

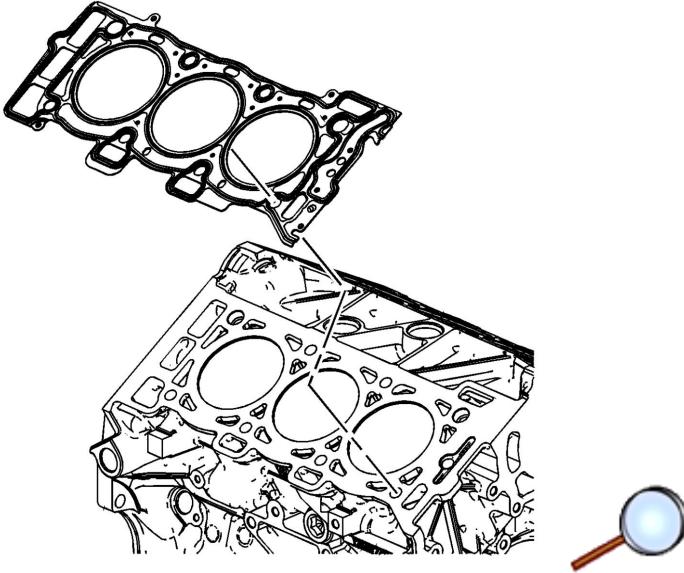
## Cylinder Head Installation - Right Side

### Special Tools

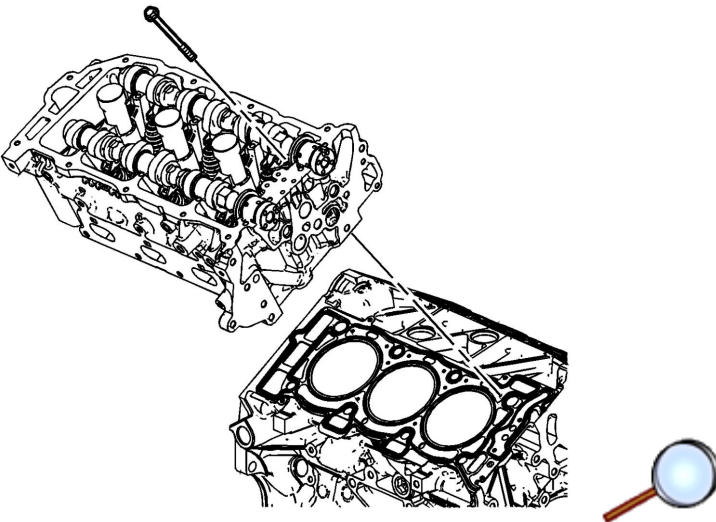
*J 45059* Angle Meter

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

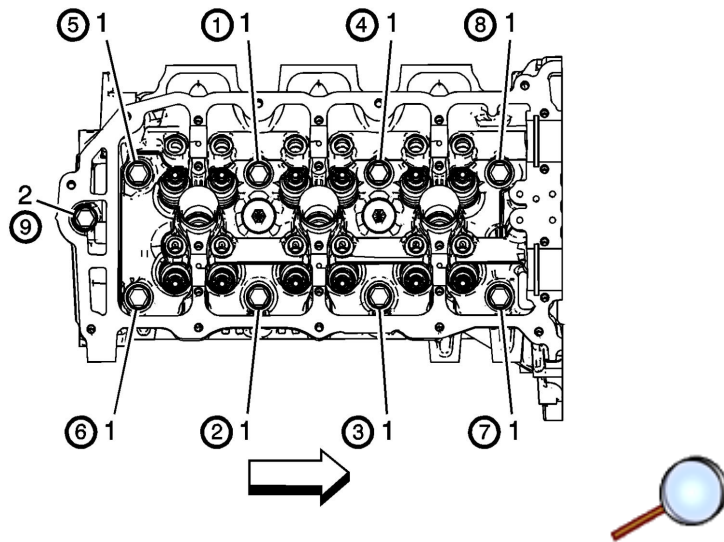
1. Ensure the cylinder head locating pins are securely mounted in the cylinder block deck face.



2. Install a NEW right cylinder head gasket using the deck face locating pins for retention.



3. Align the right cylinder head with the deck face locating pins.
4. Place the right cylinder head in position on the deck face.



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

**Note:** DO NOT allow oil on the cylinder head bolt bosses.

**Note:** DO NOT reuse the old cylinder head bolts.

5. Install the NEW M11 cylinder head bolts (1) and tighten.
  - 5.1. The M11 cylinder head bolts a first pass in sequence to 30 Y (22 lb ft).
  - 5.2. The M11 cylinder head bolts a second pass in sequence an additional 150 degrees using the *J 45059* meter .
6. Install the NEW M8 cylinder head bolt (2) and tighten.
  - 6.1. The M8 cylinder head bolt a first pass to 15 Y (11 lb ft).
  - 6.2. The M8 cylinder head bolt a second pass an additional 75 degrees using the *J 45059* meter .

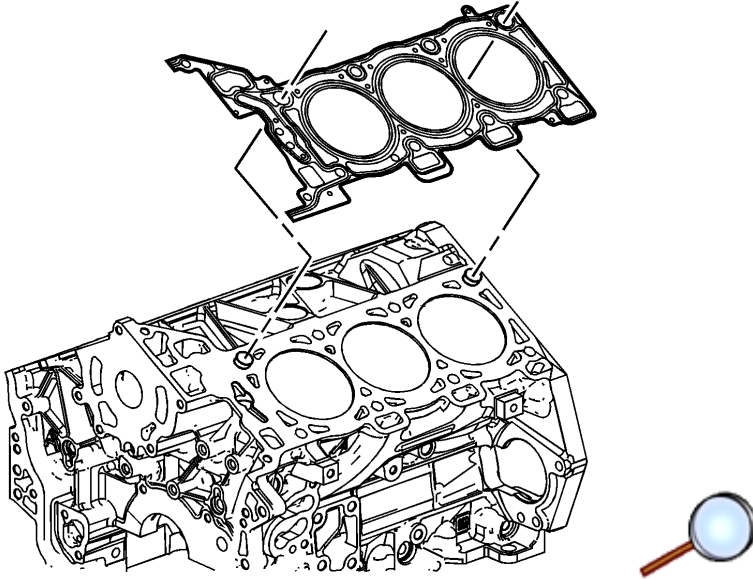
## Cylinder Head Installation - Left Side

### Special Tools

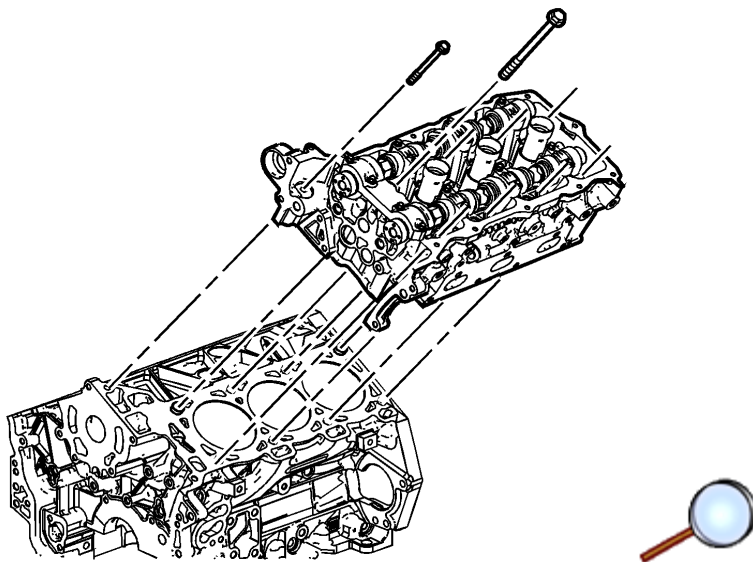
*J 45059* Angle Meter

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

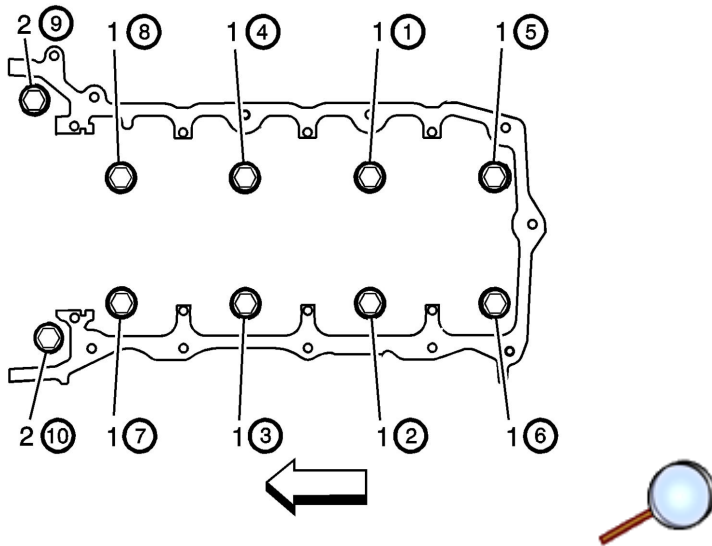
1. Ensure the cylinder head locating pins are securely mounted in the cylinder block deck face.



2. Install a NEW left cylinder head gasket using the deck face locating pins for retention.



3. Align the left cylinder head with the deck face locating pins.
4. Place the left cylinder head in position on the deck face.



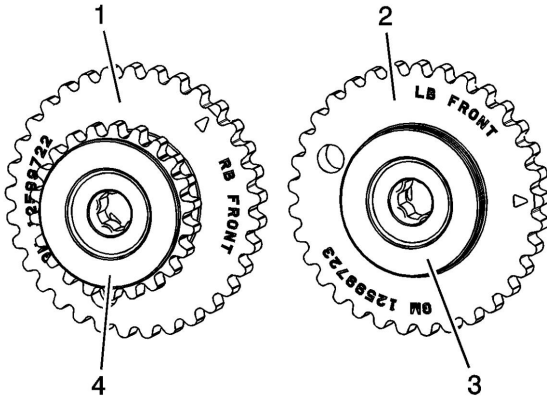
**Caution:** Refer to [Fastener Caution](#).

**Note:** DO NOT allow oil on the cylinder head bolt bosses.

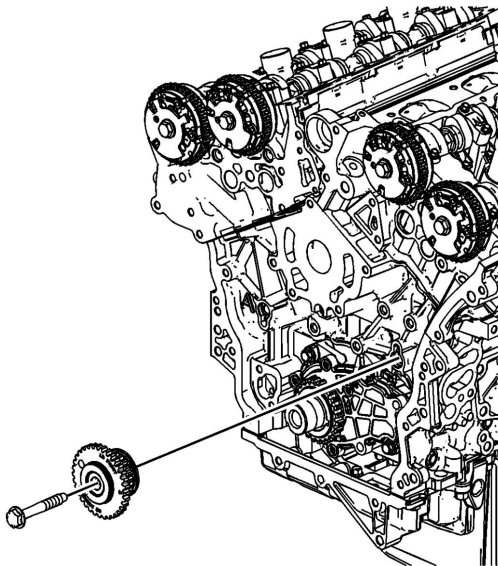
**Note:** DO NOT reuse the old cylinder head bolts.

5. Install the NEW M11 cylinder head bolts (1) and tighten.
  - 5.1. The M11 cylinder head bolts a first pass in sequence to 30 Y (22 lb ft).
  - 5.2. The M11 cylinder head bolts a second pass in sequence an additional 150 degrees using the *J* 45059 meter .
6. Install 2 NEW front M8 left cylinder head bolts (2) and tighten.
  - 6.1. The M8 cylinder head bolts a first pass to 15 Y (11 lb ft).
  - 6.2. The M8 cylinder head bolts a second pass in sequence an additional 75 degrees using the *J* 45059 meter .

## Timing Chain Idler Sprocket Installation - Left Side

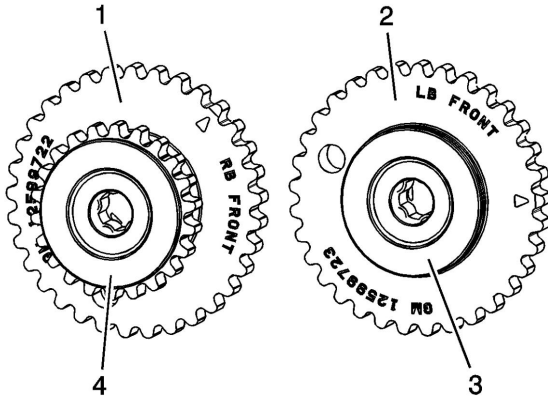


1. Ensure that the left camshaft intermediate drive chain idler (2) is being installed. The recessed hub (3) and the larger sprocket of the left camshaft intermediate drive chain idler is installed outward. The raised hub and the smaller sprocket of the left camshaft intermediate drive chain idler is installed towards the block.

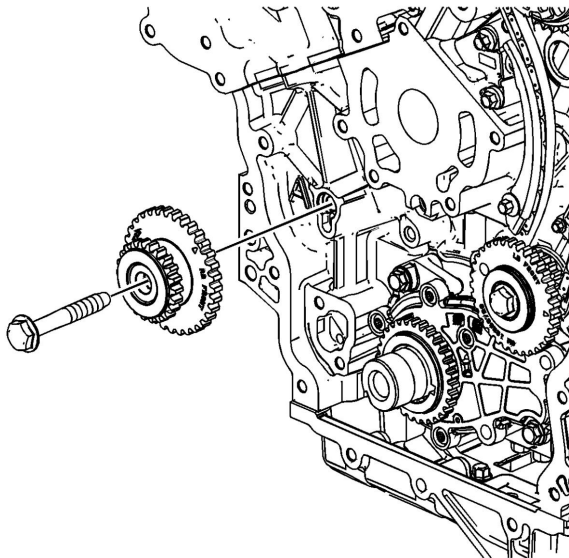


2. Place the left camshaft intermediate drive chain idler to the cylinder block.
- Caution:** Refer to [Fastener Caution](#).
3. Install the camshaft intermediate drive chain idler bolt and tighten to 58 Y (43 lb ft).

## Timing Chain Idler Sprocket Installation - Right Side



1. Ensure that the right camshaft intermediate drive chain idler (1) is being installed. The recessed hub (4) and the smaller sprocket of the right camshaft intermediate drive chain idler is installed outward. The raised hub and the larger sprocket of the right camshaft intermediate drive chain idler is installed towards the block.

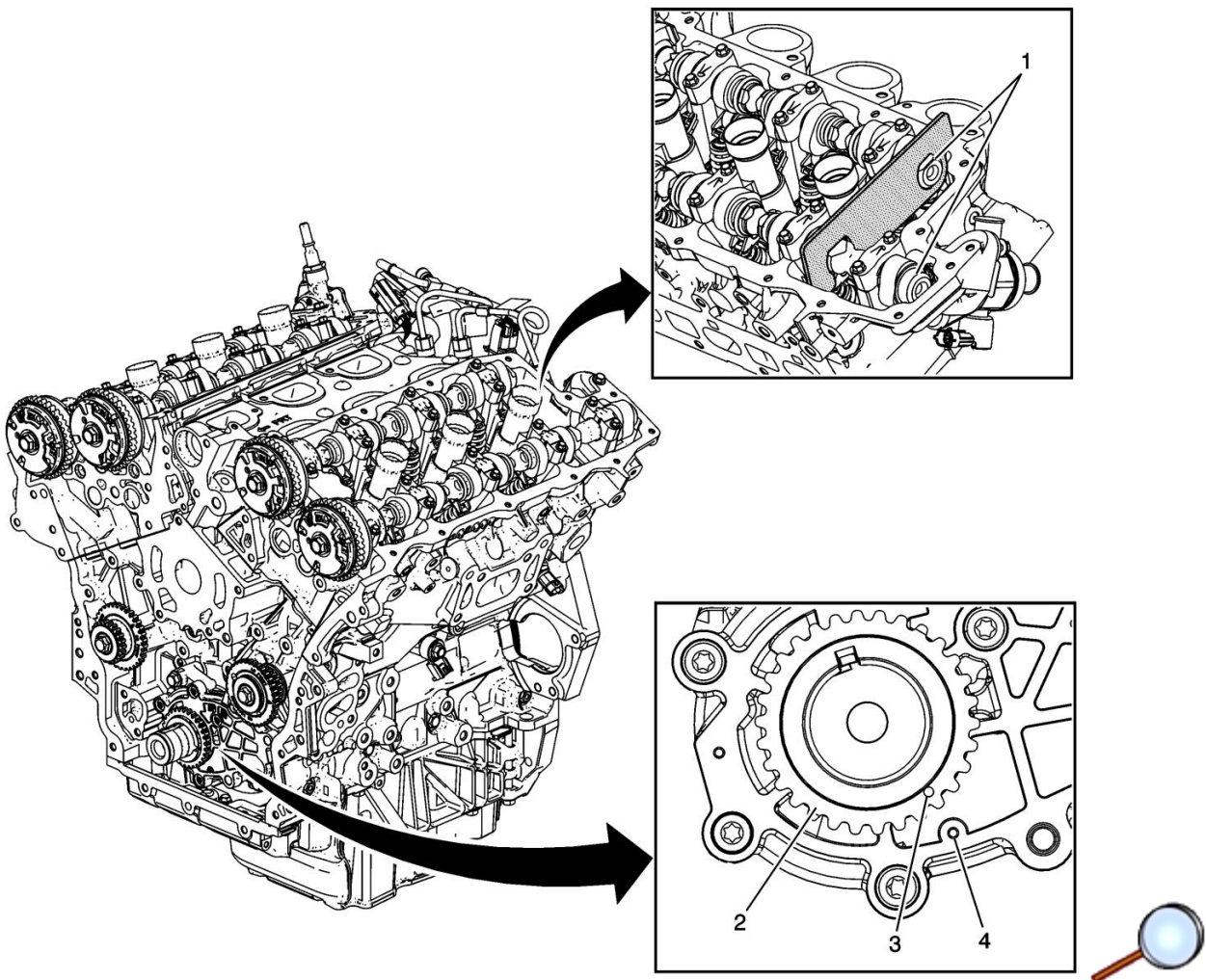


2. Install the right camshaft intermediate drive chain idler.
- Caution:** Refer to [Fastener Caution](#).
3. Install the camshaft intermediate drive chain idler bolt and tighten to 58 Y (43 lb ft).

