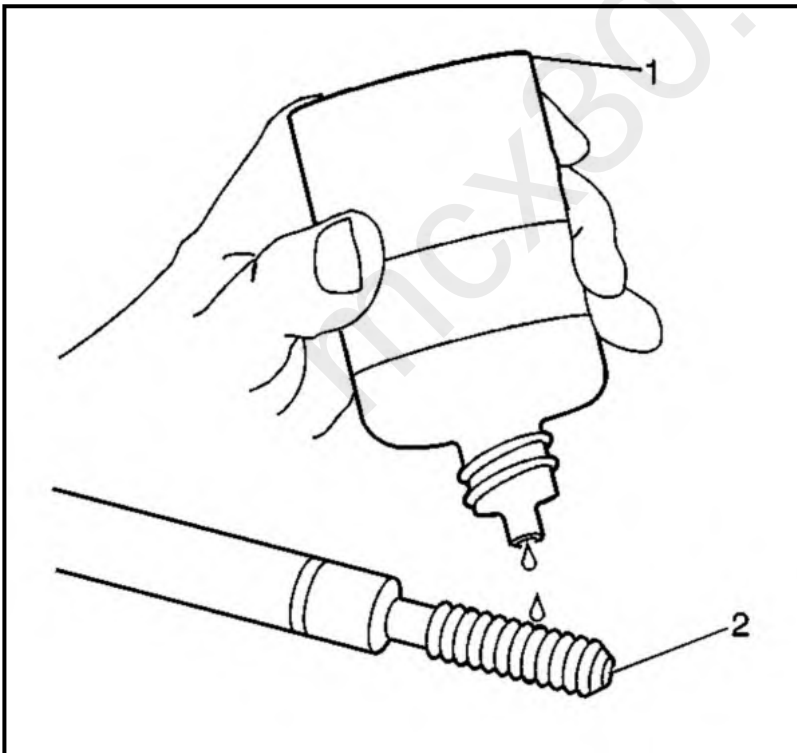


12. Using compressed air, clean out any chips.



NOTE: All chips must be removed from the tapped hole prior to insert installation.

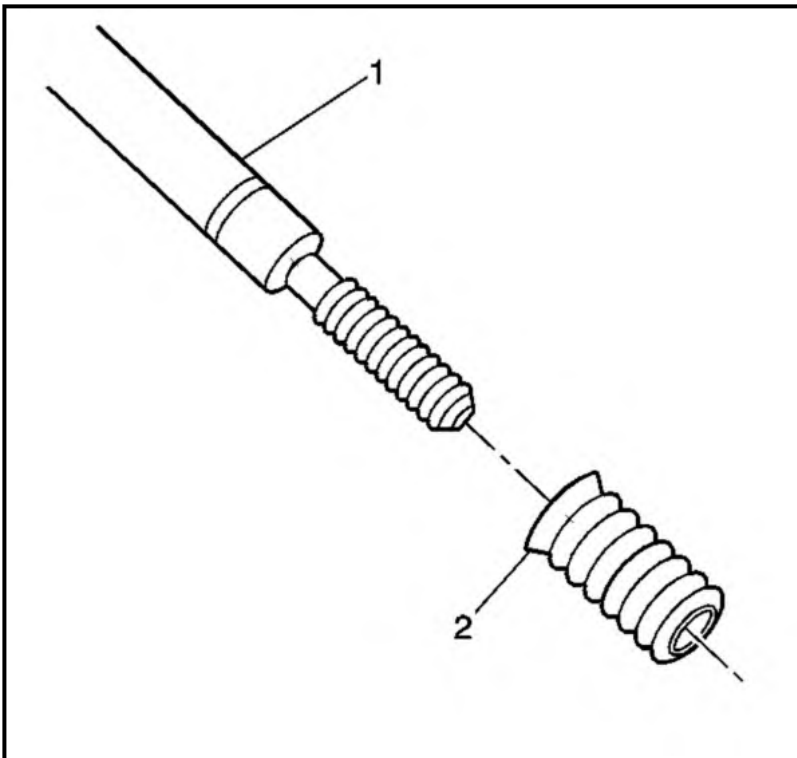
13. Lubricate the threads of the driver installation tool (2) with the EN - 42385-110 (1).



