2013 ENGINE

Engine Mechanical -3.5L TI-VCT - Explorer

SPECIFICATIONS

MATERIAL SPECIFICATIONS

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Item	Specification	Fill Capacity
Motorcraft® SAE 5W-20 Premium Synthetic Blend Motor Oil (US); Motorcraft® SAE 5W- 20 Super Premium Motor Oil (Canada) XO-5W20-QSP (US); CXO-5W20-LSP12 (Canada)	WSSM2C945-A	5.7 L (6 qt) includes filter change

TORQUE SPECIFICATIONS

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Description	Part Number	Torque
A/C compressor bolts and nut	W714077	25 Nm (18 lb-ft)
A/C compressor stud	W712610	9 Nm (80 lb-in)
A/C pressure tube fitting nuts	W520413	8 Nm (71 lb-in)
Accessory drive belt tensioner bolts	W503278	11 Nm (97 lb-in)
Battery cable power feed cable nut	N805320	9 Nm (80 lb-in)
Block oil gallery plug - LH(1)	W528207	48 Nm (35 lb-ft)
Block oil gallery plug - rear(1)	W715597	85 Nm (63 lb-ft)
Block oil gallery plug - RH(1)	W528205	32 Nm (24 lb-ft)
	6A051	40 Nm (30 lb-ft)
Camshaft bearing cap bolts	W710702	Refer to **CAMSHAFT**
CMP sensor bolts	W503275	10 Nm (89 lb-in)
Crankshaft rear seal retainer plate bolts	W503277	Refer to **CRANKSHAFT REAR SEAL WITH RETAINER PLATE**
Crankshaft pulley bolt	W701512	Refer to **CRANKSHAFT PULLEY**
Cylinder head bolts	6065	Refer to **CYLINDER HEAD - LH** Refer to **CYLINDER HEAD - RH**
CHT sensor	6G004	10 Nm (89 lb-in)
Engine block coolant drain plug - RH	W701548	10 Nm (89 lb-in) plus an additional 720 degrees
Engine block coolant drain plug - LH	W701516	16 Nm (142 lb-in) plus an additional 180 degrees
Engine front cover bolts	-	Refer to **ENGINE FRONT COVER**
Engine mount-to-engine nuts	W714682	63 Nm (46 lb-ft)
Engine oil filter	6714	5 Nm (44 lb-in) plus an additional 180 degrees

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Engine mount-to-frame bolts	W712507	90 Nm (66 lb-ft)
EOP switch	9278	Refer to **ENGINE OIL PRESSURE (EOP) SWITCH**
Exhaust manifold/catalytic converter manifold nuts	W716011	Refer to **CYLINDER HEAD - LH**
Exhaust manifold/catalytic converter manifold heat shield bolts	W703715	10 Nm (89 lb-in)
Exhaust manifold/catalytic converter manifold studs	W712244	12 Nm (106 lb-in)
Flexplate bolts	6379	Refer to **FLEXPLATE**
Ground wire-to-body bolt	W710898	10 Nm (89 lb-in)
Ground wire-to-engine bolt	W705661	10 Nm (89 lb-in)
KS bolts	W500305	20 Nm (177 lb-in)
Lower intake manifold bolts	W503279	Refer to **LOWER INTAKE MANIFOLD**
Oil cooler bolts	W503277	10 Nm (89 lb-in)
Oil filter adapter	W503283	10 Nm (89 lb-in) plus an additional 45 degrees
Oil pan bolts	-	Refer to **OIL PAN**
Oil pan drain plug	6730	27 Nm (20 lb-ft)
Oil pan-to-transaxle bolts	W714722	48 Nm (35 lb-ft)
Oil pump bolts	W503282	10 Nm (89 lb-in)
Oil pump screen and pickup tube bolts	W503278	10 Nm (89 lb-in)
Starter stud bolt	W711515	27 Nm (20 lb-ft)
Starter B terminal nut	W706414	12 Nm (106 lb-in)
Starter S-terminal nut	W705790	5 Nm (44 lb-in)
Thermostat housing bolts	W503279	10 Nm (89 lb-in)
Timing chain guide bolts	W715118	10 Nm (89 lb-in)
Timing chain tensioner bolts	W715118	10 Nm (89 lb-in)
Torque converter-to-flexplate bolts	W714722	55 Nm (41 lb-ft)
Transaxle mount bracket bolt	W712711	80 Nm (59 lb-ft)
Transaxle mount bracket nuts	W714682	63 Nm (46 lb-ft)
Transaxle-to-engine bolts	W714722	48 Nm (35 lb-ft)
Upper intake manifold bolts	9Y450	Refer to **UPPER INTAKE MANIFOLD**
Upper intake manifold-to-bracket bolt	W503275	10 Nm (89 lb-in)
Valve cover bolts (4 required)	6C519	Refer to **VALVE COVER - LH** Refer to **VALVE COVER - RH**
Valve cover stud bolts (7 required)	6C519	Refer to **VALVE COVER - LH** Refer to **VALVE COVER - RH**
(1) Discard original plug and O-ring seal. Install a new plug and O-ring seal to specified torque, no sealer or lubricant required.		

GENERAL SPECIFICATIONS

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GENERAL SPECIFICATIONS

Item	Specification
Engine	
Displacement	3.5L (4V) (214 **CID**)
No. cylinders	6
Bore/stroke	92.5 mm (3.6417 in) - 86.7 mm (3.4134 in)
Fire order	1-4-2-5-3-6
Spark plug	12405
Spark plug gap	1.25 mm (0.049 in) - 1.35 mm (0.0531 in)
Oil pressure	Minimum 30 psi @ 1, 500 rpm with engine at normal operating temperature
Compression ratio	10.5:1
Engine weight (without accessory drive components)	161 kg (354.94 lb)
Engine and transaxle weight (without accessory drive components)	260.8 kg (574.96 lb)
Cylinder Head and Valve Train	
Cylinder head gasket surface flatness	Flat within 0.08 mm (0.003 in) length end to end, area 150 mm (5.9 in) x 150 mm (5.9 in) (or full width) should be less than 0.05 mm (0.002 in)
Combustion chamber volume	56.651 cm^3 (3.46 in^3)
Valve tappet clearance - intake	0.15 mm (0.0059 in) - 0.25 mm (0.0098 in)
Valve tappet clearance - exhaust	0.36 mm (0.0142 in) - 0.46 mm (0.0181 in)
Valve guide bore inner diameter	5.519 mm (0.2173 in) - 5.549 mm (0.2185 in)
Valve stem diameter - intake	5.479 mm (0.2157 in) - 5.497 mm (0.2164 in)
Valve stem diameter - exhaust	5.466 mm (0.2152 in) - 5.484 mm (0.2159 in)
Valve stem-to-guide clearance - intake	0.022 mm (0.0009 in) - 0.07 mm (0.0028 in)
Valve stem-to-guide clearance - exhaust	0.035 mm (0.0014 in) - 0.083 mm (0.0033 in)
Valve head diameter - intake	36.82 mm (1.4496 in) - 37.18 mm (1.4638 in)
Valve head diameter - exhaust	30.82 mm (1.2134 in) - 31.18 mm (1.2276 in)
Valve face runout	0.05 mm (0.002 in)
Valve face angle	45.75 - 45.25
Valve seat width - intake	1.3 mm (0.0512 in) - 1.5 mm (0.0591 in)
Valve seat width - exhaust	1.7 mm (0.0669 in) - 2 mm (0.0787 in)
Valve seat runout	0.04 mm (0.0016 in) MAX
Valve seat angle	44.5 - 45.5
Valve spring free length (approx.)	48 mm (1.8898 in)
Valve spring compression pressure (N @ spec. length)	525 N (118.03 lb) @ 27 mm (1.063 in)
Valve spring installed height	37 mm (1.4567 in)
Valve spring installed height pressure	235 N (52.83 lb) @ 37 mm (1.4567 in)

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(N @ spec. length)	
Valve spring installed pressure - service limit	10% force loss @ specified height
Camshaft	
Theoretical valve lift @ 0 lash - intake	10 mm (0.3937 in)
Theoretical valve lift @ 0 lash - exhaust	9.68 mm (0.3811 in)
Lobe lift - intake	10 mm (0.3937 in)
Lobe lift - exhaust	9.68 mm (0.3811 in)
Allowable lobe lift loss	0.062 mm (0.0024 in)
Camshaft journal bore inside diameter - 1st journal	39.038 mm (1.5369 in) - 39.063 mm (1.5379 in)
Camshaft journal bore inside diameter - intermediate journals	25.988 mm (1.0231 in) - 26.013 mm (1.0241 in)
Camshaft bearing outside diameter - 1st journal	38.99 mm (1.535 in) - 39.01 mm (1.5358 in)
Camshaft bearing outside diameter - intermediate journals	25.963 mm (1.0222 in) - 25.937 mm (1.0211 in)
Camshaft journal-to-bearing clearance, 1st journal - service limit	0.073 mm (0.0029 in) MAX
Camshaft journal-to-bearing clearance, intermediate journals - service limit	0.076 mm (0.003 in) MAX
Runout	0.04 mm (0.0016 in) MAX
End play - standard	0.032 mm (0.0013 in) - 0.17 mm (0.0067 in)
End play - service limit	0.19 mm (0.0075 in) MAX
Cylinder Block	
Cylinder bore diameter	92.5 mm (3.6417 in) - 92.52 mm (3.6425 in)
Cylinder bore roundness	0.013 mm (0.0005 in)
Cylinder bore taper	0.01 mm (0.0004 in) per 25.4 mm (1 in)
Block main bore roundness	0.008 mm (0.0003 in)
Main bearing bore inside diameter	72.4 mm (2.8504 in) - 72.424 mm (2.8513 in)
Head gasket surface flatness	Flat within 0.08 mm (0.0031 in) in length end to end per 150 mm (5.9055 in) X 150 mm (5.9055 in) or full width should be less than 0.05 mm (0.002 in)
Crankshaft	
Main bearing journal diameter	67.5 mm (2.6575 in)
Main bearing journal maximum taper	0.004 mm (0.0002 in)
Main bearing journal maximum out-of-round	0.152 mm (0.006 in)
Main bearing journal-to-main bearing clearance	0.026 mm (0.001 in) - 0.041 mm (0.0016 in)

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Connecting rod journal diameter	55.983 mm (2.2041 in) - 56.003 mm (2.2048 in)
Connecting rod journal maximum taper	0.004 mm (0.0002 in)
Connecting rod journal maximum out of-round	0.006 mm (0.0002 in)
Crankshaft maximum end play	0.101 mm (0.004 in) - 0.291 mm (0.0115 in)
Piston and Connecting Rod	
Piston diameter - single grade	92.476 mm (3.6408 in) - 92.49 mm (3.6413 in)
Piston-to-cylinder bore clearance	0.01 mm (0.0004 in) - 0.044 mm (0.0017 in)
Piston ring end gap - compression (top, gauge diameter)	0.17 mm (0.0067 in) - 0.27 mm (0.0106 in)
Piston ring end gap - compression (bottom, gauge diameter)	0.3 mm (0.0118 in) - 0.55 mm (0.0217 in)
Piston ring end gap - oil ring (steel rail, gauge diameter)	0.15 mm (0.0059 in) - 0.45 mm (0.0177 in)
Piston ring groove width - compression (top)	1.23 mm (0.0484 in) - 1.25 mm (0.0492 in)
Piston ring groove width - compression (bottom)	1.53 mm (0.0602 in) - 1.55 mm (0.061 in)
Piston ring groove width - oil ring	2.53 mm (0.0996 in) - 2.55 mm (0.1004 in)
Piston ring width - upper compression ring	1.17 mm (0.0461 in) - 1.19 mm (0.0469 in)
Piston ring width - lower compression ring	1.47 mm (0.0579 in) - 1.49 mm (0.0587 in)
Piston ring-to-groove clearance (upper and lower compression rings)	0.04 mm (0.0016 in) - 0.08 mm (0.0031 in)
Piston pin bore diameter	23.004 mm (0.9057 in) - 23.008 mm (0.9058 in)
Piston pin diameter	22.997 mm (0.9054 in) - 23 mm (0.9055 in)
Piston pin length	55.975 mm (2.2037 in)
Piston pin-to-piston fit	0.004 mm (0.0002 in) - 0.011 mm (0.0004 in)
Piston-to-connecting rod clearance	2.7 mm (0.106 in)
Connecting rod-to-pin clearance - standard	0.007 mm (0.0003 in) - 0.022 mm (0.0009 in)
Connecting rod pin bore diameter	23.007 mm (0.9058 in) - 23.019 mm (0.9063 in)
Connecting rod length (center-to-center)	152.68 mm (6.011 in)
Connecting rod maximum allowed bend	0.038 mm (0.0015 in)
Connecting rod maximum allowed twist	0.05 mm (0.002 in)
Connecting rod bearing bore diameter - grade 1	59.866 mm (2.3569 in) - 59.872 mm (2.3572 in)
Connecting rod bearing bore diameter	59.873 mm (2.3572 in) - 59.879 mm (2.3574 in)

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- grade 2	
Connecting rod bearing bore diameter - grade 3	59.88 mm (2.3575 in) - 59.886 mm (2.3577 in)
Connecting rod bearing-to-crankshaft clearance	0.02 mm (0.0008 in) - 0.054 mm (0.0021 in)
Connecting rod side clearance (assembled to crank) - standard	0.175 mm (0.0069 in) - 0.425 mm (0.0167 in)
Connecting rod side clearance (assembled to crank) - service limit	0.175 mm (0.0069 in) - 0.425 mm (0.0167 in)

DESCRIPTION AND OPERATION

ENGINE - 3.5L TI-VCT

Overview

Engine

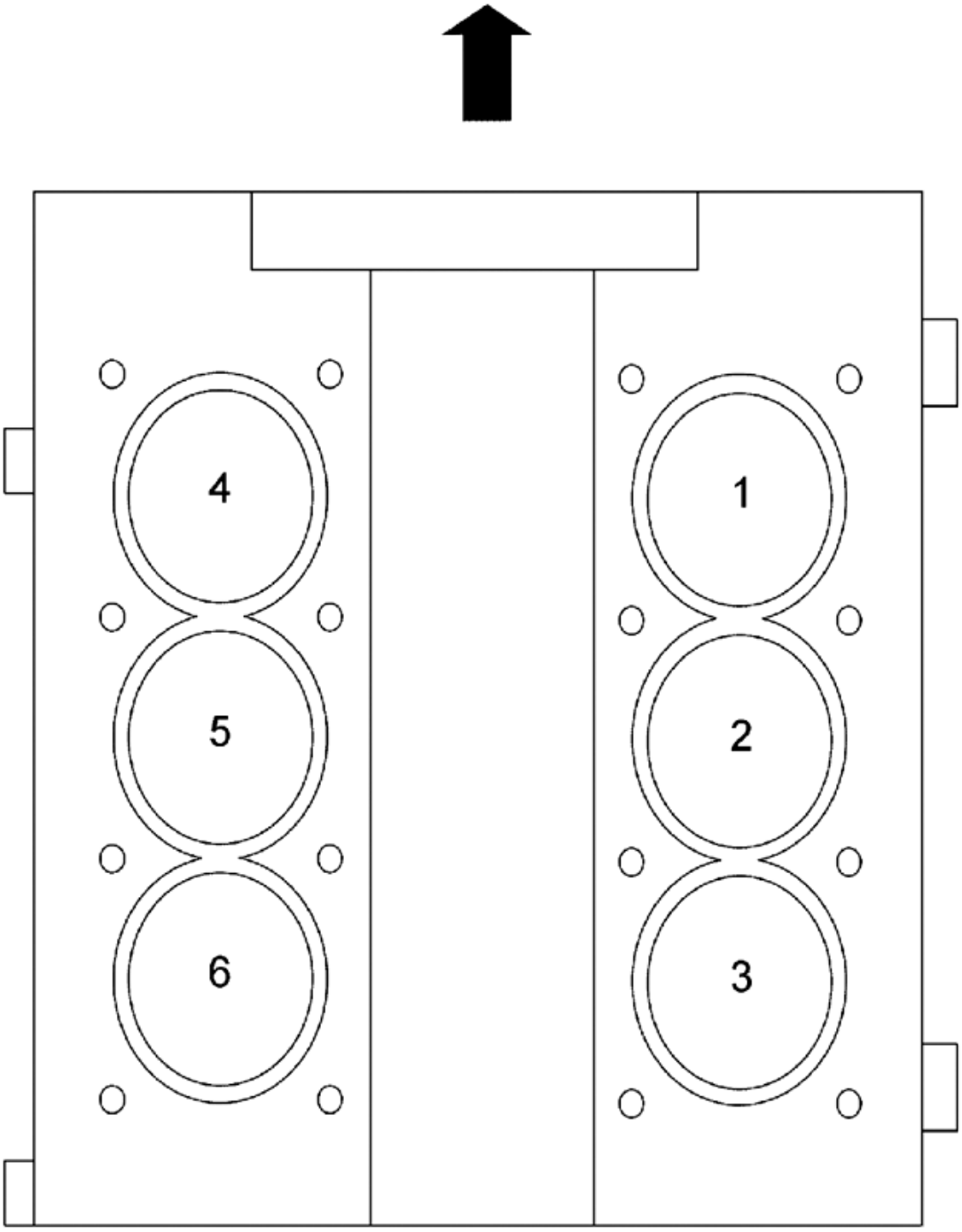
The 3.5L (4V) is a V-6 engine with the following features:

Dual overhead camshafts

- Four valves per cylinder
- **SFI**
- Composite upper and lower intake manifolds
- Aluminum cylinder heads
- An aluminum, 60-degree V-cylinder block
- Timing chain driven coolant pump
- Twin independent **VCT** system
- An electronic ignition system with 6 ignition coils

Engine Cylinder Identification

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N0069904

Fig. 1: Engine Cylinder Identification Number
Courtesy of FORD MOTOR CO.

Exhaust Emission Control System

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Operation and required maintenance of the exhaust emission control devices used on this engine is covered in the diagnostic, emission, and powertrain control system articles. Refer to **ENGINE CONTROLS - INTRODUCTION (EXCEPT DIESEL & HYBRID) (SECTION 0)** .

Induction System

The **SFI** provides the fuel/air mixture needed for combustion in the cylinders. The 6 solenoid operated fuel injectors:

- are mounted between the fuel rail and the intake manifold.
- meter fuel into the air intake stream in accordance with engine demand.
- are positioned so that their tips direct fuel just ahead of the engine intake valves.

Valve Train

The valve train uses **DAMB** . The camshaft lobes are positioned directly above mechanical buckets which are positioned on top of the valves.

Twin Independent VCT System

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

PCV System

All engines are equipped with a closed-type **PCV** system recycling the crankcase vapors to the upper intake manifold.

Lubrication System

The engine lubrication system is of the force-feed type in which oil is supplied under full pressure to the crankshaft, connecting rod bearings, timing chain tensioners, piston oil cooling jets and **VCT** solenoids. The flow of oil to the valve tappets and valve train is controlled by a restricting orifice located in the cylinder head, front camshaft cap.

Oil Pump

The lubrication system is designed to provide optimum oil flow to critical components of the engine through its entire operating range.

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

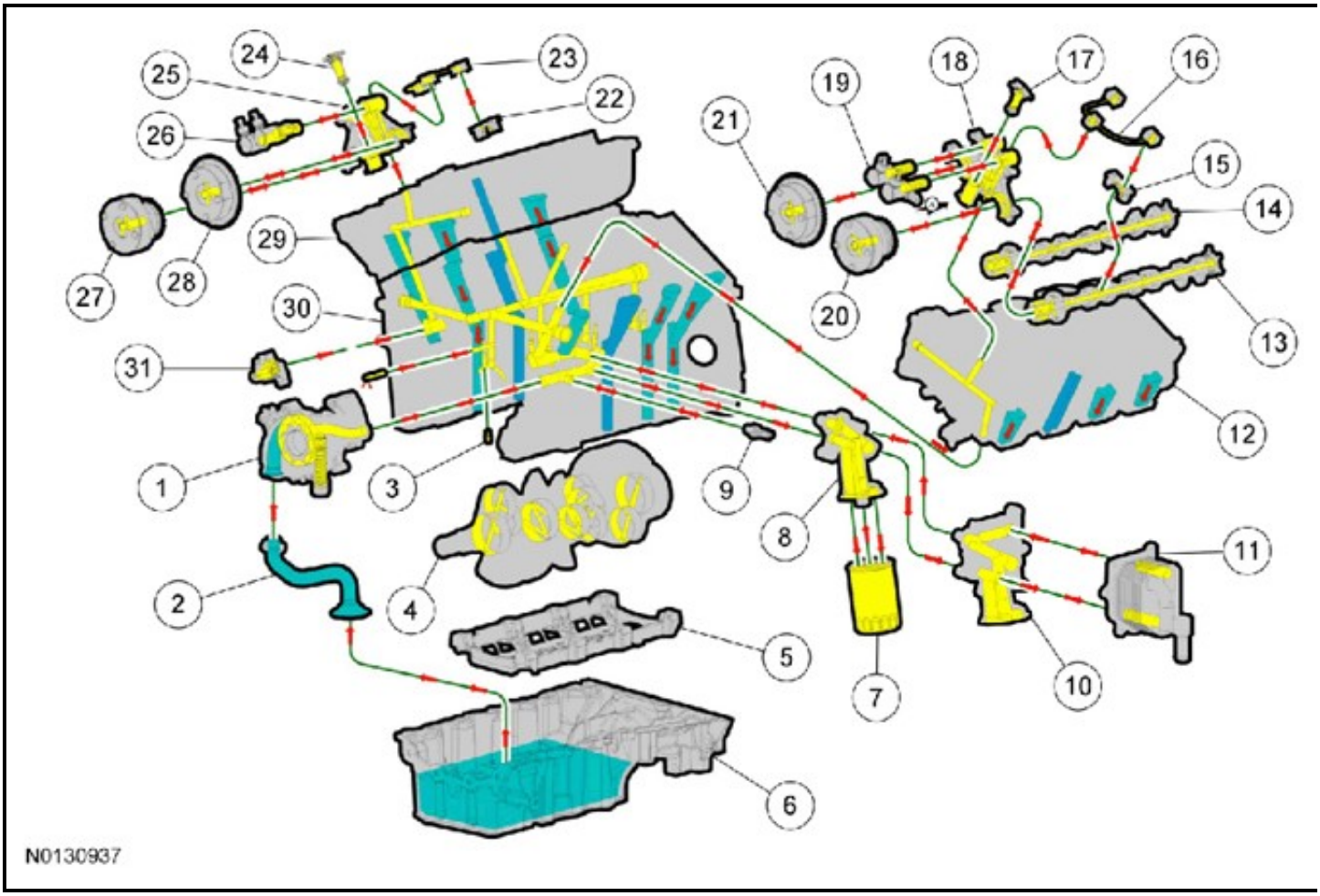
Generically, this design is known as a gerotor pump, which operates as follows:

- The oil pump is mounted on the front face of the cylinder block.
- The inner rotor is piloted on the crankshaft post and is driven through flats on the crankshaft.

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

Engine Oil Flow Illustration



Item	Part Number	Description
1	6600	Oil pump
2	6622	Oil pump screen and pickup tube
3	6K868	Piston oil cool valve
4	6303	Crankshaft
5	6C364	Engine main bearing cap support
6	6675	Oil pan

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7	6714	Oil filter
8	6881	Oil filter adapter (without oil cooler)
9	9278	EOP sensor
10	6881	Oil filter adapter (with oil cooler)
11	6A642	Oil cooler
12	6049	LH cylinder head
13	6250	Exhaust camshaft
14	6250	Intake camshaft
15	6A258	LH camshaft cap
16	6K602	LH valve train oil feed tube
17	6K254	LH secondary timing chain tensioner
18	6B280	LH camshaft mega cap
19	6M280	LH intake and exhaust camshaft **VCT** oil control solenoid
20	6C525	LH exhaust camshaft **VCT**
21	6C524	LH intake camshaft **VCT**
22	6A280	RH camshaft cap
23	6K602	RH valve train oil feed tube
24	6C270	RH secondary timing chain tensioner
25	6B280	RH camshaft mega cap
26	6M280	RH intake and exhaust camshaft **VCT** oil control solenoid
27	6C525	RH exhaust camshaft **VCT**
28	6C524	RH intake camshaft **VCT**
29	6049	RH cylinder head
30	6010	Cylinder head
31	6K254	Primary timing chain tensioner

Cooling System

The engine cooling system includes the following:

- Radiator
- Timing chain driven coolant pump
- Electric fan assembly
- Degas bottle (aids in maintaining the correct volume of engine coolant)
- Coolant thermostat
- Coolant hoses

Engine Identification

For quick identification, refer to the safety certification decal.

The decal is located on the LH front door lock face panel.

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Engine Code Information Label

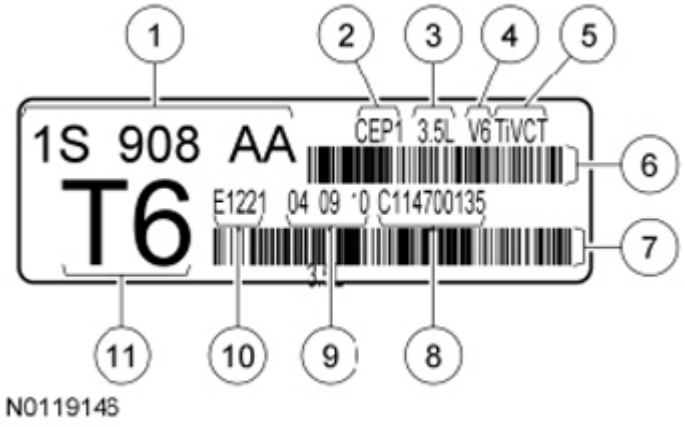


Fig. 2: Identifying Engine Code Information Label
Courtesy of FORD MOTOR CO.

Item	Description
1	Engine part number
2	Engine plant (Cleveland)
3	Engine displacement
4	Engine configuration
5	Twin independent **VCT**
6	Bar code
7	Bar code
8	Running number
9	Engine build date (DDMMYY)
10	Plant shift line
11	Derivative code

DIAGNOSIS AND TESTING

ENGINE

Engine Diagnostic Information

For basic engine mechanical concerns, REFER to **ENGINE SYSTEM - GENERAL INFORMATION** . For **PCM** DTCs, REFER to **ELECTRONIC ENGINE CONTROLS** . For driveability symptoms without DTCs, REFER to the **ENGINE CONTROLS - SYMPTOM CHARTS (EXCEPT DIESEL & HYBRID) (SECTION 3)** .

GENERAL PROCEDURES

VALVE CLEARANCE CHECK

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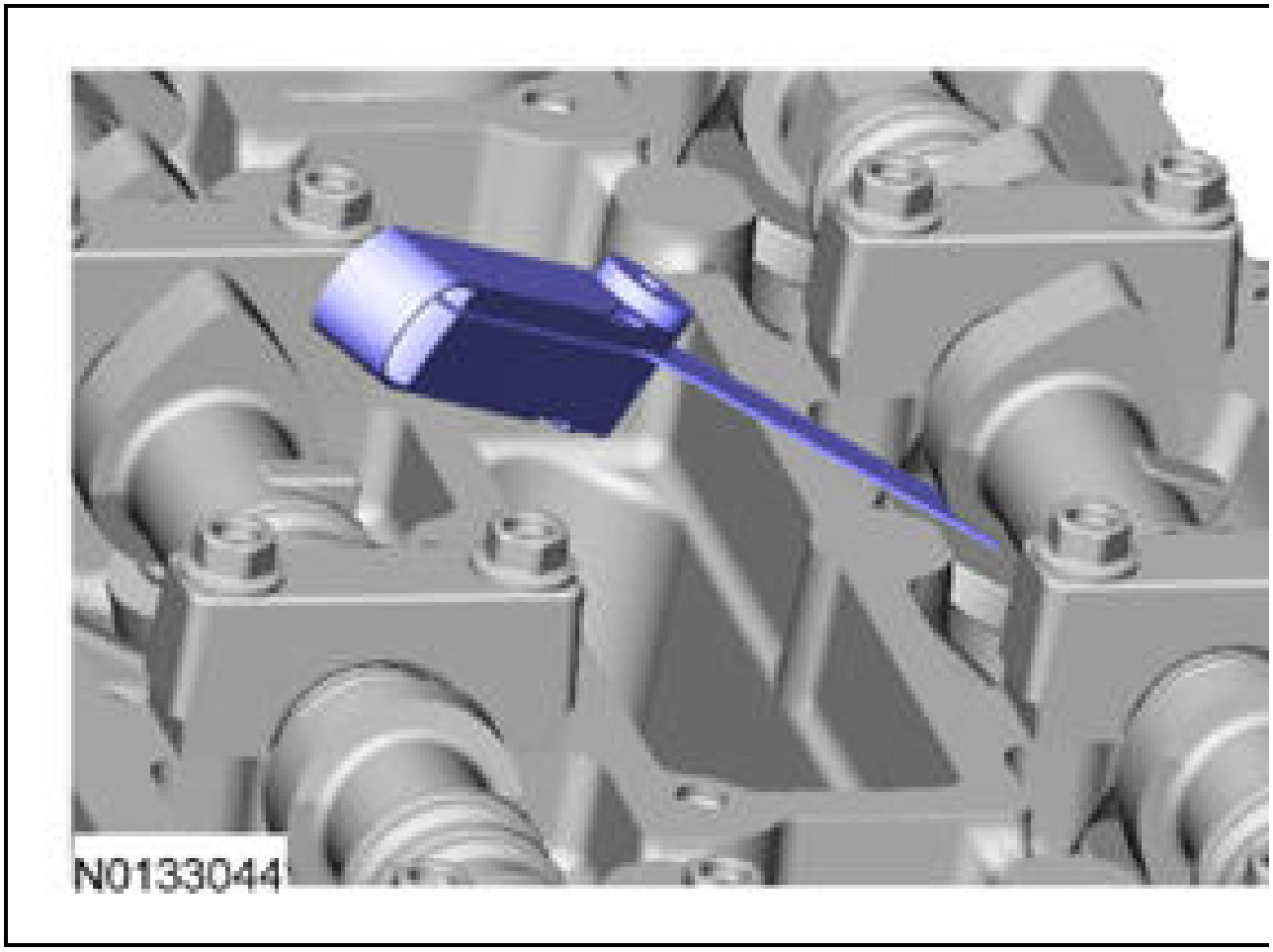
General Procedure

1. Remove the valve covers. Refer to **VALVE COVER - LH** and Refer to **VALVE COVER - RH**.

2. **NOTE: Engine must be at room temperature before measuring. The valve clearance must be measured with the camshaft at base circle. The engine will have to be rotated with the crankshaft pulley bolt to bring each valve to base circle.**

   Use a feeler gauge to measure the clearance of each valve and record its location. A midrange clearance is the most desirable:

   - Intake: 0.15 mm (0.0059 in) - 0.25 mm (0.0098 in)
   - Exhaust: 0.36 mm (0.0142 in) - 0.46 mm (0.0181 in)



3. **NOTE: The number on the valve tappet reflects the thickness of the valve tappet. For example, a tappet with the number 3.310 has the thickness of 3.31 mm (0.1303 in).**

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If any of the valve clearances are out of specification, select new tappets using this formula: tappet thickness = measured clearance + the base tappet thickness - most desirable thickness. Select the tappets and mark the installation location.

4. If required, install the new selected valve tappets in the marked locations. Refer to **VALVE TAPPETS**.

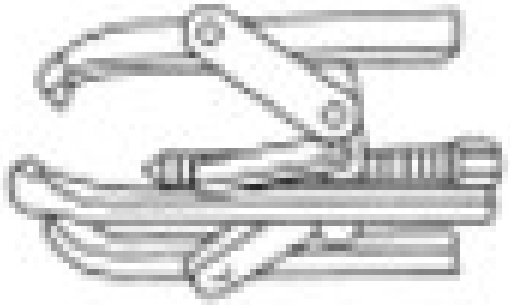
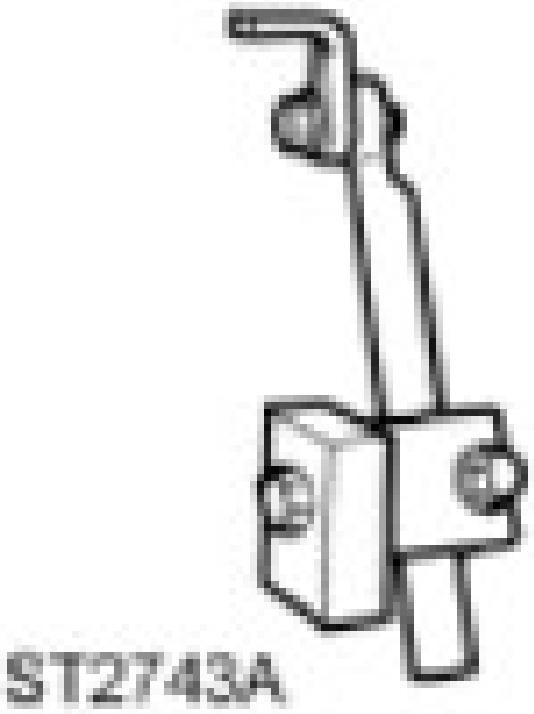
REMOVAL AND INSTALLATION

CAMSHAFT

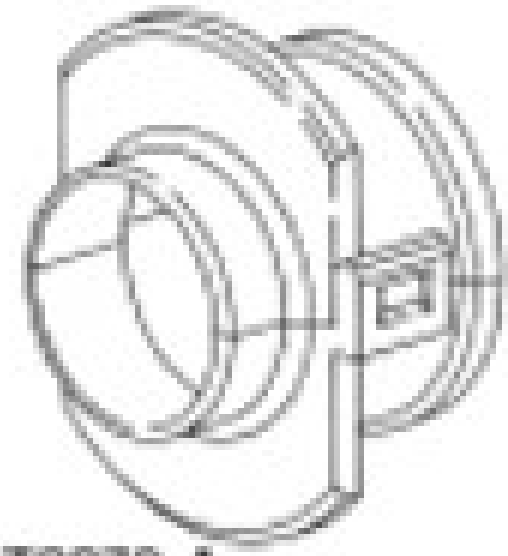
SPECIAL TOOL(S) DESCRIPTION

	2, 200# Floor Crane, Fold Away **300-OTC1819E** or equivalent
	3 Jaw Puller **303-D121** or equivalent

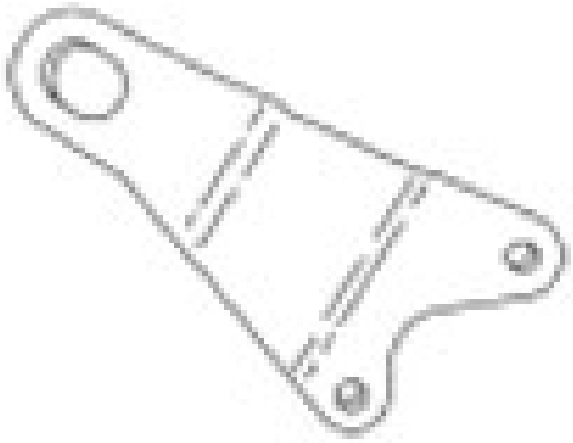
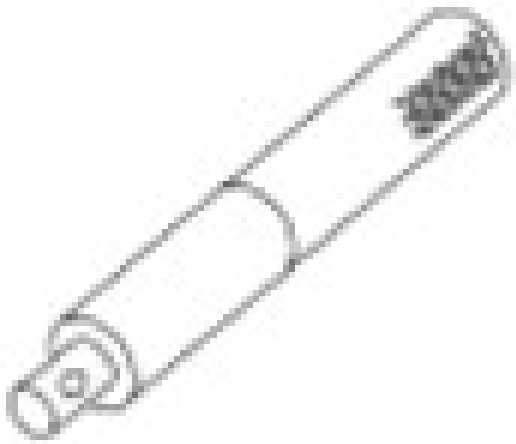
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 ST1184-A	
 ST2743A	Adjustable Grip Arm, 1735A **014-00001** or equivalent

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 ST2433-A	Alignment Pins **307-399**
 ST2870-A	Disconnect Tool, Transmission Cooler Line **307-569**

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 ST2976A	Eye, Engine Lift **303-1245**
 ST1326-A	Handle **205-153** (T80T-4000-W)

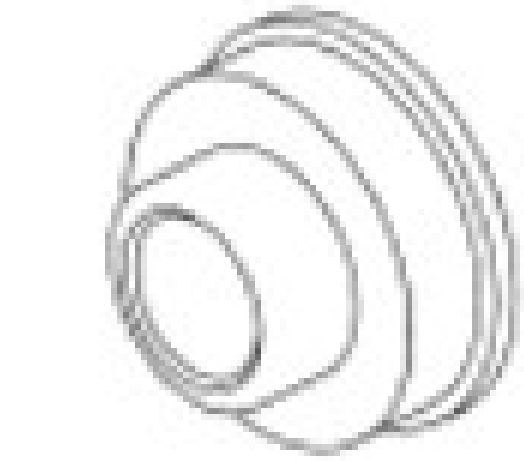
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	Hold Down, Secondary Chain **303-1530**
	Installer, Differential Bearing Cone **205-142** (T80T-4000-J)

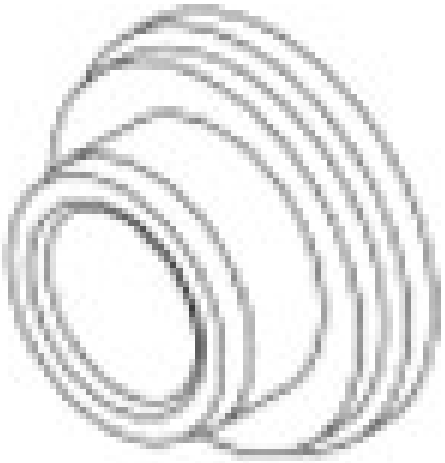
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	Installer, Front Cover Oil Seal **303-335** (T88T-6701-A)
	Installer, Front Crankshaft Seal **303-1251**

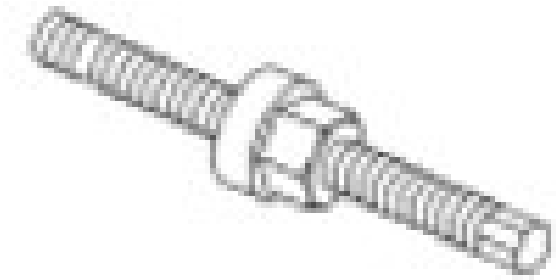
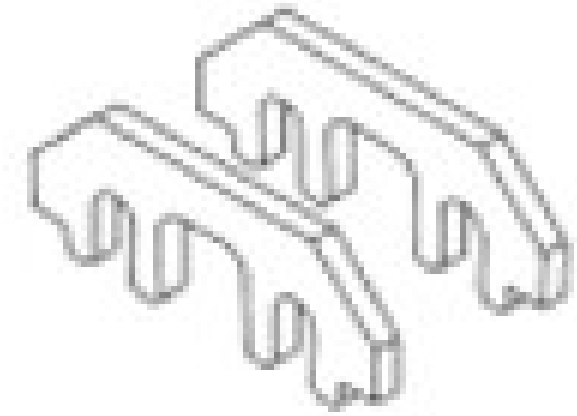
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	Installer, **VCT** Spark Plug Tube Seal **303-1247** /2
	Powertrain Lift **300-OTC1585AE** or equivalent

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 ST1385-A	Remover, Oil Seal **303-409** (T92C-6700CH)
 ST2982-A	Remover, **VCT** Spark Plug Tube Seal **303-1247** /1
	Replacer, Crankshaft Vibration Damper **303-102** (T74P-6312-B)

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 ST1287-A	
 ST2979-A	Tool, Camshaft Holding **303-1248**

MATERIAL SPECIFICATIONS

Item	Specification
Motorcraft® High Performance Engine RTV Silicone TA-357	WSEM4G323-A6
Motorcraft® Metal Surface Prep ZC-31-A	-
Motorcraft® SAE 5W-20 Premium Synthetic Blend Motor Oil (US); Motorcraft® SAE 5W-20 Super Premium Motor Oil (Canada) XO-5W20-QSP (US); CXO-5W20-LSP12 (Canada)	WSSM2C945-A

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Motorcraft® Silicone Gasket Remover ZC-30	-

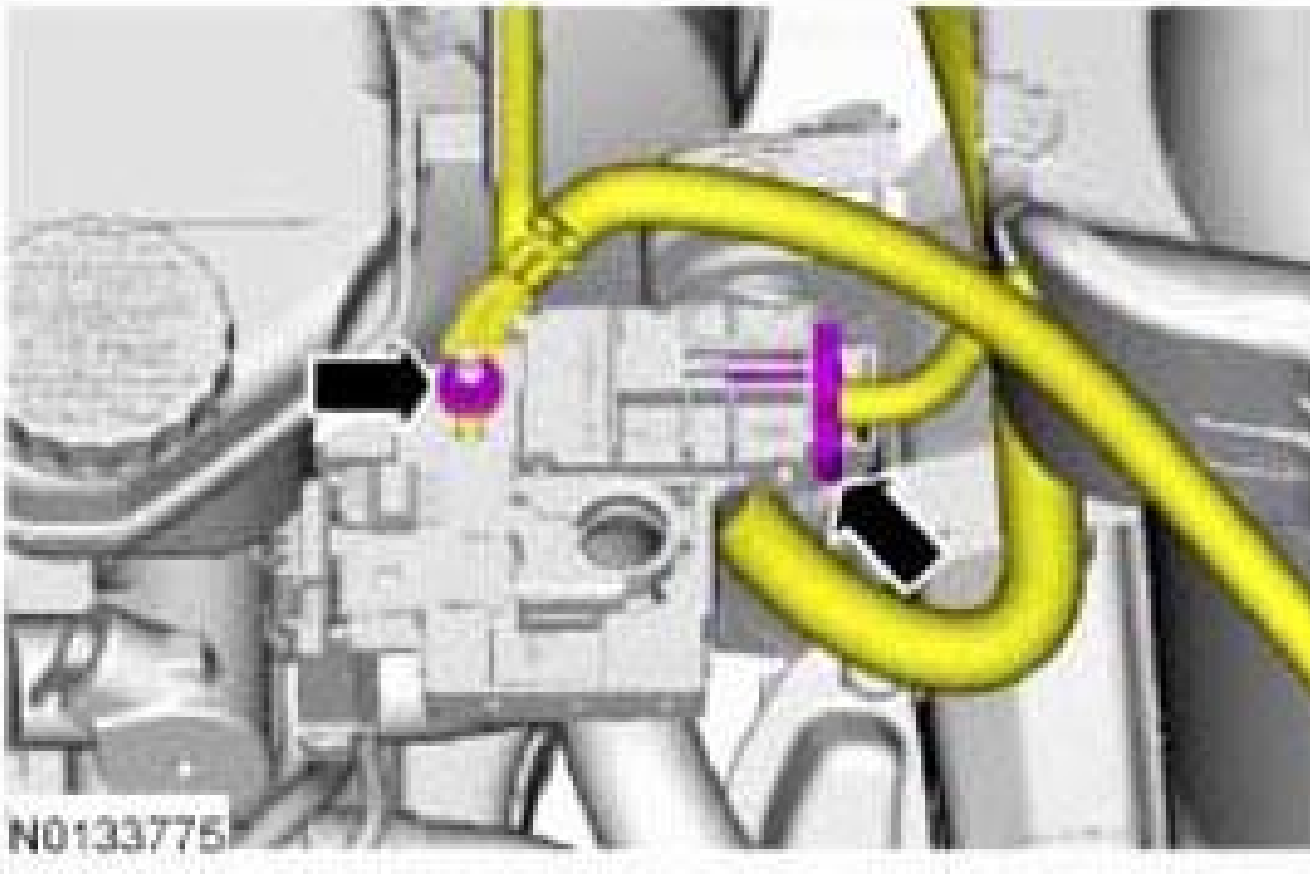
Removal

WARNING: Before beginning any service procedure, refer to SAFETY WARNINGS . Failure to follow this instruction may result in serious personal injury.

WARNING: Do not smoke, carry lighted tobacco or have an open flame of any type when working on or near any fuel-related component. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in serious personal injury.

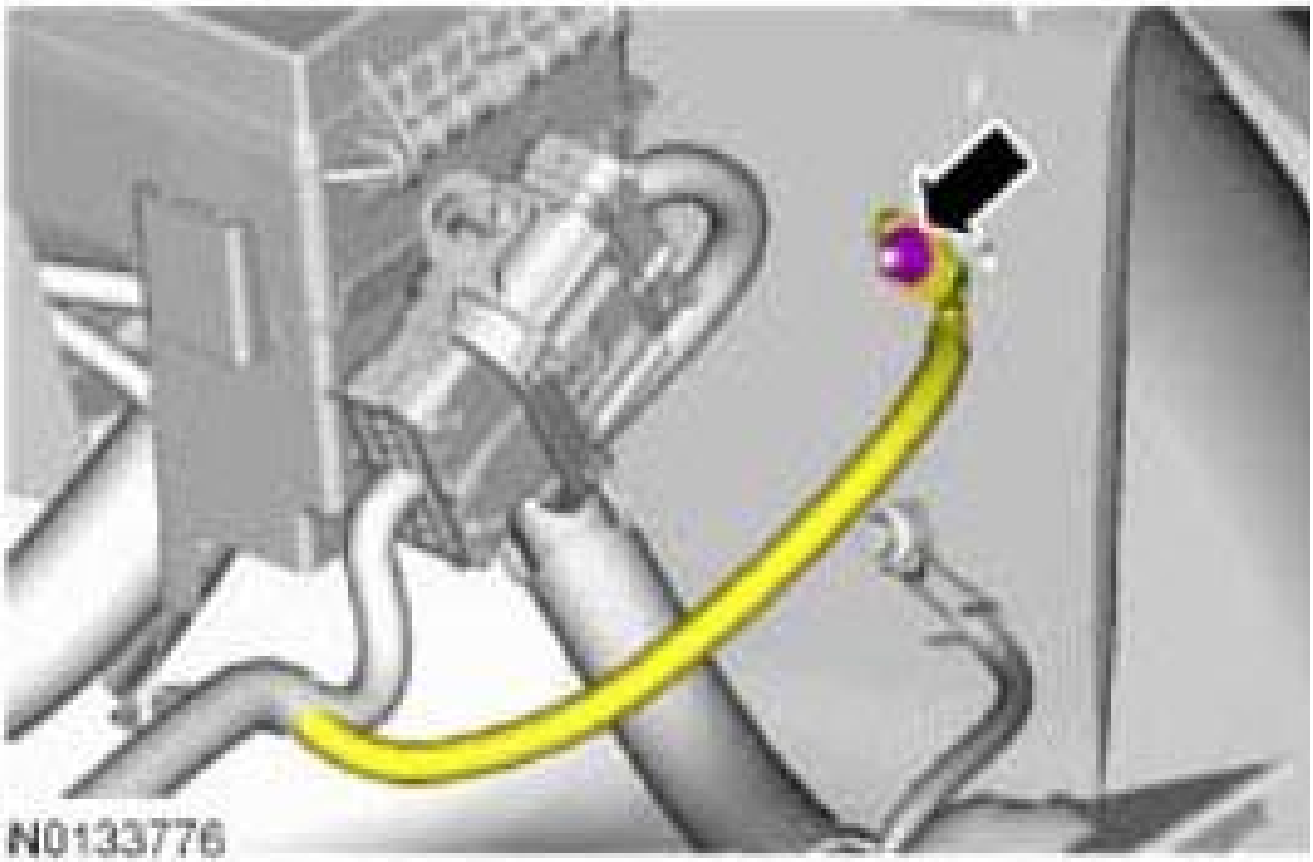
1. With the vehicle in NEUTRAL, position it on a hoist. REFER to **JACKING AND LIFTING** , Lifting Points.
2. Recover the A/C system. REFER to **AIR CONDITIONING (A/C) SYSTEM RECOVERY, EVACUATION AND CHARGING** .
3. Remove the cowl panel. REFER to **COWL PANEL** .
4. Release the fuel system pressure. REFER to **FUEL SYSTEM PRESSURE RELEASE** .
5. Remove the engine **ACL** assembly and **ACL** outlet pipe. REFER to **INTAKE AIR SYSTEM COMPONENTS - EXPLODED VIEW** .
6. Remove the battery tray. REFER to **BATTERY AND BATTERY TRAY - EXPLODED VIEW** .
7. Remove the nut and disconnect the 2 battery feed cables from the positive battery terminal.

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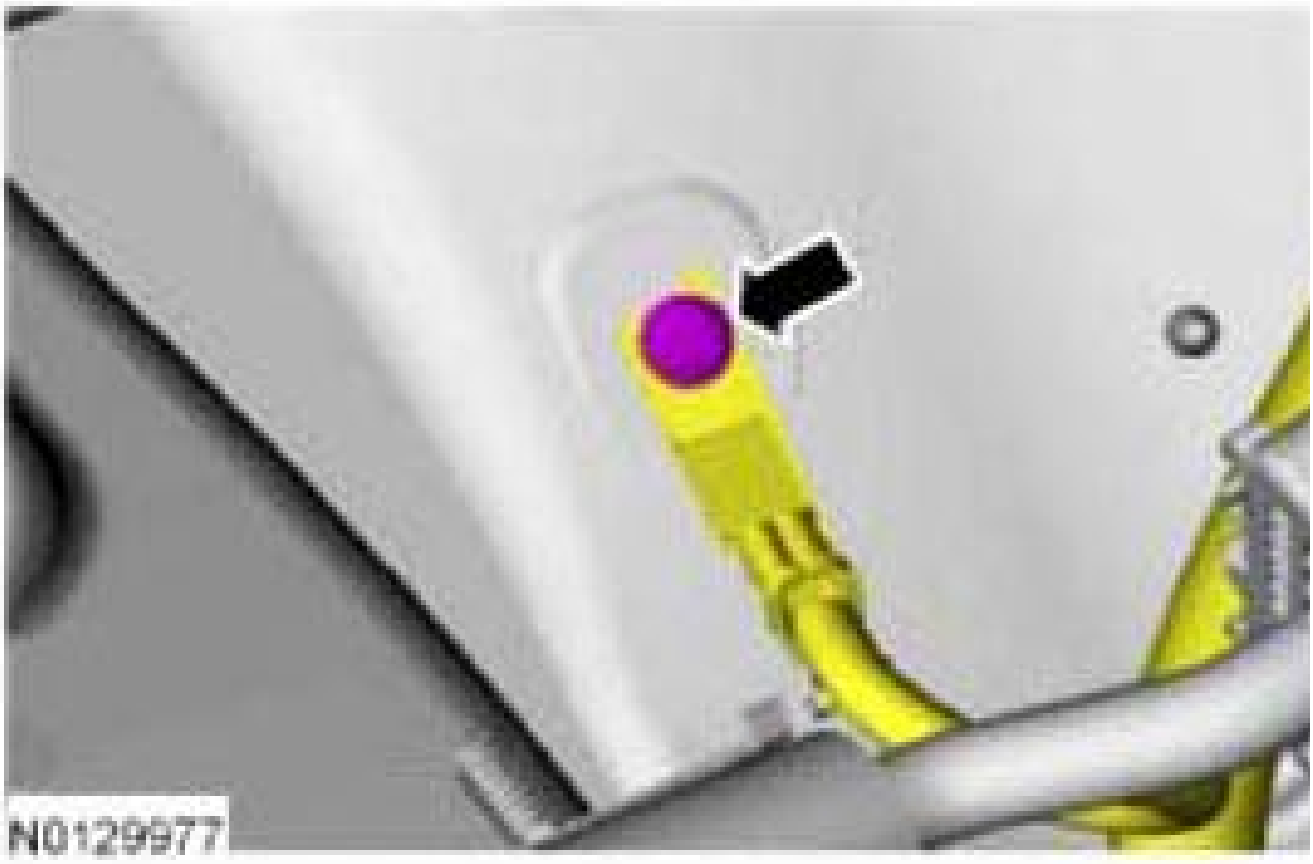
8. Remove the retainer and the ground wire cable.

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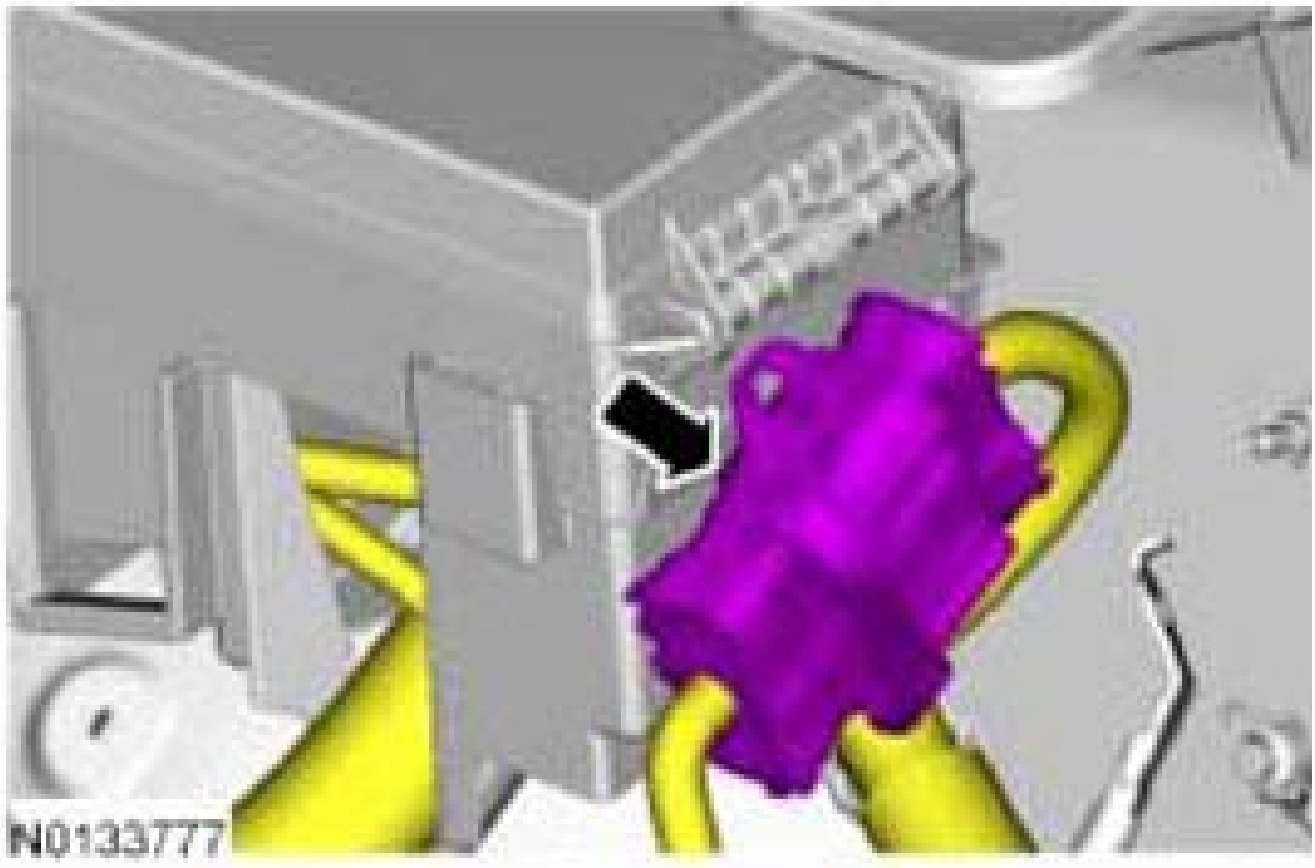
9. Remove the retainer and the ground wire cable.

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10. Disconnect the engine wiring harness electrical connector.

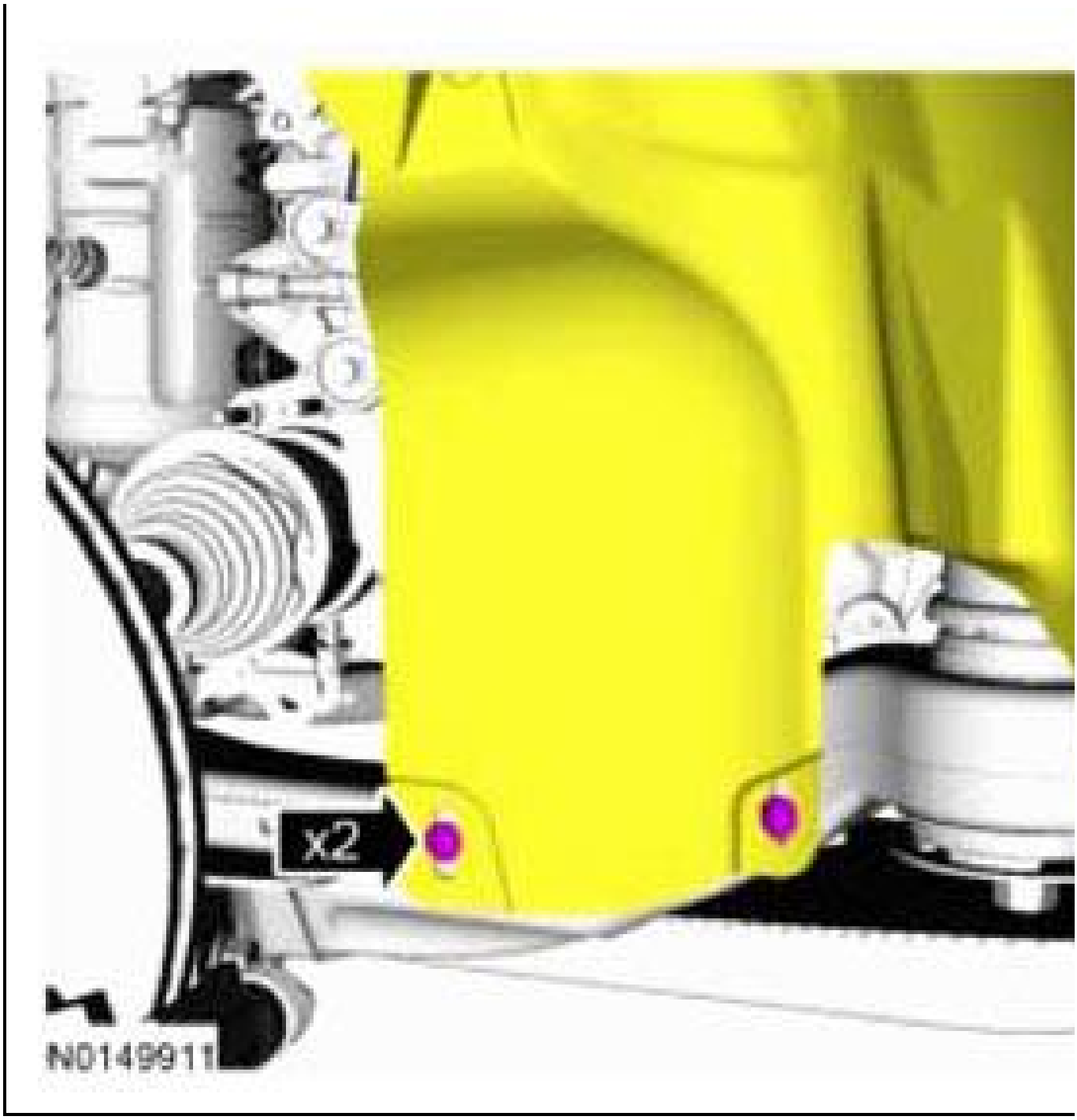
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11. Remove the front wheels and tires. REFER to **WHEEL AND TIRE** .
12. **NOTE: RH shown in illustration, LH similar.**

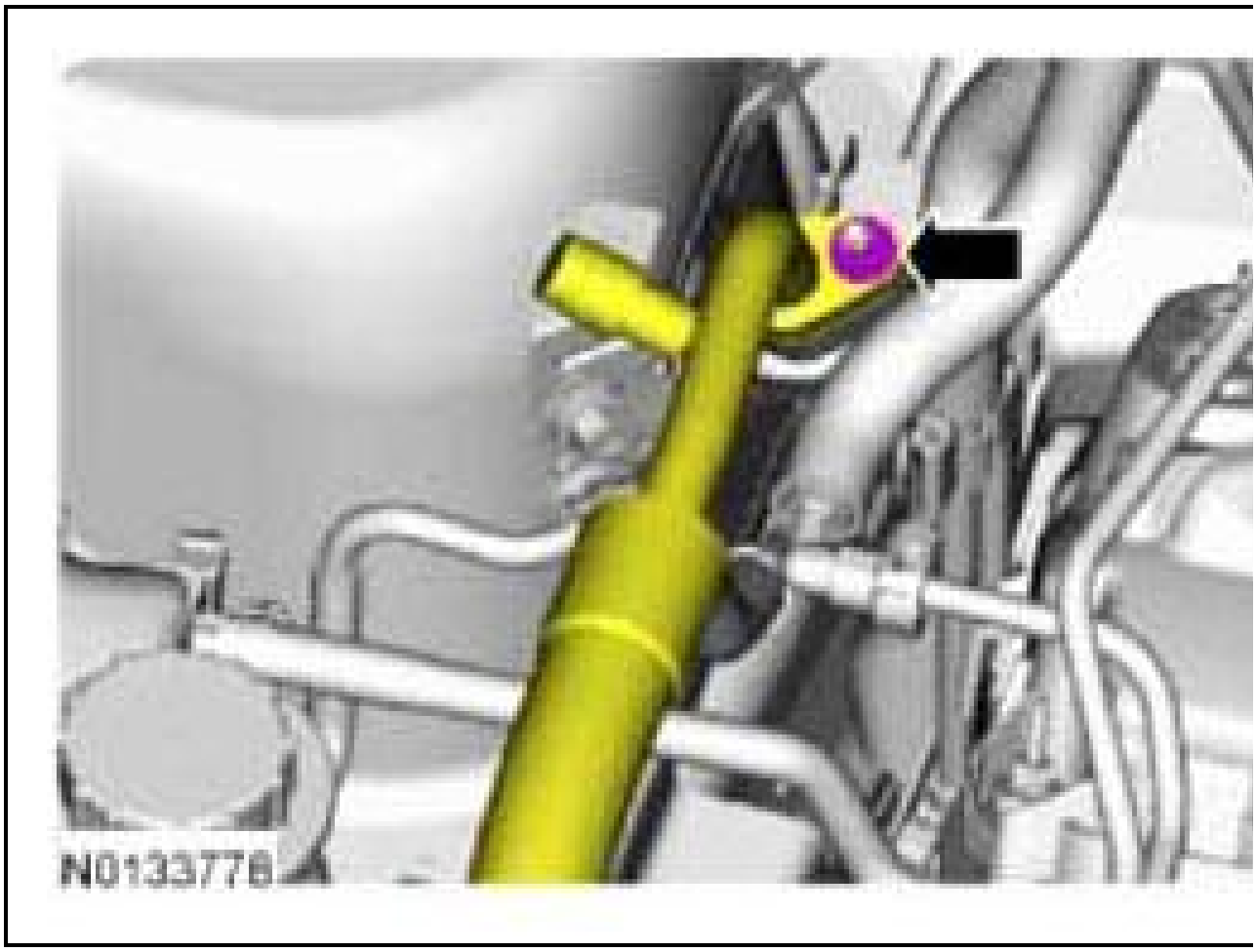
    Remove the 2 RH and 2 LH lower pin-type retainers from the engine splash shields and position the shields aside.

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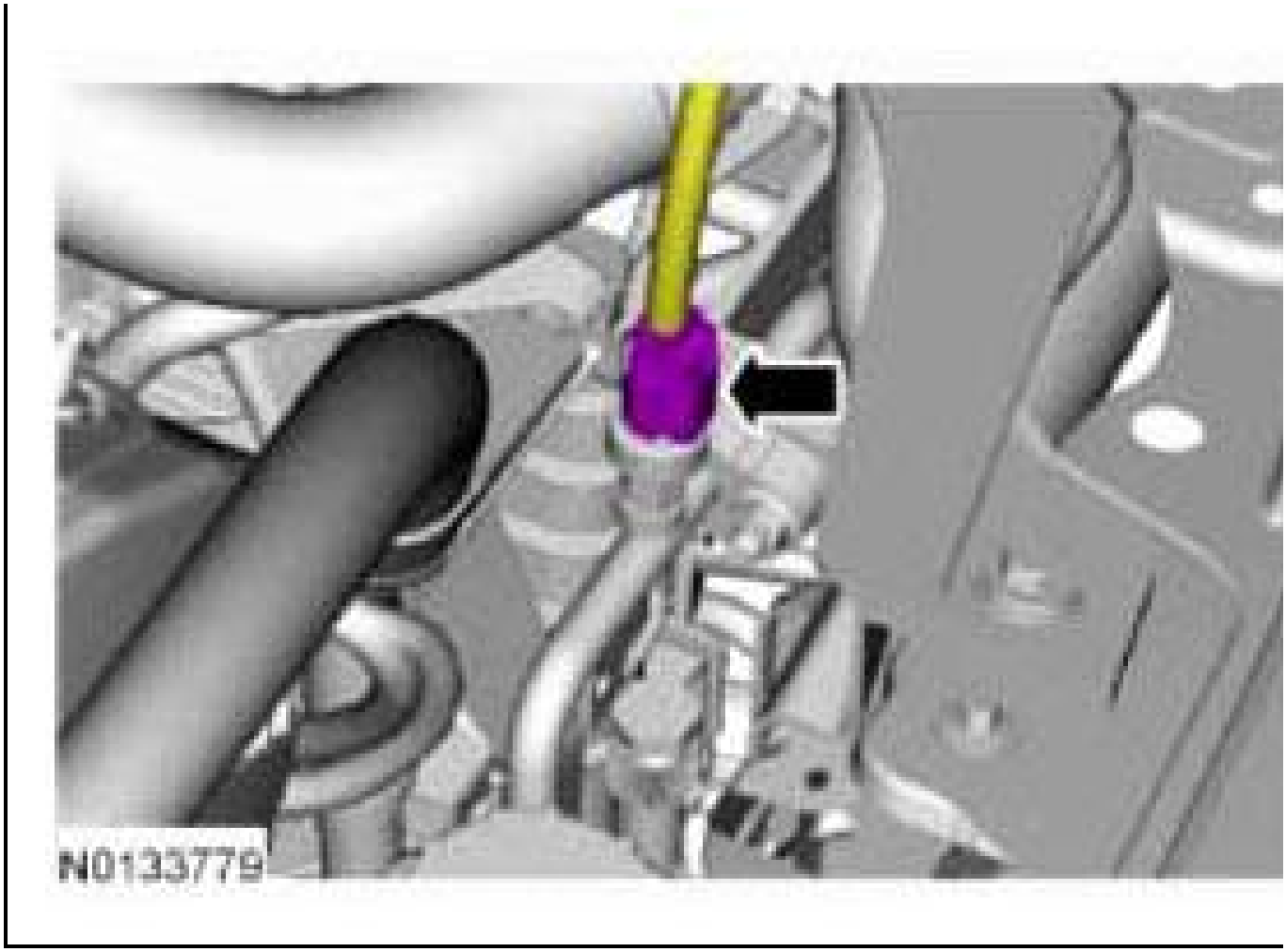
13. Remove the accessory drive belt. REFER to **ACCESSORY DRIVE BELT - 3.5L TI-VCT, 3.7L TI-VCT** .
14. Drain the cooling system. REFER to **COOLING SYSTEM DRAINING, FILLING AND BLEEDING** .
15. Remove the nut and disconnect the A/C tube.
    - Discard the O-ring seal and gasket seal.

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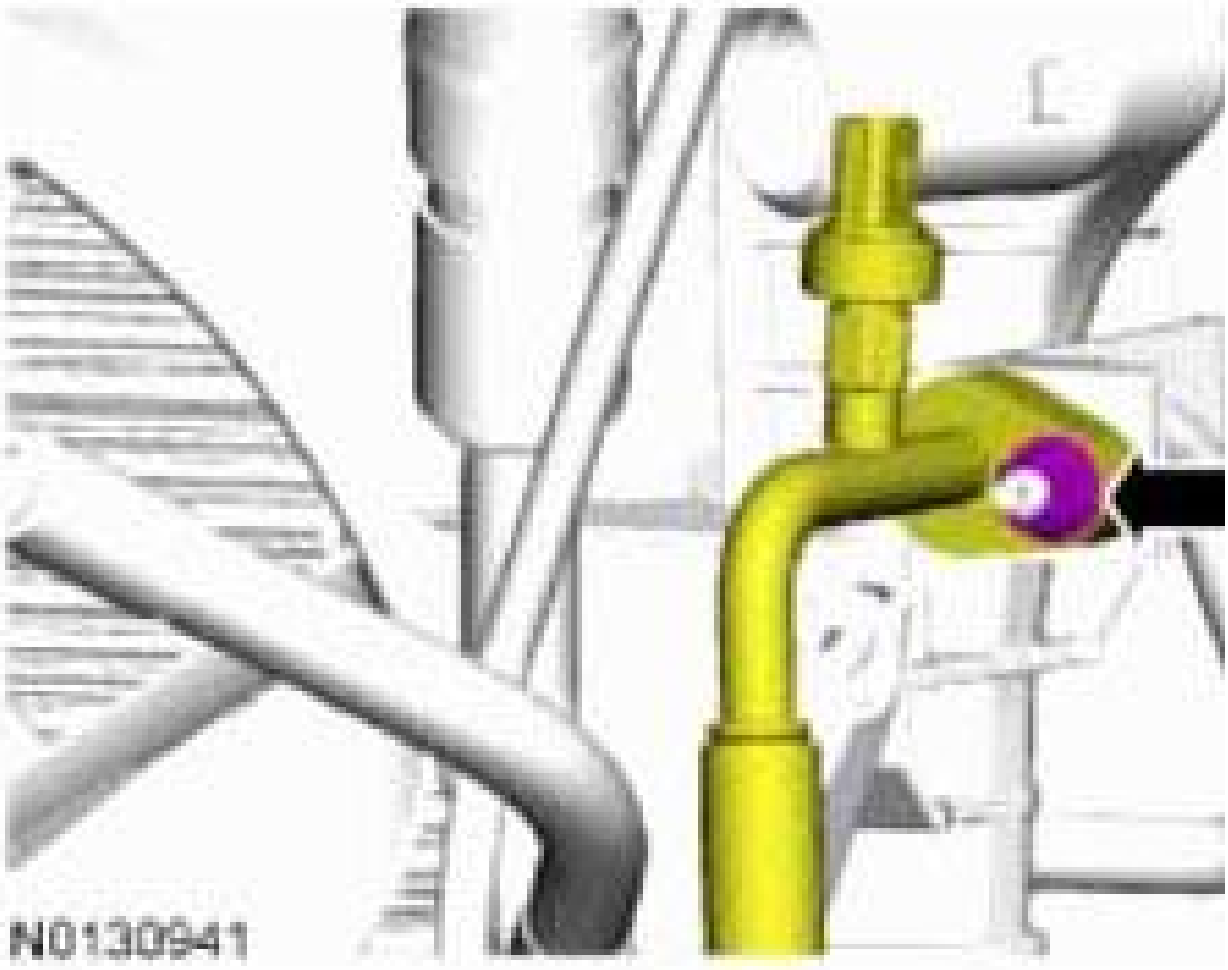
16. Disconnect the A/C pressure switch electrical connector.

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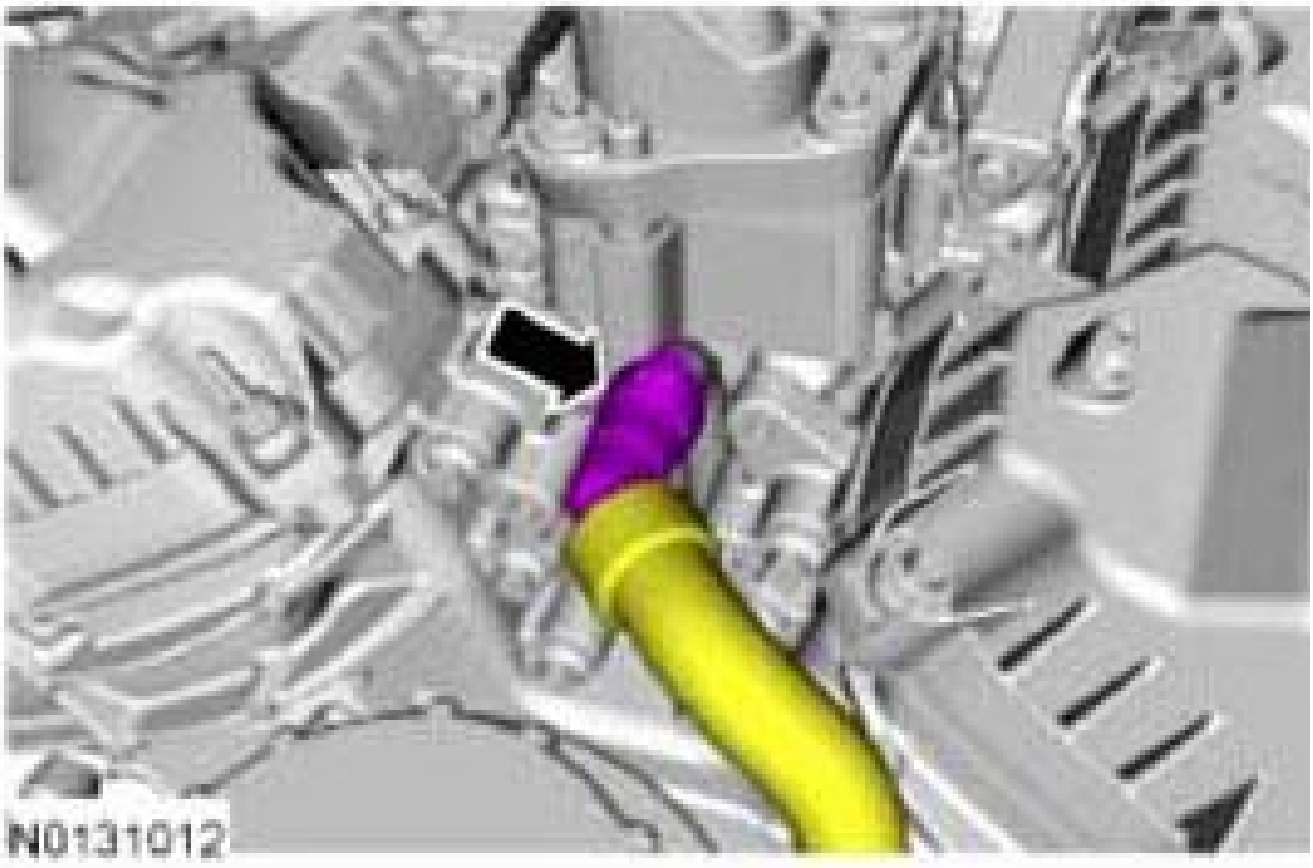
17. Remove the nut and disconnect the A/C tube.
    - Discard the O-ring seal and gasket seal.

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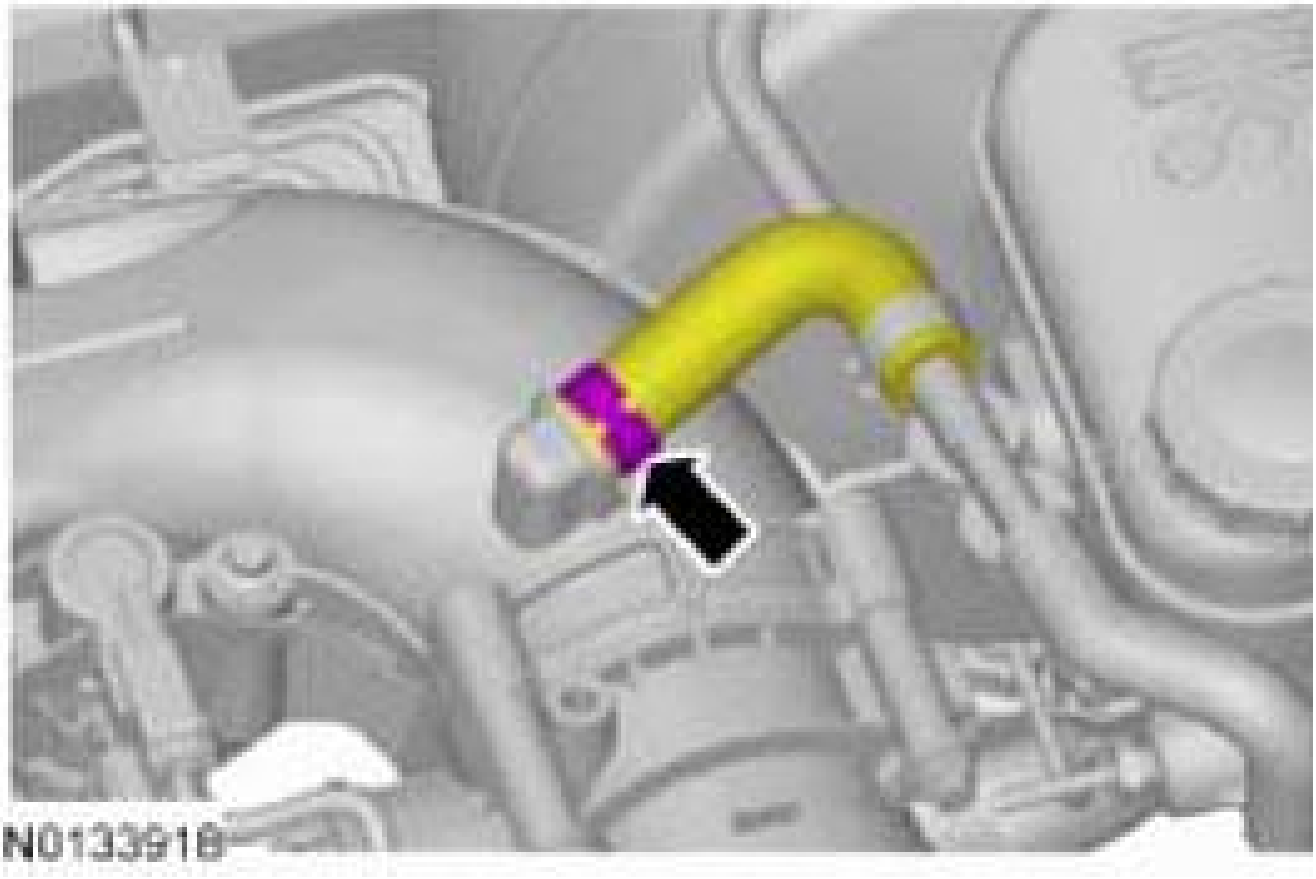
18. Remove degas bottle. REFER to **DEGAS BOTTLE** .
19. Disconnect the degas bottle coolant hose from the engine coolant tube.

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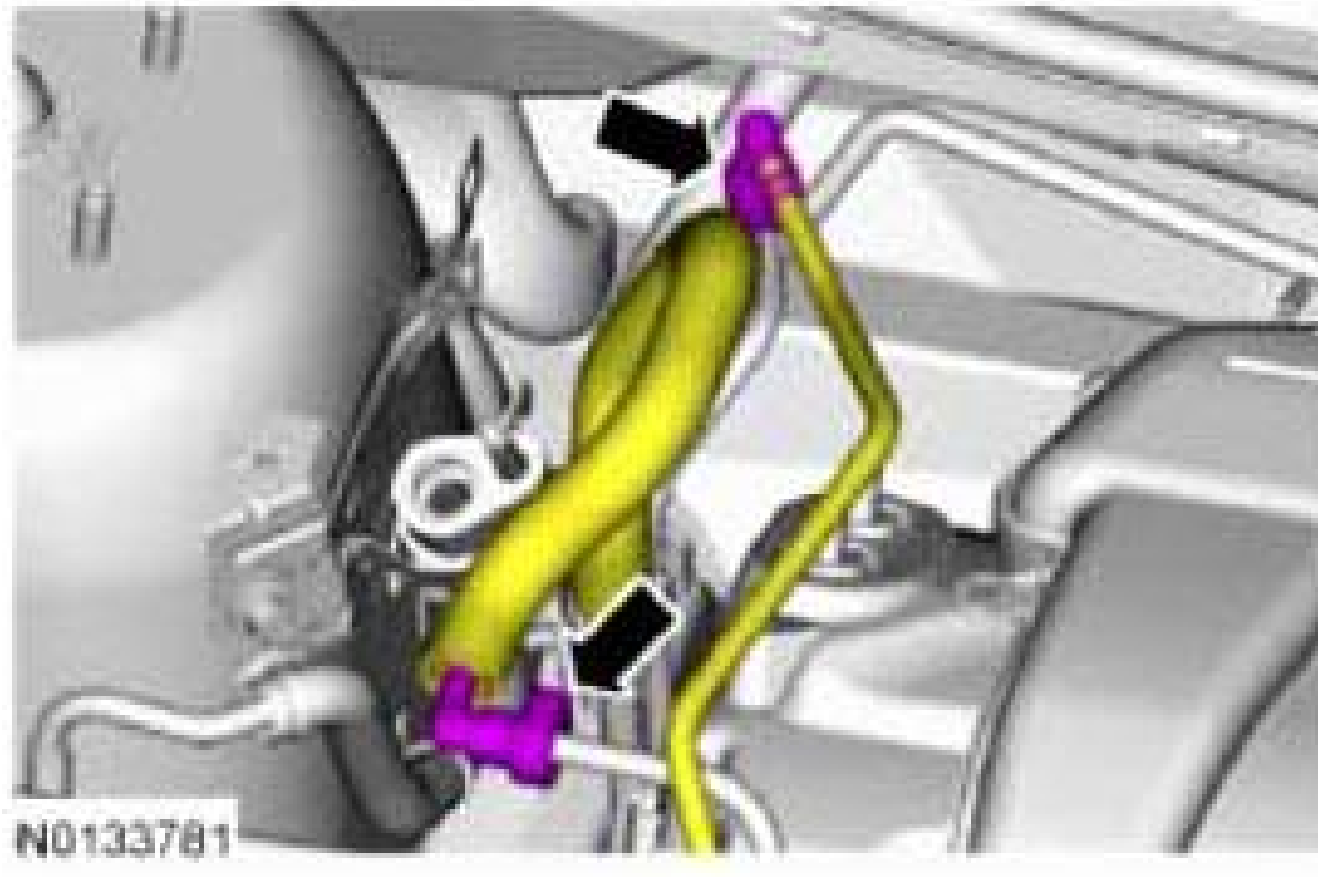
20. Disconnect the brake booster vacuum hose from the upper intake manifold.

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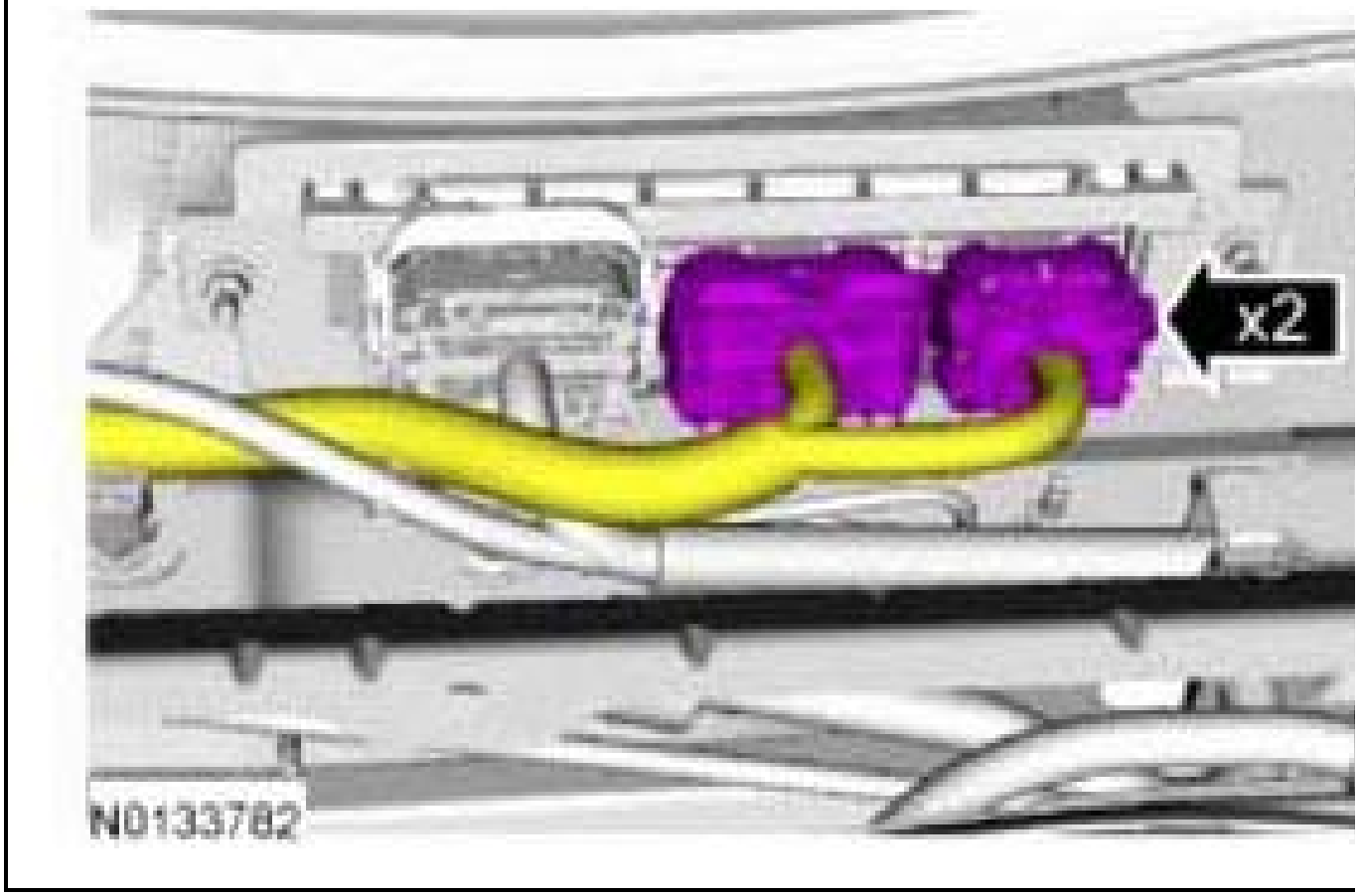
21. Disconnect the **EVAP** tube and the fuel supply tube quick connect coupling. REFER to **QUICK CONNECT COUPLING** .

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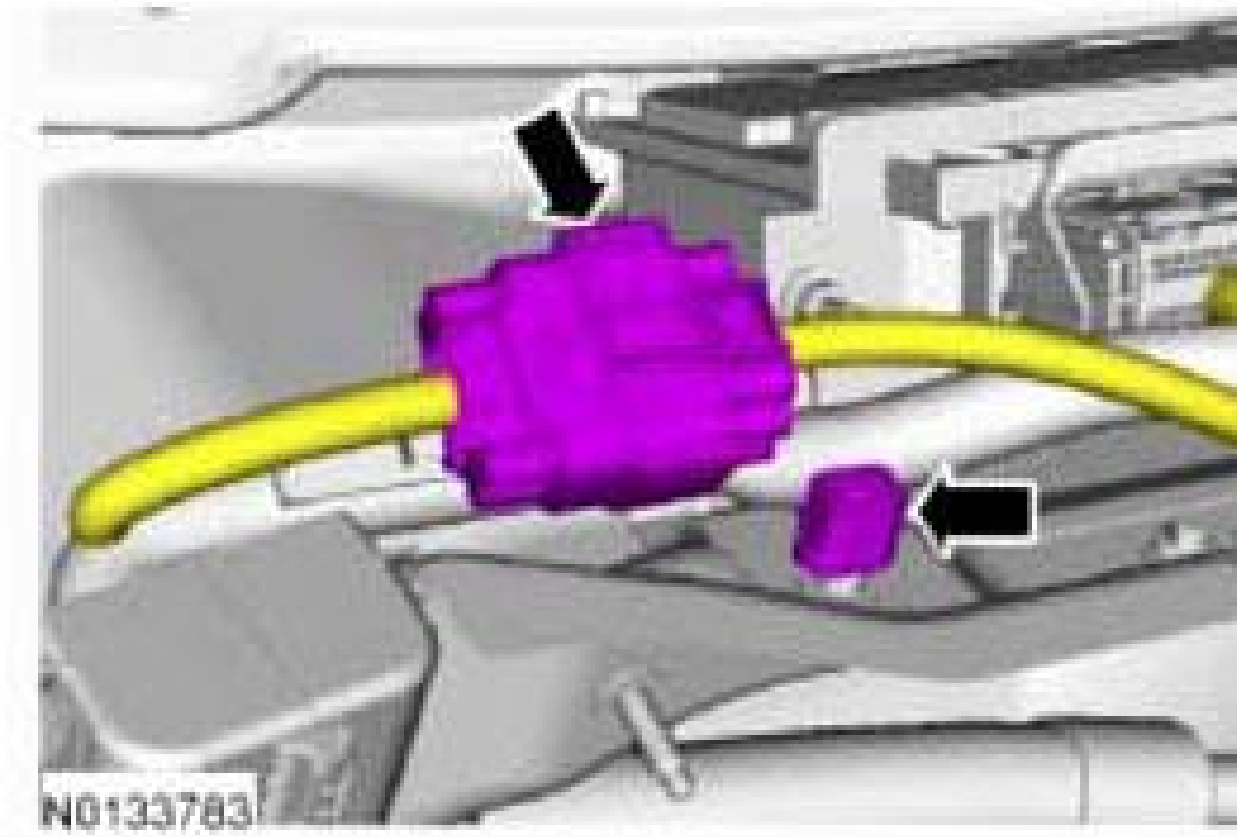
22. Disconnect the 2 **PCM** electrical connectors.

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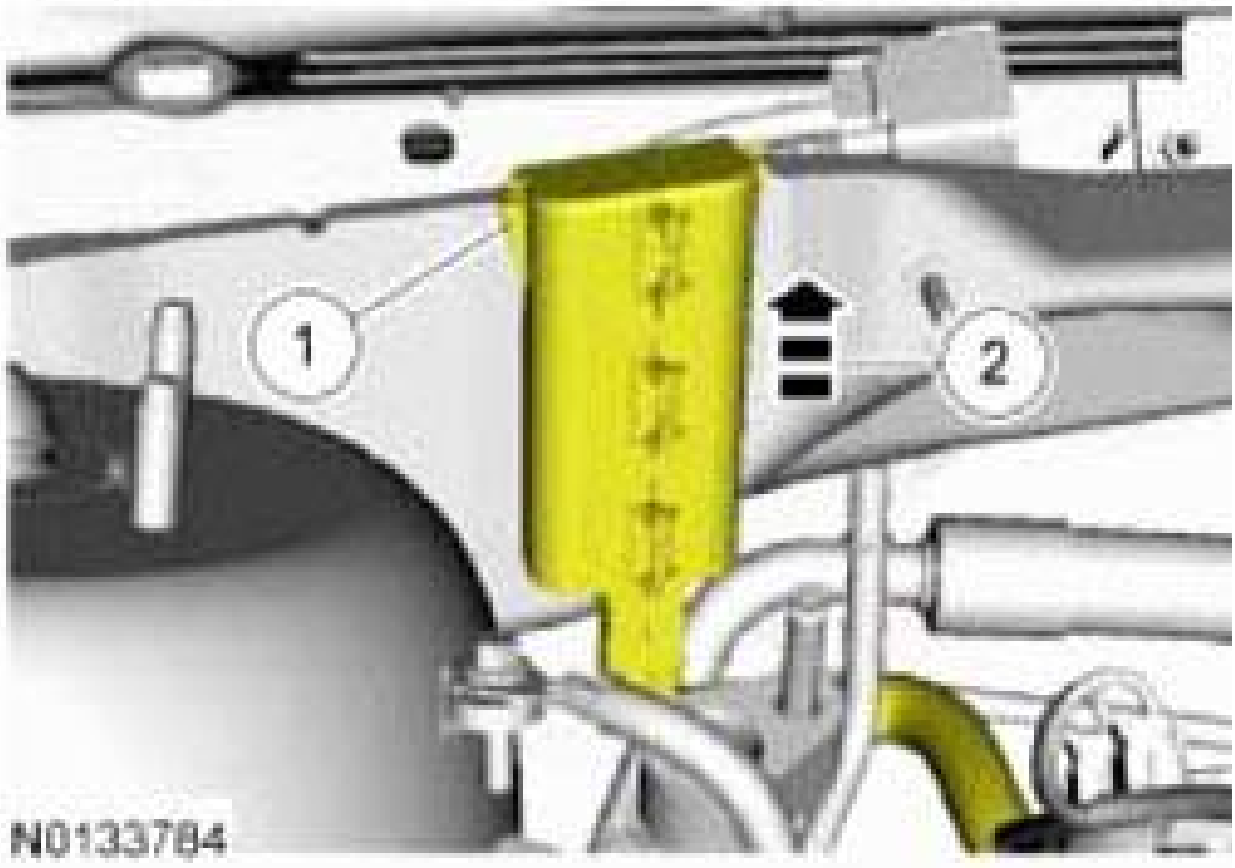
23. Disconnect the engine harness electrical connector.
    - Detach the wiring harness retainer.

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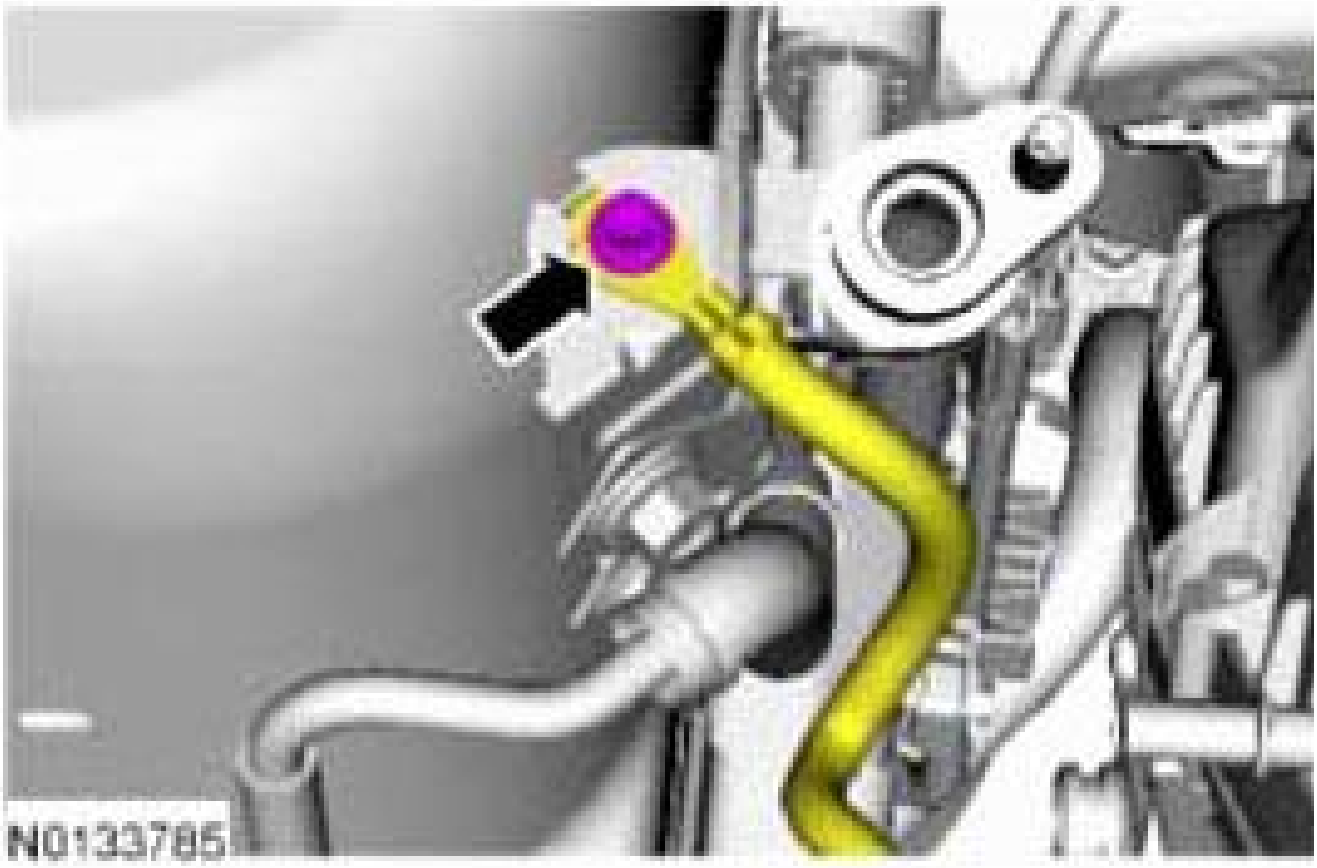
24. Remove the engine wiring harness retainer from the bulkhead.
    - Push the wiring harness retainer tab in.
    - Slide the wiring harness up and out of the bulkhead.

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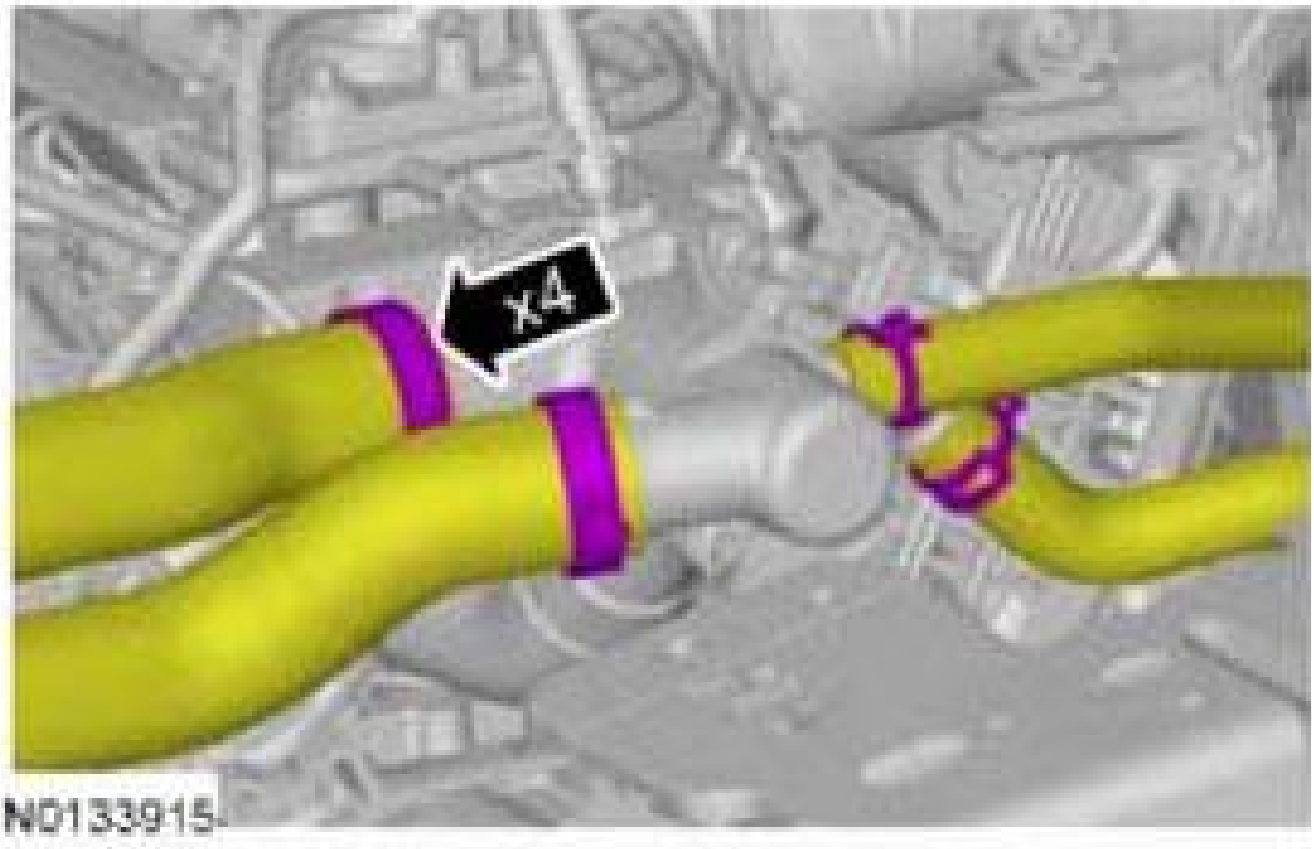
25. Remove the bolt and ground wire from the RH shock tower.

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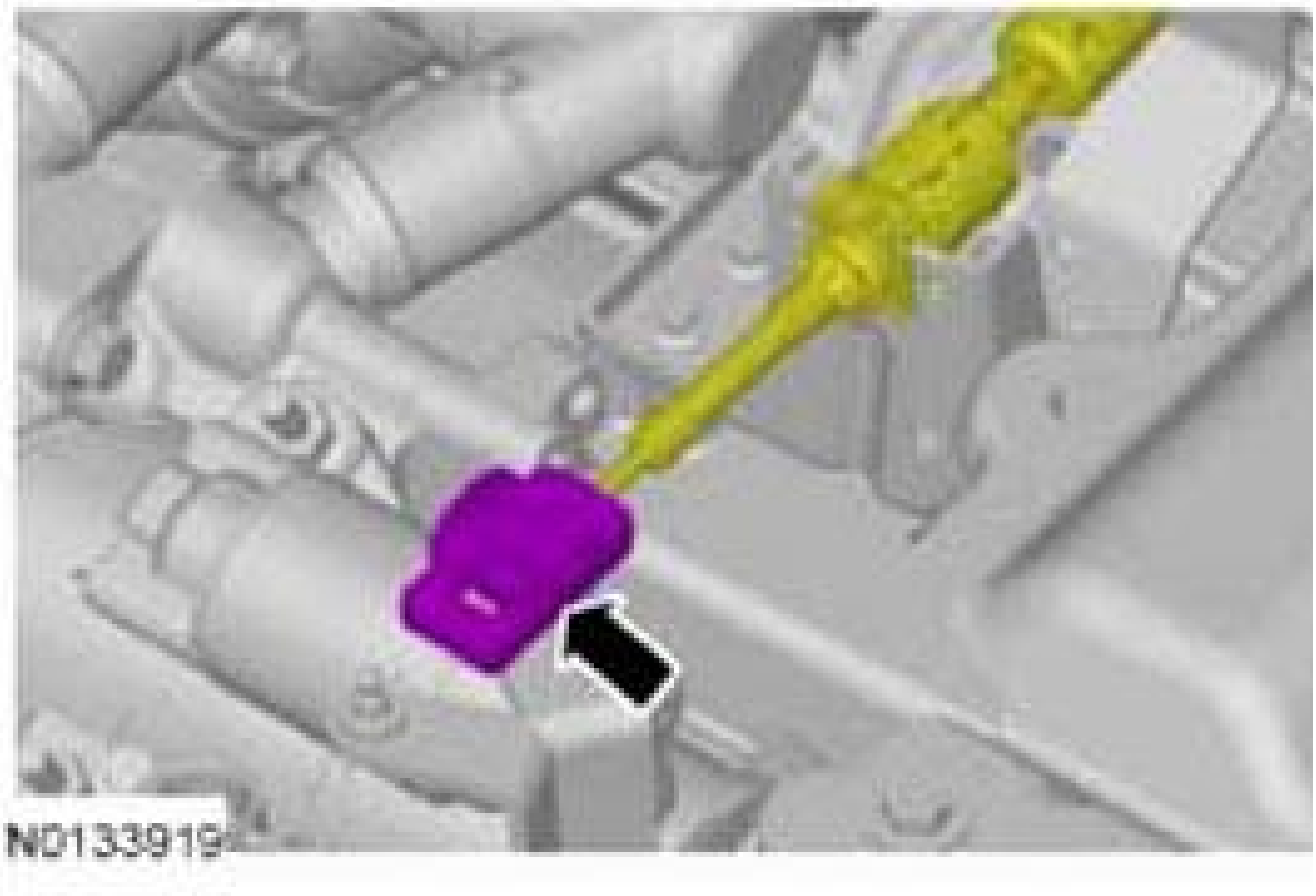
26. Disconnect the upper radiator hose, lower radiator hose and 2 heater hoses from the thermostat housing.

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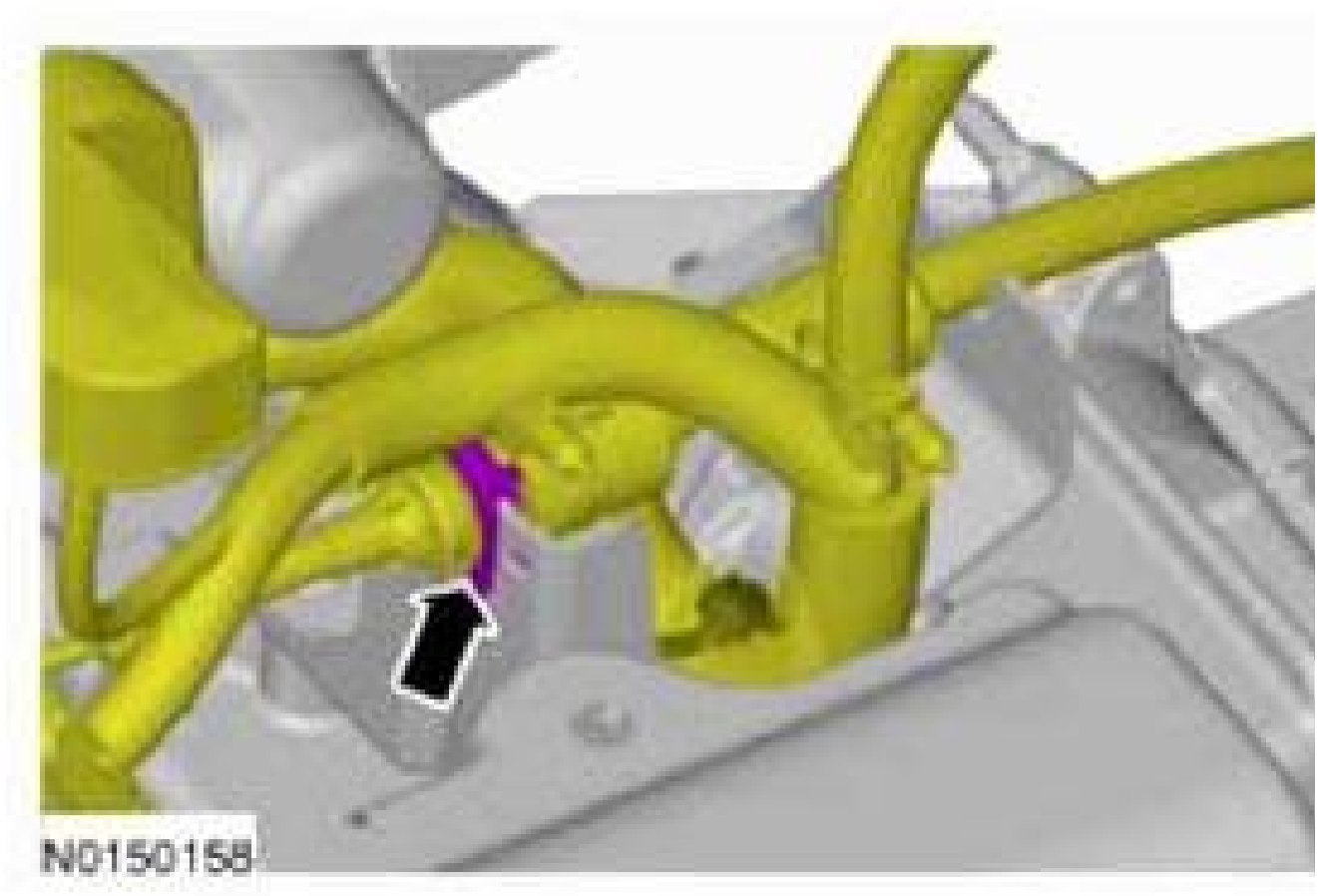
27. Disconnect the transaxle control cable from the control lever.

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28. Disconnect the transaxle control cable from the shift cable bracket.

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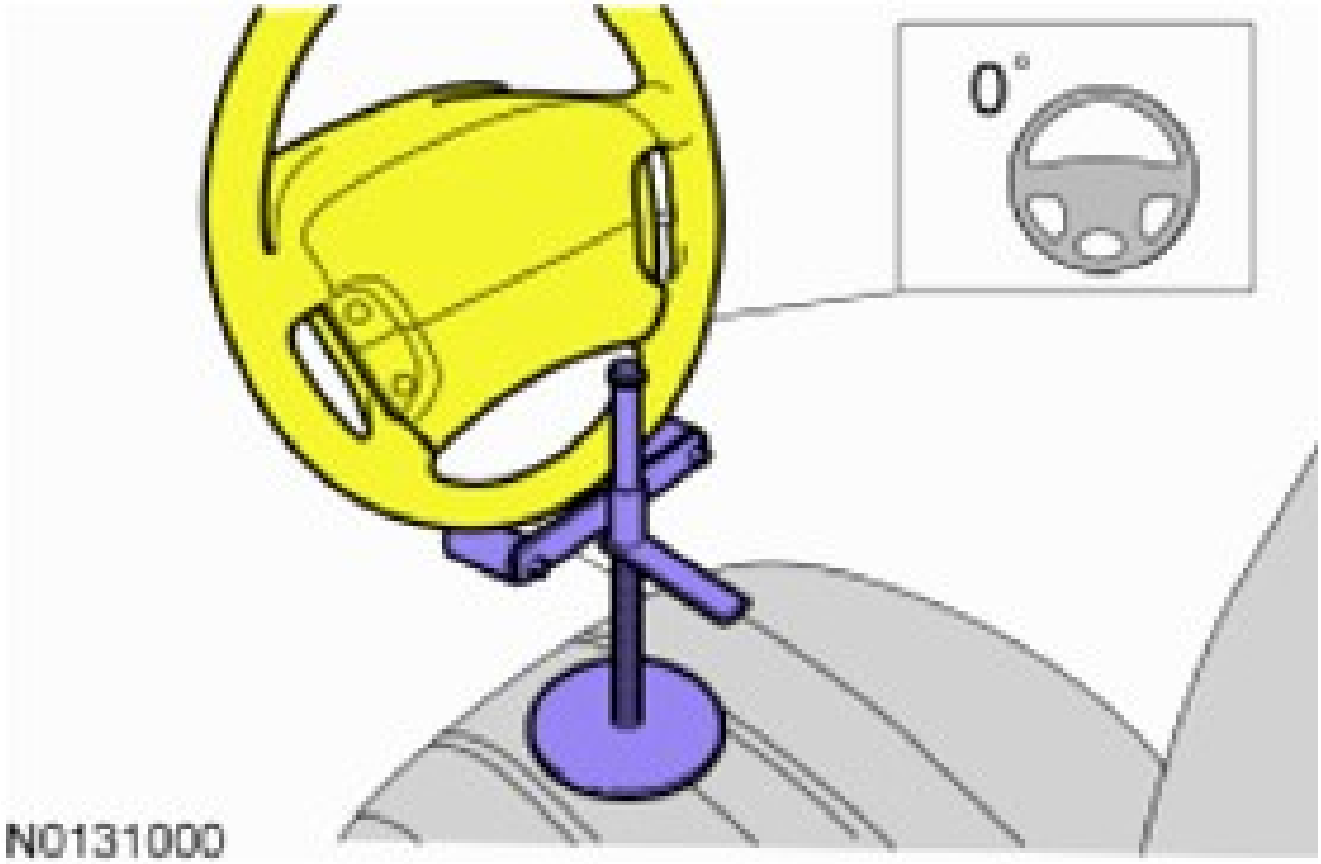


29. If equipped, detach the engine block heater harness.

NOTE: Use a steering wheel holding device (such as Hunter® 28-75-1 or equivalent).

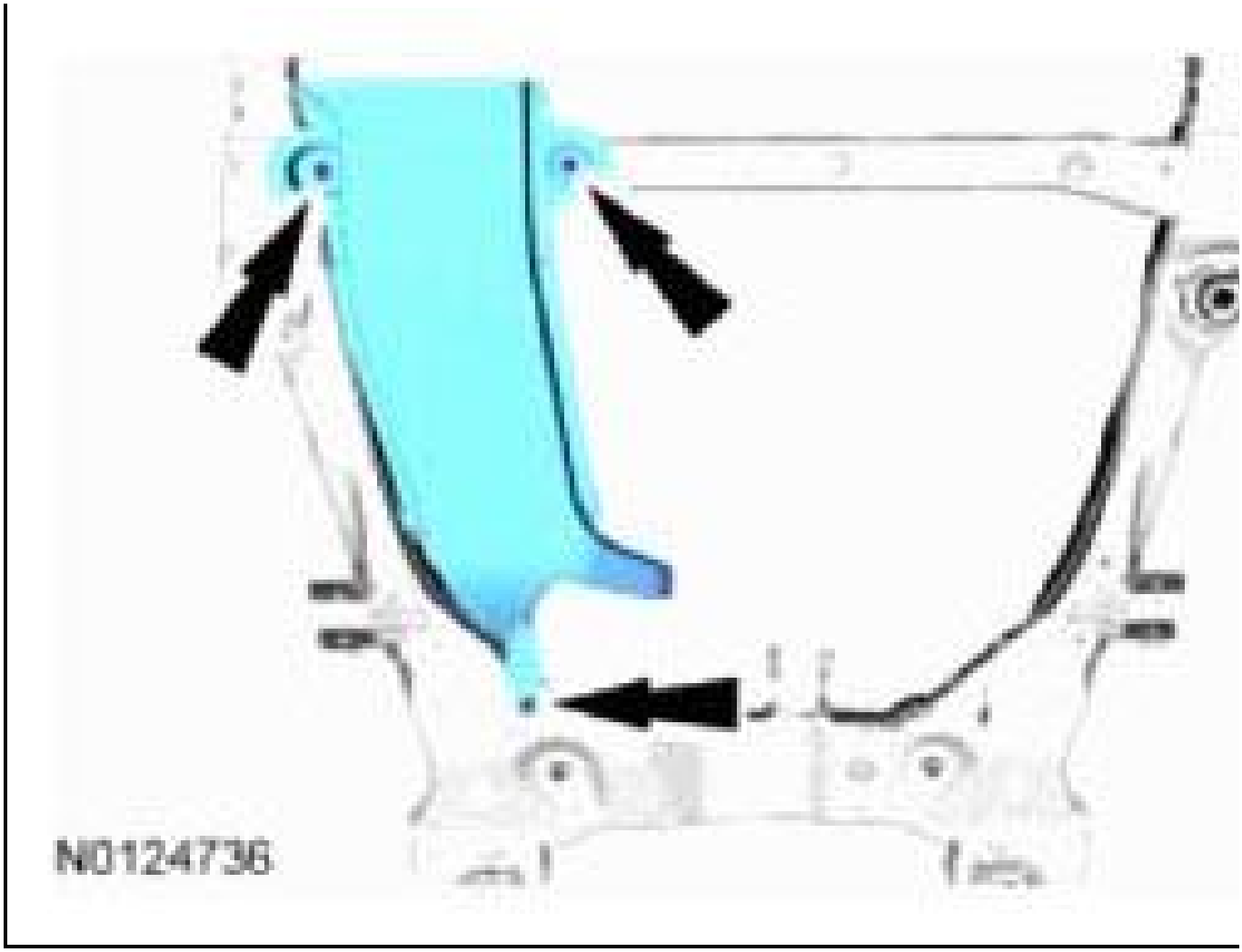
30. Using a suitable holding device, hold the steering wheel in the straight-ahead position.

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31. Remove the 3 twist lock retainers and the underbody air duct.

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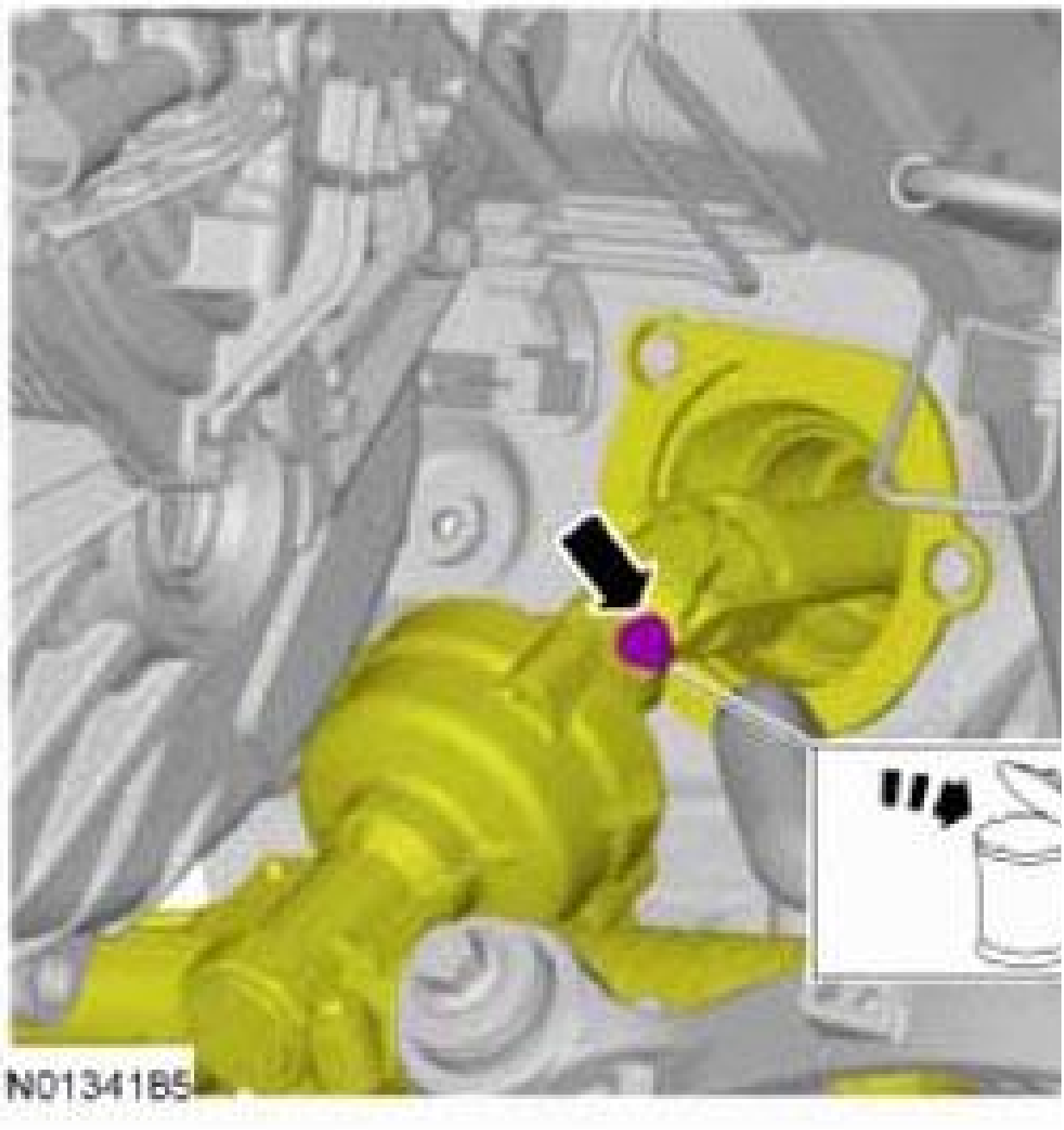
32.

NOTE: **Do not allow the intermediate shaft to rotate while it is disconnected from the gear or damage to the clockspring may occur. If there is evidence that the intermediate shaft has rotated, the clockspring must be removed and recentered. For additional information, refer to CLOCKSPRING , and CLOCKSPRING ADJUSTMENT .**

NOTE: **Index-mark the steering column shaft position to the steering gear for reference during installation.**

Remove the bolt and disconnect the steering column shaft from the steering gear.

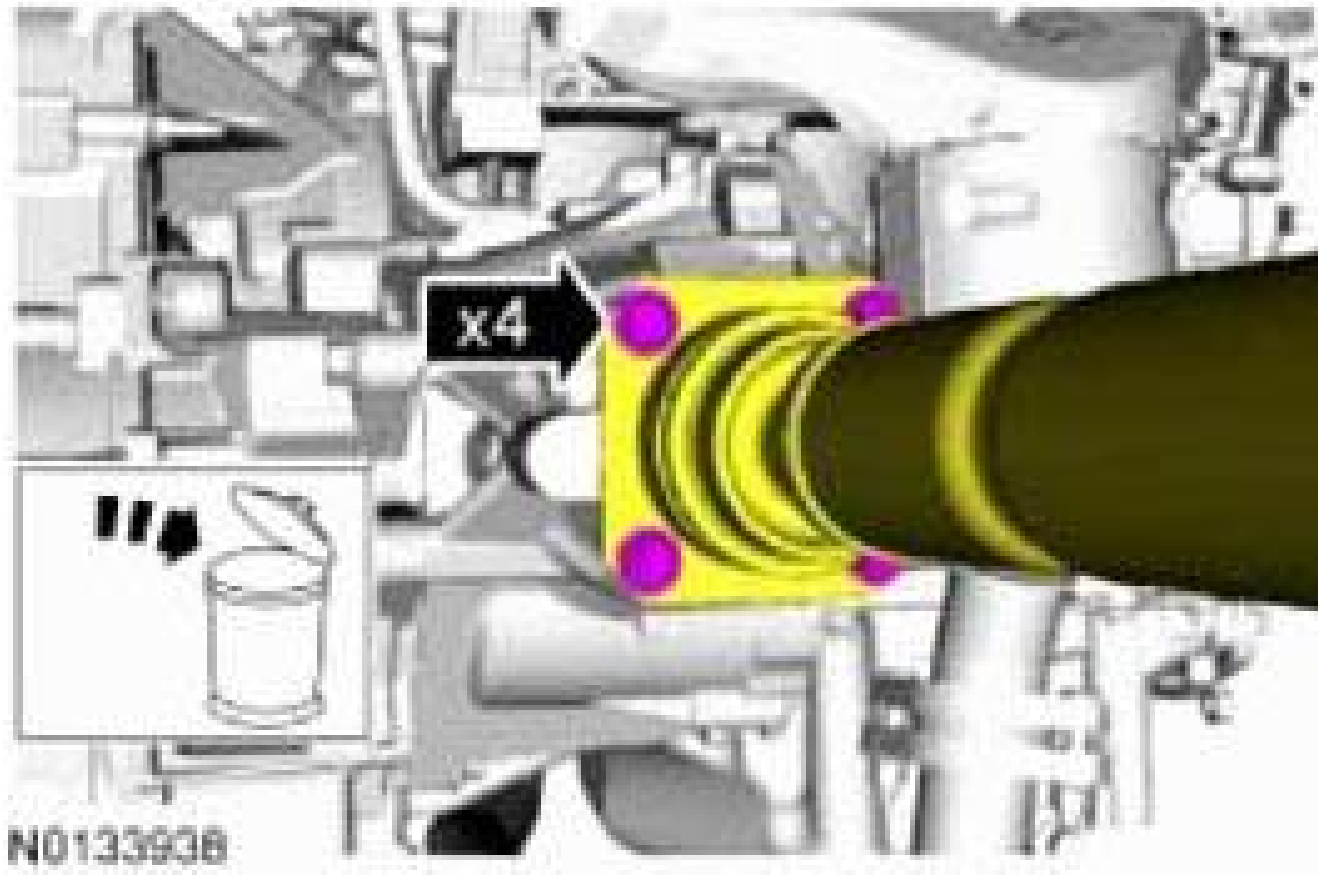
- Discard the bolt.



33. Remove the exhaust Y-pipe. For additional information, refer to **EXHAUST Y-PIPE - 3.5L TI-VCT** .
34. **NOTE: Index-mark the driveshaft for installation.**

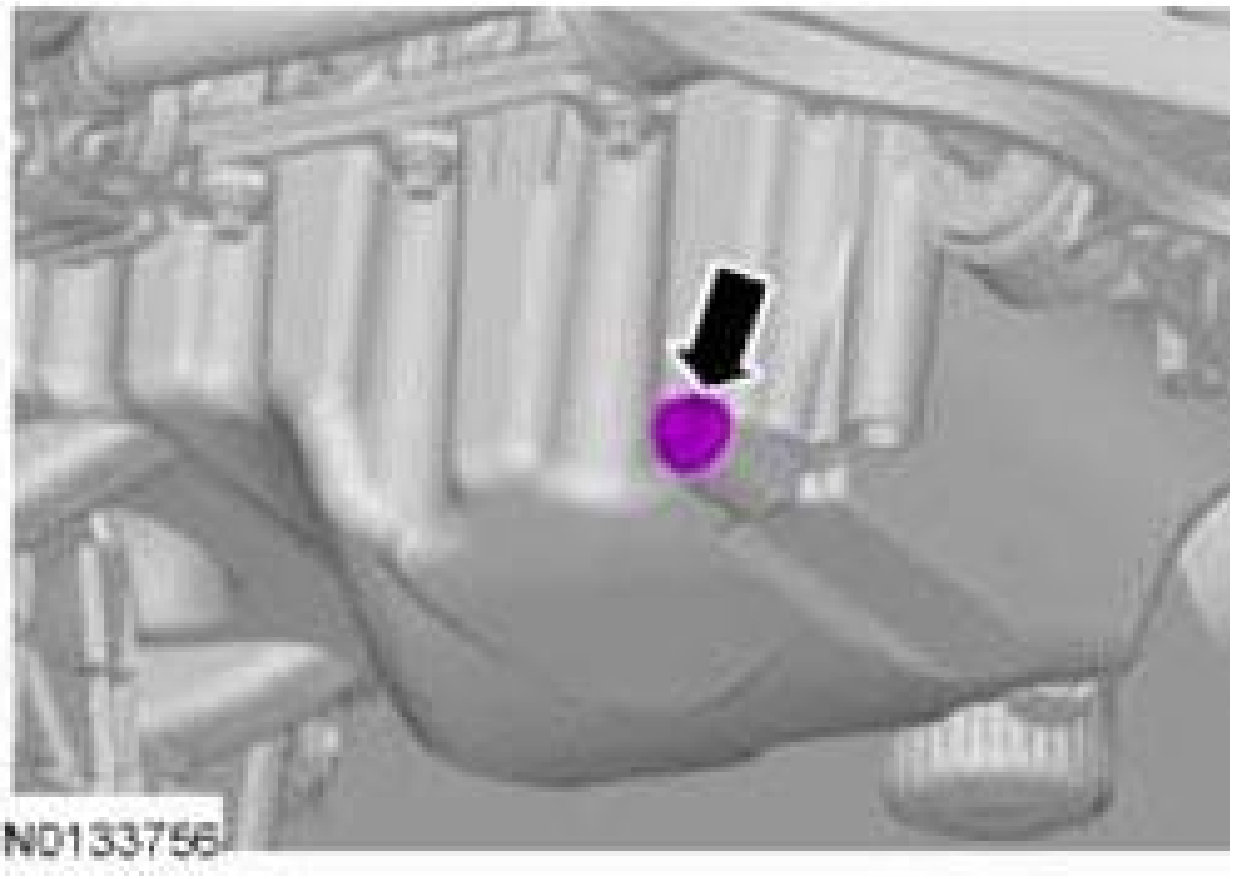
    If equipped with All-Wheel Drive (AWD), remove and discard the 4 bolts and support the driveshaft with a length of mechanic's wire.

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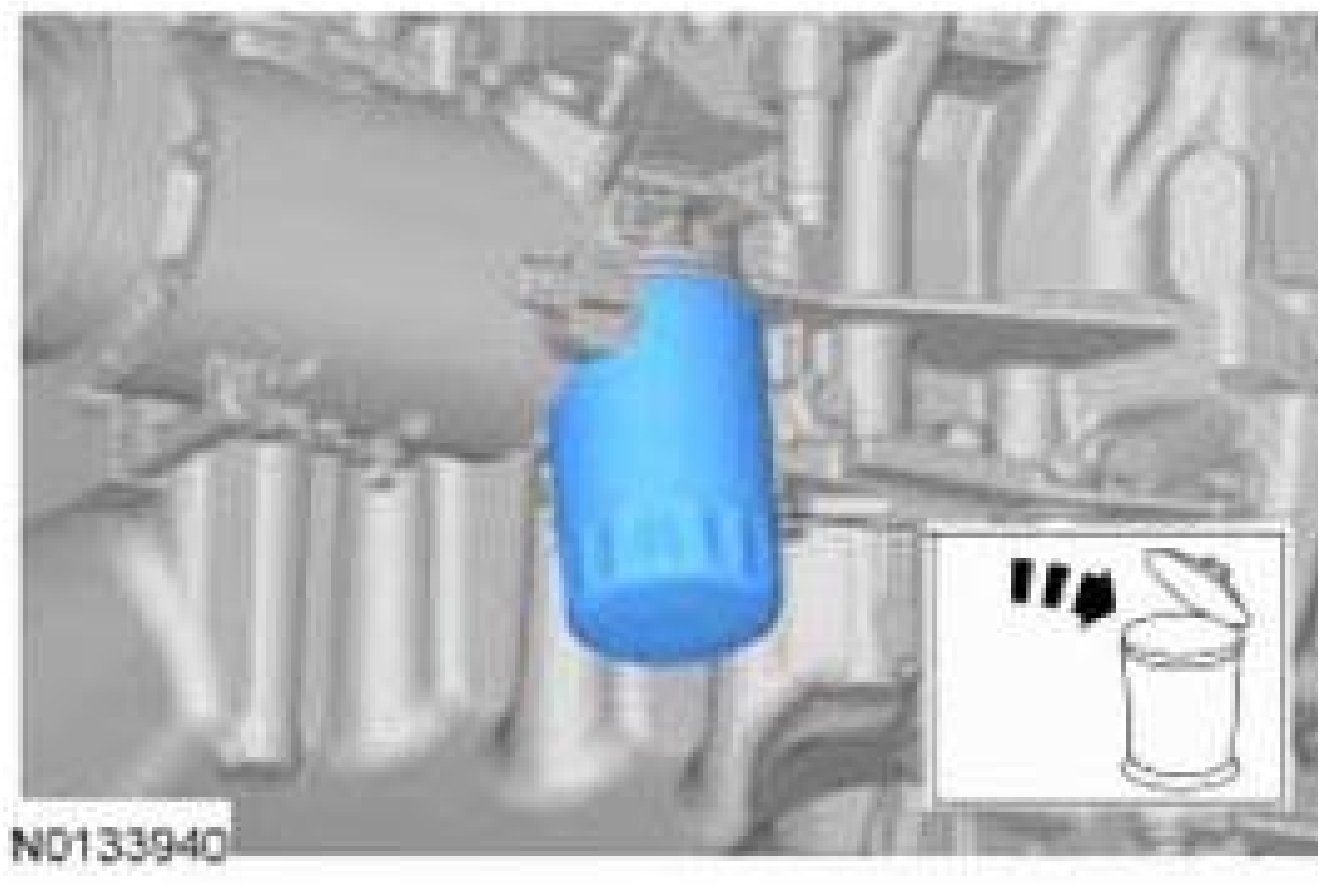
35. Remove the drain plug and drain the engine oil.
    - Install the drain plug and tighten to 27 Nm (20 lb-ft).

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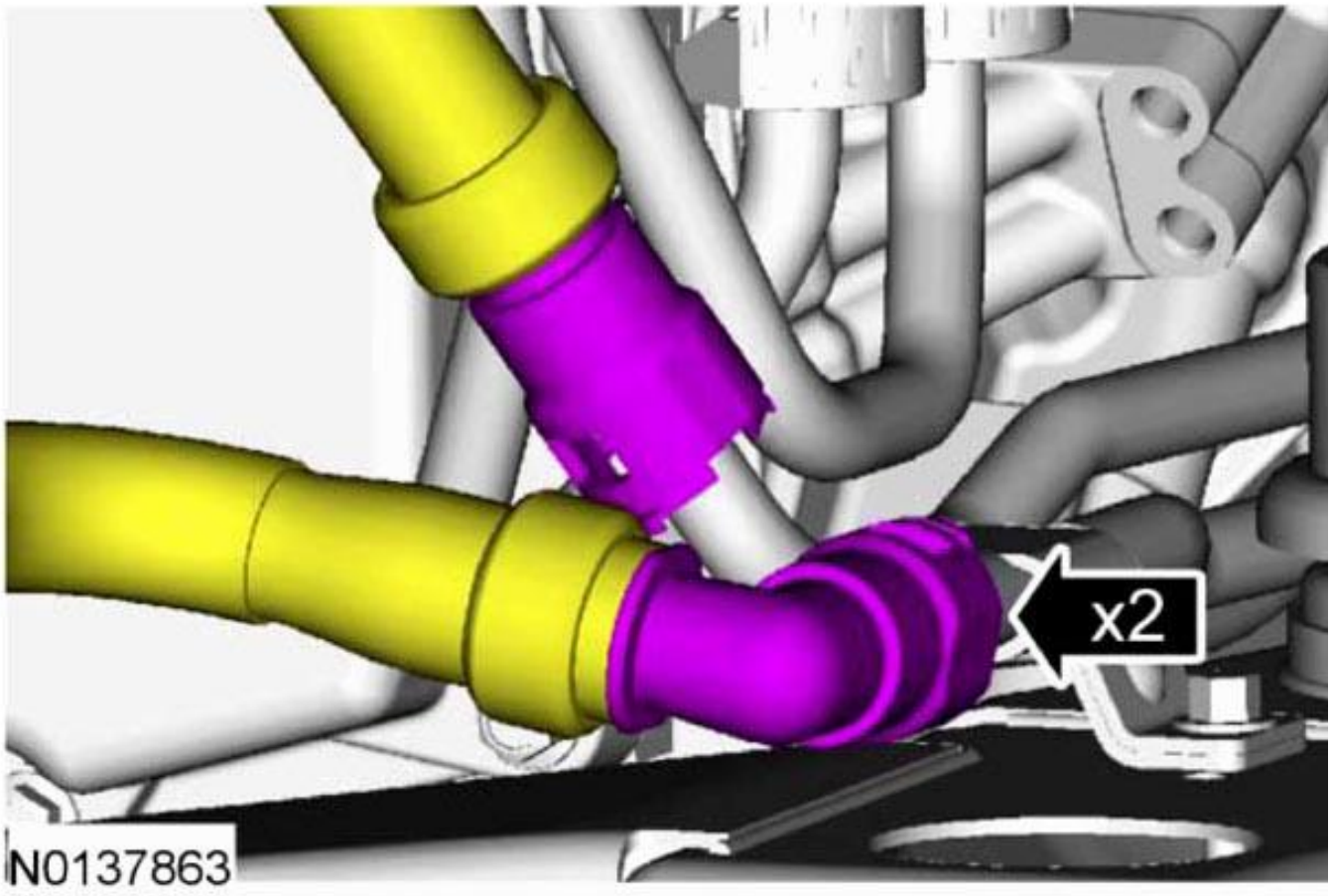
36. Remove and discard the engine oil filter.

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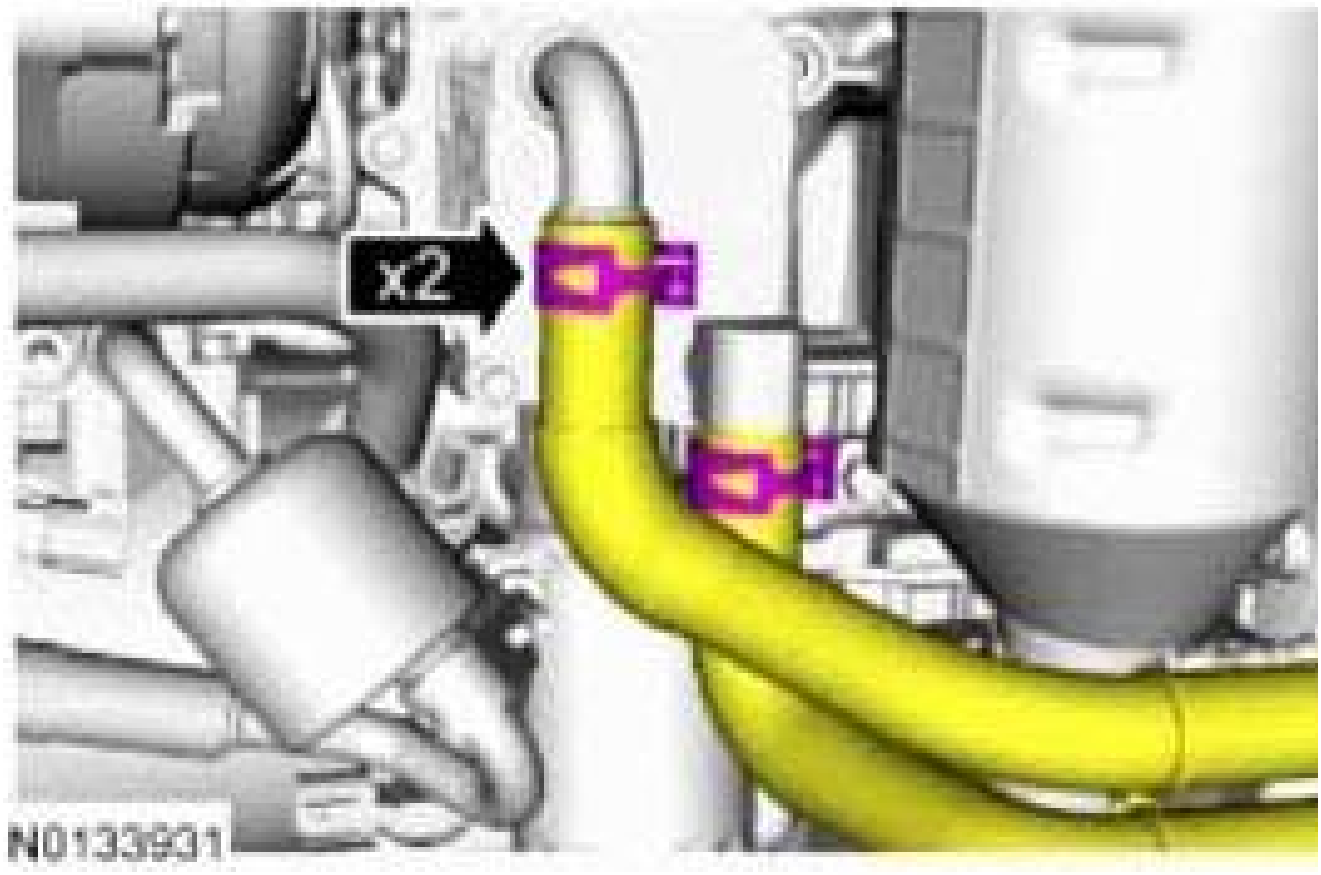
37. If equipped, disconnect the 2 **PTU** cooler hoses. For additional infomation, refer to **FUEL SYSTEM - GENERAL INFORMATION** .

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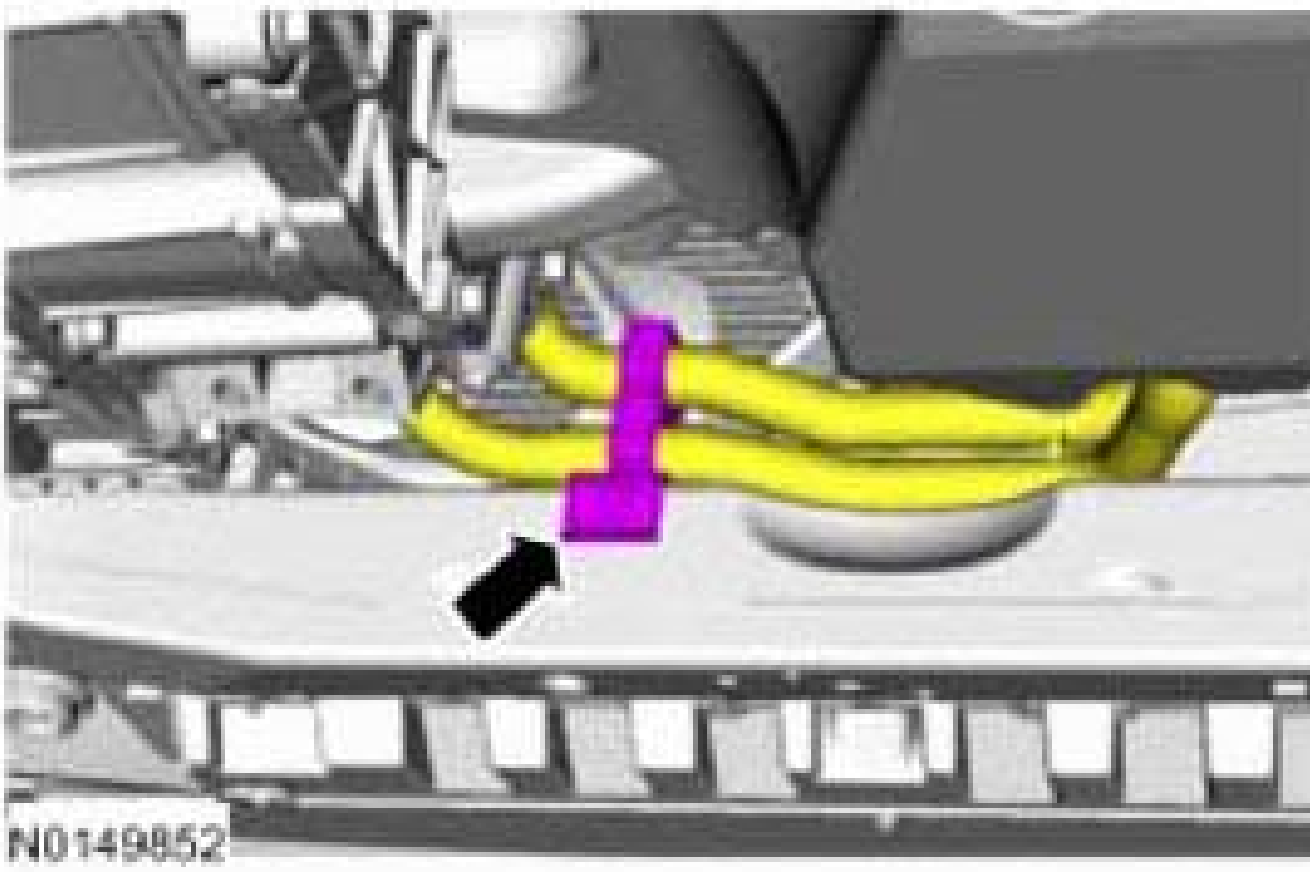
38. If equipped, disconnect the oil cooler coolant hoses.

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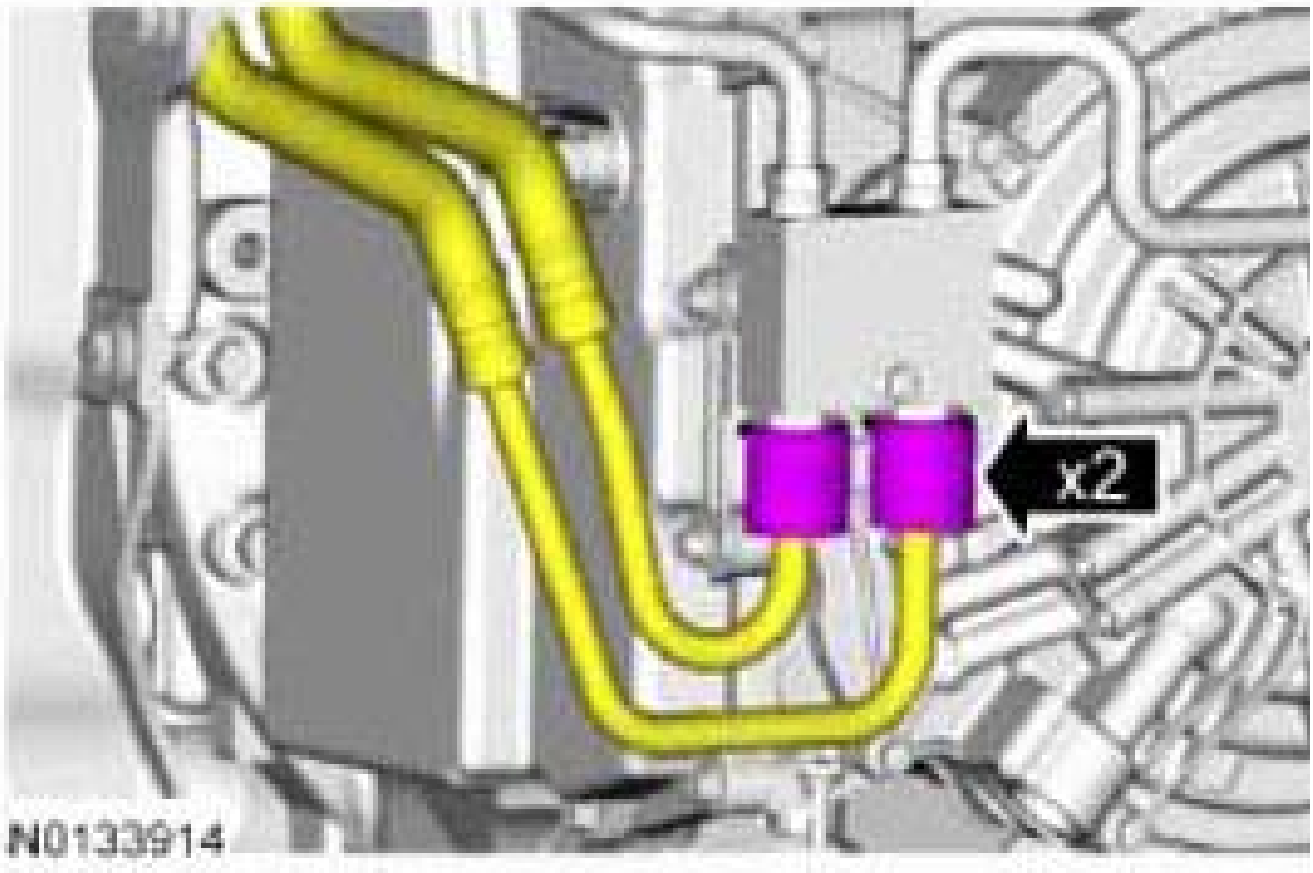
39. If equipped, unlatch the cooler hose retainer latch and pry up on the oil cooler hose retainer to release the retainer and remove it from the subframe.

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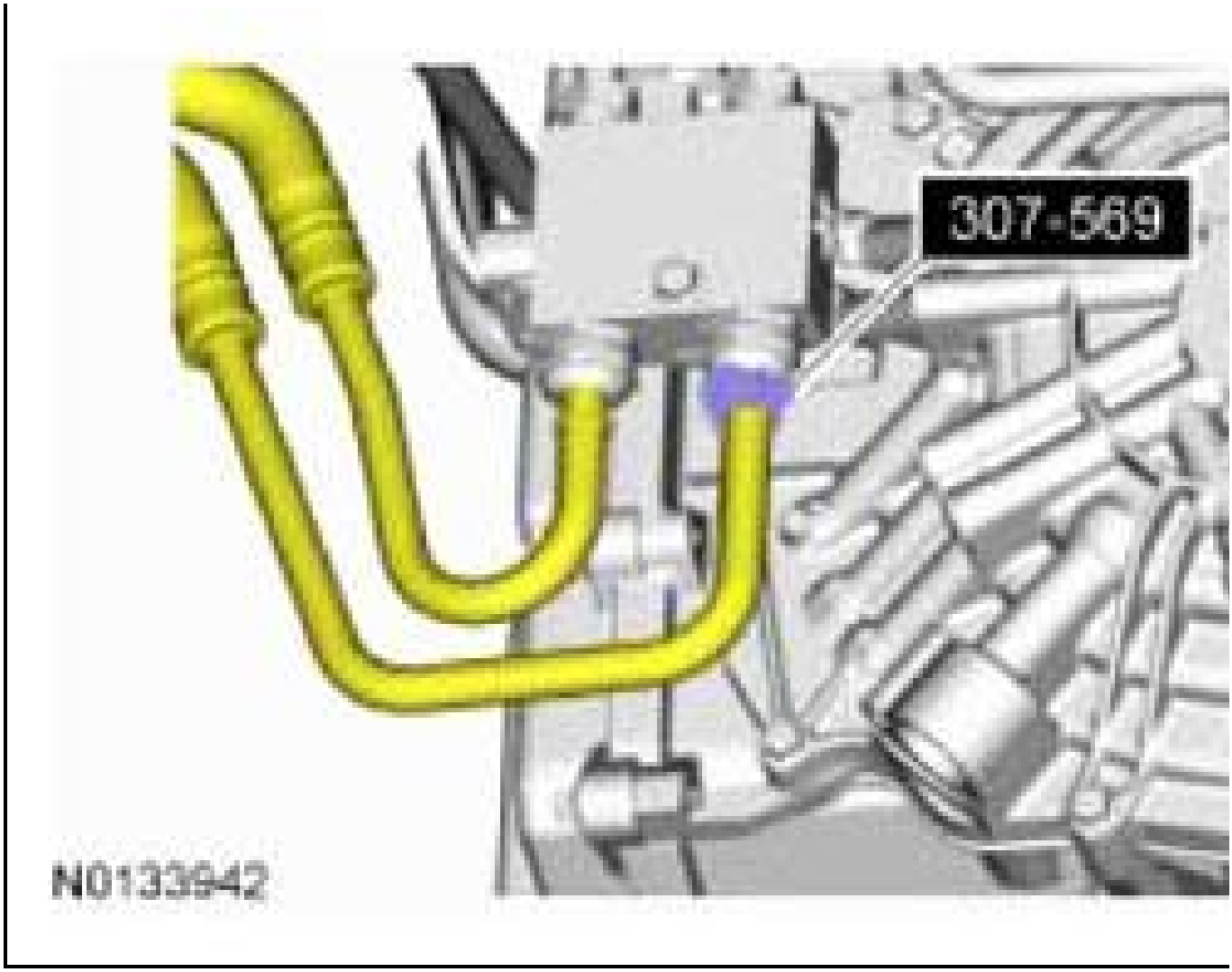
40. Remove the 2 secondary latches from the transmission fluid cooler tubes at the transmission fluid cooler thermal bypass valve.

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41. Using 307-569, disconnect the transmission fluid cooler tubes from the transmission fluid cooler thermal bypass valve.

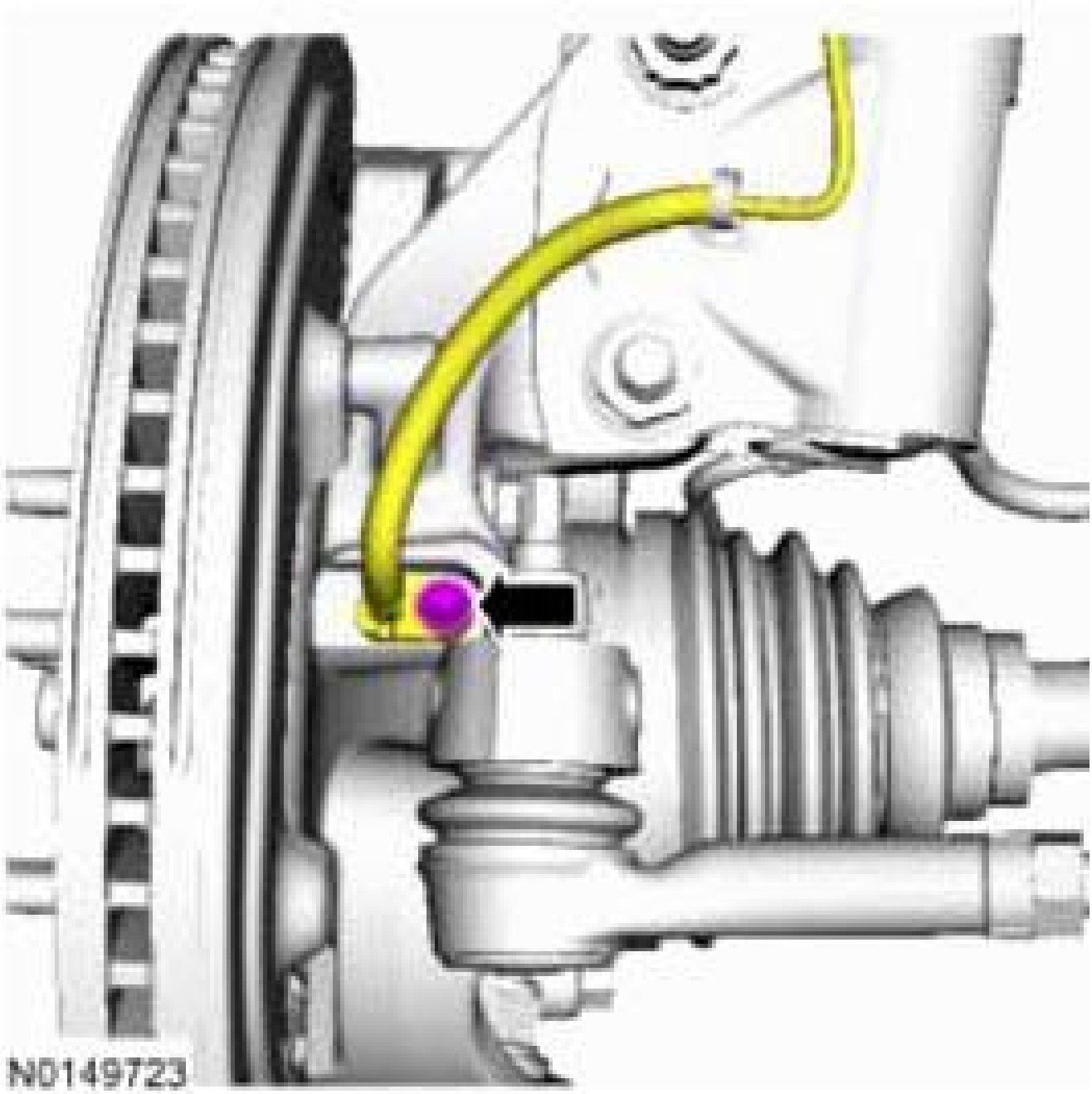
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42. **NOTE: LH shown in illustration, RH similar.**

Remove the bolt and the wheel speed sensor.

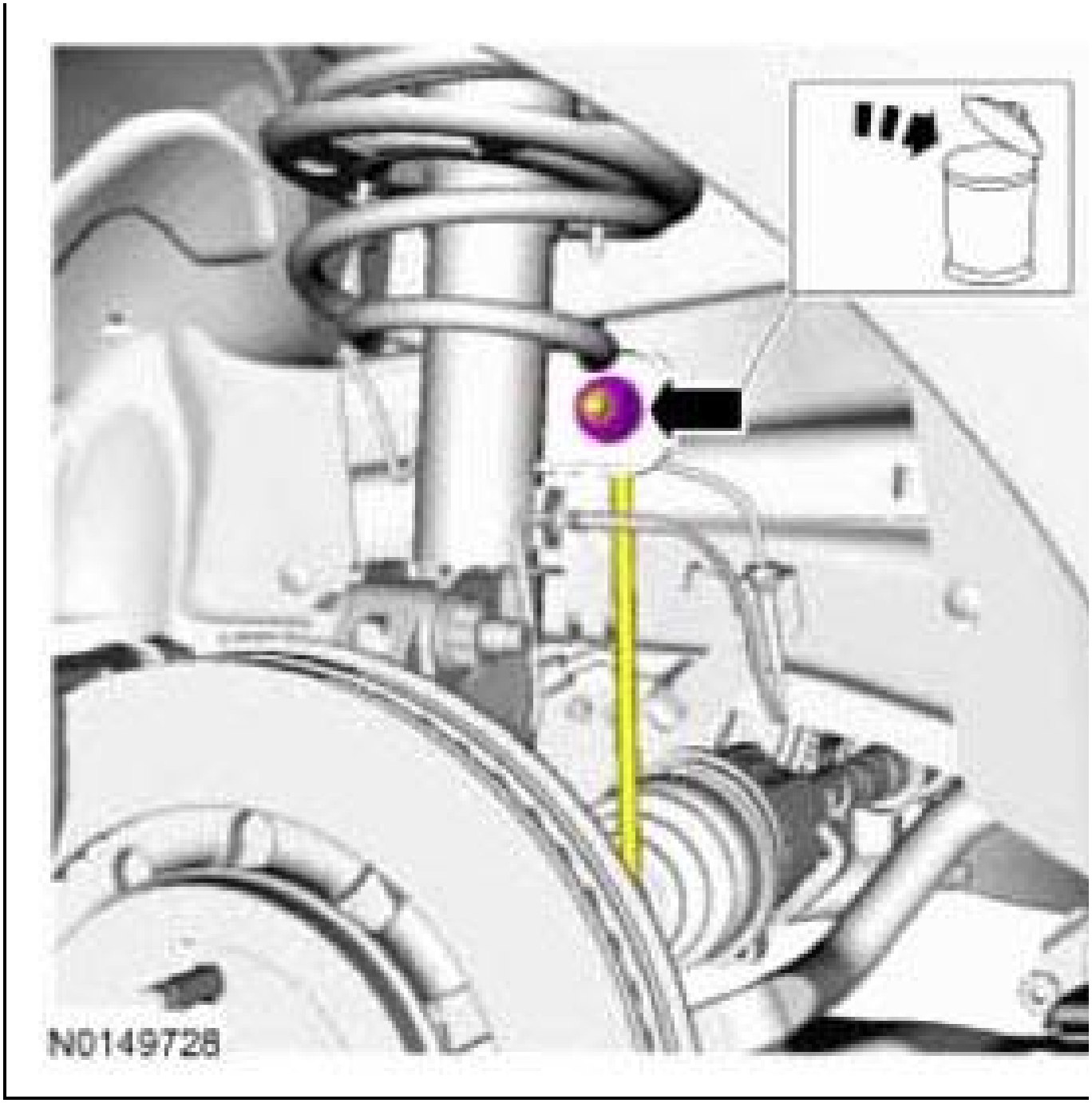
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43. **NOTE: LH shown in illustration, RH similar.**

Remove and discard the upper stabilizer link nut.

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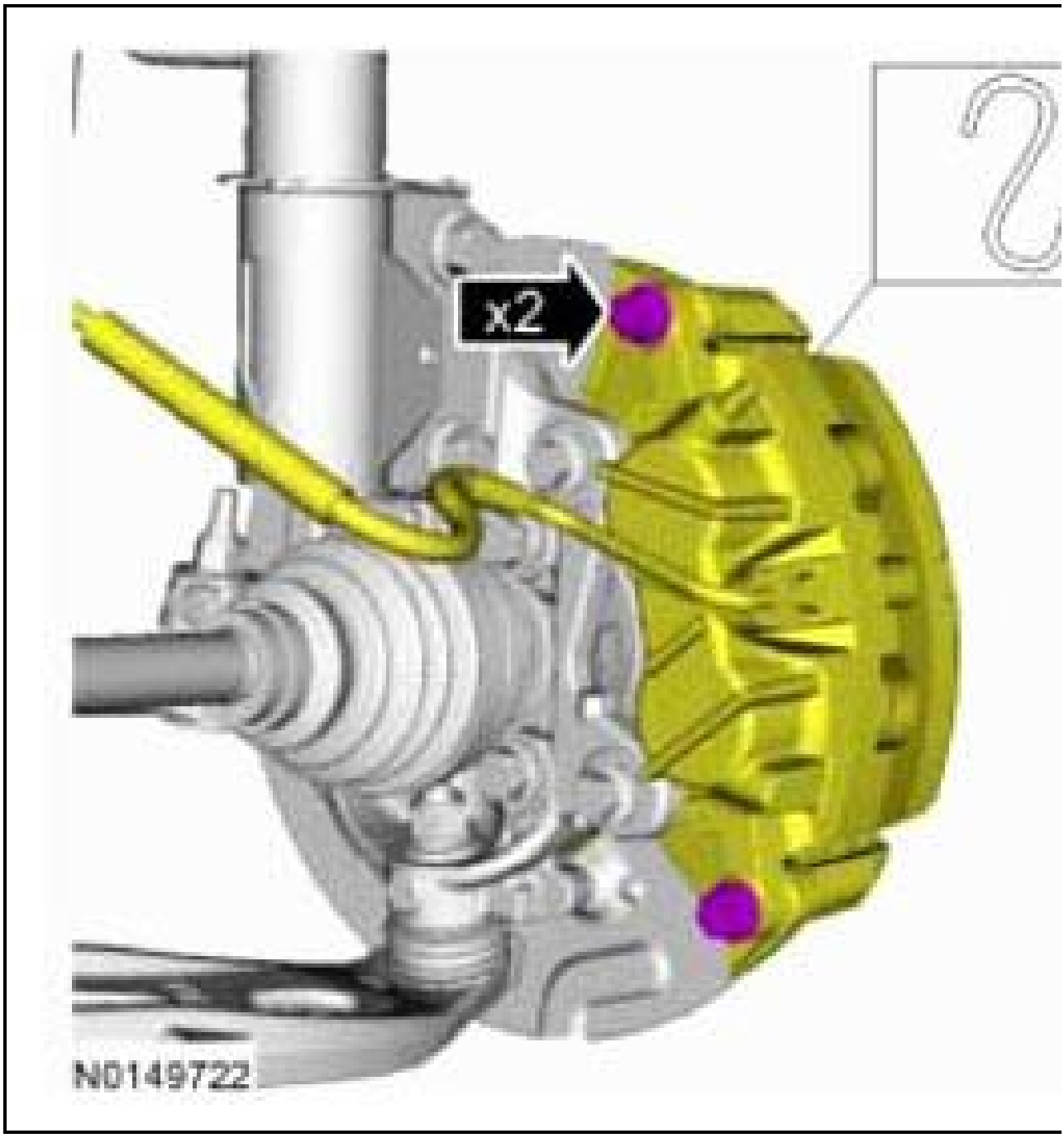
44. **NOTE: Do not allow the brake caliper to hang from the brake flexible hose or damage to the hose may occur.**

NOTE: LH shown in illustration, RH similar.

Remove the brake caliper guide pin bolts and calipers.

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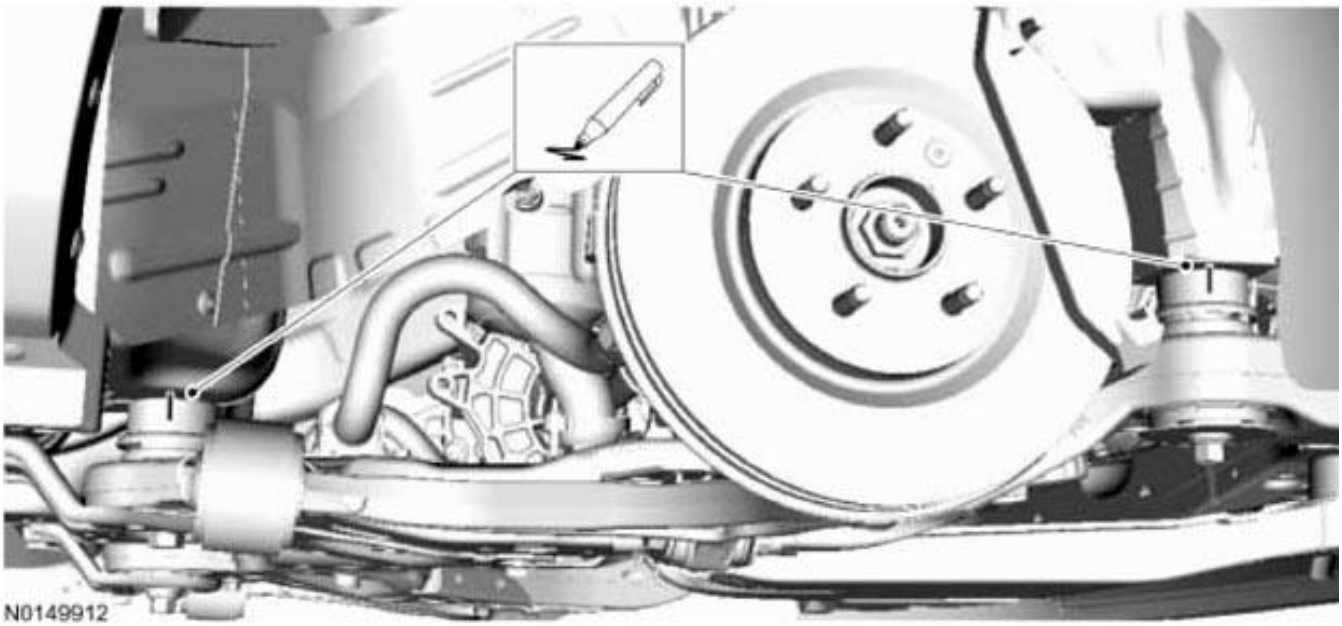
- Support the calipers.



45. **NOTE: RH shown in illustration, LH similar.**

Using a wax pencil, mark the relationship of the front and rear subframe to the underbody at the mounting locations on both side.

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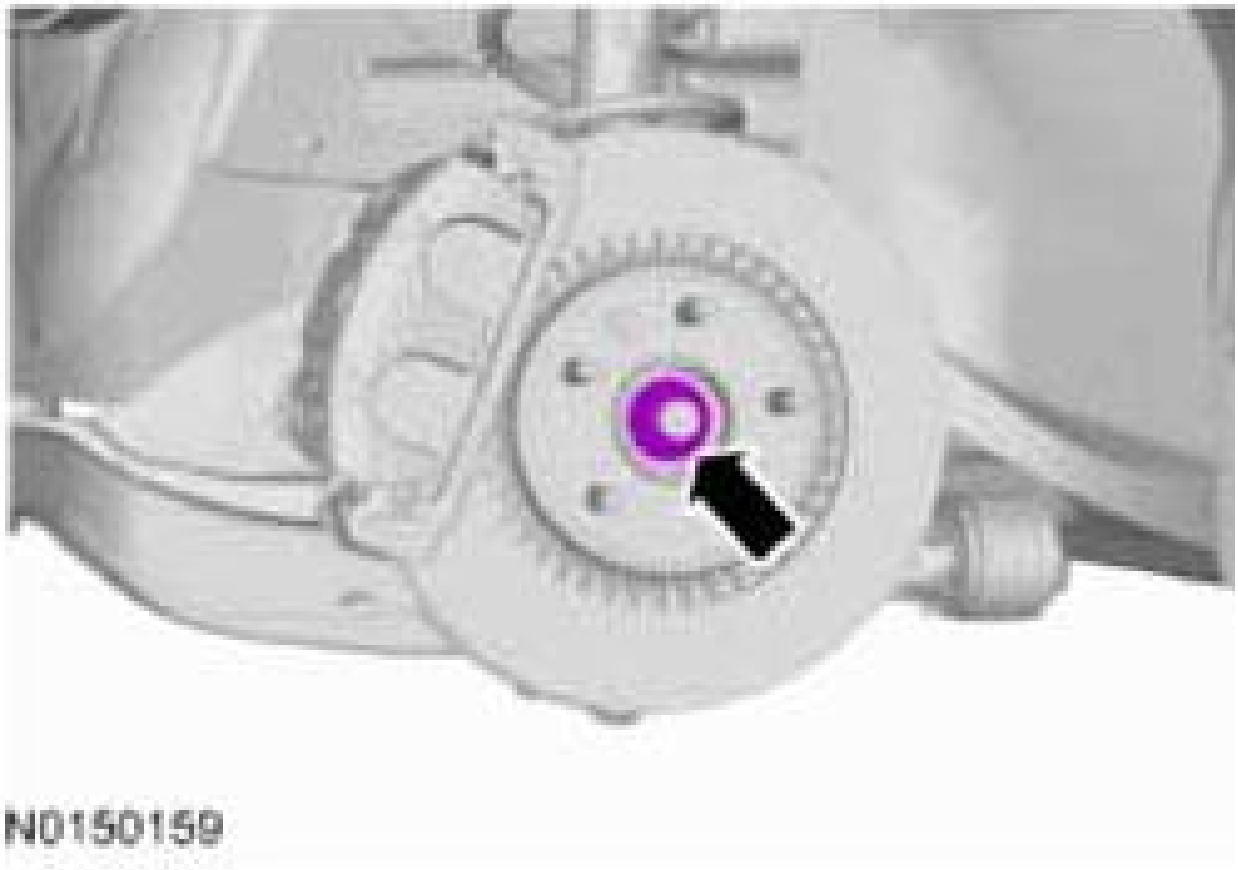


46. **NOTE: LH shown in illustration, RH similar.**

Remove the LH and RH halfshaft nuts.

- Do not discard at this time.

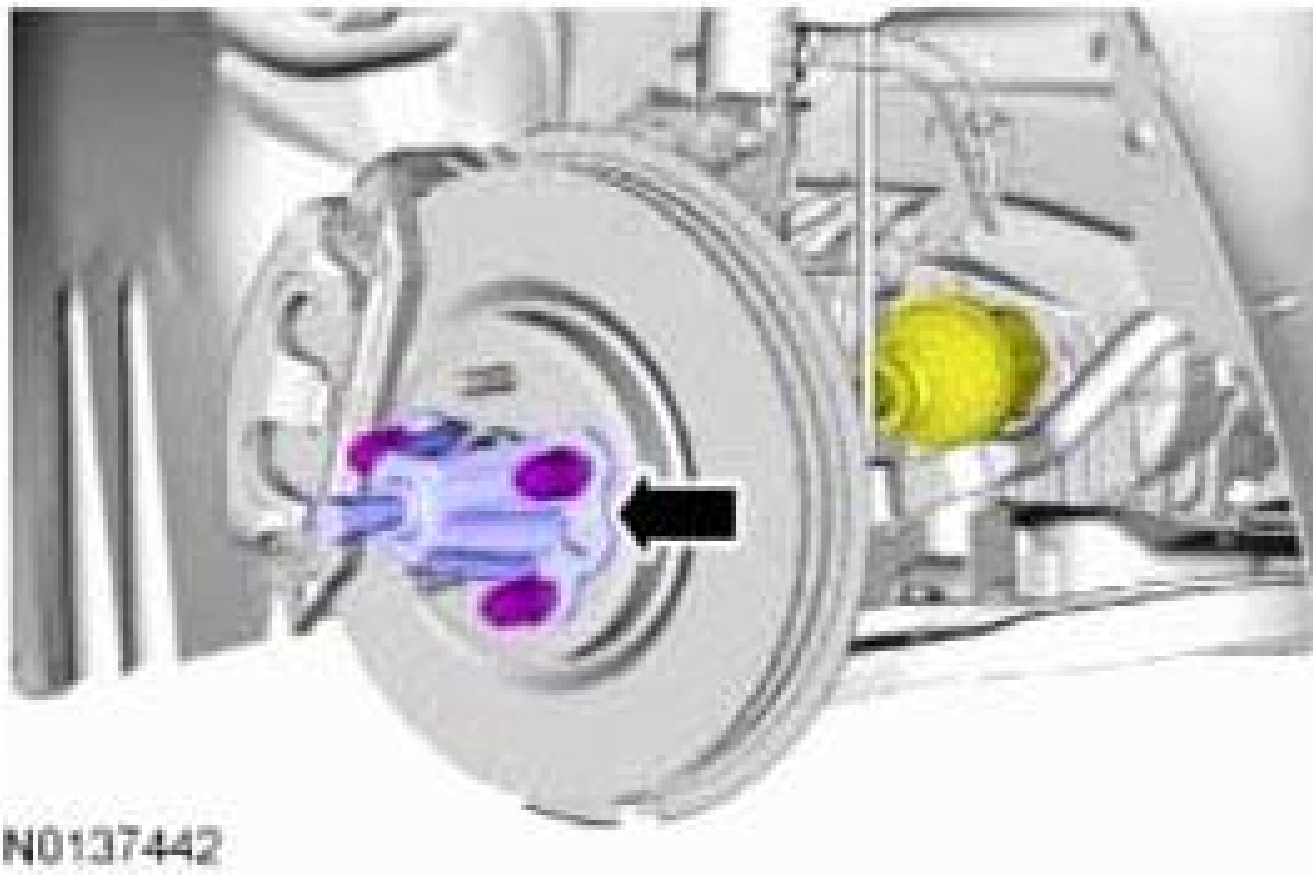
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47. **NOTE: LH shown in illustration, RH similar.**

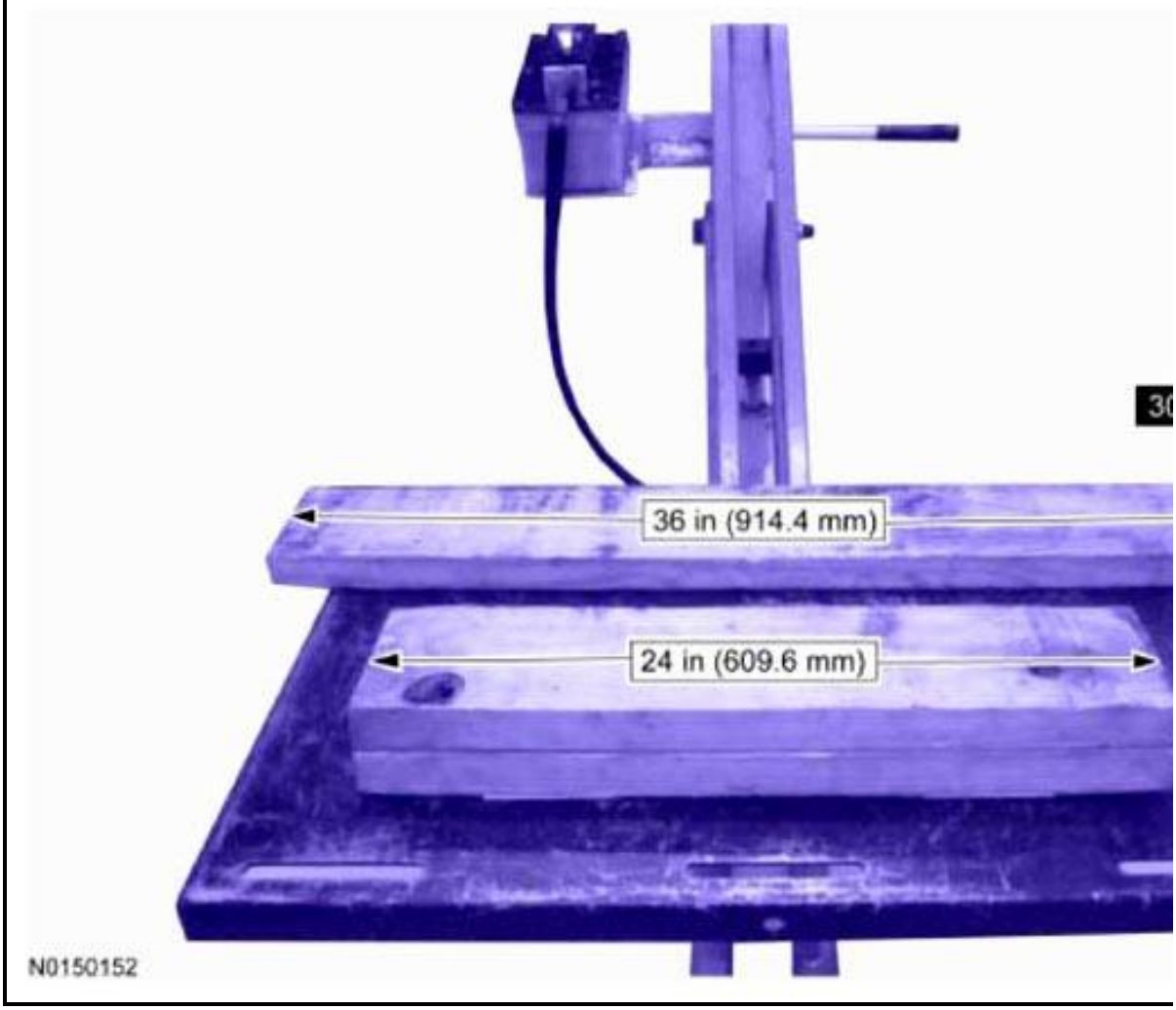
Separate the LH and RH halfshaft from the wheel hubs.

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48. Position a 2 x 6 board, 36 in (914.4 mm) in length and two 2 x 6 boards 24 in (609.6 mm) in length onto the powertrain lift.
    - Position the powertrain lift table with:
        - the long board towards the rear of the subframe.
        - the short boards under the engine and transmission.

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49. Install the Adjustable Grip Arm from the powertrain lift table to the LH engine-to-transmission bolt hole.

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50. Install a ratchet strap from the front of the subframe under the powertrain lift table to the rear of the subframe, to secure the subframe to the powertrain lift table.

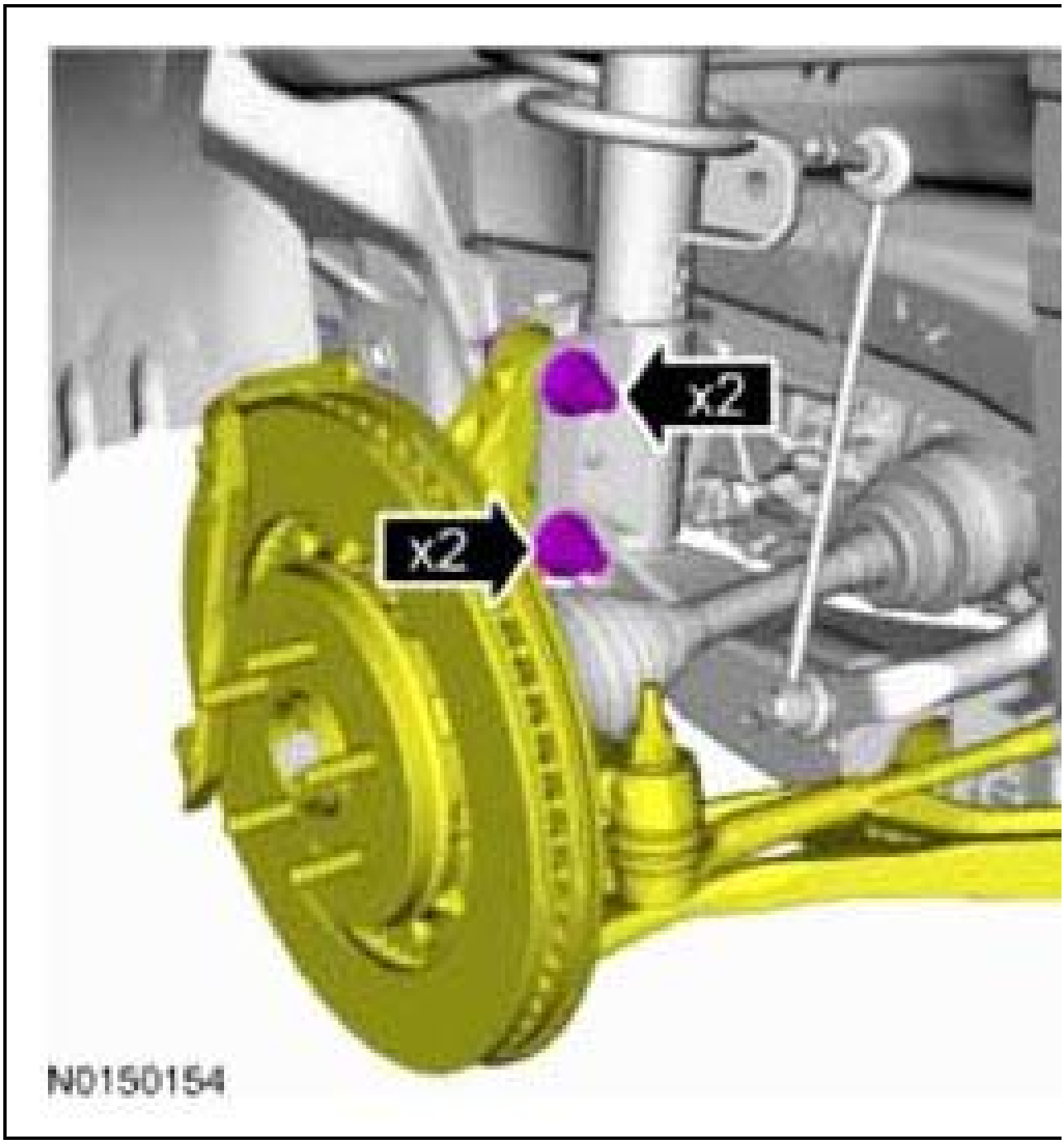
51. **NOTE: LH shown in illustration, RH similar.**

NOTE: The halfshafts are not being remove from the transmission.

Remove the strut-to-wheel knuckle nuts and bolts.

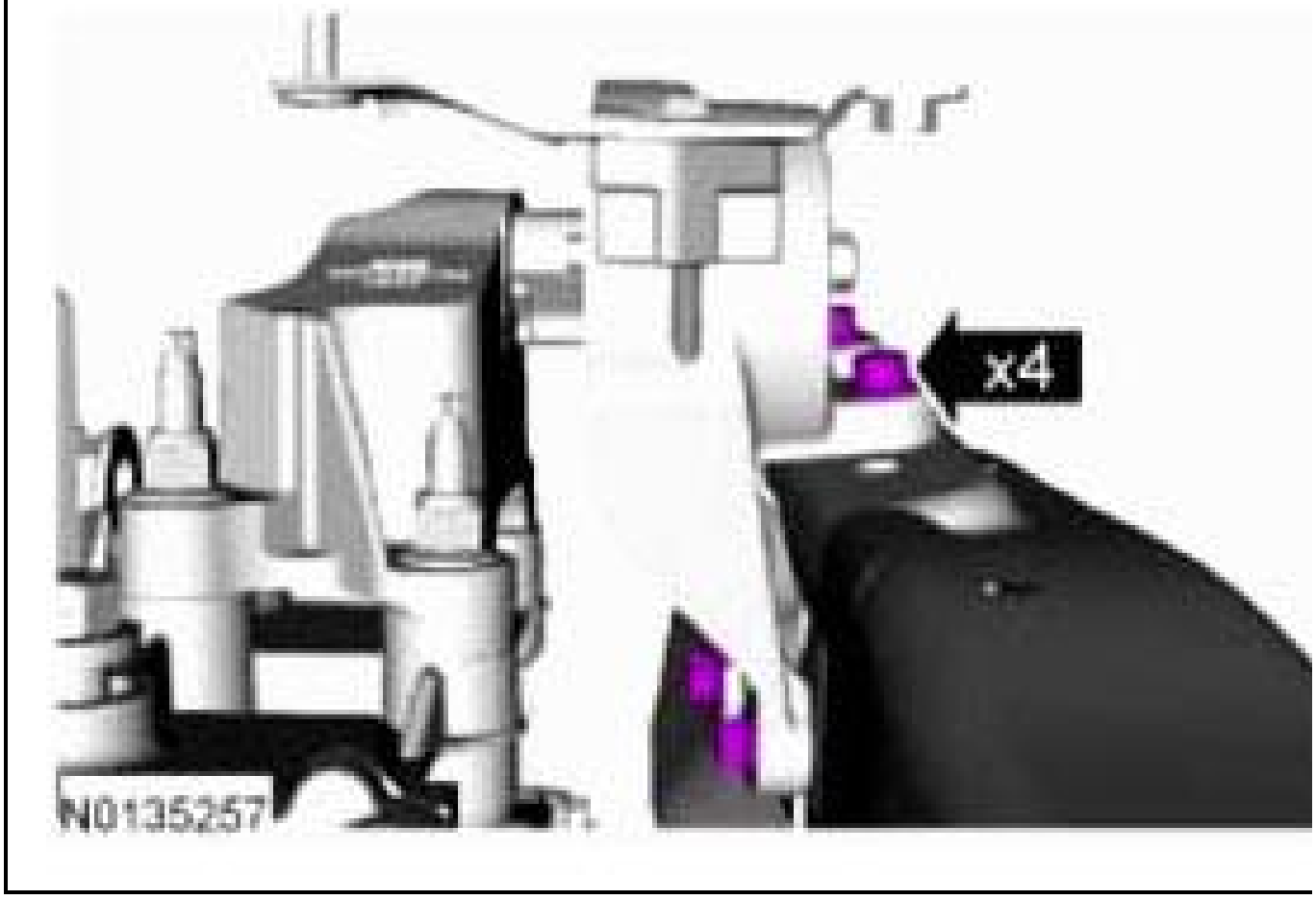
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- Remove the strut from the wheel knuckle and the halfshafts from the wheel knuckle.



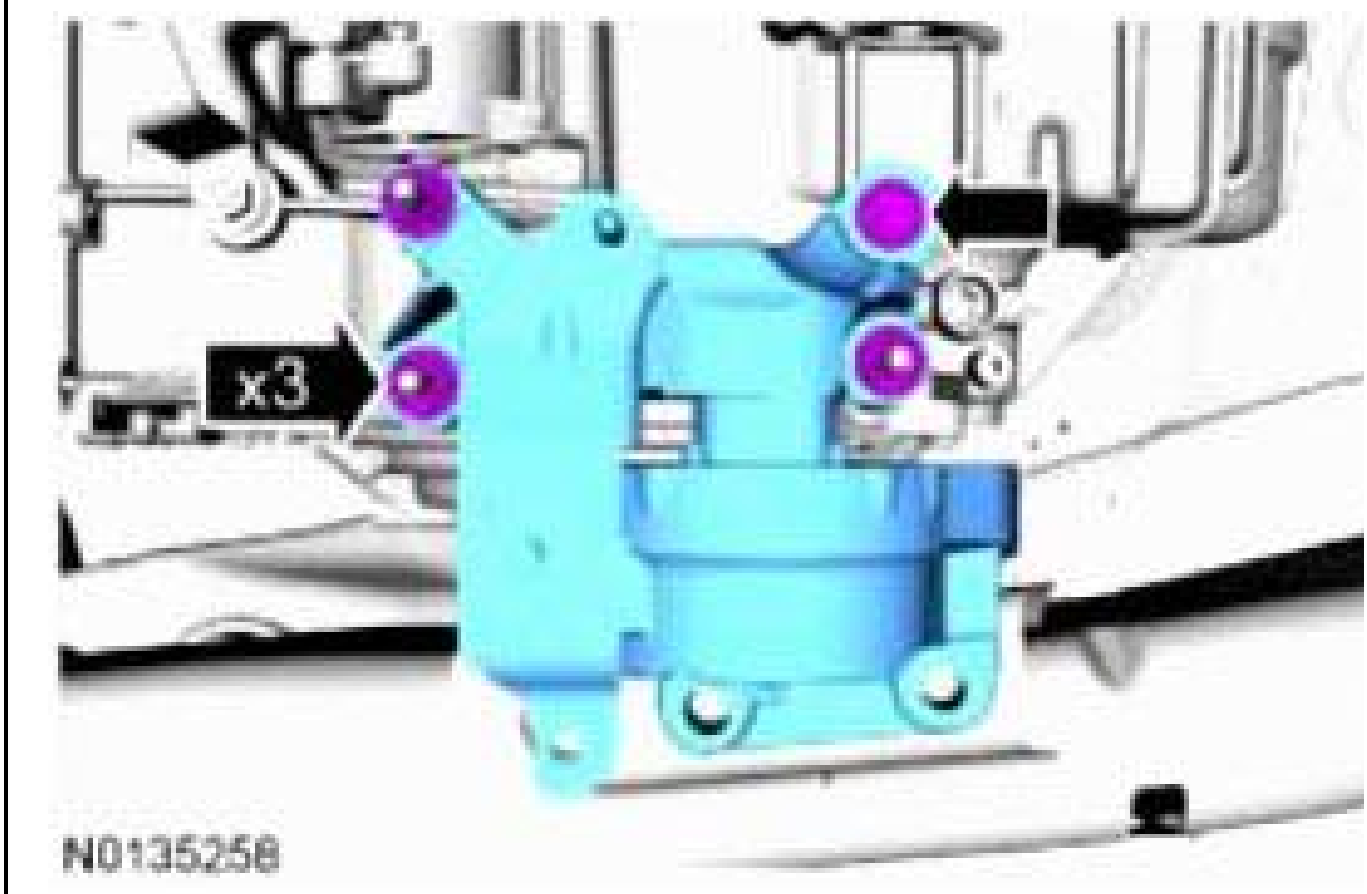
52. Remove the 4 transmission support insulator-to-frame rail bolts.

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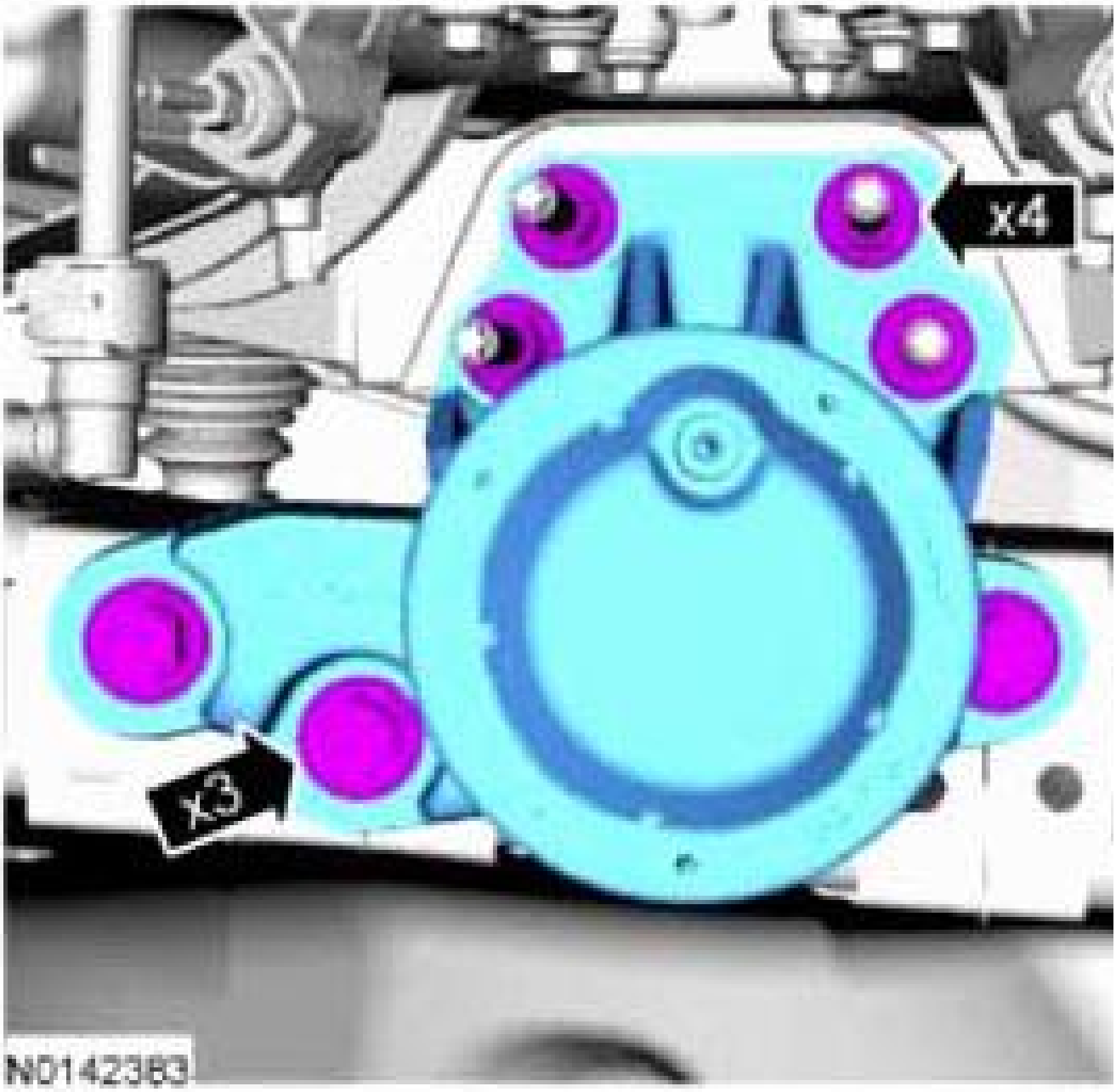
53. Remove the 3 nuts, the bolt and the transaxle support insulator assembly.

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54. Remove the 4 engine mount nuts, the 3 engine mount bolts and the engine mount.

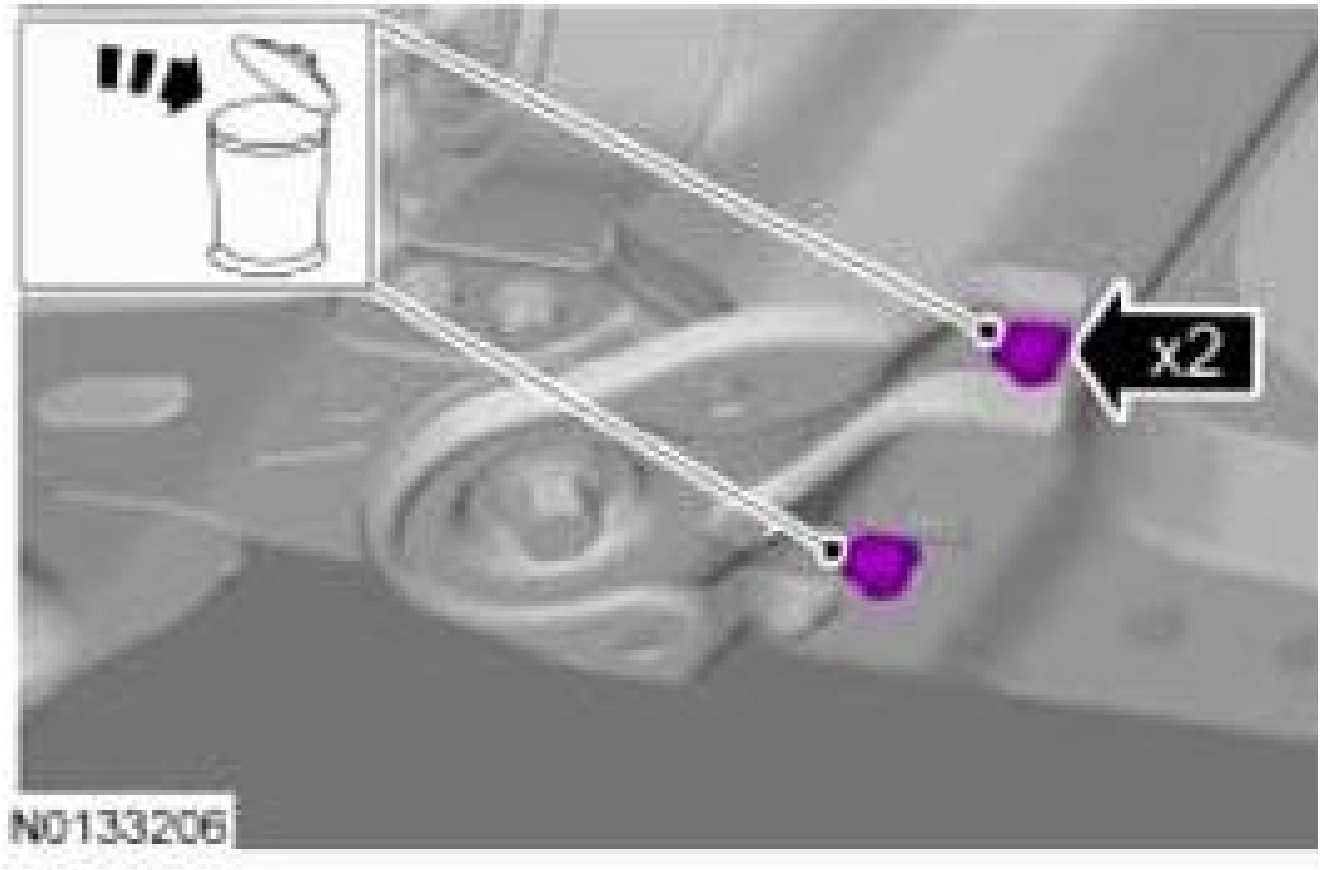
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55. **NOTE: RH shown in illustration, LH similar.**

Remove the subframe bracket-to-body bolts.

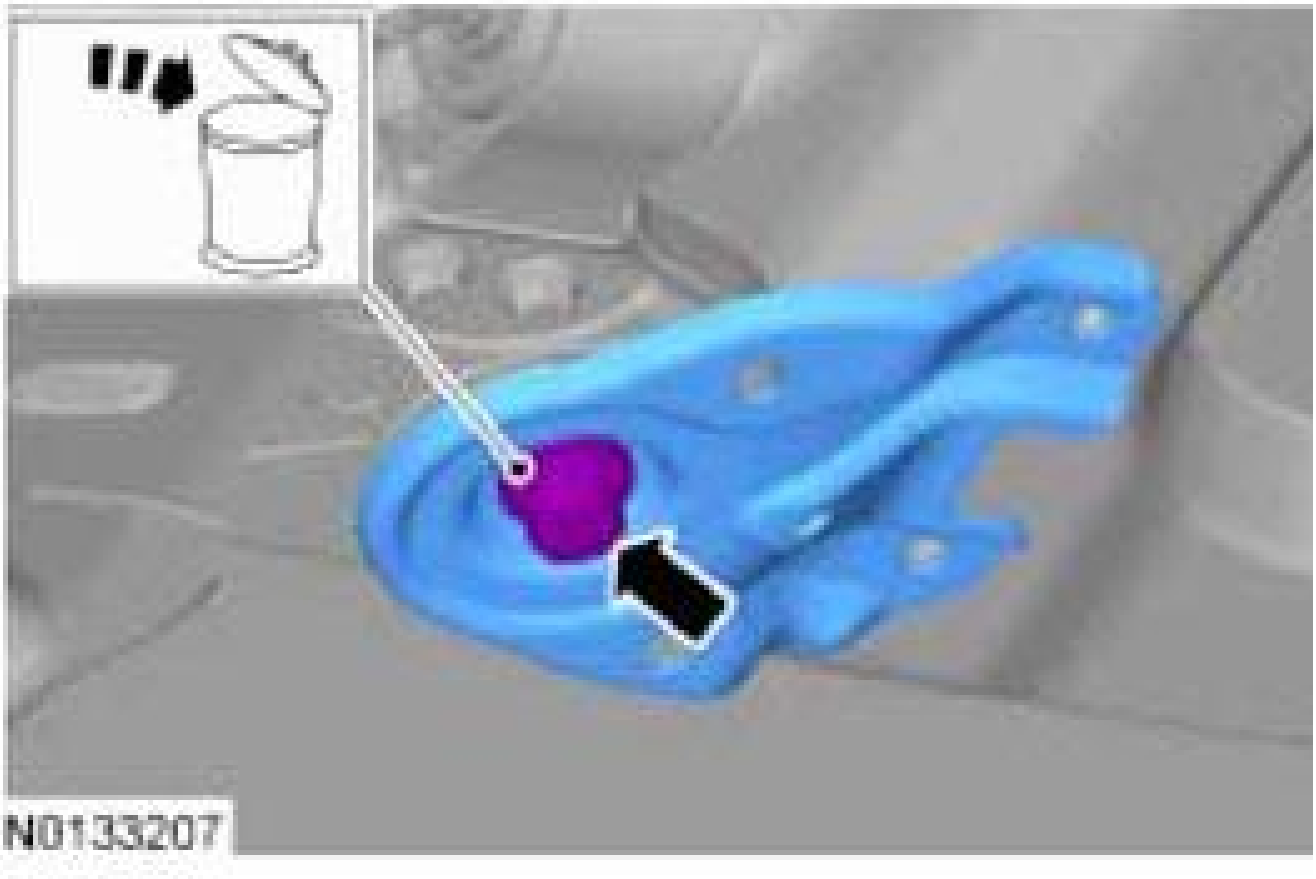
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56. **NOTE: RH shown in illustration, LH similar.**

Remove the rear subframe bolts and the subframe brackets.

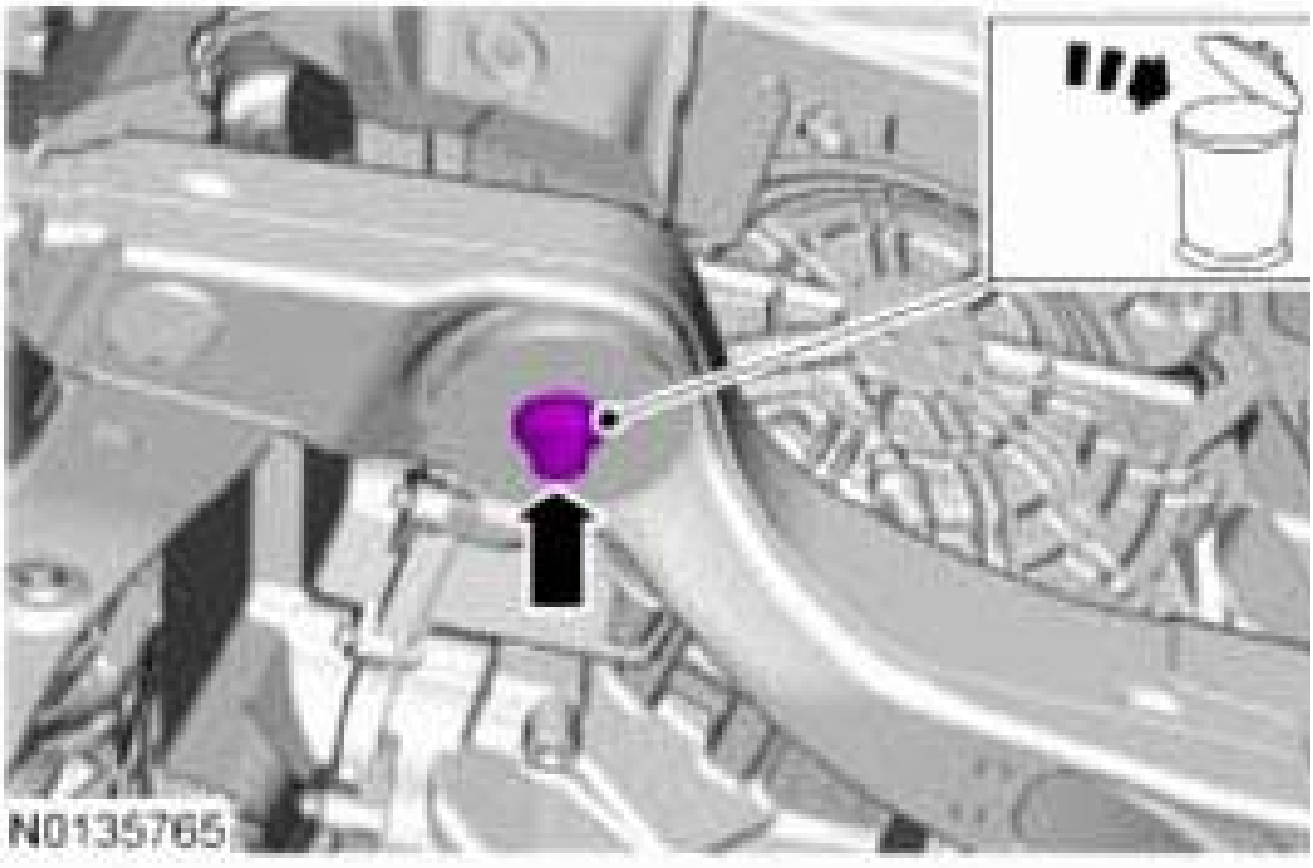
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57. **NOTE: RH shown in illustration, LH similar.**

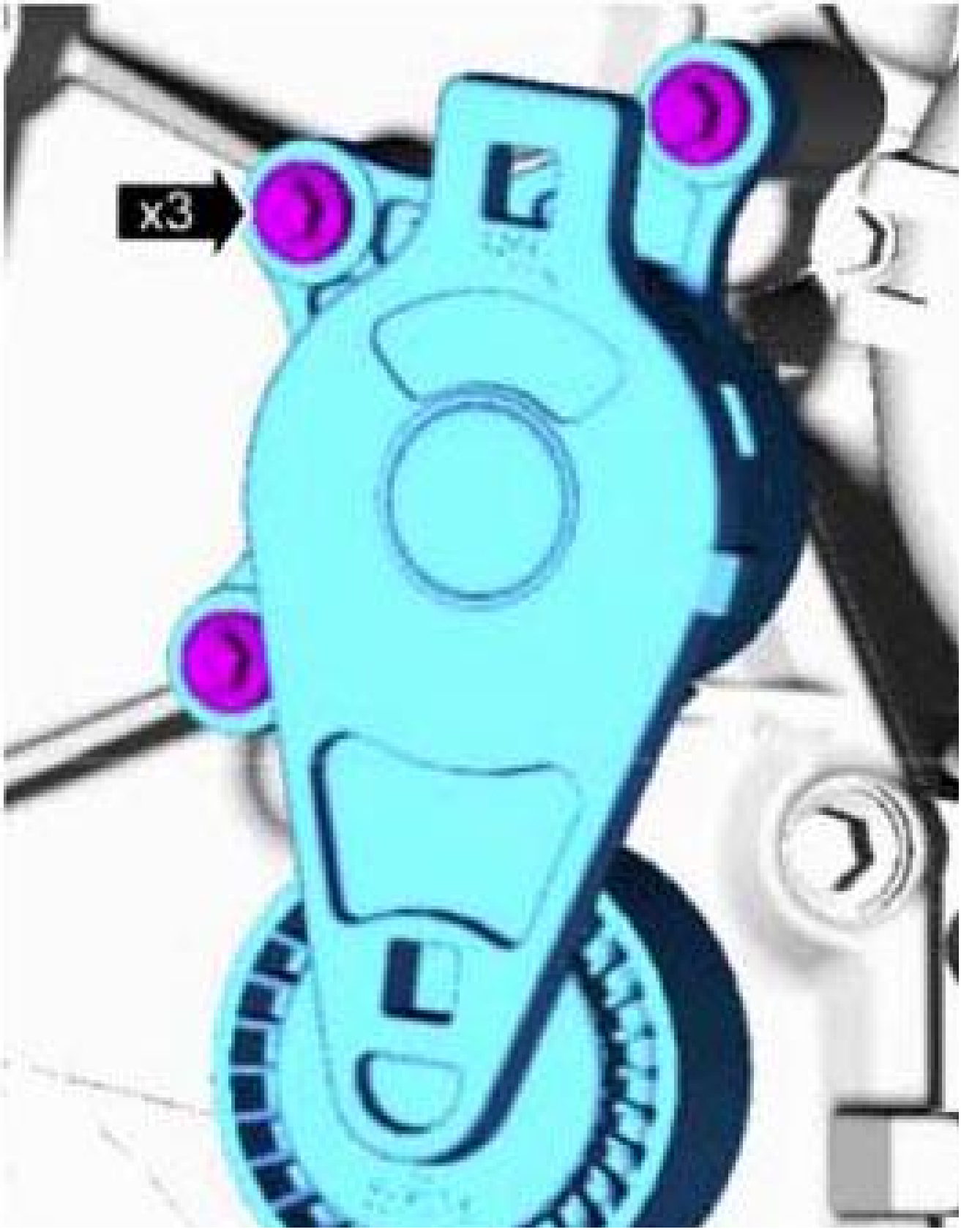
Remove the front subframe bolts.

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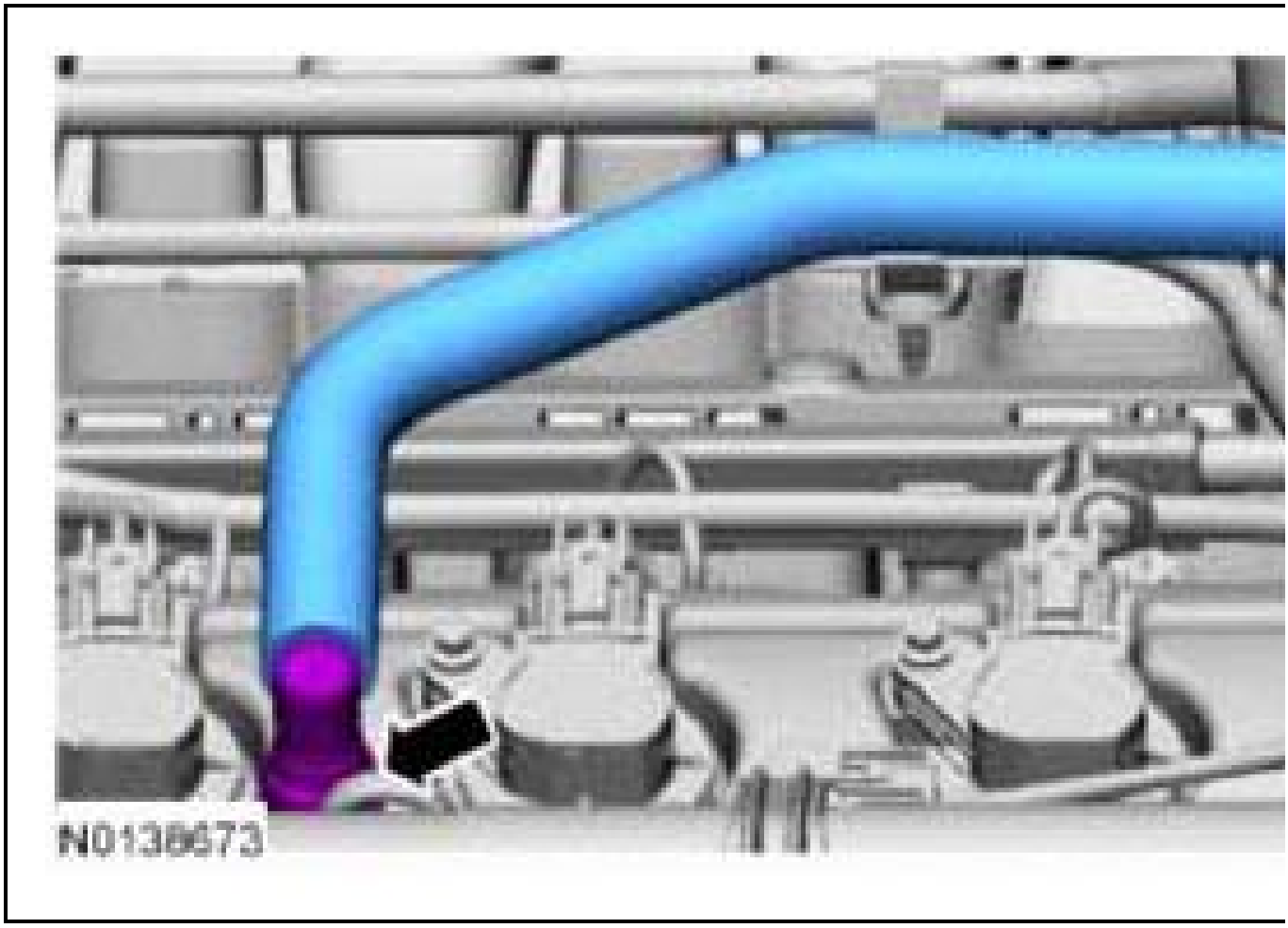
58. Lower the subframe and powertrain assembly from the vehicle.
59. Remove the 3 bolts and the accessory drive belt tensioner.

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60. Remove the crankshaft front seal. Refer to **CRANKSHAFT FRONT SEAL**.
61. Remove the crankcase vent tube. REFER to **QUICK CONNECT COUPLING** .

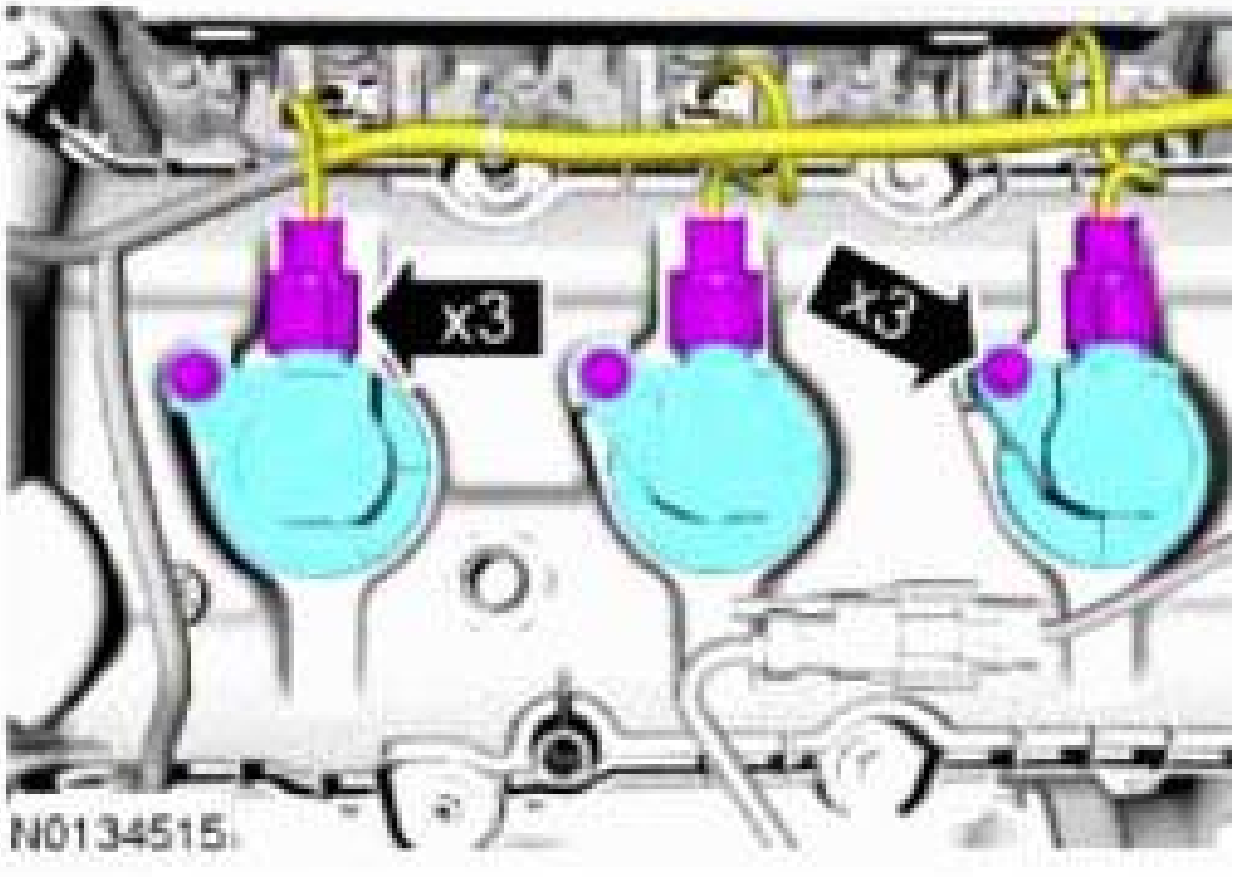


62. **NOTE: When removing the ignition coil-on-plugs, a slight twisting motion will break the seal and ease removal.**

Disconnect the 3 LH coil-on-plug electrical connectors and remove the 3 bolts and the 3 LH coil-on-plugs.

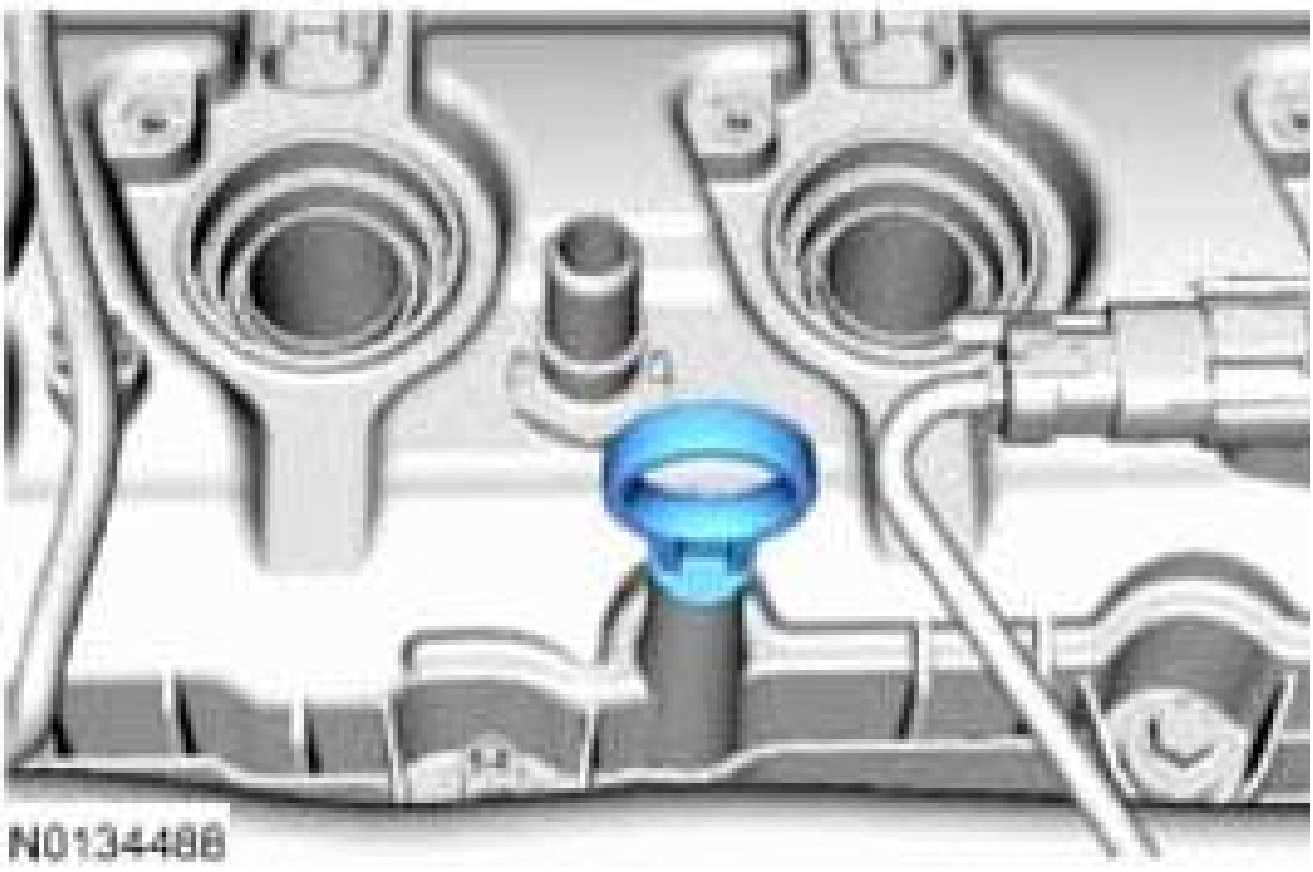
- Inspect the coil seals for rips, nicks or tears. Remove and discard any damaged coil seals.

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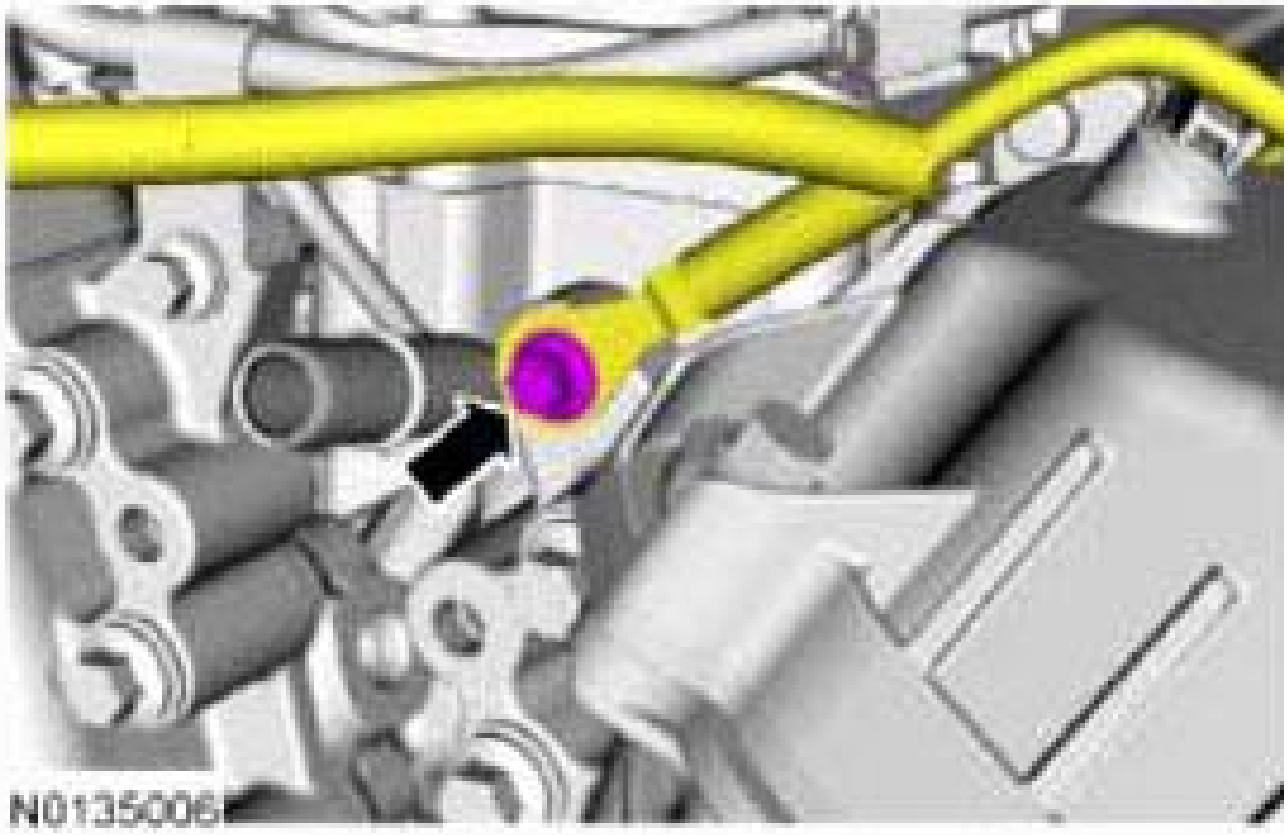
63. Remove the oil level indicator.

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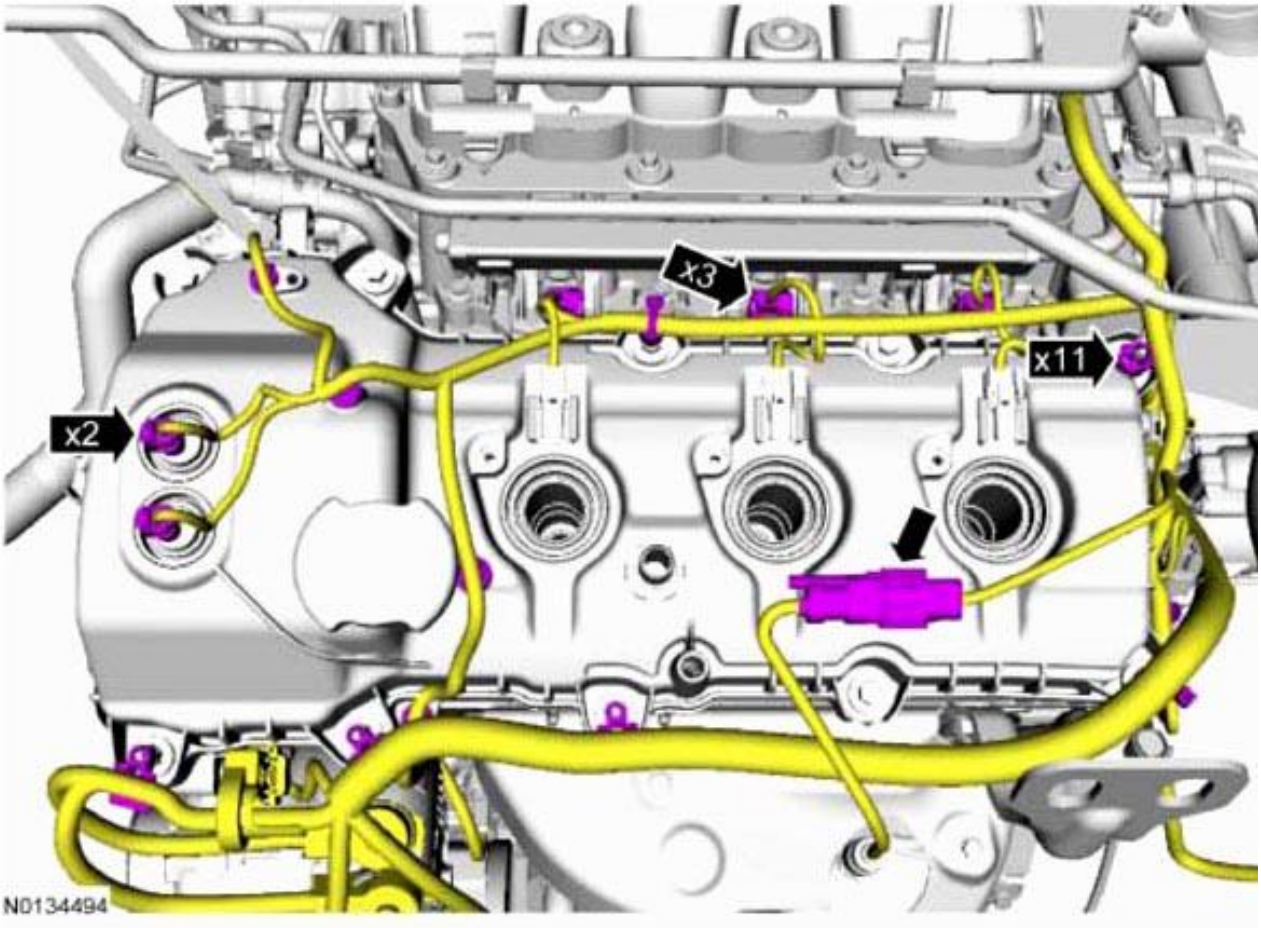
64. Remove the ground wire bolt from the engine front cover.

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65. Remove the engine wiring harness from the LH valve cover.
    - Disconnect the 2 **VCT** oil control solenoid electrical connectors.
    - Detach and disconnect the LH **HO2S** electrical connector.
    - Disconnect the 3 fuel injector electrical connectors.
    - Detach the 11 wiring harness retainers from the LH valve cover and stud bolts and position the harness aside.

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66.

NOTE: When removing valve cover do not apply excessive force to the VCT oil control solenoid.

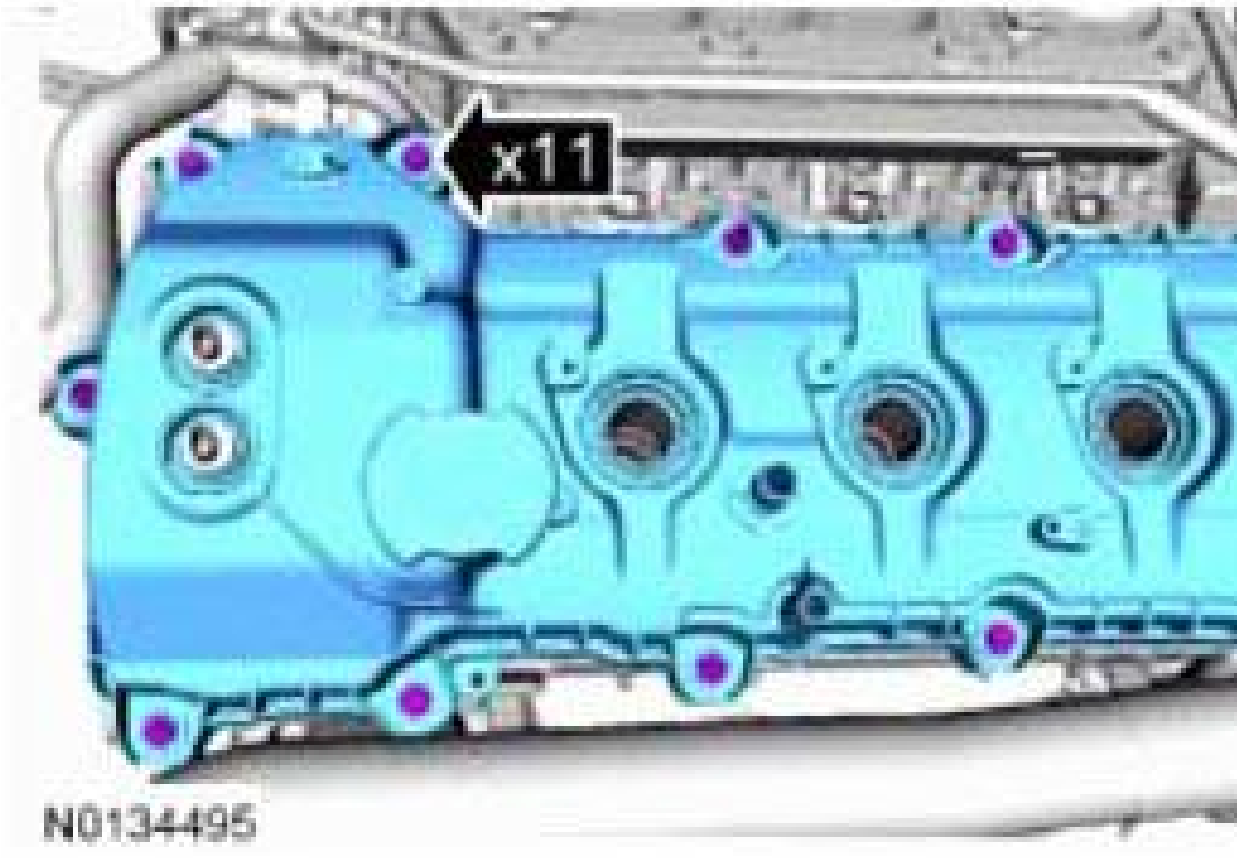
NOTE: If the VCT solenoid seal sticks to the VCT oil control solenoid, then carefully wiggle the valve cover until the bond breaks free.

NOTE: The plastic electrical connector on the VCT oil control solenoid will rotate approximately 12 degrees inside the steel housing, which is normal.

Loosen the 4 bolts and 7 stud bolts and remove the LH valve cover.

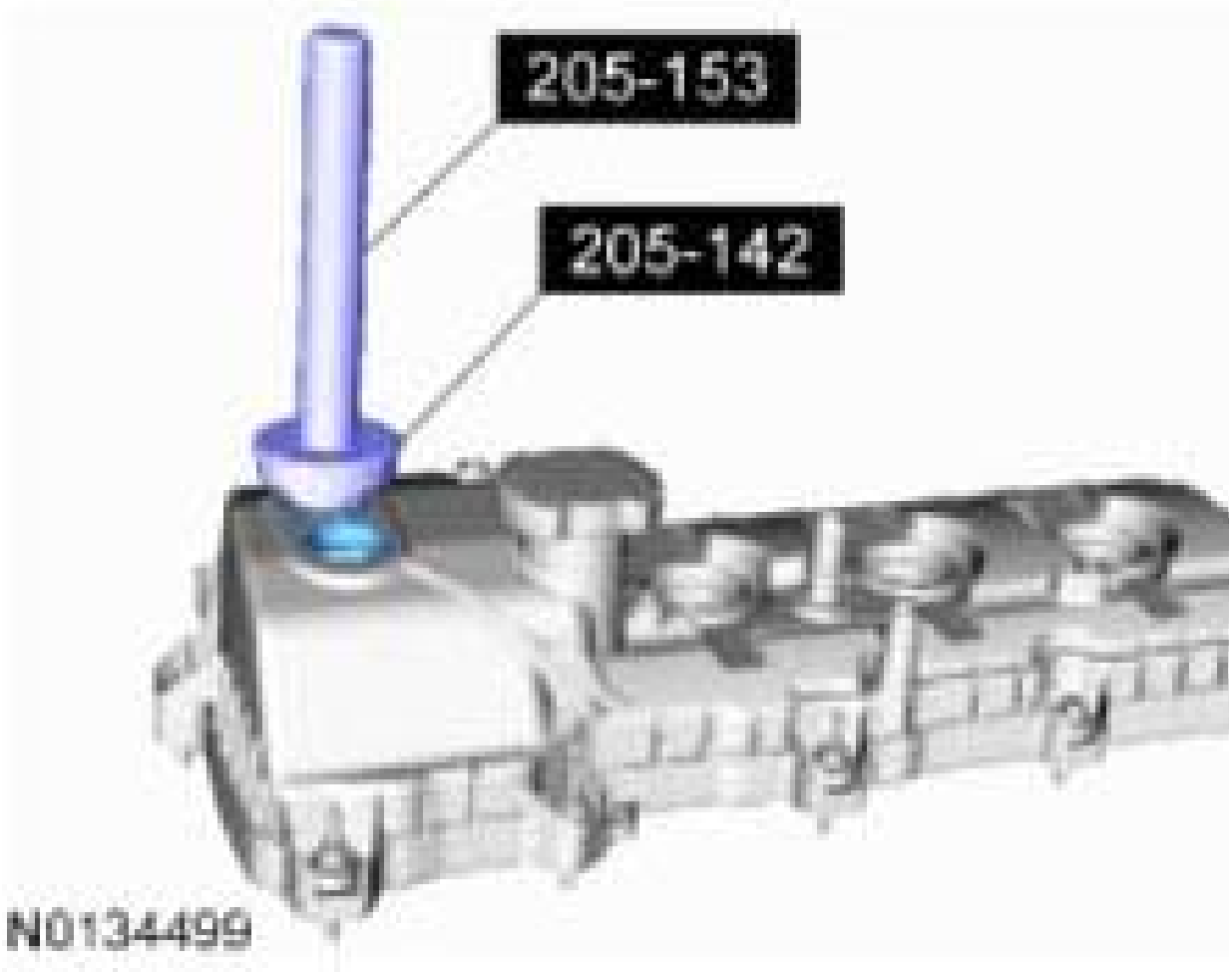
- Discard the gasket.

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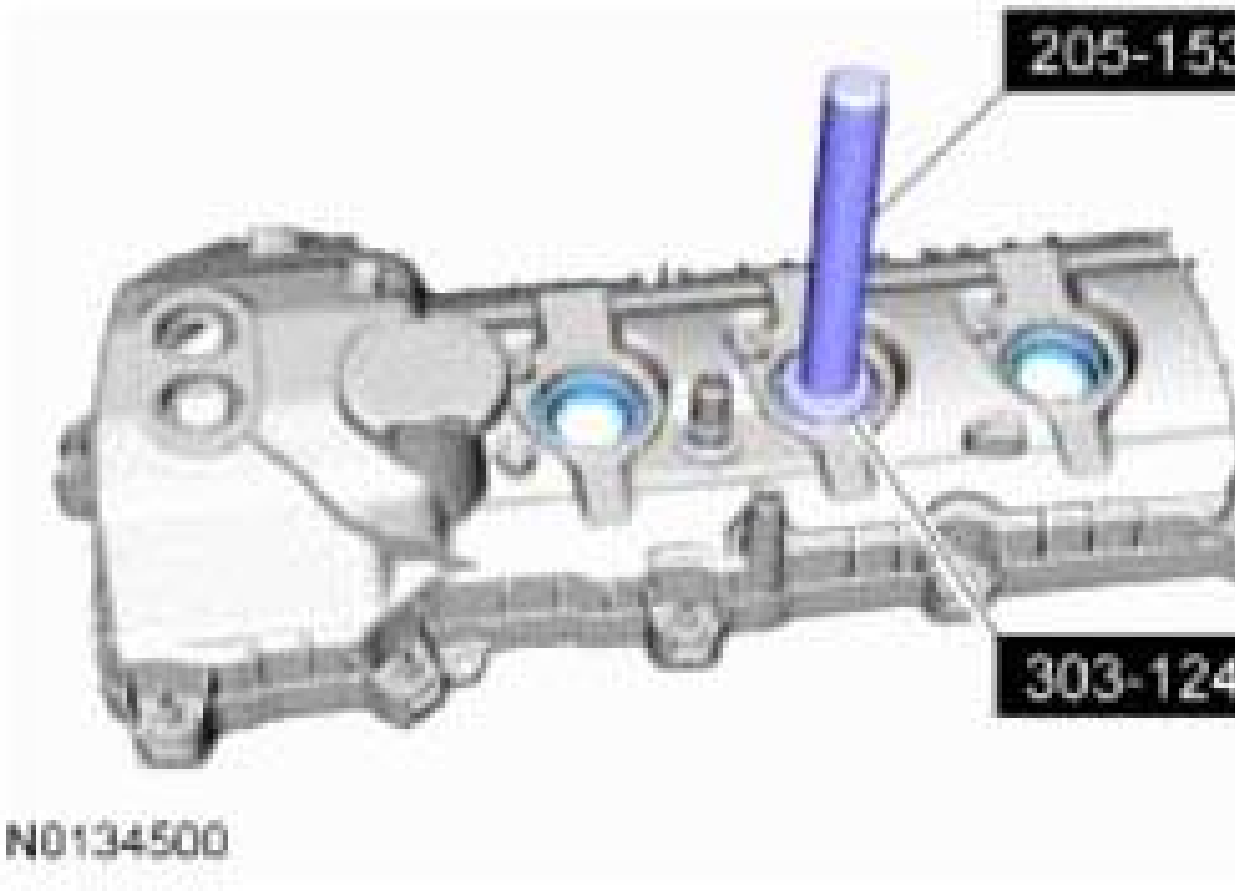
67. Inspect the 2 **VCT** solenoid seals. Remove any damaged seals.
    - Using 205-142 T80T-4000-J and 205-153 T80T-4000-W remove and discard the damaged seal(s).

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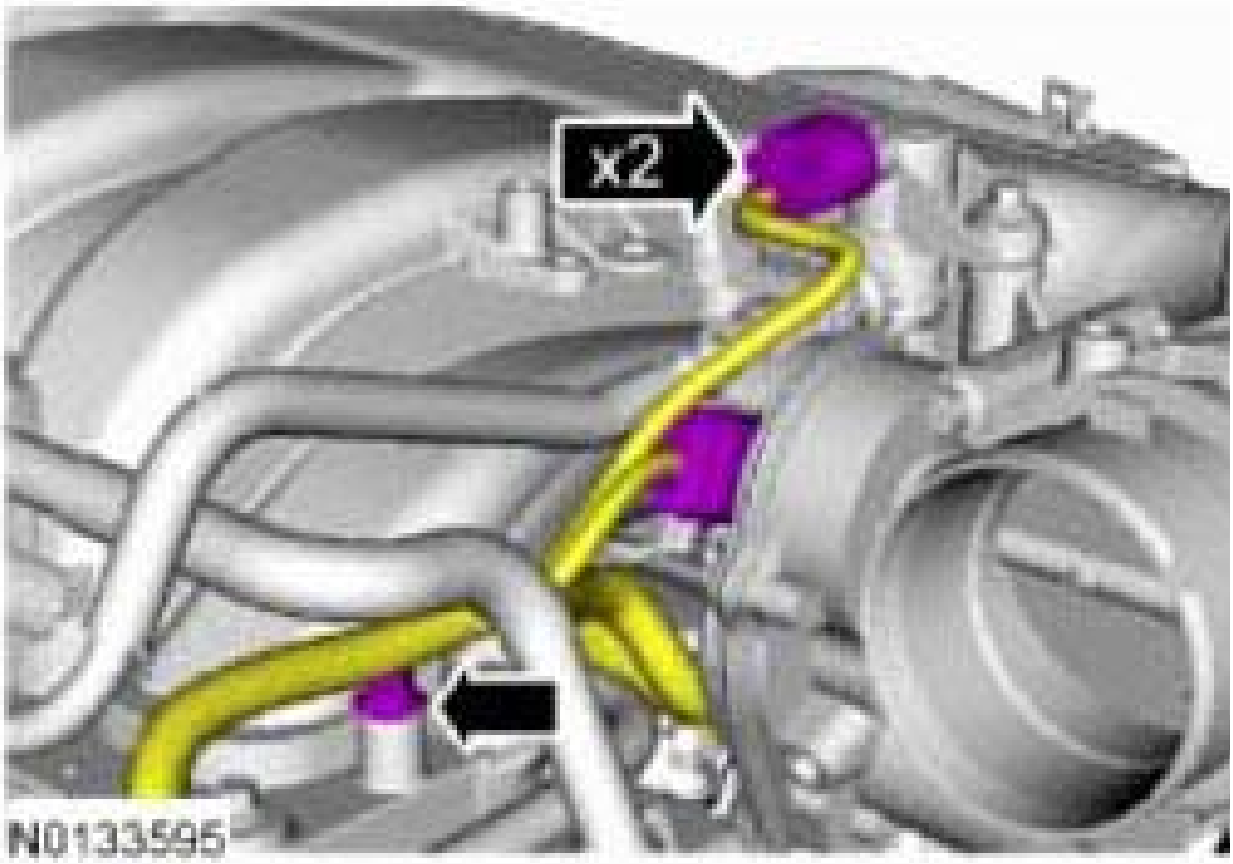
68. Inspect the spark plug tube seals. Remove any damaged seals.
    - Using 303-1247/1 and 205-153 T80T-4000-W remove and discard the damaged seal(s).

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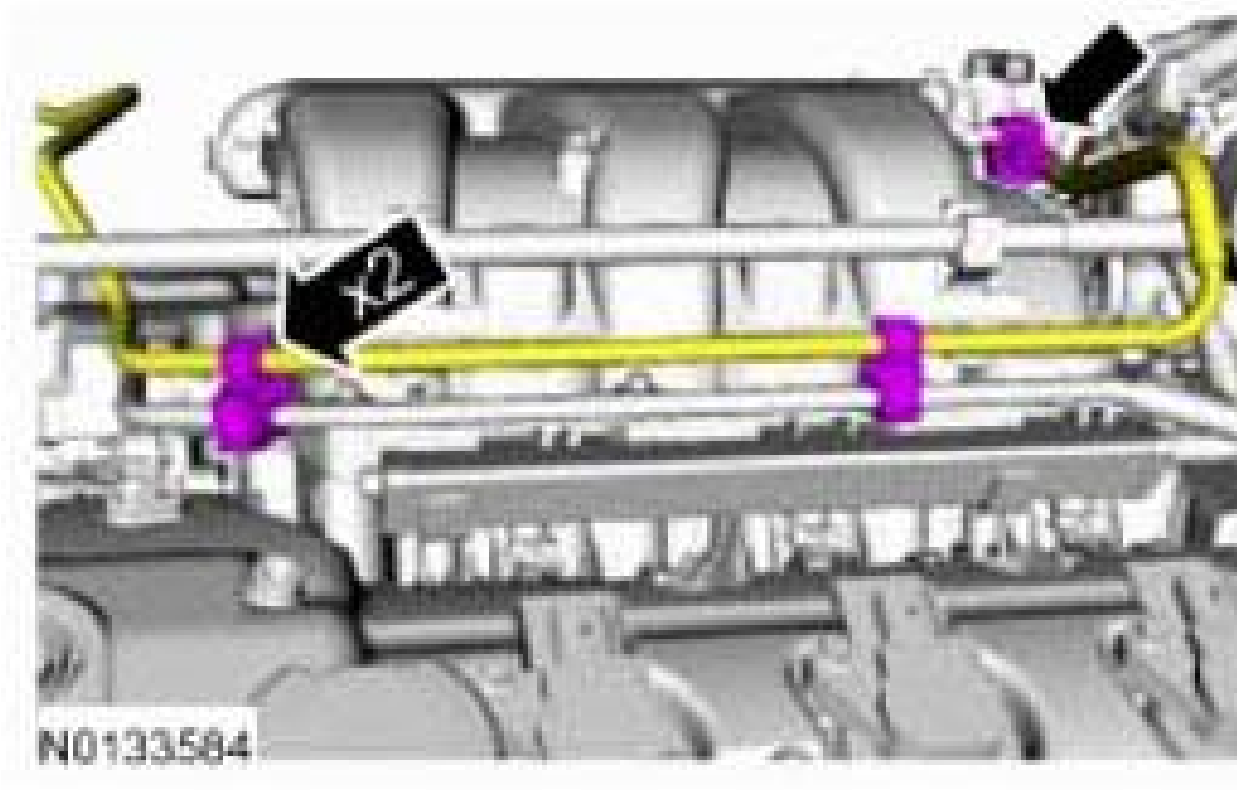
69. Disconnect the **EVAP** canister purge valve and throttle body electrical connectors.
    - Detach the wiring harness pin-type retainer.

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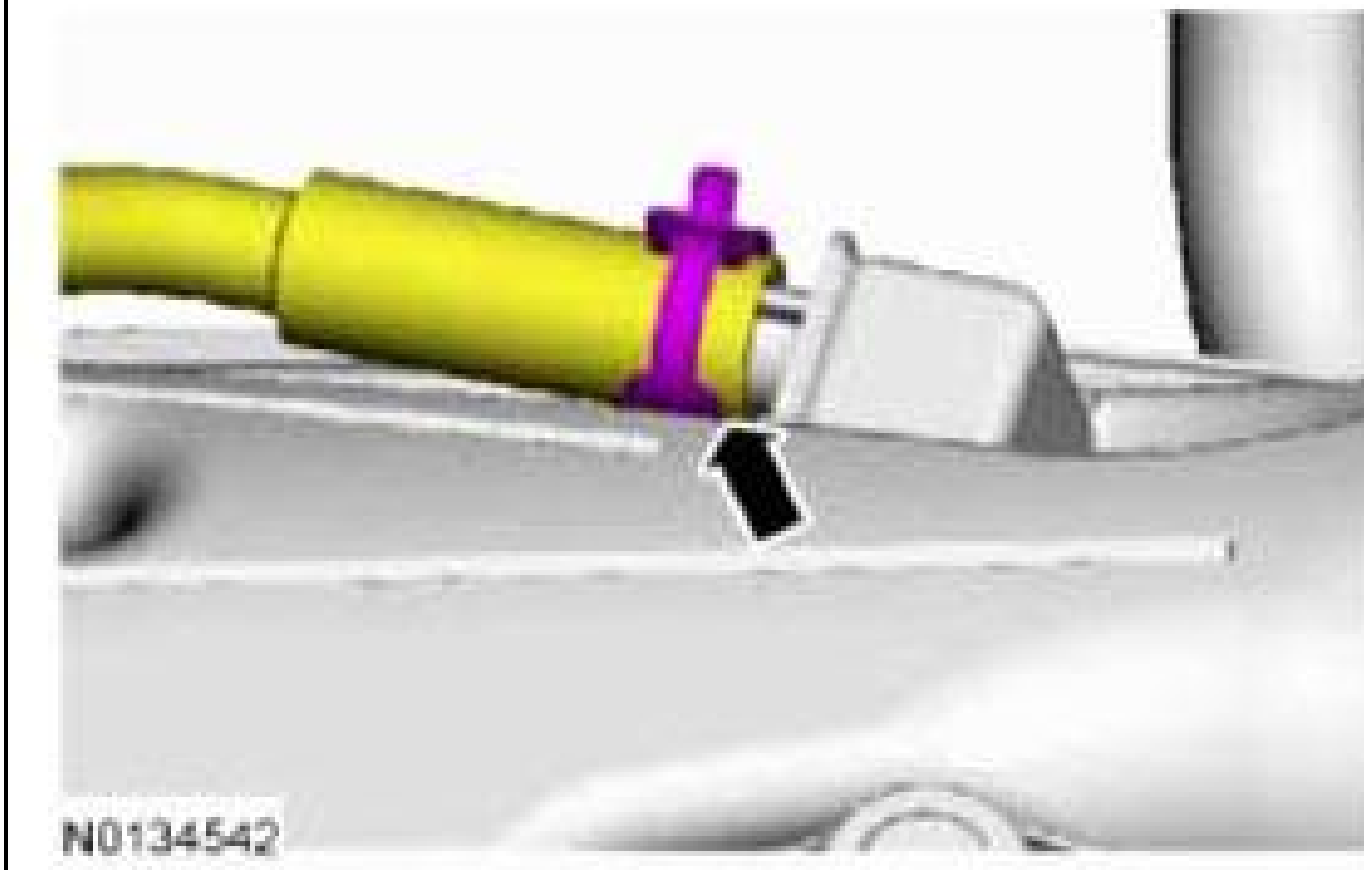
70. Disconnect the **EVAP** vapor tube from the **EVAP** canister purge valve. REFER to **QUICK CONNECT COUPLING** .
    - Detach the **EVAP** vapor tube from the 2 retainers.

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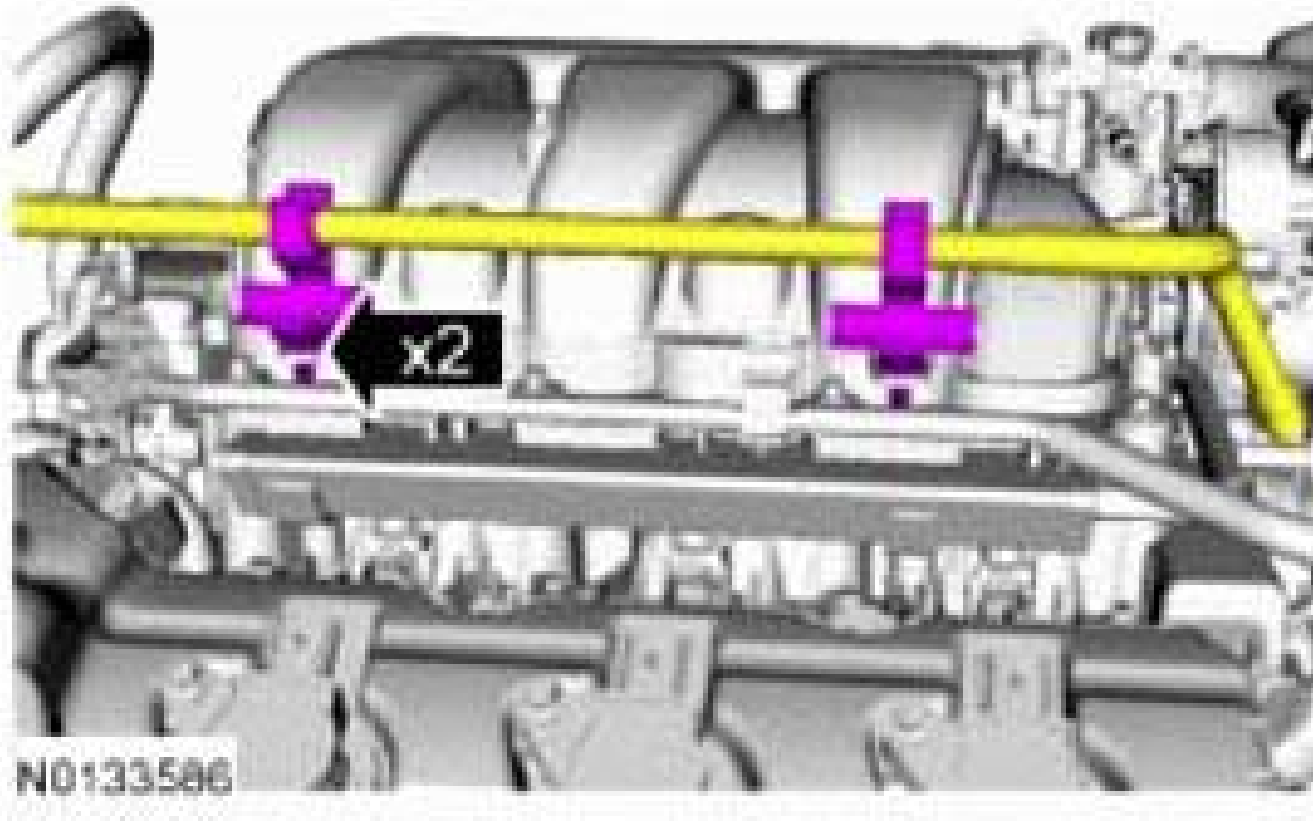
71. Disconnect the crankcase ventilation hose from the upper intake manifold.

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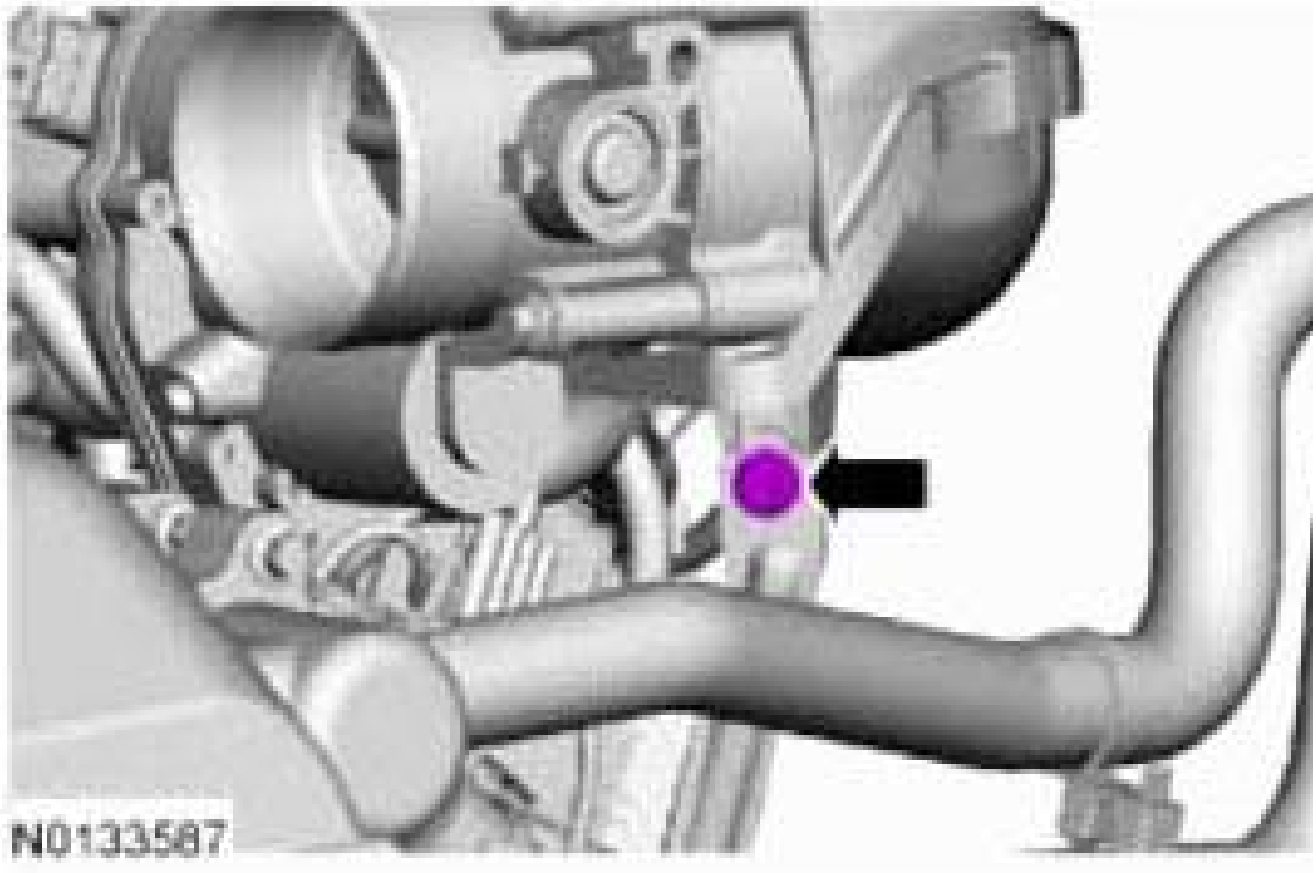
72. Detach the 2 coolant tube retainers from the upper intake manifold.

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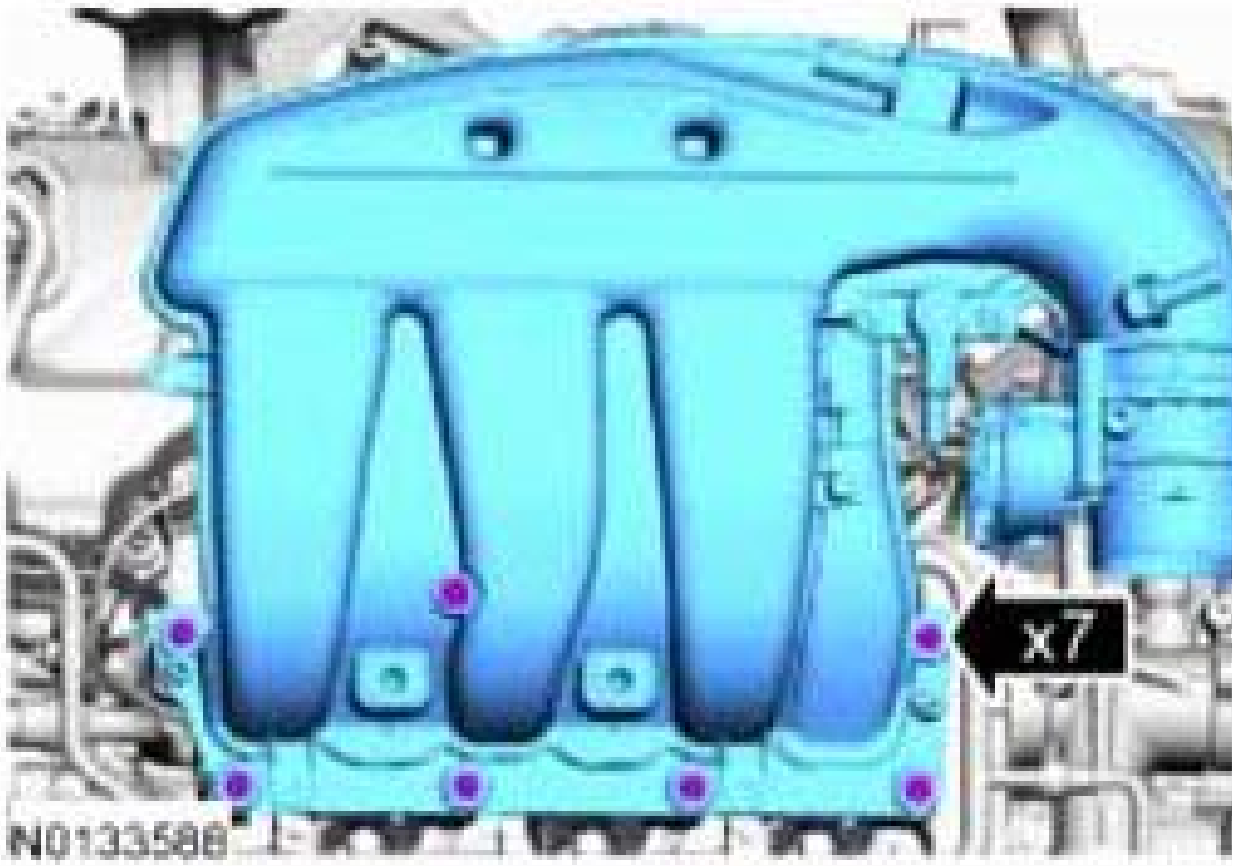
73. Remove the upper intake manifold support bracket bolt.

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74. Remove the 7 bolts and the upper intake manifold.
    - Remove and discard the gasket.
    - Clean and inspect all of the sealing surfaces of the upper and lower intake manifold.

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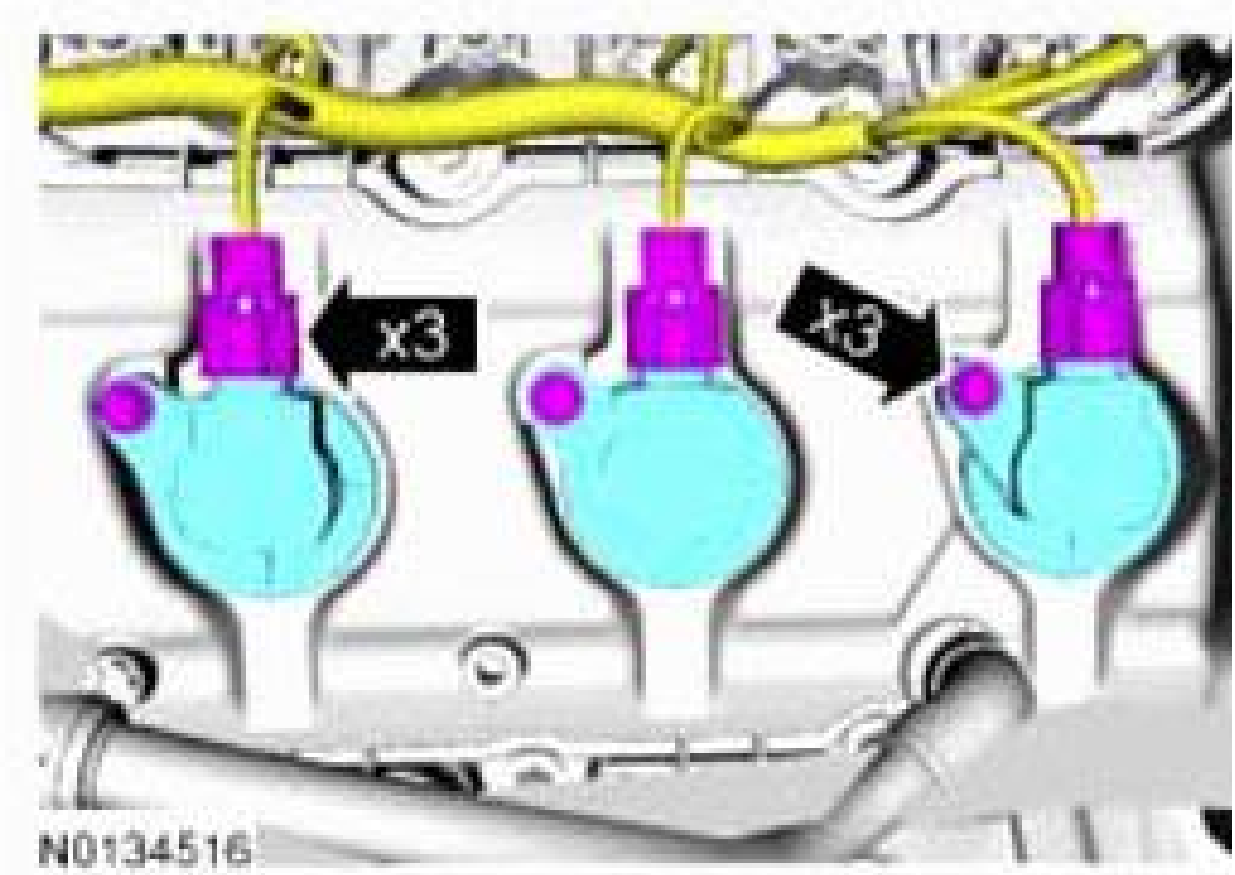


75. **NOTE: When removing the ignition coil-on-plugs, a slight twisting motion will break the seal and ease removal.**

Disconnect the 3 RH coil-on-plug electrical connectors and remove the 3 bolts and the 3 RH coil-on-plugs.

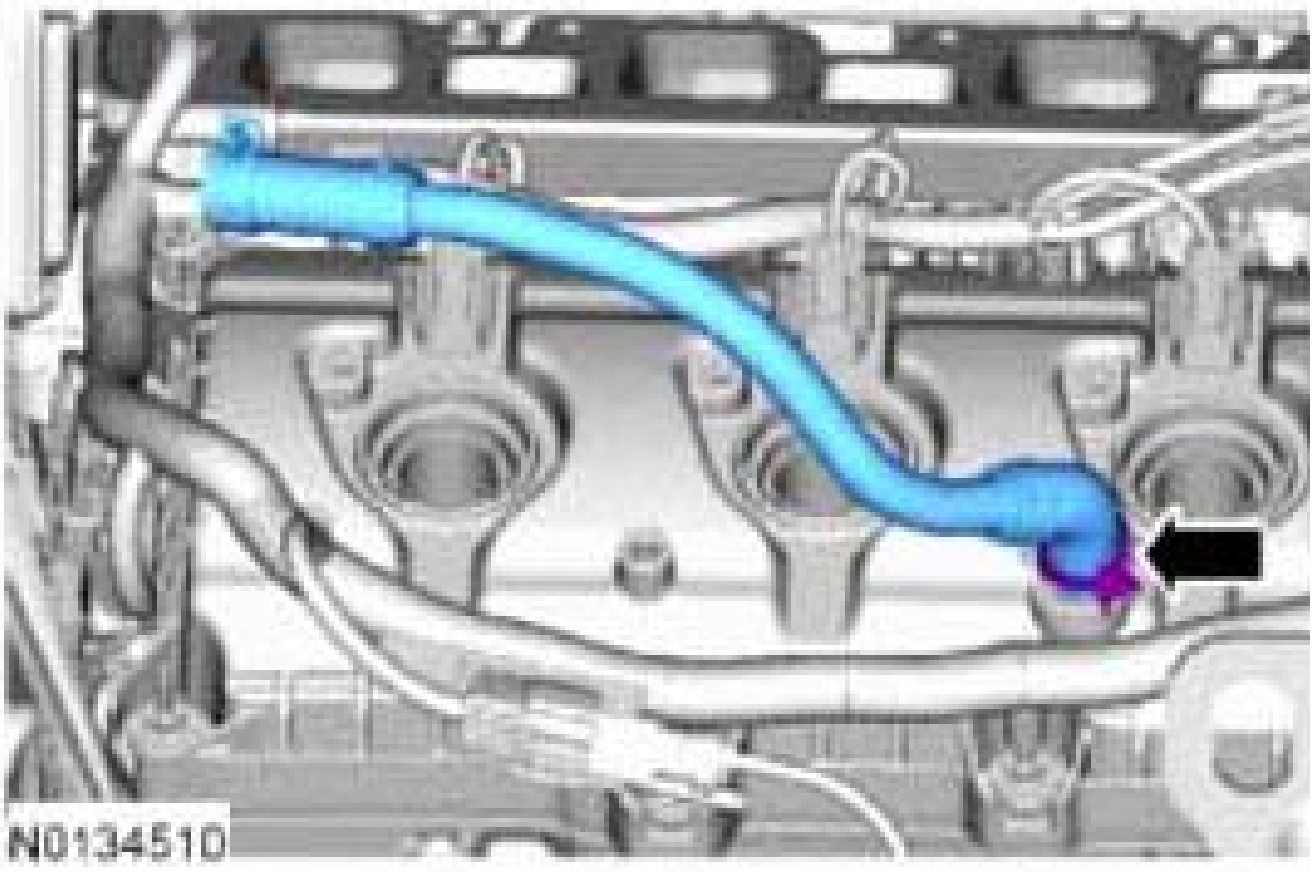
- Inspect the coil seals for rips, nicks or tears. Remove and discard any damaged coil seals.

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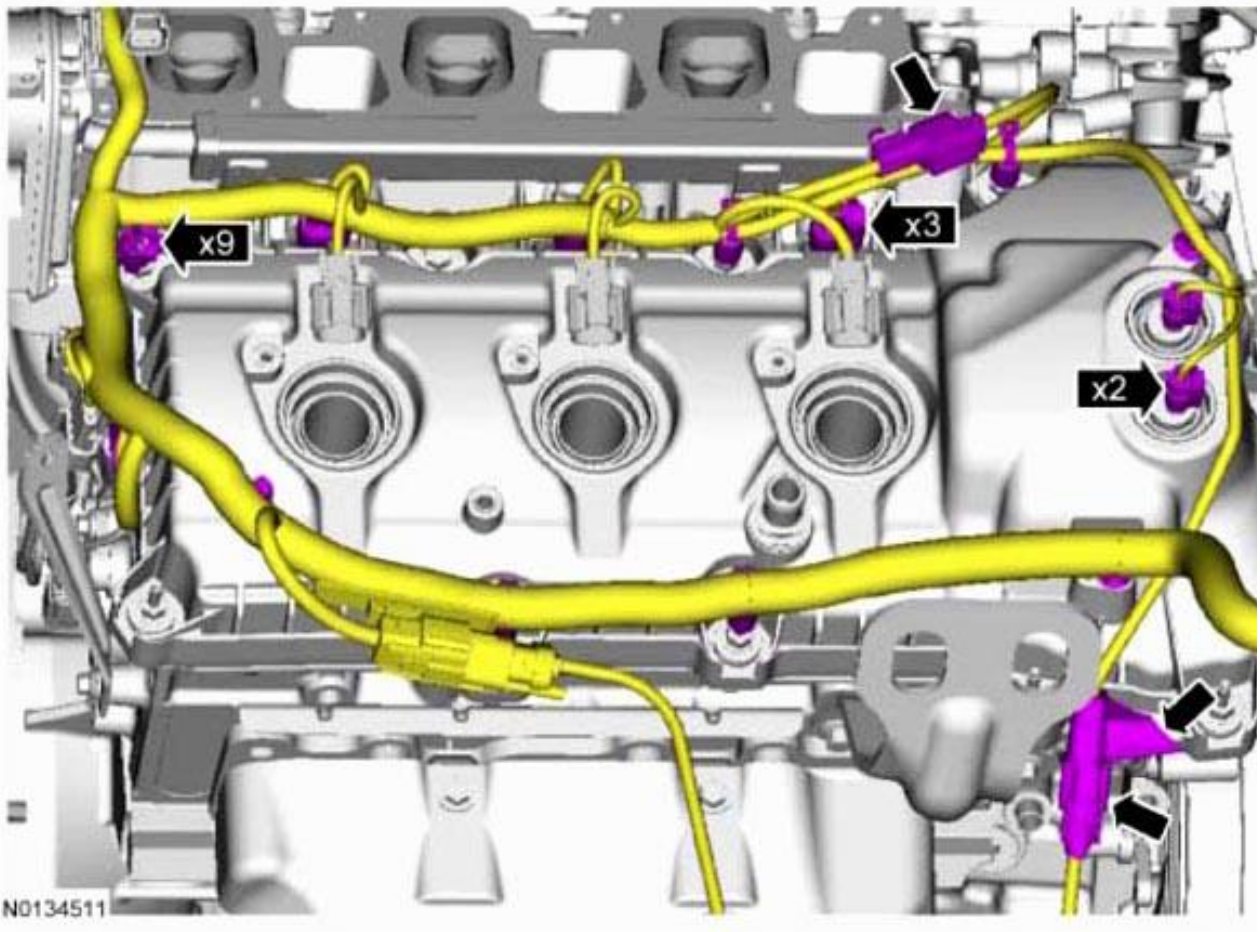
76. Remove the PCV crankcase vent tube.

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77. Remove the engine wiring harness from the RH valve cover.
    - Disconnect the 2 **VCT** oil control solenoid electrical connectors.
    - Detach and disconnect the RH **CMS** electrical connector.
    - Disconnect the 3 fuel injector electrical connectors.
    - Disconnect the **CHT** sensor wiring harness jumper electrical connector.
    - Detach the 9 wiring harness retainers from the RH valve cover and stud bolts and position the harness aside.

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78.

NOTE: When removing valve cover do not apply excessive force to the VCT oil control solenoid.

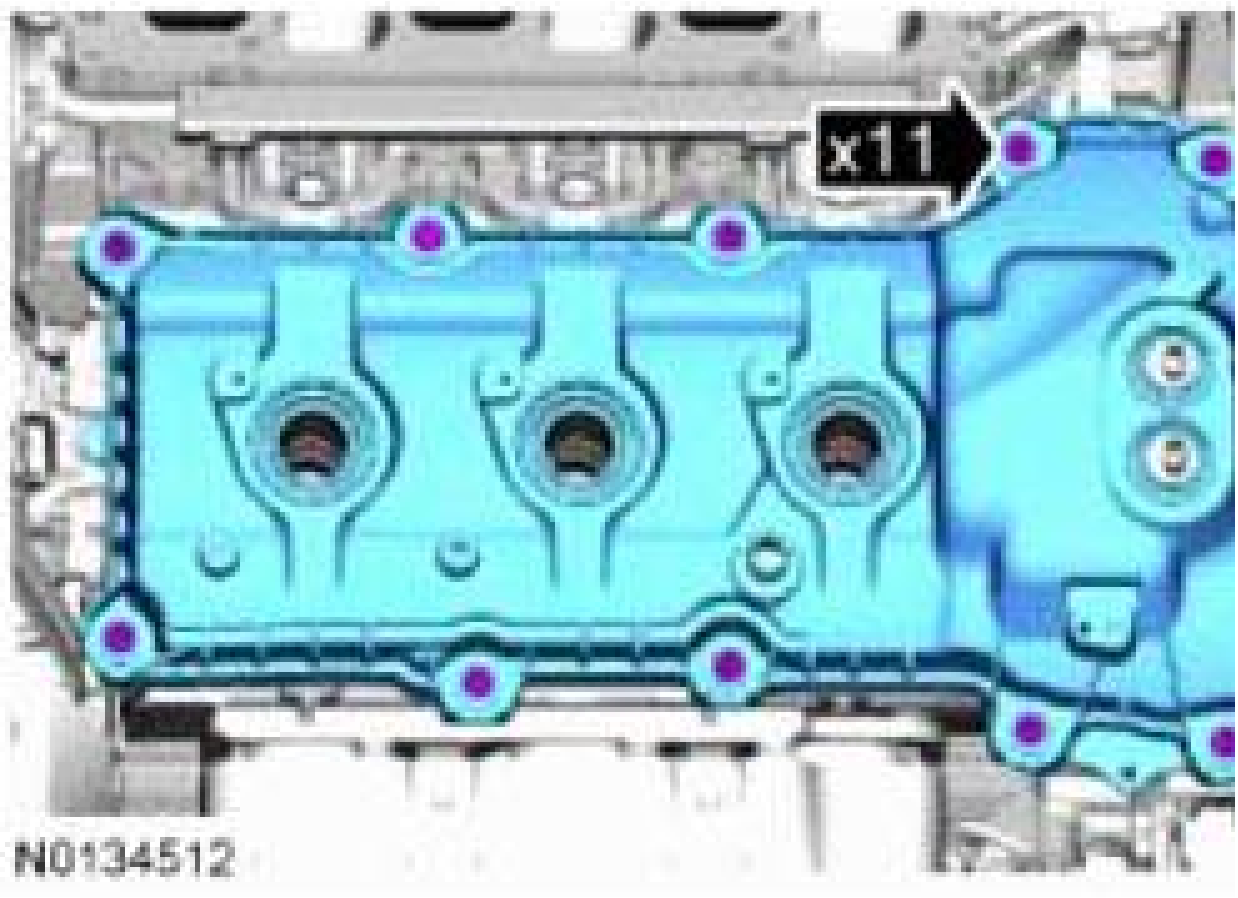
NOTE: If the VCT solenoid seal sticks to the VCT oil control solenoid, then carefully wiggle the valve cover until the bond breaks free.

NOTE: The plastic electrical connector on the VCT oil control solenoid will rotate approximately 12 degrees inside the steel housing, which is normal.

Loosen the 11 retainers and remove the RH valve cover.

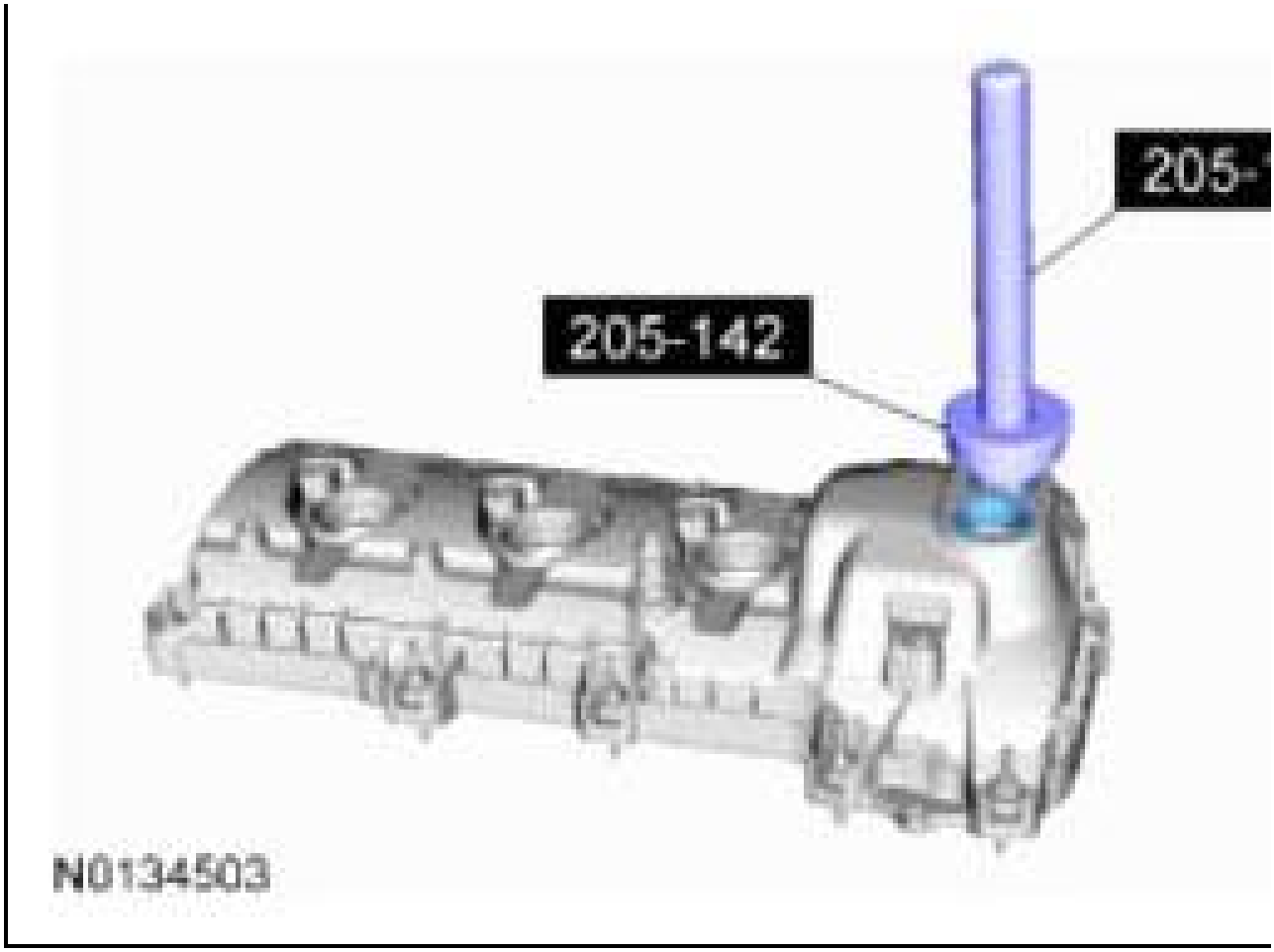
- Discard the gasket.

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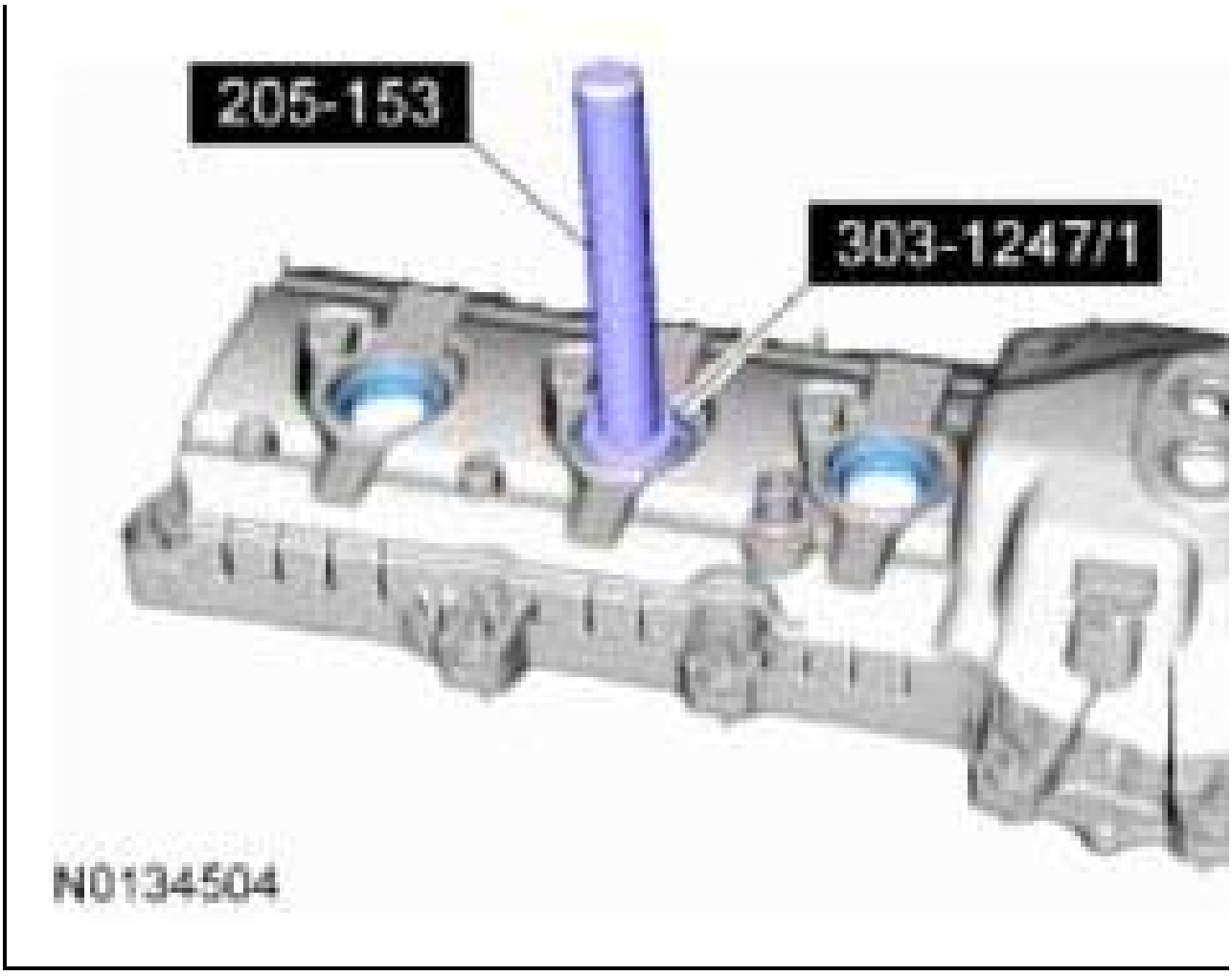
79. Inspect the 2 **VCT** solenoid seals. Remove any damaged seals.
    - Using 205-142 T80T-4000-J and 205-153 T80T-4000-W remove and discard the damaged seal(s).

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80. Inspect the spark plug tube seals. Remove any damaged seals.
    - Using 303-1247/1 and 205-153 T80T-4000-W remove and discard the damaged seal(s).

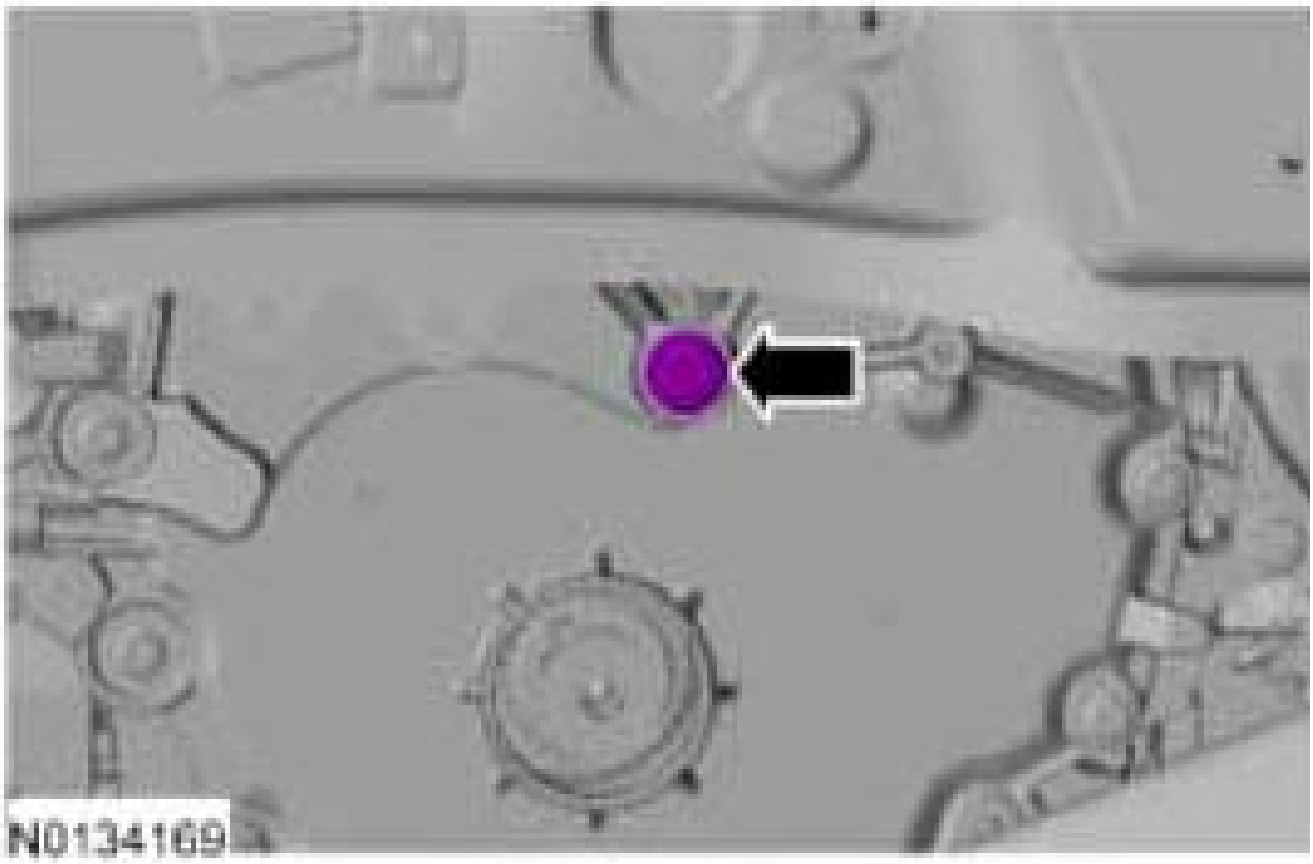
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NOTE: **It may be necessary to use the floor jack and lower the engine slightly to gain enough access to remove the bolt.**

81. Remove the lower M10 engine front cover bolt.

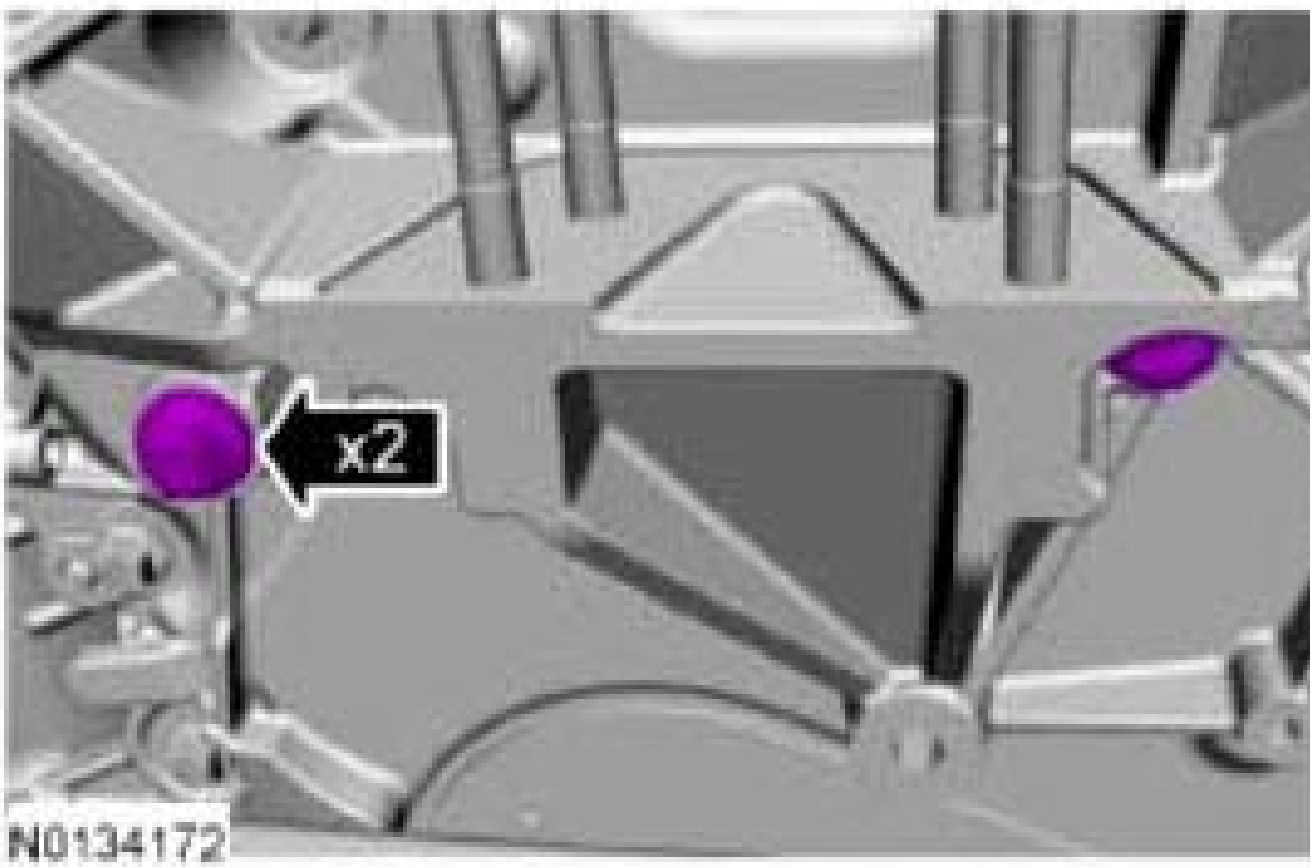
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82. **NOTE: It may be necessary to use the floor jack and raise the engine slightly to gain enough access to remove the bolts.**

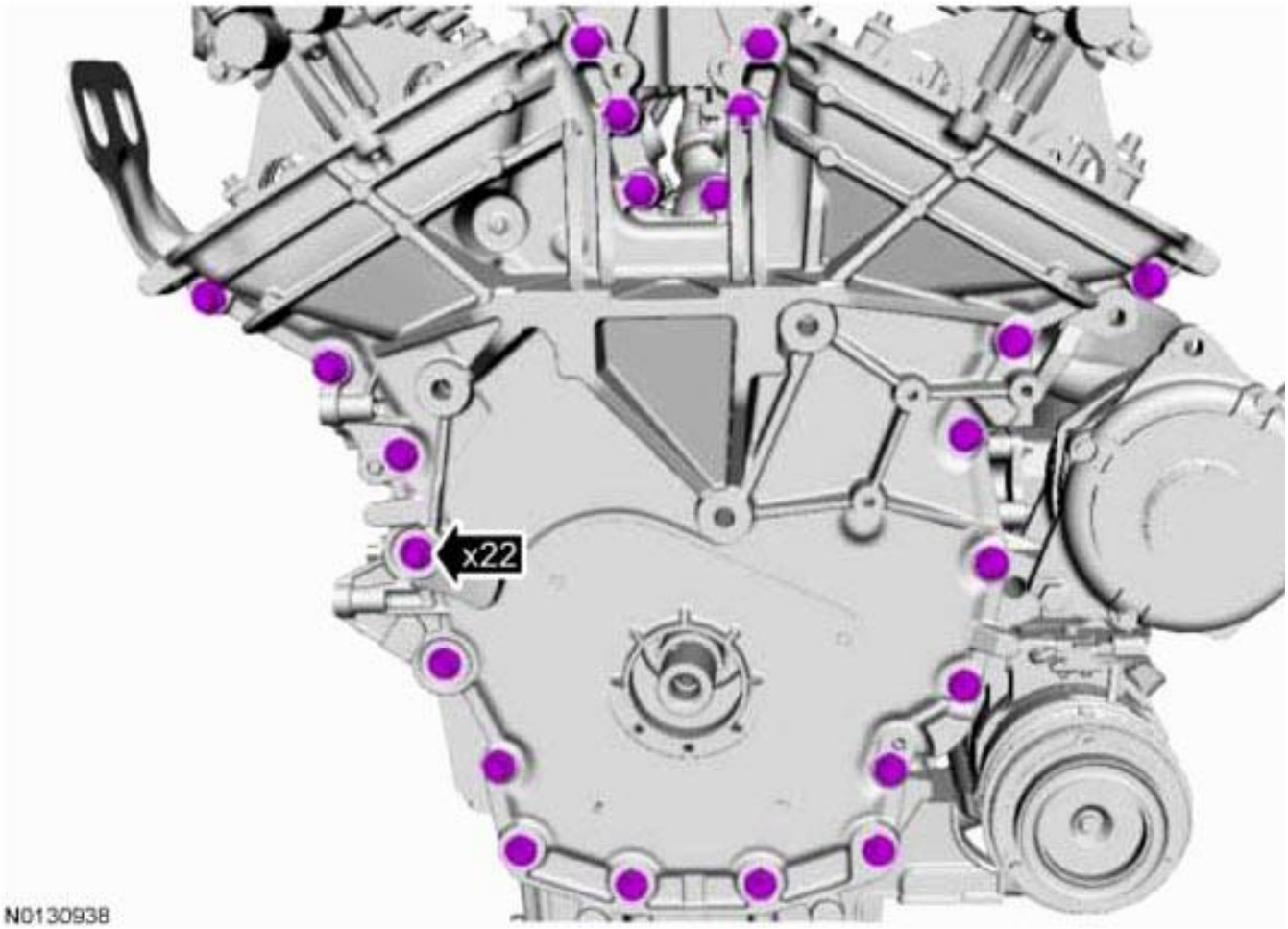
Remove the 2 M10 engine front cover bolts.

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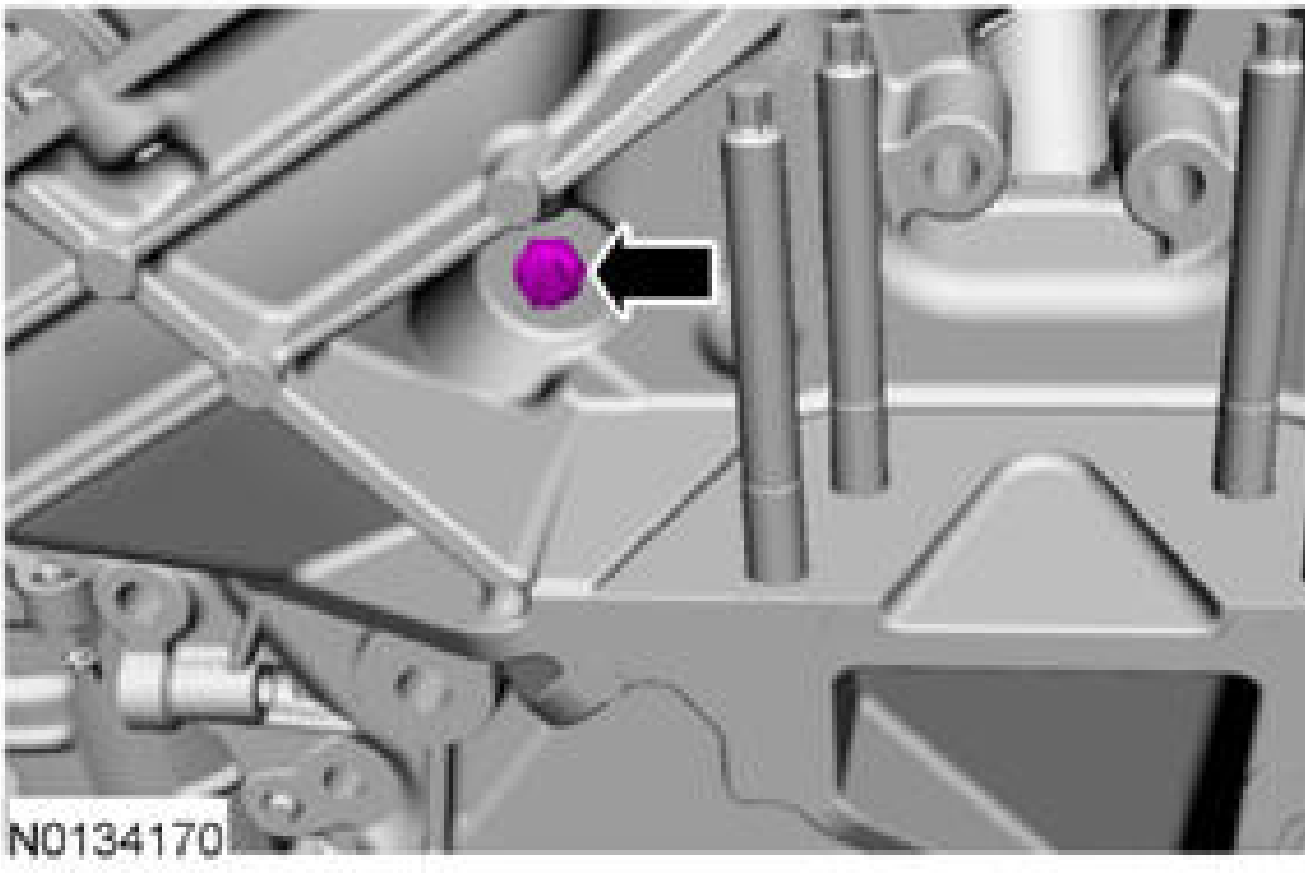
83. Remove the 22 M8 engine front cover bolts.

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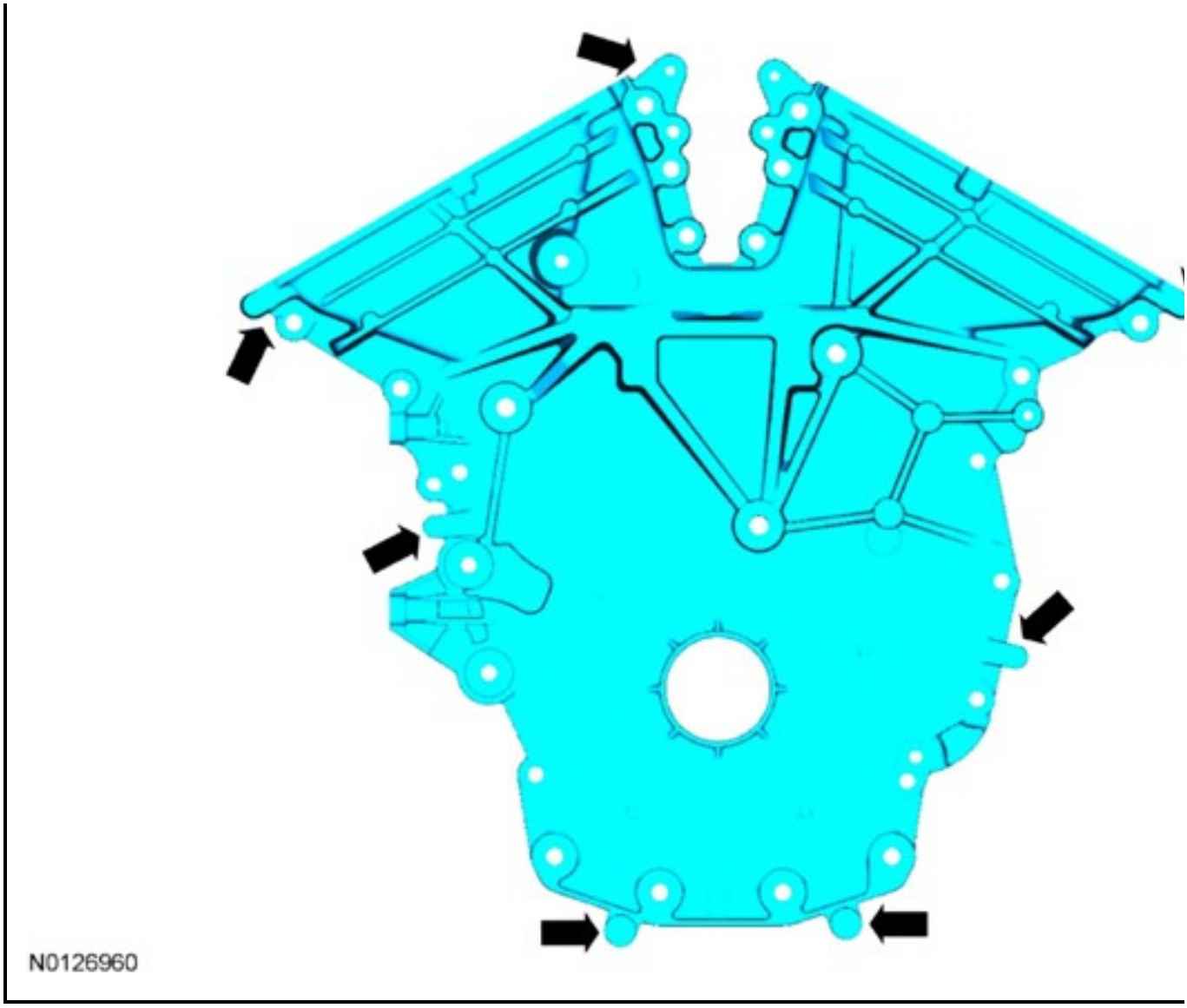
84. Remove the M6 engine front cover bolt.

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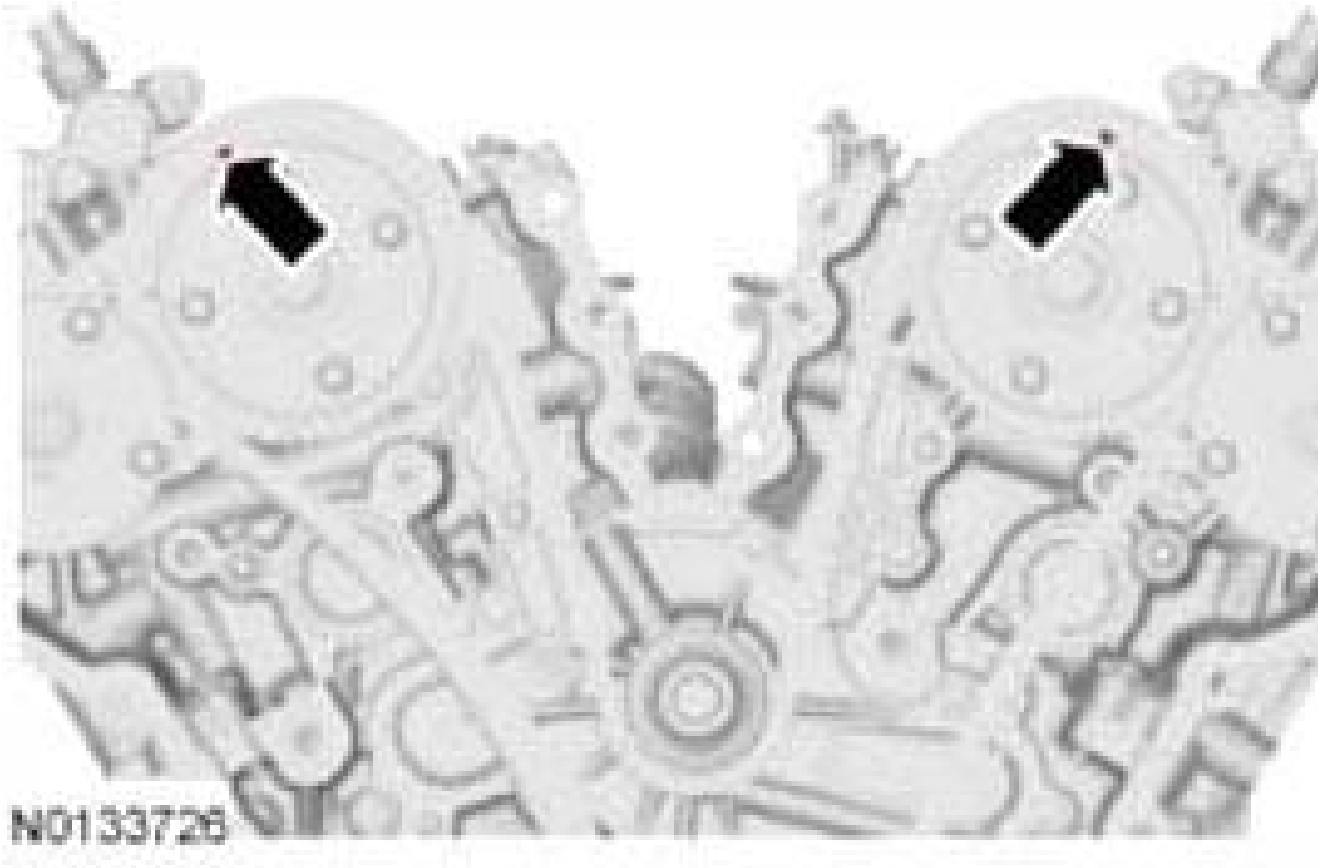
85. Using a suitable pry tool, locate the 7 pry pads shown in illustration and pry the engine front cover loose and remove.

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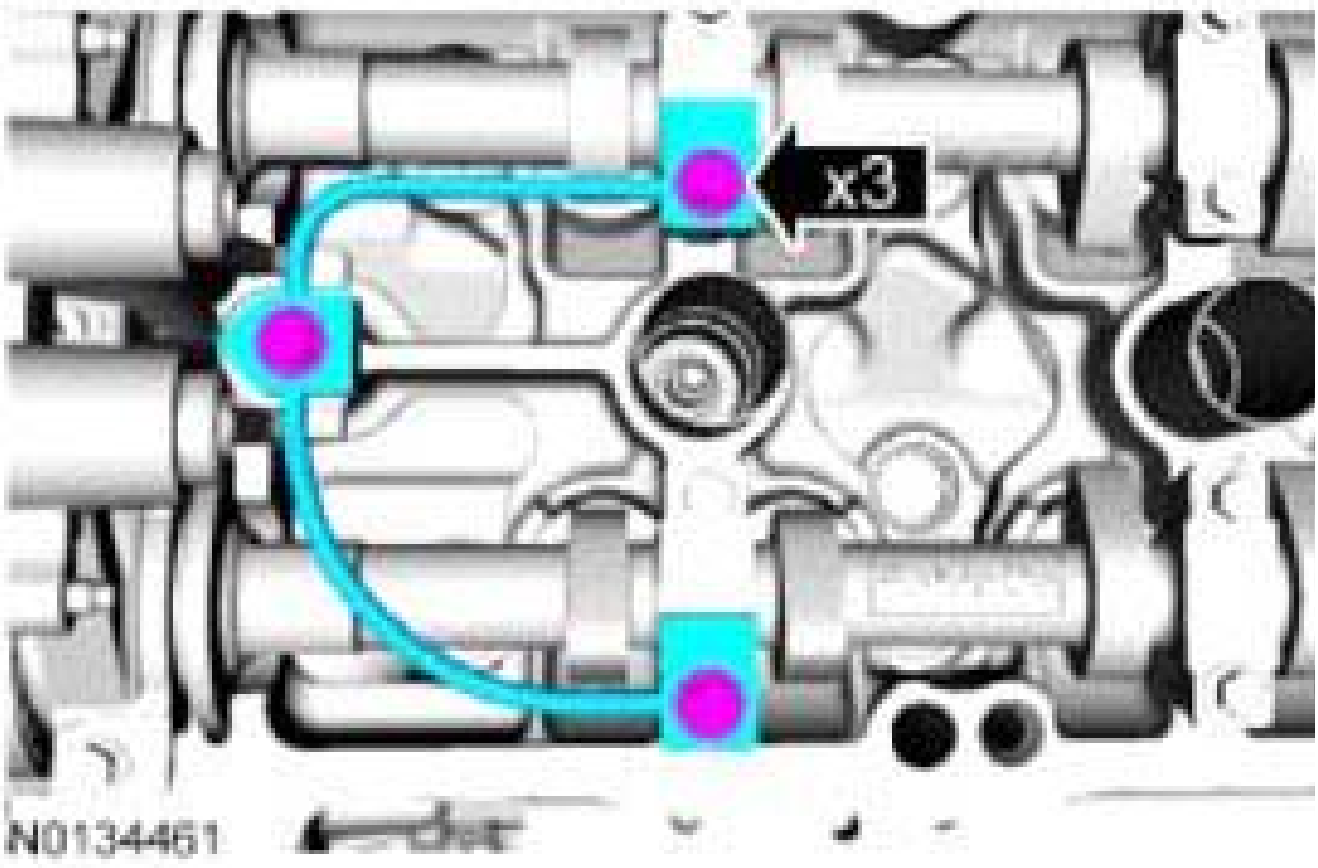
86. Rotate the crankshaft clockwise and align the timing marks on the intake **VCT** assemblies as shown in illustration.

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87. Remove the 3 bolts and the LH valve train oil tube.

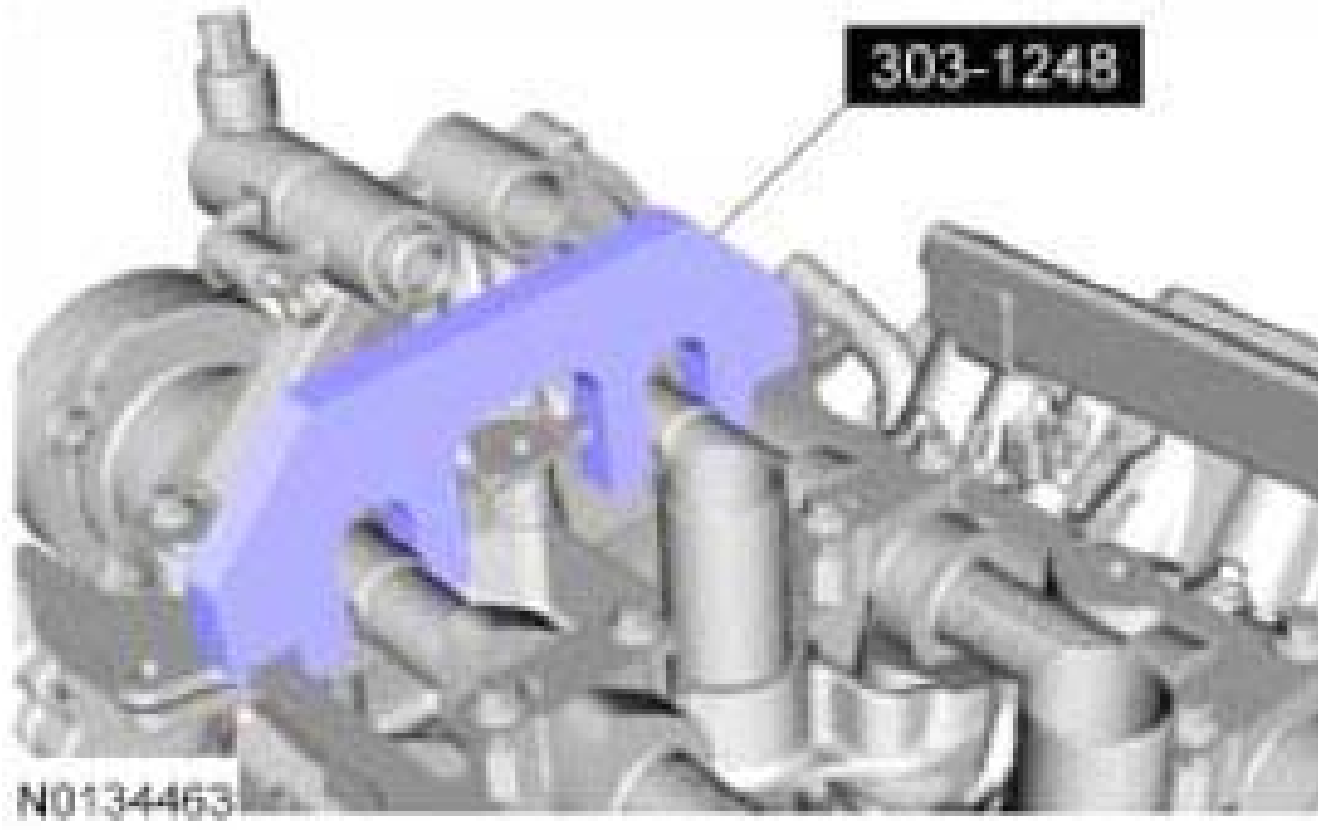
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88. **NOTE: The 303-1248 will hold the camshafts in the TDC position.**

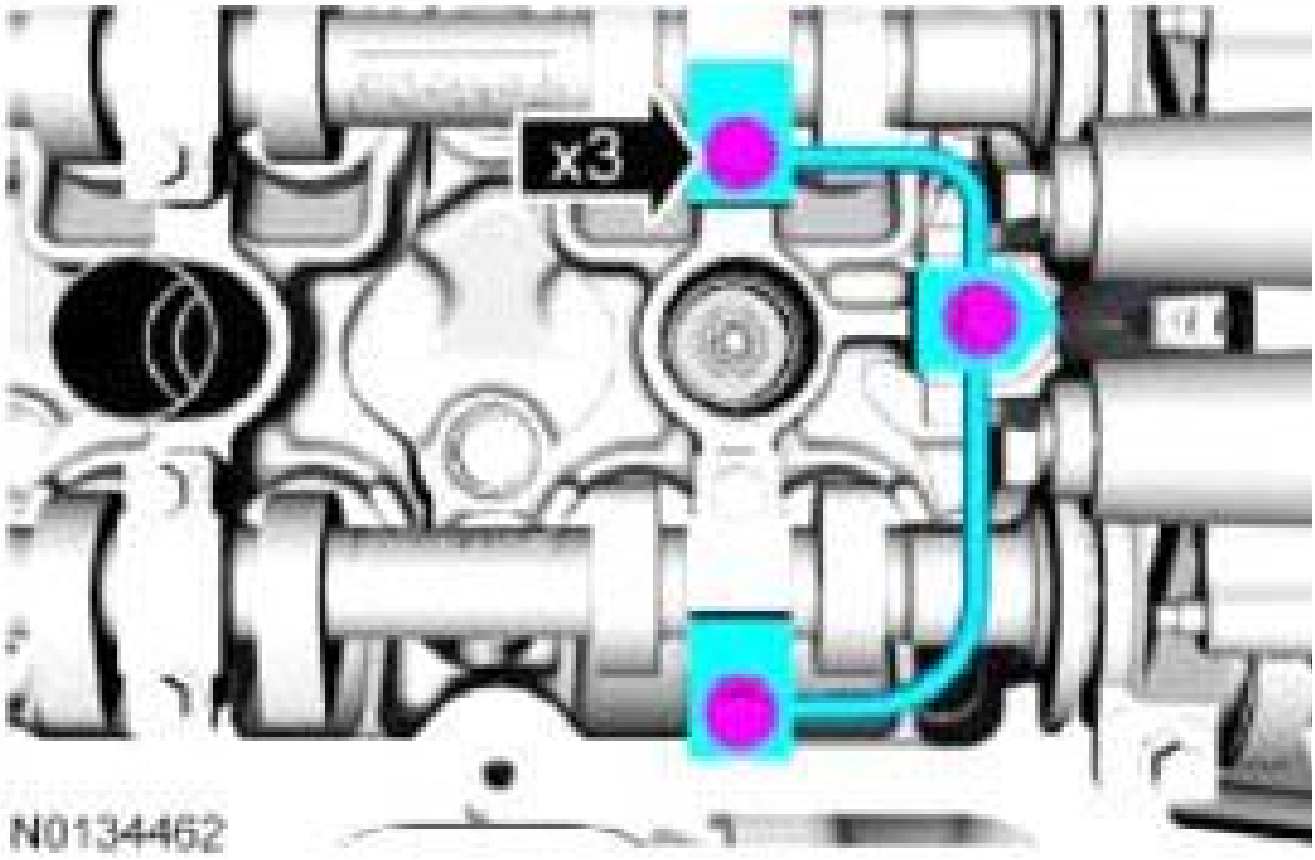
Install 303-1248 onto the flats of the LH camshafts.

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89. Remove the 3 bolts and the RH valve train oil tube.

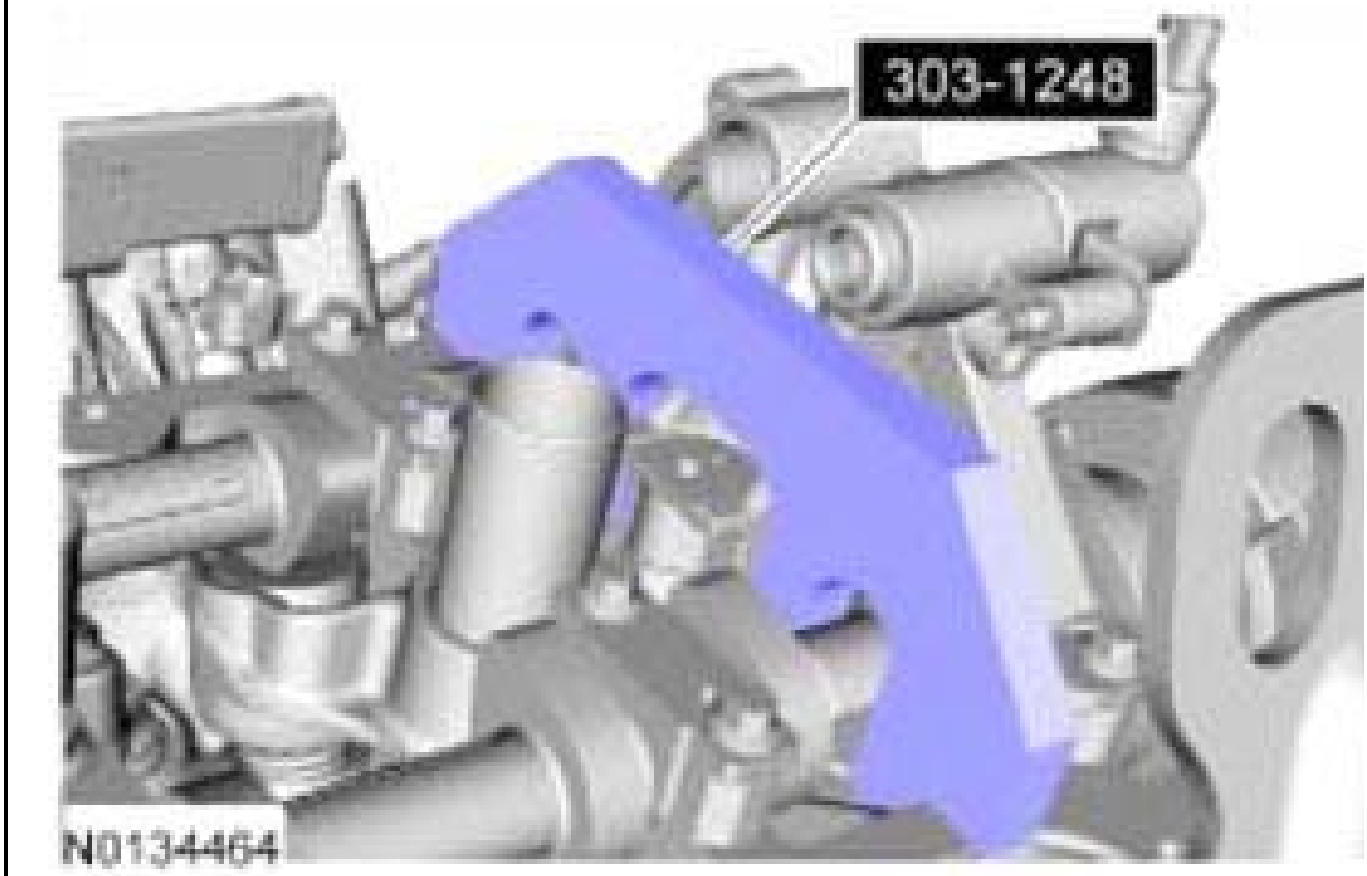
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90. **NOTE: The 303-1248 will hold the camshafts in the TDC position.**

Install 303-1248 onto the flats of the RH camshafts.

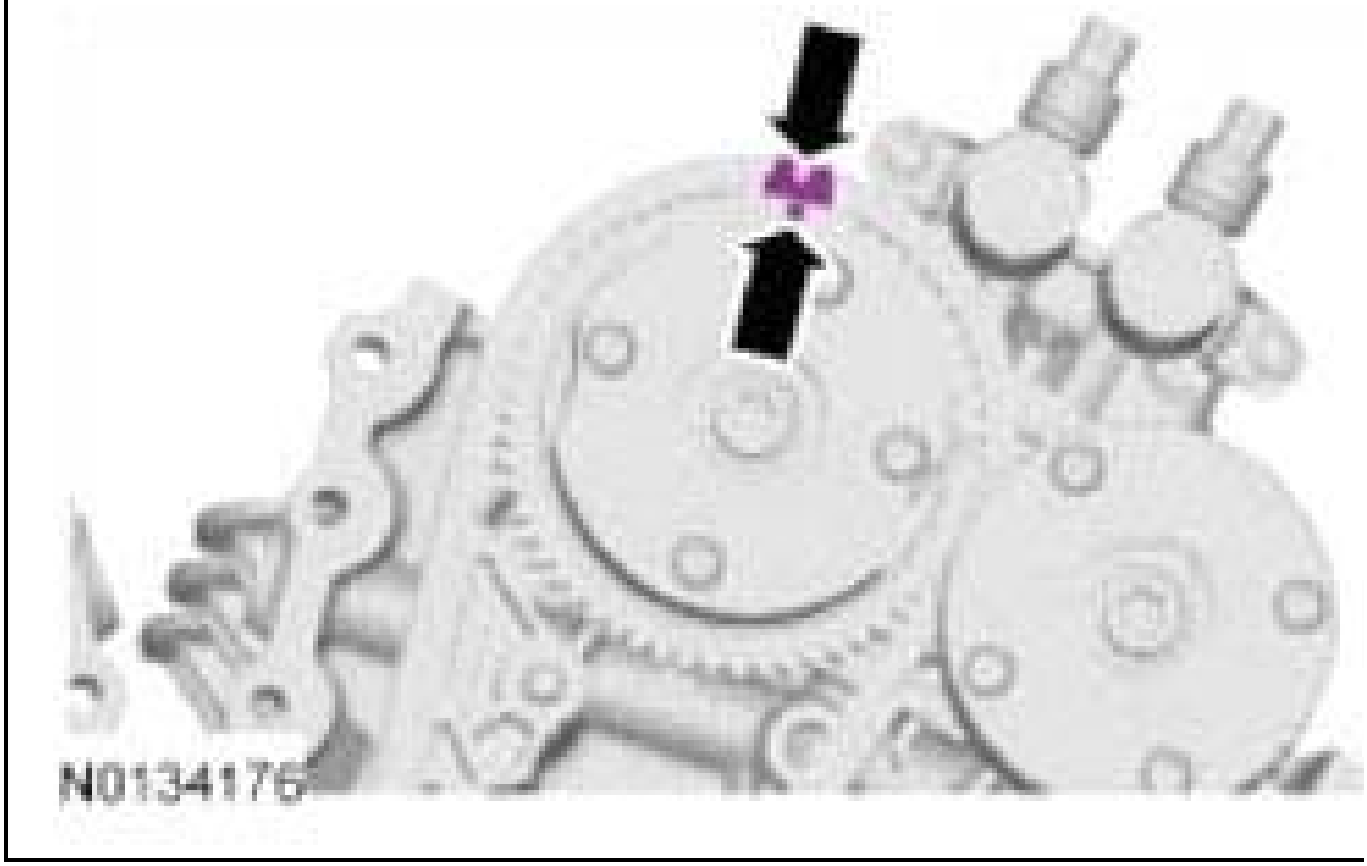
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91. **NOTE: The following 3 steps are for primary timing chains that the colored links are not visible.**

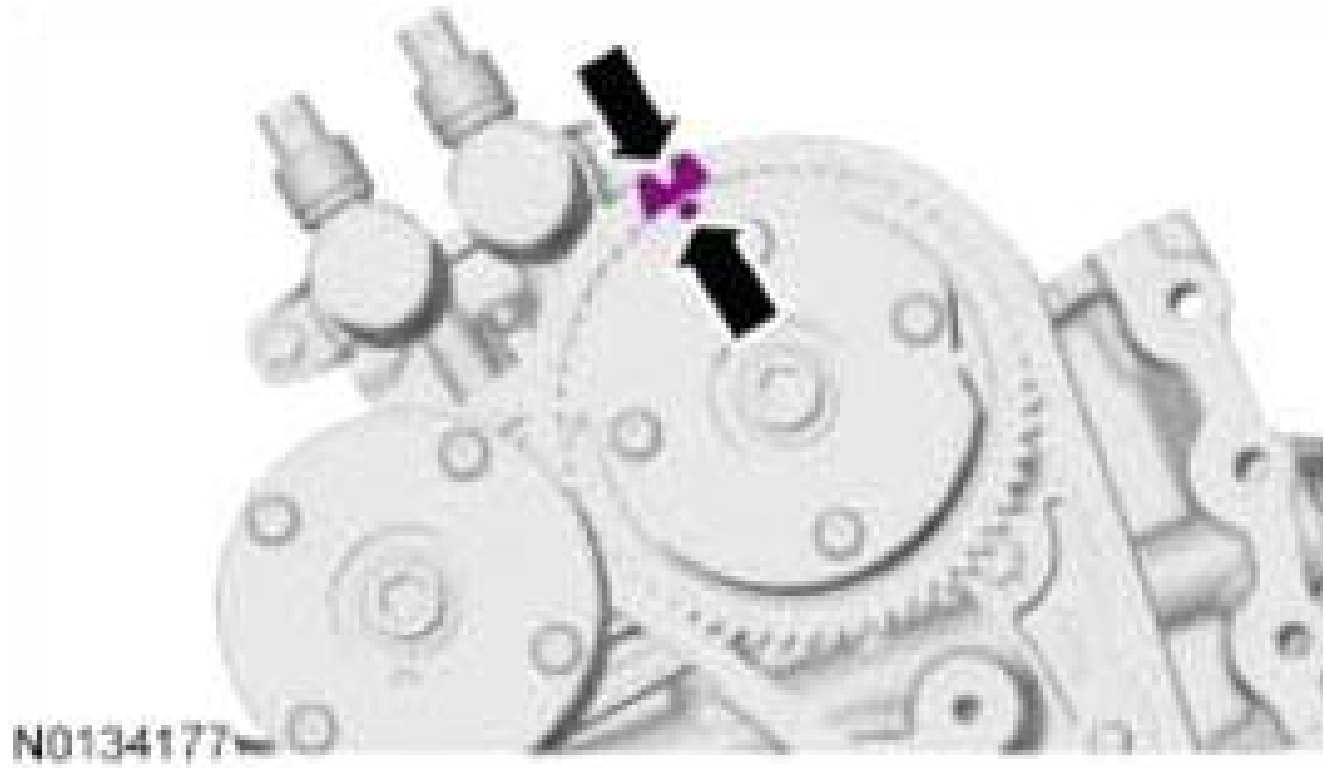
Mark the timing chain link that aligns with the timing mark on the LH intake **VCT** assembly as shown in illustration.

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92. Mark the timing chain link that aligns with the timing mark on the RH intake **VCT** assembly as shown in illustration.

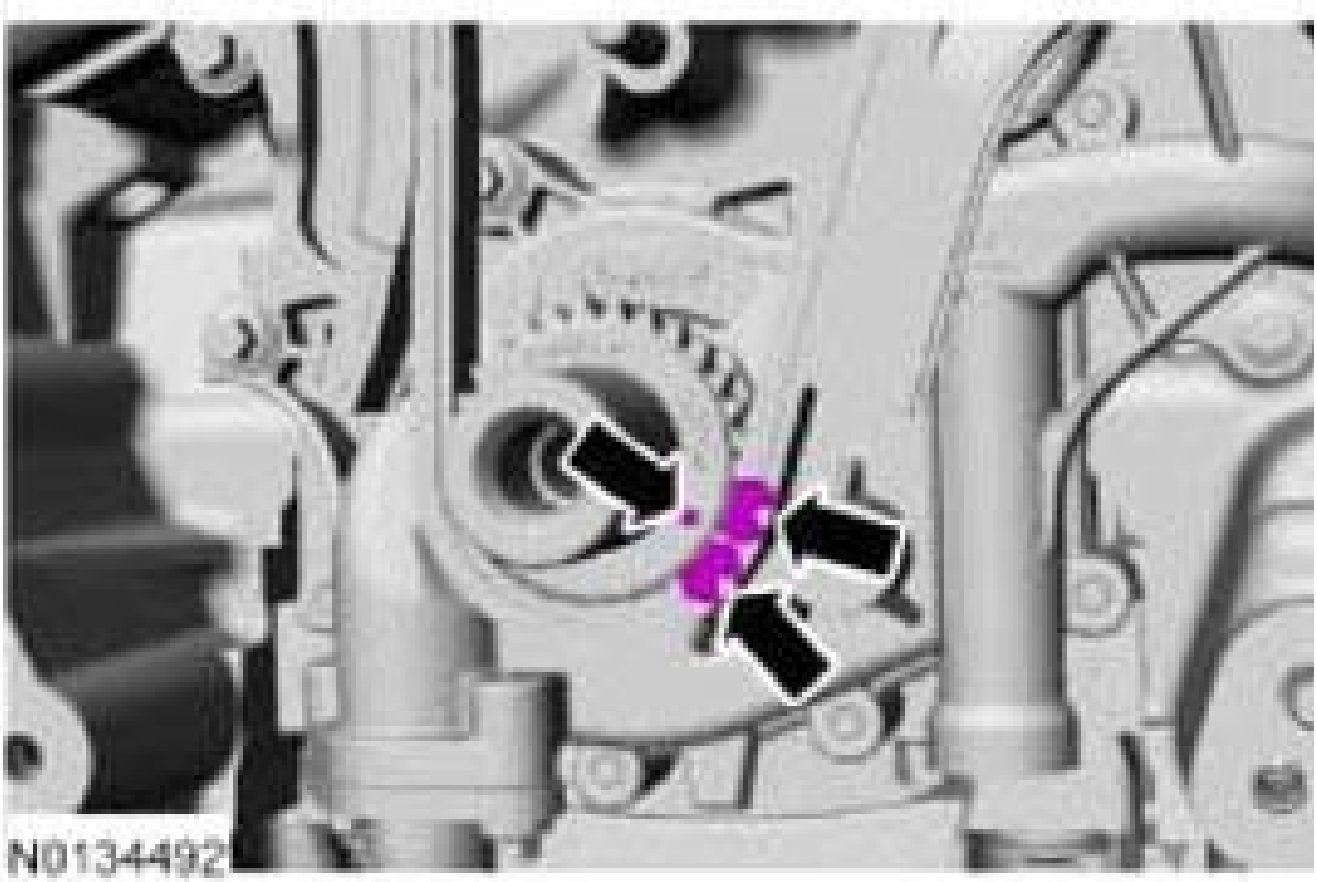
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NOTE: The crankshaft sprocket timing mark should be between the 2 colored links.

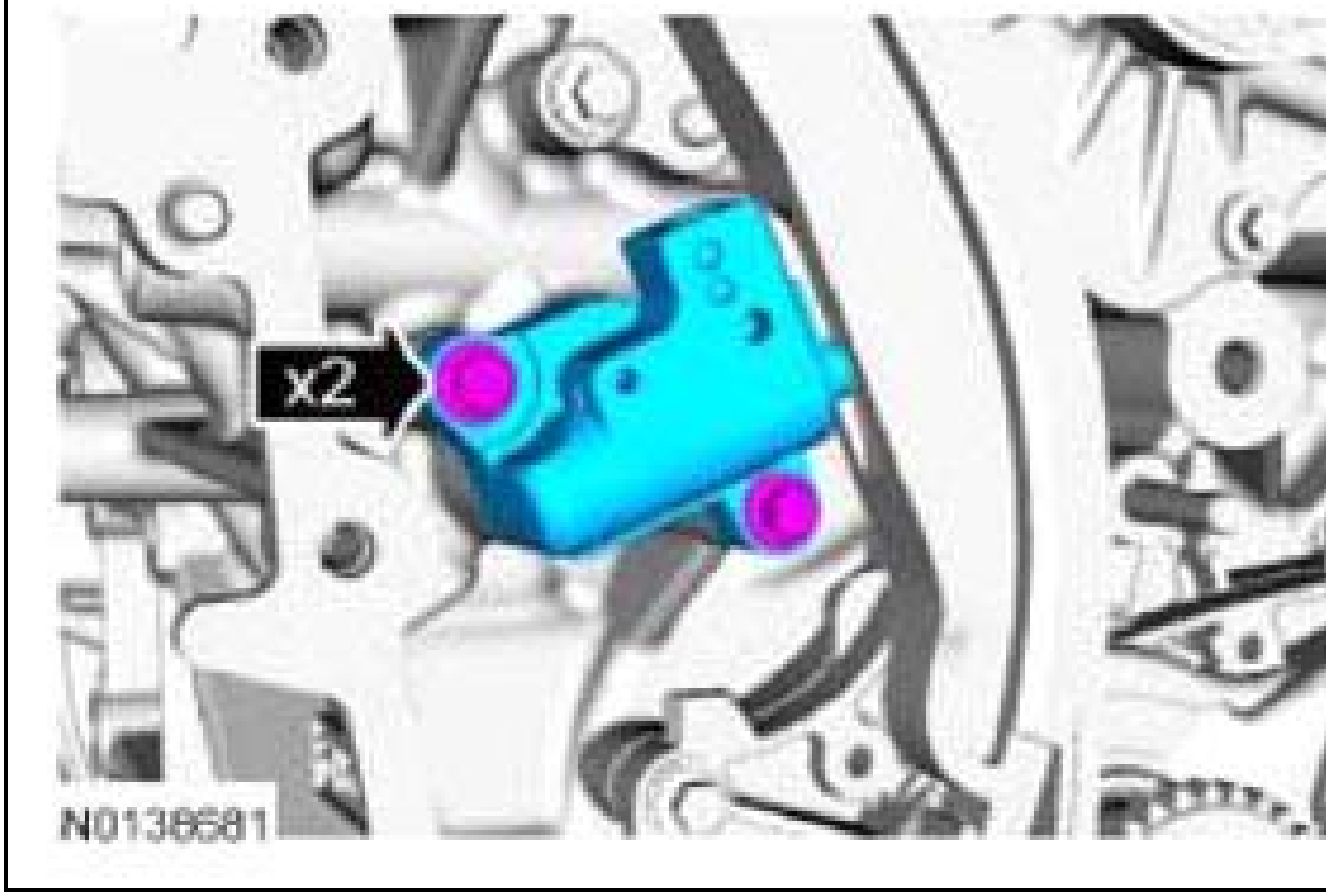
93. Mark the 2 timing chain links that align with the timing mark on the crankshaft sprocket as shown in illustration.

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94. Remove the 2 bolts and the primary timing chain tensioner.

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95. Remove the primary timing chain tensioner arm.

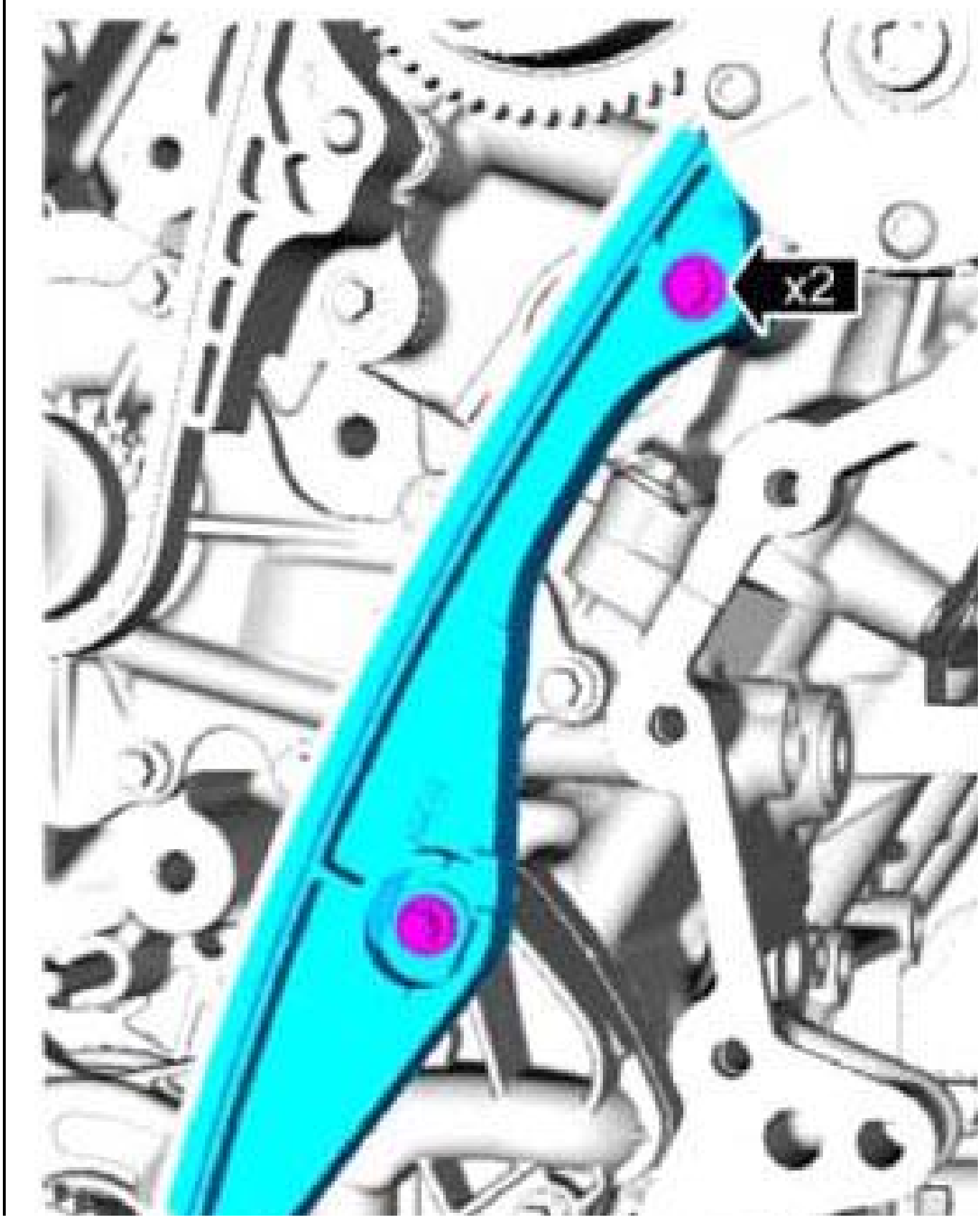
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96. Remove the 2 bolts and the lower LH primary timing chain guide.

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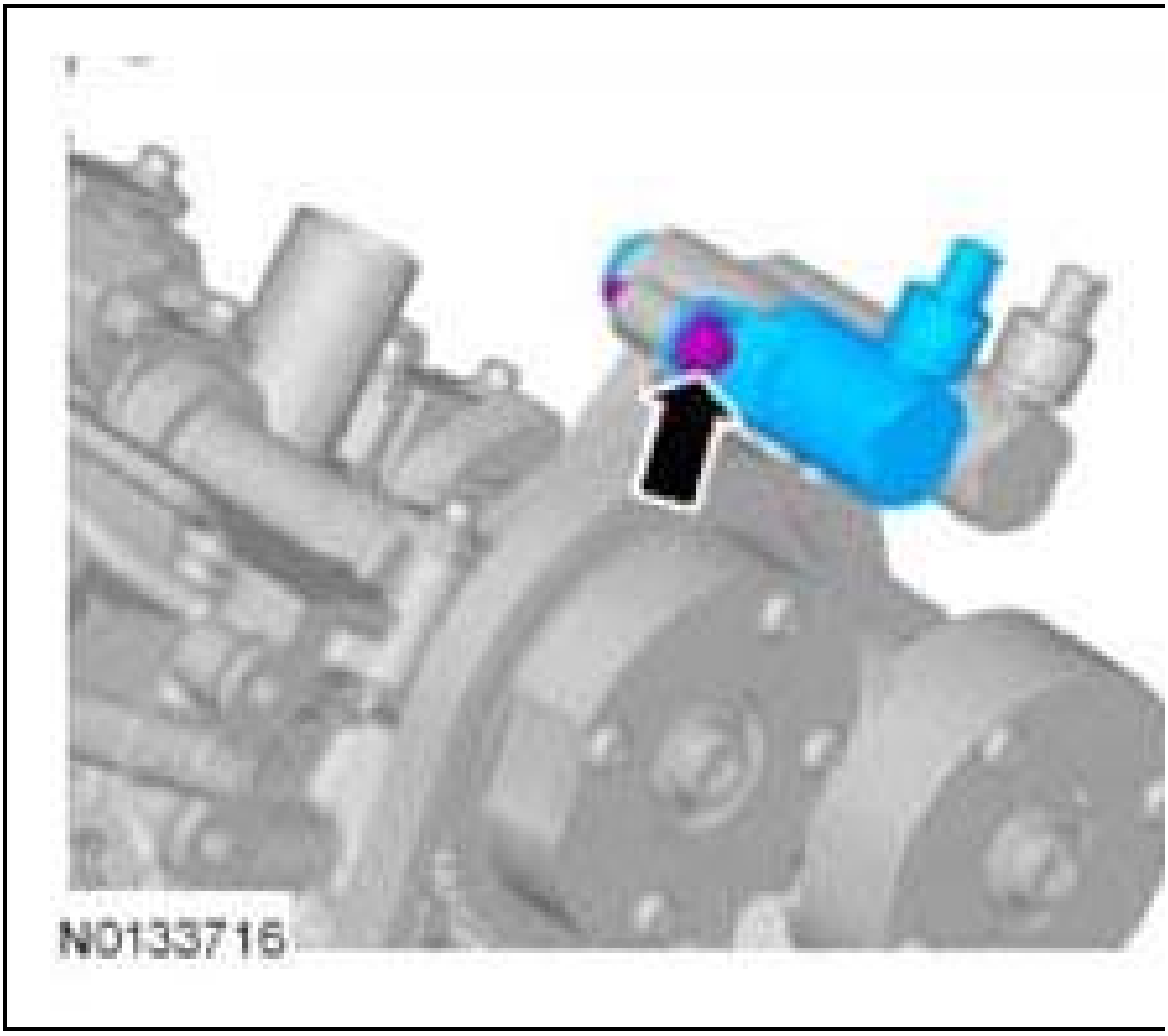
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97. **NOTE: Removal of the VCT oil control solenoid will aid in the removal of the primary timing chain.**

NOTE: A slight twisting motion will aid in the removal of the VCT oil control solenoid.

NOTE: Keep the VCT oil control solenoid clean of dirt and debris.

Remove the bolt and the LH intake **VCT** oil control solenoid.



98. **NOTE: Removal of the VCT oil control solenoid will aid in the removal of the**

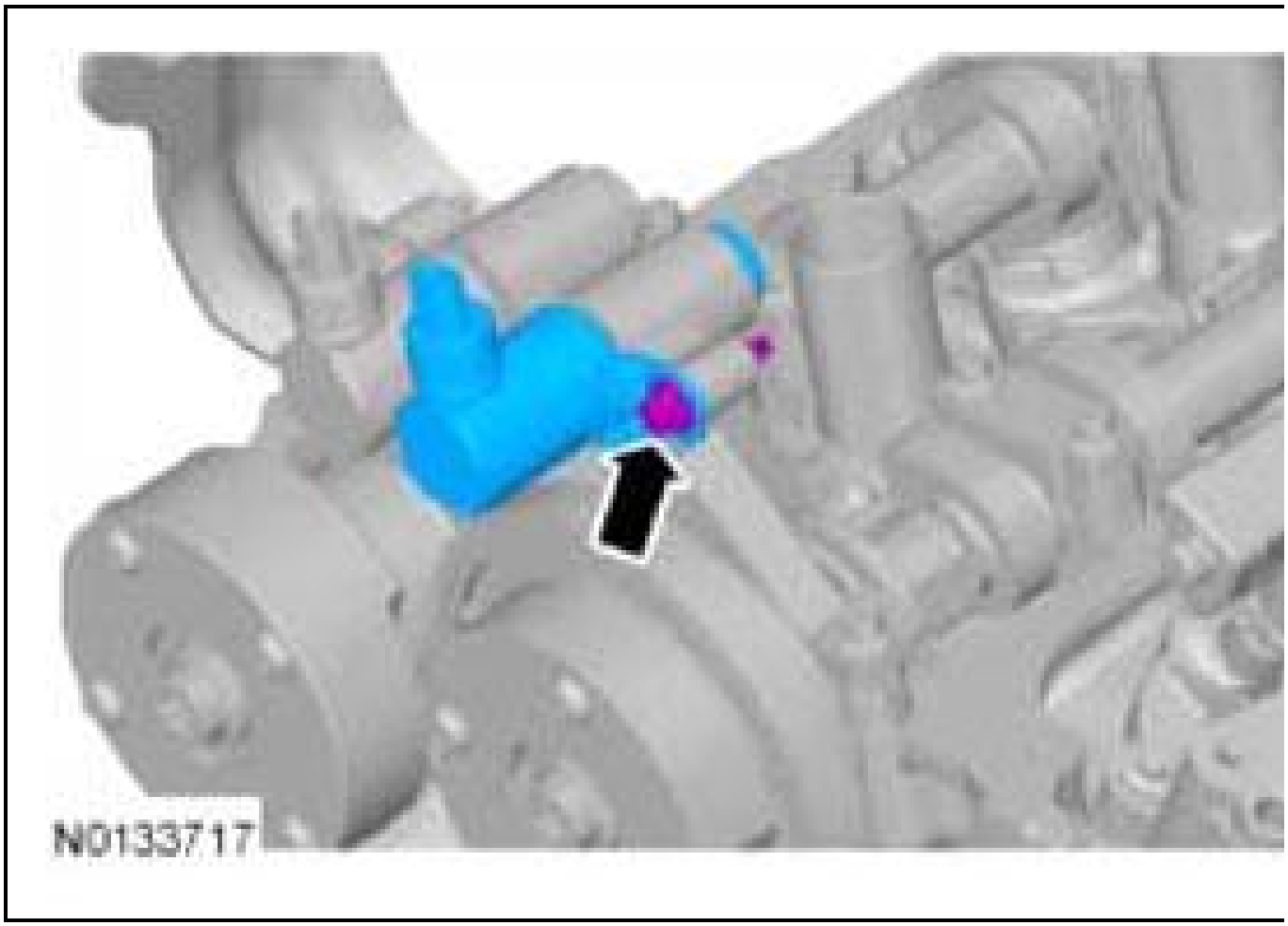
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98. **primary timing chain.**

NOTE: A slight twisting motion will aid in the removal of the VCT oil control solenoid.

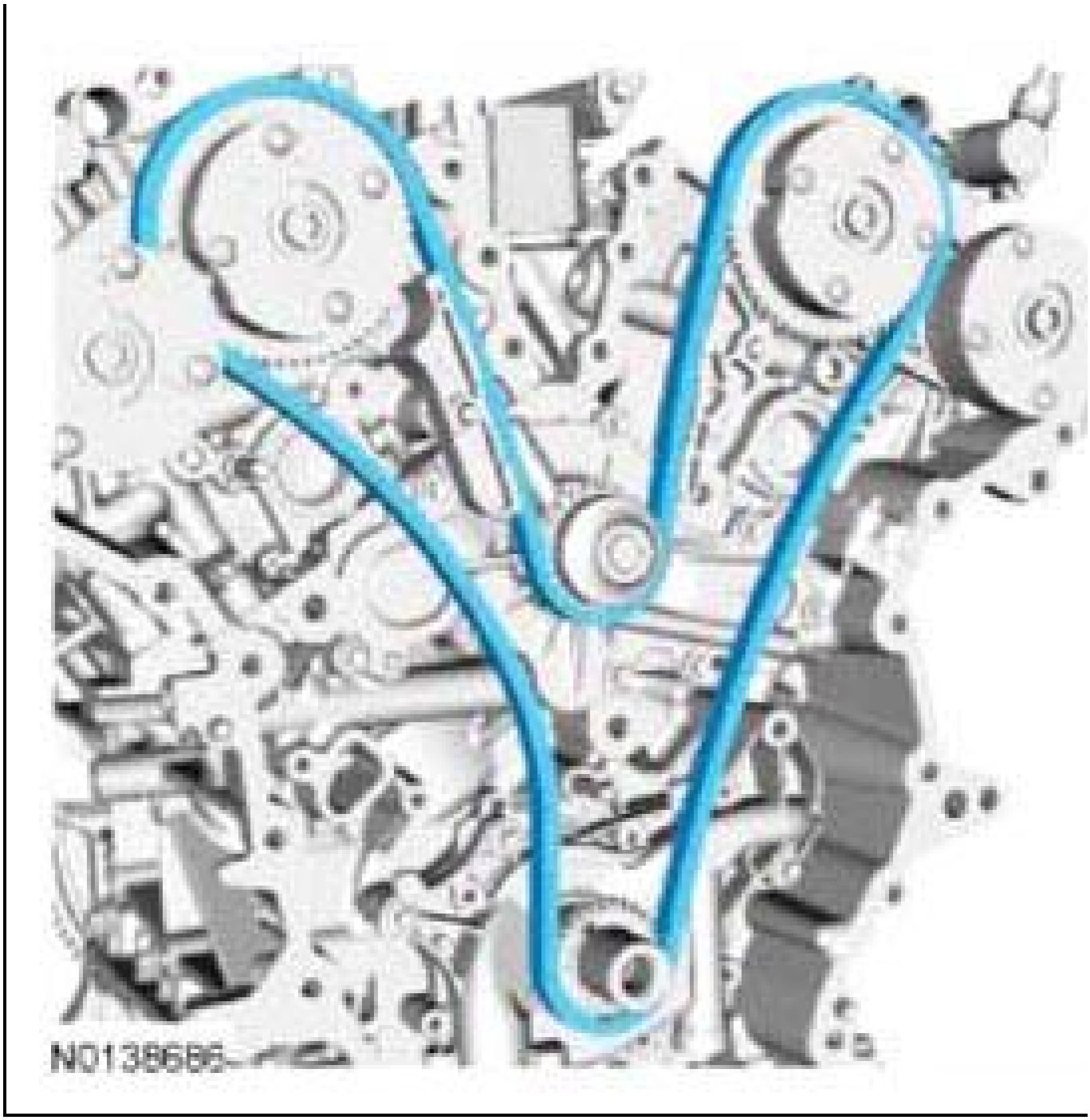
NOTE: Keep the VCT oil control solenoid clean of dirt and debris.

Remove the bolt and the RH intake **VCT** oil control solenoid.



99. Remove the primary timing chain.

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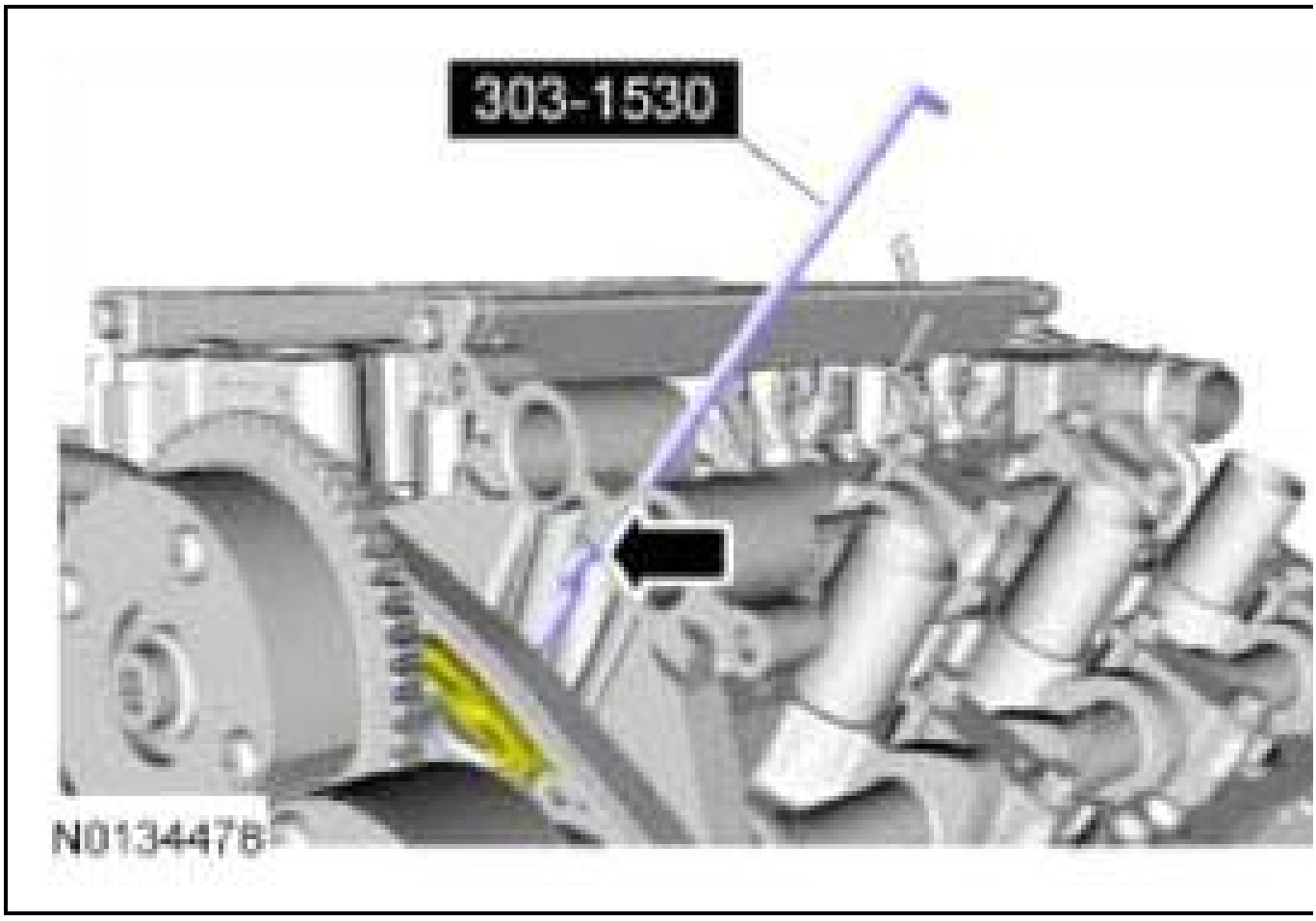
100. **NOTE:** **The following steps are to remove the LH camshafts.**

NOTE: **The 2 VCT oil control solenoids are removed for clarity.**

NOTE: **The 303-1530 is inserted through a hole in the top of the mega cap.**

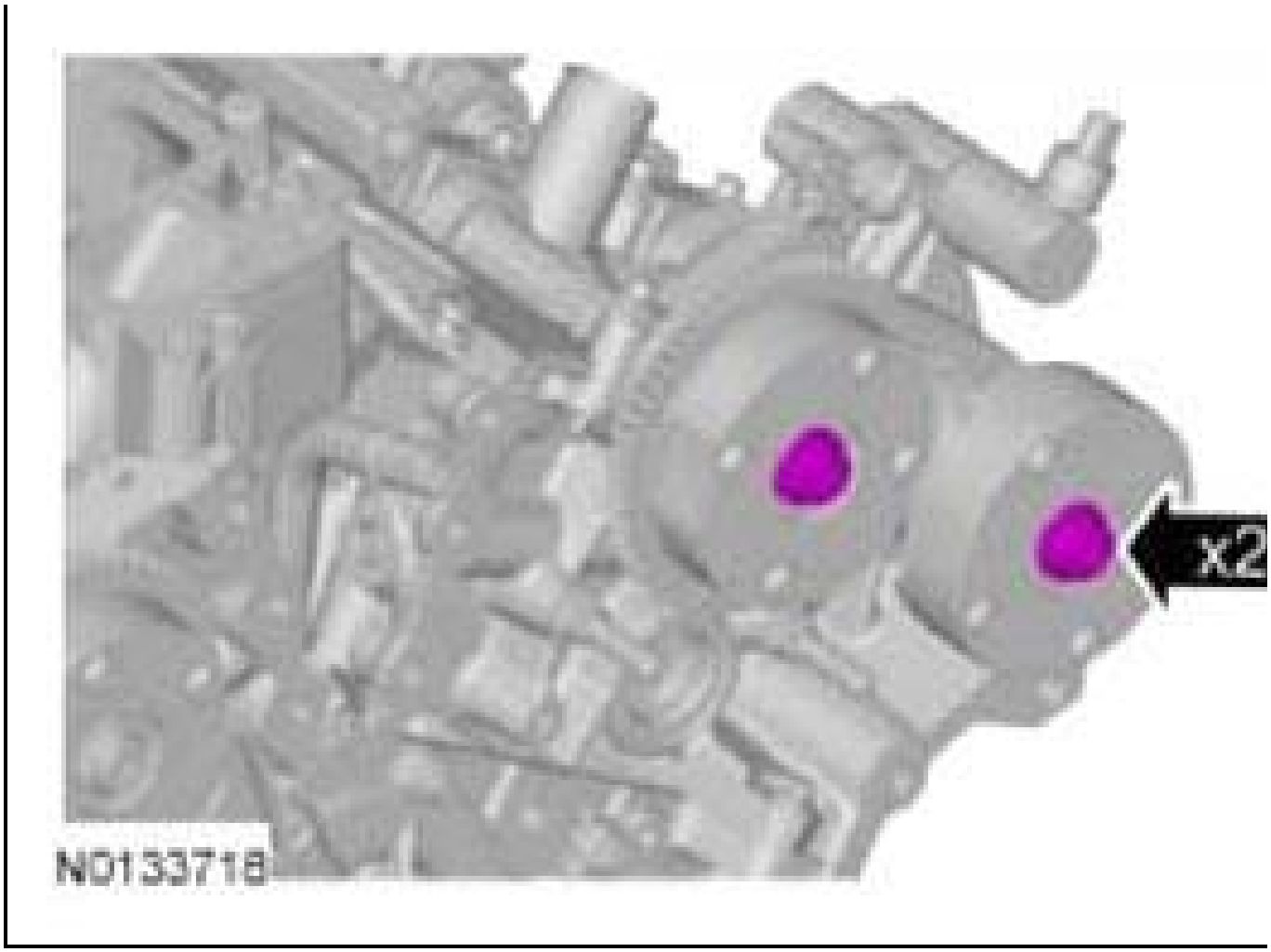
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Compress the LH secondary timing chain tensioner and install the 303-1530 in the hole on the rear of the secondary timing chain tensioner guide and let it hold against the mega cap to retain the tensioner in the collapsed position.



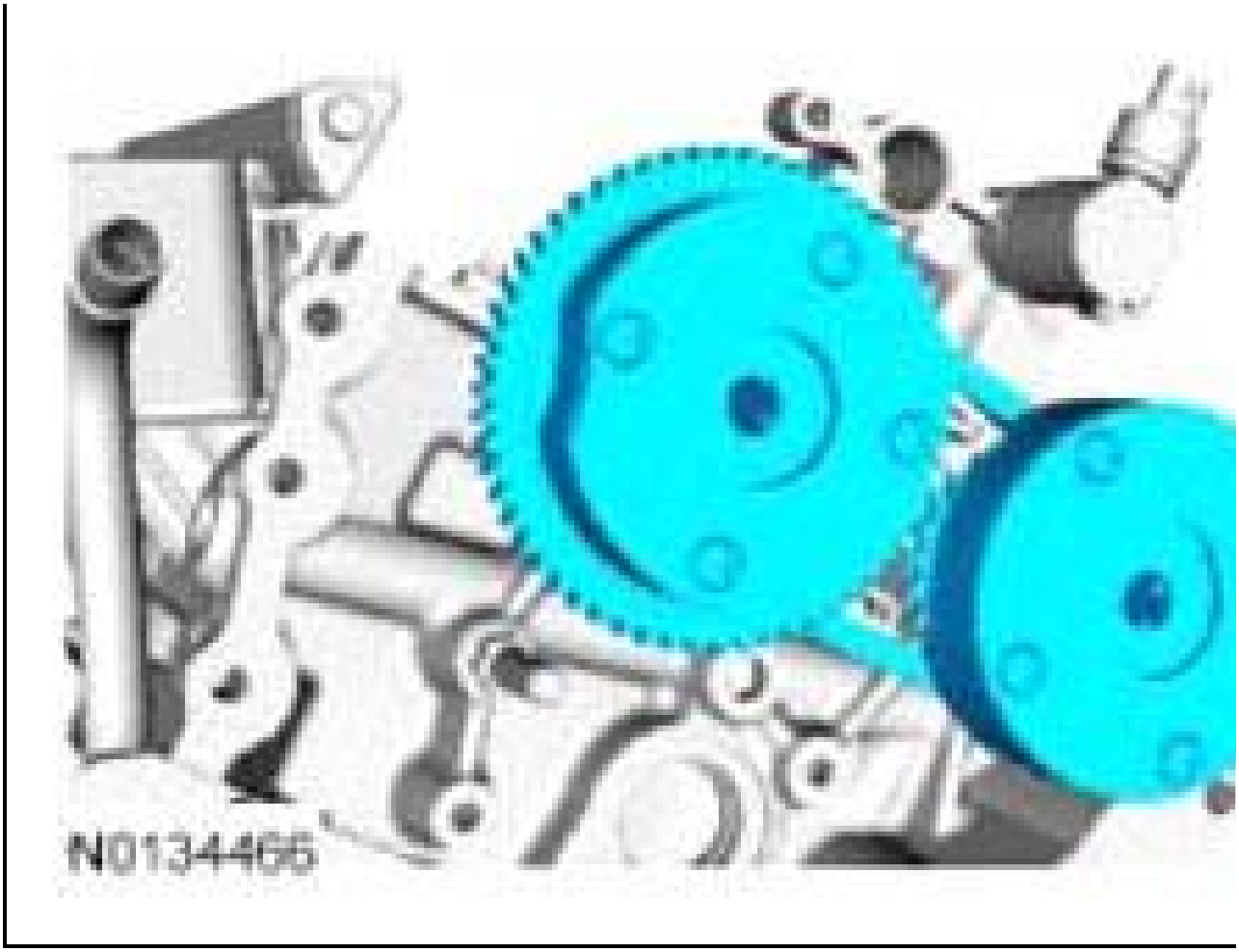
101. Remove and discard the 2 LH **VCT** assembly bolts.

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102. Remove the 2 LH **VCT** assemblies and secondary timing chain.
    - Remove the 303-1530.

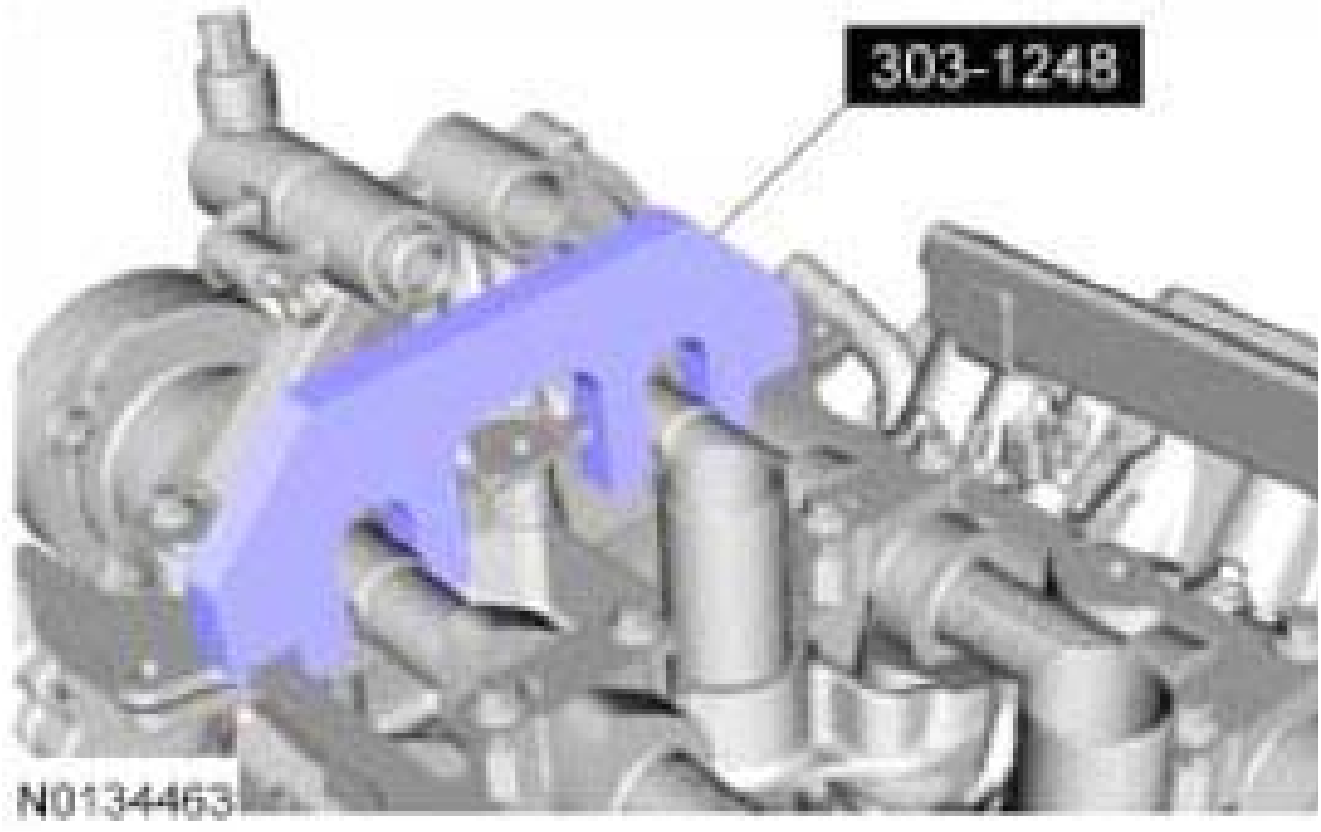
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103. **NOTE: When the 303-1248 is removed, valve spring pressure may rotate the LH camshafts approximately 3 degrees to a neutral position.**

Remove the 303-1248 from the LH camshafts.

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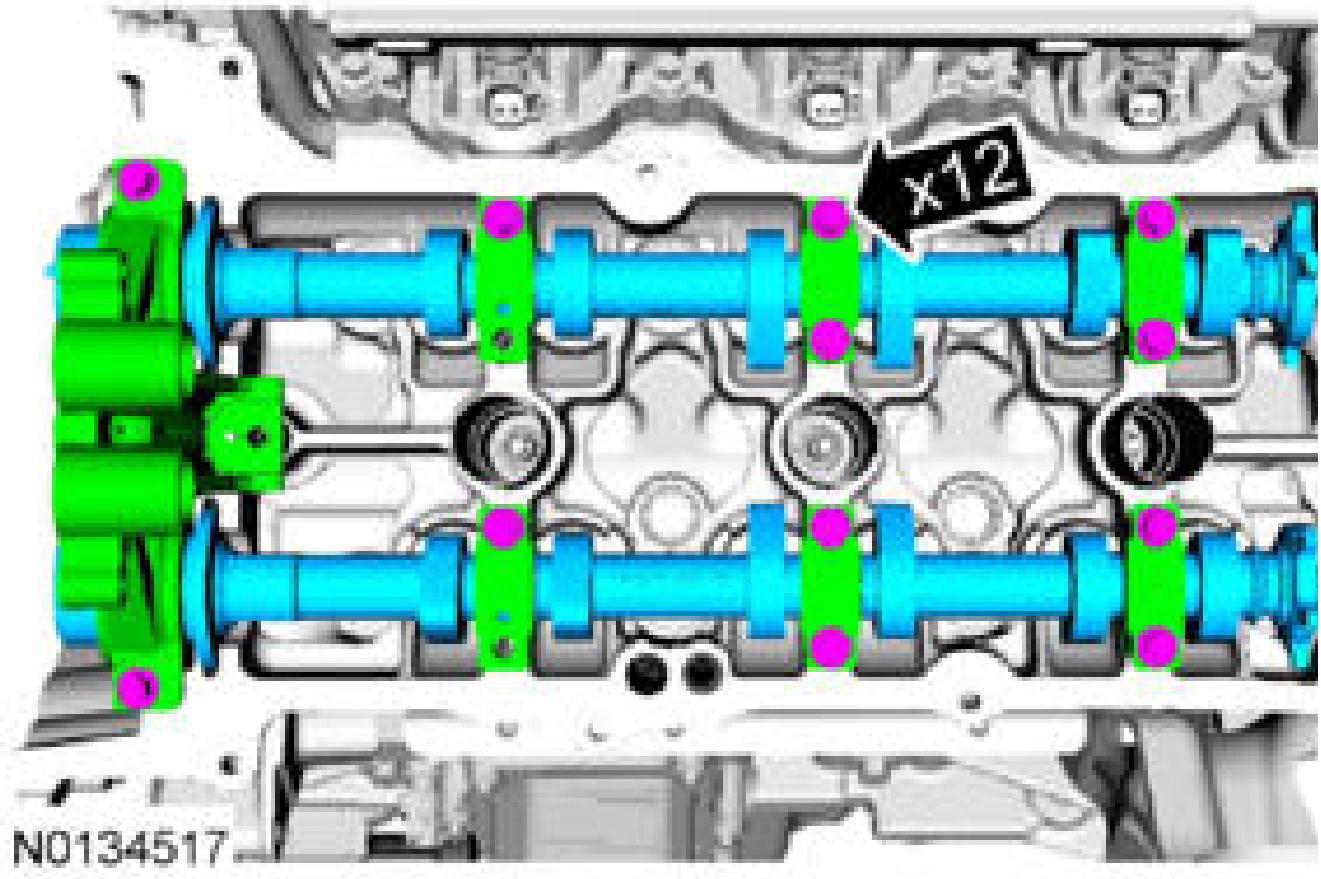
104.

NOTE: **Cylinder head camshaft bearing caps are numbered to verify that they are assembled in their original positions.**

NOTE: **Mark the exhaust and intake camshafts for installation into their original locations.**

Remove the 12 bolts, 6 camshaft caps, mega cap and the LH camshafts.

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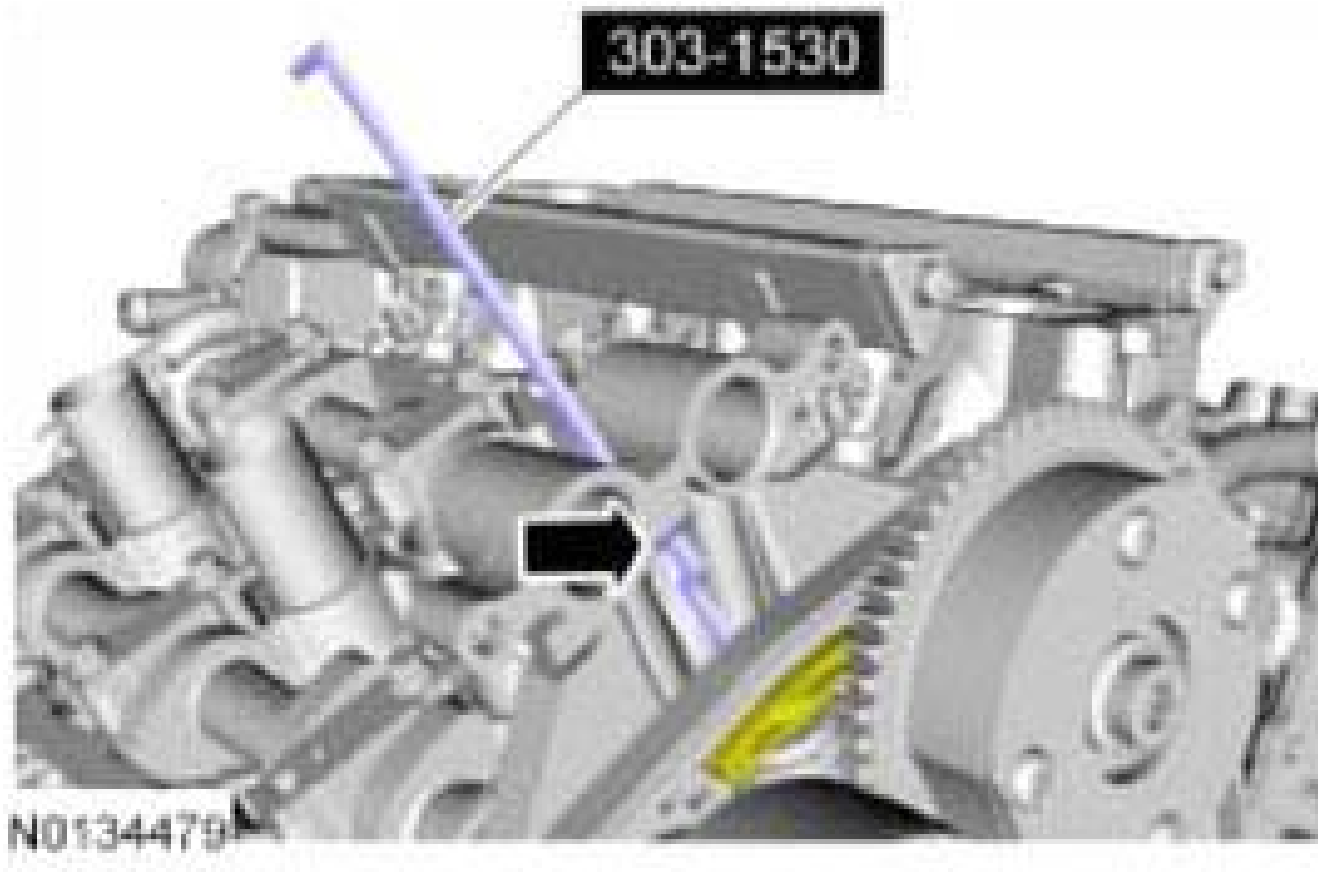
105. **NOTE: The following steps are to remove the RH camshafts.**

NOTE: The 2 VCT oil control solenoids are removed for clarity.

NOTE: The 303-1530 is inserted through a hole in the top of the mega cap.

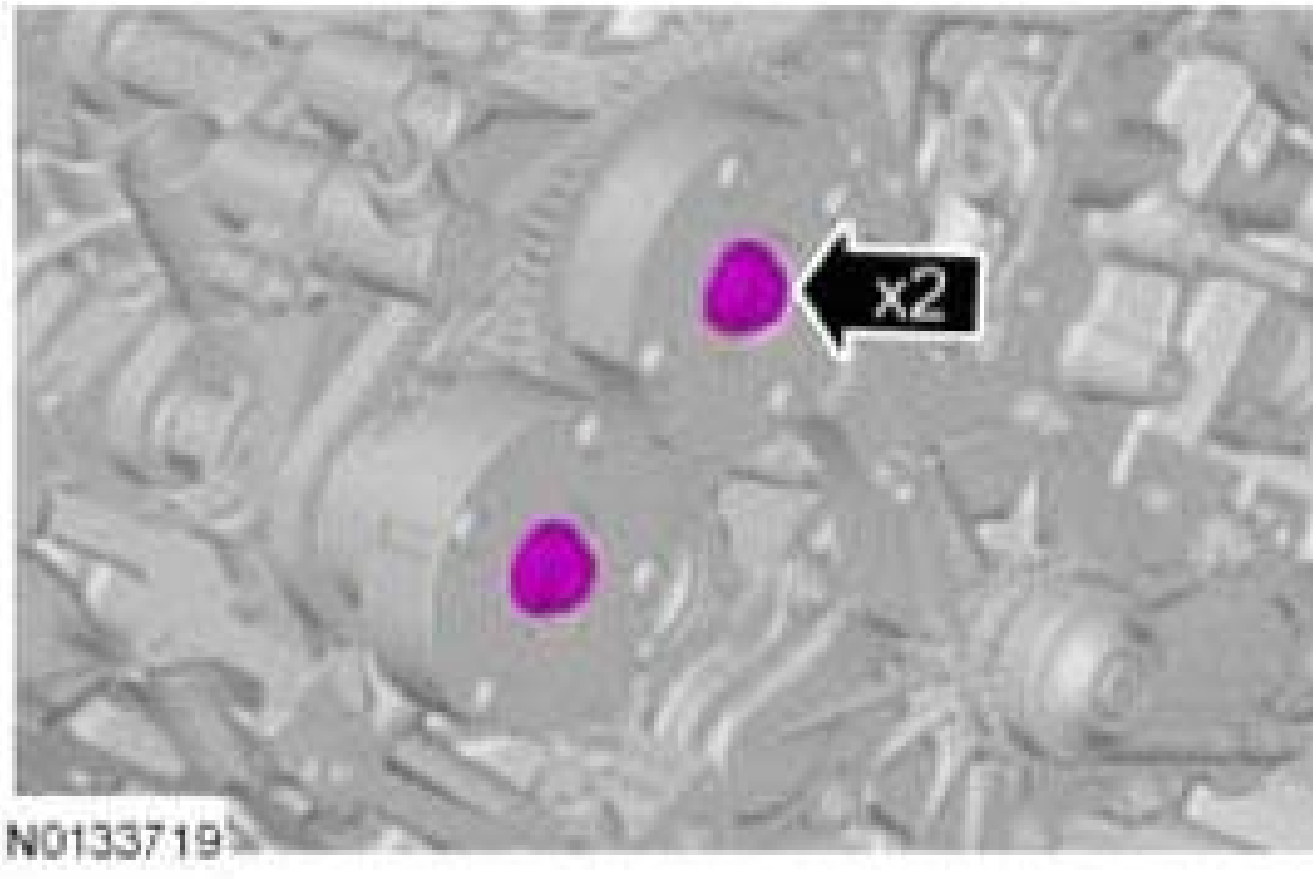
Compress the RH secondary timing chain tensioner and install the 303-1530 in the hole on the rear of the secondary timing chain tensioner guide and let it hold against the mega cap to retain the tensioner in the collapsed position.

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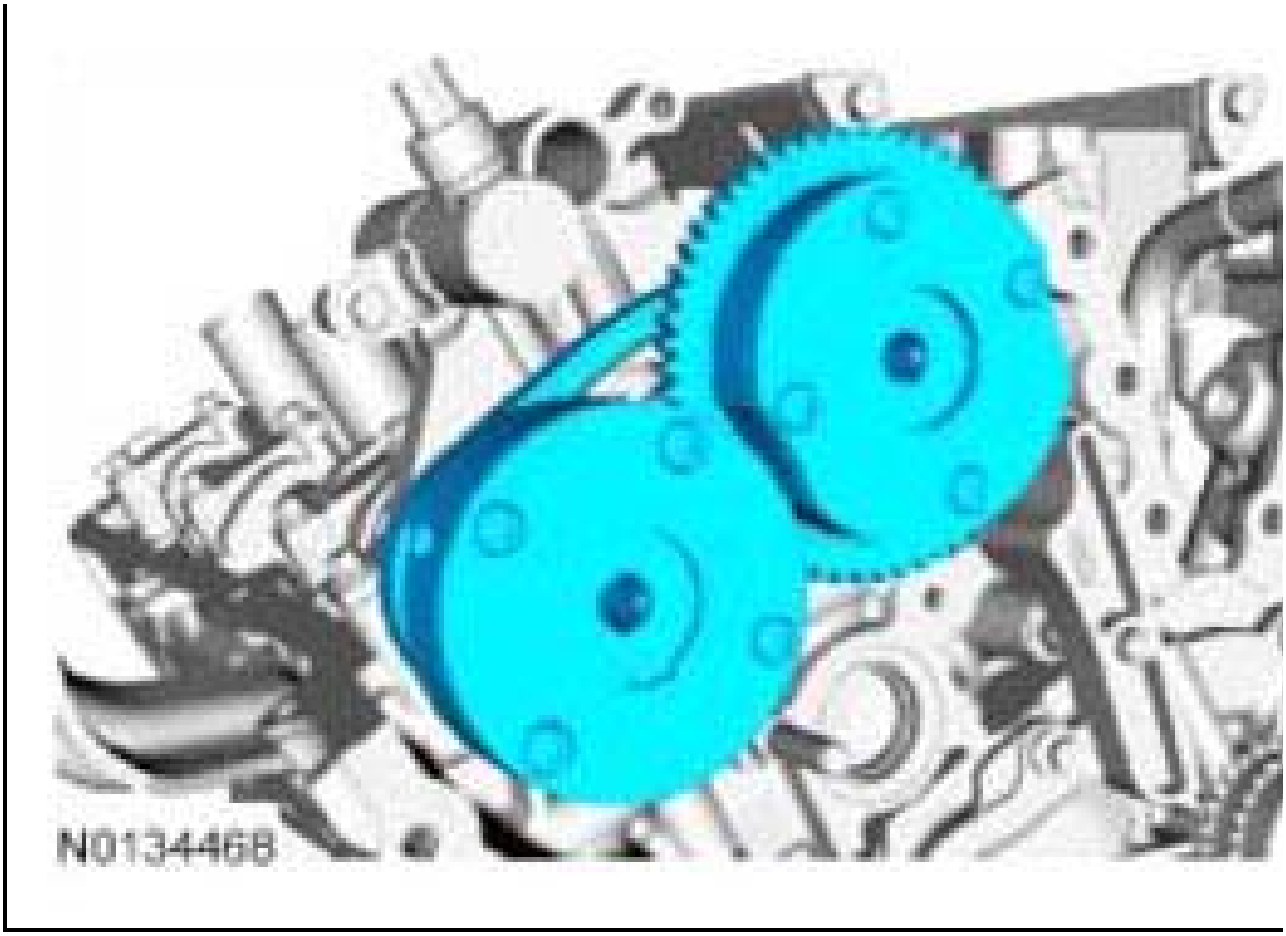
106. Remove and discard the 2 RH **VCT** assembly bolts.

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107. Remove the 2 RH **VCT** assemblies and secondary timing chain.
    - Remove the 303-1530.

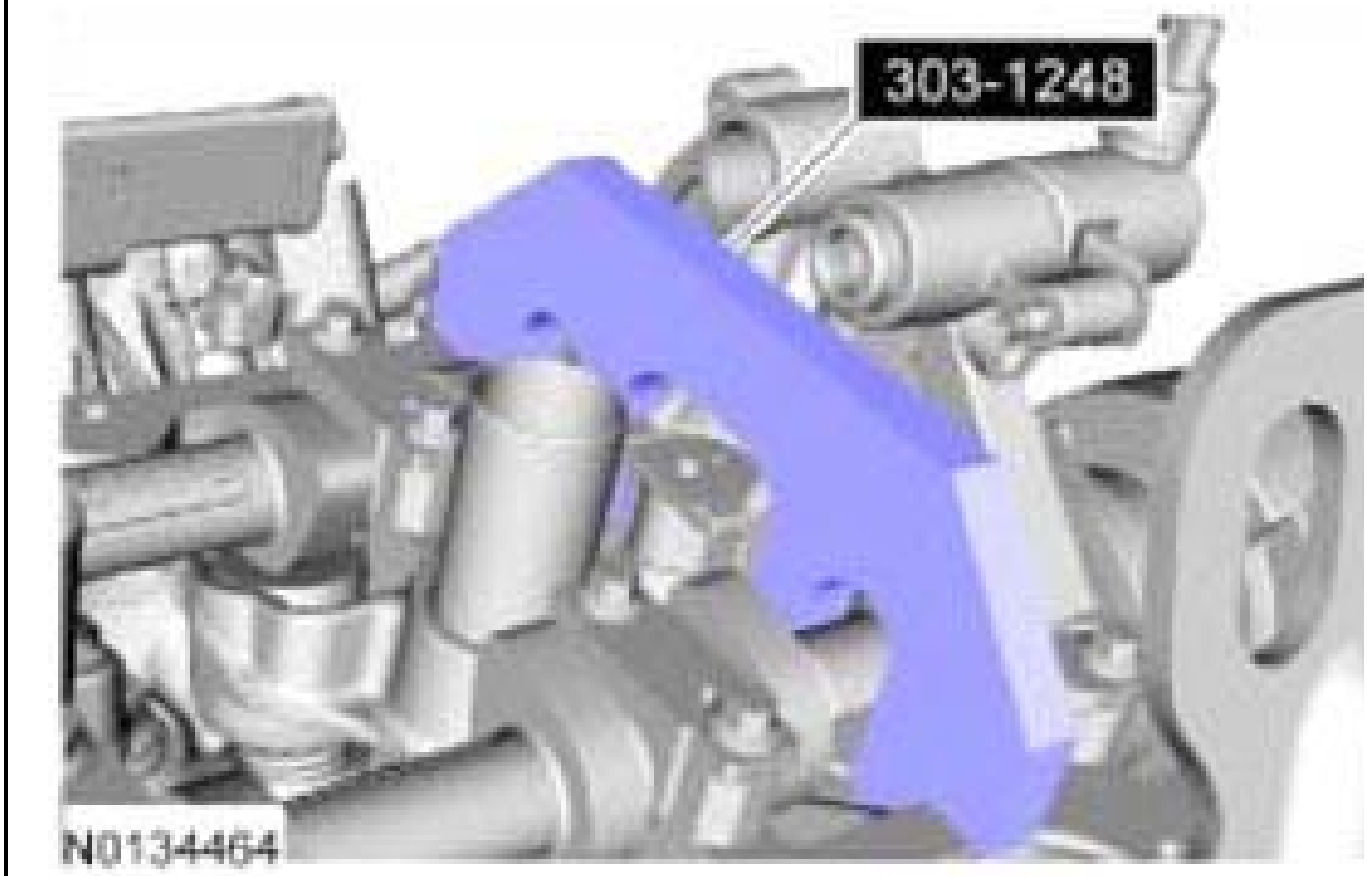
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NOTE: **When the 303-1248 is removed, valve spring pressure may rotate the RH camshafts approximately 3 degrees to a neutral position.**

108. Remove the 303-1248 from the RH camshafts.

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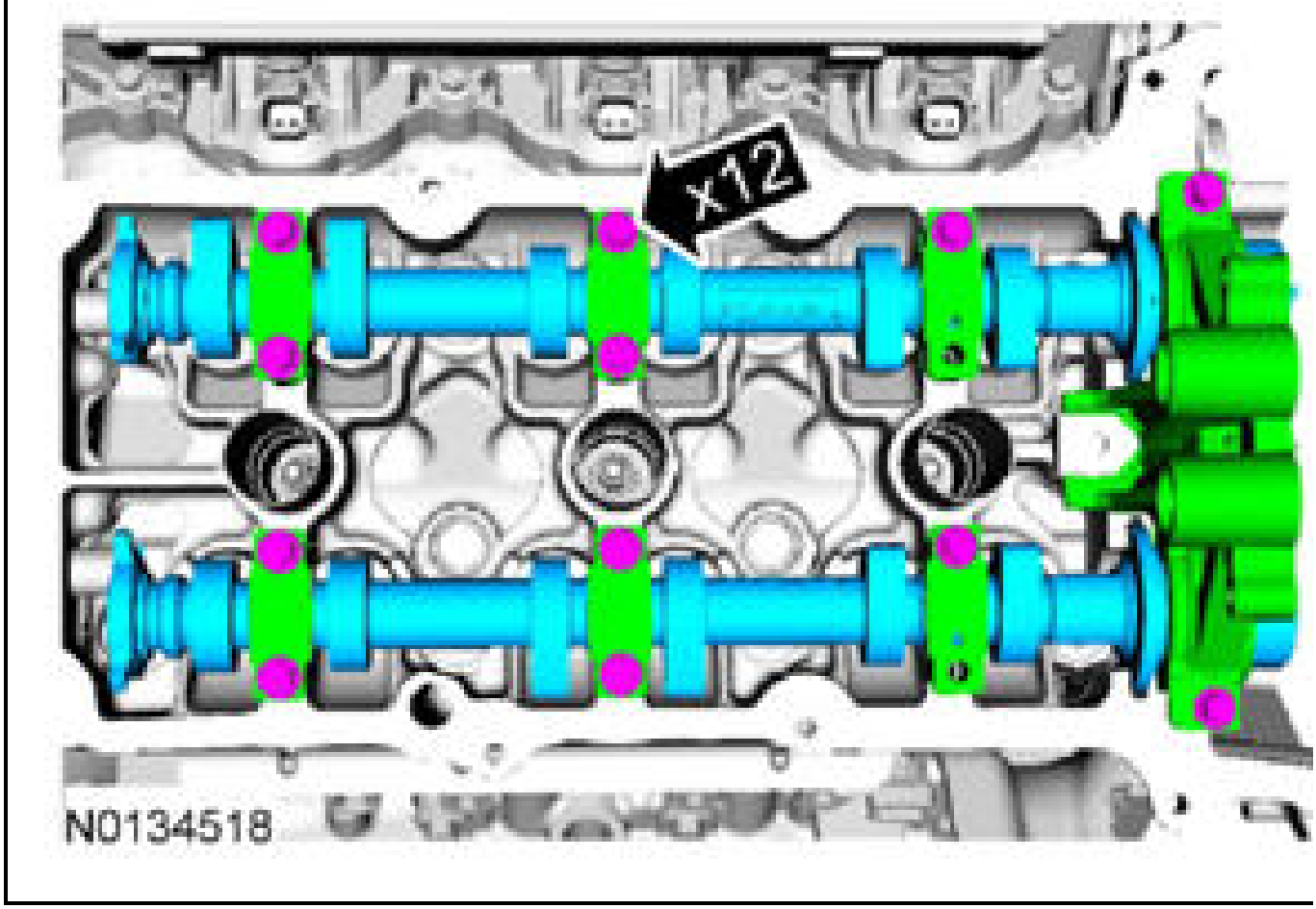
109.

NOTE: **Cylinder head camshaft bearing caps are numbered to verify that they are assembled in their original positions.**

NOTE: **Mark the exhaust and intake camshafts for installation into their original locations.**

Remove the 12 bolts, 6 camshaft caps, mega cap and the RH camshafts.

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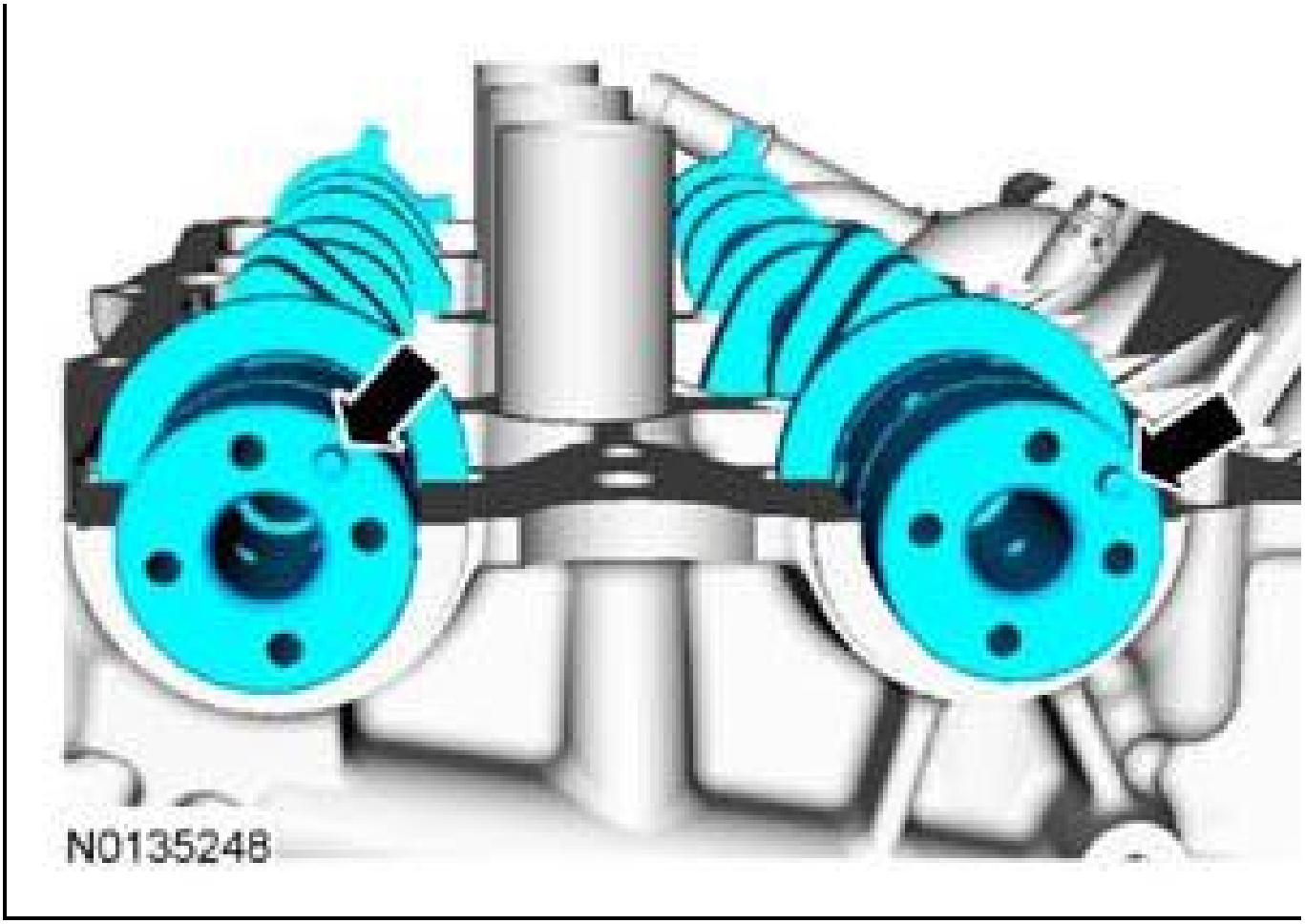
Installation

1. **NOTE: The following steps are for the RH camshafts only.**

   NOTE: Coat the camshafts with clean engine oil prior to installation.

   Position the camshafts onto the RH cylinder head in the neutral position as shown in illustration.

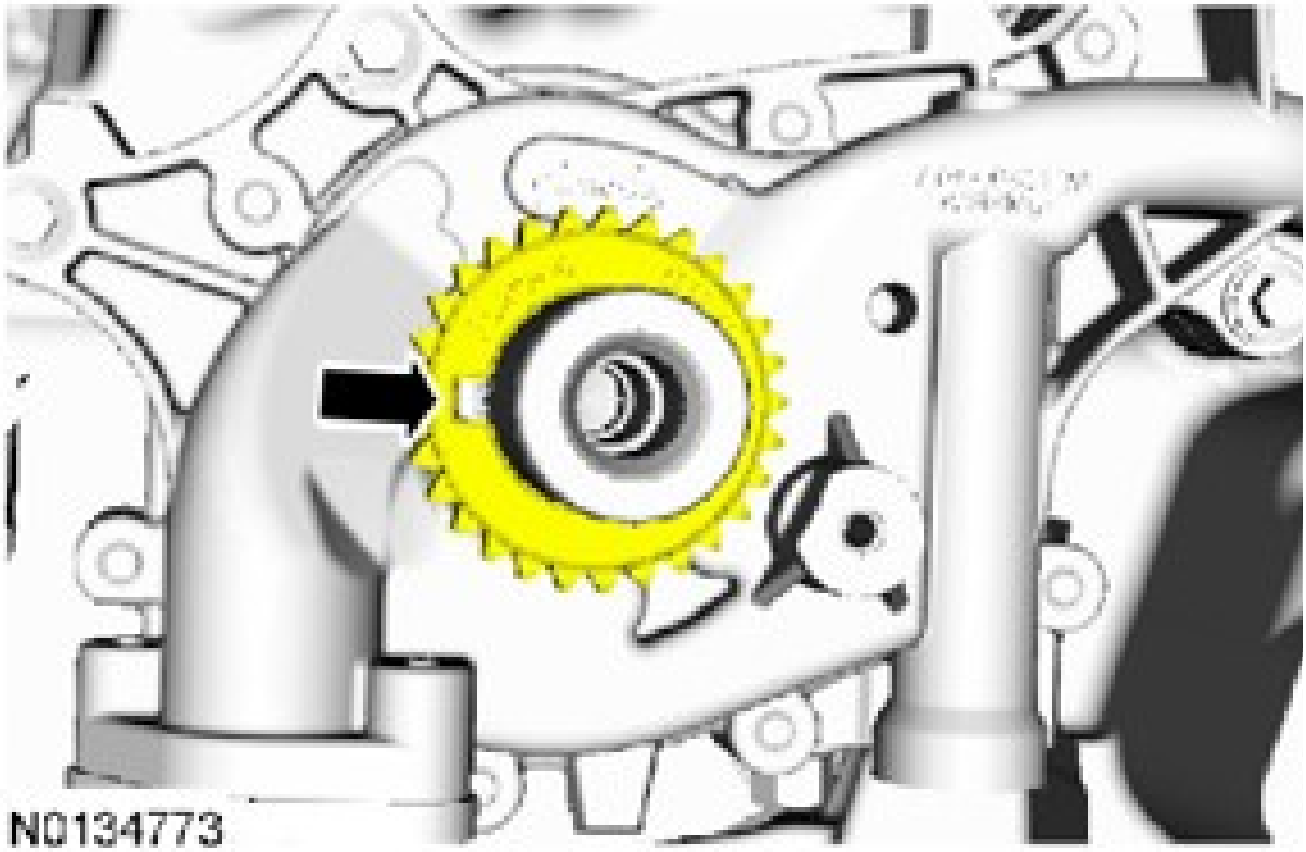
 © 2011 Mitchell Repair Information Company, LLC.



NOTE: **The crankshaft must remain in the freewheeling position (crankshaft dowel pin at 9 o'clock) until after the camshafts are installed and the valve clearance is checked/adjusted. Do not turn the crankshaft until instructed to do so. Failure to follow this process will result in severe engine damage.**

2. Rotate the crankshaft counterclockwise until the crankshaft dowel pin is in the 9 o'clock position.

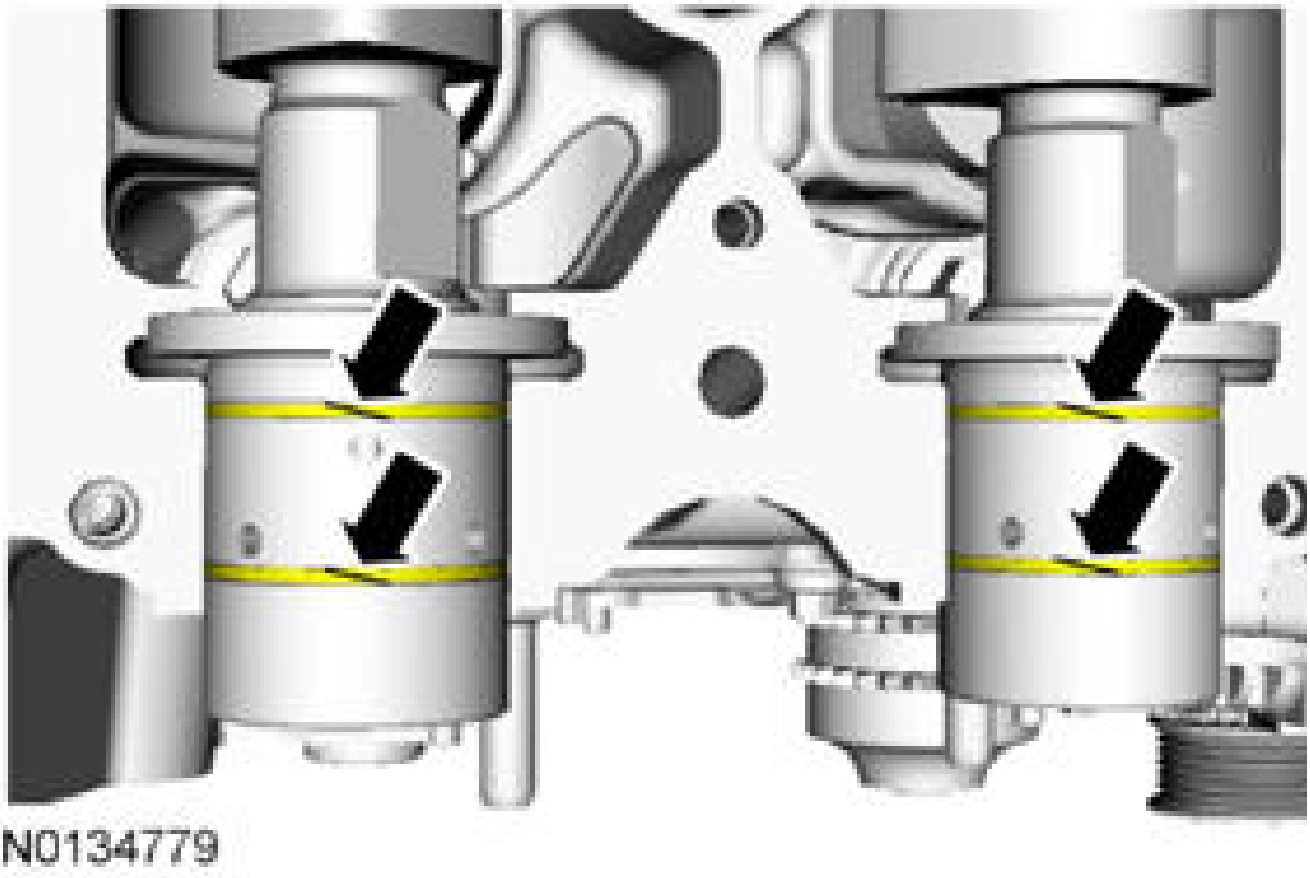
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3. **NOTE: The camshaft seal gaps must be at the 12 o'clock position or damage to the engine may occur.**

Position the 4 camshaft seals gaps as shown in illustration.

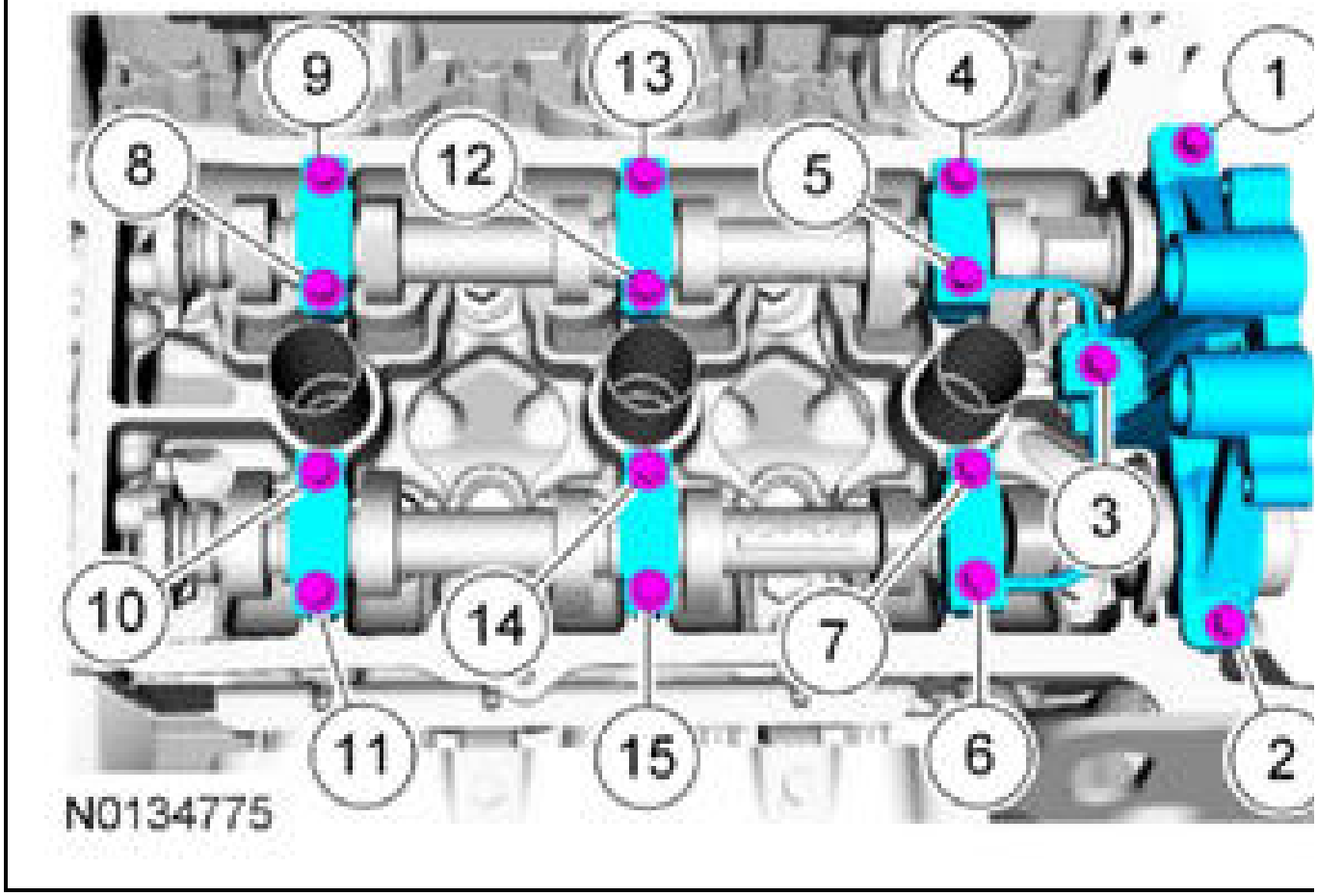
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NOTE: Cylinder head camshaft bearing caps are numbered to verify that they are assembled in their original positions.

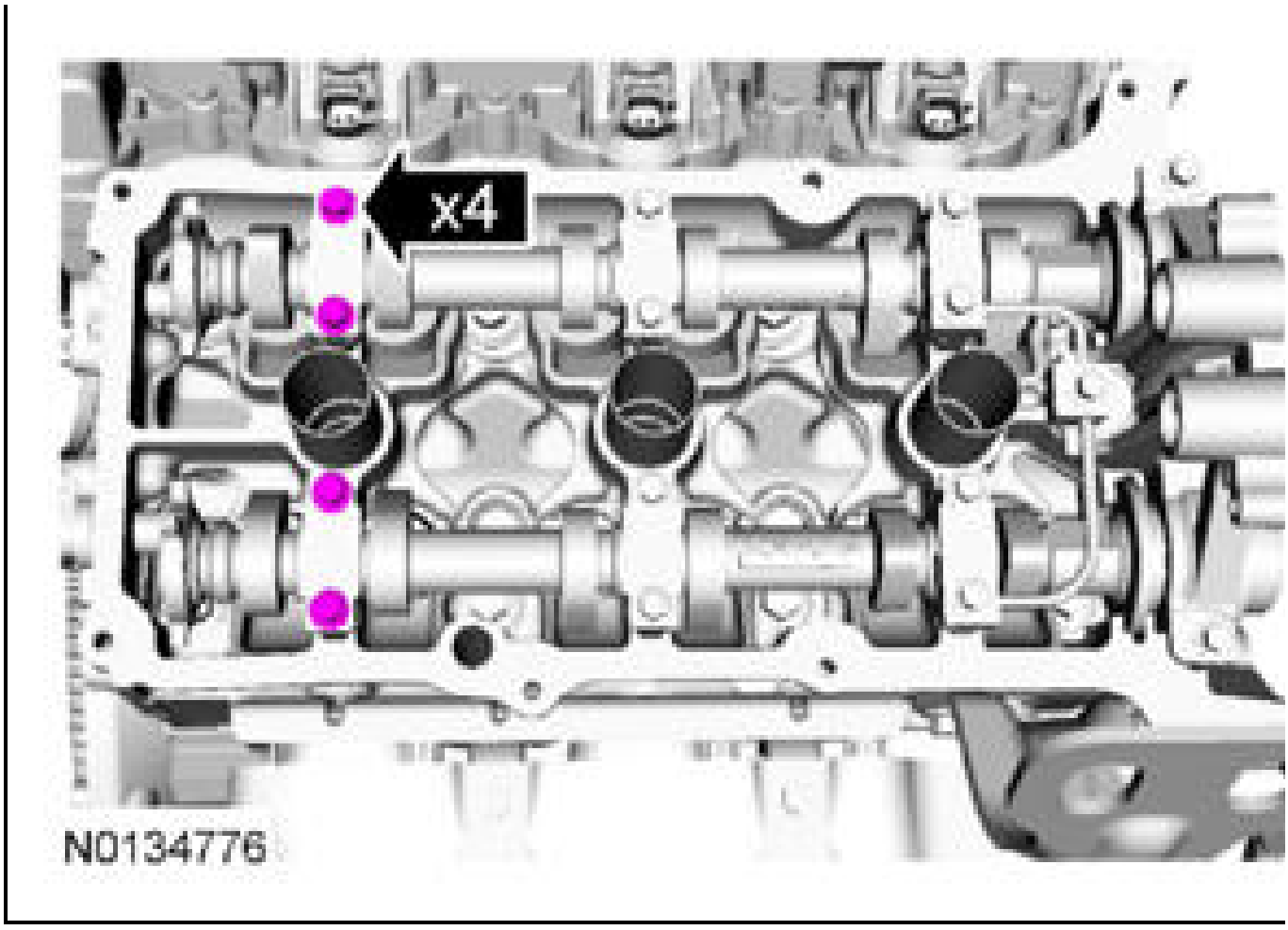
4. Install the 6 camshaft caps, mega cap, valve train oil tube and the 15 bolts in the sequence shown in illustration.

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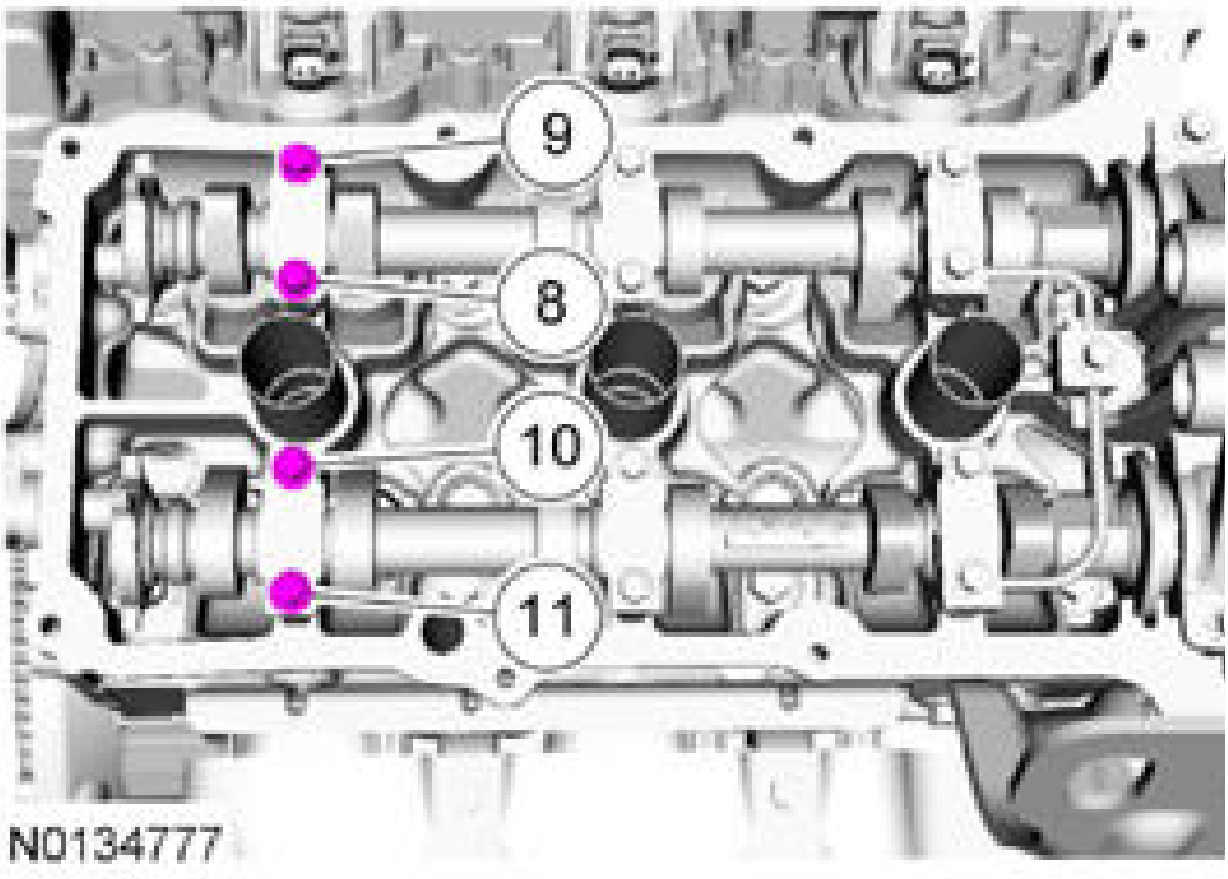
5. Loosen the 4 camshaft caps bolts.

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6. Tighten the 4 bolts in the sequence shown in illustration.
    - Tighten bolts 8, 9, 10 and 11 to 8 Nm (71 lb-in) then an additional 45 degrees.

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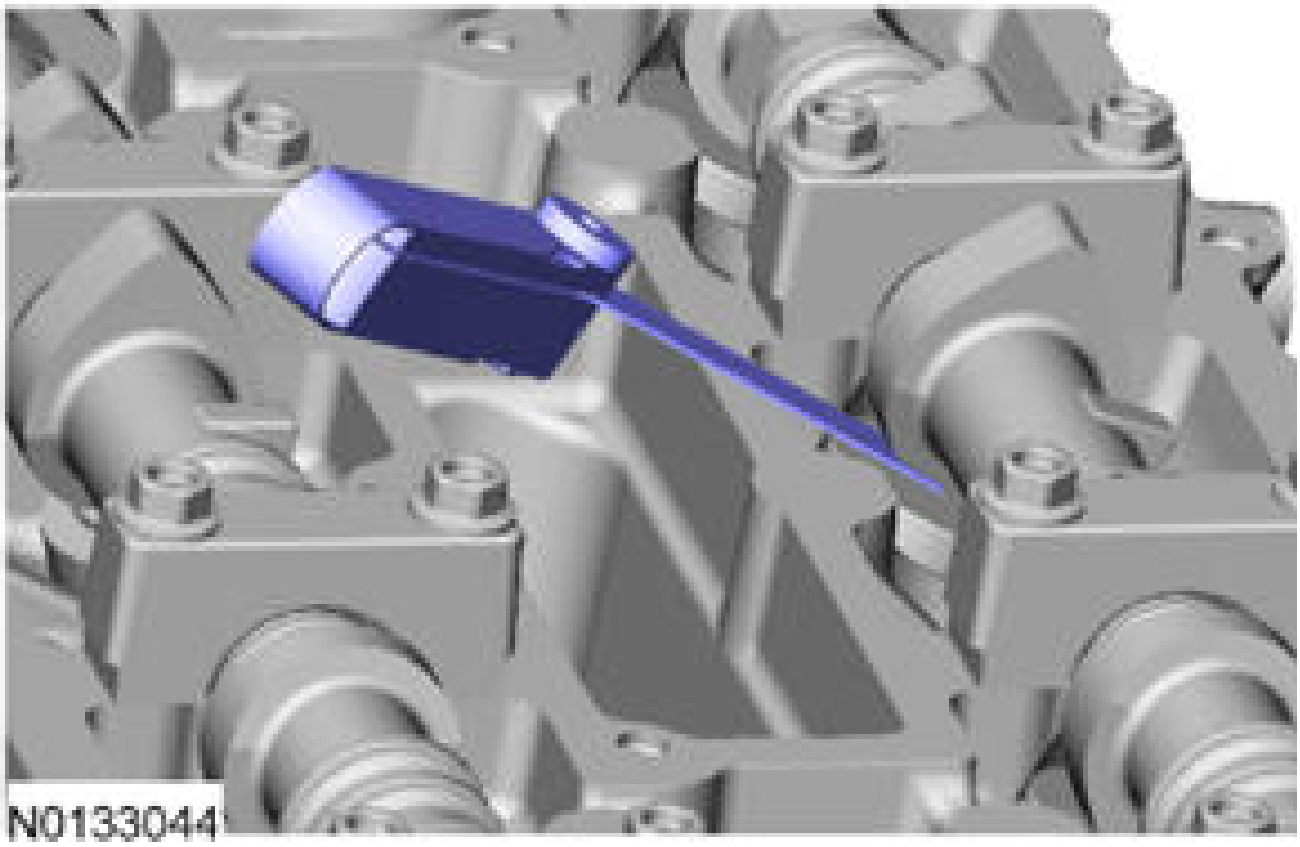
7.

NOTE: If any components are installed new, the engine valve clearance must be checked/adjusted or engine damage may occur.

NOTE: Use a camshaft sprocket bolt to turn the camshafts.

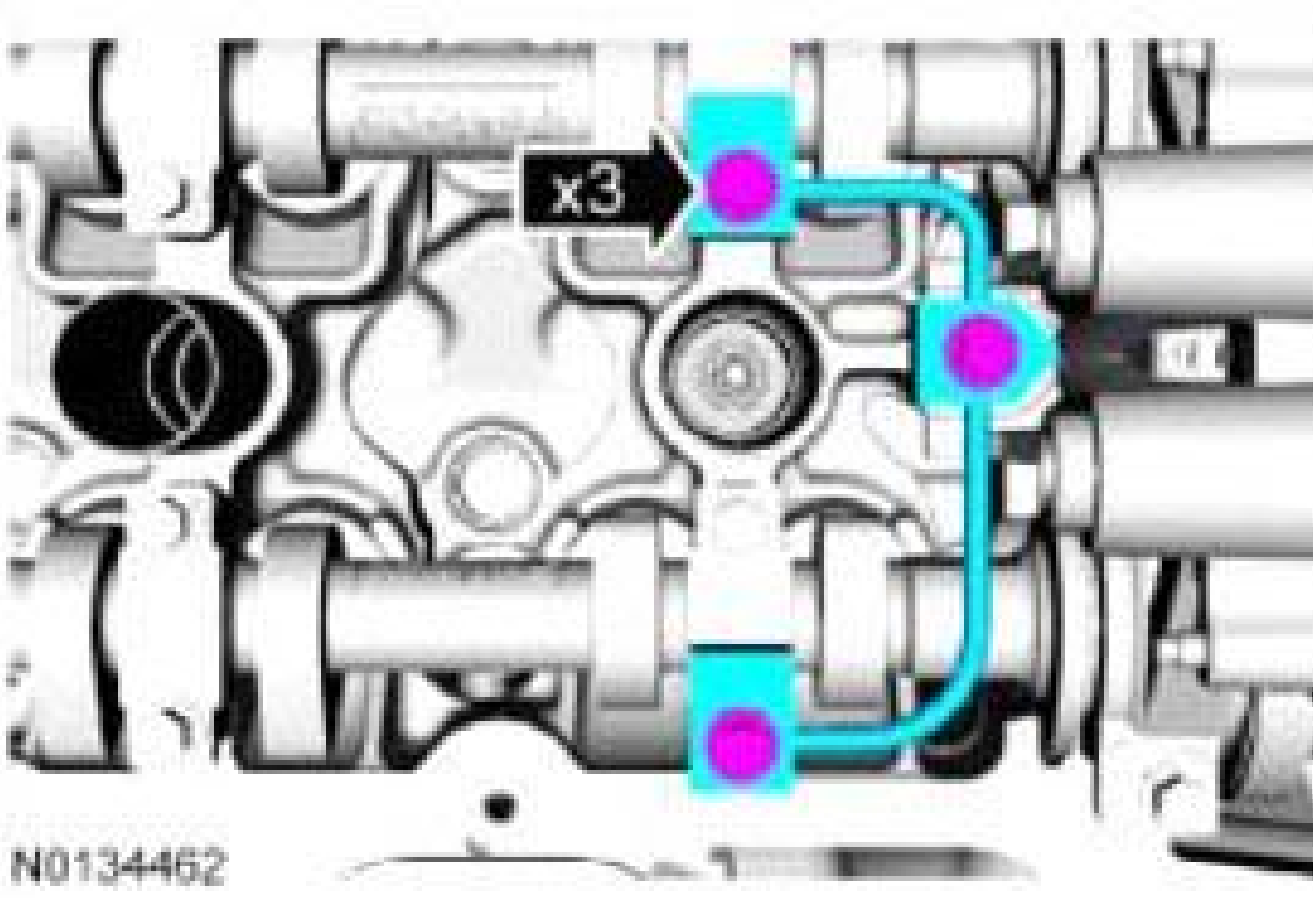
Using a feeler gauge, confirm that the valve tappet clearances are within specification. If valve tappet clearances are not within specification, the clearance must be adjusted by installing new valve tappet (s) of the correct size. Refer to **VALVE CLEARANCE CHECK**.

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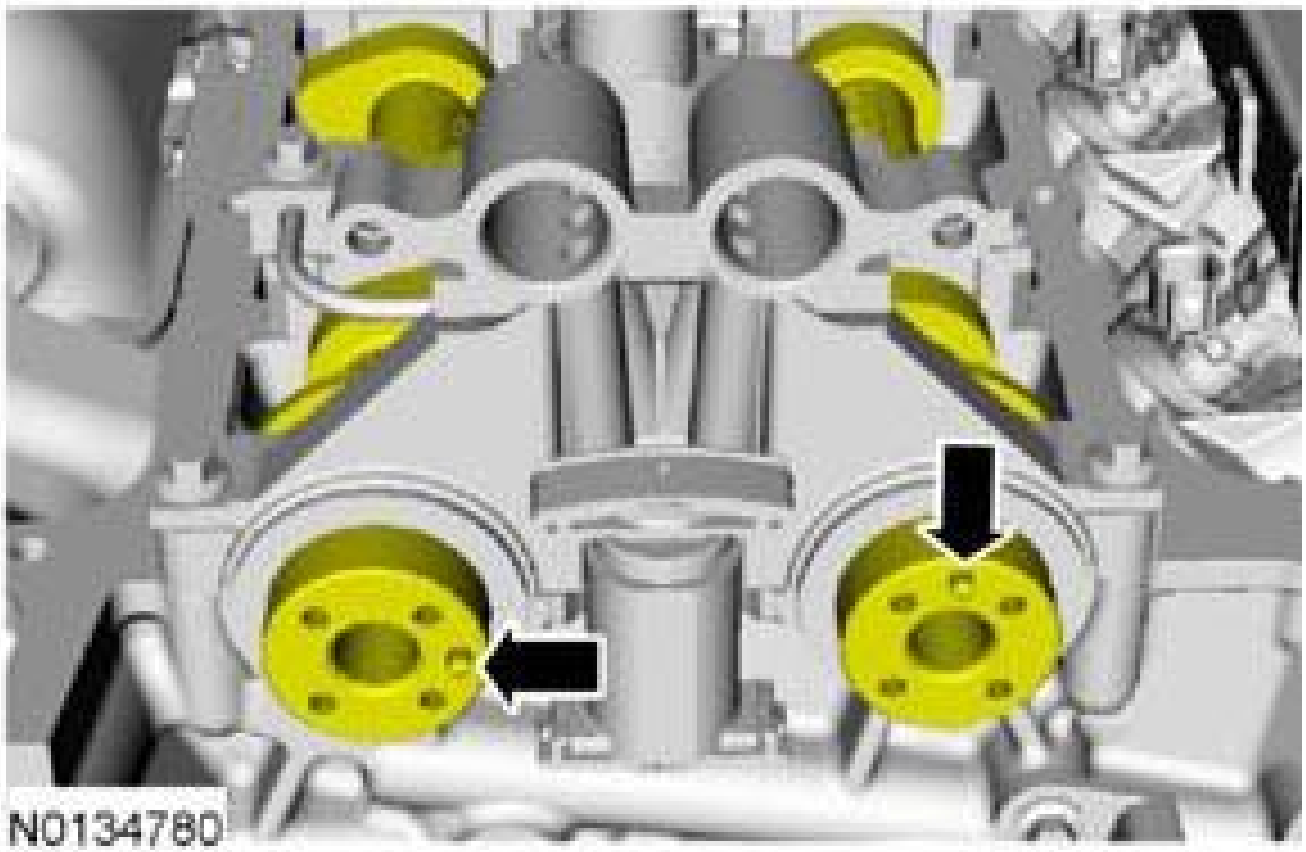
8. Remove the 3 bolts and the RH valve train oil tube.

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9. Rotate the RH camshafts to the **TDC** position as shown in illustration.