## Camshaft Timing Chain Components Installation

- Table 1: [Secondary Camshaft Intermediate Drive Chain Installation - Left Side - Step 1](#)  
Table 2: [Secondary Camshaft Intermediate Drive Chain Installation - Left Side - Step 2](#)  
Table 3: [Secondary Camshaft Drive Chain Guide and Shoe Installation - Left](#)  
Table 4: [Secondary Camshaft Drive Chain Tensioner Installation - Left Side](#)  
Table 5: [Primary Camshaft Intermediate Drive Chain Installation](#)  
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Table 8: [Stage 1 Alignment Position to the Stage 2 Alignment Position](#)  
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### [Secondary Camshaft Intermediate Drive Chain Installation - Left Side - Step 1](#)

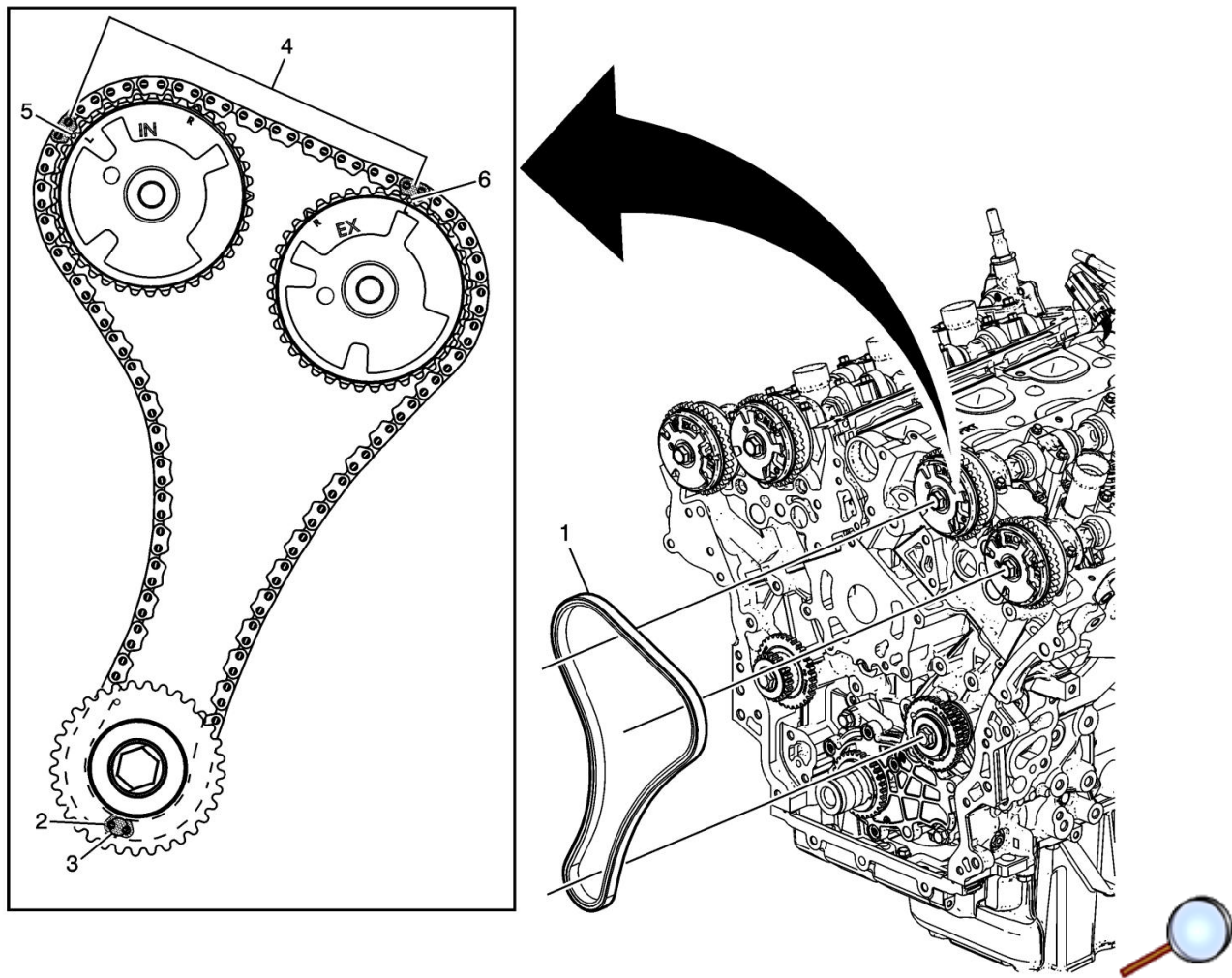


Secondary Camshaft Intermediate Drive Chain Installation - Left Side - Step 1

Callout	Component Name
<p>Note: If you are performing this procedure for the first time, it is recommended that you view video 56510.12V from the common training website before beginning (U.S. Dealers Only). To search for the video number, click on the catalog icon on the home page. Canadian dealers should view Tech Assist video 16038.01W on the LMS website and a related video on GM Global Connect (Library-Service&gt;Technician Review&gt;TAC Talk Video Help). See <a href="https://www.centerlearning.com/HomePage/Portal.asp">https://www.centerlearning.com/HomePage/Portal.asp</a> for more information.</p>	
1	<p>Left Intake and Exhaust Camshaft Procedure</p> <p>Note:</p> <ul style="list-style-type: none"> <li>◦ There should be no need to rotate the camshaft more than 10 degrees. Using the hex cast into the camshaft rotate the camshaft in order to install the <i>EN-48383</i> retaining tools .</li> <li>◦ All camshafts must be locked in place before installation of any camshaft drive chains.</li> </ul> <ol style="list-style-type: none"> <li>1. Install the <i>EN-48383-1</i> retaining tool onto the rear of the left camshafts.</li> <li>2. Ensure the <i>EN-48383-1</i> retaining tool is fully seated onto the camshafts.</li> </ol> <p>Special Tools  <i>EN-48383</i> Camshaft Retaining Tools  For equivalent regional tools, refer to <a href="#">Special Tools</a>.</p>
2	<p>Crankshaft Sprocket</p> <p>Note: Ensure the crankshaft is in the stage one timing position with the crankshaft sprocket timing mark (3) aligned to the stage one timing mark on the oil pump cover (4) using the <i>EN-48589</i> socket. Refer to <a href="#">Timing Chain Alignment Diagram</a>.</p> <p>Special Tools  <i>EN-48589</i> Crankshaft Rotation Socket  For equivalent regional tools, refer to <a href="#">Special Tools</a>.</p>
3	Crankshaft Sprocket Timing Mark
4	Stage One Timing Mark On The Oil Pump Cover

[Secondary Camshaft Intermediate Drive Chain Installation - Left Side - Step 2](#)



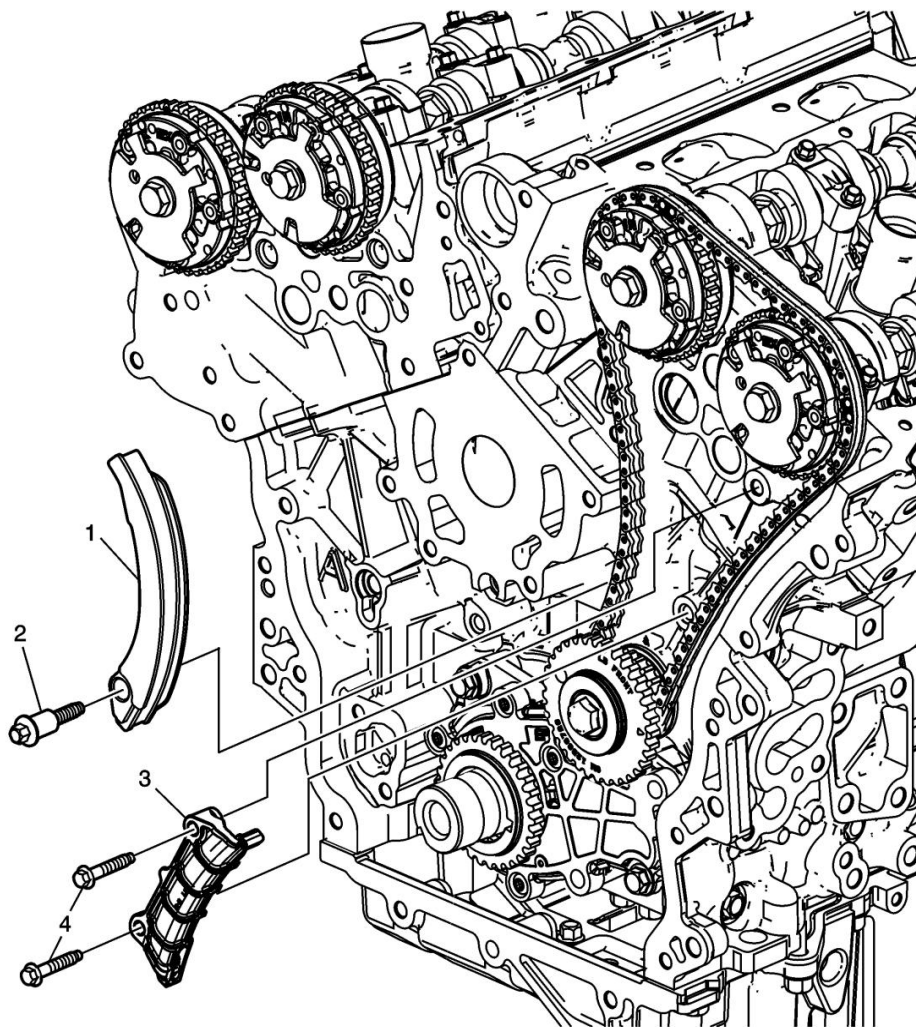


Secondary Camshaft Intermediate Drive Chain Installation - Left Side - Step 2

Callout	Component Name
<p>Note: Ensure that the left (L) camshaft position actuator sprocket alignment circle marks are used during this step.</p>	
<p>1</p>	<p>Secondary Camshaft Intermediate Drive Chain Procedure</p> <p>Note: Once the lower timing link is aligned, it may be helpful to hold the drive chain in position using a small flat blade screwdriver through the idler sprocket alignment access hole.</p> <ol style="list-style-type: none"> <li>Place the left secondary camshaft drive chain around the inner sprocket of the left camshaft intermediate drive chain idler with the camshaft drive chain timing link (2) aligned to the alignment access hole (3) in the left camshaft intermediate drive chain idler outer sprocket.</li> <li>Wrap the secondary camshaft drive chain around both left (L) actuator drive sprockets.</li> <li>Align the left (L) intake camshaft position actuator sprocket alignment circle mark (5) with the camshaft drive chain timing link.</li> <li>Align the left (L) exhaust camshaft position actuator sprocket alignment circle mark (6) with the camshaft drive chain timing link.</li> </ol>

Callout	Component Name
	5. Once aligned, ensure there are 10 chain links (4) between timing marks for the left (L) camshaft position actuator sprockets.
2	Timing Camshaft Drive Chain
3	Alignment Access Hole
4	10 Chain Links Between Timing Marks for the Left (L) Camshaft Position Actuator Sprockets
5	Left (L) Intake Camshaft Position Actuator Sprocket Alignment Circle Mark
6	Left (L) Exhaust Camshaft Position Actuator Sprocket Alignment Circle Mark

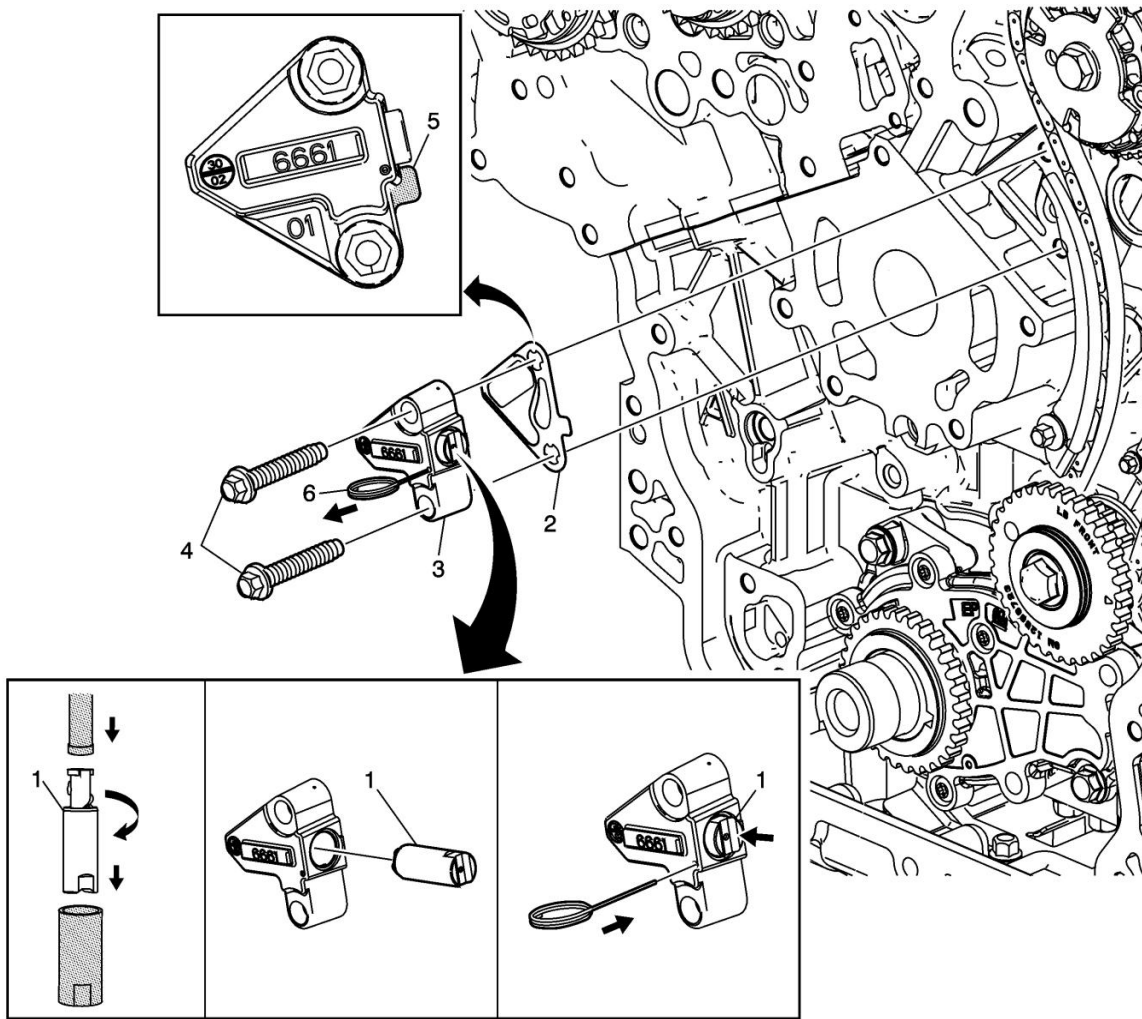
[Secondary Camshaft Drive Chain Guide and Shoe Installation - Left](#)



Secondary Camshaft Drive Chain Guide and Shoe Installation - Left

Callout	Component Name
1	Left Pivot Arm Timing Chain Guide
2	Left Pivot Arm Timing Chain Guide Bolt <b>Caution:</b> Refer to <a href="#">Fastener Caution</a> . Tighten 25 Y (18 lb ft)
3	Left Secondary Timing Chain Guide
4	Left Secondary Timing Chain Guide Bolt Tighten 25 Y (18 lb ft)

[Secondary Camshaft Drive Chain Tensioner Installation - Left Side](#)



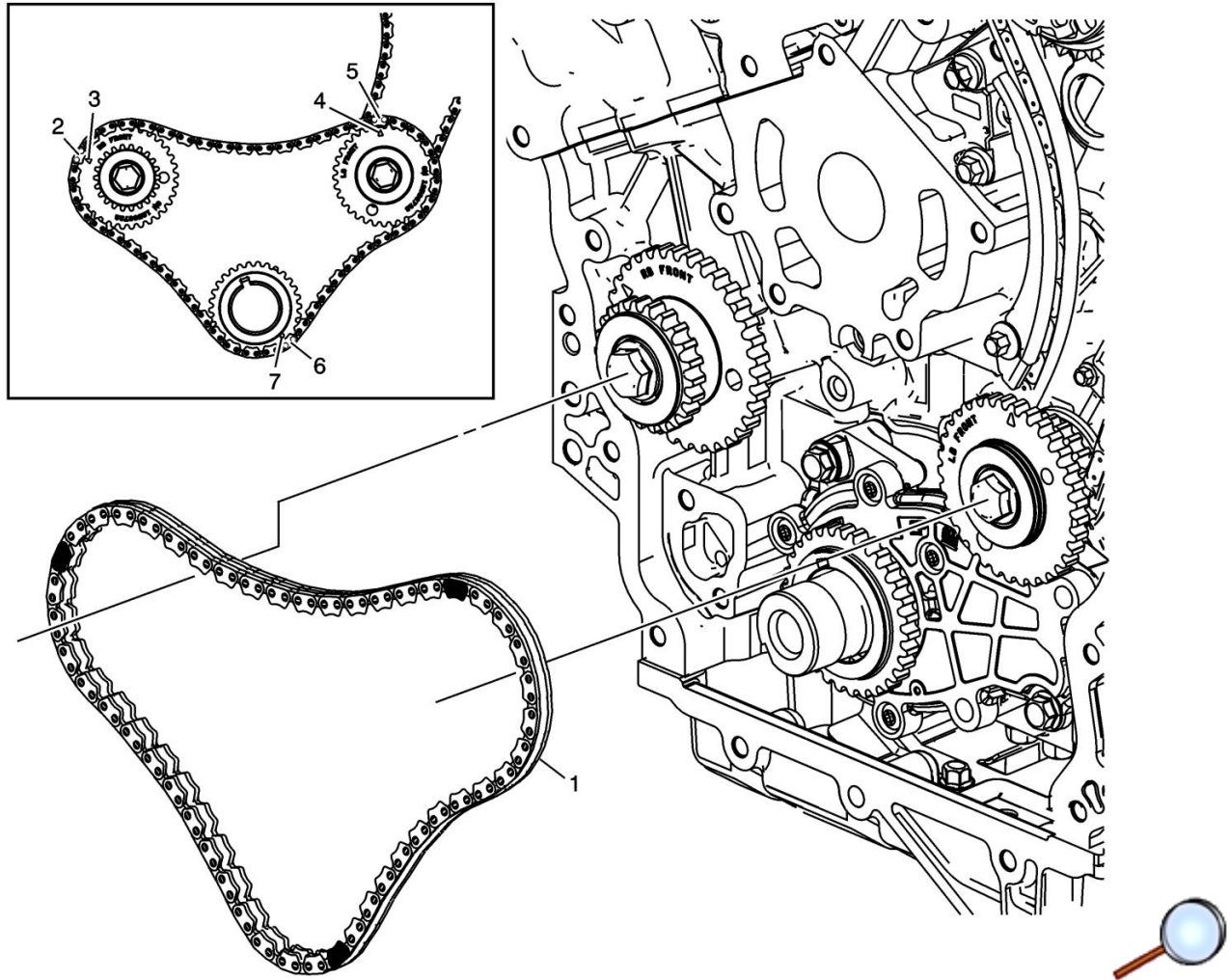
Secondary Camshaft Drive Chain Tensioner Installation - Left Side



Callout	Component Name
1	<p>Left Secondary Timing Chain Tensioner Plunger. Procedure</p> <ol style="list-style-type: none"> <li>1. Reset the left secondary camshaft drive chain tensioner plunger using <i>EN-45</i> tensioner tool.</li> <li>2. Install left secondary camshaft drive chain tensioner plunger into body.</li> <li>3. Compress the plunger into the body and lock the left secondary camshaft drive chain tensioner by inserting the <i>EN-4 11</i> tensioner retraction pins into the access hole in the side of the left secondary camshaft drive chain tensioner body.</li> <li>4. Slowly release pressure on the left secondary camshaft drive chain tensioner. The left secondary camshaft drive chain tensioner should remain compressed.</li> </ol> <p>Special Tools</p> <ul style="list-style-type: none"> <li>• <i>EN-45</i> Tensioner Tool</li> <li>• <i>EN-4 11</i> Tensioner Retraction Pins</li> </ul> <p>For equivalent regional tools, refer to <a href="#">Special Tools</a>.</p>
2	<p>Left Timing Chain Housing Gasket</p> <p><b>Note:</b> Ensure the left secondary camshaft drive 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 secondary camshaft drive chain tensioner gasket.</p>
3	Left Secondary Timing Chain Tensioner
4	<p>Left Secondary Timing Chain Tensioner Bolt Procedure</p> <ol style="list-style-type: none"> <li>1. Place the chain tensioner into position and loosely install the bolts to the block.</li> <li>2. Verify the proper placement of the drive chain tensioner gasket tab (5).</li> <li>3. Tighten the drive chain tensioner bolts in two passes.</li> <li>4. Verify the timing marks are in the correct position before releasing the drive chain tensioner.</li> <li>5. Release the drive chain tensioner by pulling out the <i>EN-4 11</i> tensioner retraction pins pin (6) and unlocking the tensioner plunger.</li> <li>6. Verify the left secondary camshaft drive chain timing mark alignments by referring to <a href="#">Timing Chain Alignment Diagram</a> - Stage One.</li> </ol> <p>Tighten</p> <ul style="list-style-type: none"> <li>• First Pass 5 Y (44 lb in)</li> <li>• Second Pass 25 Y (18 lb ft)</li> </ul>
5	Left Timing Chain Housing Gasket Tab