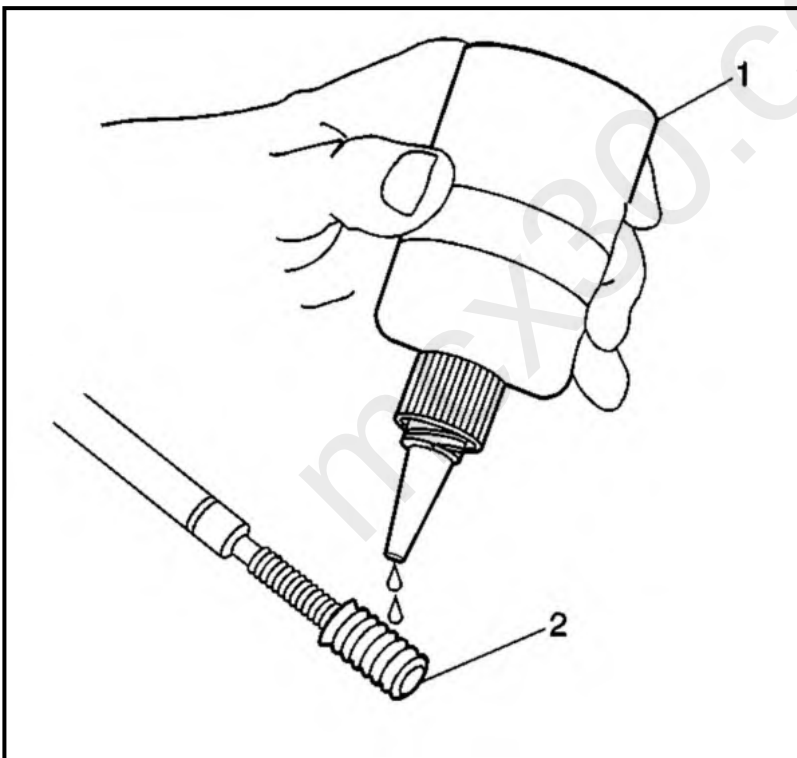
NOTE:

- Do not remove the fixture plate, ensure the fixture plate is installed during the installation process of the insert.
- Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.

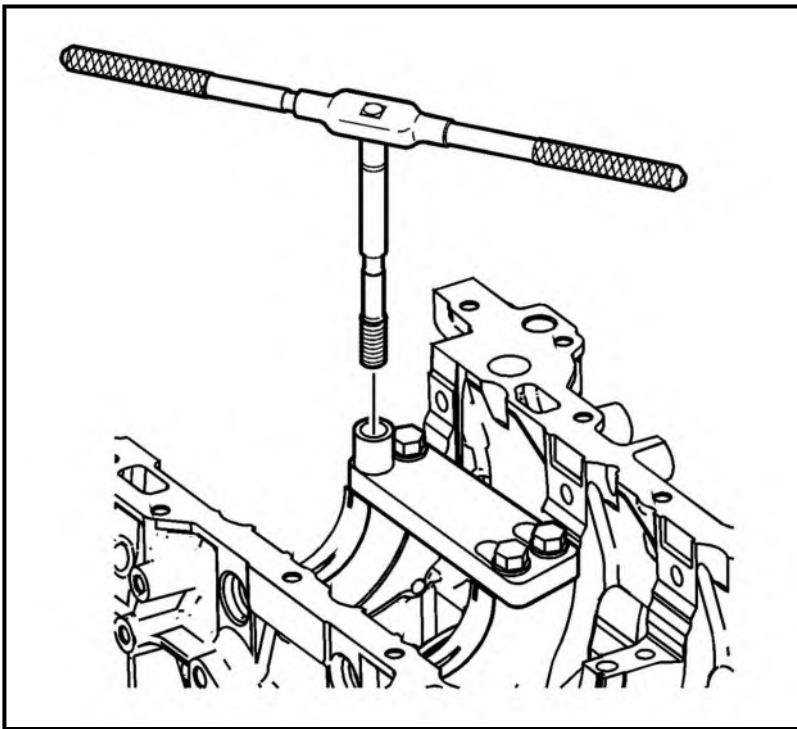
14. Install the insert (2) onto the driver installation tool (1).



15. Apply threadlock sealant, **EN - 42385-109** , LOCTITE 277Â®, or equivalent (1) to the insert OD threads (2). Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended sealant.