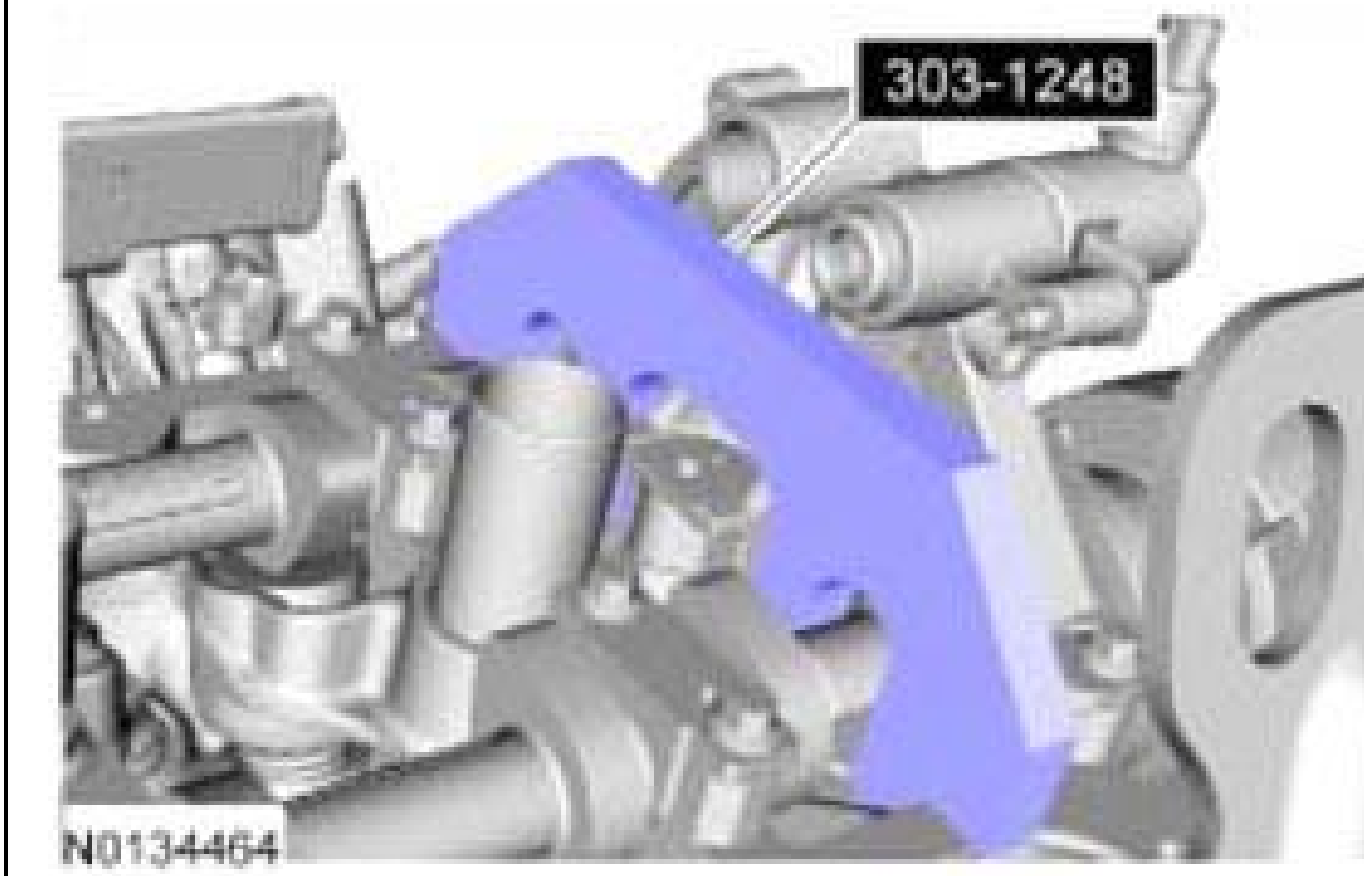
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10. **NOTE: The 303-1248 will hold the camshafts in the TDC position.**

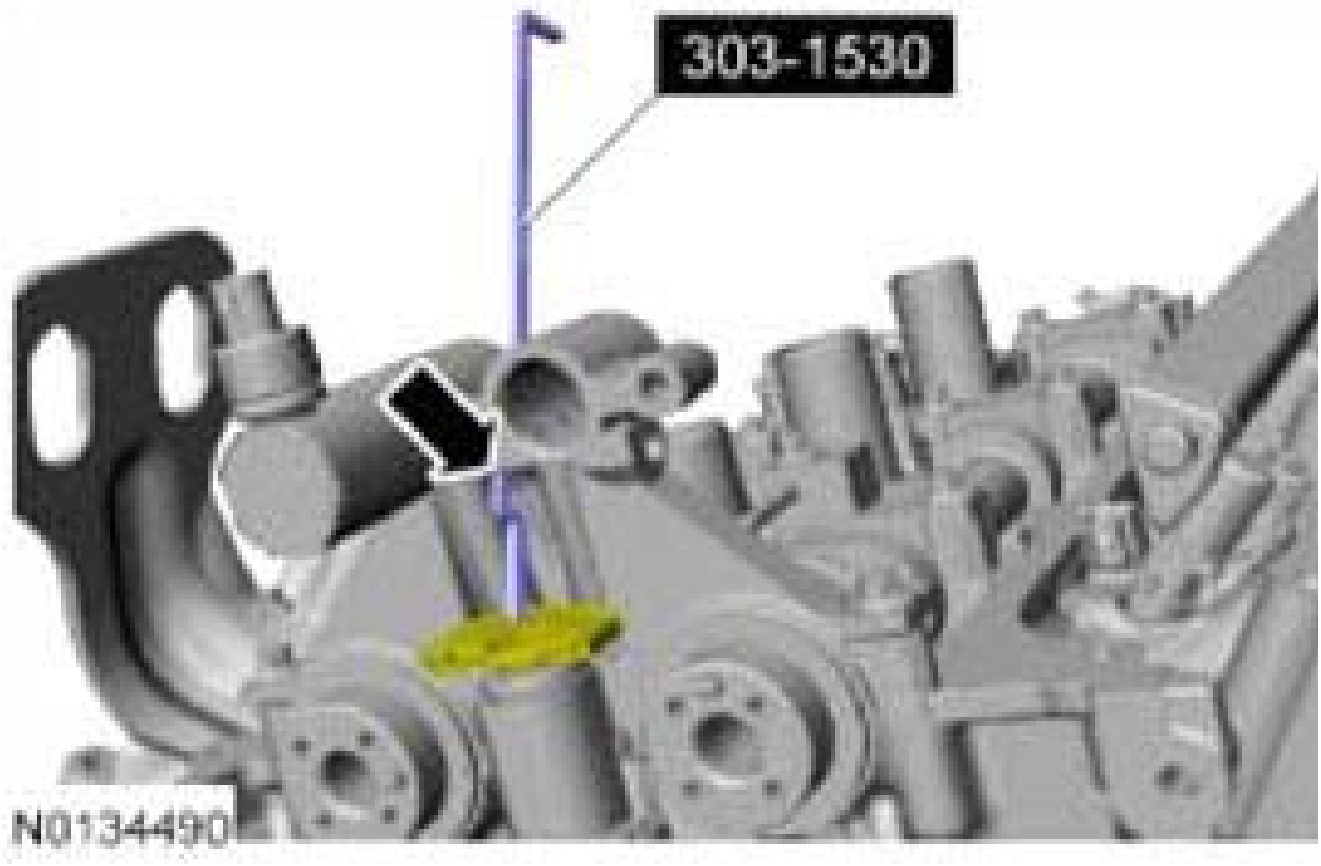
Install 303-1248 onto the flats of the RH camshafts.

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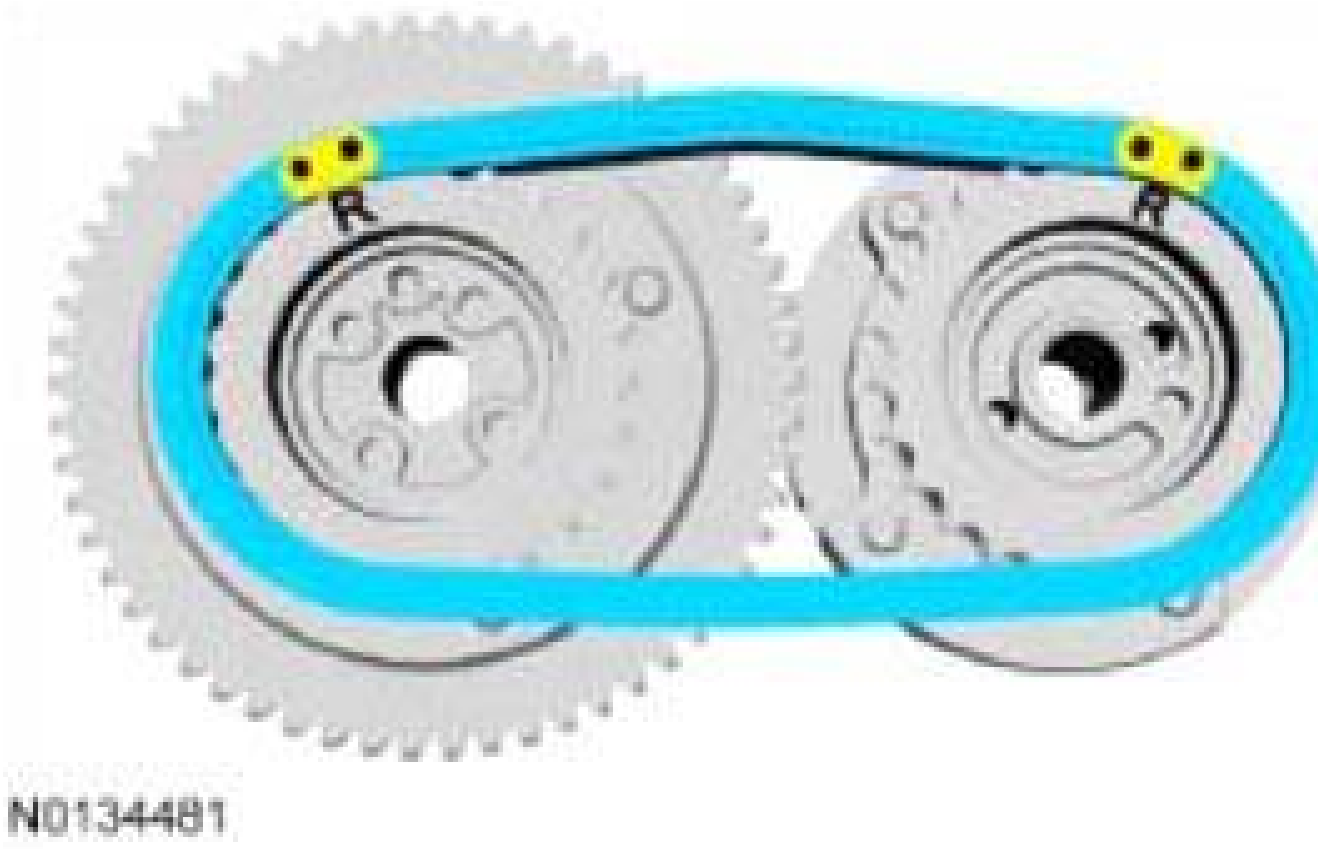
11. Compress the RH secondary timing chain tensioner and install the 303-1530 to retain the tensioner in the collapsed position.

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12. Assemble the RH **VCT** assembly, the RH exhaust camshaft sprocket and the RH secondary timing chain. Align the colored links with the timing marks.

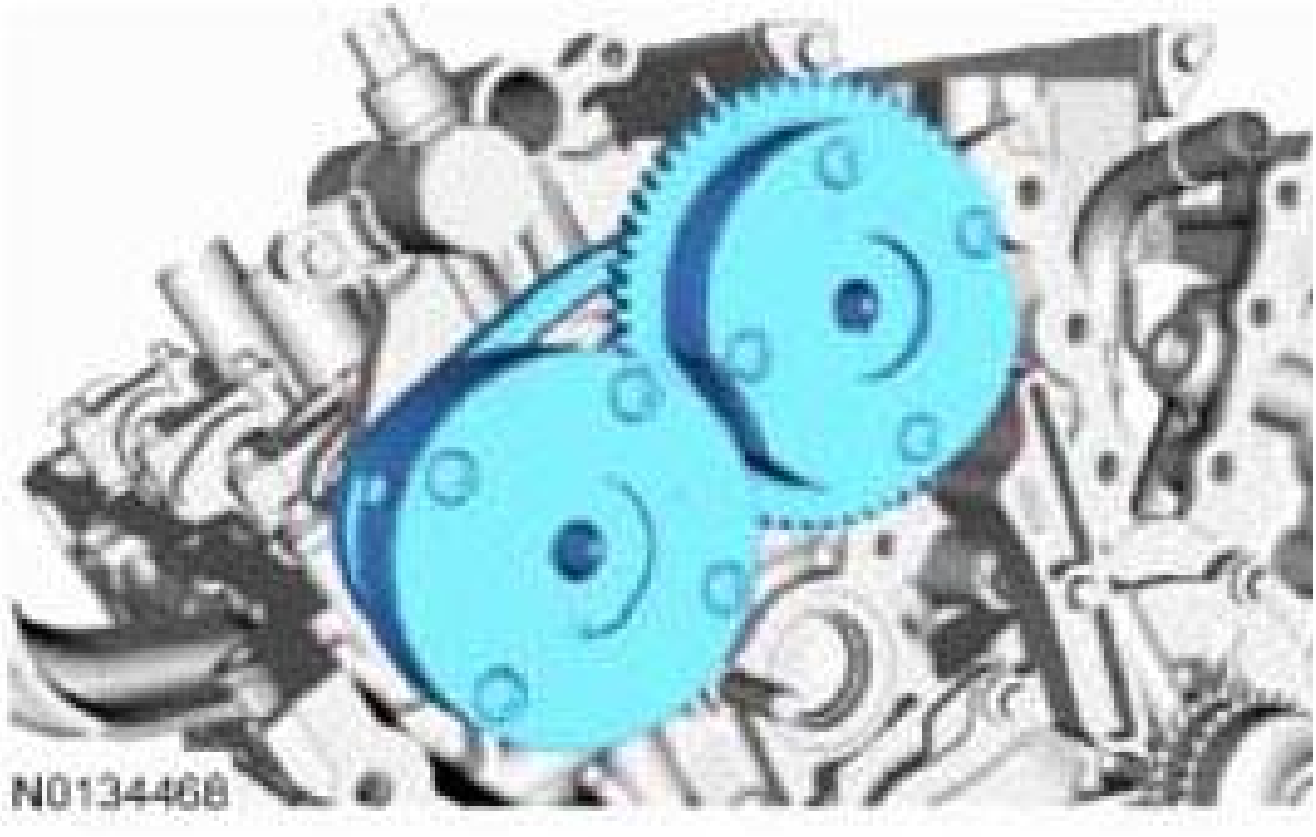
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13. **NOTE: It may be necessary to rotate the camshafts slightly, to install the RH secondary timing assembly.**

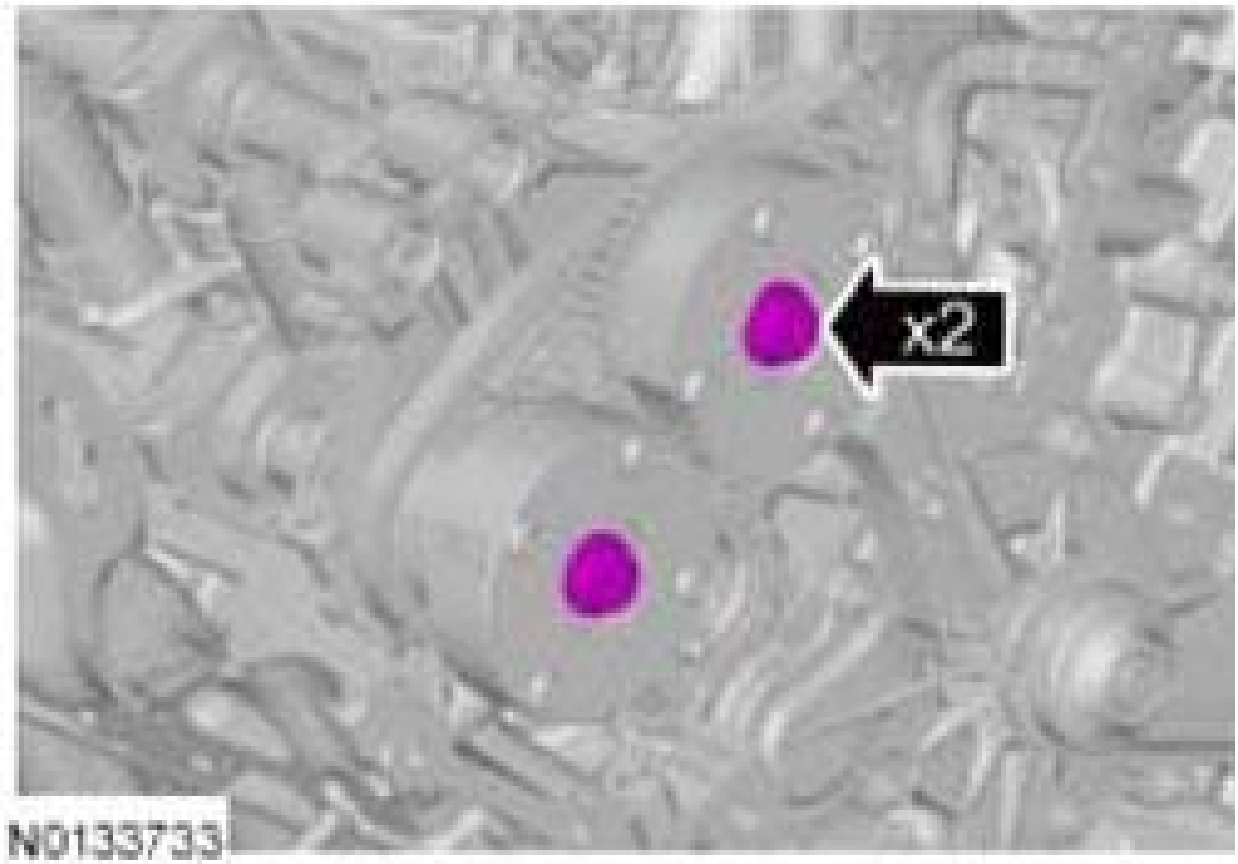
Position the 2 RH **VCT** assemblies and secondary timing chain onto the camshafts by aligning the holes in the **VCT** assemblies with the dowel pins in the camshafts.

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14. Install the 2 new RH **VCT** bolts and tighten in 4 stages.
    - Stage 1: Tighten to 40 Nm (30 lb-ft).
    - Stage 2: Loosen one full turn.
    - Stage 3: Tighten to 25 Nm (18 lb-ft).
    - Stage 4: Tighten an additional 180 degrees.

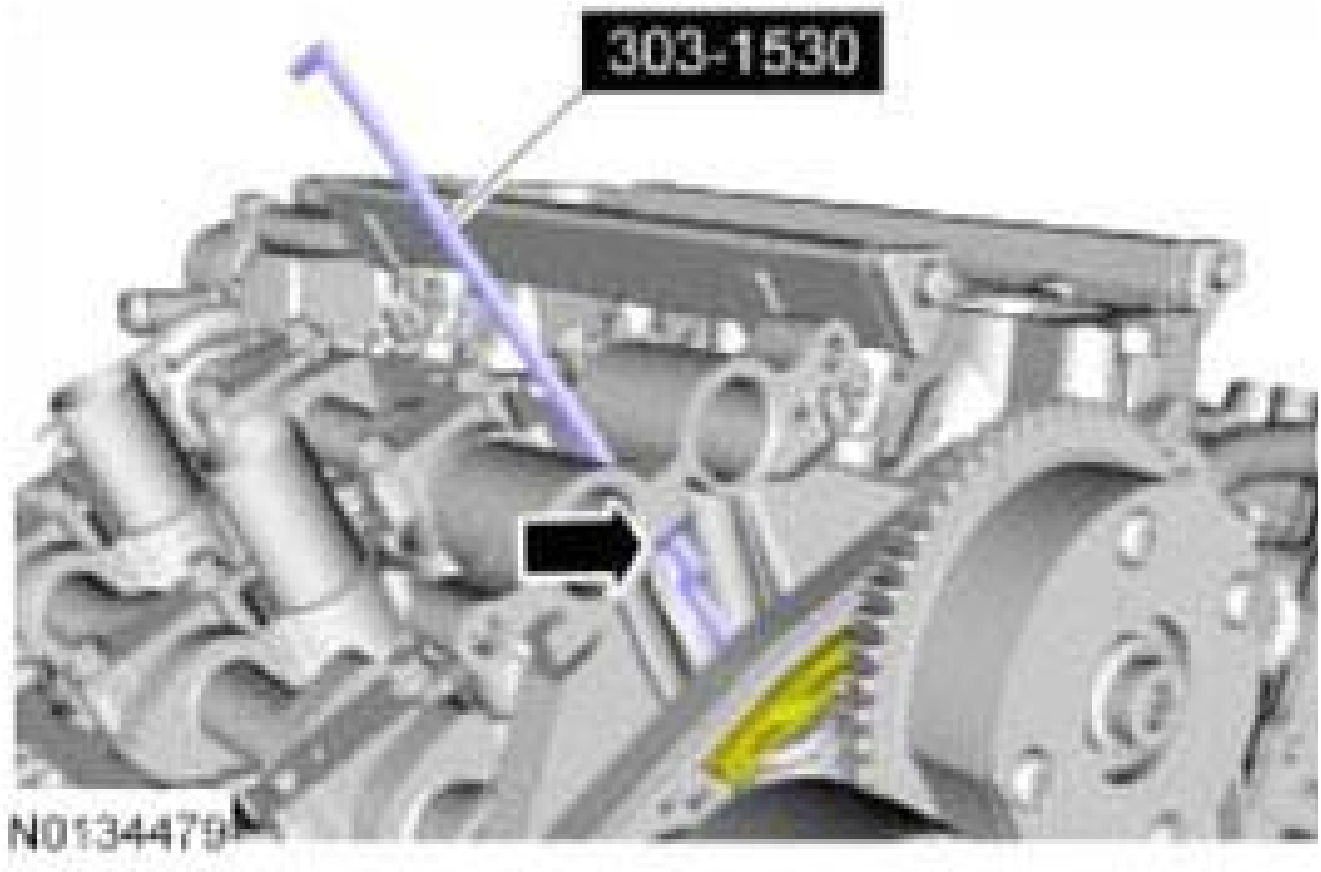
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15. **NOTE: The 2 VCT oil control solenoids are removed for clarity.**

Compress the RH secondary timing chain tensioner and remove the 303-1530. Make sure the secondary timing chain is centered on the timing chain tensioner guides.

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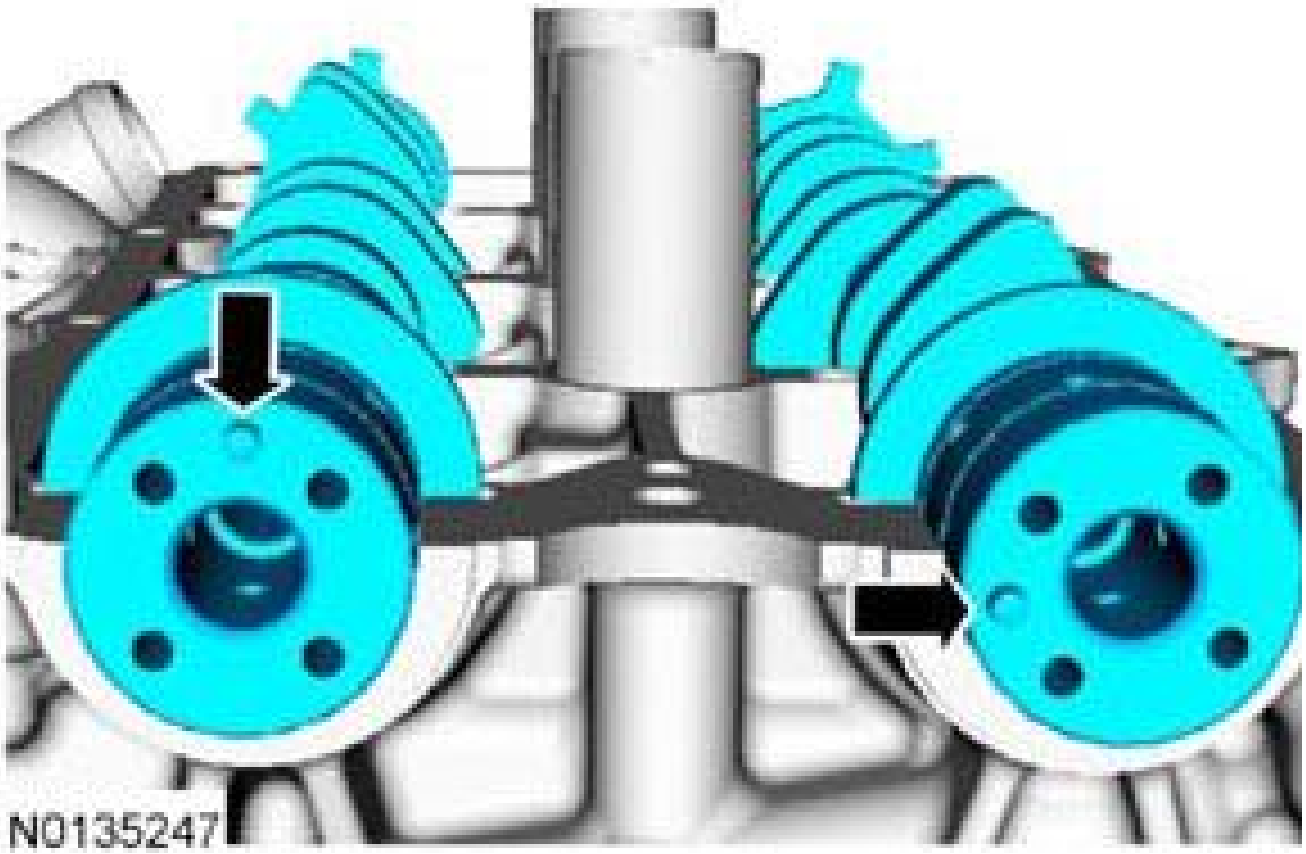


16. **NOTE: The following steps are for the Left Hand (LH) camshafts only.**

NOTE: Coat the camshafts with clean engine oil prior to installation.

Position the camshafts onto the LH cylinder head in the neutral position as shown in illustration.

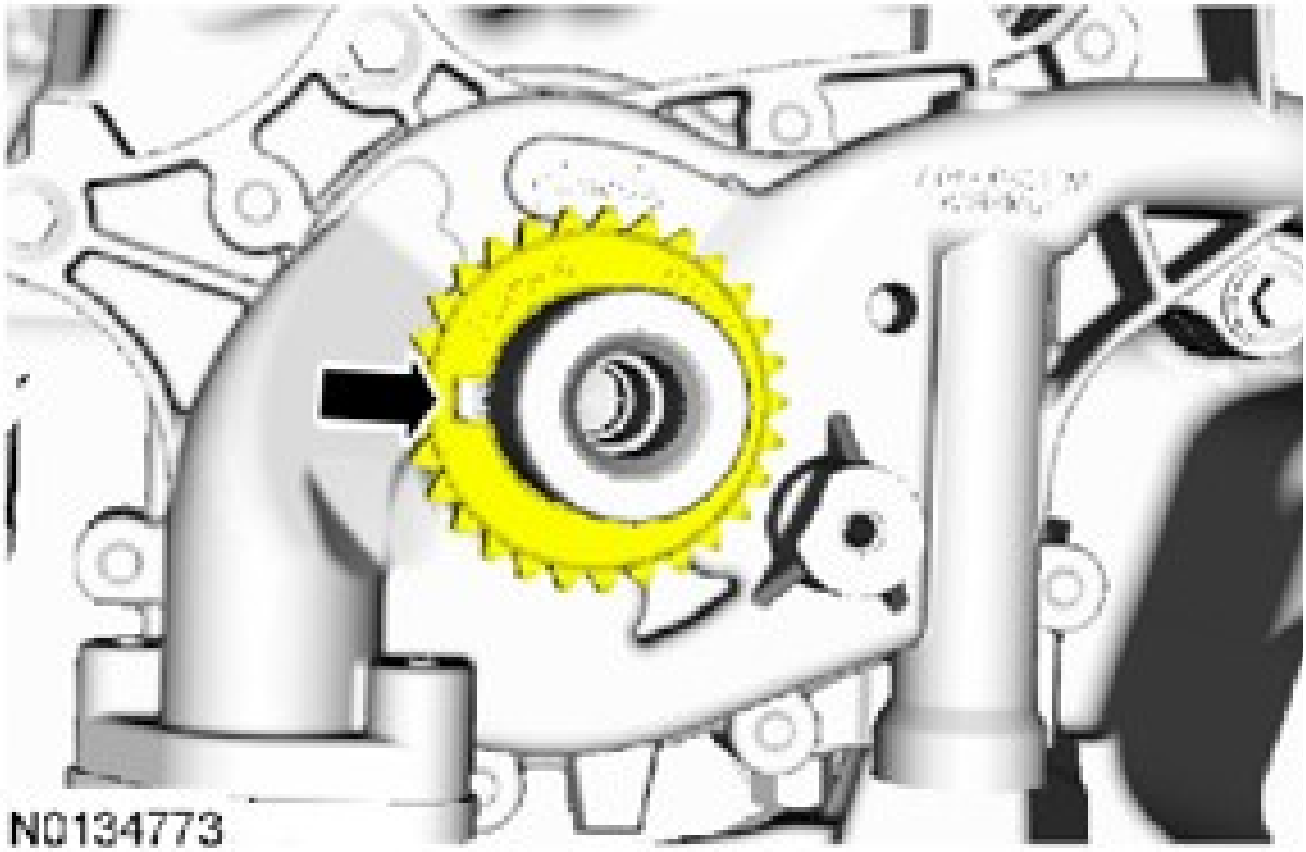
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NOTE: **The crankshaft must remain in the freewheeling position (crankshaft dowel pin at 9 o'clock) until after the camshafts are installed and the valve clearance is checked/adjusted. Do not turn the crankshaft until instructed to do so. Failure to follow this process will result in severe engine damage.**

17. Rotate the crankshaft counterclockwise until the crankshaft dowel pin is in the 9 o'clock position.

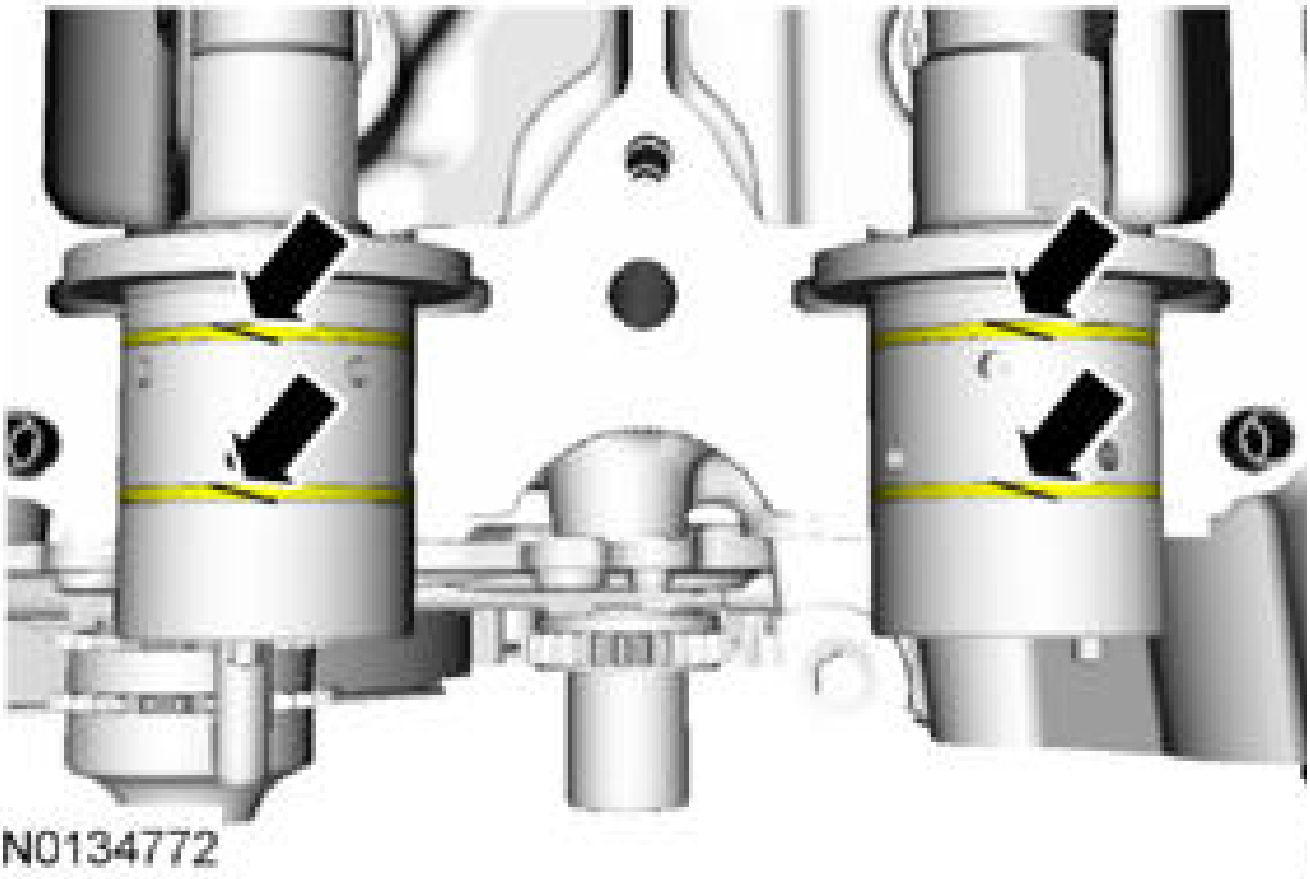
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18. **NOTE: The camshaft seal gaps must be at the 12 o'clock position or damage to the engine may occur.**

Position the 4 camshaft seals gaps as shown in illustration.

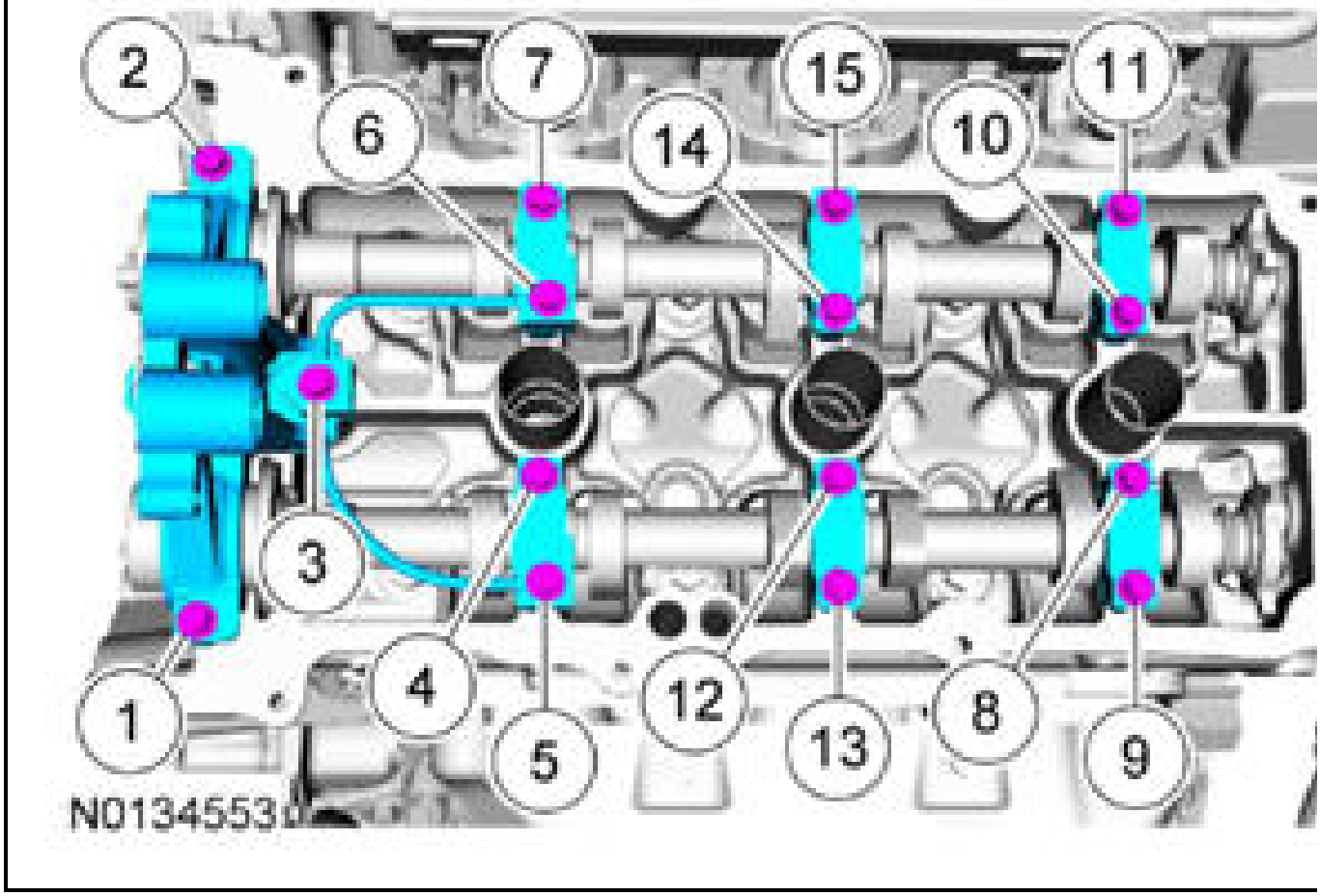
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19. **NOTE: Cylinder head camshaft bearing caps are numbered to verify that they are assembled in their original positions.**

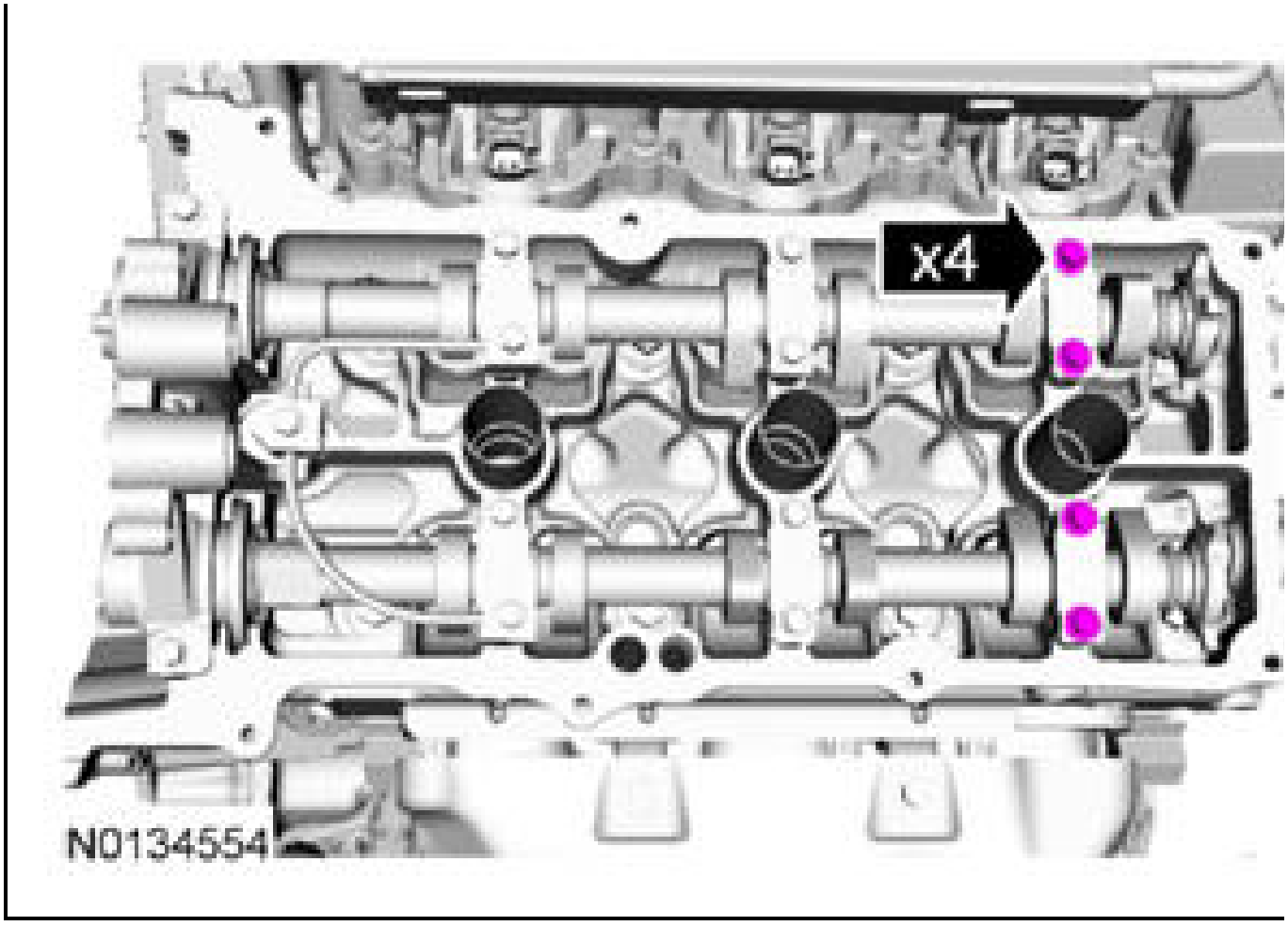
Install the 6 camshaft caps, mega cap, valve train oil tube and the 15 bolts in the sequence shown in illustration.

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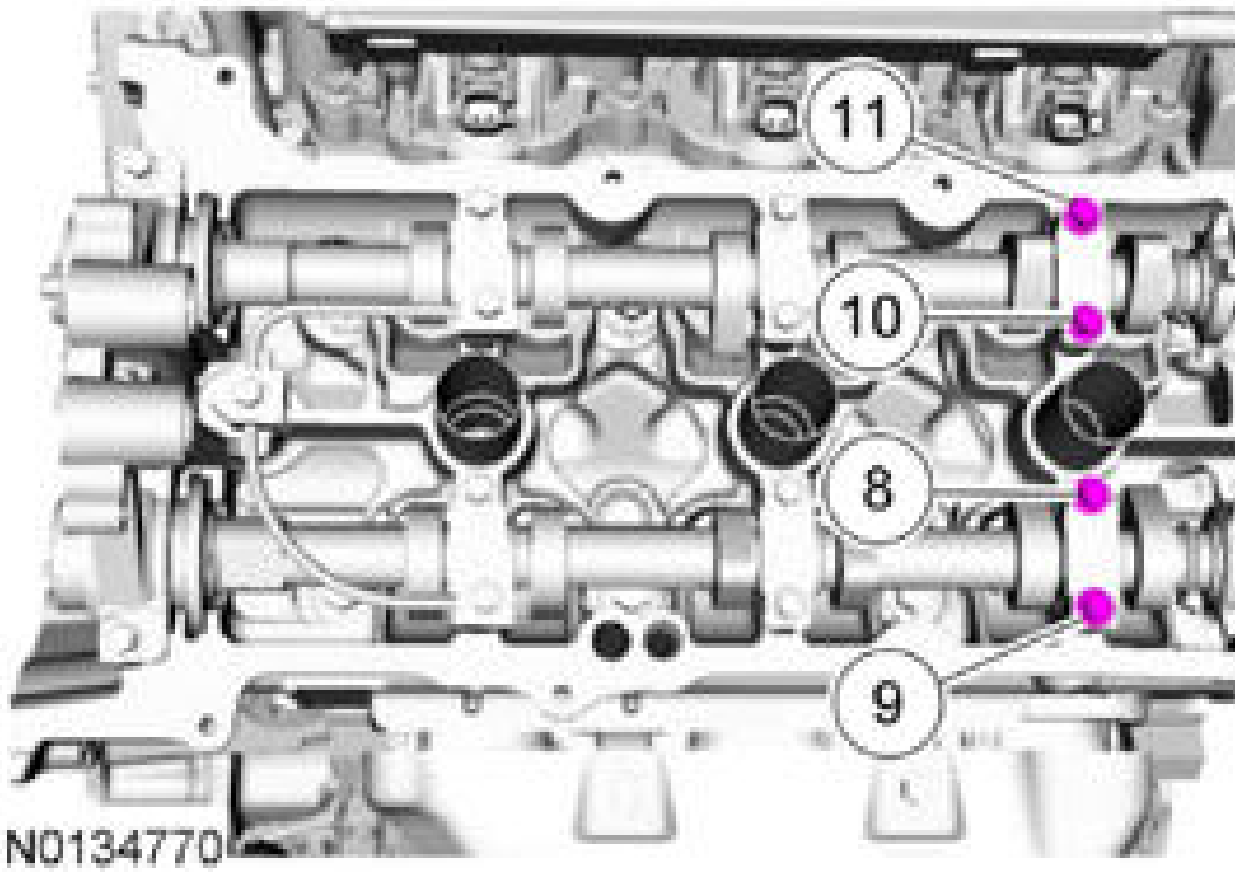
20. Loosen the 4 camshaft caps bolts.

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21. Tighten the 4 bolts in the sequence shown in illustration.
    - Tighten bolts 8, 9, 10 and 11 to 8 Nm (71 lb-in) then an additional 45 degrees.

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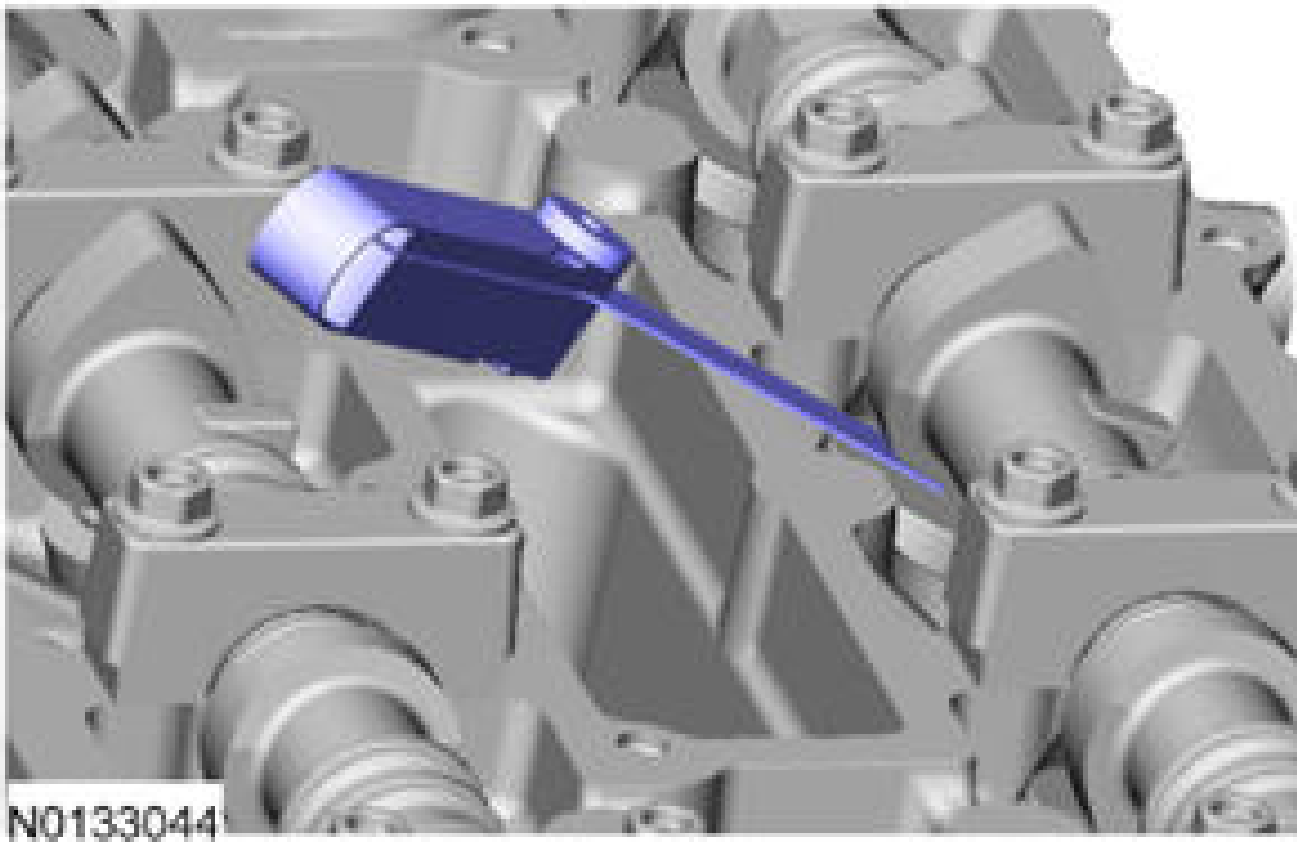
22.

NOTE: If any components are installed new, the engine valve clearance must be checked/adjusted or engine damage may occur.

NOTE: Use a camshaft sprocket bolt to turn the camshafts.

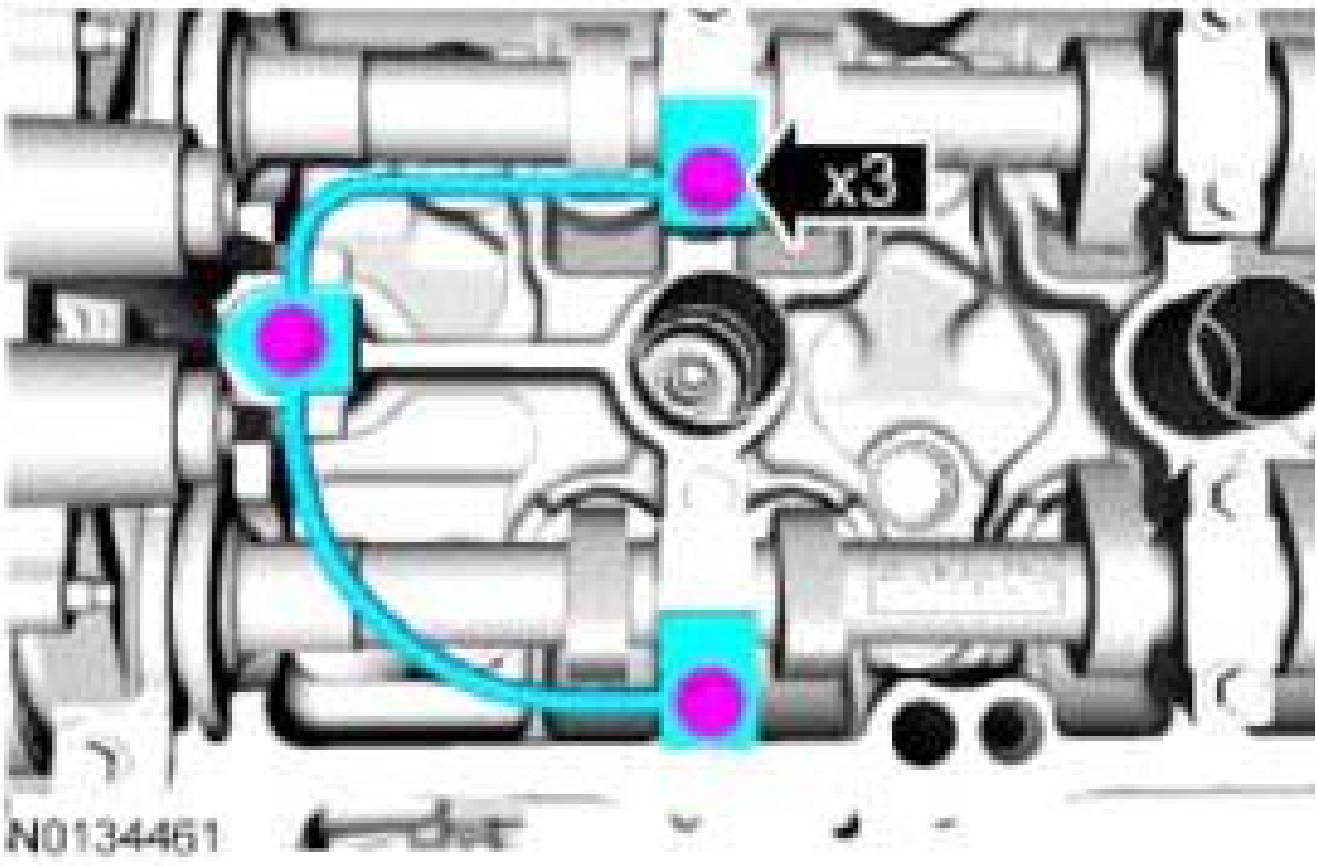
Using a feeler gauge, confirm that the valve tappet clearances are within specification. If valve tappet clearances are not within specification, the clearance must be adjusted by installing new valve tappet (s) of the correct size. Refer to **VALVE CLEARANCE CHECK**.

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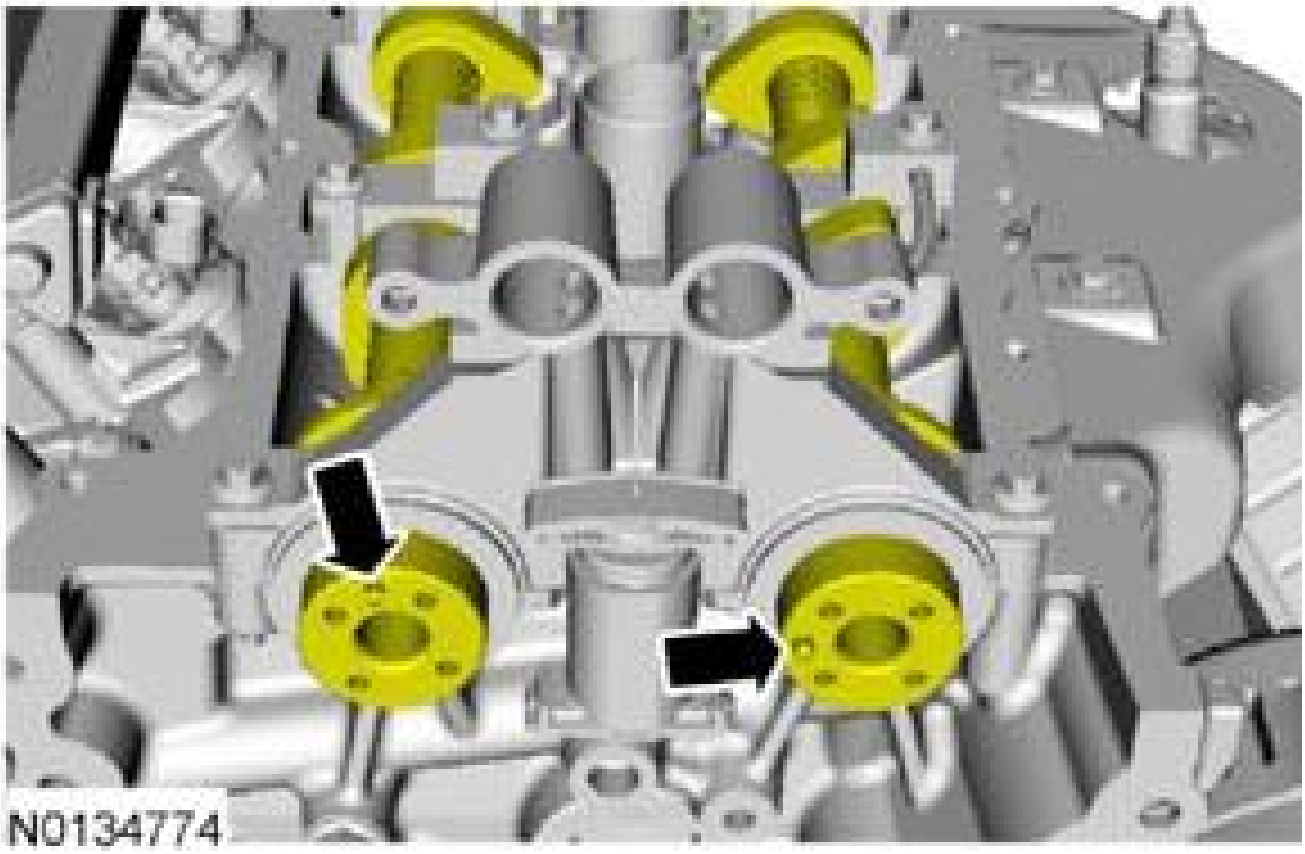
23. Remove the 3 bolts and the LH valve train oil tube.

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24. Rotate the LH camshafts to the **TDC** position as shown in illustration.

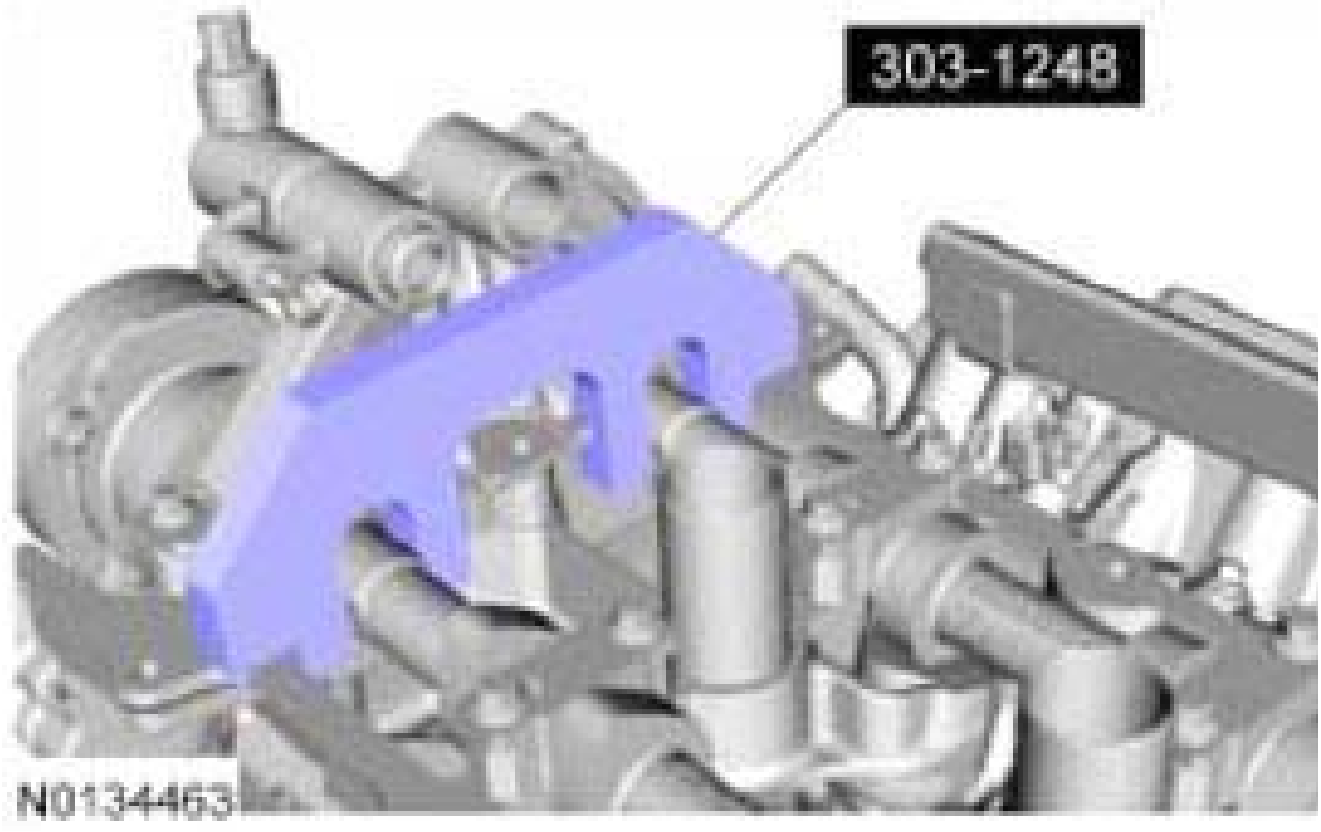
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25. **NOTE: The 303-1248 will hold the camshafts in the TDC position.**

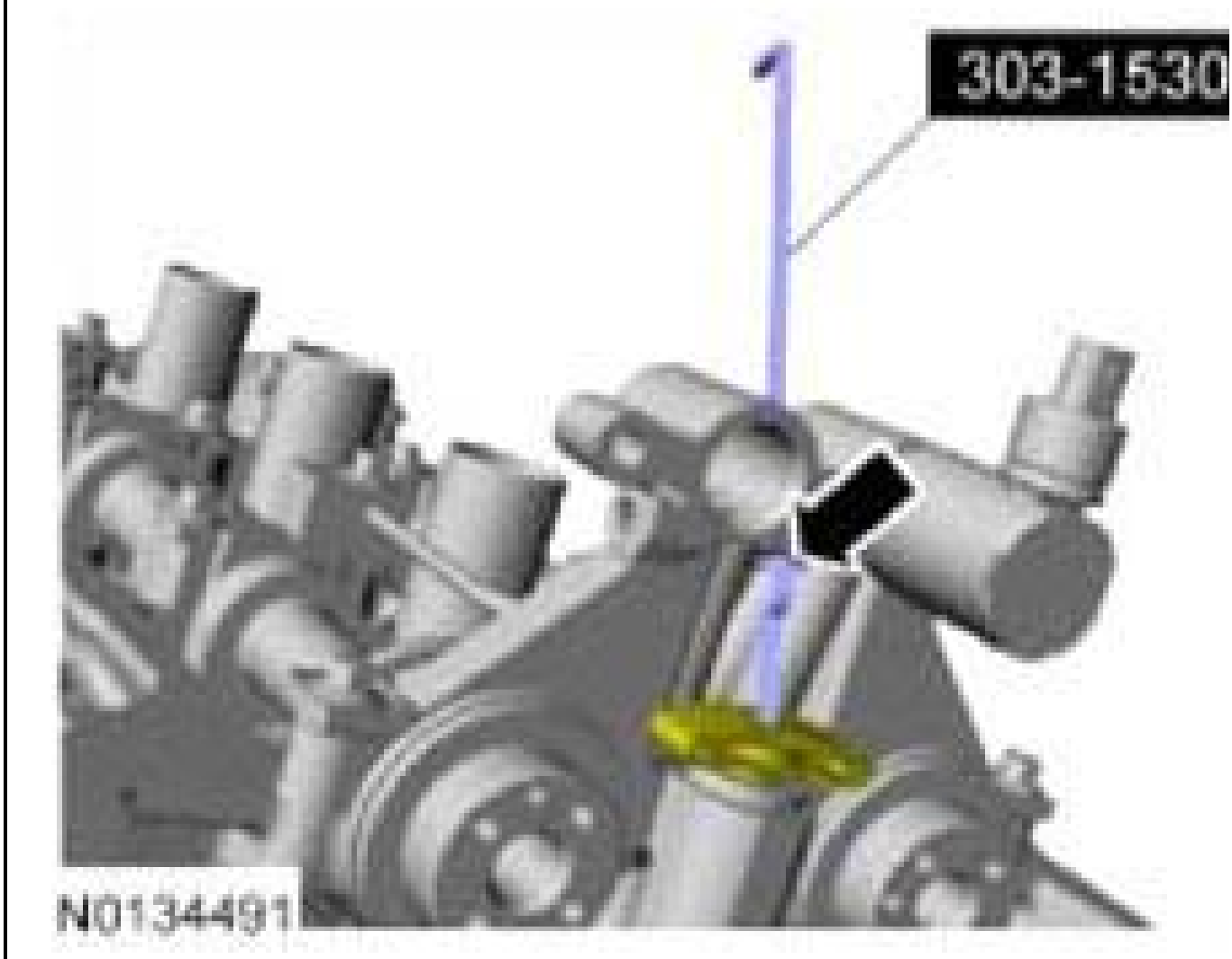
Install 303-1248 onto the flats of the LH camshafts.

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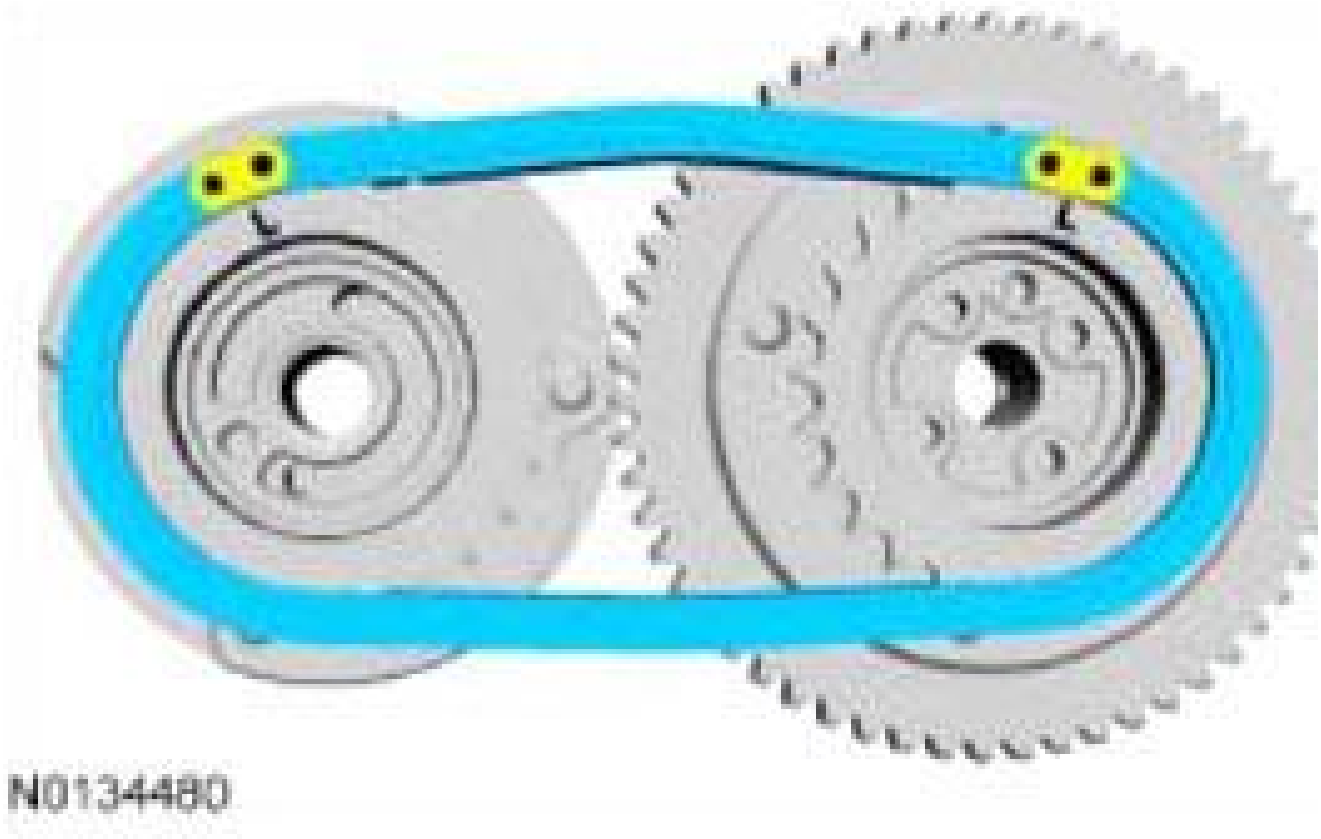
26. Compress the LH secondary timing chain tensioner and install the 303-1530 to retain the tensioner in the collapsed position.

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27. Assemble the LH **VCT** assembly, the LH exhaust camshaft sprocket and the LH secondary timing chain. Align the colored links with the timing marks.

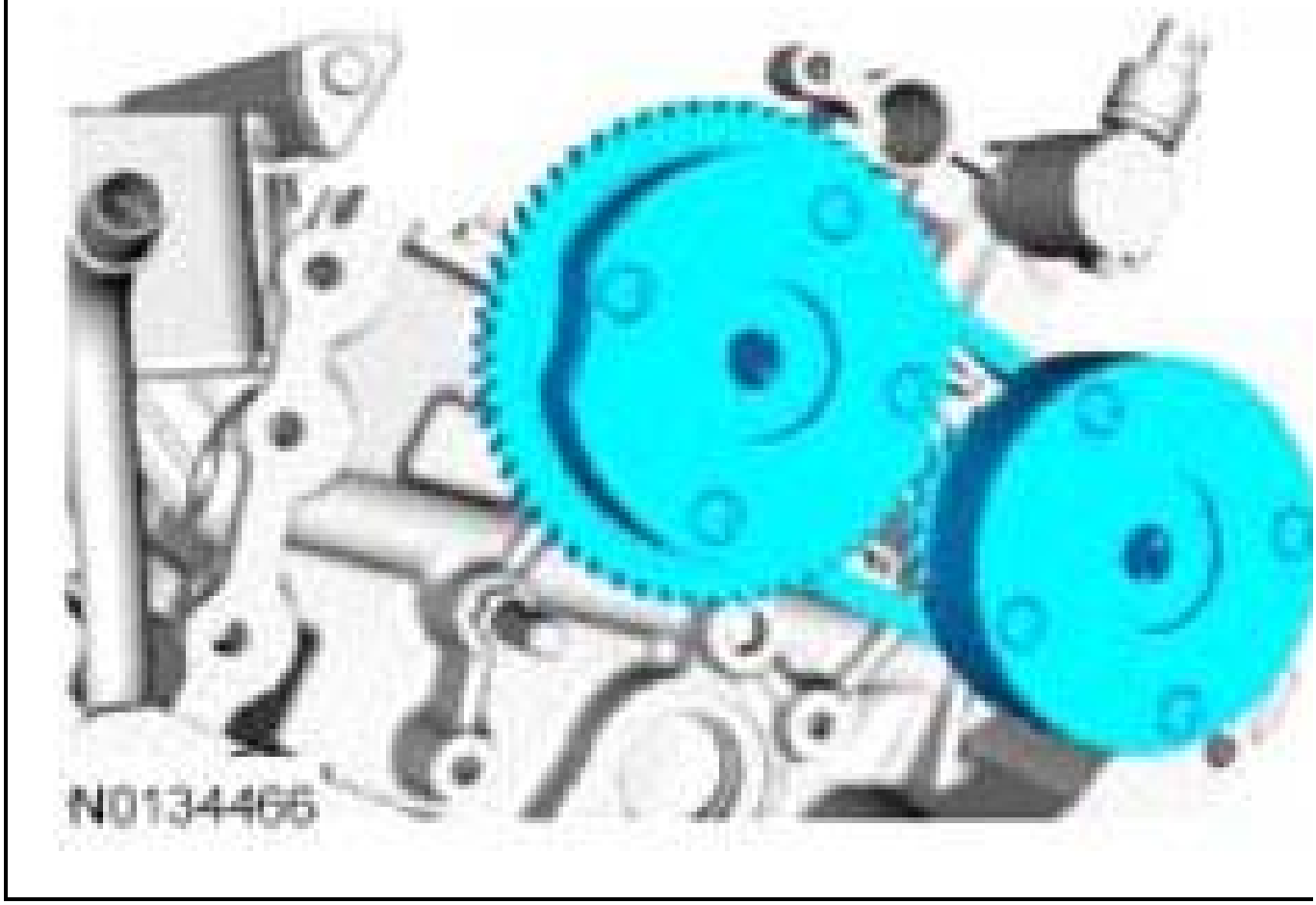
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28. **NOTE: It may be necessary to rotate the camshafts slightly, to install the LH secondary timing assembly.**

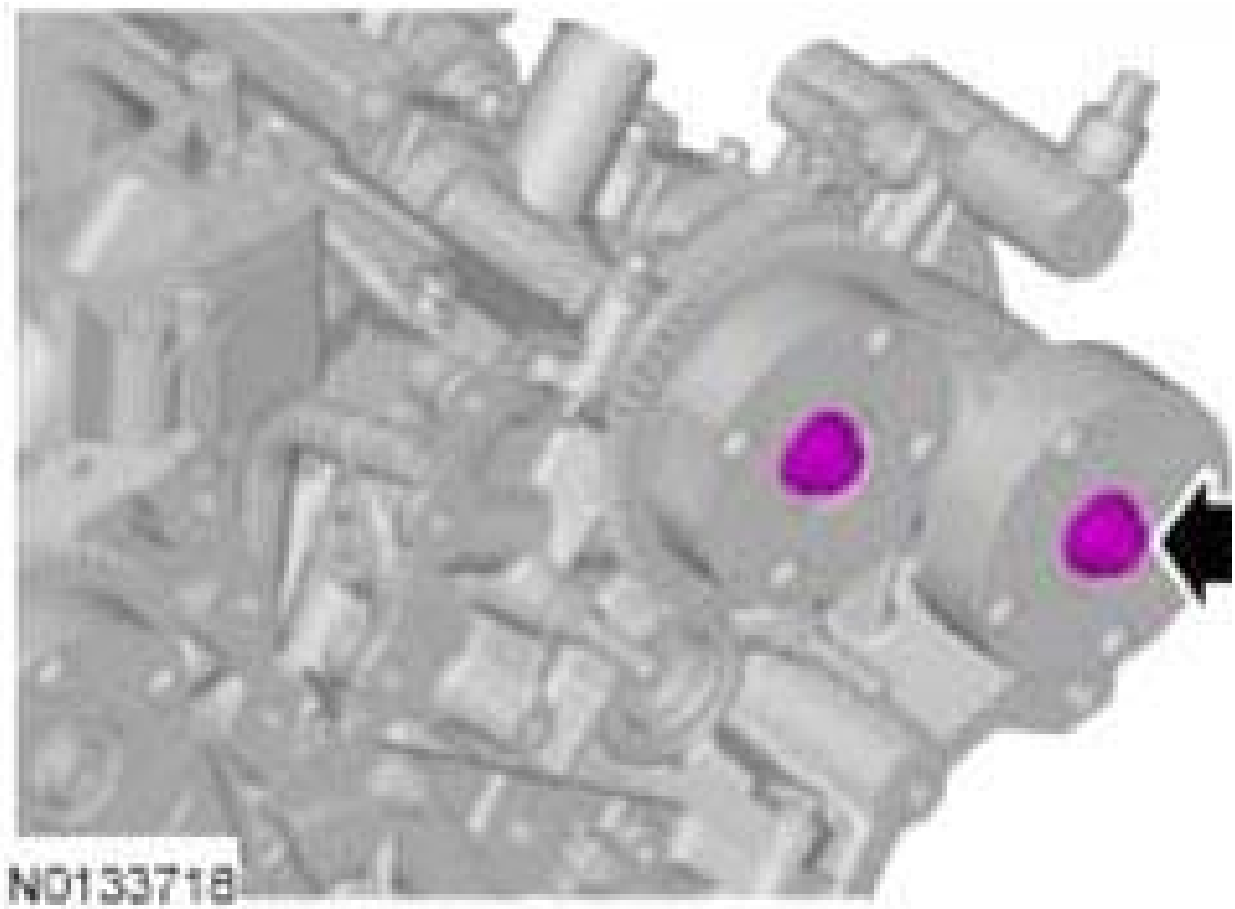
Position the 2 LH **VCT** assemblies and secondary timing chain onto the camshafts by aligning the holes in the **VCT** assemblies with the dowel pins in the camshafts.

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29. Install the 2 new LH **VCT** bolts and tighten in 4 stages.
    - Stage 1: Tighten to 40 Nm (30 lb-ft).
    - Stage 2: Loosen one full turn.
    - Stage 3: Tighten to 25 Nm (18 lb-ft).
    - Stage 4: Tighten an additional 180 degrees.

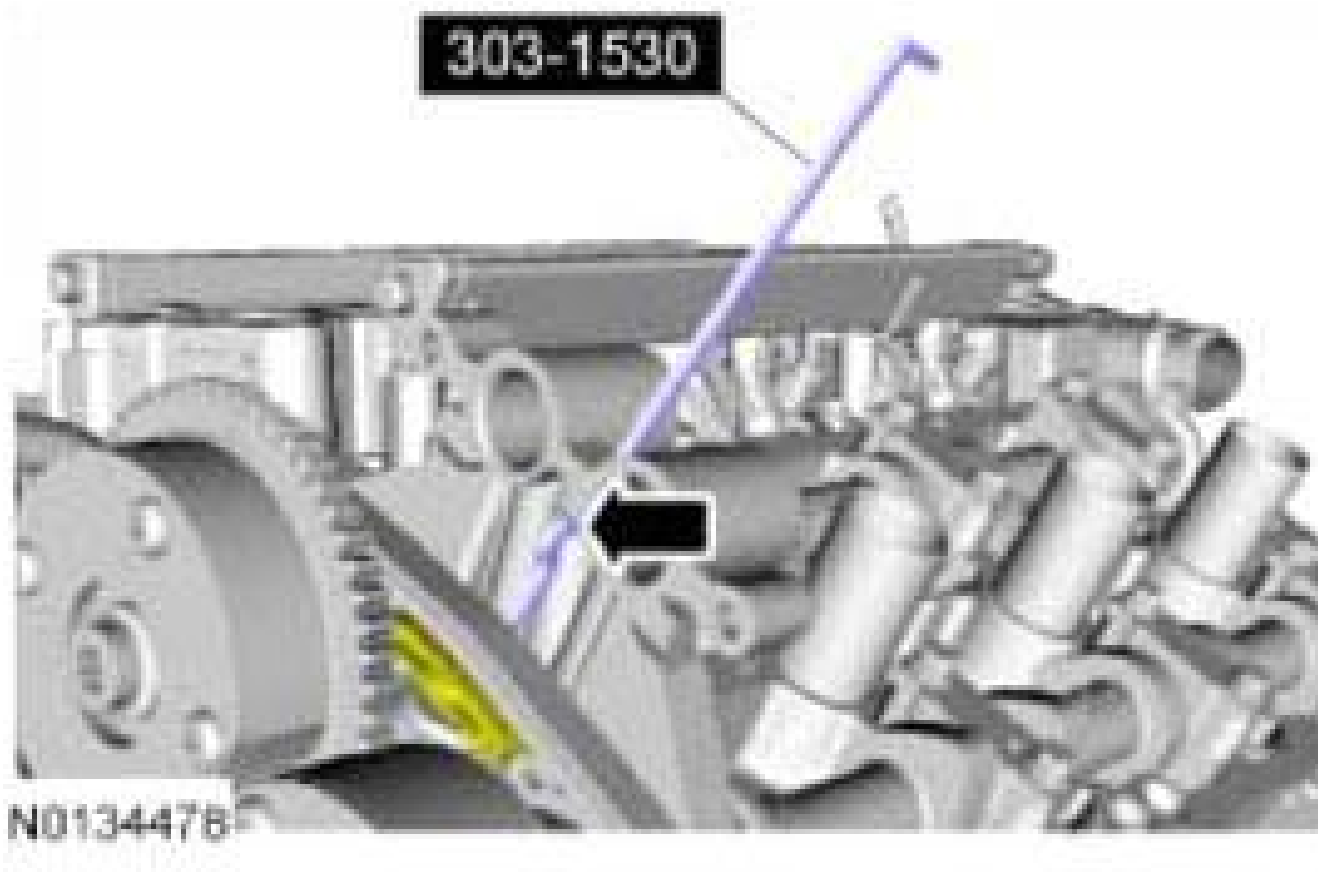
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30. **NOTE: The 2 VCT oil control solenoids are removed for clarity.**

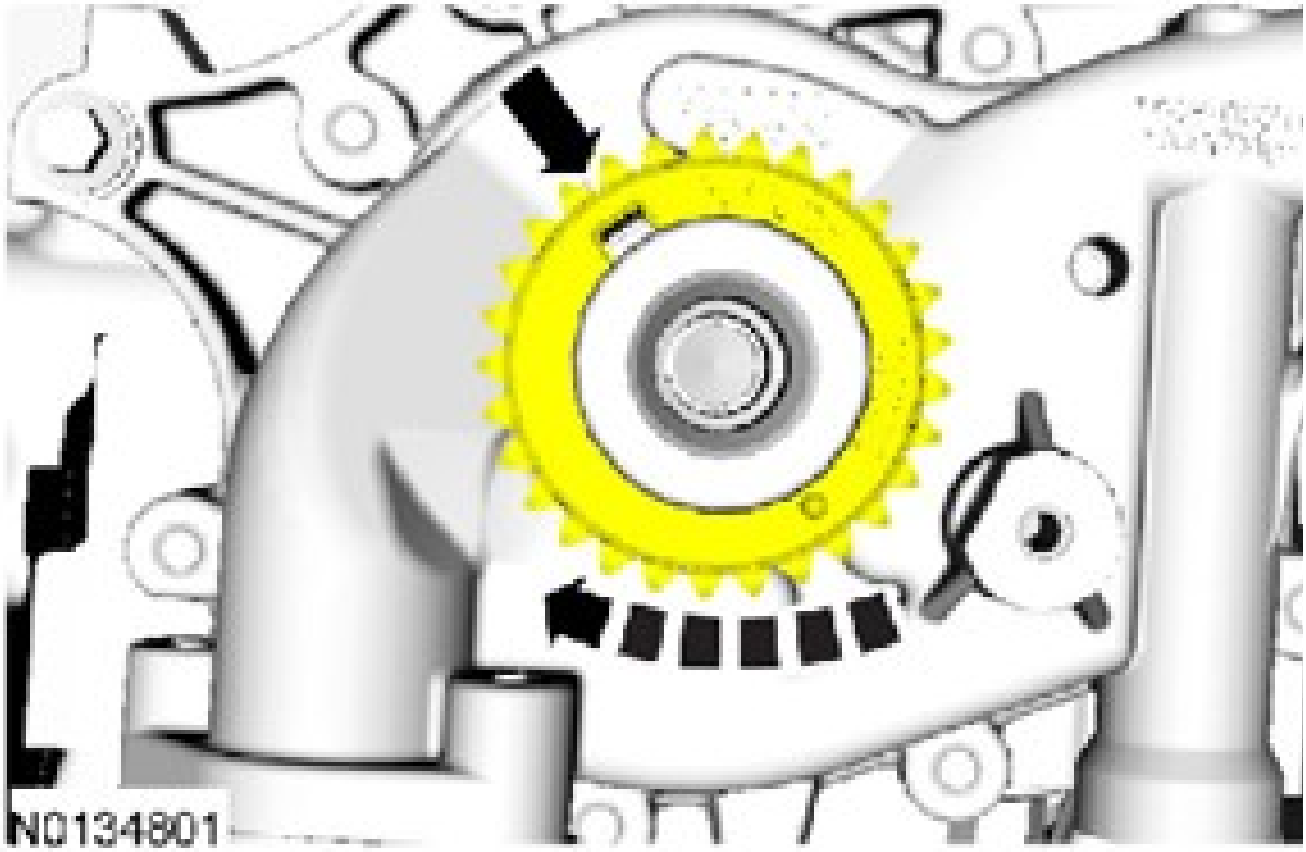
Compress the LH secondary timing chain tensioner and remove the 303-1530. Make sure the secondary timing chain is centered on the timing chain tensioner guides.

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31. Rotate the crankshaft counterclockwise until the crankshaft dowel pin is in the **TDC** position (crankshaft dowel pin at 11 o'clock).

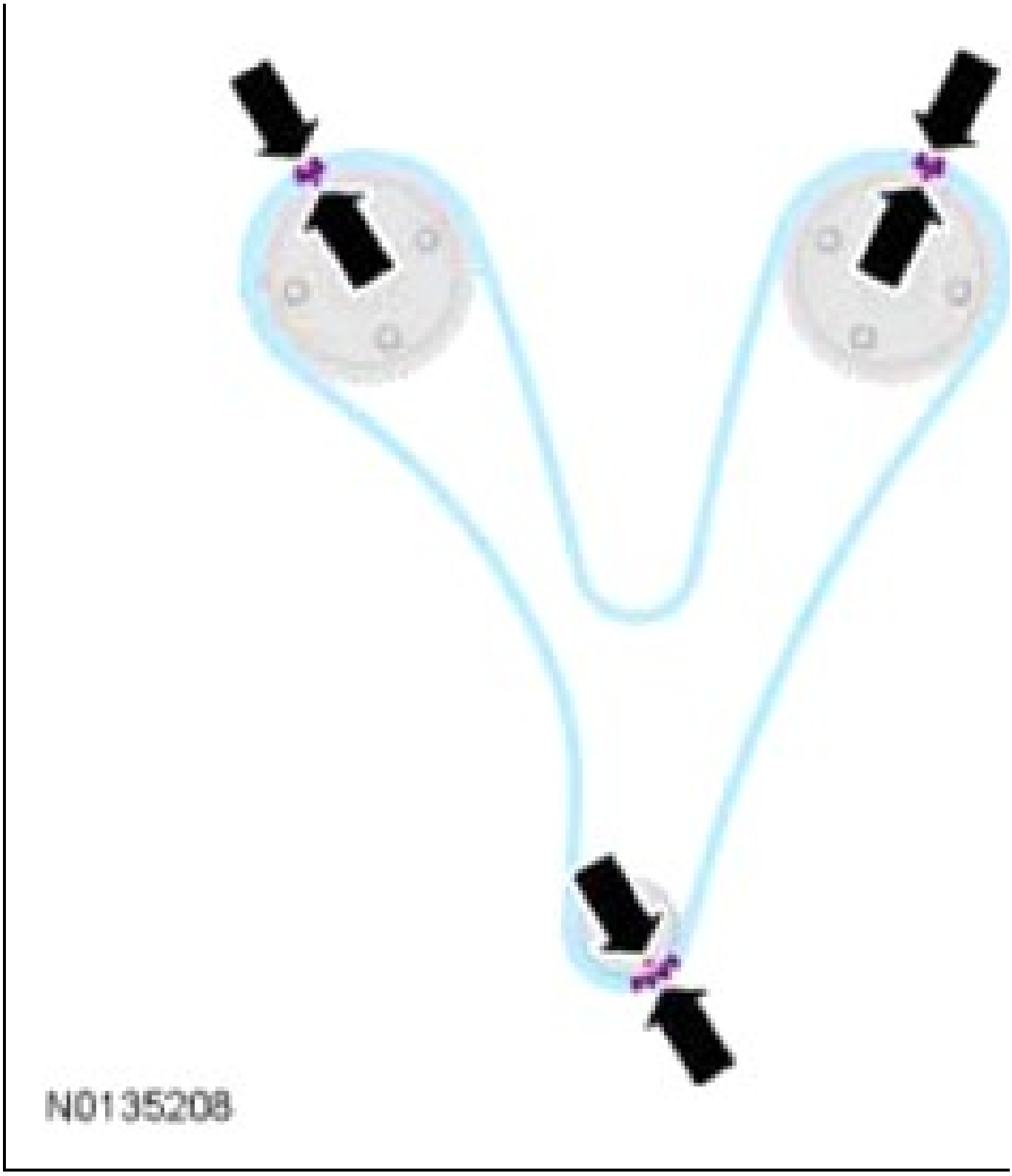
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32. **NOTE: It may be necessary to rotate the camshafts slightly, to align the timing marks.**

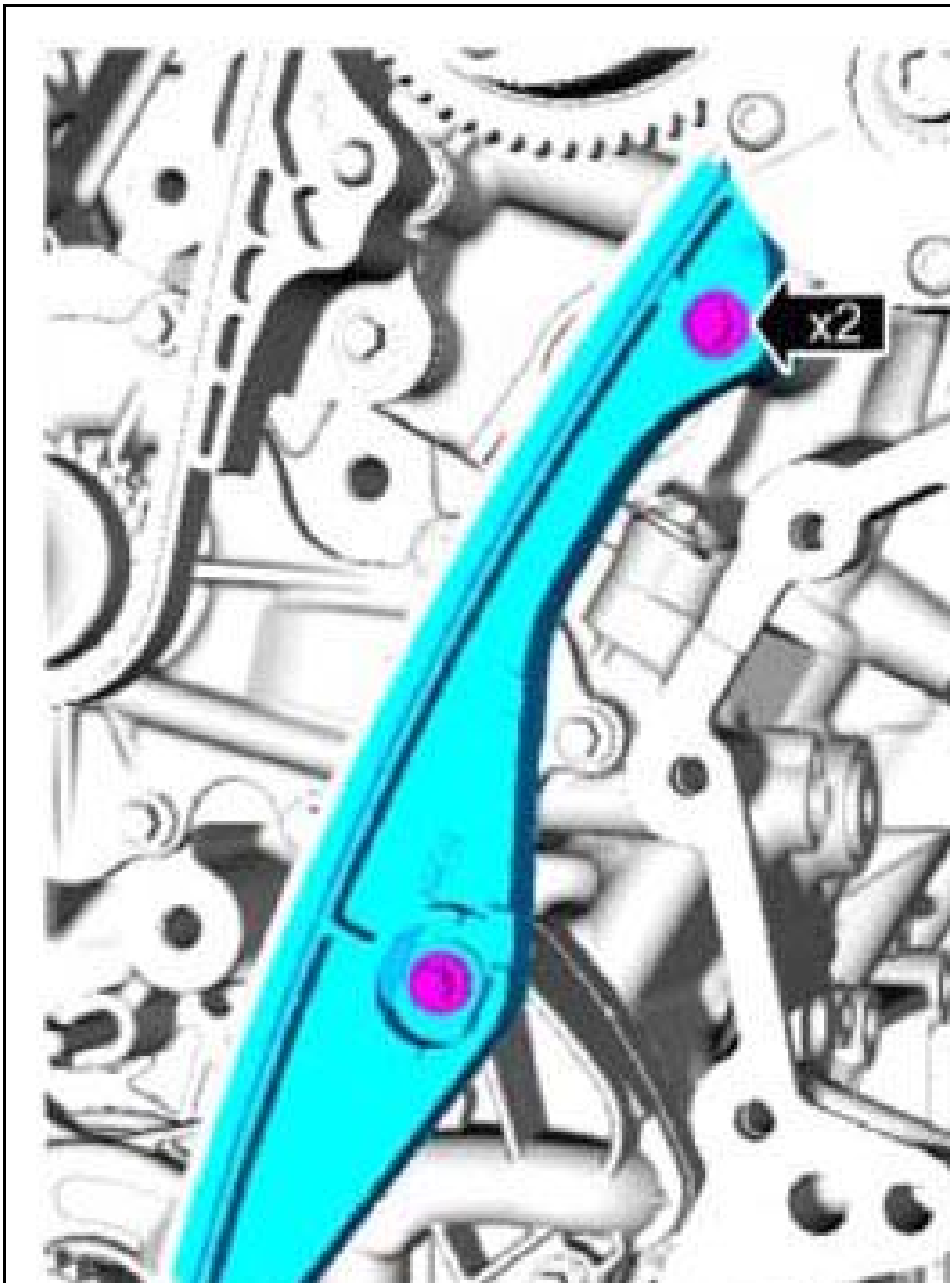
Install the primary timing chain with the colored links aligned with the timing marks on the **VCT** assemblies and the crankshaft sprocket.

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33. Install the 2 bolts and the lower LH primary timing chain guide.
    - Tighten to 10 Nm (89 lb-in).

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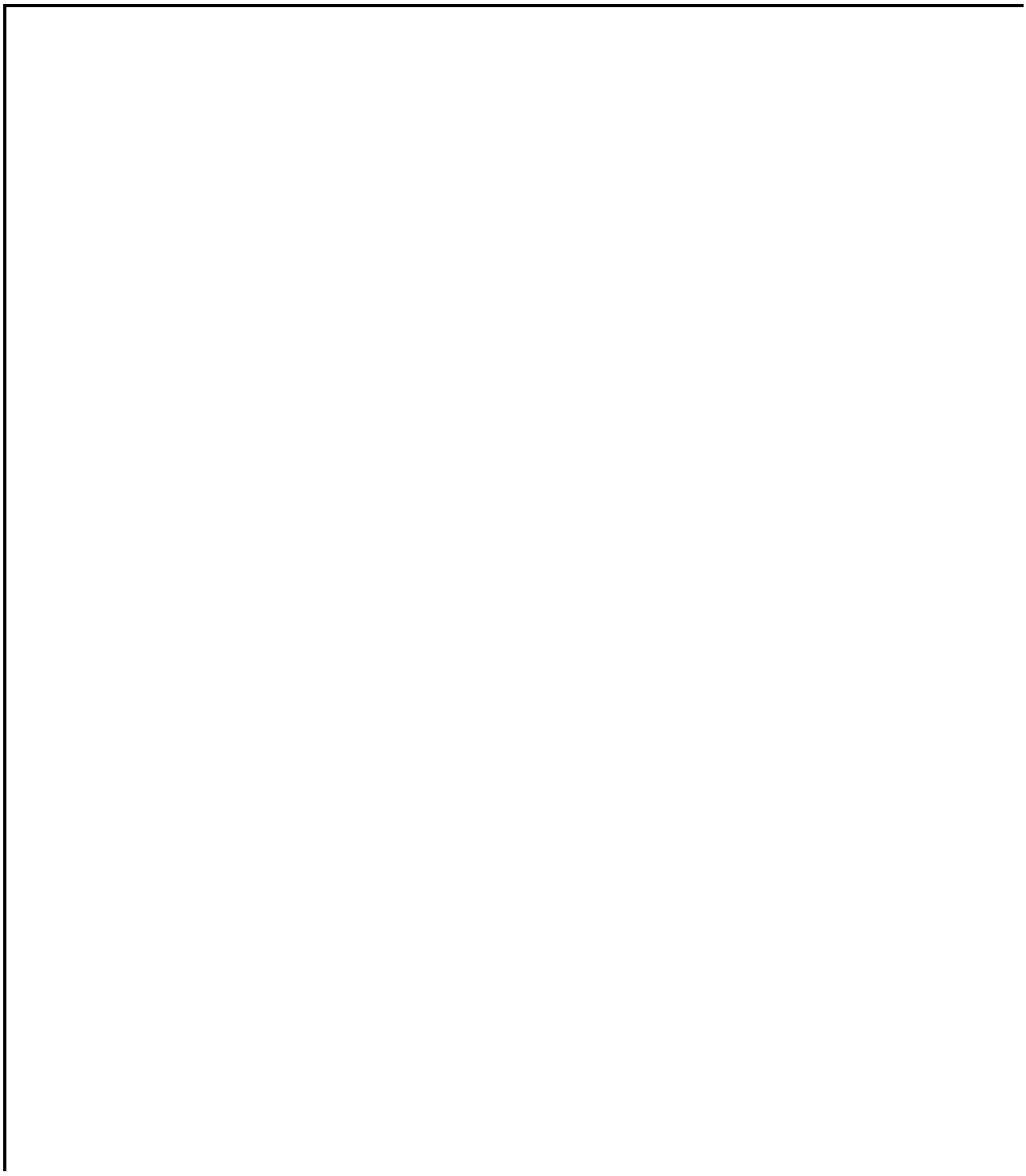
34. Install the primary timing chain tensioner arm.

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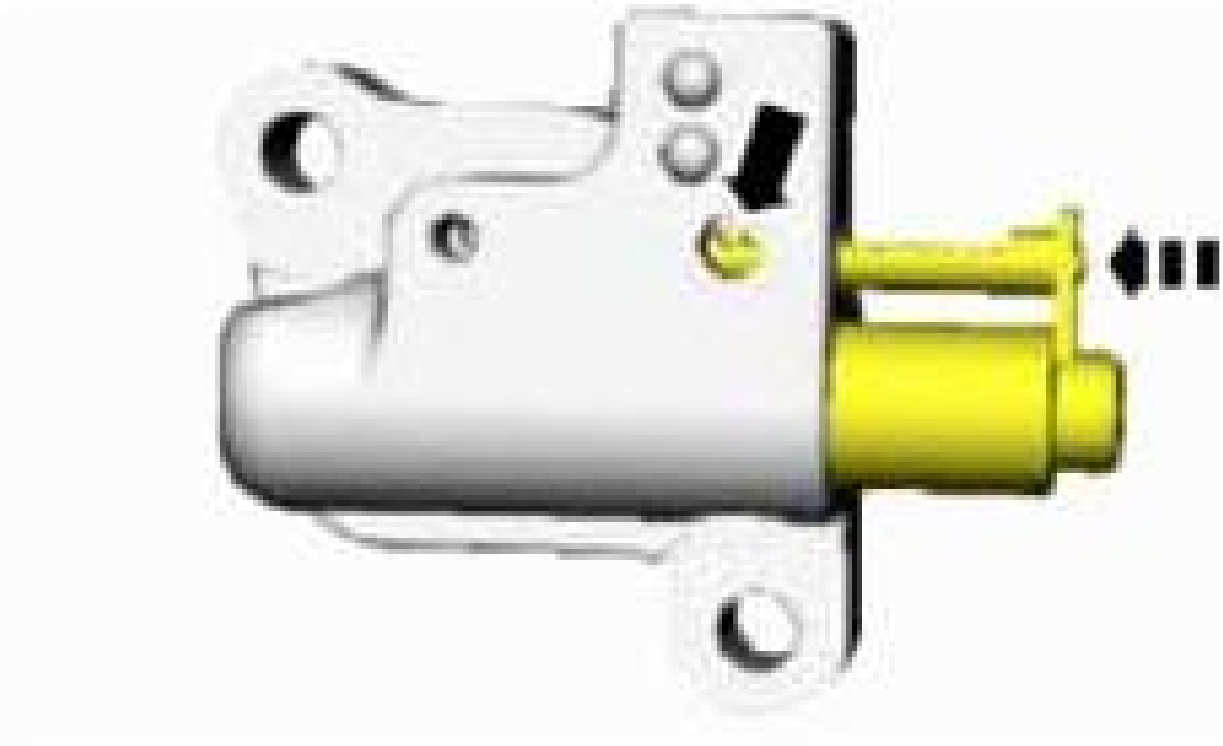


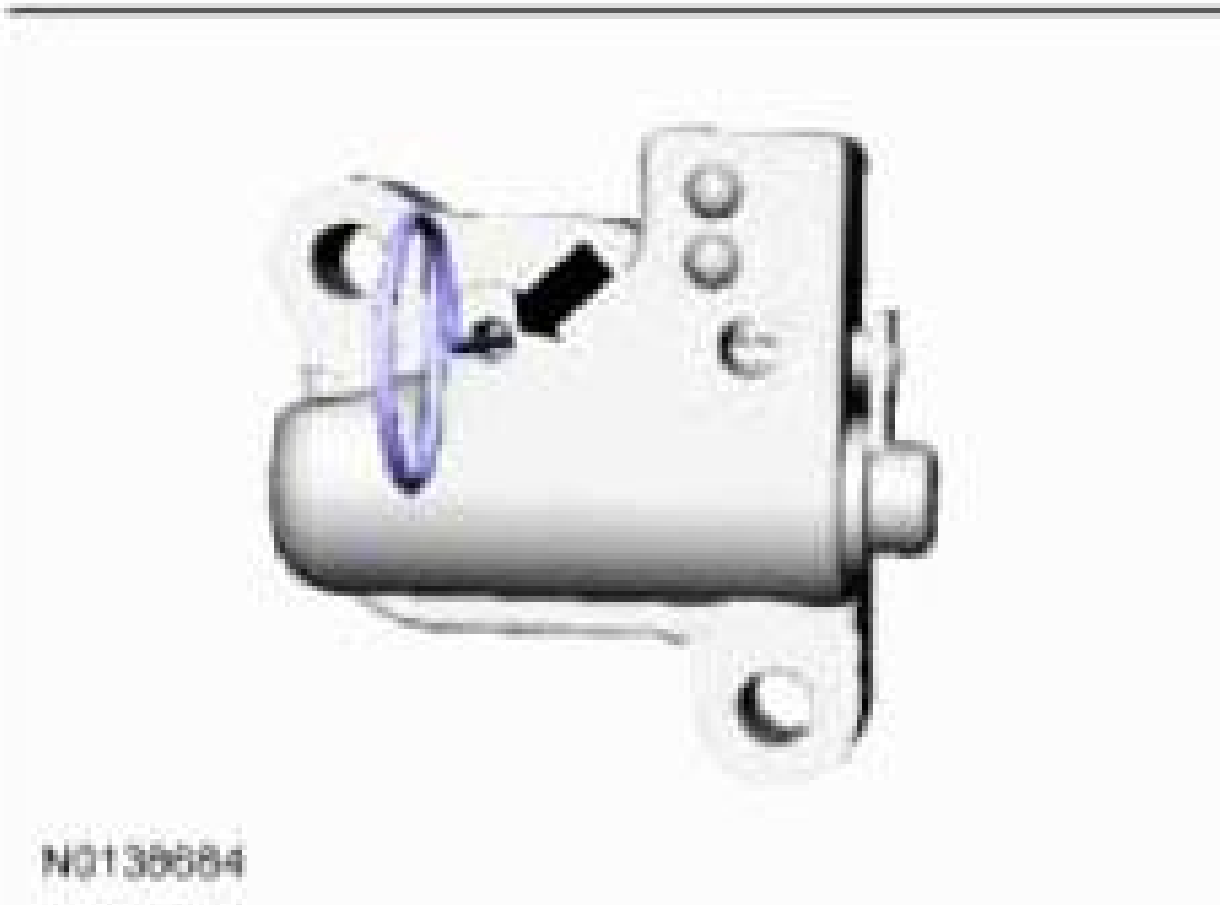
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35. Reset the primary timing chain tensioner.
    - Release the ratchet detent.
    - Using a soft-jawed vise, compress the ratchet plunger.
    - Align the hole in the ratchet plunger with the hole in the tensioner housing.
    - Install a suitable lockpin.



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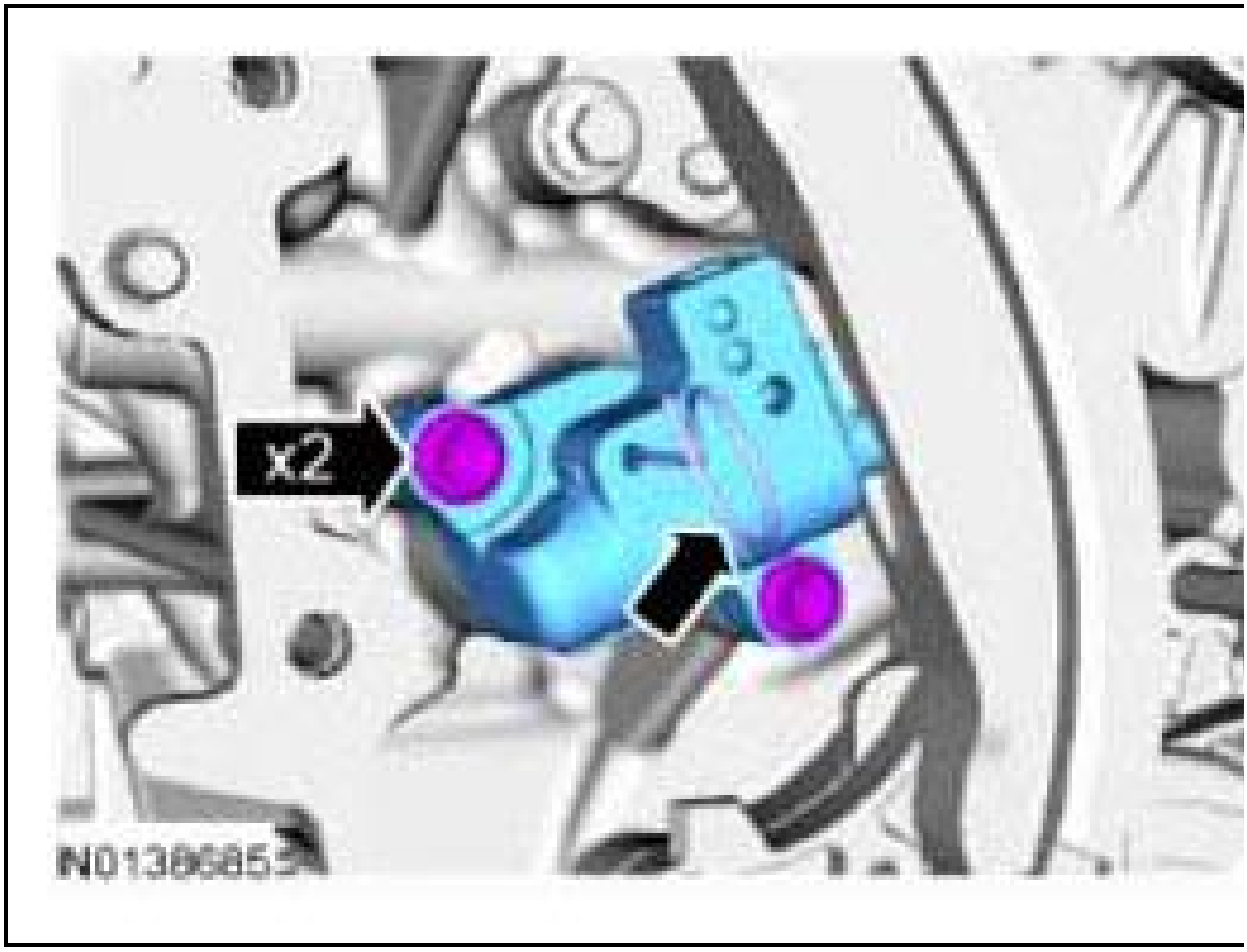


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36. **NOTE: It may be necessary to rotate the camshafts slightly to remove slack from the timing chain to install the tensioner.**

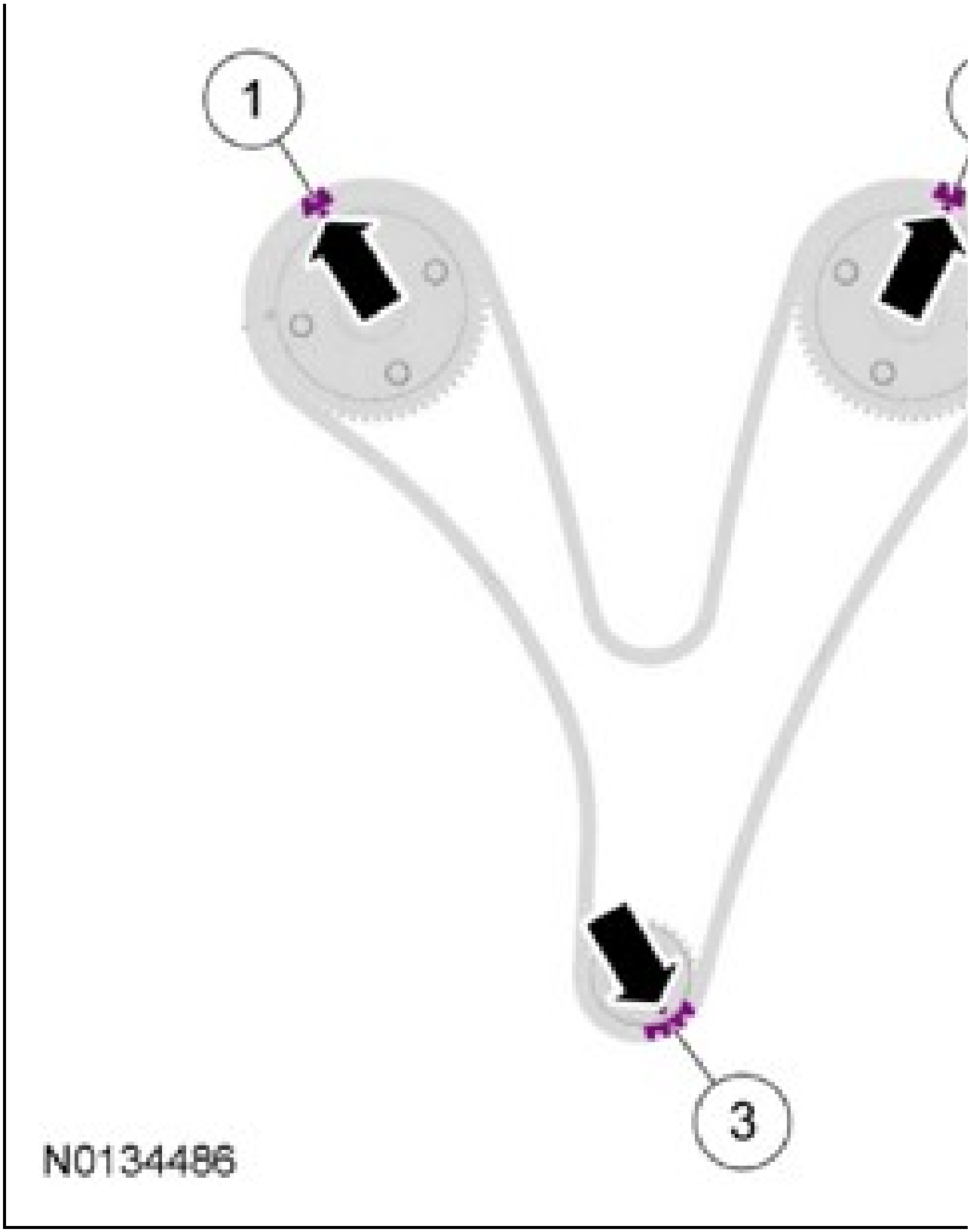
Install the 2 bolts and the primary timing chain tensioner.

- Tighten to 10 Nm (89 lb-in) and remove the lock pin.



37. As a post-check, verify correct alignment of all timing marks.
    - There are 48 links in between the RH intake **VCT** assembly colored link (1) and the LH intake VCT assembly colored link (2).
    - There are 35 links in between LH intake **VCT** assembly colored link (2) and the 2 crankshaft sprocket links (3).

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38. **NOTE: Do not use excessive force when installing the VCT oil control solenoid.**

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38. **Damage to the mega cap could cause the cylinder head to be inoperable. If difficult to install the VCT oil control solenoid, inspect the bore and VCT oil control solenoid to ensure there are no burrs, sharp edges or contaminants present on the mating surface. Only clean the external surfaces as necessary.**

NOTE: A slight twisting motion will aid in the installation of the VCT oil control solenoid.

NOTE: Keep the VCT oil control solenoid clean of dirt and debris.

Install the LH intake **VCT** oil control solenoid and the bolt.

- Tighten to 8 Nm (71 lb-in).

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NOTE: **Do not use excessive force when installing the VCT oil control solenoid. Damage to the mega cap could cause the cylinder head to be inoperable. If difficult to install the VCT oil control solenoid, inspect the bore and VCT oil control solenoid to ensure there are no burrs, sharp edges or contaminants present on the mating surface. Only clean the external surfaces as necessary.**

39.

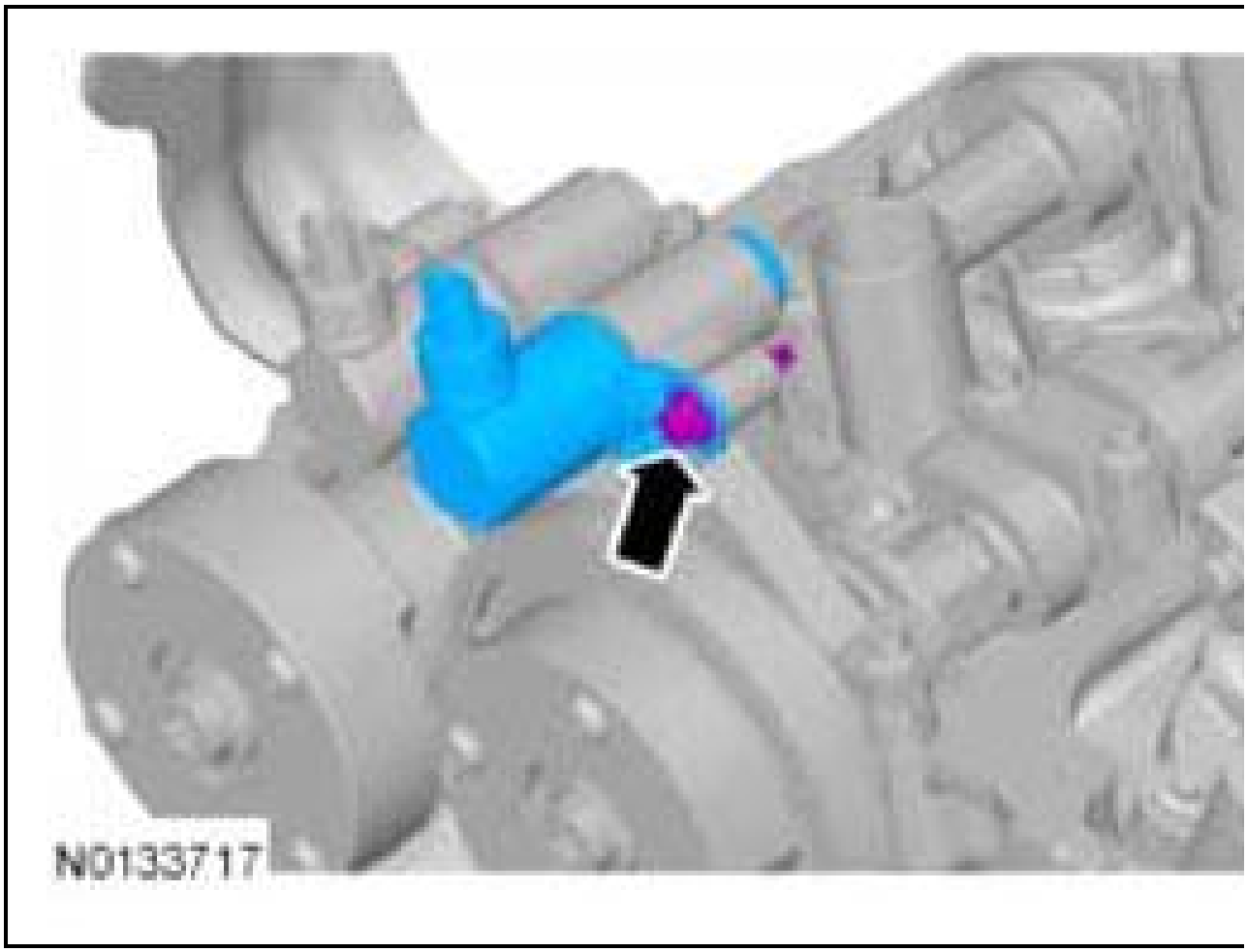
NOTE: **A slight twisting motion will aid in the installation of the VCT oil control solenoid.**

NOTE: **Keep the VCT oil control solenoid clean of dirt and debris.**

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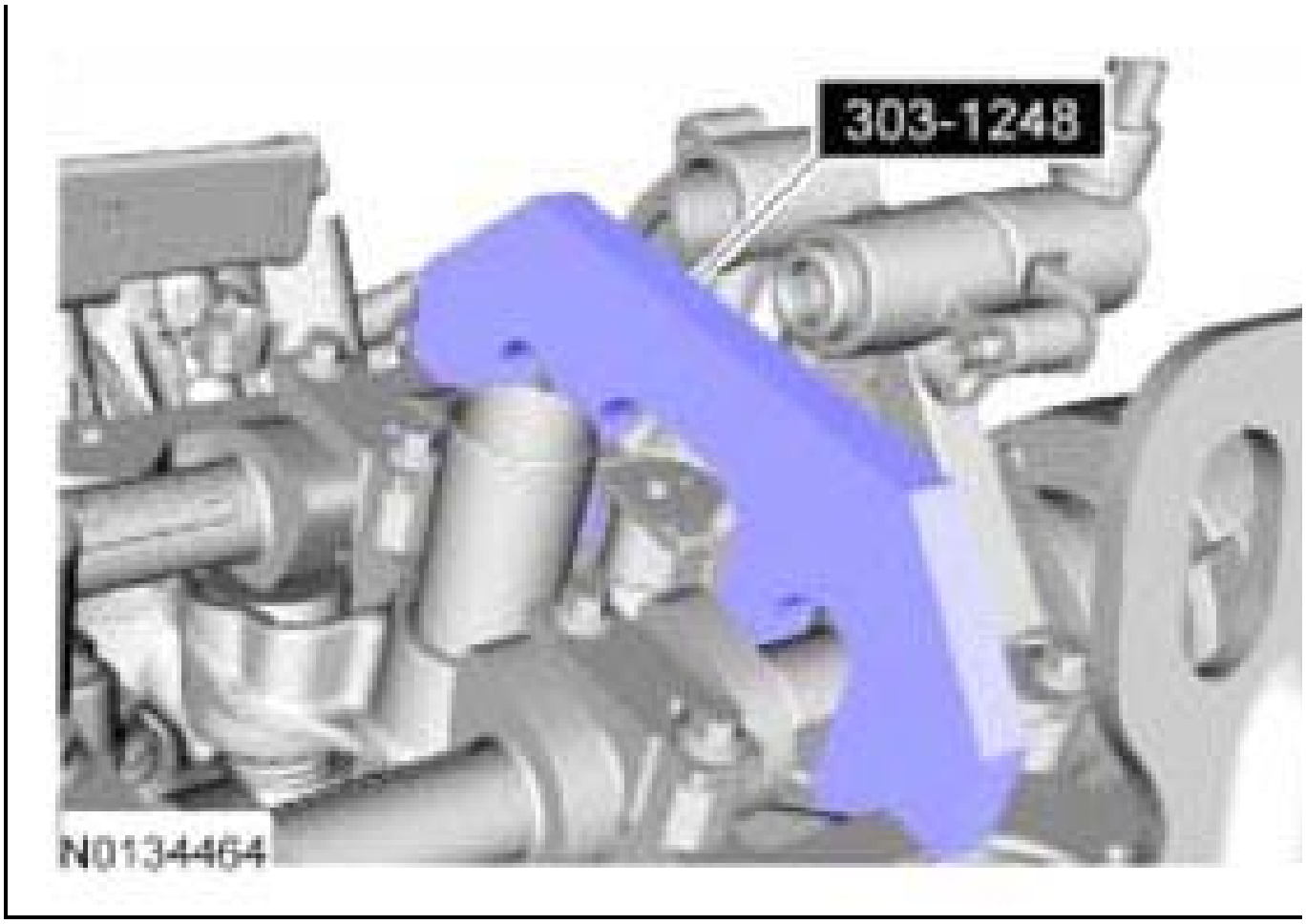
Install the LH intake **VCT** oil control solenoid and the bolt.

- Tighten to 8 Nm (71 lb-in).



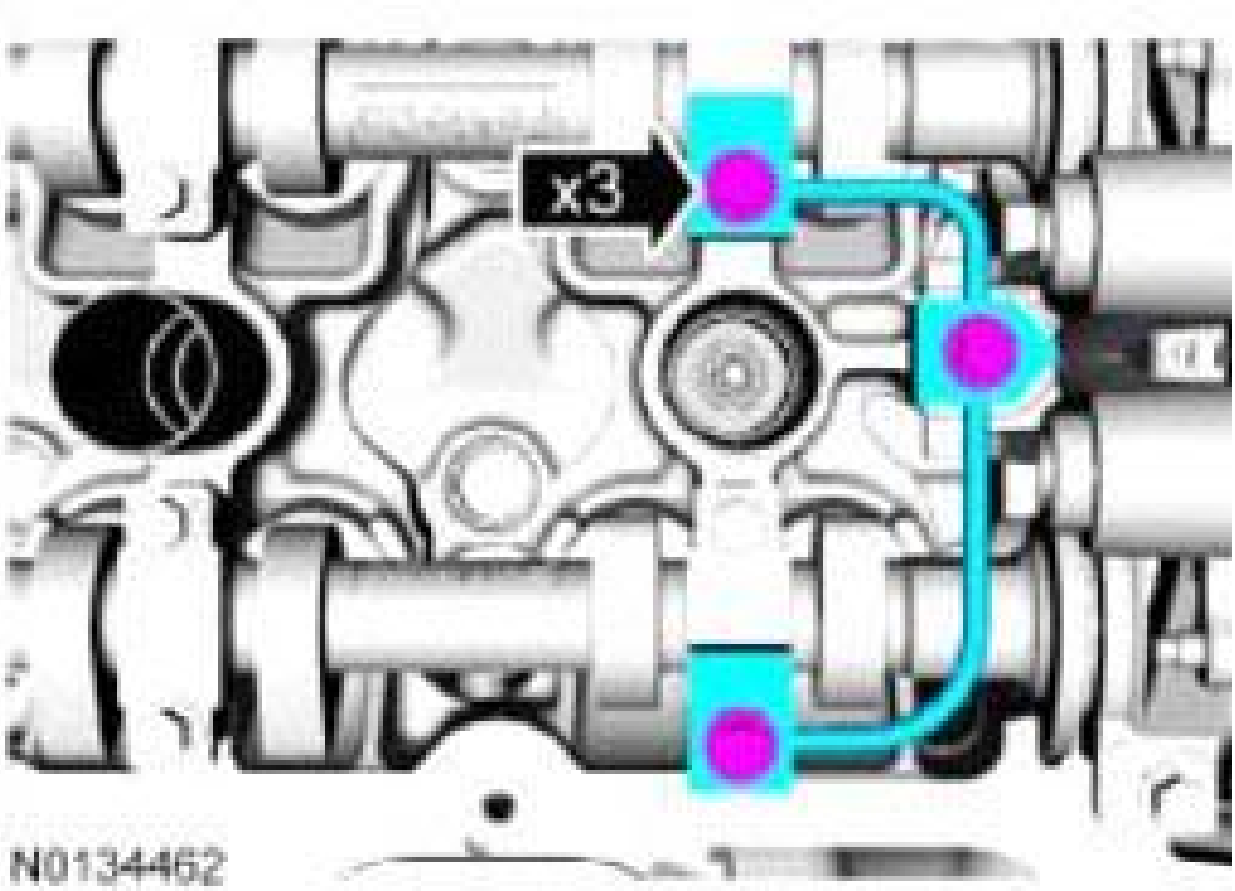
40. Remove the RH 303-1248.

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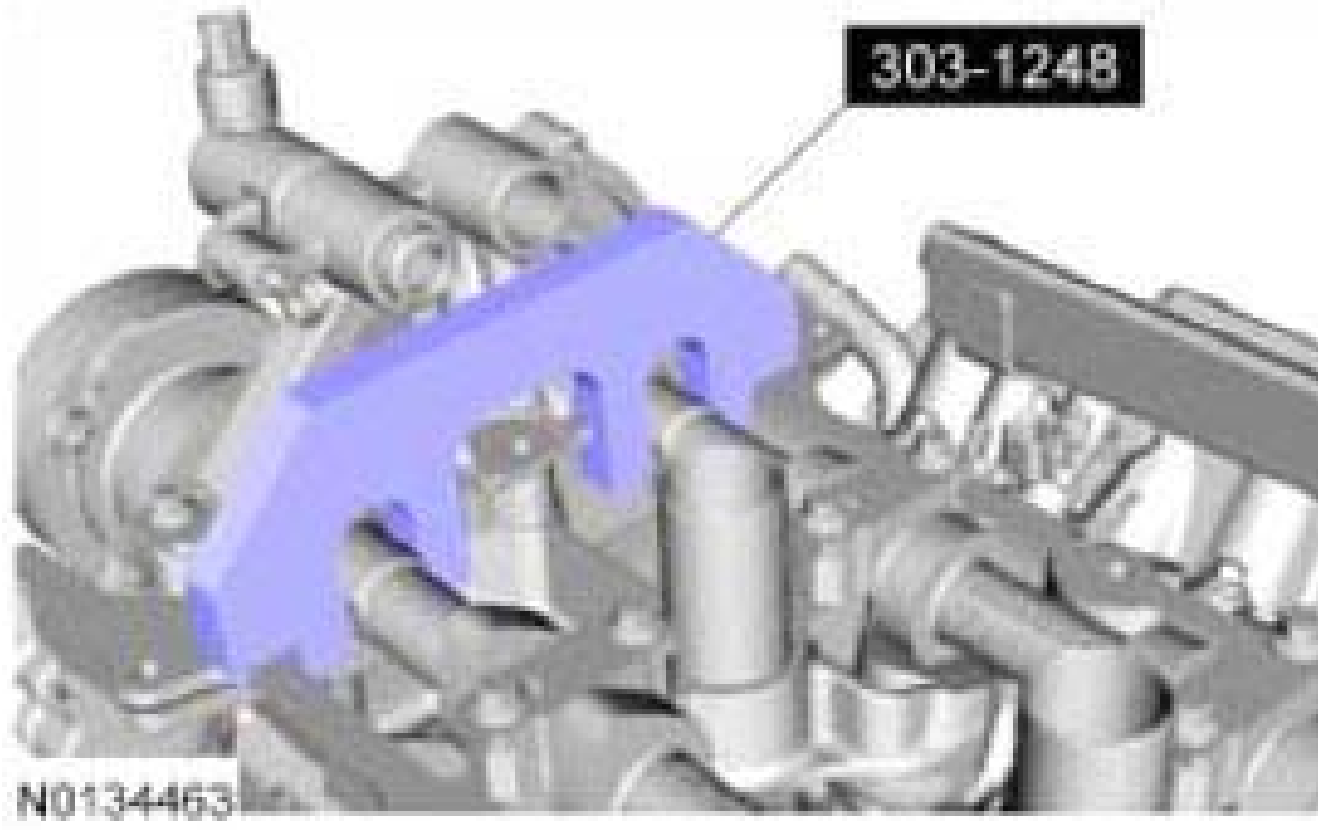
41. Install the RH valve train oil tube and the 3 bolts and tighten in 2 stages.
    - Stage 1: Tighten to 8 Nm (71 lb-in).
    - Stage 2: Tighten an additional 45 degrees.

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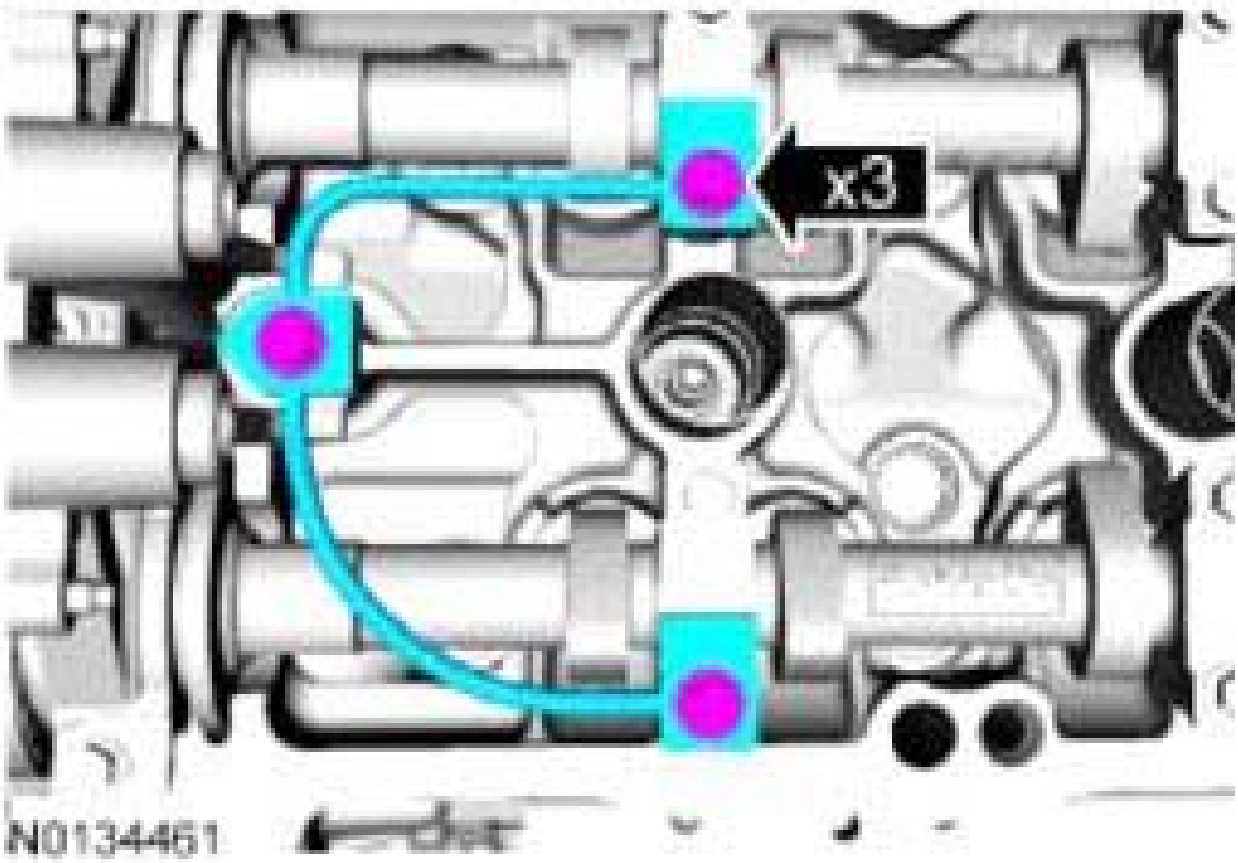
42. Remove the LH 303-1248.

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43. Install the LH valve train oil tube and the 3 bolts and tighten in 2 stages.
    - Stage 1: Tighten to 8 Nm (71 lb-in).
    - Stage 2: Tighten an additional 45 degrees.

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NOTE: **Only use a 3M Roloc® Bristle Disk (2-in white, part number 07528) to clean the engine front cover. Do not use metal scrapers, wire brushes or any other power abrasive disk to clean front cover.**

44.

Clean the engine front cover using a 3M Roloc® Bristle Disk (2-in white, part number 07528) in a suitable tool turning at the recommended speed of 15,000 rpm. Thoroughly wash the engine front cover to remove any foreign material, including any abrasive particles created during the cleaning process.

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

45.

NOTE: **Do not use wire brushes, power abrasive discs or 3M Roloc® Bristle Disk (2-in white part number 07528) to clean the sealing surfaces of engine block, cylinder heads, and oil pan. These tools can cause contamination that will cause premature engine failure. Remove all traces of the gasket.**

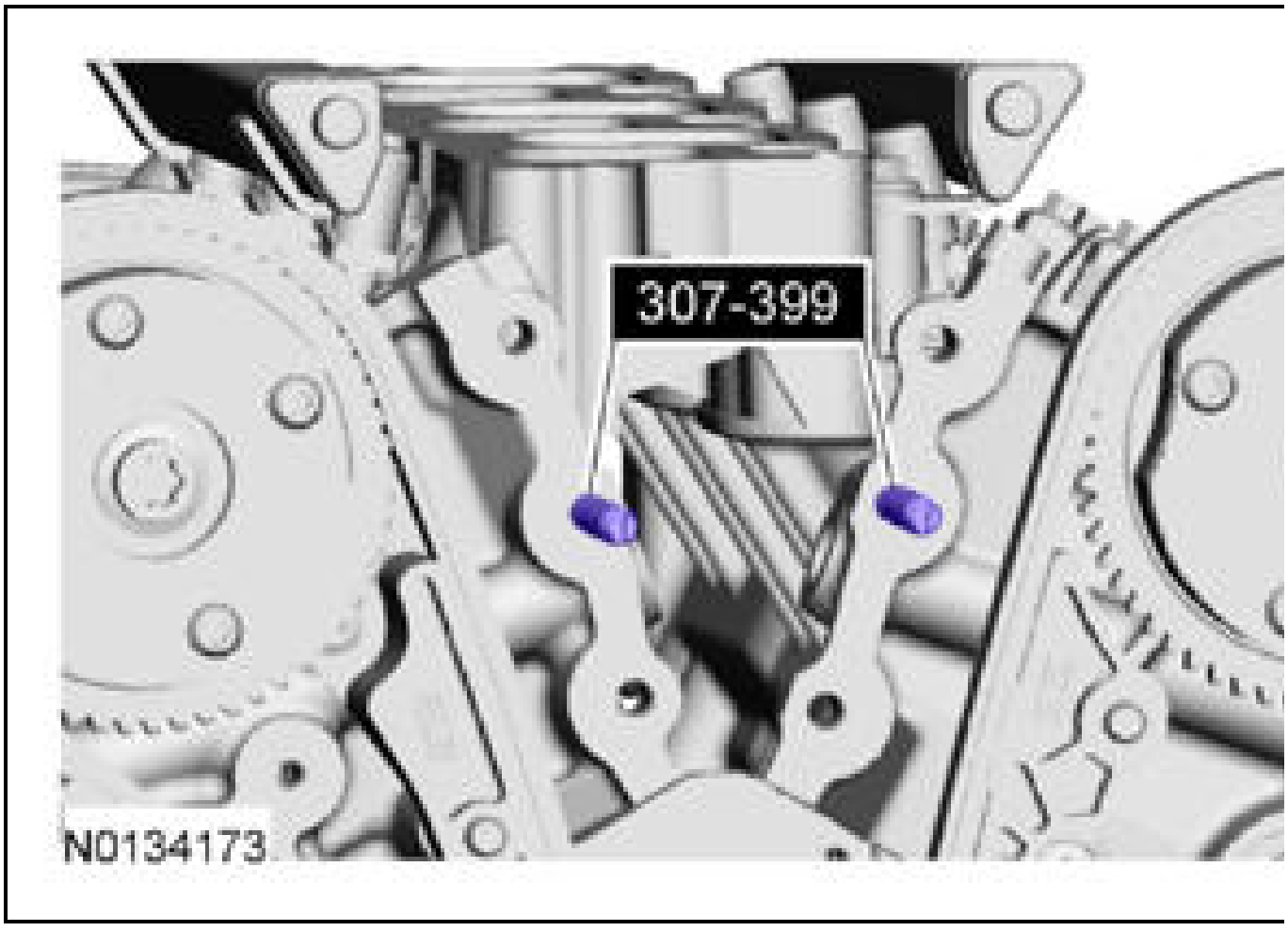
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Clean the sealing surfaces of the cylinder heads, the cylinder block and the oil pan in the following sequence.

- Remove any large deposits of silicone or gasket material.
- Apply Motorcraft® Silicone Gasket Remover and allow to set for several minutes.
- Remove the Motorcraft® Silicone Gasket Remover. A second application of Motorcraft® Silicone Gasket Remover may be required if residual traces of silicone or gasket material remain.
- Apply Motorcraft® Metal Surface Prep to remove any remaining traces of oil or coolant and to prepare the surfaces to bond. Do not attempt to make the metal shiny. Some staining of the metal surfaces is normal.

46. **NOTE: Make sure the 2 locating dowel pins are seated correctly in the cylinder block.**

Install 307-399



47. **NOTE: Failure to use Motorcraft® High Performance Engine RTV Silicone may cause the engine oil to foam excessively and result in serious engine**

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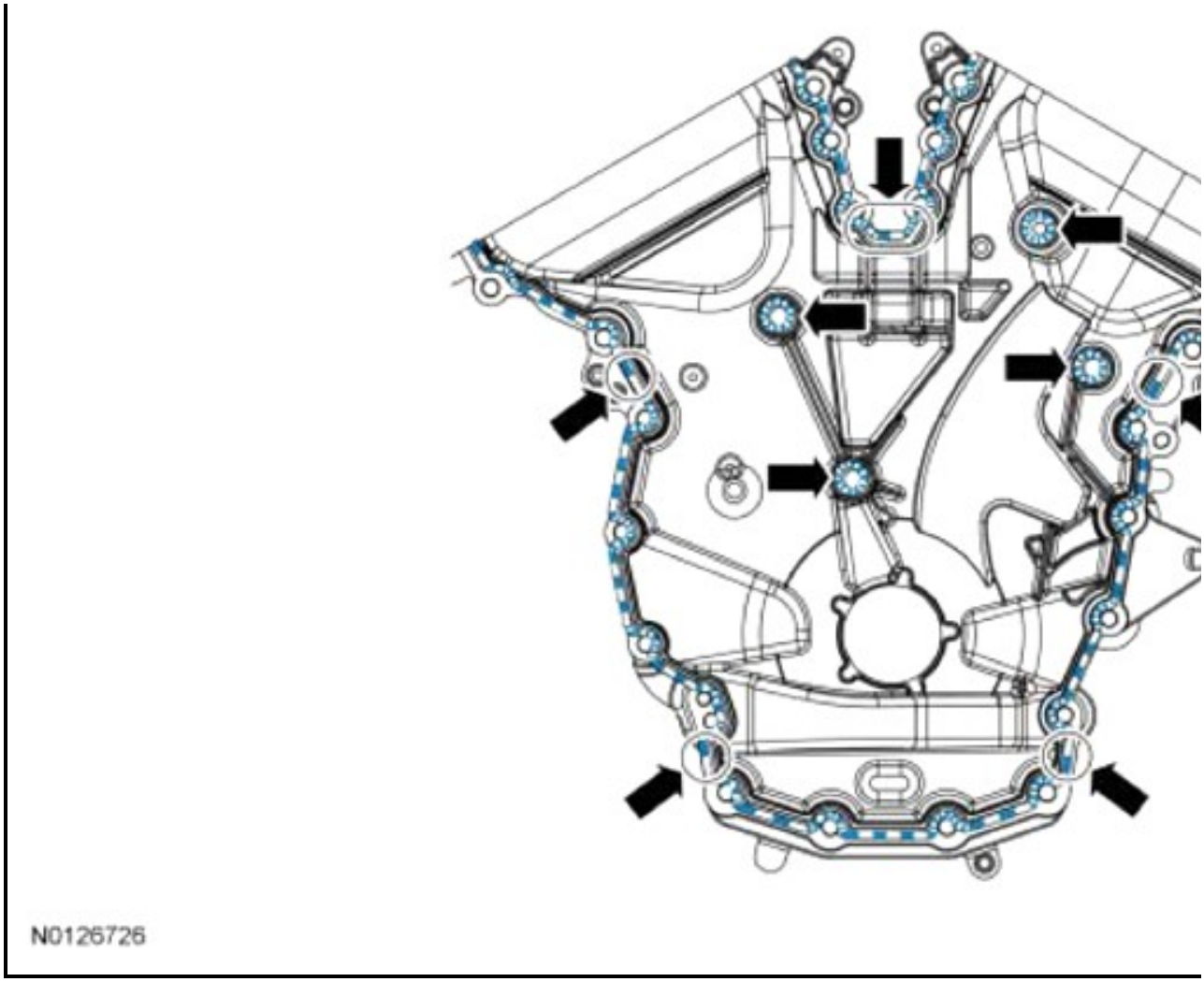
47. **damage.**

NOTE: The engine front cover and bolts 7, 8, 15, 17, 18, 21 and 22 must be installed within 4 minutes of the initial sealant application. The remainder of the engine front cover bolts must be installed and tightened within 35 minutes of the initial sealant application. If the time limits are exceeded, the sealant must be removed, the sealing area cleaned and sealant reapplied. To clean the sealing area, use Motorcraft® Silicone Gasket Remover and Motorcraft® Metal Surface Prep. Failure to follow this procedure can cause future oil leakage.

Apply a 3 mm (0.1181 in) bead of Motorcraft® High Performance Engine RTV Silicone to the sealing surface of the front cover.

- Apply a 5.5 mm (0.22 in) bead of Motorcraft® High Performance Engine RTV Silicone to the oil pan-to-cylinder block joint and the cylinder head-to-cylinder block joint areas of the engine front cover in 5 places as indicated.

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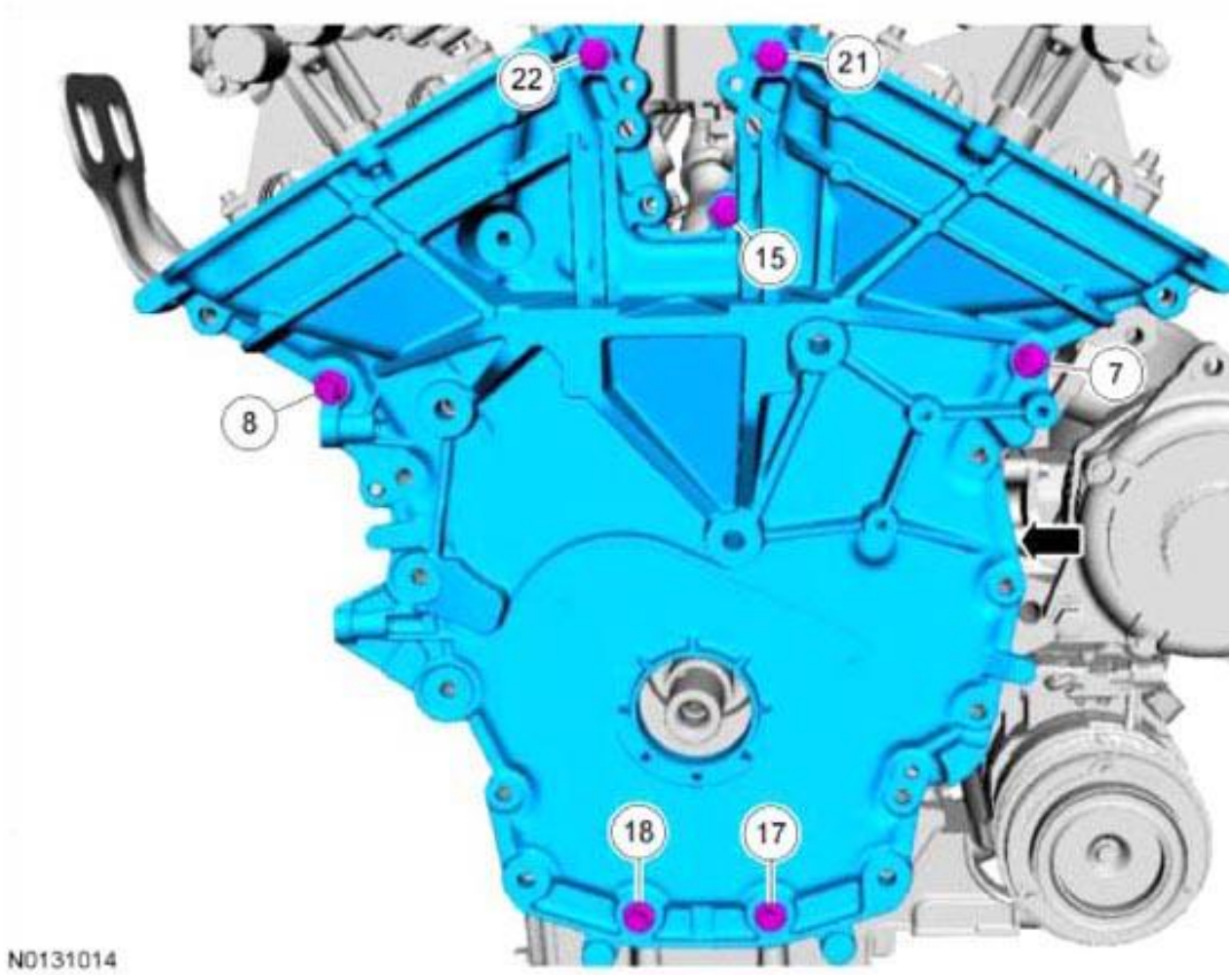


48. **NOTE: Make sure the 2 locating dowel pins are seated correctly in the cylinder block.**

Install the engine front cover and bolts 7, 8, 15, 17, 18, 21 and 22.

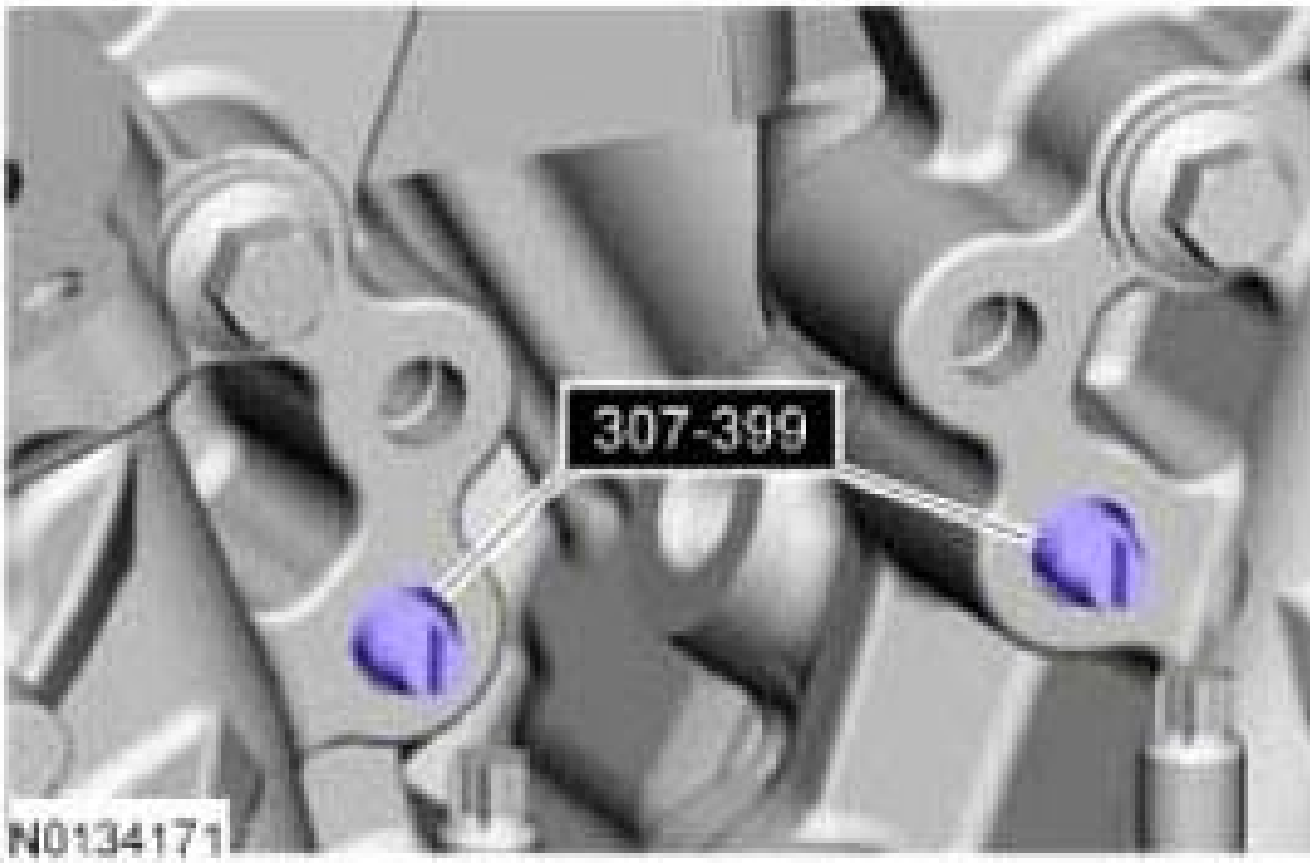
- Tighten in sequence shown in illustration to 3 Nm (27 lb-in).

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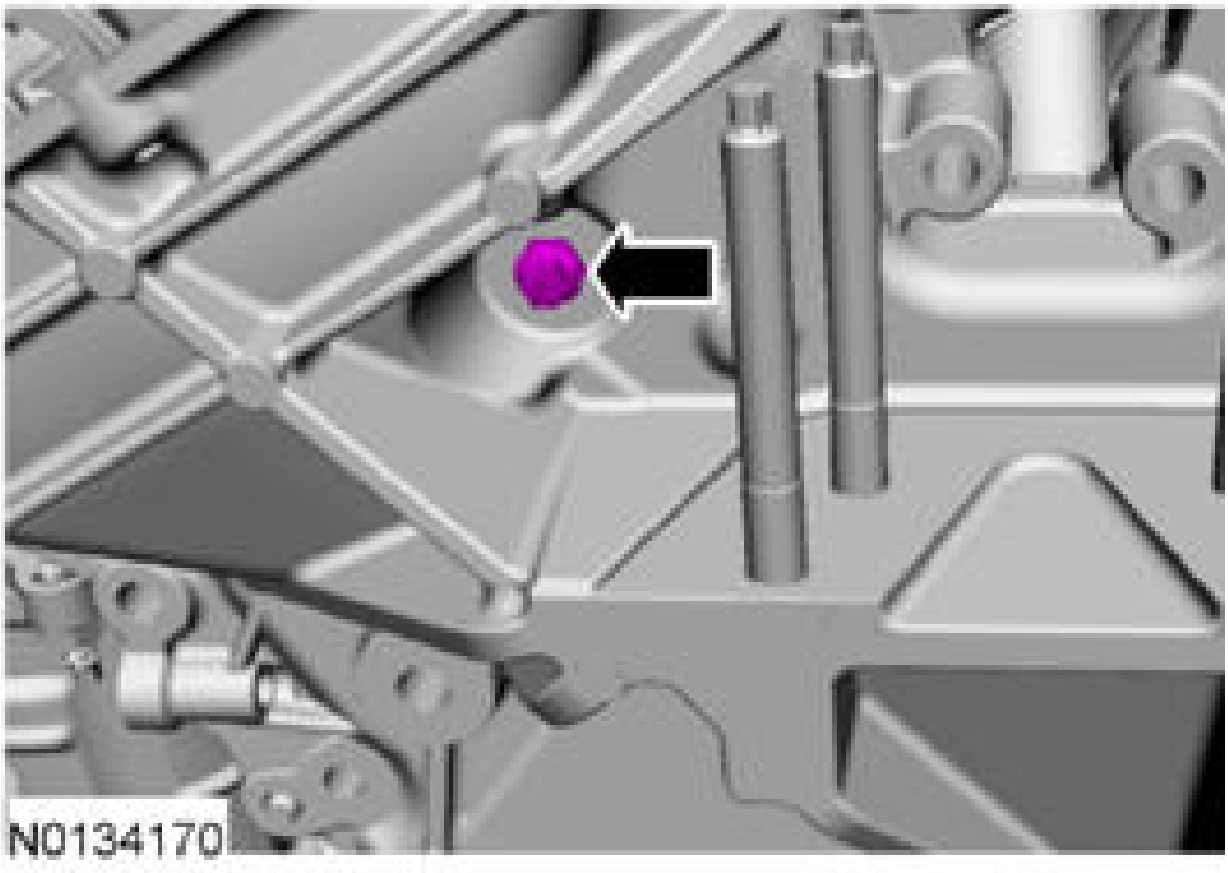
49. Remove 307-399.

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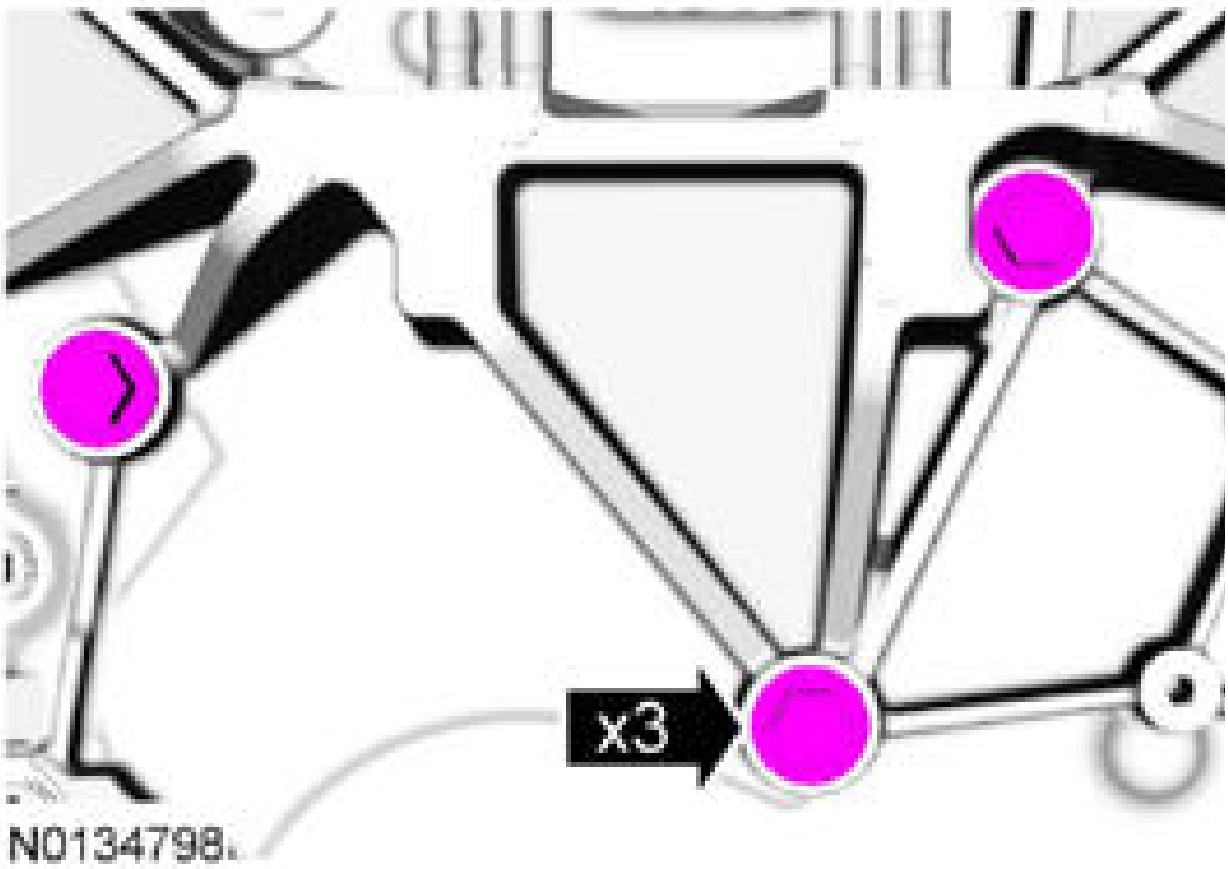
50. Install the M6 engine front cover bolt.
    - Do not tighten at this time.

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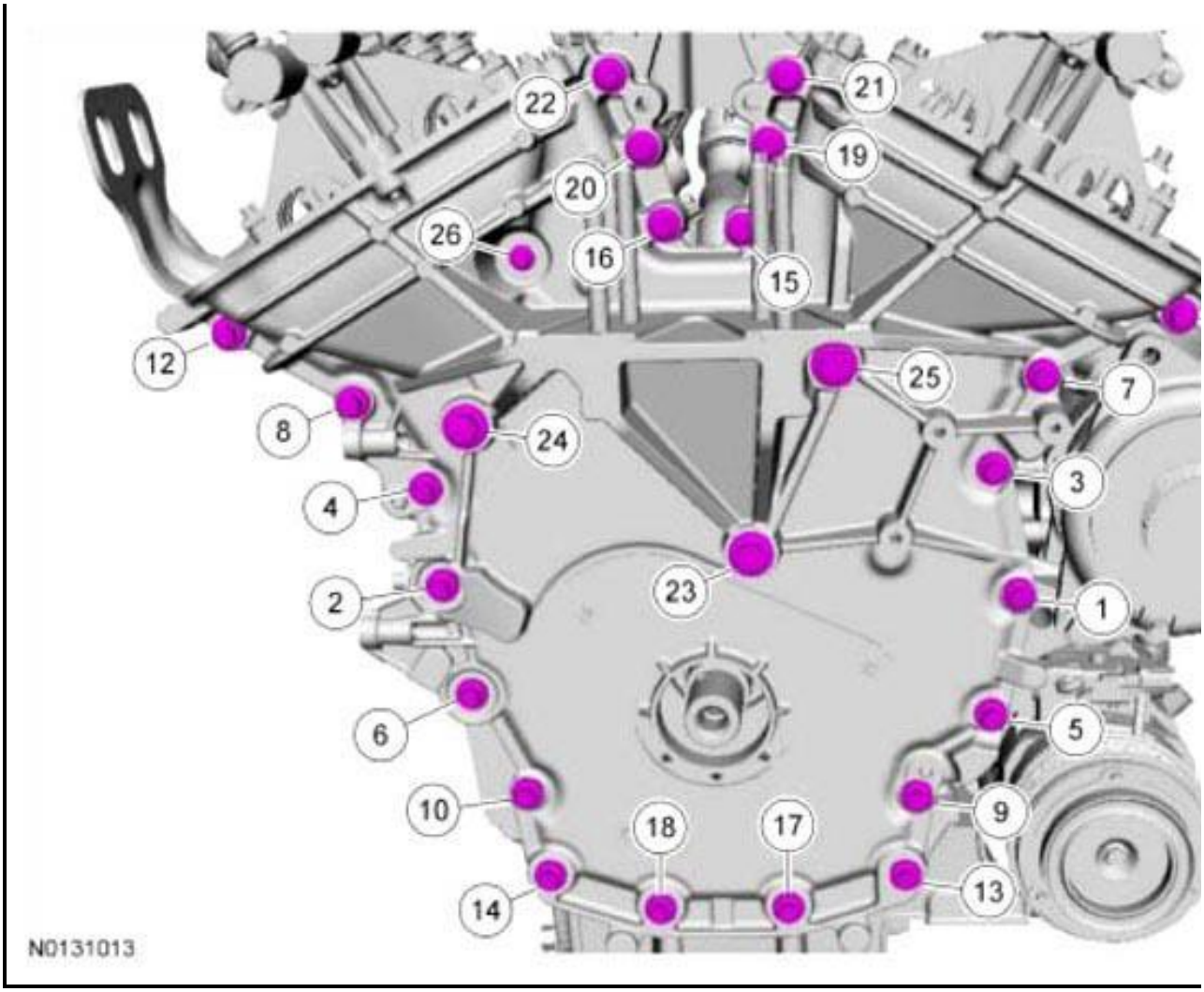
51. Install the 3 upper M10 engine front cover bolts.
    - Do not tighten the bolts at this time.

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52. Install the remaining engine front cover bolts. Tighten all of the engine front cover bolts in the sequence shown in illustration in 7 stages.
    - Stage 1: Tighten bolts 1 thru 22 to 10 Nm (89 lb-in).
    - Stage 2: Tighten bolts 23 thru 25 to 15 Nm (133 lb-in).
    - Stage 3: Tighten bolt 26 to 10 Nm (89 lb-in).
    - Stage 4: Loosen bolt 26 one full turn.
    - Stage 5: Tighten bolts 23 thru 25 to 30 Nm (22 lb-ft) plus an additional 90 degrees.
    - Stage 6: Tighten bolts 1 thru 22 to 20 Nm (177 lb-in) plus an additional 45 degrees.
    - Stage 7: Tighten bolt 26 to 10 Nm (89 lb-in) plus an additional 45 degrees.

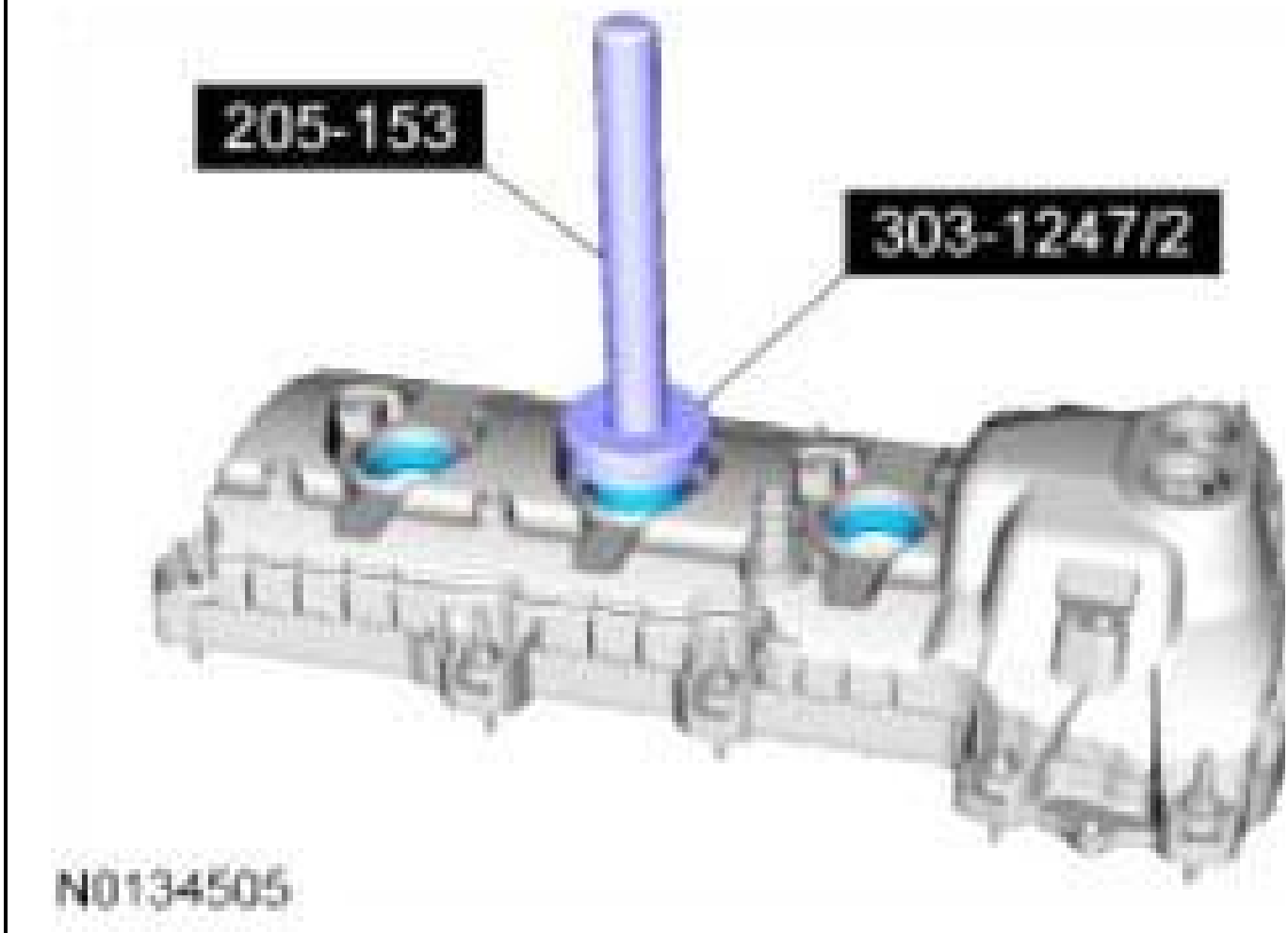
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53. **NOTE: Installation of new seals is only required if damaged seals were removed.**

Using 303-1247/2 and 205-153 T80T-4000-W install the new spark plug tube seal(s).

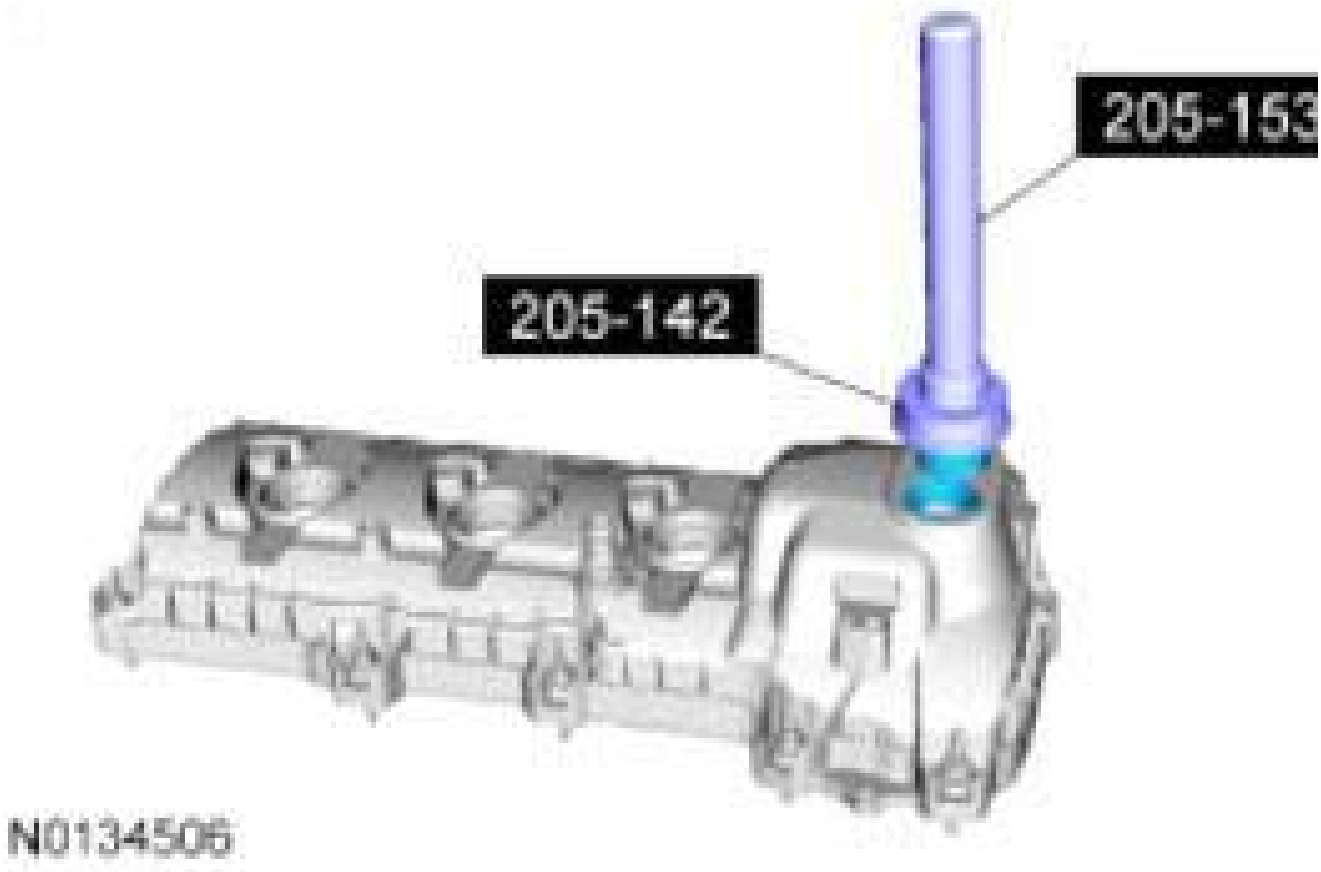
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54. **NOTE: Installation of new seals is only required if damaged seals were removed.**

Using 205-142 T80T-4000-J and 205-153 T80T-4000-W install the new **VCT** seal(s).

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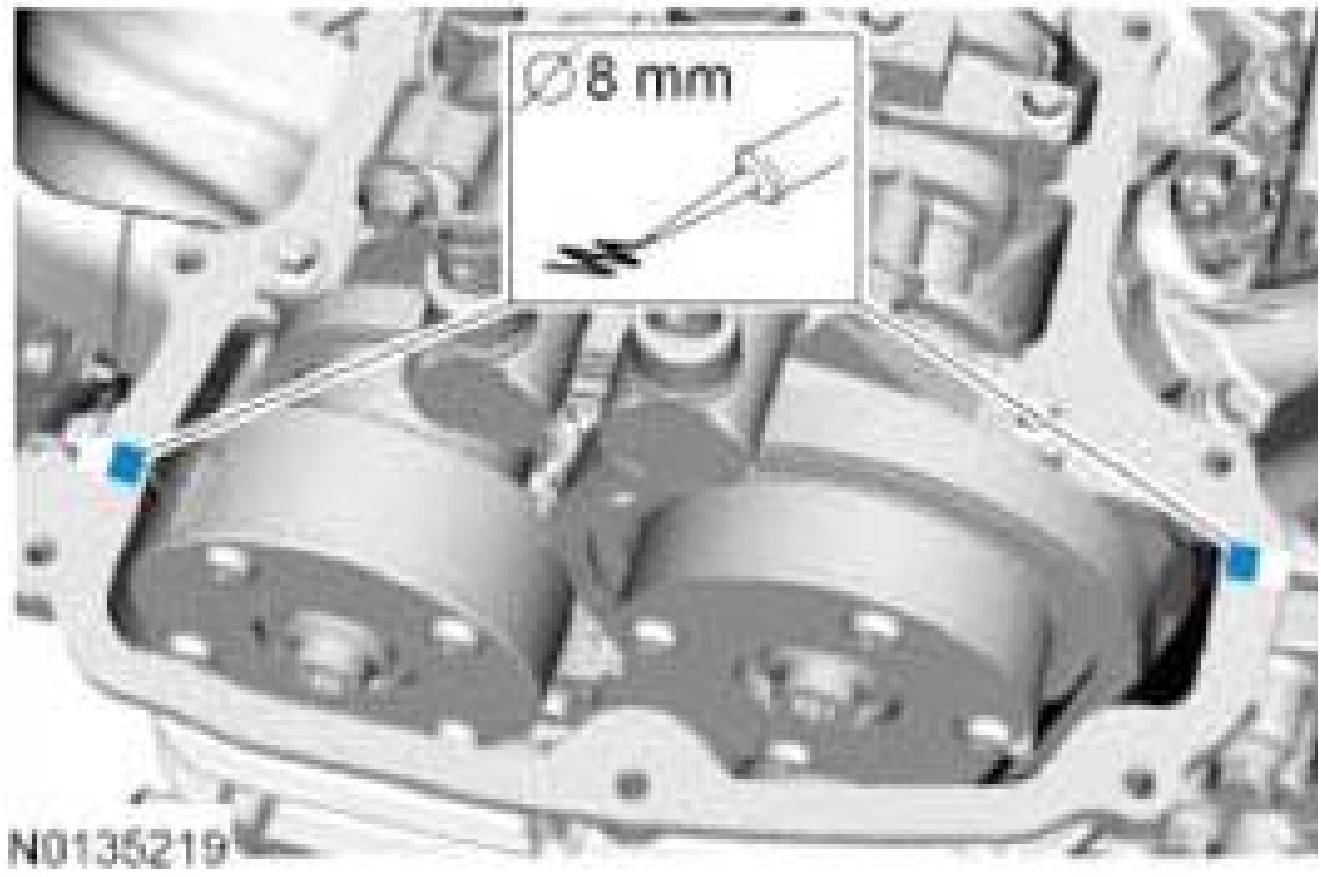
55.

NOTE: **Failure to use Motorcraft® High Performance Engine RTV Silicone may cause the engine oil to foam excessively and result in serious engine damage.**

NOTE: **If the valve cover is not installed and the fasteners tightened within 4 minutes, the sealant must be removed and the sealing area cleaned. To clean the sealing area, use Motorcraft® Silicone Gasket Remover and Motorcraft® Metal Surface Prep. Failure to follow this procedure can cause future oil leakage.**

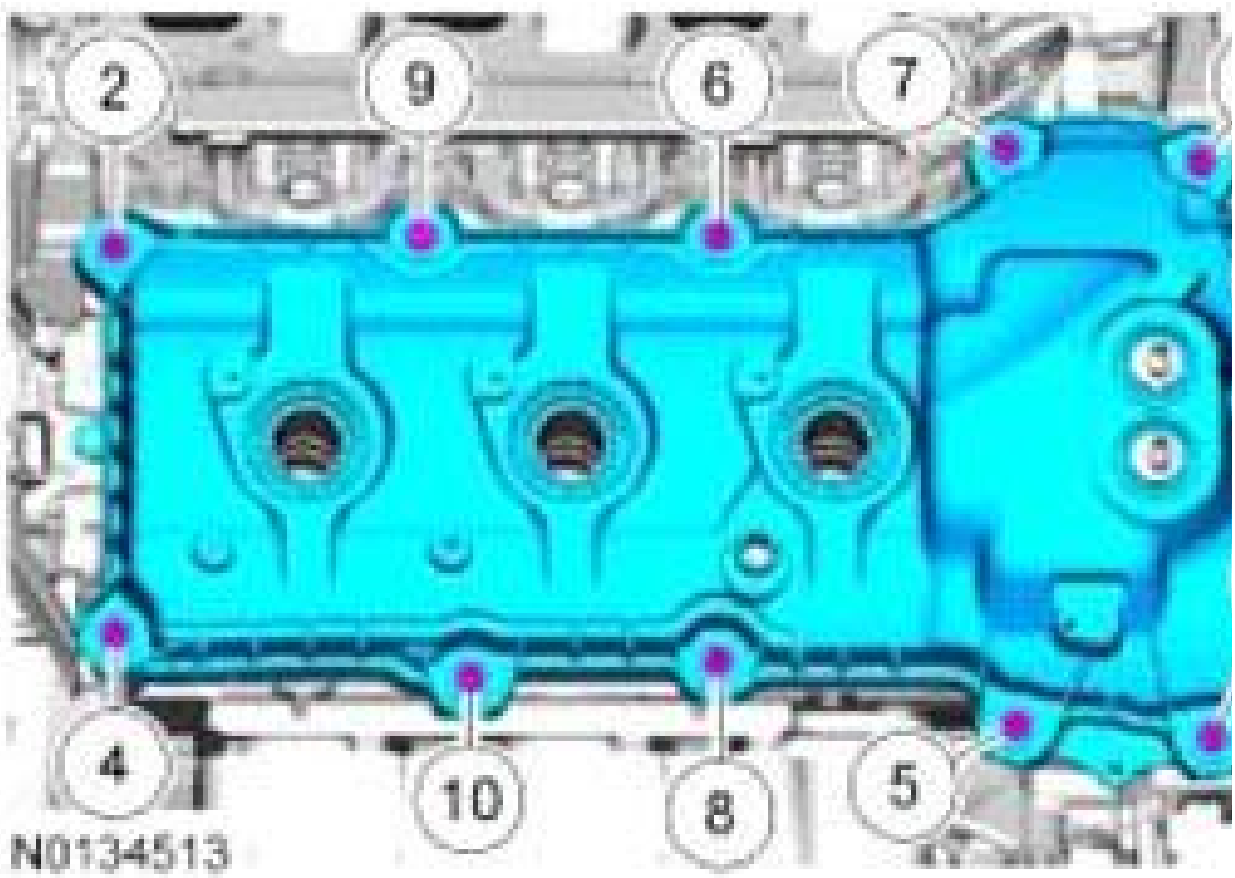
Apply an 8 mm (0.315 in) bead of Motorcraft® High Performance Engine RTV Silicone to the engine front cover-to-Right Hand (RH) cylinder head joints.

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56. Using a new gasket, install the RH valve cover and tighten the 11 retainers.
    - Tighten in the sequence shown in illustration to 10 Nm (89 lb-in).

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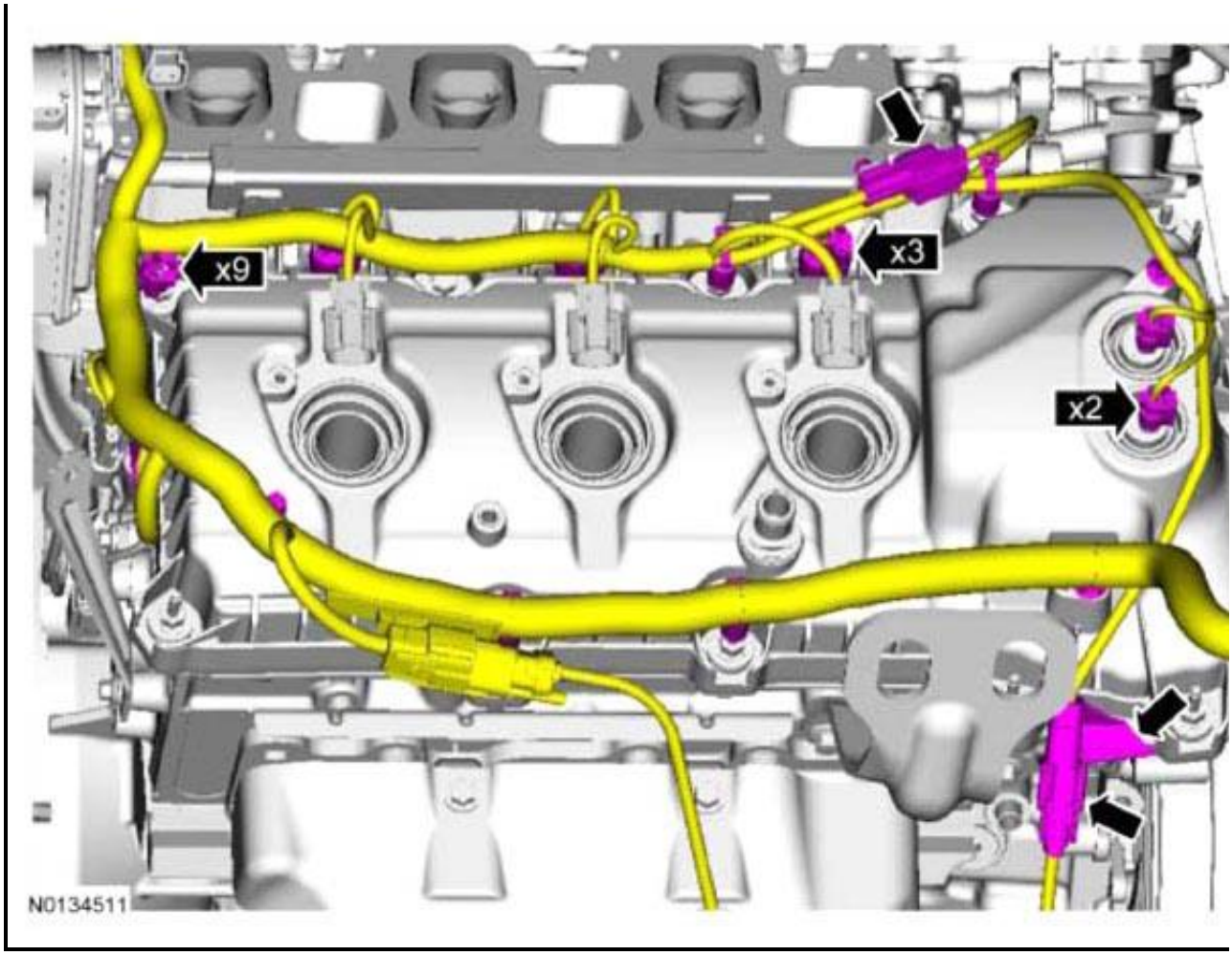
57. Ensure the **VCT** seals in the valve cover are below the top of the connector (flat portion) on the **VCT** oil control valve otherwise the interface may leak.

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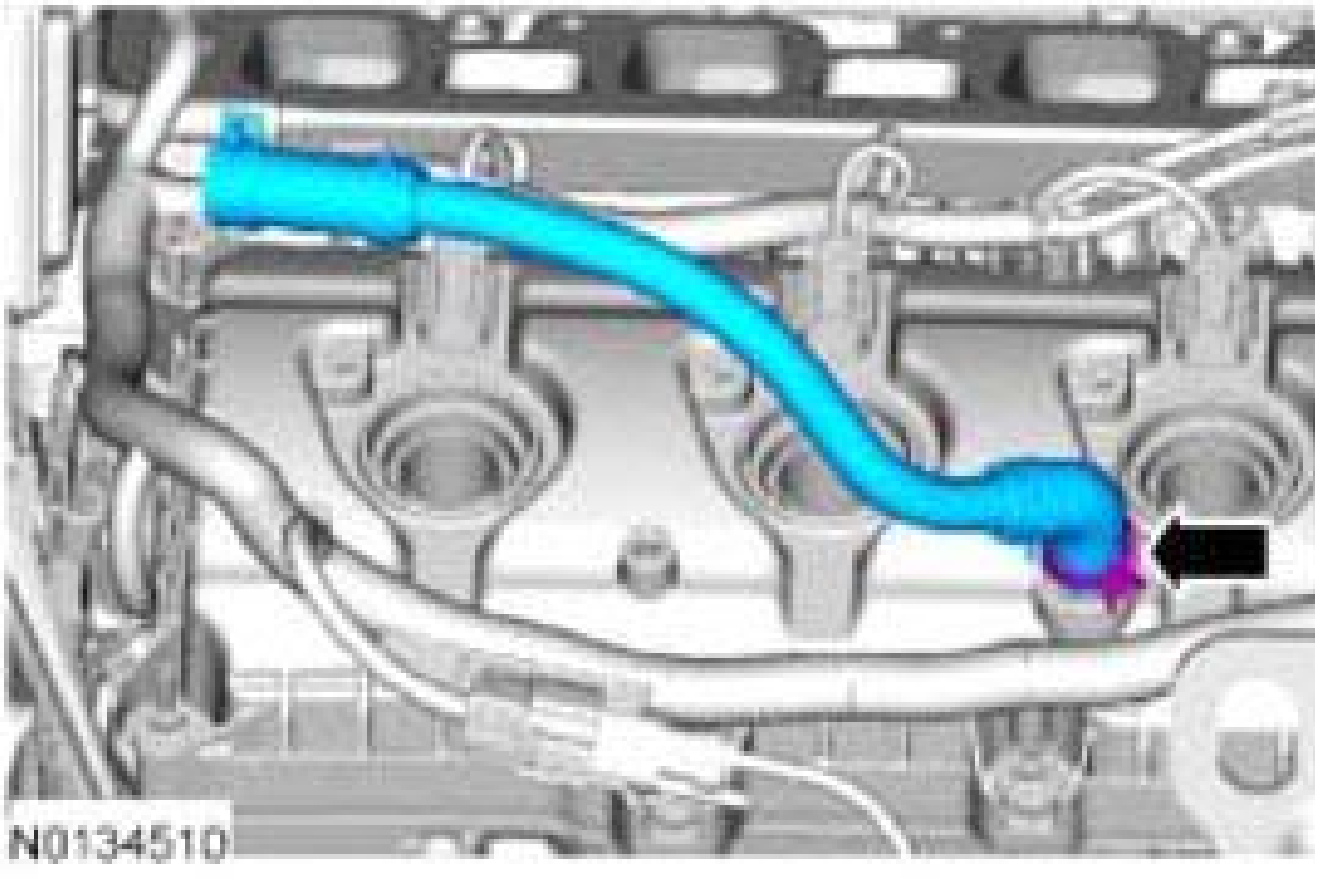
58. Install the engine wiring harness to the RH valve cover.
    - Position the wiring harness and attach the 9 wiring harness retainers to the RH valve cover and stud bolts.
    - Connect the **CHT** sensor wiring harness jumper electrical connector.
    - Connect the 3 fuel injector electrical connectors.
    - Connect and attach the RH **CMS** electrical connector.
    - Connect the 2 **VCT** oil control solenoid electrical connectors.

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59. Install the **PCV** crankcase vent tube.

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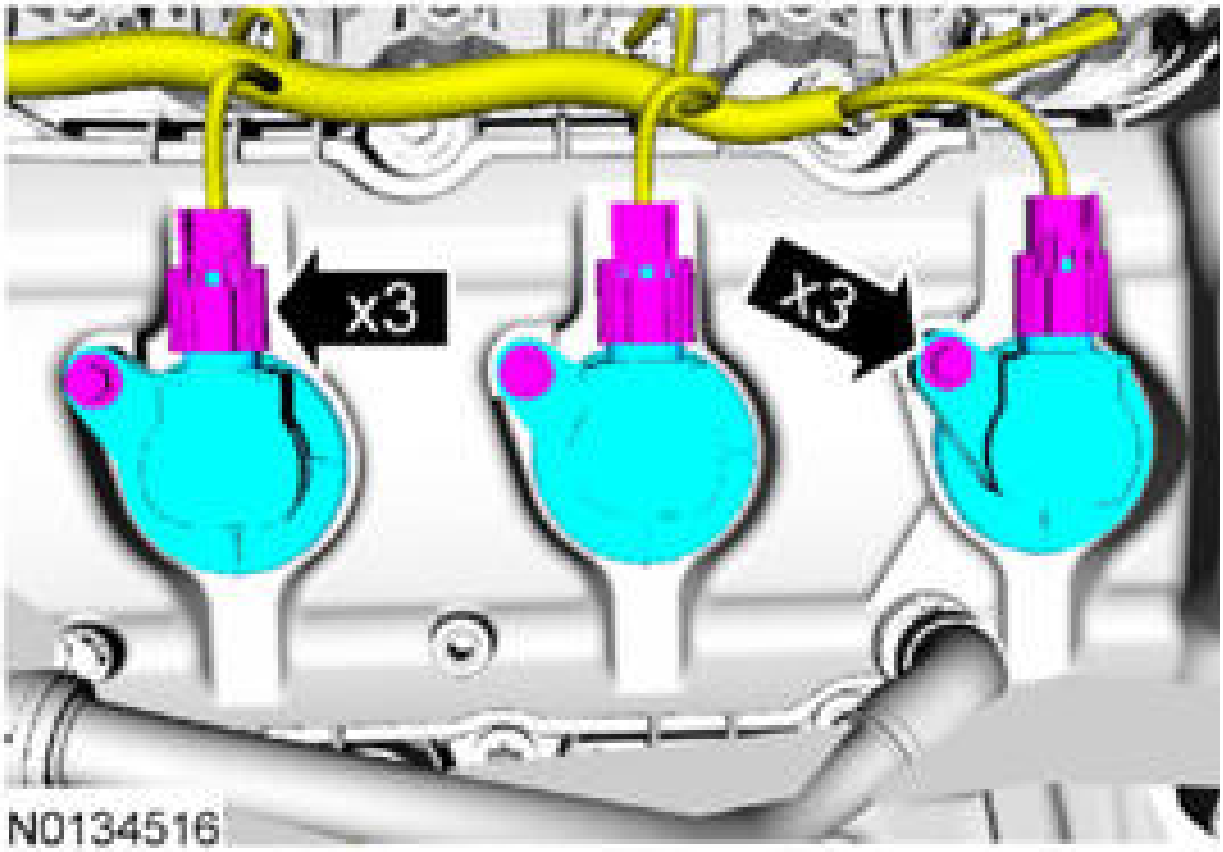


60. **NOTE: Apply a small amount of dielectric grease to the inside of the ignition coil-on-plug boots before attaching to the spark plugs.**

Install the 3 RH-coil-on-plugs and the 3 bolts.

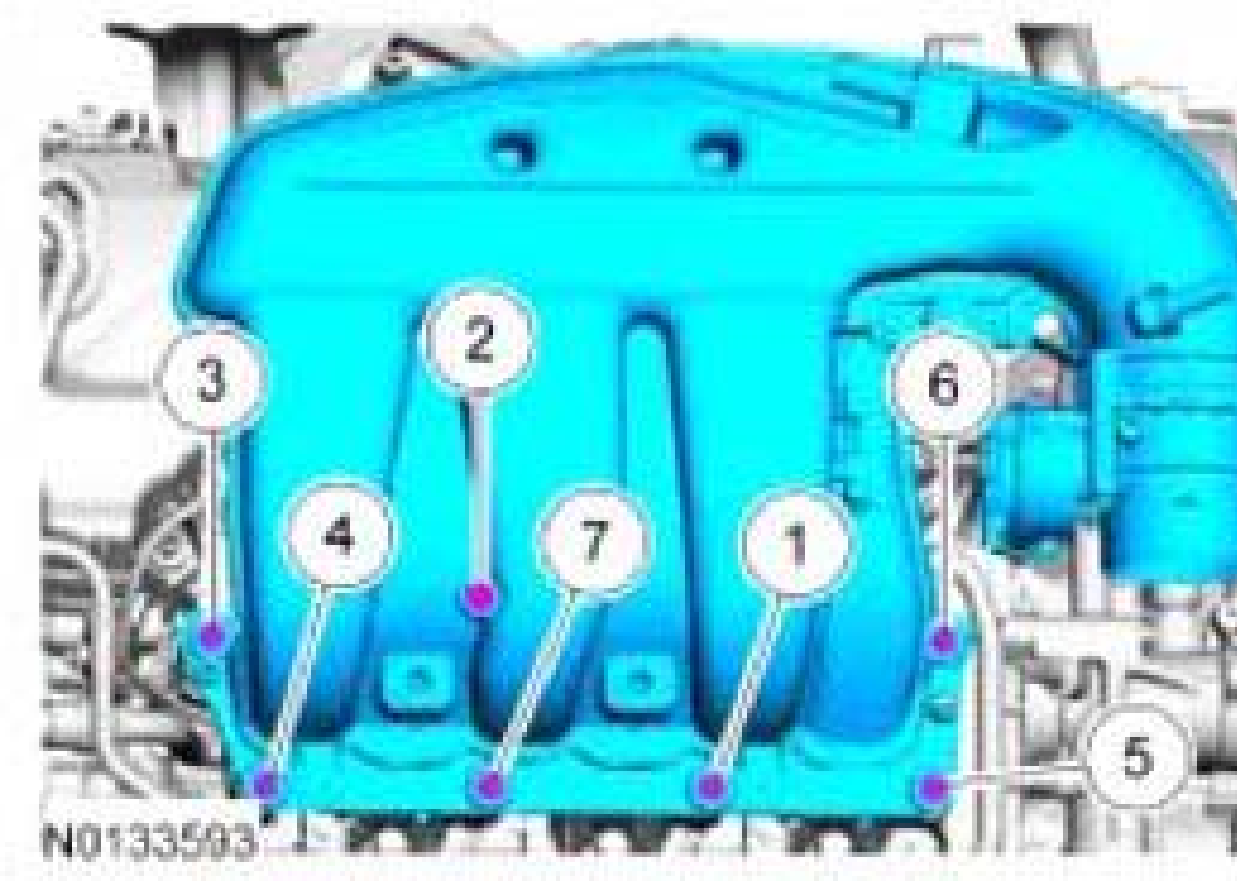
- Tighten to 7 Nm (62 lb-in).
- Connect the 3 coil-on-plug electrical connectors.

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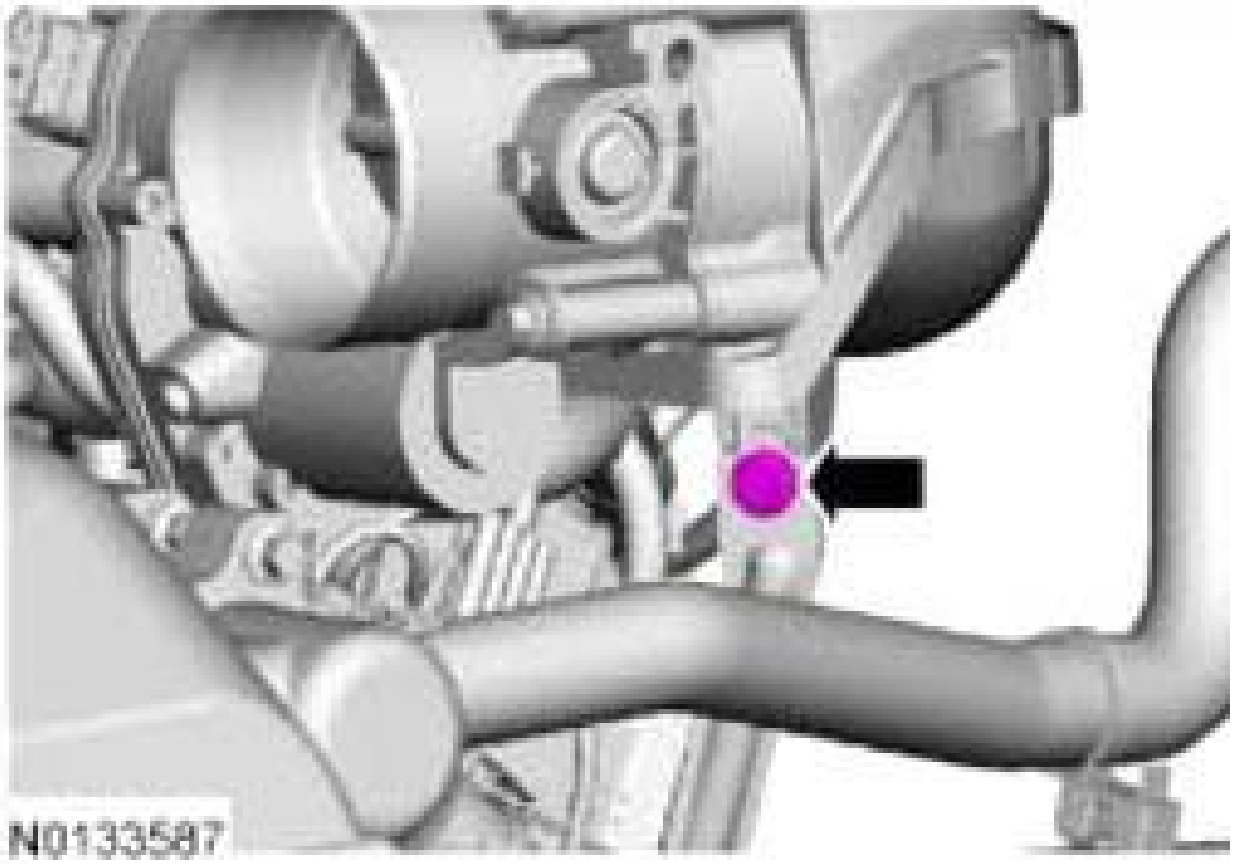
61. Using a new gasket, install the intake manifold and the 7 bolts and tighten in the sequence shown in illustration in 2 stages.
    - Stage 1: Tighten to 10 Nm (89 lb-in).
    - Stage 2: Tighten an additional 45 degrees.

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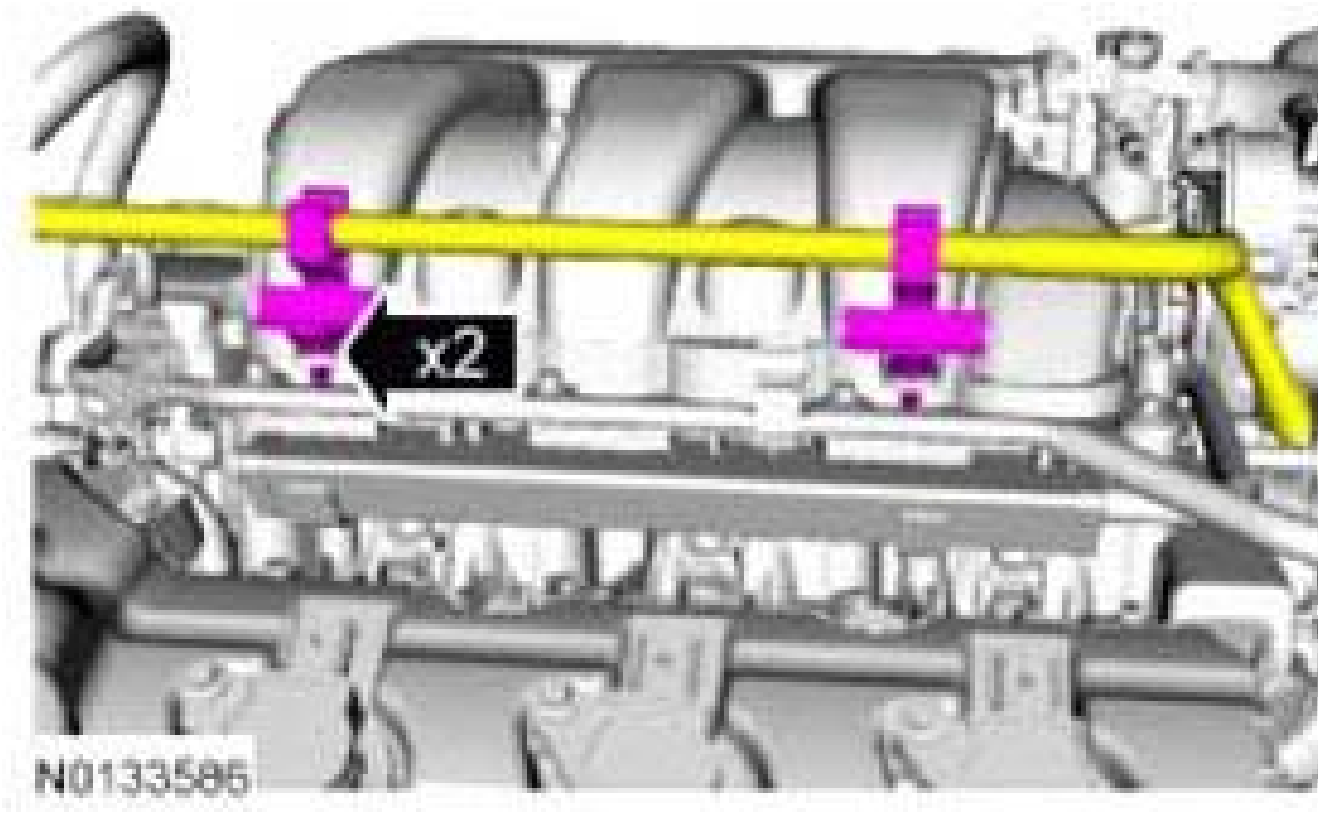
62. Install the upper intake manifold support bolt.
    - Tighten to 10 Nm (89 lb-in).

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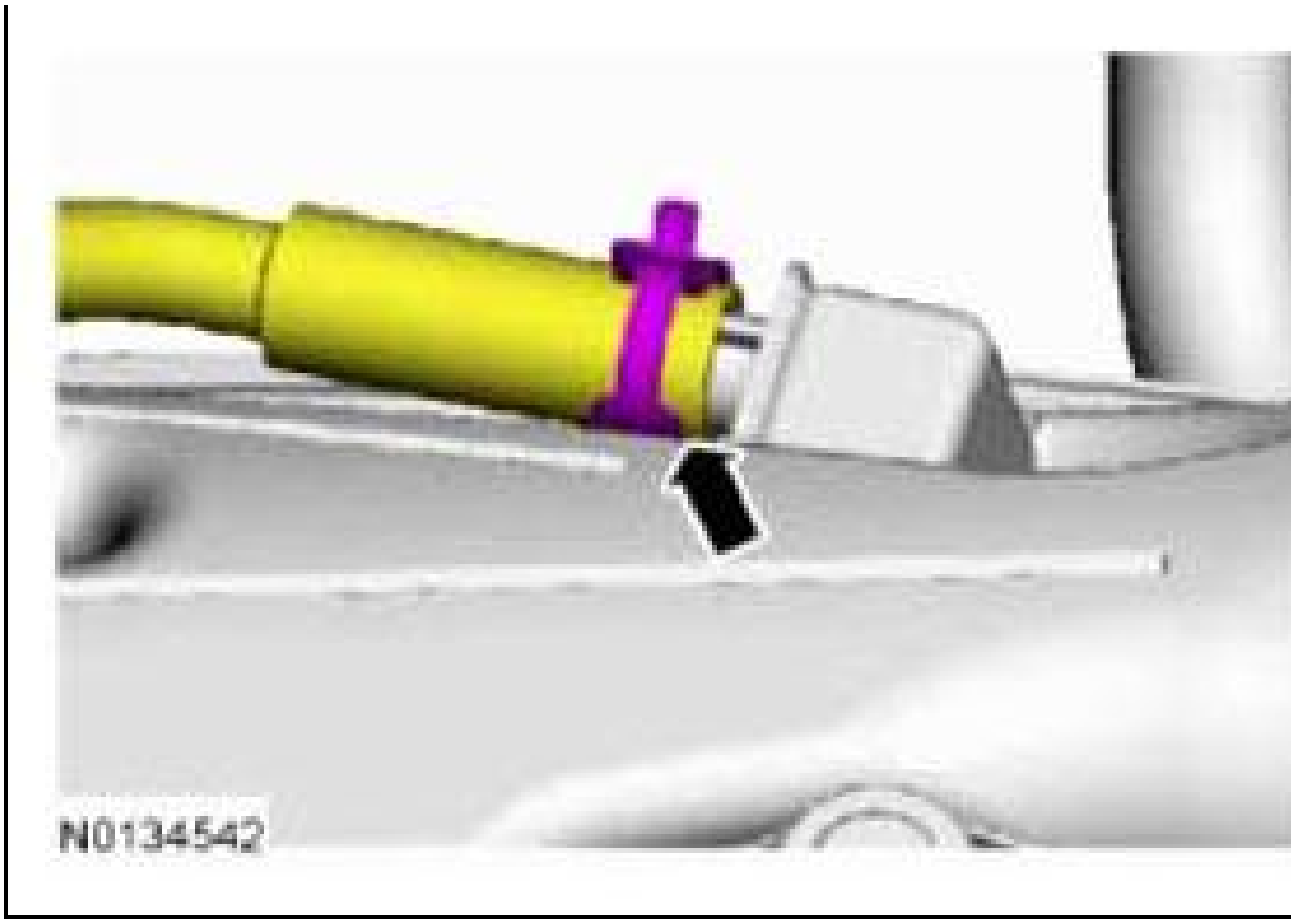
63. Attach the 2 coolant tube retainers to the upper intake manifold.

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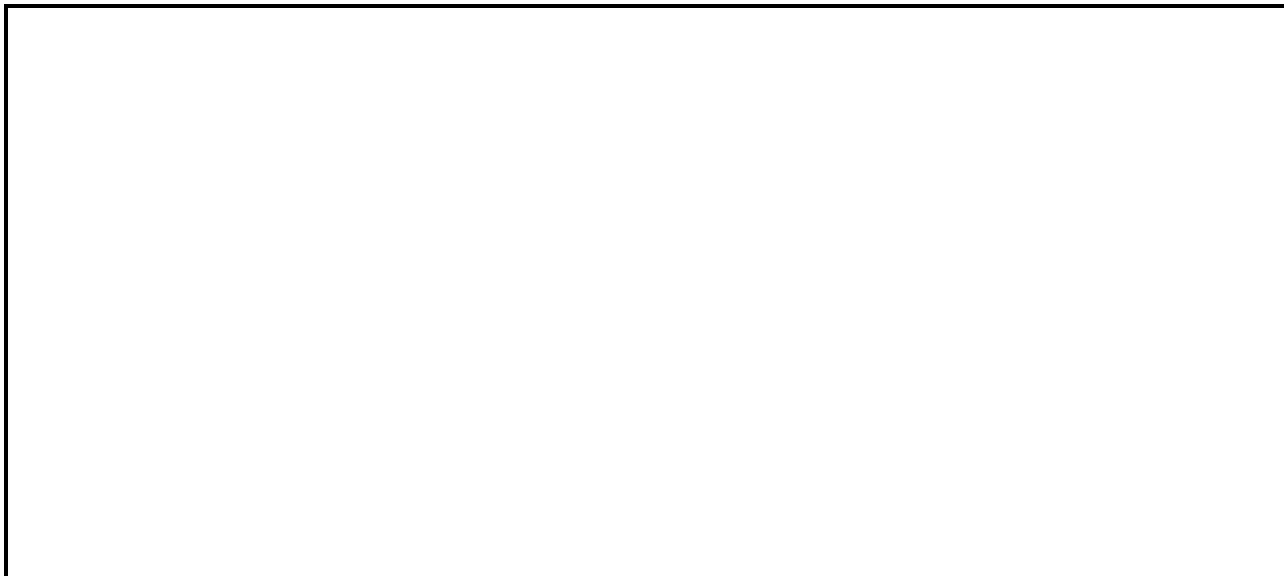


64. Connect the crankcase ventilation hose to the upper intake manifold.

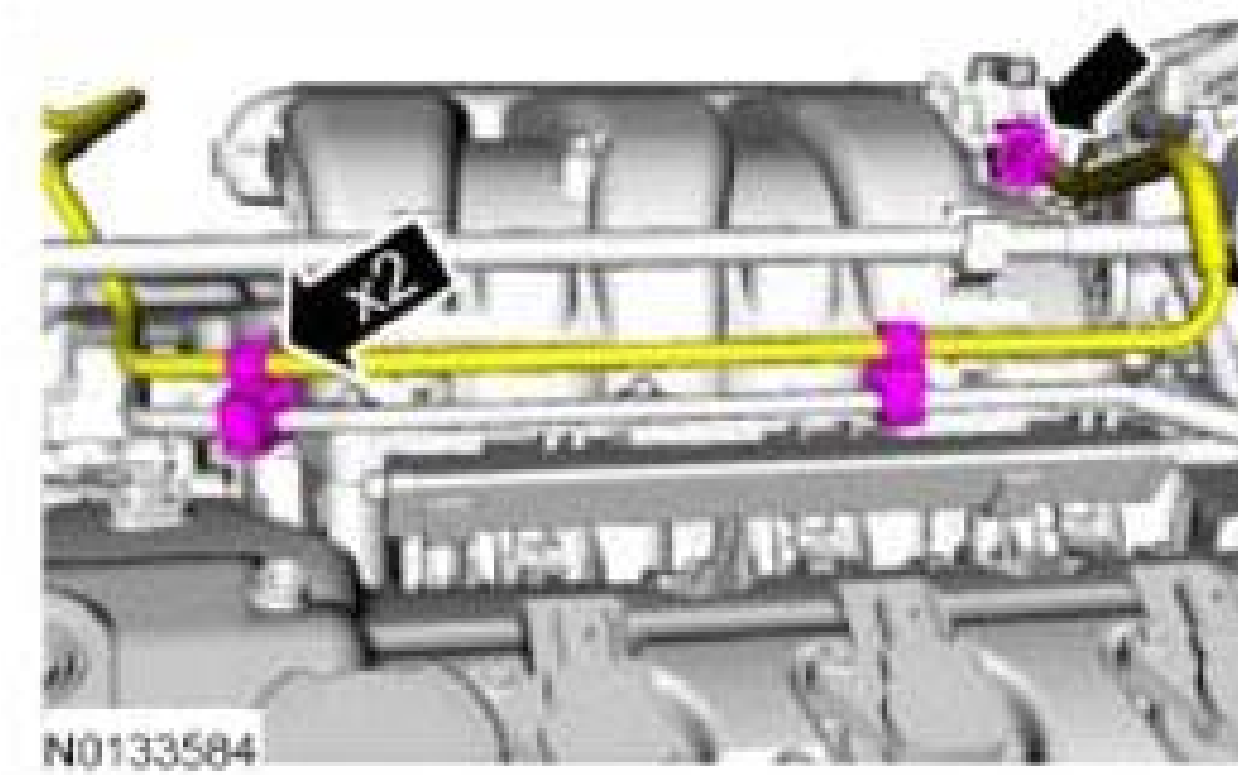
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65. Connect the **EVAP** vapor tube to the **EVAP** canister purge valve. REFER to **QUICK CONNECT COUPLING** .
    - Attach the **EVAP** vapor tube to the 2 retainers.

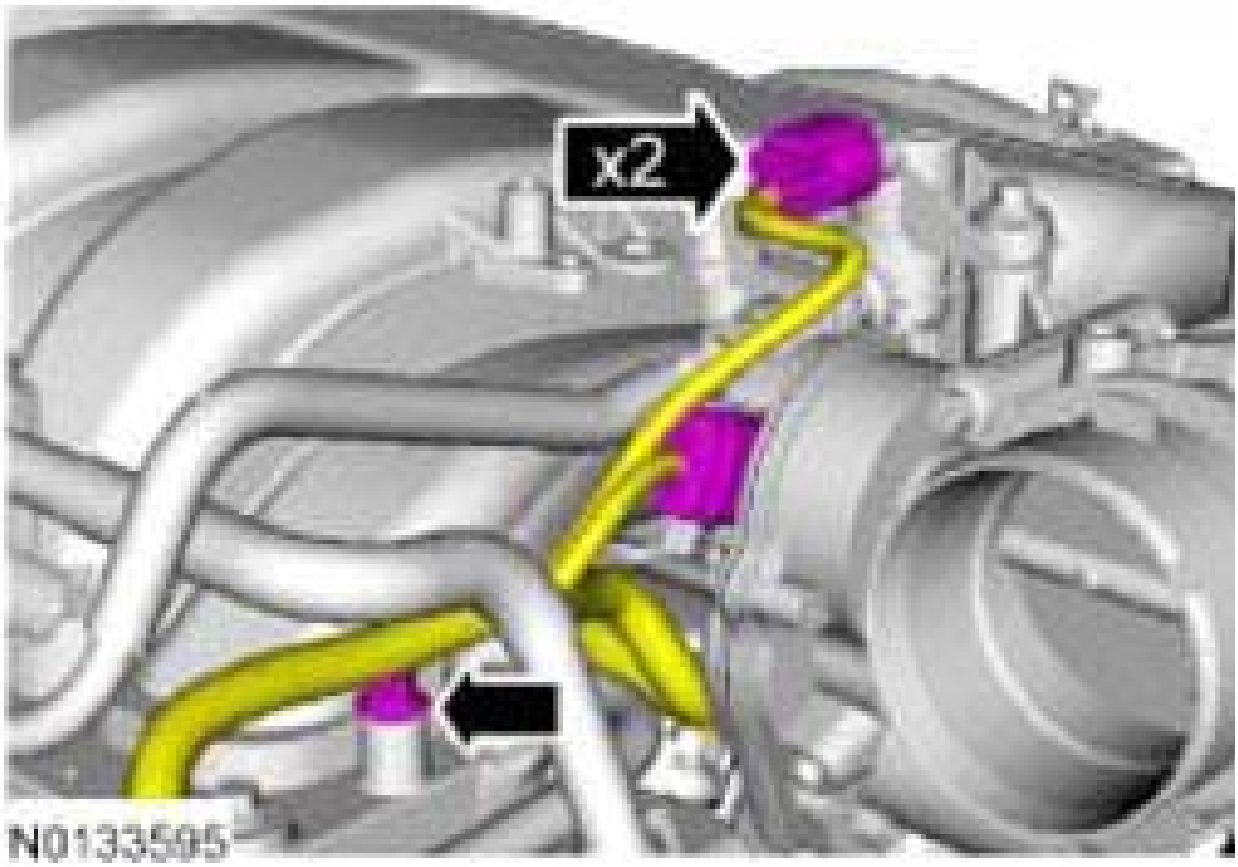


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66. Connect the **EVAP** canister purge valve and throttle body electrical connectors.
    - Attach the wiring harness pin-type retainer to the upper intake manifold.

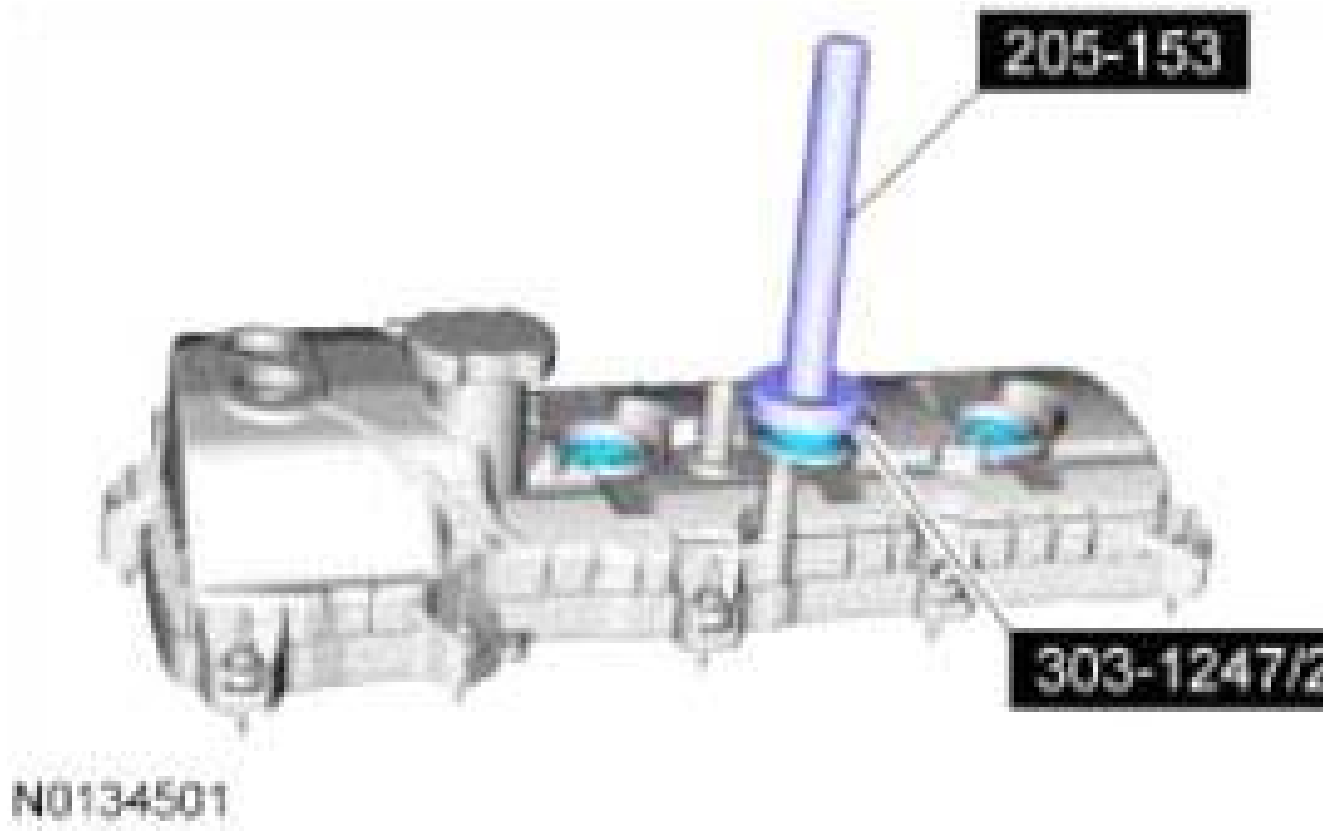
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67. **NOTE: Installation of new seals is only required if damaged seals were removed.**

Using 303-1247/2 and 205-153 T80T-4000-W install the new spark plug tube seal(s).

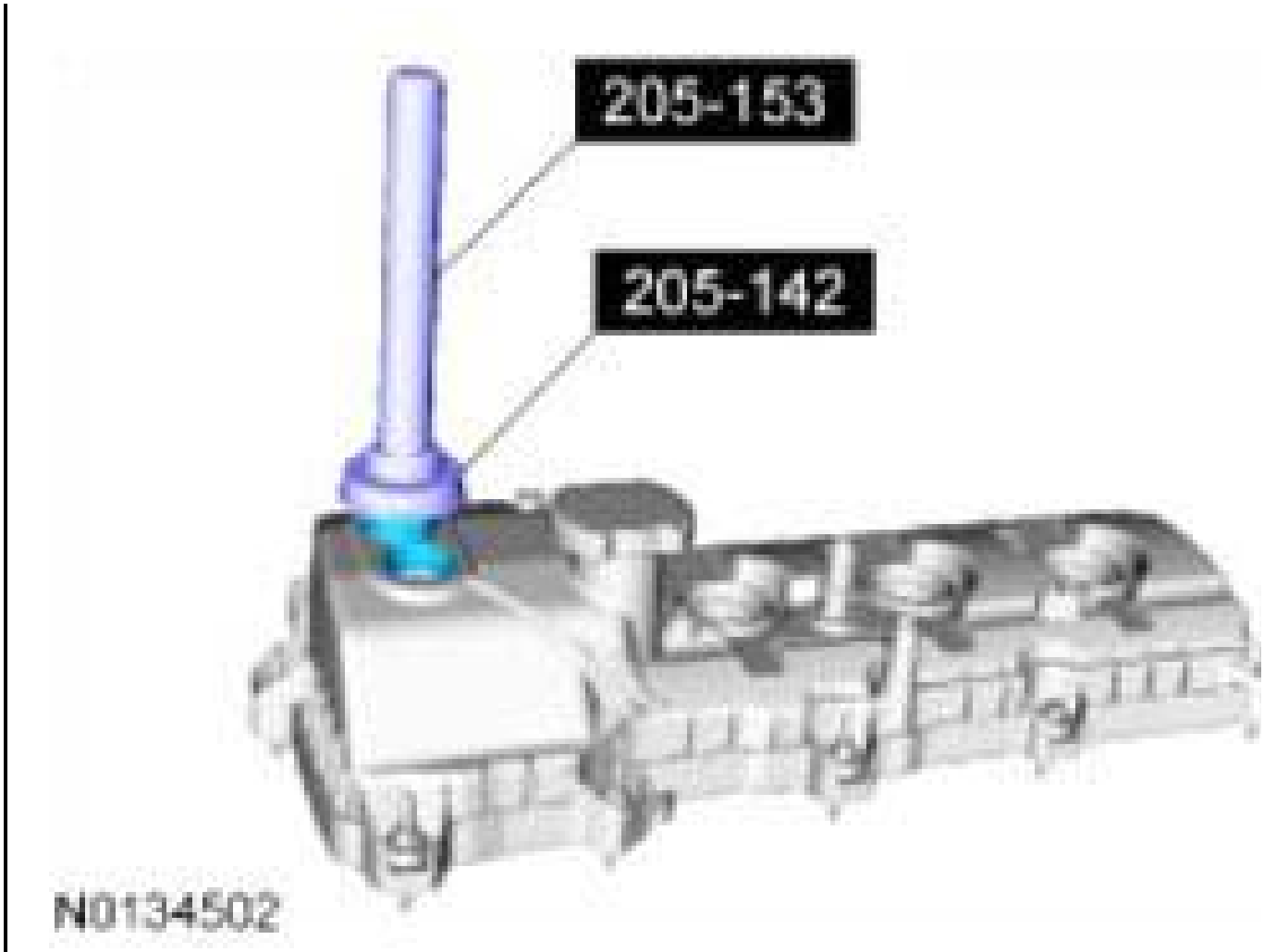
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68. **NOTE: Installation of new seals is only required if damaged seals were removed.**

Using 205-142 T80T-4000-J and 205-153 T80T-4000-W install the new **VCT** seal(s).

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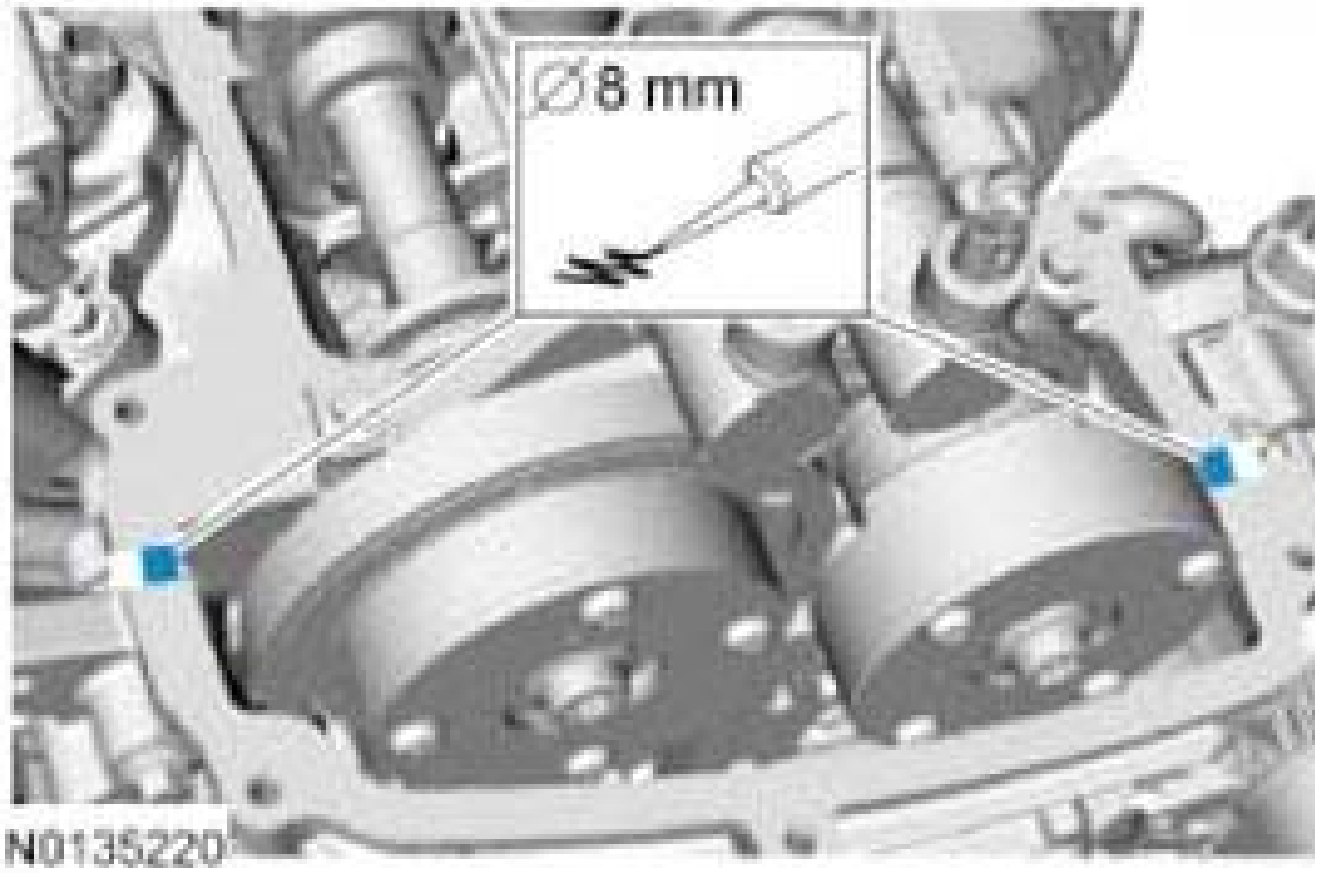
69.

NOTE: **Failure to use Motorcraft® High Performance Engine RTV Silicone may cause the engine oil to foam excessively and result in serious engine damage.**

NOTE: **If the valve cover is not installed and the fasteners tightened within 4 minutes, the sealant must be removed and the sealing area cleaned. To clean the sealing area, use Motorcraft® Silicone Gasket Remover and Motorcraft® Metal Surface Prep. Failure to follow this procedure can cause future oil leakage.**

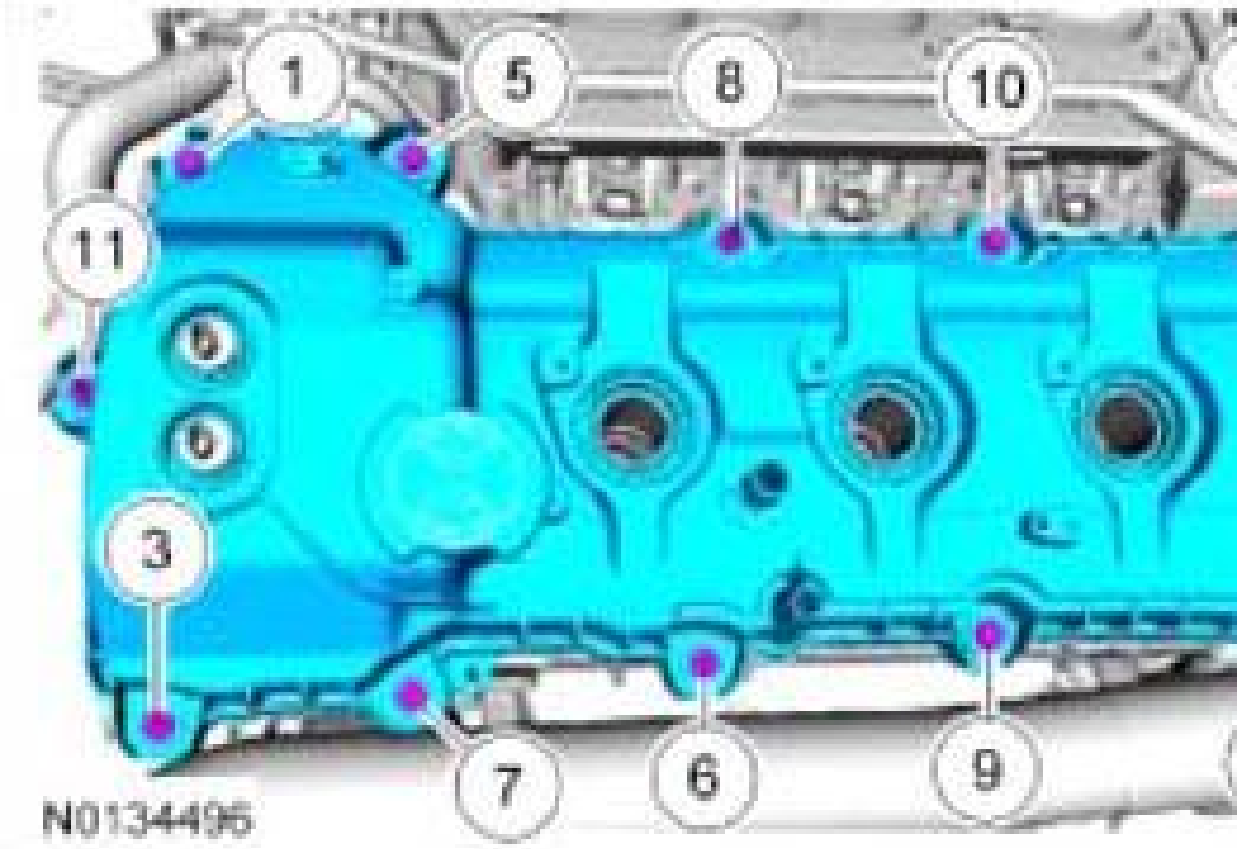
Apply an 8 mm (0.315 in) bead of Motorcraft® High Performance Engine RTV Silicone to the engine front cover-to-Left Hand (LH) cylinder head joints.

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70. Using a new gasket, install the LH valve cover and tighten the 4 bolts and 7 stud bolts.
    - Tighten in the sequence shown in illustration to 10 Nm (89 lb-in).

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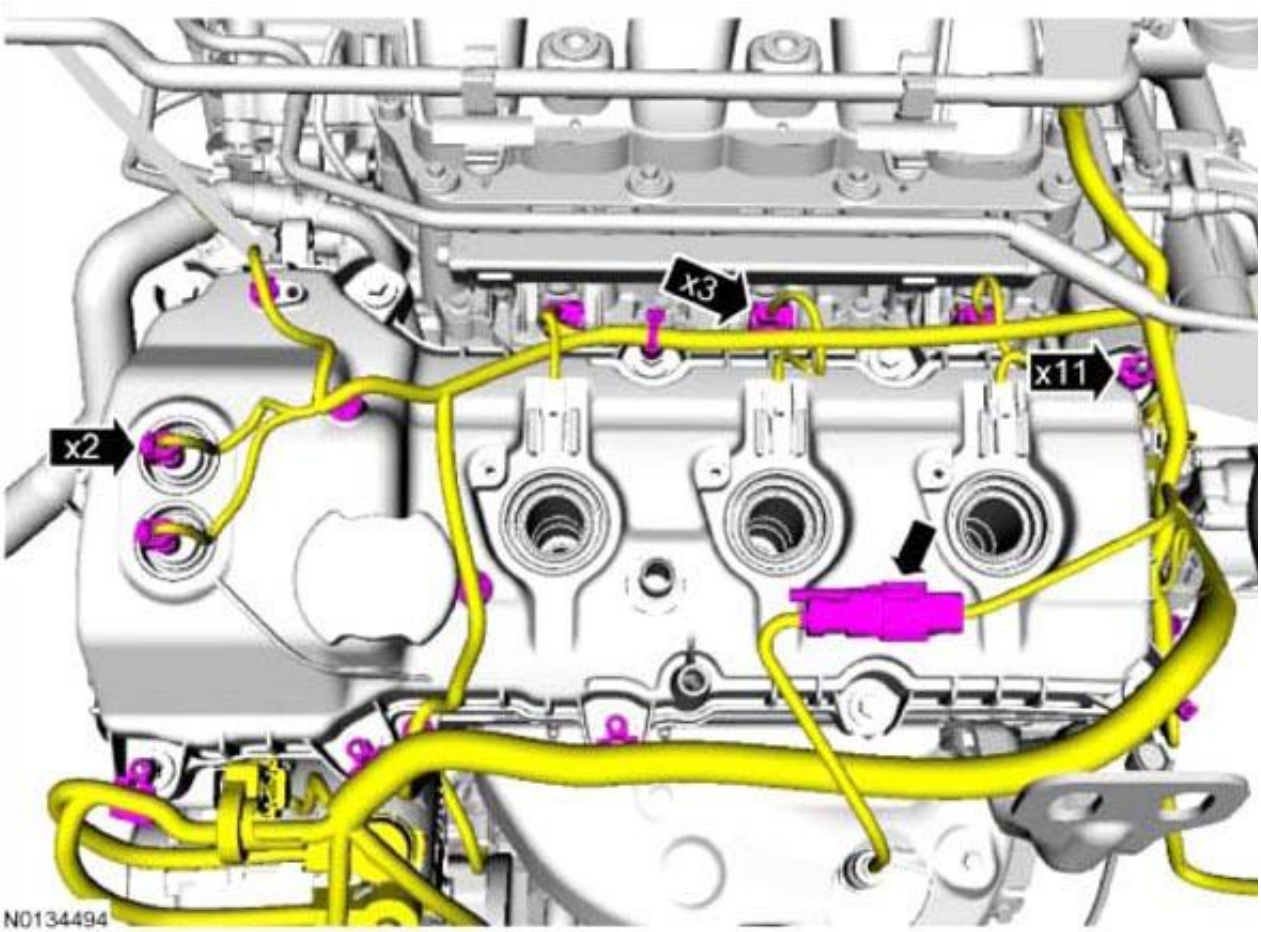
71. Ensure the **VCT** seals in the valve cover are below the top of the connector (flat portion) on the **VCT** oil control valve otherwise the interface may leak.

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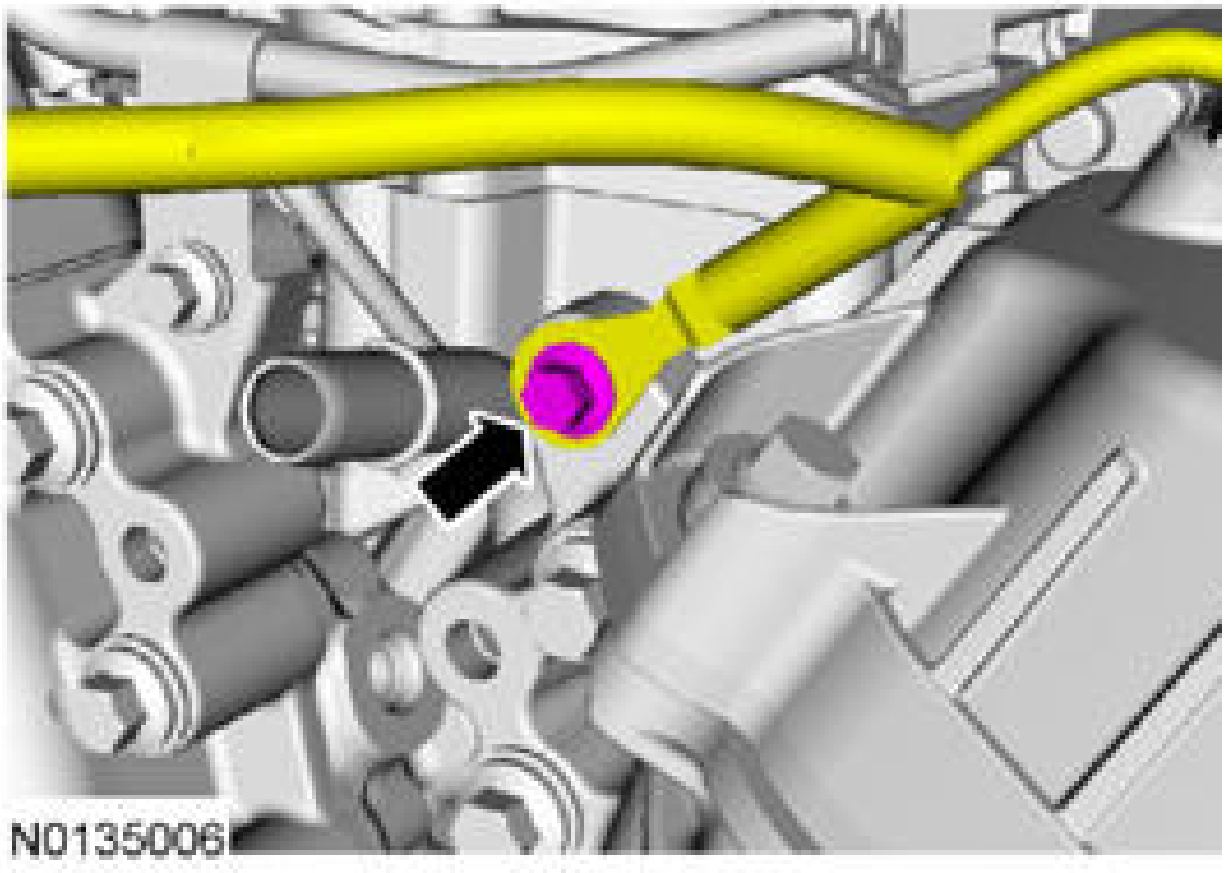
72. Install the engine wiring harness to the LH valve cover.
    - Position the wiring harness and attach the 11 wiring harness retainers to the LH valve cover and stud bolts.
    - Connect the 3 fuel injector electrical connectors.
    - Connect and attach the LH **HO2S** electrical connector.
    - Connect the 2 **VCT** oil control solenoid electrical connectors.

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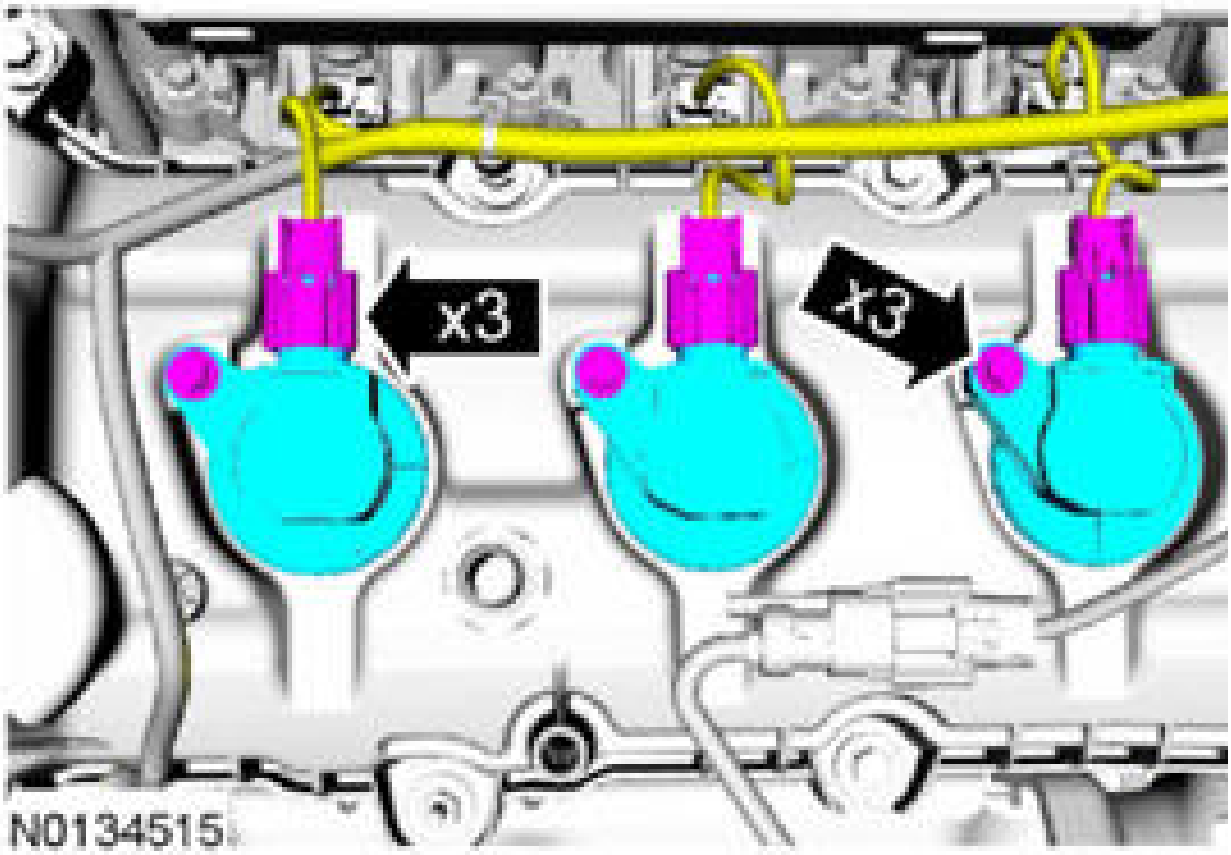
73. Install the ground wire bolt to the engine front cover.
    - Tighten to 10 Nm (89 lb-in).

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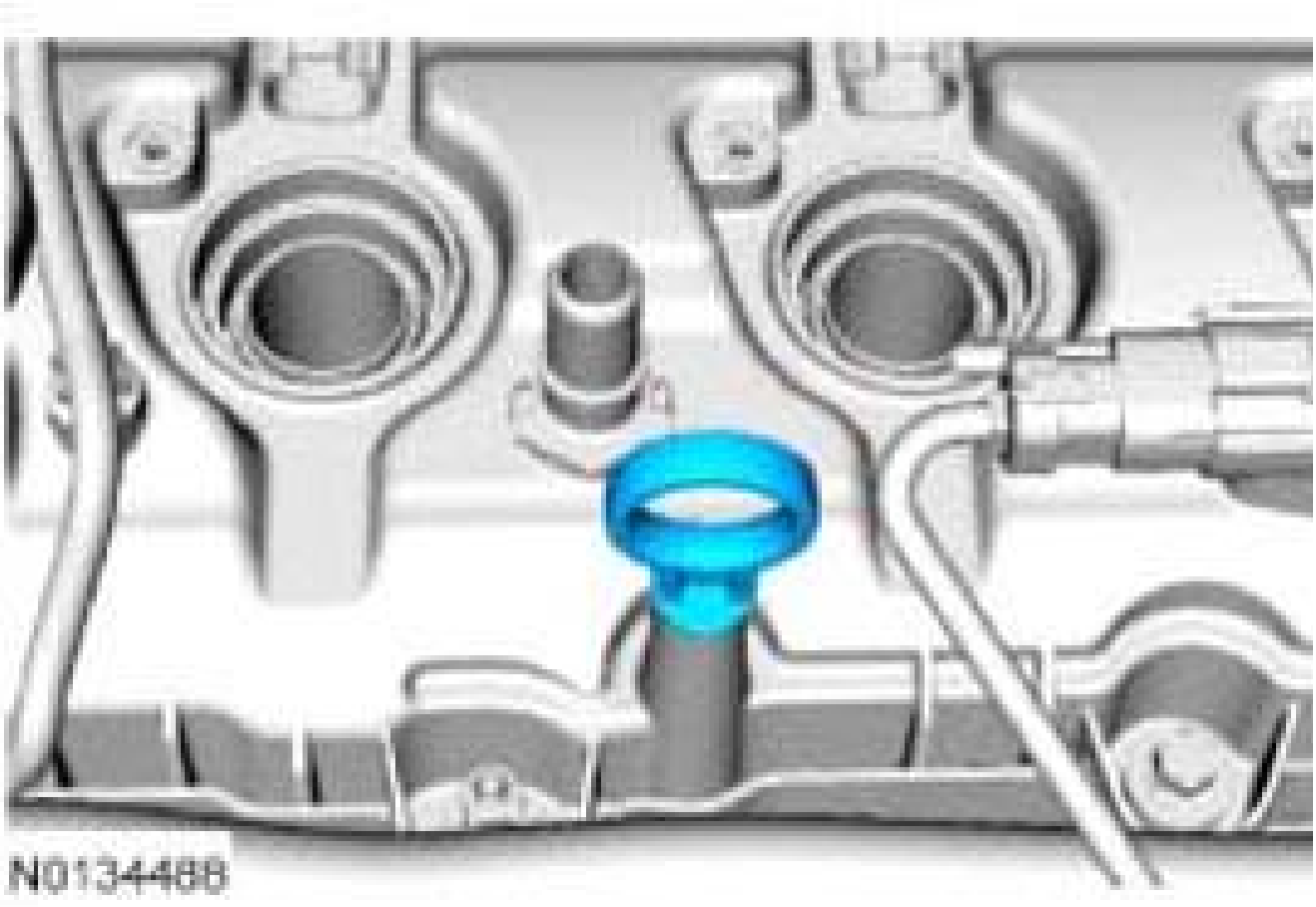
74. Install the LH ignition coils.
    - Tighten to 7 Nm (62 lb-in).
    - Connect the 3 coil-on-plug electrical connectors.

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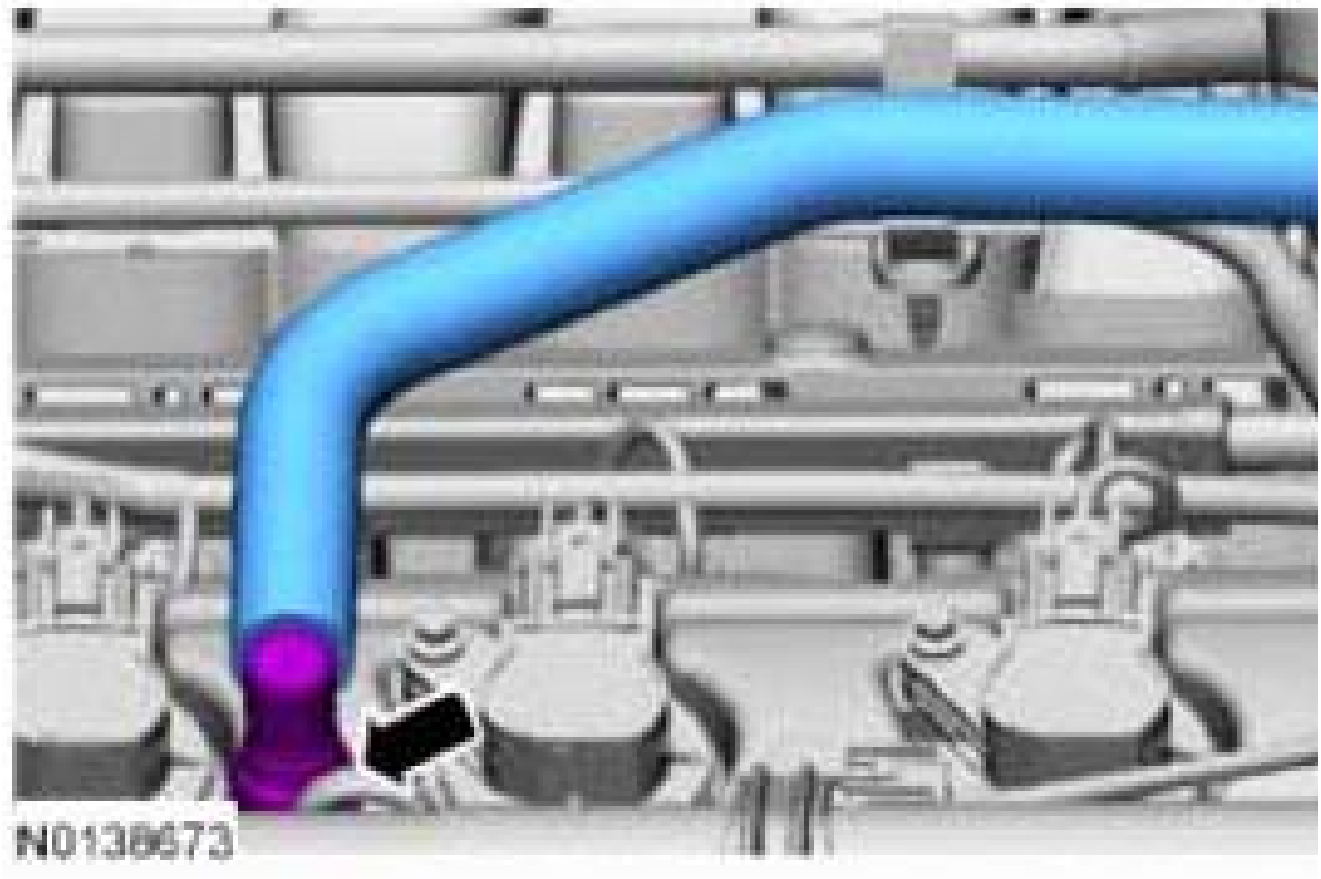
75. Install the oil level indicator.

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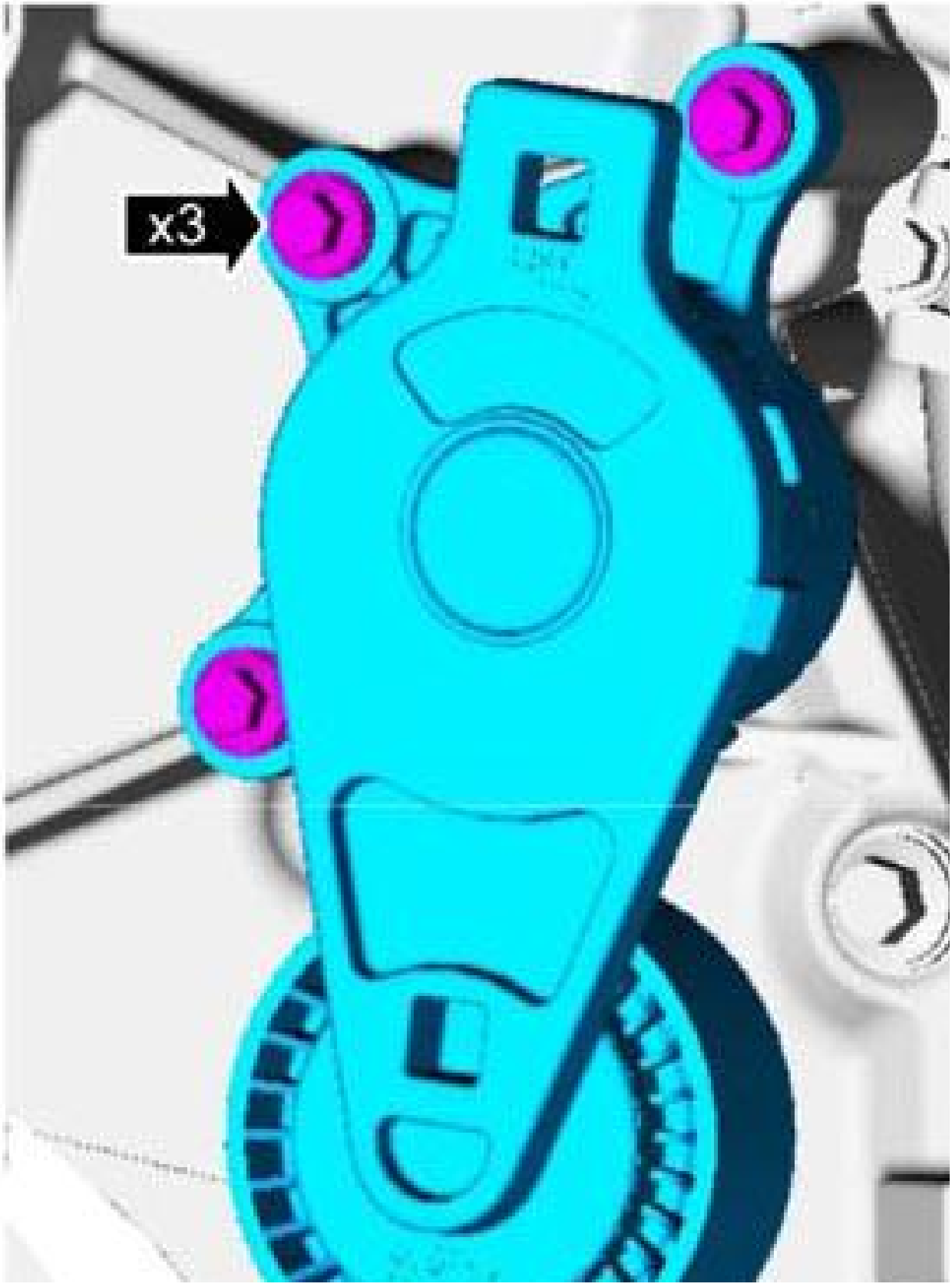
76. Connect the crankcase vent tube to the LH valve cover.

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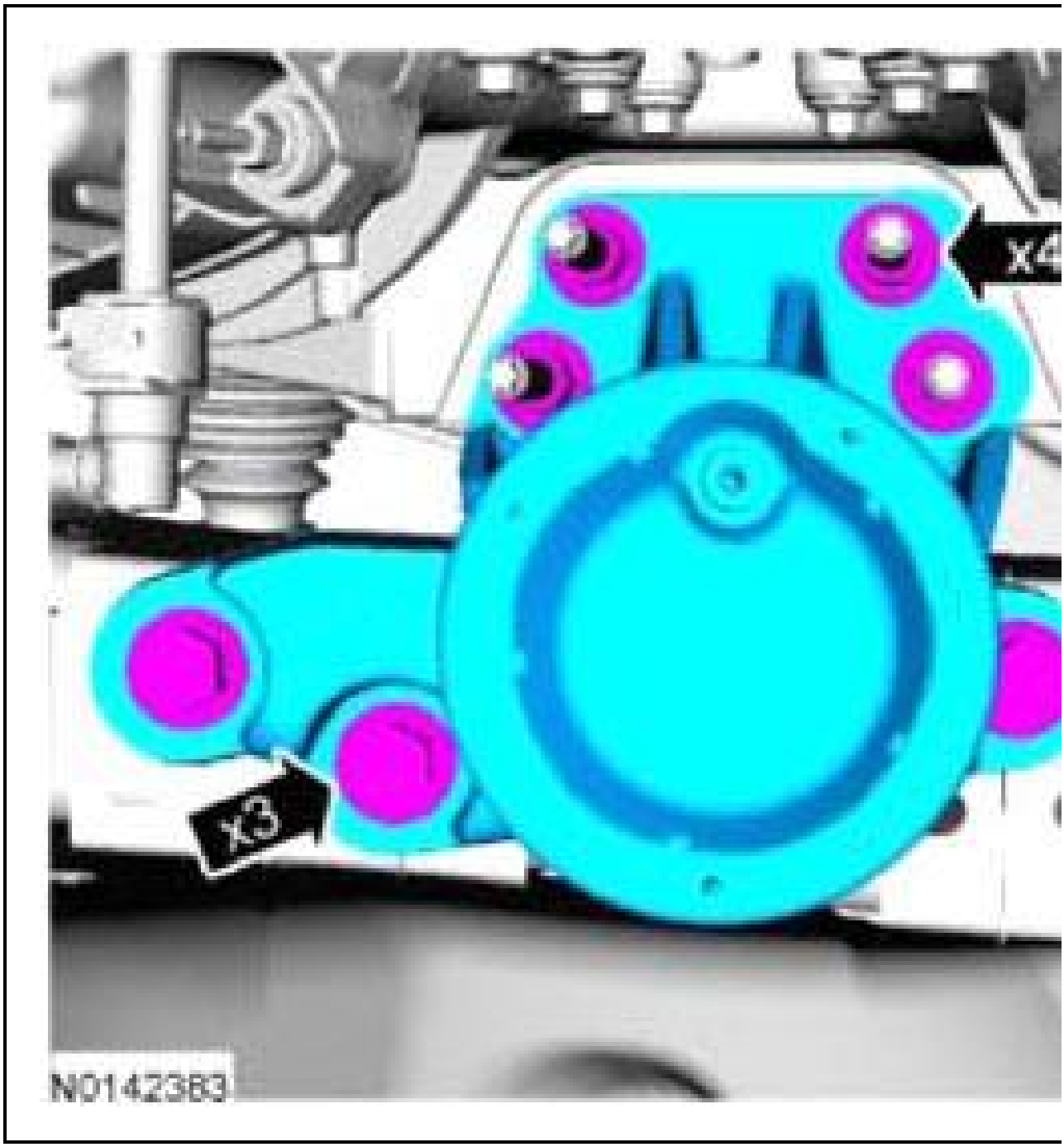
77. Install a new crankshaft front seal. Refer to **CRANKSHAFT FRONT SEAL**.
78. Install the accessory drive belt tensioner.
    - Tighten to 11 Nm (97 lb-in).

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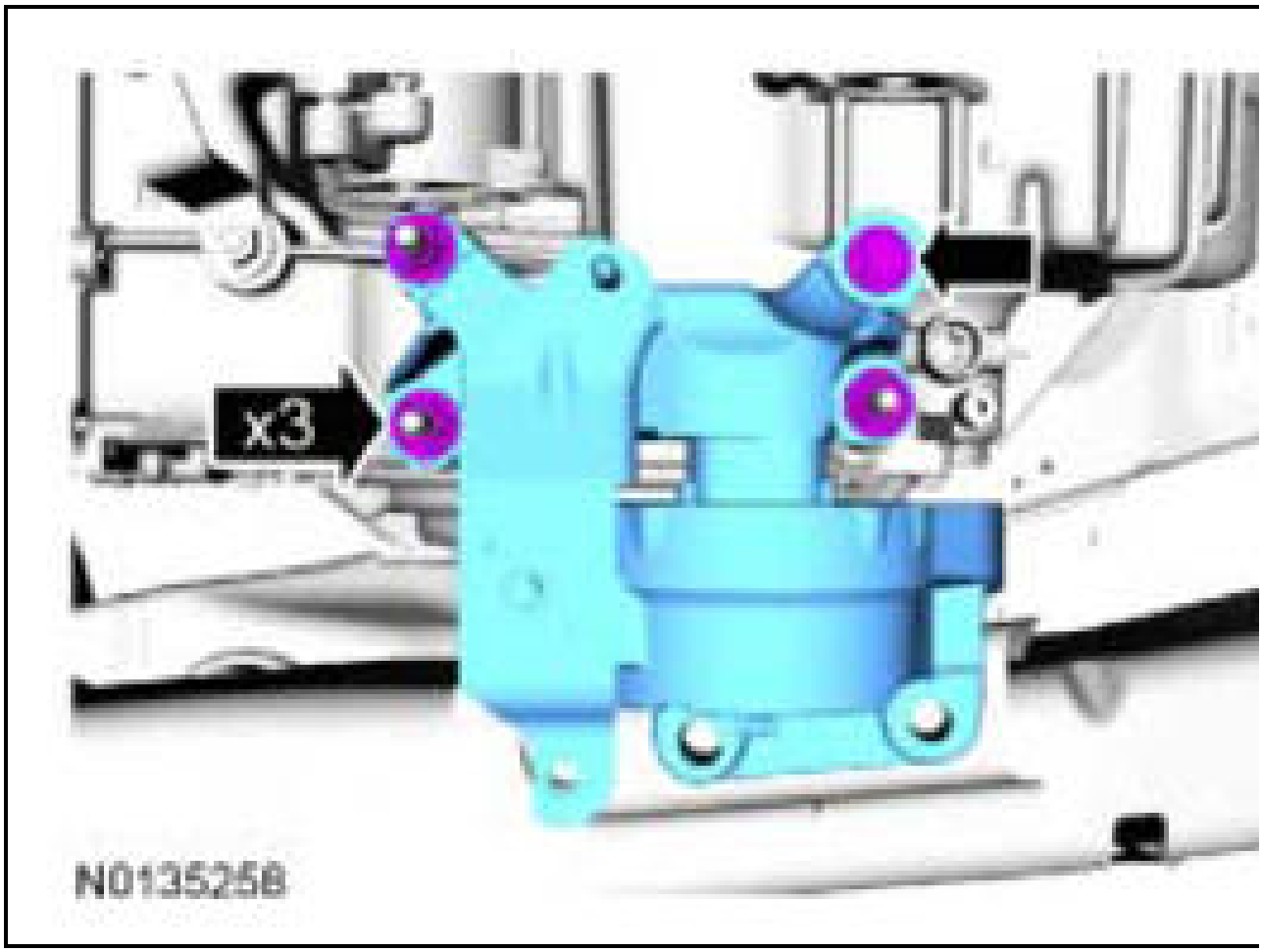
79. Raise the subframe and powertrain assembly into the vehicle.
80. Install the engine mount, the 3 bolts and the 4 engine mount nuts hand tight.
    - Tighten the 3 engine mount bolts to 90 Nm (66 lb-ft).
    - Tighten the 4 engine mount nuts to 63 Nm (46 lb-ft).



81. Install the transaxle support insulator assembly the 3 nuts and the bolt.
    - Tighten the nuts to 63 Nm (46 lb-ft).

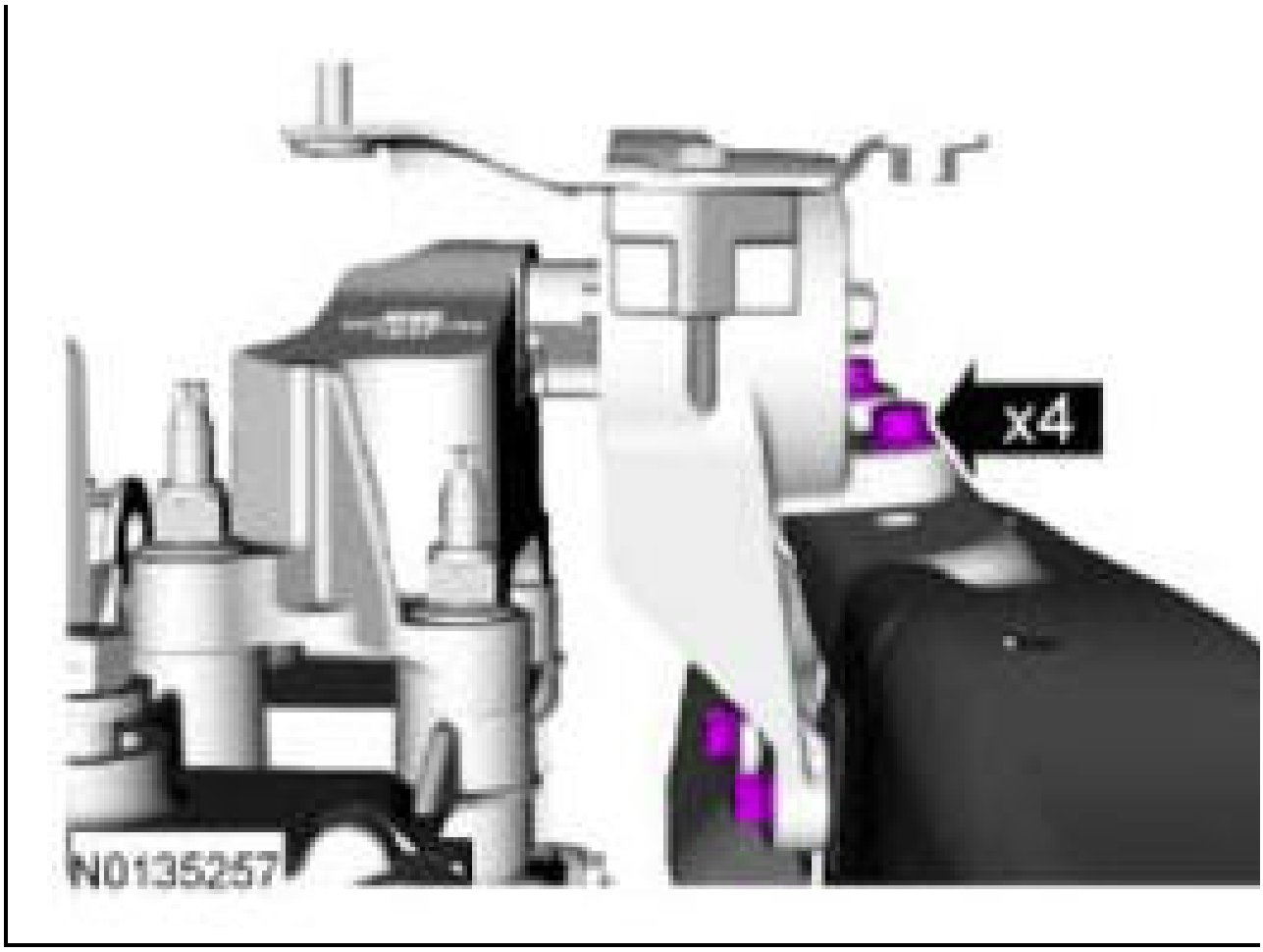
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- Tighten the bolt to 80 Nm (59 lb-ft).



82. Install the 4 transmission support insulator-to-frame rail bolts.
    - Tighten the 2 bottom bolts to 55 Nm (41 lb-ft).
    - Tighten the 2 top bolts to 70 Nm (52 lb-ft).

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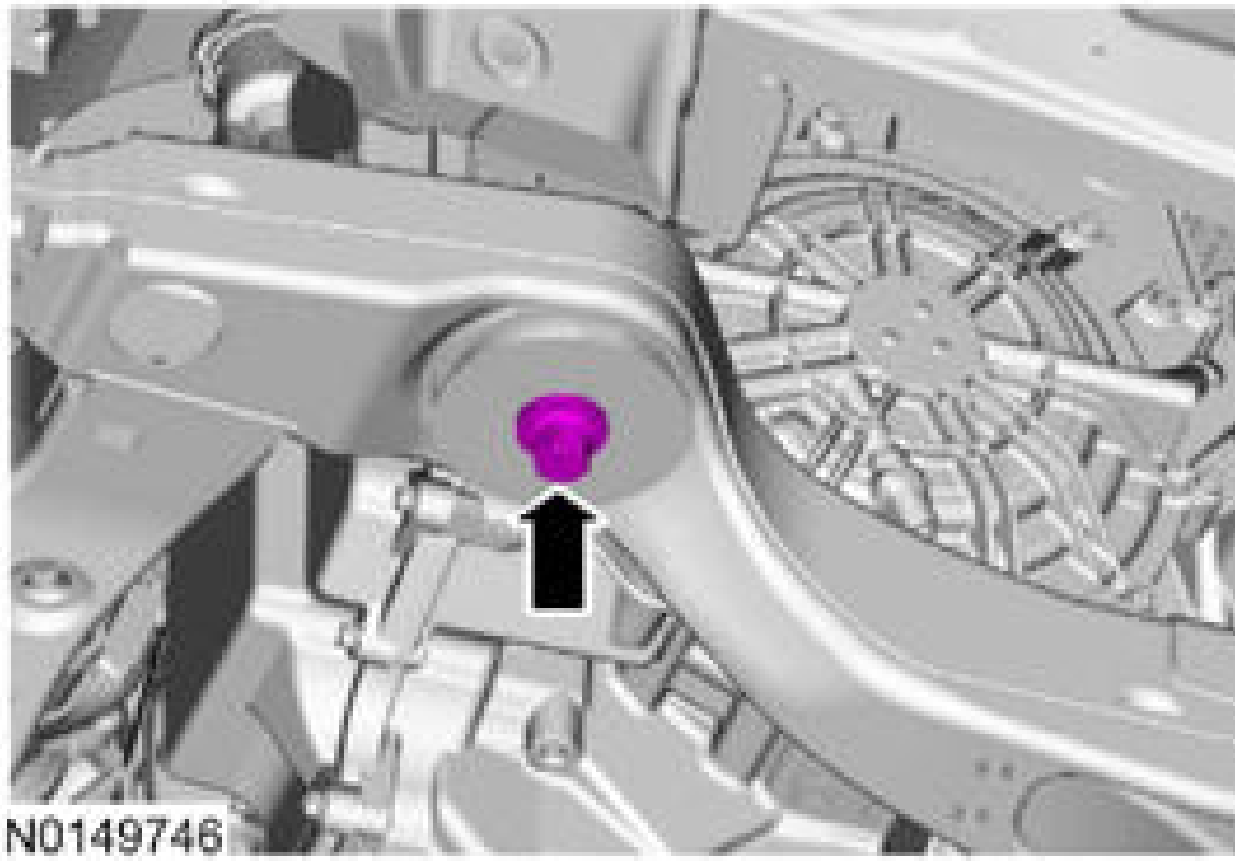


83. **NOTE: RH shown in illustration, LH similar.**

Align the subframe and install the new front subframe bolts.

- Tighten to 200 Nm (148 lb-ft).

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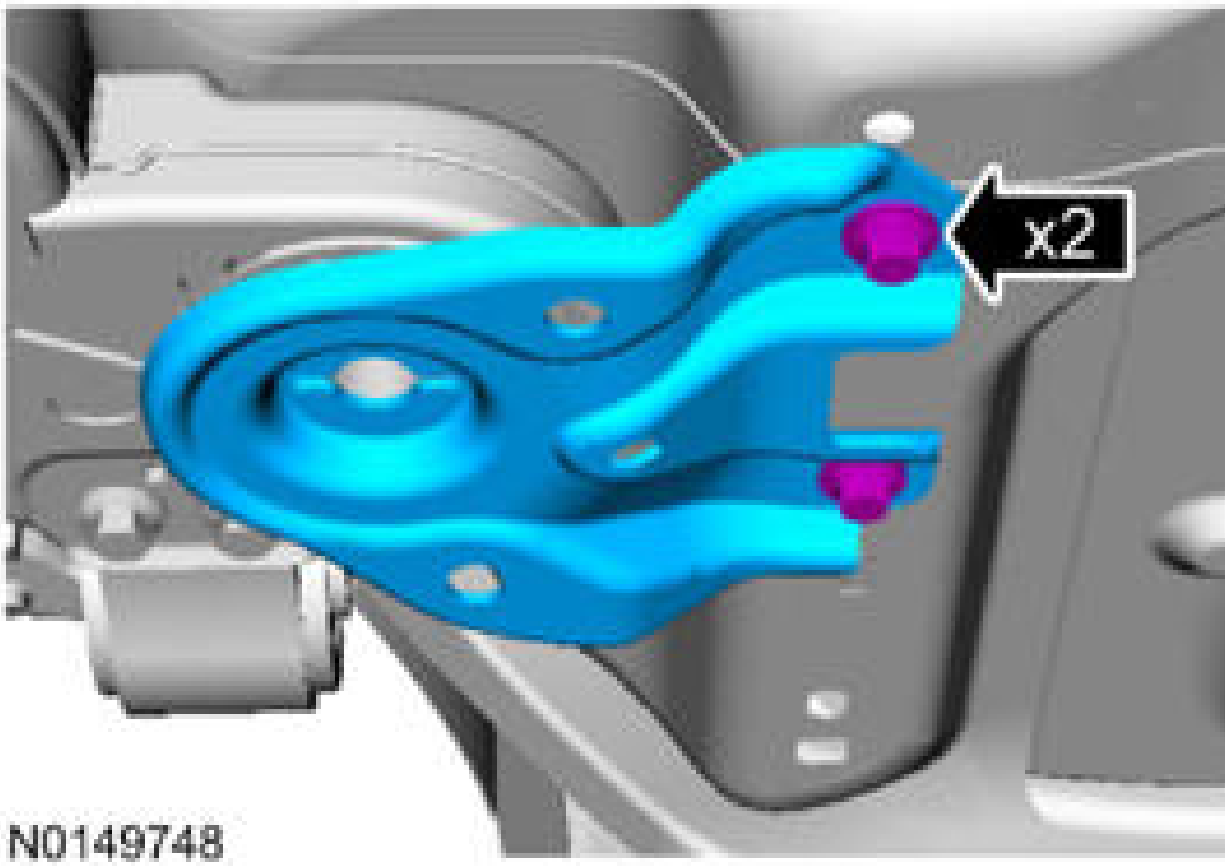


84. **NOTE: RH shown in illustration, LH similar.**

Install the rear subframe brackets and the new subframe bracket-to-body bolts.

- Finger tight at this stage.

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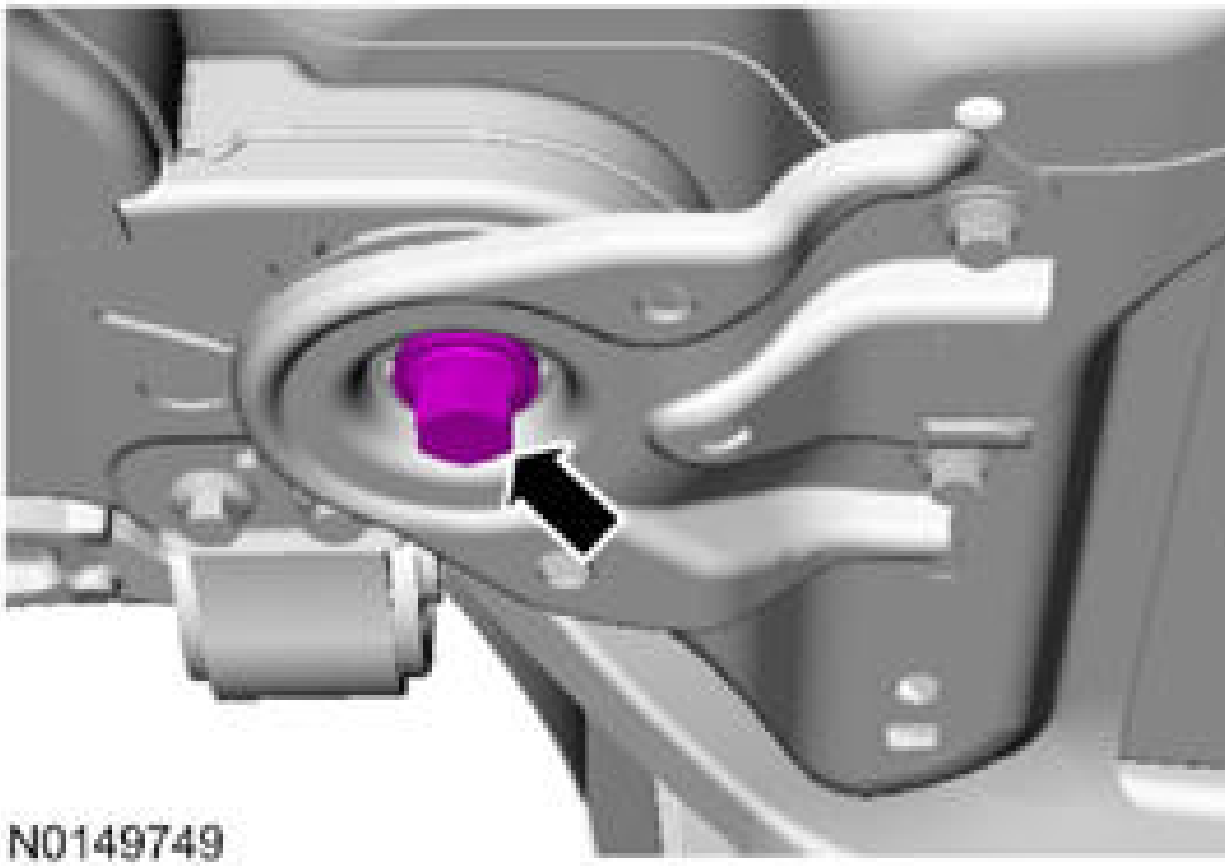


85. **NOTE: RH shown in illustration, LH similar.**

Install the new subframe bracket bolts.

- Tighten to 150 Nm (111 lb-ft).

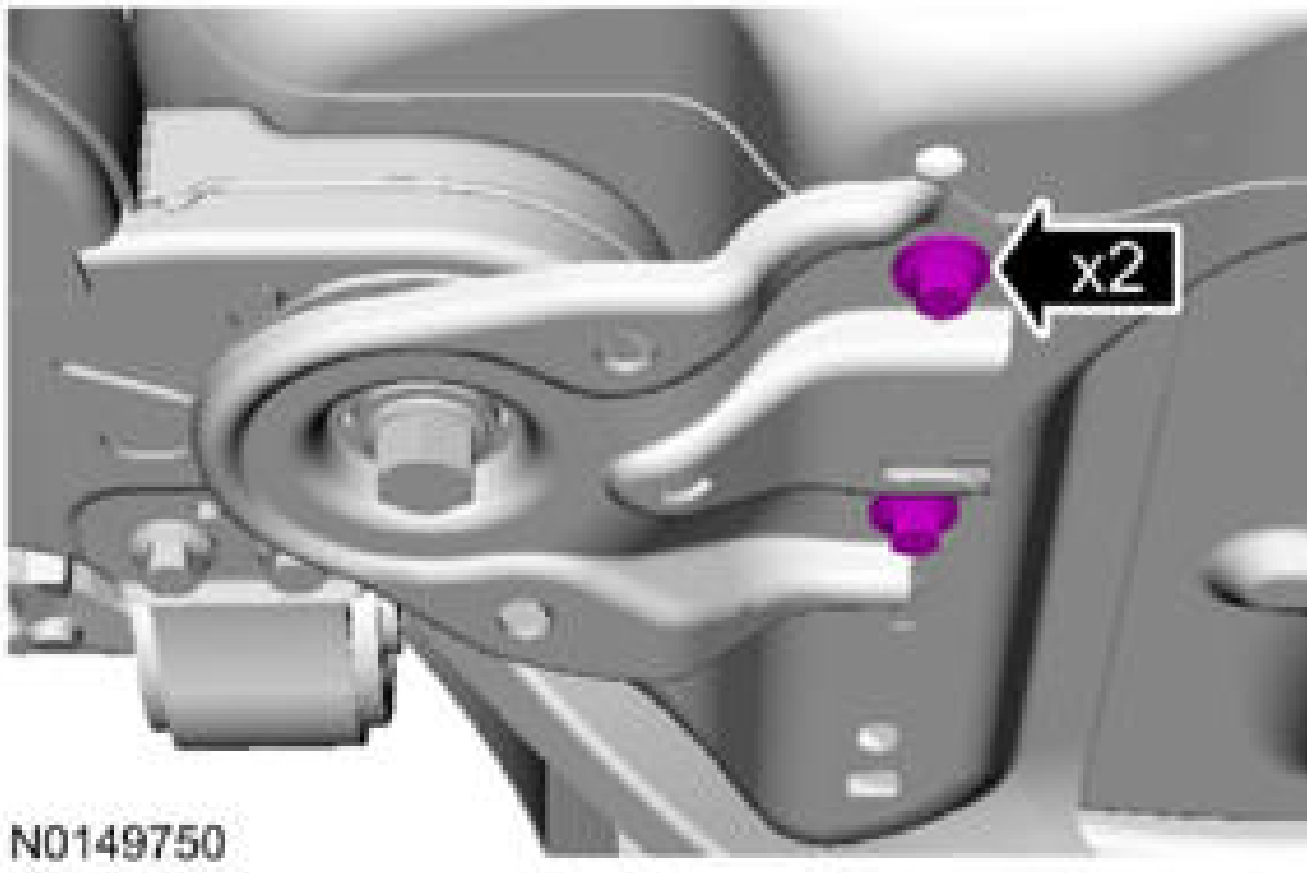
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86. **NOTE: RH shown in illustration, LH similar.**

Tighten the subframe bracket-to-body bolts to 55 Nm (41 lb-ft).

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87. Remove the ratchet strap from the front of the subframe to the rear of the subframe.
88. Remove the Adjustable Grip Arm and the powertrain lift table.

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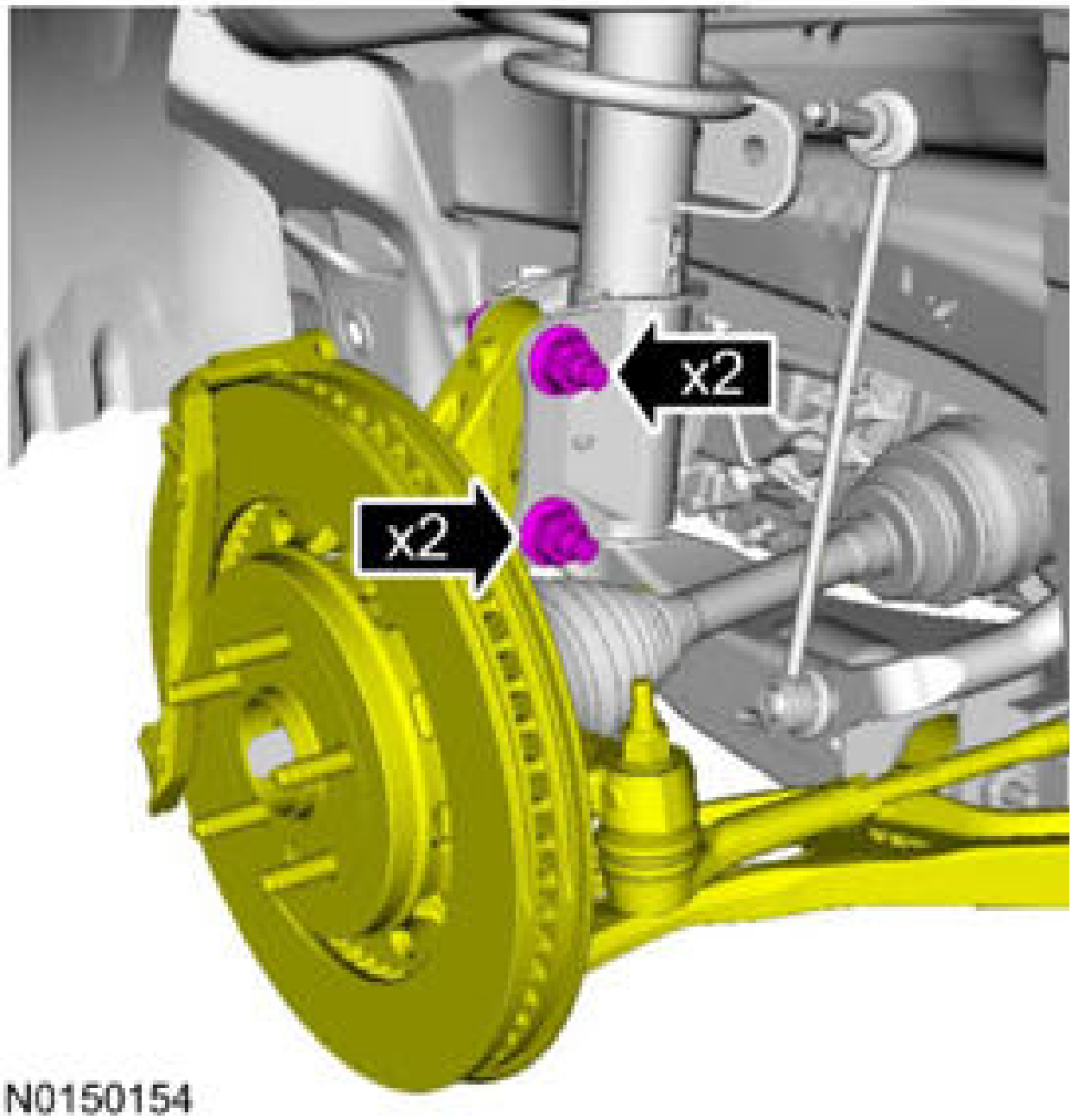


89. **NOTE: LH shown in illustration, RH similar.**

Install the strut to the wheel knuckle and install the strut-to-wheel knuckle nuts and bolts.

- Tighten to 250 Nm (184 lb-ft).

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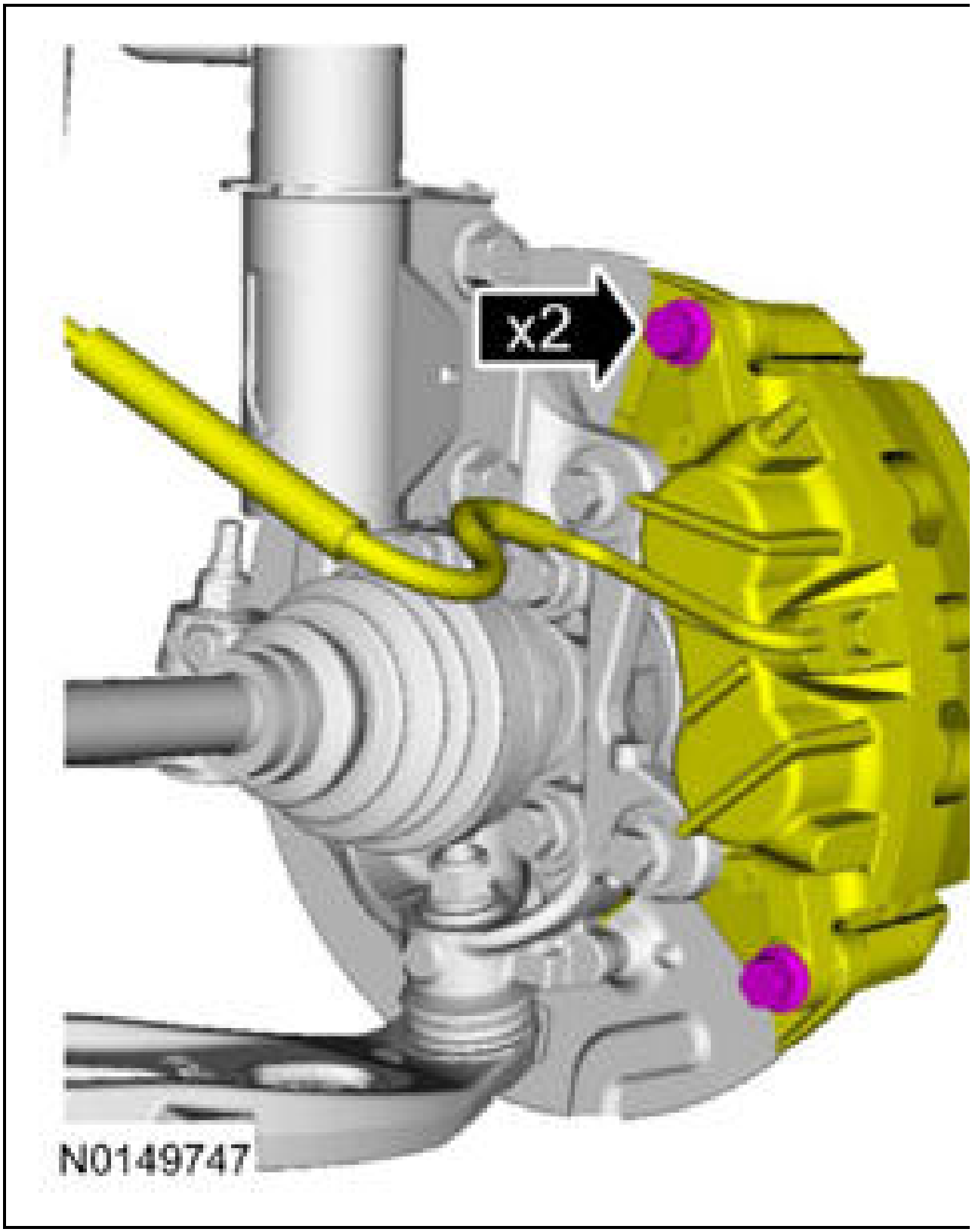


90. **NOTE: LH shown in illustration, RH similar.**

Install the brake caliper and the guide pin bolts.

- 432 mm (17 in) brakes: Tighten to 72 Nm (53 lb-ft).
- 457 mm (18 in) brakes: Tighten to 75 Nm (55 lb-ft).

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91. **NOTE: Do not tighten the wheel hub nut with the vehicle on the ground. The nut**

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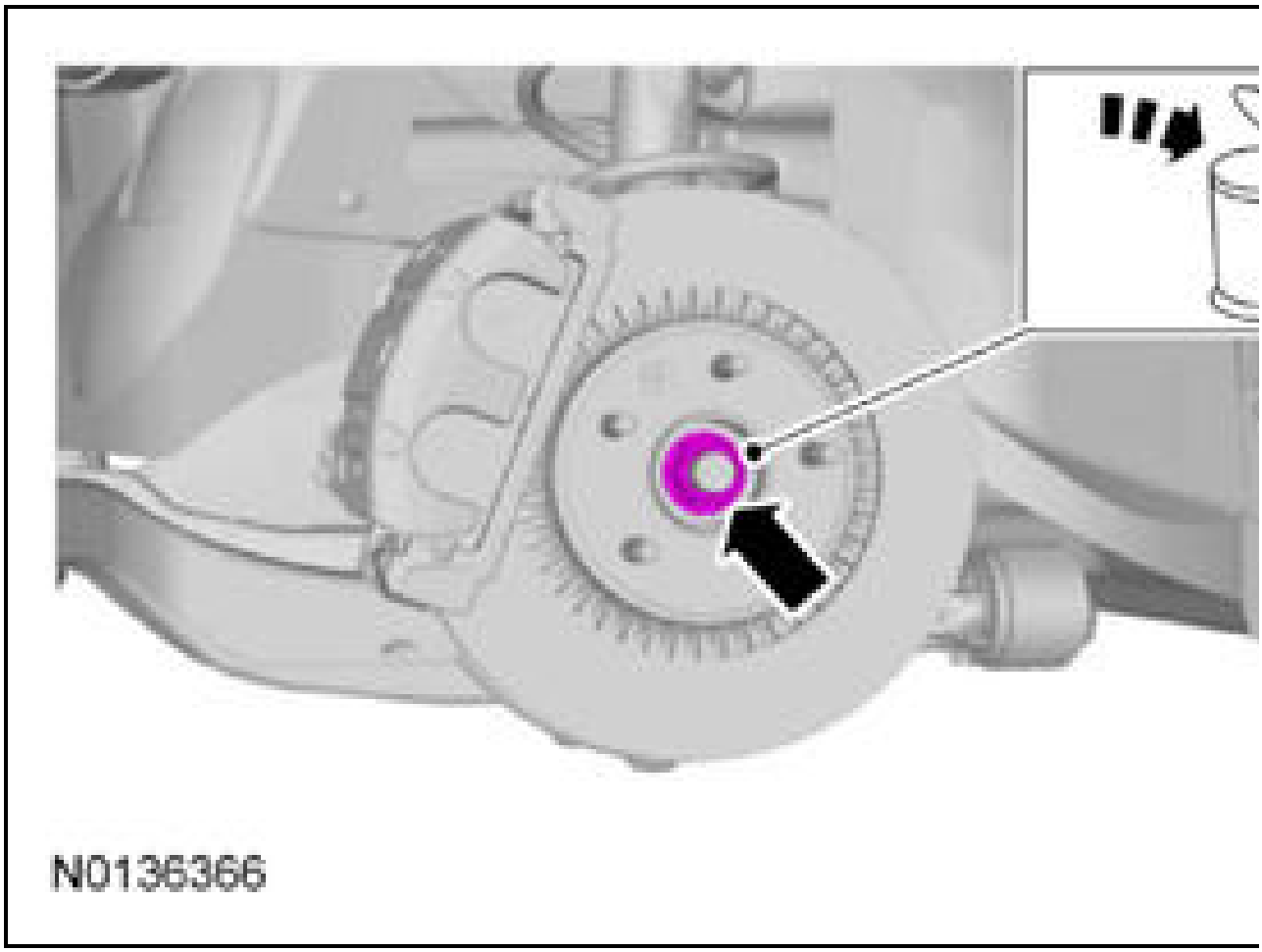
91. **must be tightened to specification before the vehicle is lowered onto the wheels. Wheel bearing damage will occur if the wheel bearing is loaded with the weight of the vehicle applied.**

NOTE: LH shown in illustration, RH similar.

NOTE: Apply the brake to keep the halfshaft from rotating.

Using the previously removed wheel hub nut, seat the LH and RH halfshafts.

- Tighten to 350 Nm (258 lb-ft).
- Remove and discard the wheel hub nuts.



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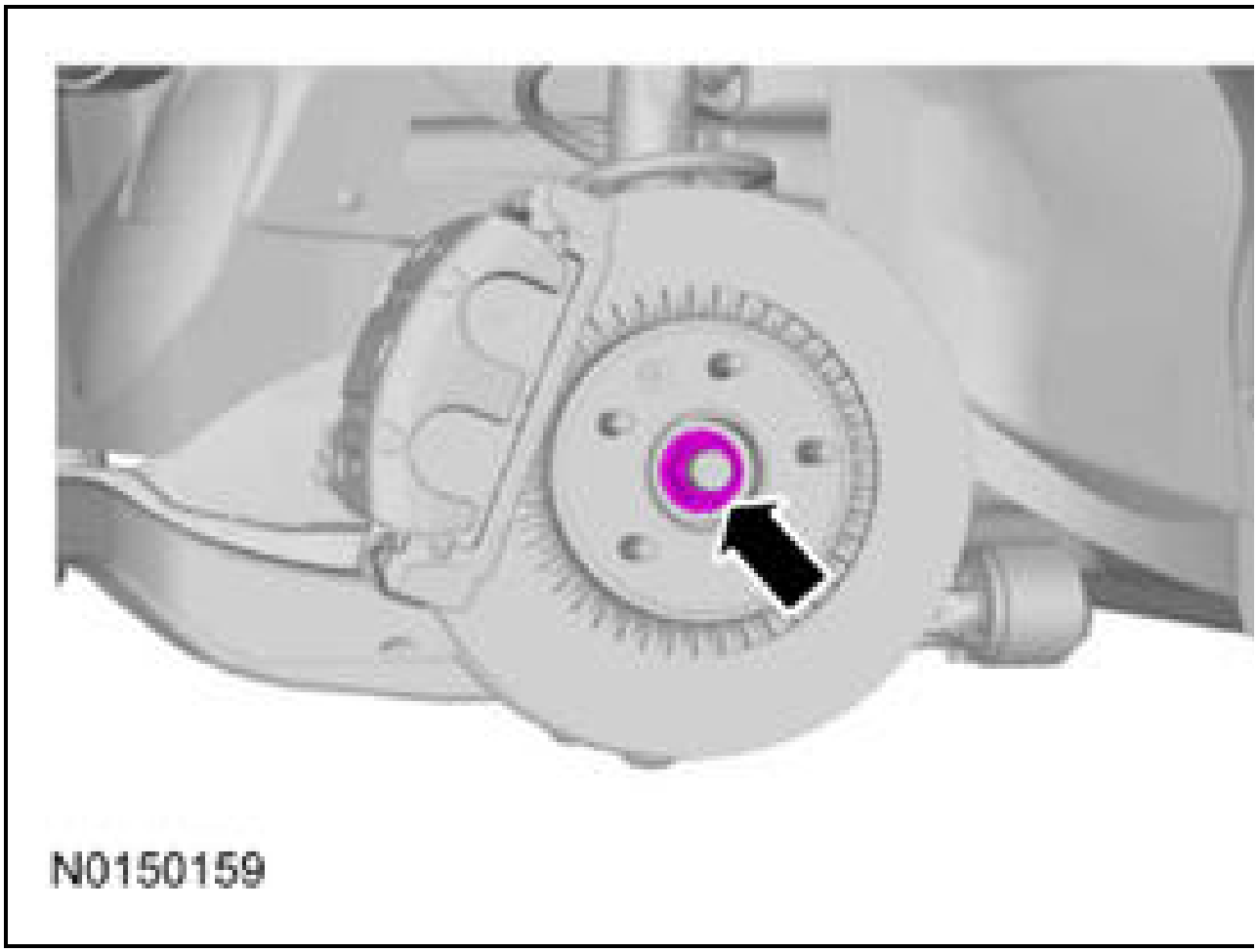
92. **NOTE: The wheel hub nut contains a one time locking chemical that is activated by the heat created when it is tightened. Install and tighten the new wheel hub nut to specification within 5 minutes of starting it on the threads. Always install a new wheel hub nut after loosening or when not tightened within the specified time or damage to the components can occur.**

NOTE: LH shown in illustration, RH similar.

NOTE: Apply the brake to keep the halfshaft from rotating.

Install a new wheel hub nuts.

- Tighten to 350 Nm (258 lb-ft).

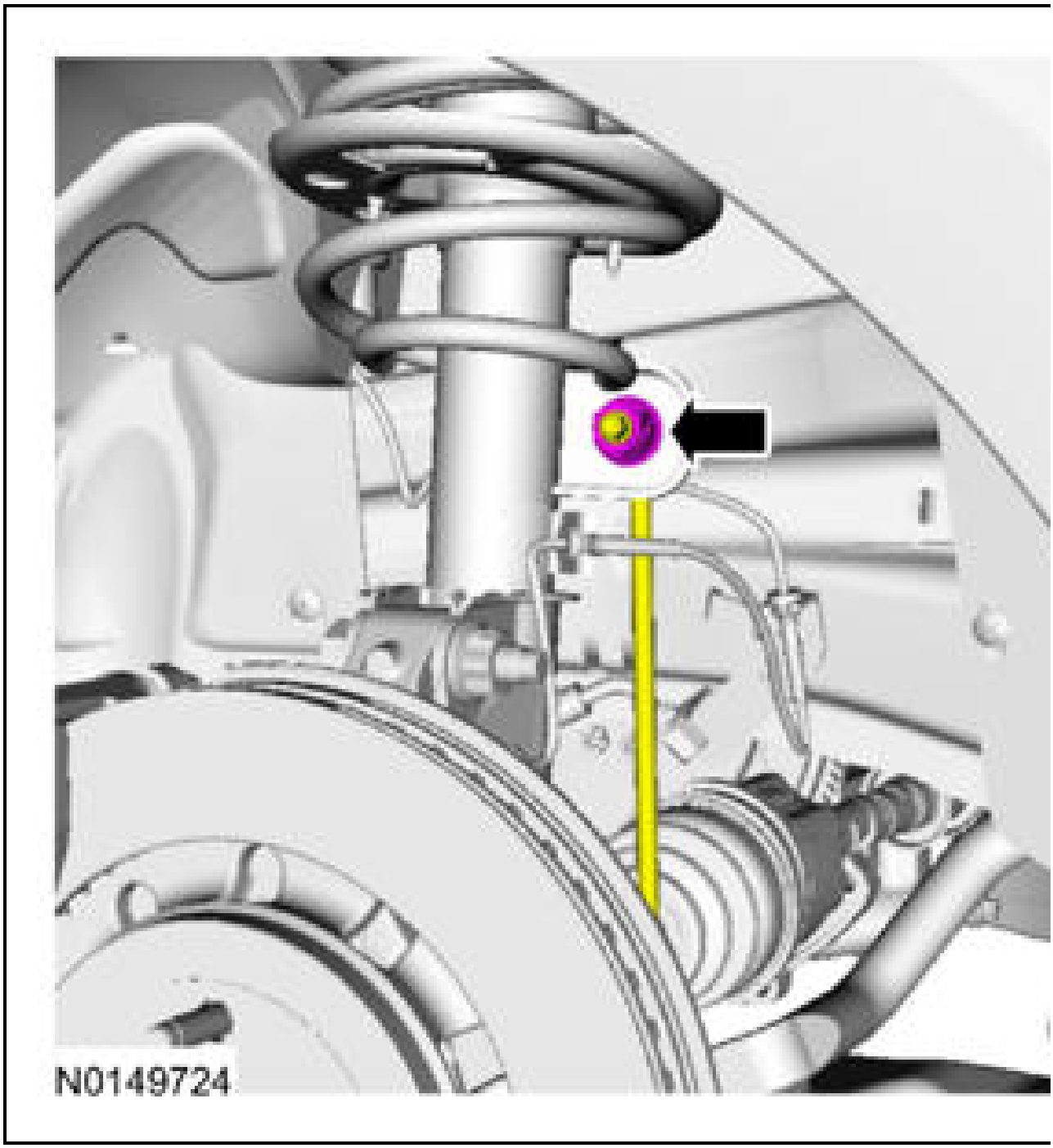


93. **NOTE: LH shown in illustration, RH similar.**

Install the new upper stabilizer link nut.

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- Tighten to 150 Nm (111 lb-ft).

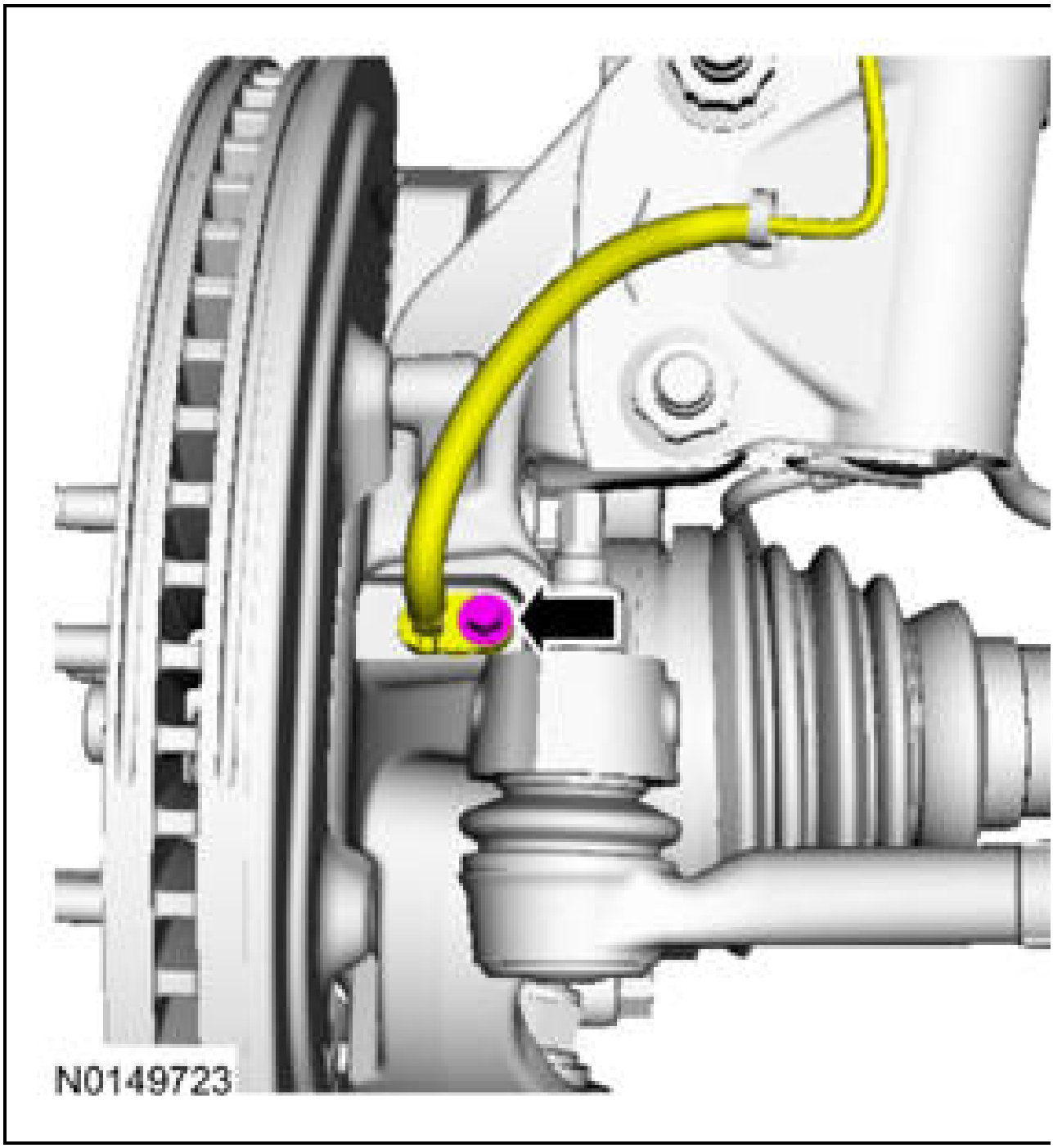


94. **NOTE: LH shown in illustration, RH similar.**

Install the wheel speed sensor and the bolt.

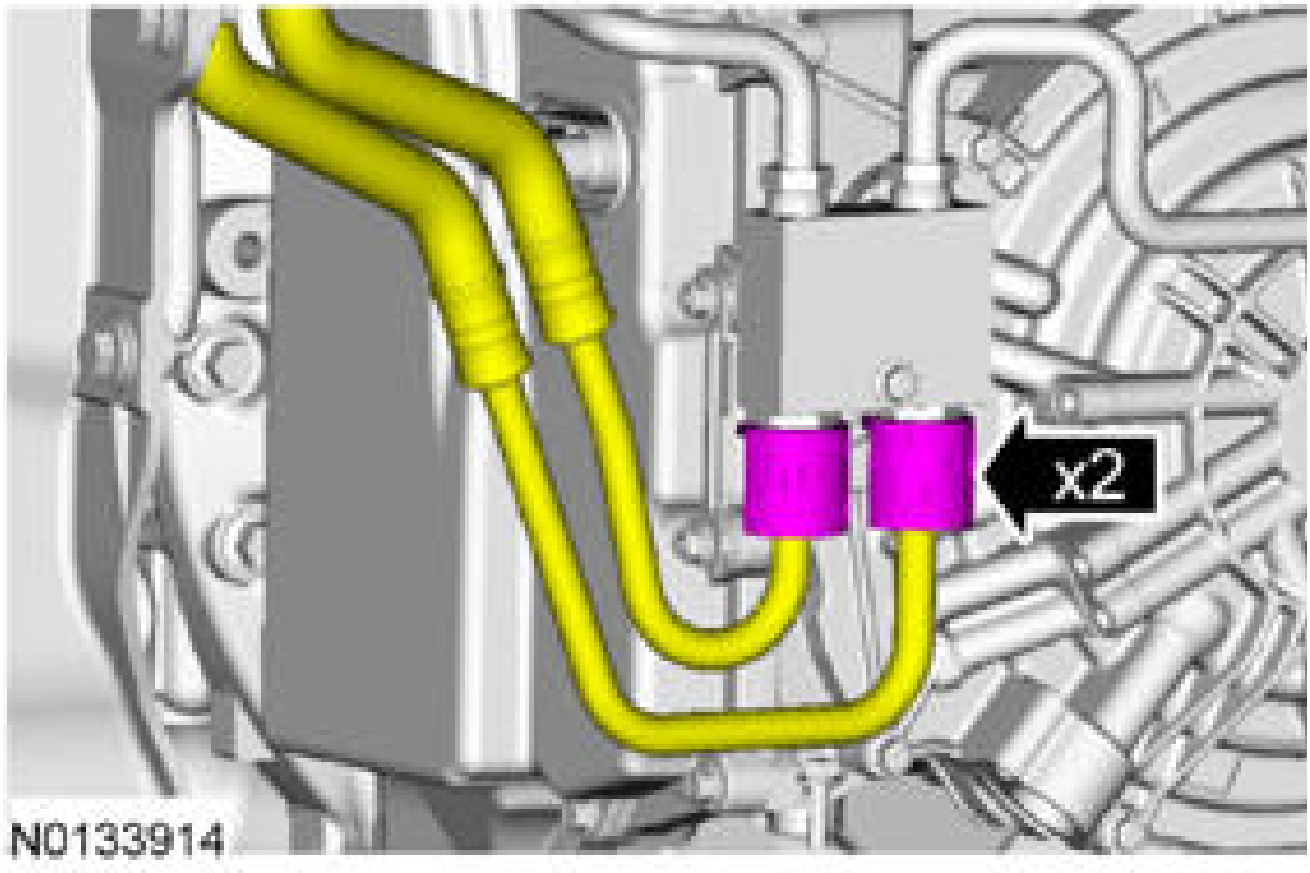
- Tighten to 15 Nm (133 lb-in).

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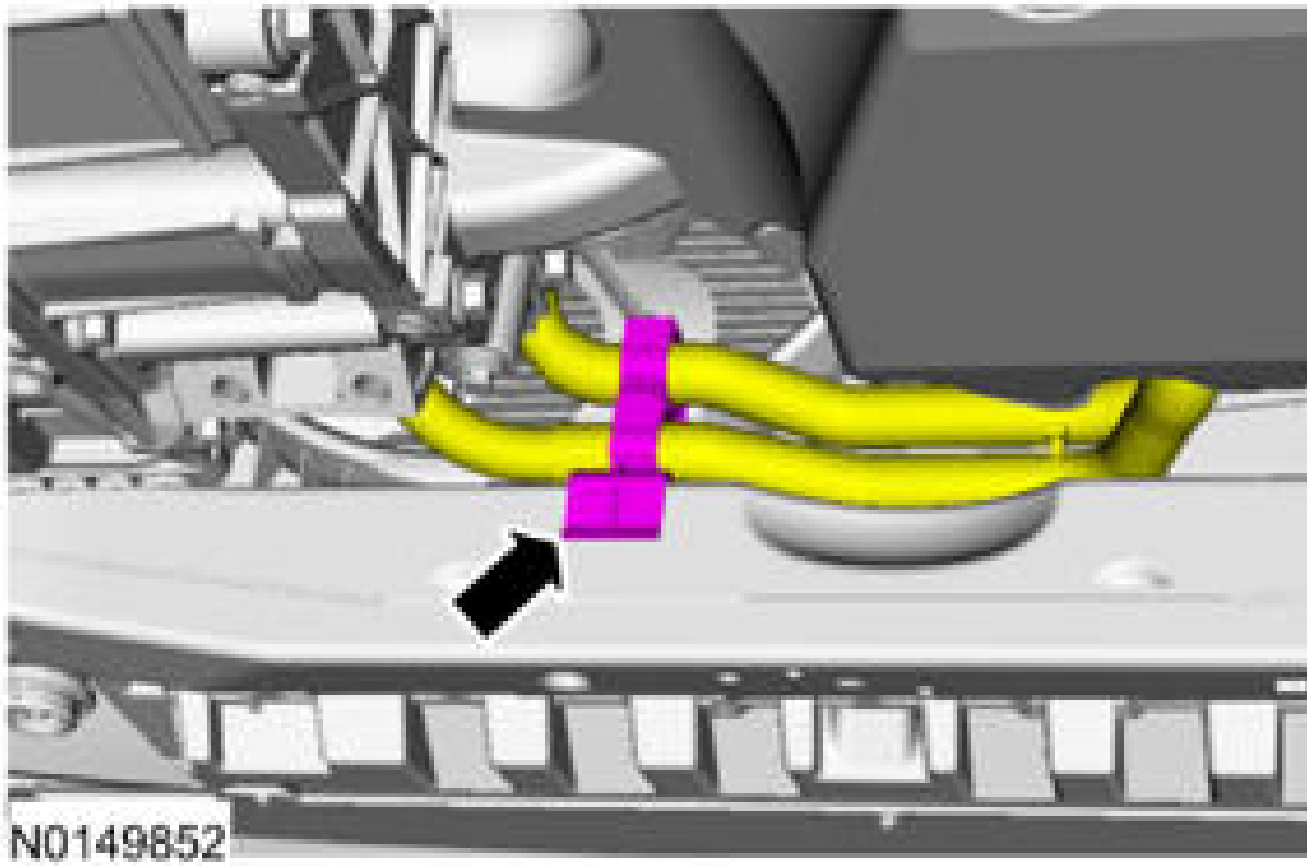
95. Connect the transaxle cooler tubes and install the 2 secondary latches.

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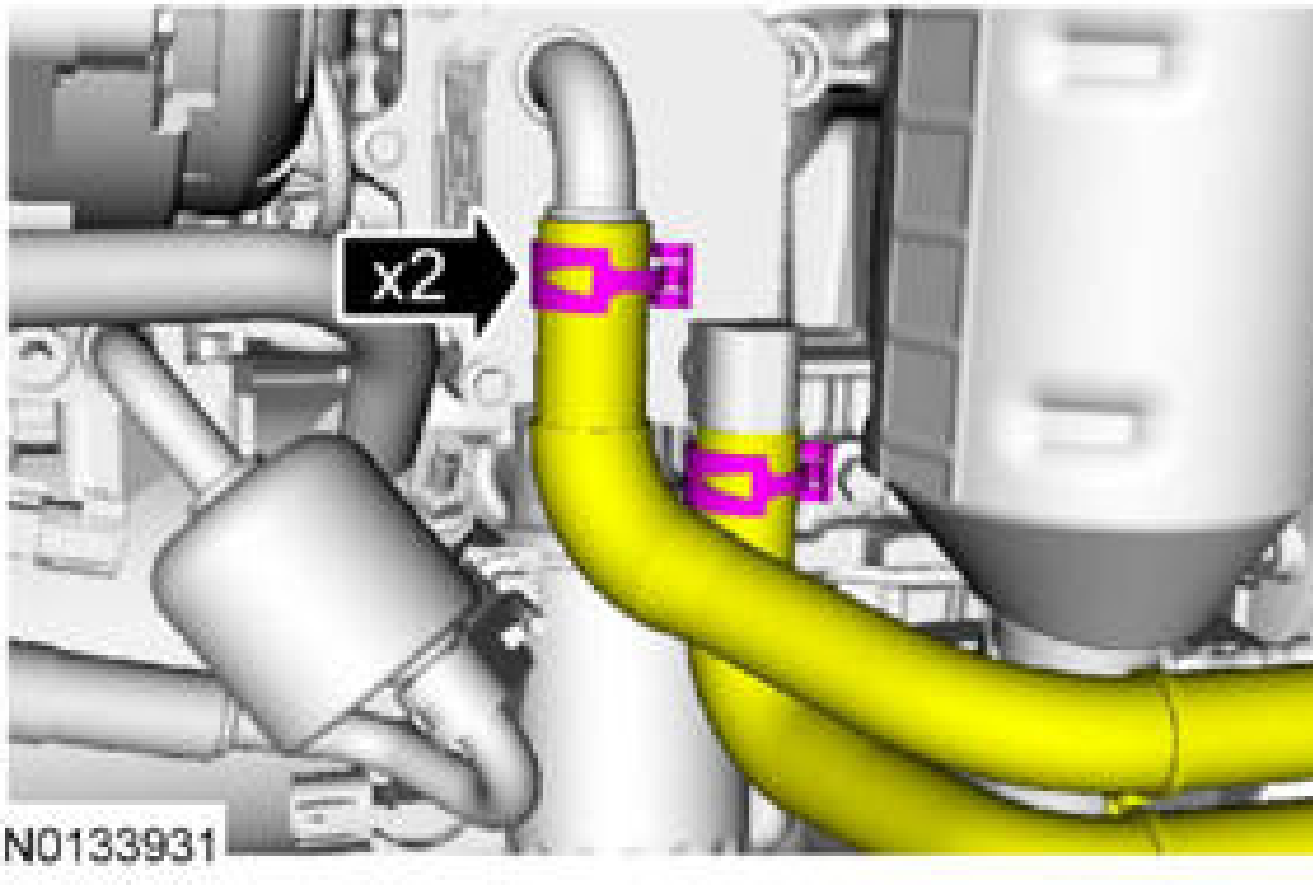
96. If equipped, install the oil cooler hose retainer to the subframe.

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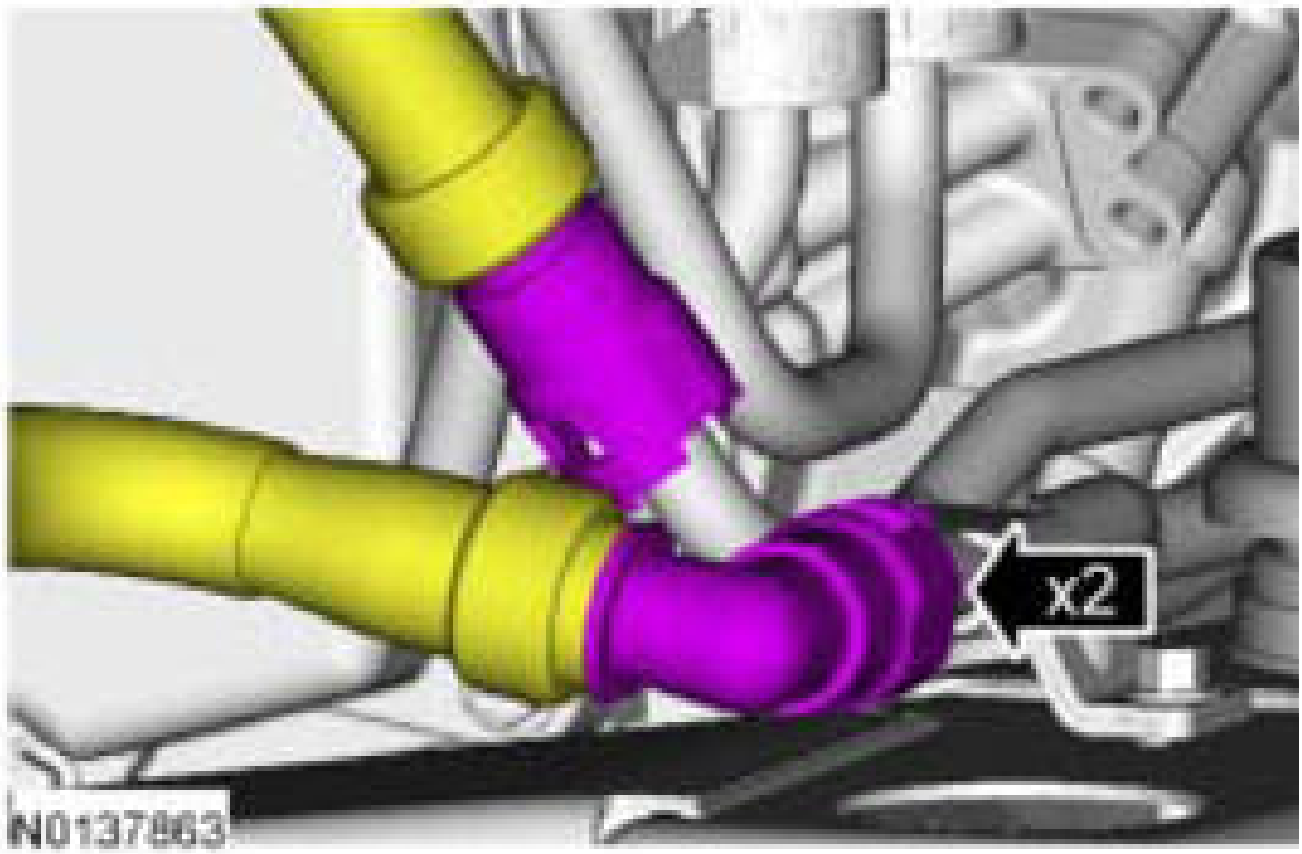
97. If equipped, connect the oil cooler coolant hoses.

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98. If equipped, connect the 2 **PTU** cooler hoses. For additional infomation, refer to **FUEL SYSTEM - GENERAL INFORMATION** .

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99. **NOTE: Do not lubricate the engine oil filter gasket.**

Install a new engine oil filter.

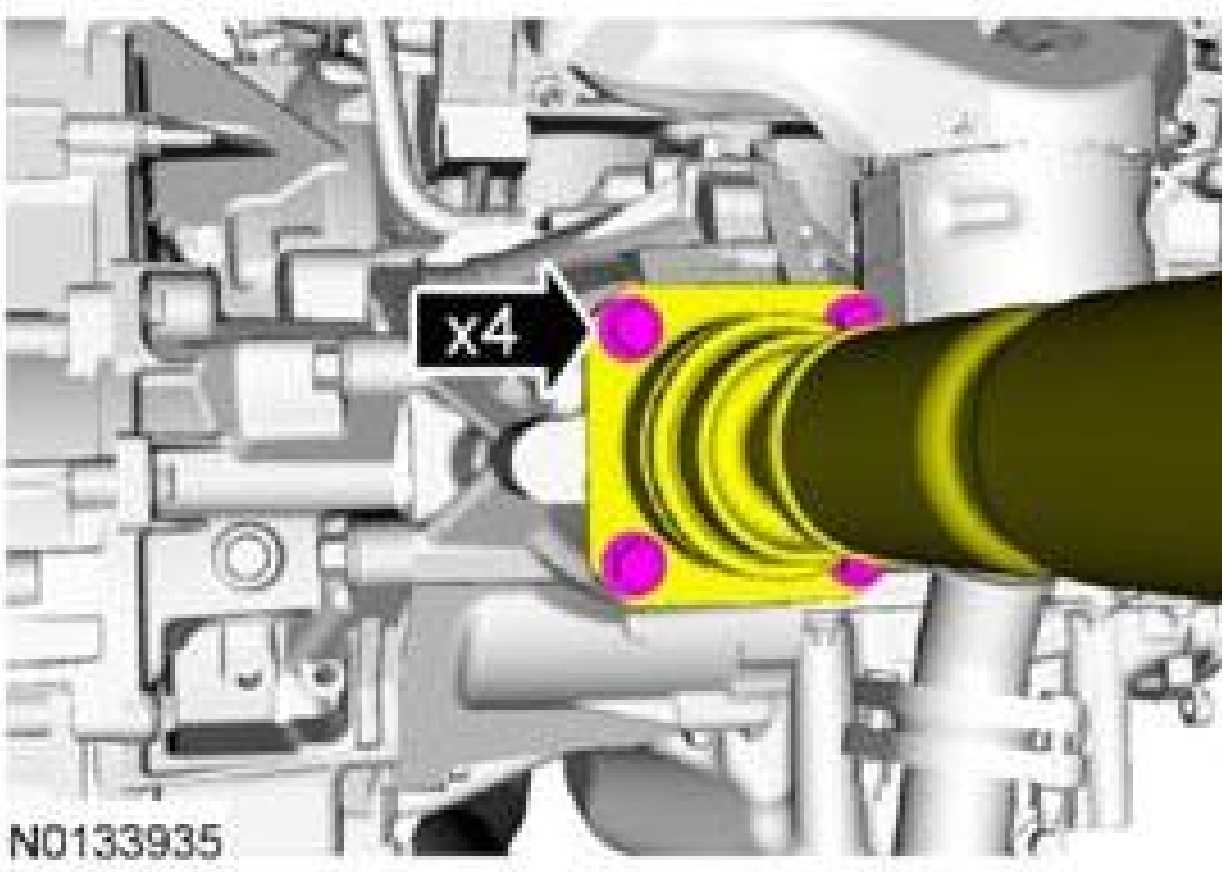
- Tighten to 5 Nm (44 lb-in) and then rotate an additional 180 degrees.

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100. If equipped with **AWD** , line up the index marks on the rear driveshaft to the index marks on the **PTU** flange made during removal and install the 4 new bolts.
    - Tighten to 70 Nm (52 lb-ft).

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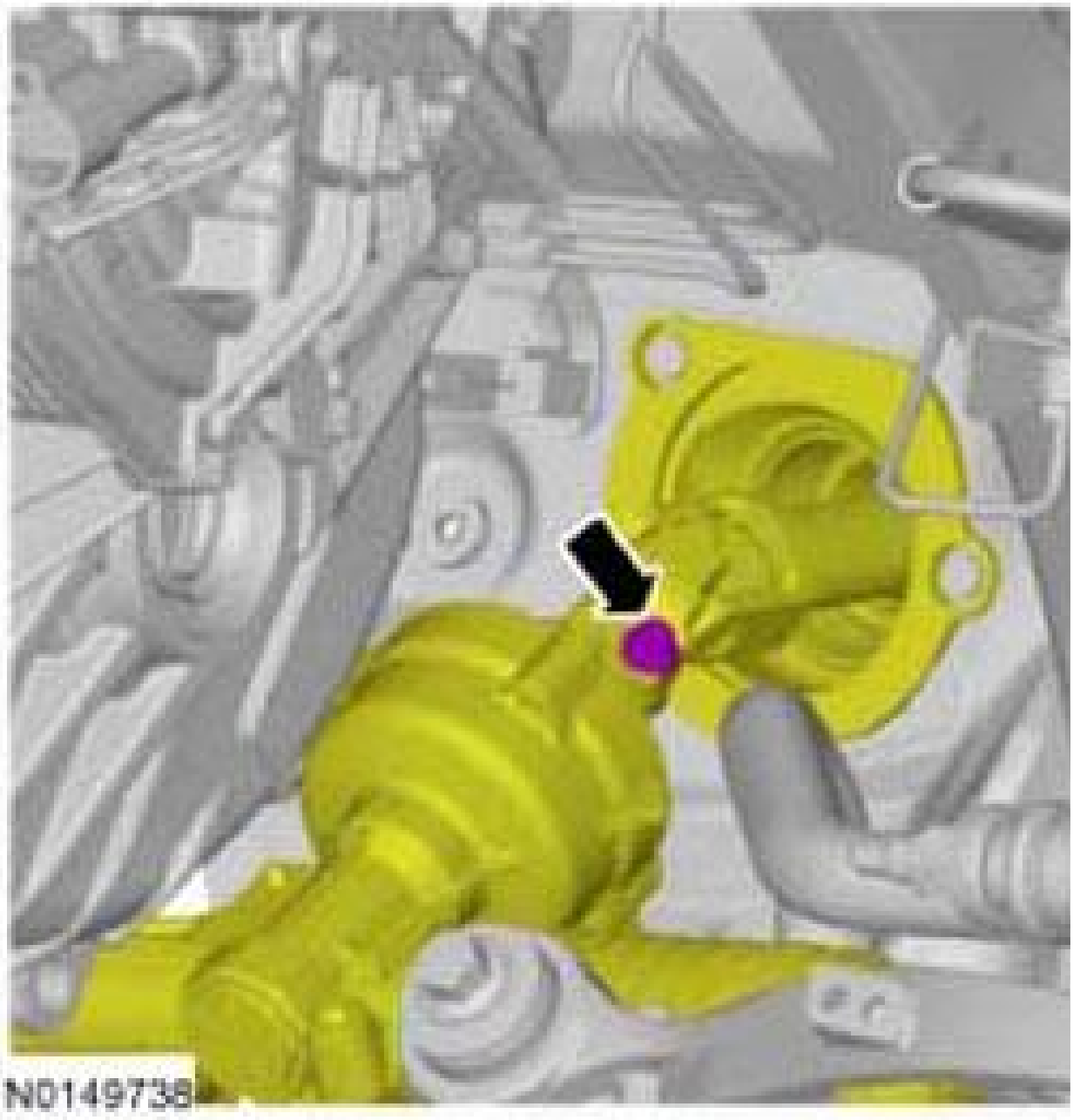
101. Install the exhaust Y-pipe. For additional information, refer to **EXHAUST Y-PIPE - 3.5L TI-VCT** .

NOTE: **Do not allow the intermediate shaft to rotate while it is disconnected from the gear or damage to the clockspring may occur. If there is evidence that the intermediate shaft has rotated, the clockspring must be removed and recentered. For additional information, refer to CLOCKSPRING , and CLOCKSPRING ADJUSTMENT .**

102. Align and connect the steering column shaft to the steering gear and install the bolt.

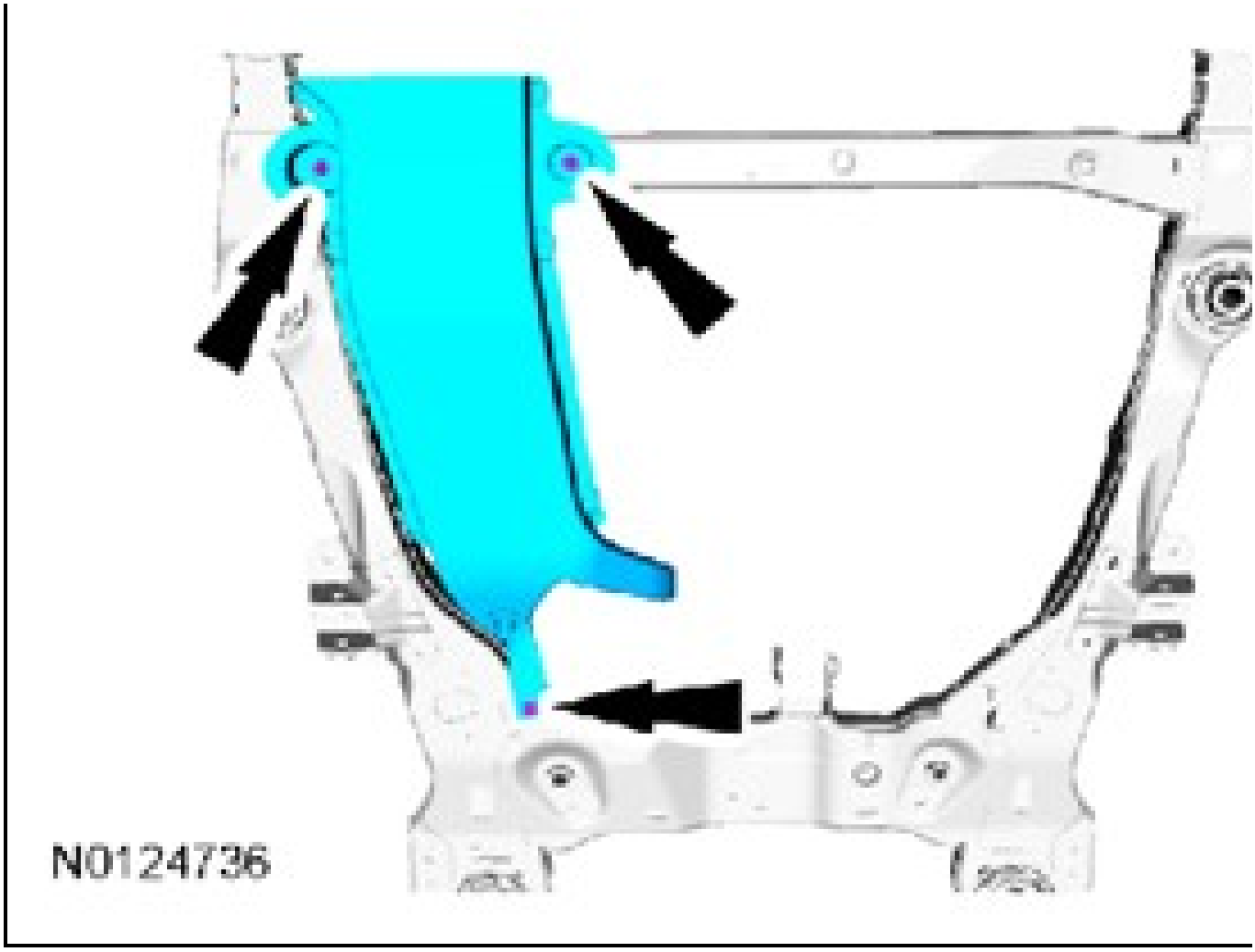
- Tighten to 20 Nm (177 lb-in).

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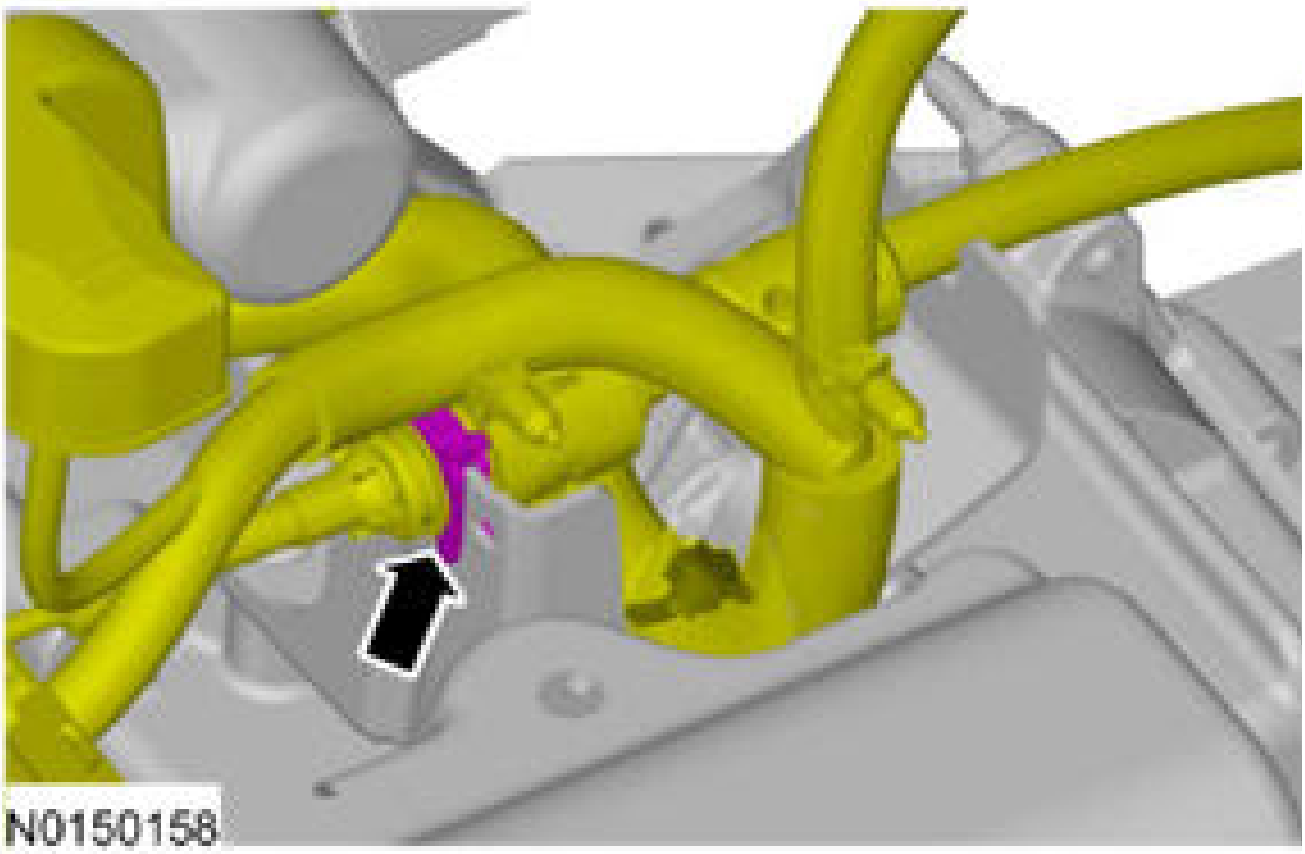
103. Install the underbody air duct and the 3 twist lock retainers.

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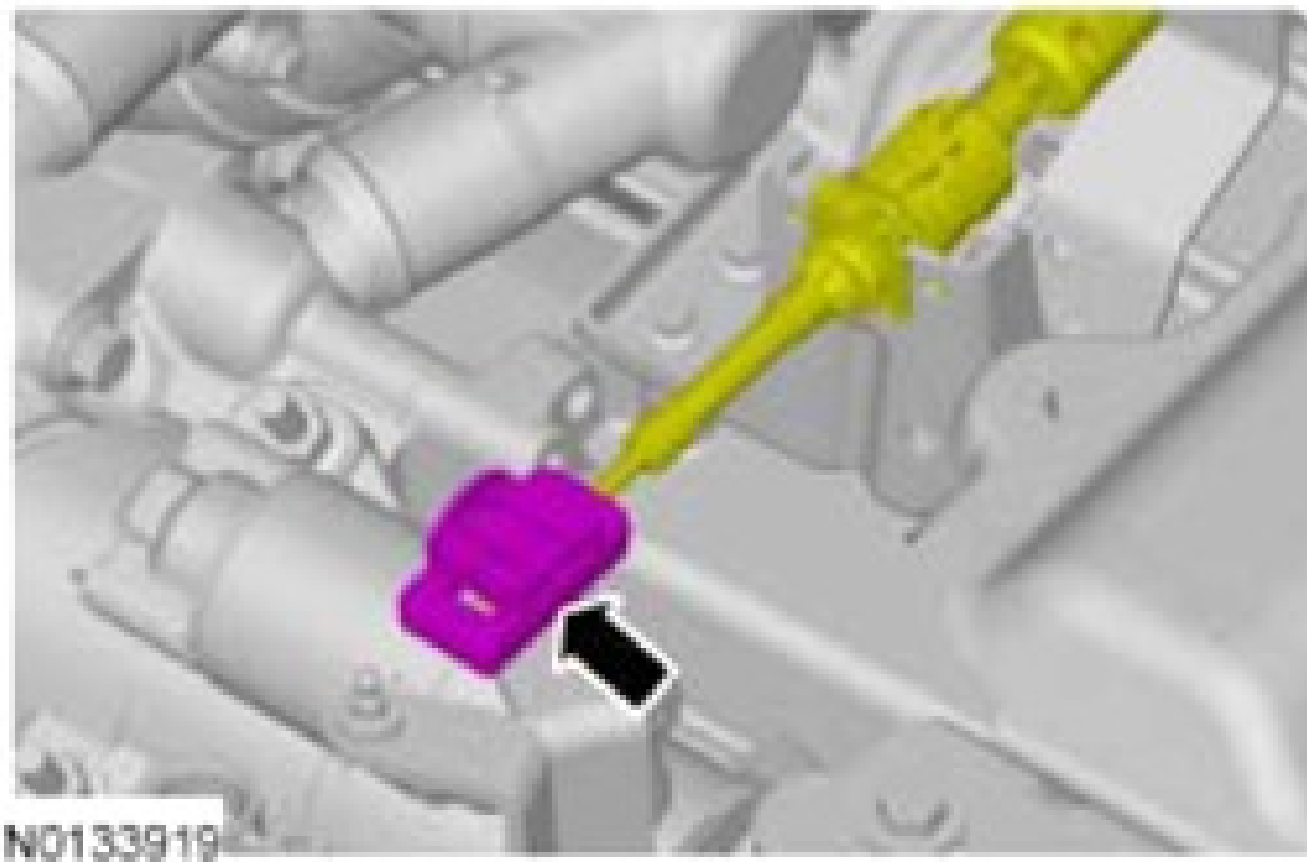
104. If equipped, attach the engine block heater harness to the radiator support.
105. Connect the transaxle control cable to the shift cable bracket.

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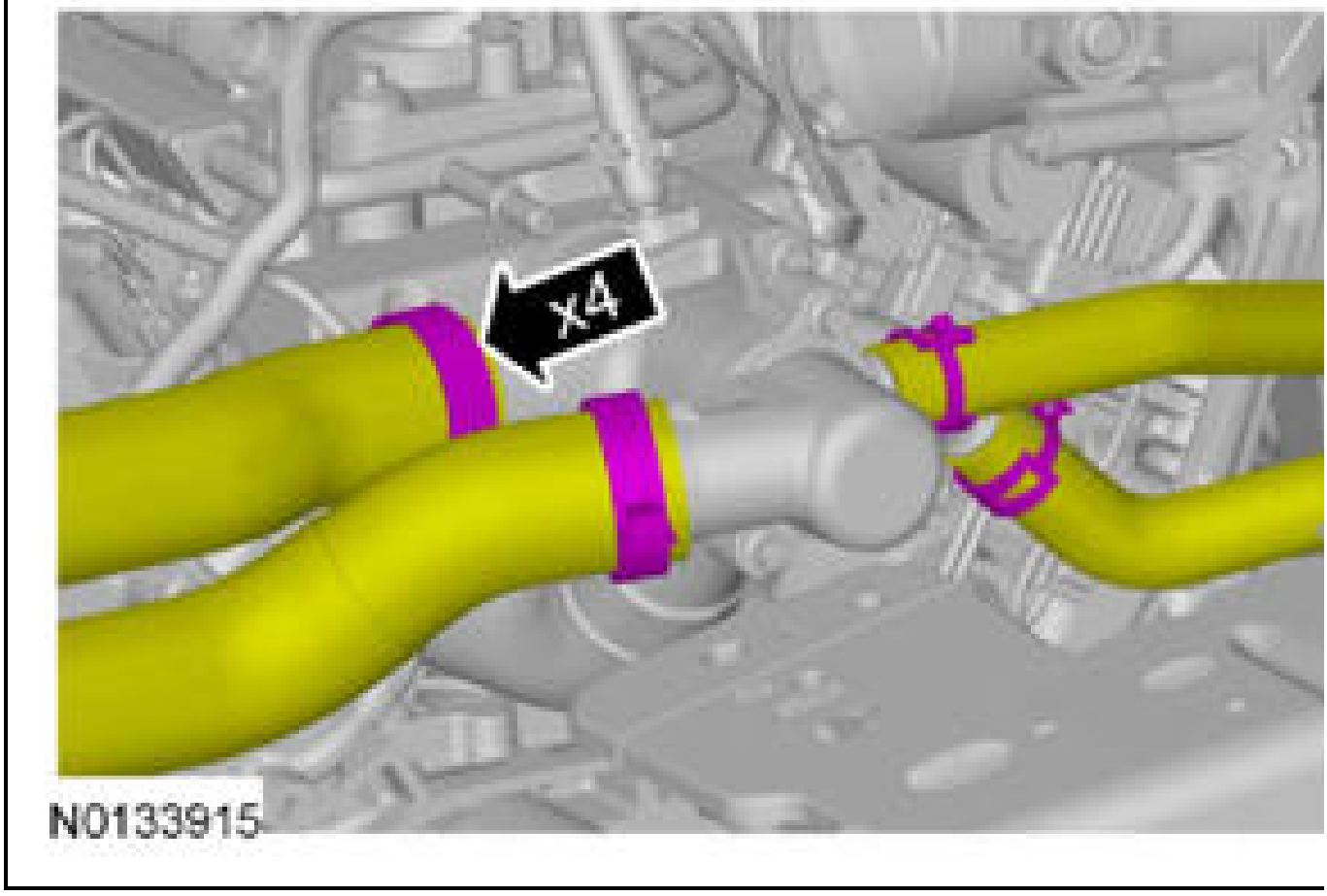
106. Connect the transaxle control cable to the control lever.

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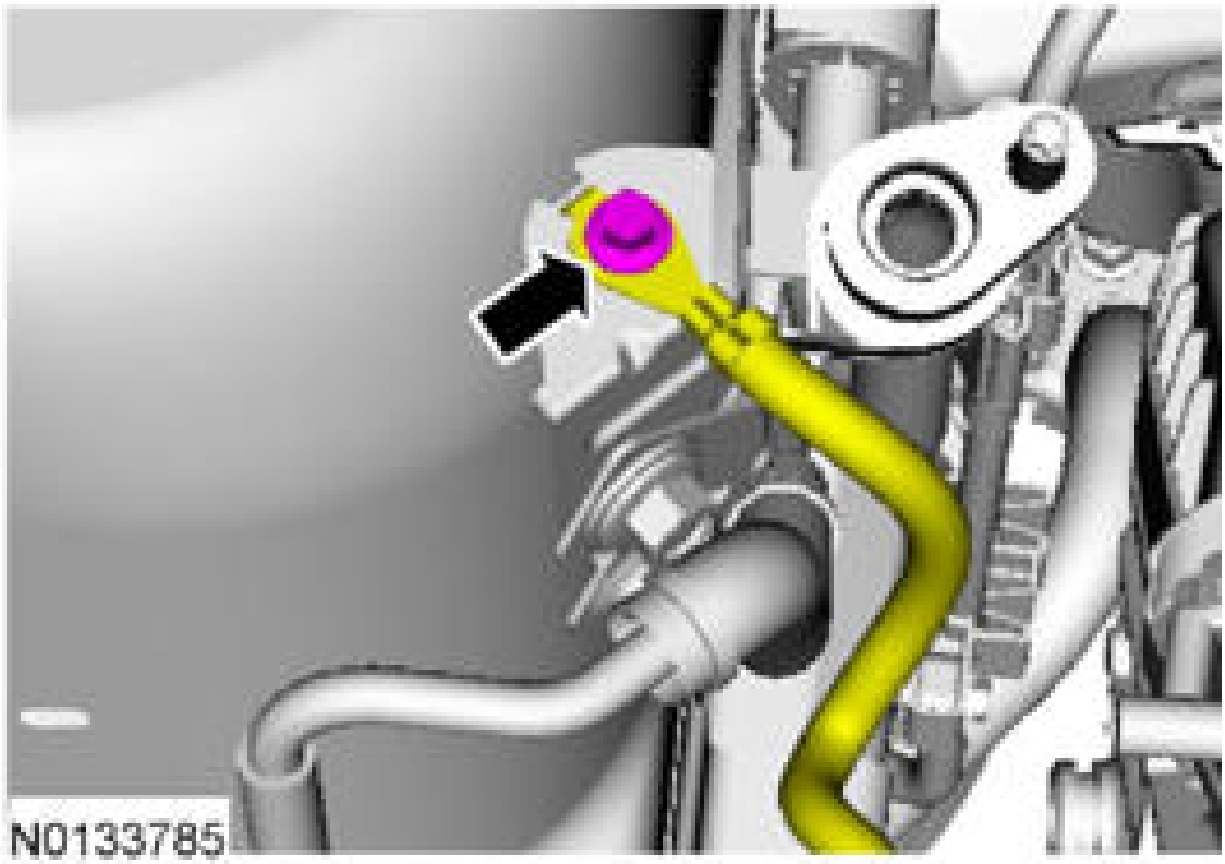
107. Connect the upper radiator hose, lower radiator hose and 2 heater hoses to the thermostat housing.

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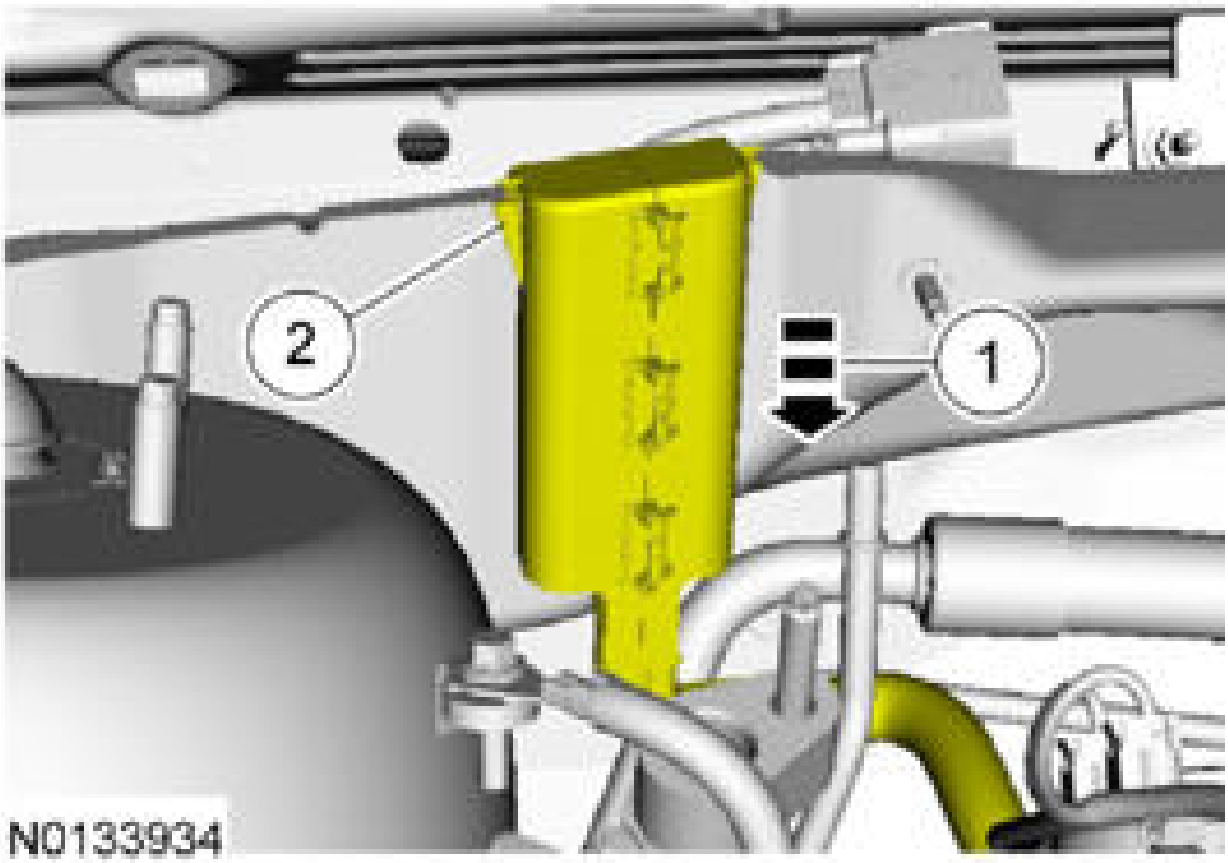
108. Install the ground wire to the RH shock tower and install the bolt.
    - Tighten to 10 Nm (89 lb-in).

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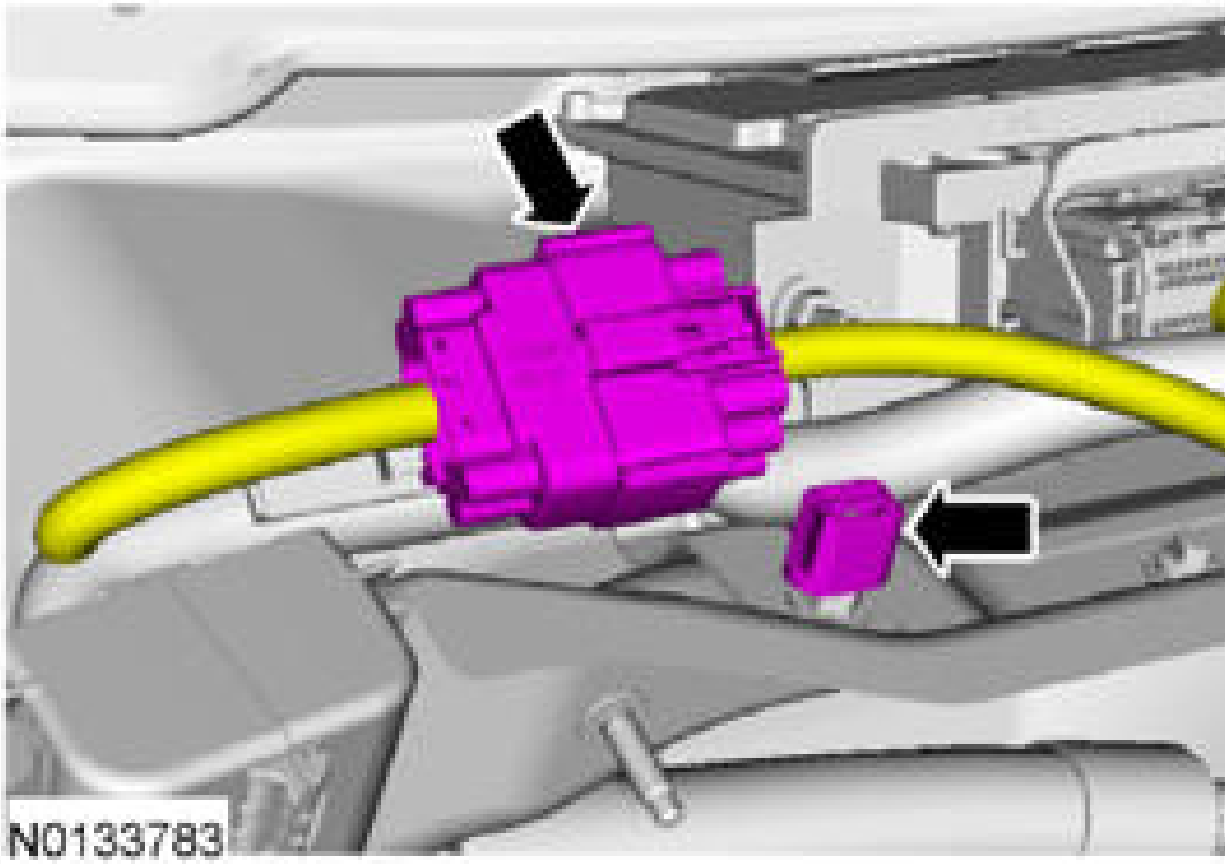
109. Install the engine wiring harness retainer to the bulkhead.
    - Slide the wiring harness in the bulkhead.
    - Make sure the wiring harness retainer tab is below the bulkhead lip.

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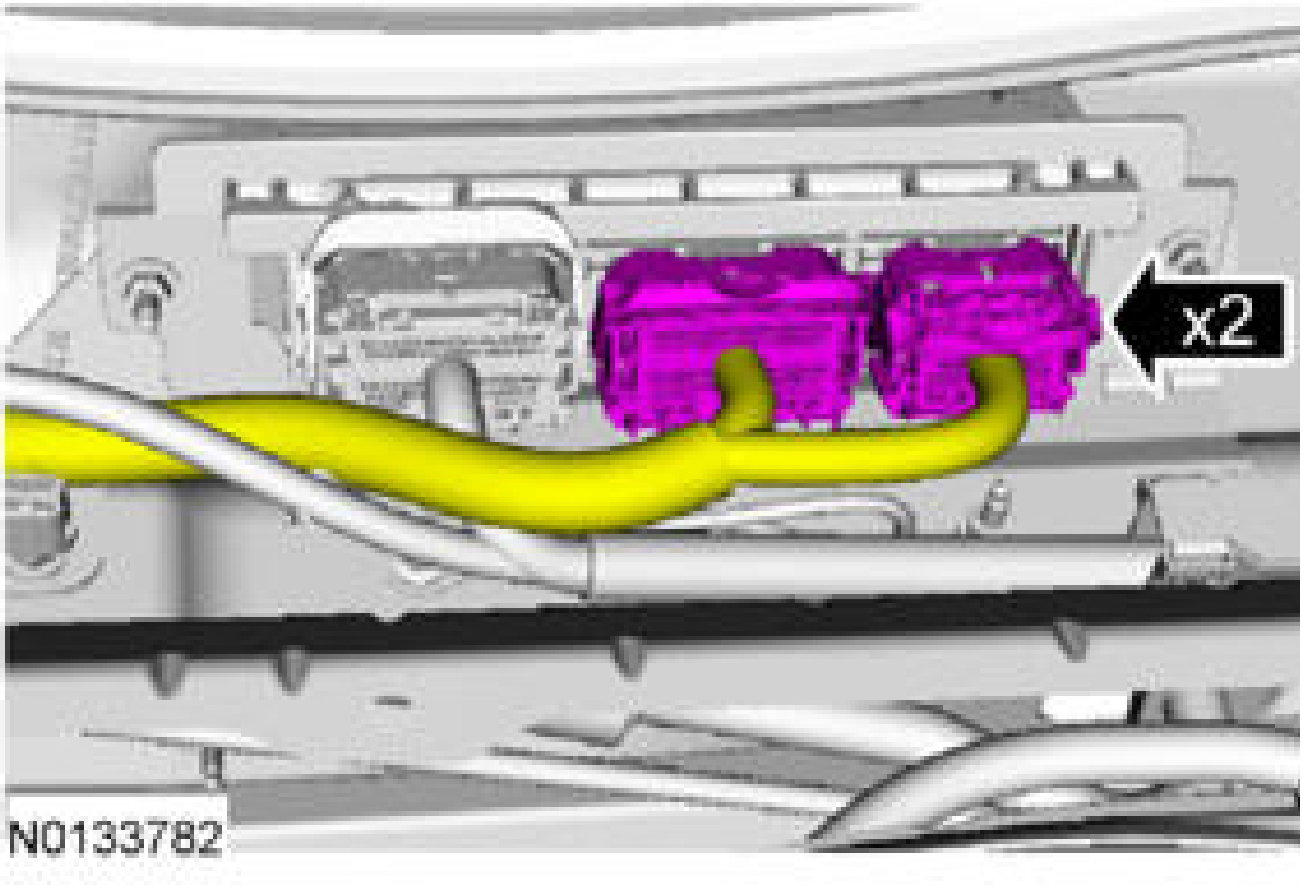
110. Connect the engine harness electrical connector.
    - Attach the wiring harness retainer.

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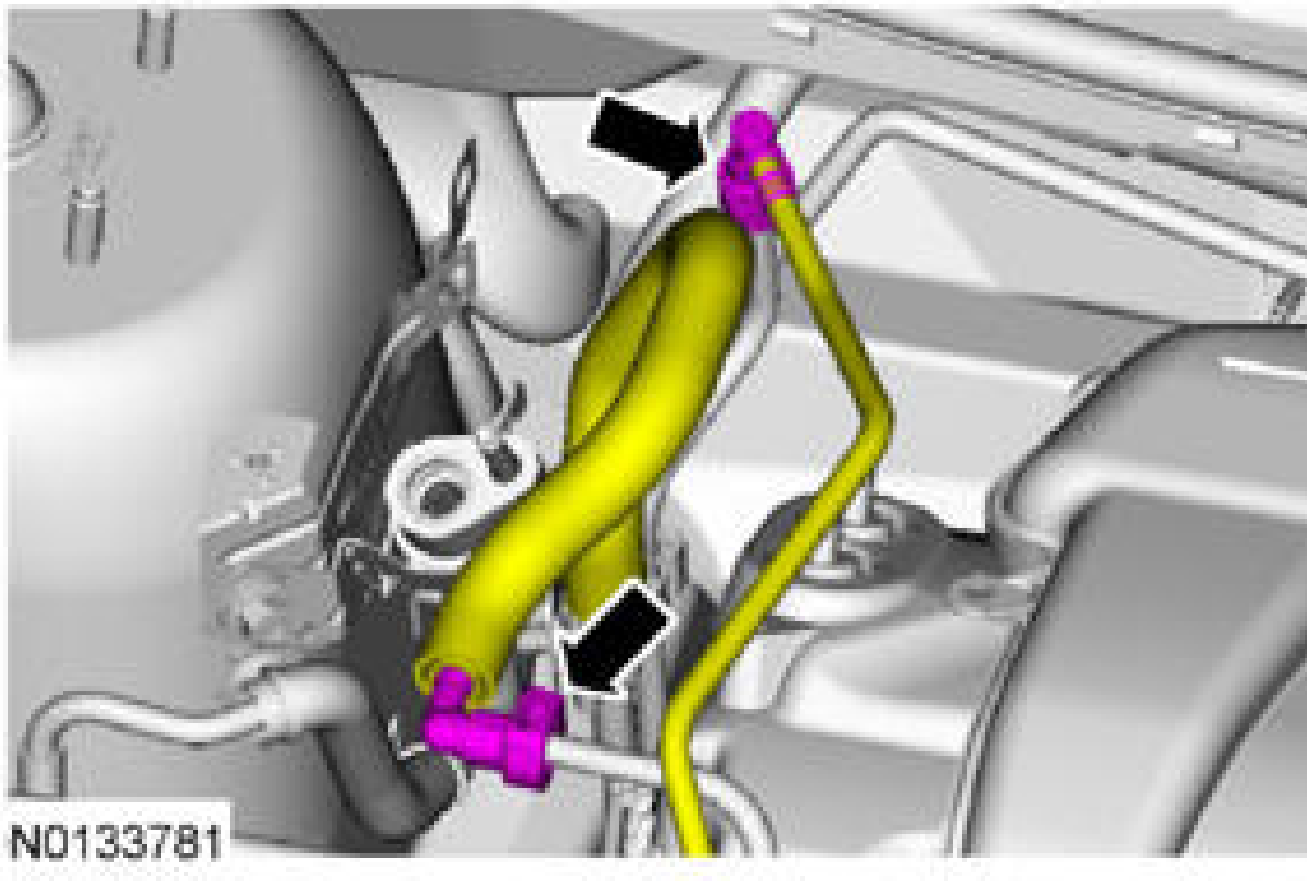
111. Connect the 2 **PCM** electrical connectors.

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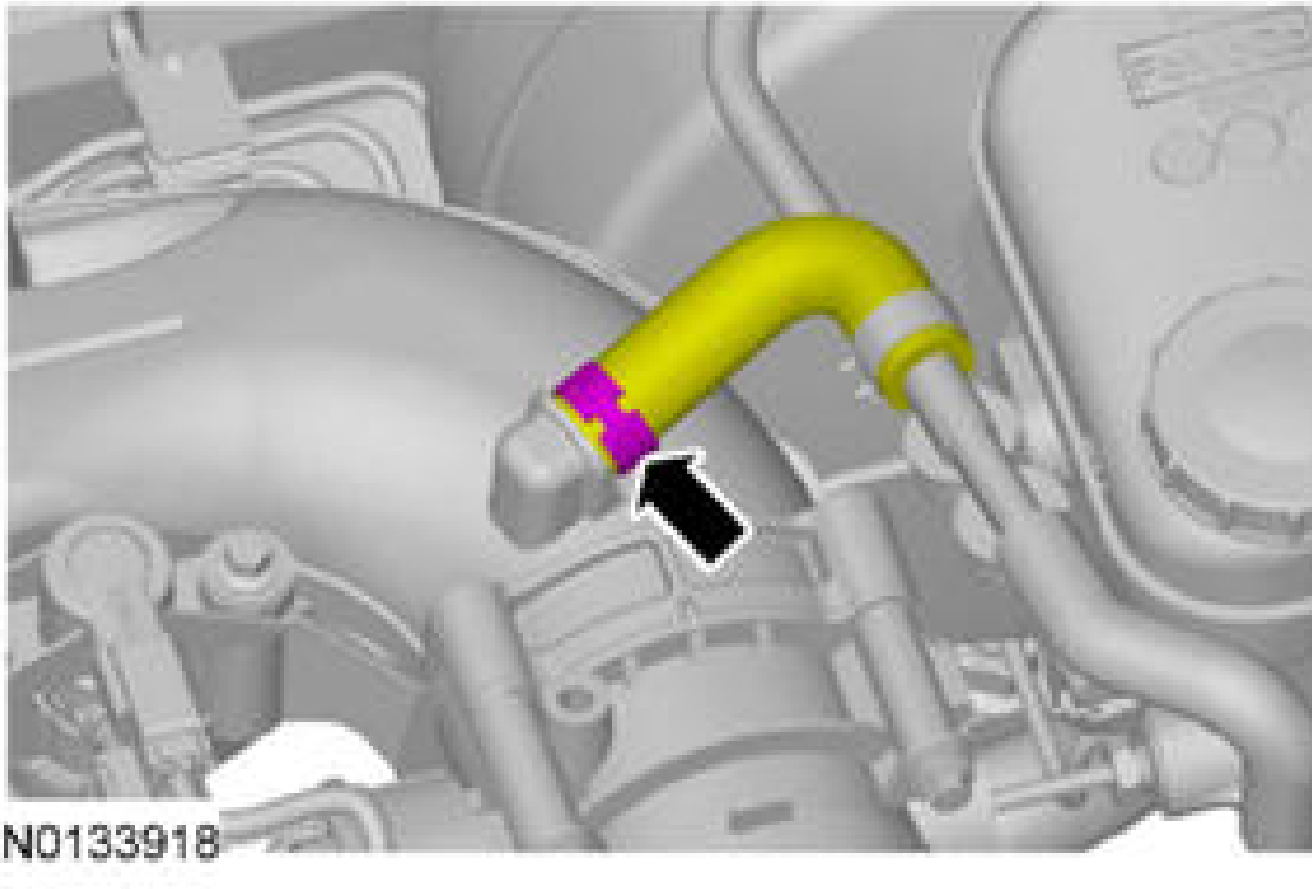
112. Connect the **EVAP** tube and the fuel supply tube quick connect coupling. REFER to **SPRING LOCK COUPLINGS** .

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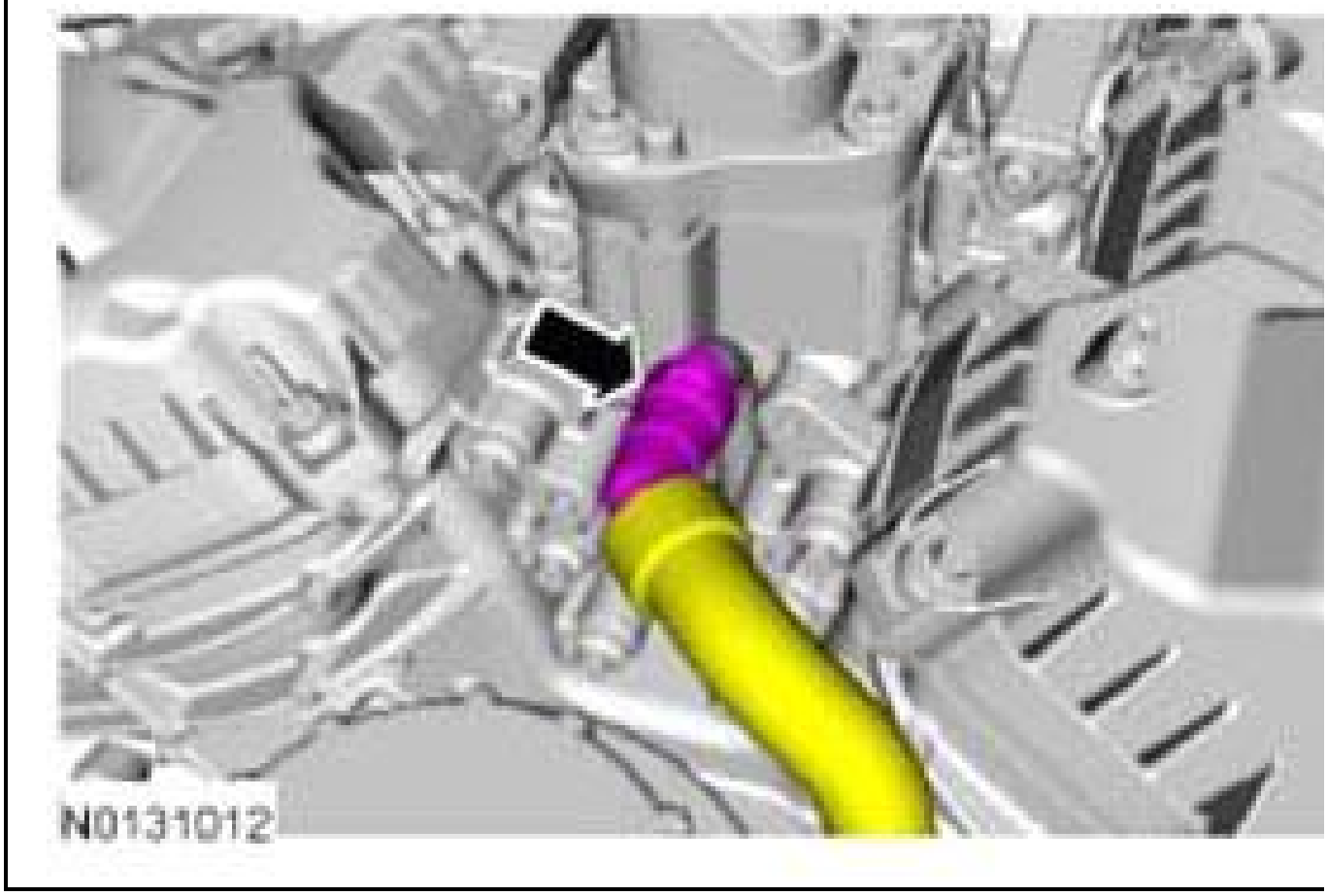
113. Connect the brake booster vacuum hose to the upper intake manifold.

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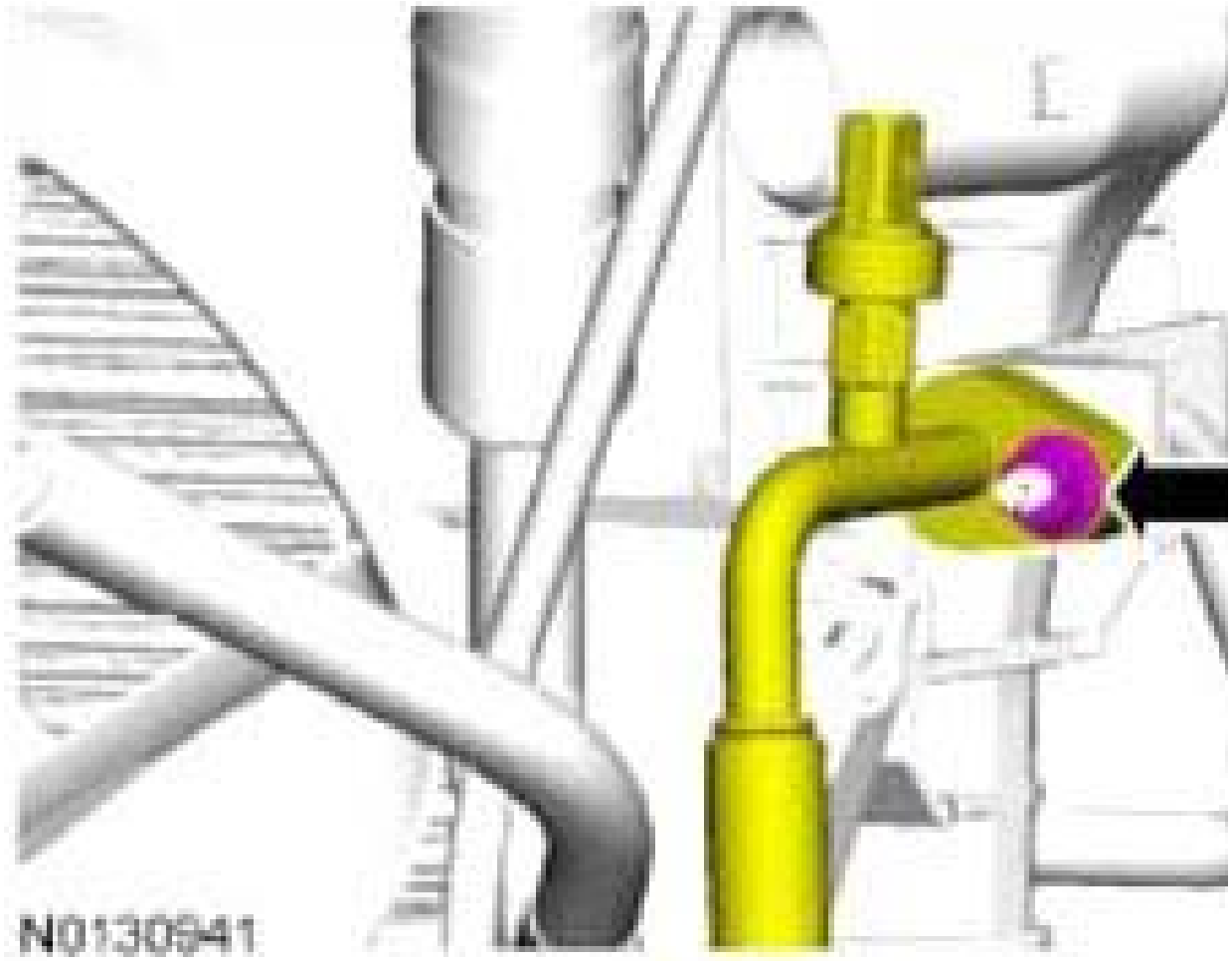
114. Connect the degas bottle coolant hose to the engine coolant tube.

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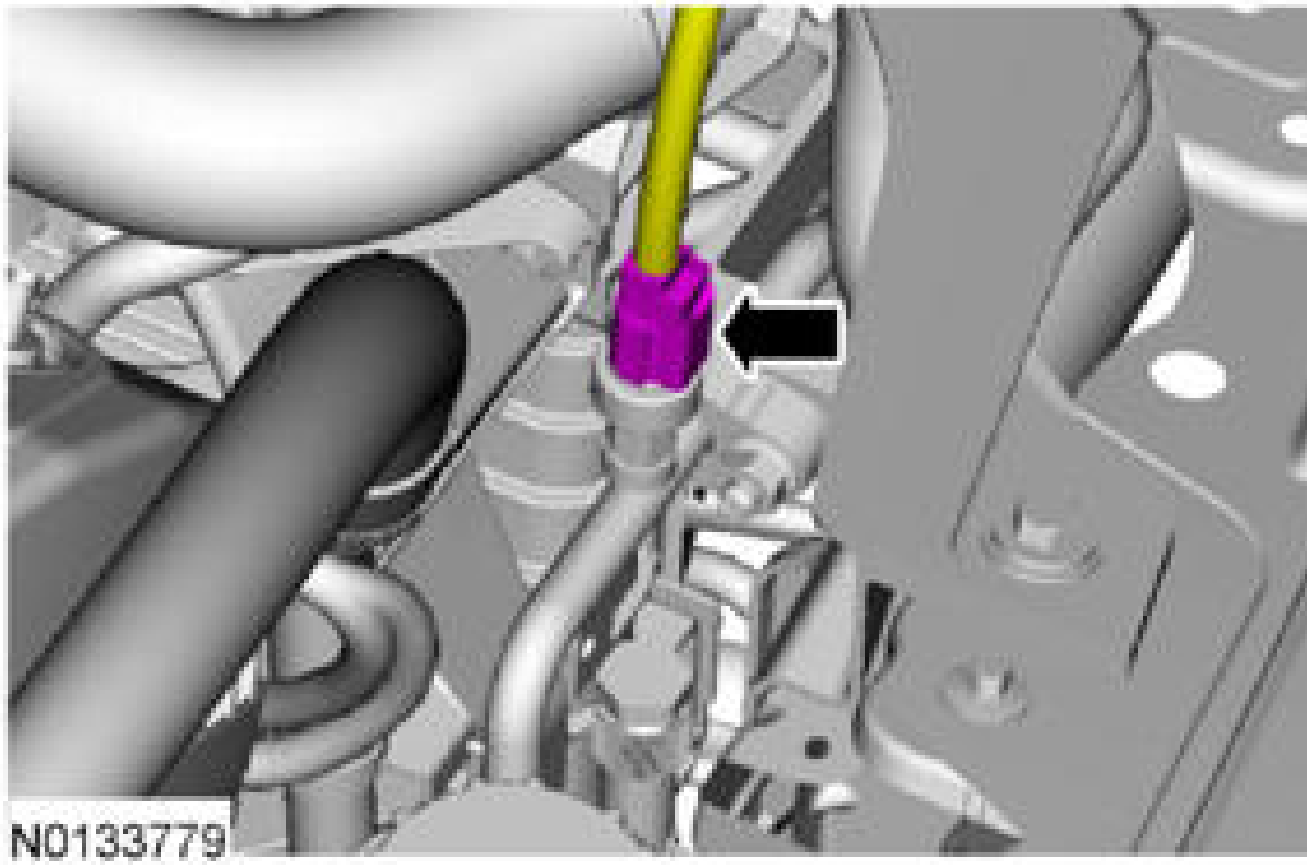
115. Install the degas bottle. REFER to **DEGAS BOTTLE** .
116. Using a new O-ring seal and gasket seal, install the A/C tube and the nut.
    - Tighten to 15 Nm (133 lb-in).

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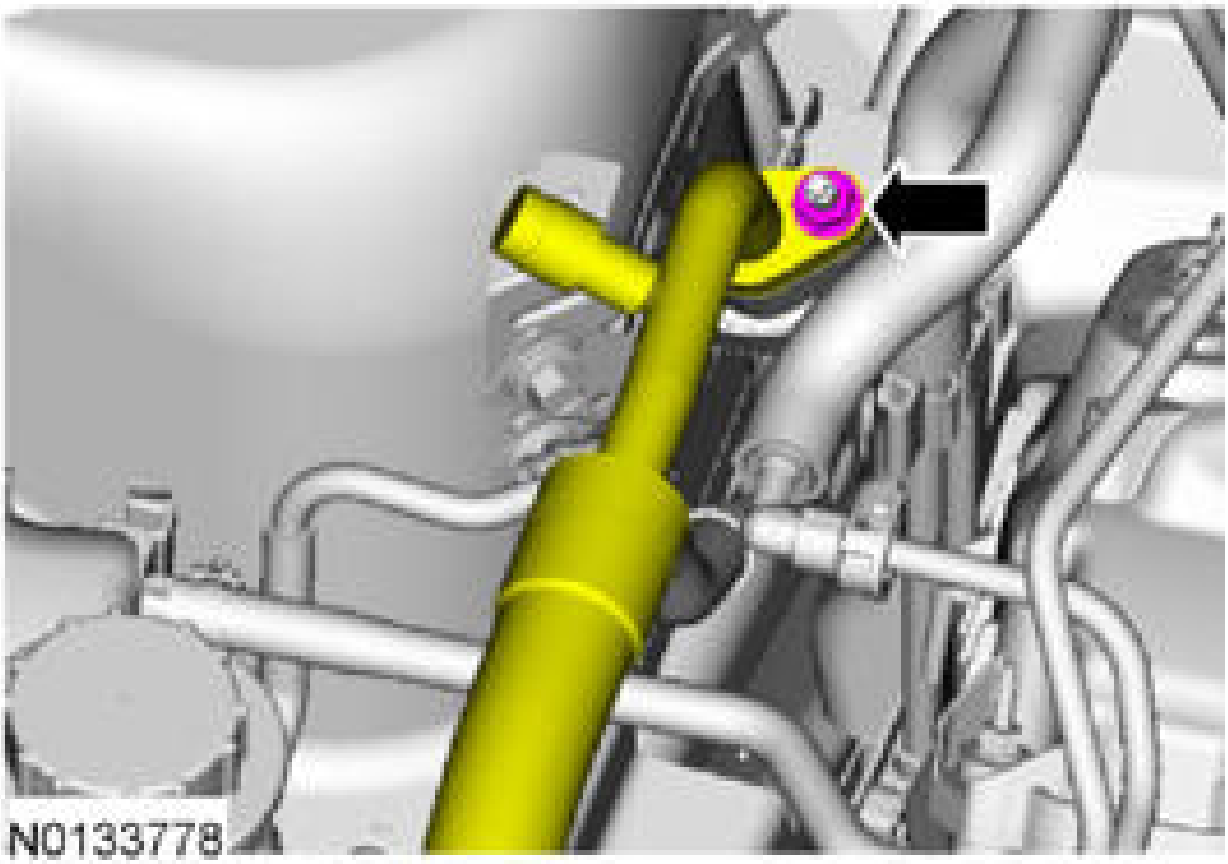
117. Connect the A/C pressure switch electrical connector.

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118. Using a new O-ring seal and gasket seal, connect the A/C tube and install the nut.
    - Tighten to 15 Nm (133 lb-in).

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119. Install the accessory drive belt. REFER to **ACCESSORY DRIVE BELT - 3.5L TI-VCT, 3.7L TI-VCT** .

120. **NOTE: RH shown in illustration, LH similar.**

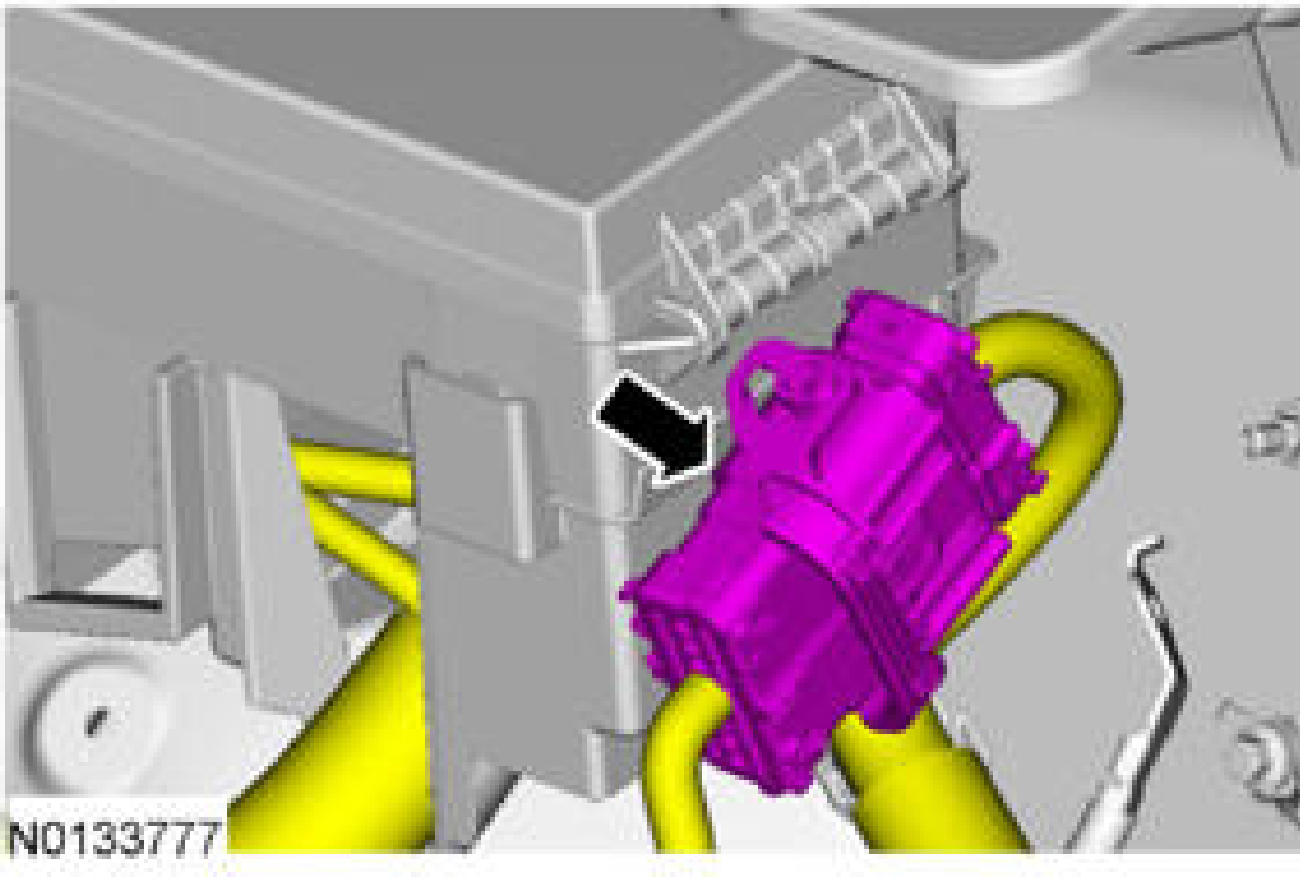
Install the 2 RH and 2 LH lower pin-type retainers for the engine splash shields.

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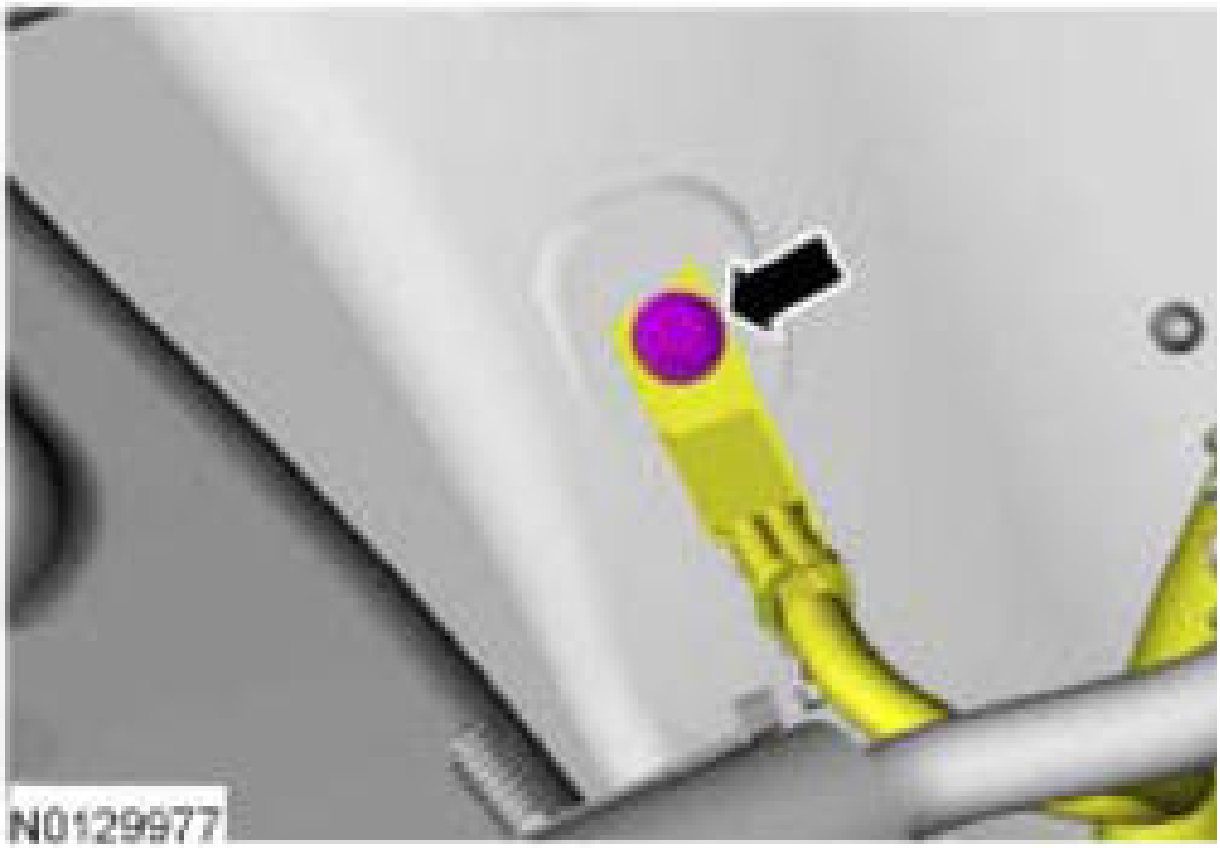
121. Install the front wheels and tires. REFER to **WHEEL AND TIRE** .
122. Connect the engine wiring harness electrical connector.

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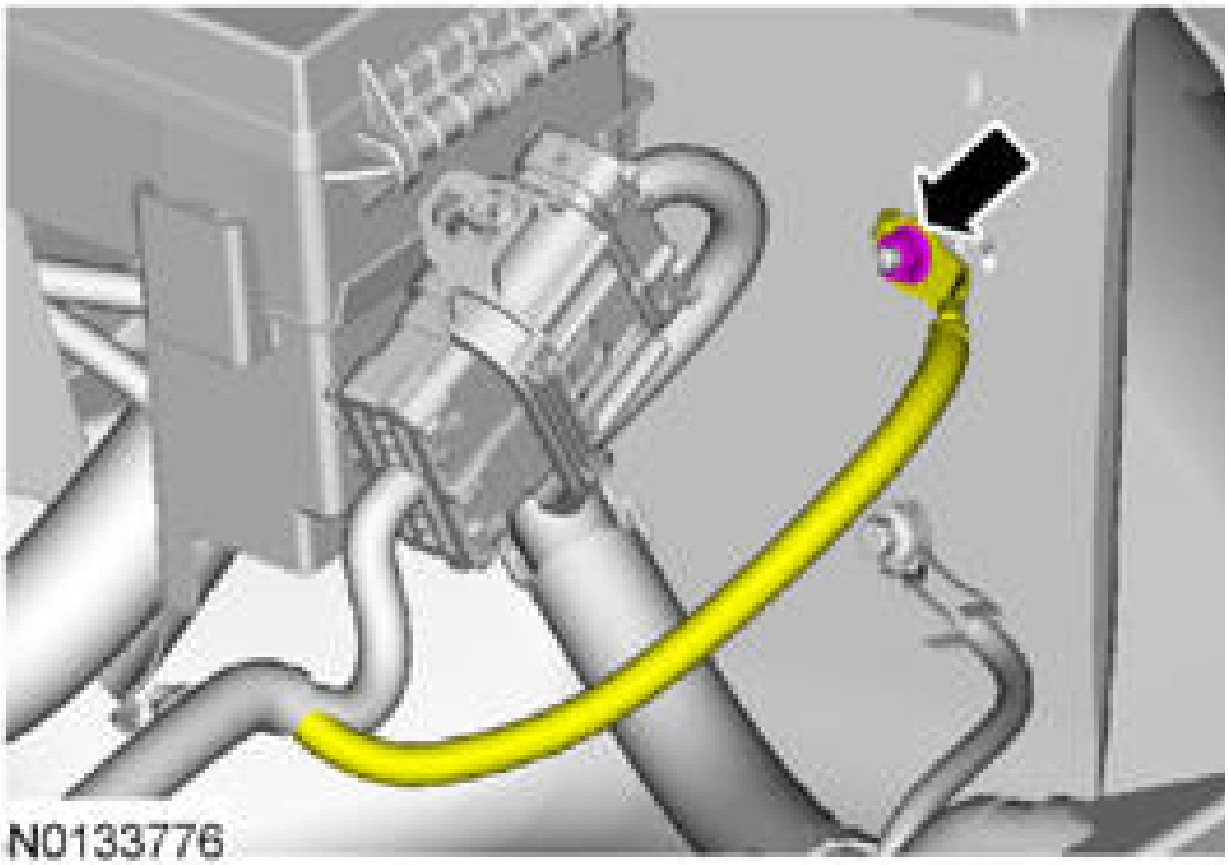
123. Install the ground wire and install the retainer.
    - Tighten to 10 Nm (89 lb-in).

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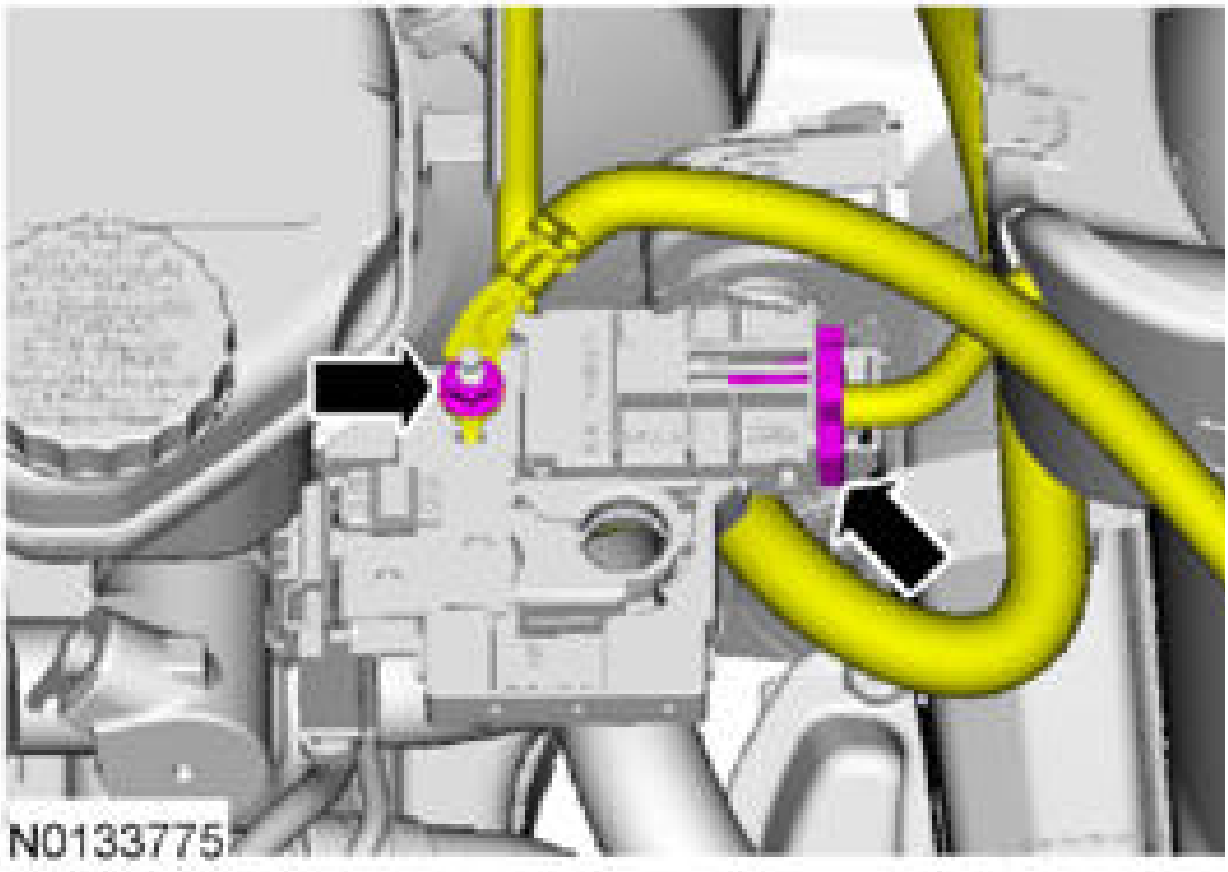
124. Install the ground wire and the retainer.
    - Tighten to 10 Nm (89 lb-in).

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125. Connect the 2 battery feed cables to the positive battery terminal and install the nut.
    - Tighten to 5 Nm (44 lb-in).

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126. Install the battery tray. REFER to **BATTERY AND BATTERY TRAY - EXPLODED VIEW** .
127. Install the engine **ACL** and **ACL** outlet pipe. REFER to **INTAKE AIR SYSTEM COMPONENTS - EXPLODED VIEW** .
128. Install the cowl panel. REFER to **COWL PANEL** .
129. Fill the engine with clean engine oil.
130. Fill and bleed the cooling system. REFER to **COOLING SYSTEM DRAINING, FILLING AND BLEEDING** .
131. Recharge the A/C system. REFER to **AIR CONDITIONING (A/C) SYSTEM RECOVERY, EVACUATION AND CHARGING** .
132. Perform the Misfire Monitor Neutral Profile Correction procedure, following the on-screen instructions.

CRANKSHAFT FRONT SEAL

SPECIAL TOOL(S) DESCRIPTION

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	Installer, Crankshaft Vibration Damper **303-102T74P-6316-B**
	Installer, Front Seal **303-1251**
	Remover, Oil Seal **303-409T92C-6700-CH**

MATERIAL SPECIFICATIONS

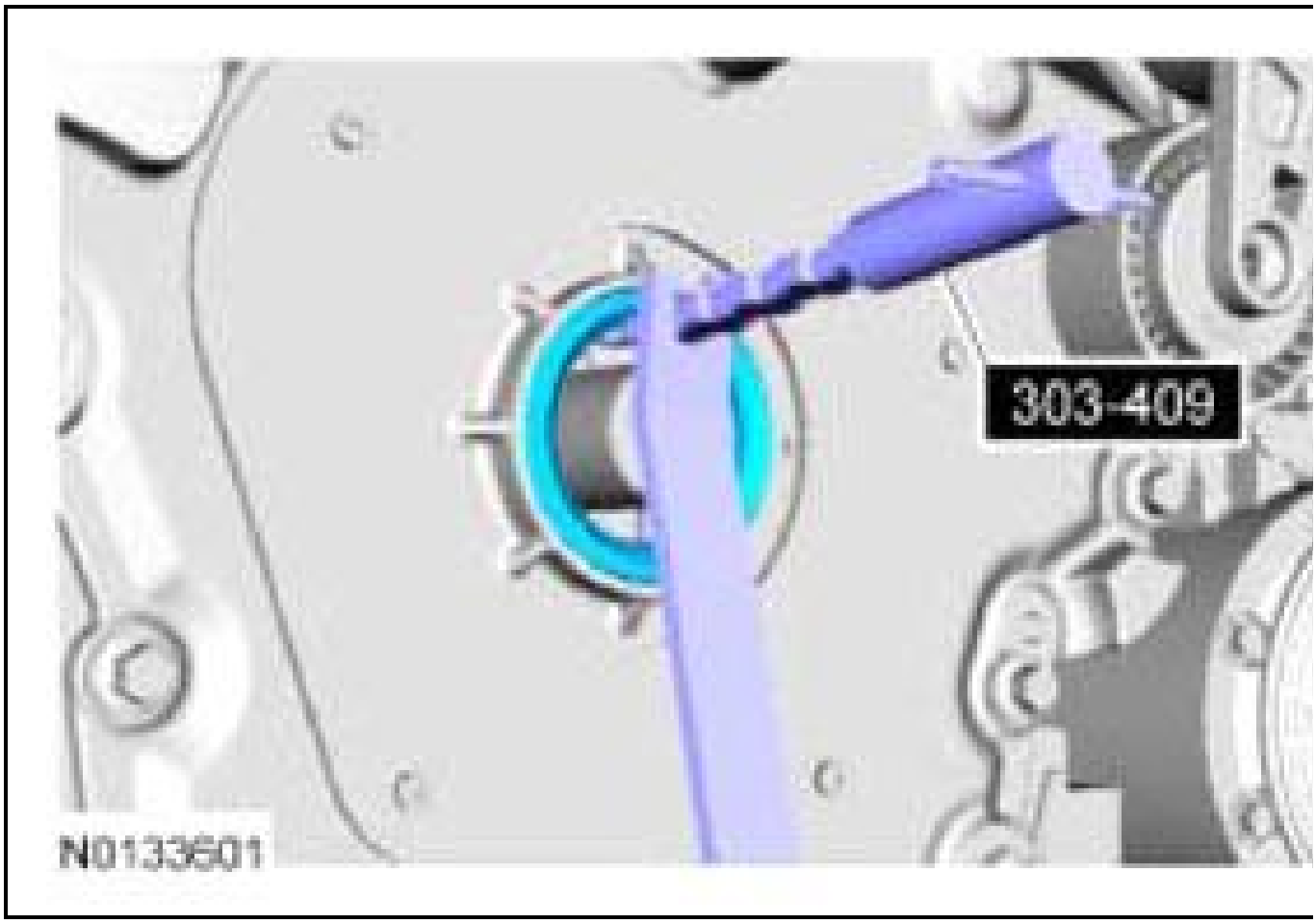
Item	Specification
Motorcraft® Metal Surface Prep ZC-31-A	-

 © 2011 Mitchell Repair Information Company, LLC.

Motorcraft® SAE 5W-20 Premium Synthetic Blend Motor Oil (US); Motorcraft® SAE 5W-20 Super Premium Motor Oil (Canada) XO-5W20-QSP (US); CXO-5W20-LSP12 (Canada)	WSSM2C945-A

Removal

1. With the vehicle in NEUTRAL, position it on a hoist. REFER to **JACKING AND LIFTING** , Lifting Points.
2. Remove the crankshaft pulley. Refer to **CRANKSHAFT PULLEY**.
3. Using 303-409 T92C-6700-CH, remove and discard the crankshaft front seal.



4. Inspect the crankshaft seal bore in the front cover for any damage or casting imperfections that may effect the crank seal outer diameter sealing. Repair/replace as necessary.

Installation

1. Clean all sealing surfaces with Motorcraft® Metal Surface Prep.

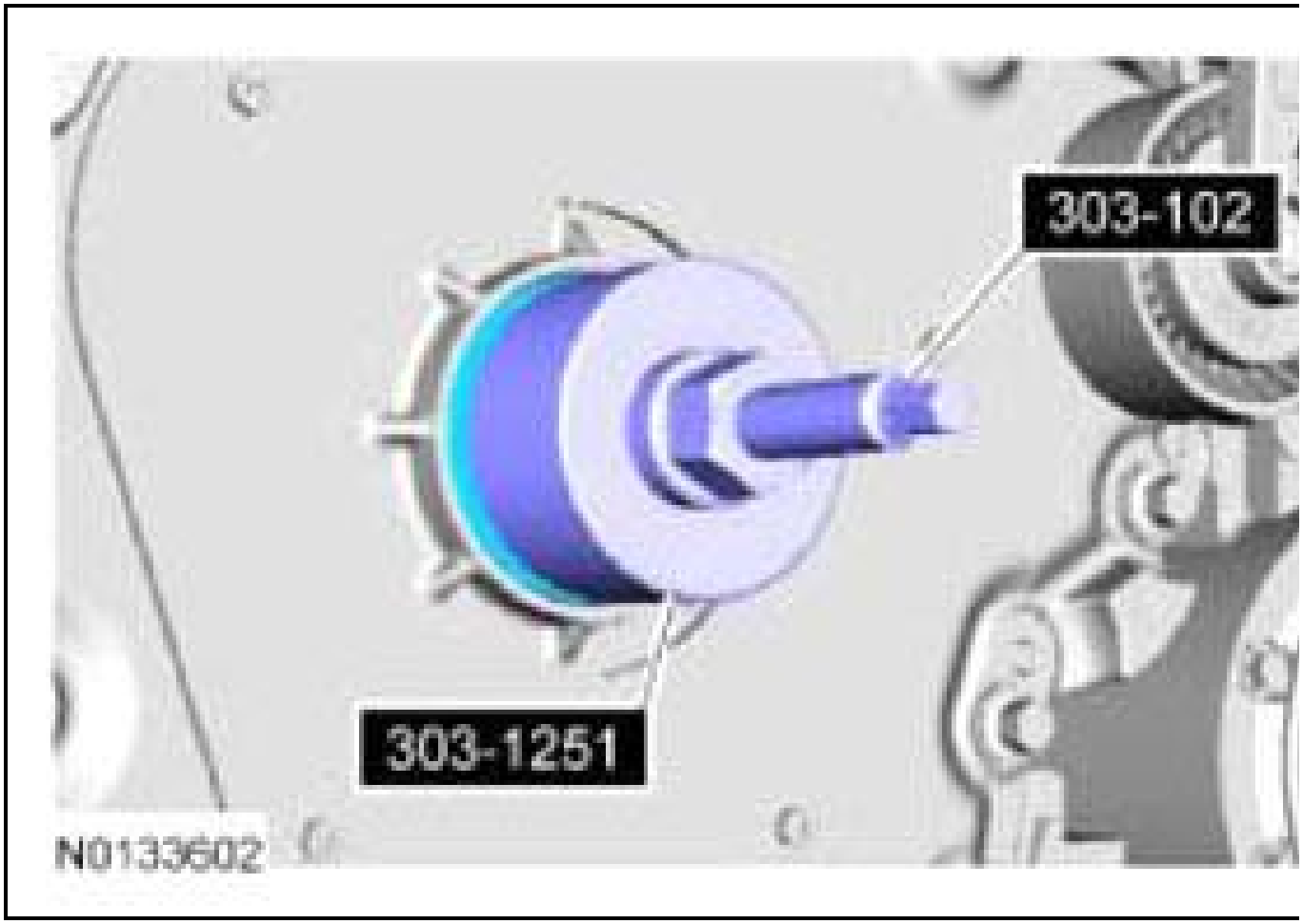
NOTE: Apply clean Motorcraft® SAE 5W-20 Premium Synthetic Blend Motor Oil (US); Motorcraft® SAE 5W-20 Super Premium Motor Oil (Canada) to the

2.

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2. **crankshaft front seal bore in the engine front cover.**

Using 303-1251 and 303-102 T74P-6316-B, install a new crankshaft front seal.



3. **NOTE: Do not use grease on seal or pulley hub as this may result in premature seal failure.**

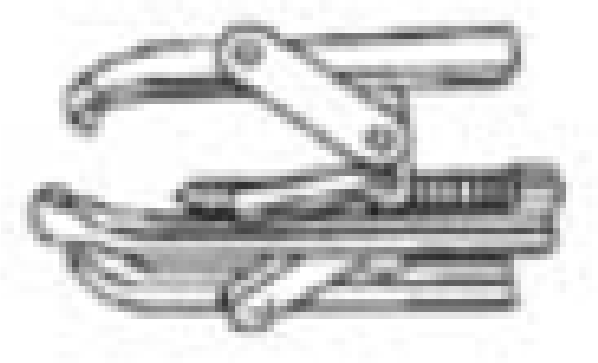
NOTE: Apply clean Motorcraft® SAE 5W-20 Premium Synthetic Blend Motor Oil (US); Motorcraft® SAE 5W-20 Super Premium Motor Oil (Canada) to the crankshaft front seal contact surface.

Install the crankshaft pulley. Refer to **CRANKSHAFT PULLEY**.

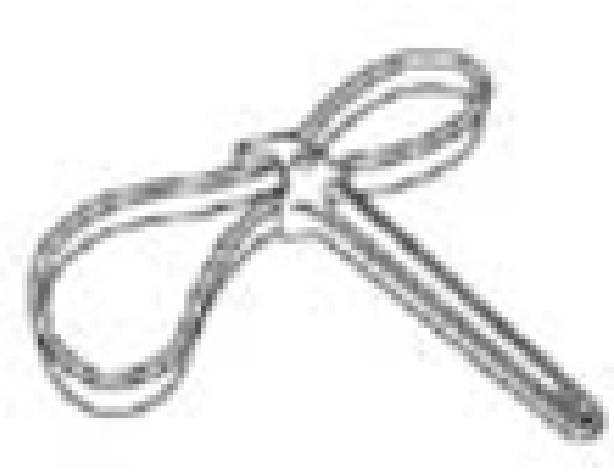
CRANKSHAFT PULLEY

SPECIAL TOOL(S) DESCRIPTION

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	3 Jaw Puller **303-D121**
	Installer, Front Cover Oil Seal **303-335T88T-6701-A**
	Installer, Crankshaft Vibration Damper **303-102T74P-6316-B**
	Strap Wrench

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	**303-D055D85L-6000-A**

MATERIAL SPECIFICATIONS

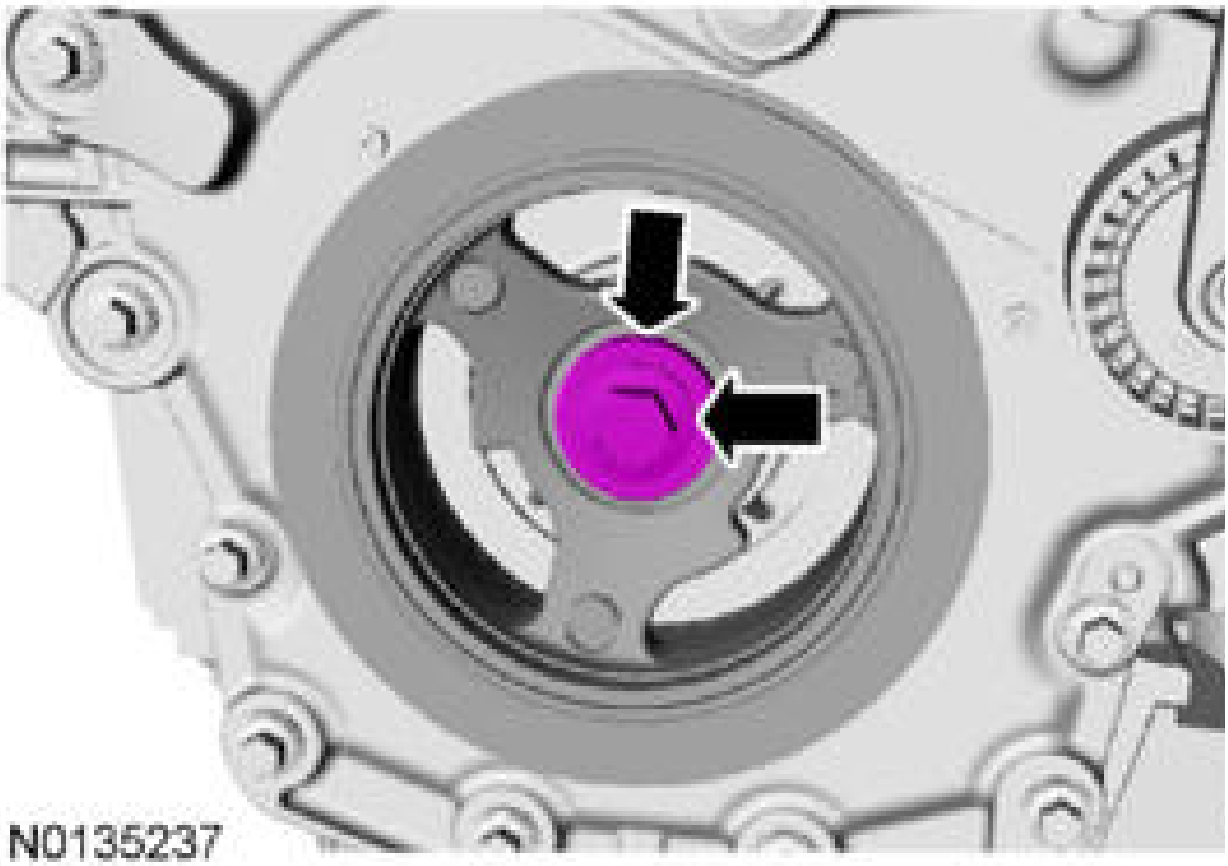
Item	Specification
Motorcraft® SAE 5W-20 Premium Synthetic Blend Motor Oil (US); Motorcraft® SAE 5W-20 Super Premium Motor Oil (Canada) XO-5W20-QSP (US); CXO-5W20-LSP12 (Canada)	WSSM2C945-A

Removal

WARNING: Before beginning any service procedure, refer to SAFETY WARNINGS . Failure to follow this instruction may result in serious personal injury.

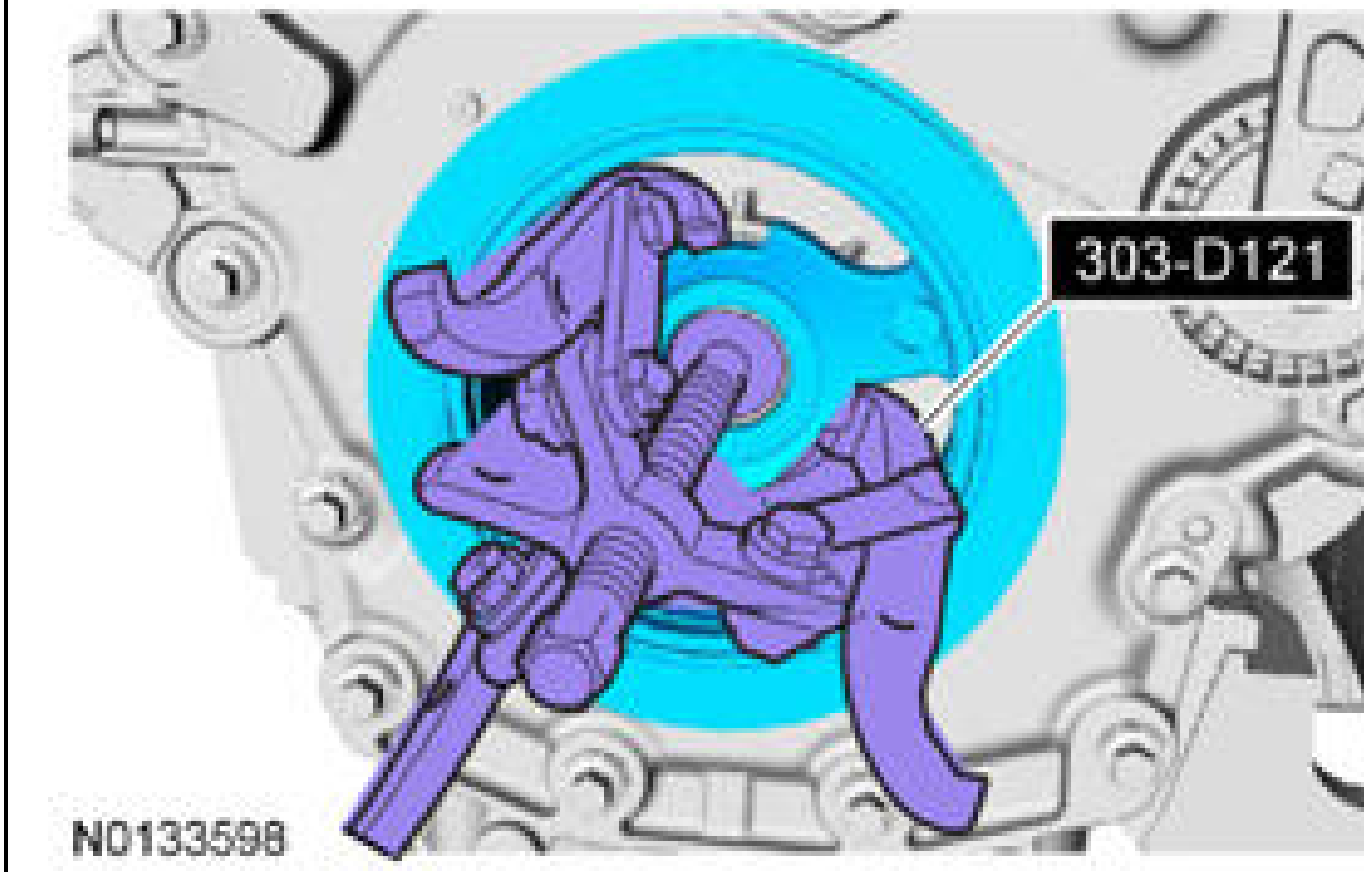
1. With the vehicle in NEUTRAL, position it on a hoist. REFER to **JACKING AND LIFTING** , Lifting Points.
2. Remove the RH splash shield. REFER to **FENDER SPLASH SHIELD** .
3. Remove the accessory drive belt. REFER to **ACCESSORY DRIVE BELT - 3.5L TI-VCT, 3.7L TI-VCT** .
4. Remove the crankshaft pulley bolt and washer.
   - Discard the bolt.

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5. Using 303-D121, remove the crankshaft pulley.

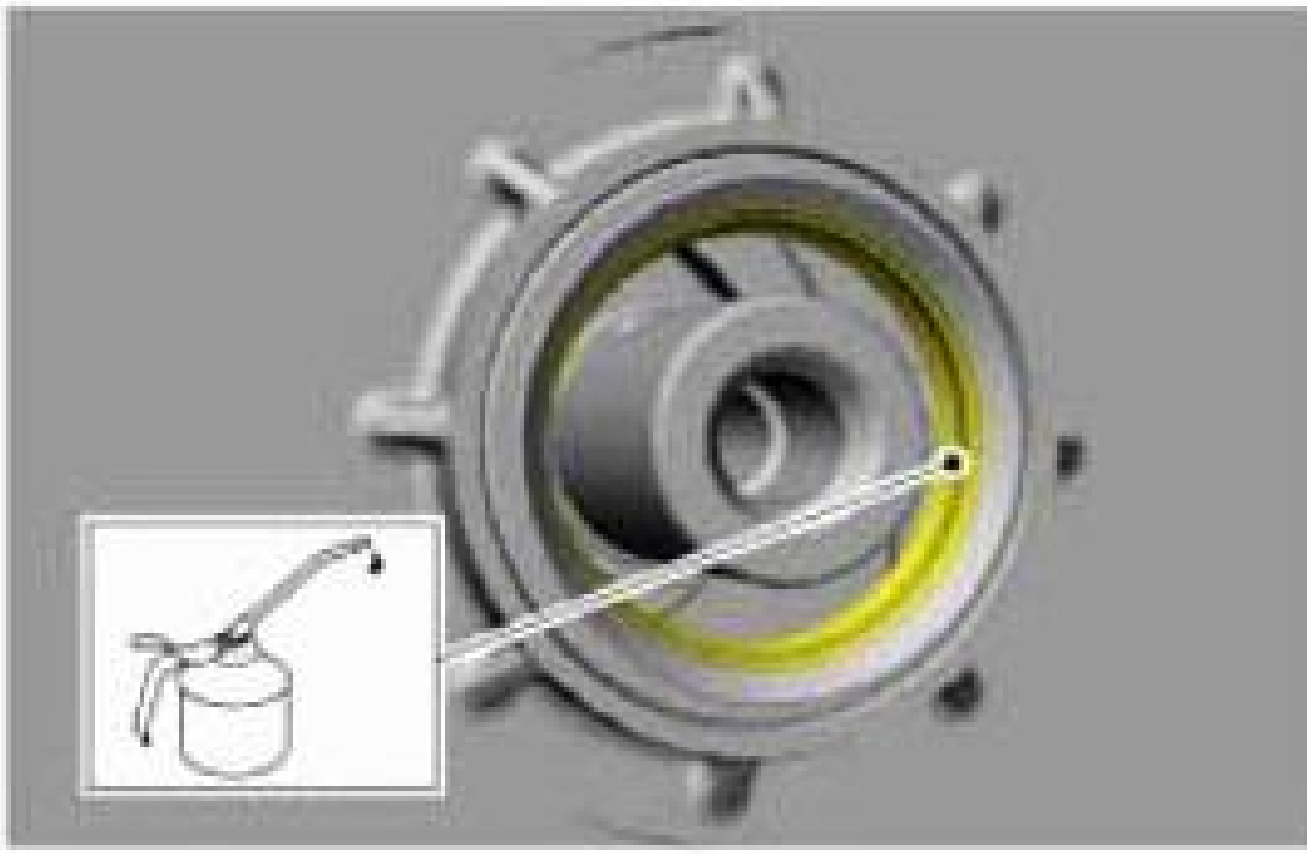
 © 2011 Mitchell Repair Information Company, LLC.

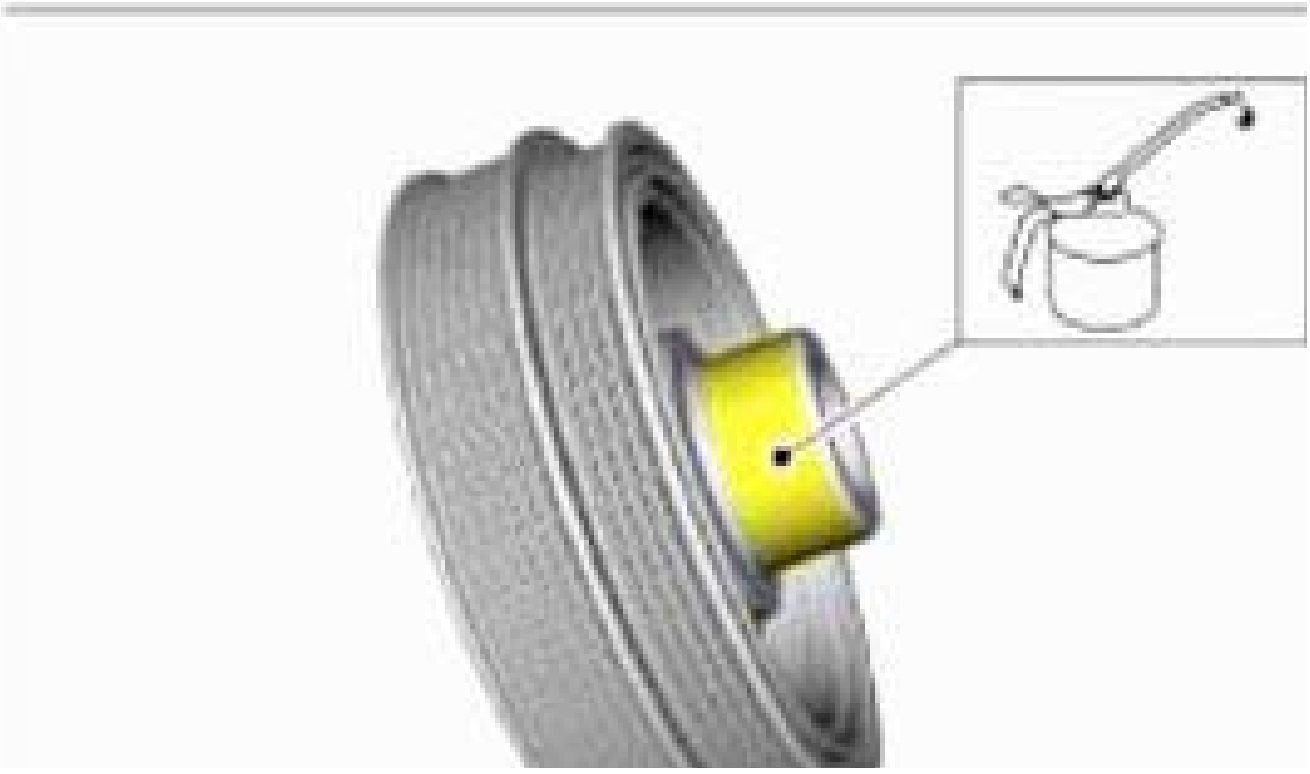


Installation

1. Lubricate the crankshaft front seal inner lip and crankshaft pulley outside diameter sealing surfaces with clean engine oil.

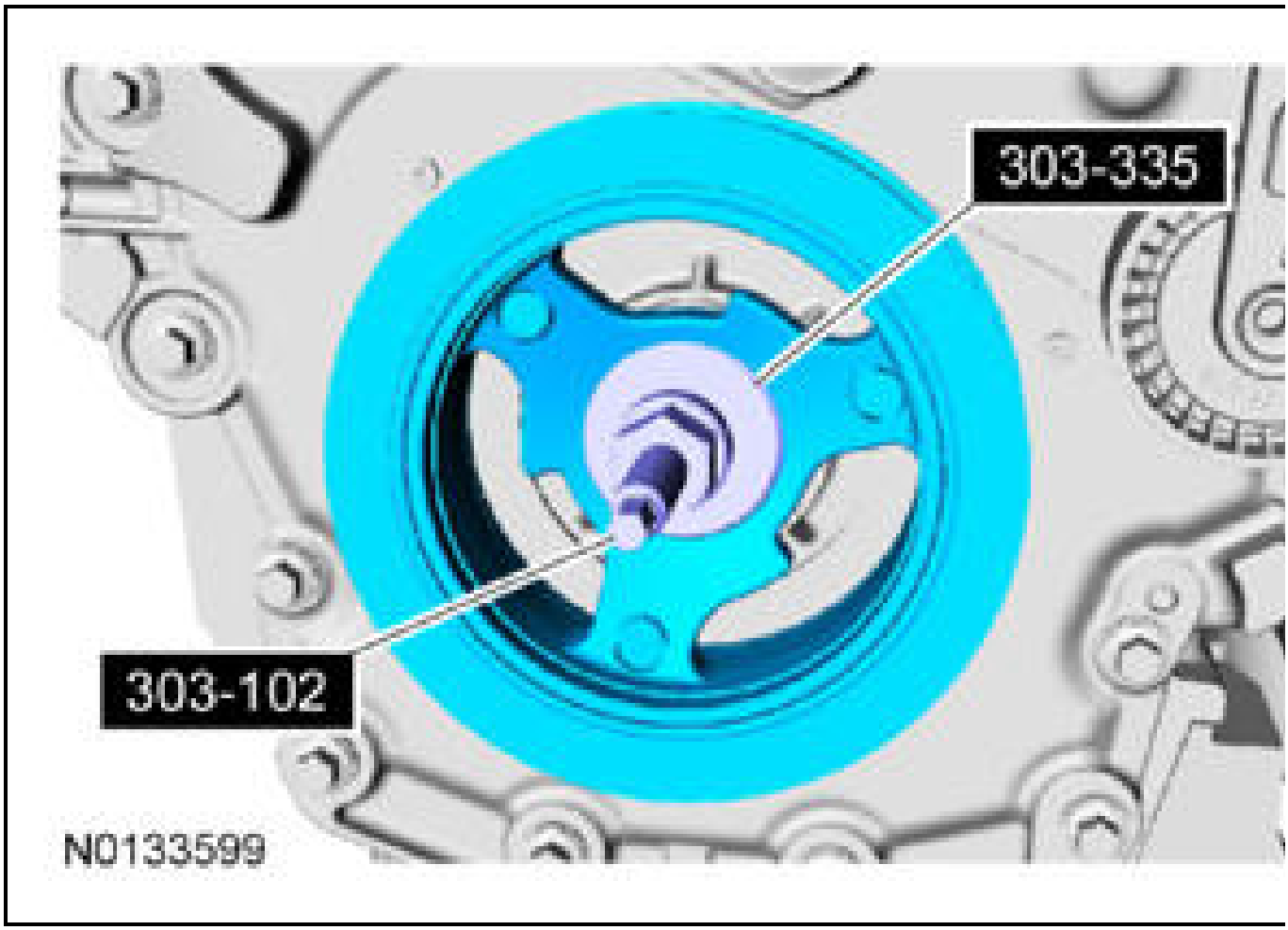
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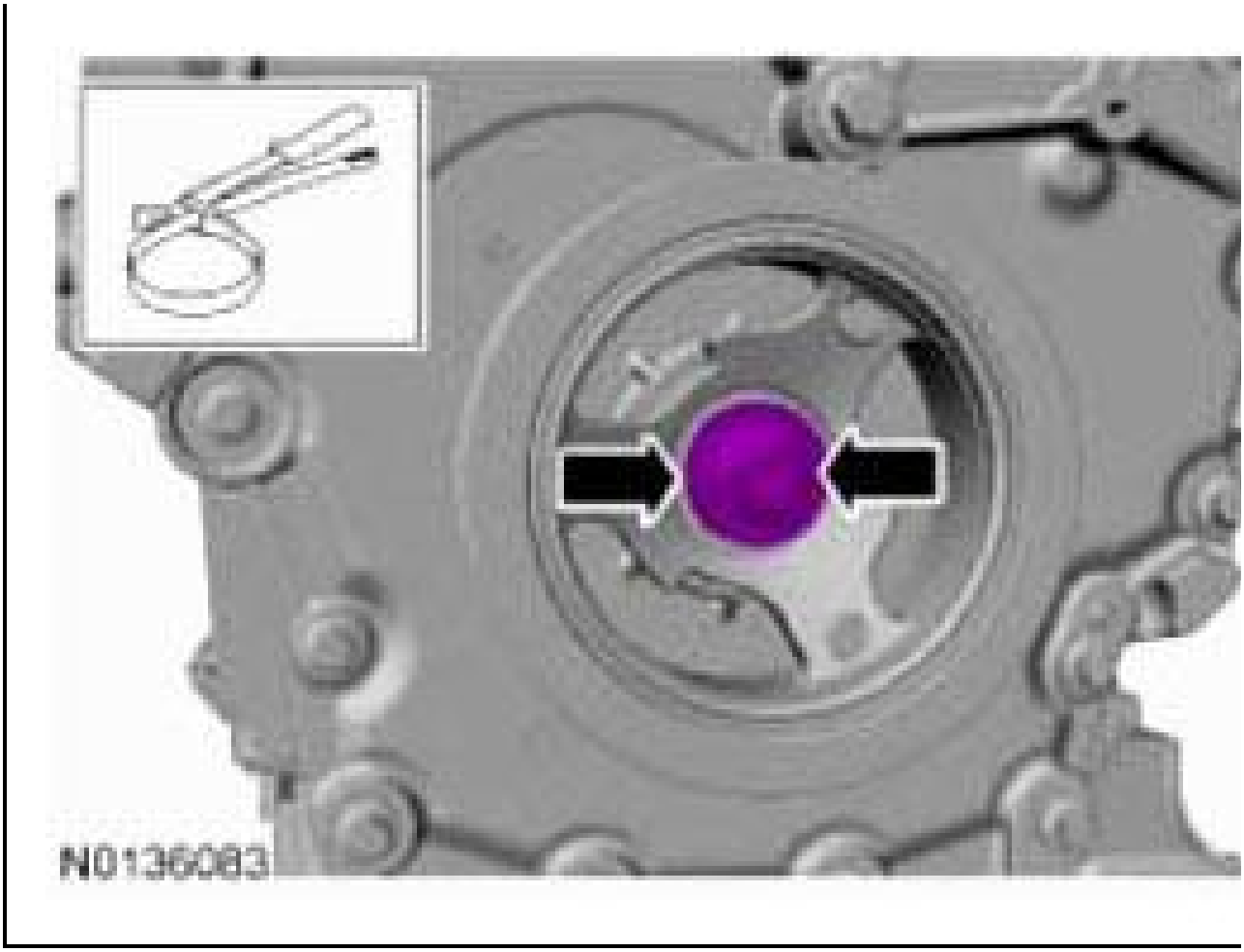
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2. Using 303-102 T74P-6316-B and 303-335 T88T-6701-A, install the crankshaft pulley.



3. Using strap wrench, install the crankshaft pulley washer and new bolt and tighten in 4 stages.
   - Stage 1: Tighten to 120 Nm (89 lb-ft).
   - Stage 2: Loosen one full turn.
   - Stage 3: Tighten to 50 Nm (37 lb-ft).
   - Stage 4: Tighten an additional 90 degrees.

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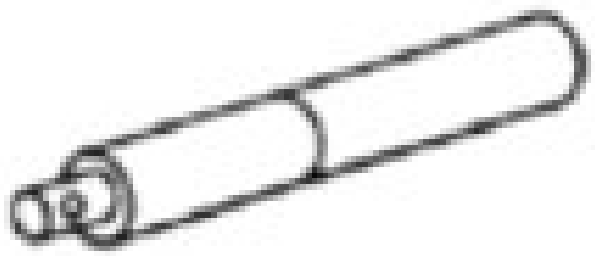
4. Install the accessory drive belt. REFER to **ACCESSORY DRIVE BELT - 3.5L TI-VCT, 3.7L TI-VCT** .
5. Install the RH splash shield. REFER to **FENDER SPLASH SHIELD** .
6. After completing the repairs, use the scan tool to perform the Misfire Monitor Neutral Profile Correction procedure, following the on-screen instructions.

CRANKSHAFT REAR SEAL

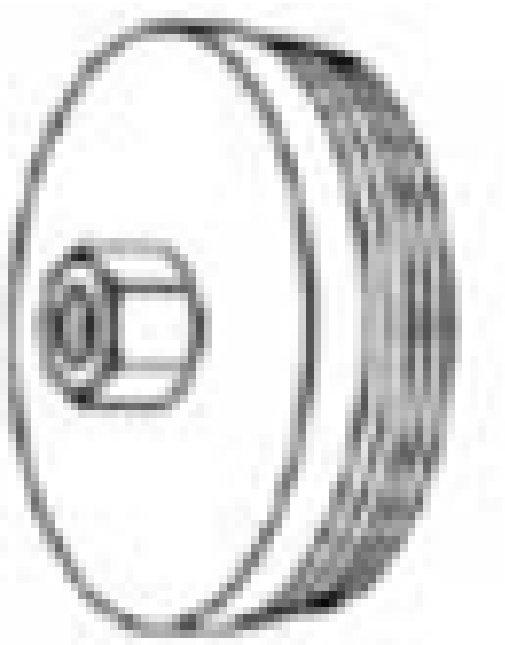
SPECIAL TOOL(S) DESCRIPTION

	Adapter For 303-224 (Handle) **205-153T80T-4000-W**

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	Seal Installer, Rear Main **303-1250**
	Remover, Crankshaft Rear Oil Seal **303-519T95P-6701-EH**

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	Slide Hammer **307-005T59L-100-B**

MATERIAL SPECIFICATIONS

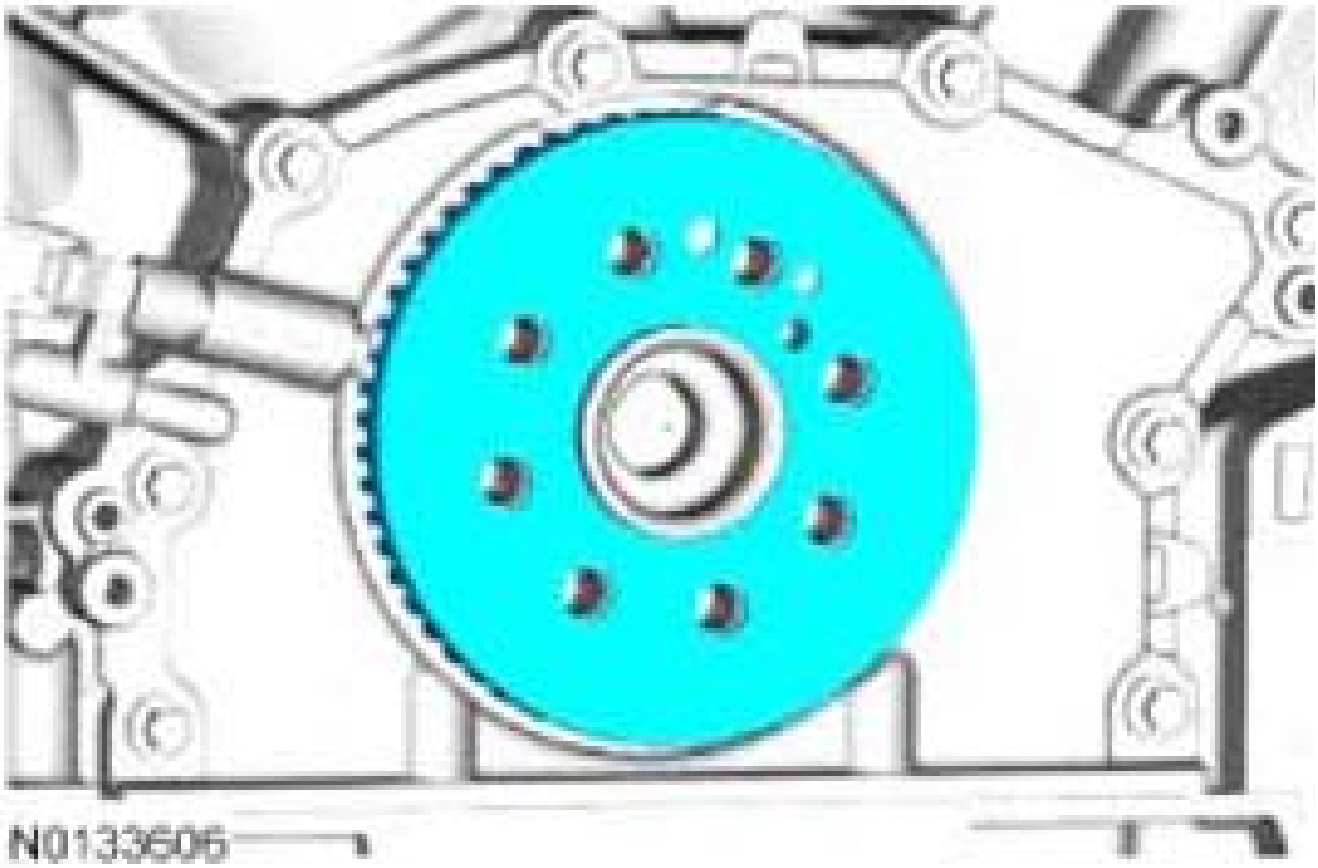
Item	Specification
Motorcraft® Metal Surface Prep ZC-31-A	-
Motorcraft® SAE 5W-20 Premium Synthetic Blend Motor Oil (US); Motorcraft® SAE 5W-20 Super Premium Motor Oil (Canada) XO-5W20-QSP (US); CXO-5W20-LSP12 (Canada)	WSSM2C945-A

Removal

NOTE: The engine is equipped with a cast aluminum (early build) or stamped steel (late build) crankshaft rear seal retainer plate. This procedure is for engines equipped with a cast aluminum plate only. If the engine is equipped with a stamped steel plate, the seal and plate must be removed as an assembly. Refer to CRANKSHAFT REAR SEAL WITH RETAINER PLATE.