Callout	Component Name
6	EN-4 11 Pin

Primary Camshaft Intermediate Drive Chain Installation

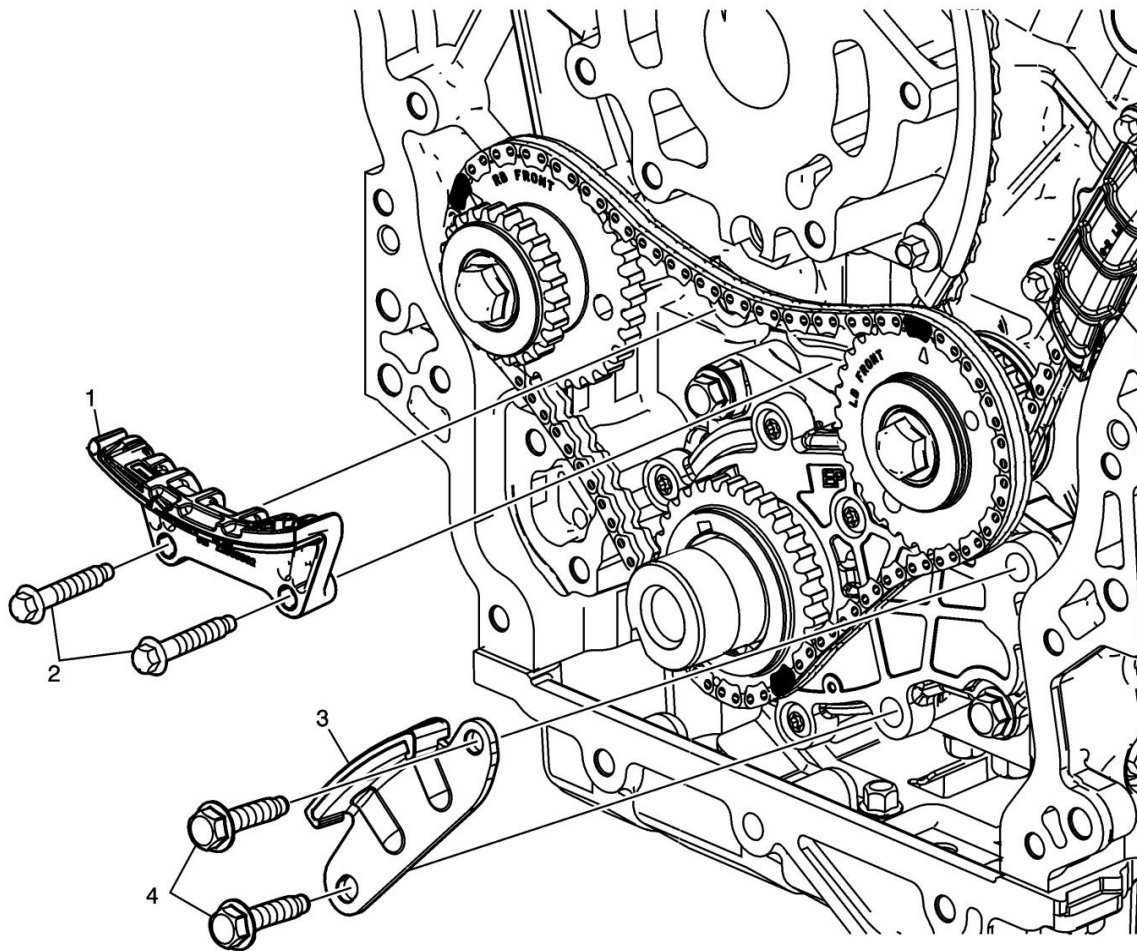


Primary Camshaft Intermediate Drive Chain Installation

Callout	Component Name
1	<p>Primary Camshaft Drive Intermediate Chain Procedure</p> <ol style="list-style-type: none"> <li>1. Wrap the primary camshaft drive chain around the large sprockets of each camshaft intermediate drive chain idler and the crankshaft sprocket.</li> <li>2. The left camshaft intermediate drive chain idler timing mark (2) will align with camshaft drive chain timing link (3).</li> <li>3. The right camshaft intermediate drive chain idler timing mark (4) will align with camshaft drive chain timing link (5).</li> <li>4. The crankshaft sprocket timing mark (7) will align with camshaft drive chain timing link (6).</li> </ol>

Callout	Component Name
2	Left Camshaft Intermediate Drive Chain Idler Timing Mark
3	Camshaft Drive Chain Timing Link
4	Right Camshaft Intermediate Drive Chain Idler Timing Mark
5	Camshaft Drive Chain Timing Link
6	Camshaft Drive Chain Timing Link
7	Crankshaft Sprocket Timing Mark

[Primary Timing Chain Guide Installation - Lower and Upper](#)

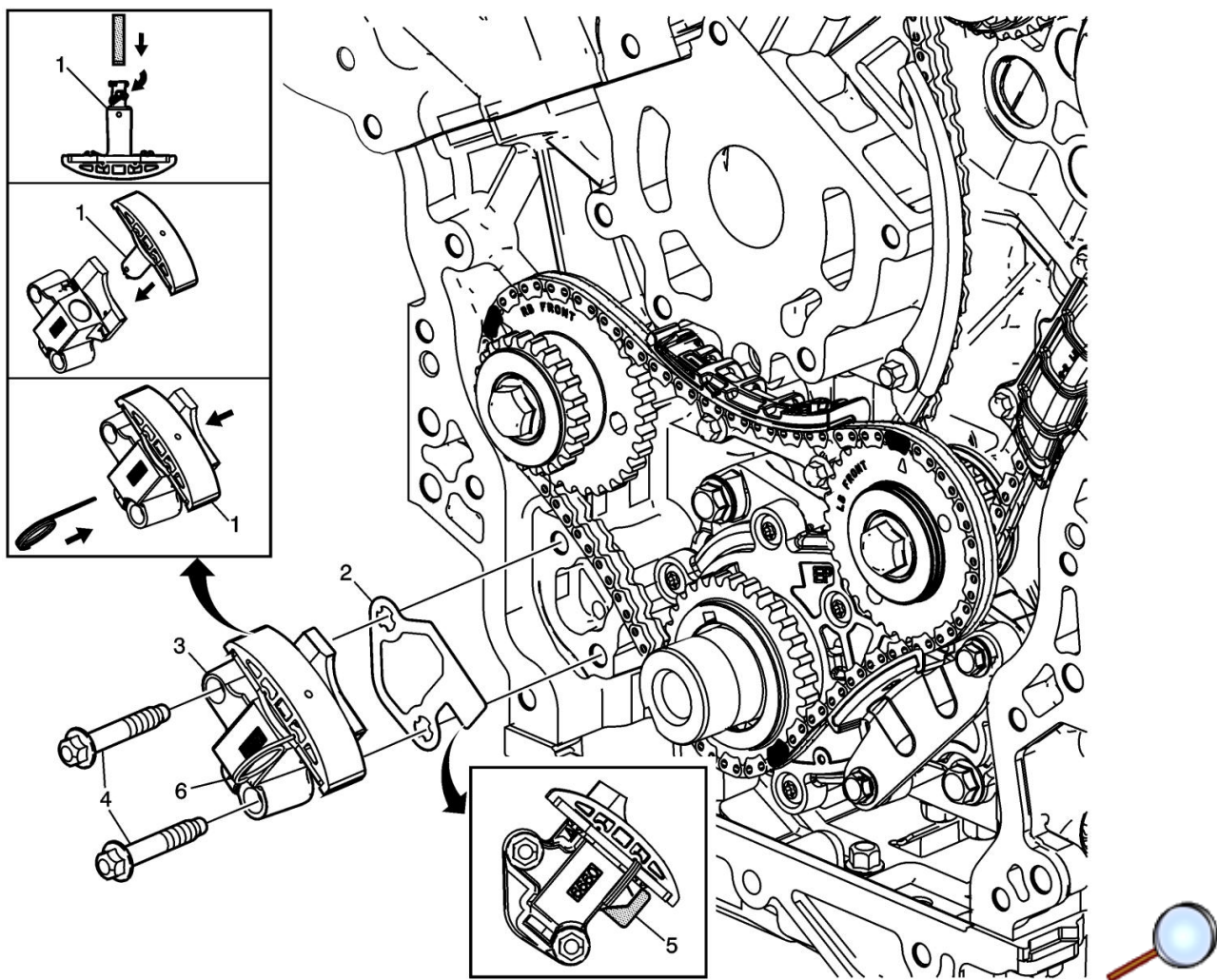


Primary Timing Chain Guide Installation - Lower and Upper

Callout	Component Name
1	Upper Primary Timing Chain Guide

Callout	Component Name
2	Upper Primary Timing Chain Guide Bolt Tighten 25 Y (18 lb ft)
3	Lower Primary Timing Chain Guide
4	Lower Primary Timing Chain Guide Bolt Tighten 25 Y (18 lb ft)

[Primary Camshaft Intermediate Drive Chain Tensioner Installation](#)



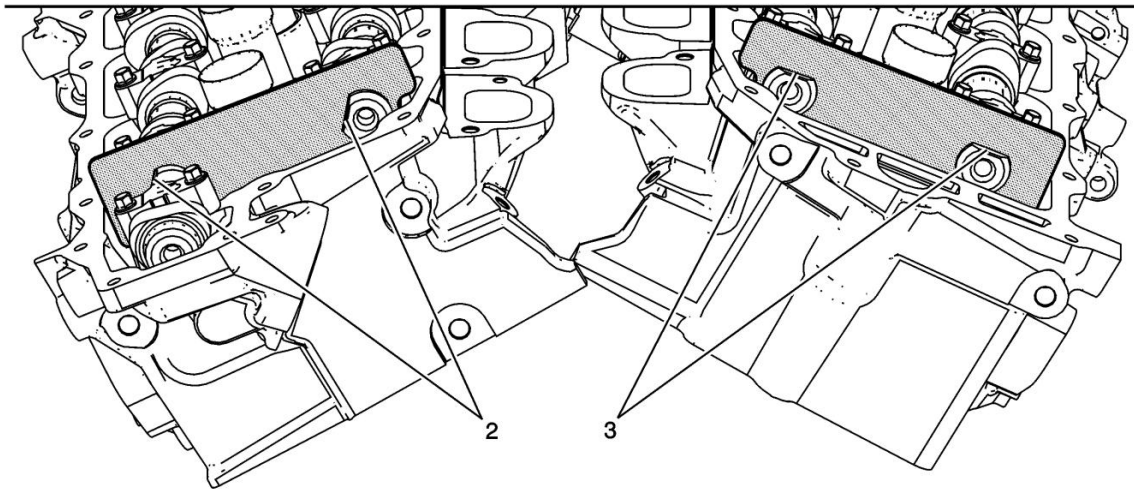
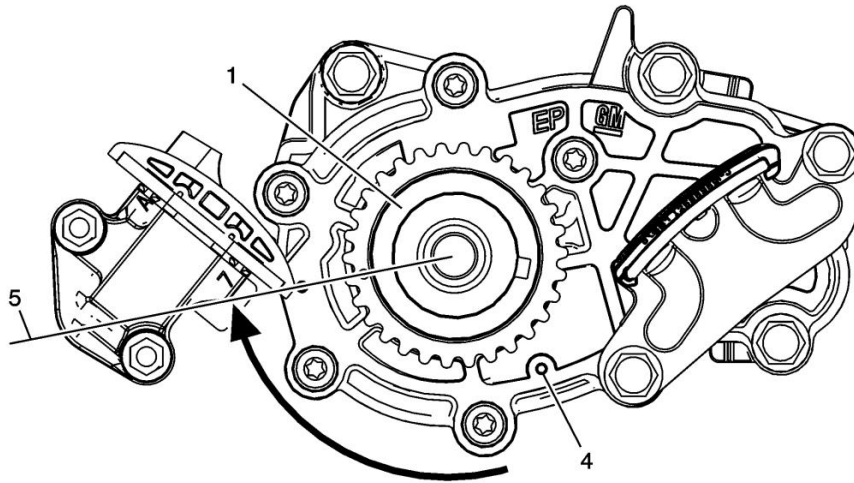
Primary Camshaft Intermediate Drive Chain Tensioner Installation

Callout	Component Name
1	Camshaft Intermediate Drive Chain Tensioner Plunger. Procedure 1. Reset the primary camshaft drive chain tensioner plunger using EN-45 tensioner tool.

Callout	Component Name
2	<p>2. Install primary camshaft drive chain tensioner plunger into body.</p> <p>3. Compress the plunger into the body and lock the primary camshaft drive chain tensioner by inserting the <i>EN-4 11</i> tensioner retraction pins into the access hole in the side of the primary camshaft drive chain tensioner body.</p> <p>4. Slowly release pressure on the primary camshaft drive chain tensioner. The primary camshaft drive chain tensioner should remain compressed.</p> <p>Special Tools</p> <ul style="list-style-type: none"> <li>• <i>EN-45</i> Tensioner Tool</li> <li>• <i>EN-4 11</i> Tensioner Retraction Pins</li> </ul> <p>For equivalent regional tools, refer to <a href="#">Special Tools</a>.</p> <p>Timing Chain Housing Gasket</p> <p><b>Note:</b> Ensure the primary camshaft drive chain tensioner mounting surface on the engine block does not have any burrs or defects that would degrade the sealing of the NEW primary camshaft drive chain tensioner gasket.</p>
3	Camshaft Intermediate Drive Chain Tensioner
4	<p>Camshaft Intermediate Drive Chain Tensioner Bolt Procedure</p> <ol style="list-style-type: none"> <li>1. Place the drive chain tensioner into position and loosely install the bolts to the block.</li> <li>2. Verify the proper placement of the drive chain tensioner gasket tab (5).</li> <li>3. Tighten the drive chain tensioner bolts in two passes.</li> <li>4. Verify the timing marks are in the correct position before releasing the drive chain tensioner.</li> <li>5. Release the drive chain tensioner by pulling out the <i>EN-4 11</i> pin (6) and unlocking the tensioner plunger.</li> <li>6. Verify the primary and left secondary camshaft drive chain timing mark alignments by referring to <a href="#">Timing Chain Alignment Diagram</a> - Stage One.</li> </ol> <p>Tighten</p> <ul style="list-style-type: none"> <li>• First Pass 5 Y (44 lb in)</li> <li>• Second Pass 25 Y (18 lb ft)</li> </ul>
5	Timing Chain Housing Gasket Tab
6	<i>EN-4 11</i> Pin

[Stage 1 lignment Position to the Stage 2 lignment Position](#)



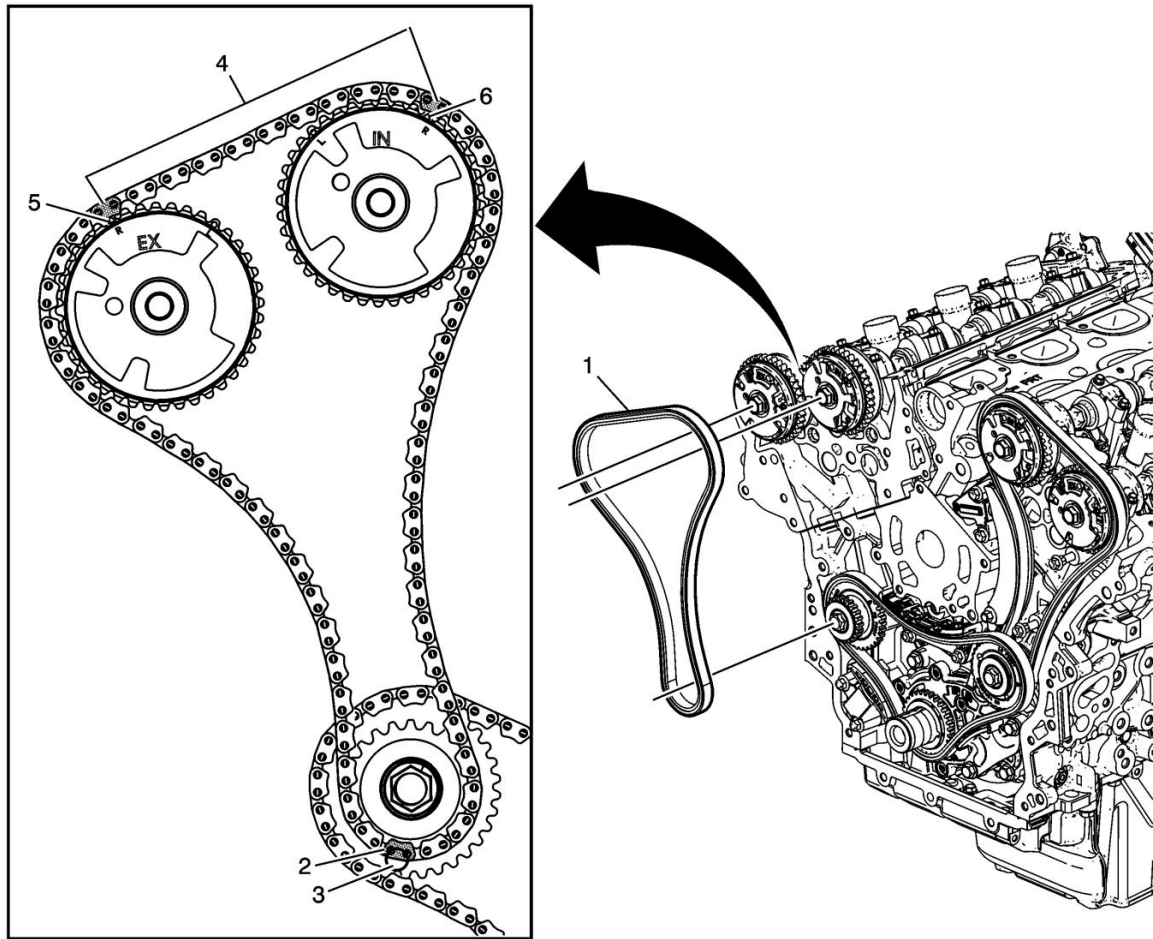


Stage 1 alignment Position to the Stage 2 alignment Position

Callout	Component Name
<p><b>Preliminary Procedure</b> Remove the EN 48383-1 from the rear of the left camshafts.</p>	
1	<p><b>Crankshaft Sprocket Procedure</b> Using the <i>EN-48589</i> crankshaft rotation socket, rotate the crankshaft and crankshaft sprocket from the stage one alignment position (4) to the stage two alignment position (5), 115 crankshaft degrees, in order to install the right secondary camshaft drive chain components.</p> <p><b>Special Tools</b> <i>EN-48589</i> Crankshaft Rotation Socket For equivalent regional tools, refer to <a href="#">Special Tools</a>.</p>
2	<p><b>Left Intake and Exhaust Camshaft Procedure</b></p> <p><b>Note:</b></p>

Callout	Component Name
3	<ul style="list-style-type: none"> <li>◦ There should be no need to rotate the camshaft more than 10 degrees. Using the hex cast into the camshaft rotate the camshaft in order to install the <i>EN-48383-</i> retainer .</li> <li>◦ All camshafts must be locked in place before installation of any camshaft drive chains.</li> </ul> <ol style="list-style-type: none"> <li>1. Install the <i>EN-48383-</i> retainer onto the rear of the left camshafts.</li> <li>2. Ensure the <i>EN-48383-</i> retainer is fully seated onto the camshafts.</li> </ol> <p>Special Tools  <i>EN-48383</i> Crankshaft Rotation Tools  For equivalent regional tools, refer to <a href="#">Special Tools</a>.</p> <hr/> <p>Right Intake and Exhaust Camshaft  Procedure</p> <p style="padding-left: 40px;"><b>Note:</b></p> <ul style="list-style-type: none"> <li>◦ There should be no need to rotate the camshaft more than 10 degrees. Using the hex cast into the camshaft rotate the camshaft in order to install the <i>EN-48383-3</i> retainer .</li> <li>◦ All camshafts must be locked in place before installation of any camshaft drive chains.</li> </ul> <ol style="list-style-type: none"> <li>1. Install the <i>EN-48383-3</i> retainer onto the rear of the right camshafts.</li> <li>2. Ensure the <i>EN-48383-3</i> retainer is fully seated onto the camshafts.</li> </ol> <p>Special Tools  <i>EN-48383</i> Crankshaft Rotation Tools  For equivalent regional tools, refer to <a href="#">Special Tools</a>.</p>
4	Stage One Alignment Position
5	Stage Two Alignment Position

[Secondary Camshaft Intermediate Drive Chain Installation - Right Side](#)