16. Install the insert and installation driver into the tapped hole by hand only.



17. Start the insert into the threaded hole.

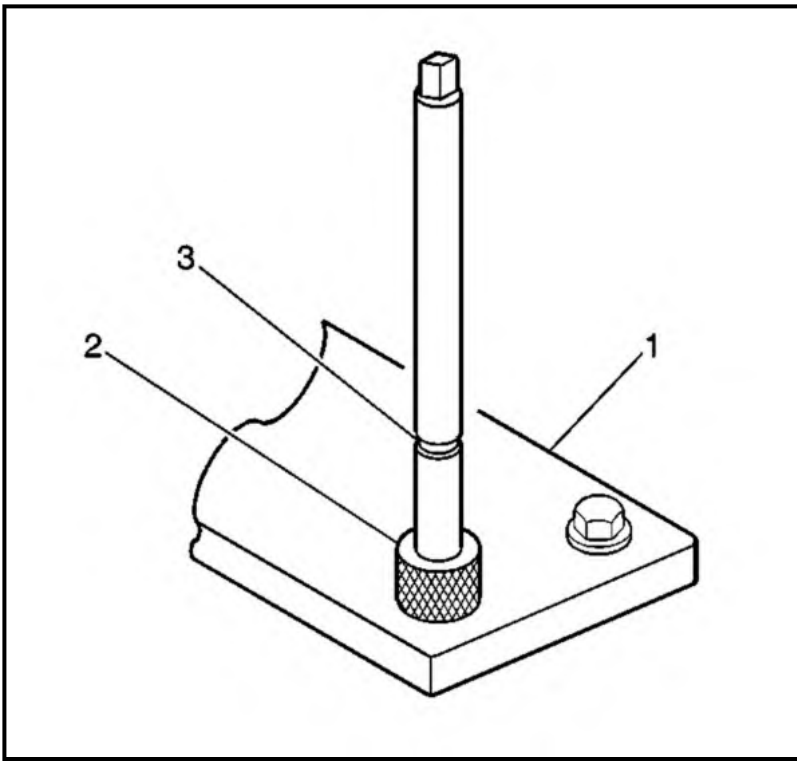
NOTE: If the insert will not thread down until the flange contacts the counterbored surface remove the insert immediately with a screw extracting tool and inspect the tapped hole for any remaining chips and/or improper tapping.

18. Install the insert until the flange of the insert contacts the counterbored surface.

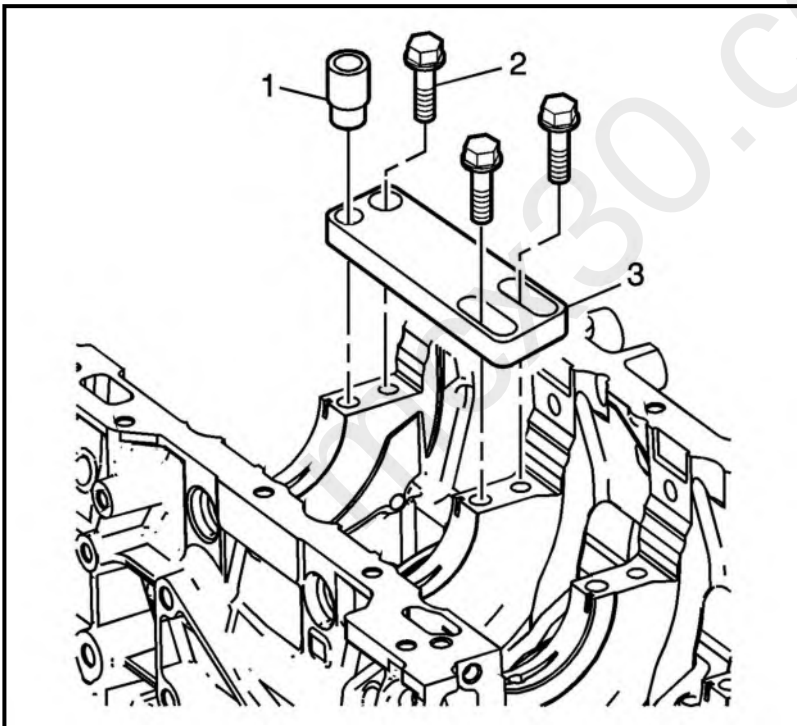
NOTE: The driver installation tool will tighten up before screwing completely through the insert. This is acceptable. The threads at the bottom of the insert are being formed and the insert is mechanically locking the insert into the base material threads.

19. Continue to rotate the driver installation tool through the insert.

20. Rotate the driver installation tool until the mark (3) on the driver installation tool aligns with the top of the drill bushing (2).



21. Inspect the insert for proper installation into the tapped hole.
22. Remove the fixture plate bolts (2).



23. Remove the fixture plate (3) and bushing (1).

SERVICE PRIOR TO ASSEMBLY

- Dirt will cause premature wear of the rebuilt engine. Clean all the components.
- Use the proper tools to measure the components when checking for excessive wear. Components not within the manufacturer's specification must be repaired or replaced.
- When the components are reinstalled into an engine, return the components to their original location, position, and direction.
- During assembly, lubricate all the moving parts with clean engine oil (unless otherwise specified). This will provide initial lubrication when the engine is first started.