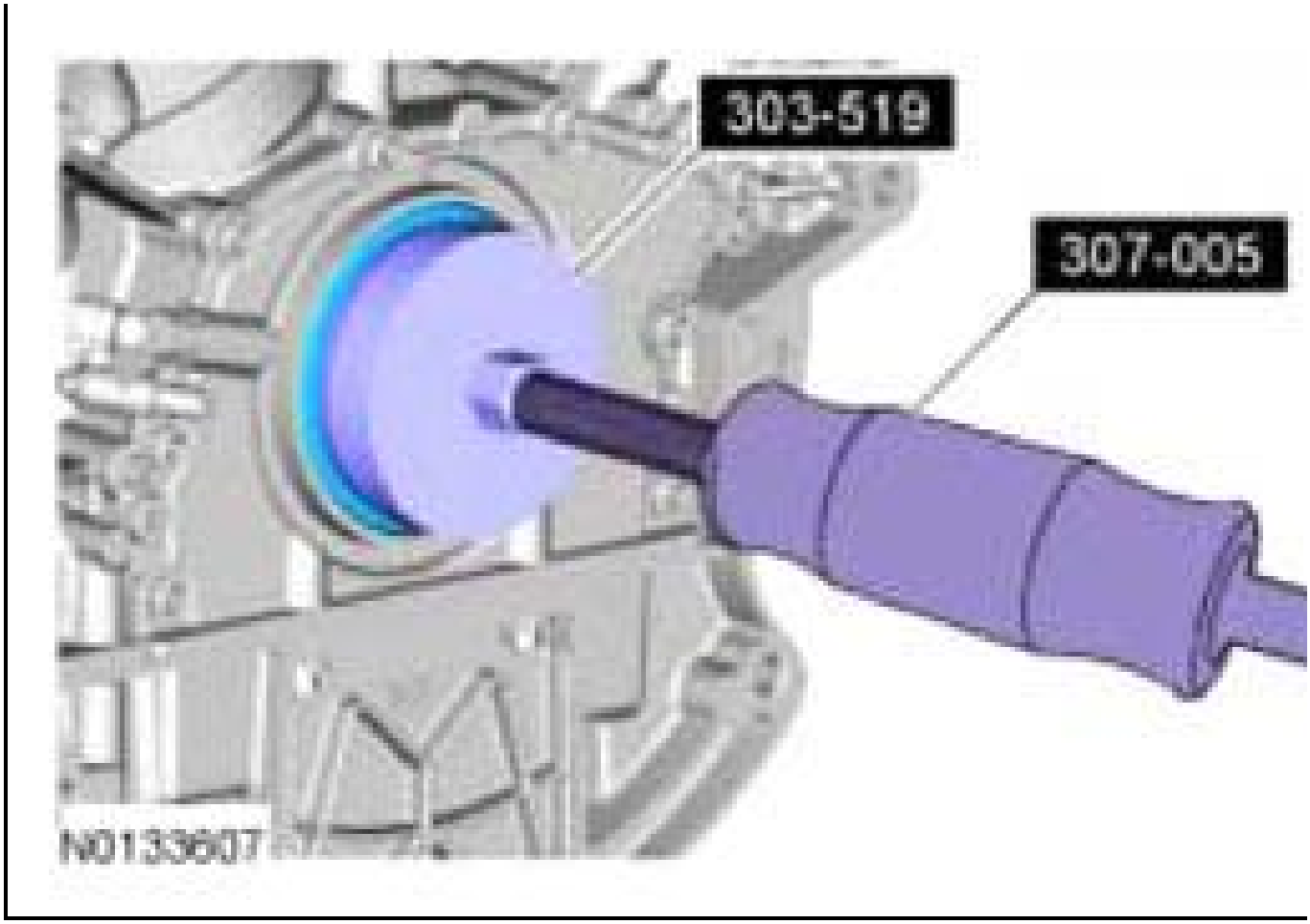
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1. With the vehicle in NEUTRAL, position it on a hoist. REFER to **JACKING AND LIFTING** , Lifting Points.
2. Remove the flexplate. Refer to **FLEXPLATE**.
3. Remove the crankshaft sensor ring.



4. Using 303-519 T95P-6701-EH and 307-005 T59L-100-B, remove and discard the crankshaft rear seal.

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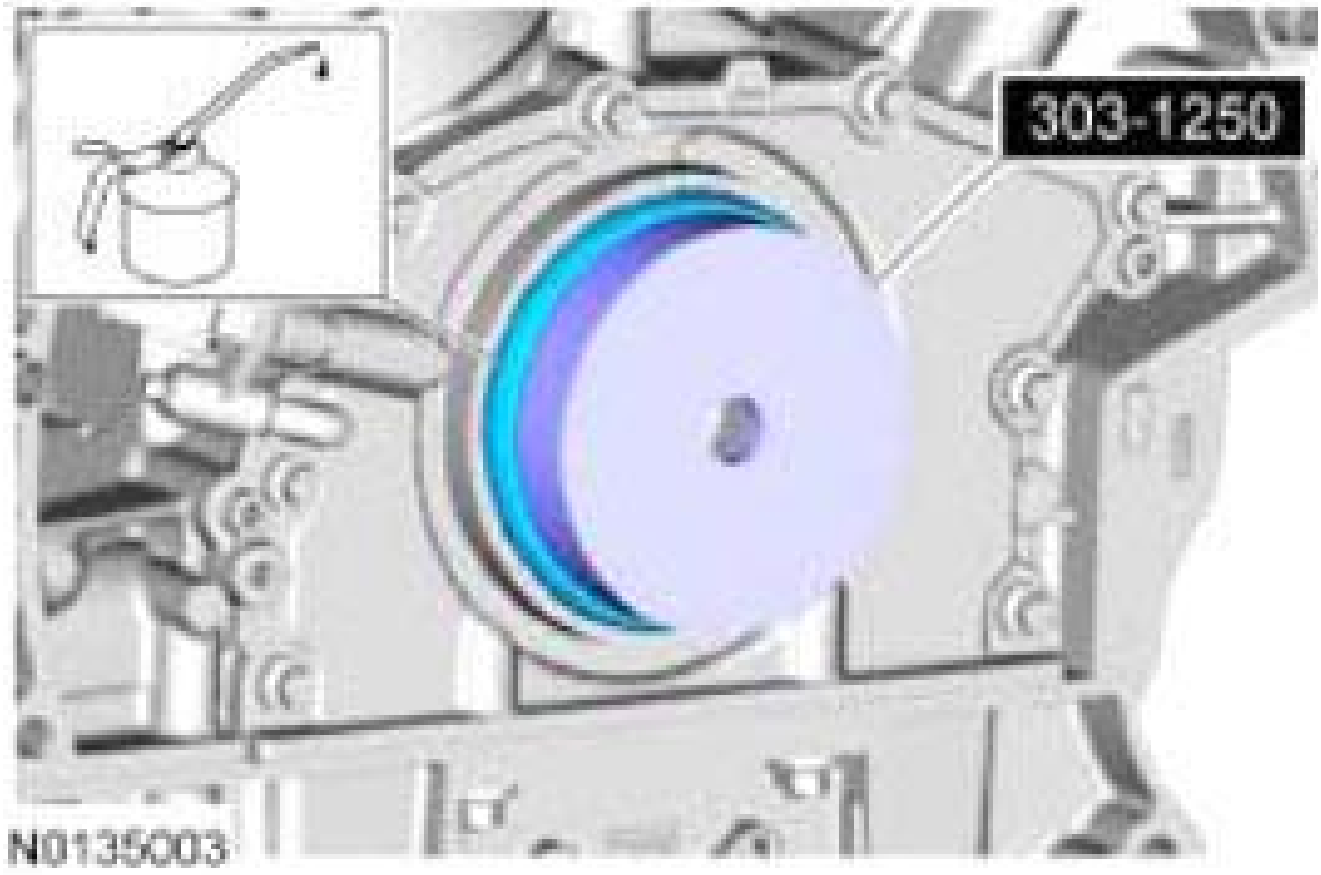
Installation

1. Clean all sealing surfaces with Motorcraft® Metal Surface Prep.

   NOTE: Lubricate the seal lips and bore with clean Motorcraft® SAE 5W-20 Premium Synthetic Blend Motor Oil (US); Motorcraft® SAE 5W-20 Super Premium Motor Oil (Canada) prior to installation.

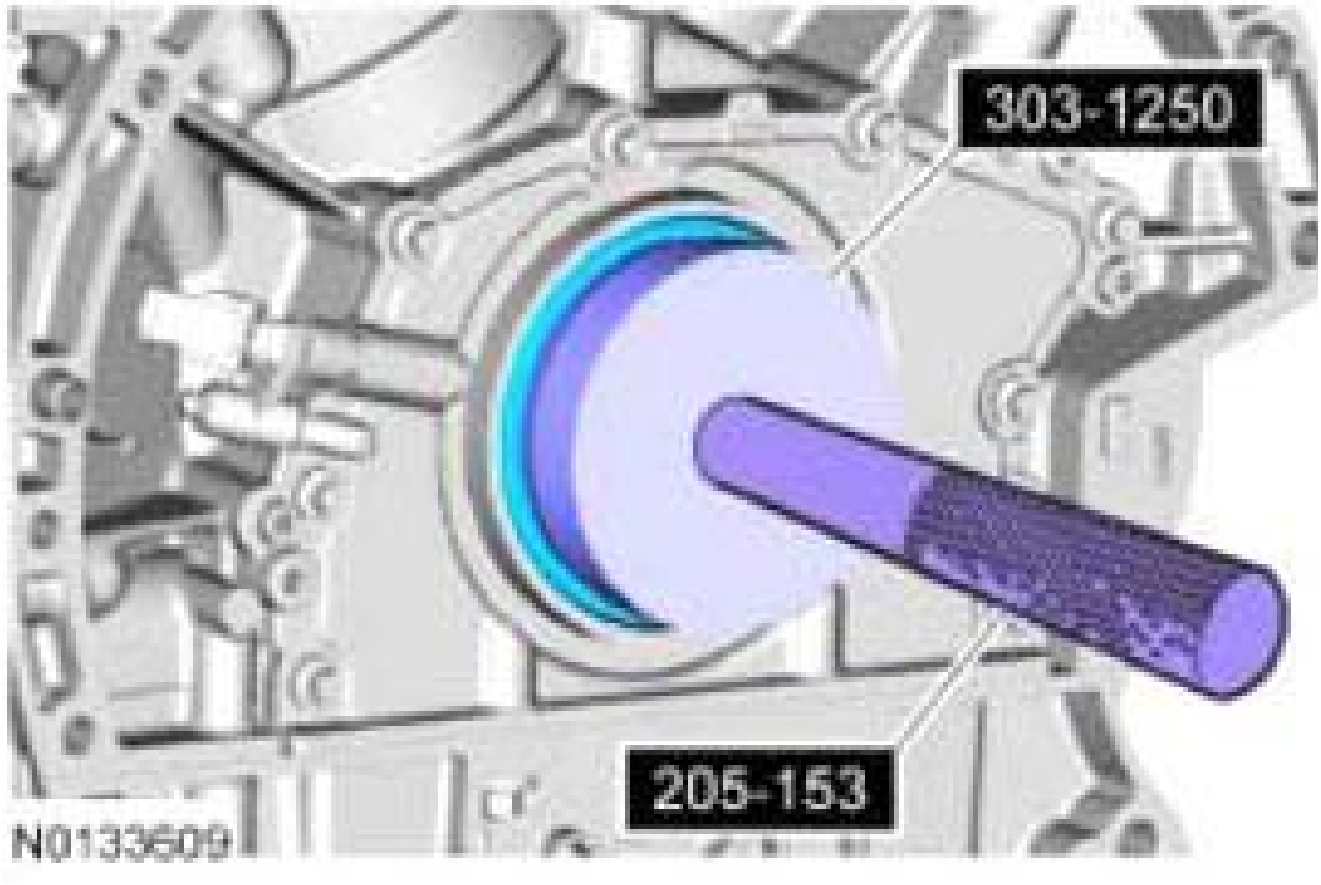
2. Position 303-1250 onto the end of the crankshaft and slide a new crankshaft rear seal onto the tool.

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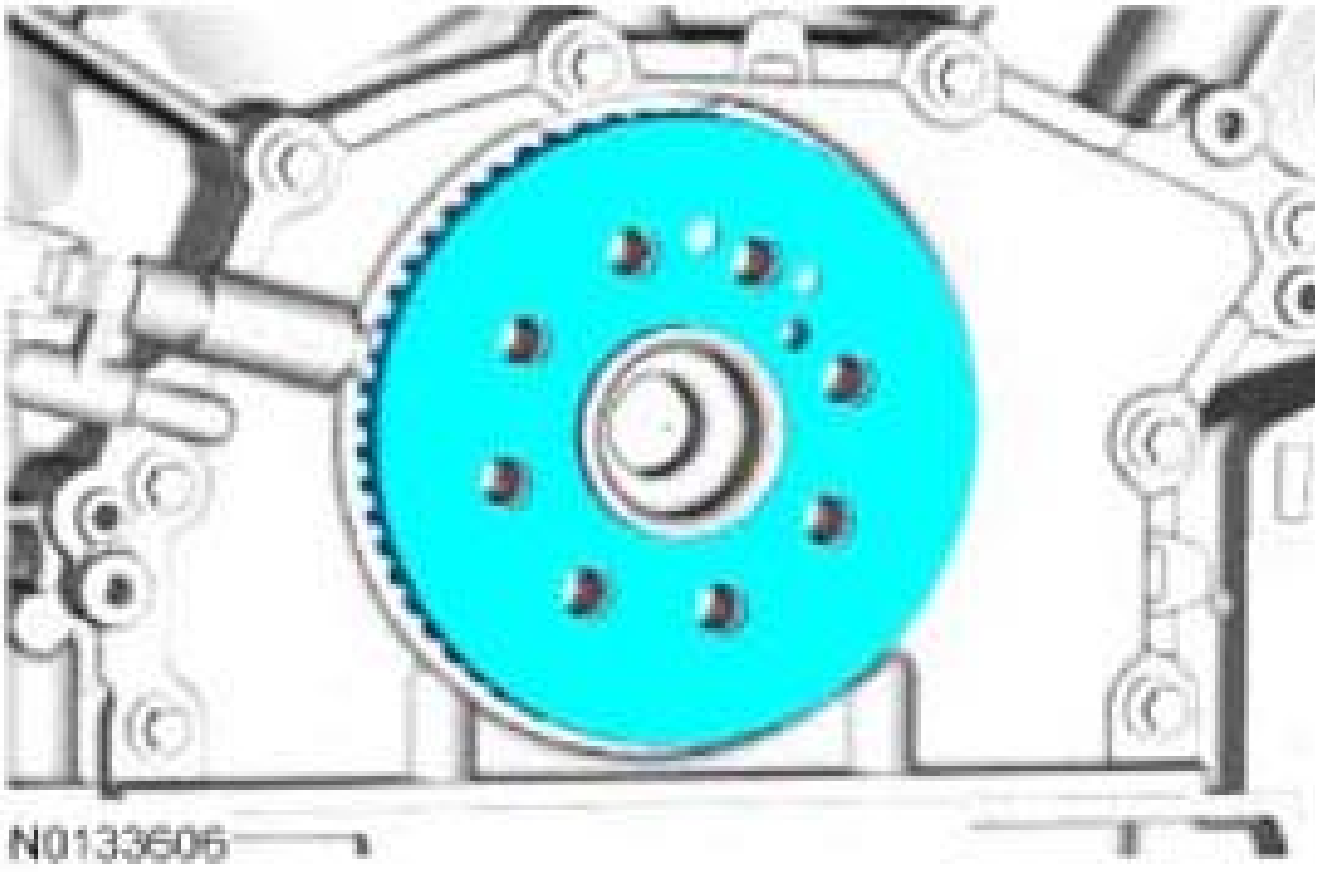
3. Using 303-1250 and 205-153 T80T-4000-W, install the new crankshaft rear seal.

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4. Install the crankshaft sensor ring.

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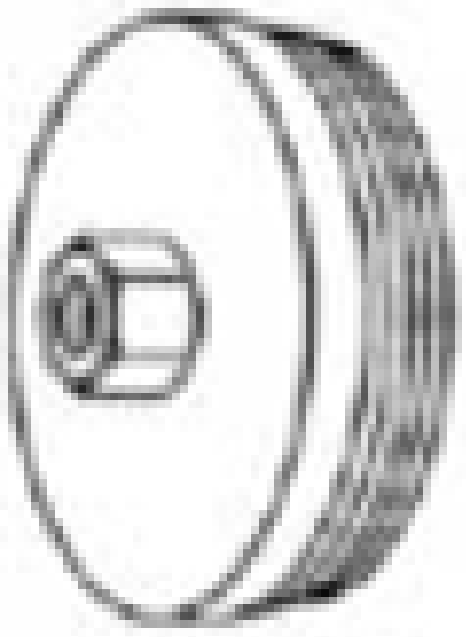
5. Install the flexplate. Refer to **FLEXPLATE**.

CRANKSHAFT REAR SEAL WITH RETAINER PLATE

SPECIAL TOOL(S) DESCRIPTION

	Adapter For 303-224 (Handle) **205-153T80T-4000-W**

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 ST2980-A	Seal Installer, Rear Main **303-1250**
	Remover, Crankshaft Rear Oil Seal **303-519T95P-6701-EH**
	Slide Hammer **307-005T59L-100-B**

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MATERIAL SPECIFICATIONS

Item	Specification
Motorcraft® High Performance Engine RTV Silicone TA-357	WSEM4G323-A6
Motorcraft® SAE 5W-20 Premium Synthetic Blend Motor Oil (US); Motorcraft® SAE 5W-20 Super Premium Motor Oil (Canada) XO-5W20-QSP (US); CXO-5W20-LSP12 (Canada)	WSSM2C945-A
Motorcraft® Metal Surface Prep ZC-31-A	-
Motorcraft® Silicone Gasket Remover ZC-30	-

Removal

WARNING: Before beginning any service procedure, refer to SAFETY WARNINGS . Failure to follow this instruction may result in serious personal injury.

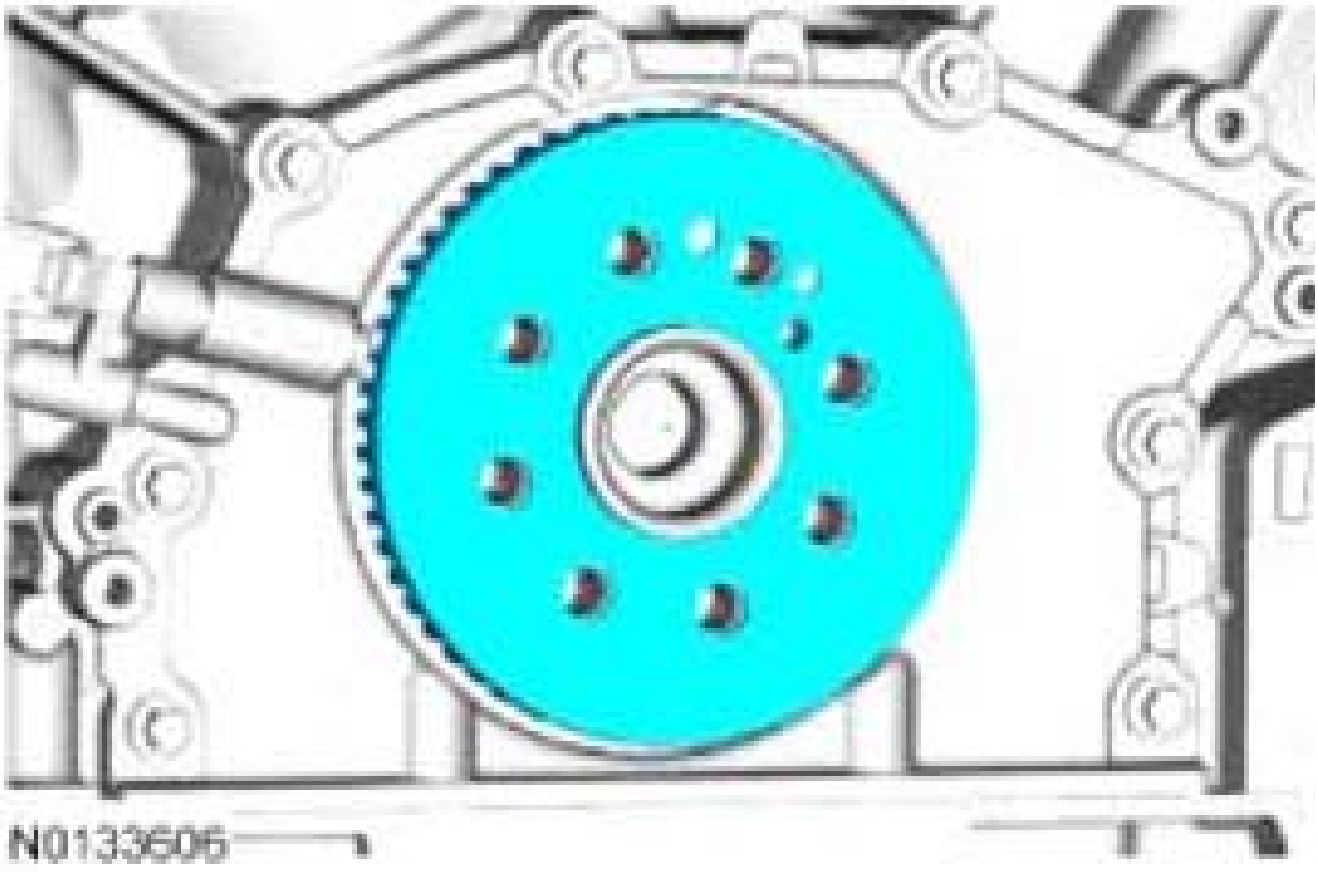
NOTE: During engine repair procedures, cleanliness is extremely important. Any foreign material, including any material created while cleaning gasket surfaces that enters the oil passages, coolant passages or the oil pan, may cause engine failure.

NOTE: The engine is equipped with a cast aluminum (early build) or stamped steel (late build) crankshaft rear seal retainer plate. If the engine is equipped with a stamped steel plate, the seal and plate must be removed as an assembly and discarded.

NOTE: Cast aluminum (early build) shown in illustration crankshaft rear seal retainer plate, stamped steel (late build) crankshaft rear seal retainer plate is similar.

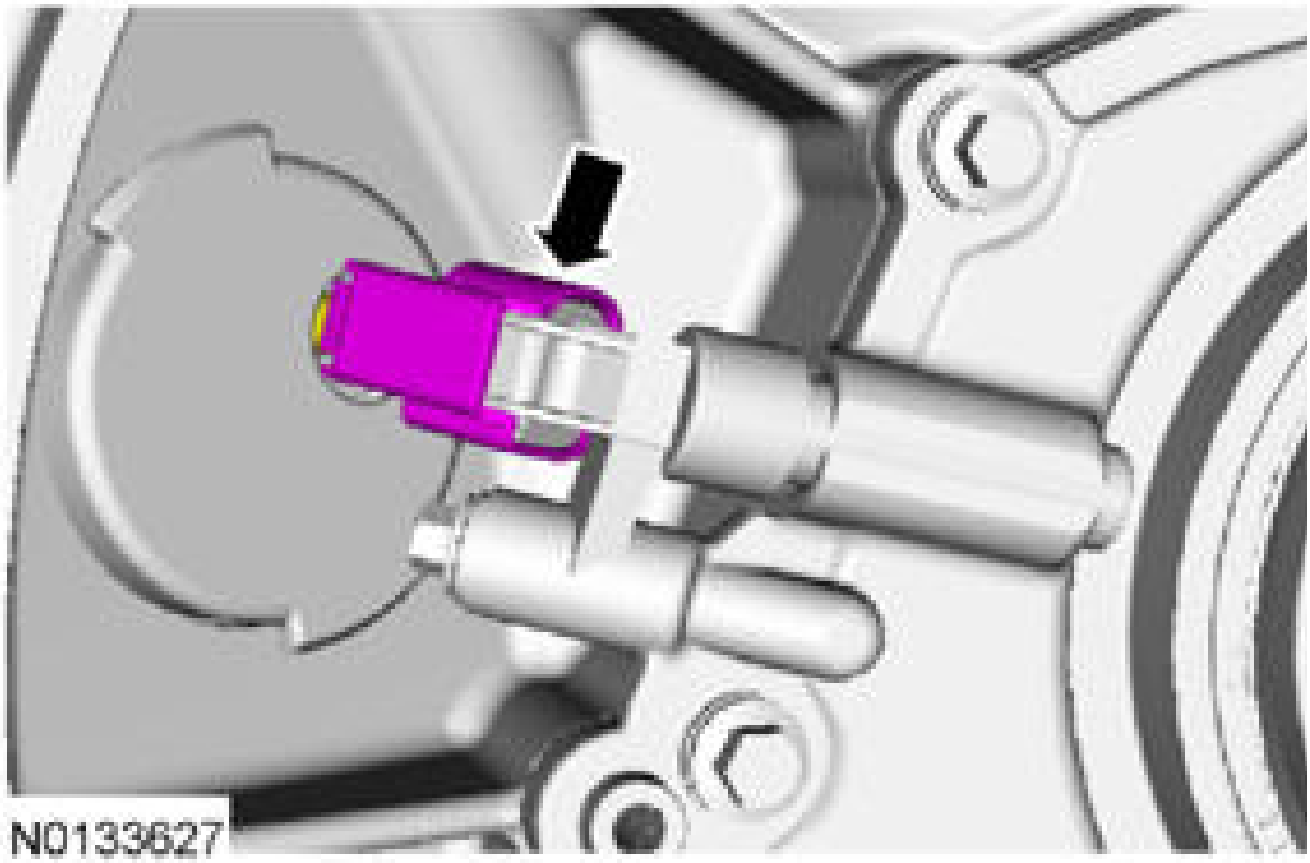
1. With the vehicle in NEUTRAL, position it on a hoist. REFER to **JACKING AND LIFTING** .
2. Remove the flexplate. Refer to **FLEXPLATE**.
3. Remove the crankshaft sensor ring.

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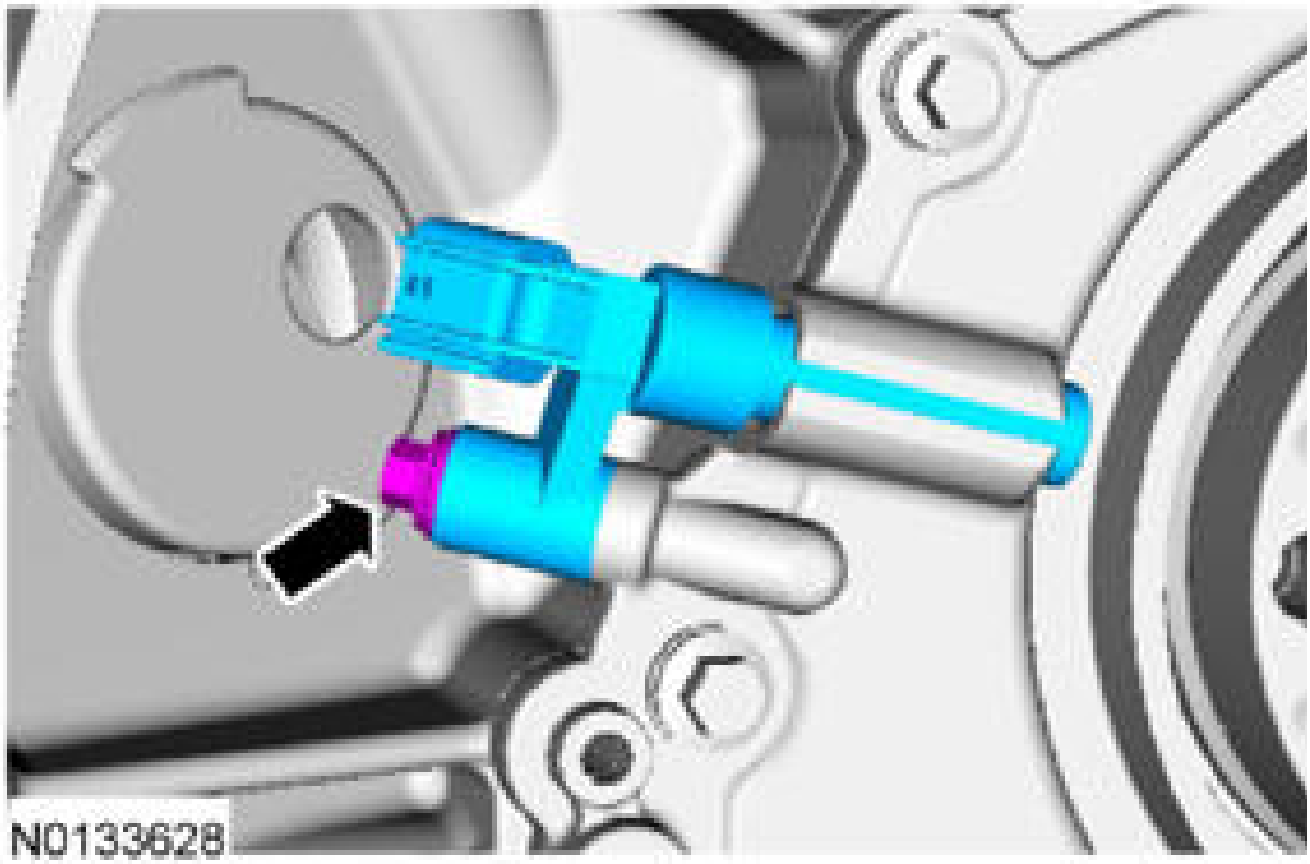
4. Disconnect the **CKP** sensor electrical connector.

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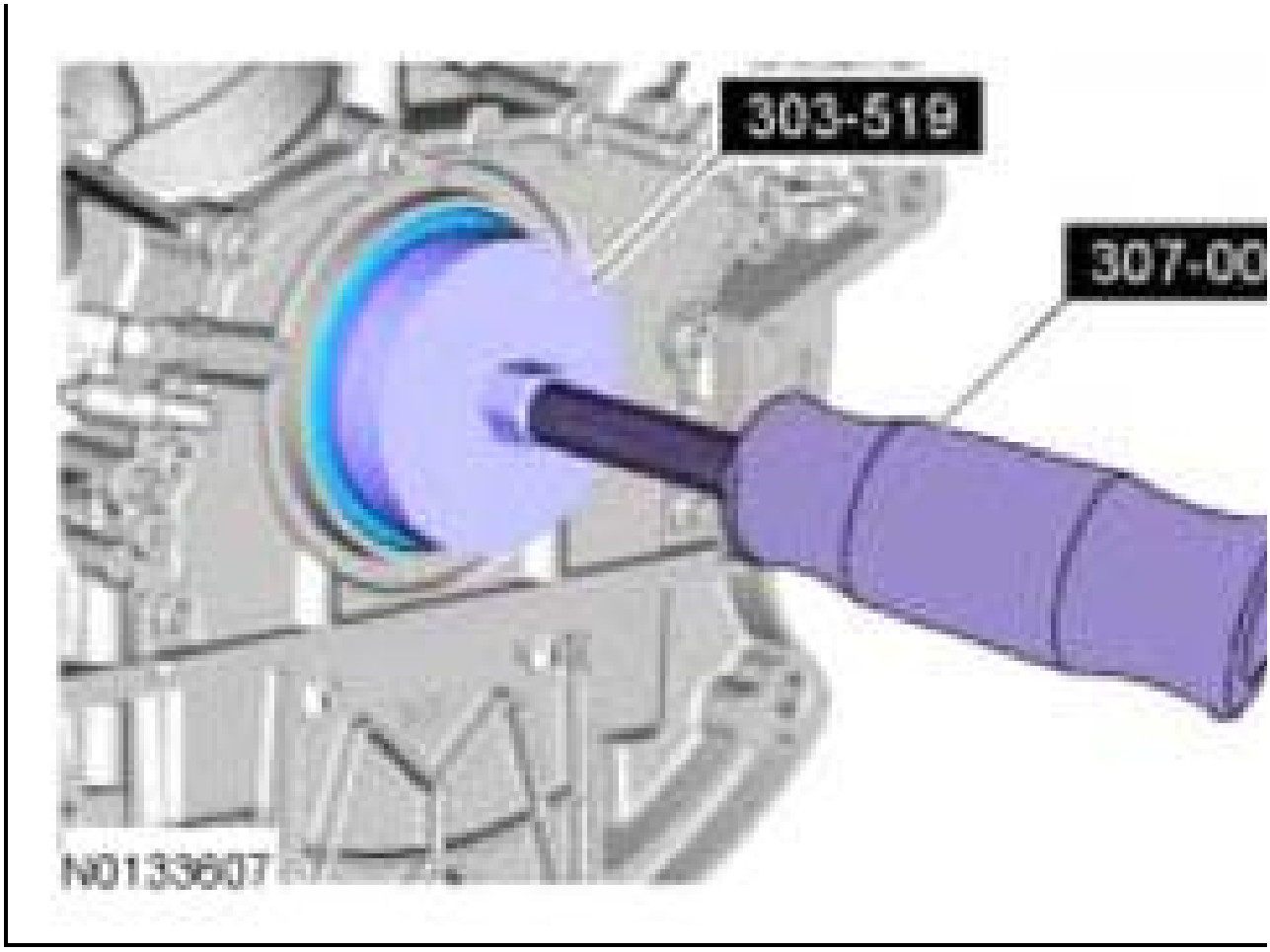
5. Remove the bolt and the **CKP** sensor.

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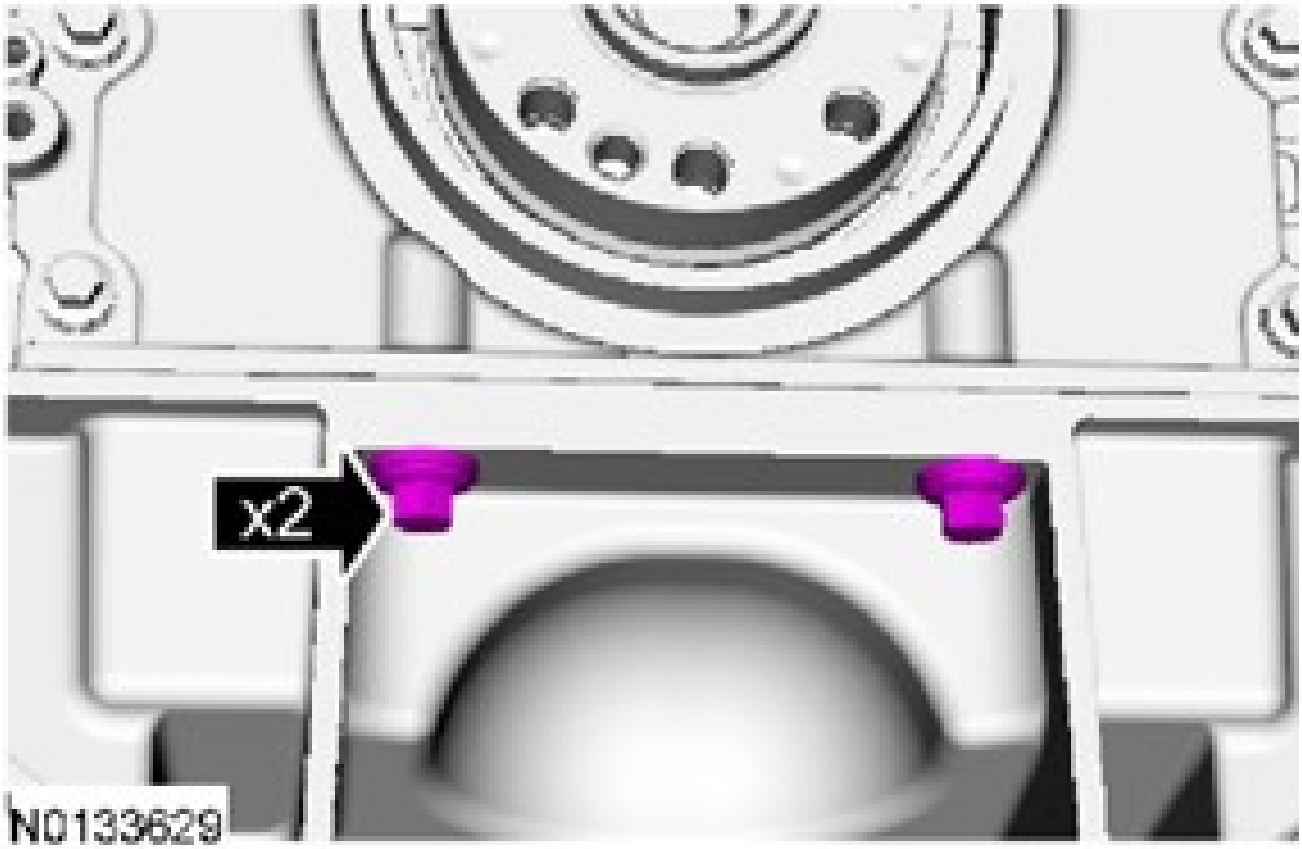
6. If equipped with a cast aluminum crankshaft rear seal retainer plate, use the 303-519 T95P-6701-EH and 307-005 T59L-100-B to remove the rear crankshaft seal.
    - Discard the seal.

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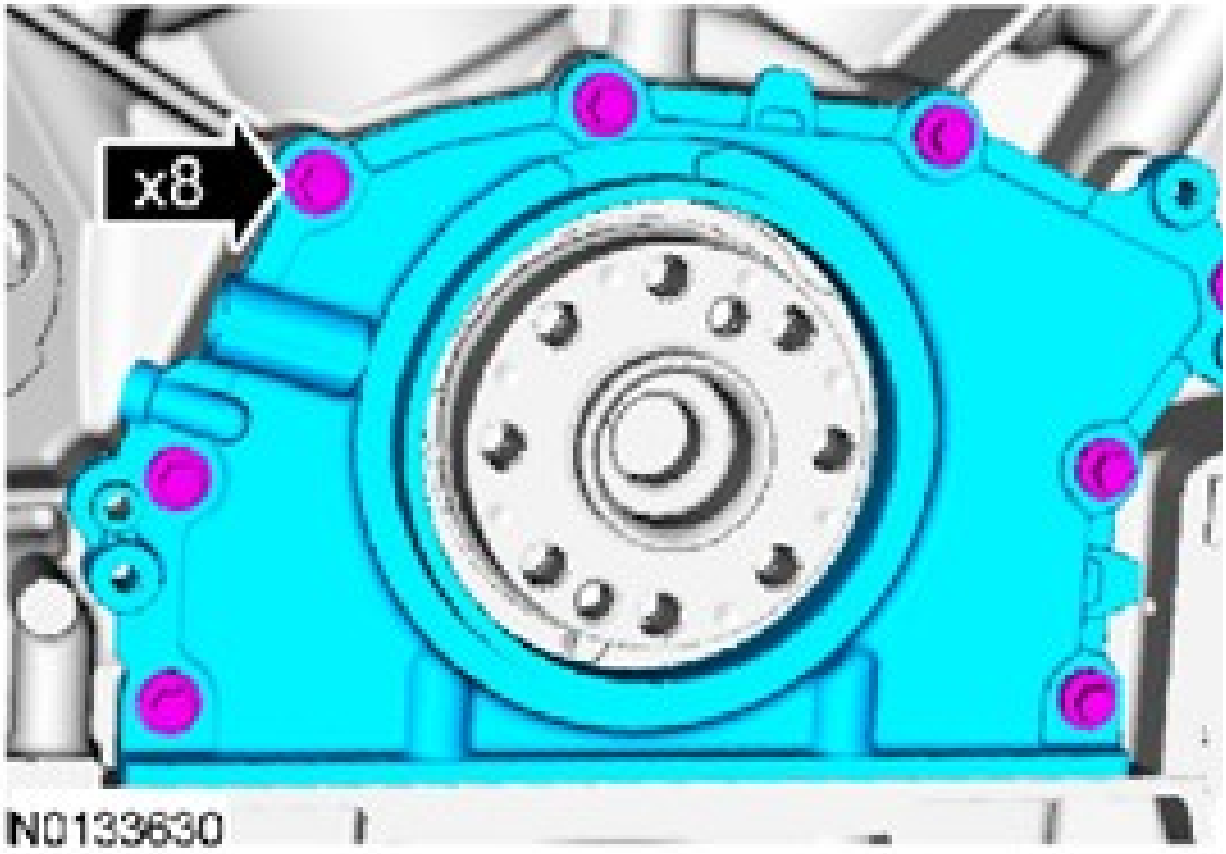
7. Remove the 2 oil pan to crankshaft rear seal retainer bolts.

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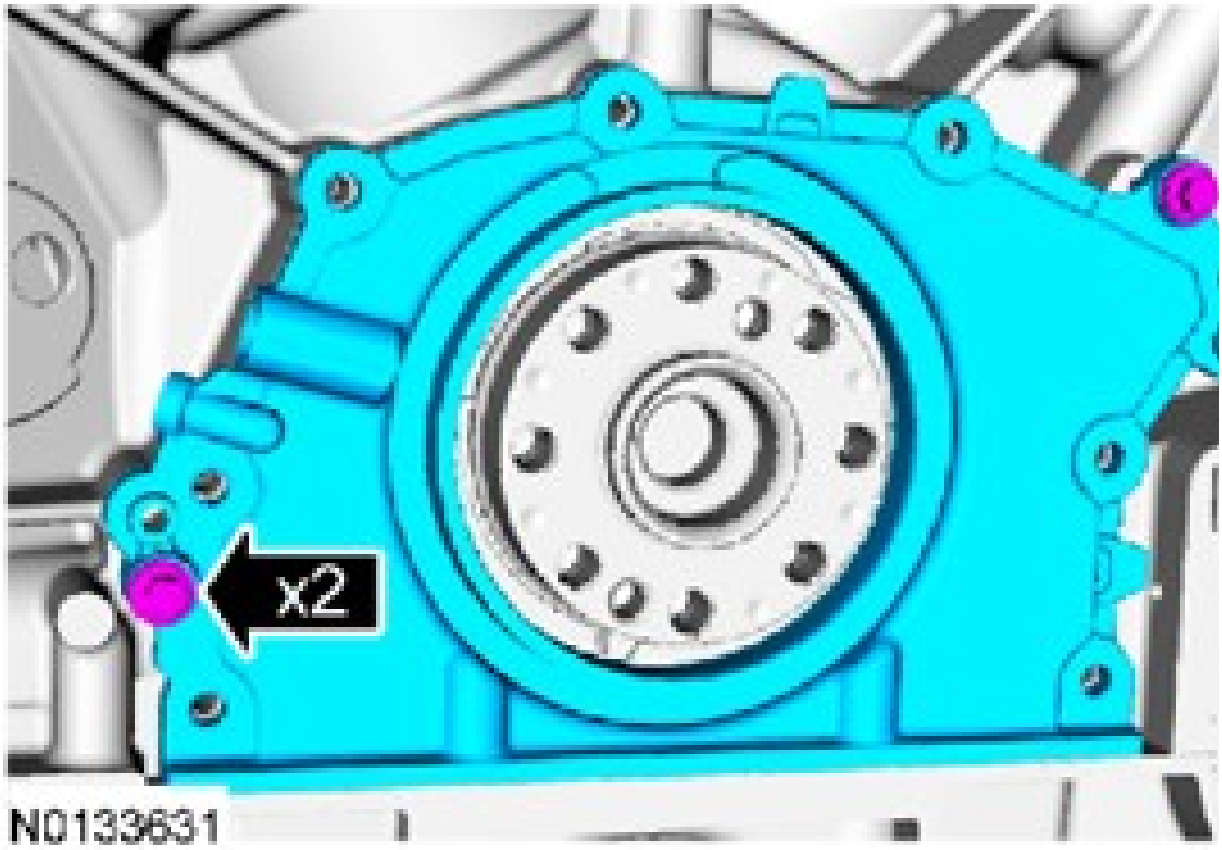
8. Remove the 8 crankshaft rear seal retainer bolts.
    - If equipped with a stamped steel rear seal retainer plate, remove and discard the plate and seal.

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9. If equipped with a cast aluminum rear seal retainer plate, install the 2 M6 oil pan bolts (finger-tight) into the 2 threaded holes in the crankshaft rear seal retainer.
    - Alternately tighten the 2 bolts one turn at a time until the crankshaft rear seal retainer-to-cylinder block seal is released.
    - Remove the crankshaft rear seal retainer plate.

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NOTE: **Only use a 3M Roloc® Bristle Disk (2-in white, part number 07528) to clean the crankshaft rear seal retainer plate. Do not use metal scrapers, wire brushes or any other power abrasive disk to clean the crankshaft rear seal retainer plate. These tools cause scratches and gouges that make leak paths.**

10.

If equipped with a cast aluminum rear seal retainer plate, clean the crankshaft rear seal retainer plate using a 3M Roloc® Bristle Disk (2-in white, part number 07528) in a suitable tool turning at the recommended speed of 15,000 rpm. Thoroughly wash the crankshaft rear seal retainer plate to remove any foreign material, including any abrasive particles created during the cleaning process.

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

11.

NOTE: **Do not use wire brushes, power abrasive discs or 3M Roloc® Bristle Disk**

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(2-in white, part number 07528) to clean the sealing surfaces. These tools cause scratches and gouges that make leak paths. They also cause contamination that will cause premature engine failure. Remove all traces of the gasket.

Clean the sealing surfaces of the cylinder block and oil pan flange in the following sequence.

- Remove any large deposits of silicone or gasket material.
- Apply Motorcraft® Silicone Gasket Remover and allow to set for several minutes.
- Remove the Motorcraft® Silicone Gasket Remover. A second application of Motorcraft® Silicone Gasket Remover may be required if residual traces of silicone or gasket material remain.
- Apply Motorcraft® Metal Surface Prep to remove any remaining traces of oil or coolant and to prepare the surfaces to bond. Do not attempt to make the metal shiny. Some staining of the metal surfaces is normal.

Installation

1. **NOTE: Failure to use Motorcraft® High Performance Engine RTV Silicone may cause the engine oil to foam excessively and result in serious engine damage.**

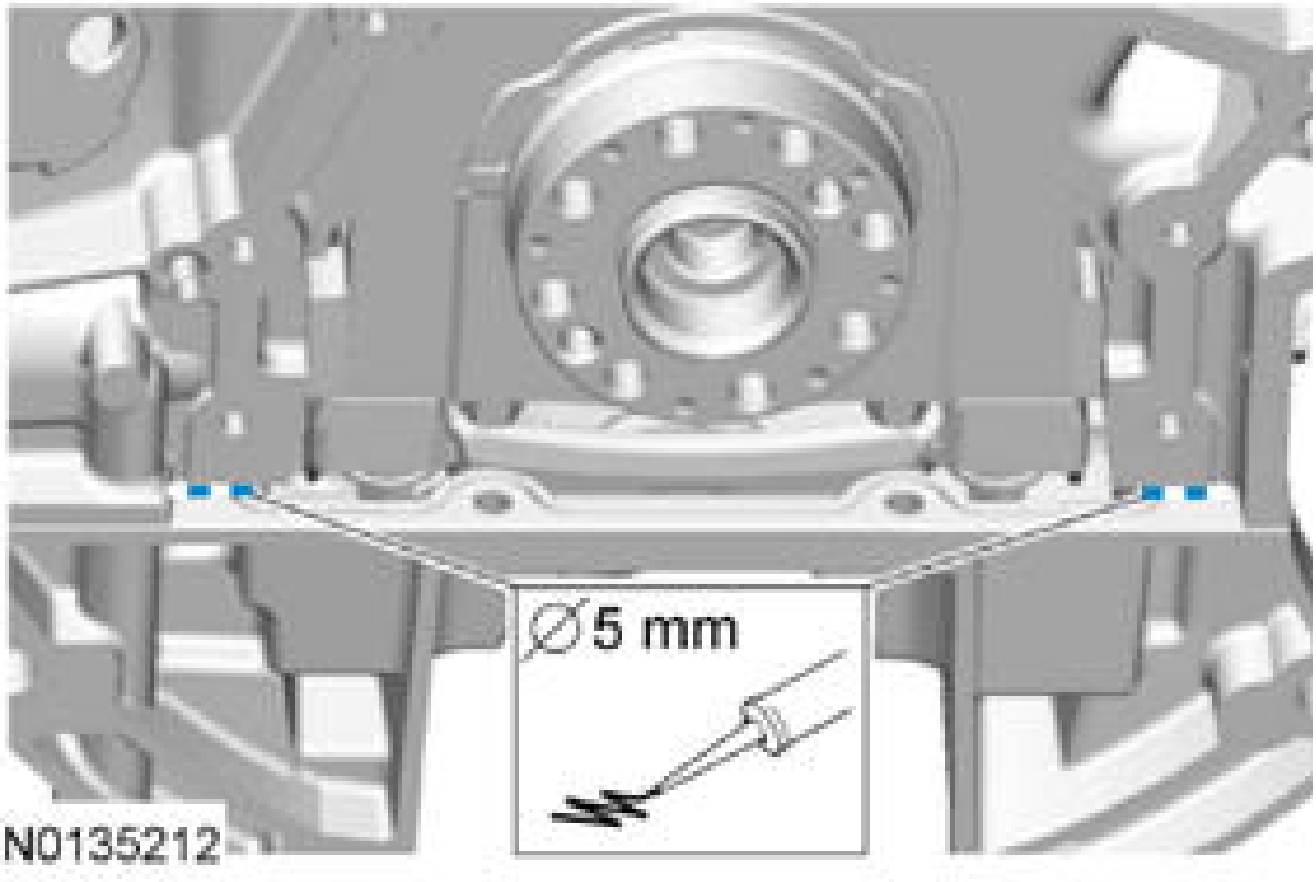
NOTE: The engine is equipped with a cast aluminum (early build) or stamped steel (late build) crankshaft rear seal retainer plate. If the engine is equipped with a stamped steel plate, the seal and plate must be removed as an assembly and discarded.

NOTE: Cast aluminum (early build) shown in illustration crankshaft rear seal retainer plate, stamped steel (late build) crankshaft rear seal retainer plate is similar.

NOTE: The crankshaft rear seal retainer must be installed and the bolts tightened within 10 minutes of sealant application.

Apply a 5 mm (0.20 in) bead of Motorcraft® High Performance Engine RTV Silicone to the 2 cylinder block/oil pan joints.

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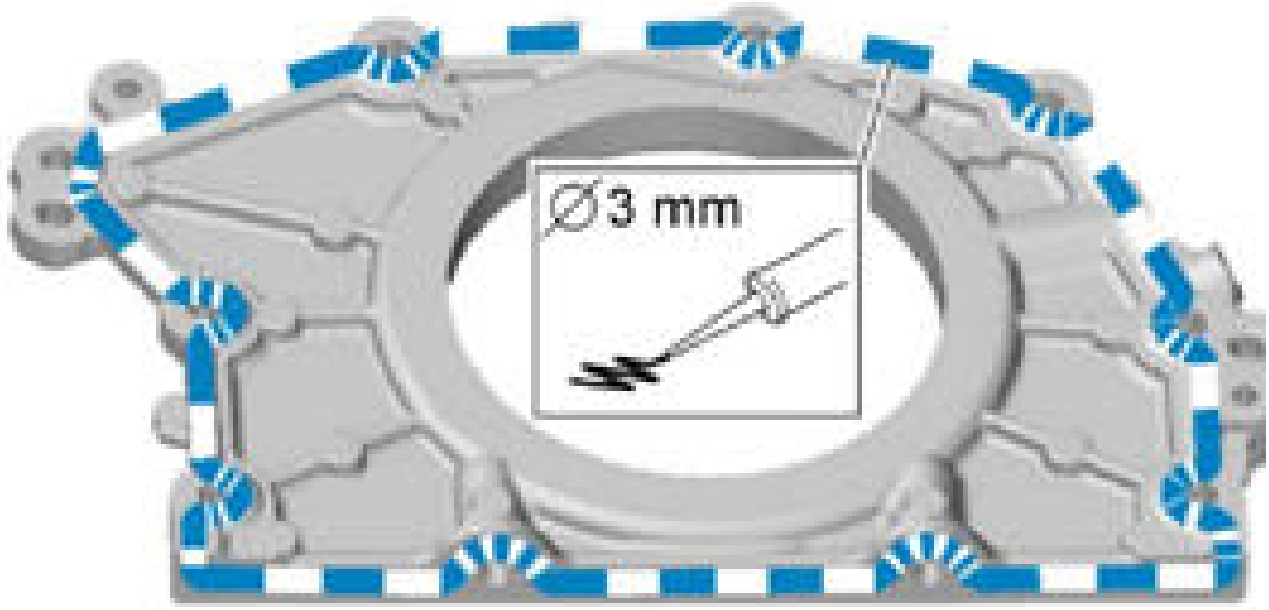
2.

NOTE: **Failure to use Motorcraft® High Performance Engine RTV Silicone may cause the engine oil to foam excessively and result in serious engine damage.**

NOTE: **The crankshaft rear seal retainer must be installed and the bolts tightened within 10 minutes of sealant application.**

Apply a 3 mm (0.1181 in) bead of Motorcraft® High Performance Engine RTV Silicone to the sealing surface of the crankshaft rear seal retainer.

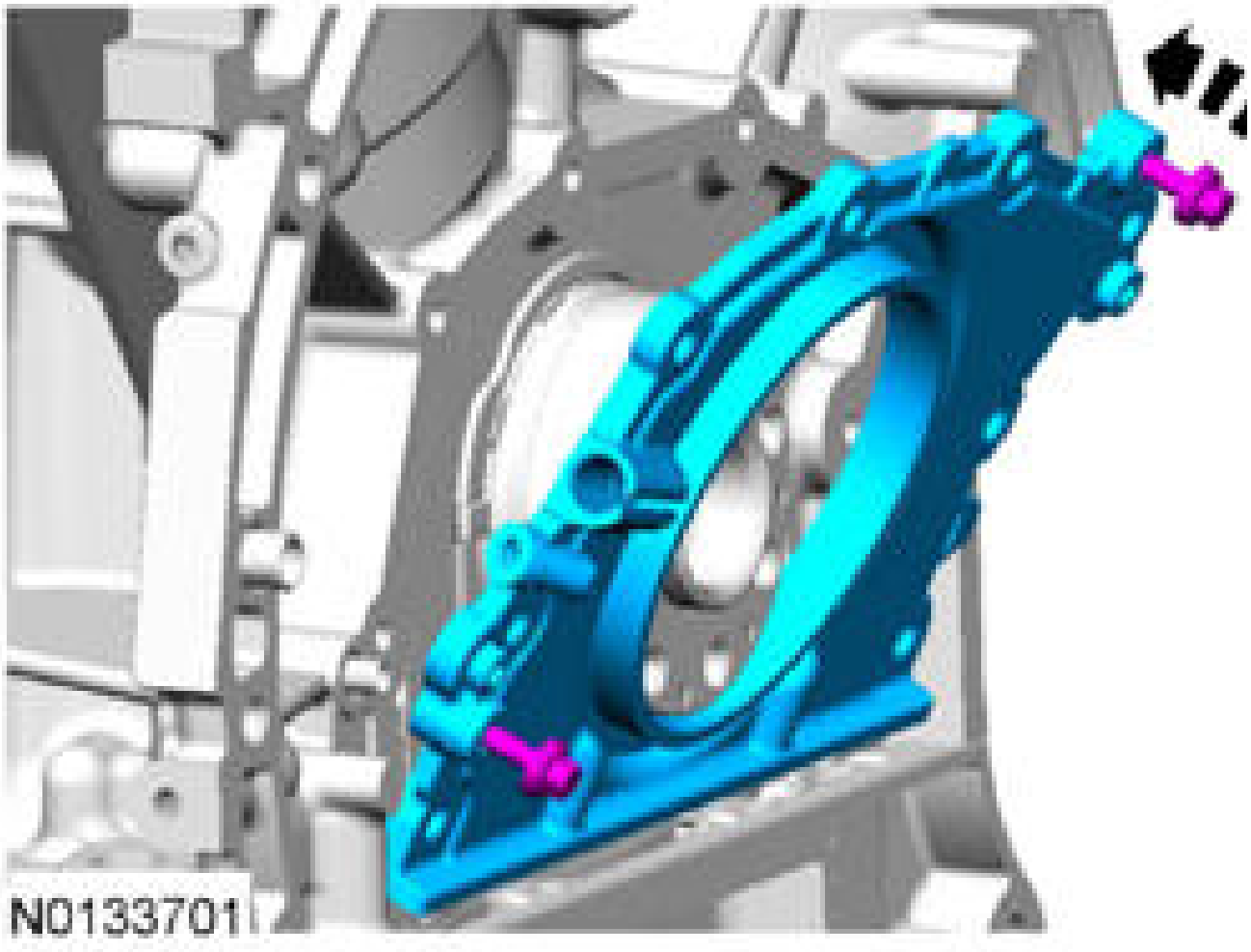
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NOTE: **If equipped with a cast aluminum crankshaft rear seal retainer plate, use the 2 oil pan bolts as handles during installation to avoid touching the sealant.**

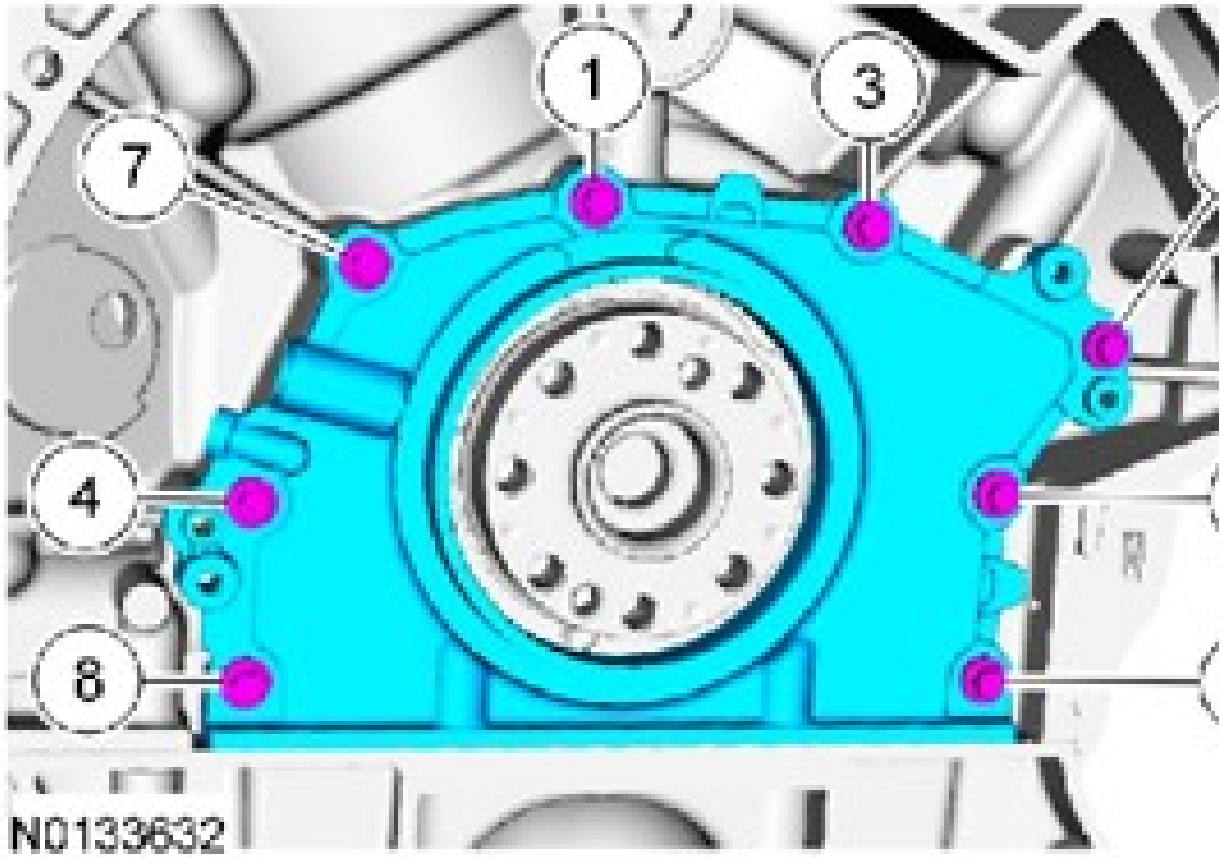
3. Install the crankshaft rear seal retainer at an angle above the oil pan flange to avoid scraping off the sealer. Tilt the seal retainer up and onto the rear of the cylinder block.

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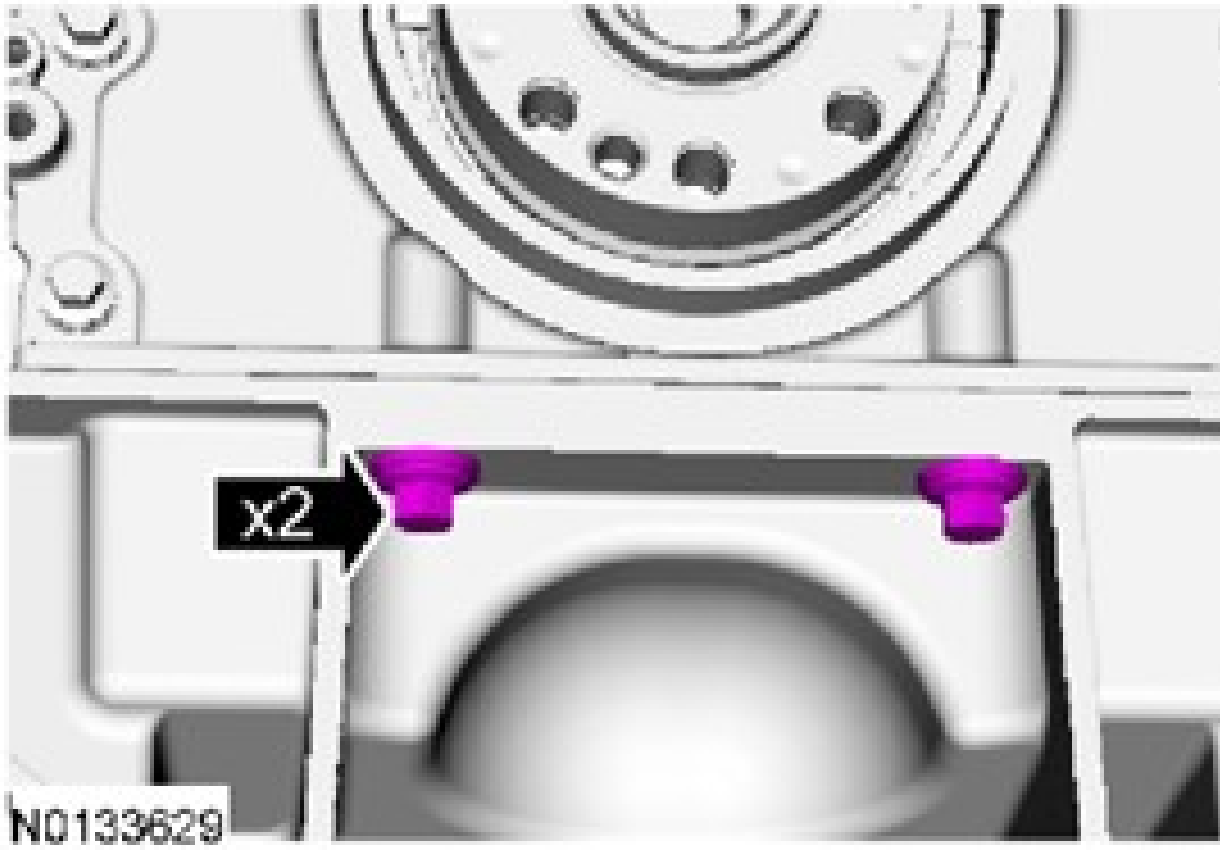
4. Install the rear seal retainer and the 8 bolts in the sequence shown in illustration.
   - Tighten to 10 Nm (89 lb-in).

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5. Install the 2 oil pan to crankshaft rear seal retainer bolts.
    - Tighten in the sequence shown in illustration to 10 Nm (89 lb-in) plus an additional 45 degrees.

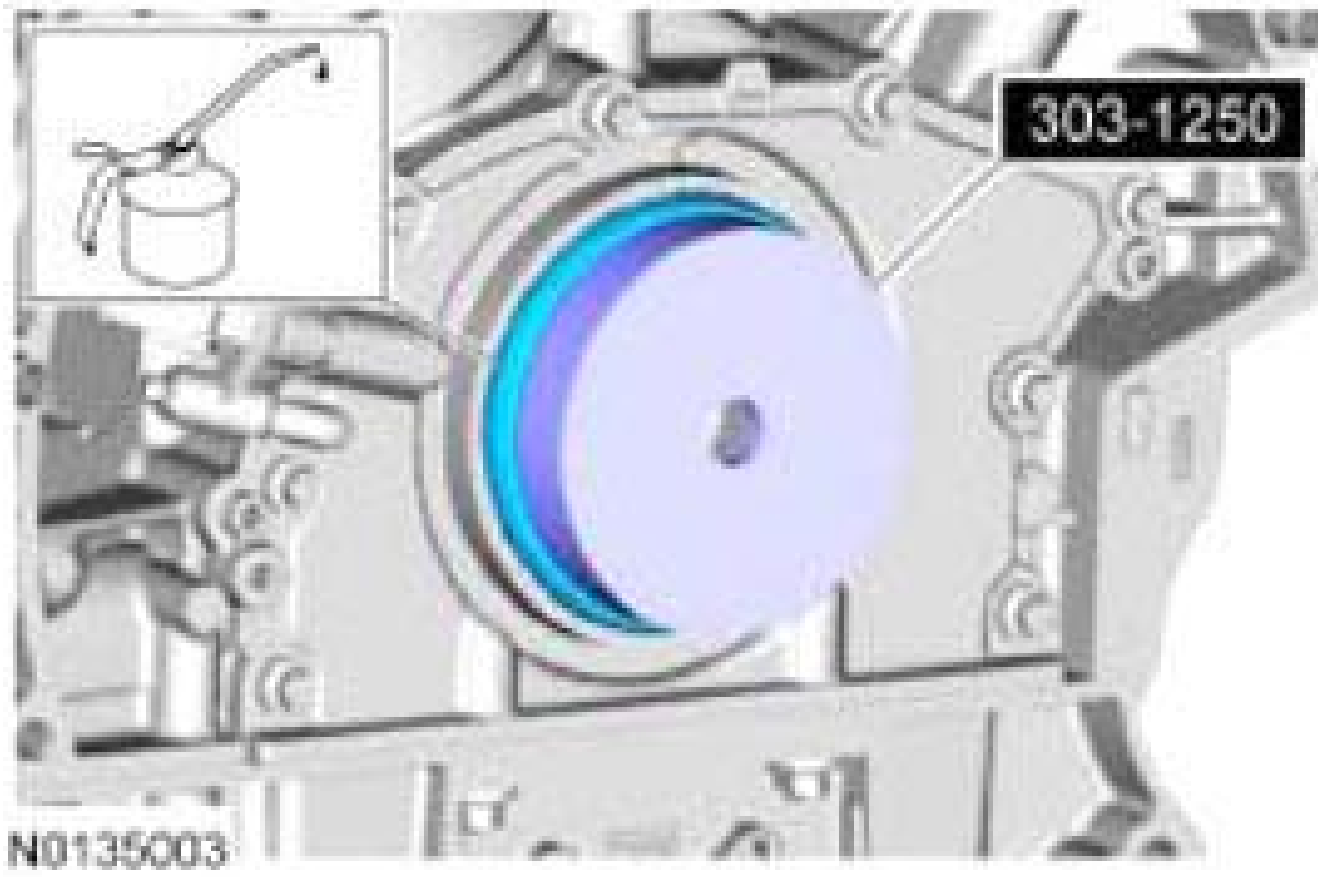
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6. **NOTE: Lubricate the seal lips and bore with clean engine oil prior to installation.**

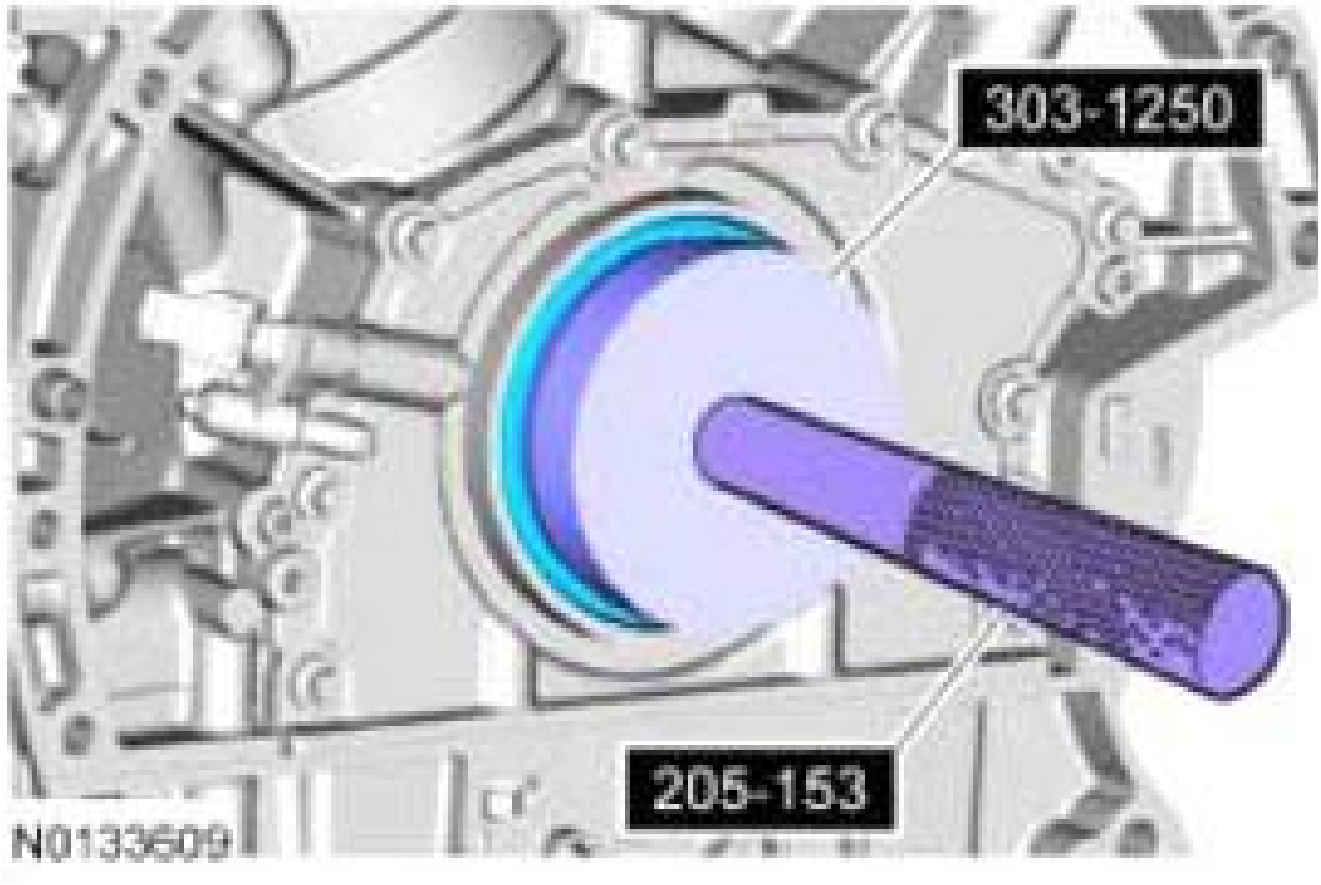
If equipped with a cast aluminum crankshaft rear seal retainer plate, position the Rear Main Seal Installer onto the end of the crankshaft and slide a new crankshaft rear seal onto the tool.

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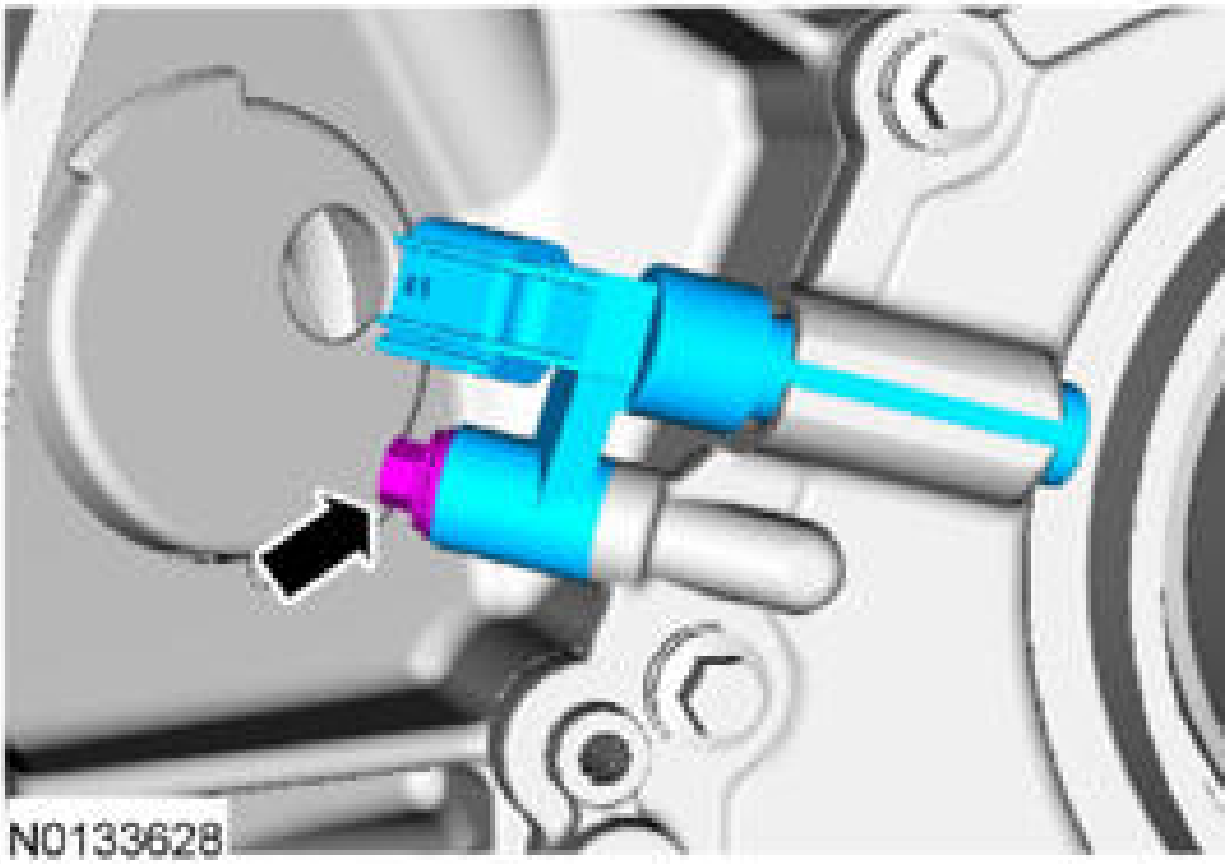
7. If equipped with a cast aluminum crankshaft rear seal retainer plate, use 303-1250 and 205-153 T80T-4000-W to install the new crankshaft rear seal.

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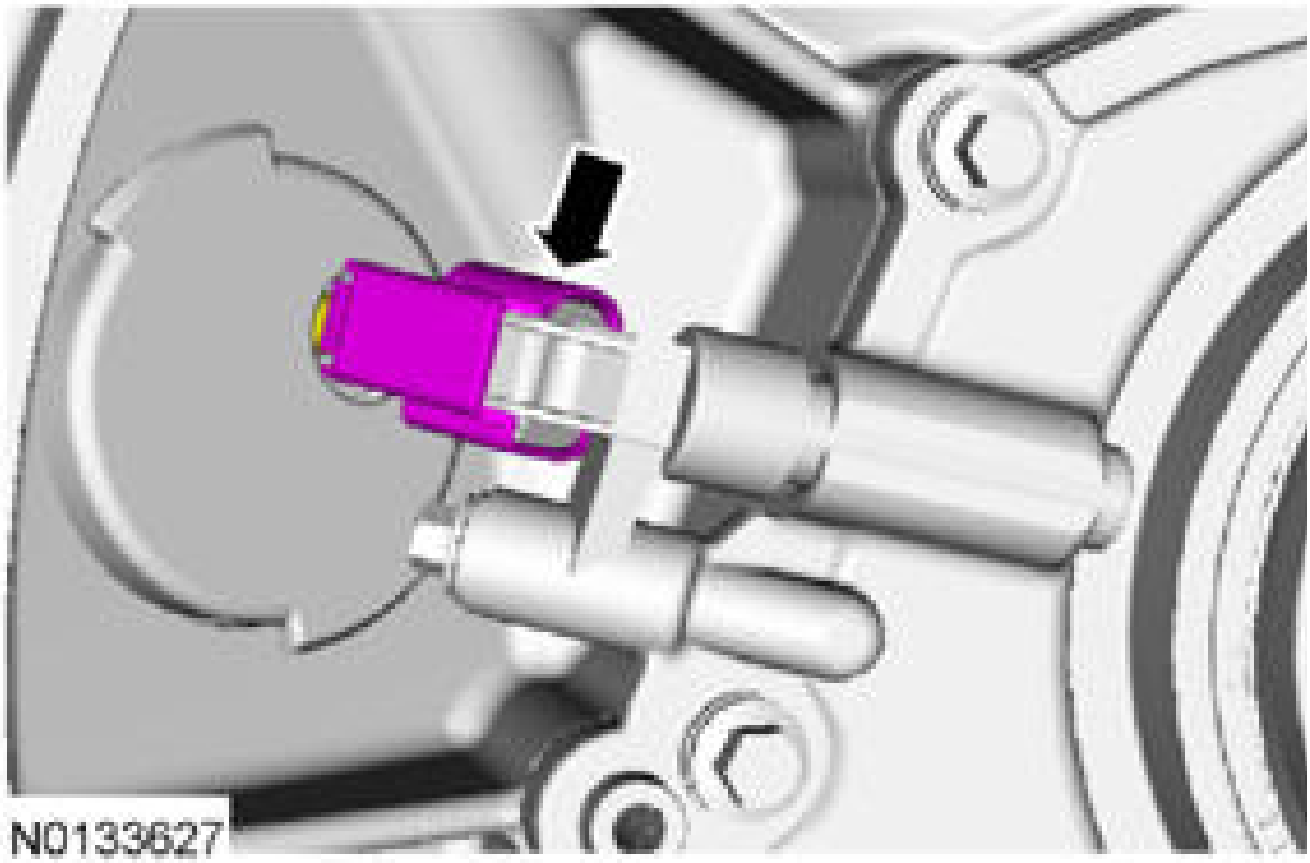
8. Install the **CKP** sensor and install the bolt.
    - Tighten to 10 Nm (89 lb-in).

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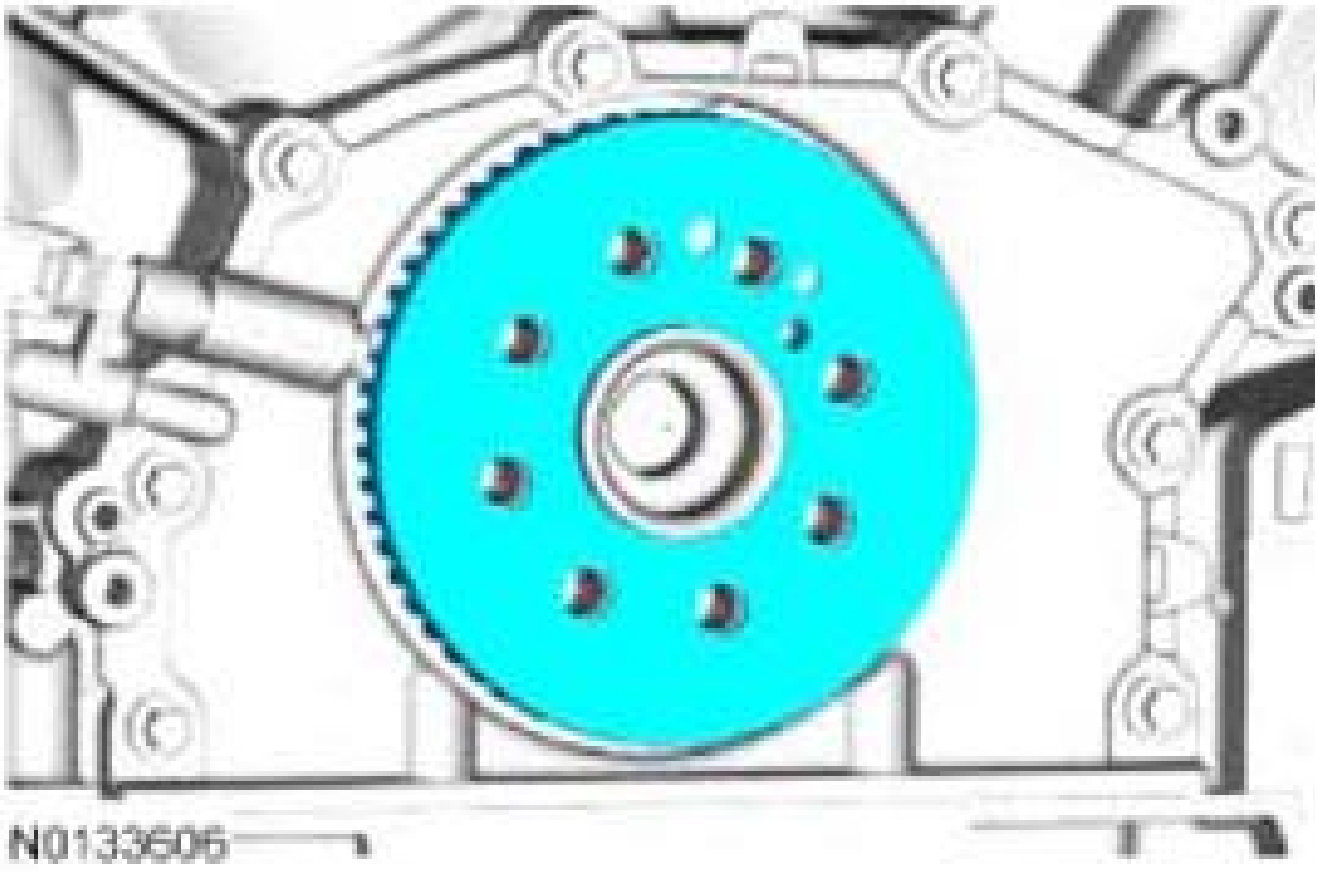
9. Connect the **CKP** sensor electrical connector.

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10. Install the crank sensor ring.

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11. Install the flexplate. Refer to **FLEXPLATE**.

CYLINDER HEAD - LH

MATERIAL SPECIFICATIONS

Item	Specification
High Temperature Nickel Anti-Seize Lubricant XL-2	-
Motorcraft® SAE 5W-20 Premium Synthetic Blend Motor Oil (US); Motorcraft® SAE 5W-20 Super Premium Motor Oil (Canada) XO-5W20-QSP (US); CXO-5W20-LSP12 (Canada)	WSSM2C945-A
Motorcraft® Metal Surface Prep ZC-31-A	-
Penetrating and Lock Lubricant (US); Penetrating Fluid (Canada) XL-1 (US); CXC-51-A (Canada)	-
Motorcraft® Silicone Gasket Remover ZC-30	-

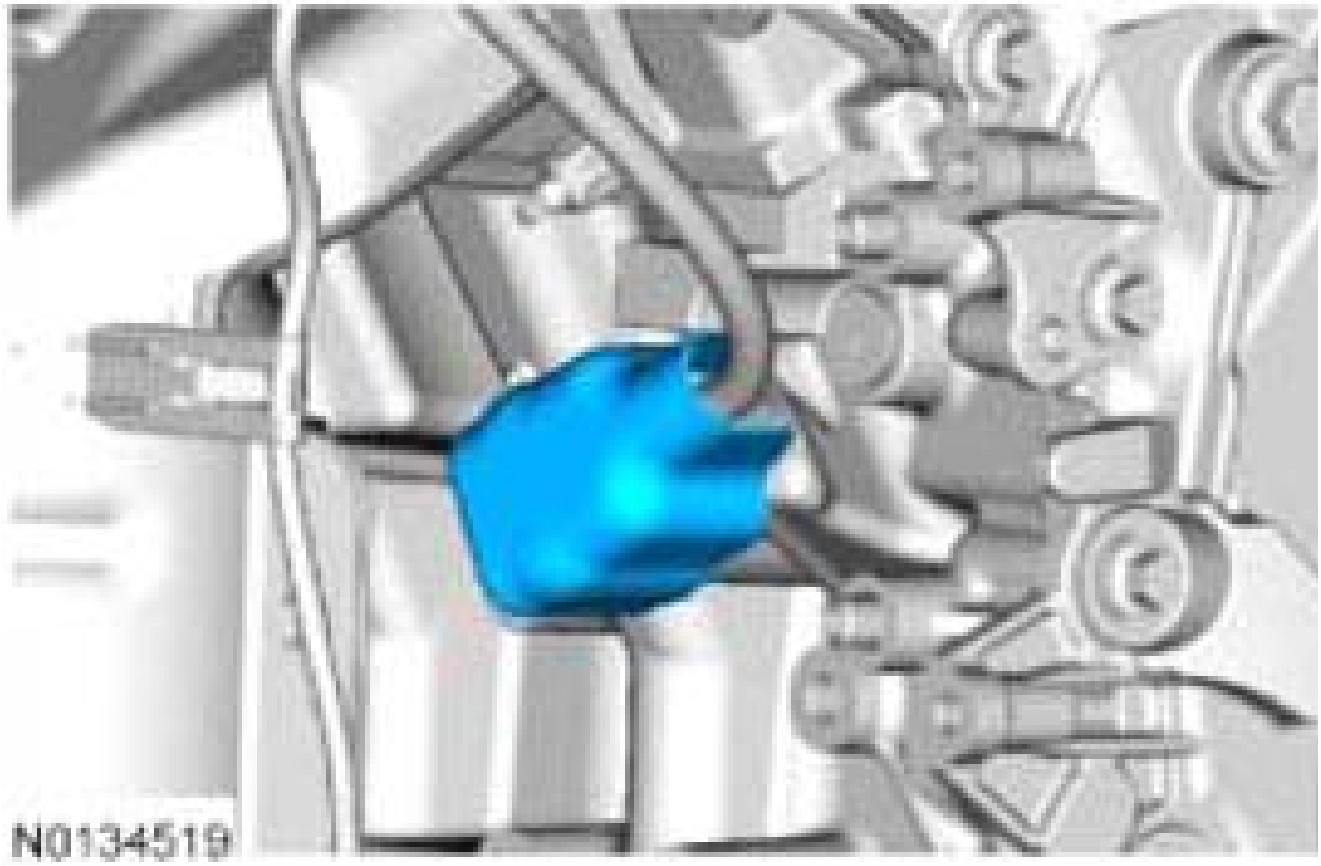
Removal

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NOTE: **Place clean shop towels over exposed engine cavities. Carefully remove the towels so foreign material is not dropped into the engine. Any foreign material (including any material created while cleaning gasket surfaces) that enters the oil passages or the oil pan, may cause engine failure.**

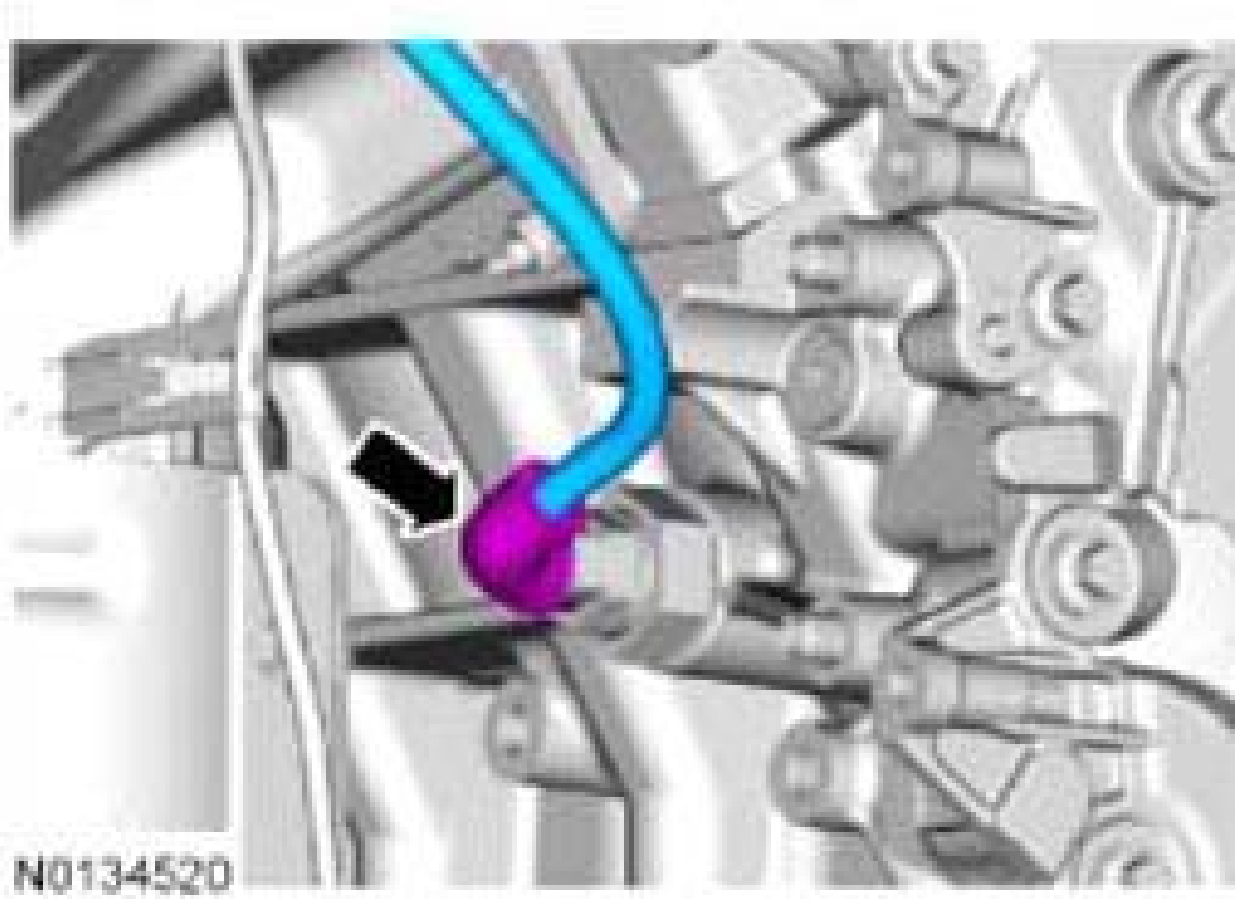
NOTE: **If the cylinder head is replaced, a new secondary timing chain tensioner will need to be installed.**

1. Remove the LH camshafts. Refer to **CAMSHAFT**.
2. If equipped, remove the block heater heat shield.



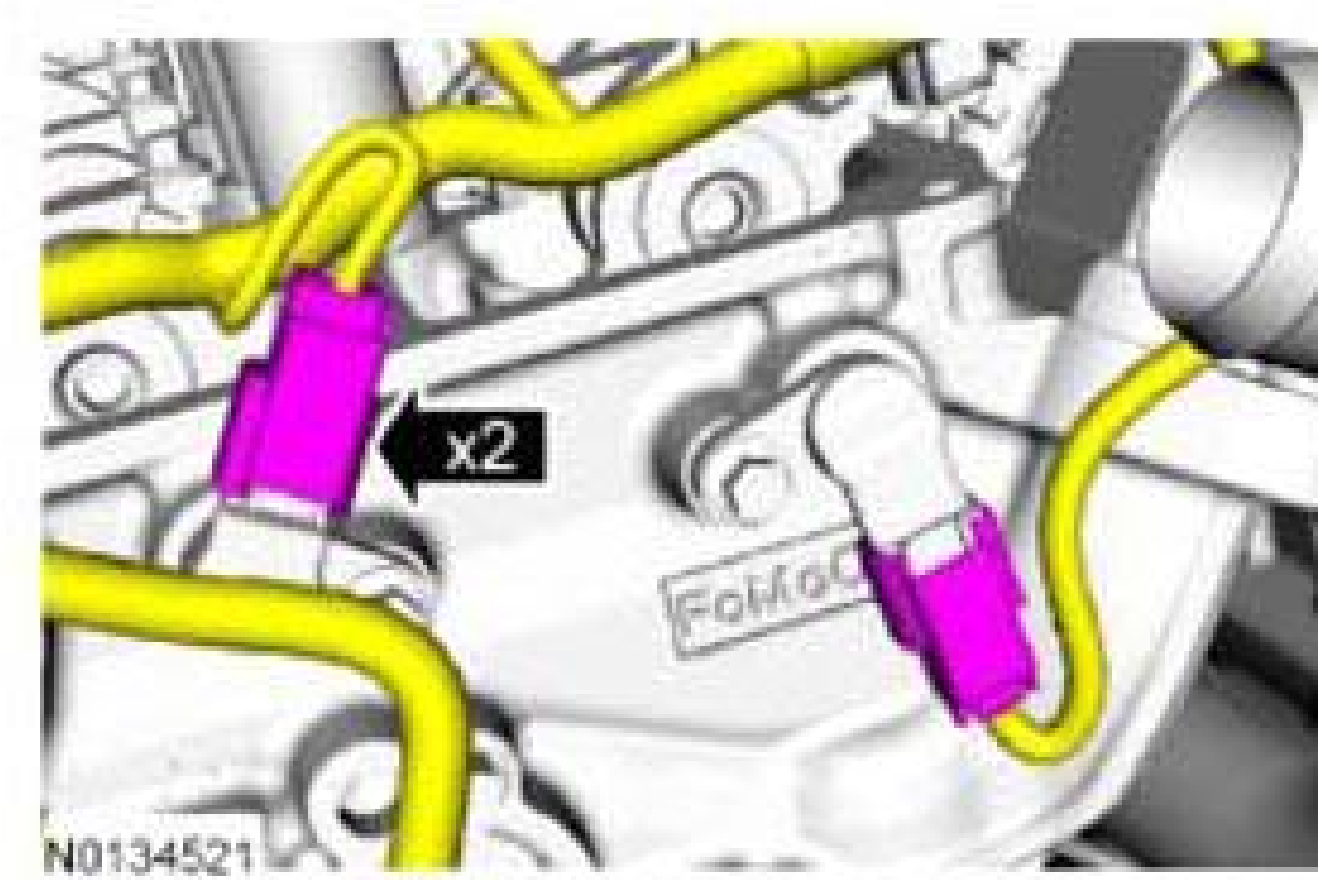
3. If equipped, disconnect the block heater electrical connector.
   - Remove the block heater wiring harness from the engine.

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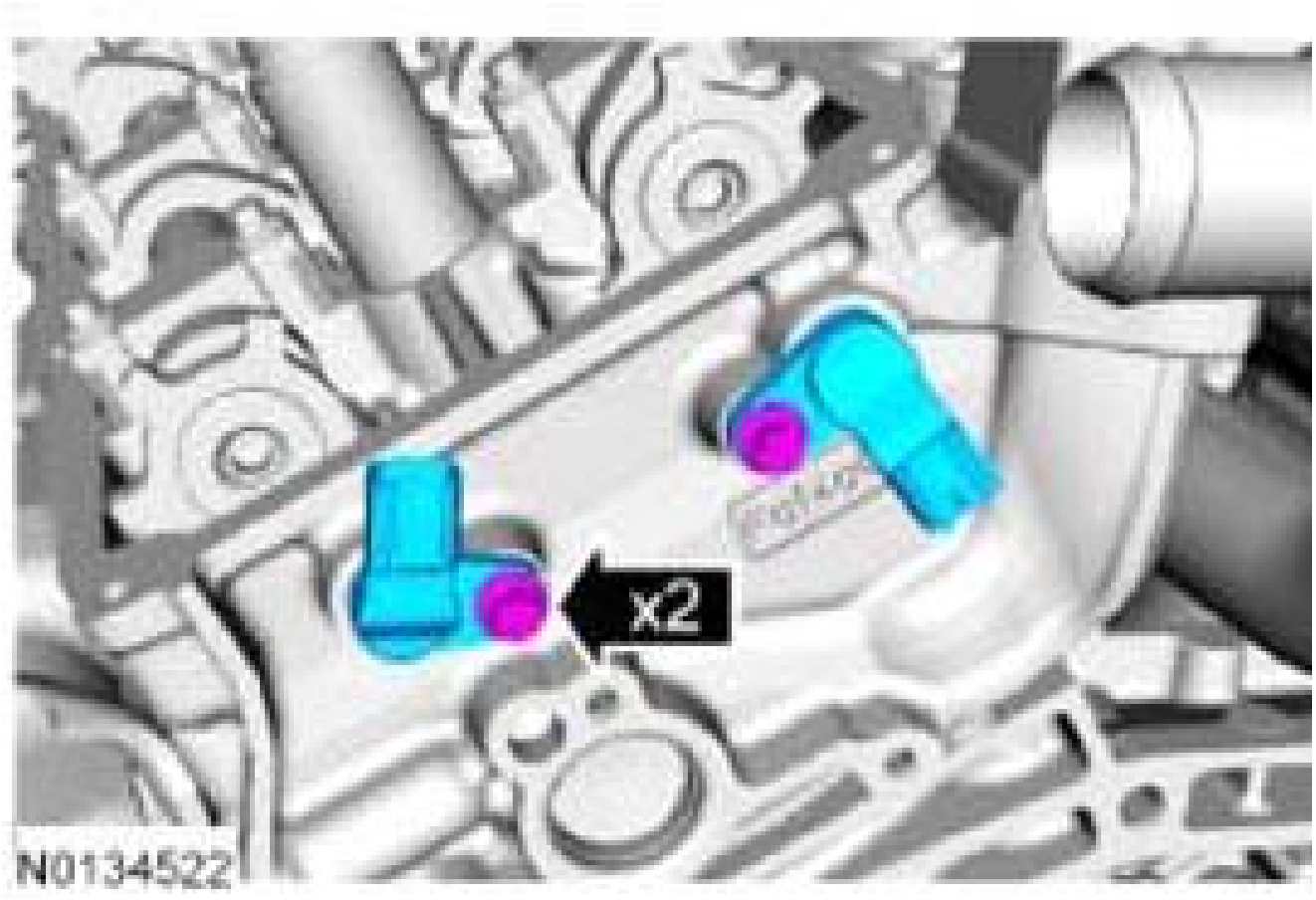
4. Disconnect the 2 LH **CMP** sensor electrical connectors.

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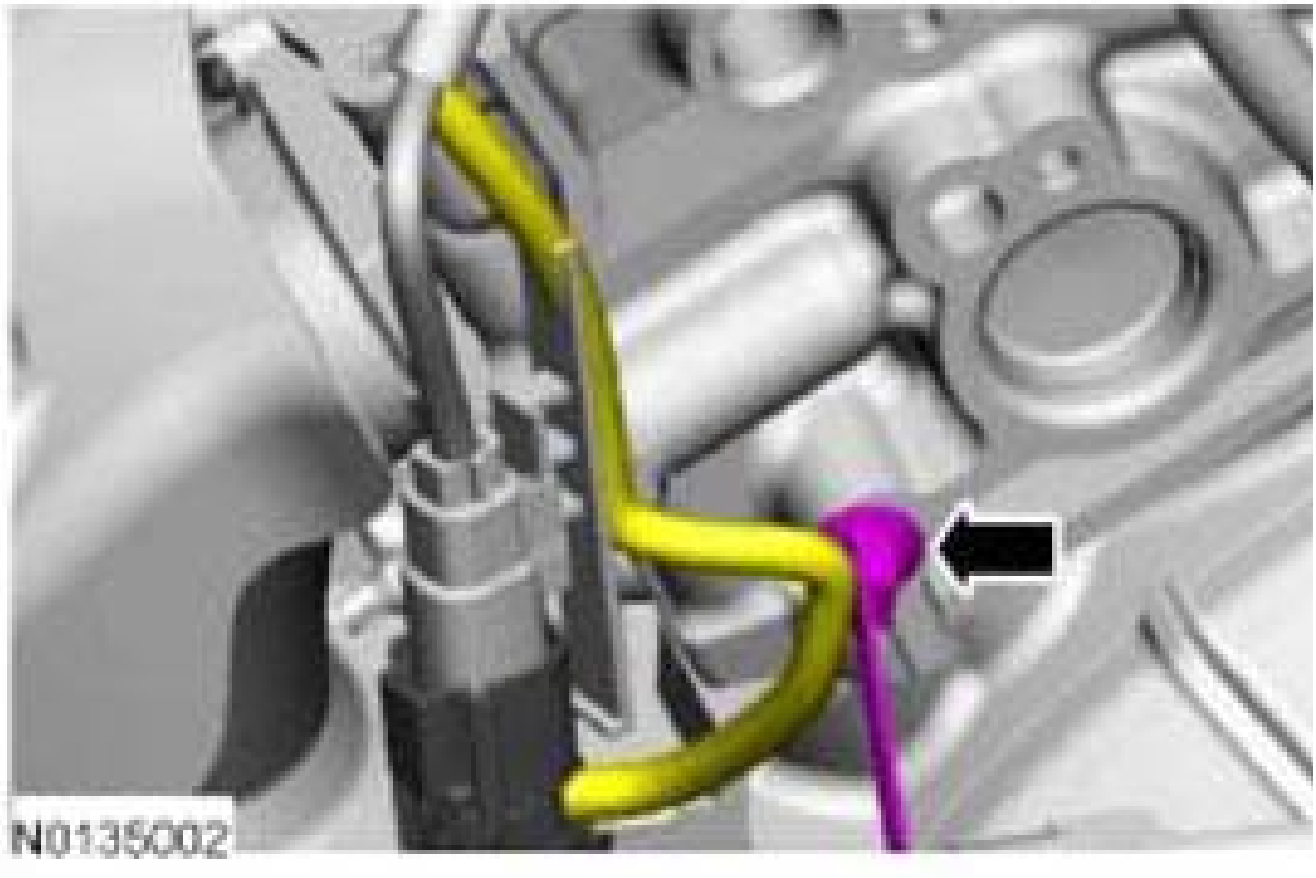
5. Remove the 2 bolts and the 2 **CMP** sensors.

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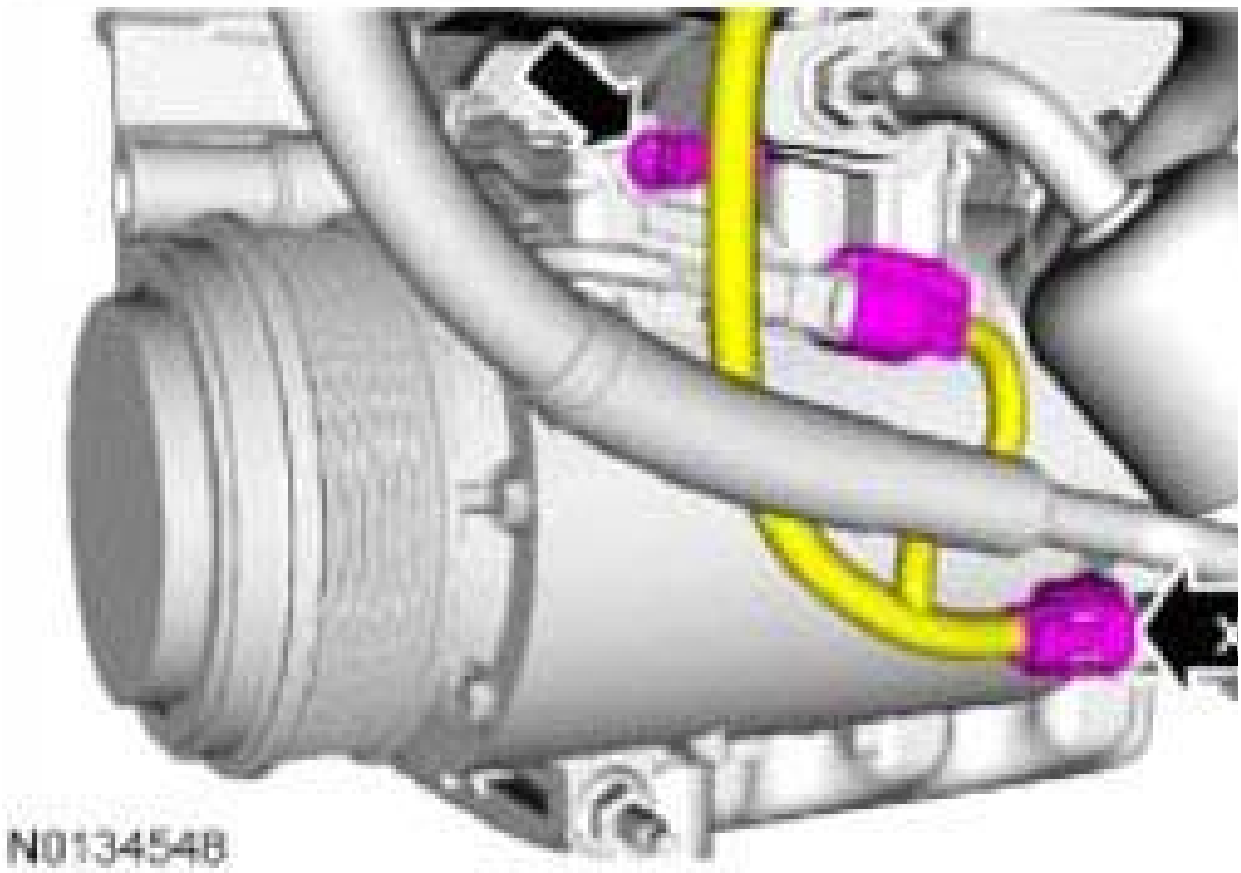
6. Remove the wiring harness retainer from the rear of the LH cylinder head.

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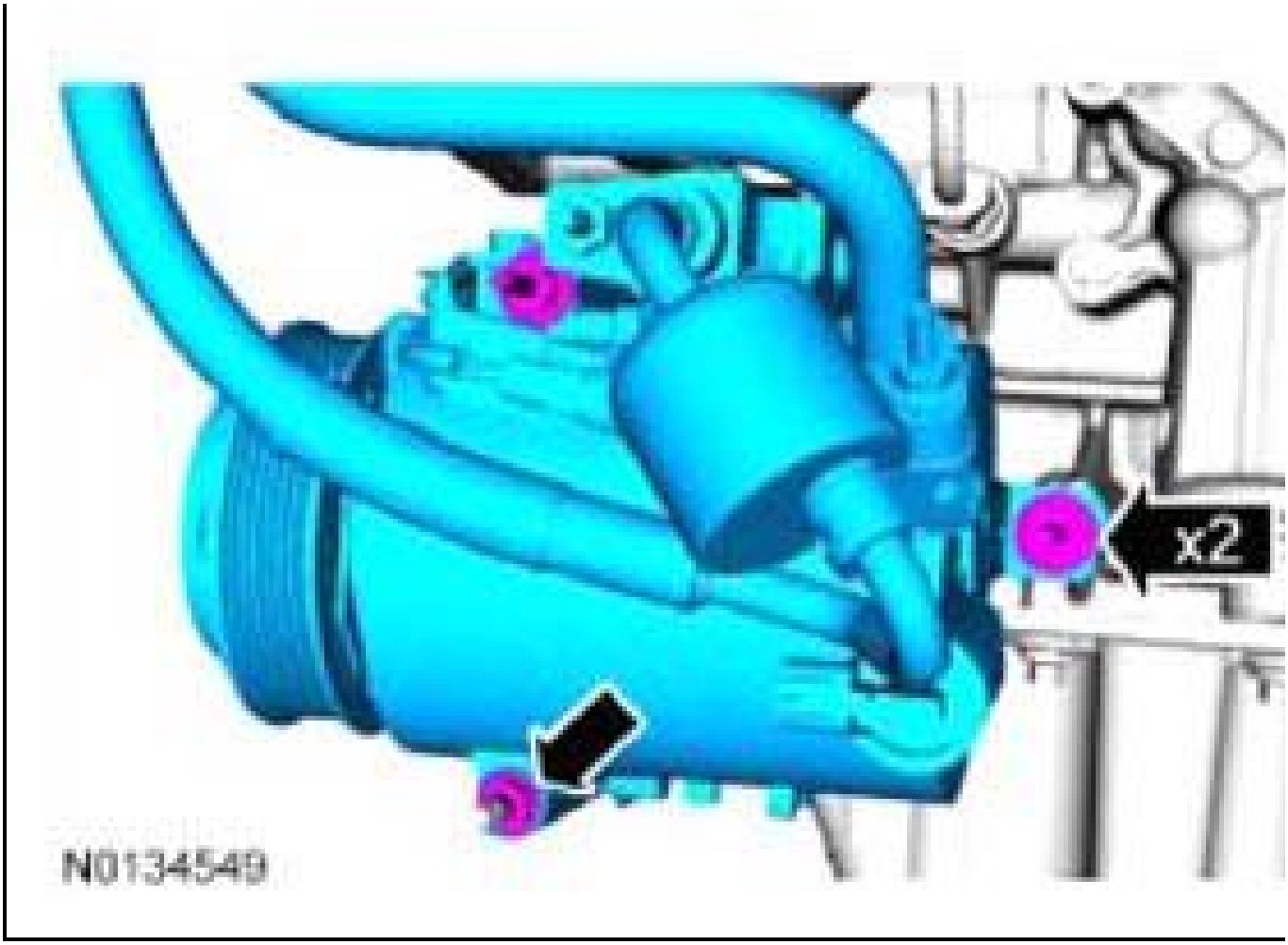
7. Disconnect the 2 A/C compressor electrical connectors.
    - Detach the A/C wiring harness retainer.

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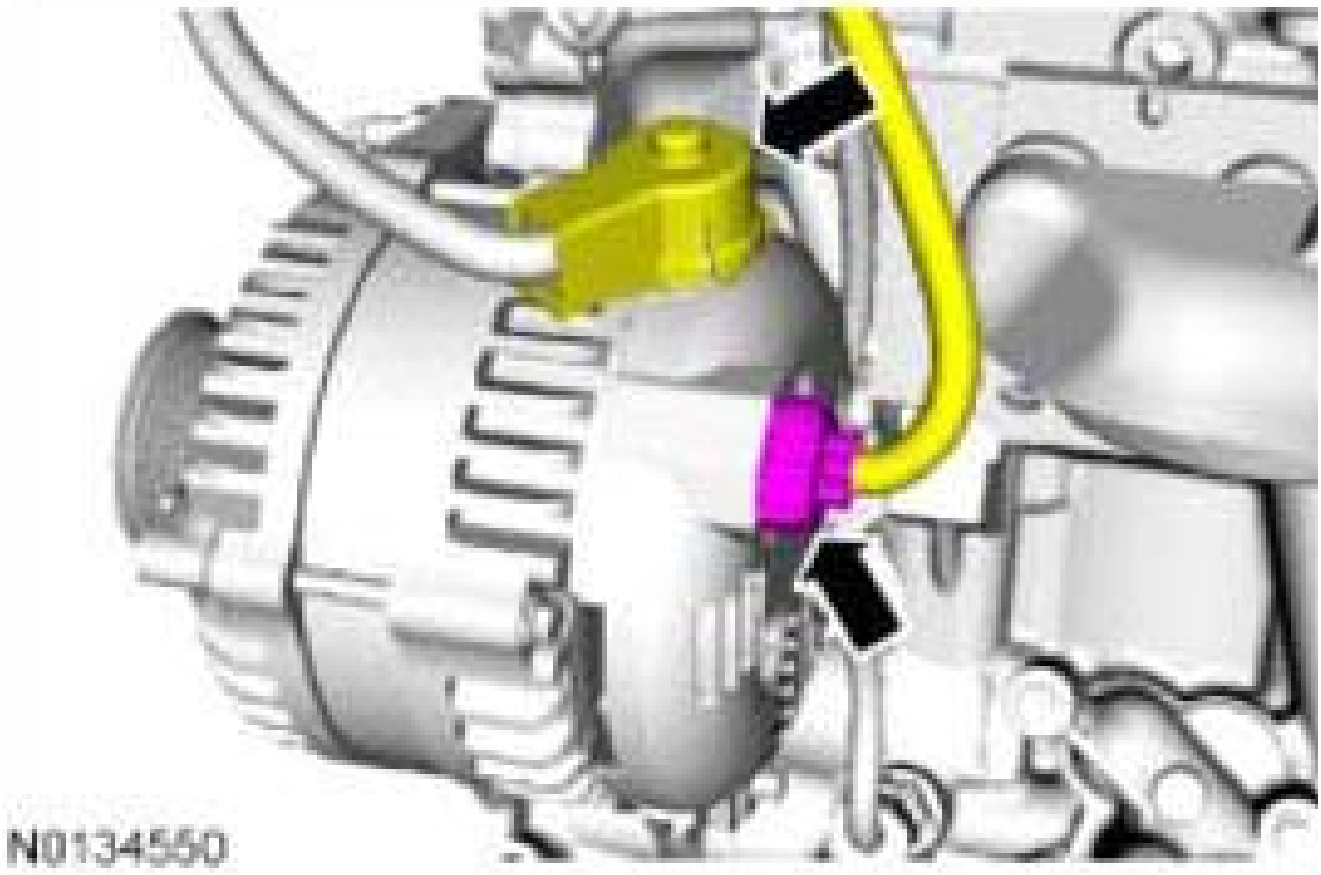
8. Remove the nut, 2 stud bolts and the A/C compressor.

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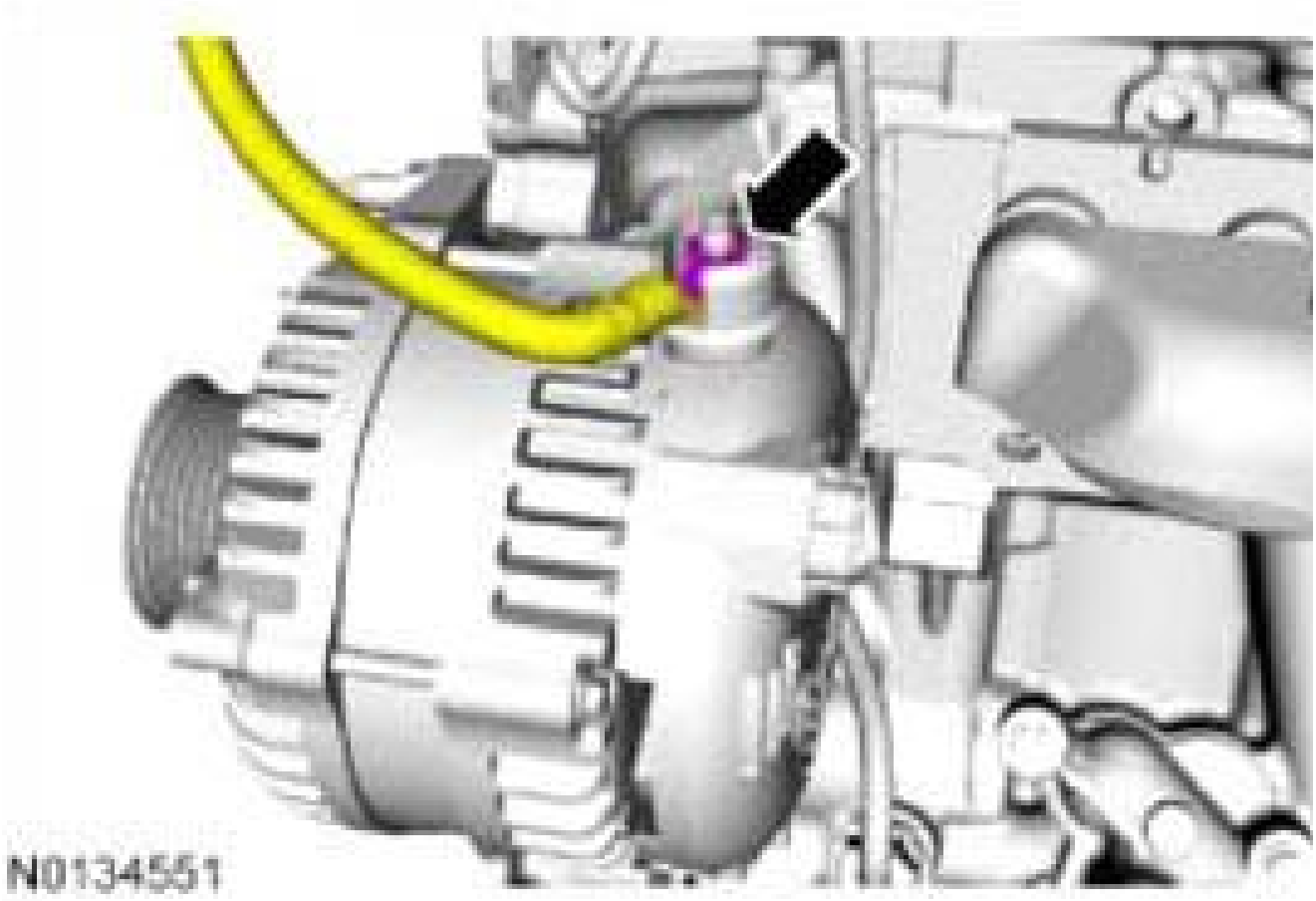
9. Disconnect the generator electrical connector and position the generator B+ cable cover aside.

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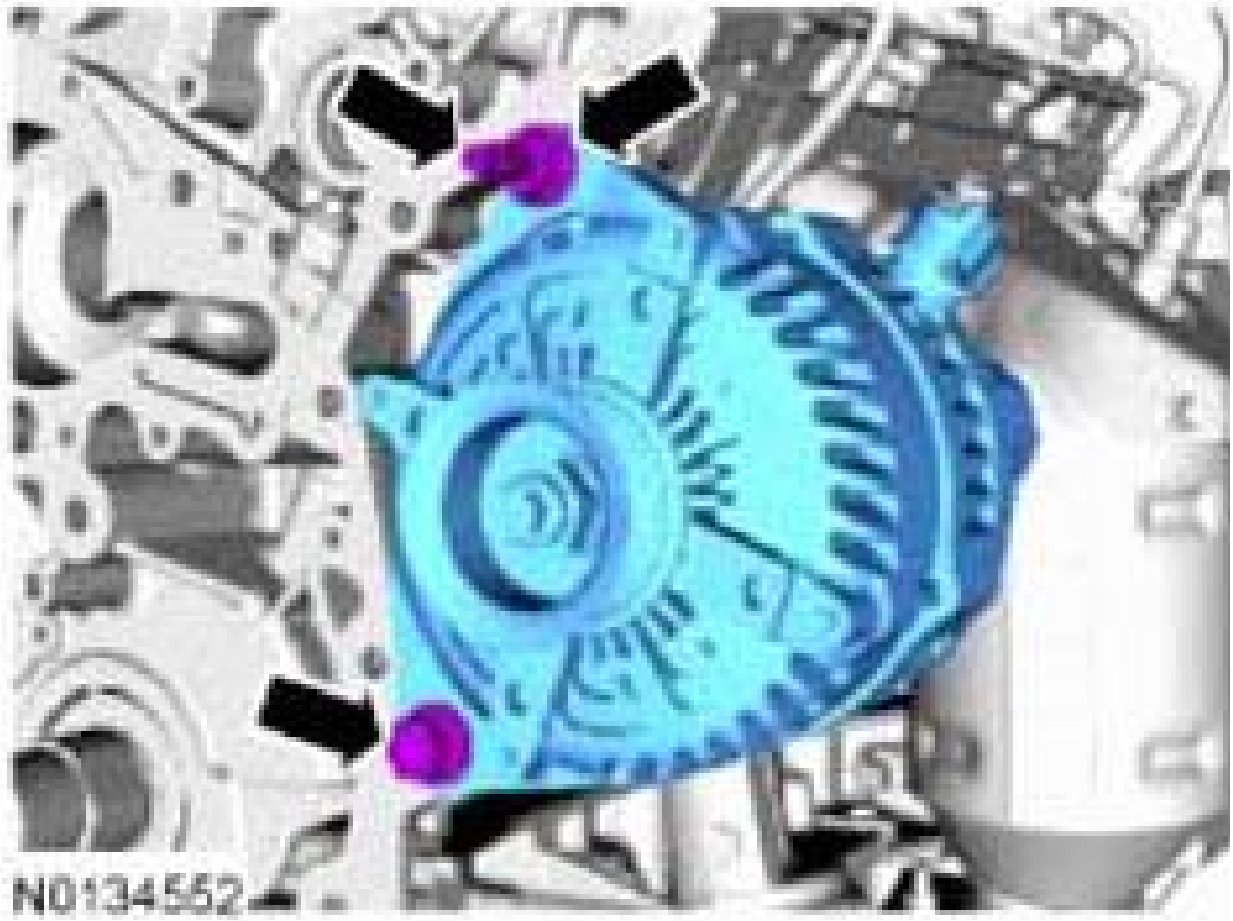
10. Remove the nut and disconnect the generator B+ cable.

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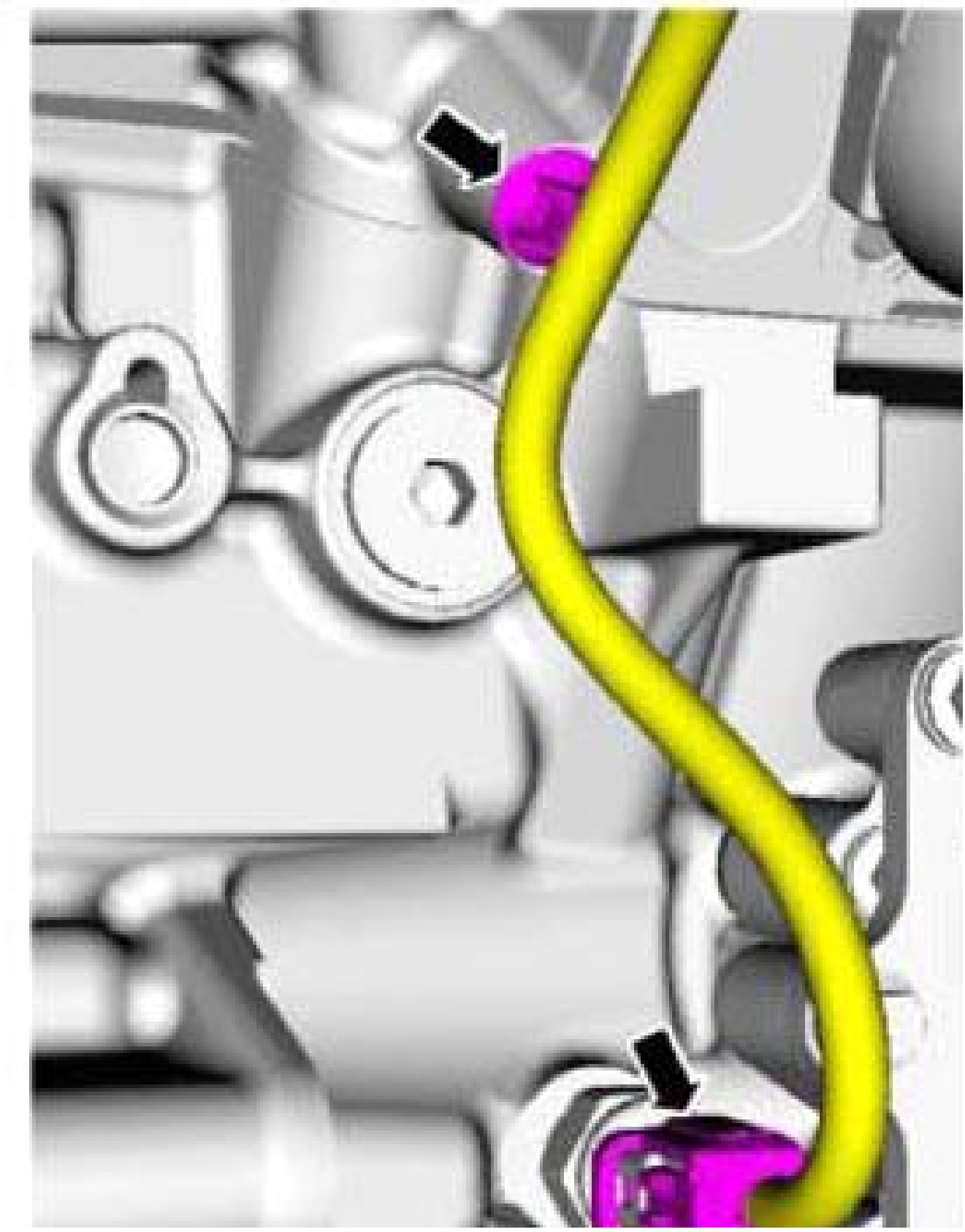
11. Remove the nut, bolt and the generator.
    - Remove the generator stud.

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12. Disconnect the **EOP** switch electrical connector and the wiring harness pin-type retainer.

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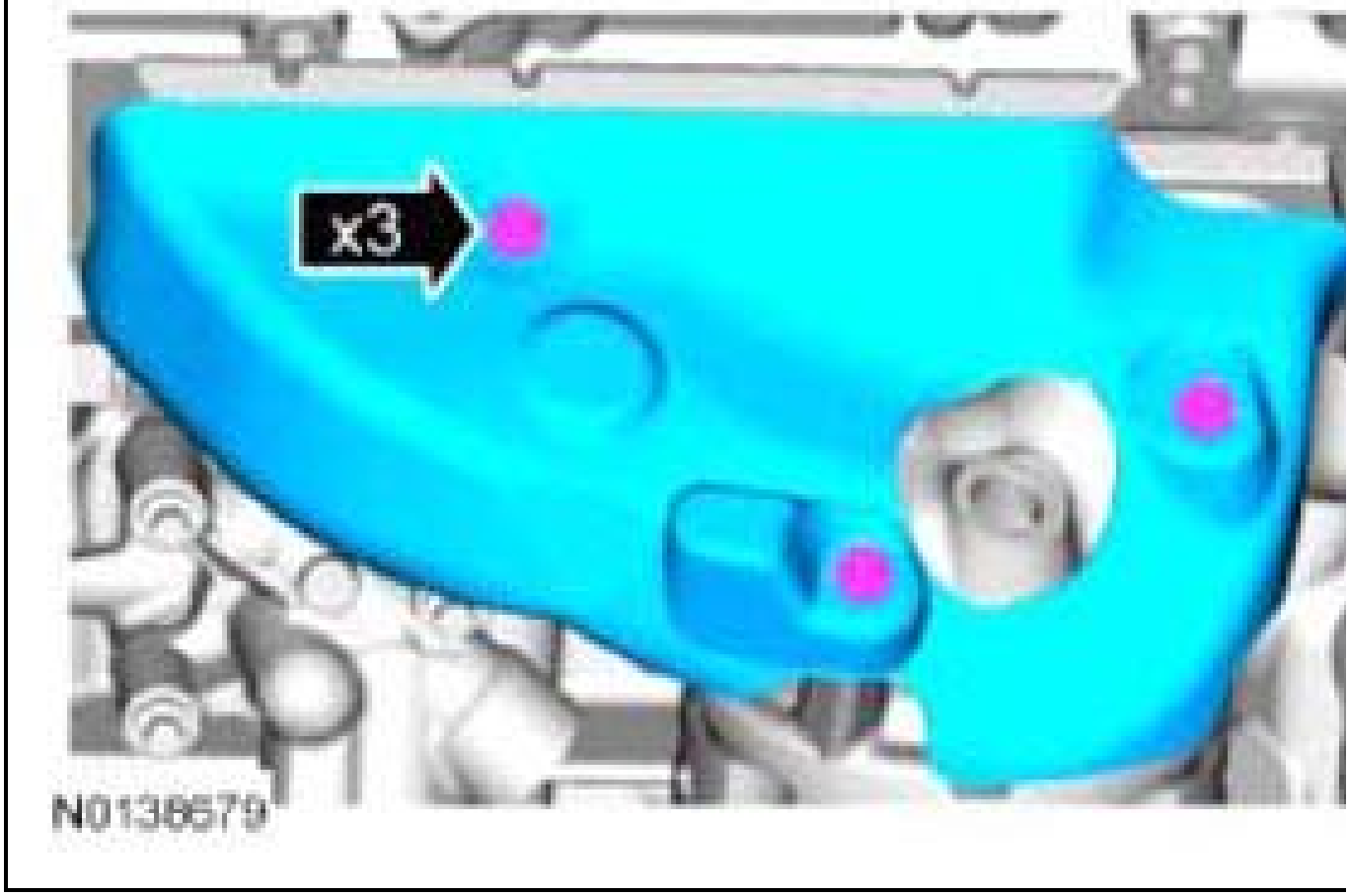
13. **NOTE: If necessary, lubricate the HO2S with penetrating and lock lubricant to assist in removal.**

Remove the LH **HO2S** .



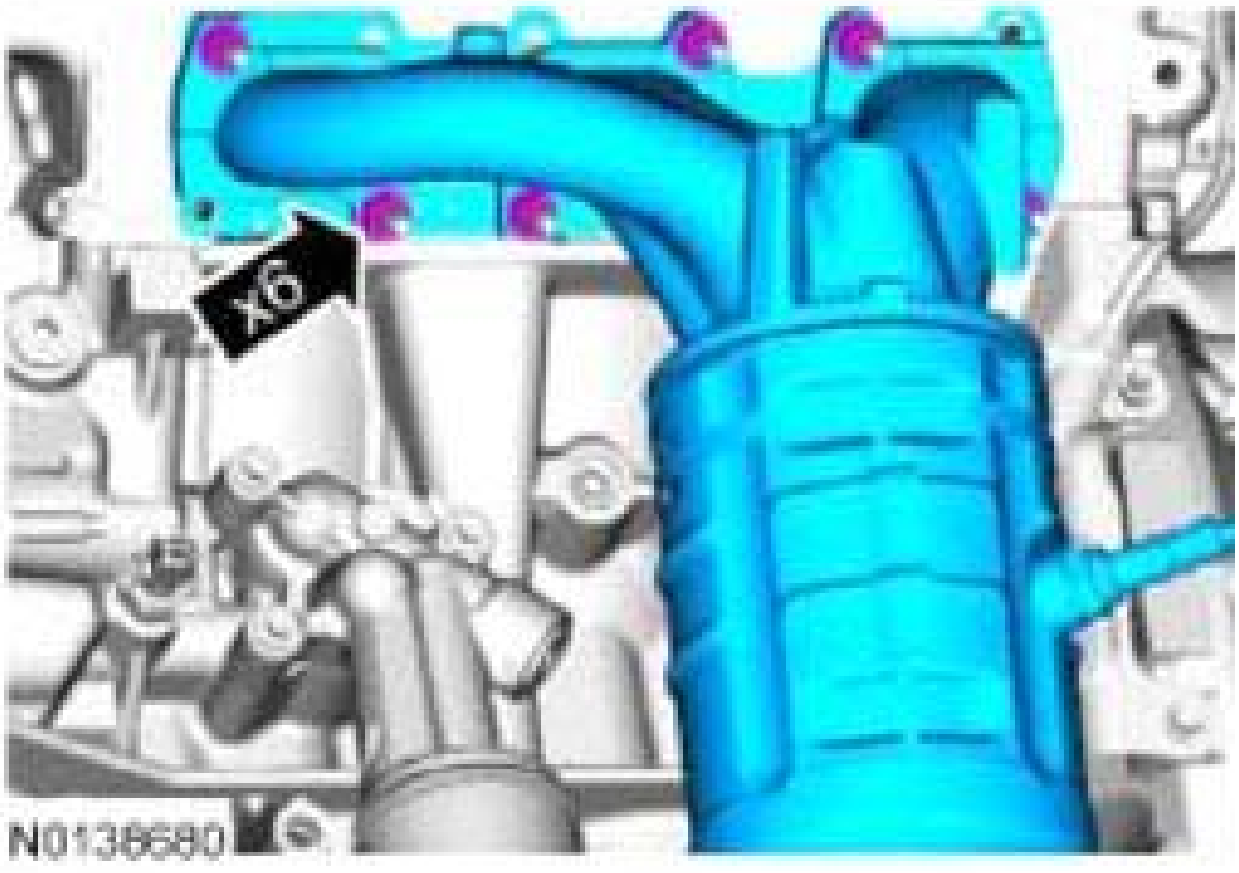
14. Remove the 3 bolts and the LH exhaust heat shield.

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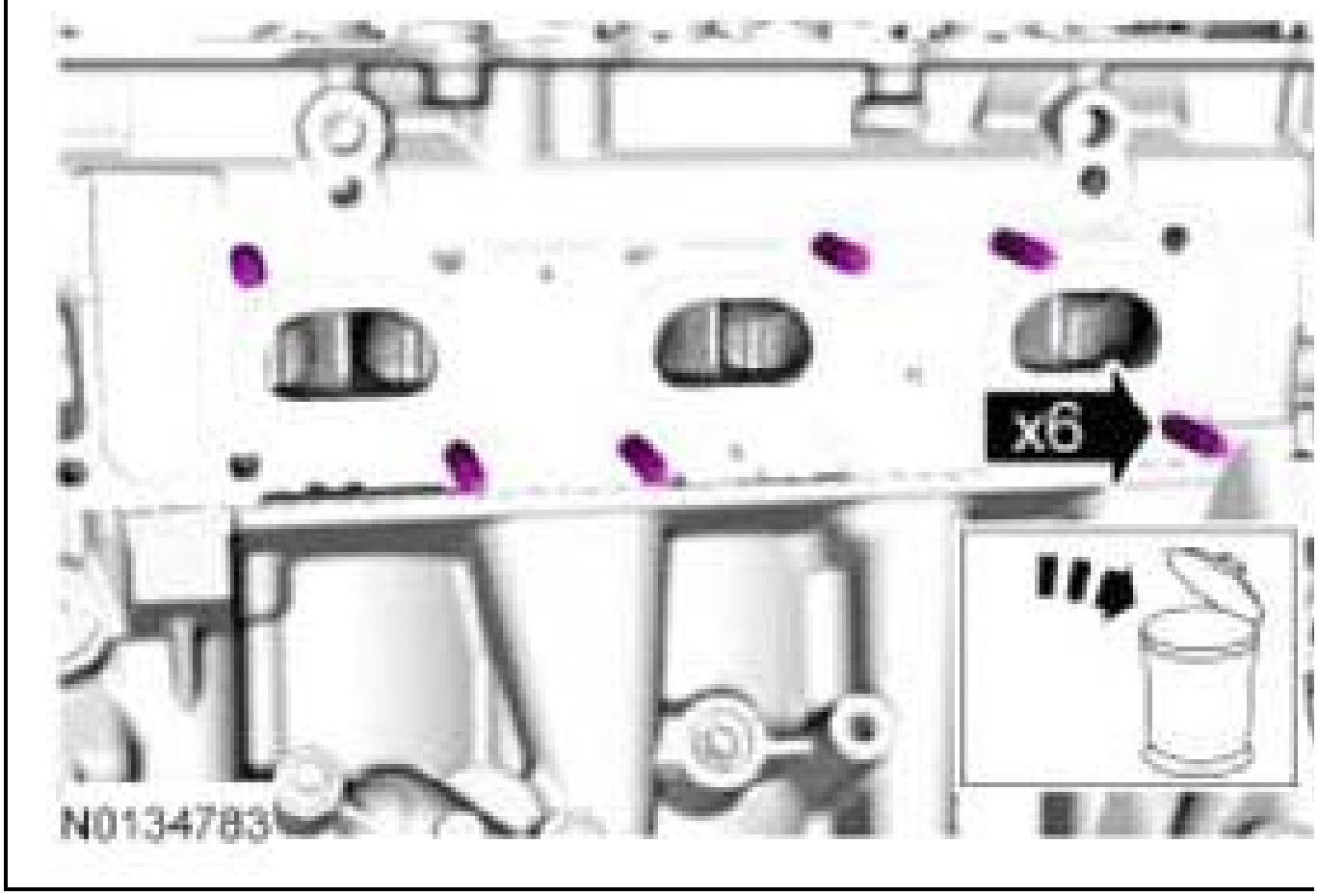
15. Remove the 6 nuts and the LH catalytic converter.
    - Discard the nuts and the gasket.

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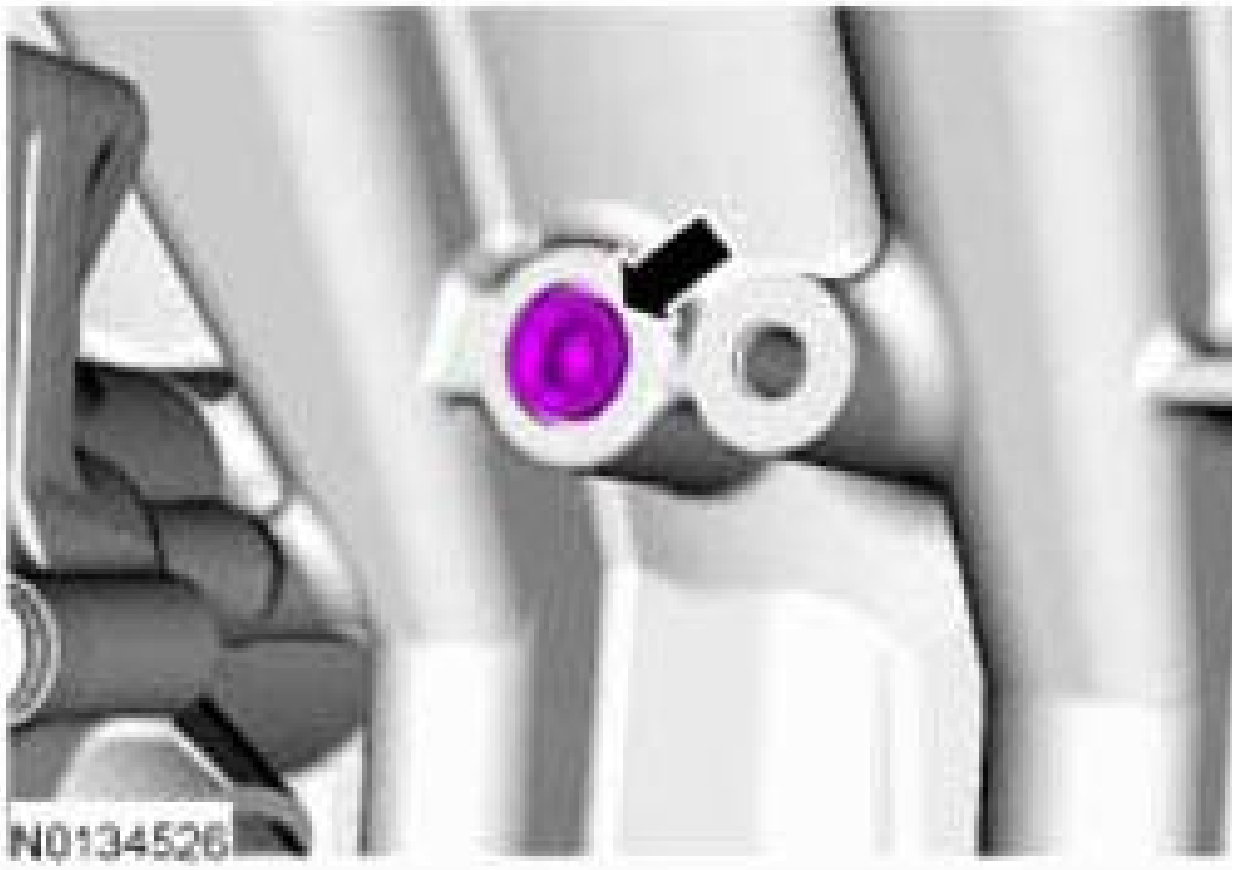
16. Clean and inspect the catalytic converter flange. REFER to **EXHAUST MANIFOLD CLEANING AND INSPECTION** .
17. Remove and discard the 6 LH exhaust manifold studs.

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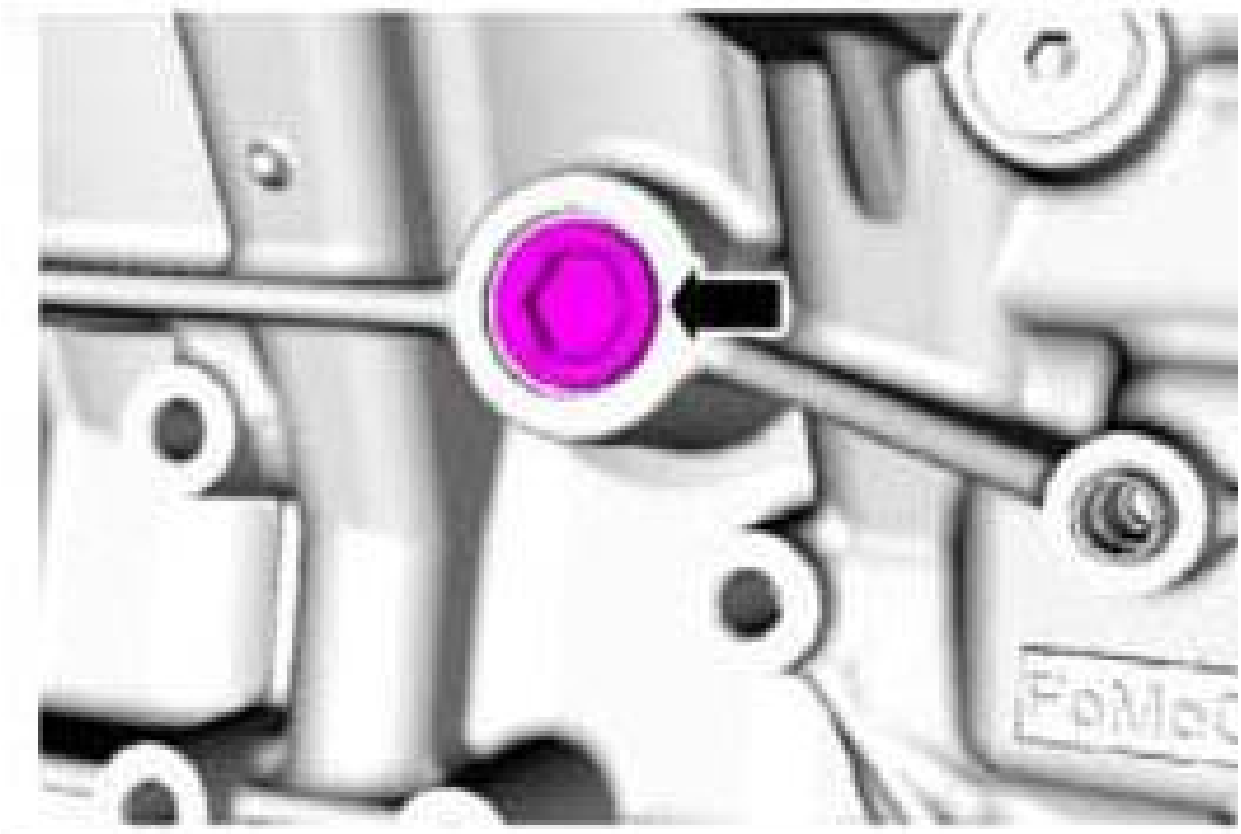
18. Remove the LH cylinder block drain plug.
    - Allow coolant to drain from the cylinder block.

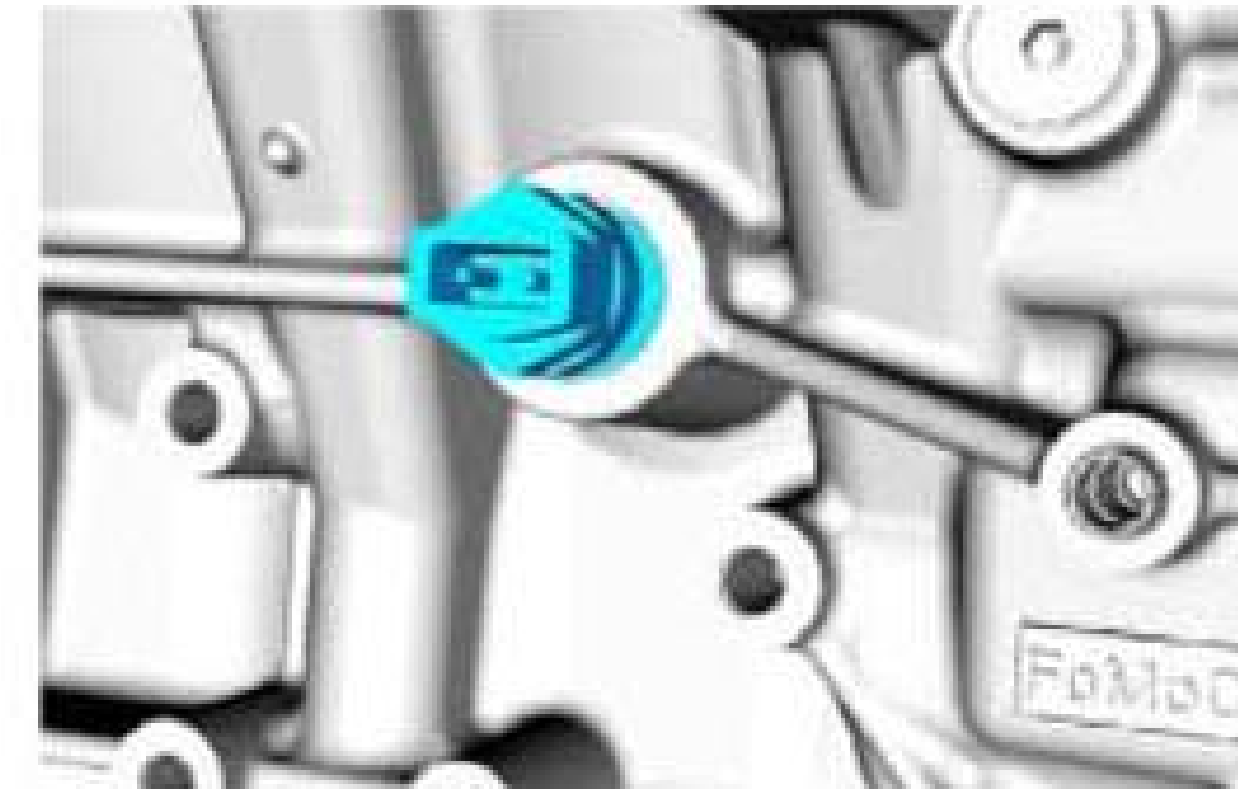
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19. Remove the RH cylinder block drain plug or, if equipped, the block heater.
    - Allow coolant to drain from the cylinder block.

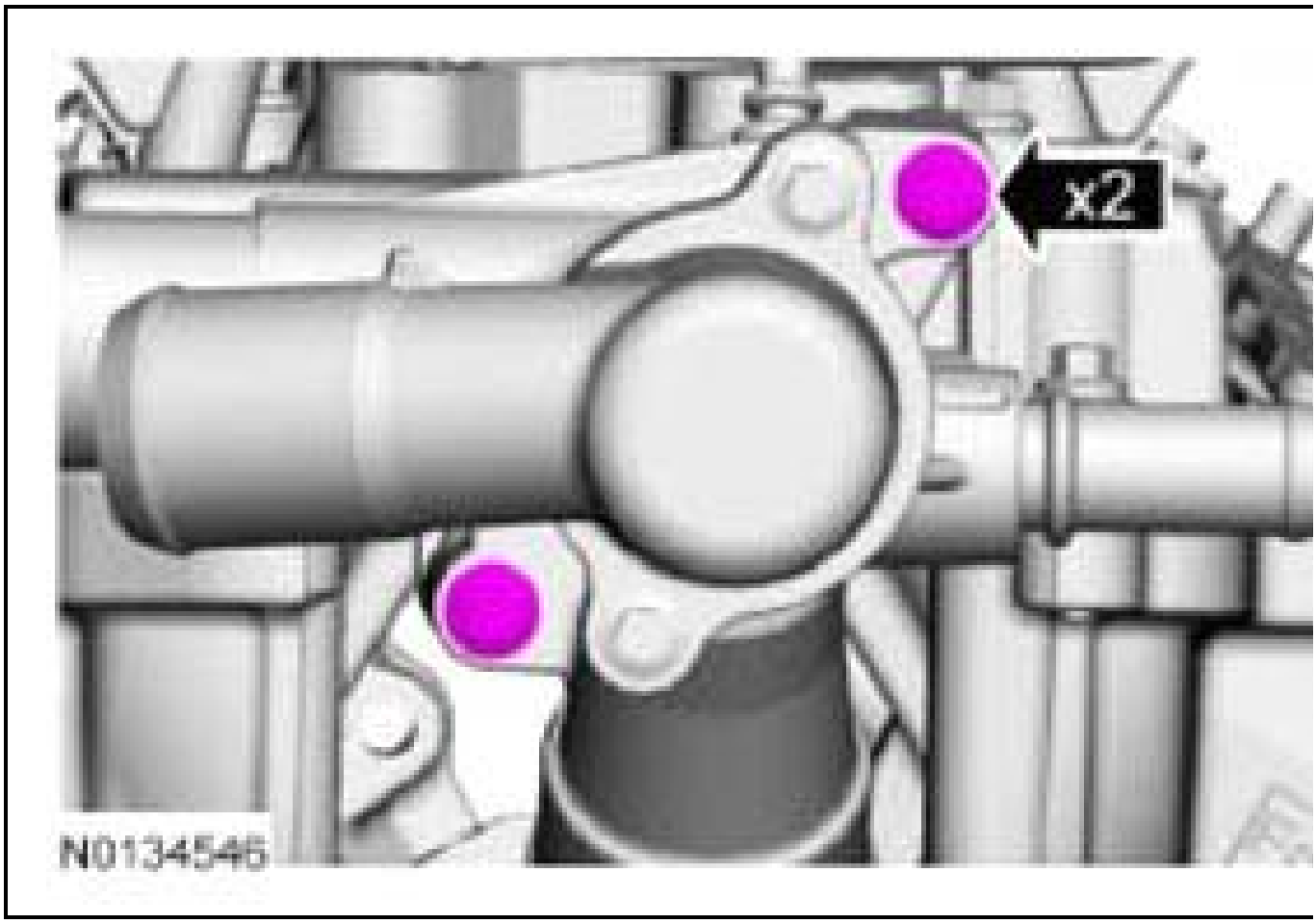
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20. Remove the 2 thermostat housing-to-lower intake manifold bolts.

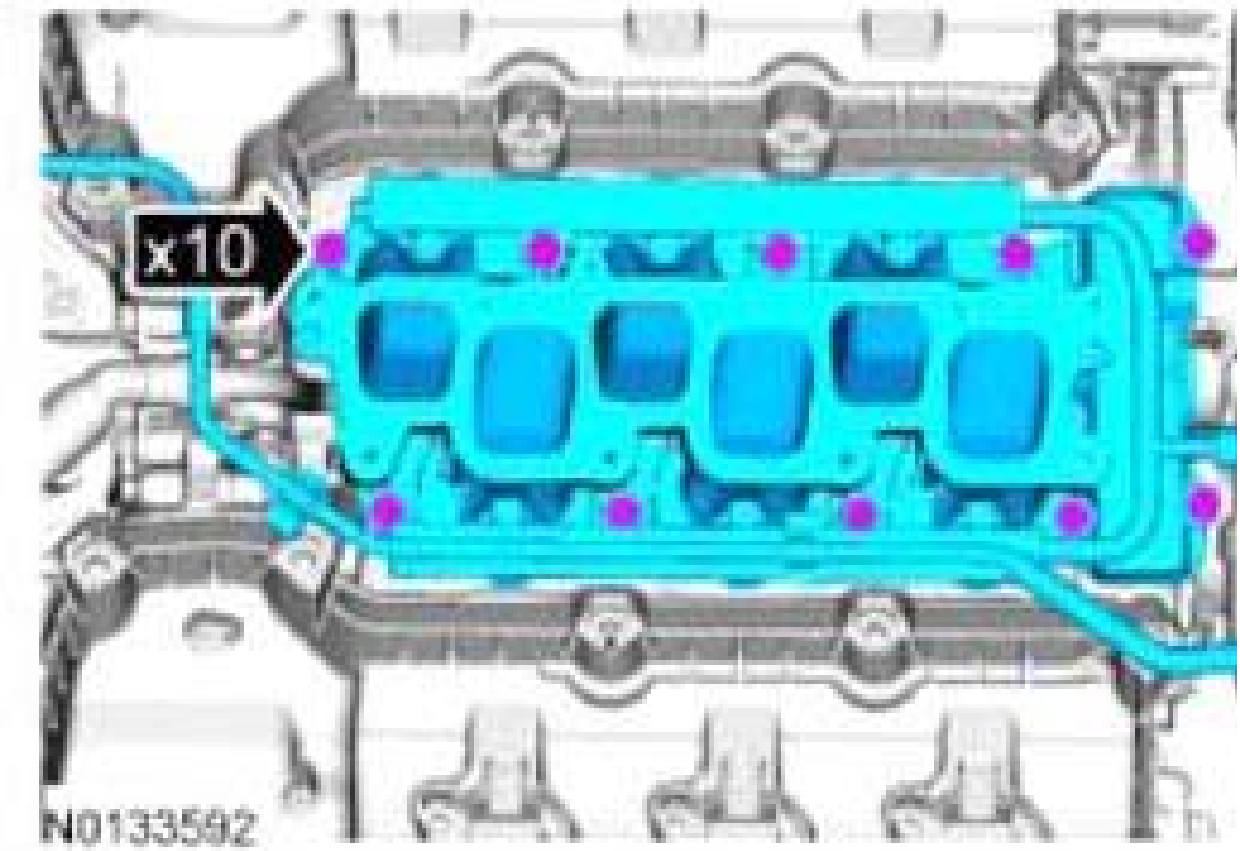


NOTE: **If the engine is repaired or replaced because of upper engine failure, typically including valve or piston damage, check the intake manifold for metal debris. If metal debris is found, install a new intake manifold. Failure to follow these instructions can result in engine damage.**

21. Remove the 10 bolts and the lower intake manifold.

- Remove and discard the intake manifold and thermostat housing gaskets.
- Clean and inspect all sealing surfaces.

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22. **NOTE: Do not use power tools to remove the bolt or damage to the LH primary timing chain guide may occur.**

Remove the bolt and the LH primary timing chain guide.

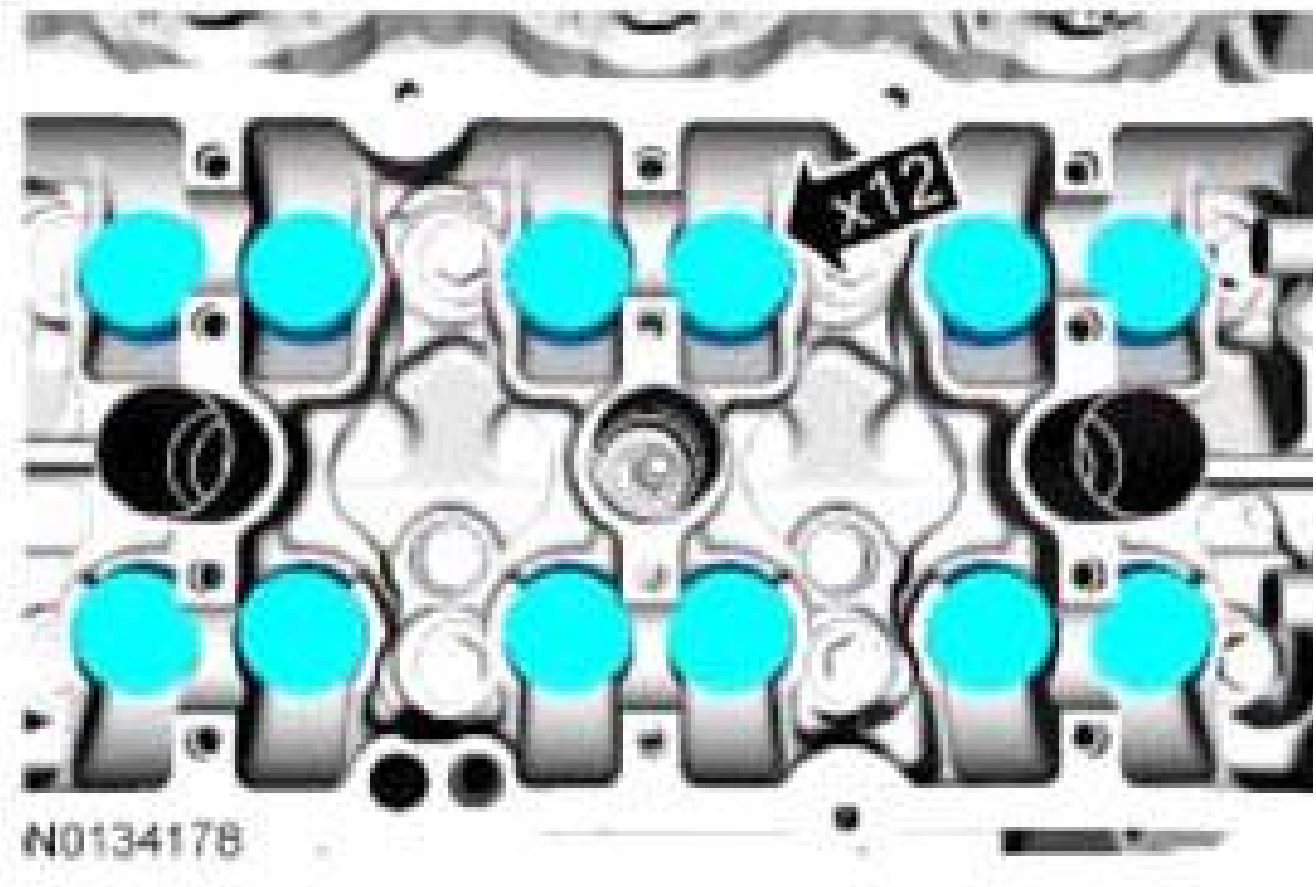
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NOTE: **If the components are to be reinstalled, they must be installed in the same positions. Mark the components for installation into their original locations.**

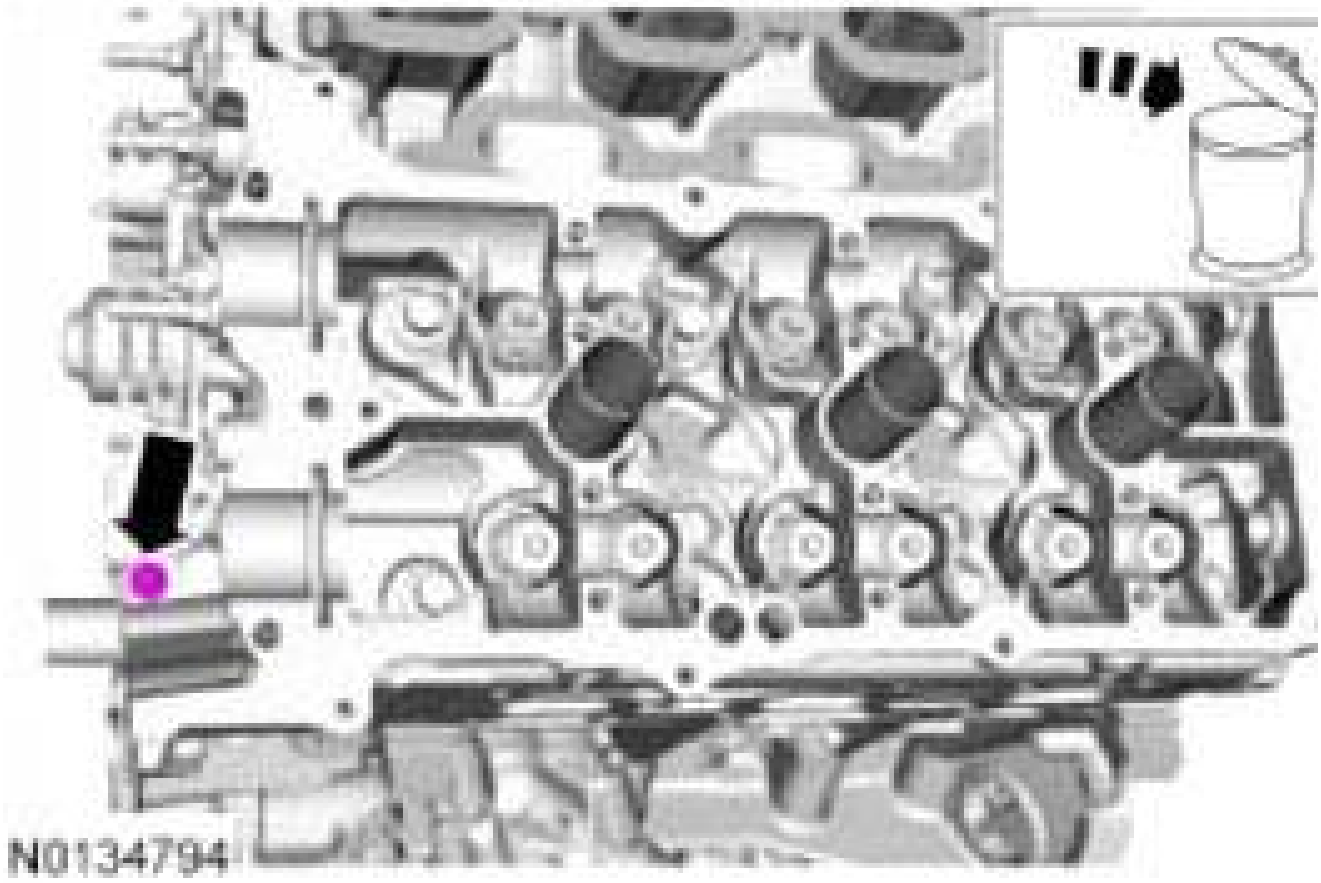
23. Remove the valve tappets from the cylinder head.

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24. Inspect the valve tappets. REFER to **VALVE TAPPET INSPECTION** .
25. Remove and discard the M6 bolt.

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26.

NOTE: **Place clean shop towels over exposed engine cavities. Carefully remove the towels so foreign material is not dropped into the engine. Any foreign material (including any material created while cleaning gasket surfaces) that enters the oil passages or the oil pan, may cause engine failure.**

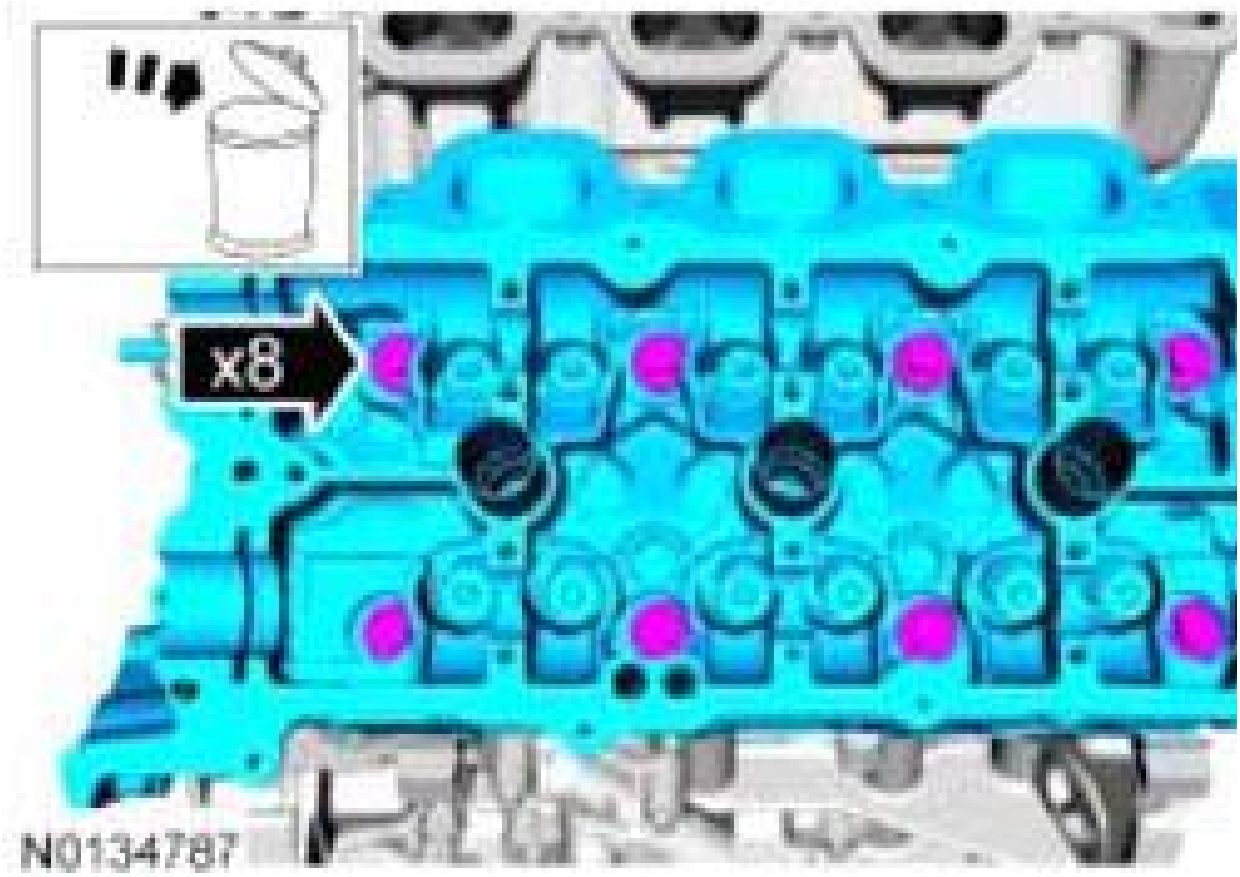
NOTE: **Aluminum surfaces are soft and can be scratched easily. Never place the cylinder head gasket surface, unprotected, on a bench surface.**

NOTE: **The cylinder head bolts must be discarded and new bolts must be installed. They are tighten-to-yield designed and cannot be reused.**

Remove and discard the 8 bolts from the cylinder head.

- Remove the cylinder head.
- Discard the cylinder head gasket.

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27.

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

NOTE: **Observe all warnings or cautions and follow all application directions contained on the packaging of the silicone gasket remover and the metal surface prep.**

NOTE: **If there is no residual gasket material present, metal surface prep can be used to clean and prepare the surfaces.**

Clean the cylinder head-to-cylinder block mating surfaces of both the cylinder heads and the cylinder block in the following sequence.

- Remove any large deposits of silicone or gasket material with a plastic scraper.
- Apply silicone gasket remover, following package directions, and allow to set for several minutes.

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- Remove the silicone gasket remover with a plastic scraper. A second application of silicone gasket remover may be required if residual traces of silicone or gasket material remain.
- Apply metal surface prep, following package directions, to remove any remaining traces of oil or coolant and to prepare the surfaces to bond with the new gasket. Do not attempt to make the metal shiny. Some staining of the metal surfaces is normal.

28. Support the cylinder head on a bench with the head gasket side up. Check the cylinder head distortion and the cylinder block distortion. REFER to **CYLINDER HEAD DISTORTION** and REFER to **CYLINDER BLOCK DISTORTION** .

Installation

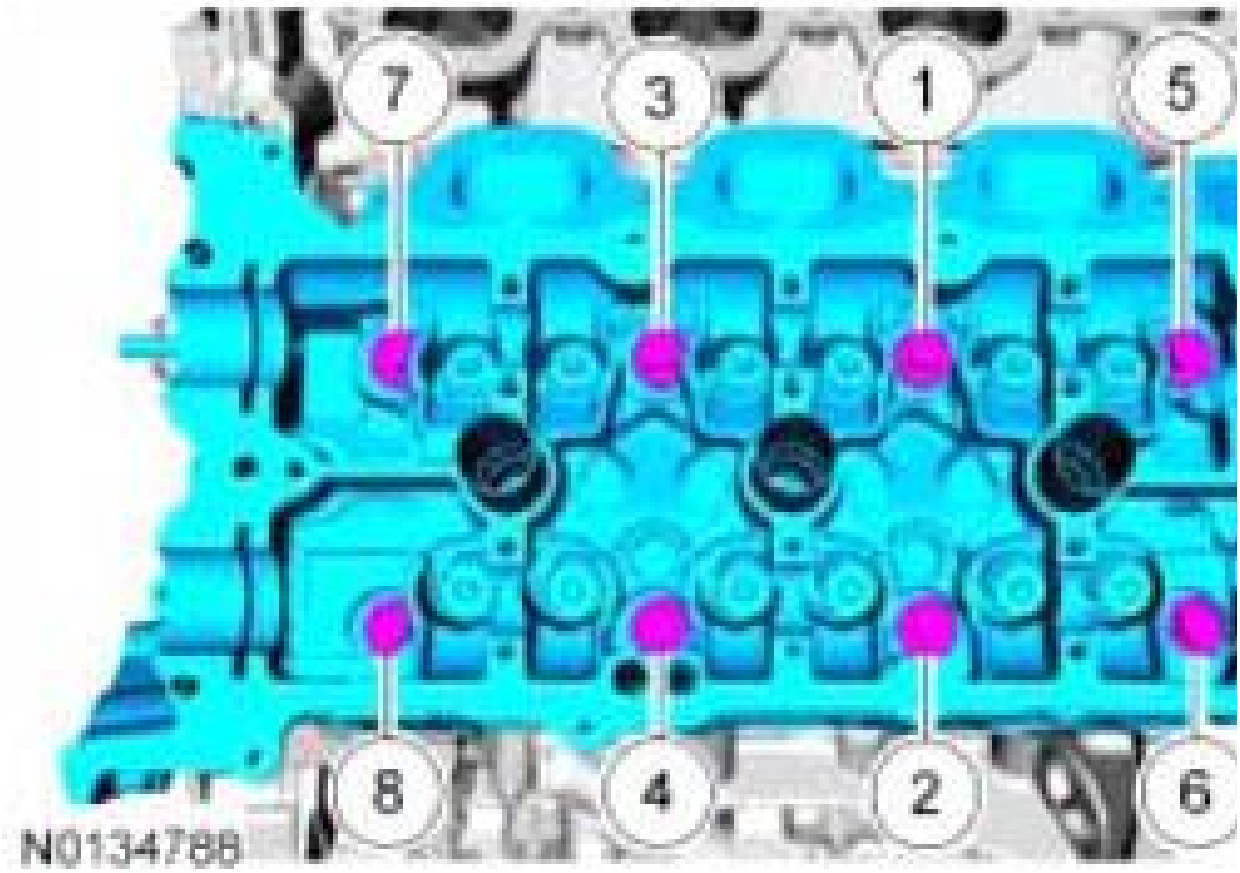
NOTE: During engine repair procedures, cleanliness is extremely important. Any foreign material, including any material created while cleaning gasket surfaces that enters the oil passages, coolant passages or the oil pan, can cause engine failure.

NOTE: If the cylinder head is replaced, a new secondary timing chain tensioner will need to be installed.

NOTE: The valve tappets must be installed in their original positions. Coat the valve tappets with clean engine oil prior to installation.

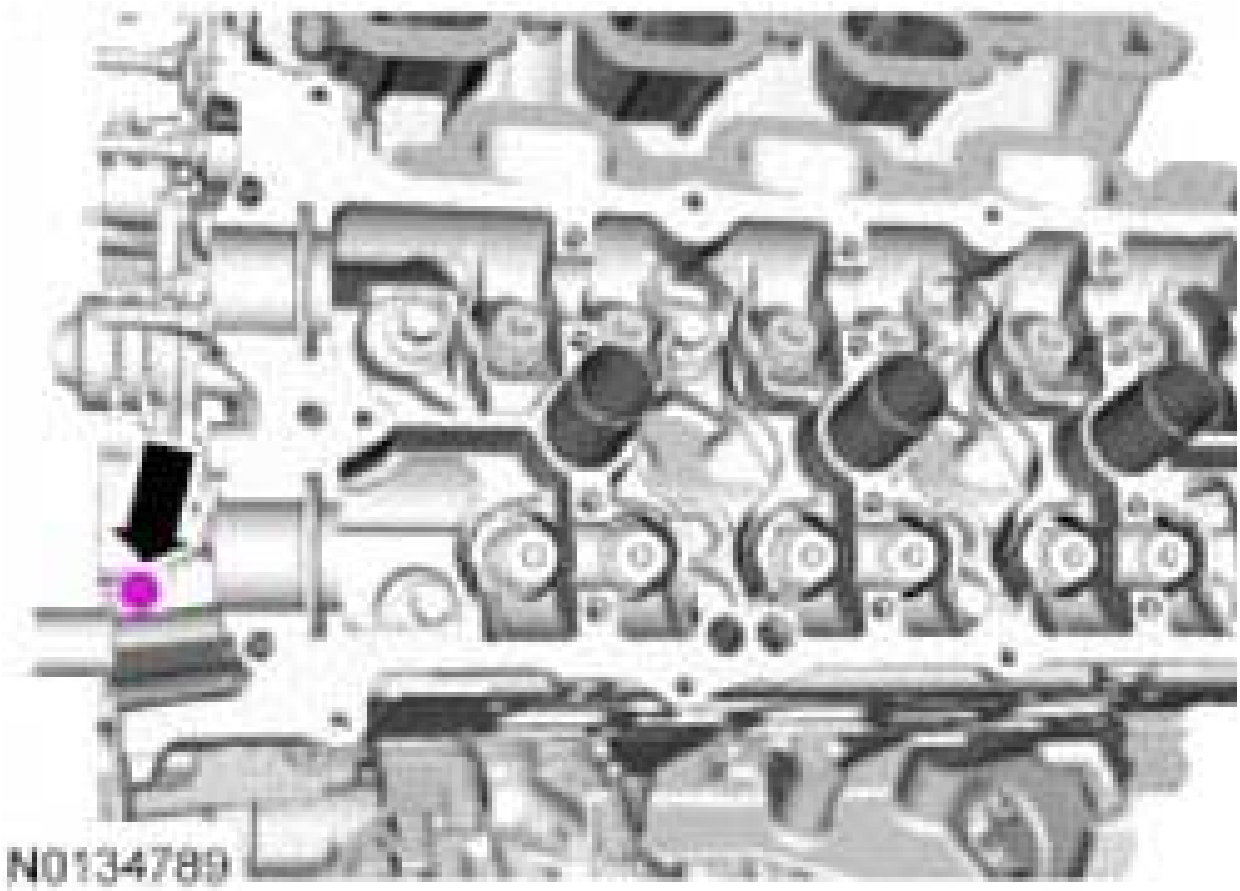
1. Install a new gasket, the LH cylinder head and 8 new bolts. Tighten the bolts in the sequence shown in illustration below in 5 stages:
   - Stage 1: Tighten to 20 Nm (177 lb-in).
   - Stage 2: Tighten to 35 Nm (26 lb-ft).
   - Stage 3: Tighten 90 degrees.
   - Stage 4: Tighten 90 degrees.
   - Stage 5: Tighten 45 degrees.

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2. Install the M6 bolt.
    - Tighten to 10 Nm (89 lb-in).

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3. **NOTE: The valve tappets must be installed in their original positions.**

   NOTE: Coat the valve tappets with clean engine oil prior to installation.

   Install the valve tappets.

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4. Install the LH upper primary timing chain guide and the bolt.
   - Tighten to 10 Nm (89 lb-in).

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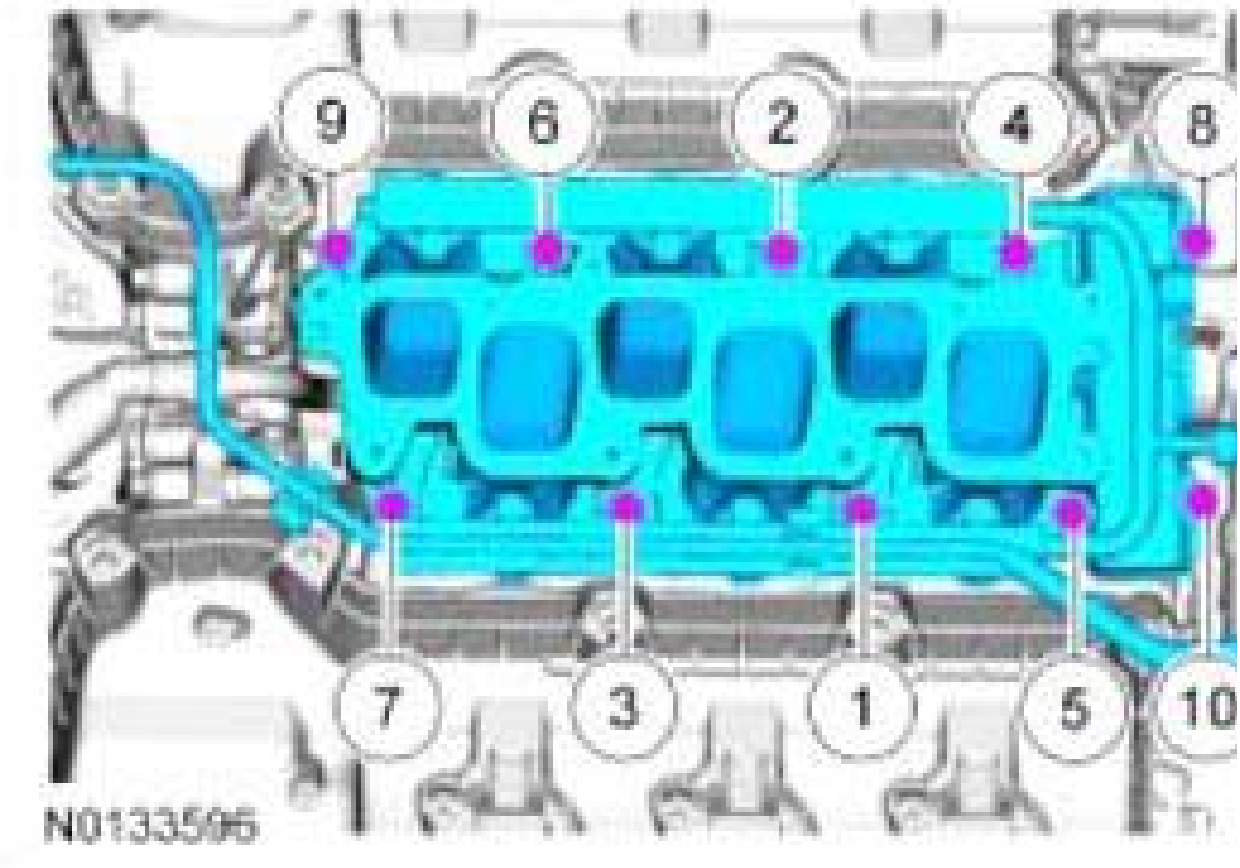


NOTE: **If the engine is repaired or replaced because of upper engine failure, typically including valve or piston damage, check the intake manifold for metal debris. If metal debris is found, install a new intake manifold. Failure to follow these instructions can result in engine damage.**

5. Using new intake manifold and thermostat housing gaskets, install the lower intake manifold and the 10 bolts.

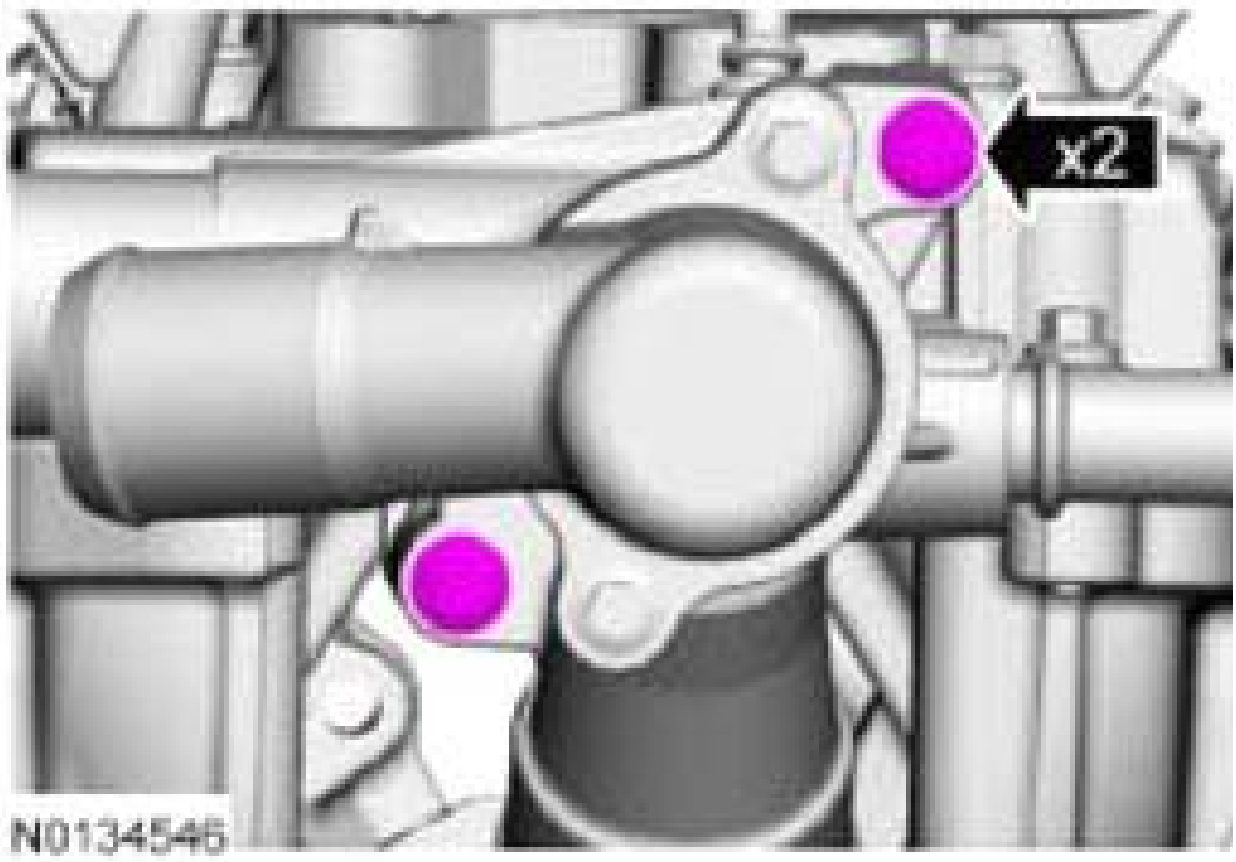
- Tighten in the sequence shown in illustration to 10 Nm (89 lb-in).

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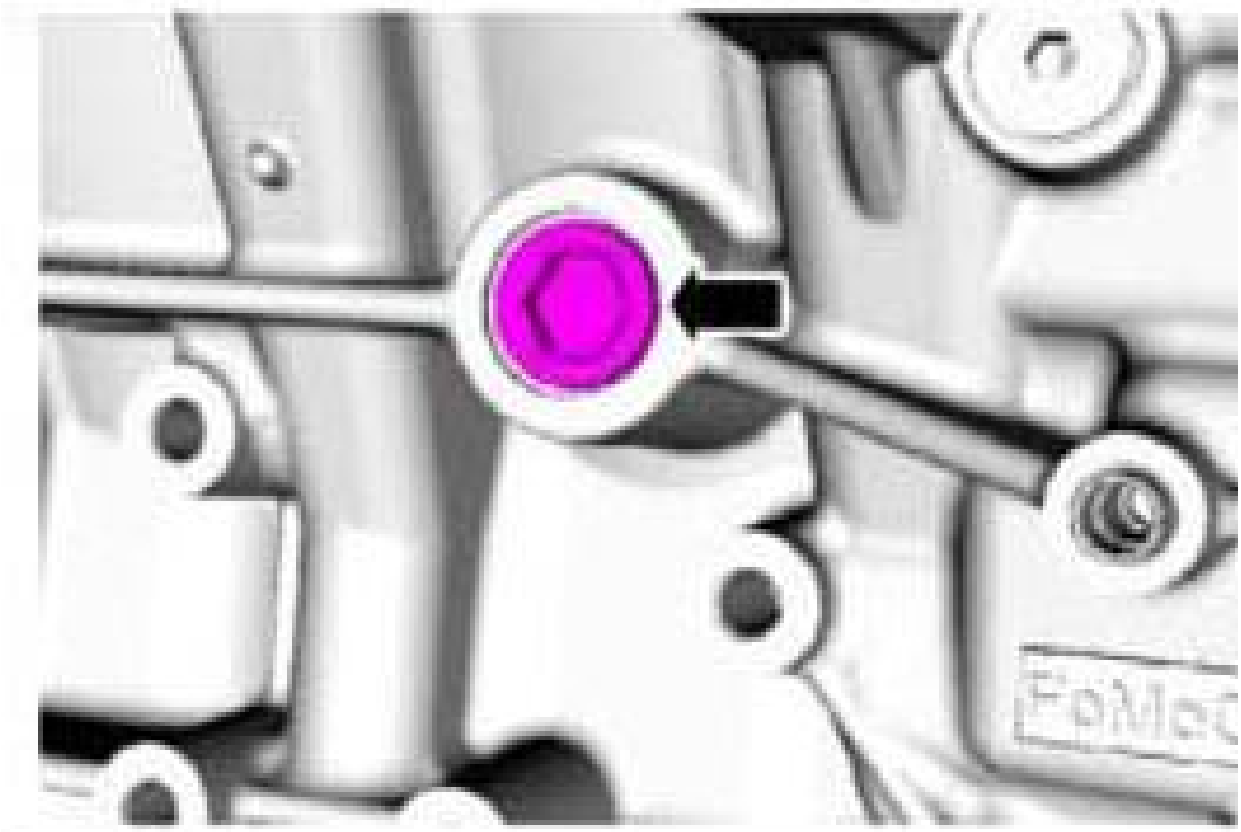
6. Install the 2 thermostat housing-to-lower intake manifold bolts.
    - Tighten to 10 Nm (89 lb-in).

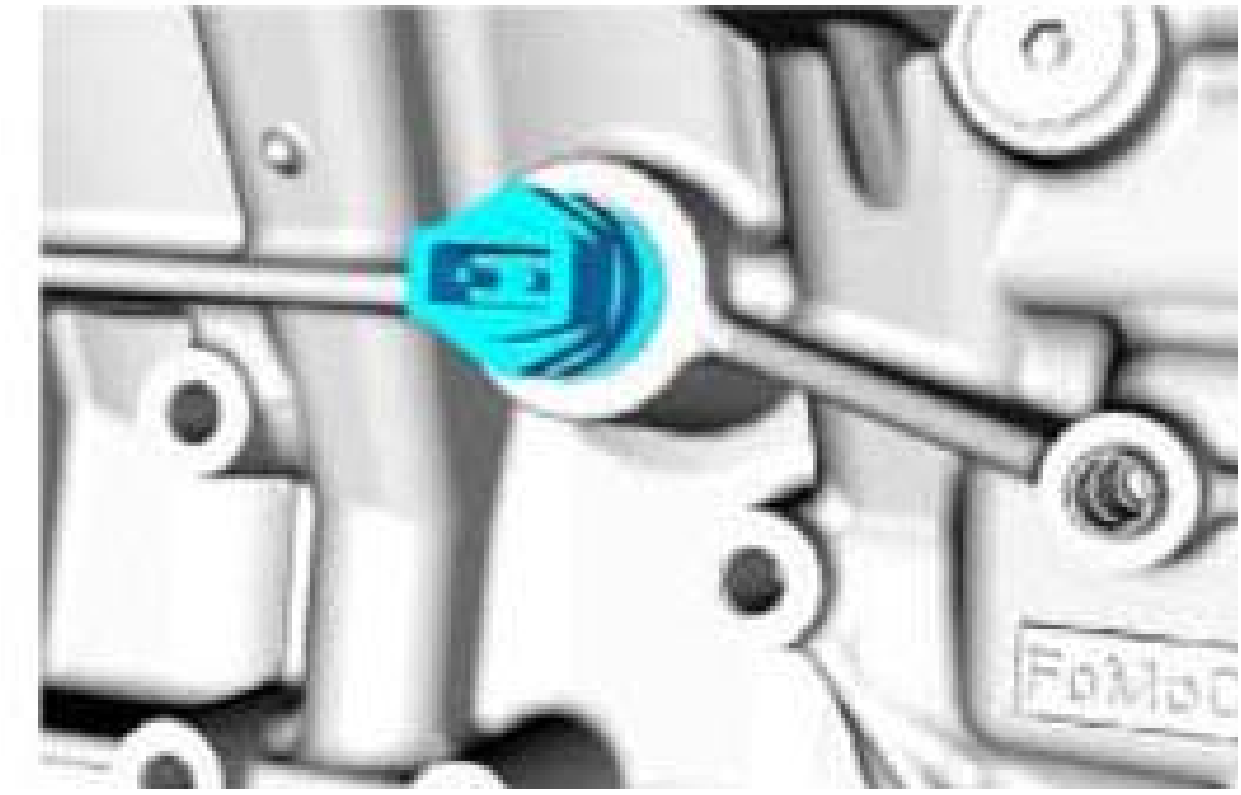
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7. If equipped, install the block heater wiring harness onto the engine.
    - Stage 1: Tighten the cylinder block drain plug to 10 Nm (89 lb-in) plus an additional 10 Nm (89 lb-in).
    - Stage 2: Tighten the block heater to 40 Nm (30 lb-ft).

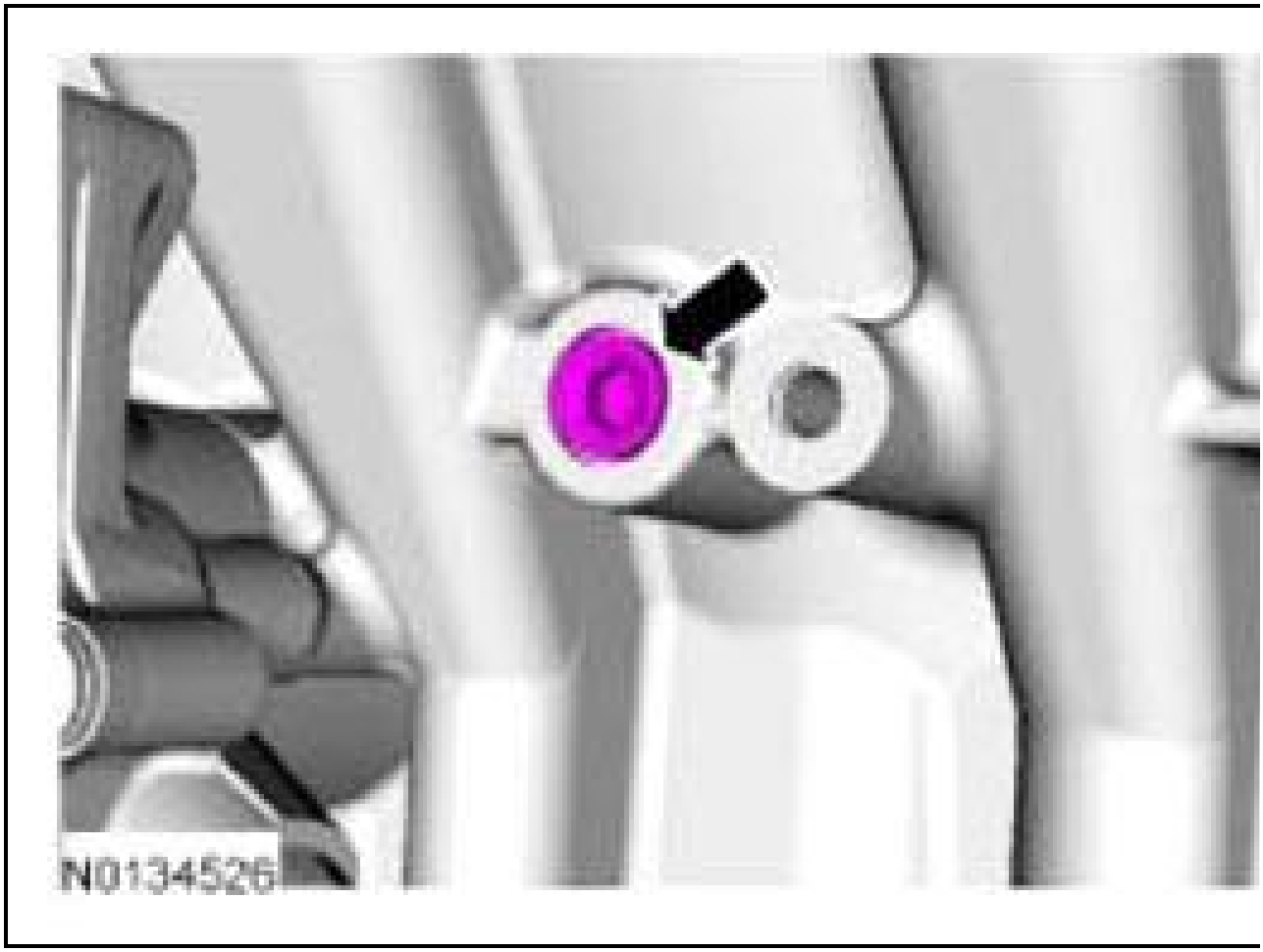
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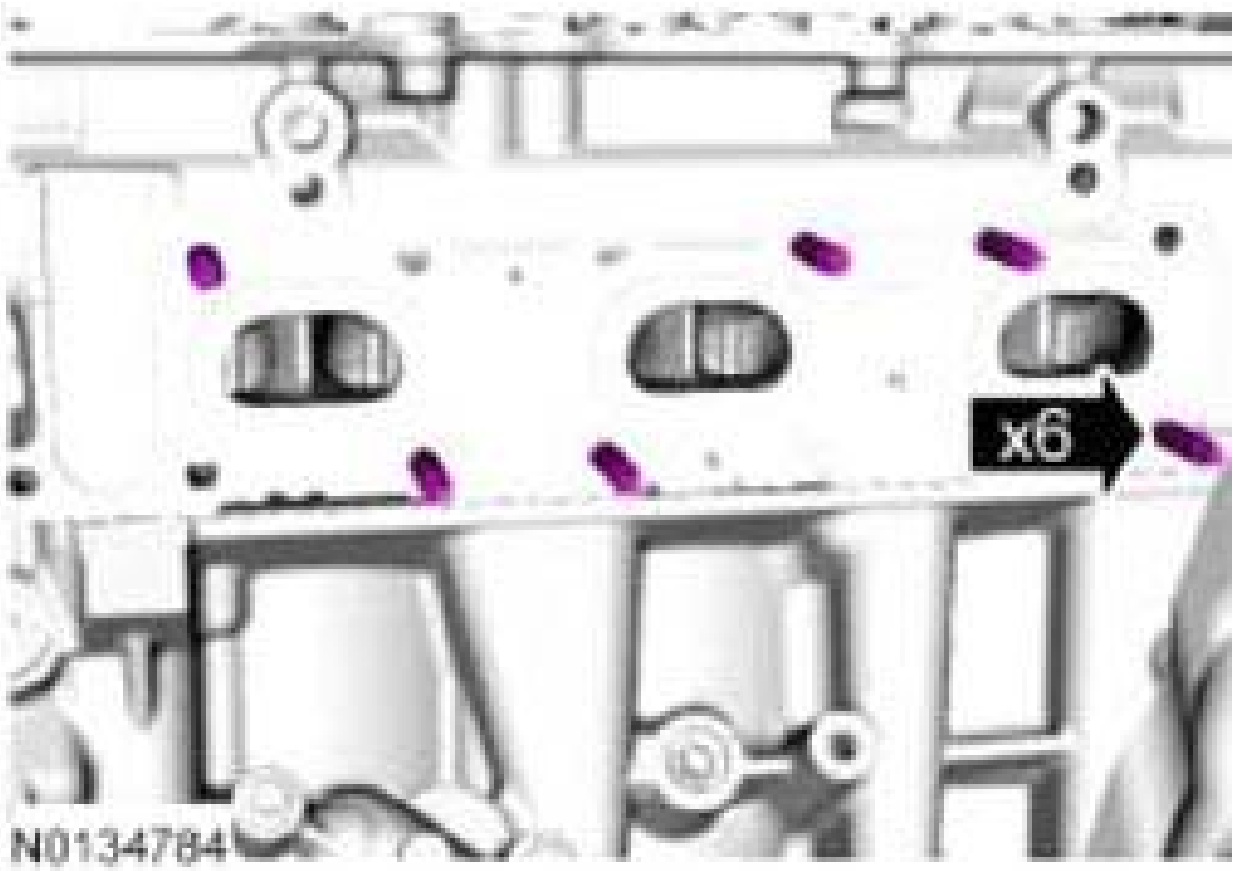
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8. Install the LH cylinder block drain plug.
    - Tighten to 16 Nm (142 lb-in) plus an additional 180 degrees.



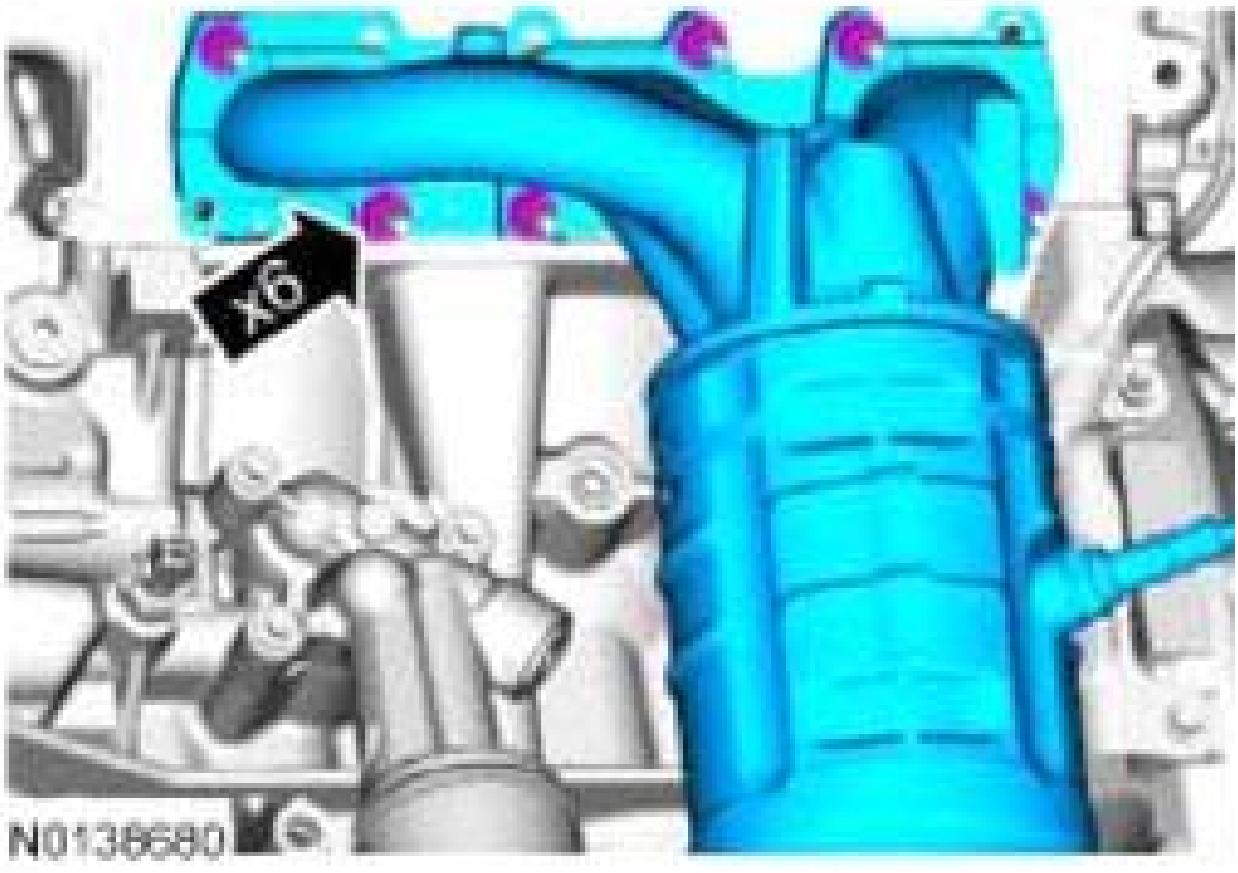
9. Install 6 new LH exhaust manifold studs.
    - Tighten to 12 Nm (106 lb-in).

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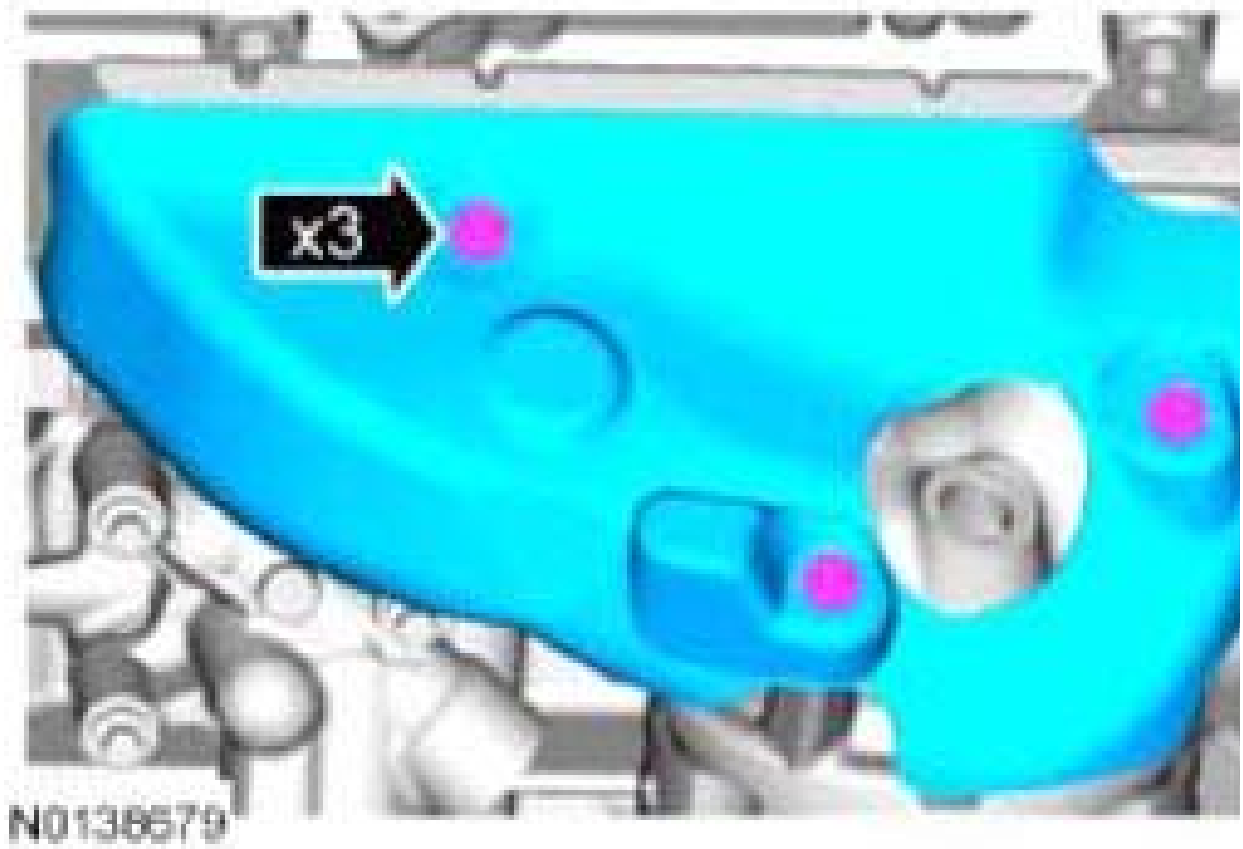
10. Using a new gasket, install the LH catalytic converter and 3 new lower LH catalytic converter manifold-to-cylinder head nuts. Tighten in 2 stages in the sequence shown in illustration:
    - Stage 1: Tighten the 3 lower LH catalytic converter manifold-to-cylinder head nuts to 25 Nm (18 lb-ft).
    - Stage 2: Install the 3 new upper LH catalytic converter manifold-to-cylinder head nuts and tighten to 25 Nm (18 lb-ft).

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11. Install the LH exhaust heat shield and the 3 bolts.
    - Tighten to 12 Nm (106 lb-in).

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12. **NOTE: Apply anti-seize to the threads of the HO2S prior to installing.**

Install the LH **HO2S** .

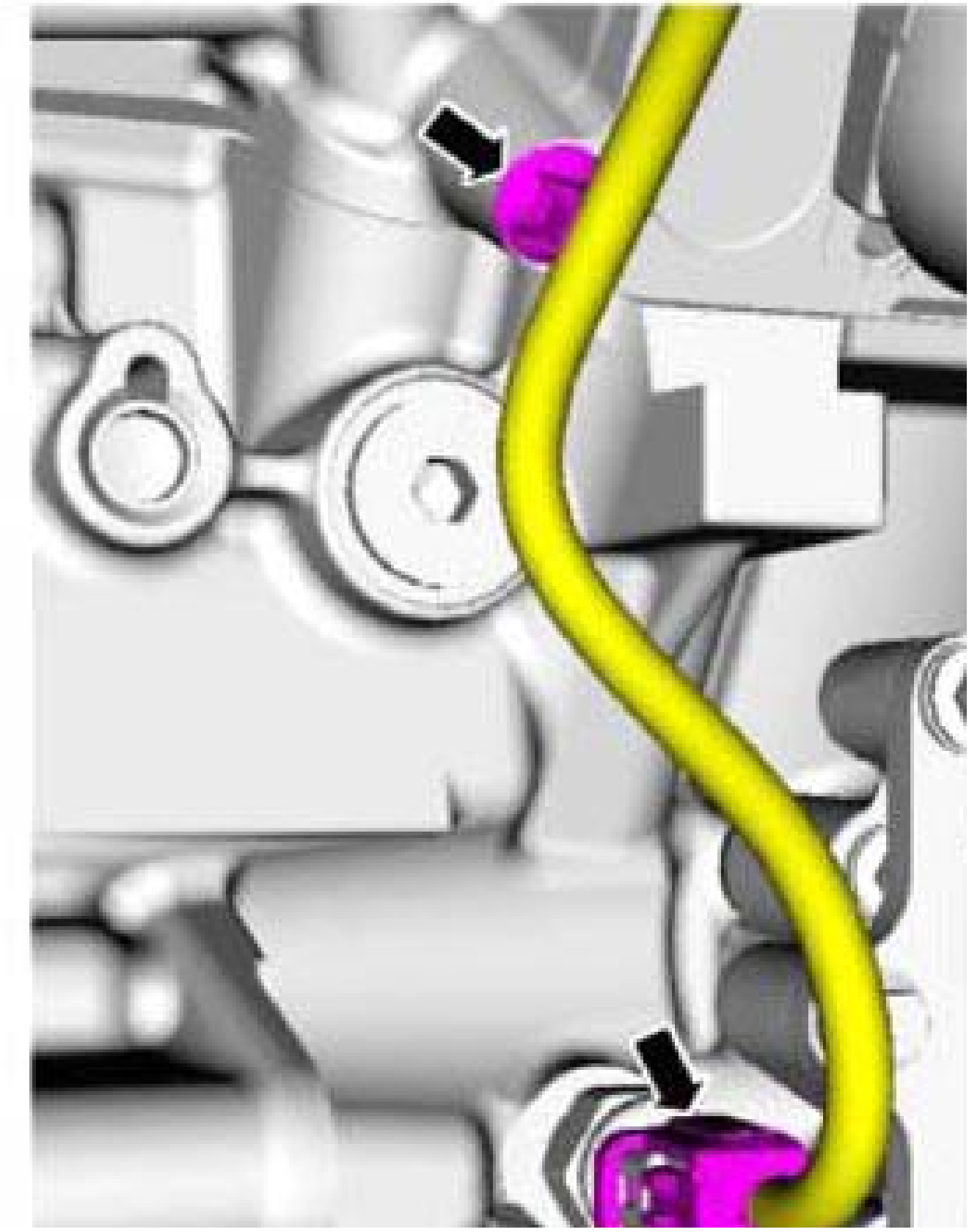
- Tighten to 48 Nm (35 lb-ft).

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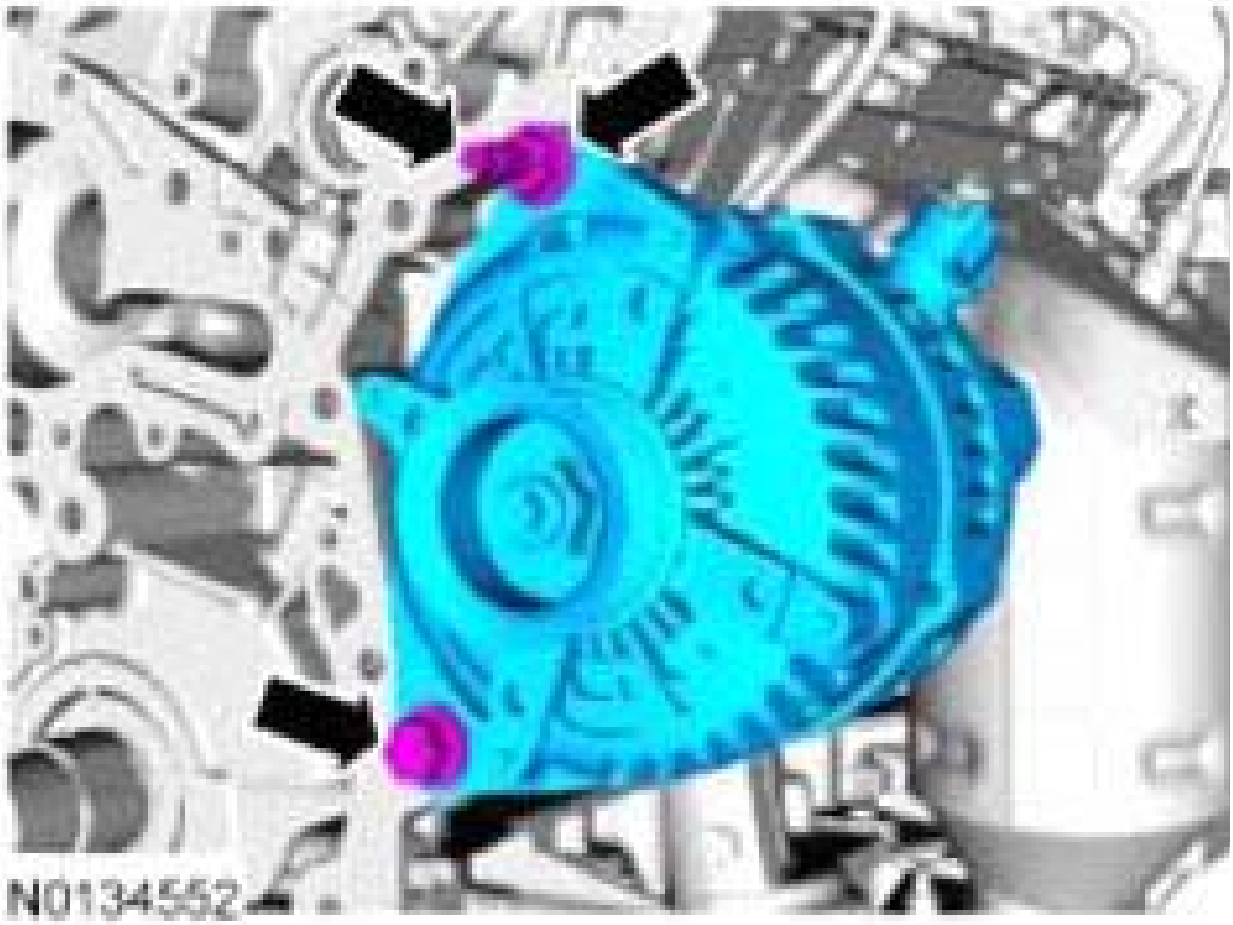
13. Connect the **EOP** switch electrical connector and the wiring harness pin-type retainer.

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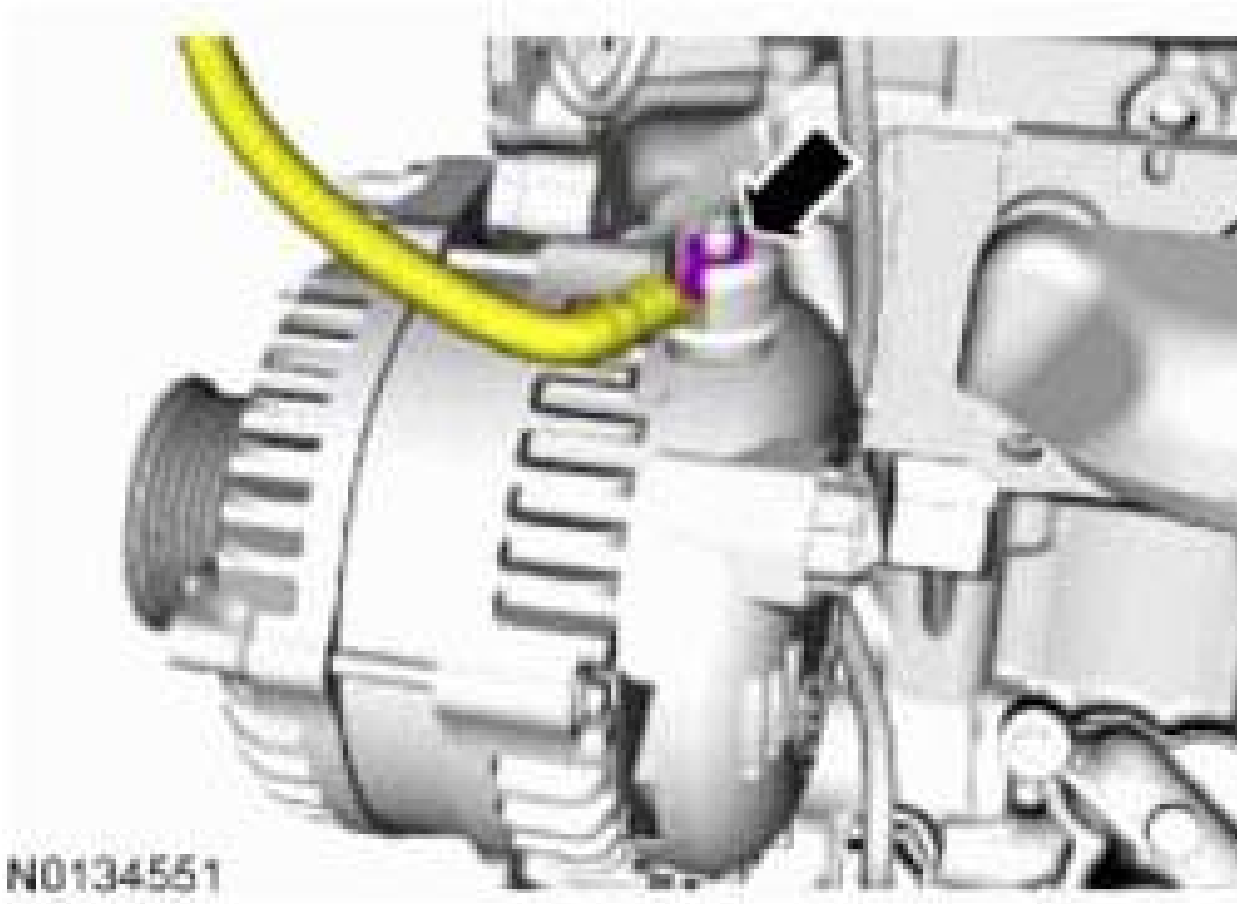
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14. Install the generator stud, generator and the nut and bolt.
    - Tighten the stud to 8 Nm (71 lb-in).
    - Tighten the nut and bolt to 48 Nm (35 lb-ft).



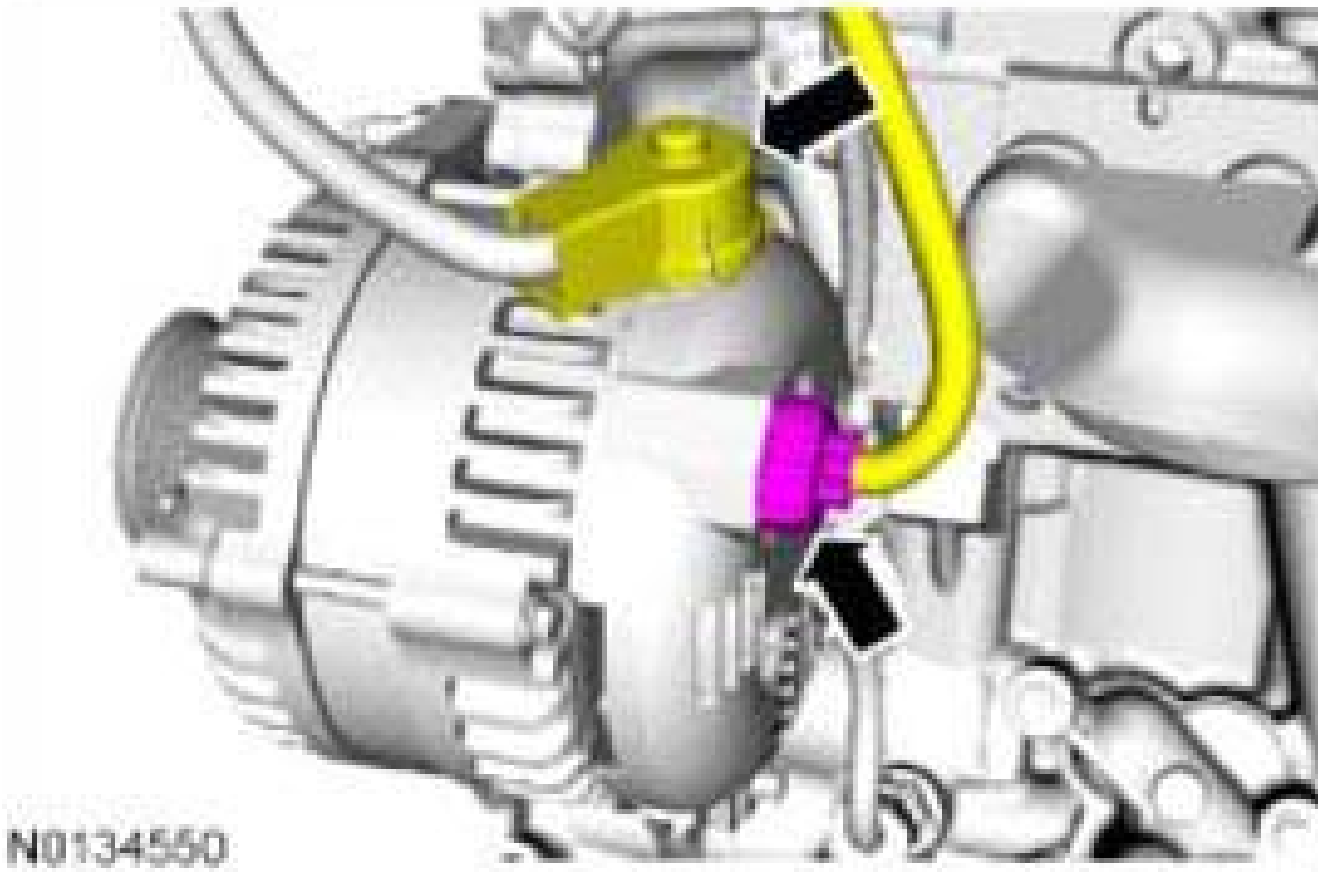
15. Connect the generator B+ cable and install the nut.
    - Tighten to 17 Nm (150 lb-in).

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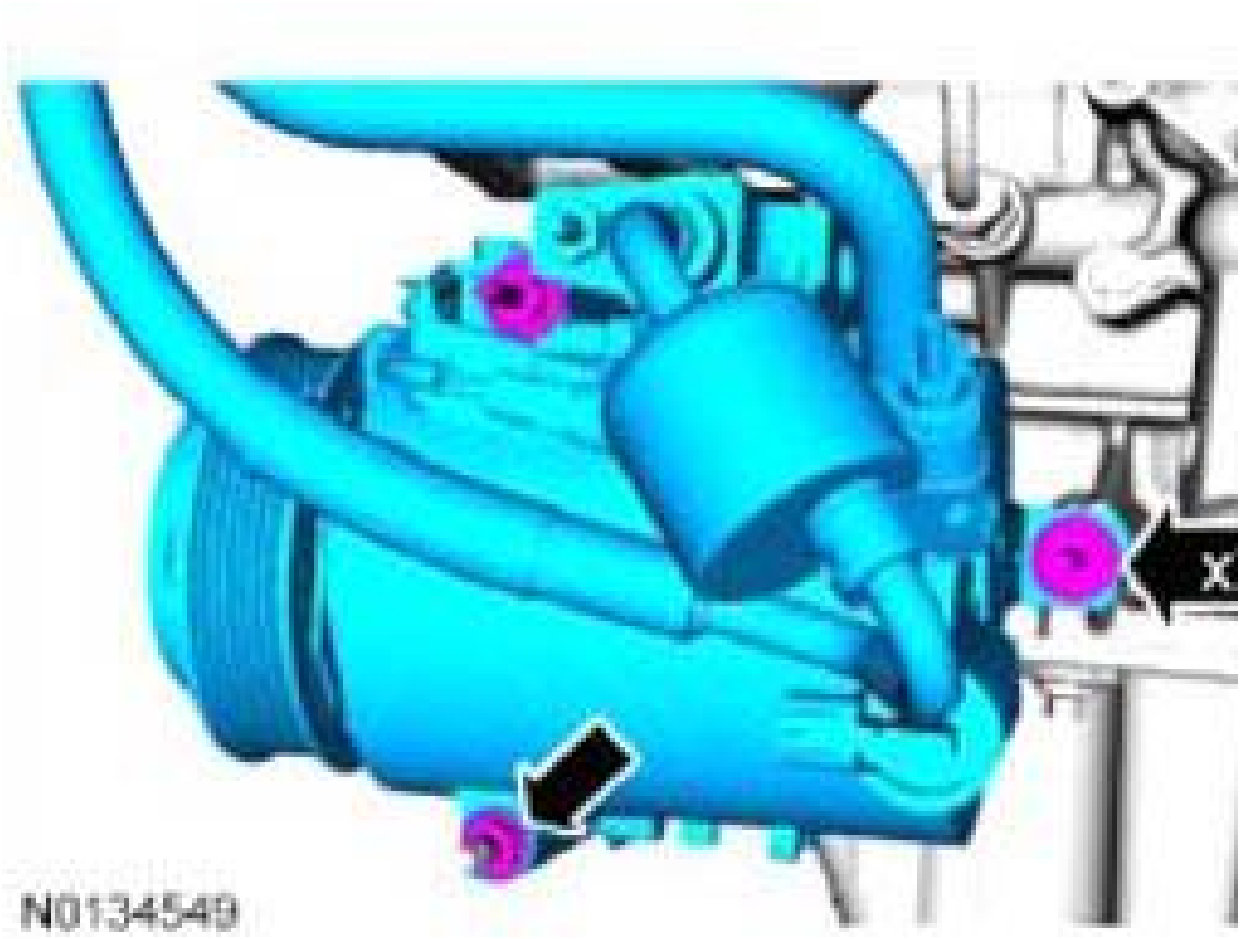
16. Position back the generator B+ cable cover and connect the generator electrical connector.

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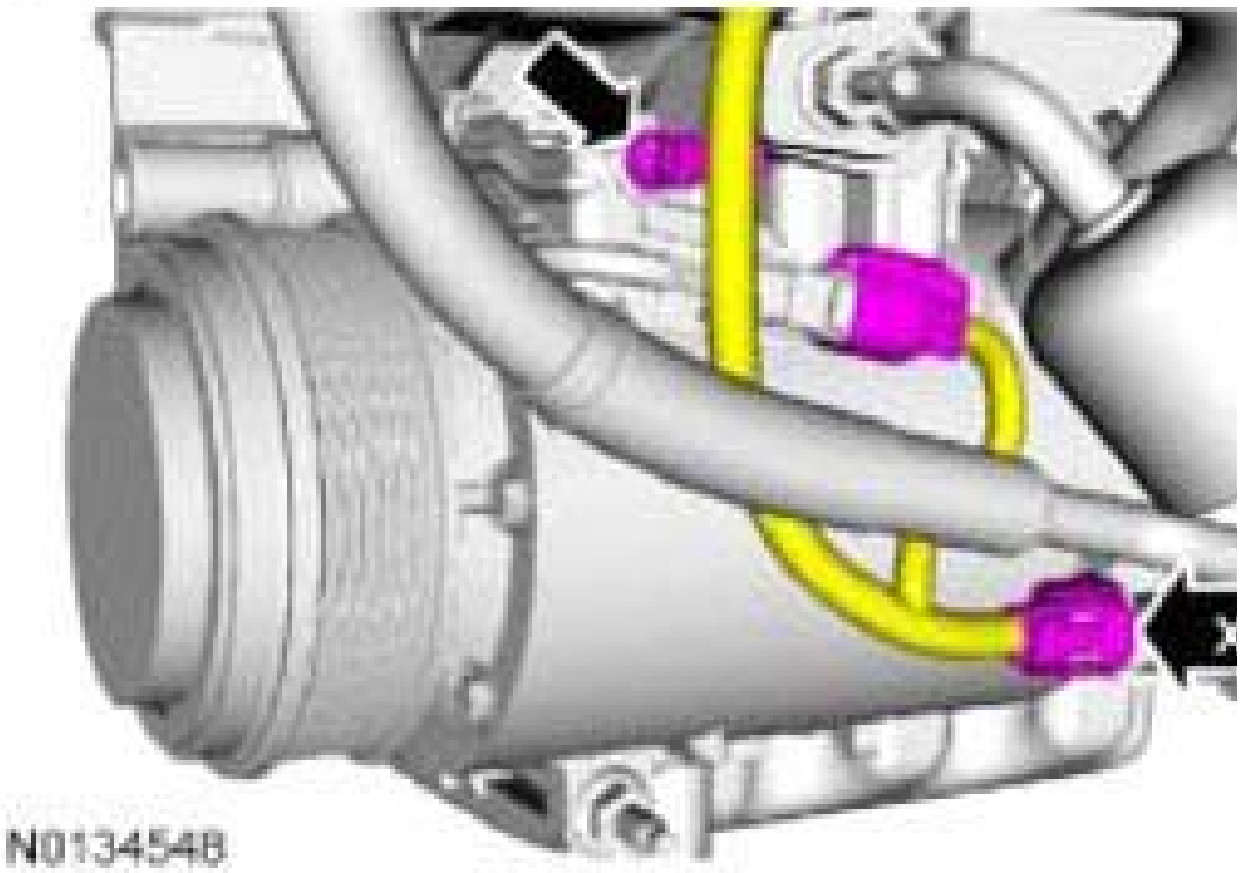
17. Install the A/C compressor the nut and the 2 stud bolts.
    - Tighten to 25 Nm (18 lb-ft).

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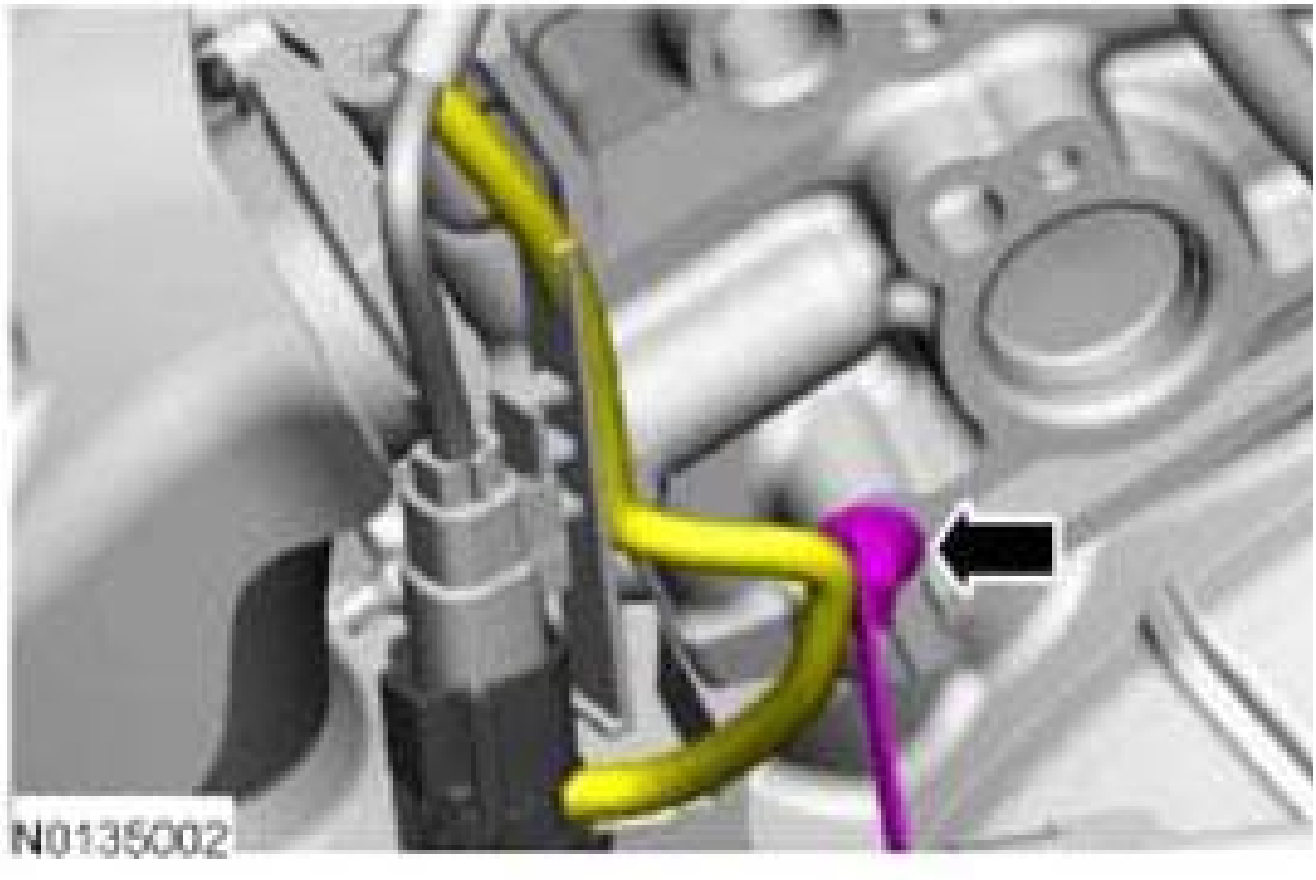
18. Connect the 2 A/C compressor electrical connectors.
    - Attach the A/C wiring harness retainer.

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19. Install the wiring harness retainer to the rear of the LH cylinder head.

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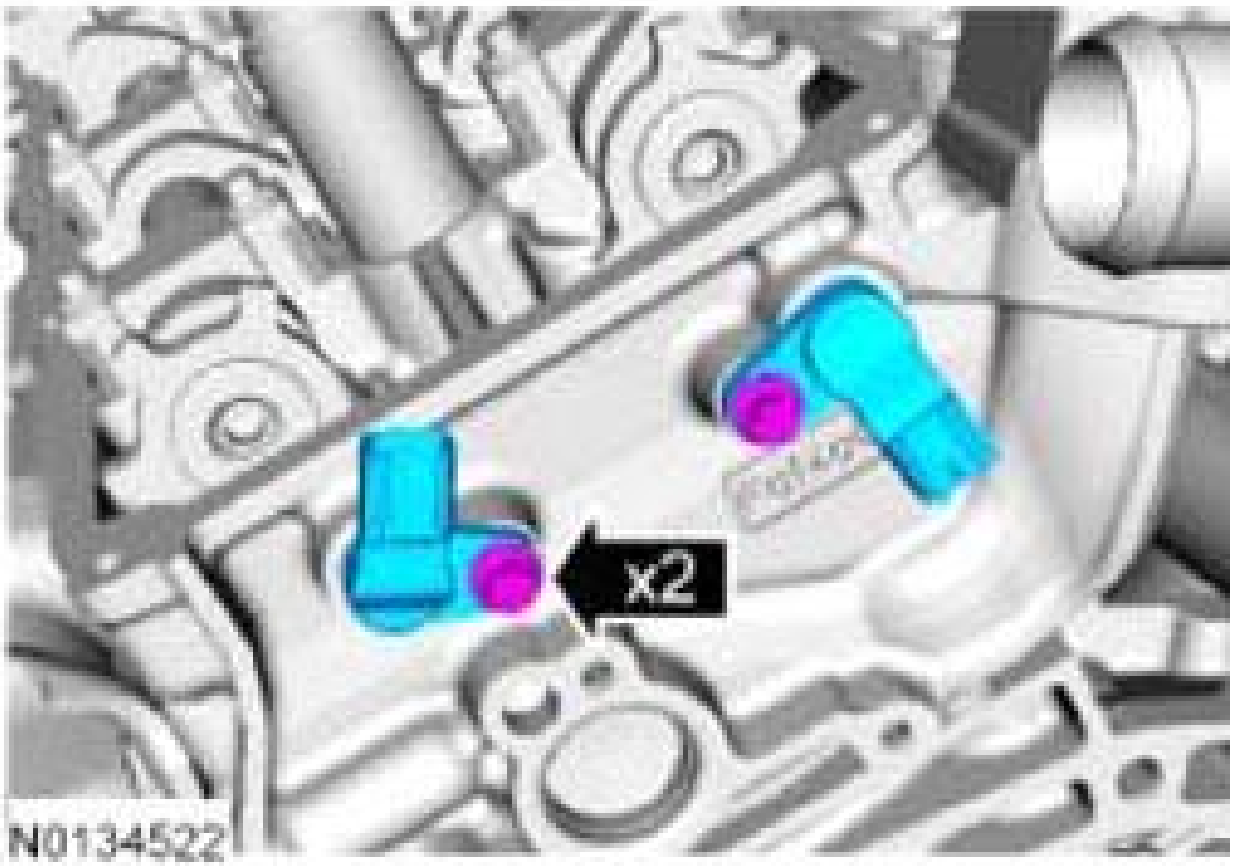


NOTE: Lubricate the CMP sensor O-ring seal with clean engine oil before installing the CMP sensor.

20. Install the 2 **CMP** sensors and the 2 bolts.

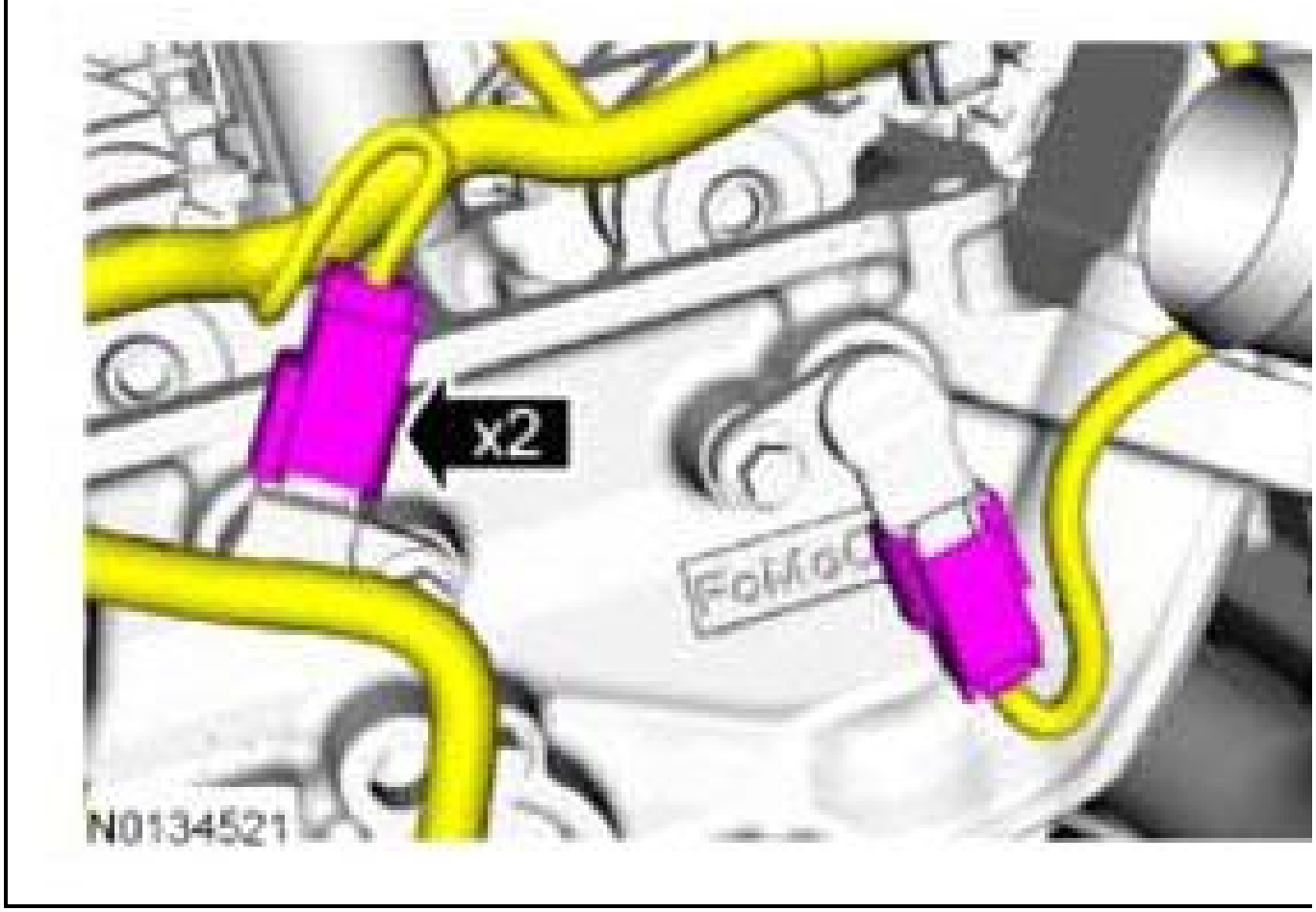
- Tighten to 10 Nm (89 lb-in).

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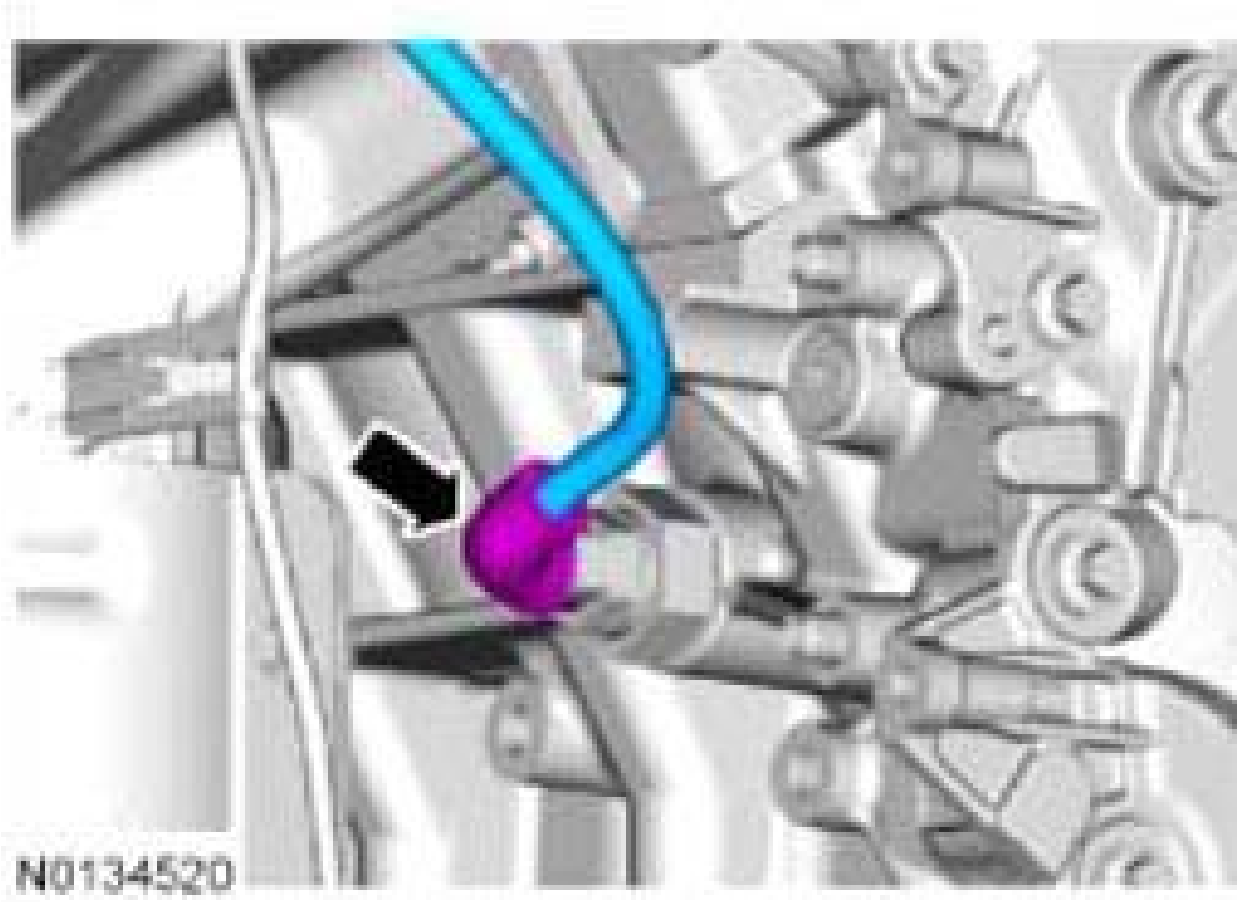
21. Connect the 2 LH **CMP** sensor electrical connectors.

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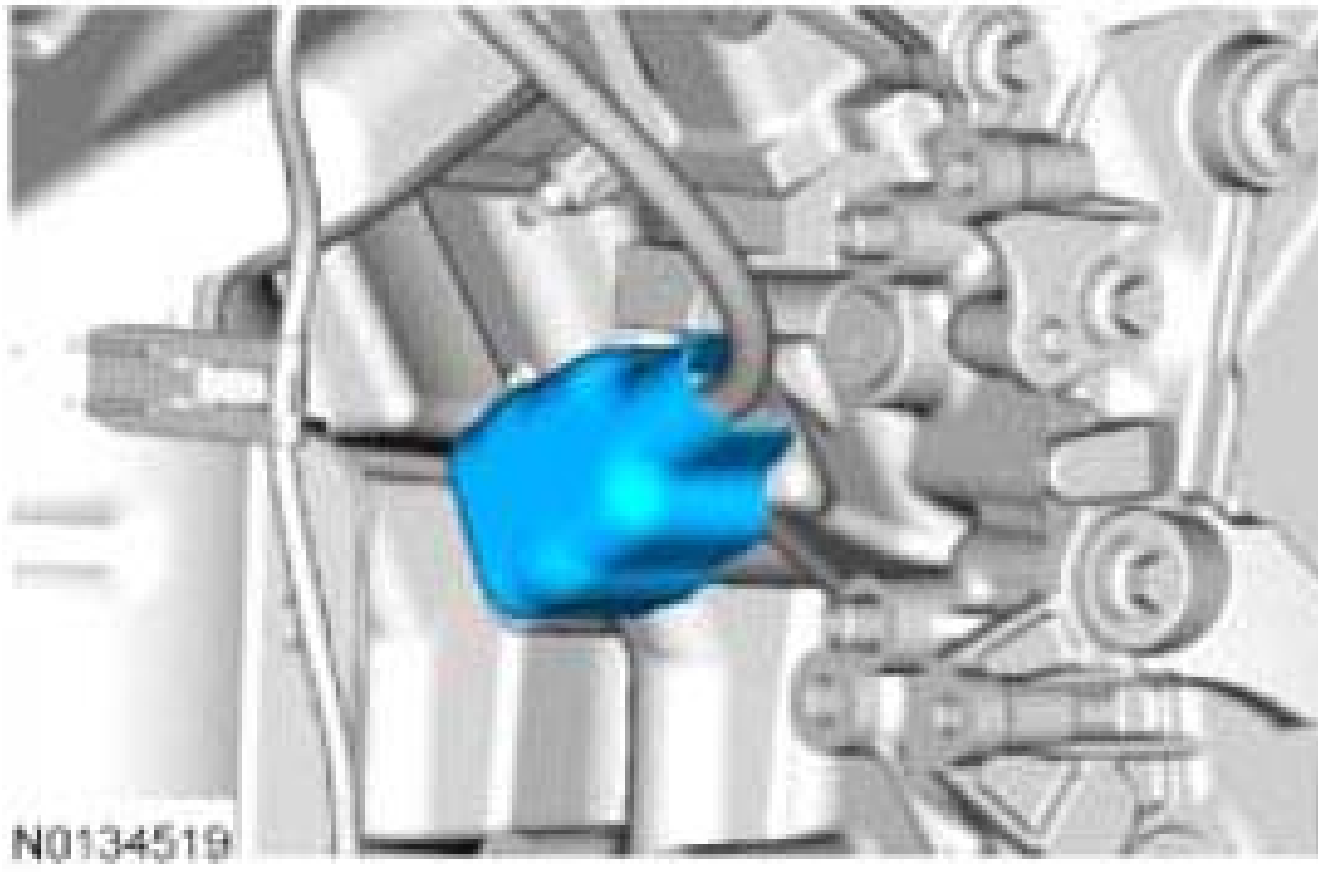
22. If equipped, connect the block heater electrical connector.
    - Install the block heater wiring harness to the engine.

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23. If equipped, install the block heater heat shield.

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24. Install the LH camshafts. REFER to **CAMSHAFT**, **INSTALLATION**.

CYLINDER HEAD - RH

MATERIAL SPECIFICATIONS

Item	Specification
Motorcraft® Metal Surface Prep ZC-31-A	-
Motorcraft® SAE 5W-20 Premium Synthetic Blend Motor Oil (US); Motorcraft® SAE 5W-20 Super Premium Motor Oil (Canada) XO-5W20-QSP (US); CXO-5W20-LSP12 (Canada)	WSSM2C945-A
Motorcraft® Silicone Gasket Remover ZC-30	-

Removal

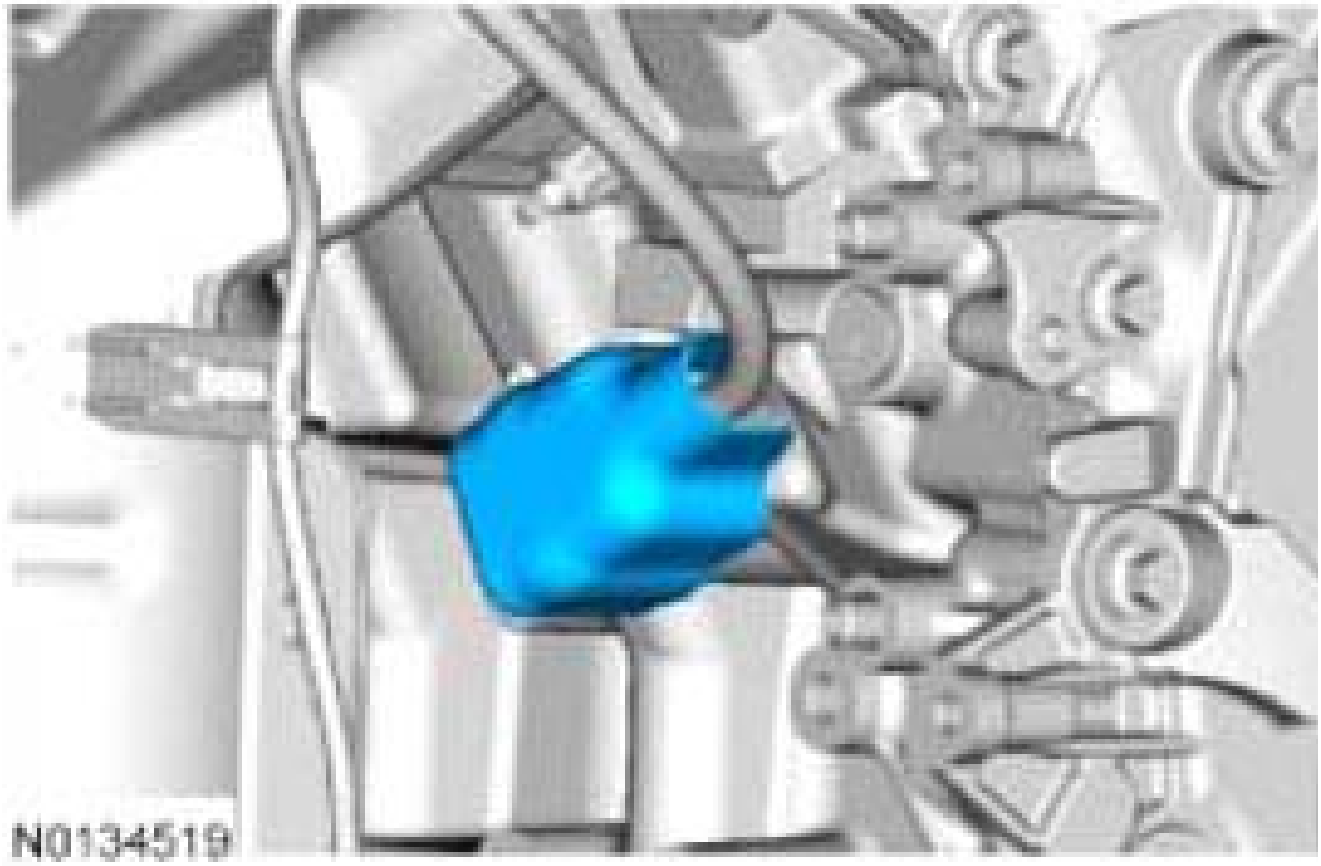
WARNING: Before beginning any service procedure, refer to SAFETY WARNINGS . Failure to follow this instruction may result in serious personal injury.

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NOTE: **Place clean shop towels over exposed engine cavities. Carefully remove the towels so foreign material is not dropped into the engine. Any foreign material (including any material created while cleaning gasket surfaces) that enters the oil passages or the oil pan, may cause engine failure.**

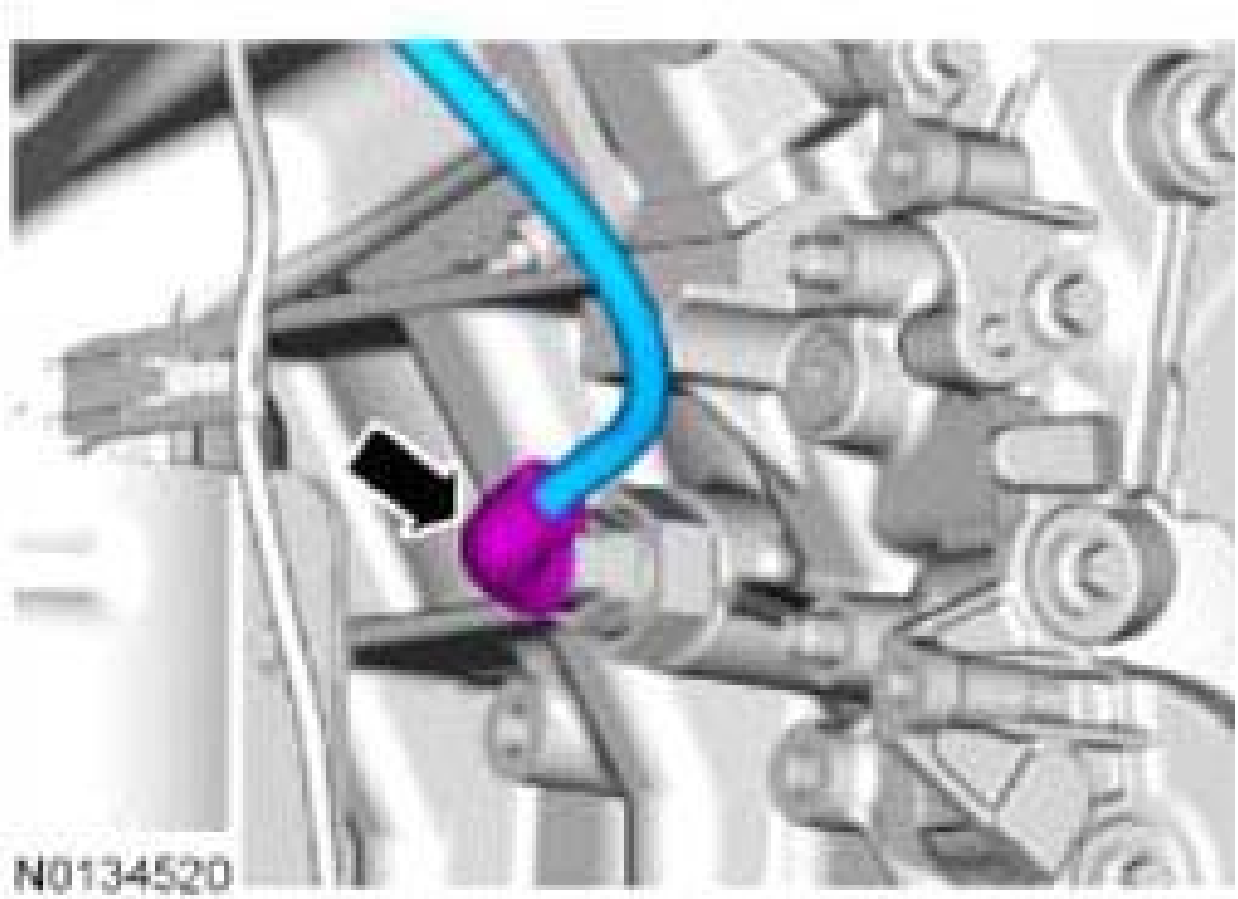
NOTE: **If the cylinder head is replaced, a new secondary timing chain tensioner will need to be installed.**

1. Remove the RH camshafts. Refer to **CAMSHAFT**.
2. If equipped, remove the block heater heat shield.



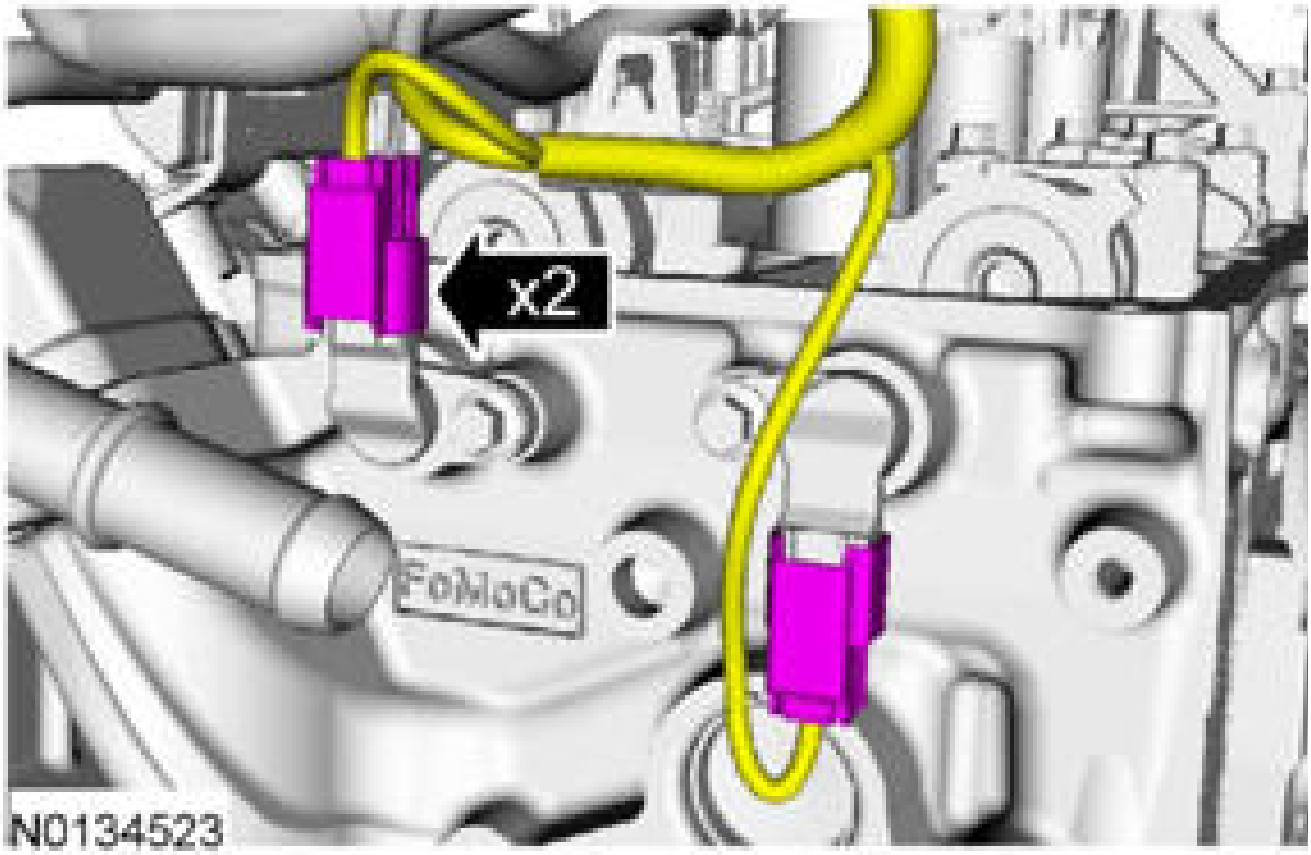
3. If equipped, disconnect the block heater electrical connector.
   - Remove the block heater wiring harness from the engine.

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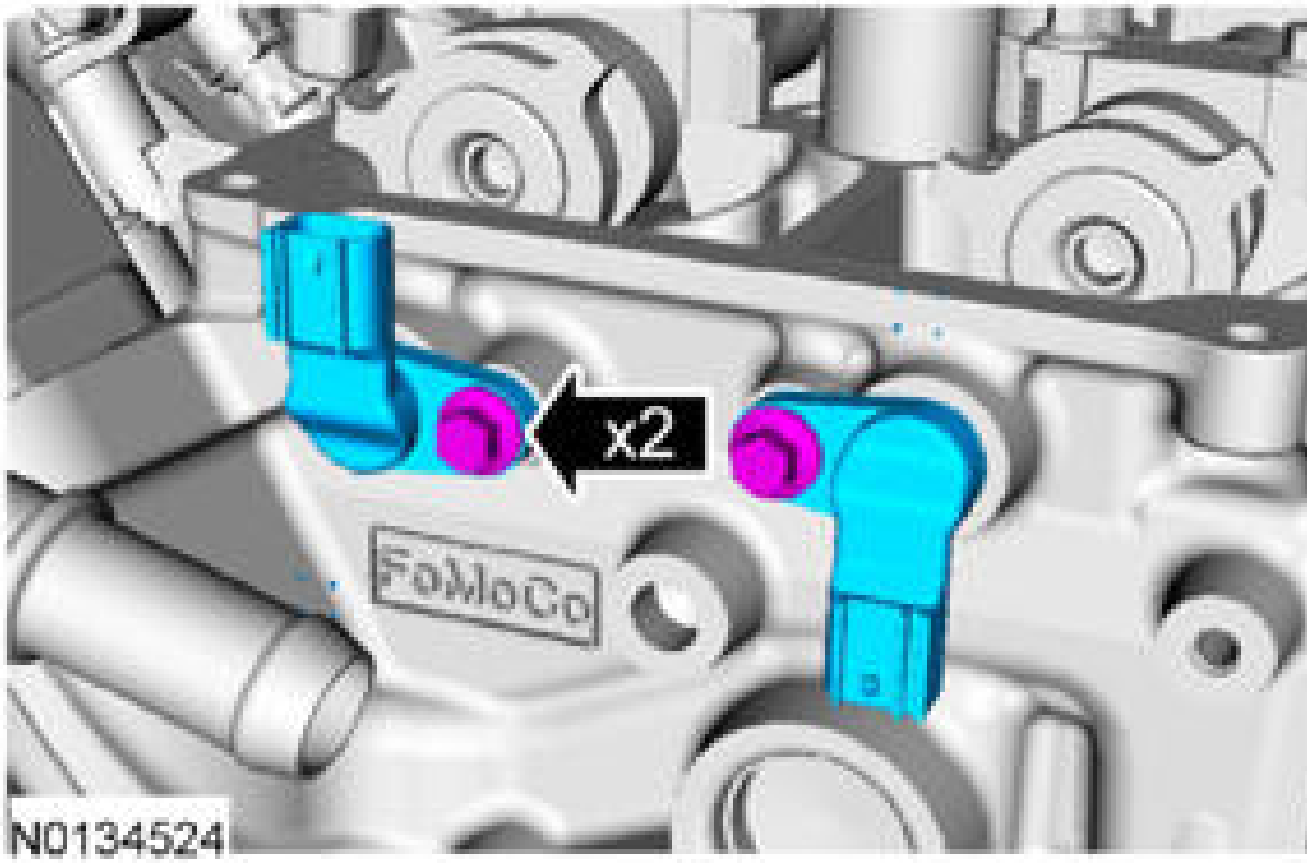
4. Disconnect the 2 RH **CMP** sensor electrical connectors.

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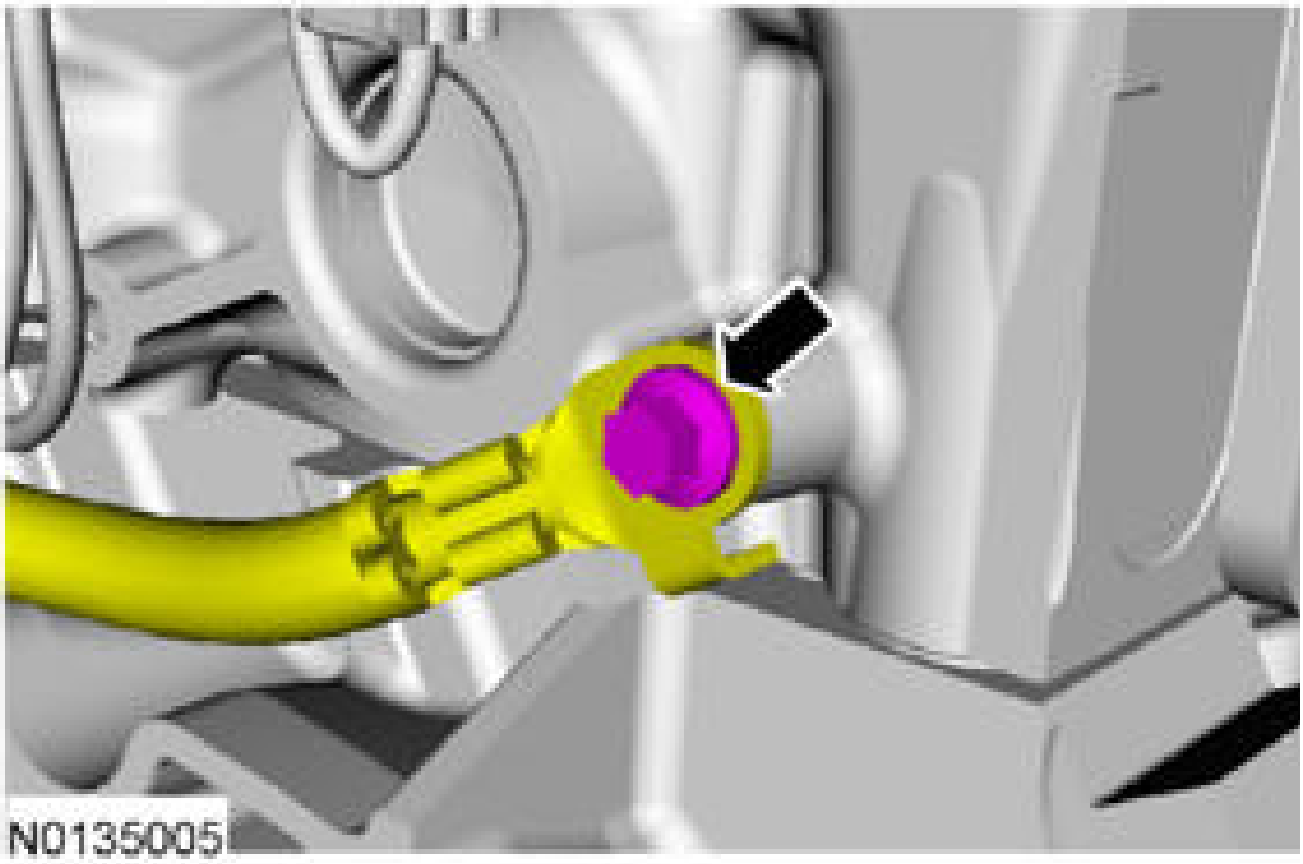
5. Remove the 2 bolts and the 2 **CMP** sensors.

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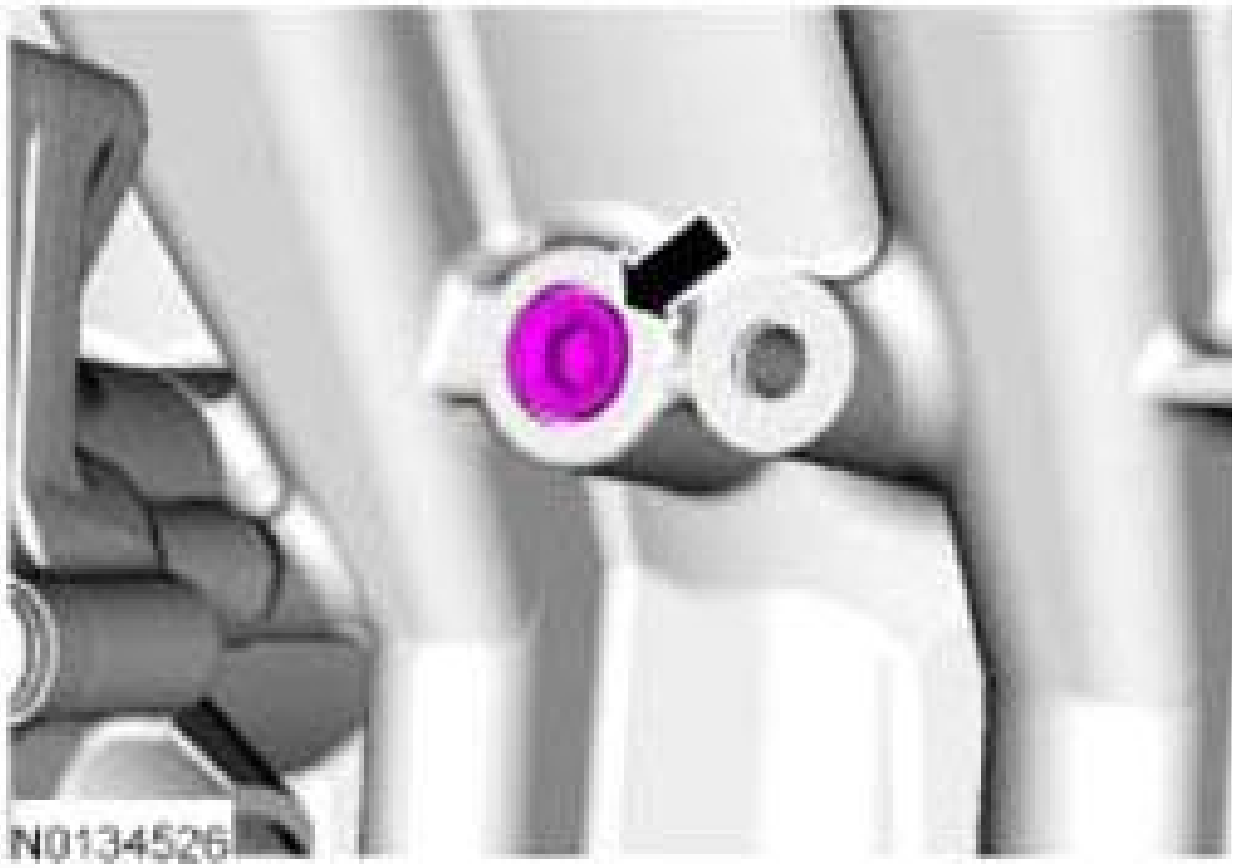
6. Remove the bolt and the ground cable from the RH cylinder head.

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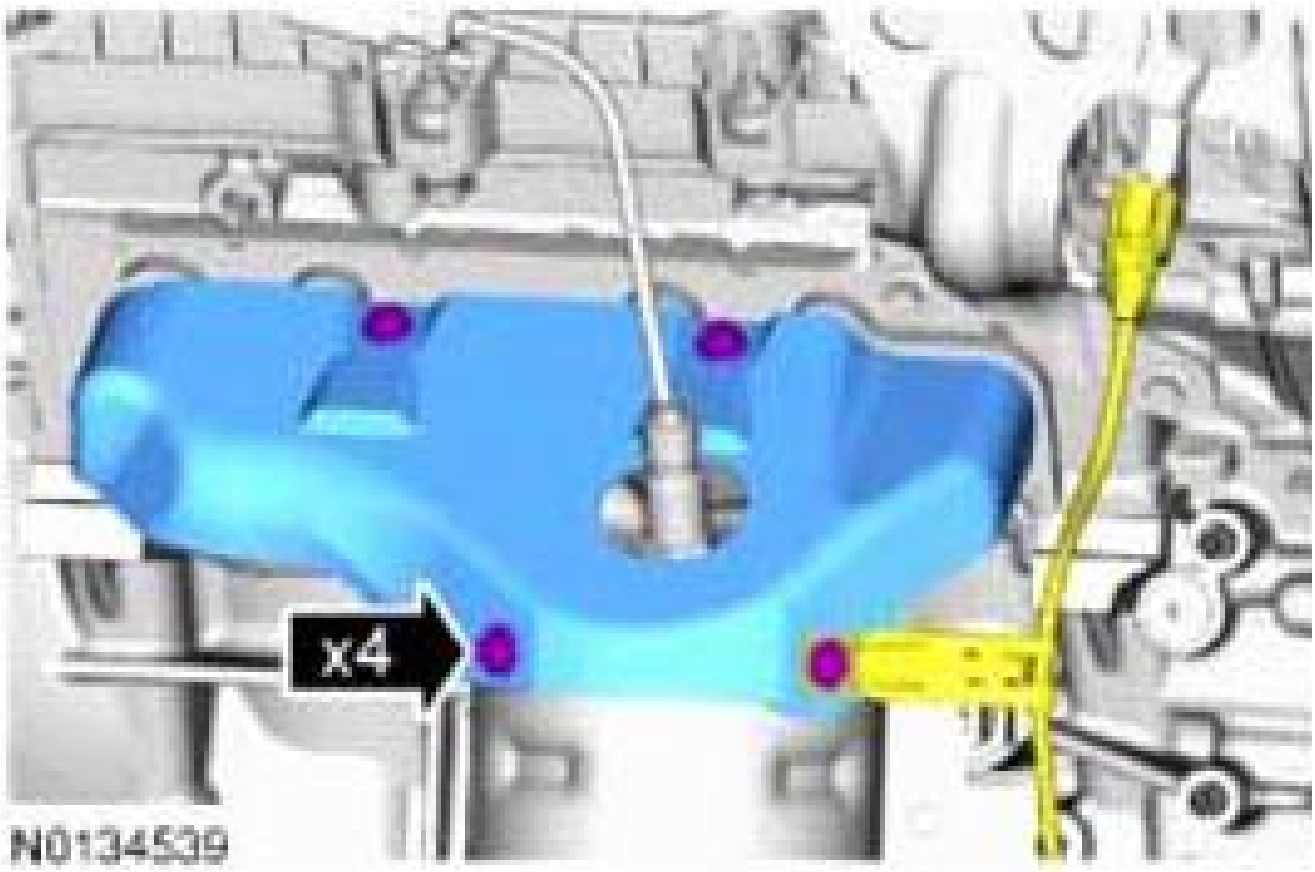
7. Remove the LH cylinder block drain plug.
    - Allow coolant to drain from the cylinder block.

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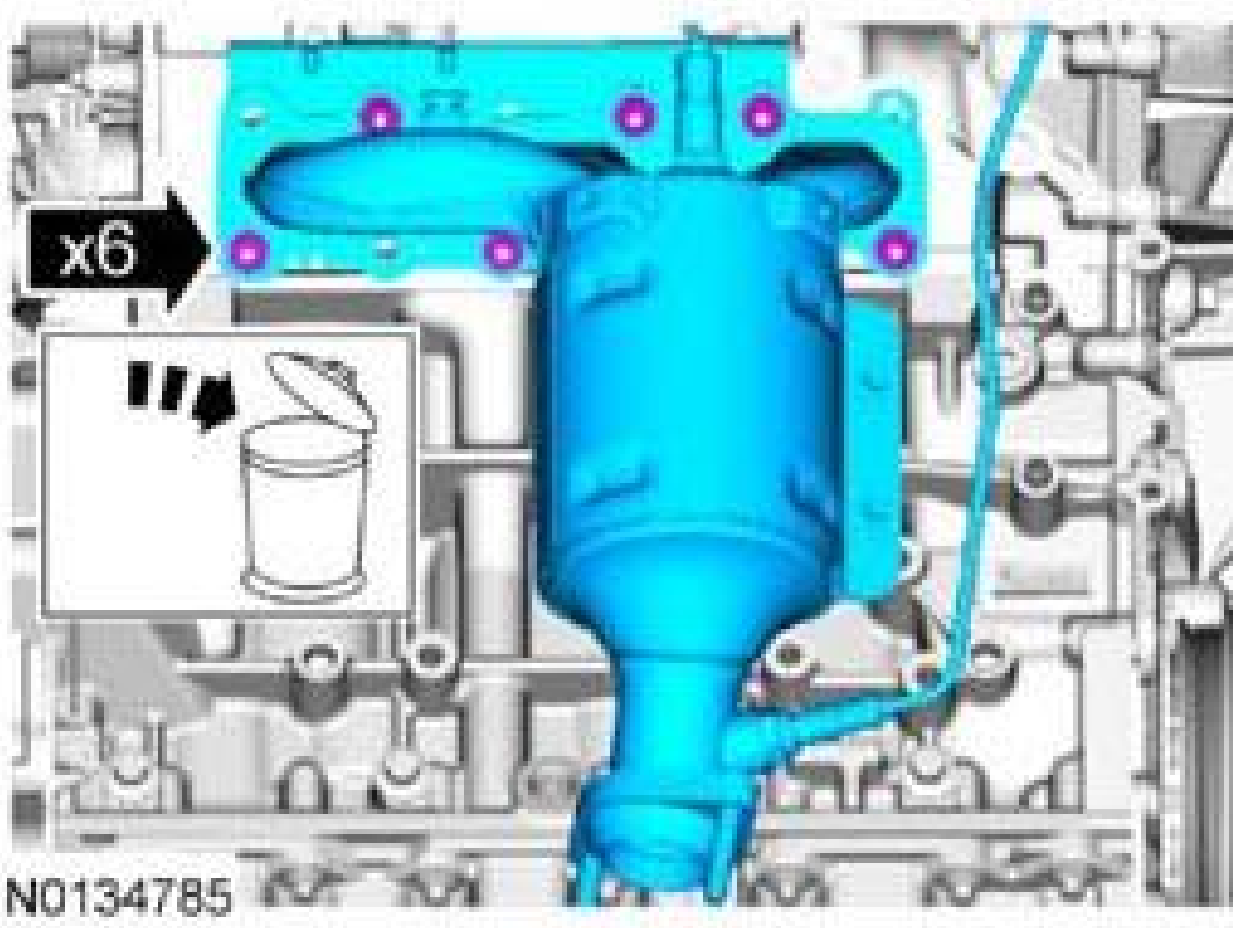
8. Remove the 4 bolts and the RH catalytic converter heat shield.

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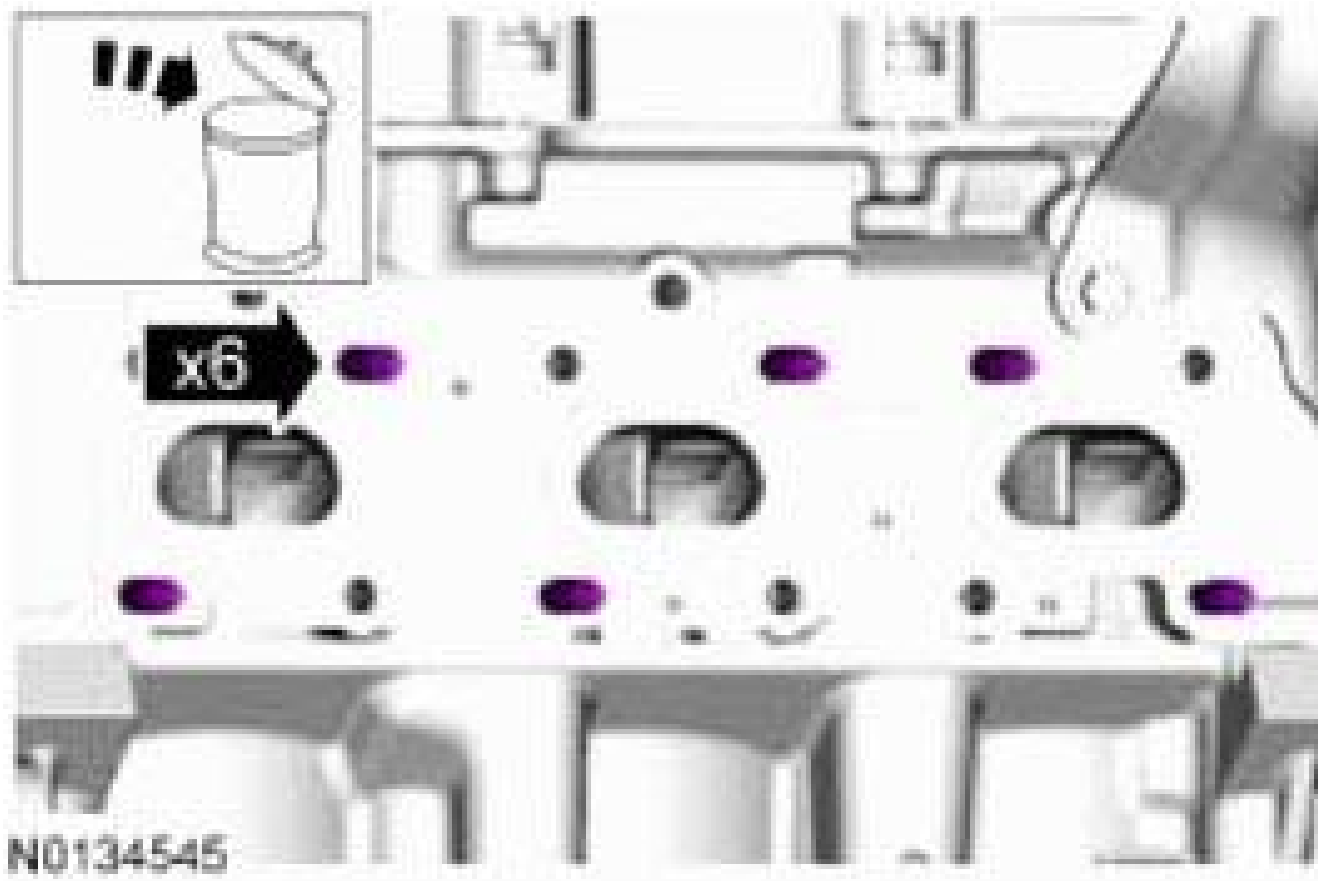
9. Remove the 6 nuts and the RH catalytic converter manifold.
    - Discard the nuts and catalytic converter gasket.

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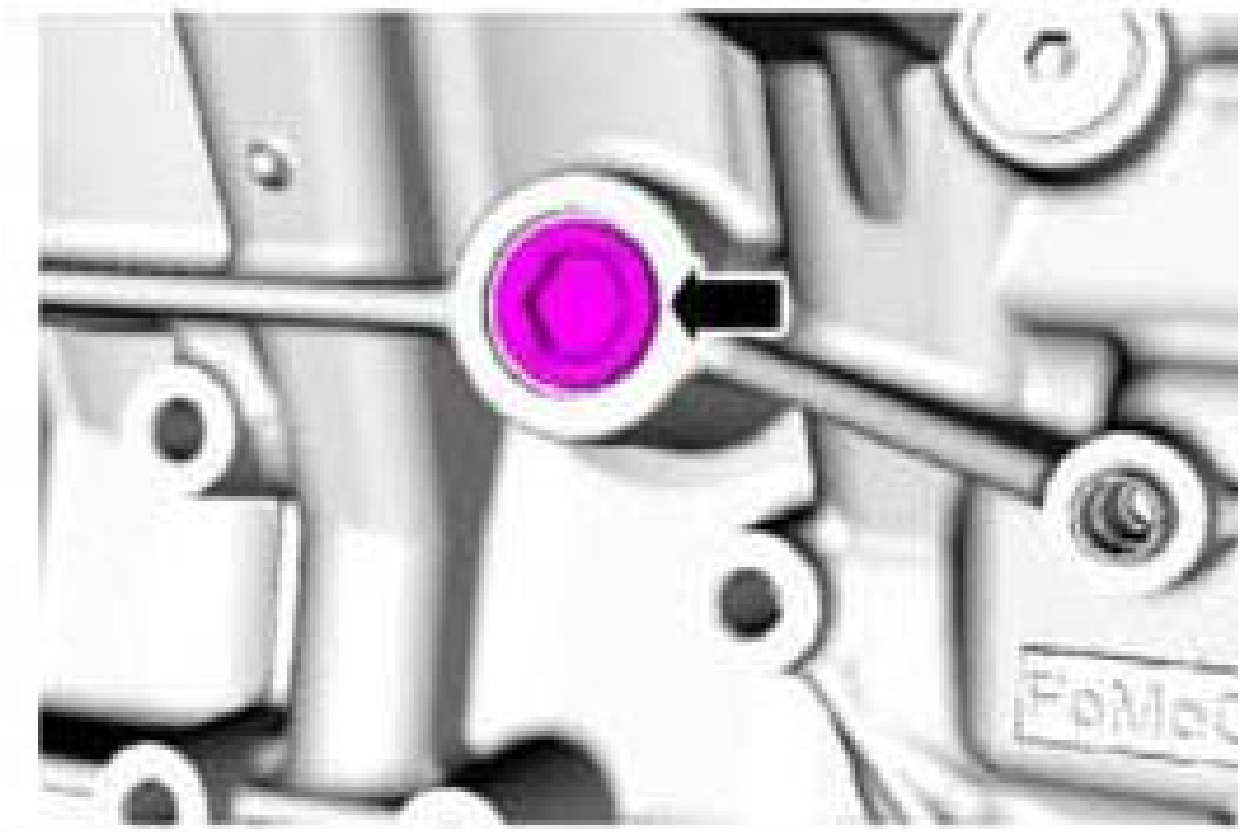
10. Clean and inspect the RH exhaust manifold. REFER to **EXHAUST MANIFOLD CLEANING AND INSPECTION** .
11. Remove and discard the 6 RH exhaust manifold studs.

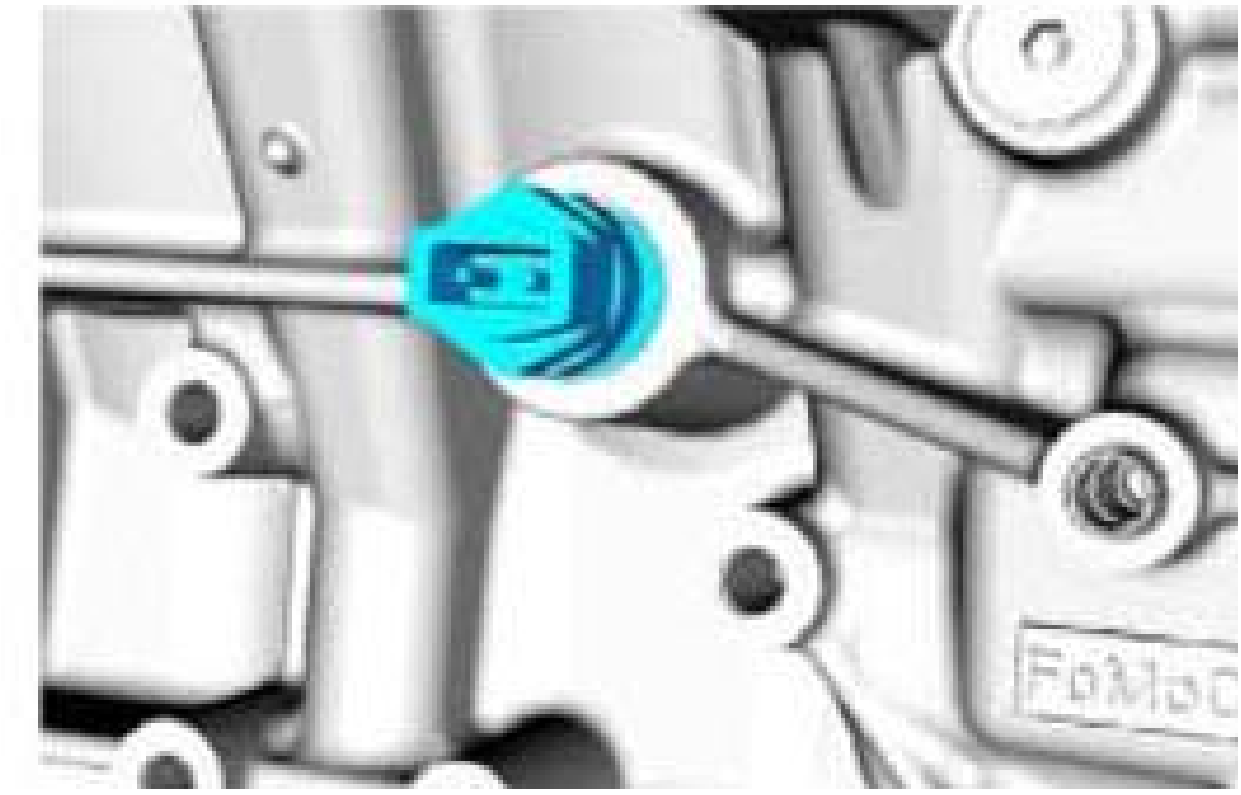
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12. Remove the RH cylinder block drain plug or, if equipped, the block heater.
    - Allow coolant to drain from the cylinder block.

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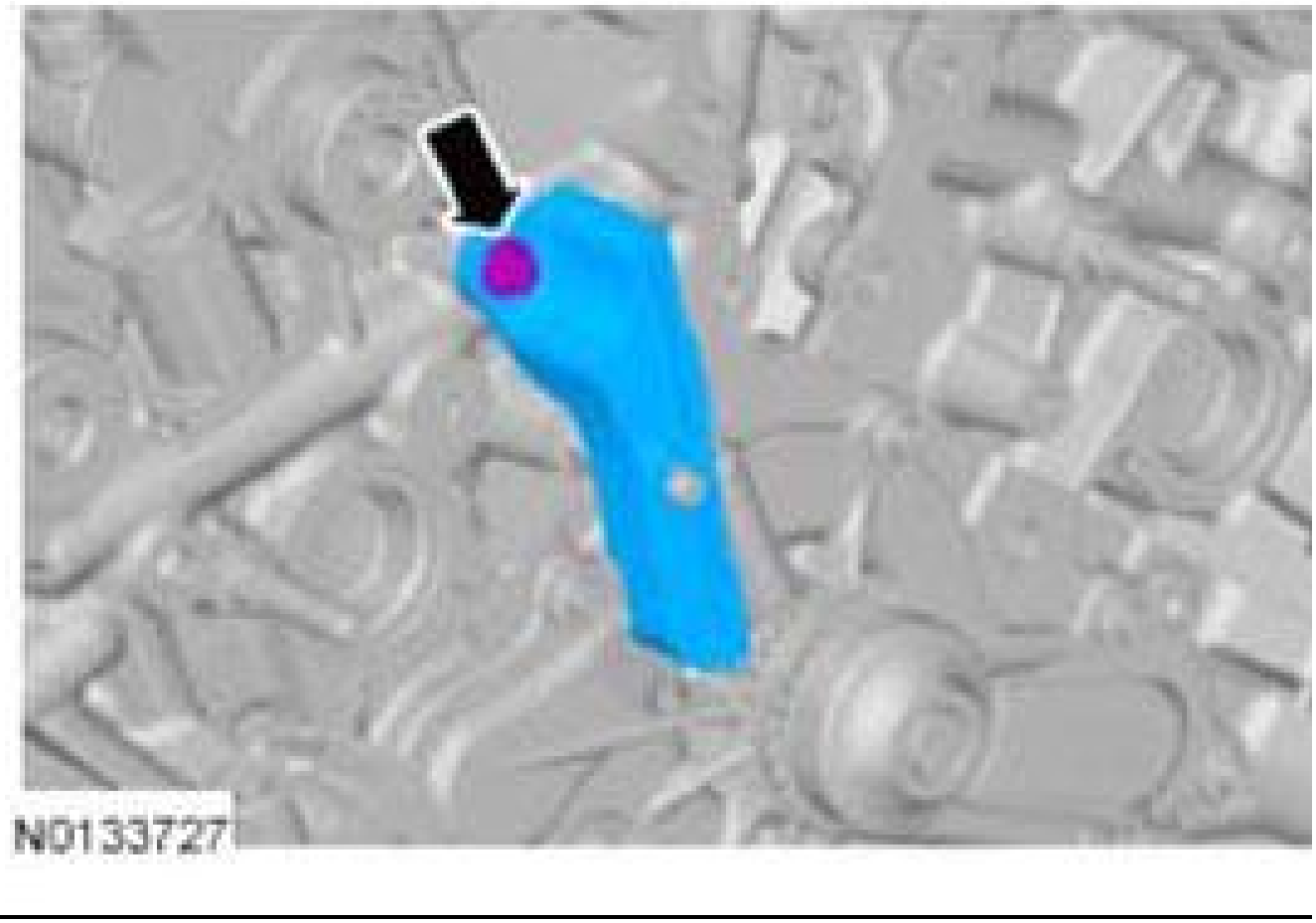




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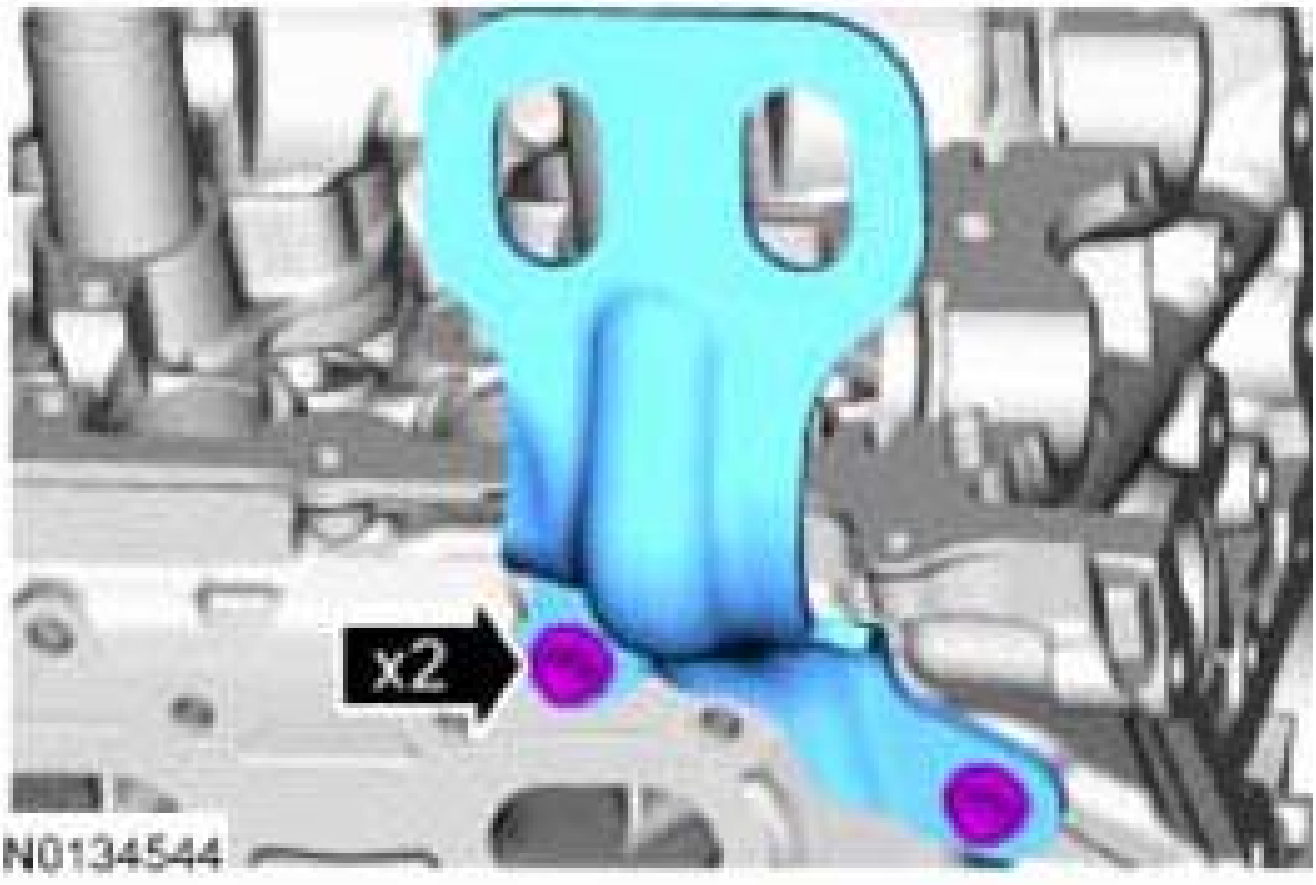
13. **NOTE: Do not use power tools to remove the bolt or damage to the RH primary timing chain guide may occur.**

Remove the bolt and the RH primary timing chain guide.



14. Remove the 2 bolts and the engine lifting eye.

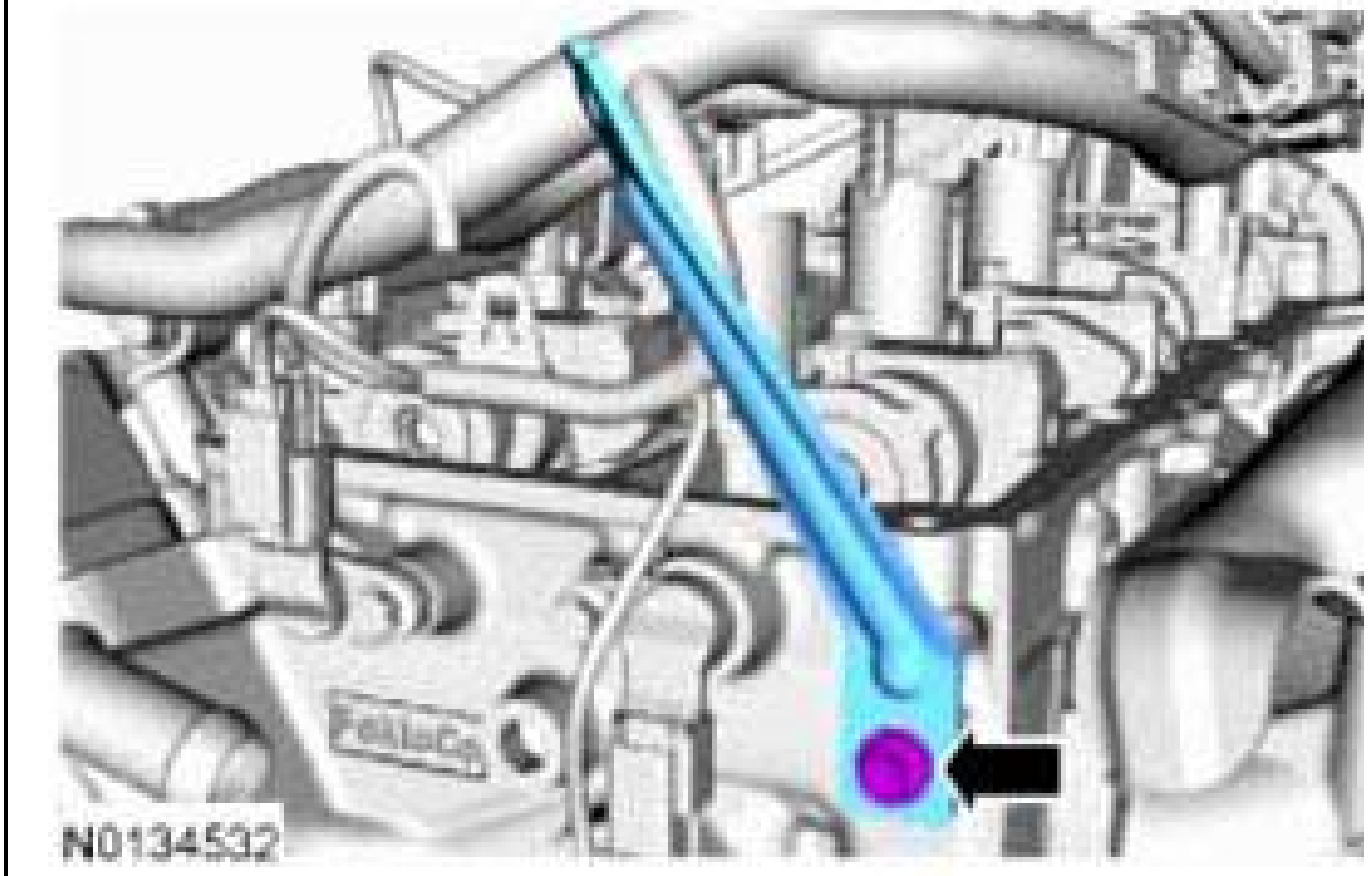
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15. **NOTE: Index-mark the location of the bracket on the cylinder head for installation.**

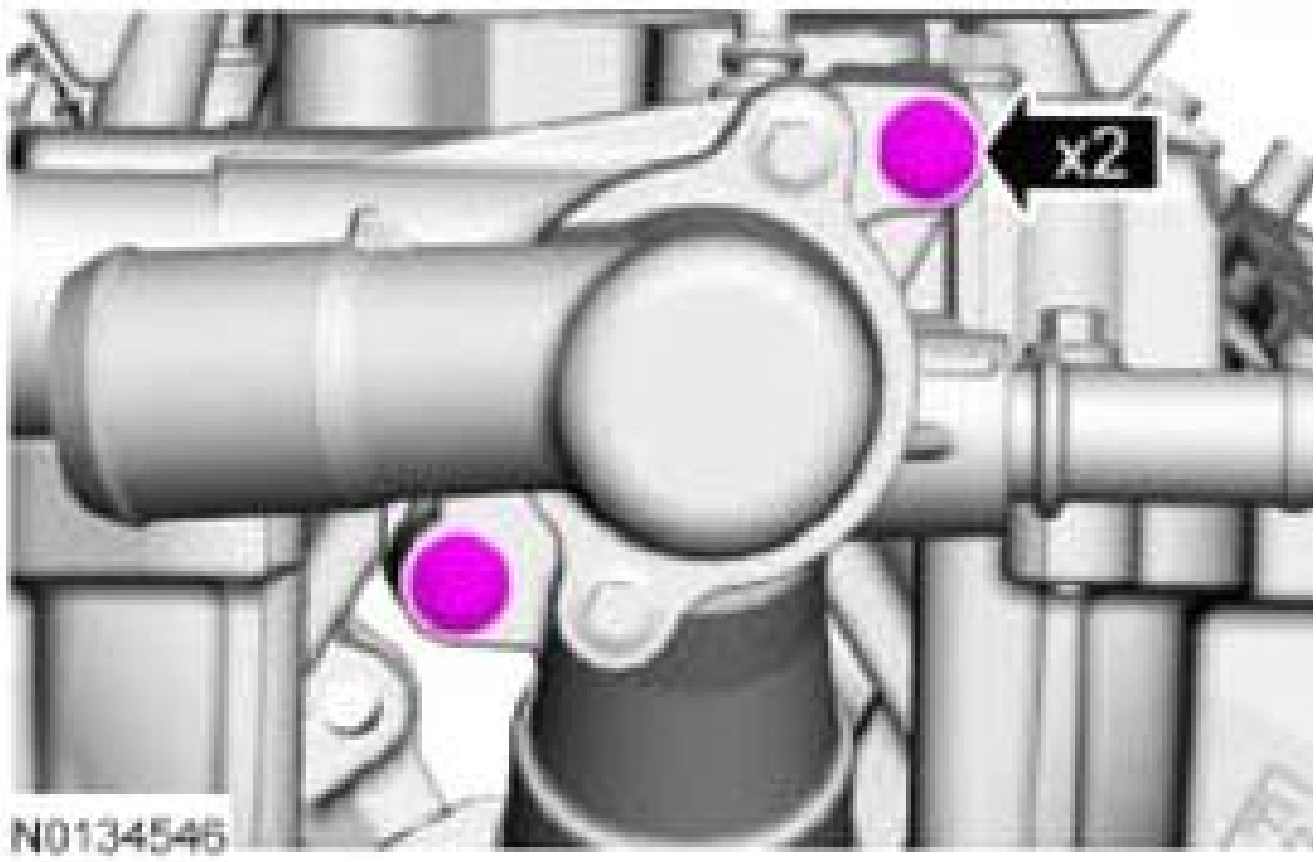
Remove the bolt and the upper intake manifold bracket.

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16. Remove the 2 thermostat housing-to-lower intake manifold bolts.

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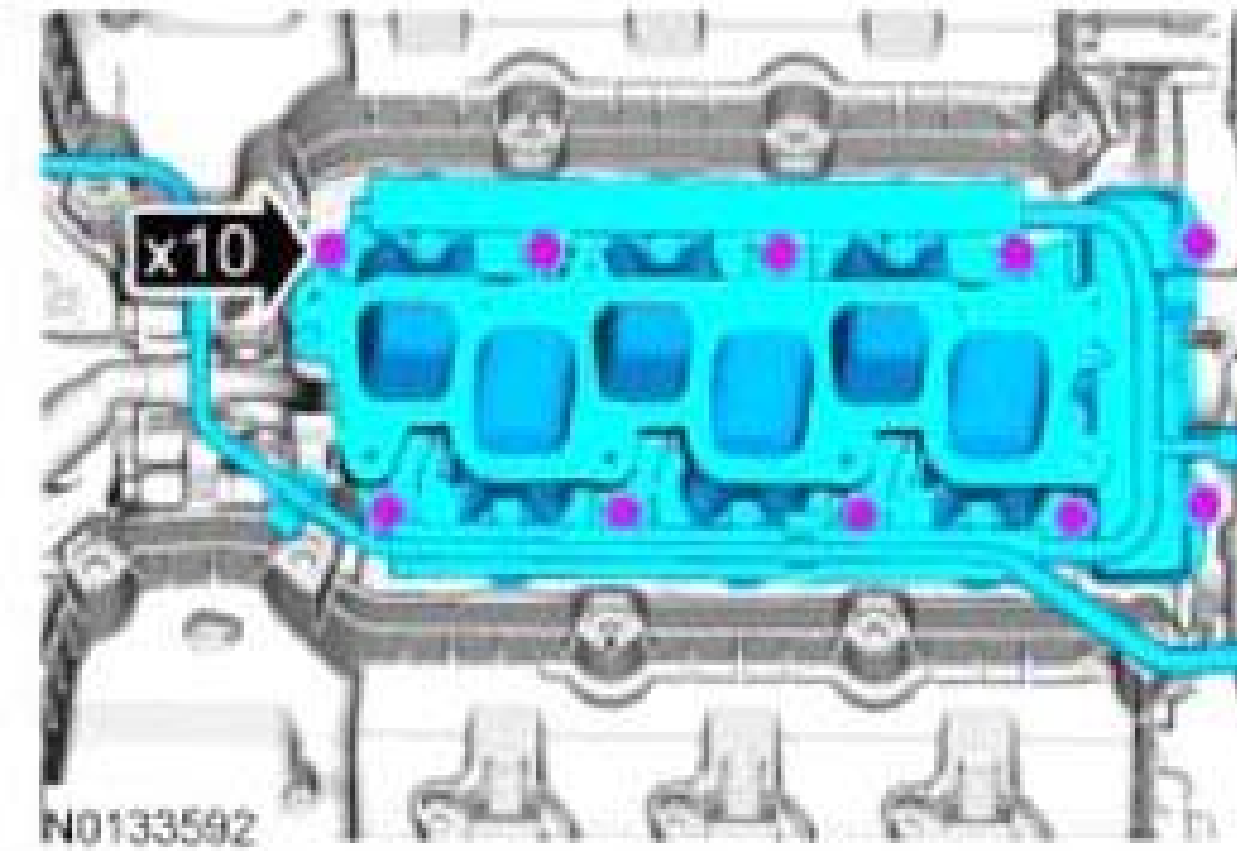


NOTE: **If the engine is repaired or replaced because of upper engine failure, typically including valve or piston damage, check the intake manifold for metal debris. If metal debris is found, install a new intake manifold. Failure to follow these instructions can result in engine damage.**

17. Remove the 10 bolts and the lower intake manifold.

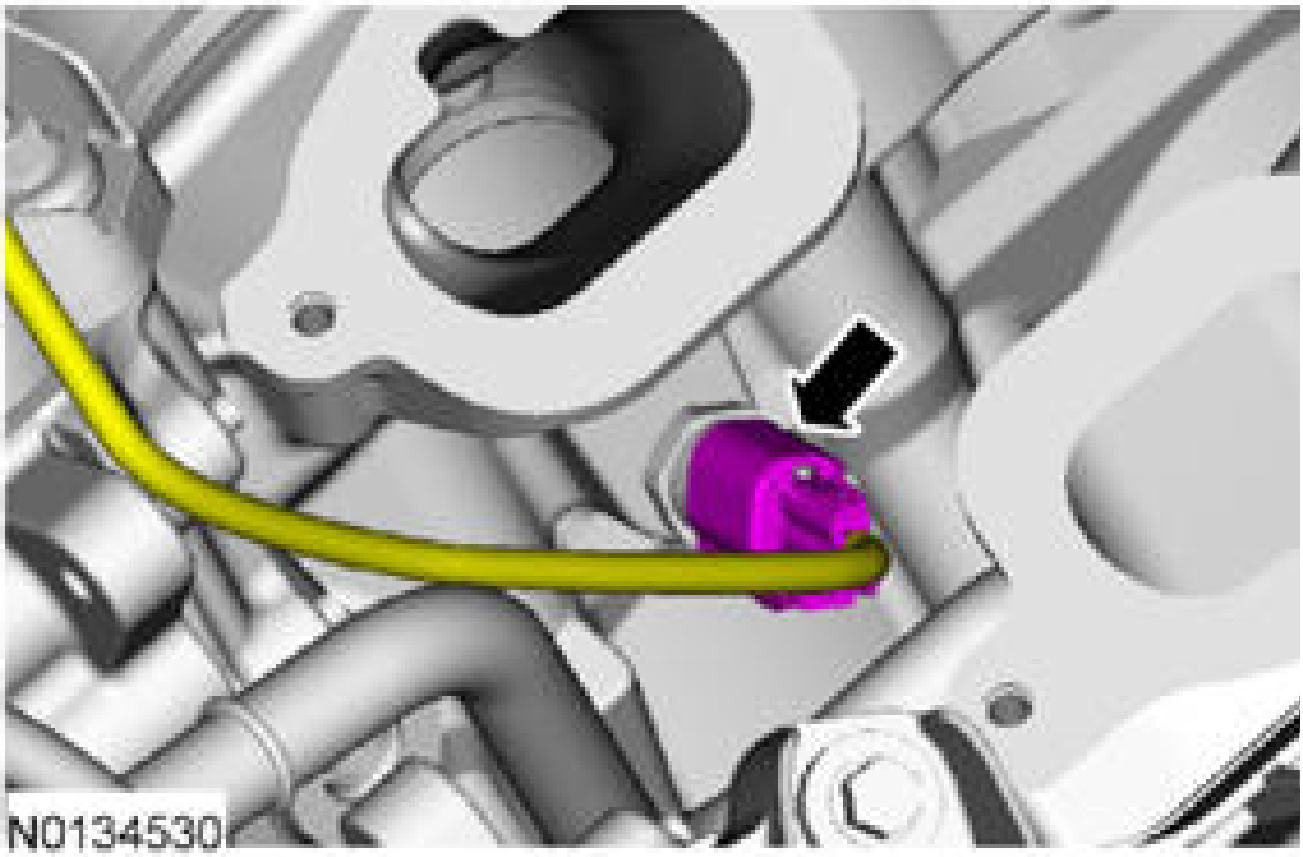
- Remove and discard the intake manifold and thermostat housing gaskets.
- Clean and inspect all sealing surfaces.

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18. Disconnect the **CHT** sensor jumper harness.

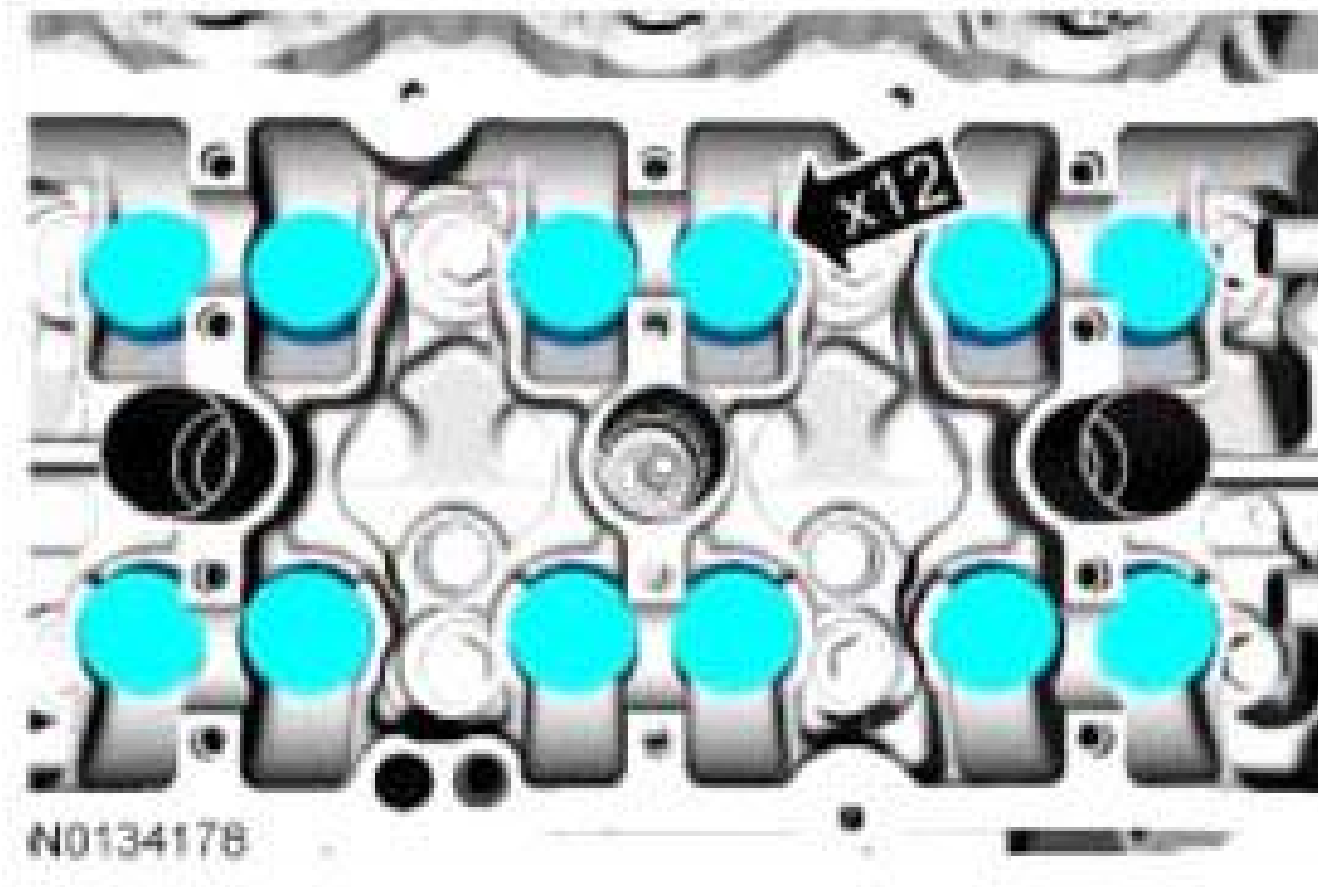
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NOTE: **If the components are to be reinstalled, they must be installed in the same positions. Mark the components for installation into their original locations.**

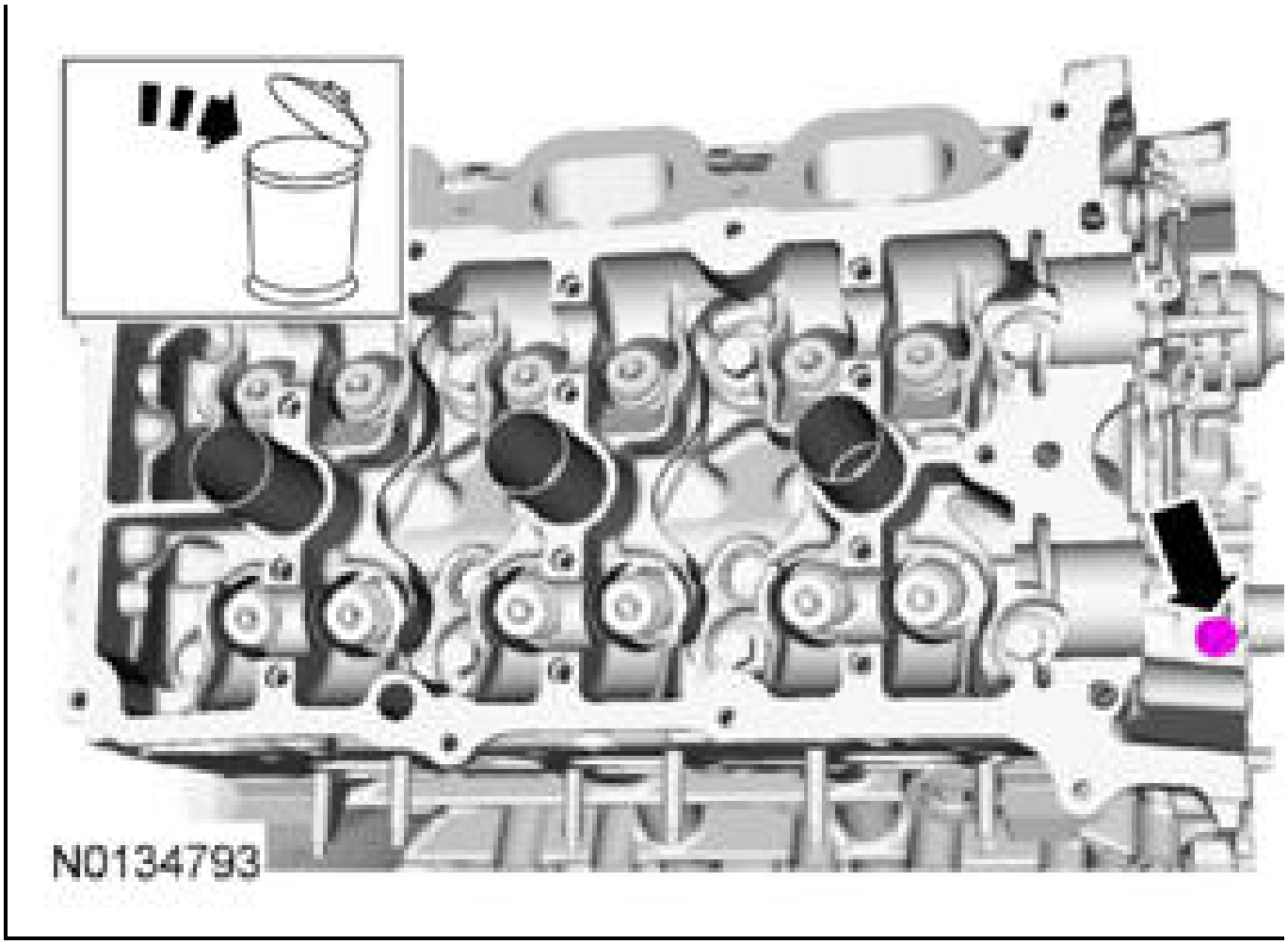
19. Remove the valve tappets from the cylinder head.

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20. Inspect the valve tappets. REFER to **VALVE TAPPET INSPECTION** .
21. Remove and discard the M6 bolt.

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22.

NOTE: **Place clean shop towels over exposed engine cavities. Carefully remove the towels so foreign material is not dropped into the engine. Any foreign material (including any material created while cleaning gasket surfaces) that enters the oil passages or the oil pan, may cause engine failure.**

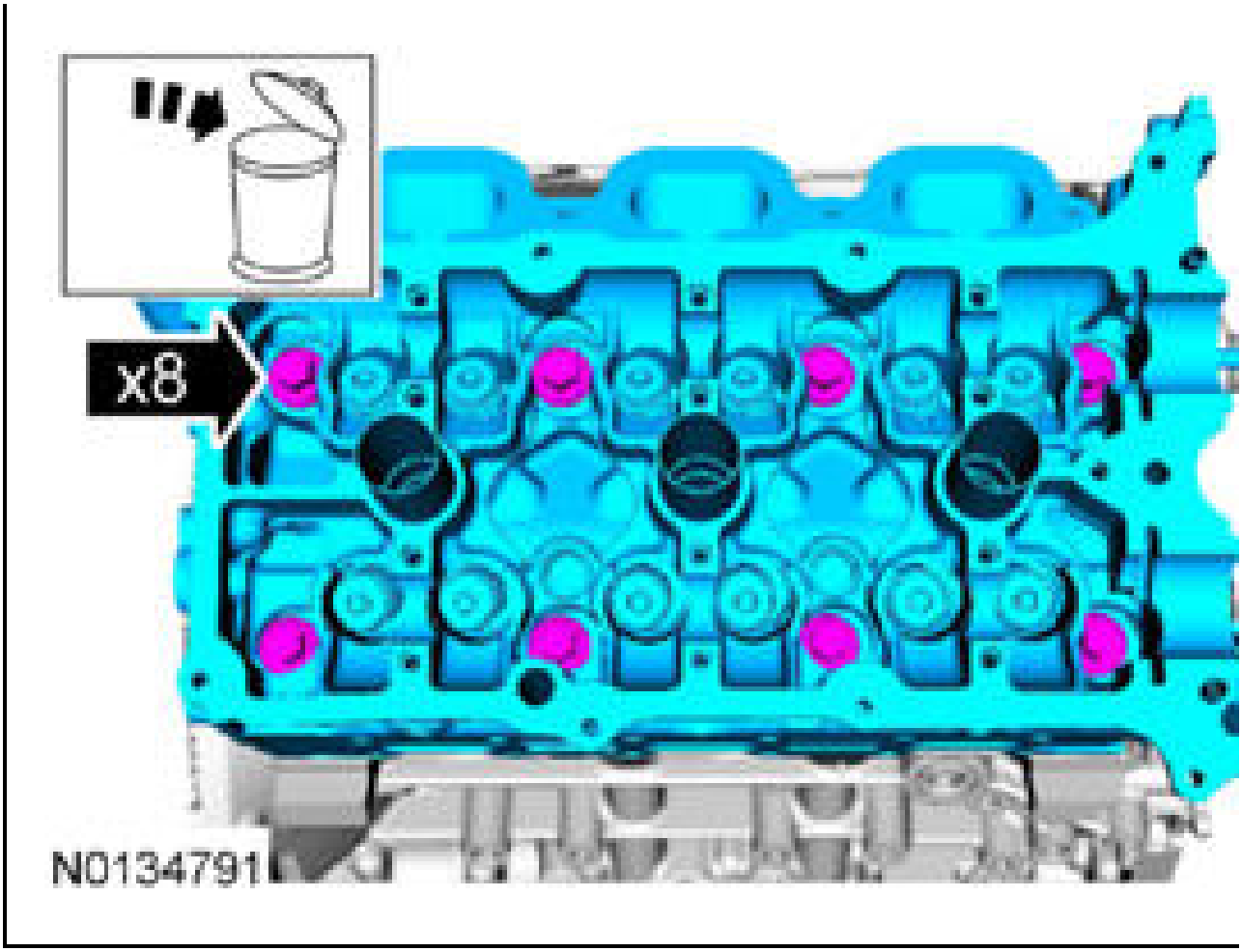
NOTE: **Aluminum surfaces are soft and can be scratched easily. Never place the cylinder head gasket surface, unprotected, on a bench surface.**

NOTE: **The cylinder head bolts must be discarded and new bolts must be installed. They are tighten-to-yield designed and cannot be reused.**

Remove and discard the 8 bolts from the cylinder head.

- Remove the cylinder head.
- Discard the cylinder head gasket.

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23.

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

NOTE: **Observe all warnings or cautions and follow all application directions contained on the packaging of the silicone gasket remover and the metal surface prep.**

NOTE: **If there is no residual gasket material present, metal surface prep can be used to clean and prepare the surfaces.**

Clean the cylinder head-to-cylinder block mating surfaces of both the cylinder heads and the cylinder block in the following sequence.

- Remove any large deposits of silicone or gasket material with a plastic scraper.
- Apply silicone gasket remover, following package directions, and allow to set for several minutes.
- Remove the silicone gasket remover with a plastic scraper. A second application of silicone gasket

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remover may be required if residual traces of silicone or gasket material remain.

- Apply metal surface prep, following package directions, to remove any remaining traces of oil or coolant and to prepare the surfaces to bond with the new gasket. Do not attempt to make the metal shiny. Some staining of the metal surfaces is normal.

24. Support the cylinder head on a bench with the head gasket side up. Check the cylinder head distortion and the cylinder block distortion. REFER to **CYLINDER HEAD DISTORTION** and REFER to **CYLINDER BLOCK DISTORTION** .

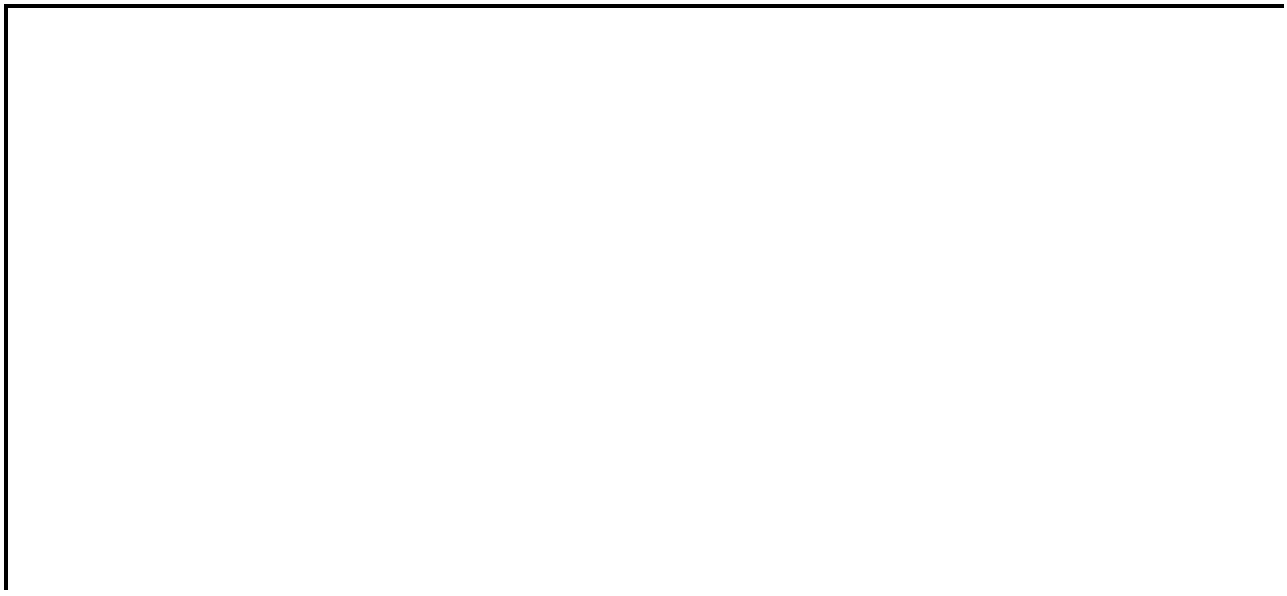
Installation

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

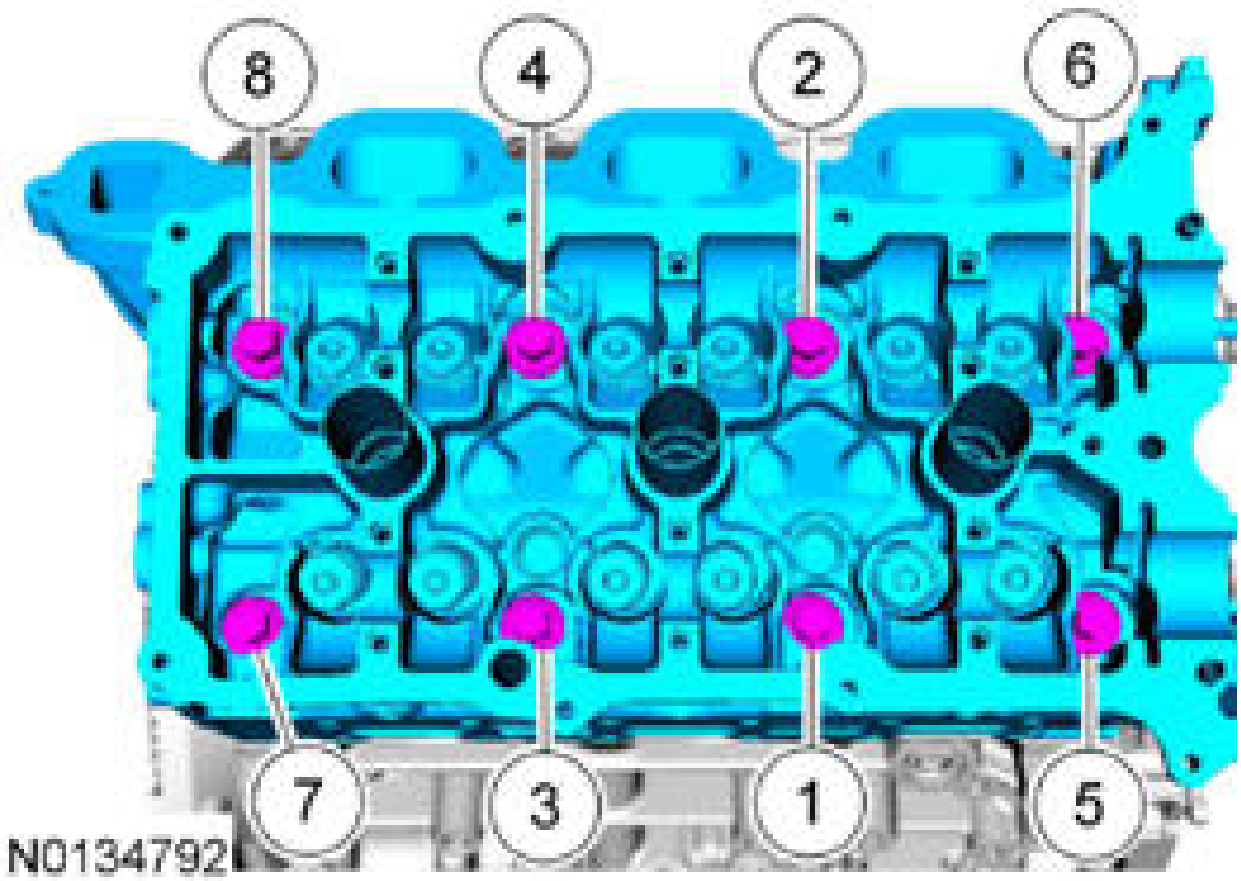
NOTE: If the cylinder head is replaced, a new secondary timing chain tensioner will need to be installed.

NOTE: The valve tappets must be installed in their original positions. Coat the valve tappets with clean engine oil prior to installation.

1. Install a new gasket, the RH cylinder head and 8 new bolts. Tighten the bolts in the sequence shown in illustration below in 5 stages:
   - Stage 1: Tighten to 20 Nm (177 lb-in).
   - Stage 2: Tighten to 35 Nm (26 lb-ft).
   - Stage 3: Tighten 90 degrees.
   - Stage 4: Tighten 90 degrees.
   - Stage 5: Tighten 45 degrees.

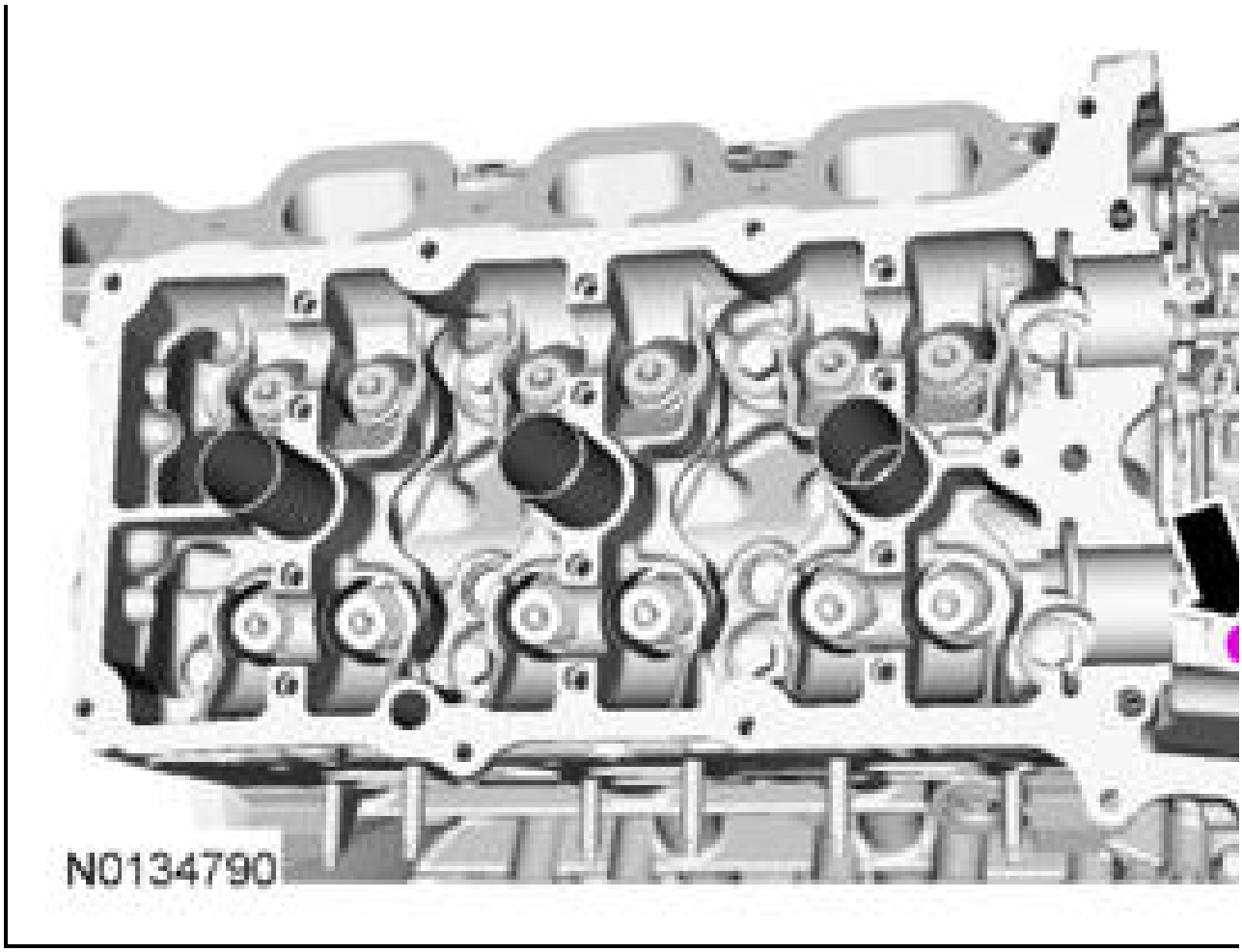


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2. Install the bolt.
    - Tighten to 10 Nm (89 lb-in).

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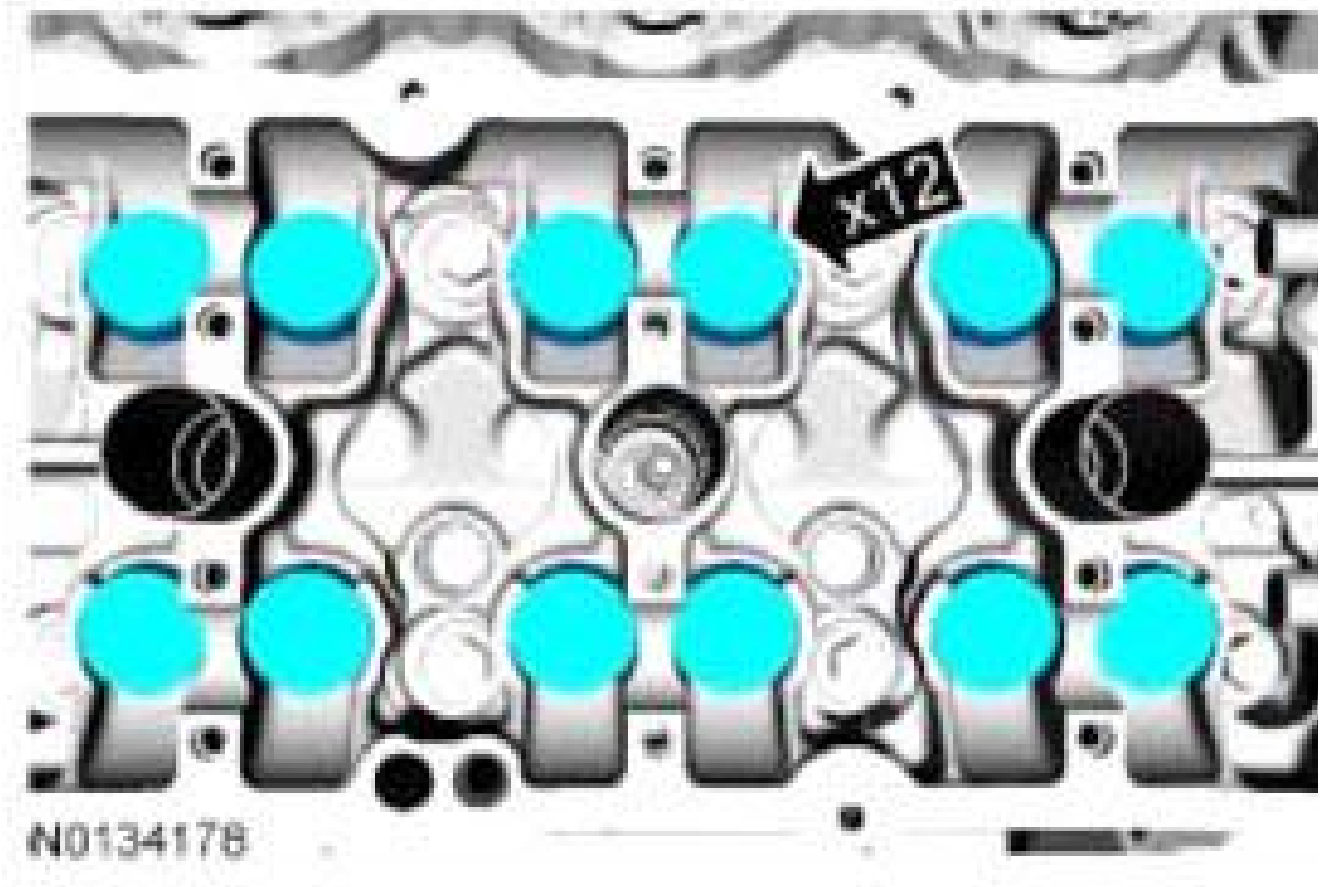


3. **NOTE: The valve tappets must be installed in their original positions.**

   NOTE: Coat the valve tappets with clean engine oil prior to installation.

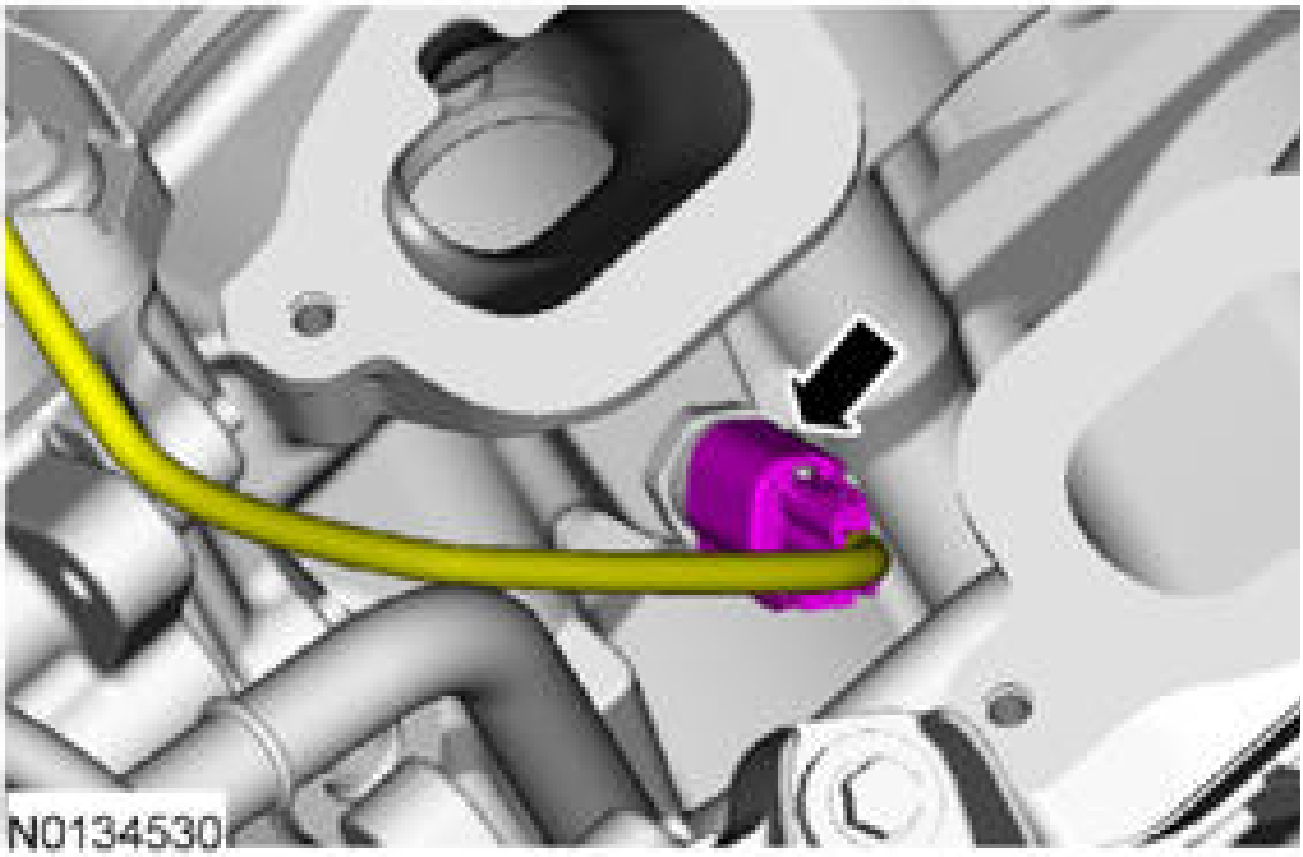
   Install the valve tappets.

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4. Connect the **CHT** sensor jumper harness.

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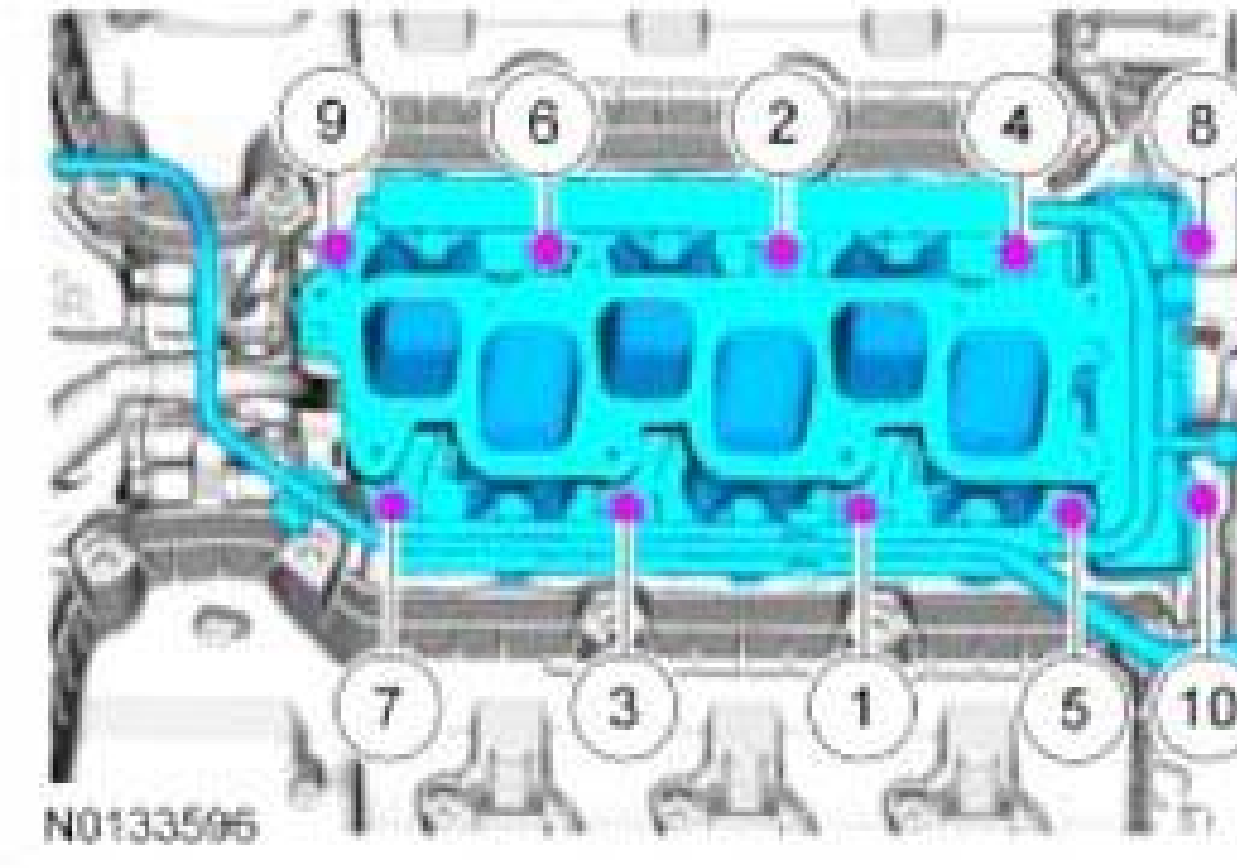


NOTE: **If the engine is repaired or replaced because of upper engine failure, typically including valve or piston damage, check the intake manifold for metal debris. If metal debris is found, install a new intake manifold. Failure to follow these instructions can result in engine damage.**

5. Using new intake manifold and thermostat housing gaskets, install the lower intake manifold and the 10 bolts.

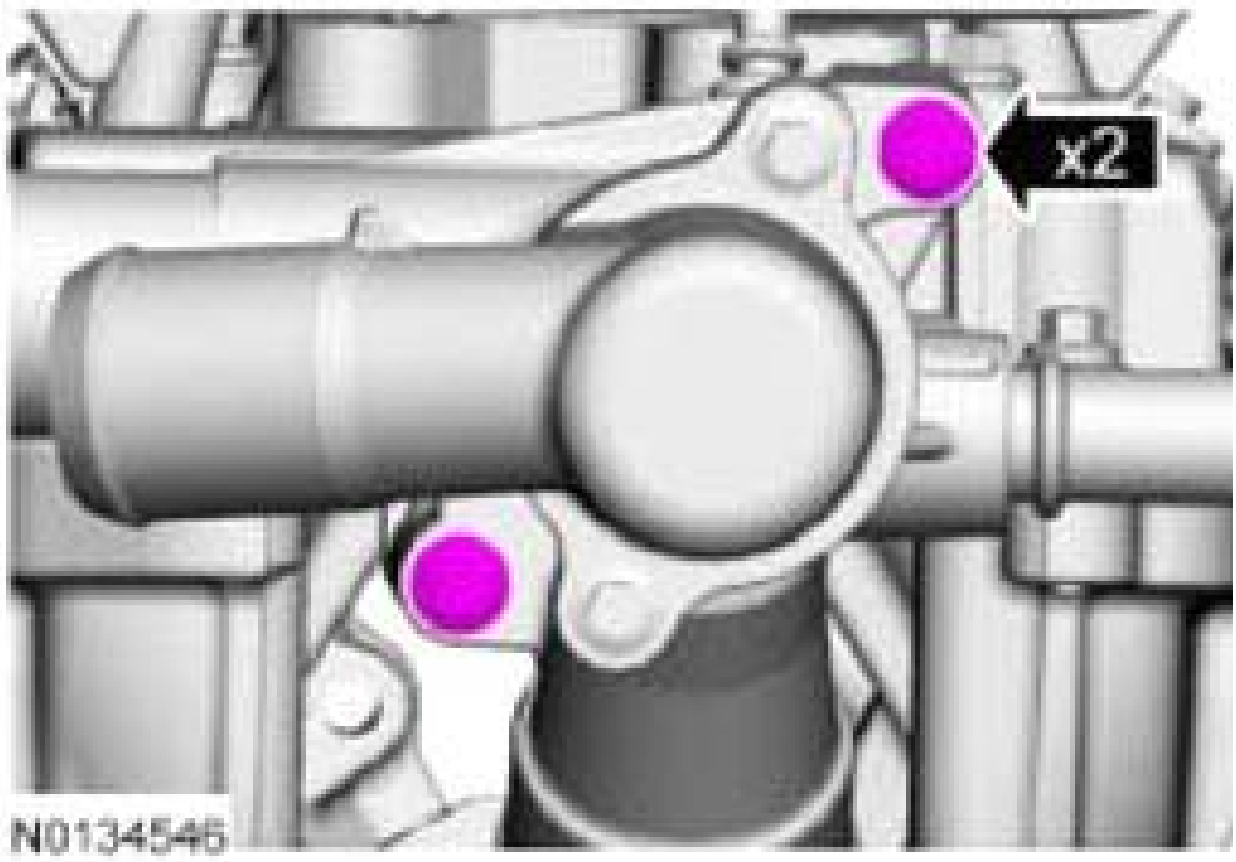
- Tighten in the sequence shown in illustration to 10 Nm (89 lb-in).

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6. Install the 2 thermostat housing-to-lower intake manifold bolts.
    - Tighten to 10 Nm (89 lb-in).

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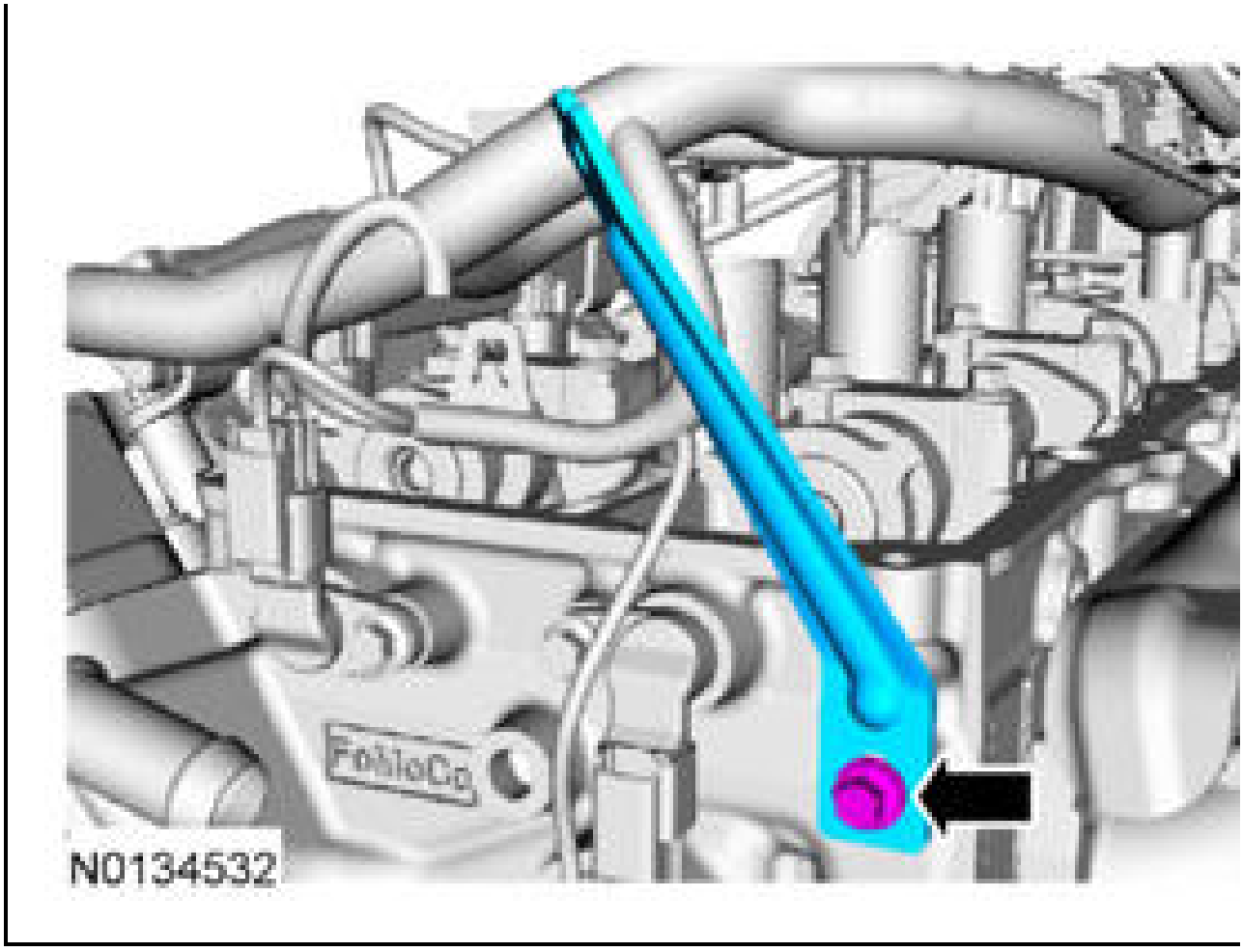


7. **NOTE: Align the bracket with the index mark made during removal.**

Install the upper intake manifold bracket and the bolt.

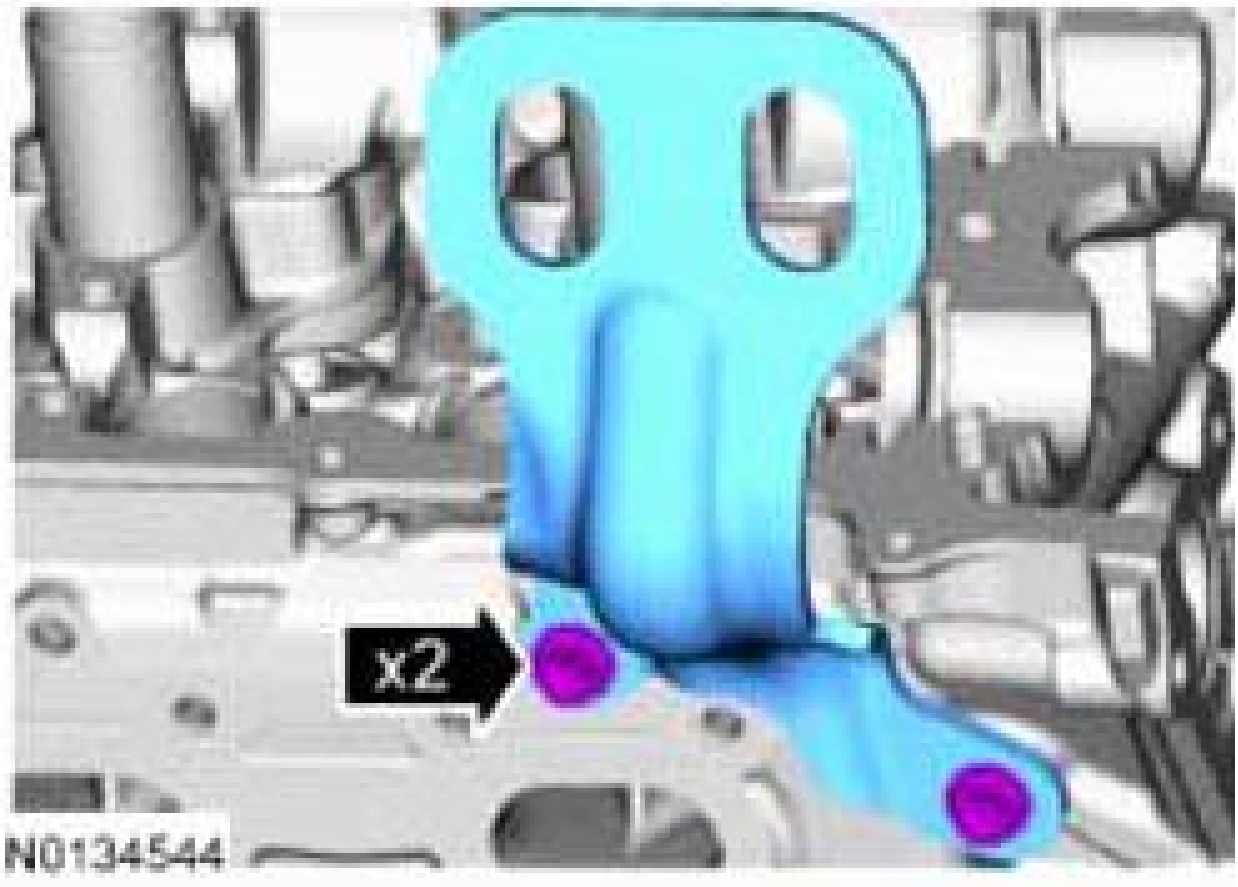
- Tighten to 10 Nm (89 lb-in).

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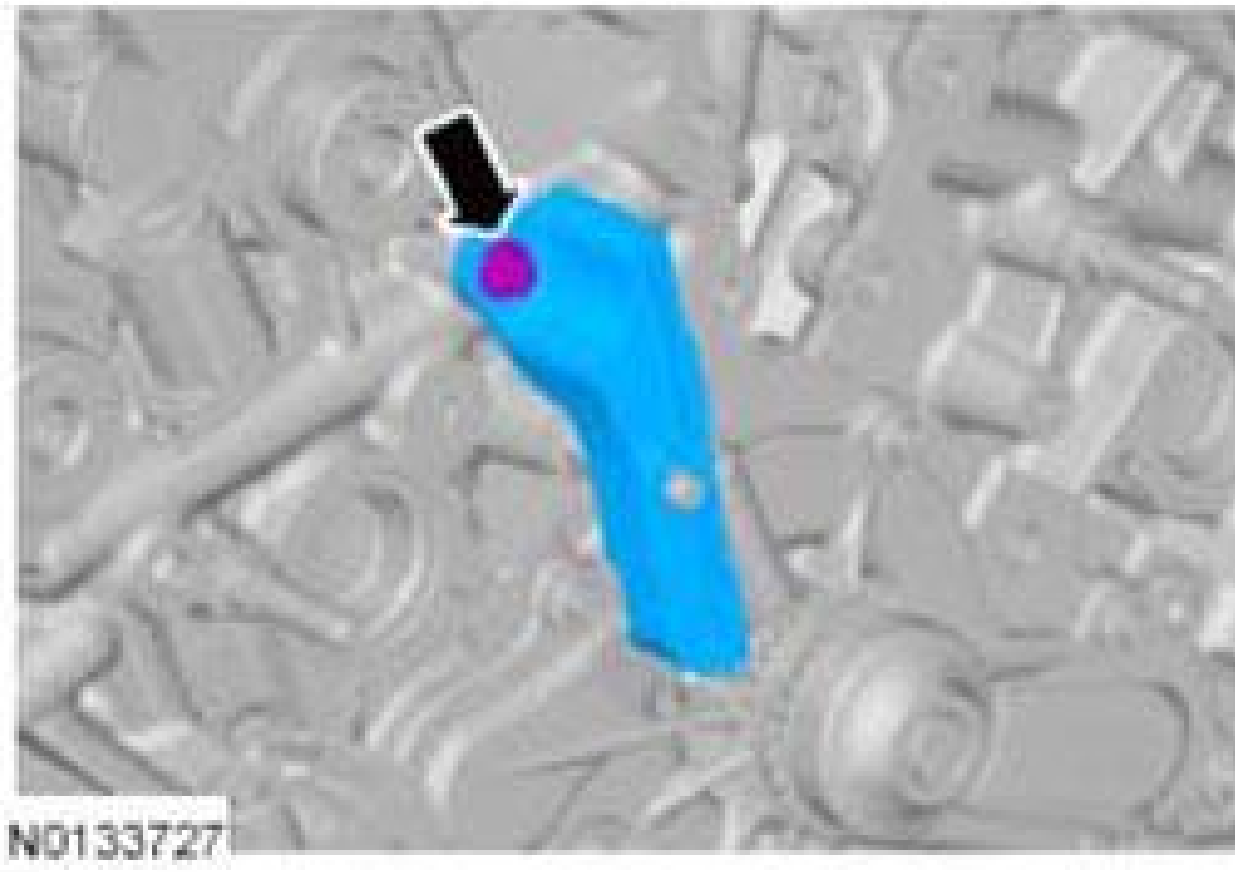
8. Install the engine lifting eye and the 2 bolts.
    - Tighten to 24 Nm (18 lb-ft).

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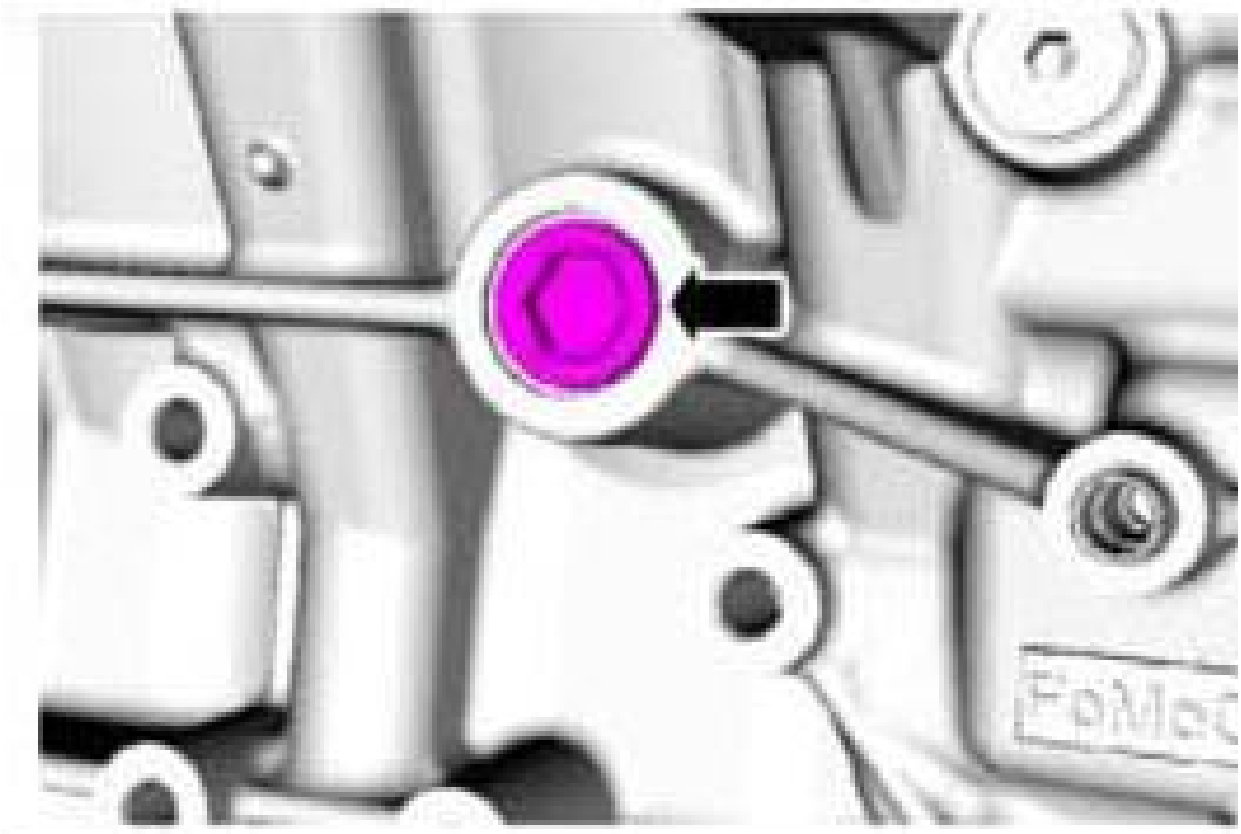
9. Install the RH primary timing chain guide and the bolt.
    - Tighten to 10 Nm (89 lb-in).

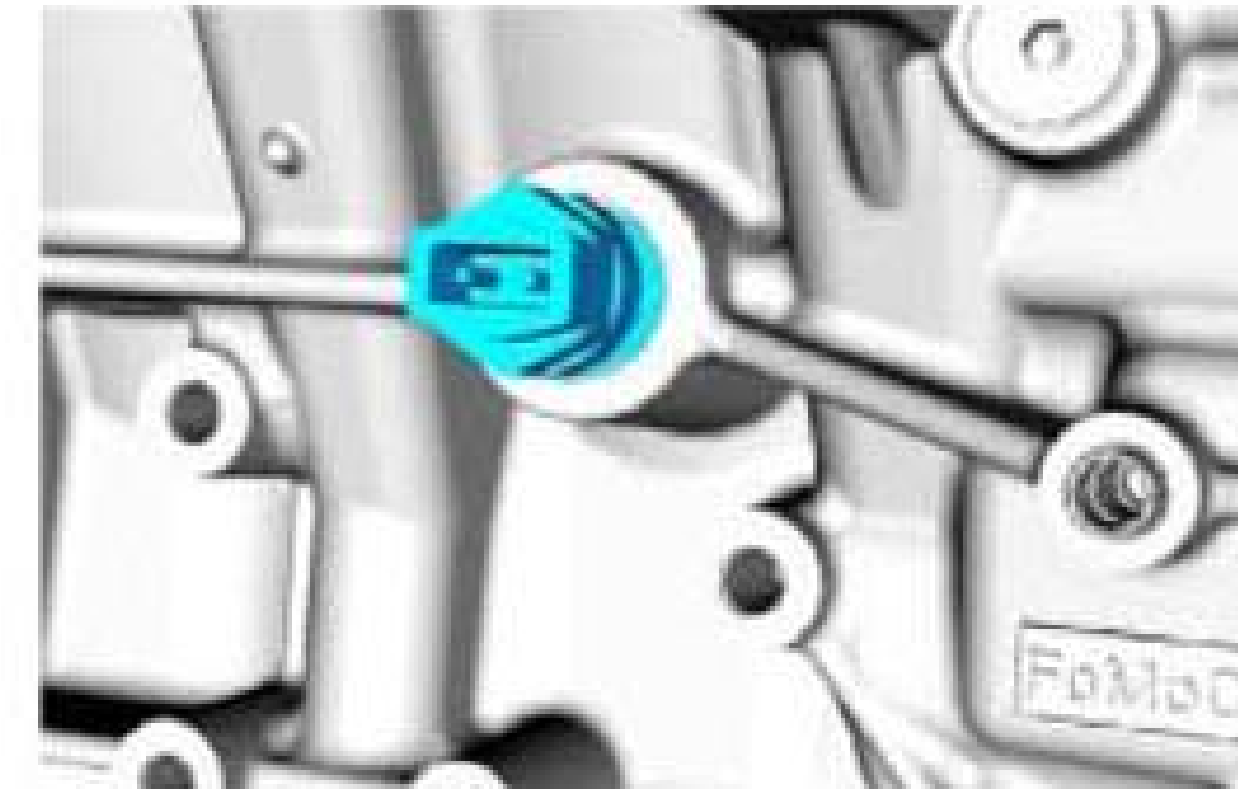
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10. If equipped, install the block heater wiring harness onto the engine.
    - Tighten the cylinder block drain plug to 10 Nm (89 lb-in) plus an additional 720 degrees.
    - Tighten the block heater to 40 Nm (30 lb-ft).

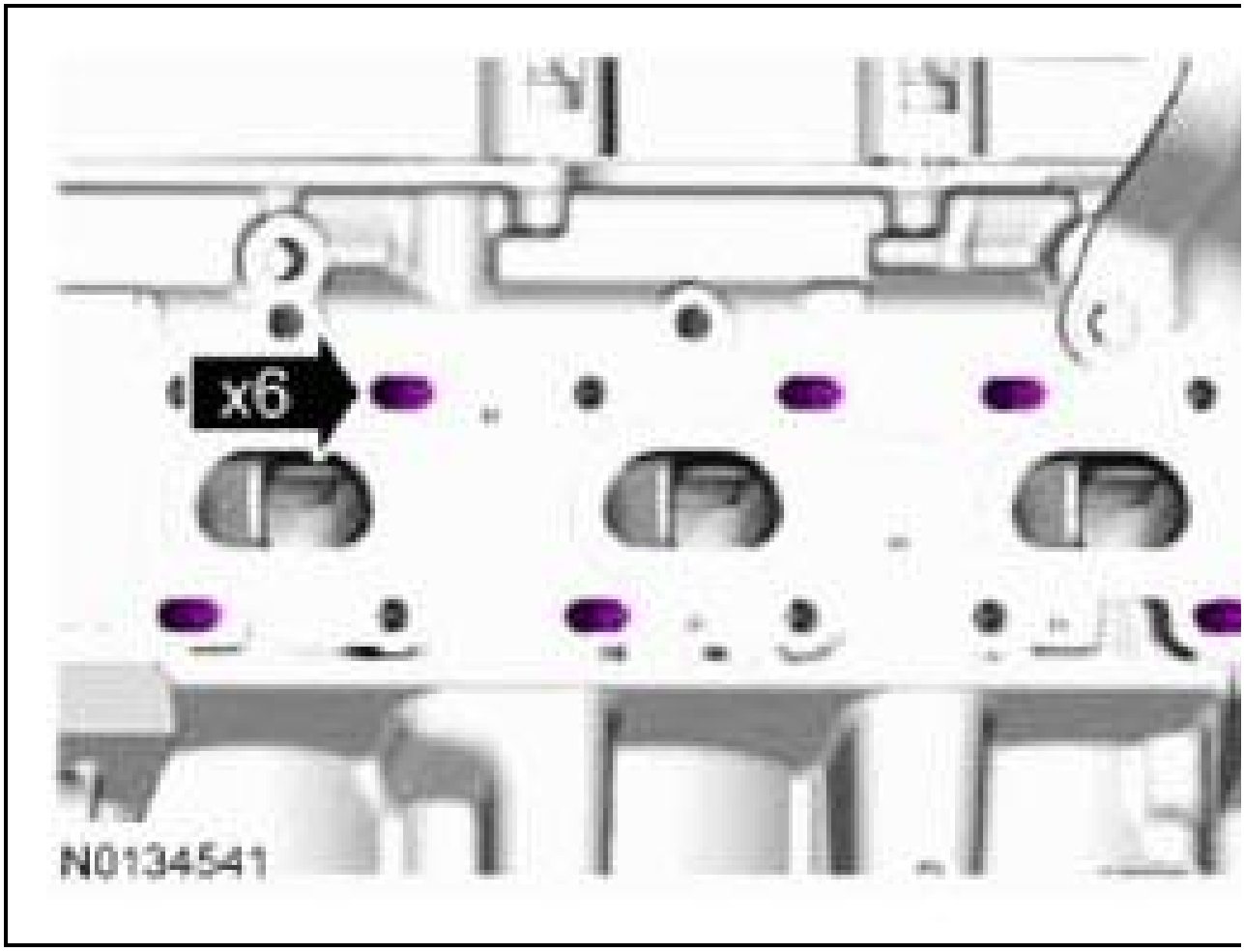
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11. Install 6 new RH exhaust manifold studs.
    - Tighten to 12 Nm (106 lb-in).

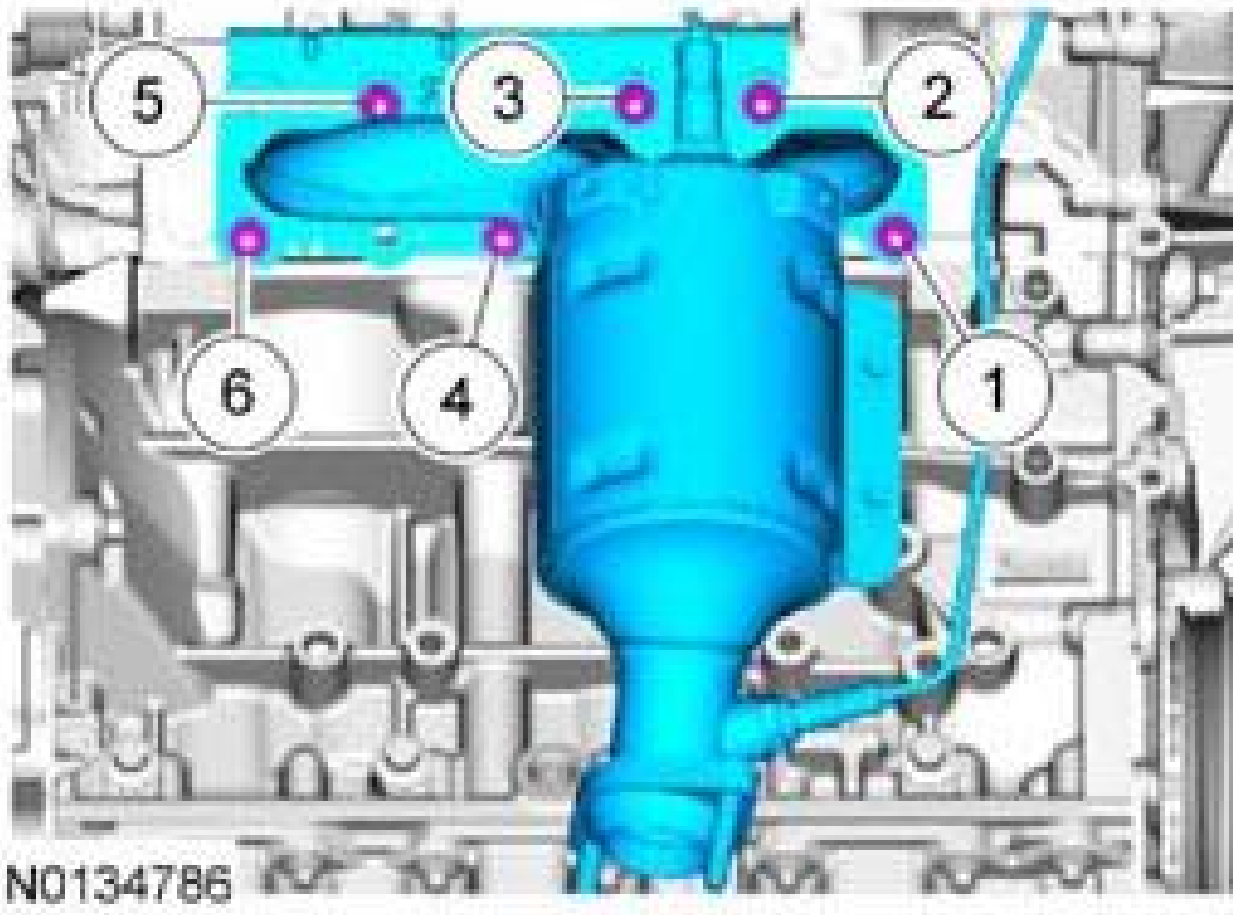


12. **NOTE: Failure to tighten the exhaust manifold nuts to specification a second time will cause the exhaust manifold to develop an exhaust leak.**

Using a new gasket, install the RH exhaust manifold and 6 new nuts. Tighten in 2 stages in the sequence shown in illustration:

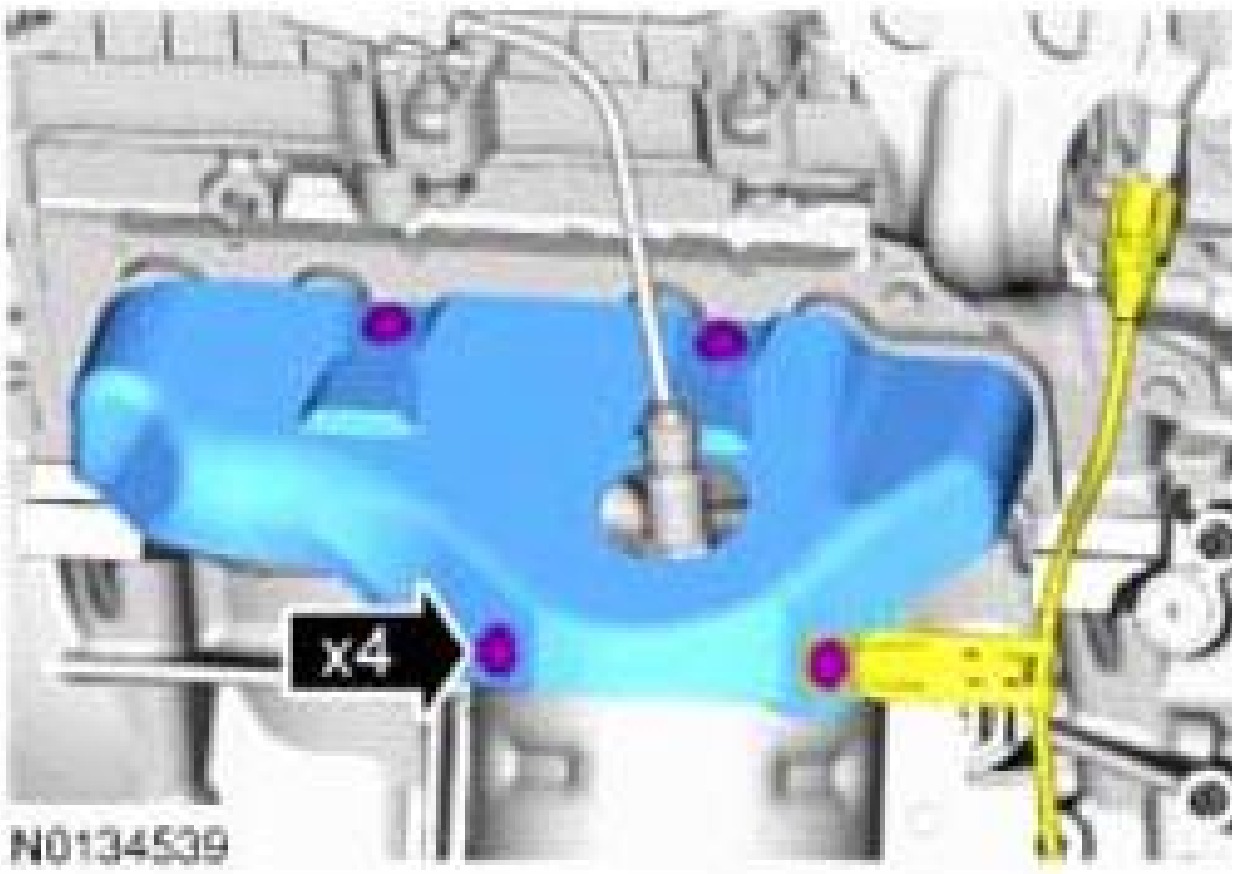
- Stage 1: Tighten to 20 Nm (177 lb-in).
- Stage 2: Tighten to 25 Nm (18 lb-ft).

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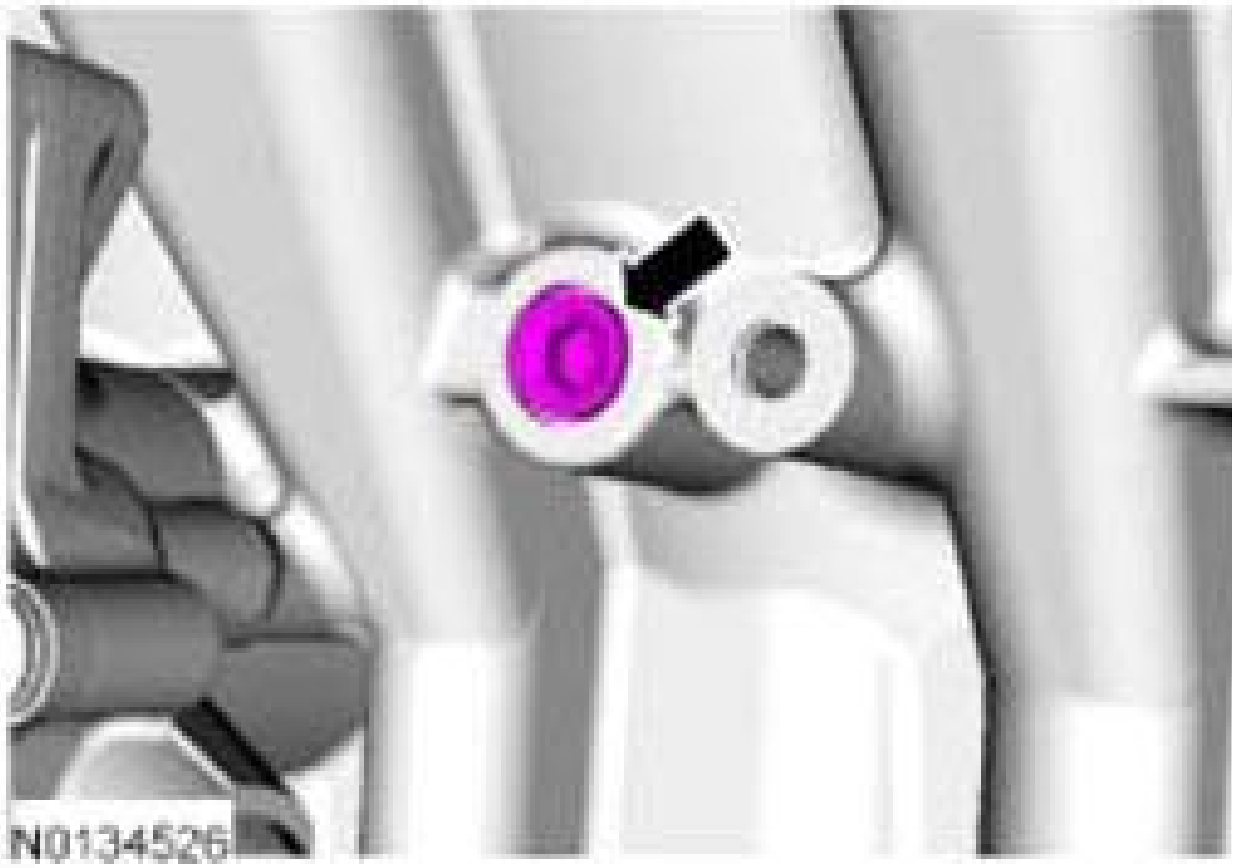
13. Install the RH catalytic converter heat shield and the 4 bolts.
    - Tighten to 10 Nm (89 lb-in).

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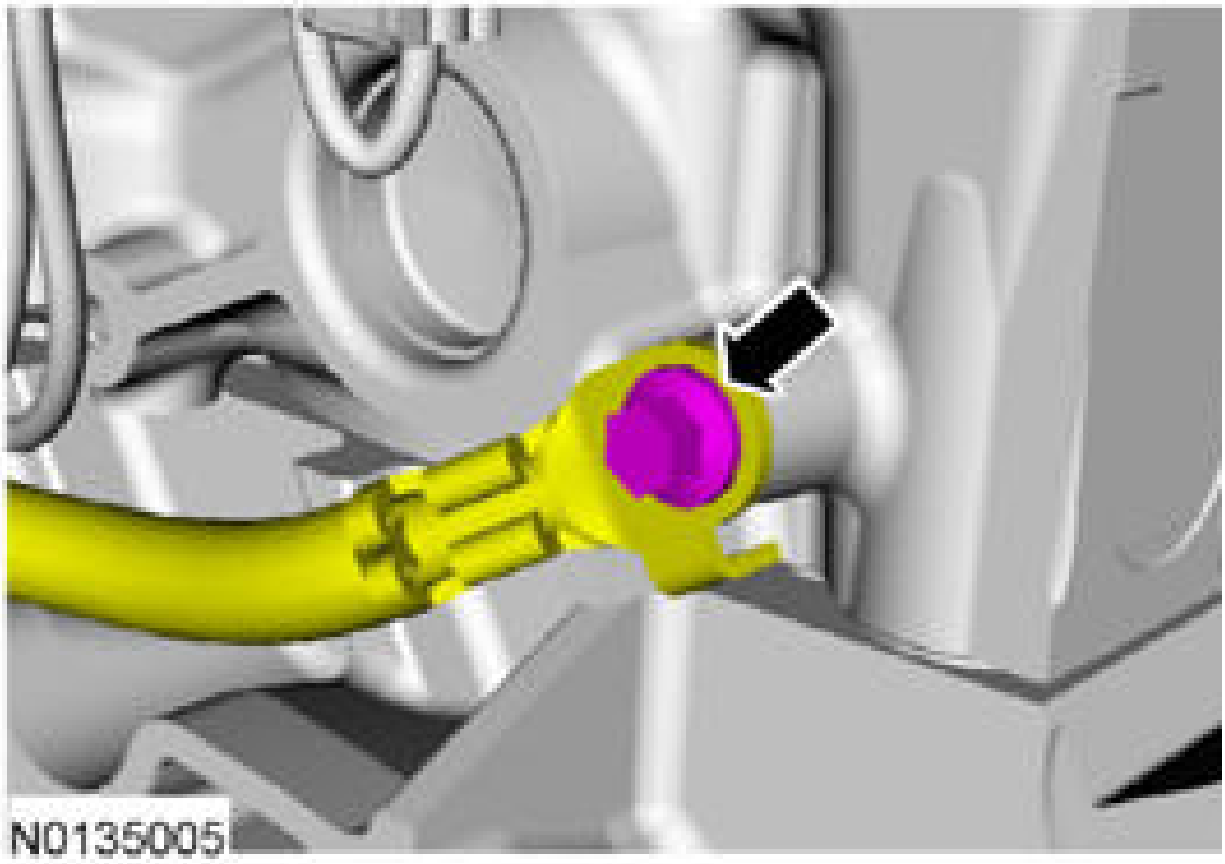
14. Install the LH cylinder block drain plug.
    - Tighten to 16 Nm (142 lb-in) plus an additional 180 degrees.

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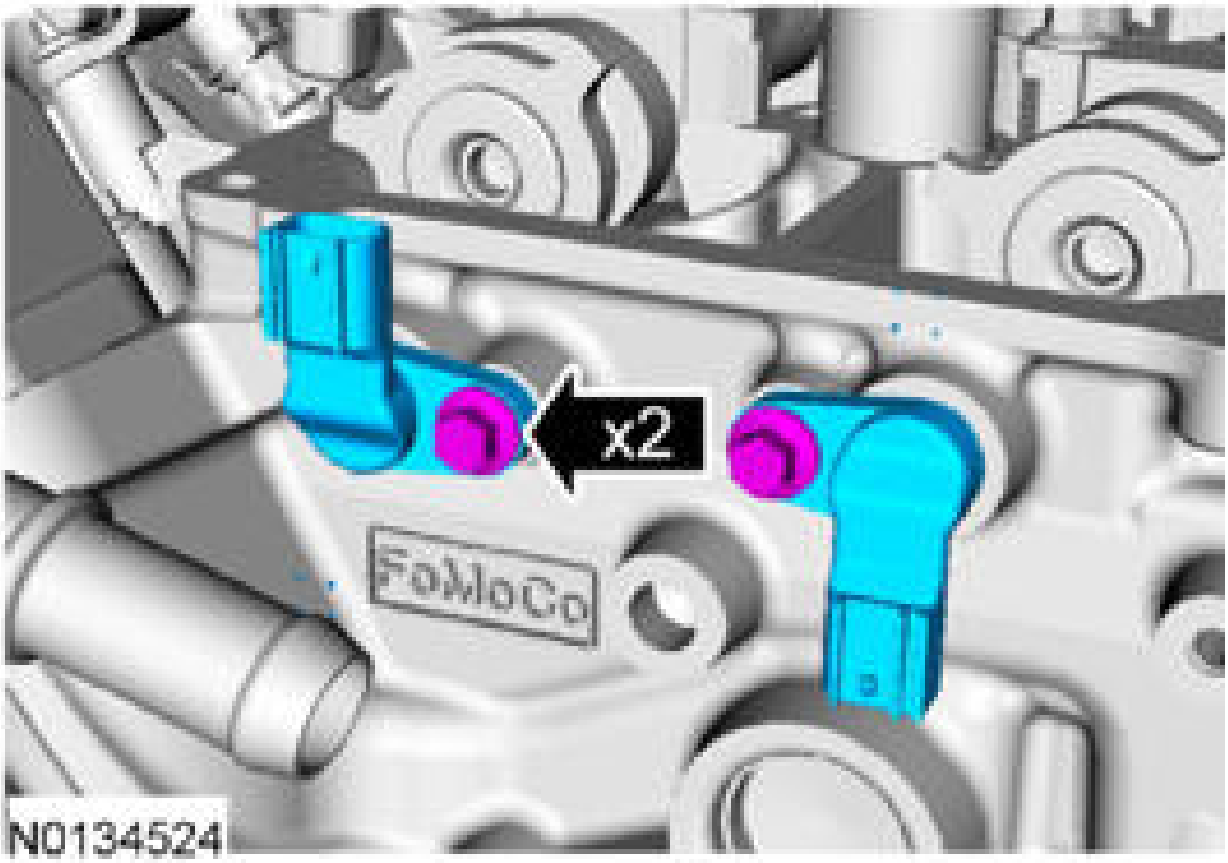
15. Install the ground cable and bolt to the RH cylinder head.
    - Tighten to 10 Nm (89 lb-in).

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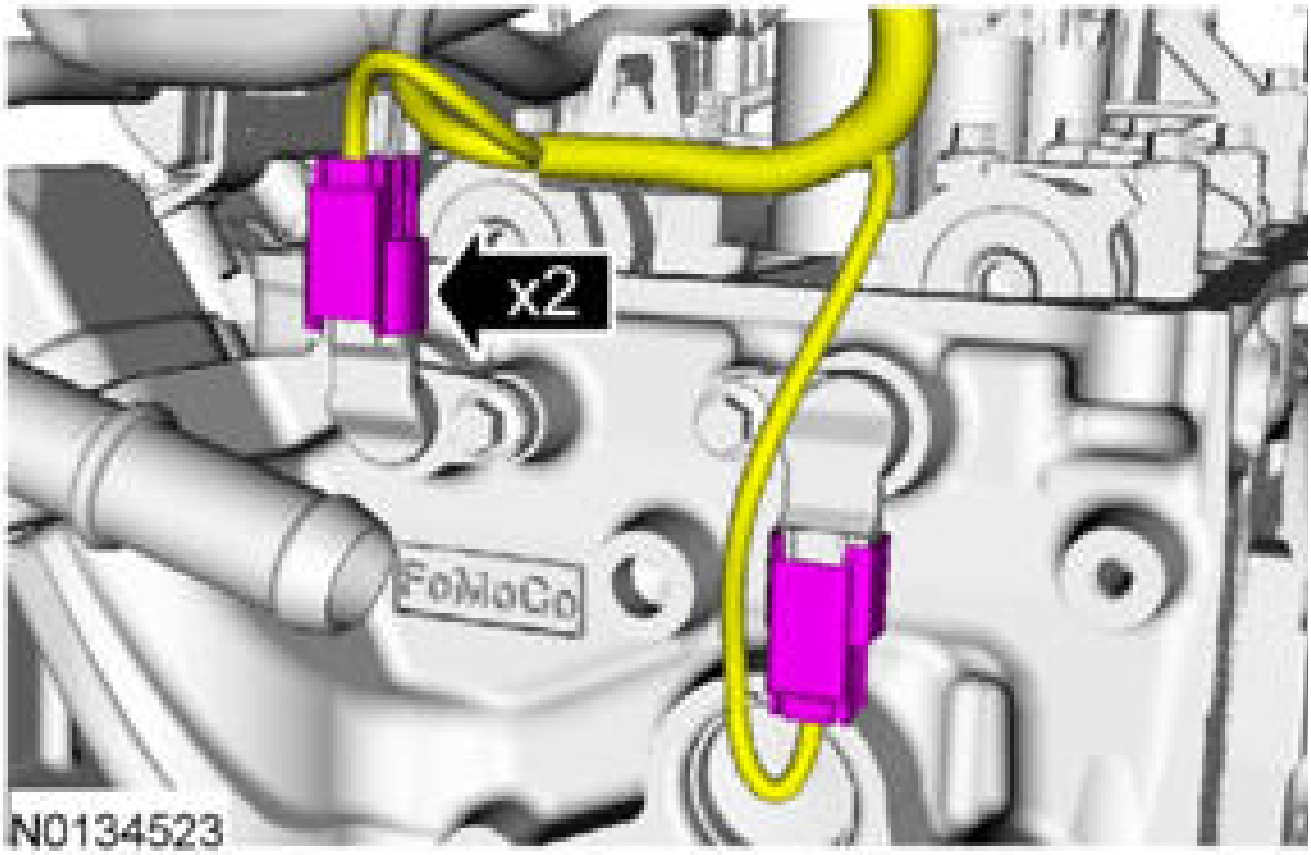
16. Install the 2 **CMP** sensors and the 2 bolts.
    - Tighten to 10 Nm (89 lb-in).

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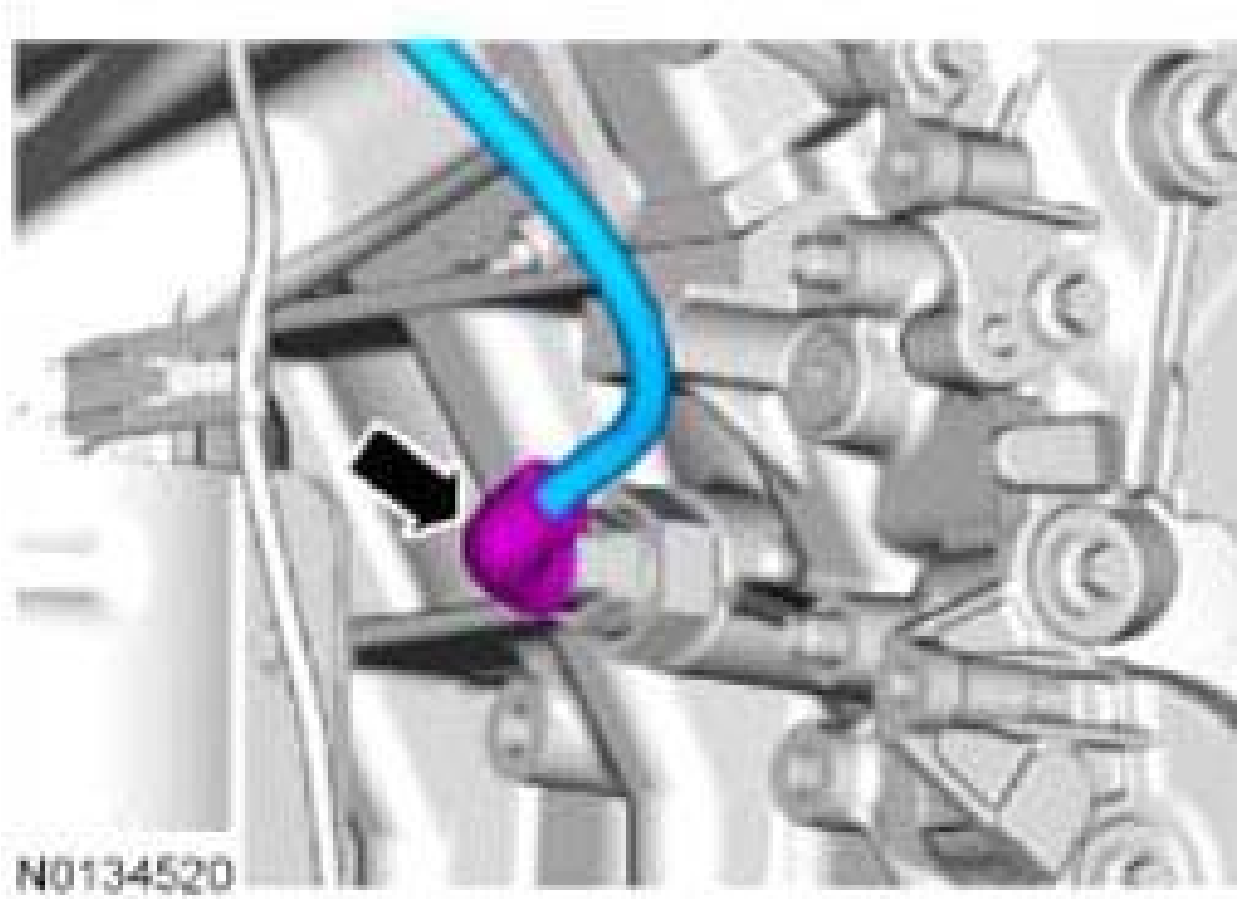
17. Connect the 2 RH **CMP** sensor electrical connectors.

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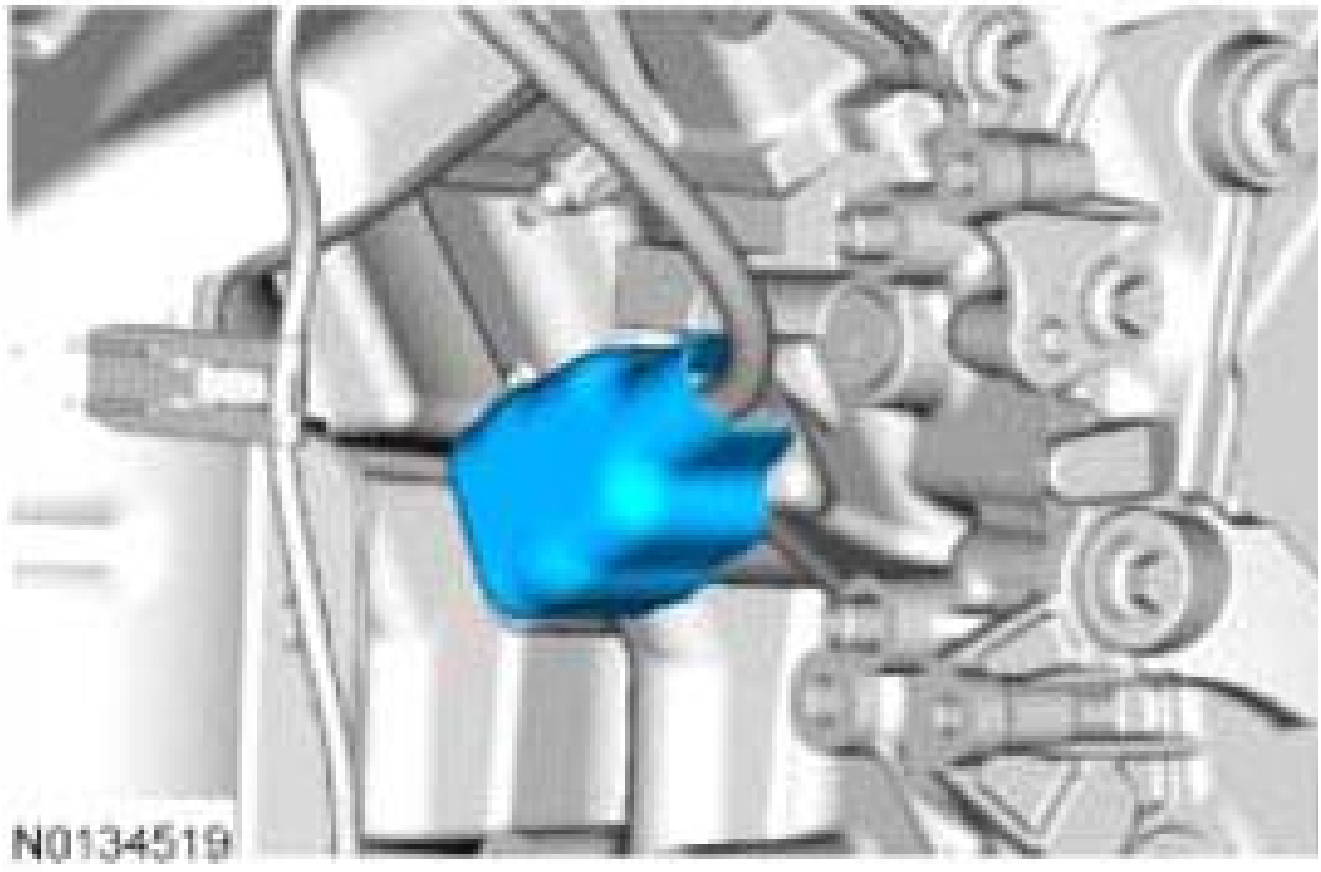
18. If equipped, connect the block heater electrical connector.
    - Install the block heater wiring harness to the engine.

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19. If equipped, install the block heater heat shield.

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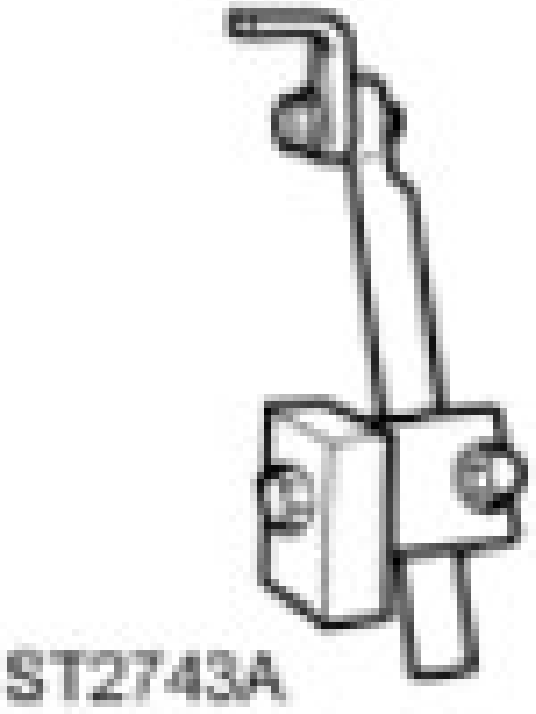
20. Install the RH camshafts. Refer to **CAMSHAFT**.

ENGINE - ALL WHEEL DRIVE (AWD)

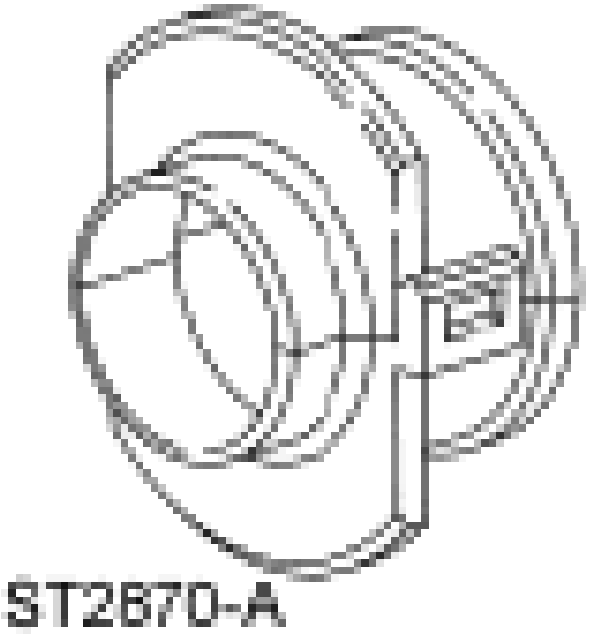
SPECIAL TOOL(S) DESCRIPTION

	2, 200# Floor Crane, Fold Away **300-OTC1819E** or equivalent

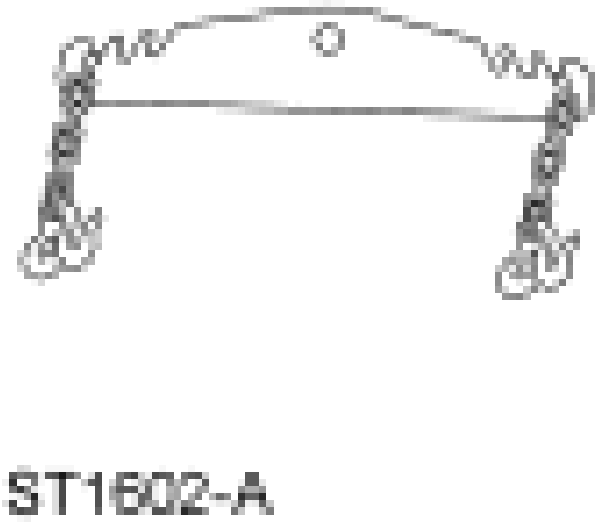
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 ST1341-A	
 ST2743A	Adjustable Grip Arm, 1735A **014-00001** or equivalent

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	Disconnect Tool, Transmission Cooler Line **307-569**
	Eye, Engine Lift **303-1245**

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	Powertrain Lift **300-OTC1585AE** or equivalent
	Spreader Bar **303-D089** (D93P-6001-A3) or equivalent

MATERIAL SPECIFICATIONS

Item	Specification
Motorcraft® SAE 5W-20 Premium Synthetic Blend Motor Oil (US); Motorcraft® SAE 5W-20 Super Premium Motor Oil (Canada) XO-5W20-QSP (US); CXO-5W20-LSP12 (Canada)	WSS-M2C945-A

Removal

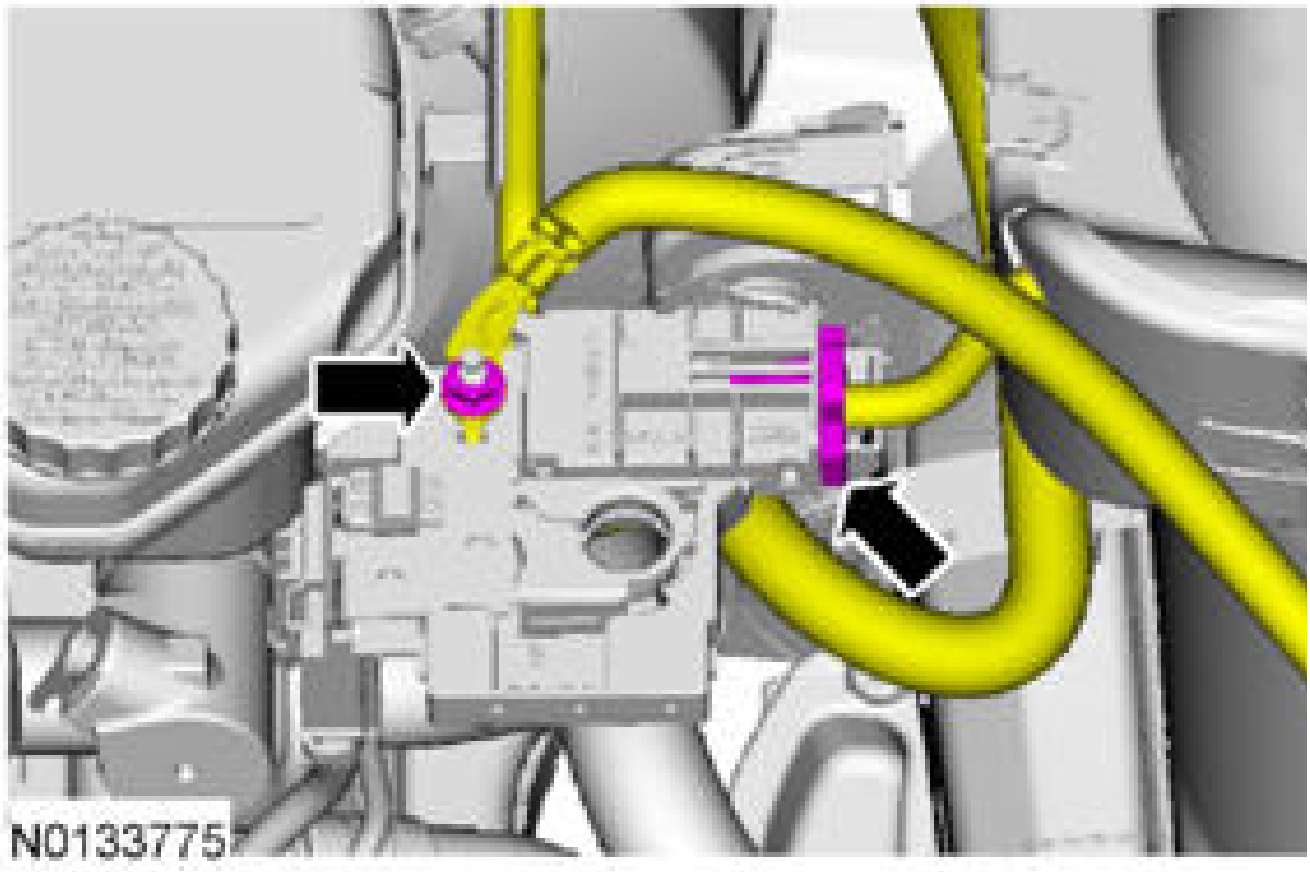
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WARNING: Before beginning any service procedure, refer to SAFETY WARNINGS . Failure to follow this instruction may result in serious personal injury.

WARNING: Do not smoke, carry lighted tobacco or have an open flame of any type when working on or near any fuel-related component. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in serious personal injury.

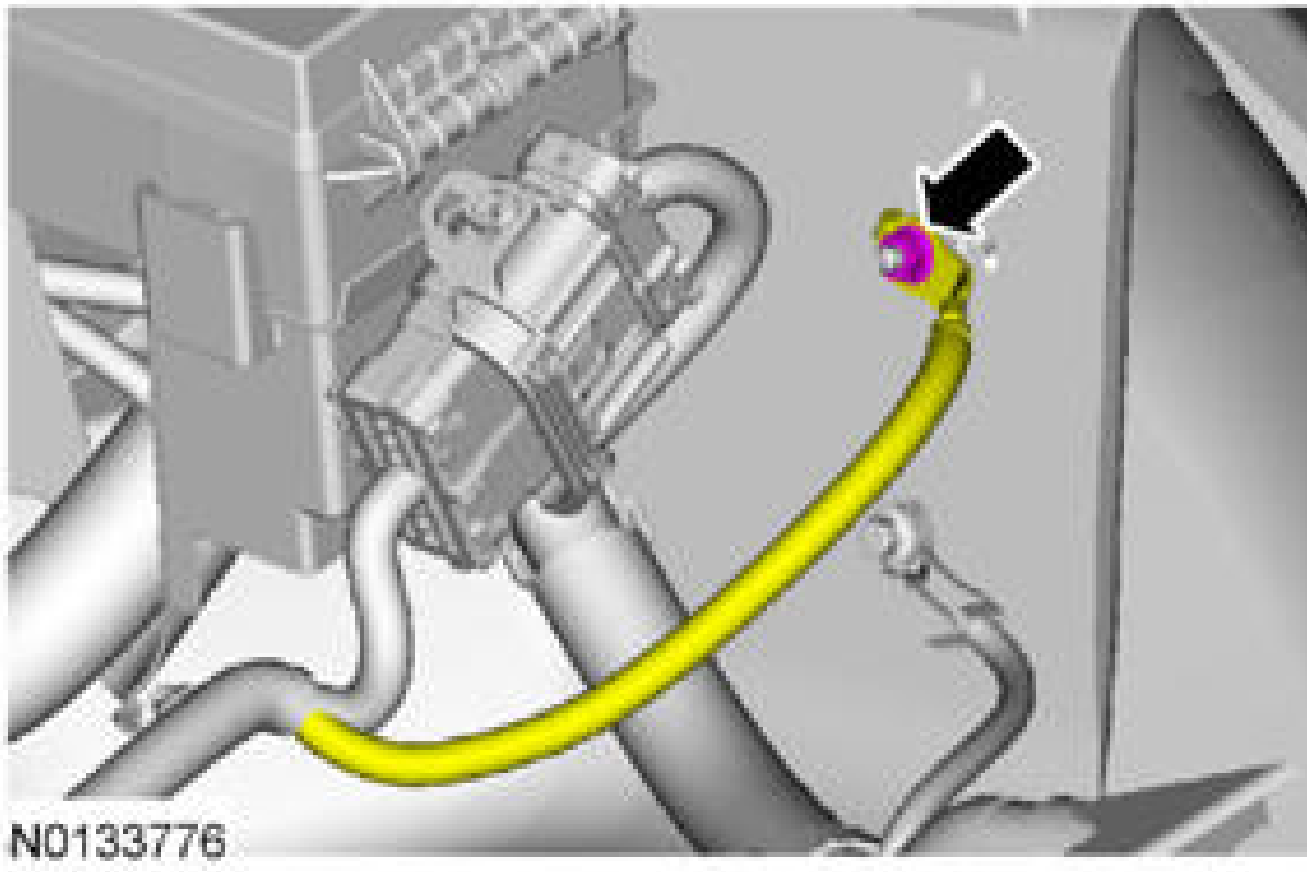
1. With the vehicle in NEUTRAL, position it on a hoist. REFER to **JACKING AND LIFTING** , Lifting Points.
2. Recover the A/C system. REFER to **AIR CONDITIONING (A/C) SYSTEM RECOVERY, EVACUATION AND CHARGING** .
3. Remove the cowl panel. REFER to **COWL PANEL** .
4. Release the fuel system pressure. REFER to **FUEL SYSTEM PRESSURE RELEASE** .
5. Remove the engine **ACL** assembly and **ACL** outlet pipe. REFER to **INTAKE AIR SYSTEM COMPONENTS - EXPLODED VIEW** .
6. Remove the battery tray. REFER to **BATTERY AND BATTERY TRAY - EXPLODED VIEW** .
7. Remove the nut and disconnect the 2 battery feed cables from the positive battery terminal.

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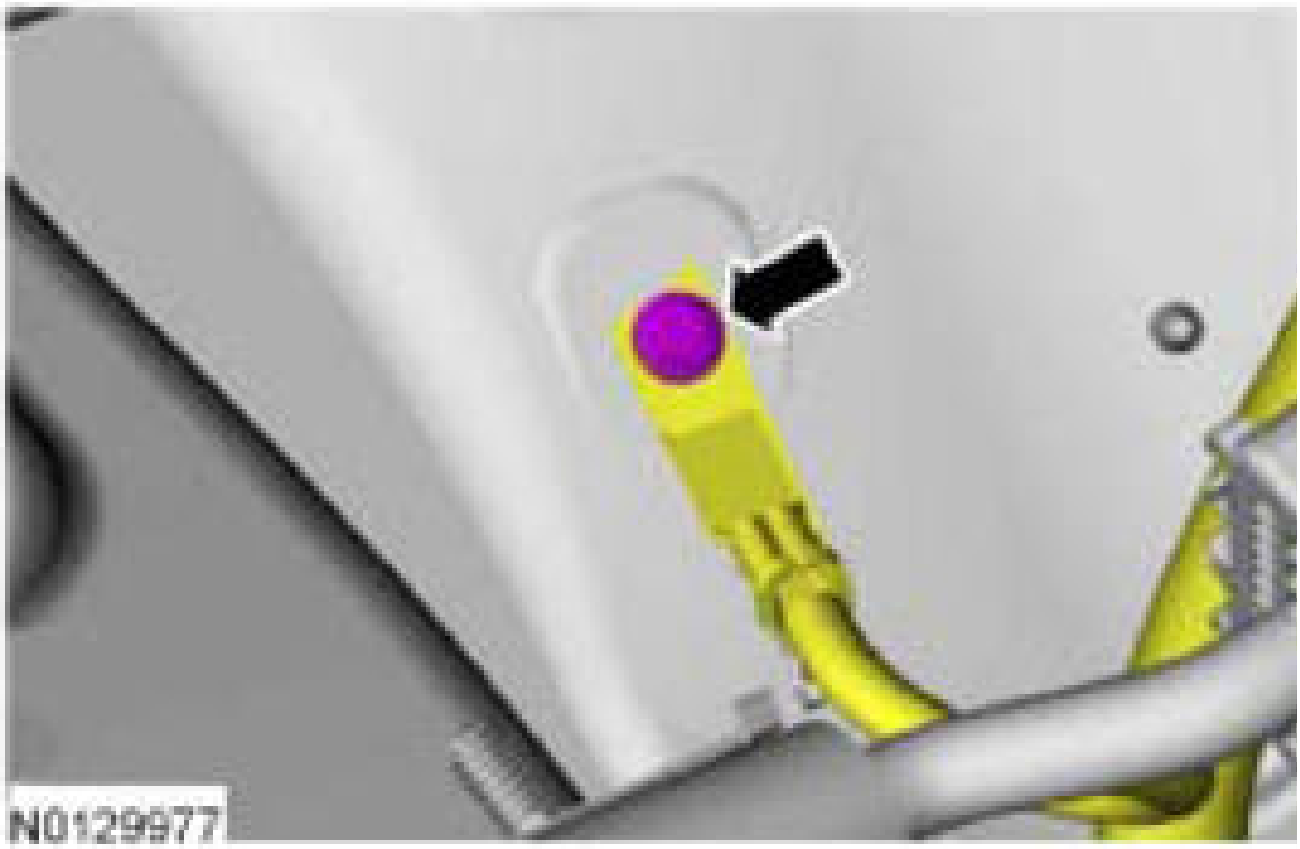
8. Remove the retainer and the ground wire cable.

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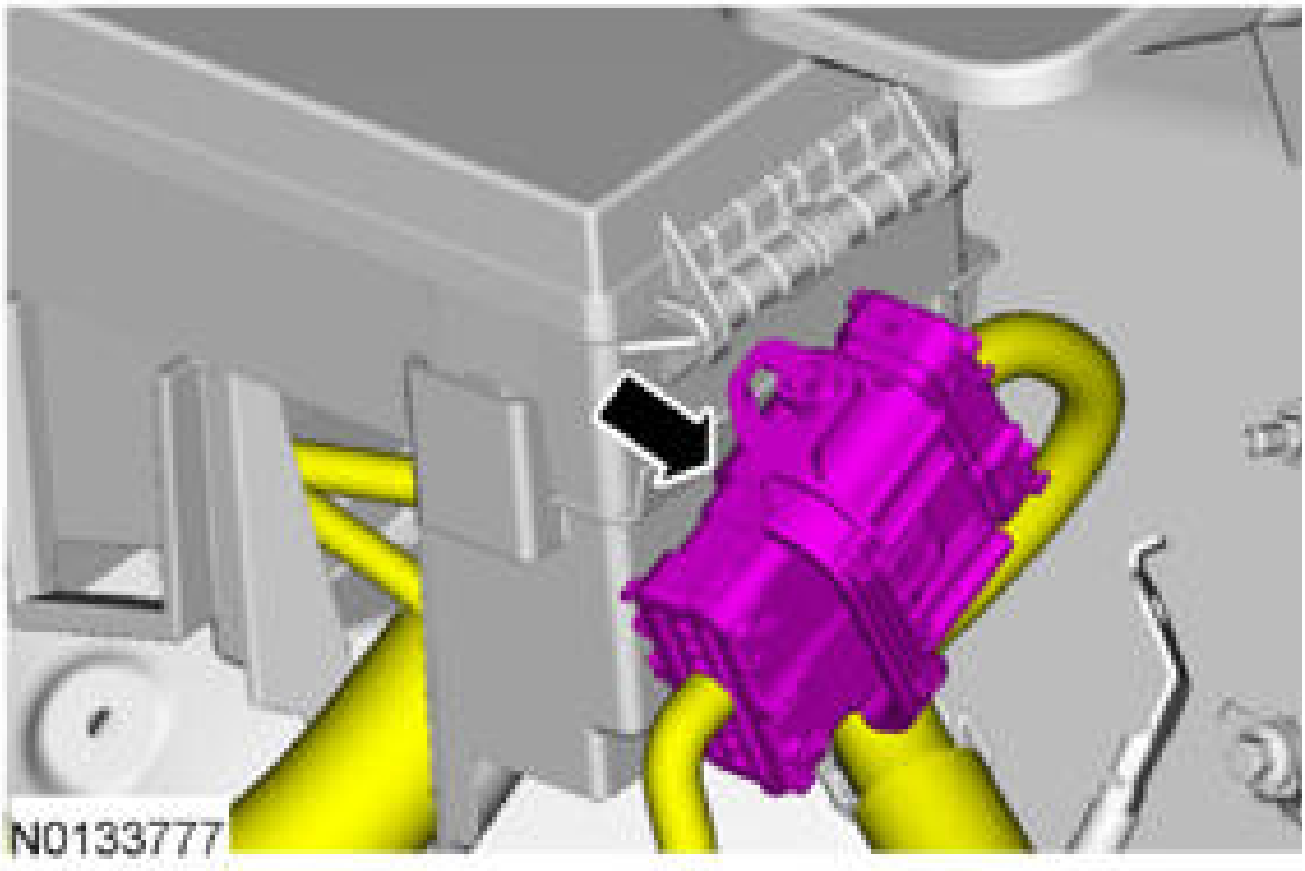
9. Remove the retainer and the ground wire cable.

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10. Disconnect the engine wiring harness electrical connector.

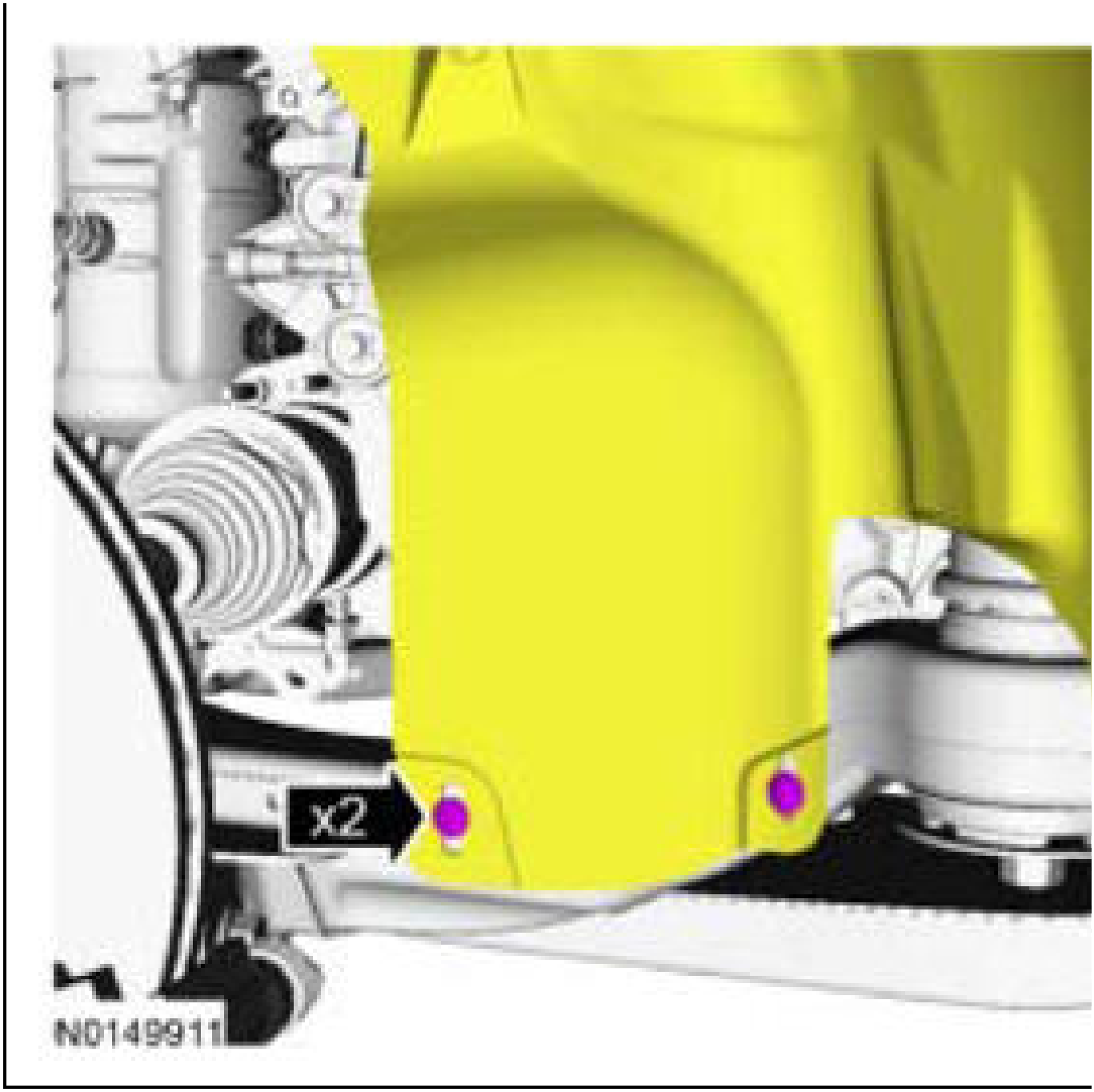
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11. Remove the front wheels and tires. REFER to **WHEEL AND TIRE** .
12. **NOTE: RH shown in illustration, LH similar.**

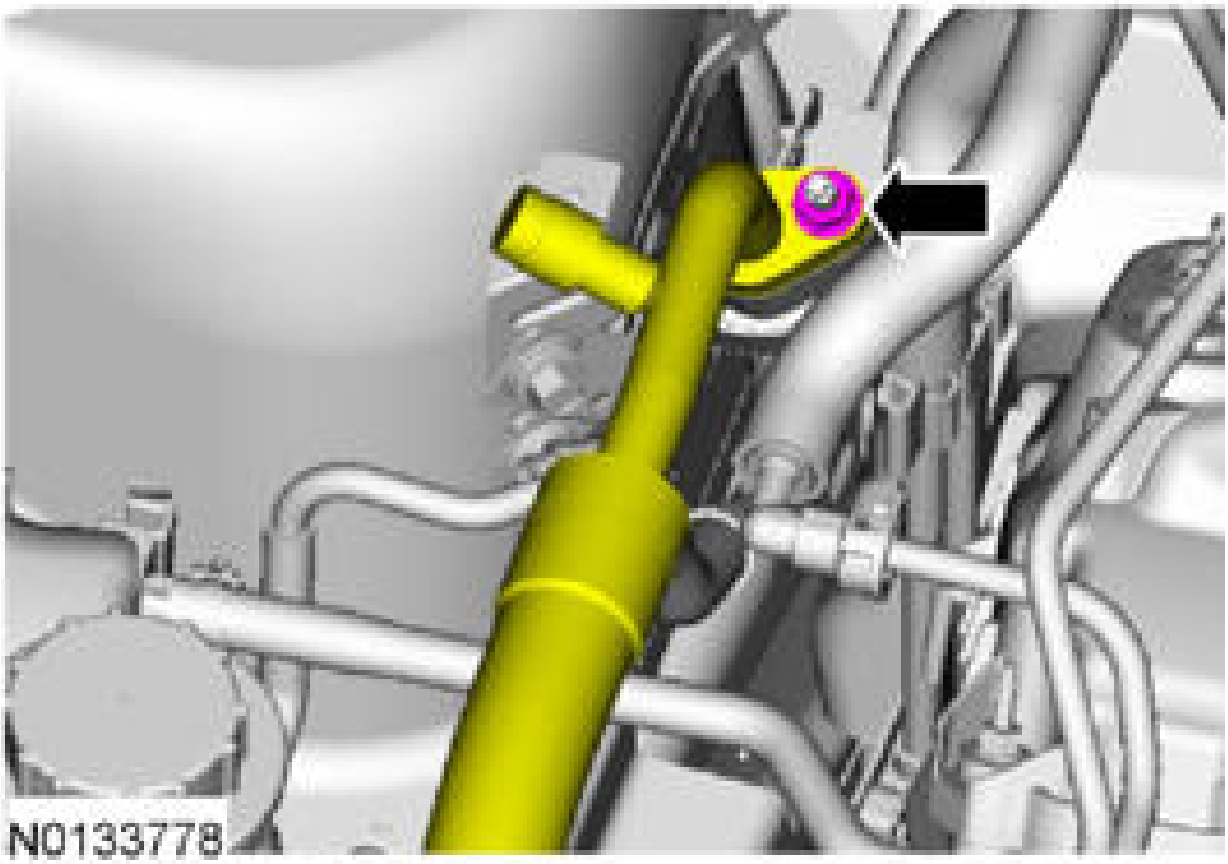
    Remove the 2 RH and 2 LH lower pin-type retainers from the engine splash shields and position the shields aside.