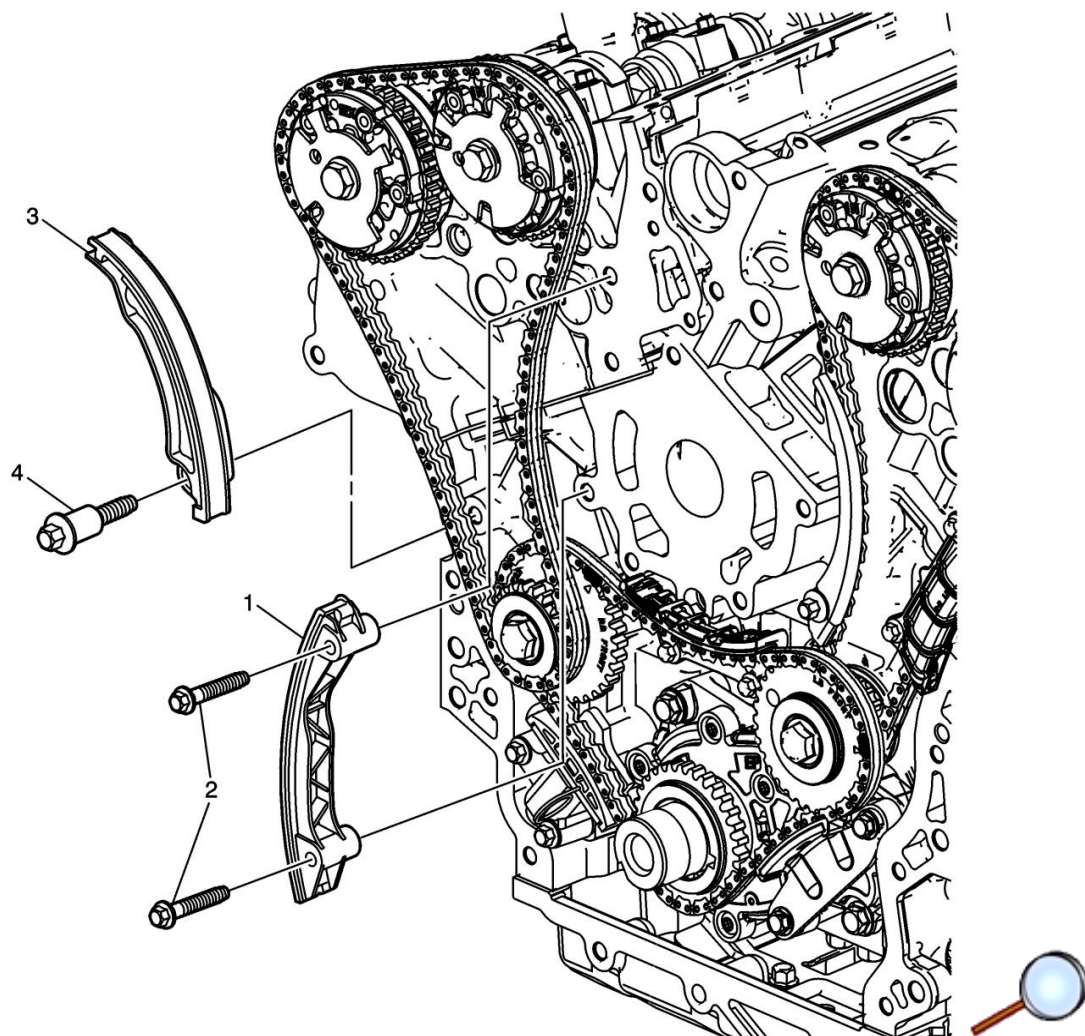


Secondary Camshaft Intermediate Drive Chain Installation - ight Side

Callout	Component Name
<p>Note: Ensure that the right (R) camshaft position actuator sprocket alignment triangle marks are used during this step.</p>	
<p>1</p>	<p>Secondary Camshaft Intermediate Drive Chain                      Note: Ensure that the crankshaft is in the stage 2 timing drive assembly position.                      Procedure</p> <ol style="list-style-type: none"> <li>1. Place the secondary camshaft intermediate drive chain around the right camshaft intermediate drive chain idler outer sprocket, aligning the camshaft drive chain timing link (2) with the alignment access hole (3) in the right camshaft intermediate drive chain idler inner sprocket.</li> <li>2. Wrap the secondary camshaft intermediate drive chain around both right (R) actuator drive sprockets.</li> <li>3. Align the right (R) intake camshaft position actuator sprocket alignment triangle mark (5) with the camshaft drive chain timing link.</li> <li>4. Align the right (R) exhaust camshaft position actuator sprocket alignment triangle mark (6) with the camshaft drive chain timing link.</li> <li>5. Once aligned, ensure there are 10 chain links (4) between timing marks for the right (R) camshaft position actuator sprockets.</li> </ol>

Callout	Component Name
	6. There will be 22 links between the right camshaft intermediate drive chain idler timing camshaft drive chain link and each right camshaft position actuator sprocket timing camshaft drive chain link.
2	Camshaft Drive Chain Timing Link
3	Alignment Access Hole
4	10 Chain Links Between Timing Marks for the Right (R) Camshaft Position Actuator Sprockets
5	Right (R) Intake Camshaft Position Actuator Sprocket Alignment Triangle Mark
6	Right (R) Exhaust Camshaft Position Actuator Sprocket Alignment Triangle Mark

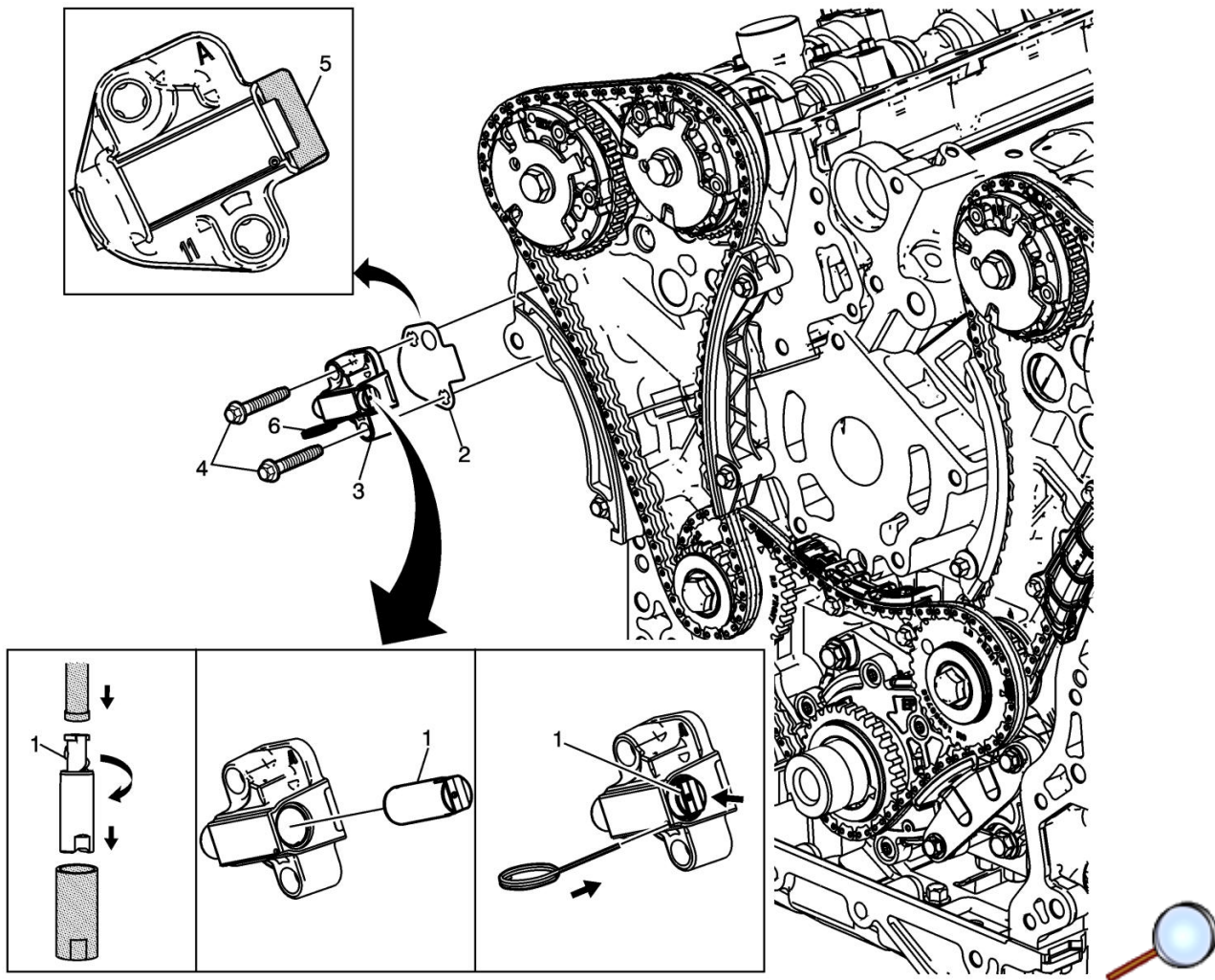
[Secondary Camshaft Drive Chain Guide and Shoe Installation - ight Side](#)



Secondary Camshaft Drive Chain Guide and Shoe Installation - ight Side

Callout	Component Name
1	Right Pivot Arm Timing Chain Guide
2	Right Pivot Arm Timing Chain Guide Bolt Tighten 25 Y (18 lb ft)
3	Right Secondary Timing Chain Guide
4	Right Secondary Timing Chain Guide Bolt Tighten 25 Y (18 lb ft)

[Secondary Camshaft Drive Chain Tensioner Installation - ight Side](#)

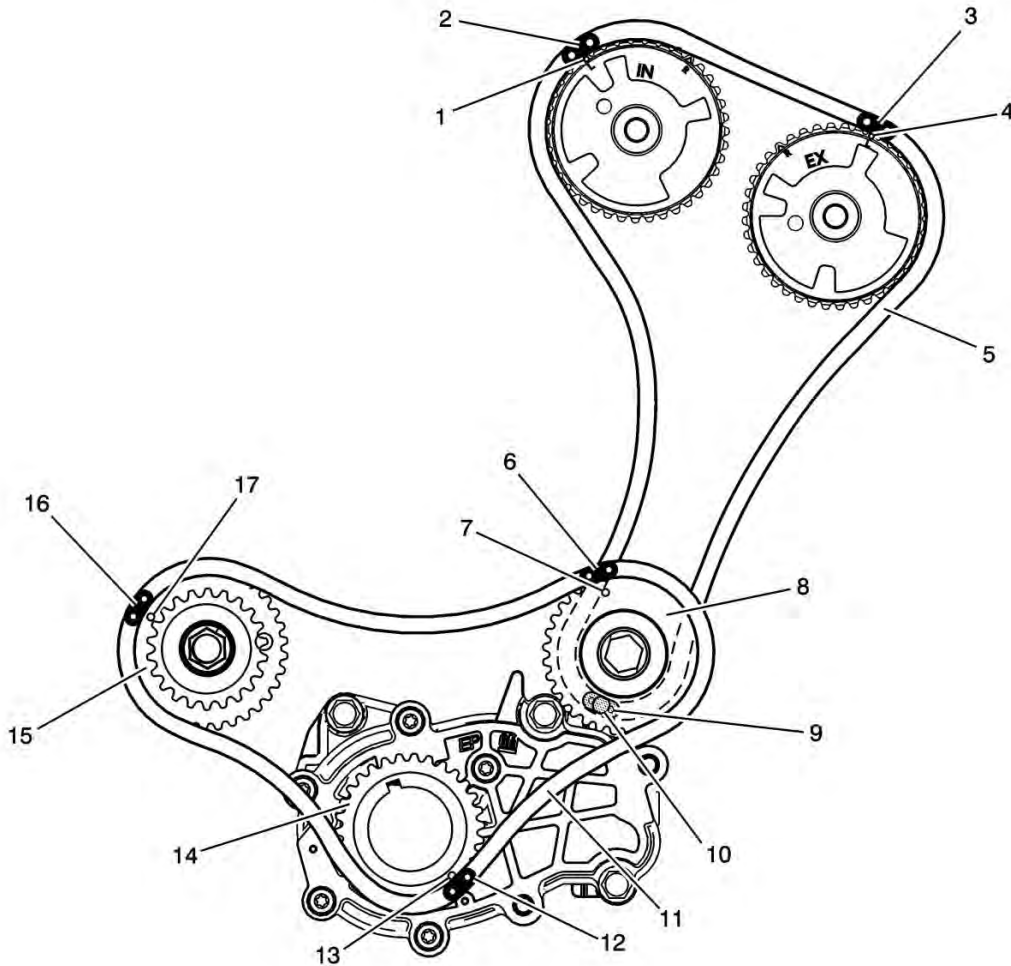


Secondary Camshaft Drive Chain Tensioner Installation - ight Side

Callout	Component Name
1	Right Secondary Timing Chain Tensioner Plunger Procedure

Callout	Component Name
2	<p>1. Reset the right secondary camshaft drive chain tensioner plunger using <i>EN-45</i> tensioner tool.</p> <p>2. Install right secondary camshaft drive chain tensioner plunger into body.</p> <p>3. Compress the plunger into the body and lock the right secondary camshaft drive chain tensioner by inserting the <i>EN-4 11</i> tensioner retraction pins into the access hole in the side of the right secondary camshaft drive chain tensioner body.</p> <p>4. Slowly release pressure on the right secondary camshaft drive chain tensioner. The right secondary camshaft drive chain tensioner should remain compressed.</p> <p>Special Tools</p> <ul style="list-style-type: none"> <li>• <i>EN-45</i> Tensioner Tool</li> <li>• <i>EN-4 11</i> Tensioner Retraction Pins</li> </ul> <p>For equivalent regional tools, refer to <a href="#">Special Tools</a>.</p> <p>Right Timing Chain Housing Gasket</p> <p><b>Note:</b> Ensure the right secondary camshaft drive 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 secondary camshaft drive chain tensioner gasket.</p>
3	Right Secondary Timing Chain Tensioner
4	<p>Right Secondary Timing Chain Tensioner Bolt Procedure</p> <ol style="list-style-type: none"> <li>1. Place the right secondary drive chain tensioner into position and loosely install the bolts to the block.</li> <li>2. Verify the proper placement of the right secondary drive chain tensioner gasket tab (5).</li> <li>3. Tighten the drive chain tensioner bolts in two passes.</li> <li>4. Verify the timing marks are in the correct position before releasing the drive chain tensioner.</li> <li>5. Release the right secondary drive chain tensioner by pulling out the <i>EN-4 11</i> pin (6) and unlocking the tensioner plunger.</li> <li>6. Verify all primary and secondary camshaft drive chain timing mark alignments by referring to <a href="#">Timing Chain Alignment Diagram</a> - Stage One.</li> </ol> <p>Tighten</p> <ul style="list-style-type: none"> <li>• First Pass 5 Y (44 lb in)</li> <li>• Second Pass 25 Y (18 lb ft)</li> </ul>
5	Right Timing Chain Housing Gasket Tab
6	<i>EN-4 11</i> Pin

## Stage One



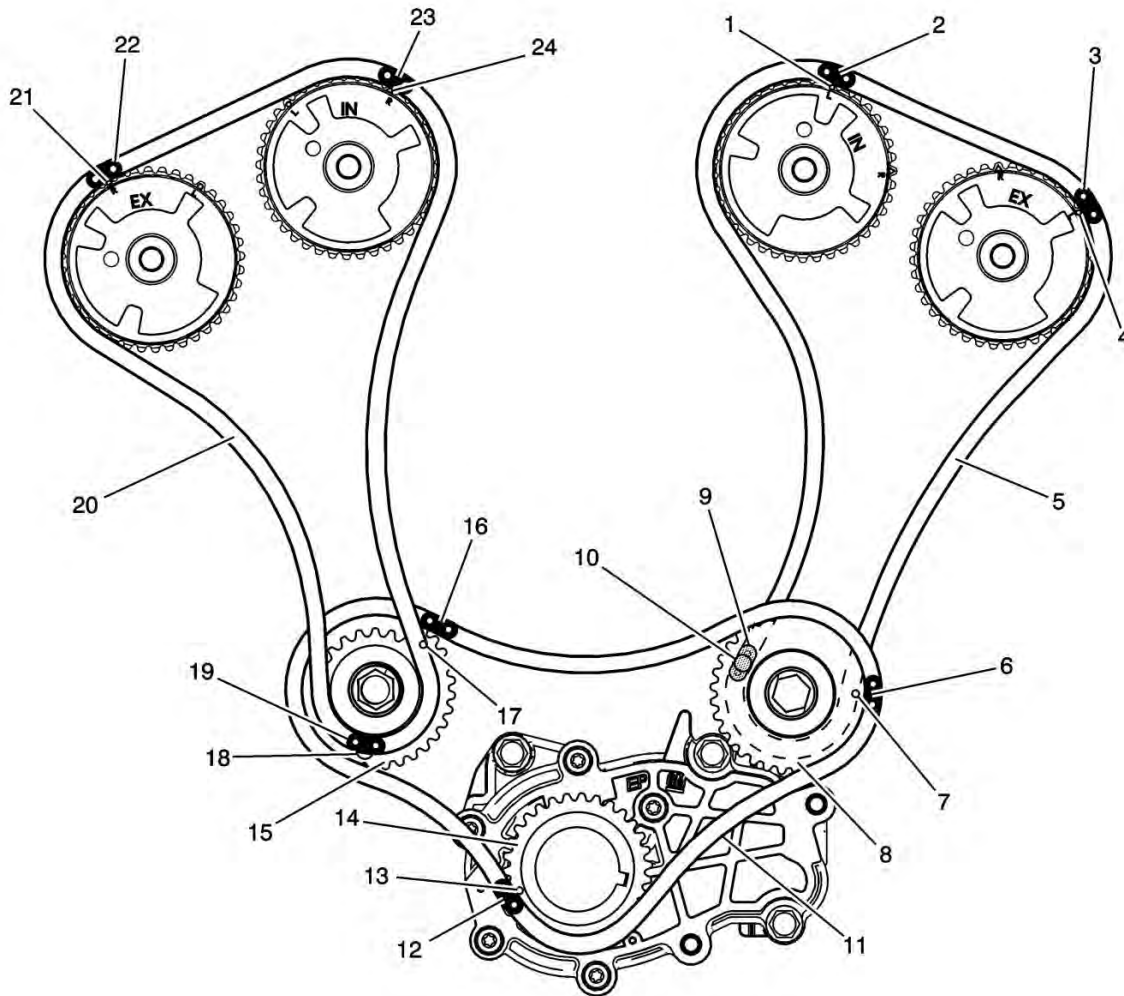
- (1) Left (L) Intake Camshaft Position Actuator Timing Mark– Circle
- (2) Left Intake Secondary Camshaft Timing Drive Chain Timing Link
- (3) Left Exhaust Secondary Camshaft Timing Drive Chain Timing Link
- (4) Left (L) Exhaust Camshaft Position Actuator Timing Mark– Circle
- (5) Left Secondary Camshaft Timing Drive Chain
- (6) Primary Camshaft Drive Chain Timing Link for the Left Primary Camshaft Intermediate Drive Chain Sprocket
- (7) Left Primary Camshaft Intermediate Drive Chain Sprocket Timing Mark for the Primary Camshaft Drive Chain
- (8) Left Primary Camshaft Intermediate Drive Chain Sprocket
- (9) Left Secondary Camshaft Timing Drive Chain Timing Link for the Left Primary Camshaft Intermediate Drive Chain Sprocket – Behind Hole in Sprocket
- (10) Left Primary Camshaft Intermediate Drive Chain Sprocket Timing Window for the Left Secondary Camshaft Timing Drive Chain Timing Link
- (11) Primary Camshaft Drive Chain
- (12) Primary Camshaft Drive Chain Timing Link for the Crankshaft Sprocket

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- (13) Crankshaft Sprocket Timing Mark
- (14) Crankshaft Sprocket
- (15) Right Primary Camshaft Intermediate Drive Chain Sprocket
- (16) Primary Camshaft Drive Chain Timing Link for the Right Primary Camshaft Intermediate Drive Chain Sprocket
- (17) Right Primary Camshaft Intermediate Drive Chain Sprocket Timing Mark