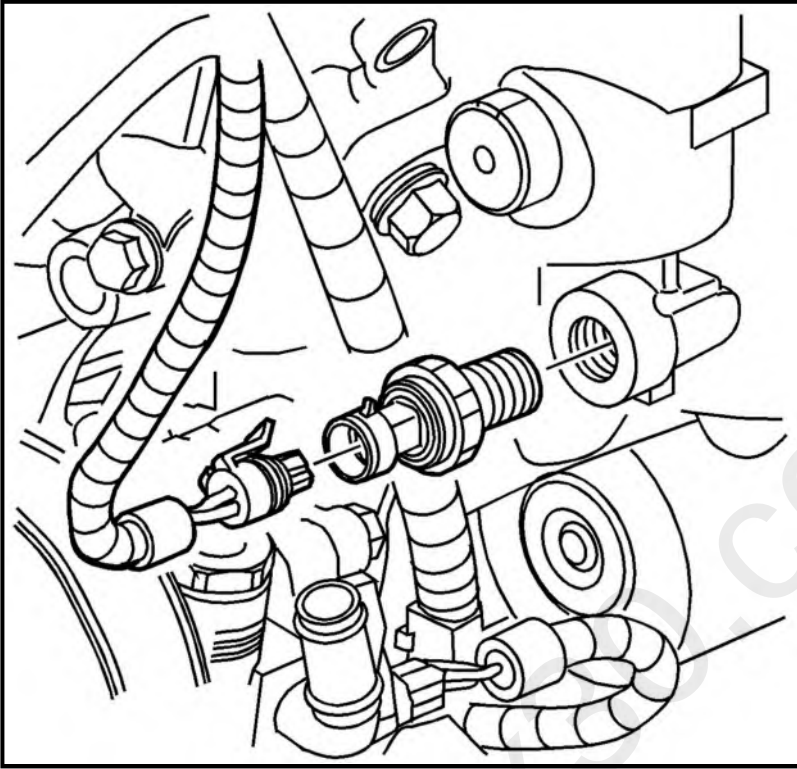
ENGINE PRELUBING

Special Tools

- **EN-21867-6** Oil Pressure Adapter Fitting
- **EN-45299** Engine Preluber

Equivalent regional tools: [Special Tools](#)

1. Remove the oil filter cap.



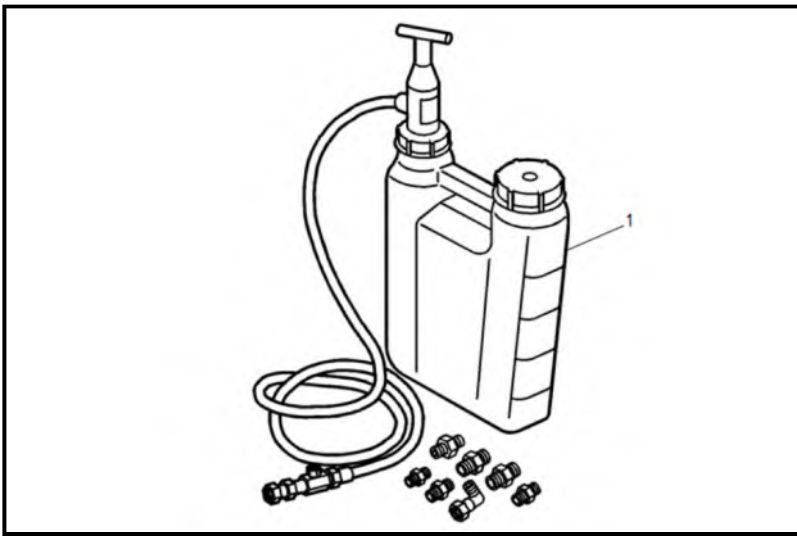
CAUTION: If any malfunction is experienced which may cause debris to enter the oil supply, you must replace the engine oil cooler and hoses if equipped. Debris in the engine oil cooler and oil cooler hoses may be pulled back into the engine causing severe engine damage.

NOTE: A constant and continuous flow of clean engine oil is required to properly prime the engine. Be sure to use an approved engine oil.

2. Install a NEW oil filter.
3. Lubricate the threads of the oil filter cap with clean engine oil.

CAUTION: Refer to [Fastener Caution](#) .

4. Install the oil filter cap and tighten to 25 N.m (18 lb ft).
5. Remove the oil pressure sending unit from the oil filter adapter.
6. Install the **EN-21867-6** fitting.
7. Install the flexible hose to the adapter and open the valve.



8. Pump the handle on the **EN-45299** preluber to flow a minimum of 1 - 1.9 liters (1 - 2 quarts) of engine oil. Observe the flow of engine oil through the flexible hose and into the engine assembly.
 9. Close the valve and remove the flexible hose and adapter from the engine.
 10. Install the oil pressure sending unit and tighten to 20 N.m (15 lb ft).
 11. Top-off the engine oil to the proper level.
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