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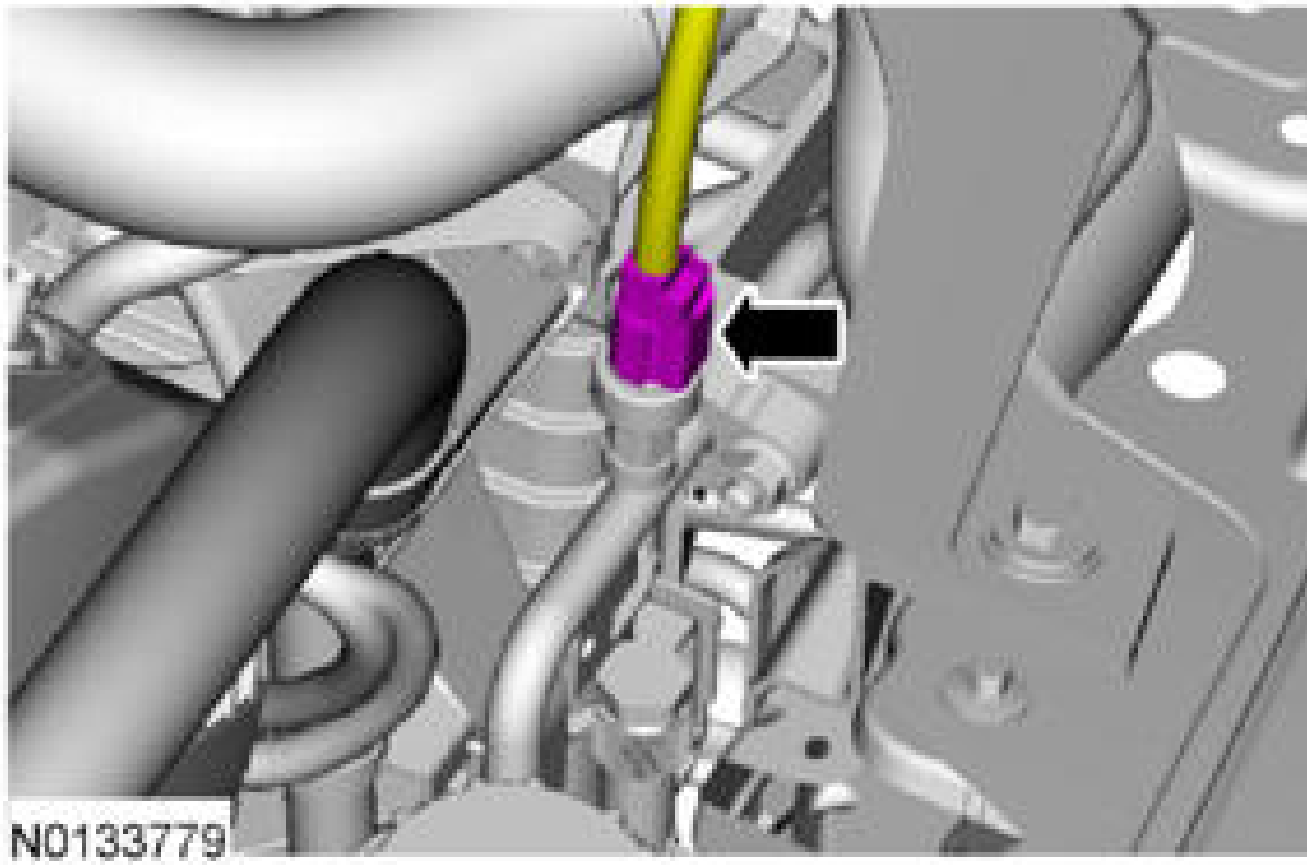
13. Remove the accessory drive belt. REFER to **ACCESSORY DRIVE BELT - 3.5L TI-VCT, 3.7L TI-VCT** .
14. Drain the cooling system. REFER to **COOLING SYSTEM DRAINING, FILLING AND BLEEDING** .
15. Remove the nut and disconnect the A/C tube.
    - Discard the O-ring seal and gasket seal.

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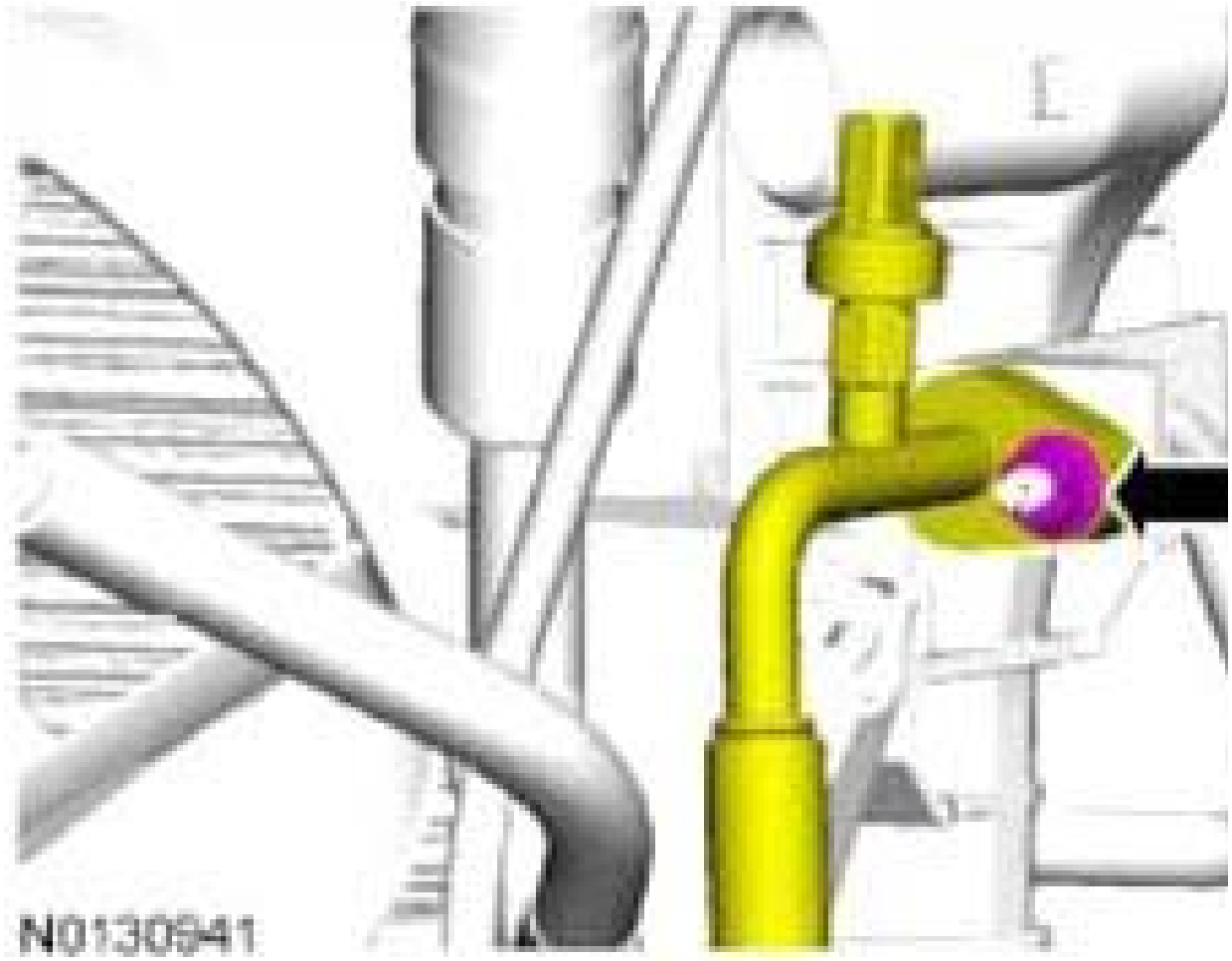
16. Disconnect the A/C pressure switch electrical connector.

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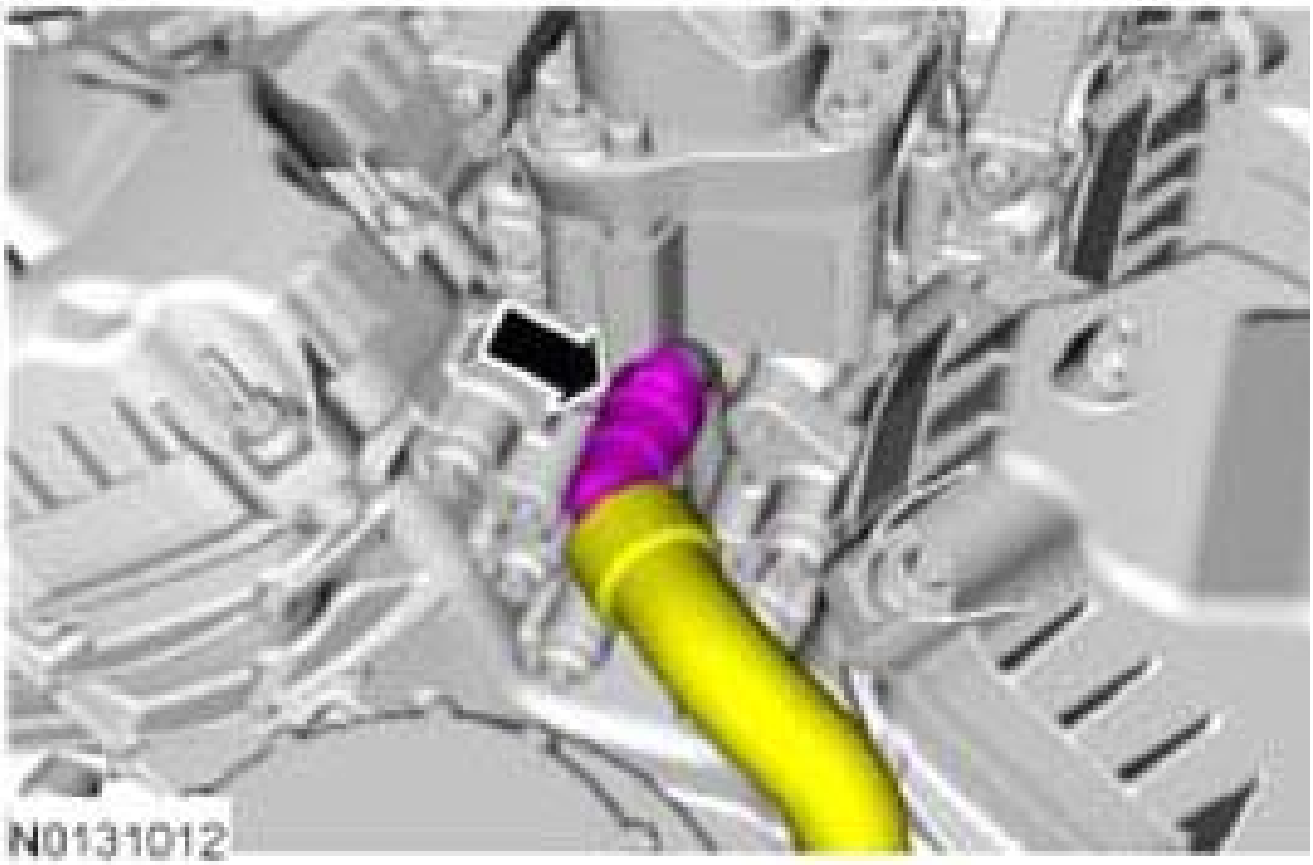
17. Remove the nut and disconnect the A/C tube.
    - Discard the O-ring seal and gasket seal.

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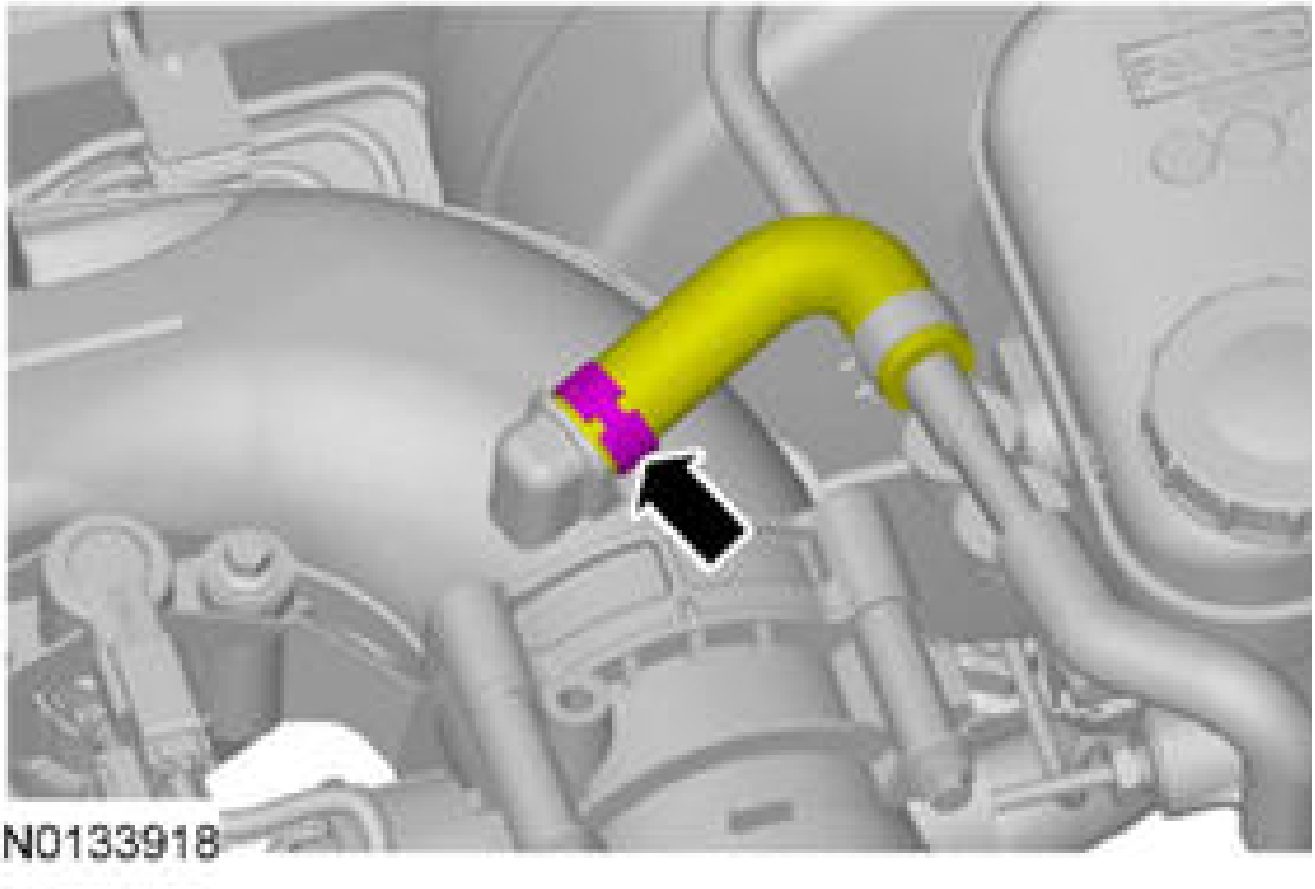
18. Remove degas bottle. REFER to **DEGAS BOTTLE** .
19. Disconnect the degas bottle coolant hose from the engine coolant tube.

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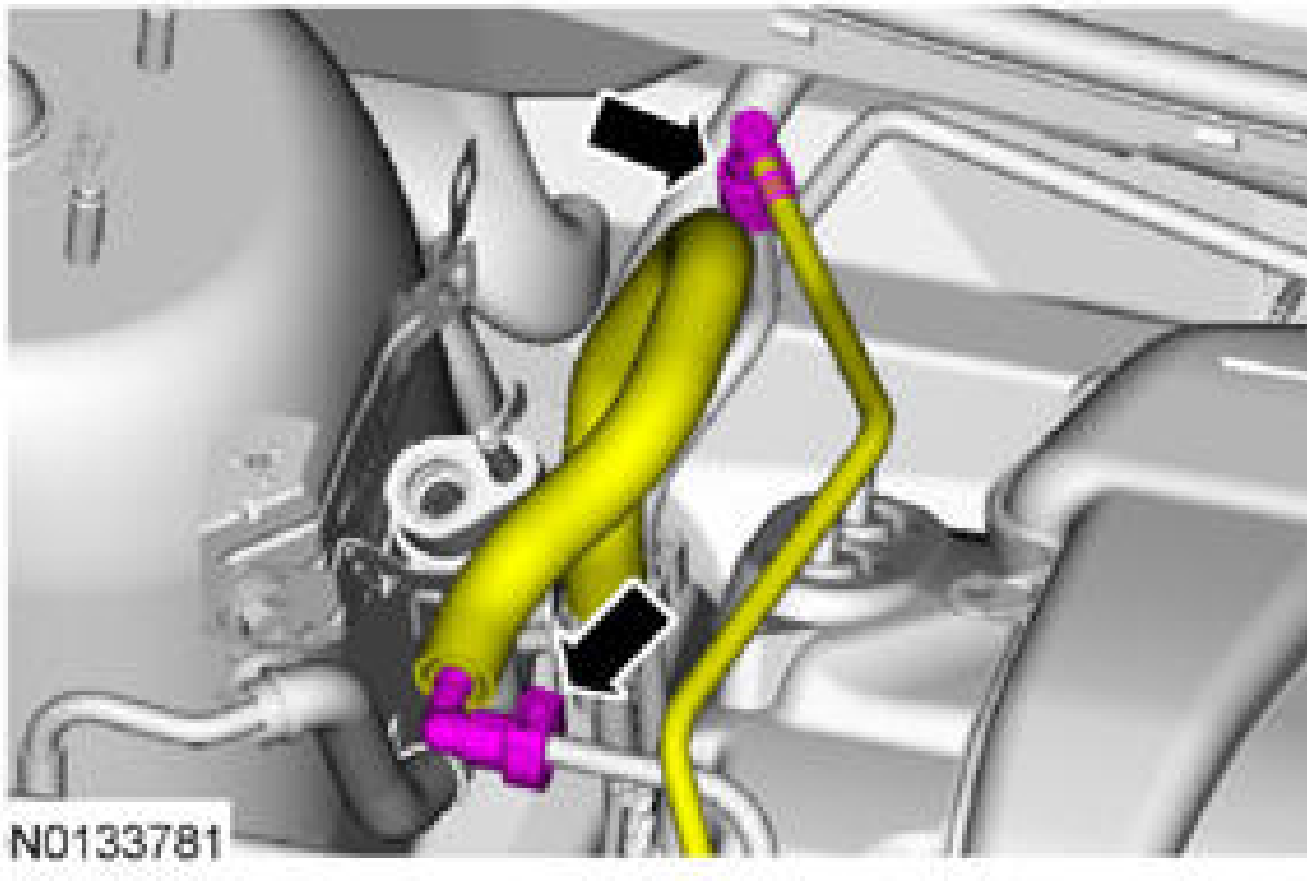
20. Disconnect the brake booster vacuum hose from the upper intake manifold.

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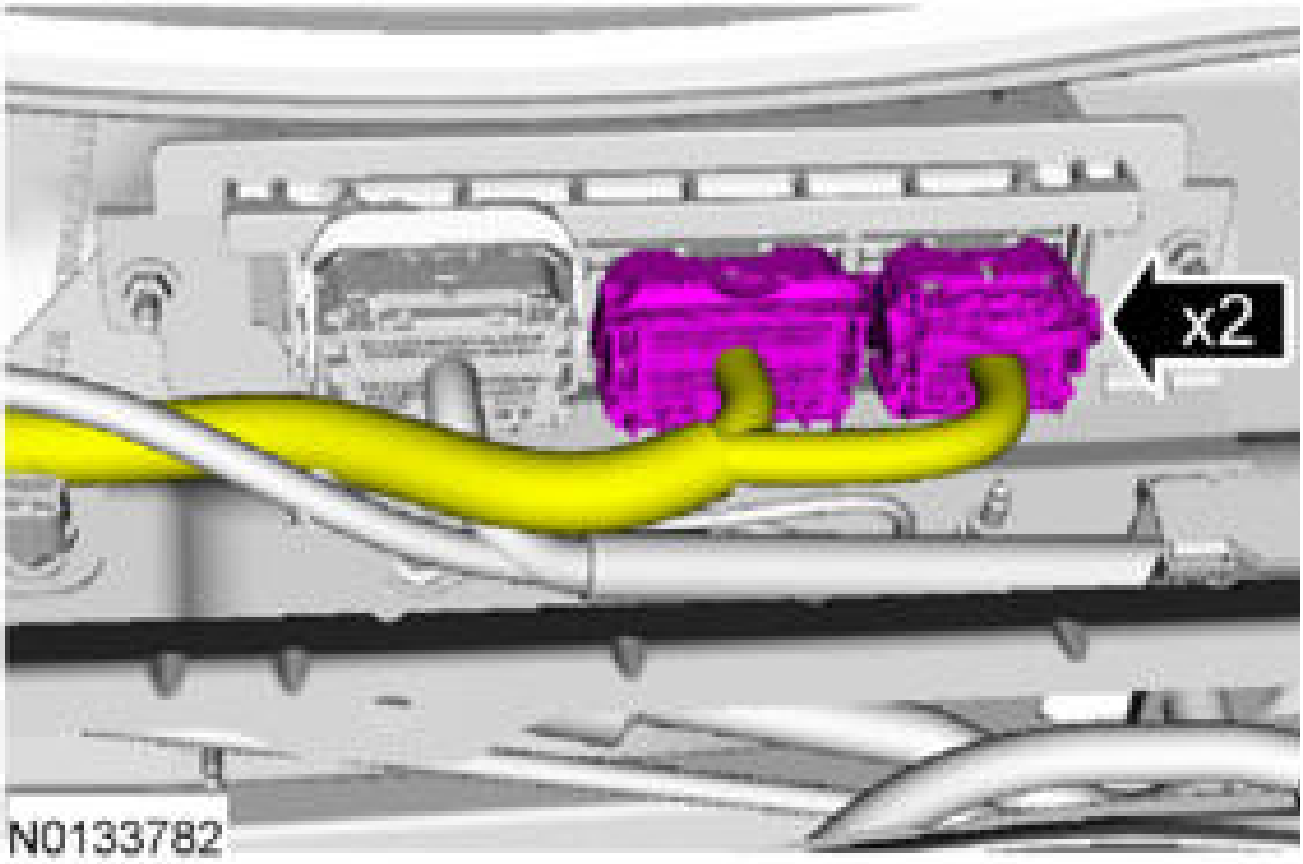
21. Disconnect the **EVAP** tube and the fuel supply tube quick connect coupling. REFER to **QUICK CONNECT COUPLING** .

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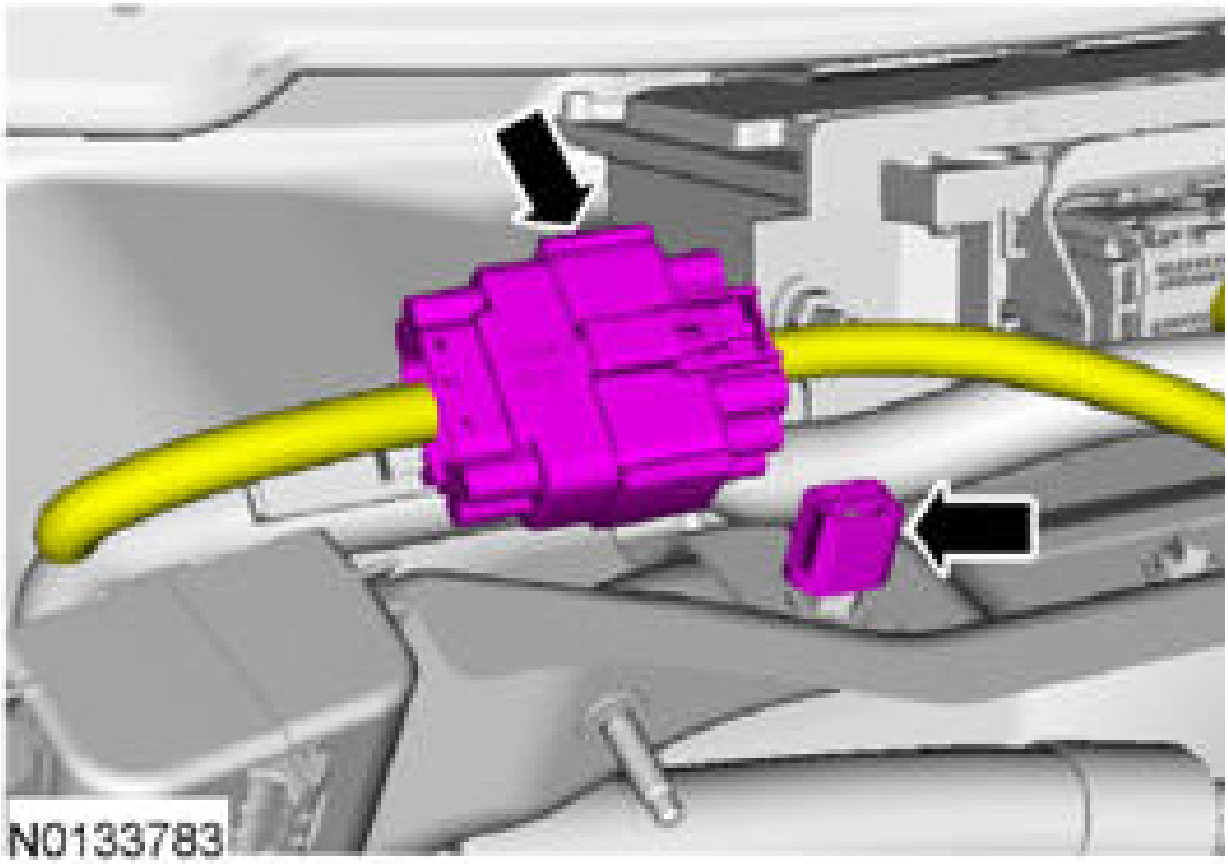
22. Disconnect the 2 **PCM** electrical connectors.

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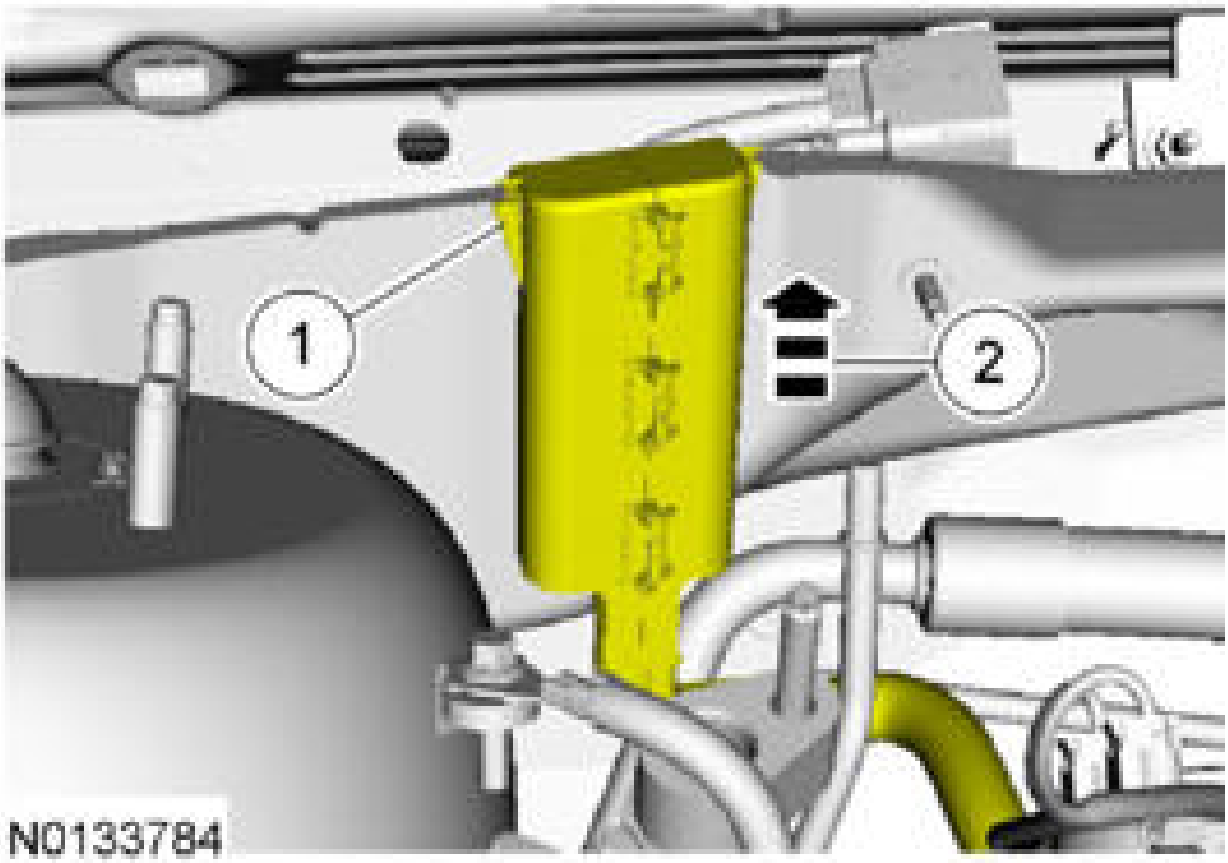
23. Disconnect the engine harness electrical connector.
    - Detach the wiring harness retainer.

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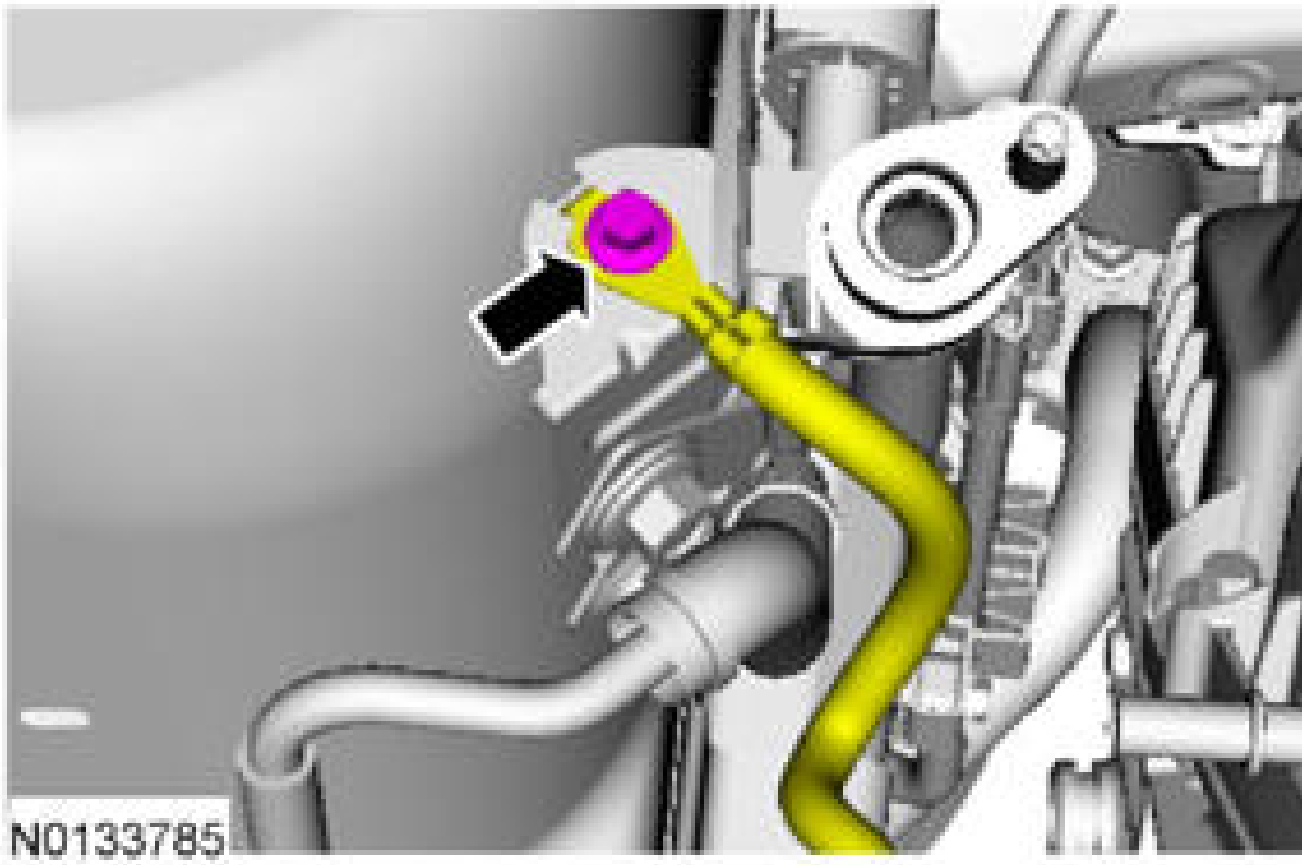
24. Remove the engine wiring harness retainer from the bulkhead.
    - Push the wiring harness retainer tab in.
    - Slide the wiring harness up and out of the bulkhead.

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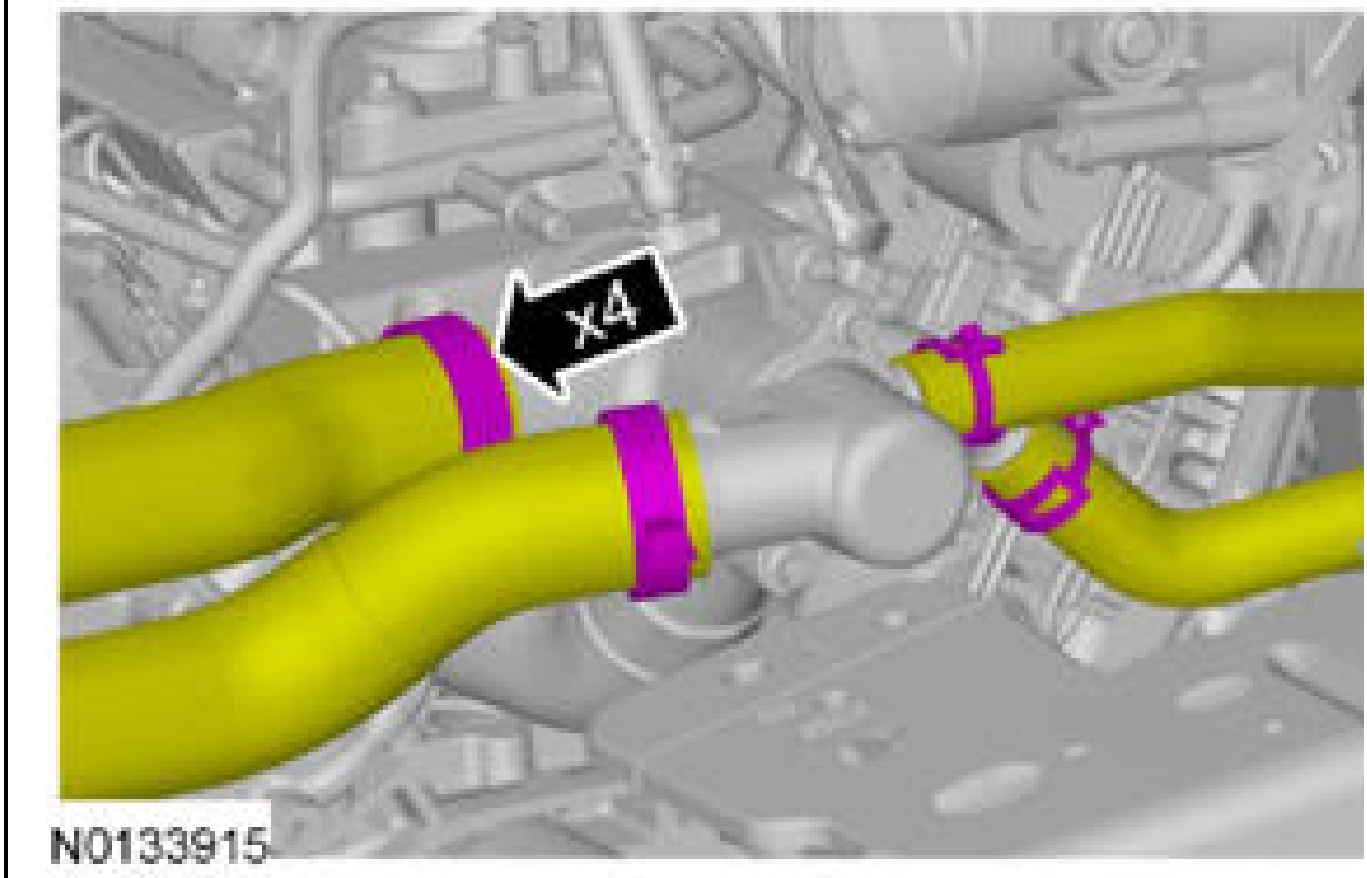
25. Remove the bolt and ground wire from the RH shock tower.

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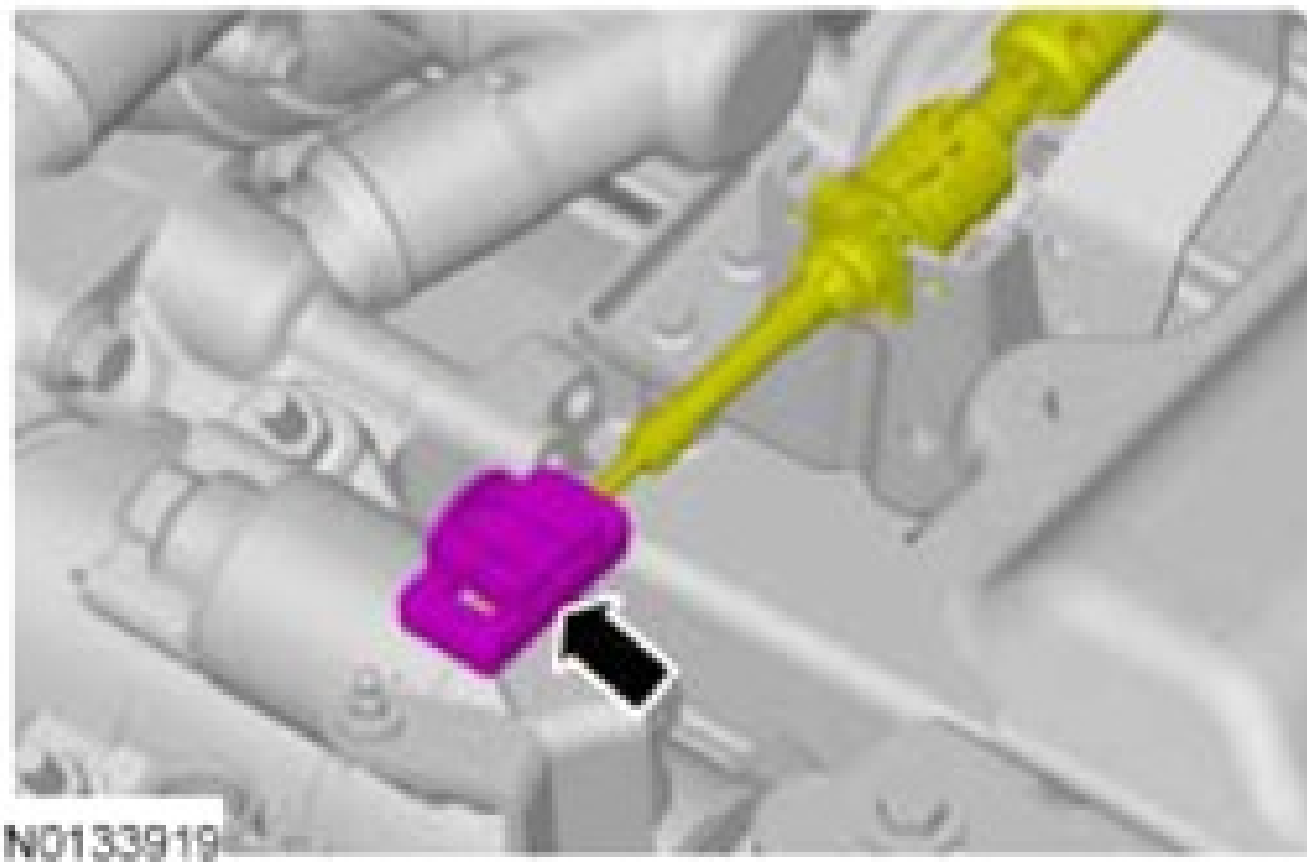
26. Disconnect the upper radiator hose, lower radiator hose and 2 heater hoses from the thermostat housing.

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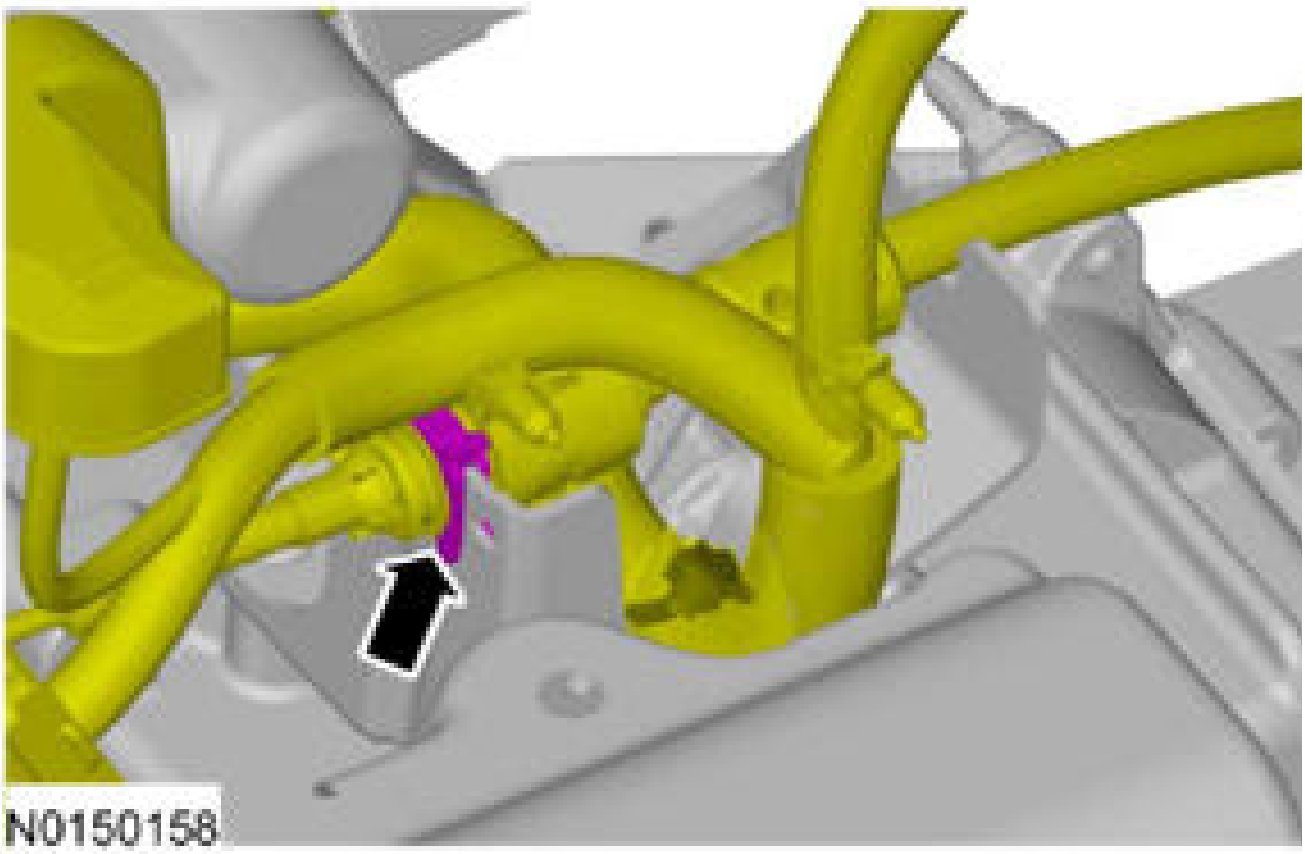
27. Disconnect the transaxle control cable from the control lever.

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28. Disconnect the transaxle control cable from the shift cable bracket.

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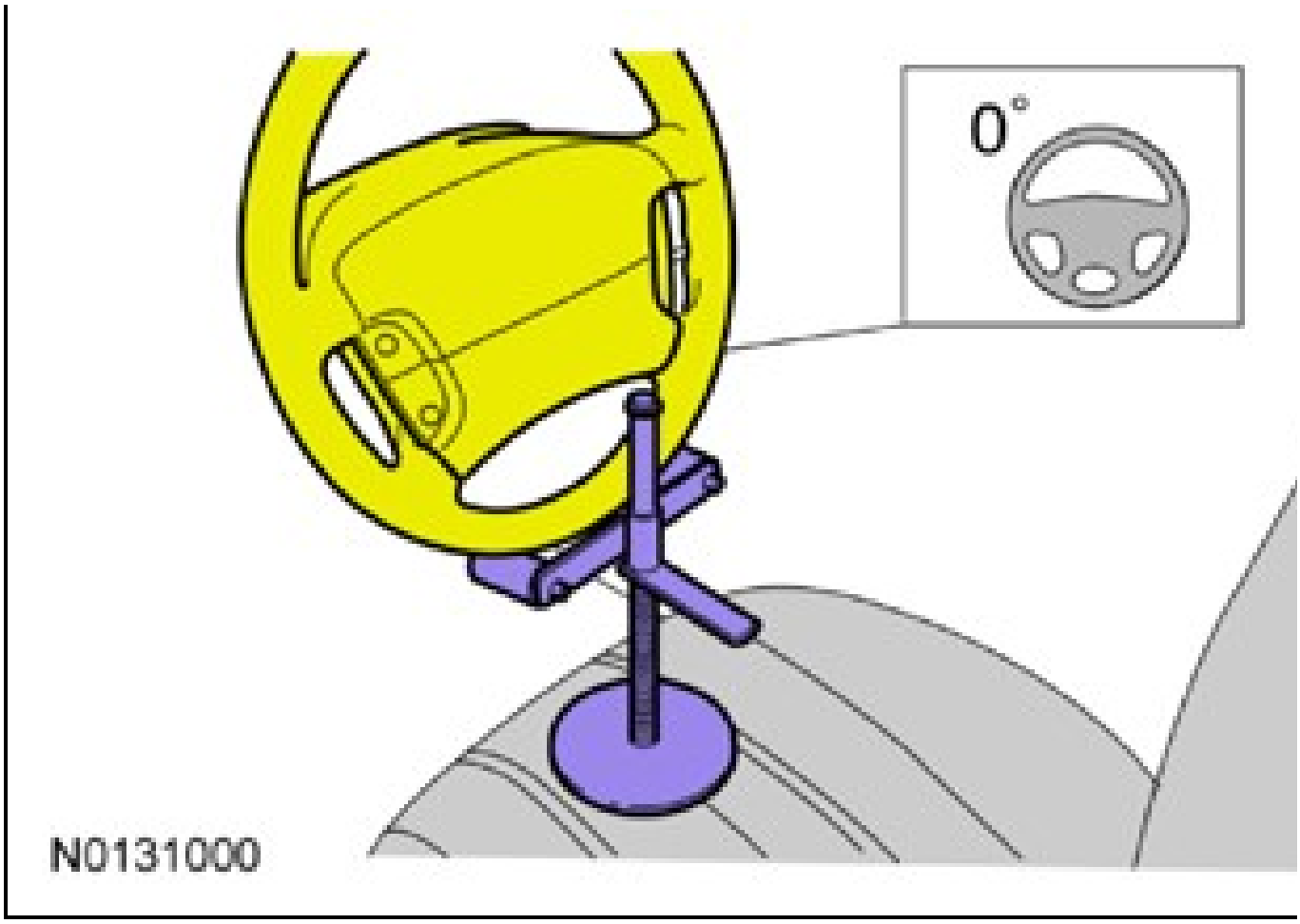


29. If equipped, detach the engine block heater harness.

NOTE: Use a steering wheel holding device (such as Hunter® 28-75-1 or equivalent).

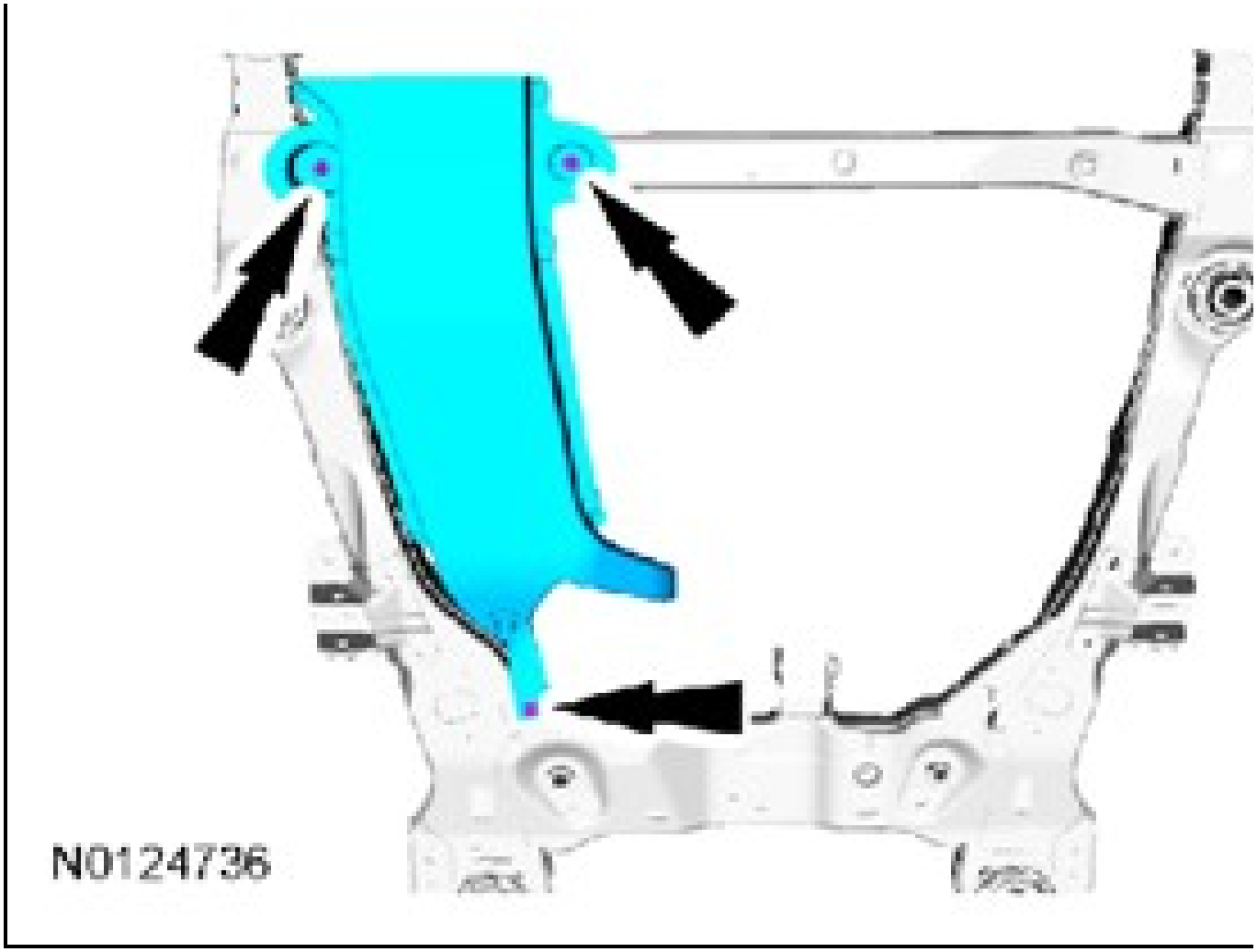
30. Using a suitable holding device, hold the steering wheel in the straight-ahead position.

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31. Remove the 3 twist lock retainers and the underbody air duct.

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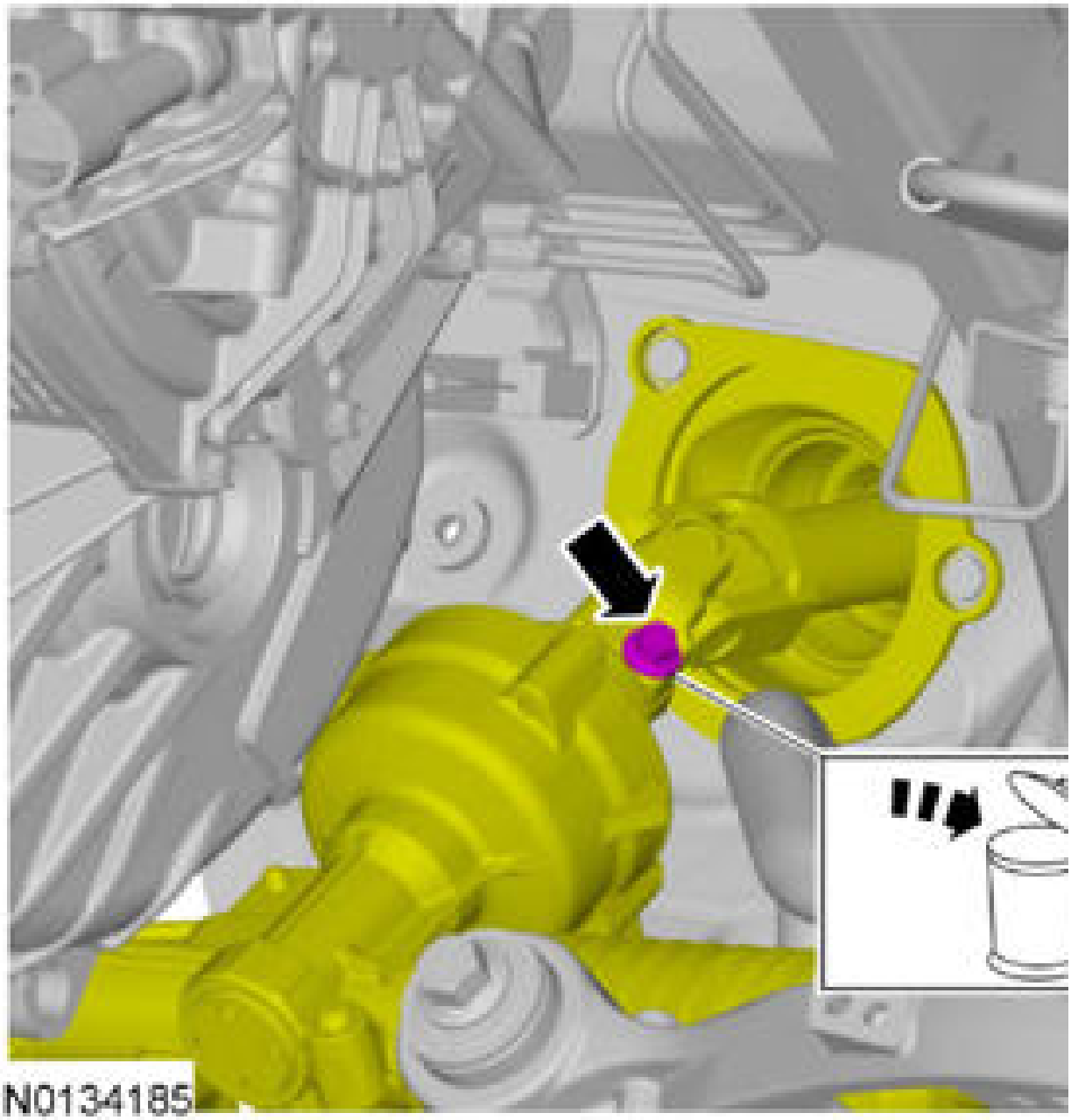
32. **NOTE:** **Do not allow the intermediate shaft to rotate while it is disconnected from the gear or damage to the clockspring may occur. If there is evidence that the intermediate shaft has rotated, the clockspring must be removed and recentered. For additional information, refer to CLOCKSPRING , and CLOCKSPRING ADJUSTMENT .**

NOTE: **Index-mark the steering column shaft position to the steering gear for reference during installation.**

Remove the bolt and disconnect the steering column shaft from the steering gear.

- Discard the bolt.

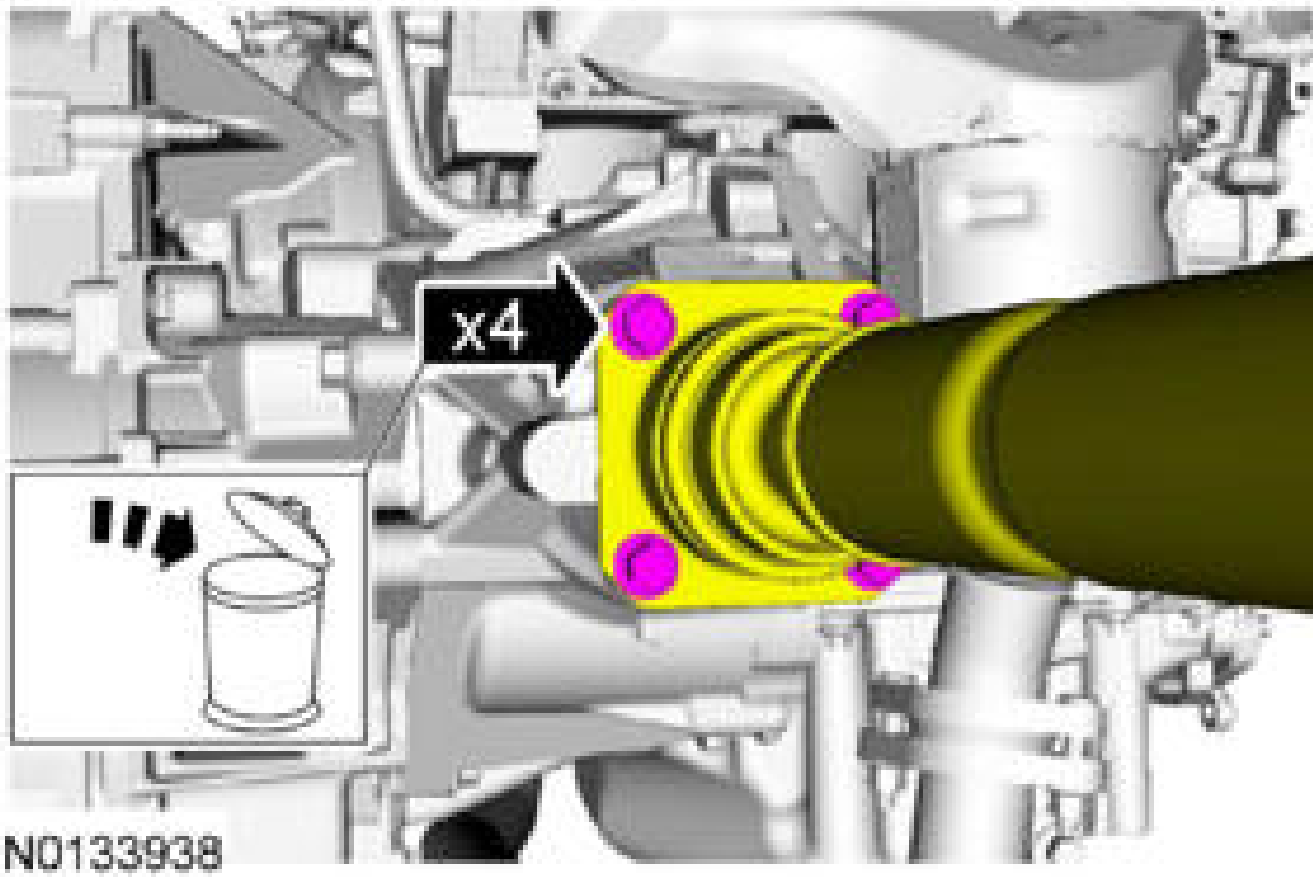
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33. Remove the exhaust Y-pipe. For additional information, refer to **EXHAUST Y-PIPE - 3.5L TI-VCT** .
34. **NOTE: Index-mark the driveshaft for installation.**

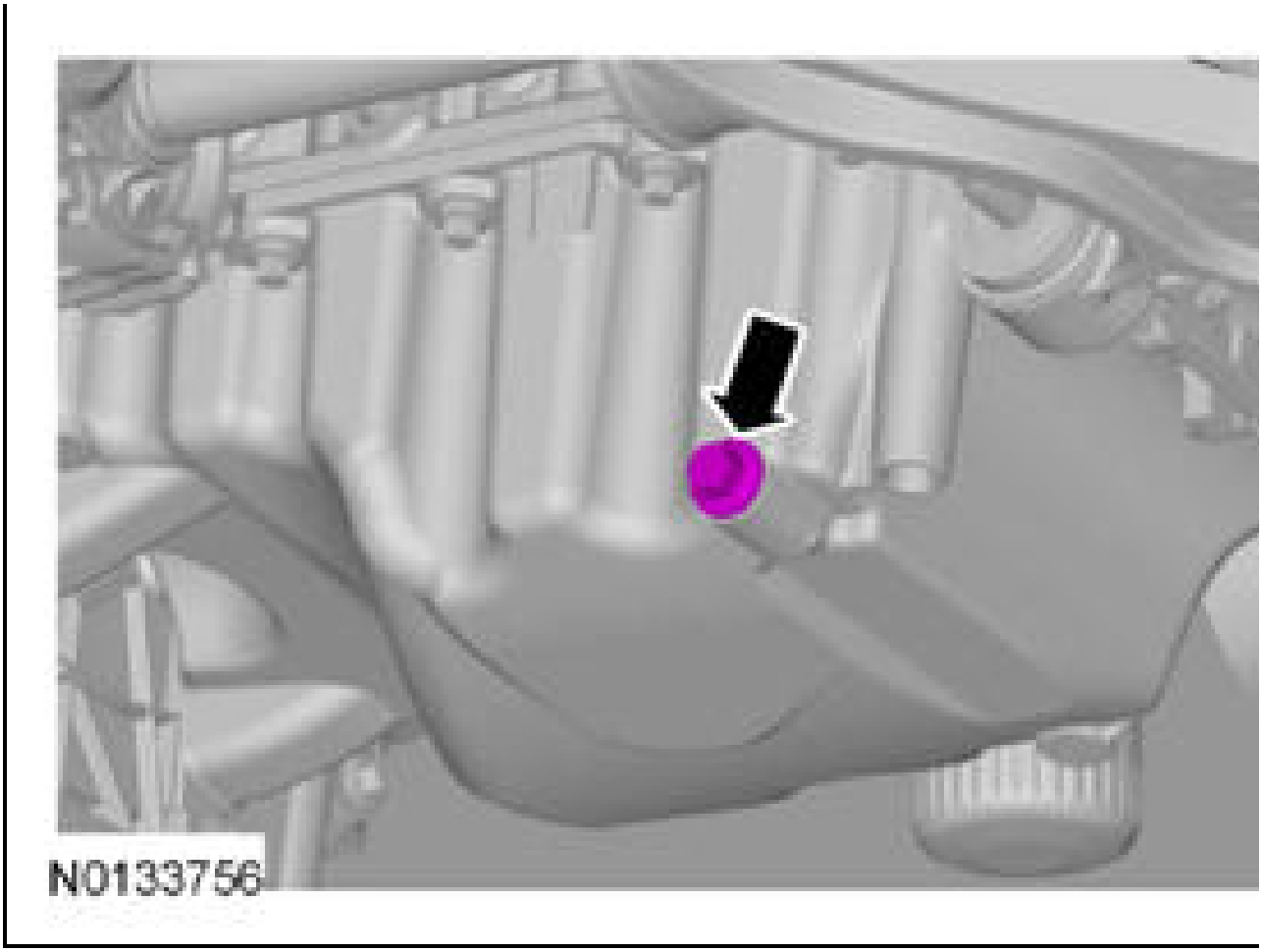
    Remove and discard the 4 bolts and support the driveshaft with a length of mechanic's wire.

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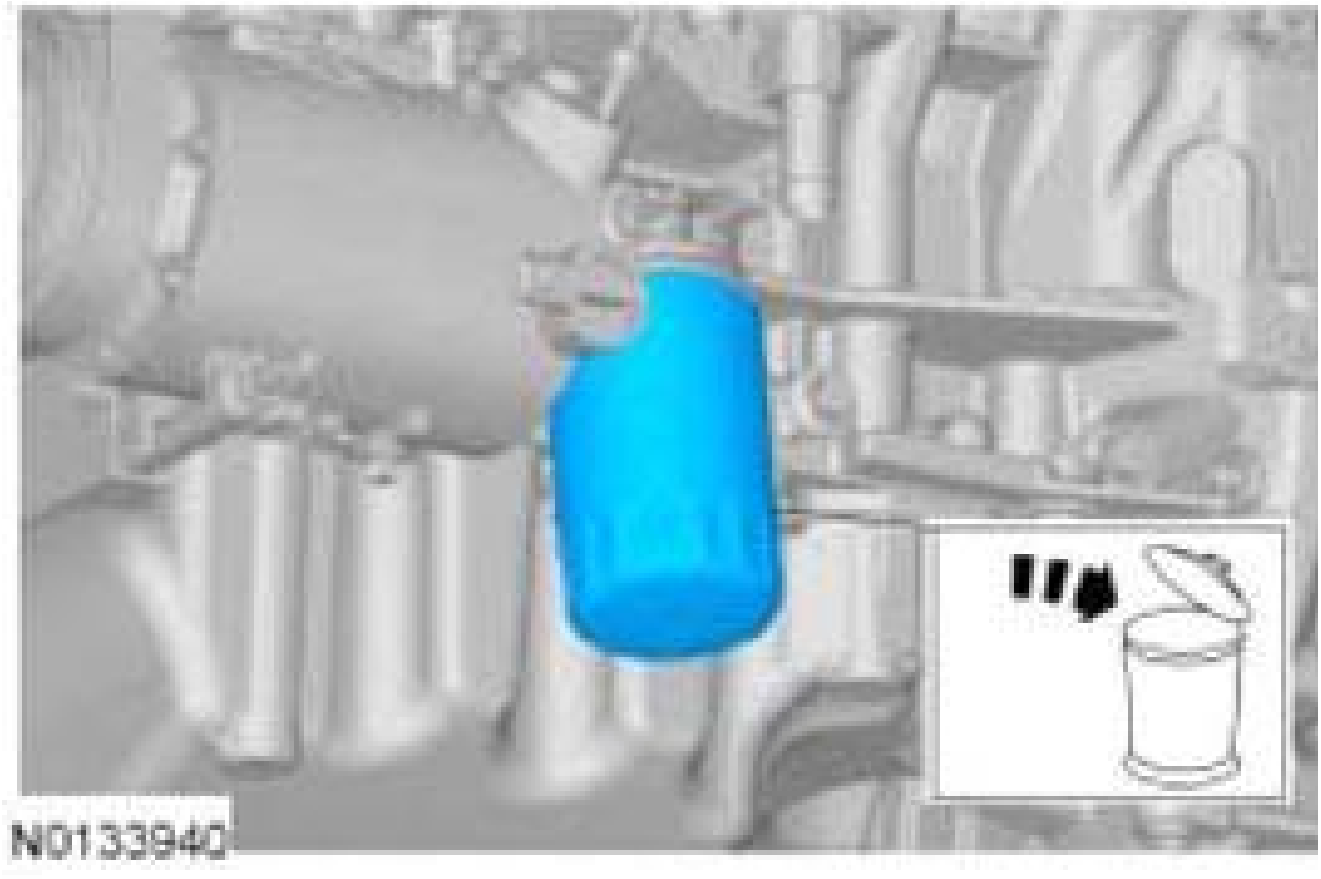
35. Remove the drain plug and drain the engine oil.
    - Install the drain plug and tighten to 27 Nm (20 lb-ft).

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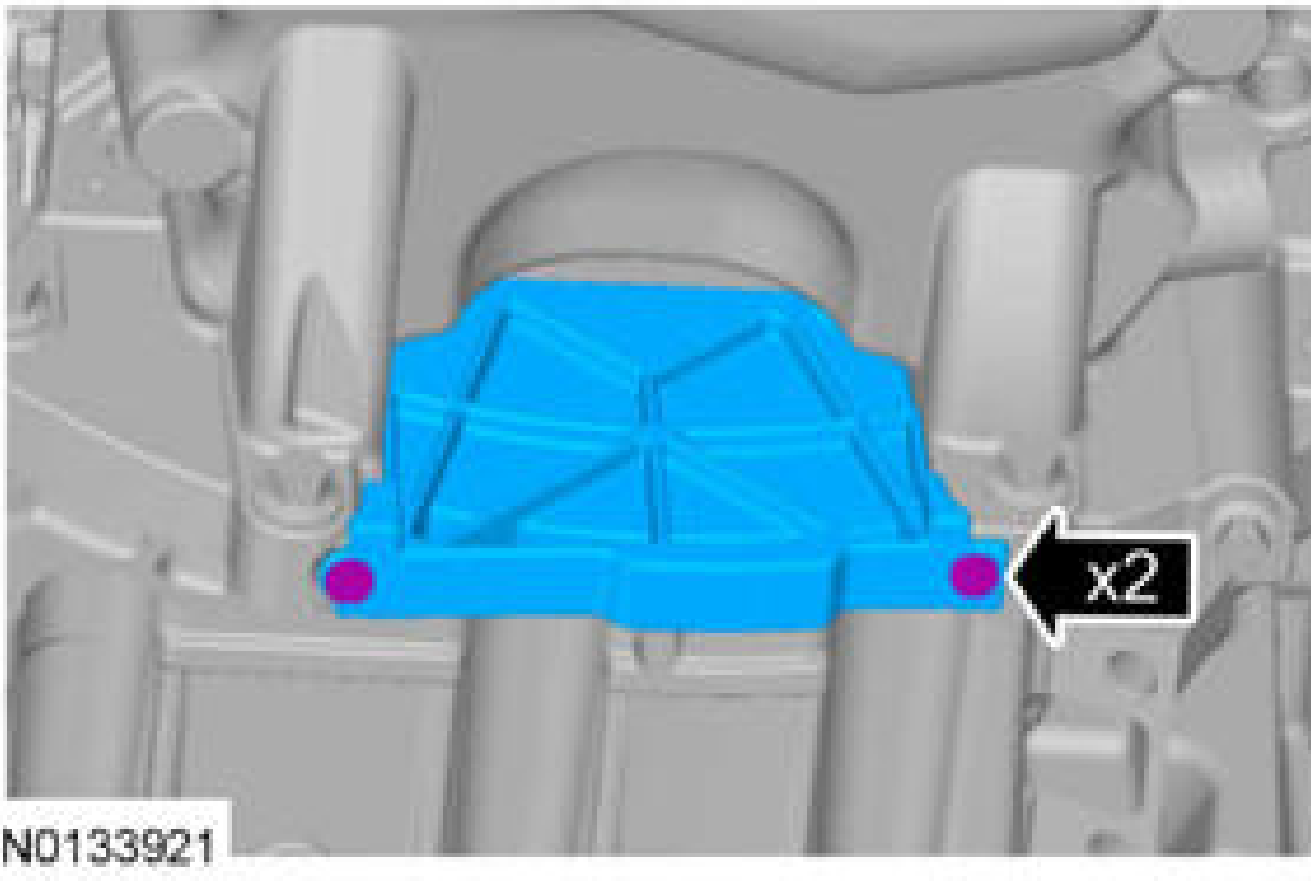
36. Remove and discard the engine oil filter.

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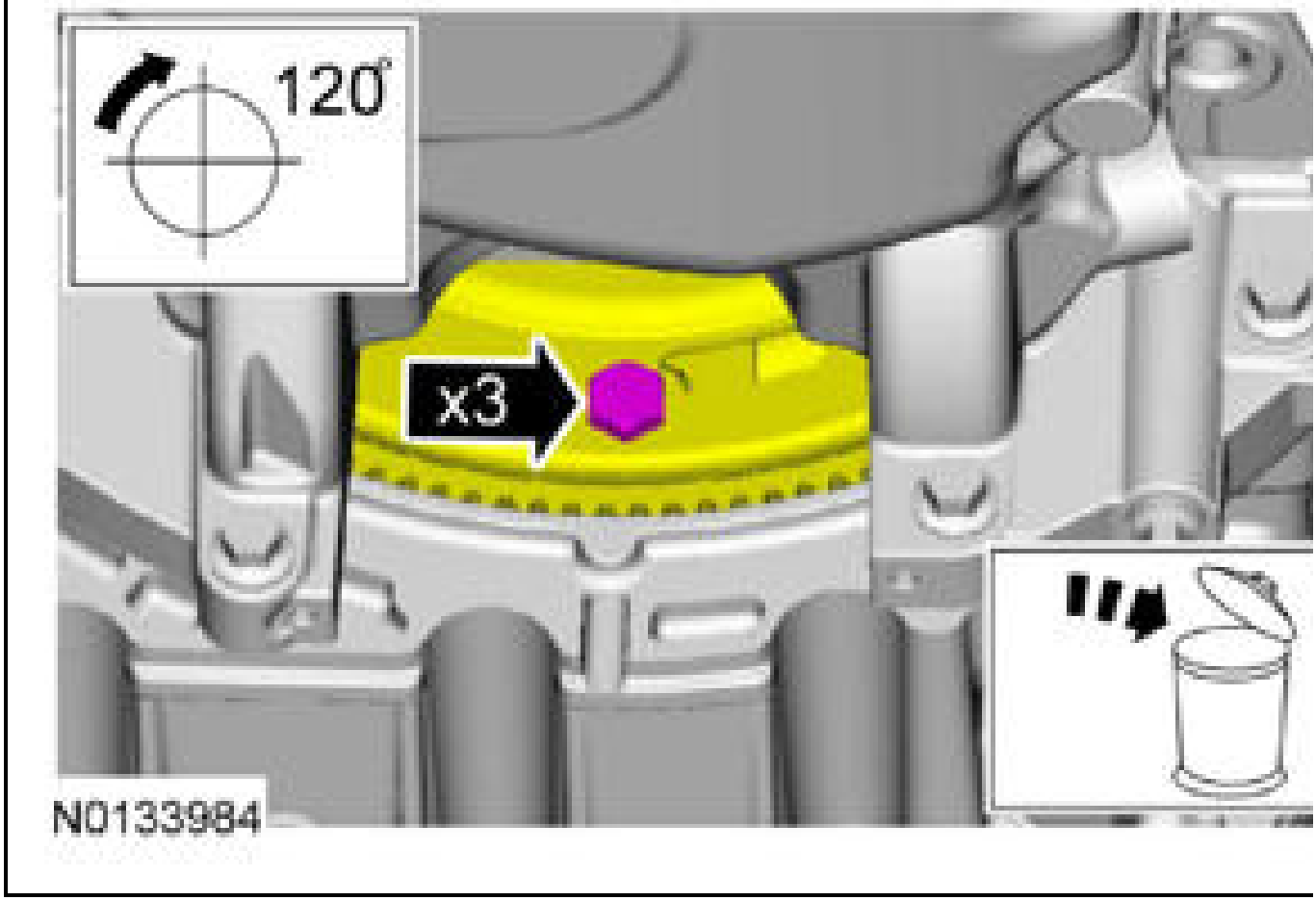
37. Remove the 2 fasteners and the inspection cover.

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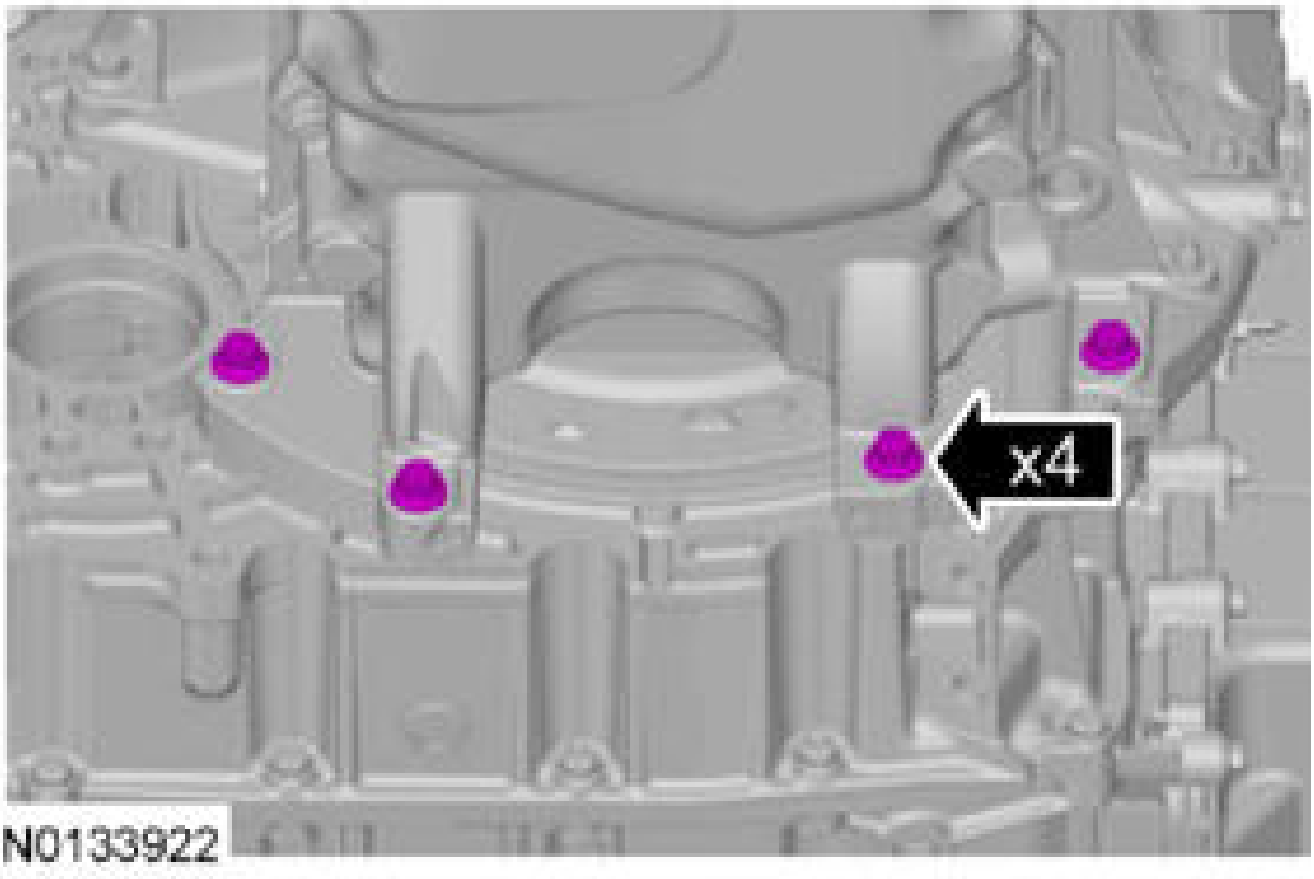
38. Remove and discard the 3 torque converter bolts.

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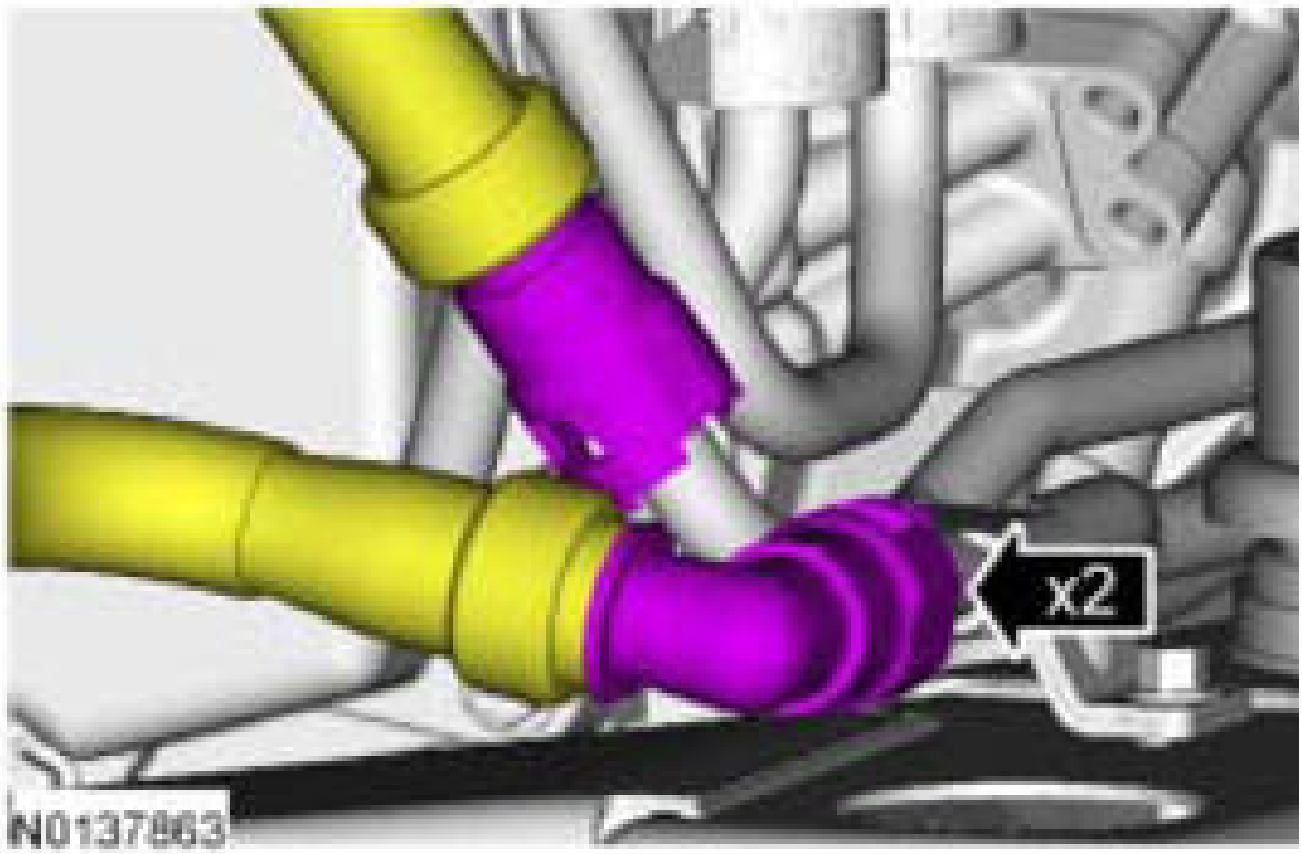
39. Remove the 4 oil pan-to-transaxle bolts.

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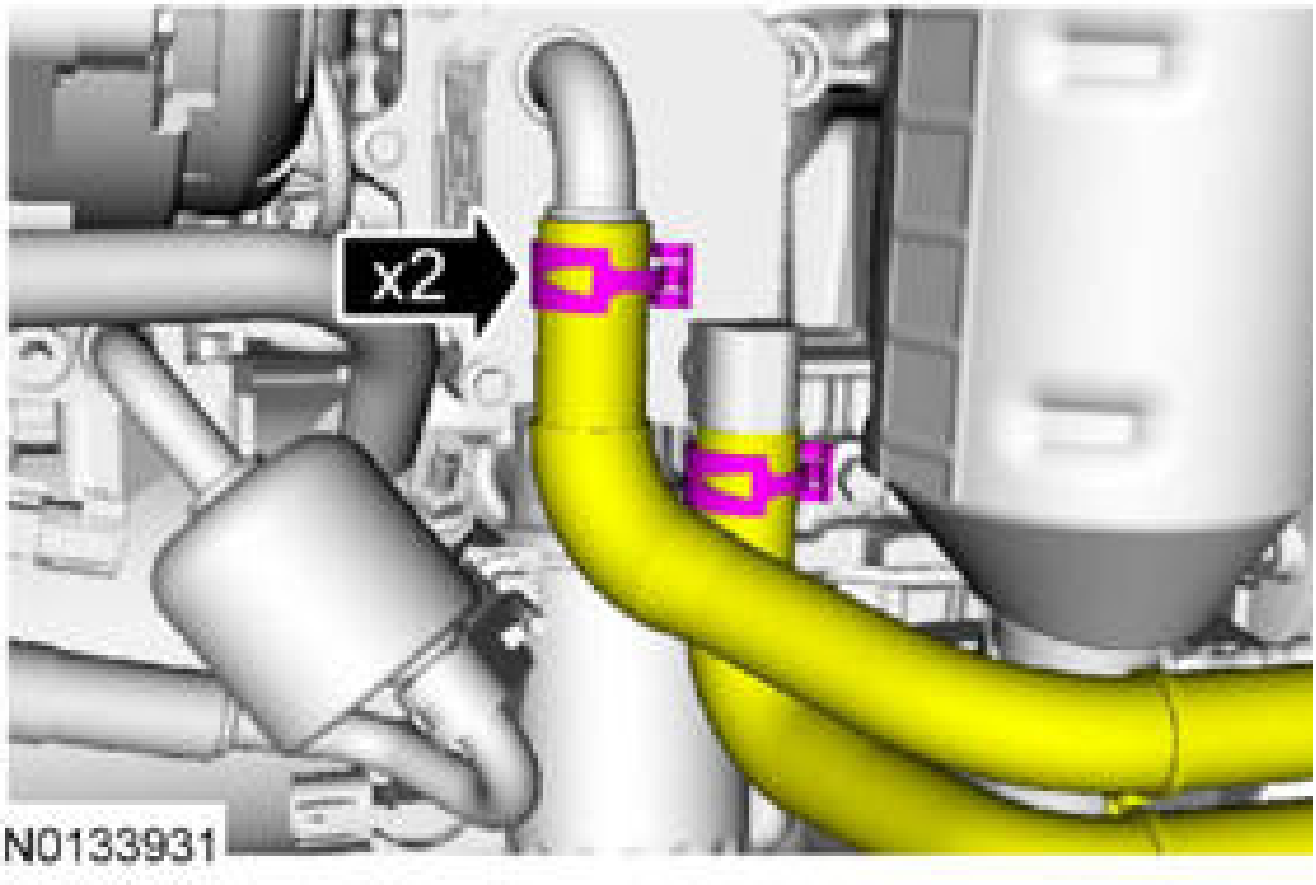
40. If equipped, disconnect the 2 **PTU** cooler hoses. For additional infomation, refer to **FUEL SYSTEM - GENERAL INFORMATION** .

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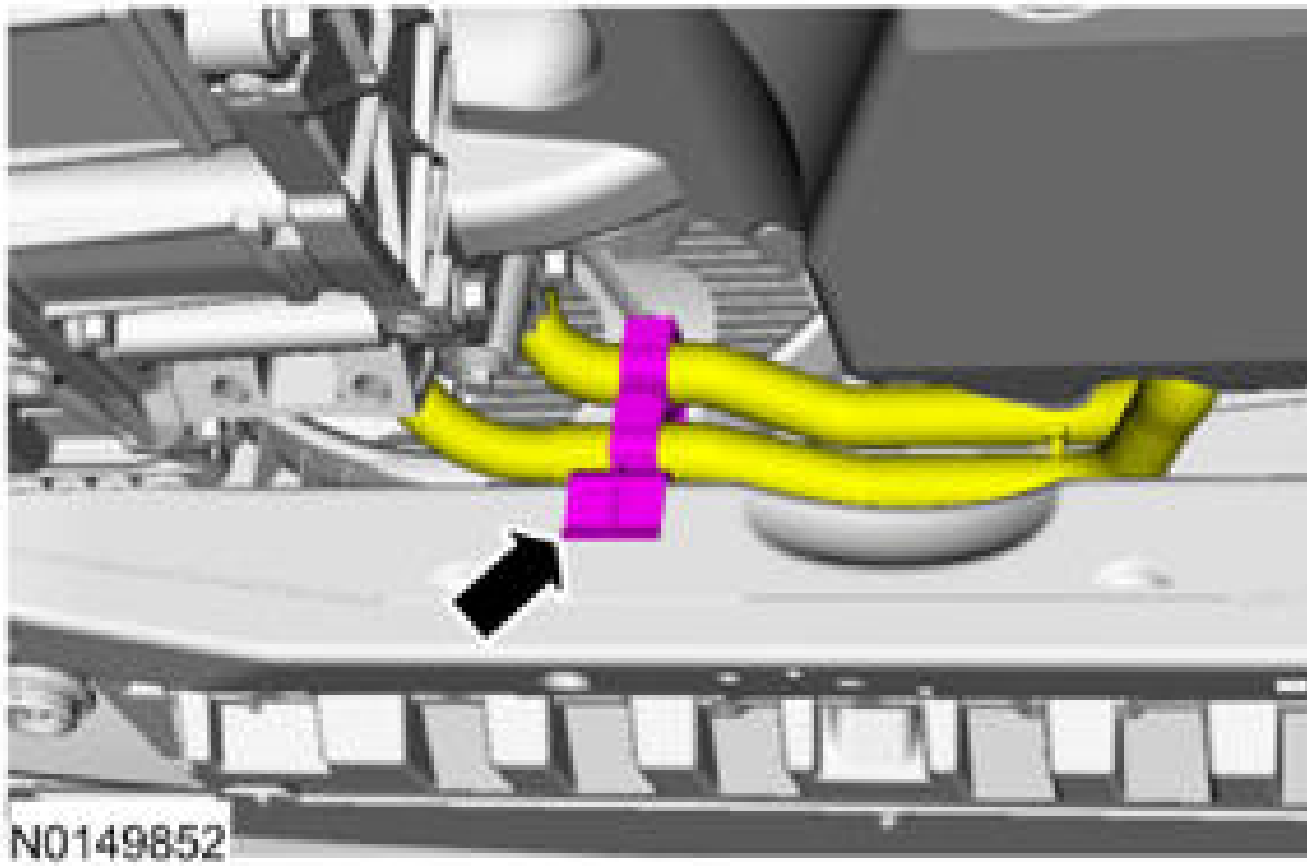
41. If equipped, disconnect the oil cooler coolant hoses.

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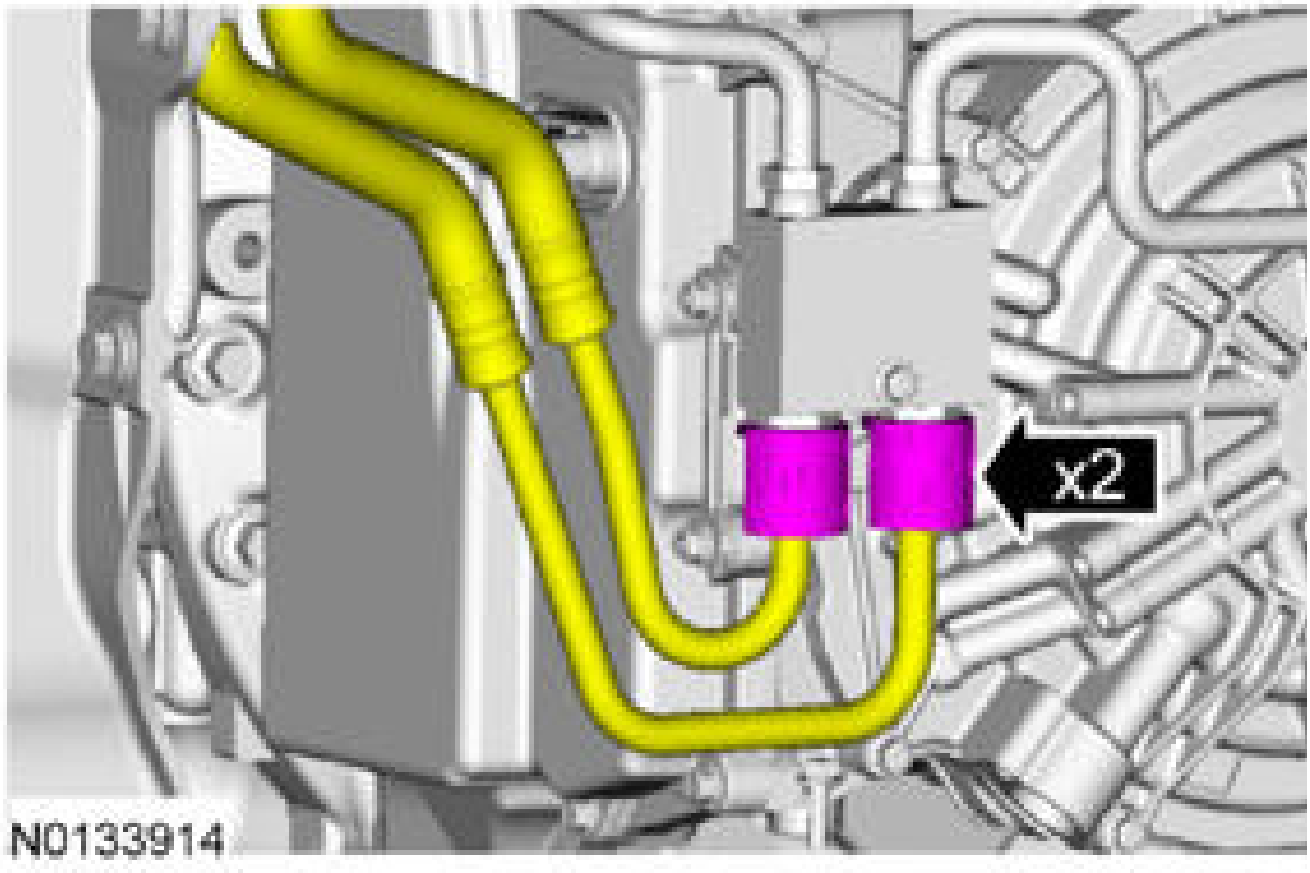
42. If equipped, unlatch the cooler hose retainer latch and pry up on the oil cooler hose retainer to release the retainer and remove it from the subframe.

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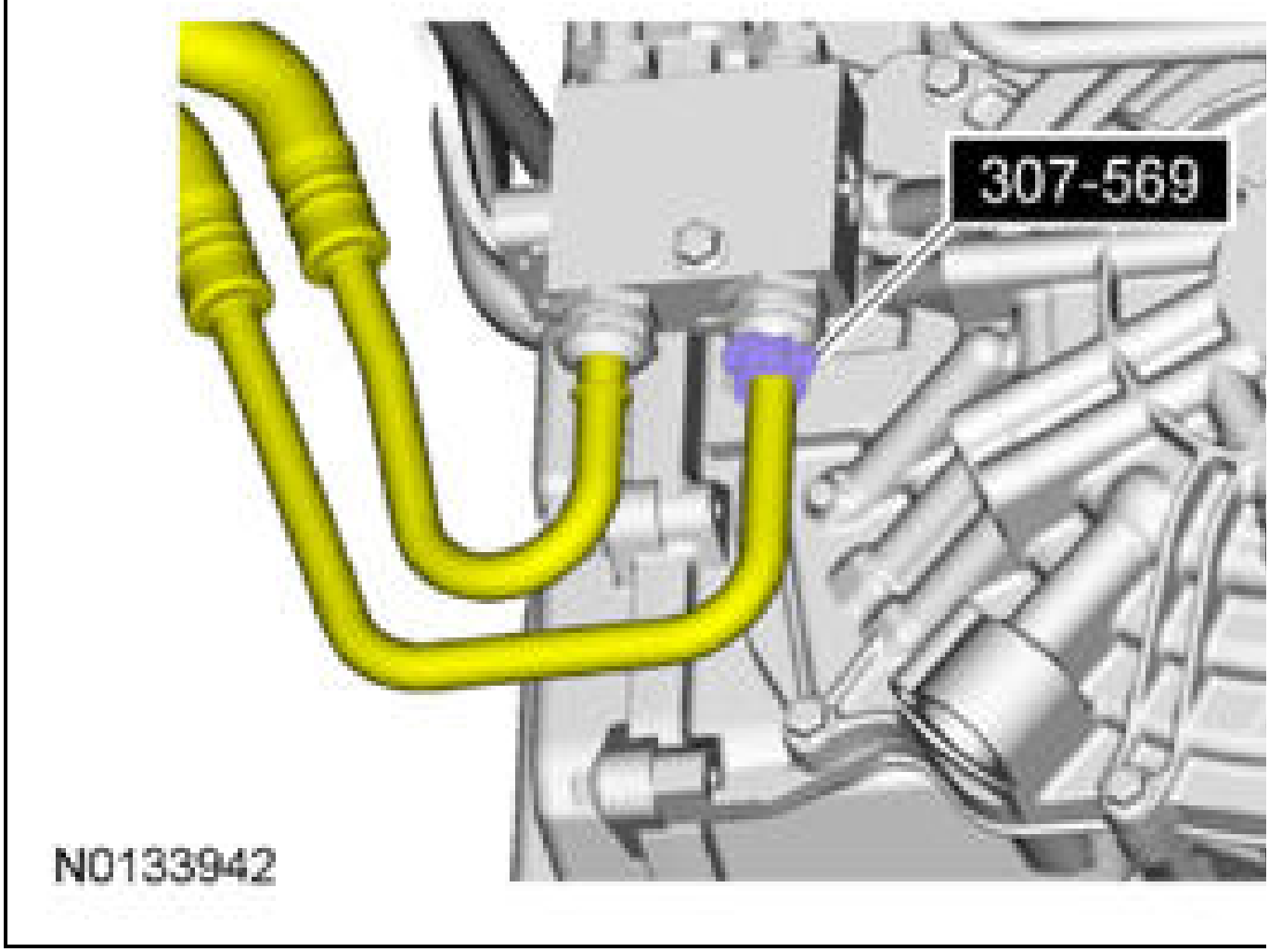
43. Remove the 2 secondary latches from the transmission fluid cooler tubes at the transmission fluid cooler thermal bypass valve.

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44. Using 307-569, disconnect the transmission fluid cooler tubes from the transmission fluid cooler thermal bypass valve.

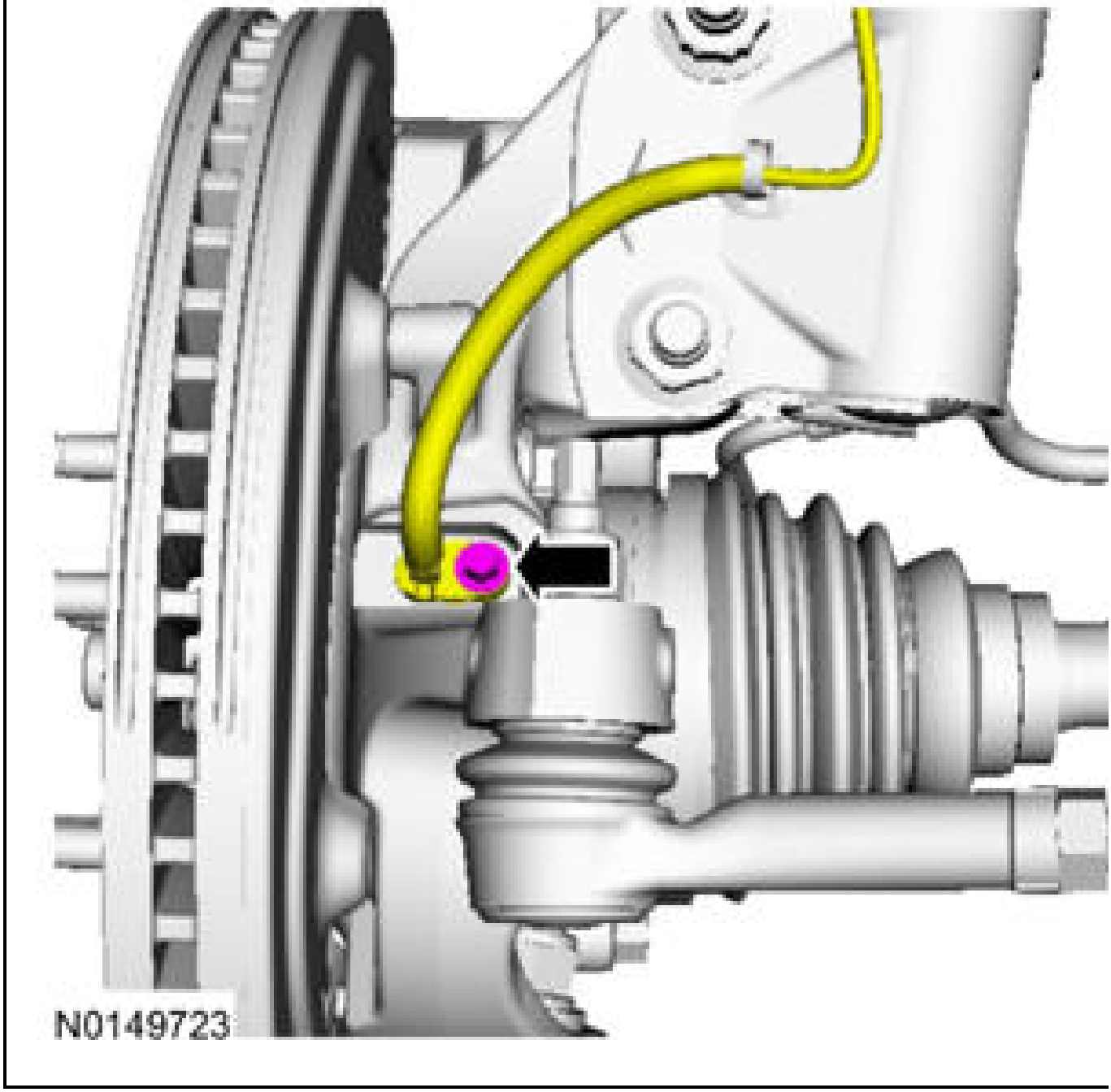
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45. **NOTE: LH shown in illustration, RH similar.**

Remove the bolt and the wheel speed sensor.

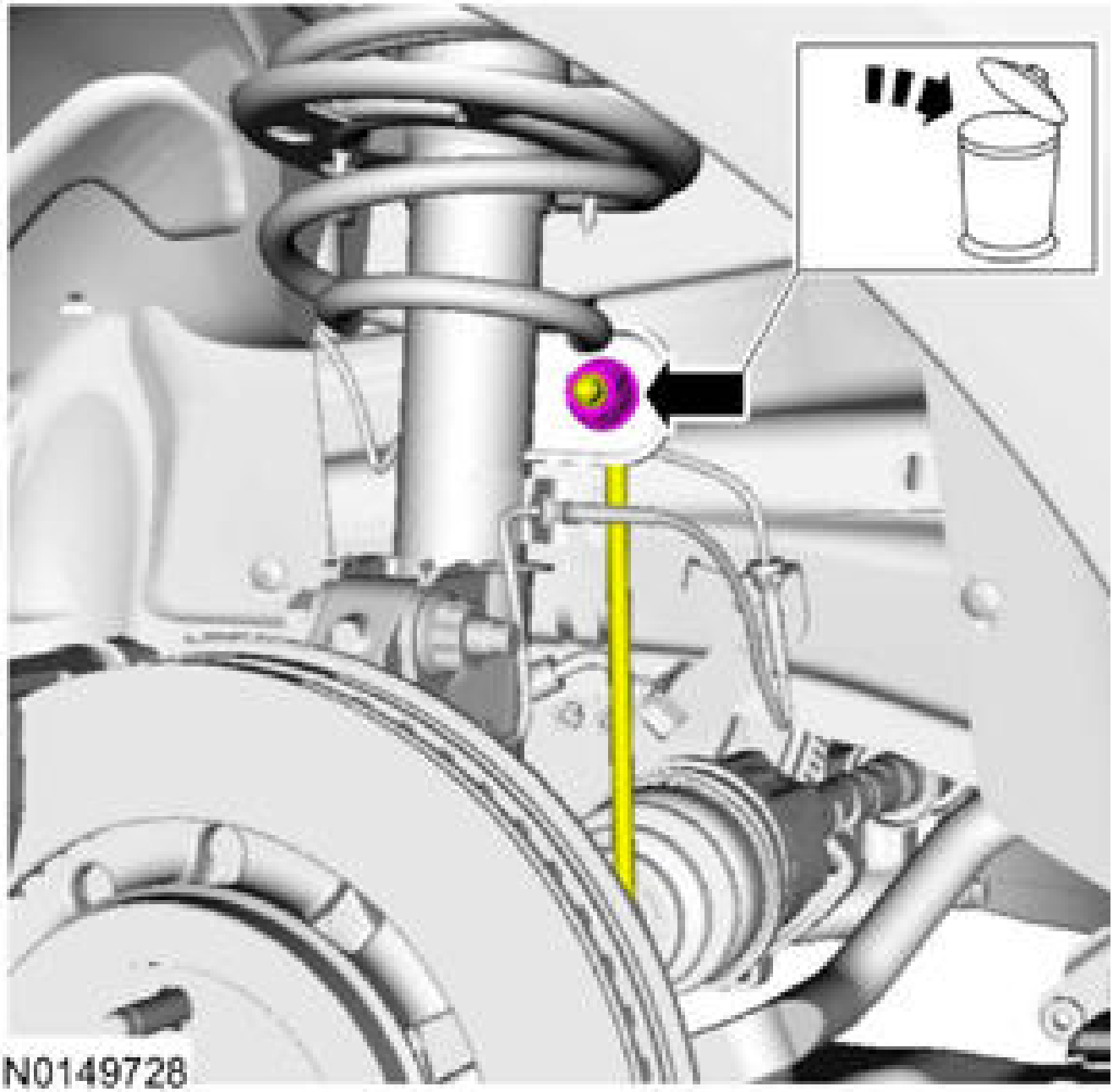
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46. **NOTE: LH shown in illustration, RH similar.**

Remove and discard the upper stabilizer link nut.

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47.

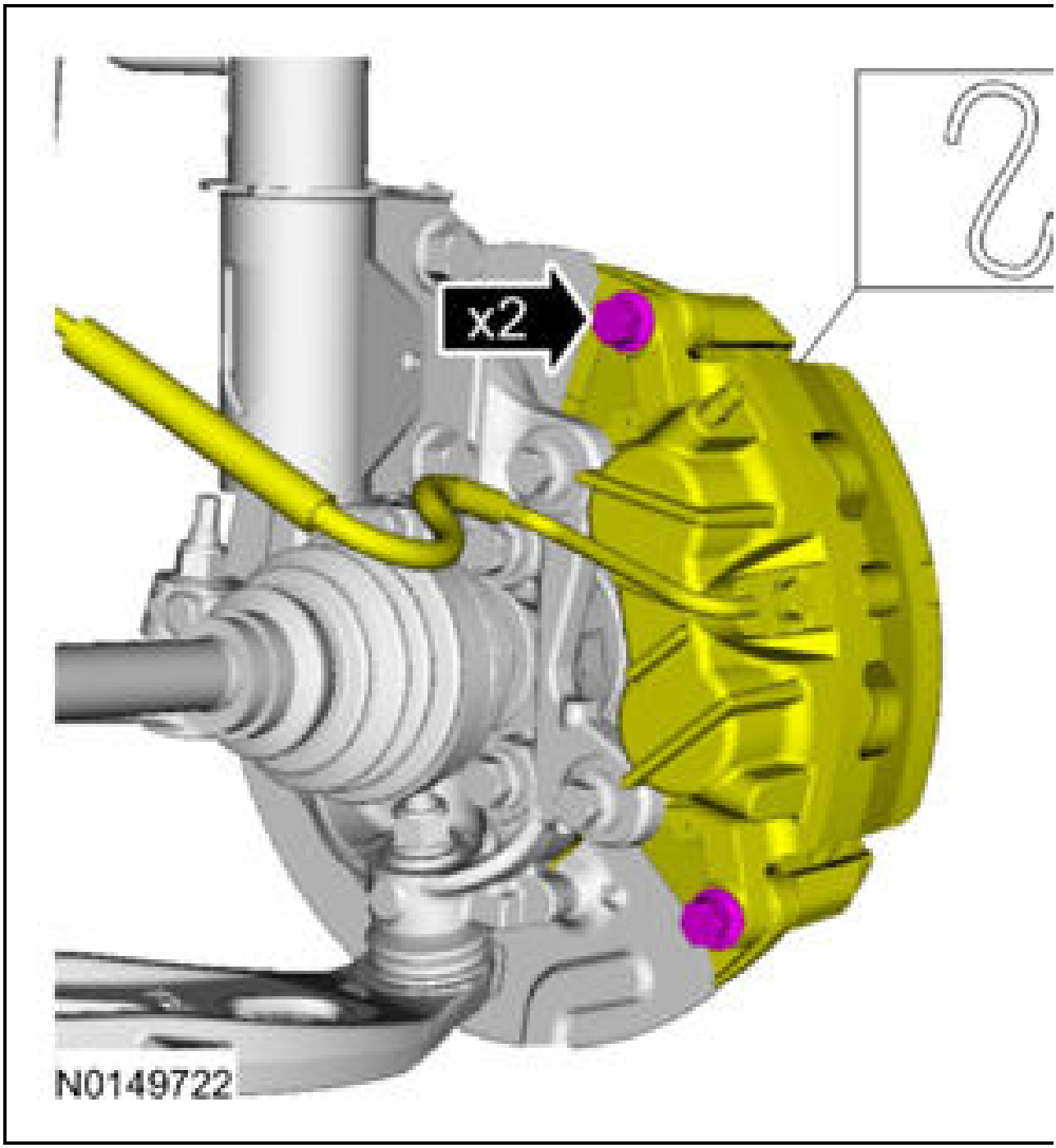
NOTE: **Do not allow the brake caliper to hang from the brake flexible hose or damage to the hose may occur.**

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

Remove the brake caliper guide pin bolts and calipers.

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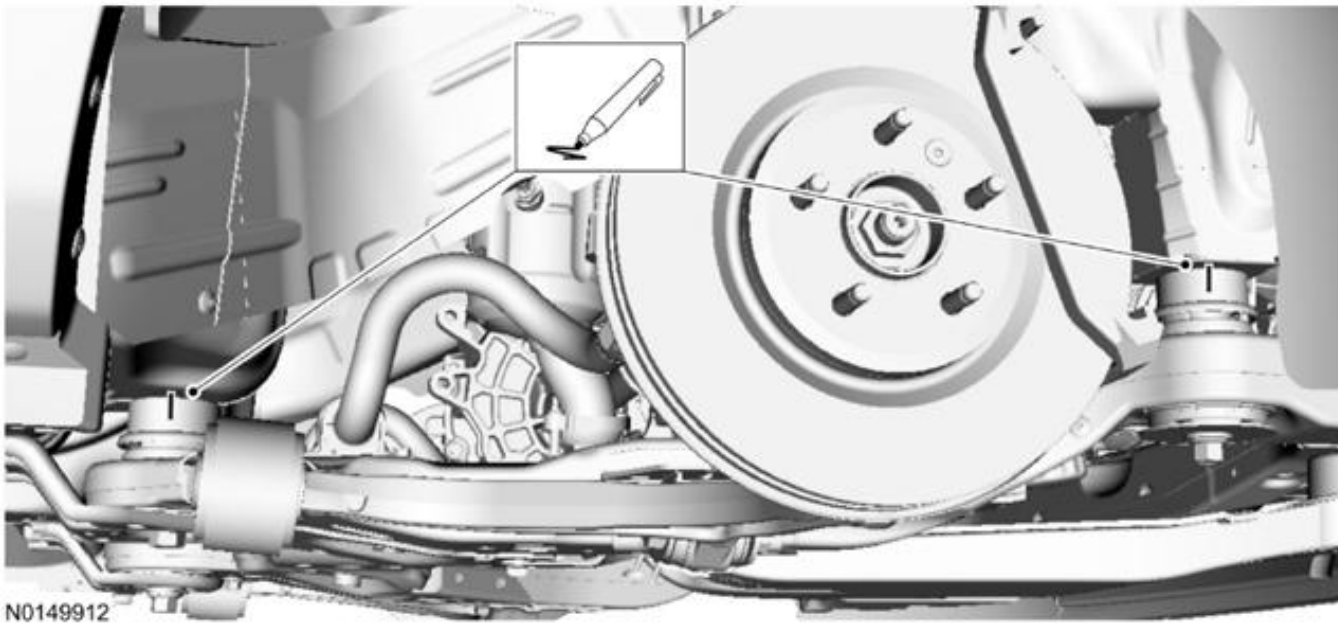
- Support the calipers.



48. **NOTE: RH shown in illustration, LH similar.**

Using a wax pencil, mark the relationship of the front and rear subframe to the underbody at the mounting locations on both side.

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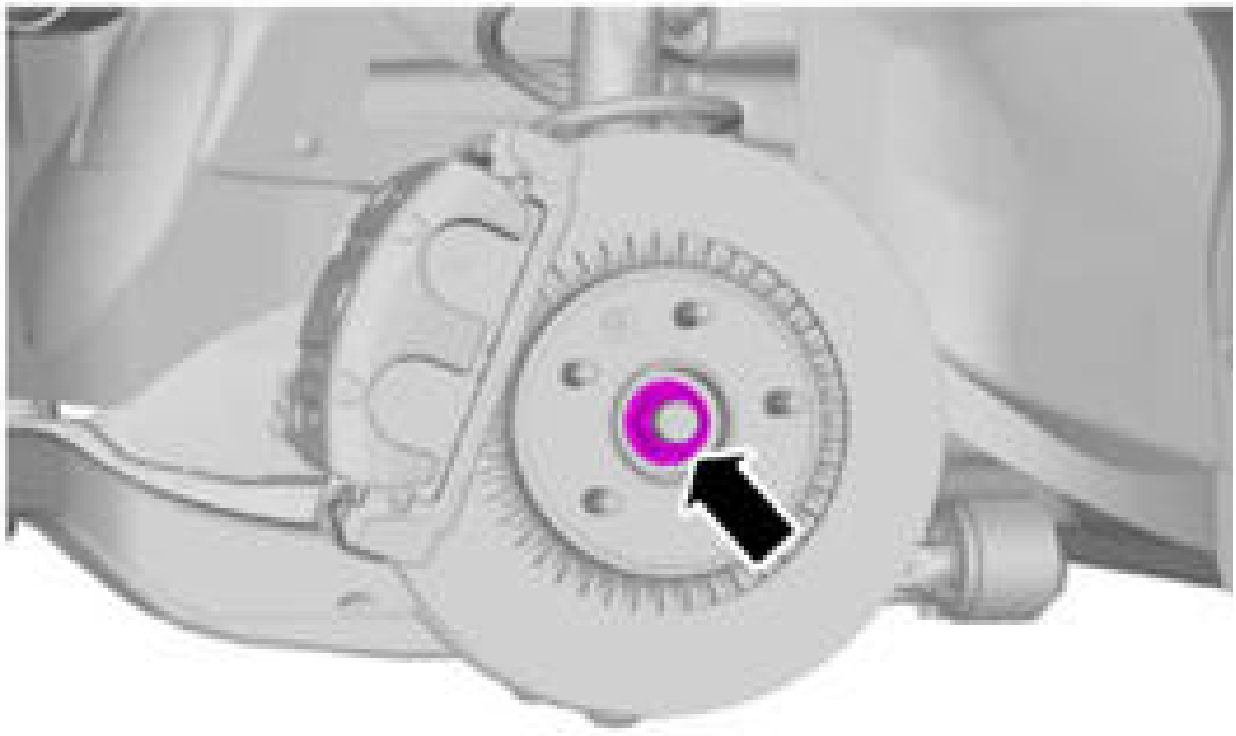


49. **NOTE: LH shown in illustration, RH similar.**

Remove the LH and RH halfshaft nuts.

- Do not discard at this time.

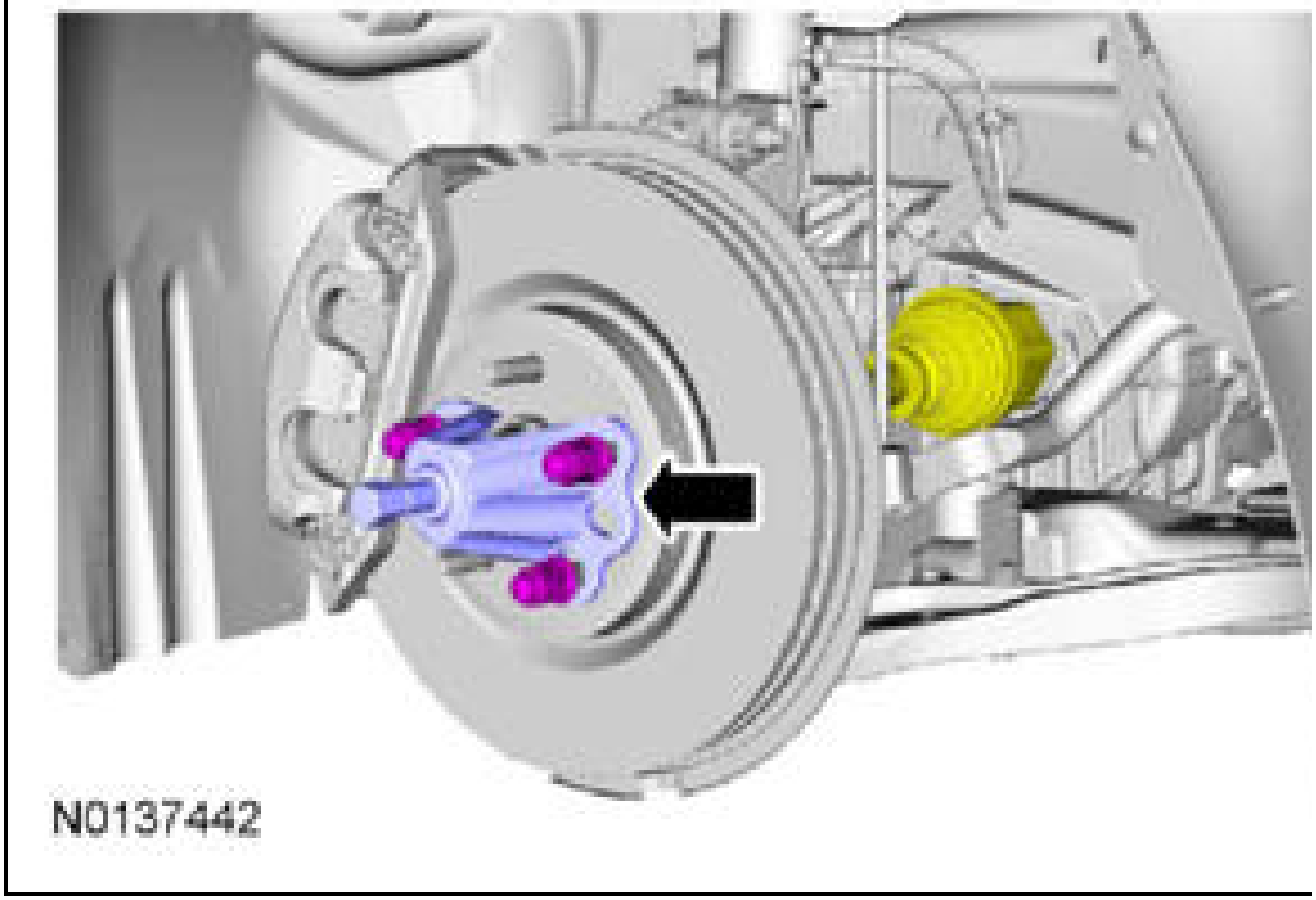
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50. **NOTE: LH shown in illustration, RH similar.**

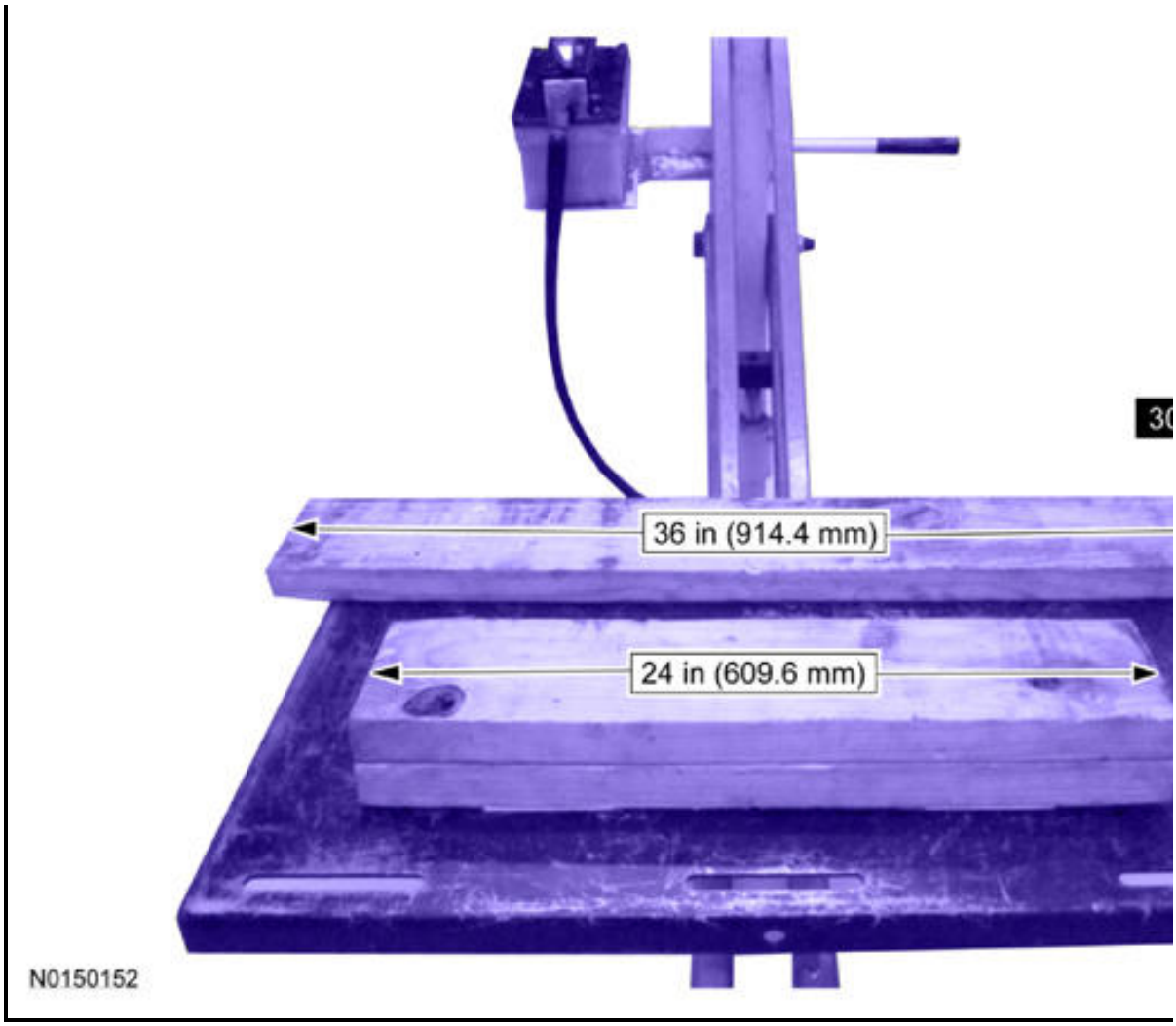
Separate the LH and RH halfshaft from the wheel hubs.

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51. Position a 2 x 6 board, 36 in (914.4 mm) in length and two 2 x 6 boards 24 in (609.6 mm) in length onto the powertrain lift.
    - Position the powertrain lift table with:
        - the long board towards the rear of the subframe.
        - the short boards under the engine and transmission.

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52. Install the Adjustable Grip Arm from the powertrain lift table to the LH engine-to-transmission bolt hole.

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53. Install a ratchet strap from the front of the subframe under the powertrain lift table to the rear of the subframe, to secure the subframe to the powertrain lift table.

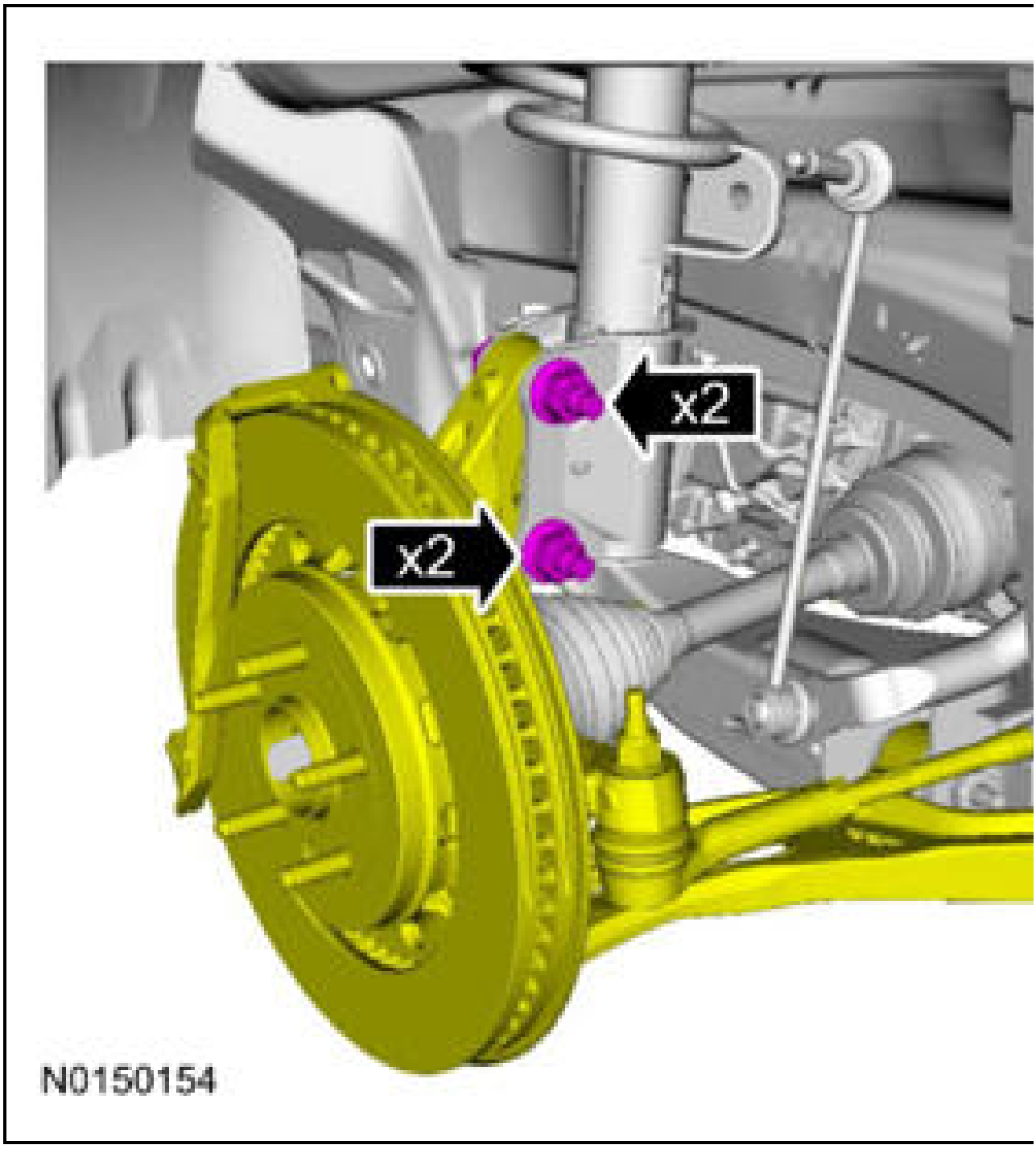
54. **NOTE: LH shown in illustration, RH similar.**

NOTE: The halfshafts are not being remove from the transmission.

Remove the strut-to-wheel knuckle nuts and bolts.

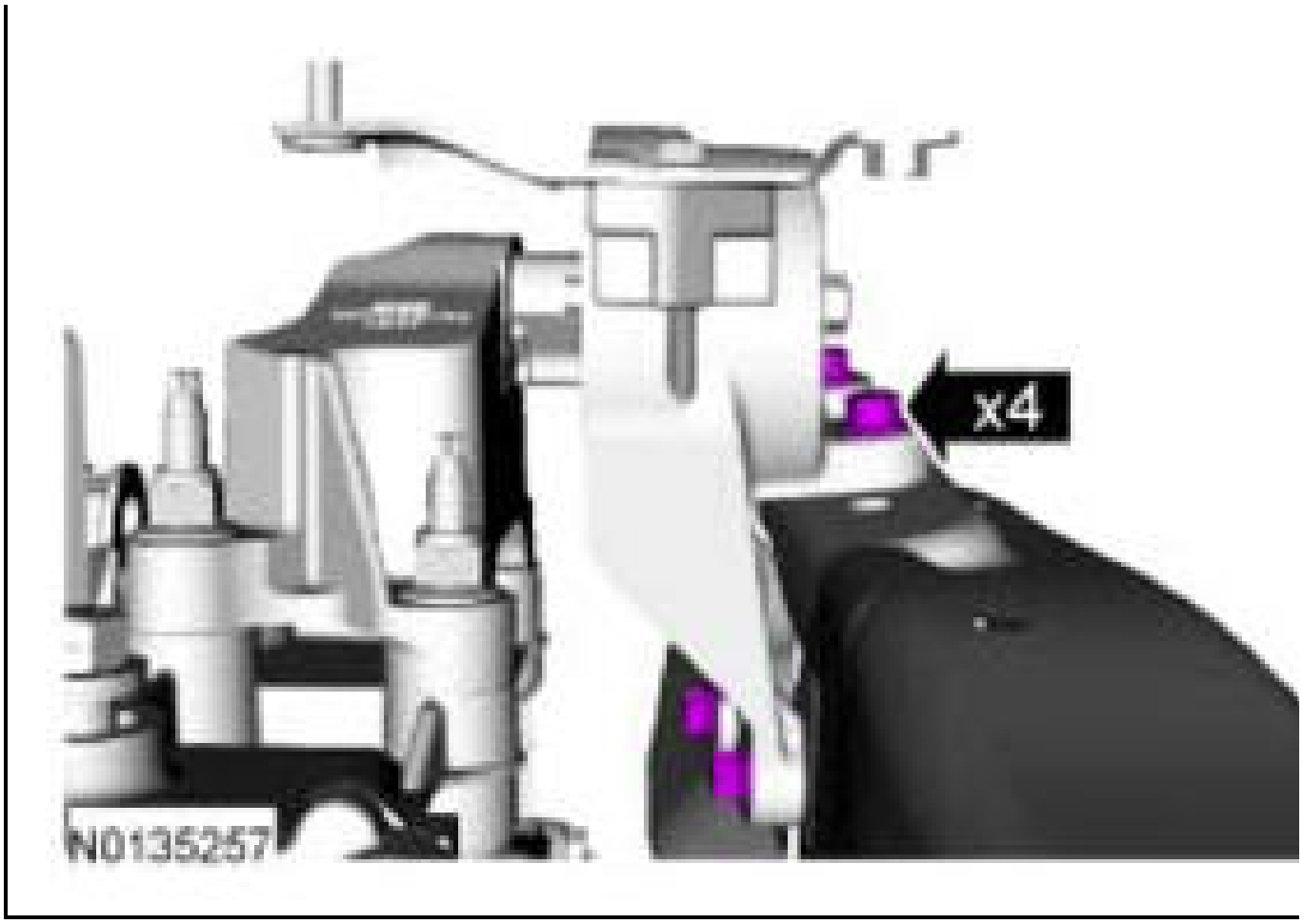
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- Remove the strut from the wheel knuckle and the halfshafts from the wheel knuckle.



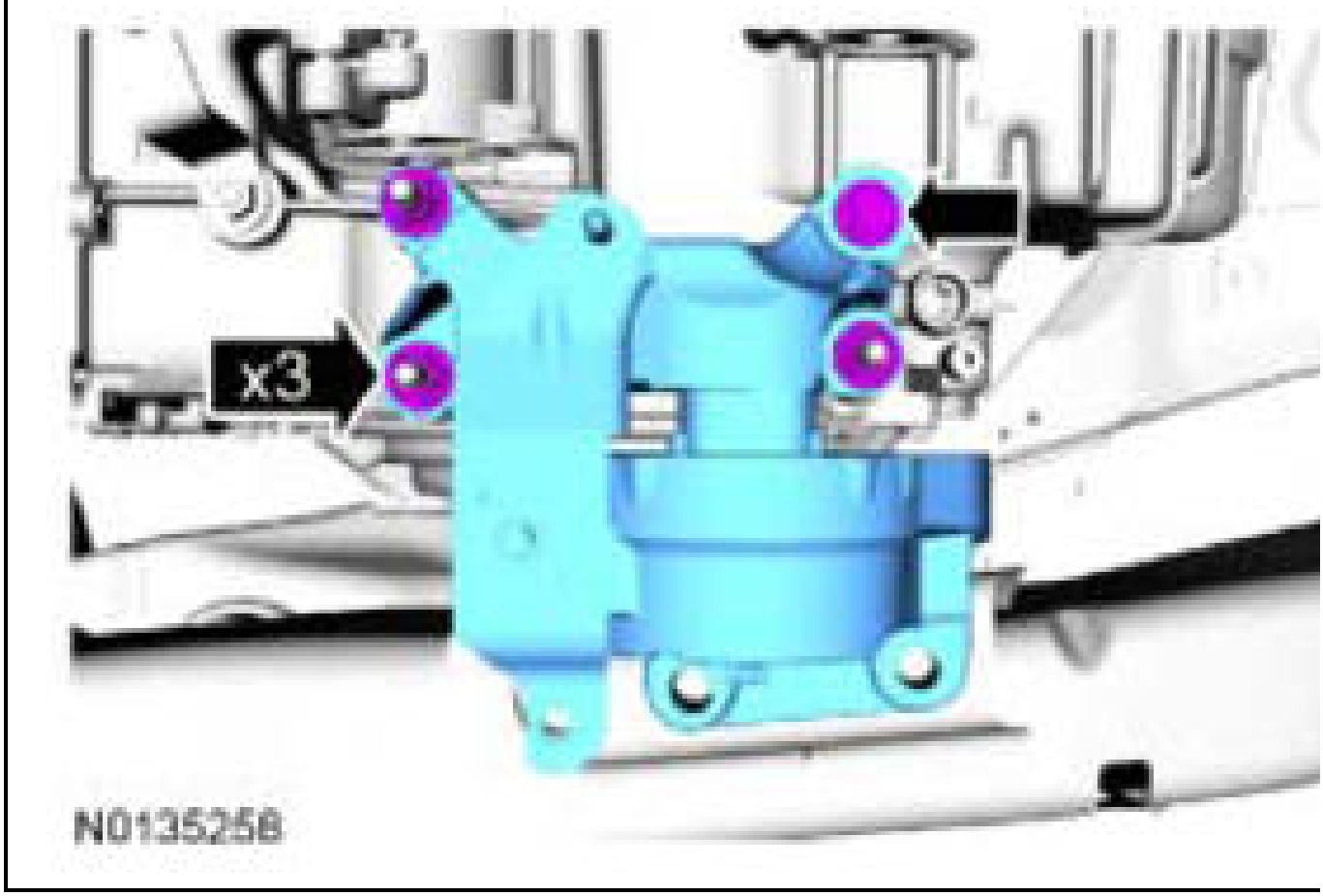
55. Remove the 4 transmission support insulator-to-frame rail bolts.

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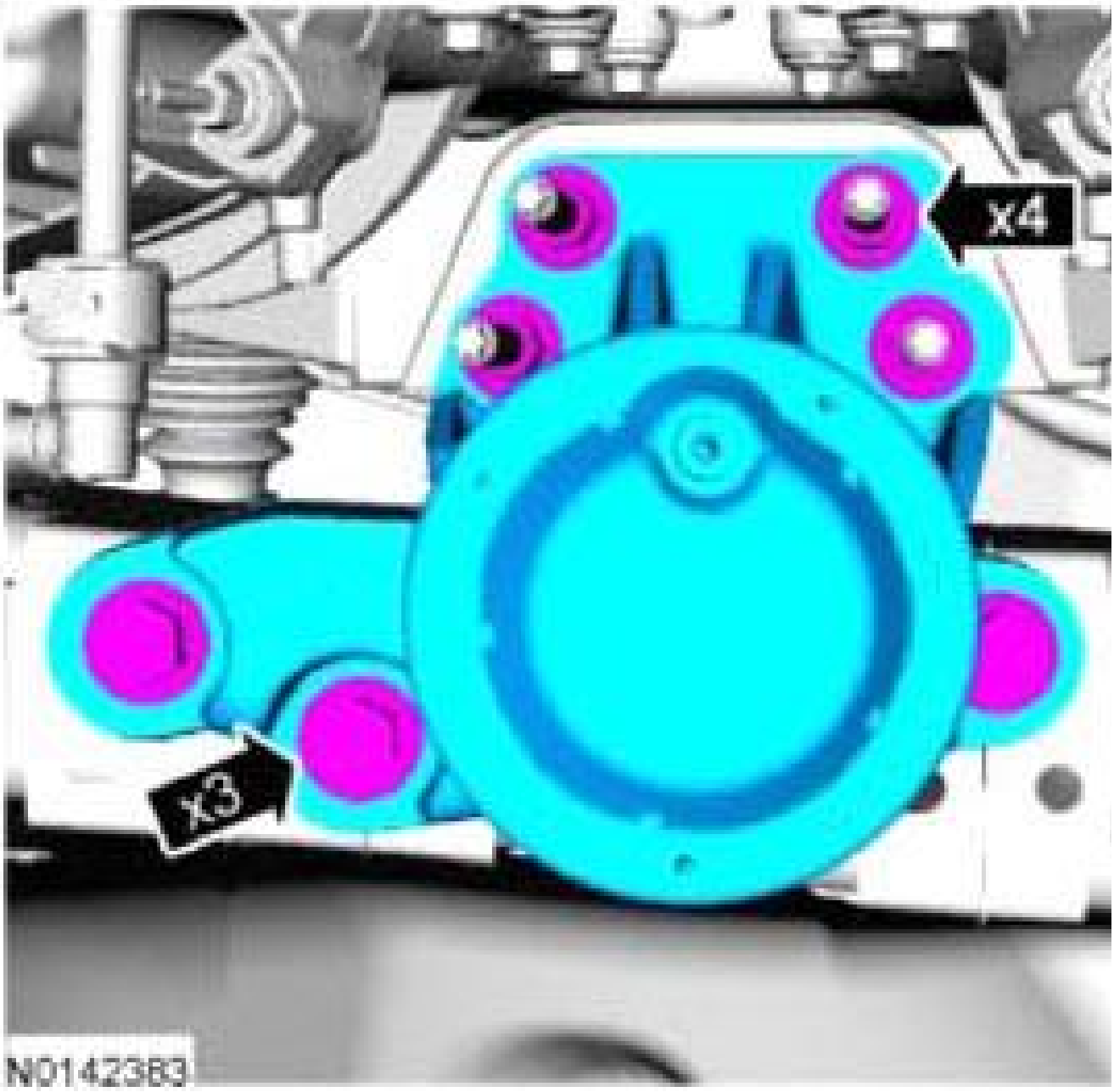
56. Remove the 3 nuts, the bolt and the transaxle support insulator assembly.

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57. Remove the 4 engine mount nuts, the 3 engine mount bolts and the engine mount.

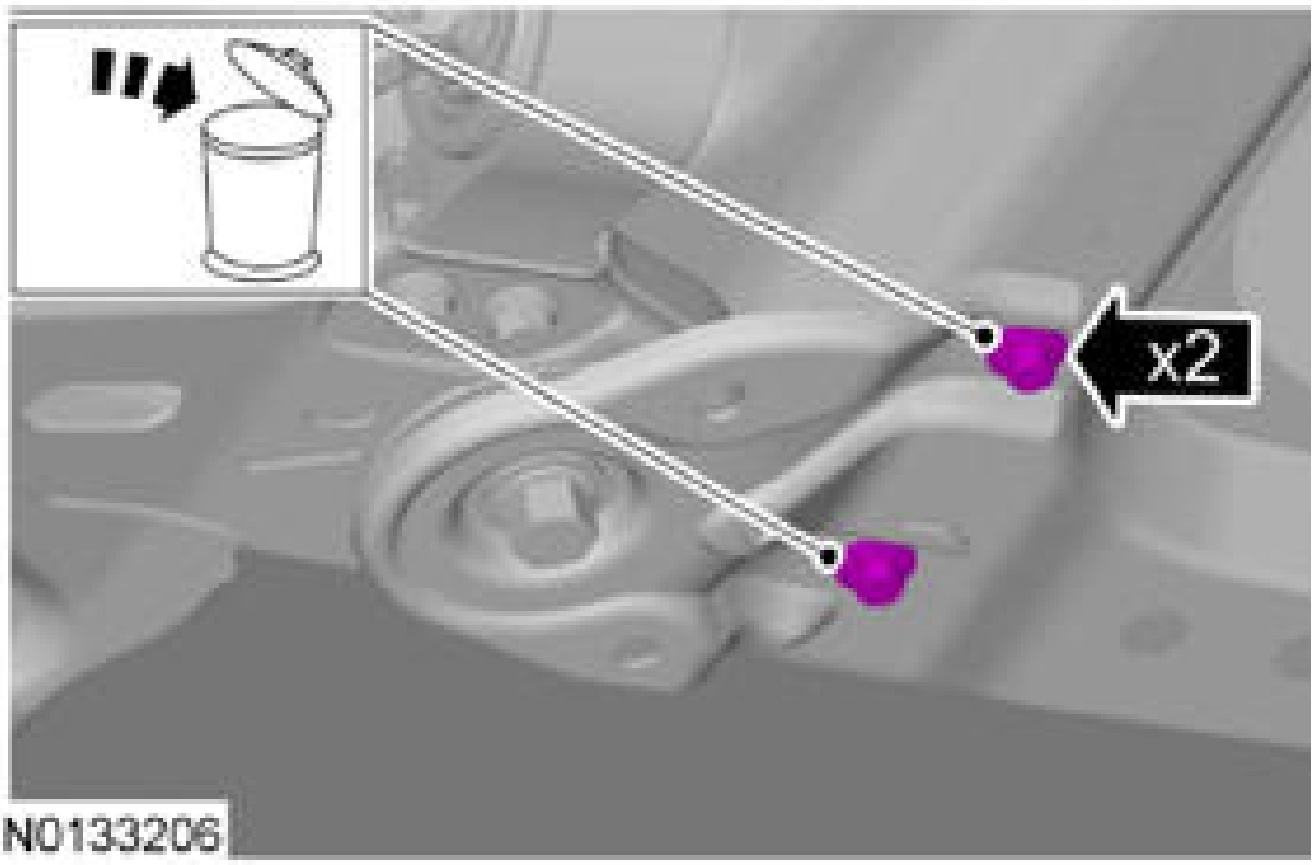
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58. **NOTE: RH shown in illustration, LH similar.**

Remove the subframe bracket-to-body bolts.

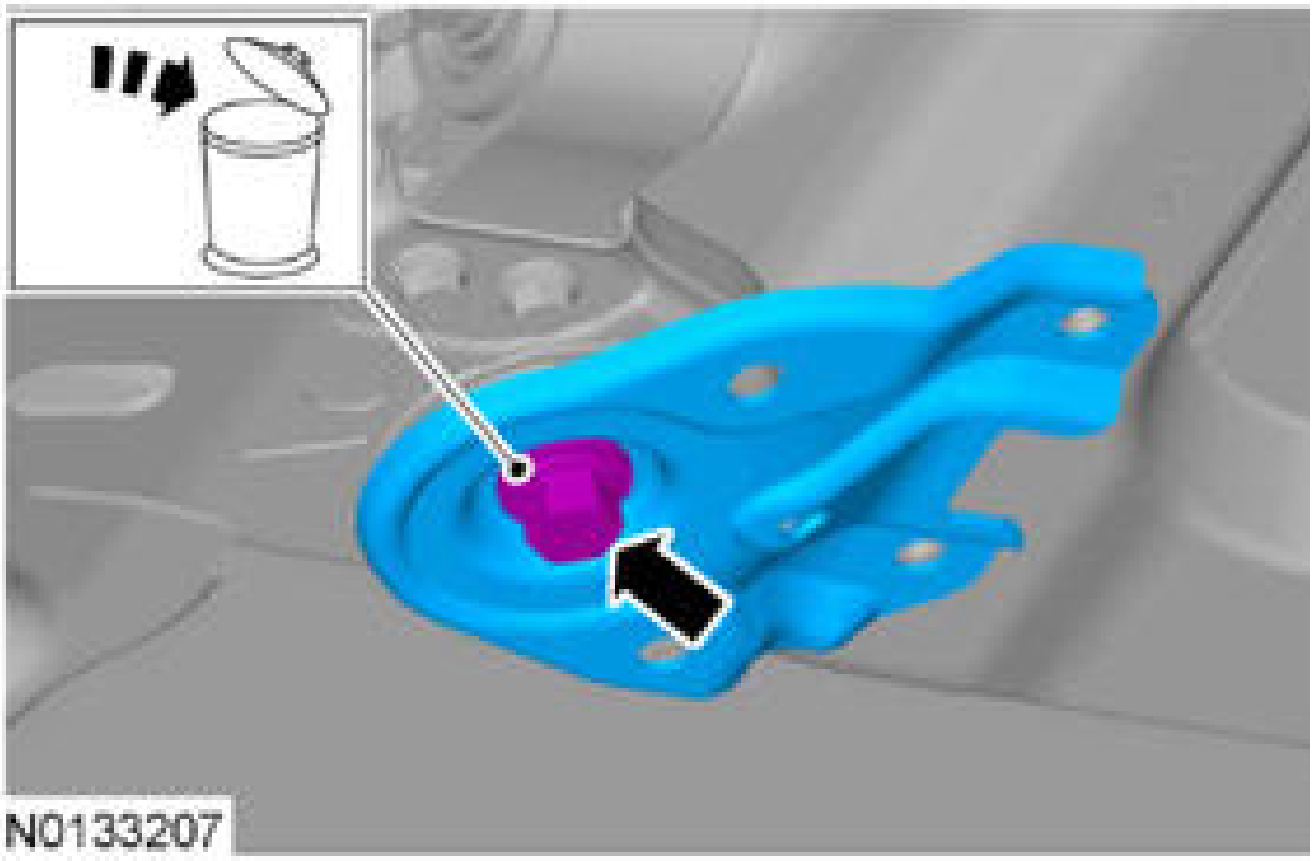
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59. **NOTE: RH shown in illustration, LH similar.**

Remove the rear subframe bolts and the subframe brackets.

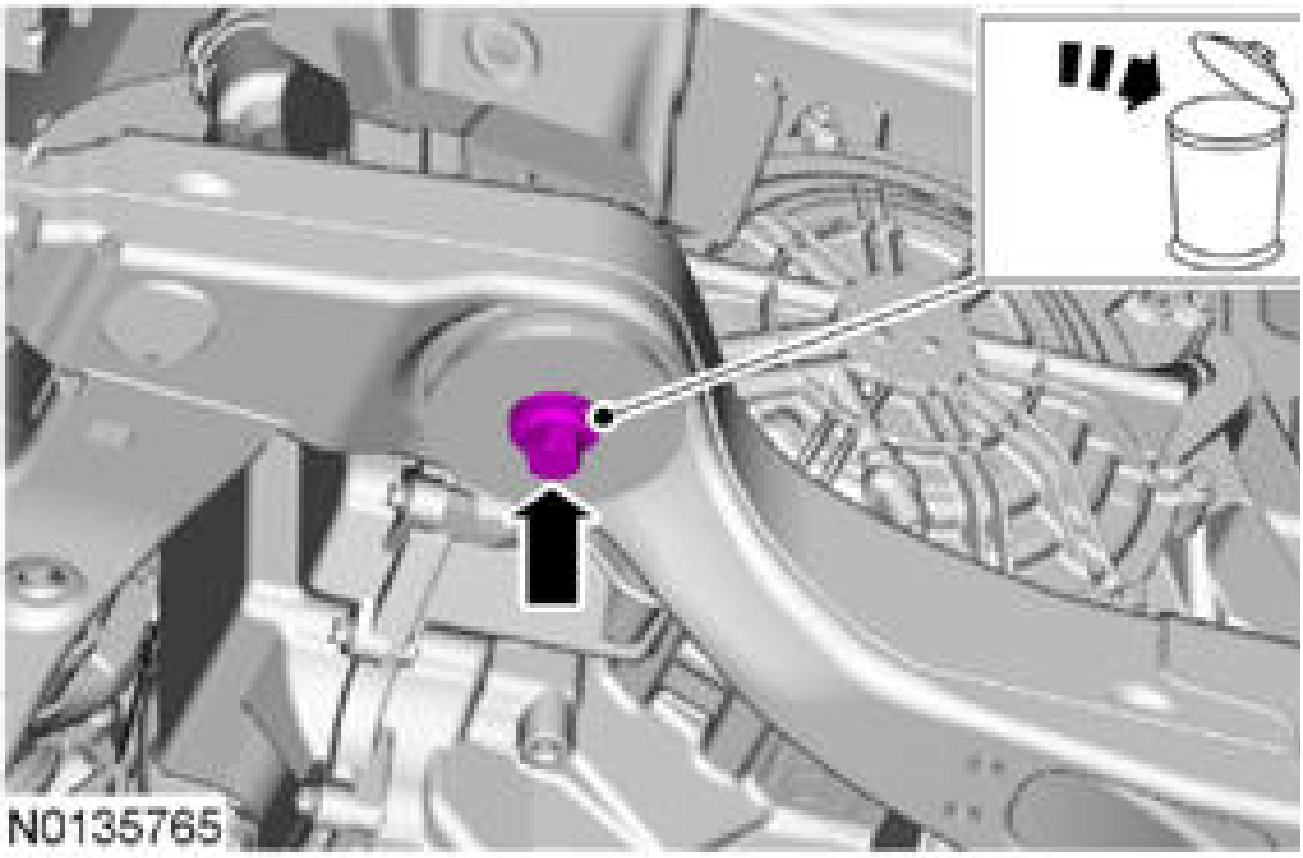
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60. **NOTE: RH shown in illustration, LH similar.**

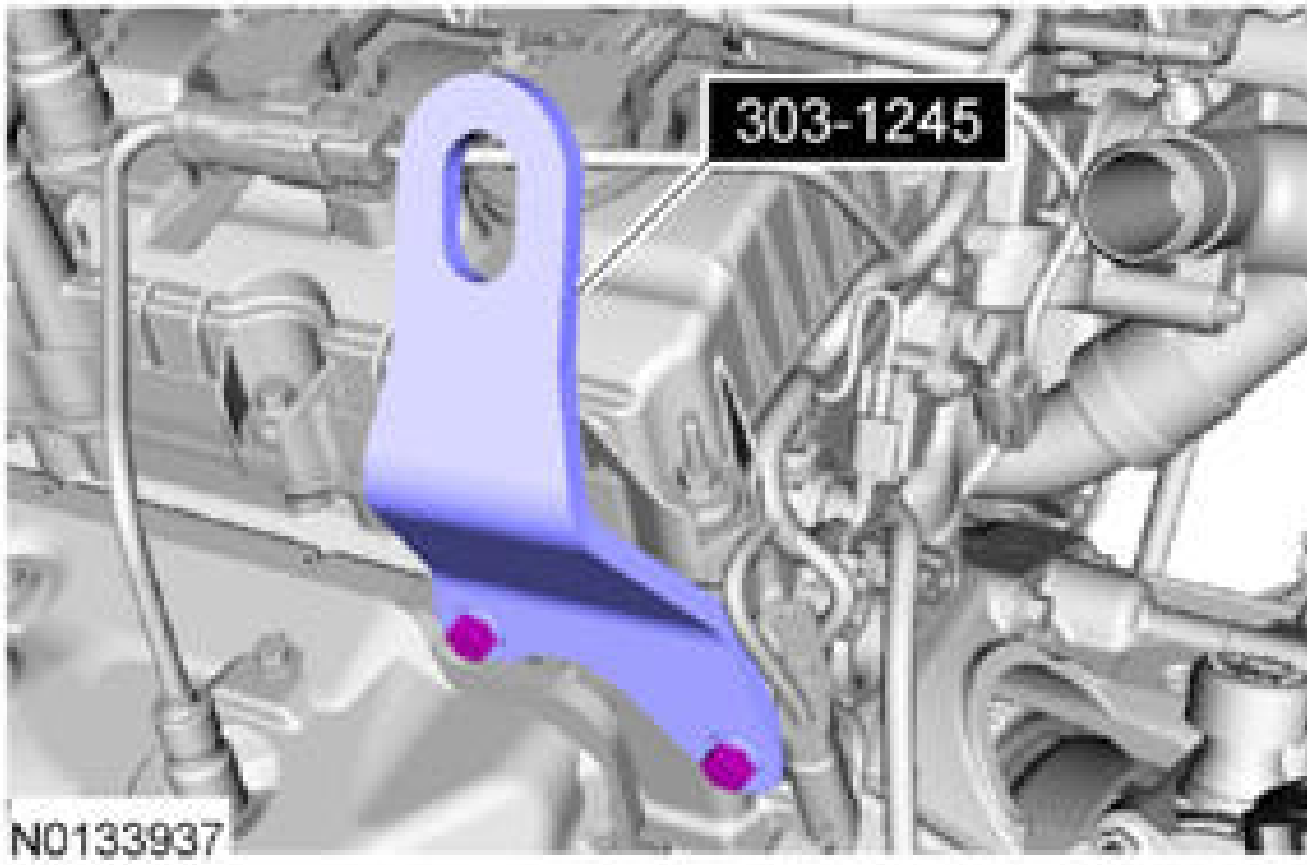
Remove the front subframe bolts.

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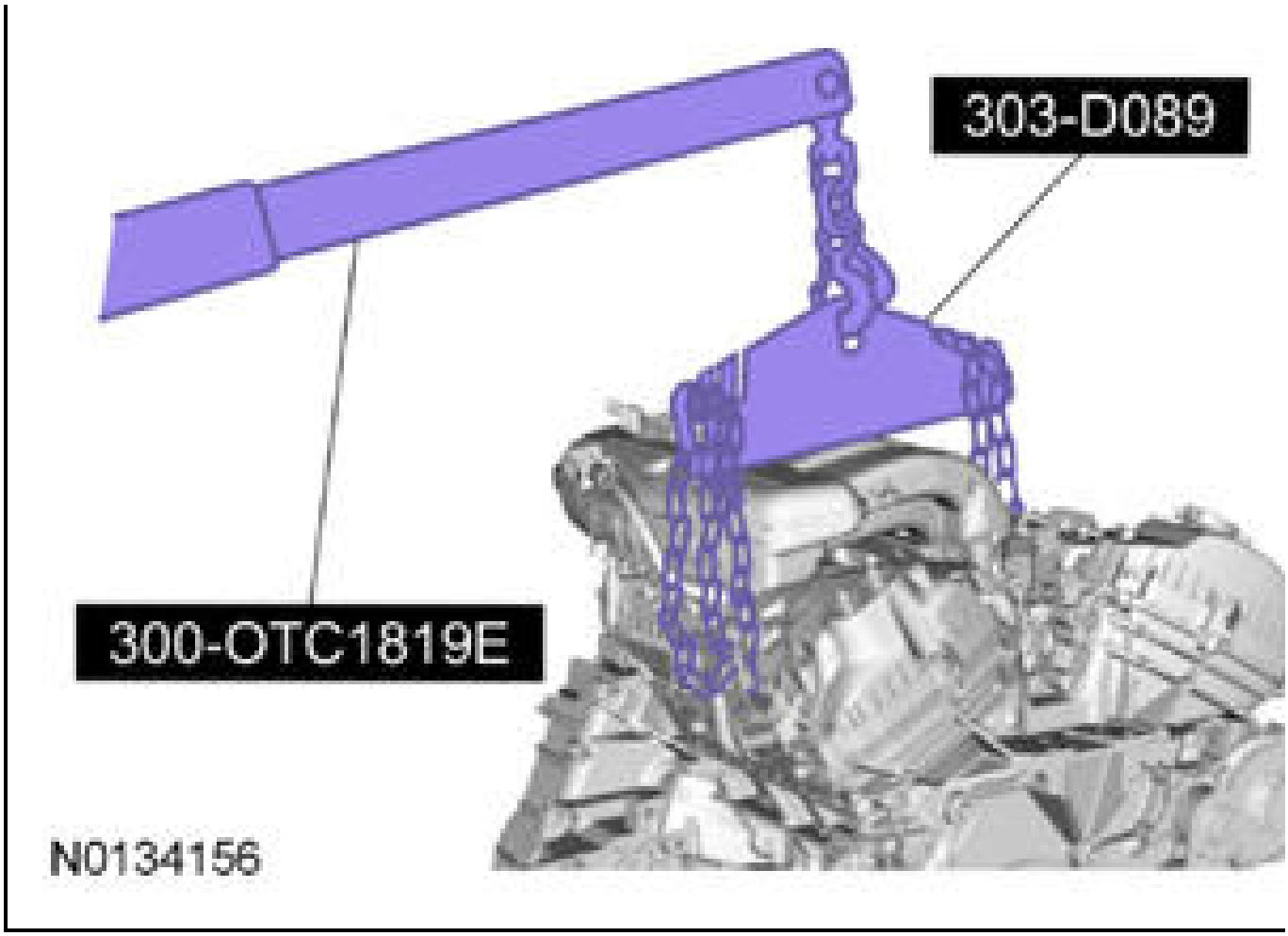
61. Lower the subframe and powertrain assembly from the vehicle.
62. Install 303-1245 on the LH cylinder head.

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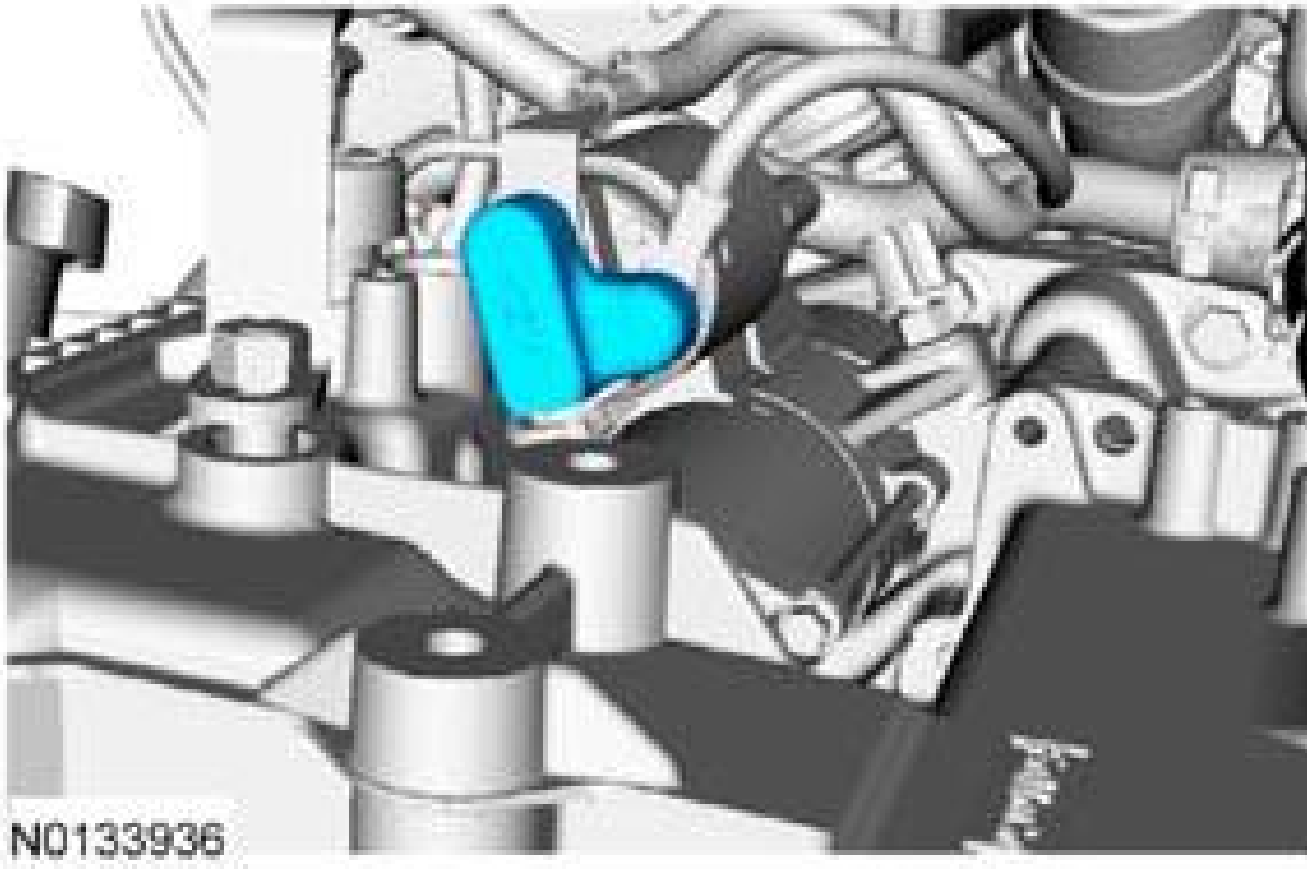
63. Install the Heavy Duty Floor Crane and Spreader Bar.

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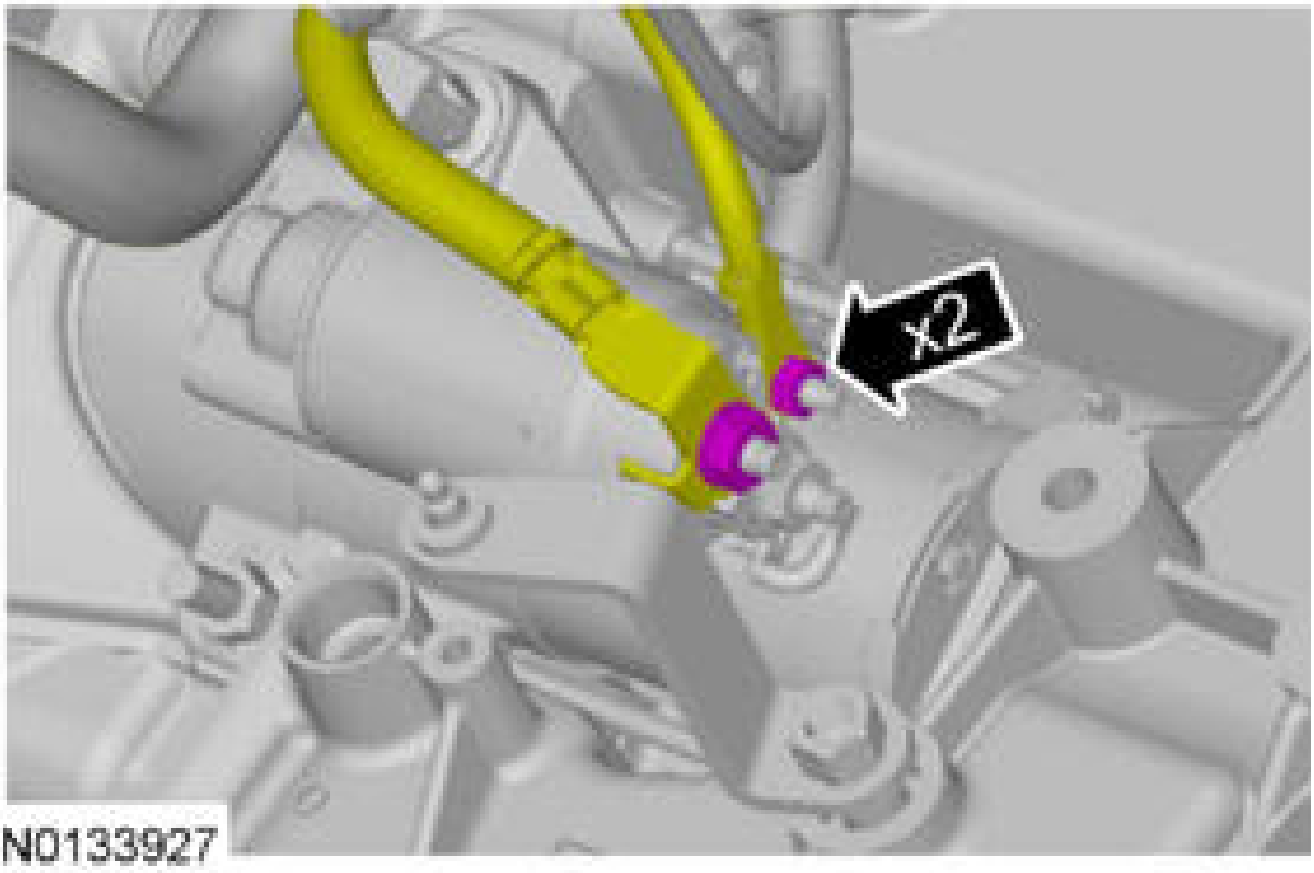
64. Remove the starter motor solenoid cover.

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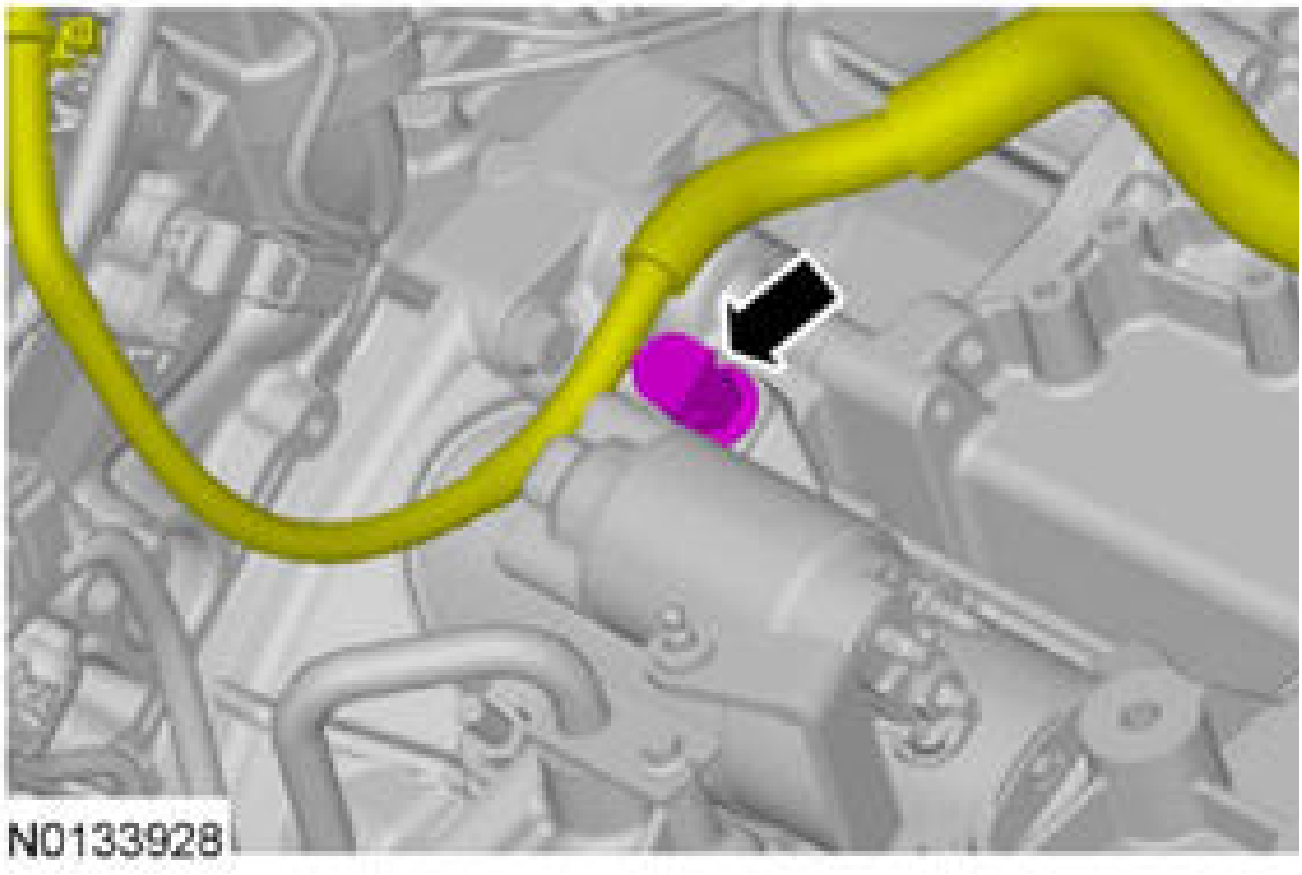
65. Remove the 2 nuts and the starter motor wiring terminals.

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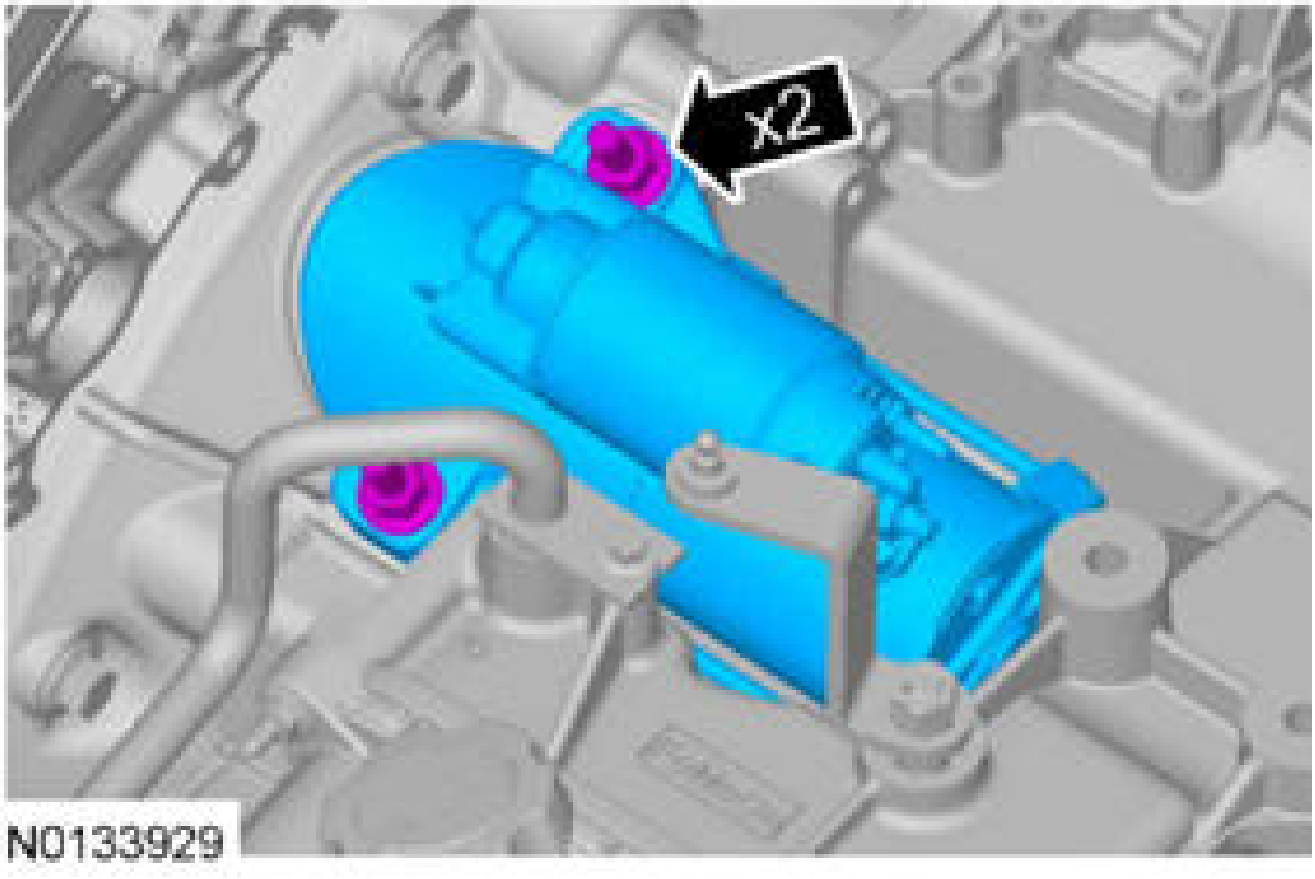
66. Disconnect the wiring harness retainer from the starter motor stud bolt.

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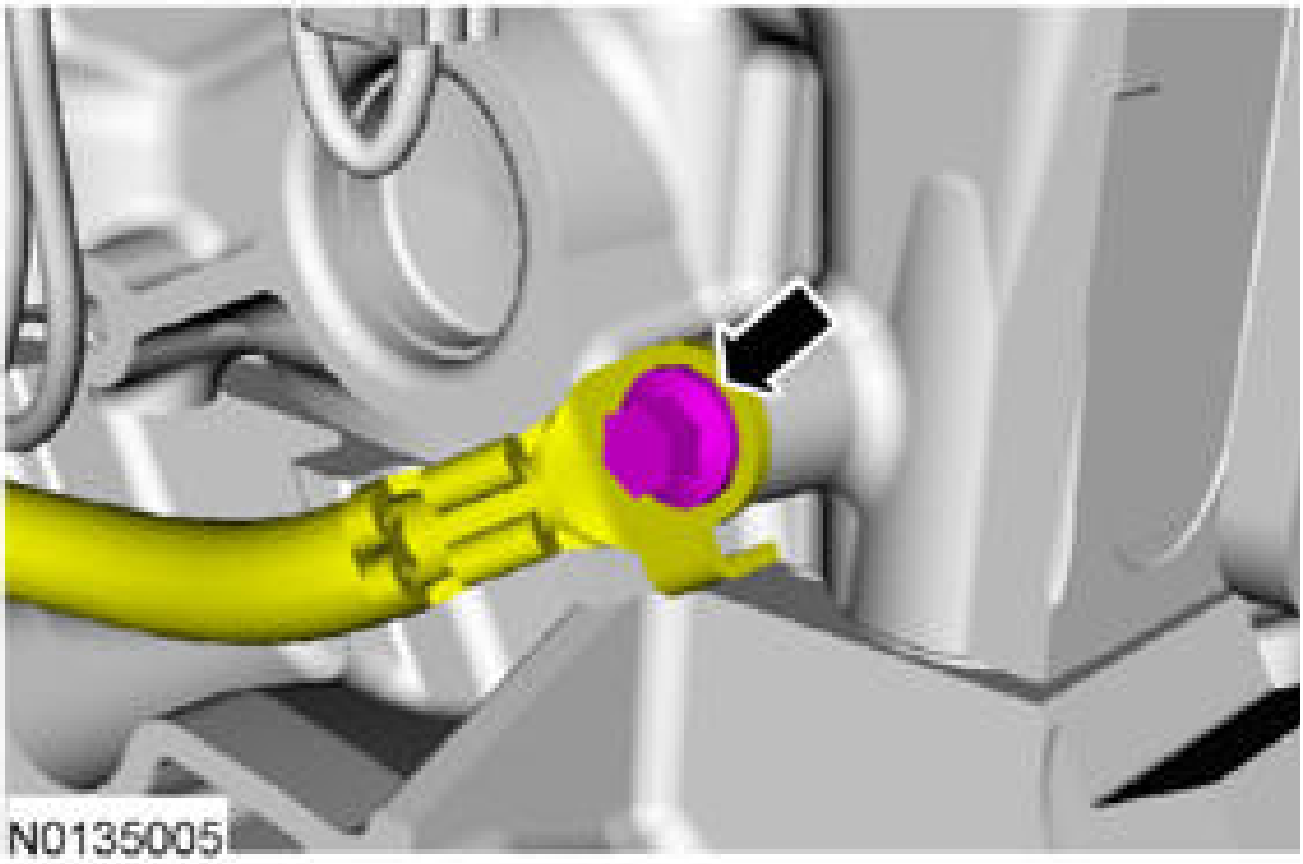
67. Remove the stud bolts and the starter.

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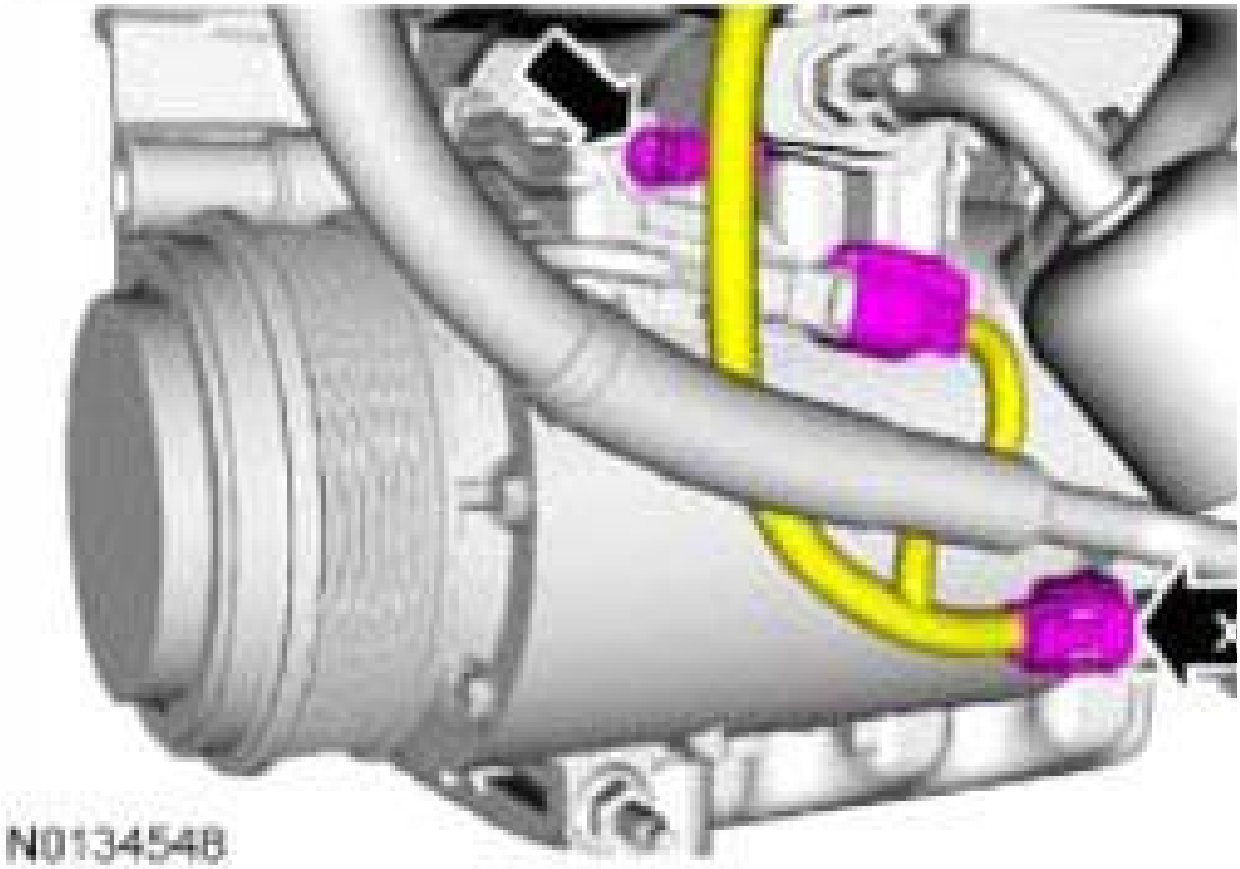
68. Remove the bolt and the ground wire from the RH cylinder head.

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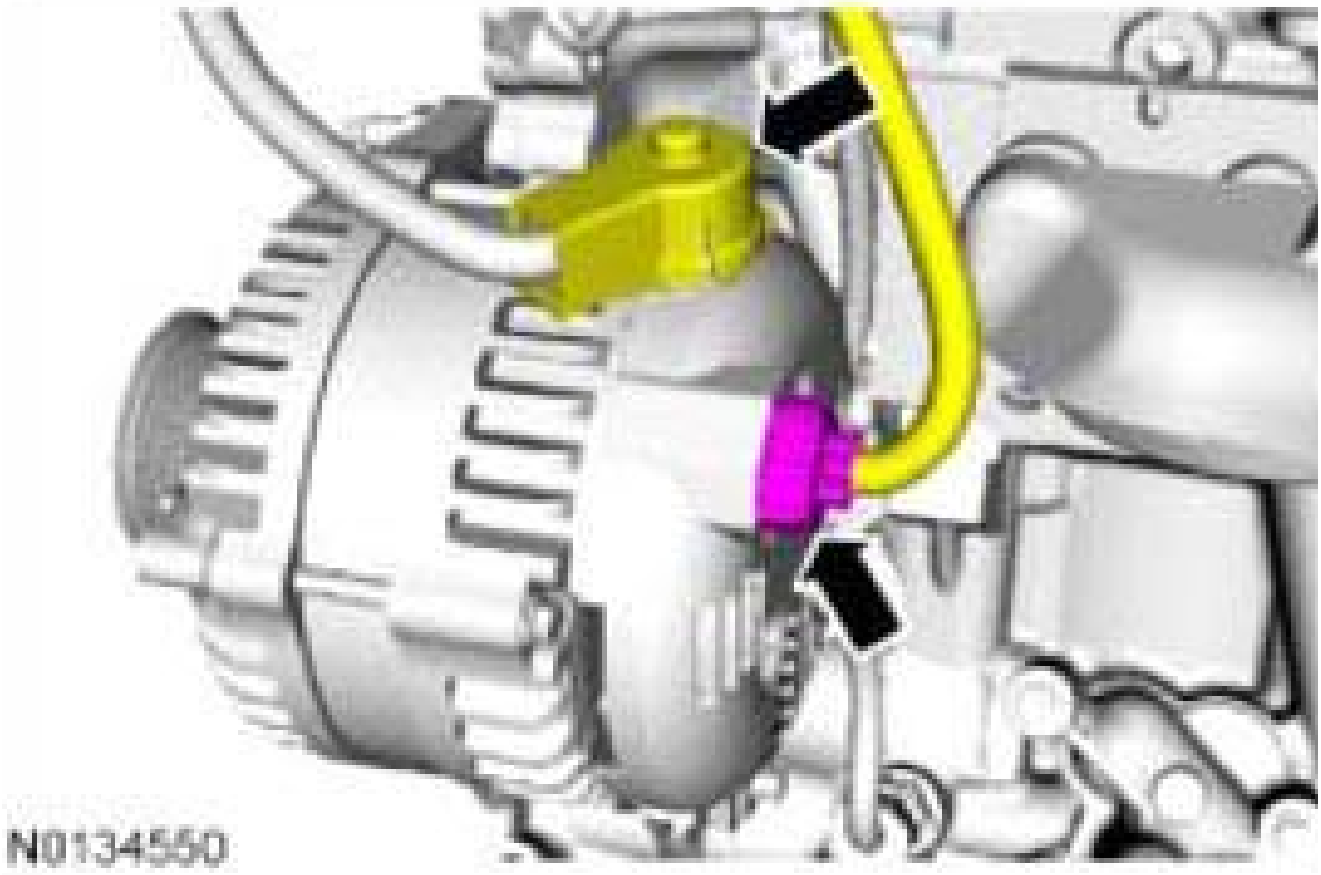
69. Disconnect the 2 A/C compressor electrical connectors.
    - Detach the A/C wiring harness retainer.

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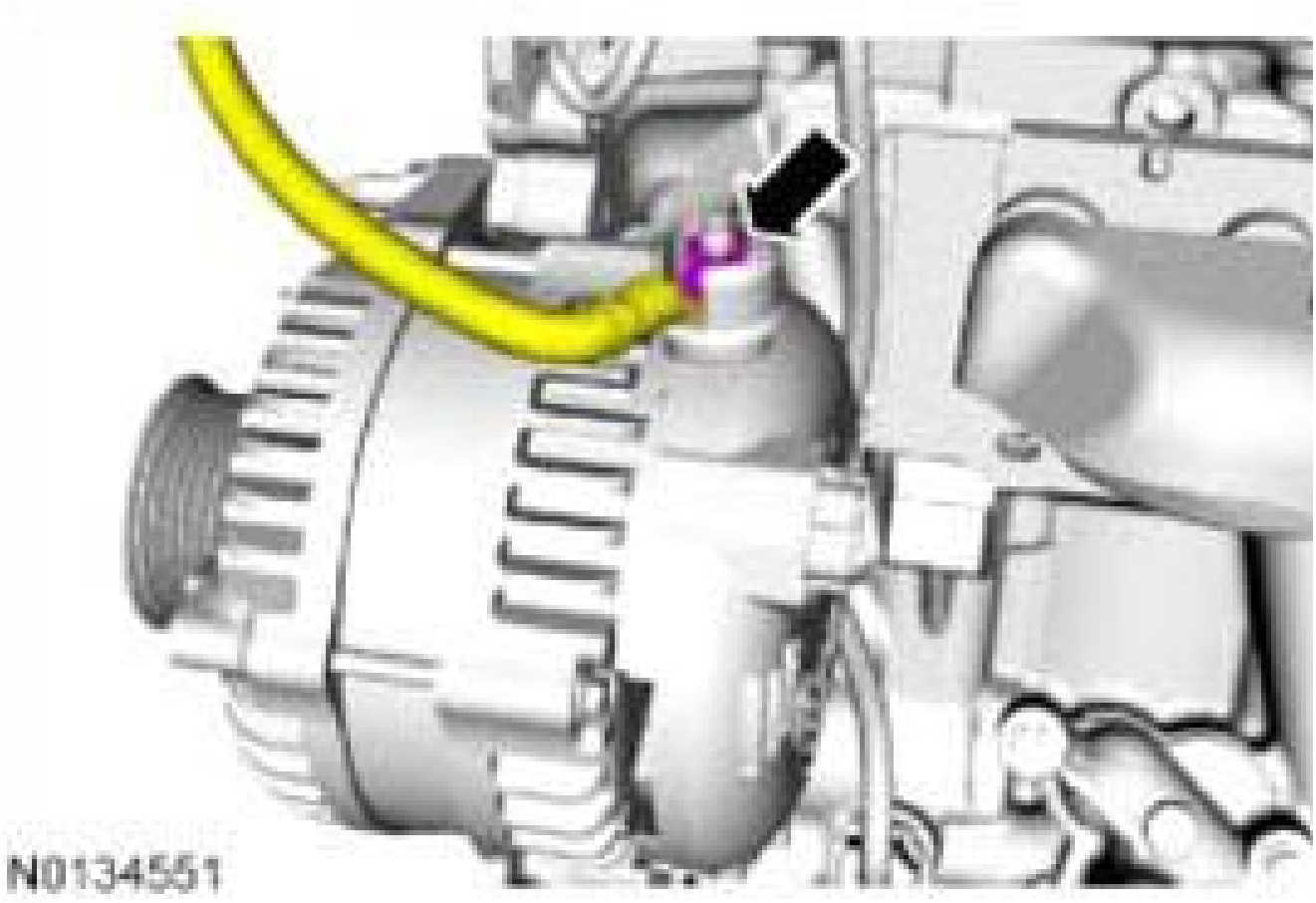
70. Disconnect the generator electrical connector and position the generator B+ cable cover aside.

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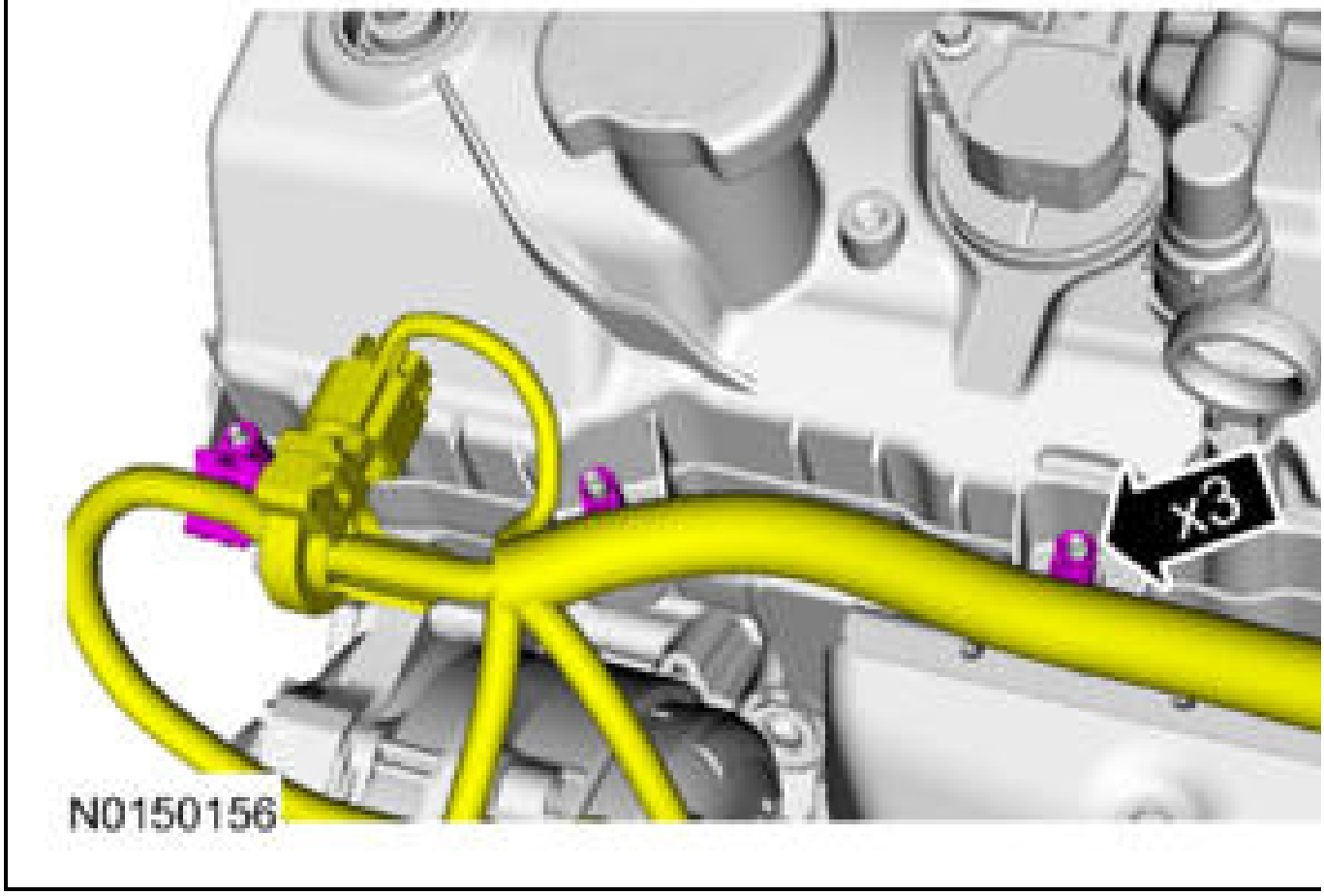
71. Remove the nut and disconnect the generator B+ cable.

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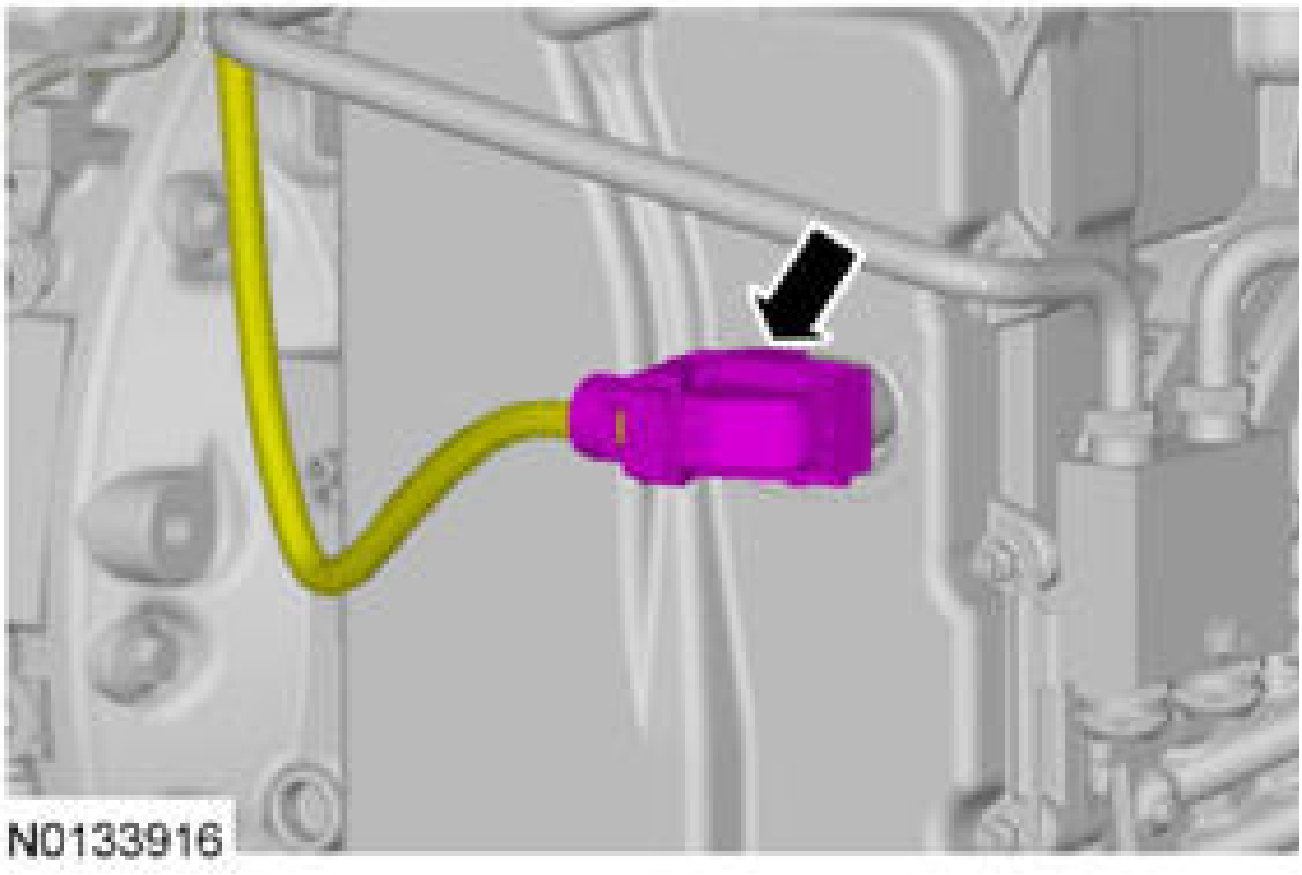
72. Detach the 3 wiring harness retainer from the valve cover stud bolt and position the harness on transmission.

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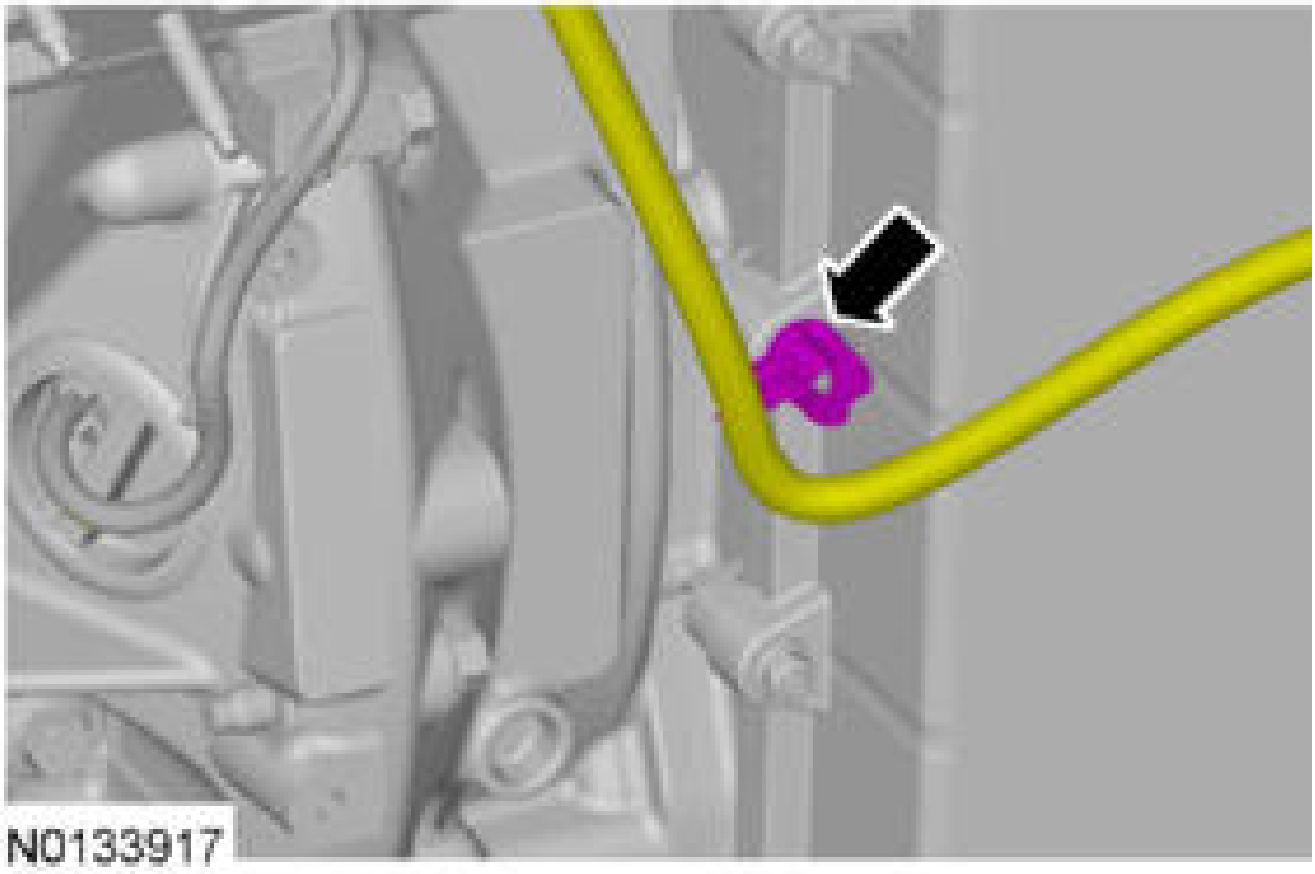
73. Disconnect the transaxle control electrical connector.

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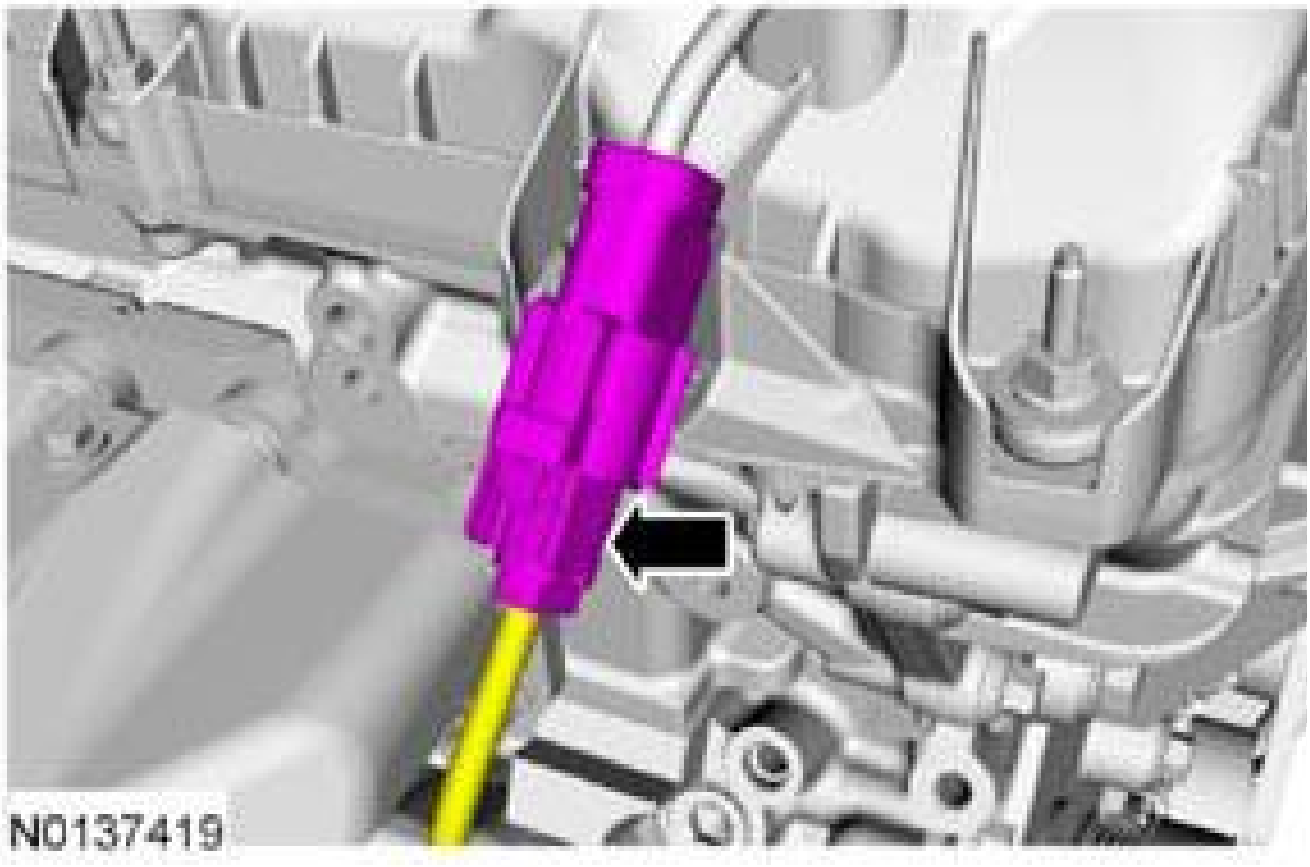
74. Detach the transaxle control wire harness retainer from the transaxle stud bolt.

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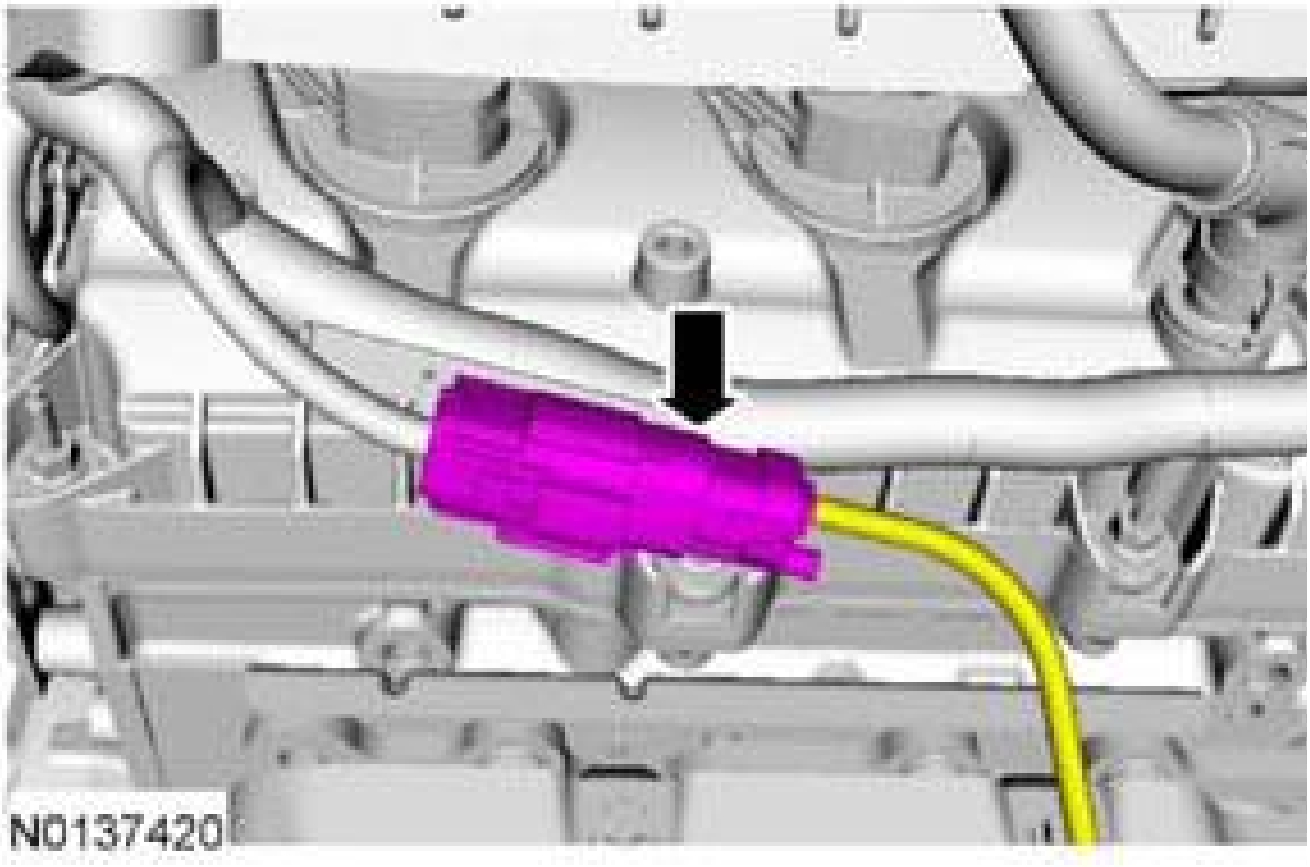
75. Disconnect the RH catalyst monitor electrical connector.

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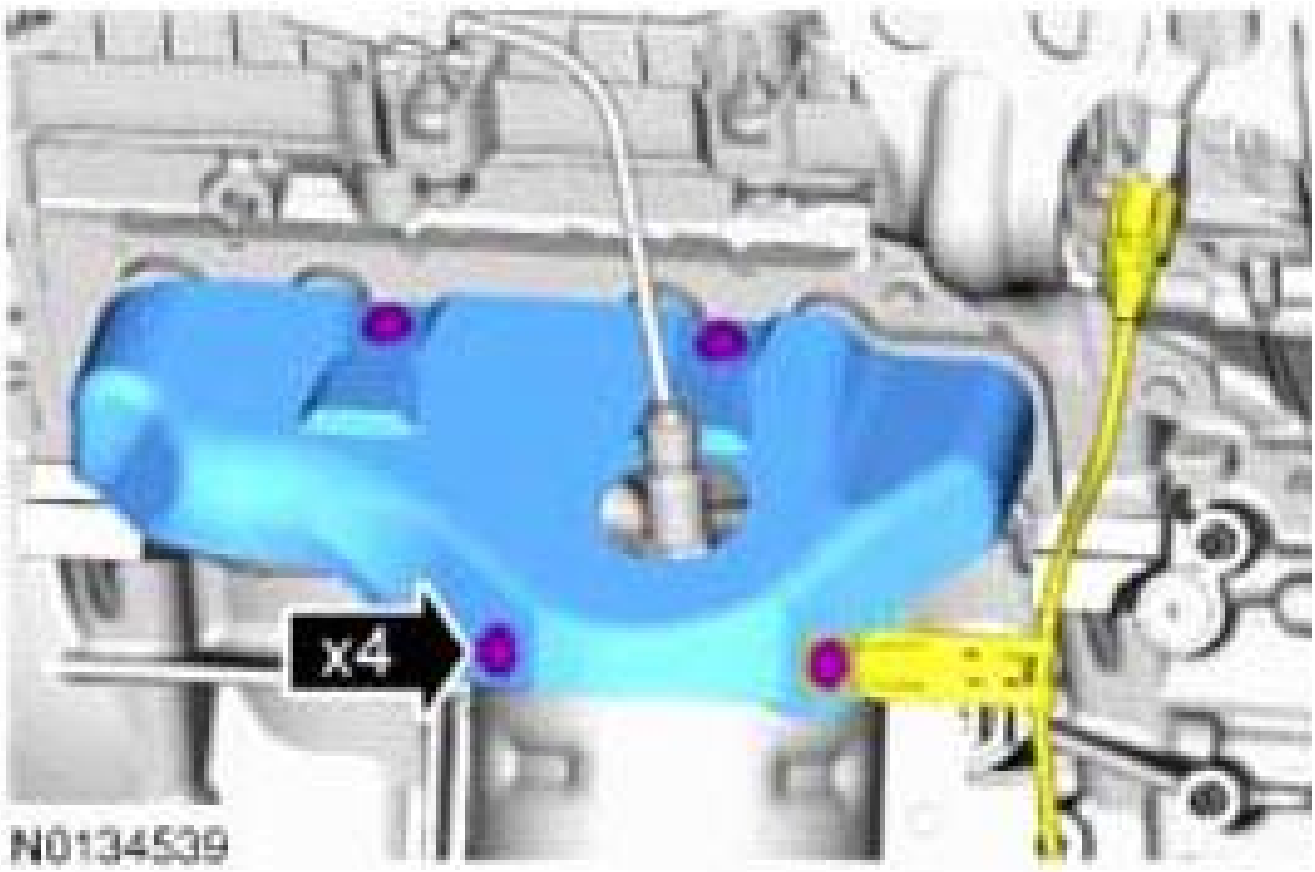
76. Disconnect the RH Heated Oxygen Sensor (HO2S) electrical connector.

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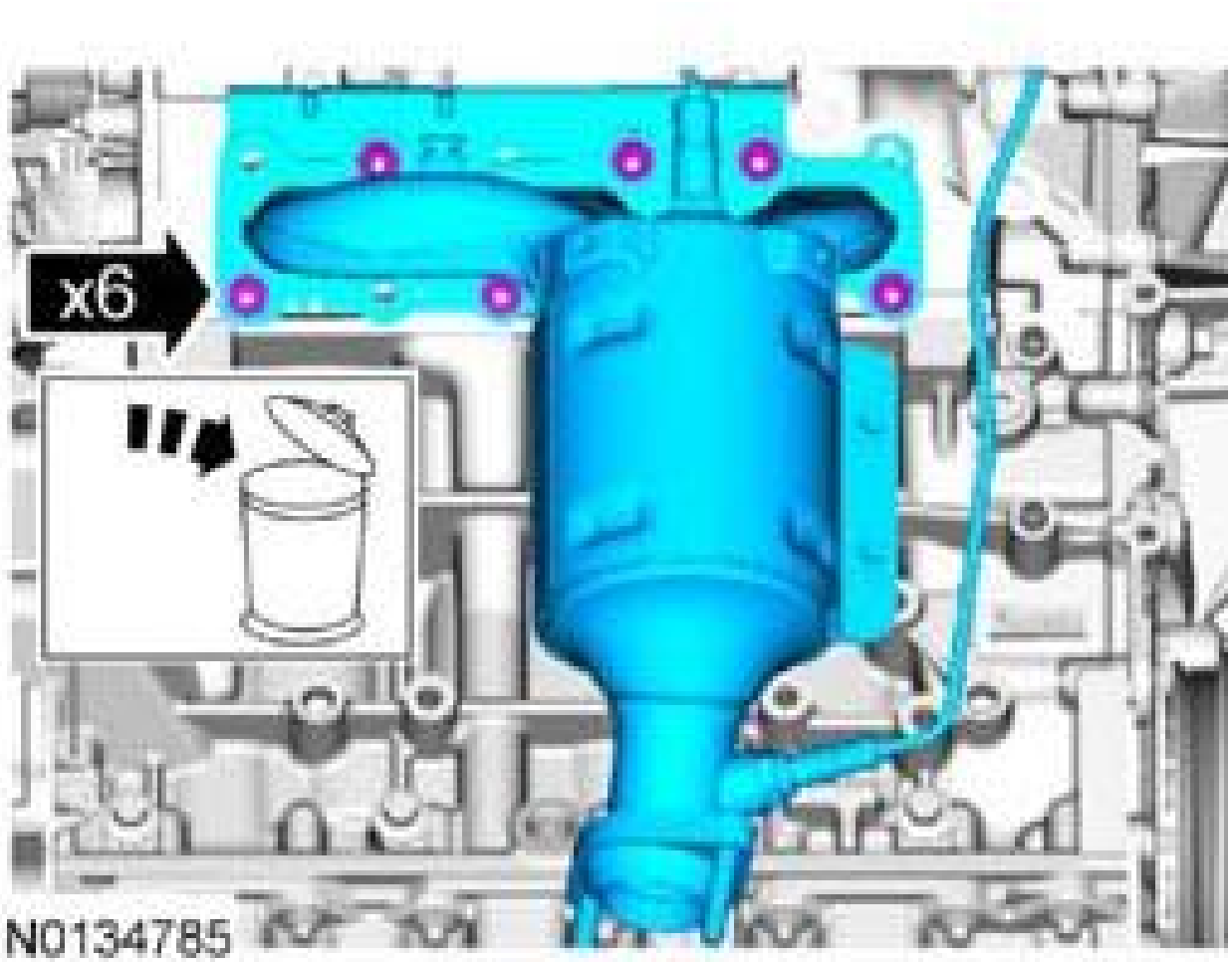
77. Remove the 4 nuts and the RH catalytic converter heat shield.

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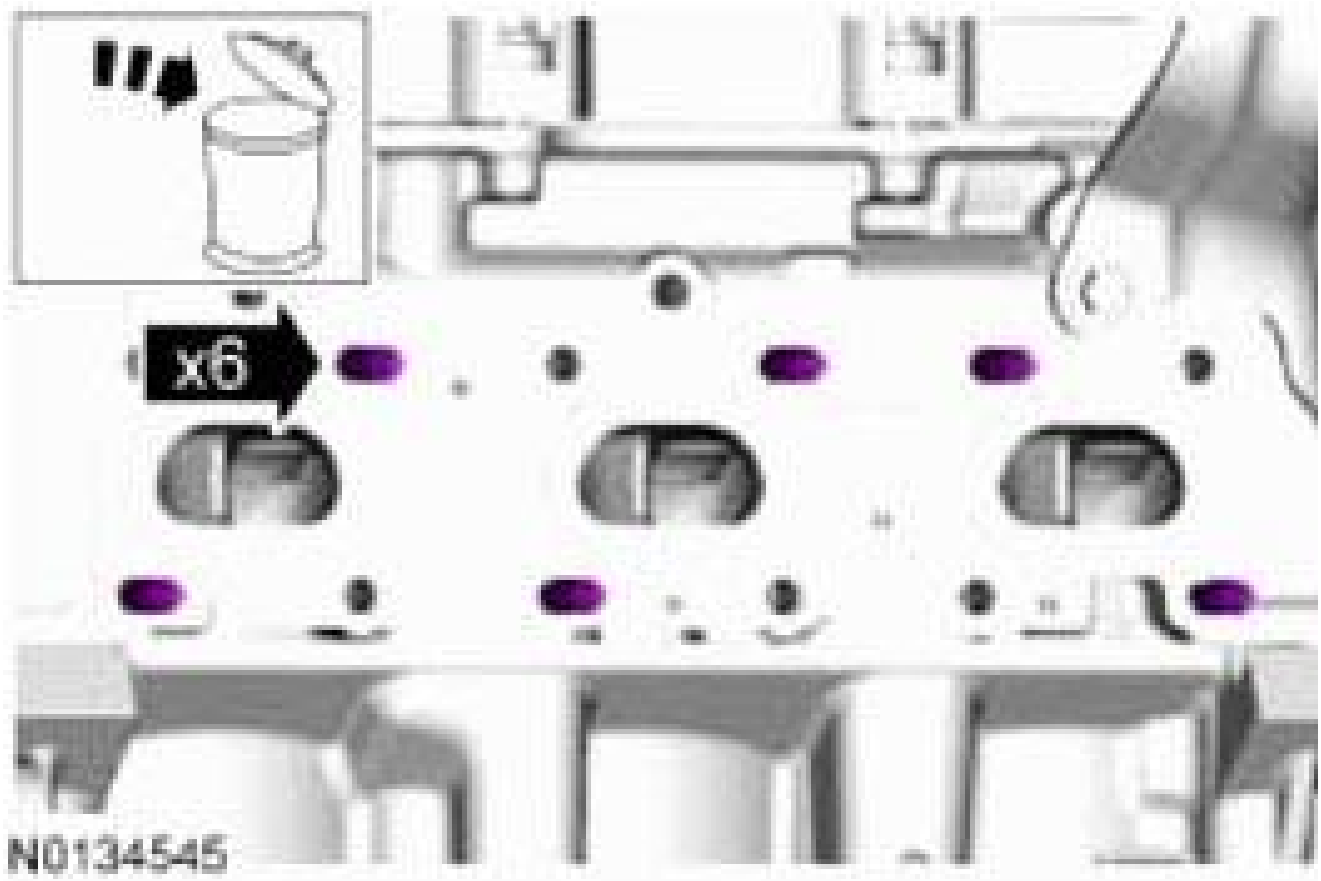
78. Remove the 6 nuts and the RH catalytic converter manifold.
    - Discard the nuts and RH catalytic converter manifold gasket.

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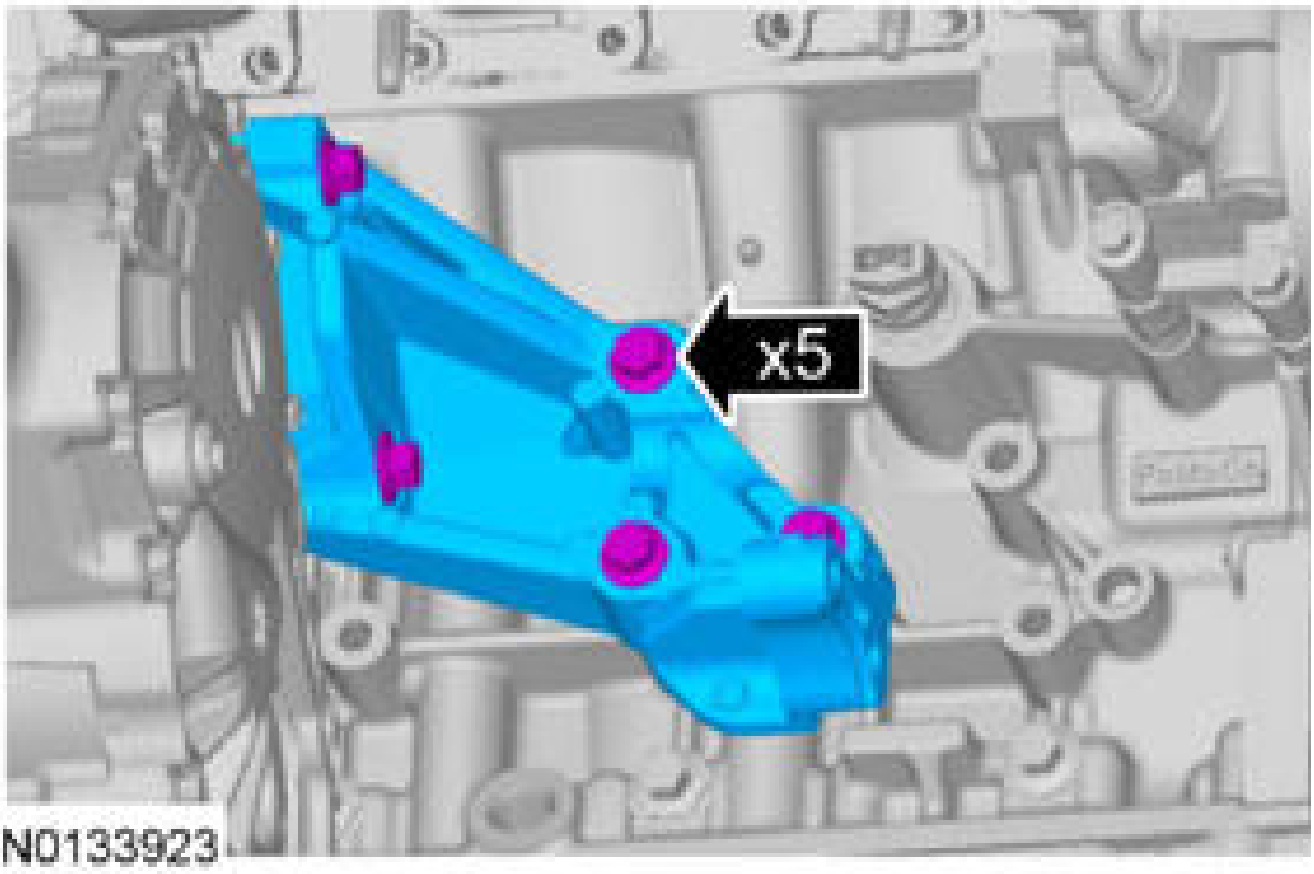
79. Remove and discard the 6 RH catalytic converter manifold studs.

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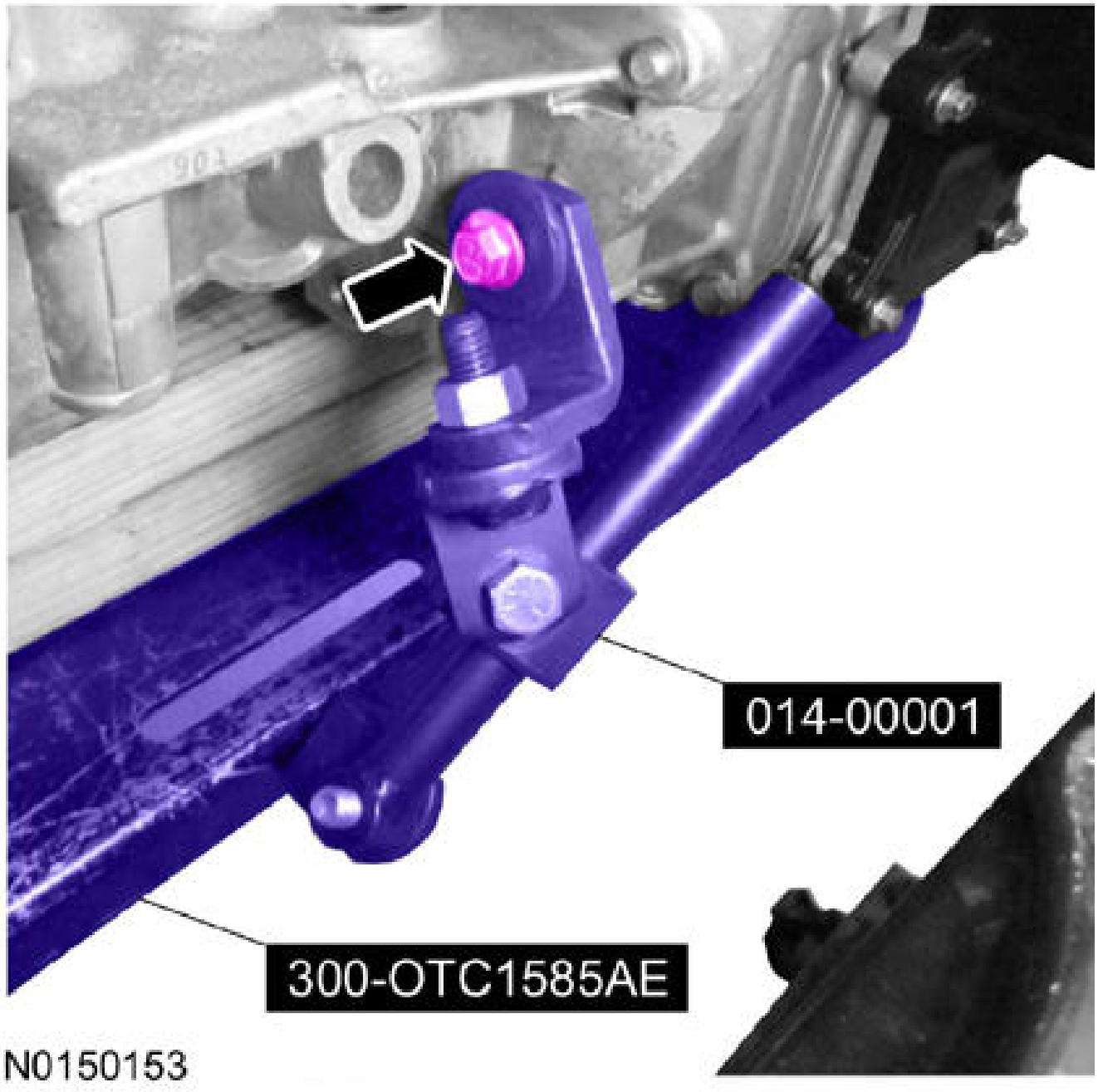
80. Remove the 5 bolts and the Power Transfer Unit (PTU) support bracket.

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81. Remove the Adjustable Grip Arm.

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82. Remove the ratchet strap from the front of the subframe under the powertrain lift table to the rear of the subframe.

83. **NOTE: LH shown in illustration, RH similar.**

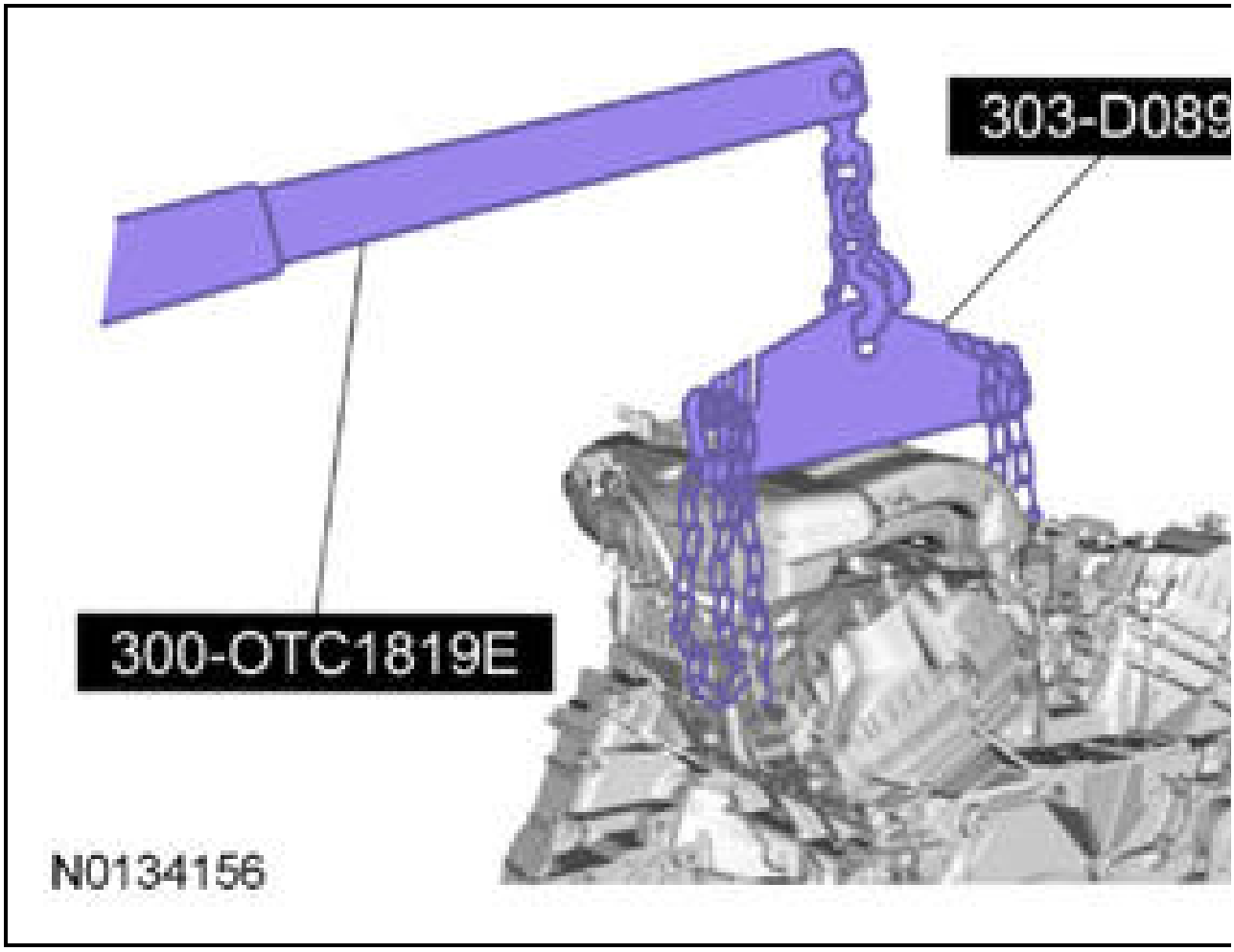
Install the ratchet strap from the front subframe to the LH engine lift eye and from the rear of the subframe to the RH engine lift eye.

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84. Using the Floor Crane and Spreader Bar, remove the powertrain and subframe as an assembly from the powertrain lift table and set on the ground.
    - Position wood blocks under the engine and transmission.



85. **NOTE: LH shown in illustration, RH similar.**

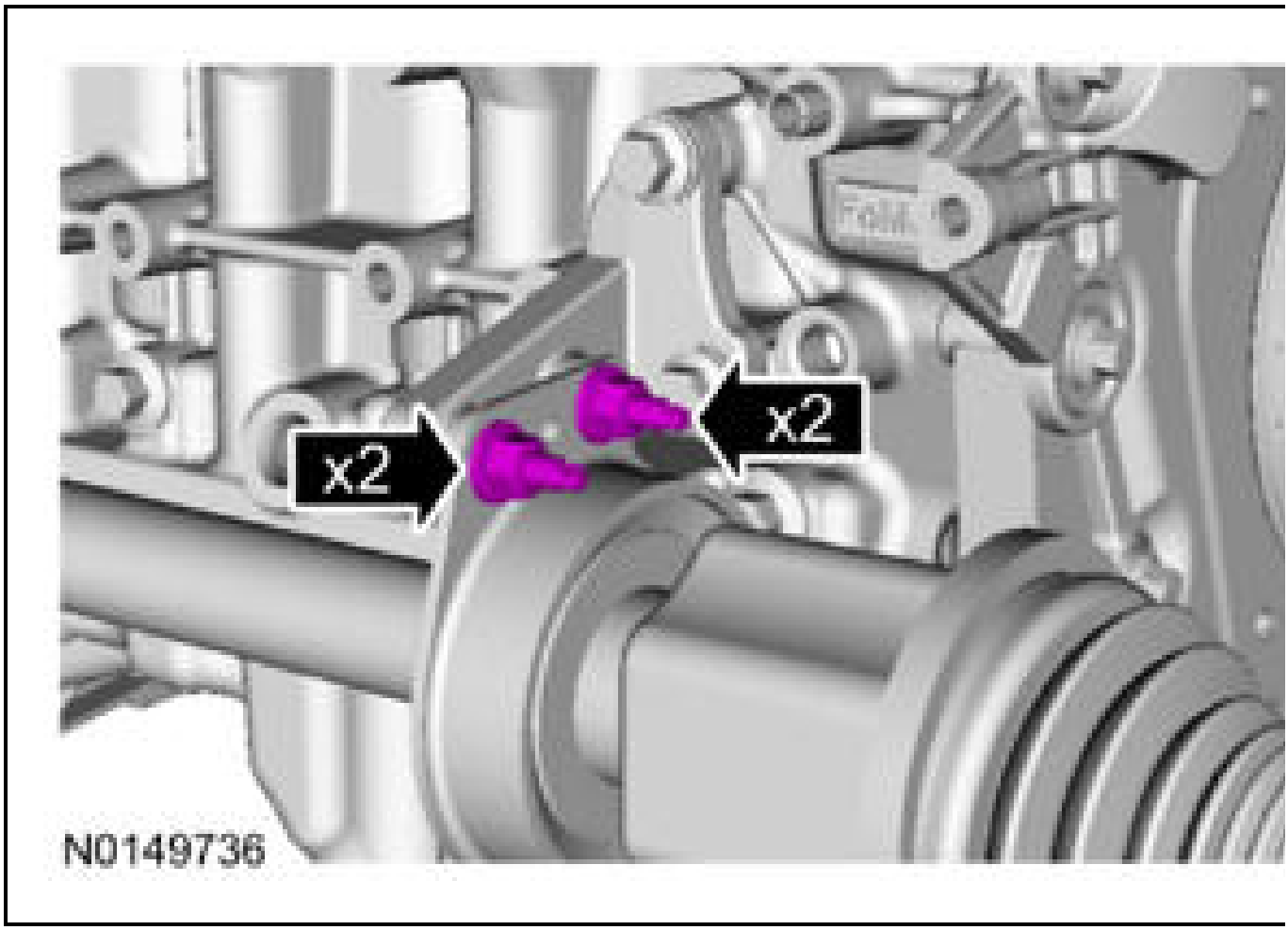
Remove the ratchet strap from the front subframe to the LH engine lift eye and from the rear of the subframe to the RH engine lift eye.

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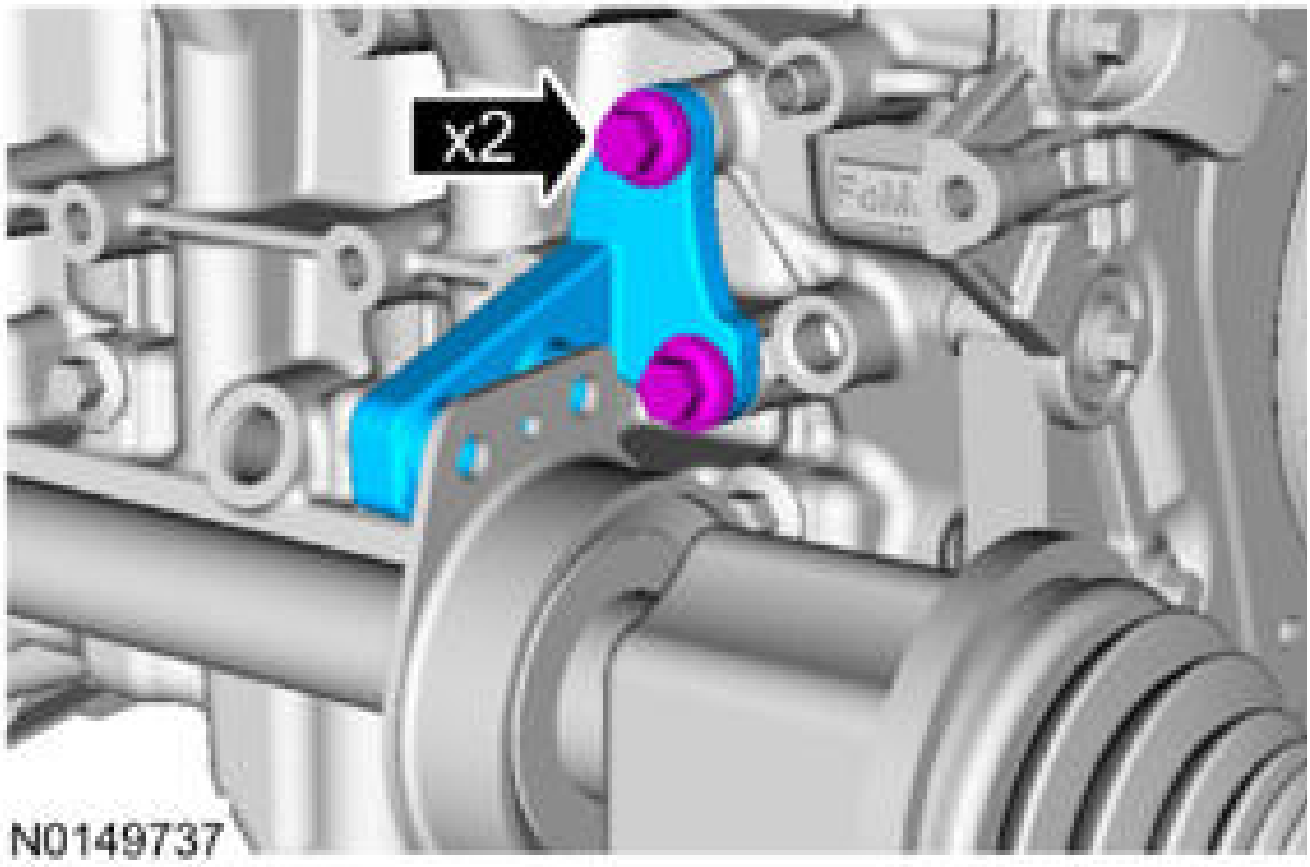
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86. Remove the 2 intermediate shaft bracket nuts and the 2 studs.



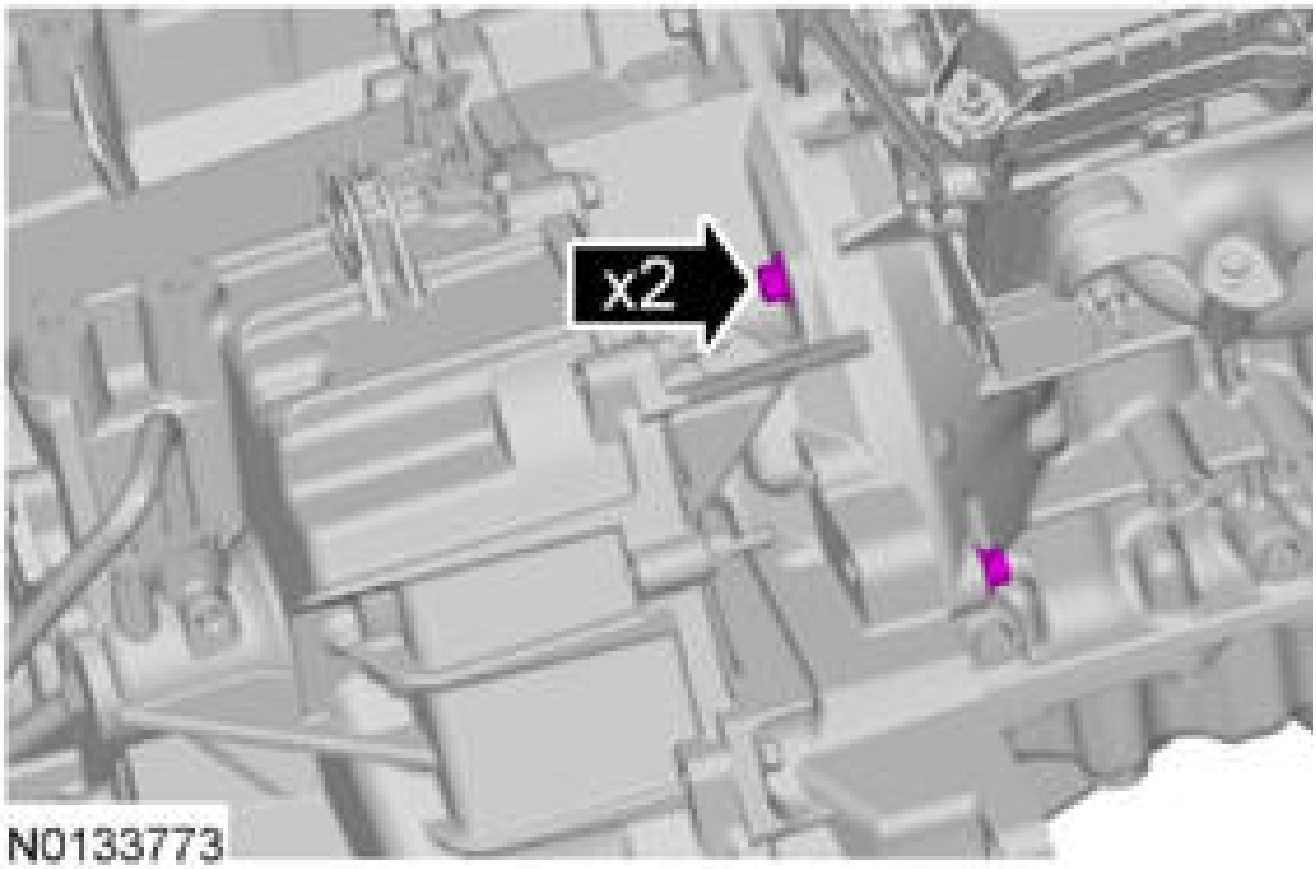
87. Remove the 2 bolts and the RH halfshaft support bracket.

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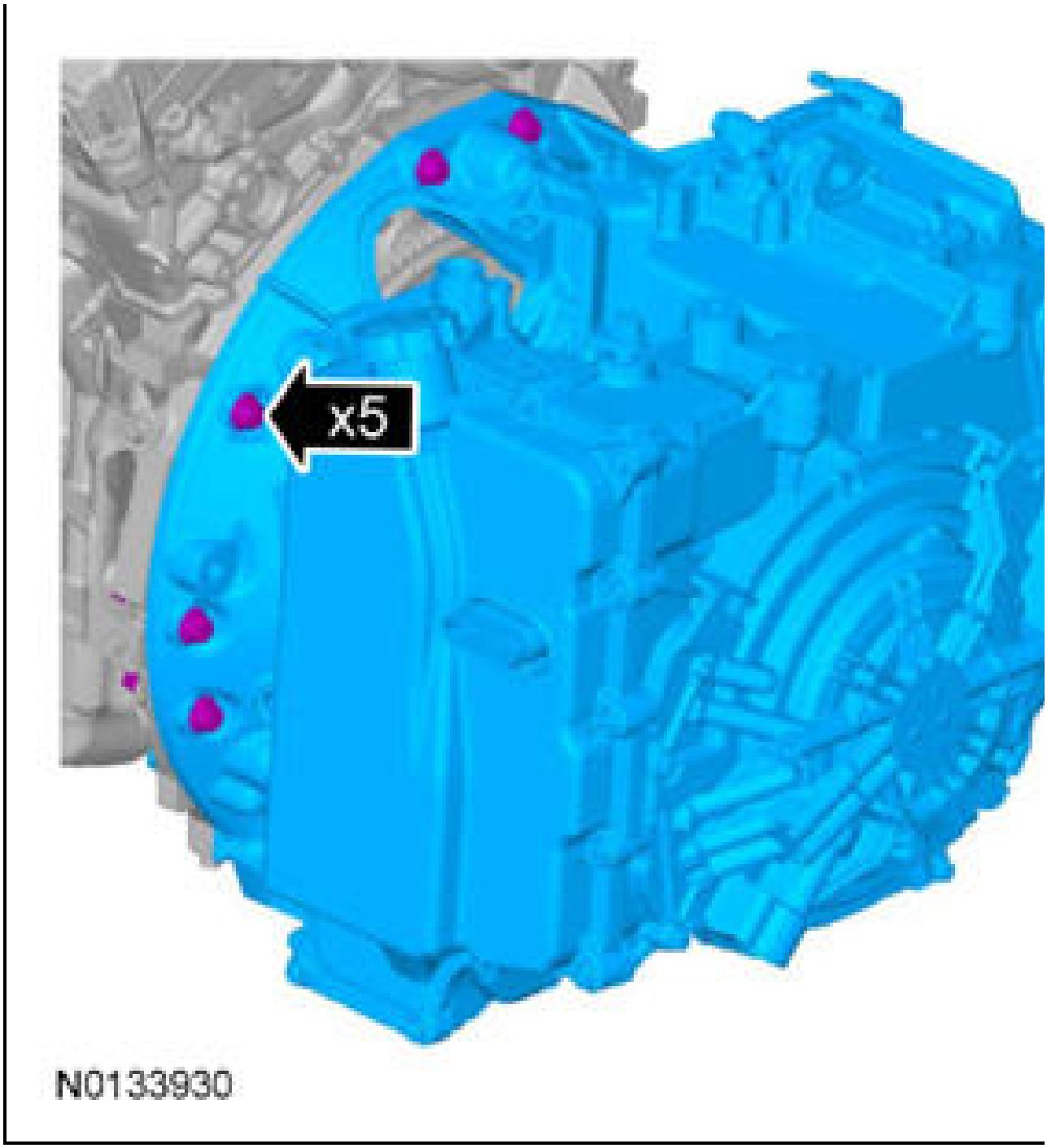
88. Remove the 2 engine-to-transaxle bolts.

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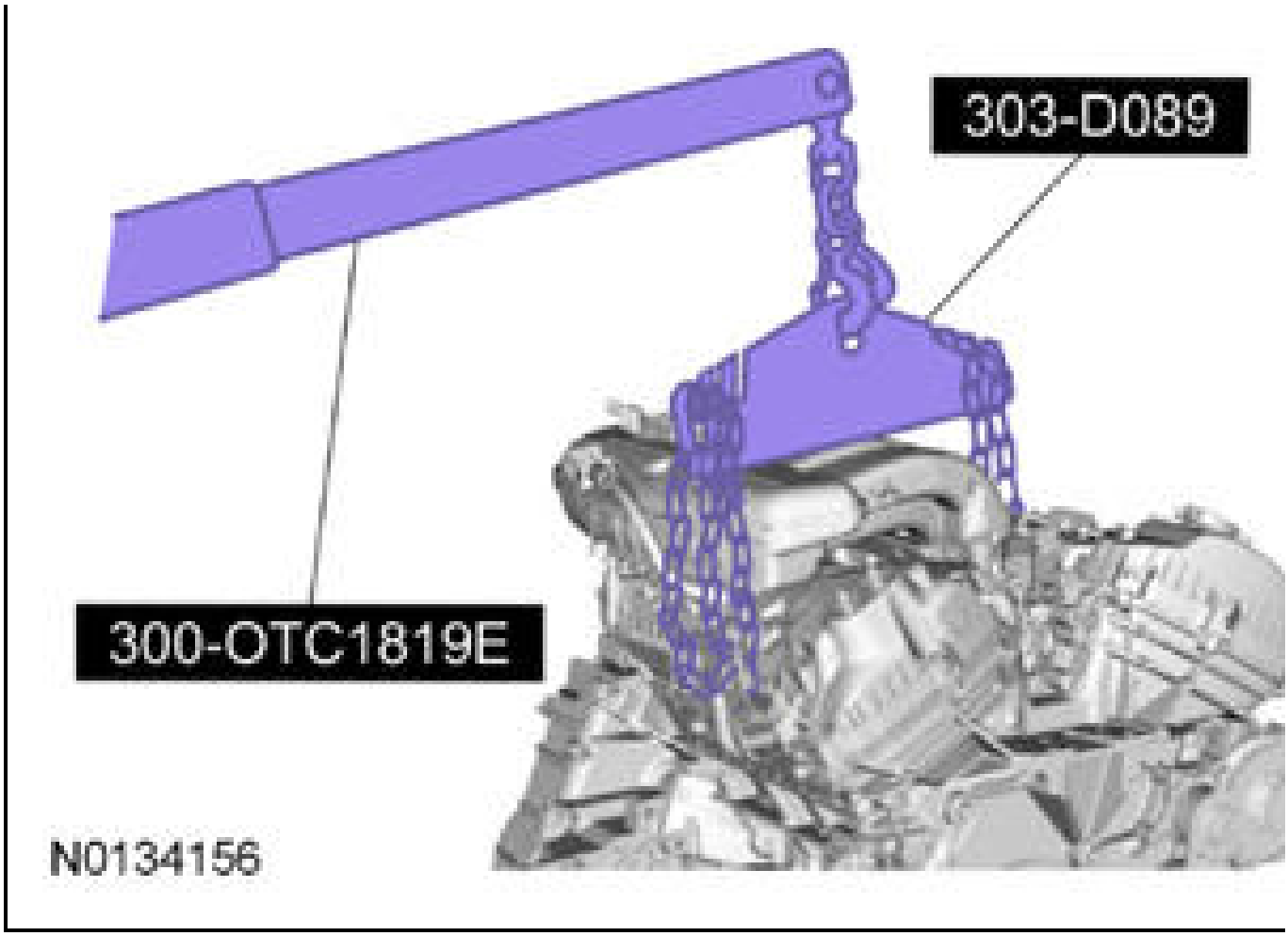
89. Remove the 5 transaxle-to-engine bolts.
    - Separate the transaxle from the engine.

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90. Using the Floor Crane and Spreader Bar, remove the engine from the transaxle.

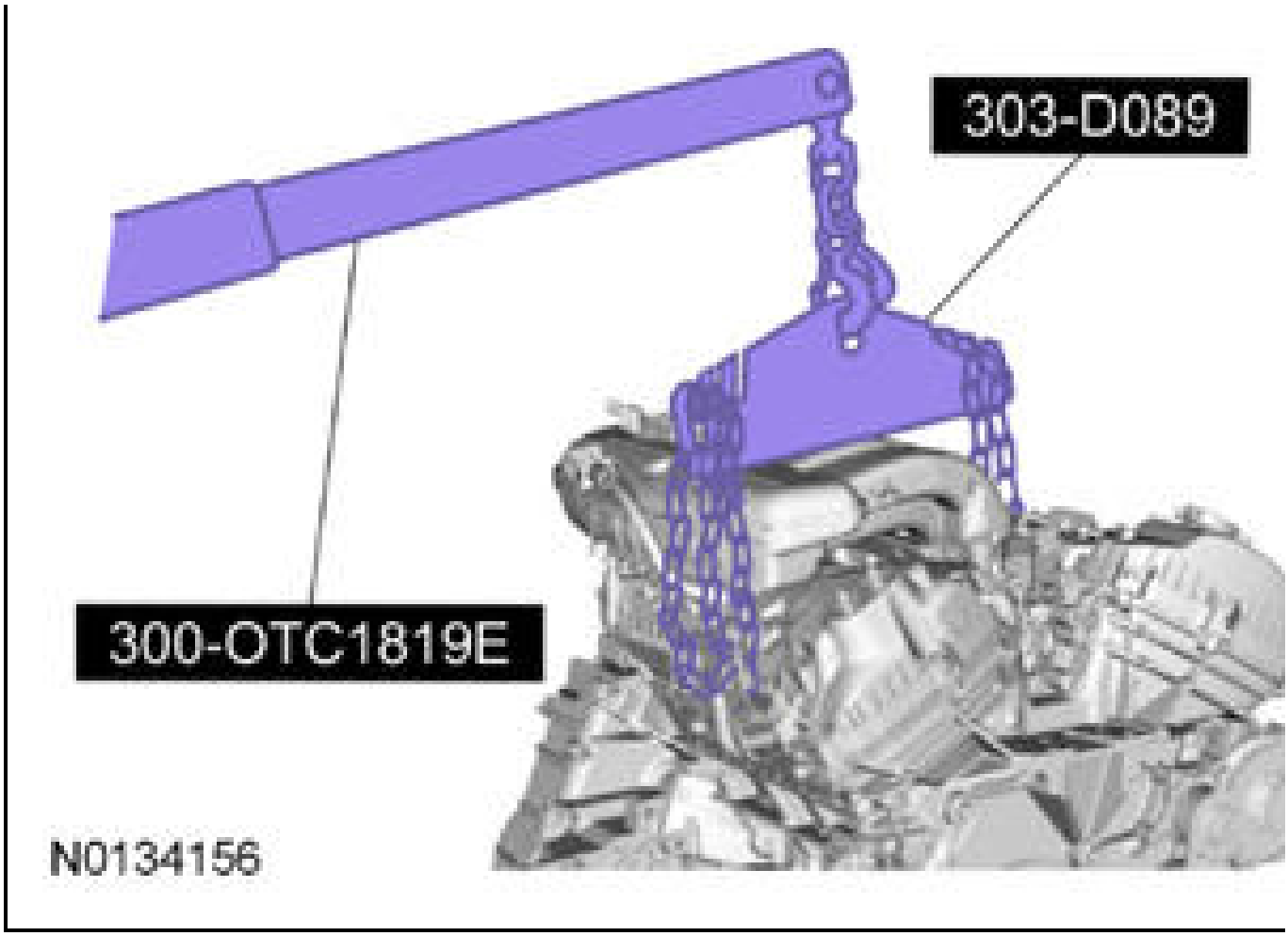
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Installation

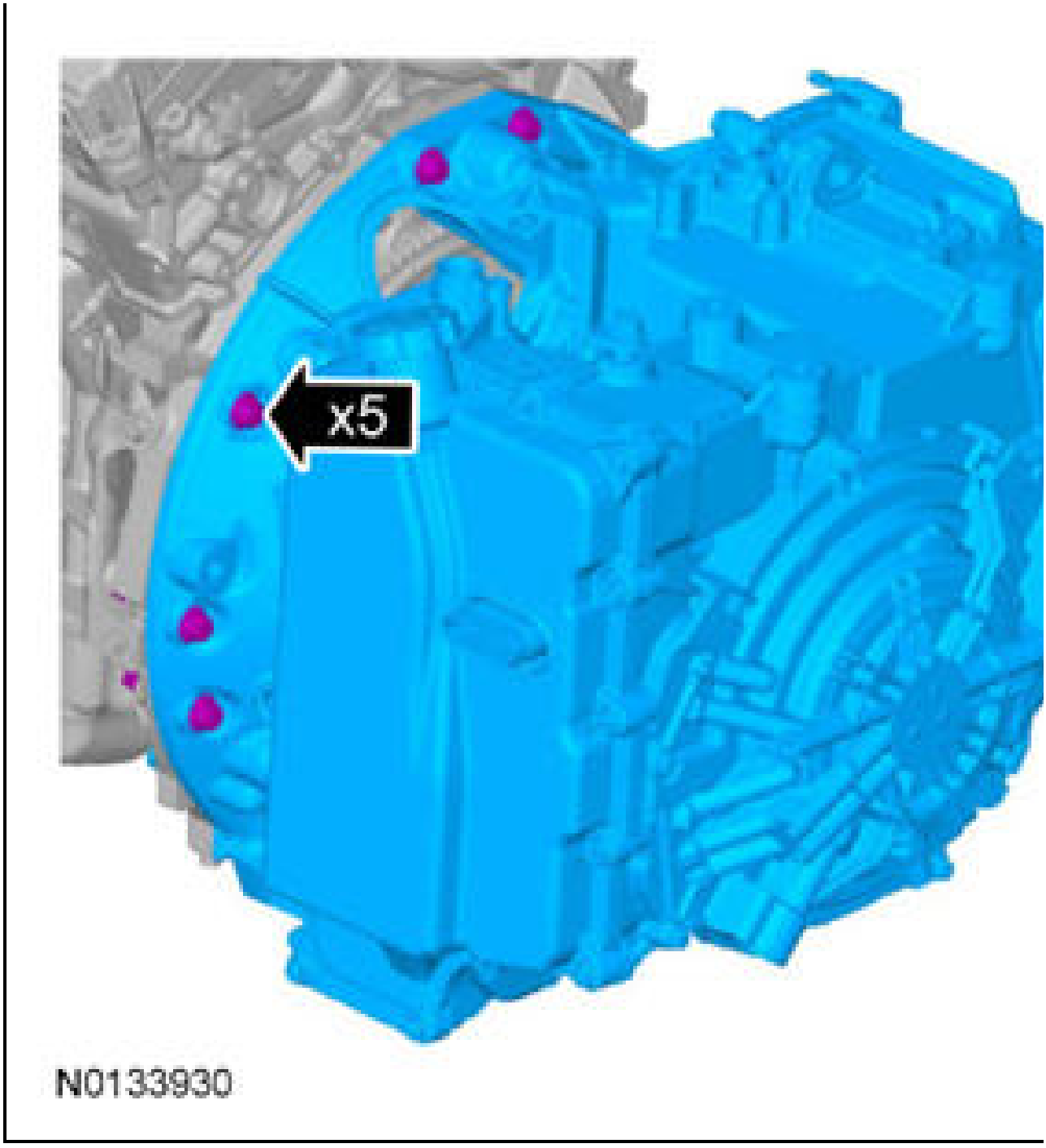
1. Using the Floor Crane and Spreader Bar, align the transaxle to the engine.

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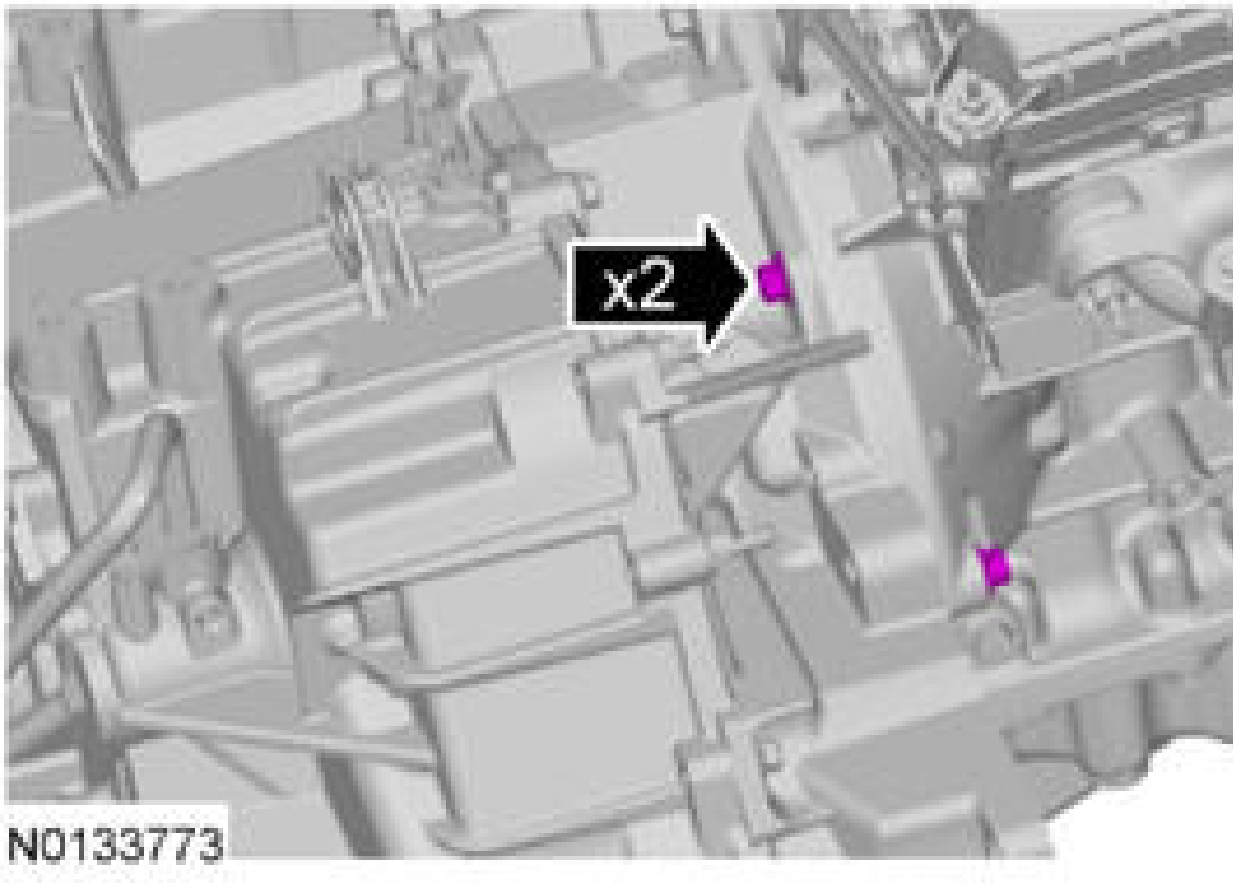
2. Align the transaxle to the engine and install the 5 transaxle-to-engine bolts.
    - Tighten to 48 Nm (35 lb-ft).

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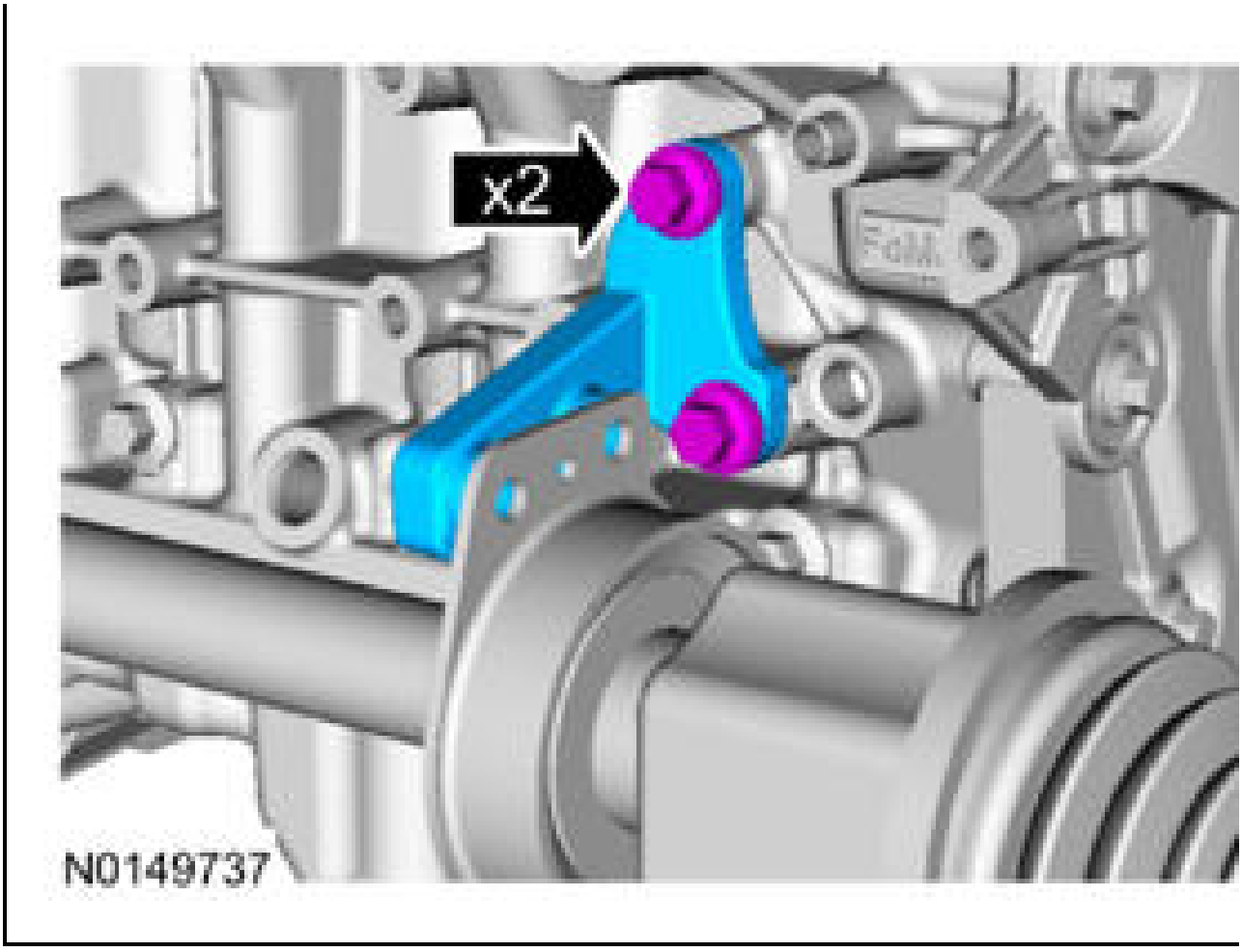
3. Install the 2 engine-to-transaxle bolts.
    - Tighten to 48 Nm (35 lb-ft).

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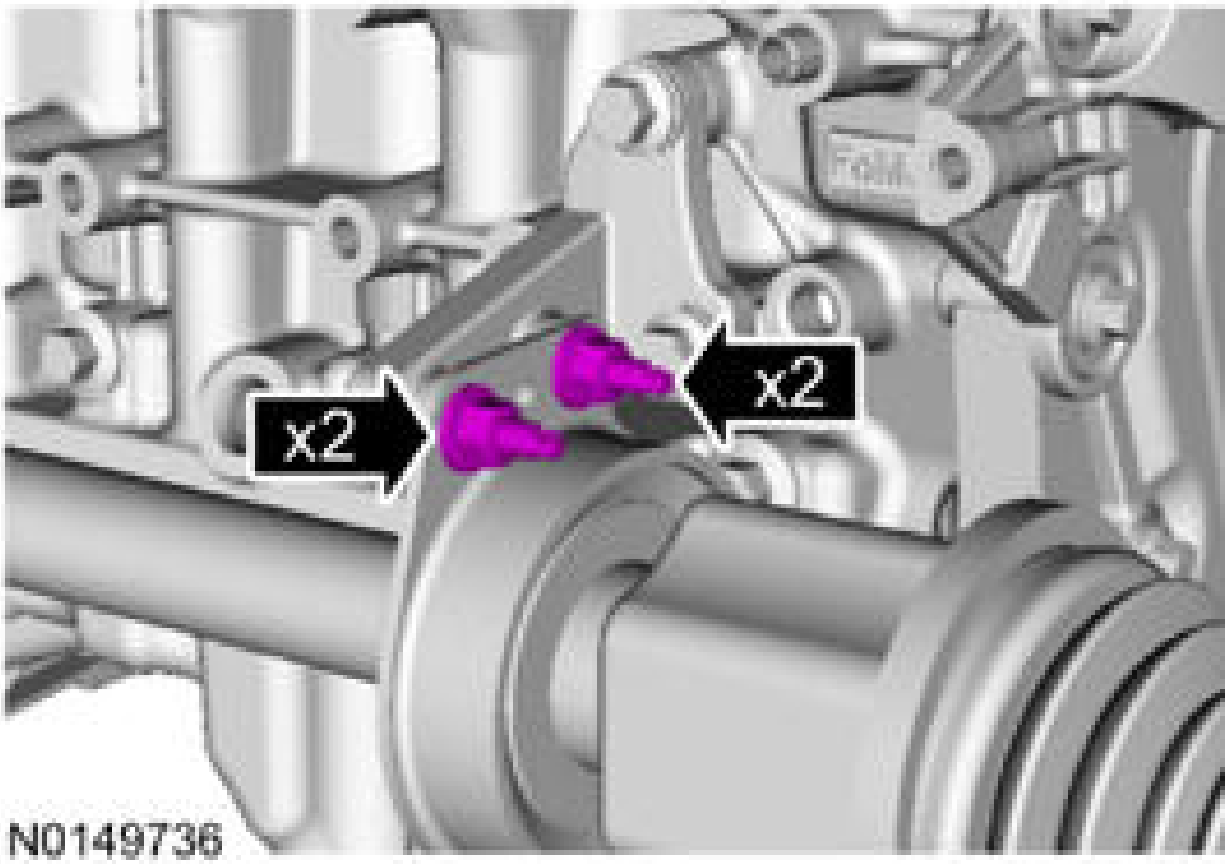
4. Install the RH halfshaft support bracket and the 2 bolts.
    - Tighten to 40 Nm (30 lb-ft).

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5. Install the 2 intermediate shaft bracket studs and nuts.
    - Tighten the studs to 10 Nm (89 lb-in).
    - Tighten the nuts to 25 Nm (18 lb-ft).

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6. **NOTE: LH shown in illustration, RH similar.**

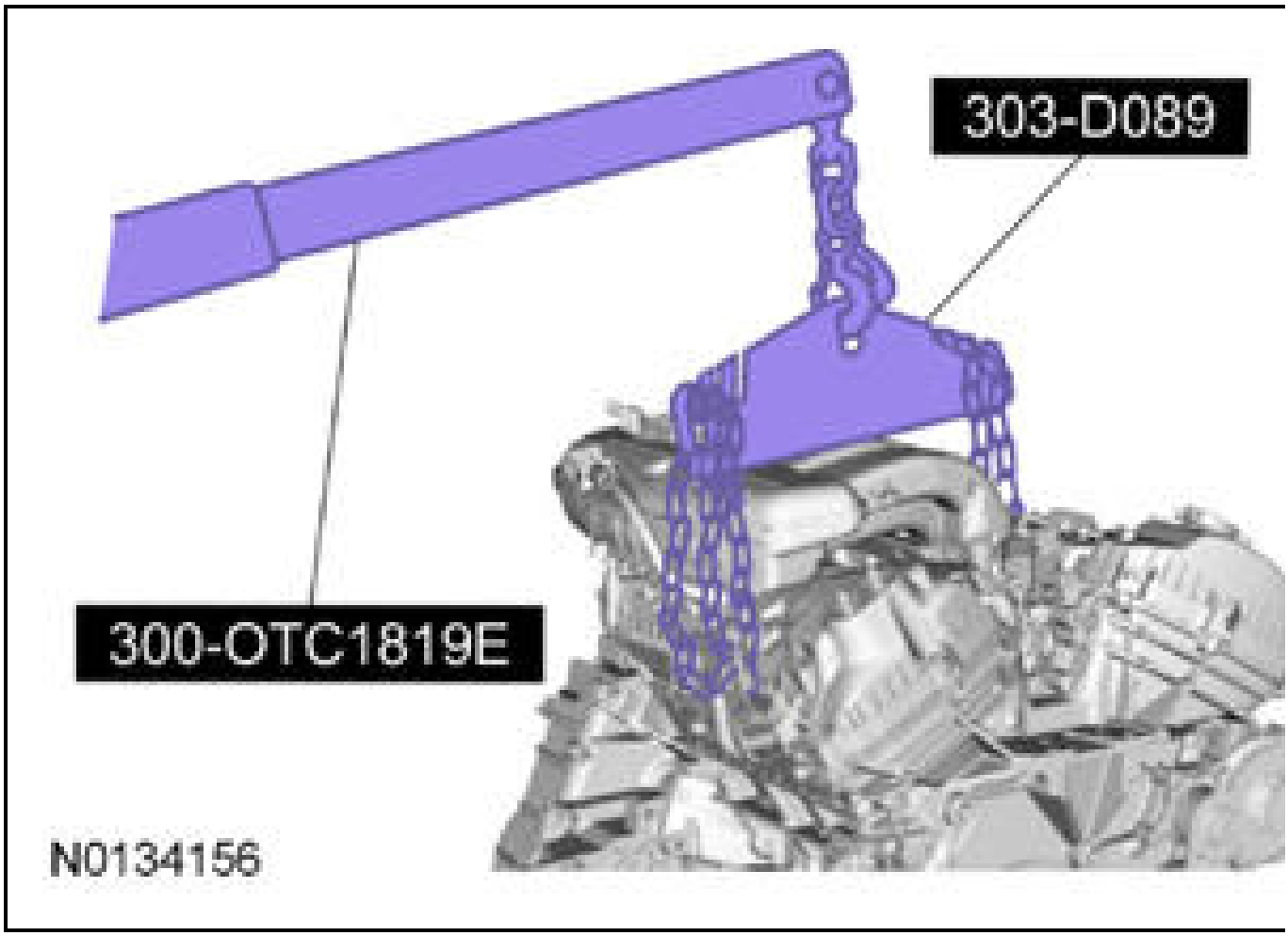
Install the ratchet strap from the front subframe to the LH engine lift eye and from the rear of the subframe to the RH engine lift eye.

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7. Using the Floor Crane and Spreader Bar, install the powertrain and subframe as an assembly on the powertrain lift table.



8. **NOTE: LH shown in illustration, RH similar.**

Remove the ratchet strap from the front subframe to the LH engine lift eye and from the rear of the subframe to the RH engine lift eye.

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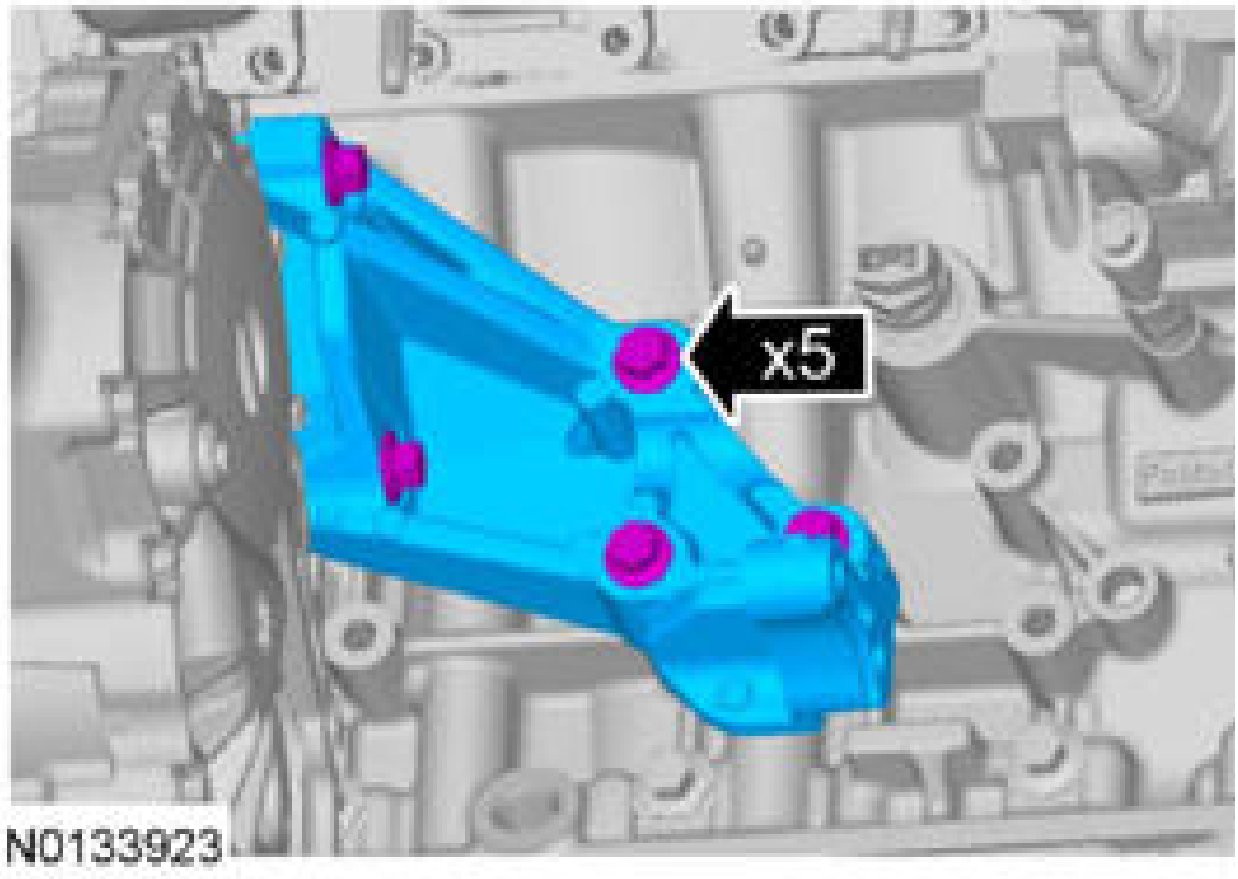
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9. Install the Adjustable Grip Arm.



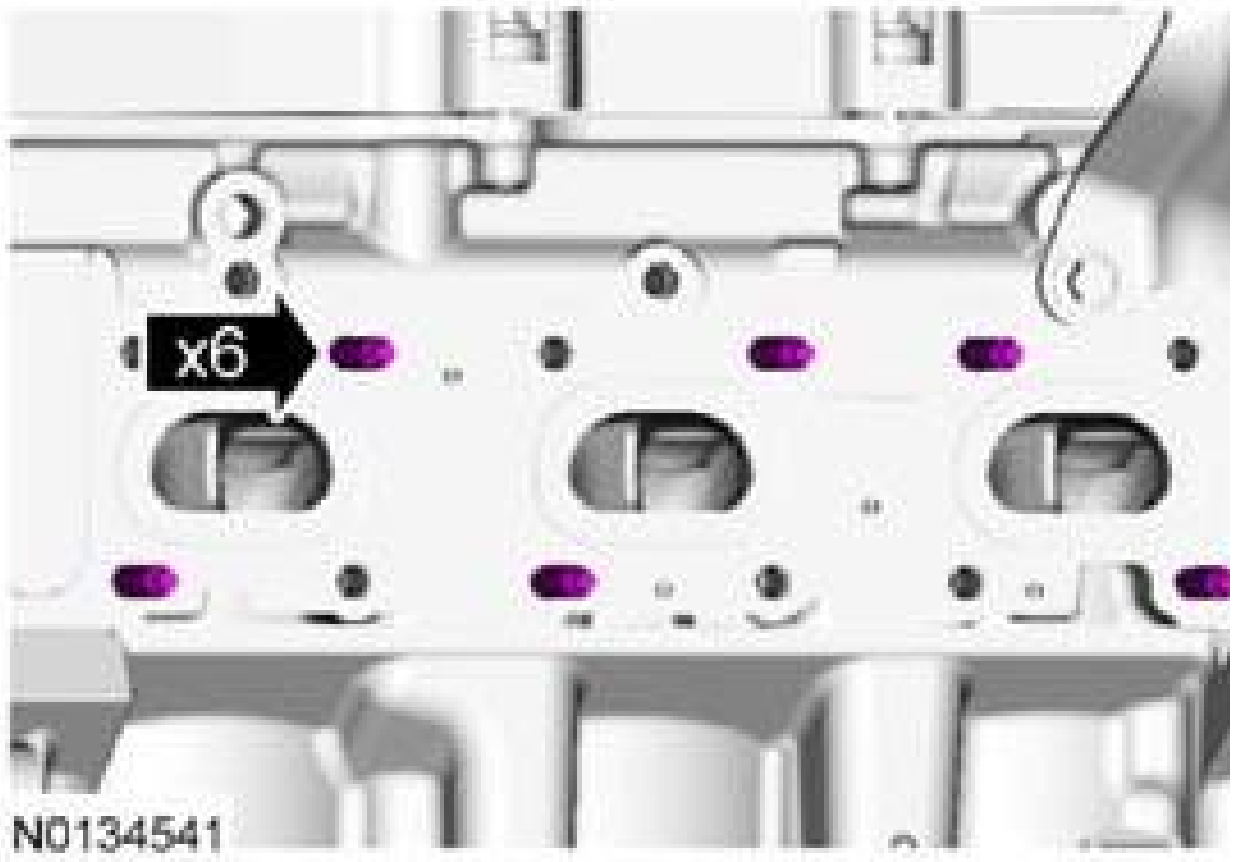
10. Install a ratchet strap from the front of the subframe under the powertrain lift table to the rear of the subframe, to secure the subframe to the powertrain lift table.
11. Position the **PTU** support bracket in place and install the 5 bolts.
    - Tighten to 70 Nm (52 lb-ft).

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12. Install 6 new RH exhaust manifold studs.
    - Tighten to 12 Nm (106 lb-in).

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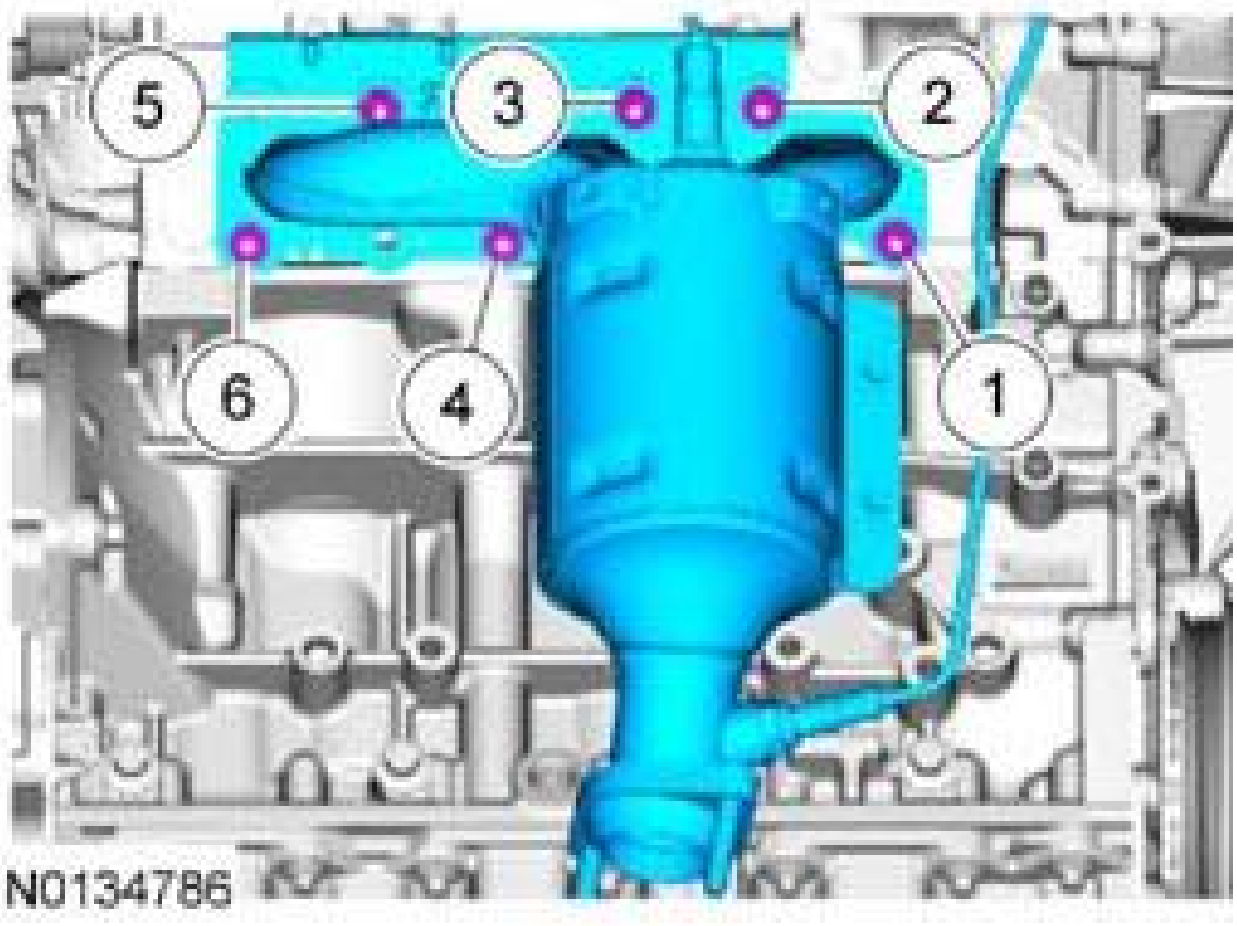


13. **NOTE: Failure to tighten the exhaust manifold nuts to specification a second time will cause the exhaust manifold to develop an exhaust leak.**

Using a new gasket, install the RH exhaust manifold and 6 new nuts. Tighten in 2 stages in the sequence shown in illustration:

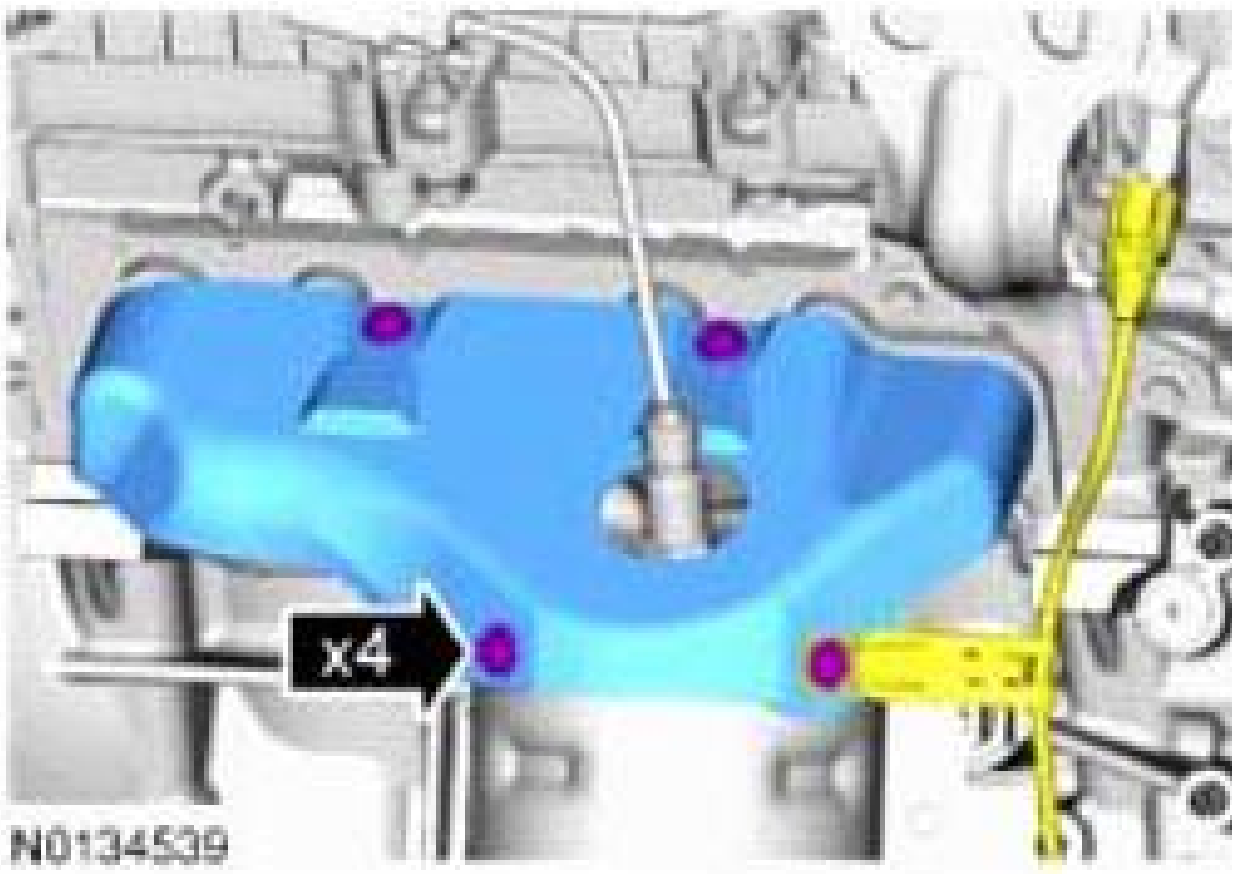
- Stage 1: Tighten to 20 Nm (177 lb-in).
- Stage 2: Tighten to 25 Nm (18 lb-ft).

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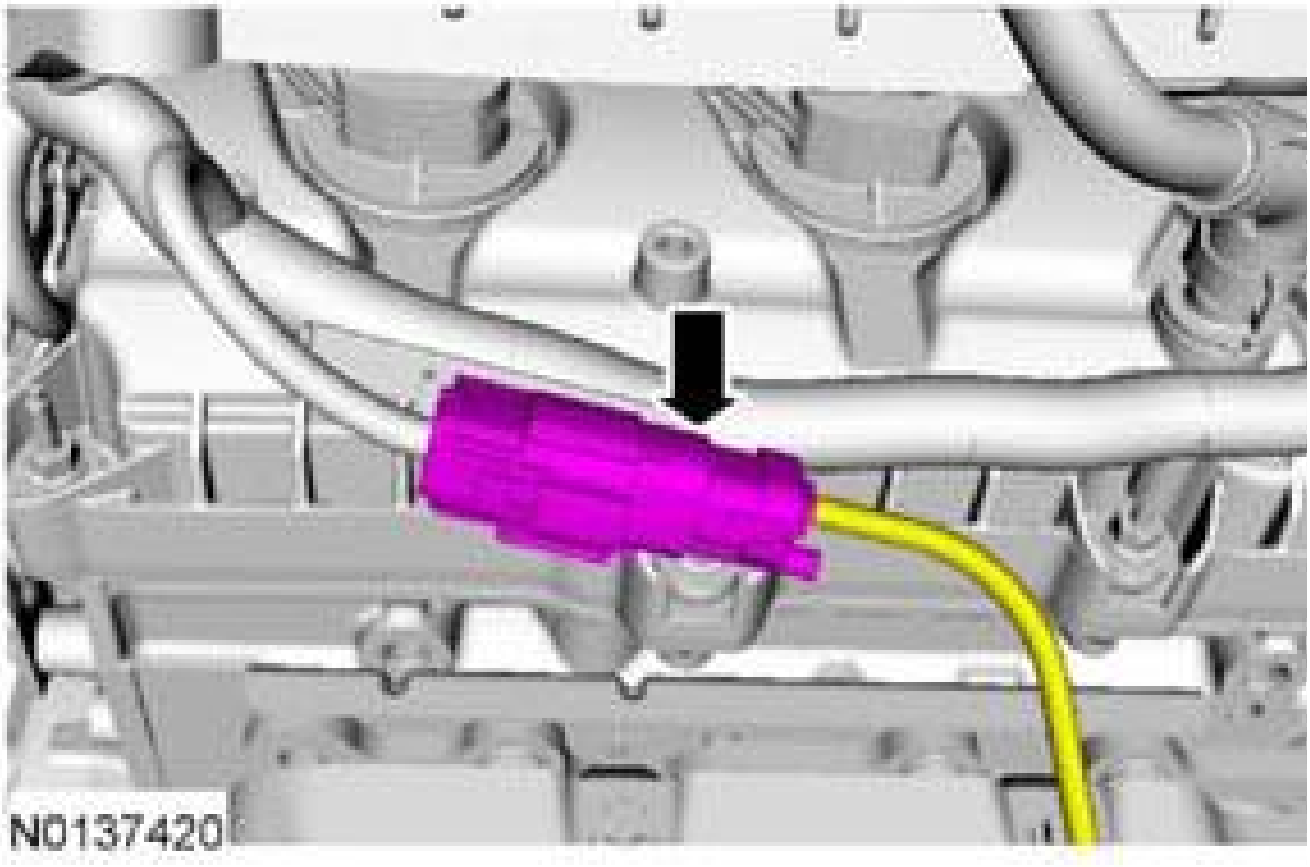
14. Install the RH catalytic converter heat shield, Catalyst Monitor Sensor (CMS) wiring harness bracket and the 4 bolts.
    - Tighten to 10 Nm (89 lb-in).

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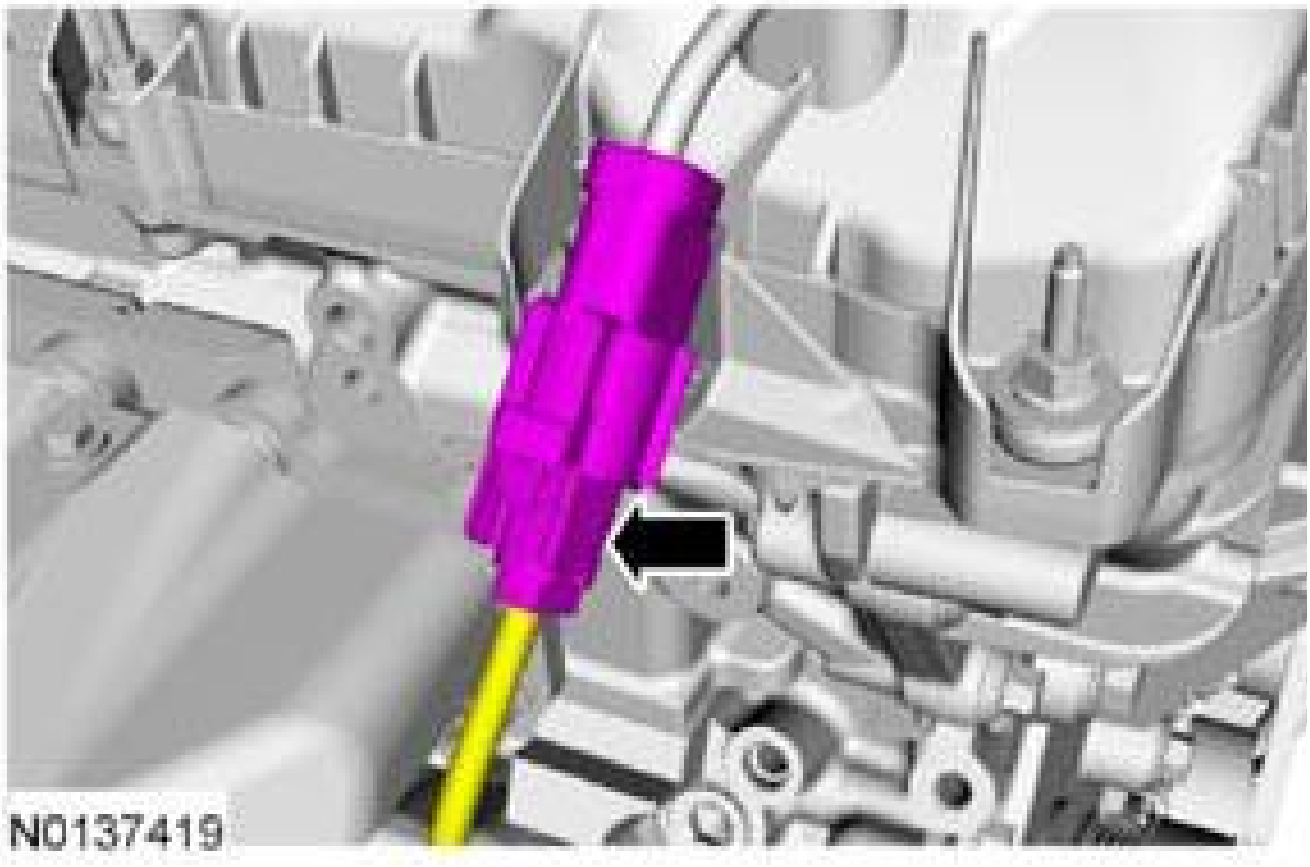
15. Connect the RH Heated Oxygen Sensor (HO2S) electrical connector.

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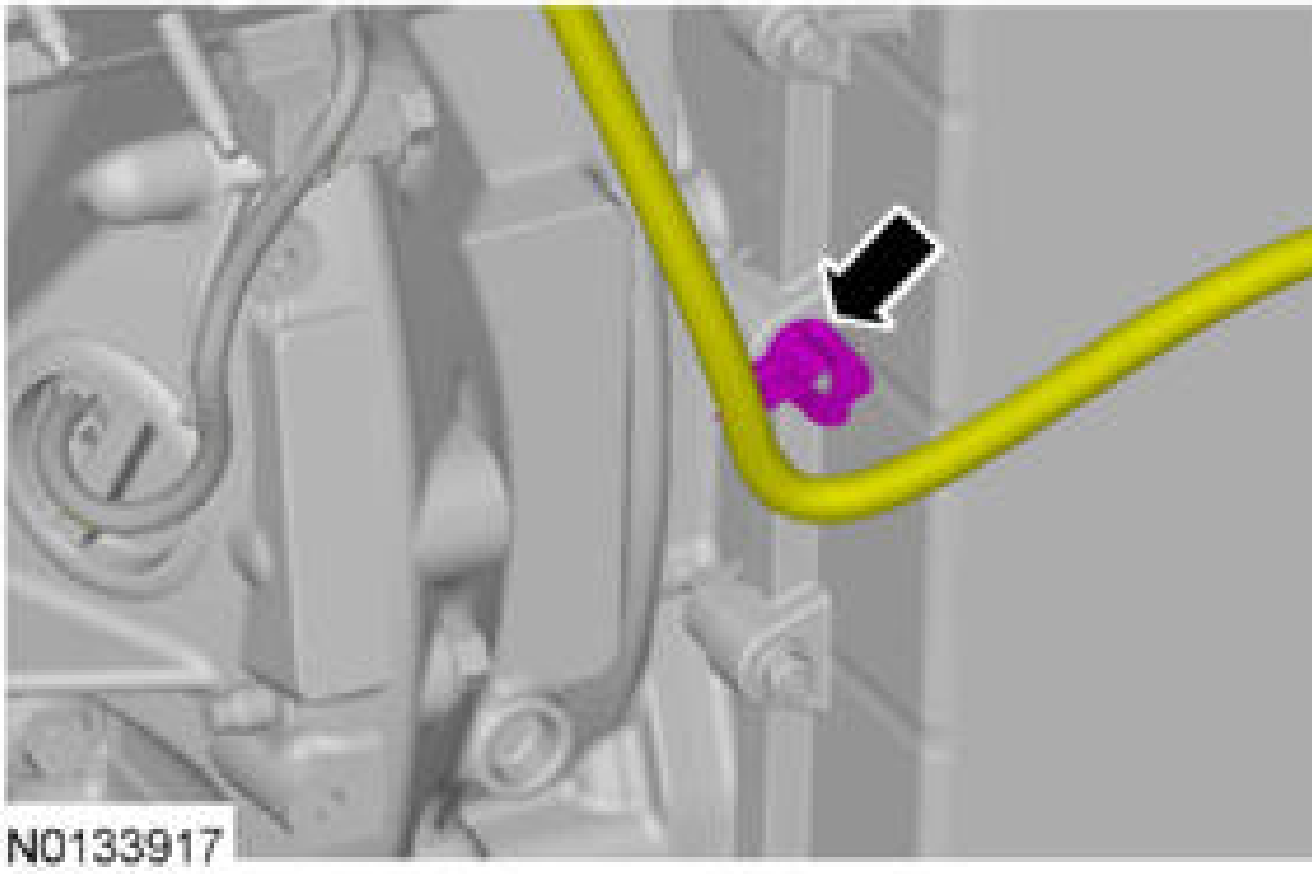
16. Connect the RH **CMS** electrical connector.

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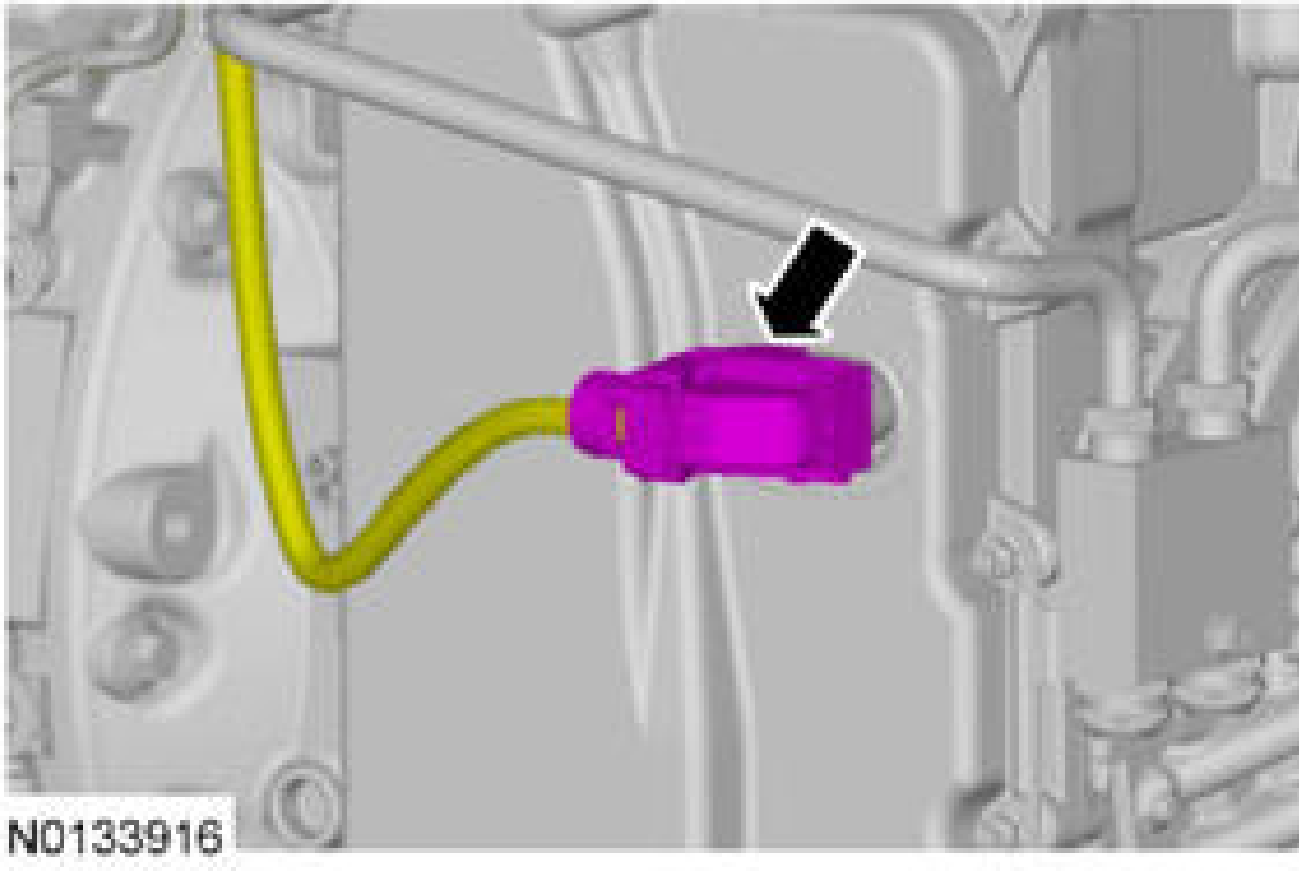
17. Attach the transaxle control wire harness retainer to the transaxle stud bolt.

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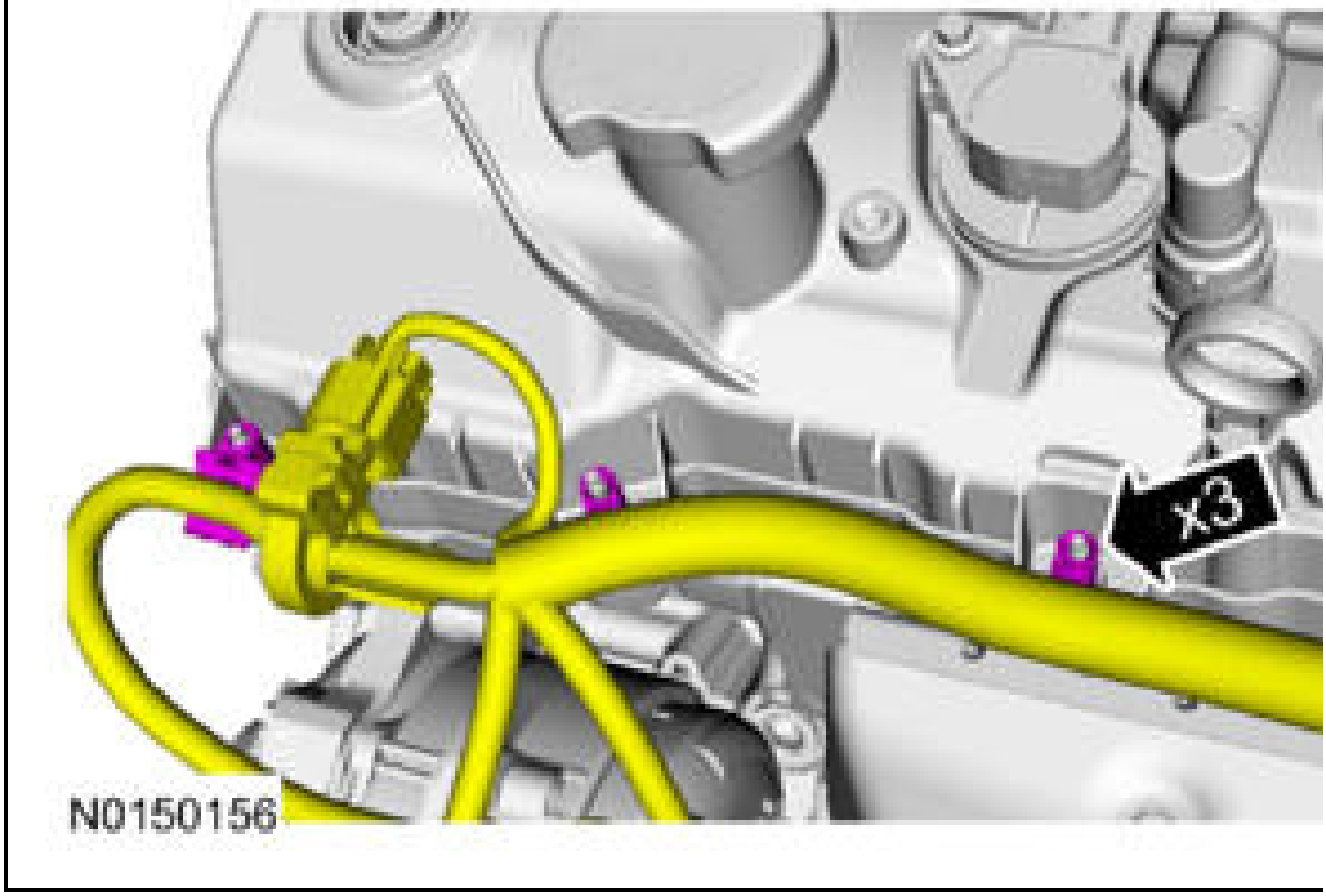
18. Connect the transaxle control electrical connector.

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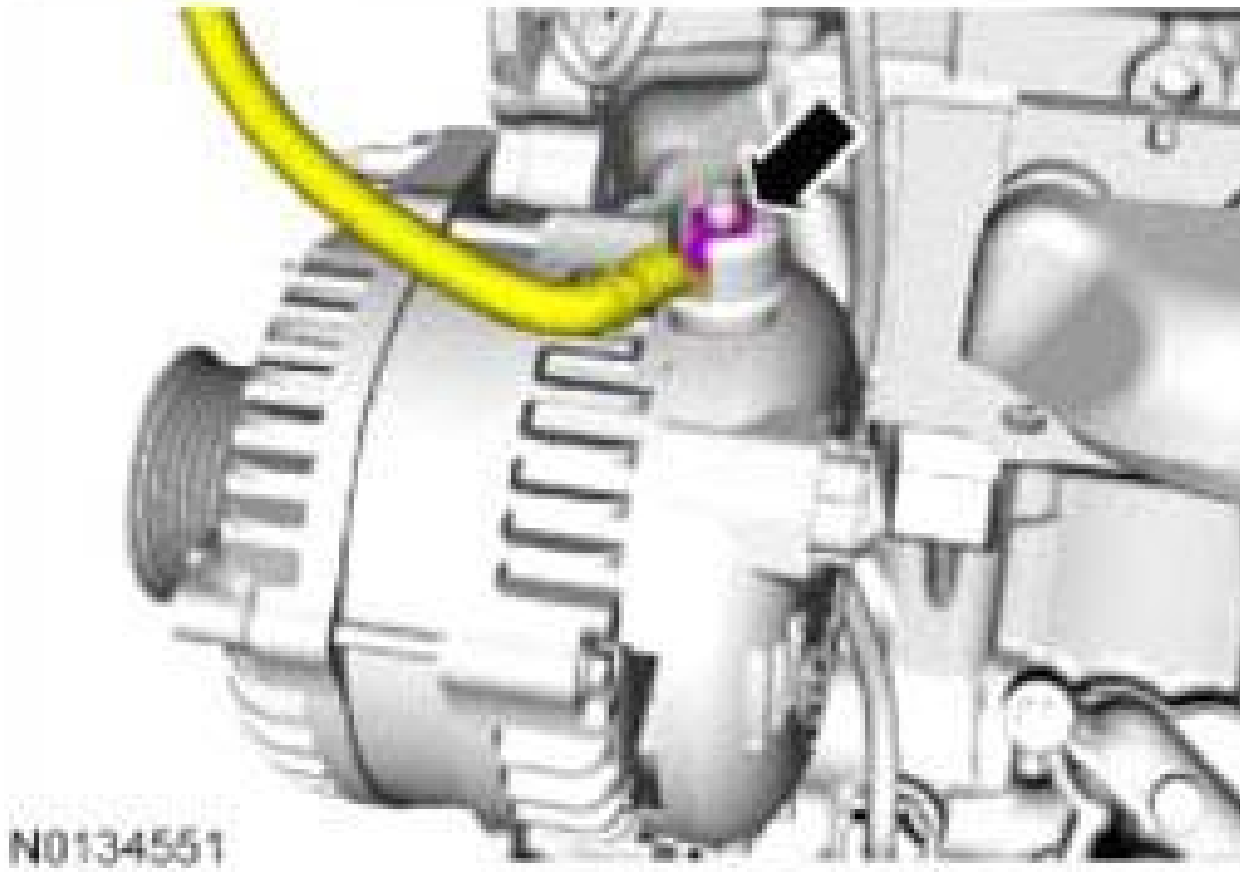
19. Position the wiring harness and attach the 3 wiring harness retainer to the valve cover stud bolt.

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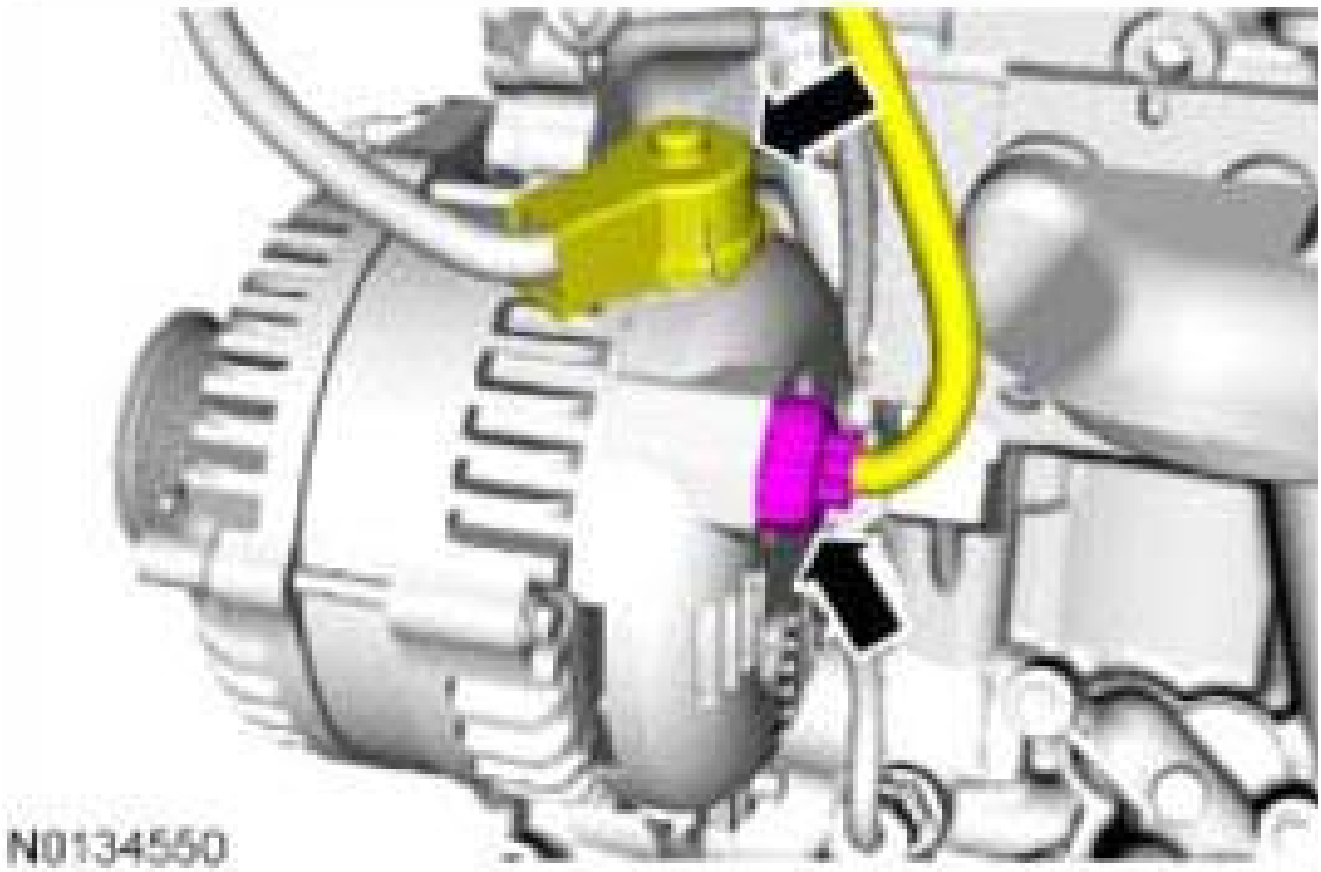
20. Connect the generator B+ cable and install the nut.
    - Tighten to 17 Nm (150 lb-in).

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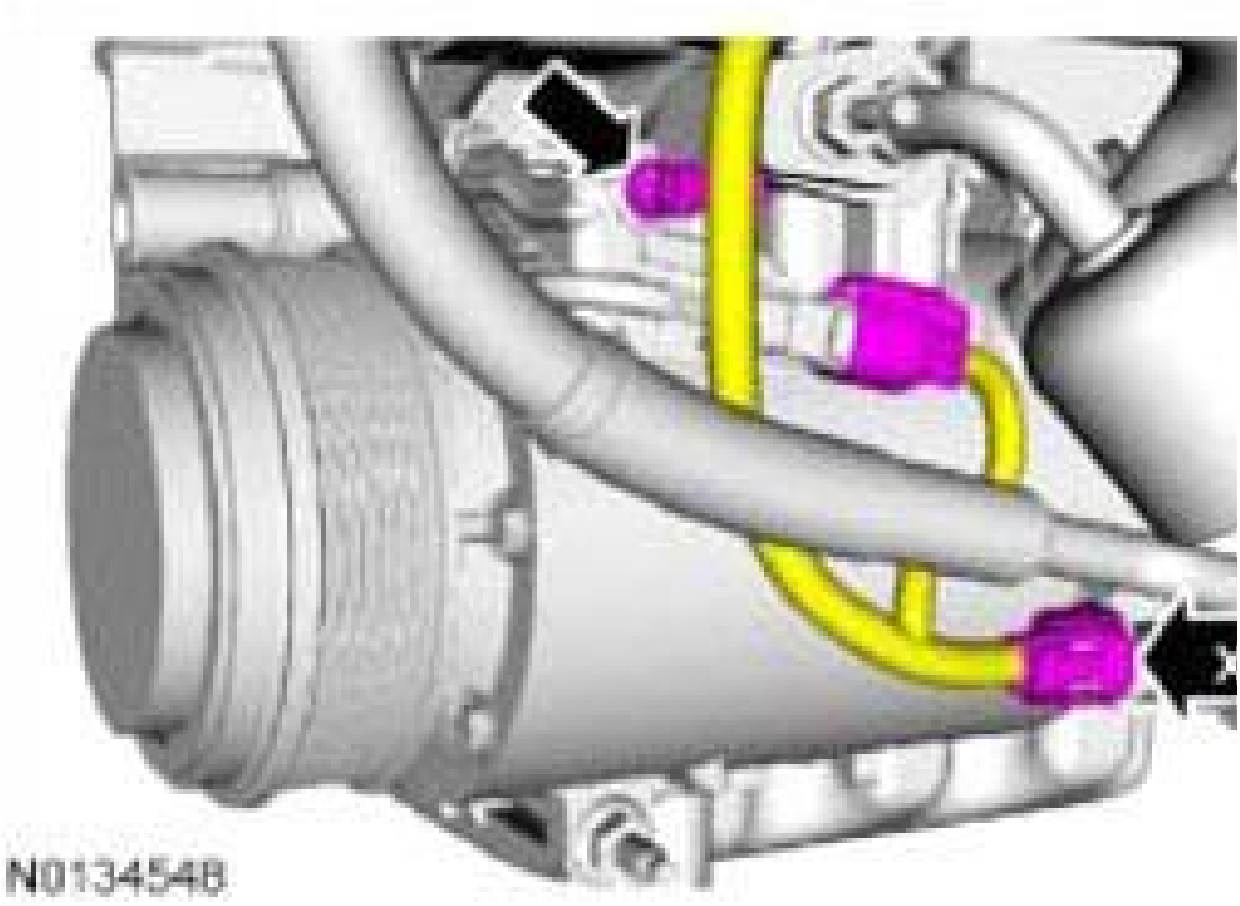
21. Position back the generator B+ cable cover and connect the generator electrical connector.

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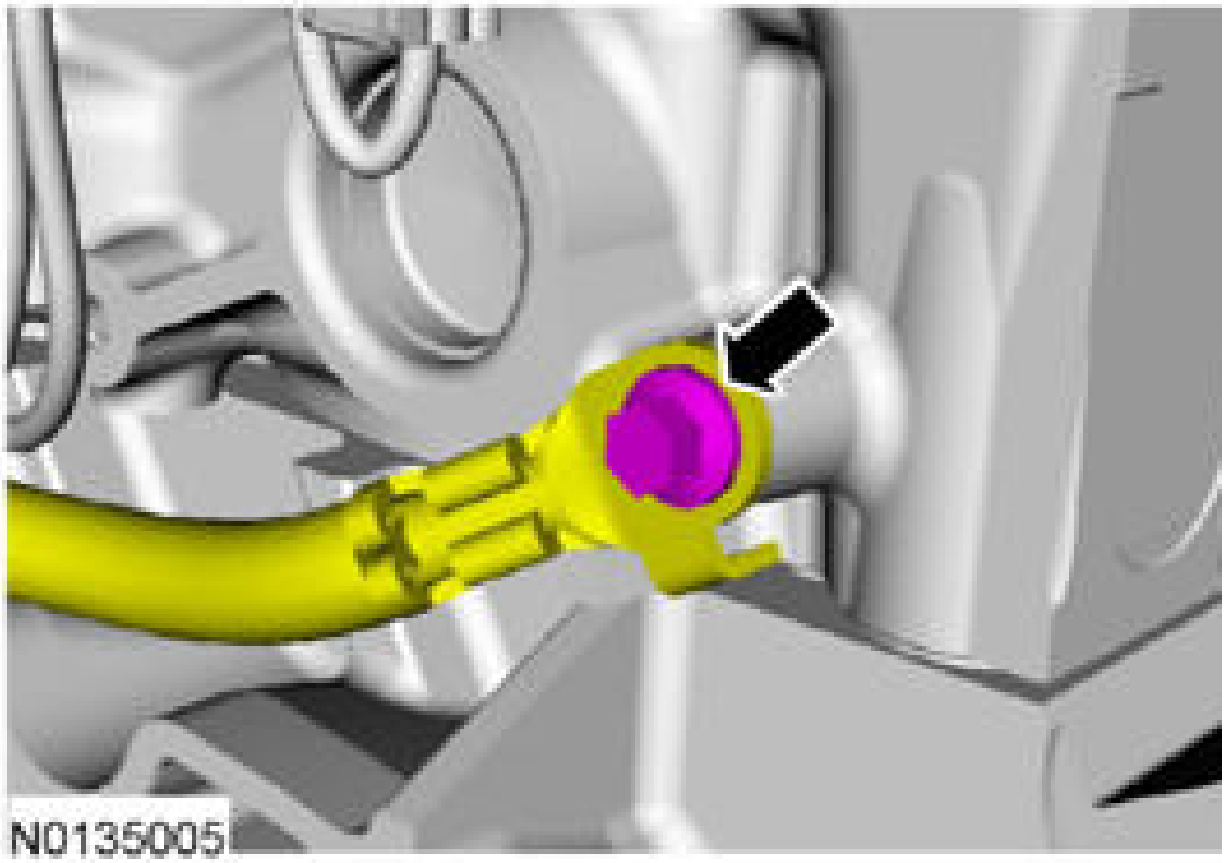
22. Connect the 2 A/C compressor electrical connectors.
    - Attach the A/C wiring harness retainer.

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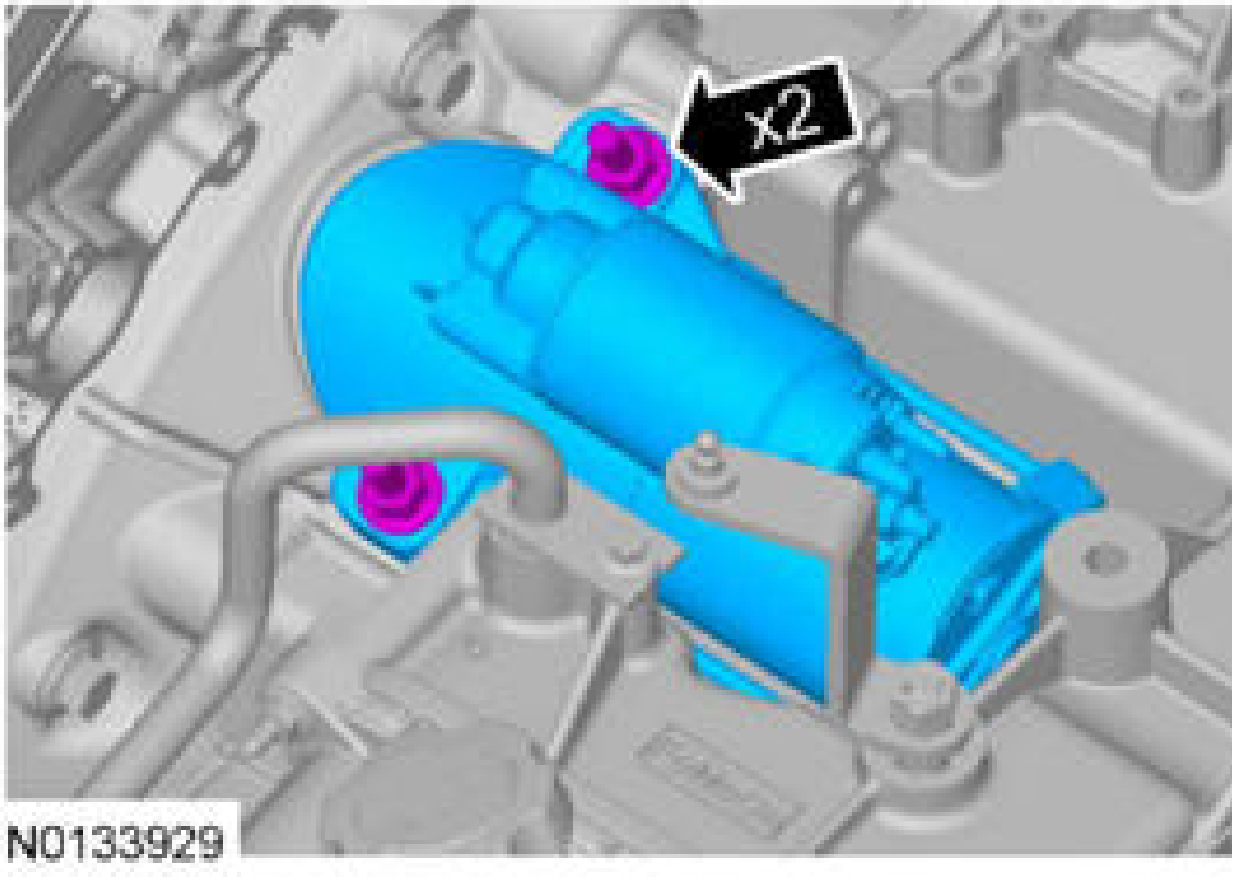
23. Install the ground wire to the RH cylinder head and install the bolt.
    - Tighten to 10 nm (89 lb-In).

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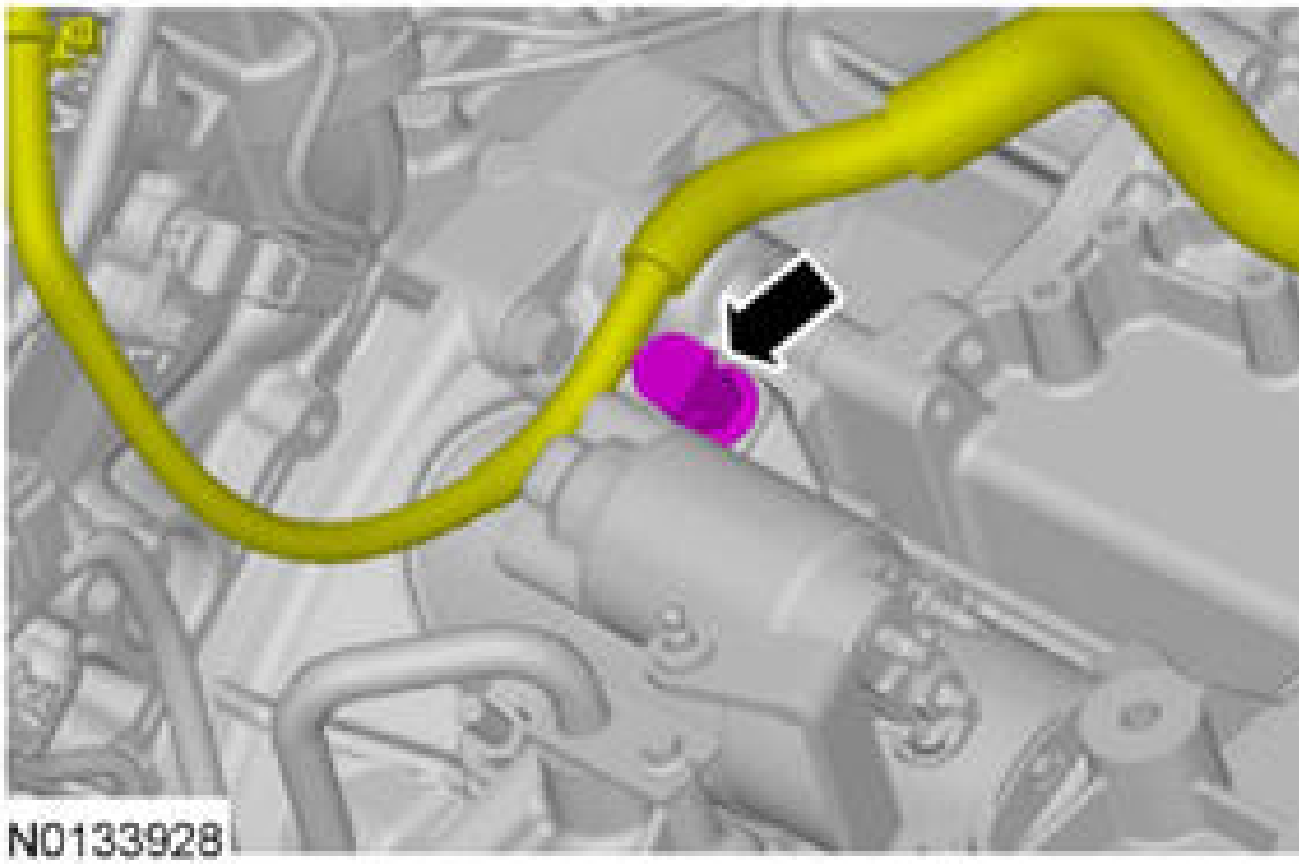
24. Install the starter and the stud bolts.
    - Tighten to 27 Nm (20 lb-ft).

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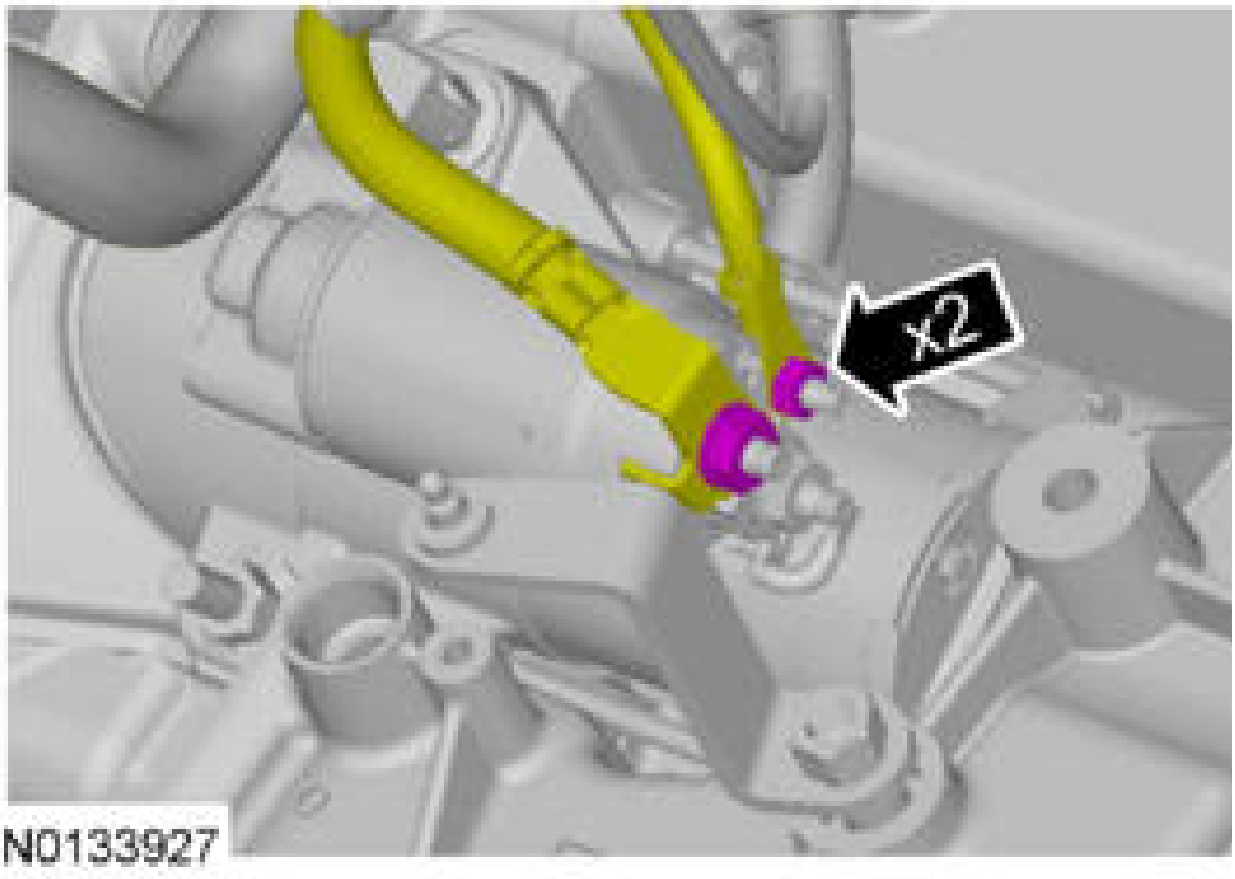
25. Connect the wiring harness retainer to the starter motor stud bolt.

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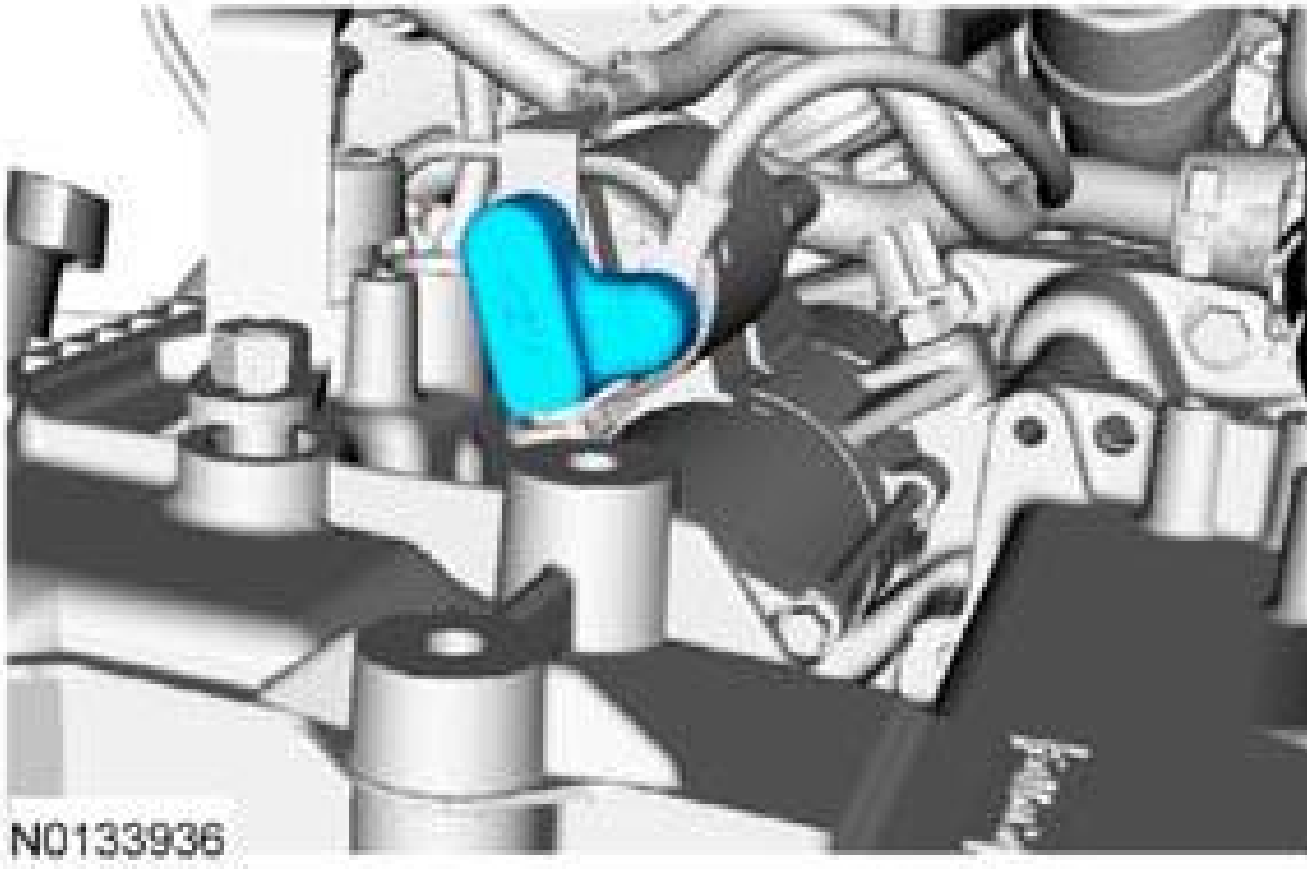
26. Attach the starter wire terminals and install the 2 nuts.
    - Tighten the B+ terminal nut to 12 Nm (106 lb-in).
    - Tighten the S-terminal nut to 5 Nm (44 lb-in).

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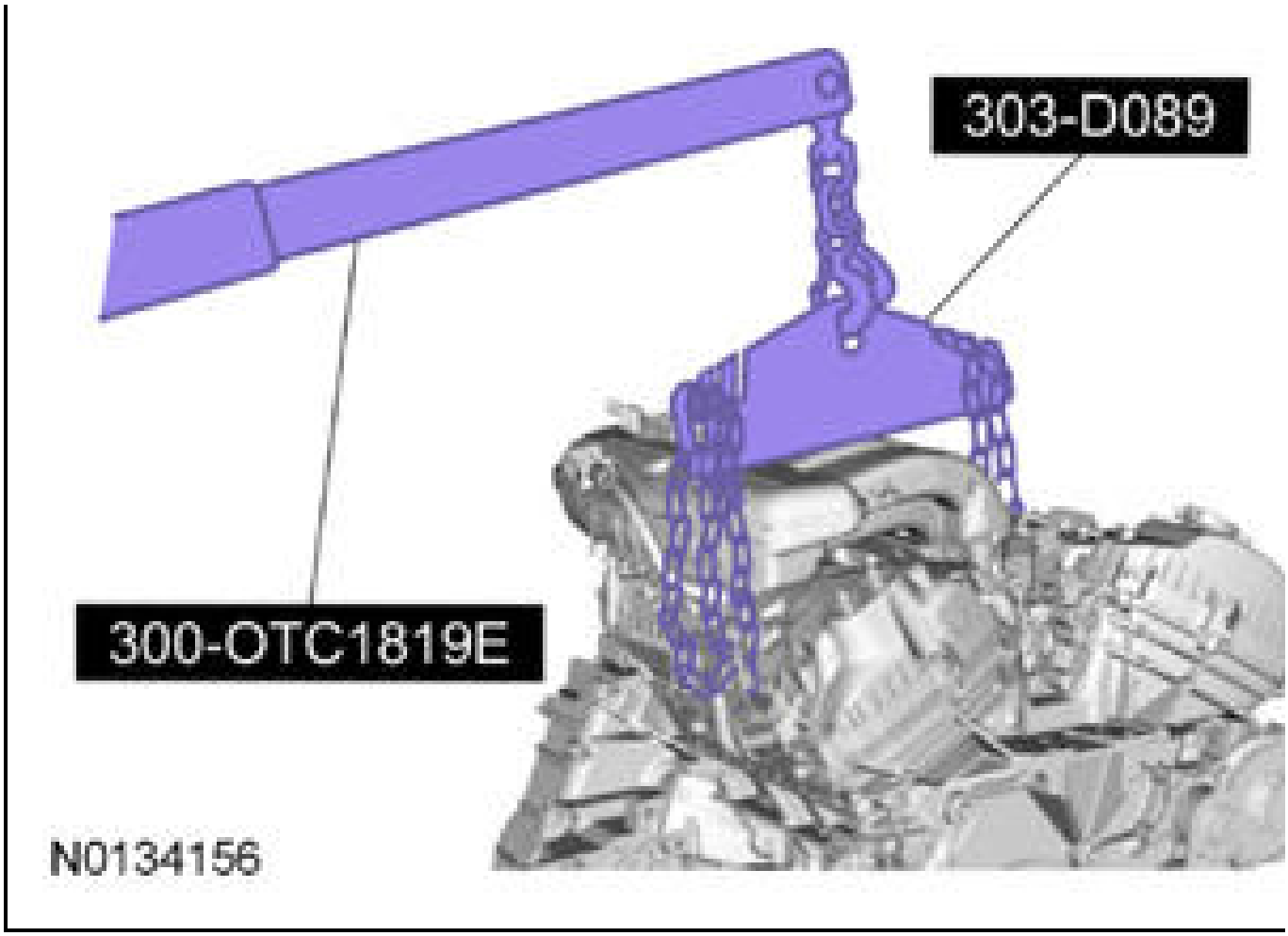
27. Install the starter motor solenoid cover.

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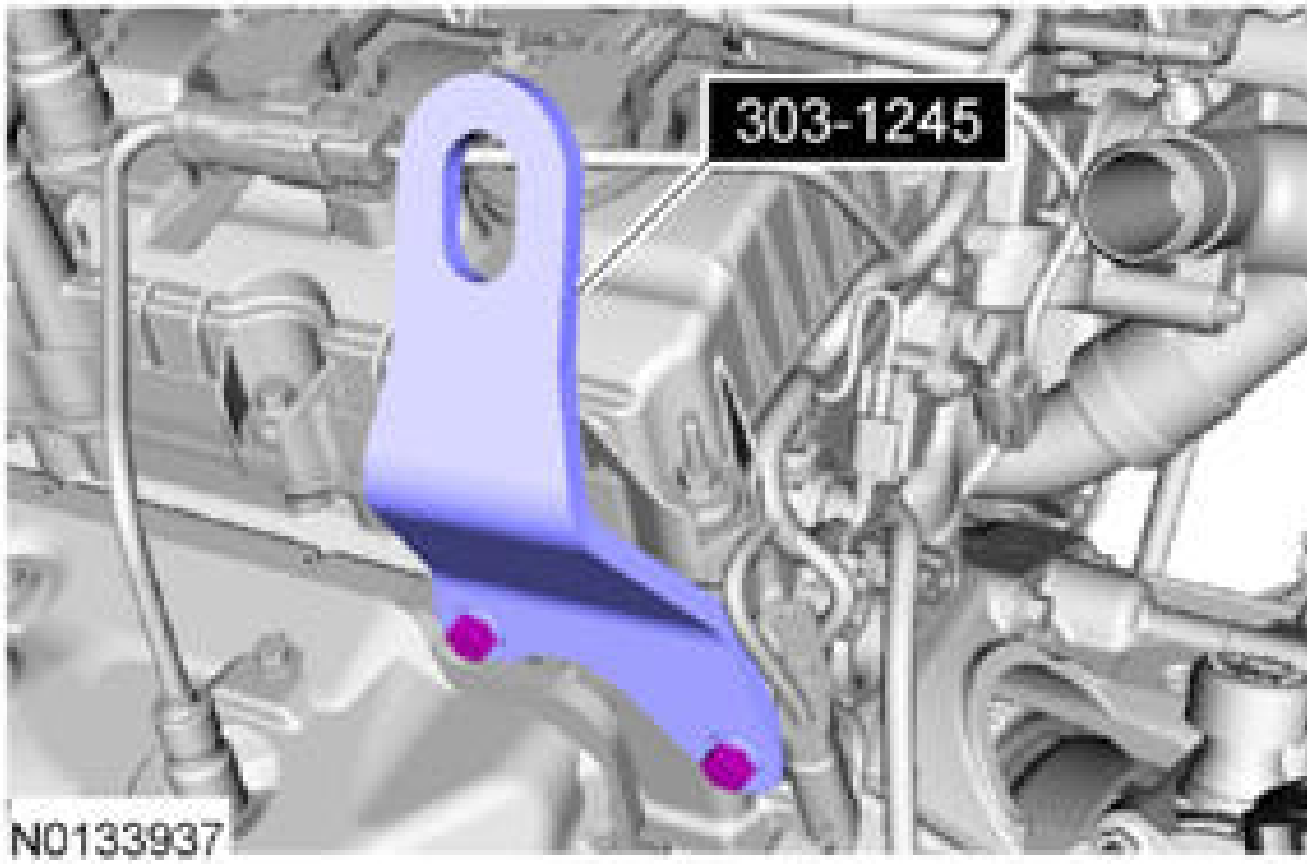
28. Remove the Heavy Duty Floor Crane and Spreader Bar.

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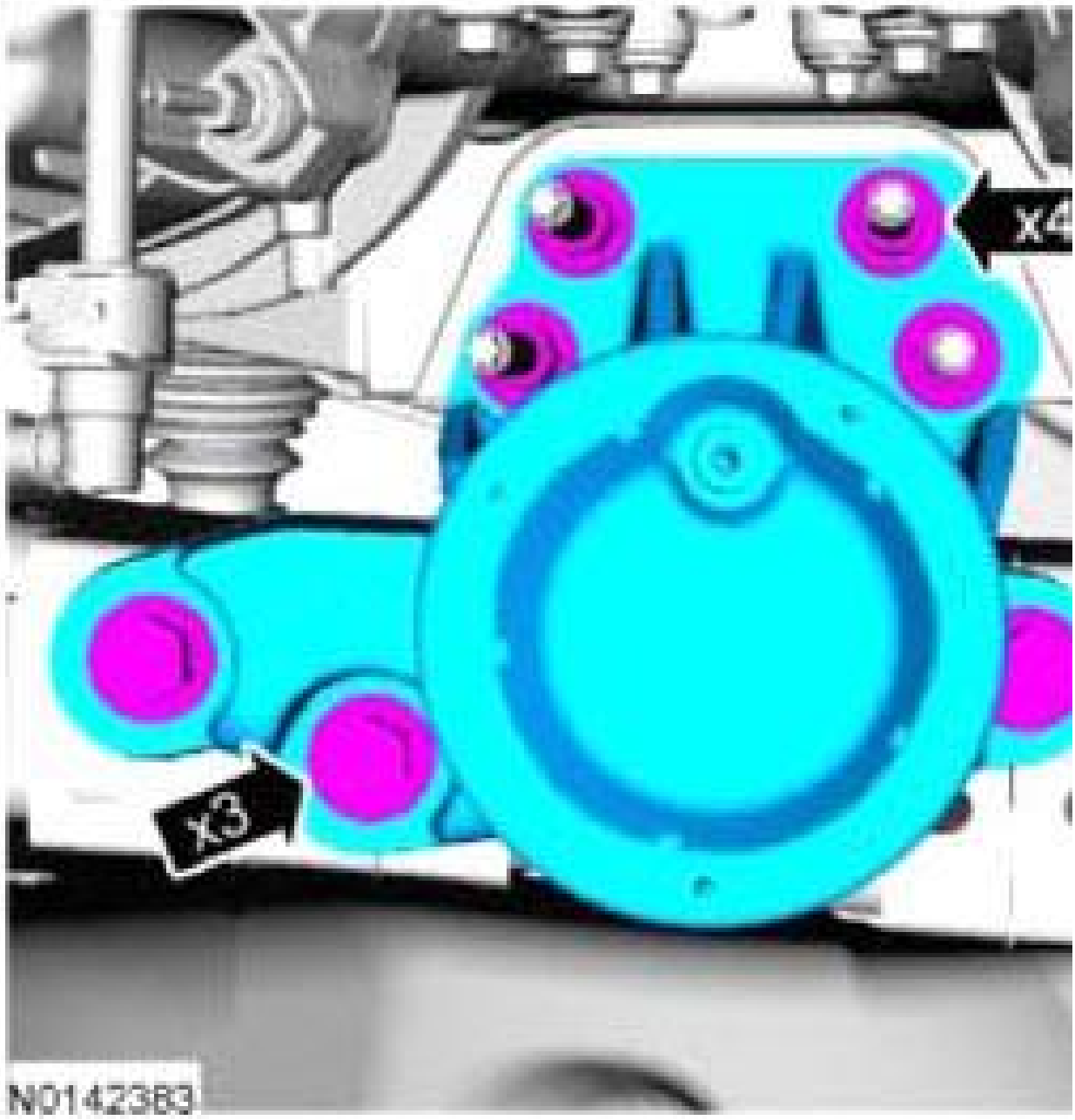
29. Remove 303-1245 from the LH cylinder head.

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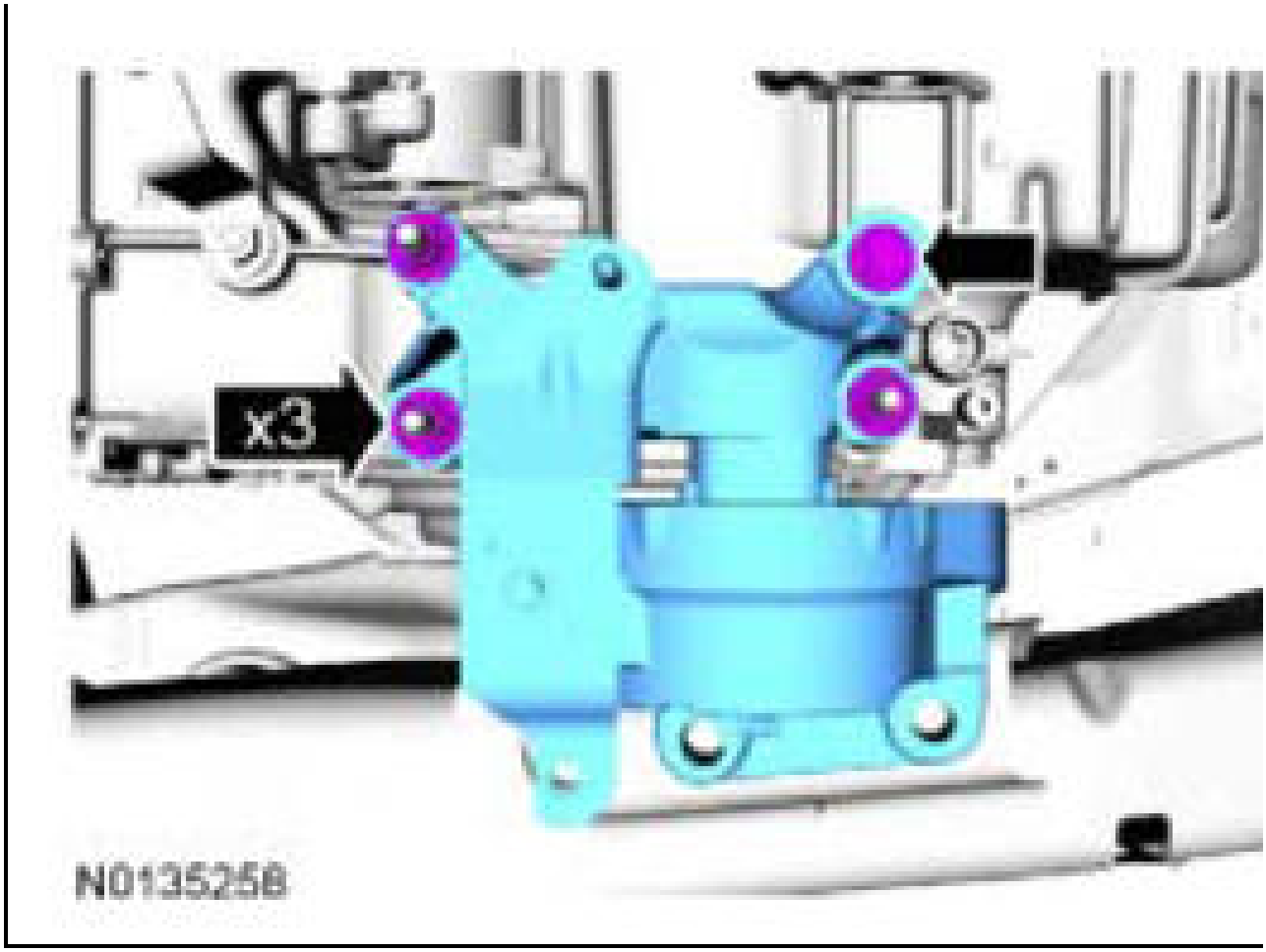
30. Raise the subframe and powertrain assembly into the vehicle.
31. Install the engine mount, the 3 bolts and the 4 engine mount nuts hand tight.
    - Tighten the 3 engine mount bolts to 90 Nm (66 lb-ft).
    - Tighten the 4 engine mount nuts to 63 Nm (46 lb-ft).

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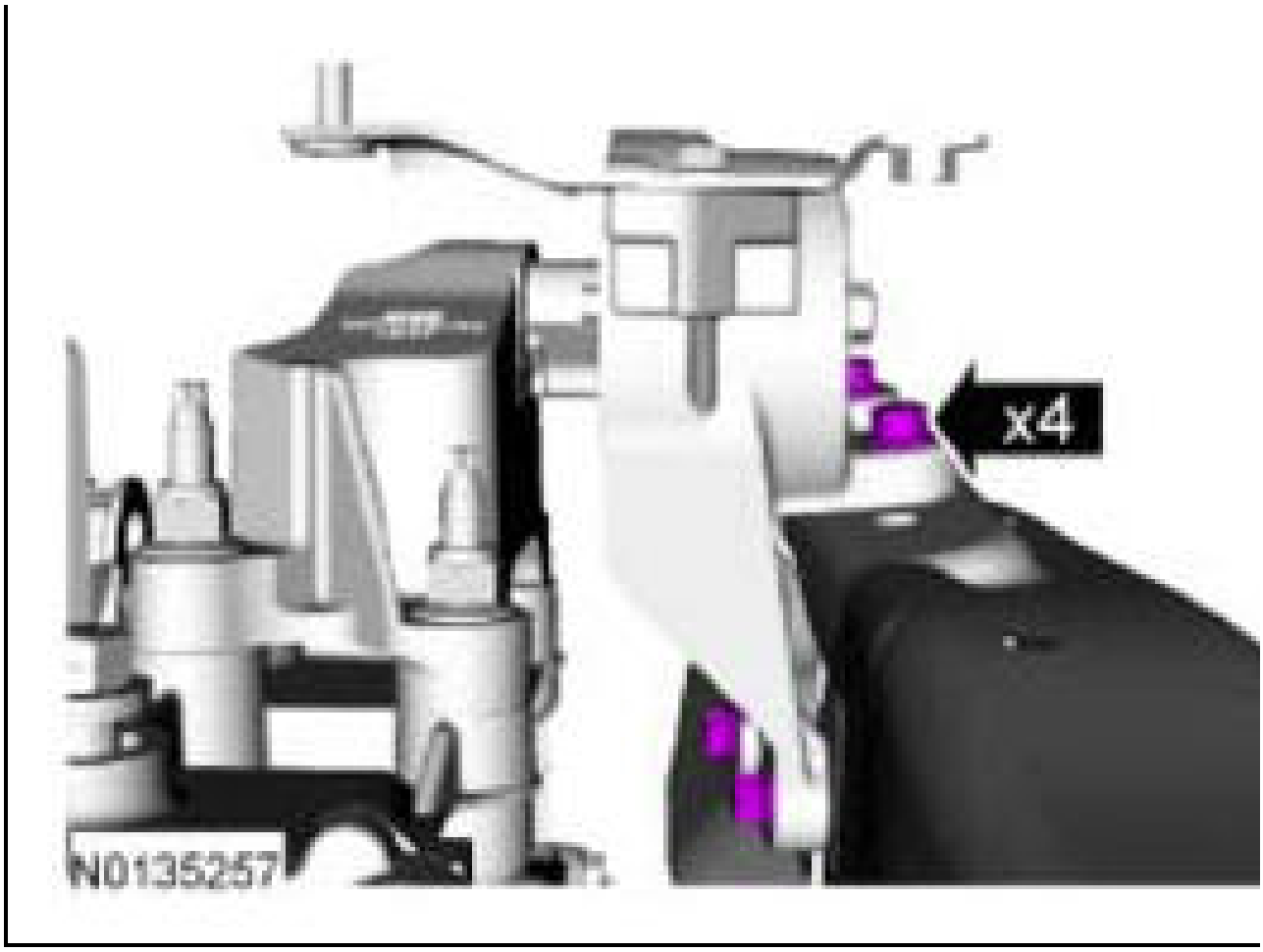
32. Install the transaxle support insulator assembly the 3 nuts and the bolt.
    - Tighten the nuts to 63 Nm (46 lb-ft).
    - Tighten the bolt to 80 Nm (59 lb-ft).

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33. Install the 4 transmission support insulator-to-frame rail bolts.
    - Tighten the 2 bottom bolts to 55 Nm (41 lb-ft).
    - Tighten the 2 top bolts to 70 Nm (52 lb-ft).

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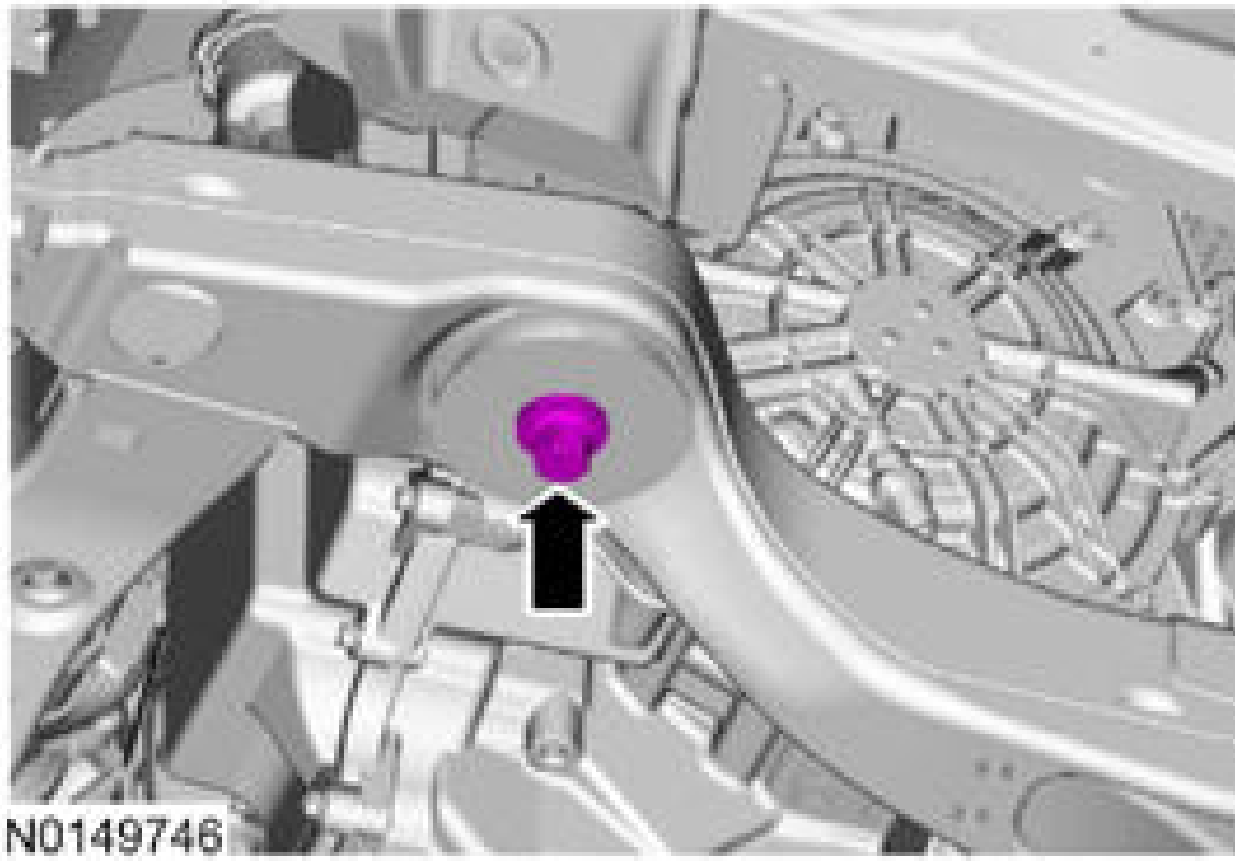


34. **NOTE: RH shown in illustration, LH similar.**

Align the subframe and install the new front subframe bolts.

- Tighten to 200 Nm (148 lb-ft).

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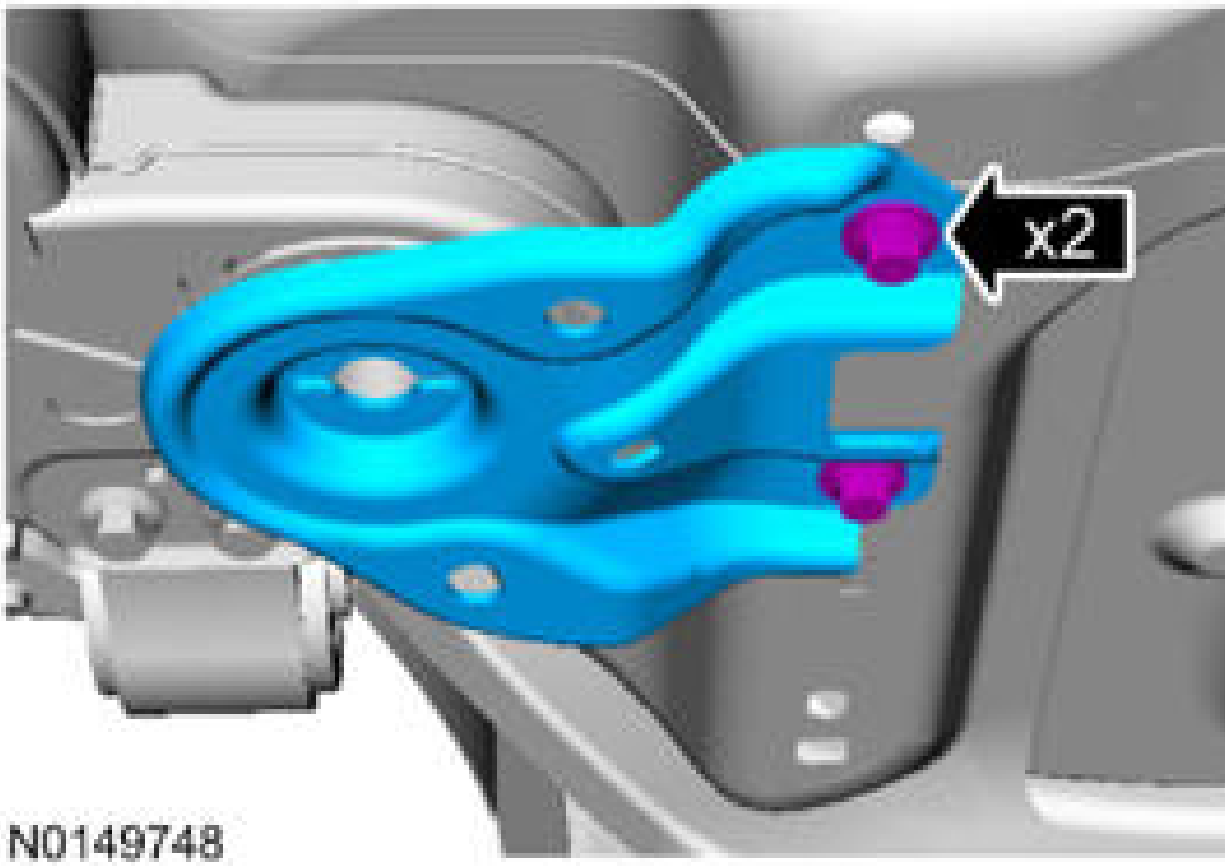


35. **NOTE: RH shown in illustration, LH similar.**

Install the rear subframe brackets and the new subframe bracket-to-body bolts.

- Finger tight at this stage.

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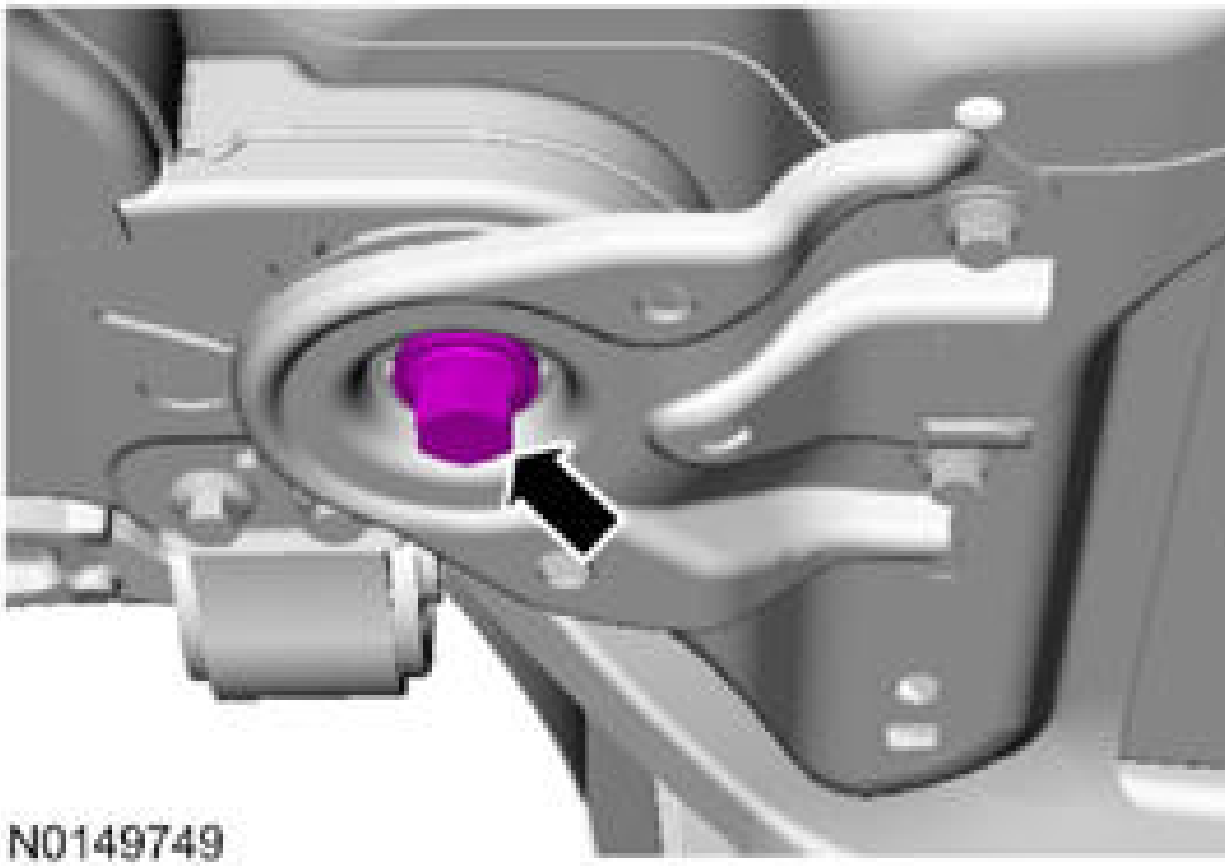


36. **NOTE: RH shown in illustration, LH similar.**

Install the new subframe bracket bolts.

- Tighten to 150 Nm (111 lb-ft).

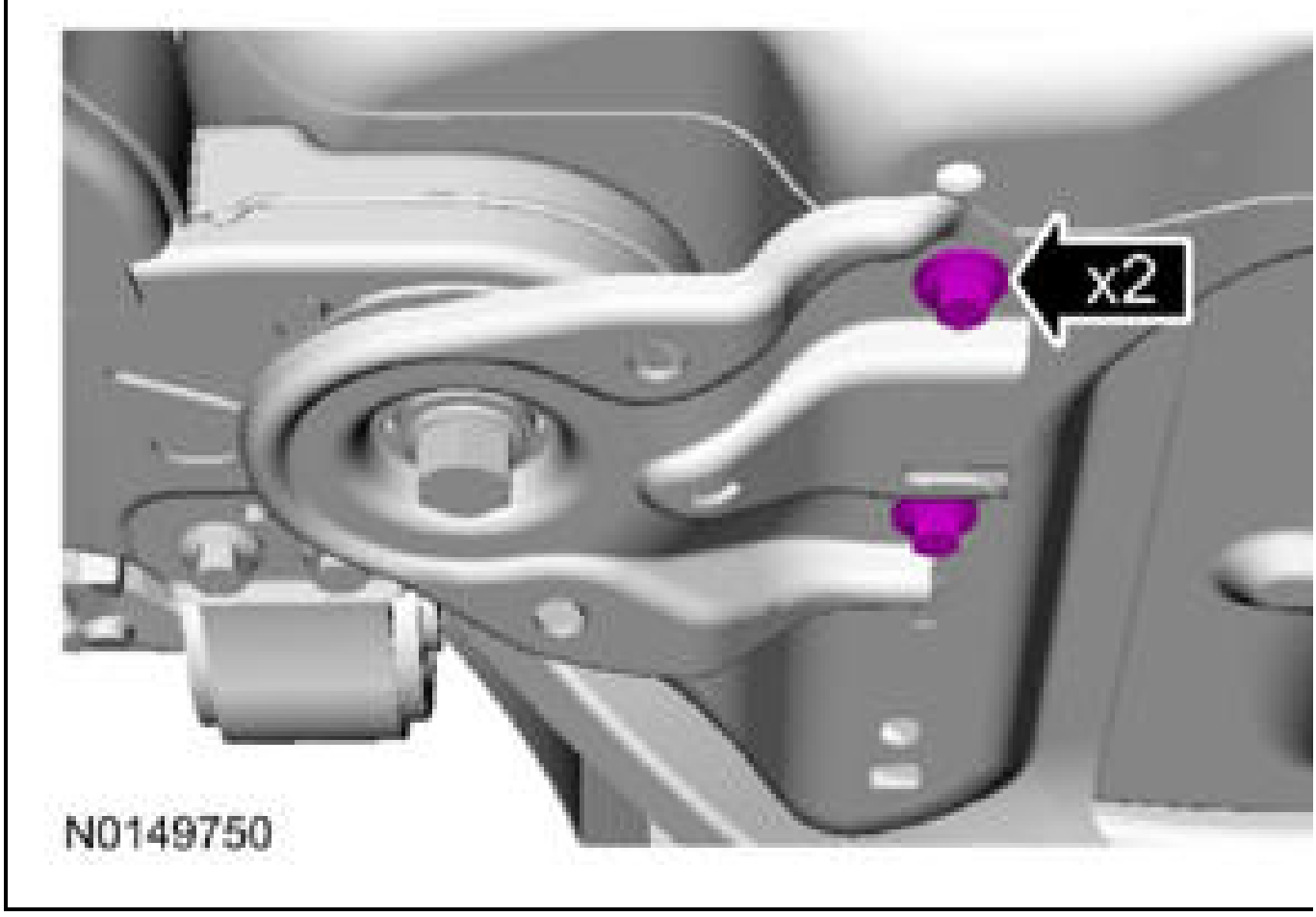
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37. **NOTE: RH shown in illustration, LH similar.**

Tighten the subframe bracket-to-body bolts to 55 Nm (41 lb-ft).

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38. Remove the ratchet strap from the front of the subframe to the rear of the subframe.
39. Remove the Adjustable Grip Arm and the powertrain lift table.

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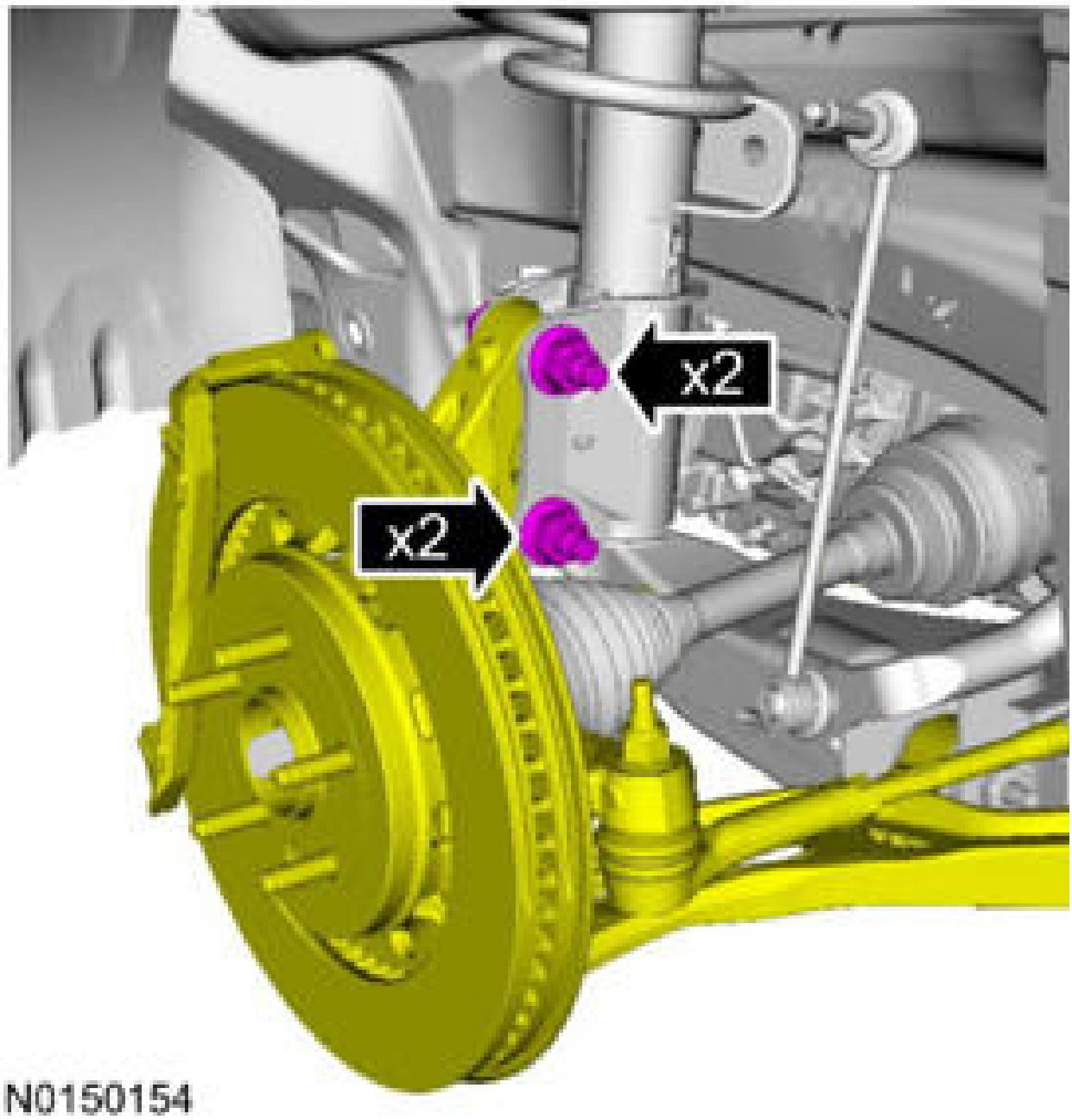


40. **NOTE: LH shown in illustration, RH similar.**

Install the strut to the wheel knuckle and install the strut-to-wheel knuckle nuts and bolts.

- Tighten to 250 Nm (184 lb-ft).

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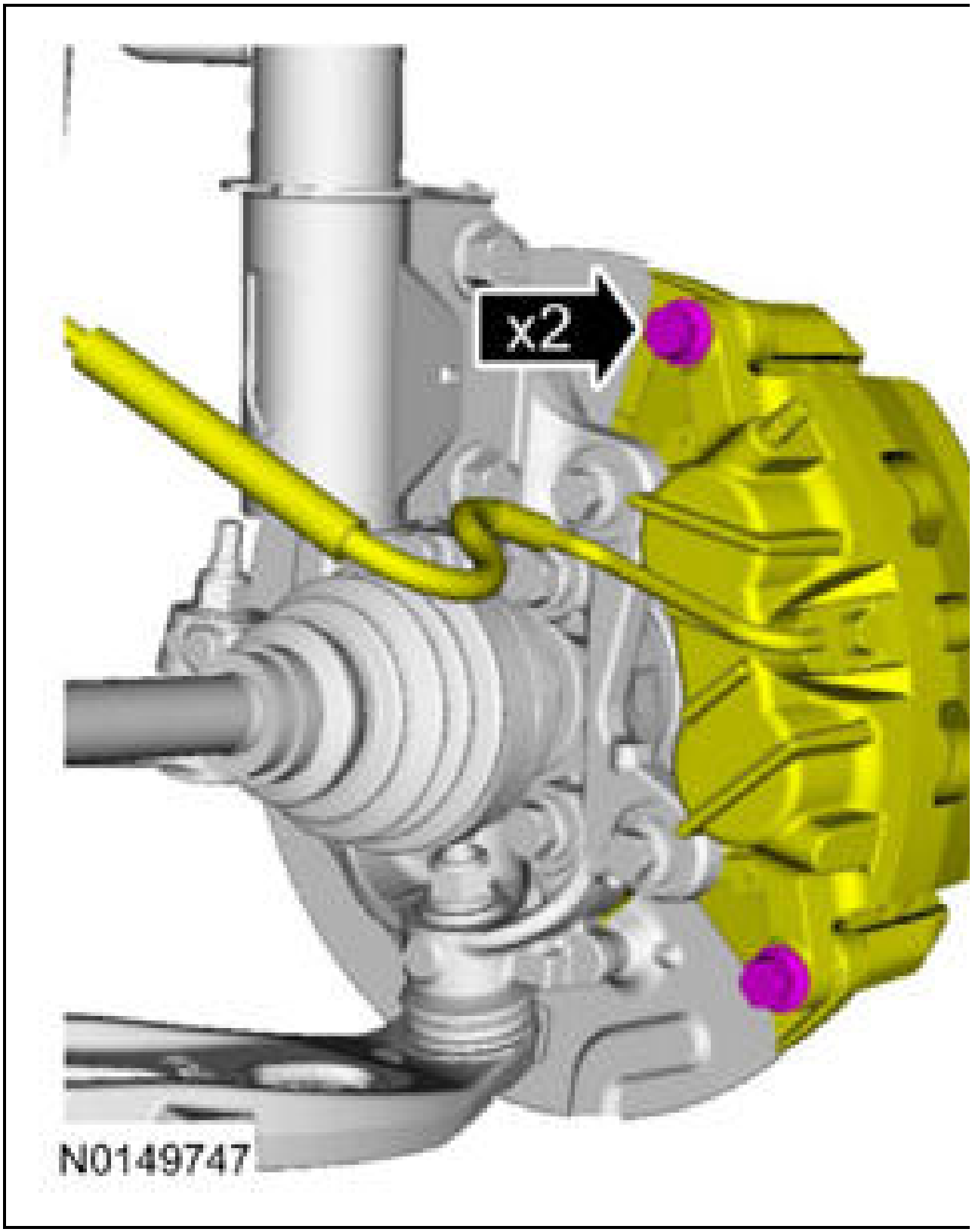


41. **NOTE: LH shown in illustration, RH similar.**

Install the brake caliper and the guide pin bolts.

- 432 mm (17 in) brakes: Tighten to 72 Nm (53 lb-ft).
- 457 mm (18 in) brakes: Tighten to 75 Nm (55 lb-ft).

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42. **NOTE: Do not tighten the wheel hub nut with the vehicle on the ground. The nut**

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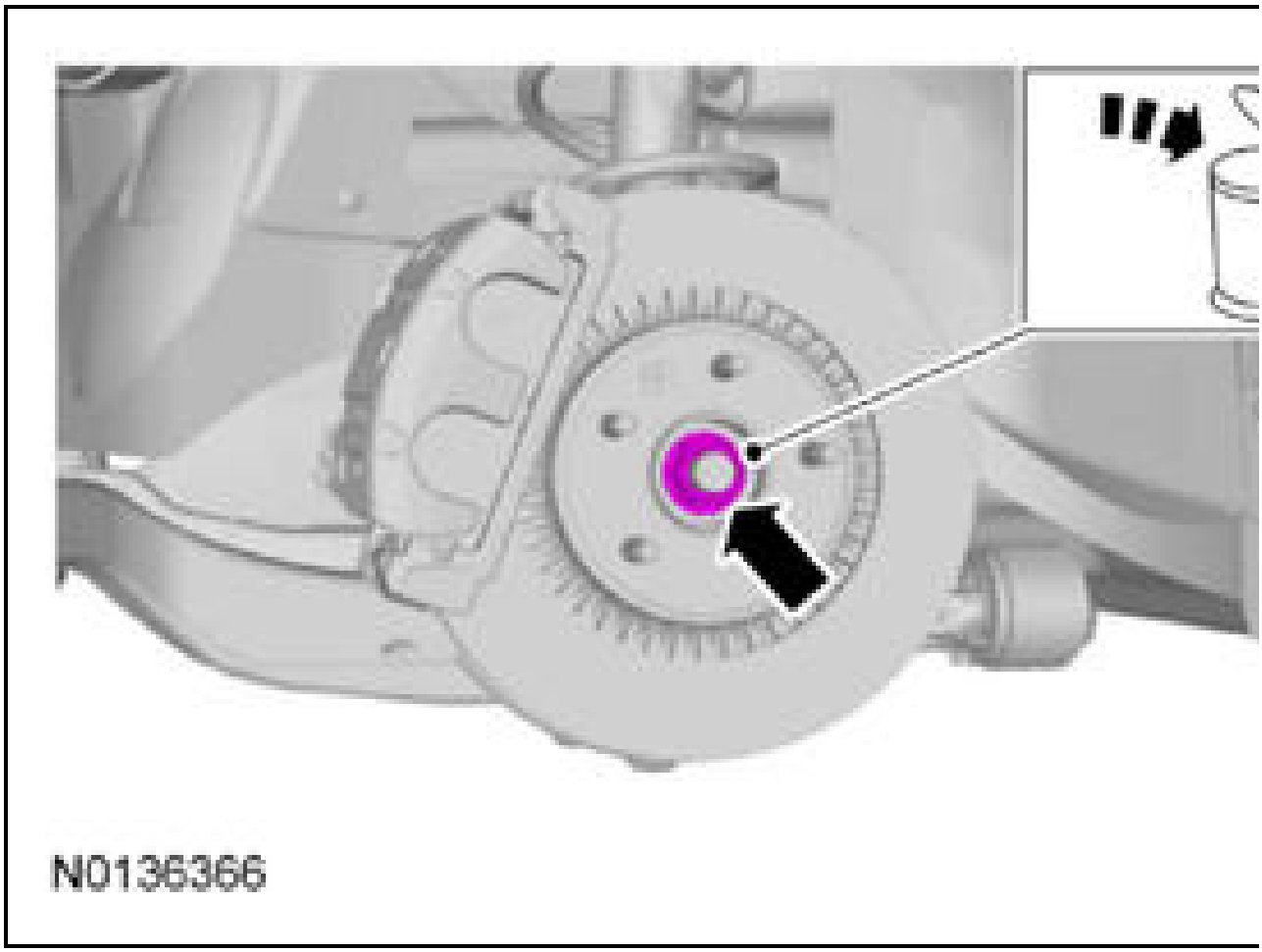
42. **must be tightened to specification before the vehicle is lowered onto the wheels. Wheel bearing damage will occur if the wheel bearing is loaded with the weight of the vehicle applied.**

NOTE: LH shown in illustration, RH similar.

NOTE: Apply the brake to keep the halfshaft from rotating.

Using the previously removed wheel hub nut, seat the LH and RH halfshafts.

- Tighten to 350 Nm (258 lb-ft).
- Remove and discard the wheel hub nuts.



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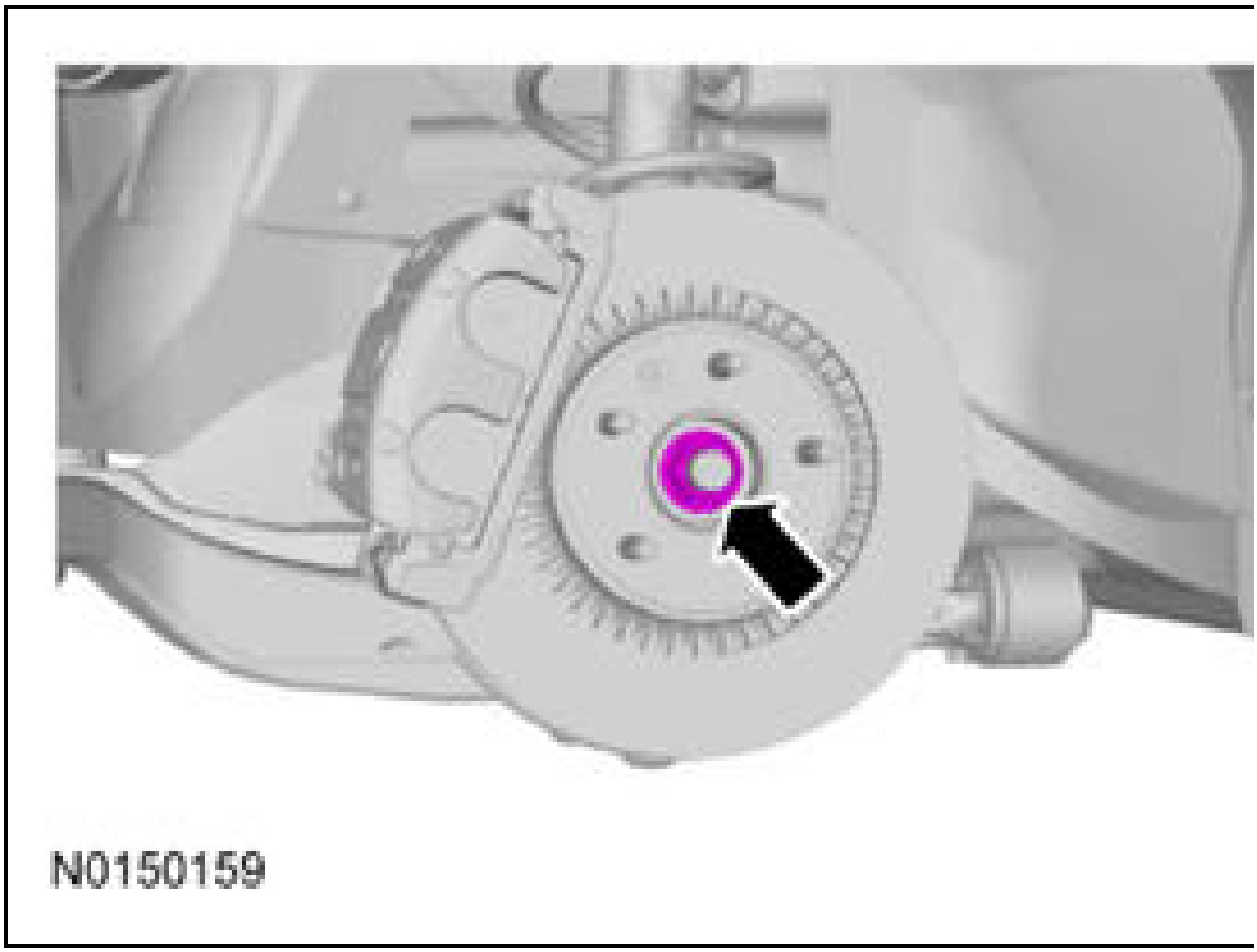
43. **NOTE: The wheel hub nut contains a one time locking chemical that is activated by the heat created when it is tightened. Install and tighten the new wheel hub nut to specification within 5 minutes of starting it on the threads. Always install a new wheel hub nut after loosening or when not tightened within the specified time or damage to the components can occur.**

NOTE: LH shown in illustration, RH similar.

NOTE: Apply the brake to keep the halfshaft from rotating.

Install a new wheel hub nuts.

- Tighten to 350 Nm (258 lb-ft).

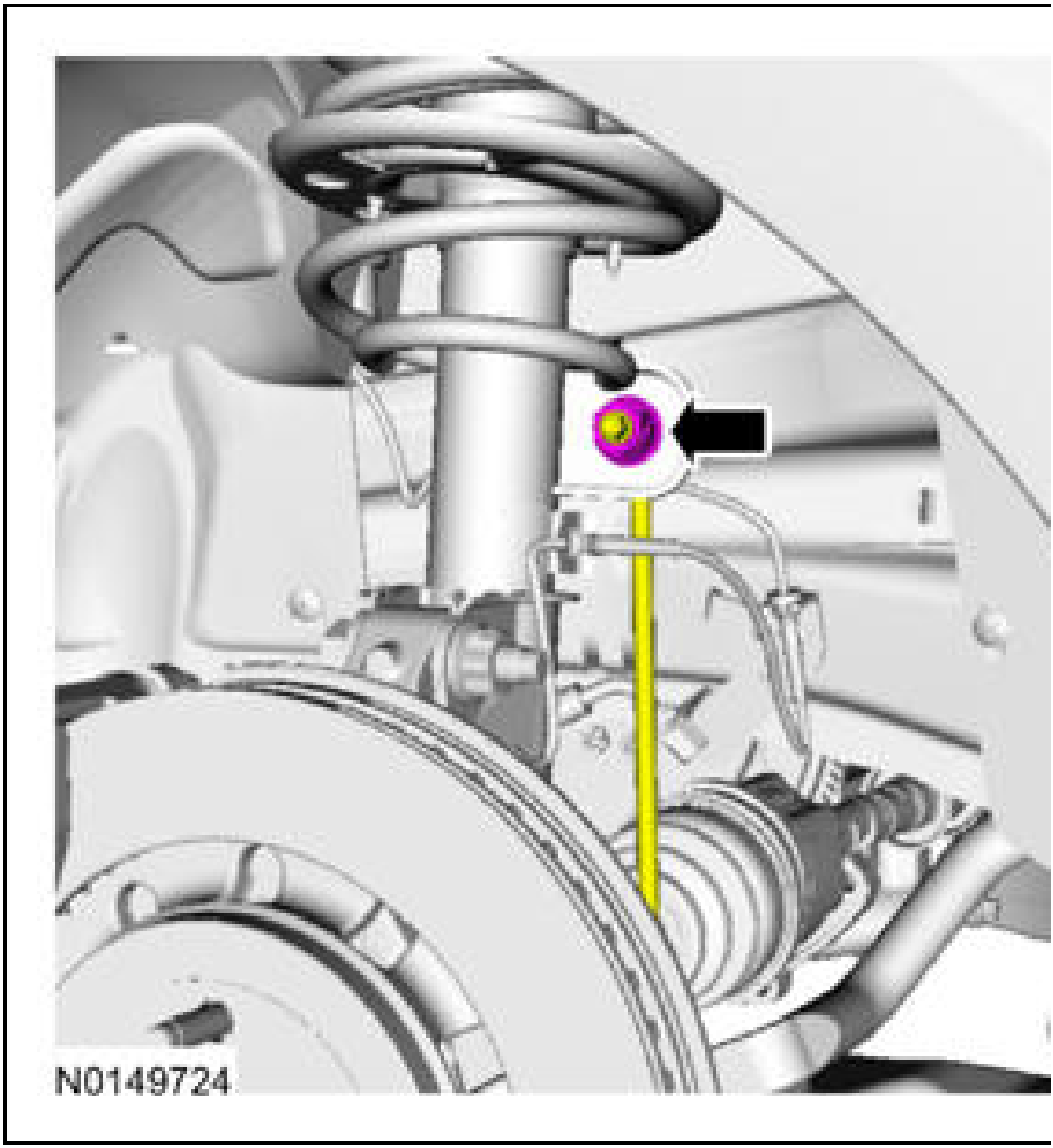


44. **NOTE: LH shown in illustration, RH similar.**

Install the new upper stabilizer link nut.

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- Tighten to 150 Nm (111 lb-ft).

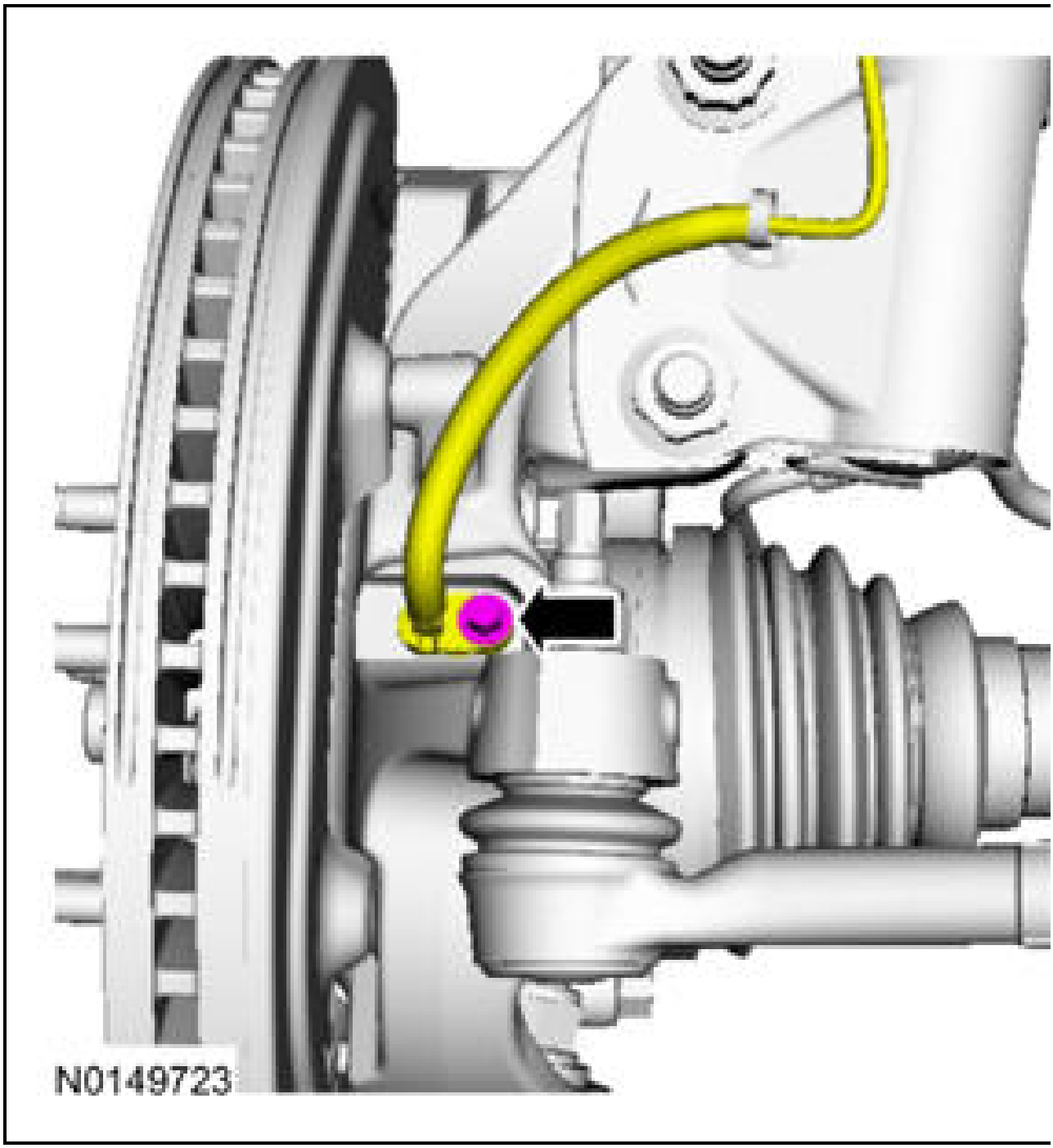


45. **NOTE: LH shown in illustration, RH similar.**

Install the wheel speed sensor and the bolt.

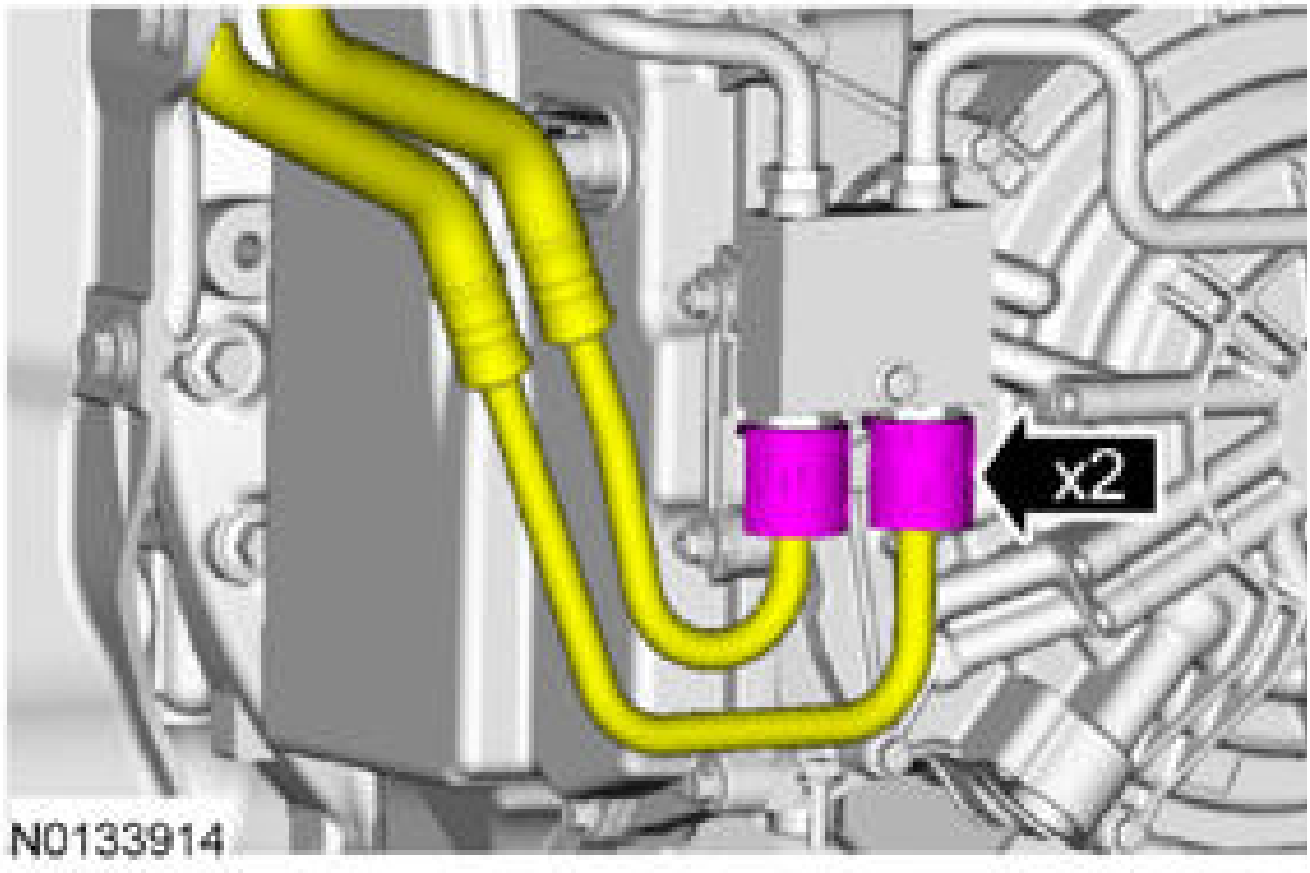
- Tighten to 15 Nm (133 lb-in).

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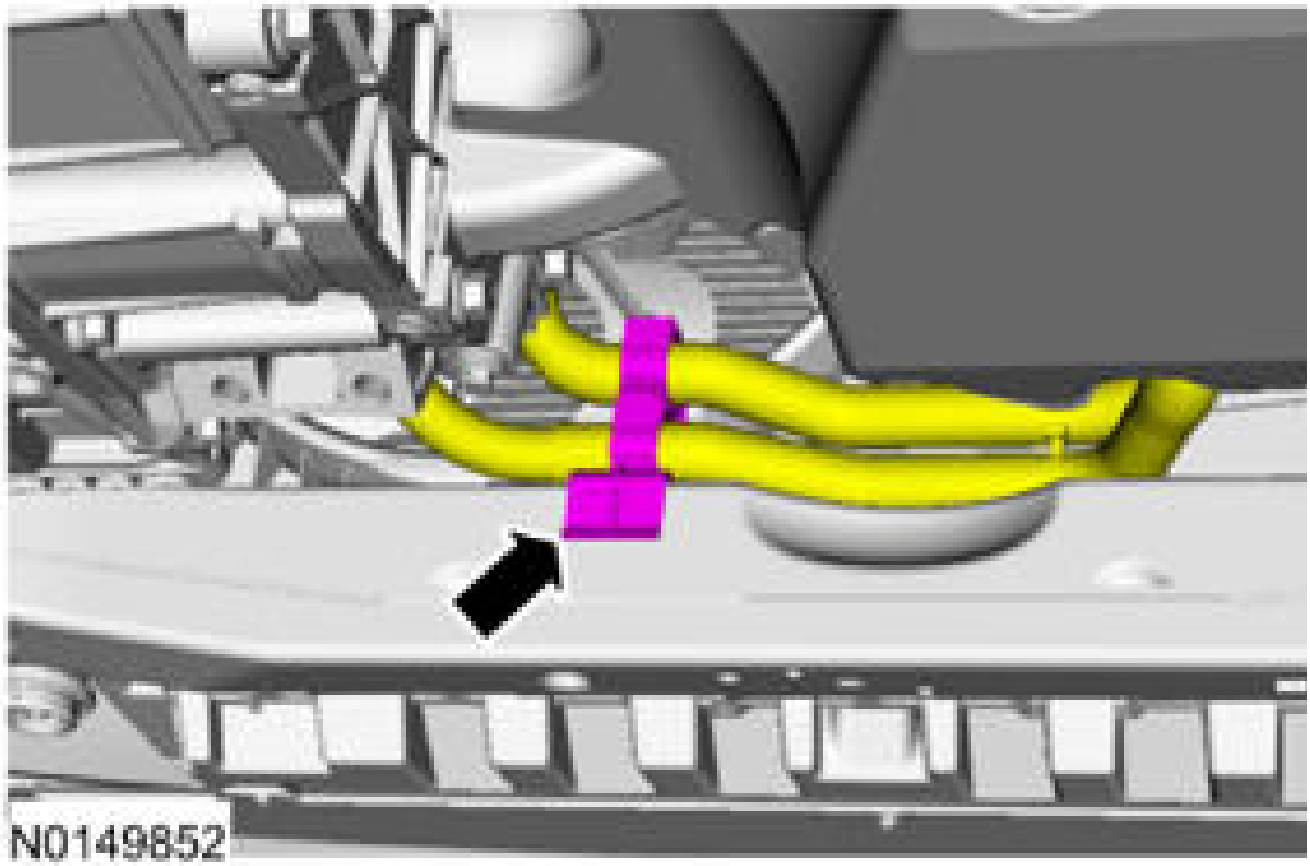
46. Connect the transaxle cooler tubes and install the 2 secondary latches.

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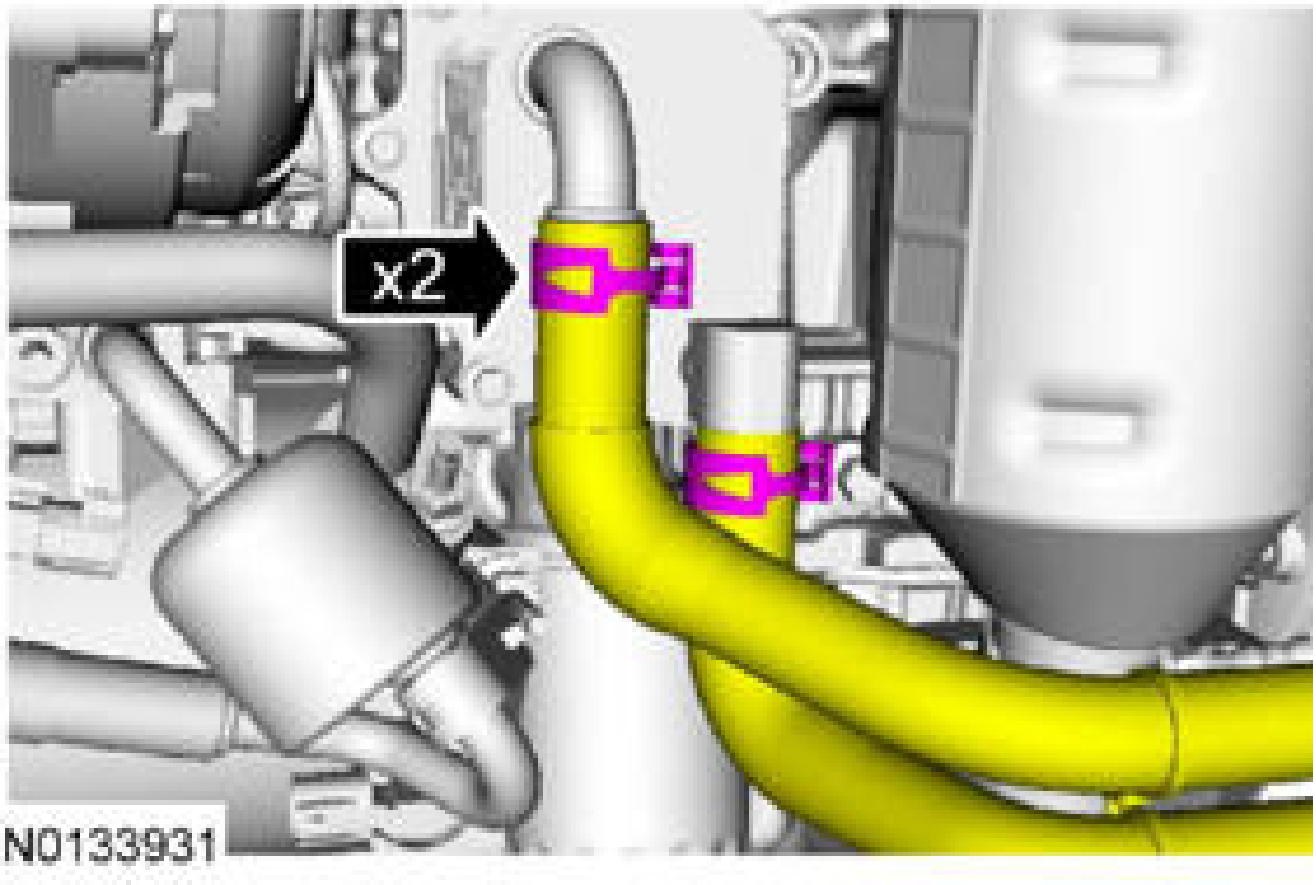
47. If equipped, install the oil cooler hose retainer to the subframe.

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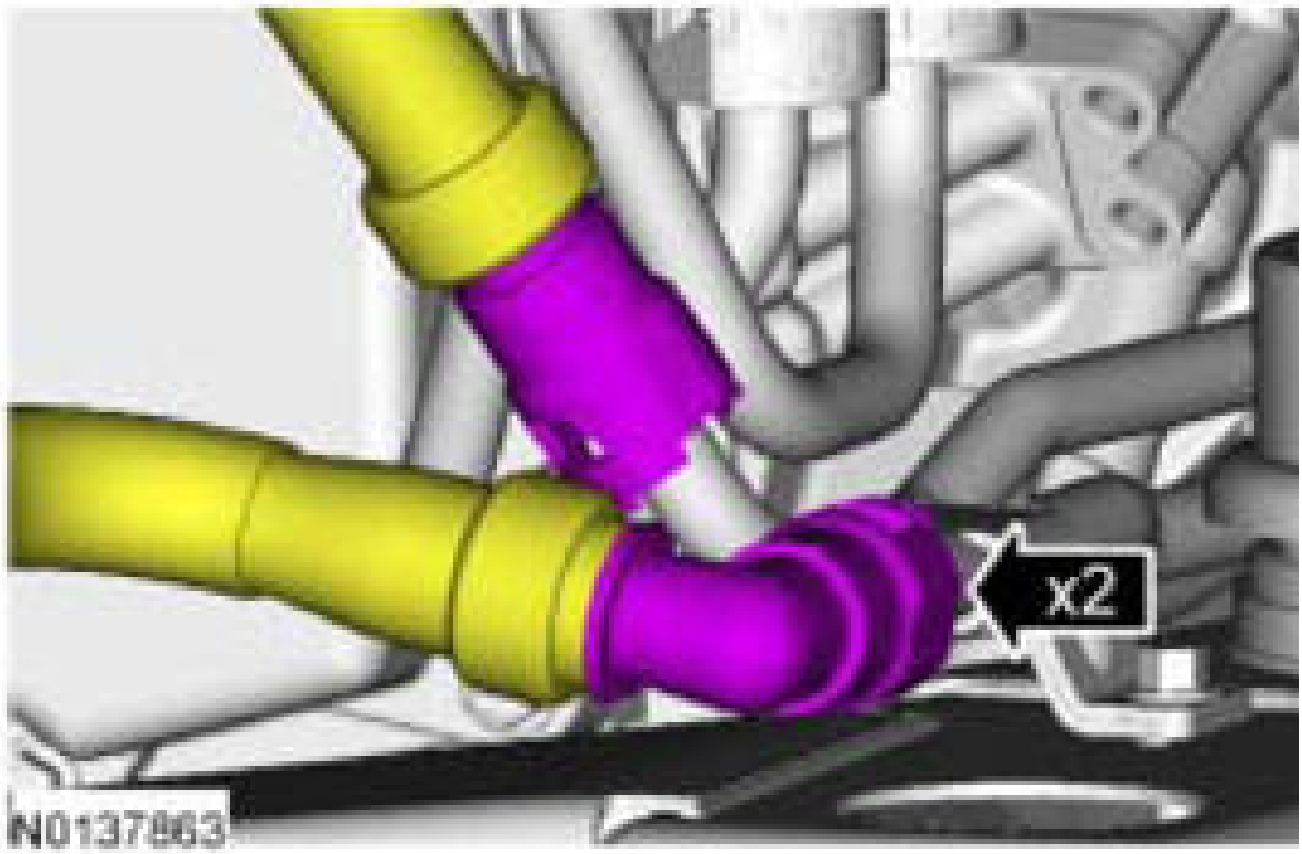
48. If equipped, connect the oil cooler coolant hoses.

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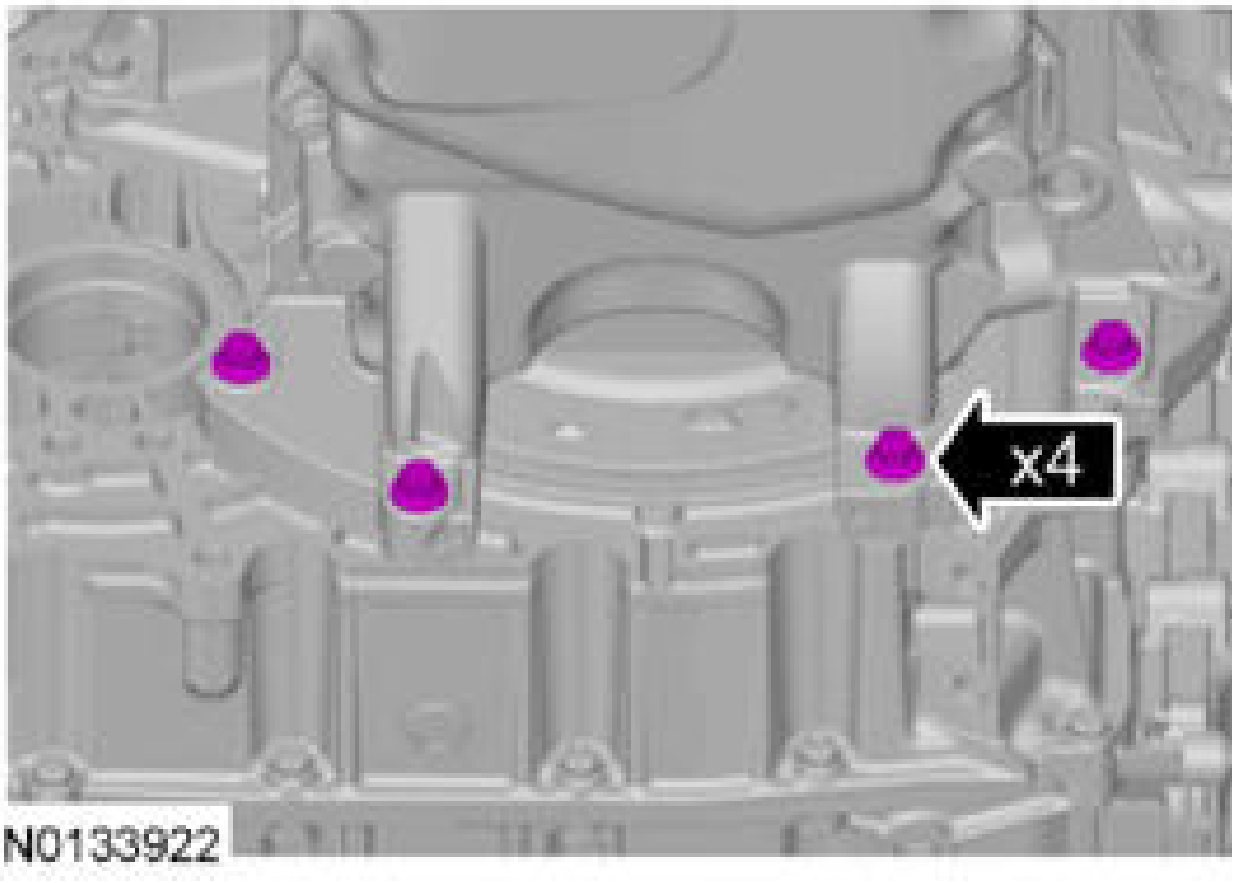
49. If equipped, connect the 2 **PTU** cooler hoses. For additional infomation, refer to **FUEL SYSTEM - GENERAL INFORMATION** .

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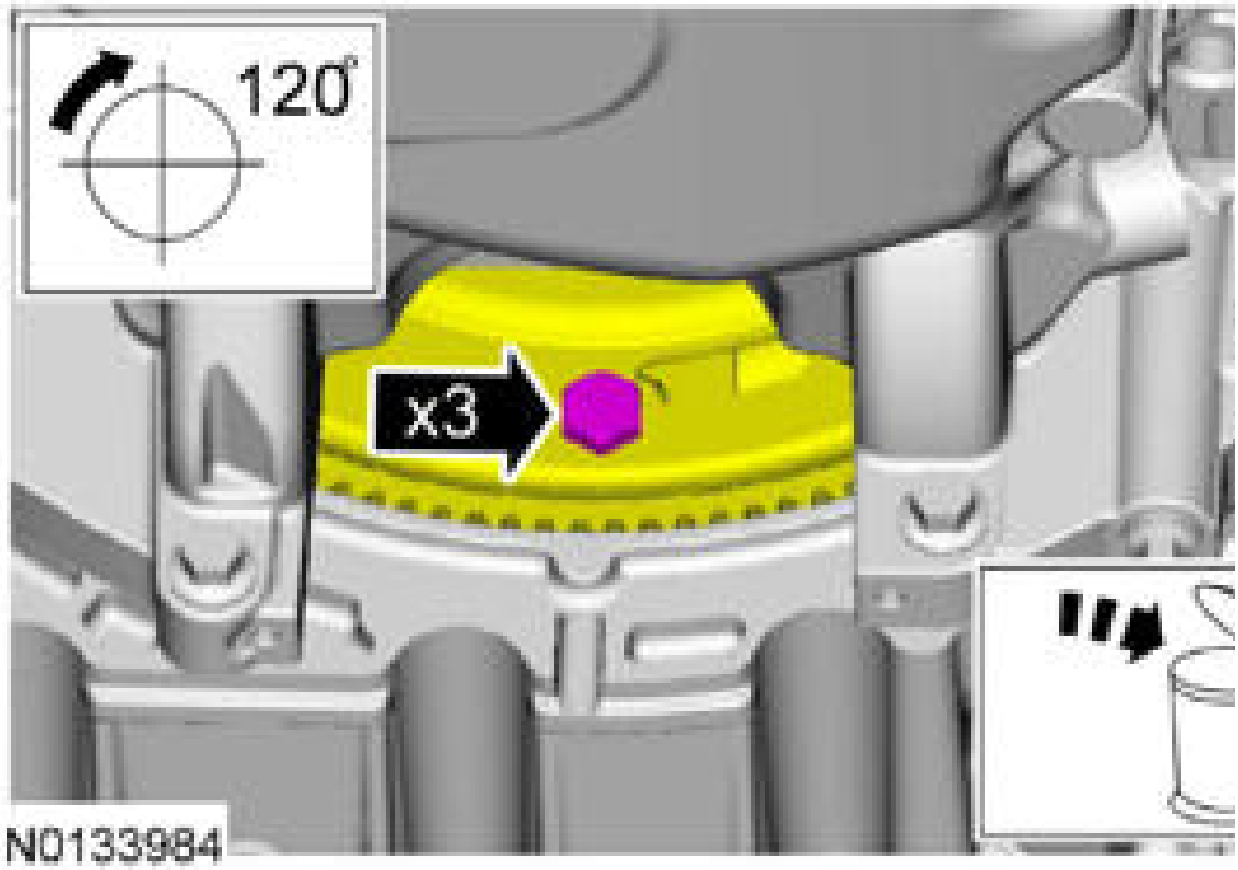
50. Install the 4 oil pan-to-transaxle bolts.
    - Tighten to 48 Nm (35 lb-ft).

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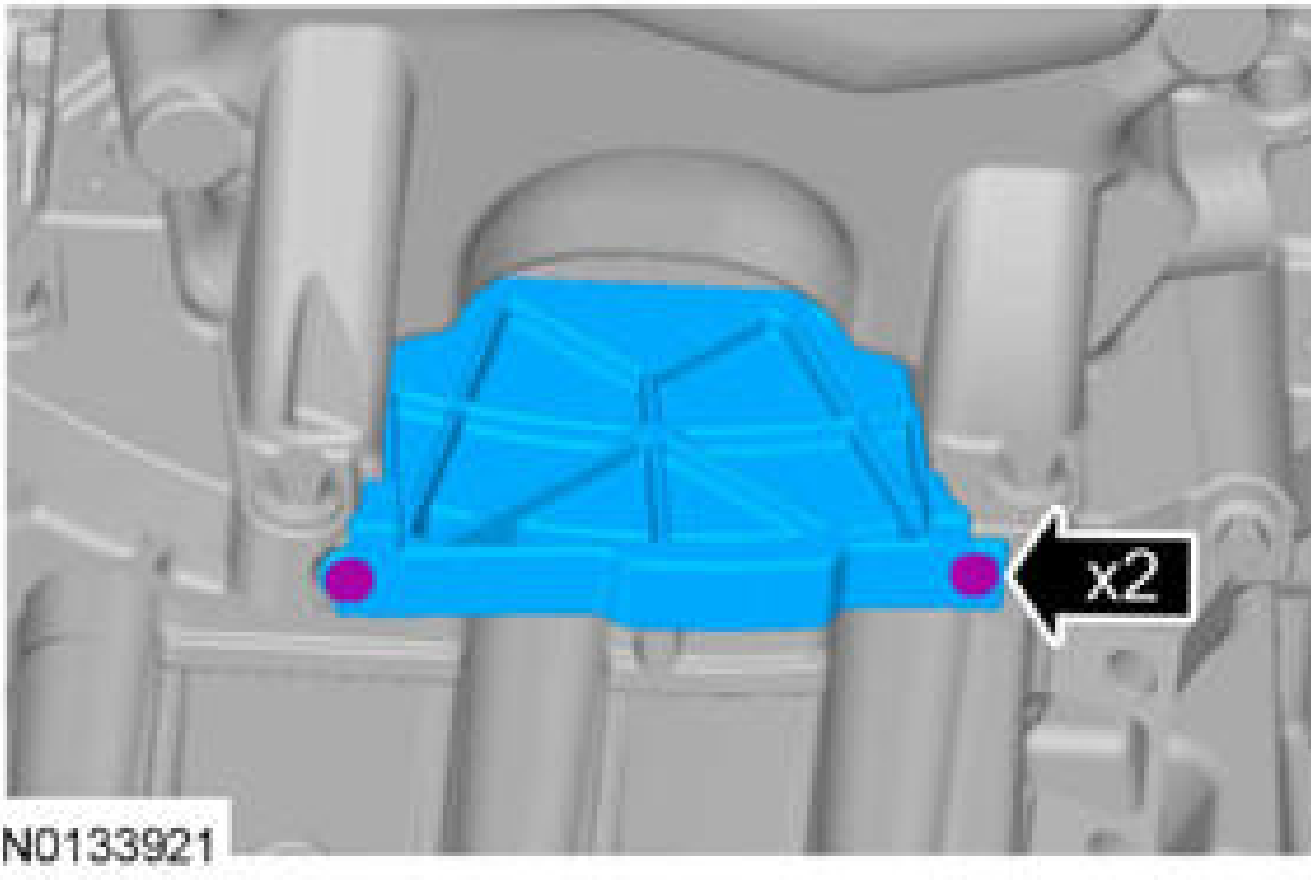
51. Install 3 new torque converter bolts by rotating the crankshaft clockwise.
    - Tighten to 55 Nm (41 lb-ft).

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52. Install the inspection cover and the 2 fasteners.

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53. **NOTE: Do not lubricate the engine oil filter gasket.**

Install a new engine oil filter.

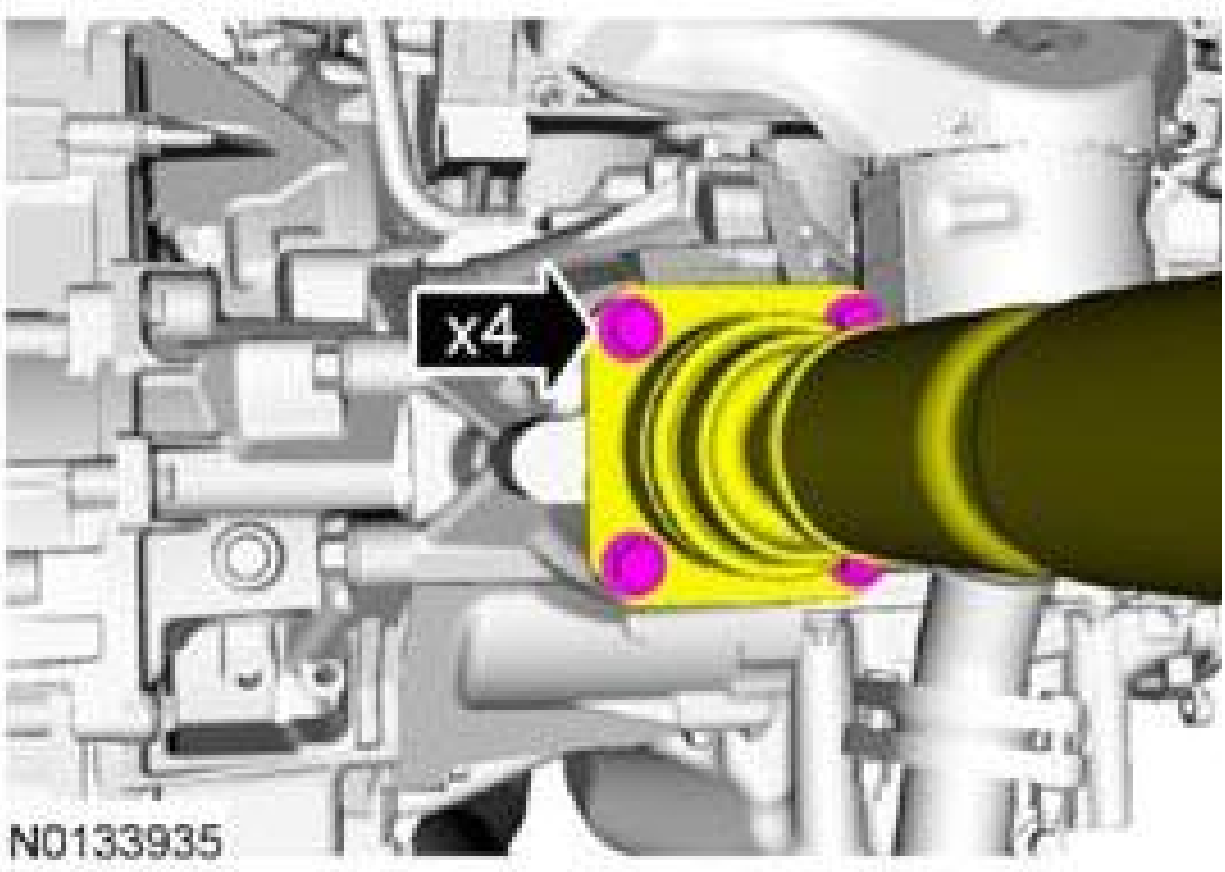
- Tighten to 5 Nm (44 lb-in) and then rotate an additional 180 degrees.

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54. Line up the index marks on the rear driveshaft to the index marks on the **PTU** flange made during removal and install the 4 new bolts.
    - Tighten to 70 Nm (52 lb-ft).

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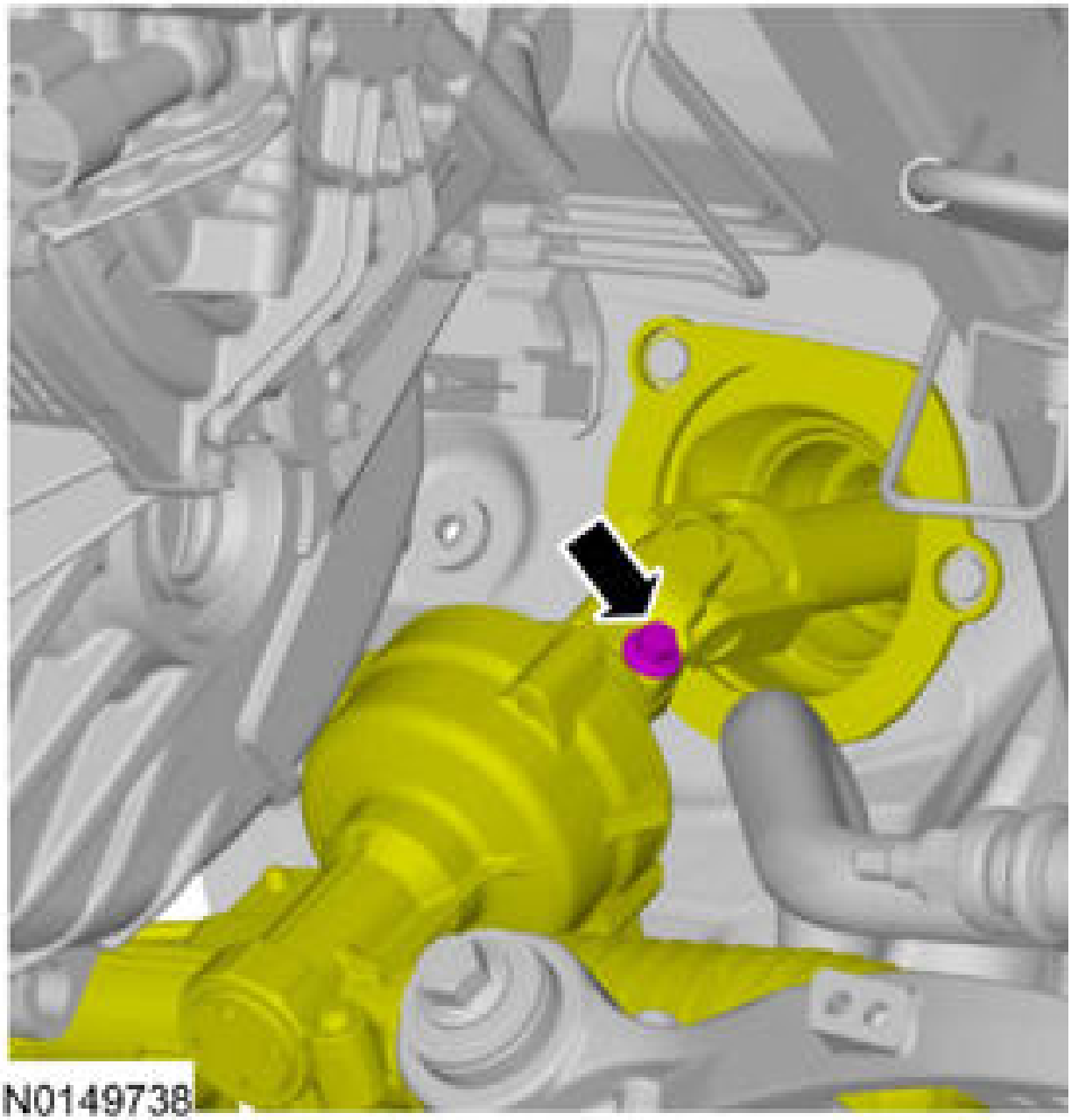
55. Install the exhaust Y-pipe. For additional information, refer to **EXHAUST Y-PIPE - 3.5L TI-VCT** .