## Stage Two



- (1) Left (L) Intake Camshaft Position Actuator Timing Mark– Circle
- (2) Left Intake Secondary Camshaft Timing Drive Chain Timing Link
- (3) Left Exhaust Secondary Camshaft Timing Drive Chain Timing Link
- (4) Left (L) Exhaust Camshaft Position Actuator Timing Mark– Circle
- (5) Left Secondary Camshaft Timing Drive Chain
- (6) Primary Camshaft Drive Chain Timing Link for the Left Primary Camshaft Intermediate Drive Chain Sprocket
- (7) Left Primary Camshaft Intermediate Drive Chain Sprocket Timing Mark for the Primary Camshaft Drive Chain
- (8) Left Primary Camshaft Intermediate Drive Chain Sprocket
- (9) Left Secondary Camshaft Timing Drive Chain Timing Link for the Left Primary Camshaft Intermediate Drive Chain Sprocket – Behind Hole in Sprocket
- (10) Left Primary Camshaft Intermediate Drive Chain Sprocket Timing Window
- (11) Primary Camshaft Drive Chain
- (12) Primary Camshaft Drive Chain Timing Link for the Crankshaft Sprocket
- (13) Crankshaft Sprocket Timing Mark

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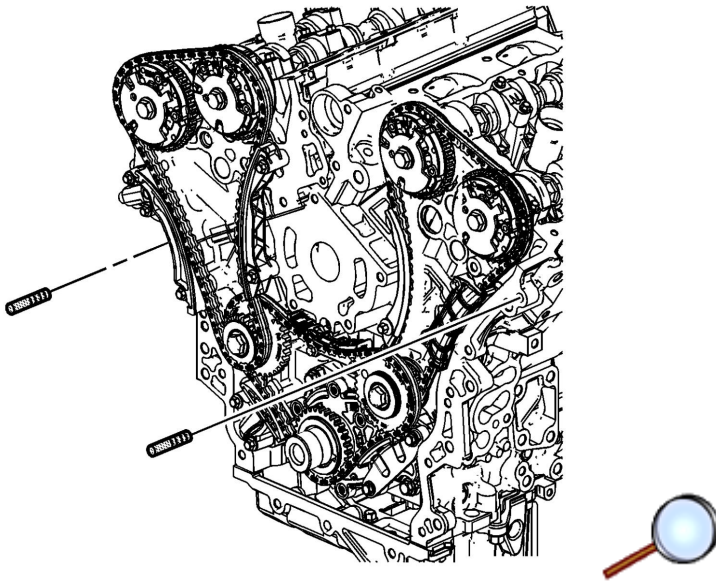
- (14) Crankshaft Sprocket
- (15) Right Primary Camshaft Intermediate Drive Chain Sprocket
- (16) Primary Camshaft Drive Chain Timing Link for the Right Primary Camshaft Intermediate Drive Chain Sprocket
- (17) Right Primary Camshaft Intermediate Drive Chain Sprocket Timing Mark for the Primary Camshaft Drive Chain
- (18) Right Primary Camshaft Intermediate Drive Chain Sprocket Timing Mark/Window for the Right Secondary Camshaft Timing Drive Chain
- (19) Right Secondary Camshaft Timing Drive Chain Timing Link for the Right Primary Camshaft Intermediate Drive Chain Sprocket
- (20) Right Secondary Camshaft Timing Drive Chain
- (21) Right (R) Exhaust Camshaft Position Actuator Timing Mark– Triangle
- (22) Right Exhaust Secondary Camshaft Timing Drive Chain Timing Link
- (23) Right Intake Secondary Camshaft Timing Drive Chain Timing Link
- (24) Right (R) Intake Camshaft Position Actuator Timing Mark– Triangle

## Engine Front Cover Installation

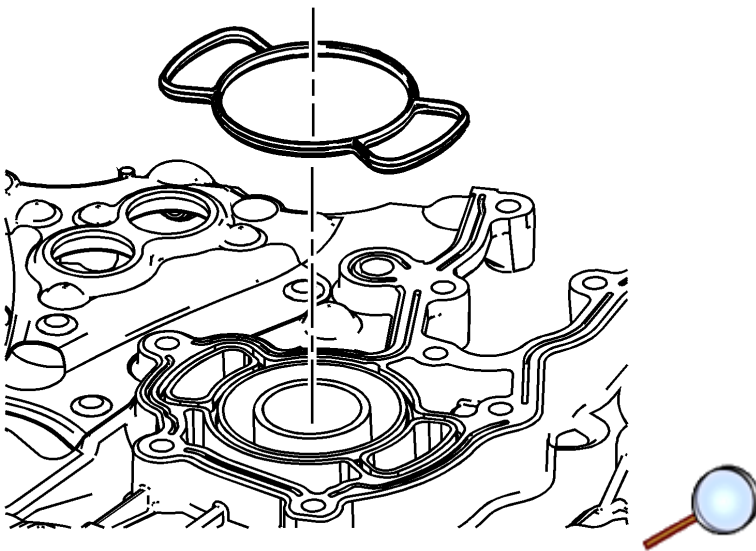
### Special Tools

EN-46109 Guide Pins

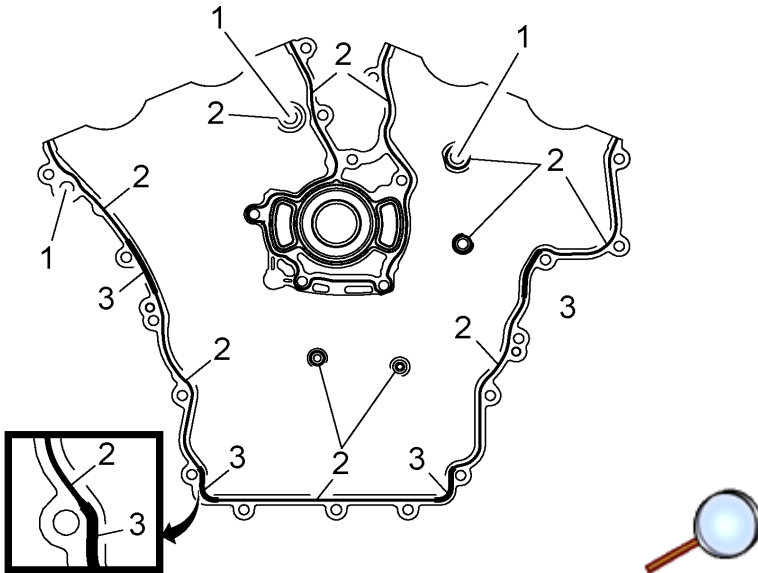
For equivalent regional tools, refer to [Special Tools](#).



1. Install the 8 mm (0.315 in) guide from the EN-46109 pins into the cylinder block positions as shown.



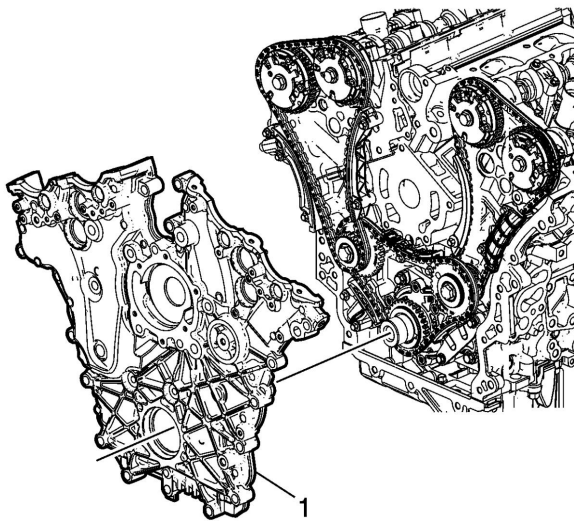
2. Install the NEW engine front cover to cylinder block seal.



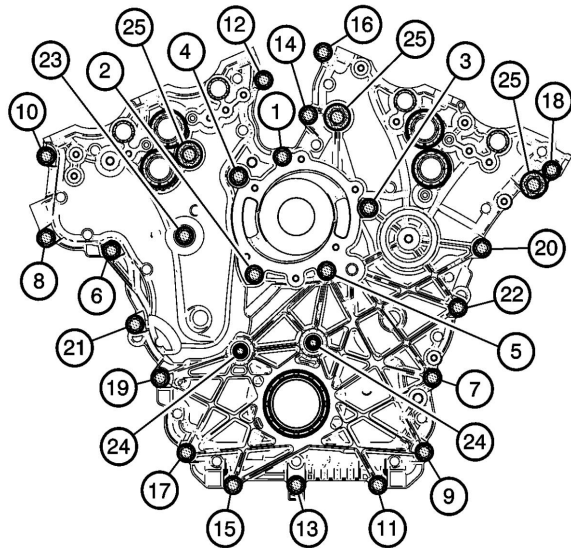
Note:

- No RTV sealant should be visible in the M12 bolt holes (1) upon final assembly of front cover to engine.
- Keep the RTV bead path on the outward edge of the t-joints to ensure proper sealant coverage.

3. Ensure proper use of room temperature vulcanizing (RTV) sealant. [Use of Room Temperature Vulcanizing \(RTV\) and Anaerobic Sealant](#)
4. Apply a 3 mm (0.118 in) bead of RTV sealant on the engine front cover as shown (2).
5. Apply a 5 mm (0.197 in) bead of RTV sealant on the engine front cover as shown (3). Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended sealant.



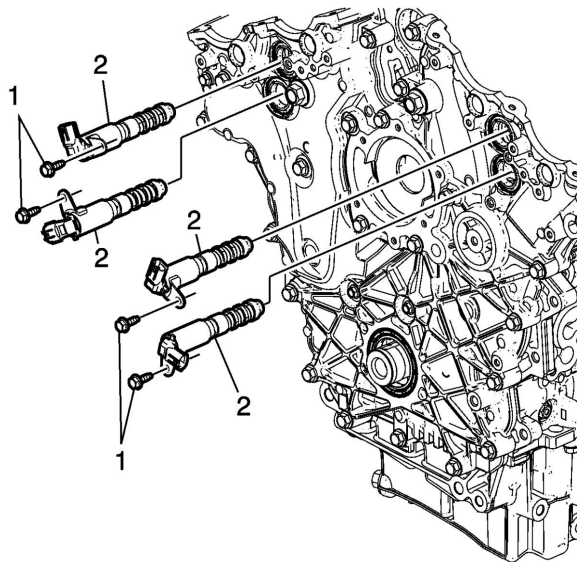
6. Place the engine front cover (1) onto the *EN-46109* pins and slide into position.
7. Remove the *EN-46109* pins from the cylinder block.
8. Hand start all the engine front cover bolts.



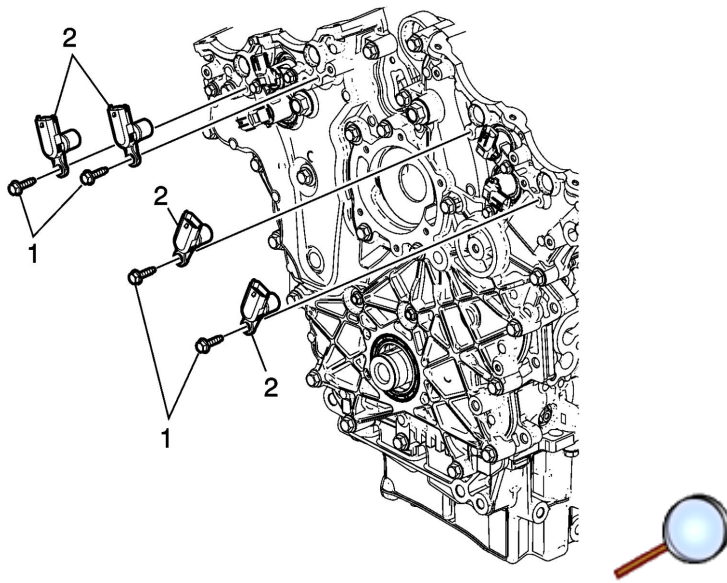
**Caution:** Refer to [Fastener Caution](#).

**Note:** Engine front cover bolts in the number (25) location are model dependent and may not apply.

9. Tighten the engine front cover bolts (1–23) in the sequence shown to 20 Y (15 lb ft).
  - 9.1. Tighten the engine front cover bolts (1–23) a second pass in sequence to 20 Y (15 lb ft).
  - 9.2. Tighten the engine front cover bolts (1–23) a third pass in sequence an additional 60 degrees.
  - 9.3. Tighten the engine front cover bolts (24) to 15 Y (11 lb ft).
  - 9.4. Tighten the engine front cover bolts (25) to 65 Y (48 lb ft).



10. Place the camshaft position actuator valves (2) in position on the front cover.
11. Install the camshaft position actuator valve bolts (1) and tighten to 10 Y (89 lb in).



Note: Inspect the camshaft position sensor O-ring seals. If the seals are damaged, the entire camshaft position sensor must be replaced.

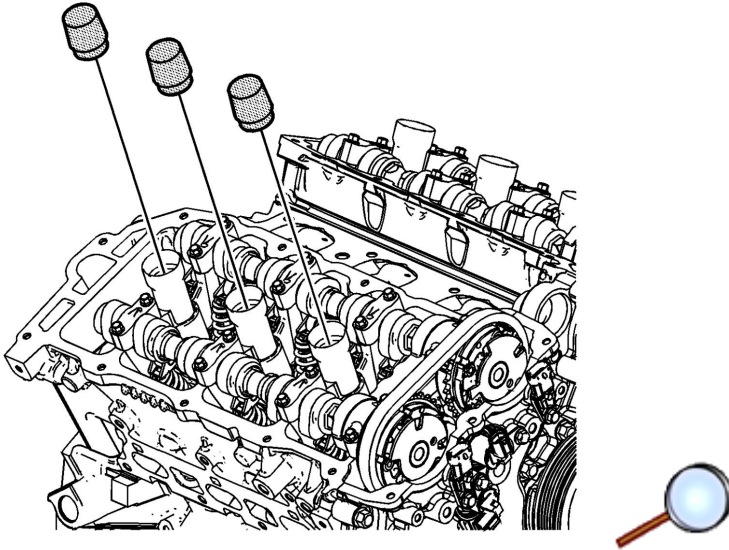
12. Place the camshaft position sensors (2) in position on the front cover.
13. Install the camshaft position sensor bolts (1) and tighten to 10 Y (89 lb in).

## Camshaft Cover Installation - Right Side

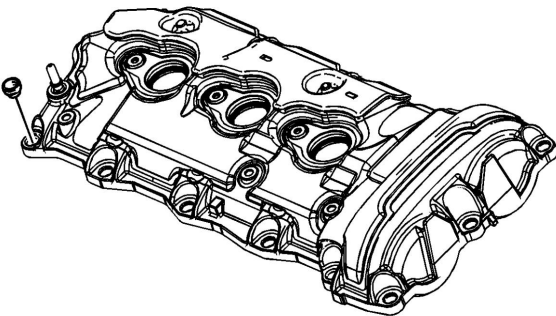
### Special Tools

*EN-46101* Spark Plug Tube Seal Guide

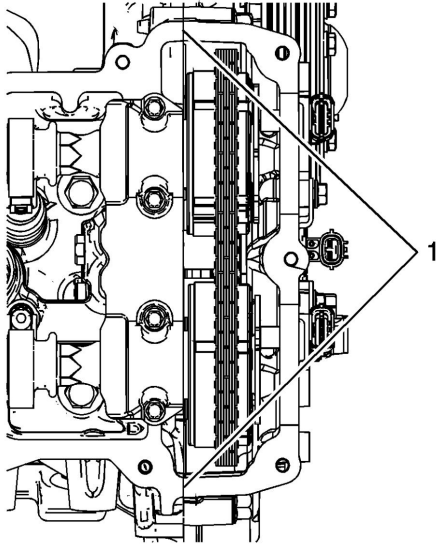
For equivalent regional tools, refer to [Special Tools](#).



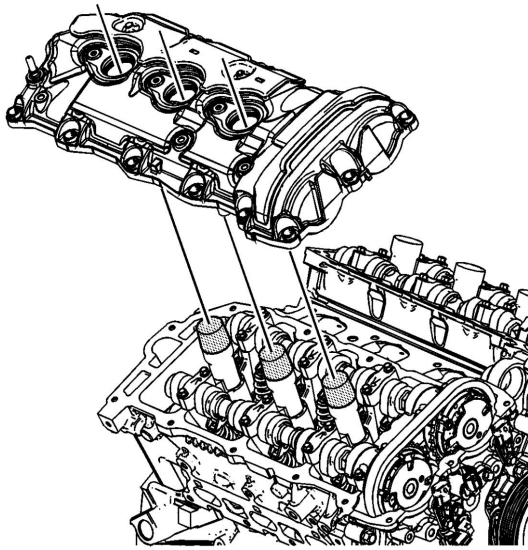
1. Install the *EN-46101* guide onto the spark plug tubes of the right cylinder head.



2. Install the NEW camshaft cover bolt grommets prior to installing the camshaft cover bolts.
3. Wipe the camshaft cover sealing surface on the right cylinder head with a clean, lint-free cloth.

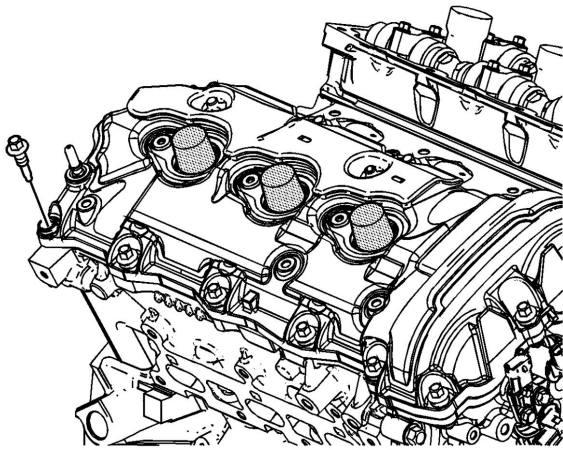


4. Ensure proper use of room temperature vulcanizing (RTV) sealant. [Use of Room Temperature Vulcanizing \(RTV\) and Anaerobic Sealant](#)
5. Place a bead 8 mm (0.3150 in) in diameter by 4 mm (0.1575 in) in height of RTV sealant, on the engine front cover split lines (1). Refer to [Adhesives, Fluids, Lubricants, and Sealers](#).

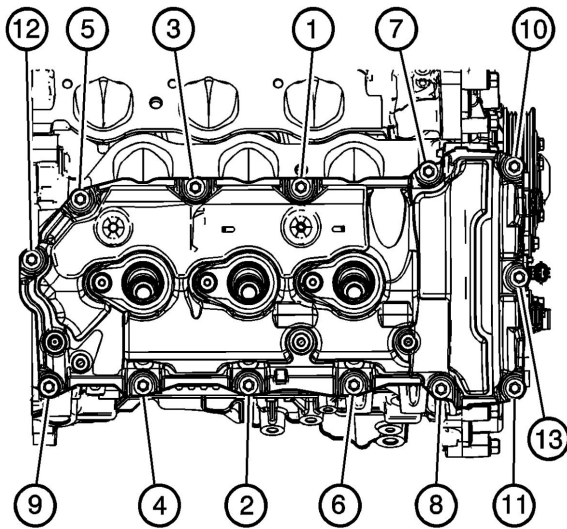


6. Place the right camshaft cover into position onto the right cylinder head.





7. Loosely install the right camshaft cover bolts.

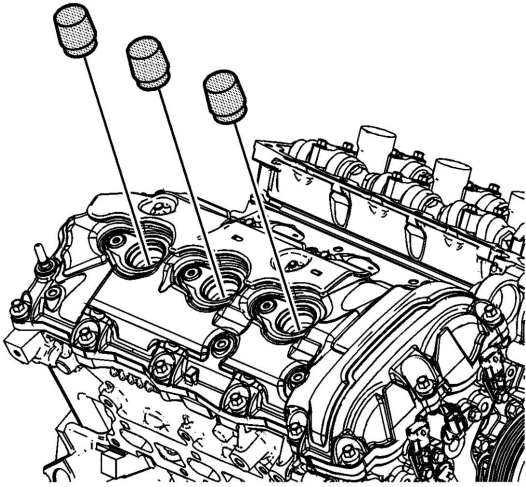


**Caution:** Refer to [Fastener Caution](#).

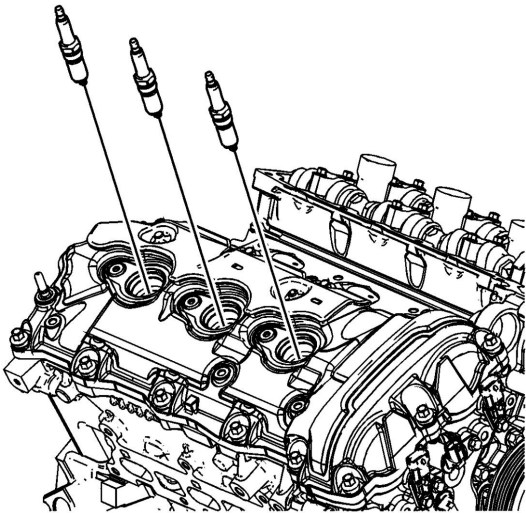
8. Tighten the right camshaft cover bolts in the sequence shown.

8.1. Tighten the right camshaft cover bolts to 10 Y (89 lb in).

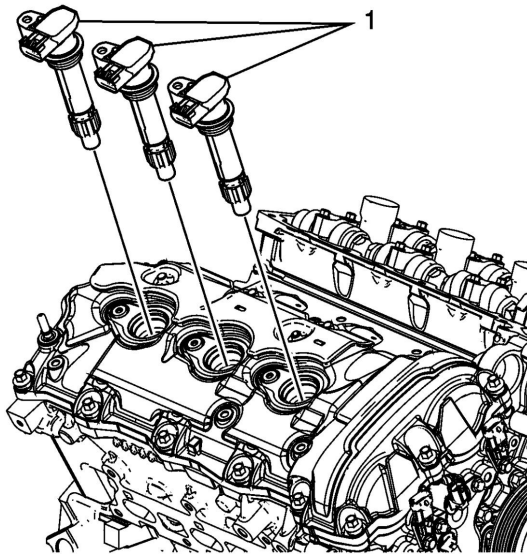
8.2. Tighten the right camshaft cover bolts a second pass to 10 Y (89 lb in).



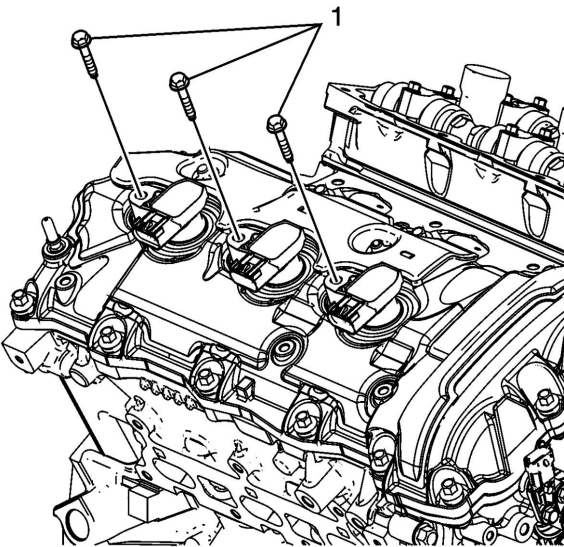
9. Remove the *EN-46101* guide from the spark plug tubes of the right cylinder head.



10. Install the NEW spark plugs into the right cylinder head and tighten to 18 Y (13 lb ft).



11. Inspect the inside of the ignition coil rubber boot for a thin, even coat of grease. If there is no grease present or additional grease is necessary, complete the following procedure:
  - 11.1. Apply a thin coating of dielectric grease evenly to the inside of the ignition coil rubber boot, up to a depth of 15 mm from the end of the boot. Refer to [Adhesives, Fluids, Lubricants, and Sealers](#).
  - 11.2. Remove any excess grease from around the end of the boot, and ensure there is not an excessive amount within the boot.
12. Install the ignition coils.



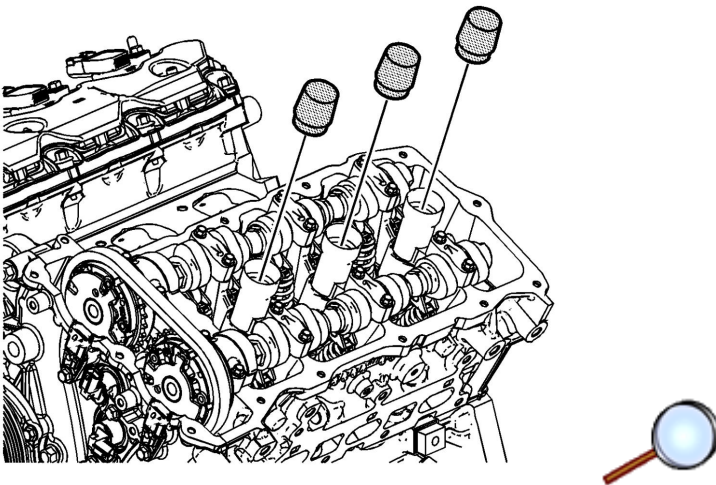
13. Install the ignition coil bolts and tighten to 10Y (89 lb in).

## Camshaft Cover Installation - Left Side

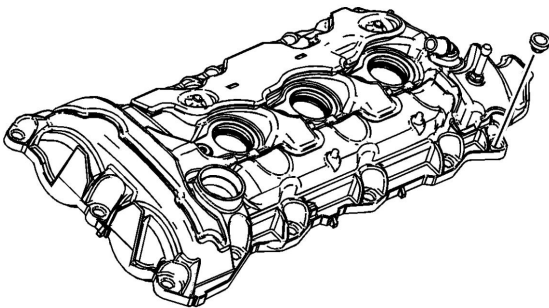
### Special Tools

*EN-46101* Spark Plug Tube Seal Guide

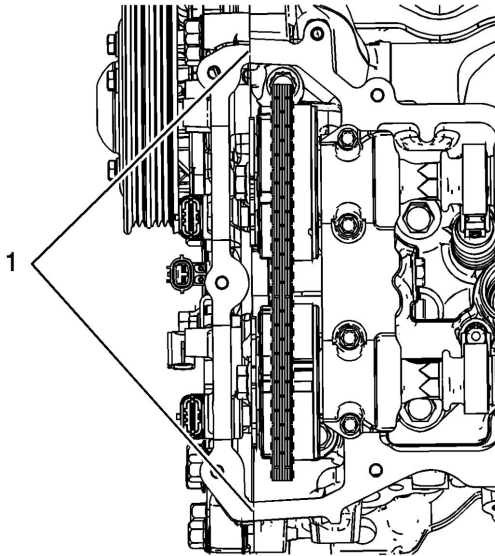
For equivalent regional tools, refer to [Special Tools](#).



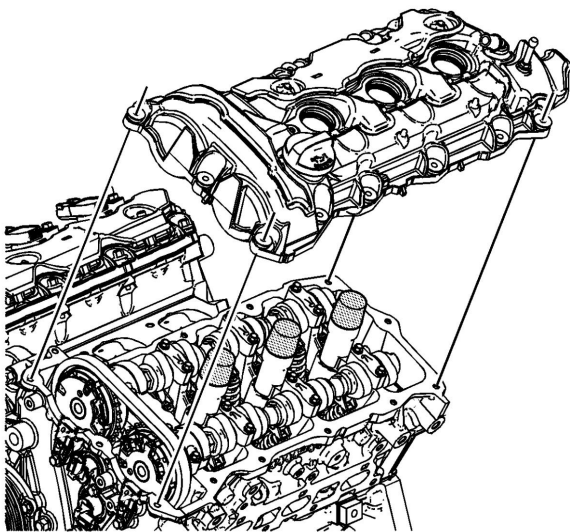
1. Install the *EN-46101* guide onto the spark plug tubes of the left cylinder head.



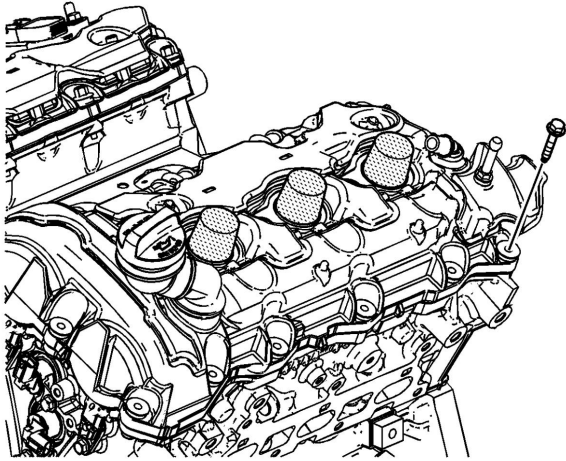
2. Install the NEW camshaft cover bolt grommets prior to installing the camshaft cover bolts.
3. Wipe the camshaft cover sealing surface on the left cylinder head with a clean, lint-free cloth.



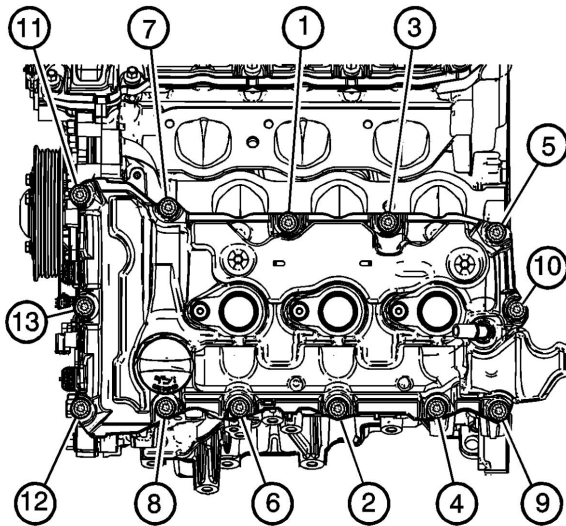
4. Ensure proper use of room temperature vulcanizing (RTV) sealant. [Use of Room Temperature Vulcanizing \(RTV\) and Anaerobic Sealant](#)
5. Place a bead 8 mm (0.3150 in) in diameter by 4 mm (0.1575 in) in height of RTV sealant, on the engine front cover split lines (1). Refer to [Adhesives, Fluids, Lubricants, and Sealers](#) for recommended sealant.



6. Place the left camshaft cover into position onto the left cylinder head.

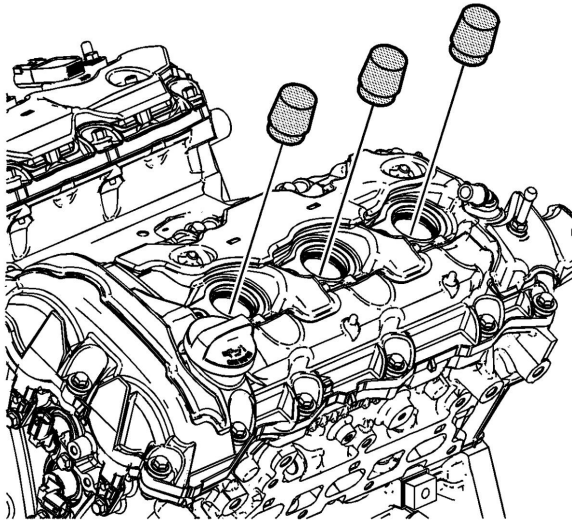


7. Loosely install the left camshaft cover bolts.

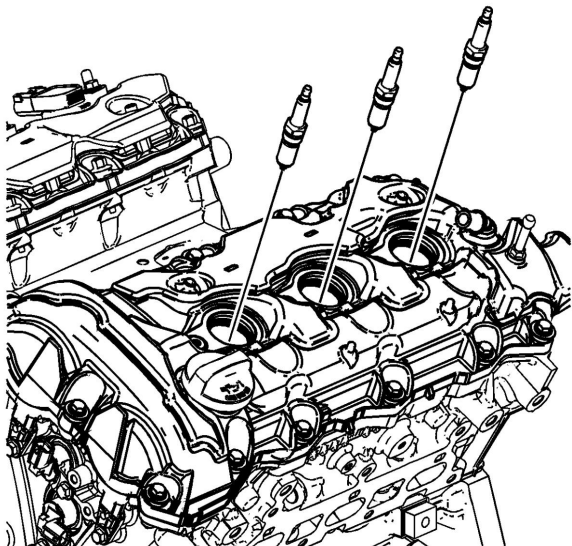


**Caution:** Refer to [Fastener Caution](#).

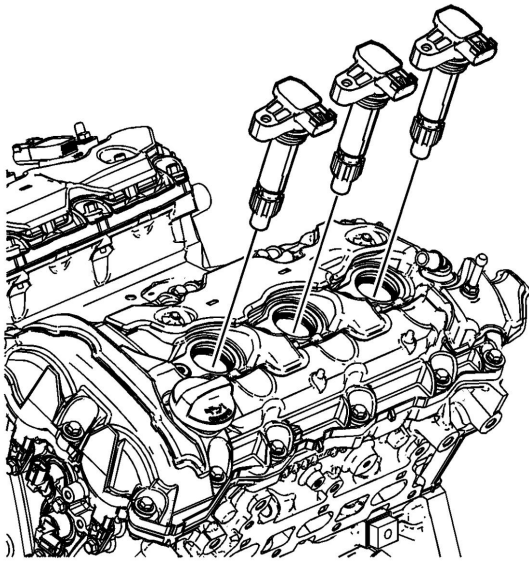
8. Tighten the left camshaft cover bolts in the sequence shown, tighten to 10Y (89 lb in).



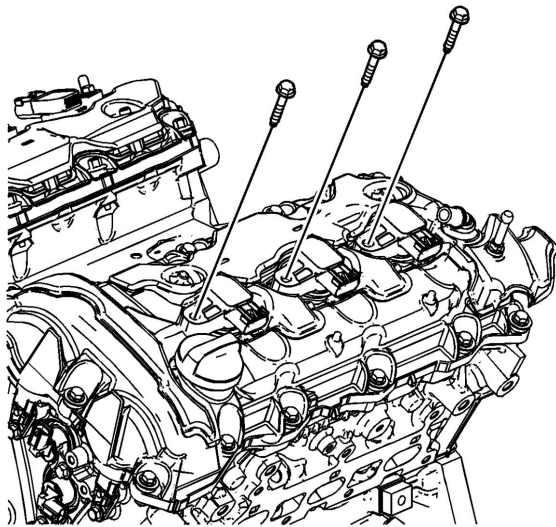
9. Remove the *EN 46101* guide from the spark plug tubes of the left cylinder head.



10. Install the **NEW** spark plugs into the left cylinder head and tighten to 18 Y (13 lb ft).



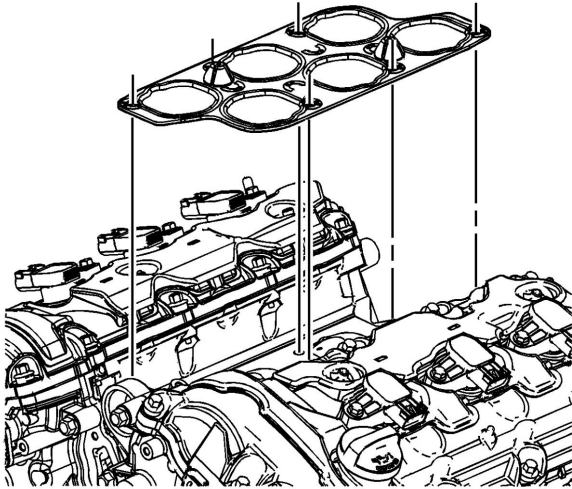
11. Install the ignition coils.



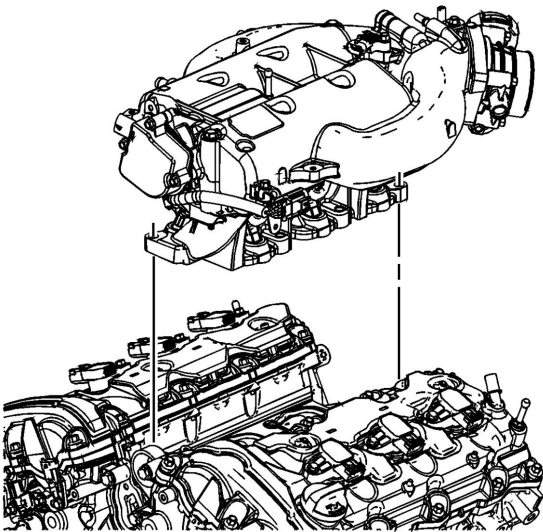
12. Install the ignition coil bolts and tighten to 10 Y (89 lb in).



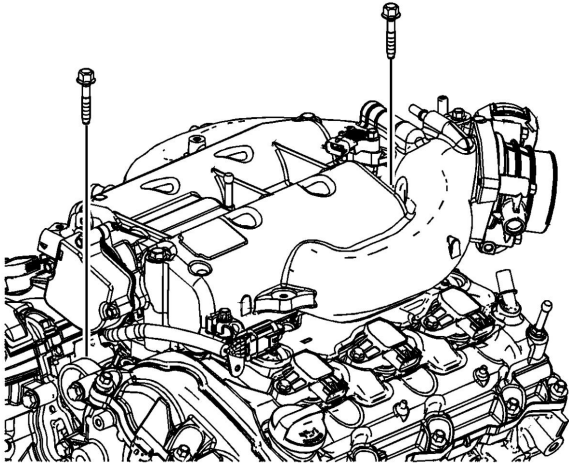
## Intake Manifold Installation



1. Install the NEW lower intake manifold gasket.

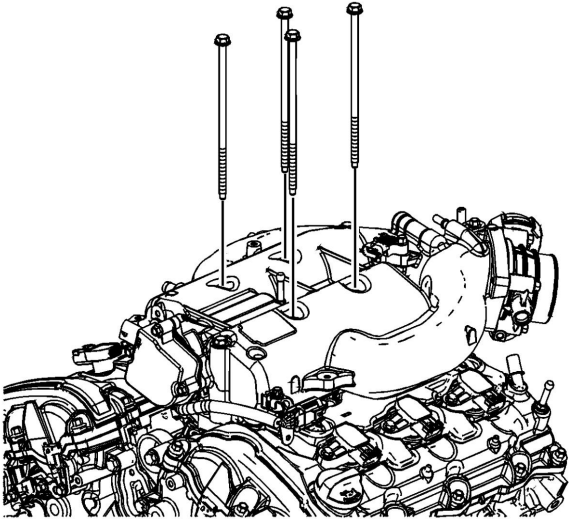


2. Install the intake manifold assembly.



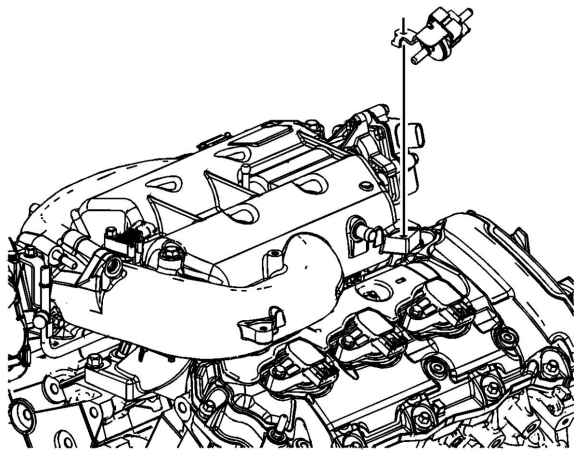
**Caution:** Refer to [Fastener Caution](#).