NOTE: **Do not allow the intermediate shaft to rotate while it is disconnected from the gear or damage to the clockspring may occur. If there is evidence that the intermediate shaft has rotated, the clockspring must be removed and recentered. For additional information, refer to CLOCKSPRING , and CLOCKSPRING ADJUSTMENT .**

56. Align and connect the steering column shaft to the steering gear and install the bolt.

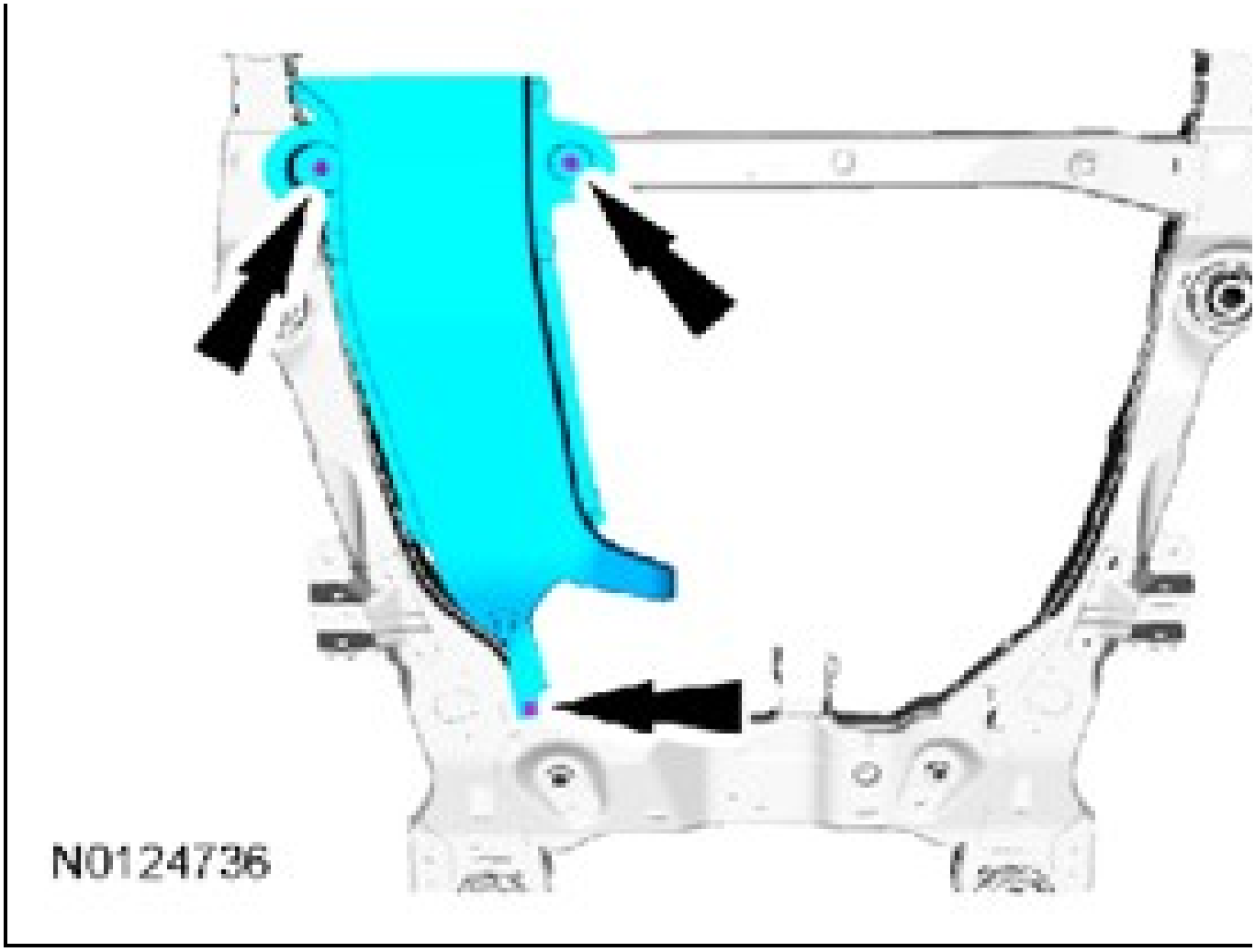
- Tighten to 20 Nm (177 lb-in).

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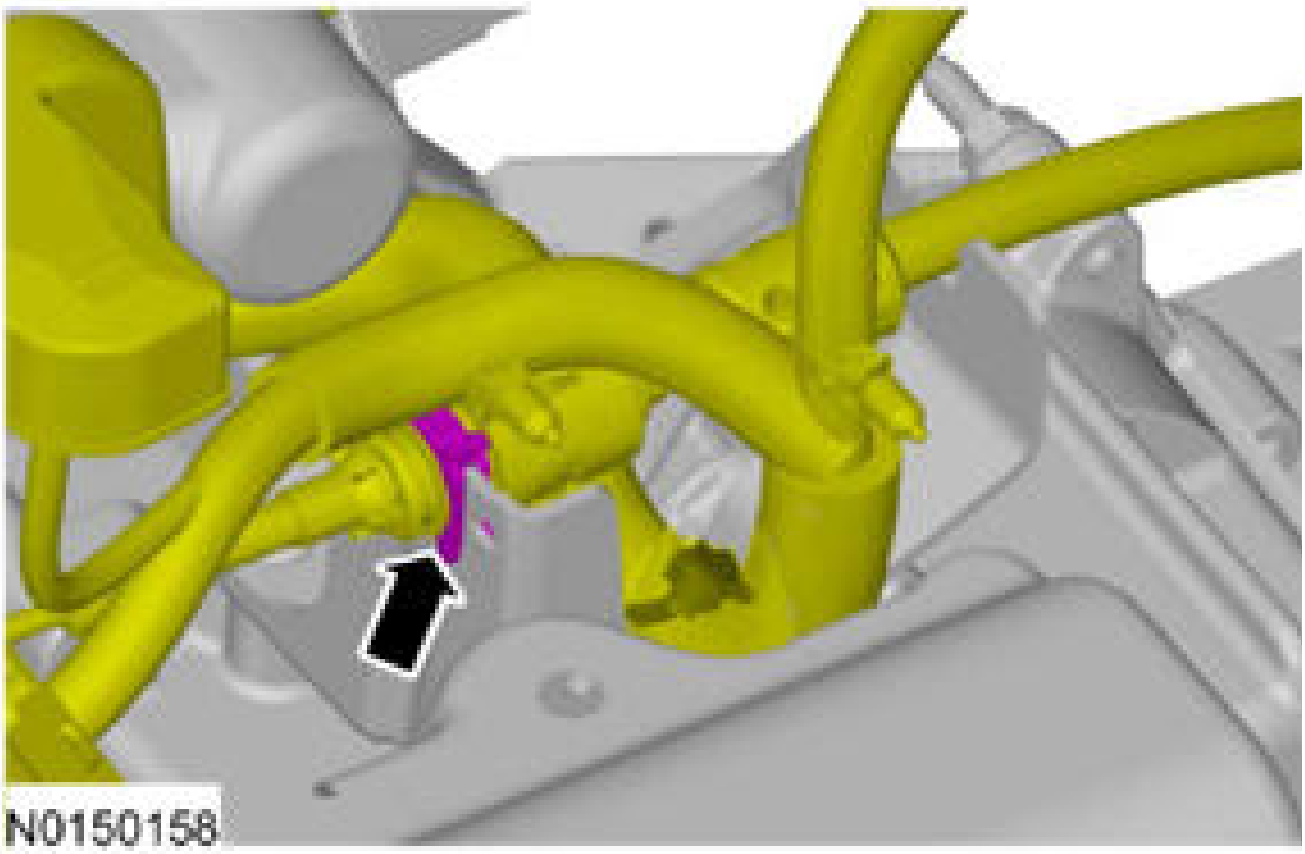
57. Install the underbody air duct and the 3 twist lock retainers.

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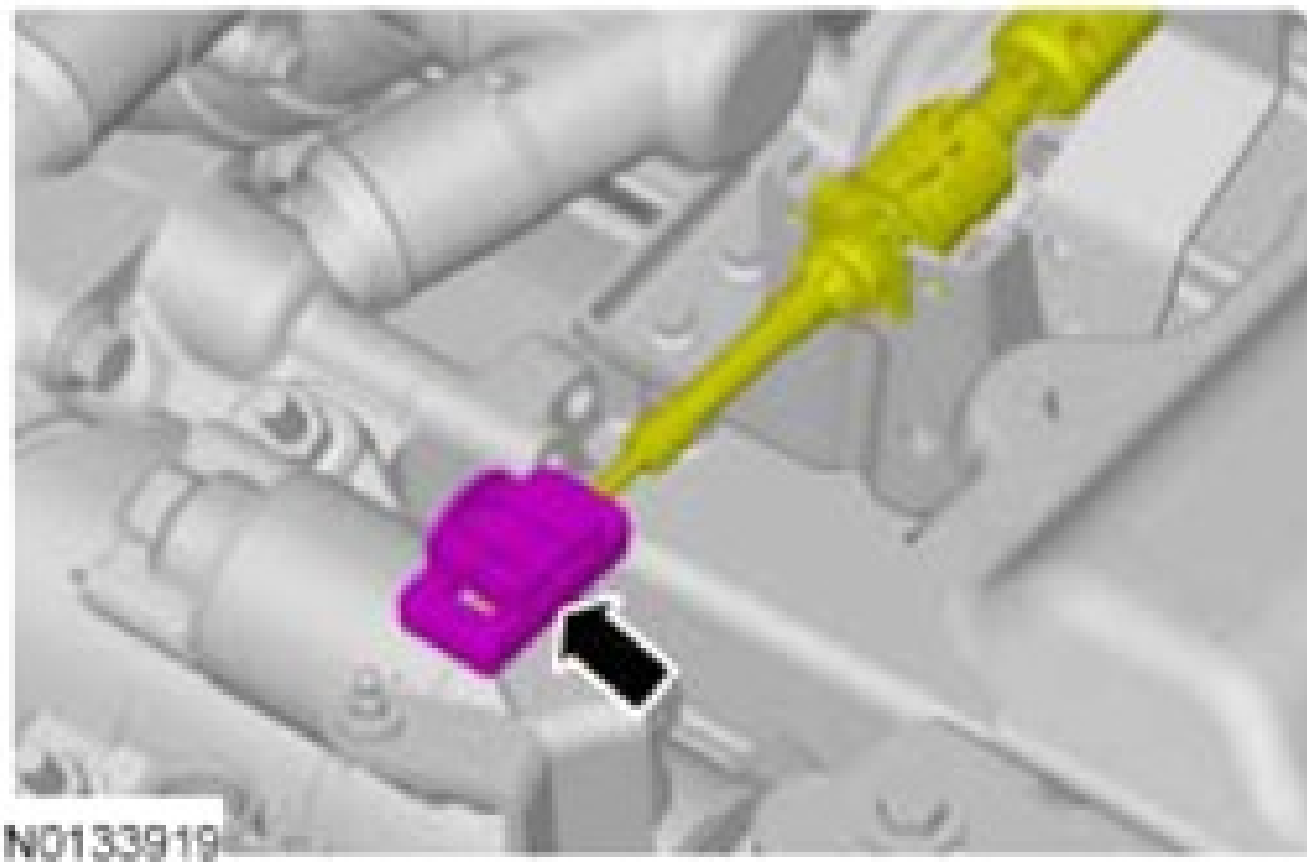
58. If equipped, attach the engine block heater harness to the radiator support.
59. Connect the transaxle control cable to the shift cable bracket.

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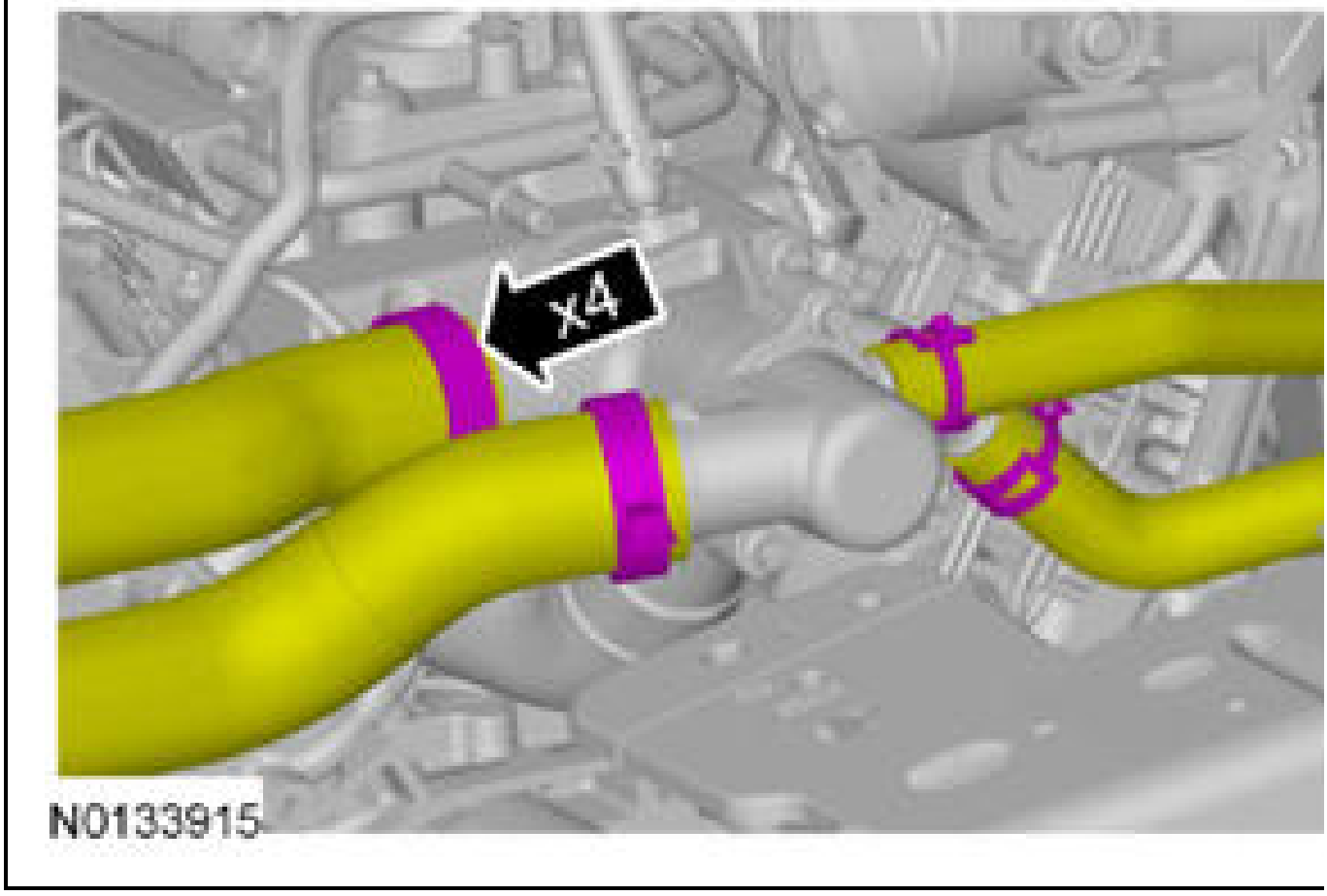
60. Connect the transaxle control cable to the control lever.

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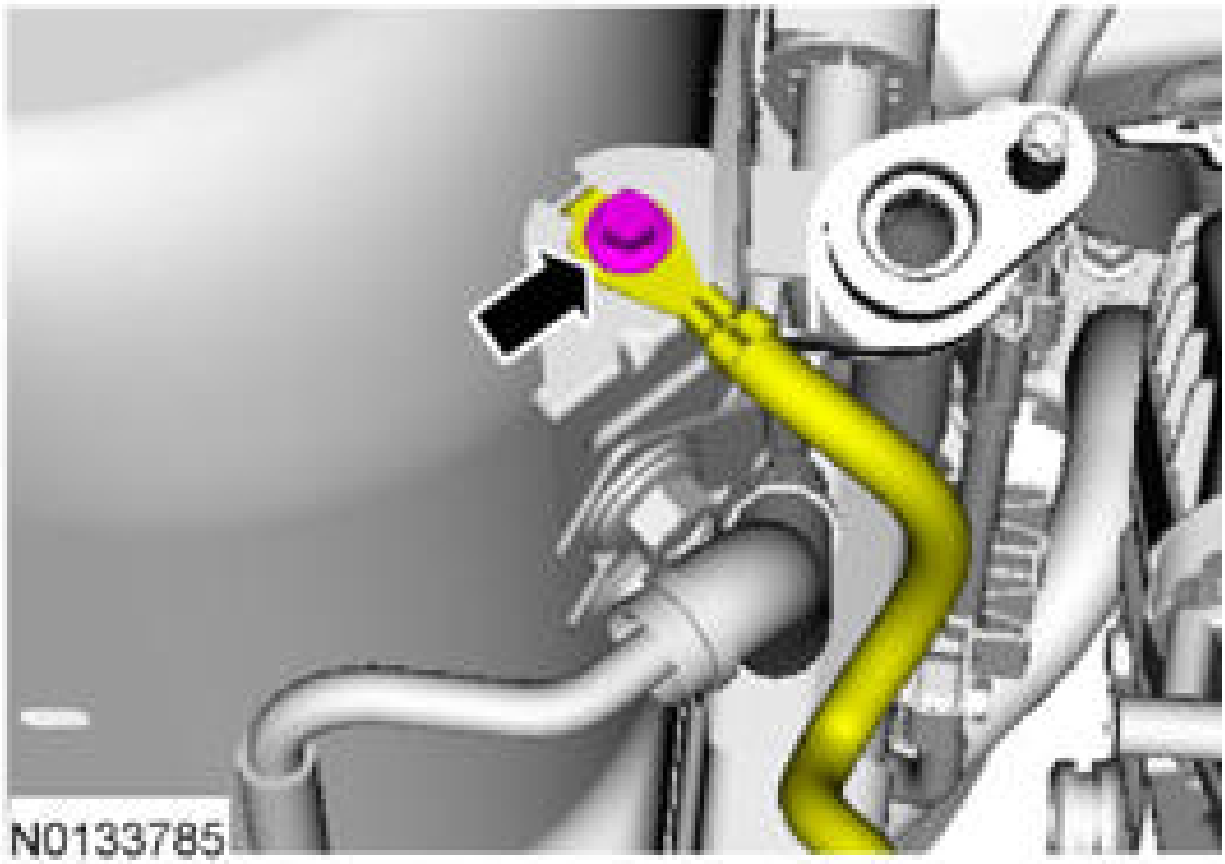
61. Connect the upper radiator hose, lower radiator hose and 2 heater hoses to the thermostat housing.

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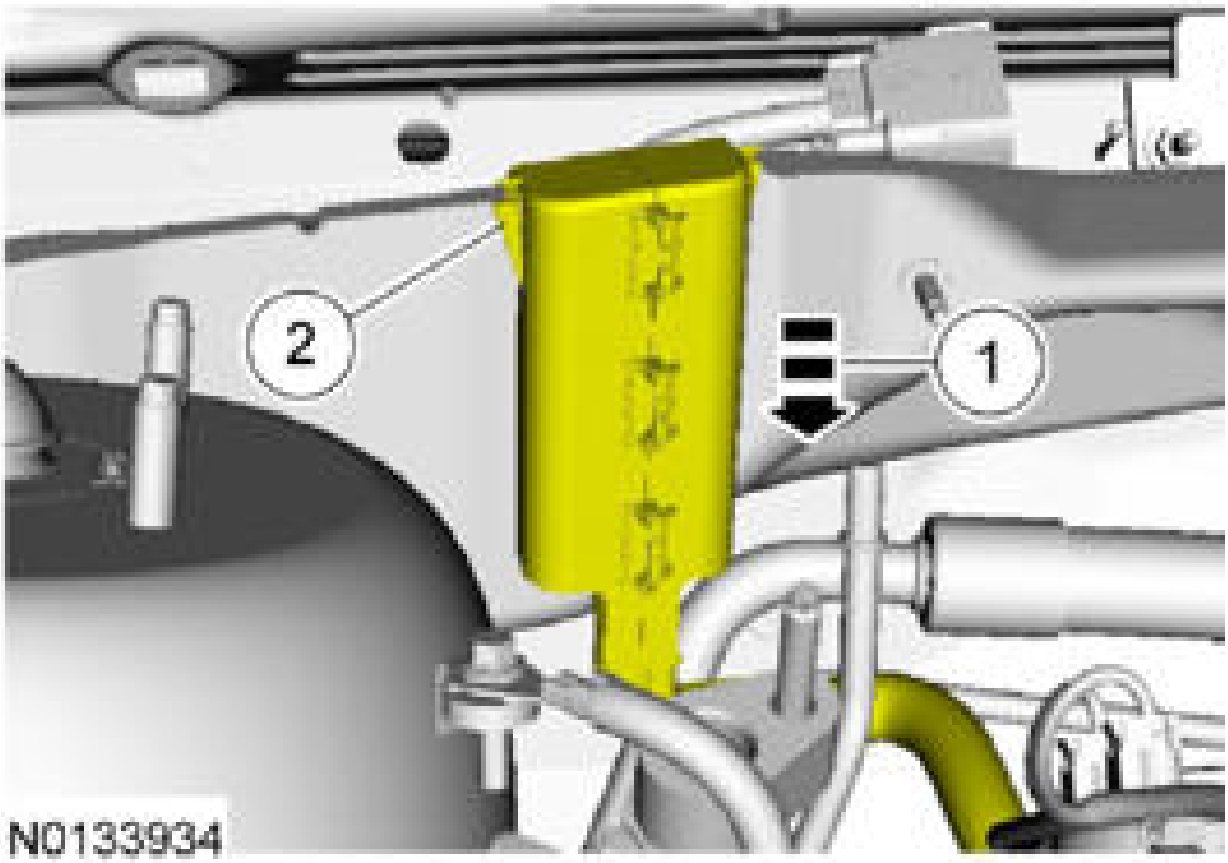
62. Install the ground wire to the RH shock tower and install the bolt.
    - Tighten to 10 Nm (89 lb-in).

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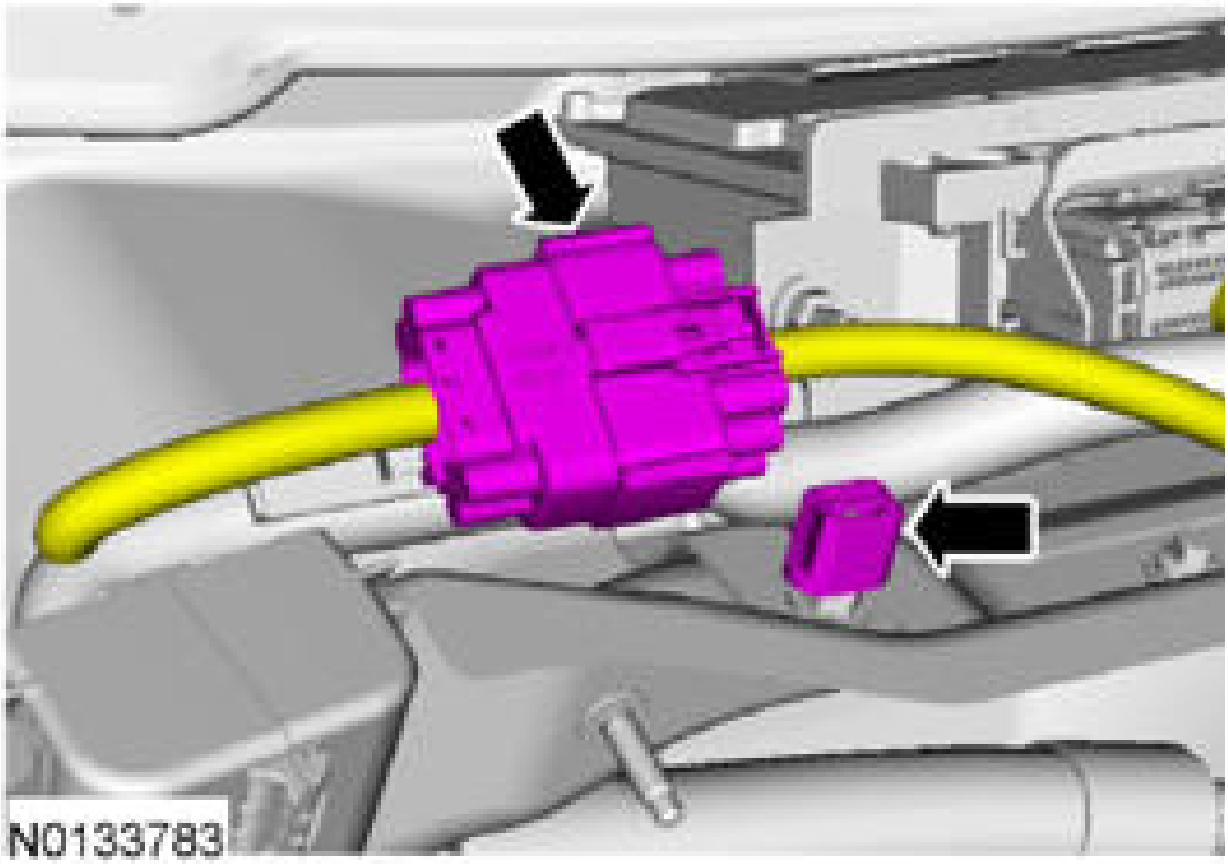
63. Install the engine wiring harness retainer to the bulkhead.
    - Slide the wiring harness in the bulkhead.
    - Make sure the wiring harness retainer tab is below the bulkhead lip.

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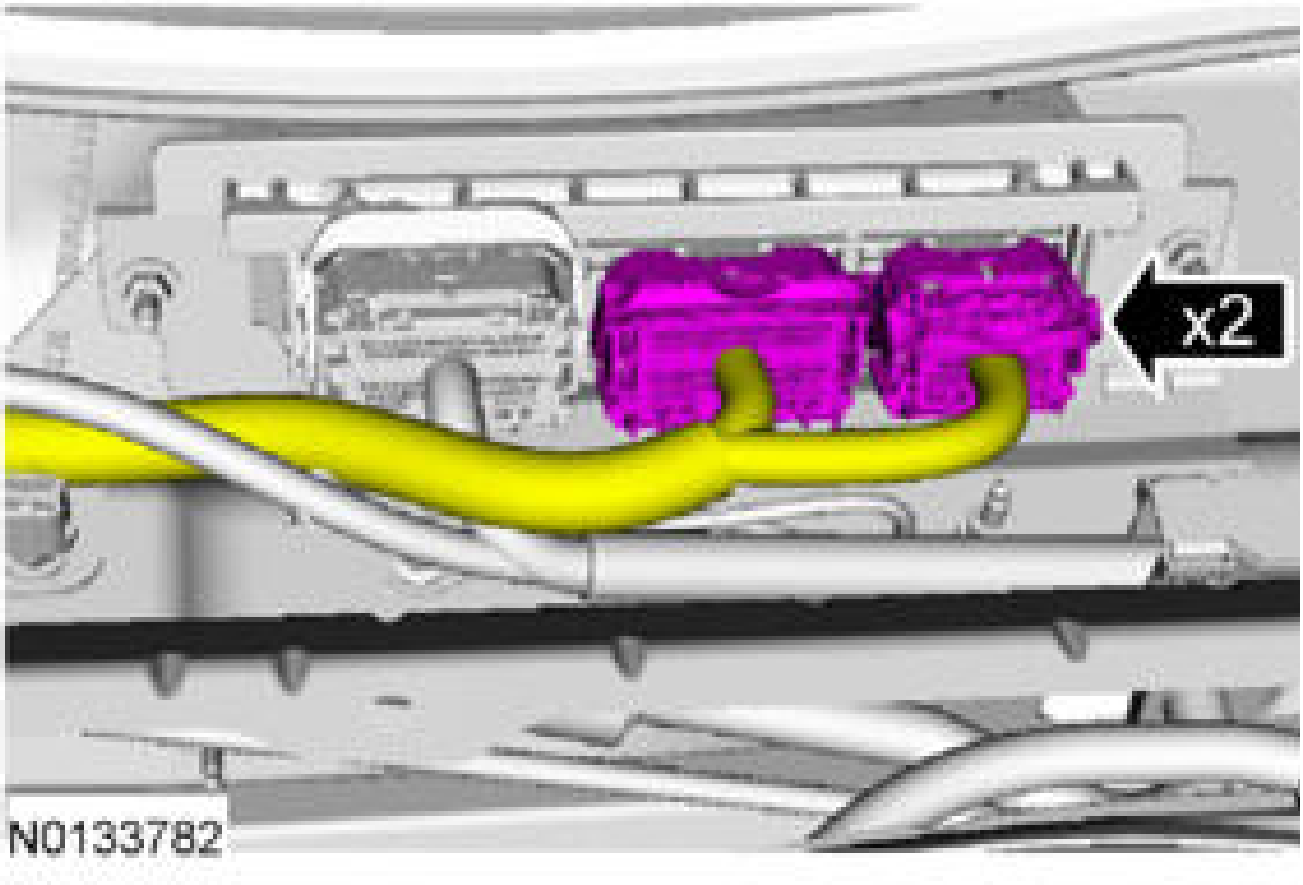
64. Connect the engine harness electrical connector.
    - Attach the wiring harness retainer.

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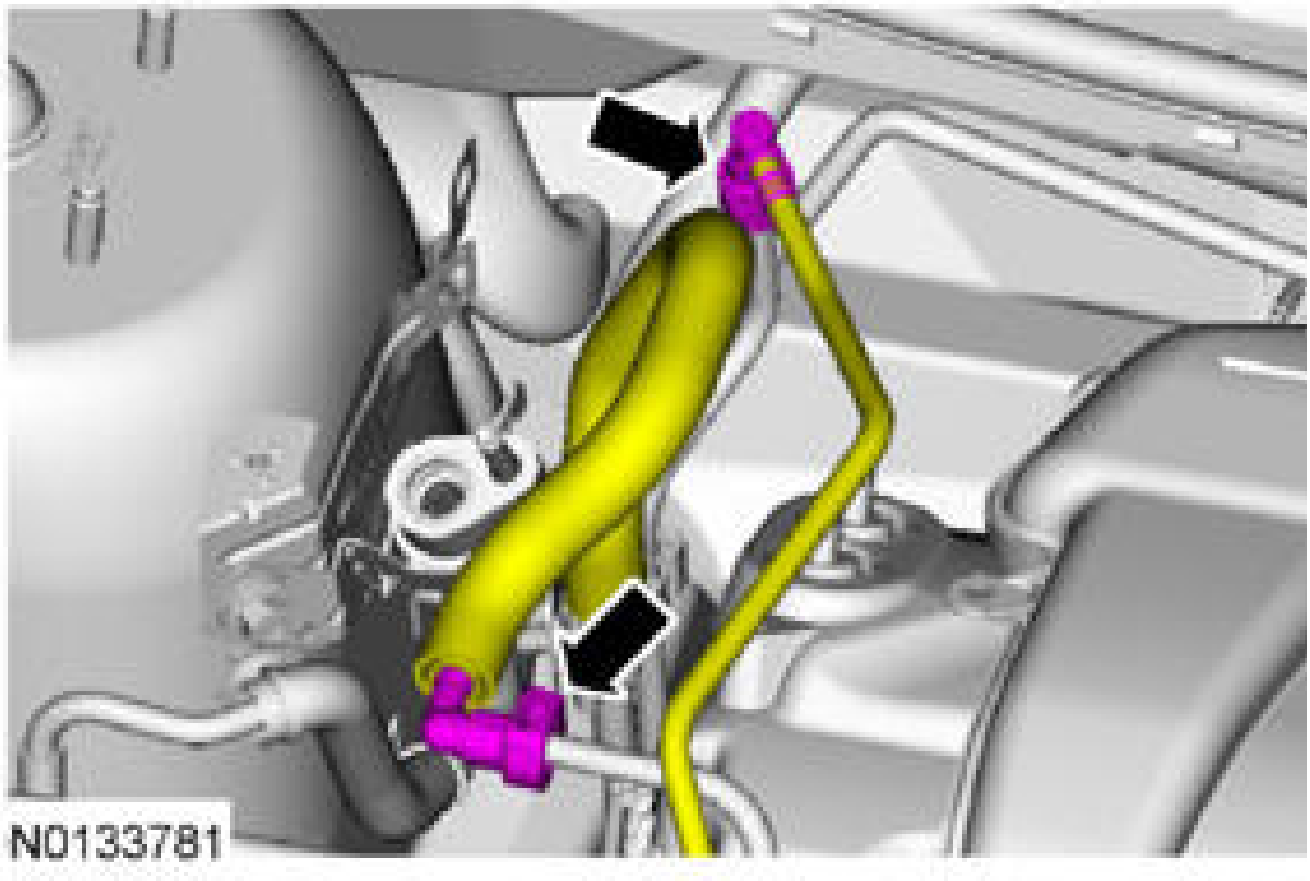
65. Connect the 2 **PCM** electrical connectors.

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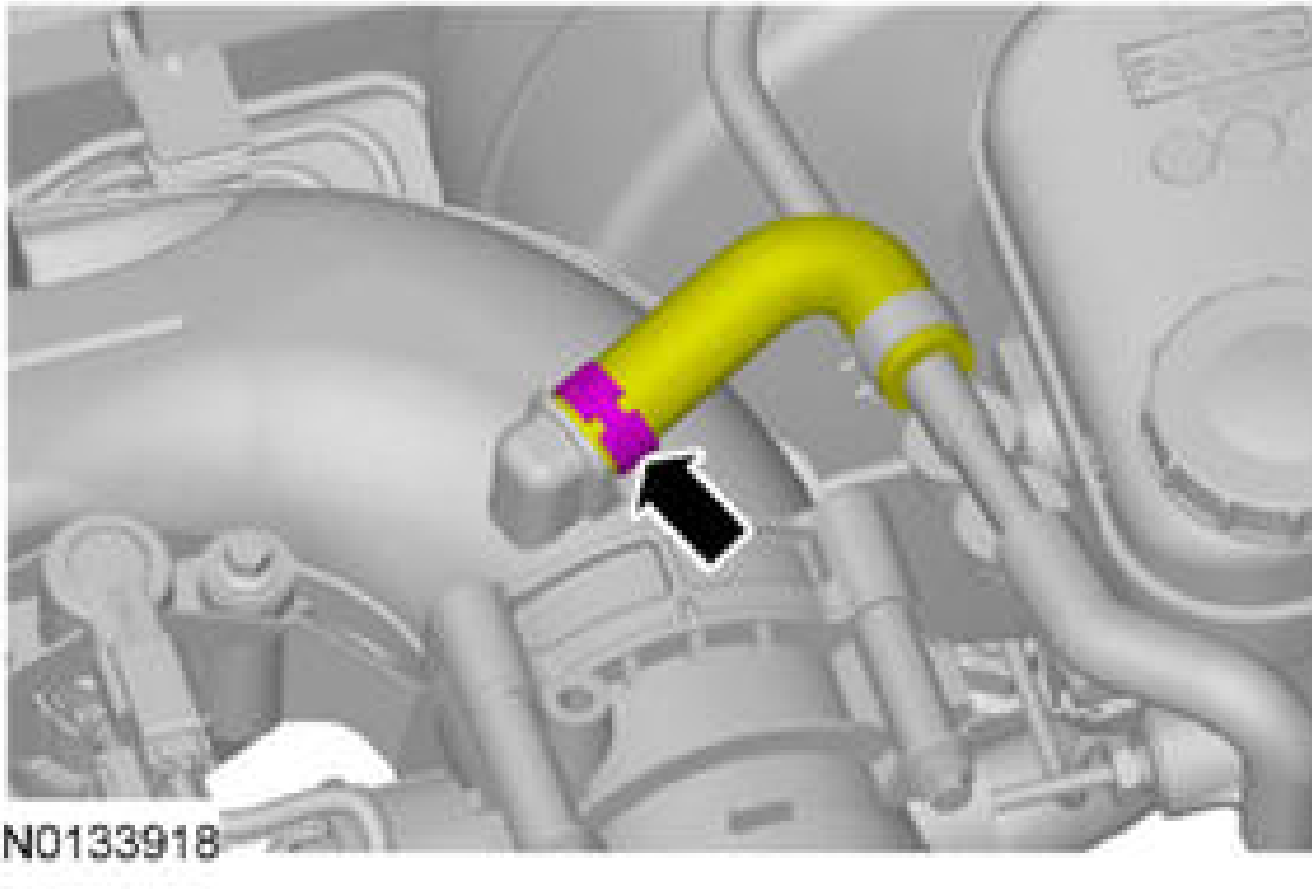
66. Connect the **EVAP** tube and the fuel supply tube quick connect coupling. REFER to **SPRING LOCK COUPLINGS** .

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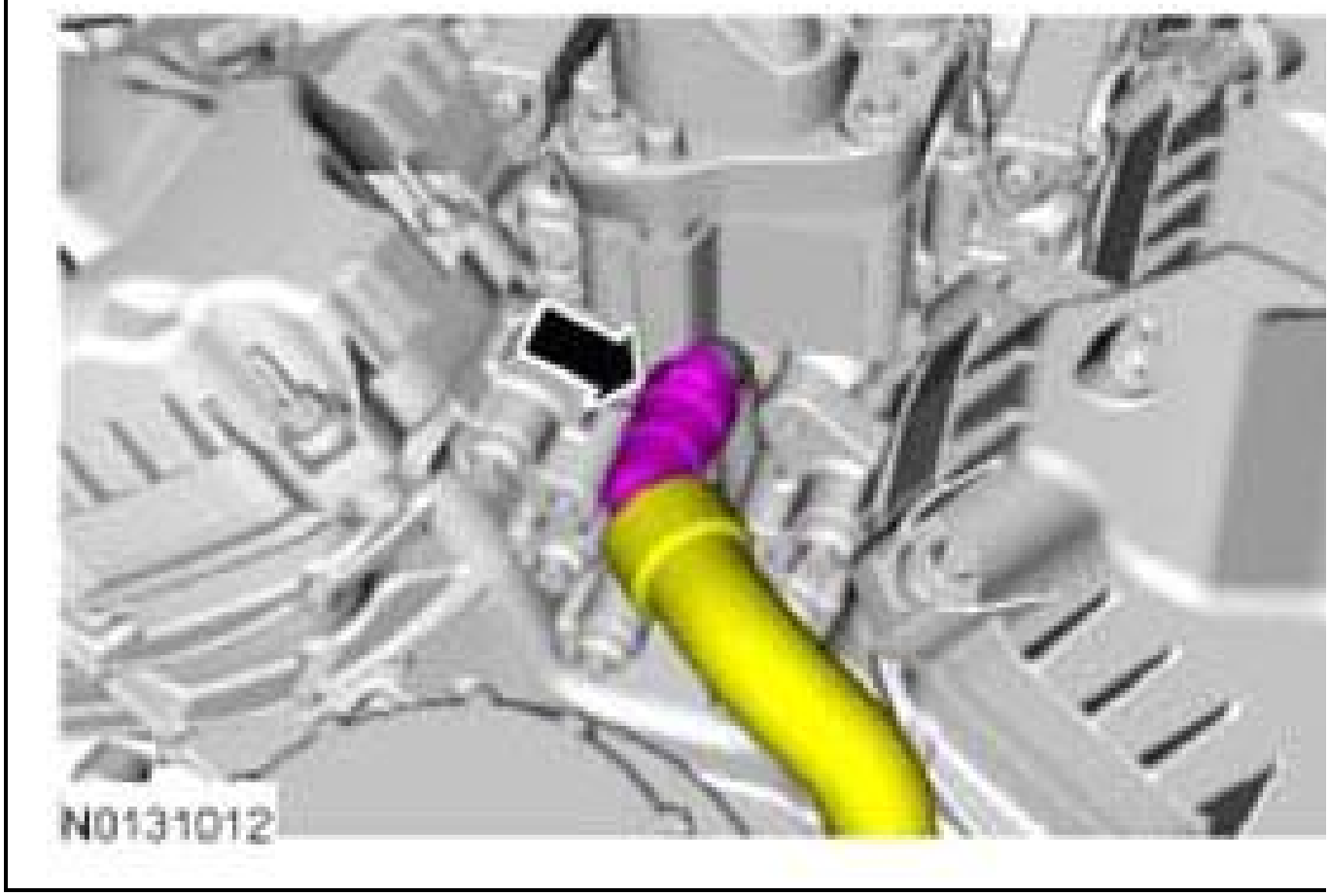
67. Connect the brake booster vacuum hose to the upper intake manifold.

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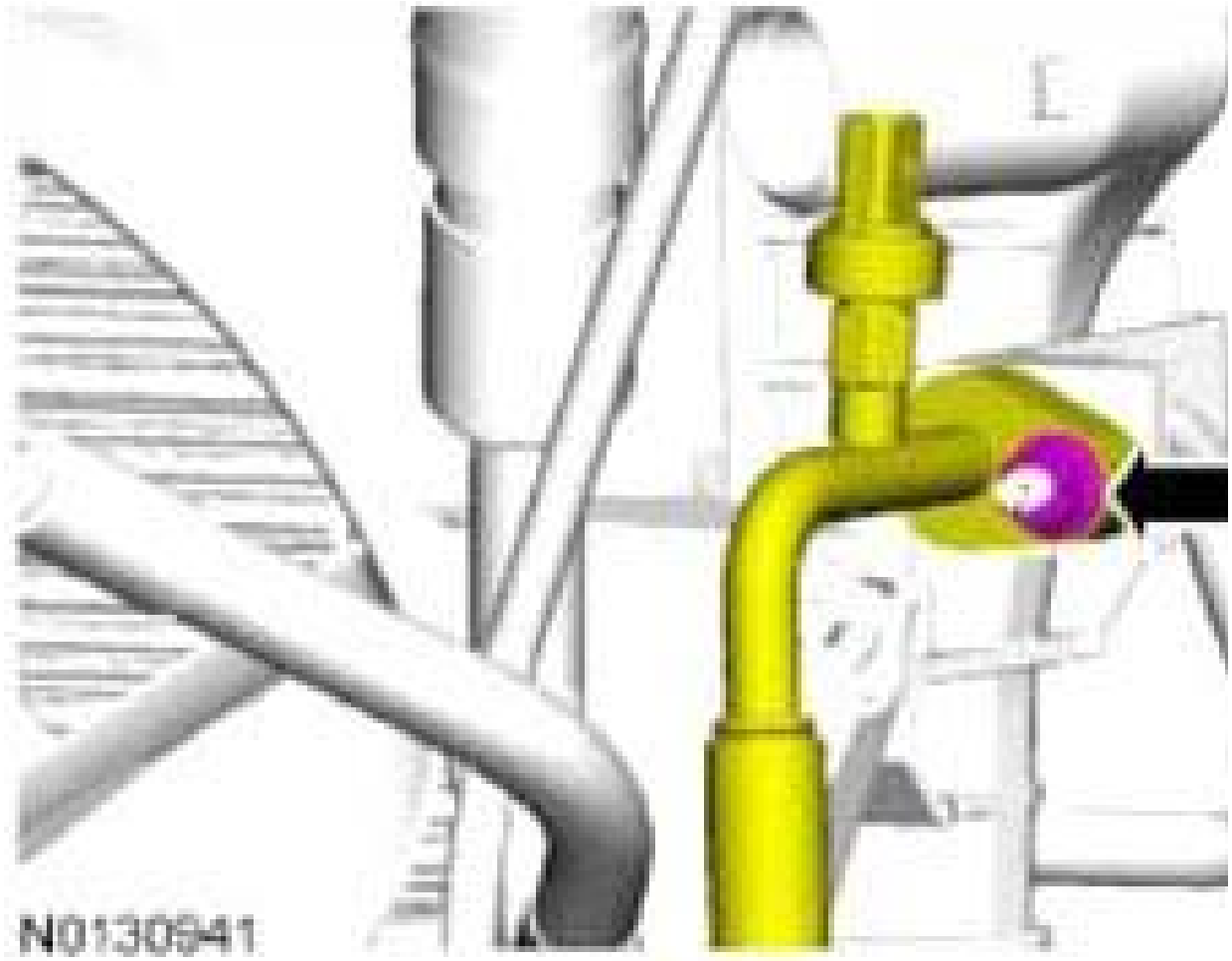
68. Connect the degas bottle coolant hose to the engine coolant tube.

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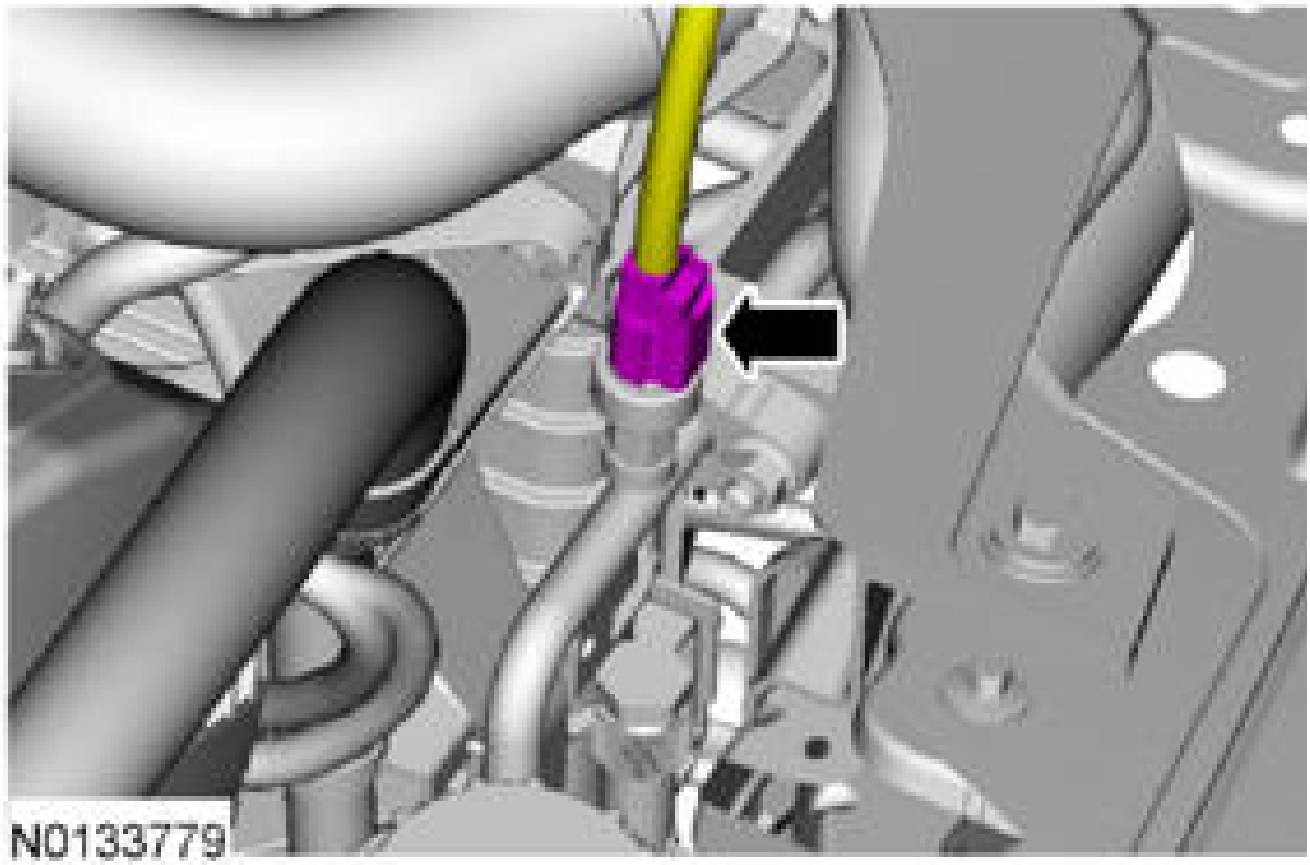
69. Install the degas bottle. REFER to **DEGAS BOTTLE** .
70. Using a new O-ring seal and gasket seal, install the A/C tube and the nut.
    - Tighten to 15 Nm (133 lb-in).

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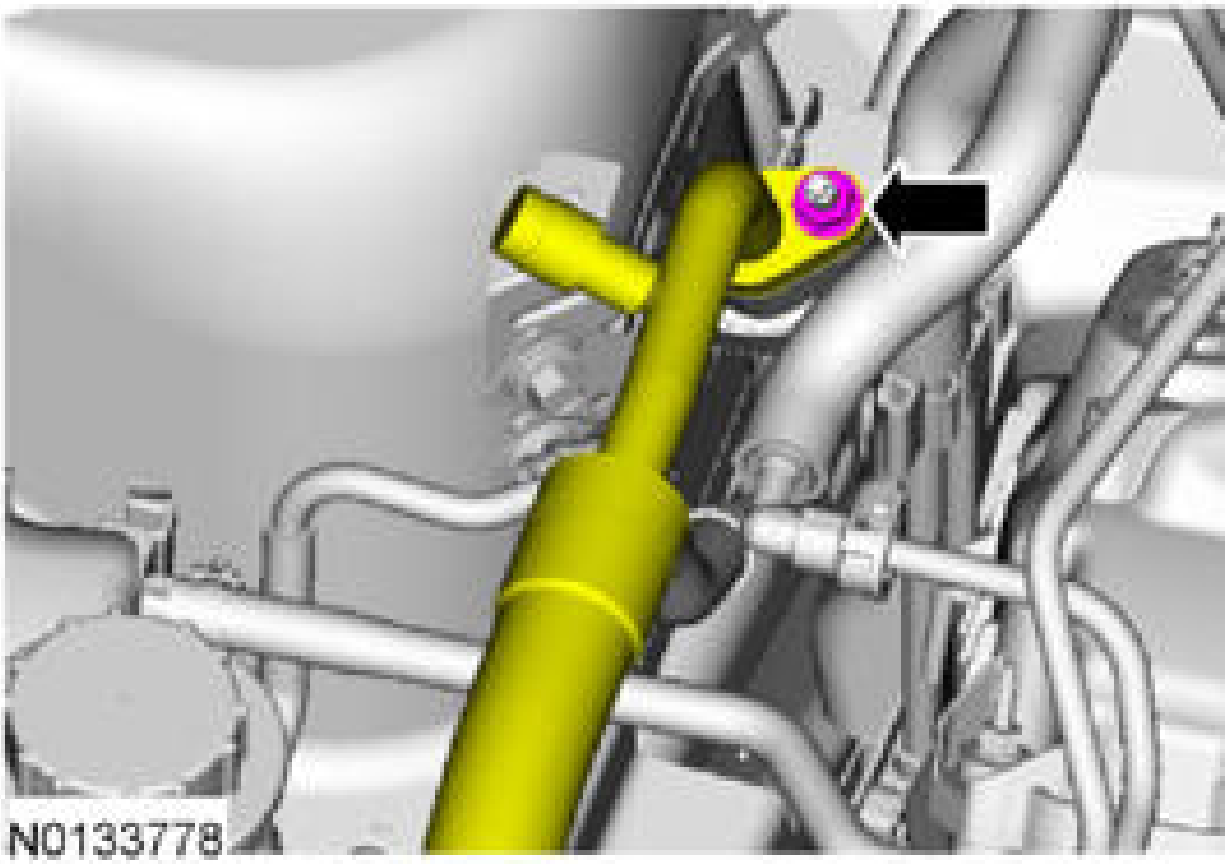
71. Connect the A/C pressure switch electrical connector.

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72. Using a new O-ring seal and gasket seal, connect the A/C tube and install the nut.
    - Tighten to 15 Nm (133 lb-in).

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73. Install the accessory drive belt. REFER to **ACCESSORY DRIVE BELT - 3.5L TI-VCT, 3.7L TI-VCT** .

74. **NOTE: RH shown in illustration, LH similar.**

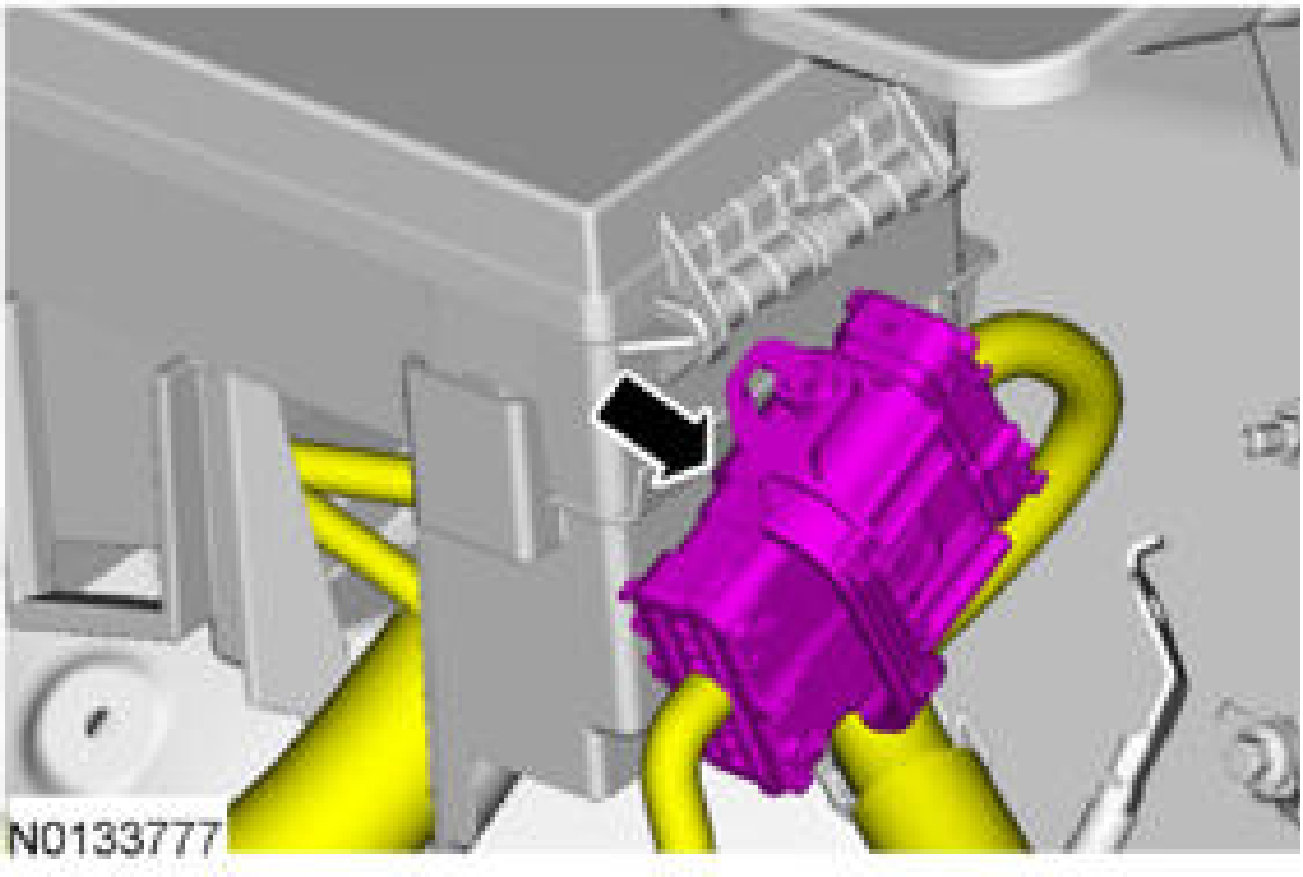
Install the 2 RH and 2 LH lower pin-type retainers for the engine splash shields.

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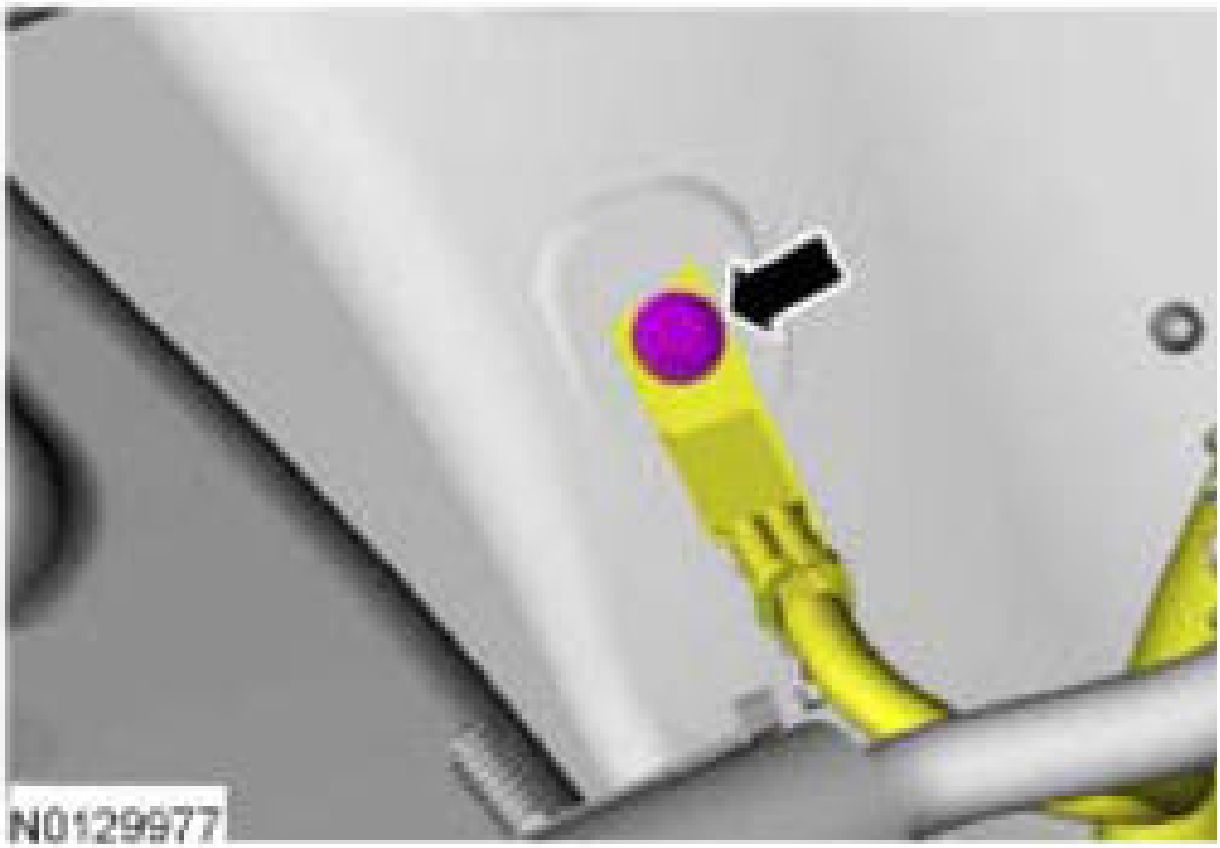
75. Install the front wheels and tires. REFER to **WHEEL AND TIRE** .
76. Connect the engine wiring harness electrical connector.

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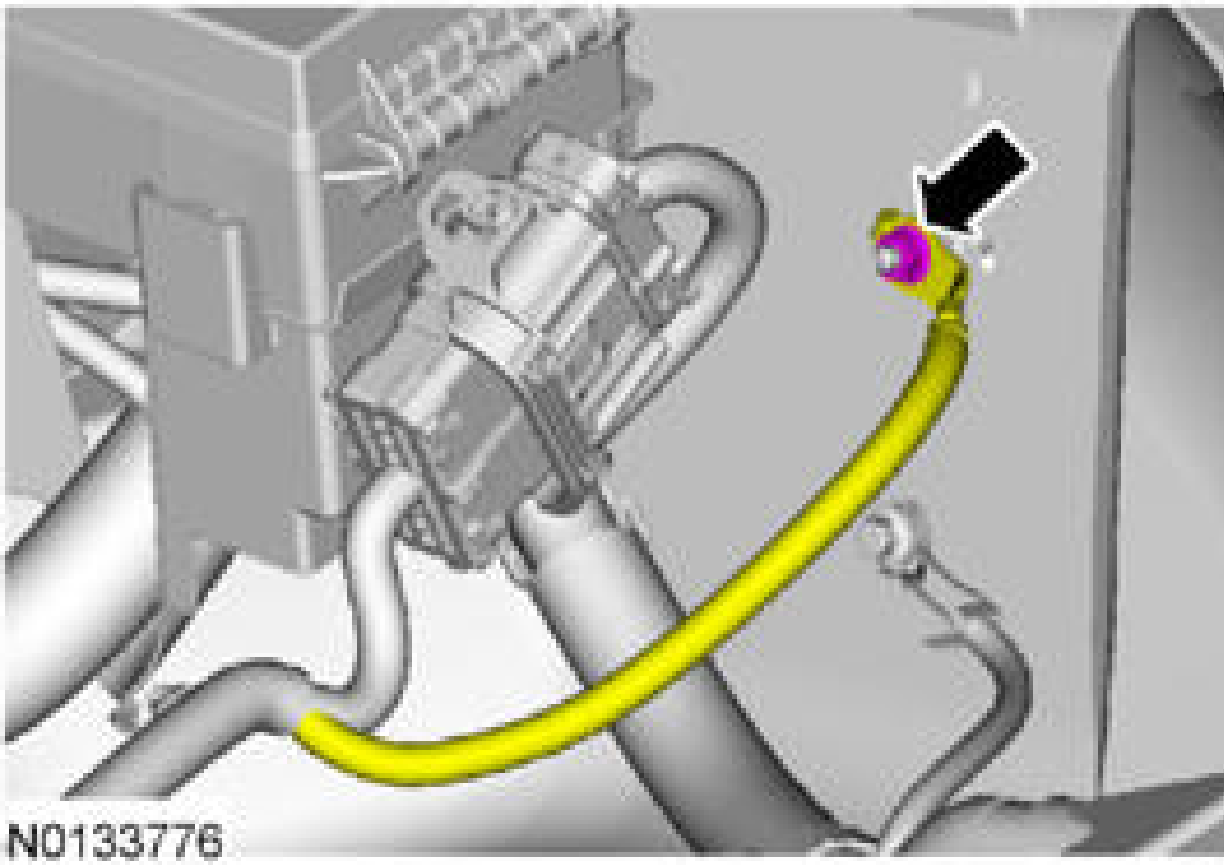
77. Install the ground wire and install the retainer.
    - Tighten to 10 Nm (89 lb-in).

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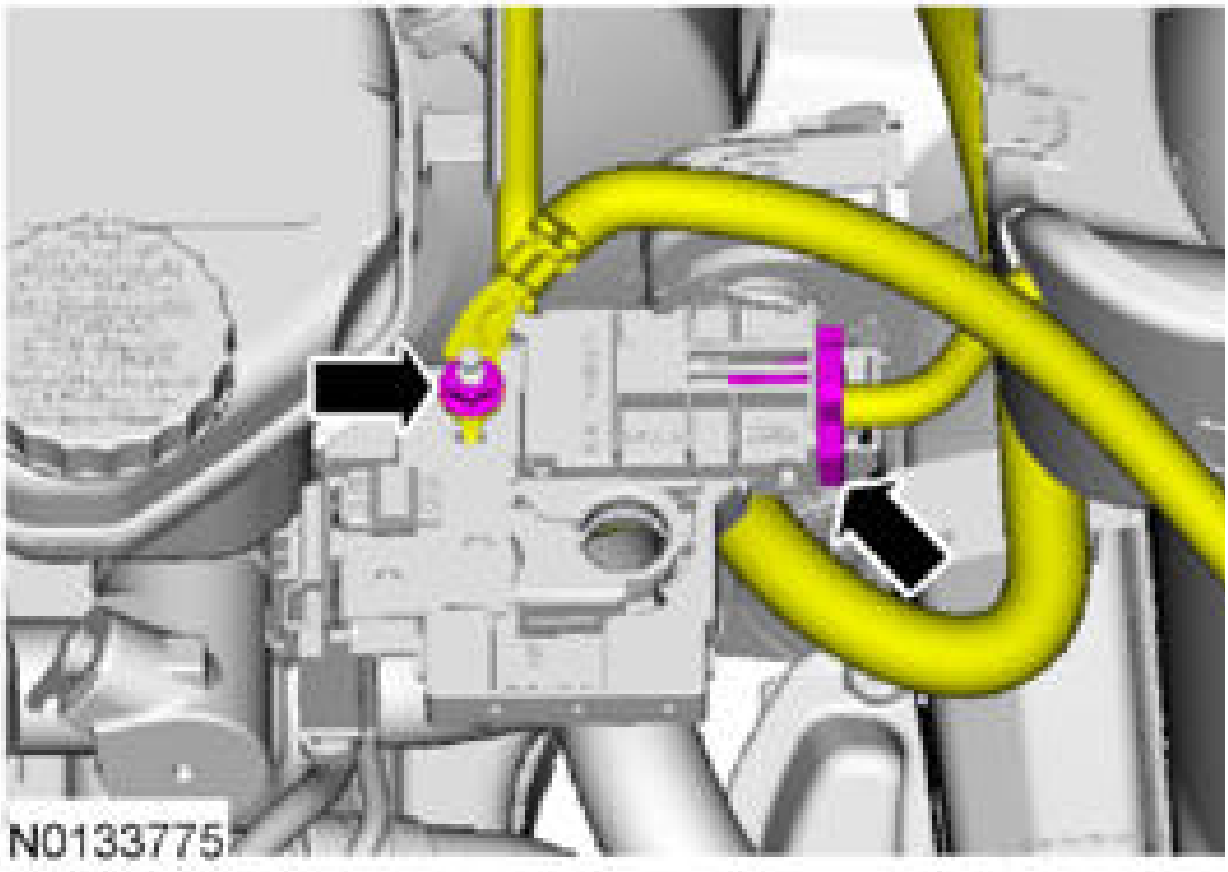
78. Install the ground wire and the retainer.
    - Tighten to 10 Nm (89 lb-in).

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79. Connect the 2 battery feed cables to the positive battery terminal and install the nut.
    - Tighten to 5 Nm (44 lb-in).

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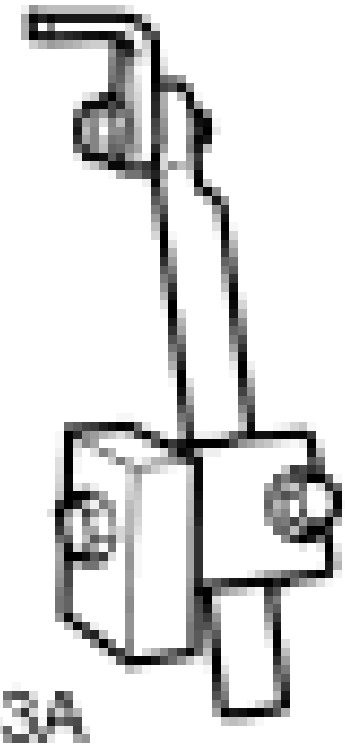


80. Install the battery tray. REFER to **BATTERY AND BATTERY TRAY - EXPLODED VIEW** .
81. Install the engine **ACL** and **ACL** outlet pipe. REFER to **INTAKE AIR SYSTEM COMPONENTS - EXPLODED VIEW** .
82. Install the cowl panel. REFER to **COWL PANEL** .
83. Fill the engine with clean engine oil.
84. Fill and bleed the cooling system. REFER to **COOLING SYSTEM DRAINING, FILLING AND BLEEDING** .
85. Recharge the A/C system. REFER to **AIR CONDITIONING (A/C) SYSTEM RECOVERY, EVACUATION AND CHARGING** .
86. Perform the Misfire Monitor Neutral Profile Correction procedure, following the on-screen instructions.

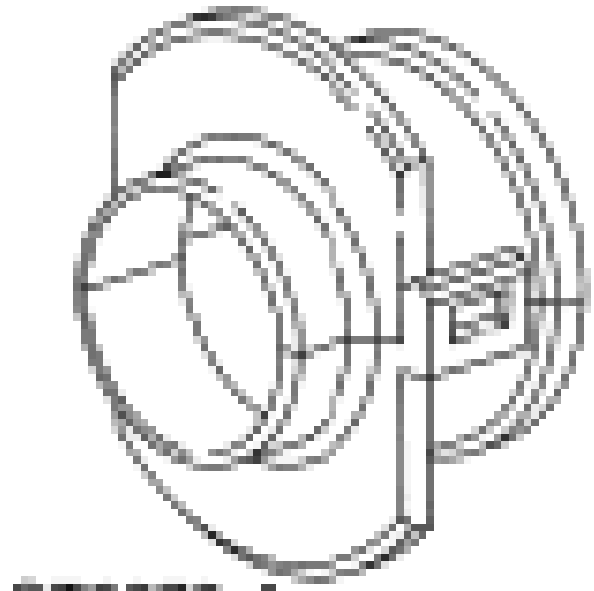
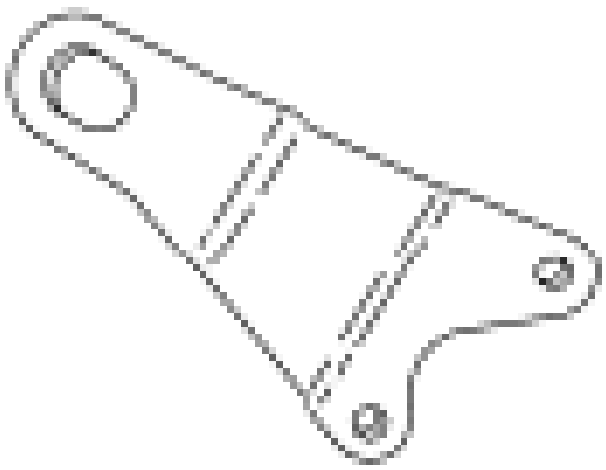
ENGINE - 2WD

SPECIAL TOOL(S) DESCRIPTION

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 ST1341-A	2, 200# Floor Crane, Fold Away **300-OTC1819E** or equivalent
 ST2743A	Adjustable Grip Arm, 1735A **014-00001** or equivalent

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	Disconnect Tool, Transmission Cooler Line **307-569**
	Eye, Engine Lift **303-1245**

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	Powertrain Lift **300-OTC1585AE** or equivalent
	Spreader Bar **303-D089** (D93P-6001-A3) or equivalent

MATERIAL SPECIFICATIONS

Item	Specification
Motorcraft® SAE 5W-20 Premium Synthetic Blend Motor Oil (US); Motorcraft® SAE 5W-20 Super Premium Motor Oil (Canada) XO-5W20-QSP (US); CXO-5W20-LSP12 (Canada)	M2C945-A

Removal

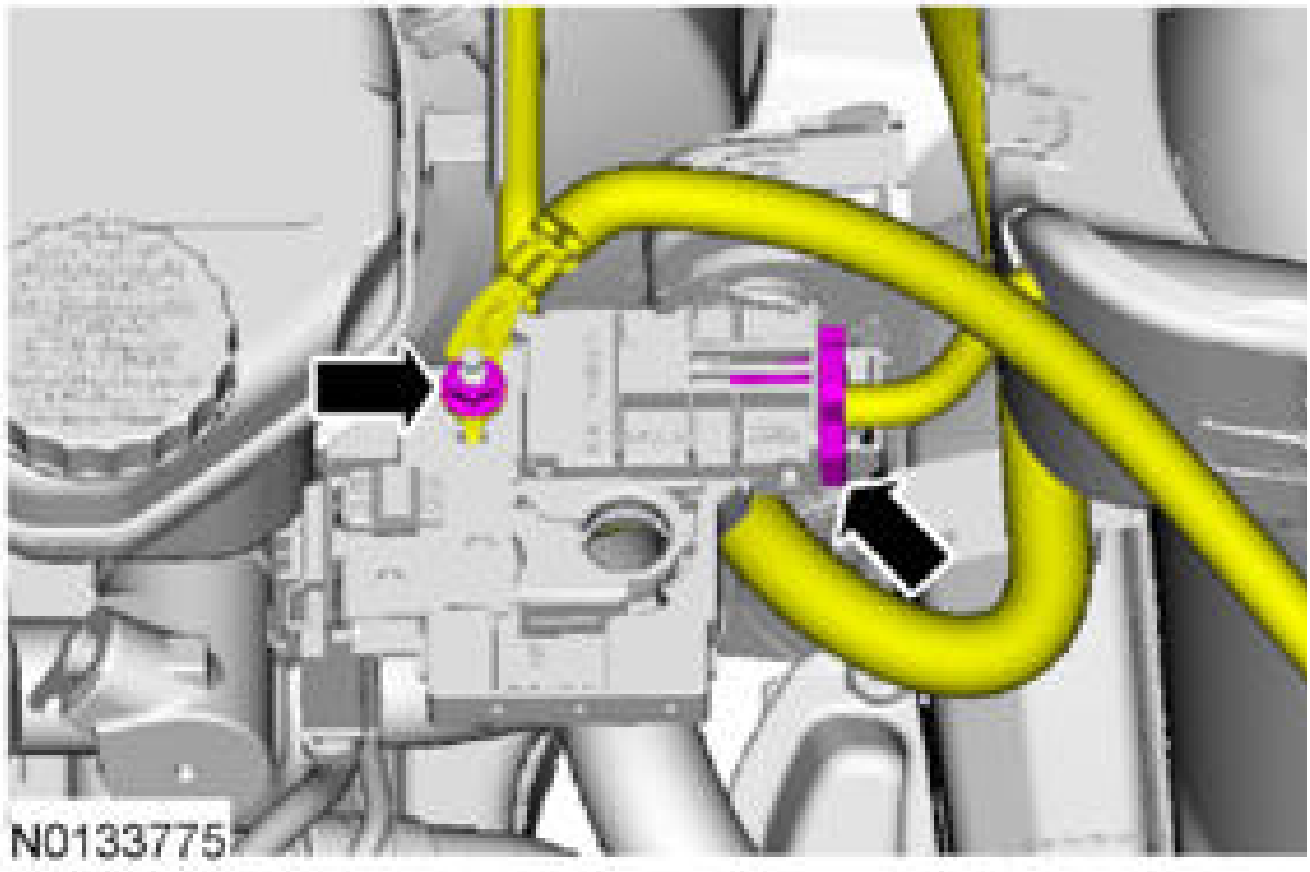
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WARNING: Before beginning any service procedure, refer to SAFETY WARNINGS . Failure to follow this instruction may result in serious personal injury.

WARNING: Do not smoke, carry lighted tobacco or have an open flame of any type when working on or near any fuel-related component. Highly flammable mixtures are always present and may be ignited. Failure to follow these instructions may result in serious personal injury.

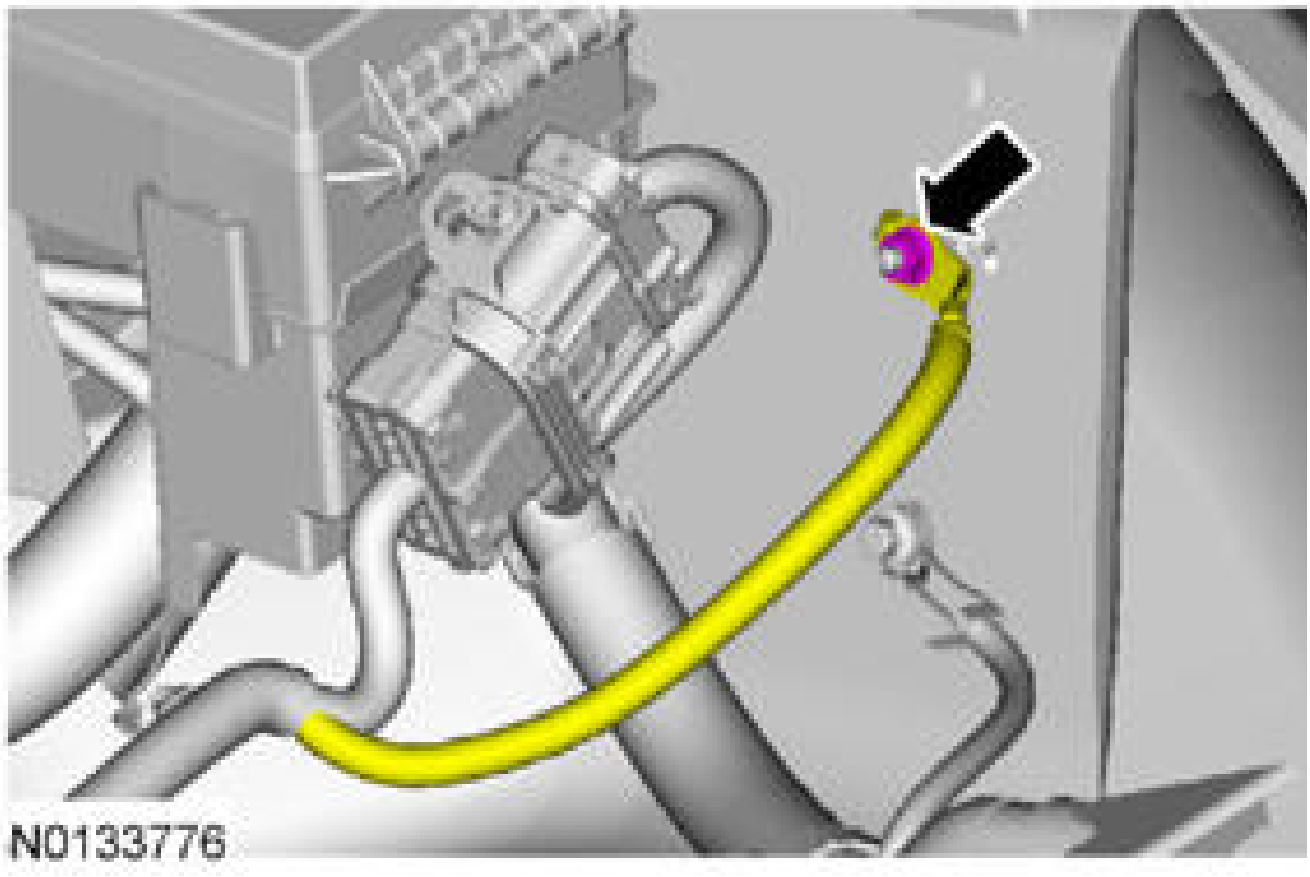
1. With the vehicle in NEUTRAL, position it on a hoist. REFER to **JACKING AND LIFTING** , Lifting Points.
2. Recover the A/C system. REFER to **AIR CONDITIONING (A/C) SYSTEM RECOVERY, EVACUATION AND CHARGING** .
3. Release the fuel system pressure. REFER to **FUEL SYSTEM PRESSURE RELEASE** .
4. Remove the cowl panel. REFER to **COWL PANEL** .
5. Remove the engine **ACL** assembly and **ACL** outlet pipe. REFER to **INTAKE AIR SYSTEM COMPONENTS - EXPLODED VIEW** .
6. Remove the battery tray. REFER to **BATTERY AND BATTERY TRAY - EXPLODED VIEW** .
7. Remove the nut and disconnect the 2 battery feed cables from the positive battery terminal.

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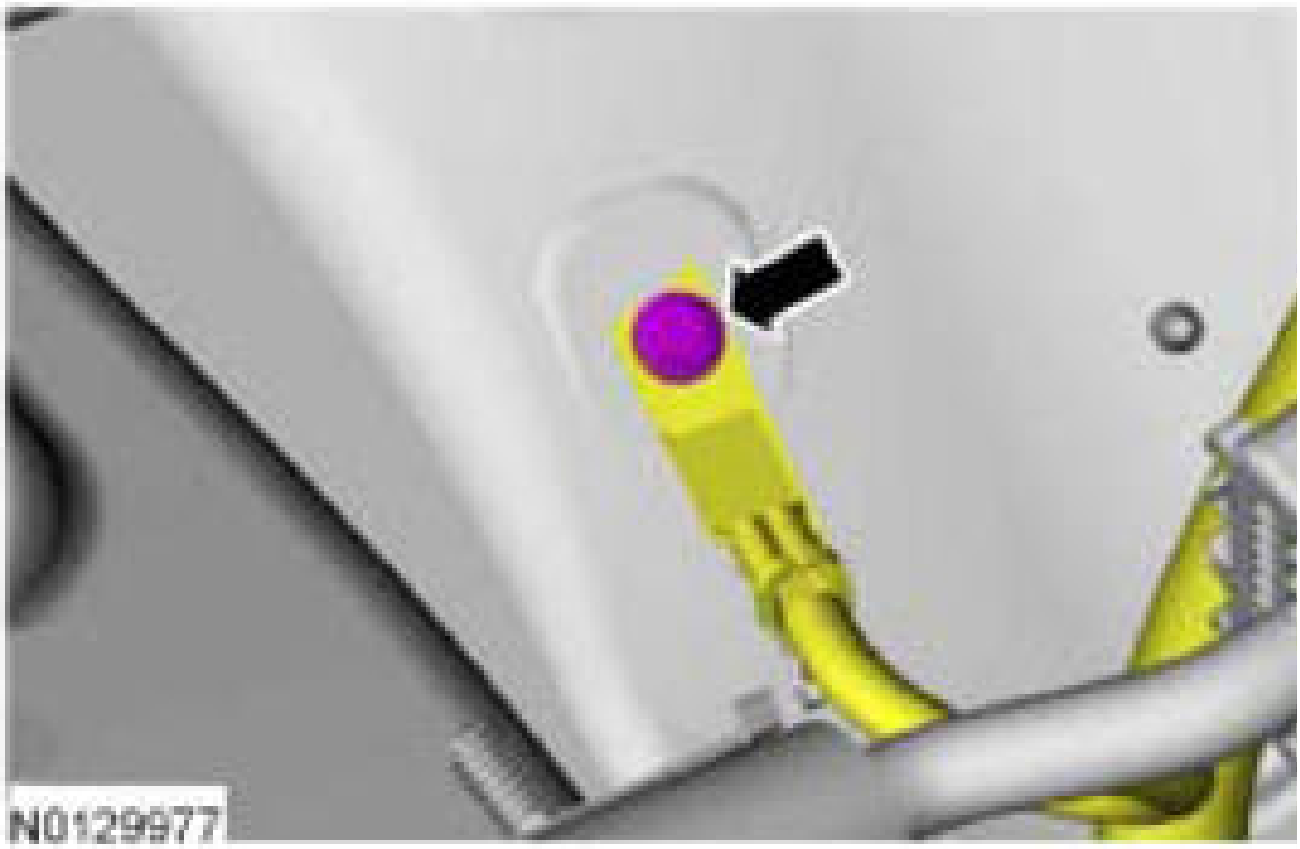
8. Remove the retainer and the ground wire cable.

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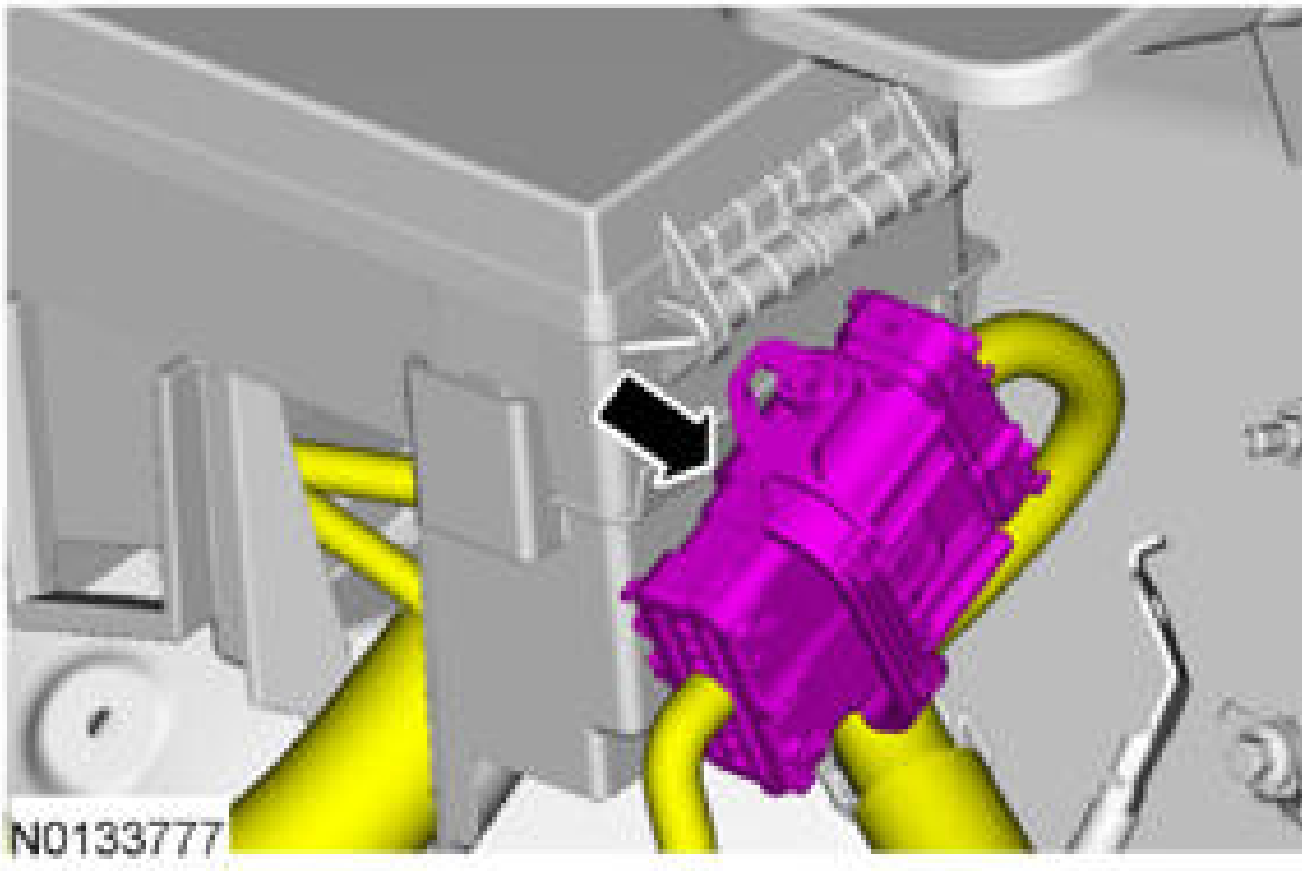
9. Remove the retainer and the ground wire cable.

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10. Disconnect the engine wiring harness electrical connector.

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11. Remove the front wheels and tires. REFER to **WHEEL AND TIRE** .
12. **NOTE: RH shown in illustration, LH similar.**

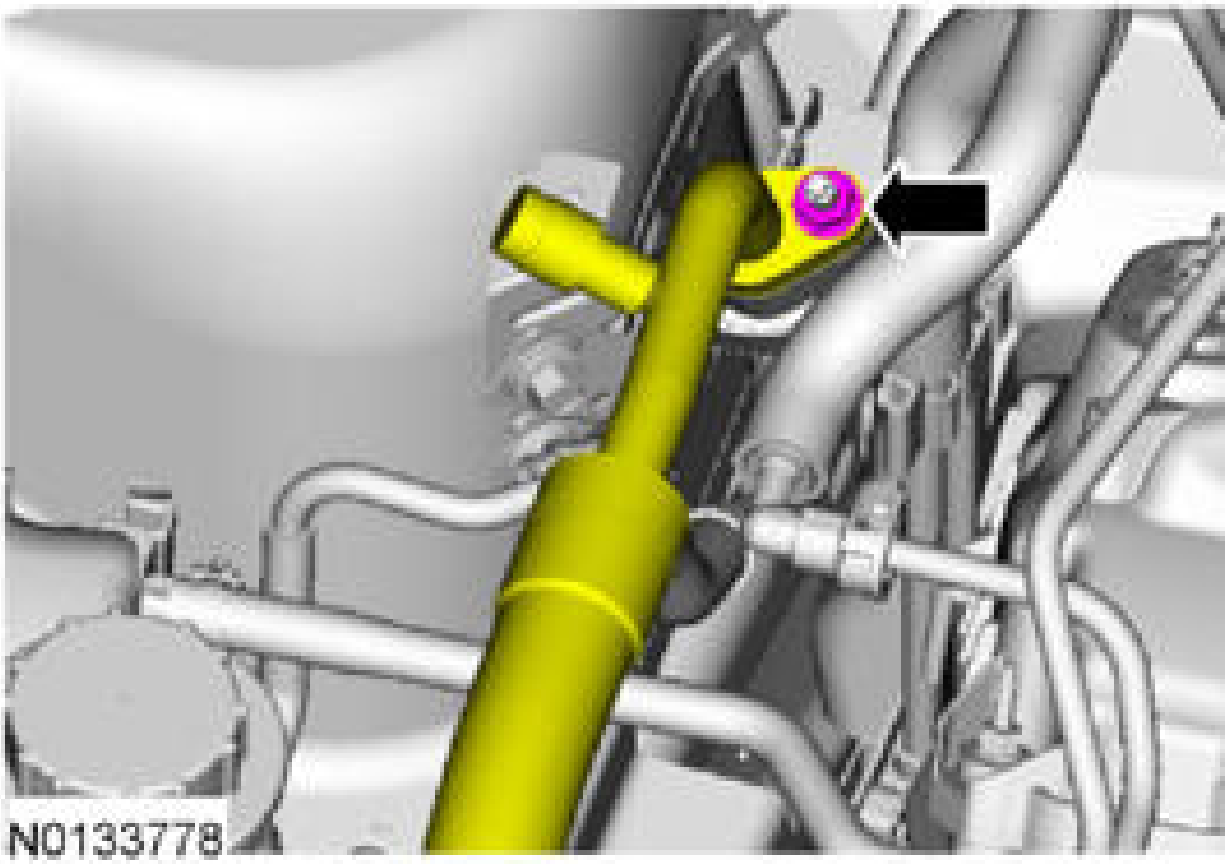
    Remove the 2 RH and 2 LH lower pin-type retainers from the engine splash shields and position the shields aside.

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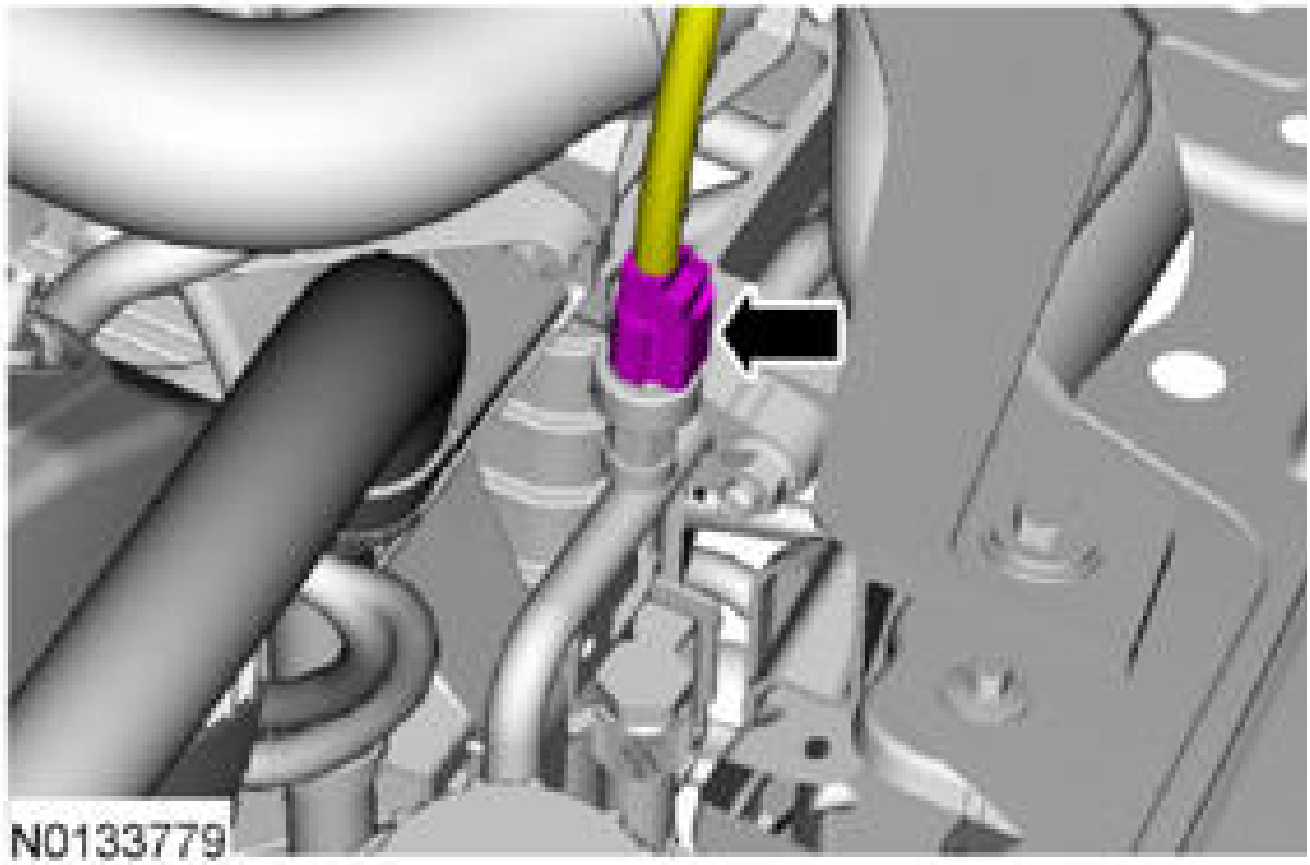
13. Remove the accessory drive belt. REFER to **ACCESSORY DRIVE BELT - 3.5L TI-VCT, 3.7L TI-VCT** .
14. Drain the cooling system. REFER to **COOLING SYSTEM DRAINING, FILLING AND BLEEDING** .
15. Remove the nut and disconnect the A/C tube.
    - Discard the O-ring seal and gasket seal.

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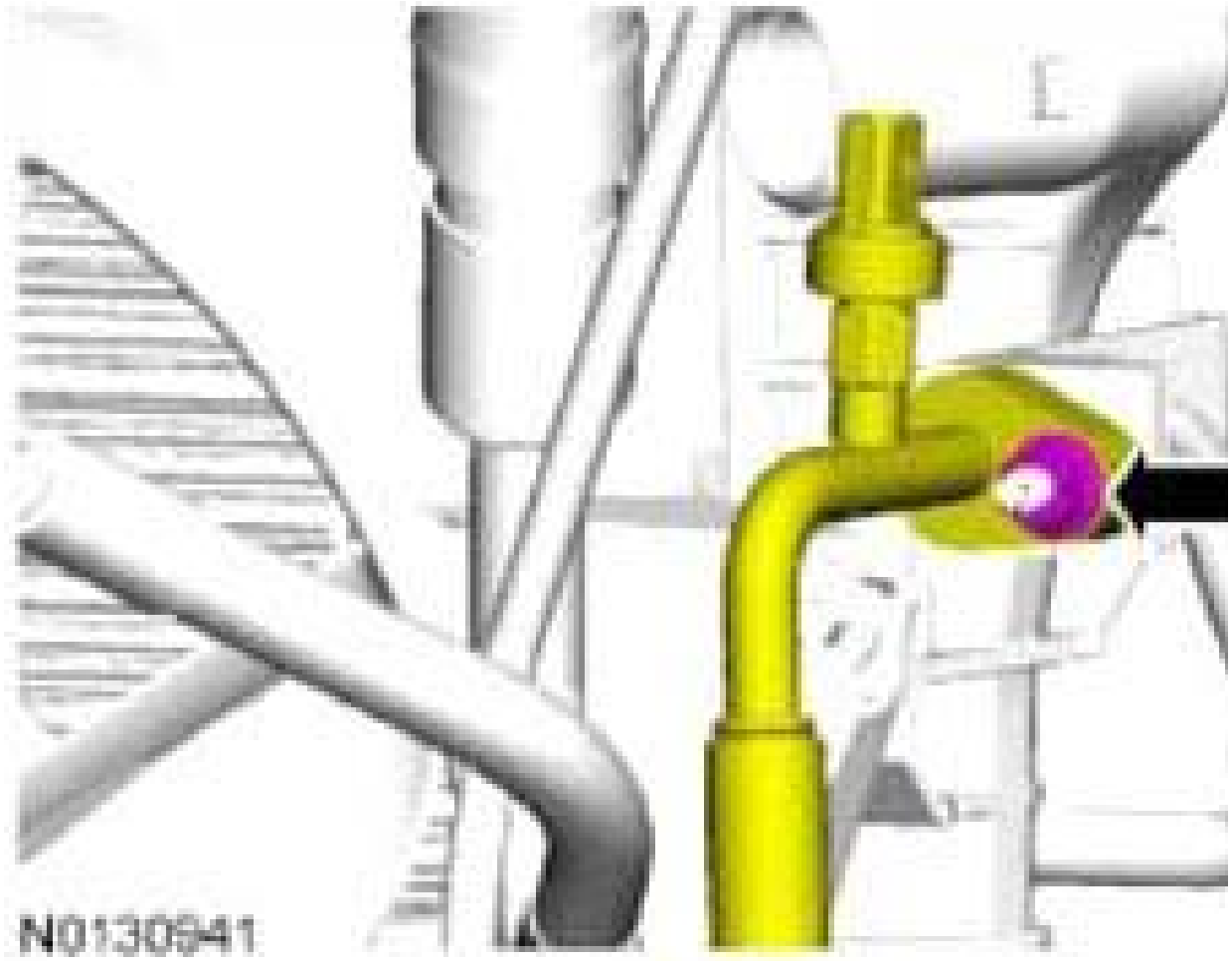
16. Disconnect the A/C pressure switch electrical connector.

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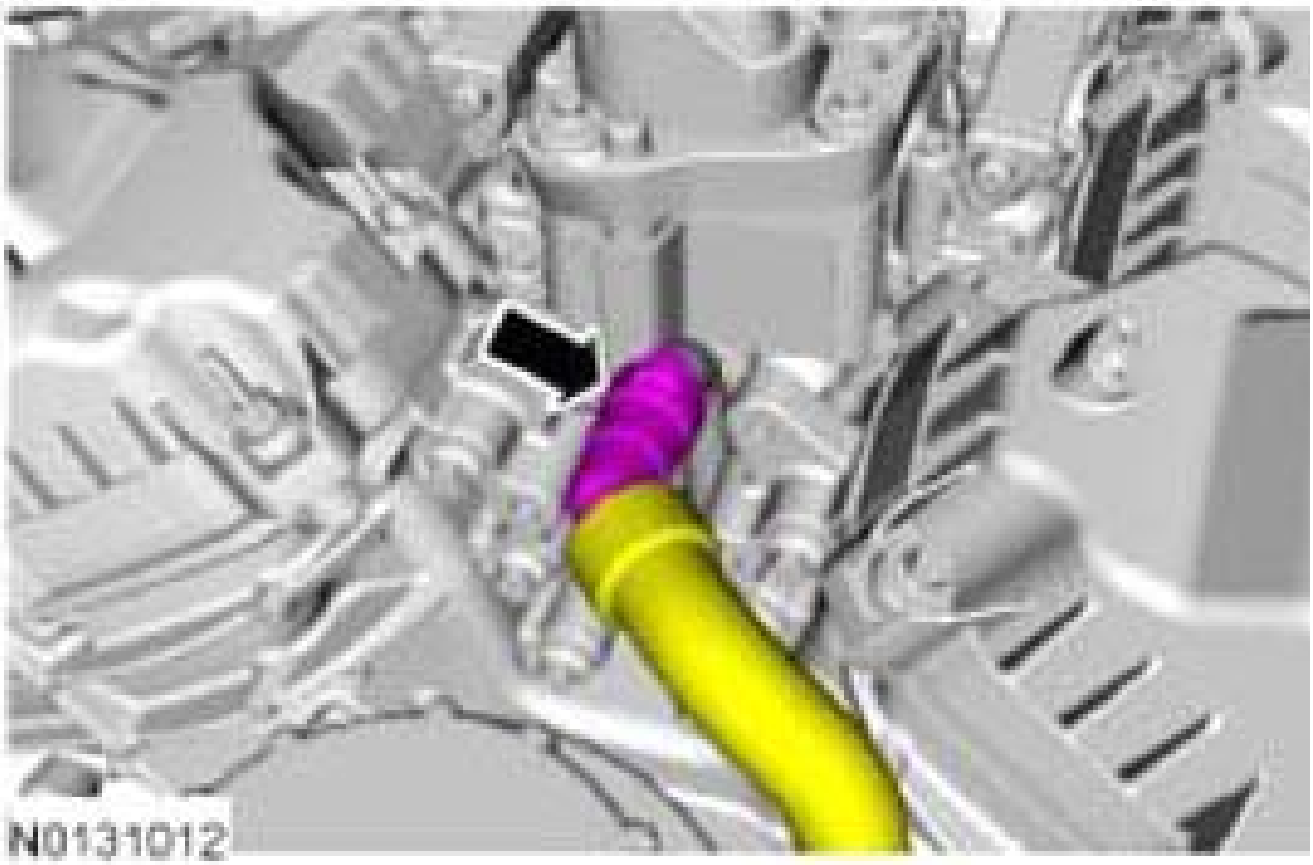
17. Remove the nut and disconnect the A/C tube.
    - Discard the O-ring seal and gasket seal.

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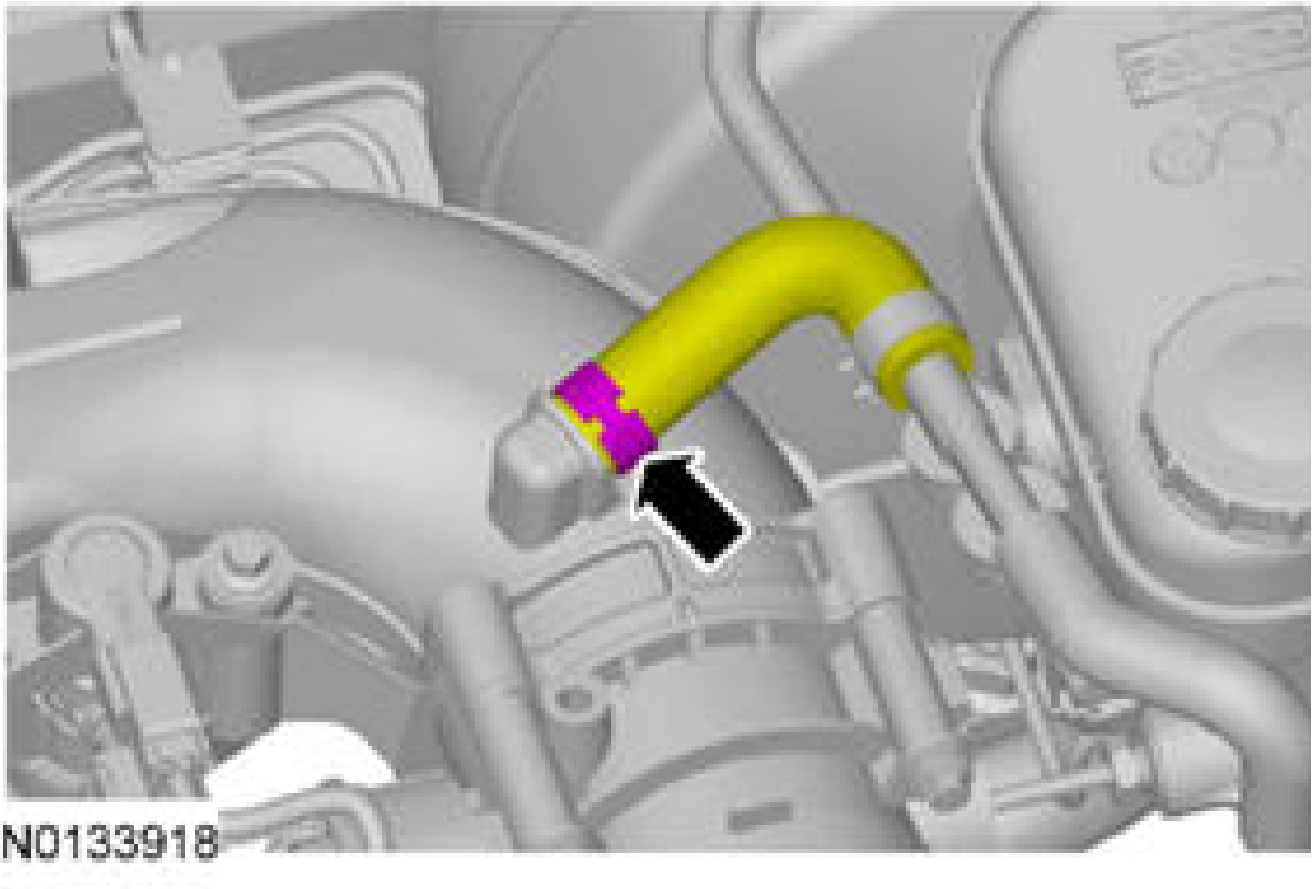
18. Remove degas bottle. REFER to **DEGAS BOTTLE** .
19. Disconnect the degas bottle coolant hose from the engine coolant tube.

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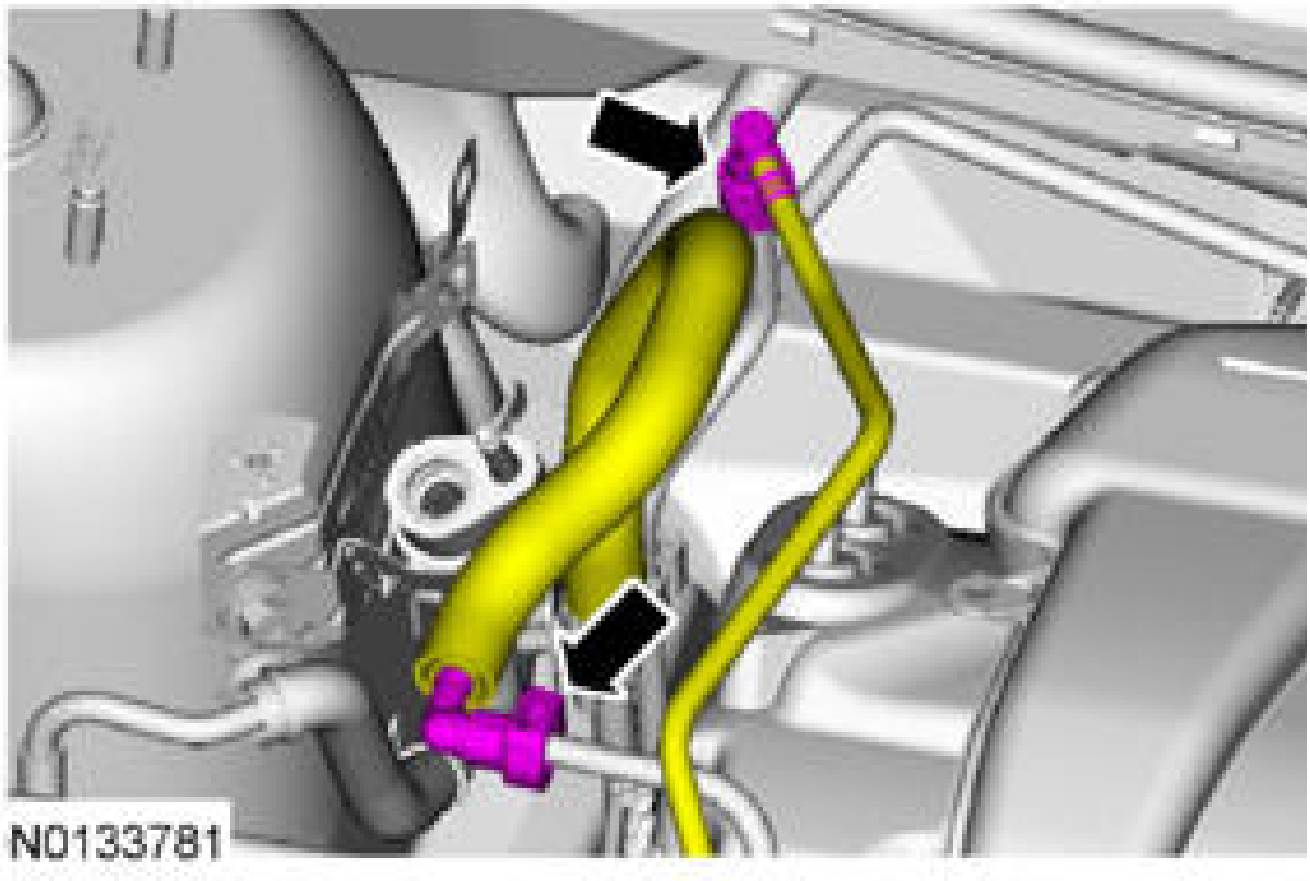
20. Disconnect the brake booster vacuum hose from the upper intake manifold.

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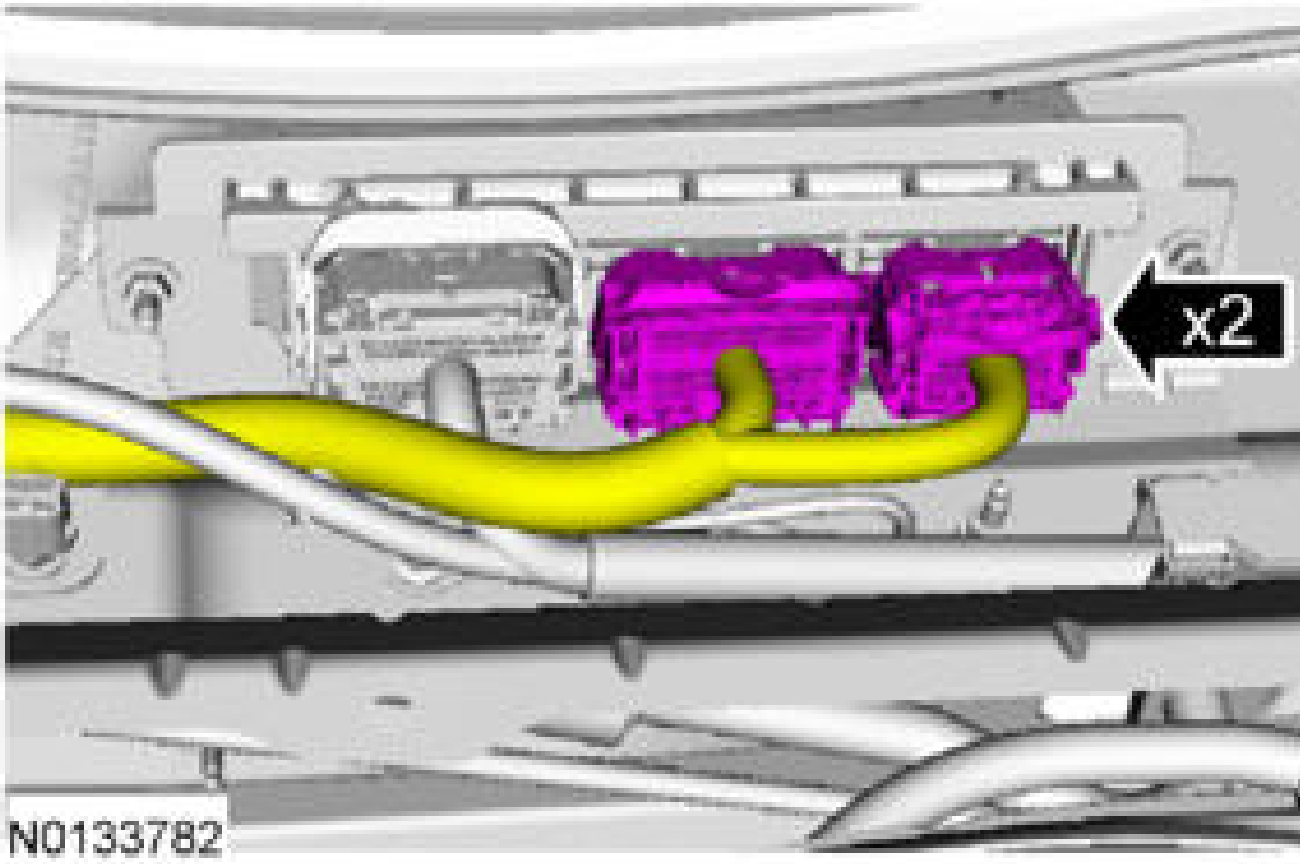
21. Disconnect the **EVAP** tube and the fuel supply tube quick connect coupling. REFER to **QUICK CONNECT COUPLING** .

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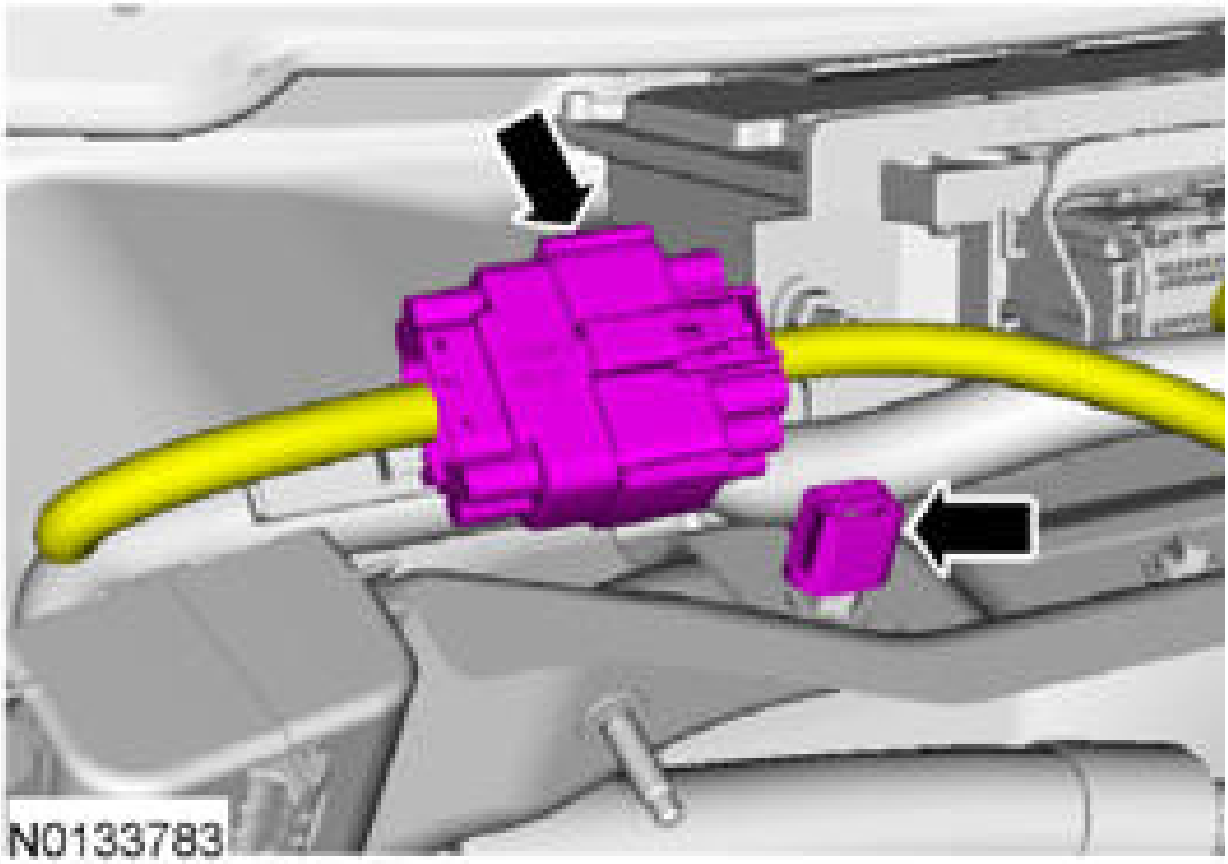
22. Disconnect the 2 **PCM** electrical connectors.

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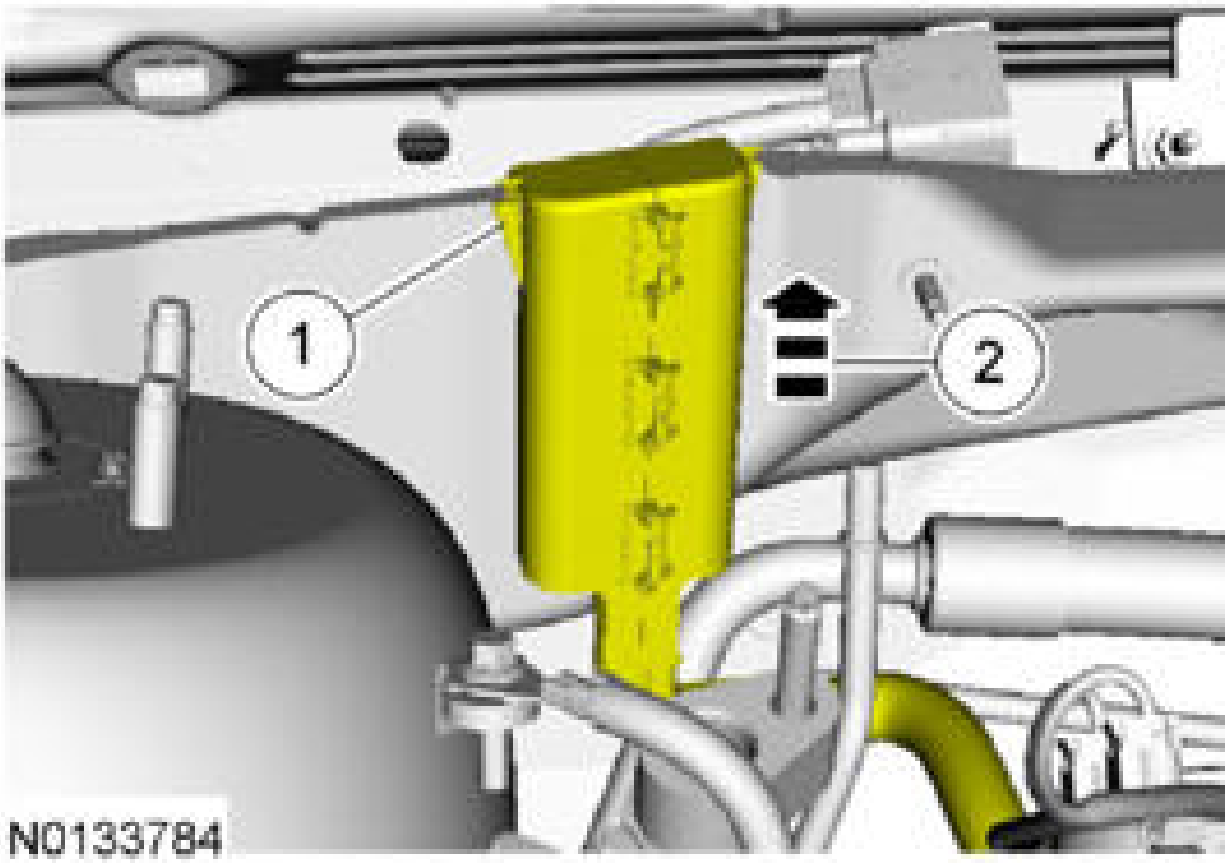
23. Disconnect the engine harness electrical connector.
    - Detach the wiring harness retainer.

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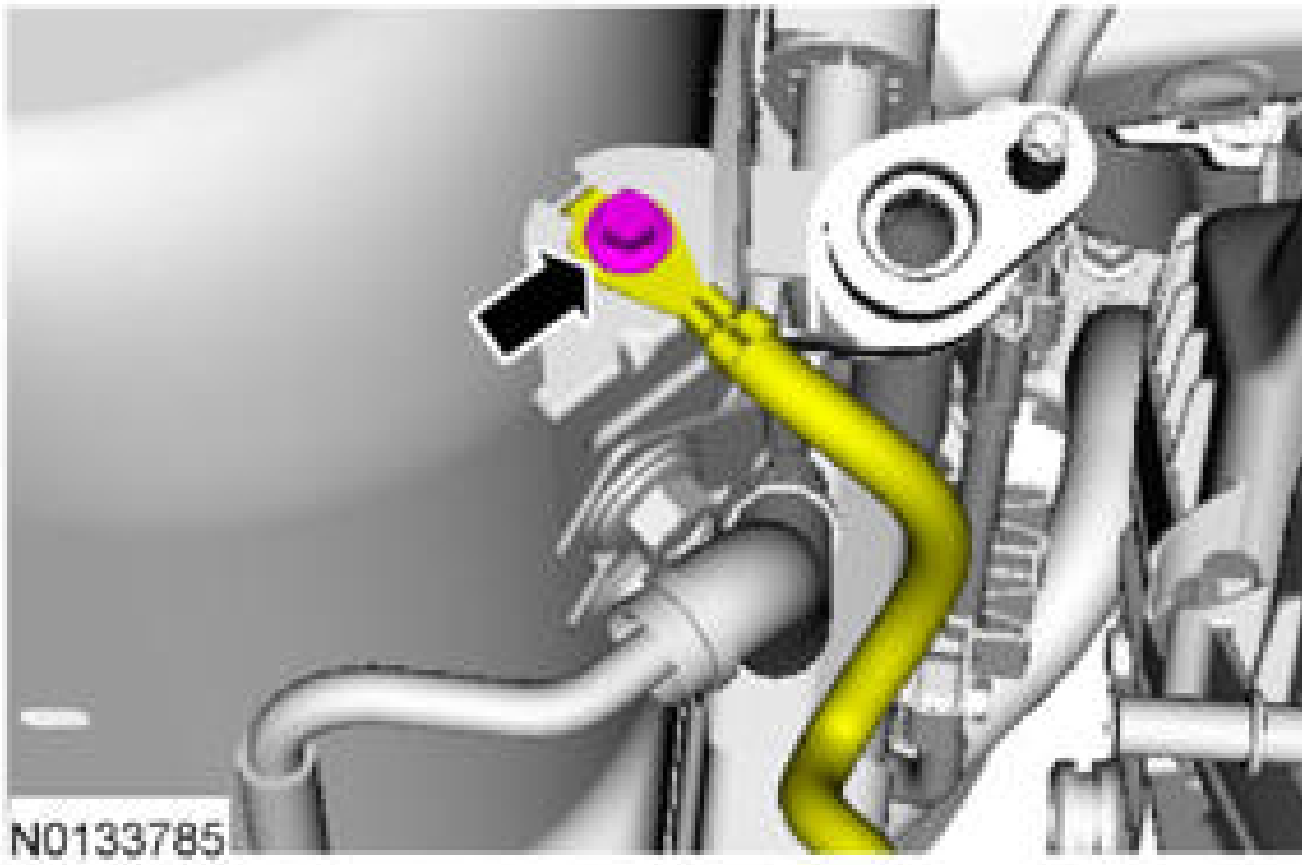
24. Remove the engine wiring harness retainer from the bulkhead.
    - Push the wiring harness retainer tab in.
    - Slide the wiring harness up and out of the bulkhead.

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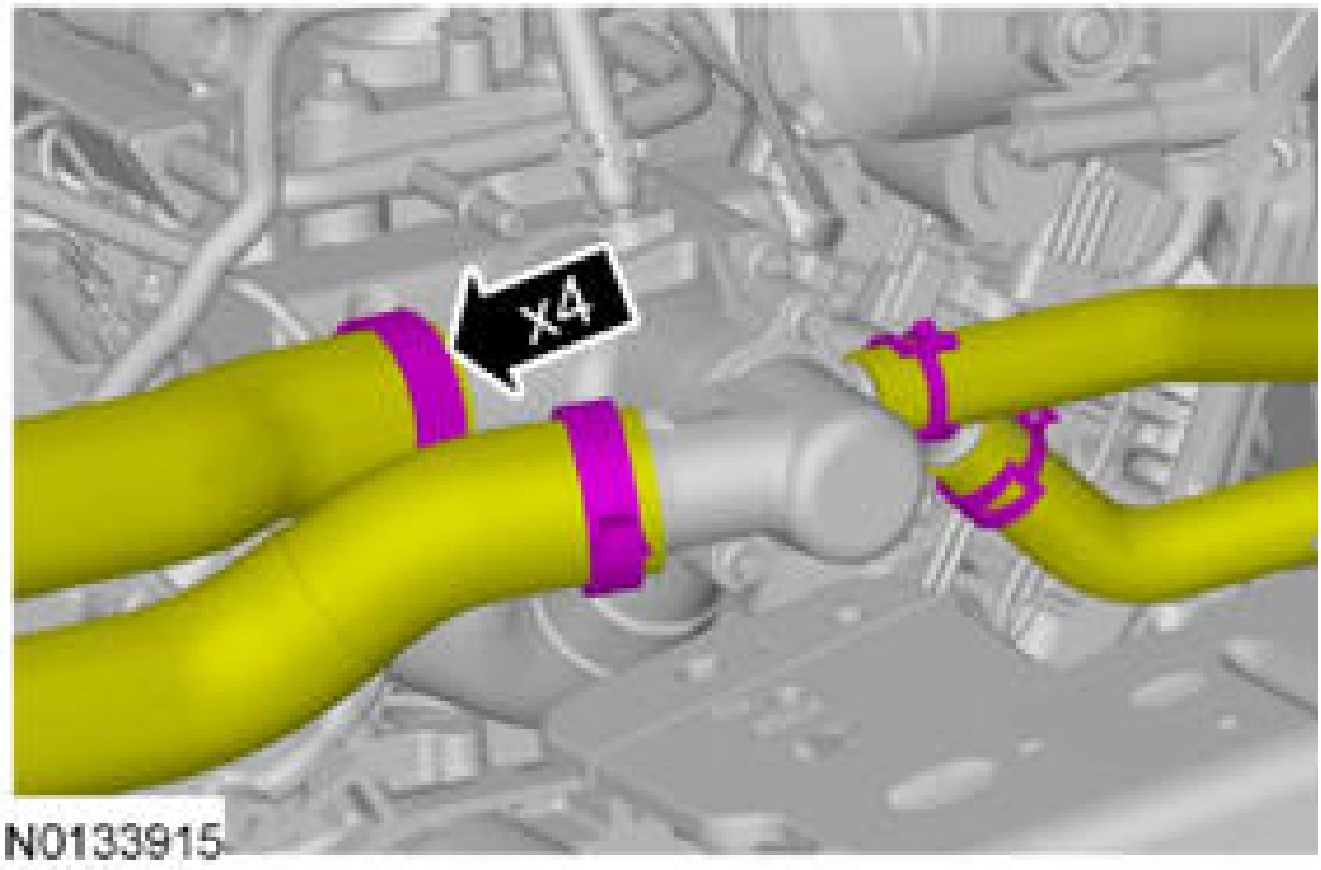
25. Remove the bolt and ground wire from the RH shock tower.

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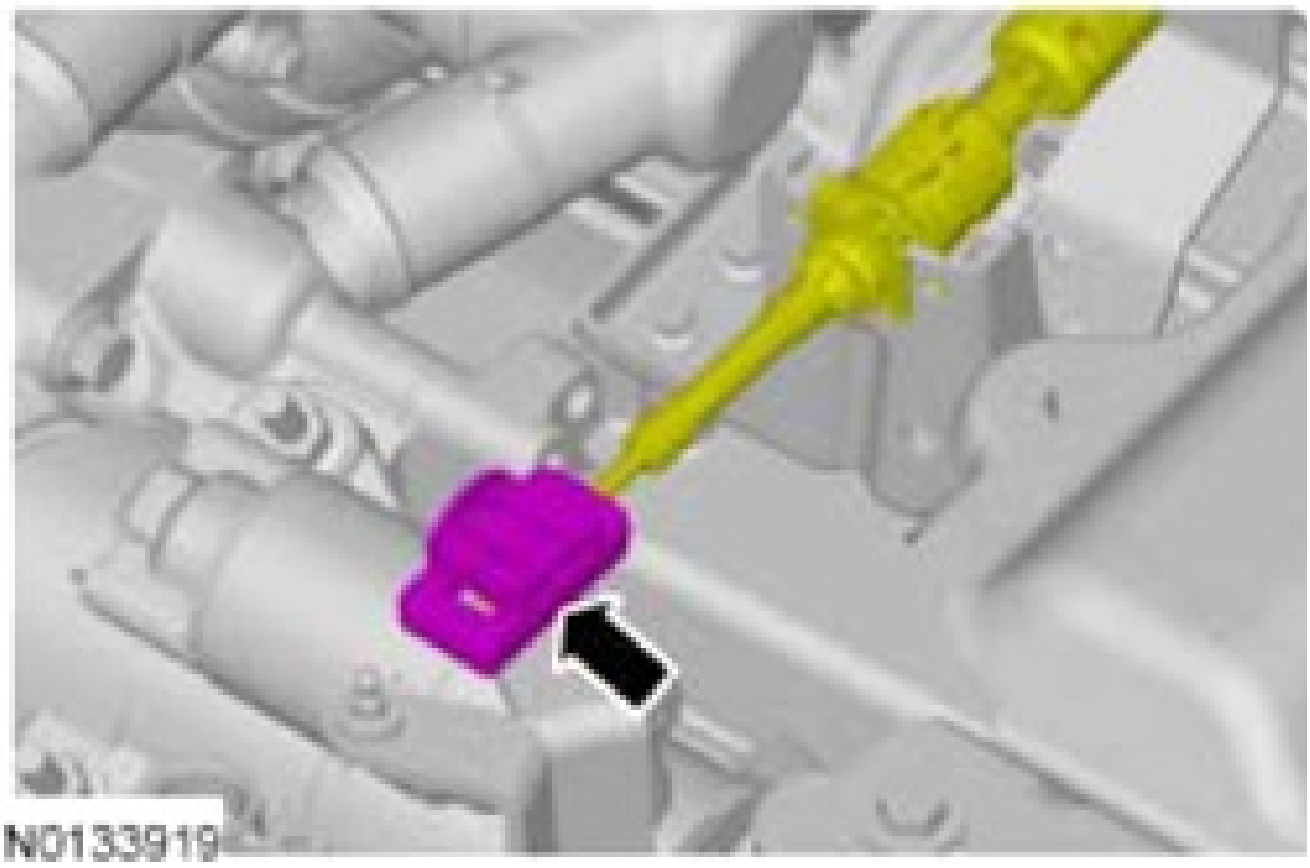
26. Disconnect the upper radiator hose, lower radiator hose and 2 heater hoses from the thermostat housing.

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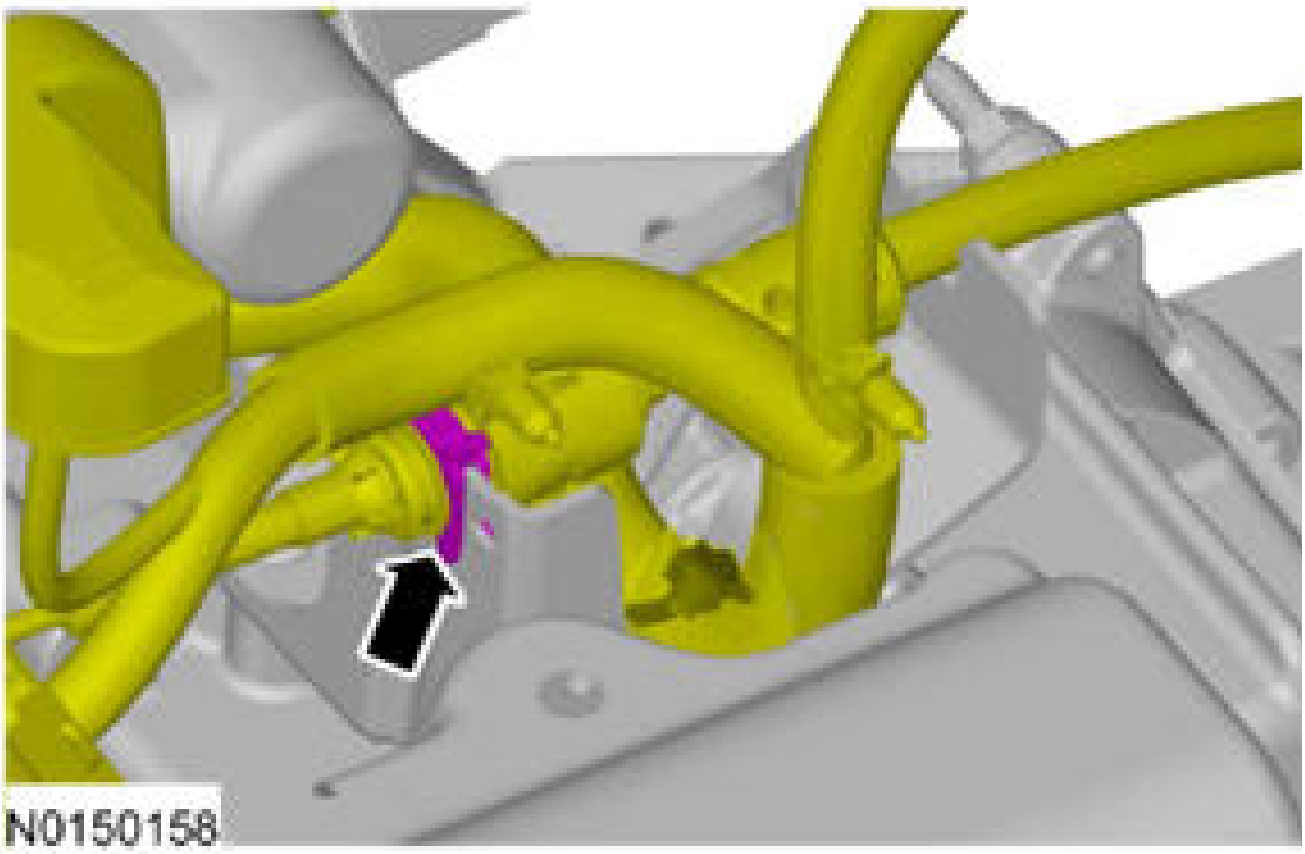
27. Disconnect the transaxle control cable from the control lever.

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28. Disconnect the transaxle control cable from the shift cable bracket.

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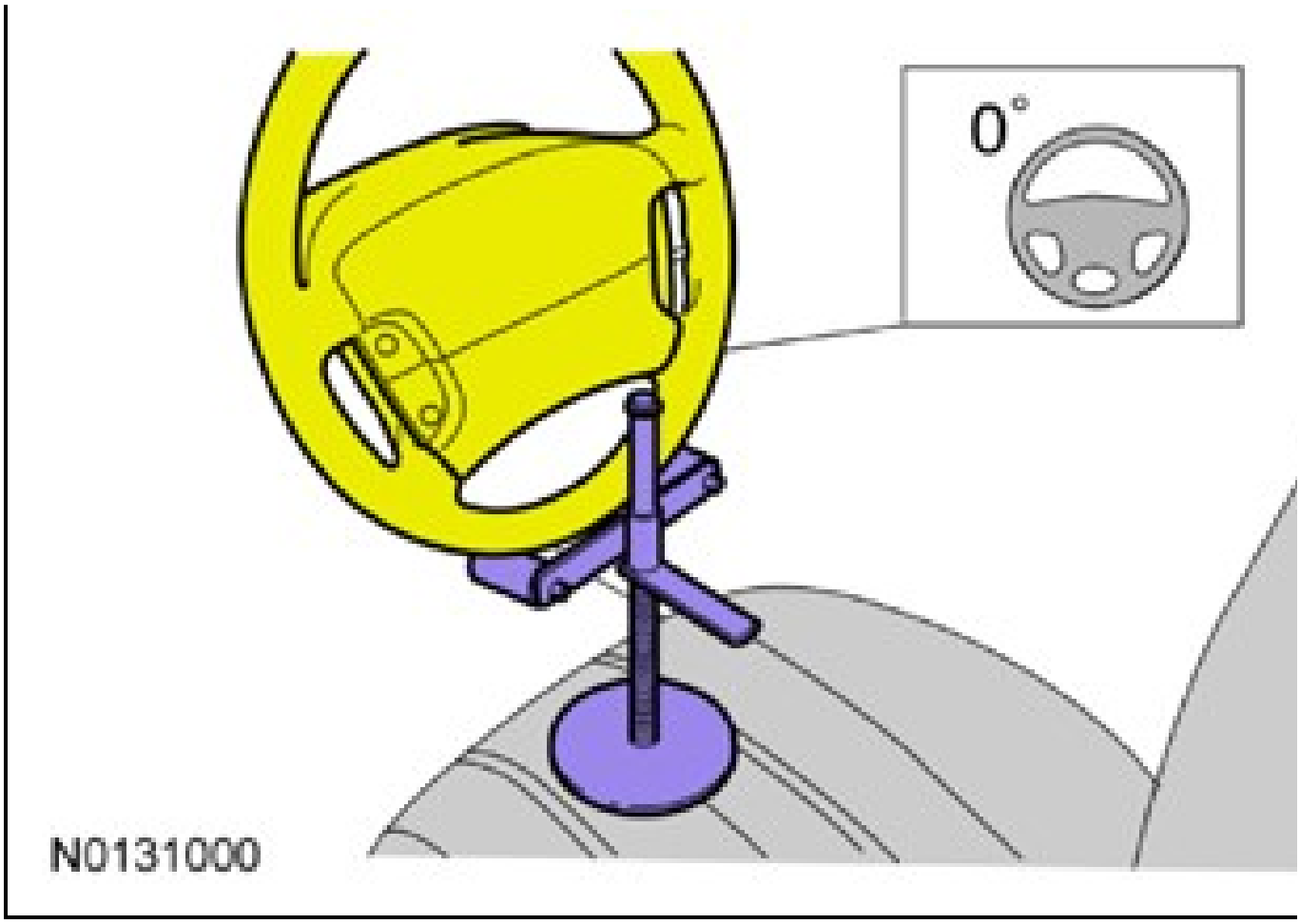


29. If equipped, detach the engine block heater harness.

NOTE: Use a steering wheel holding device (such as Hunter® 28-75-1 or equivalent).

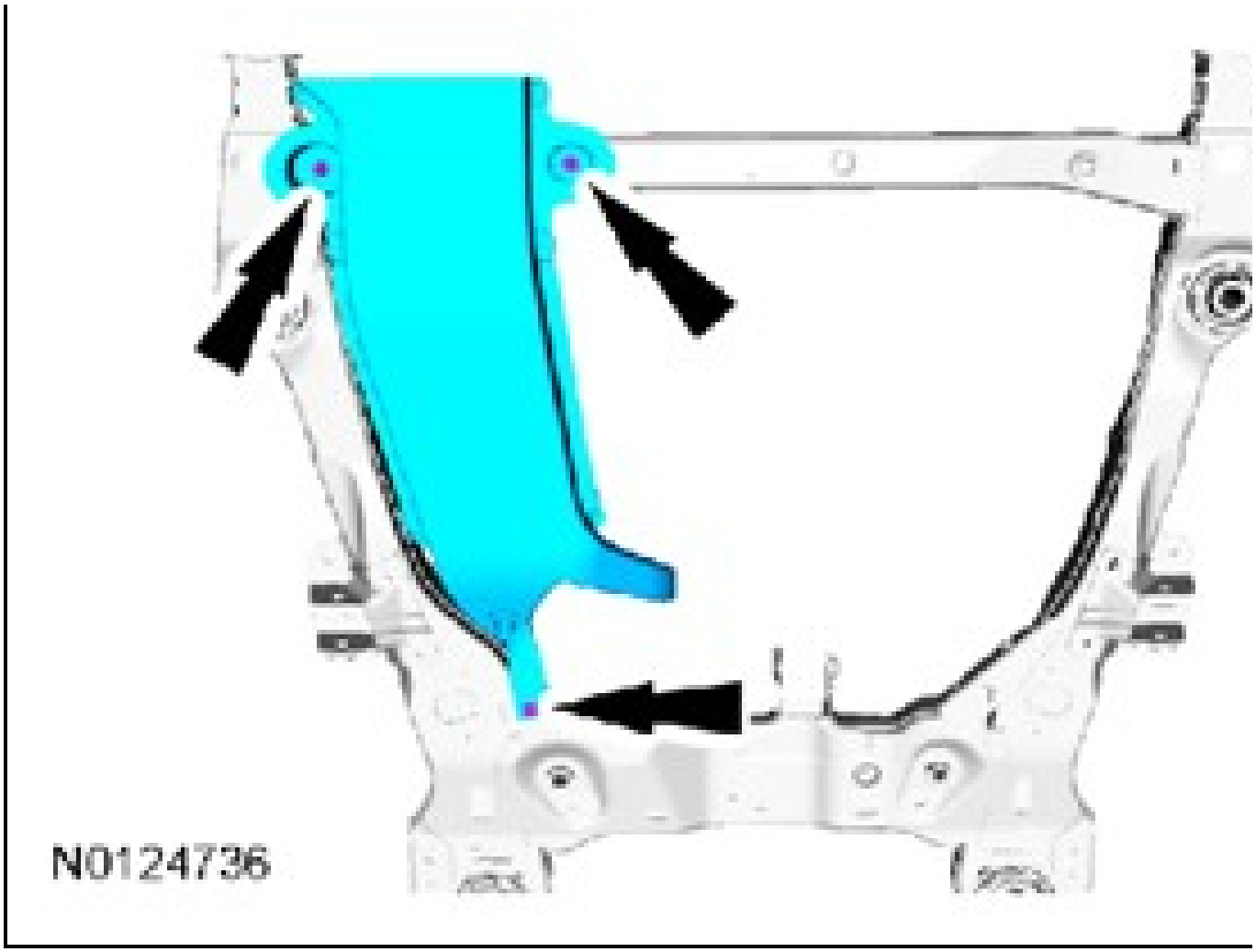
30. Using a suitable holding device, hold the steering wheel in the straight-ahead position.

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31. Remove the 3 twist lock retainers and the underbody air duct.

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32.

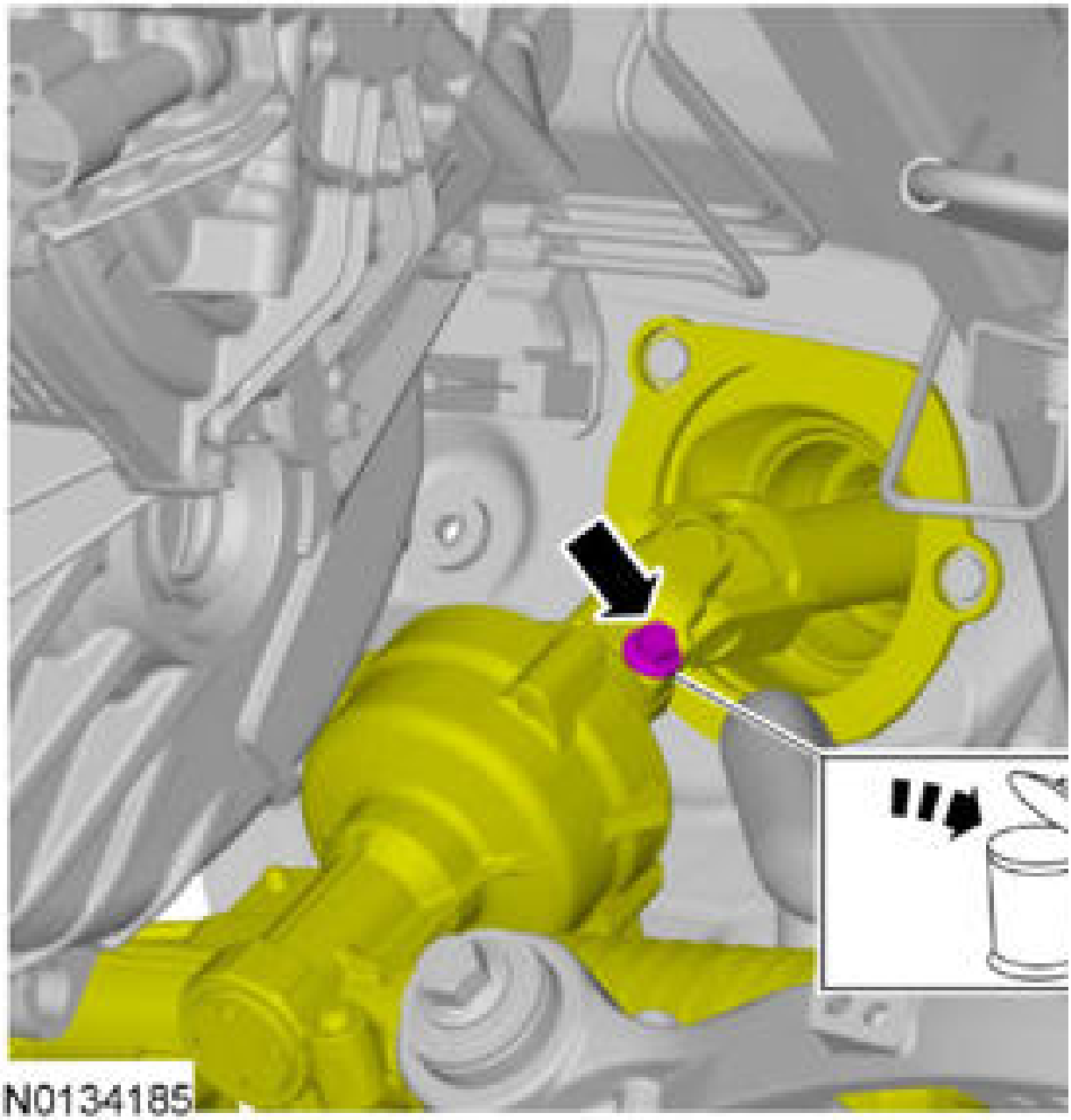
NOTE: **Do not allow the intermediate shaft to rotate while it is disconnected from the gear or damage to the clockspring may occur. If there is evidence that the intermediate shaft has rotated, the clockspring must be removed and recentered. For additional information, refer to CLOCKSPRING , and CLOCKSPRING ADJUSTMENT .**

NOTE: **Index-mark the steering column shaft position to the steering gear for reference during installation.**

Remove the bolt and disconnect the steering column shaft from the steering gear.

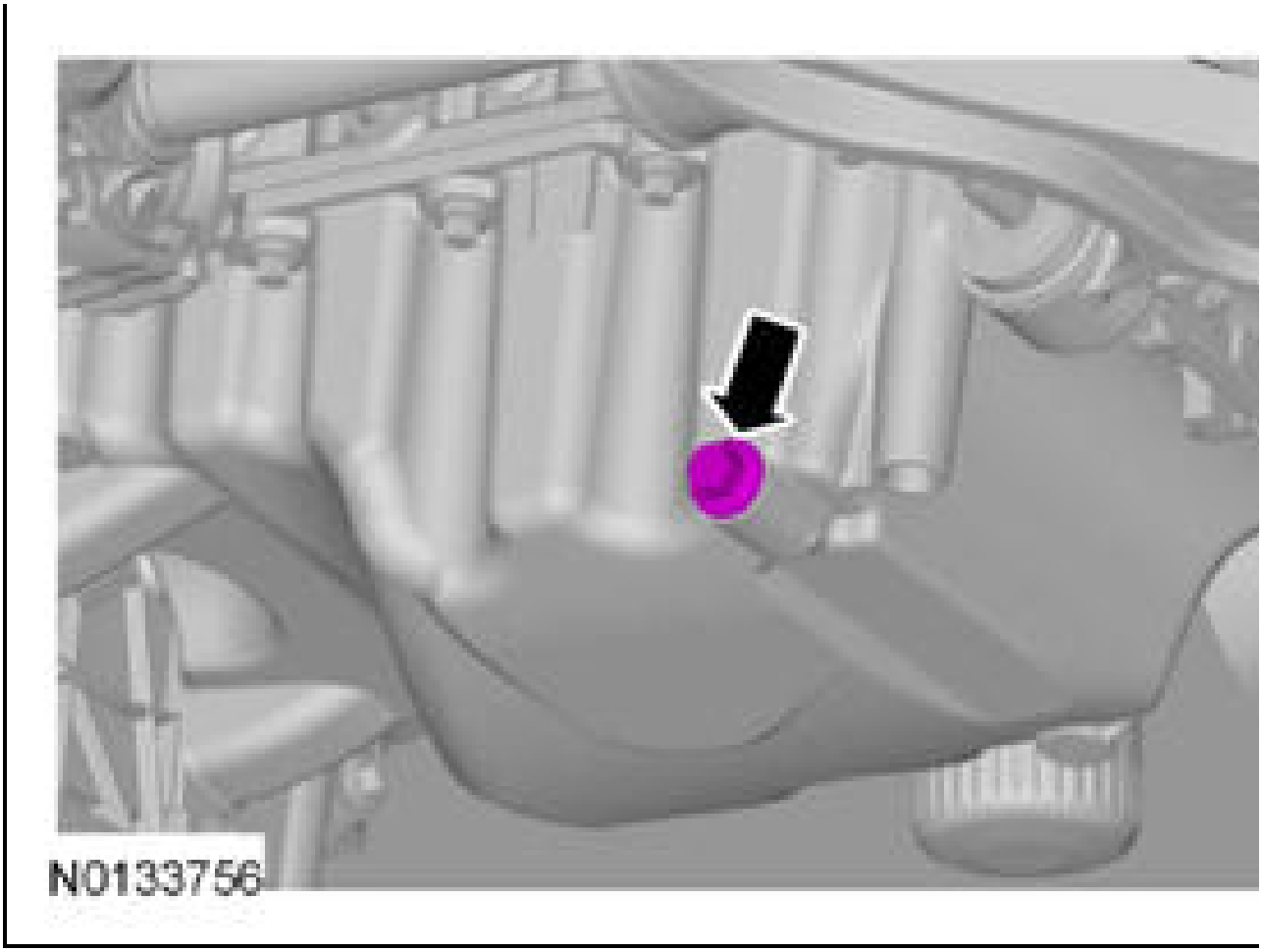
- Discard the bolt.

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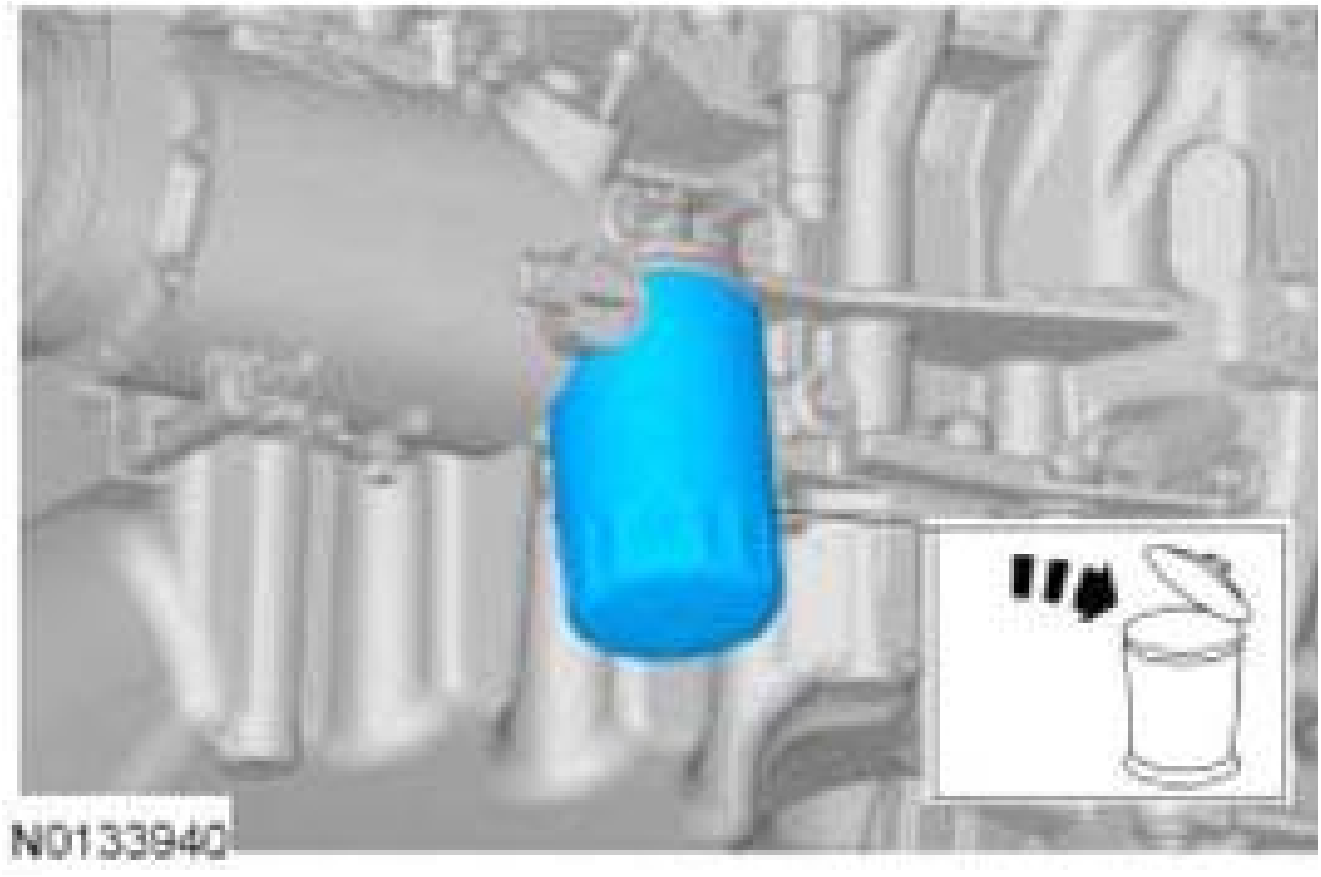
33. Remove the exhaust Y-pipe. For additional information, refer to **EXHAUST Y-PIPE - 3.5L TI-VCT** .
34. Remove the drain plug and drain the engine oil.
    - Install the drain plug and tighten to 27 Nm (20 lb-ft).

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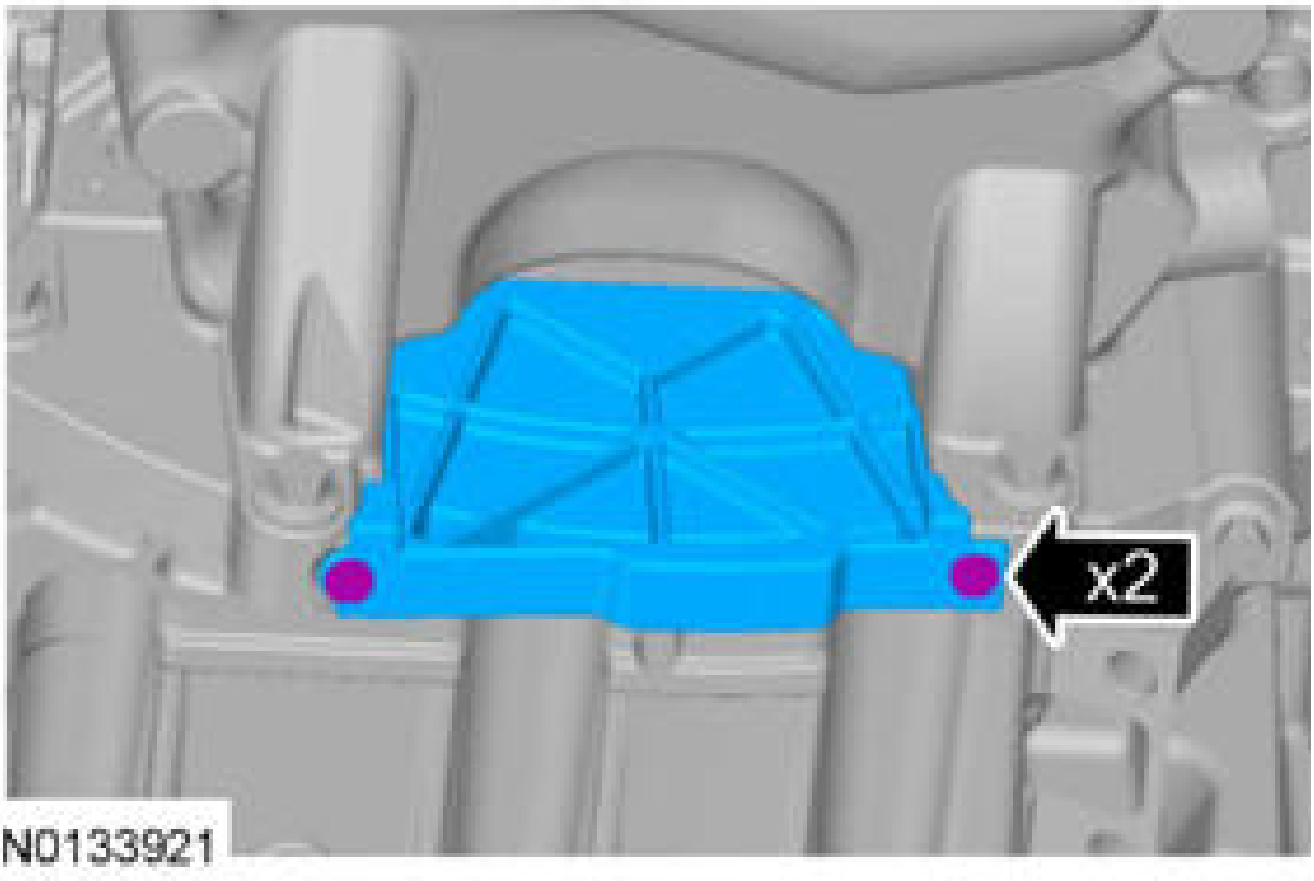
35. Remove and discard the engine oil filter.

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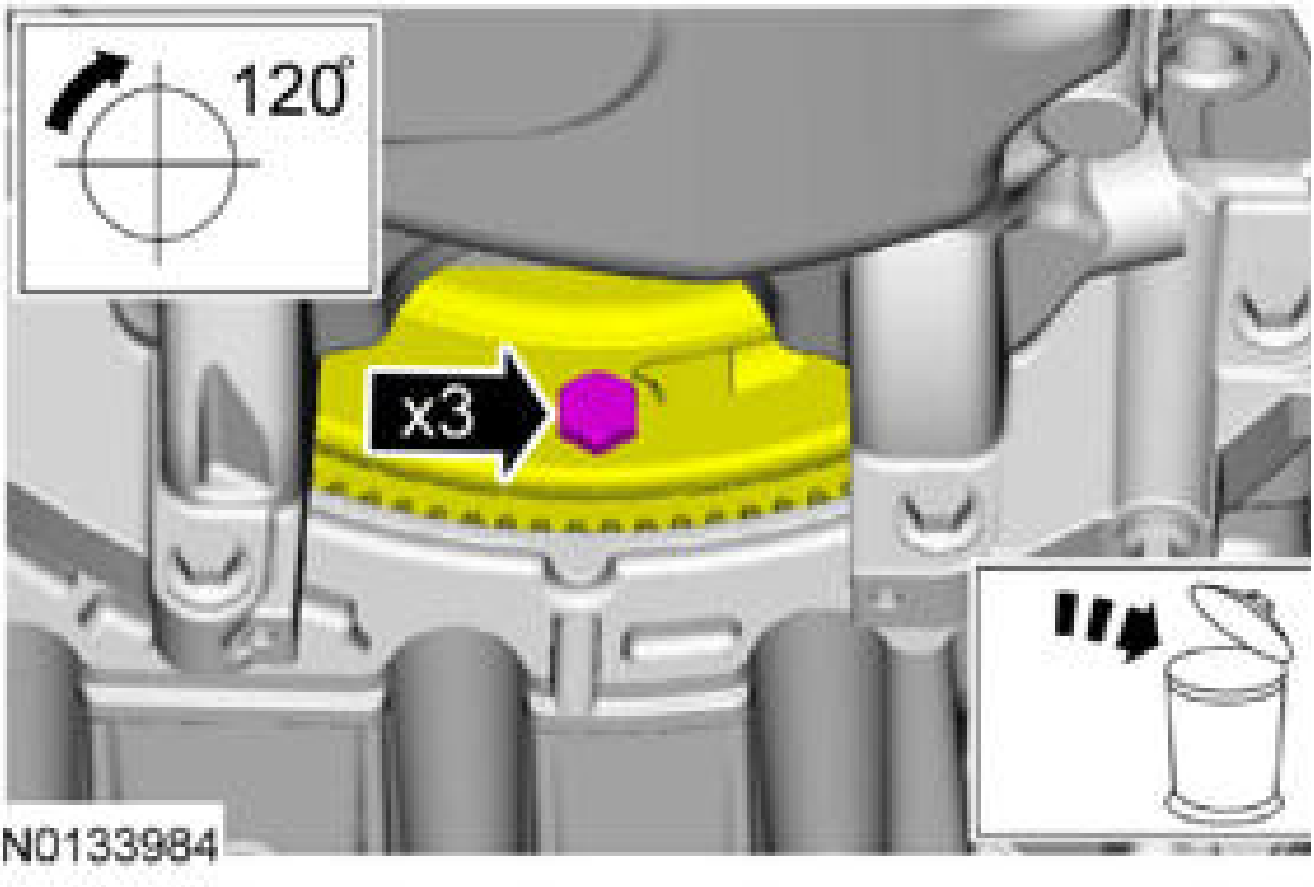
36. Remove the 2 fasteners and the inspection cover.

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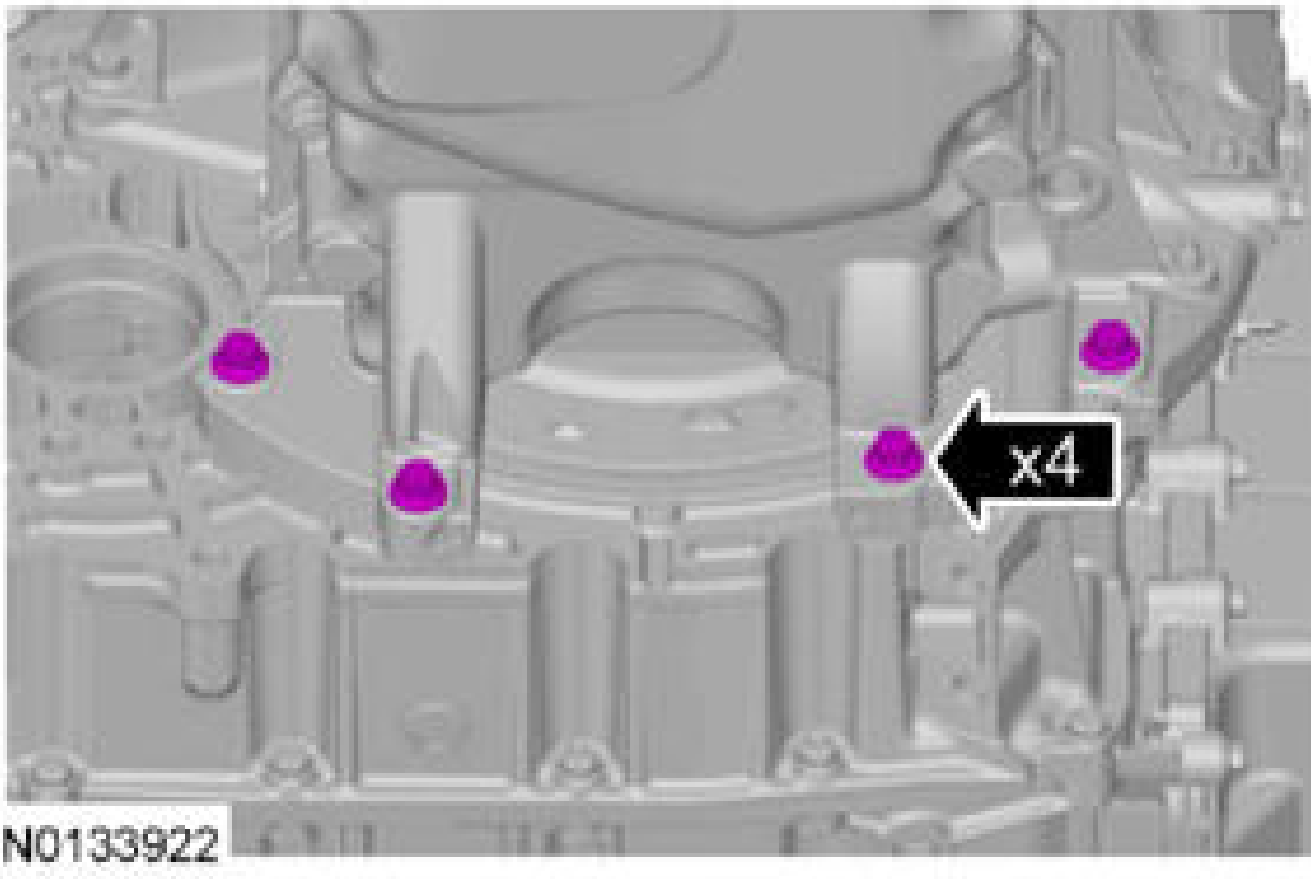
37. Remove and discard the 3 torque converter bolts.

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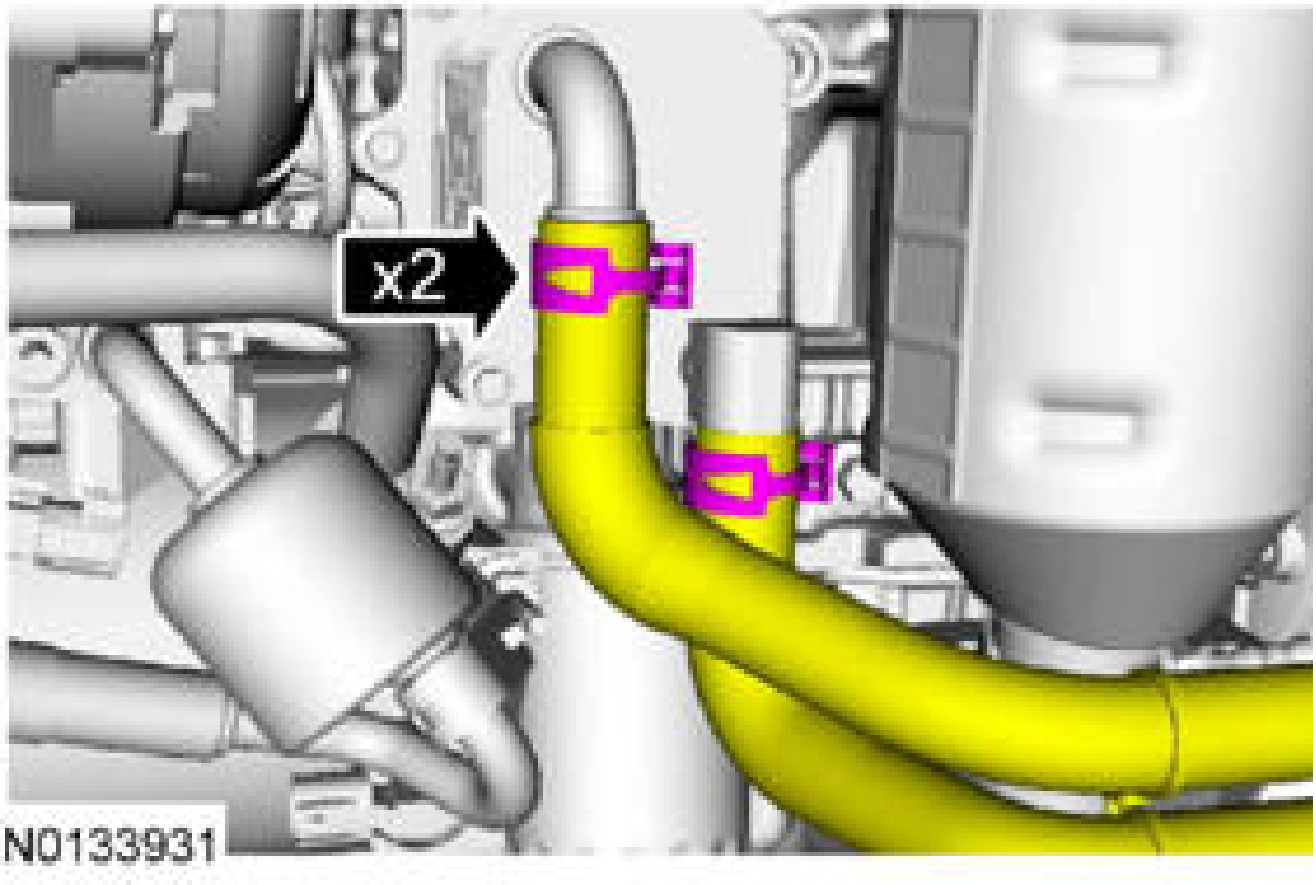
38. Remove the 4 oil pan-to-transaxle bolts.

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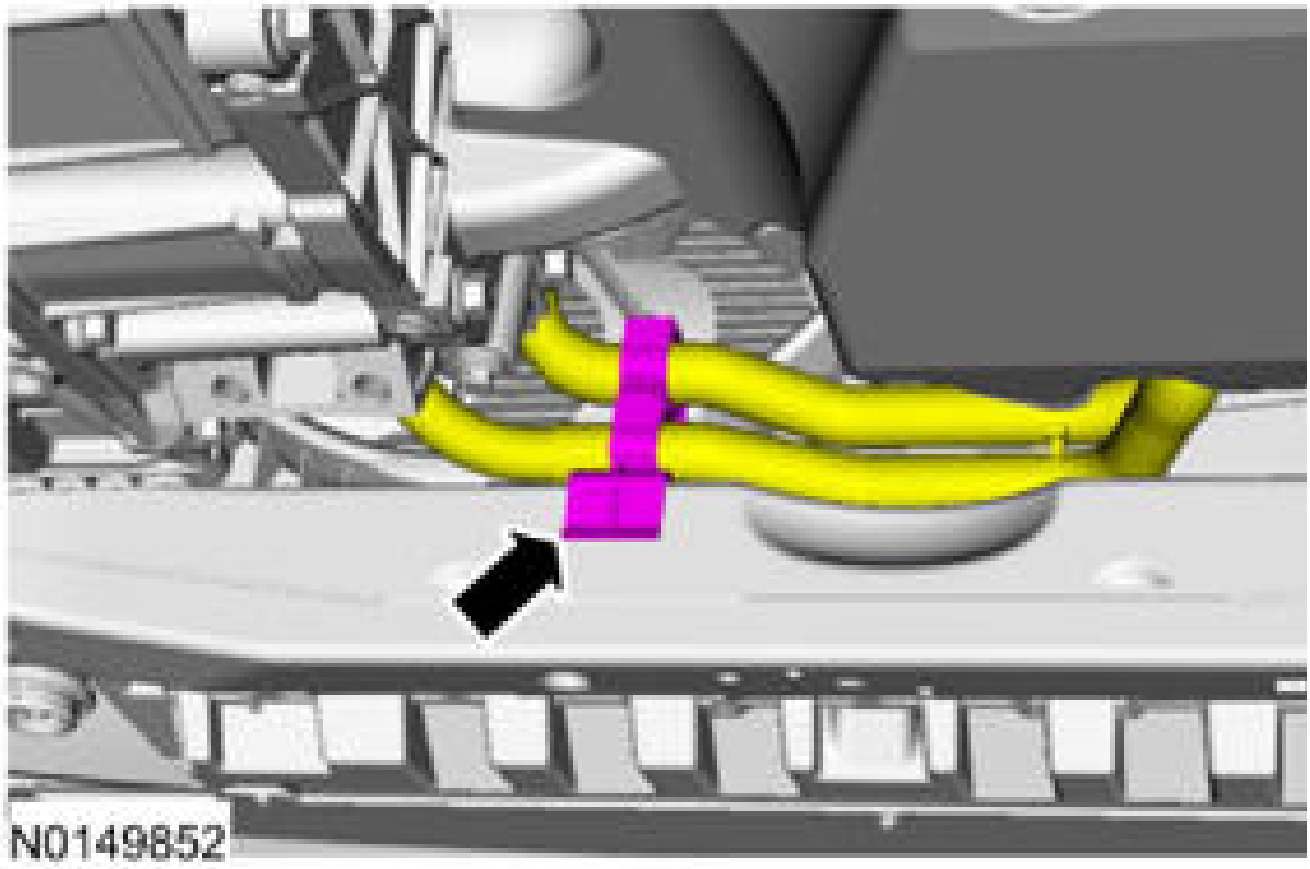
39. If equipped, disconnect the oil cooler coolant hoses.

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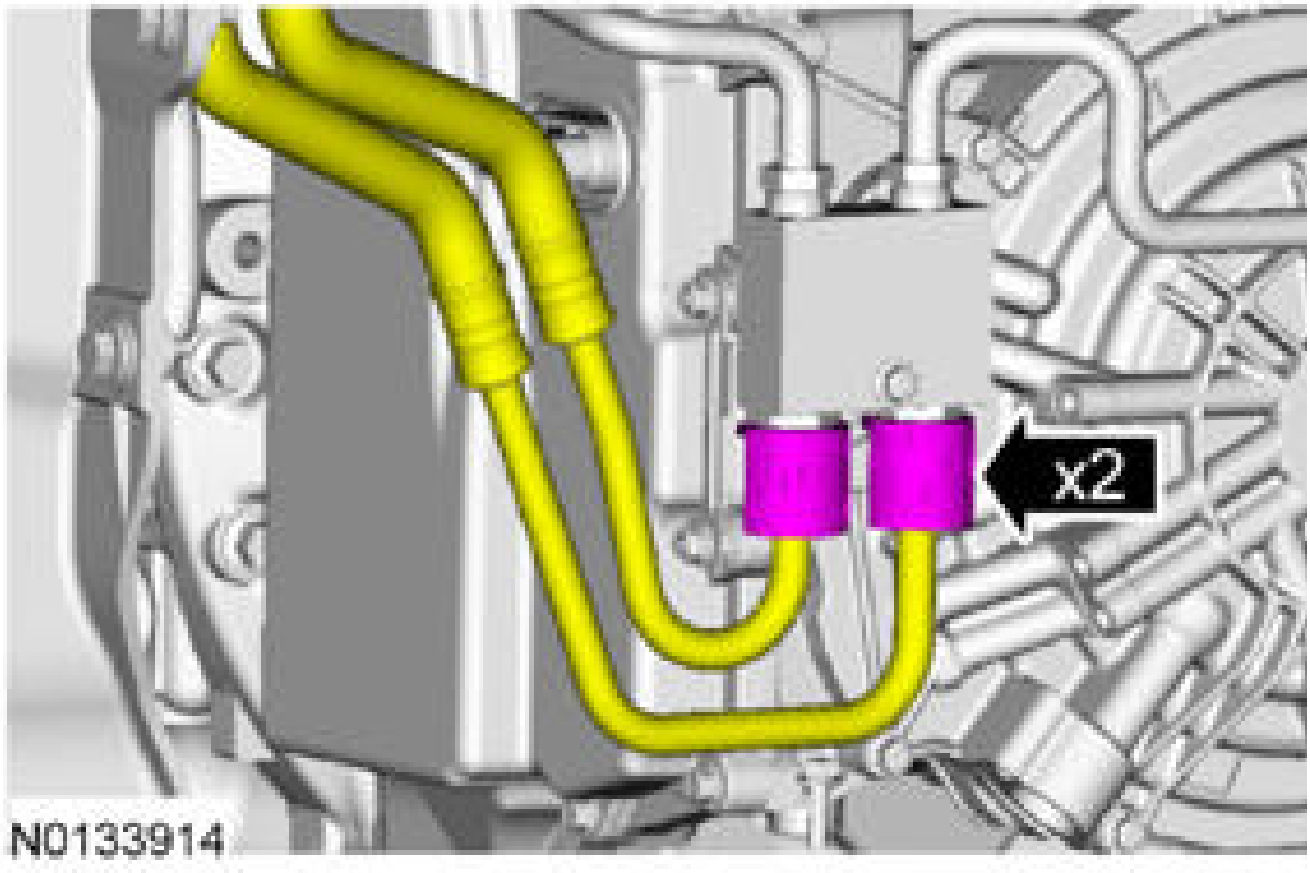
40. If equipped, unlatch the cooler hose retainer latch and pry up on the oil cooler hose retainer to release the retainer and remove it from the subframe.

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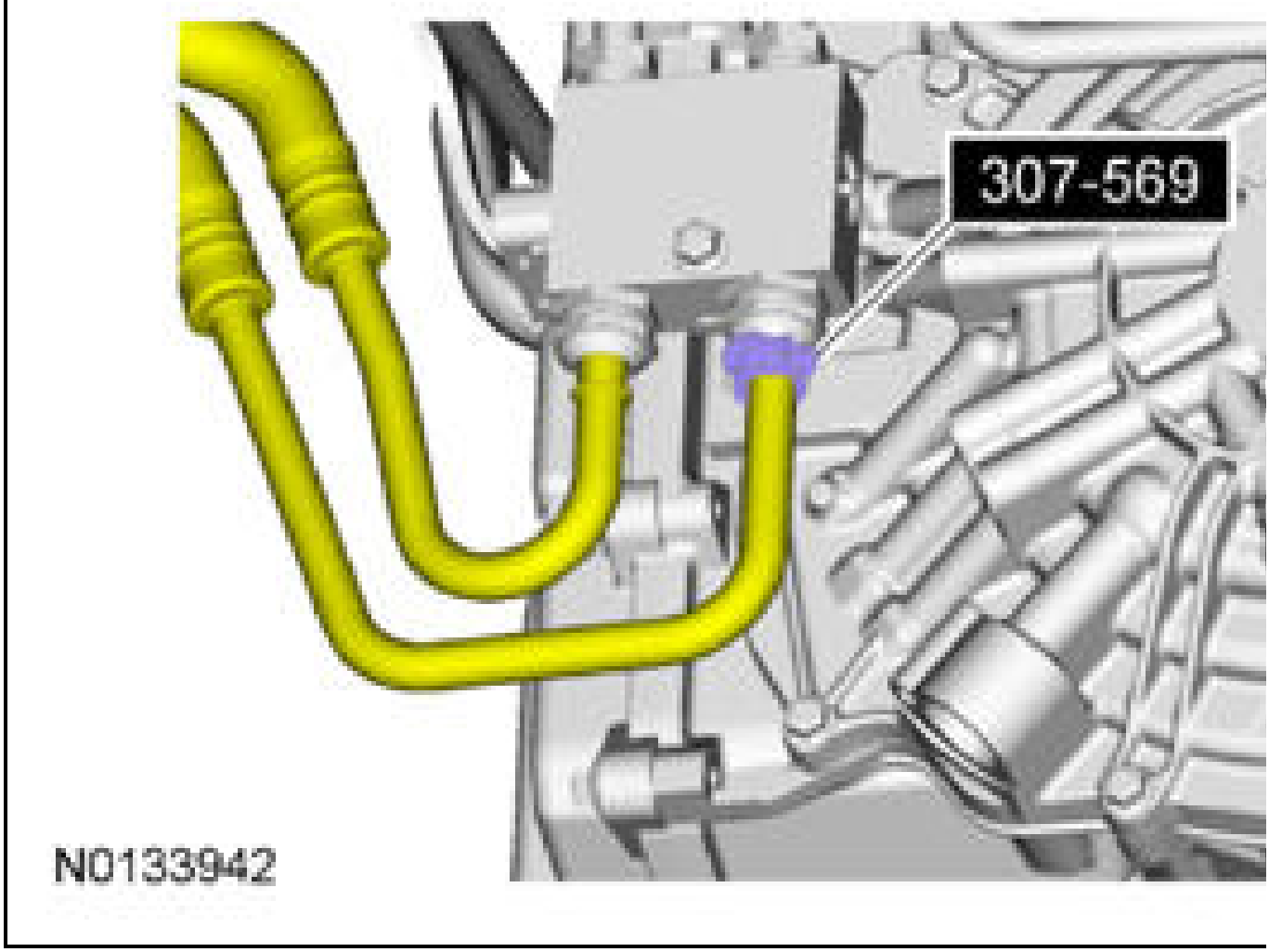
41. Remove the 2 secondary latches from the transmission fluid cooler tubes at the transmission fluid cooler thermal bypass valve.

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42. Using 307-569, disconnect the transmission fluid cooler tubes from the transmission fluid cooler thermal bypass valve.

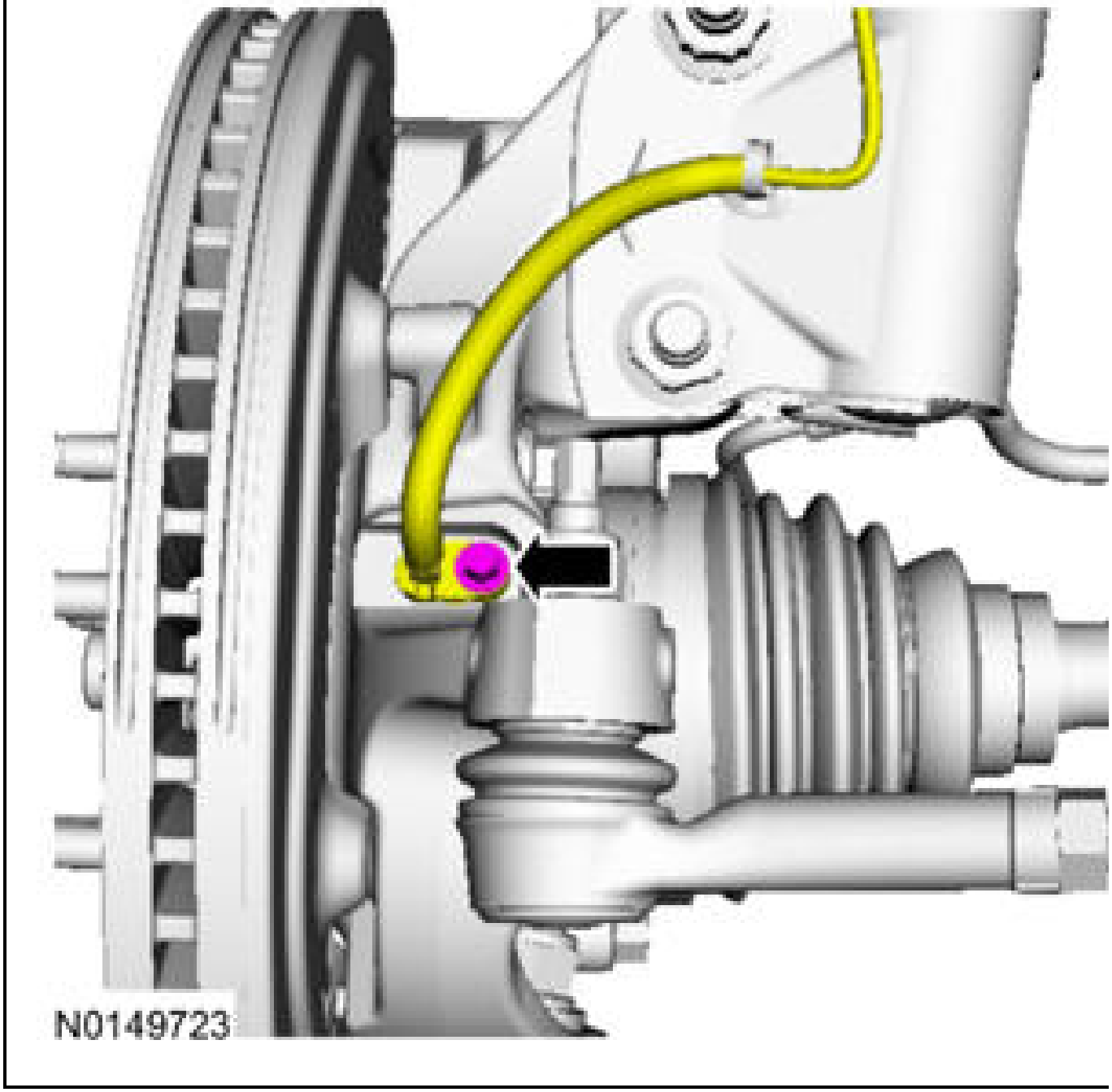
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43. **NOTE: LH shown in illustration, RH similar.**

Remove the bolt and the wheel speed sensor.

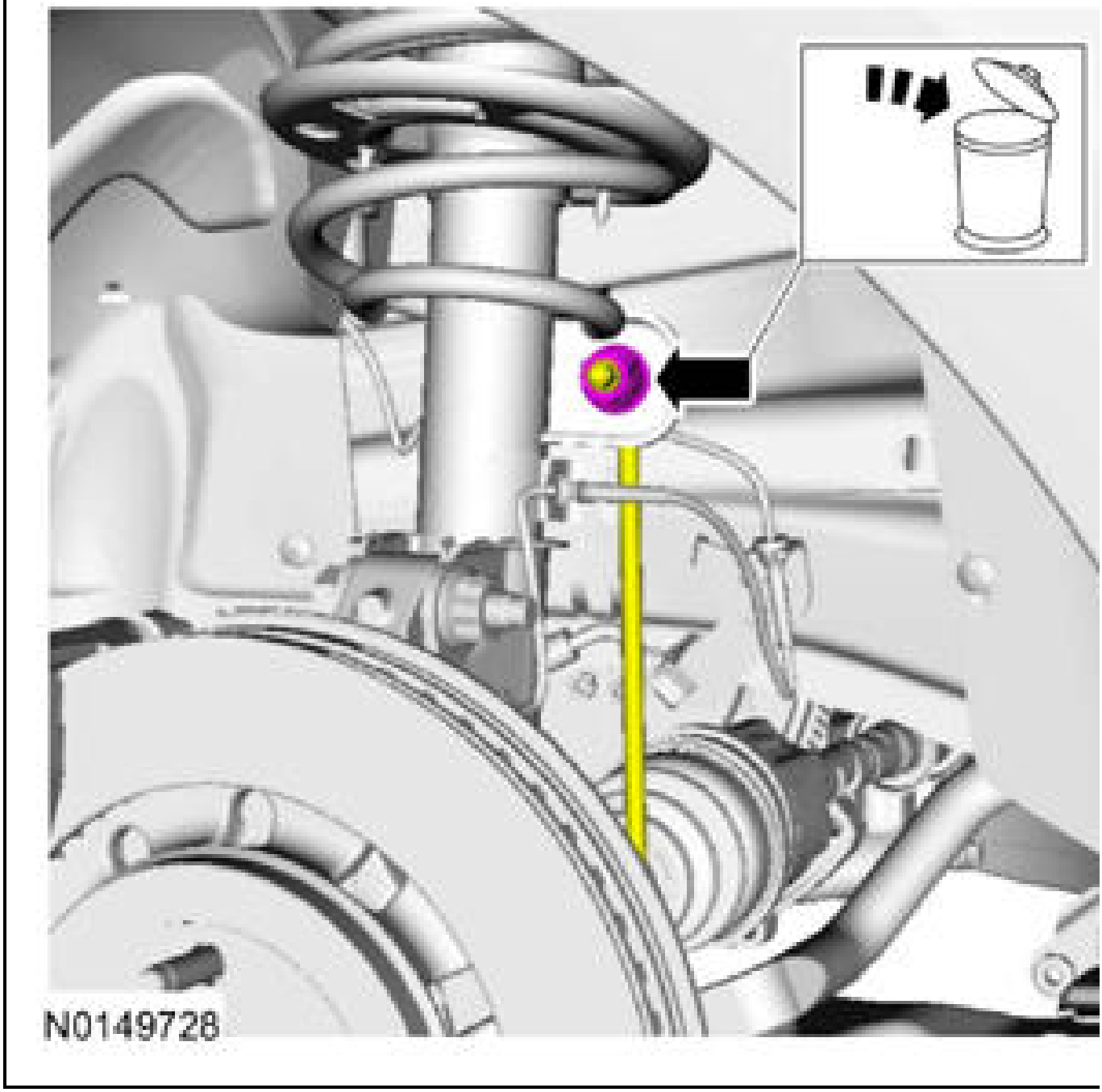
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44. **NOTE: LH shown in illustration, RH similar.**

Remove and discard the upper stabilizer link nut.

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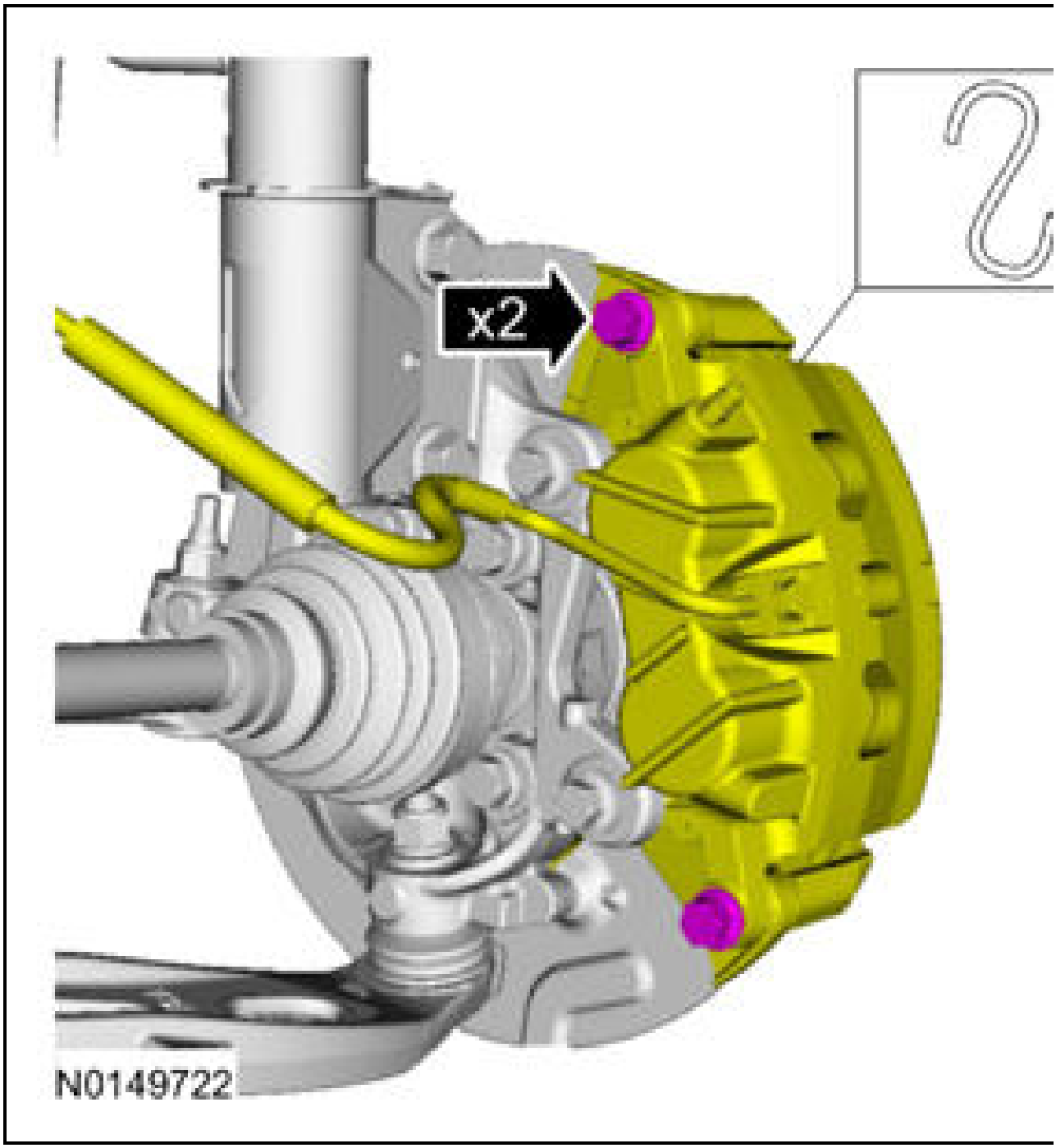
45. **NOTE: Do not allow the brake caliper to hang from the brake flexible hose or damage to the hose may occur.**

NOTE: LH shown in illustration, RH similar.

Remove the brake caliper guide pin bolts and calipers.

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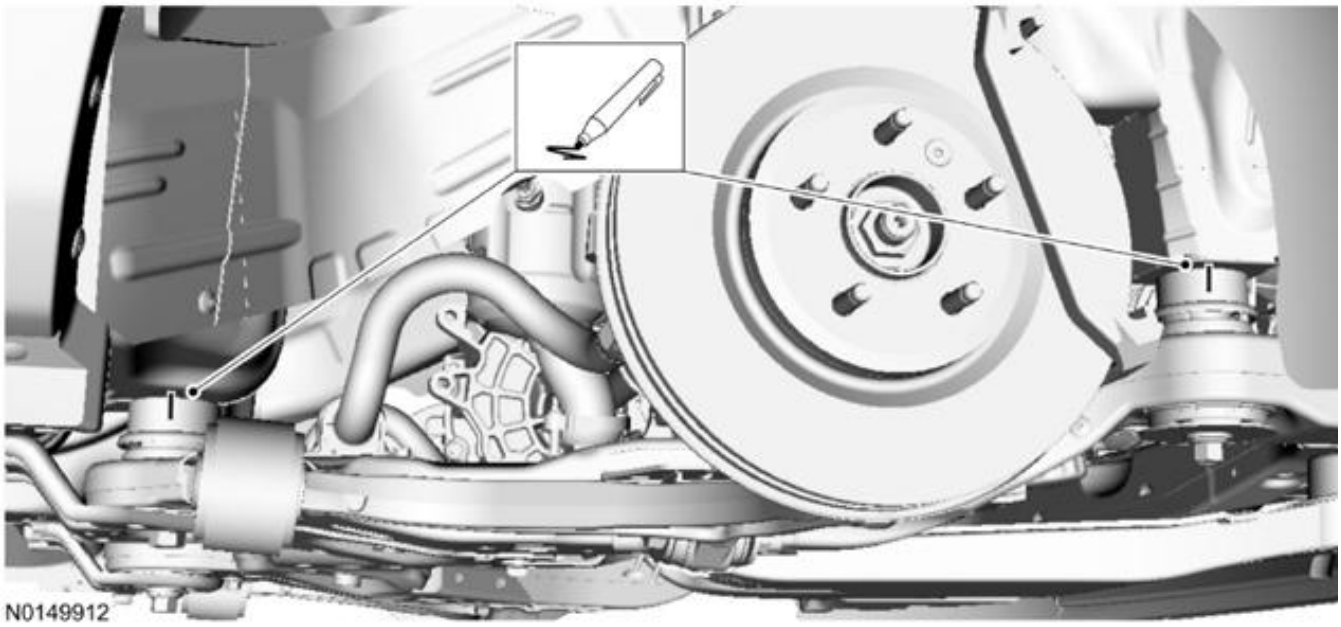
- Support the calipers.



46. **NOTE: RH shown in illustration, LH similar.**

Using a wax pencil, mark the relationship of the front and rear subframe to the underbody at the mounting locations on both side.

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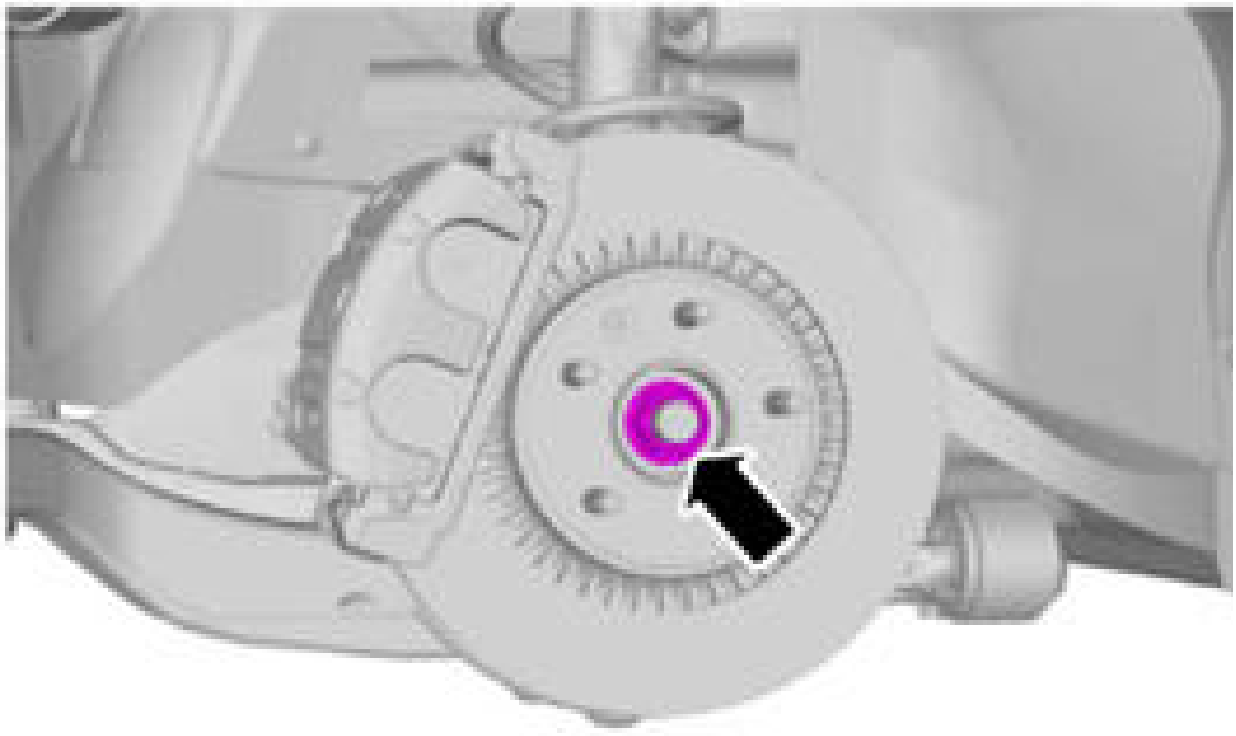


47. **NOTE: LH shown in illustration, RH similar.**

Remove the LH and RH halfshaft nuts.

- Do not discard at this time.

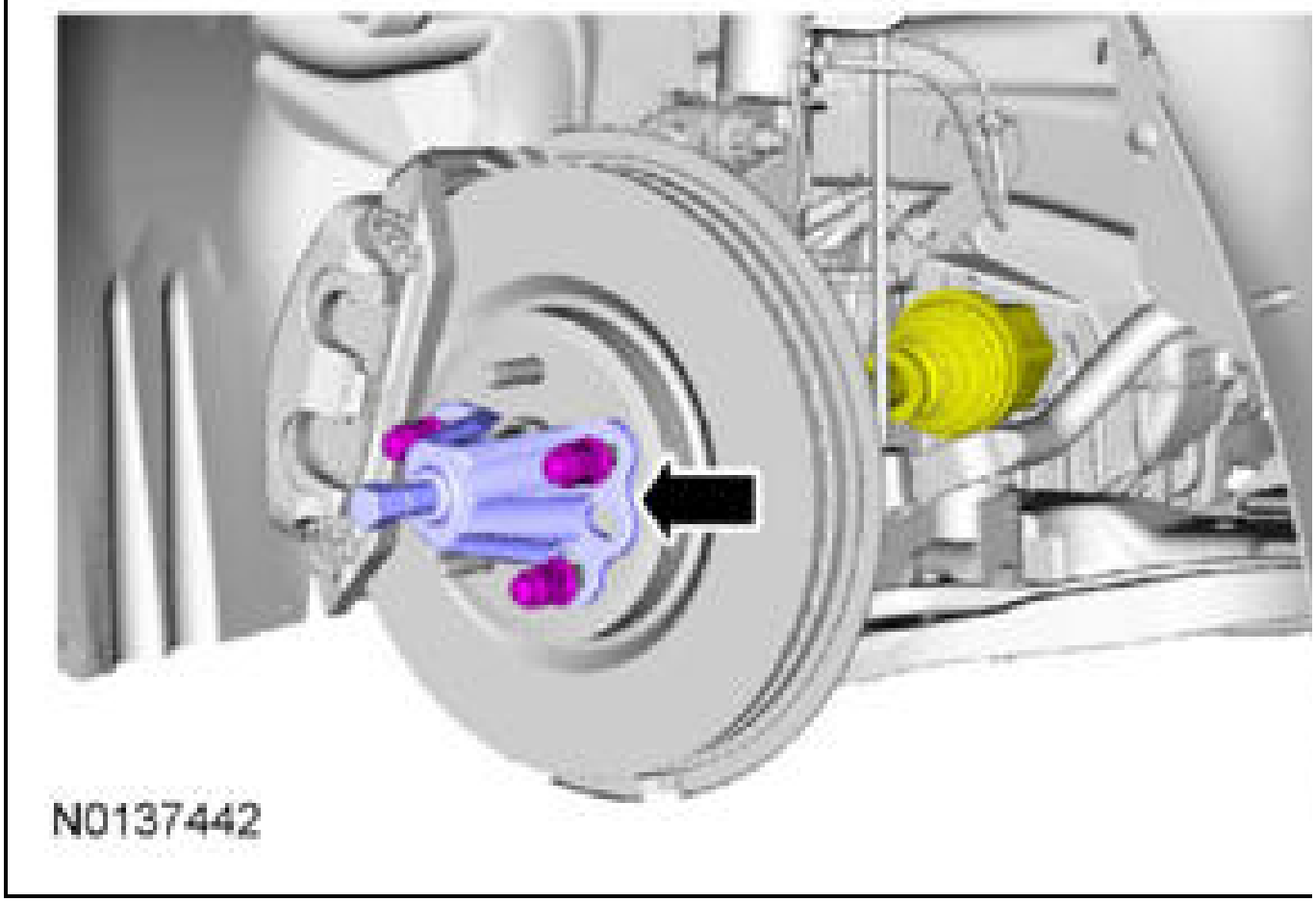
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48. **NOTE: LH shown in illustration, RH similar.**

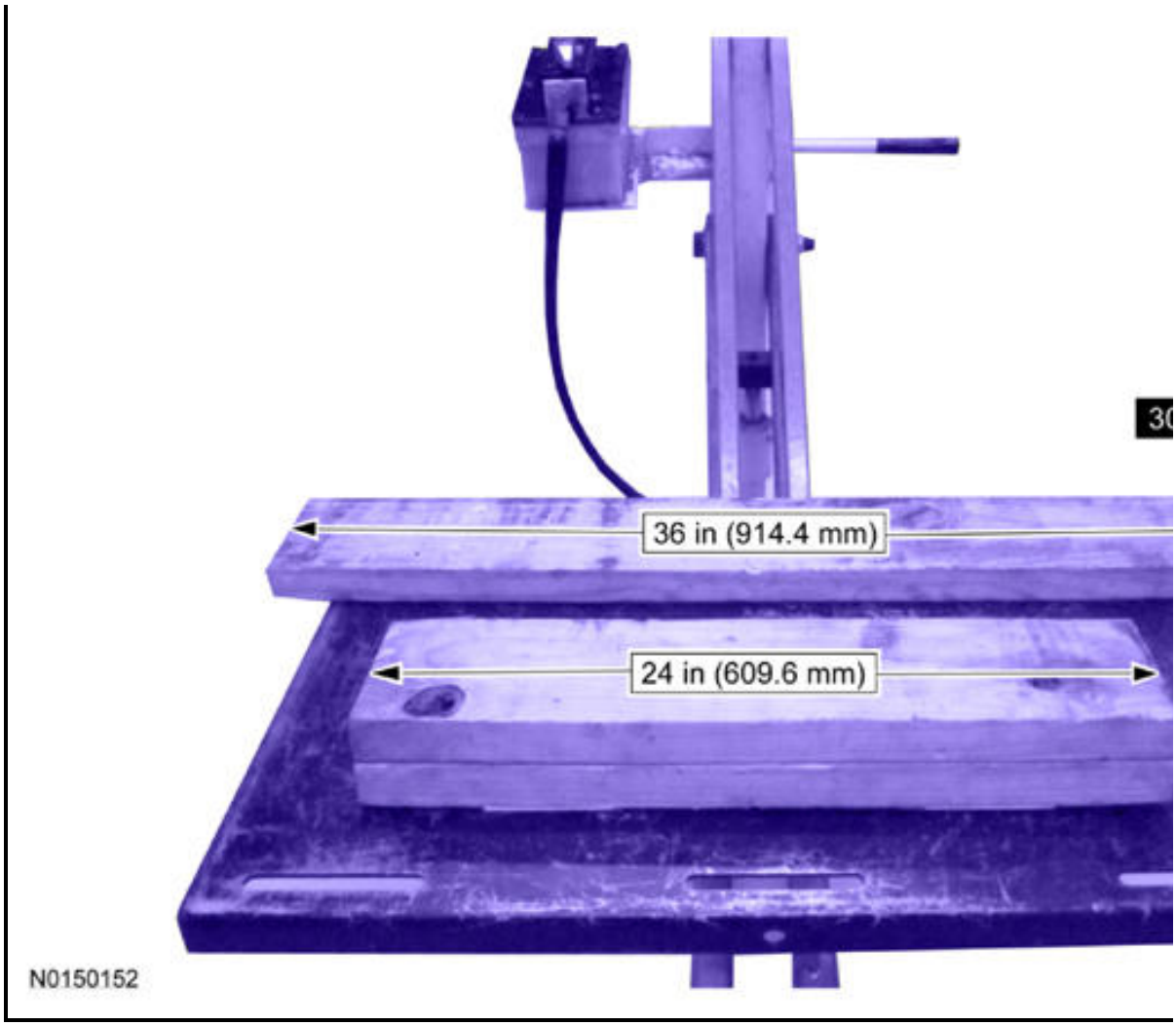
Separate the LH and RH halfshaft from the wheel hubs.

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49. Position a 2 x 6 board, 36 in (914.4 mm) in length and two 2 x 6 boards 24 in (609.6 mm) in length onto the powertrain lift.
    - Position the powertrain lift table with:
        - the long board towards the rear of the subframe.
        - the short boards under the engine and transmission.

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50. Install the Adjustable Grip Arm from the powertrain lift table to the LH engine-to-transmission bolt hole.

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51. Install a ratchet strap from the front of the subframe under the powertrain lift table to the rear of the subframe, to secure the subframe to the powertrain lift table.

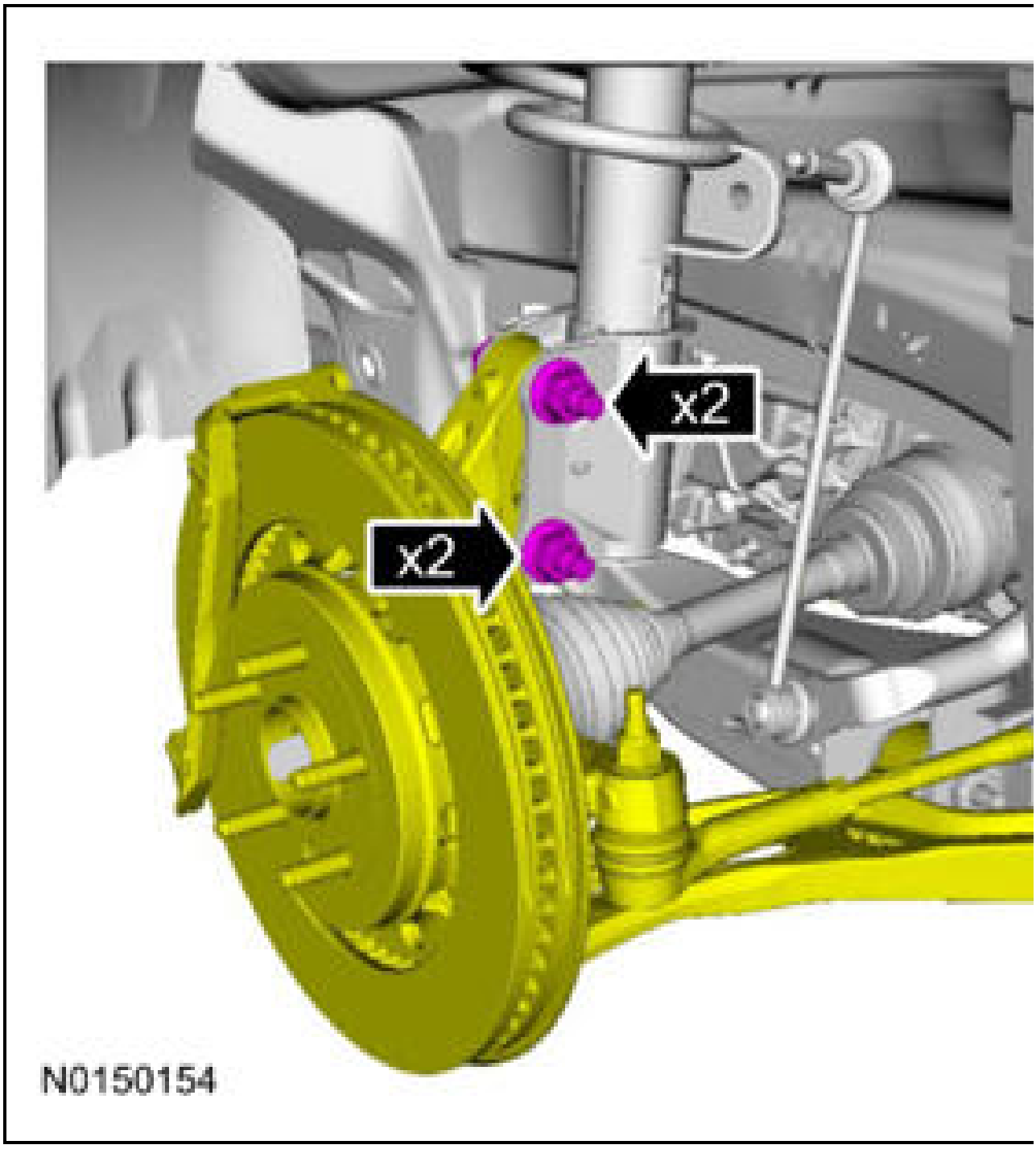
52. **NOTE: LH shown in illustration, RH similar.**

NOTE: The halfshafts are not being remove from the transmission.

Remove the strut-to-wheel knuckle nuts and bolts.

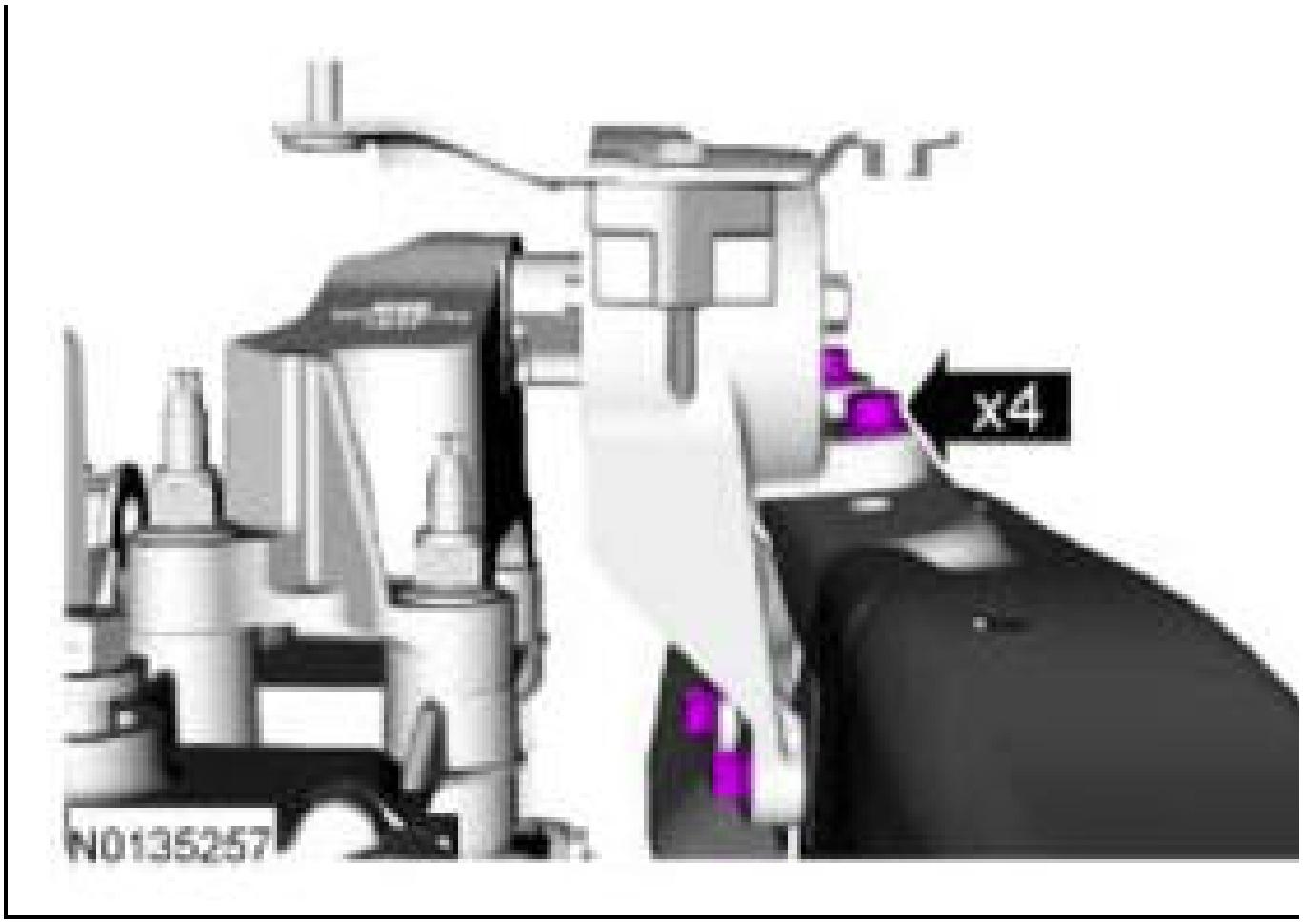
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- Remove the strut from the wheel knuckle and the halfshafts from the wheel knuckle.



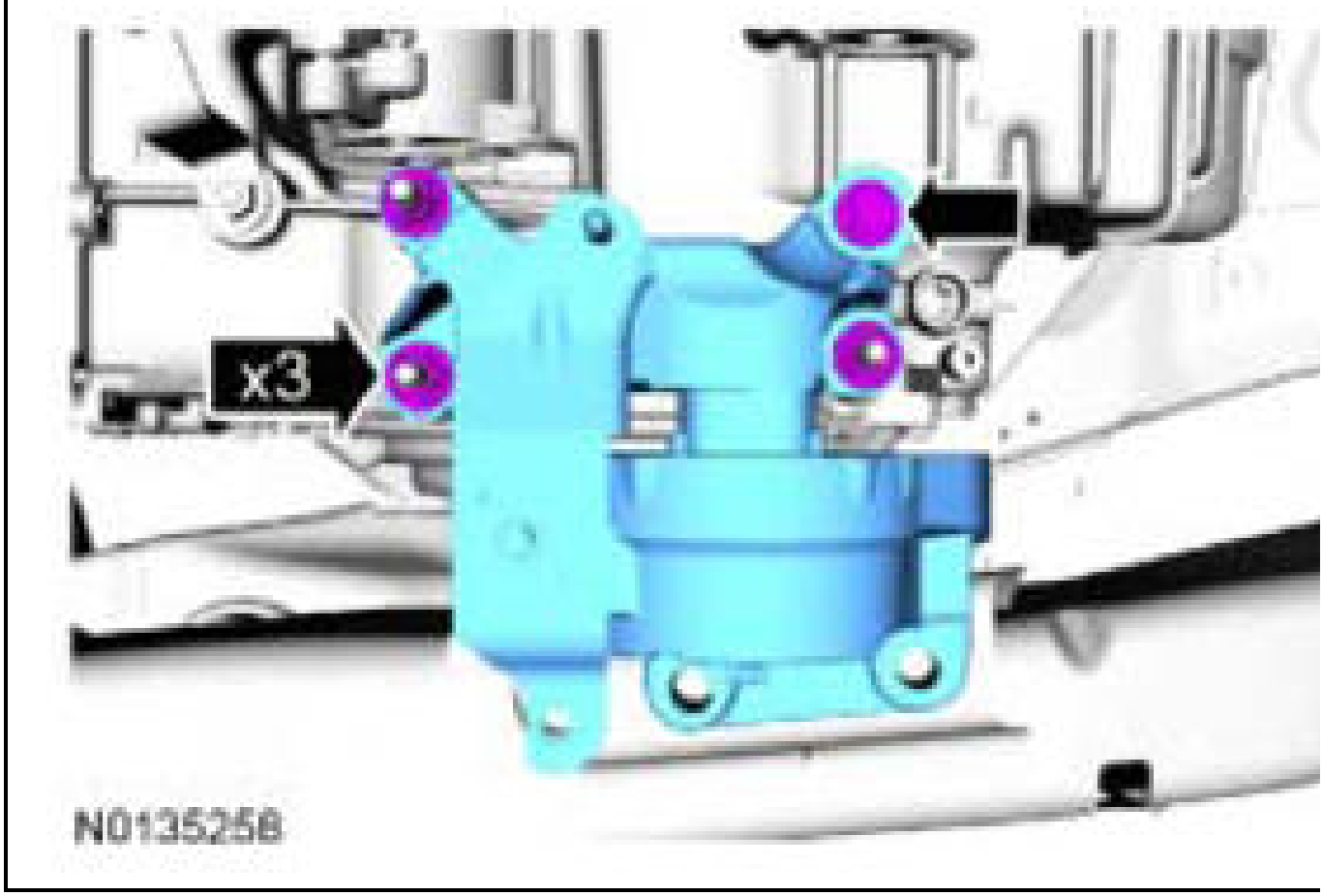
53. Remove the 4 transmission support insulator-to-frame rail bolts.

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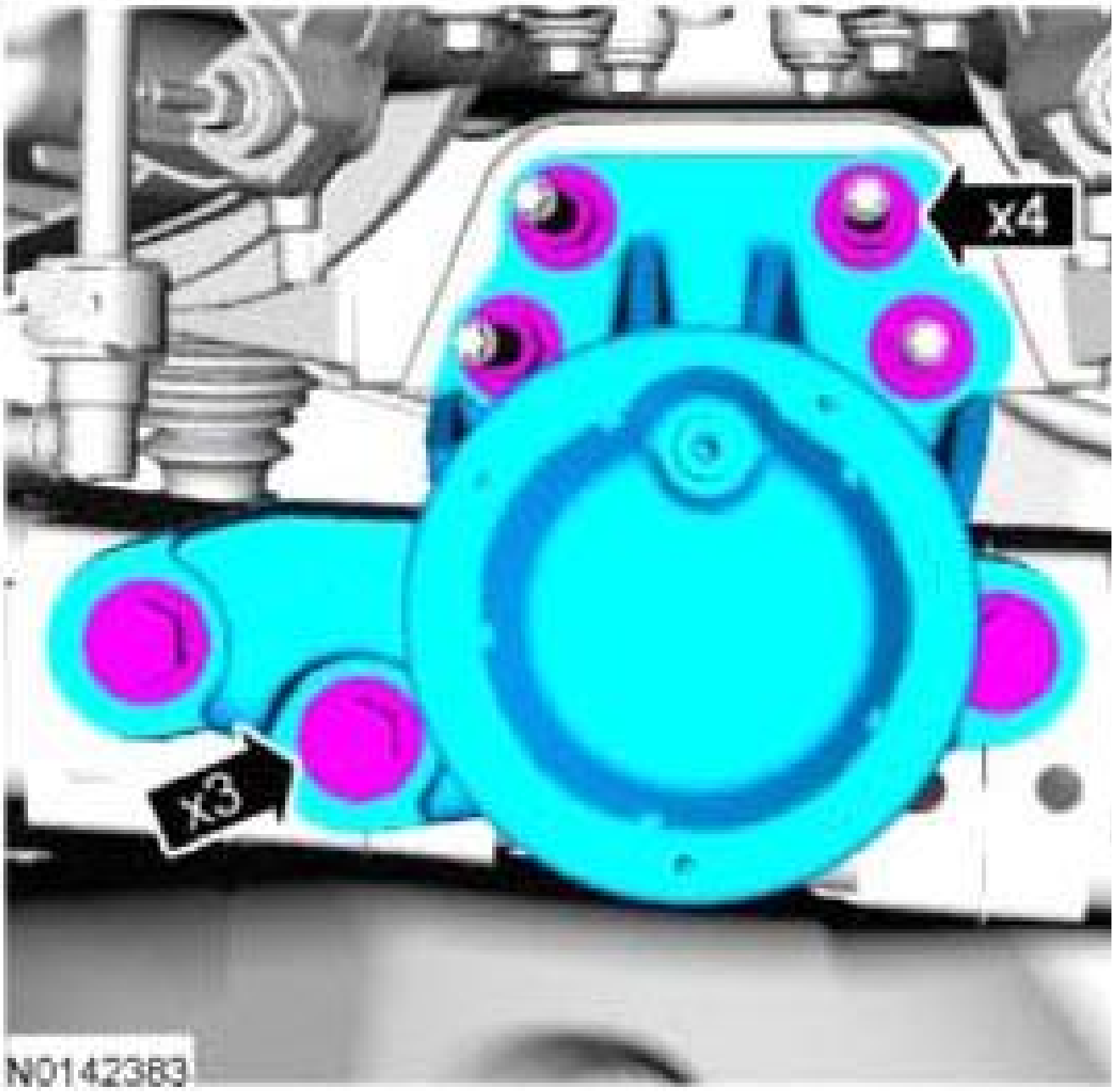
54. Remove the 3 nuts, the bolt and the transaxle support insulator assembly.

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55. Remove the 4 engine mount nuts, the 3 engine mount bolts and the engine mount.

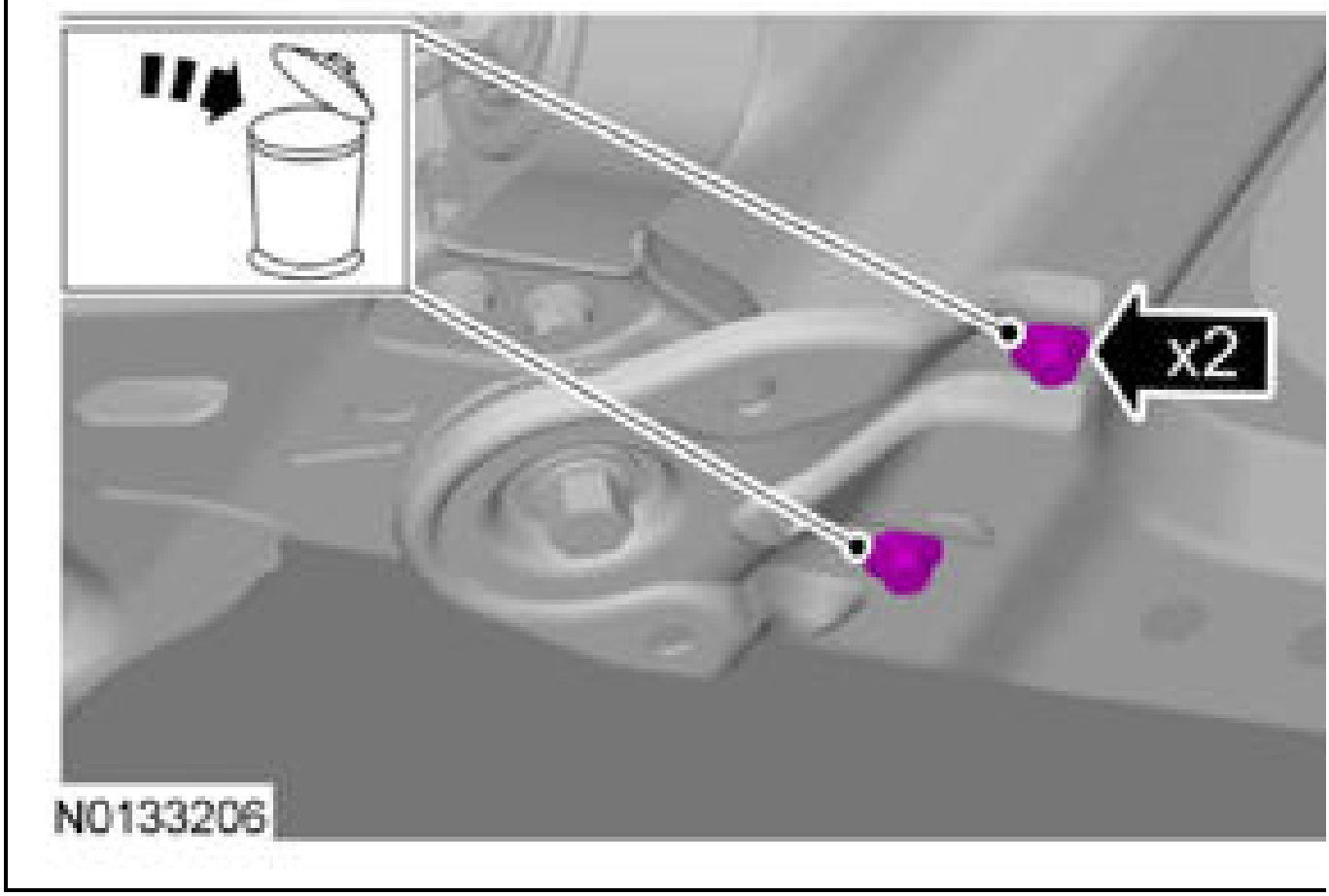
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56. **NOTE: RH shown in illustration, LH similar.**

Remove the subframe bracket-to-body bolts.

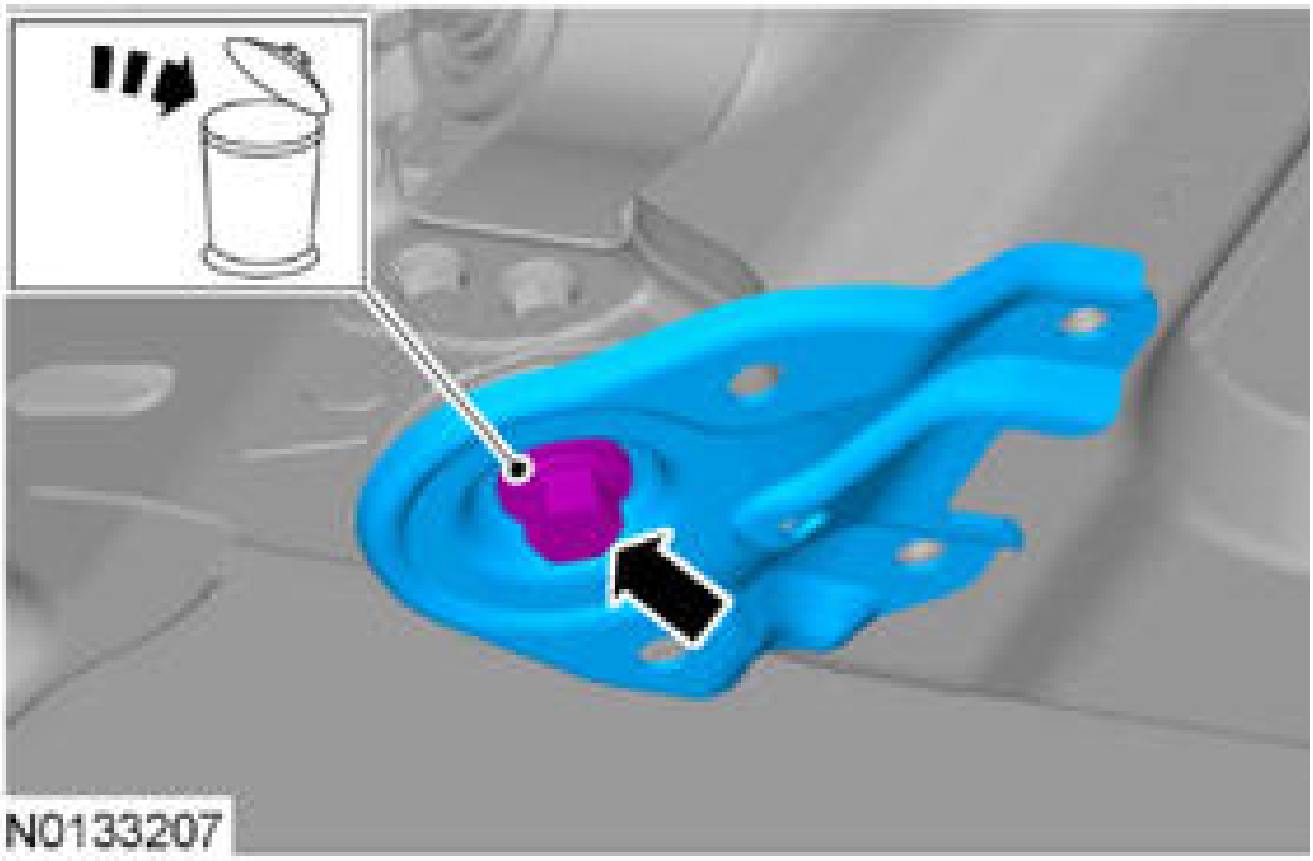
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57. **NOTE: RH shown in illustration, LH similar.**

Remove the rear subframe bolts and the subframe brackets.

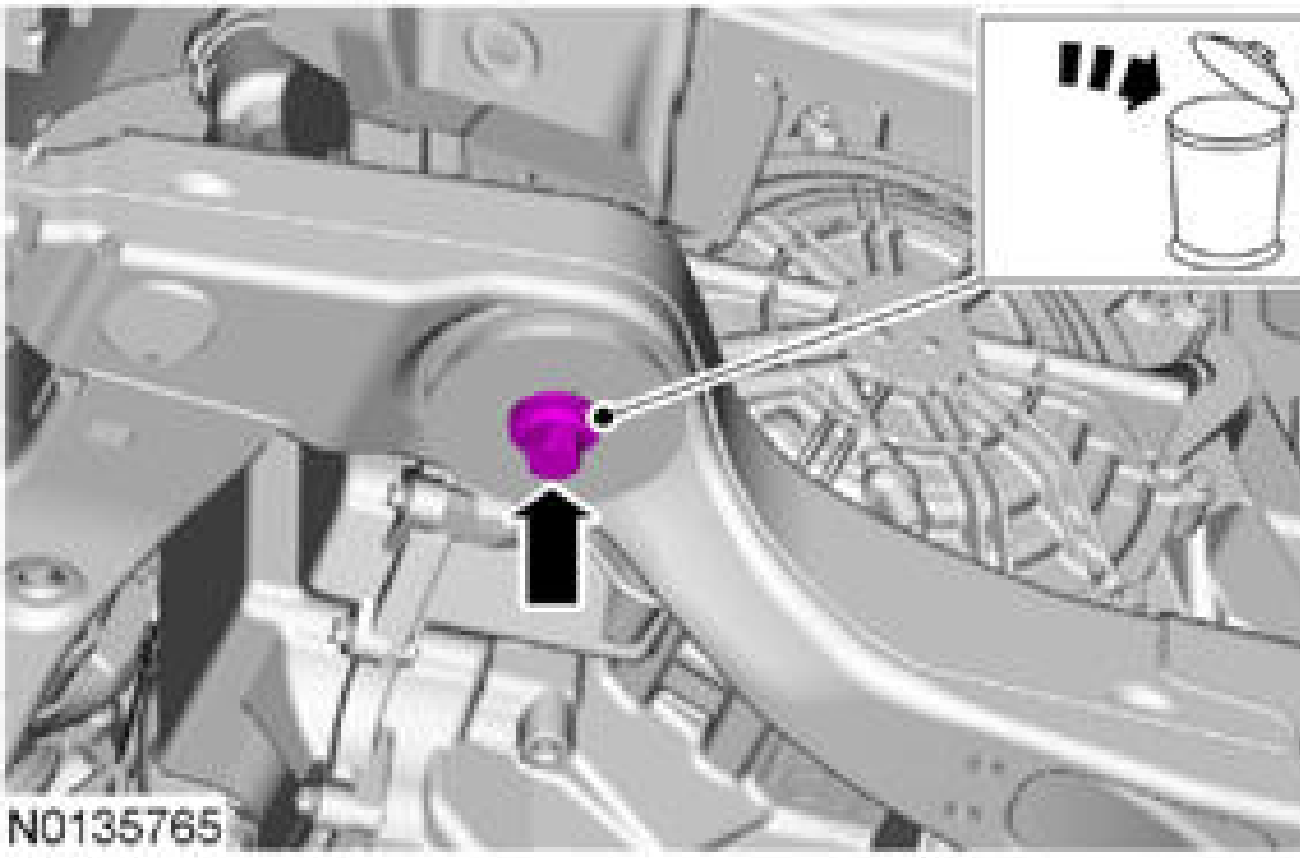
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58. **NOTE: RH shown in illustration, LH similar.**

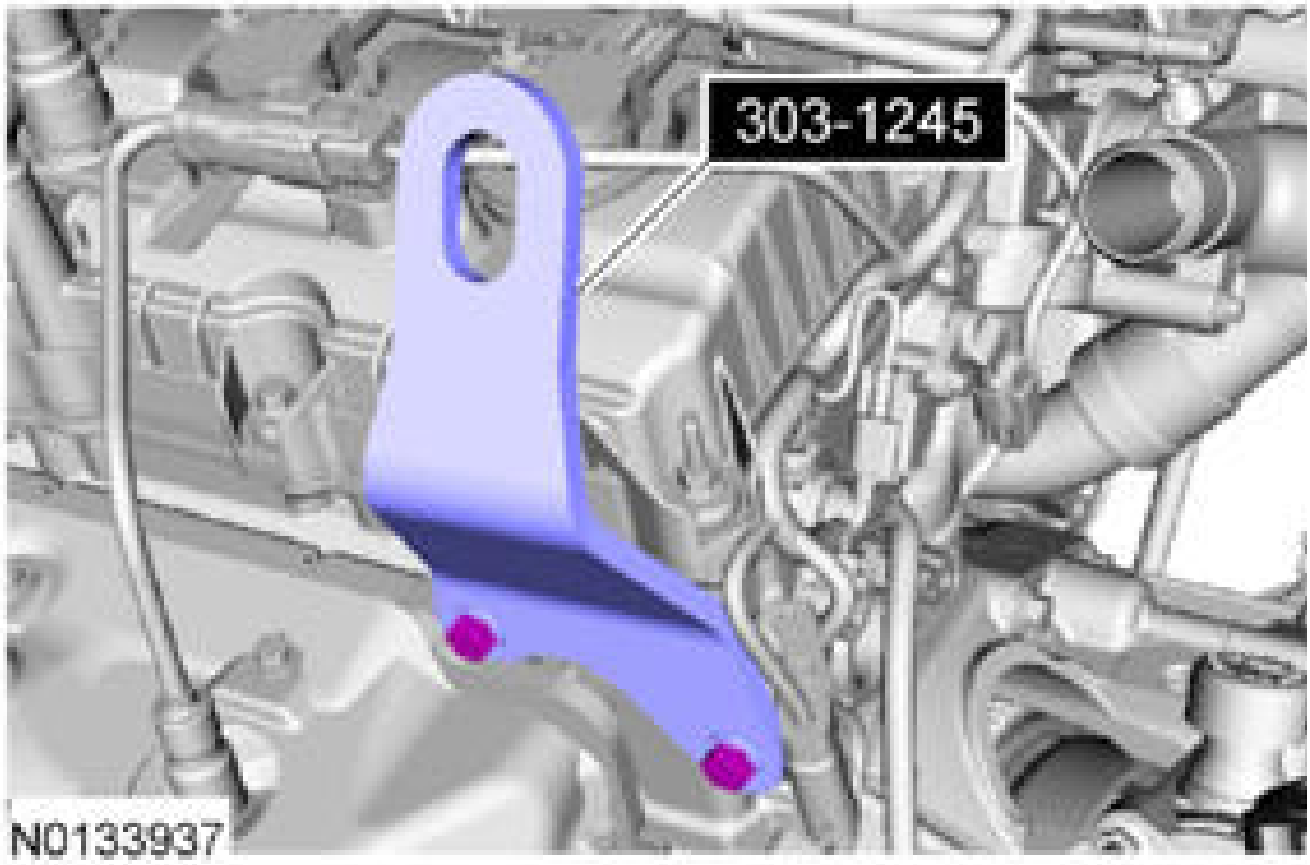
Remove the front subframe bolts.

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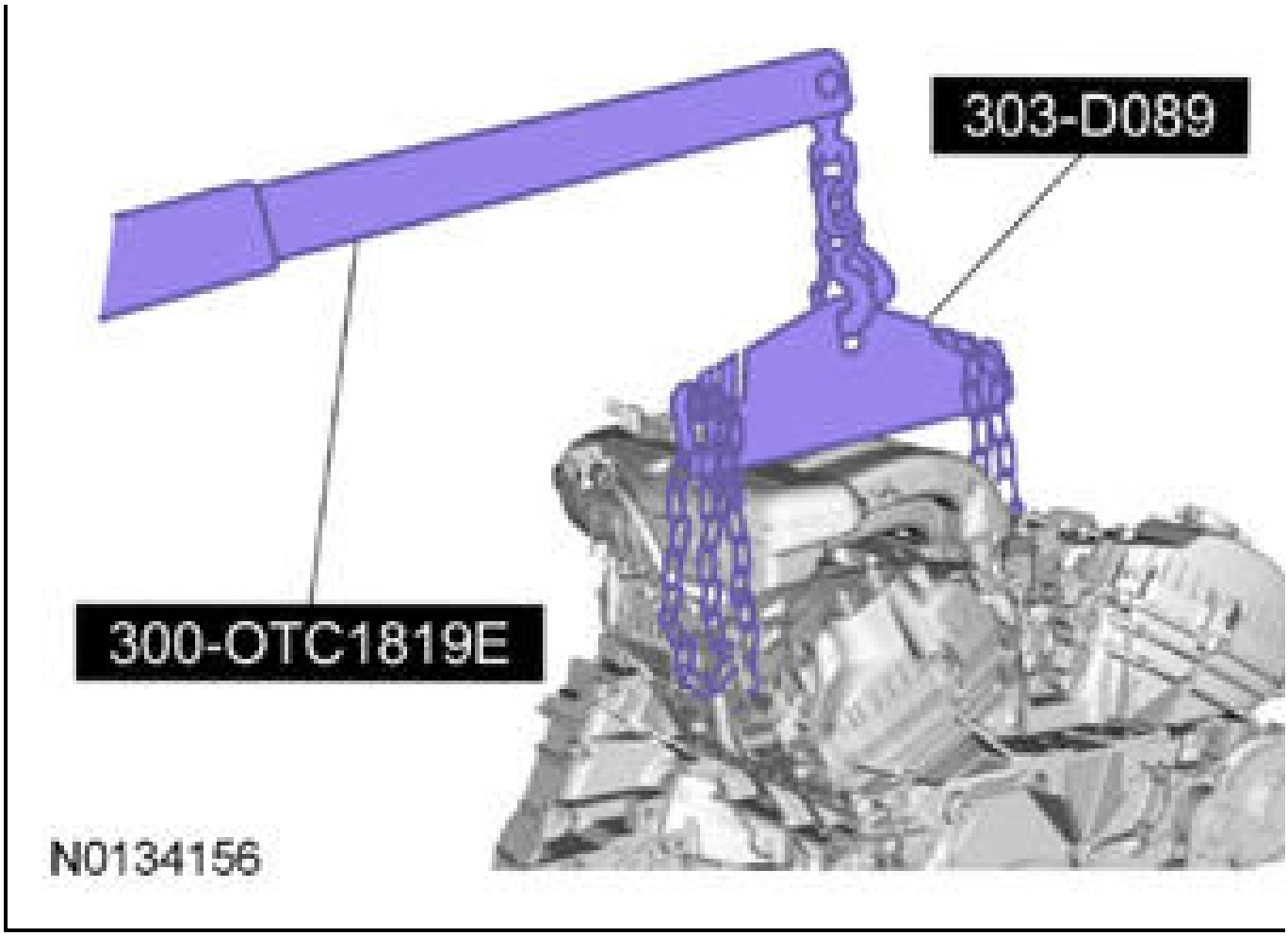
59. Lower the engine and transaxle assembly from the vehicle.
60. Install 303-1245 on the LH cylinder head.

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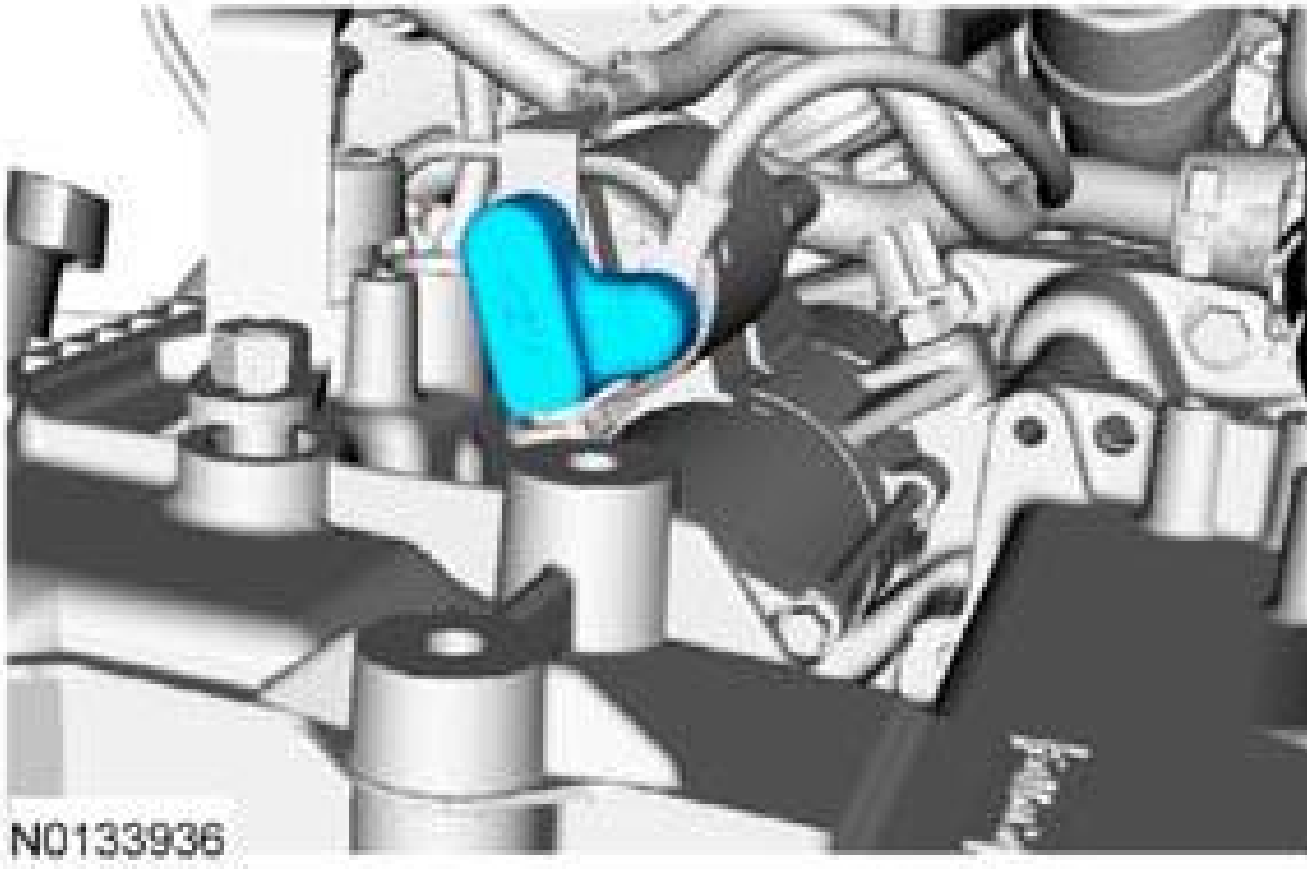
61. Install the Heavy Duty Floor Crane and Spreader Bar.

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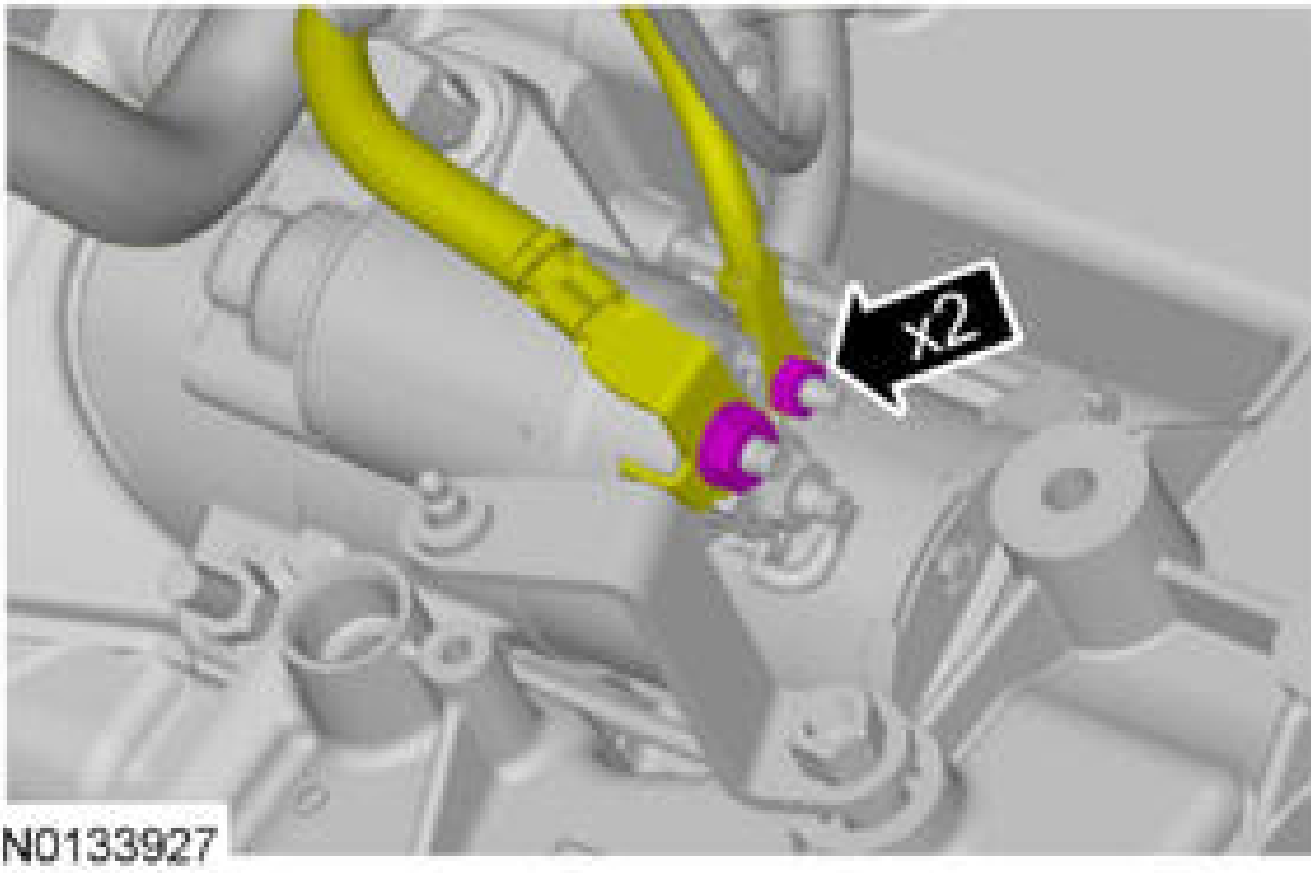
62. Remove the starter motor solenoid cover.

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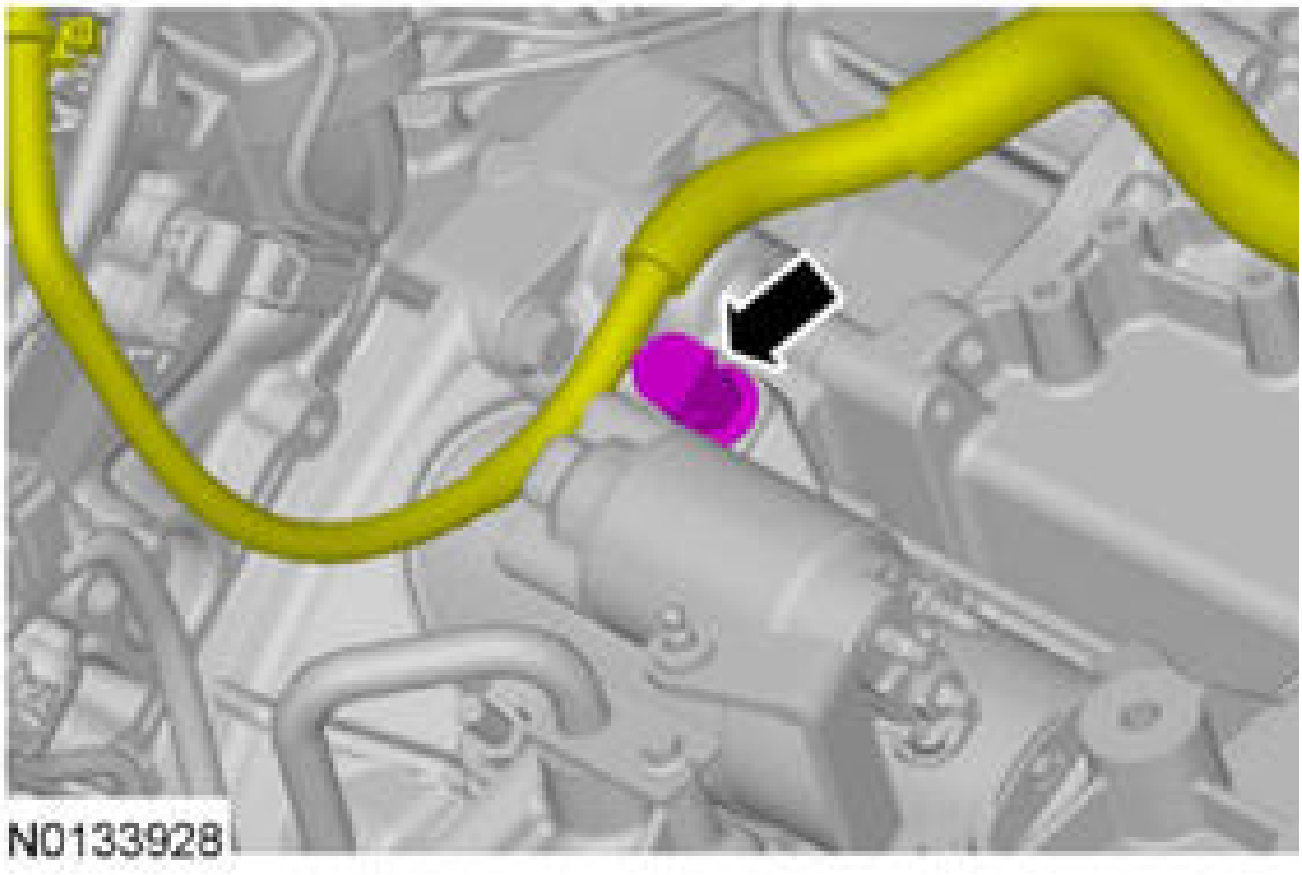
63. Remove the 2 nuts and the starter motor wiring terminals.

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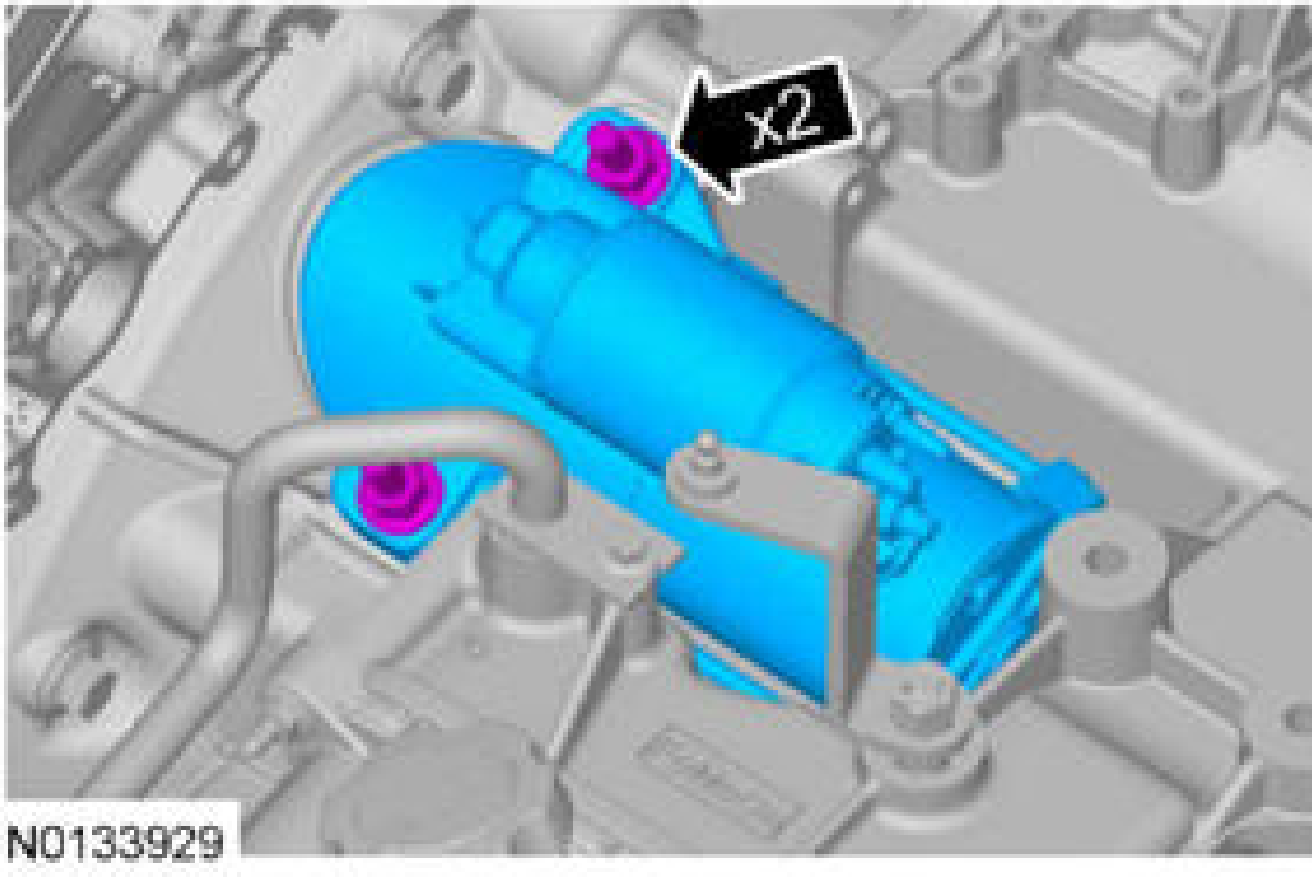
64. Disconnect the wiring harness retainer from the starter motor stud bolt.

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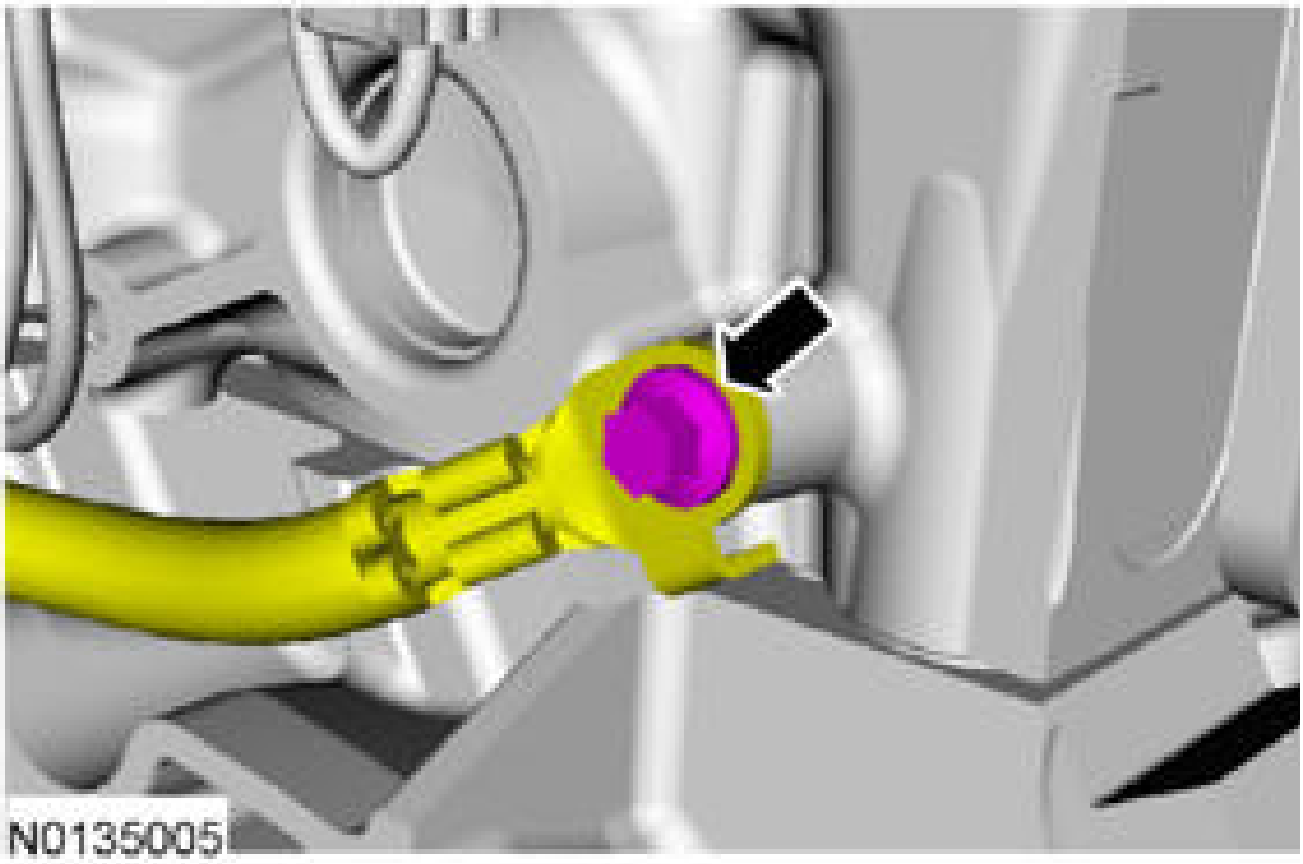
65. Remove the stud bolts and the starter.

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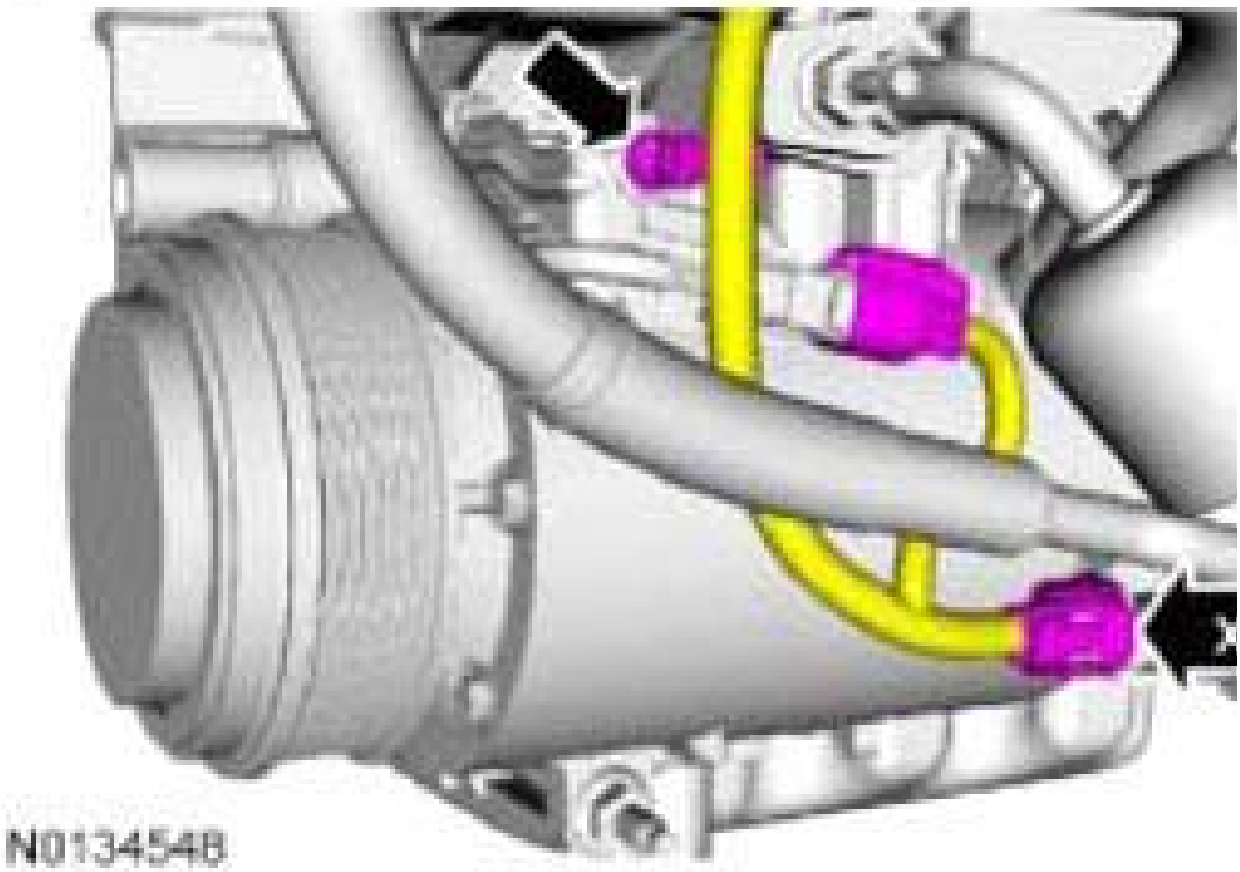
66. Remove the bolt and the ground wire from the RH cylinder head.

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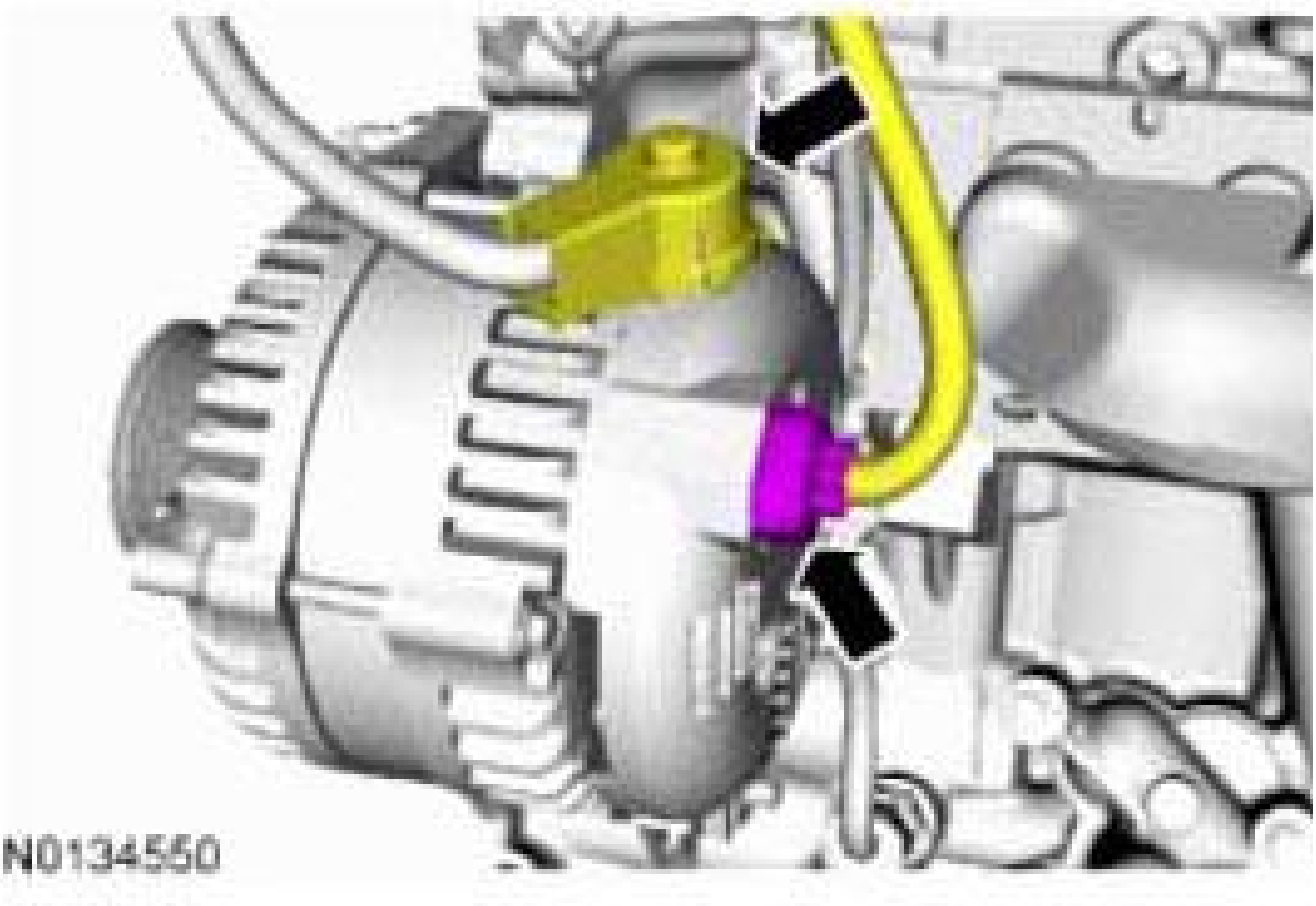
67. Disconnect the 2 A/C compressor electrical connectors.
    - Detach the A/C wiring harness retainer.

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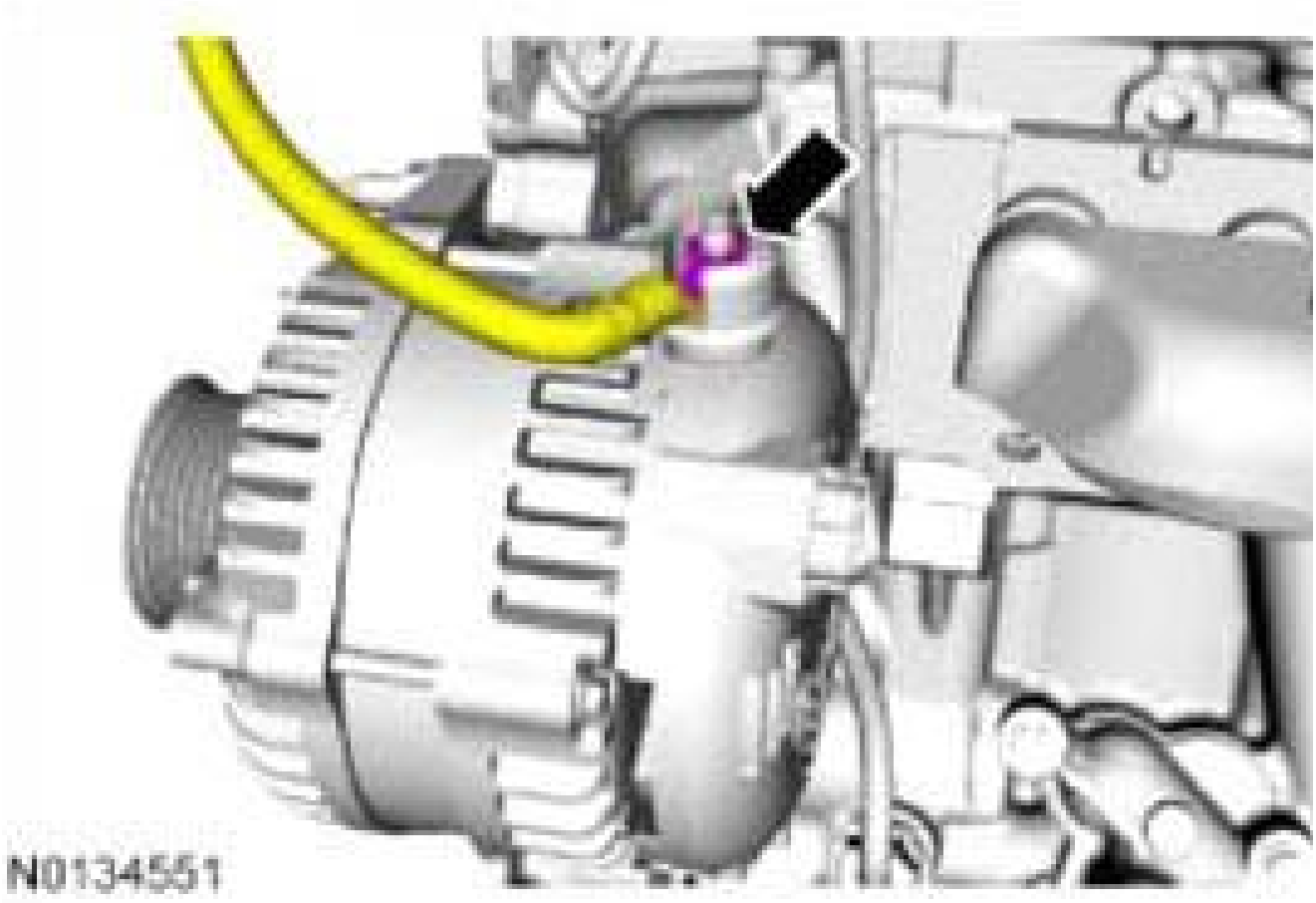
68. Disconnect the generator electrical connector and position the generator B+ cable cover aside.

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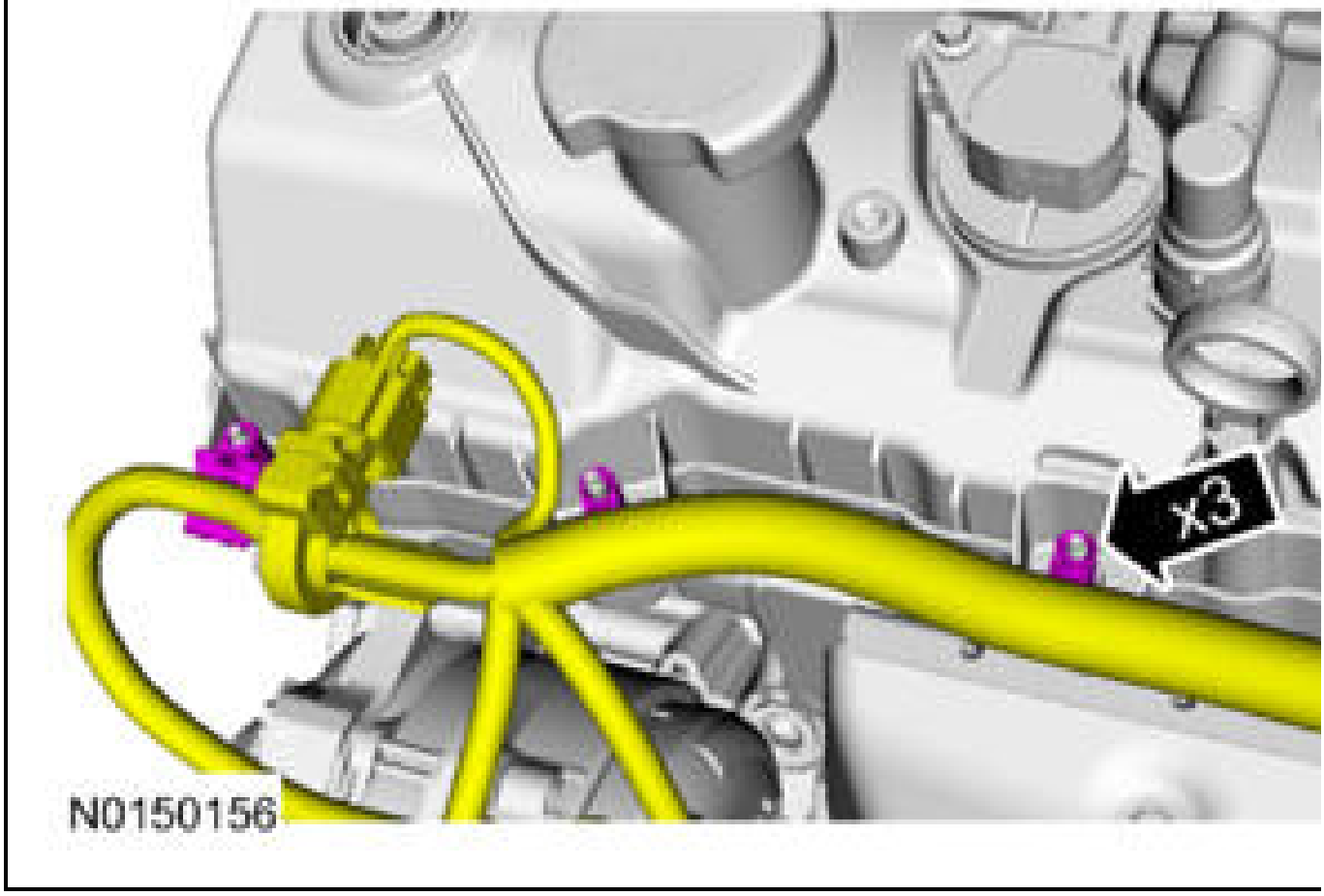
69. Remove the nut and disconnect the generator B+ cable.

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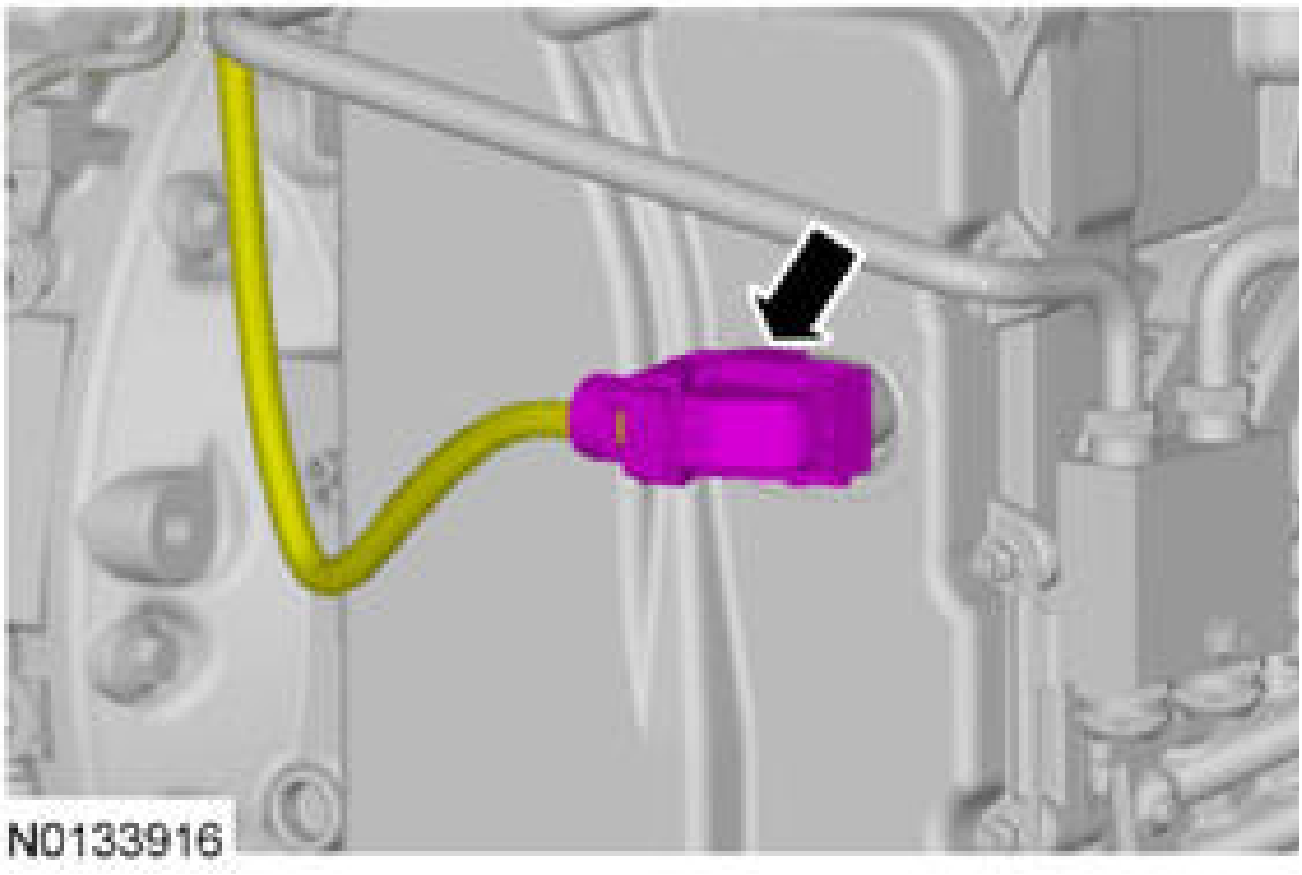
70. Detach the 3 wiring harness retainer from the valve cover stud bolt and position the harness on transmission.

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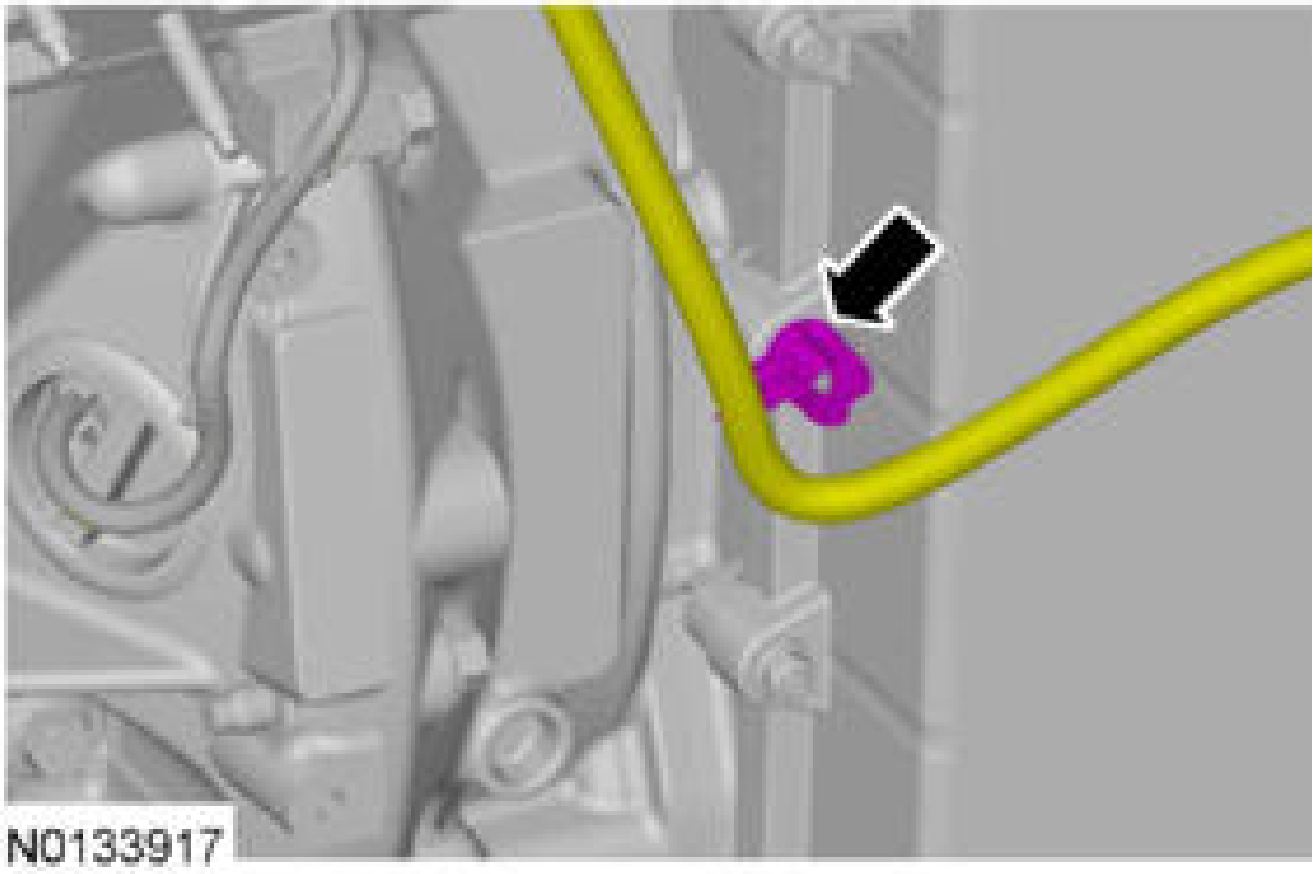
71. Disconnect the transaxle control electrical connector.

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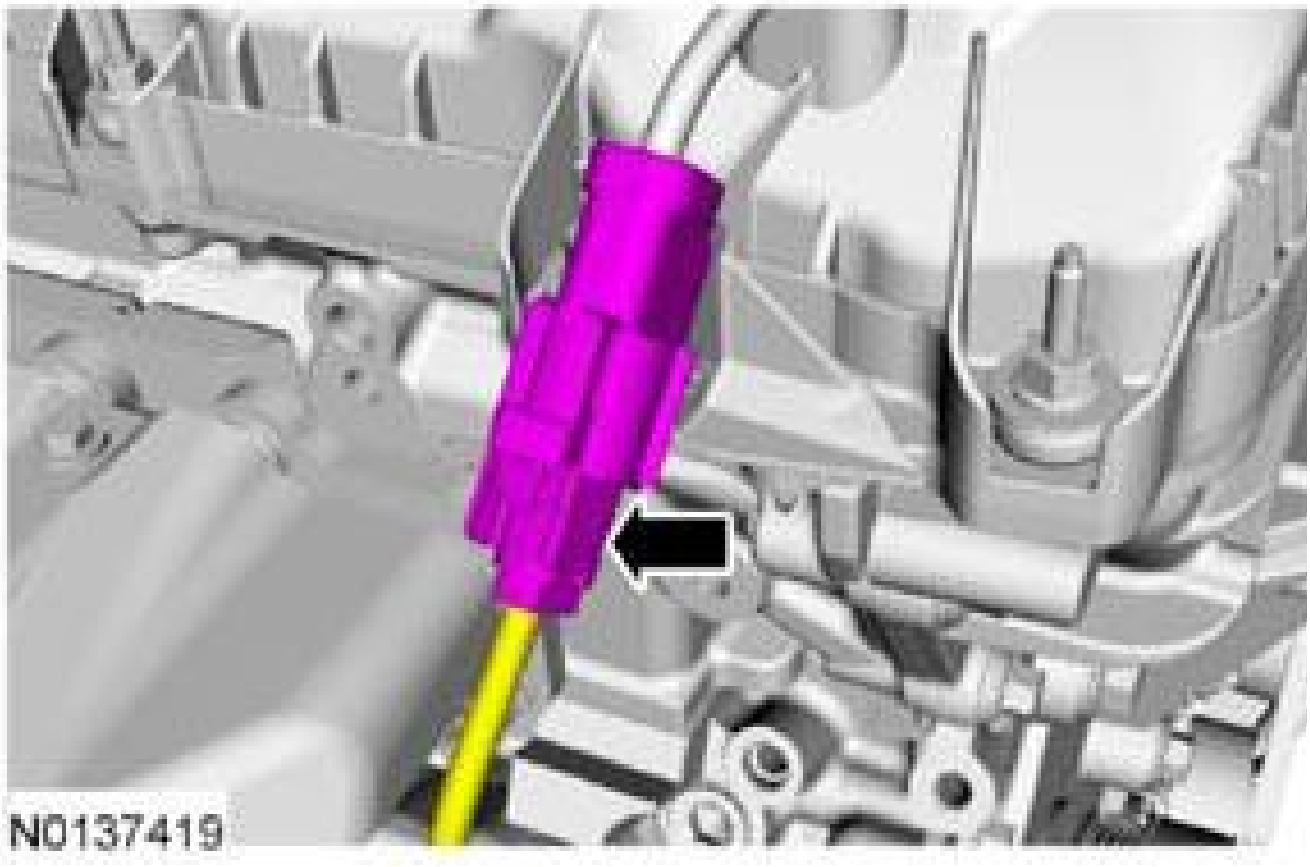
72. Detach the transaxle control wire harness retainer from the transaxle stud bolt.

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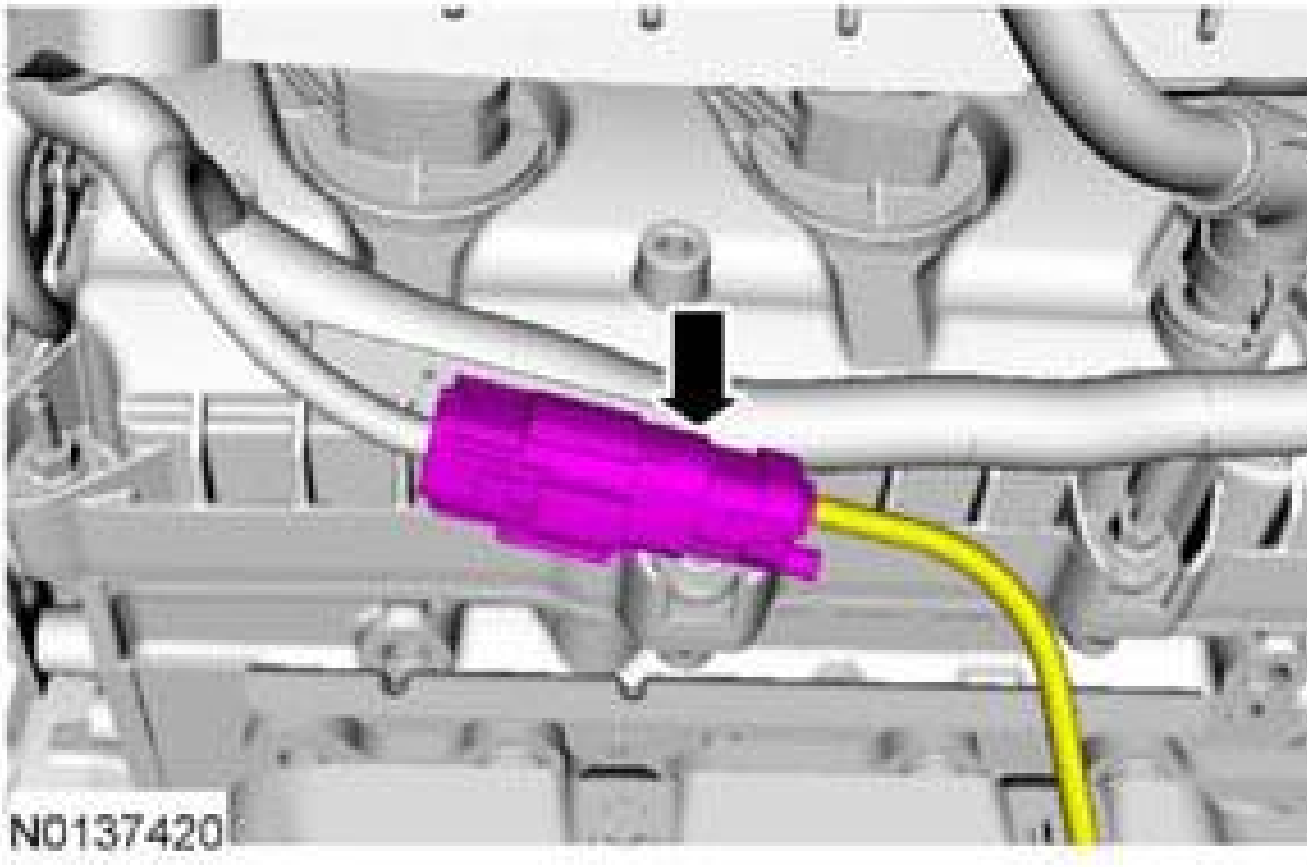
73. Disconnect the RH catalyst monitor electrical connector.

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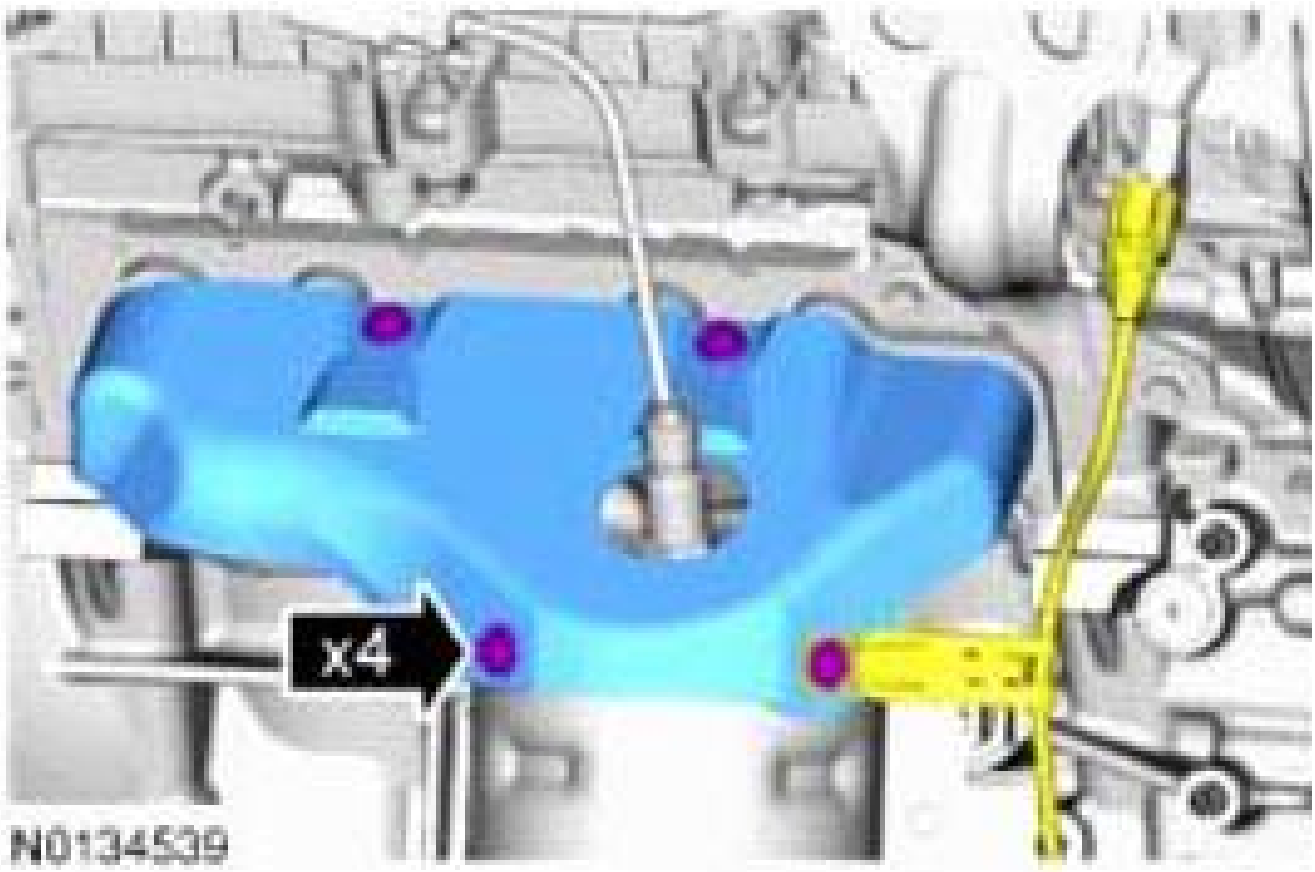
74. Disconnect the RH Heated Oxygen Sensor (HO2S) electrical connector.

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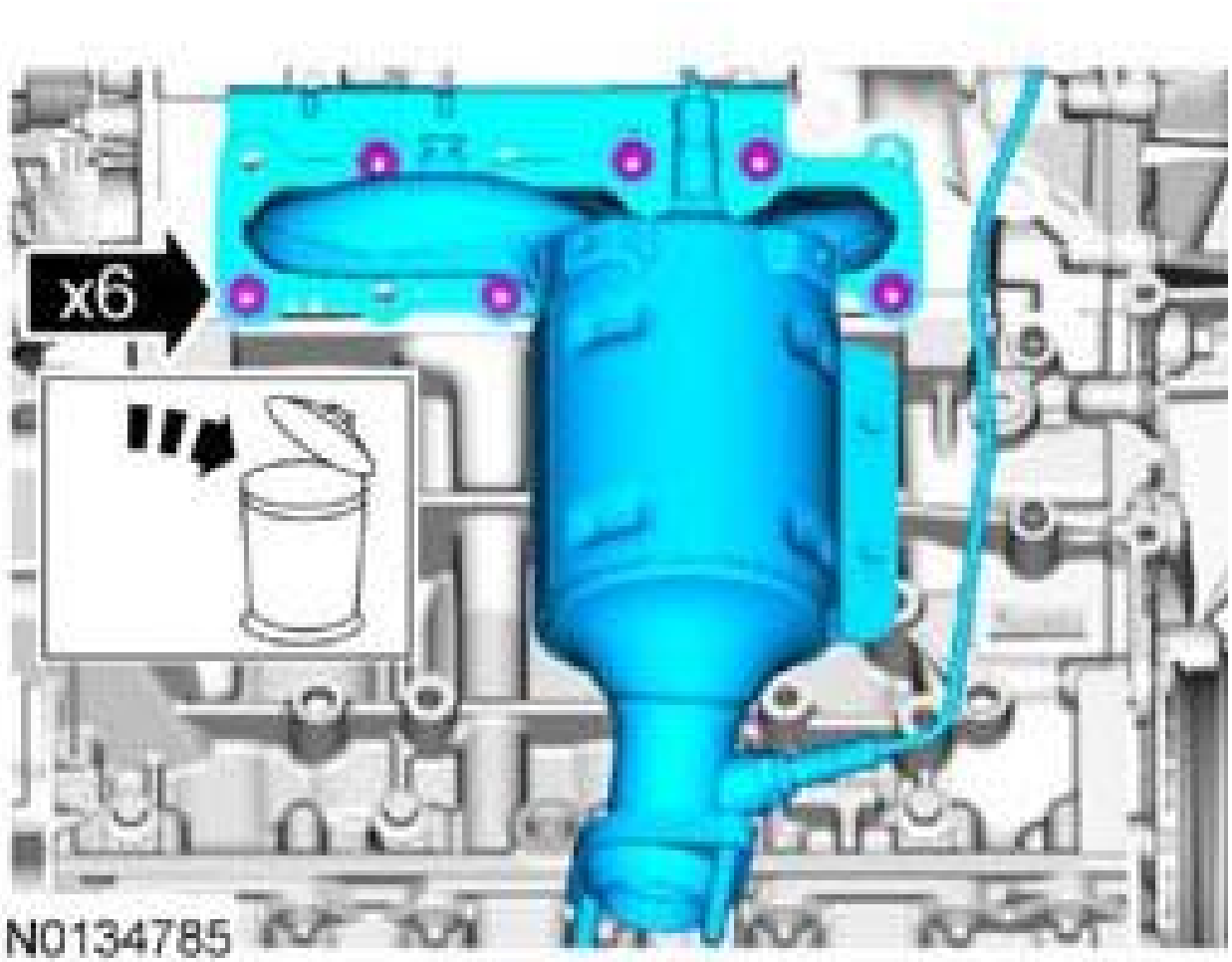
75. Remove the 4 nuts and the RH catalytic converter heat shield.

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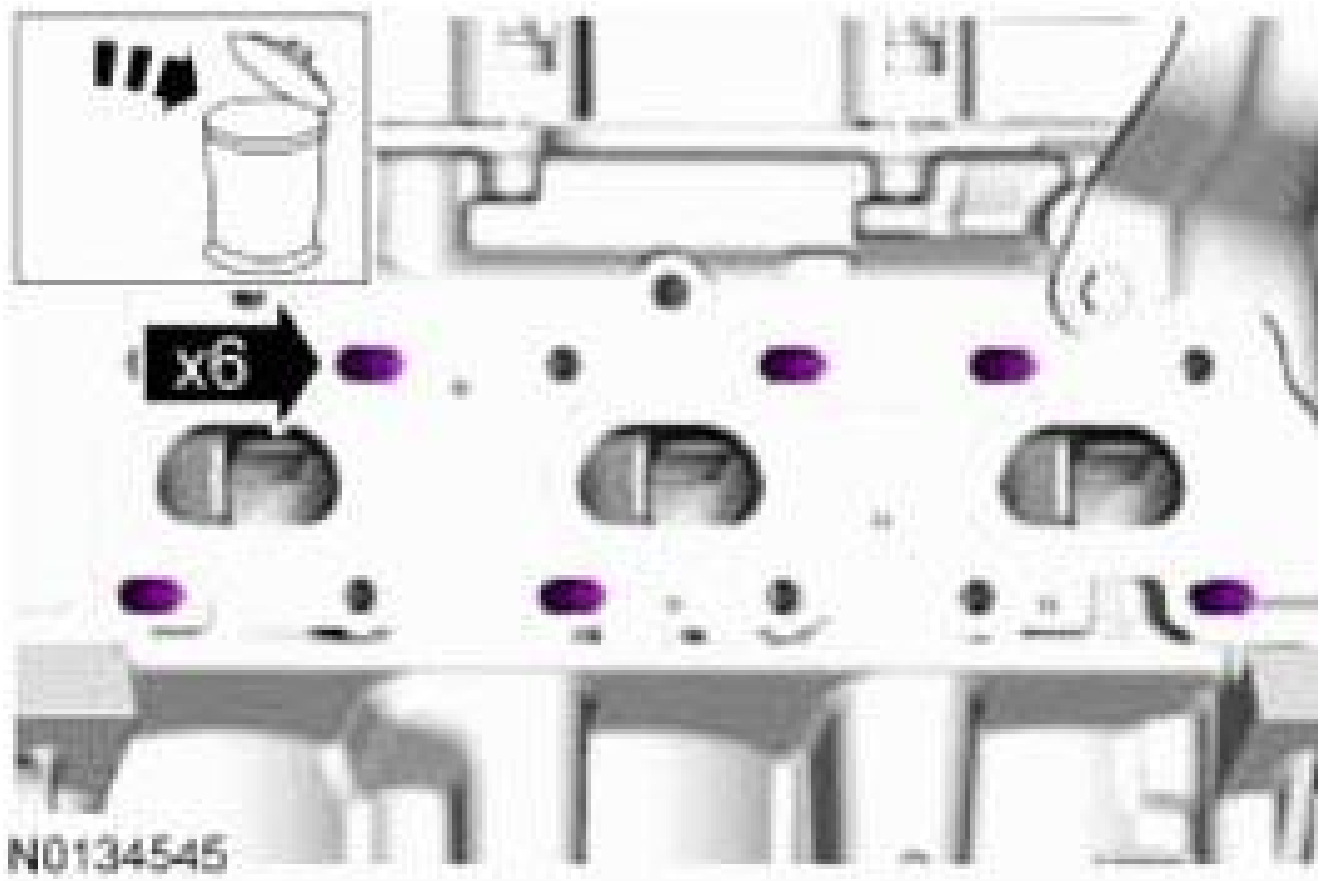
76. Remove the 6 nuts and the RH catalytic converter manifold.
    - Discard the nuts and RH catalytic converter manifold gasket.

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77. Remove and discard the 6 RH catalytic converter manifold studs.

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78. Remove the Adjustable Grip Arm.

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79. Remove the ratchet strap from the front of the subframe under the powertrain lift table to the rear of the subframe.

80. **NOTE: LH shown in illustration, RH similar.**

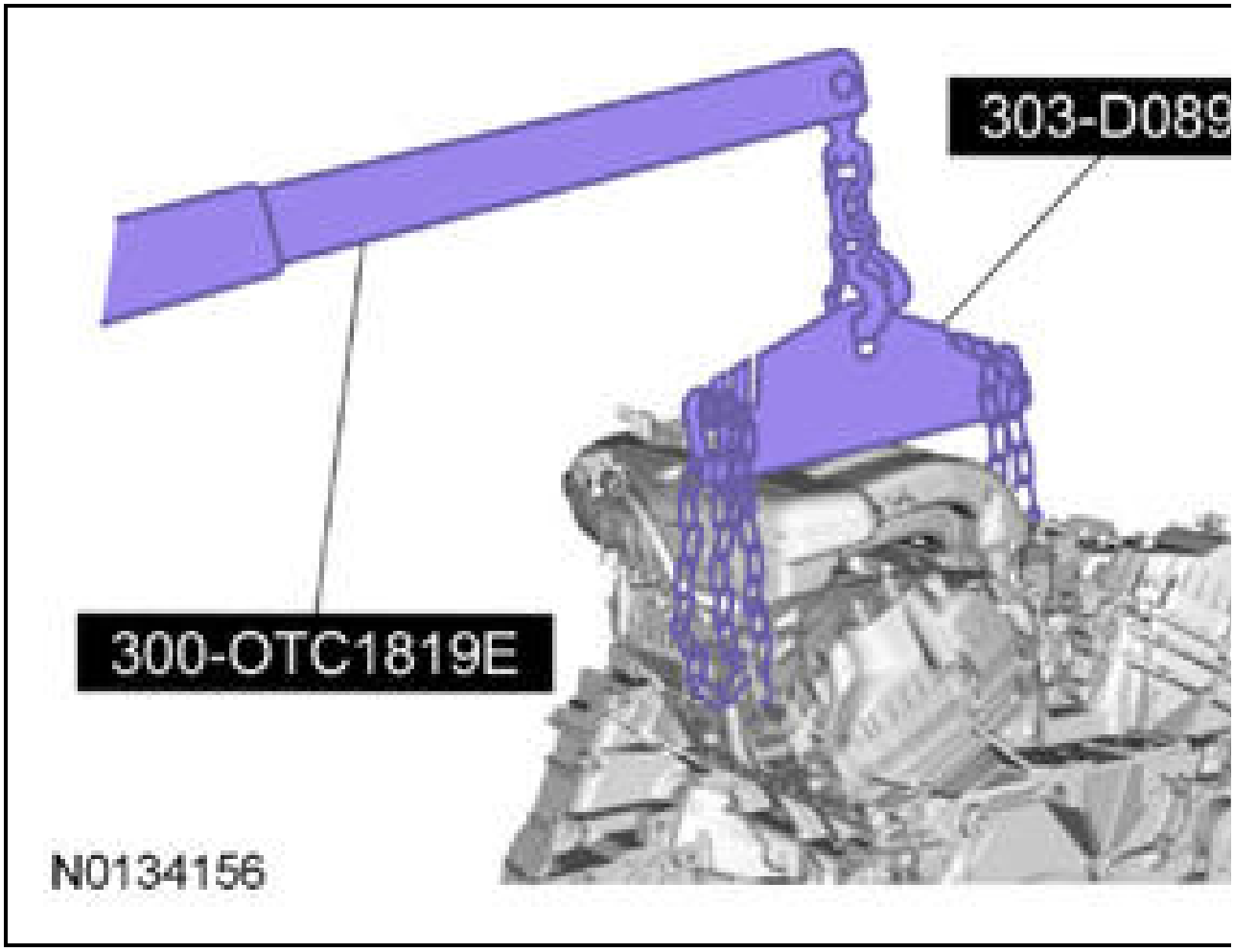
Install the ratchet strap from the front subframe to the LH engine lift eye and from the rear of the subframe to the RH engine lift eye.

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81. Using the Floor Crane and Spreader Bar, remove the powertrain and subframe as an assembly from the powertrain lift table and set on the ground.
    - Position wood blocks under the engine and transmission.



82. **NOTE: LH shown in illustration, RH similar.**

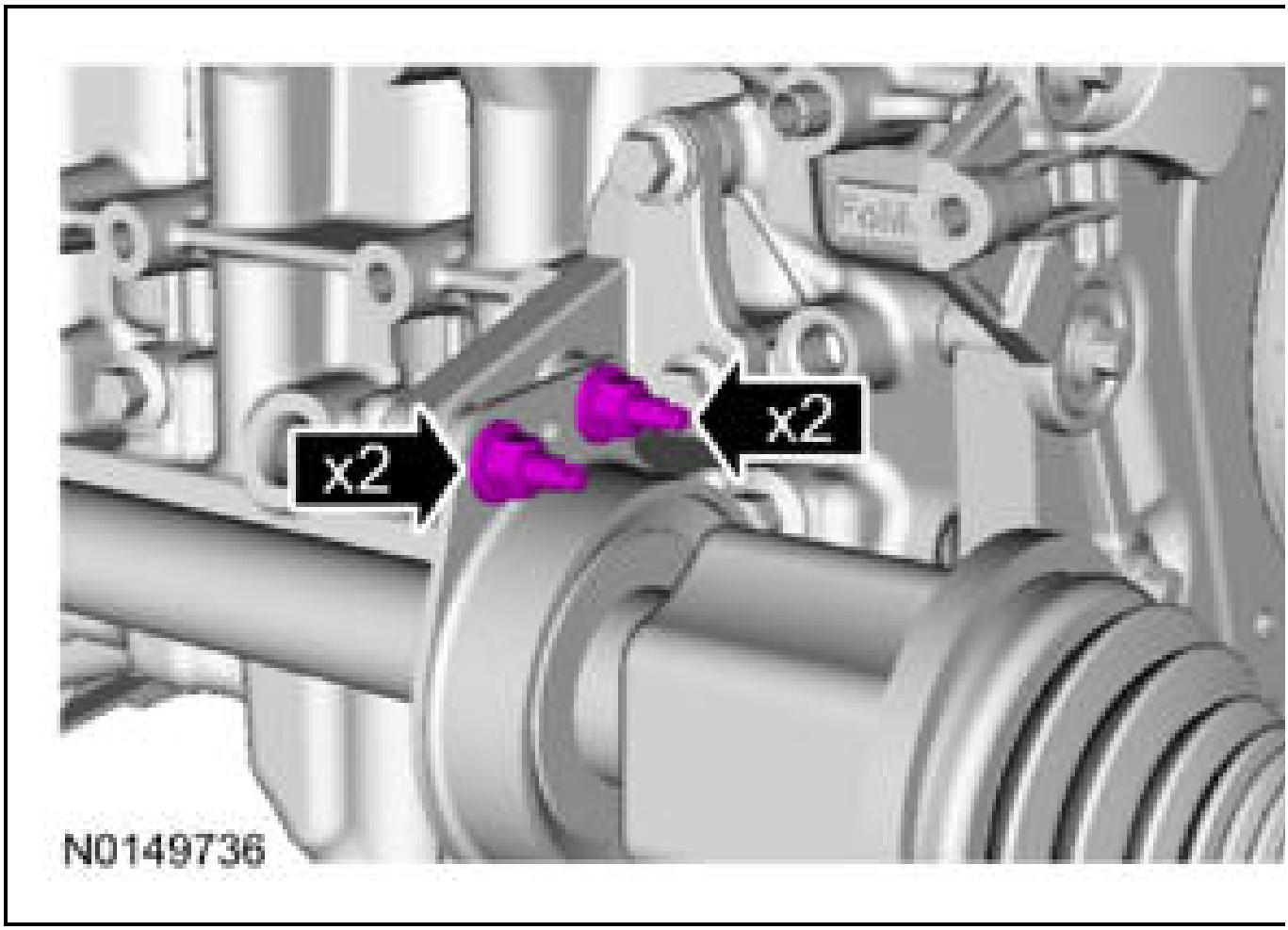
Remove the ratchet strap from the front subframe to the LH engine lift eye and from the rear of the subframe to the RH engine lift eye.

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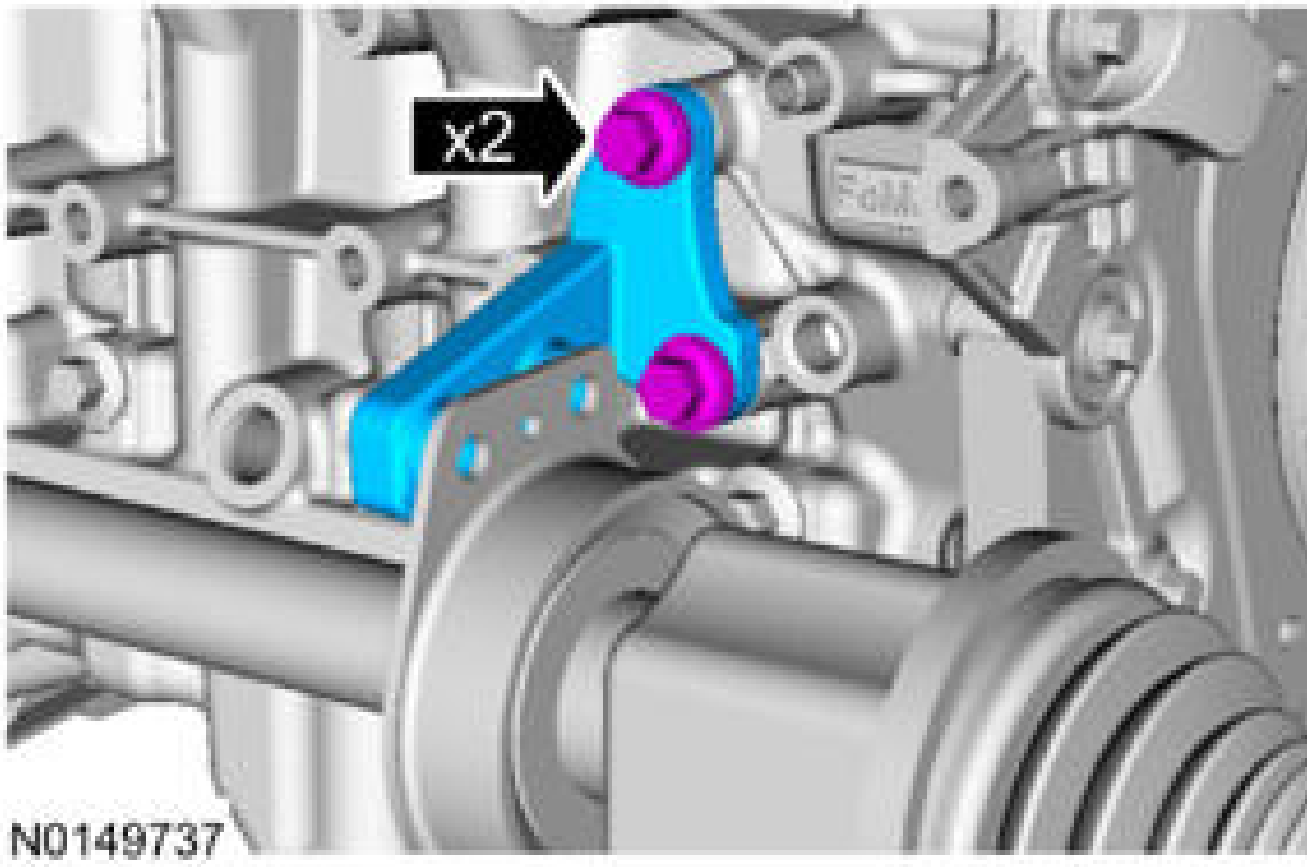
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83. Remove the 2 intermediate shaft bracket nuts and the 2 studs.



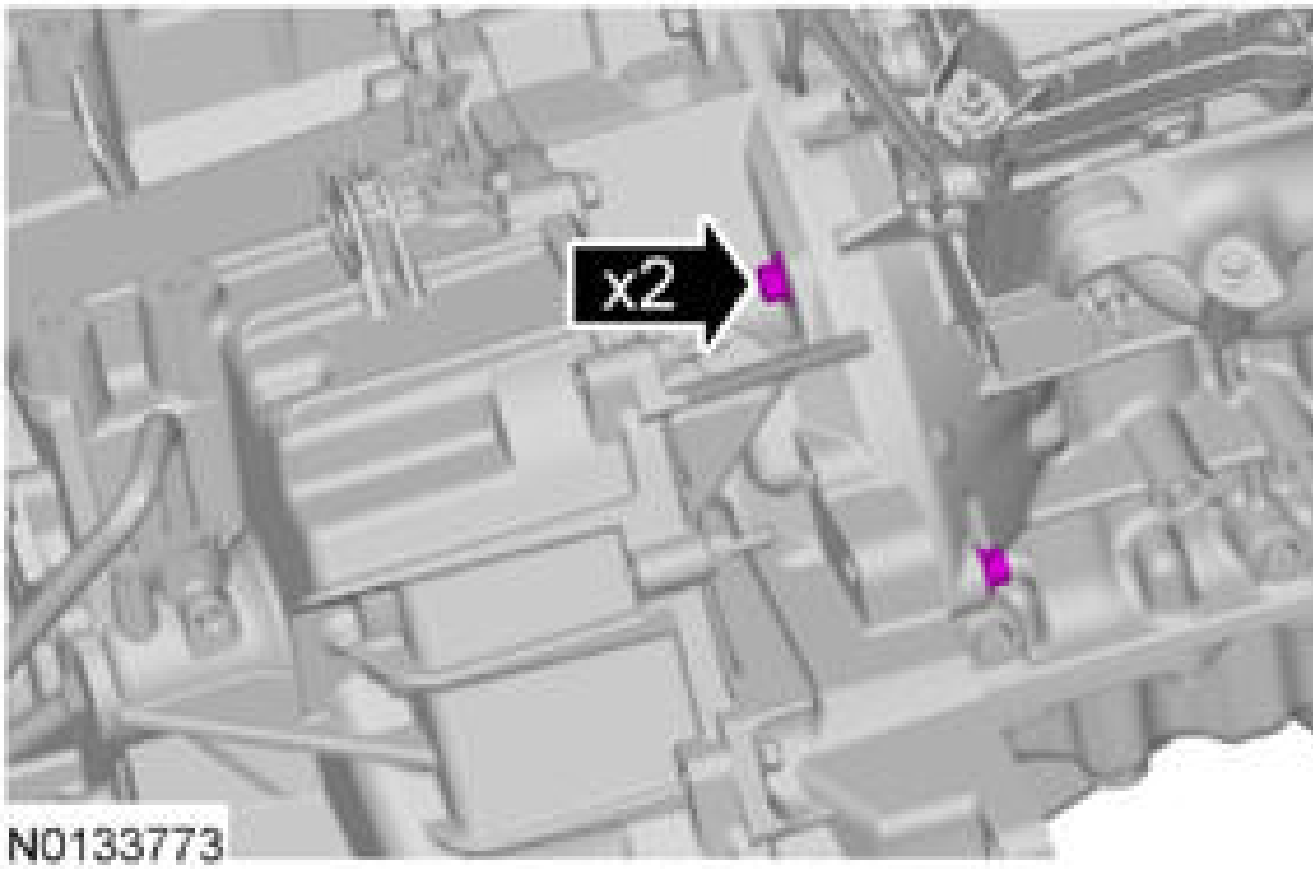
84. Remove the 2 bolts and the RH halfshaft support bracket.

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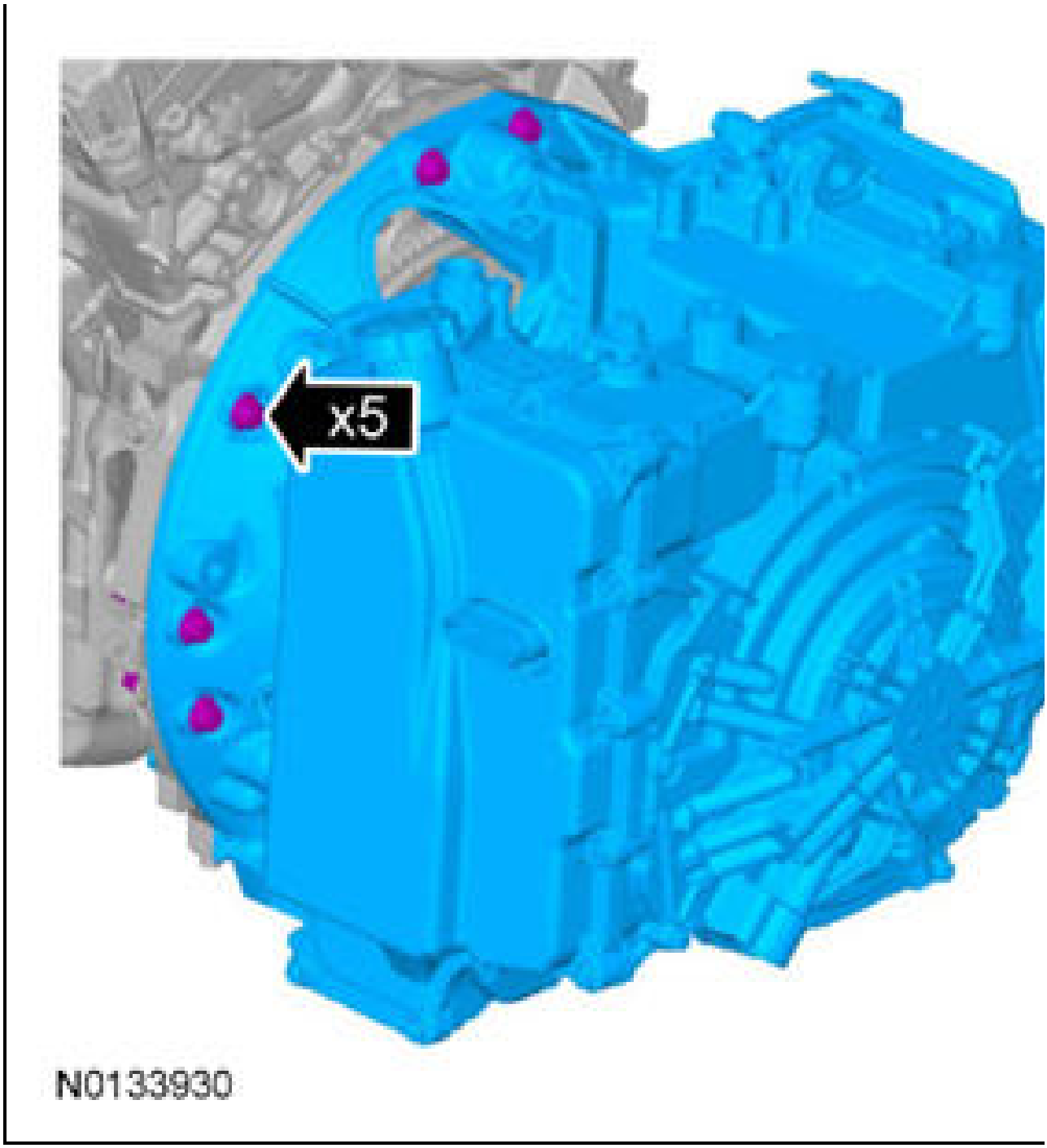
85. Remove the 2 engine-to-transaxle bolts.

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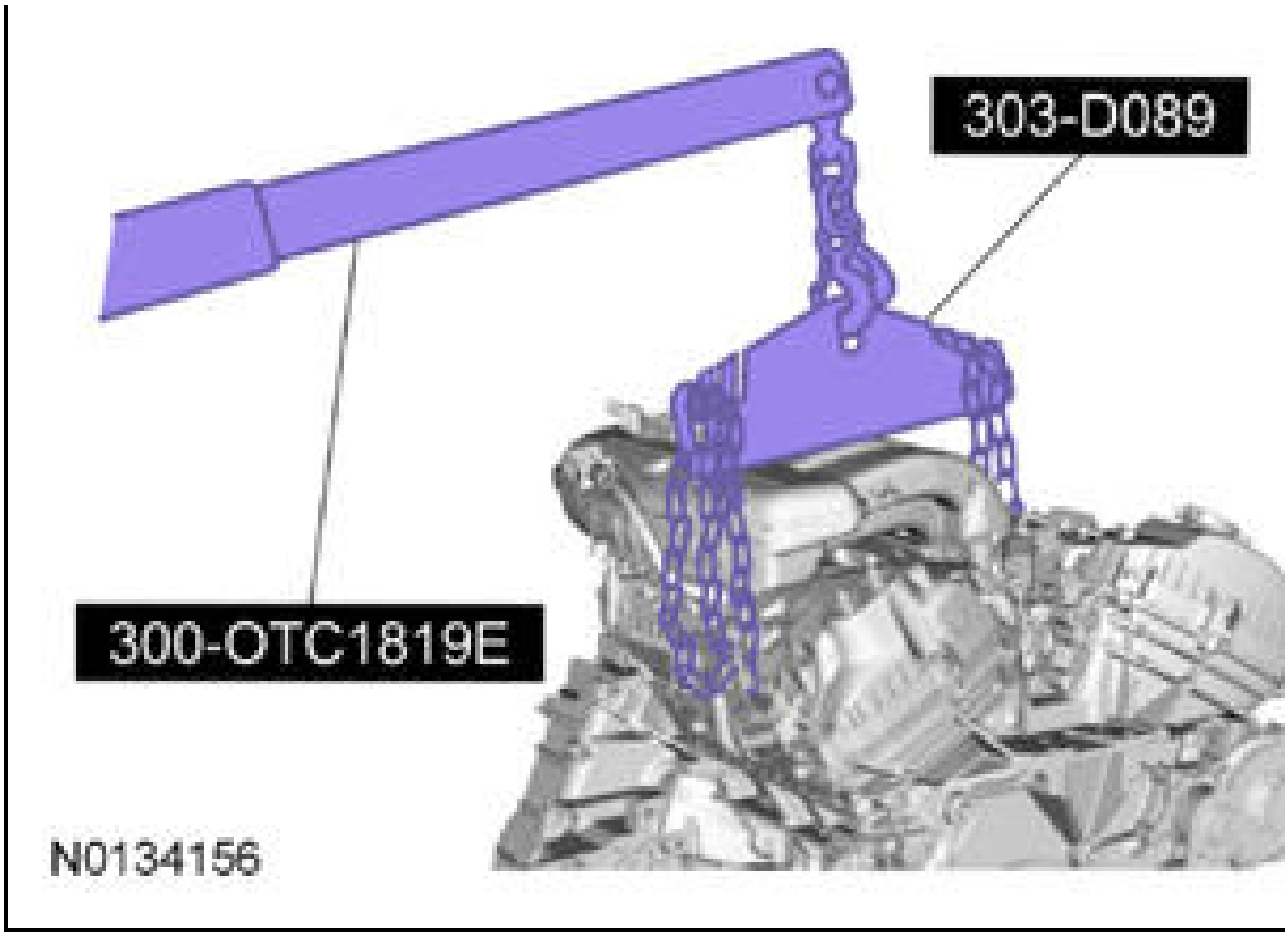
86. Remove the 5 transaxle-to-engine bolts.
    - Separate the transaxle from the engine.

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87. Using the Floor Crane and Spreader Bar, remove the engine from the transaxle.

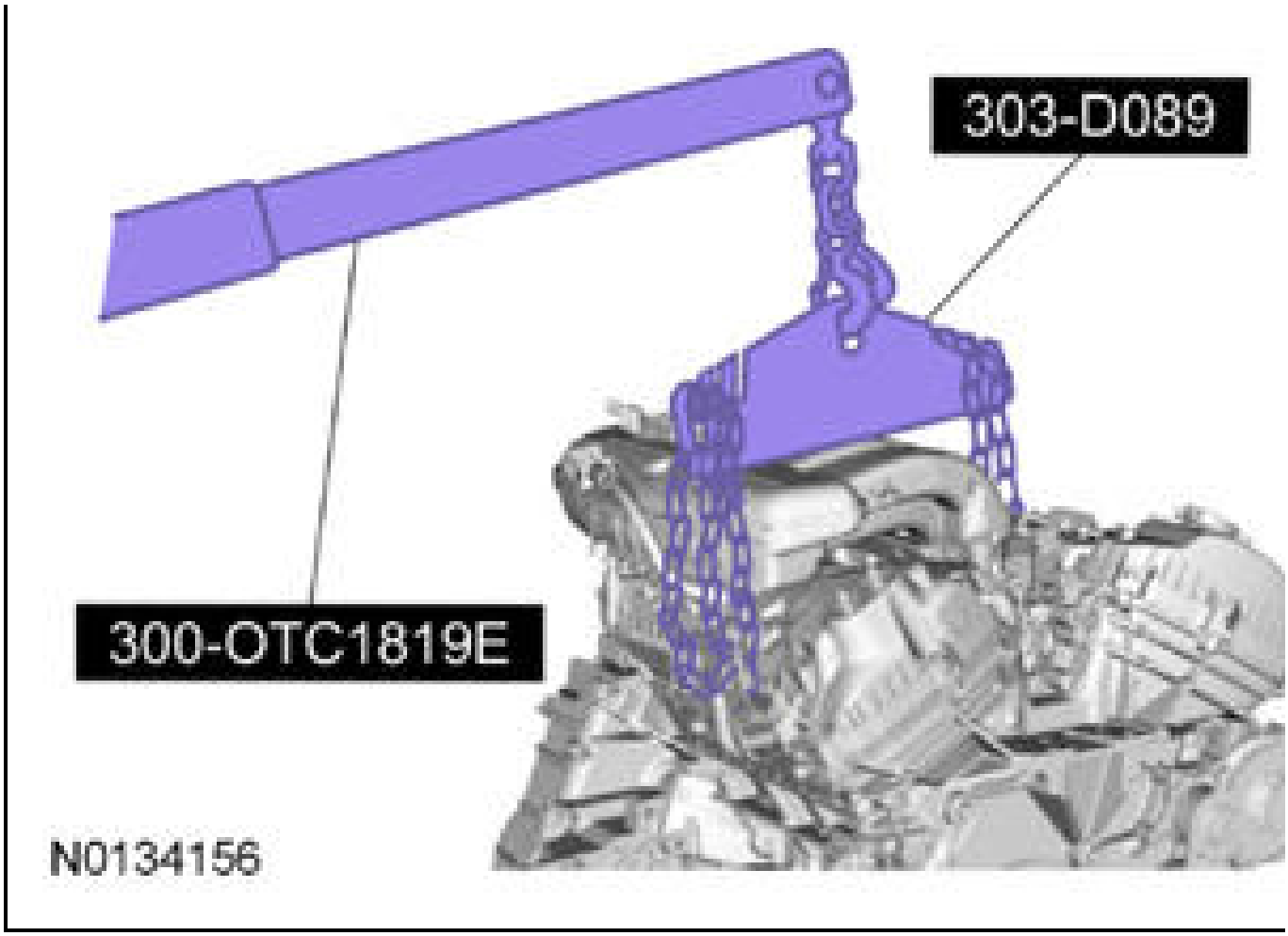
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Installation

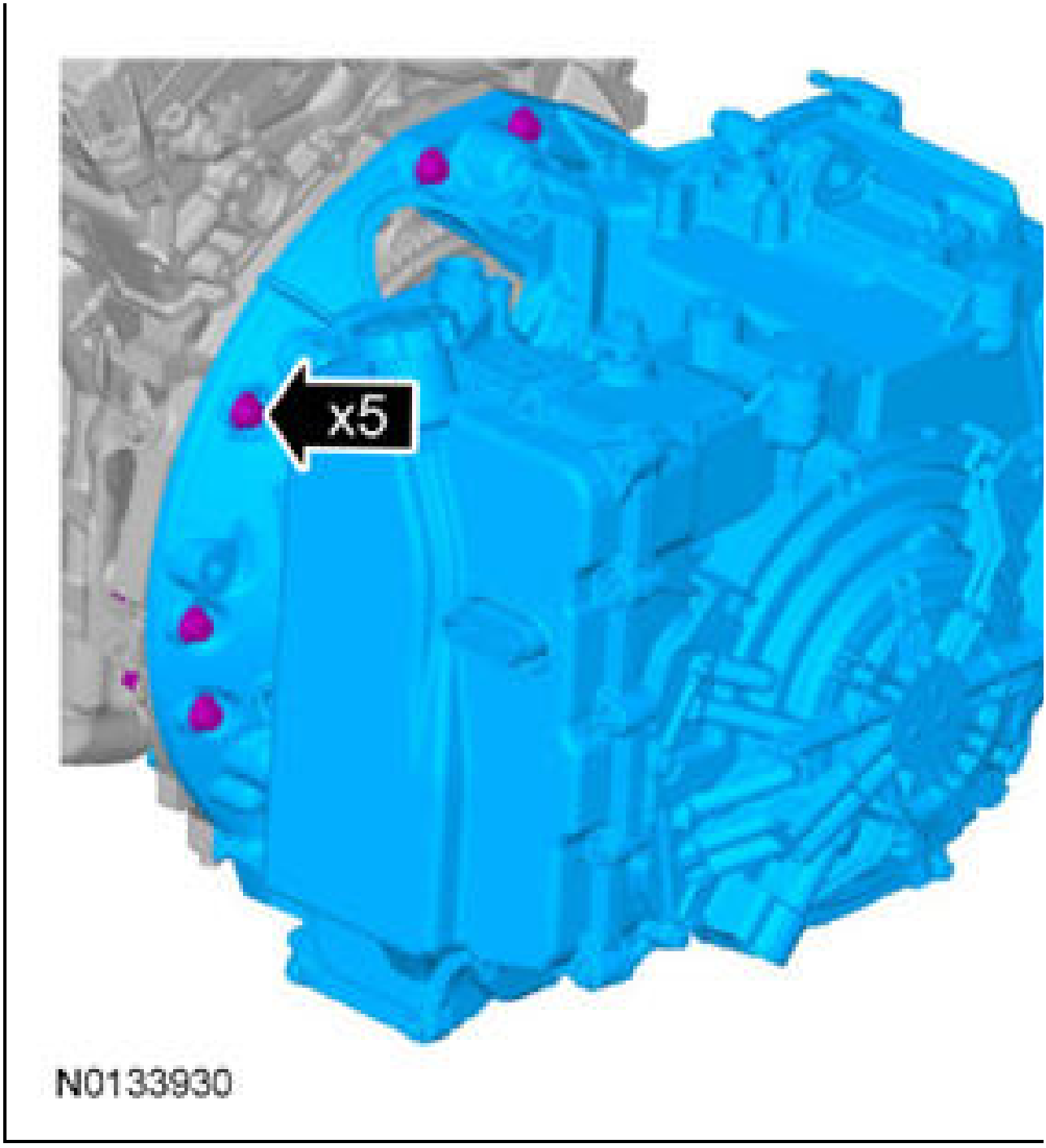
1. Using the Floor Crane and Spreader Bar, align the transaxle to the engine.

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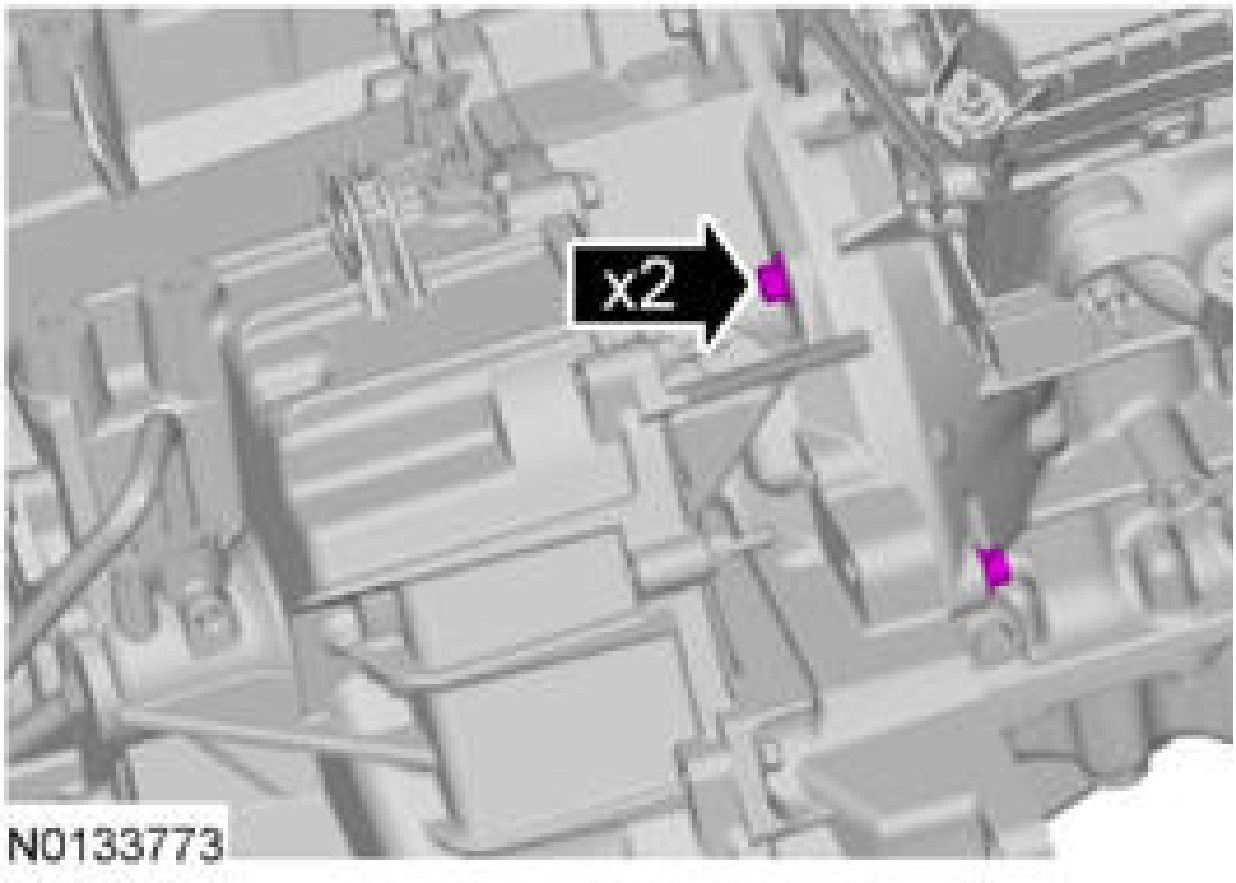
2. Align the transaxle to the engine and install the 5 transaxle-to-engine bolts.
   - Tighten to 48 Nm (35 lb-ft).

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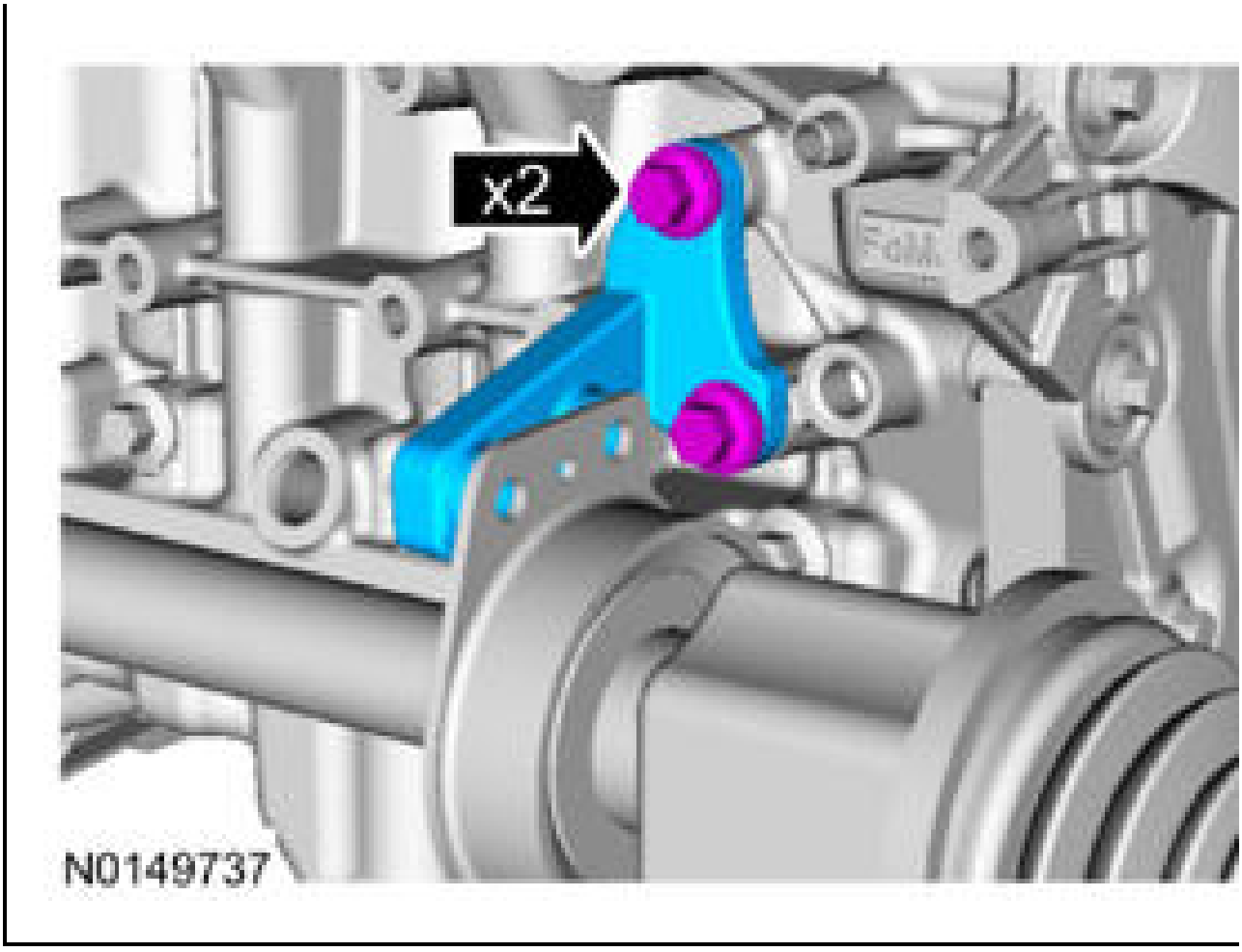
3. Install the 2 engine-to-transaxle bolts.
    - Tighten to 48 Nm (35 lb-ft).

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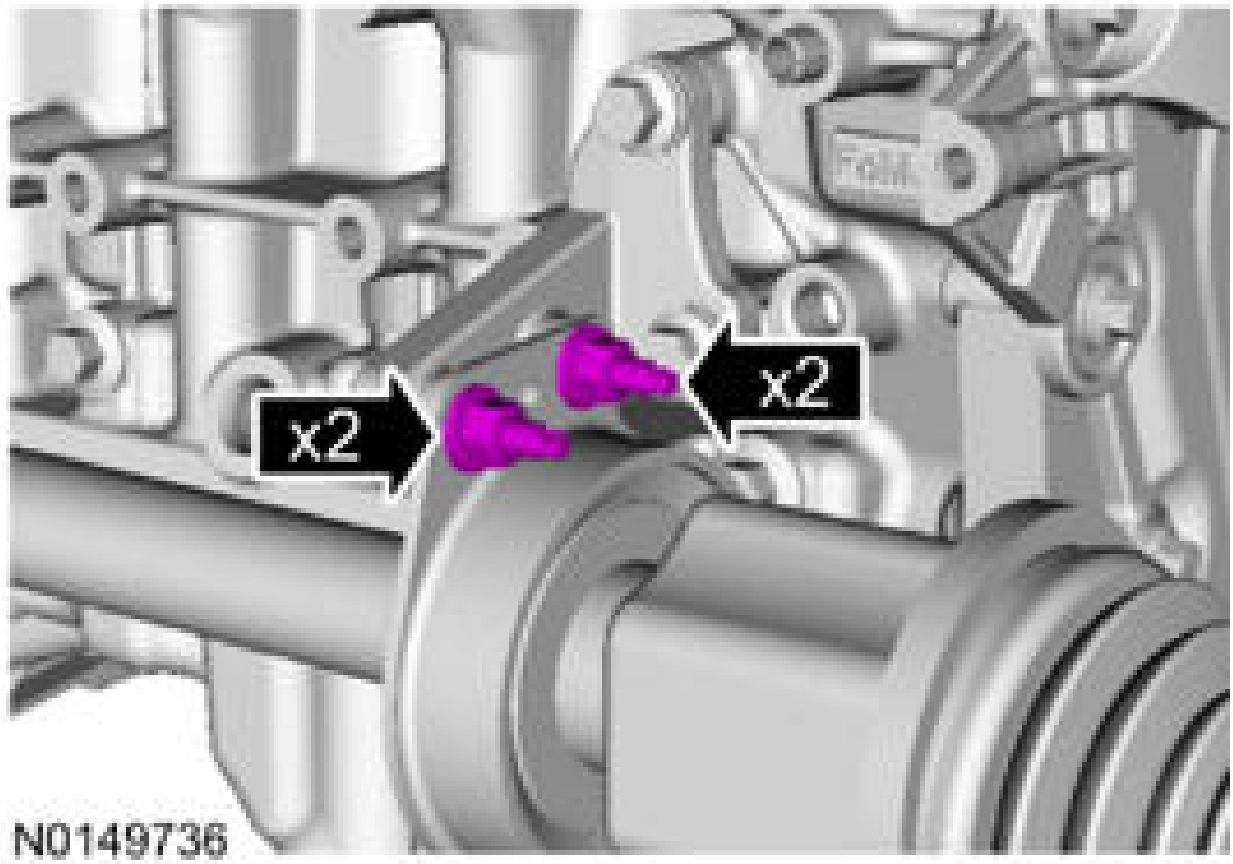
4. Install the RH halfshaft support bracket and the 2 bolts.
    - Tighten to 40 Nm (30 lb-ft).

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5. Install the 2 intermediate shaft bracket studs and nuts.
    - Tighten the studs to 10 Nm (89 lb-in).
    - Tighten the nuts to 25 Nm (18 lb-ft).

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6. **NOTE: LH shown in illustration, RH similar.**

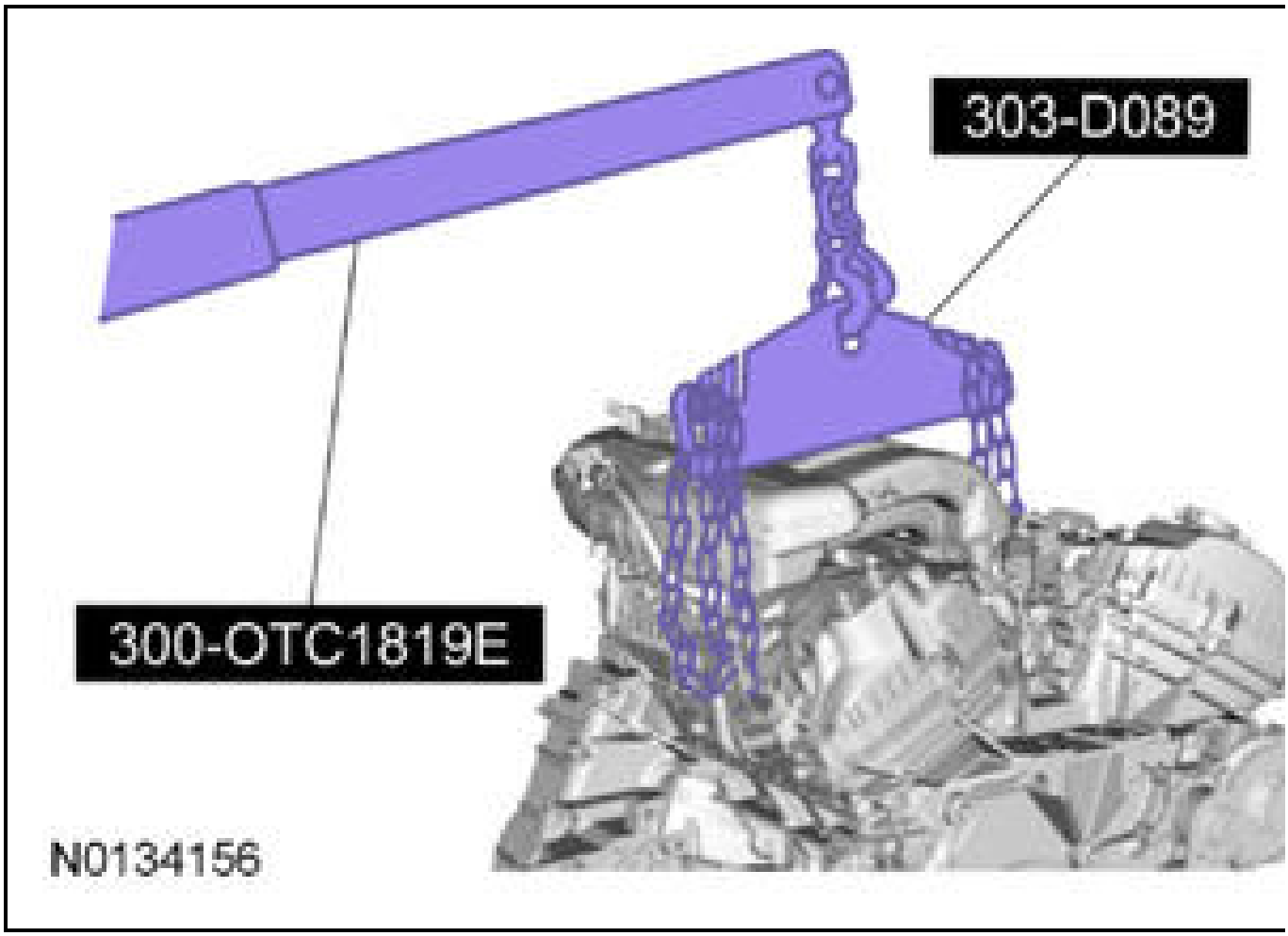
Install the ratchet strap from the front subframe to the LH engine lift eye and from the rear of the subframe to the RH engine lift eye.

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7. Using the Floor Crane and Spreader Bar, install the powertrain and subframe as an assembly on the powertrain lift table.



8. **NOTE: LH shown in illustration, RH similar.**

Remove the ratchet strap from the front subframe to the LH engine lift eye and from the rear of the subframe to the RH engine lift eye.

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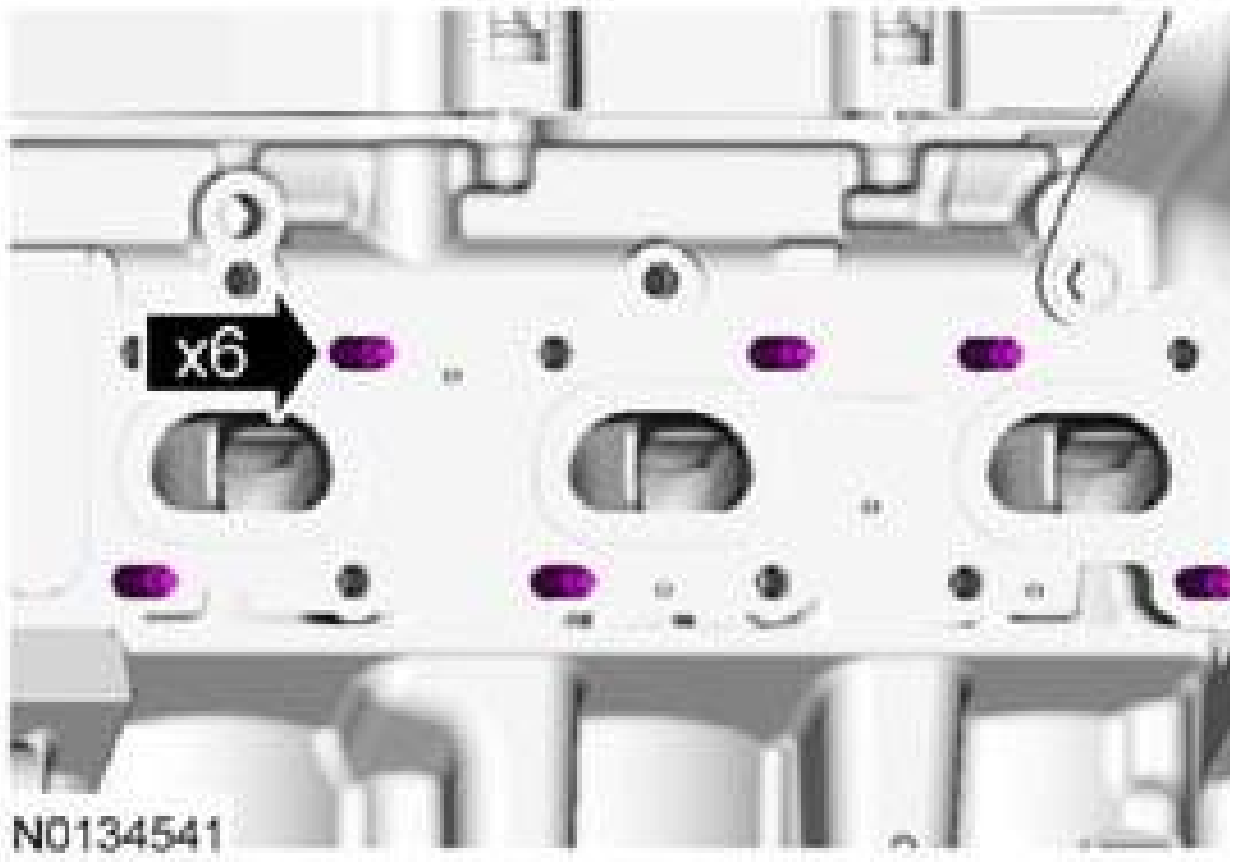
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9. Install the Adjustable Grip Arm.



10. Install a ratchet strap from the front of the subframe under the powertrain lift table to the rear of the subframe, to secure the subframe to the powertrain lift table.
11. Install 6 new RH exhaust manifold studs.
    - Tighten to 12 Nm (106 lb-in).

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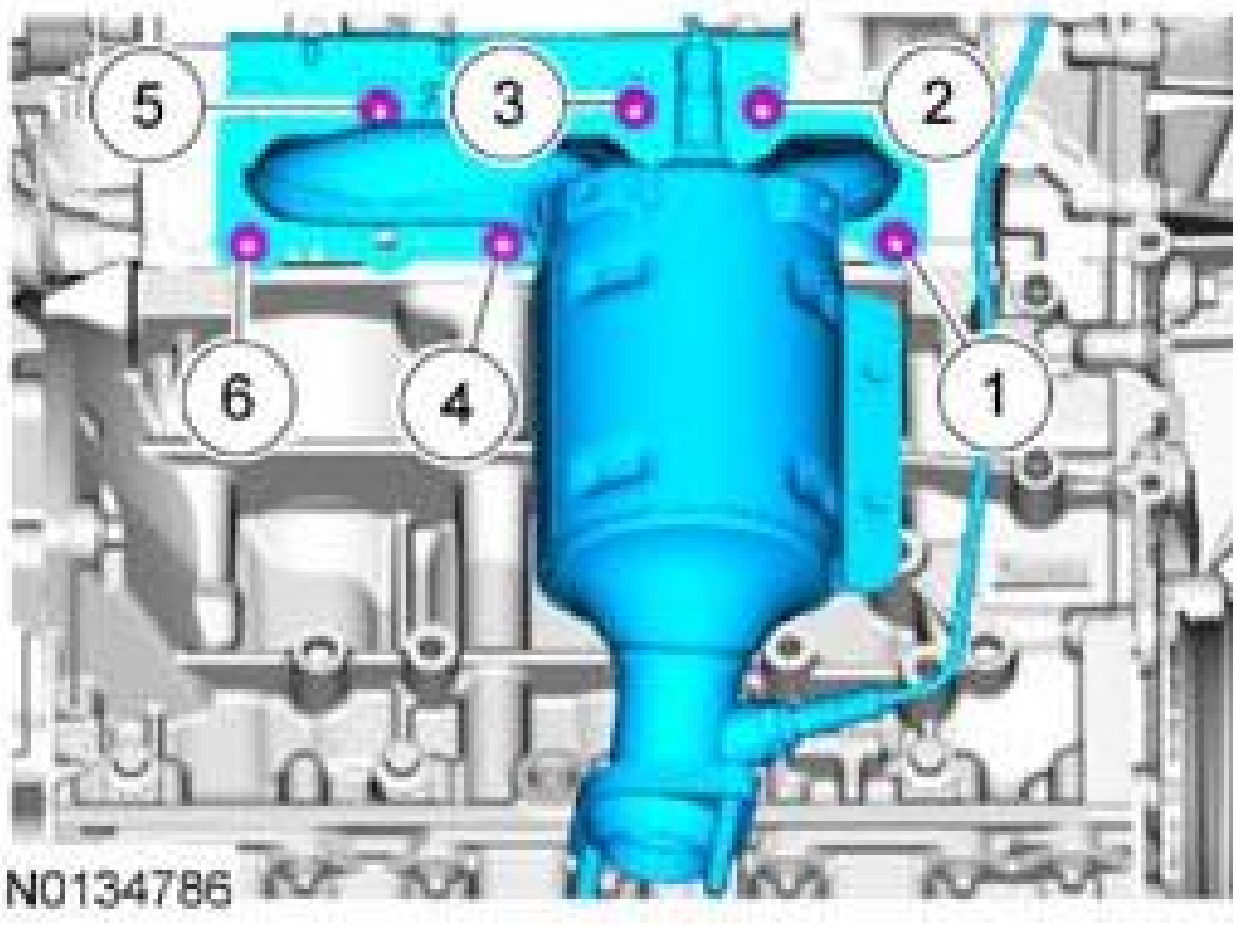


12. **NOTE: Failure to tighten the exhaust manifold nuts to specification a second time will cause the exhaust manifold to develop an exhaust leak.**

Using a new gasket, install the RH exhaust manifold and 6 new nuts. Tighten in 2 stages in the sequence shown in illustration:

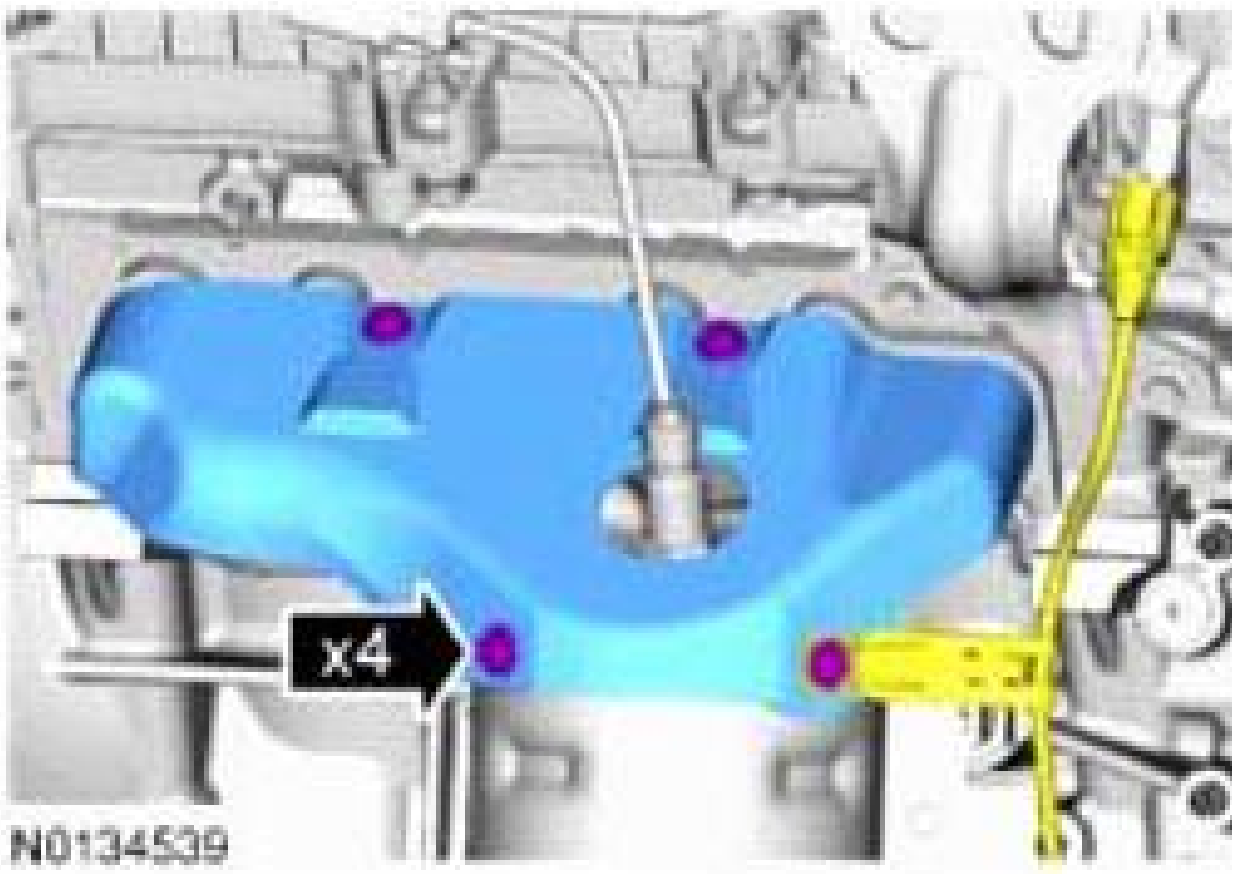
- Stage 1: Tighten to 20 Nm (177 lb-in).
- Stage 2: Tighten to 25 Nm (18 lb-ft).

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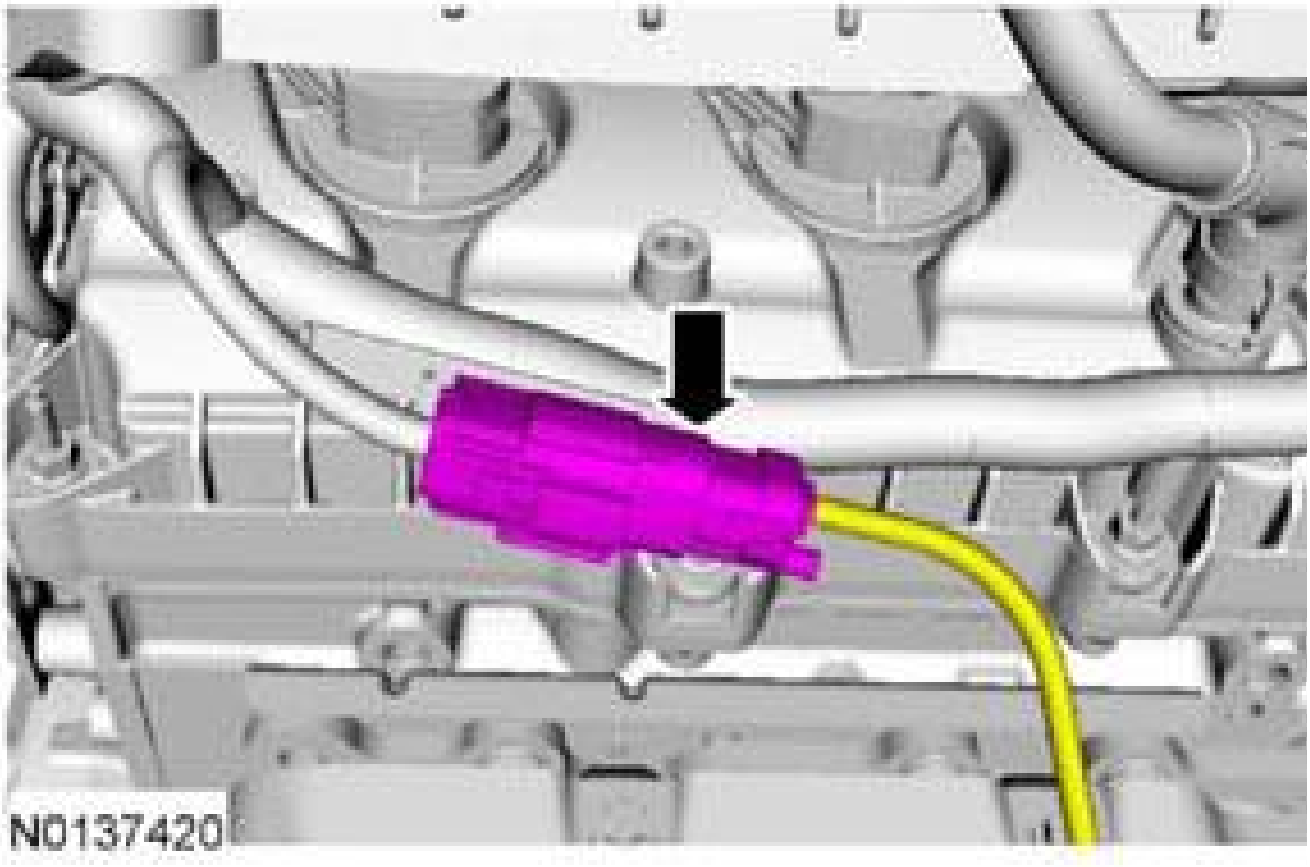
13. Install the RH catalytic converter heat shield, Catalyst Monitor Sensor (CMS) wiring harness bracket and the 4 bolts.
    - Tighten to 10 Nm (89 lb-in).

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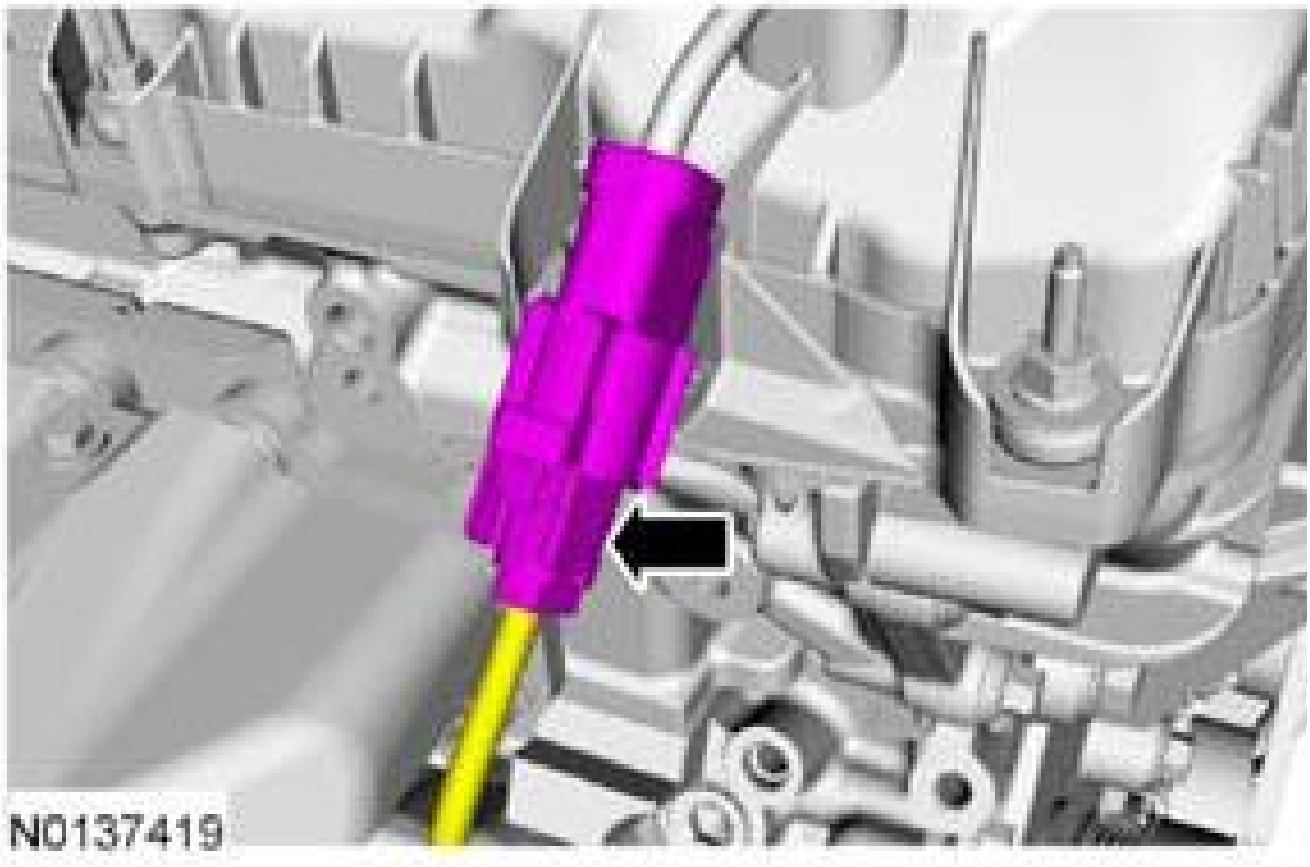
14. Connect the RH Heated Oxygen Sensor (HO2S) electrical connector.

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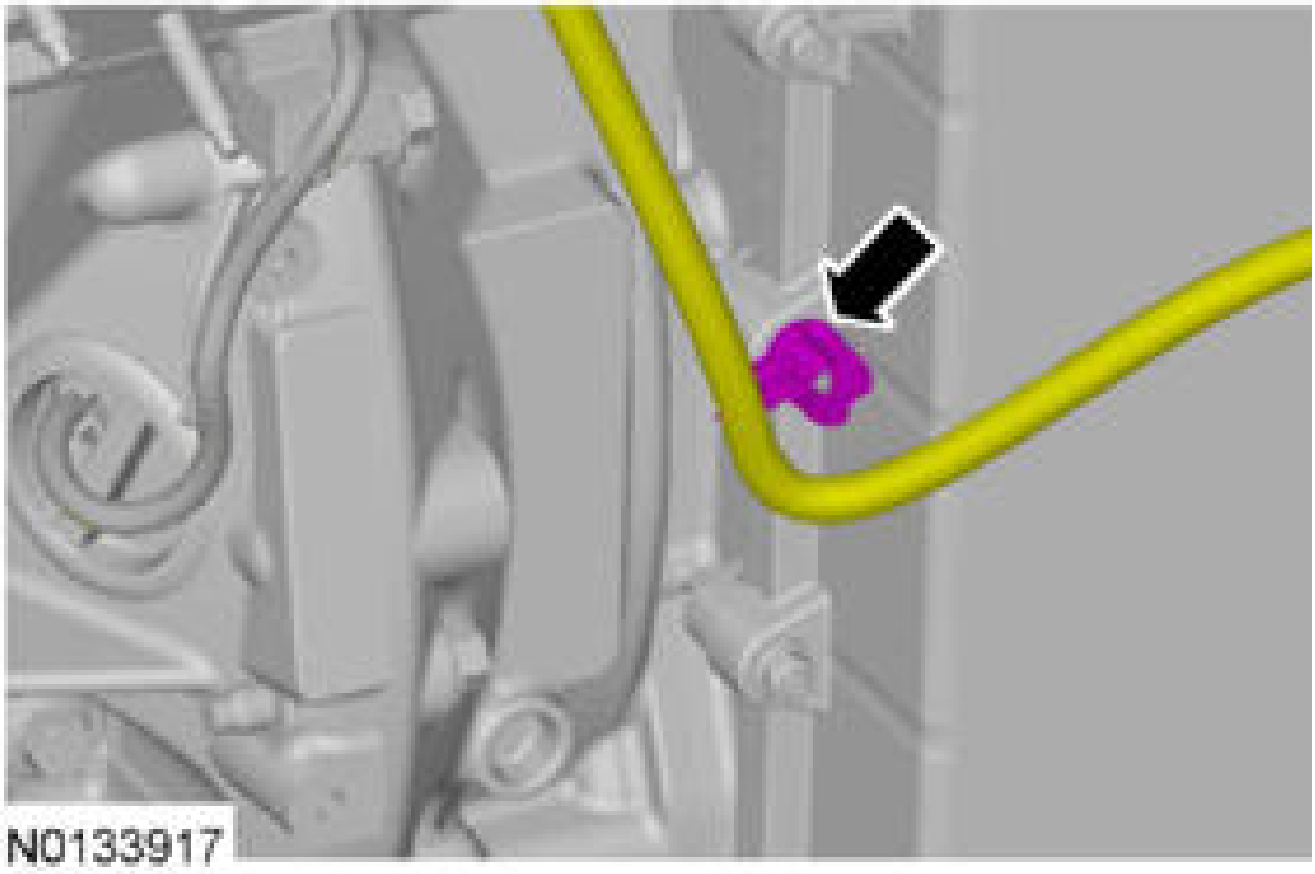
15. Connect the RH **CMS** electrical connector.

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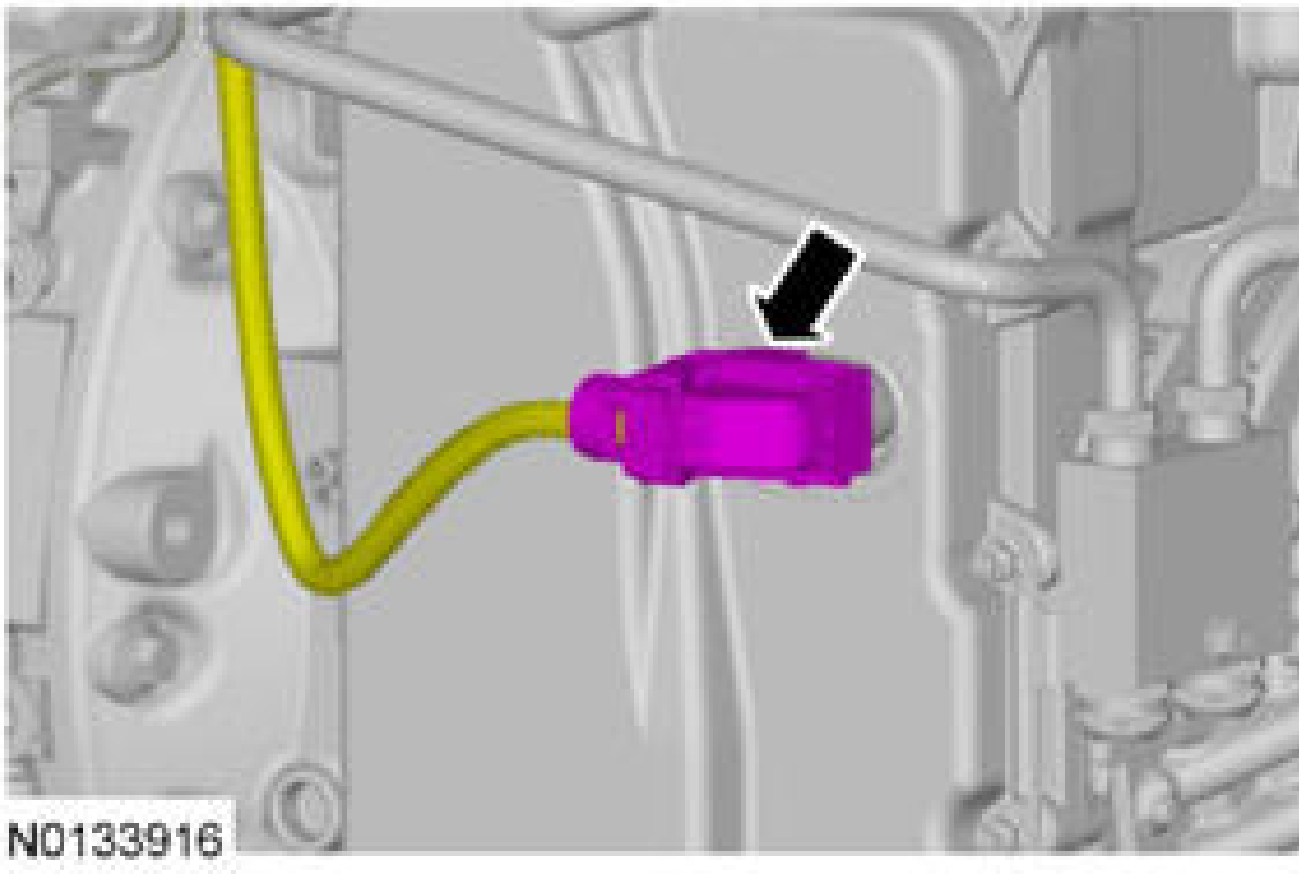
16. Attach the transaxle control wire harness retainer to the transaxle stud bolt.

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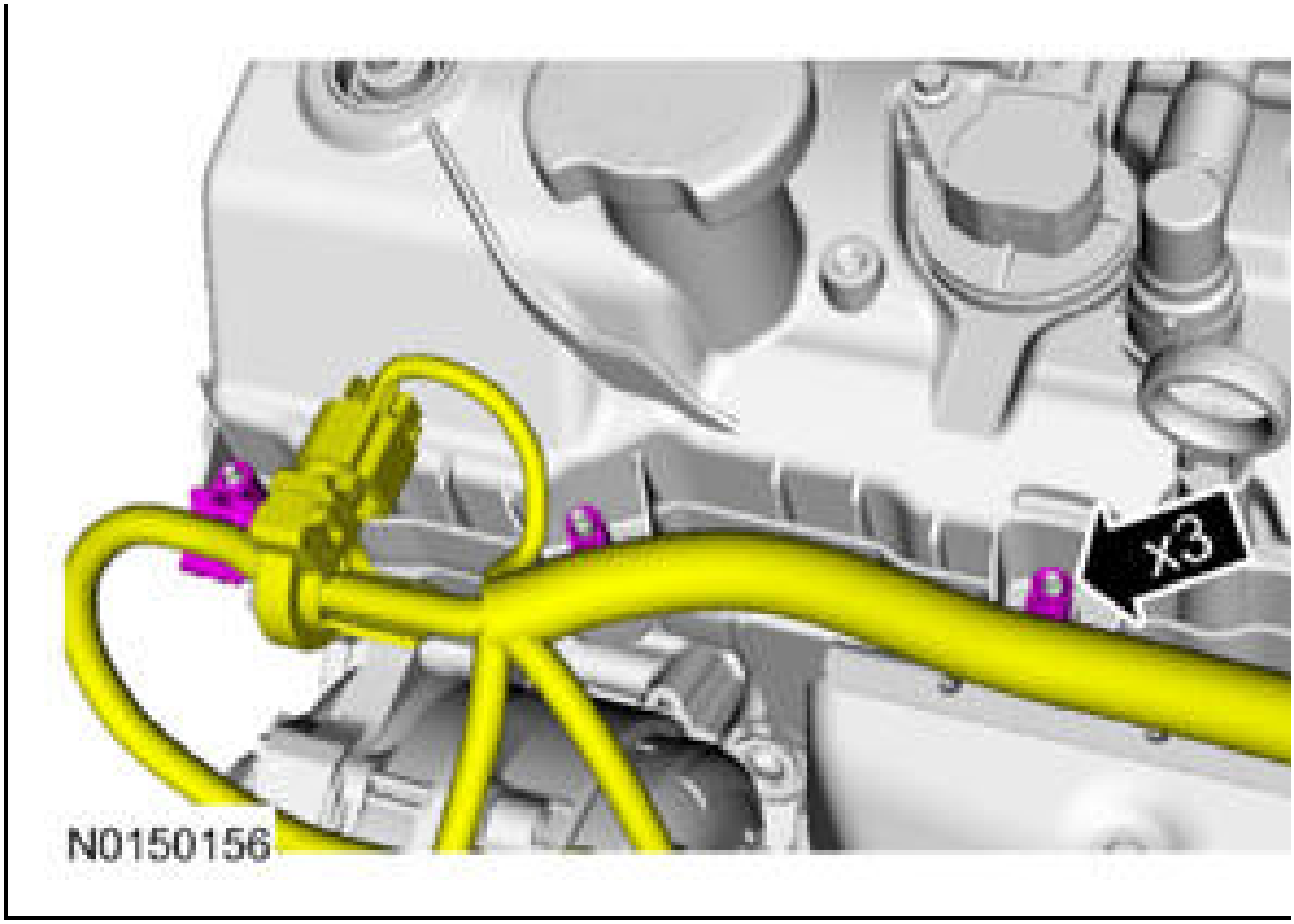
17. Connect the transaxle control electrical connector.

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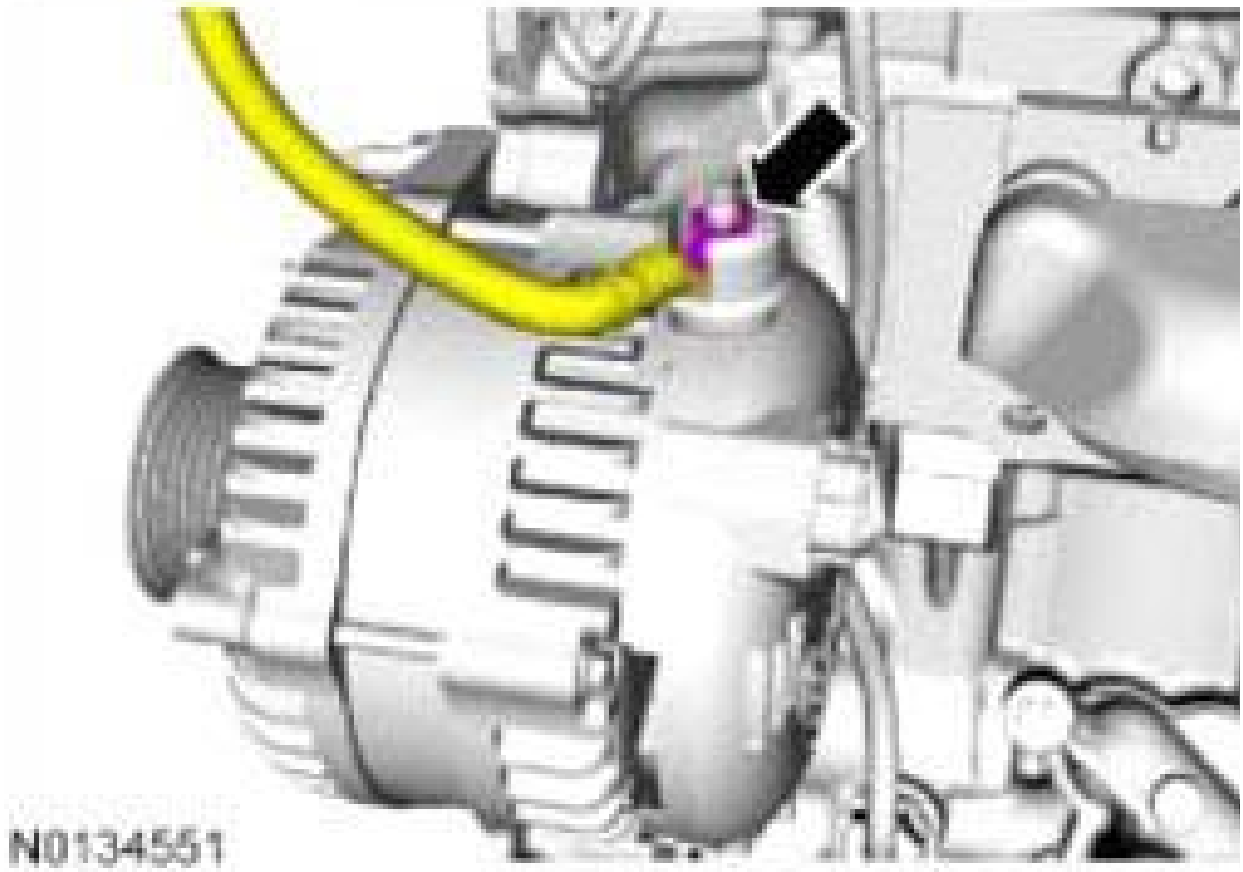
18. Position the wiring harness and attach the 3 wiring harness retainer to the valve cover stud bolt.

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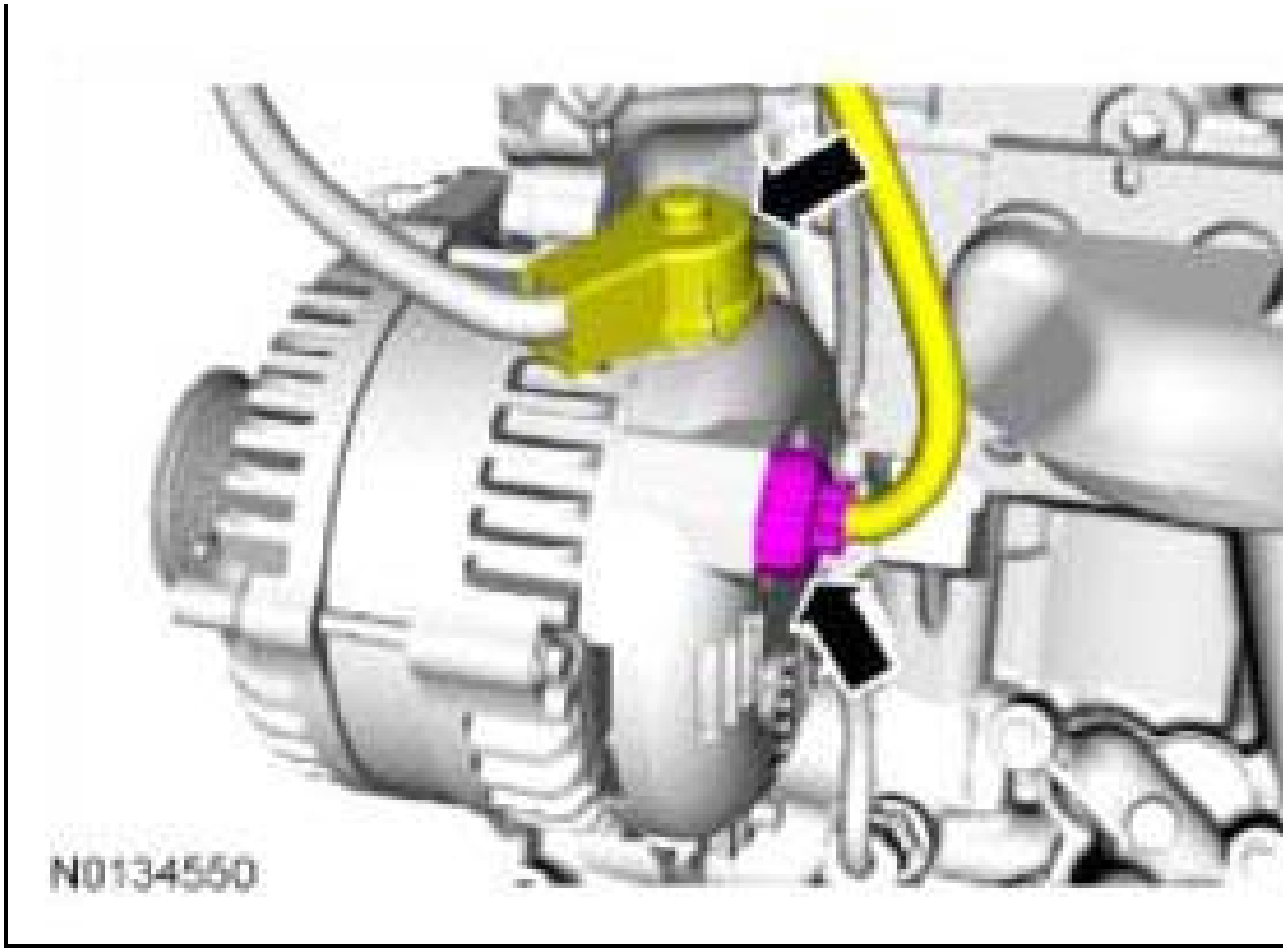
19. Connect the generator B+ cable and install the nut.
    - Tighten to 17 Nm (150 lb-in).

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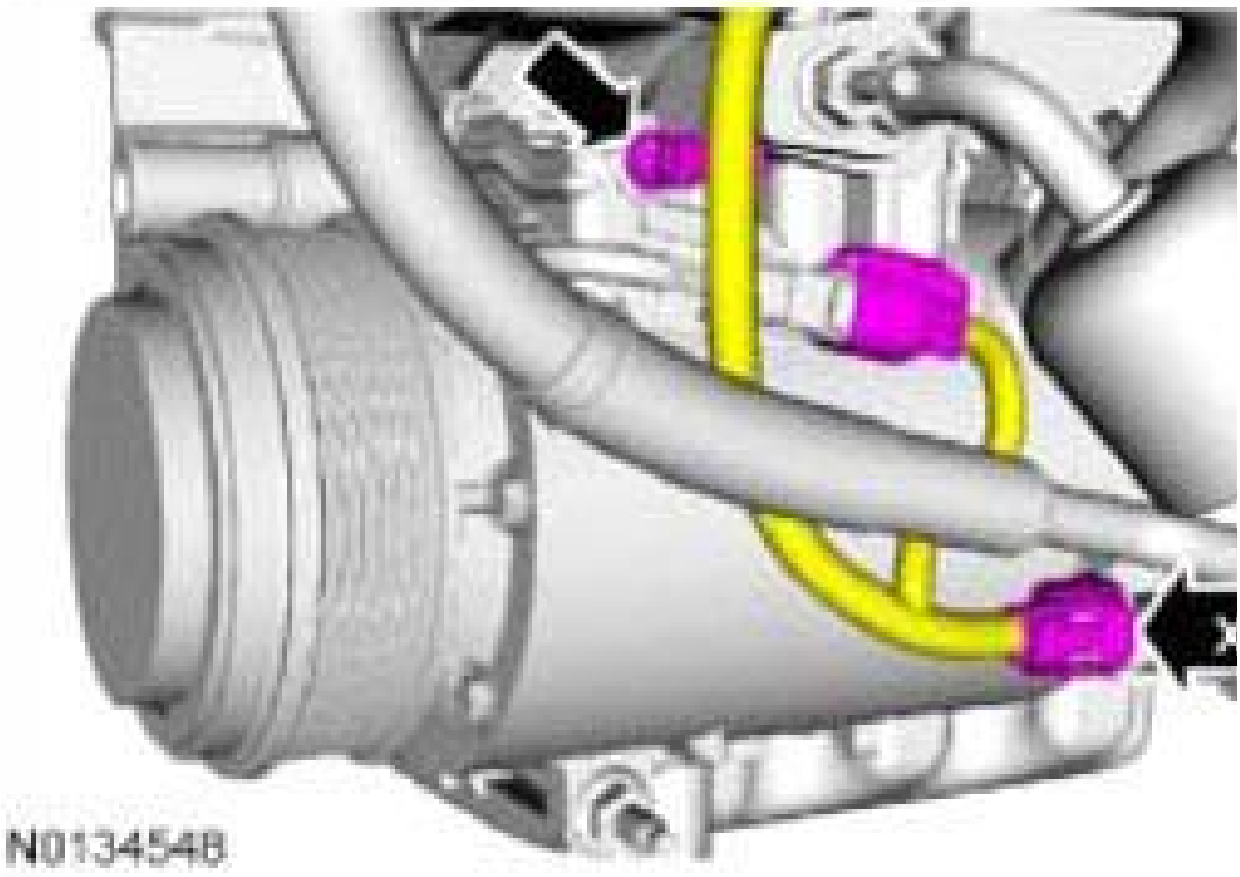
20. Position back the generator B+ cable cover and connect the generator electrical connector.

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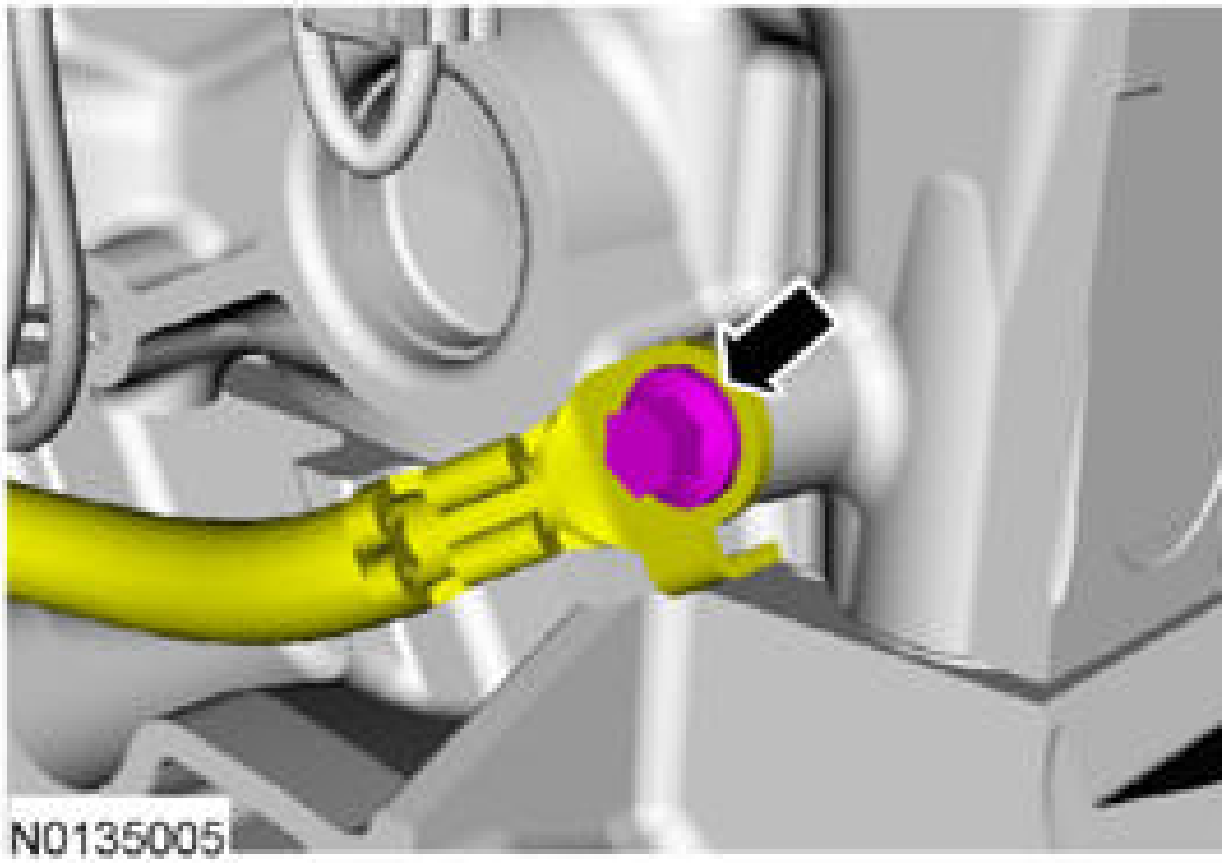
21. Connect the 2 A/C compressor electrical connectors.
    - Attach the A/C wiring harness retainer.

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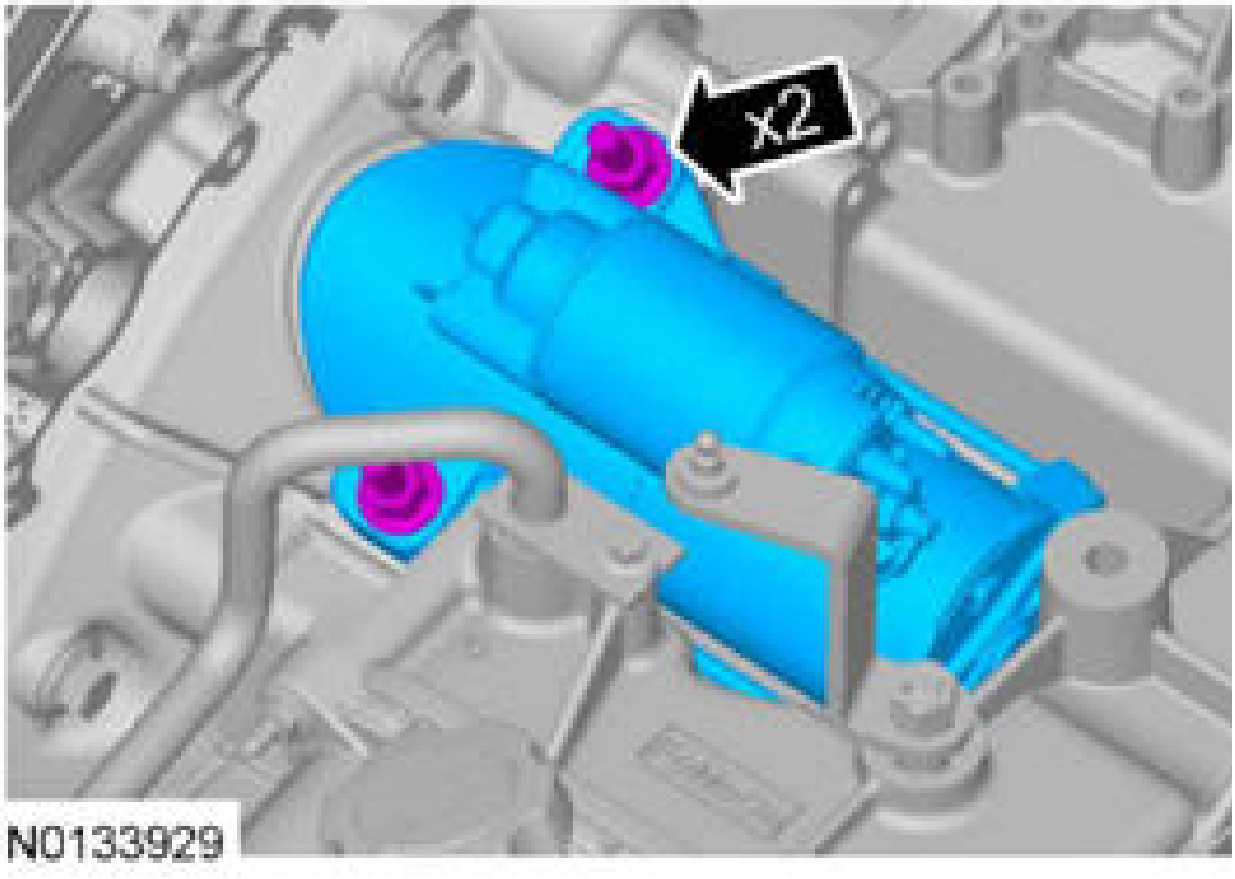
22. Install the ground wire to the RH cylinder head and install the bolt.
    - Tighten to 10 nm (89 lb-In).

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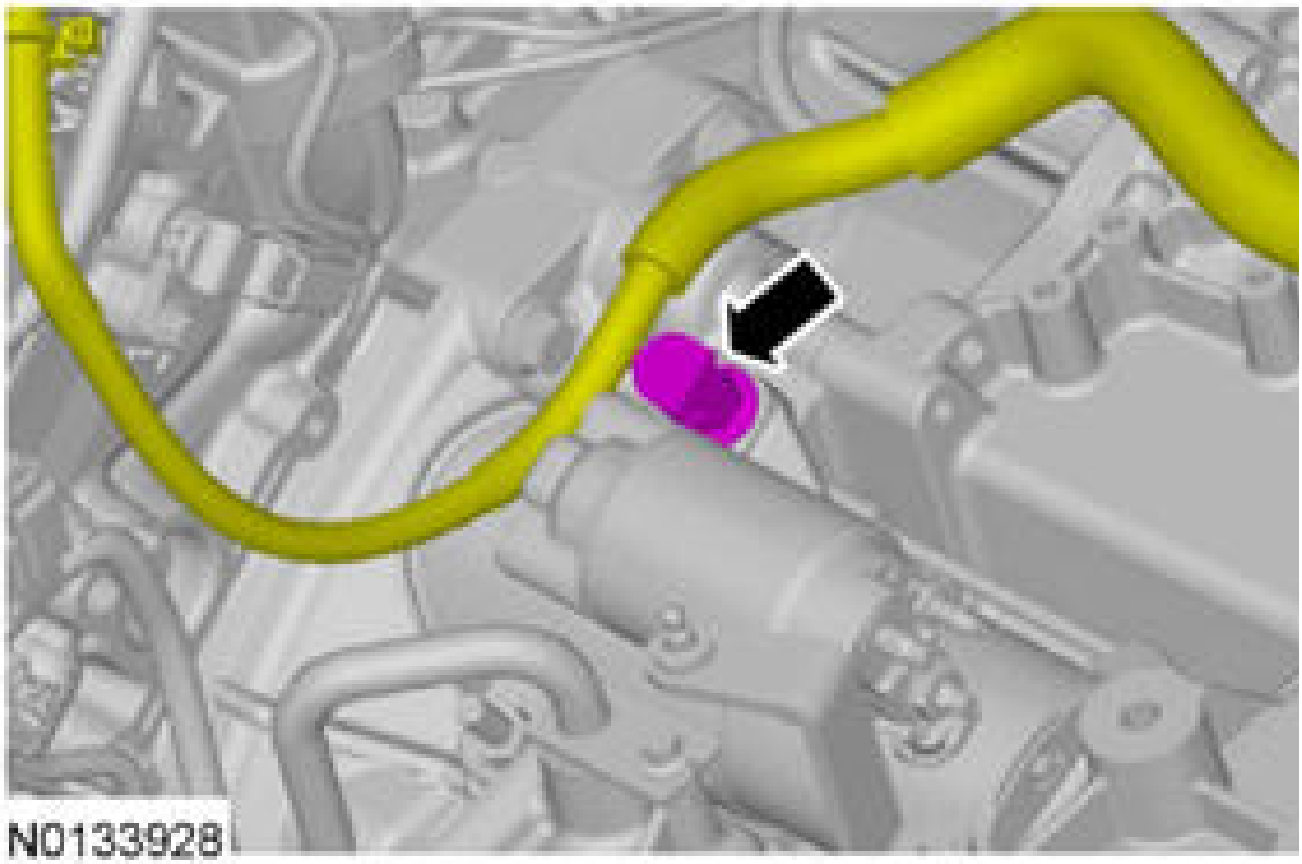
23. Install the starter and the stud bolts.
    - Tighten to 27 Nm (20 lb-ft).

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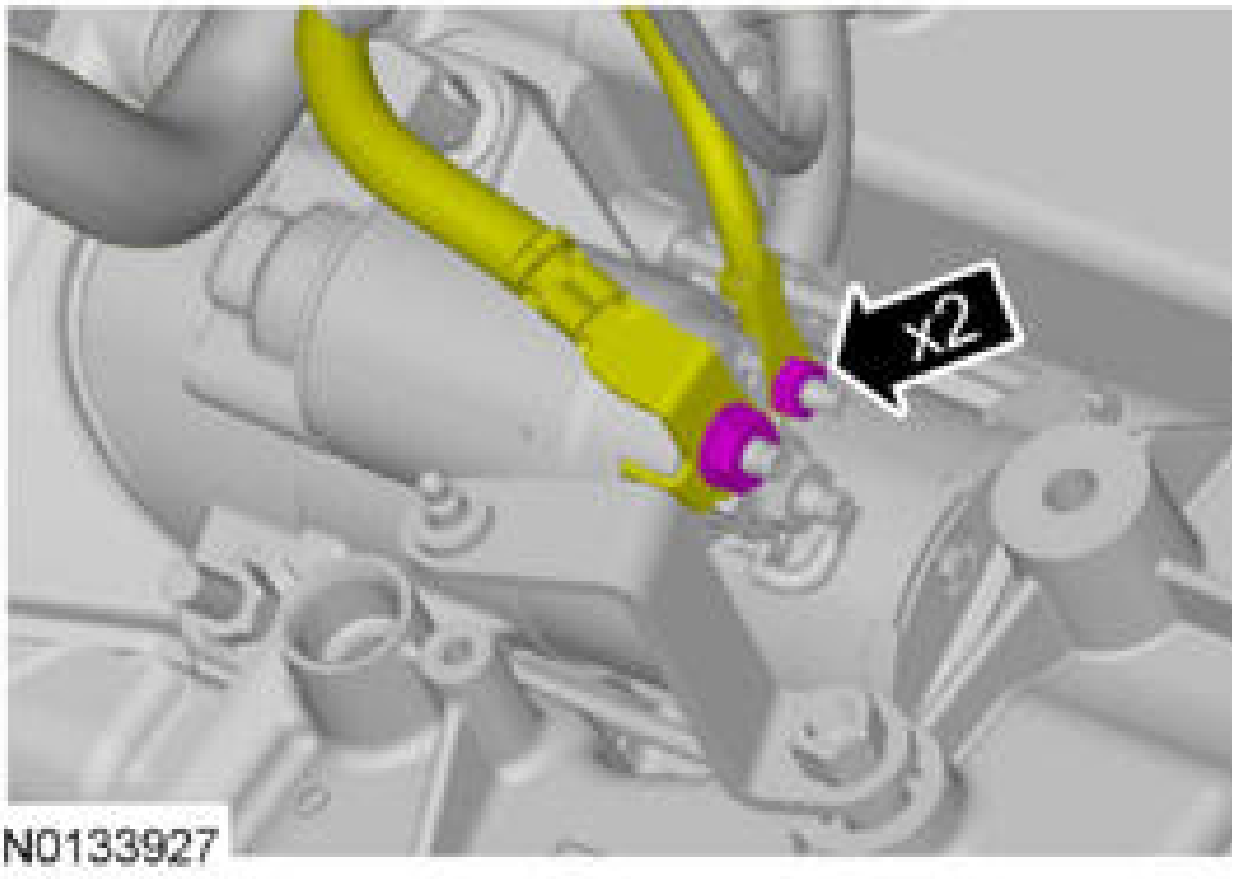
24. Connect the wiring harness retainer to the starter motor stud bolt.

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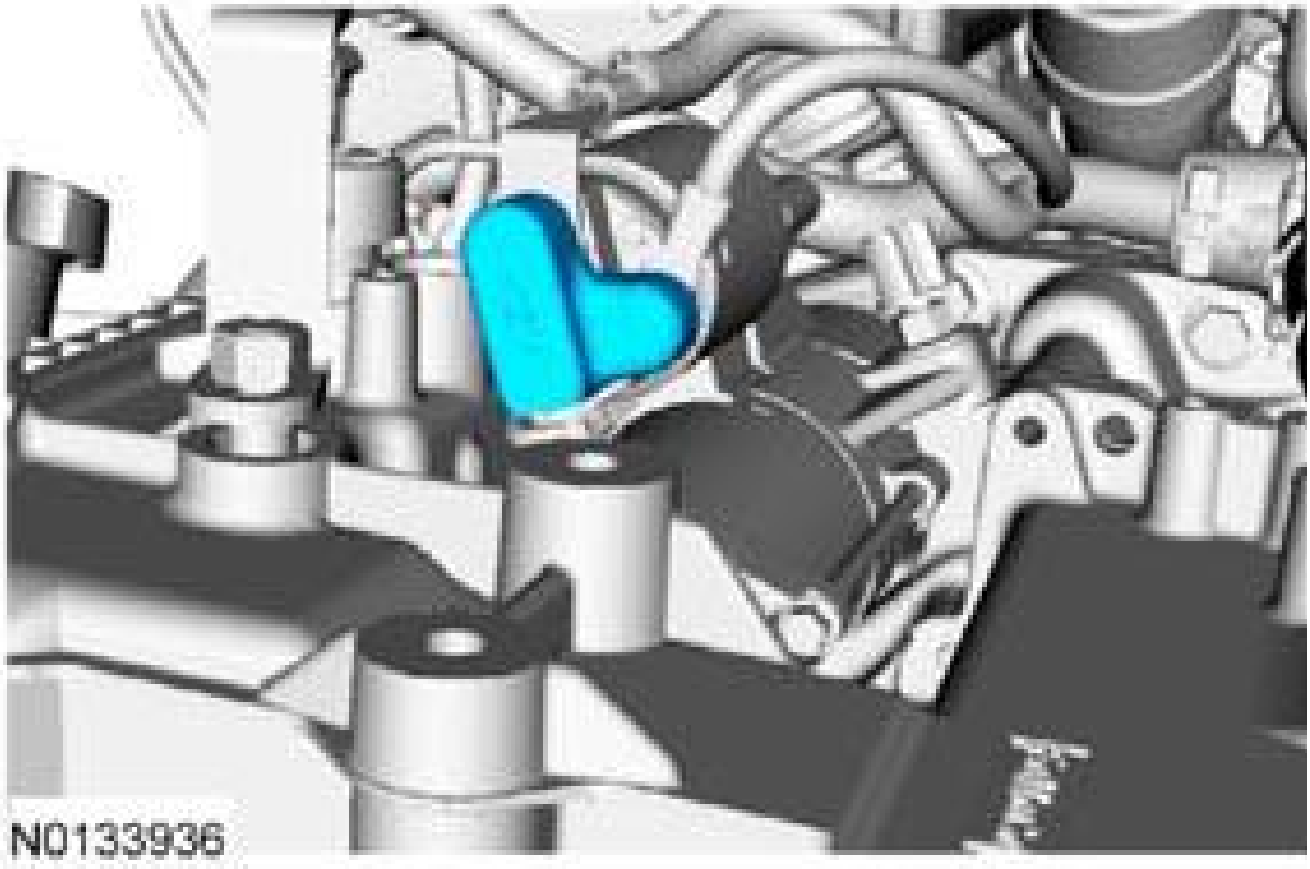
25. Attach the starter wire terminals and install the 2 nuts.
    - Tighten the B+ terminal nut to 12 Nm (106 lb-in).
    - Tighten the S-terminal nut to 5 Nm (44 lb-in).

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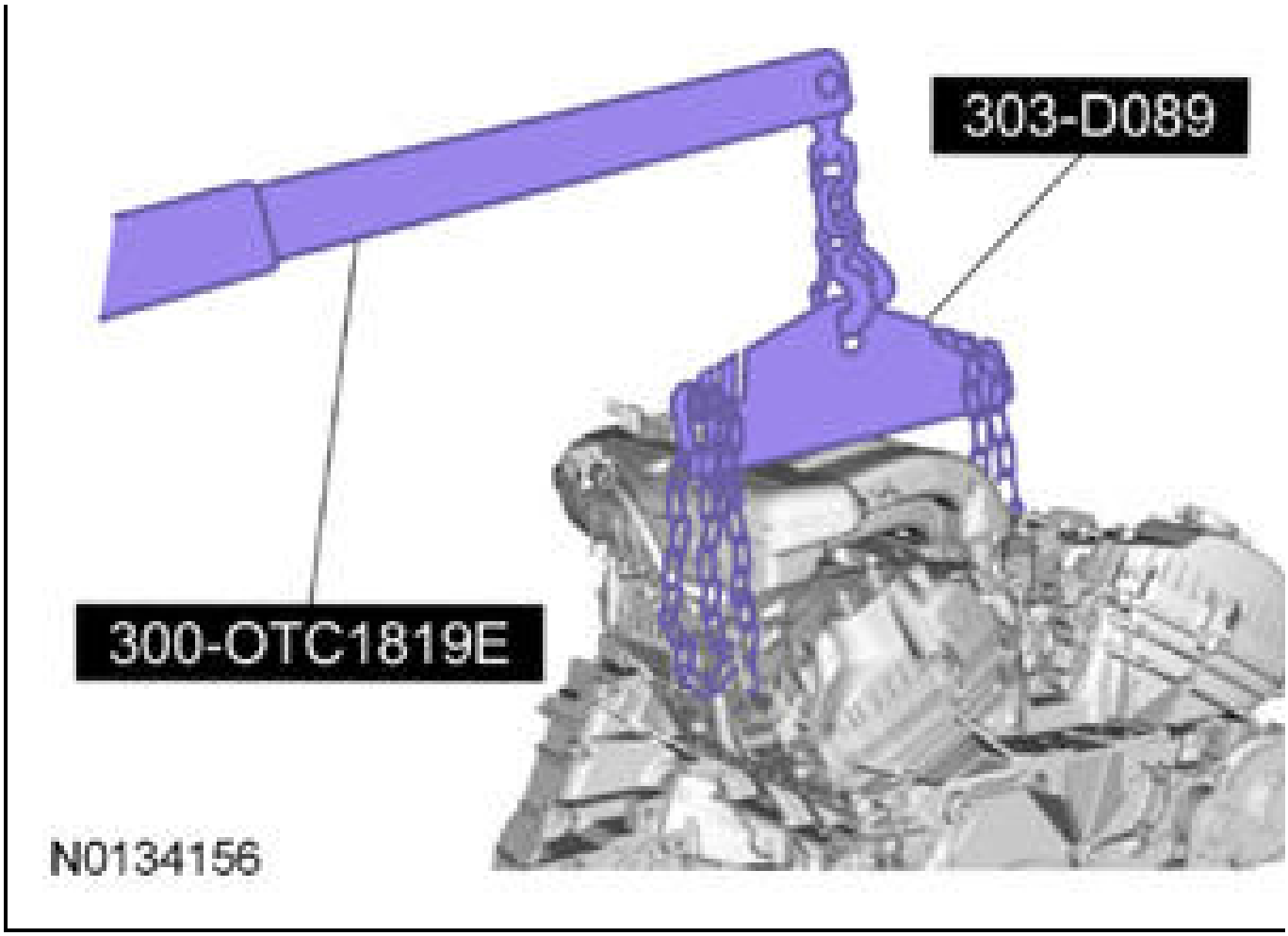
26. Install the starter motor solenoid cover.

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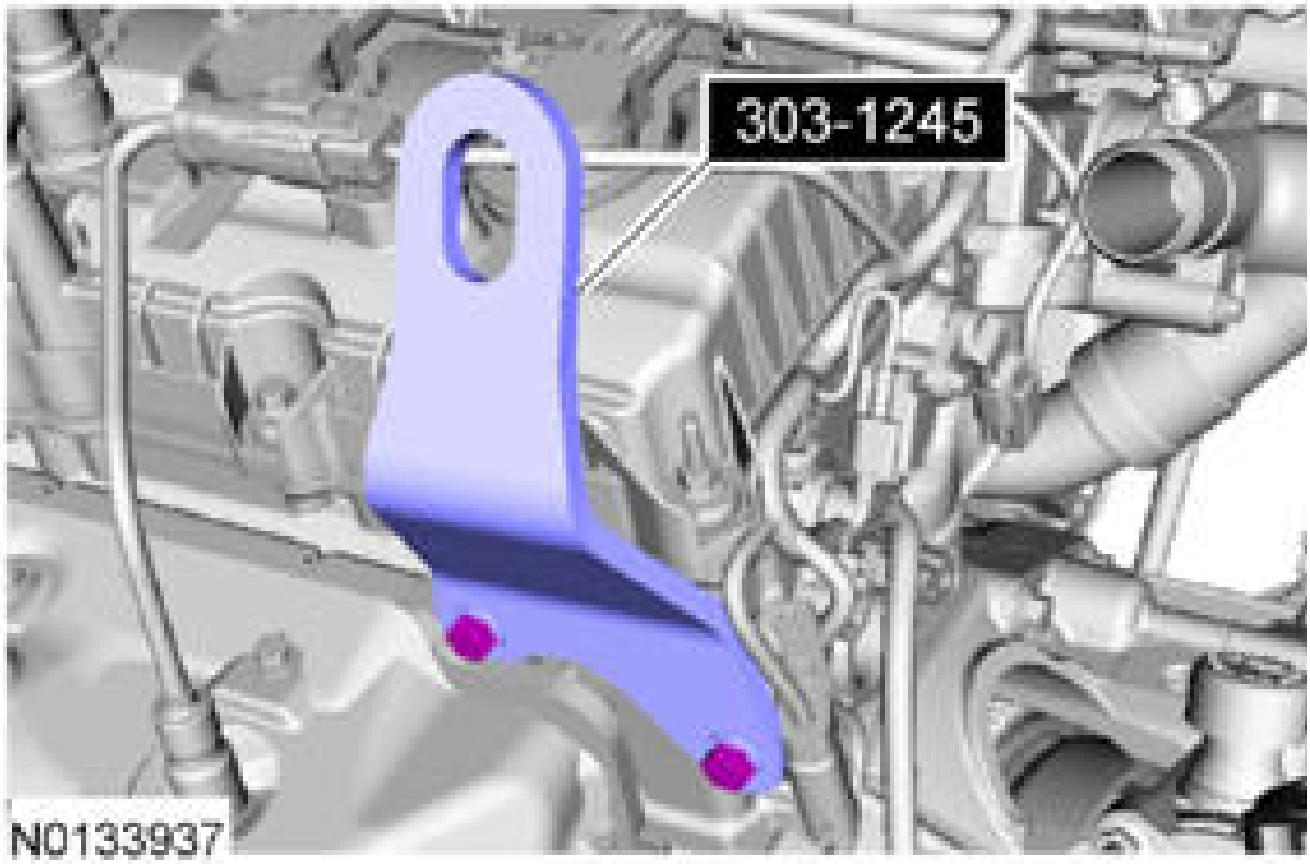
27. Remove the Heavy Duty Floor Crane and Spreader Bar.

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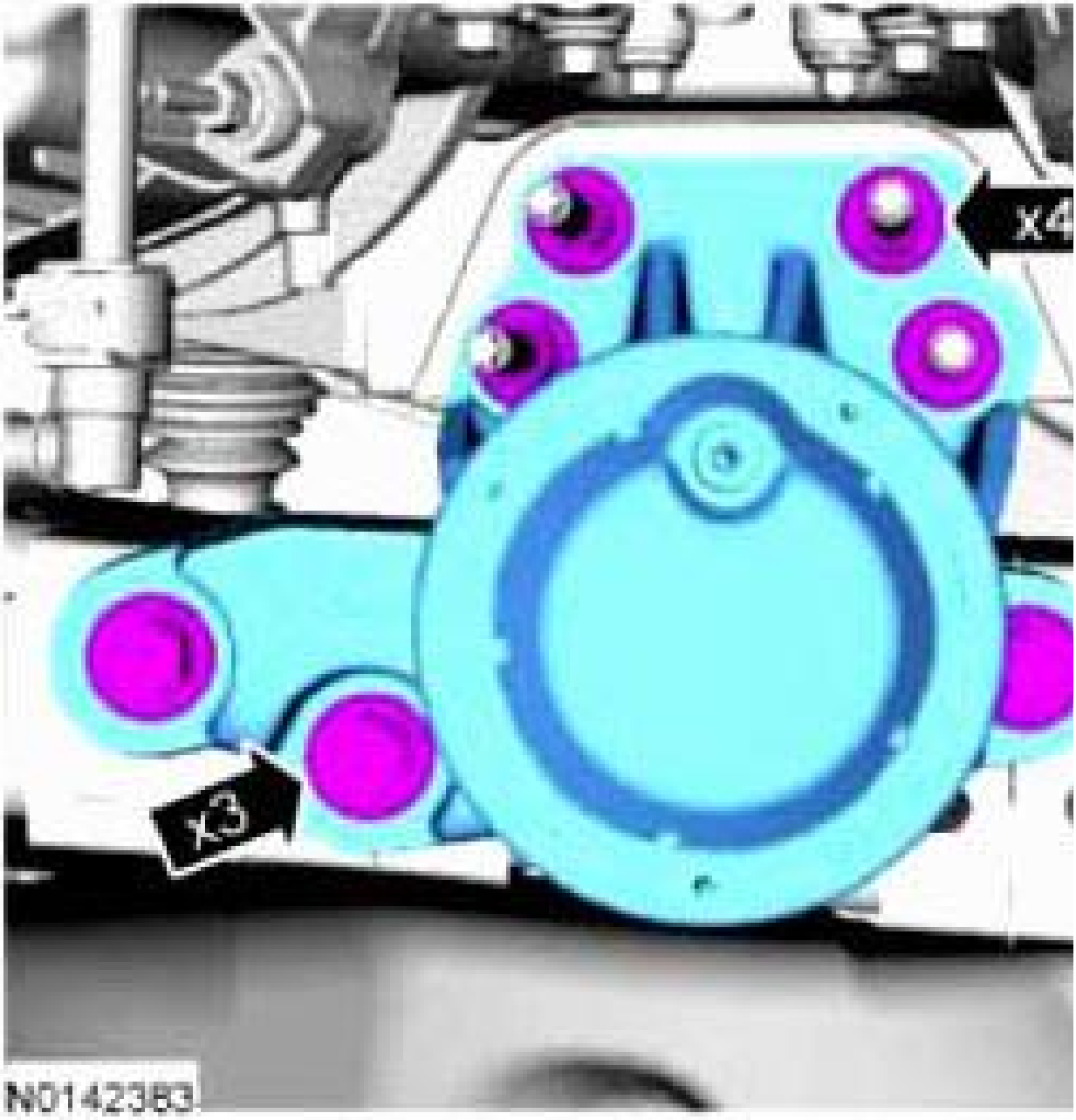
28. Remove 303-1245 from the LH cylinder head.

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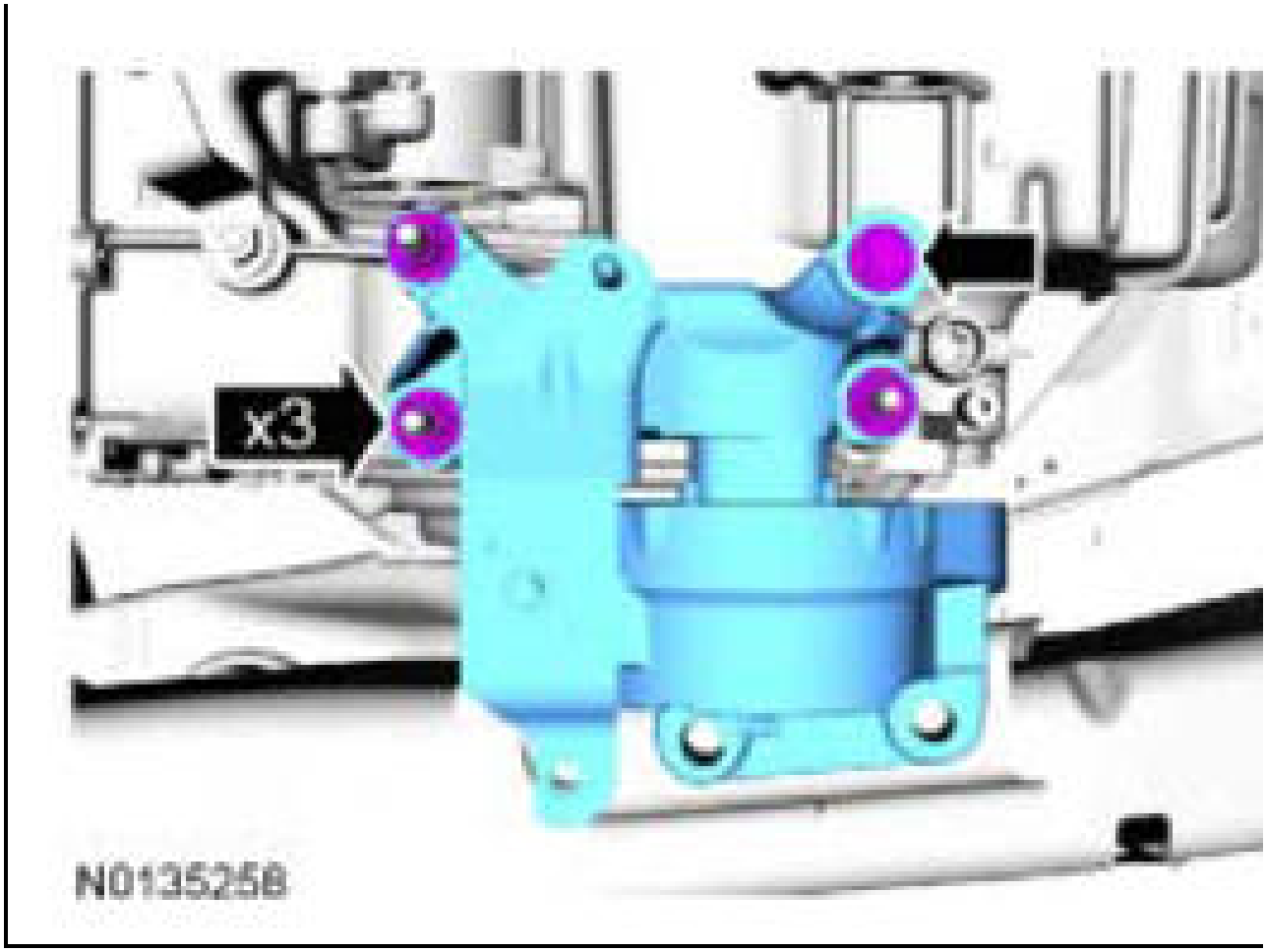
29. Raise the subframe and powertrain assembly into the vehicle.
30. Install the engine mount, the 3 bolts and the 4 engine mount nuts hand tight.
    - Tighten the 3 engine mount bolts to 90 Nm (66 lb-ft).
    - Tighten the 4 engine mount nuts to 63 Nm (46 lb-ft).

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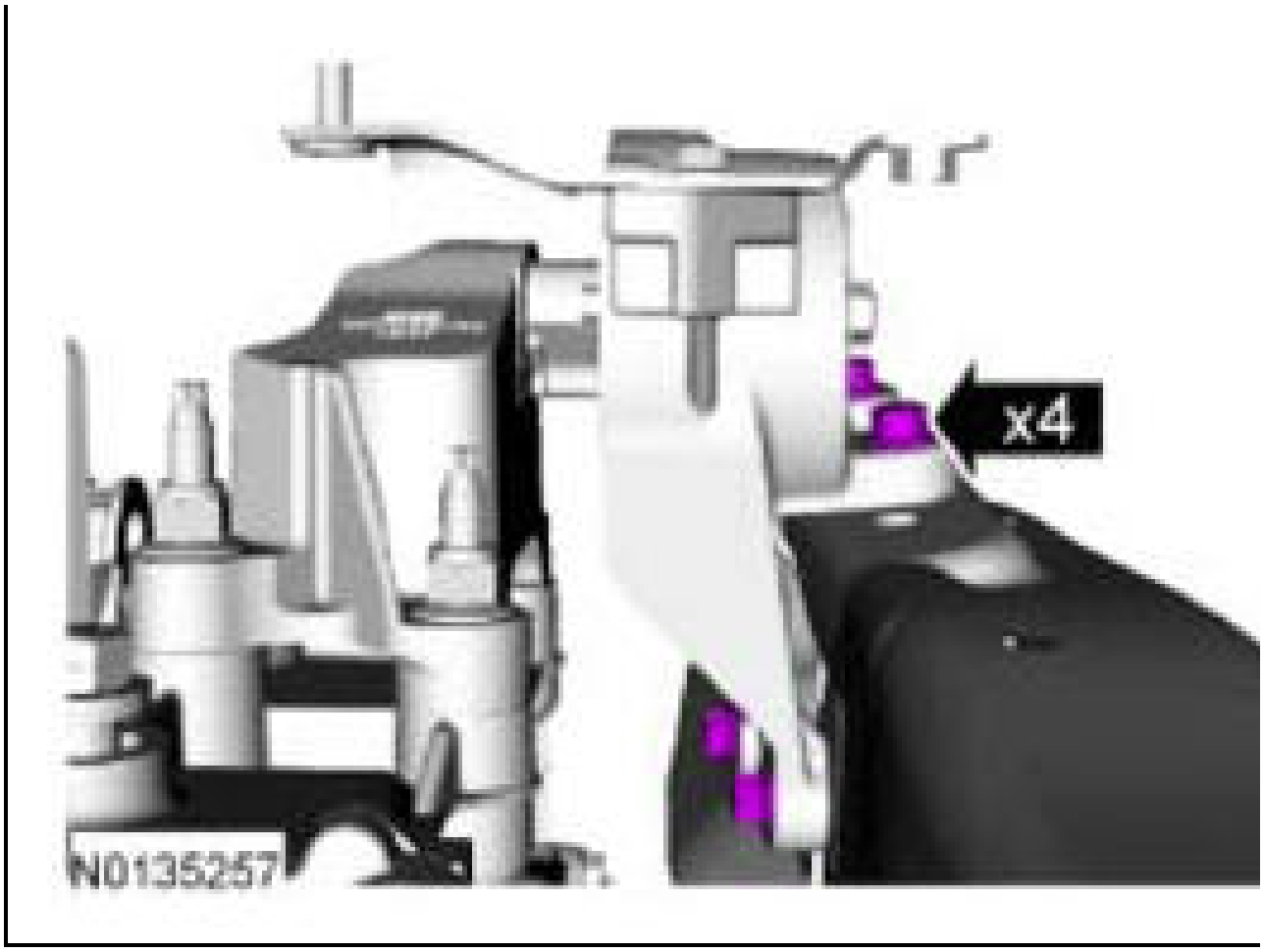
31. Install the transaxle support insulator assembly the 3 nuts and the bolt.
    - Tighten the nuts to 63 Nm (46 lb-ft).
    - Tighten the bolt to 80 Nm (59 lb-ft).

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32. Install the 4 transmission support insulator-to-frame rail bolts.
    - Tighten the 2 bottom bolts to 55 Nm (41 lb-ft).
    - Tighten the 2 top bolts to 70 Nm (52 lb-ft).

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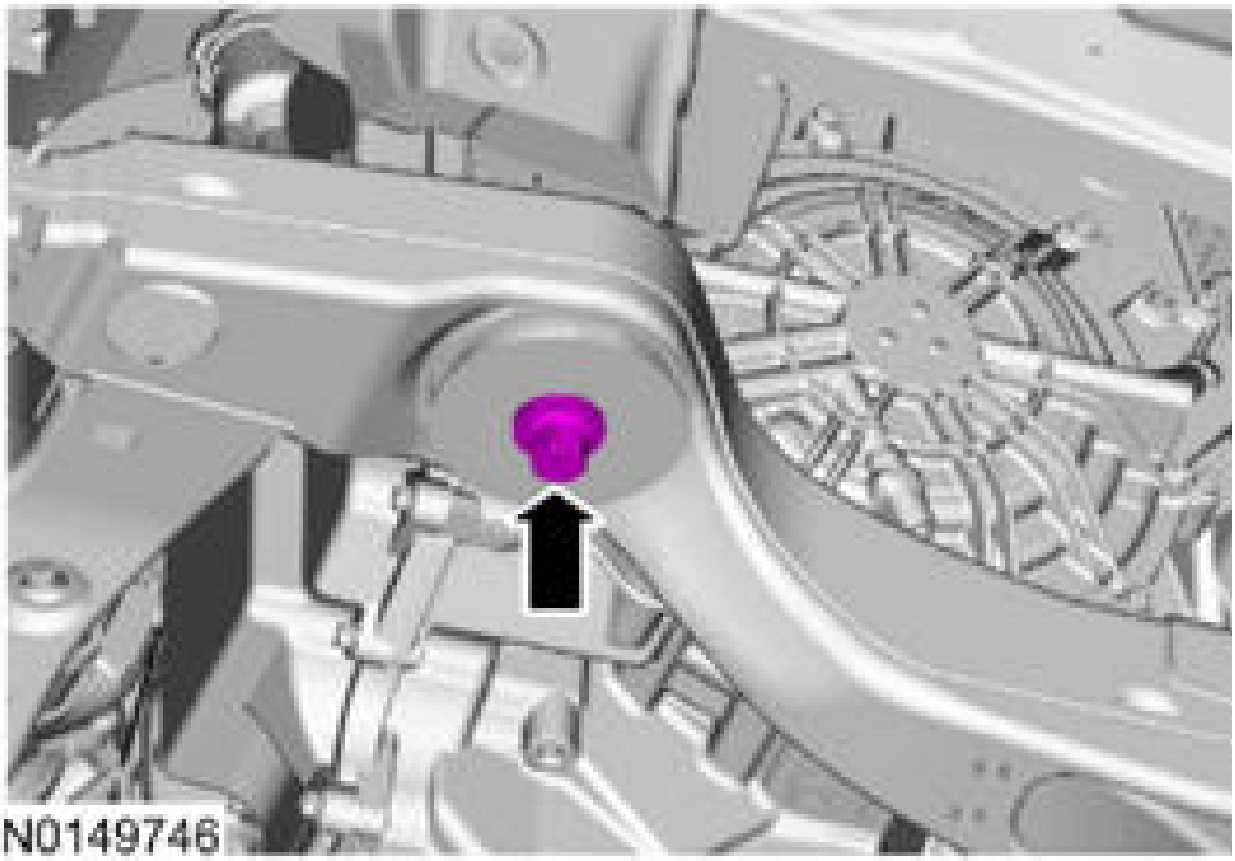


33. **NOTE: RH shown in illustration, LH similar.**

Align the subframe and install the new front subframe bolts.

- Tighten to 200 Nm (148 lb-ft).

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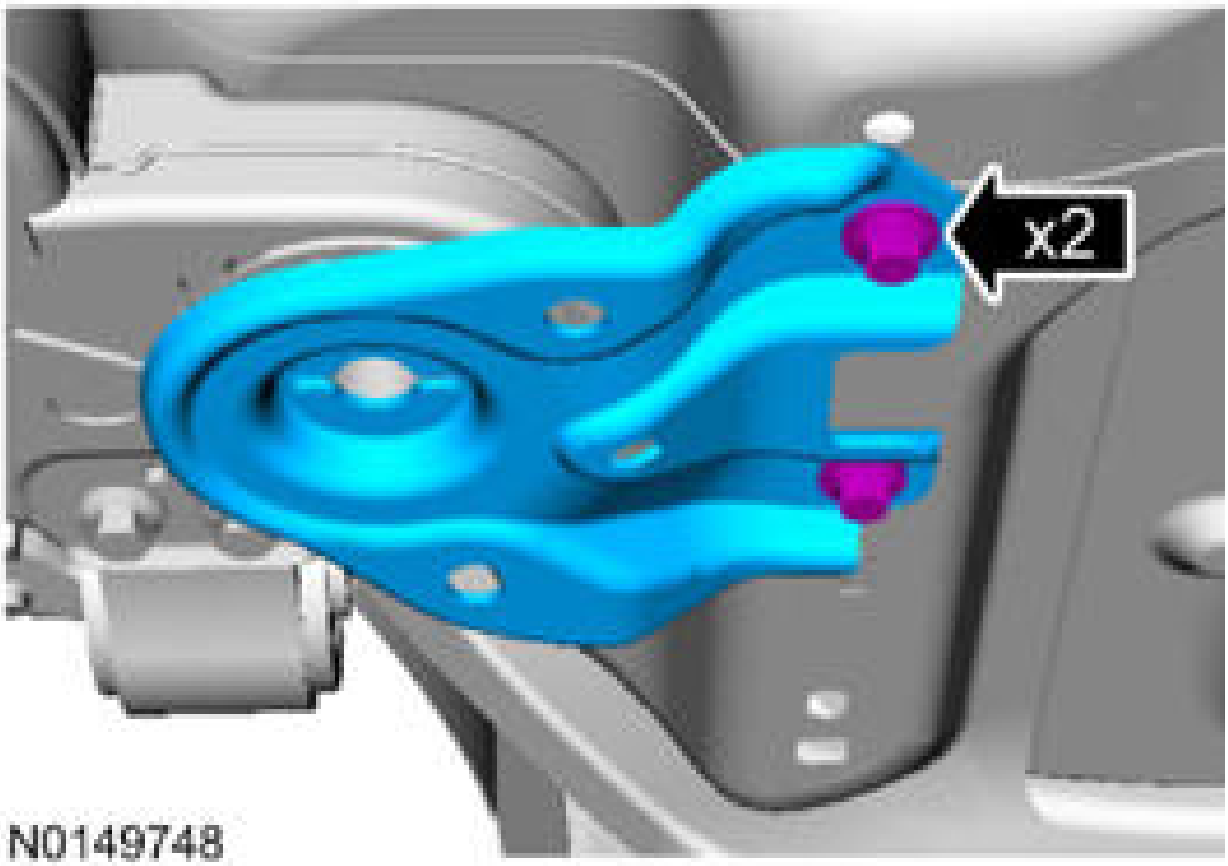


34. **NOTE: RH shown in illustration, LH similar.**

Install the rear subframe brackets and the new subframe bracket-to-body bolts.

- Finger tight at this stage.

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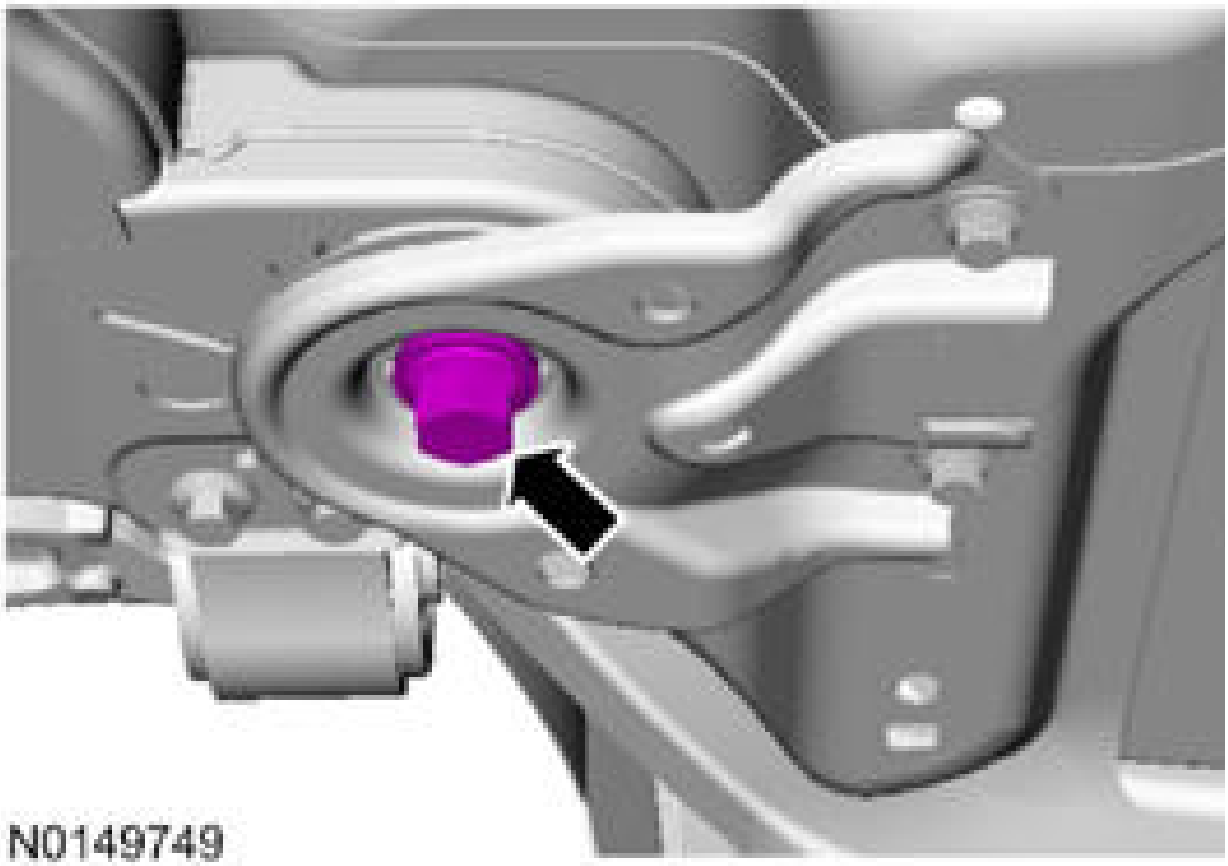


35. **NOTE: RH shown in illustration, LH similar.**

Install the new subframe bracket bolts.

- Tighten to 150 Nm (111 lb-ft).

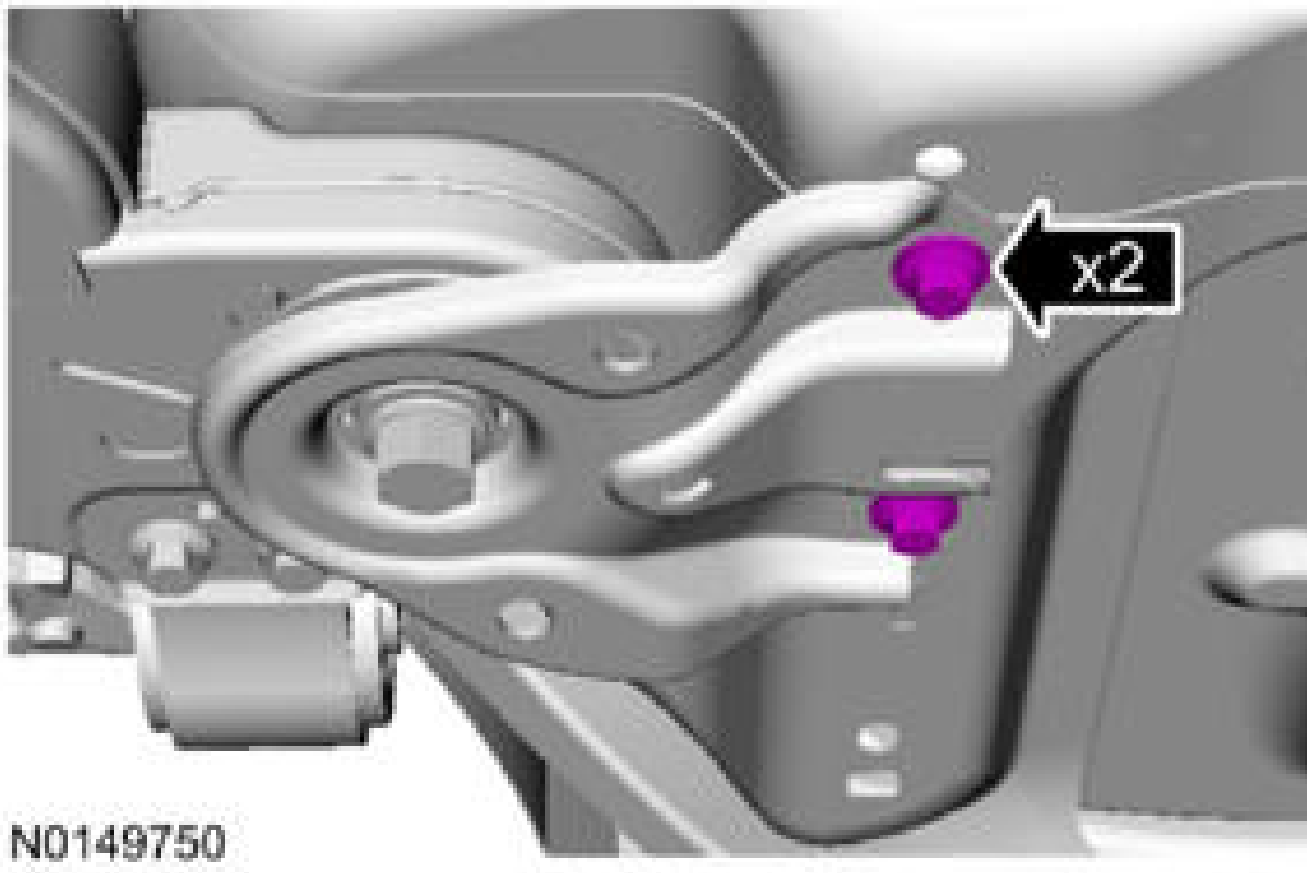
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36. **NOTE: RH shown in illustration, LH similar.**

Tighten the subframe bracket-to-body bolts to 55 Nm (41 lb-ft).

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37. Remove the ratchet strap from the front of the subframe to the rear of the subframe.
38. Remove the Adjustable Grip Arm and the powertrain lift table.

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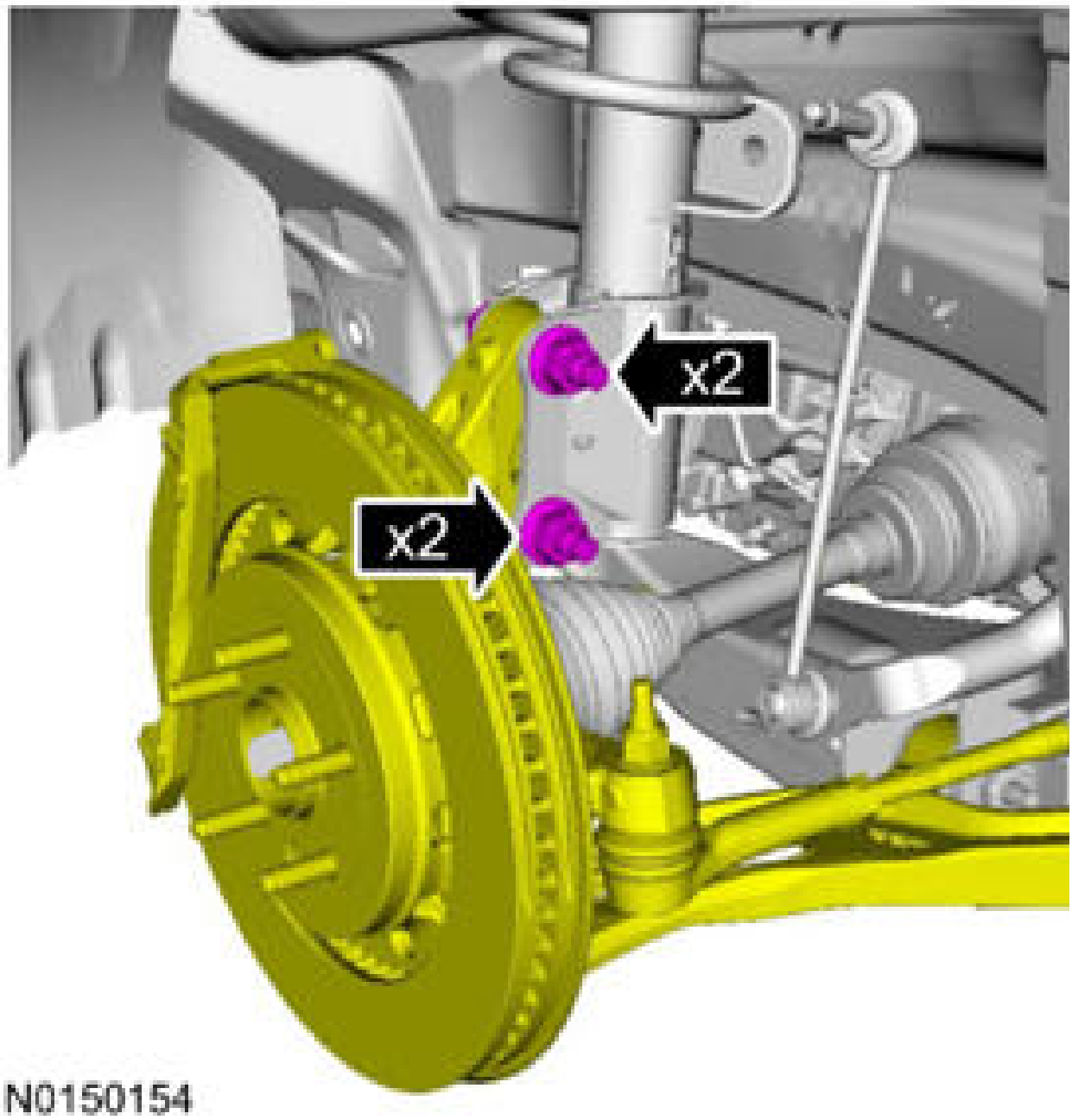


39. **NOTE: LH shown in illustration, RH similar.**

Install the strut to the wheel knuckle and install the strut-to-wheel knuckle nuts and bolts.

- Tighten to 250 Nm (184 lb-ft).

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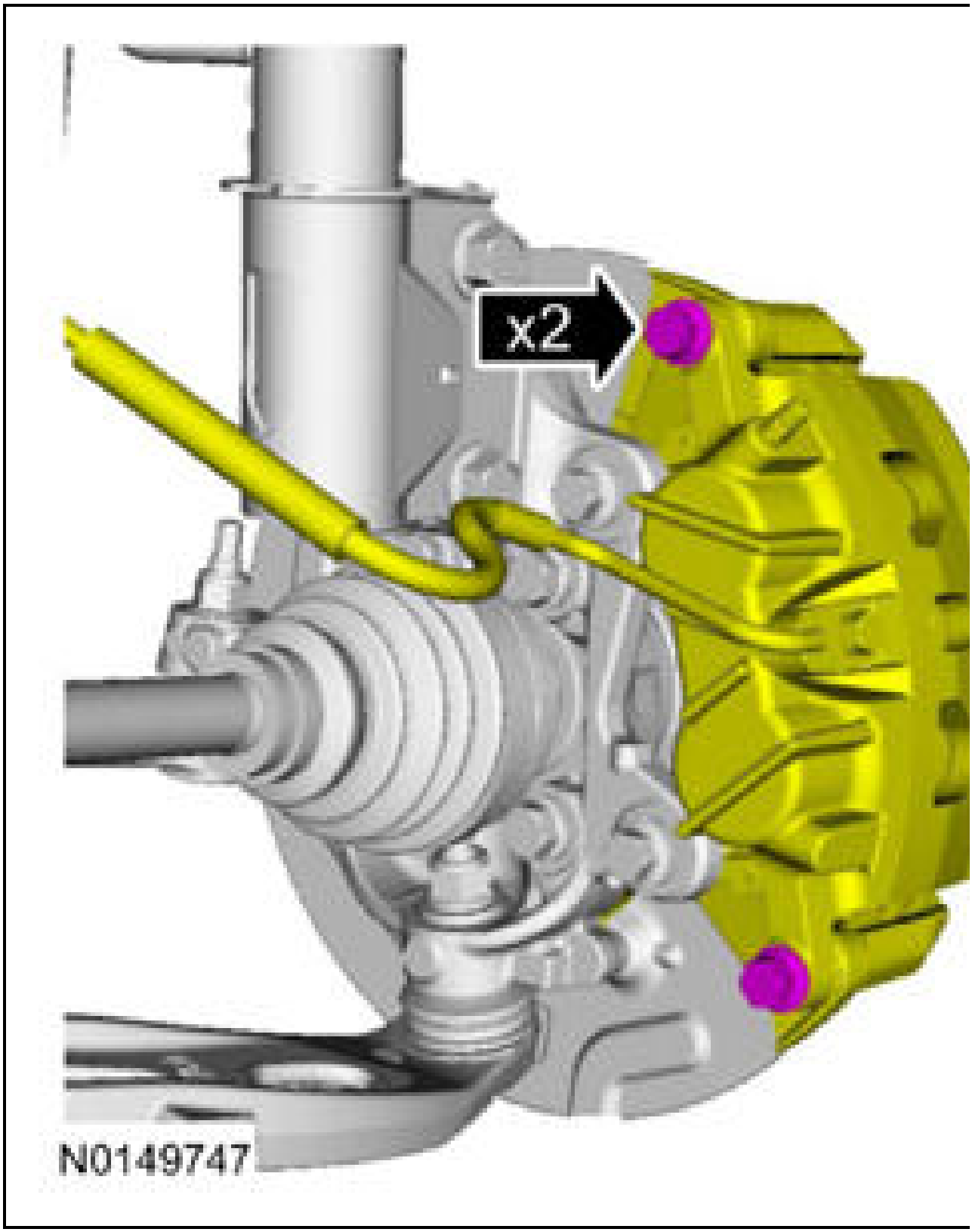


40. **NOTE: LH shown in illustration, RH similar.**

Install the brake caliper and the guide pin bolts.

- 432 mm (17 in) brakes: Tighten to 72 Nm (53 lb-ft).
- 457 mm (18 in) brakes: Tighten to 75 Nm (55 lb-ft).

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41. **NOTE: Do not tighten the wheel hub nut with the vehicle on the ground. The nut**

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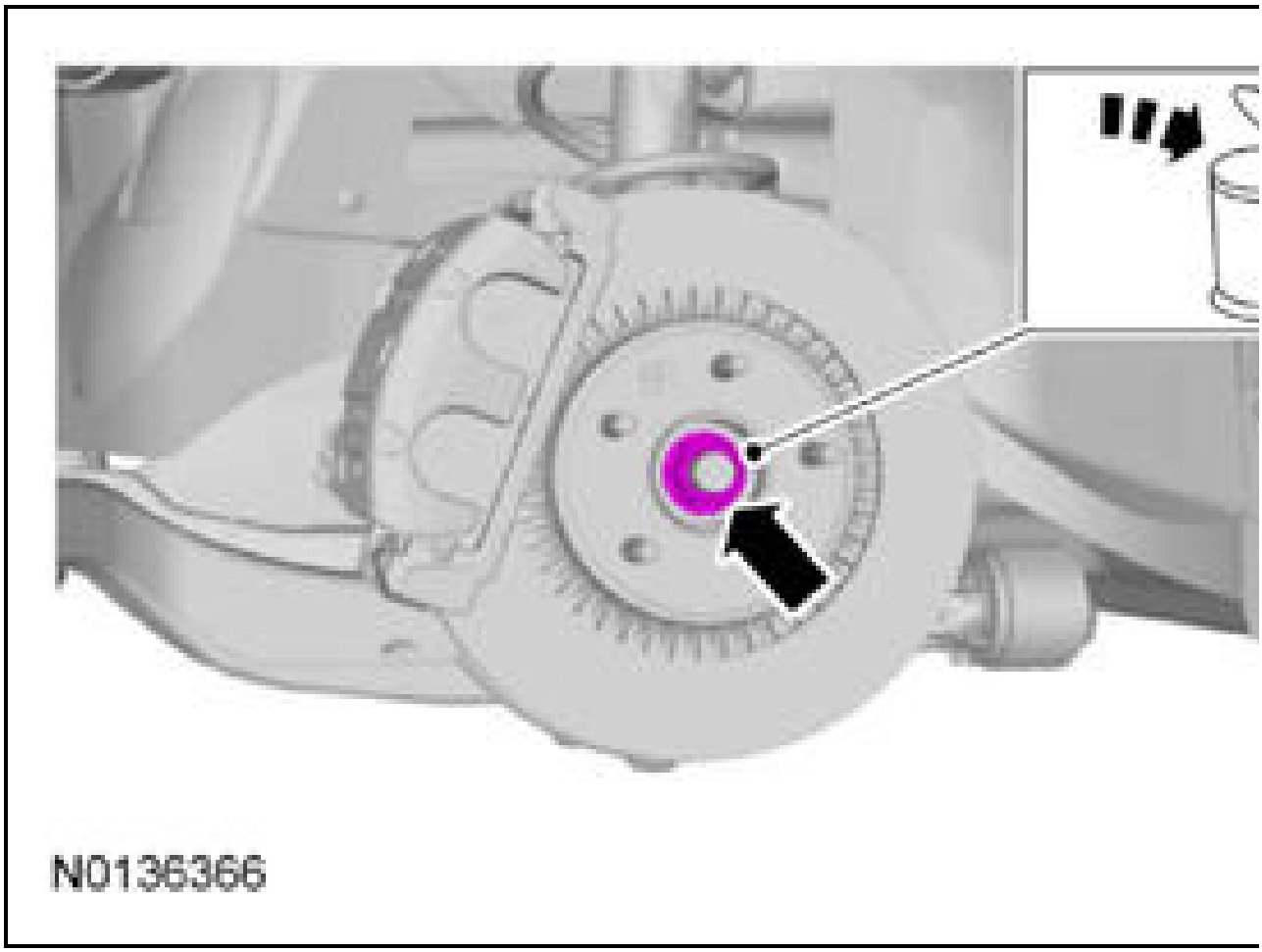
41. **must be tightened to specification before the vehicle is lowered onto the wheels. Wheel bearing damage will occur if the wheel bearing is loaded with the weight of the vehicle applied.**

NOTE: LH shown in illustration, RH similar.

NOTE: Apply the brake to keep the halfshaft from rotating.

Using the previously removed wheel hub nut, seat the LH and RH halfshafts.

- Tighten to 350 Nm (258 lb-ft).
- Remove and discard the wheel hub nuts.



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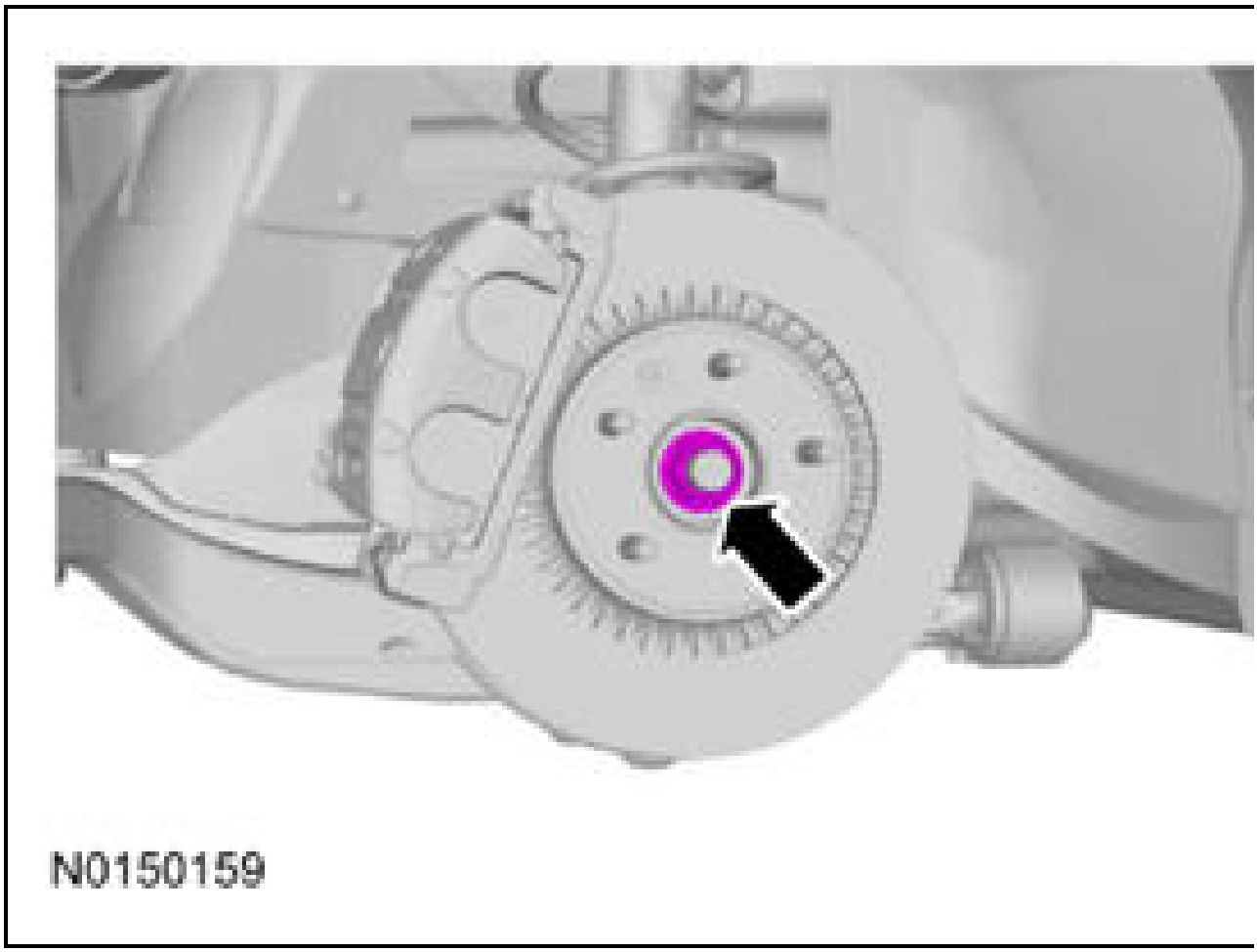
42. **NOTE: The wheel hub nut contains a one time locking chemical that is activated by the heat created when it is tightened. Install and tighten the new wheel hub nut to specification within 5 minutes of starting it on the threads. Always install a new wheel hub nut after loosening or when not tightened within the specified time or damage to the components can occur.**

NOTE: LH shown in illustration, RH similar.

NOTE: Apply the brake to keep the halfshaft from rotating.

Install a new wheel hub nuts.

- Tighten to 350 Nm (258 lb-ft).

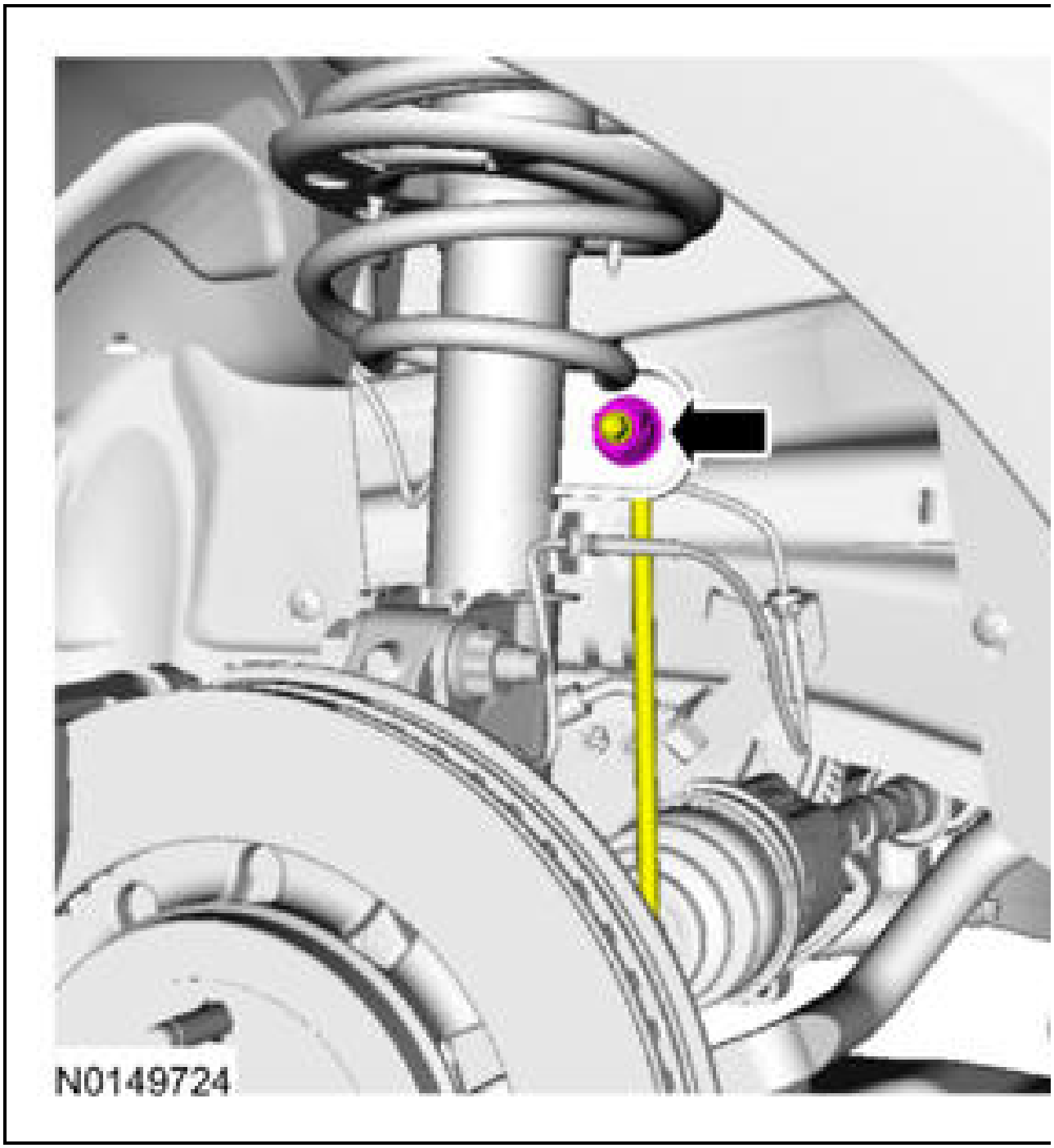


43. **NOTE: LH shown in illustration, RH similar.**

Install the new upper stabilizer link nut.

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- Tighten to 150 Nm (111 lb-ft).

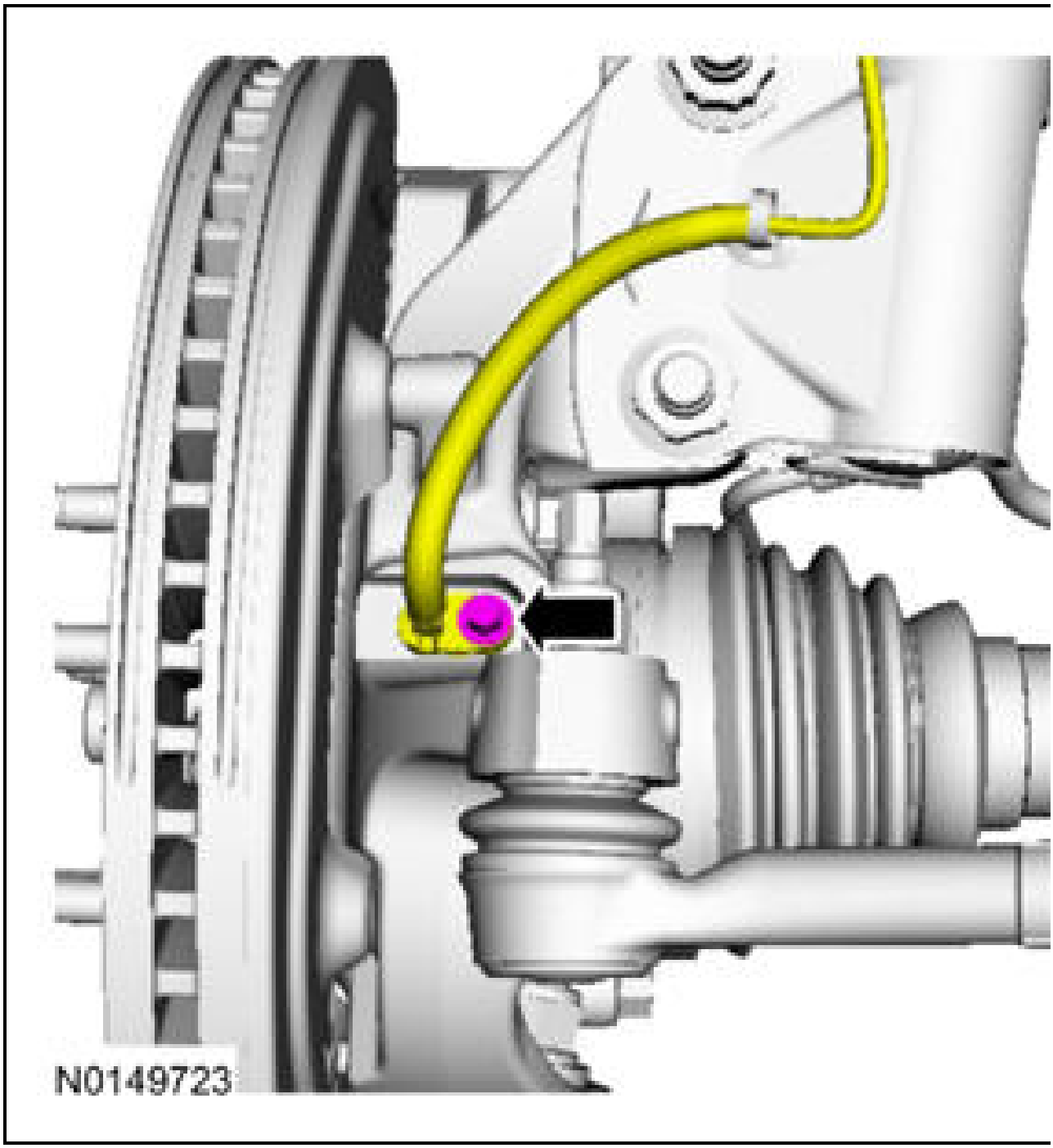


44. **NOTE: LH shown in illustration, RH similar.**

Install the wheel speed sensor and the bolt.

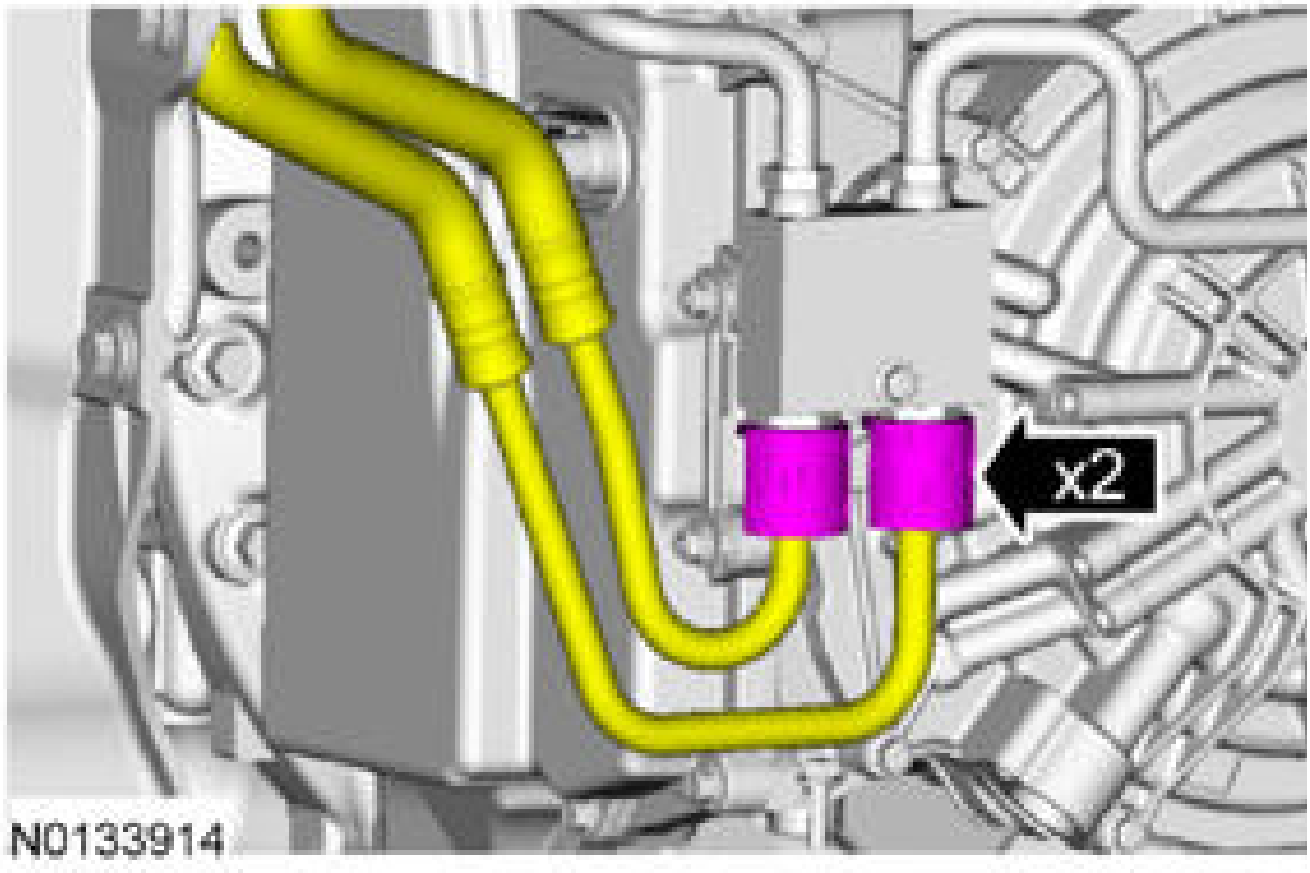
- Tighten to 15 Nm (133 lb-in).

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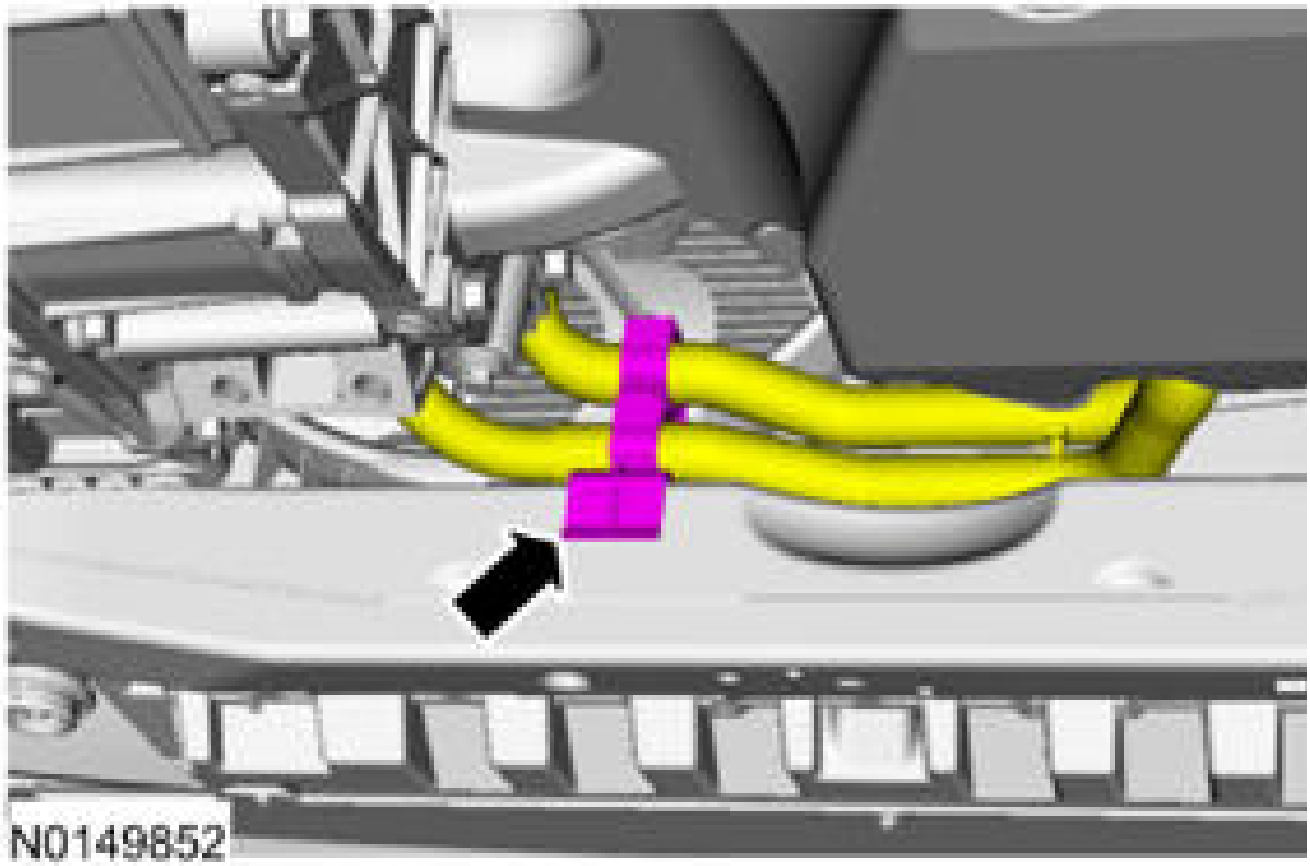
45. Connect the transaxle cooler tubes and install the 2 secondary latches.

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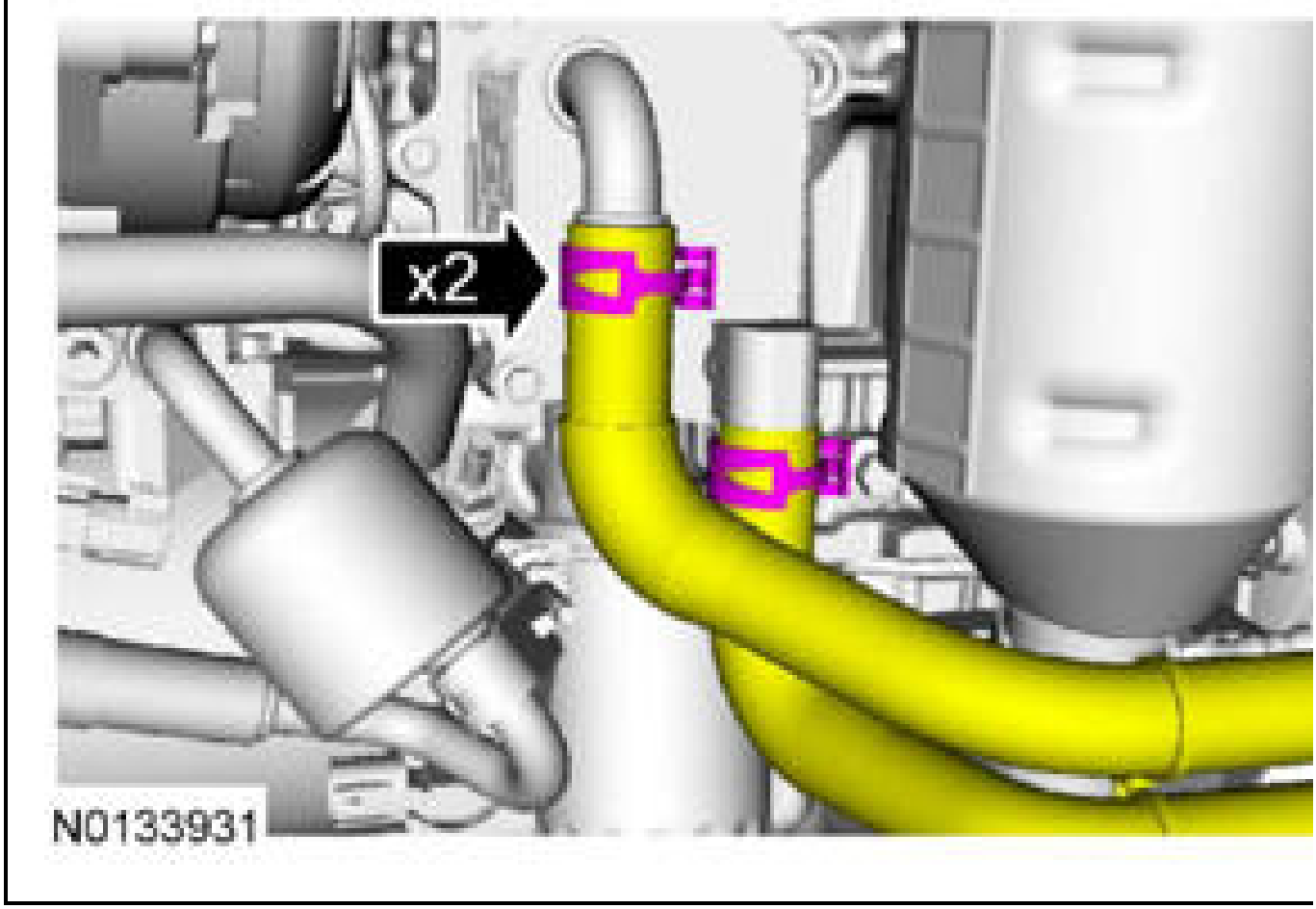
46. If equipped, install the oil cooler hose retainer to the subframe.

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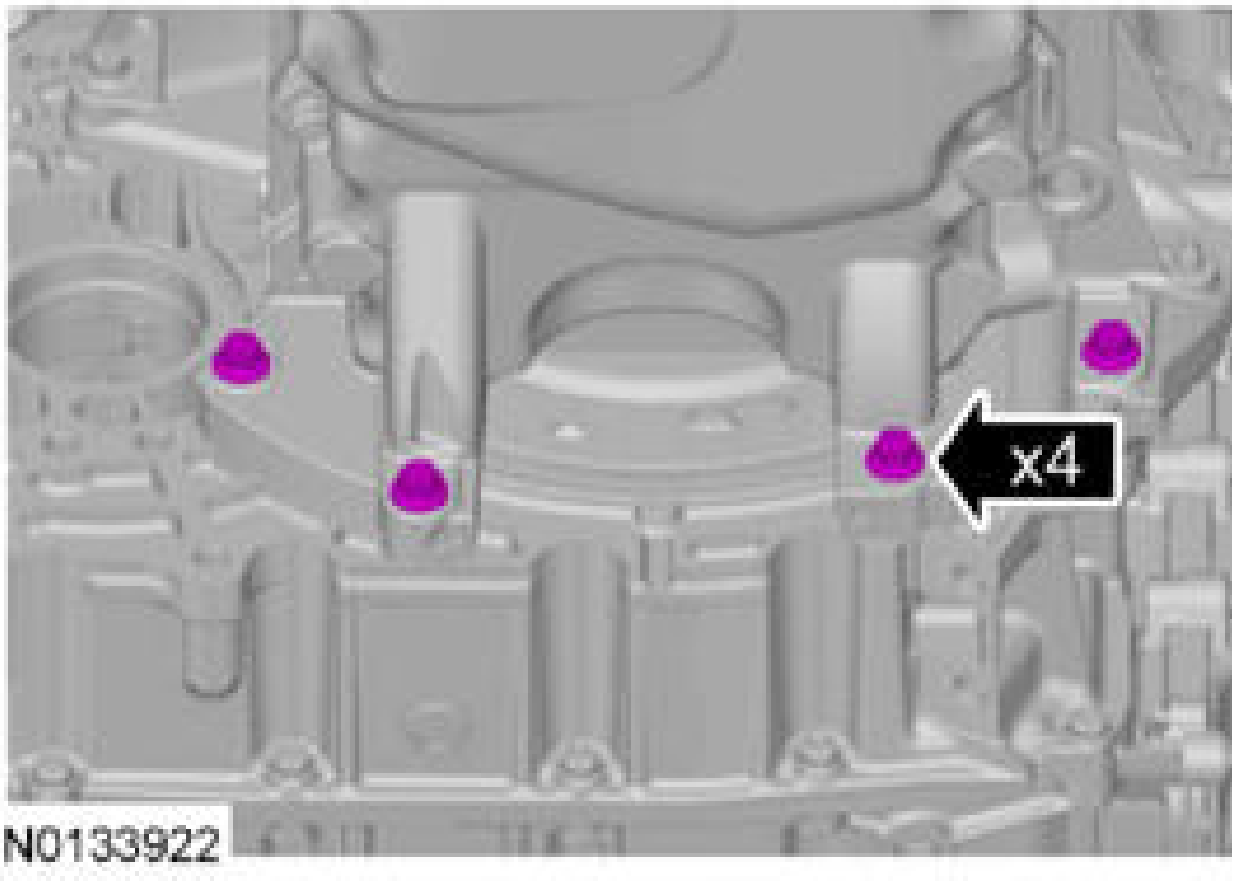
47. If equipped, connect the oil cooler coolant hoses.

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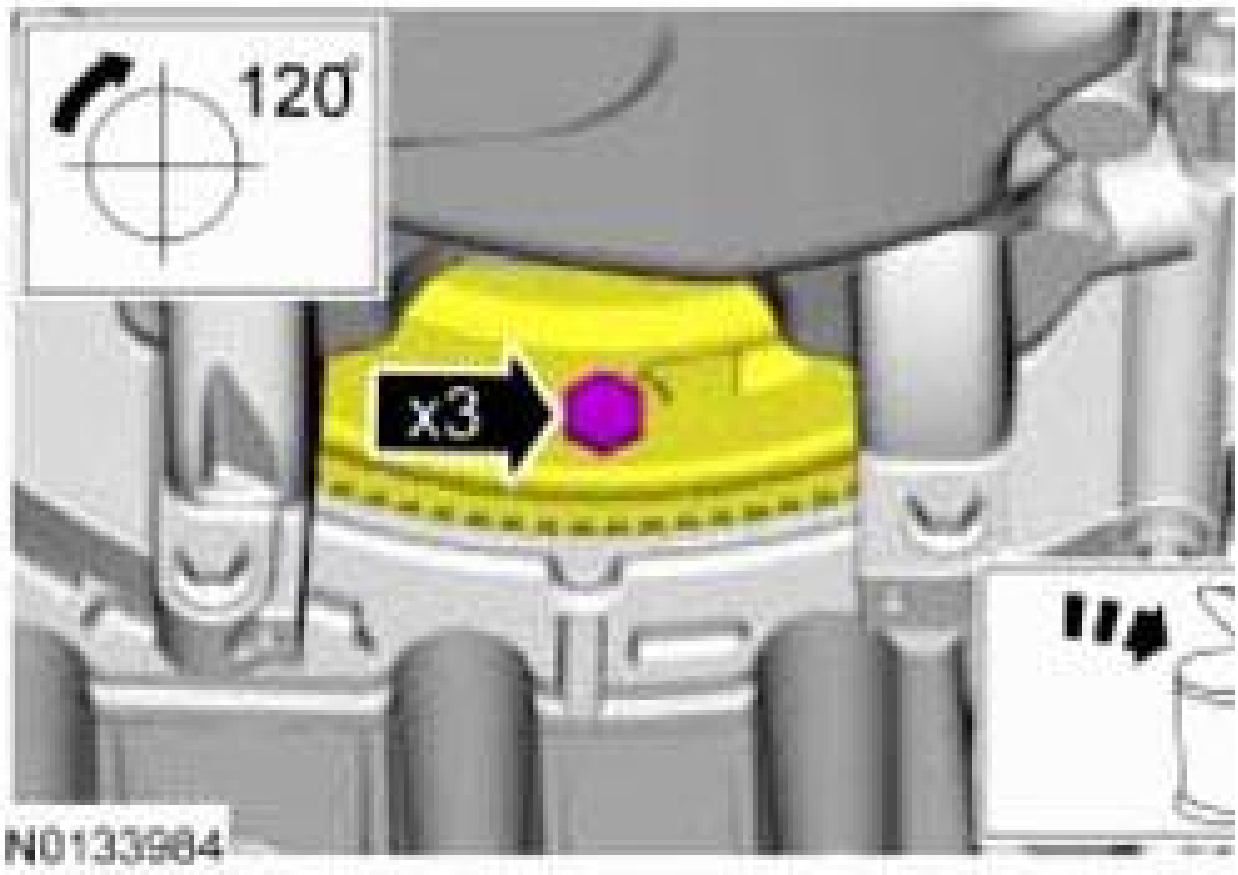
48. Install the 4 oil pan-to-transaxle bolts.
    - Tighten to 48 Nm (35 lb-ft).

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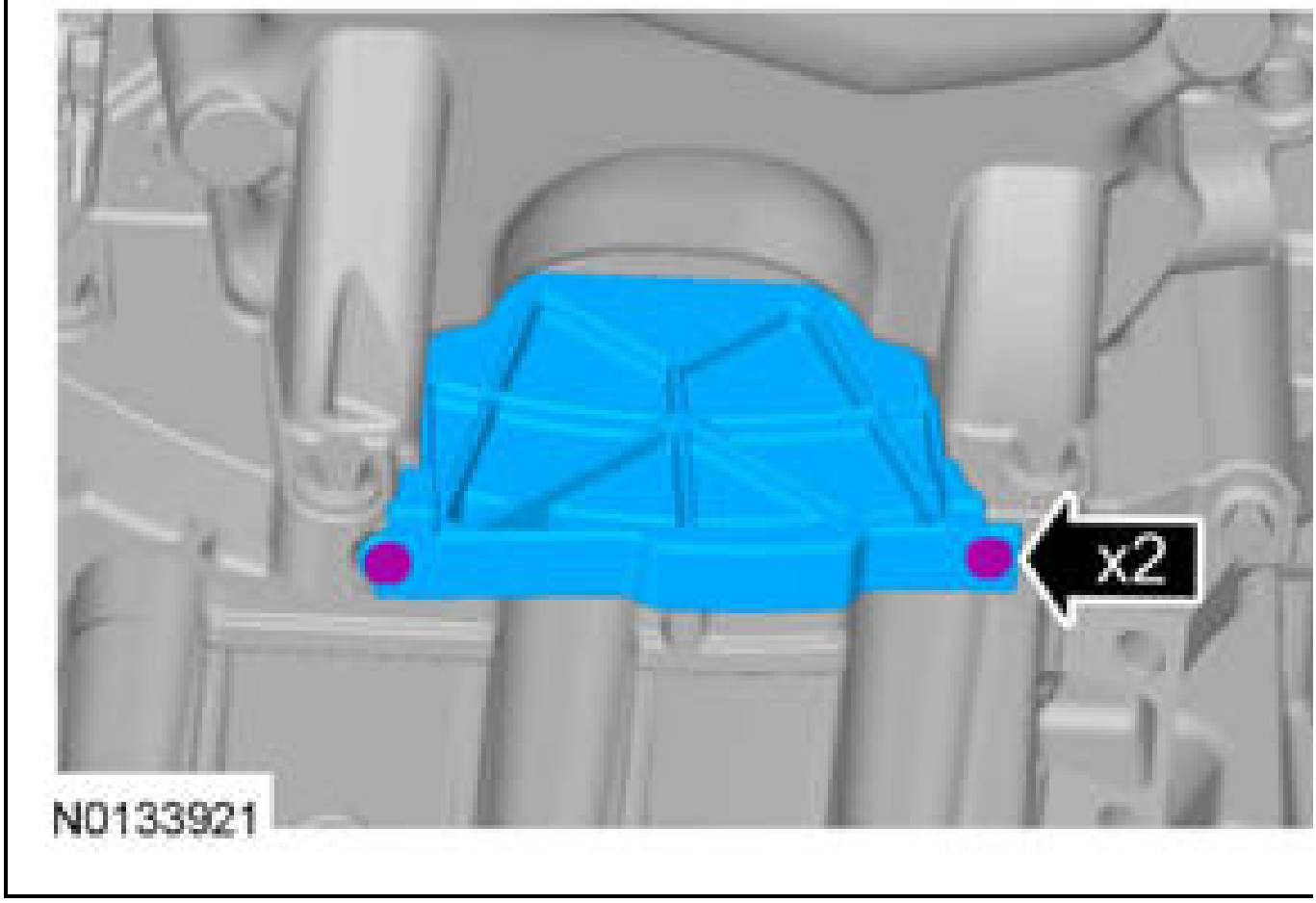
49. Install 3 new torque converter bolts by rotating the crankshaft clockwise.
    - Tighten to 55 Nm (41 lb-ft).

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50. Install the inspection cover and the 2 fasteners.

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51. **NOTE: Do not lubricate the engine oil filter gasket.**

Install a new engine oil filter.

- Tighten to 5 Nm (44 lb-in) and then rotate an additional 180 degrees.

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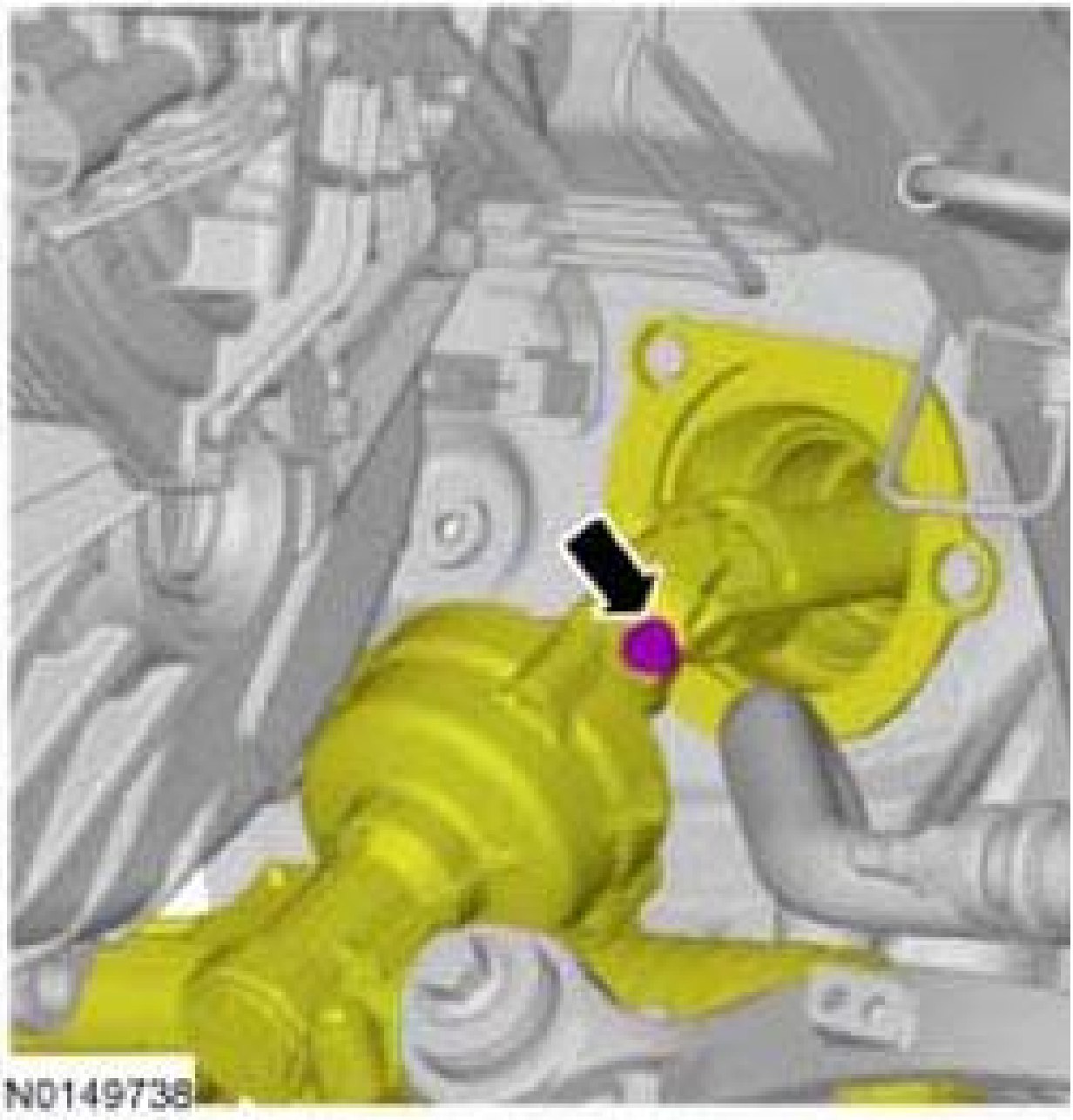
52. Install the exhaust Y-pipe. For additional information, refer to **EXHAUST Y-PIPE - 3.5L TI-VCT** .

NOTE: **Do not allow the intermediate shaft to rotate while it is disconnected from the gear or damage to the clockspring may occur. If there is evidence that the intermediate shaft has rotated, the clockspring must be removed and recentered. For additional information, refer to CLOCKSPRING , and CLOCKSPRING ADJUSTMENT .**

53. Align and connect the steering column shaft to the steering gear and install the bolt.

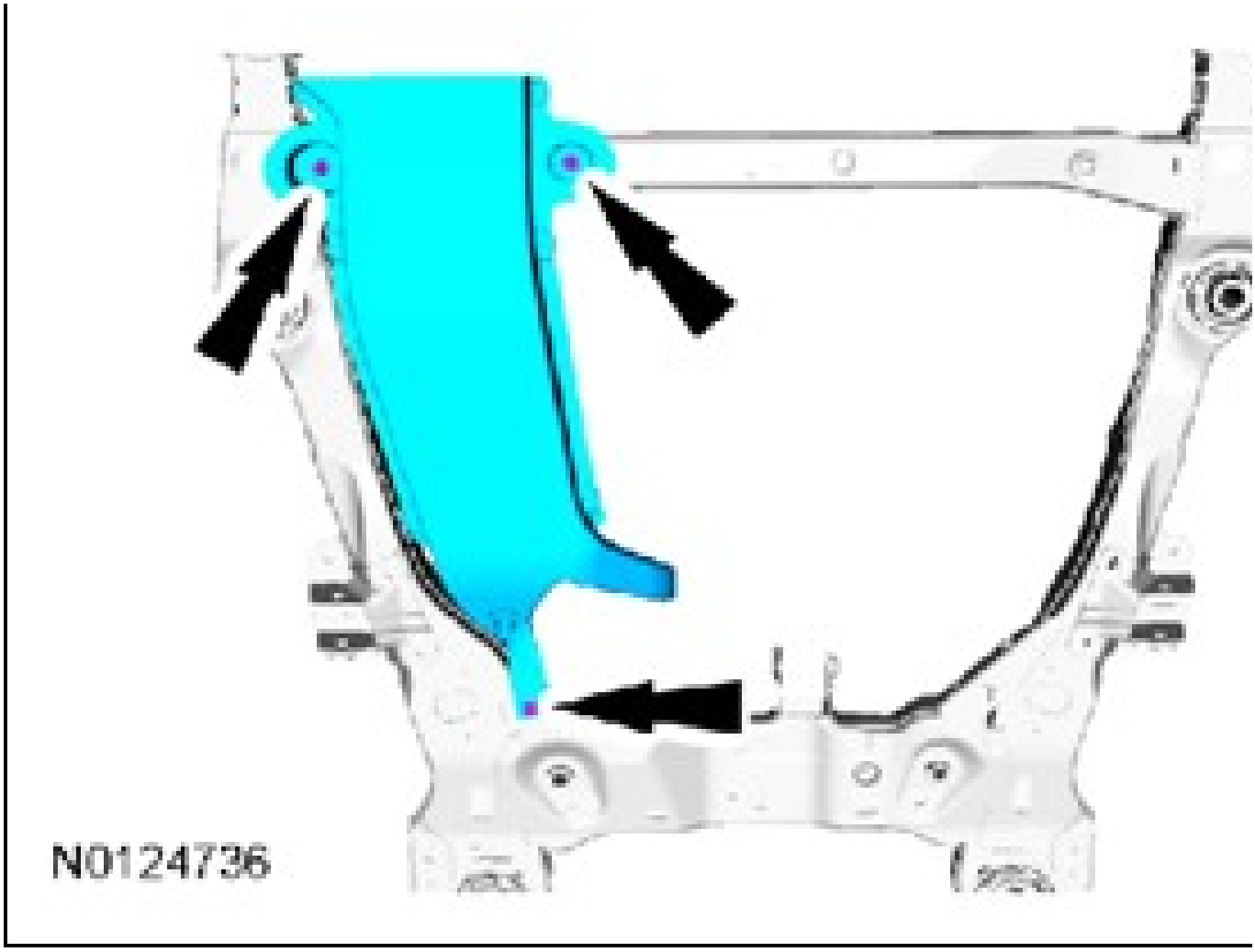
- Tighten to 20 Nm (177 lb-in).

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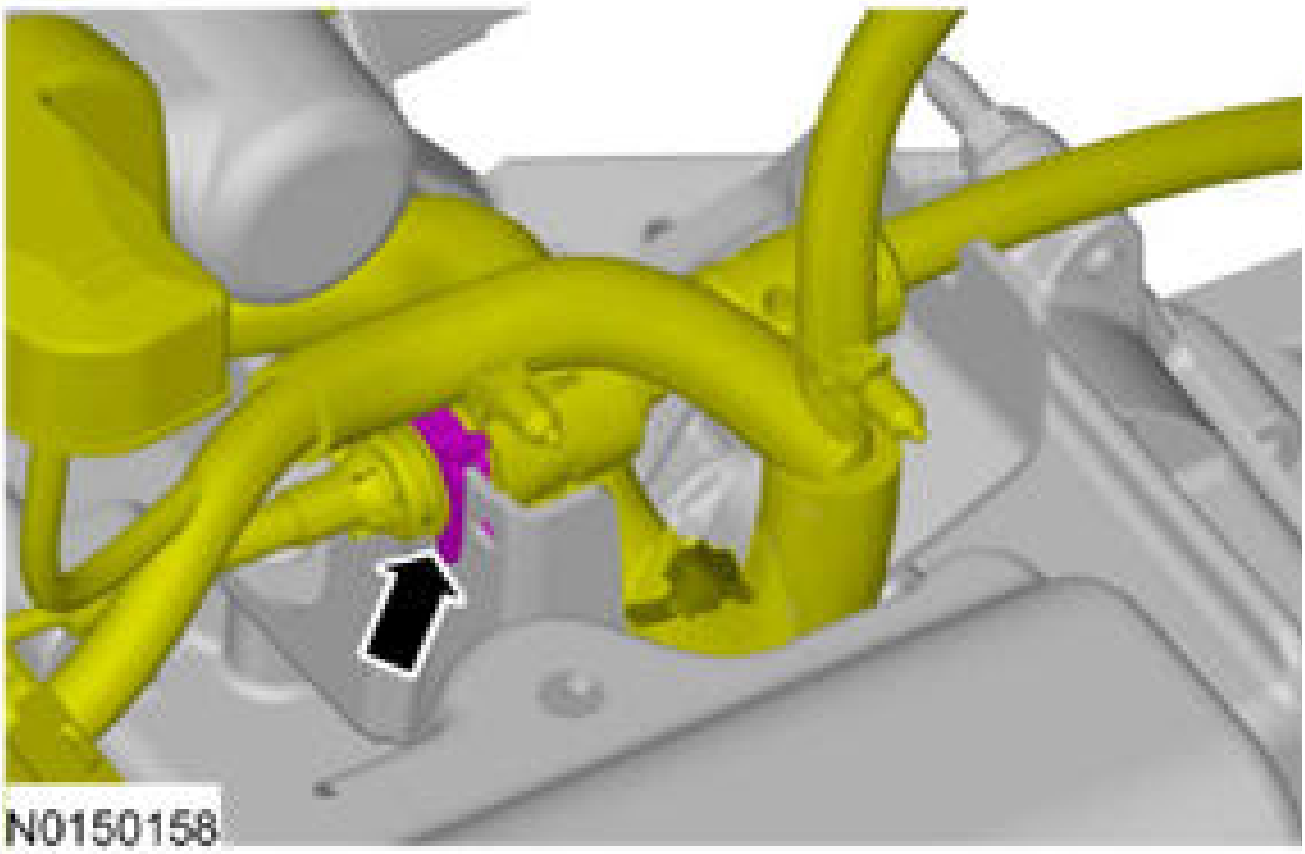
54. Install the underbody air duct and the 3 twist lock retainers.

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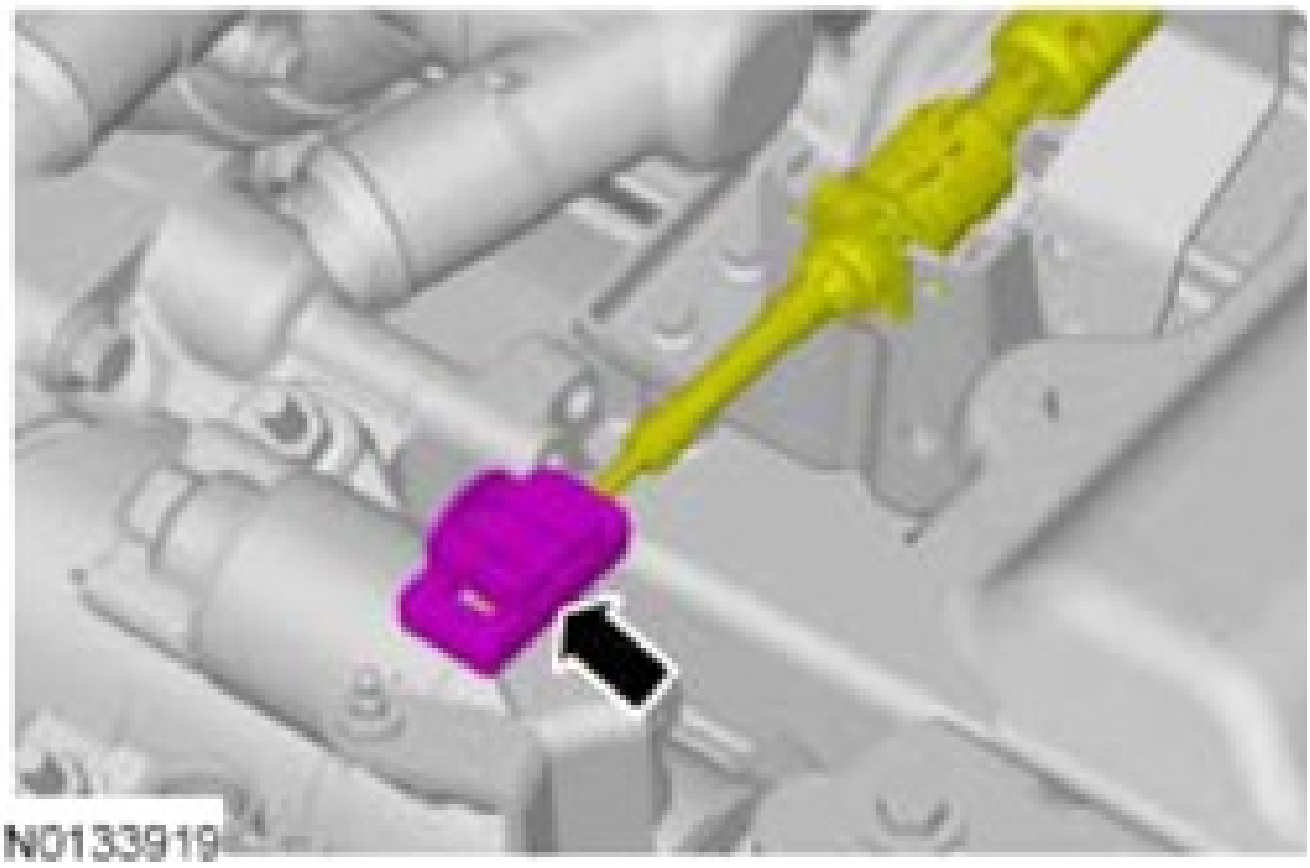
55. If equipped, attach the engine block heater harness to the radiator support.
56. Connect the transaxle control cable to the shift cable bracket.

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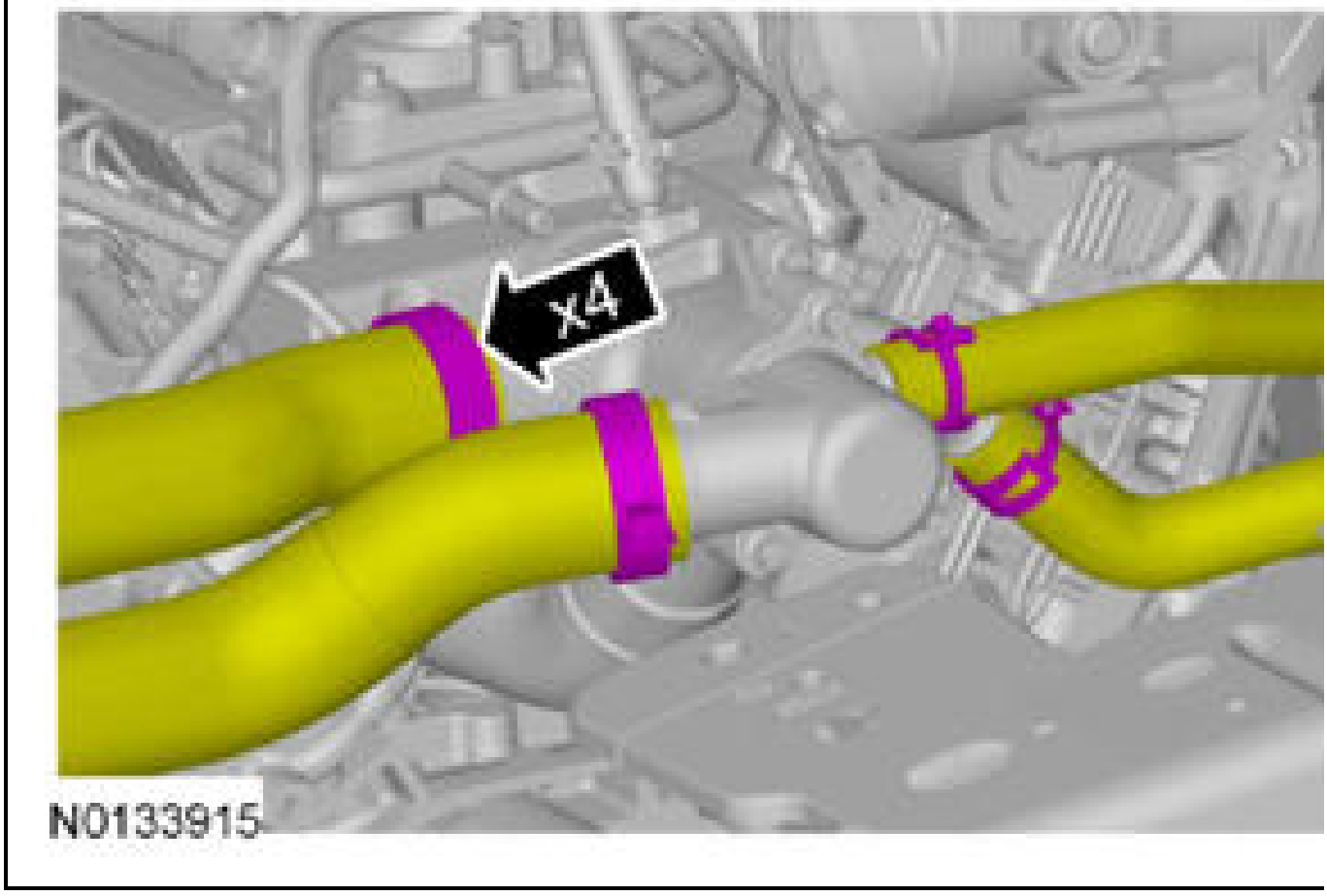
57. Connect the transaxle control cable to the control lever.

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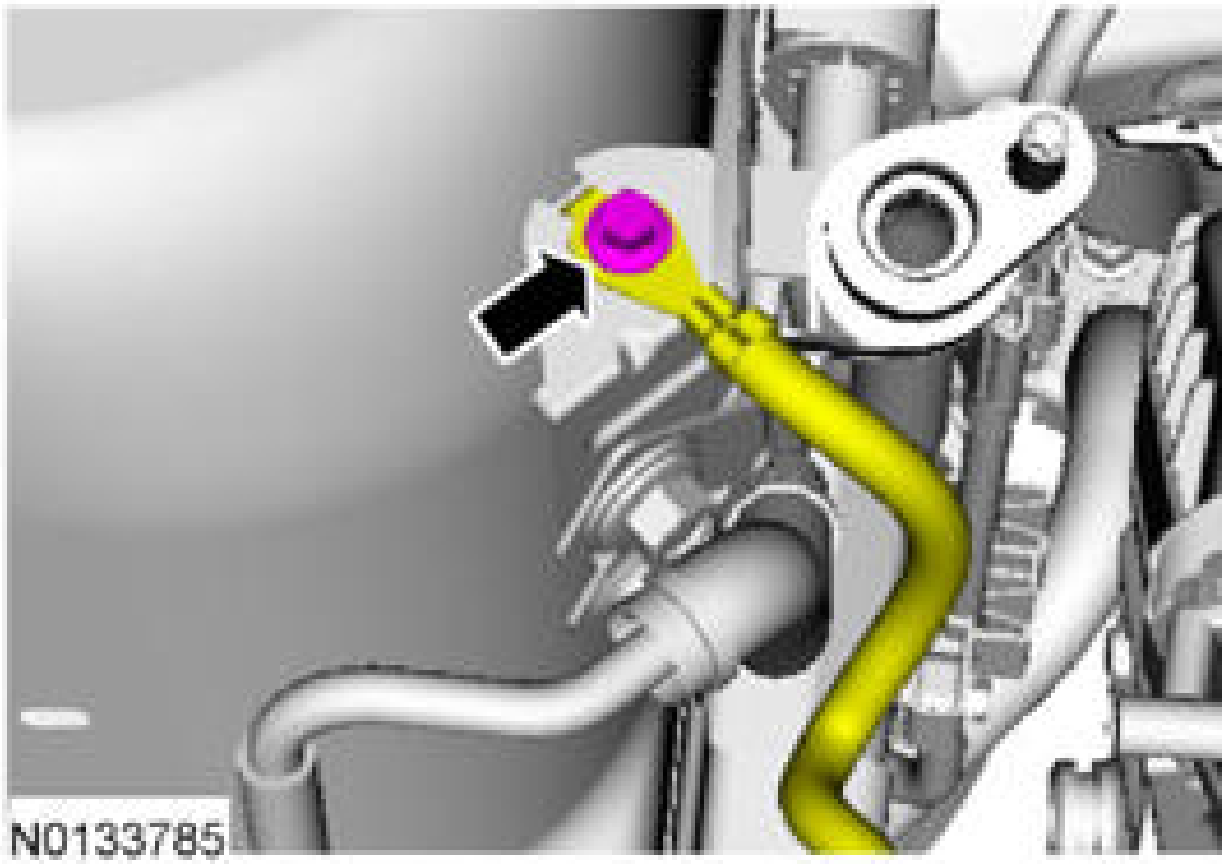
58. Connect the upper radiator hose, lower radiator hose and 2 heater hoses to the thermostat housing.

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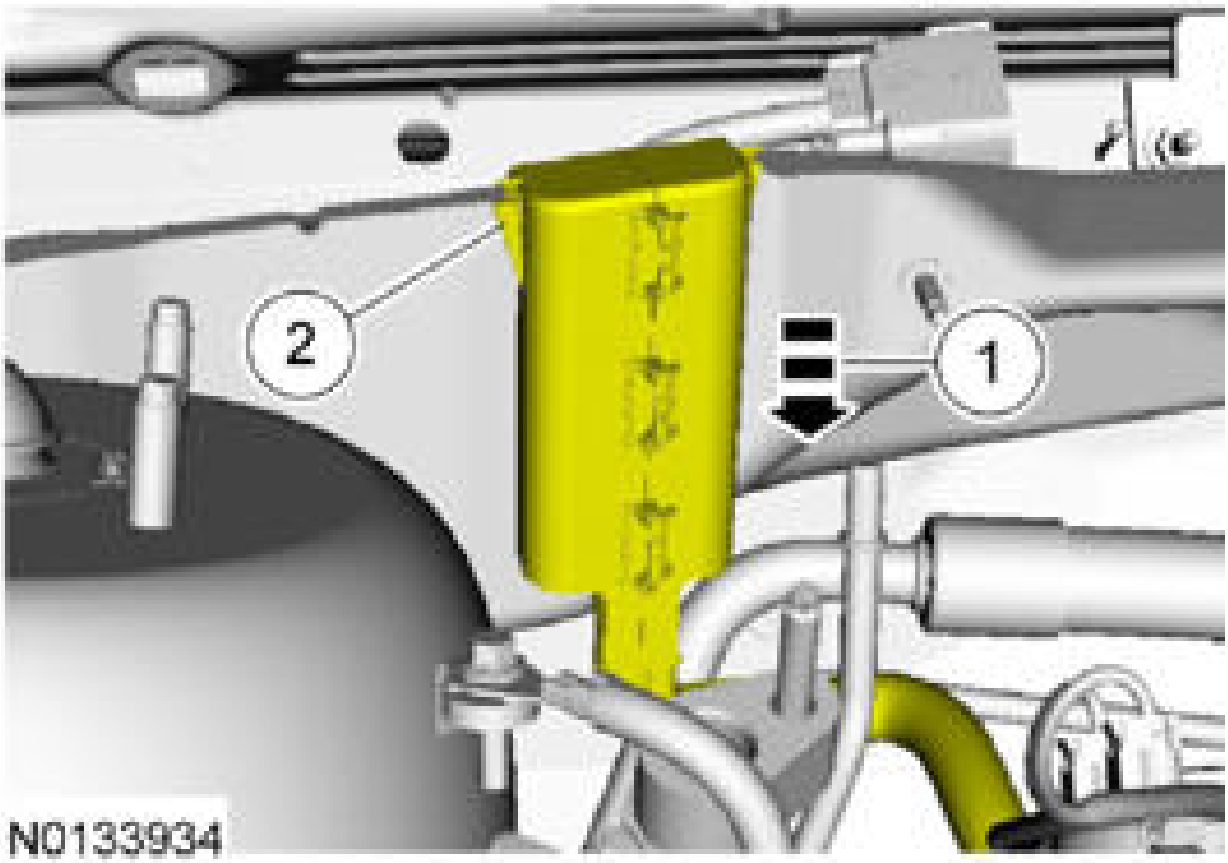
59. Install the ground wire to the RH shock tower and install the bolt.
    - Tighten to 10 Nm (89 lb-in).

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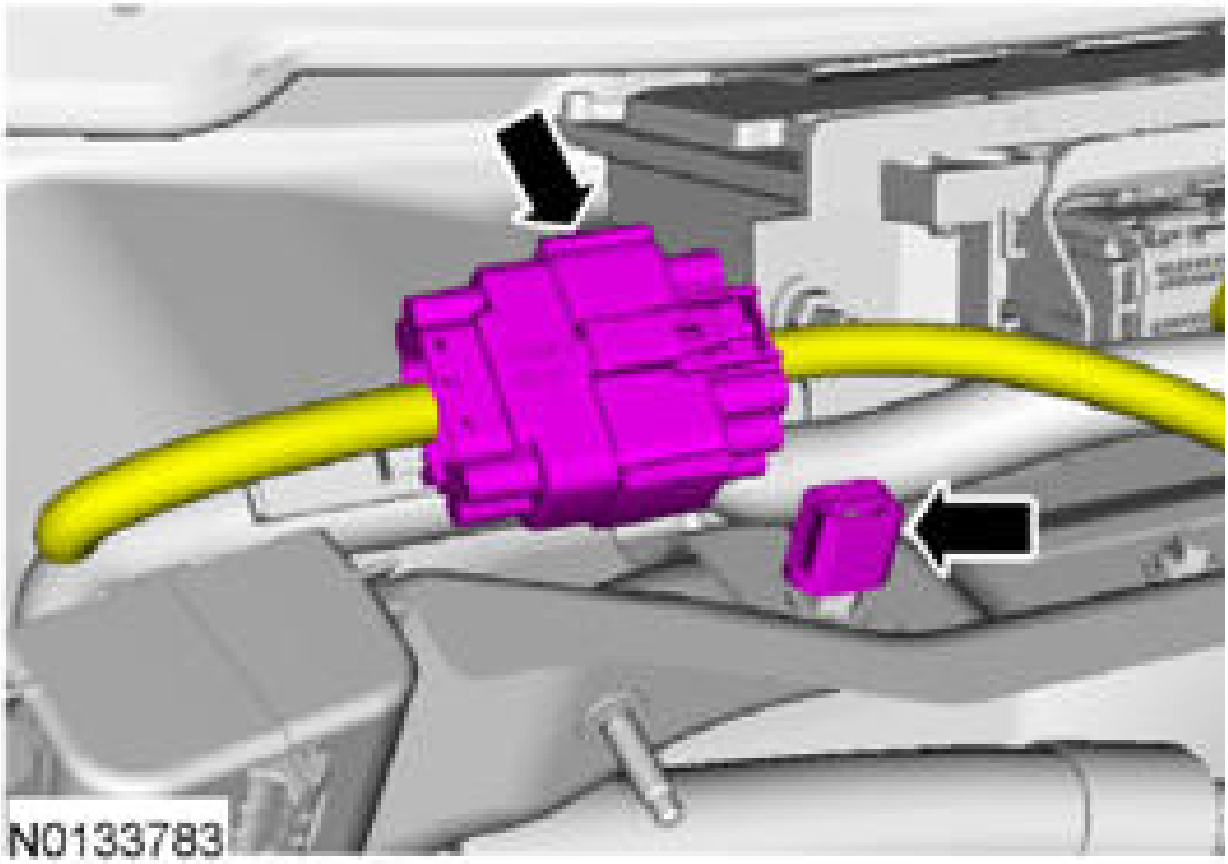
60. Install the engine wiring harness retainer to the bulkhead.
    - Slide the wiring harness in the bulkhead.
    - Make sure the wiring harness retainer tab is below the bulkhead lip.

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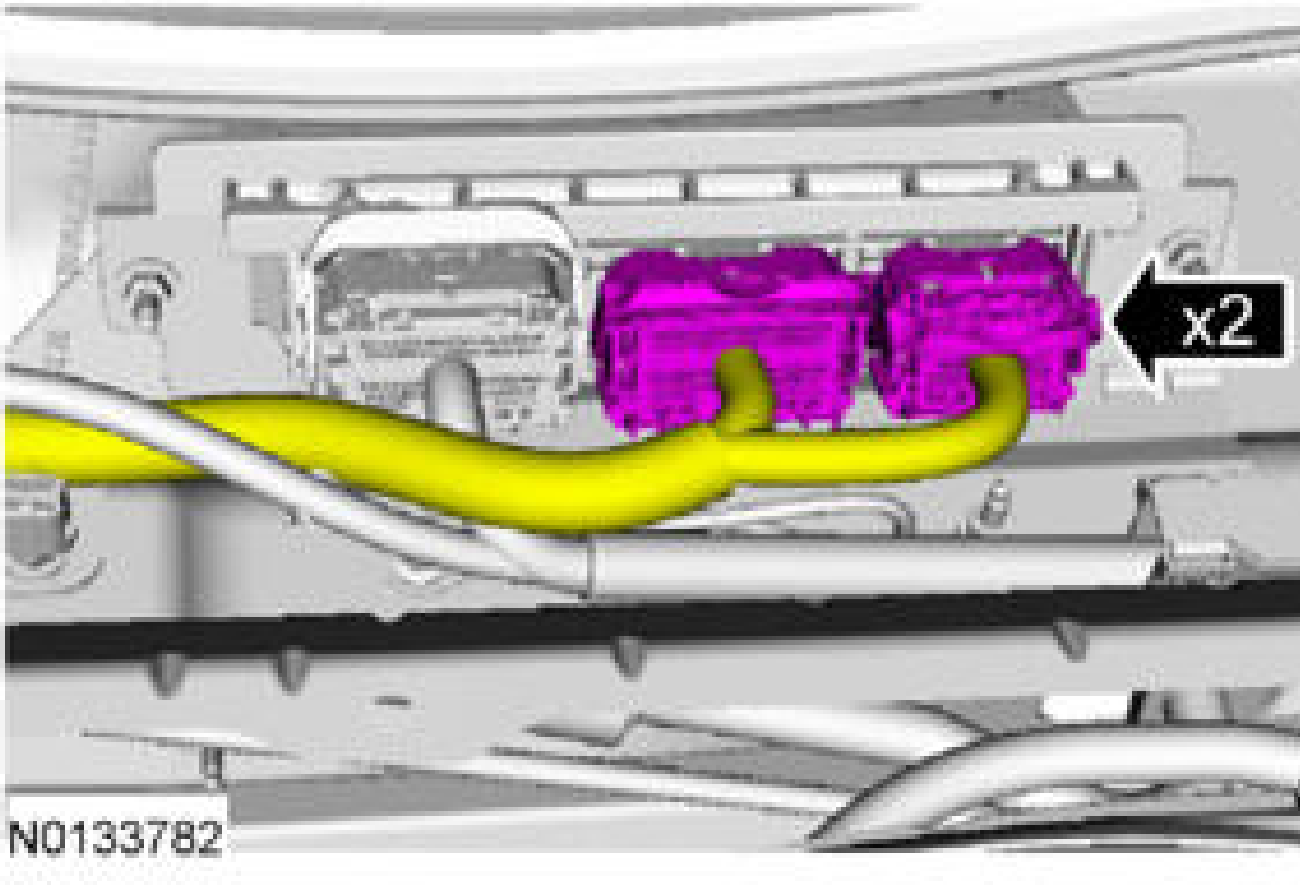
61. Connect the engine harness electrical connector.
    - Attach the wiring harness retainer.

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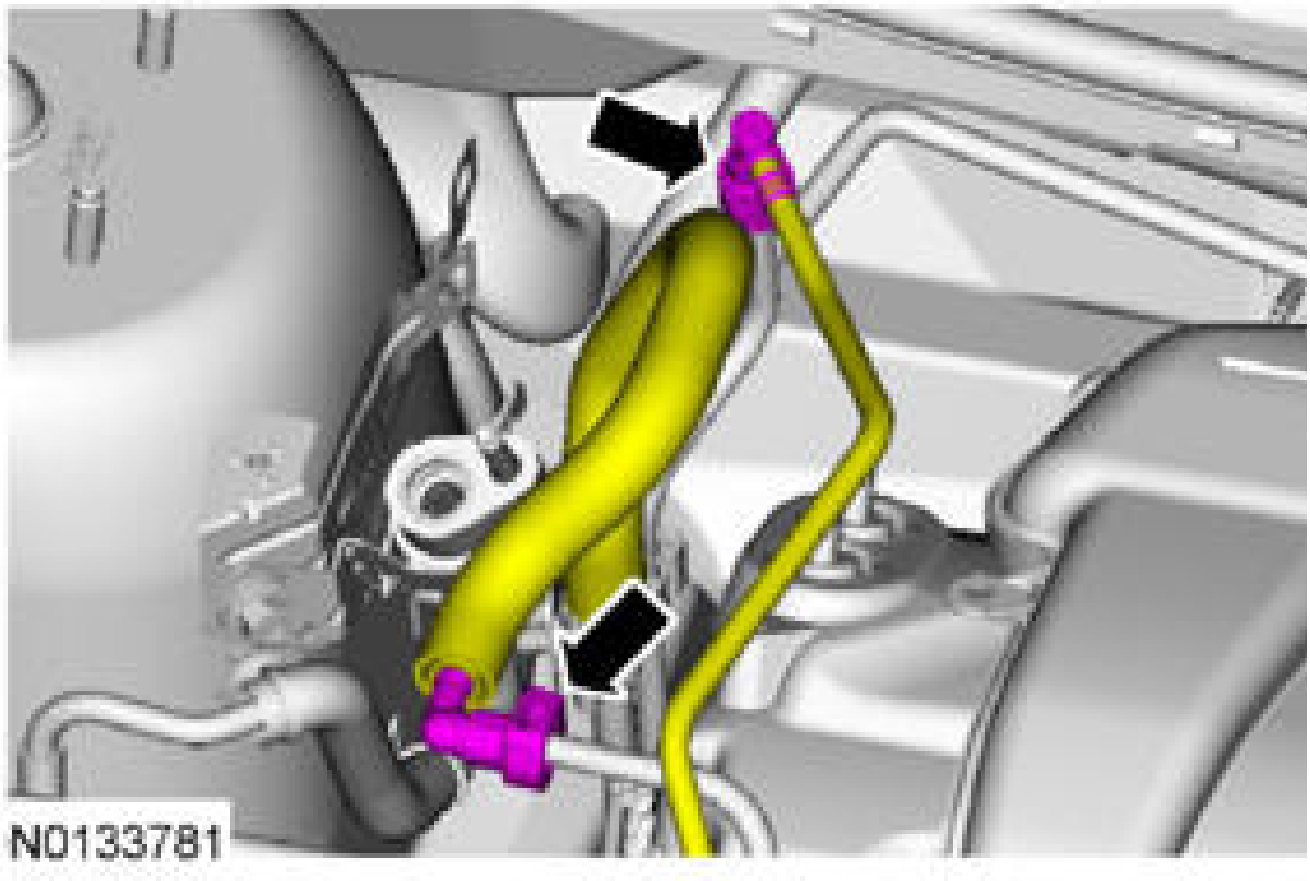
62. Connect the 2 **PCM** electrical connectors.

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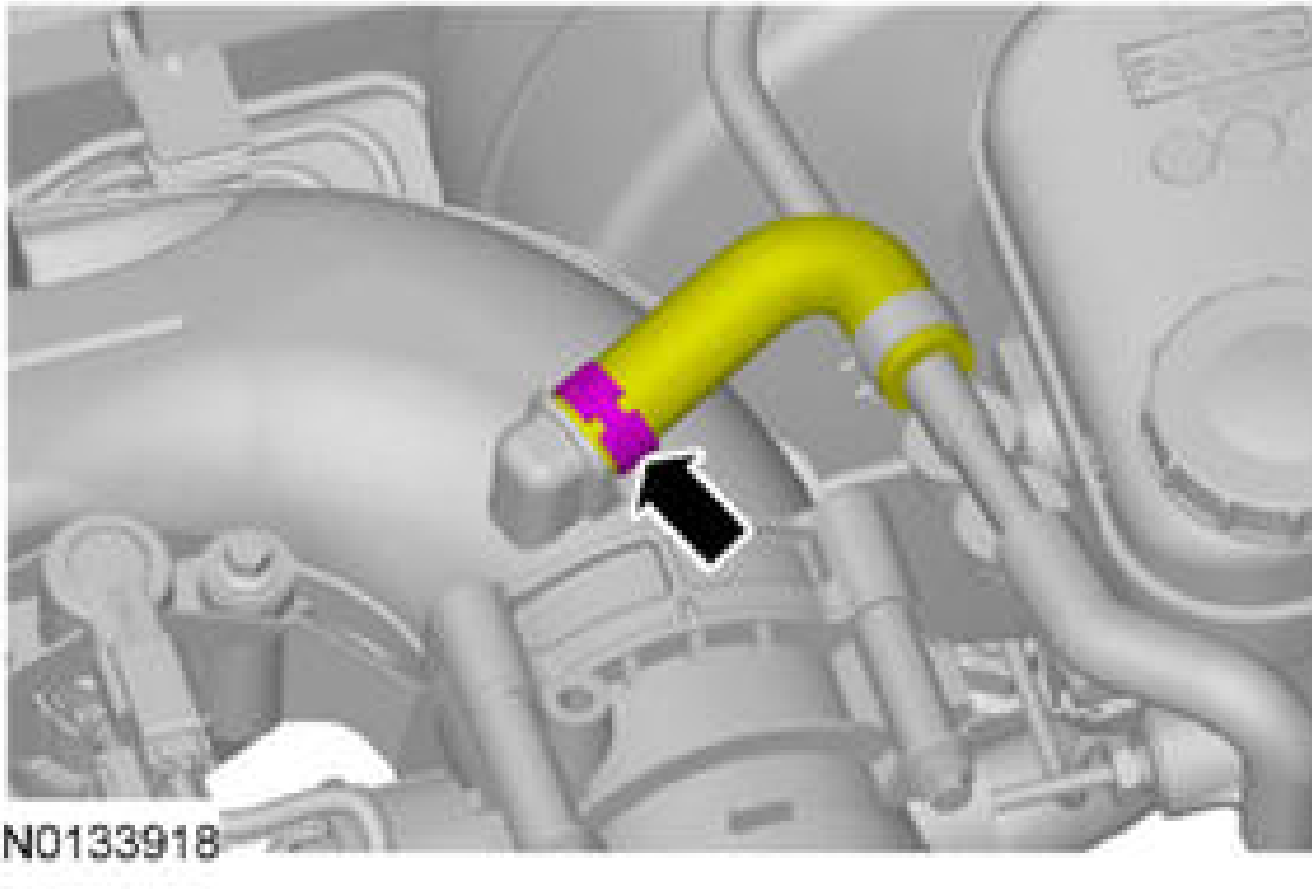
63. Connect the **EVAP** tube and the fuel supply tube quick connect coupling. REFER to **SPRING LOCK COUPLINGS** .

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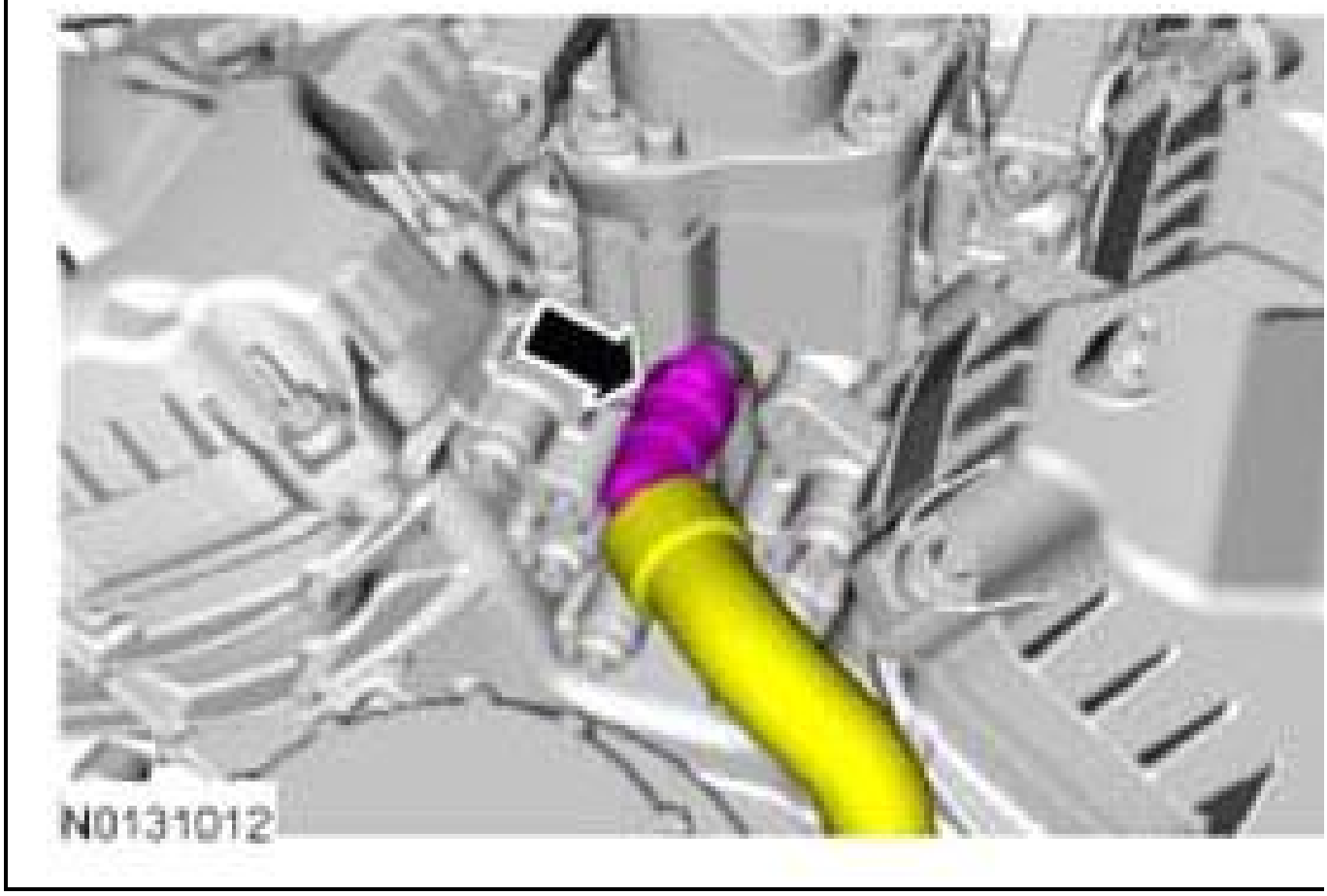
64. Connect the brake booster vacuum hose to the upper intake manifold.

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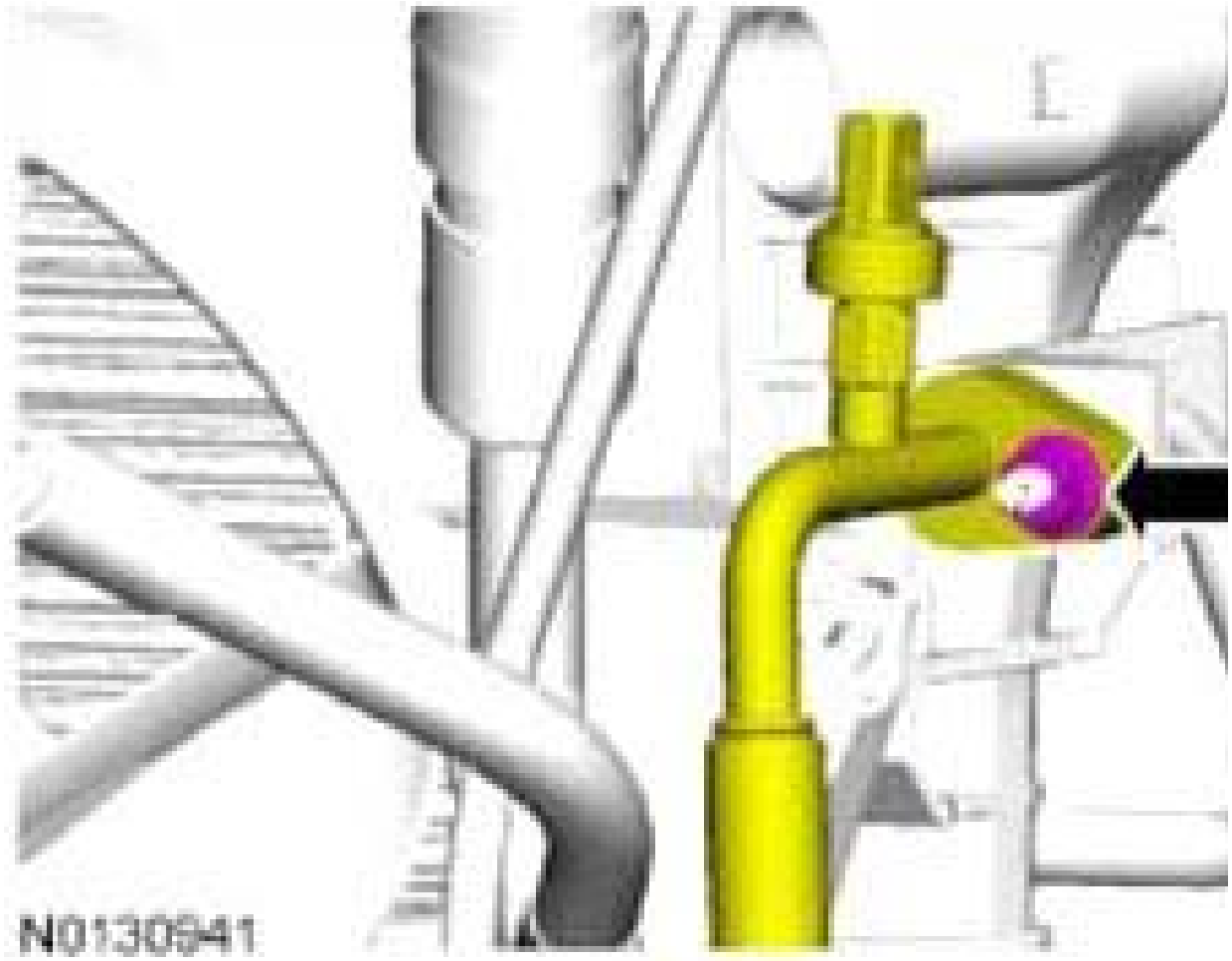
65. Connect the degas bottle coolant hose to the engine coolant tube.

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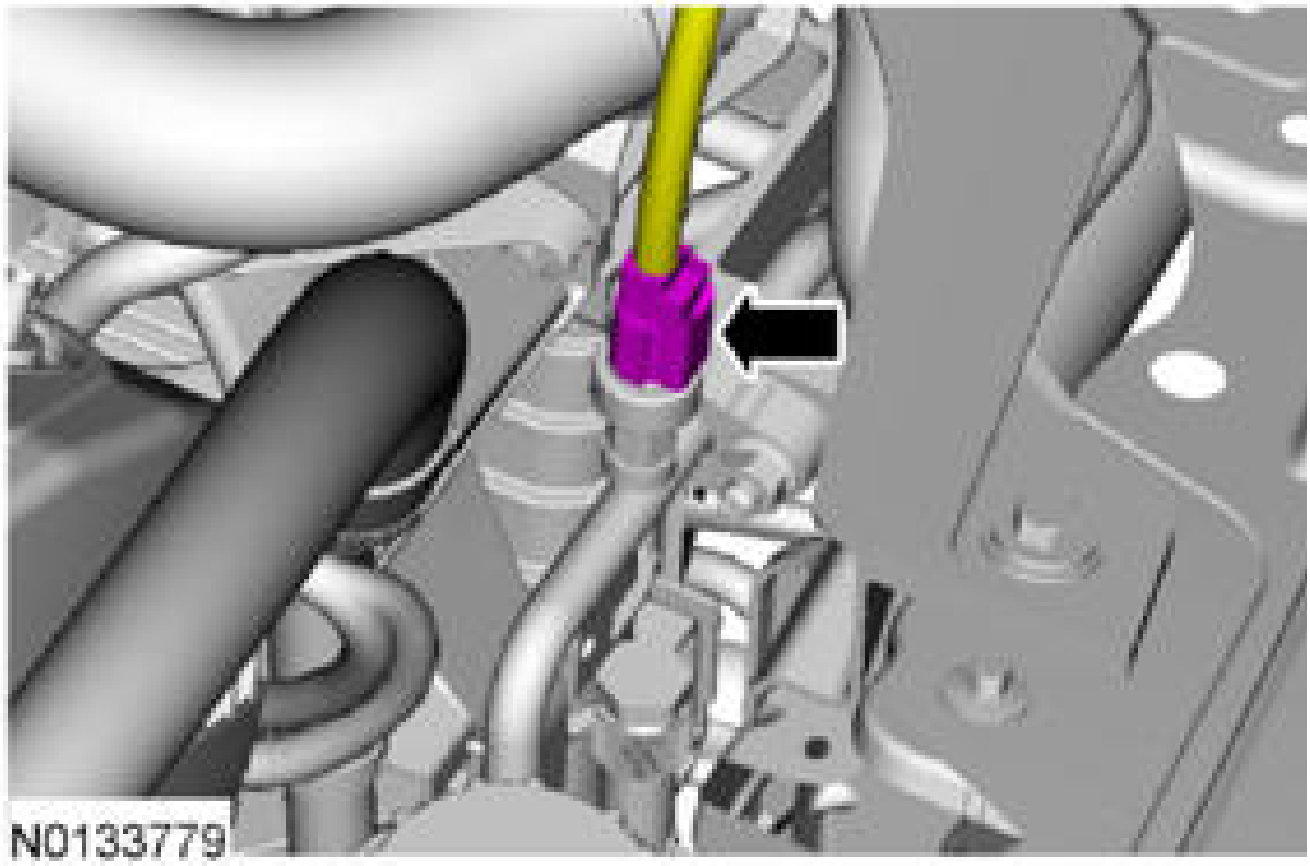
66. Install the degas bottle. REFER to **DEGAS BOTTLE** .
67. Using a new O-ring seal and gasket seal, install the A/C tube and the nut.
    - Tighten to 15 Nm (133 lb-in).

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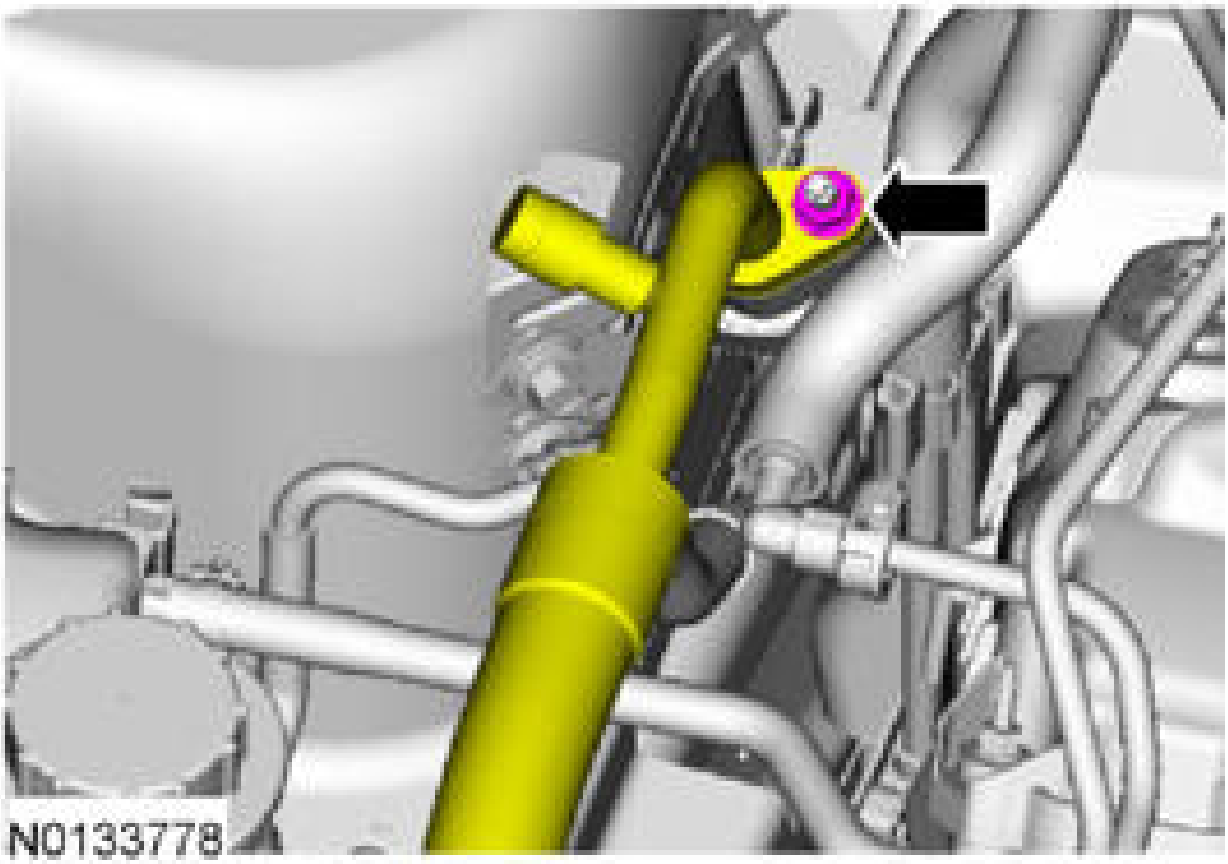
68. Connect the A/C pressure switch electrical connector.

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69. Using a new O-ring seal and gasket seal, connect the A/C tube and install the nut.
    - Tighten to 15 Nm (133 lb-in).

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70. Install the accessory drive belt. REFER to **ACCESSORY DRIVE BELT - 3.5L TI-VCT, 3.7L TI-VCT** .

71. **NOTE: RH shown in illustration, LH similar.**

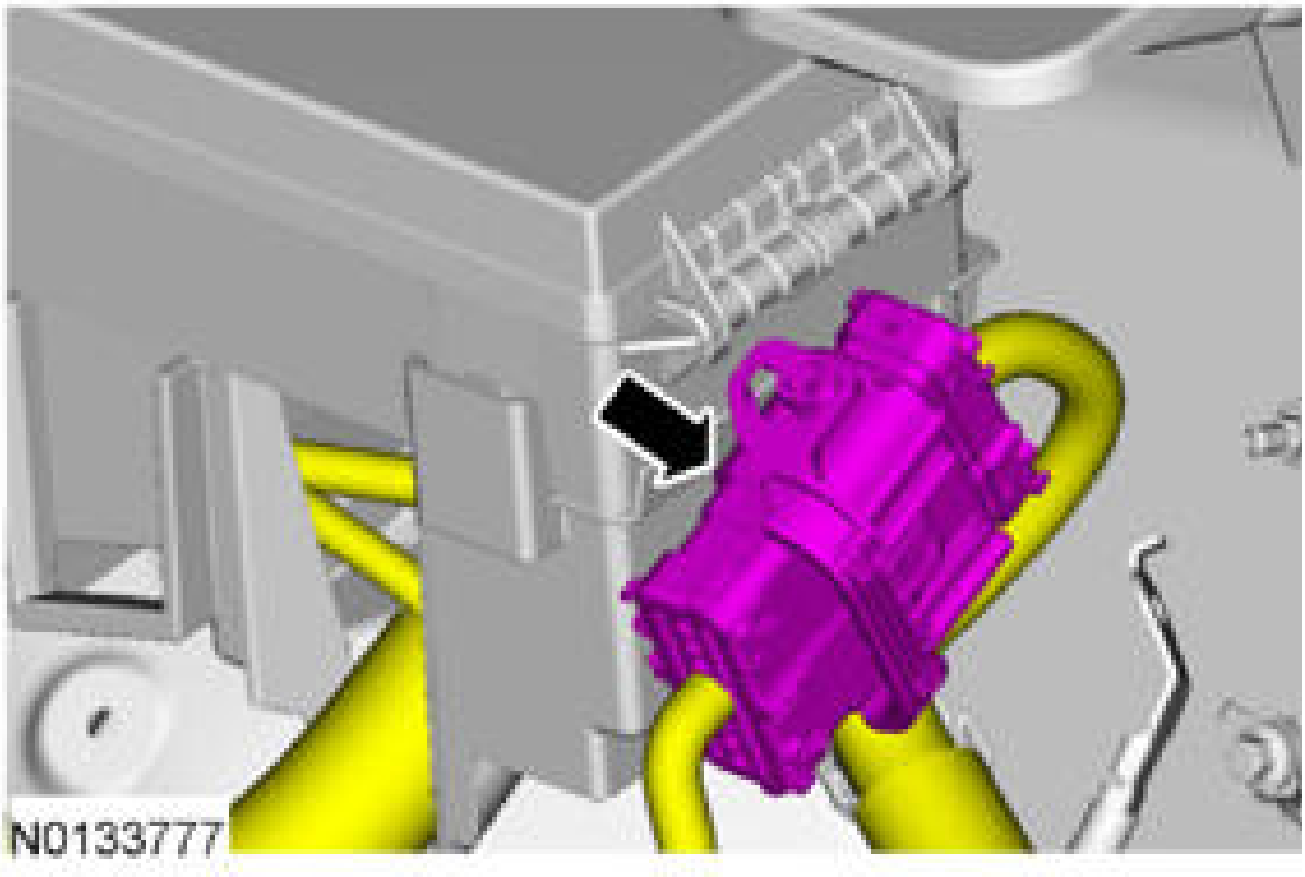
Install the 2 RH and 2 LH lower pin-type retainers for the engine splash shields.

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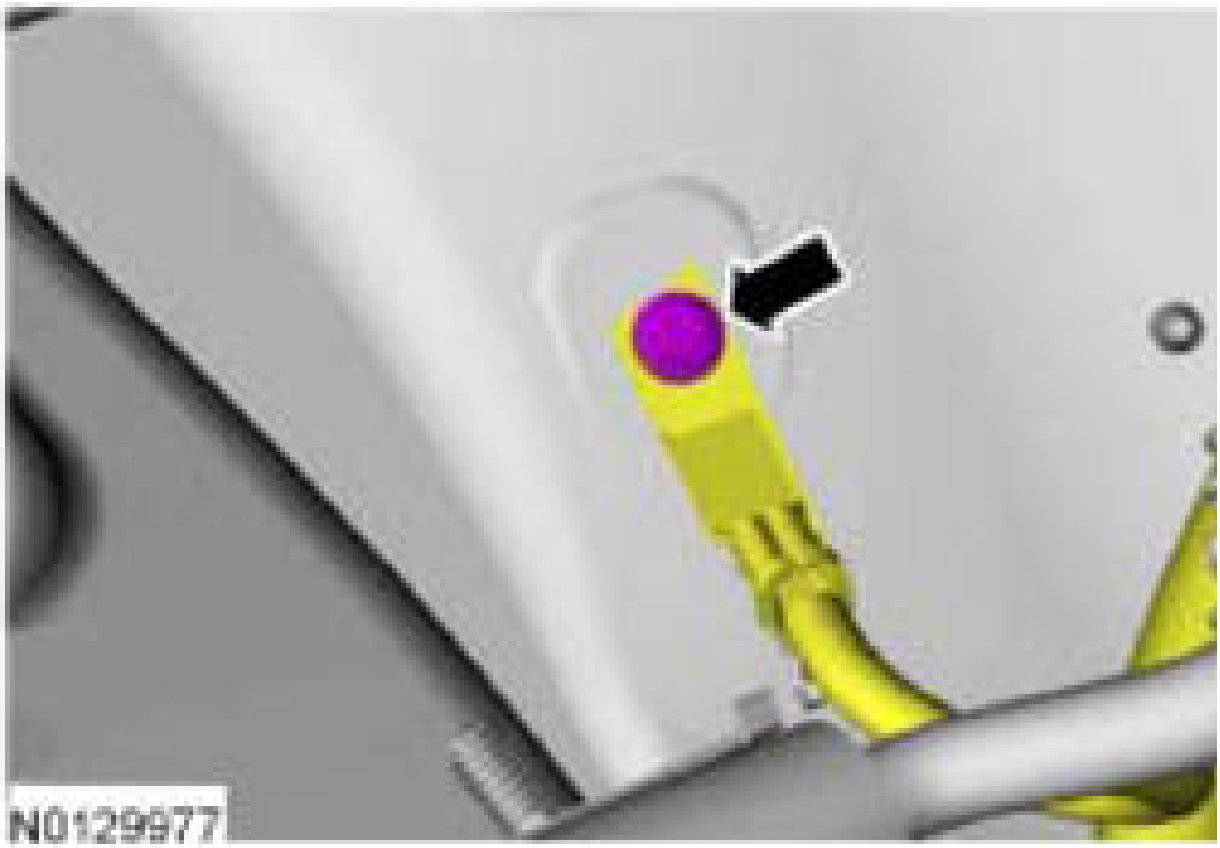
72. Install the front wheels and tires. REFER to **WHEEL AND TIRE** .
73. Connect the engine wiring harness electrical connector.

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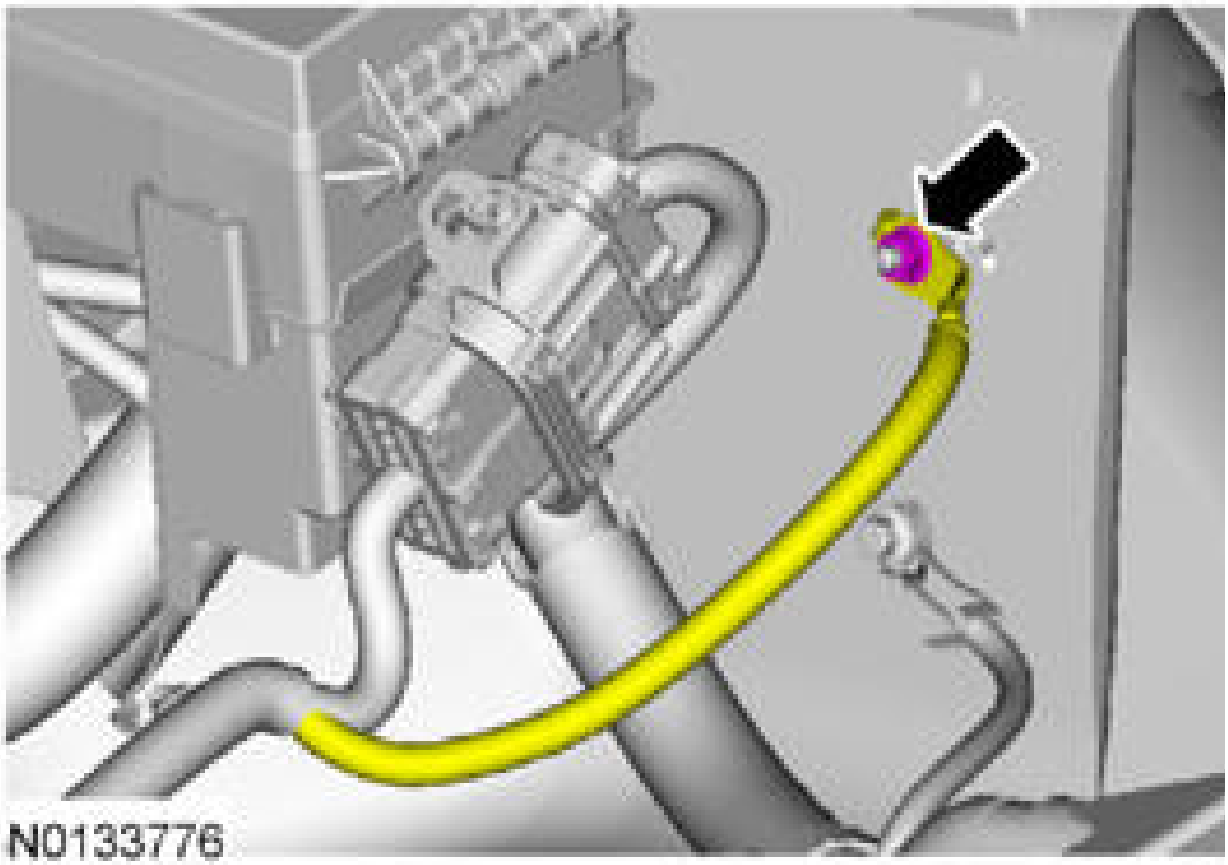
74. Install the ground wire and install the retainer.
    - Tighten to 10 Nm (89 lb-in).

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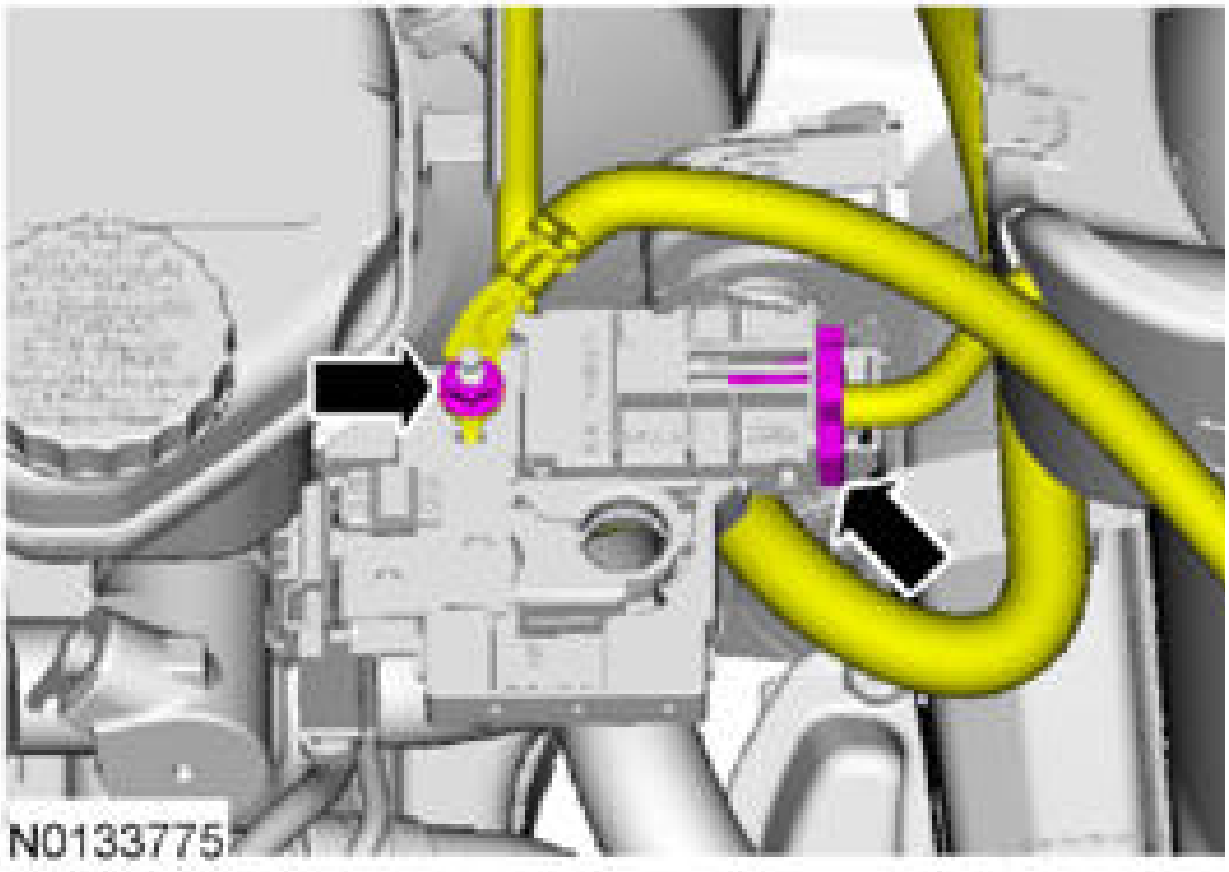
75. Install the ground wire and the retainer.
    - Tighten to 10 Nm (89 lb-in).

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76. Connect the 2 battery feed cables to the positive battery terminal and install the nut.
    - Tighten to 5 Nm (44 lb-in).

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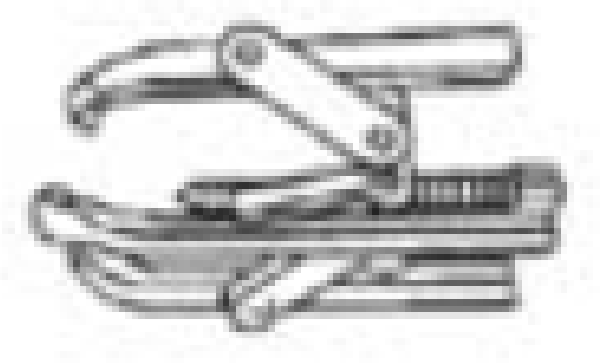


77. Install the battery tray. REFER to **BATTERY AND BATTERY TRAY - EXPLODED VIEW** .
78. Install the engine **ACL** and **ACL** outlet pipe. REFER to **INTAKE AIR SYSTEM COMPONENTS - EXPLODED VIEW** .
79. Install the cowl panel. REFER to **COWL PANEL** .
80. Fill the engine with clean engine oil.
81. Fill and bleed the cooling system. REFER to **COOLING SYSTEM DRAINING, FILLING AND BLEEDING** .
82. Recharge the A/C system. REFER to **AIR CONDITIONING (A/C) SYSTEM RECOVERY, EVACUATION AND CHARGING** .
83. Perform the Misfire Monitor Neutral Profile Correction procedure, following the on-screen instructions.

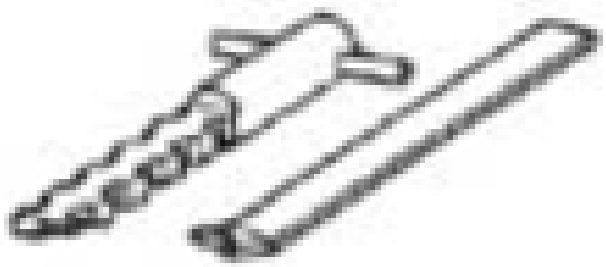
ENGINE FRONT COVER

SPECIAL TOOL(S) DESCRIPTION

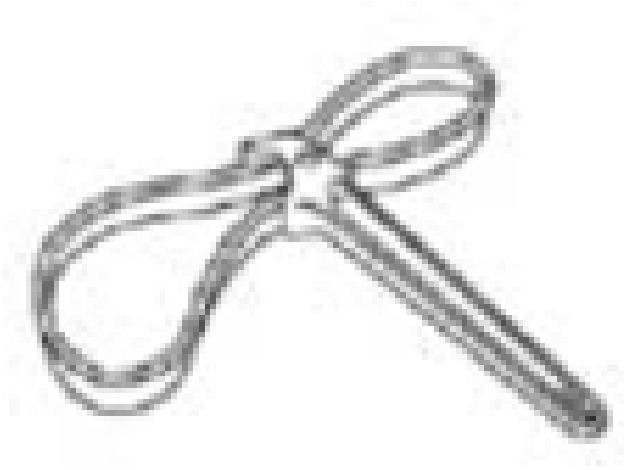
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	3 Jaw Puller **303-D121**
	Alignment Pins, Transmission Fluid Pump **307-399**
	Installer, Front Cover Oil Seal **303-335T88T-6701-A**

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	Installer, Front Seal **303-1251**
	Remover, Oil Seal **303-409T92C-6700-CH**
	Installer, Crankshaft Vibration Damper **303-102T74P-6316-B**

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	Strap Wrench **303-D055D85L-6000-A**

MATERIAL SPECIFICATIONS

Item	Specification
Motorcraft® High Performance Engine RTV Silicone TA-357	WSEM4G323-A6
Motorcraft® Metal Surface Prep ZC-31-A	-
Motorcraft® SAE 5W-20 Premium Synthetic Blend Motor Oil (US); Motorcraft® SAE 5W-20 Super Premium Motor Oil (Canada) XO-5W20-QSP (US); CXO-5W20-LSP12 (Canada)	WSSM2C945-A
Motorcraft® Silicone Gasket Remover ZC-30	-

Removal

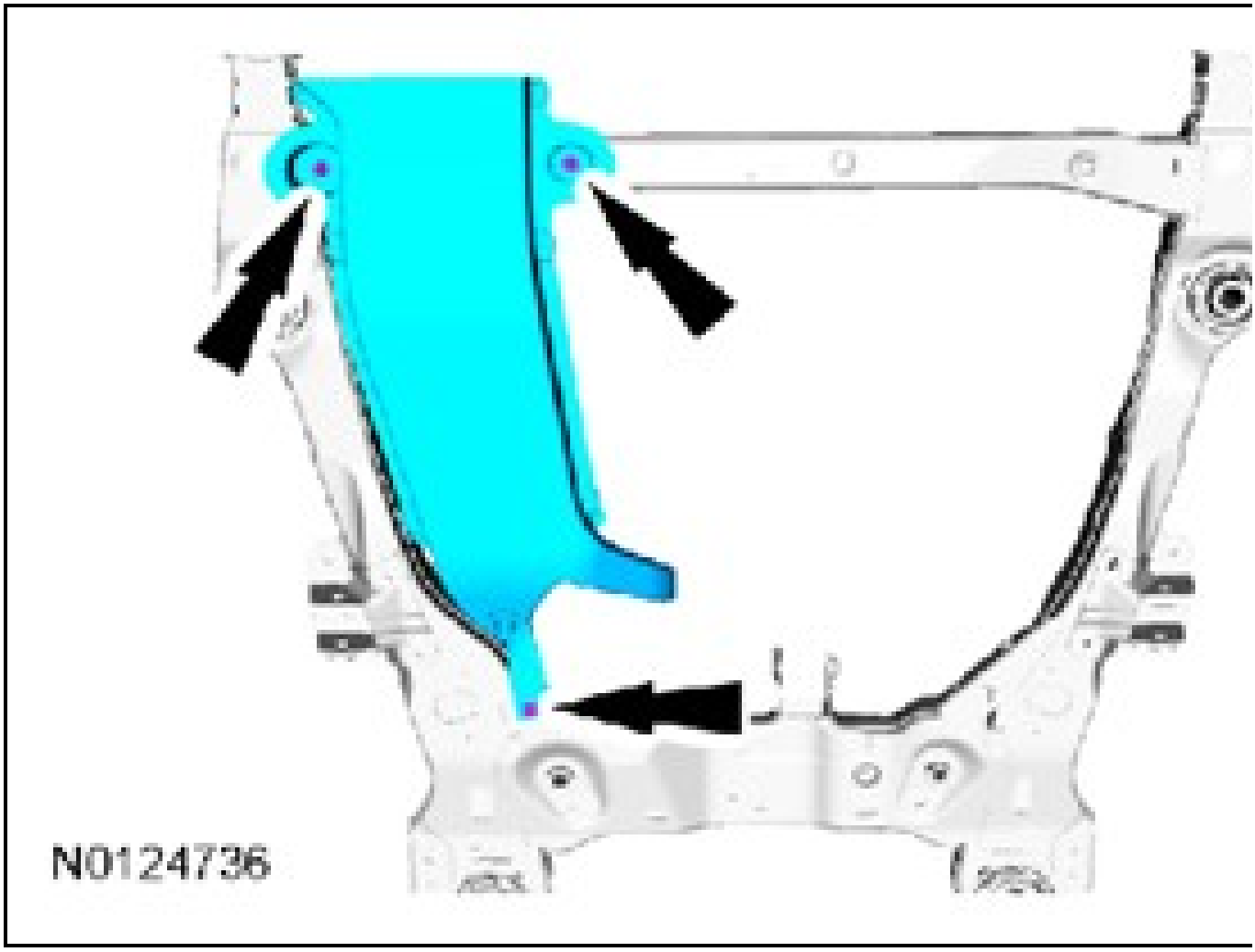
WARNING: Before beginning any service procedure, refer to SAFETY WARNINGS . Failure to follow this instruction may result in serious personal injury.

NOTE: Place clean, lint-free shop towels over exposed engine cavities. Carefully remove the towels so foreign material is not dropped into the engine. Any foreign material (including any material created while cleaning gasket surfaces) that enters the oil passages or the oil pan, may cause engine failure.

1. With the vehicle in NEUTRAL, position it on a hoist. REFER to **JACKING AND LIFTING** .
2. Recover the A/C system. REFER to **AIR CONDITIONING (A/C) SYSTEM RECOVERY, EVACUATION AND CHARGING** .
3. Release the fuel system pressure. REFER to **FUEL SYSTEM PRESSURE RELEASE** .
4. Disconnect the battery ground cable. REFER to **BATTERY DISCONNECT** .

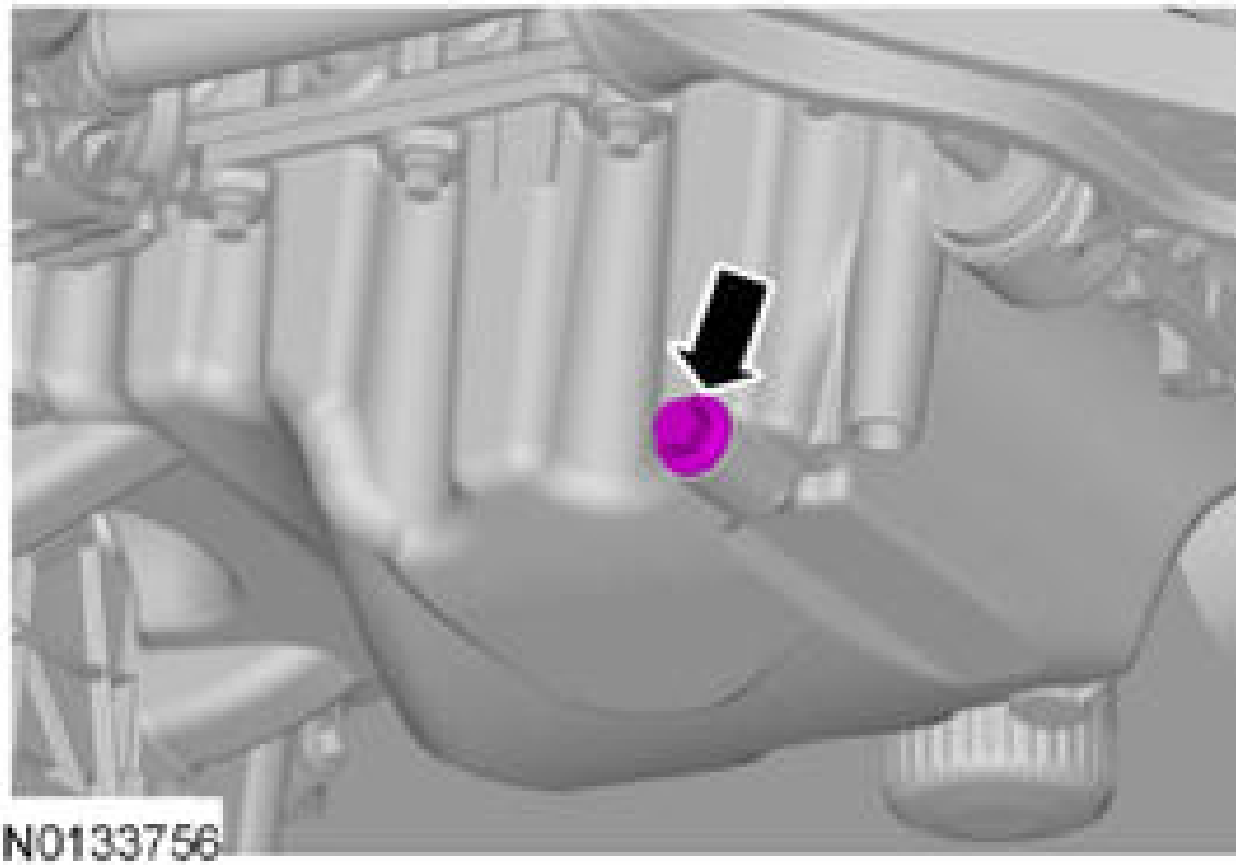
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5. Remove the RH fender splash shield. REFER to **FENDER SPLASH SHIELD** .
6. Remove the 3 twist lock retainers and the underbody air duct.



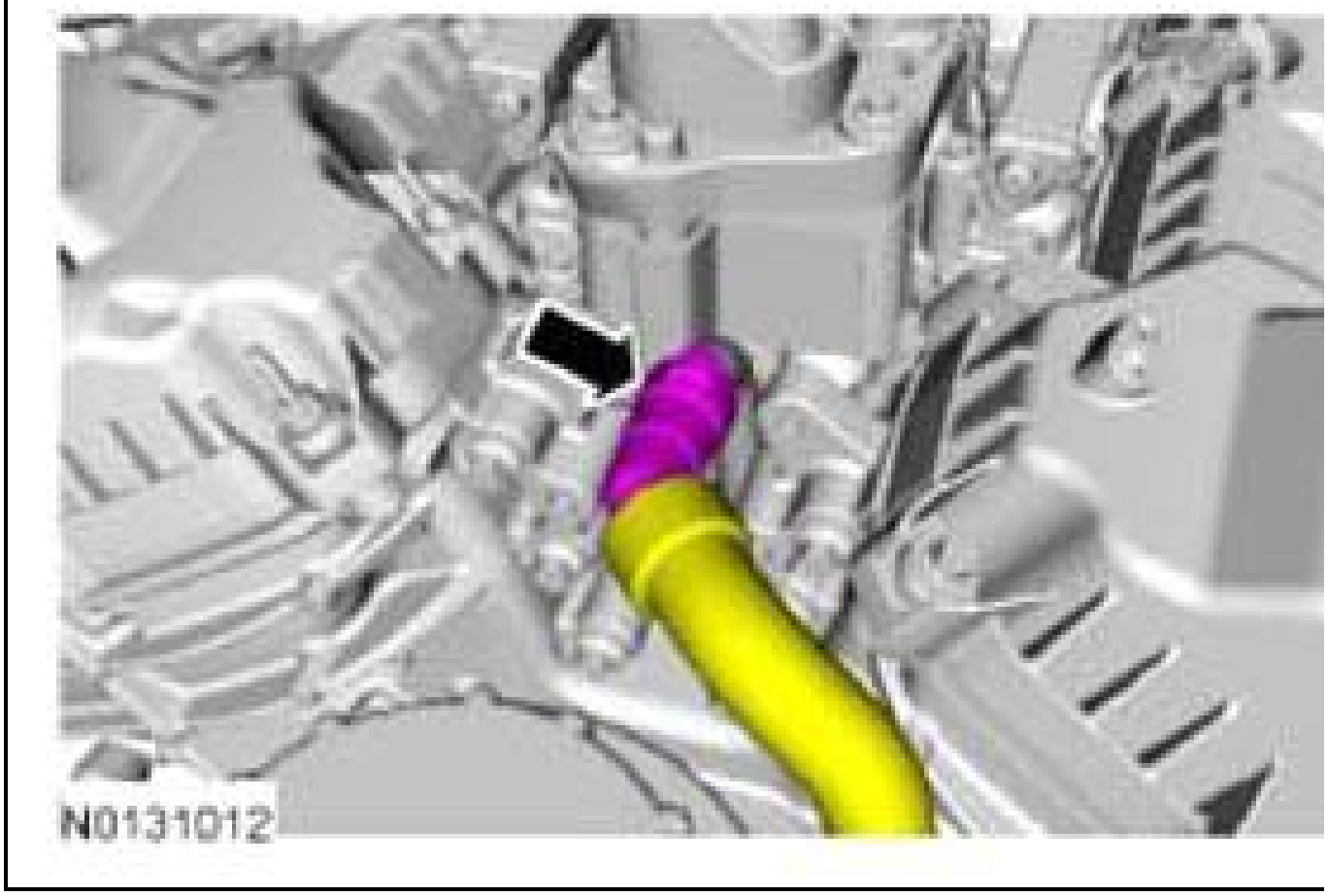
7. Drain the cooling system. REFER to **COOLING SYSTEM DRAINING, FILLING AND BLEEDING** .
8. Remove the crankshaft front seal. Refer to **CRANKSHAFT FRONT SEAL**.
9. Remove the accessory drive belt tensioner. REFER to **ACCESSORY DRIVE BELT TENSIONER - 3.5L TI-VCT, 3.7L TI-VCT** .
10. Remove the drain plug and drain the engine oil.
    - Install the oil drain plug and tighten to 27 Nm (20 lb-ft).

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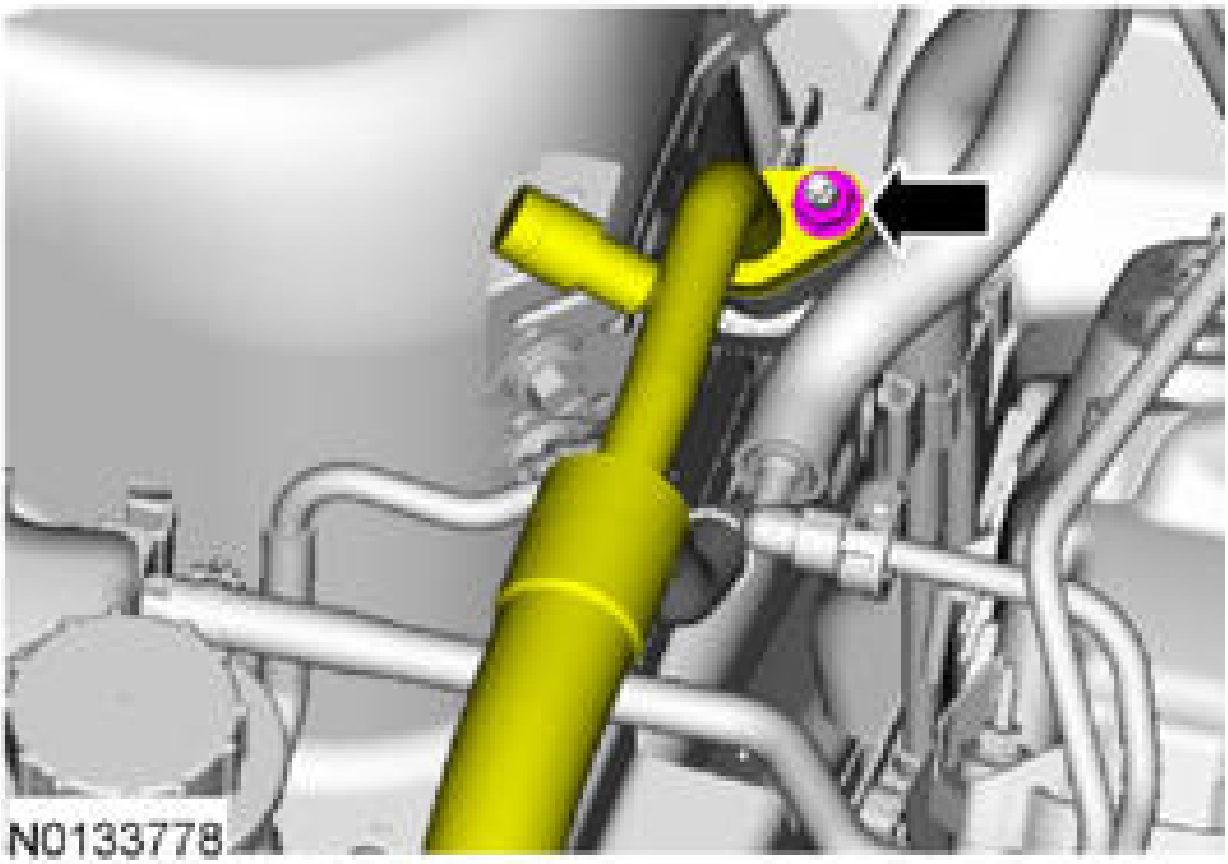
11. Remove degas bottle. REFER to **DEGAS BOTTLE** .
12. Disconnect the degas bottle coolant hose from the engine coolant tube.

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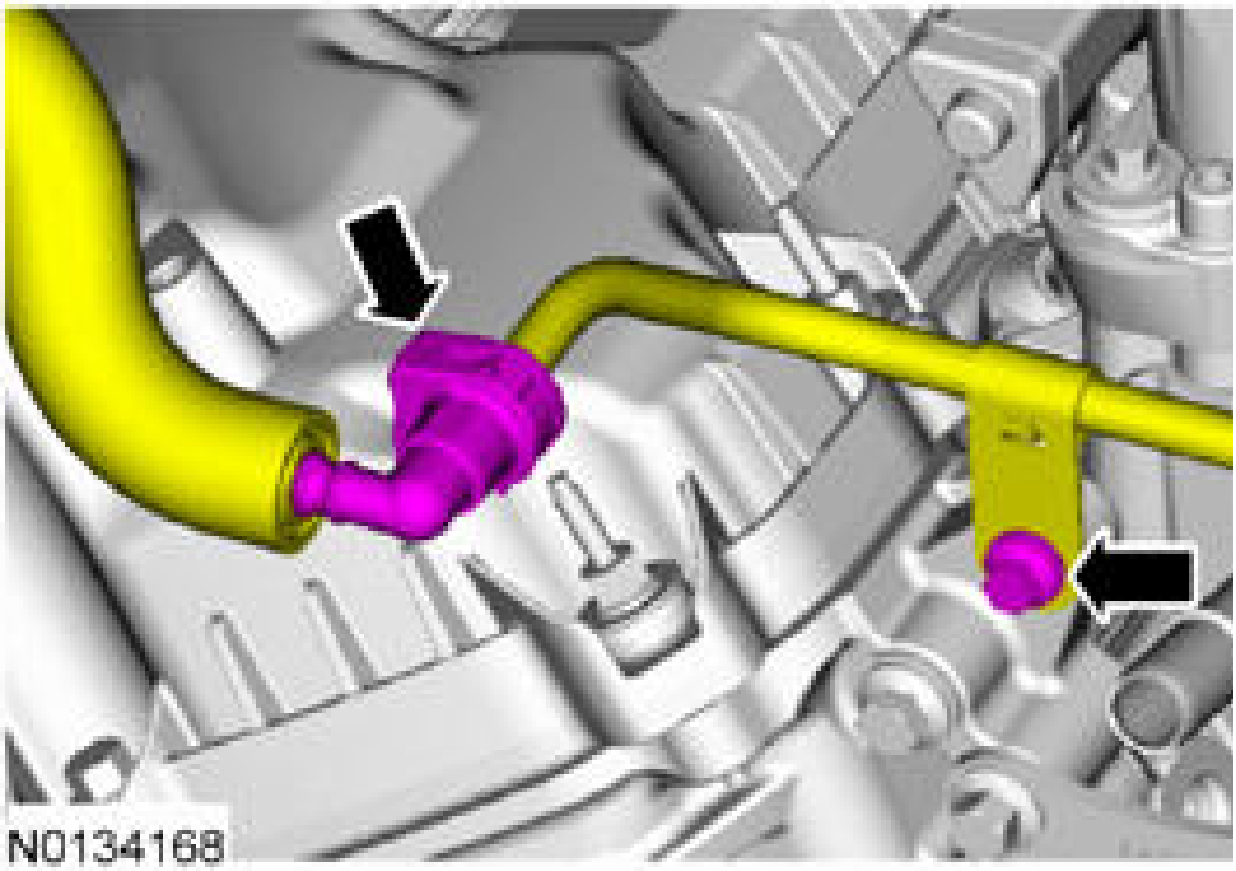
13. Remove the nut and disconnect the A/C tube.
    - Discard the O-ring seal.

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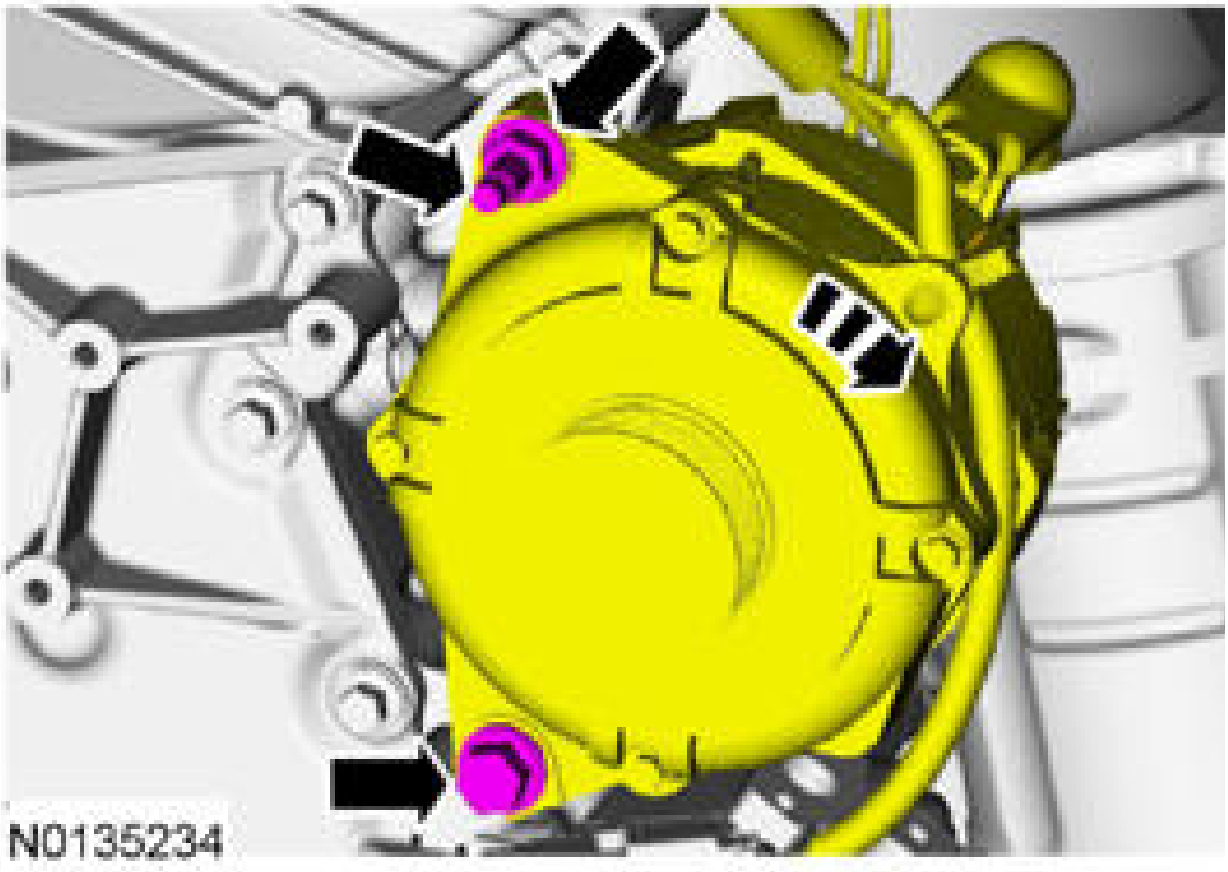
14. Disconnect the fuel supply tube from the fuel rail supply tube. REFER to **QUICK CONNECT COUPLING** .
    - Remove the fuel tube-to-engine front cover bolt.

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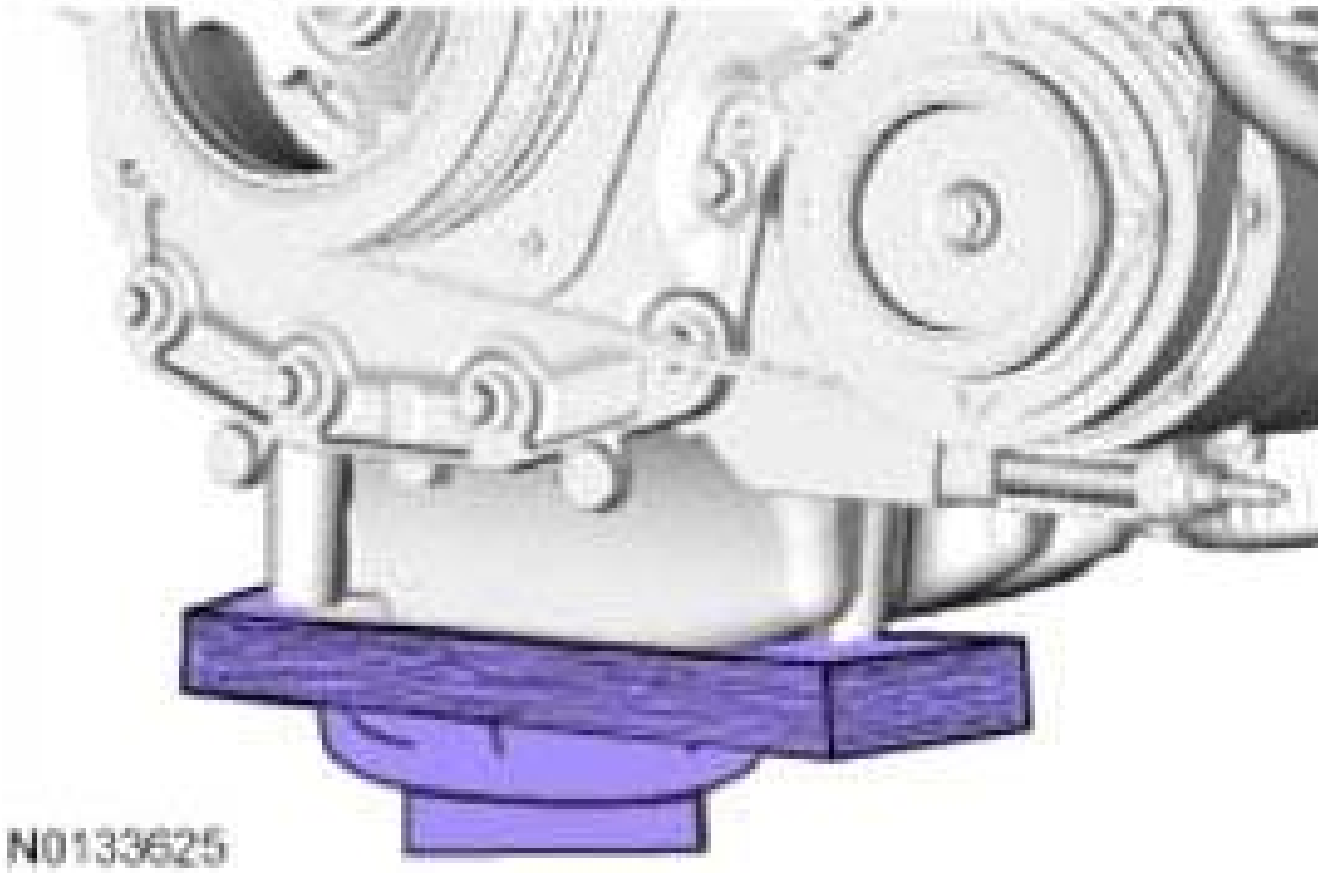
15. Remove the LH and RH valve covers. Refer to **VALVE COVER - LH** and Refer to **VALVE COVER - RH**.
16. Remove the generator nut and stud.
    - Loosen the bolt and position the generator aside.

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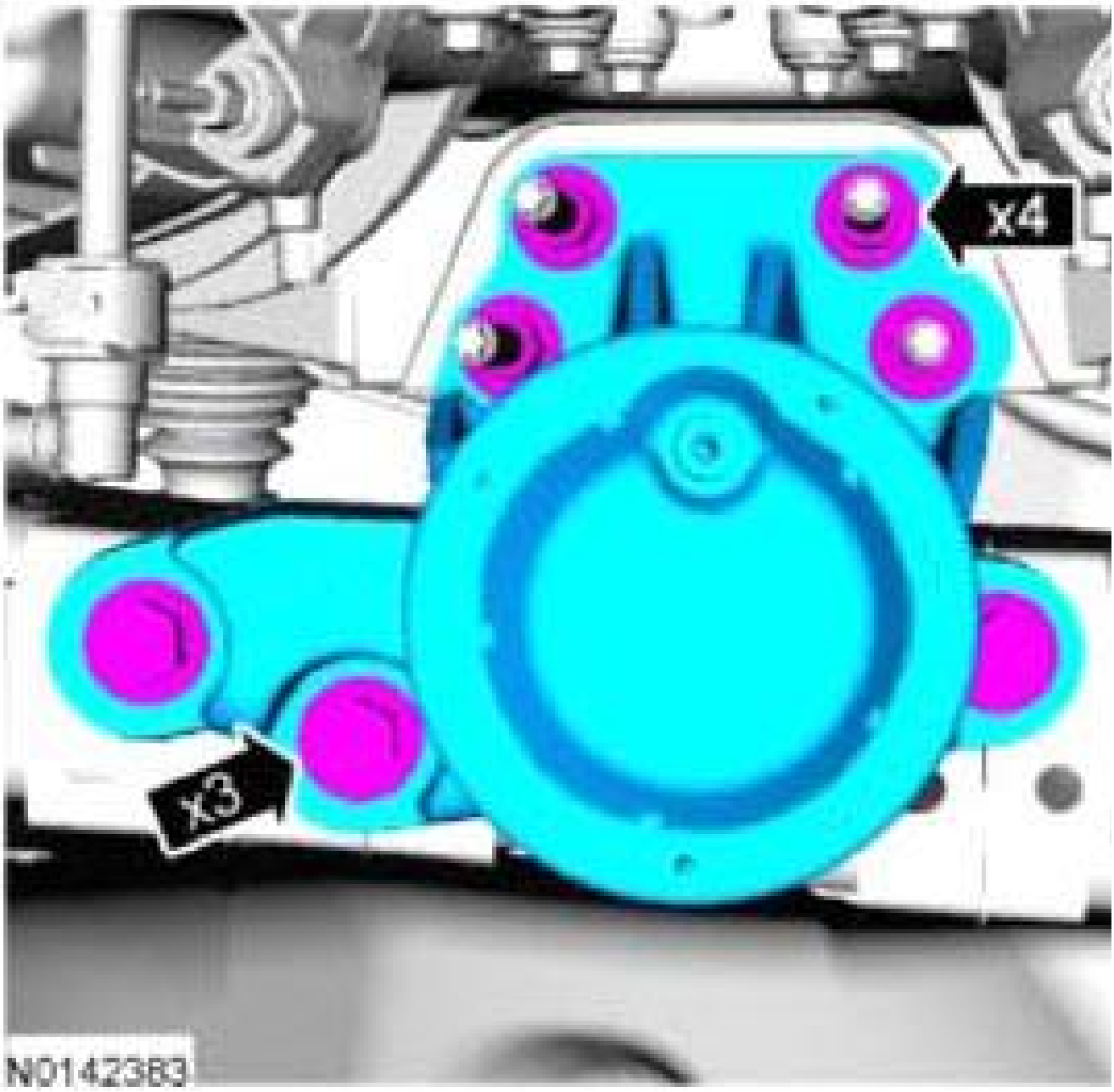
17. Position a floor jack with a block of wood under the front of the oil pan.

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18. Remove the 4 engine mount nuts and the 3 engine mount bolts and remove the mount.

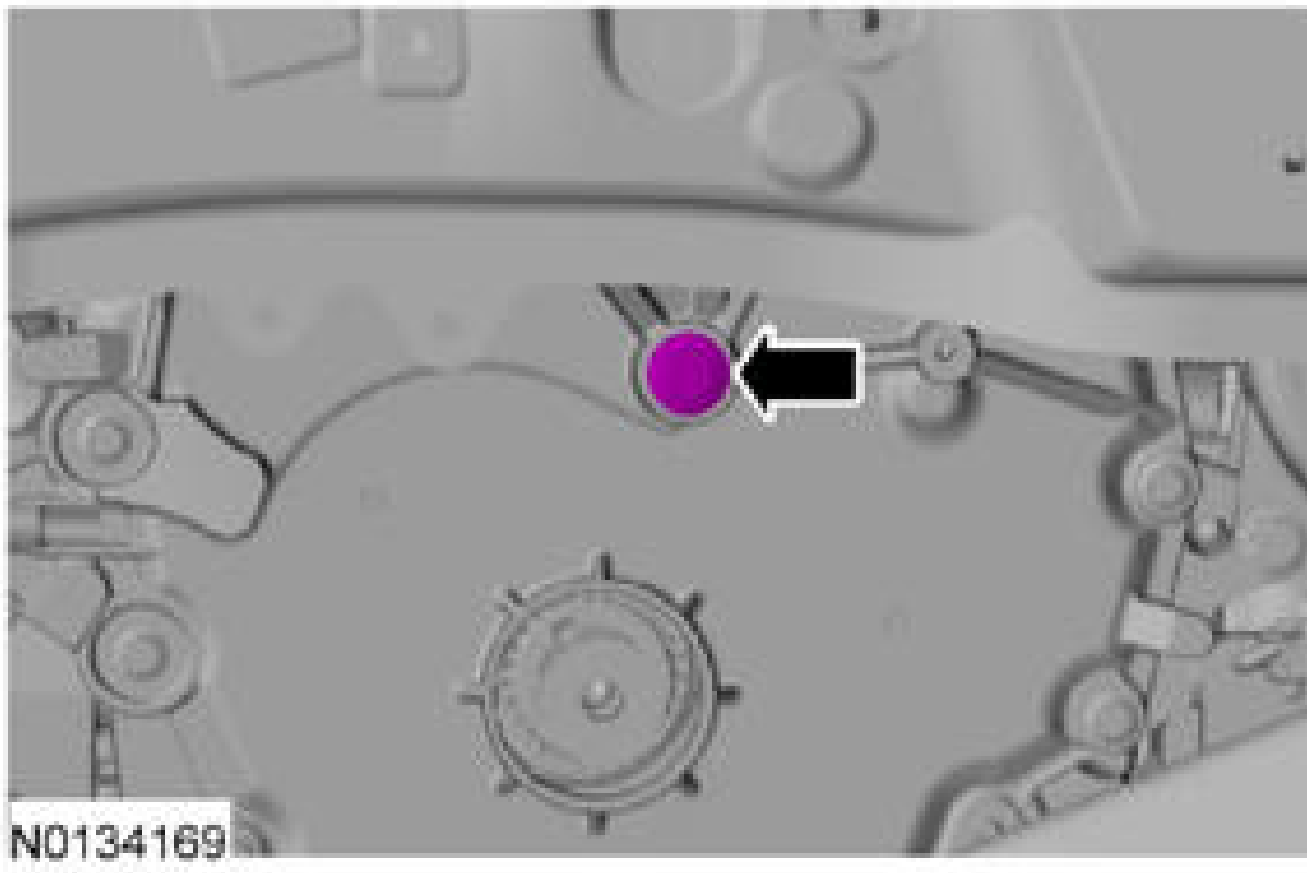
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19. **NOTE: It may be necessary to use the floor jack and lower the engine slightly to gain enough access to remove the bolt.**

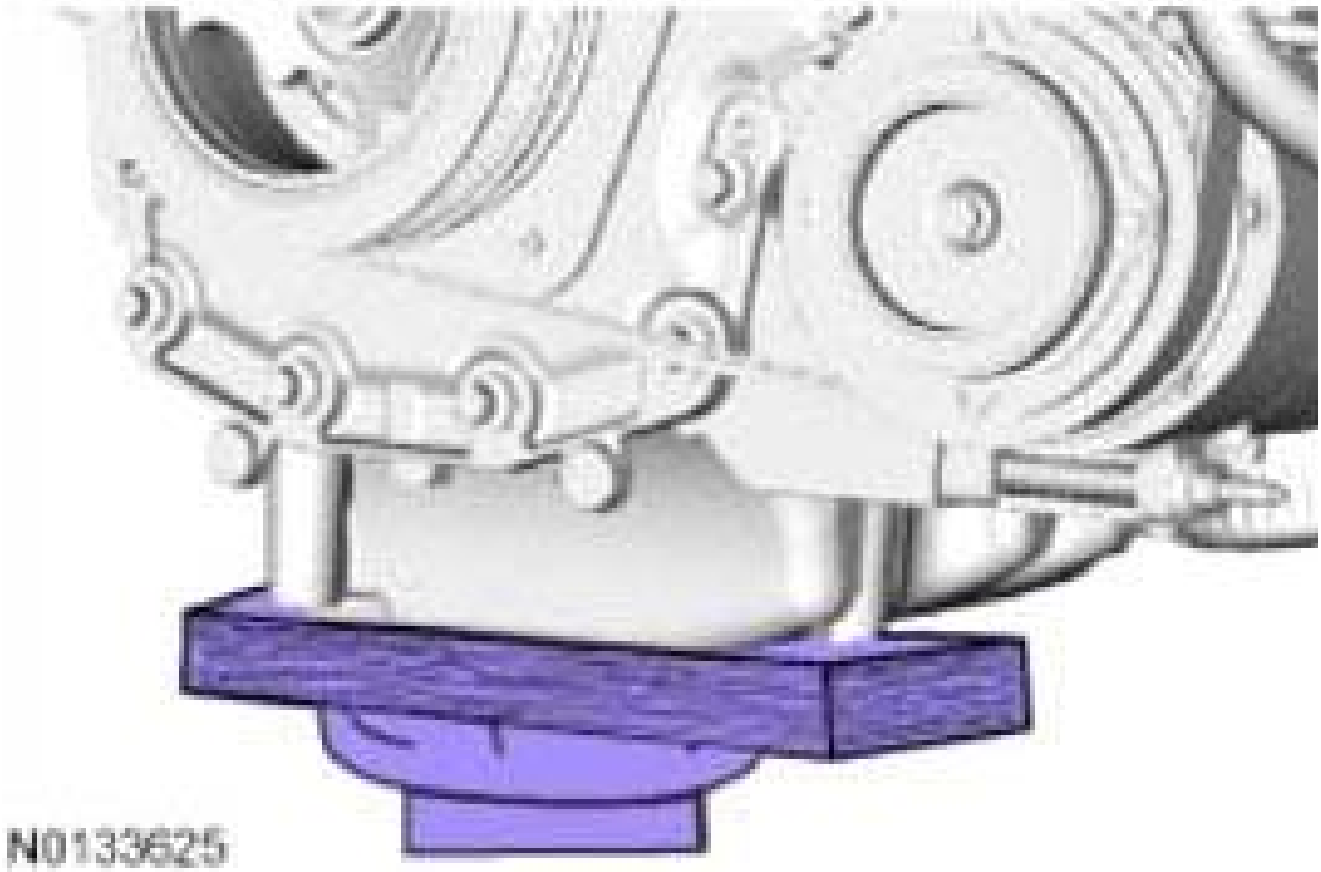
Remove the lower M10 engine front cover bolt.

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20. Using the floor jack, raise the engine.

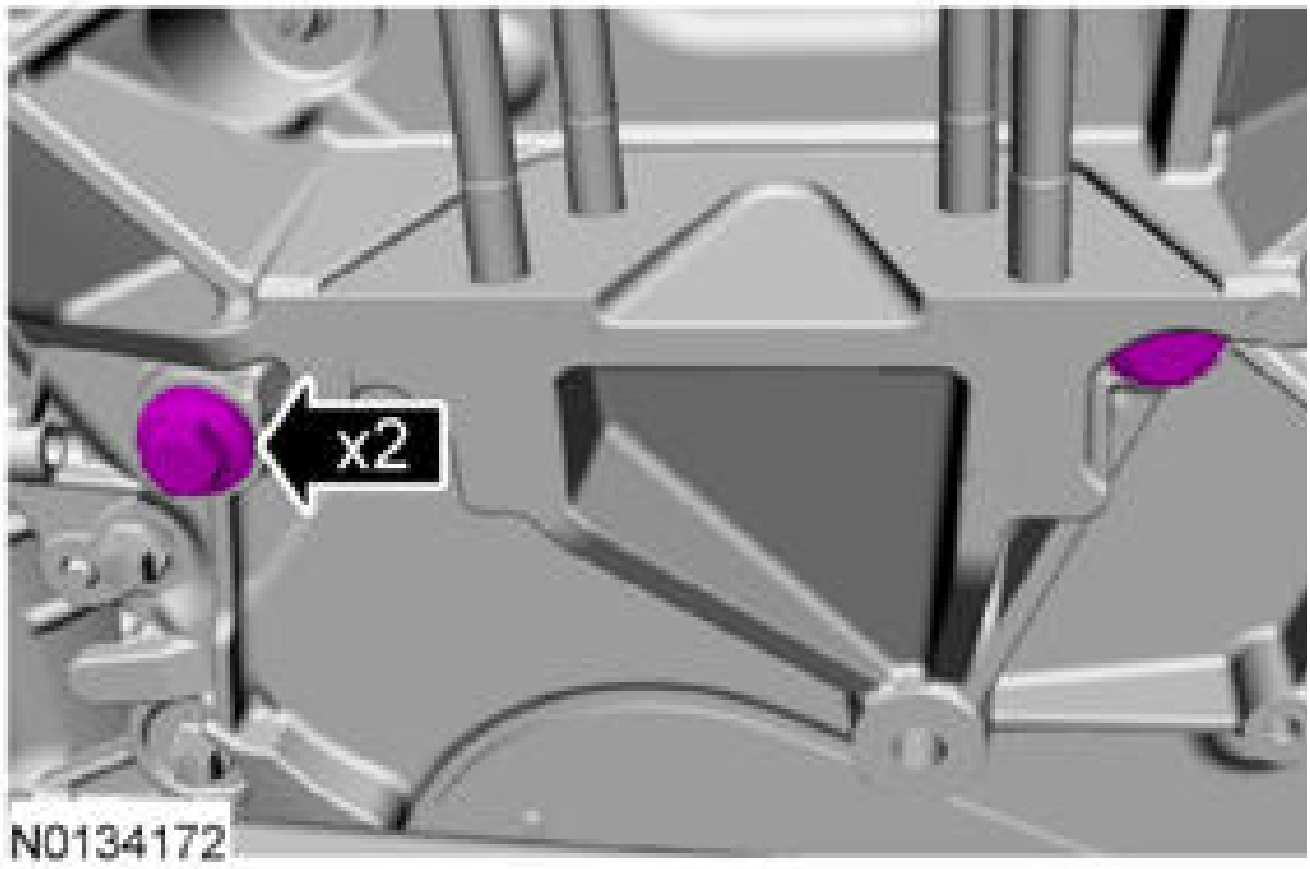
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NOTE: **It may be necessary to use the floor jack and raise the engine slightly to gain enough access to remove the bolts.**

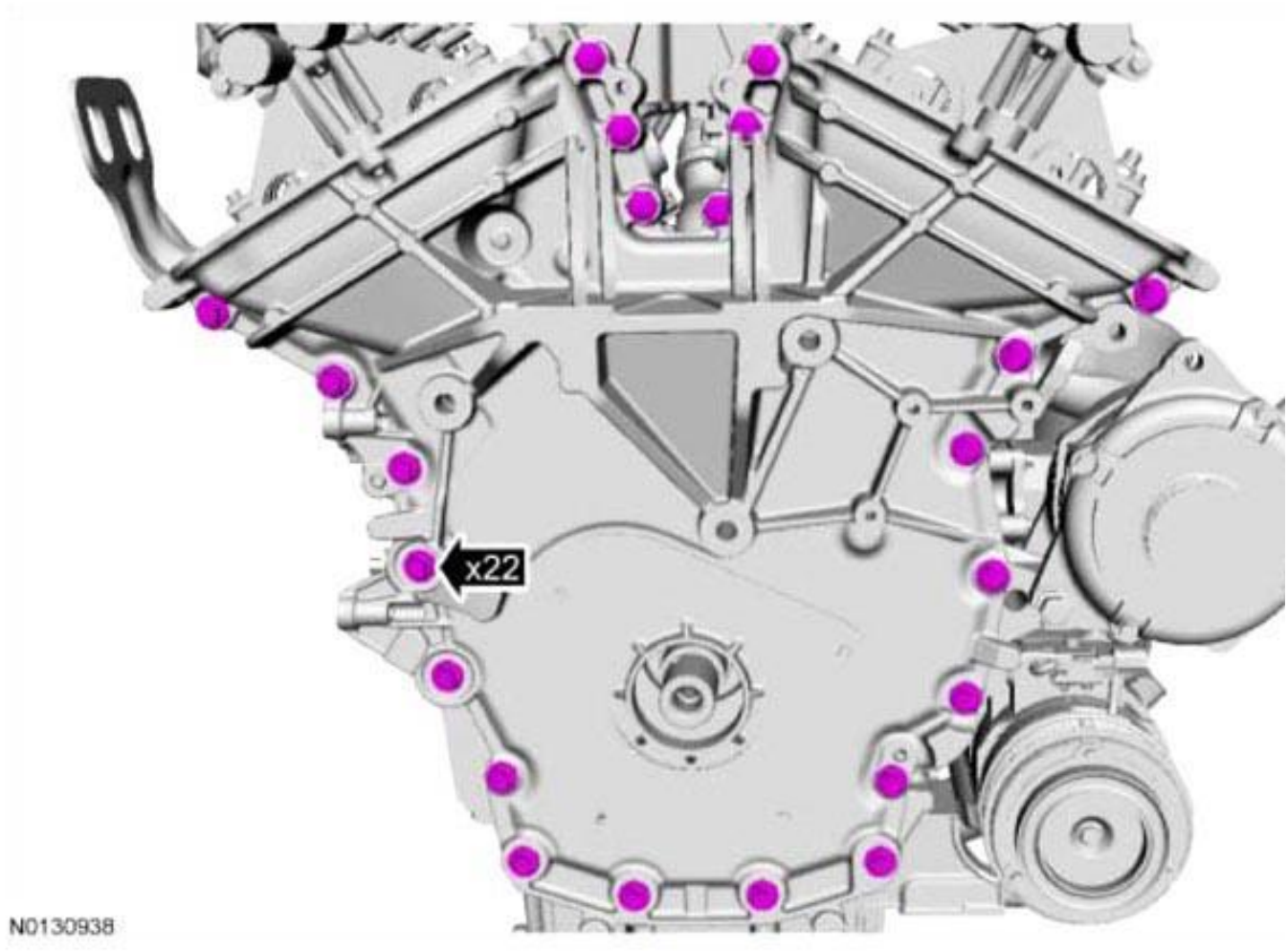
21. Remove the 2 M10 engine front cover bolts.

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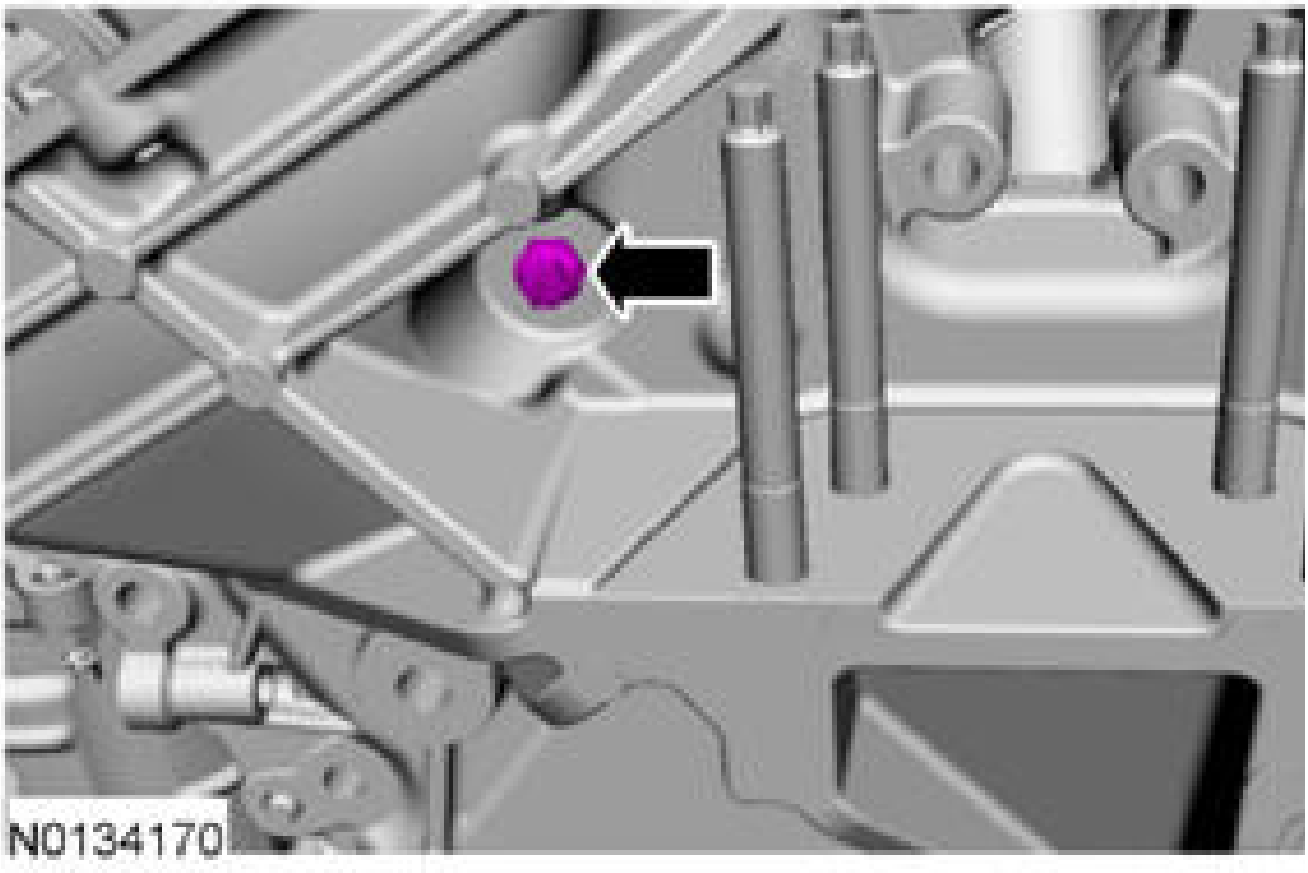
22. Remove the 22 M8 engine front cover bolts.

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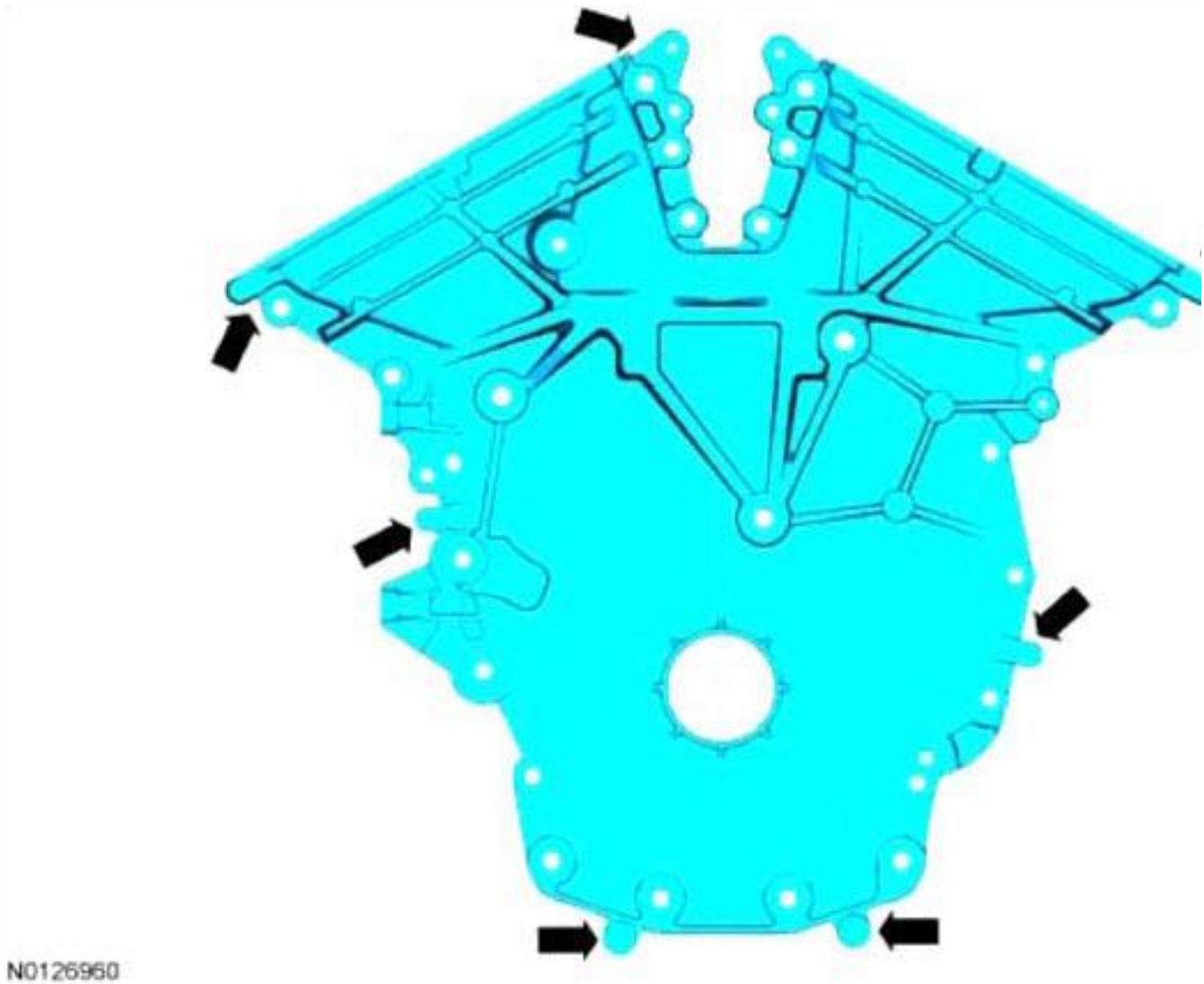
23. Remove the M6 engine front cover bolt.

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24. Using a suitable pry tool, locate the 7 pry pads shown in illustration and pry the engine front cover loose and remove.

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Installation

1. **NOTE: Only use a 3M Roloc® Bristle Disk (2-in white, part number 07528) to clean the engine front cover. Do not use metal scrapers, wire brushes or any other power abrasive disk to clean front cover.**

Clean the engine front cover using a 3M Roloc® Bristle Disk (2-in white, part number 07528) in a suitable tool turning at the recommended speed of 15,000 rpm. Thoroughly wash the engine front cover to remove any foreign material, including any abrasive particles created during the cleaning process.

2. **NOTE: Place clean, lint-free shop towels over exposed engine cavities. Carefully remove the towels so foreign material is not dropped into the engine. Any foreign material (including any material created while cleaning gasket surfaces) that enters the oil passages or the oil pan, may cause engine**

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2. **failure.**

NOTE: Do not use wire brushes, power abrasive discs or 3M Roloc® Bristle Disk (2-in white part number 07528) to clean the sealing surfaces of engine block, cylinder heads, and oil pan. These tools can cause contamination that will cause premature engine failure. Remove all traces of the gasket.

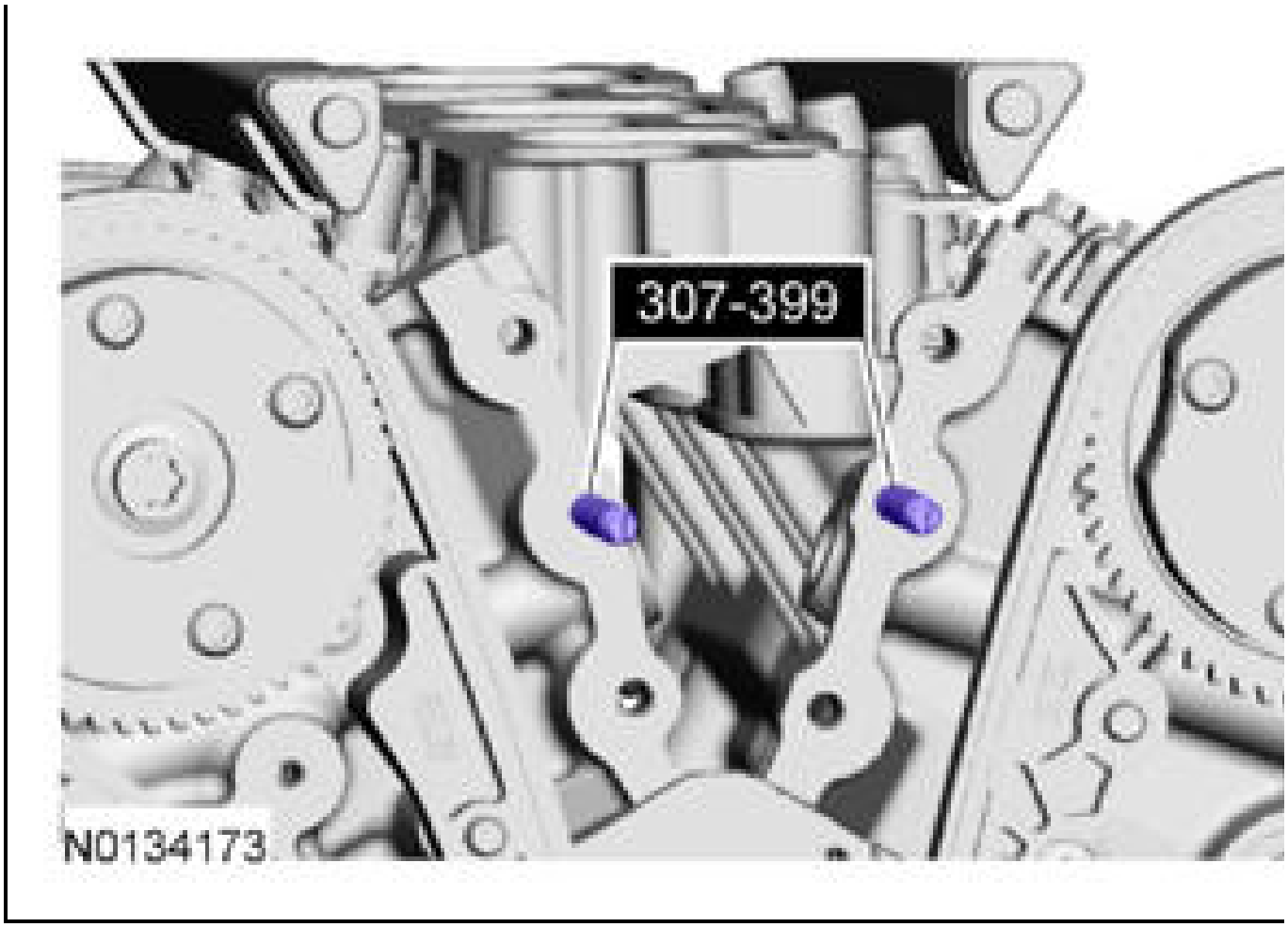
Clean the sealing surfaces of the cylinder heads, the cylinder block and the oil pan in the following sequence.

- Remove any large deposits of silicone or gasket material.
- Apply Motorcraft® Silicone Gasket Remover and allow to set for several minutes.
- Remove the Motorcraft® Silicone Gasket Remover. A second application of Motorcraft® Silicone Gasket Remover may be required if residual traces of silicone or gasket material remain.
- Apply Motorcraft® Metal Surface Prep to remove any remaining traces of oil or coolant and to prepare the surfaces to bond. Do not attempt to make the metal shiny. Some staining of the metal surfaces is normal.

3. **NOTE: Make sure the 2 locating dowel pins are seated correctly in the cylinder block.**

Install 307-399.

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NOTE: **Failure to use Motorcraft® High Performance Engine RTV Silicone may cause the engine oil to foam excessively and result in serious engine damage.**

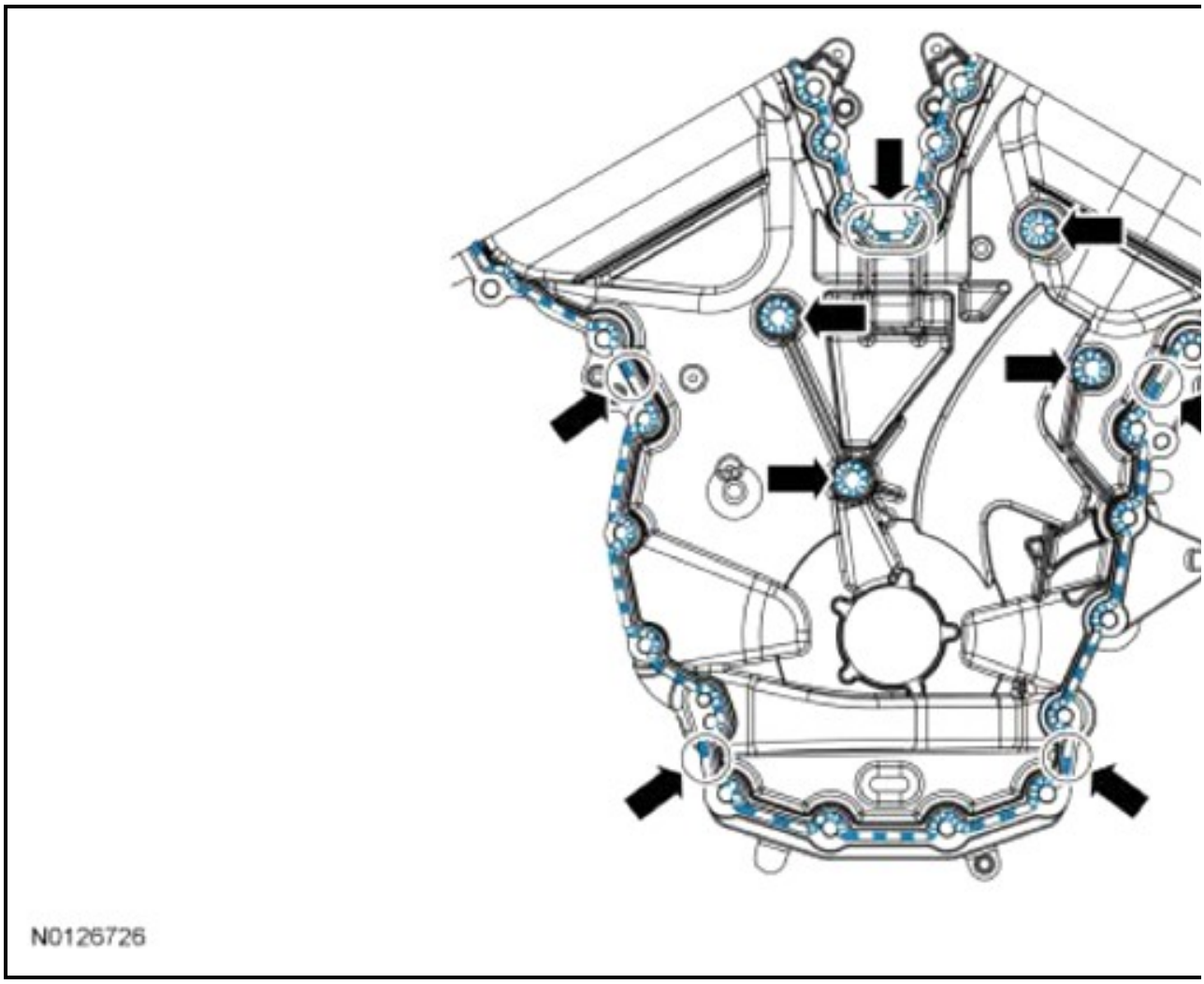
4.

NOTE: **The engine front cover and bolts 7, 8, 15, 17, 18, 21 and 22 must be installed within 4 minutes of the initial sealant application. The remainder of the engine front cover bolts must be installed and tightened within 35 minutes of the initial sealant application. If the time limits are exceeded, the sealant must be removed, the sealing area cleaned and sealant reapplied. To clean the sealing area, use Motorcraft® Silicone Gasket Remover and Motorcraft® Metal Surface Prep. Failure to follow this procedure can cause future oil leakage.**

Apply a 3 mm (0.1181 in) bead of Motorcraft® High Performance Engine RTV Silicone to the sealing surface of the front cover.

- Apply a 5.5 mm (0.22 in) bead of Motorcraft® High Performance Engine RTV Silicone to the oil pan-to-cylinder block joint and the cylinder head-to-cylinder block joint areas of the engine front cover in 5 places as indicated.

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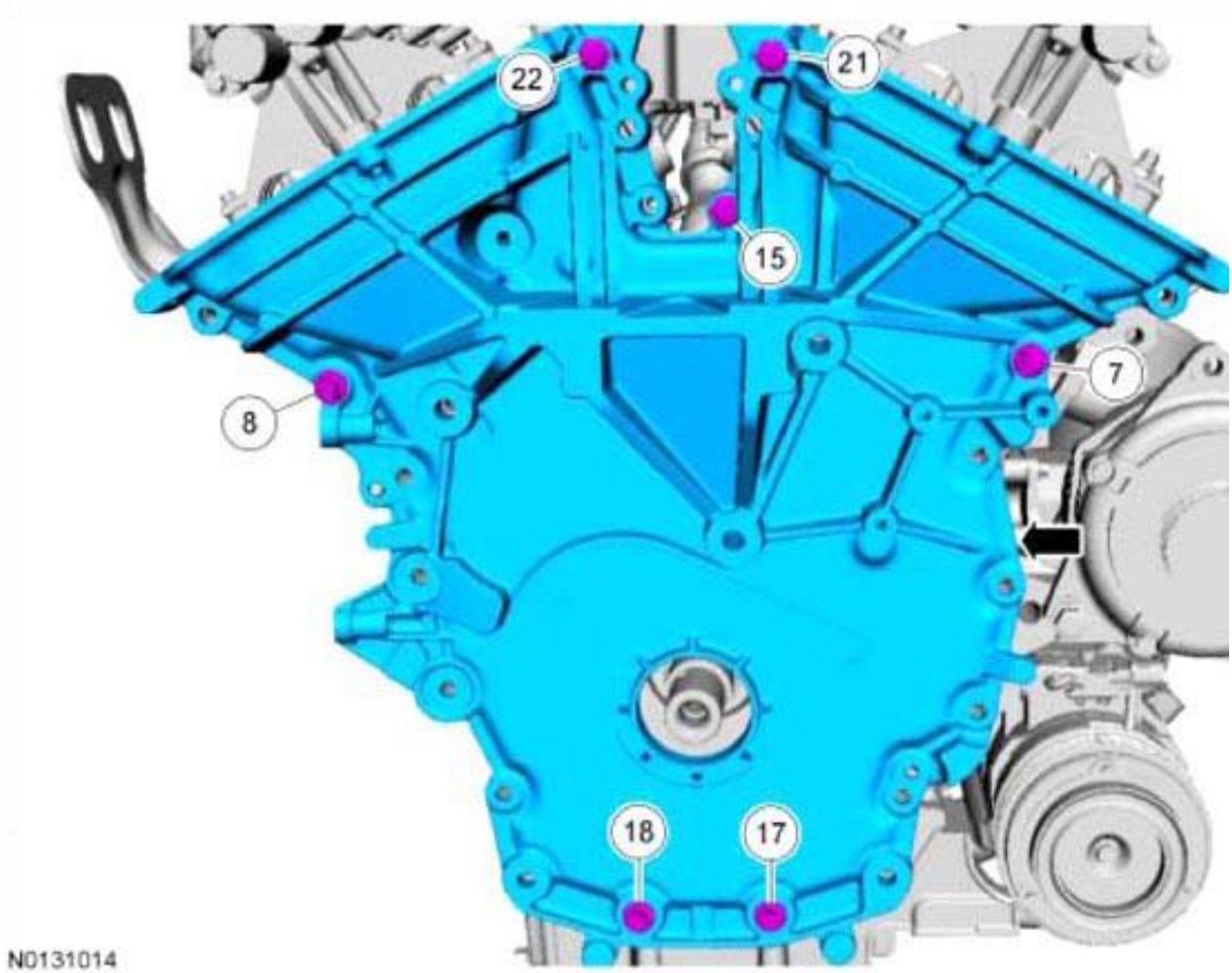


5. **NOTE: Make sure the 2 locating dowel pins are seated correctly in the cylinder block.**

Install the engine front cover and bolts 7, 8, 15, 17, 18, 21 and 22.

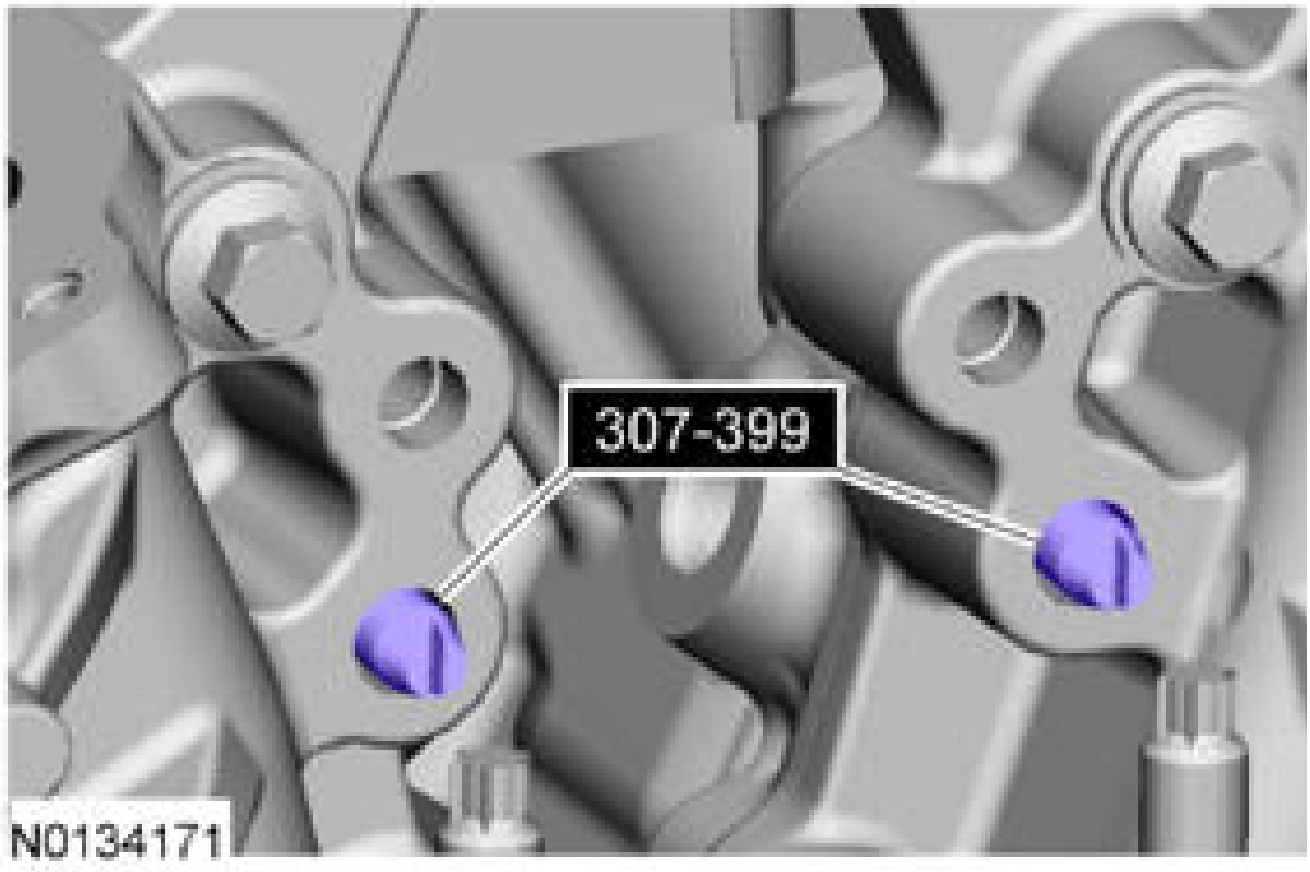
- Tighten in sequence shown in illustration to 3 Nm (27 lb-in).

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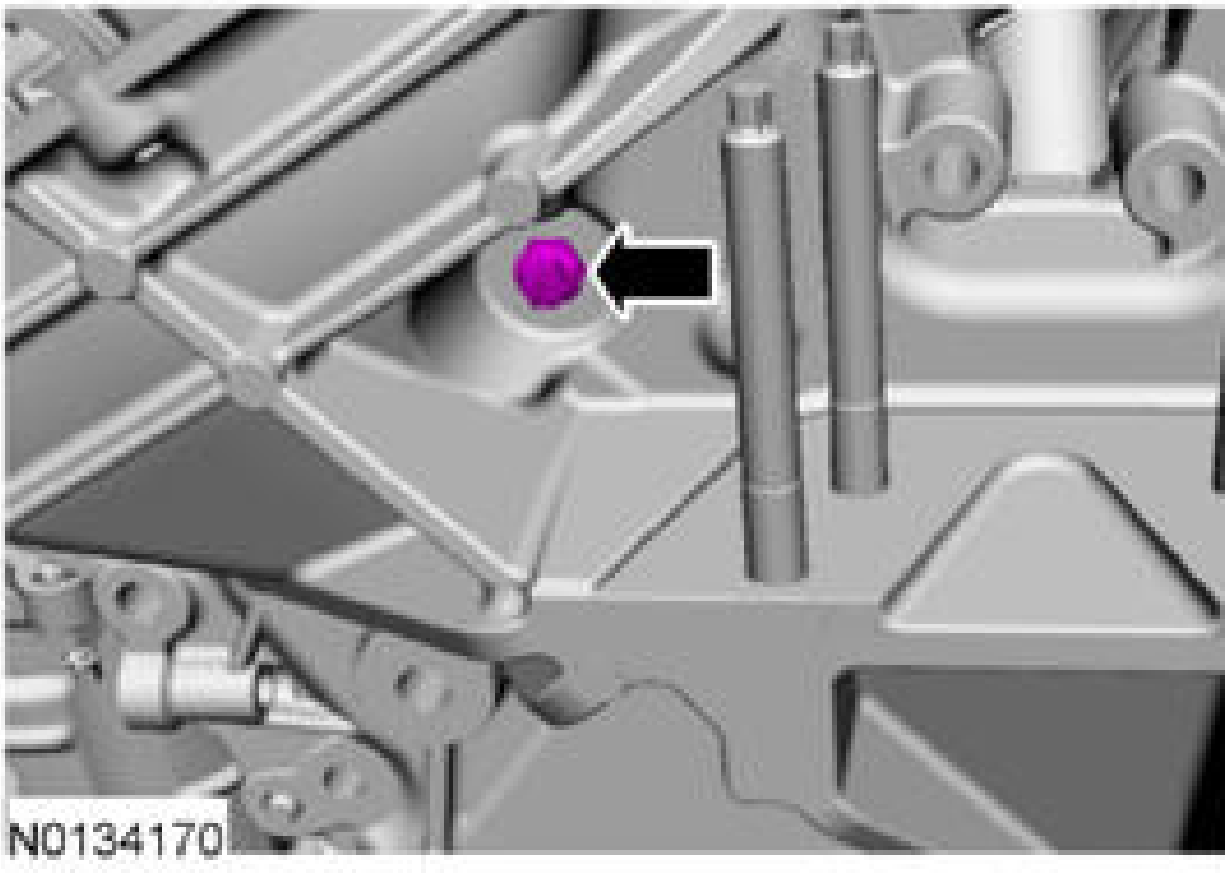
6. Remove 307-399.

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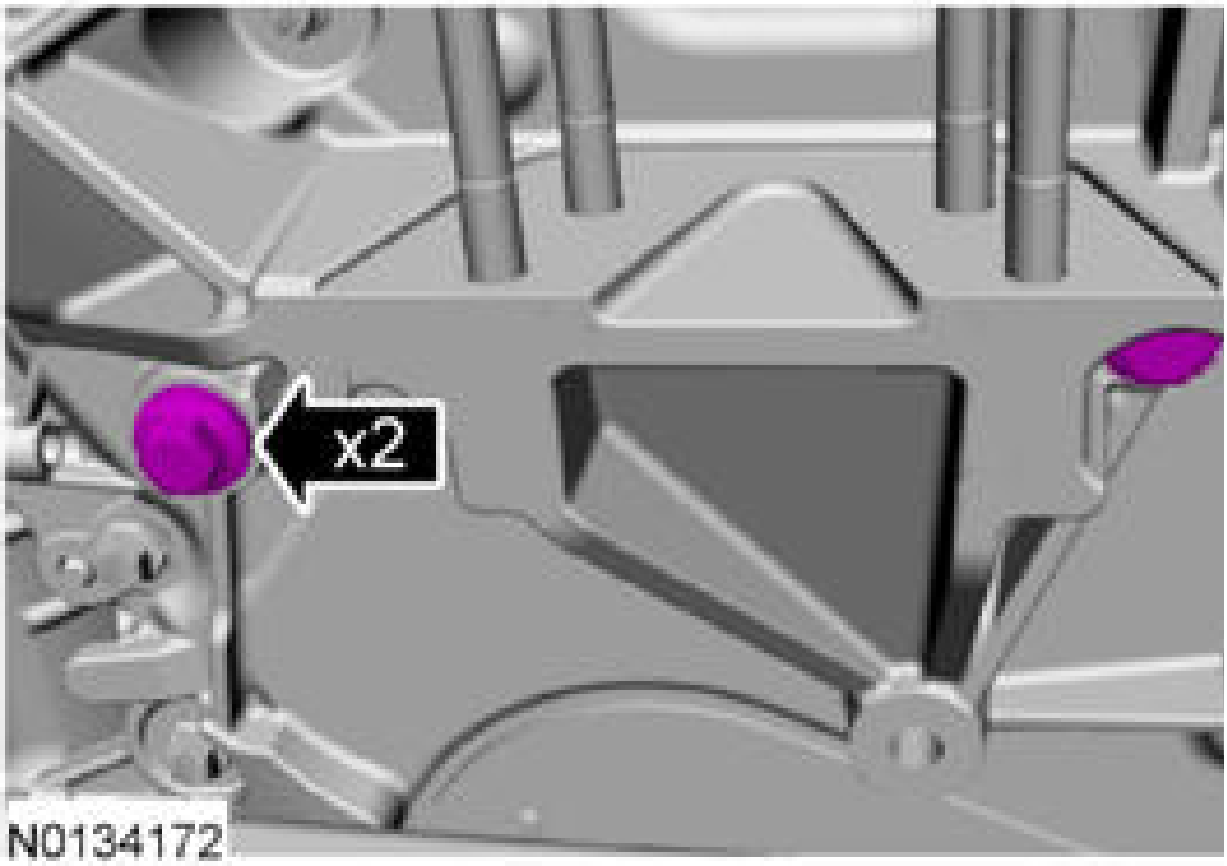
7. Install the M6 engine front cover bolt.
    - Do not tighten at this time.

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8. Install the 2 upper M10 engine front cover bolts.
    - Do not tighten the bolts at this time.

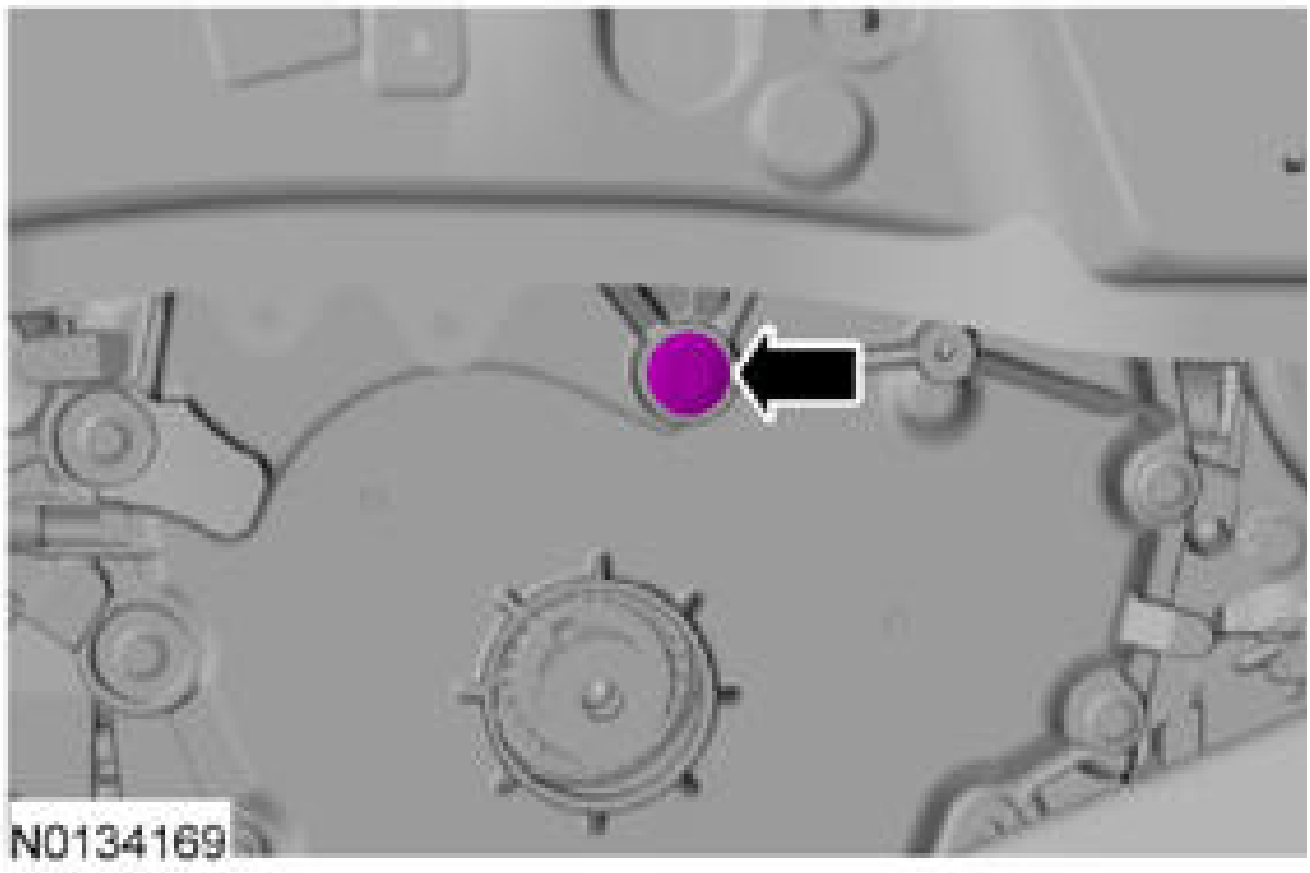
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9. **NOTE: It may be necessary to use the floor jack and lower the engine slightly to gain enough access to install the bolt.**

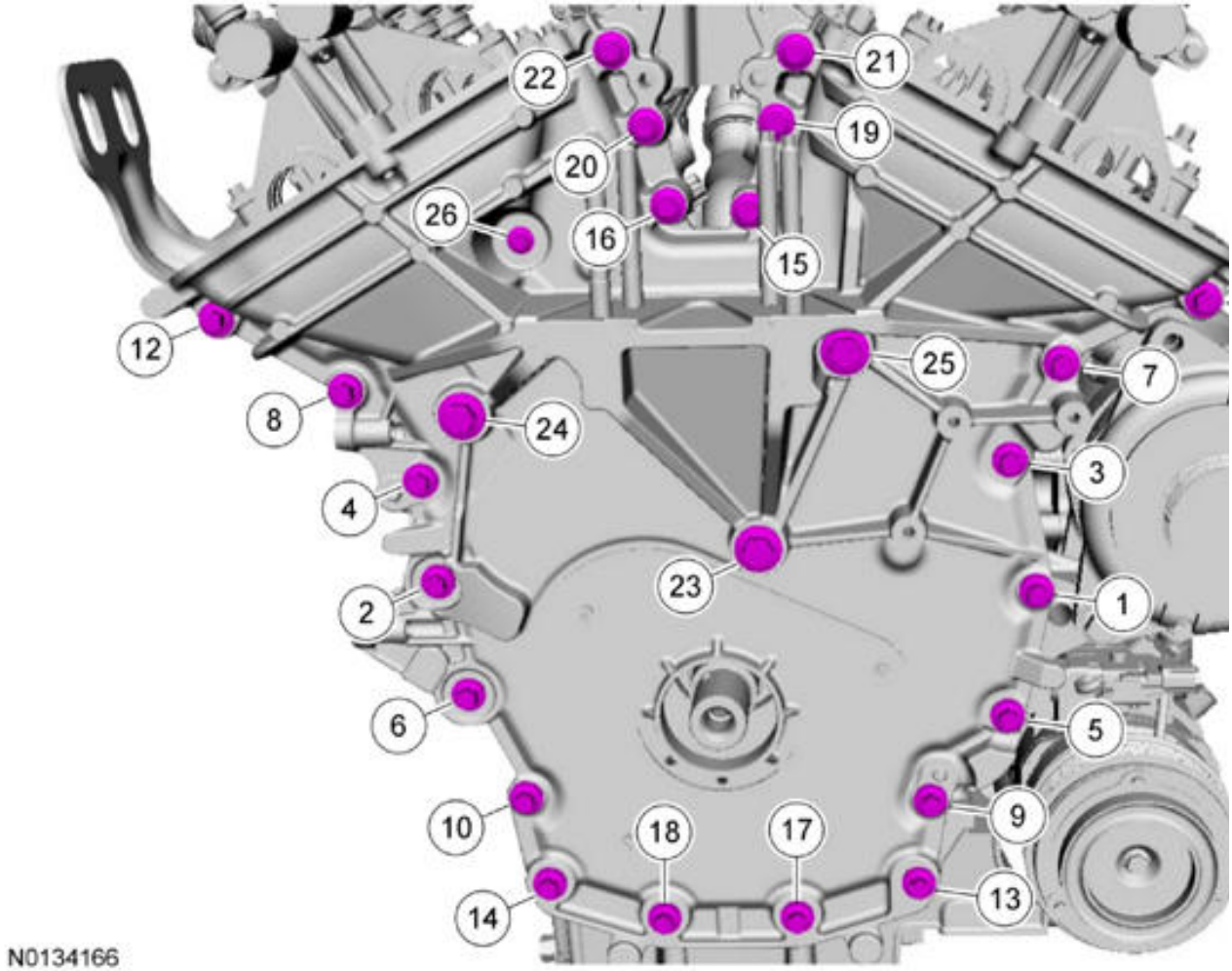
Install the lower M10 bolt. Do not tighten at this time.

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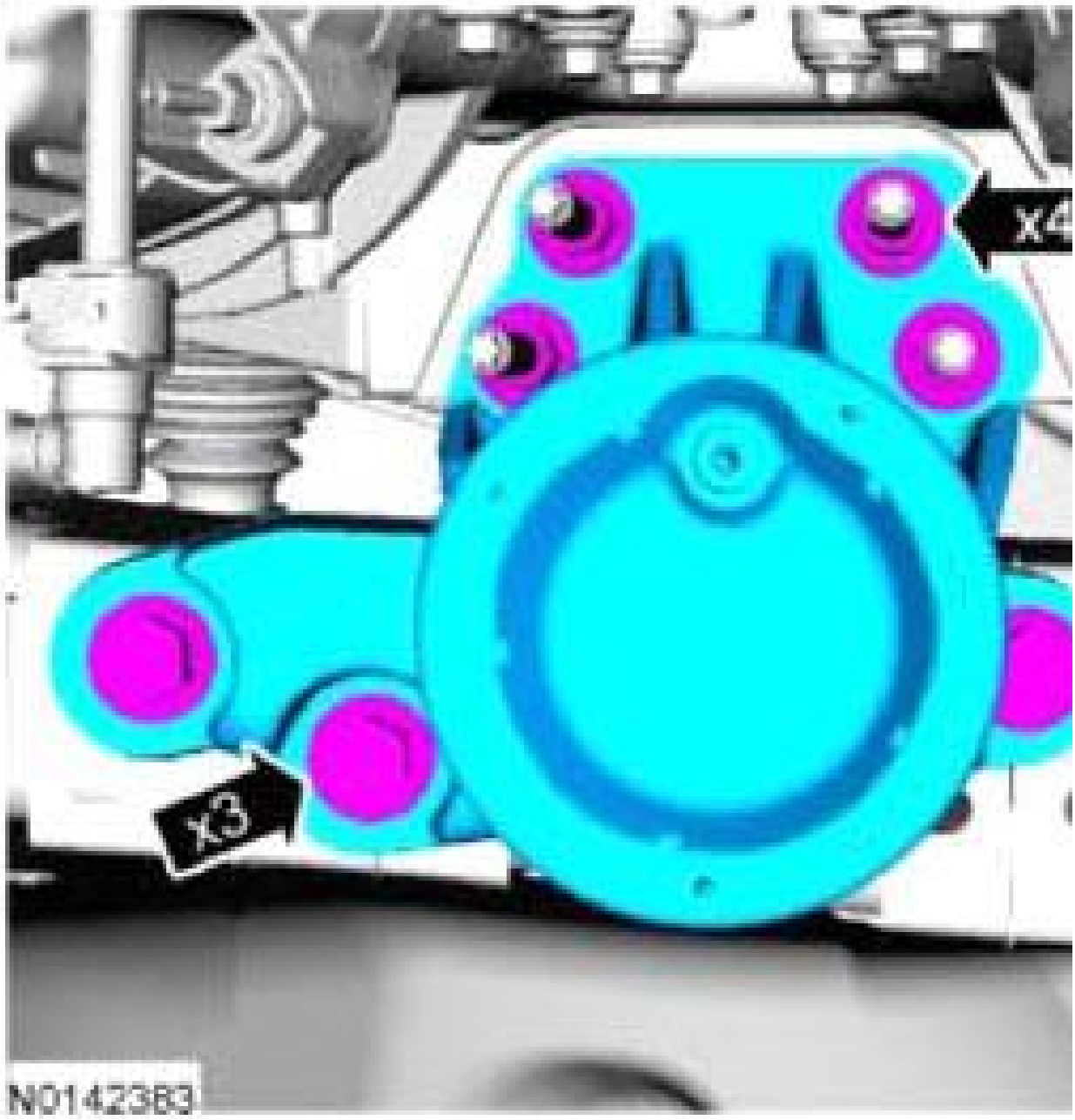
10. Install the remaining engine front cover bolts. Tighten all of the engine front cover bolts in the sequence shown in illustration in 7 stages.
    - Stage 1: Tighten bolts 1 thru 22 to 10 Nm (89 lb-in).
    - Stage 2: Tighten bolts 23 thru 25 to 15 Nm (133 lb-in).
    - Stage 3: Tighten bolt 26 to 10 Nm (89 lb-in).
    - Stage 4: Loosen bolt 26 one full turn.
    - Stage 5: Tighten bolts 23 thru 25 to 30 Nm (22 lb-ft) plus an additional 90 degrees.
    - Stage 6: Tighten bolts 1 thru 22 to 20 Nm (177 lb-in) plus an additional 45 degrees.
    - Stage 7: Tighten bolt 26 to 10 Nm (89 lb-in) plus an additional 45 degrees.

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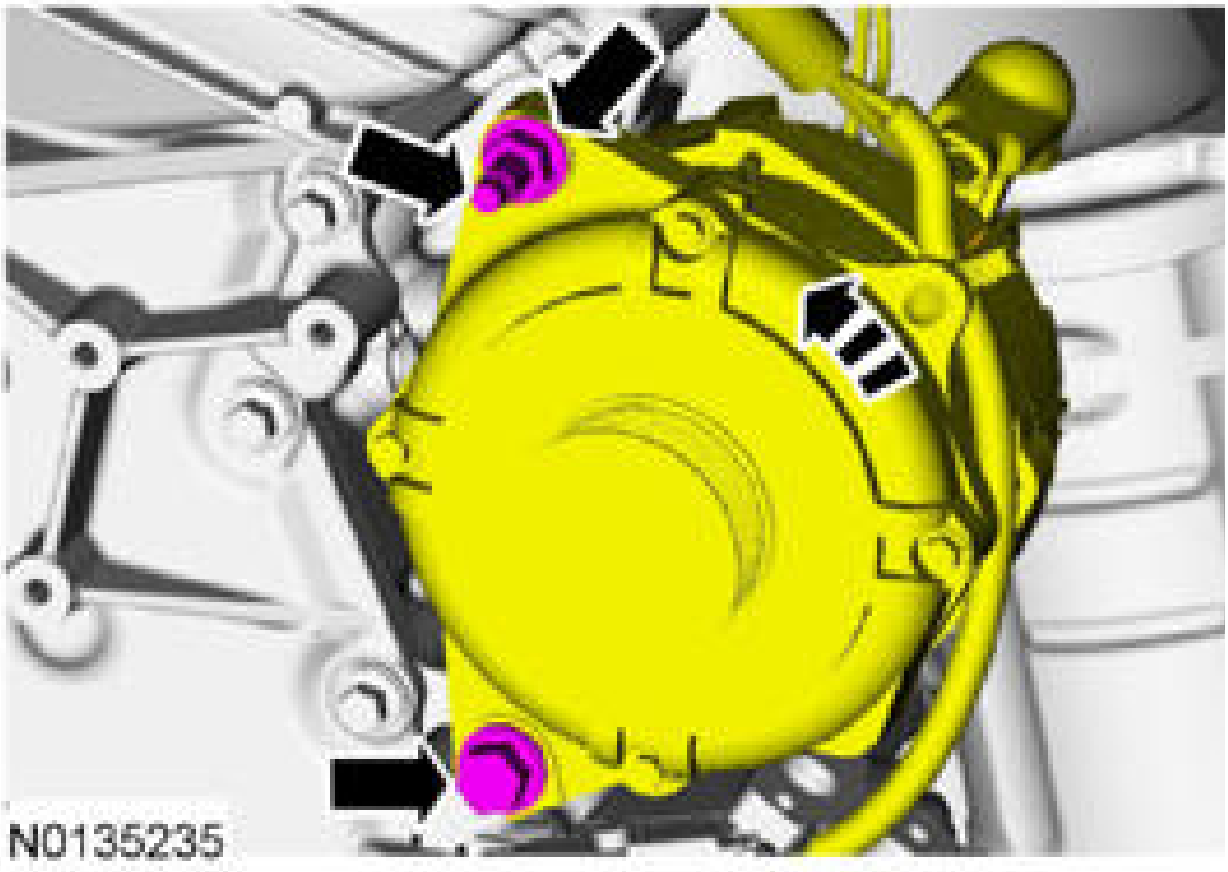
11. Install the engine mount, 4 engine mount nuts and 3 engine mount bolts hand tight.
    - Tighten the 3 engine mount bolts to 90 Nm (66 lb-ft).
    - Tighten the 4 engine mount nuts to 63 Nm (46 lb-ft).

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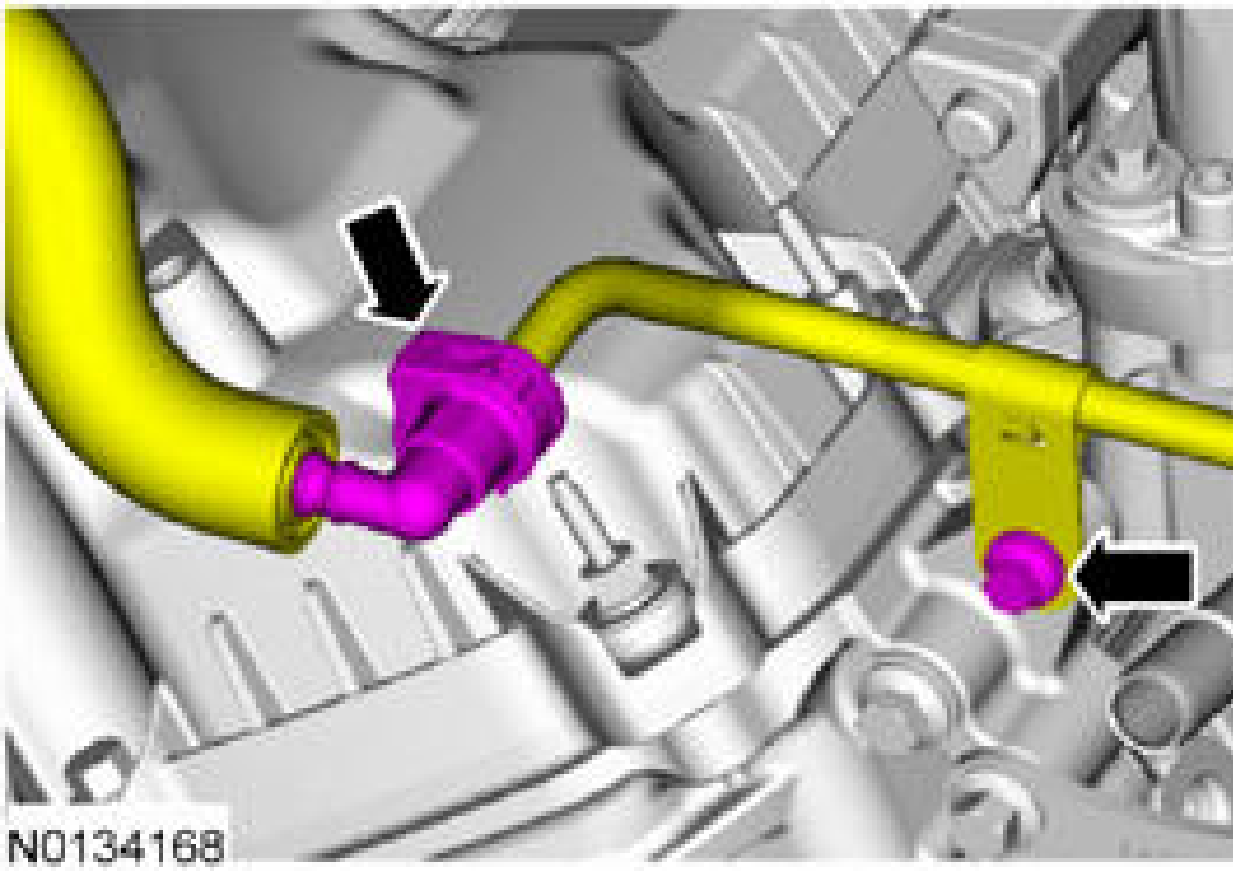
12. Position the generator and install the stud and nut.
    - Tighten the stud to 8 Nm (71 lb-in).
    - Tighten the nut to 47 Nm (35 lb-ft).
    - Tighten the bolt to 47 Nm (35 lb-ft).

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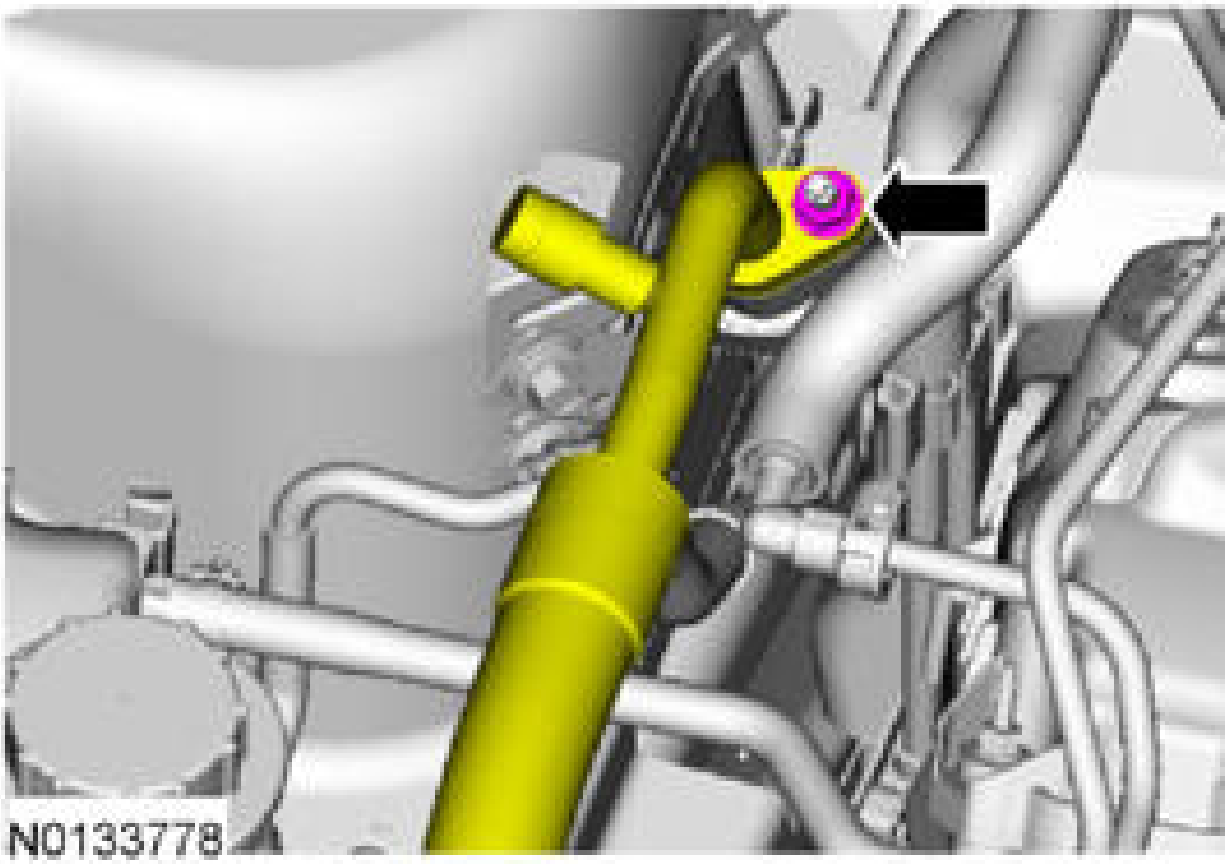
13. Install the LH and RH valve covers. Refer to **VALVE COVER - LH** and Refer to **VALVE COVER - RH**.
14. Install the fuel tube-to-engine front cover bolt.
    - Tighten the bolt to 10 Nm (89 lb-in).
    - Connect the fuel supply tube to the fuel rail supply tube. REFER to **QUICK CONNECT COUPLING** .

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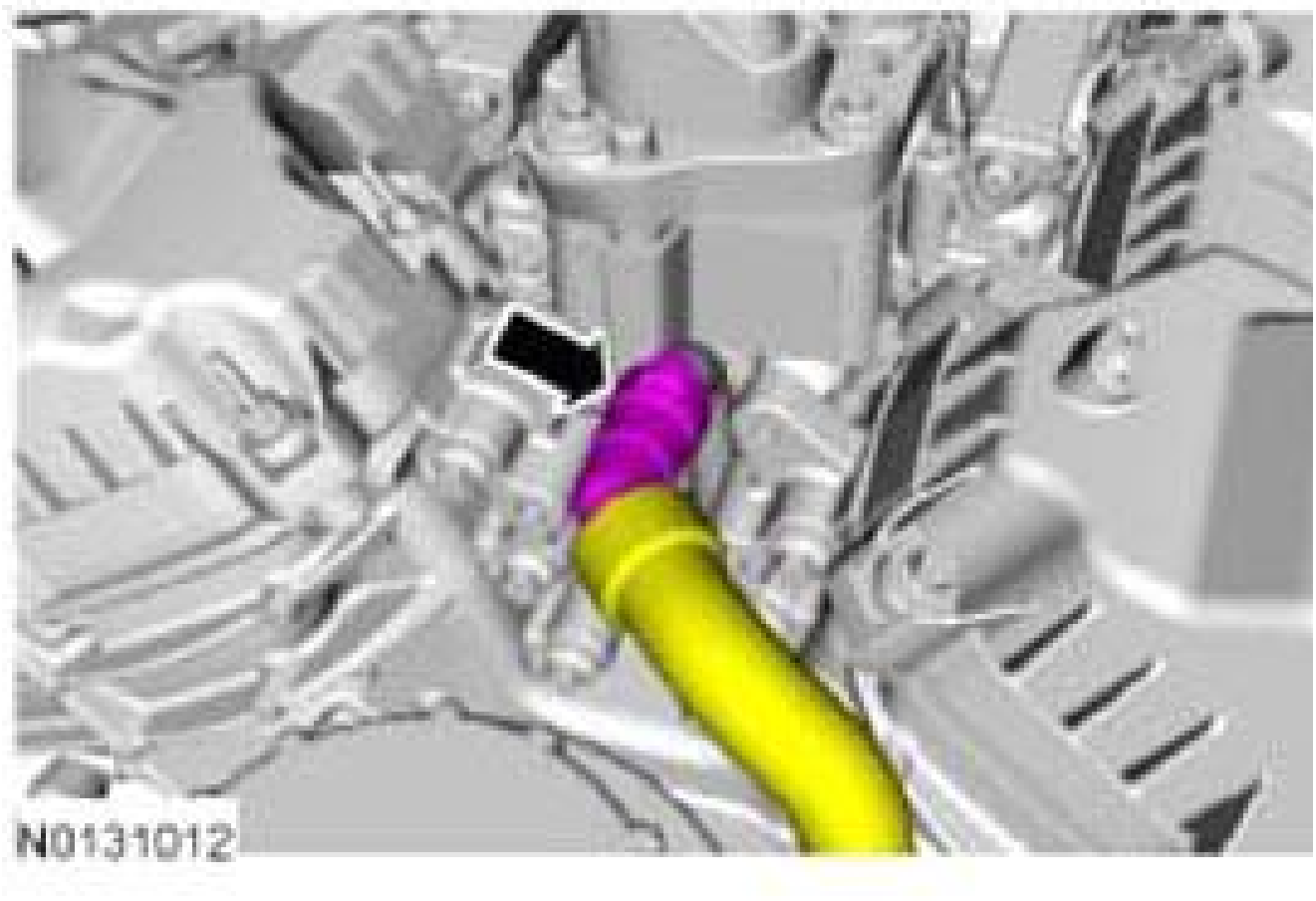
15. Using a new O-ring seal, connect the A/C pressure tube fitting and install the nut.
    - Tighten to 8 Nm (71 lb-in).

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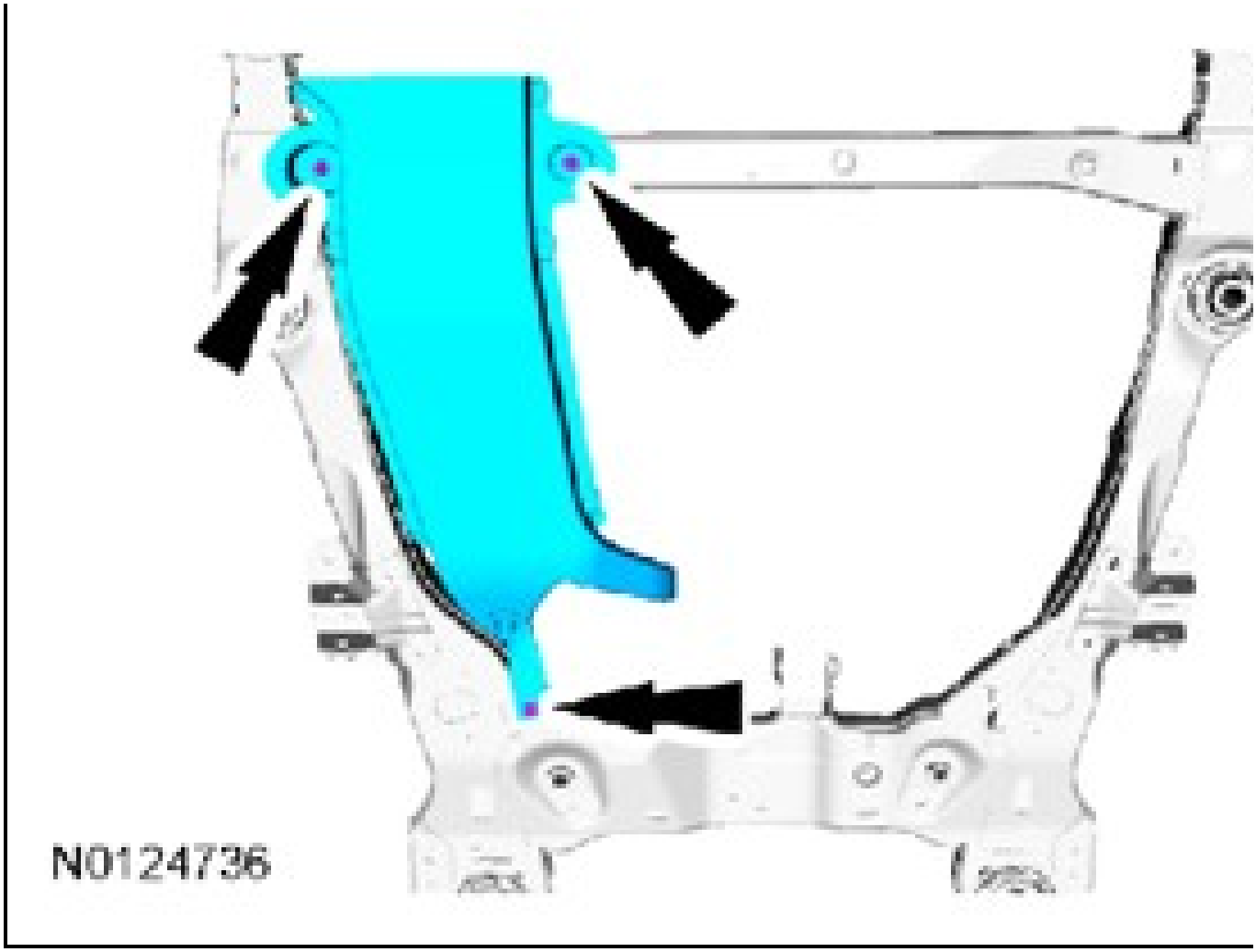
16. Connect the degas bottle coolant hose to the engine coolant tube.

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17. Install degas bottle. REFER to **DEGAS BOTTLE** .
18. If equipped, attach the engine block heater harness to the radiator support, the A/C suction tube and the engine wiring harness.
19. Install the accessory drive belt tensioner. REFER to **ACCESSORY DRIVE BELT TENSIONER - 3.5L TI-VCT, 3.7L TI-VCT** .
20. Install the crankshaft front seal. Refer to **CRANKSHAFT FRONT SEAL**.
21. Install the underbody air duct and the 3 twist lock retainers.

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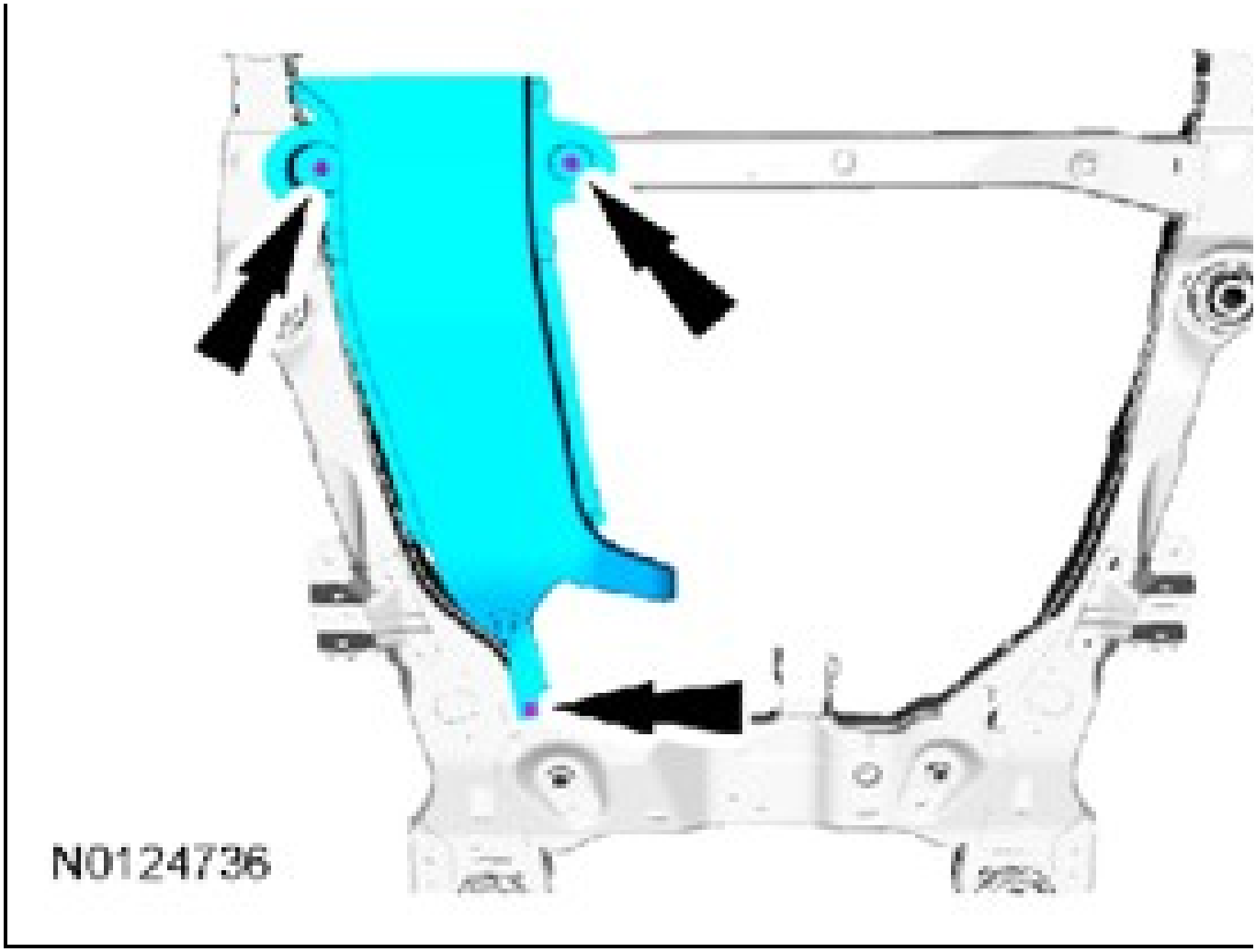
22. Install the RH fender splash shield. REFER to **FENDER SPLASH SHIELD** .
23. Fill the engine with clean engine oil.
24. Fill the cooling system. REFER to **COOLING SYSTEM DRAINING, FILLING AND BLEEDING** .
25. Connect the battery ground cable. REFER to **BATTERY DISCONNECT** for connection procedure.
26. Evacuate and recharge the A/C system. REFER to **AIR CONDITIONING (A/C) SYSTEM RECOVERY, EVACUATION AND CHARGING** .

ENGINE MOUNT

Removal

1. With the vehicle in NEUTRAL, position it on a hoist. REFER to **JACKING AND LIFTING** .
2. Remove degas bottle. REFER to **DEGAS BOTTLE** .
3. Remove the 3 twist-type retainers and remove the air duct from the subframe.

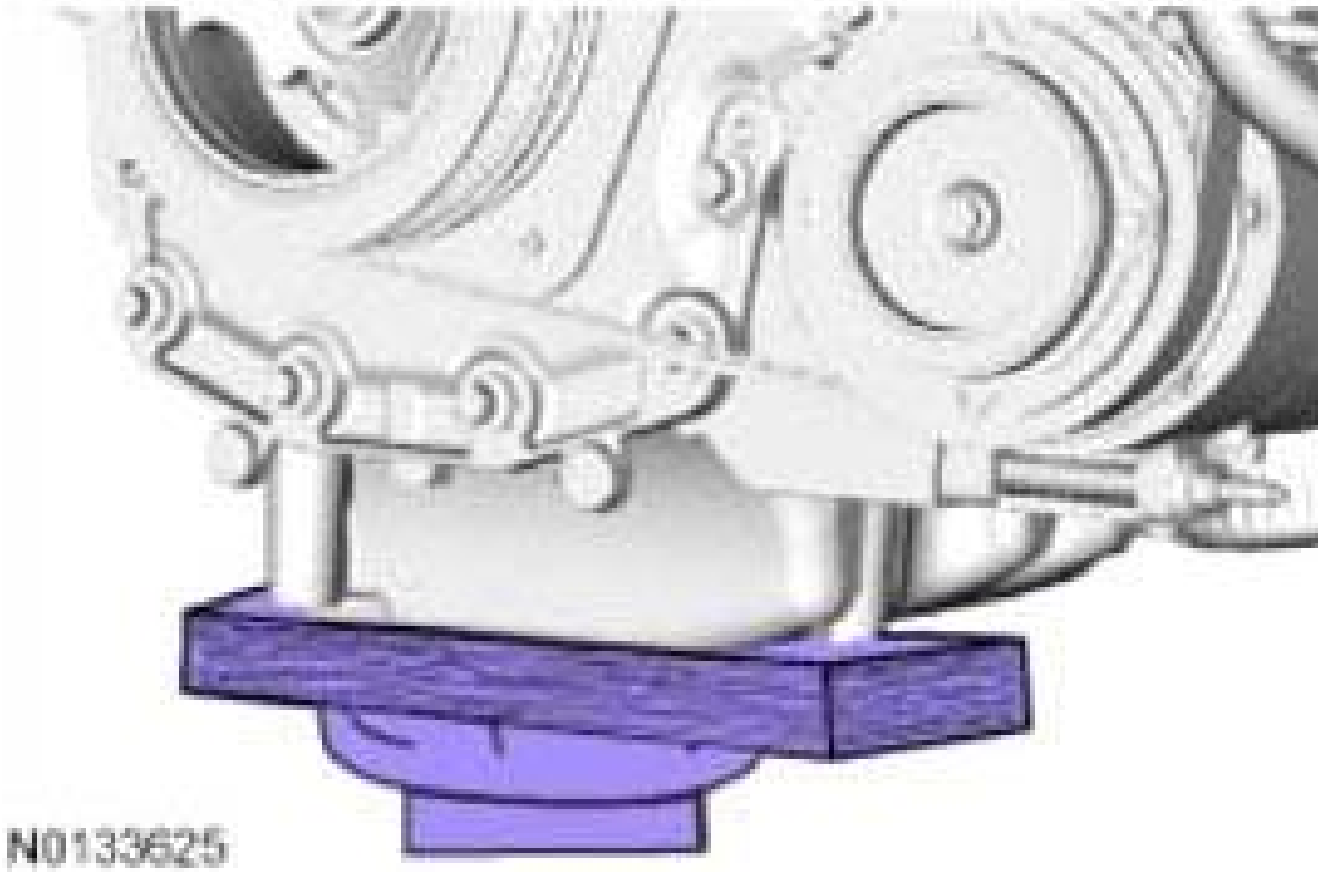
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4. **NOTE: Failure to position the wood block and floor jack as illustrated can result in damage to the oil pan**

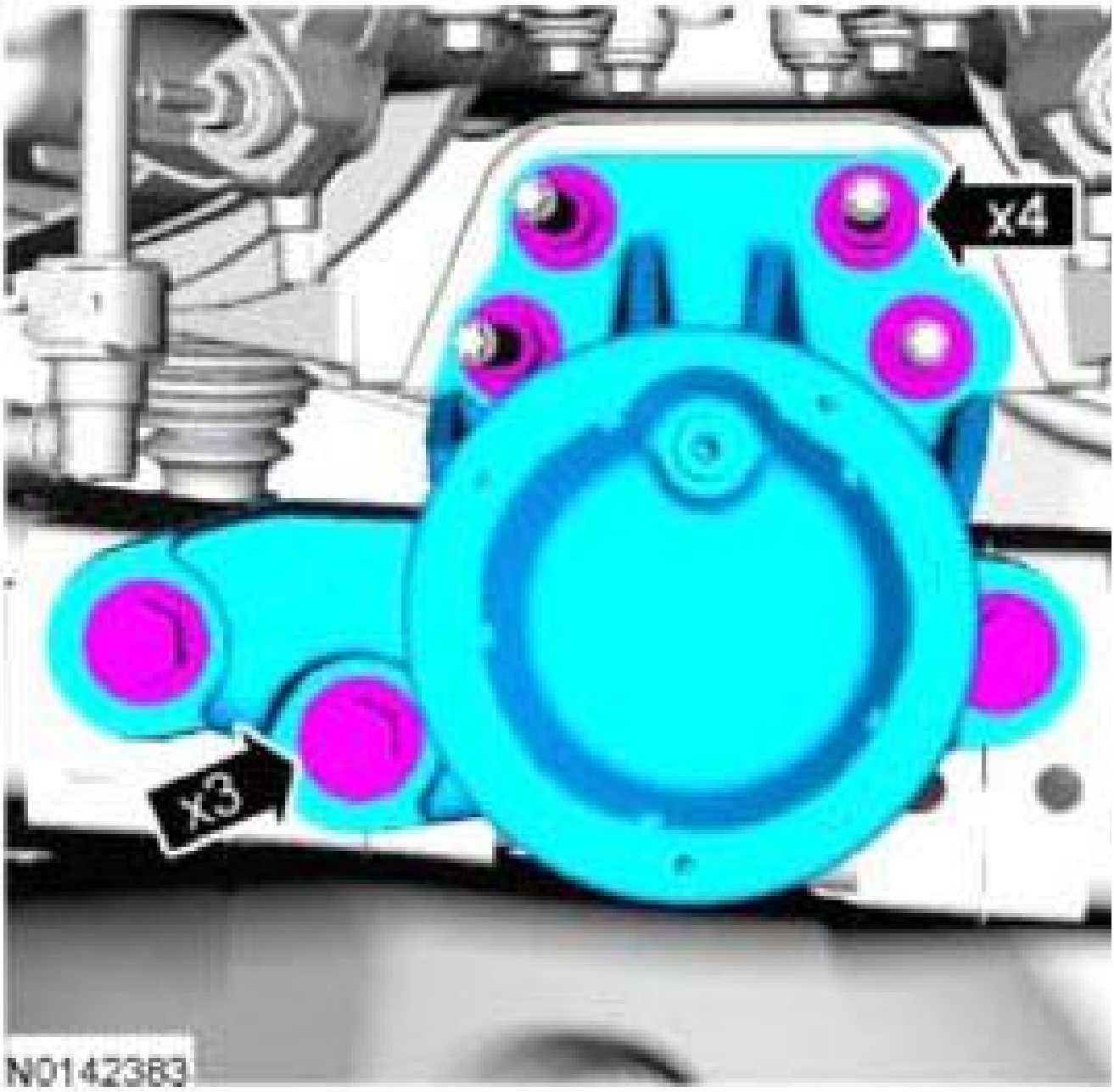
Position a floor jack with a block of wood under the front of the oil pan to support the engine.

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5. Remove the 4 engine mount nuts, the 3 engine mount bolts and the engine mount.

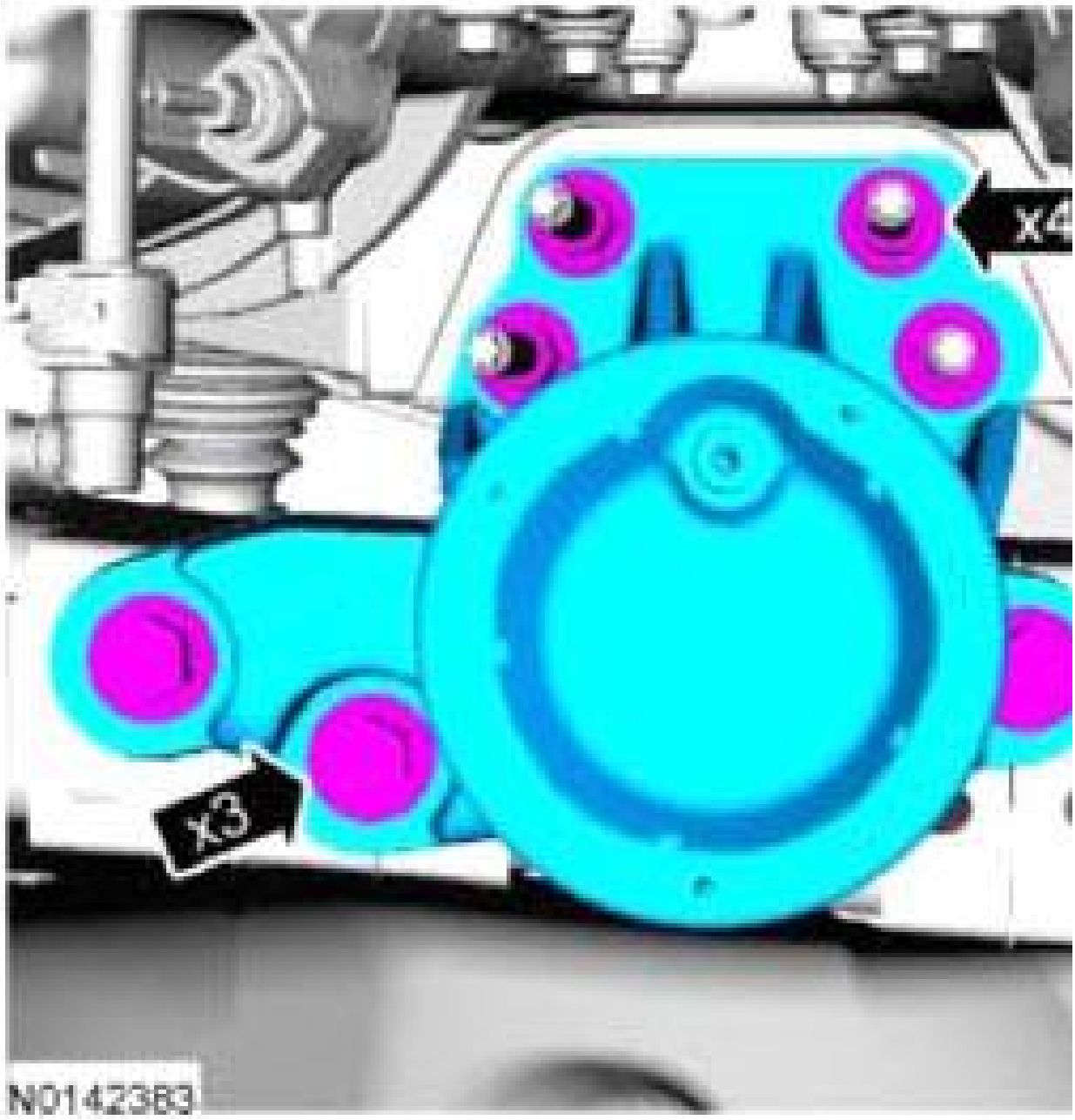
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Installation

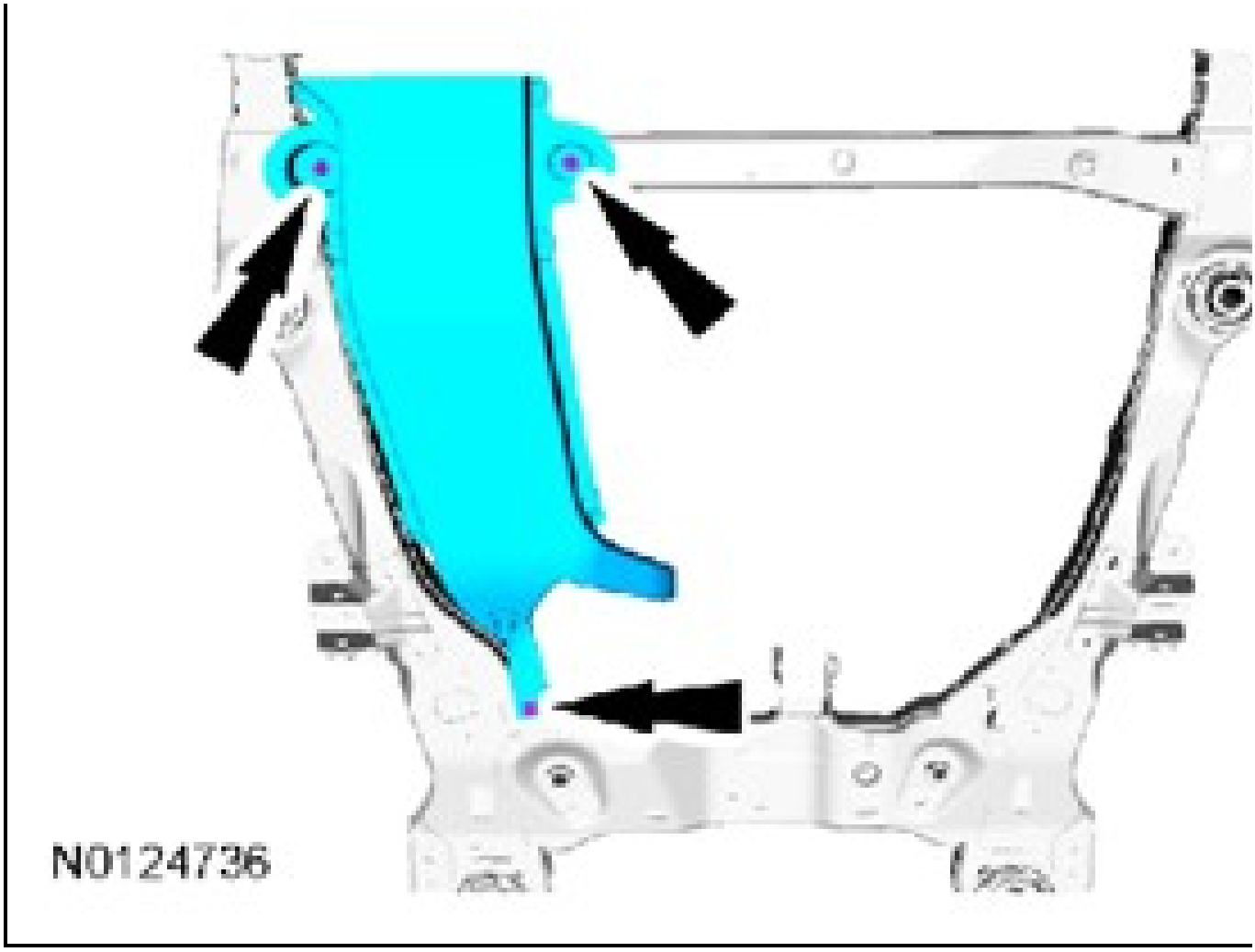
1. Position the engine mount onto the engine studs and install the 4 nuts and 3 bolts hand tight.
   - Tighten the 3 engine mount-to-frame bolts to 90 Nm (66 lb-ft).
   - Tighten the 4 engine mount-to-engine nuts to 63 Nm (46 lb-ft).

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2. Install the 3 twist-type retainers and the air duct to the subframe.

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3. Install degas bottle. REFER to **DEGAS BOTTLE** .

ENGINE OIL PRESSURE (EOP) SWITCH

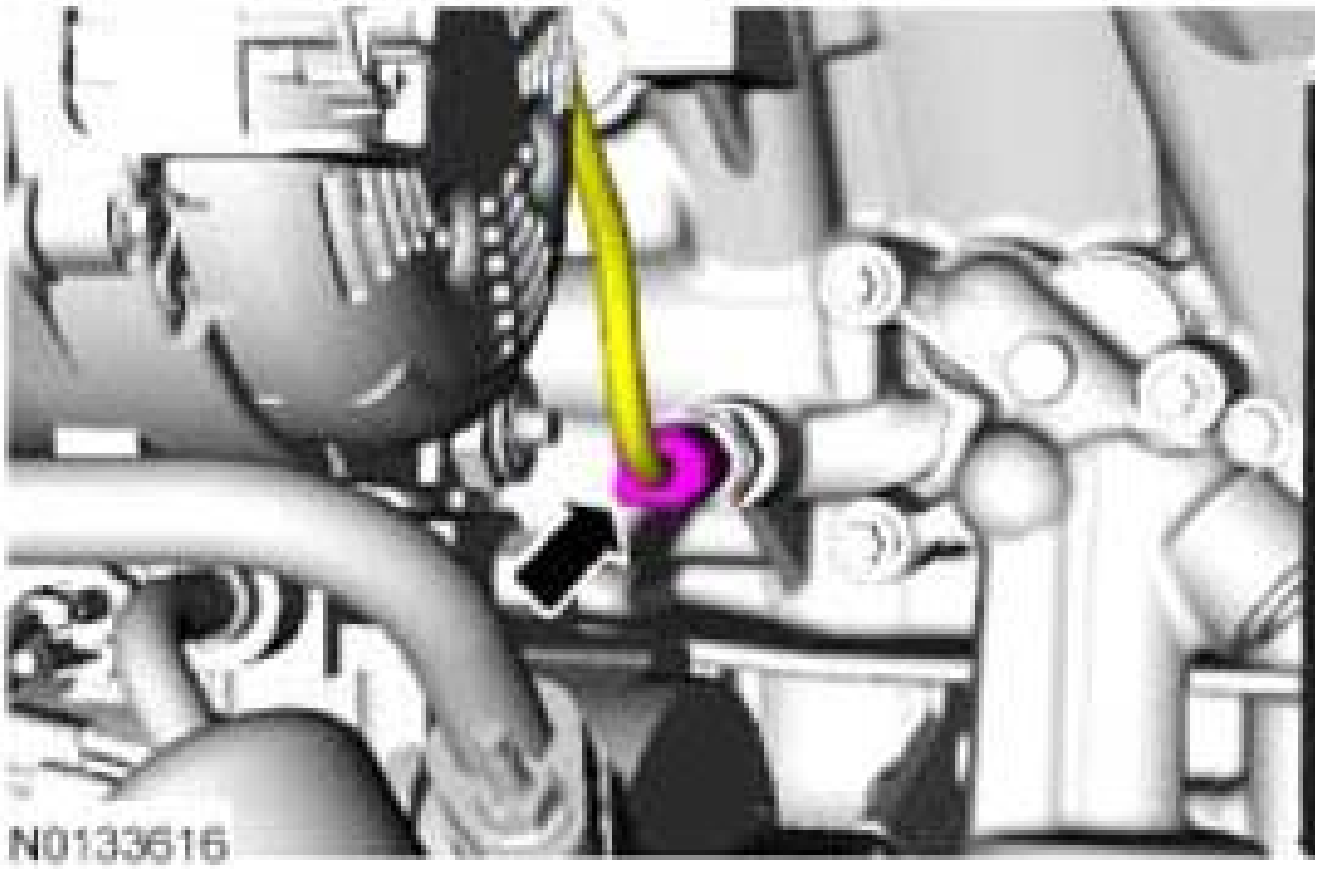
MATERIAL SPECIFICATIONS

Item	Specification
Thread Sealant with PTFE TA-24	WSK-M2G350-A2

Removal

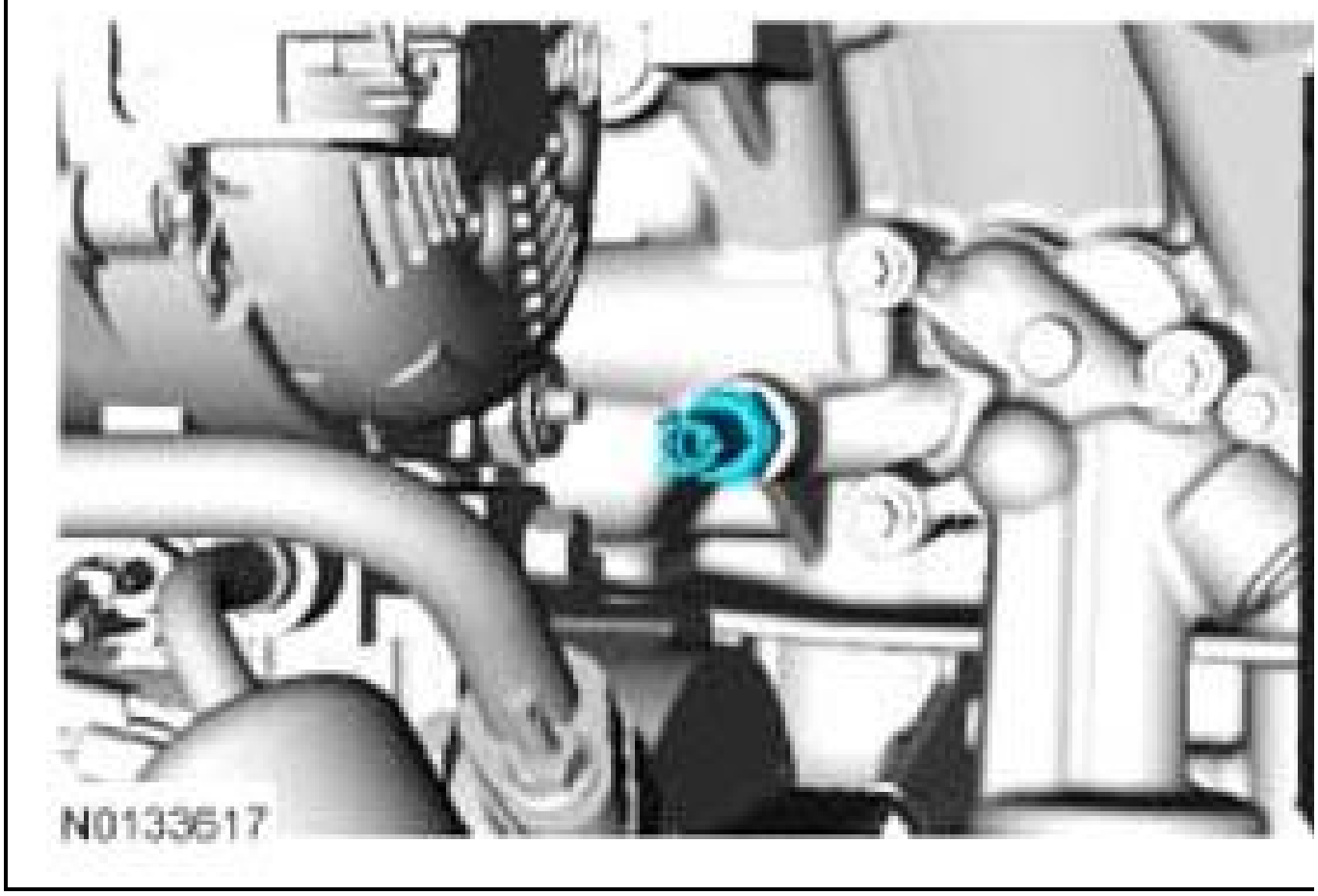
1. If equipped, remove the engine oil cooler. Refer to **OIL COOLER**.
2. Disconnect the **EOP** switch electrical connector.

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3. Remove the **EOP** switch.

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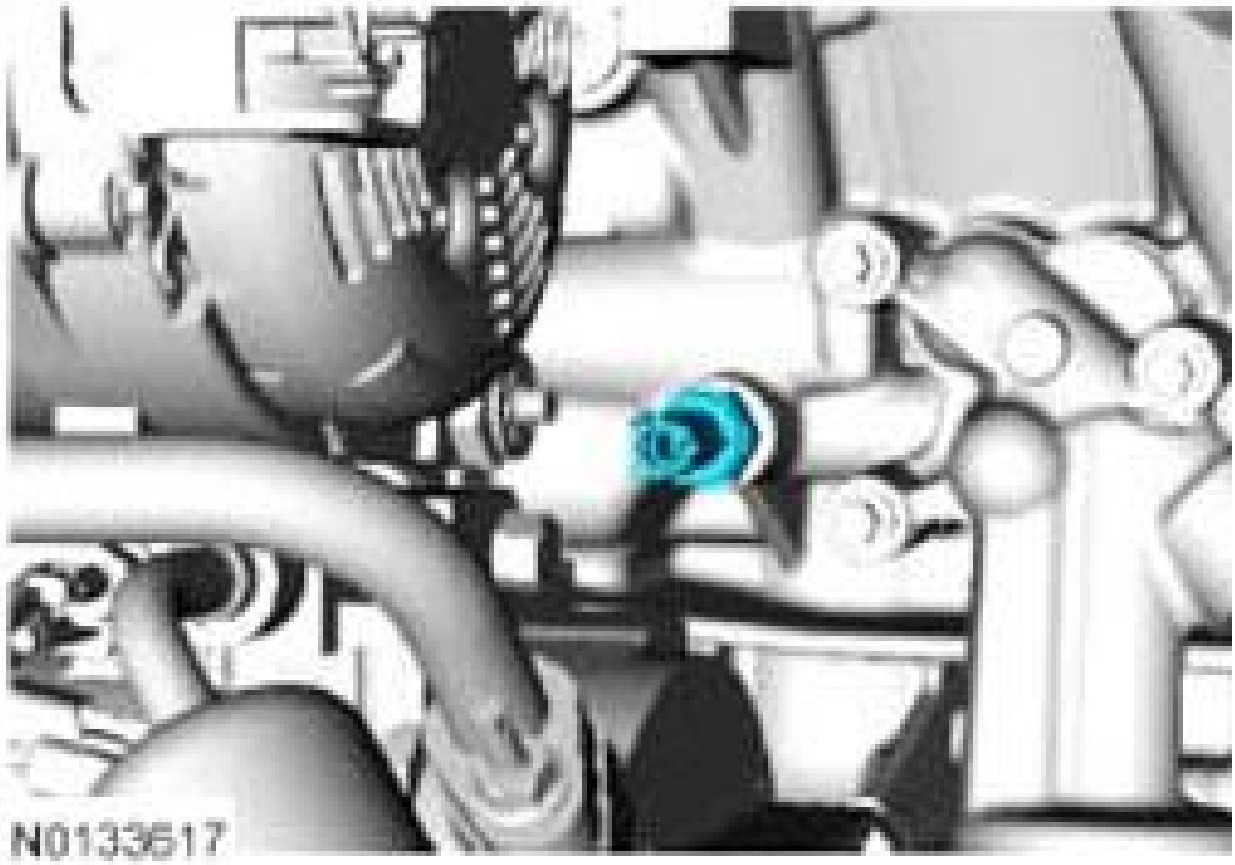


Installation

NOTE: Apply Thread Sealant with PTFE to the EOP switch threads prior to installation.

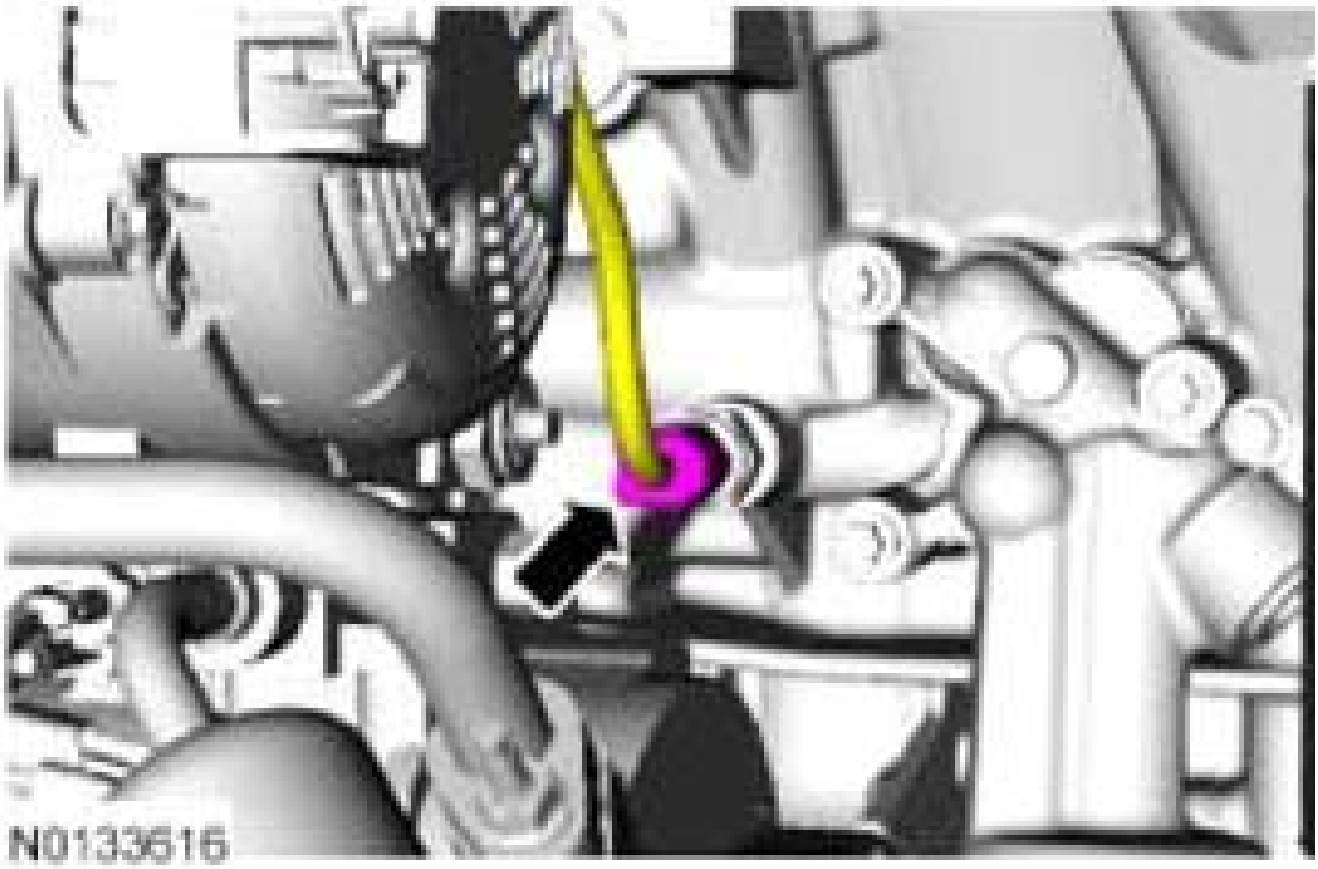
1. Install the **EOP** switch.
   - Tighten to 14 Nm (124 lb-in) plus an additional 180 degrees.

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2. Connect the **EOP** switch electrical connector.

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3. If equipped, install the engine oil cooler. Refer to **OIL COOLER**.

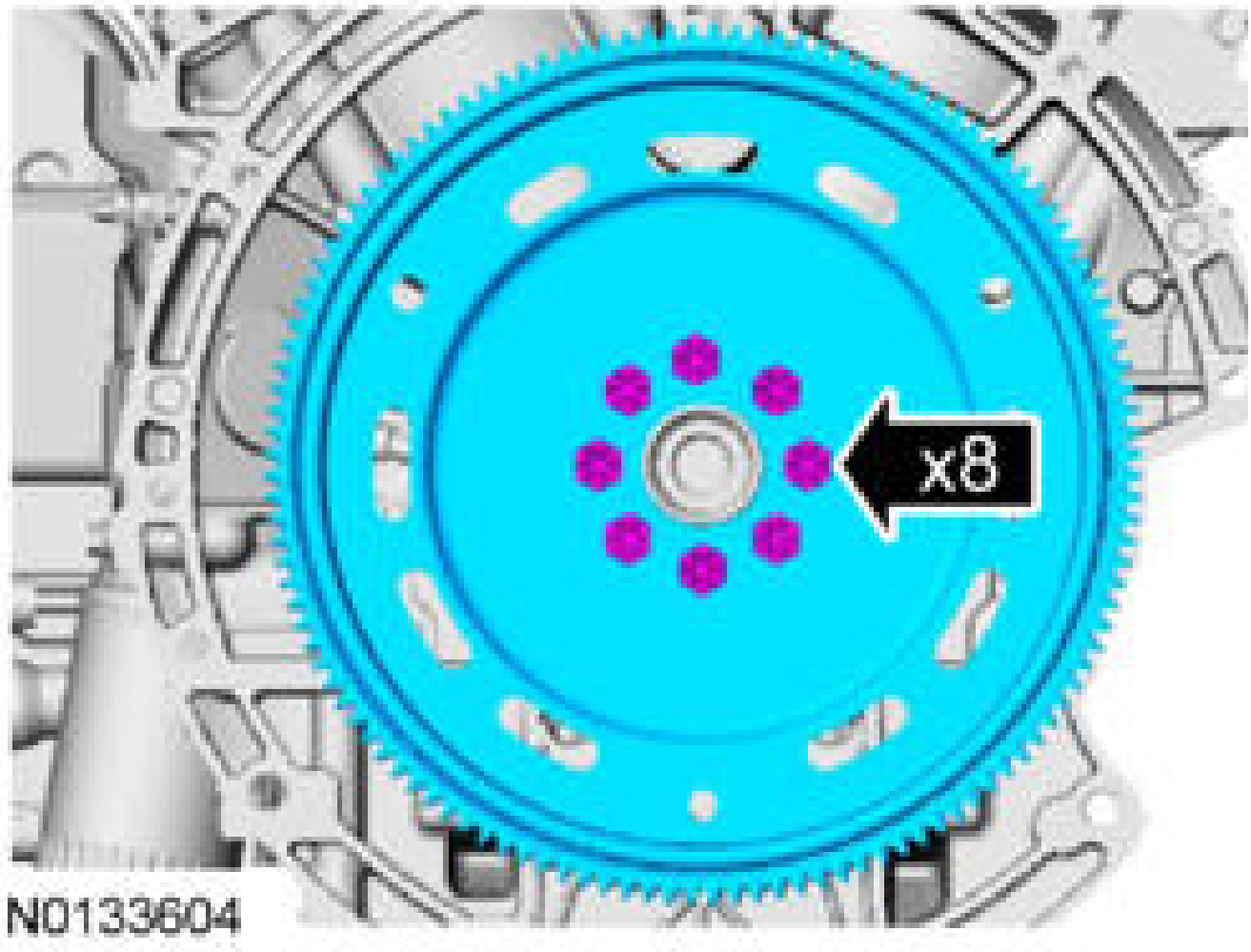
FLEXPLATE

Removal

WARNING: Before beginning any service procedure, refer to SAFETY WARNINGS . Failure to follow this instruction may result in serious personal injury.

1. With the vehicle in NEUTRAL, position it on a hoist. REFER to **JACKING AND LIFTING** , Lifting Points.
2. Remove the transaxle. REFER to **TRANSMISSION - FRONT WHEEL DRIVE (FWD)** or REFER to **TRANSMISSION - ALL WHEEL DRIVE (AWD)** .
3. Remove the 8 bolts and the flexplate.

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Installation

NOTE: One of the 8 flexplate holes are offset so the flexplate can only be installed in one position.

1. Install the flexplate and the 8 bolts.
   - Tighten in the sequence shown in illustration to 80 Nm (59 lb-ft).

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2. Install the transaxle. REFER to **TRANSMISSION - FRONT WHEEL DRIVE (FWD)** or REFER to **TRANSMISSION - ALL WHEEL DRIVE (AWD)** .
3. After completing the repairs, use the scan tool to perform the Misfire Monitor Neutral Profile Correction procedure, following the on-screen instructions.

LOWER INTAKE MANIFOLD

Removal

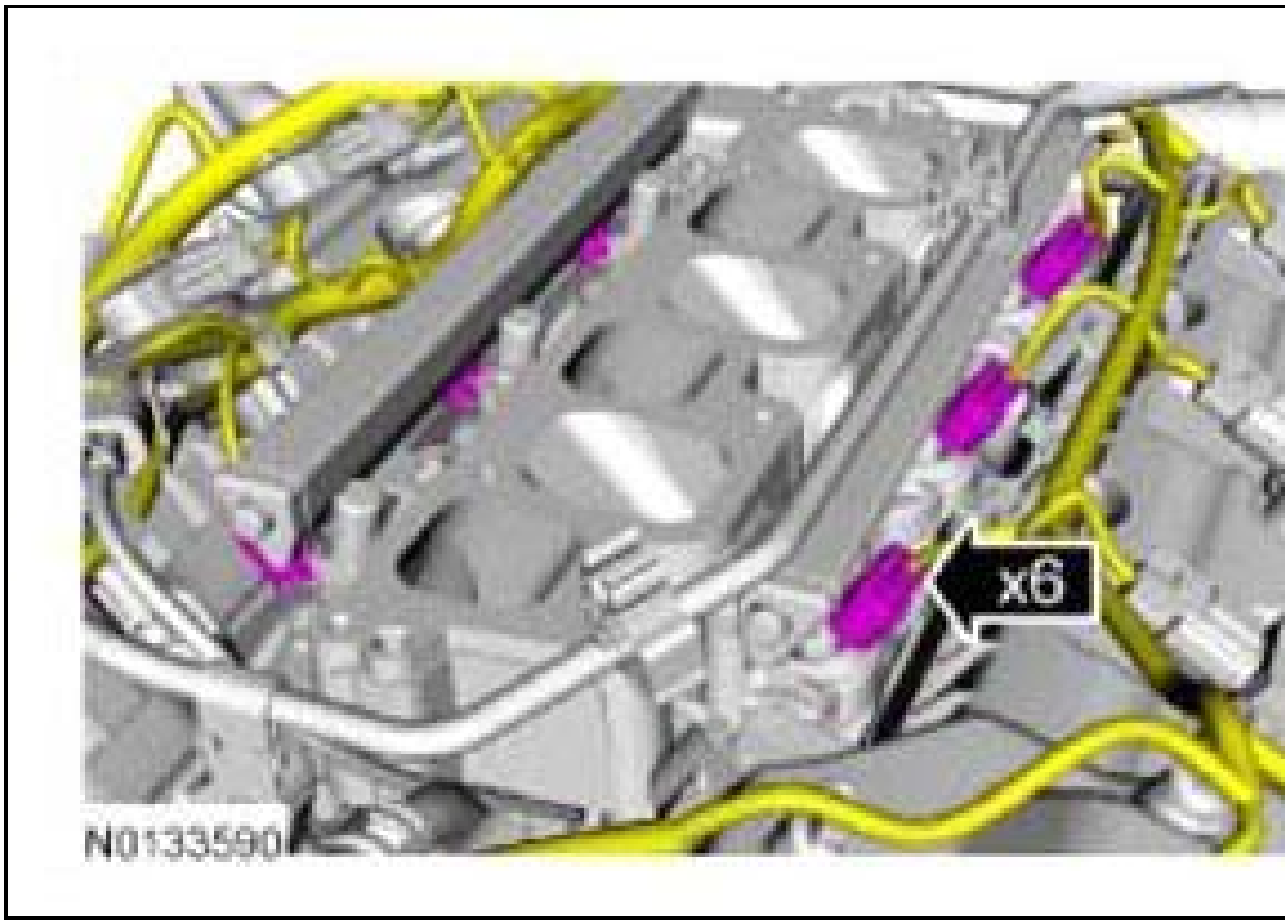
NOTE: During engine repair procedures, cleanliness is extremely important. Any foreign material, including any material created while cleaning gasket surfaces that enters the oil passages, coolant passages or the oil pan, can cause engine failure.

1. With the vehicle in NEUTRAL, position it on a hoist. REFER to **JACKING AND LIFTING** , Lifting

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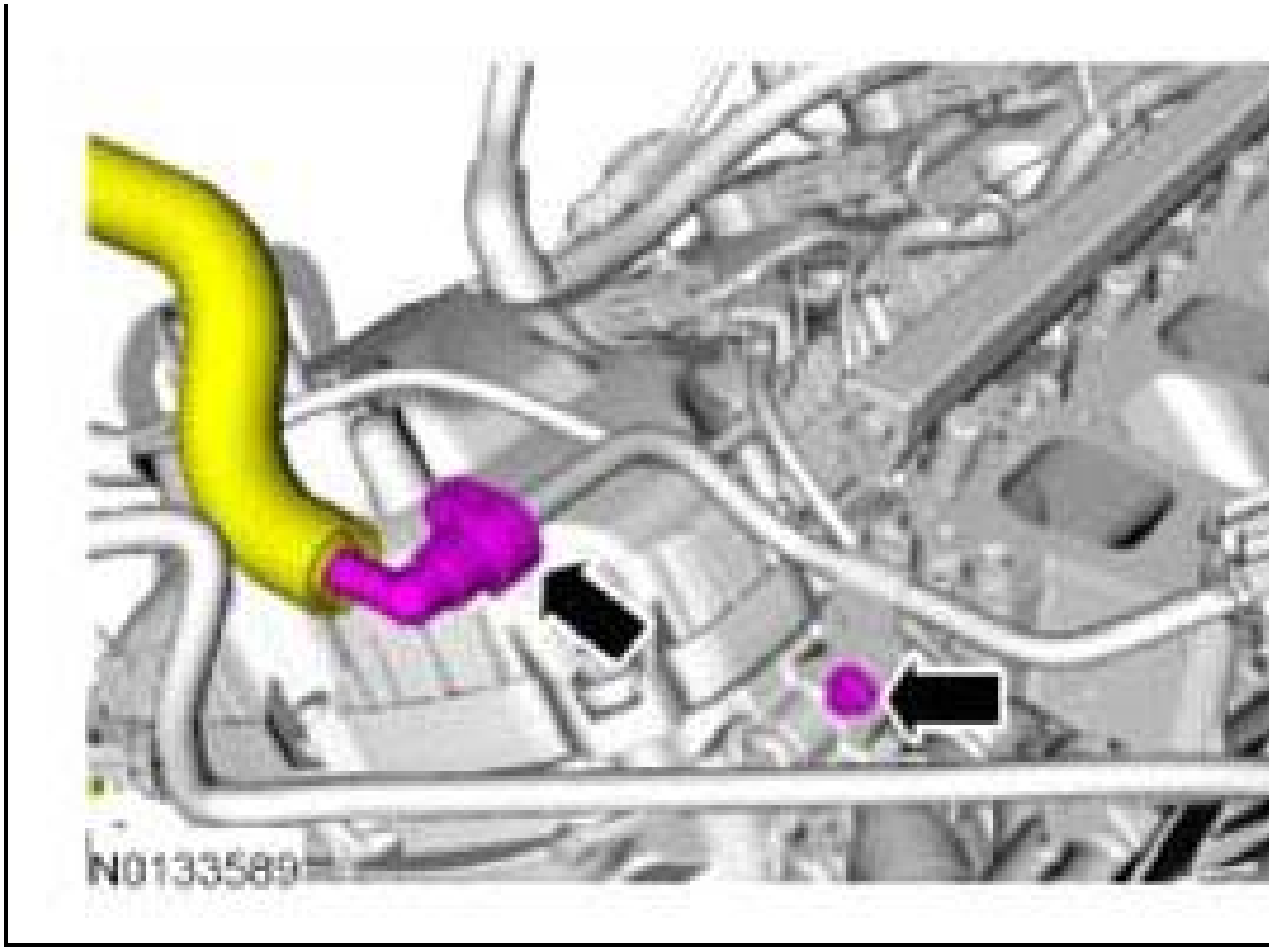
Points.

2. Release the fuel system pressure. REFER to **FUEL SYSTEM PRESSURE RELEASE** .
3. Disconnect the battery ground cable. REFER to **BATTERY DISCONNECT** .
4. Drain the cooling system. REFER to **COOLING SYSTEM DRAINING, FILLING AND BLEEDING** .
5. Remove the upper intake manifold. Refer to **UPPER INTAKE MANIFOLD**.
6. Disconnect the 6 fuel injector electrical connectors.



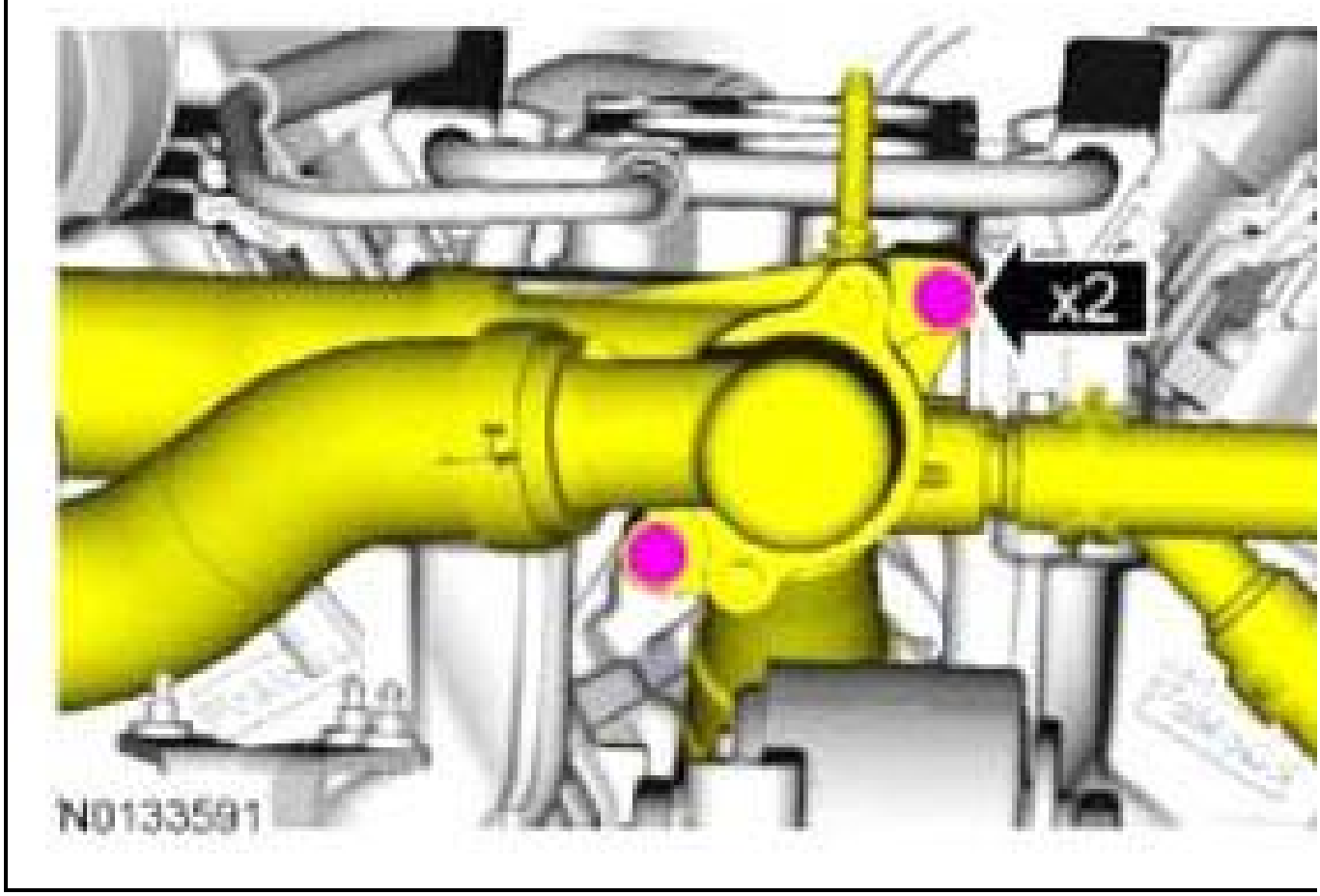
7. Disconnect the fuel supply tube-to-fuel rail quick connect coupling. REFER to **QUICK CONNECT COUPLING** . Position fuel supply tube aside.
   - Remove the bolt from the fuel supply tube-to-rail bracket.

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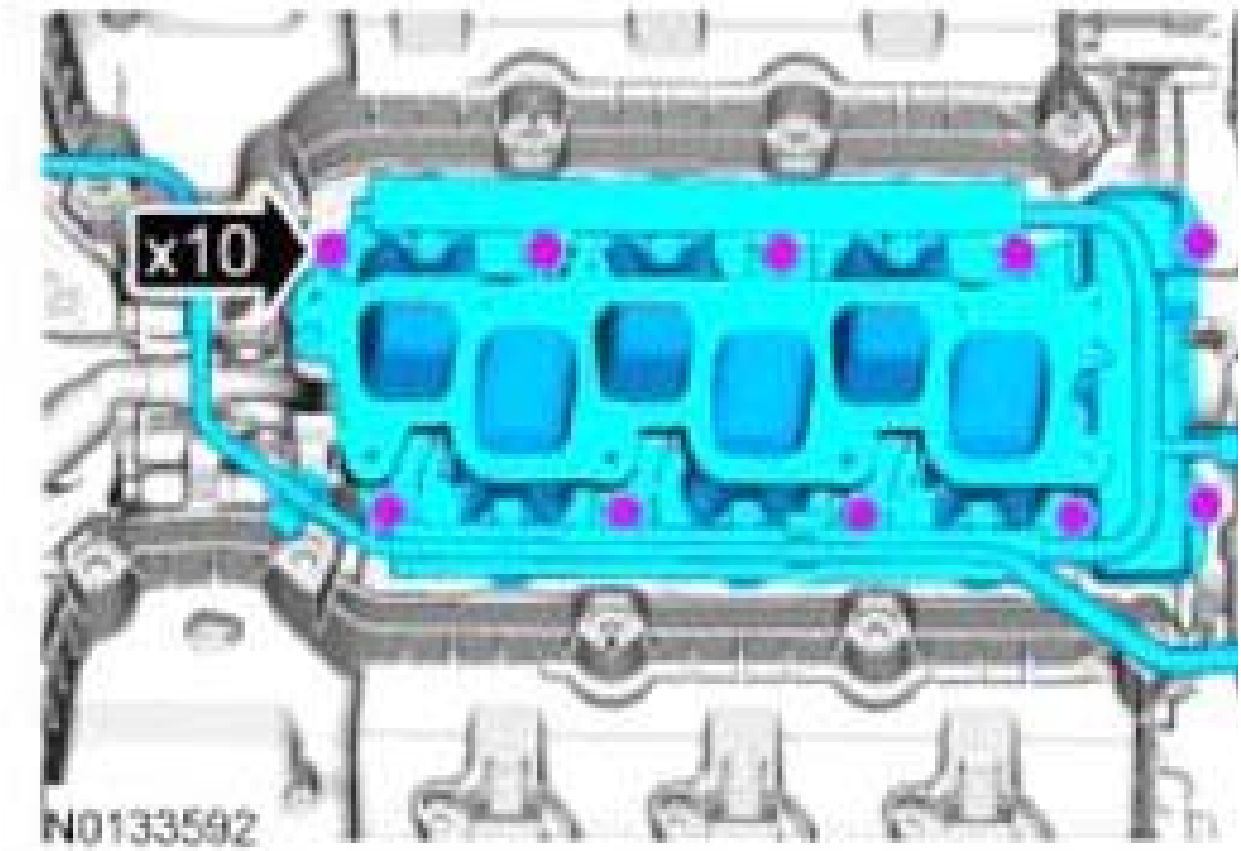
8. Remove the 2 thermostat housing-to-lower intake manifold bolts.

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9. Remove the 10 bolts and the lower intake manifold.
    - Remove and discard the intake manifold and thermostat housing gaskets.
    - Clean and inspect all sealing surfaces.

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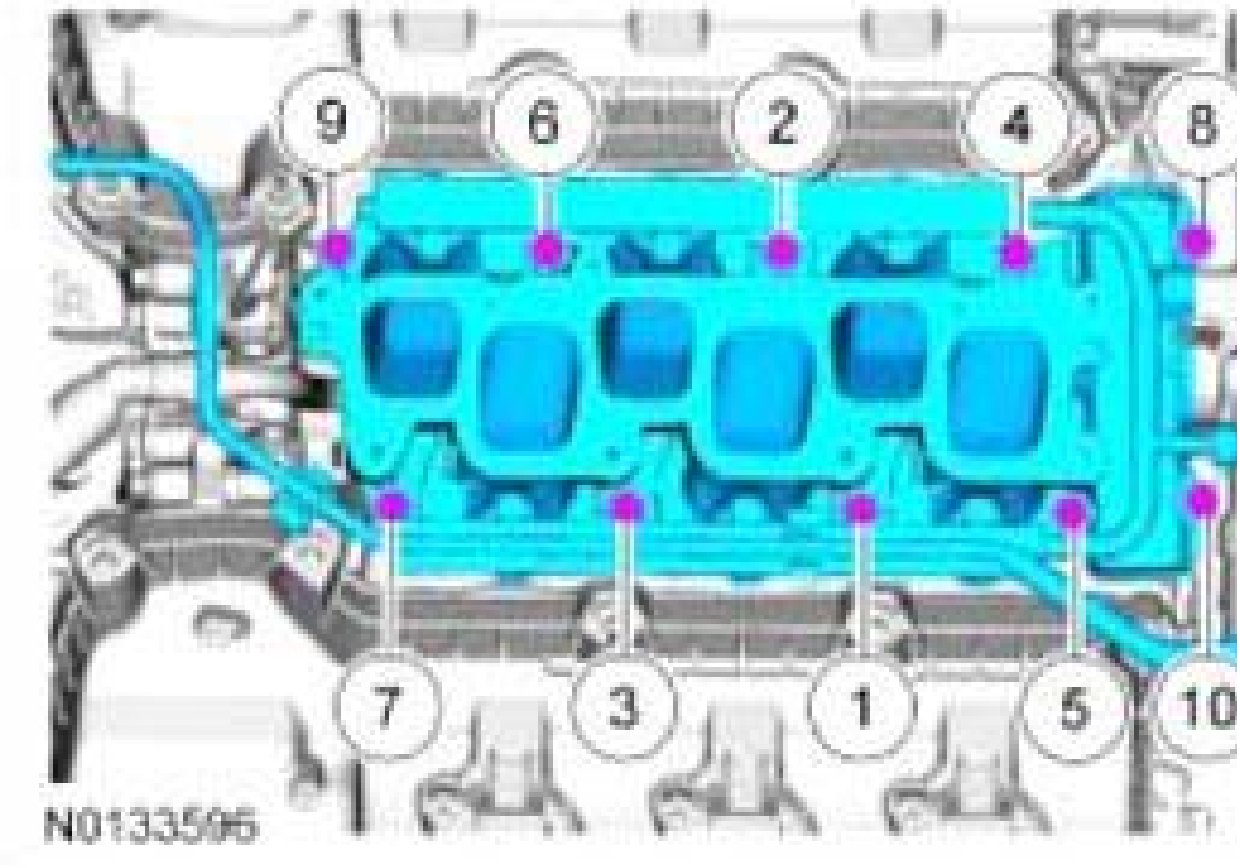
Installation

NOTE: If the engine is repaired or replaced because of upper engine failure, typically including valve or piston damage, check the intake manifold for metal debris. If metal debris is found, install a new intake manifold. Failure to follow these instructions can result in engine damage.

1. Using new intake manifold and thermostat housing gaskets, install the lower intake manifold and the 10 bolts.

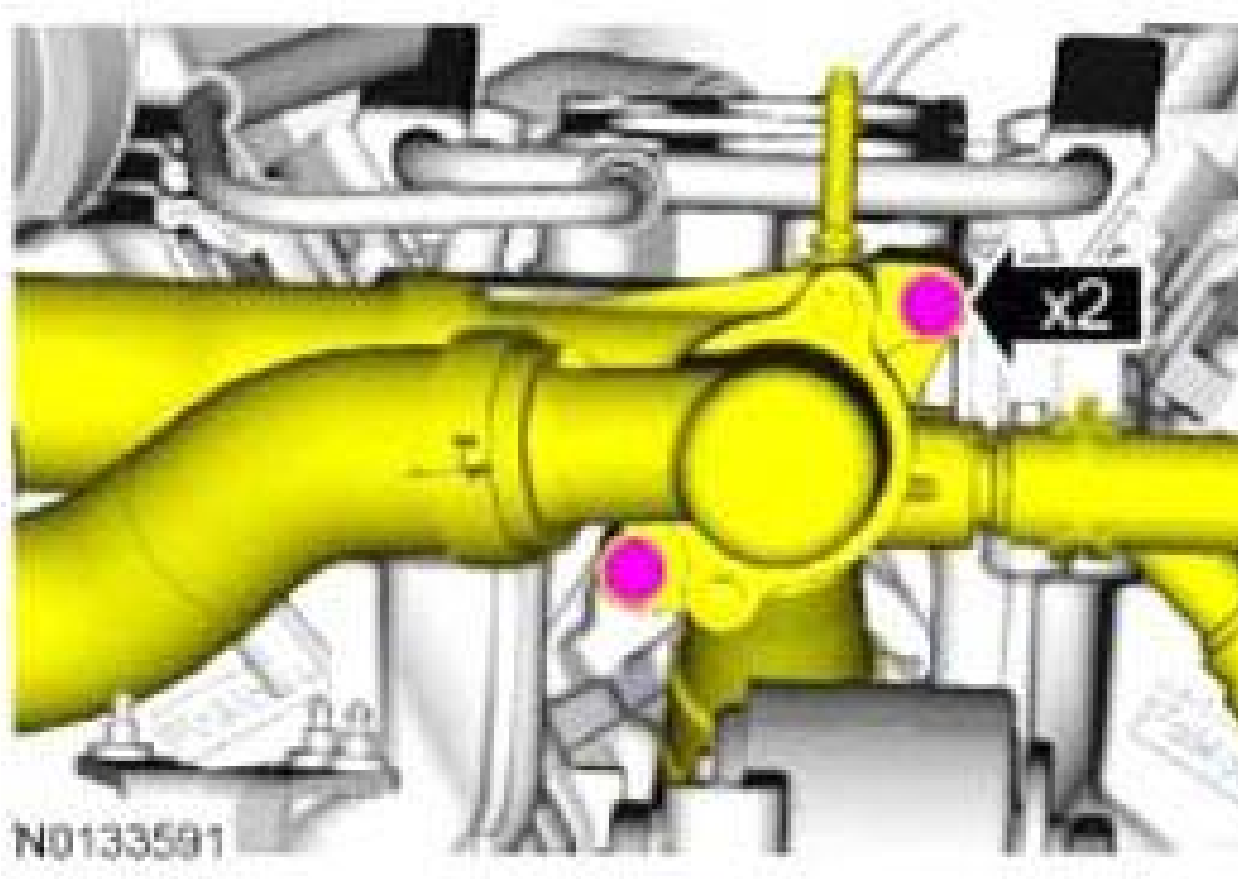
   - Tighten in the sequence shown in illustration to 10 Nm (89 lb-in).

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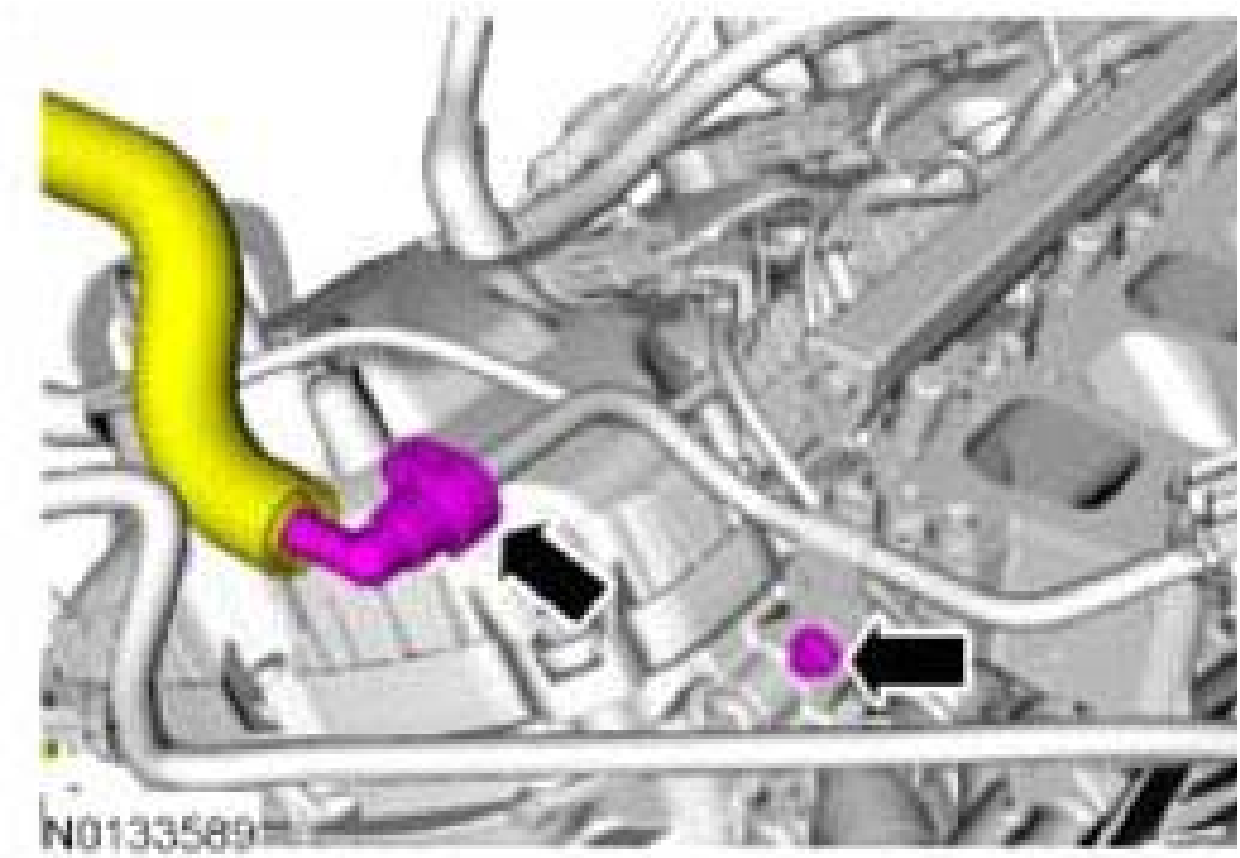
2. Install the 2 thermostat housing-to-lower intake manifold bolts.
    - Tighten to 10 Nm (89 lb-in).

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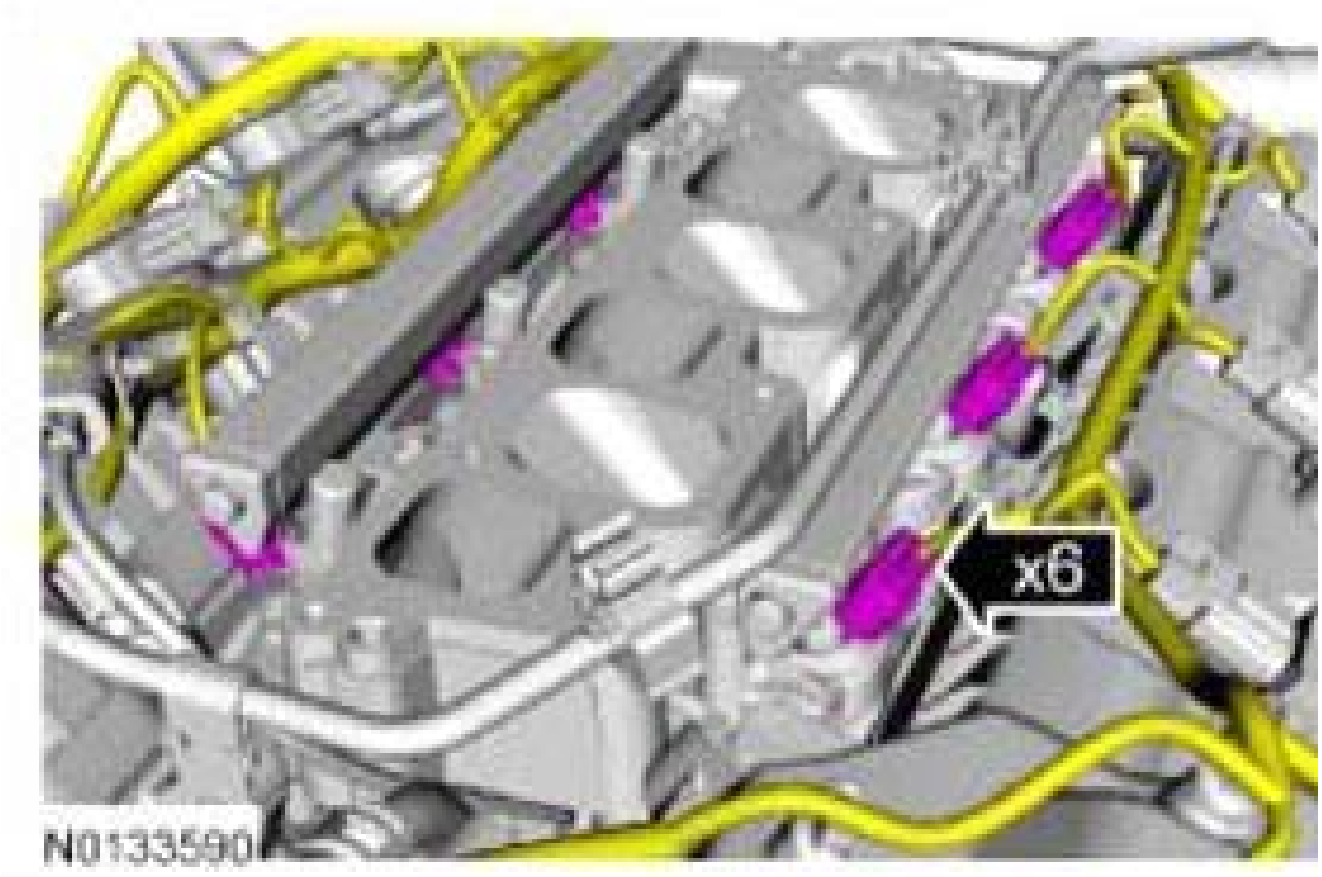
3. Connect the fuel supply tube-to-fuel rail quick connect coupling. REFER to **QUICK CONNECT COUPLING** .
   - Install the bolt to the fuel supply tube-to-rail bracket and tighten to 10 Nm (89 lb-in).

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4. Connect the 6 fuel injector electrical connectors.

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5. Install the upper intake manifold. Refer to **UPPER INTAKE MANIFOLD**.
6. Connect the battery ground cable. REFER to **BATTERY DISCONNECT** for connection procedure.
7. Fill and bleed the cooling system. REFER to **COOLING SYSTEM DRAINING, FILLING AND BLEEDING** .

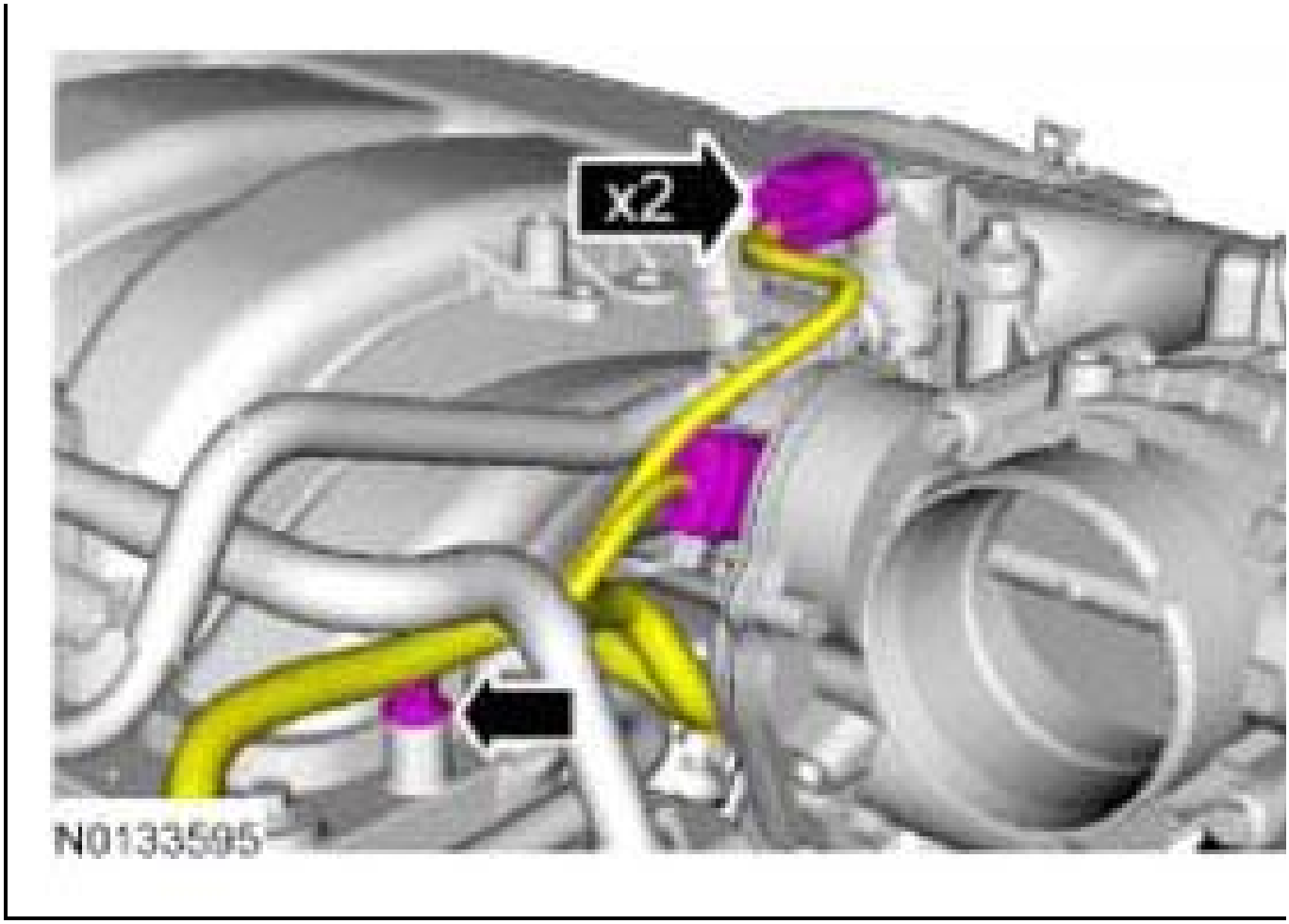
UPPER INTAKE MANIFOLD

Removal

NOTE: **If the engine is repaired or replaced because of upper engine failure, typically including valve or piston damage, check the intake manifold for metal debris. If metal debris is found, install a new intake manifold. Failure to follow these instructions can result in engine damage.**

1. Remove the **ACL** outlet pipe. REFER to **INTAKE AIR SYSTEM COMPONENTS - EXPLODED VIEW** .
2. Disconnect the **EVAP** canister purge valve and throttle body electrical connectors.

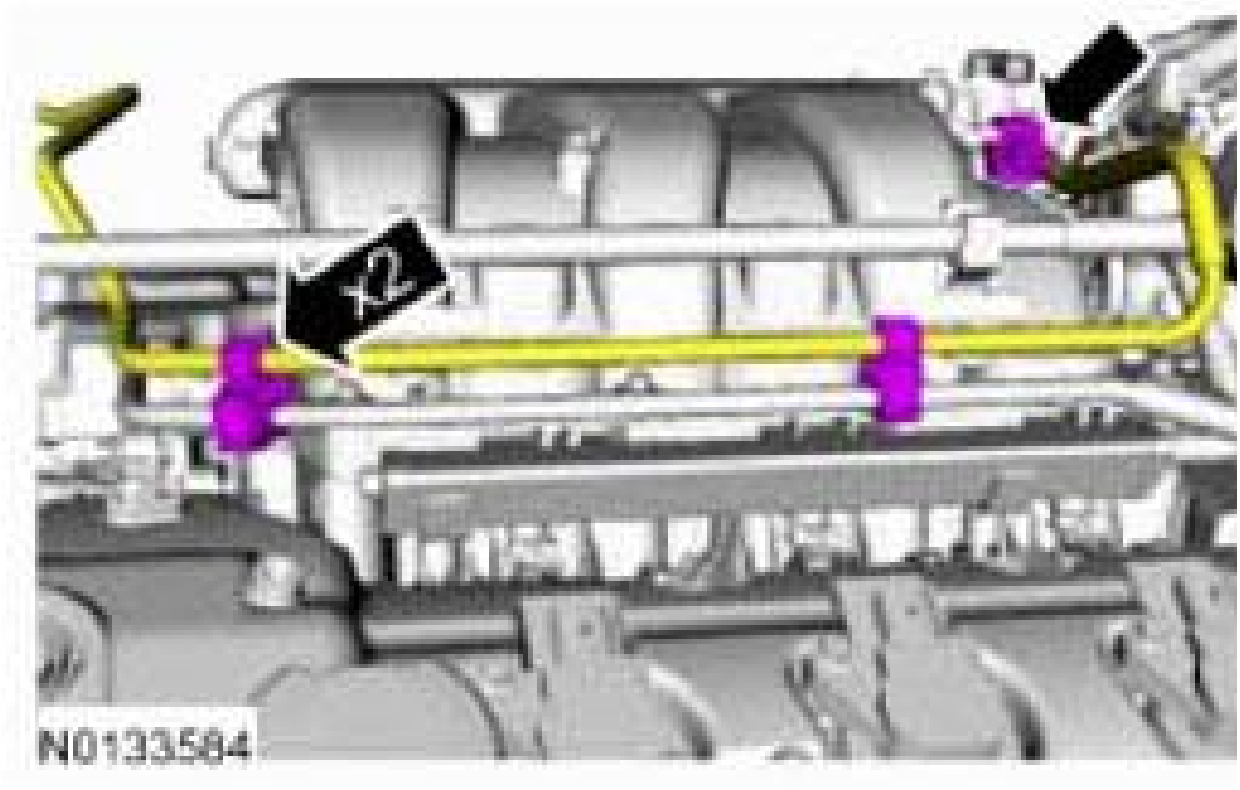
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- Detach the wiring harness pin-type retainer.

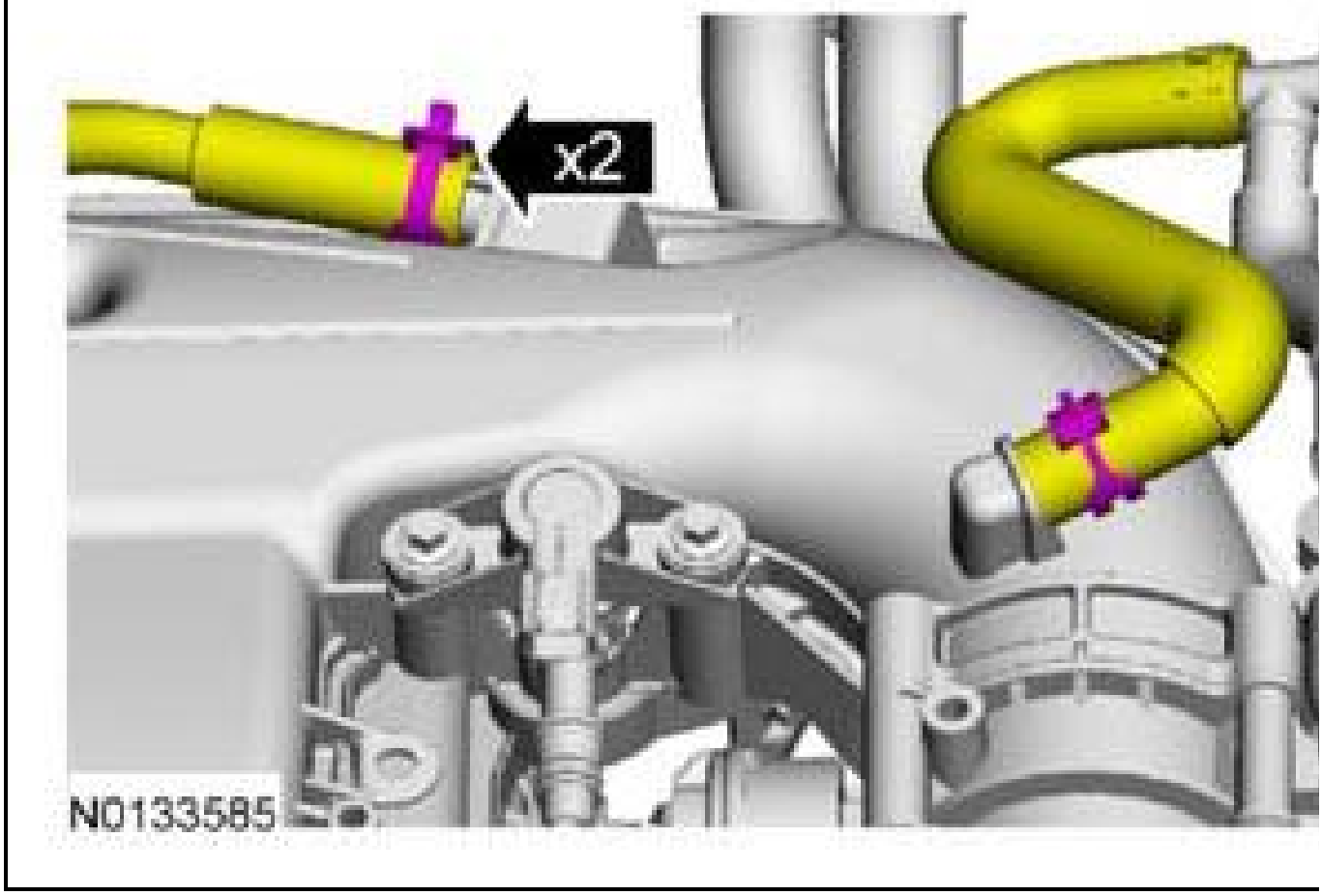
3. Disconnect the **EVAP** vapor tube from the **EVAP** canister purge valve. REFER to **QUICK CONNECT COUPLING** .
   - Detach the **EVAP** vapor tube from the 2 retainers.

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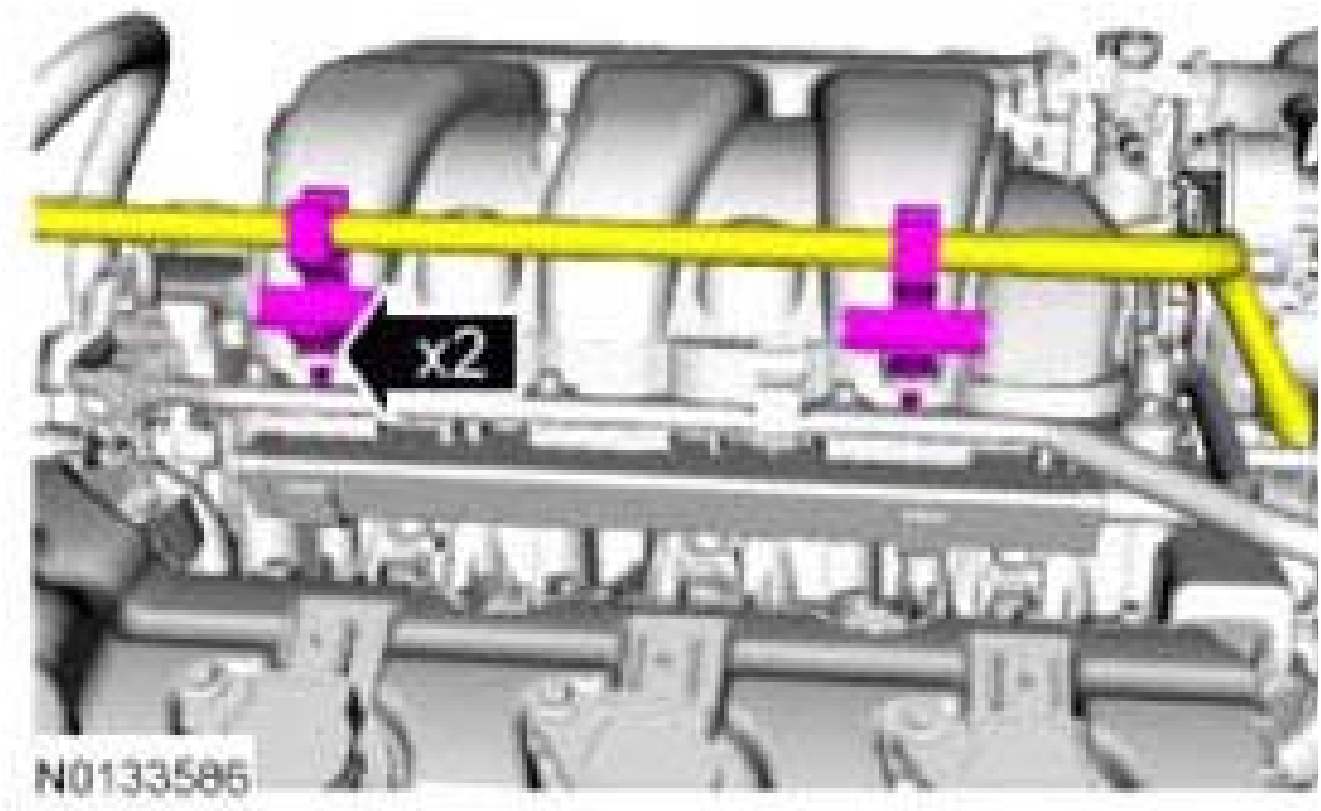
4. Release the clamps and disconnect the power brake booster vacuum supply hose and crankcase ventilation hose from the upper intake manifold.

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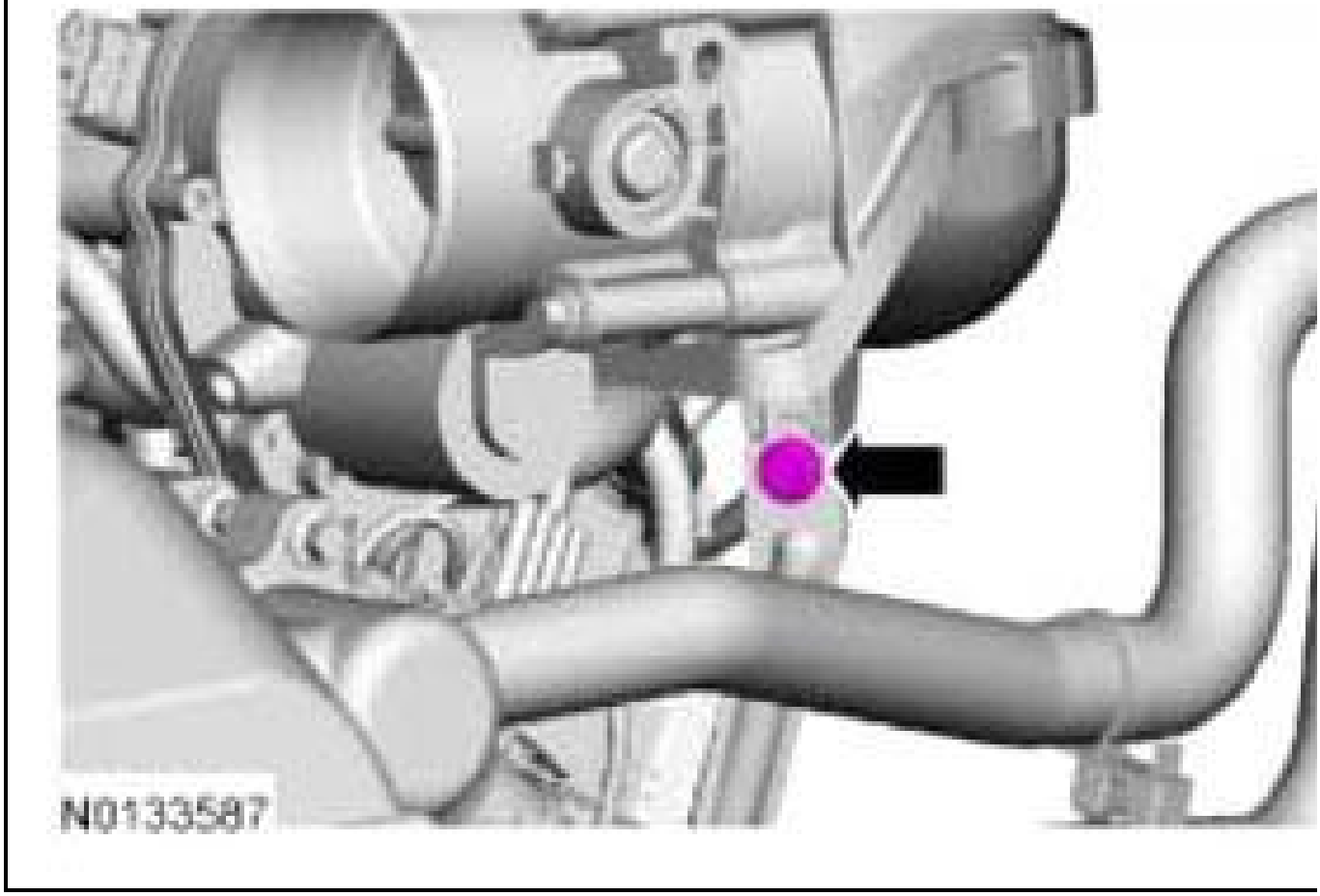
5. Detach the 2 coolant tube retainers from the upper intake manifold.

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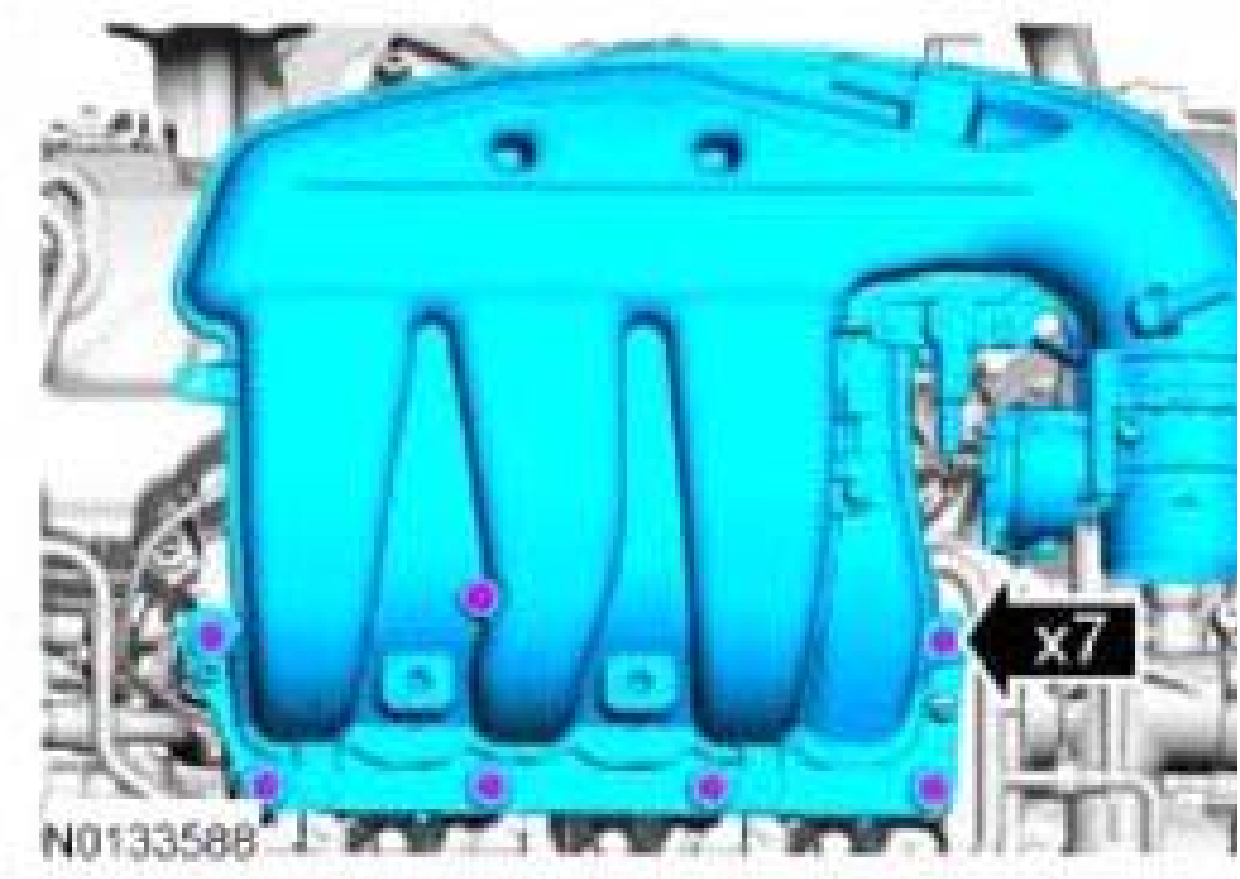
6. Remove the upper intake manifold support bracket bolt.

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7. Remove the 7 bolts and the upper intake manifold.
    - Remove and discard the gasket.
    - Clean and inspect all of the sealing surfaces of the upper and lower intake manifold.

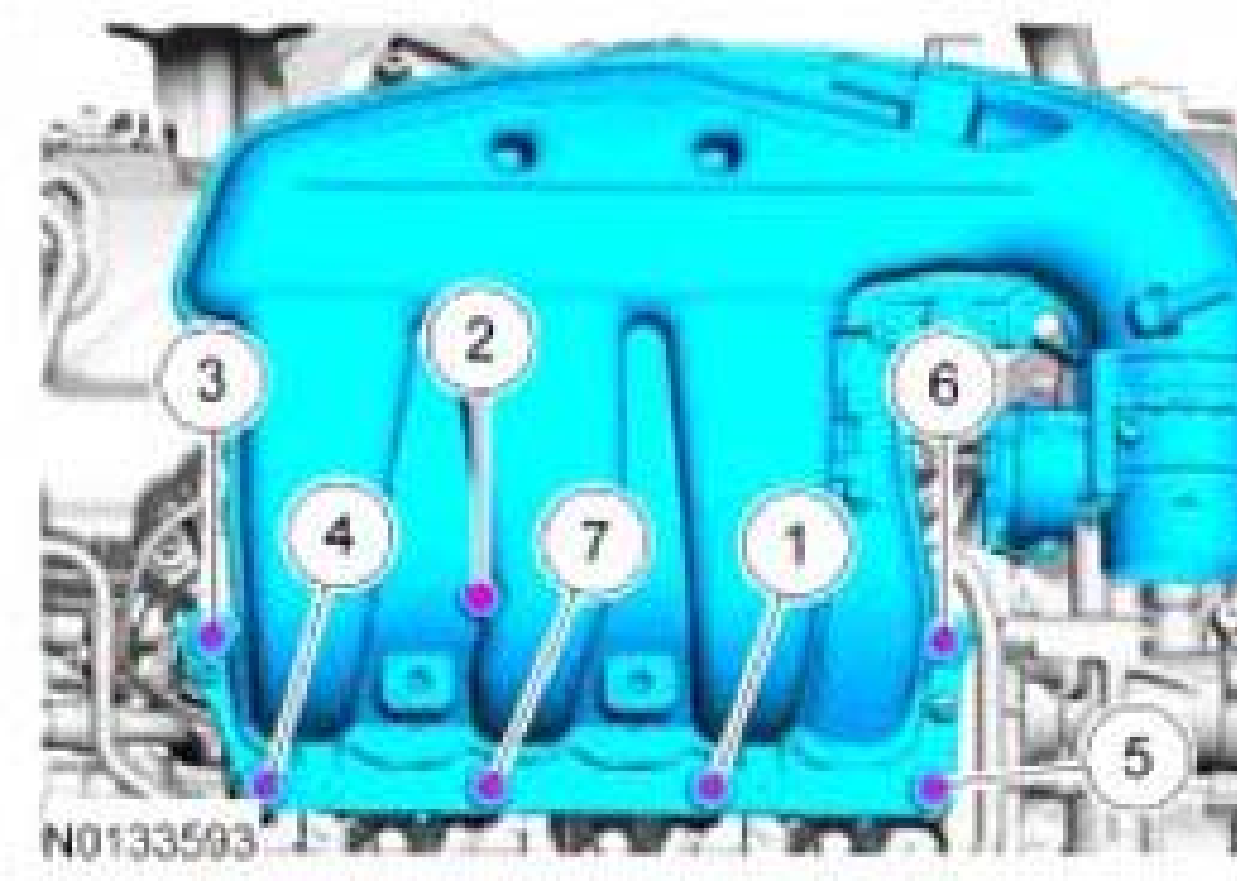
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Installation

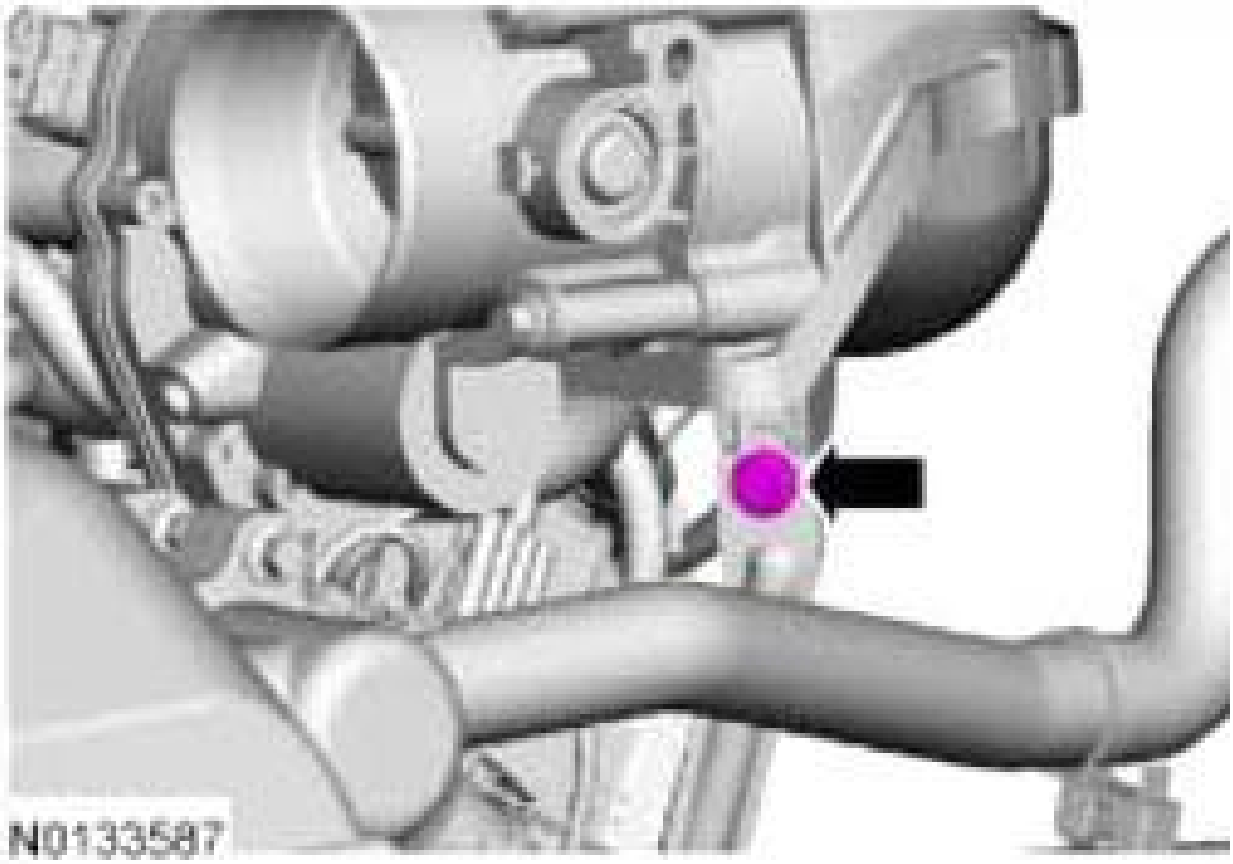
1. Using a new gasket, install the intake manifold and the 7 bolts and tighten in the sequence shown in illustration in 2 stages.
   - Stage 1: Tighten to 10 Nm (89 lb-in).
   - Stage 2: Tighten an additional 45 degrees.

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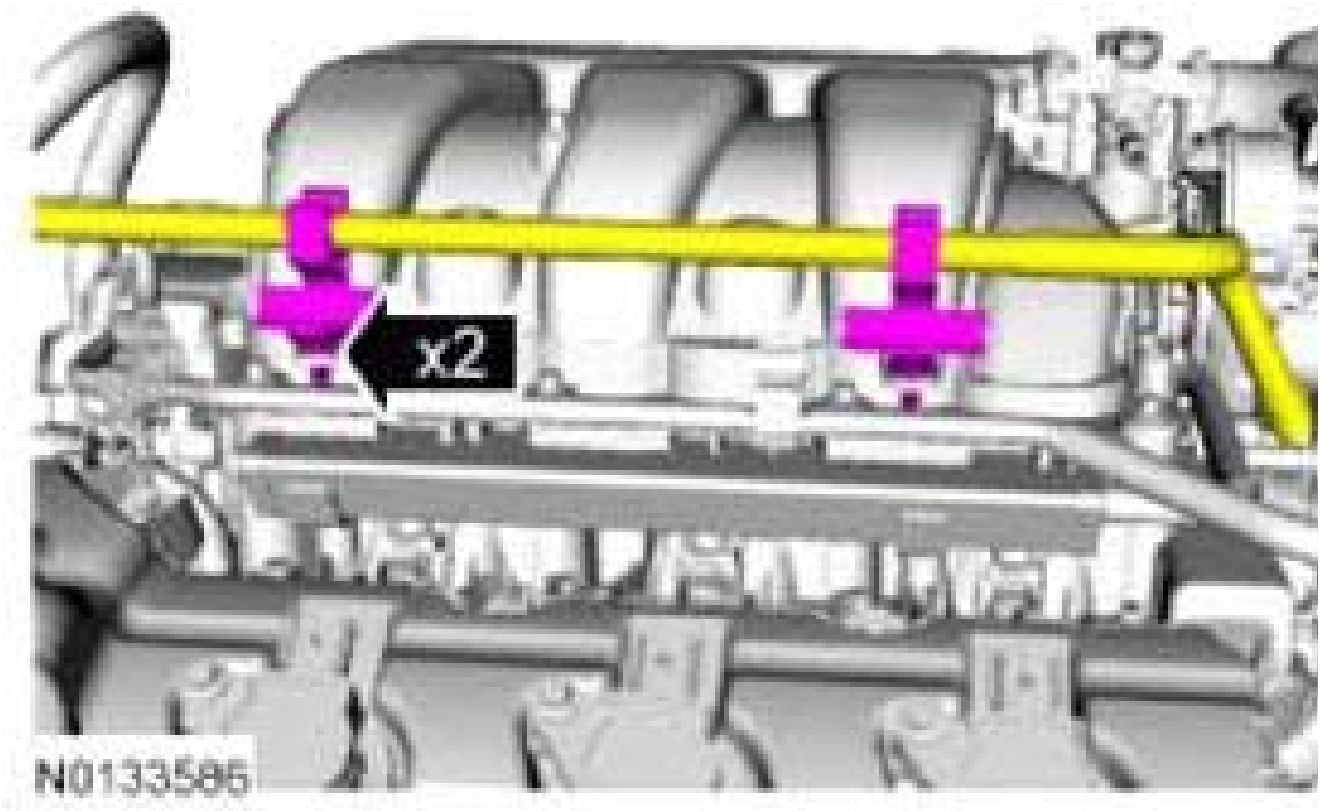
2. Install the upper intake manifold support bolt.
    - Tighten to 10 Nm (89 lb-in).

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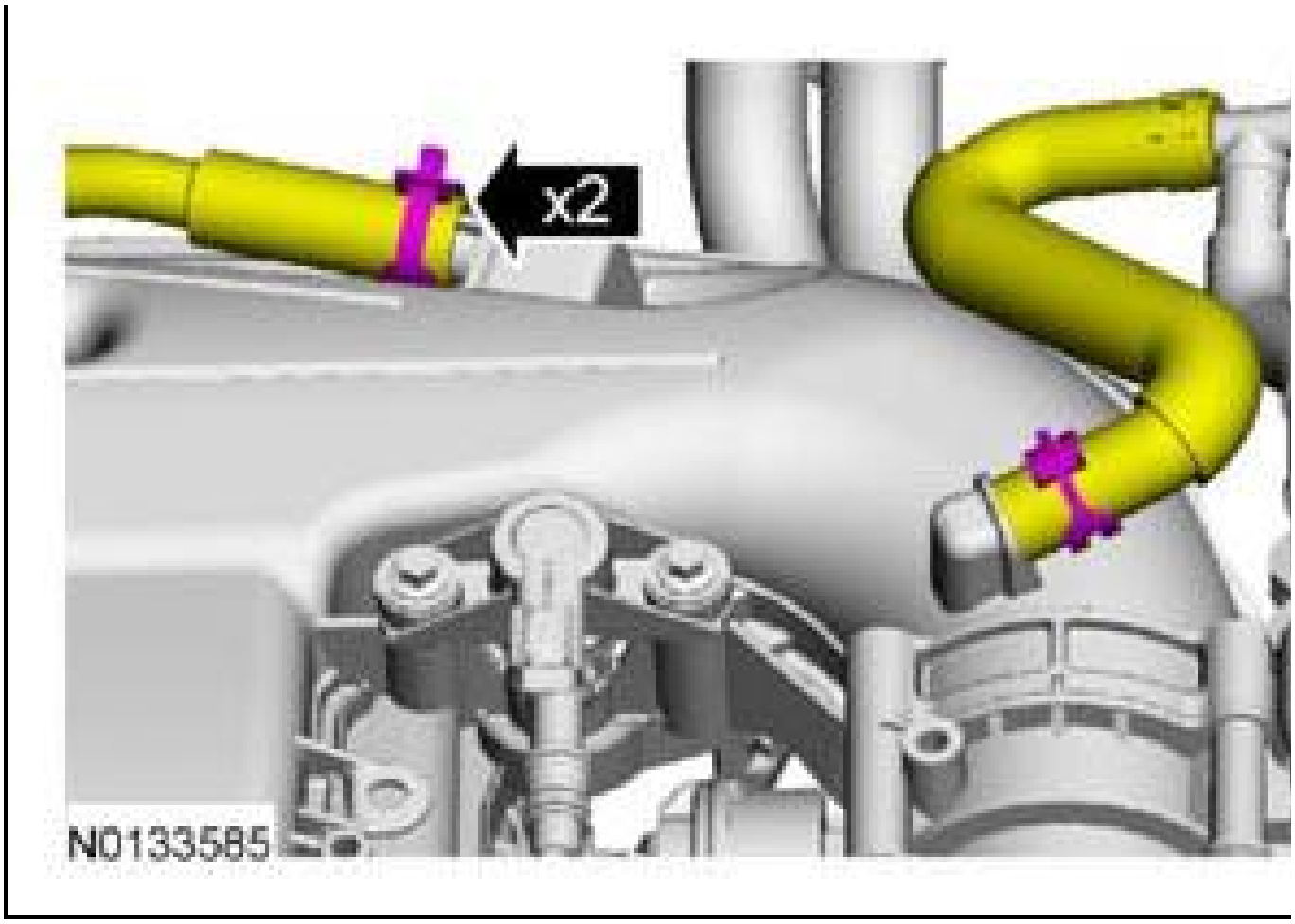
3. Attach the 2 coolant tube retainers to the upper intake manifold.

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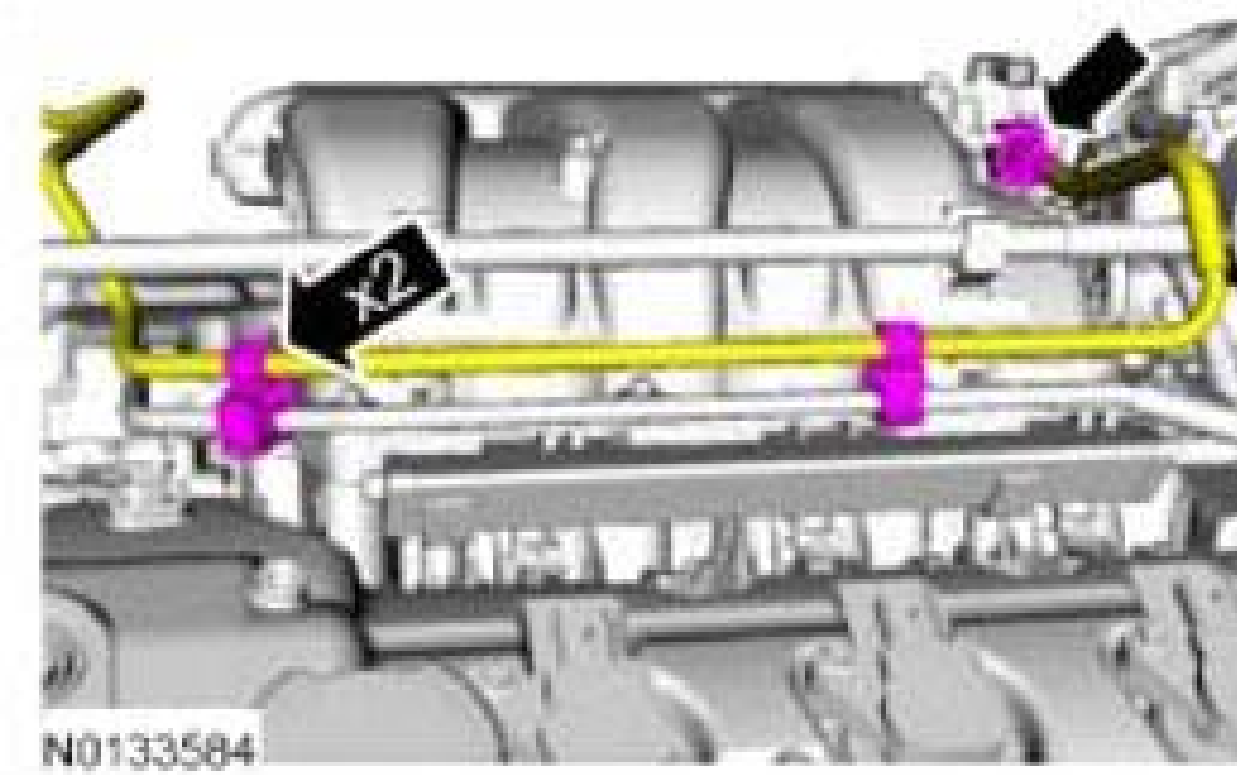
4. Connect the power brake booster vacuum supply hose and crankcase ventilation hose to the upper intake manifold.

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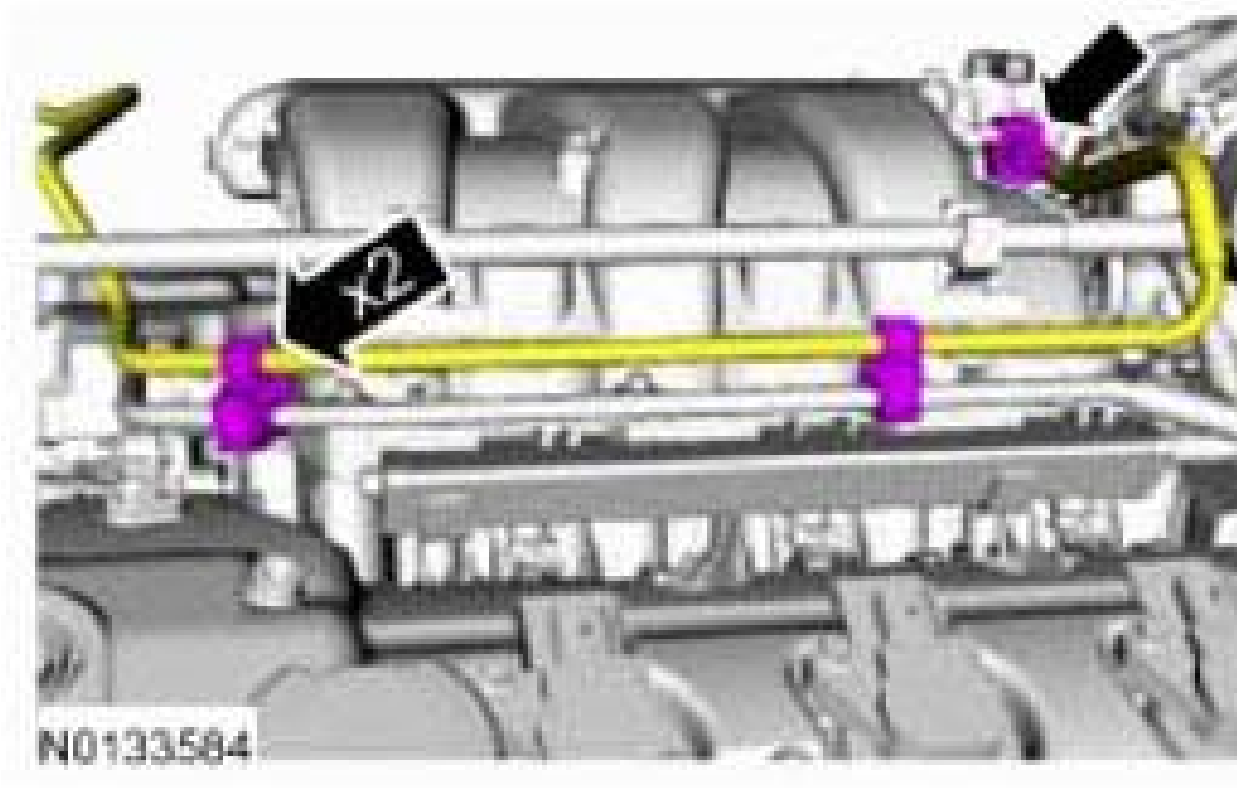
5. Connect the **EVAP** vapor tube to the **EVAP** canister purge valve. REFER to **QUICK CONNECT COUPLING** .
   - Attach the **EVAP** vapor tube to the 2 retainers.

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6. Connect the **EVAP** canister purge valve and throttle body electrical connectors.
    - Attach the wiring harness pin-type retainer to the upper intake manifold.

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7. Install the **ACL** outlet pipe. REFER to **INTAKE AIR SYSTEM COMPONENTS - EXPLODED VIEW** .

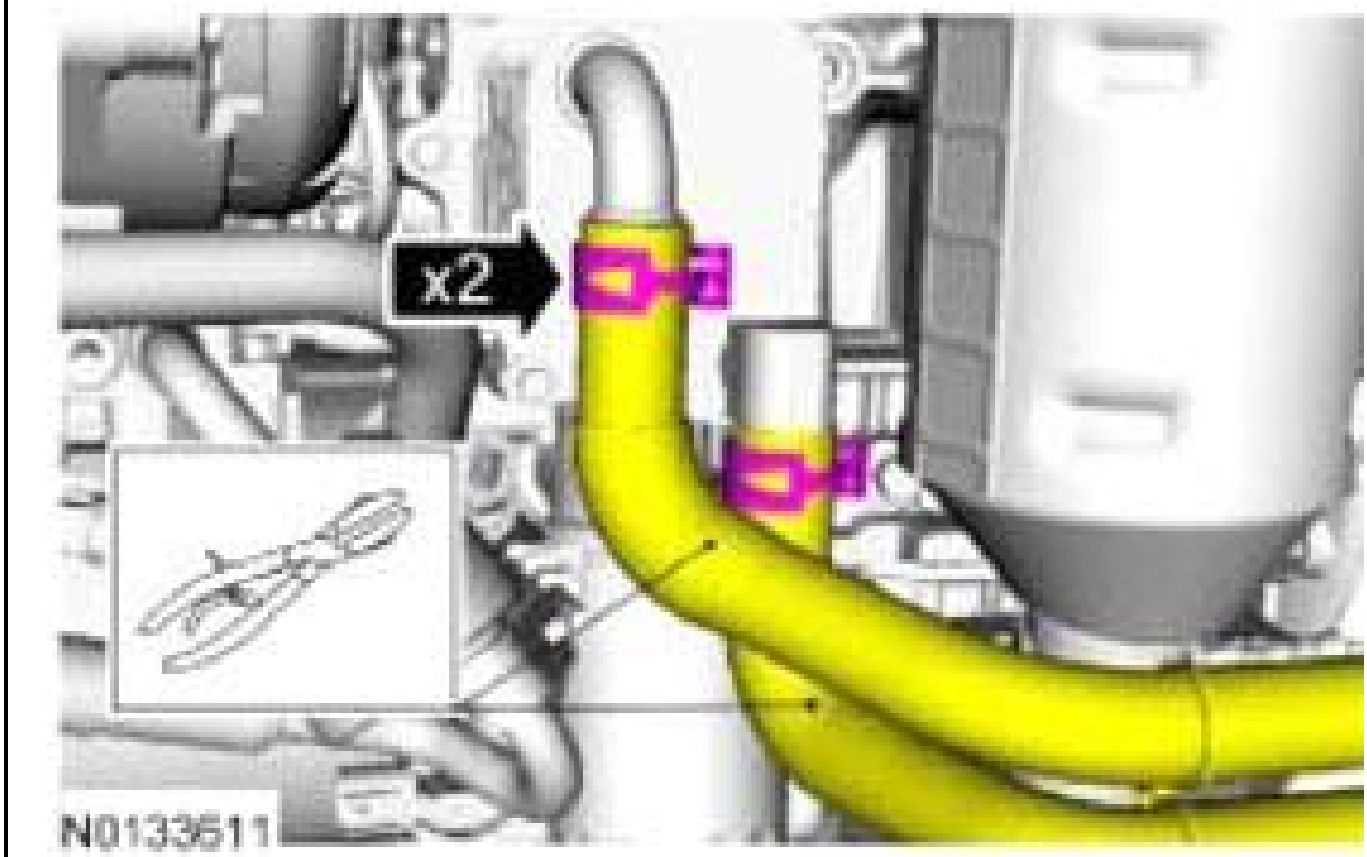
OIL COOLER

Removal

WARNING: Before beginning any service procedure, refer to SAFETY WARNINGS . Failure to follow this instruction may result in serious personal injury.

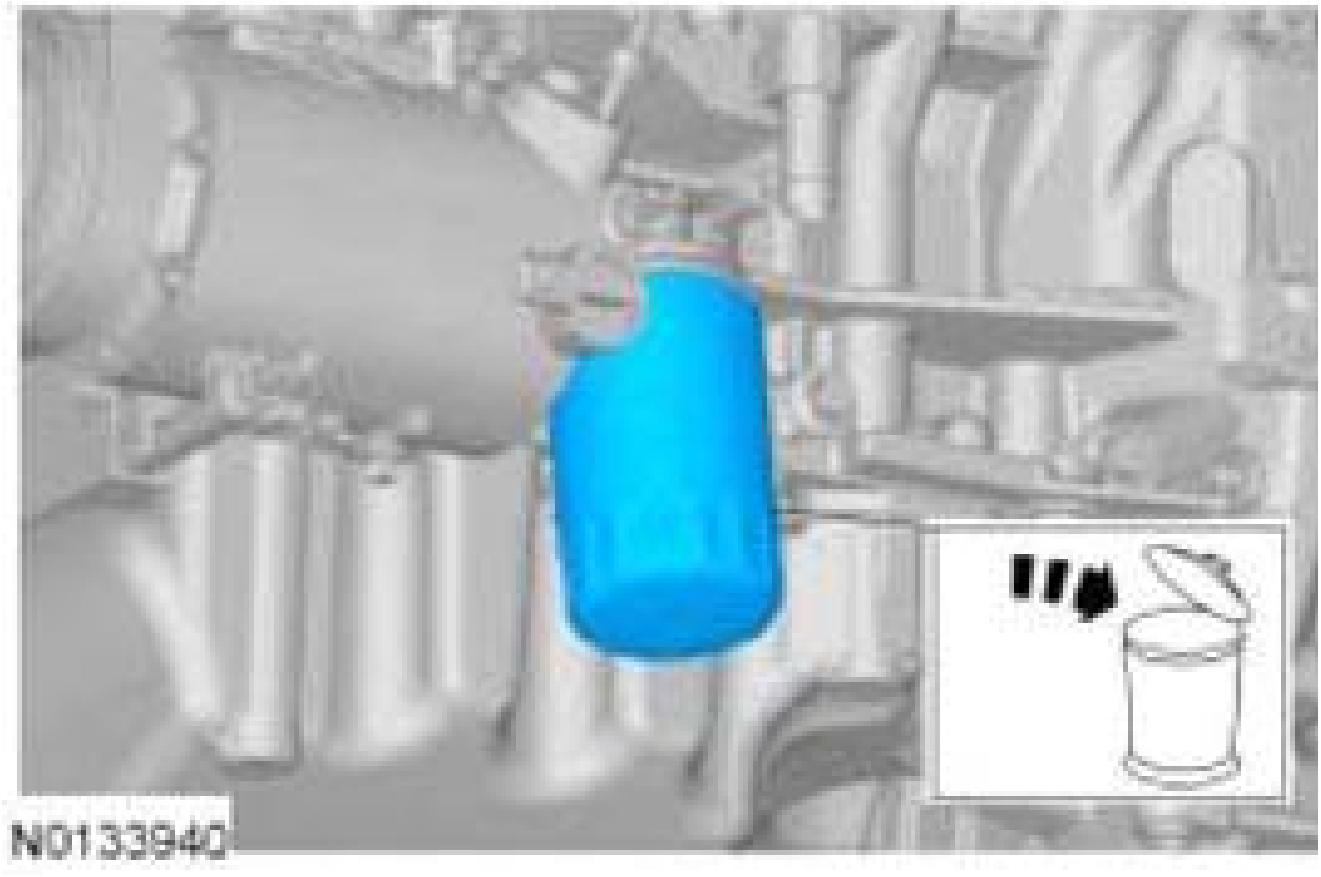
1. With the vehicle in NEUTRAL, position it on a hoist. REFER to **JACKING AND LIFTING** .
2. Using hose clamp pliers, clamp the 2 oil cooler coolant hoses and remove the 2 coolant hoses from the oil cooler.

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3. Remove the oil filter and discard.

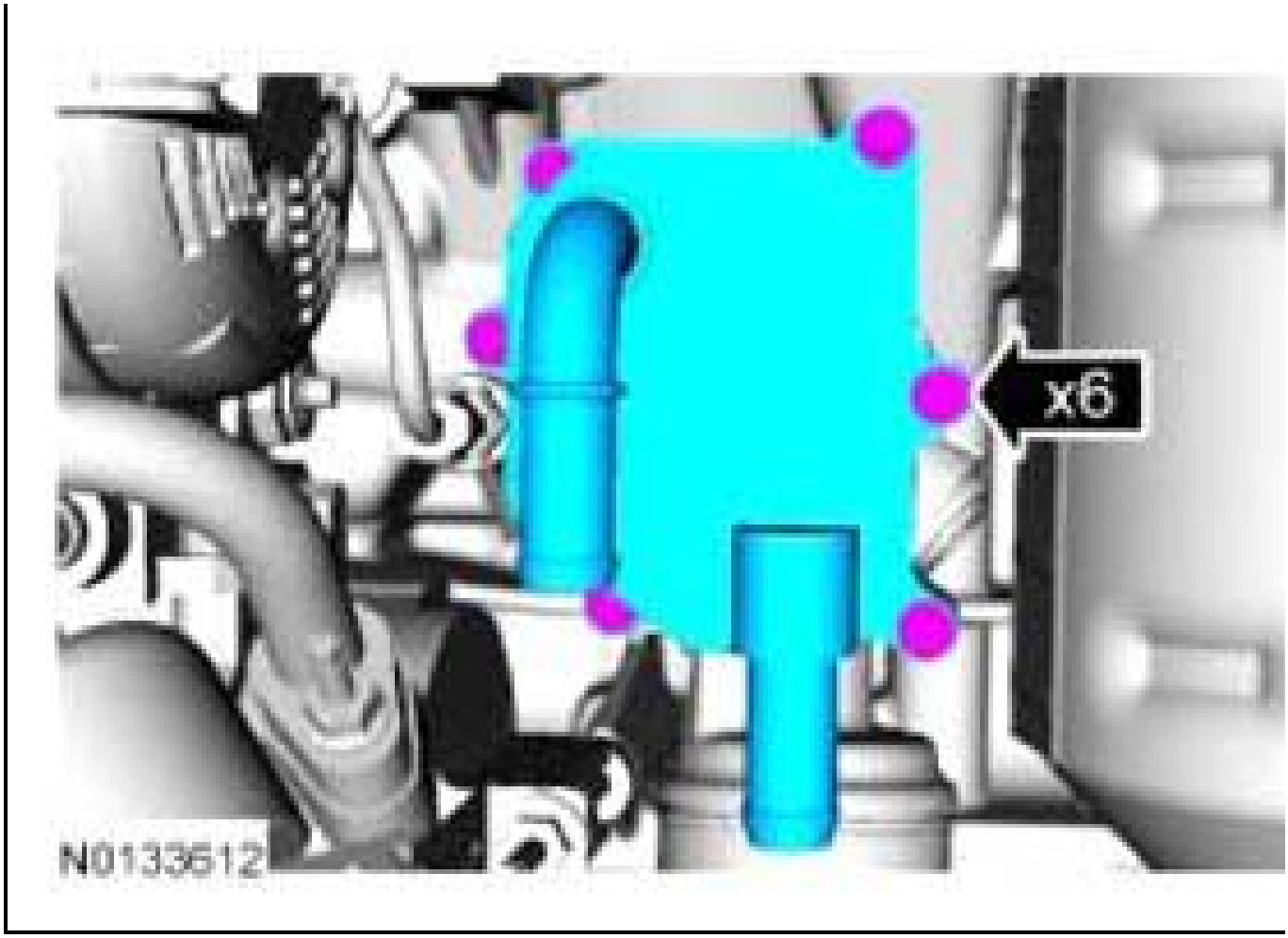
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NOTE: **If metal or aluminum is present in the oil cooler, mechanical concerns exist. Failure to correct these concerns may result in engine failure. To diagnose mechanical concerns, REFER to ENGINE .**

4. Remove the 6 bolts and the oil cooler.

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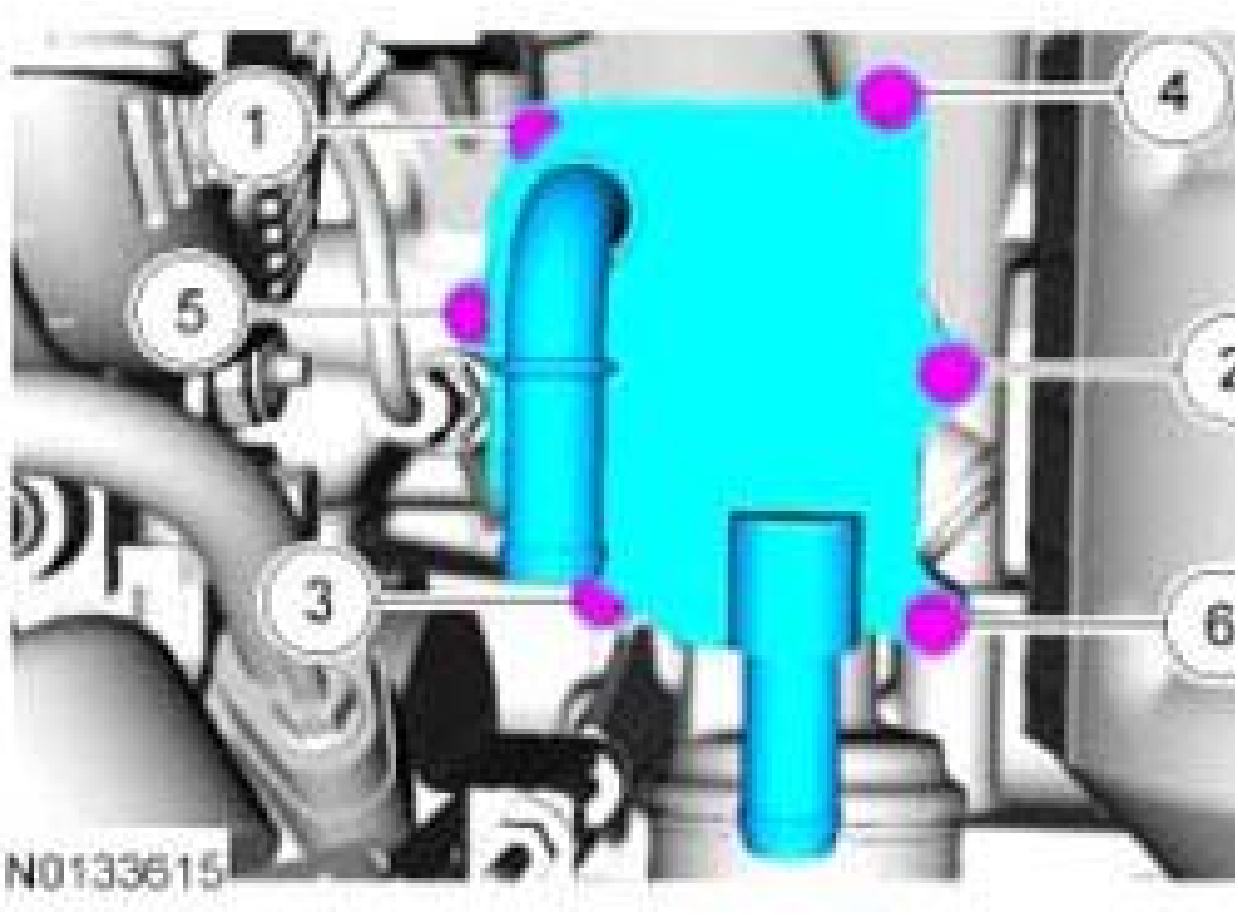


5. Discard the oil cooler gasket and inspect the oil cooler. Clean and inspect all sealing surfaces.

Installation

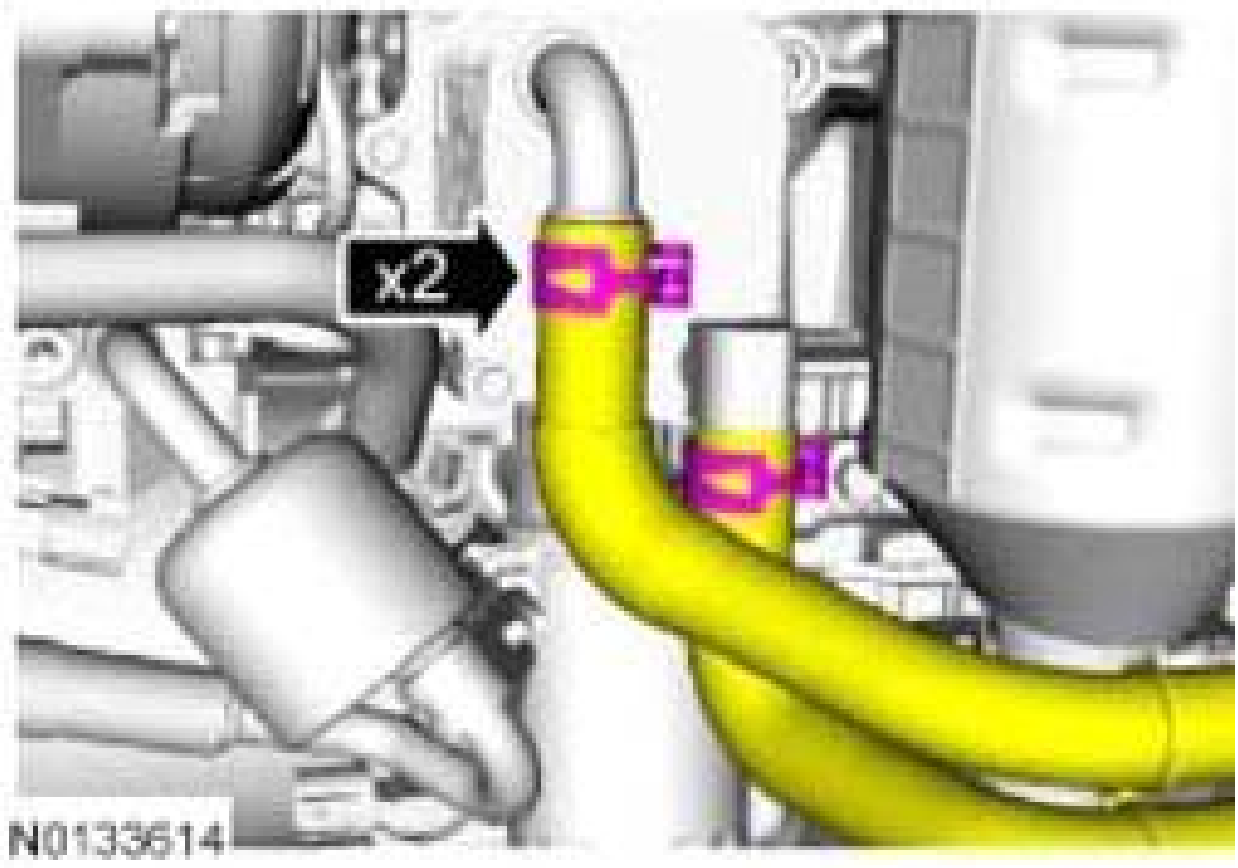
1. Using new gaskets, install the oil cooler and the 6 bolts.
    - Tighten in the sequence shown in illustration to 10 Nm (89 lb-in).

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2. Install the 2 coolant hoses to the oil cooler.
    - Remove the 2 hose clamp pliers.

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3. **NOTE: Do not lubricate the engine oil filter gasket.**

Install a new engine oil filter.

- Tighten to 5 Nm (44 lb-in), then turn an additional 180 degrees.

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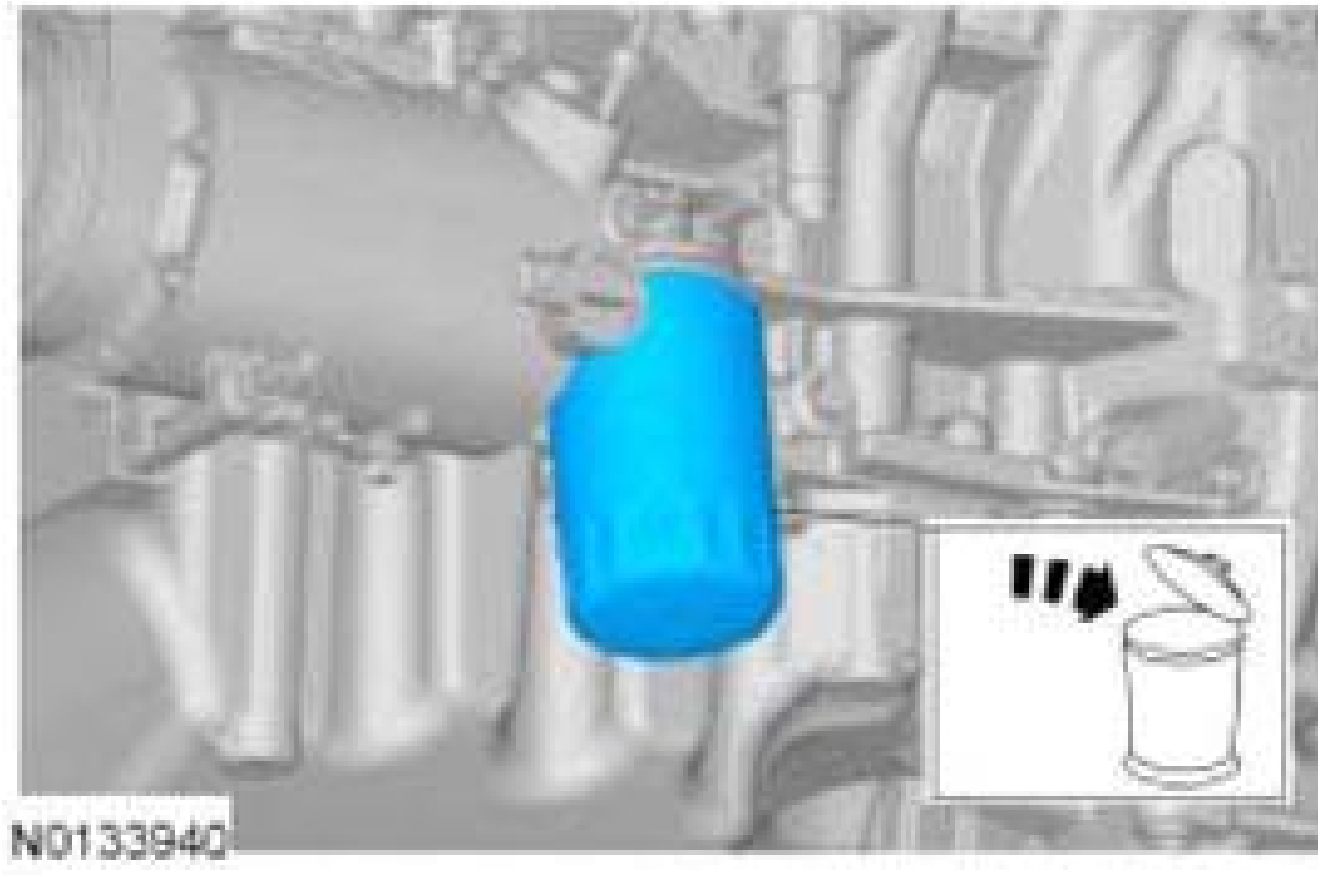


OIL FILTER ADAPTER

Removal

1. With the vehicle in NEUTRAL, position it on a hoist. REFER to **JACKING AND LIFTING** , Lifting Points.
2. Remove and discard the engine oil filter.

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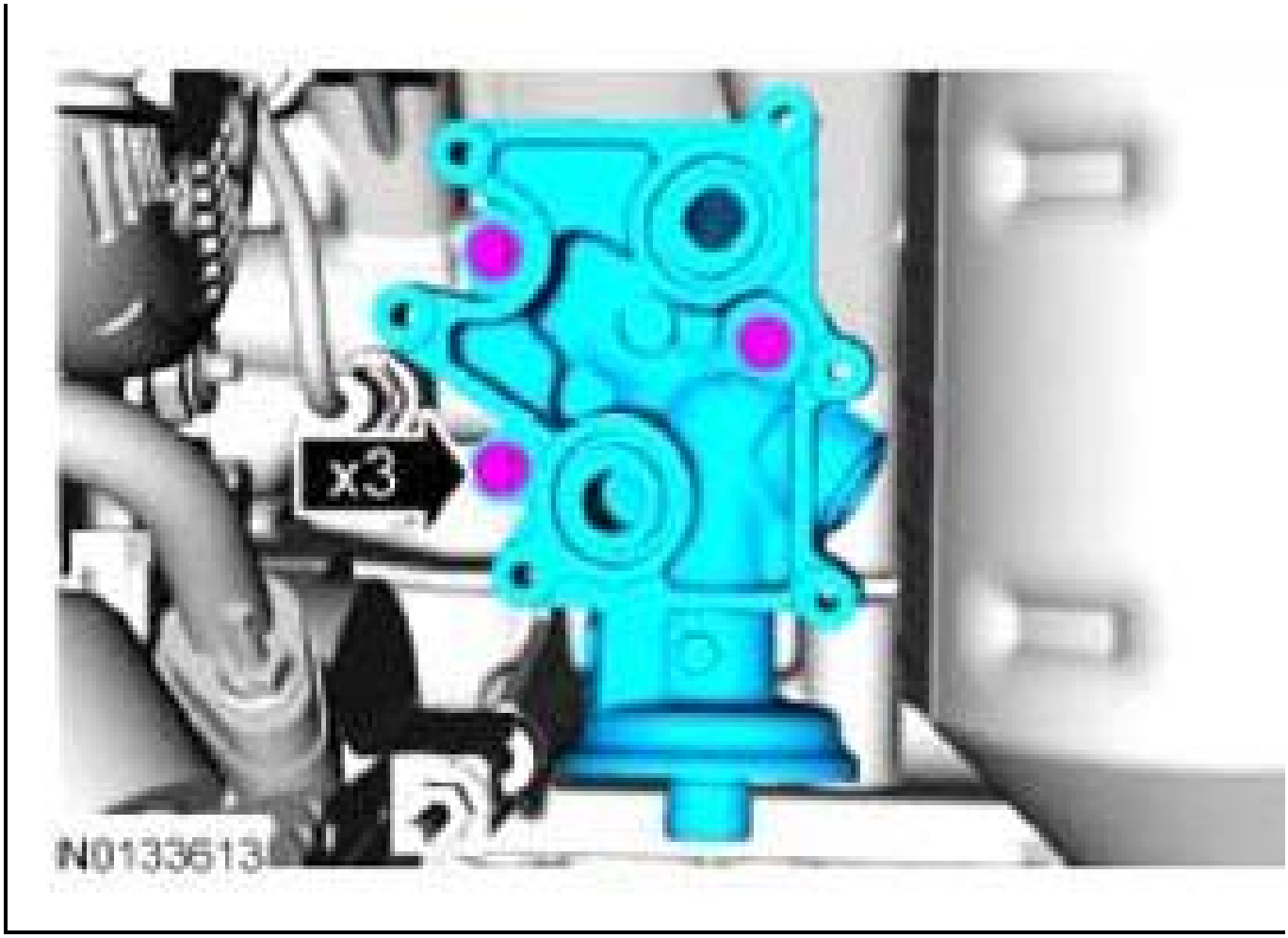
3. If equipped, remove the oil cooler. Refer to **OIL COOLER**.

NOTE: **Oil filter adapter with oil cooler shown in illustration, oil filter adapter without oil cooler similar.**

4. Remove the 3 oil filter adapter bolts and the oil filter adapter.

- Discard the gasket.

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Installation

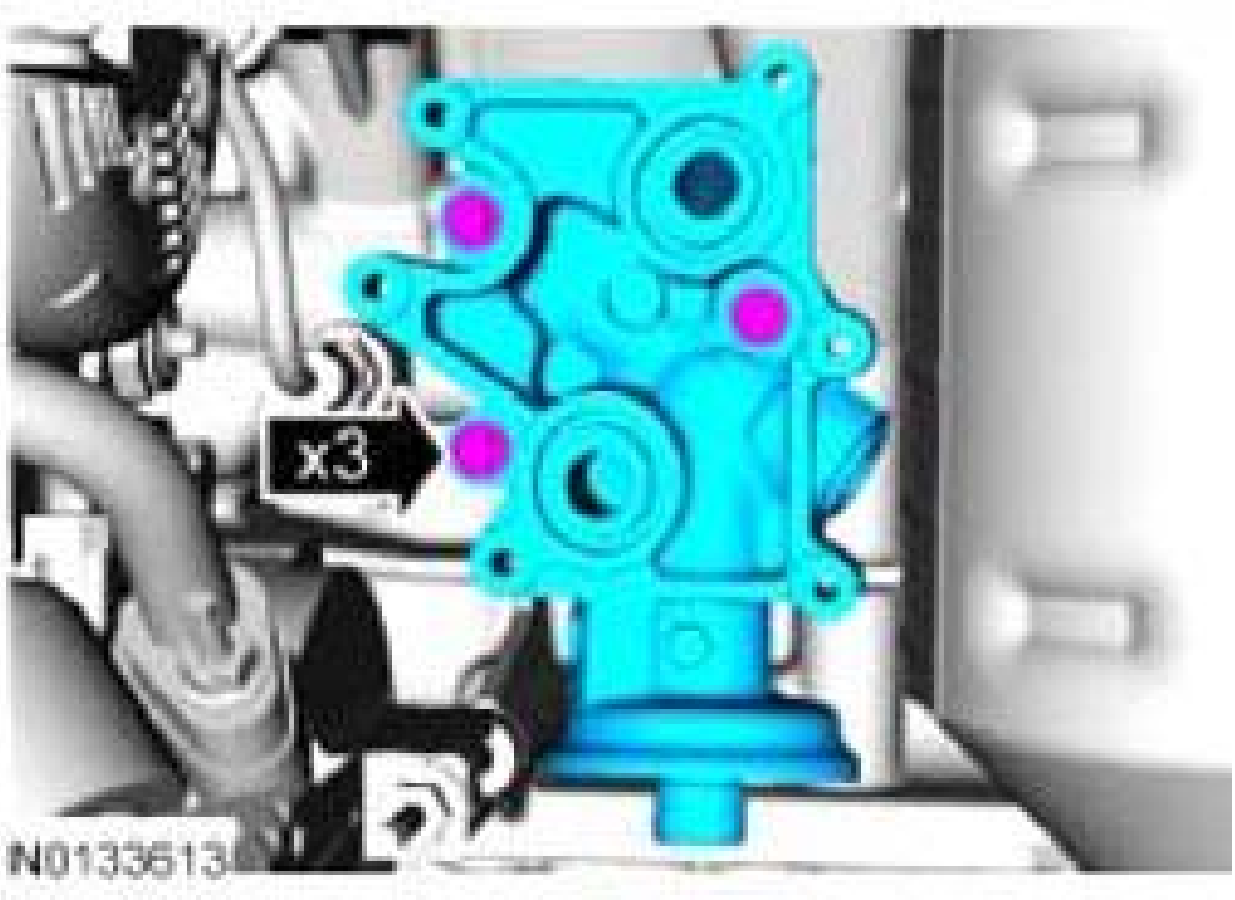
1. **NOTE: Clean and inspect all sealing surfaces.**

   NOTE: Oil filter adapter with oil cooler shown in illustration, oil filter adapter without oil cooler similar.

   Using a new gasket, install the oil filter adapter and the 3 oil filter adapter bolts.

   - Tighten to 10 Nm (89 lb-in) plus an additional 45 degrees.

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2. If equipped, install the oil cooler. Refer to **OIL COOLER**.
3. **NOTE: Do not lubricate the engine oil filter gasket.**

   Install a new engine oil filter.

   - Tighten to 5 Nm (44 lb-in) and then rotate an additional 180 degrees.

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OIL PAN

MATERIAL SPECIFICATIONS

Item	Specification
Motorcraft® High Performance Engine RTV Silicone TA-357	WSEM4G323-A6
Motorcraft® Metal Surface Prep ZC-31-A	-
Motorcraft® SAE 5W-20 Premium Synthetic Blend Motor Oil (US); Motorcraft® SAE 5W-20 Super Premium Motor Oil (Canada) XO-5W20-QSP (US); CXO-5W20-LSP12 (Canada)	WSSM2C945-A
Motorcraft® Silicone Gasket Remover ZC-30	-

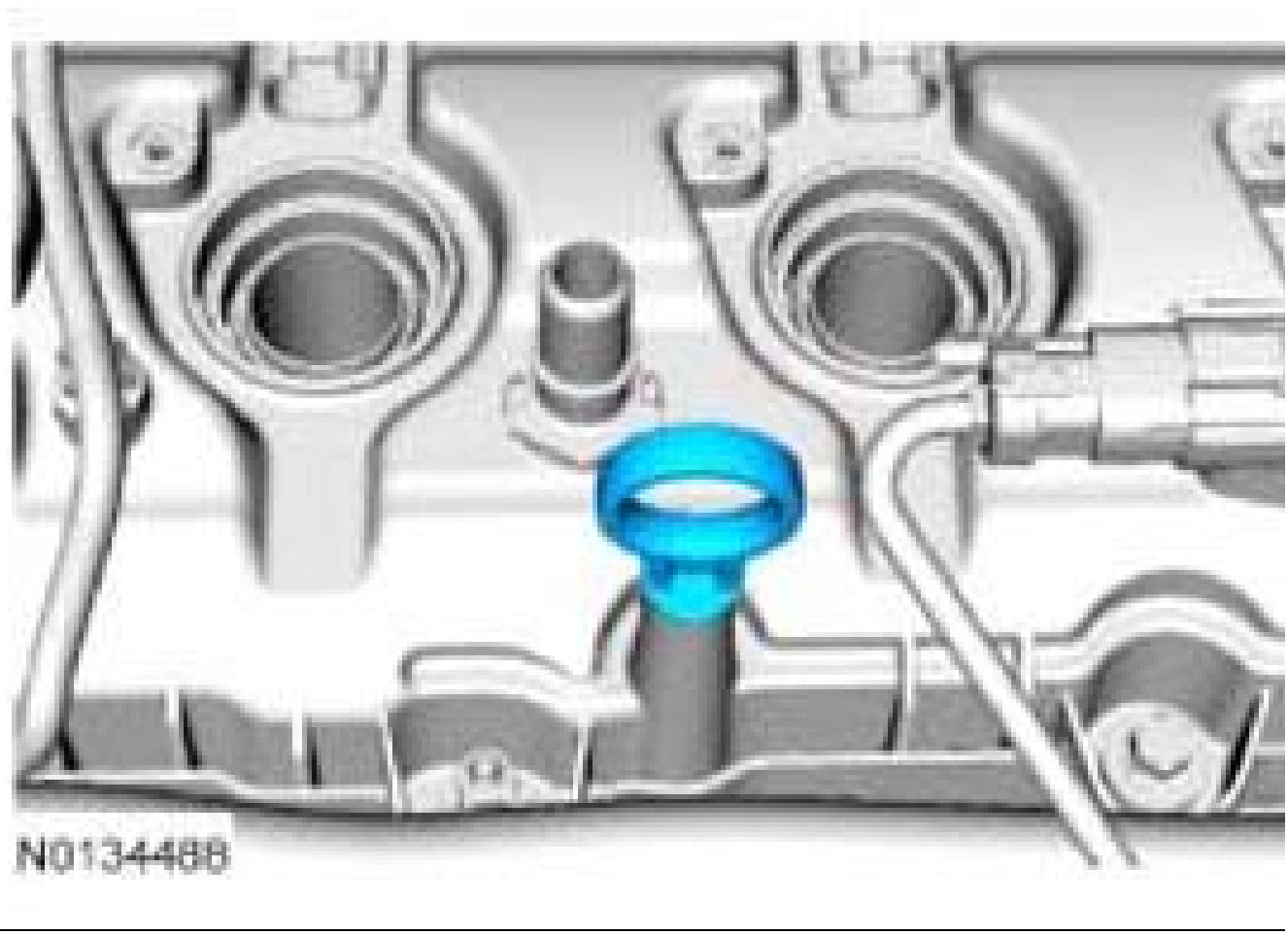
Removal

WARNING: Before beginning any service procedure, refer to SAFETY WARNINGS . Failure to follow this instruction may result in serious personal injury.

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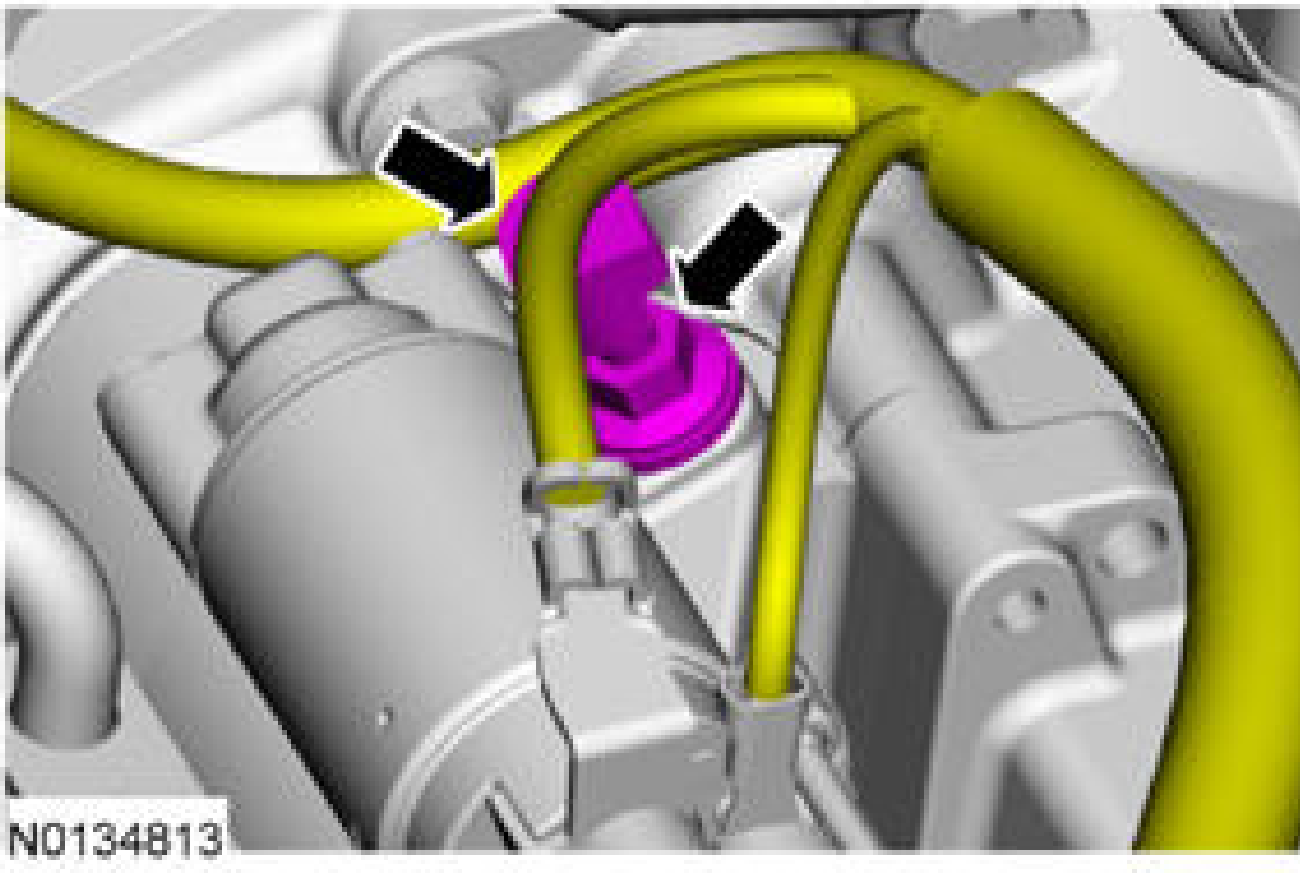
NOTE: **During engine repair procedures, cleanliness is extremely important. Any foreign material, including any material created while cleaning gasket surfaces that enters the oil passages, coolant passages or the oil pan, can cause engine failure.**

1. With the vehicle in NEUTRAL, position it on a hoist. REFER to **JACKING AND LIFTING** .
2. Remove the **ACL** tray assembly and **ACL** outlet pipe. REFER to **INTAKE AIR SYSTEM COMPONENTS - EXPLODED VIEW** .
3. Remove the battery tray. REFER to **BATTERY AND BATTERY TRAY - EXPLODED VIEW** .
4. Remove the oil level indicator.



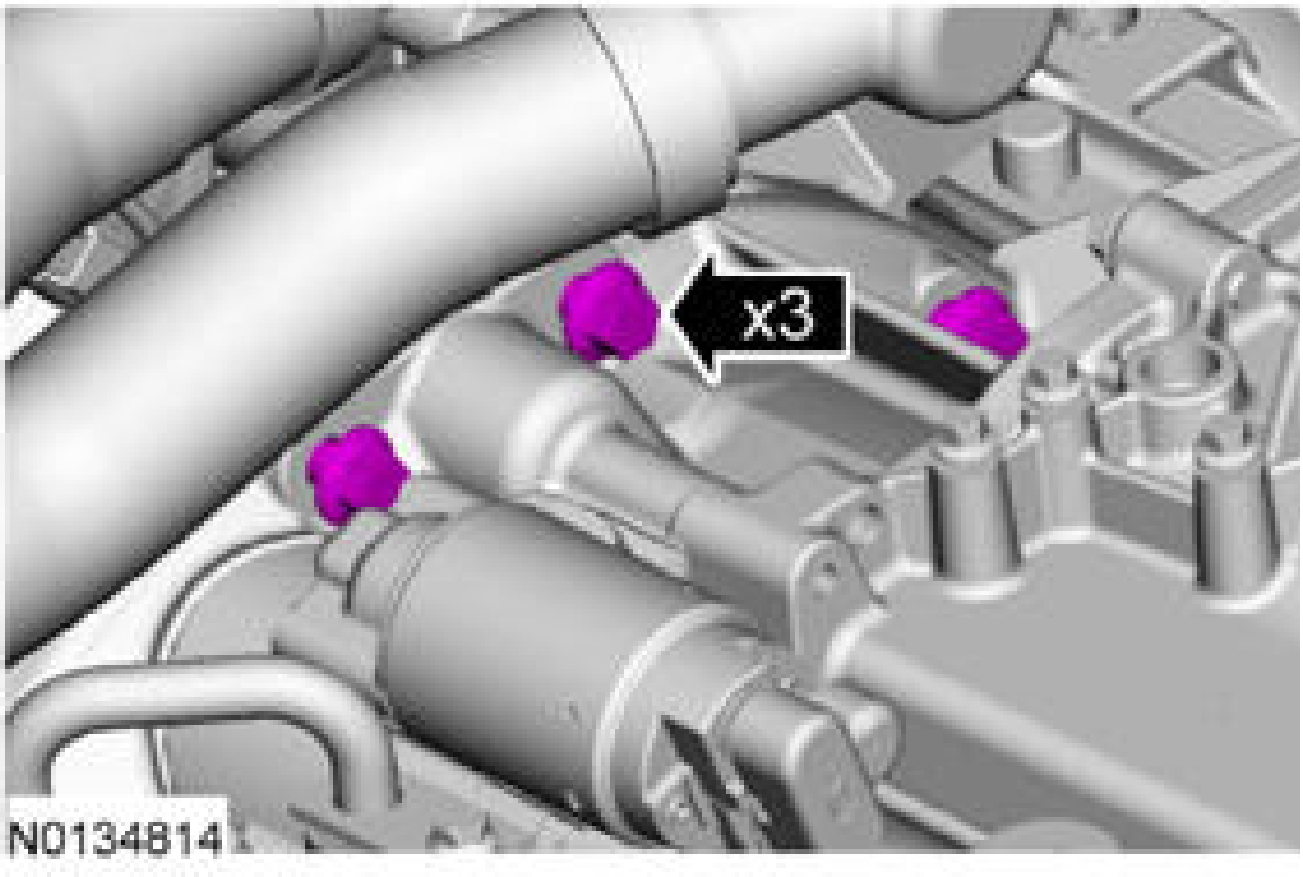
5. Detach the wiring harness retainer from the starter stud bolt and remove the starter stud bolt.

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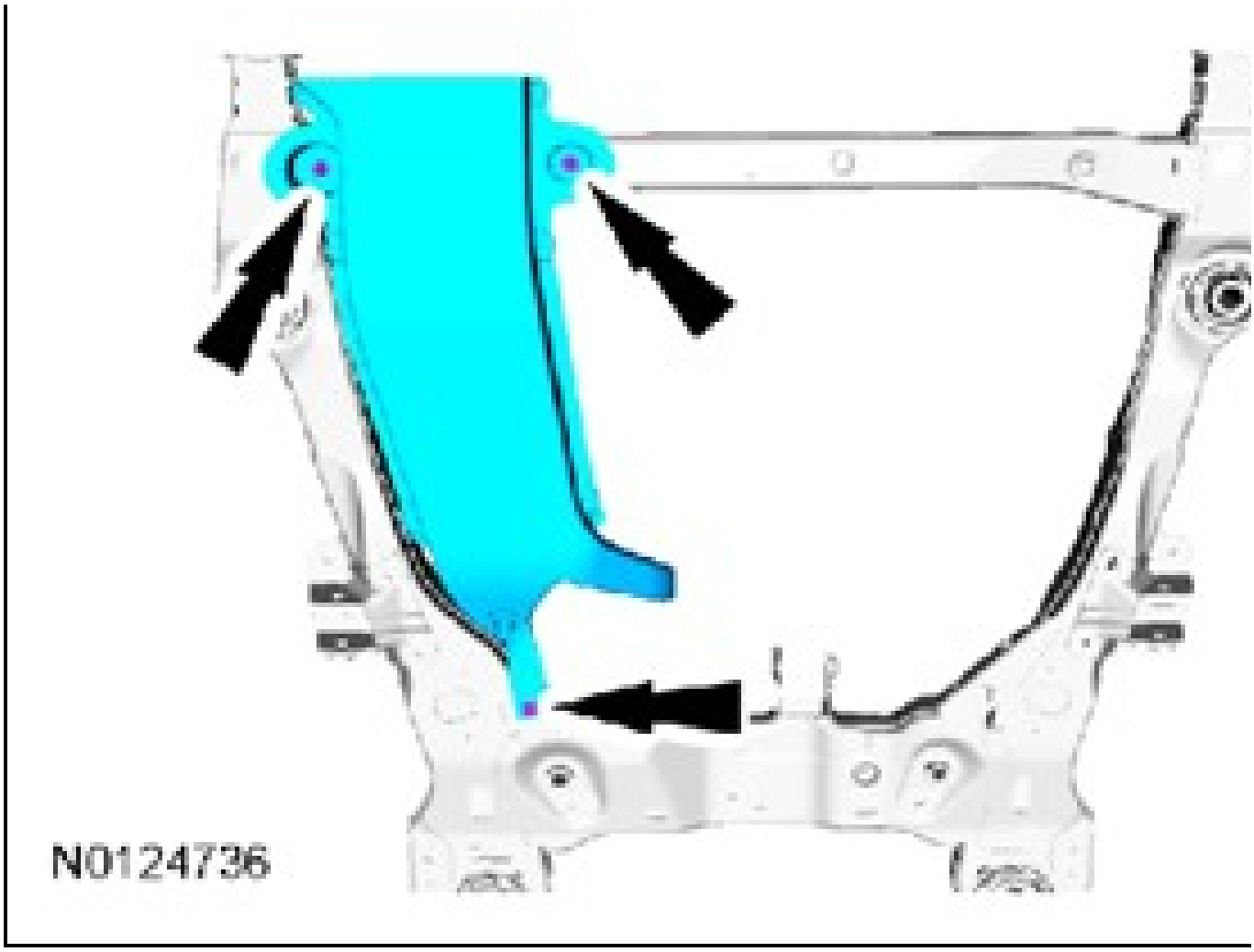
6. Loosen the 3 upper bellhousing-to-engine bolts 5 mm (0.20 in).

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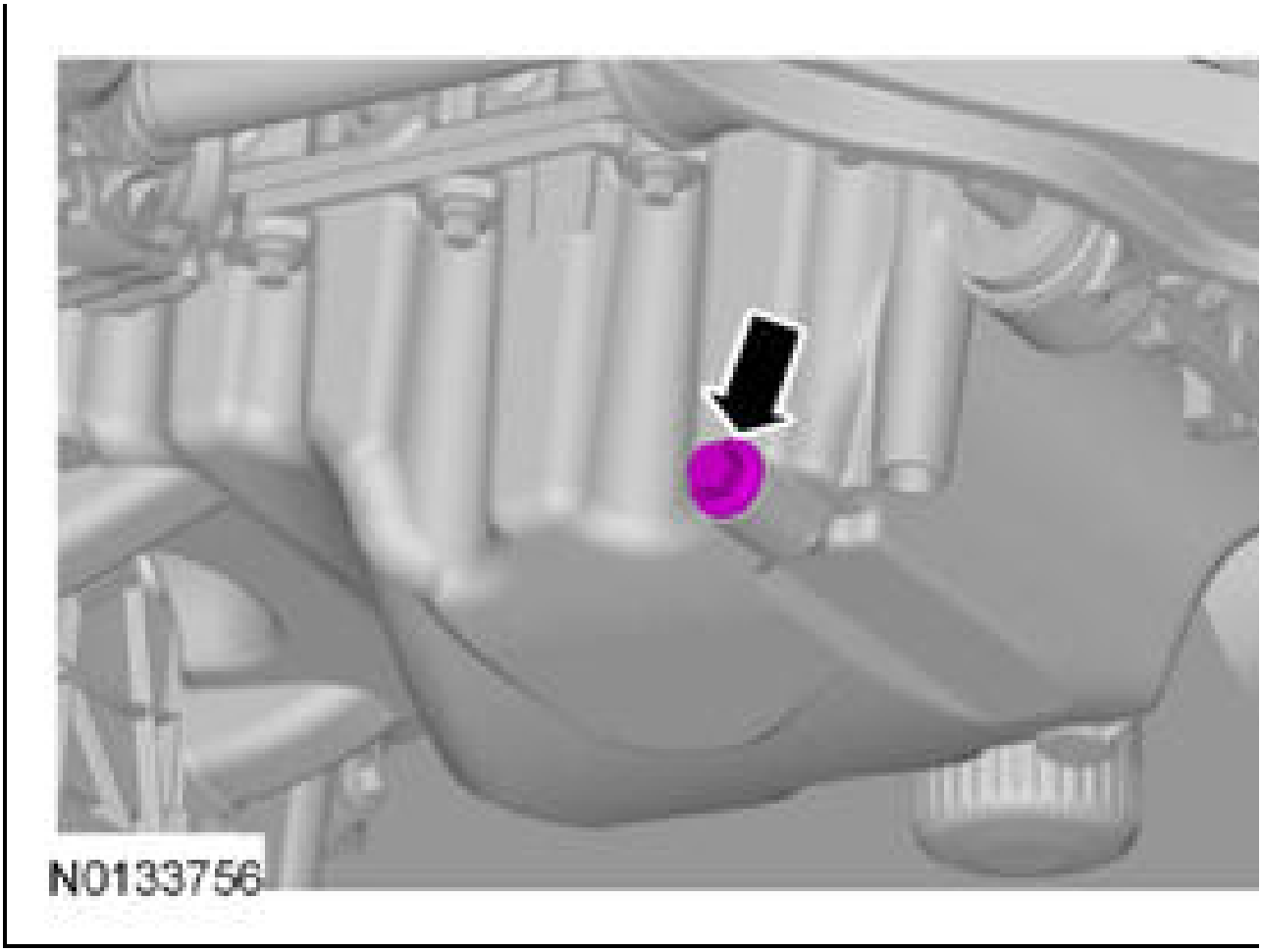
7. Remove the 3 twist-type retainers and remove the air duct from the subframe.

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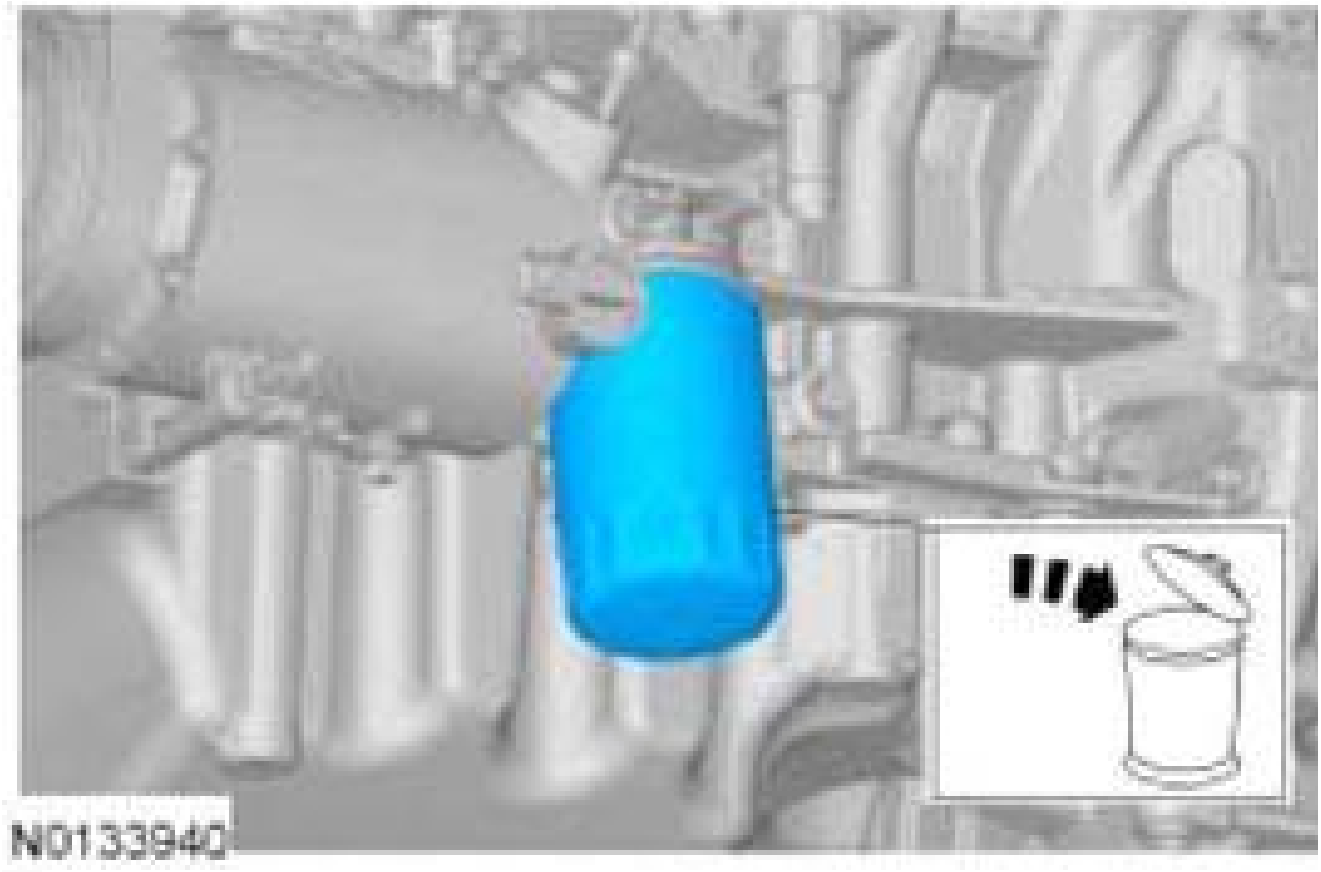
8. Remove the drain plug and drain the engine oil and re-install the drain plug.
    - Tighten to 27 Nm (20 lb-ft).

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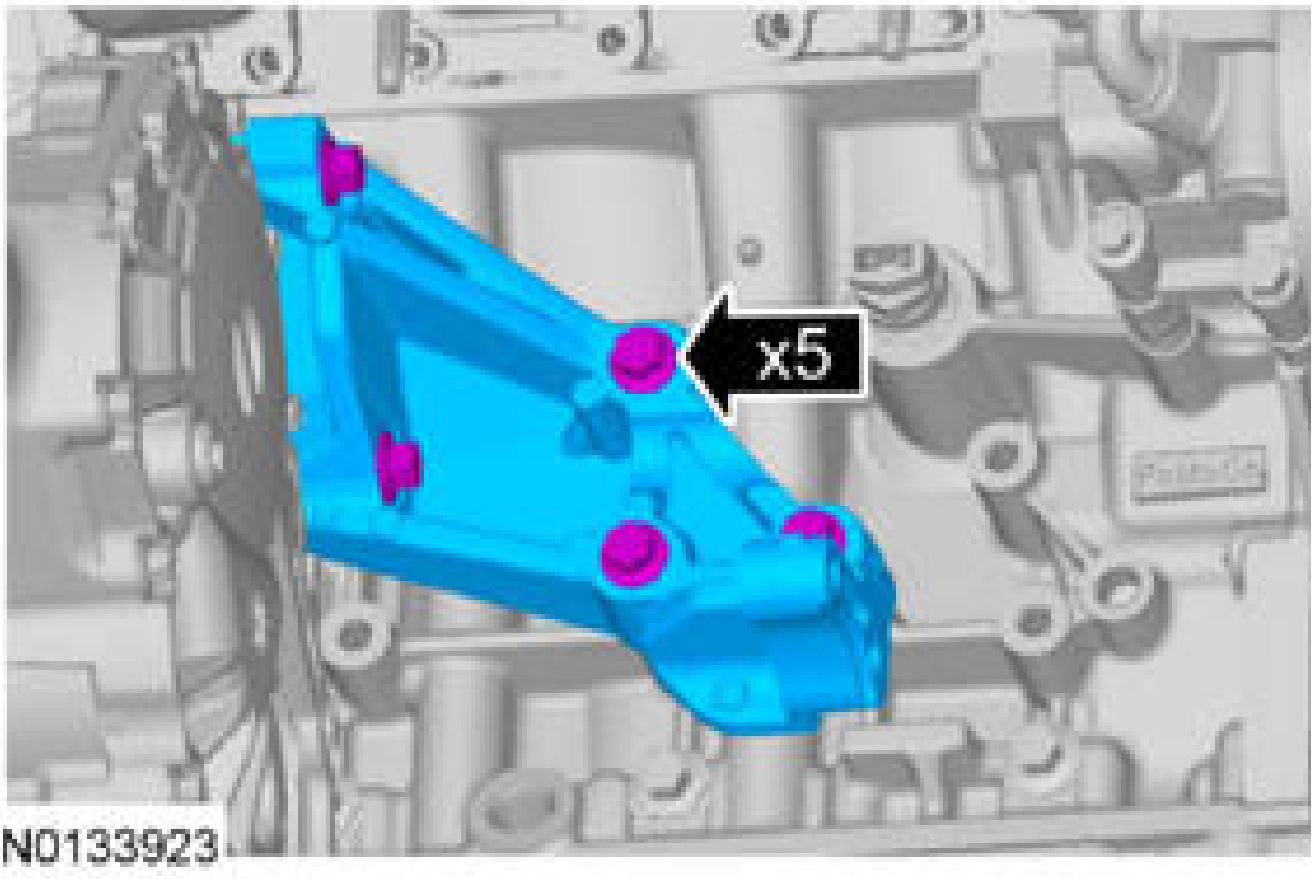
9. Remove and discard the engine oil filter.

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10. Remove the exhaust Y-pipe. REFER to **EXHAUST Y-PIPE - 3.5L TI-VCT** .
11. Remove the transaxle support insulator - anti-roll. For FWD vehicles, REFER to **TRANSMISSION SUPPORT INSULATOR - ANTI-ROLL FWD** or for **AWD** vehicles, REFER to **TRANSMISSION SUPPORT INSULATOR - ANTI-ROLL AWD** .
12. If equipped with **AWD** , remove the catalytic converter - RH manifold. REFER to **CATALYTIC CONVERTER - RH MANIFOLD** .
13. If equipped with **AWD** , remove the 5 **PTU** support bracket bolts and the **PTU** support bracket.

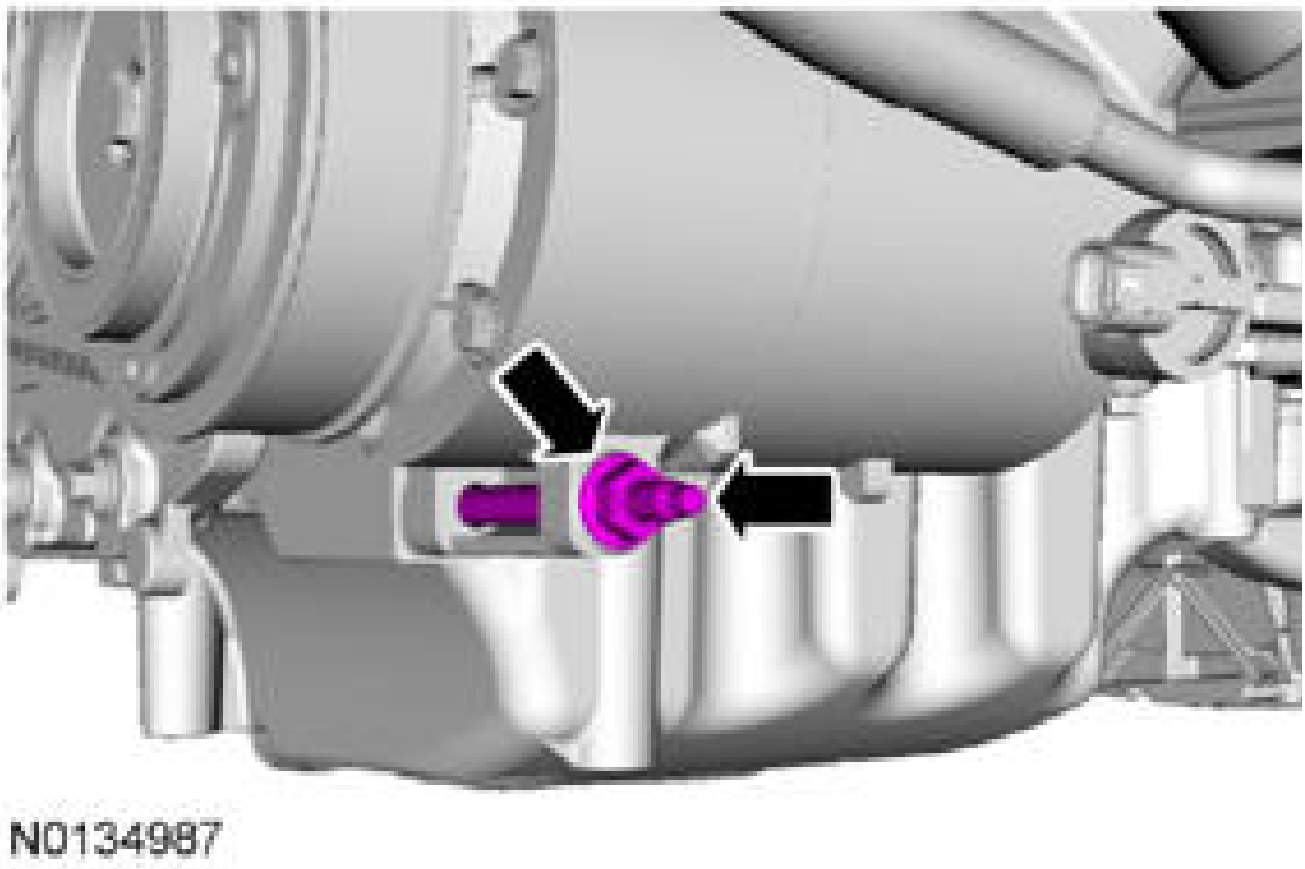
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14. **NOTE: It may be necessary to roll the bottom of the engine back for the A/C compressor stud to clear the subframe.**

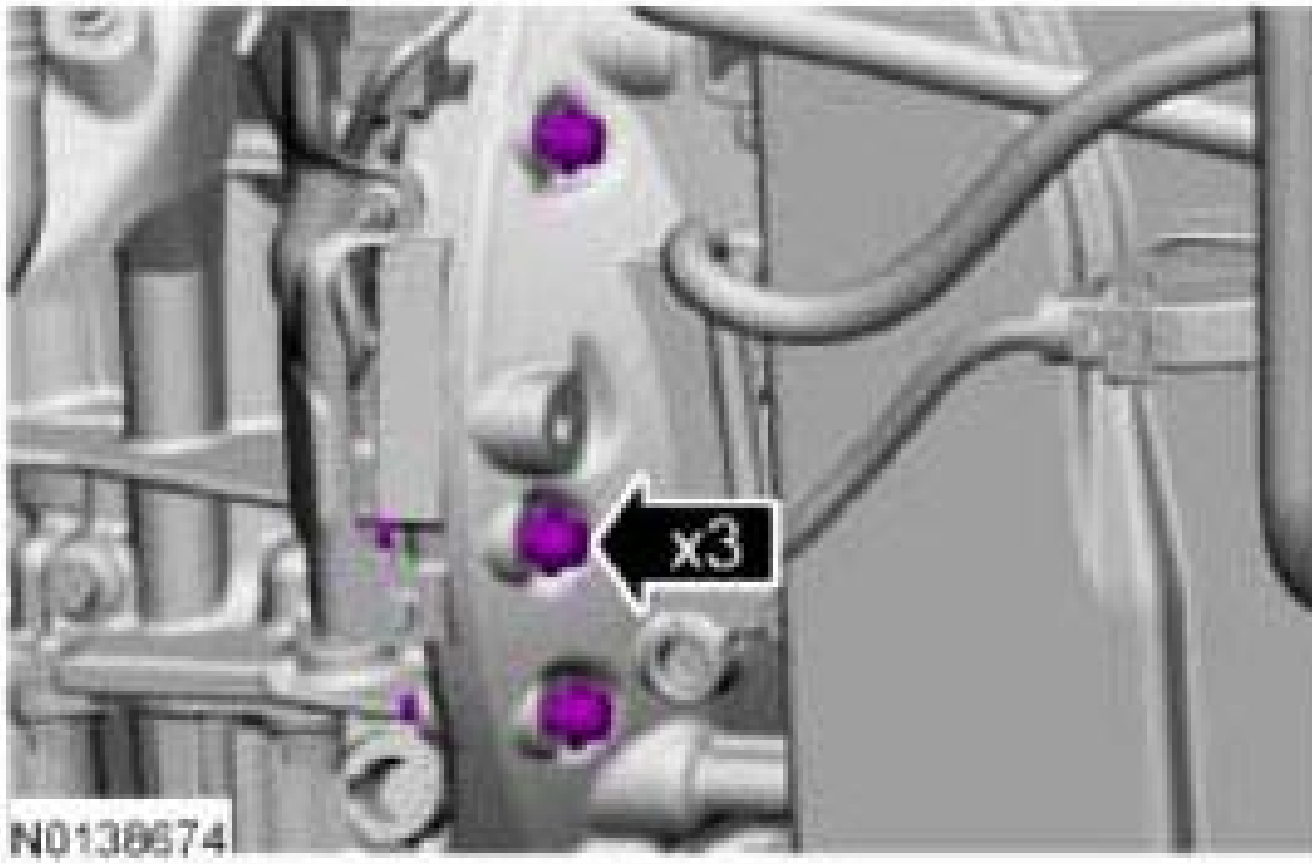
Remove the A/C compressor nut and stud.

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15. Loosen the 3 LH bellhousing-to-engine bolts 5 mm (0.20 in).