3. Loosely install the short intake manifold bolts.

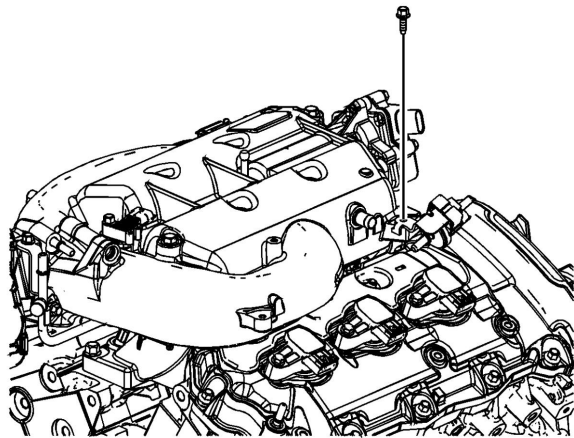


**Note:** Tighten the intake manifold bolts in an X pattern starting with the inside bolts and moving outward.

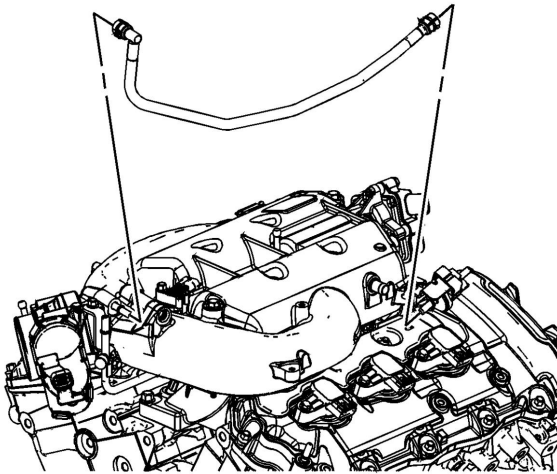
4. Loosely install the long intake manifold bolts and tighten all of the intake manifold bolts to 25 Y (18 lb ft).



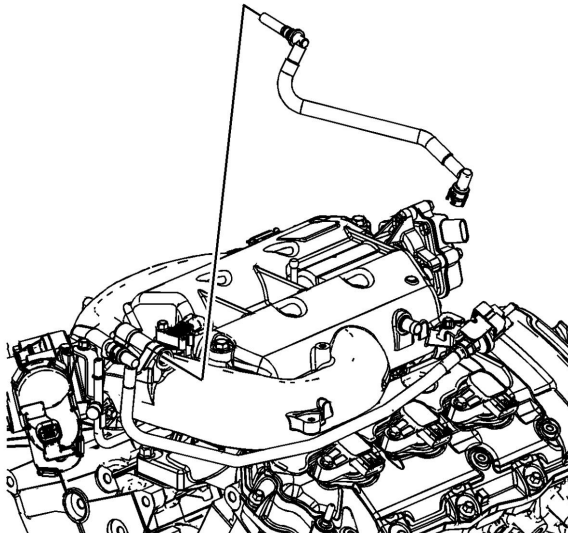
5. Install the evaporative emissions (EVAP) solenoid.



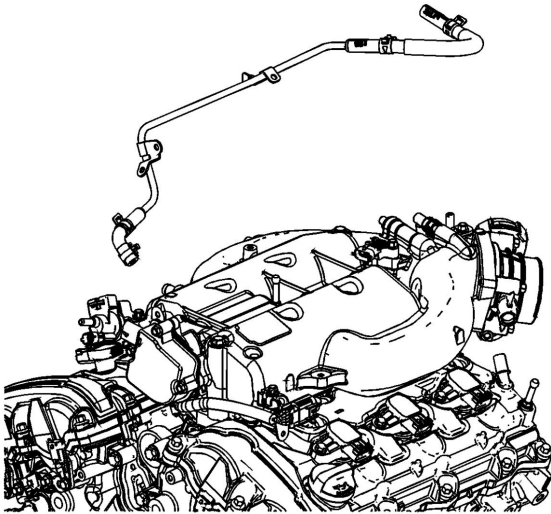
6. Install the EVAP solenoid bolt and tighten to 10Y (89 lb in).



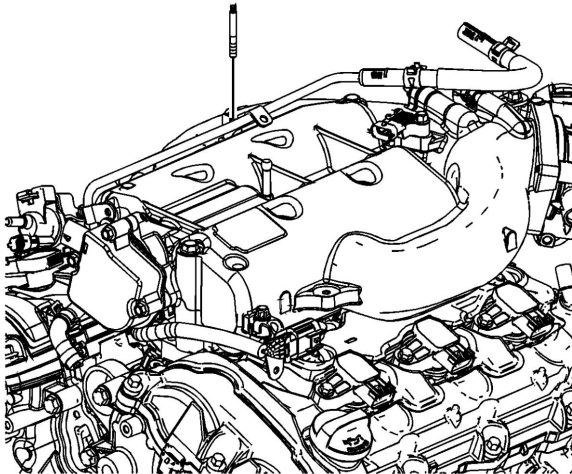
7. Install and connect the intake manifold-to-solenoid EVAP hose to the intake manifold and to the EVAP solenoid.



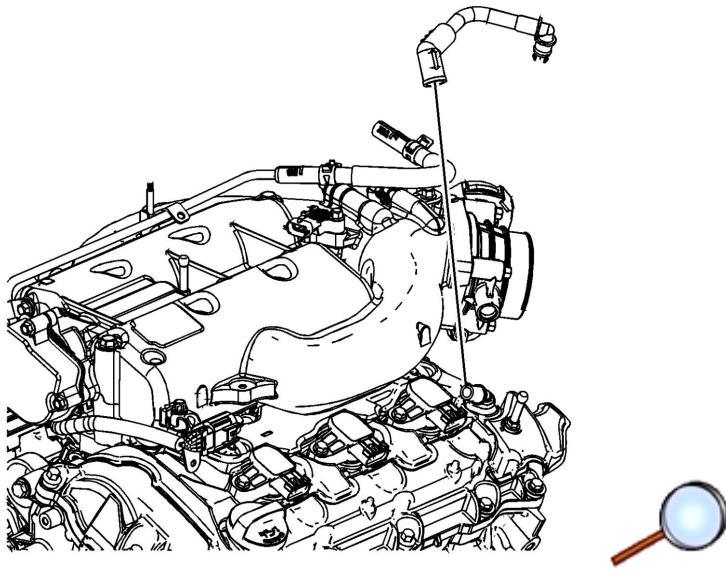
8. Install and connect the dirty air positive crankcase ventilation (PCV) hose to the intake manifold and to the right camshaft cover fitting.



9. Install the engine coolant air bleed pipe.

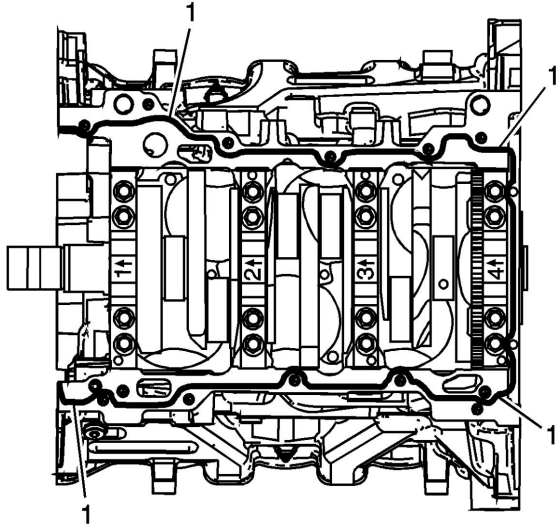


10. Install the engine coolant air bleed pipe bracket bolts to the upper intake manifold and tighten to 10 Y (89 lb in)..

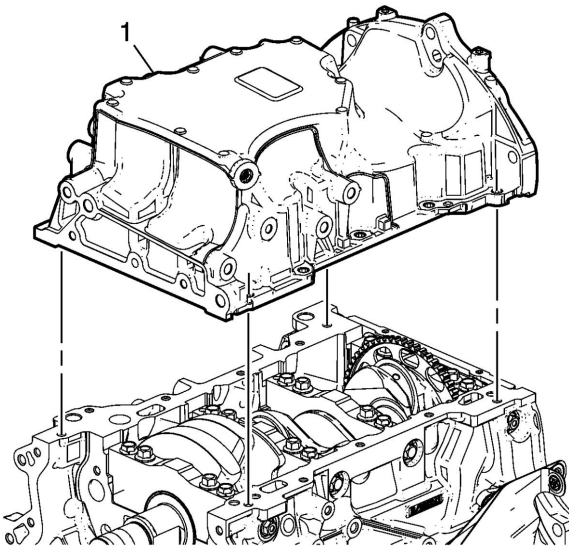


11. Install and connect the fresh air PCV hose to the left camshaft cover fitting.

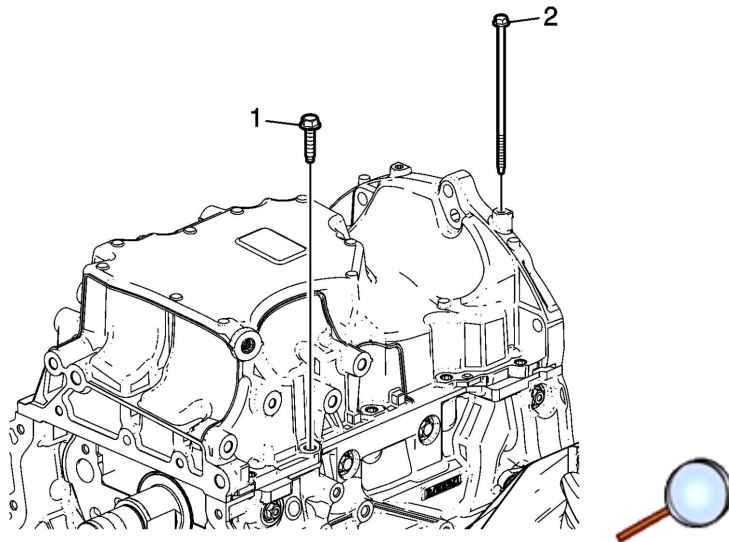
## Oil Pan Installation



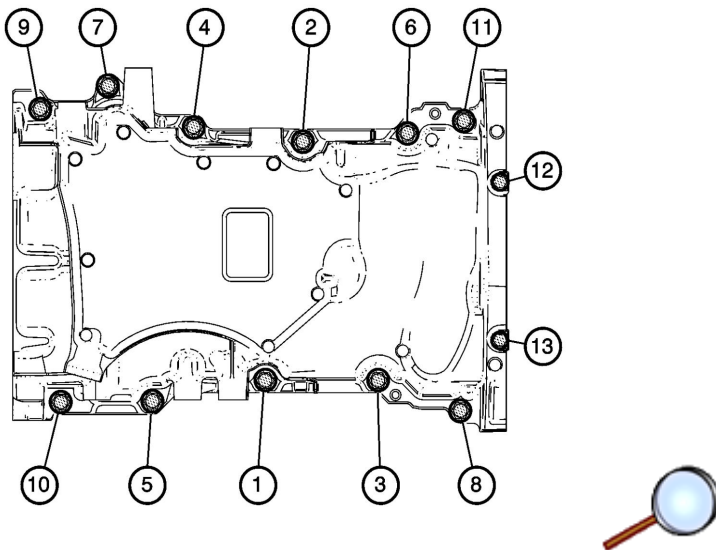
1. Ensure proper use of room temperature vulcanizing (RTV) sealant. [Use of Room Temperature Vulcanizing \(RTV\) and Anaerobic Sealant](#)
2. Place a 3 mm (0.118 in) bead of RTV sealant, on the block pan rail and the crankshaft rear oil seal housing (1). Refer to [Adhesives, Fluids, Lubricants, and Sealers](#).



3. Position the oil pan (1) onto the block.



4. Loosely install the oil pan bolts (1) and (2).



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

5. Tighten the oil pan bolts in sequence shown.

5.1. Tighten the 8 mm bolts (1–11) to 25 Y (18 lb ft).

5.2. Tighten the 6 mm bolts (12, 13) to 10 Y (89 lb in).

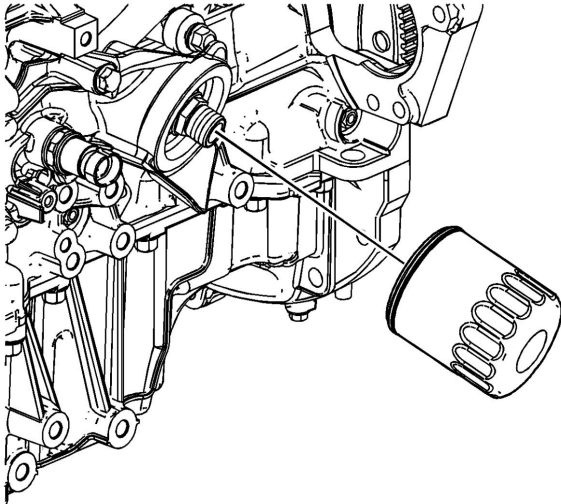


## Engine Prelubing

### Special Tools

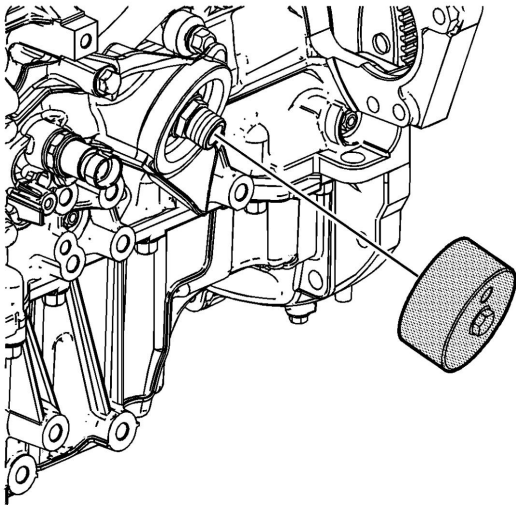
- EN-47971 Oil Pressure Gauge Adapter
- J 45299 Engine Preluber

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



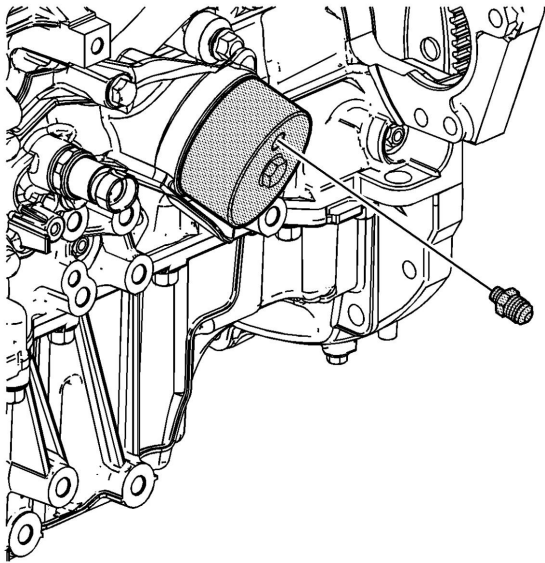
**Note:** Ensure the oil cooler lines are disconnected and the oil filter adapter oil cooler line ports are blocked in order to direct the oil from the engine preluber into the engine.

1. Remove the engine oil filter.

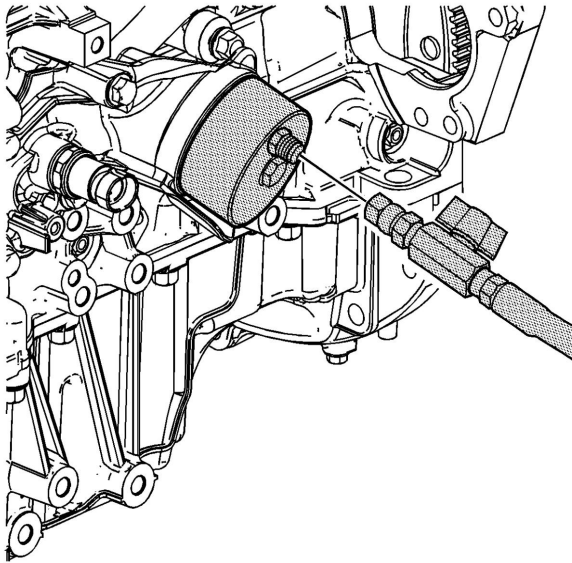


**Caution:** Special new tool EN 47971 must be used. Due to the special size and thread pitch of the oil filter adapter fitting ensure the proper tool is used or component damage will result.

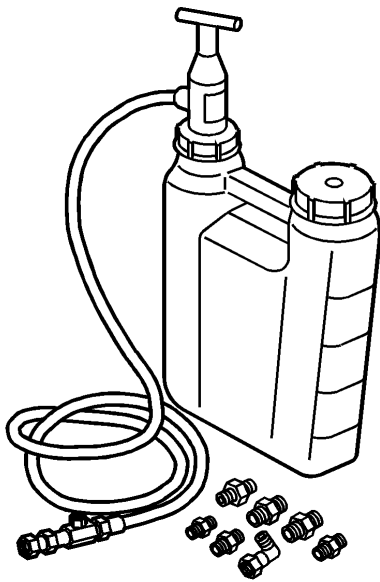
2. Install the EN-47971 adapter onto the oil filter adapter.



3. Install the 1/8 NPT fitting from the *J 45299* preluber into the port on the *EN-47971* adapter .



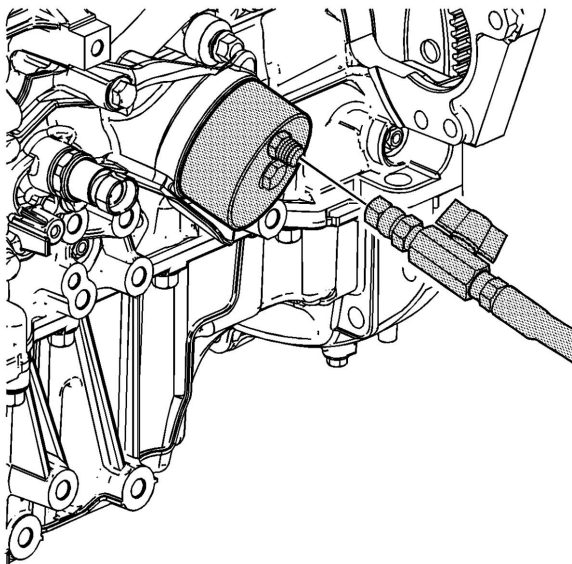
4. Install the *J 45299* preluber flexible hose to the fitting.



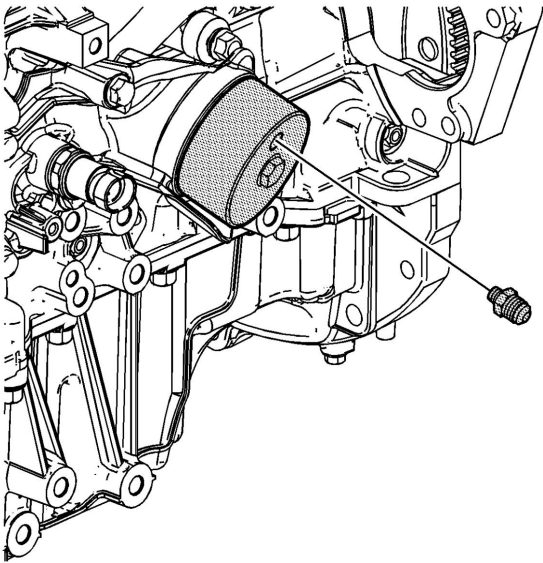
5. Open the valve of the *J 45299* preluber .

**Note:** A constant and continuous flow of clean engine oil is required in order to properly prime the engine. Use the approved engine oil as specified in the owner's manual.

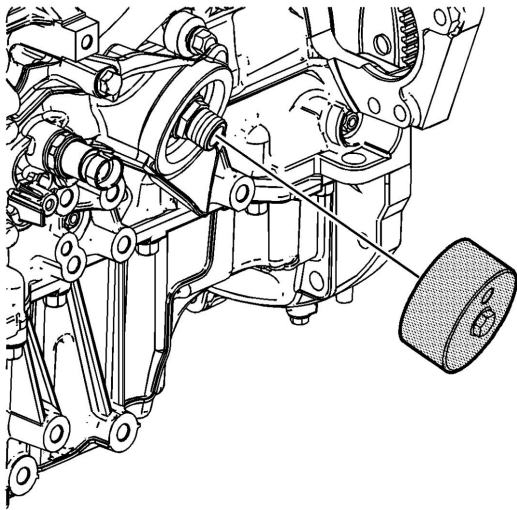
6. Pump the handle of the *J 45299* preluber in order to flow a minimum of 1–1.9 liters (1–2 quarts) of fresh clean engine oil. Observe the flow of engine oil through the flexible hose and into the engine assembly.
7. Close the valve of the *J 45299* preluber .