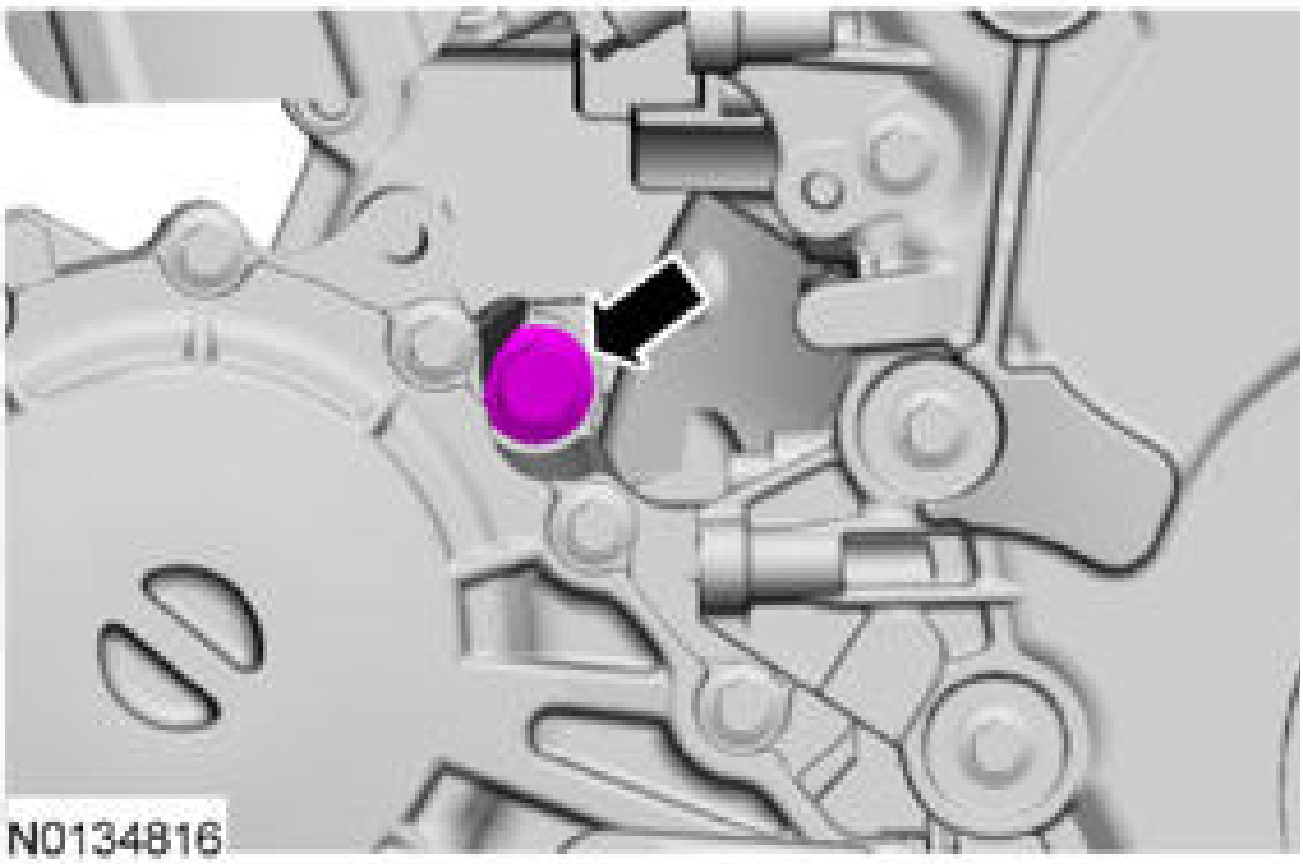
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NOTE: **AWD vehicle shown in illustration, FWD similar. Parts removed from graphic for clarity.**

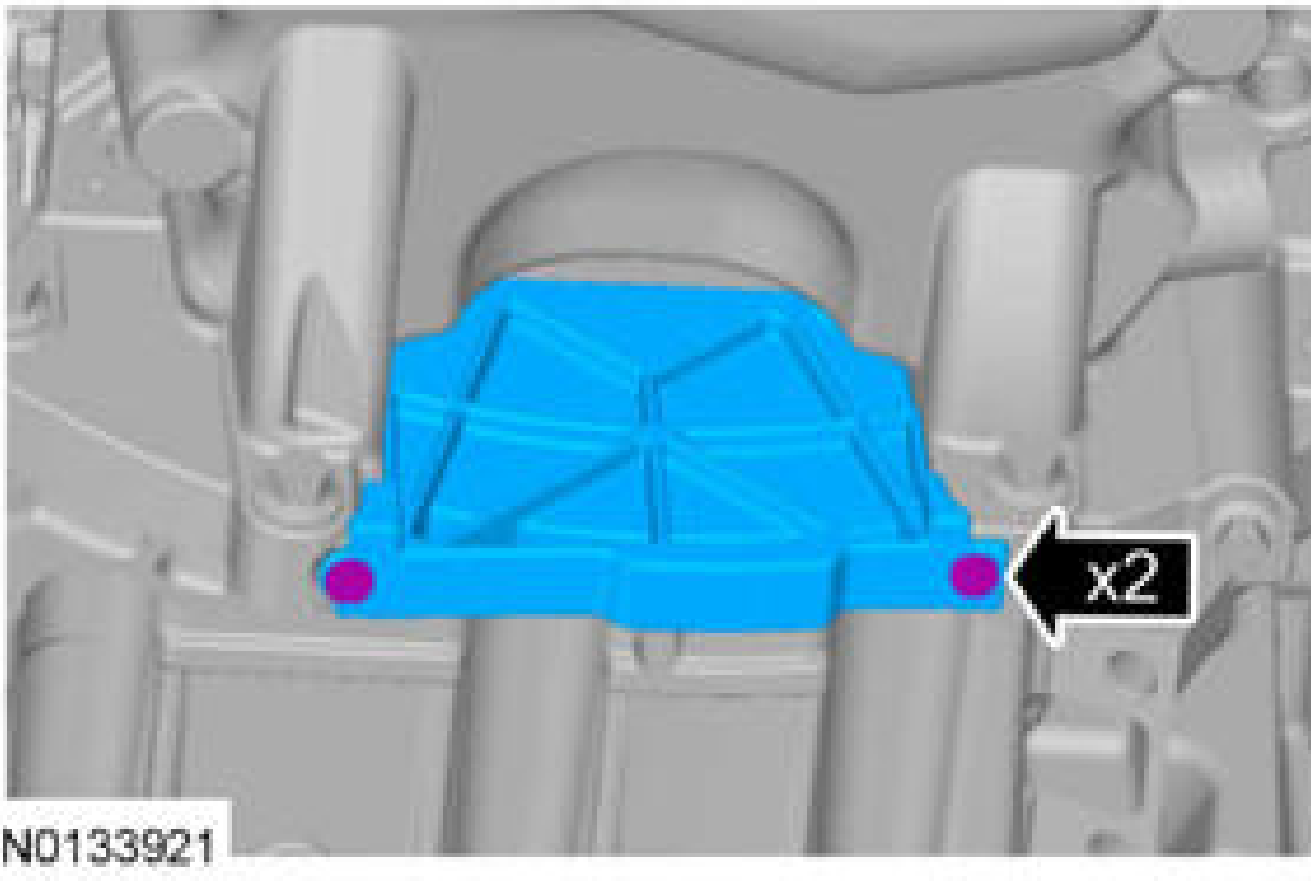
16. Loosen the RH engine-to-bellhousing bolt 5 mm (0.20 in).

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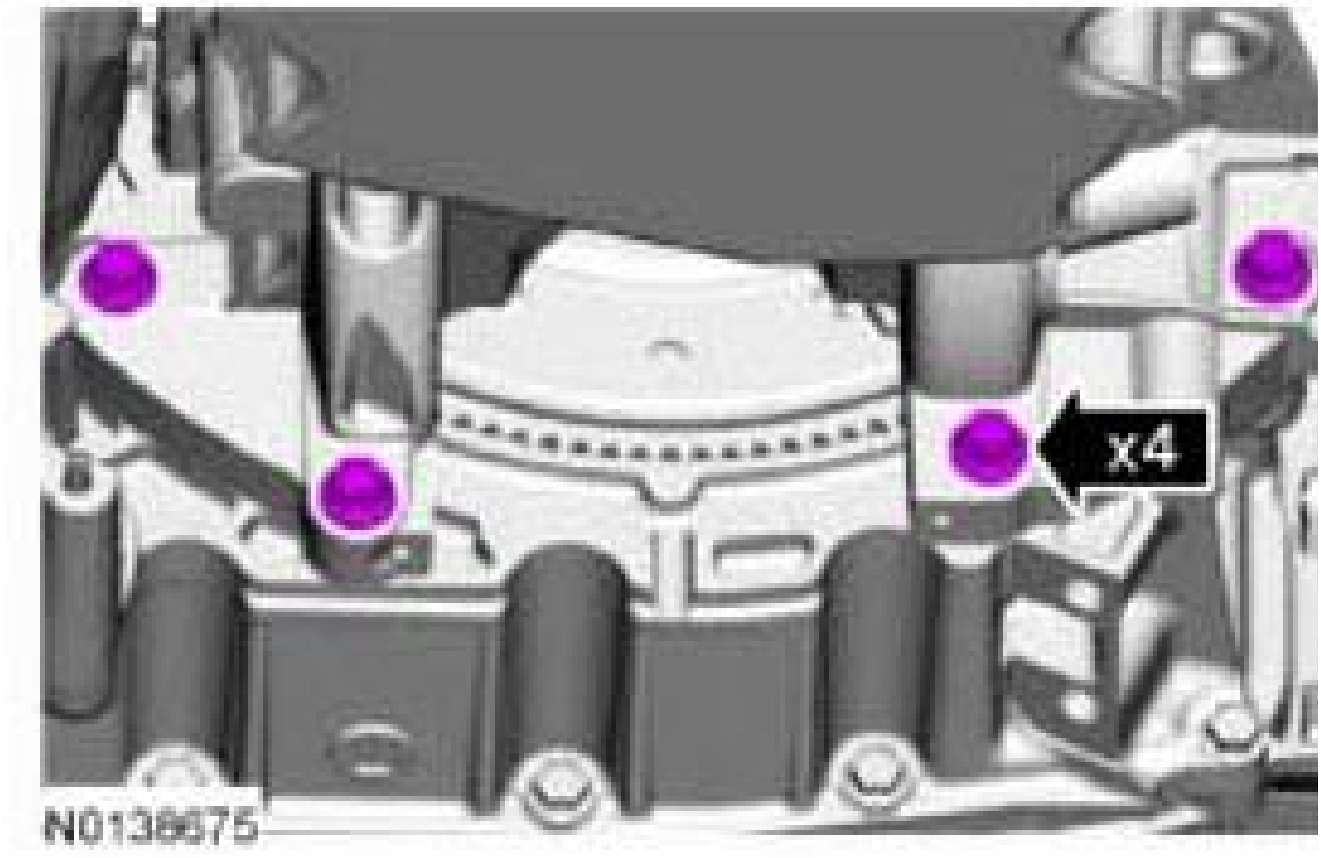
17. Remove the 2 fasteners and the inspection cover.

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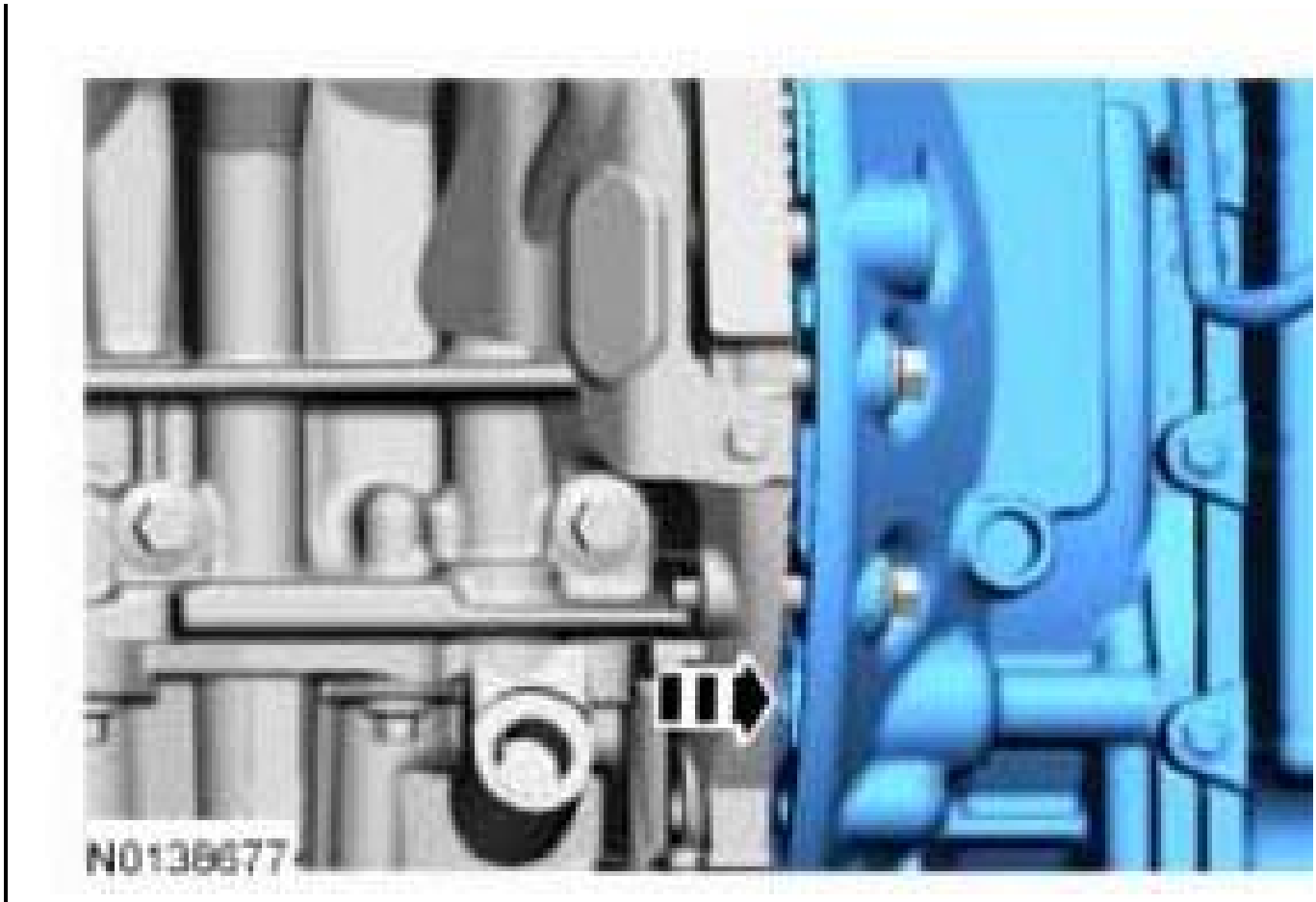
18. Remove the 4 oil pan-to-bellhousing bolts.

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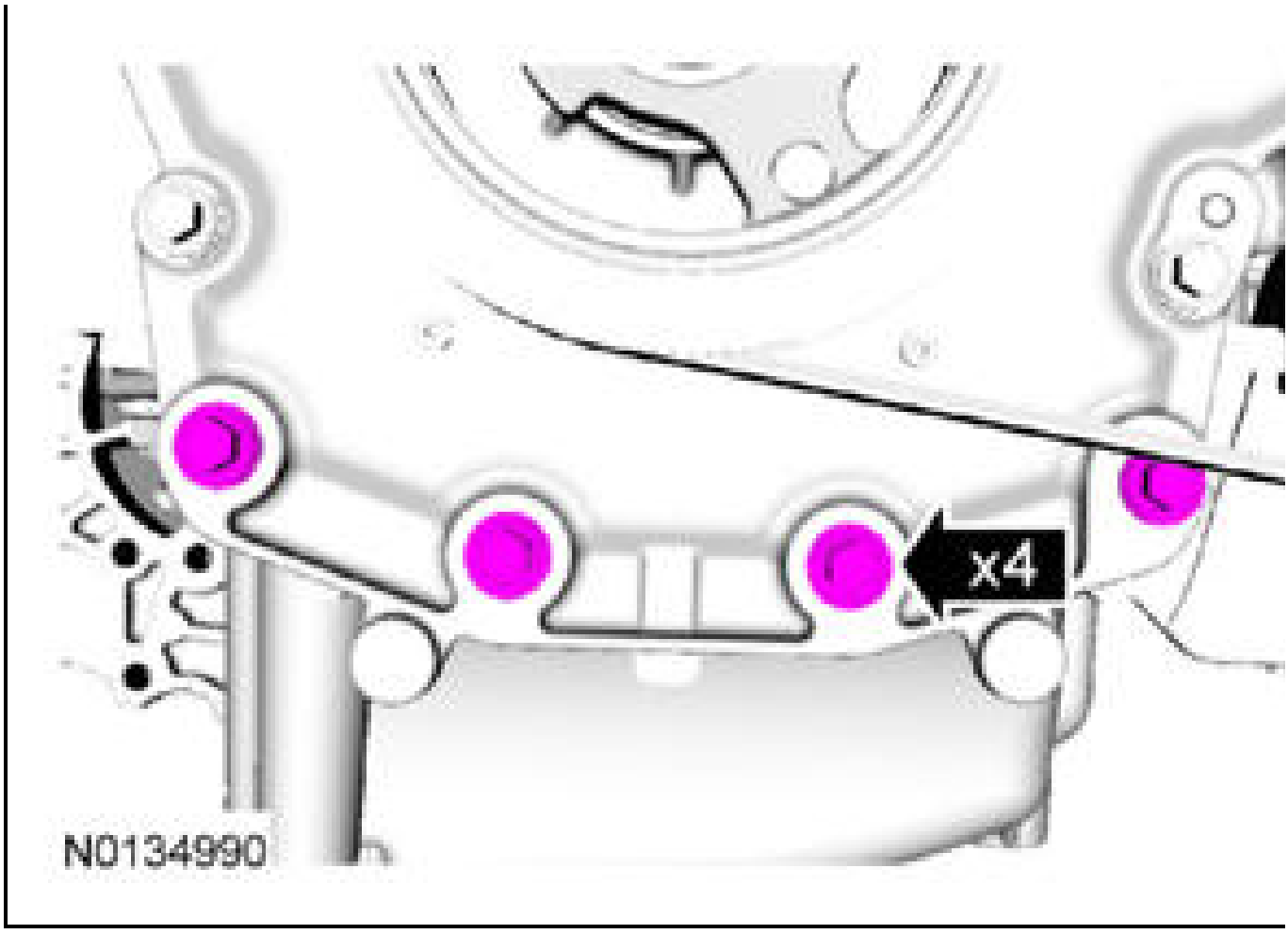
19. Separate the engine and transaxle 5 mm (0.20 in).

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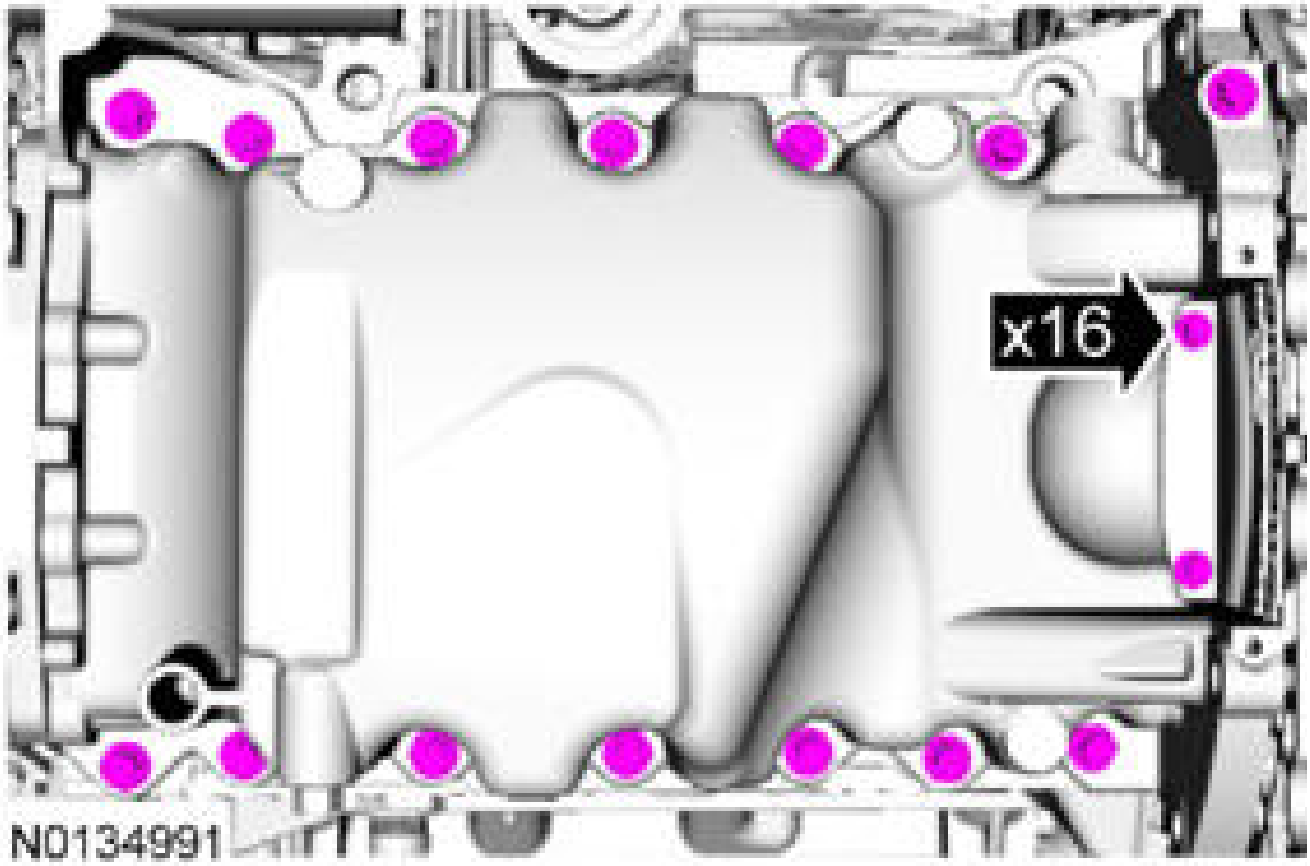
20. Remove the 4 lower engine front cover bolts.

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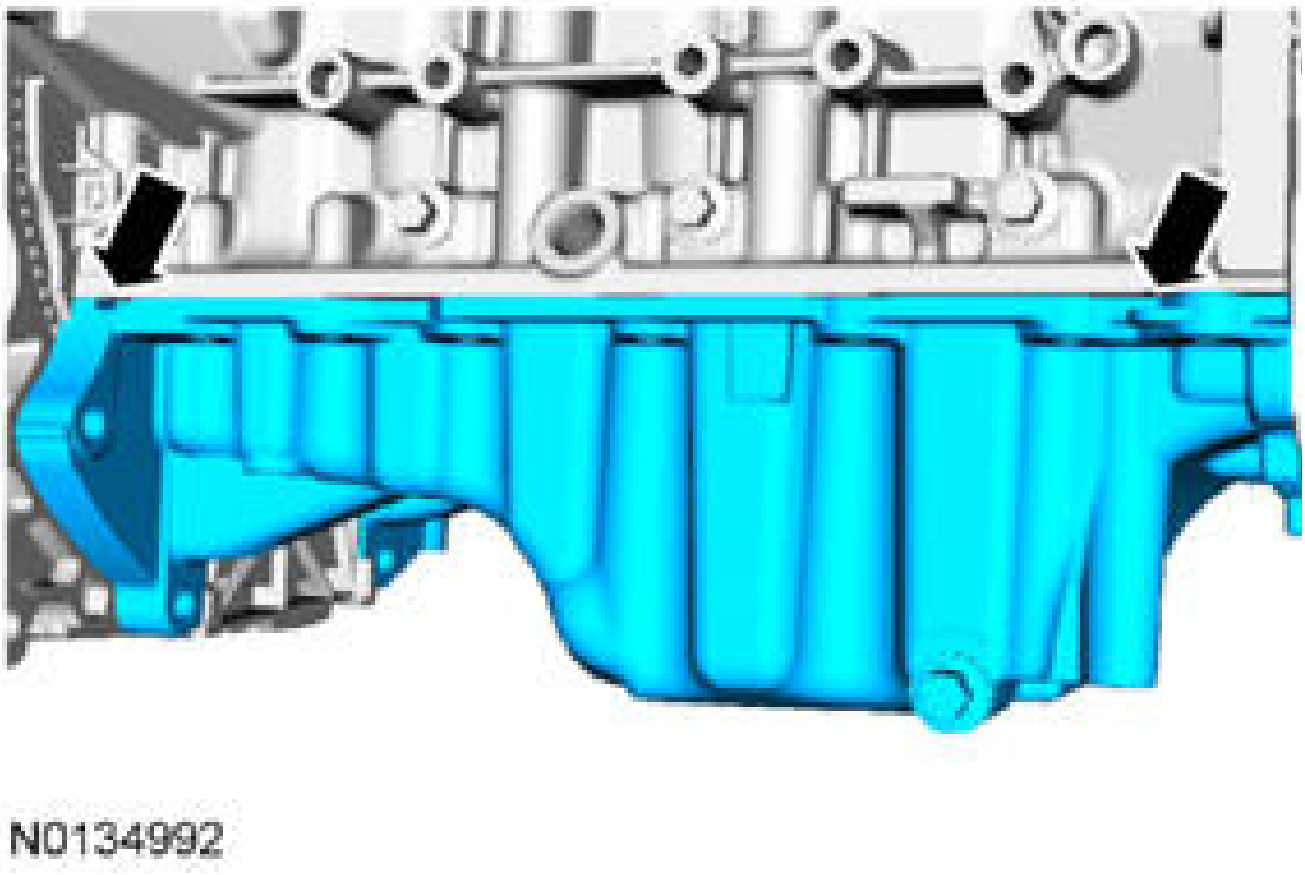
21. Remove the 16 oil pan bolts.

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22. Using a suitable pry tool, locate the pry pads and pry the oil pan loose and remove.

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23. **NOTE: Only use a 3M Roloc® Bristle Disk (2-in white, part number 07528) to clean the oil pan. Do not use metal scrapers, wire brushes or any other power abrasive disk to clean. These tools cause scratches and gouges that make leak paths.**

Clean the engine oil pan using a 3M Roloc® Bristle Disk (2-in white, part number 07528) in a suitable tool turning at the recommended speed of 15,000 rpm. Thoroughly wash the oil pan to remove any foreign material, including any abrasive particles created during the cleaning process.

24. **NOTE: Do not use wire brushes, power abrasive discs or 3M Roloc® Bristle Disk (2-in white, part number 07528) to clean the sealing surfaces. These tools cause scratches and gouges that make leak paths. They also cause contamination that causes premature engine failure. Remove all traces of the gasket.**

Clean the sealing surfaces of the cylinder block and engine front cover in the following sequence.

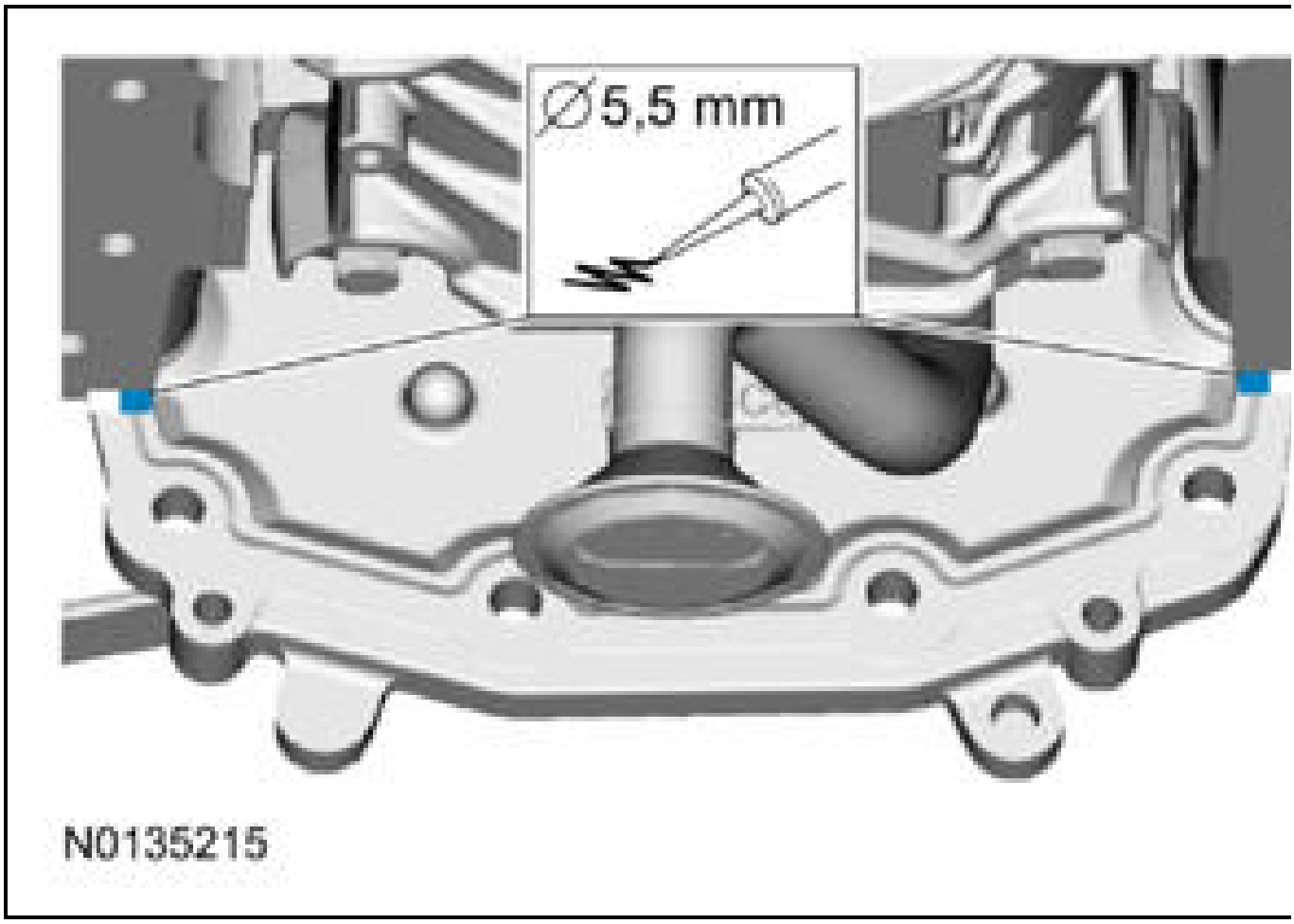
- Remove any large deposits of silicone or gasket material.

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- Apply silicone gasket remover and allow to set for several minutes.
- Remove the silicone gasket remover. A second application of silicone gasket remover may be required if residual traces of silicone or gasket material remain.
- Apply Motorcraft® Metal Surface Prep to remove any remaining traces of oil and to prepare the surfaces to bond. Do not attempt to make the metal shiny. Some staining of the metal surfaces is normal.

Installation

1. Apply a 5.5 mm (0.22 in) bead of Motorcraft® High Performance Engine RTV Silicone to the 2 engine front cover-to-cylinder block joint areas on the sealing surface of the oil pan.



2. **NOTE: Failure to use Motorcraft® High Performance Engine RTV Silicone may cause the engine oil to foam excessively and result in serious engine damage.**

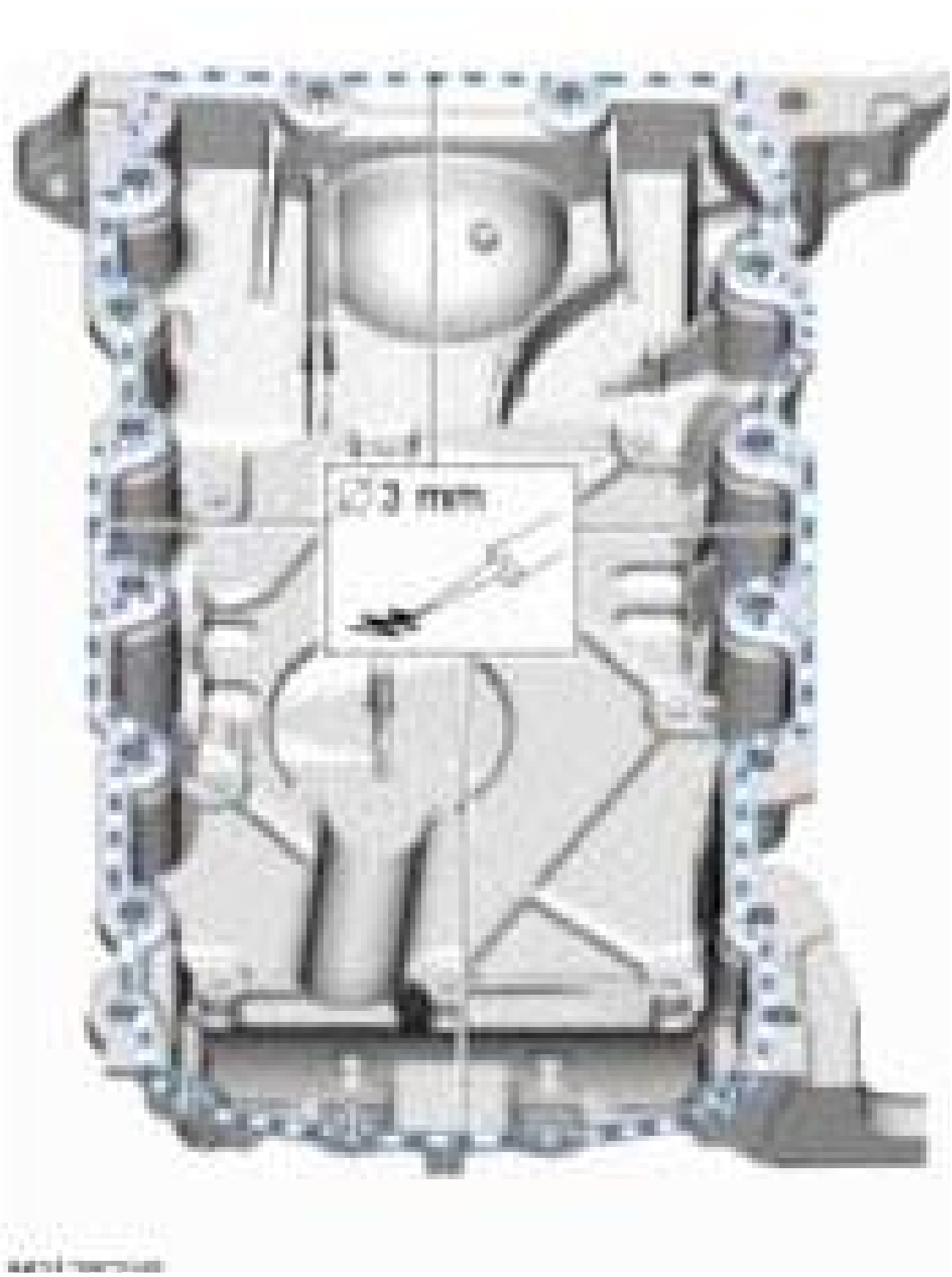
NOTE: The oil pan and the 4 specified bolts must be installed and the oil pan aligned to the cylinder block within 4 minutes of sealant application. Final

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tightening of the oil pan bolts must be carried out within 60 minutes of sealant application.

Apply a 3 mm (0.12 in) bead of Motorcraft® High Performance Engine RTV Silicone to the sealing surface of the oil pan-to-engine block and to the oil pan-to-engine front cover mating surface.

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3. Apply a 5.5 mm (0.2165 in) bead of Motorcraft® High Performance Engine RTV Silicone to the 2 crankshaft seal retainer plate-to-cylinder block joint areas on the sealing surface of the oil pan.

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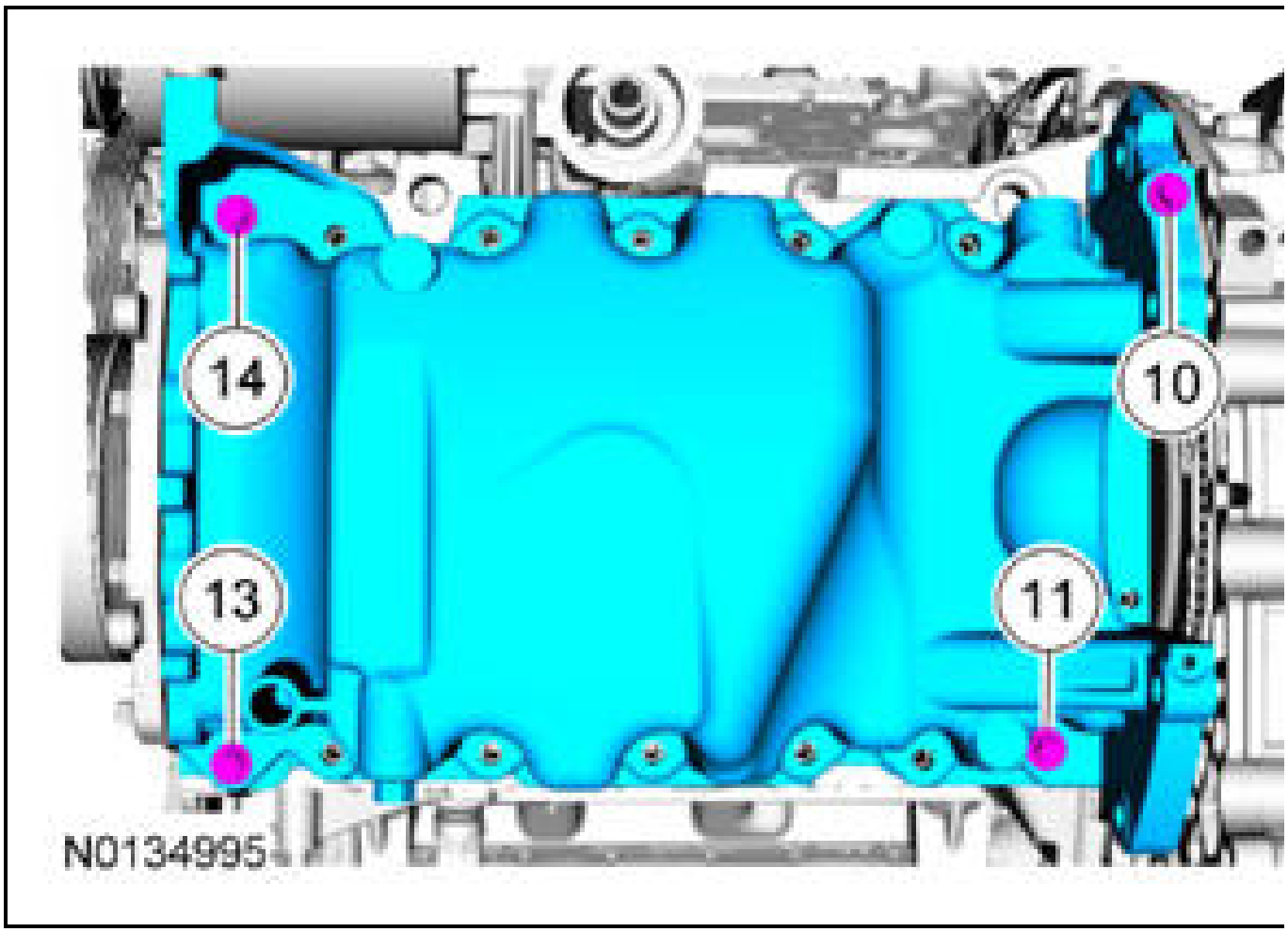


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4. **NOTE: The oil pan and the 4 specified bolts must be installed within 4 minutes of sealant application.**

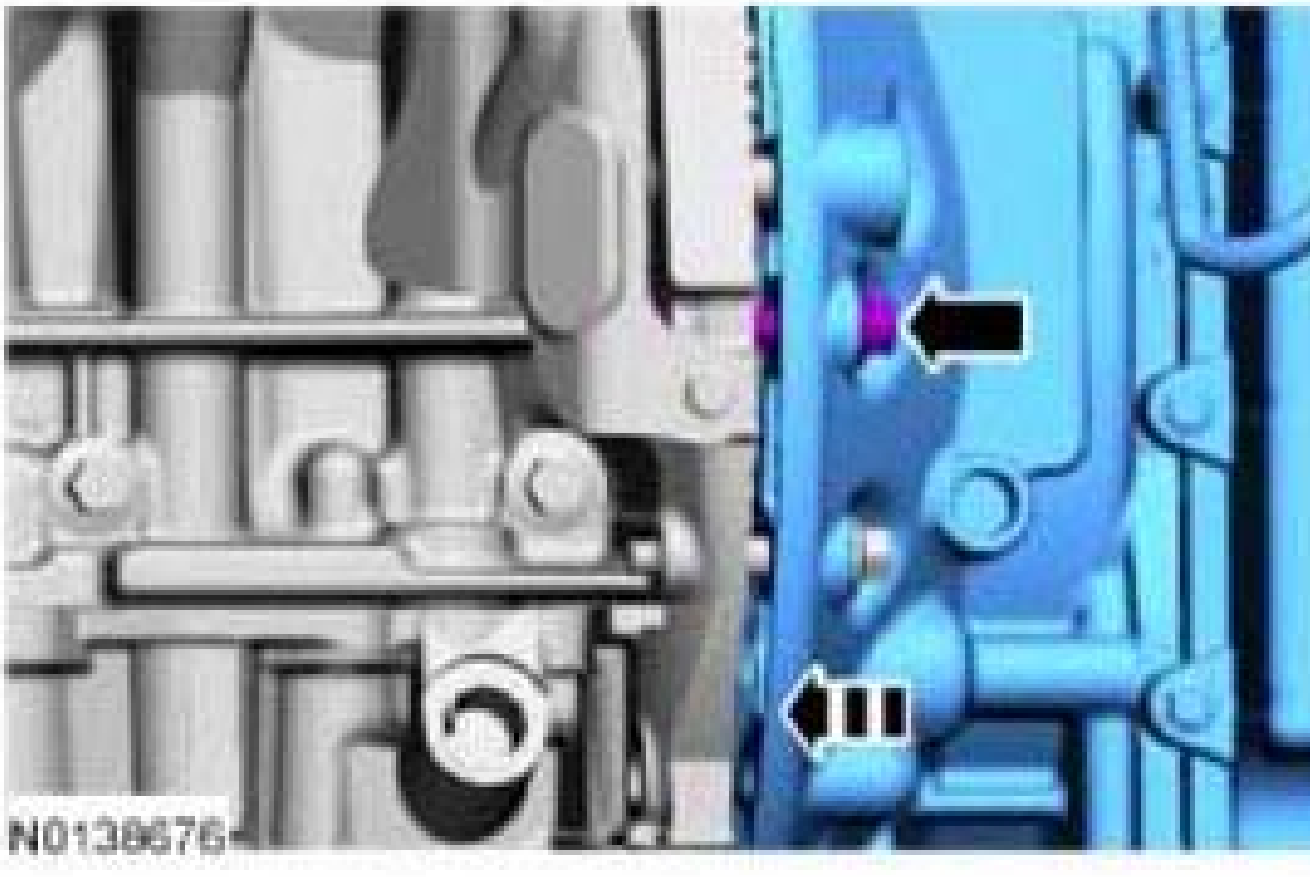
NOTE: Keep the oil pan as close as possible to the transmission while installing, then slide forward towards the engine front cover to prevent wiping off of the sealant.

Install the oil pan and bolts 10, 11, 13 and 14 finger tight.



5. Draw the bellhousing up to the engine by tightening the LH bellhousing-to-engine bolt. Do not torque at this time.

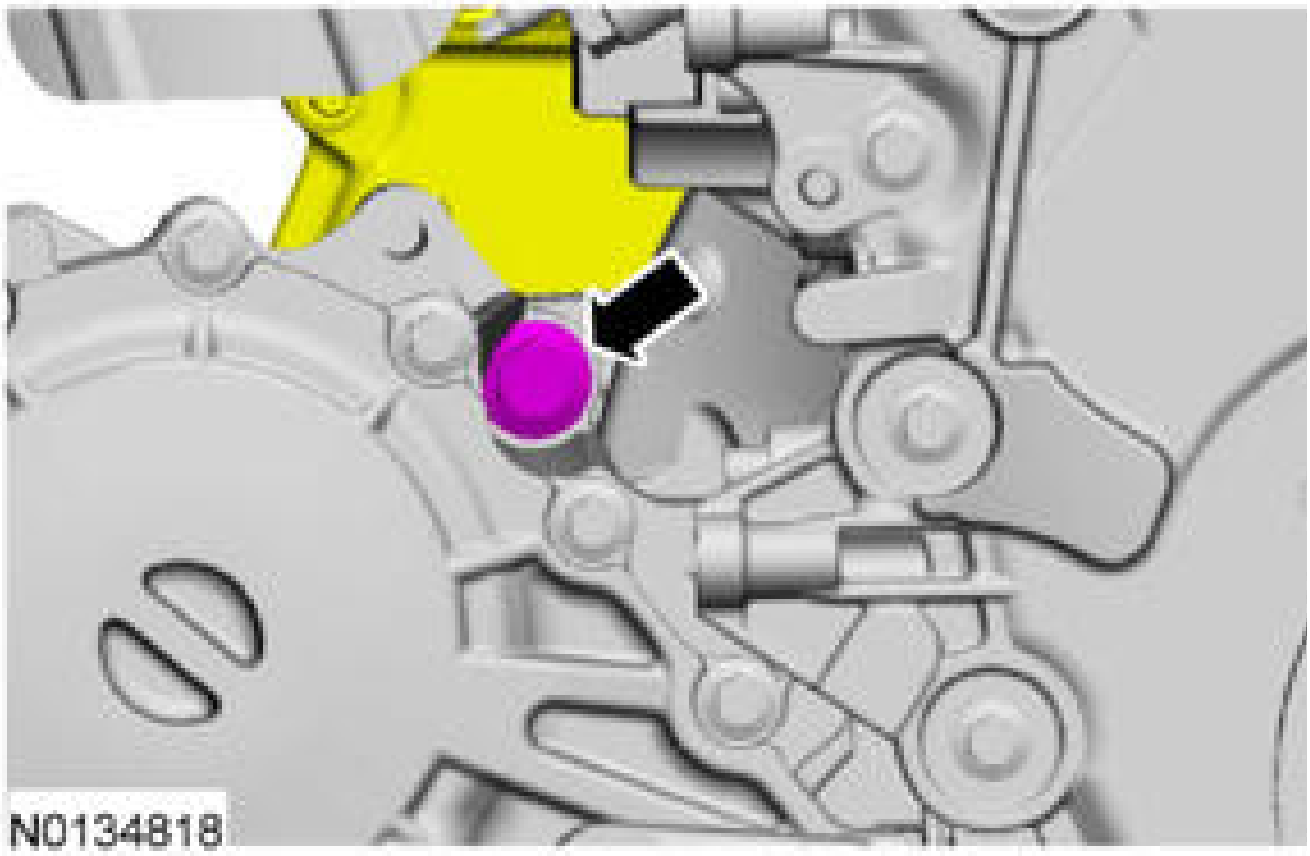
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NOTE: AWD vehicle shown in illustration, FWD similar. Parts removed from graphic for clarity.

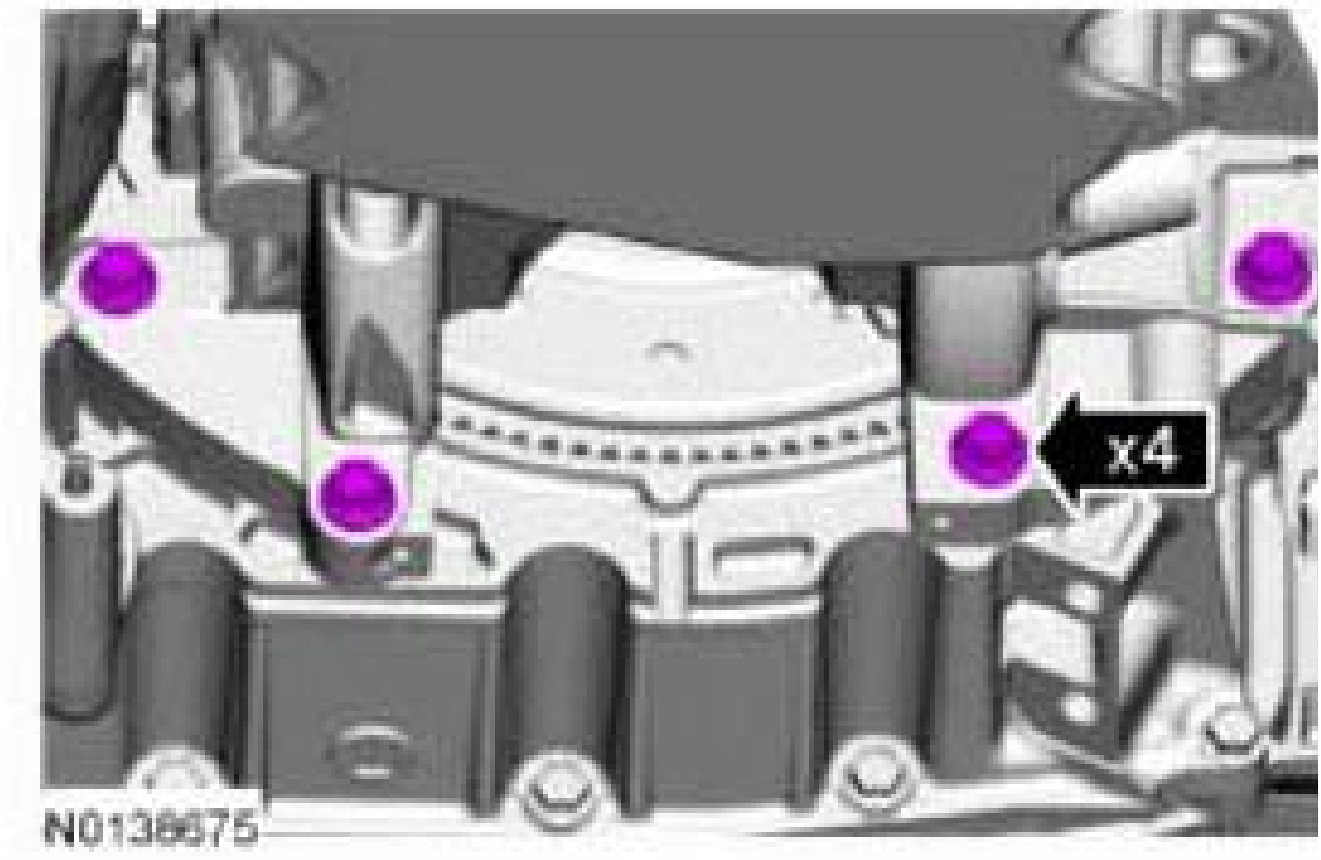
6. Draw the bellhousing up to the engine by tightening the RH bellhousing-to-engine bolt. Do not torque at this time.

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7. Install the 4 oil pan-to-bellhousing bolts. Do not torque at this time.

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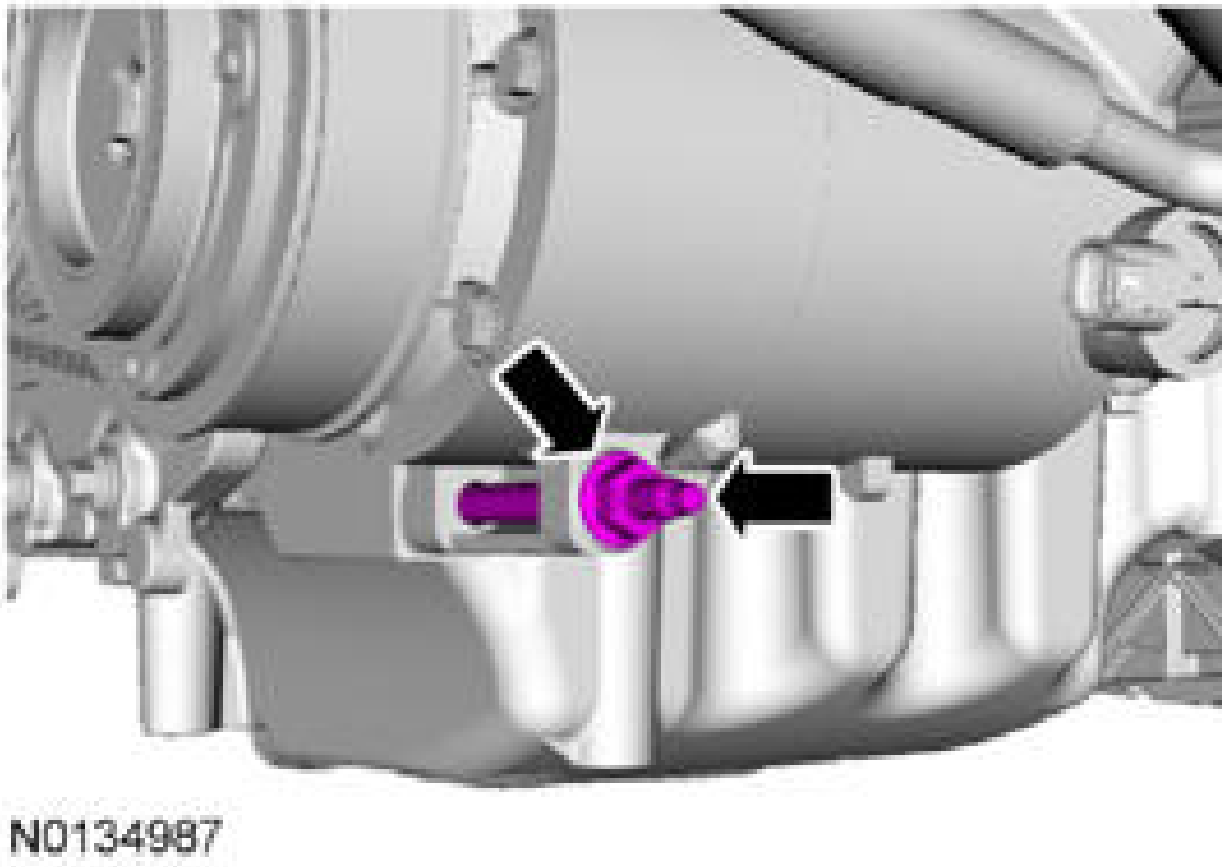


8. **NOTE: It may be necessary to roll the bottom of the engine back for the A/C compressor stud to clear the subframe.**

Install the A/C compressor nut and stud.

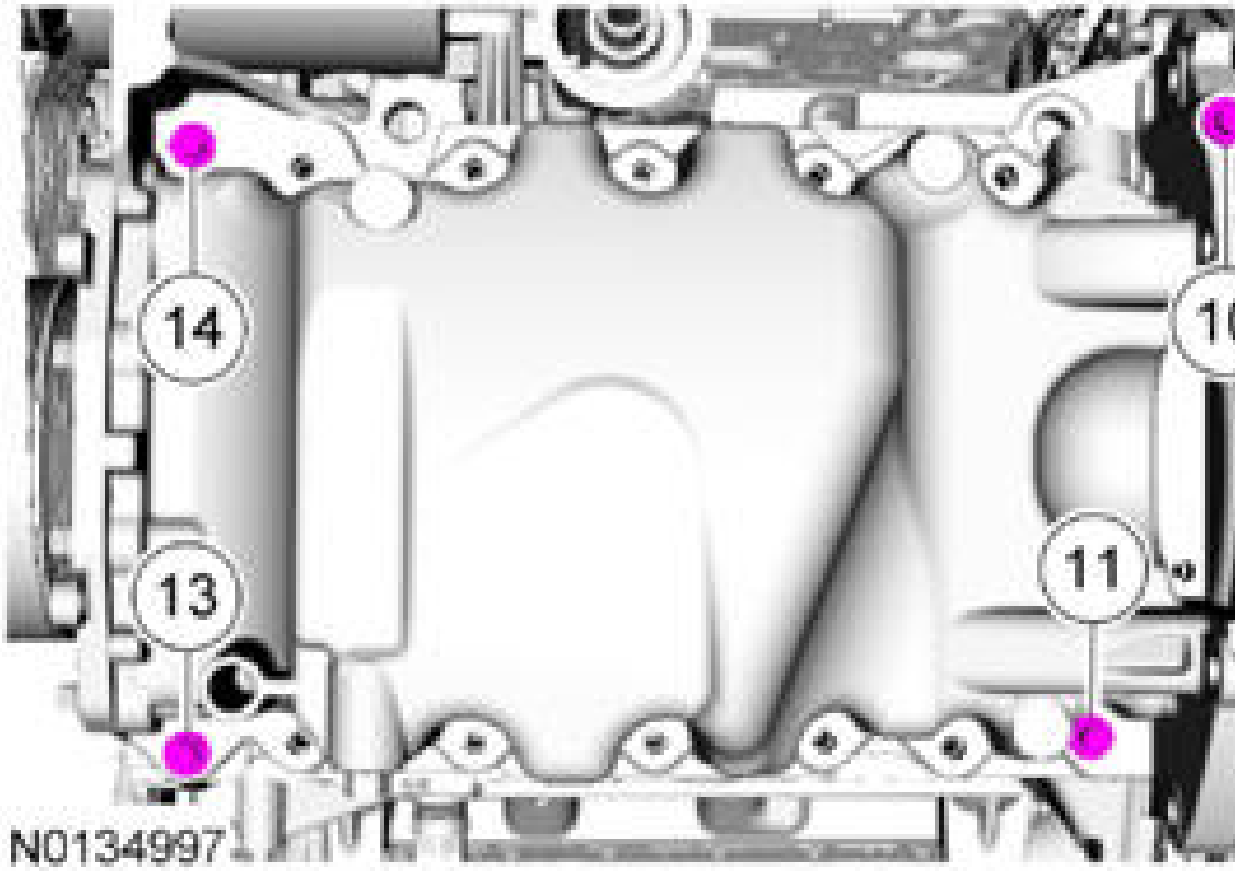
- Tighten the stud to 9 Nm (80 lb-in).
- Hand tighten the nut.

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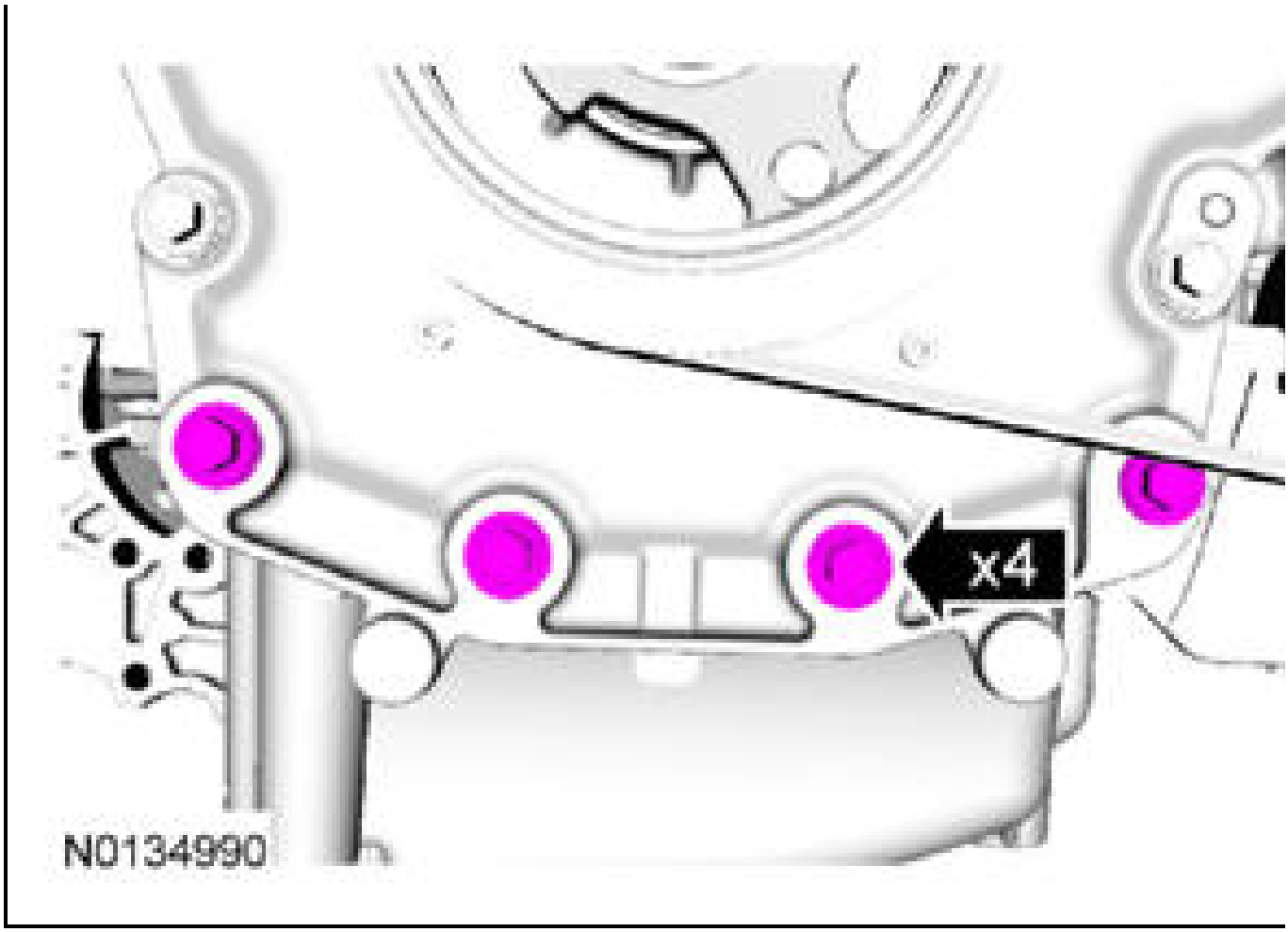
9. Tighten bolts 10, 11, 13 and 14 in the sequence shown in illustration.
    - Tighten to 3 Nm (27 lb-in).

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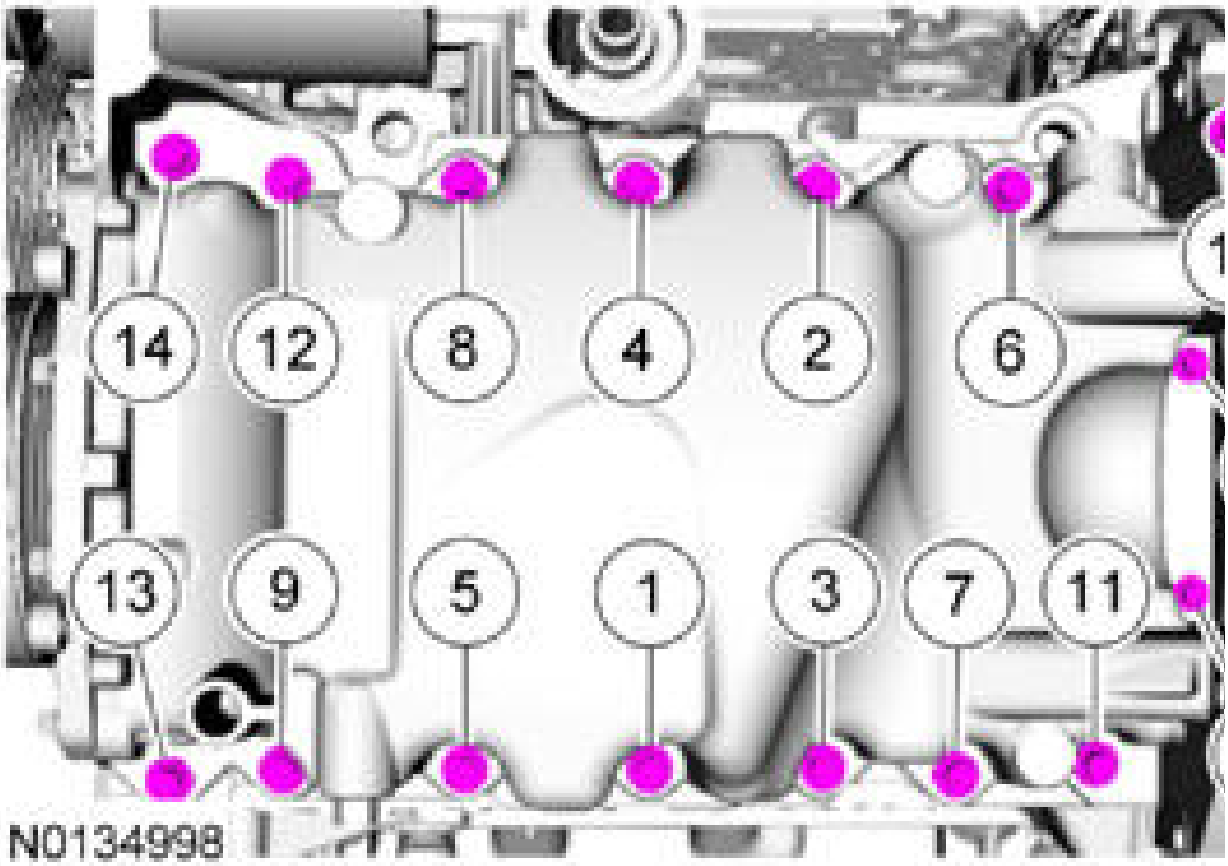
10. Install the 4 lower engine front cover bolts. Do not torque at this time.

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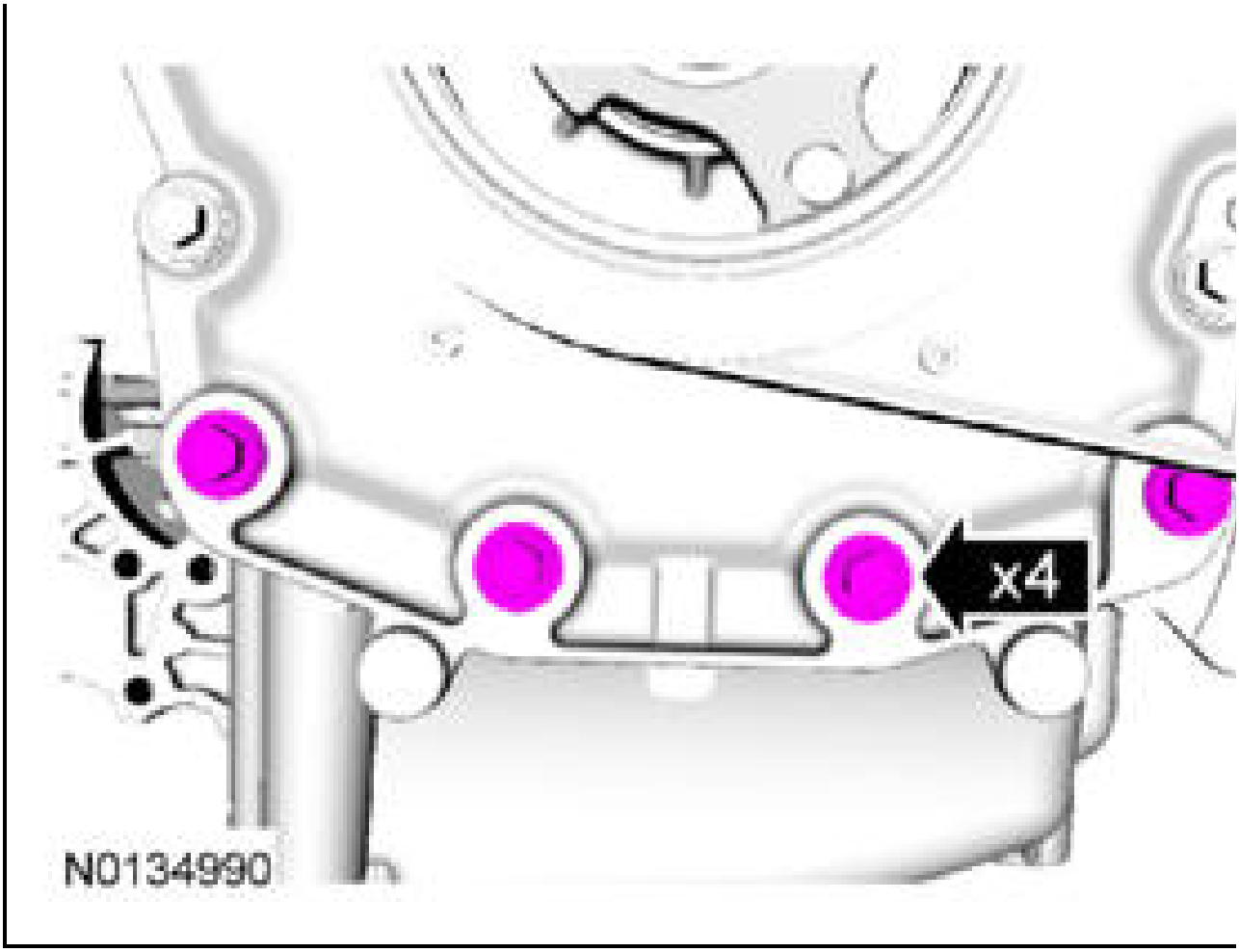
11. Install the remaining oil pan bolts and tighten in the sequence shown in illustration.
    - Tighten bolts 1 through 9 and 11 through 14 to 20 Nm (177 lb-in), then rotate and additional 45 degrees.
    - Tighten bolts 15 and 16 to 10 Nm (89 lb-in), then rotate and additional 45 degrees.
    - Tighten bolt 10 to 20 Nm (177 lb-in), then rotate and additional 45 degrees.

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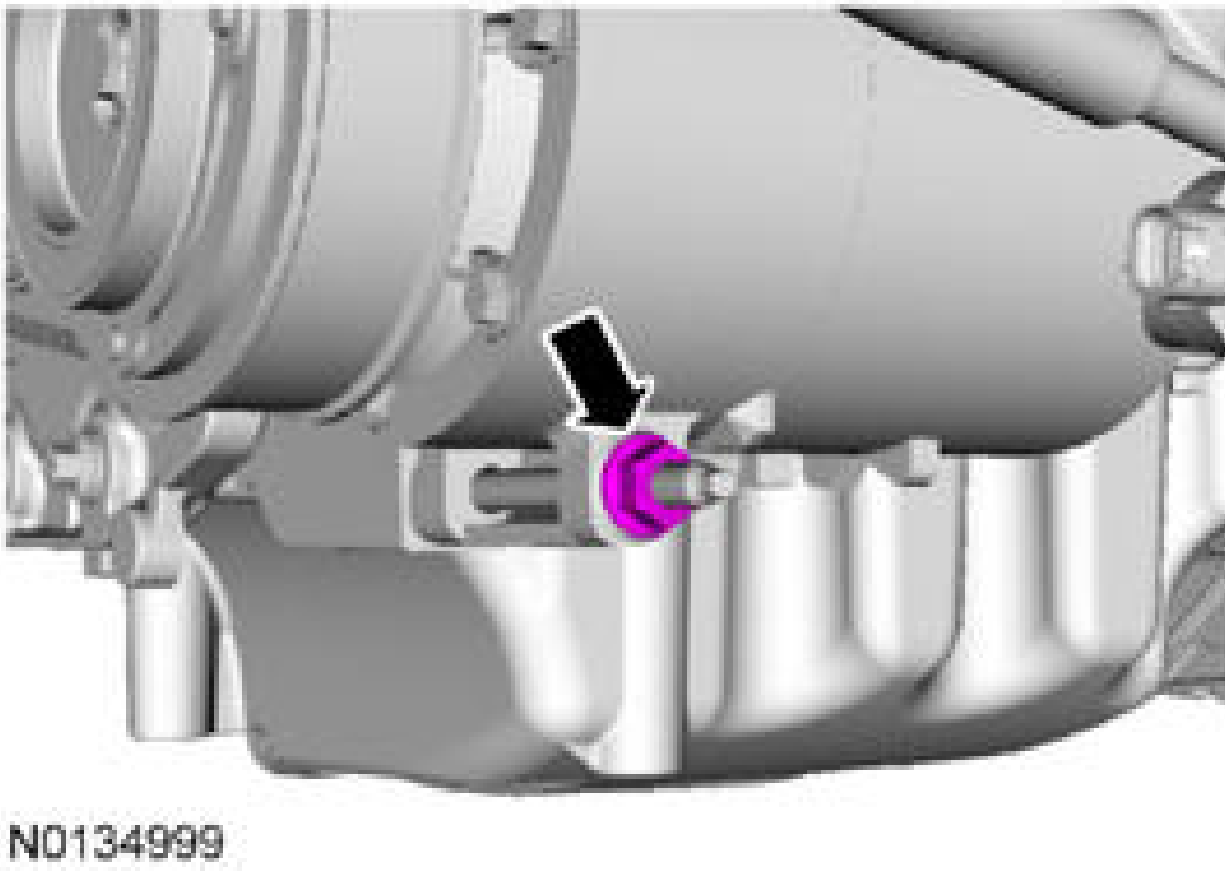
12. Tighten the 4 lower engine front cover bolts.
    - Tighten to 24 Nm (18 lb-ft).

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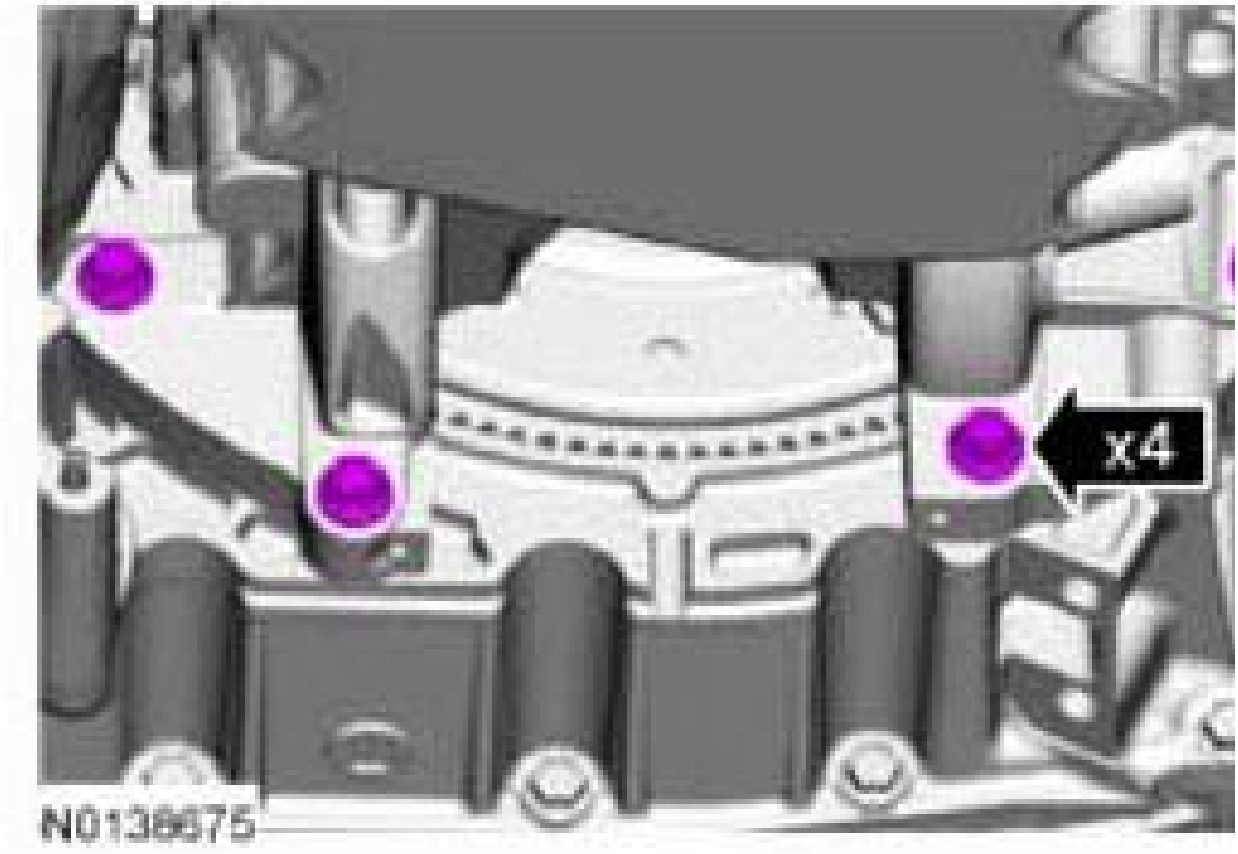
13. Tighten the A/C compressor nut.
    - Tighten to 25 Nm (18 lb-ft).

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14. Tighten the 4 oil pan-to-bellhousing bolts.
    - Tighten to 48 Nm (35 lb-ft).

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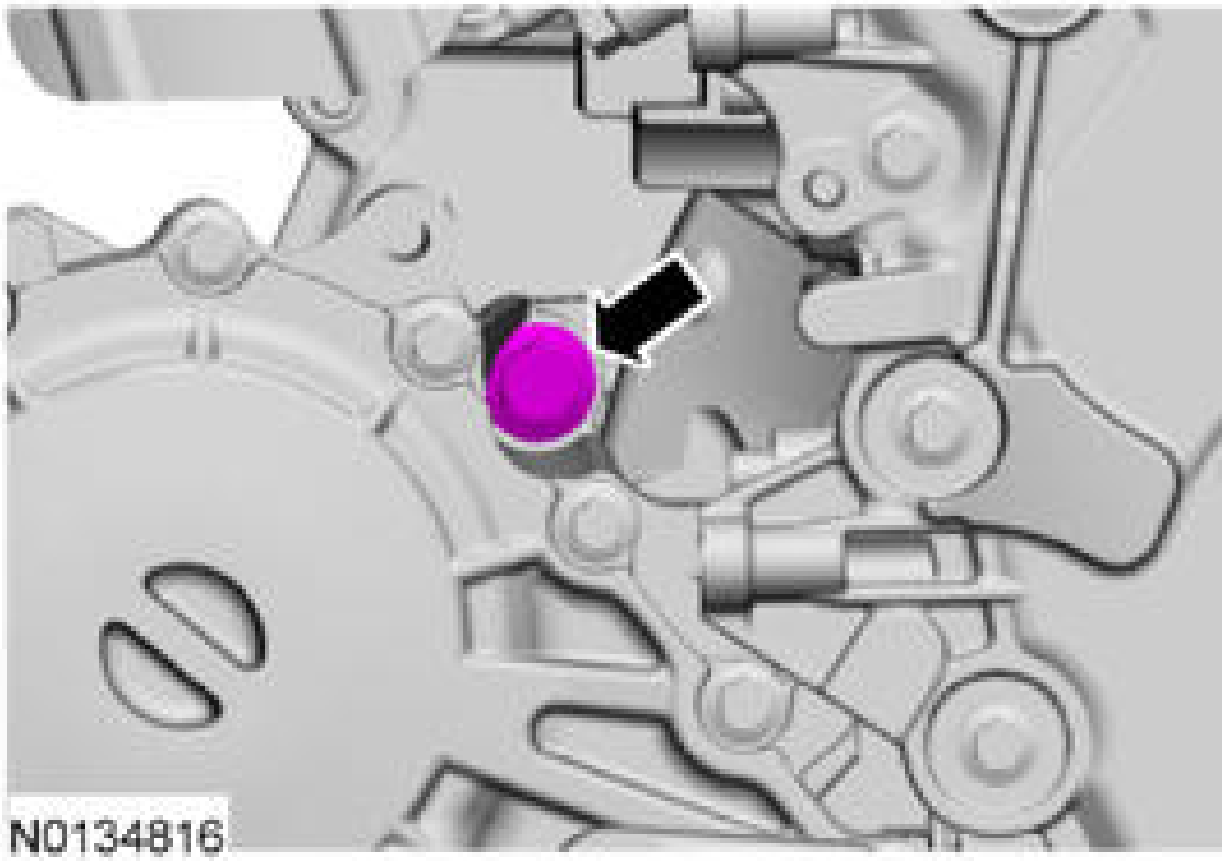


15. **NOTE: AWD vehicle shown in illustration, FWD similar. Parts removed from graphic for clarity.**

Tighten the RH bellhousing-to-engine bolt.

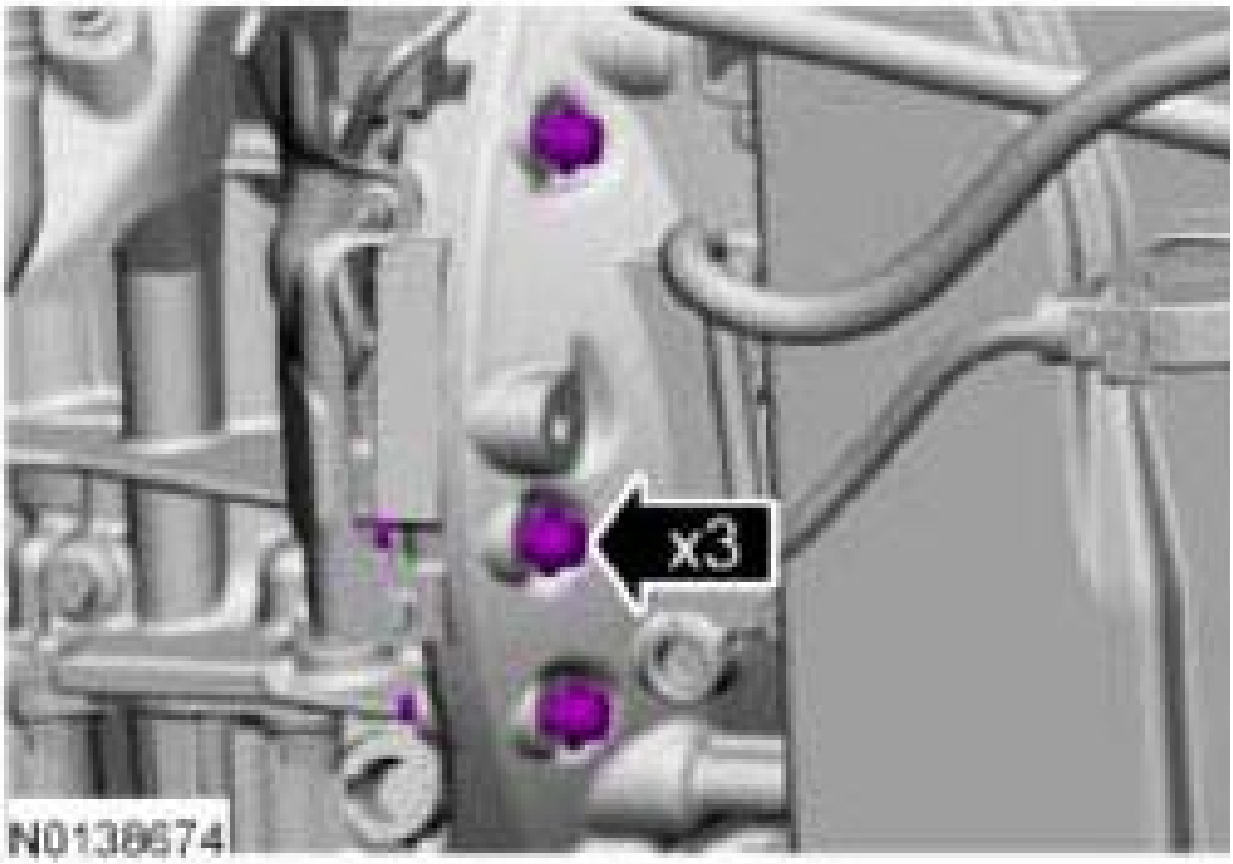
- Tighten to 48 Nm (35 lb-ft).

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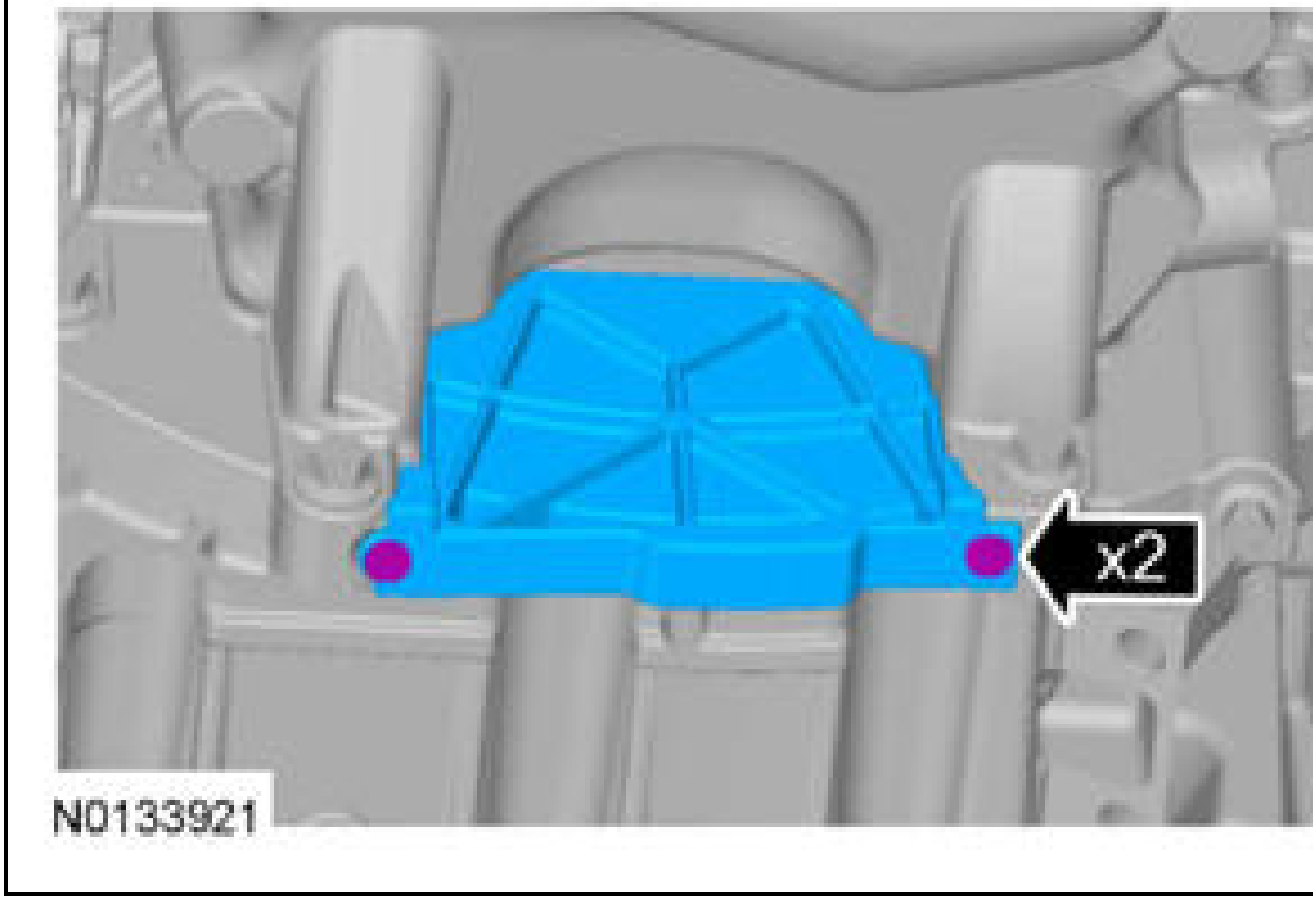
16. Tighten the 3 LH bellhousing-to-engine bolts.
    - Tighten to 48 Nm (35 lb-ft).

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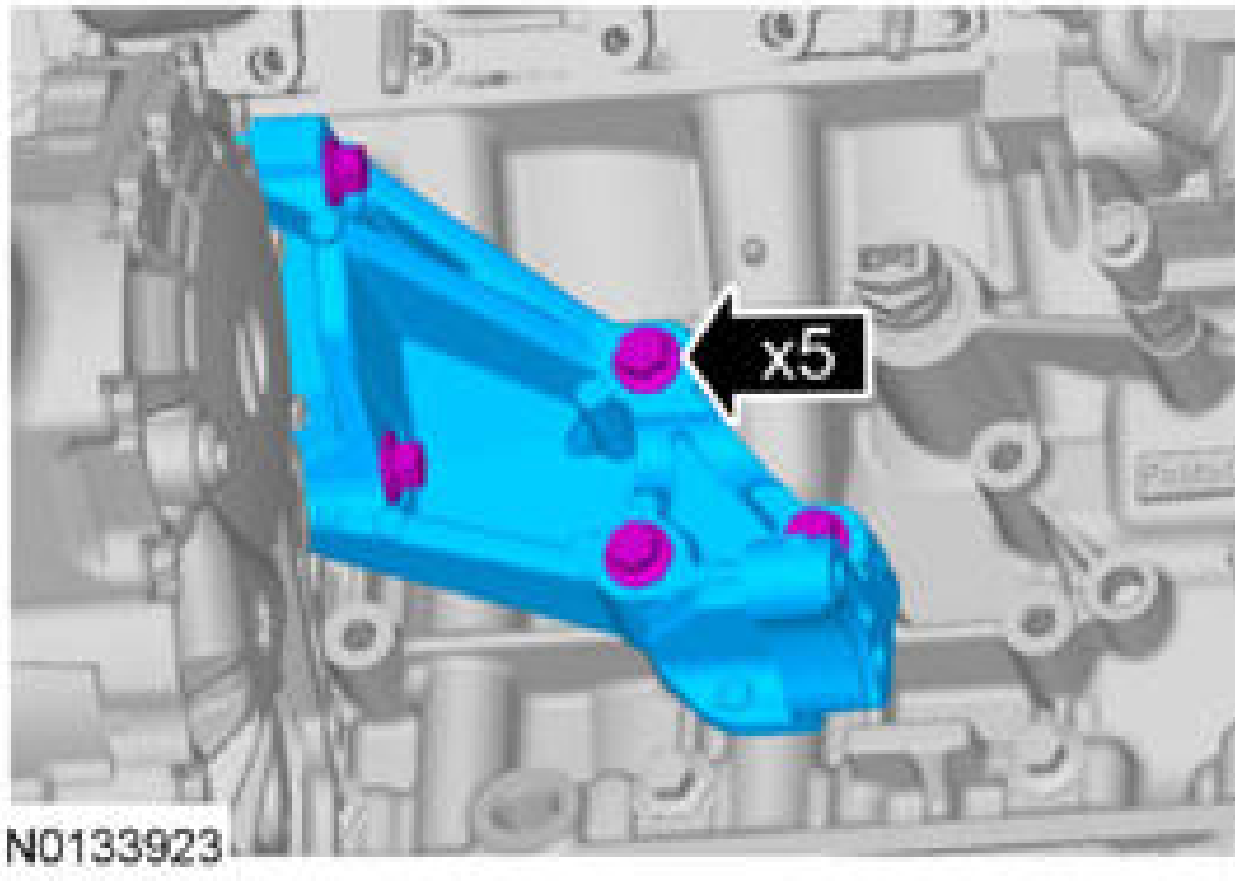
17. Install the inspection cover and the 2 fasteners.

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18. If equipped with **AWD** , install the 5 **PTU** support bracket bolts and the **PTU** support bracket.
    - Tighten to 70 Nm (52 lb-ft).

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19. If equipped with **AWD** , install the catalytic converter - RH manifold. REFER to **CATALYTIC CONVERTER - RH MANIFOLD** .

20. **NOTE: Do not lubricate the engine oil filter gasket.**

    Install a new engine oil filter.

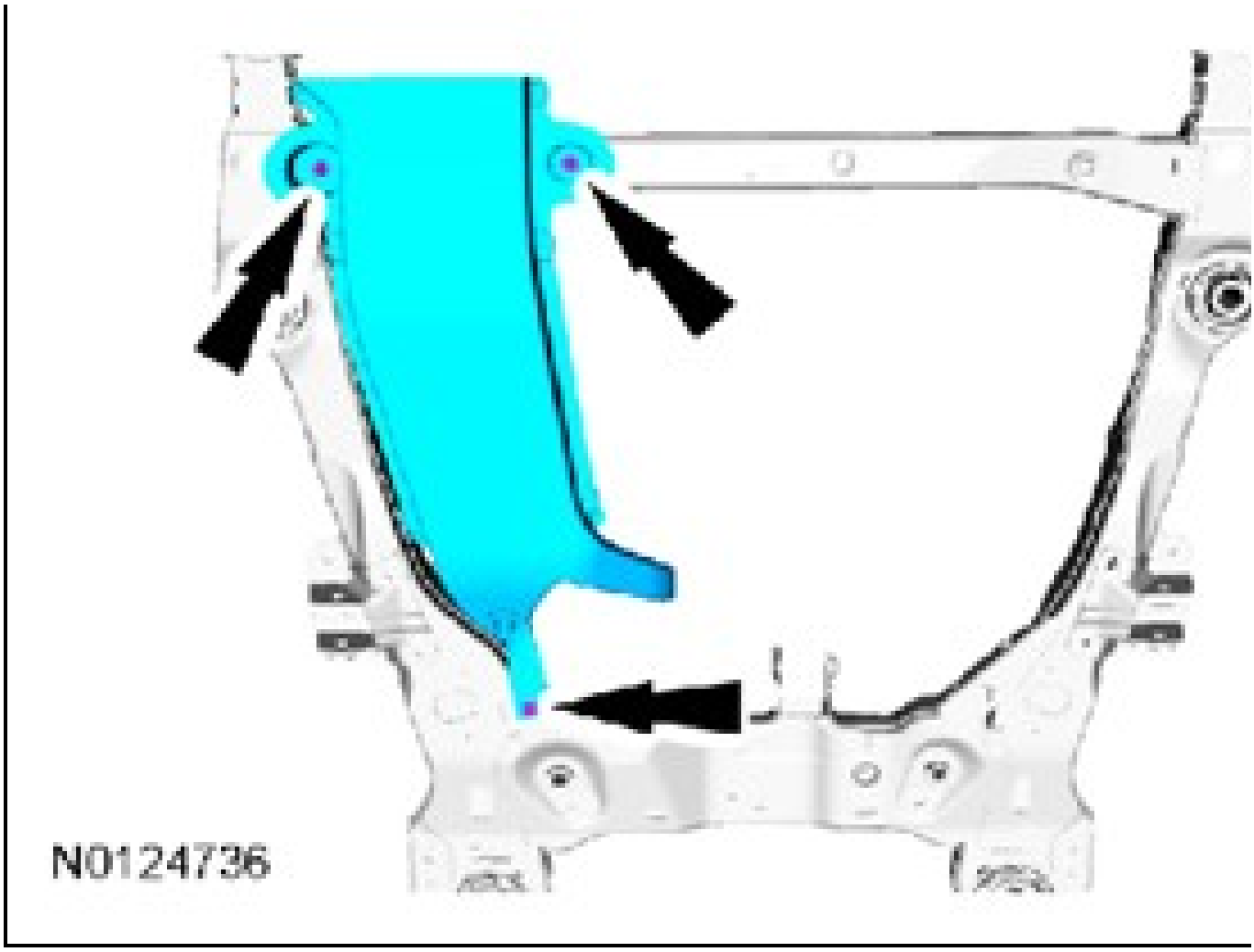
    - Tighten to 5 Nm (44 lb-in) and then rotate an additional 180 degrees.

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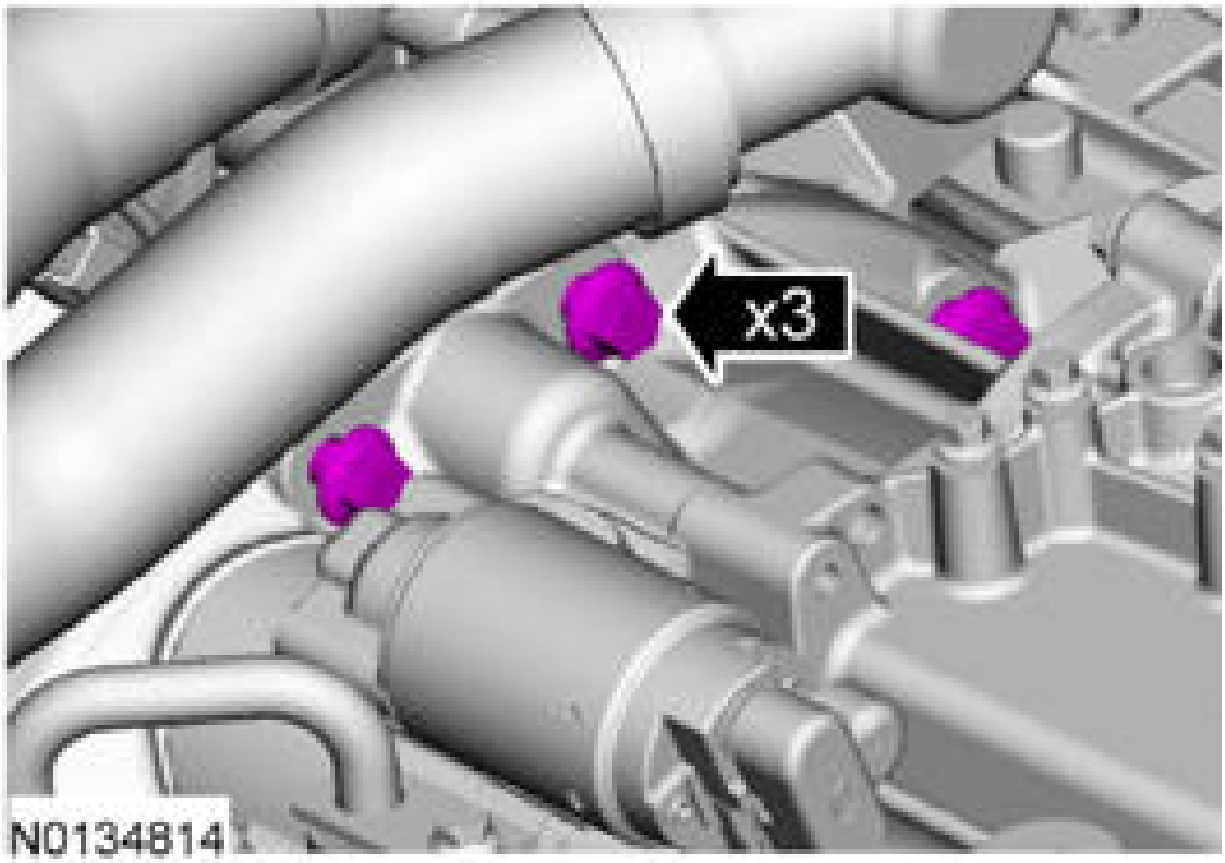
21. Install the transaxle support insulator - anti-roll. For FWD vehicles, REFER to **TRANSMISSION SUPPORT INSULATOR - ANTI-ROLL FWD** or for **AWD** vehicles, REFER to **TRANSMISSION SUPPORT INSULATOR - ANTI-ROLL AWD** .
22. Install the exhaust Y-pipe. REFER to **EXHAUST Y-PIPE - 3.5L TI-VCT** .
23. Install the air duct and 3 twist-type retainers to the subframe.

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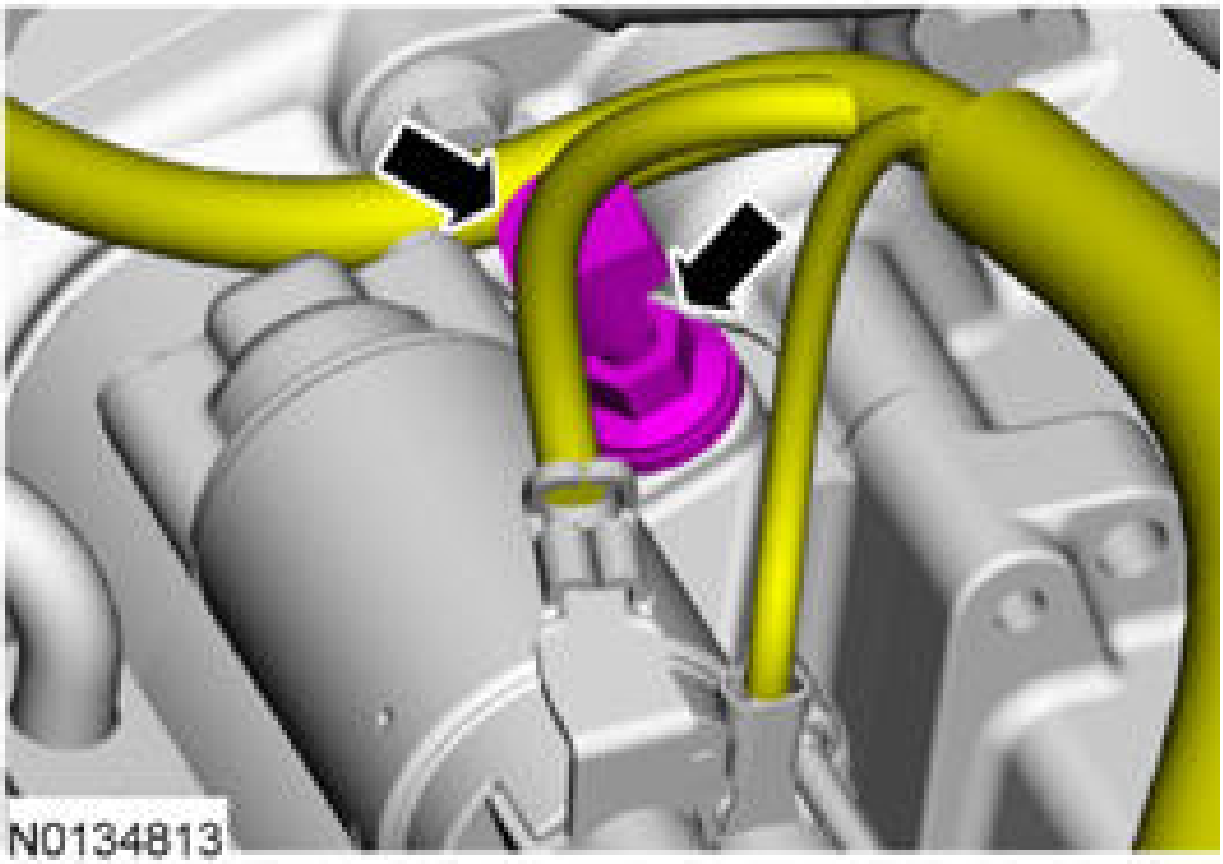
24. Tighten the 3 upper bellhousing-to-engine bolts.
    - Tighten to 48 Nm (35 lb-ft).

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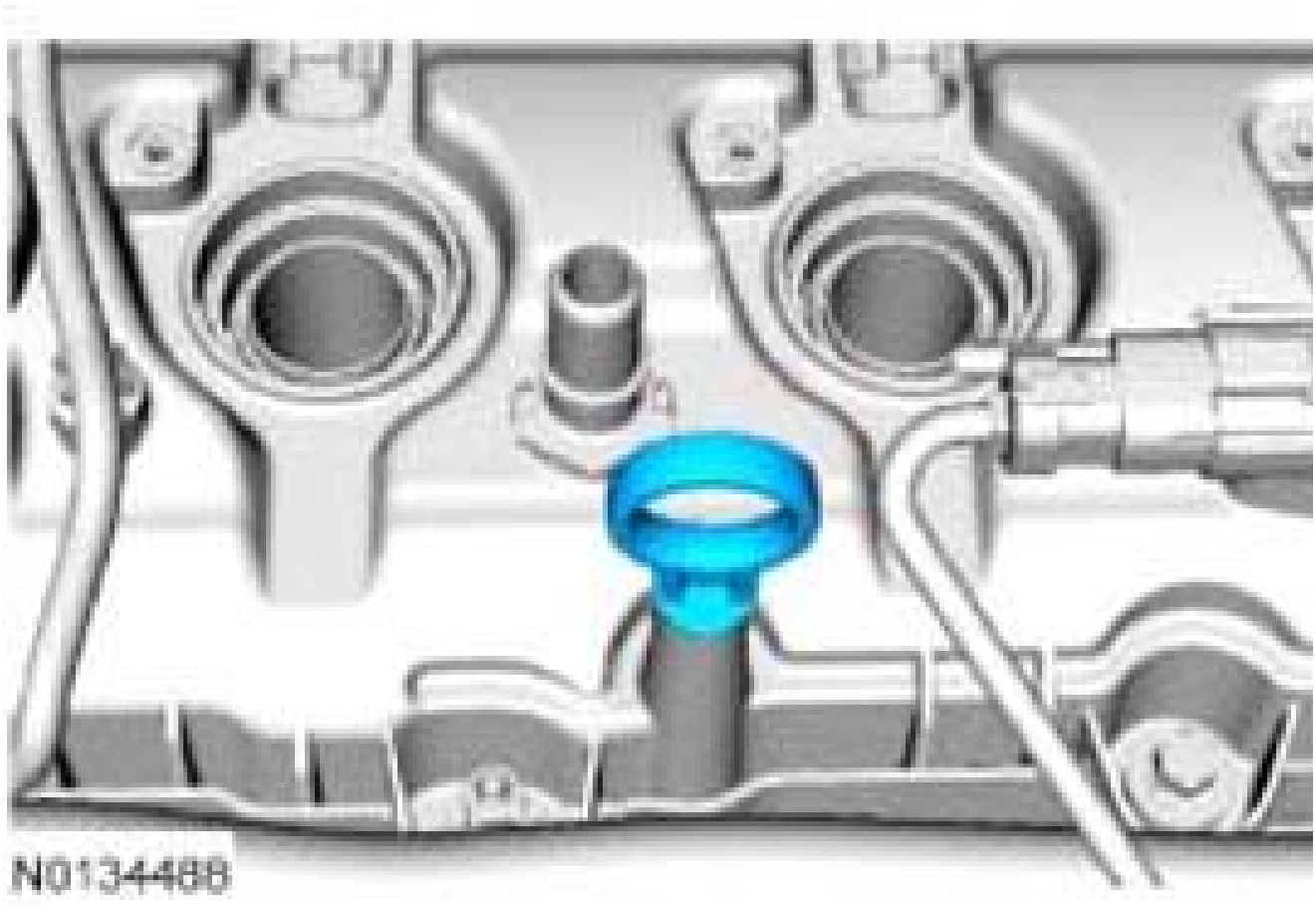
25. Install the starter stud bolt and attach the wire harness retainer to the starter stud bolt.
    - Tighten to 27 Nm (20 lb-ft).

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26. Install the oil level indicator.

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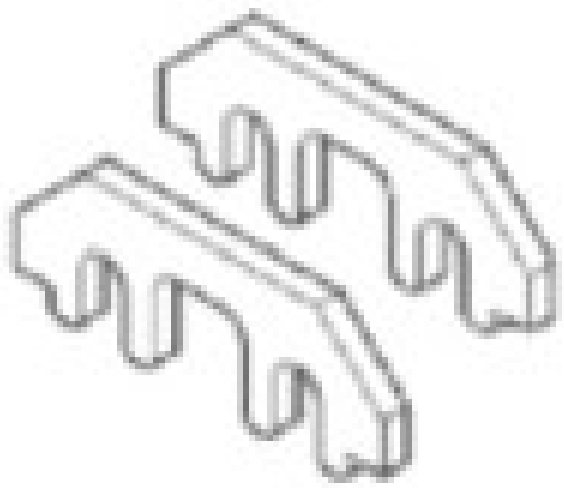
27. Install the battery tray. REFER to **BATTERY AND BATTERY TRAY - EXPLODED VIEW** .
28. Install the ACL tray assembly and ACL outlet pipe. REFER to **INTAKE AIR SYSTEM COMPONENTS - EXPLODED VIEW** .
29. Fill the engine with clean engine oil.

OIL PUMP

SPECIAL TOOL(S) DESCRIPTION

	Camshaft Holding Tools **303-1248**

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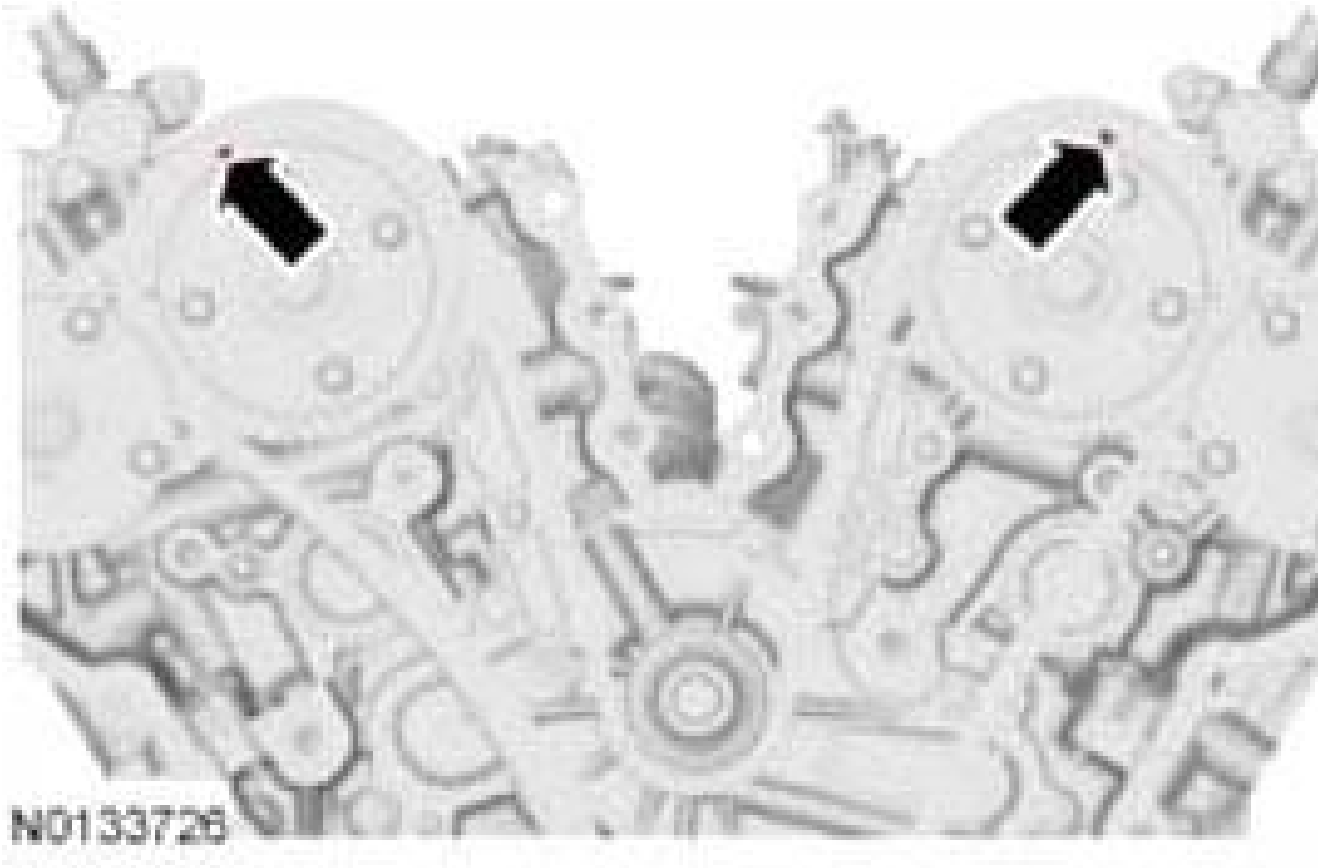


Removal

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

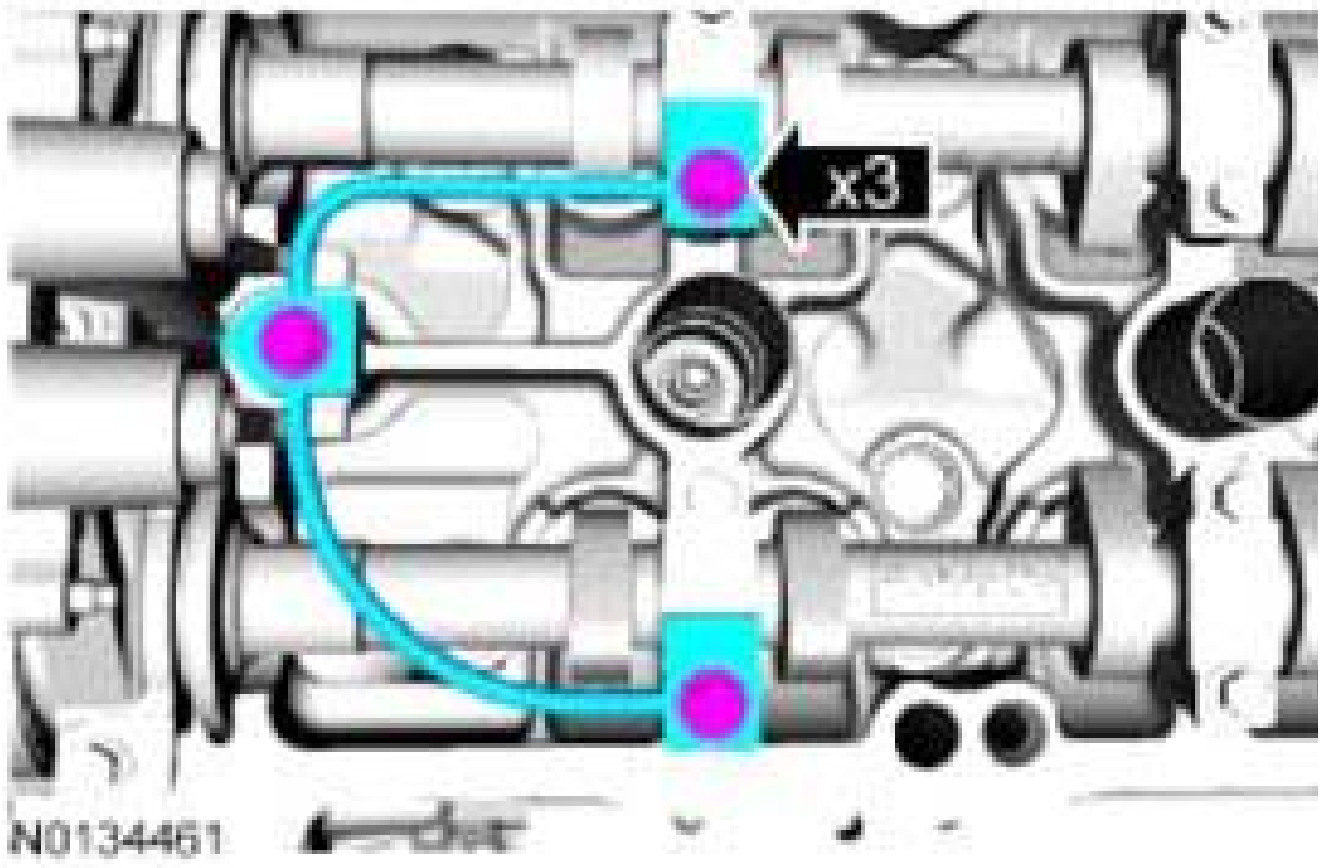
1. Remove the engine front cover. Refer to **ENGINE FRONT COVER**.
2. Rotate the crankshaft clockwise and align the timing marks on the intake **VCT** assemblies as shown in illustration.

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3. Remove the 3 bolts and the LH valve train oil tube.

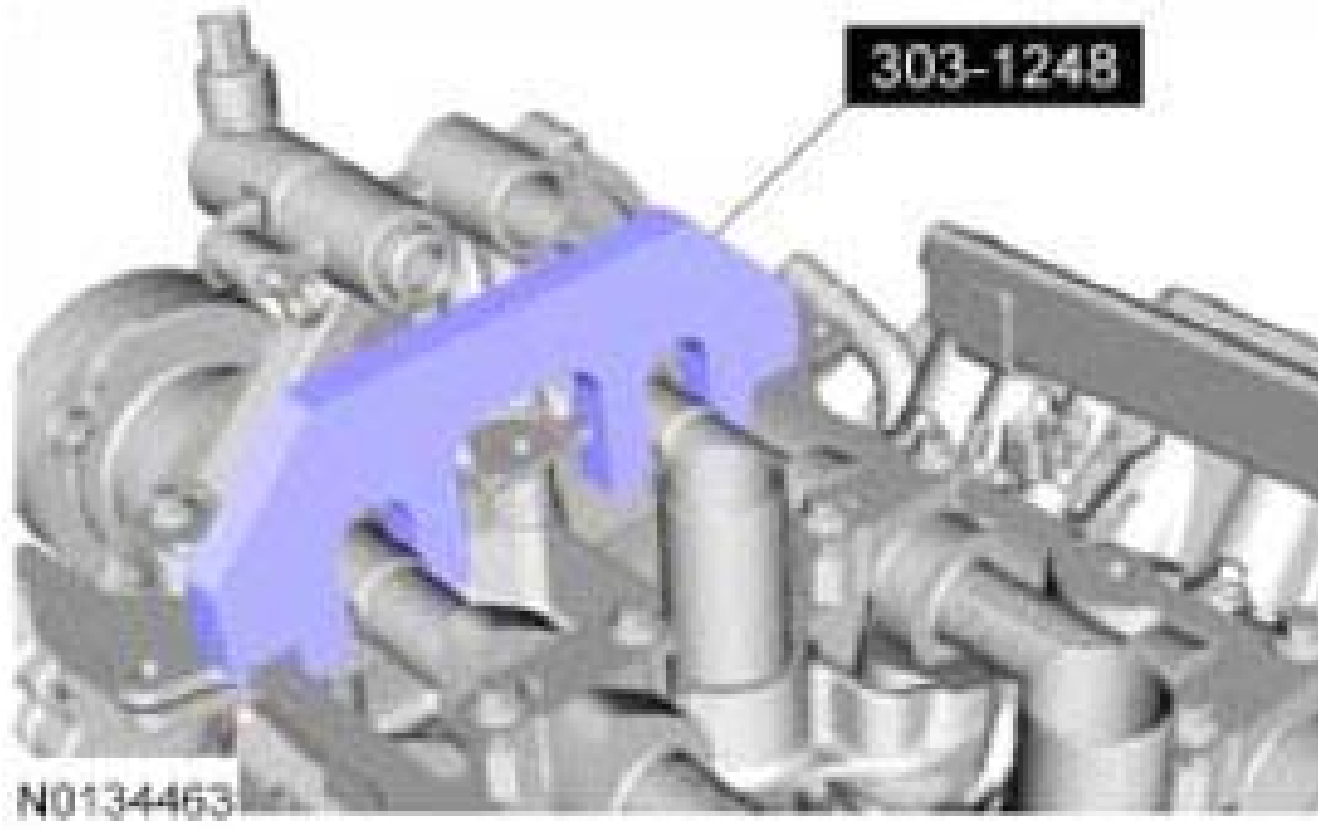
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4. **NOTE: The 303-1248 will hold the camshafts in the TDC position.**

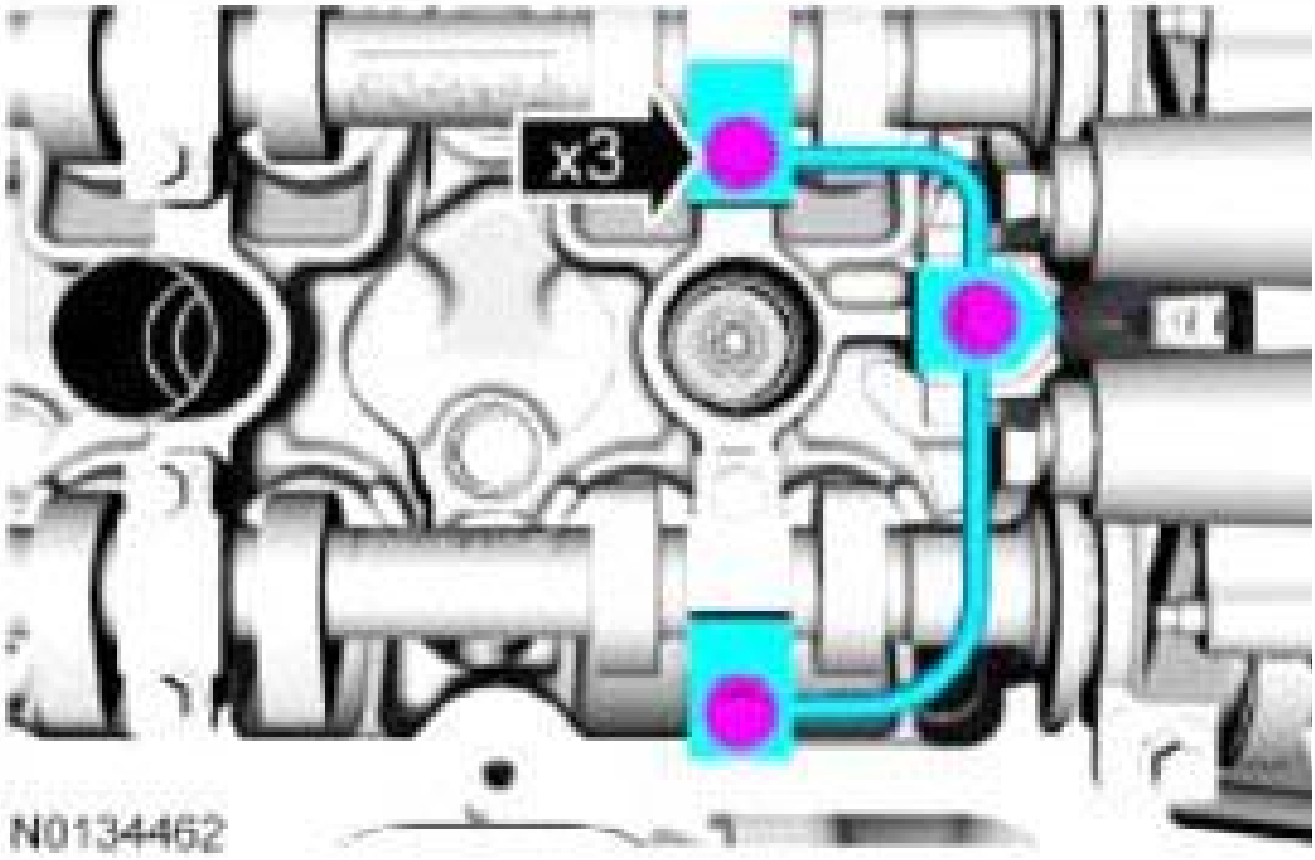
Install 303-1248 onto the flats of the LH camshafts.

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5. Remove the 3 bolts and the RH valve train oil tube.

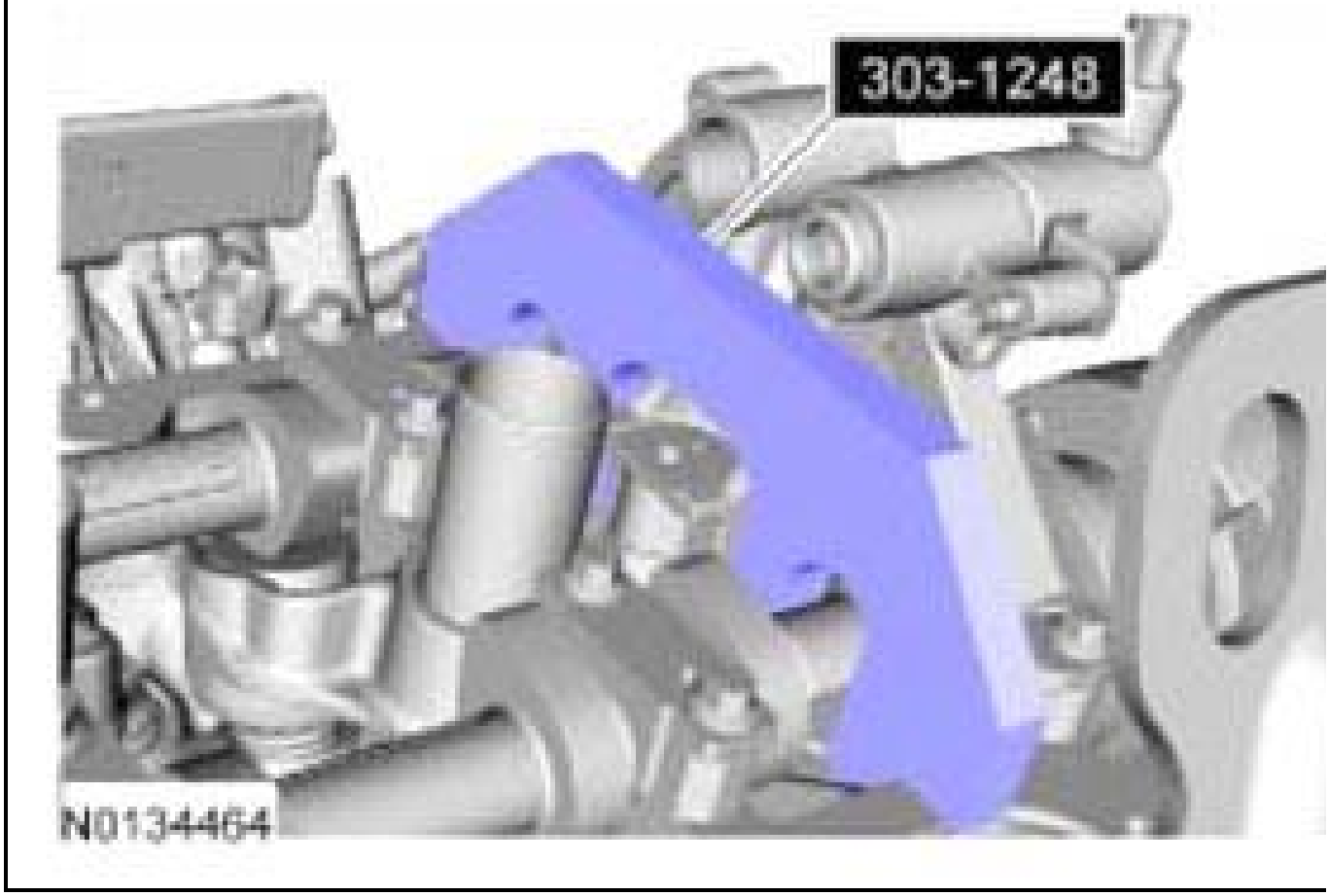
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6. **NOTE: The 303-1248 will hold the camshafts in the TDC position.**

Install 303-1248 onto the flats of the RH camshafts.

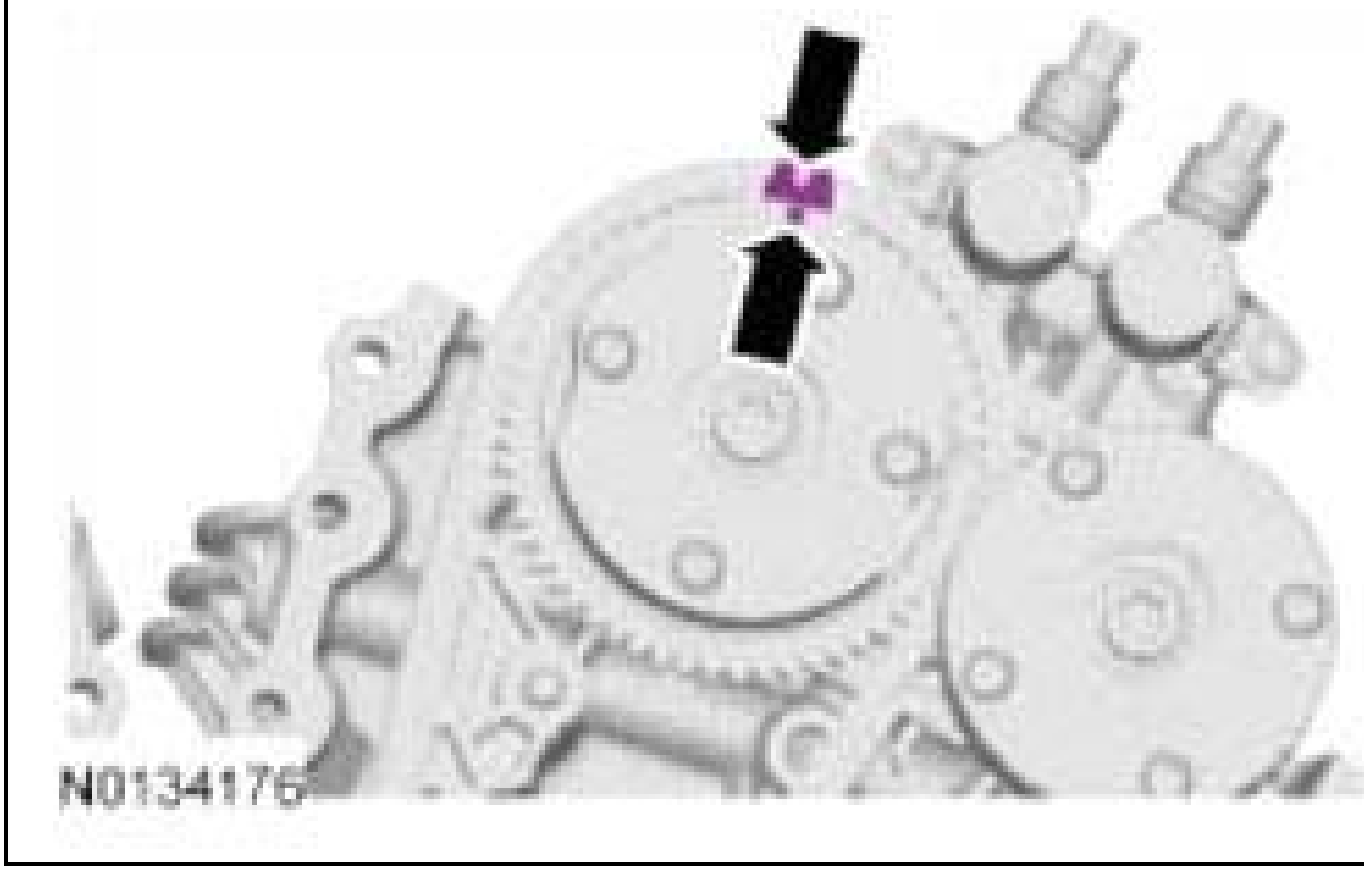
 © 2011 Mitchell Repair Information Company, LLC.



7. **NOTE: The following 3 steps are for primary timing chains that the colored links are not visible.**

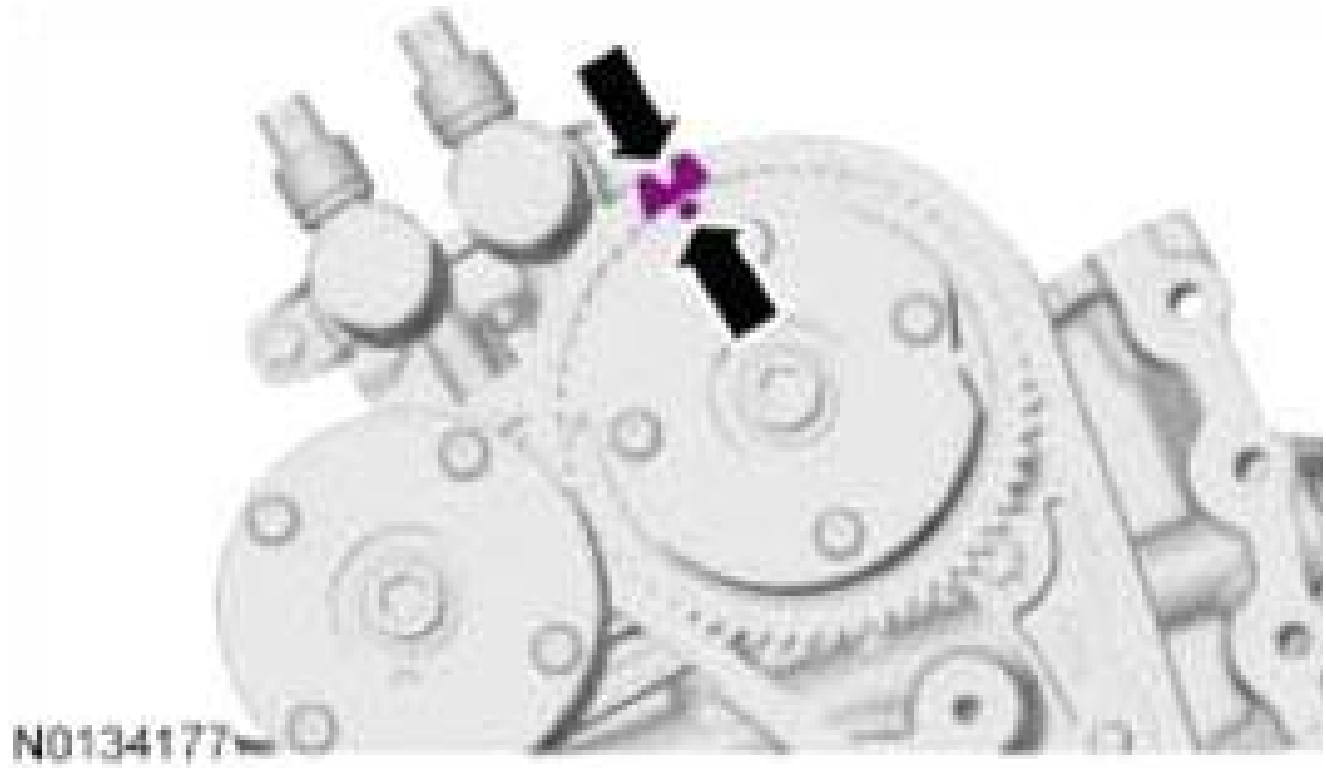
Mark the timing chain link that aligns with the timing mark on the LH intake **VCT** assembly as shown in illustration.

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8. Mark the timing chain link that aligns with the timing mark on the RH intake **VCT** assembly as shown in illustration.

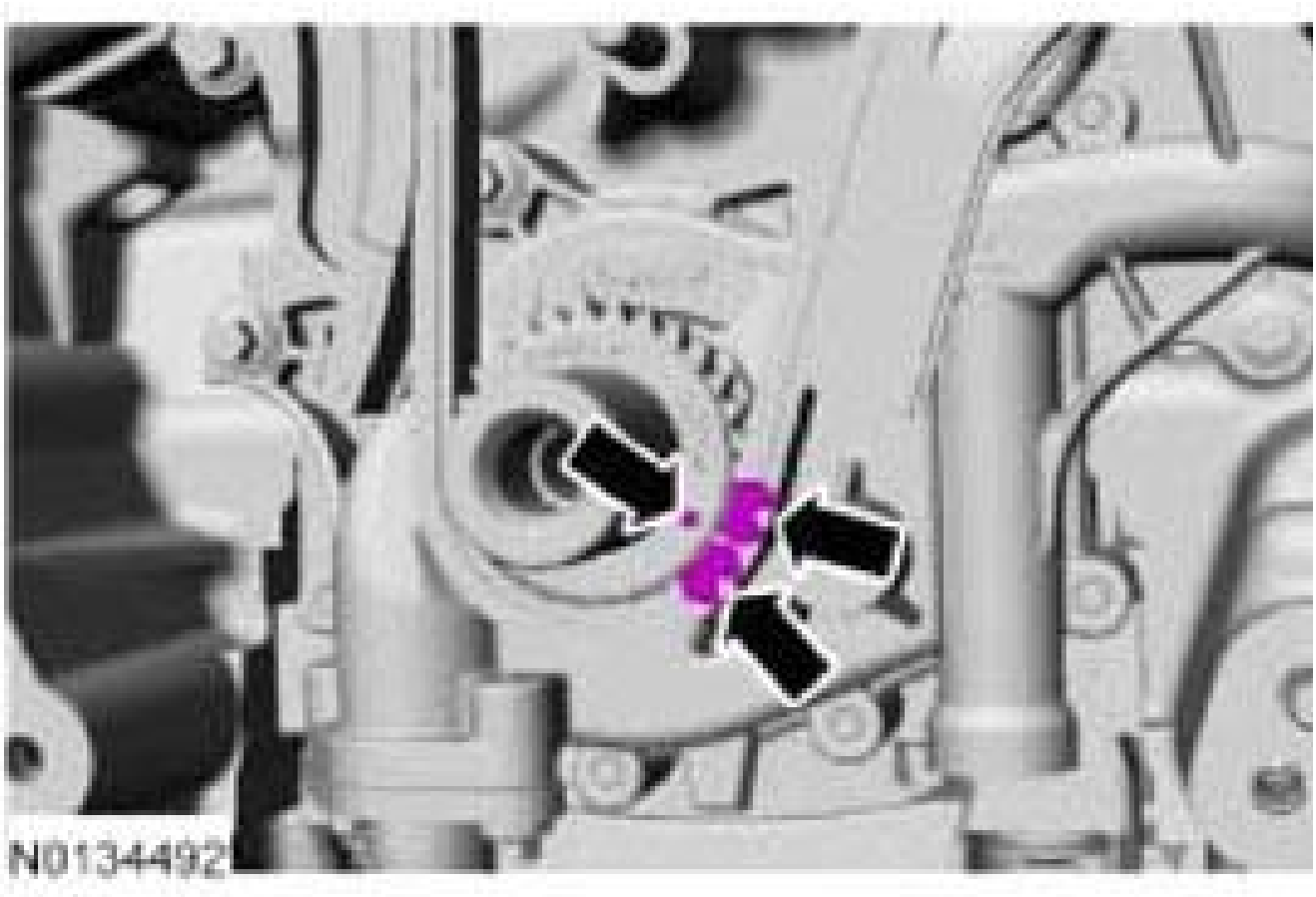
 © 2011 Mitchell Repair Information Company, LLC.



NOTE: The crankshaft sprocket timing mark should be between the 2 colored links.

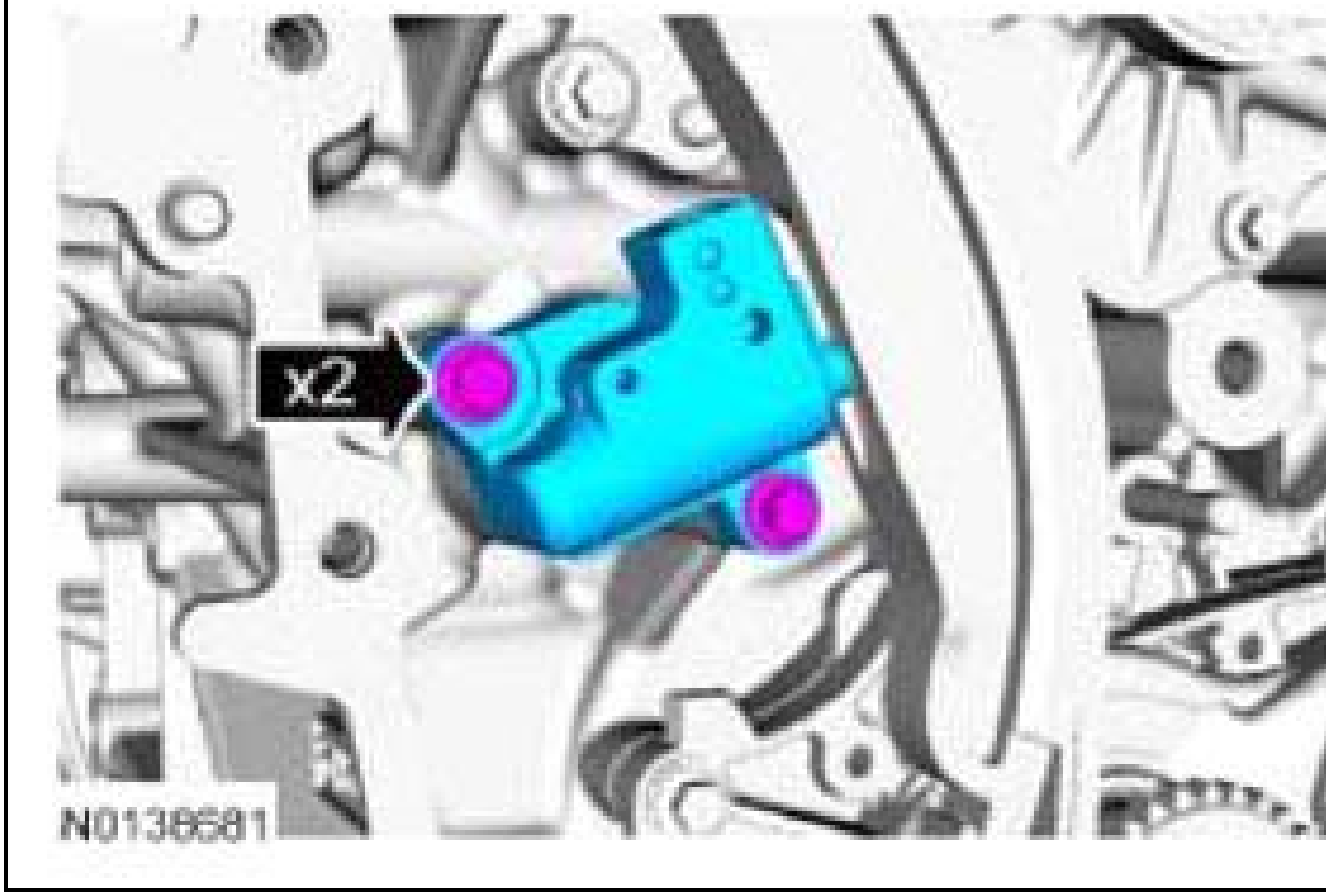
9. Mark the 2 timing chain links that align with the timing mark on the crankshaft sprocket as shown in illustration.

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10. Remove the 2 bolts and the primary timing chain tensioner.

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11. Remove the primary timing chain tensioner arm.

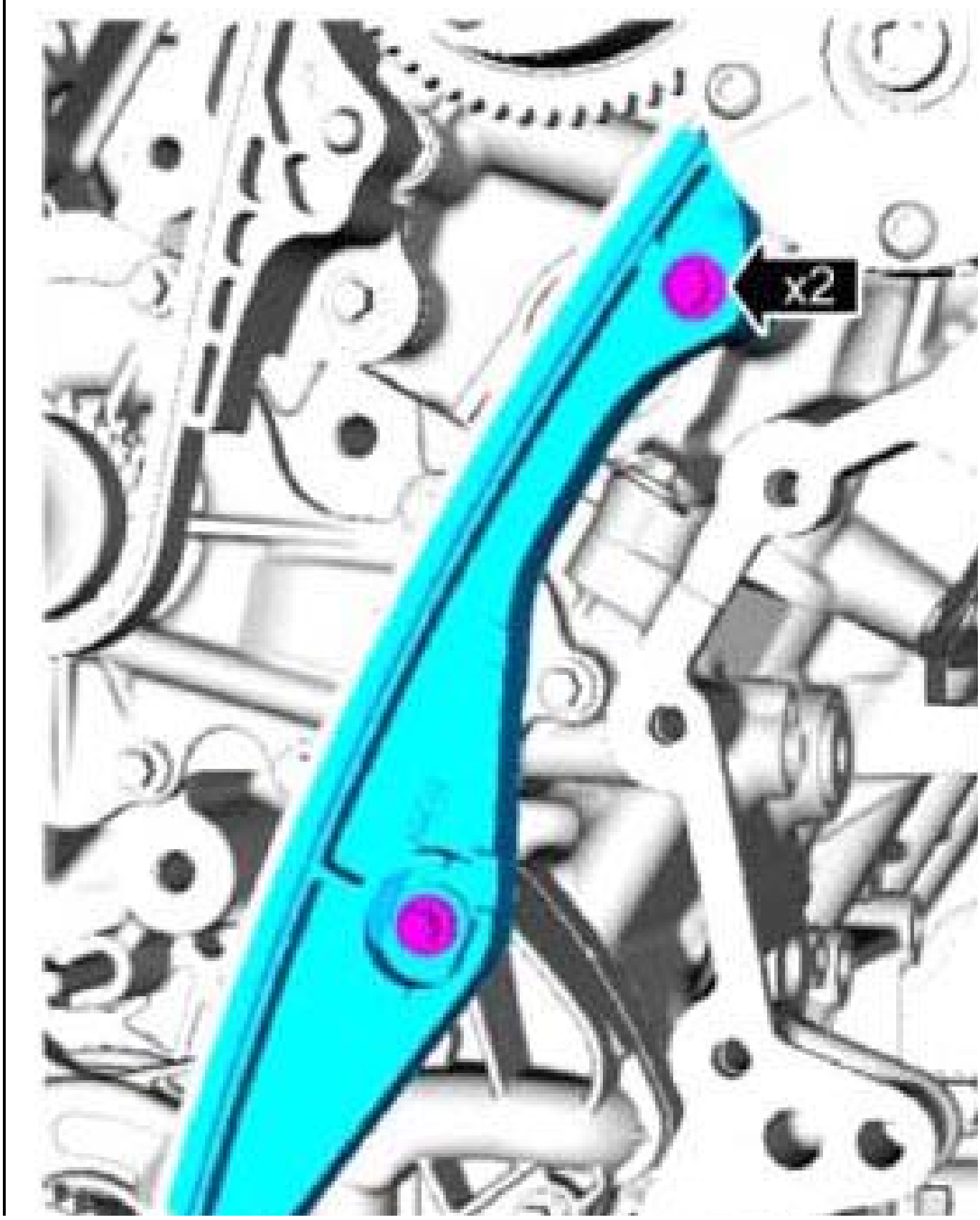
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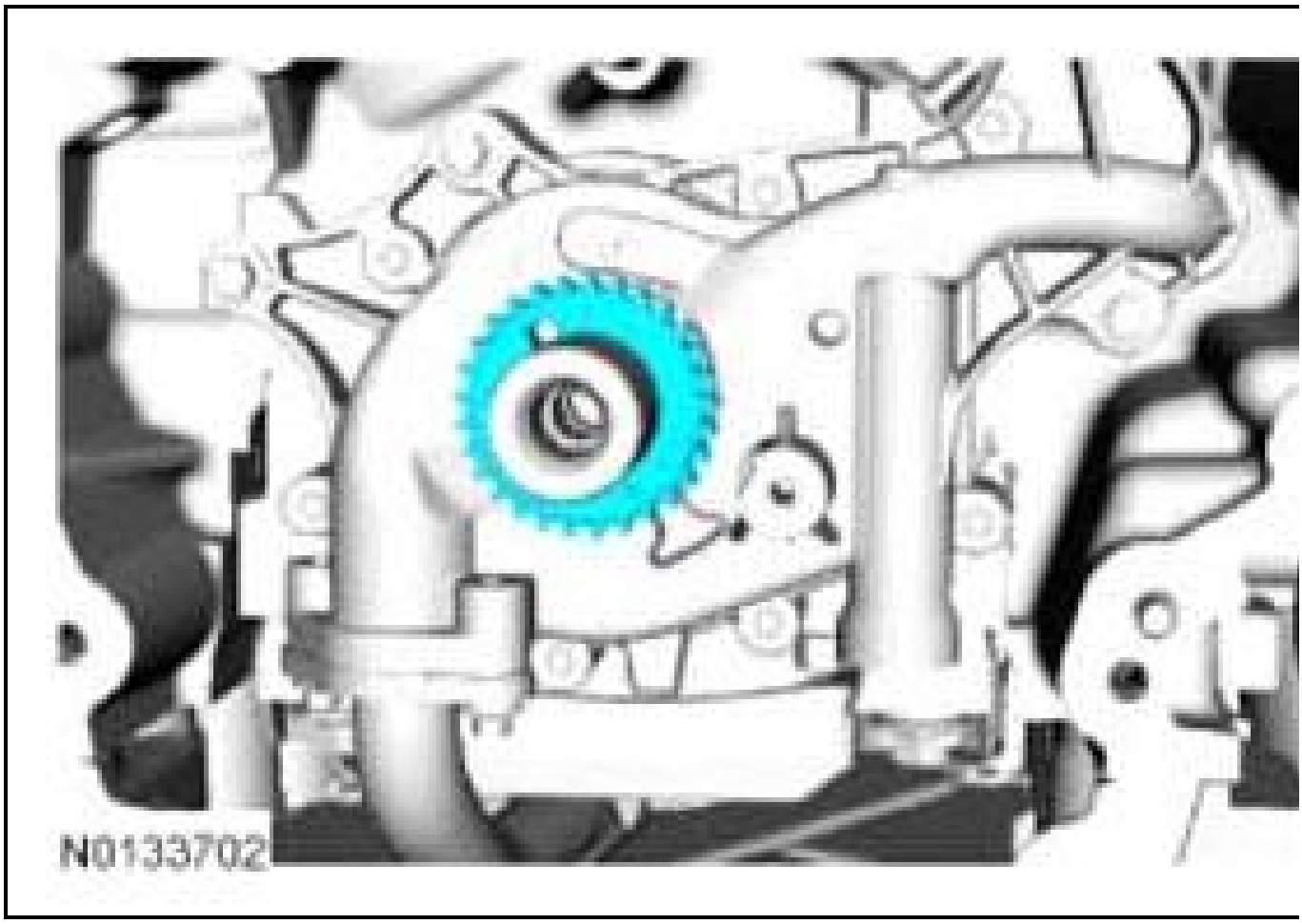
12. Remove the 2 bolts and the lower LH primary timing chain guide.

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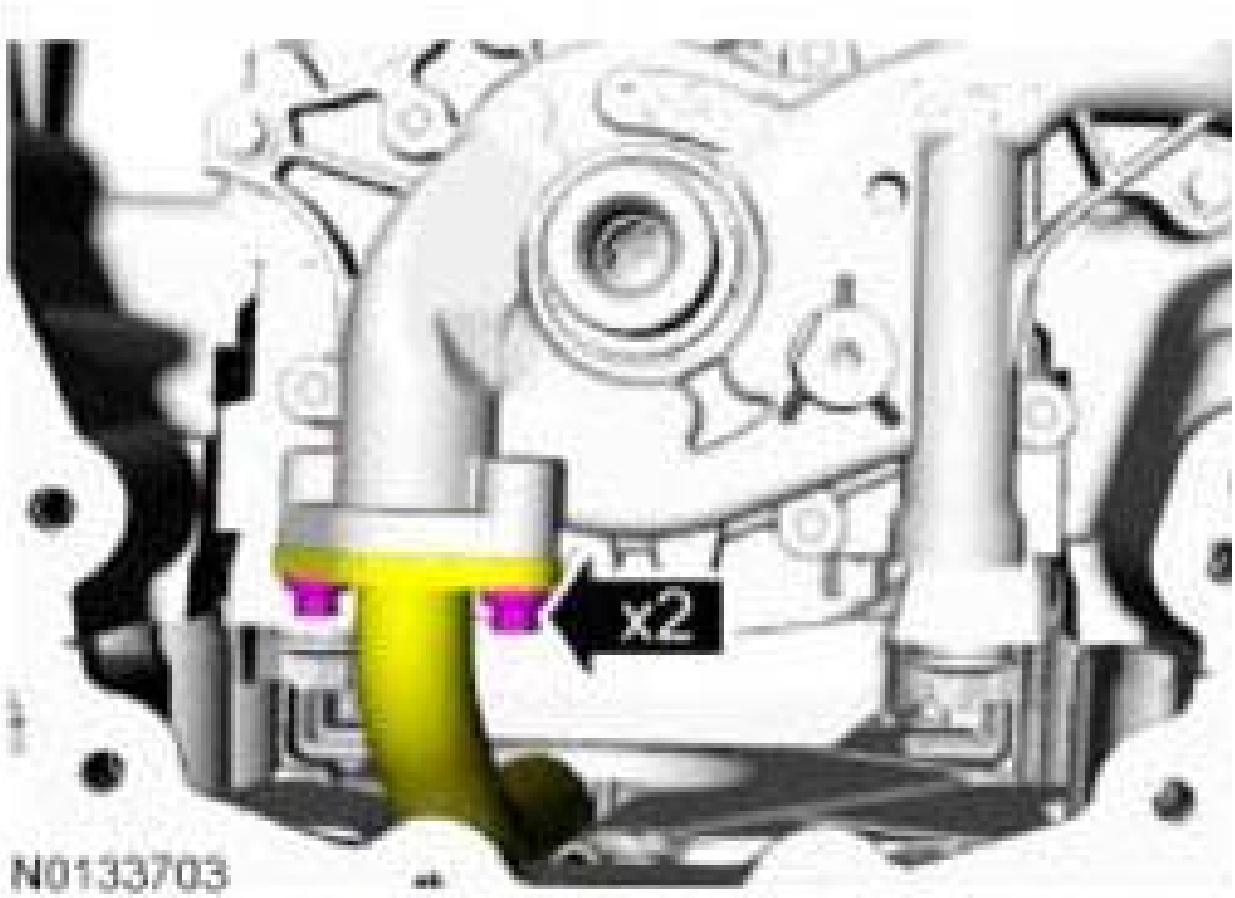
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13. Position the primary timing chain aside and remove the crankshaft timing chain sprocket.



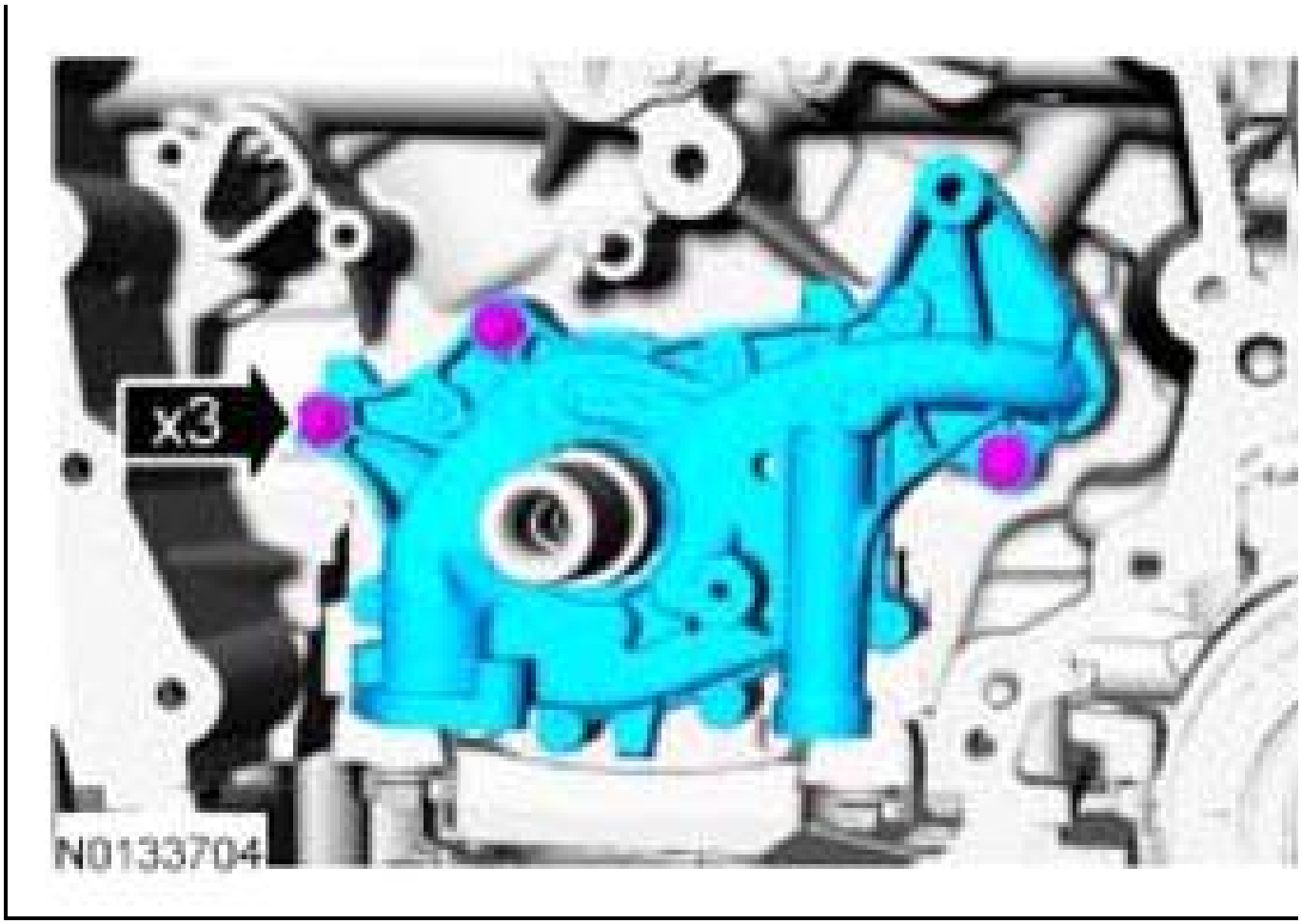
14. Remove the 2 bolts and the oil pump screen and pickup tube.
    - Discard the O-ring seal.

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15. Remove the 3 bolts and the oil pump.

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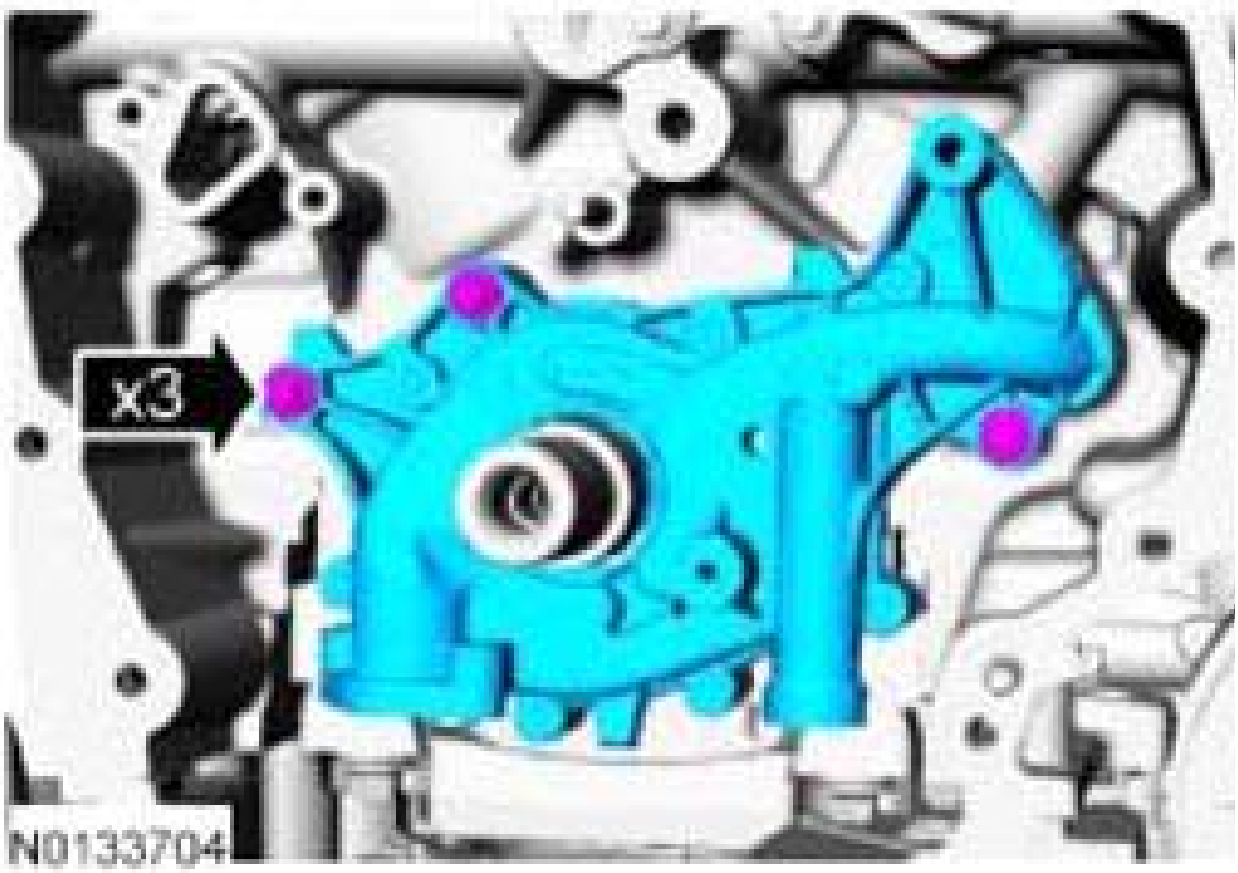


Installation

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

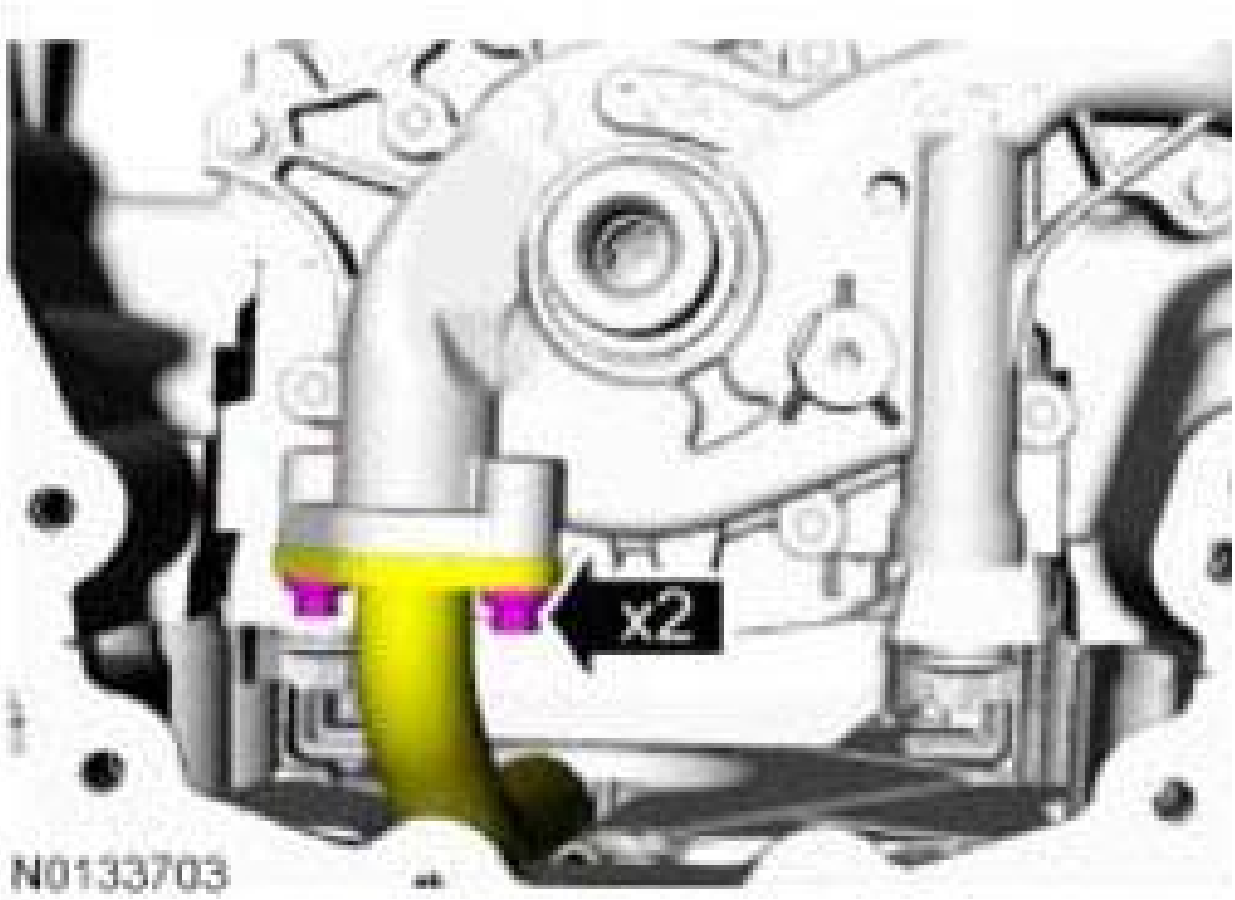
1. Install the oil pump and the 3 bolts.
   - Tighten to 10 Nm (89 lb-in).

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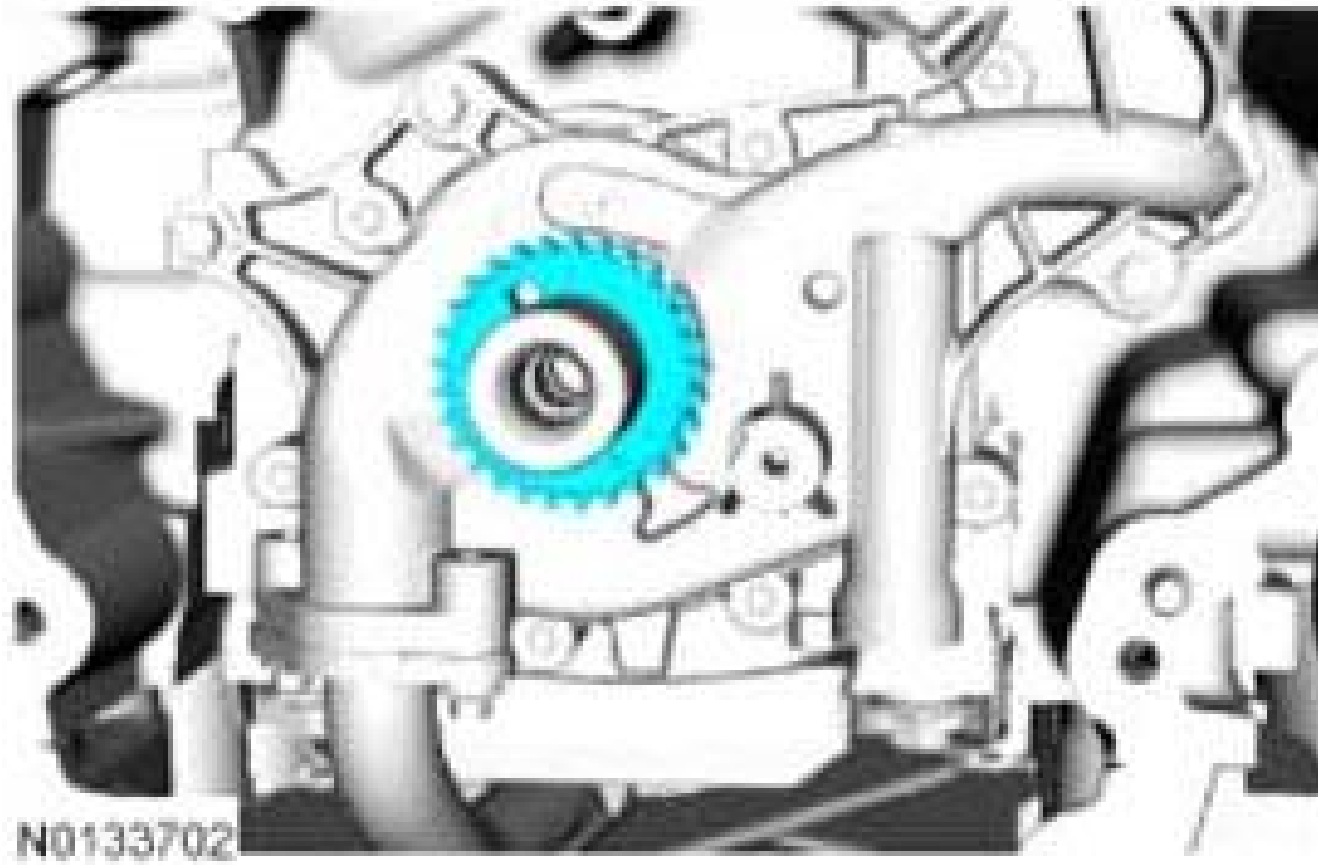
2. Using a new O-ring seal, install the oil pump screen and pickup tube and the 2 bolts.
   - Tighten to 10 Nm (89 lb-in).

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3. Install the crankshaft timing chain sprocket with timing dot mark out.

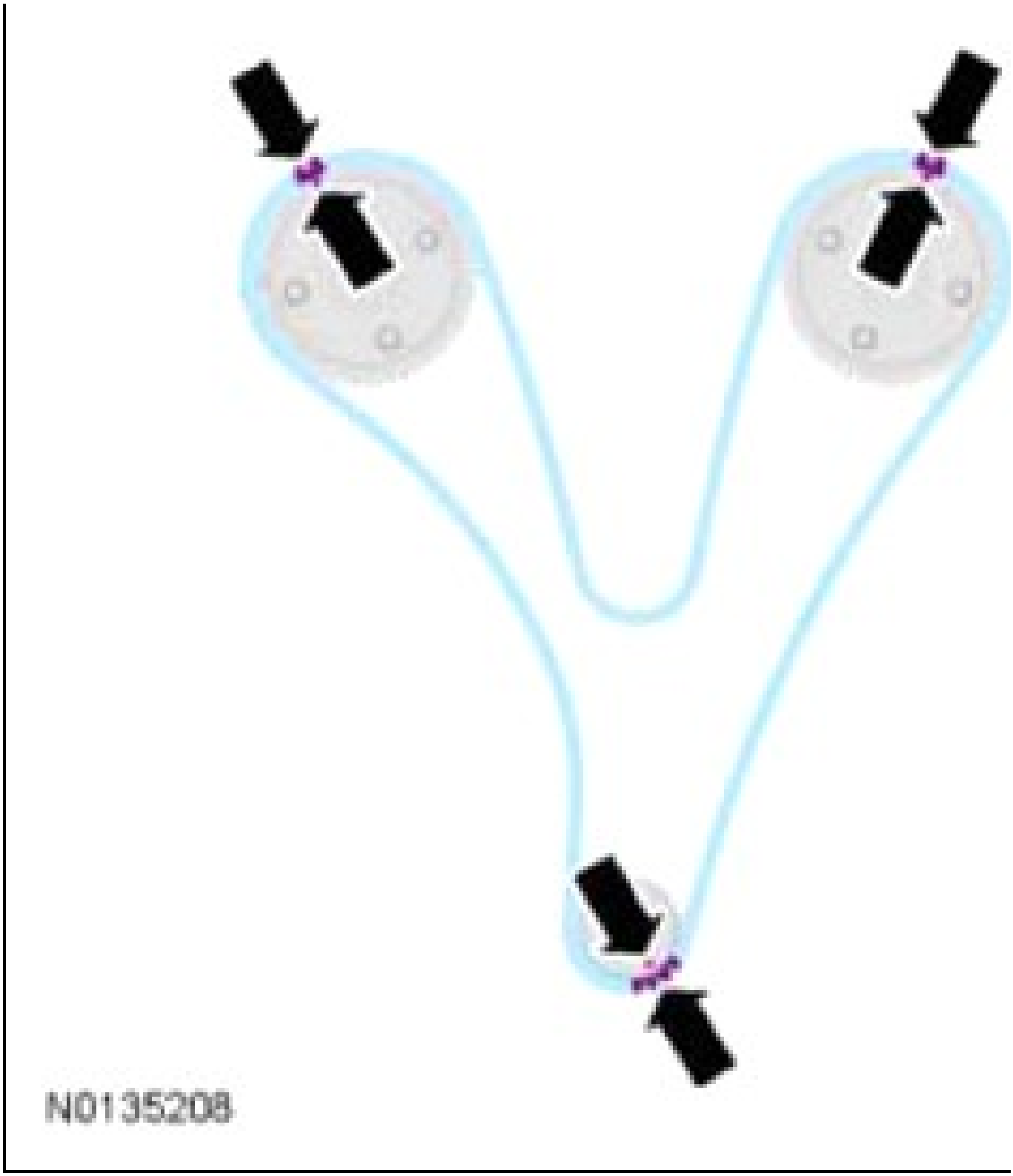
 © 2011 Mitchell Repair Information Company, LLC.



NOTE: **It may be necessary to rotate the camshafts slightly, to align the timing marks.**

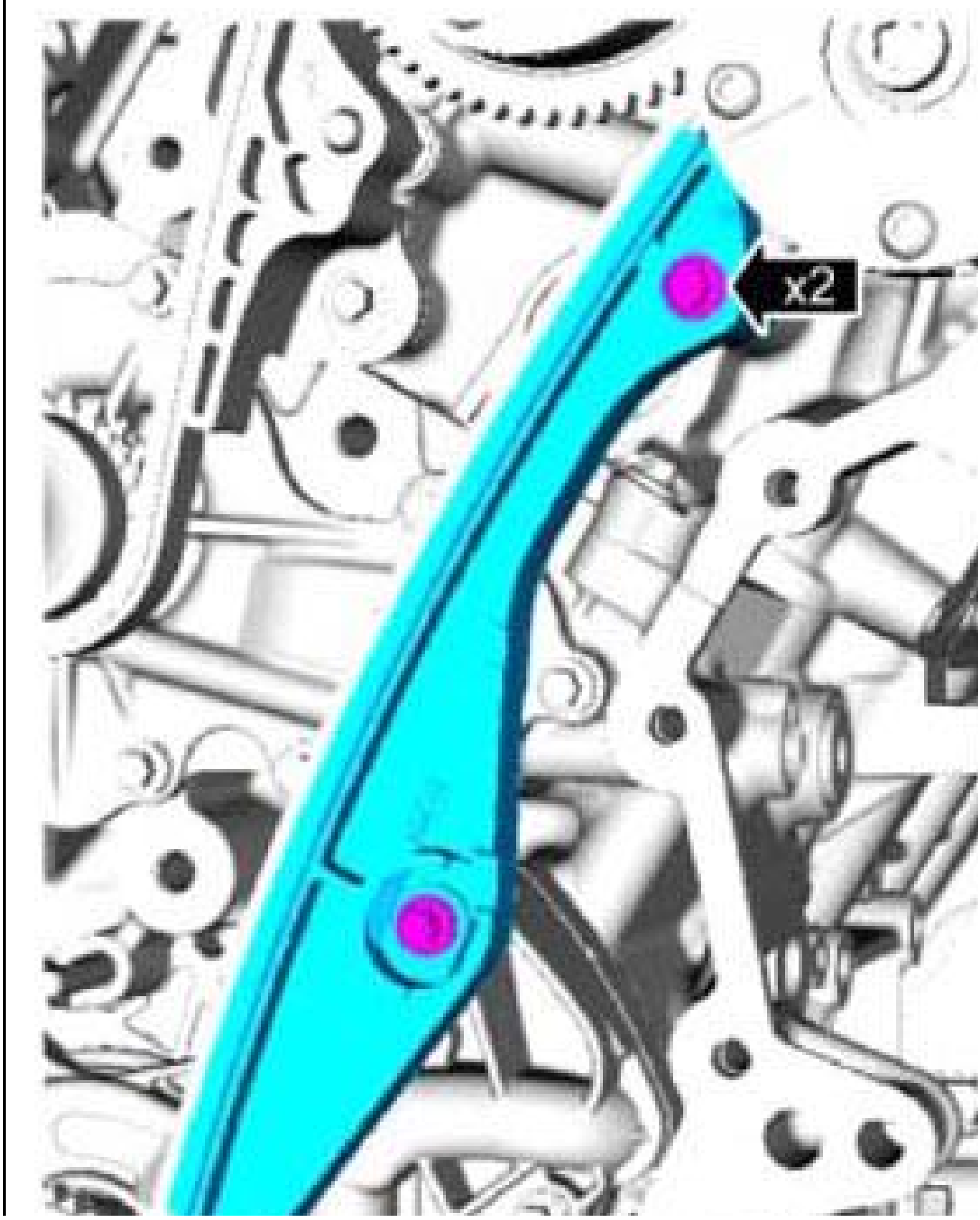
4. Position the primary timing chain with the colored links aligned with the timing marks on the VCT assemblies and the crankshaft sprocket.

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5. Install the lower LH primary timing chain guide and the 2 bolts.

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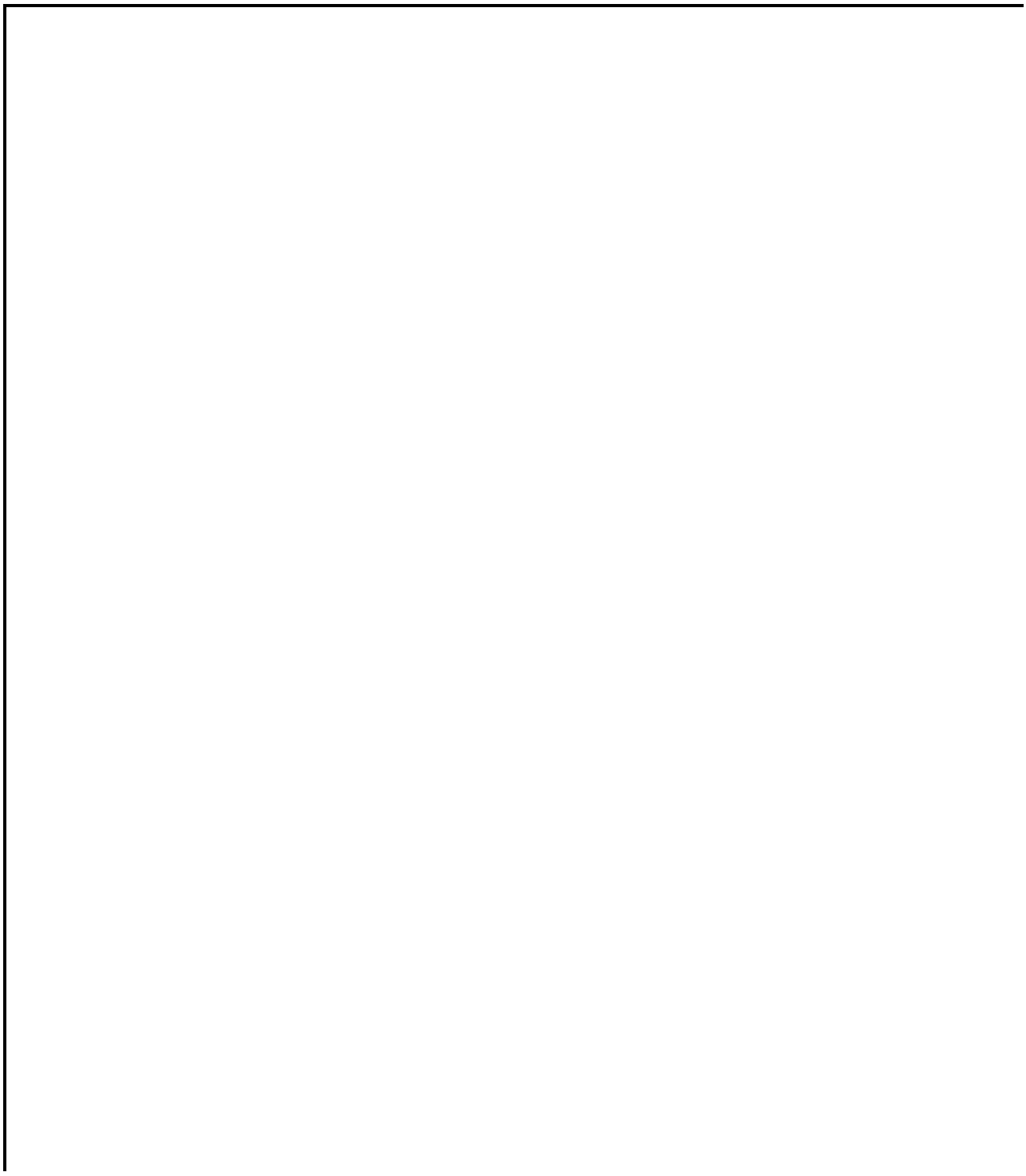
6. Install the primary timing chain tensioner arm.

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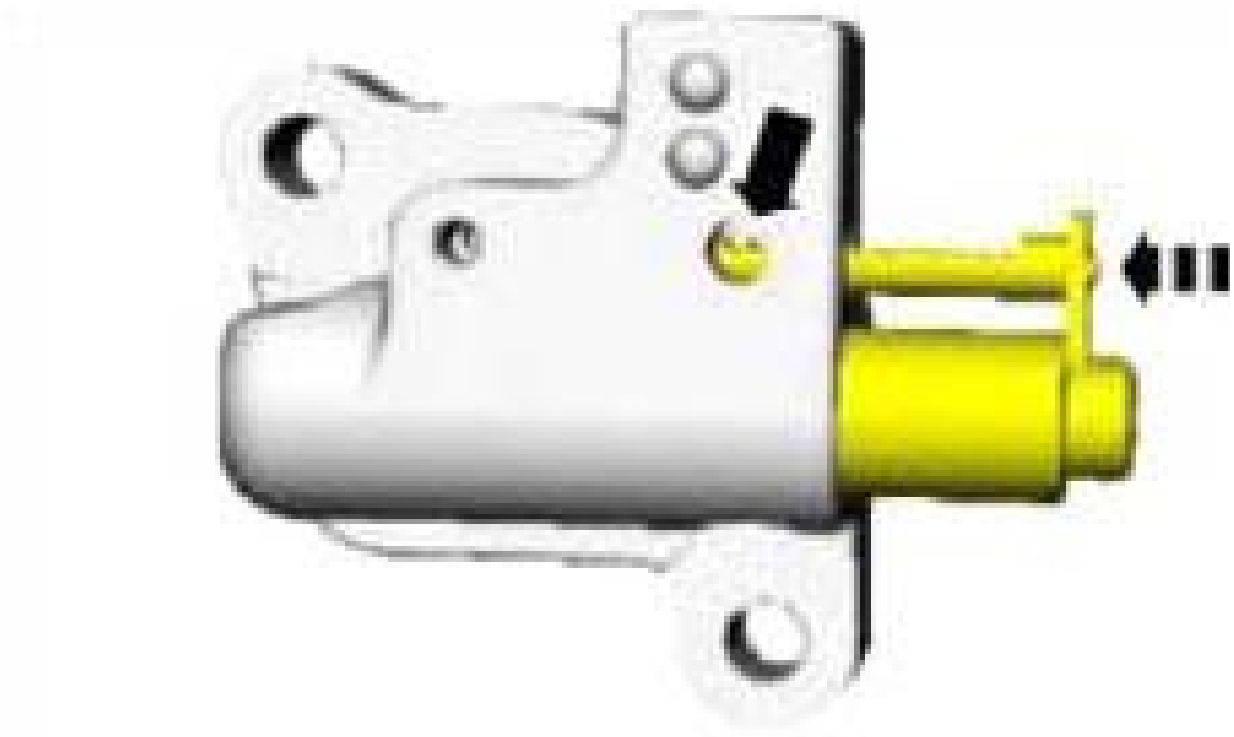


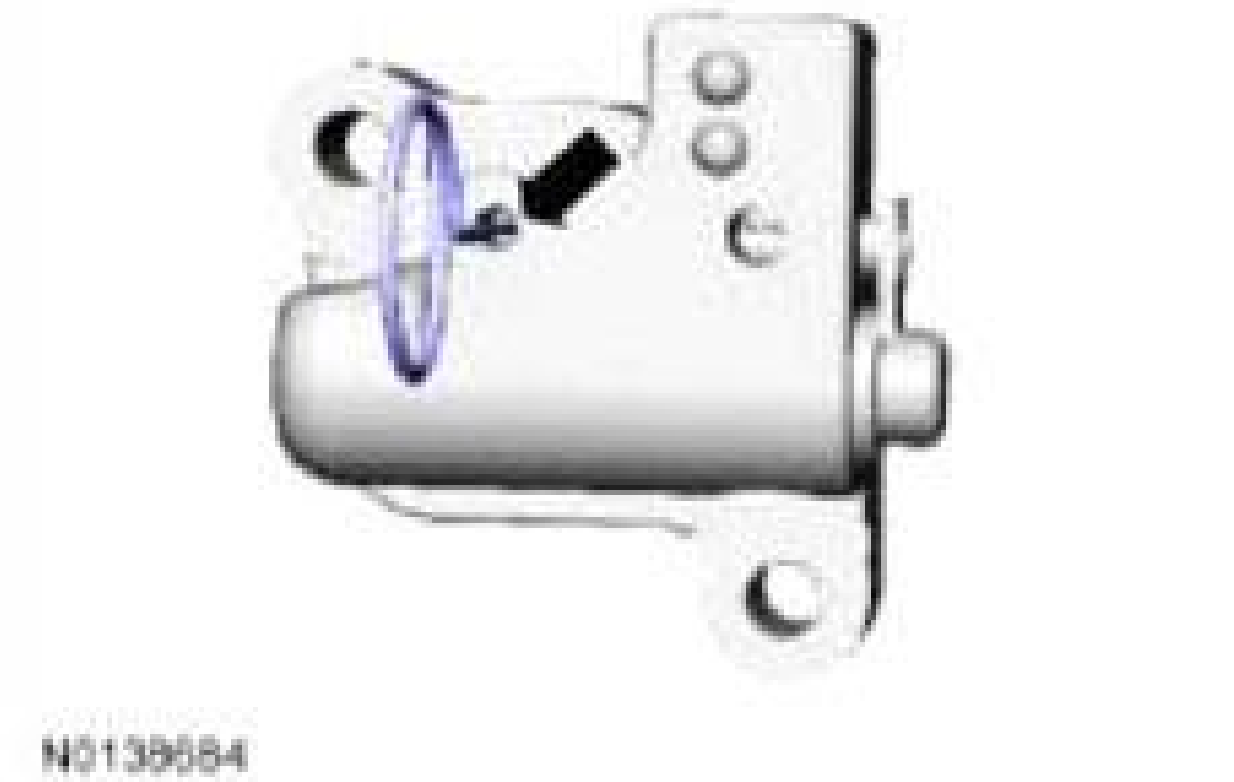
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7. Reset the primary timing chain tensioner.
    - Release the ratchet detent.
    - Using a soft-jawed vise, compress the ratchet plunger.
    - Align the hole in the ratchet plunger with the hole in the tensioner housing.
    - Install a suitable lockpin.



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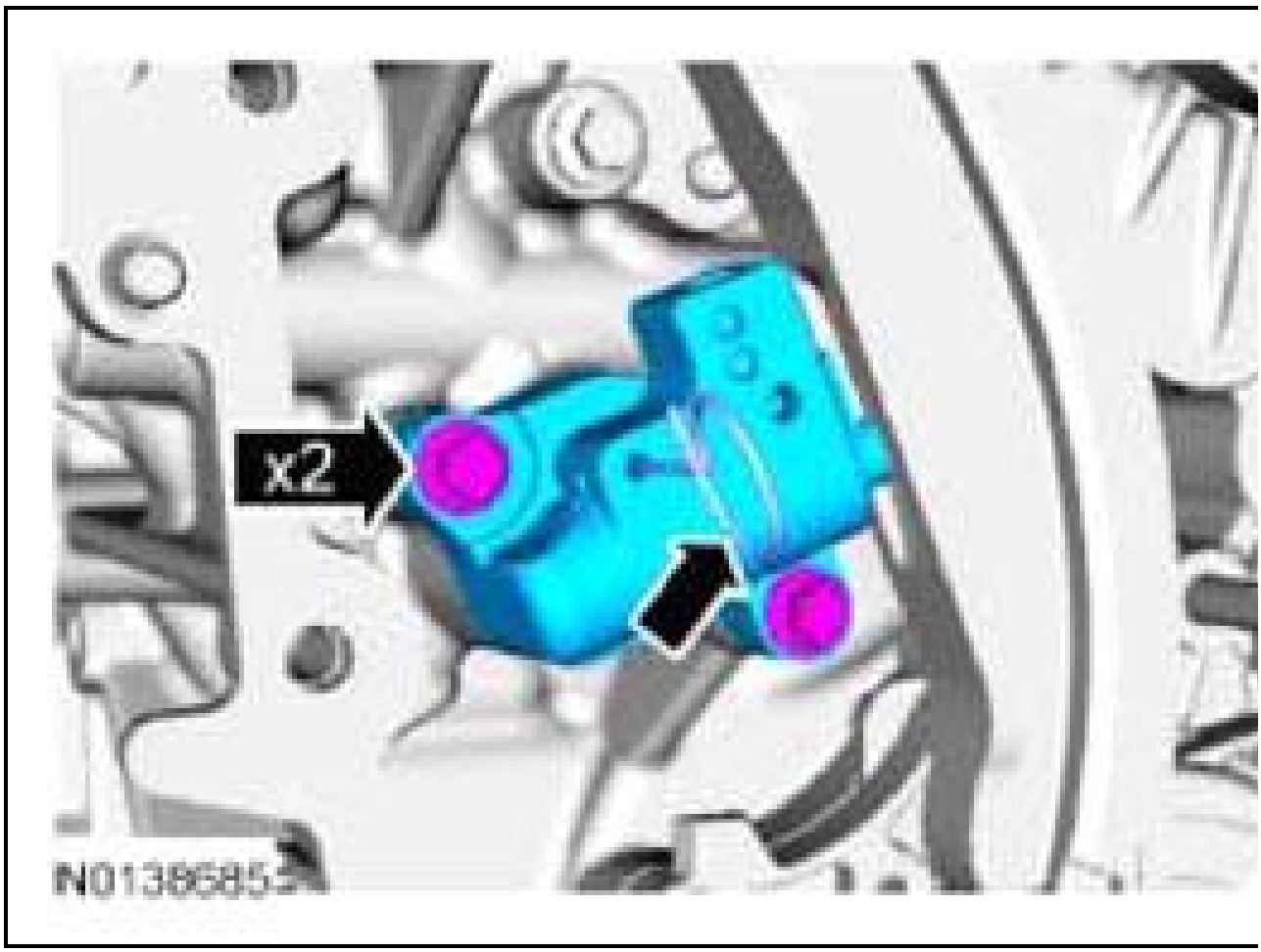


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8. **NOTE: It may be necessary to rotate the camshafts slightly to remove slack from the timing chain to install the tensioner.**

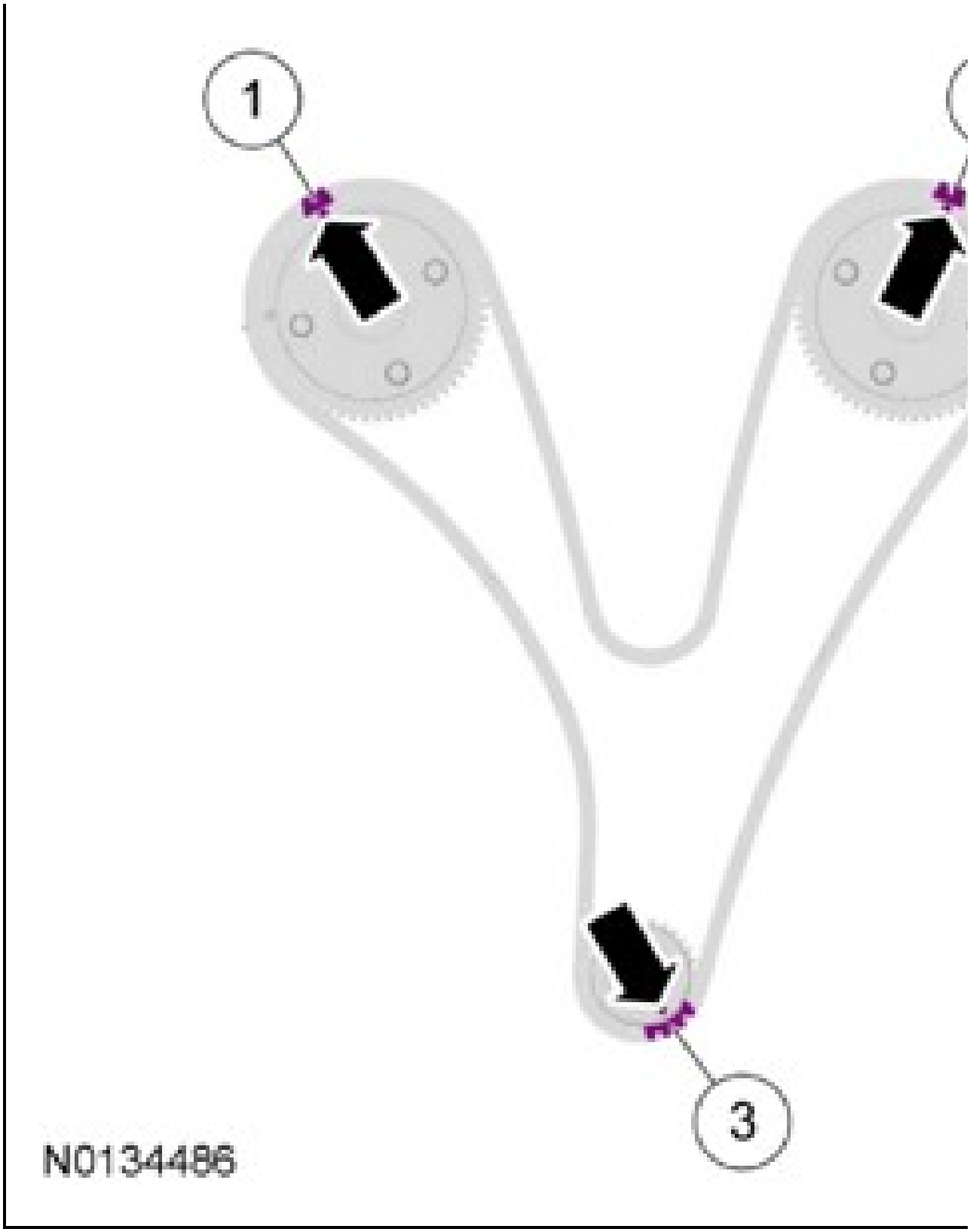
Install the primary tensioner and the 2 bolts.

- Tighten to 10 Nm (89 lb-in).
- Remove the lockpin.



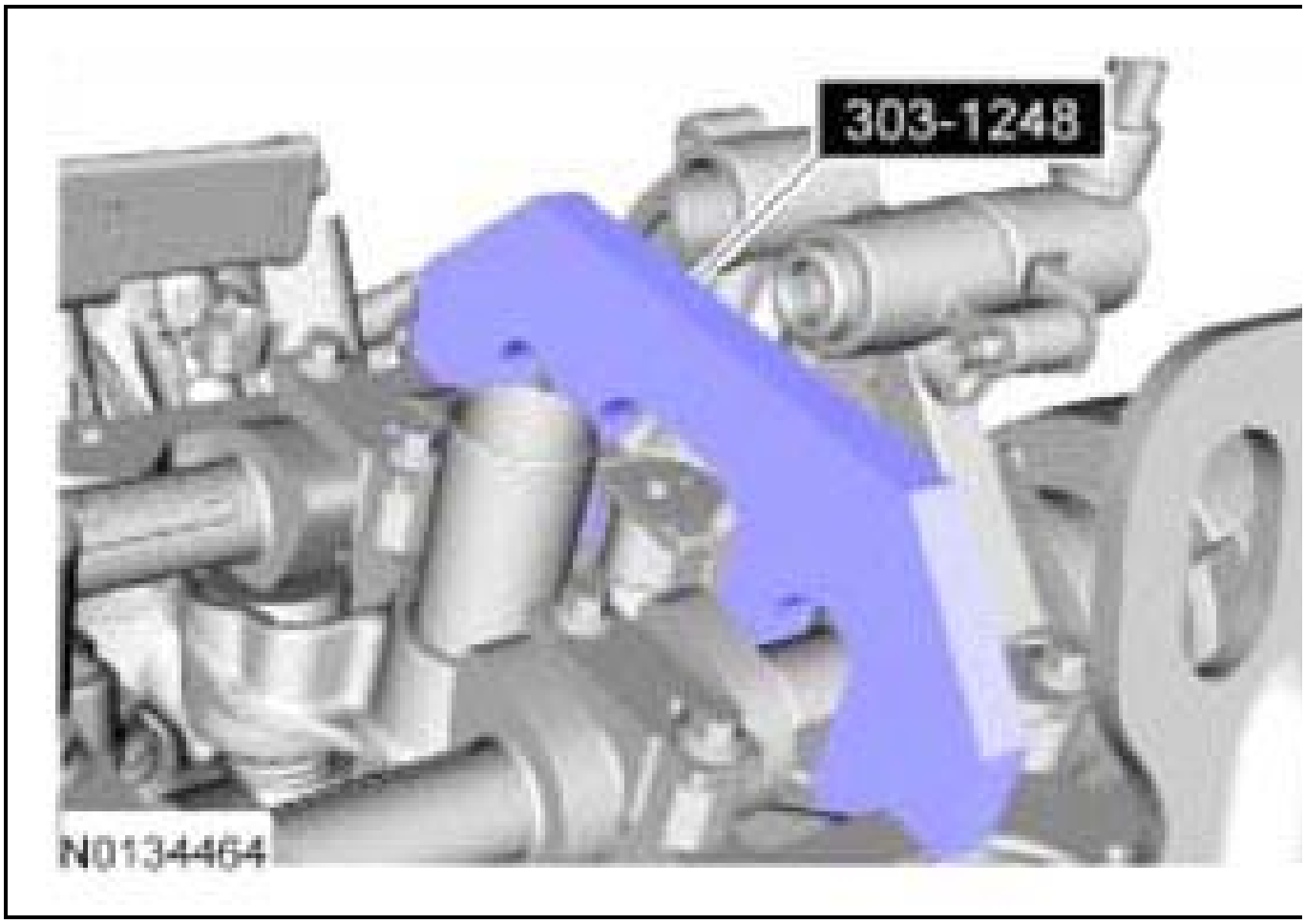
9. As a post-check, verify correct alignment of all timing marks.
   - There are 48 links in between the RH intake **VCT** assembly colored link (1) and the LH intake **VCT** assembly colored link (2).
   - There are 35 links in between LH intake **VCT** assembly colored link (2) and the 2 crankshaft sprocket links (3).

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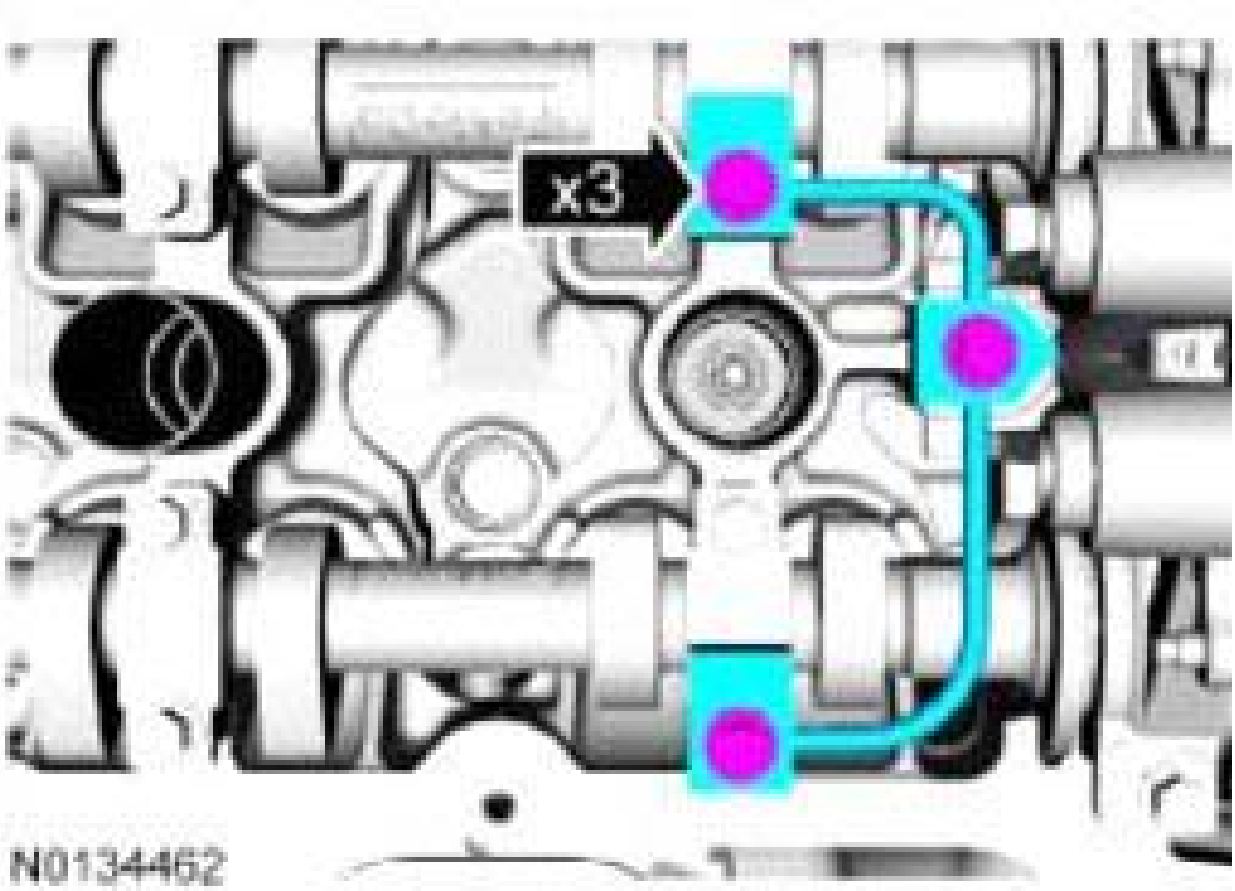
10. Remove the RH 303-1248.

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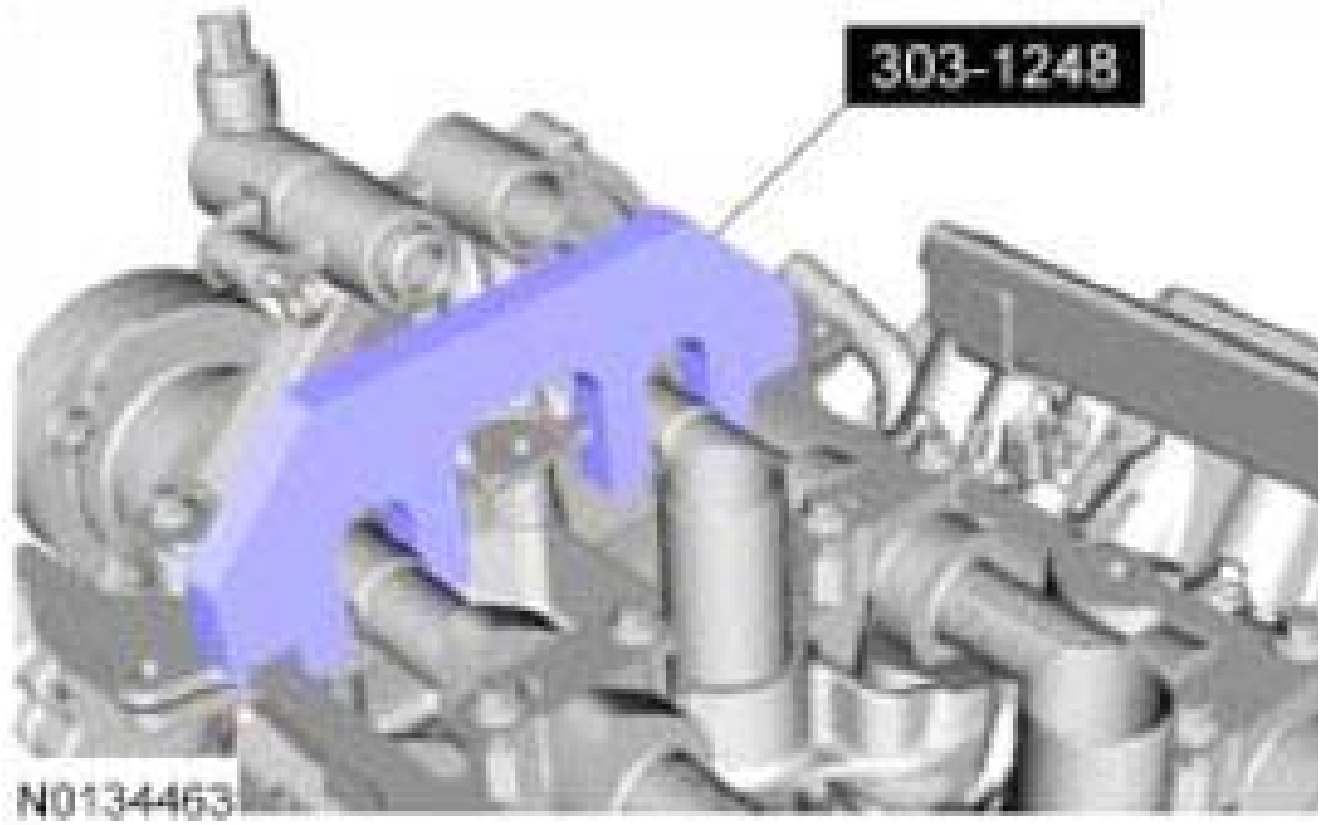
11. Install the RH valve train oil tube and the 3 bolts and tighten in 2 stages.
    - Stage 1: Tighten to 8 Nm (71 lb-in).
    - Stage 2: Tighten an additional 45 degrees.

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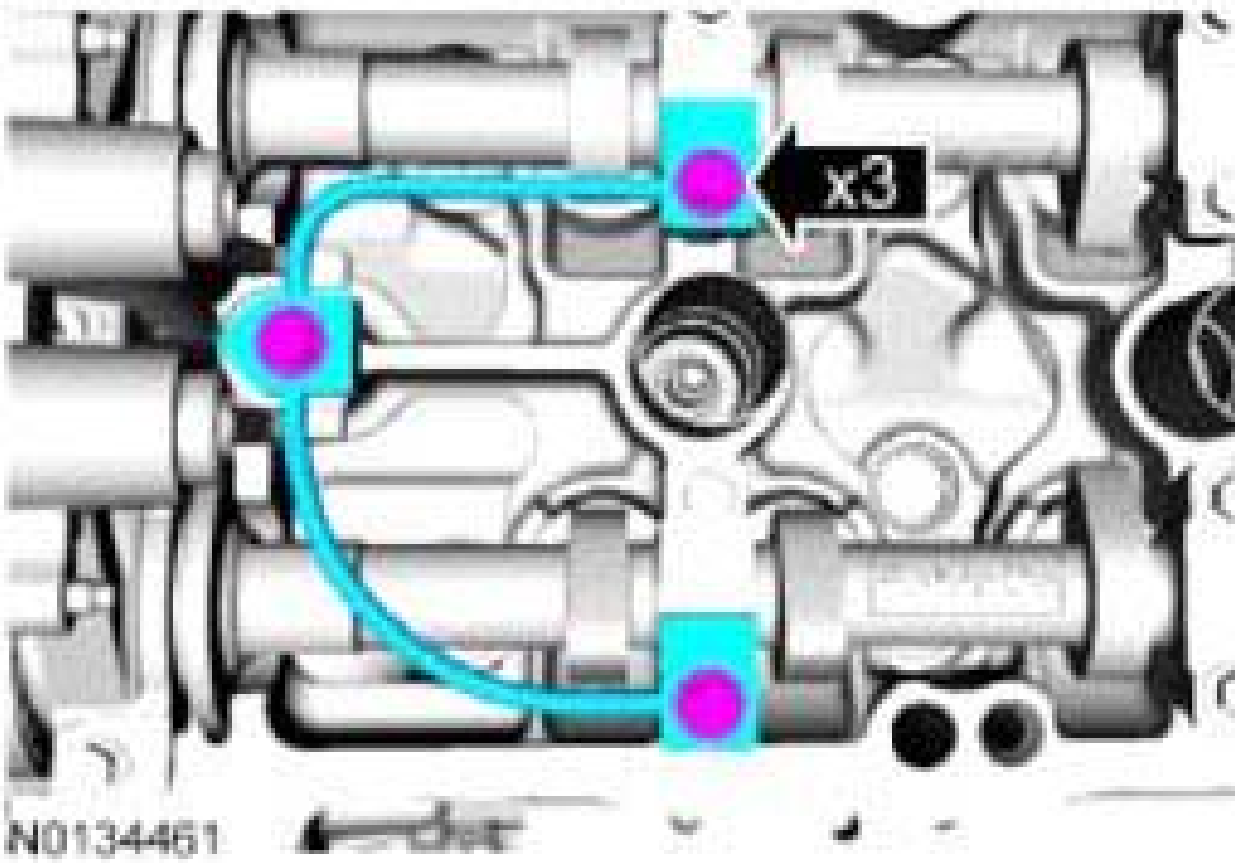
12. Remove the LH 303-1248.

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13. Install the Left Hand (LH) valve train oil tube and the 3 bolts and tighten in 2 stages.
    - Stage 1: Tighten to 8 Nm (71 lb-in).
    - Stage 2: Tighten an additional 45 degrees.

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14. Install the engine front cover. Refer to **ENGINE FRONT COVER**.

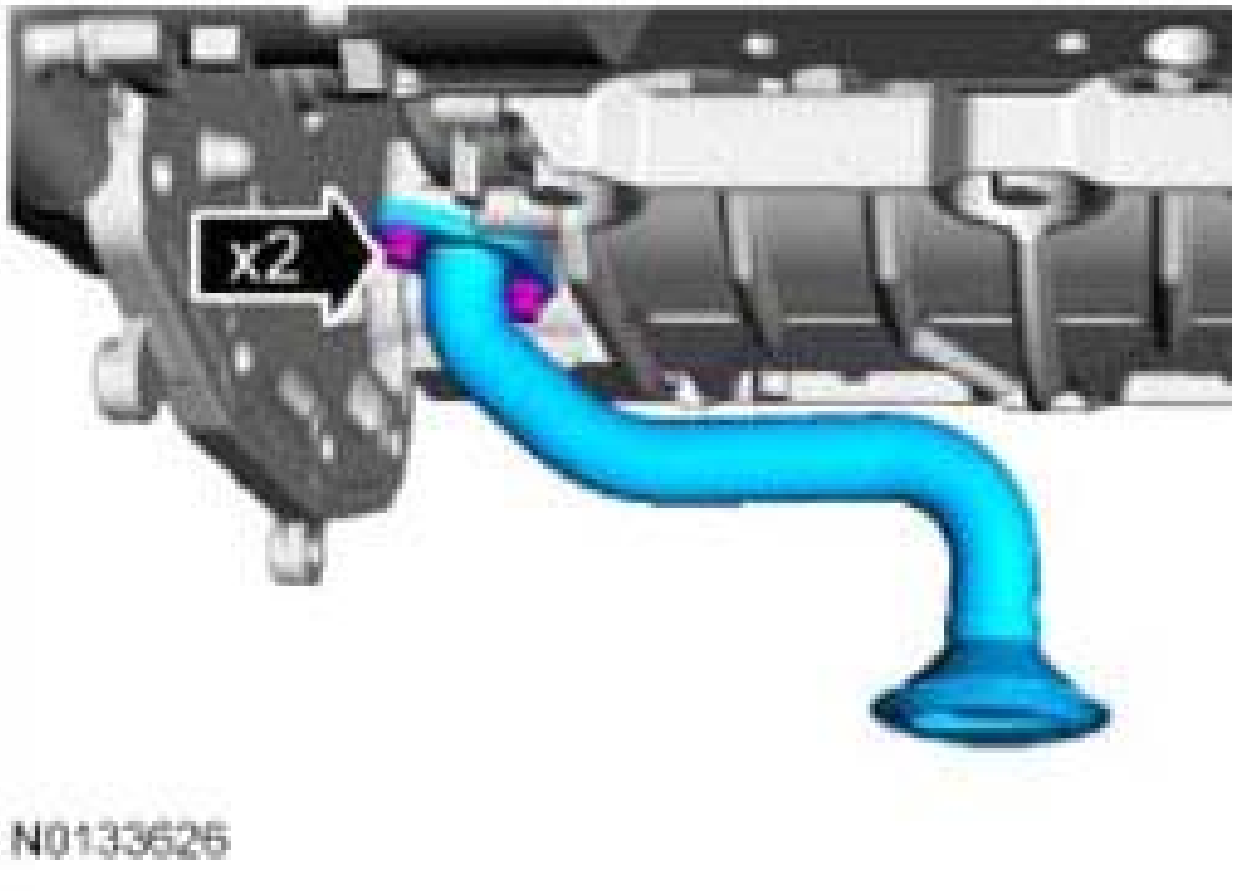
OIL PUMP SCREEN AND PICKUP TUBE

Removal

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

1. Remove the oil pan. Refer to **OIL PAN**.
2. Remove the 2 bolts and the oil pump screen and pickup tube.
   - Discard the O-ring seal.

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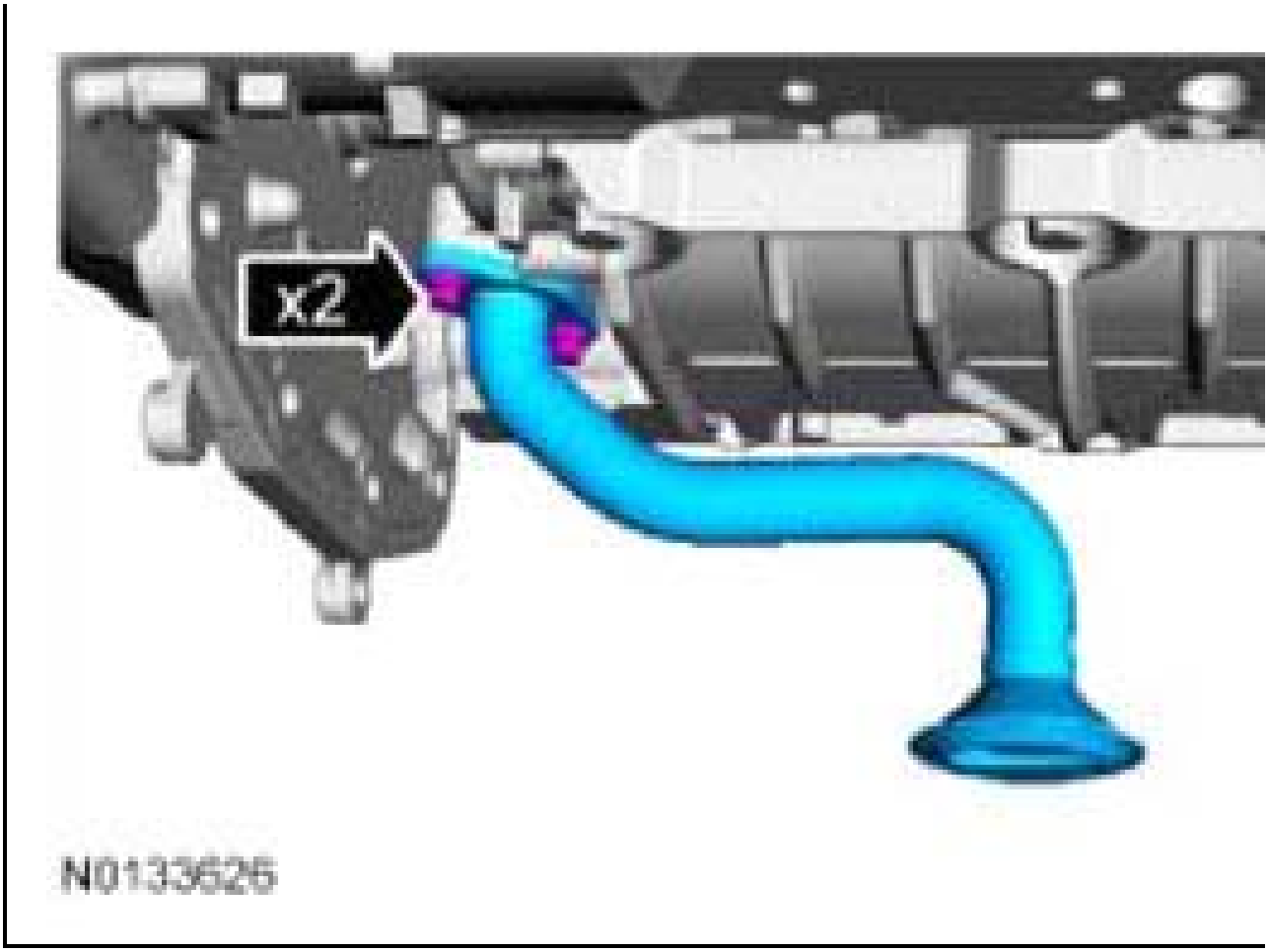


Installation

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

1. Using a new O-ring seal, install the oil pump screen and pickup tube and the 2 bolts.
   - Tighten to 10 Nm (89 lb-in).

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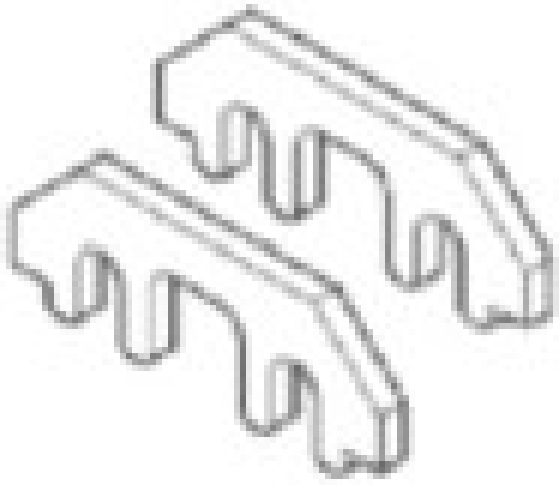
2. Install the oil pan. Refer to **OIL PAN**.

TIMING DRIVE COMPONENTS

SPECIAL TOOL(S) DESCRIPTION

	Tool, Chain Tensioner Hold Down **303-1530**

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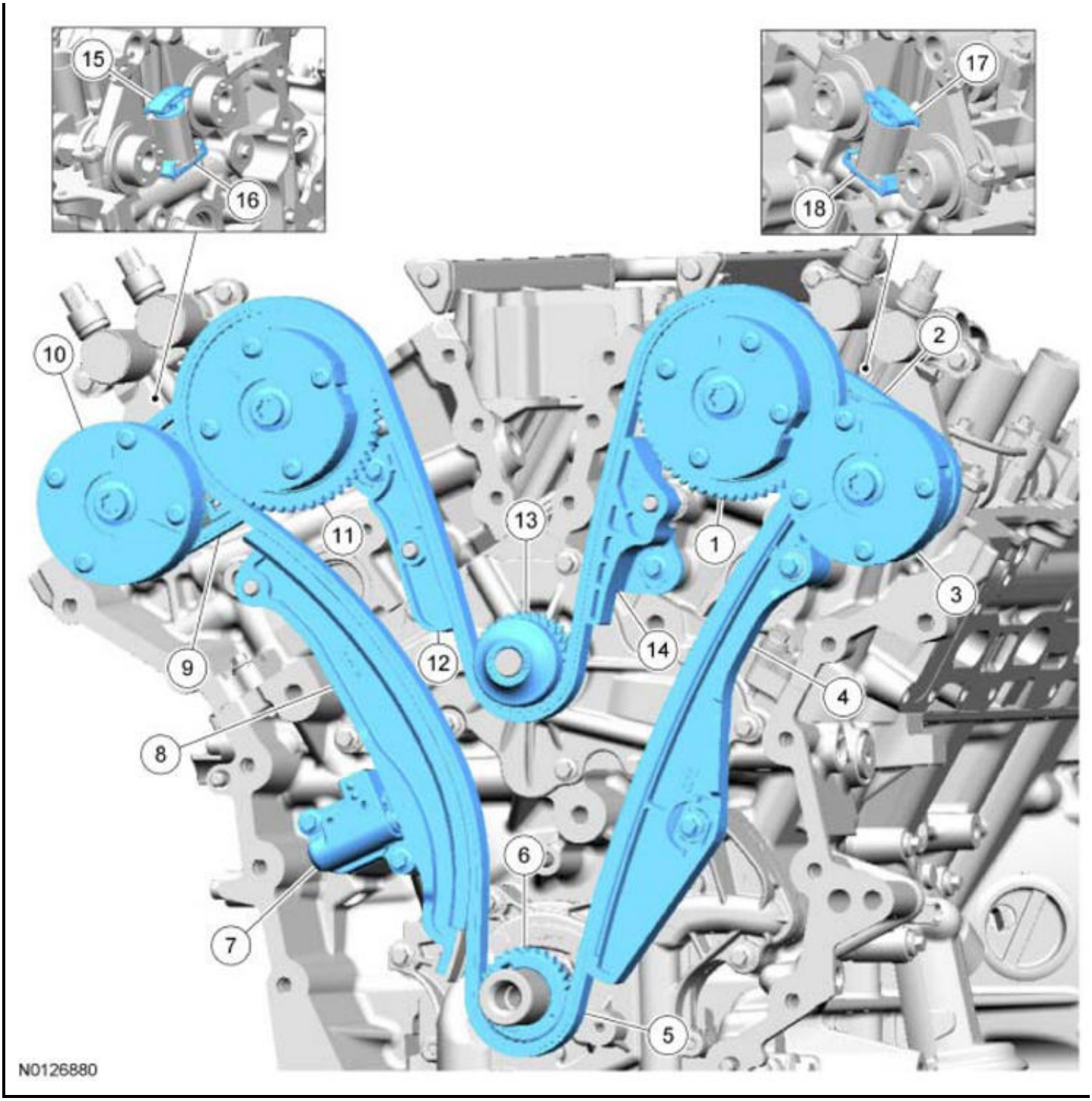
	
	Camshaft Holding Tools **303-1248**

MATERIAL SPECIFICATIONS

Item	Specification
Motorcraft® SAE 5W-20 Premium Synthetic Blend Motor Oil (US); Motorcraft® SAE 5W-20 Super Premium Motor Oil (Canada) XO-5W20-QSP (US); CXO-5W20-LSP12 (Canada)	WSSM2C945-A

Exploded View

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Item	Part Number	Description
1	6C524	LH intake **VCT** assembly
2	6268	LH secondary timing chain
3	6C525	LH exhaust **VCT** assembly
4	6B274	LH primary timing chain

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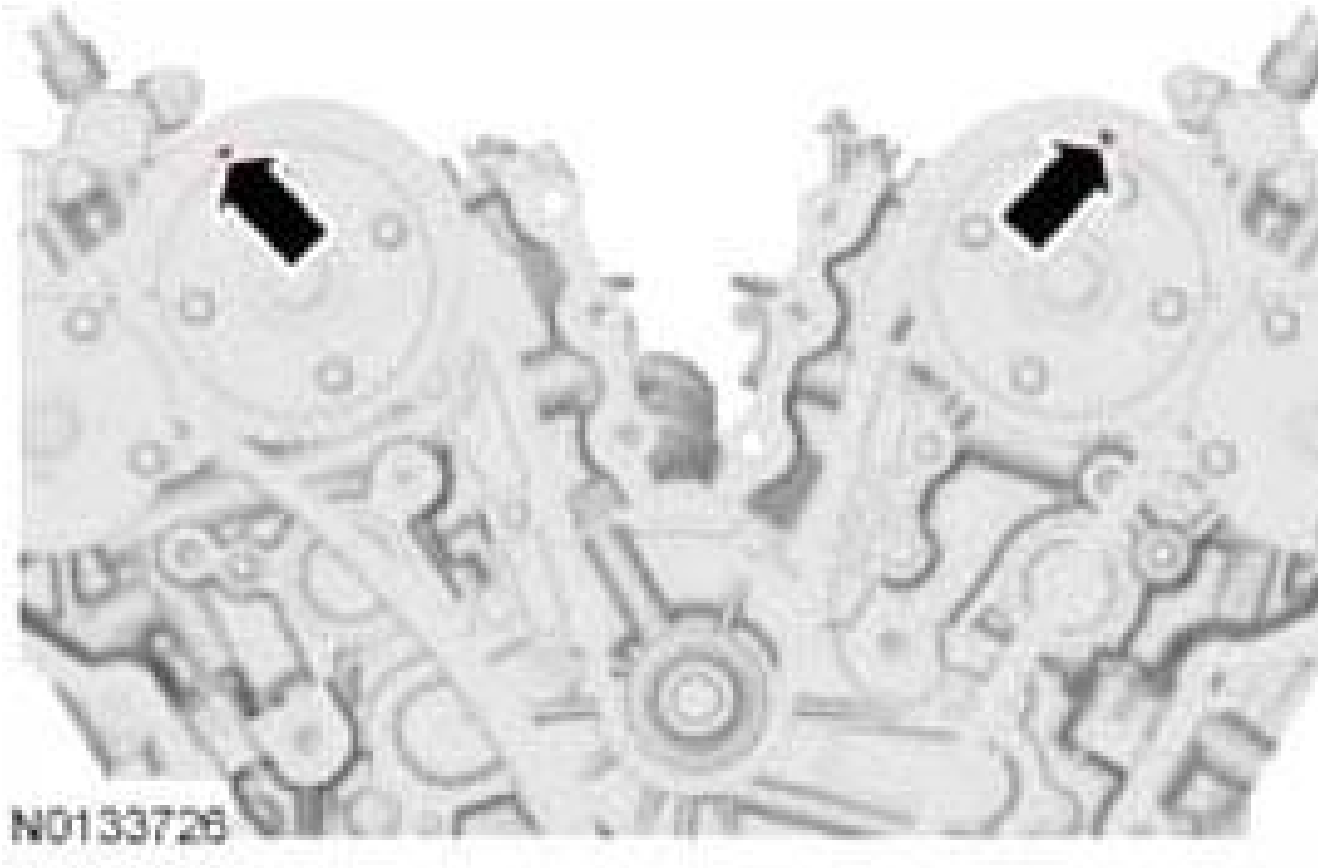
5	6268	Primary timing chain
6	6306	Crankshaft timing chain sprocket
7	6L266	Primary timing chain tensioner
8	6K255	RH primary timing chain tensioner arm
9	6268	RH secondary timing chain
10	6C525	RH exhaust **VCT** assembly
11	6C524	RH intake **VCT** assembly
12	6K297	RH primary timing chain guide
13	-	Coolant pump gear (part of 8501)
14	6K297	LH primary timing chain guide
15	6K254	RH secondary timing chain tensioner
16	6K297	RH secondary timing chain tensioner shoe
17	6K254	LH secondary timing chain tensioner
18	6K297	LH secondary timing chain tensioner shoe

Removal

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

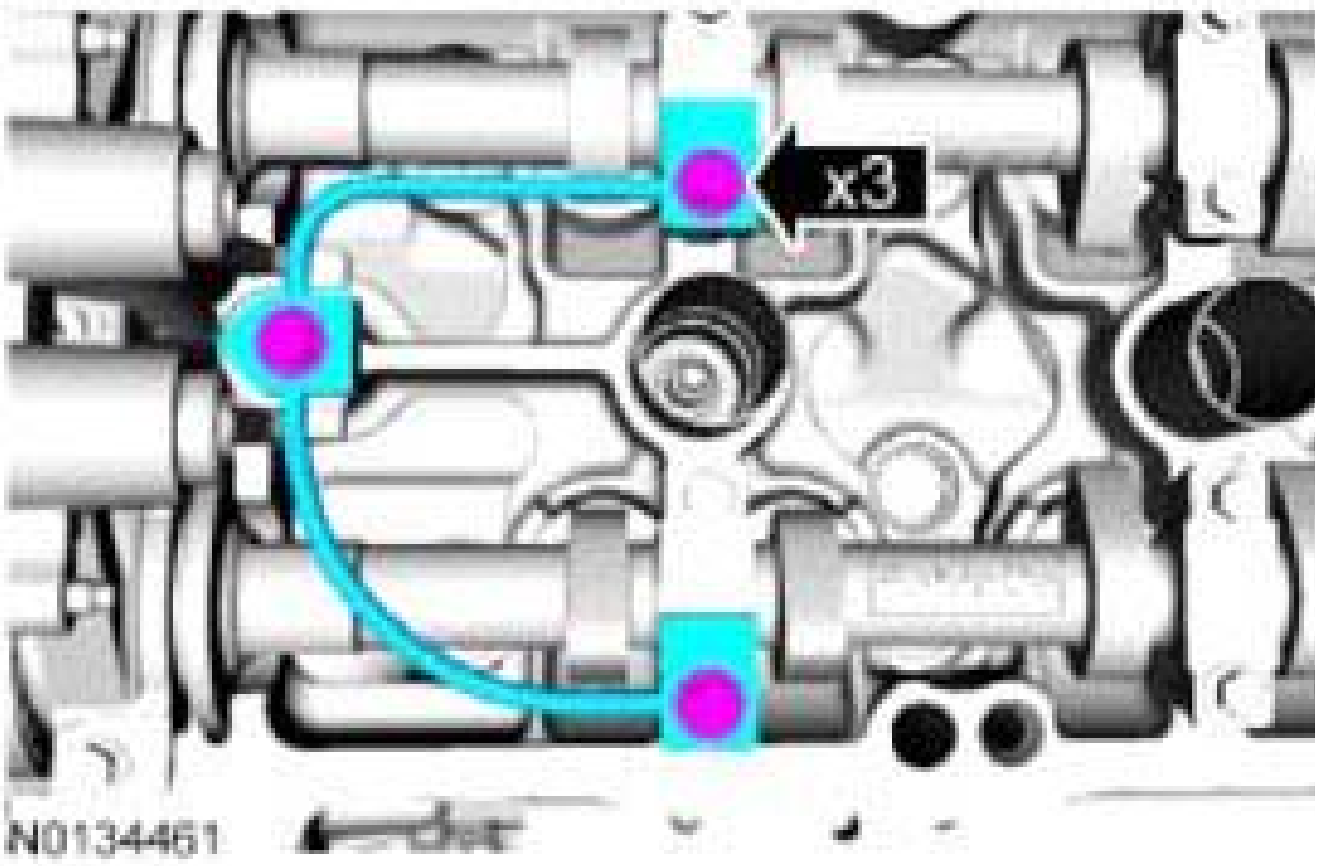
1. Remove the engine front cover. Refer to **ENGINE FRONT COVER**.
2. Rotate the crankshaft clockwise and align the timing marks on the intake **VCT** assemblies as shown in illustration.

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3. Remove the 3 bolts and the LH valve train oil tube.

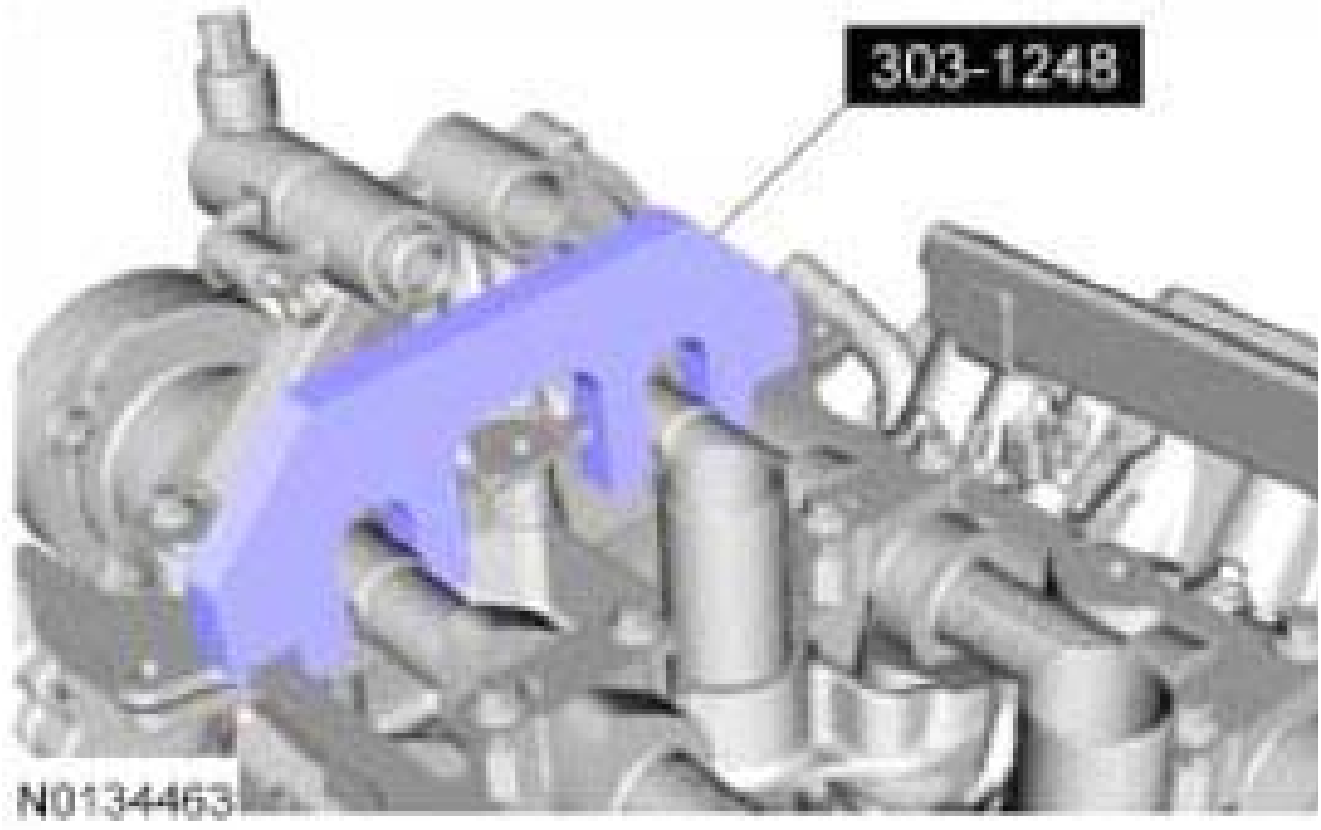
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4. **NOTE: The Camshaft Holding Tool will hold the camshafts in the TDC position.**

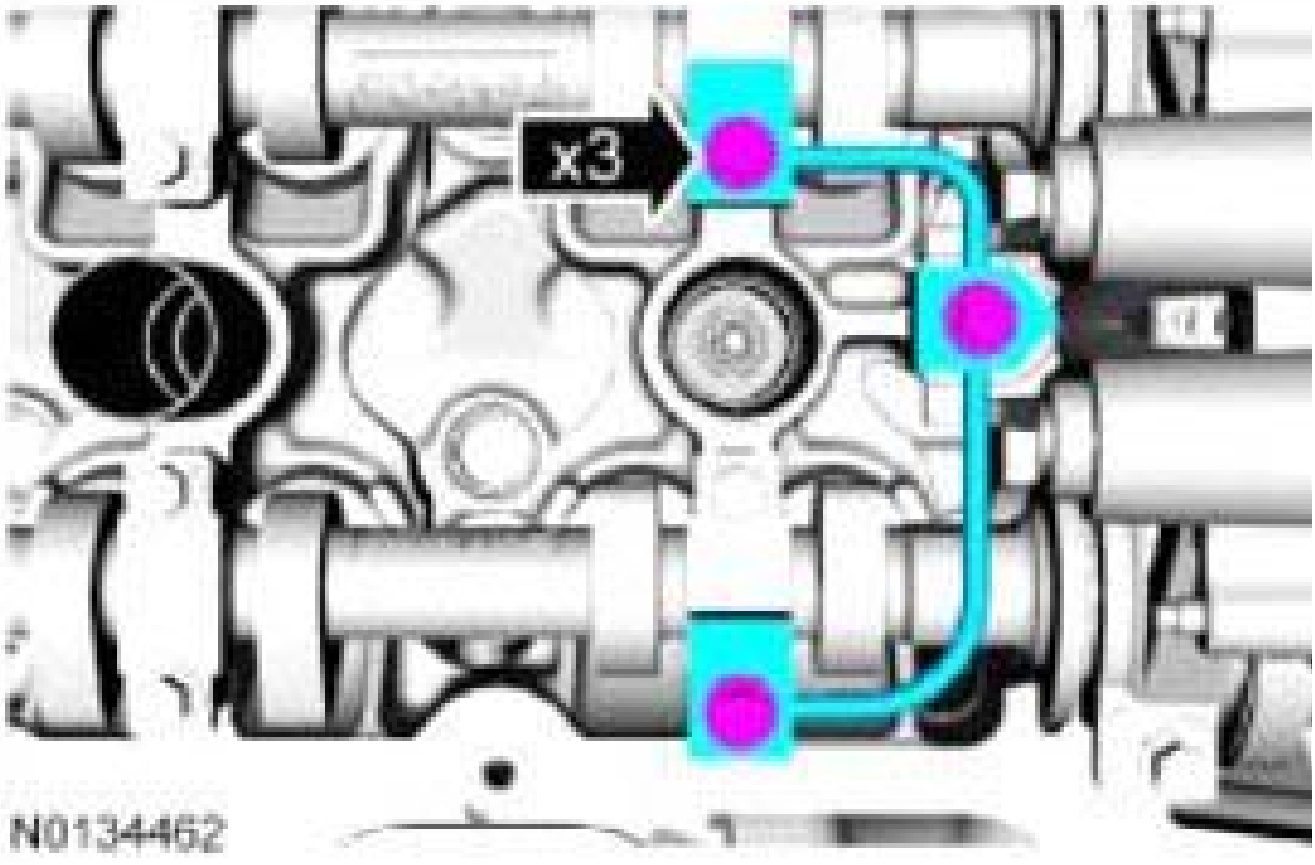
Install the Camshaft Holding Tool onto the flats of the LH camshafts.

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5. Remove the 3 bolts and the RH valve train oil tube.

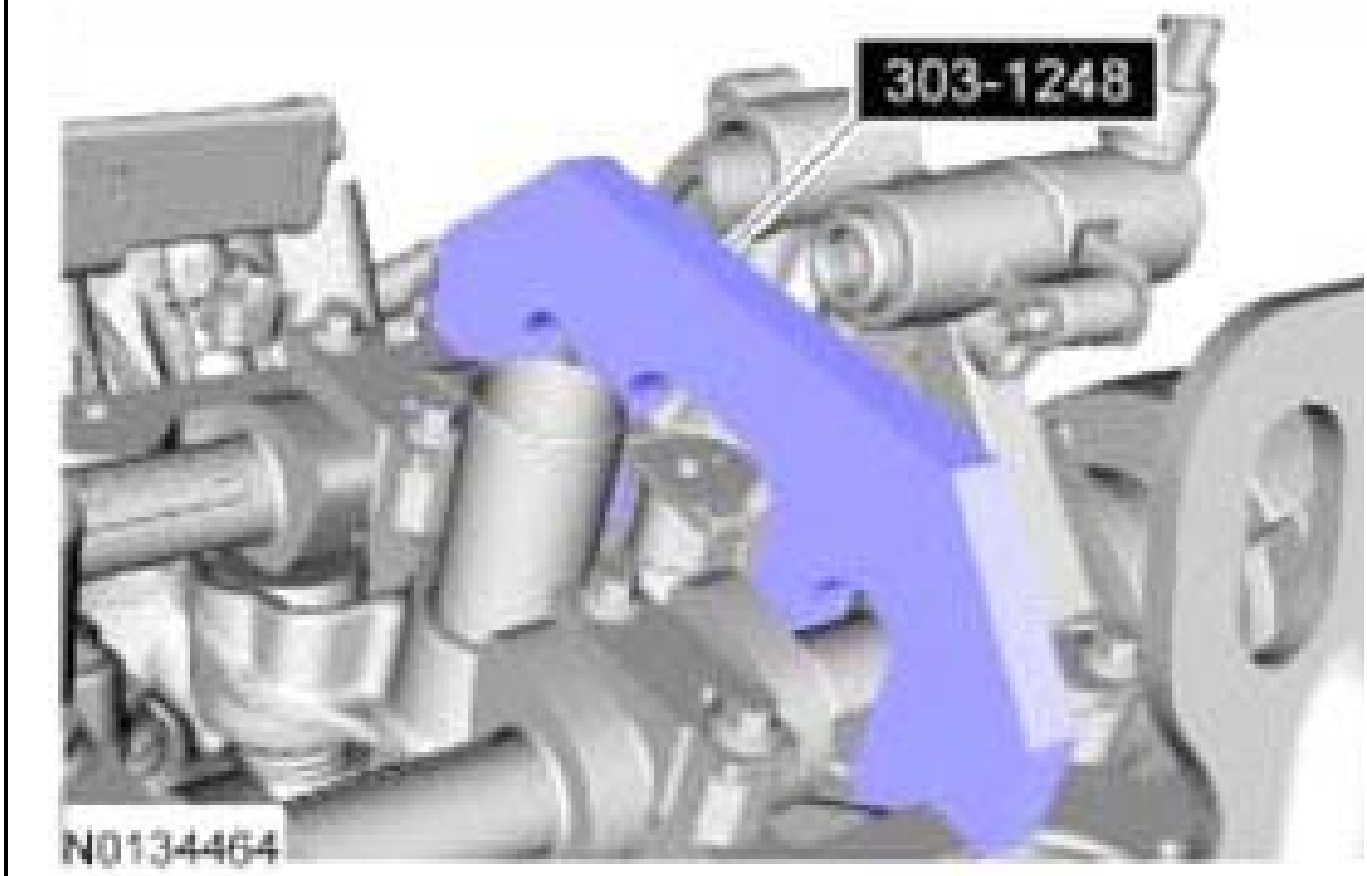
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6. **NOTE: The Camshaft Holding Tool will hold the camshafts in the TDC position.**

Install the Camshaft Holding Tool onto the flats of the RH camshafts.

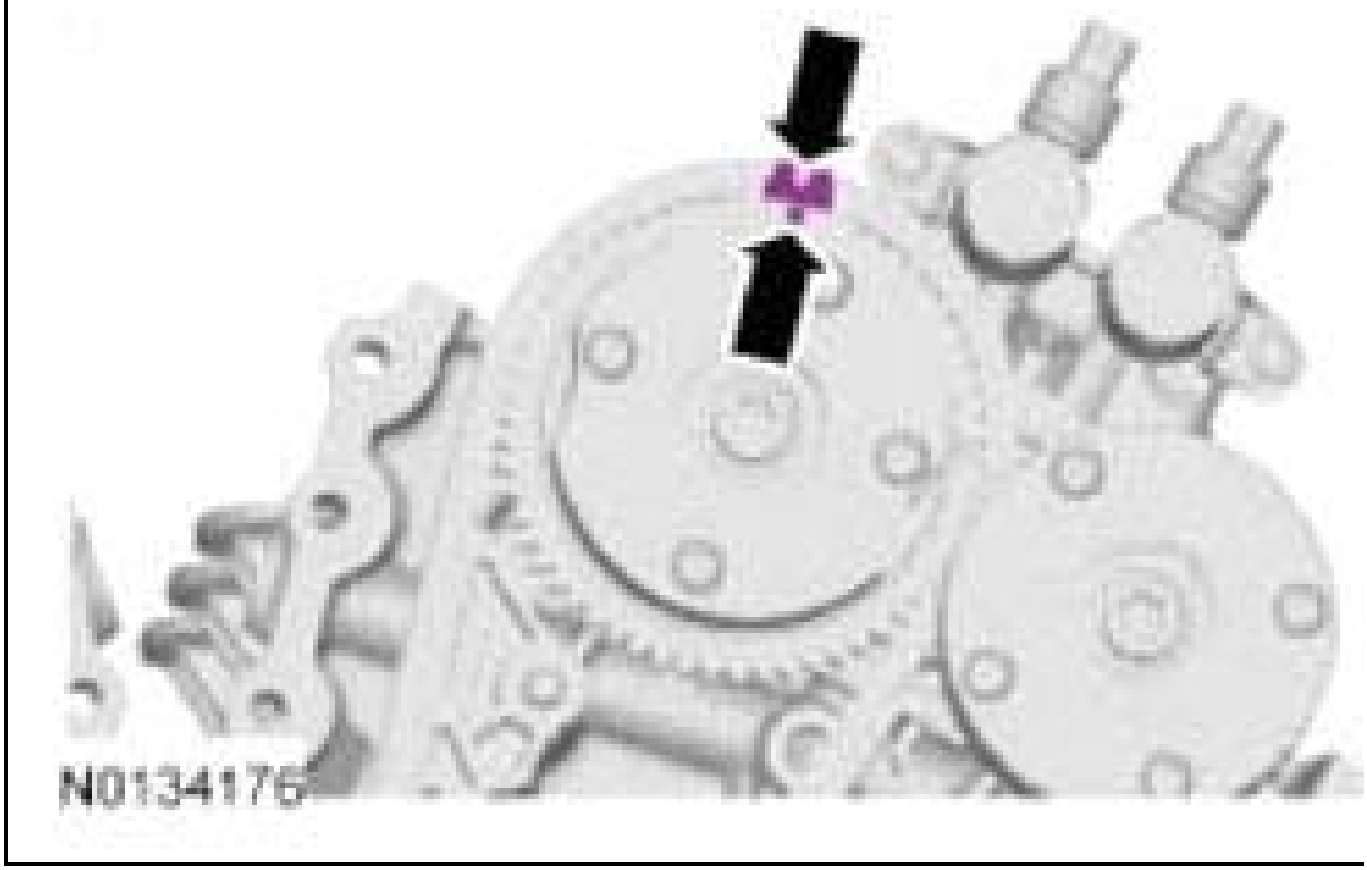
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NOTE: The following 3 steps are for primary timing chains that the colored links are not visible.

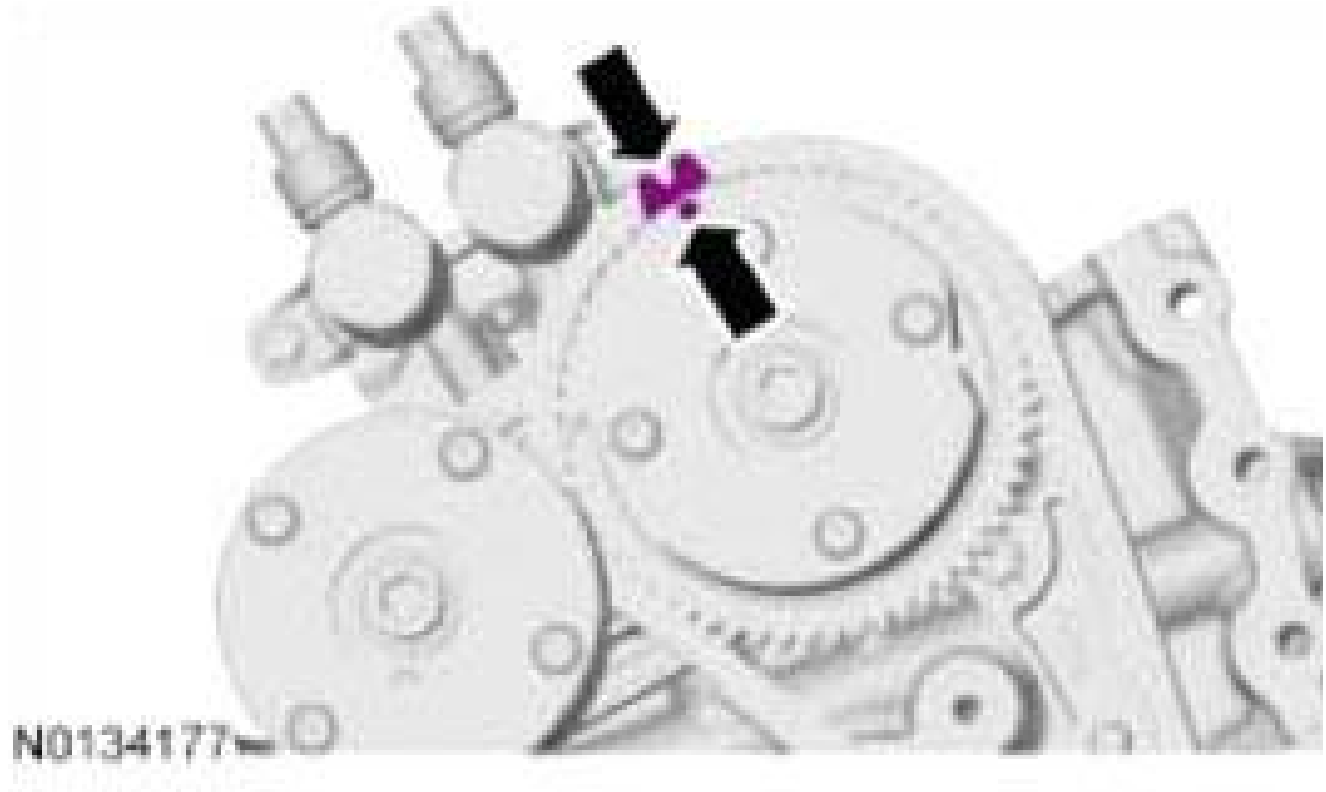
7. Mark the timing chain link that aligns with the timing mark on the LH intake **VCT** assembly as shown in illustration.

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8. Mark the timing chain link that aligns with the timing mark on the RH intake **VCT** assembly as shown in illustration.

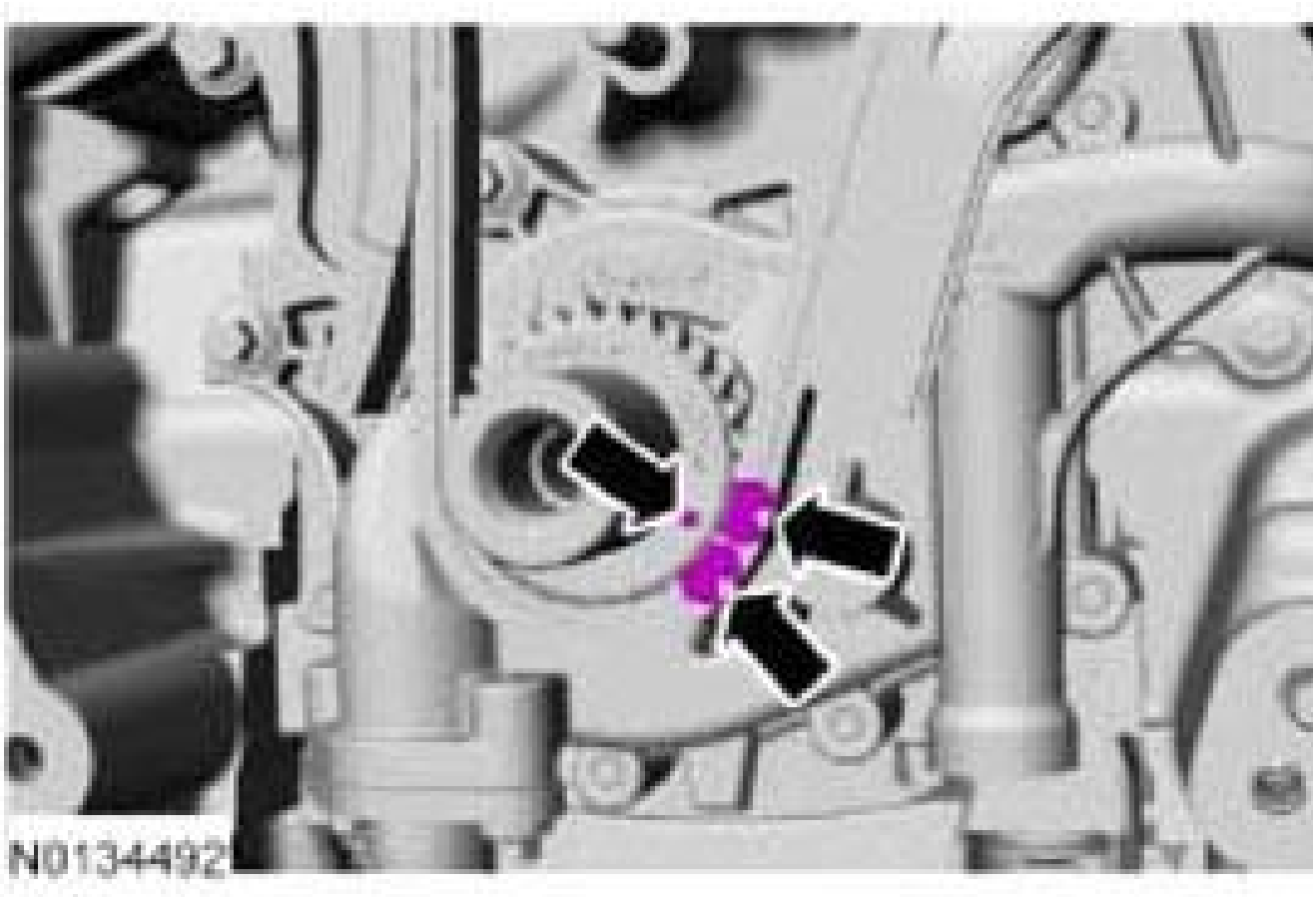
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NOTE: The crankshaft sprocket timing mark should be between the 2 colored links.

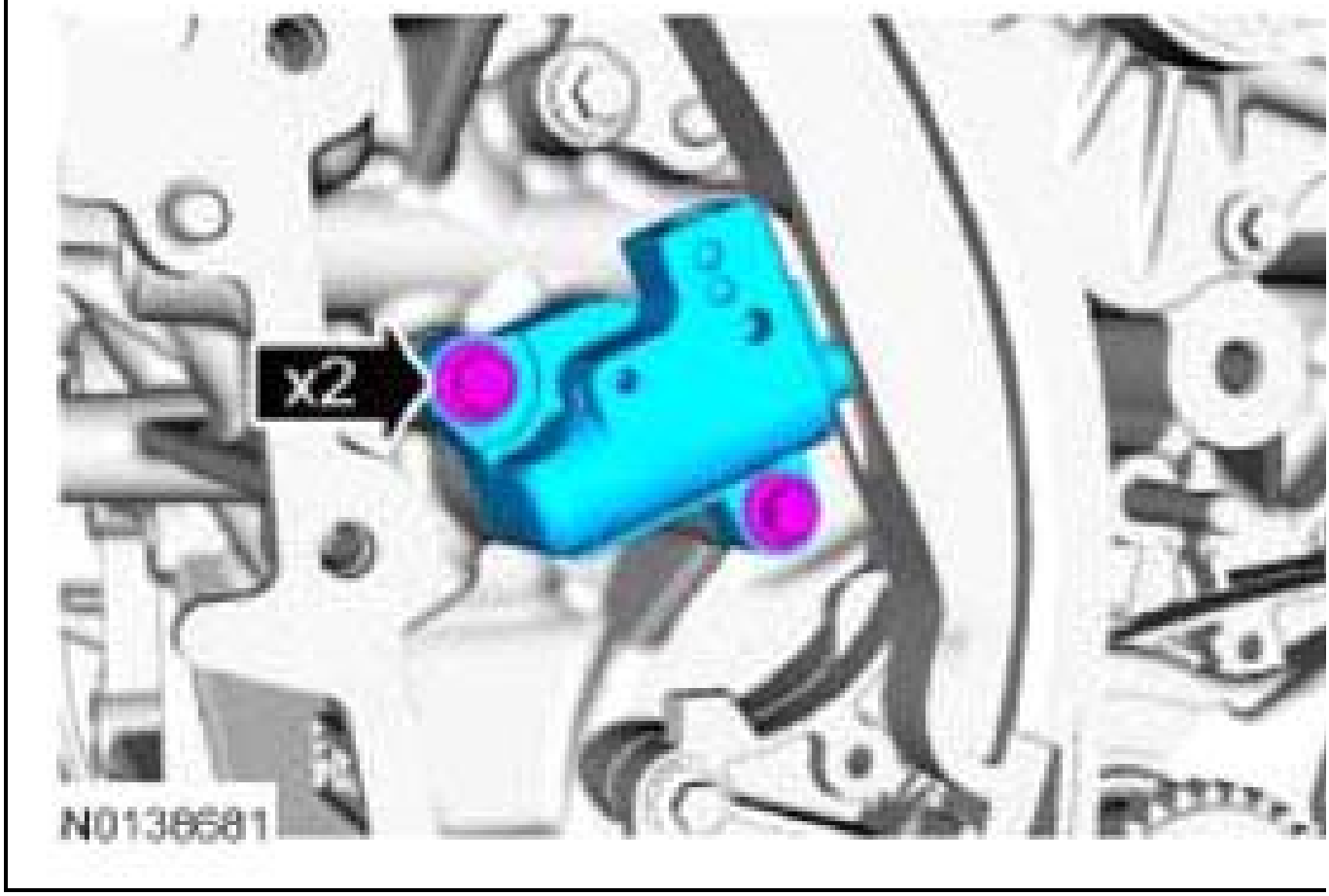
9. Mark the 2 timing chain links that align with the timing mark on the crankshaft sprocket as shown in illustration.

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10. Remove the 2 bolts and the primary timing chain tensioner.

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11. Remove the primary timing chain tensioner arm.

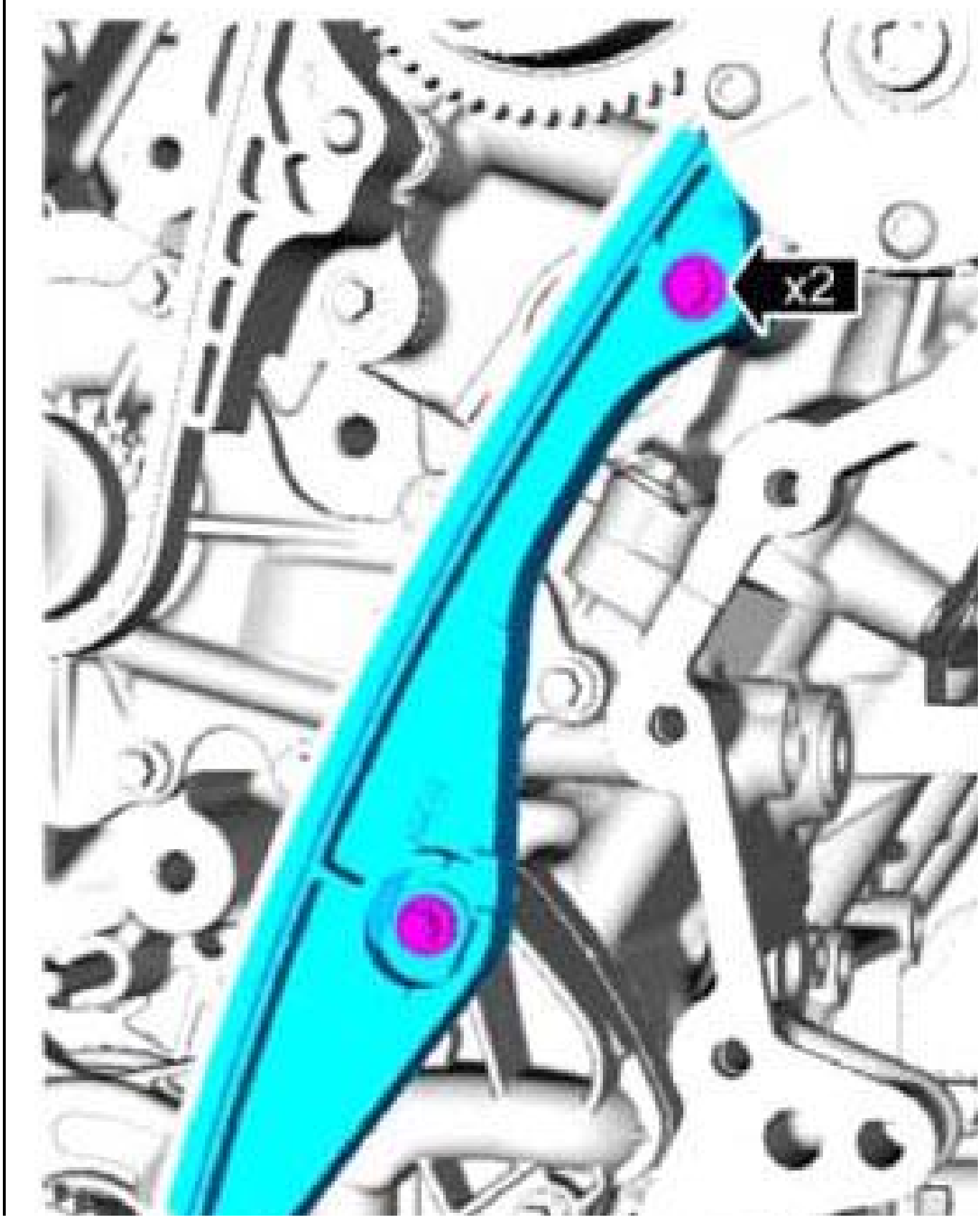
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12. Remove the 2 bolts and the lower LH primary timing chain guide.

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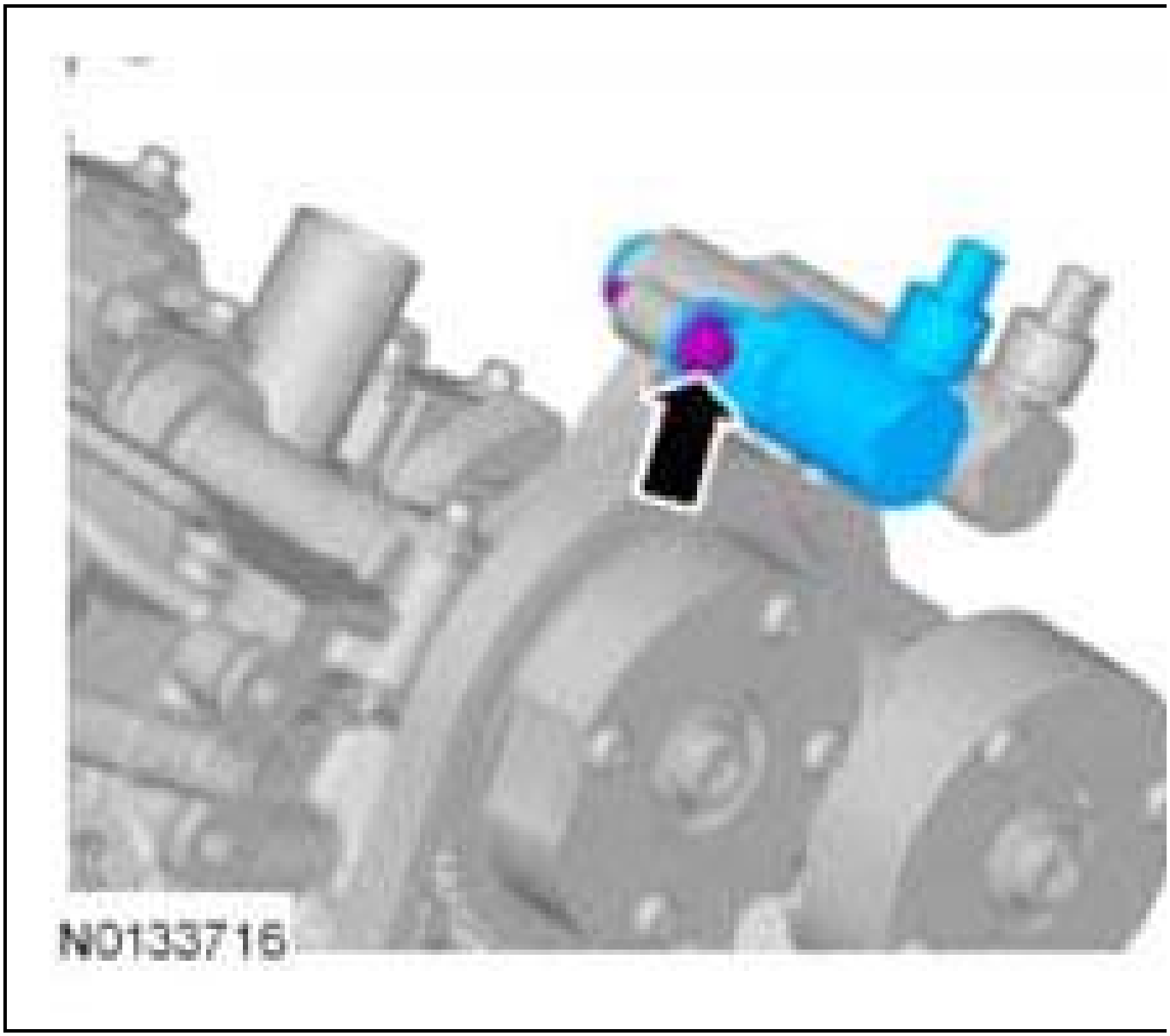
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13. **NOTE: Removal of the VCT oil control solenoid will aid in the removal of the primary timing chain.**

NOTE: A slight twisting motion will aid in the removal of the VCT oil control solenoid.

NOTE: Keep the VCT oil control solenoid clean of dirt and debris.

Remove the bolt and the LH intake **VCT** oil control solenoid.



14. **NOTE: Removal of the VCT oil control solenoid will aid in the removal of the**

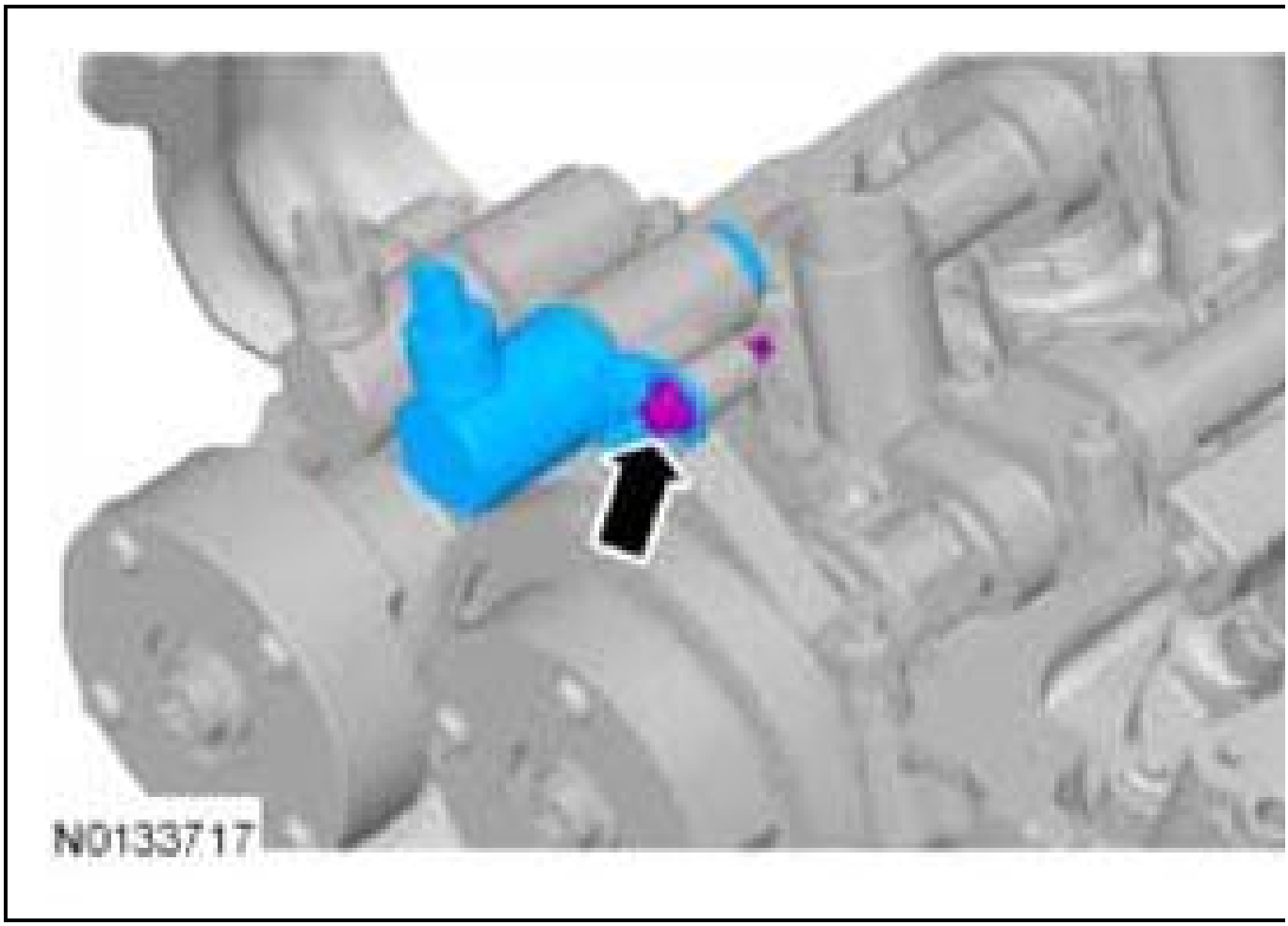
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14. **primary timing chain.**

NOTE: A slight twisting motion will aid in the removal of the VCT oil control solenoid.

NOTE: Keep the VCT oil control solenoid clean of dirt and debris.

Remove the bolt and the RH intake **VCT** oil control solenoid.



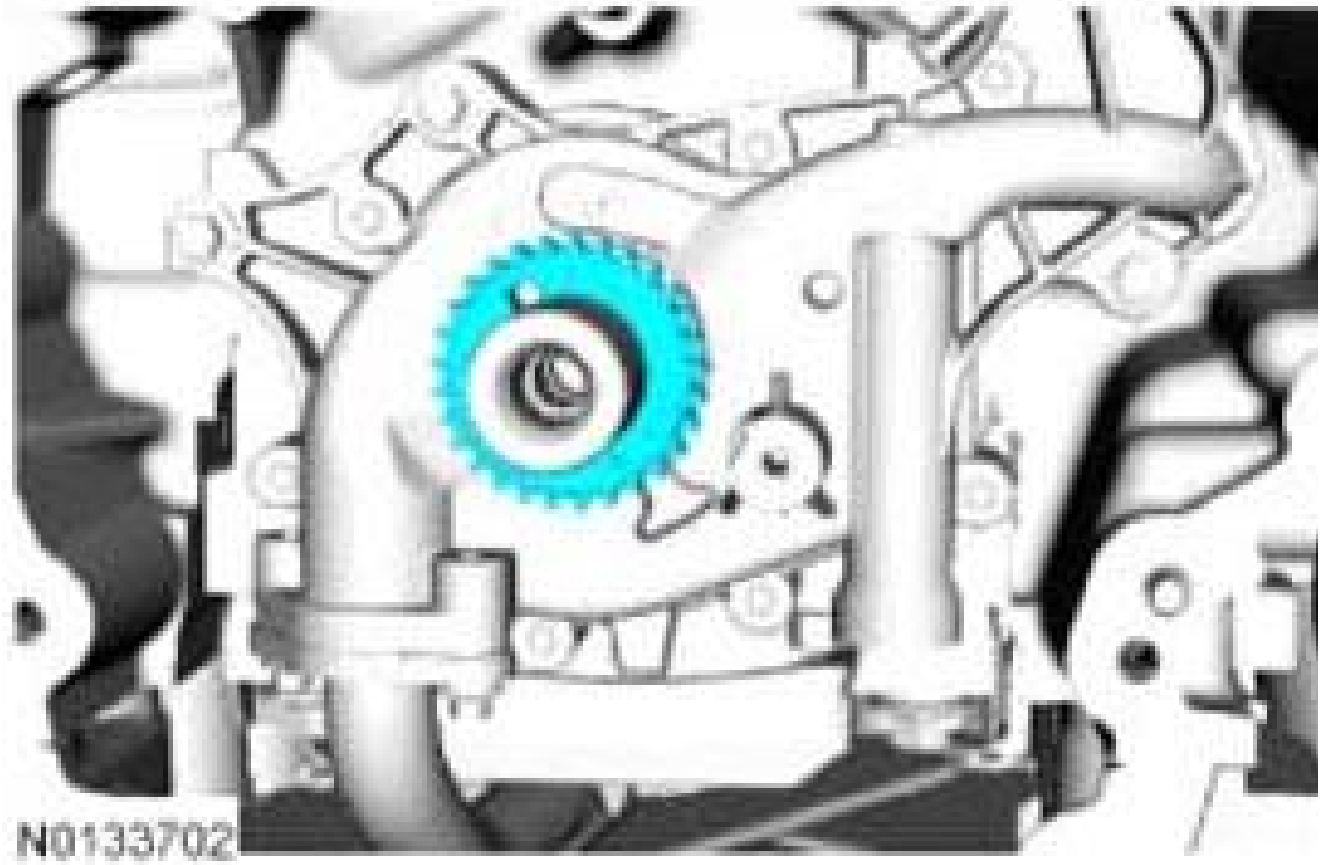
15. Remove the primary timing chain.

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16. Remove the crankshaft timing chain sprocket.

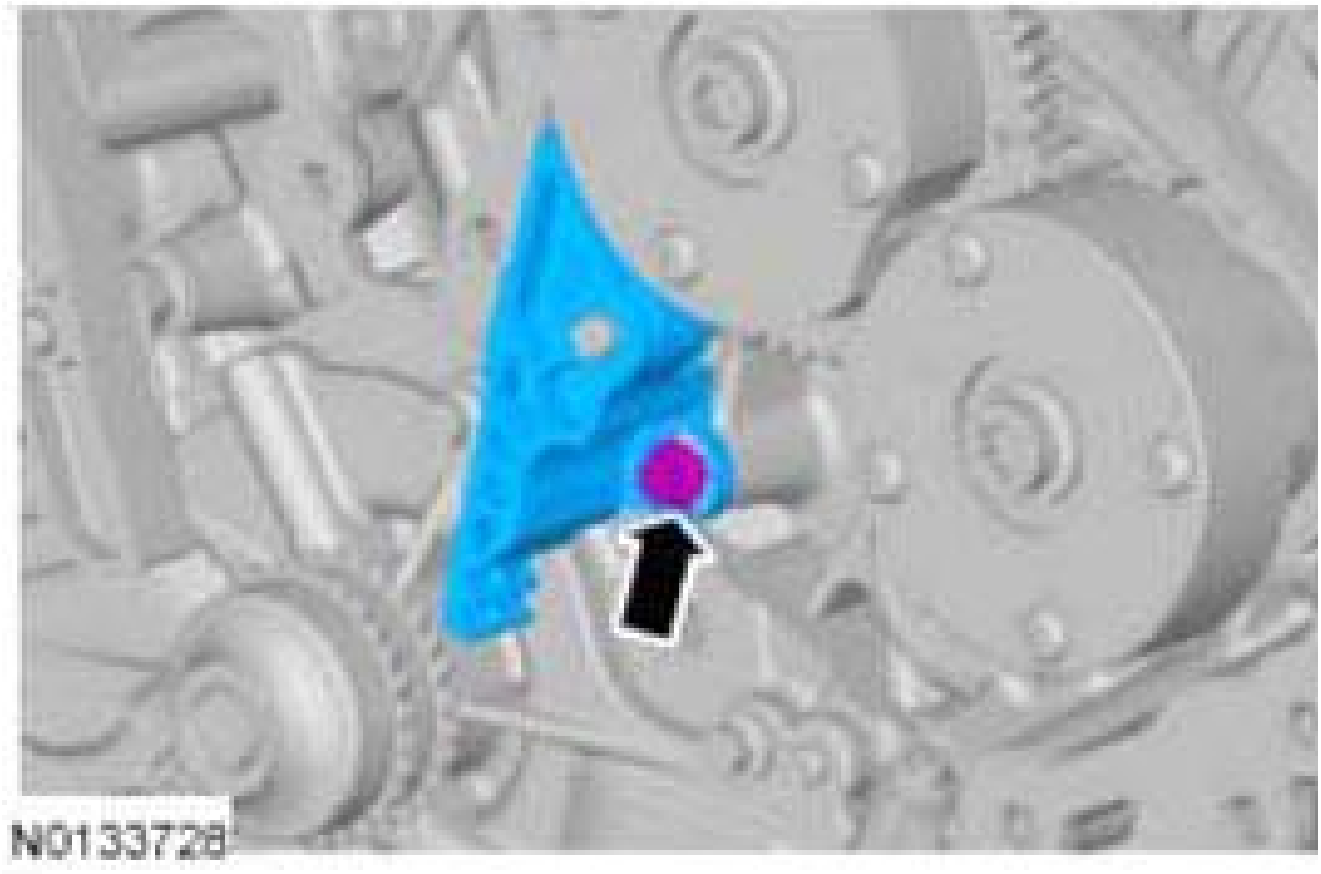
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17. **NOTE: Do not use power tools to remove the bolt or damage to the LH primary timing chain guide may occur.**

Remove the bolt and the upper LH primary timing chain guide

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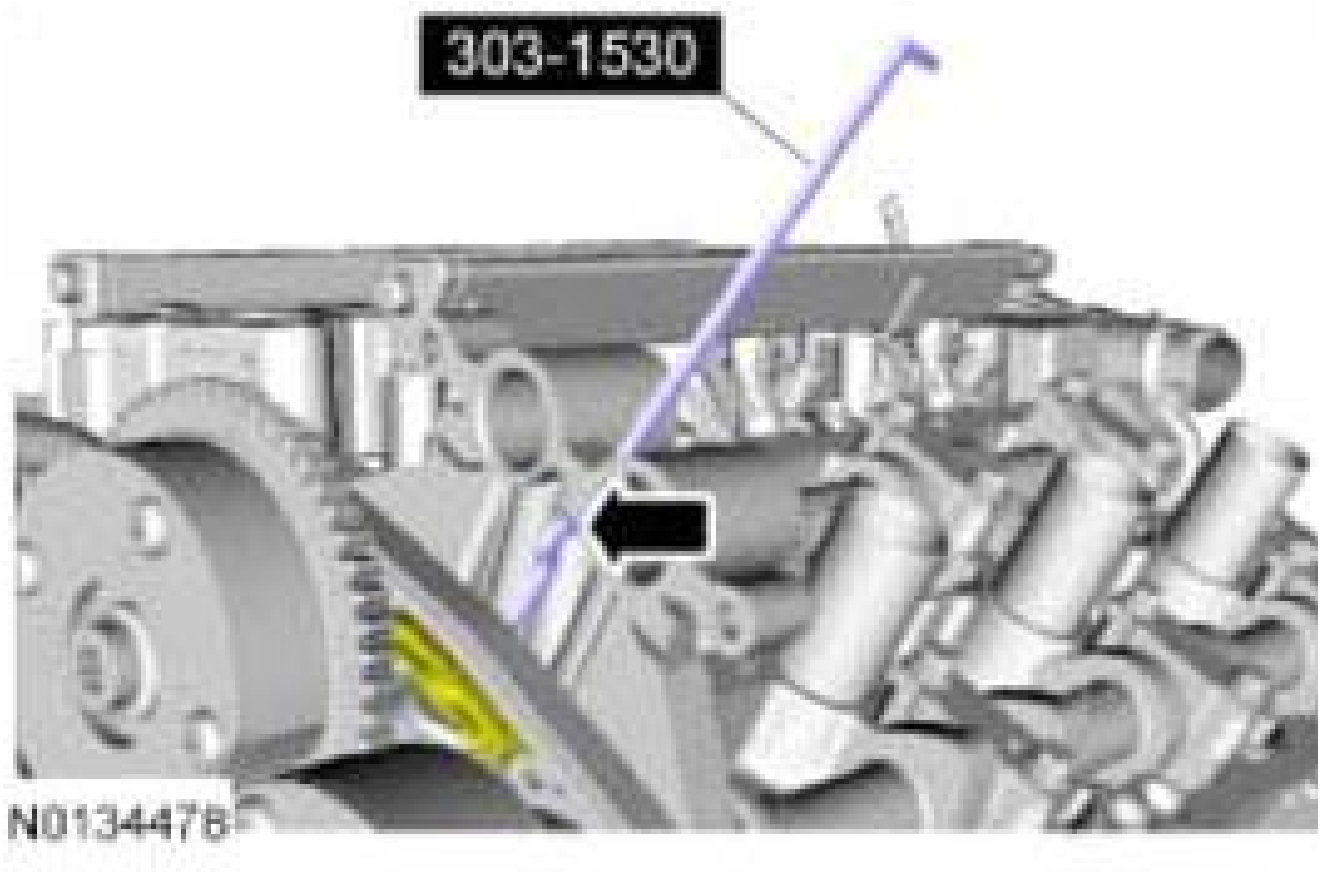


18. **NOTE: The 2 VCT oil control solenoids are removed for clarity.**

NOTE: The Secondary Chain Hold Down is inserted through a hole in the top of the mega cap.

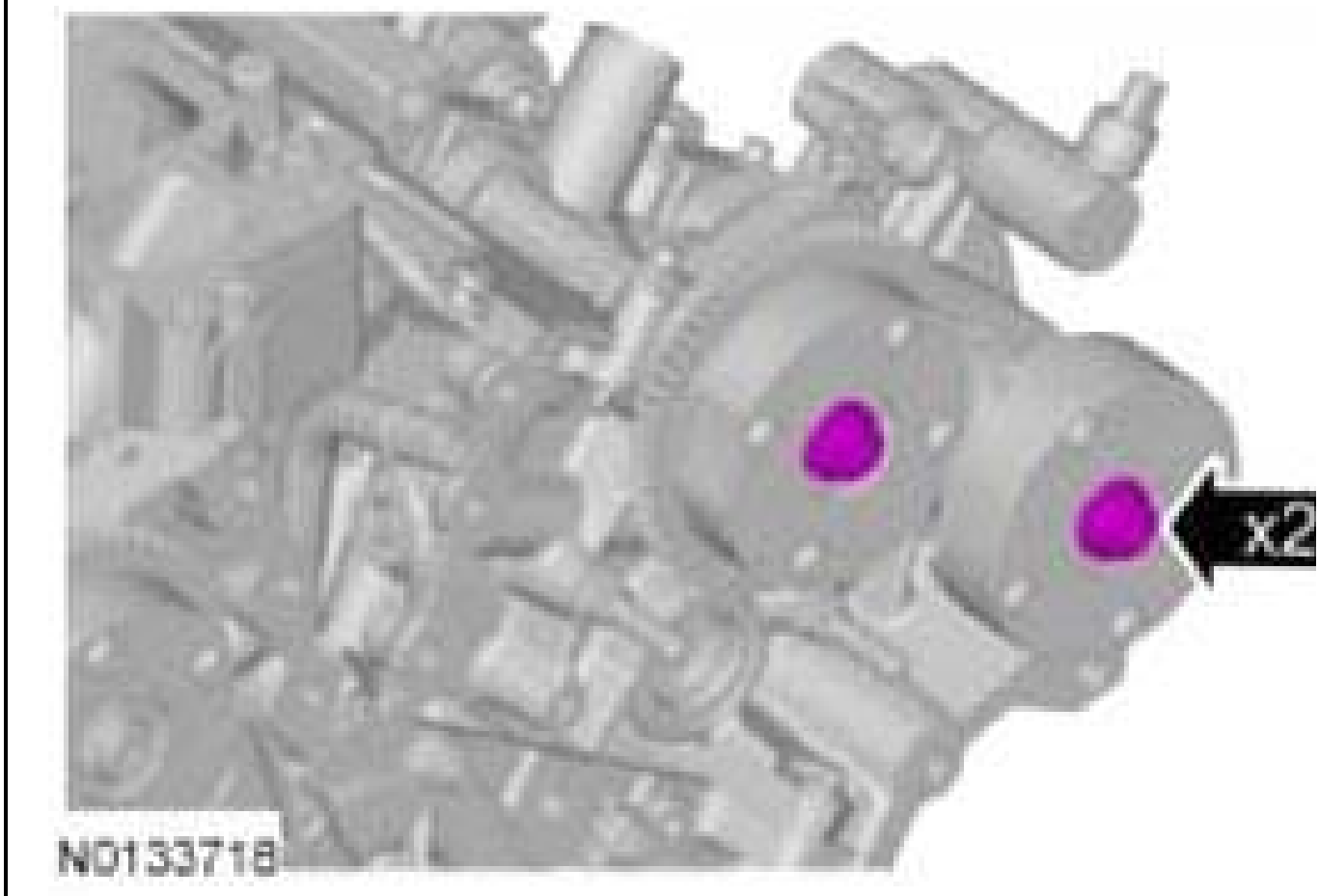
Compress the LH secondary timing chain tensioner and install the Secondary Chain Hold Down in the hole on the rear of the secondary timing chain tensioner guide and let it hold against the mega cap to retain the tensioner in the collapsed position.

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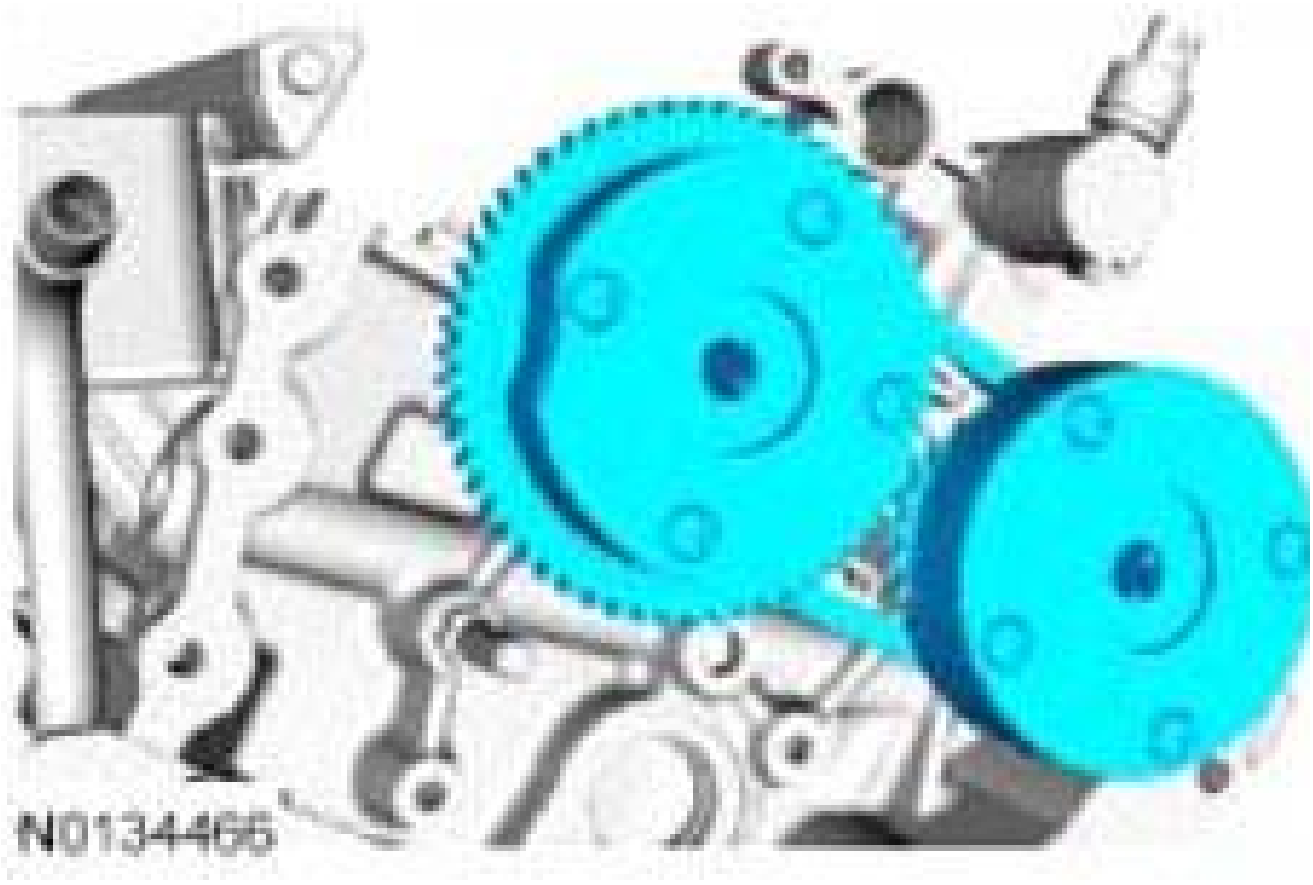
19. Remove and discard the 2 LH **VCT** assembly bolts.

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20. Remove the 2 LH **VCT** assemblies and secondary timing chain.

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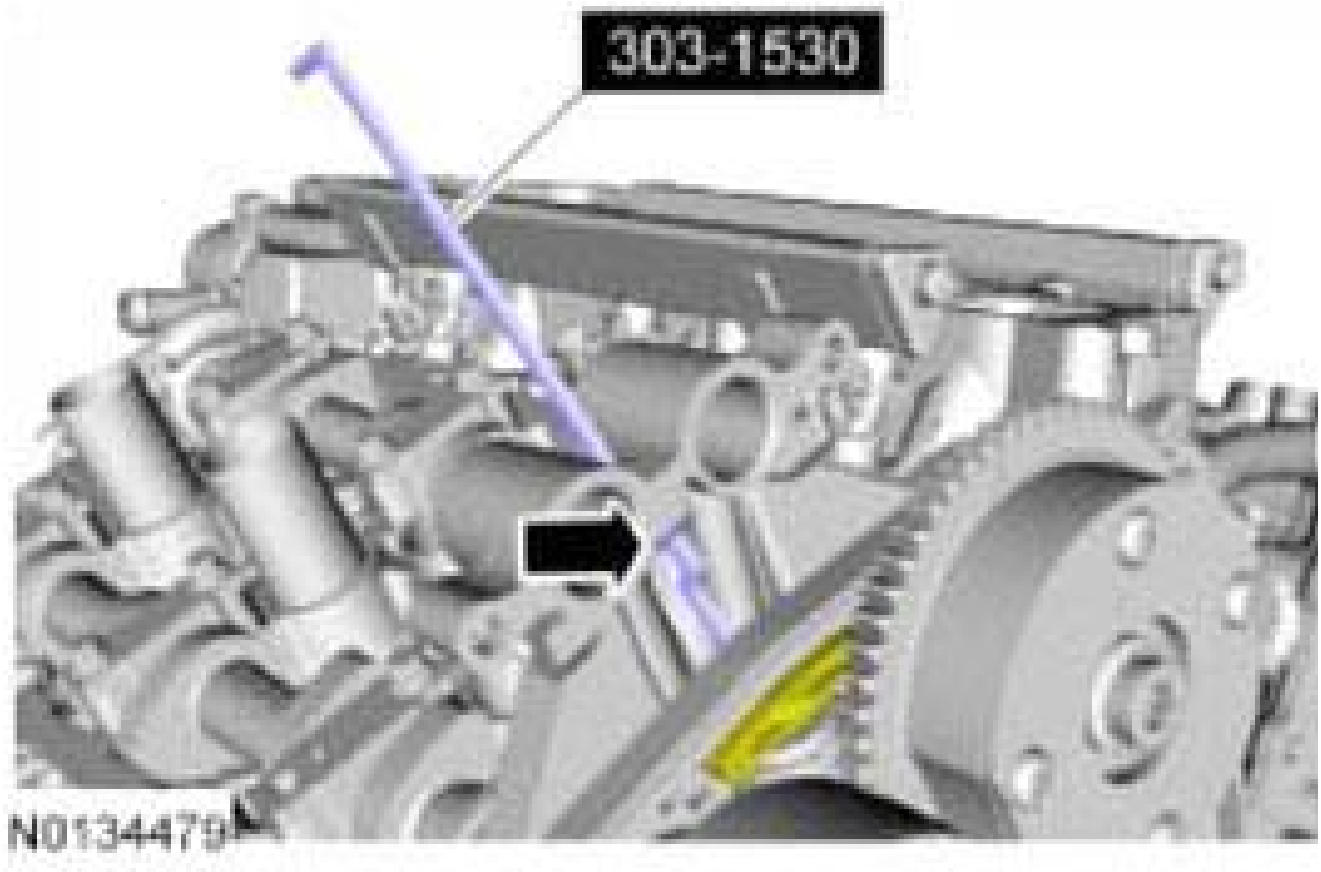


21. **NOTE: The 2 VCT oil control solenoids are removed for clarity.**

NOTE: The Secondary Chain Hold Down is inserted through a hole in the top of the mega cap.

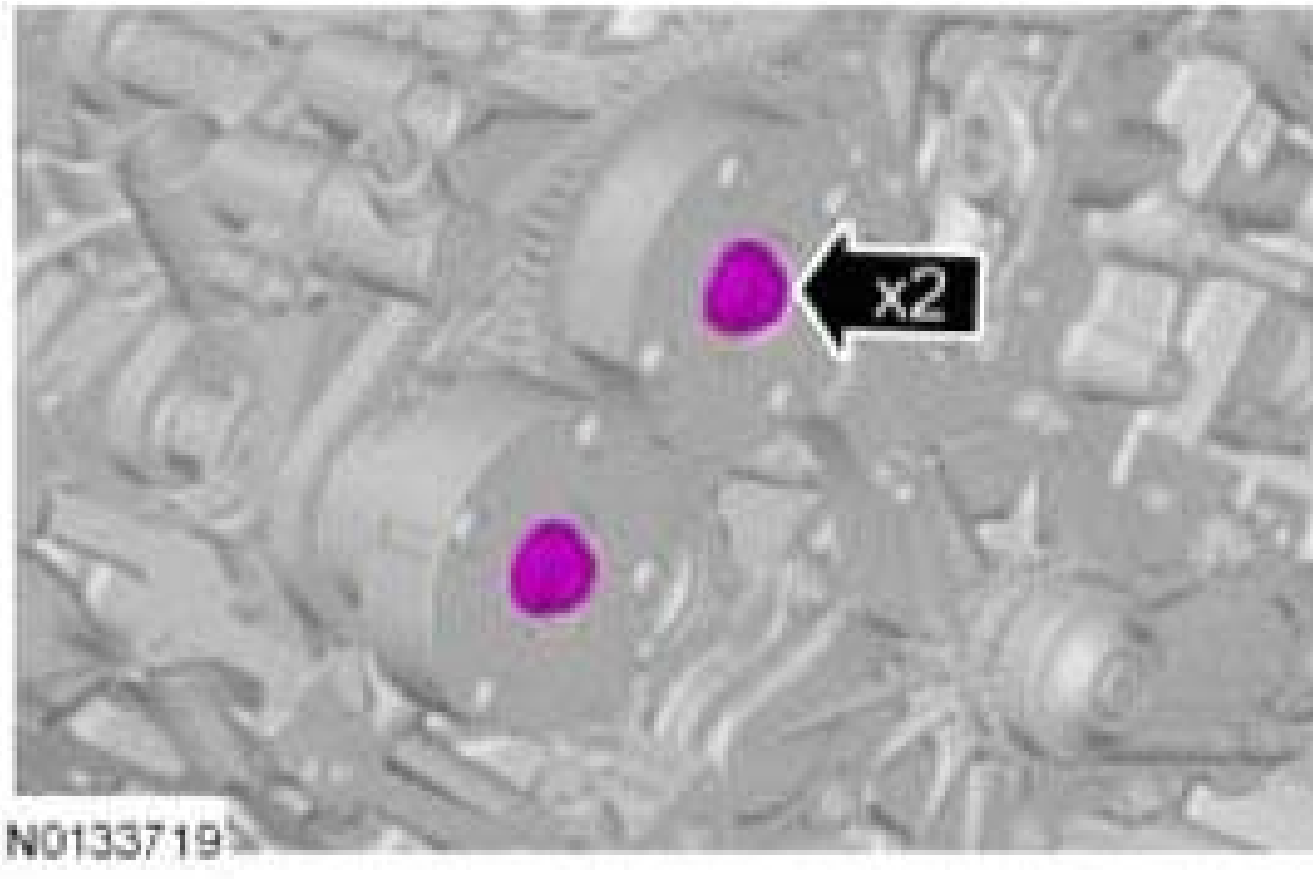
Compress the RH secondary timing chain tensioner and install the Secondary Chain Hold Down in the hole on the rear of the secondary timing chain tensioner guide and let it hold against the mega cap to retain the tensioner in the collapsed position.

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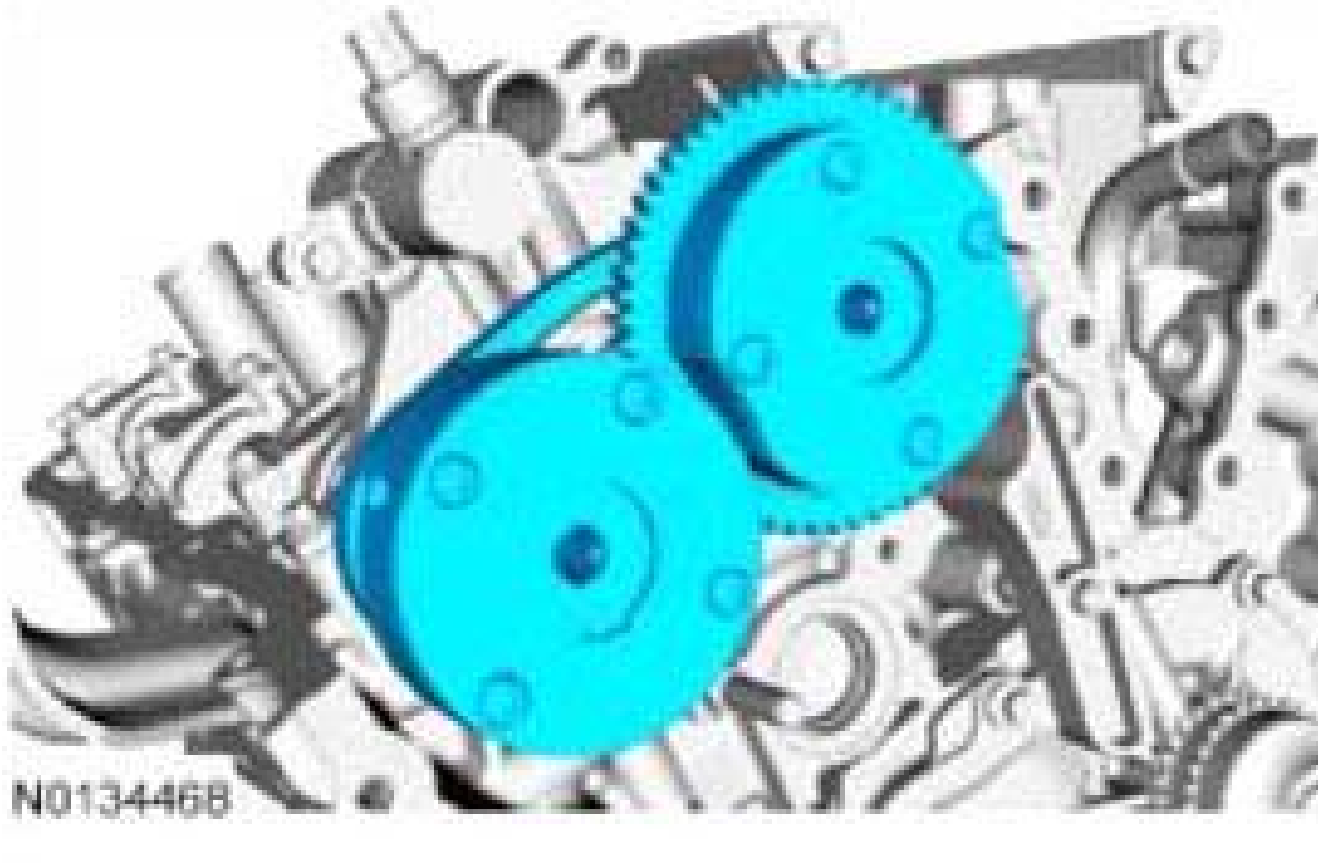
22. Remove and discard the 2 RH **VCT** assembly bolts.

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23. Remove the 2 RH **VCT** assemblies and secondary timing chain.

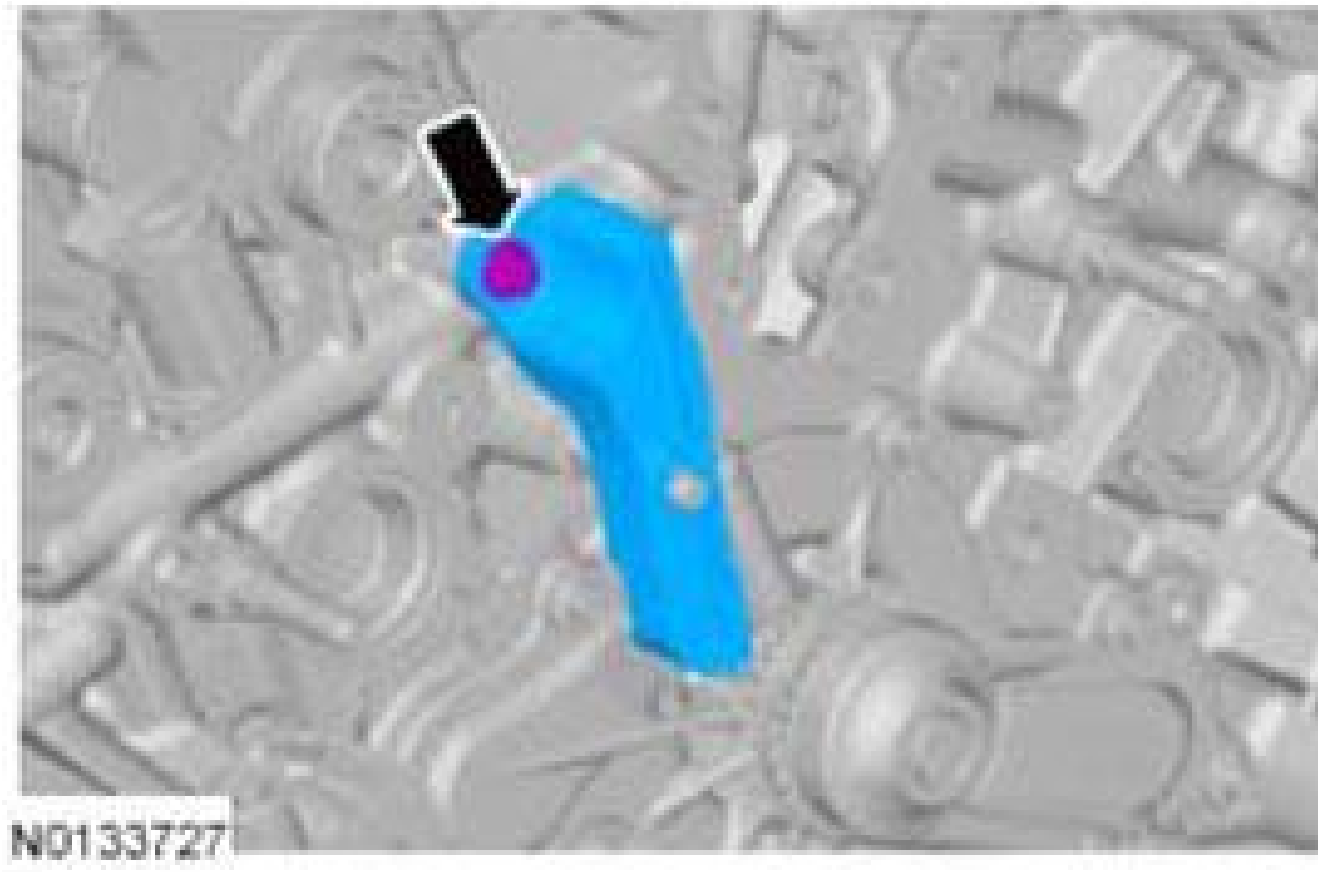
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NOTE: **Do not use power tools to remove the bolt or damage to the RH primary timing chain guide may occur.**

24. Remove the bolt and the RH primary timing chain guide.

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25. **NOTE: The following steps are only for the replacement of the secondary timing chain tensioners. Do not reuse the secondary timing chain tensioners if removed, or damage to the engine may occur.**

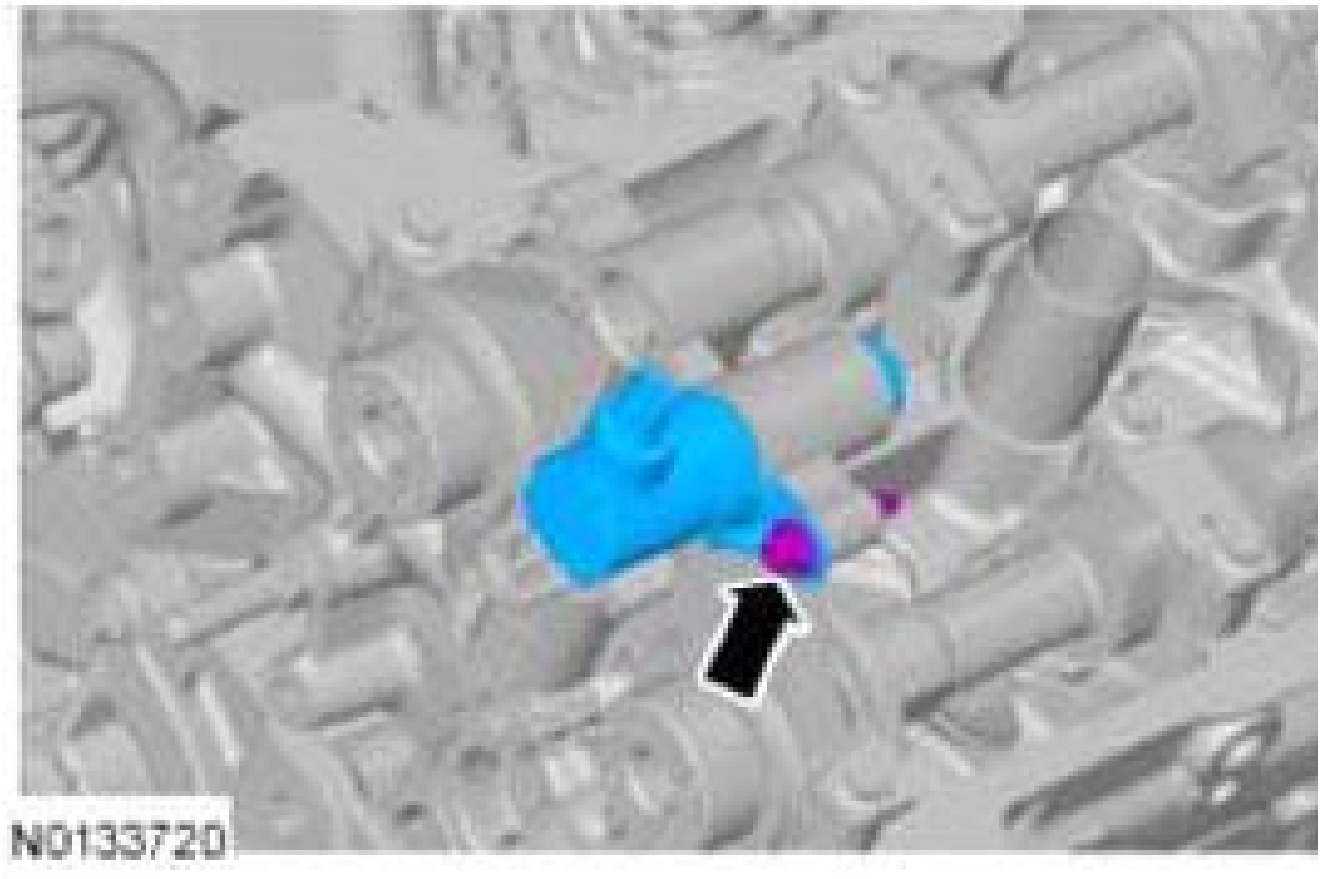
For replacement of the secondary timing chain tensioner, perform the following 6 steps.

26. **NOTE: A slight twisting motion will aid in the removal of the VCT oil control solenoid.**

NOTE: Keep the VCT oil control solenoid clean of dirt and debris.

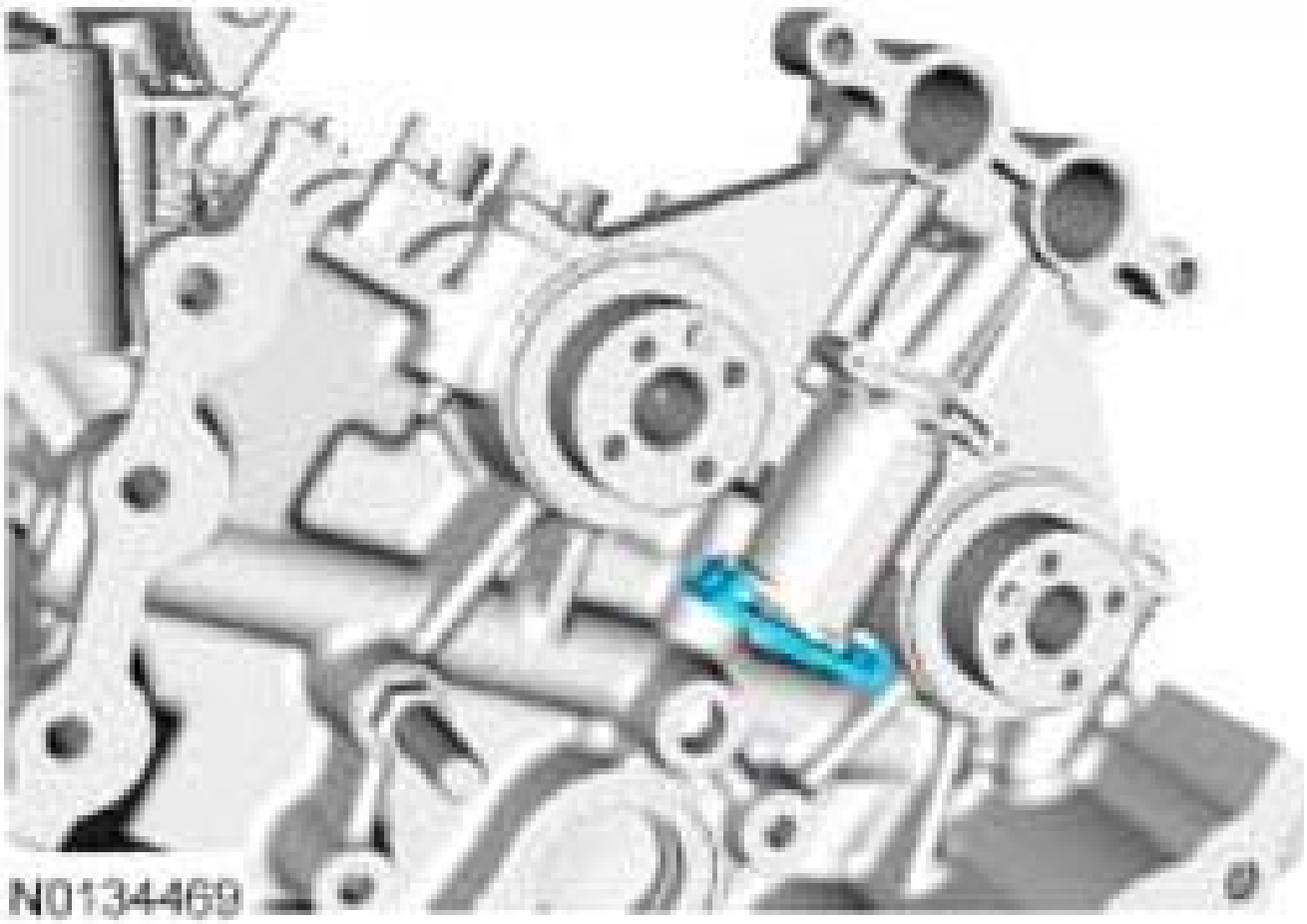
Remove the LH exhaust **VCT** oil control solenoid.

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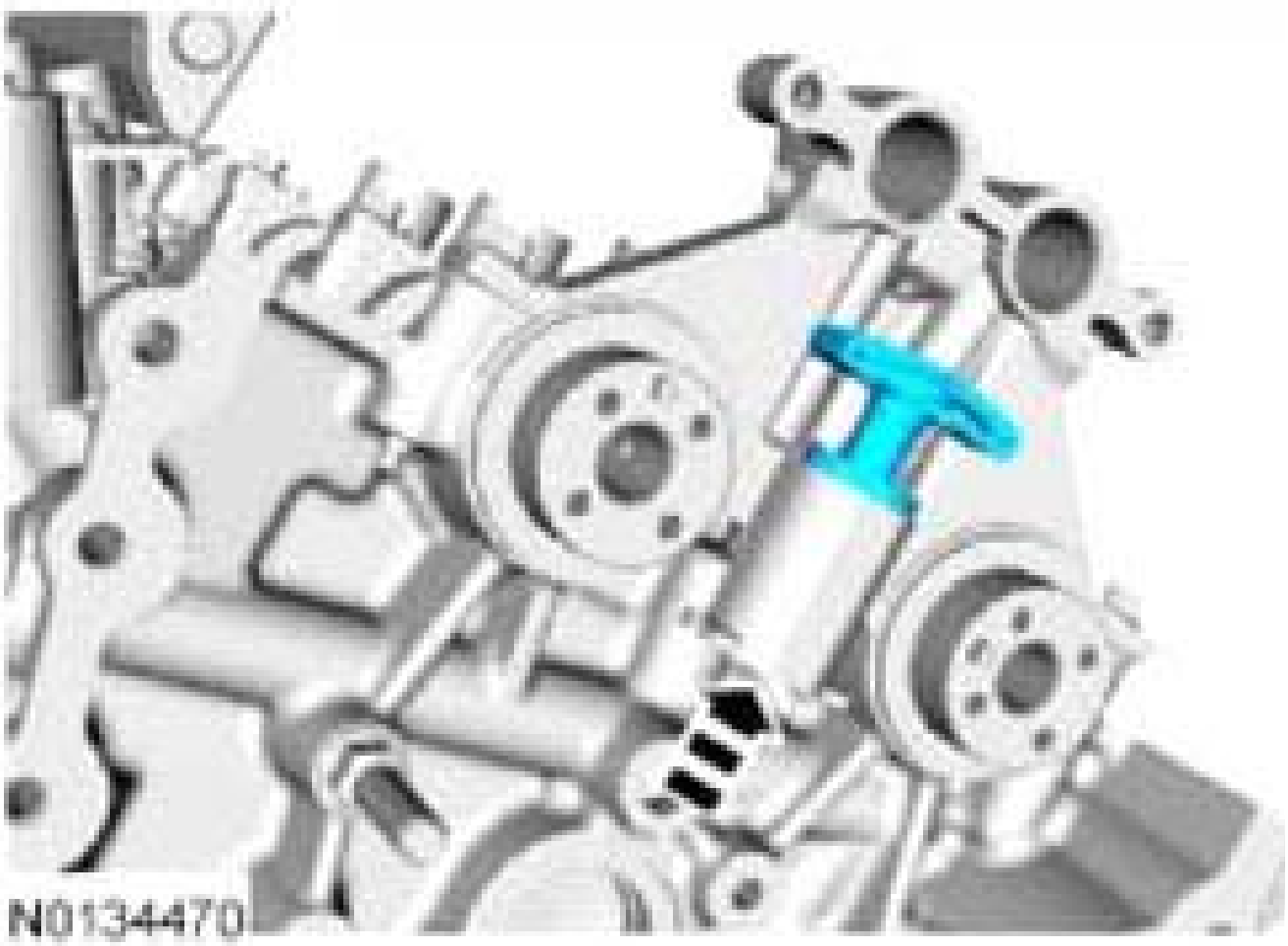
27. Remove the LH secondary timing chain tensioner shoe.

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28. Remove the LH secondary timing chain tensioner by pushing up from the bottom and remove.

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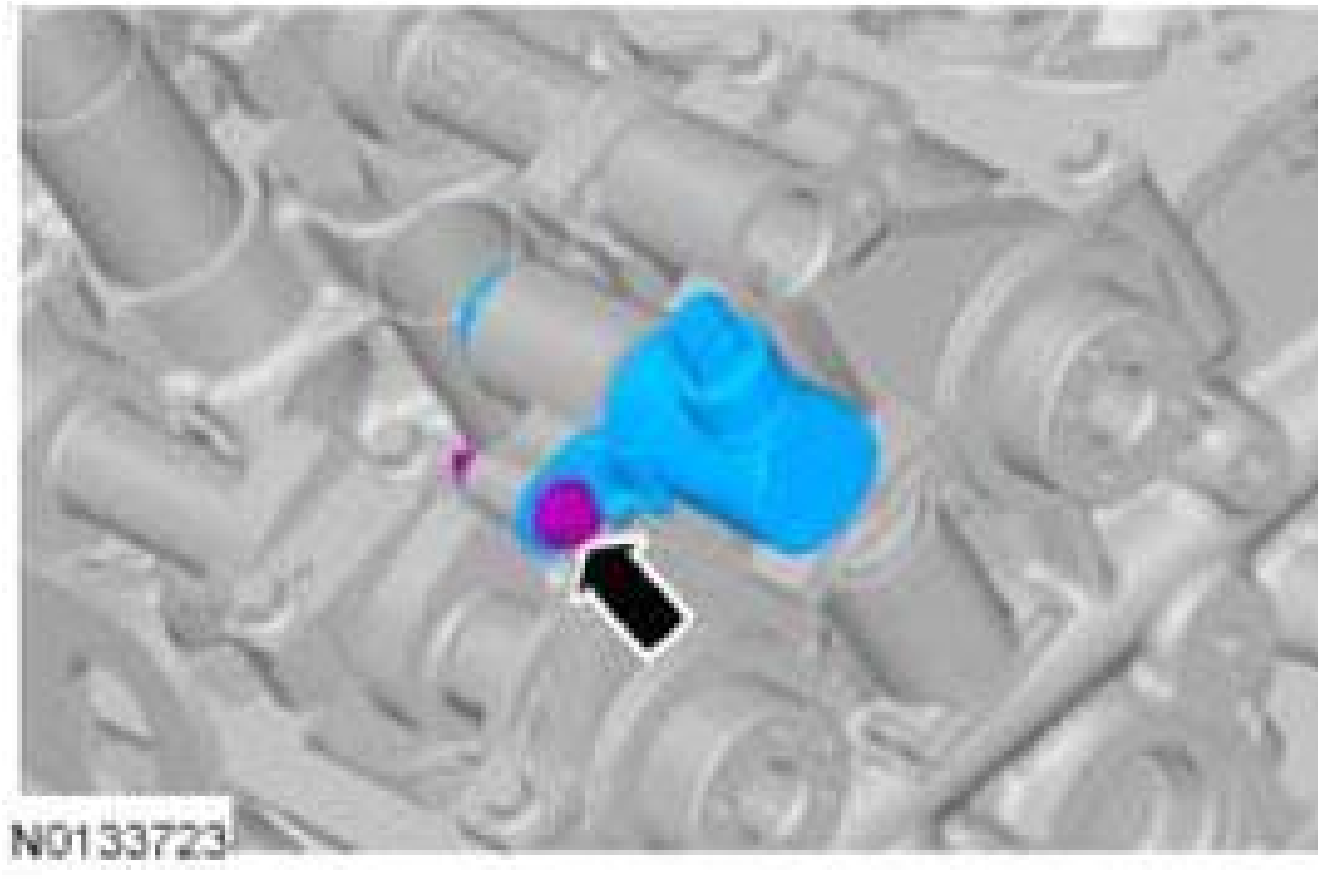
29.

NOTE: A slight twisting motion will aid in the removal of the VCT oil control solenoid.

NOTE: Keep the VCT oil control solenoid clean of dirt and debris.

Remove the RH exhaust **VCT** oil control solenoid.

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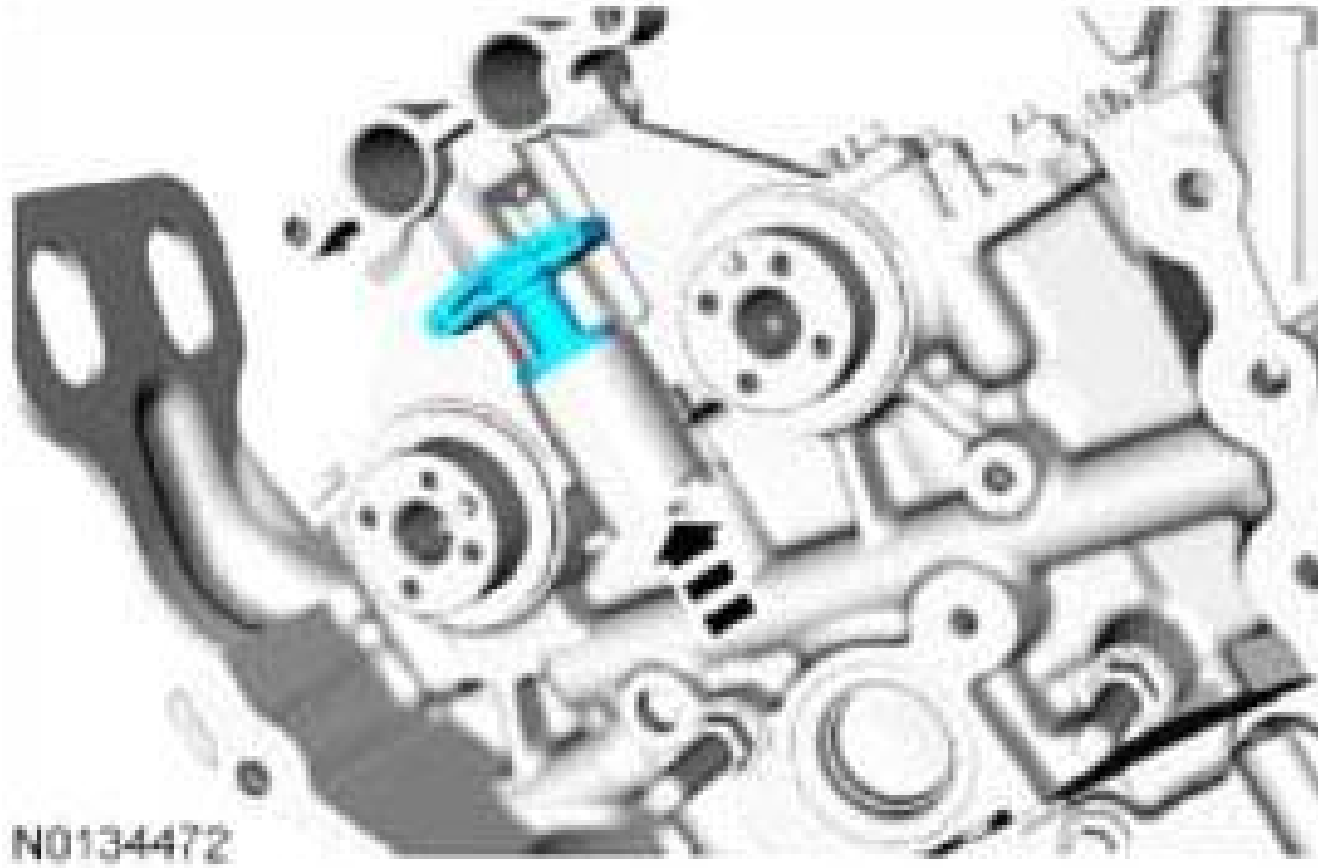
30. Remove the RH secondary timing chain tensioner shoe.

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31. Remove the RH secondary timing chain tensioner by pushing up from the bottom and remove.

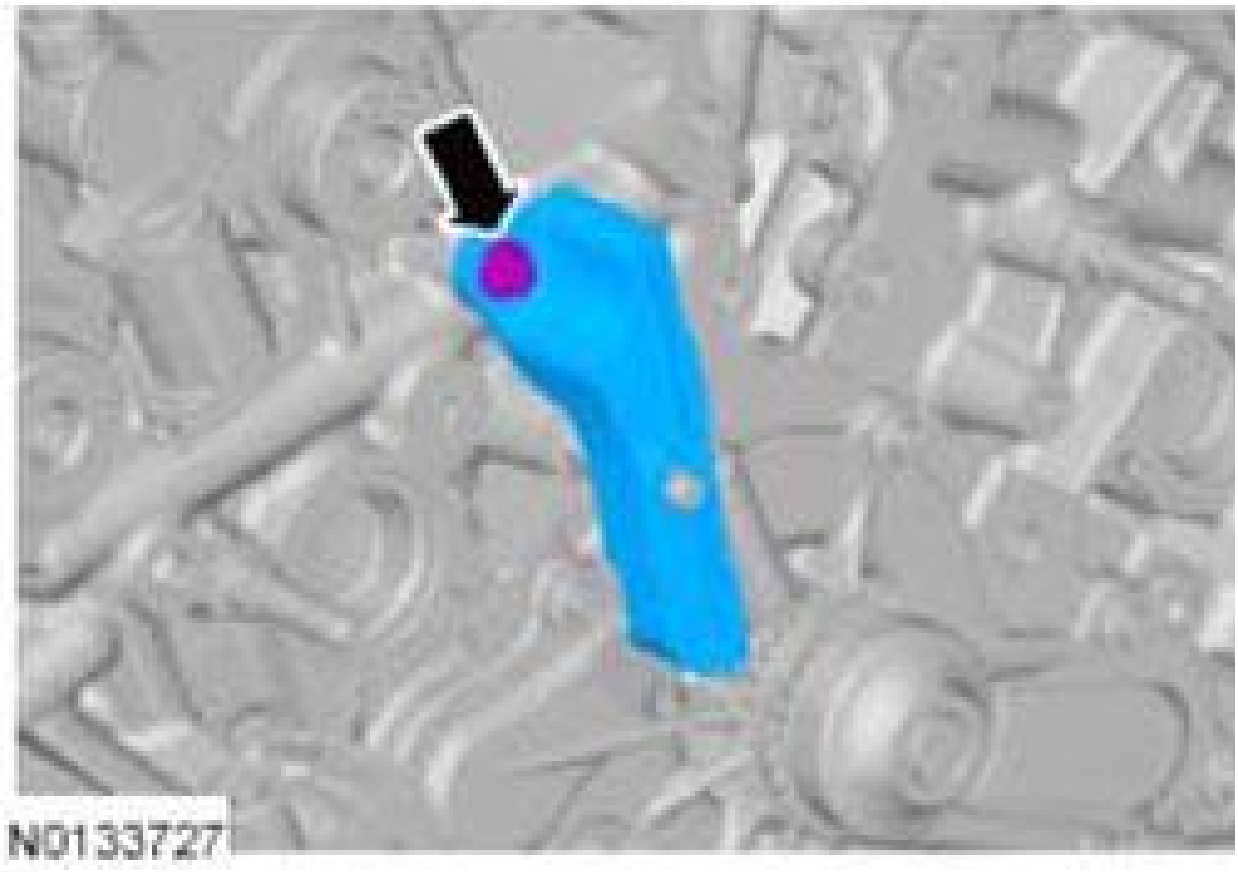
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Installation

1. Install the RH primary timing chain guide and the bolt.
    - Tighten to 10 Nm (89 lb-in).

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2. **NOTE: The following steps are only for the replacement of the secondary timing chain tensioners. Do not reuse the secondary timing chain tensioners if removed, or damage to the engine may occur.**

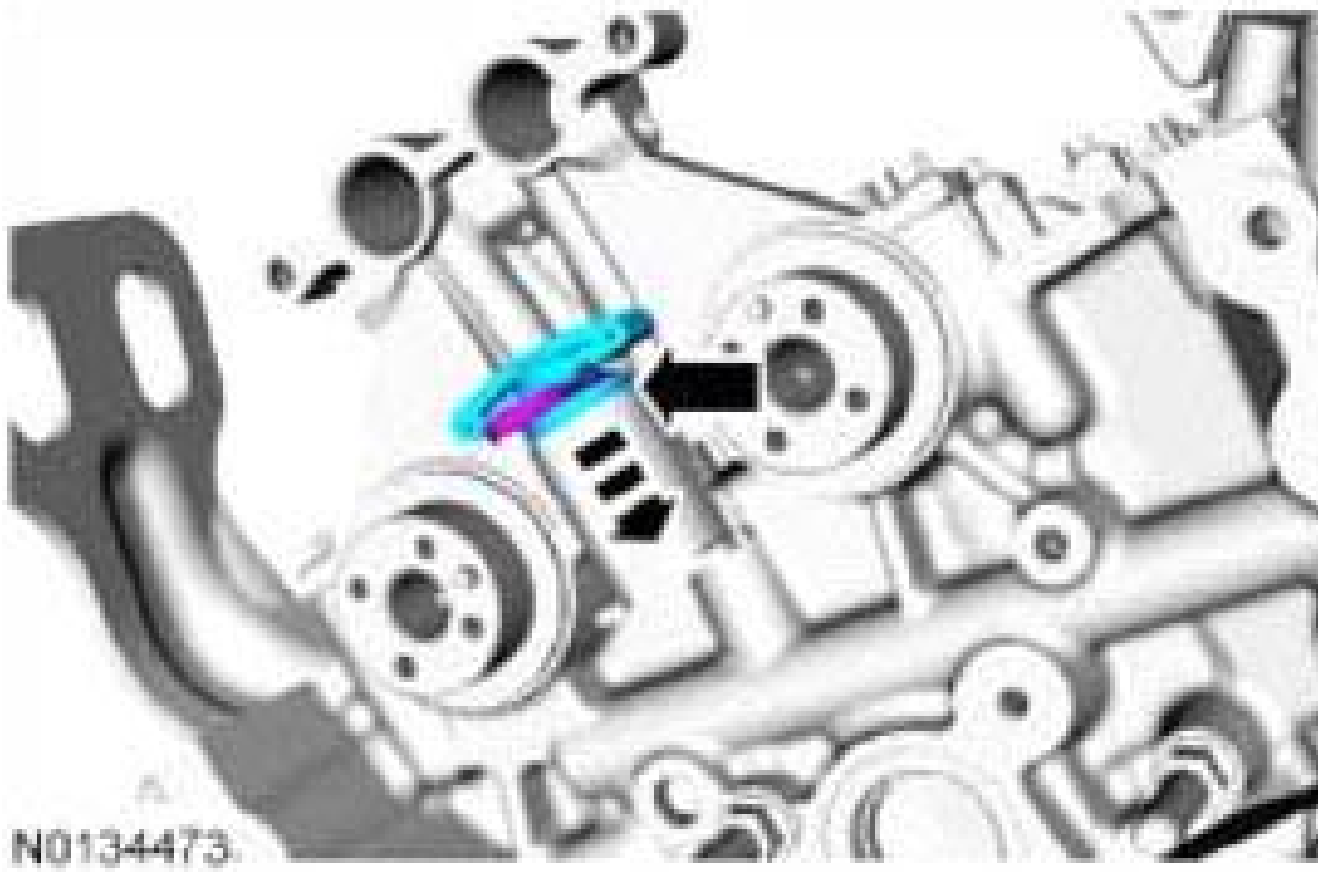
For installation of the secondary timing chain tensioner, if removed. Perform the following steps 3 through 18.

3. **NOTE: Apply clean engine oil to the secondary timing chain tensioner O-ring seals and mega cap bore.**

NOTE: Do not remove the secondary timing chain tensioner shipping clip, until instructed to do so.

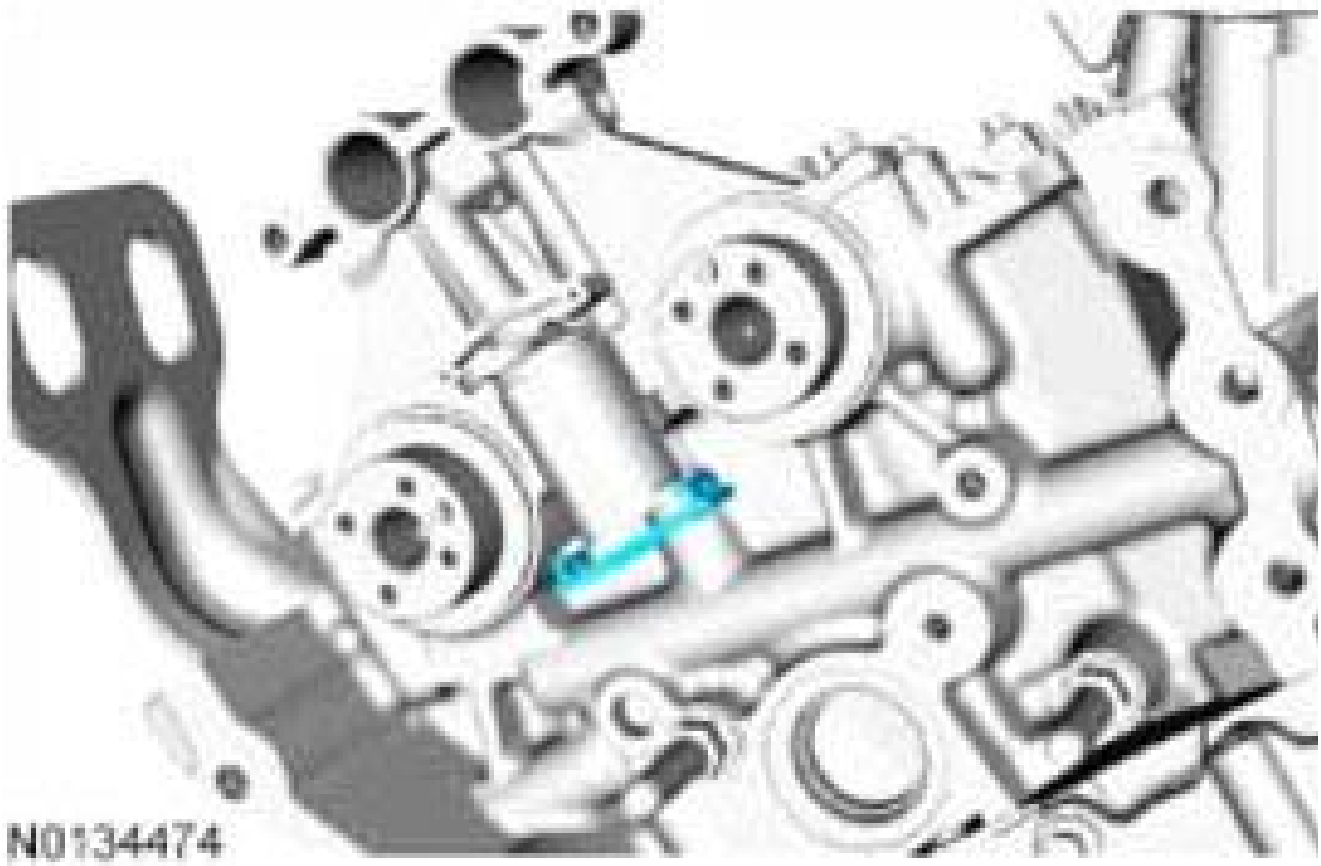
Install the RH secondary timing chain tensioner by pushing it down all the way until a snap is heard and the tensioner is seated all the way down the mega cap bore.

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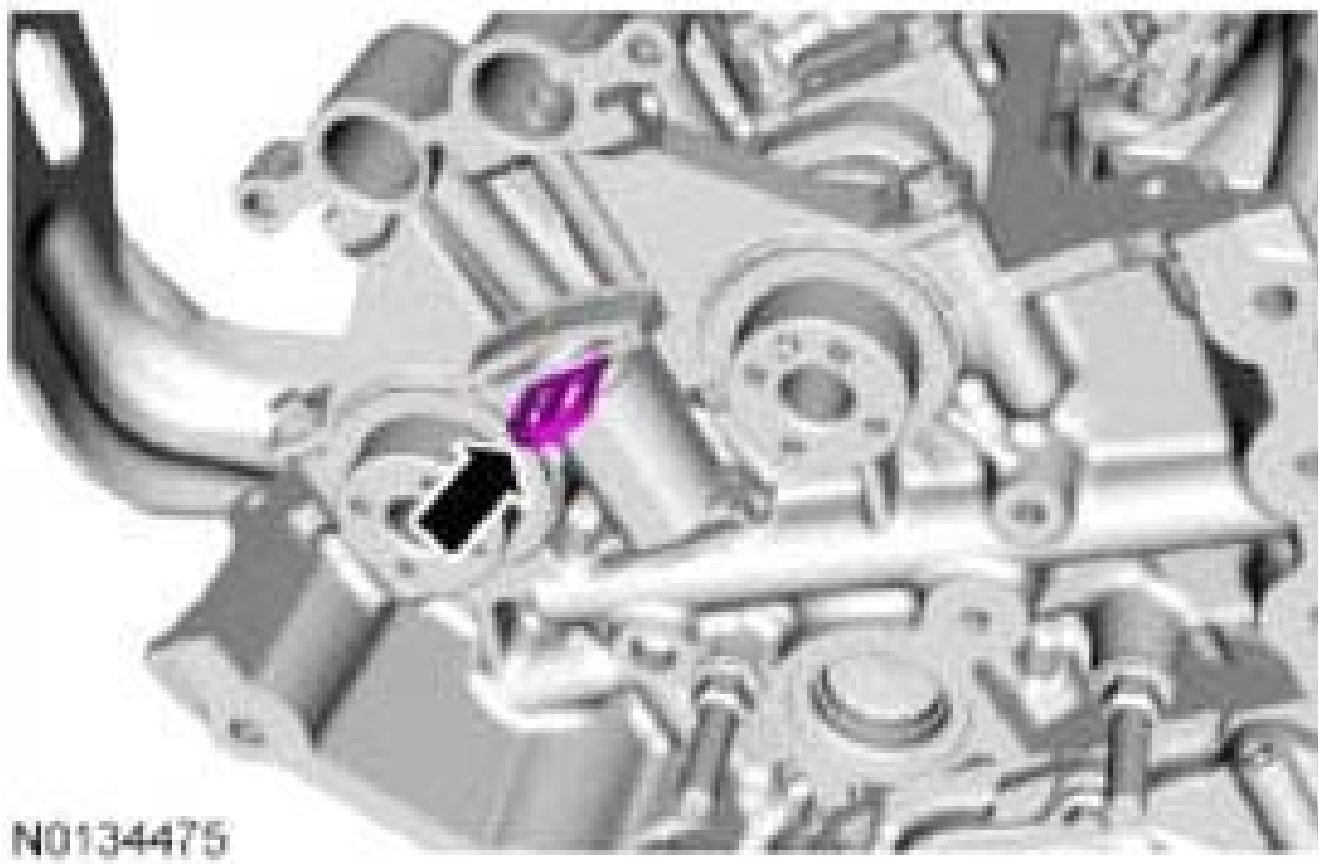
4. Install the RH secondary timing chain tensioner shoe.

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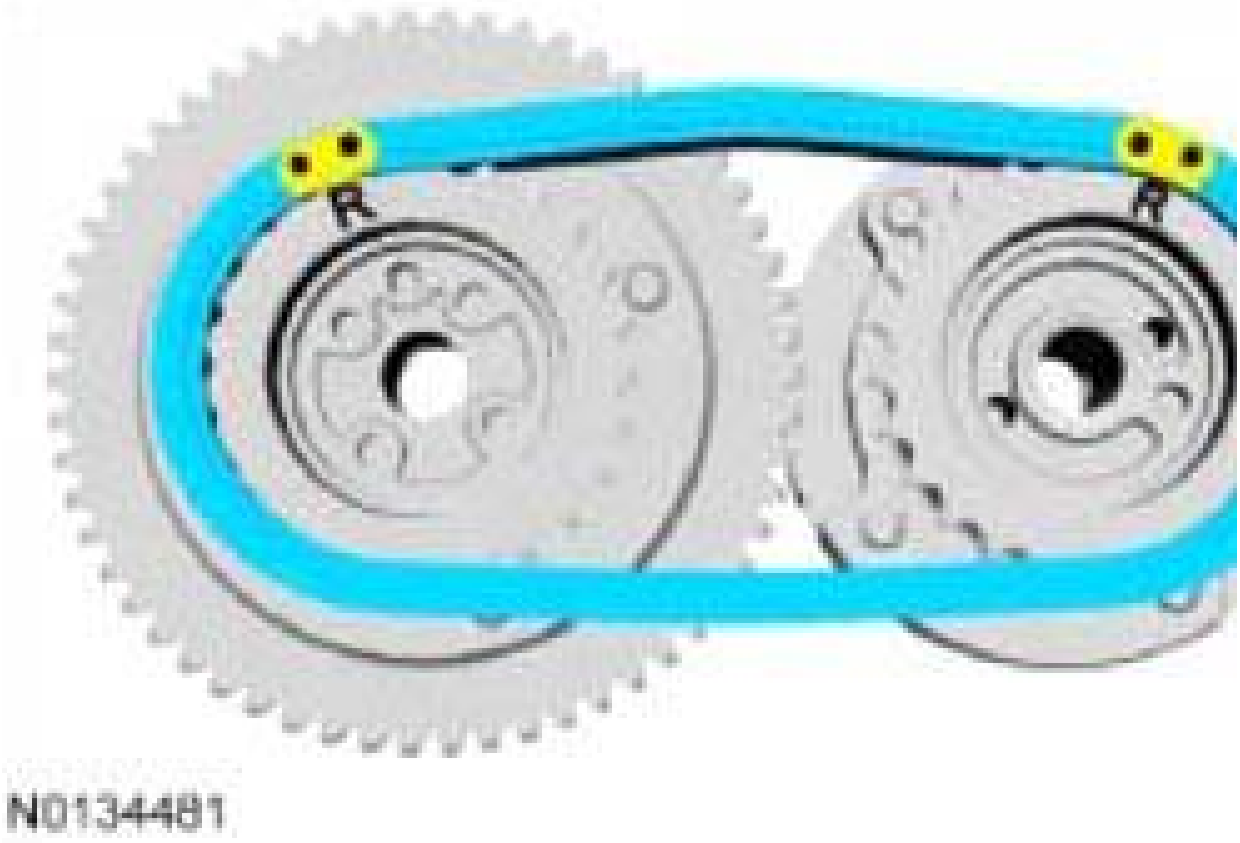
5. Remove and discard the RH secondary timing chain tensioner shipping clip.

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6. Assemble the RH **VCT** assembly, the RH exhaust camshaft sprocket and the RH secondary timing chain.
   - Align the colored links with the timing marks.

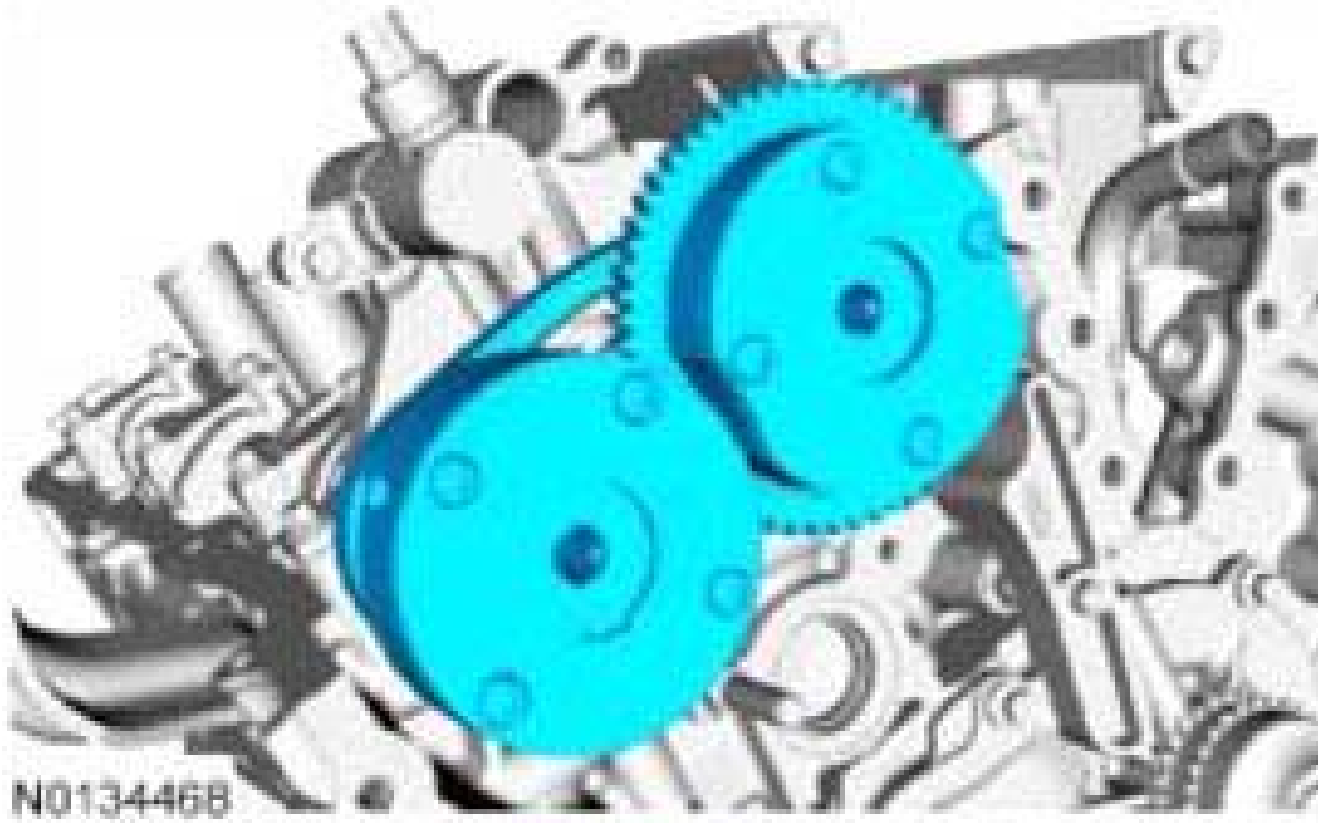
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NOTE: It may be necessary to rotate the camshafts slightly, to install the RH secondary timing assembly.

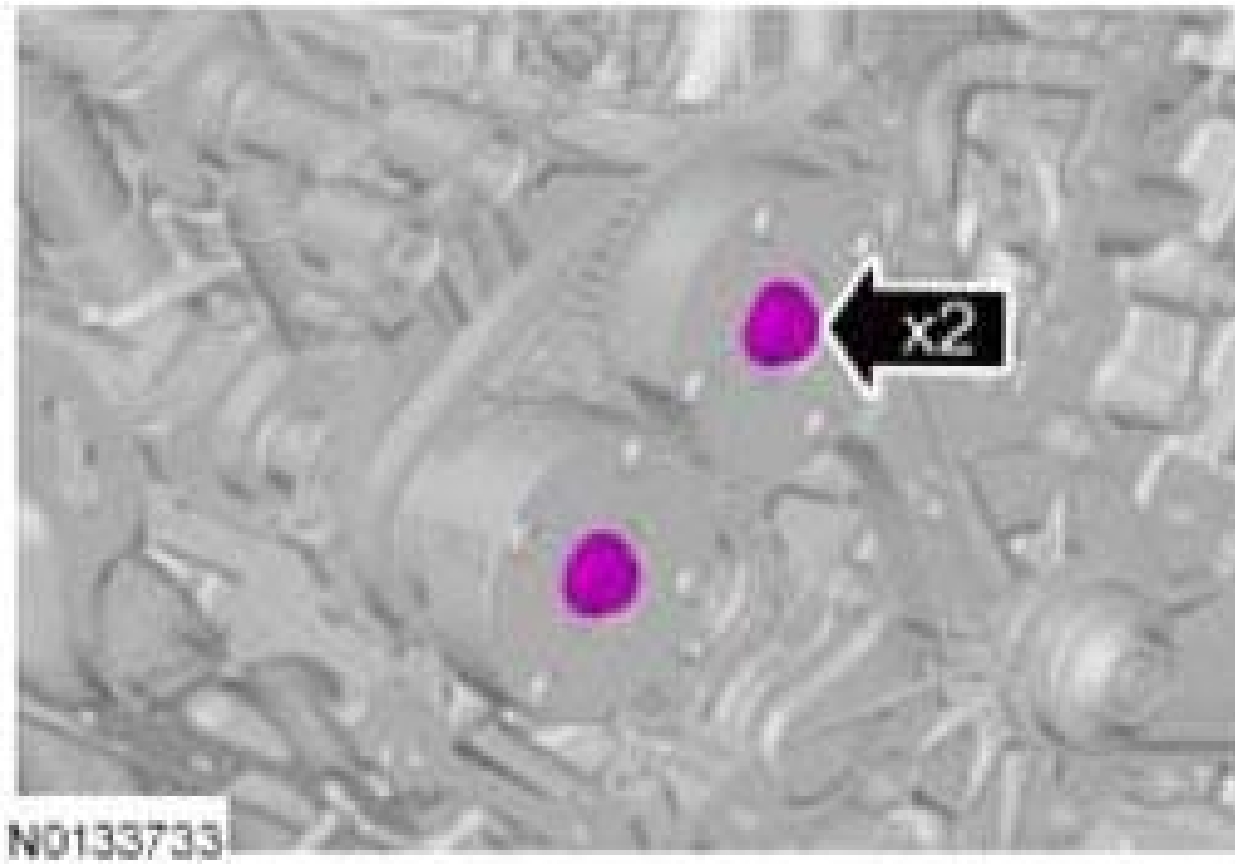
7. Position the 2 RH **VCT** assemblies and secondary timing chain onto the camshafts by aligning the holes in the **VCT** assemblies with the dowel pins in the camshafts.

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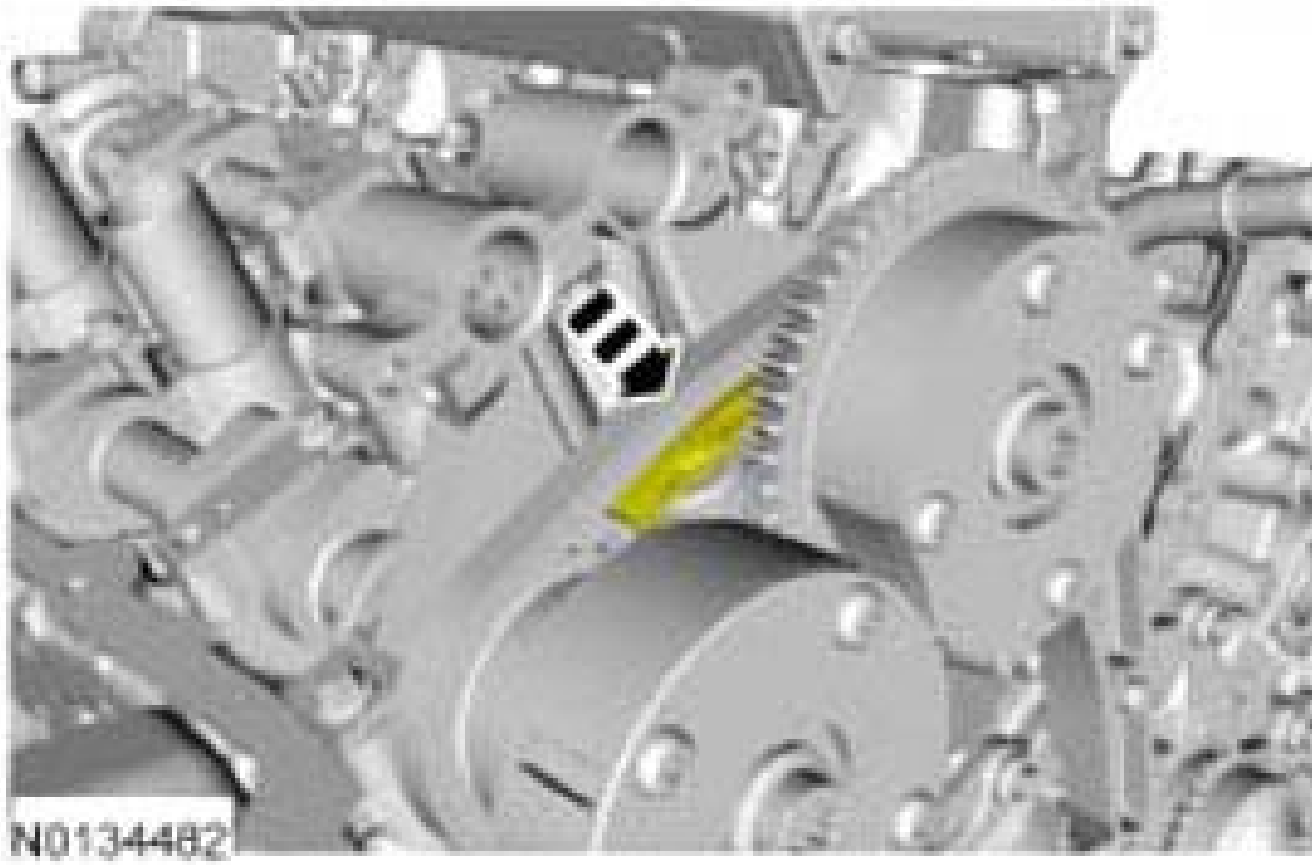
8. Install the 2 new RH **VCT** bolts and tighten in 4 stages:
    - Stage 1: Tighten to 40 Nm (30 lb-ft).
    - Stage 2: Loosen one full turn.
    - Stage 3: Tighten to 25 Nm (18 lb-ft).
    - Stage 4: Tighten an additional 180 degrees.

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9. Activate the RH secondary timing chain tensioner by pressing down on the secondary tensioner top shoe until it bottoms out, let go of the tensioner and it will spring up putting tension on the chain.

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NOTE: **Do not use excessive force when installing the VCT oil control solenoid. Damage to the mega cap could cause the cylinder head to be inoperable. If difficult to install the VCT oil control solenoid, inspect the bore and VCT oil control solenoid to ensure there are no burrs, sharp edges or contaminants present on the mating surface. Only clean the external surfaces as necessary.**

10.

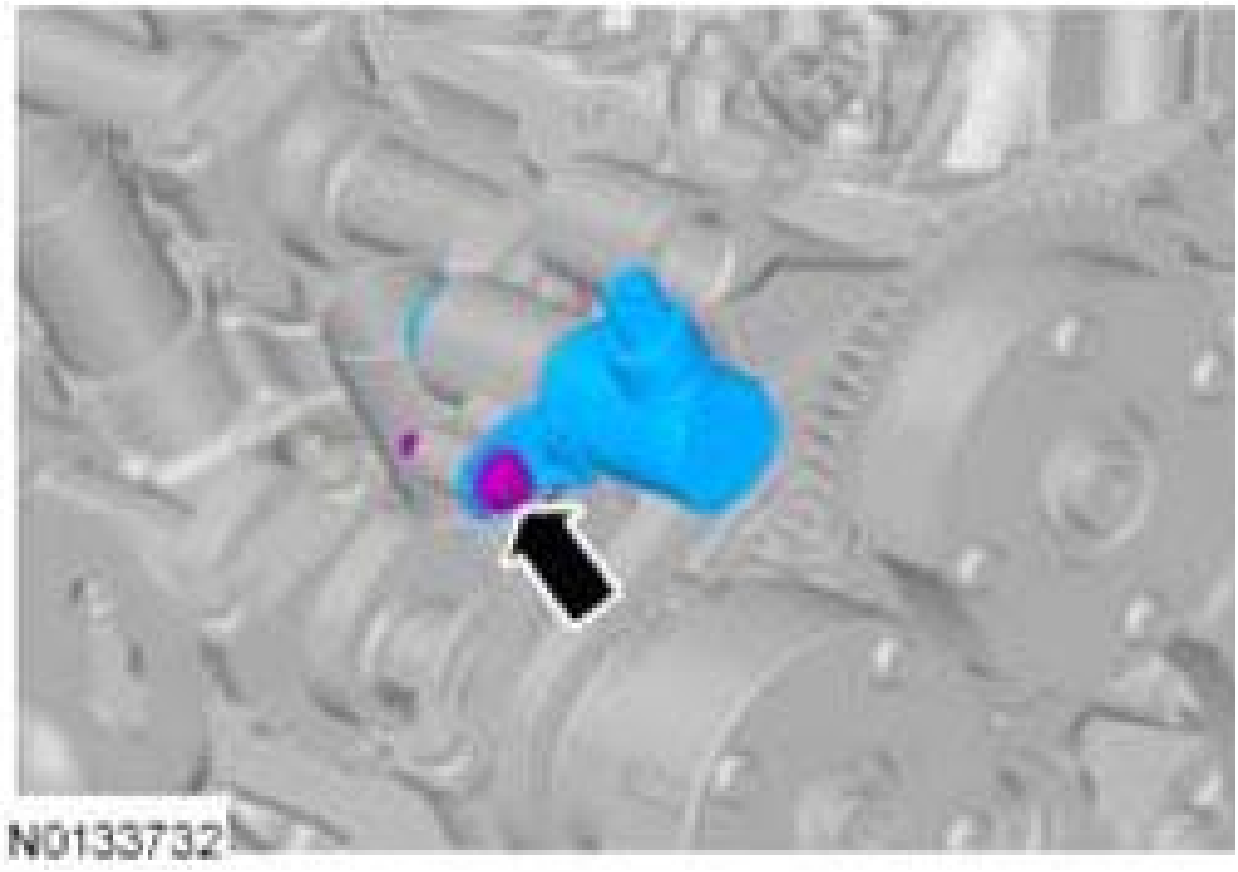
NOTE: **A slight twisting motion will aid in the installation of the VCT oil control solenoid.**

NOTE: **Keep the VCT oil control solenoid clean of dirt and debris.**

Install the RH exhaust **VCT** oil control solenoid.

- Tighten to 8 Nm (71 lb-in) then an additional 20 degrees.

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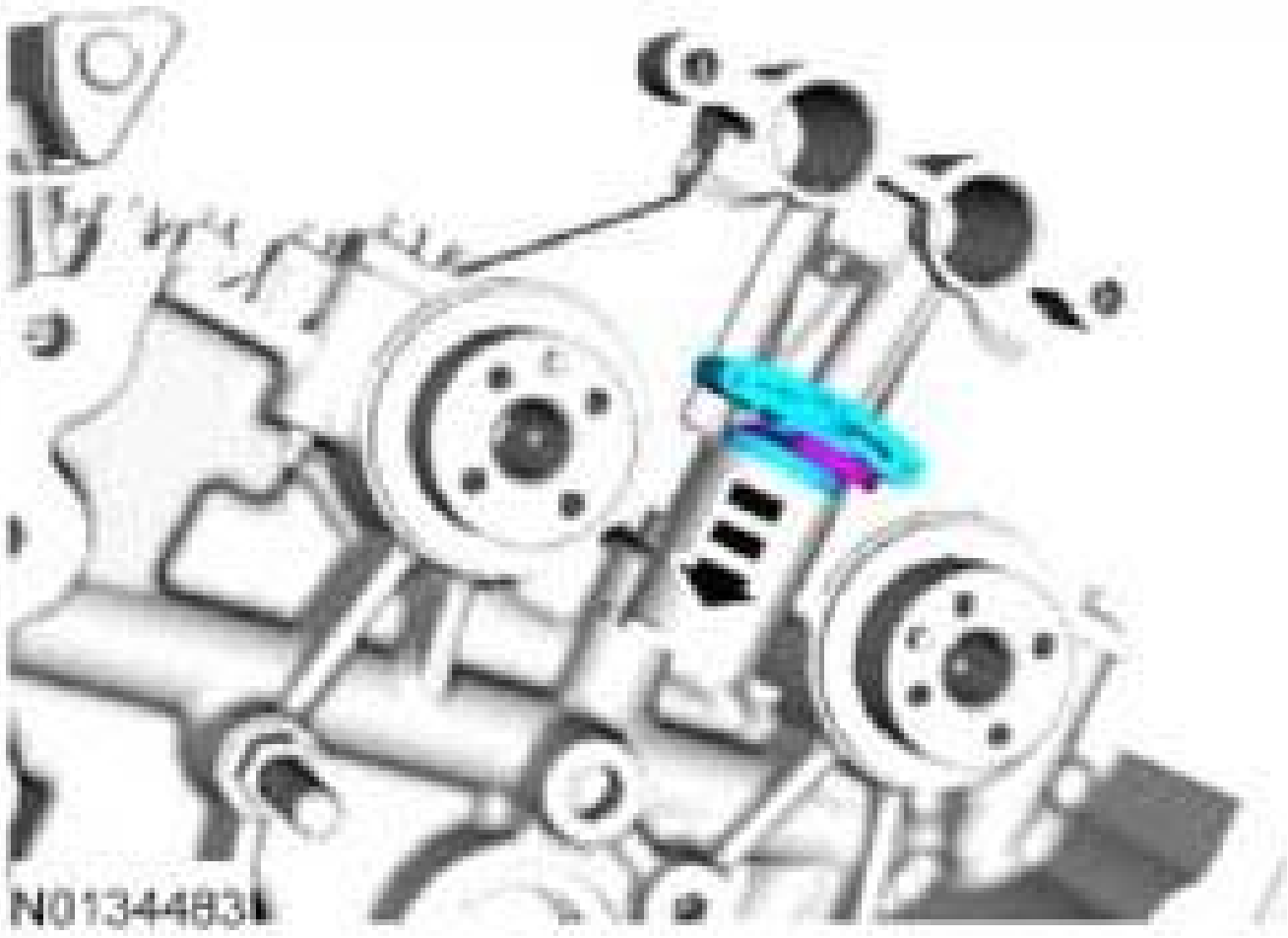


11. **NOTE: Apply clean engine oil to the secondary timing chain tensioner O-ring seals and mega cap bore.**

NOTE: Do not remove the secondary timing chain tensioner shipping clip, until instructed to do so.

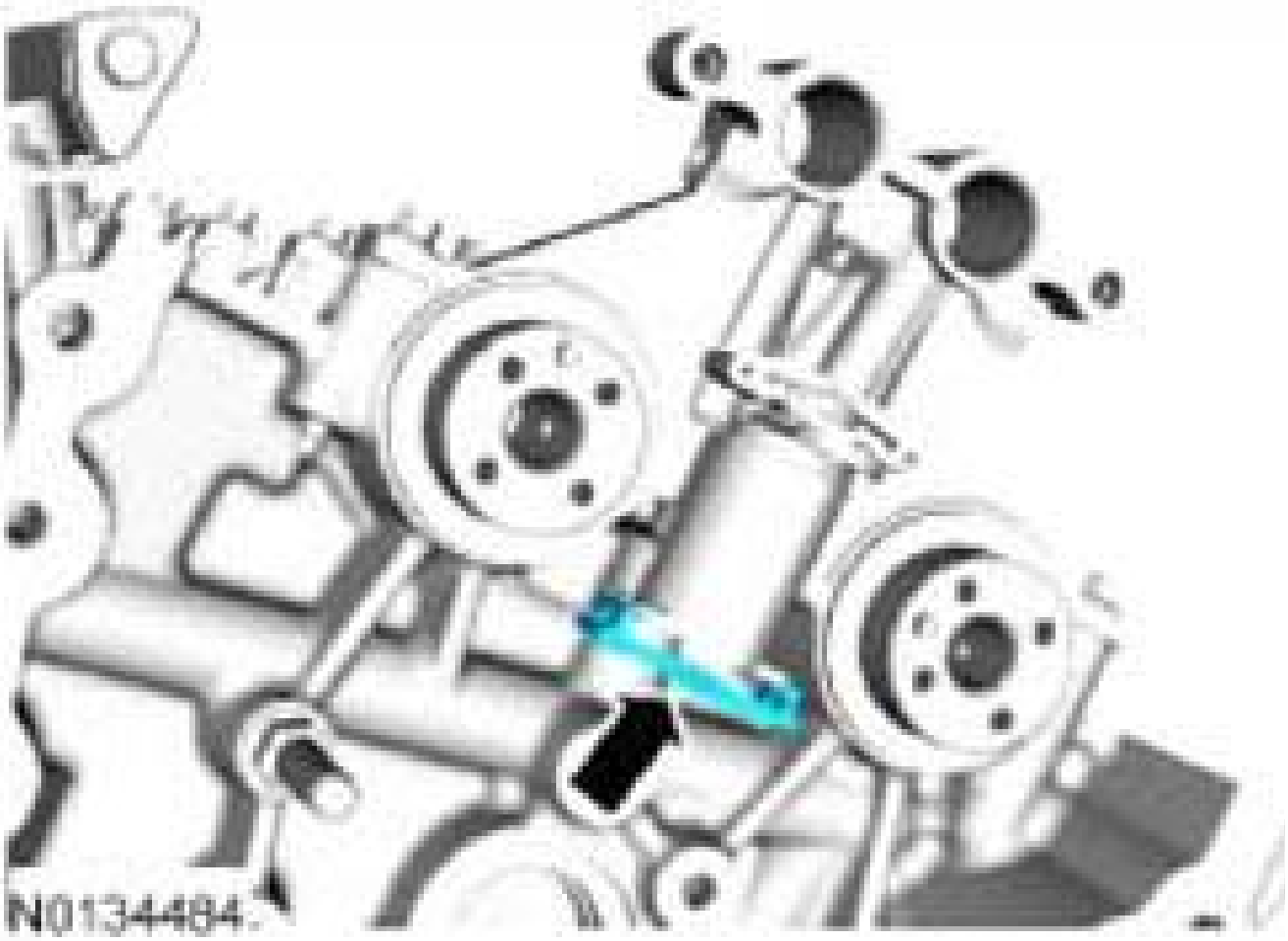
Install the LH secondary timing chain tensioner by pushing it down all the way until a snap is heard and the tensioner is seated all the way down the mega cap bore.

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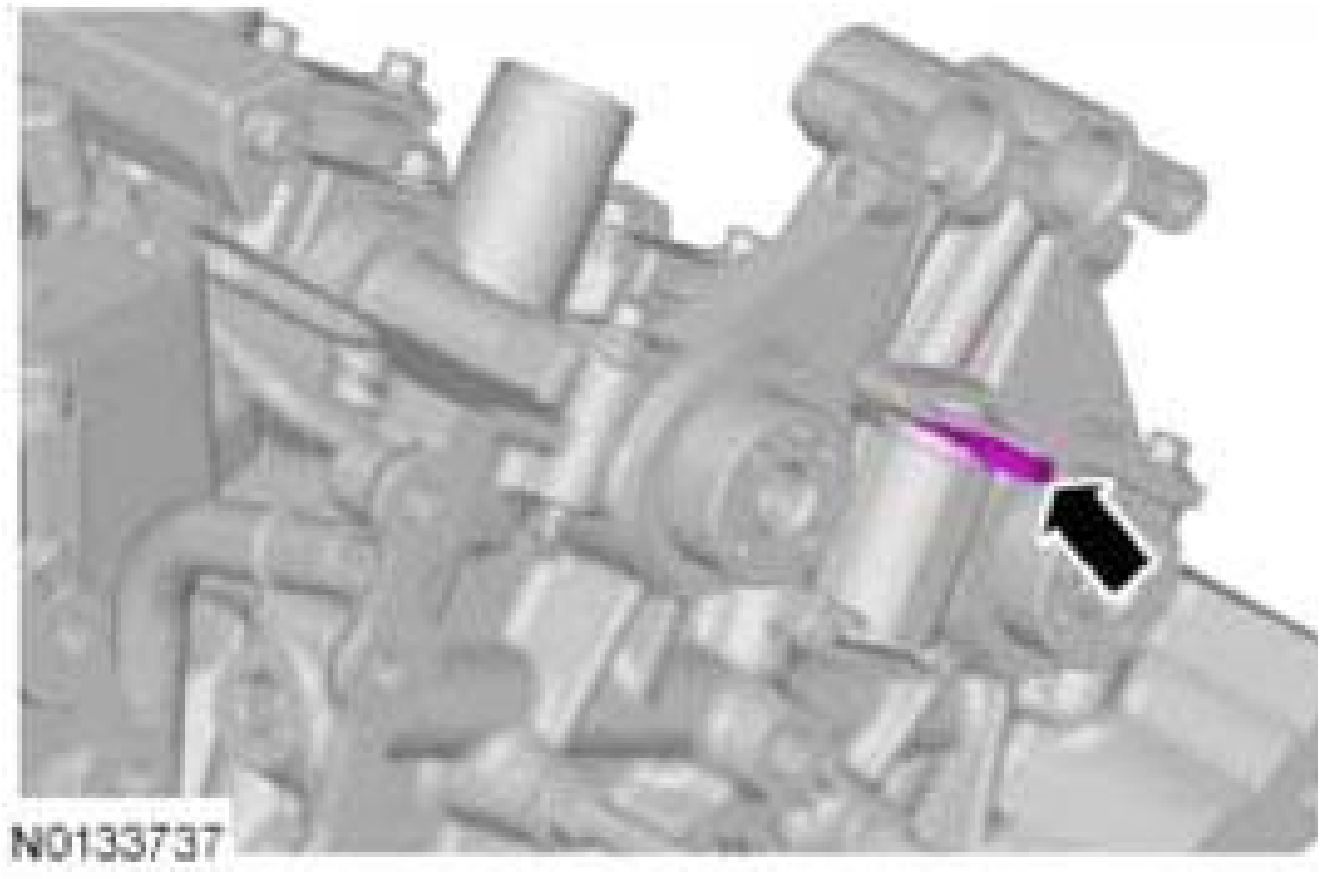
12. Install the LH secondary timing chain tensioner shoe.

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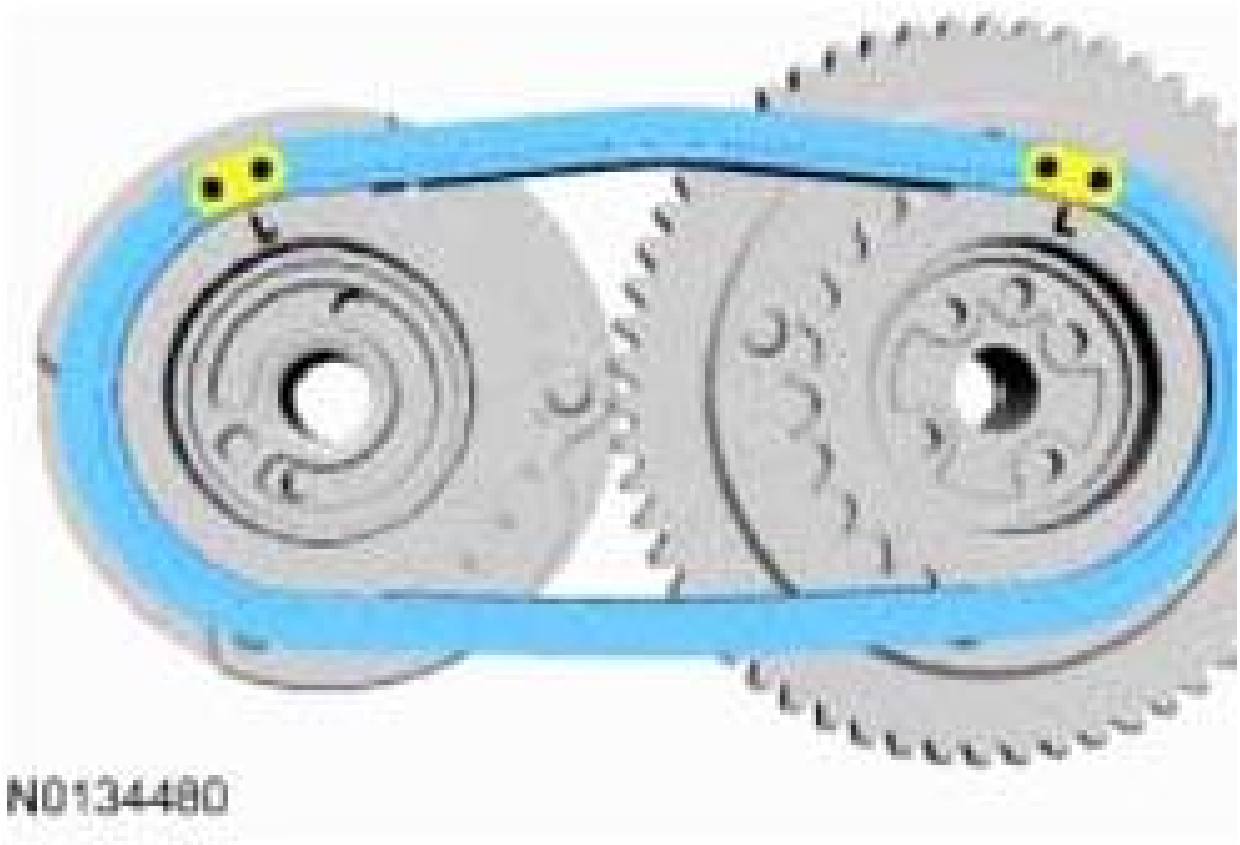
13. Remove and discard the LH secondary timing chain tensioner shipping clip.

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14. Assemble the 2 LH **VCT** assemblies and the LH secondary timing chain.
    - Align the colored links with the timing marks.

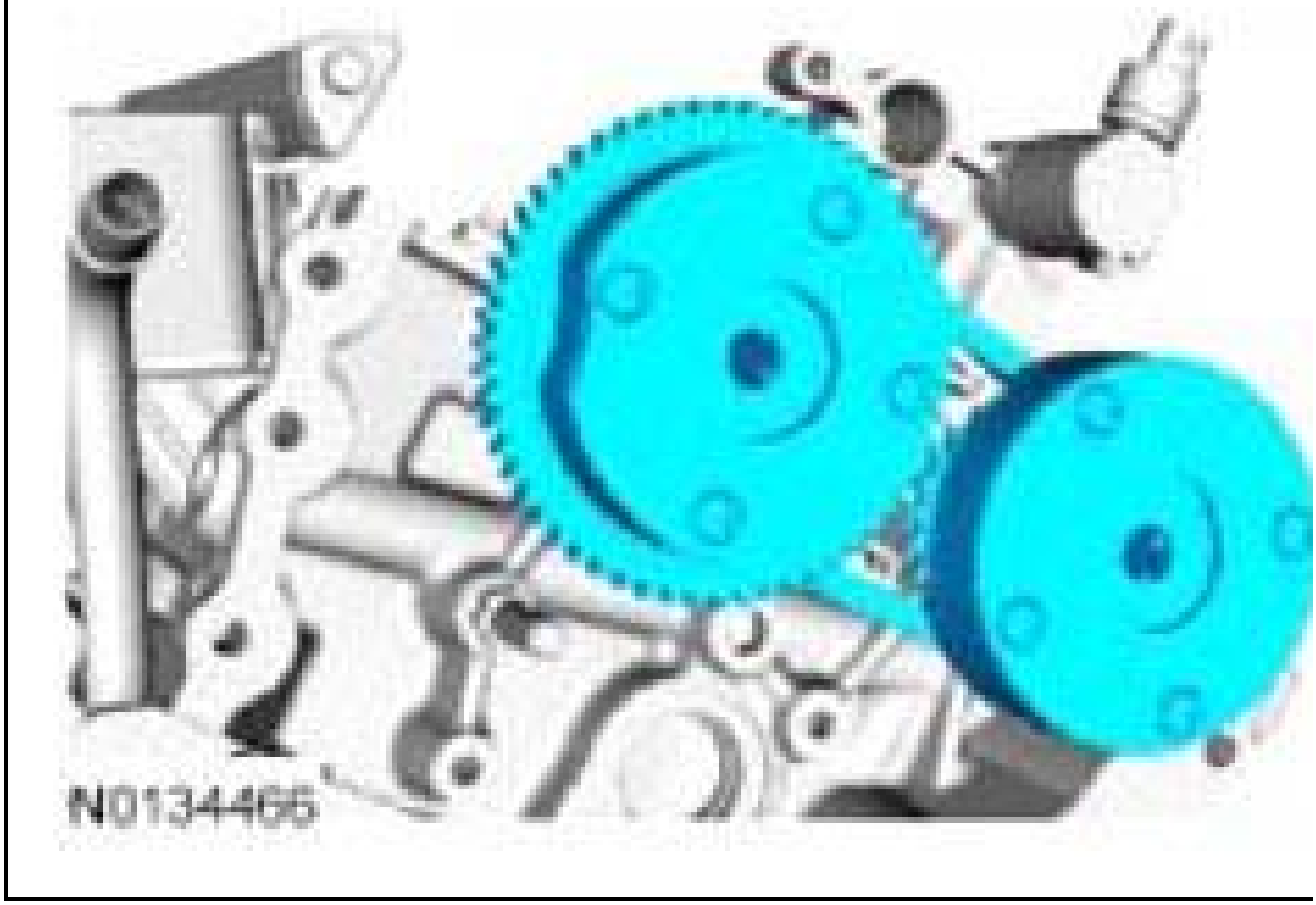
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15. **NOTE: It may be necessary to rotate the camshafts slightly, to install the LH secondary timing assembly.**

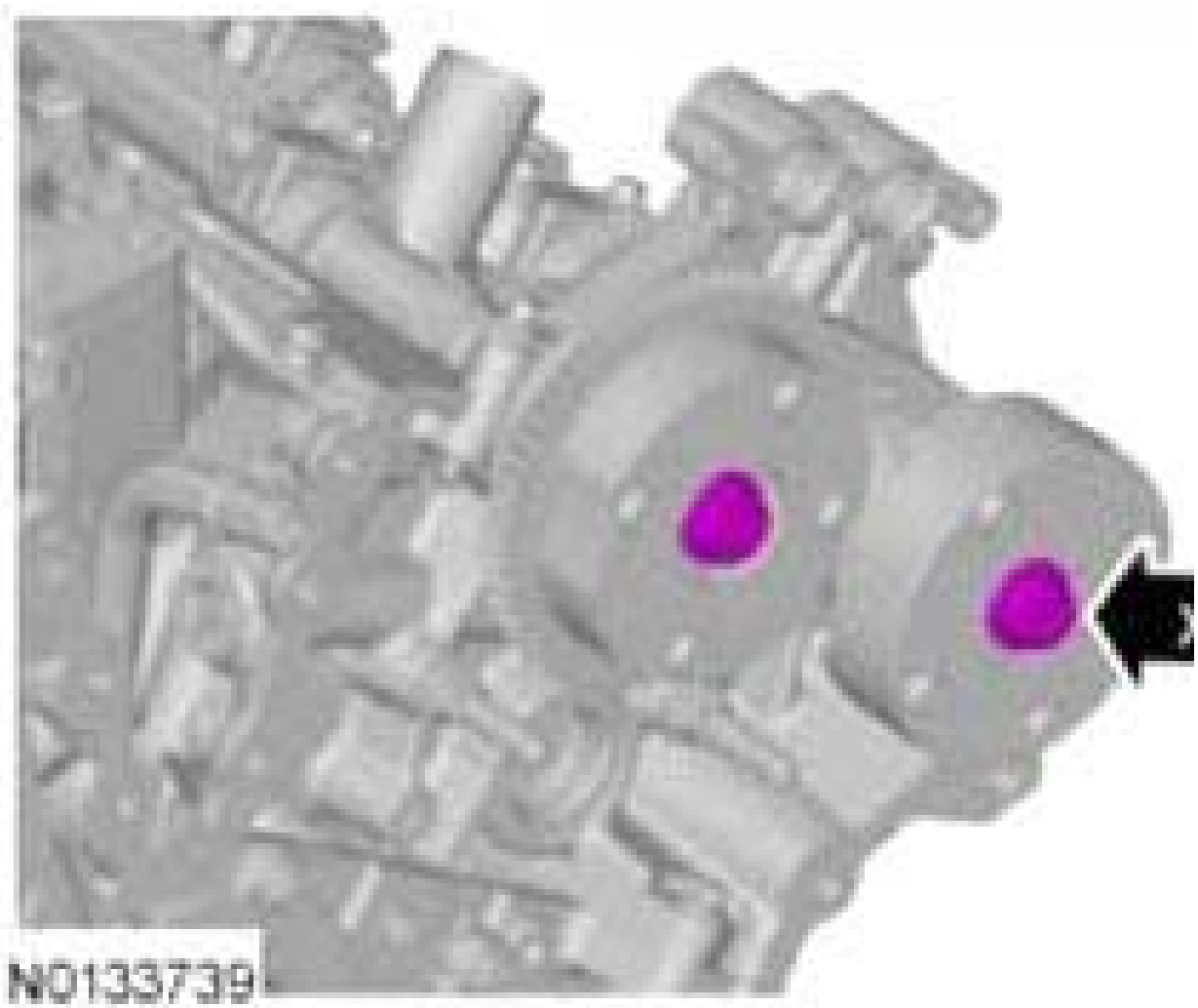
Position the 2 LH **VCT** assemblies and secondary timing chain onto the camshafts by aligning the holes in the **VCT** assemblies with the dowel pins in the camshafts.

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16. Install the 2 new LH **VCT** bolts and tighten in 4 stages:
    - Stage 1: Tighten to 40 Nm (30 lb-ft).
    - Stage 2: Loosen one full turn.
    - Stage 3: Tighten to 25 Nm (18 lb-ft).
    - Stage 4: Tighten an additional 180 degrees.

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17. Activate the LH secondary timing chain tensioner by pressing down on the secondary tensioner top shoe until it bottoms out, let go of the tensioner and it will spring up putting tension on the chain.

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18.

NOTE: **Do not use excessive force when installing the VCT oil control solenoid. Damage to the mega cap could cause the cylinder head to be inoperable. If difficult to install the VCT oil control solenoid, inspect the bore and VCT oil control solenoid to ensure there are no burrs, sharp edges or contaminants present on the mating surface. Only clean the external surfaces as necessary.**

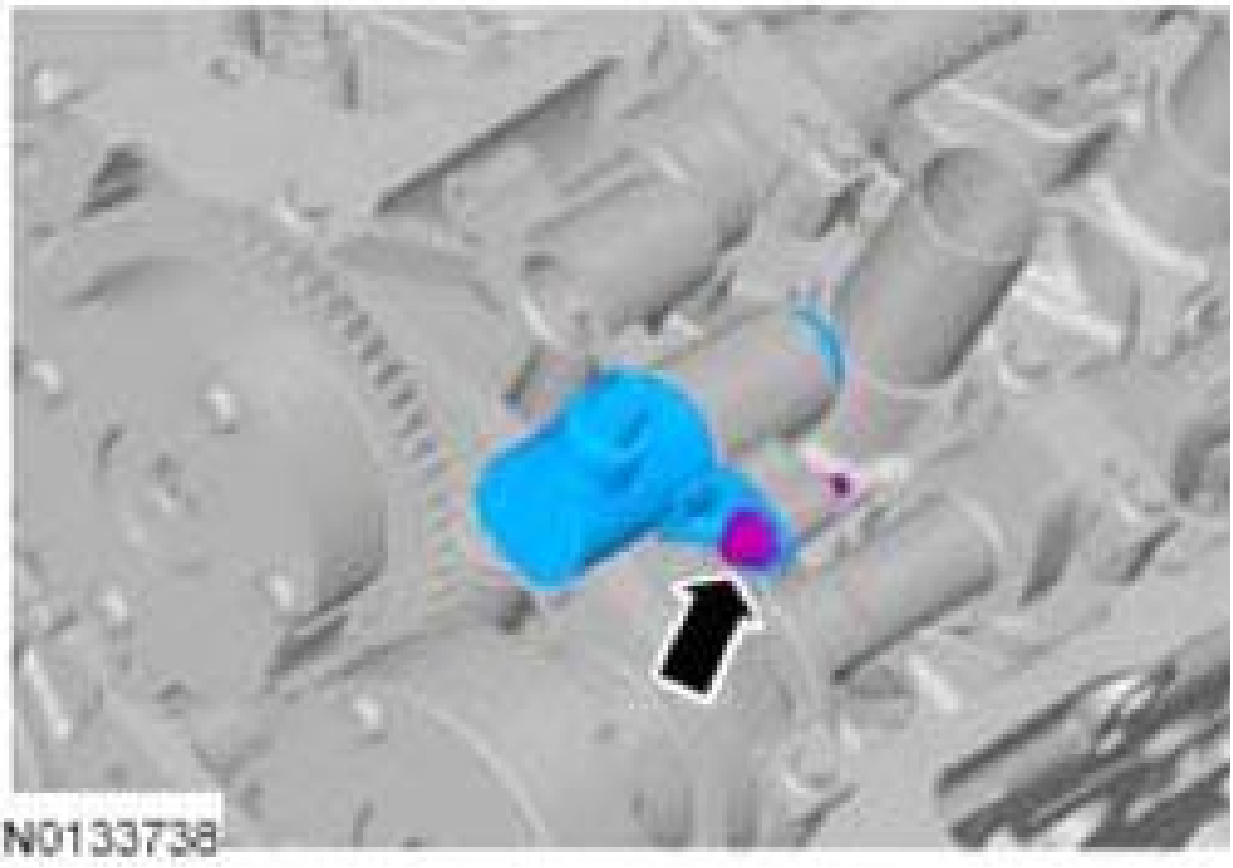
NOTE: **A slight twisting motion will aid in the installation of the VCT oil control solenoid.**

NOTE: **Keep the VCT oil control solenoid clean of dirt and debris.**

Install the LH exhaust **VCT** oil control solenoid.

- 8 Nm (71 lb-in) then an additional 20 degrees.

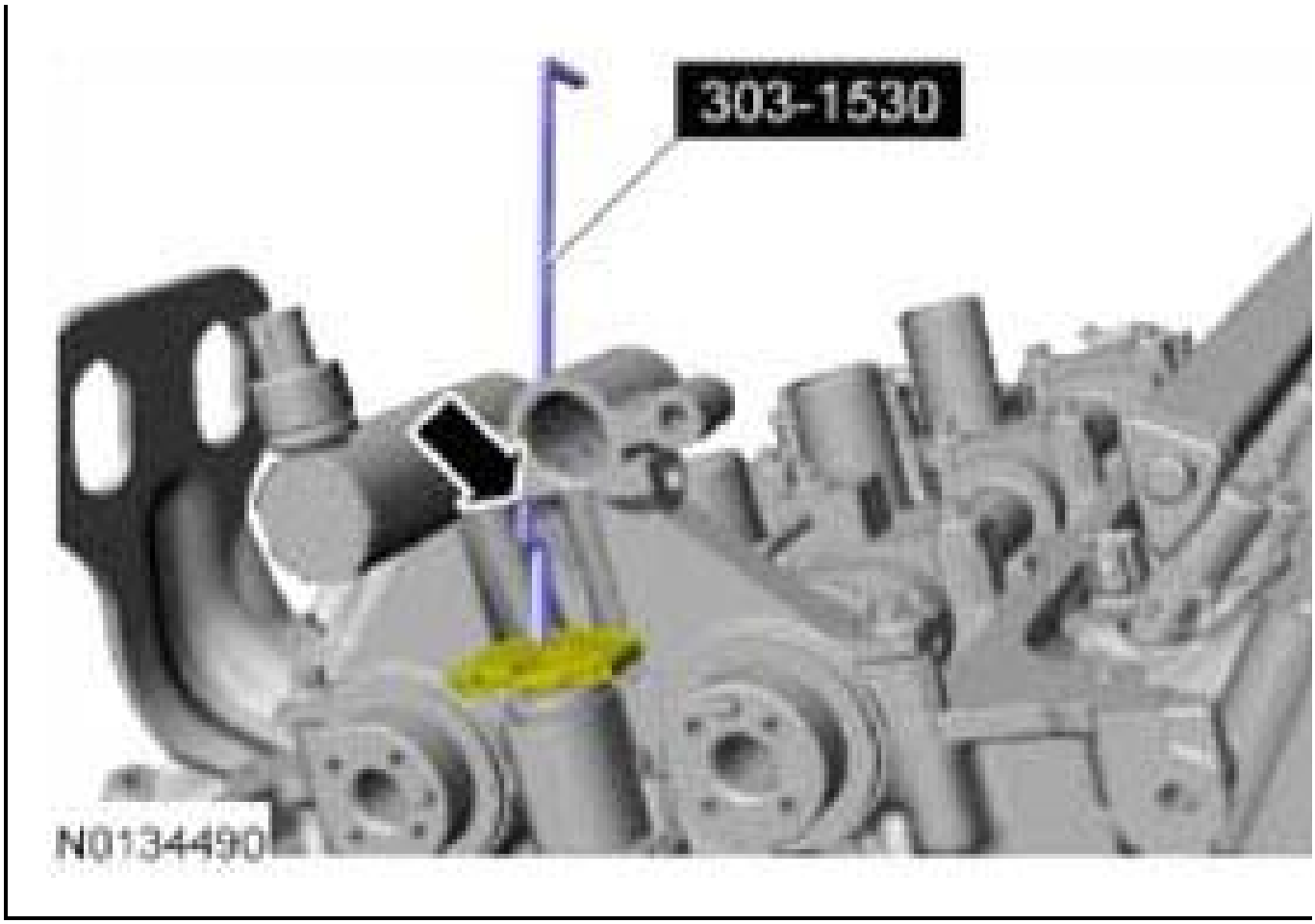
 © 2011 Mitchell Repair Information Company, LLC.



NOTE: The following steps are for engines with secondary timing chain tensioner not removed.

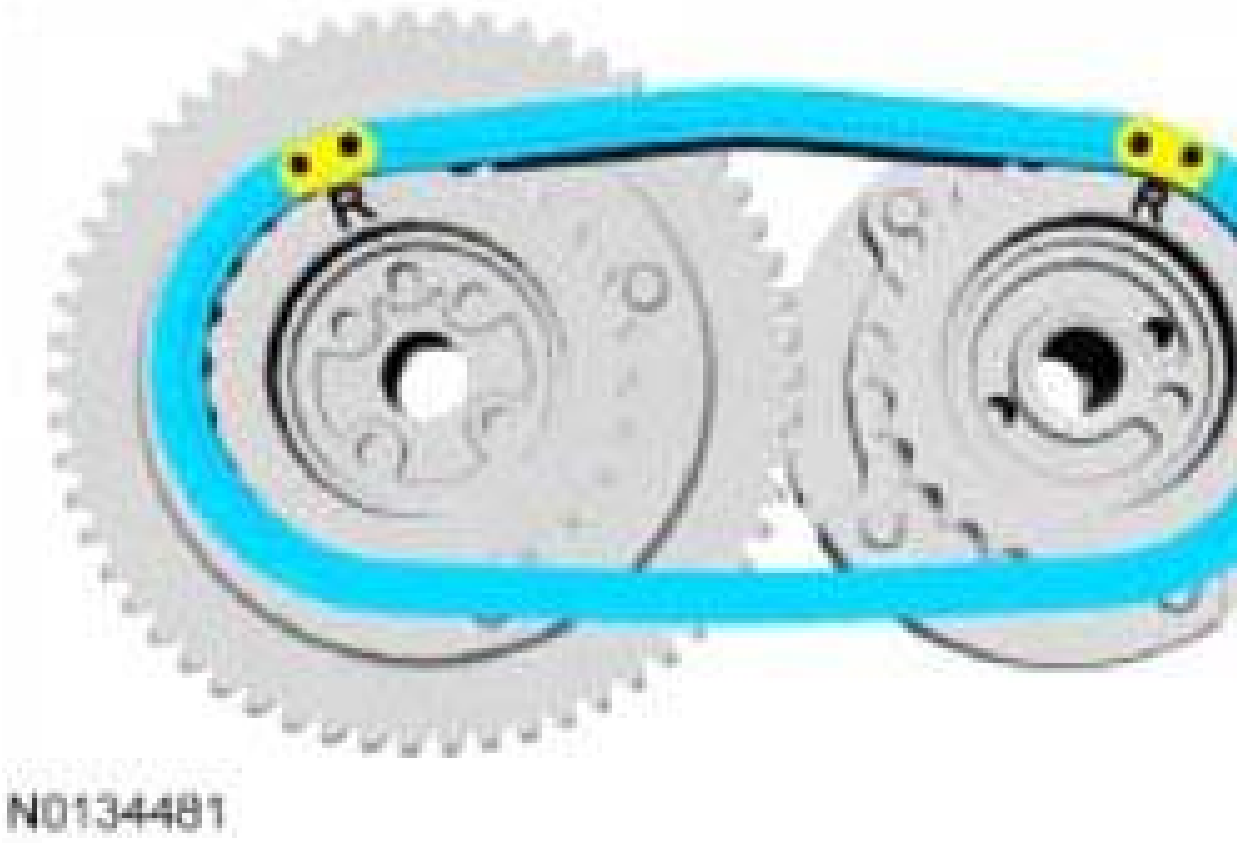
19. Compress the RH secondary timing chain tensioner and install the Secondary Chain Hold Down to retain the tensioner in the collapsed position.

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20. Assemble the RH **VCT** assembly, the RH exhaust camshaft sprocket and the RH secondary timing chain.
    - Align the colored links with the timing marks.

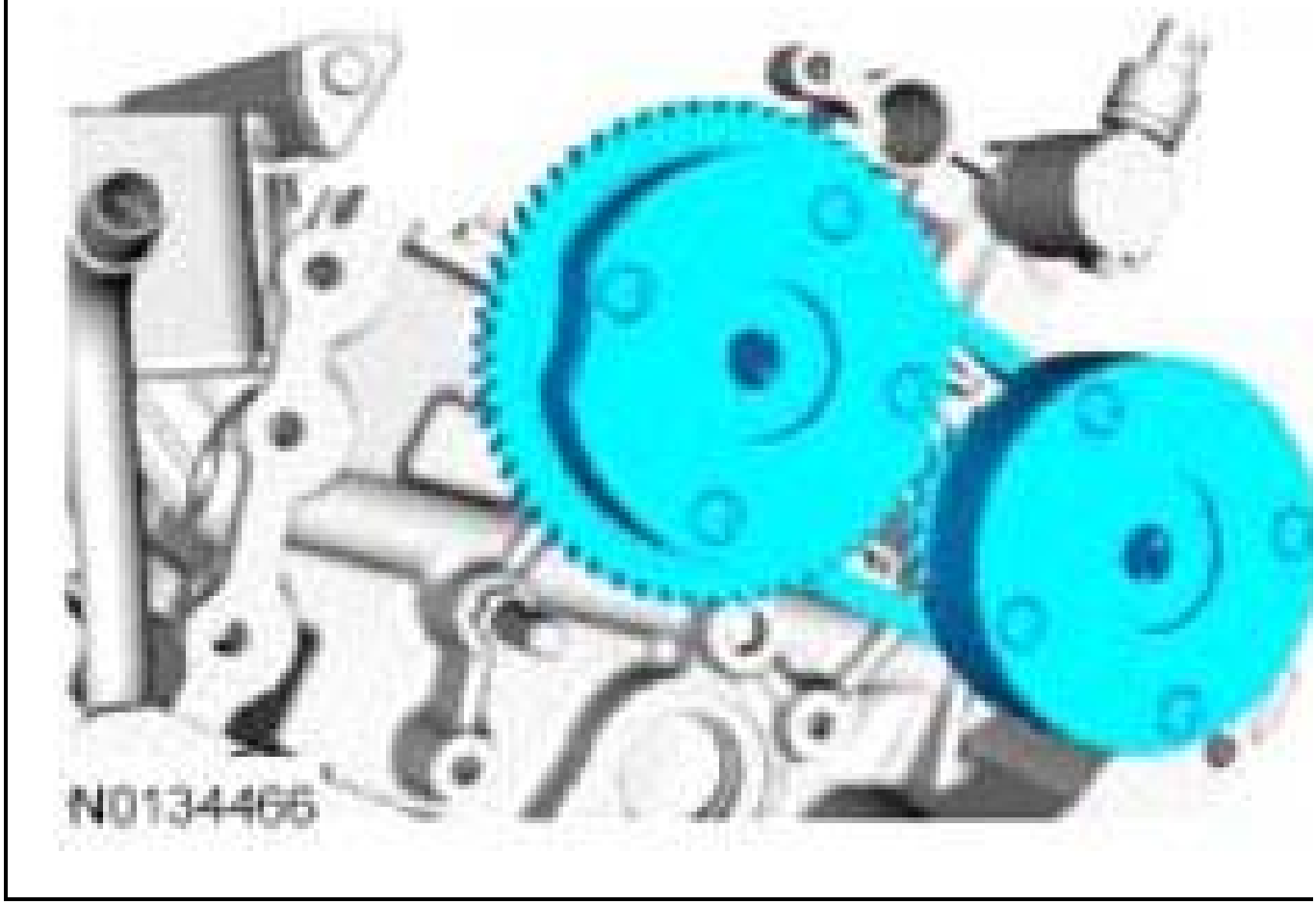
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21. **NOTE: It may be necessary to rotate the camshafts slightly, to install the RH secondary timing assembly.**

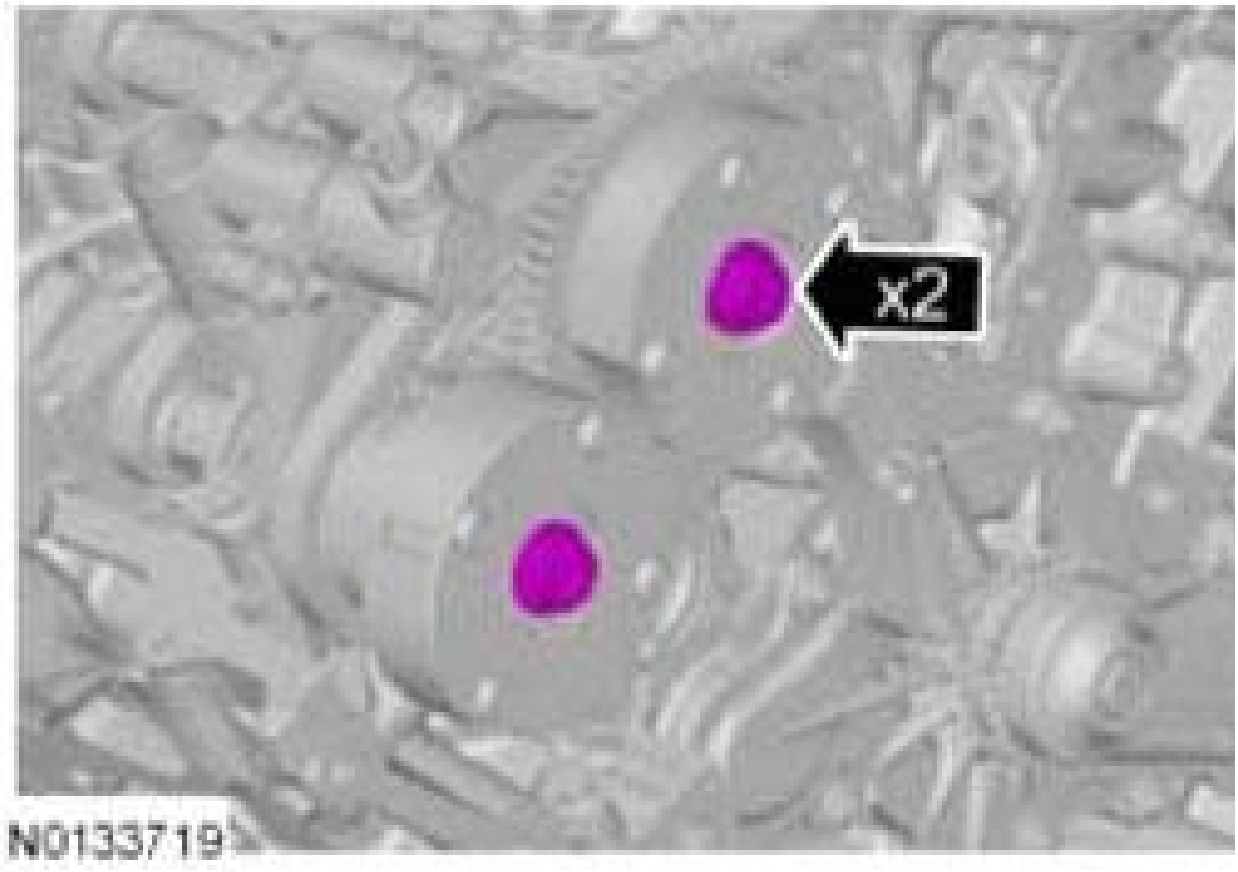
Position the 2 RH **VCT** assemblies and secondary timing chain onto the camshafts by aligning the holes in the **VCT** assemblies with the dowel pins in the camshafts.

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22. Install the 2 new RH **VCT** bolts and tighten in 4 stages:
    - Stage 1: Tighten to 40 Nm (30 lb-ft).
    - Stage 2: Loosen one full turn.
    - Stage 3: Tighten to 25 Nm (18 lb-ft).
    - Stage 4: Tighten an additional 180 degrees.

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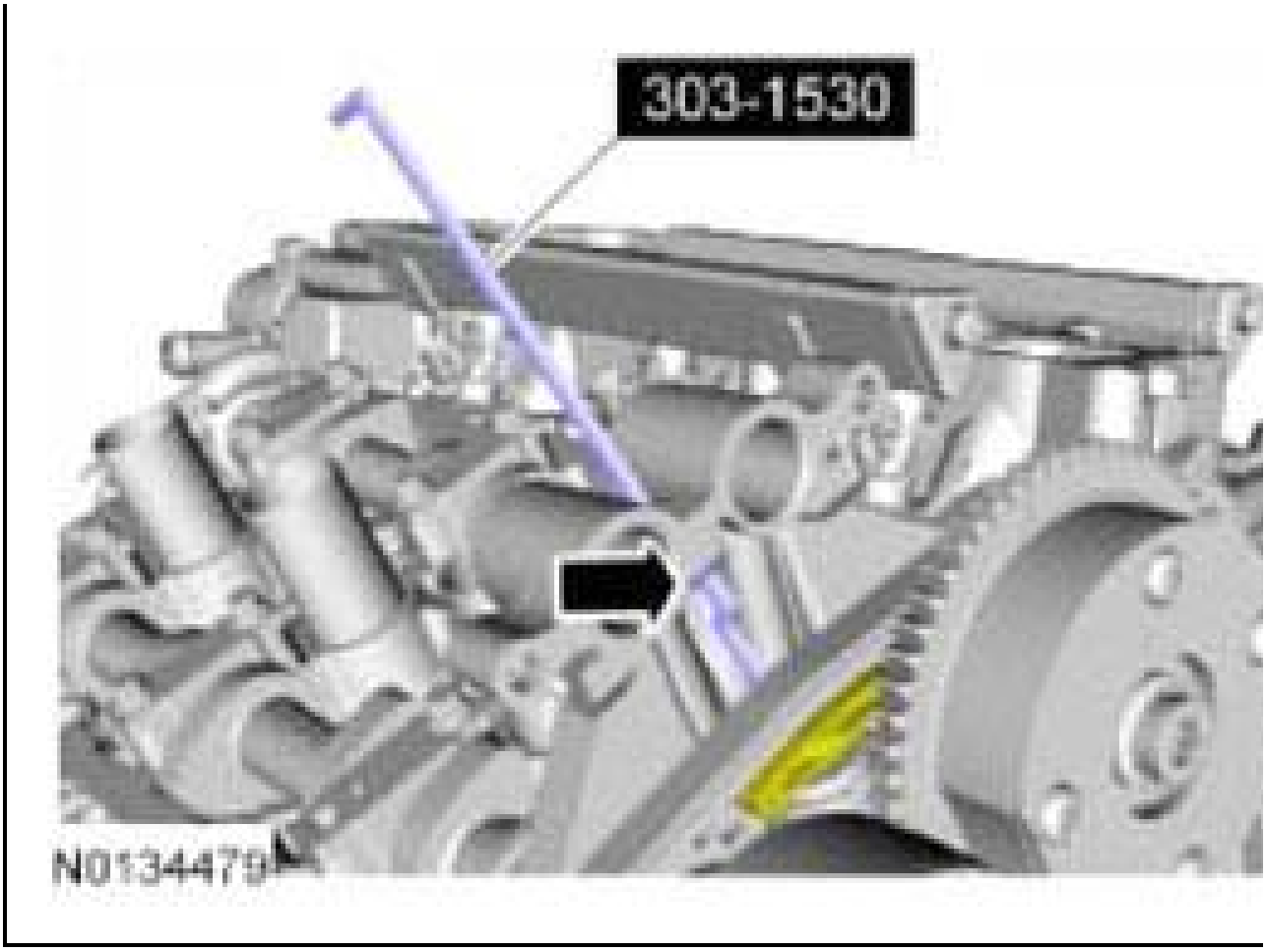


23. **NOTE: The 2 VCT oil control solenoids are removed for clarity.**

Compress the RH secondary timing chain tensioner and remove the Secondary Chain Hold Down.

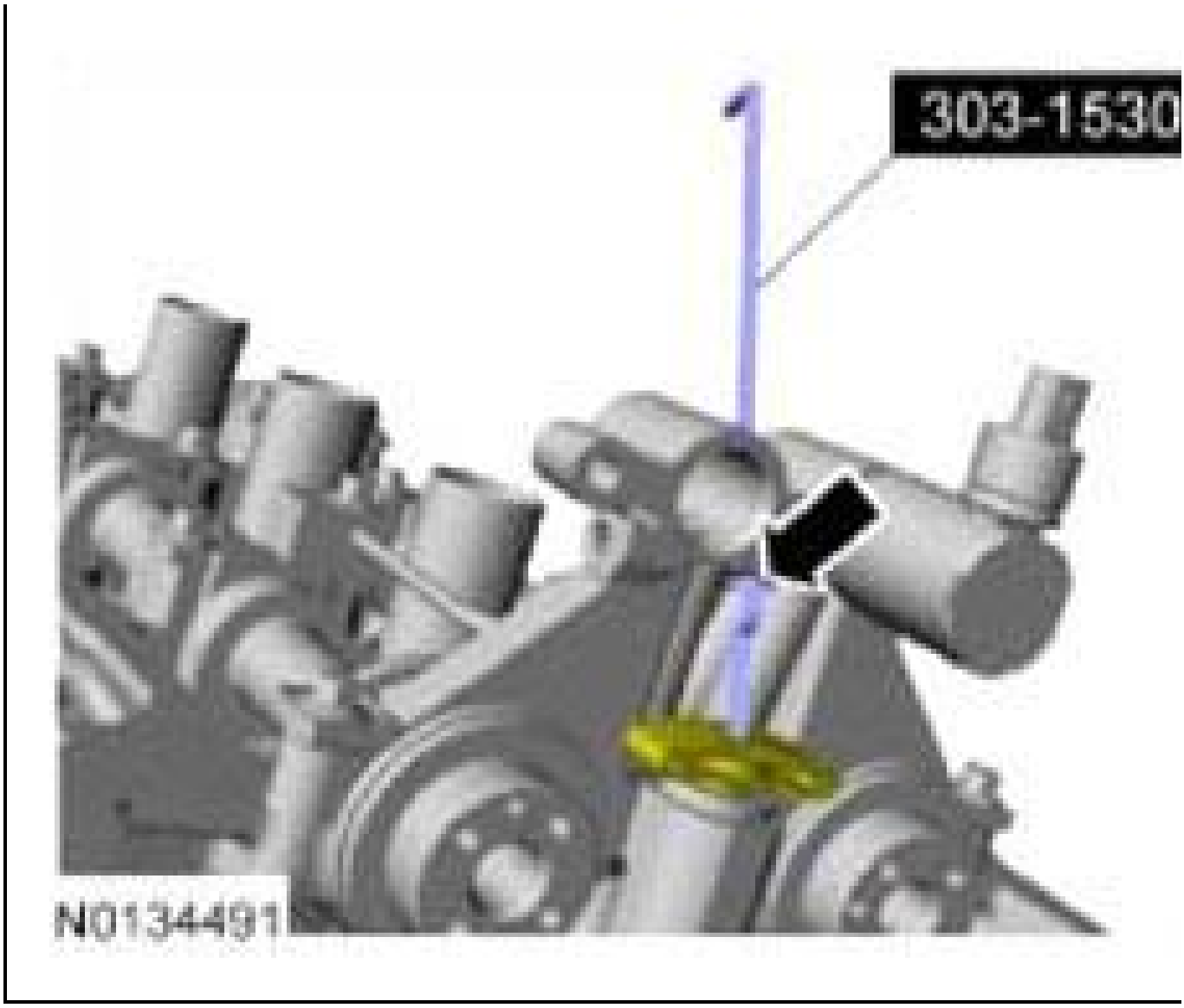
- Make sure the secondary timing chain is centered on the timing chain tensioner guides.

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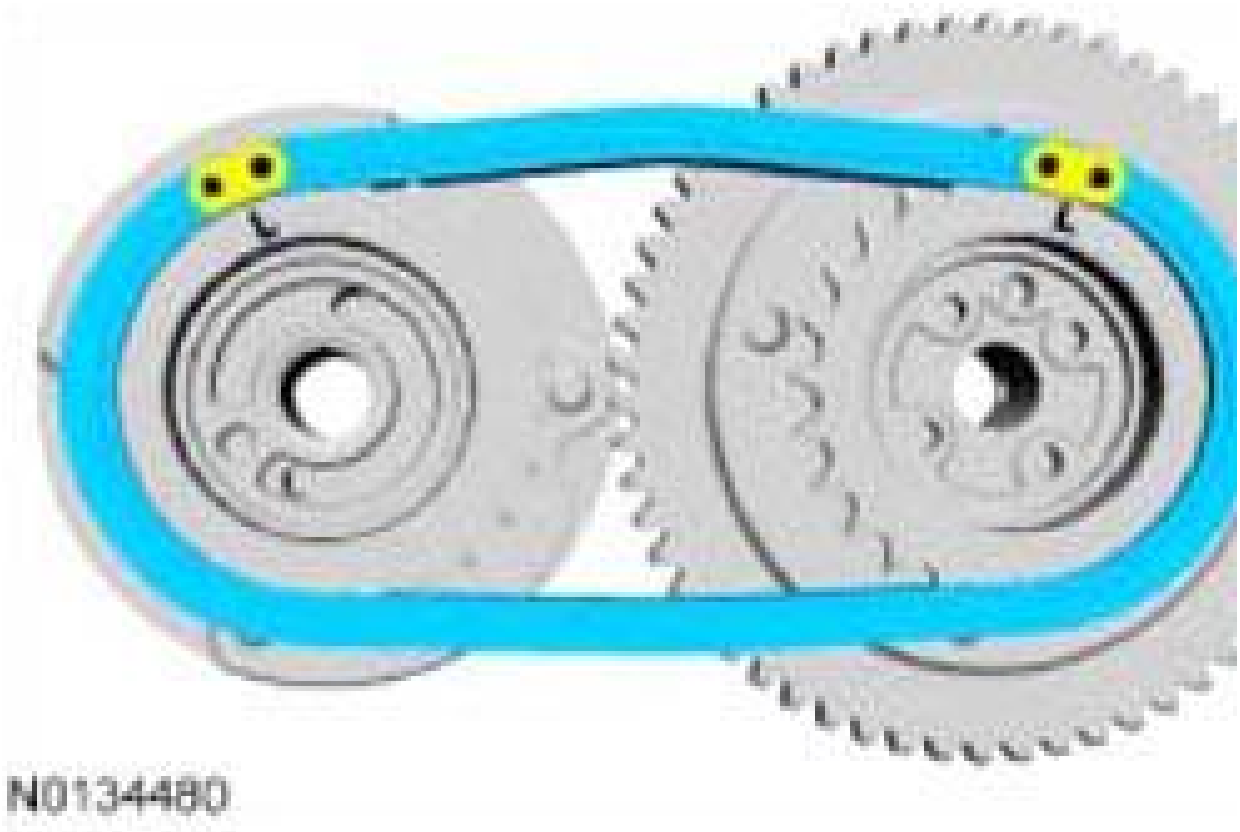
24. Compress the LH secondary timing chain tensioner and install the Secondary Chain Hold Down to retain the tensioner in the collapsed position.

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25. Assemble the 2 LH **VCT** assemblies and the LH secondary timing chain.
    - Align the colored links with the timing marks.

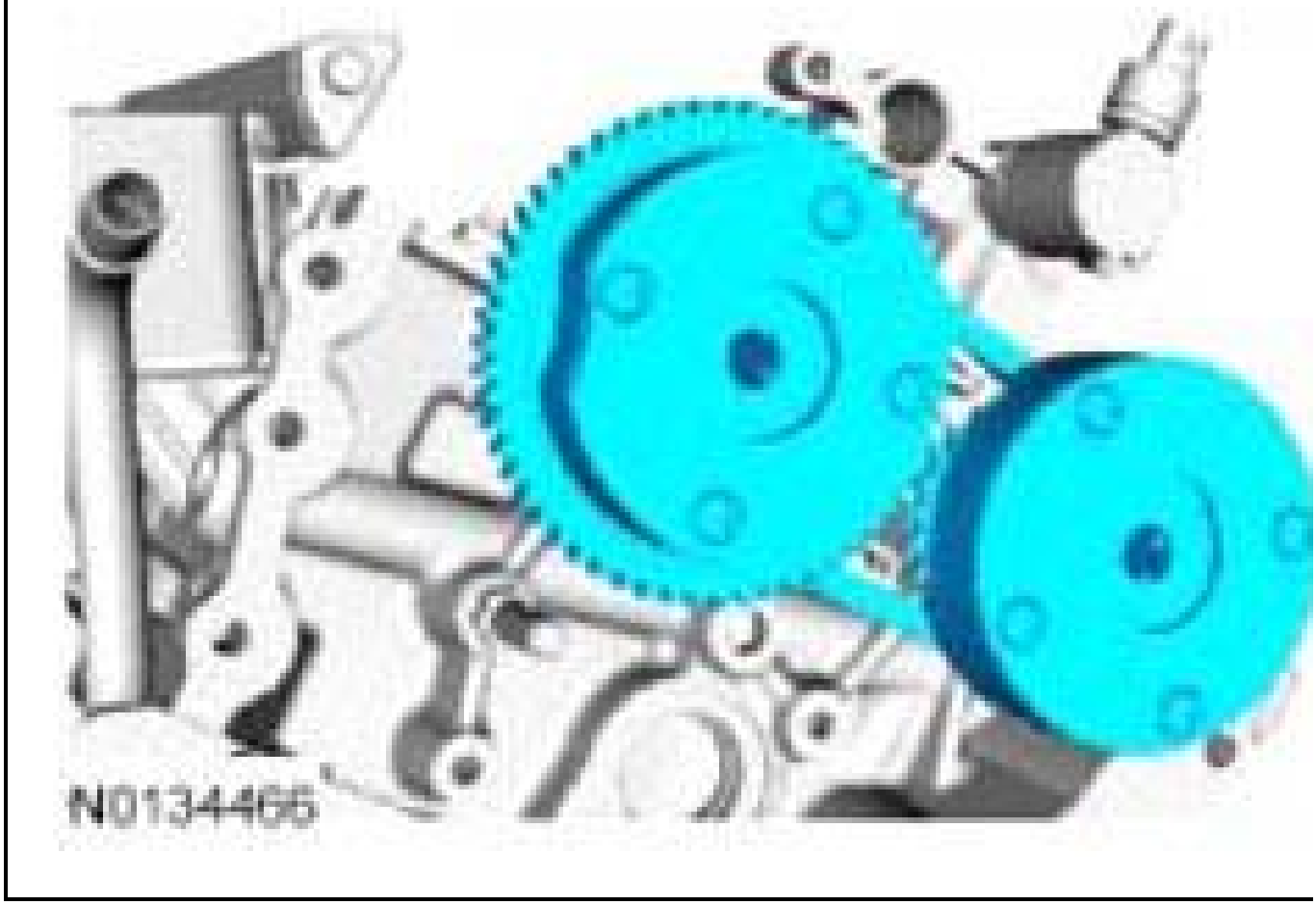
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NOTE: It may be necessary to rotate the camshafts slightly, to install the LH secondary timing assembly.

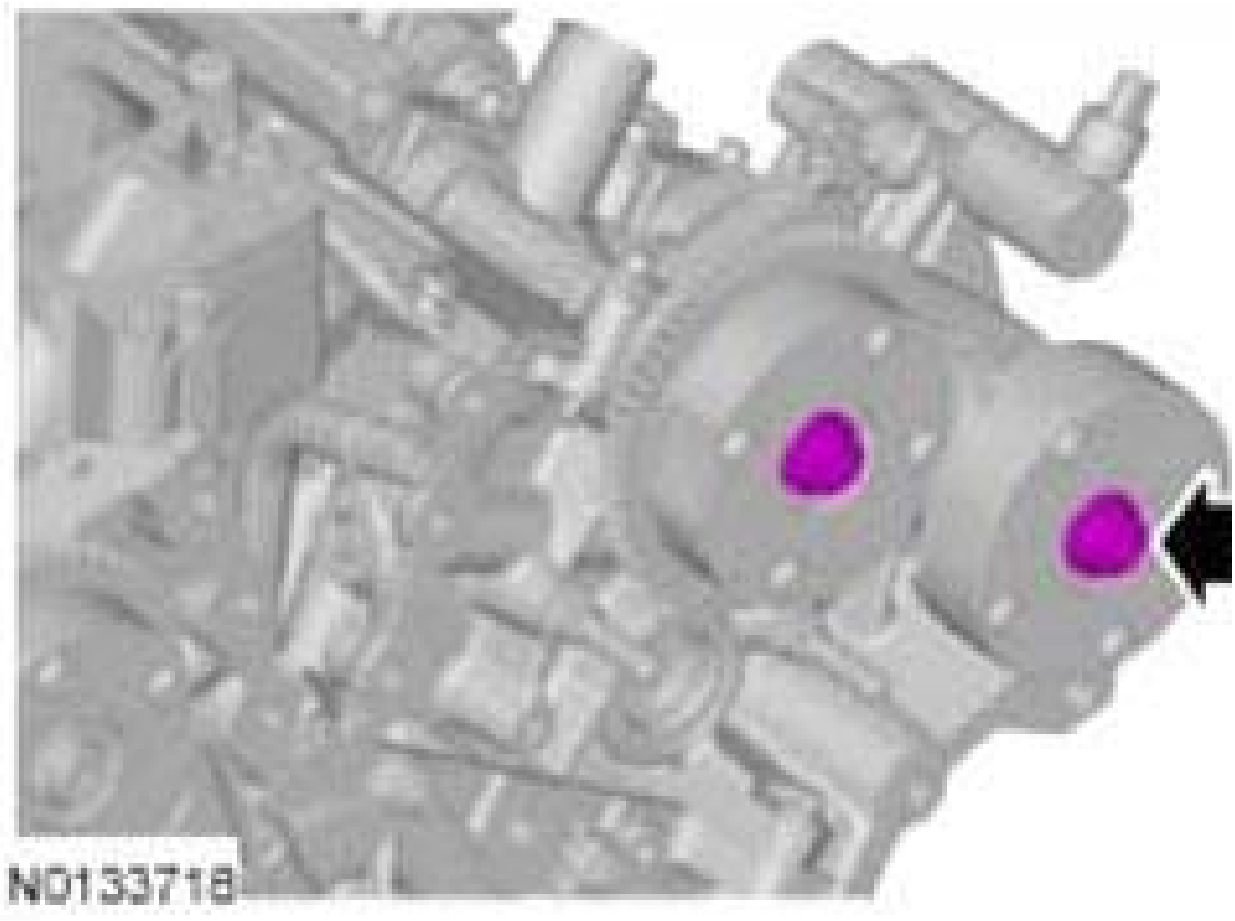
26. Position the 2 LH **VCT** assemblies and secondary timing chain onto the camshafts by aligning the holes in the **VCT** assemblies with the dowel pins in the camshafts.

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27. Install the 2 new LH **VCT** bolts and tighten in 4 stages:
    - Stage 1: Tighten to 40 Nm (30 lb-ft).
    - Stage 2: Loosen one full turn.
    - Stage 3: Tighten to 25 Nm (18 lb-ft).
    - Stage 4: Tighten an additional 180 degrees.

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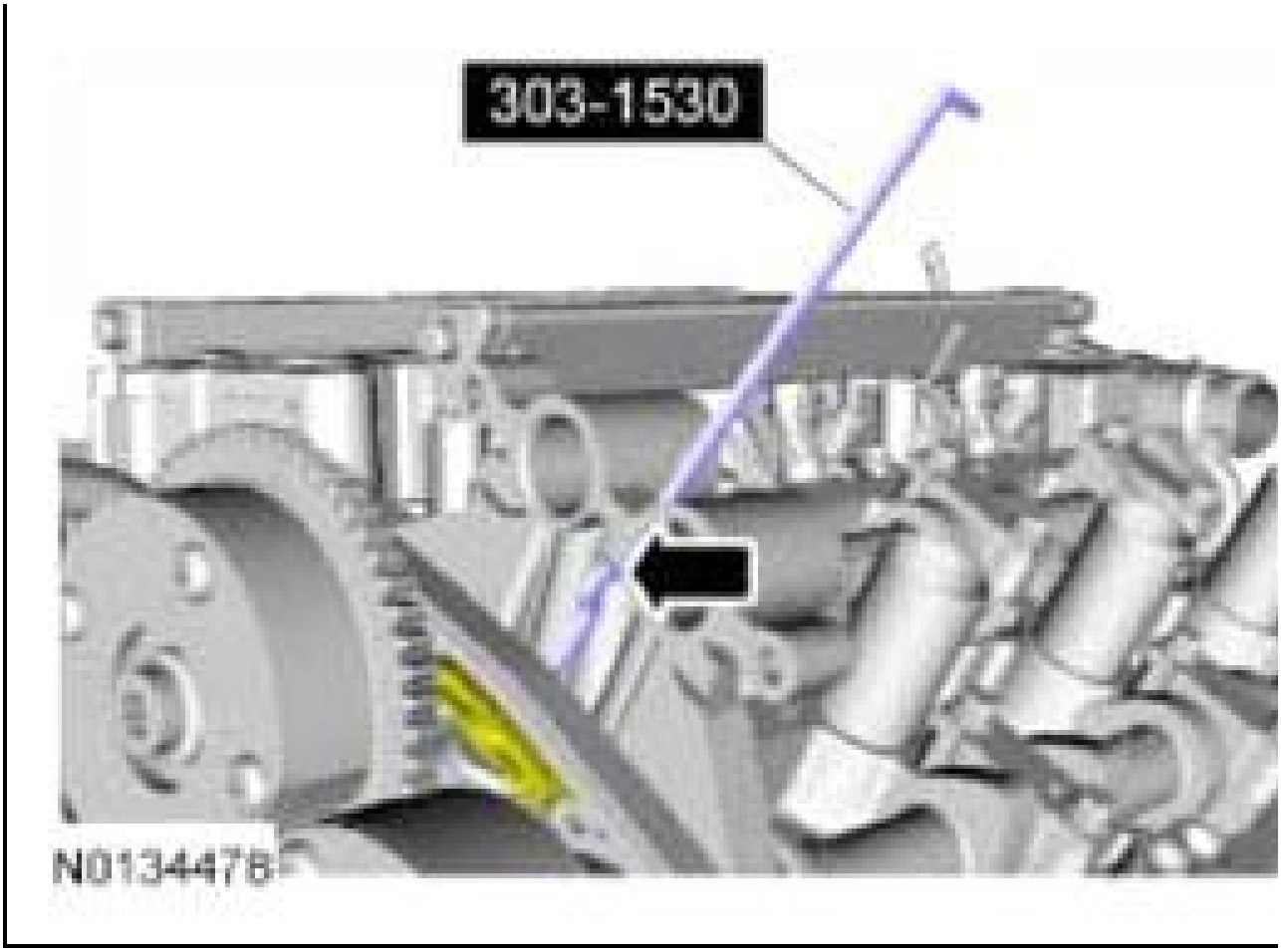


28. **NOTE: The 2 VCT oil control solenoids are removed for clarity.**

Compress the LH secondary timing chain tensioner and remove the Secondary Chain Hold Down.

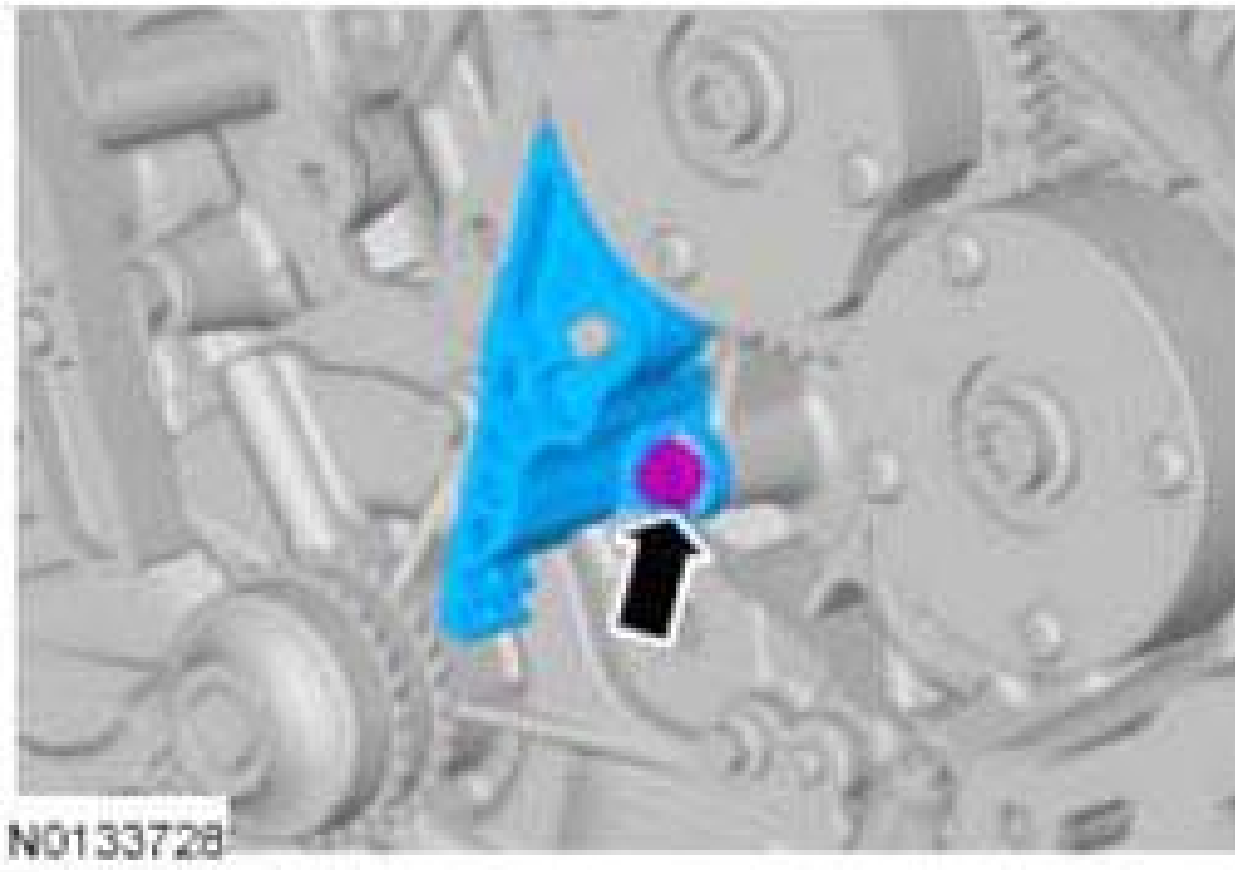
- Make sure the secondary timing chain is centered on the timing chain tensioner guides.