8. Remove the *J 45299* preluber flexible hose.



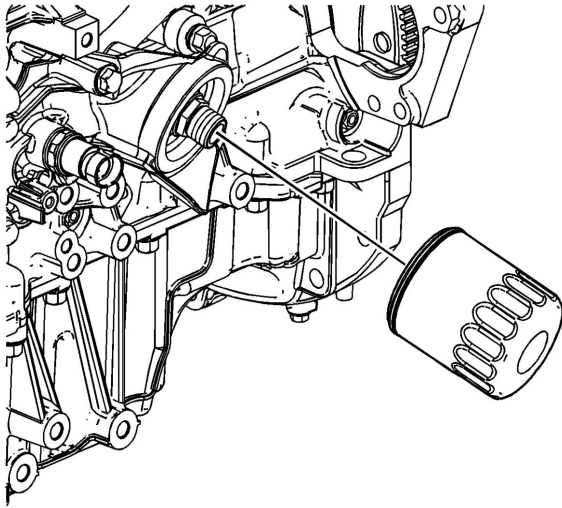
9. Remove the fitting from the *EN-47971* adapter .



10. Remove the *EN-47971* adapter from the oil filter adapter.

**Caution:** This engine uses a special high performance oil filter. Use of any other filter may lead to filter failure and/or severe engine damage.

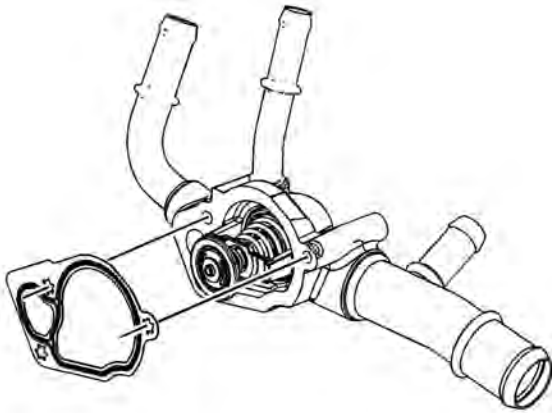
11. Ensure the NEW oil filter is filled with clean fresh engine oil.



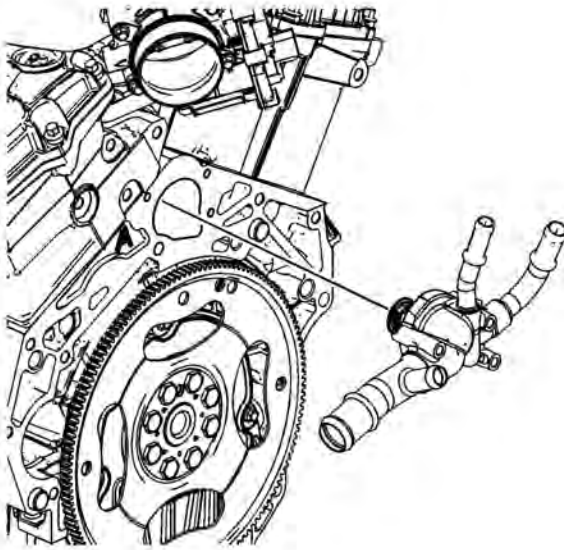
**Caution:** Refer to [Fastener Caution](#).

12. Install the NEW oil filter and tighten to 30 Y (22 lb ft).

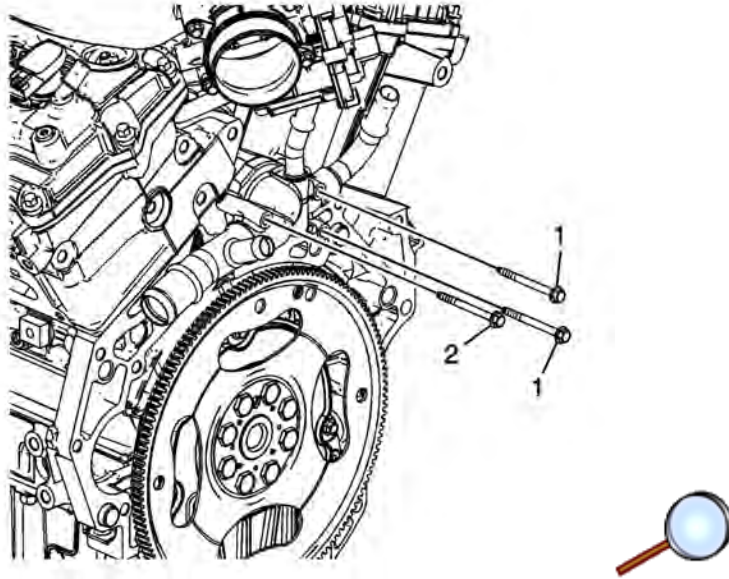
## Engine Coolant Thermostat Housing Installation



1. Install a NEW gasket onto the thermostat housing.



2. Install the thermostat housing.



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

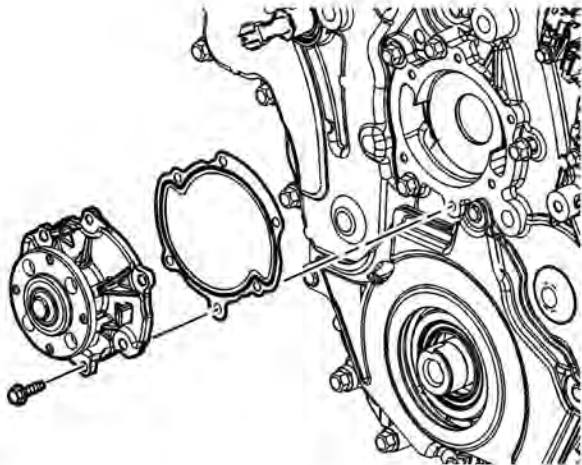
3. Install the thermostat housing bolts. Ensure to install the short bolts (1) and the long bolt (2) in the proper position and tighten the thermostat housing bolts to 10 Y (89 lb in).

## Water Pump Installation

### Special Tools

EN-46104 Water Pump Pulley Holding Tool

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

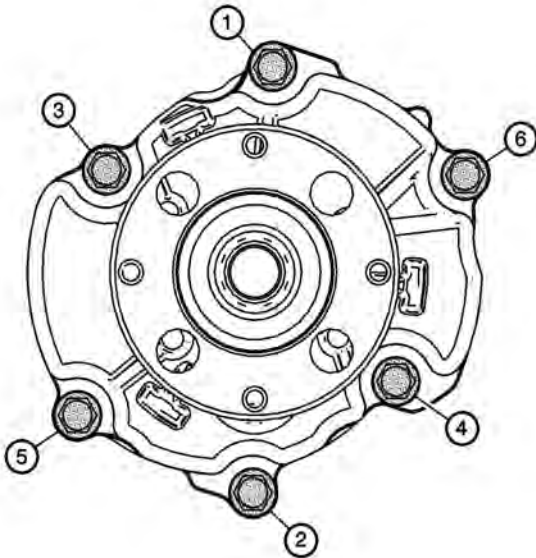


1. Ensure that the engine front cover and water pump are clear of old gasket material.
2. Ensure that the water pump mounting bolt holes in the front cover are completely clean and dry.
3. Place a NEW water pump gasket on the water pump.
4. Place the water pump in position on the front cover.

**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. Install the NEW water pump bolts finger tight.





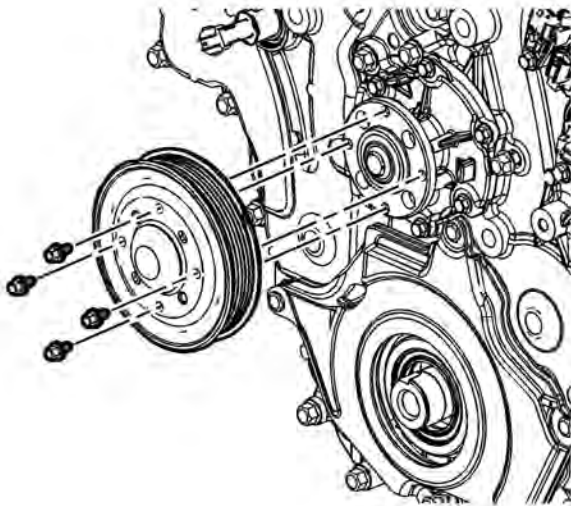
**Caution:** Refer to [Fastener Caution](#).

6. Tighten the NEW water pump bolts.

6.1. Tighten the bolts a first pass in the sequence shown to 10 Y (89 lb in).

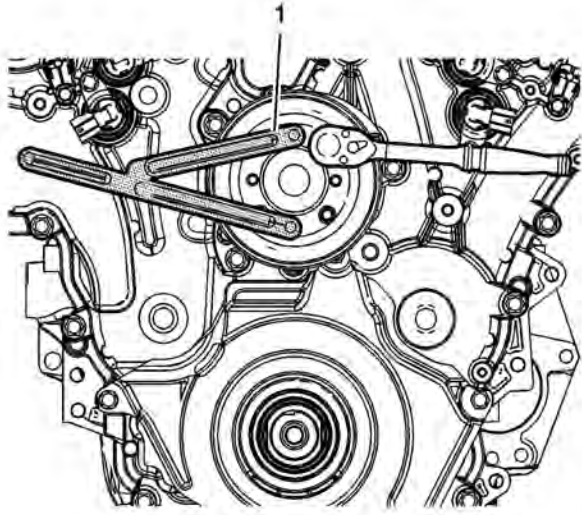
6.2. Tighten the bolts a second pass in the sequence shown to 10 Y (89 lb in).

6.3. Tighten the bolts a final pass in the sequence shown an additional 45 degrees.



7. Install the water pump pulley.

8. Loosely install the water pump pulley bolts.



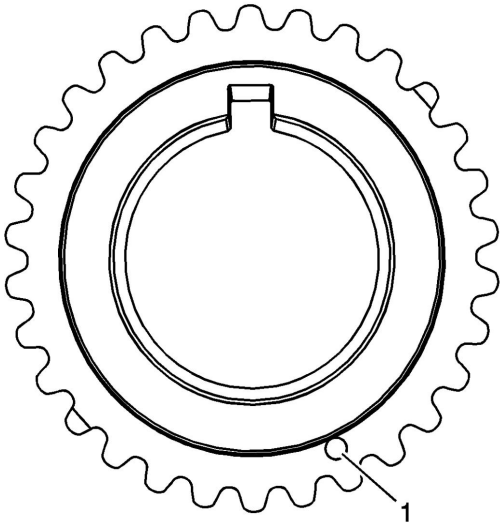
9. Install the *EN-46104* tool (1) onto the water pump pulley and tighten to 10 Y (89 lb in).

# Crankshaft Sprocket Installation

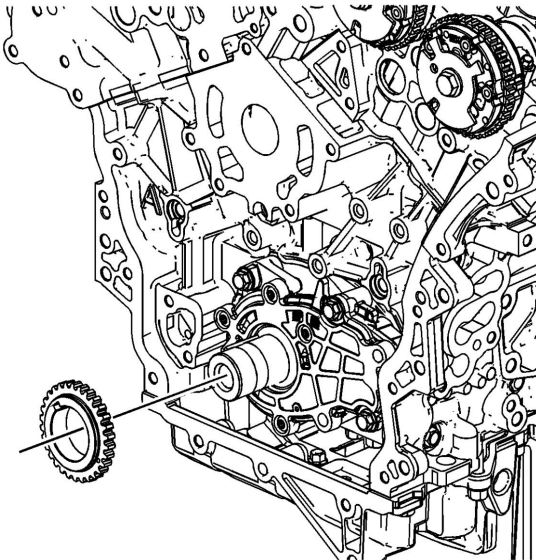
## Special Tools

EN-48589 Crankshaft Rotation Socket

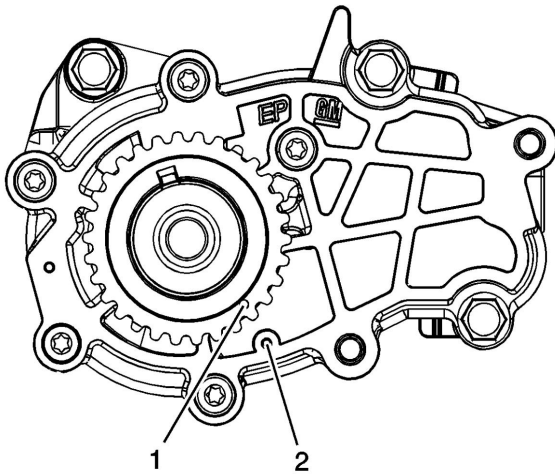
For equivalent regional tools, refer to [Special Tools](#).



1. Ensure the crankshaft sprocket is installed with the timing mark (1) visible.



2. Install the crankshaft sprocket onto the nose of the crankshaft.
3. Align the notch in the crankshaft sprocket with the pin in the crankshaft.
4. Slide the crankshaft sprocket on the crankshaft nose until the crankshaft sprocket contacts the step in the crankshaft.



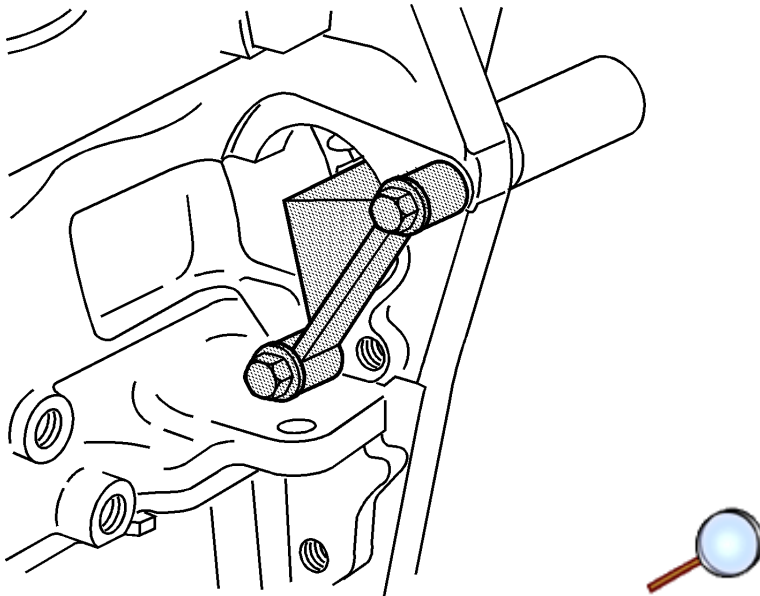
5. Ensure the crankshaft is in the stage one timing position with the crankshaft sprocket timing mark (1) aligned to the stage one timing mark on the oil pump cover (2) using the *EN-48589* socket . Refer to [Timing Chain Alignment Diagram](#).

## Crankshaft Balancer Installation

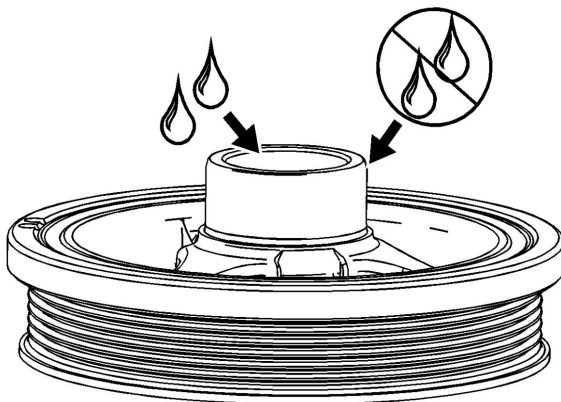
### Special Tools

- *EN 46106* Engine Flywheel Holding Tool
- *J 41998-B* Crankshaft Balancer Installer
- *J 45059* Angle Meter

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



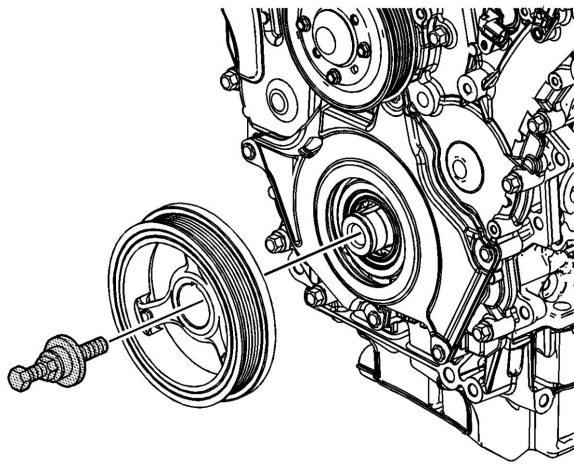
1. The *EN 46106* tool must be installed onto the flywheel.
2. Use the *J 41998-B* installer, nut, bearing and washer to install the crankshaft balancer.



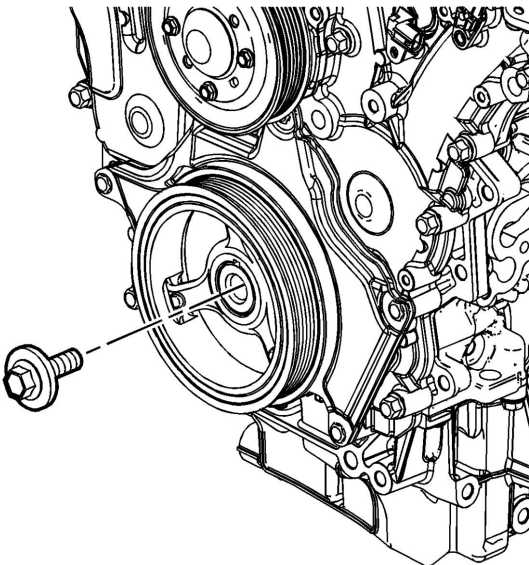
**Note:** Do not lubricate the crankshaft front oil seal or crankshaft balancer sealing surfaces. The crankshaft balancer is installed into a dry seal.

3. Apply lubricant to the inside of the crankshaft balancer hub bore.

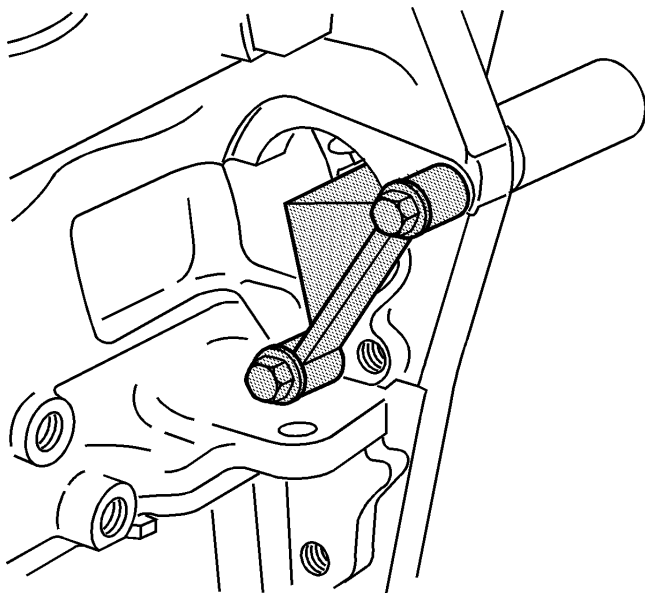
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4. Place the crankshaft balancer in position on the crankshaft.
5. Thread the *J 41998-B* installer in the crankshaft. Ensure you engage at least 10 threads of the *J 41998-B* installer before pressing the crankshaft balancer in place.
6. Push the crankshaft balancer into position by tightening the nut on the *J 41998-B* installer until the large washer bottoms out on the crankshaft end.
7. Remove the *J 41998-B* installer .



8. Install the NEW crankshaft balancer bolt.
  - Caution:** Refer to [Fastener Caution](#).
9. Tighten the crankshaft balancer bolt.
  - 9.1. Tighten the crankshaft balancer bolt to 100Y (74 lb ft).
  - 9.2. Tighten the crankshaft balancer bolt an additional 150 degrees using the *J 45059* meter .



10. Remove the *EN 46106* tool .