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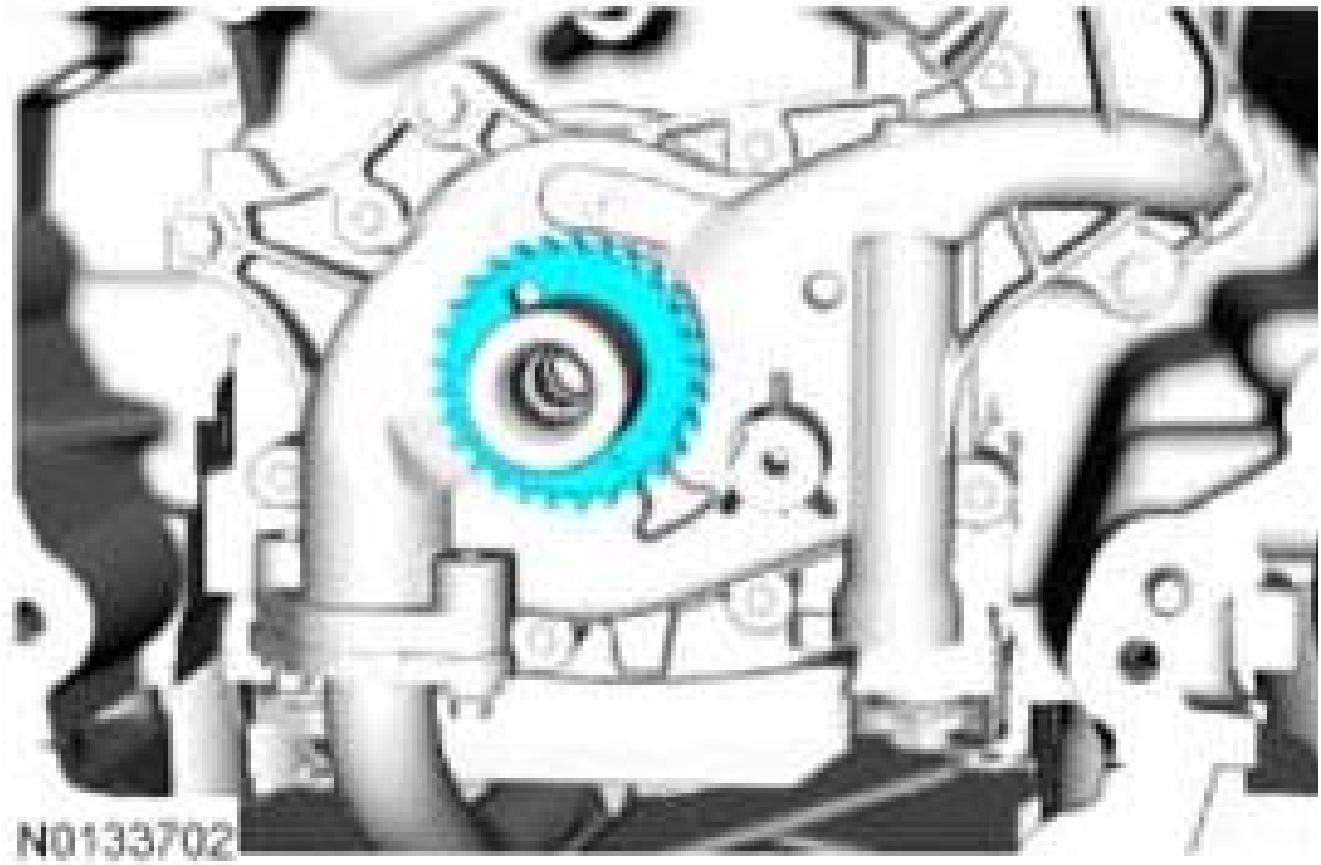
29. Install the upper LH primary timing chain guide and the bolt.
    - Tighten to 10 Nm (89 lb-in).

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30. Install the crankshaft timing chain sprocket with timing dot mark out.

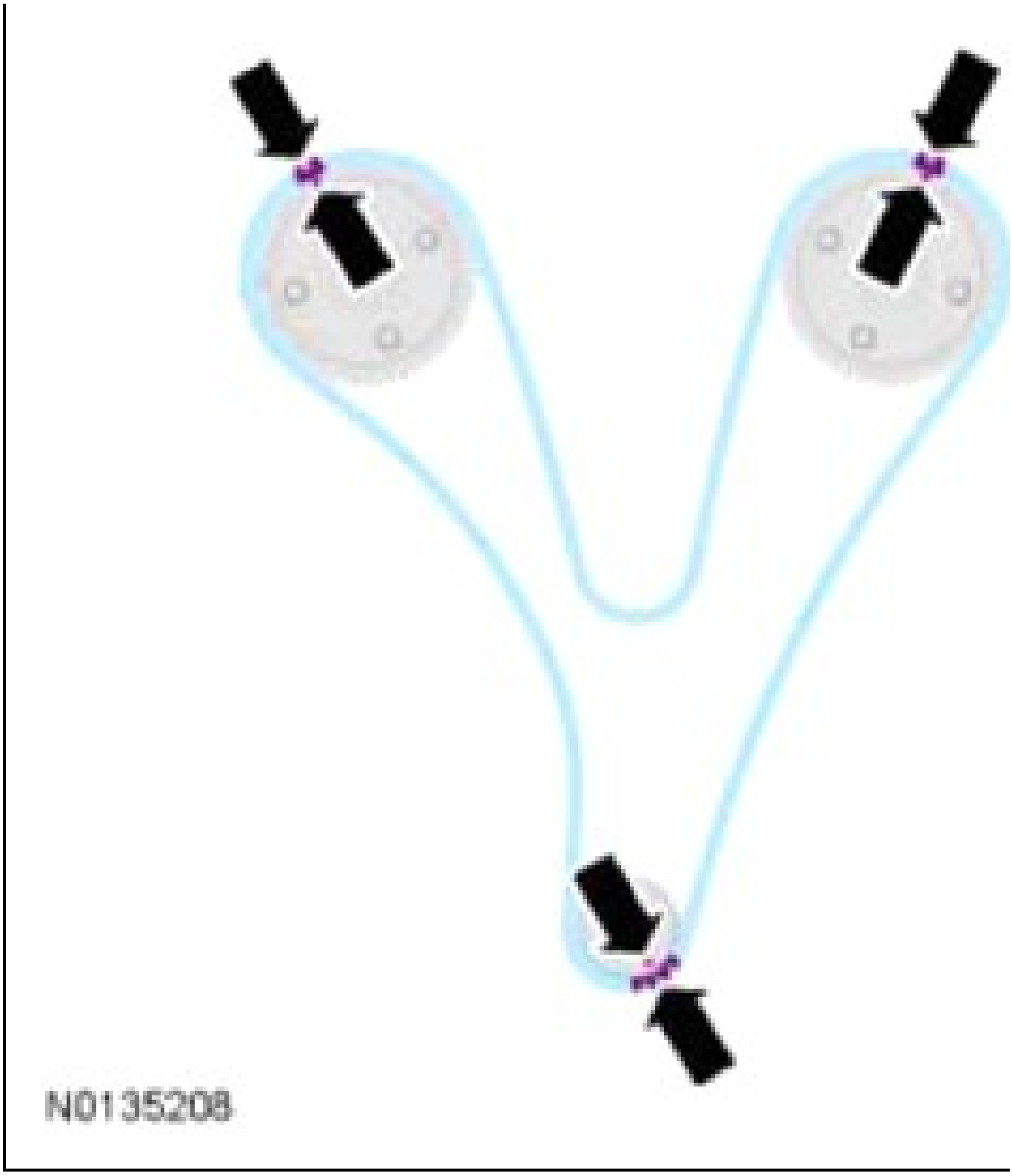
 © 2011 Mitchell Repair Information Company, LLC.



31. **NOTE: It may be necessary to rotate the camshafts slightly, to align the timing marks.**

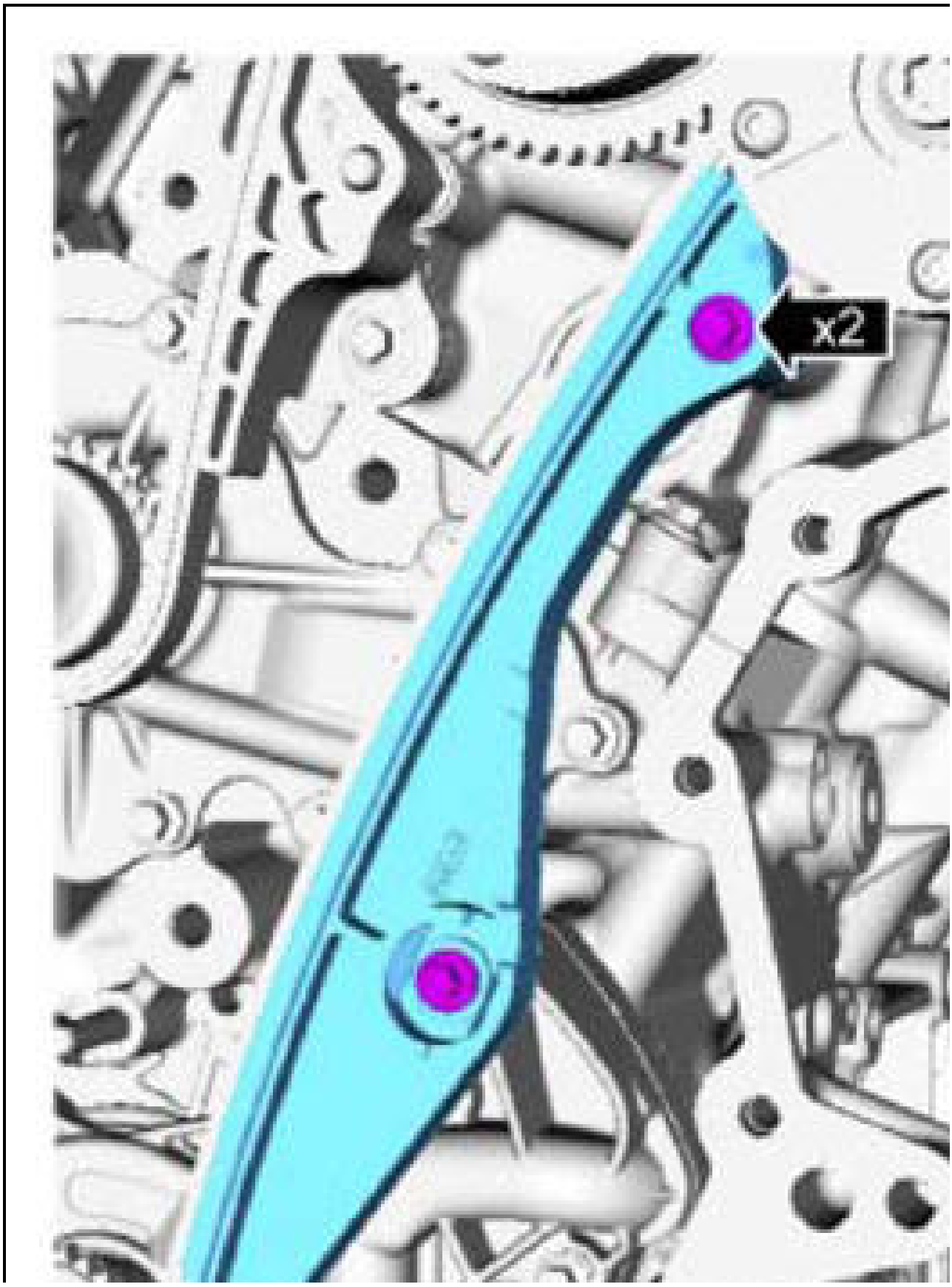
Install the primary timing chain with the colored links aligned with the timing marks on the **VCT** assemblies and the crankshaft sprocket.

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32. Install the lower LH primary timing chain guide and the 2 bolts.
    - Tighten to 10 Nm (89 lb-in).

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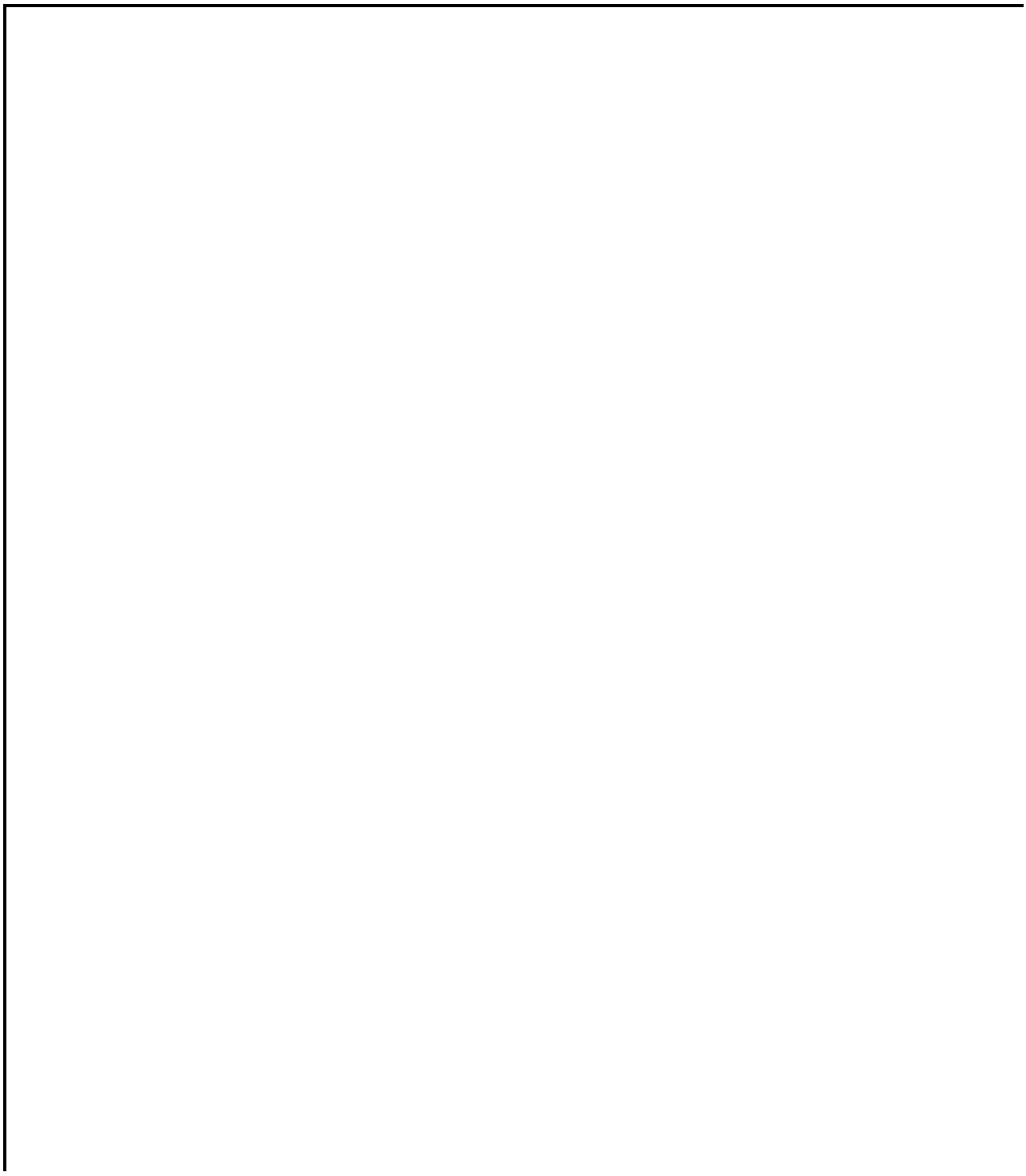
33. Install the primary timing chain tensioner arm.

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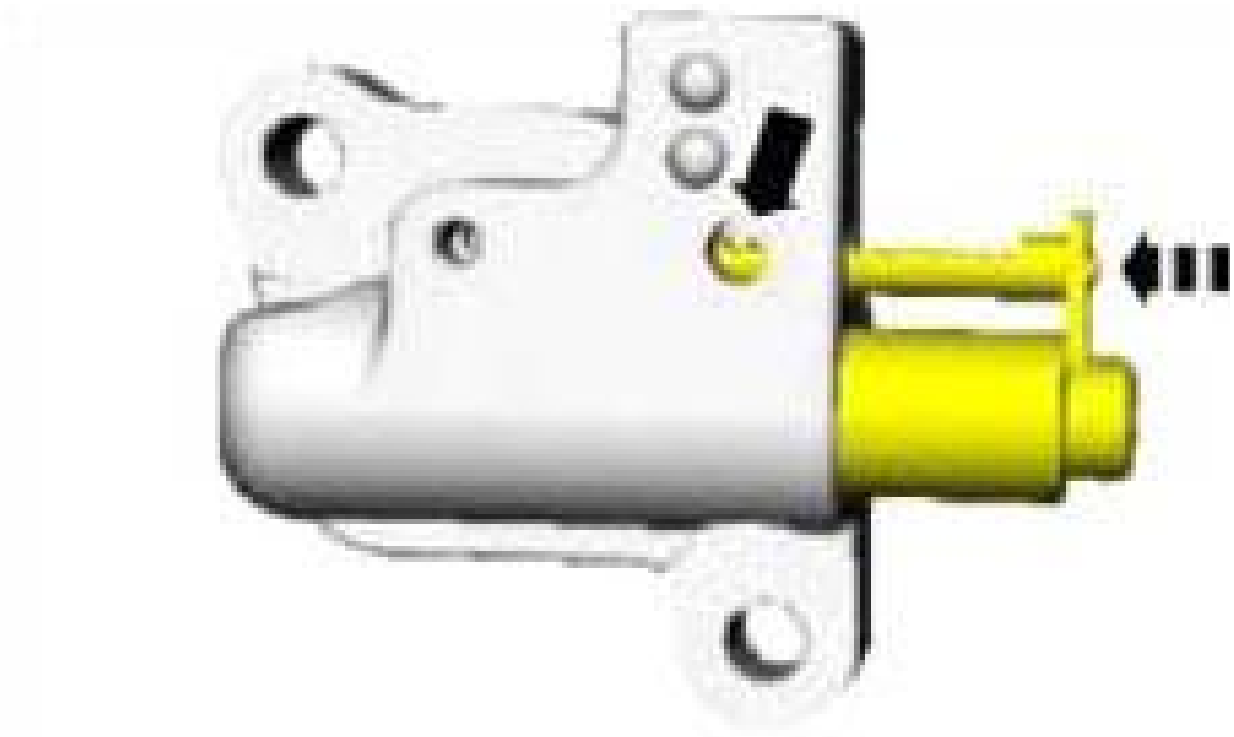


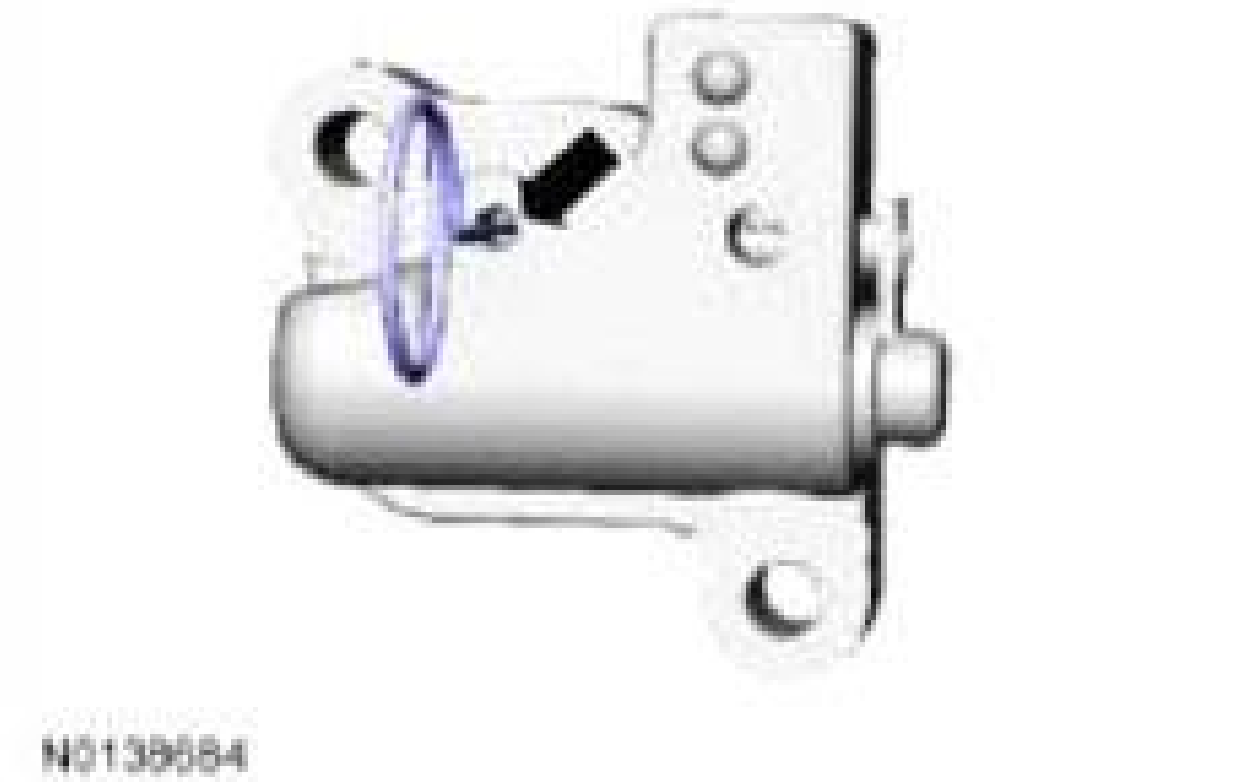
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34. Reset the primary timing chain tensioner.
    - Release the ratchet detent.
    - Using a soft-jawed vise, compress the ratchet plunger.
    - Align the hole in the ratchet plunger with the hole in the tensioner housing.
    - Install a suitable lockpin.



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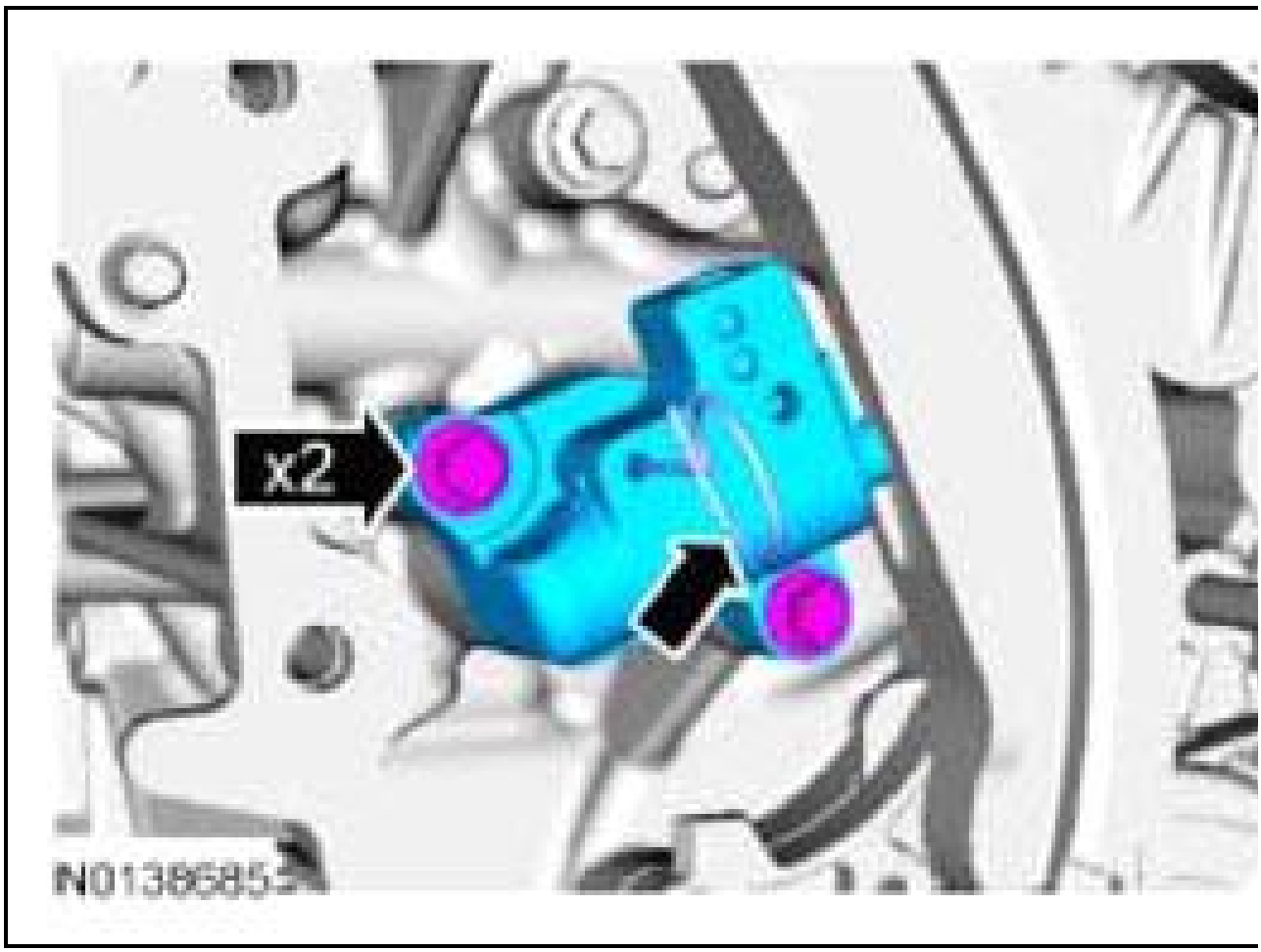


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35. **NOTE: It may be necessary to rotate the camshafts slightly to remove slack from the timing chain to install the tensioner.**

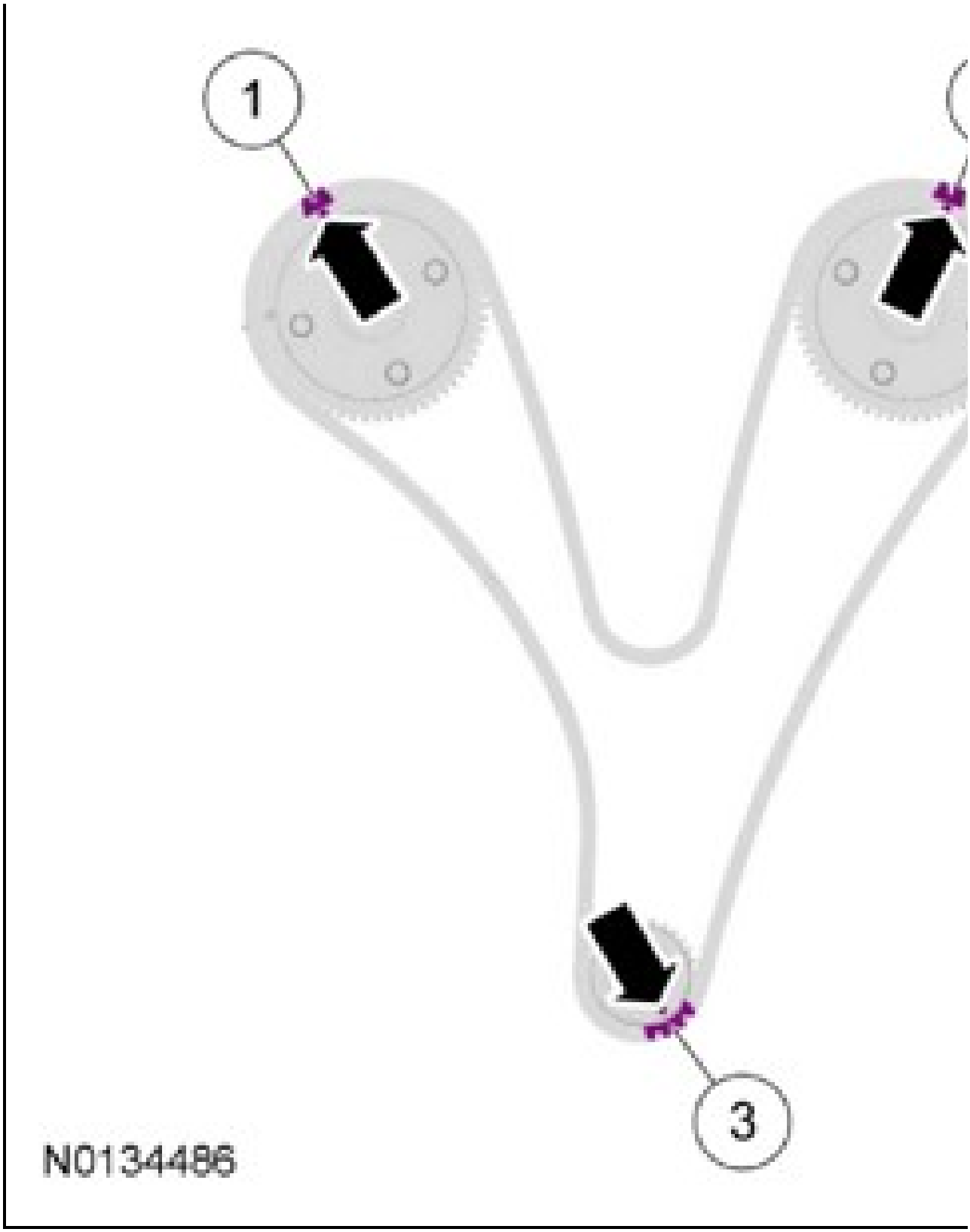
Install the primary tensioner and the 2 bolts.

- Tighten to 10 Nm (89 lb-in).
- Remove the lockpin.



36. As a post-check, verify correct alignment of all timing marks.
    - There are 48 links in between the RH intake **VCT** assembly colored link (1) and the LH intake **VCT** assembly colored link (2).
    - There are 35 links in between LH intake **VCT** assembly colored link (2) and the 2 crankshaft sprocket links (3).

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37. **NOTE: Do not use excessive force when installing the VCT oil control solenoid.**

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37. **Damage to the mega cap could cause the cylinder head to be inoperable. If difficult to install the VCT oil control solenoid, inspect the bore and VCT oil control solenoid to ensure there are no burrs, sharp edges or contaminants present on the mating surface. Only clean the external surfaces as necessary.**

NOTE: A slight twisting motion will aid in the installation of the VCT oil control solenoid.

NOTE: Keep the VCT oil control solenoid clean of dirt and debris.

Install the LH intake **VCT** oil control solenoid and the bolt.

- Tighten to 8 Nm (71 lb-in) then an additional 20 degrees.

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38.

NOTE: **Do not use excessive force when installing the VCT) oil control solenoid. Damage to the mega cap could cause the cylinder head to be inoperable. If difficult to install the VCT oil control solenoid, inspect the bore and VCT oil control solenoid to ensure there are no burrs, sharp edges or contaminants present on the mating surface. Only clean the external surfaces as necessary.**

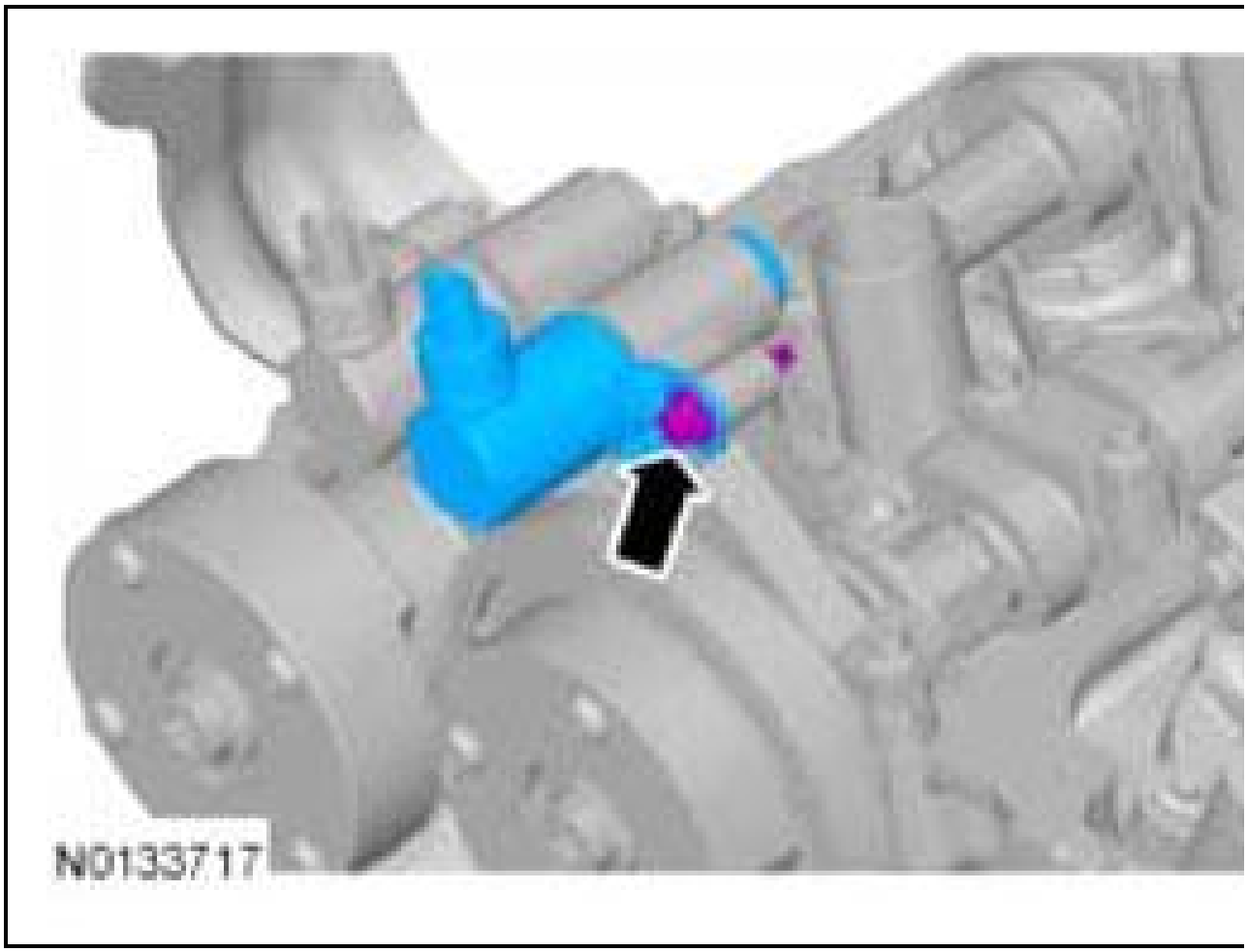
NOTE: **A slight twisting motion will aid in the installation of the VCT oil control solenoid.**

NOTE: **Keep the VCT oil control solenoid clean of dirt and debris.**

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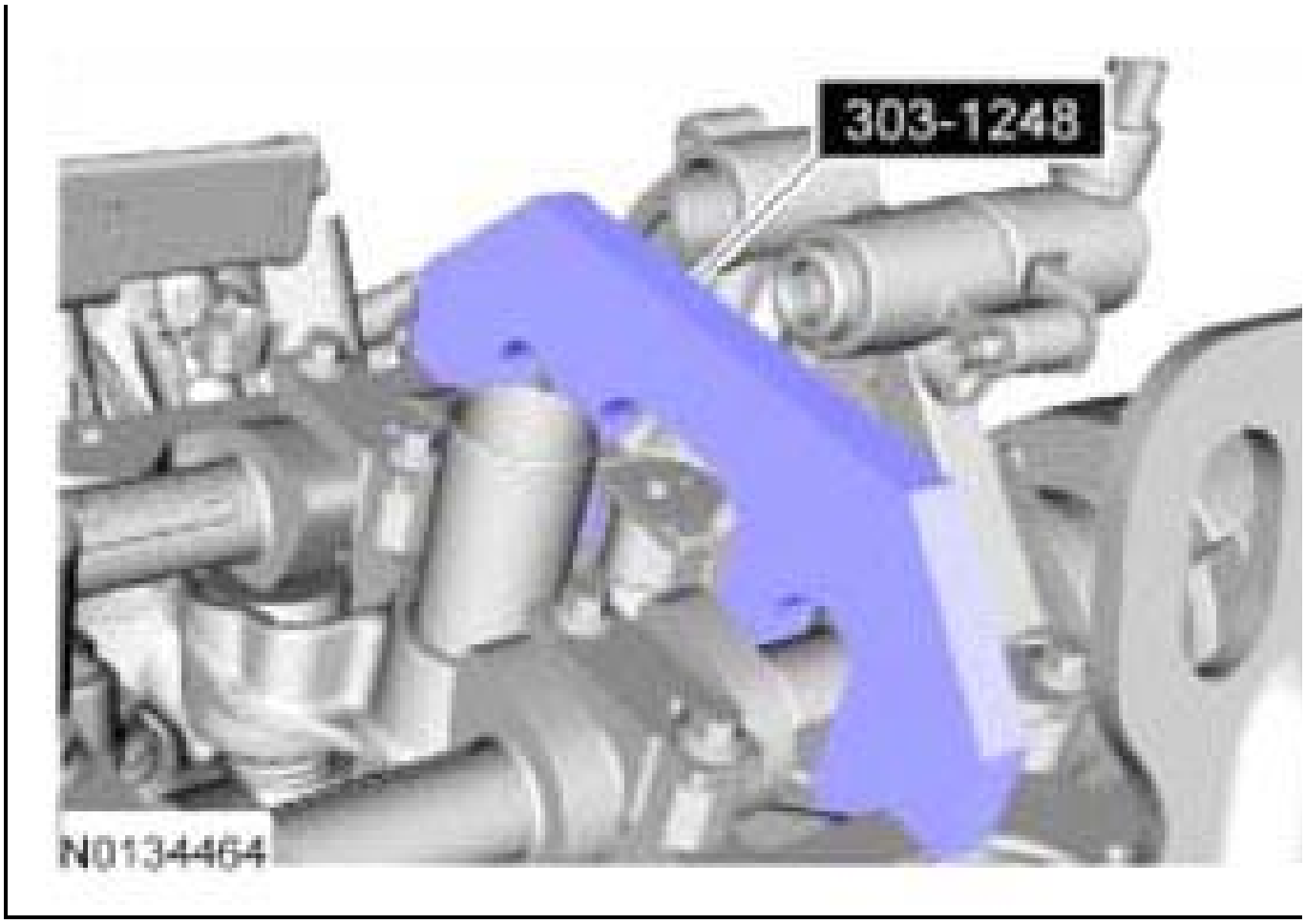
Install the RH intake **VCT** oil control solenoid and the bolt.

- Tighten to 8 Nm (71 lb-in) then an additional 20 degrees.



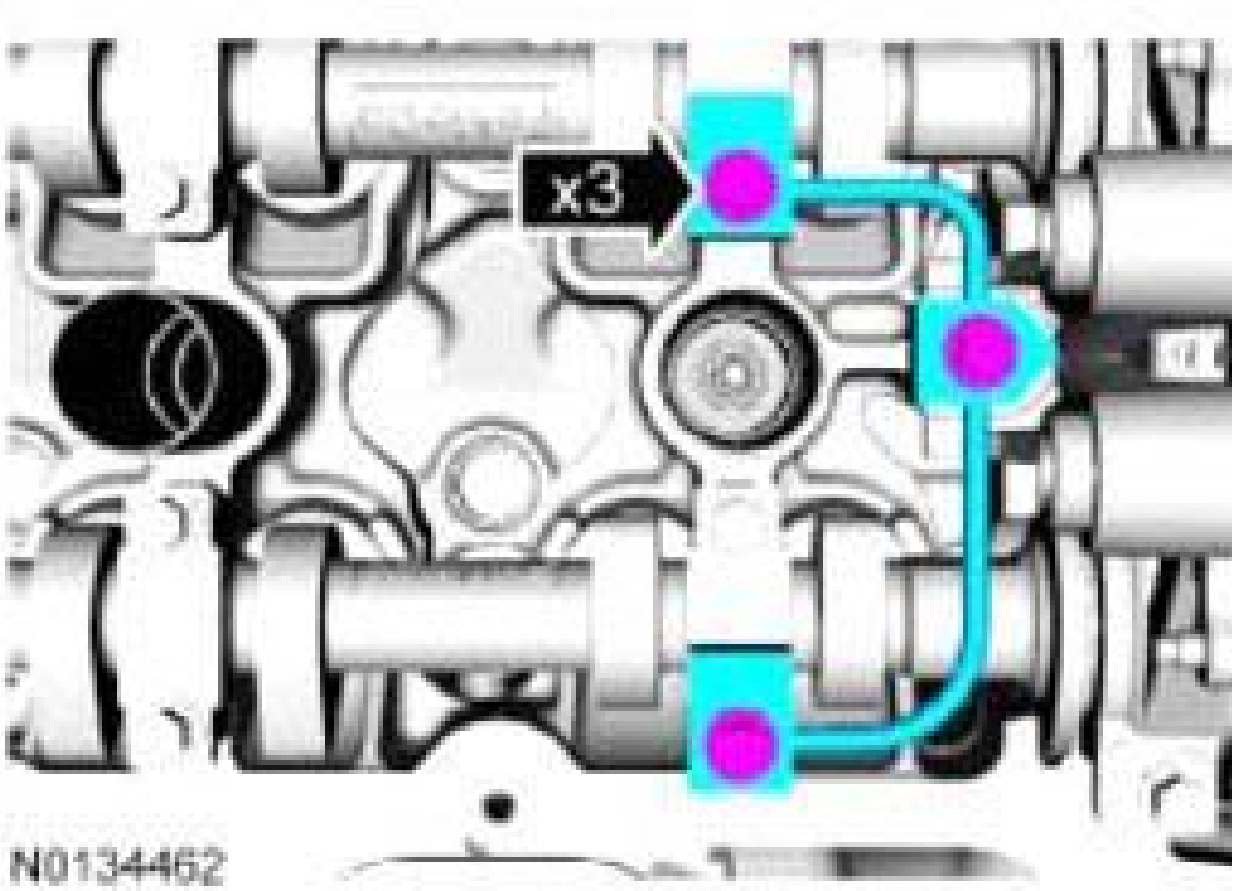
39. Remove the RH Camshaft Holding Tool.

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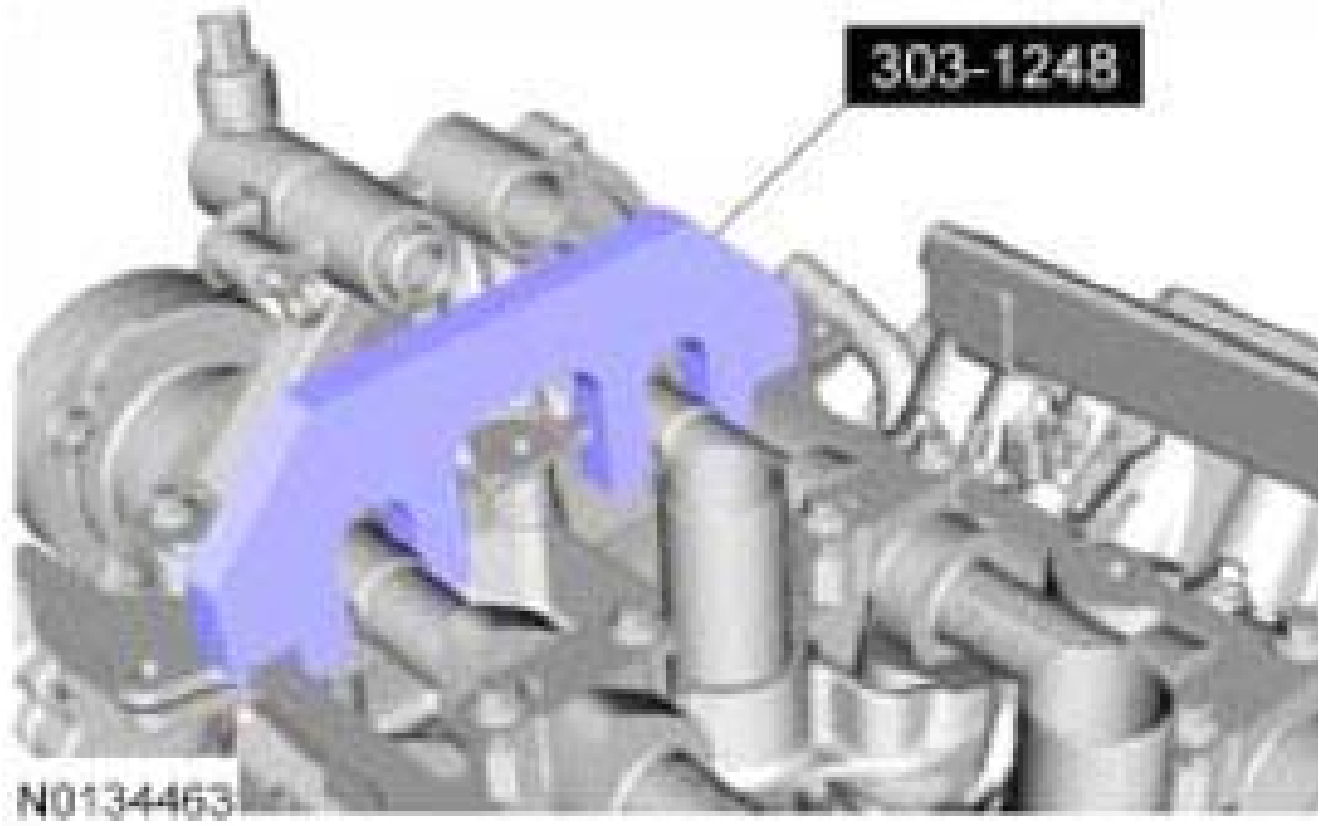
40. Install the RH valve train oil tube and the 3 bolts and tighten in 2 stages:
    - Stage 1: Tighten to 8 Nm (71 lb-in).
    - Stage 2: Tighten an additional 45 degrees.

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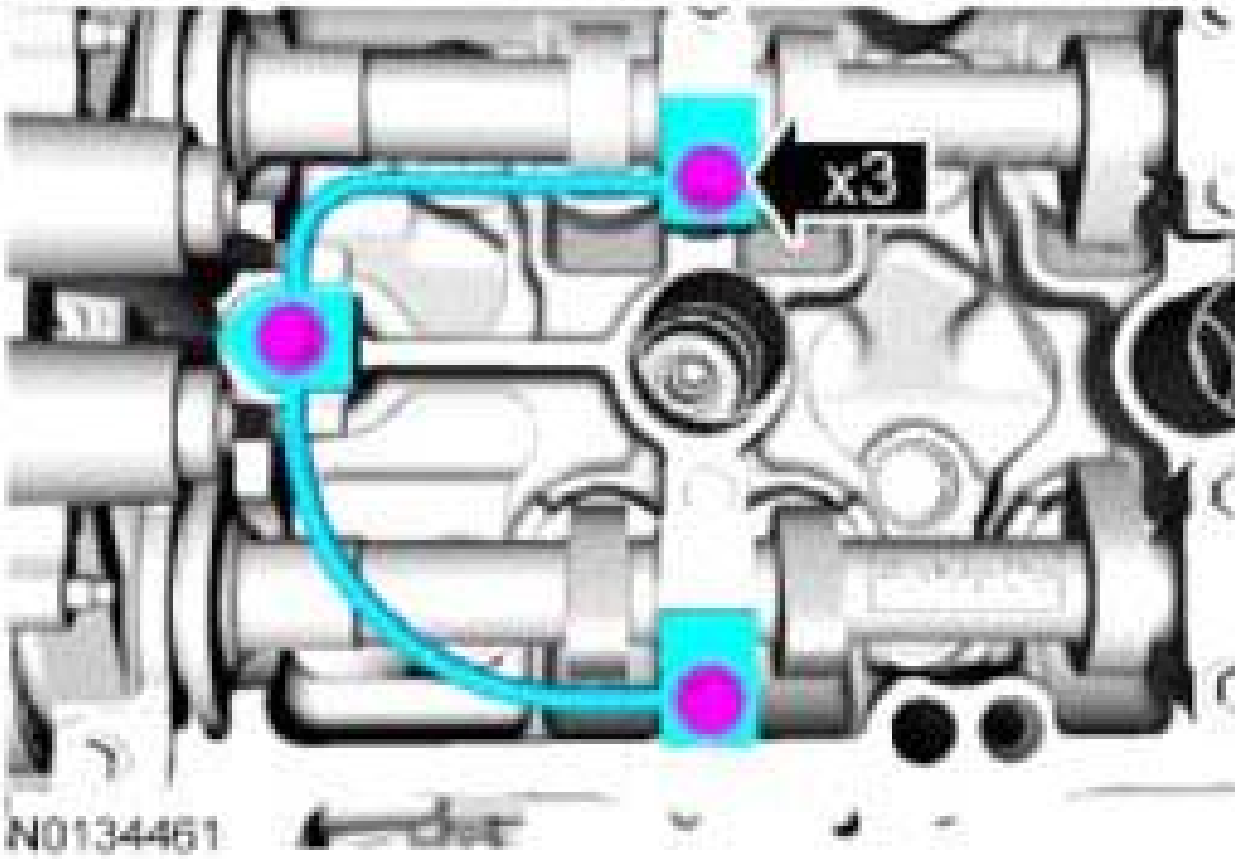
41. Remove the LH Camshaft Holding Tool.

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42. Install the LH valve train oil tube and the 3 bolts and tighten in 2 stages:
    - Stage 1: Tighten to 8 Nm (71 lb-in).
    - Stage 2: Tighten an additional 45 degrees.

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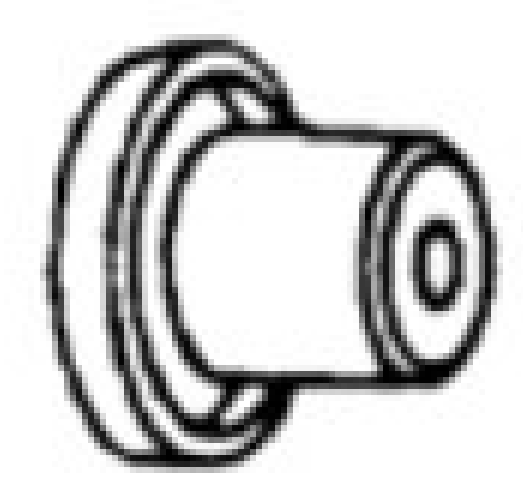
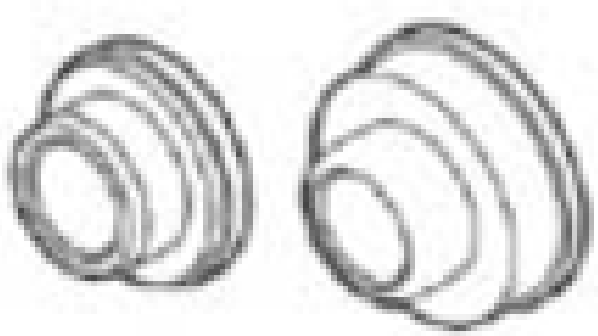
43. Install the engine front cover. Refer to **ENGINE FRONT COVER**.

VALVE COVER - LH

SPECIAL TOOL(S) DESCRIPTION

	Adapter For 303-224 (Handle) **205-153T80T-4000-W**

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	Installer, Differential Bearing Cone **205-142T80T-4000-J**
	VCT Spark Plug Tube Seal Remover And Installer **303-1247**

MATERIAL SPECIFICATIONS

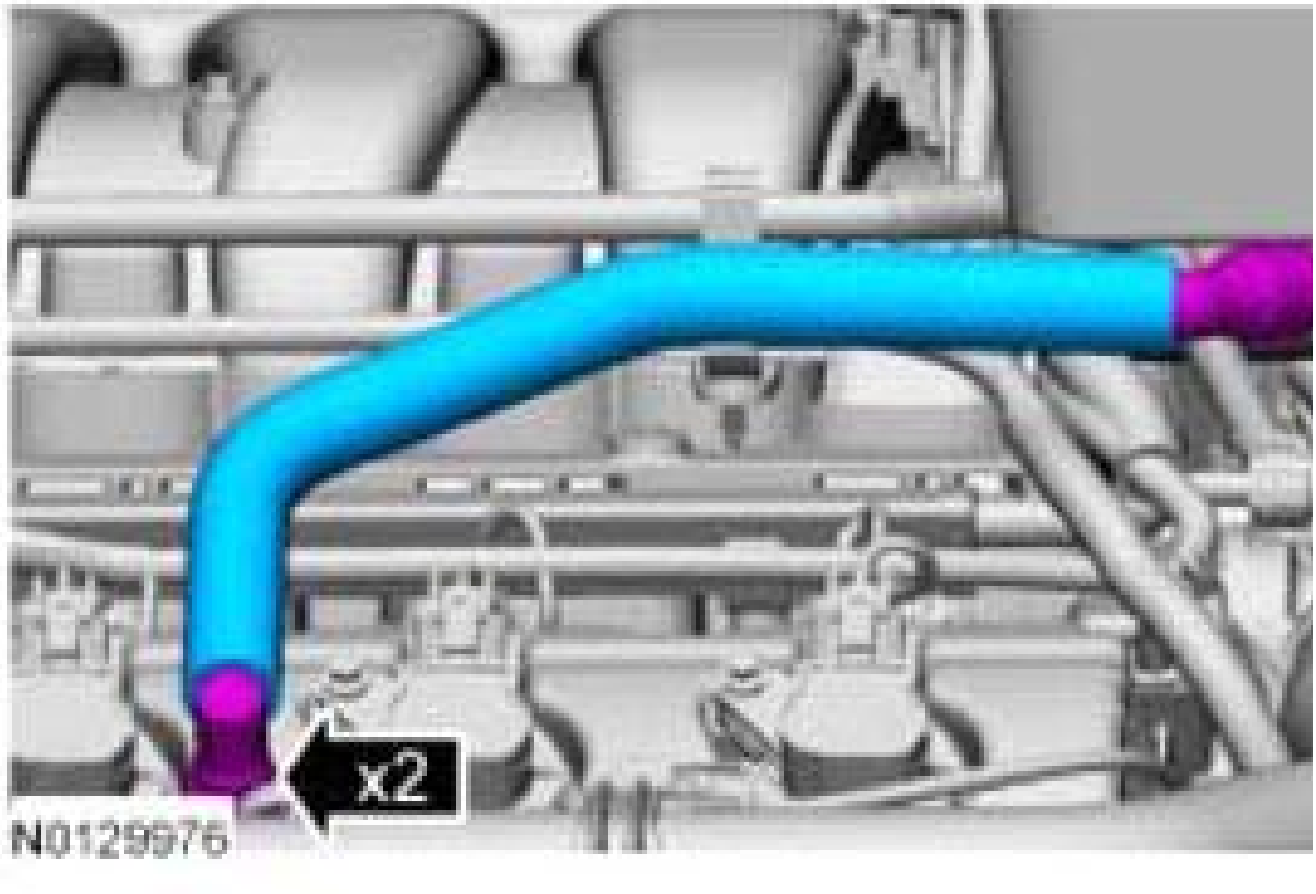
Item	Specification
Motorcraft® High Performance Engine RTV Silicone TA-357	WSE-M4G323-A6
Motorcraft® Metal Surface Prep ZC-31-A	-
Motorcraft® Silicone Gasket Remover ZC-30	-

Removal

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

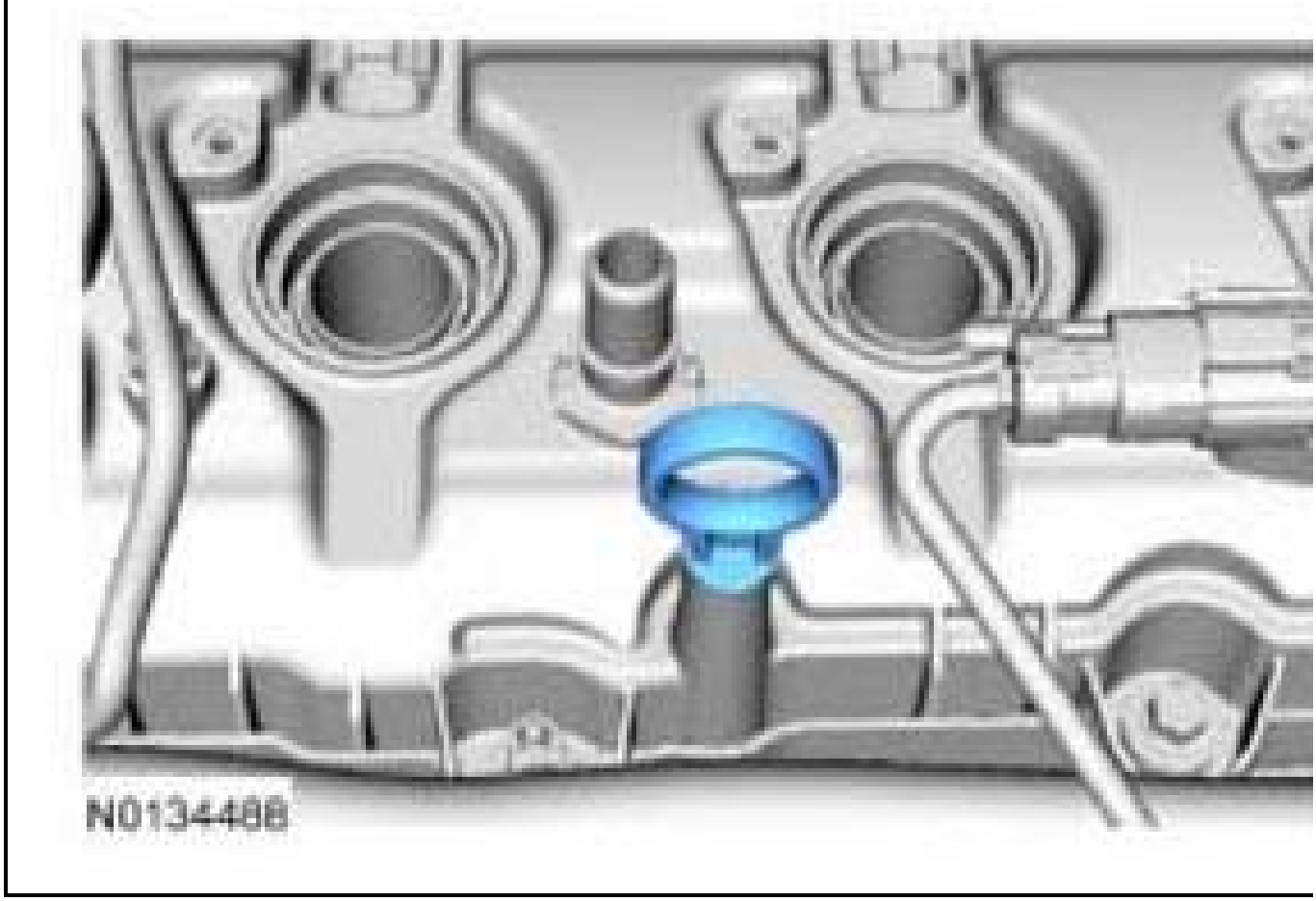
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1. Remove the crankcase vent tube. REFER to **QUICK CONNECT COUPLING** .



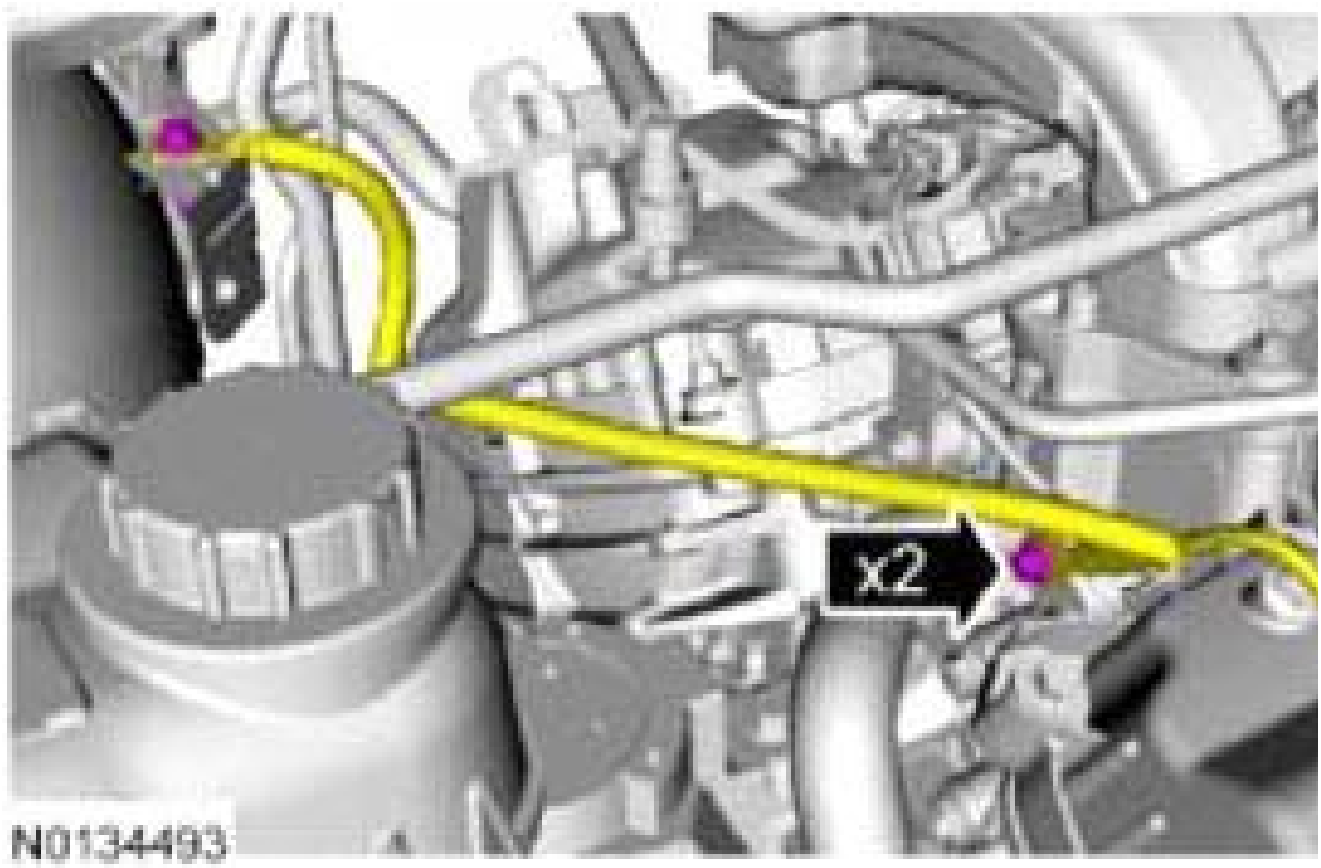
2. Remove the LH ignition coils. REFER to **IGNITION COIL-ON-PLUG - LH** .
3. Remove the oil level indicator.

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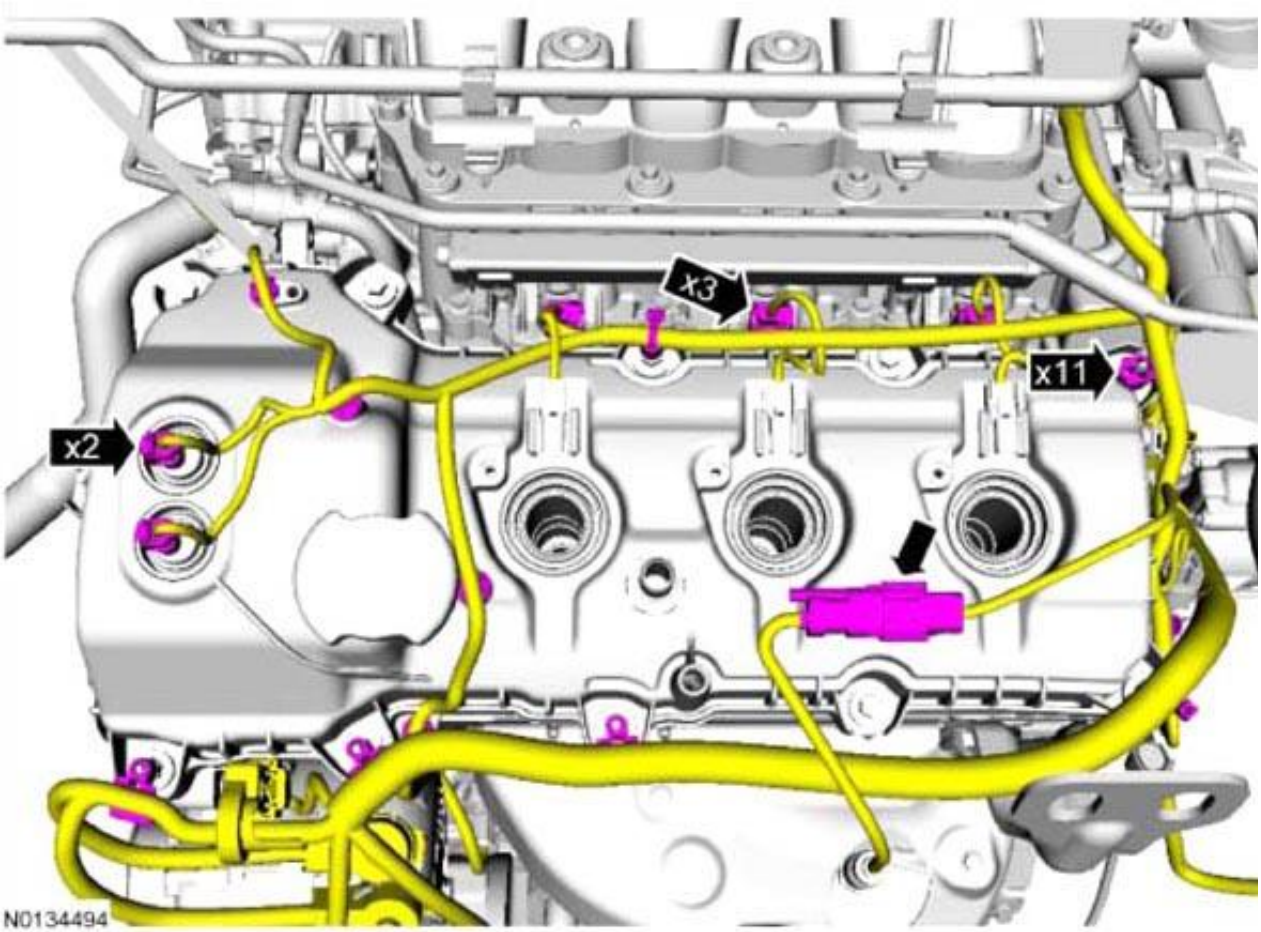
4. Remove the 2 ground wire bolts from the engine front cover and the RH strut tower.

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5. Remove the engine wiring harness from the LH valve cover.
   - Disconnect the 2 **VCT** oil control solenoid electrical connectors.
   - Detach and disconnect the LH **HO2S** electrical connector.
   - Disconnect the 3 fuel injector electrical connectors.
   - Detach the 11 wiring harness retainers from the LH valve cover and stud bolts and position the harness aside.

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6.

NOTE: When removing valve cover do not apply excessive force to the VCT oil control solenoid.

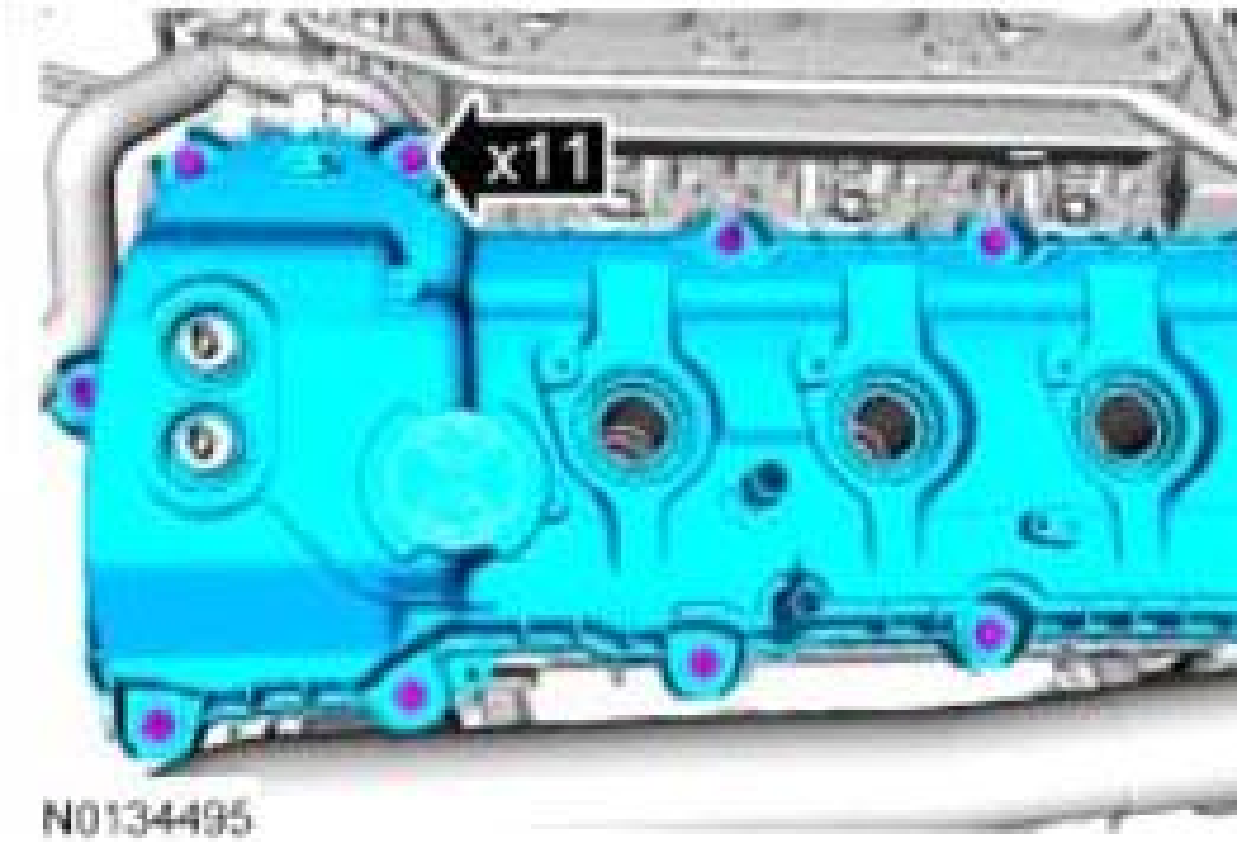
NOTE: If the VCT solenoid seal sticks to the VCT oil control solenoid, then carefully wiggle the valve cover until the bond breaks free.

NOTE: The plastic electrical connector on the VCT oil control solenoid will rotate approximately 12 degrees inside the steel housing, which is normal.

Loosen the 4 bolts and 7 stud bolts and remove the valve cover.

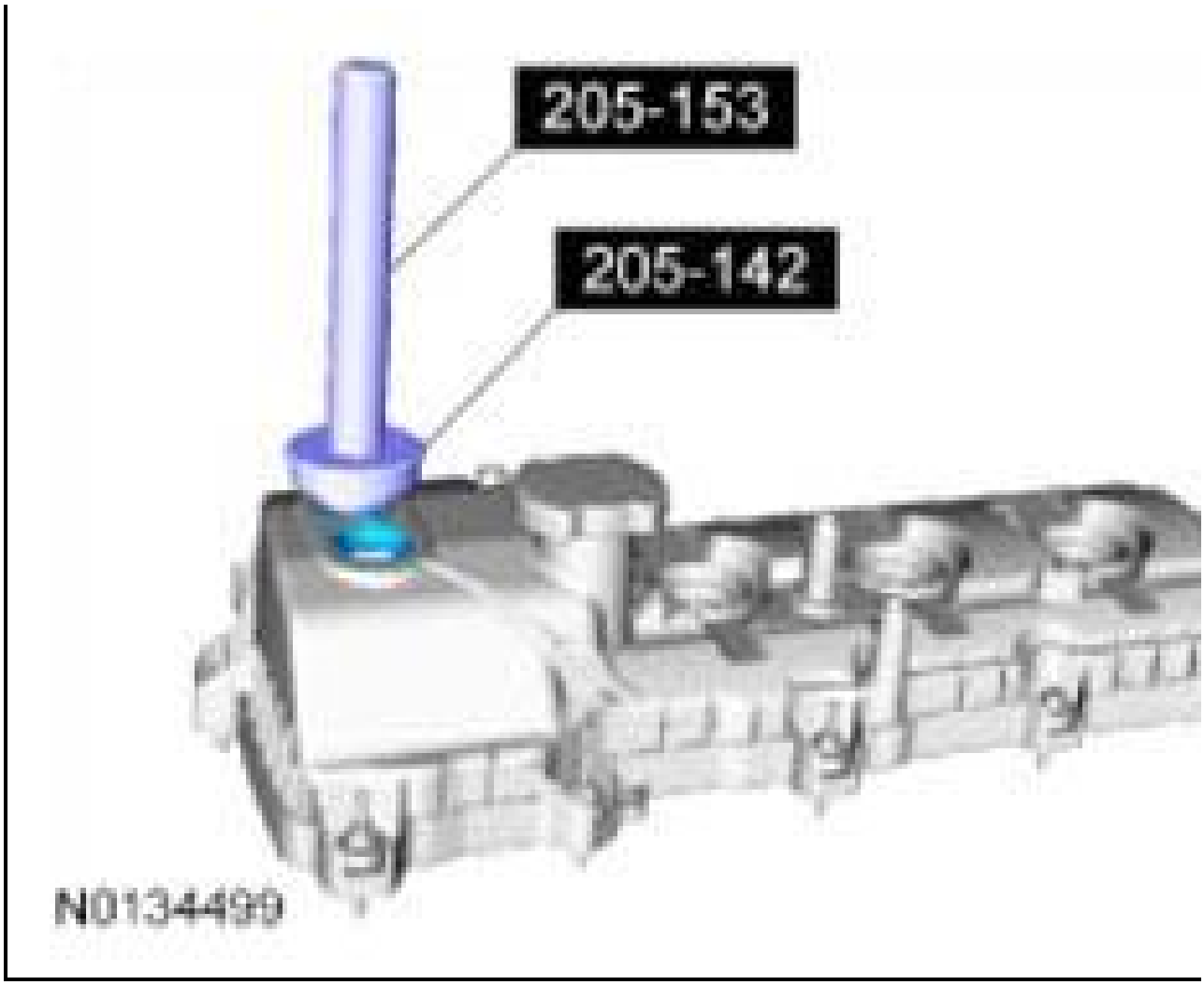
- Discard the gasket.

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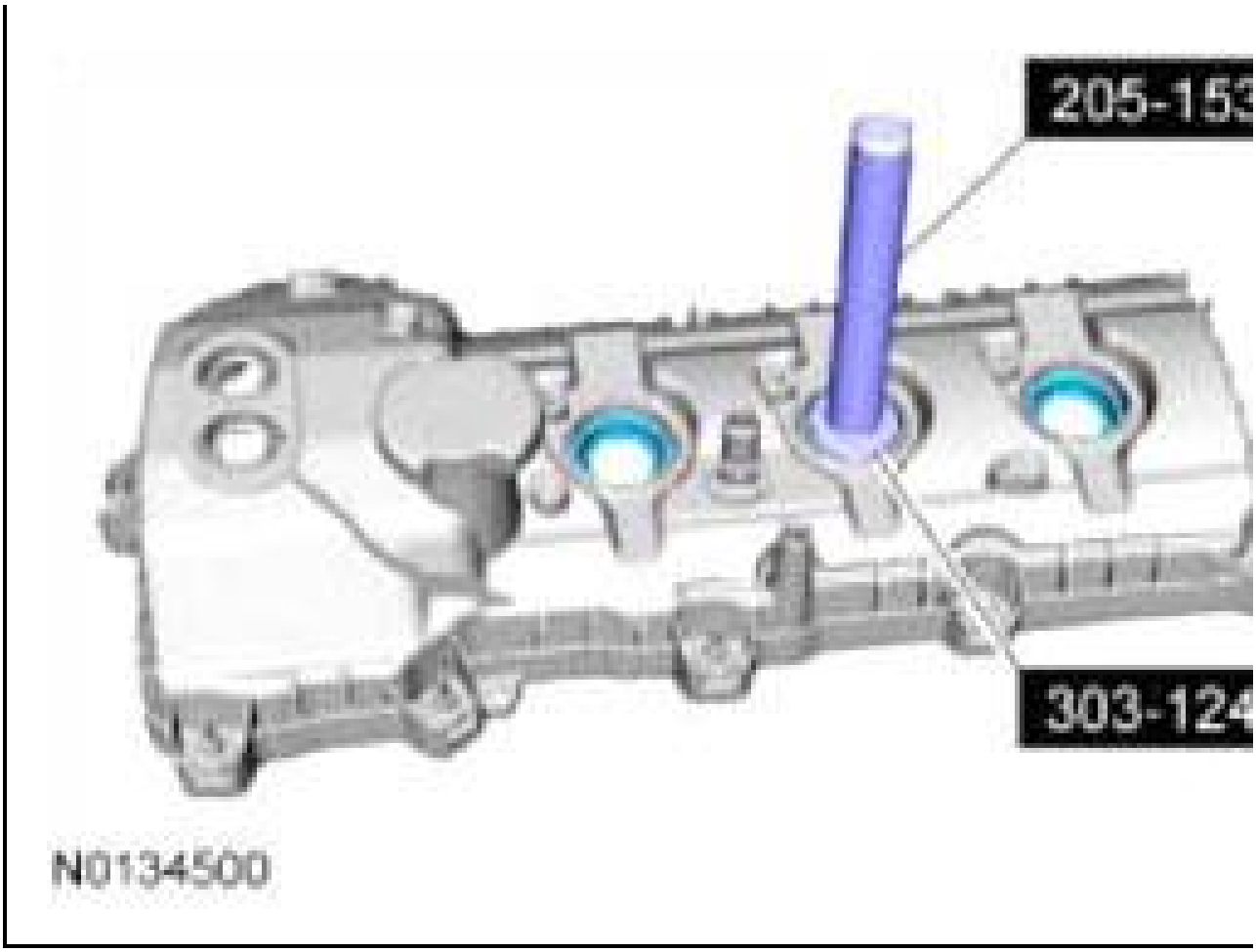
7. Inspect the 2 **VCT** solenoid seals. Remove any damaged seals.
    - Using 205-142 T80T-4000-J and 205-153 T80T-4000-W remove and discard the damaged seal(s).

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8. Inspect the spark plug tube seals. Remove any damaged seals.
    - Using 303-1247/1 and 205-153 T80T-4000-W remove and discard the damaged seal(s).

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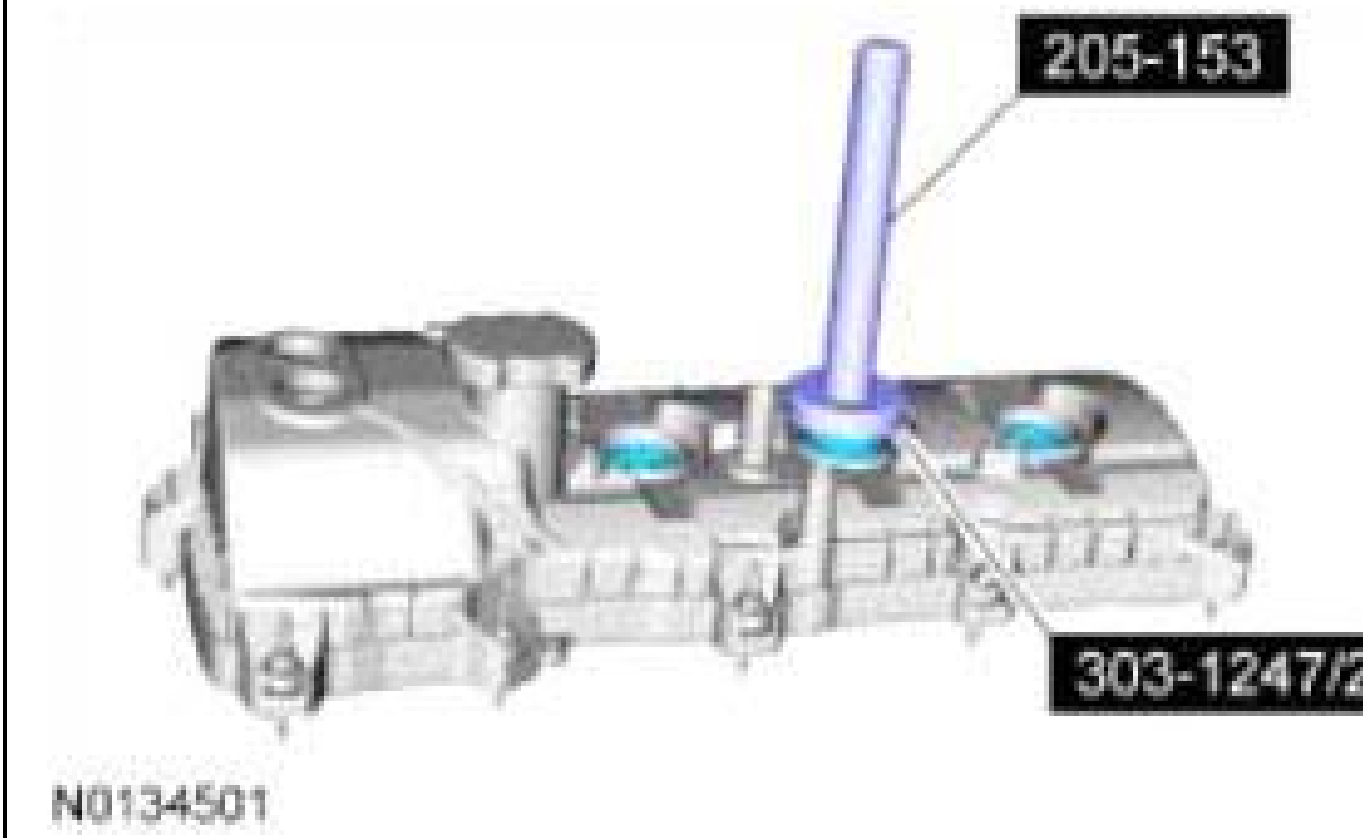
9. Clean the valve cover, cylinder head and engine front cover sealing surfaces using Motorcraft® Metal Surface Prep.

Installation

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

   Using 303-1247/2 and 205-153 T80T-4000-W install the new spark plug tube seal(s).

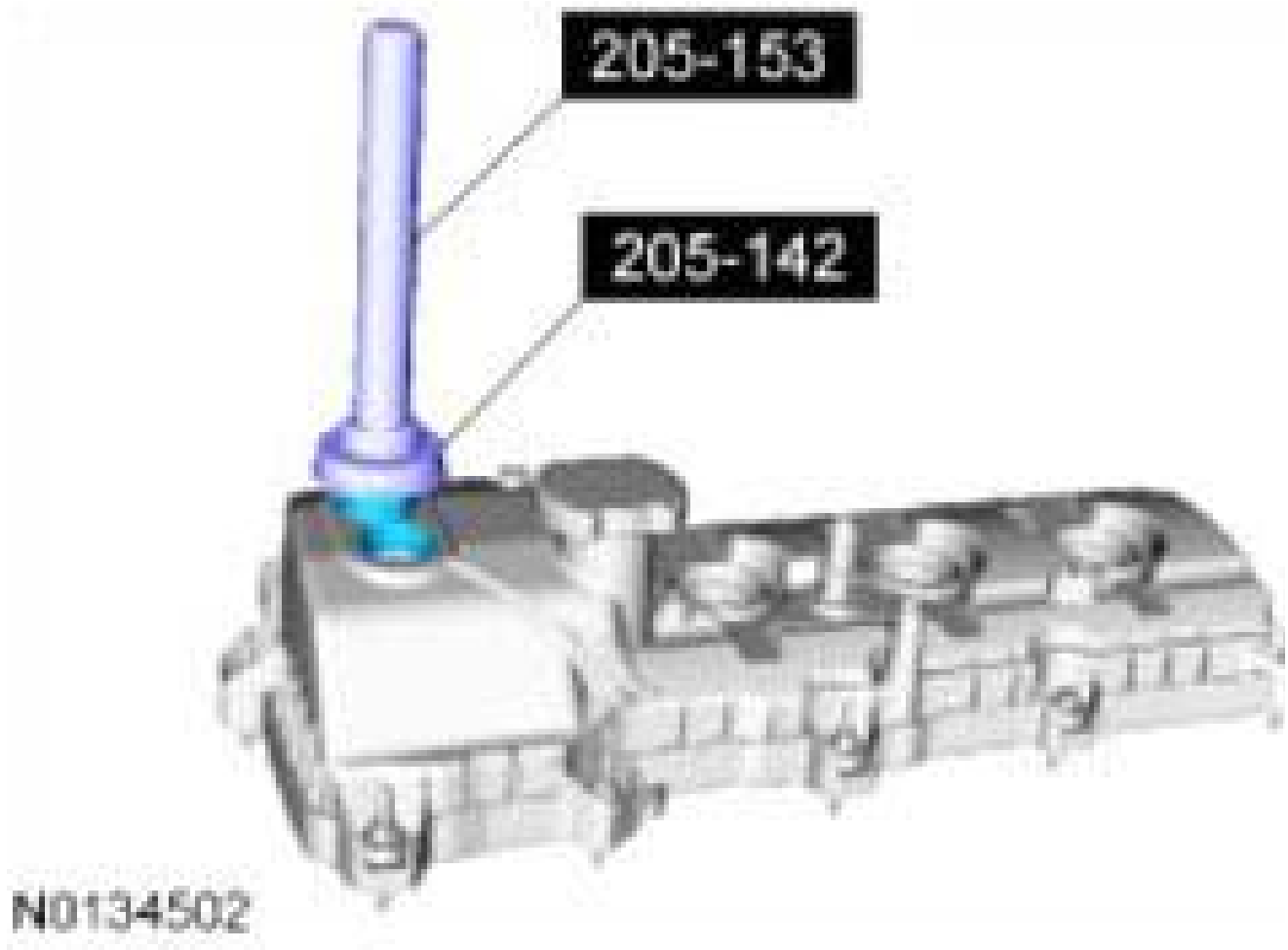
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2. **NOTE: Installation of new seals is only required if damaged seals were removed.**

Using 205-142 T80T-4000-J and 205-153 T80T-4000-W install the new **VCT** seal(s).

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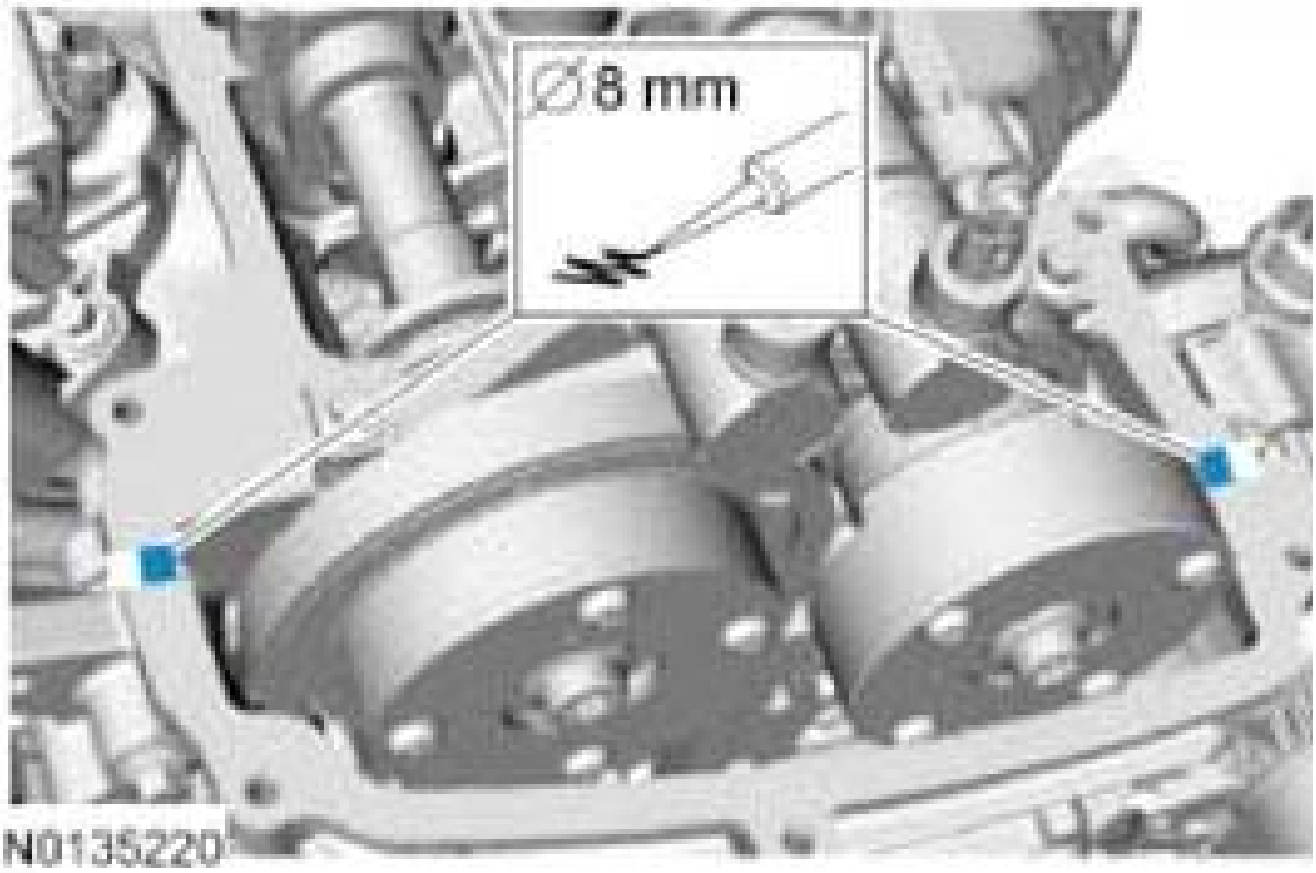
3.

NOTE: **Failure to use Motorcraft® High Performance Engine RTV Silicone may cause the engine oil to foam excessively and result in serious engine damage.**

NOTE: **If the valve cover is not installed and the fasteners tightened within 4 minutes, the sealant must be removed and the sealing area cleaned. To clean the sealing area, use Motorcraft® Silicone Gasket Remover and Motorcraft® Metal Surface Prep. Failure to follow this procedure can cause future oil leakage.**

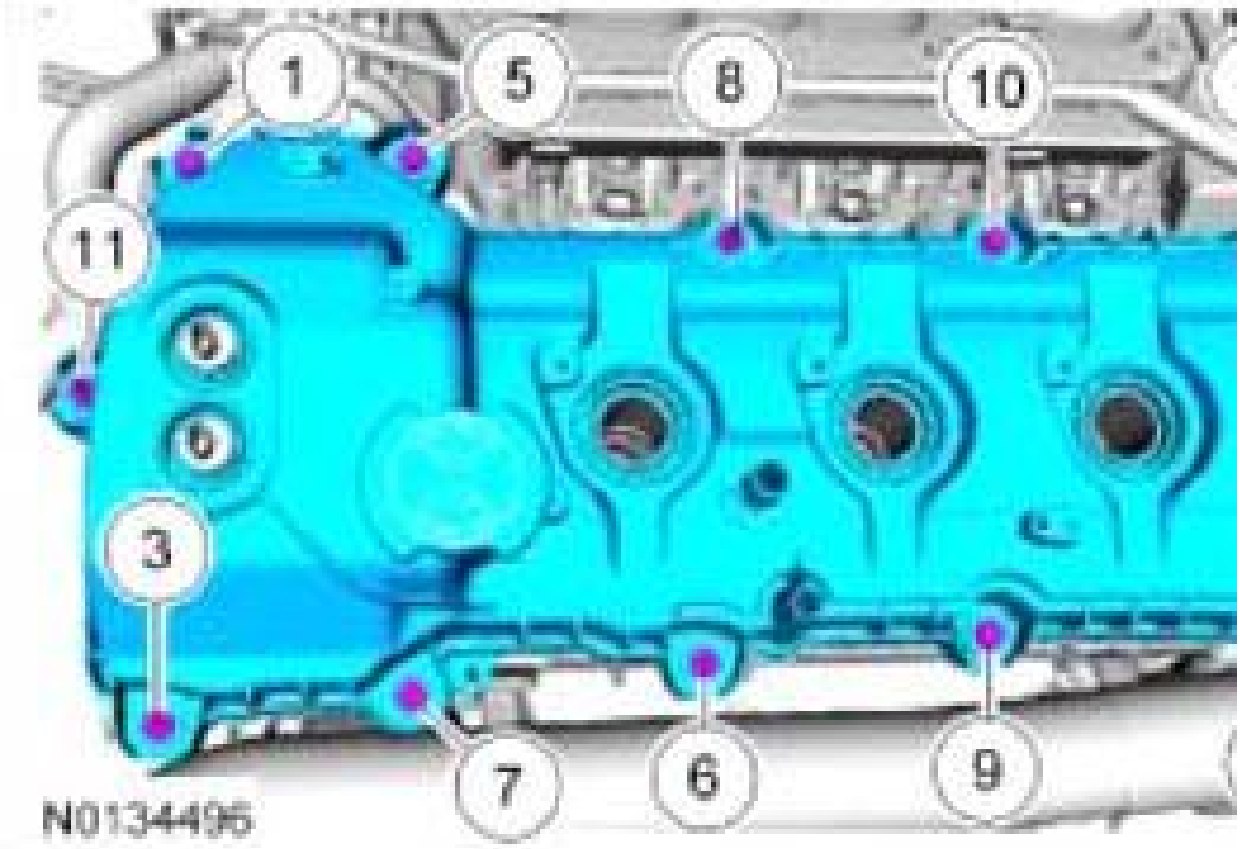
Apply an 8 mm (0.315 in) bead of Motorcraft® High Performance Engine RTV Silicone to the engine front cover-to-Left Hand (LH) cylinder head joints.

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4. Using a new gasket, install the LH valve cover and tighten the 4 bolts and 7 stud bolts.
   - Tighten in the sequence shown in illustration to 10 Nm (89 lb-in).

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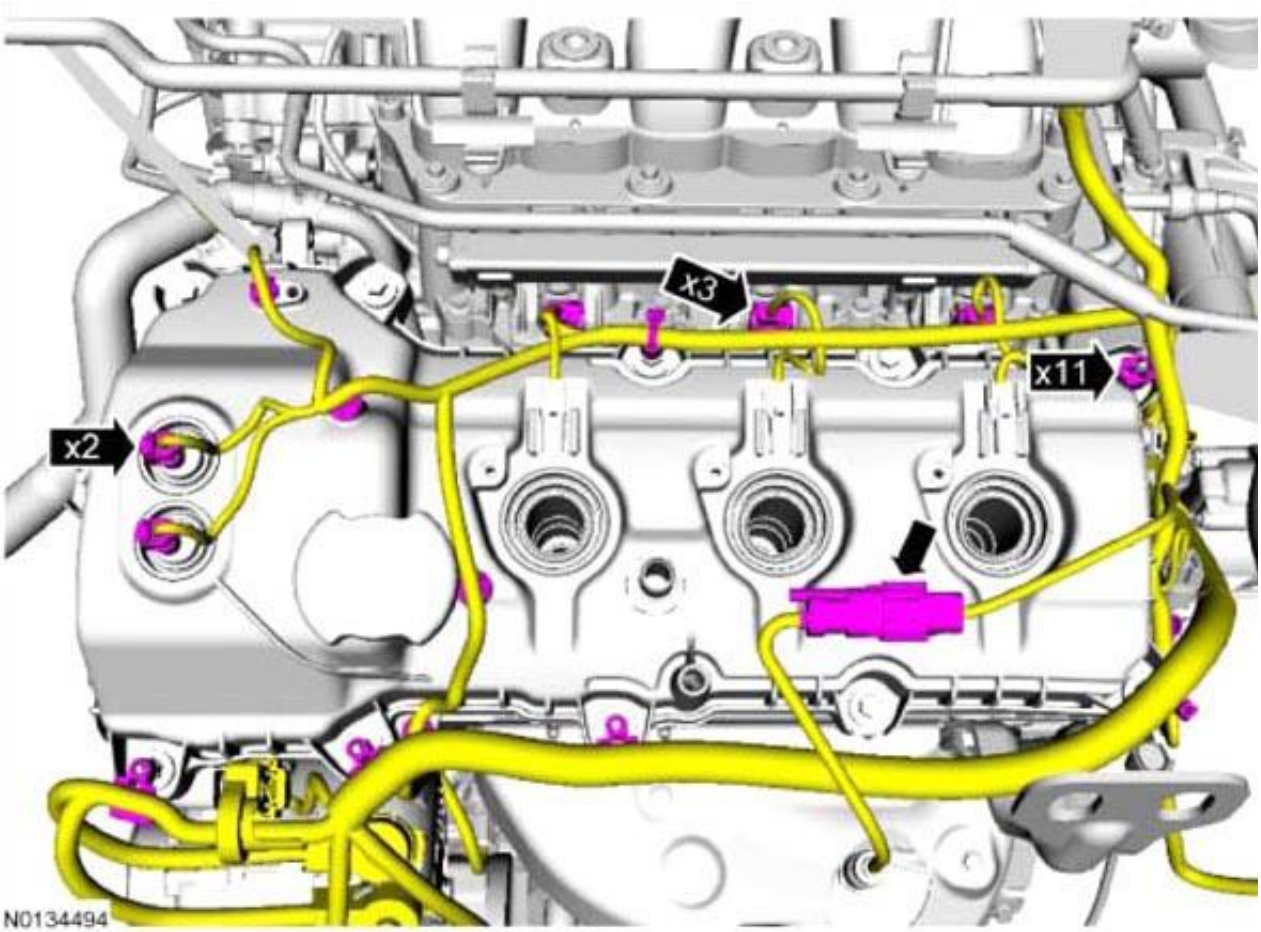
5. Ensure the **VCT** seals in the valve cover are below the top of the connector (flat portion) on the **VCT** oil control valve otherwise the interface may leak.

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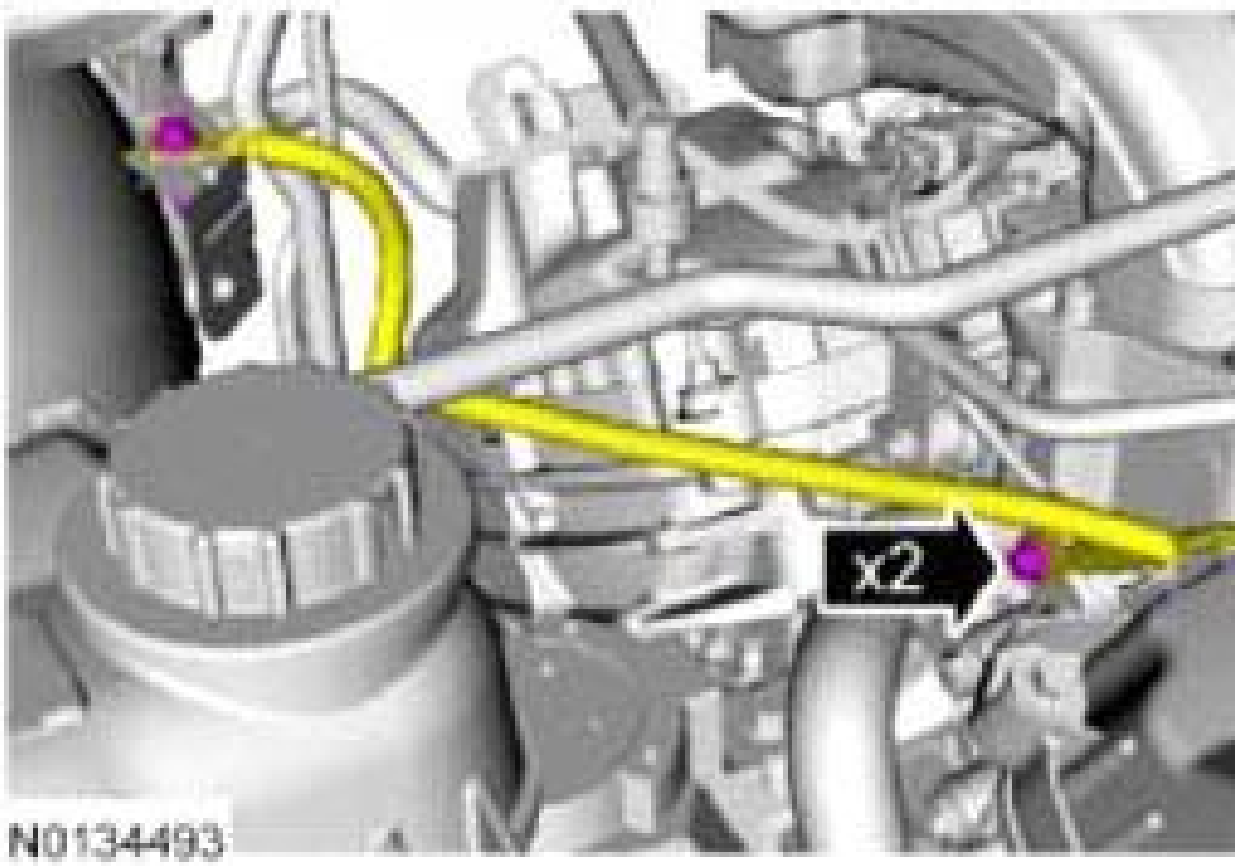
6. Install the engine wiring harness to the LH valve cover.
    - Position the wiring harness and attach the 11 wiring harness retainers to the LH valve cover and stud bolts.
    - Connect the 3 fuel injector electrical connectors.
    - Connect and attach the LH **HO2S** electrical connector.
    - Connect the 2 **VCT** oil control solenoid electrical connectors.

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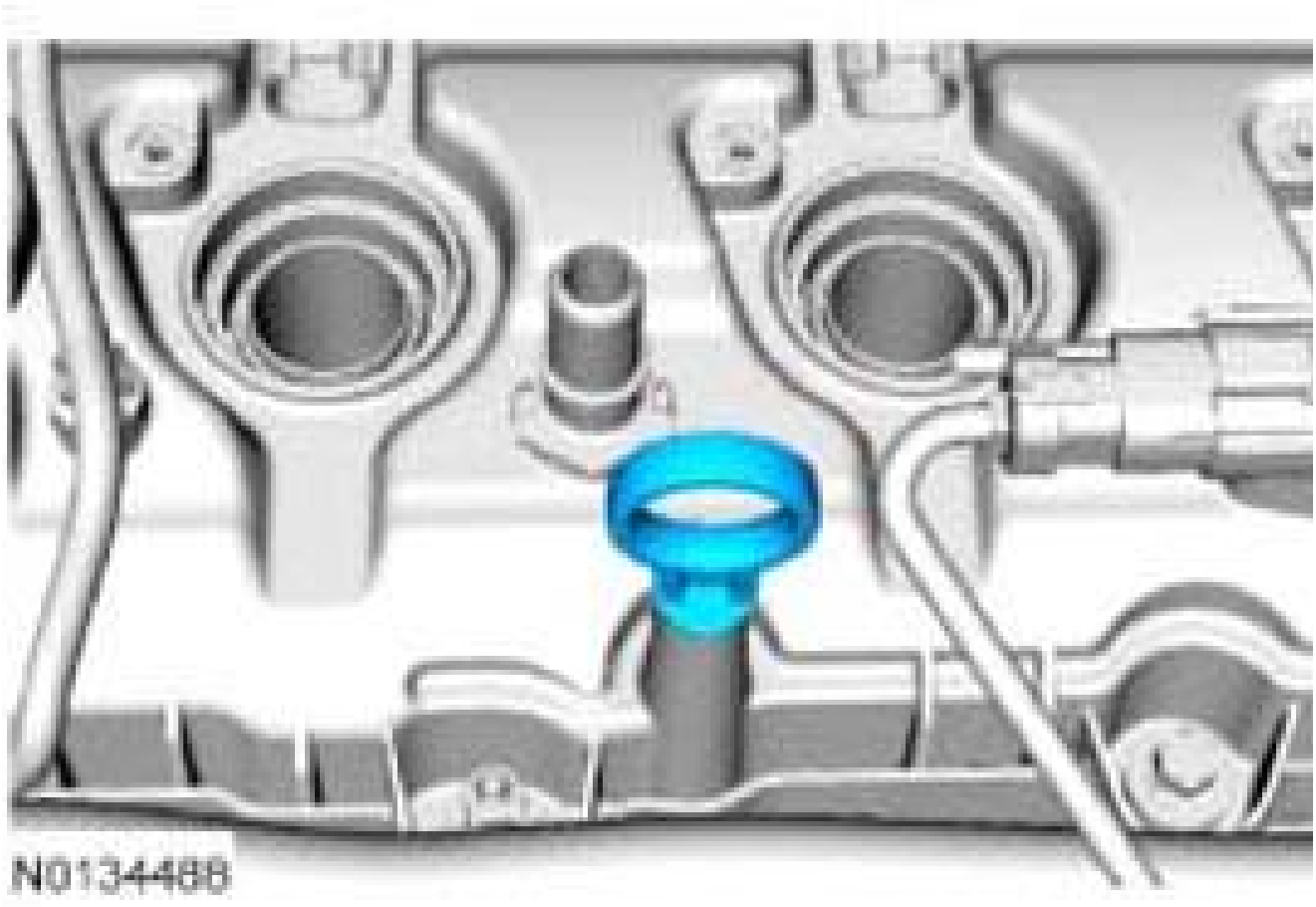
7. Position the ground wires to the engine front cover and the RH strut tower and install the 2 bolts.
    - Tighten to 10 Nm (89 lb-in).

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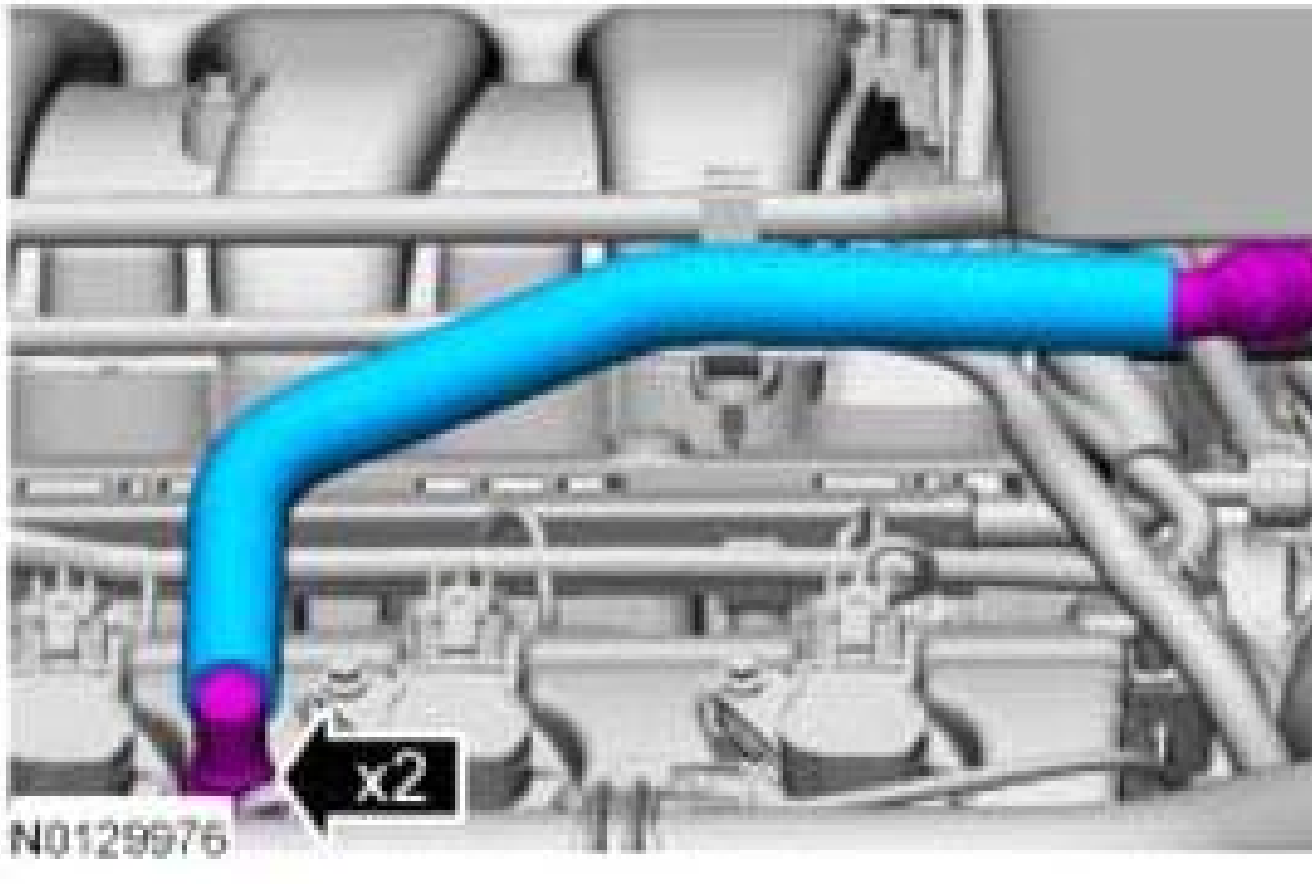
8. Install the oil level indicator.

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9. Install the LH ignition coils. REFER to **IGNITION COIL-ON-PLUG - LH** .
10. Install the crankcase vent tube. REFER to **QUICK CONNECT COUPLING** .

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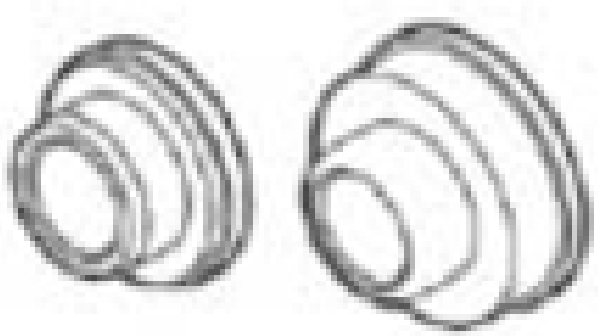
11. Install the engine appearance cover.

VALVE COVER - RH

SPECIAL TOOL(S) DESCRIPTION

	Adapter For 303-224 (Handle) **205-153T80T-4000-W**

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	Installer, Differential Bearing Cone **205-142T80T-4000-J**
	VCT Spark Plug Tube Seal Remover And Installer **303-1247**

MATERIAL SPECIFICATIONS

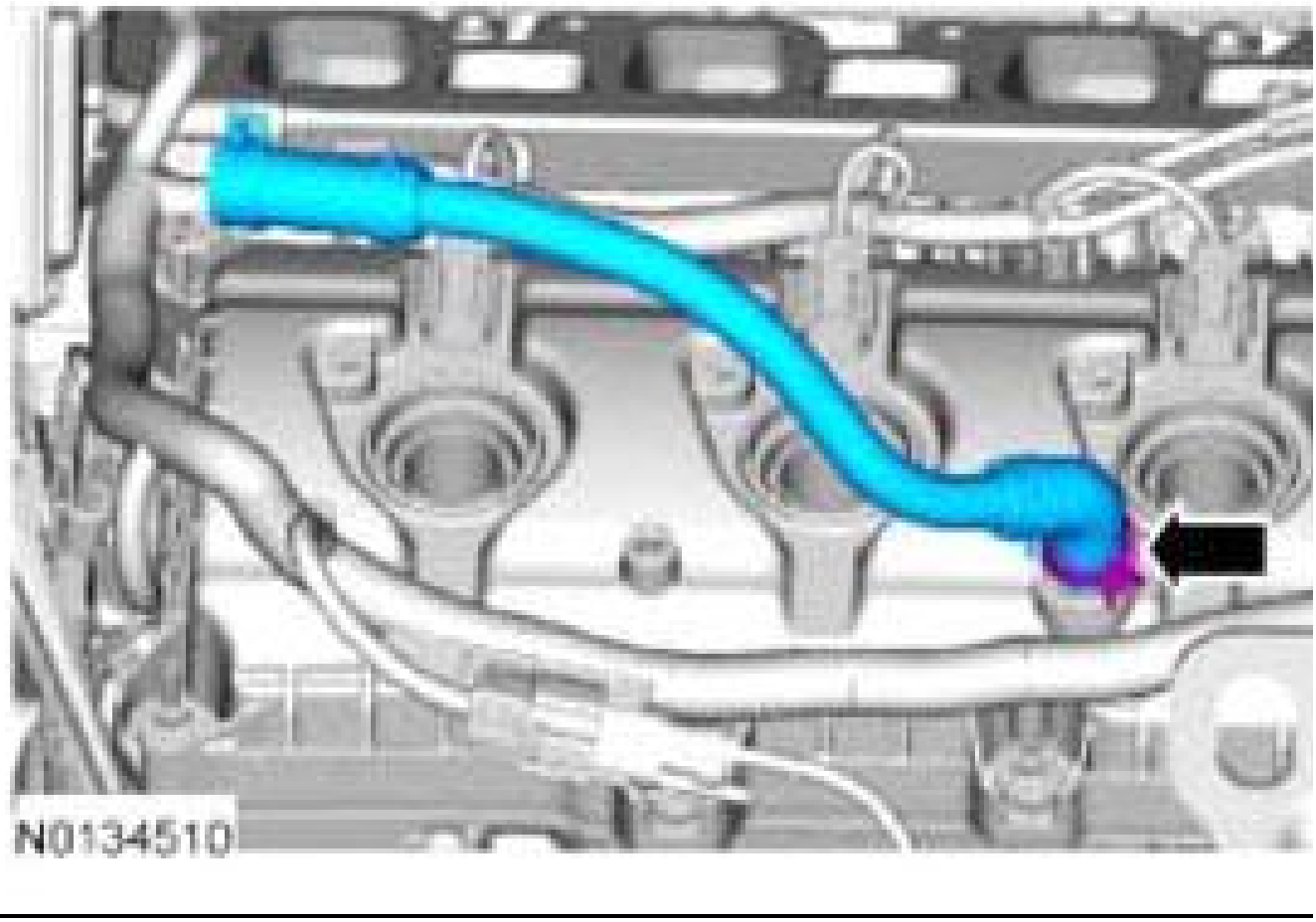
Item	Specification
Motorcraft® High Performance Engine RTV Silicone TA-357	WSE-M4G323-A6
Motorcraft® Metal Surface Prep ZC-31-A	-
Motorcraft® Silicone Gasket Remover ZC-30	-

Removal

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

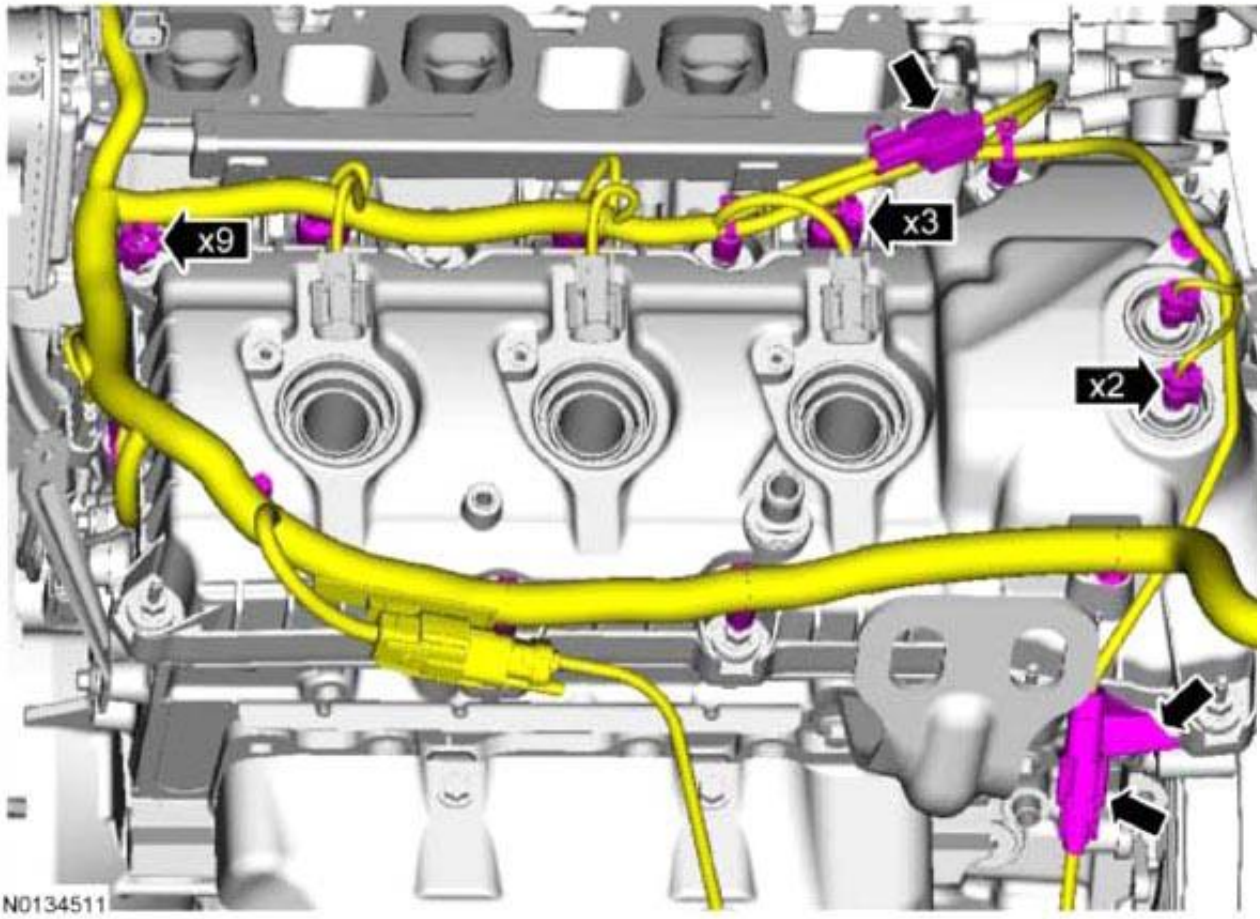
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1. Remove the RH ignition coils. REFER to **IGNITION COIL-ON-PLUG - RH** .
2. Remove the **PCV** crankcase vent tube.



3. Remove the engine wiring harness from the RH valve cover.
   - Disconnect the 2 **VCT** oil control solenoid electrical connectors.
   - Detach and disconnect the RH **CMS** electrical connector.
   - Disconnect the 3 fuel injector electrical connectors.
   - Disconnect the **CHT** sensor wiring harness jumper electrical connector.
   - Detach the 9 wiring harness retainers from the RH valve cover and stud bolts and position the harness aside.

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4. **NOTE: When removing valve cover do not apply excessive force to the VCT oil control solenoid.**

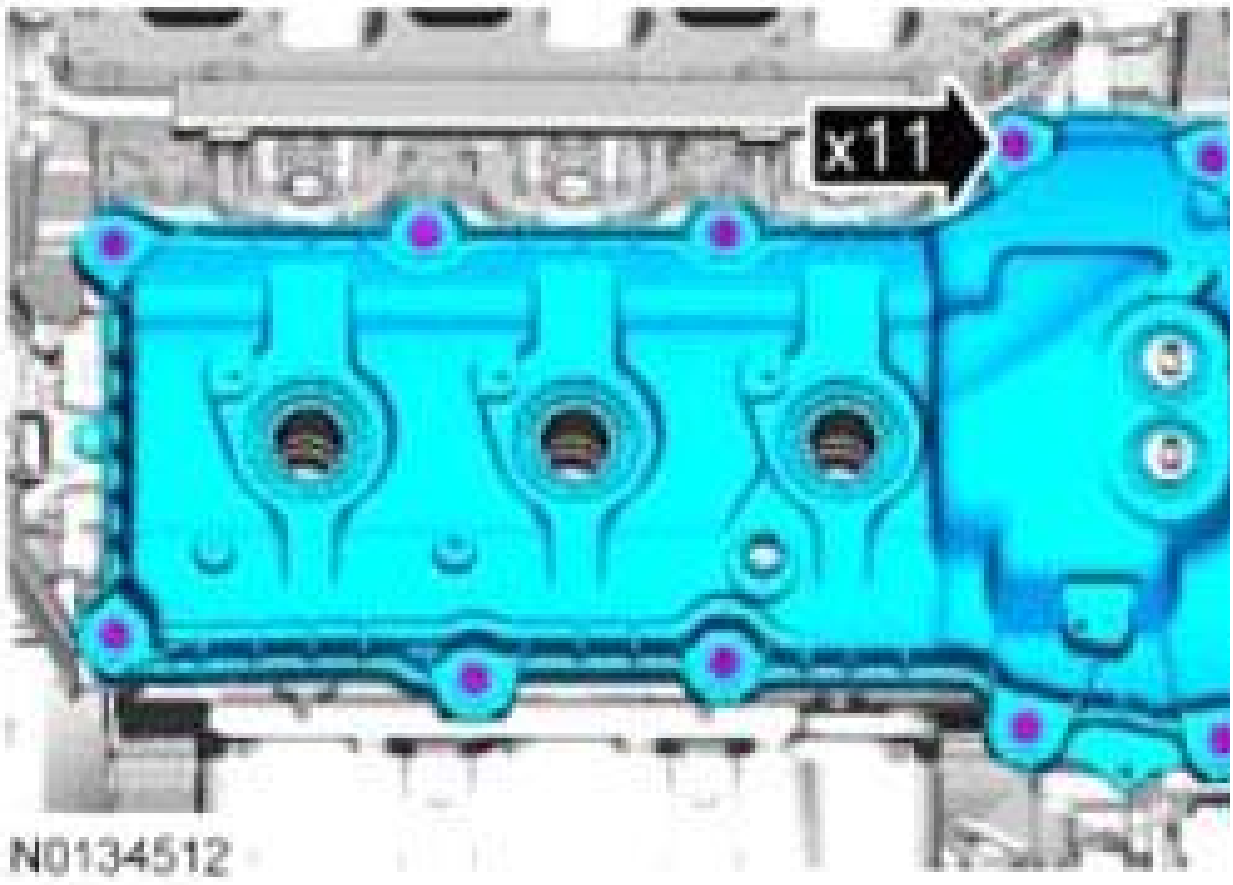
NOTE: If the VCT solenoid seal sticks to the VCT oil control solenoid, then carefully wiggle the valve cover until the bond breaks free.

NOTE: The plastic electrical connector on the VCT oil control solenoid will rotate approximately 12 degrees inside the steel housing, which is normal.

Loosen the 11 retainers and remove the valve cover.

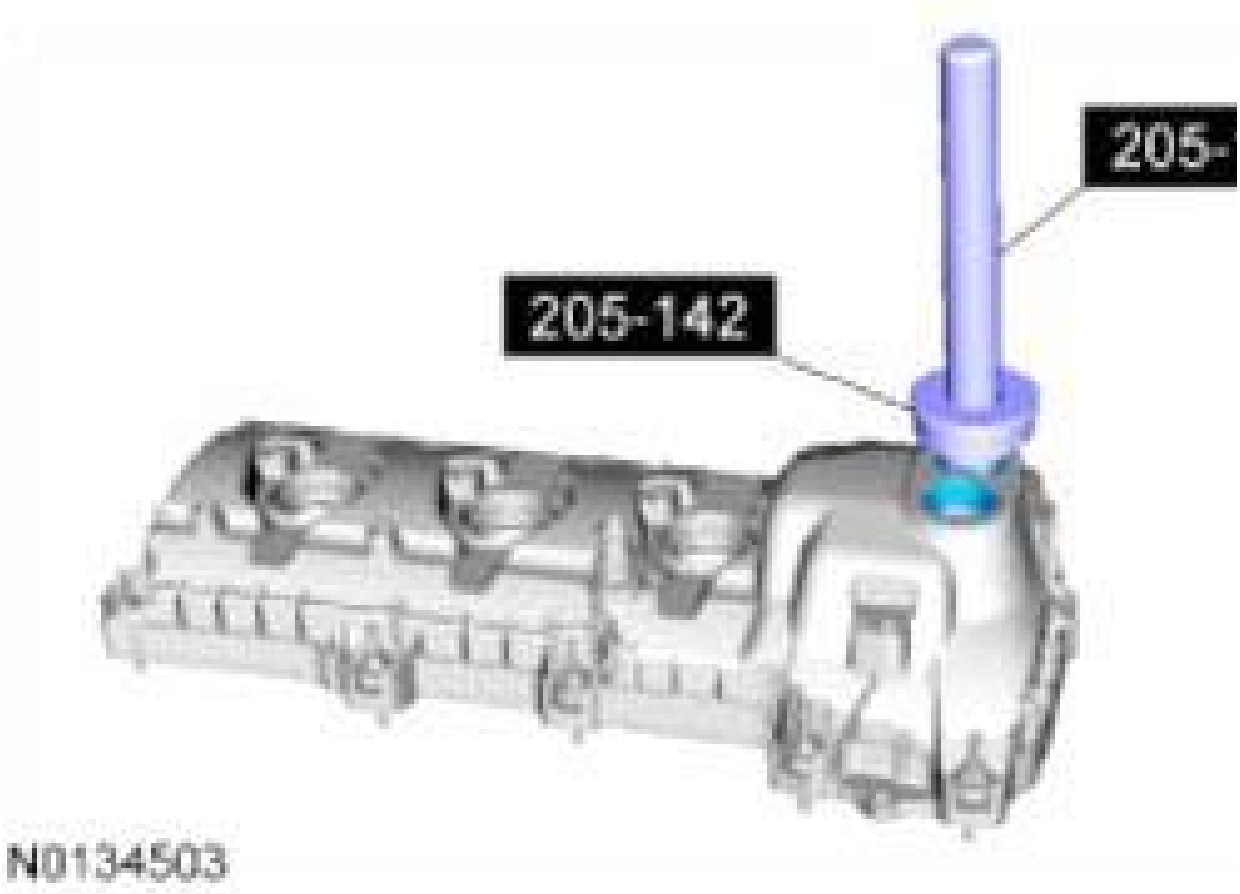
- Discard the gasket.

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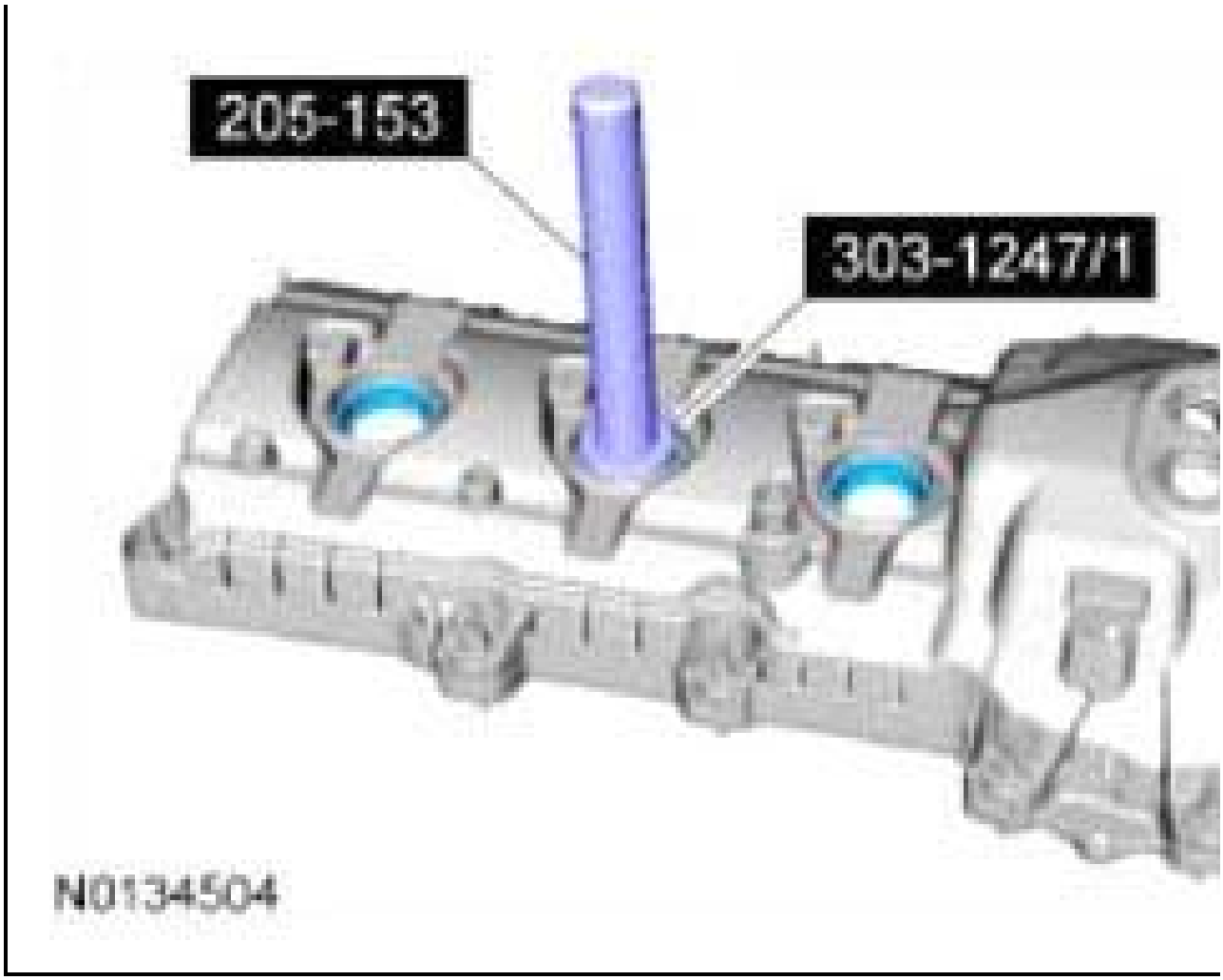
5. Inspect the 2 **VCT** solenoid seals. Remove any damaged seals.
    - Using 205-142 T80T-4000-J and 205-153 T80T-4000-W remove and discard the damaged seal(s).

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6. Inspect the spark plug tube seals. Remove any damaged seals.
    - Using 303-1247/1 and 205-153 T80T-4000-W remove and discard the damaged seal(s).

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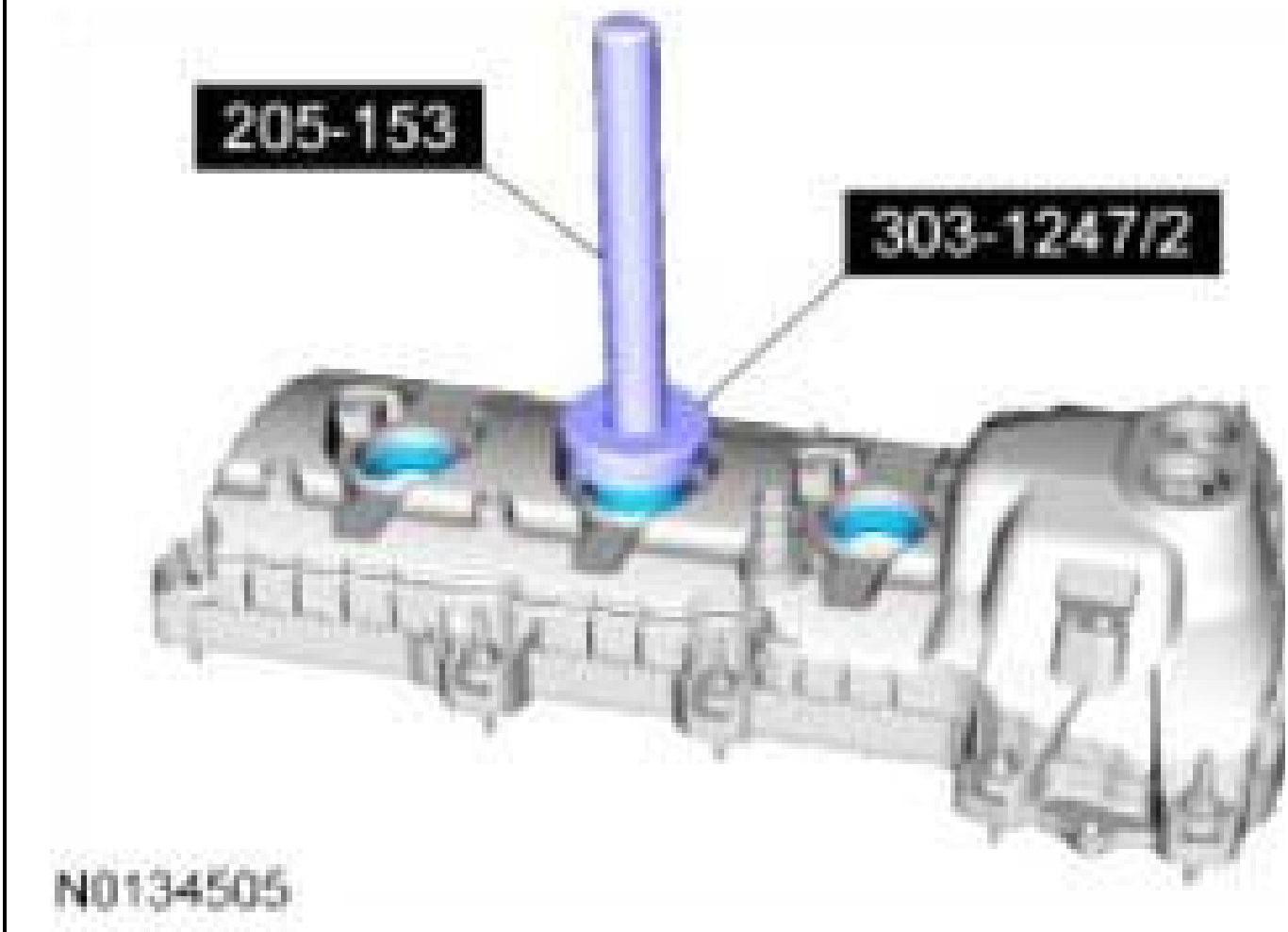
7. Clean the valve cover, cylinder head and engine front cover sealing surfaces using Motorcraft® Metal Surface Prep.

Installation

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

   Using 303-1247/2 and 205-153 T80T-4000-W install the new spark plug tube seal(s).

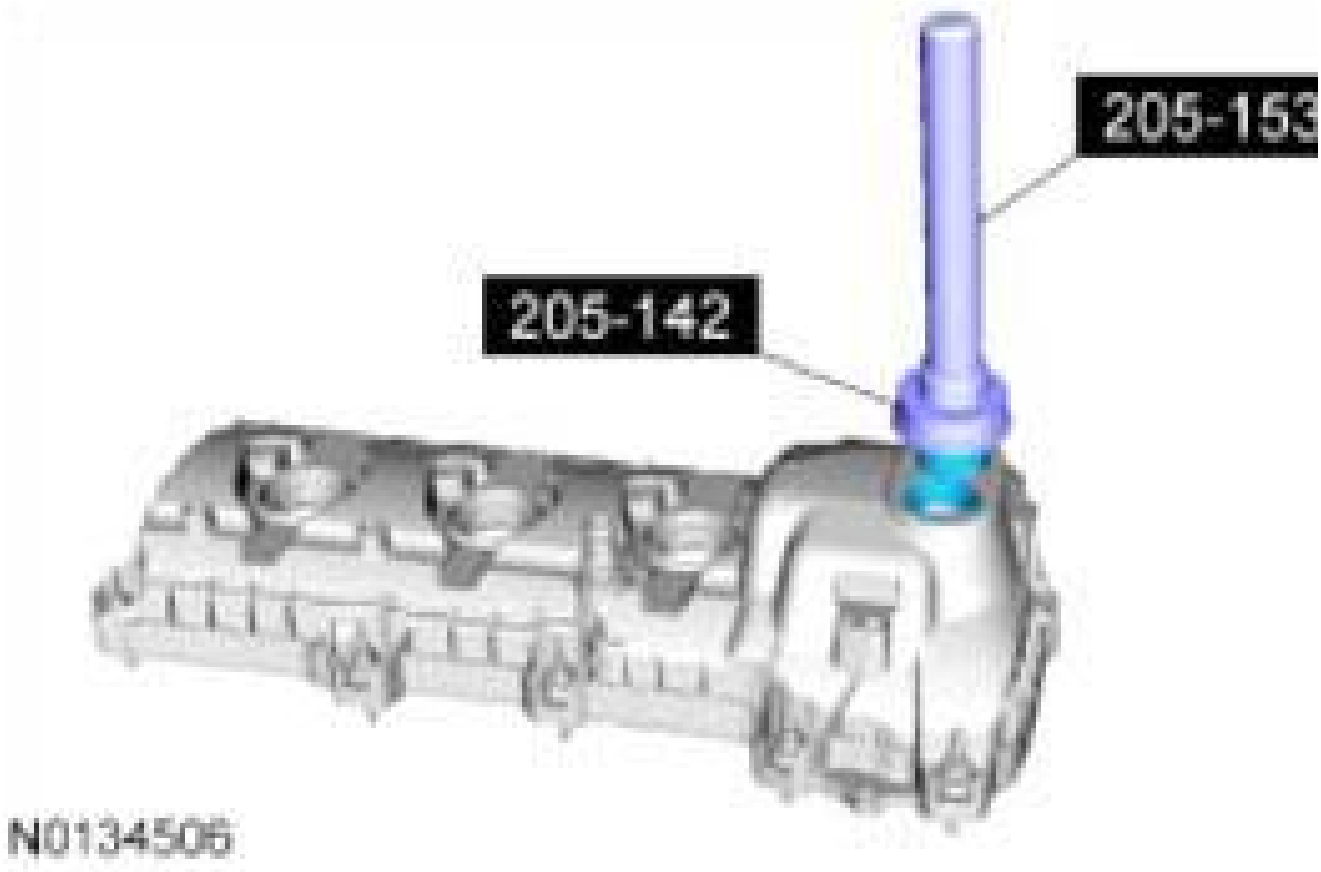
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2. **NOTE: Installation of new seals is only required if damaged seals were removed.**

Using 205-142 T80T-4000-J and 205-153 T80T-4000-W install the new **VCT** seal(s).

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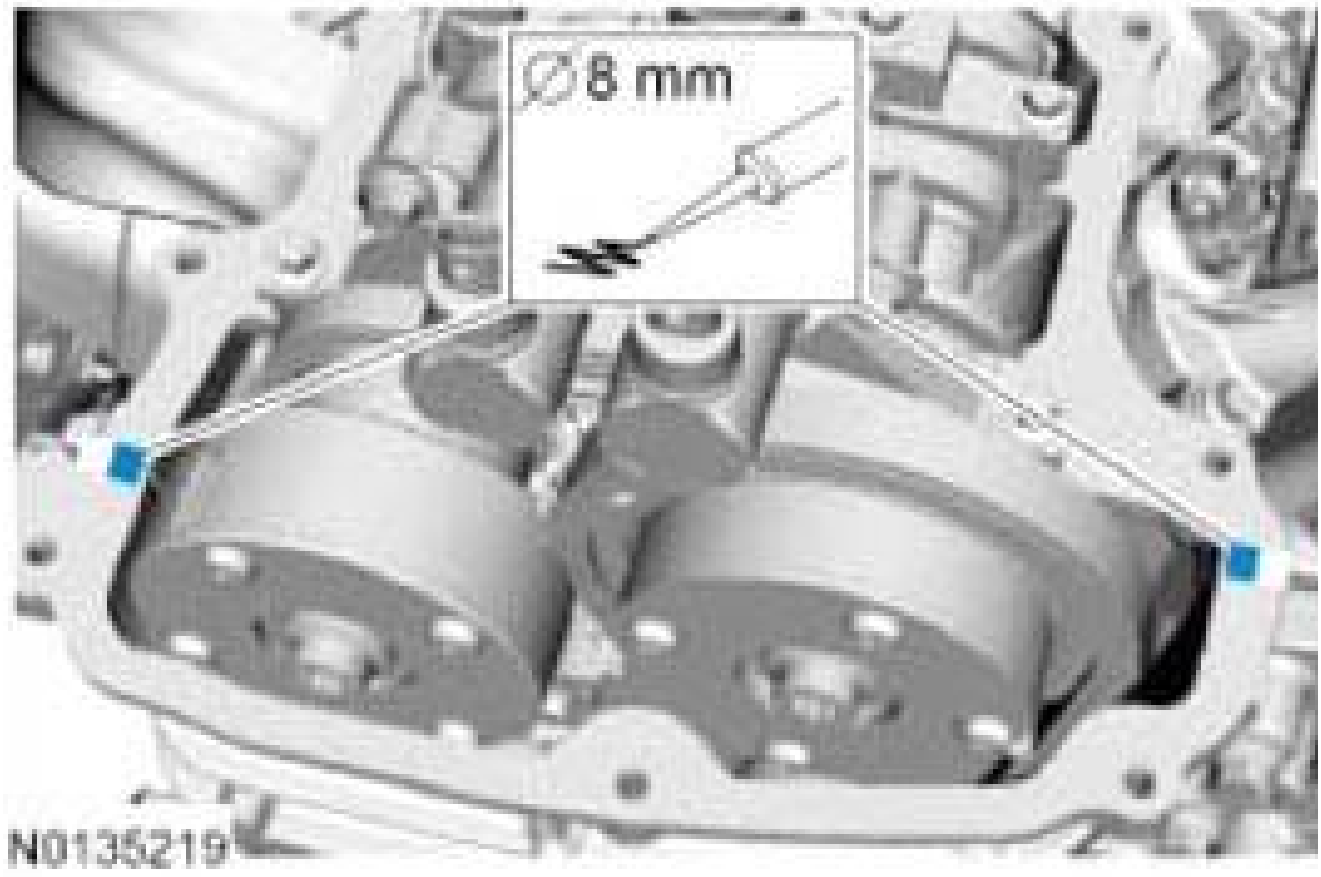
3.

NOTE: **Failure to use Motorcraft® High Performance Engine RTV Silicone may cause the engine oil to foam excessively and result in serious engine damage.**

NOTE: **If the valve cover is not installed and the fasteners tightened within 4 minutes, the sealant must be removed and the sealing area cleaned. To clean the sealing area, use Motorcraft® Silicone Gasket Remover and Motorcraft® Metal Surface Prep. Failure to follow this procedure can cause future oil leakage.**

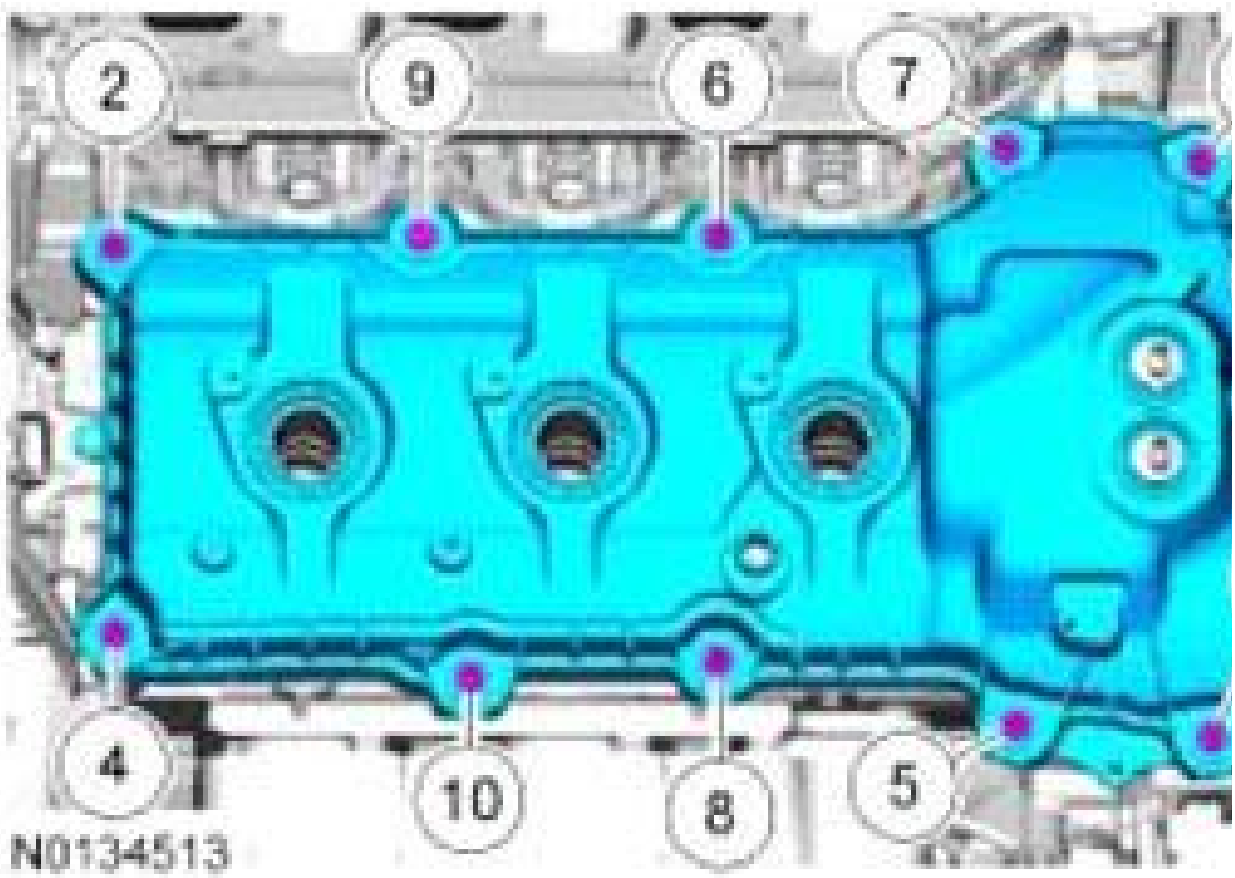
Apply an 8 mm (0.315 in) bead of Motorcraft® High Performance Engine RTV Silicone to the engine front cover-to-Right Hand (RH) cylinder head joints.

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4. Using a new gasket, install the RH valve cover and tighten the 11 retainers.
    - Tighten in the sequence shown in illustration to 10 Nm (89 lb-in).

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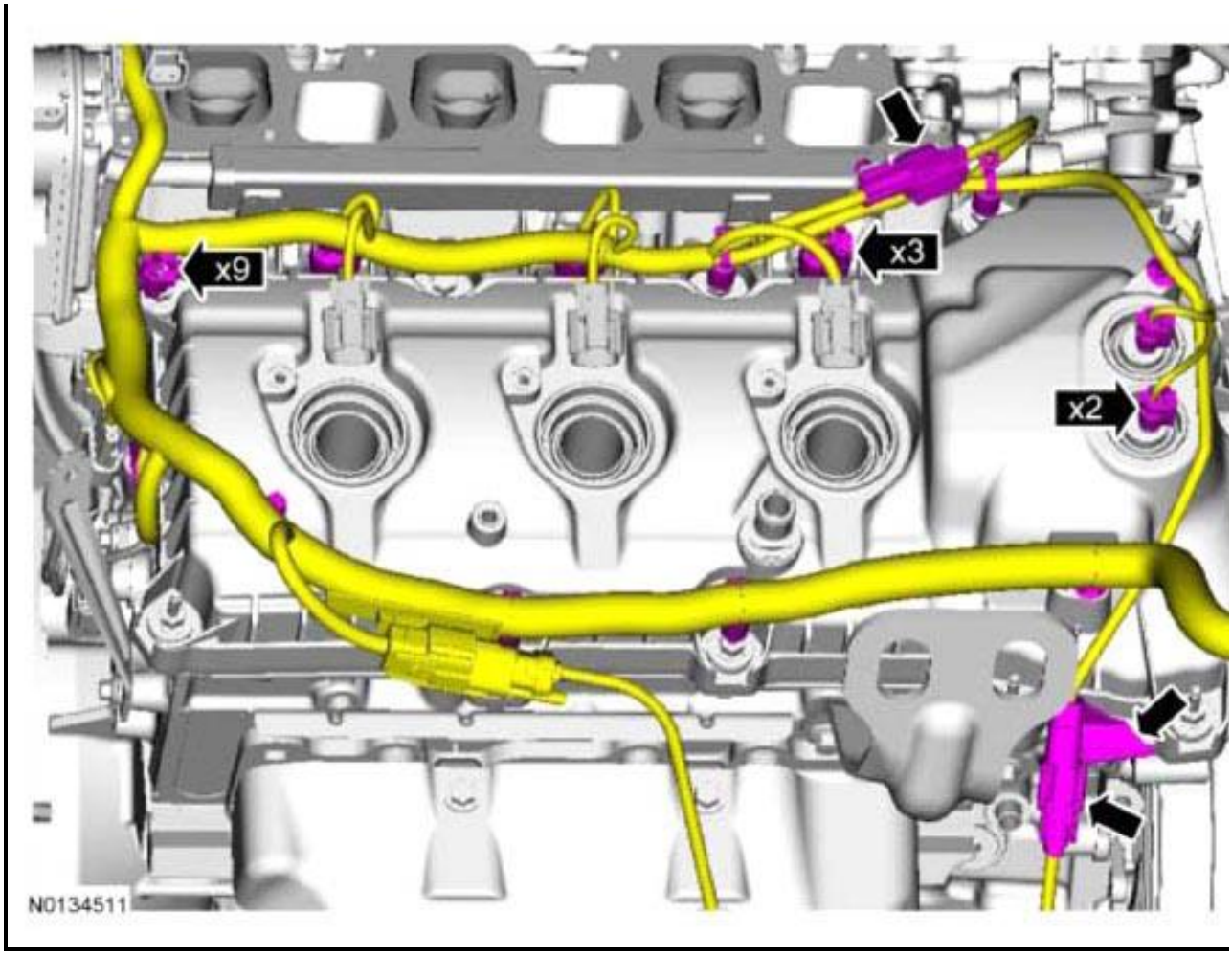
5. Ensure the **VCT** seals in the valve cover are below the top of the connector (flat portion) on the **VCT** oil control valve otherwise the interface may leak.

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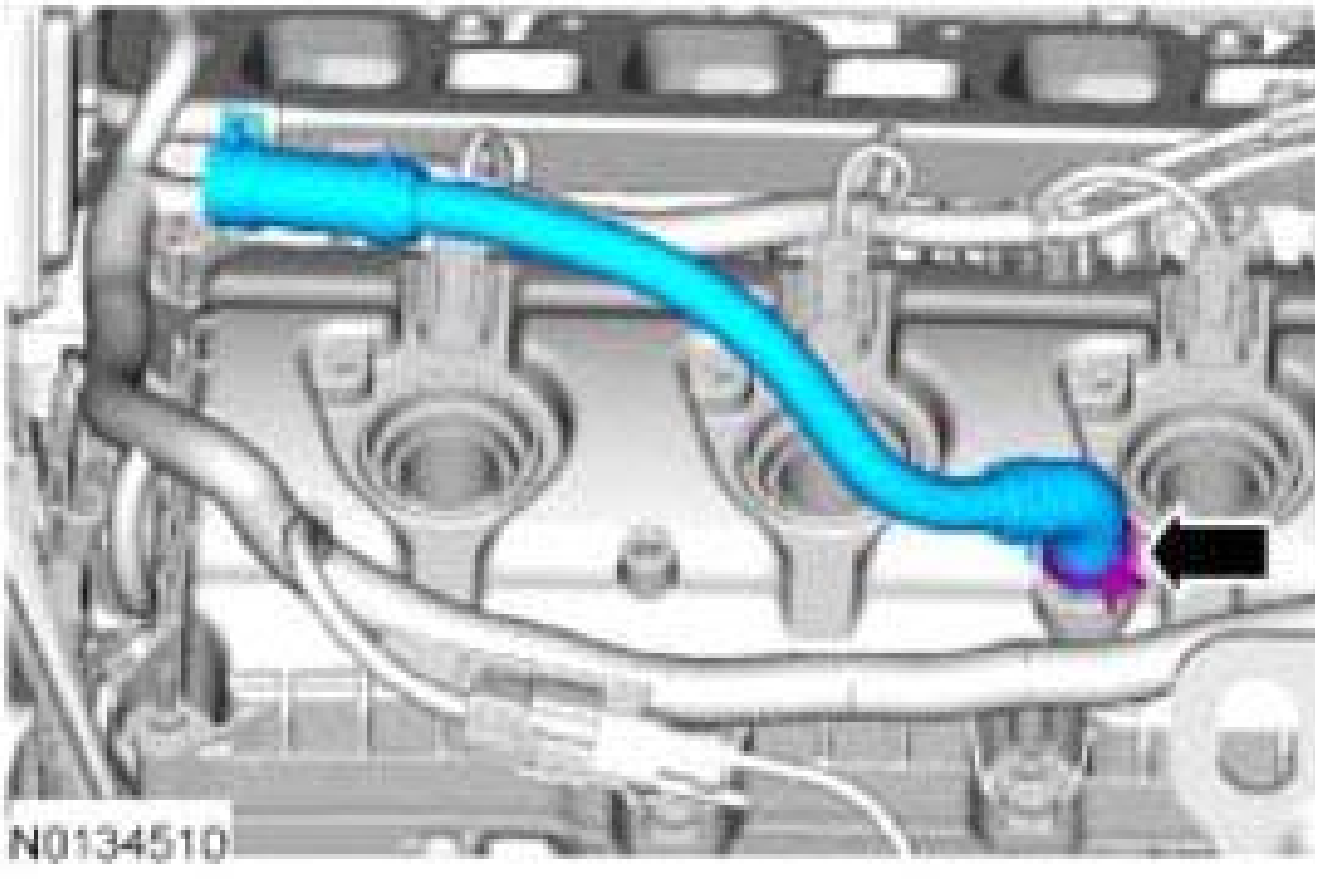
6. Install the engine wiring harness to the RH valve cover.
    - Position the wiring harness and attach the 9 wiring harness retainers to the RH valve cover and stud bolts.
    - Connect the **CHT** sensor wiring harness jumper electrical connector.
    - Connect the 3 fuel injector electrical connectors.
    - Connect and attach the RH **CMS** electrical connector.
    - Connect the 2 **VCT** oil control solenoid electrical connectors.

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7. Install the **PCV** crankcase vent tube.

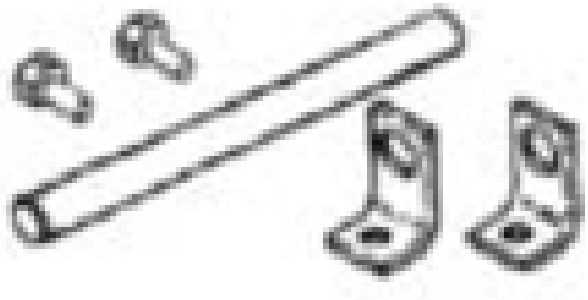
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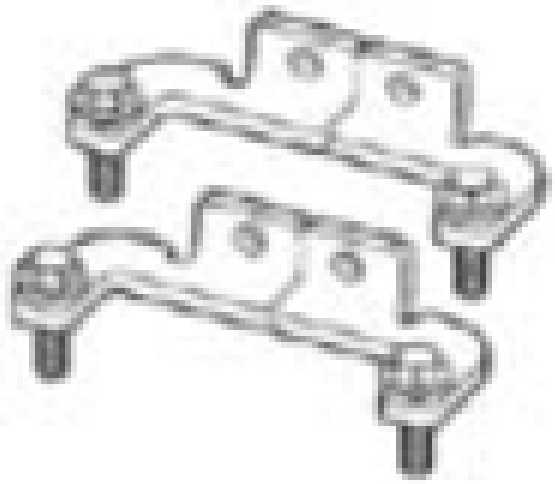
8. Install the RH ignition coils. REFER to **IGNITION COIL-ON-PLUG - RH** .

VALVE SPRING, RETAINER AND SEAL

SPECIAL TOOL(S) DESCRIPTION

	Compressor, Valve Spring **303-300T87C-6565-A**

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	Compressor, Valve Spring **303-350T89P-6565-A**
	Valve Spring Compressor **303-1249**

MATERIAL SPECIFICATIONS

Item	Specification
Motorcraft® SAE 5W-20 Premium Synthetic Blend Motor Oil (US); Motorcraft® SAE 5W-20 Super Premium Motor Oil (Canada) XO-5W20-QSP (US); CXO-5W20-LSP12 (Canada)	WSSM2C945-A

Removal

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

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failure.

1. Remove the valve tappets from the cylinder being serviced. Refer to **VALVE TAPPETS**.
2. Rotate the crankshaft until the piston for the valve being serviced is at the top of its stroke.

NOTE: If air pressure has forced the piston to the bottom of the cylinder, any loss of air pressure will allow the valve to fall into the cylinder. If air pressure must be removed, support the valve prior to removal or engine damage may occur.

3.

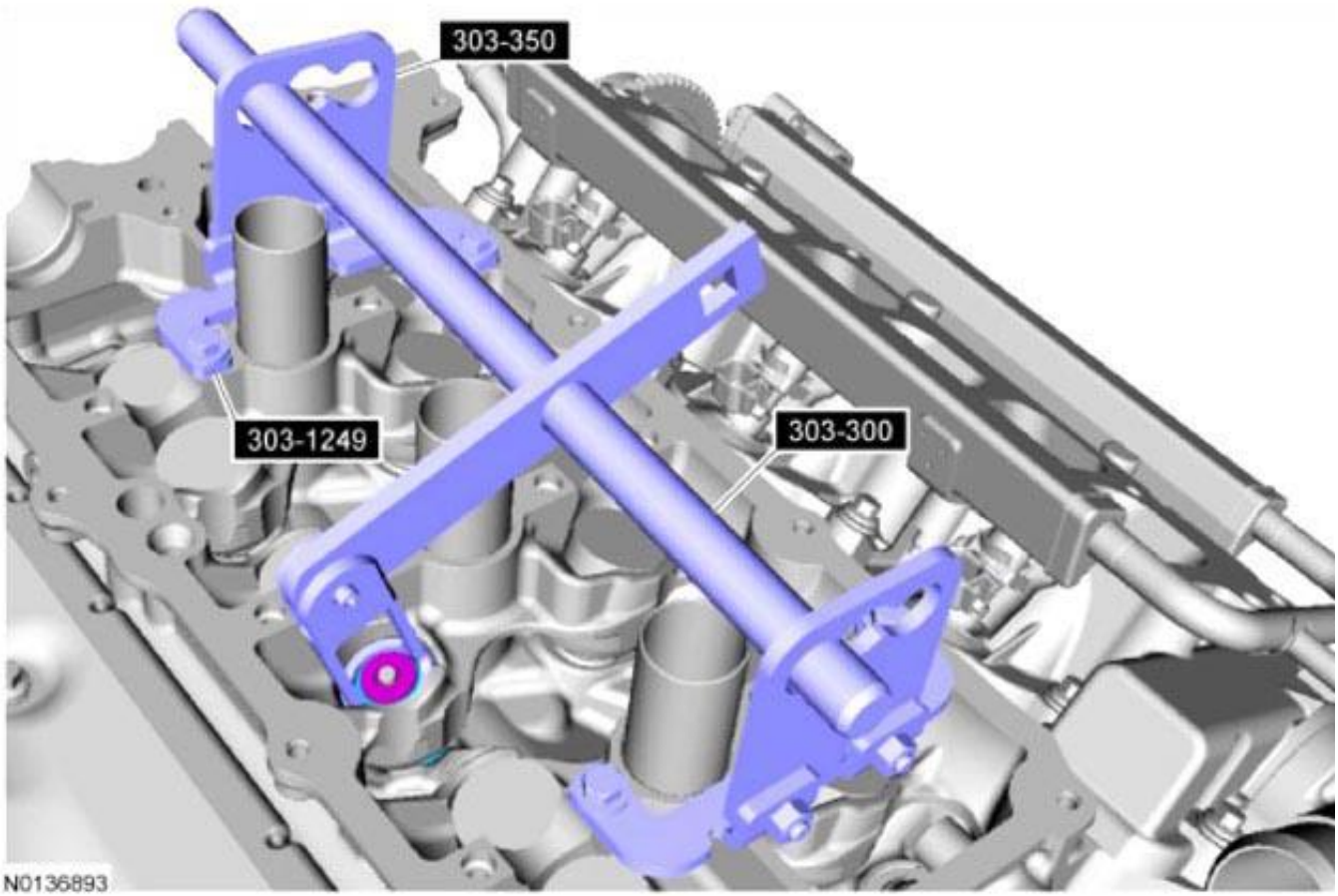
NOTE: If the components are to be reinstalled, they must be installed in the same positions. Mark the components for installation into their original locations.

NOTE: If a valve drops into the cylinder, remove the cylinder head. Refer to CYLINDER HEAD - LH or Refer to CYLINDER HEAD - RH.

Pressurize the cylinder using compressed air.

4. Using 303-300 T87C-6565-A, 303-350 T89P-6565-A and 303-1249, remove the keys, retainer and spring.

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5. Remove and discard the valve stem seal.

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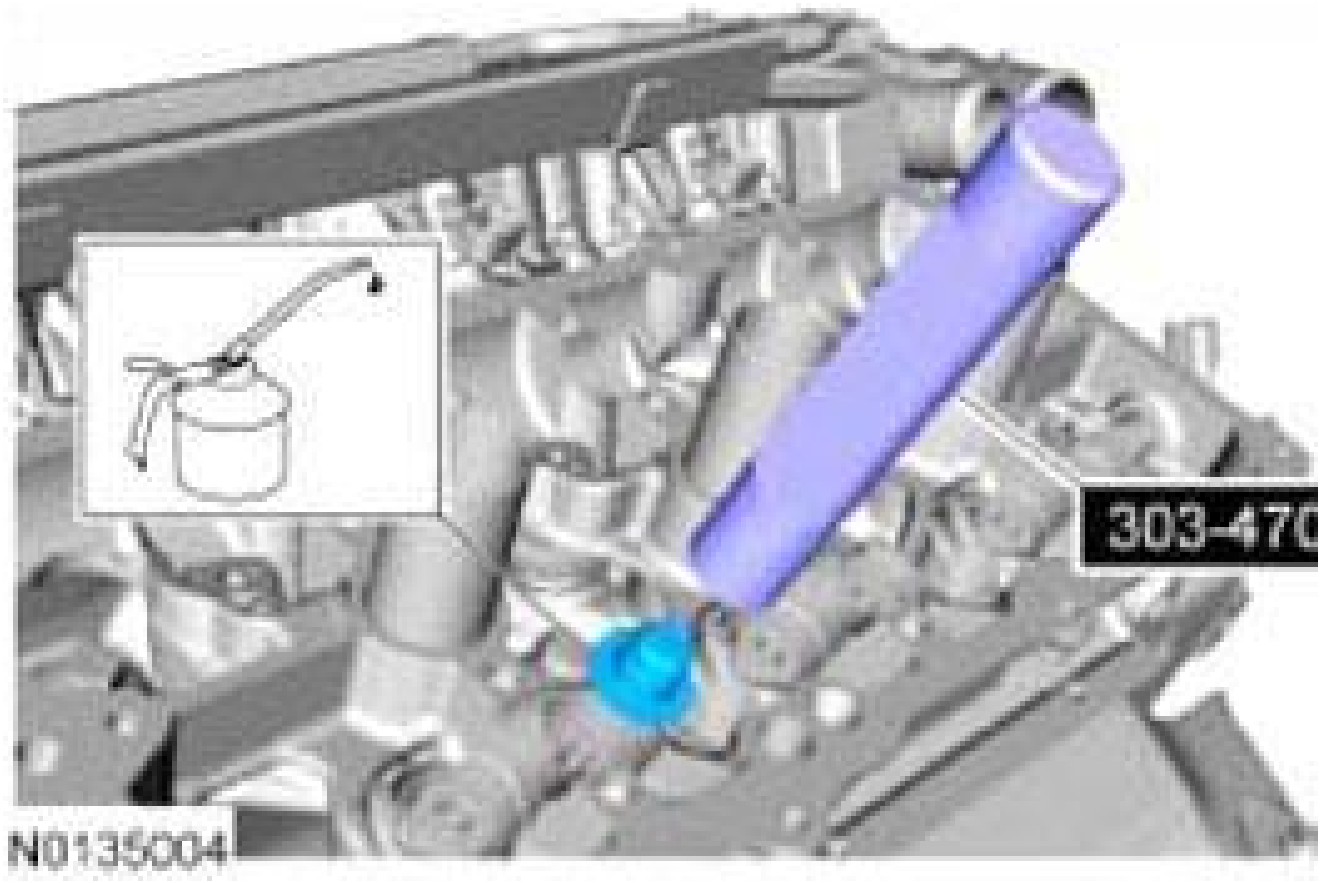


Installation

1. **NOTE: Lubricate the valve stem seal with clean engine oil prior to installation.**

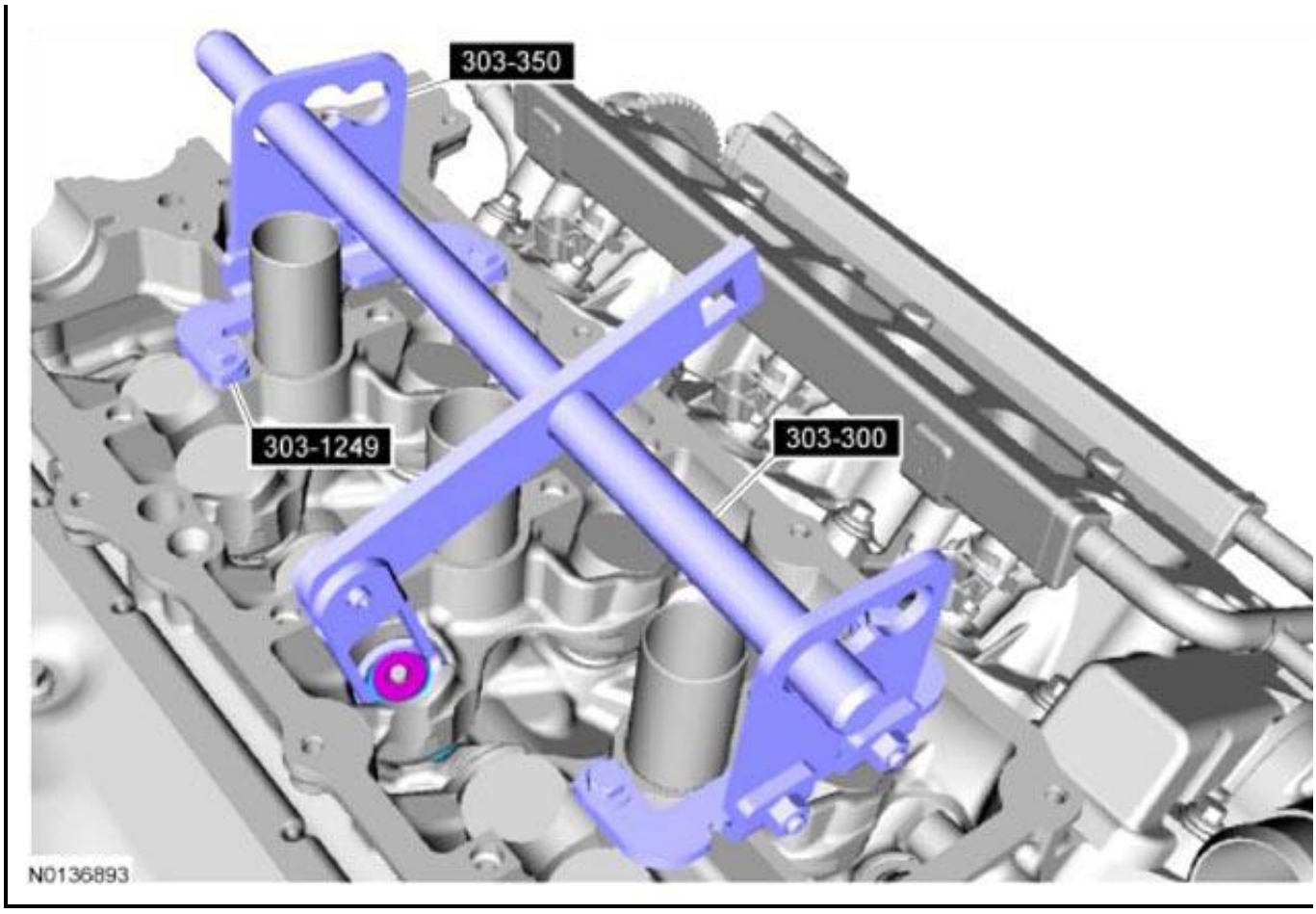
   Using 303-470 T94P-6510-CH, install a new valve stem seal.

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2. Using 303-300 T87C-6565-A, 303-350 T89P-6565-A and 303-1249, install the valve spring, retainer and key.

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3. Install the valve tappets. Refer to **VALVE TAPPETS**.

VALVE TAPPETS

MATERIAL SPECIFICATIONS

Item	Specification
Motorcraft® SAE 5W-20 Premium Synthetic Blend Motor Oil (US); Motorcraft® SAE 5W-20 Super Premium Motor Oil (Canada) XO-5W20-QSP (US); CXO-5W20-LSP12 (Canada)	WSSM2C945-A

Removal

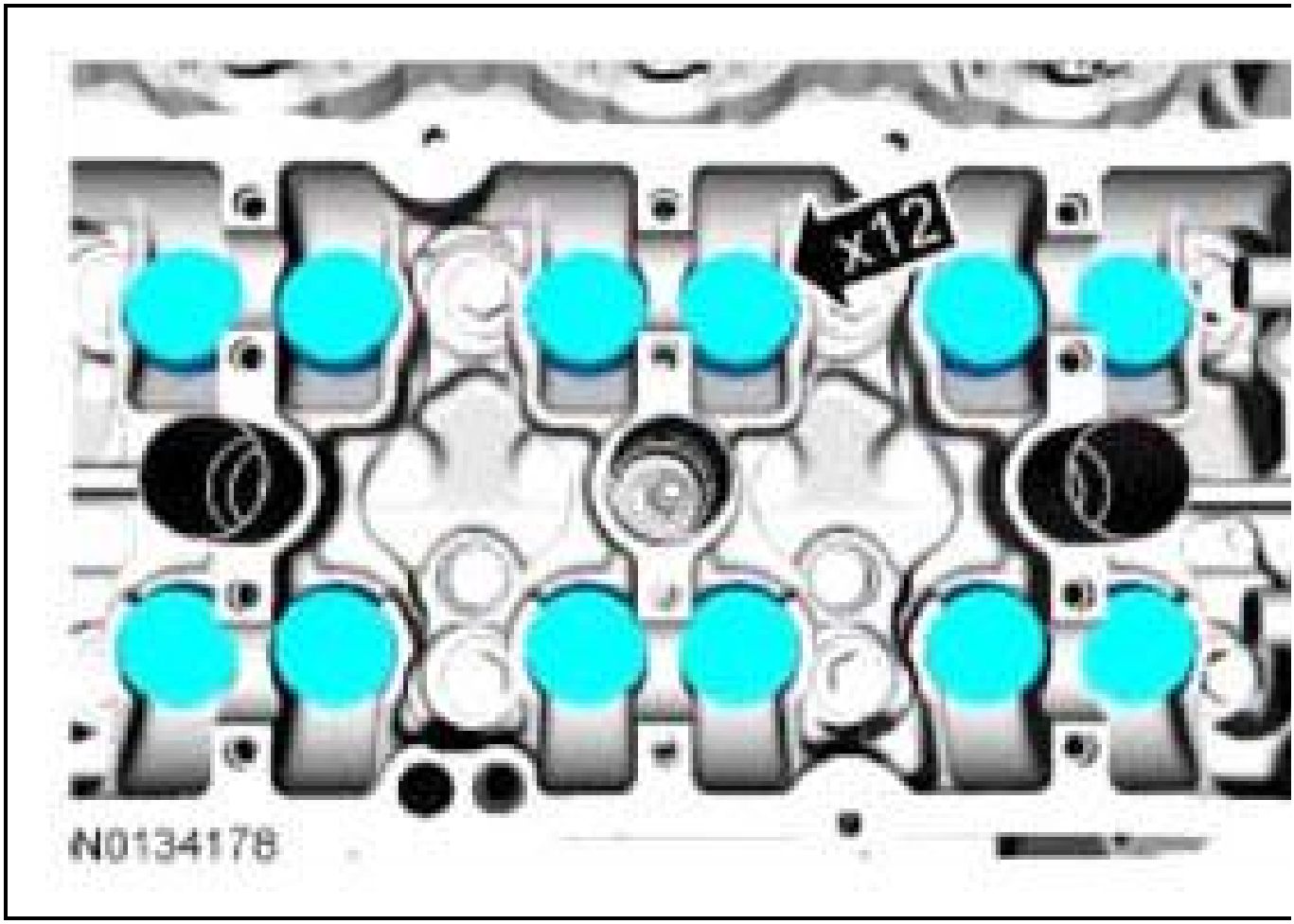
NOTE: During engine repair procedures, cleanliness is extremely important. Any foreign material, including any material created while cleaning gasket surfaces that enters the oil passages, coolant passages or the oil pan, may cause engine failure.

1. Depending on the valve tappets being serviced, remove the LH and/or the RH camshafts. Refer to **CAMSHAFT**.

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

2. Remove the valve tappets from the cylinder head.



Installation

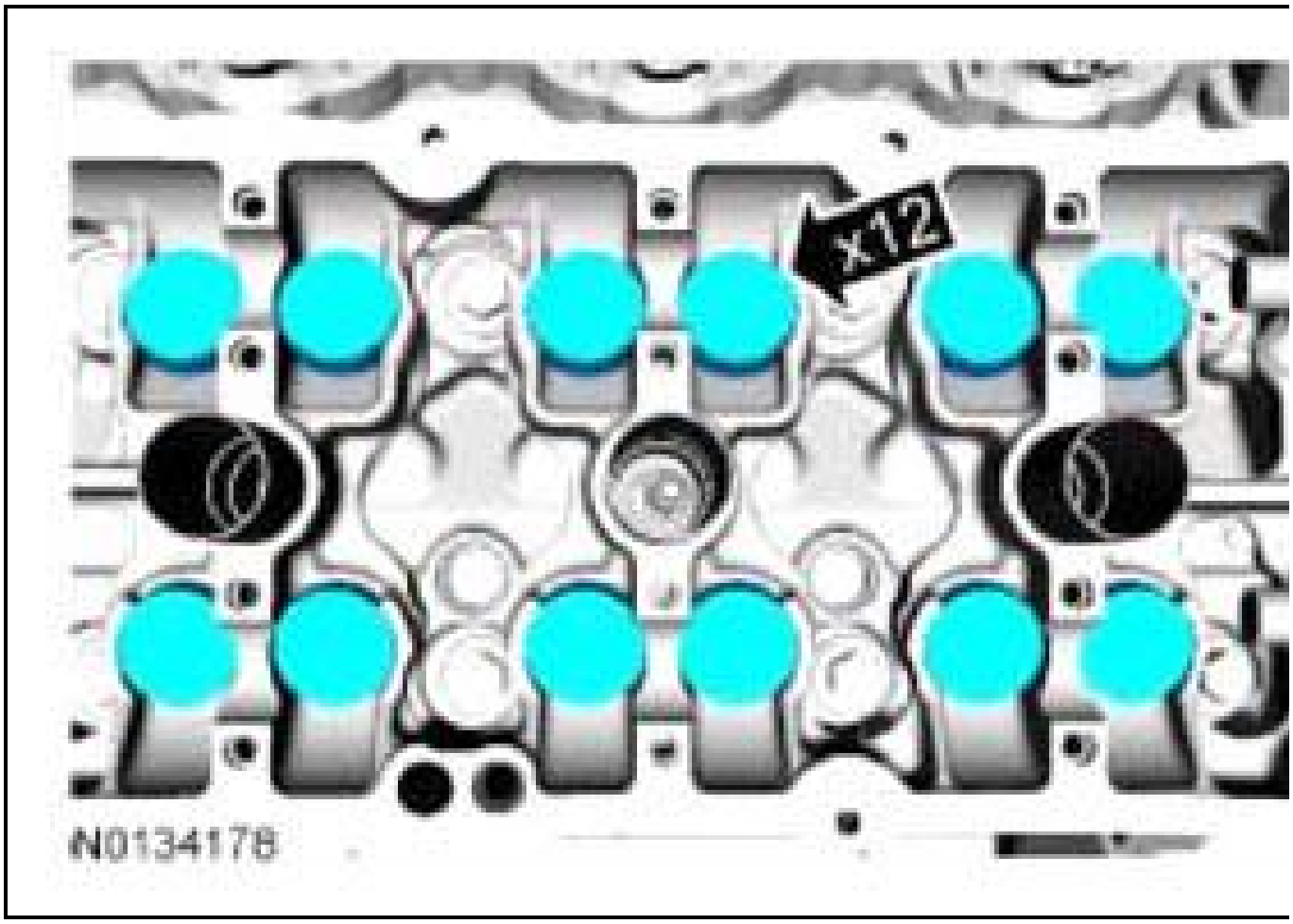
NOTE: **During engine repair procedures, cleanliness is extremely important. Any foreign material, including any material created while cleaning gasket surfaces that enters the oil passages, coolant passages or the oil pan, may cause engine failure.**

1. **NOTE:** **The valve tappets must be installed in their original positions.**

   NOTE: **Coat the valve tappets with clean engine oil prior to installation.**

   Install the valve tappets.

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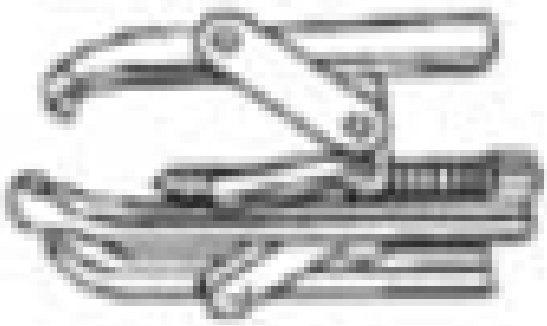
2. Depending on the valve tappets being serviced, install the LH and/or the RH camshafts. Refer to **CAMSHAFT**.

ENGINE

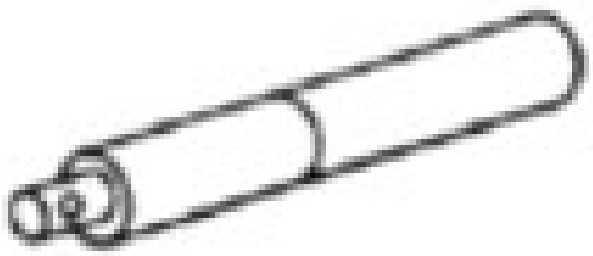
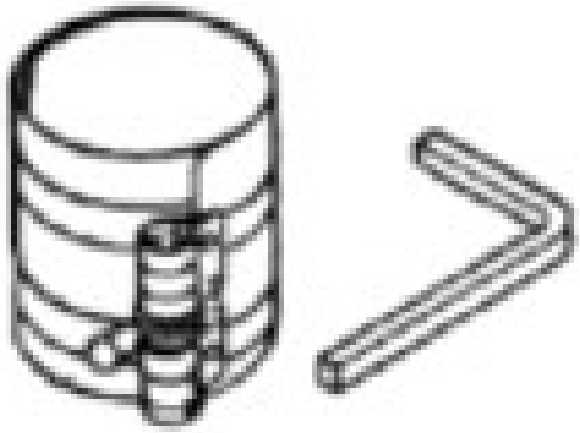
SPECIAL TOOL(S) DESCRIPTION

	2, 200# FLOOR CRANE, FOLD AWAY **300-OTC1819E**

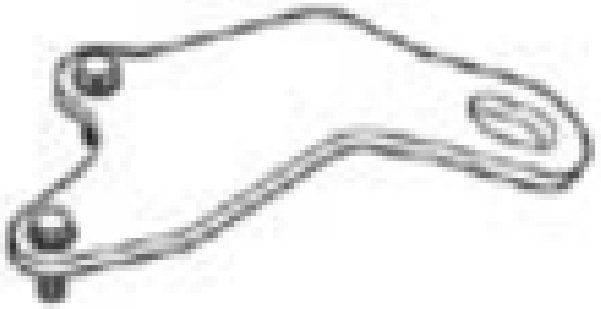
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 ST1341-A	
	3 Jaw Puller **303-D121**
	Adapter For 303-224 (Handle) **205-153T80T-4000-W**

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	Alignment Pins, Transmission Fluid Pump **307-399**
	Compressor, Piston Ring **303-D032D81L-6002-C**

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	Dial Indicator Gauge With Holding Fixture **100-002TOOL-4201-C**
	Engine Lift Eye **303-1245**
	Installer, Crankshaft Vibration Damper **303-102T74P-6316-B**

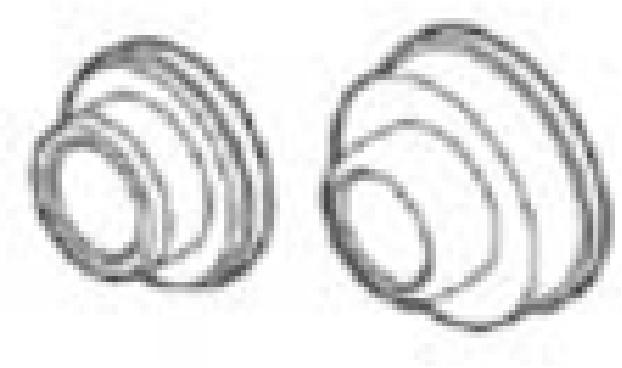
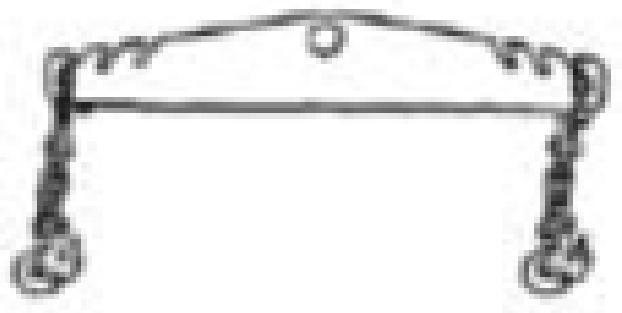
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	Installer, Differential Bearing Cone **205-142T80T-4000-J**
	Installer, Front Cover Oil Seal **303-335T88T-6701-A**
	Installer, Front Seal **303-1251**

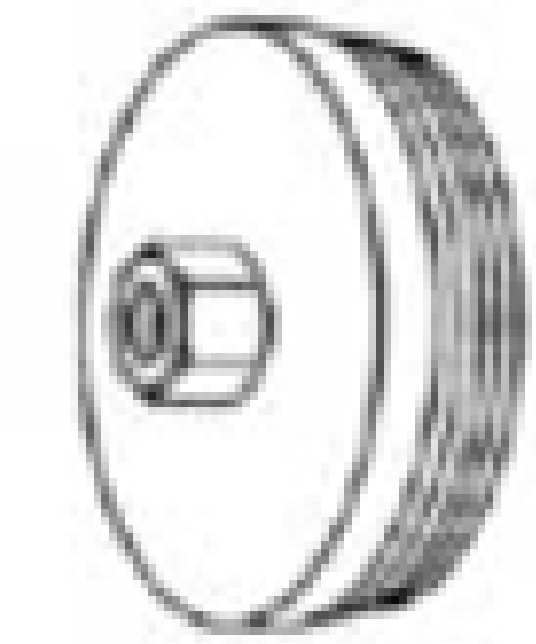
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 ST2980-A	Seal Installer, Rear Main **303-1250**
	VCT Spark Plug Tube Seal Remover And Installer **303-1247**

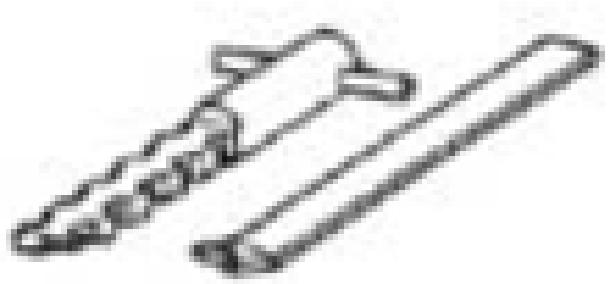
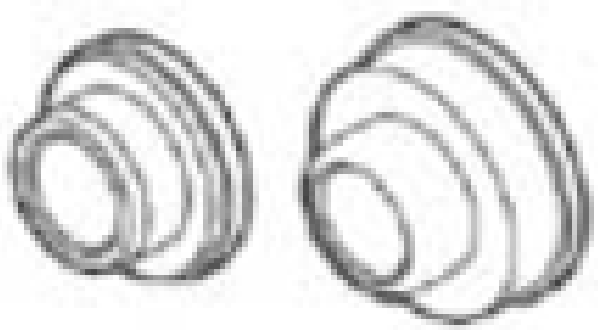
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	Installer, Wheel Hub Bearing Cup **204-023T73T-1217-A**
	Spreader Bar **303-D089D93P-6001-A3**

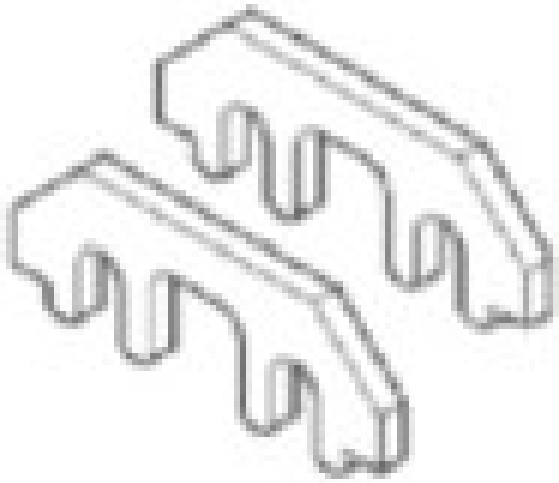
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	Tool, Chain Tensioner Hold Down **303-1530**
	Remover, Crankshaft Rear Oil Seal **303-519T95P-6701-EH**

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	Remover, Oil Seal **303-409T92C-6700-CH**
	VCT Spark Plug Tube Seal Remover And Installer **303-1247**
	Slide Hammer **307-005T59L-100-B**
	Strap Wrench **303-D055D85L-6000-A**

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	Camshaft Holding Tools **303-1248**

MATERIAL SPECIFICATIONS

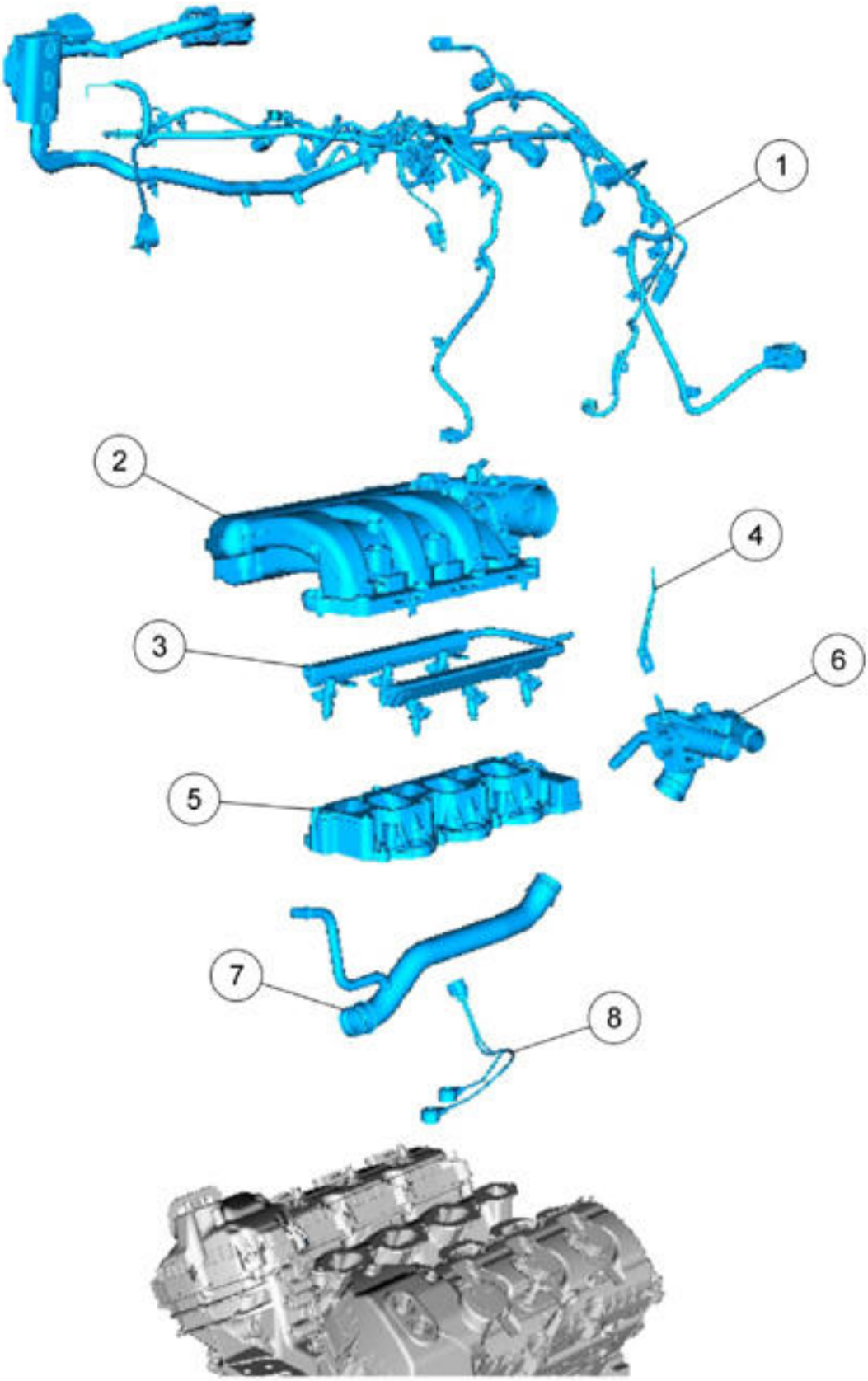
Item	Specification
High Temperature Nickel Anti-Seize Lubricant XL-2	-
Motorcraft® High Performance Engine RTV Silicone TA-357	WSEM4G323-A6
Motorcraft® Metal Surface Prep ZC-31-A	-
Motorcraft® SAE 5W-20 Premium Synthetic Blend Motor Oil (US); Motorcraft® SAE 5W-20 Super Premium Motor Oil (Canada) XO-5W20-QSP (US); CXO-5W20-LSP12 (Canada)	WSSM2C945-A
Motorcraft® Specialty Green Engine Coolant	WSSM97B55-A

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VC-10-A2 (US); CVC-10-A (Canada)	
Penetrating and Lock Lubricant (US); Penetrating Fluid (Canada) XL-1 (US); CXC-51-A (Canada)	-
Motorcraft® Silicone Gasket Remover ZC-30	-
Thread Sealant with PTFE TA-24	WSKM2G350-A2

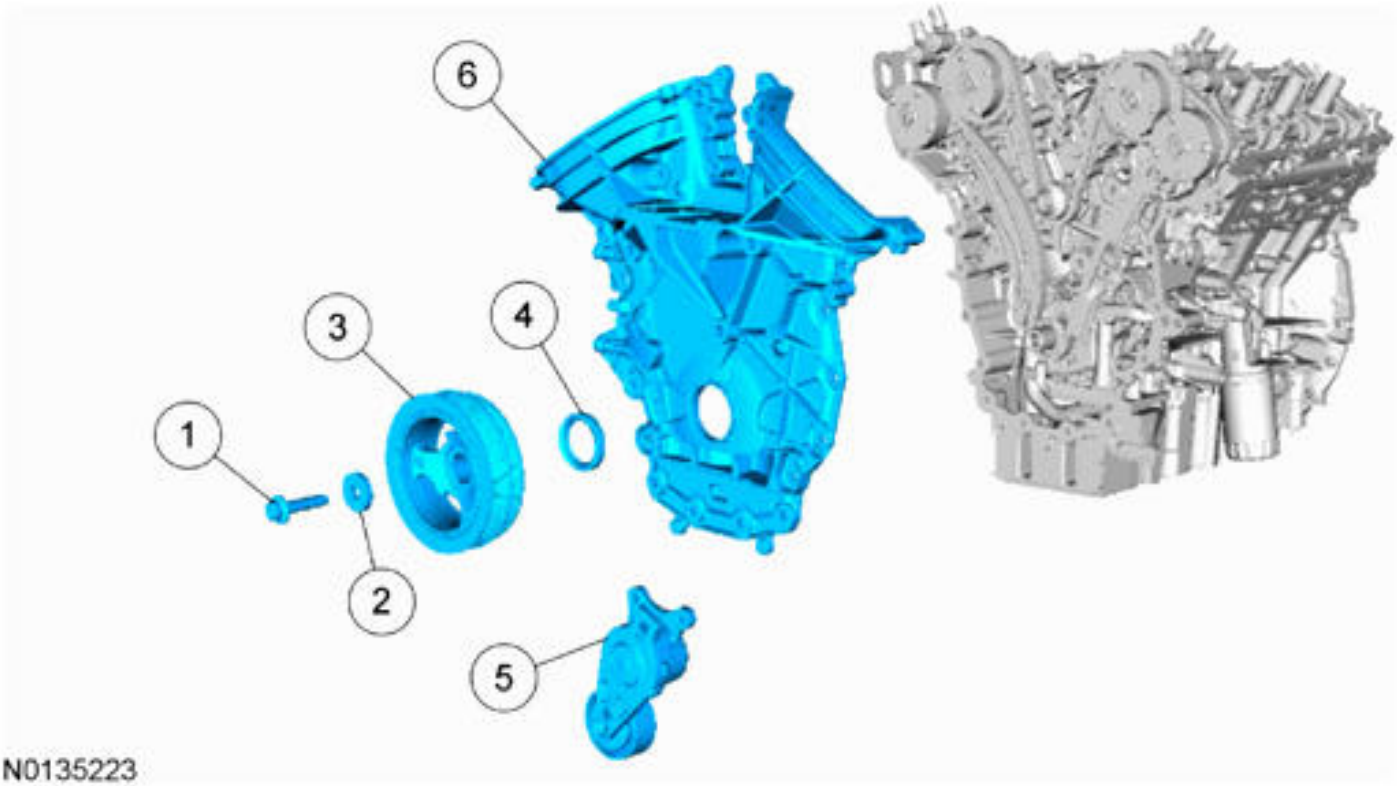
Exploded View

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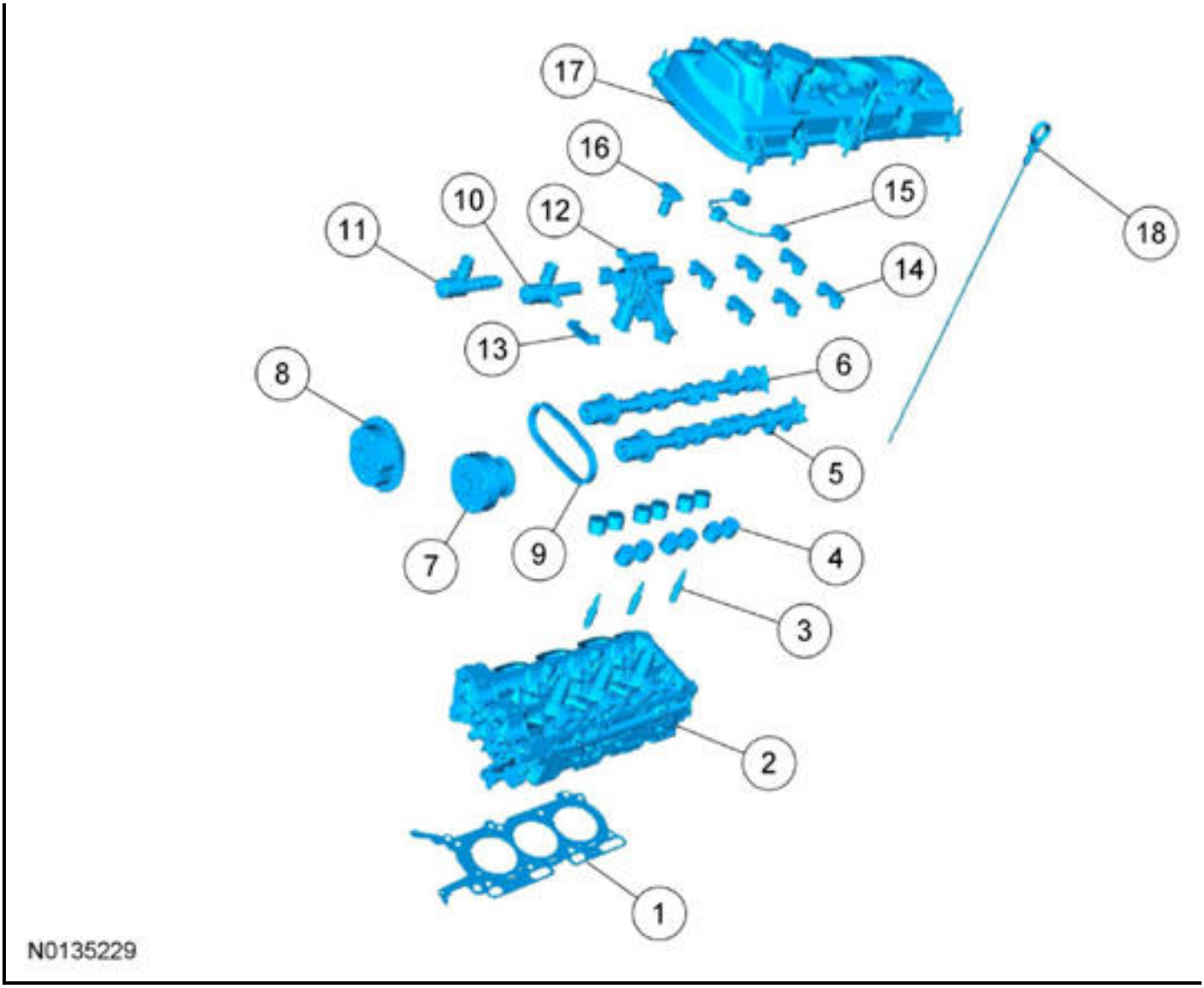
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Item	Service Part Number	Description
1	12C508	Engine control wiring harness
2	9424	Upper intake manifold
3	9F797	Fuel rail
4	9J444	Upper intake manifold support bracket
5	9424	Lower intake manifold
6	8A856	Thermostat housing
7	9N271	Coolant tube
8	9N271	**KS**



Item	Service Part Number	Description
1	W701512	Crankshaft pulley bolt
2	N806165	Crankshaft pulley washer
3	6316	Crankshaft pulley
4	6700	Crankshaft front seal
5	6B209	Accessory drive belt tensioner
6	6019	Engine front cover

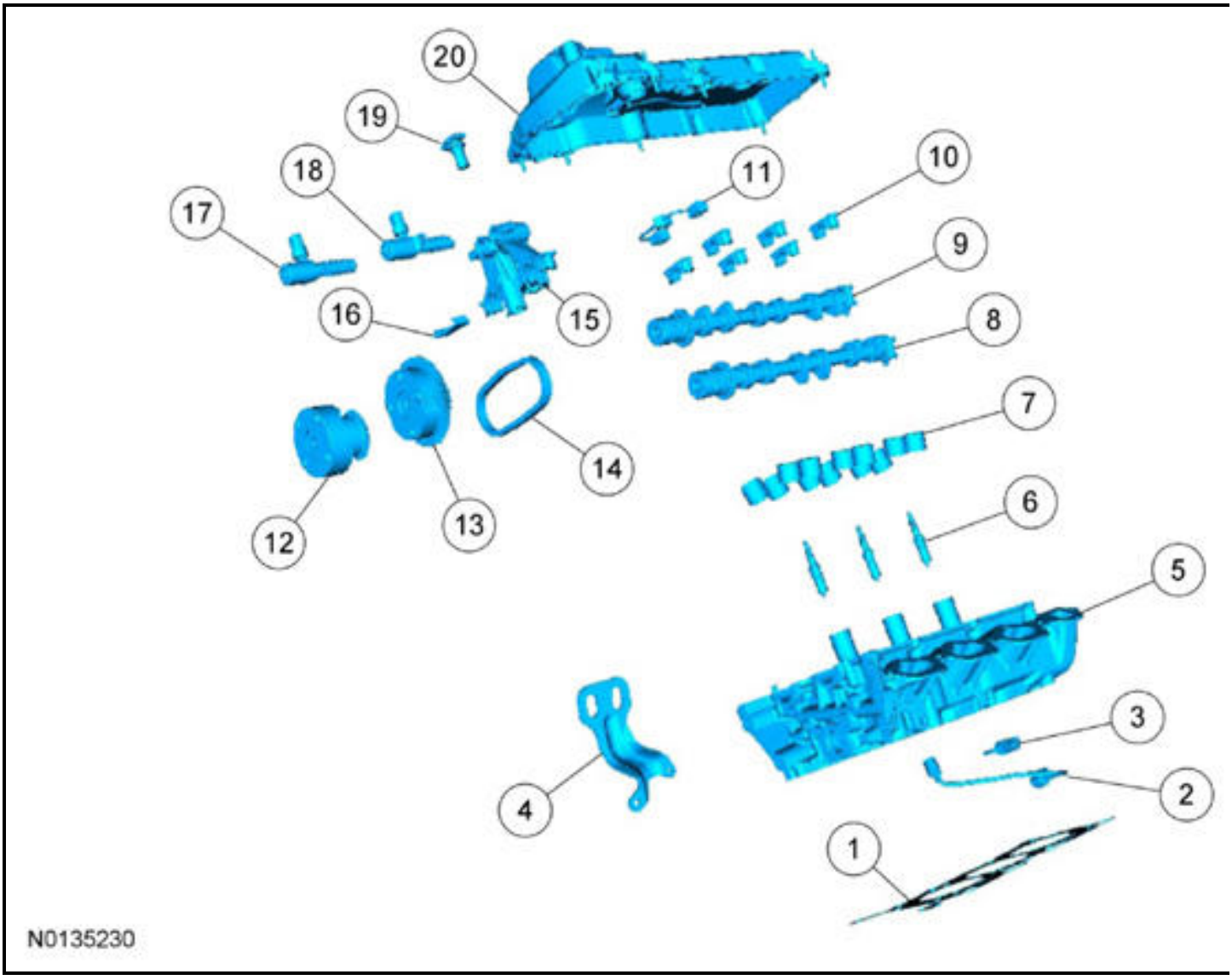
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Item	Service Part Number	Description
1	6083	LH cylinder head gasket
2	6050	LH cylinder head
3	12405	Spark plug (3 required)
4	6500	Valve tappet (12 required)
5	6A269	Engine front cover
6	6A267	LH exhaust camshaft
7	6C525	Exhaust camshaft **VCT** assembly
8	6C524	Intake camshaft **VCT** assembly
9	6C256	LH secondary timing chain
10	6B297	Exhaust camshaft **VCT** oil control solenoid
11	6B297	Intake camshaft **VCT** oil control solenoid

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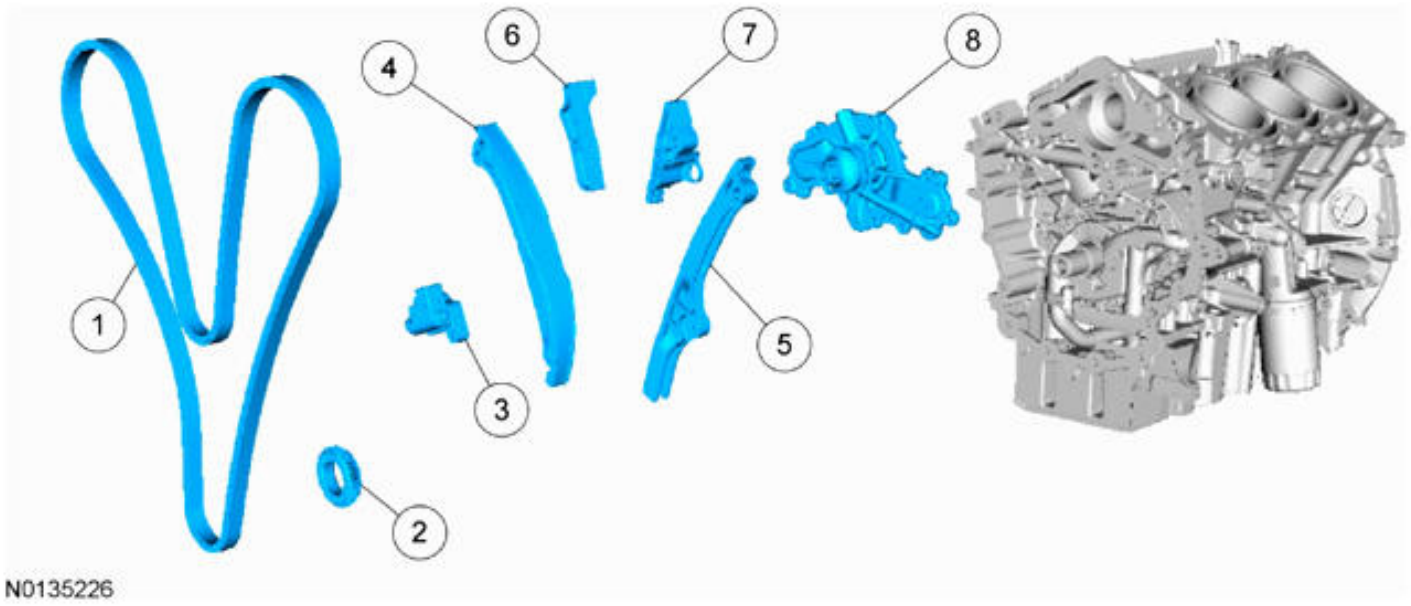
12	6B280	Camshaft mega cap
13	6K297	LH secondary tensioner shoe
14	6A258	LH camshaft cap (6 required)
15	6K602	Valve train oil feed tube
16	6C270	LH secondary timing chain tensioner
17	6K273	LH valve cover
18	6750	Oil level indicator



Item	Service Part Number	Description
1	6051	RH cylinder head gasket
2	14B485	**CHT** sensor jumper harness
3	6G004	**CHT** sensor
4	17A084	Engine lift eye

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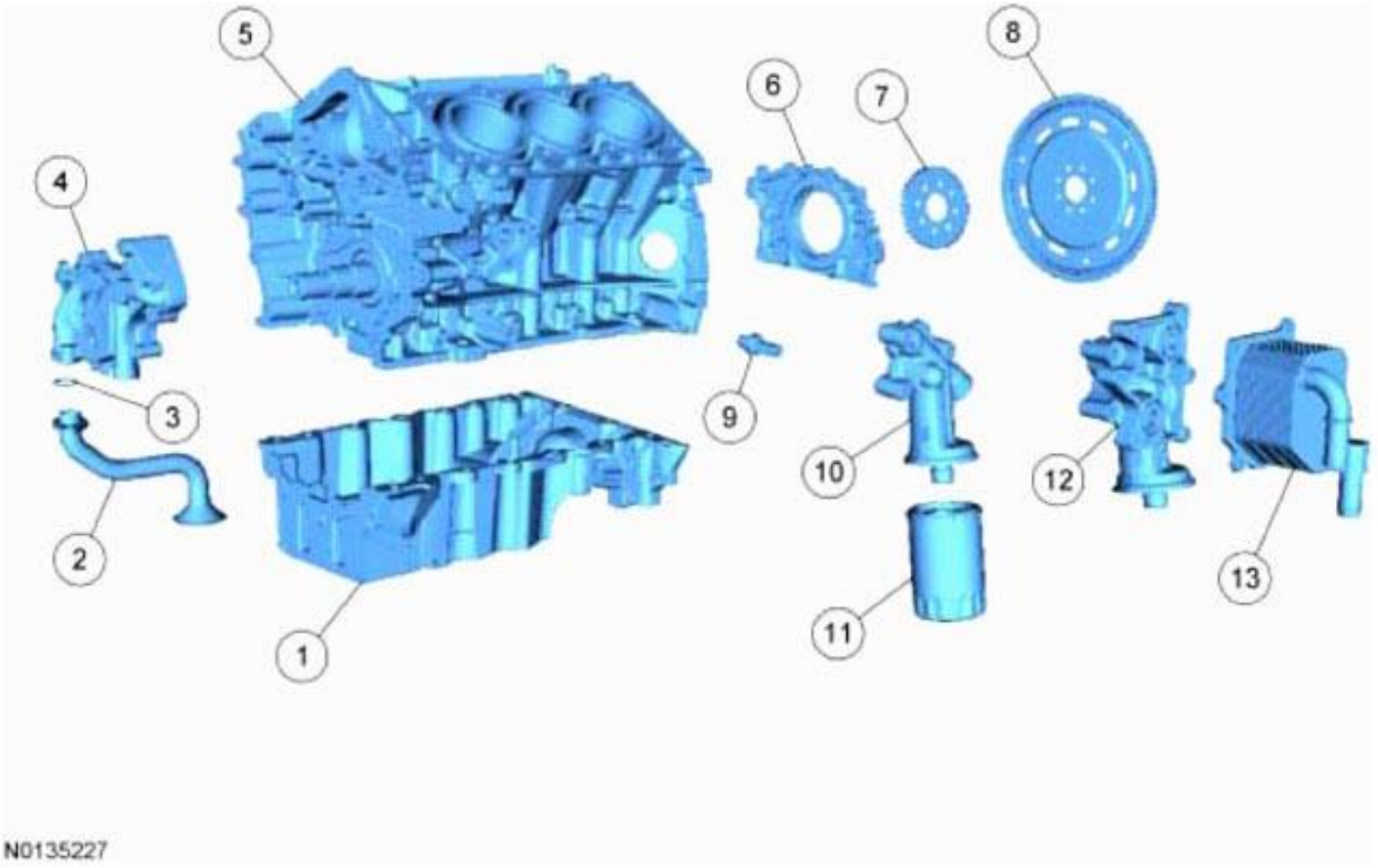
5	6049	RH cylinder head
6	12405	Spark plug (3 required)
7	6500	Valve tappet (12 required)
8	6A266	RH intake camshaft
9	6A268	RH exhaust camshaft
10	6A258	RH camshaft cap (8 required)
11	6K602	Valve train oil feed tube
12	6C525	Exhaust camshaft **VCT** assembly
13	6C524	Intake camshaft **VCT** assembly
14	6C256	RH secondary timing chain
15	6B280	Camshaft mega cap
16	6K297	RH secondary tensioner shoe
17	6B297	Exhaust camshaft **VCT** oil control solenoid
18	6B297	Intake camshaft **VCT** oil control solenoid
19	6C270	RH secondary timing chain tensioner
20	6K271	RH valve cover



Item	Service Part Number	Description
1	6268	Timing chain
2	6306	Crankshaft timing sprocket
3	6L266	Primary timing chain tensioner
4	6K255	Primary timing chain tensioner arm
5	6B274	LH lower primary timing chain guide
6	6K297	RH primary timing chain guide
7	6K297	LH upper primary timing chain guide

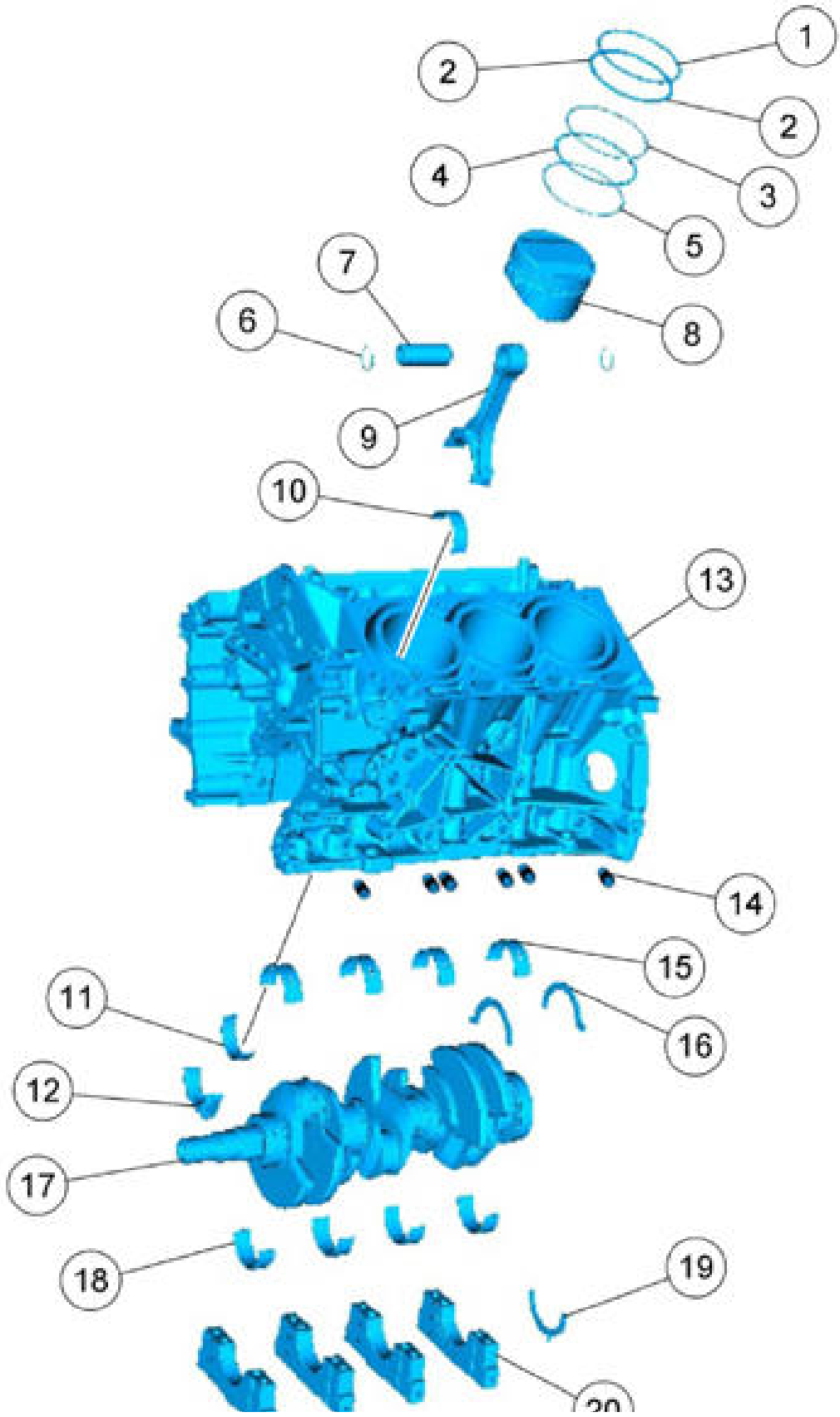
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8	8501	Coolant pump



Item	Service Part Number	Description
1	6675	Oil pan
2	6622	Oil pump screen and pickup tube
3	6625	Oil pump screen and pickup tube O-ring seal
4	6621	Oil pump
5	6010	Cylinder block
6	6D327	Crankshaft rear seal retainer plate
7	12A227	Crankshaft sensor ring
8	6375	Flexplate
9	9278	EOP switch
10	6881	Oil filter adapter (without oil cooler)
11	6714	Engine oil filter
12	6881	Oil filter adapter (with oil cooler)
13	6A642	Oil cooler

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Item	Service Part Number	Description
1	(part of 6148)	Piston compression upper ring (6 required)
2	(part of 6148)	Piston compression lower ring (6 required)
3	(part of 6148)	Piston oil control upper segment ring (6 required)
4	(part of 6148)	Piston oil control spacer (6 required)
5	(part of 6148)	Piston oil control lower segment ring (6 required)
6	6140	Piston pin retainer (12 required)
7	6135	Piston pin (6 required)
8	6110	Piston (6 required)
9	6200	Connecting rod (6 required)
10	6211	Connecting rod upper bearing (6 required)
11	6211	Connecting rod lower bearing (6 required)
12	(part of 6200)	Connecting rod cap (6 required)
13	6010	Cylinder block
14	6K868	Piston oil cool valve (6 required)
15	6333	Cylinder block crankshaft main bearing (4 required)
16	6A341	Connecting rod cap (6 required)
17	6303	Crankshaft
18	6A338	Lower crankshaft main bearings (4 required)
19	6K302	Crankshaft lower thrust washer
20	6325	Lower crankshaft main bearing caps (4 required)
21	6C364	Main bearing cap support brace

Disassembly

WARNING: Before beginning any service procedure, refer to SAFETY WARNINGS . Failure to follow this instruction may result in serious personal injury.

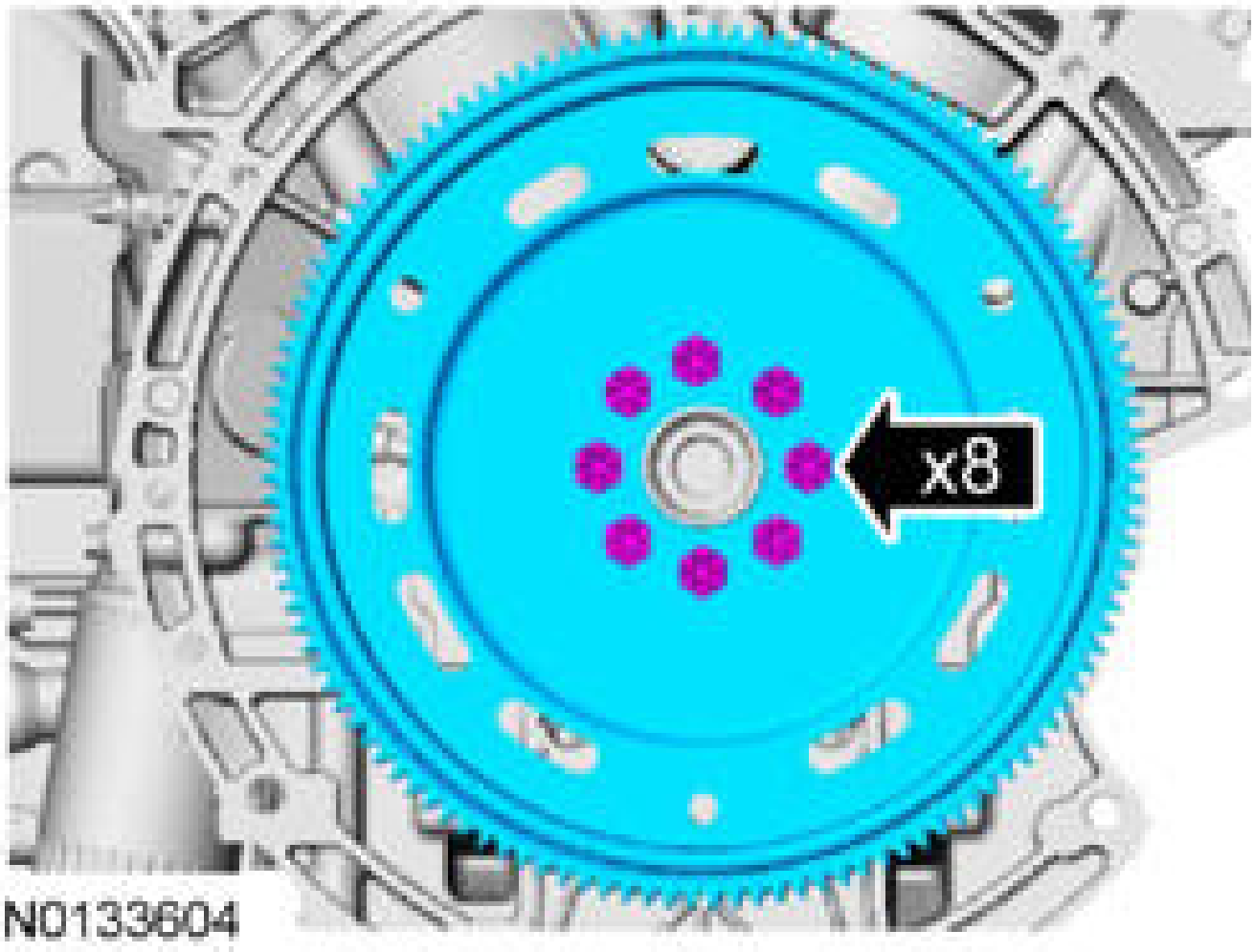
NOTE: During engine repair procedures, cleanliness is extremely important. Any foreign material, including any material created while cleaning gasket surfaces that enters the oil passages, coolant passages or the oil pan, can cause engine failure.

NOTE: The engine is equipped with a cast aluminum (early build) or stamped steel (late build) crankshaft rear seal retainer plate. If the engine is equipped with a stamped steel plate, the seal and plate must be removed as an assembly and discarded.

NOTE: If the cylinder head(s) is replaced, a new secondary timing chain tensioner will need to be installed.

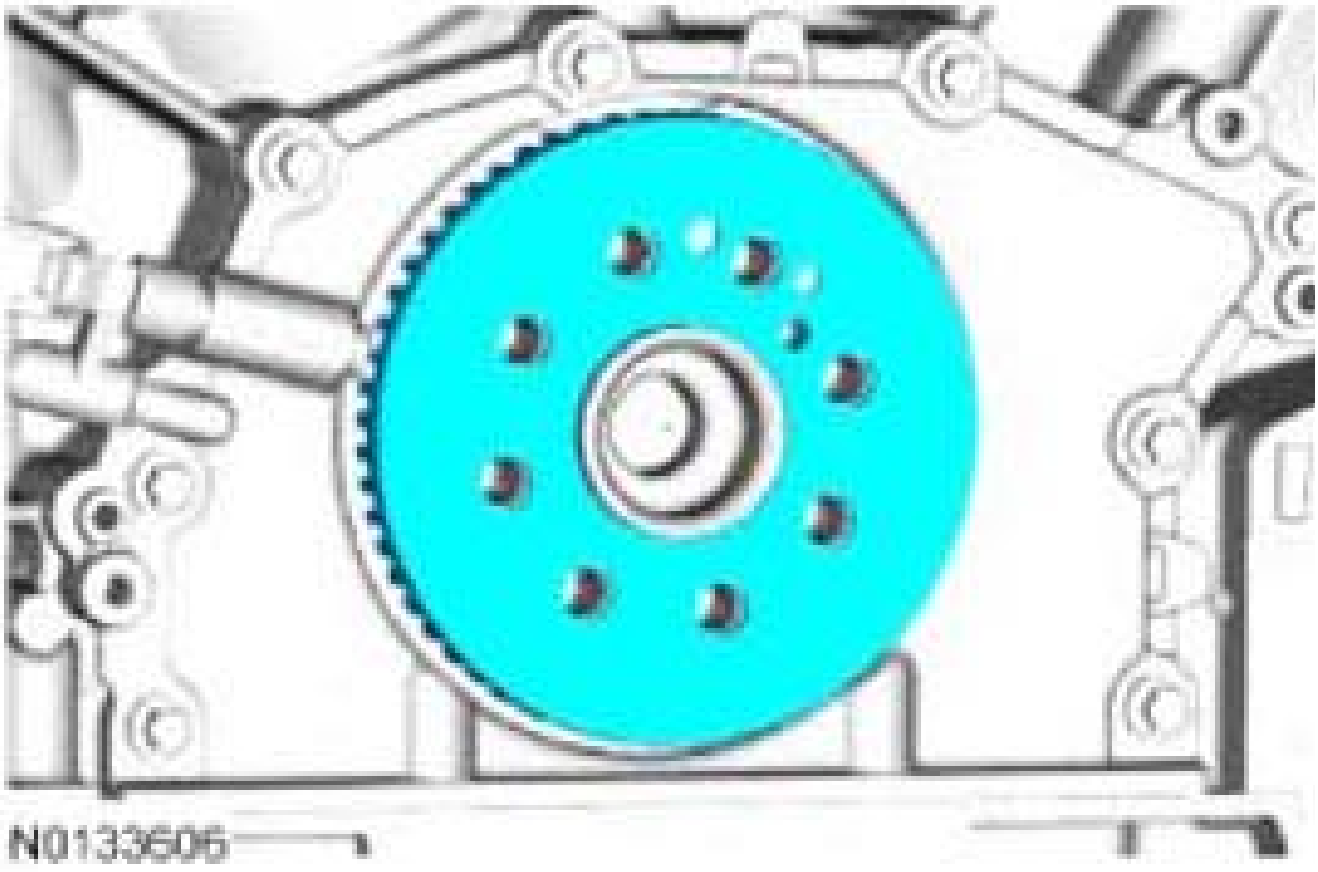
1. Remove the 8 bolts and the flexplate.

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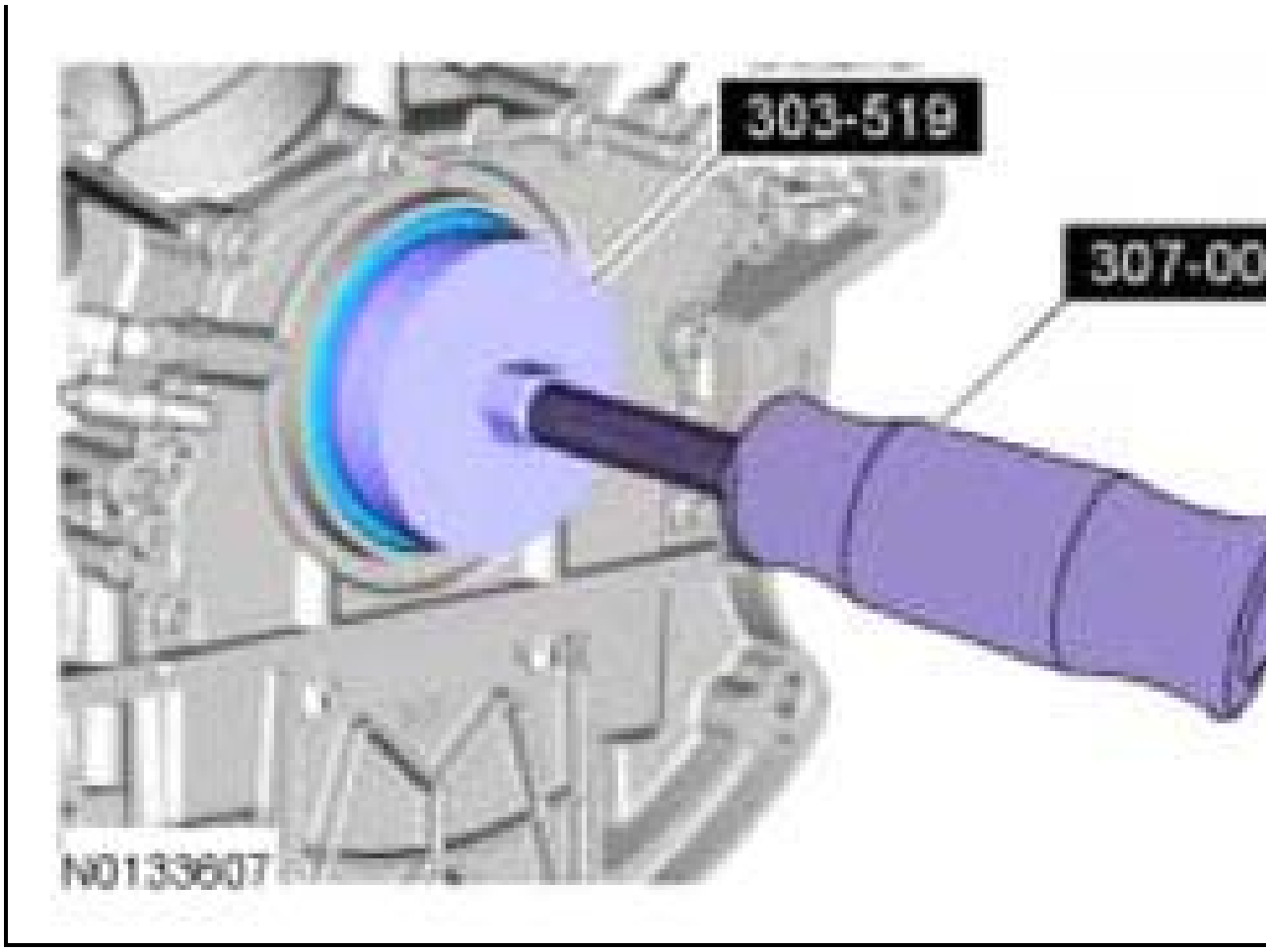
2. Remove the crankshaft sensor ring.

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3. If equipped with a cast aluminum crankshaft rear seal retainer plate, use the 303-519 T95P-6701-EH and 307-005 T59L-100-B to remove the rear crankshaft seal.
    - Discard the seal.

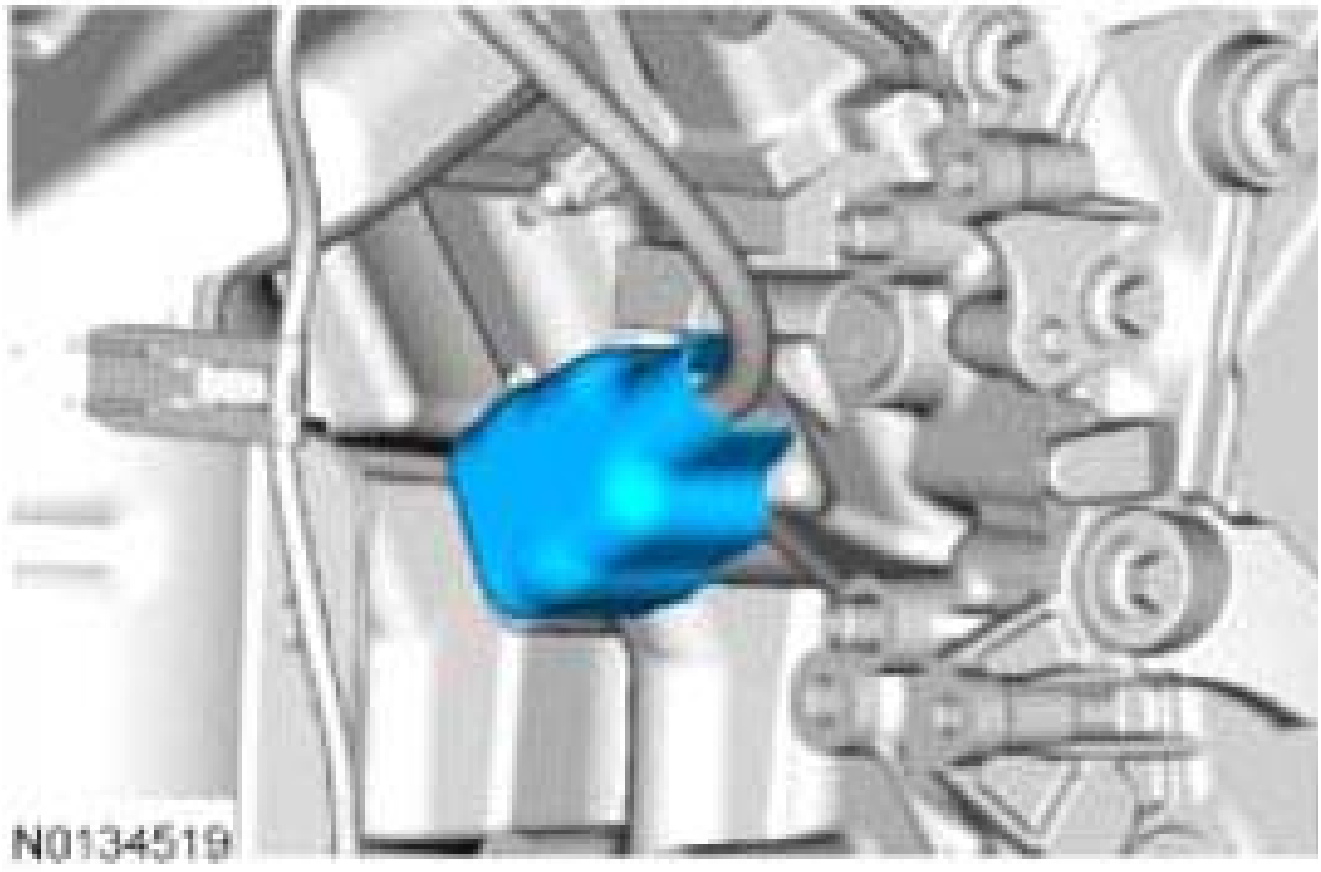
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NOTE: Install the engine stand bolts into the cylinder block only. Do not install the bolts into the oil pan.

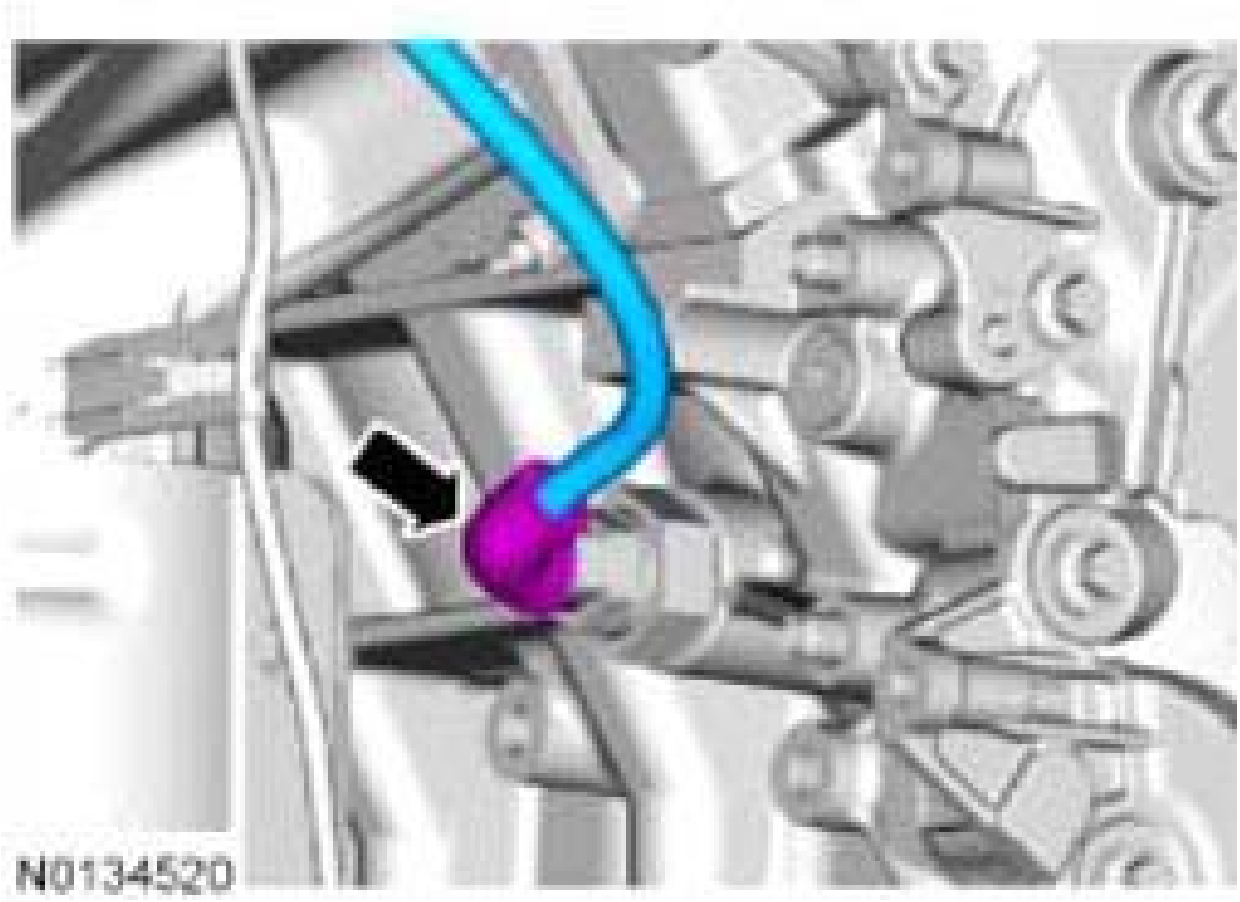
4. Mount the engine on a suitable engine stand.
5. If equipped, remove the block heater heat shield.

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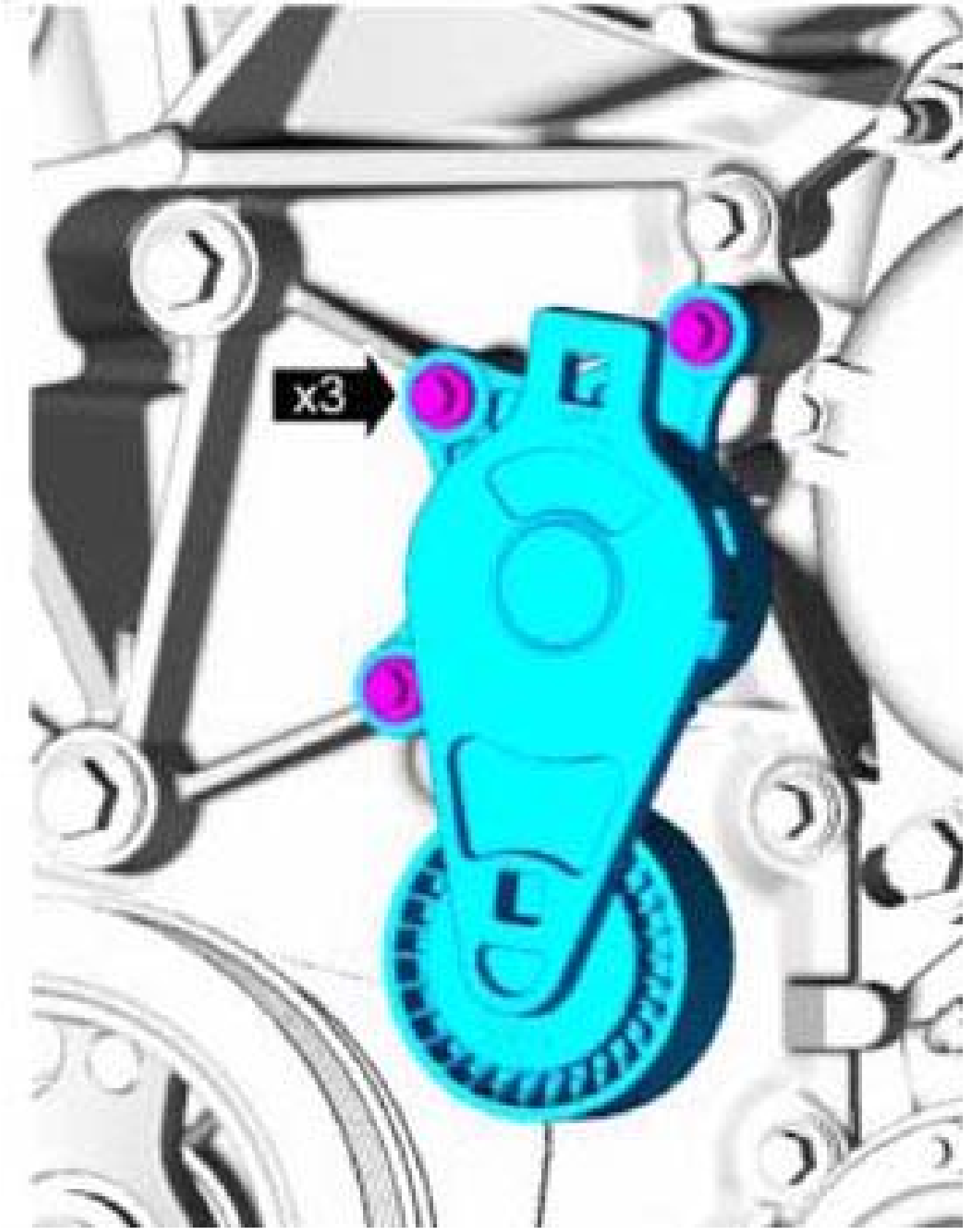
6. If equipped, disconnect the block heater electrical connector.
    - Detach all of the engine block heater harness retainers and remove the harness.

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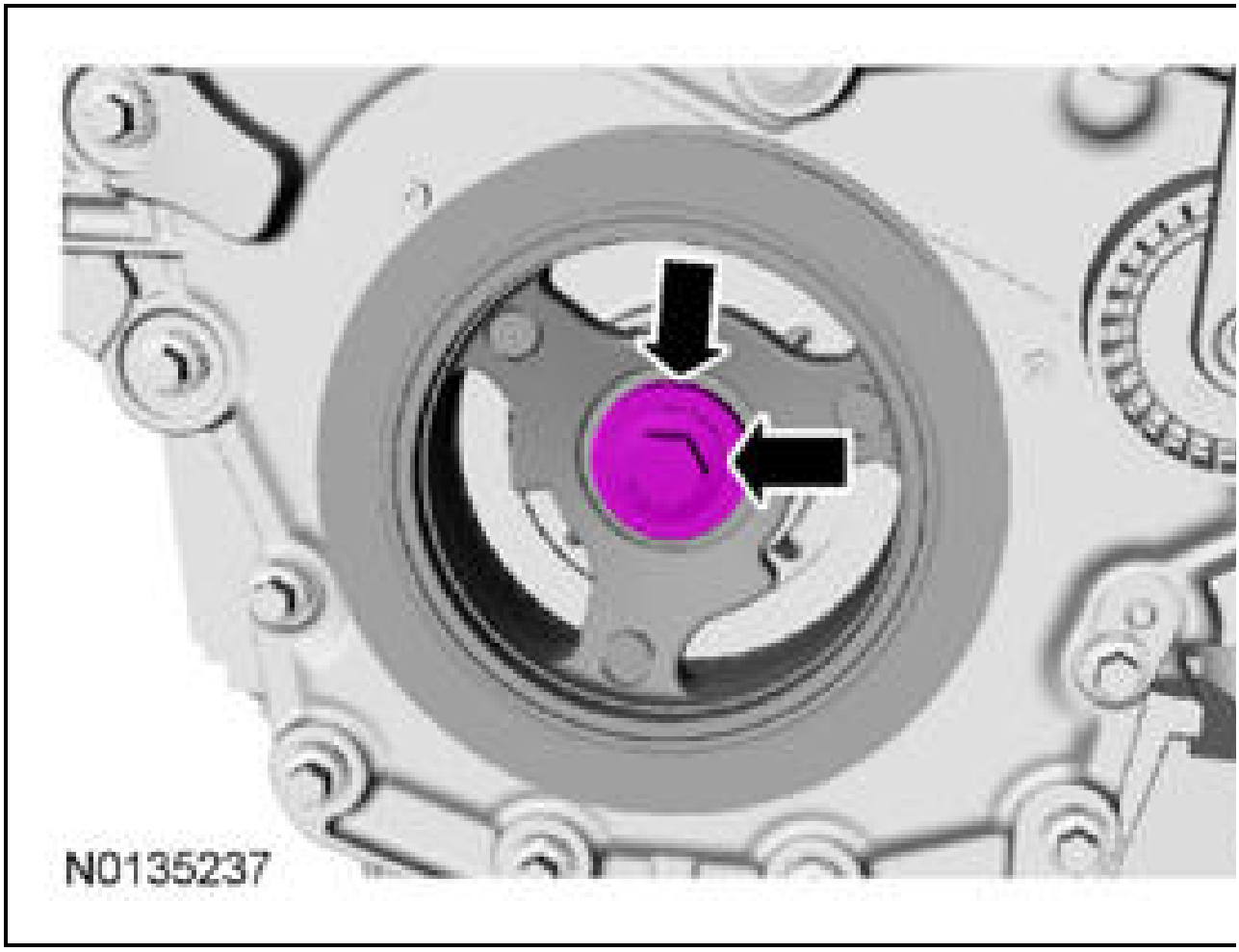
7. Remove the 3 bolts and the accessory drive belt tensioner.

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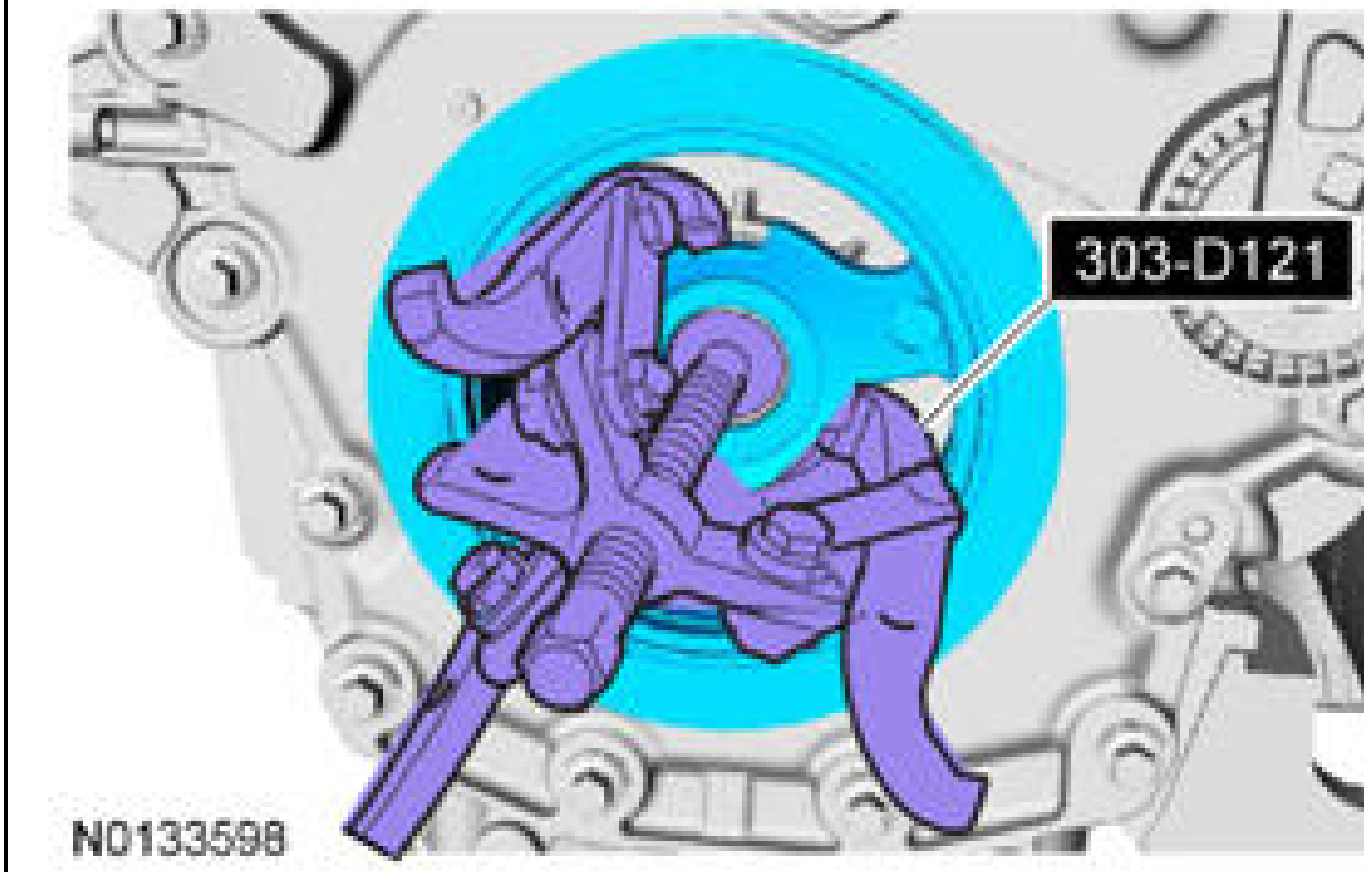
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8. Using the 303-D055 D85L-6000-A, remove the crankshaft pulley bolt and washer.
    - Discard the bolt.



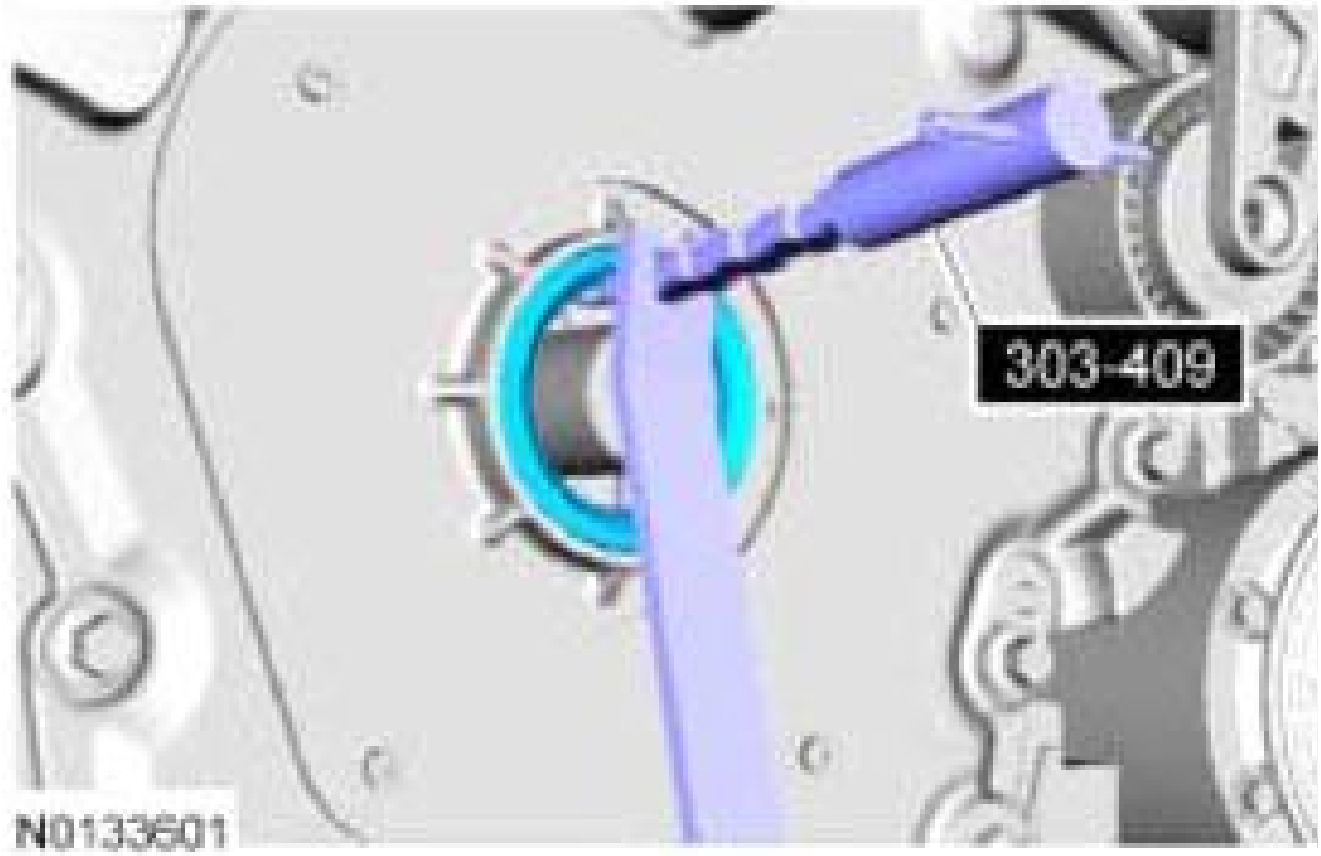
9. Using the 303-D021 D80L-100-S, remove the crankshaft pulley.

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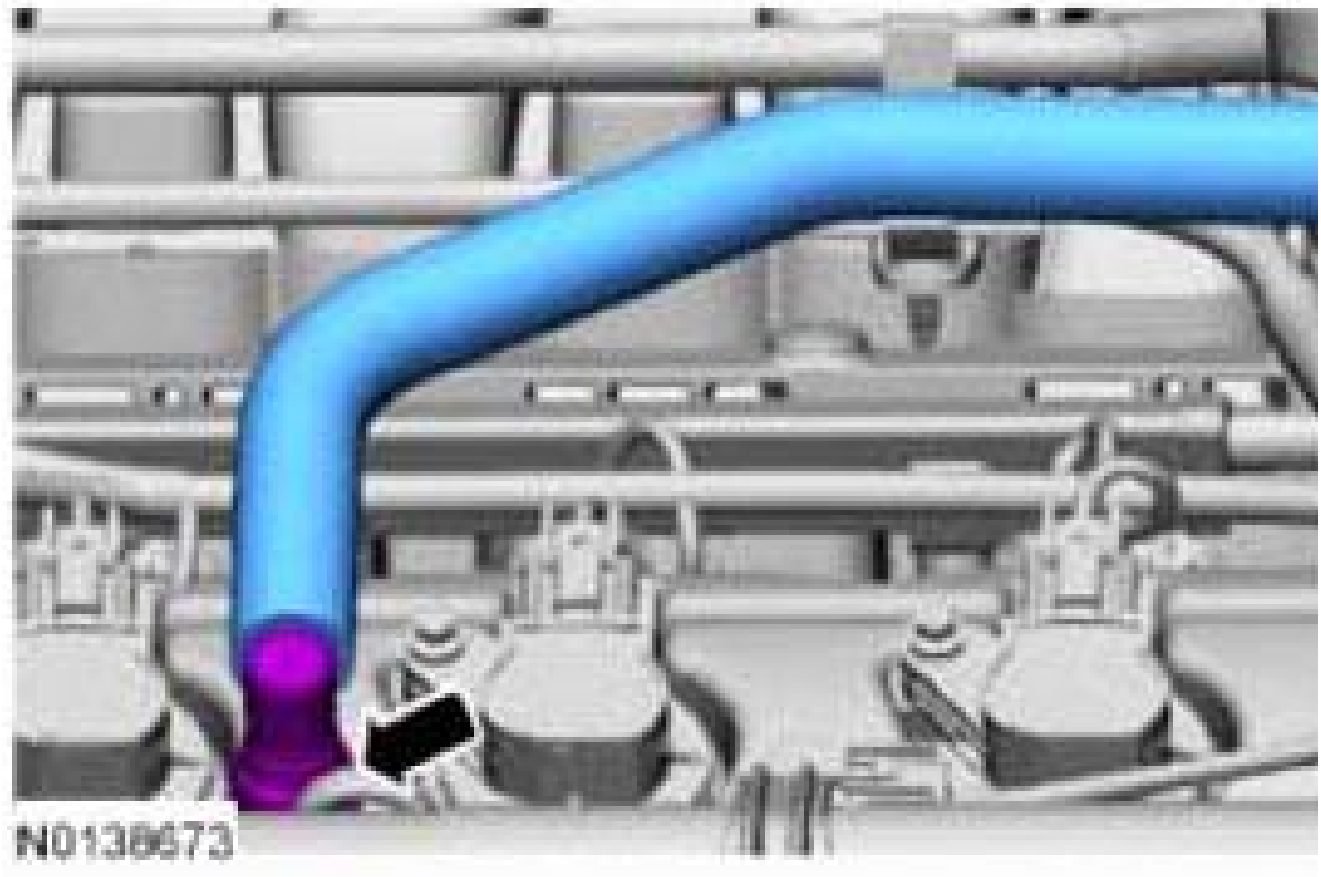
10. Using the 303-409 T92C-6700-CH, remove and discard the crankshaft front seal.

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11. Remove the crankcase vent tube. REFER to **QUICK CONNECT COUPLING** .

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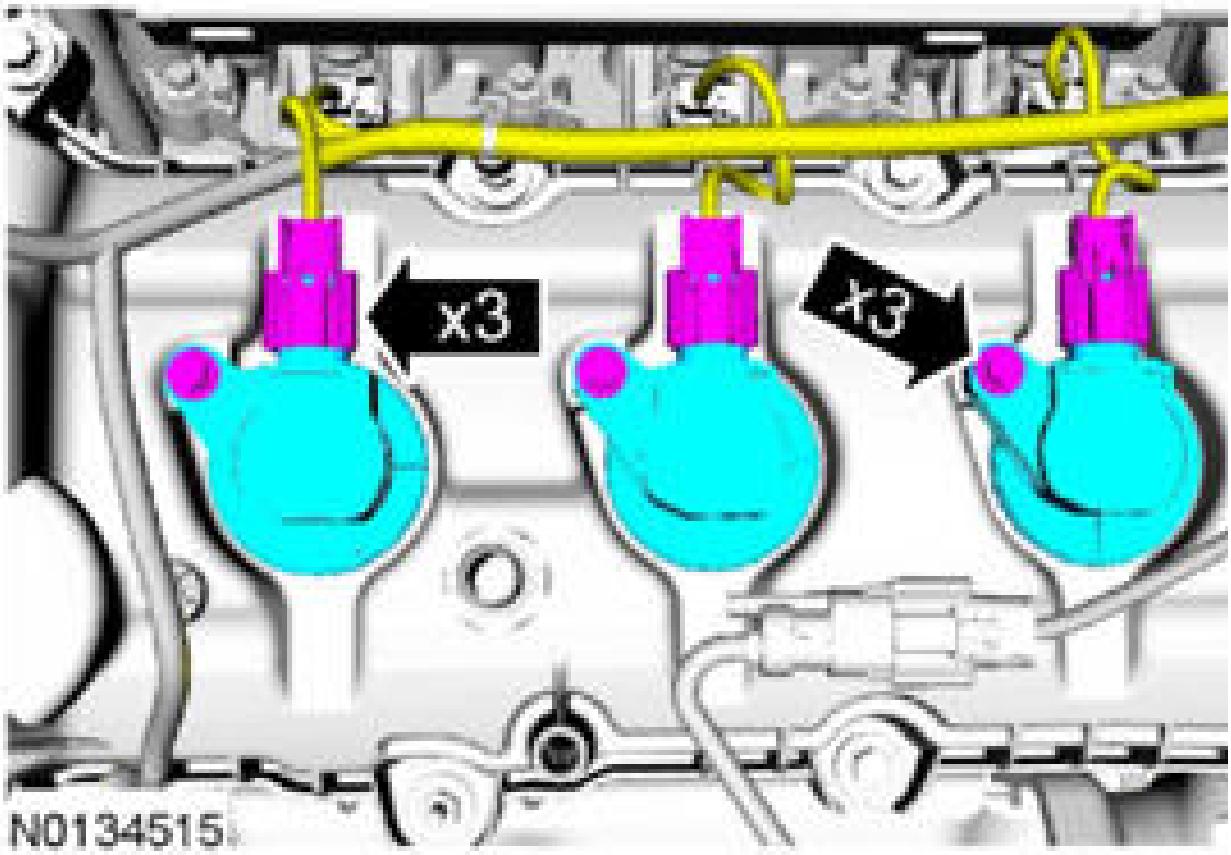


NOTE: When removing the ignition coil-on-plugs, a slight twisting motion will break the seal and ease removal.

12. Disconnect the 3 LH coil-on-plug electrical connectors and remove the 3 bolts and the 3 LH coil-on-plugs.

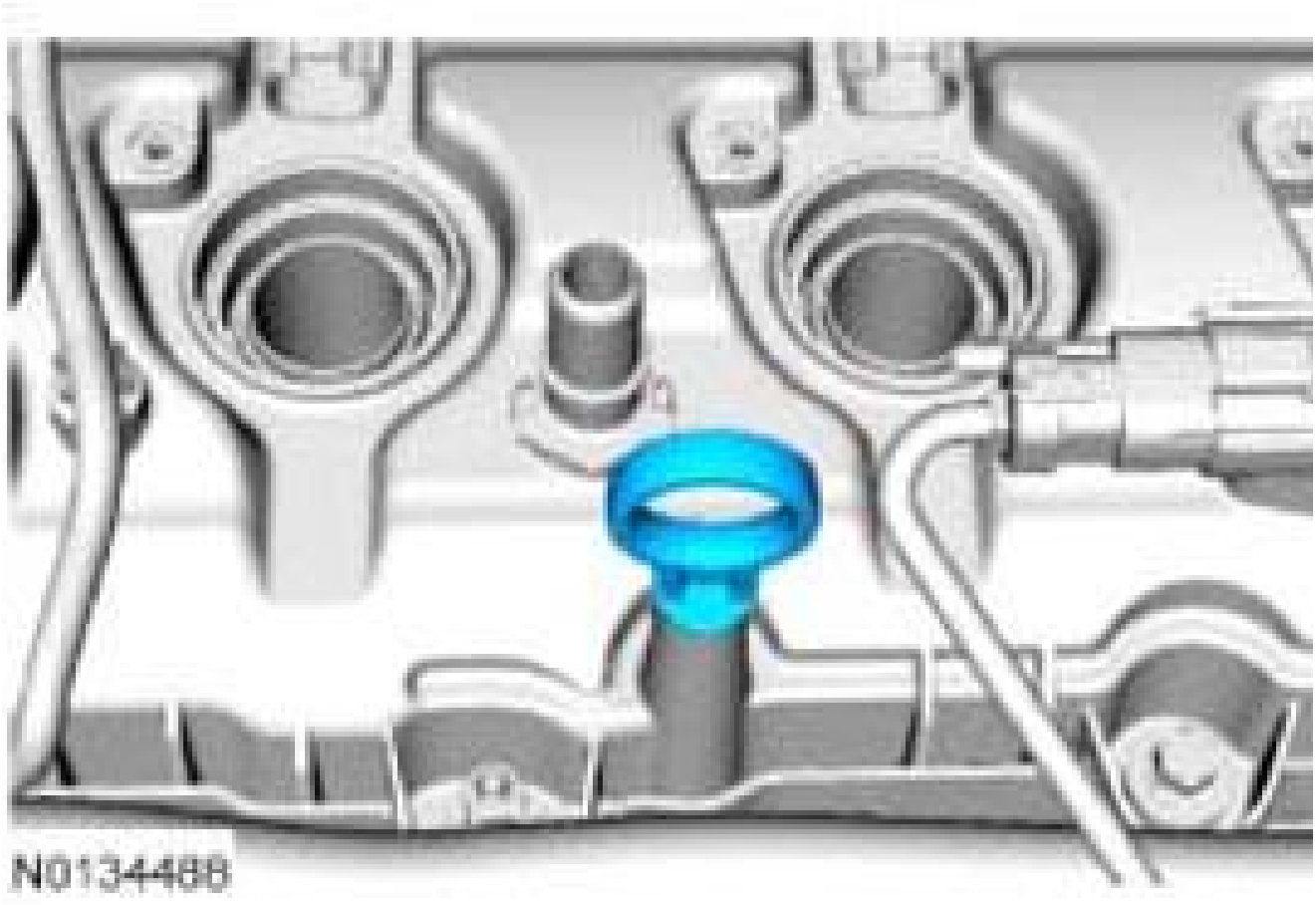
- Inspect the coil seals for rips, nicks or tears. Remove and discard any damaged coil seals.

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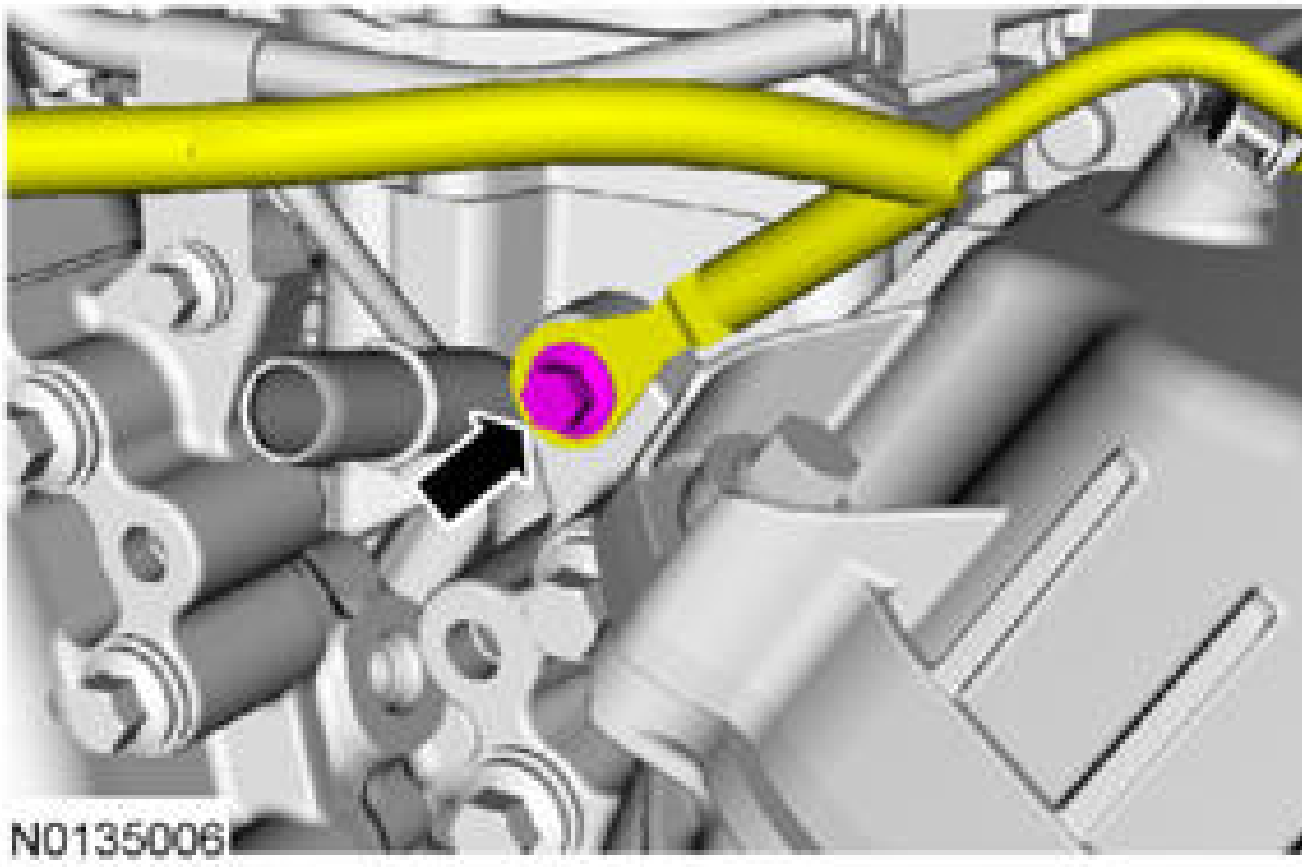
13. Remove the oil level indicator.

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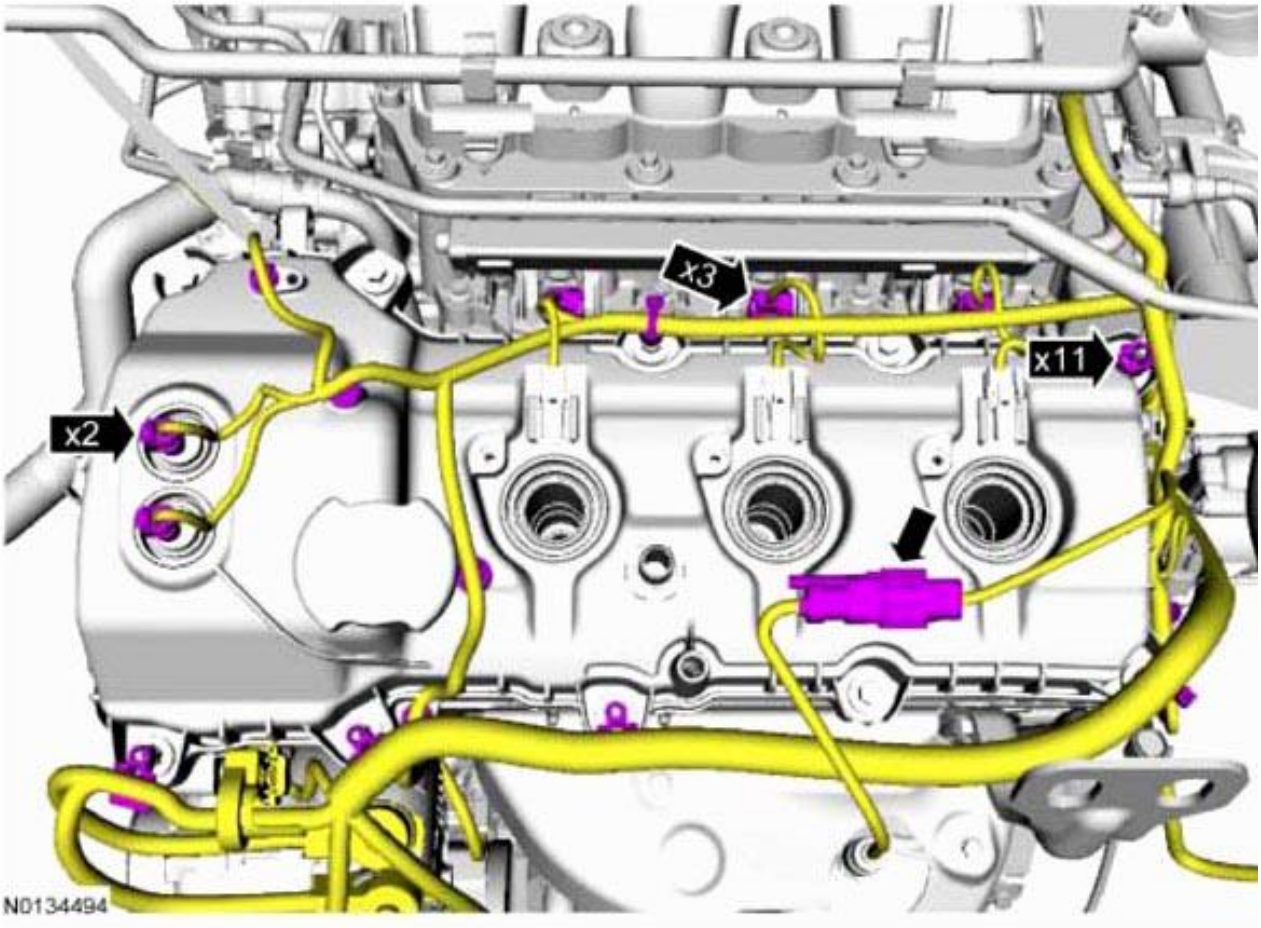
14. Remove the bolt and position the wire harness aside.

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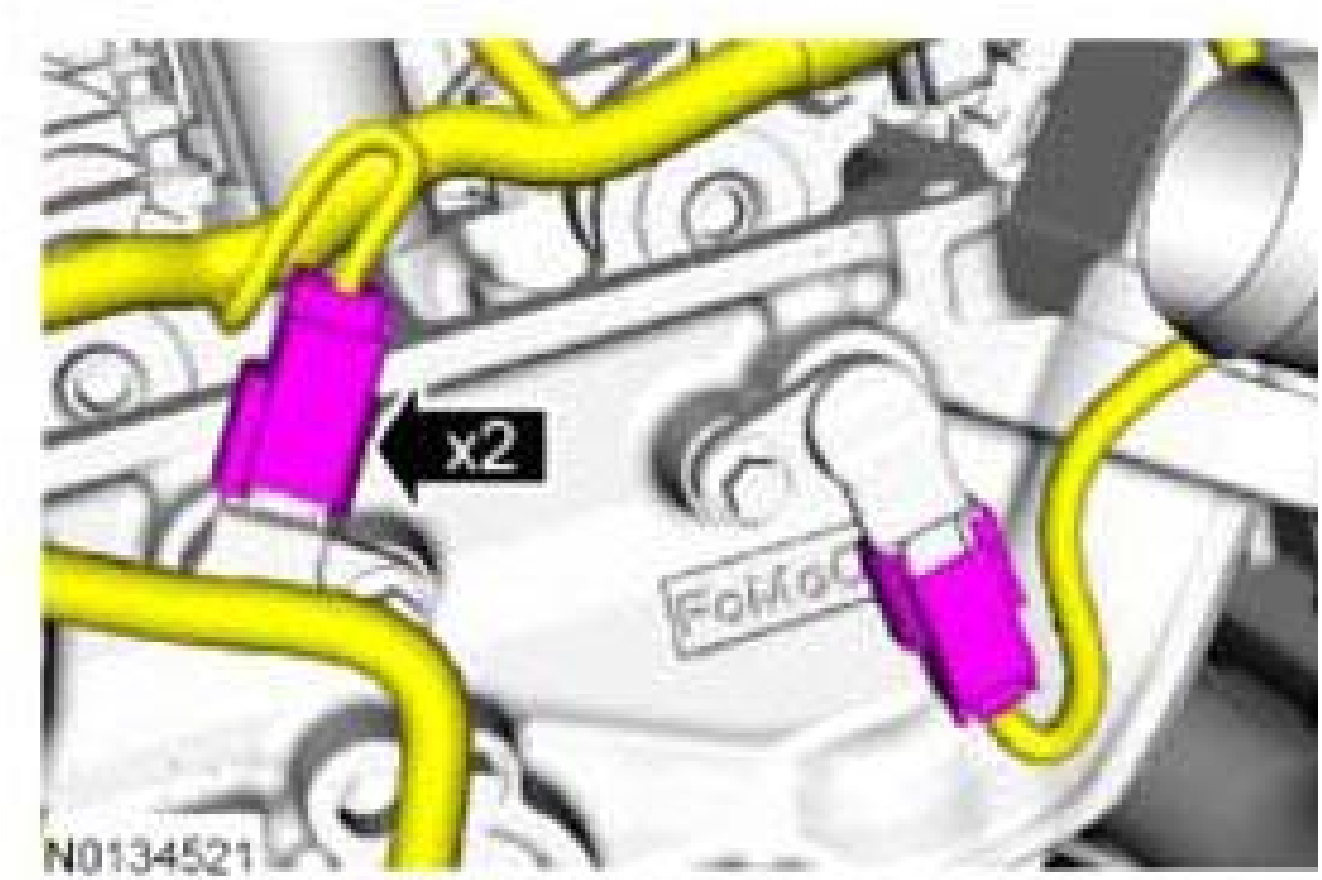
15. Remove the engine wiring harness from the LH valve cover.
    - Disconnect the 2 **VCT** oil control solenoid electrical connectors.
    - Detach and disconnect the LH **HO2S** electrical connector.
    - Disconnect the 3 fuel injector electrical connectors.
    - Detach the 11 wiring harness retainers from the LH valve cover and stud bolts and position the harness aside.

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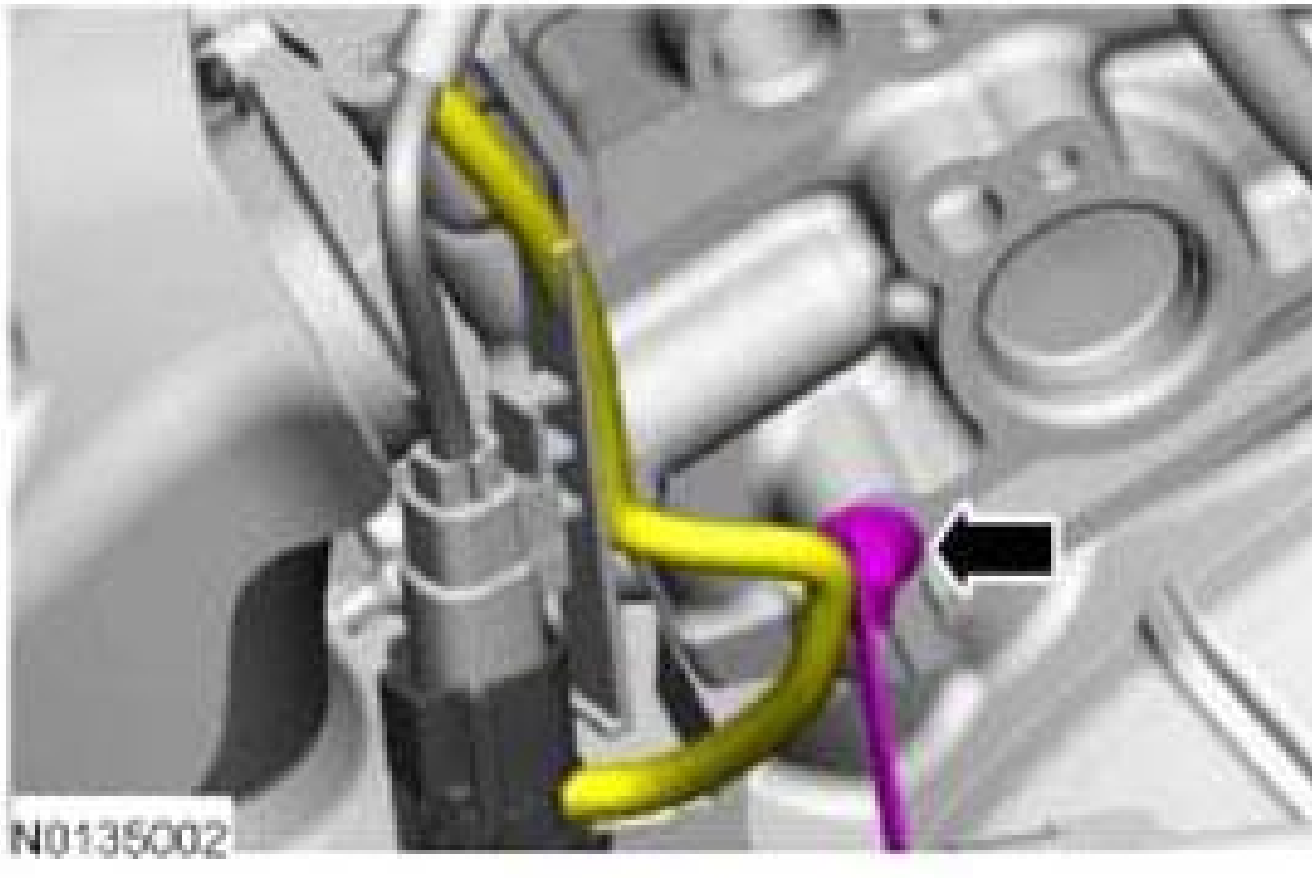
16. Disconnect the 2 LH **CMP** sensor electrical connectors.

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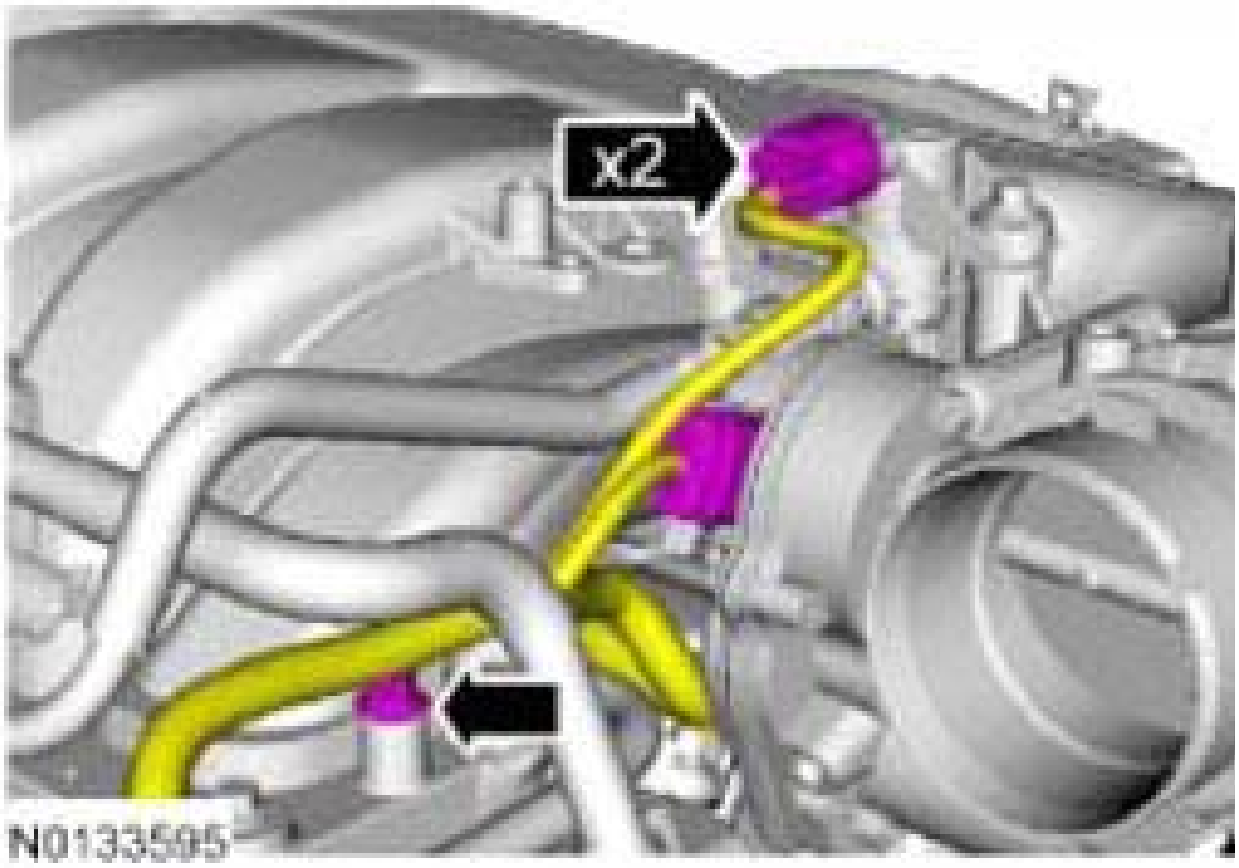
17. Disconnect the wiring harness retainer from the rear of the LH cylinder head.

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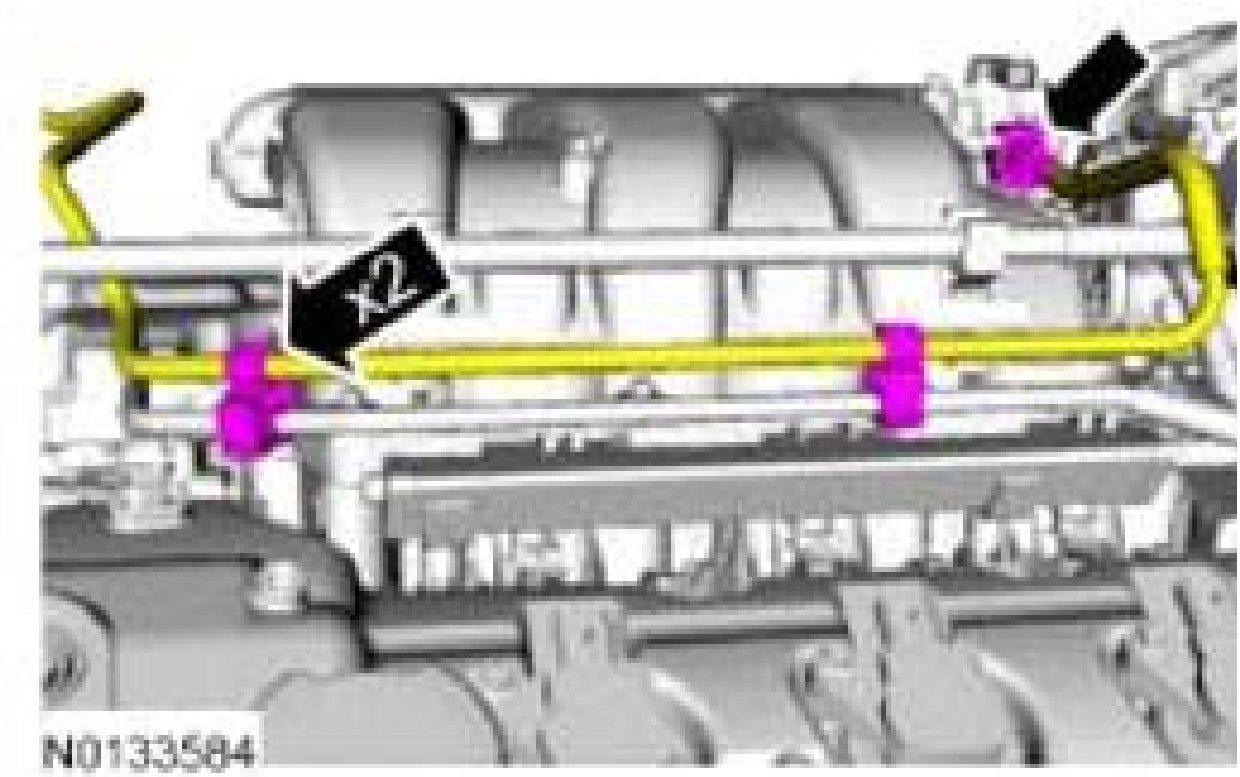
18. Disconnect the **EVAP** canister purge valve and throttle body electrical connectors.
    - Detach the wiring harness pin-type retainer.

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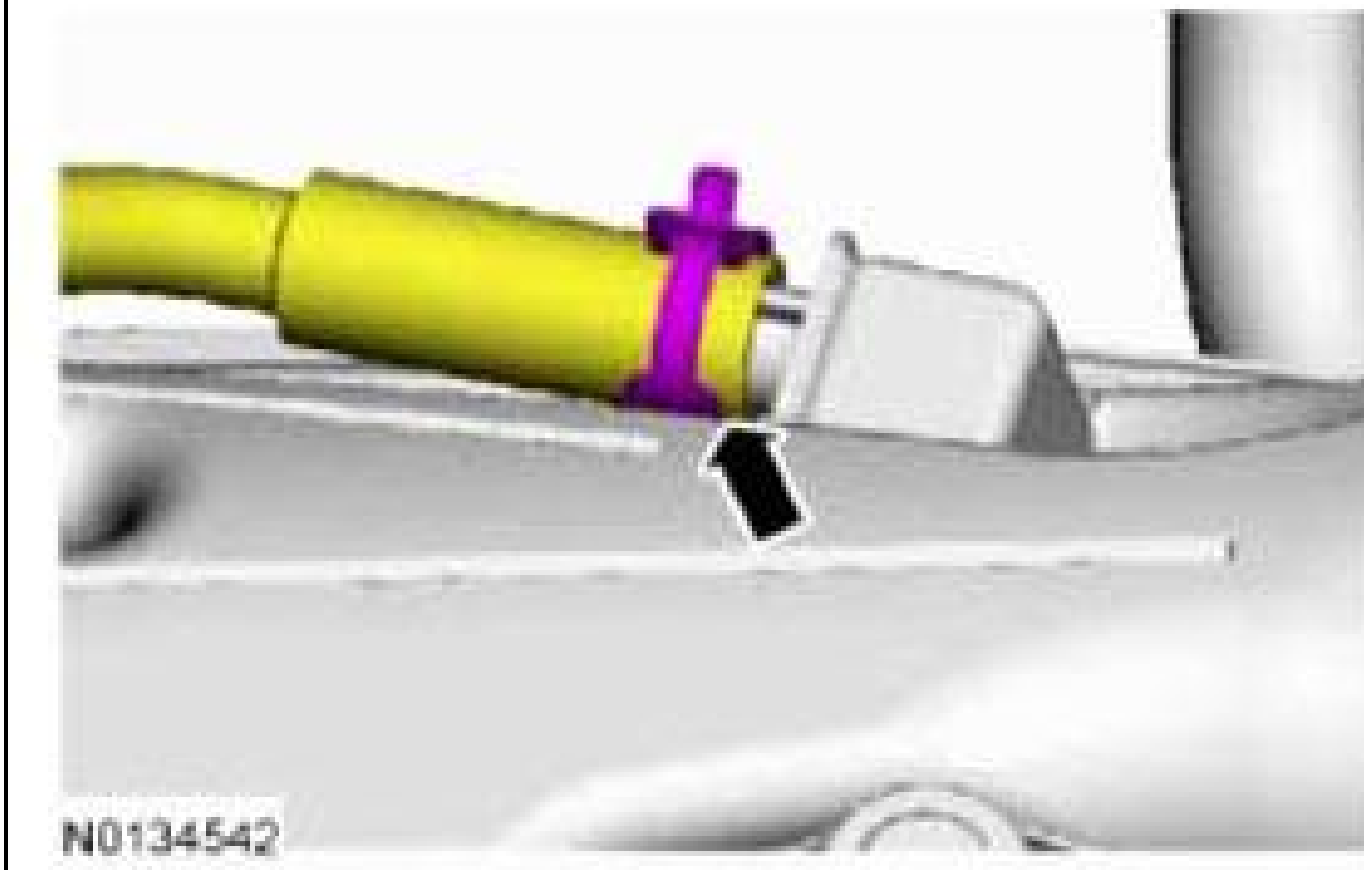
19. Disconnect the **EVAP** vapor tube from the **EVAP** canister purge valve. REFER to **QUICK CONNECT COUPLING** .
    - Detach the **EVAP** vapor tube from the 2 retainers.

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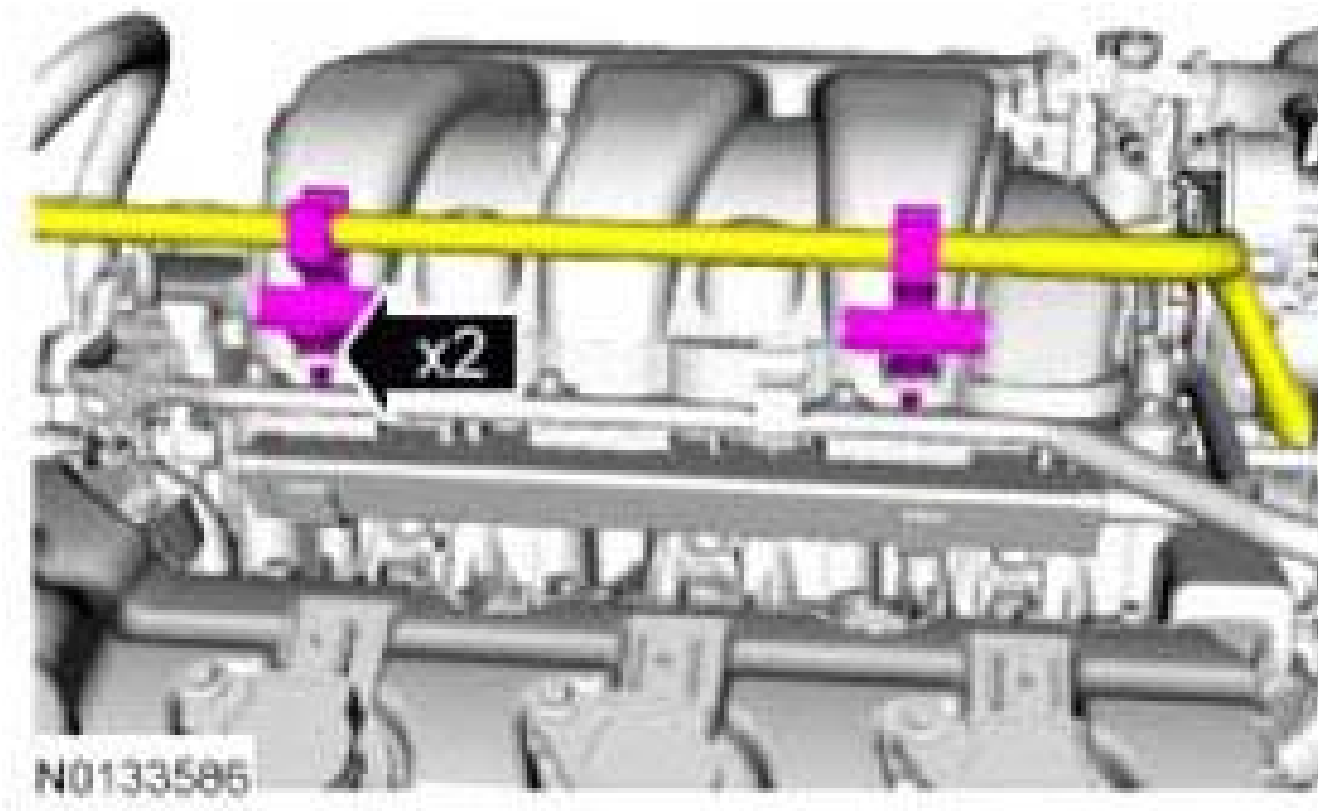
20. Disconnect the crankcase ventilation hose from the upper intake manifold.

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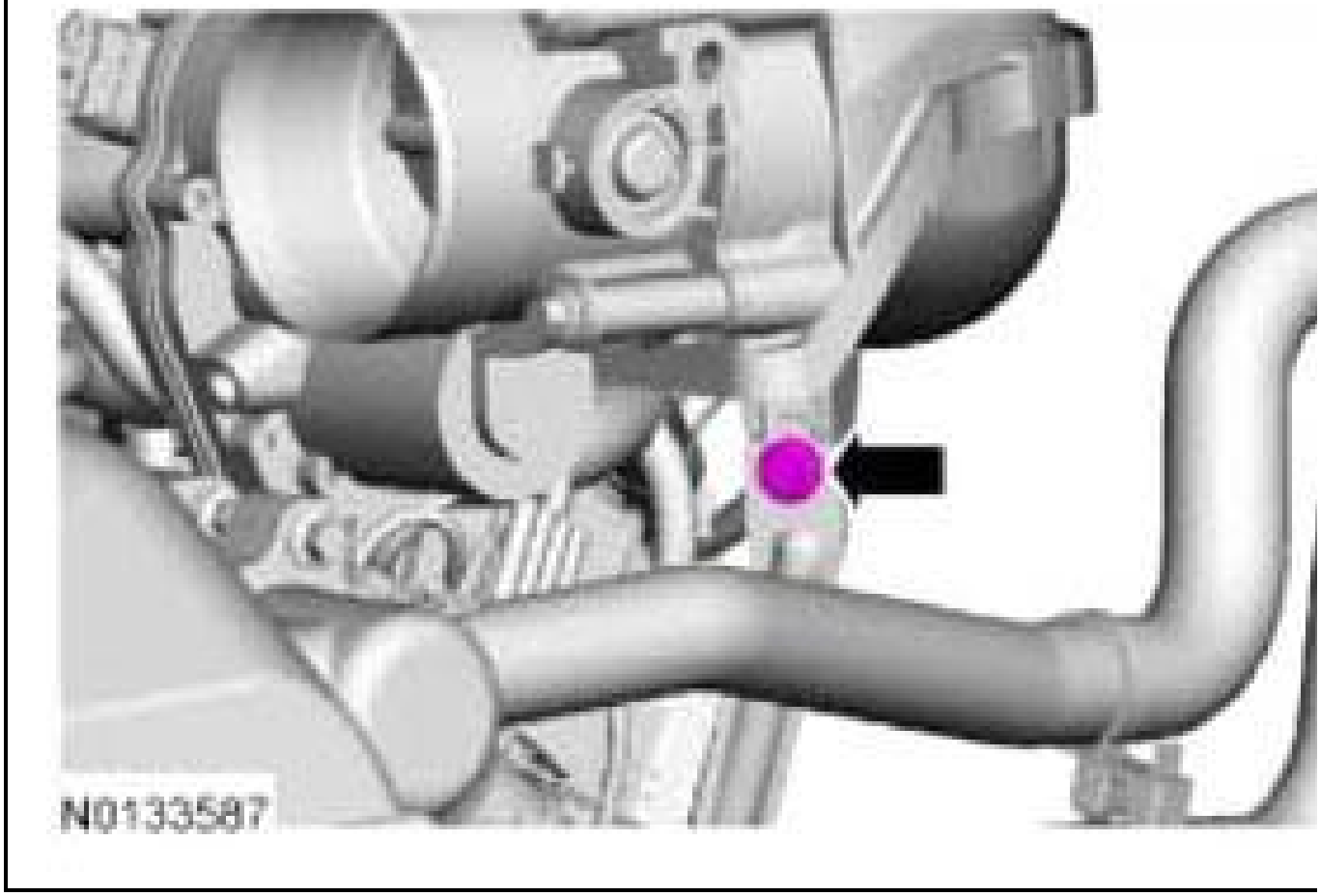
21. Detach the 2 coolant tube retainers from the upper intake manifold.

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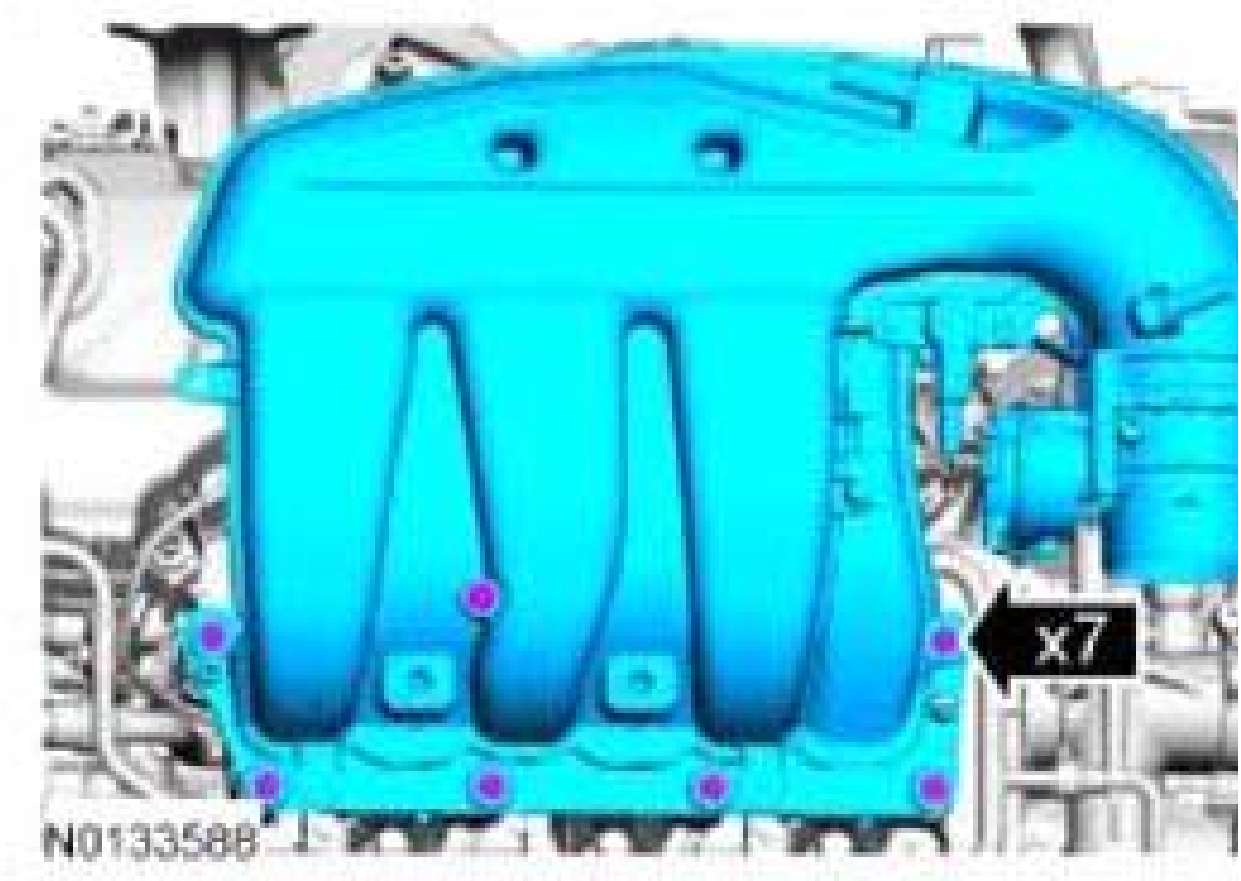
22. Remove the upper intake manifold support bracket bolt.

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23. Remove the 7 bolts and the upper intake manifold.
    - Remove and discard the gasket.
    - Clean and inspect all of the sealing surfaces of the upper and lower intake manifold.

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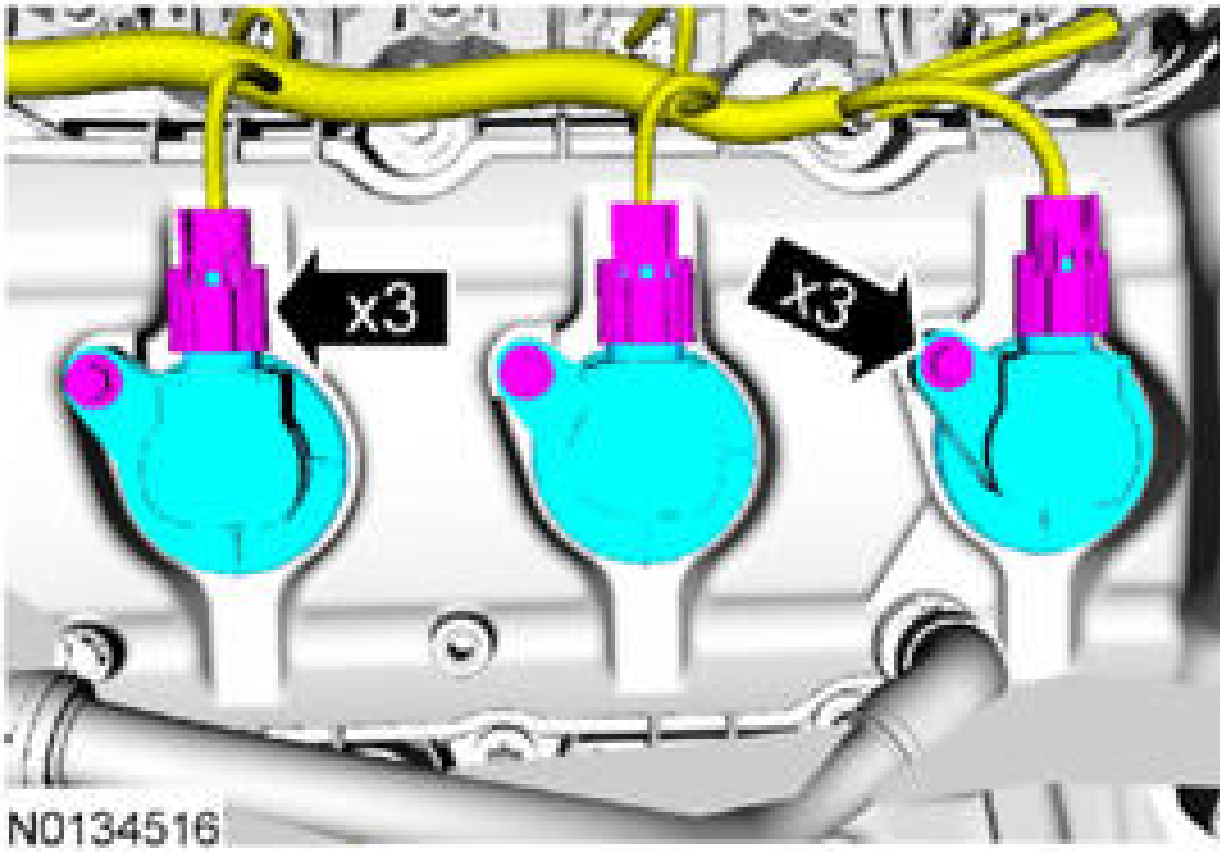


NOTE: When removing the ignition coil-on-plugs, a slight twisting motion will break the seal and ease removal.

24. Disconnect the 3 RH coil-on-plug electrical connectors and remove the 3 bolts and the 3 RH coil-on-plugs.

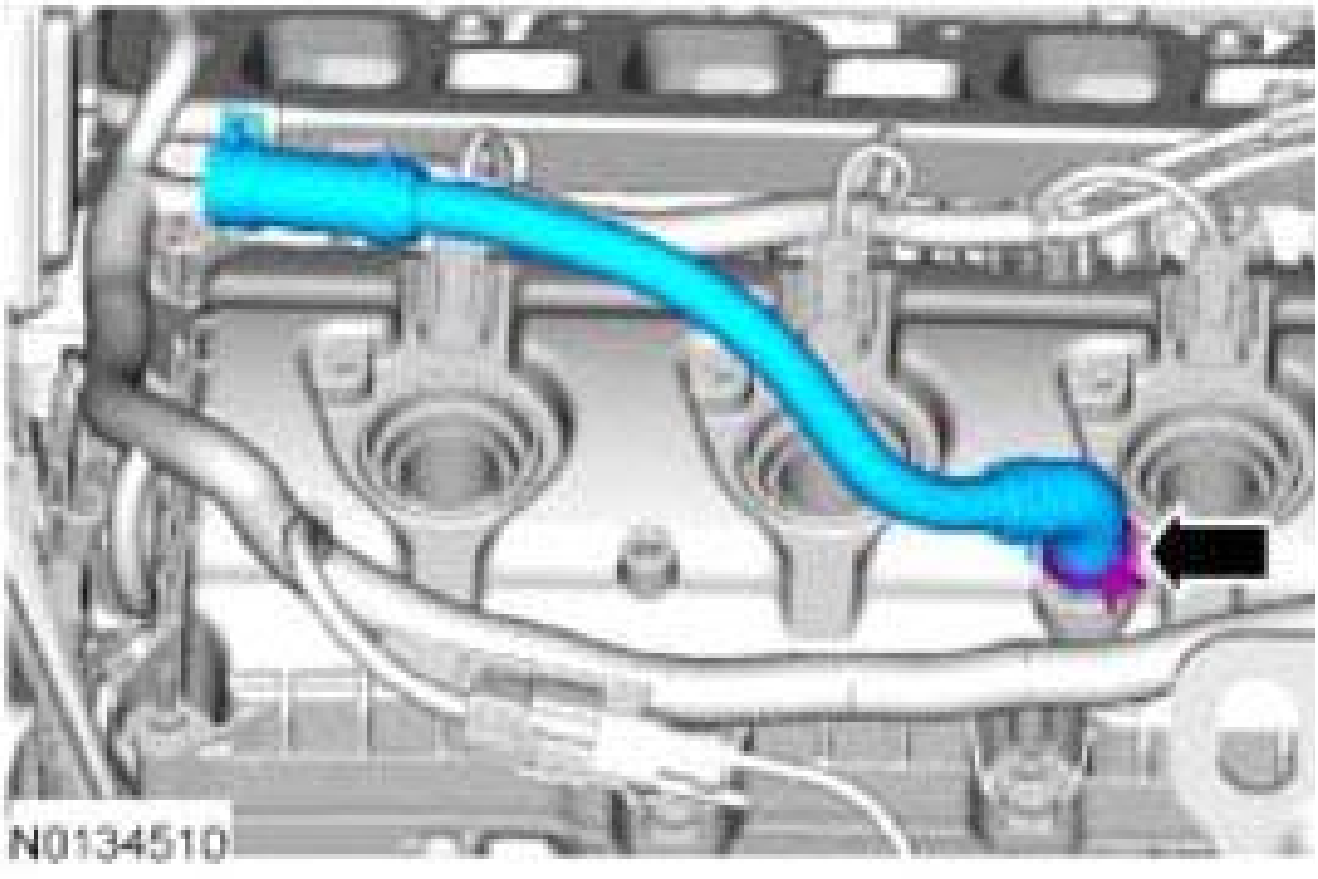
- Inspect the coil seals for rips, nicks or tears. Remove and discard any damaged coil seals.

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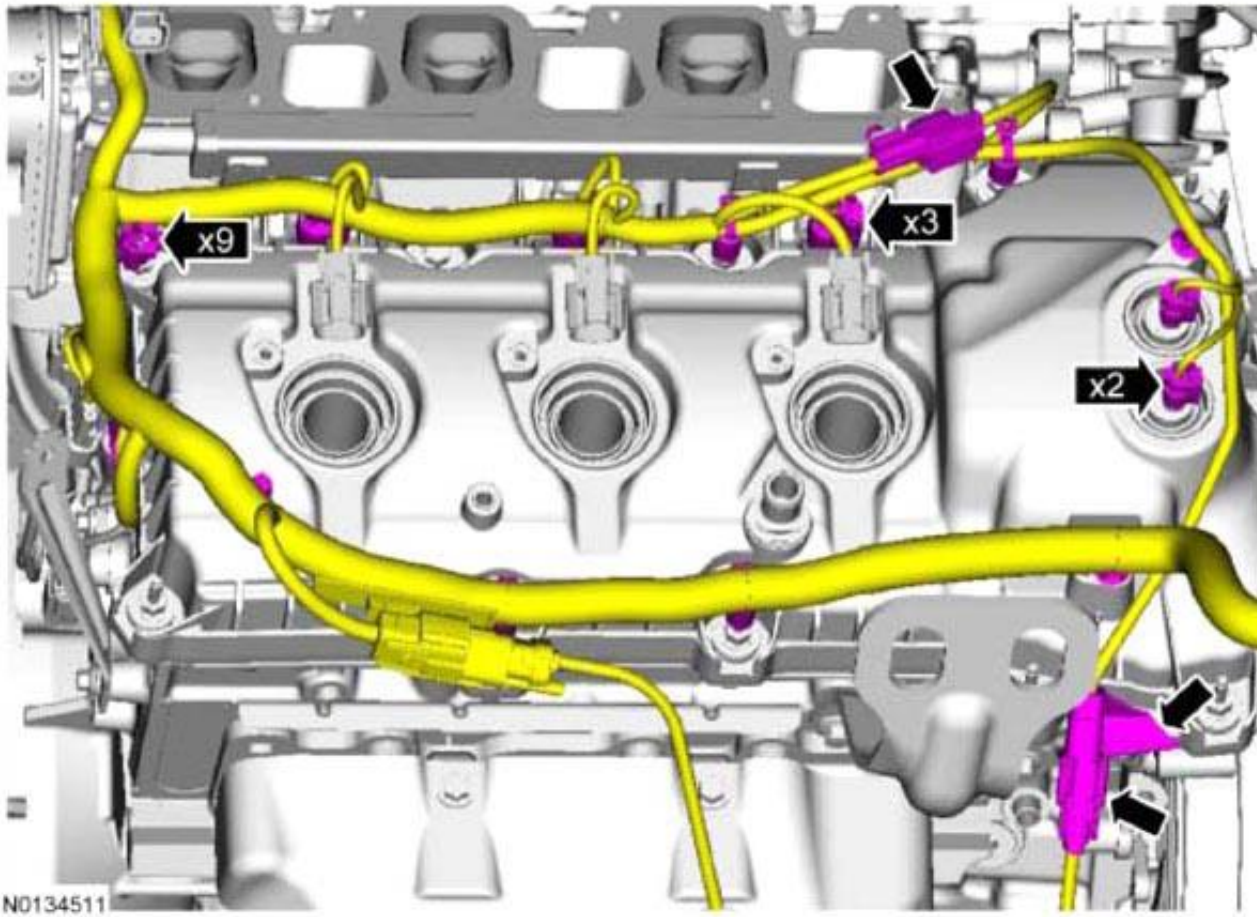
25. Remove the **PCV** crankcase vent tube.

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26. Remove the engine wiring harness from the RH valve cover.
    - Disconnect the 2 **VCT** oil control solenoid electrical connectors.
    - Detach and disconnect the RH **CMS** electrical connector.
    - Disconnect the 3 fuel injector electrical connectors.
    - Disconnect the **CHT** sensor wiring harness jumper electrical connector.
    - Detach the 9 wiring harness retainers from the RH valve cover and stud bolts and position the harness aside.

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27.

NOTE: While removing the valve cover do not apply excessive force to the VCT oil control solenoid or damage may occur.

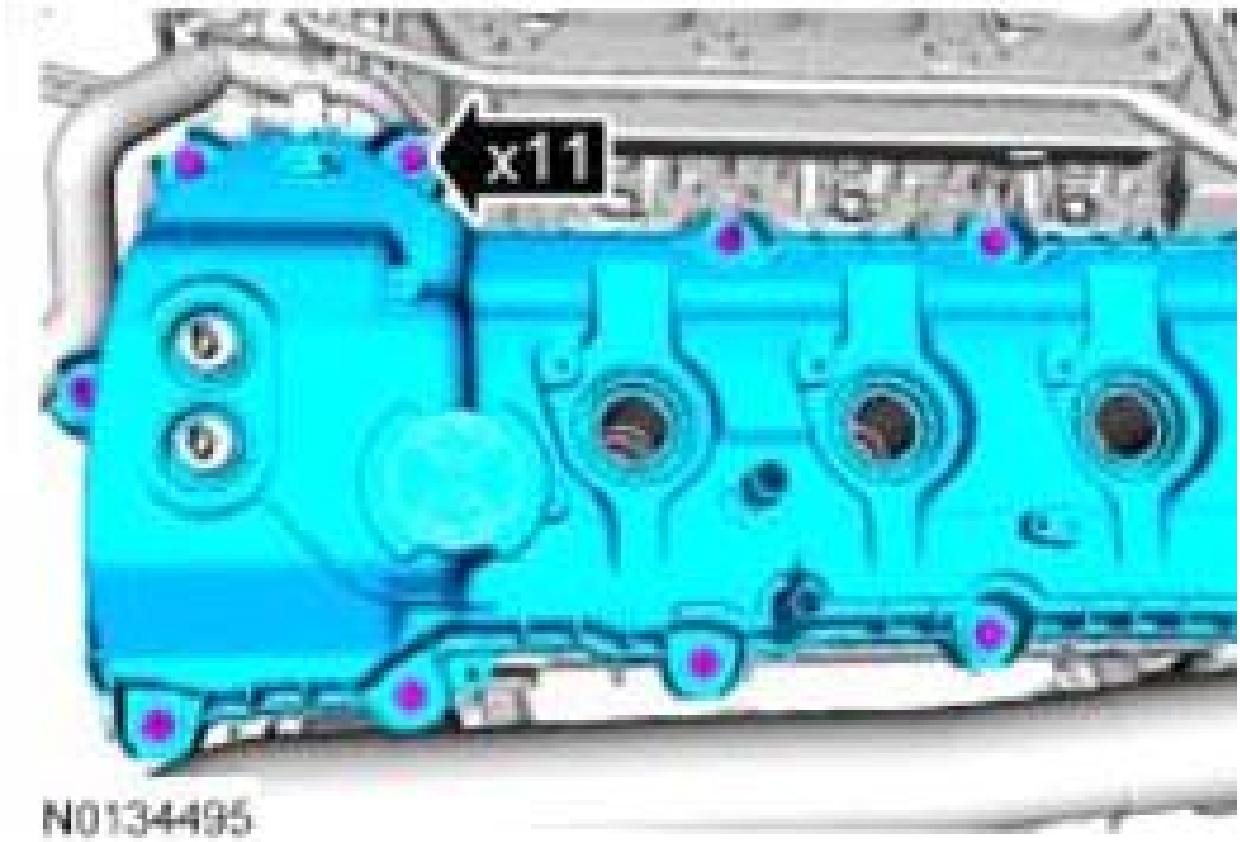
NOTE: If the VCT solenoid seal sticks to the VCT oil control solenoid, then carefully wiggle the valve cover until the bond breaks free.

NOTE: The plastic electrical connector on the VCT oil control solenoid will rotate approximately 12 degrees inside the steel housing, which is normal.

Loosen the 4 bolts and 7 stud bolts and remove the LH valve cover.

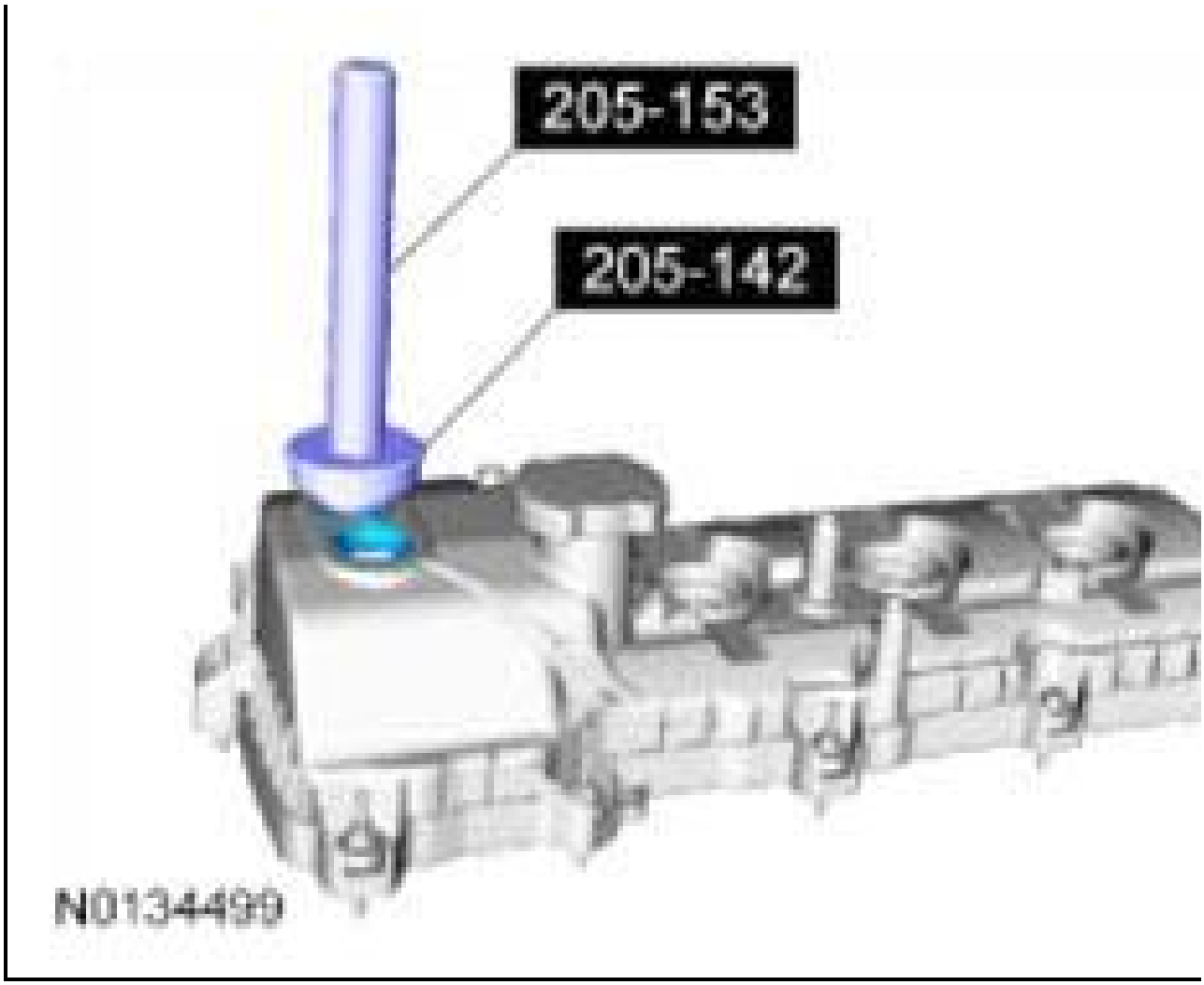
- Discard the gasket.

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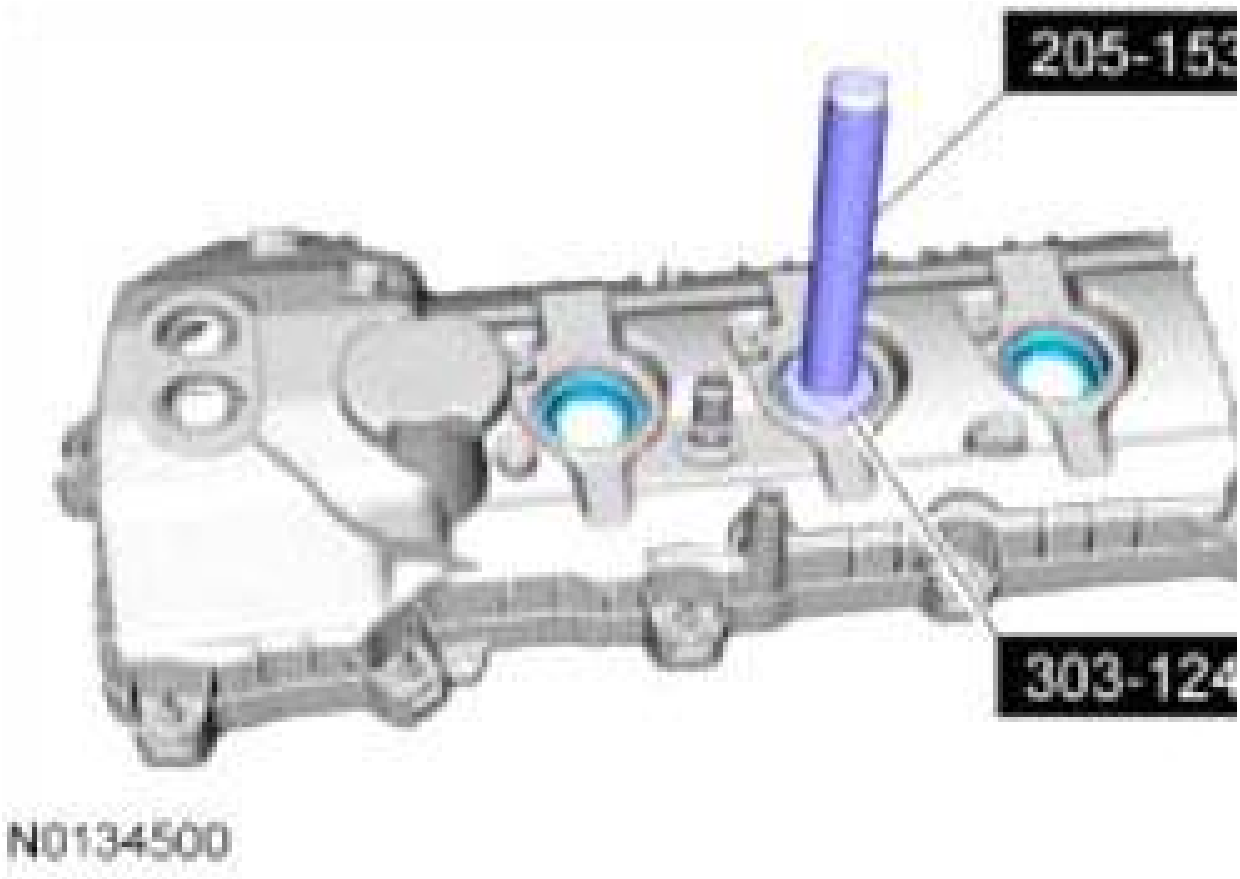
28. Inspect the 2 **VCT** solenoid seals. Remove any damaged seals.
    - Using 205-142 T80T-4000-J and 205-153 T80T-4000-W, remove and discard the damaged seal(s).

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29. Inspect the spark plug tube seals. Remove any damaged seals.
    - Using 303-1247/1 and 205-153 T80T-4000-W, remove and discard the damaged seal(s).

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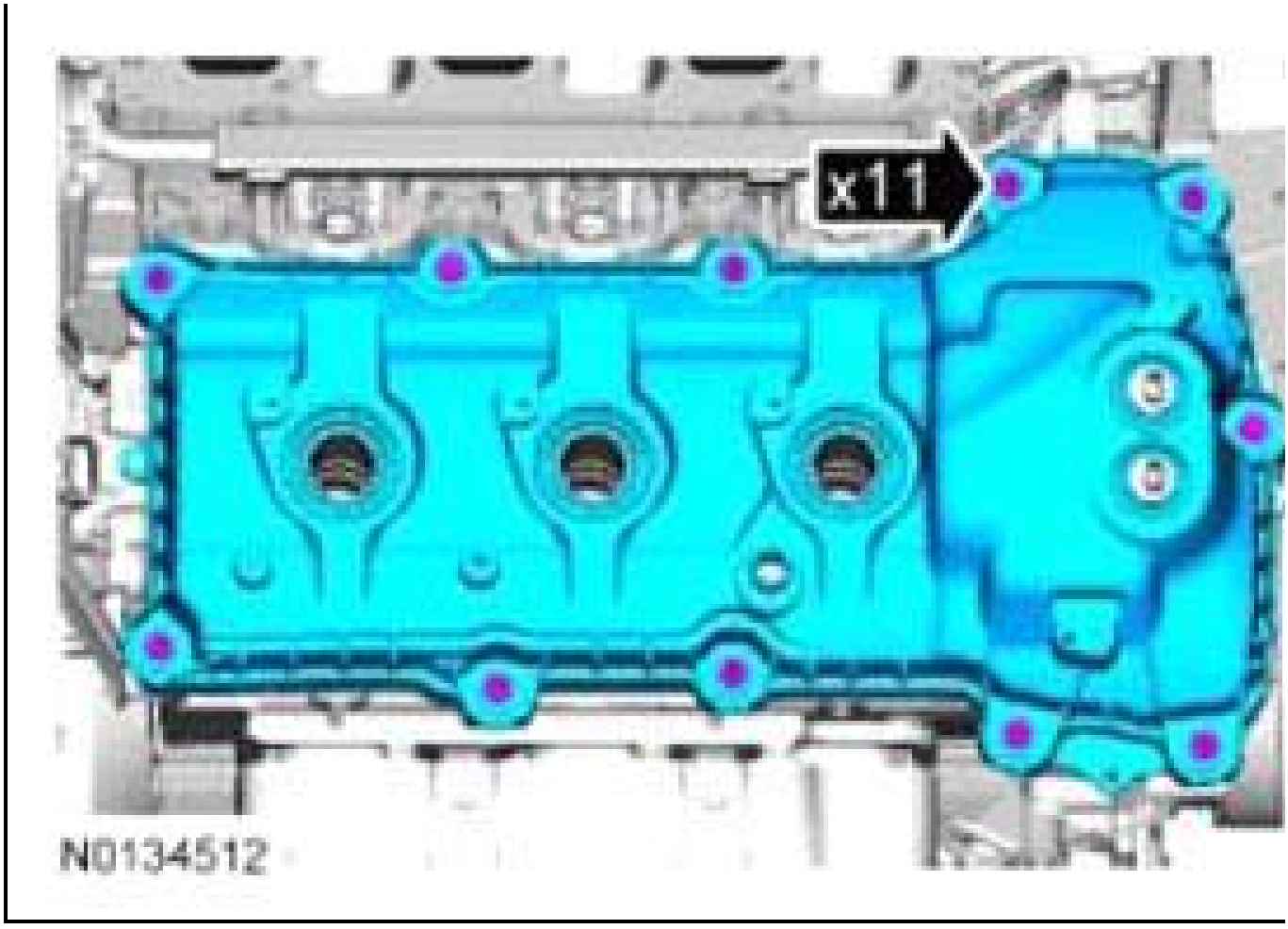
30. **NOTE: While removing the valve cover do not apply excessive force to the VCT oil control solenoid or damage may occur.**

NOTE: If the VCT solenoid seal sticks to the VCT oil control solenoid, then carefully wiggle the valve cover until the bond breaks free.

NOTE: The plastic electrical connector on the VCT oil control solenoid will rotate approximately 12 degrees inside the steel housing, which is normal.

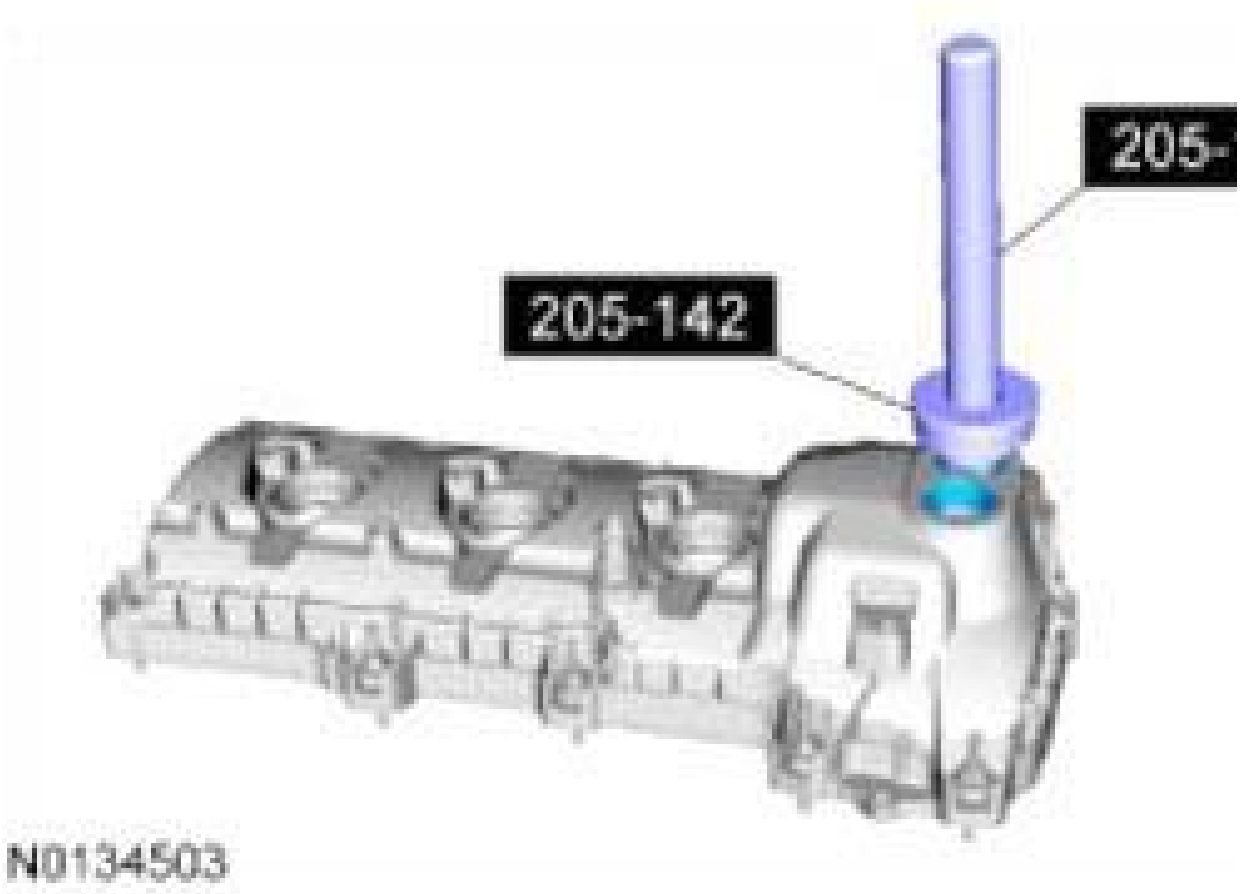
Loosen the 3 bolts and 8 stud bolts. Remove the RH valve cover. Discard the gasket.

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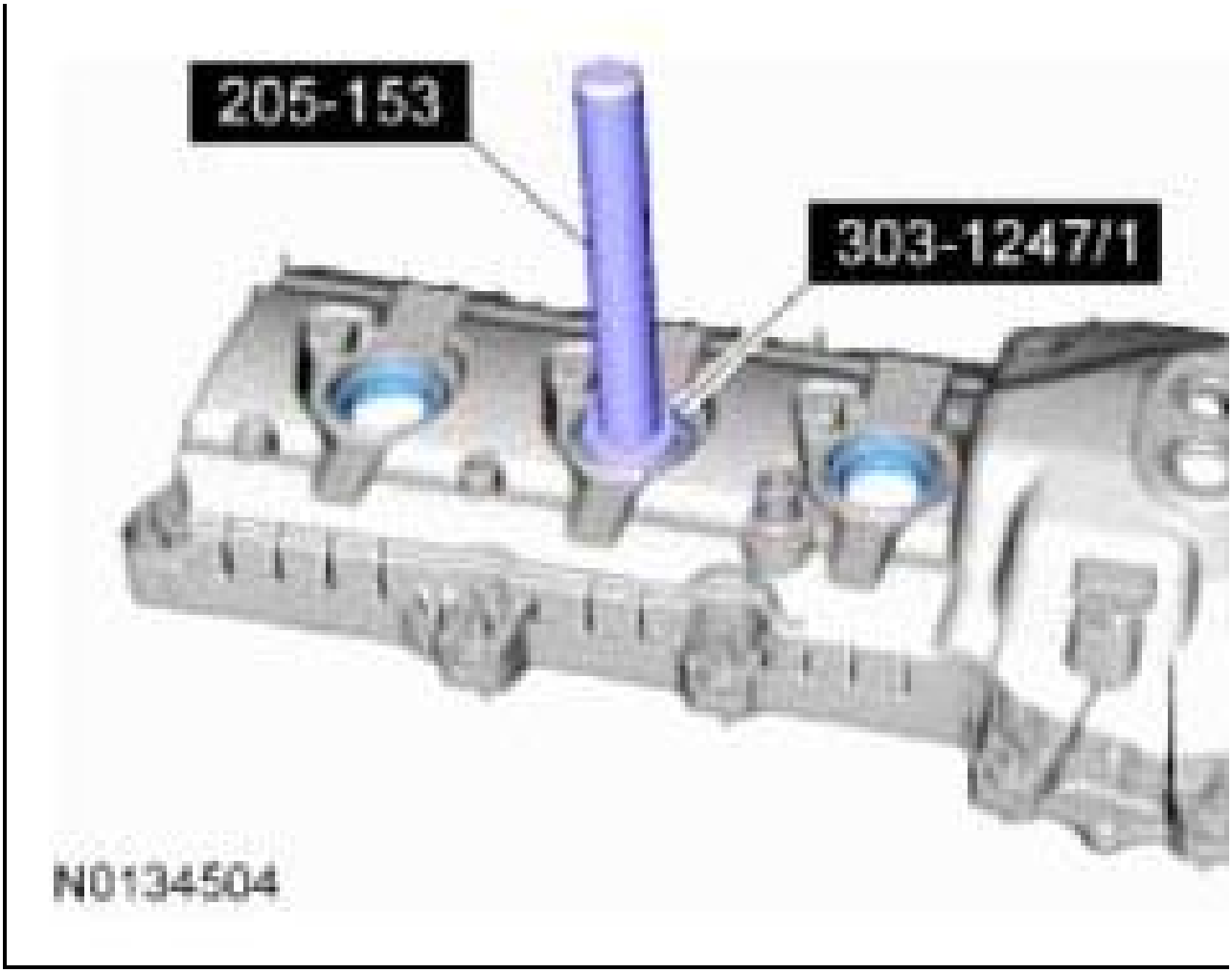
31. Inspect the 2 **VCT** solenoid seals. Remove any damaged seals.
    - Using 205-142 T80T-4000-J and 205-153 T80T-4000-W, remove and discard the damaged seal(s).

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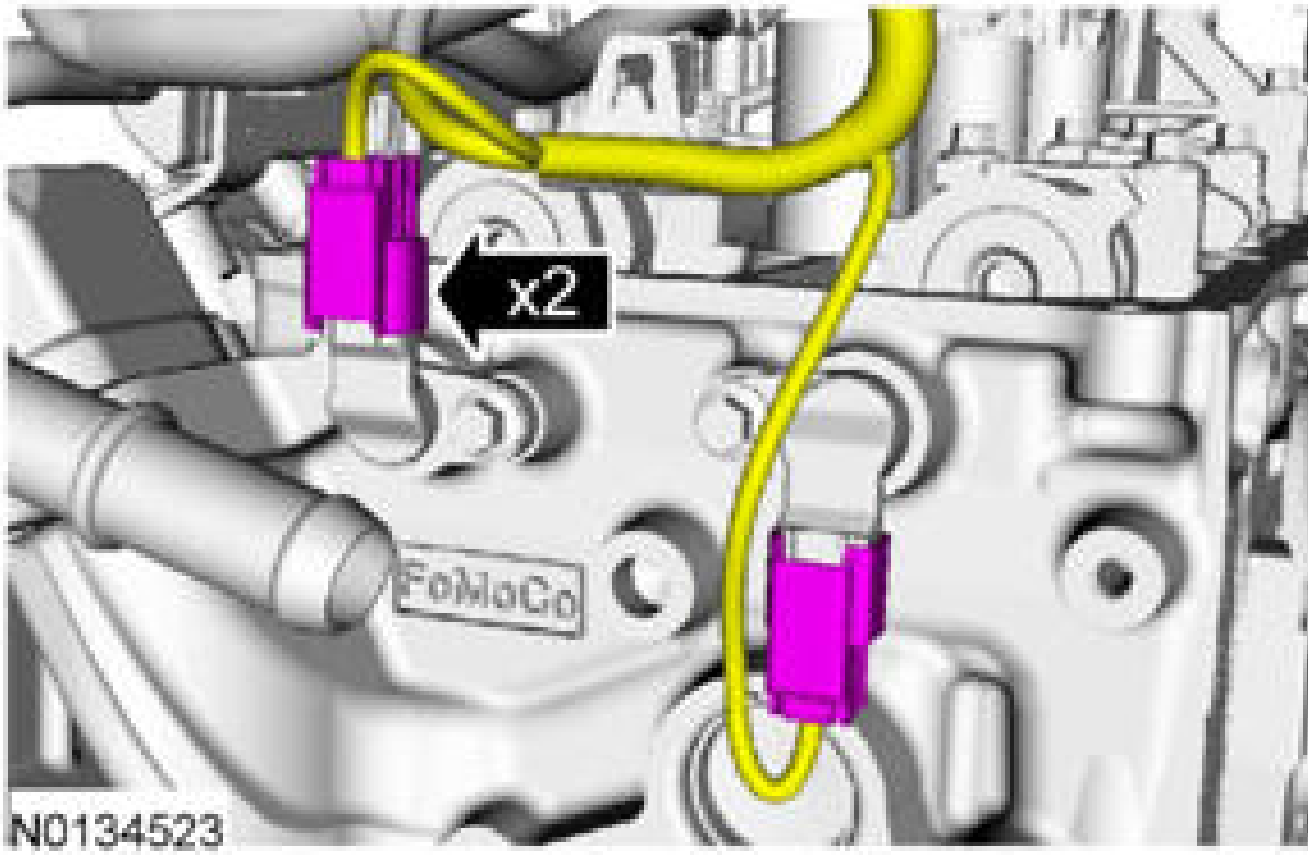
32. Inspect the spark plug tube seals. Remove any damaged seals.
    - Using 303-1247/1 and 205-153 T80T-4000-W, remove and discard the damaged seal(s).

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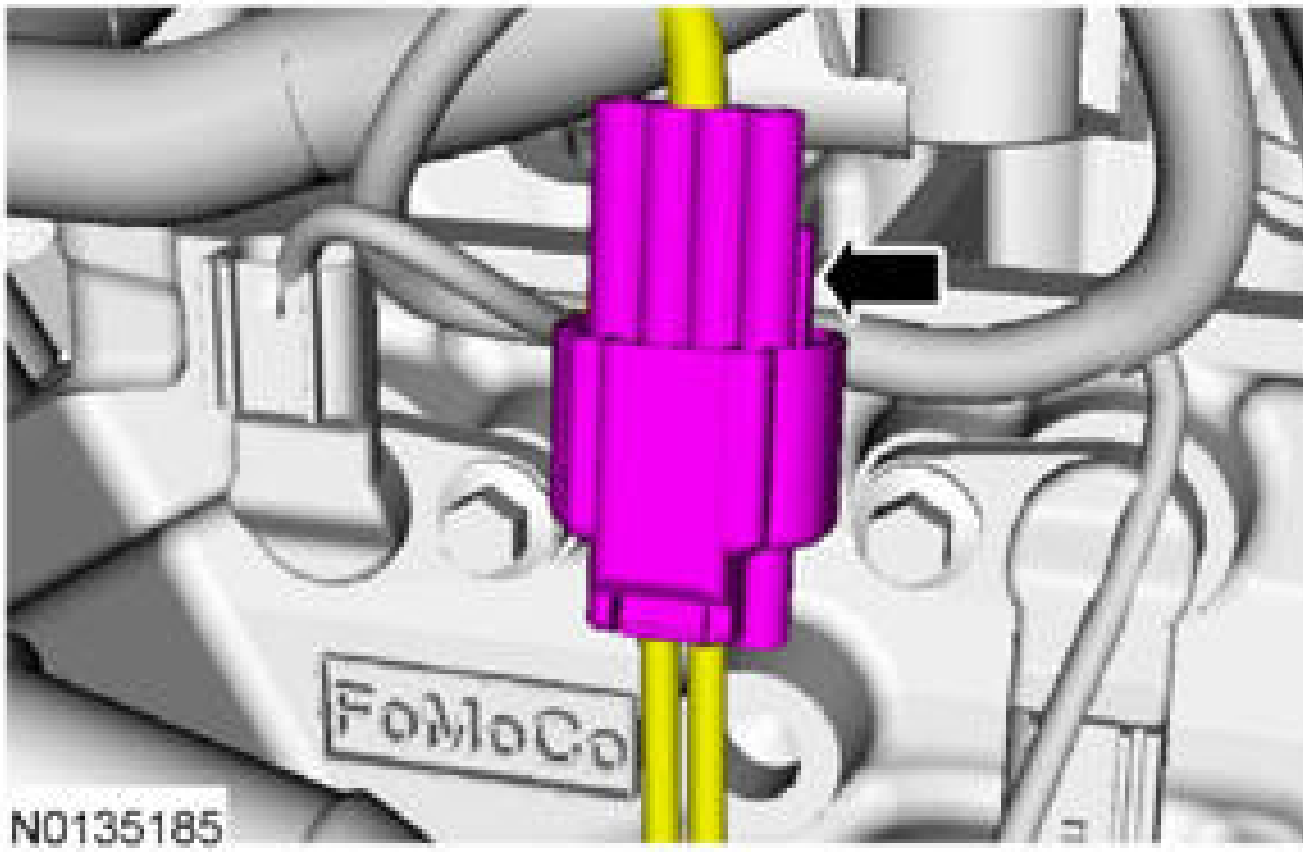
33. Clean the valve covers, cylinder heads and engine front cover sealing surfaces with metal surface prep.
34. Disconnect the 2 RH **CMP** sensor electrical connectors.

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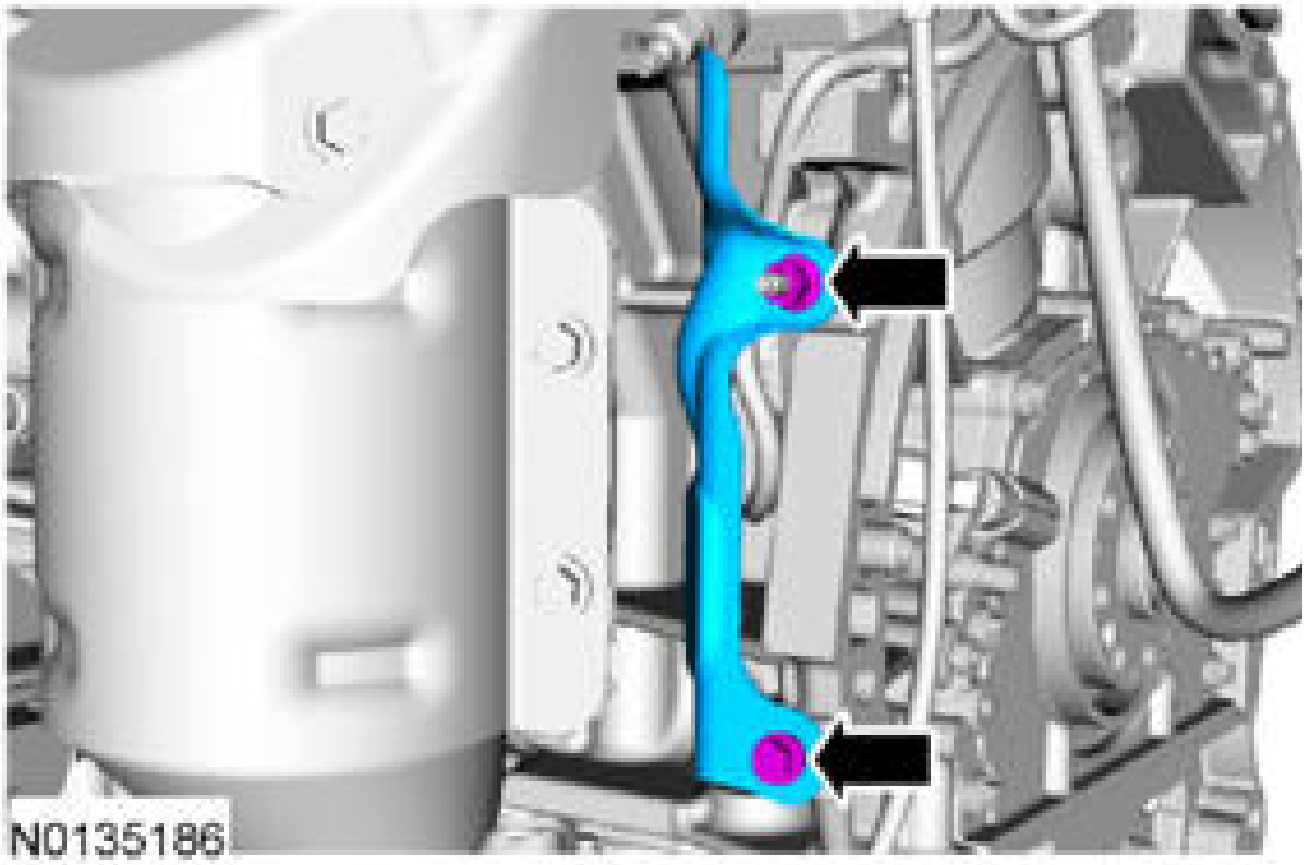
35. Disconnect the KS electrical connector.

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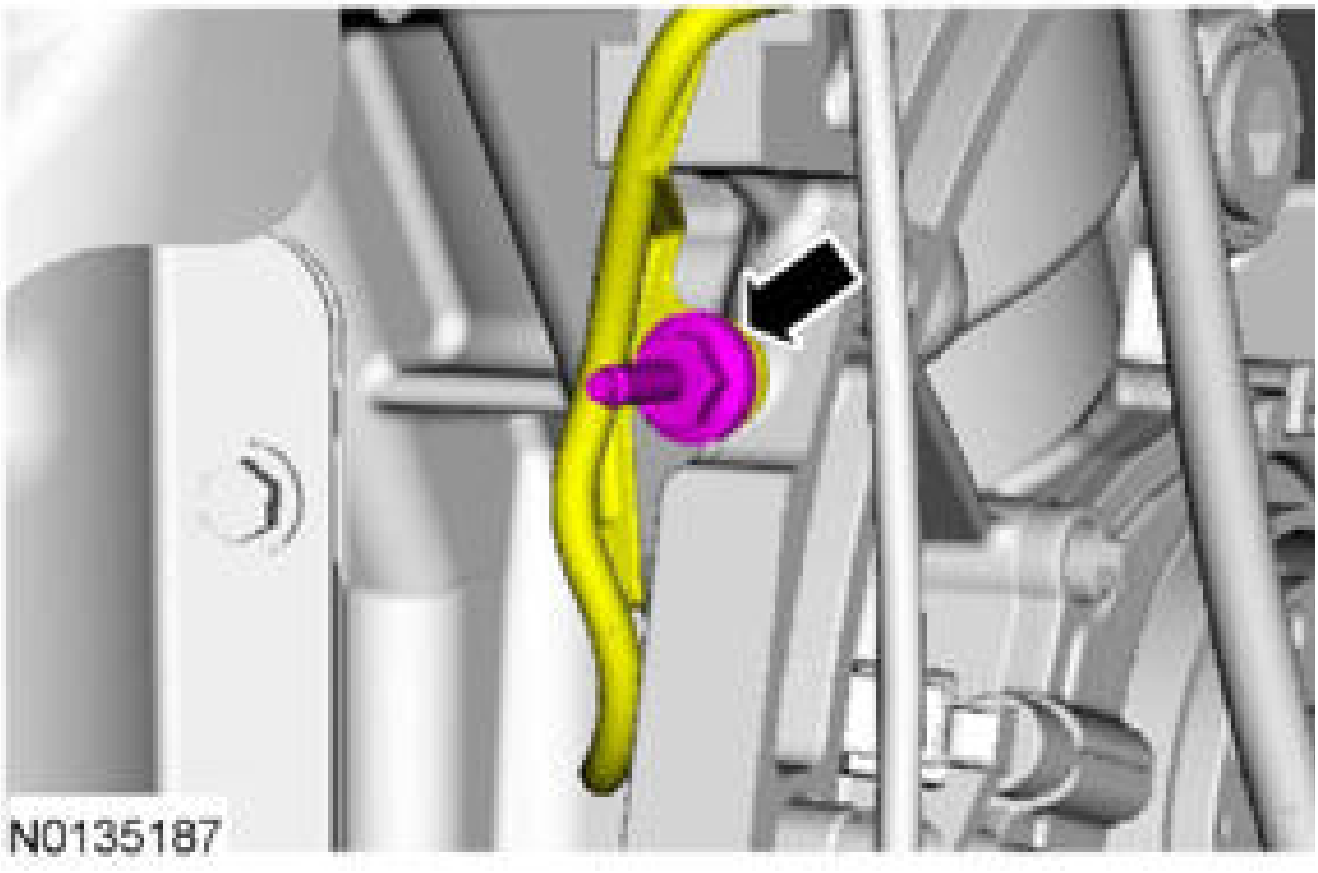
36. Remove the nut, the bolt and the heat shield.

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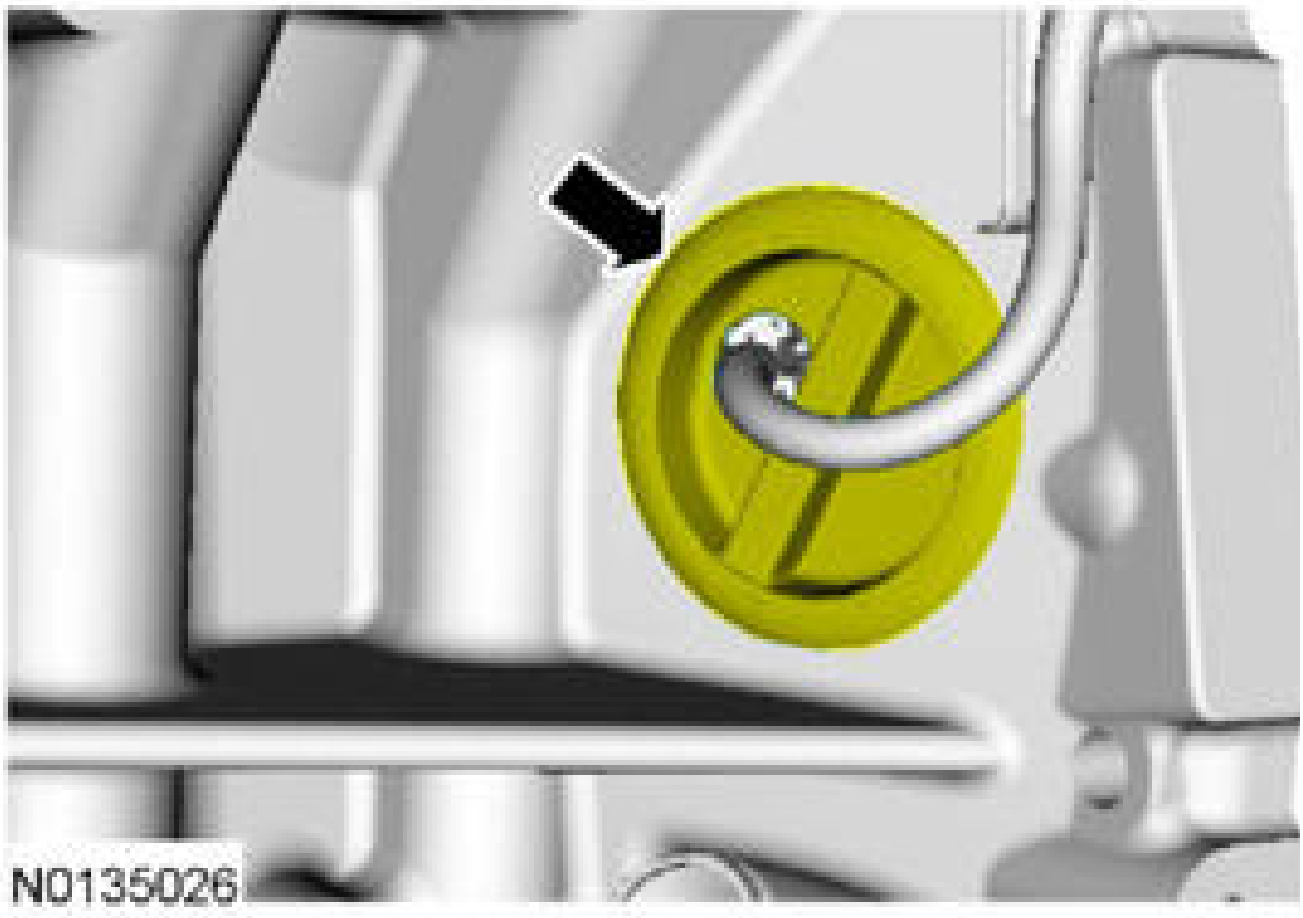
37. Remove the wiring harness retainer stud bolt.

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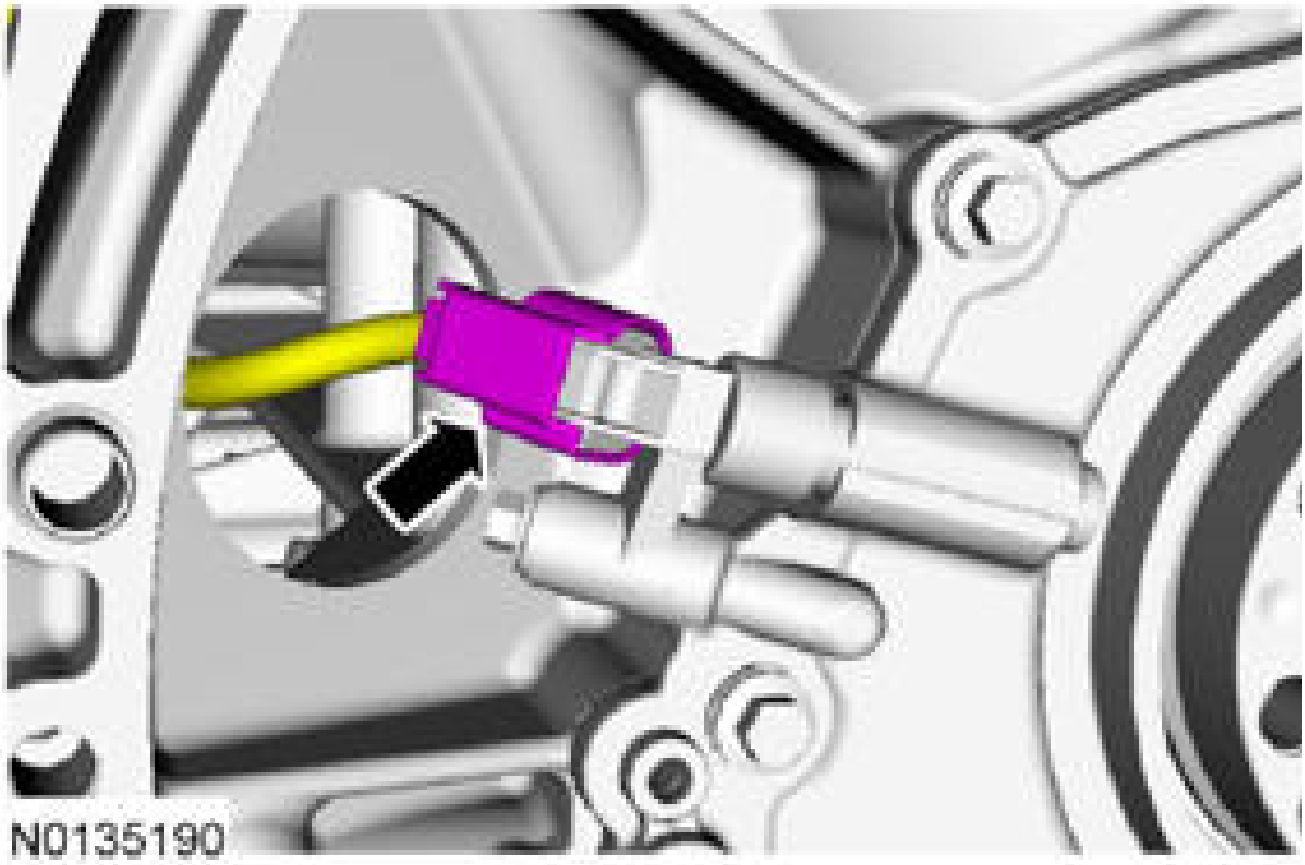
38. Remove the wiring harness grommet.

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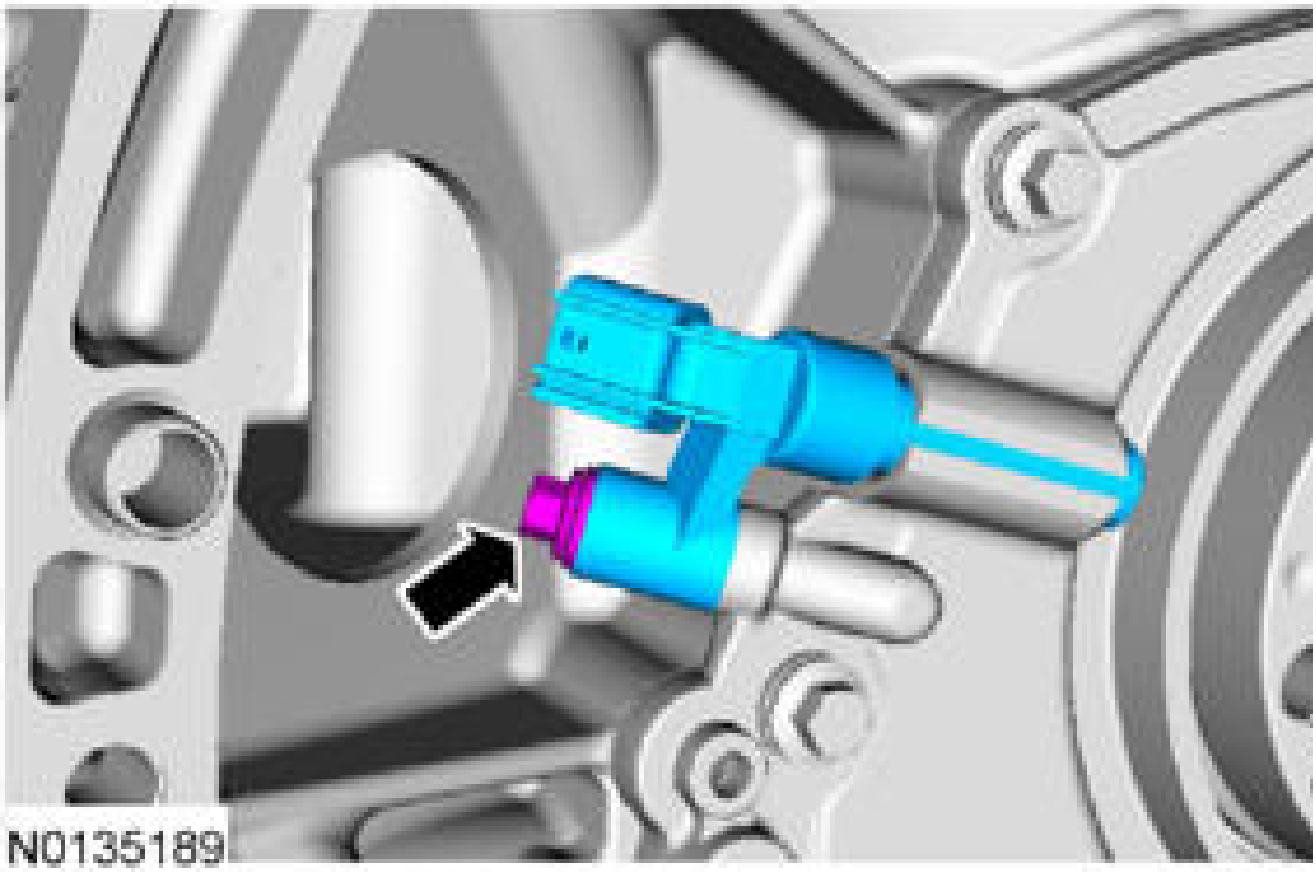
39. Disconnect the **CKP** sensor electrical connector.

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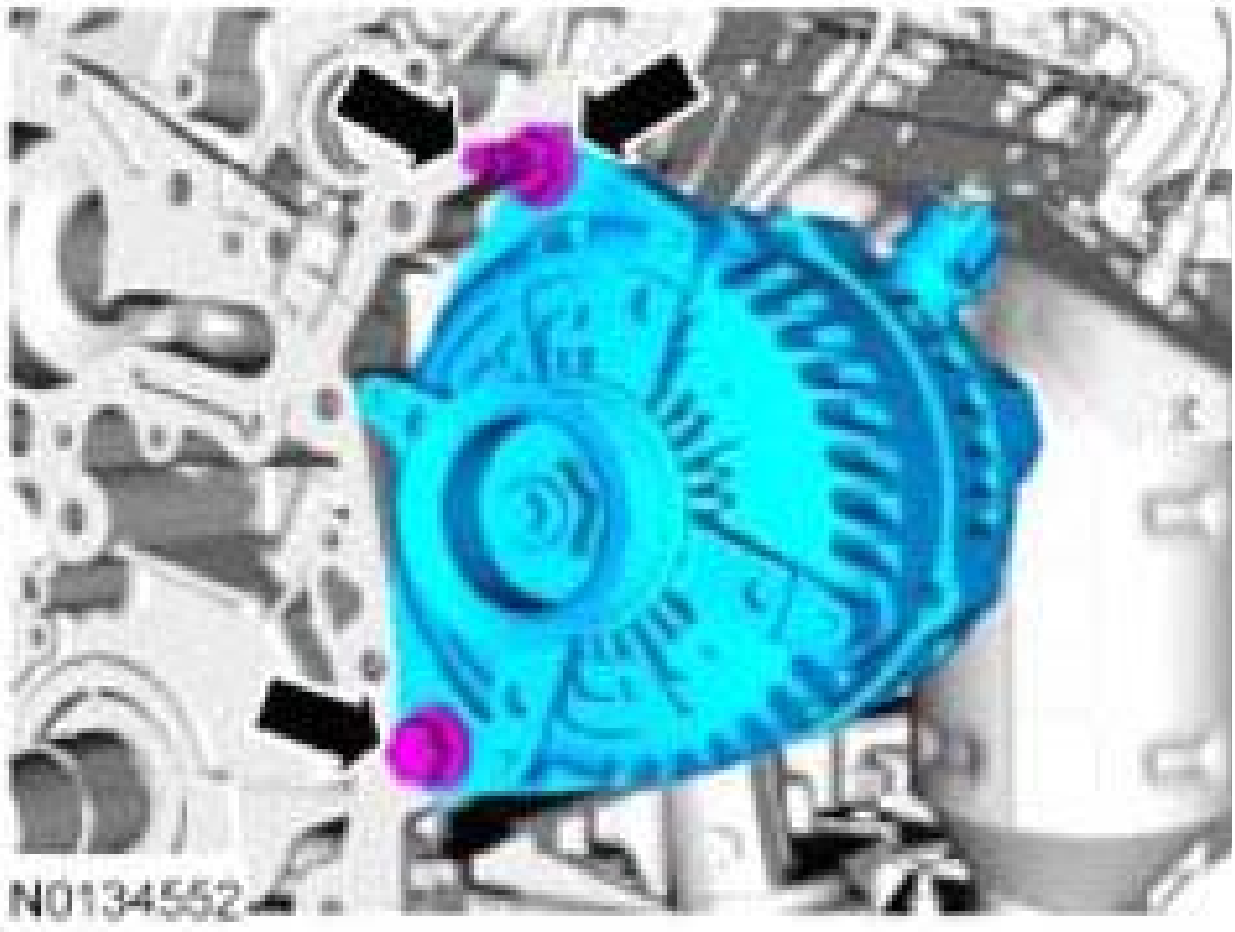
40. Remove the bolt and the **CKP** sensor.

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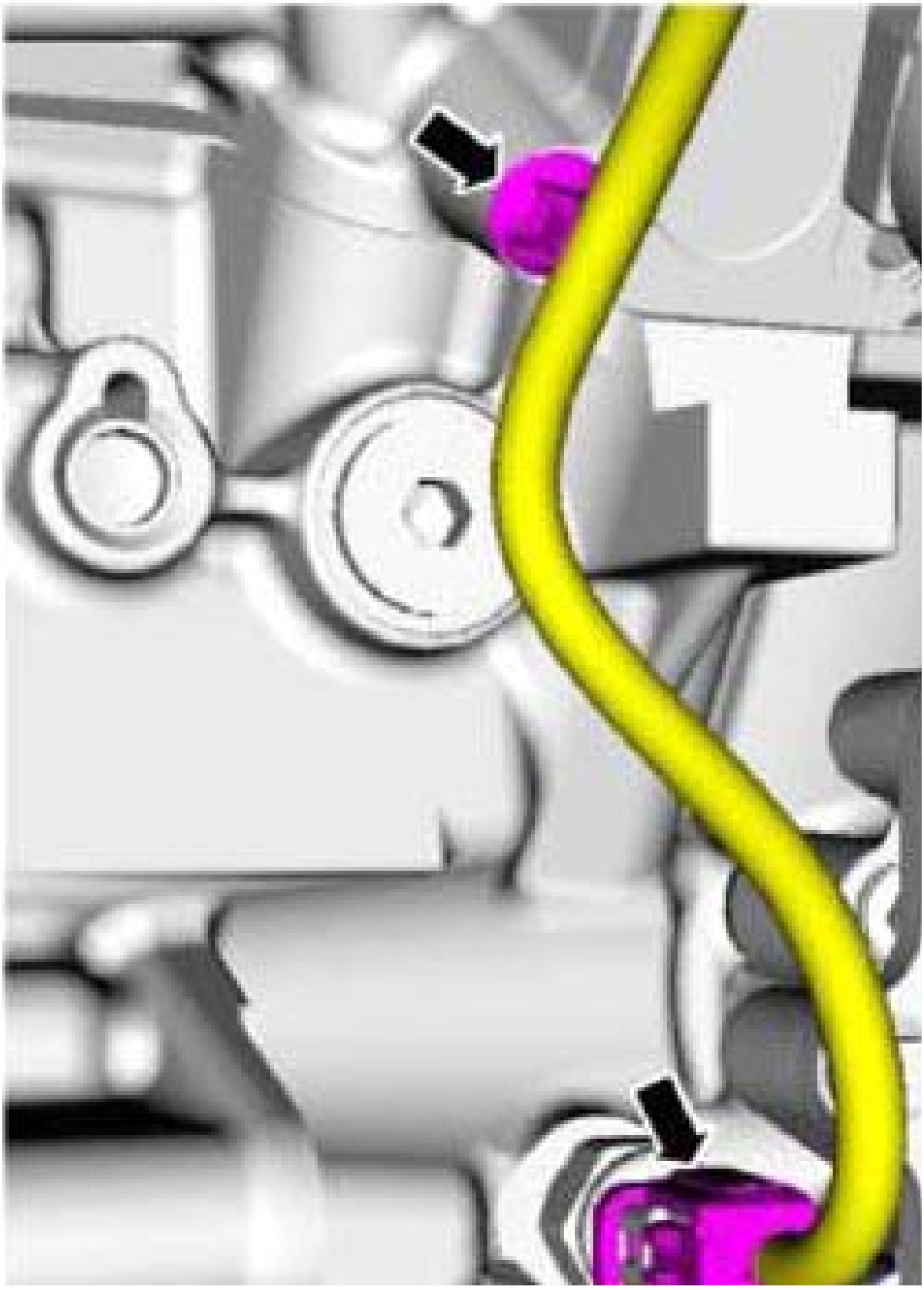
41. Remove the nut, bolt and the generator.
    - Remove the generator stud.

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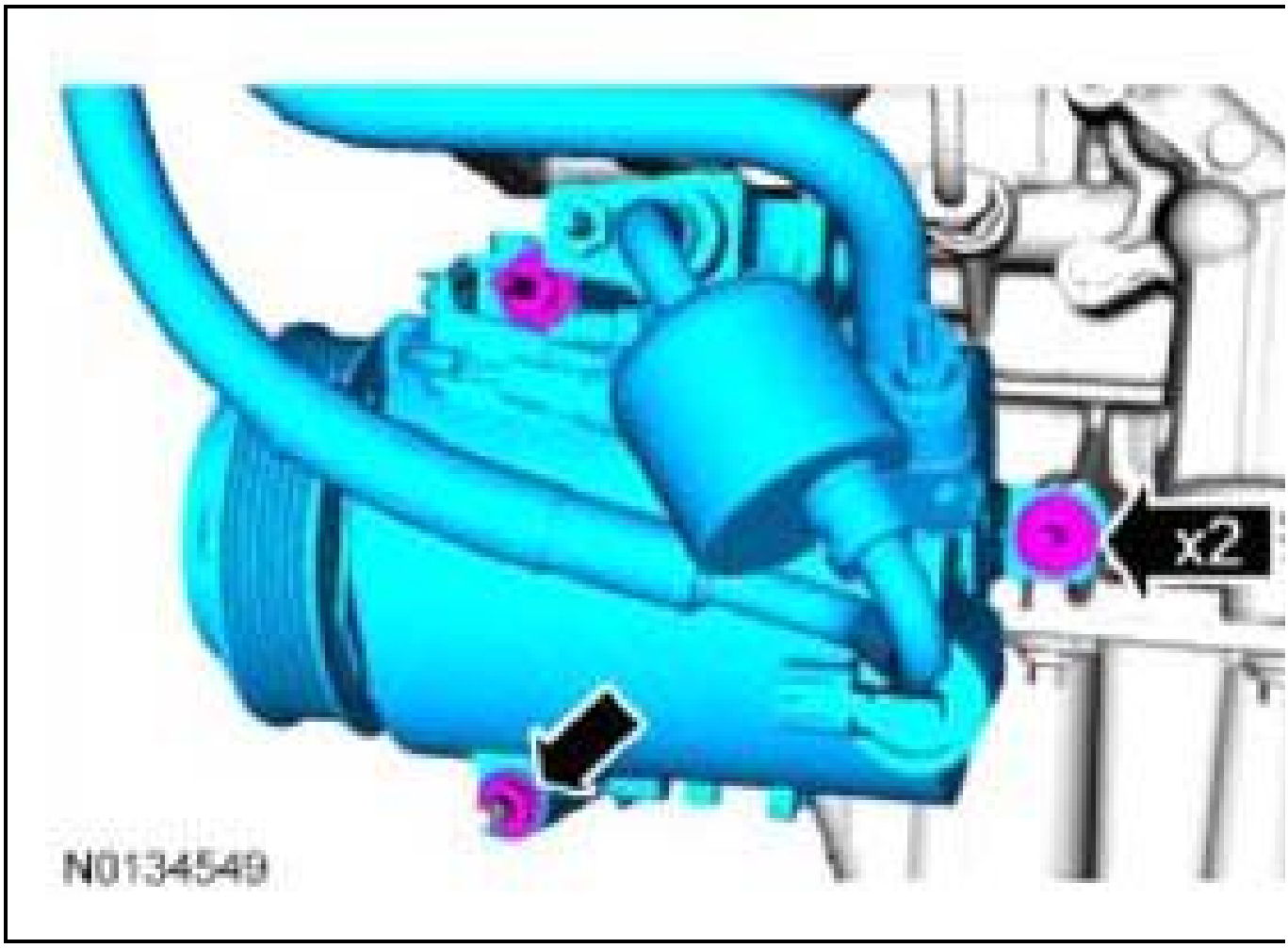
42. Disconnect the EOP switch electrical connector and the wiring harness pin-type retainer.
    - Remove the wiring harness from the engine.

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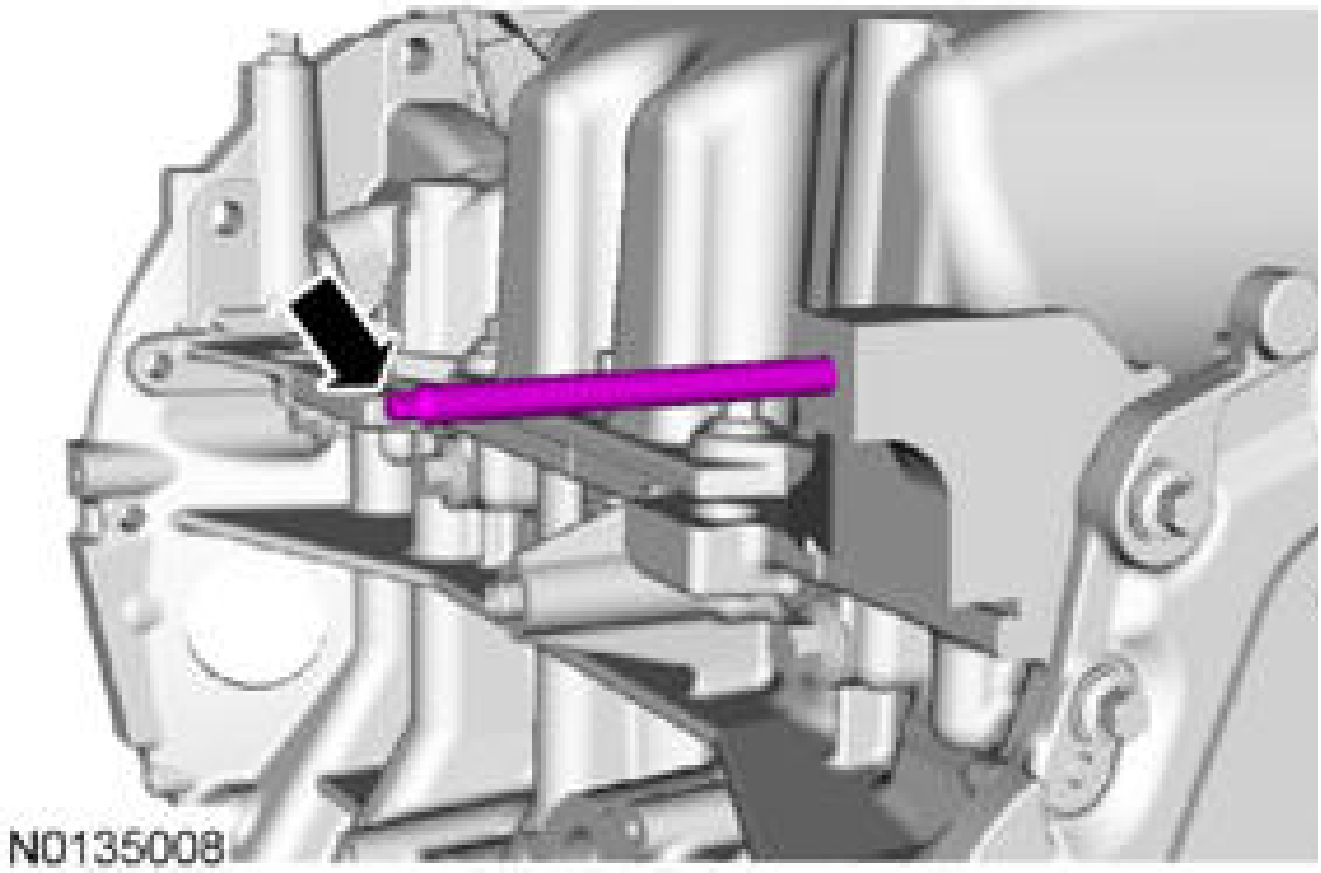
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43. Remove the nut, 2 stud bolts and the A/C compressor.



44. Remove the A/C compressor mounting stud from the oil pan.

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45. **NOTE: If necessary, lubricate the Left Hand (LH) HO2S with penetrating and lock lubricant to assist in removal.**

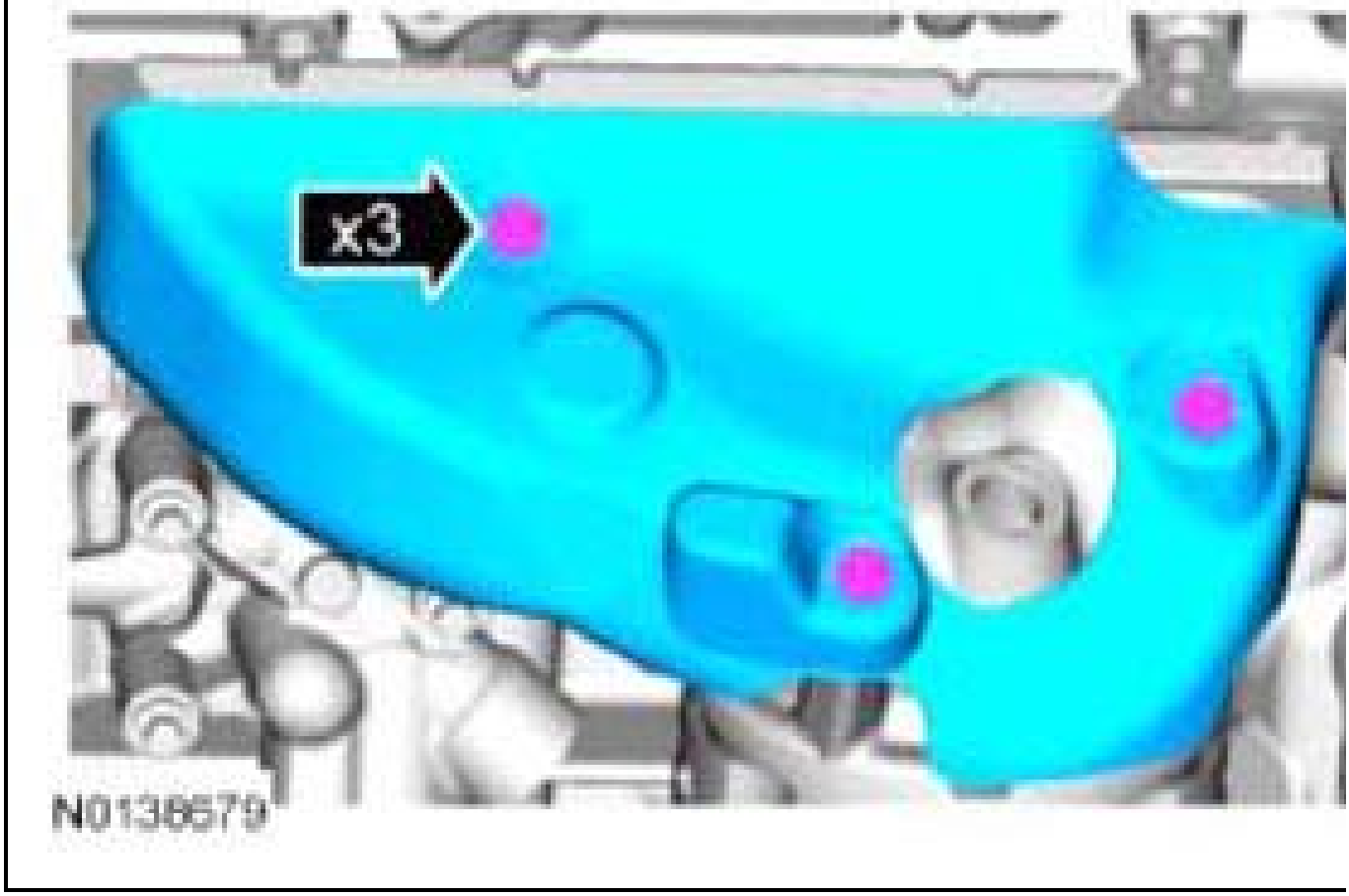
Remove the LH **HO2S** .

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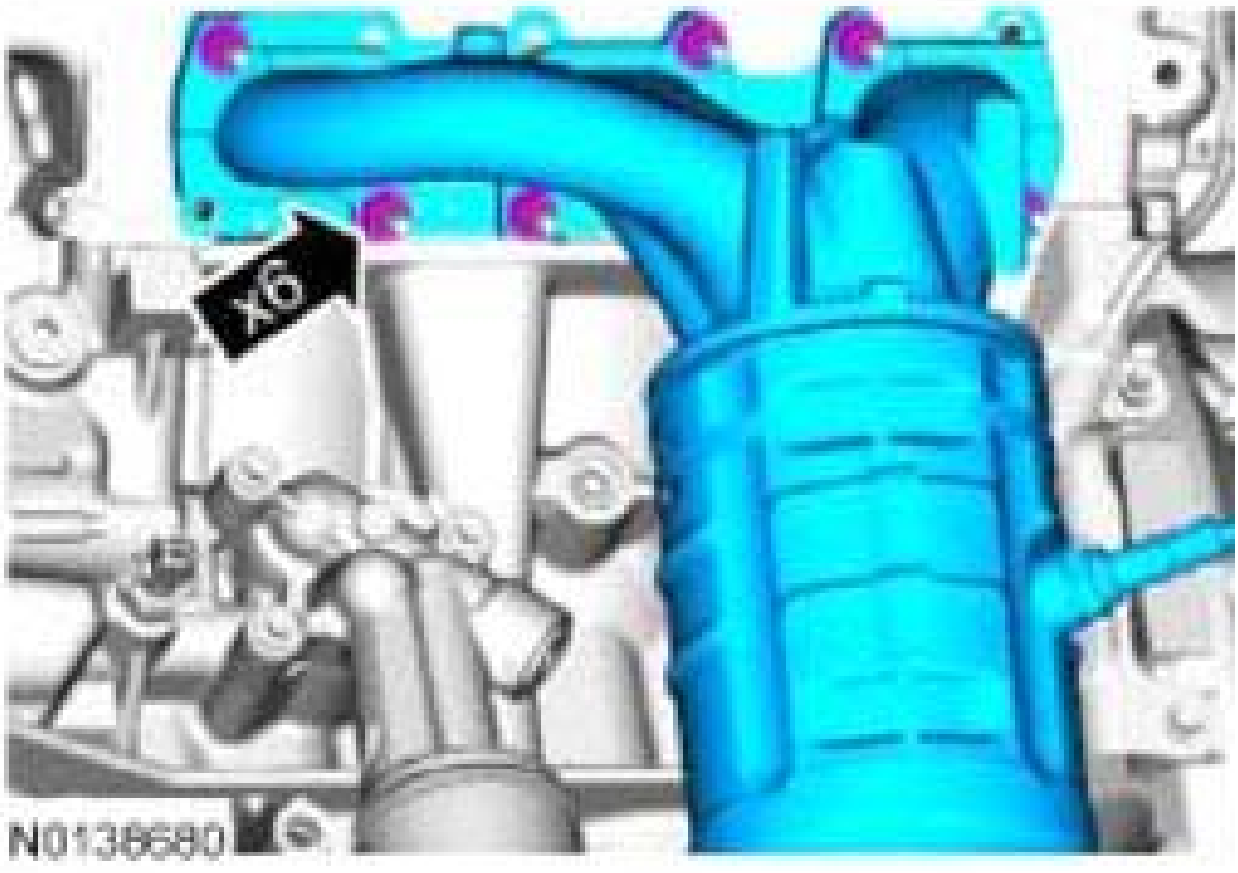
46. Remove the 3 bolts and the LH exhaust heat shield.

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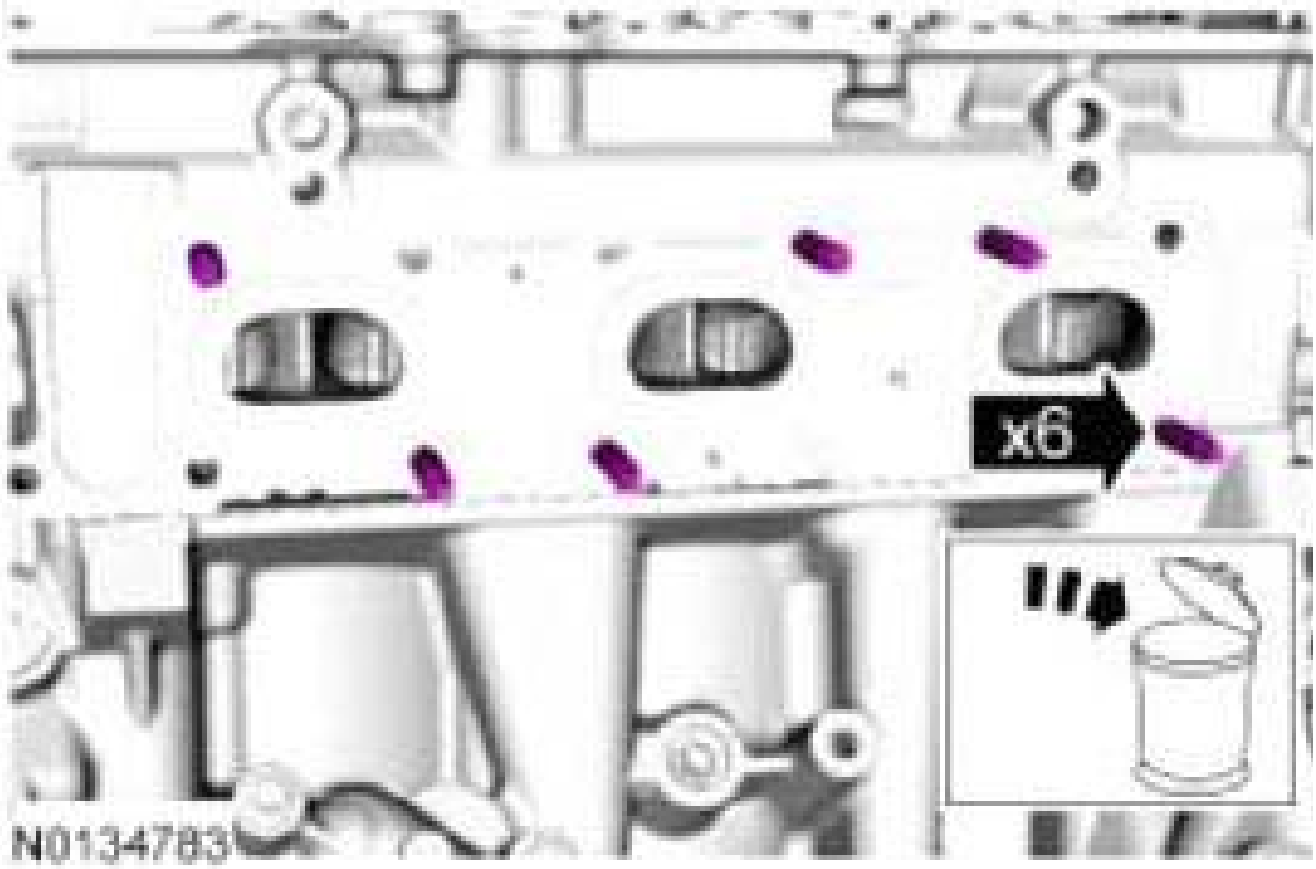
47. Remove the 6 nuts and the LH catalytic converter.
    - Discard the nuts and the gasket.

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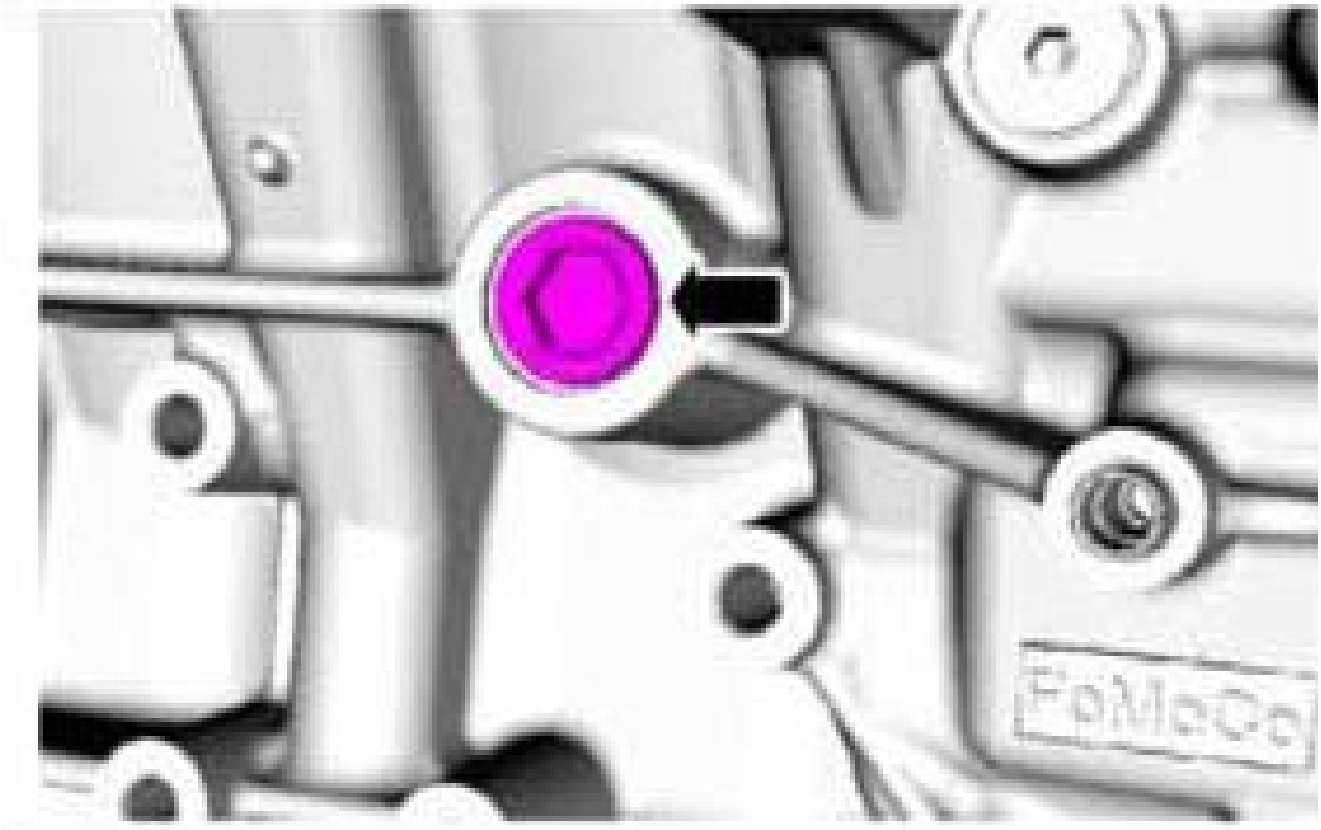
48. Clean and inspect the catalytic converter flange. REFER to **EXHAUST MANIFOLD CLEANING AND INSPECTION** .
49. Remove and discard the 6 LH exhaust manifold studs.

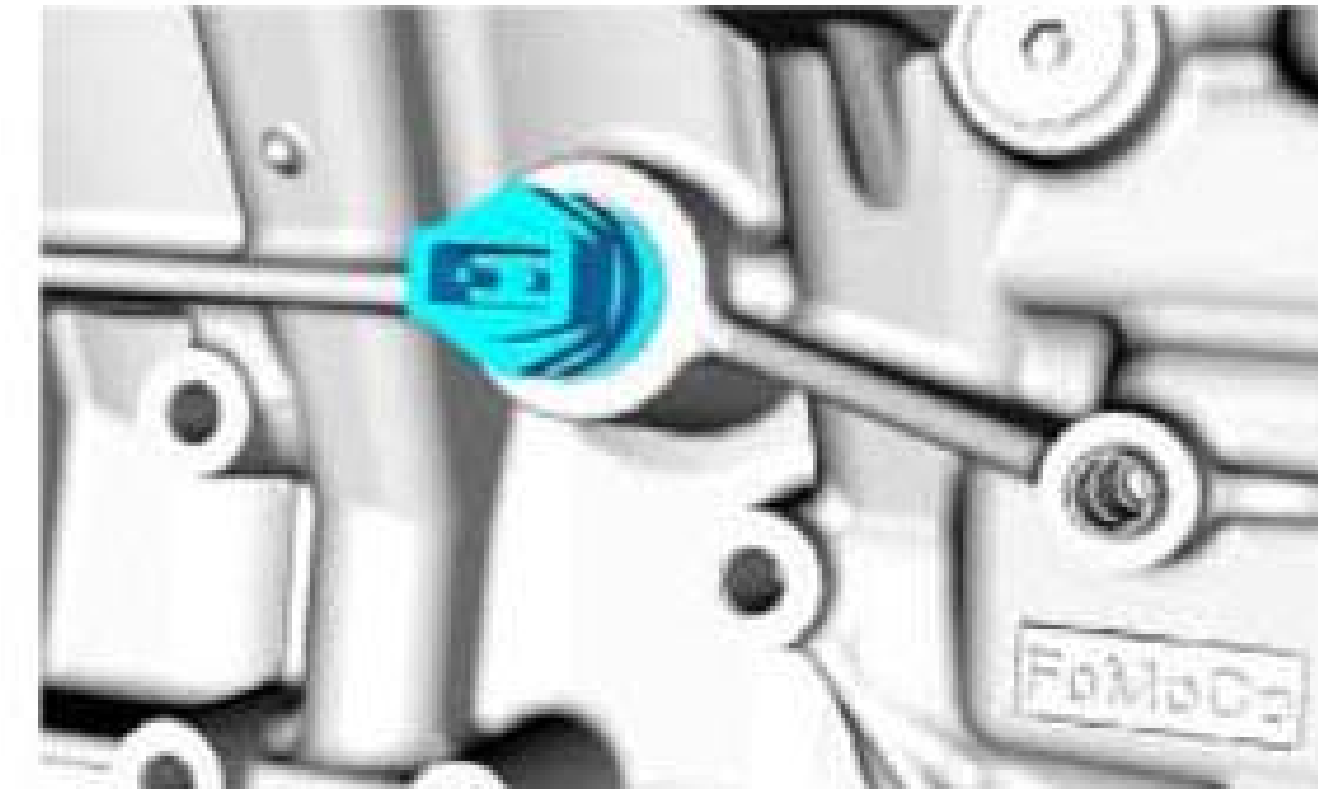
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50. Remove the RH cylinder block drain plug or, if equipped, the block heater. Allow coolant to drain from the cylinder block.

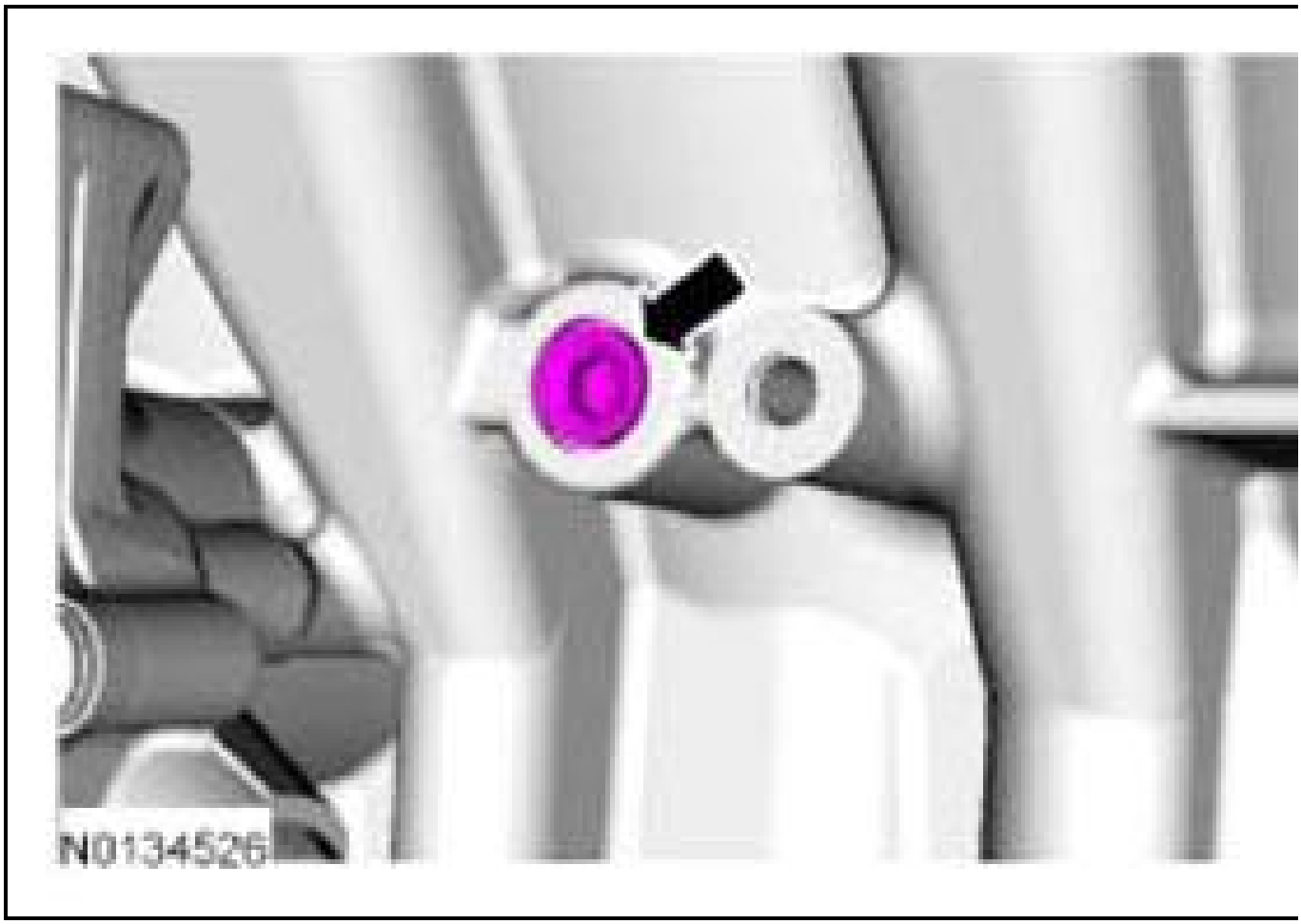
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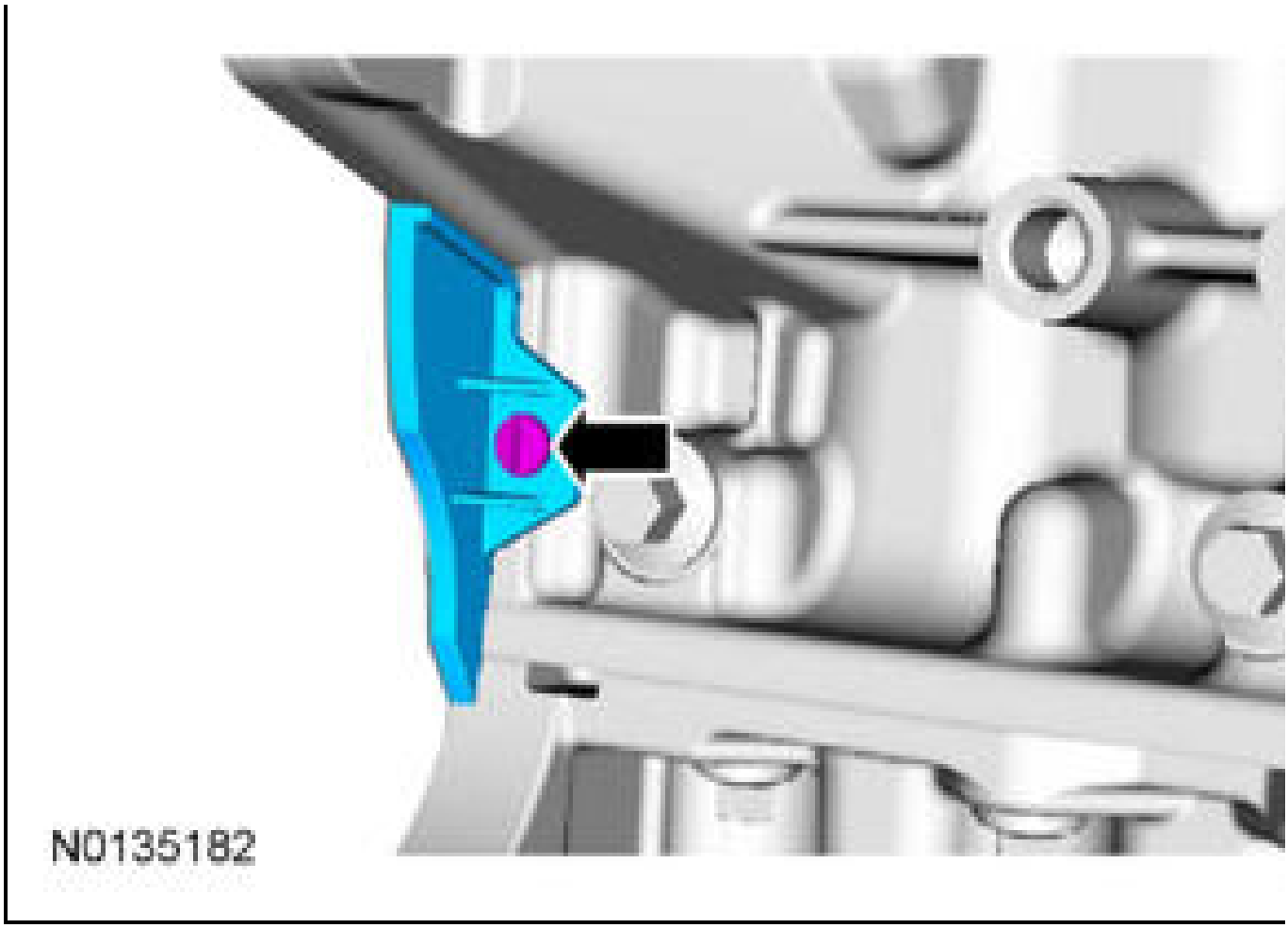
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51. Remove the LH cylinder block drain plug. Allow coolant to drain from the cylinder block.



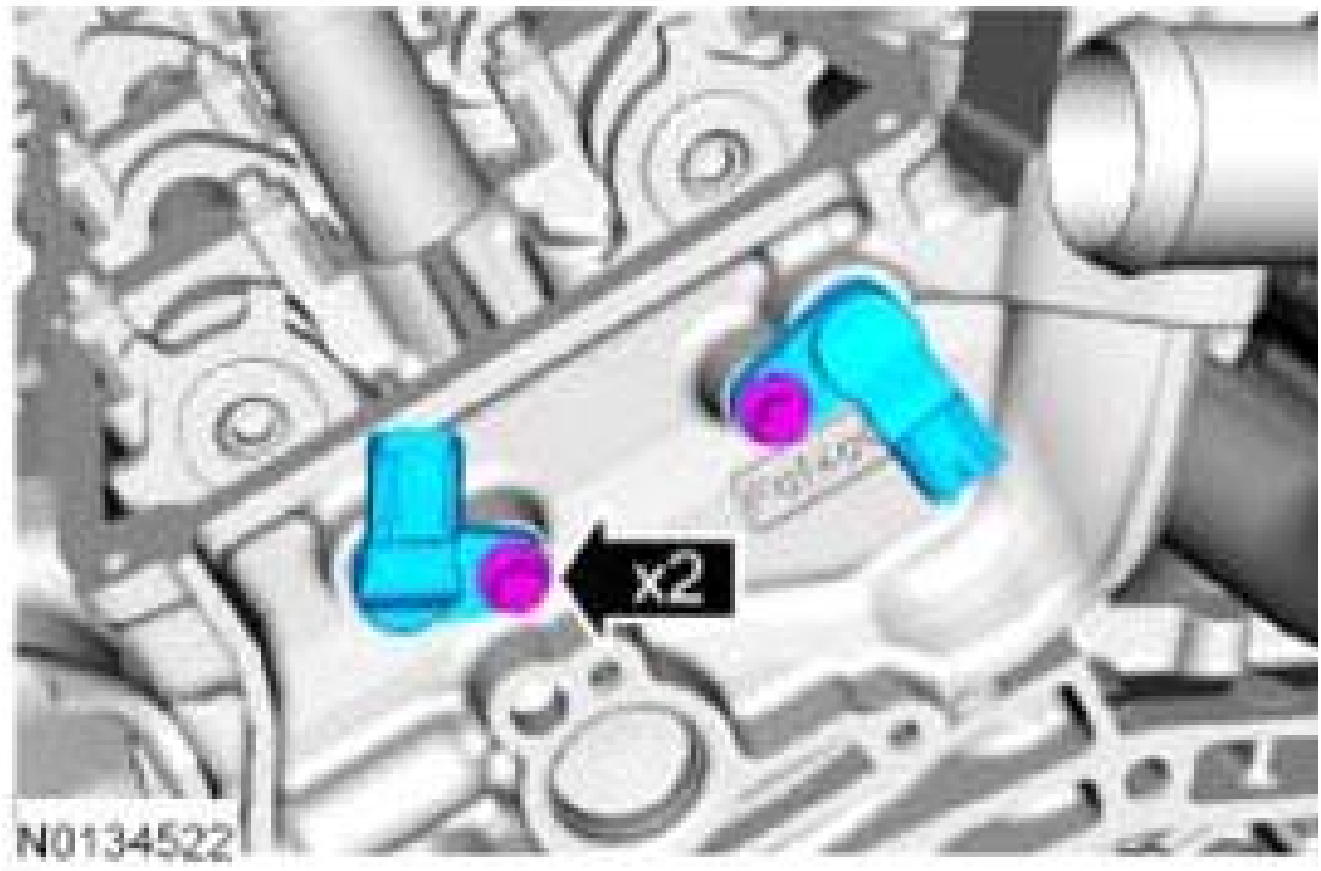
52. Remove the pin-type retainer and the cover.

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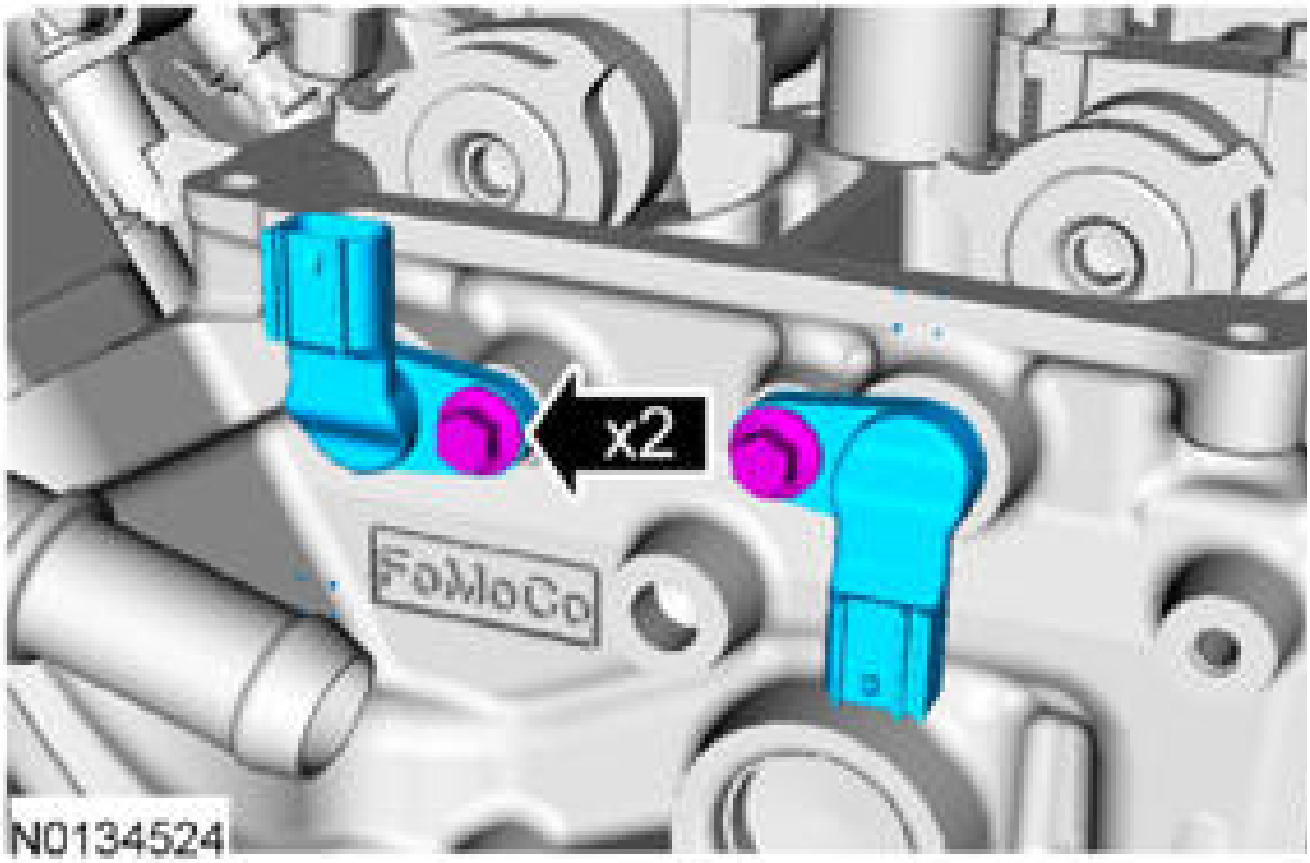
53. Remove the 2 bolts and the 2 LH CMP sensors.

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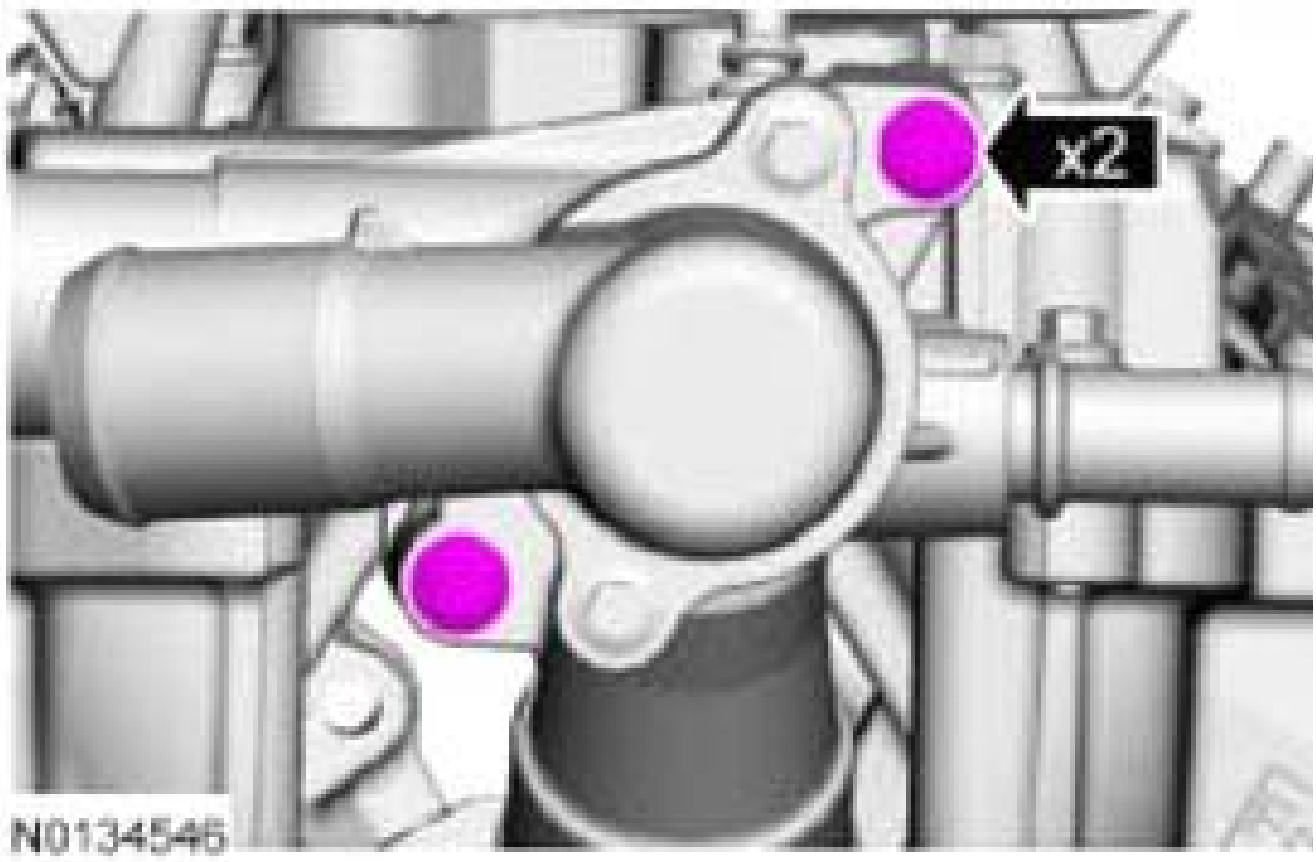
54. Remove the 2 bolts and the 2 LH CMP sensors.

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55. Remove the 2 thermostat housing-to-lower intake manifold bolts.

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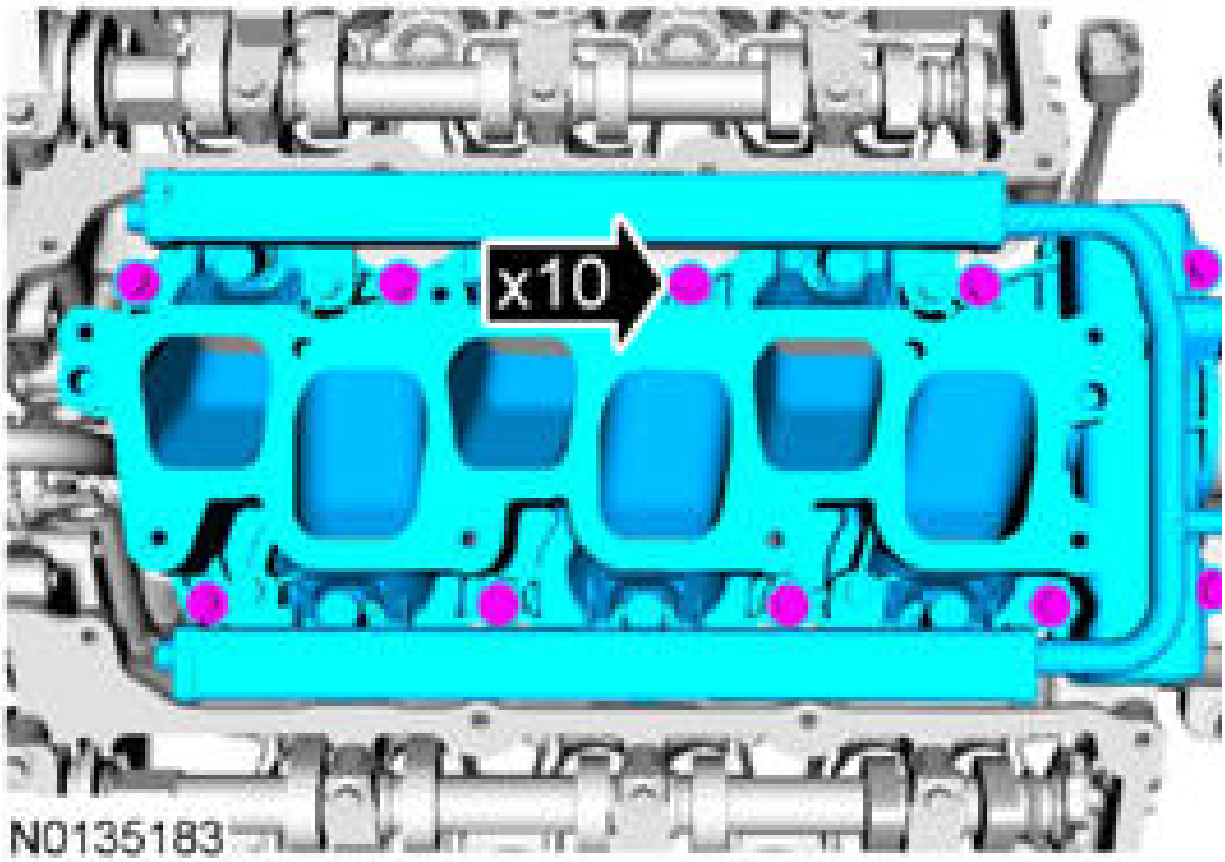


56. **NOTE: If the engine is repaired or replaced because of upper engine failure, typically including valve or piston damage, check the intake manifold for metal debris. If metal debris is found, install a new intake manifold. Failure to follow these instructions can result in engine damage.**

Remove the 10 bolts and the lower intake manifold.

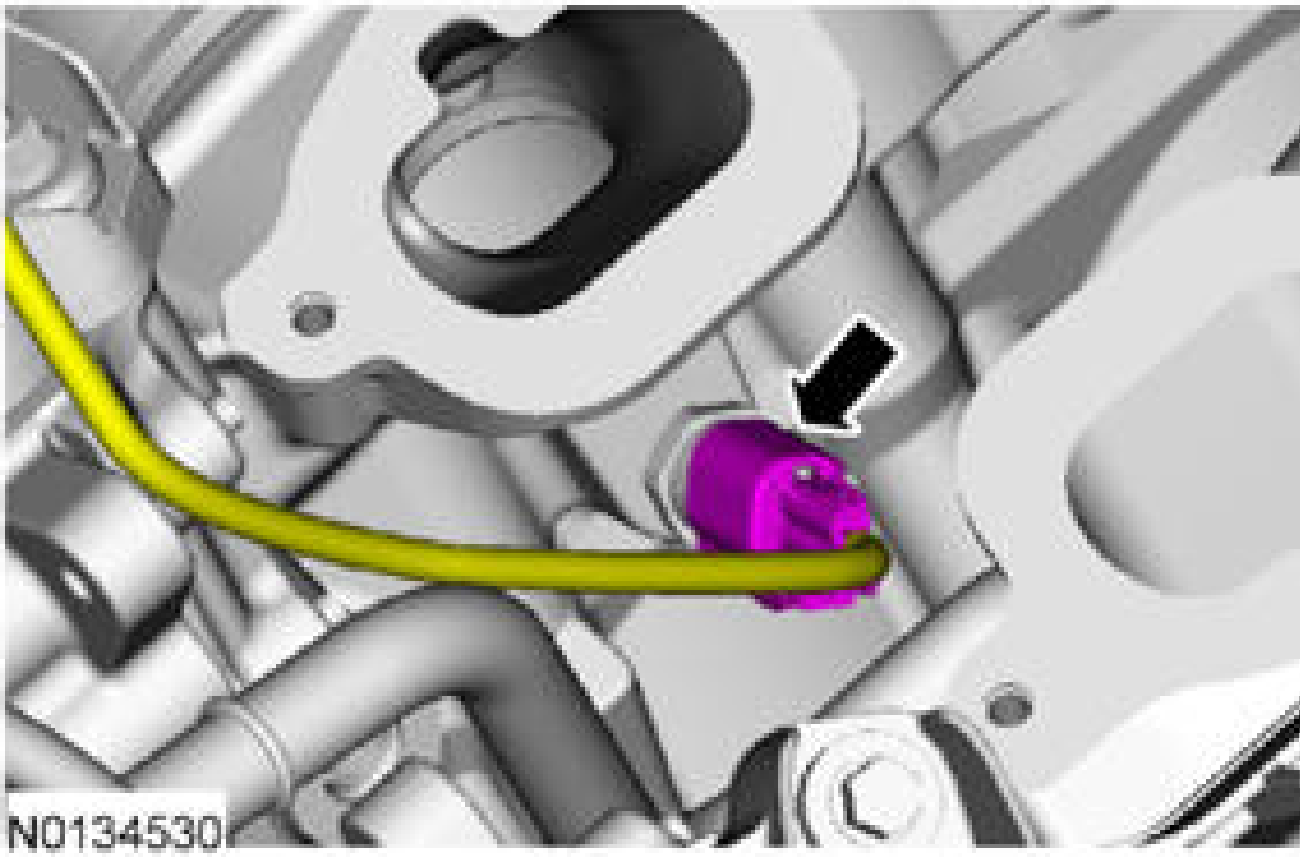
- Remove and discard the intake manifold and thermostat housing gaskets.
- Clean and inspect all sealing surfaces.

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57. Disconnect and remove the **CHT** sensor jumper harness.

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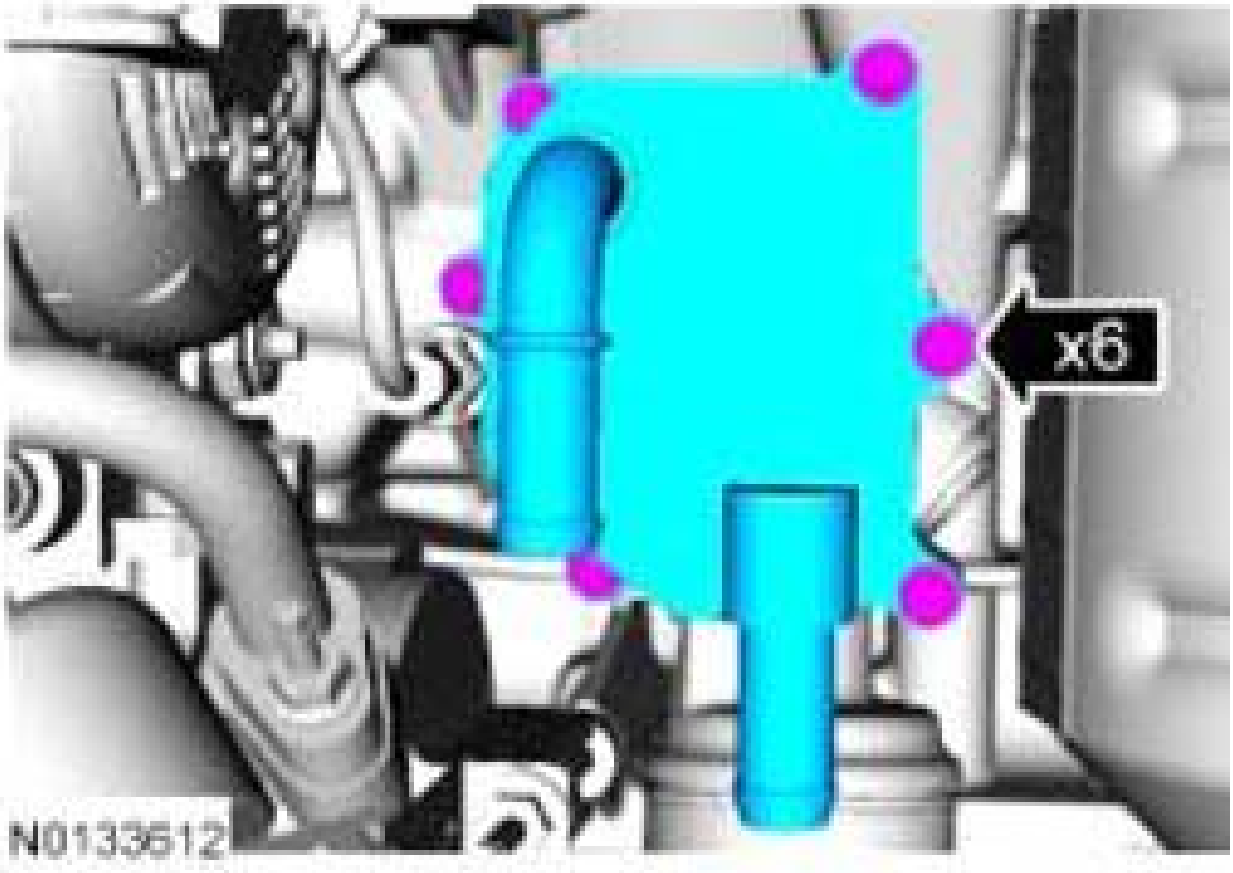


58. **NOTE: A new oil cooler must be installed or severe damage to the engine can occur.**

If equipped, remove the 6 bolts and the oil cooler.

- Discard the oil cooler and gasket.

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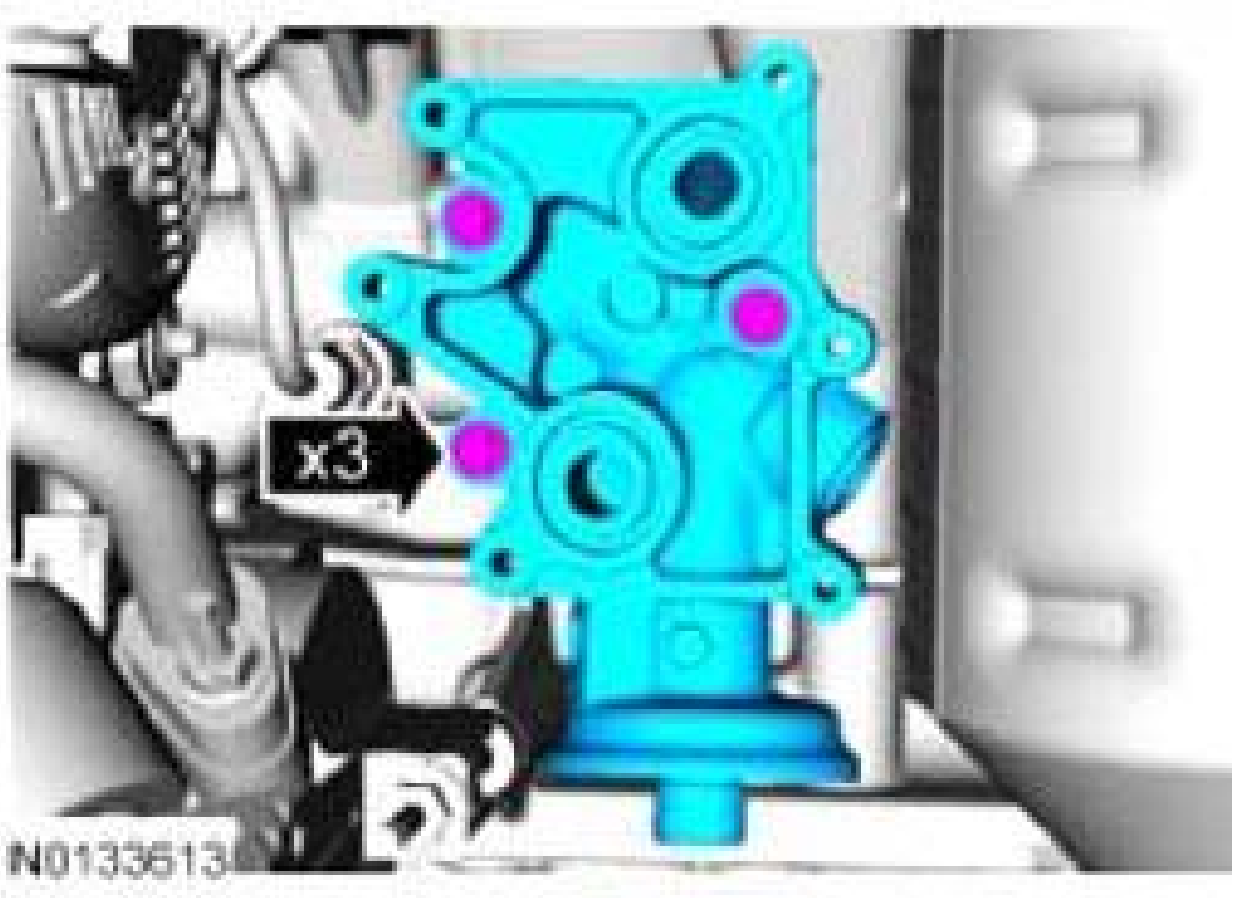


59. **NOTE: Oil filter adapter with oil cooler shown in illustration, oil filter adapter without oil cooler similar.**

Remove the 3 bolts and the oil filter adapter.

- Discard the gasket.

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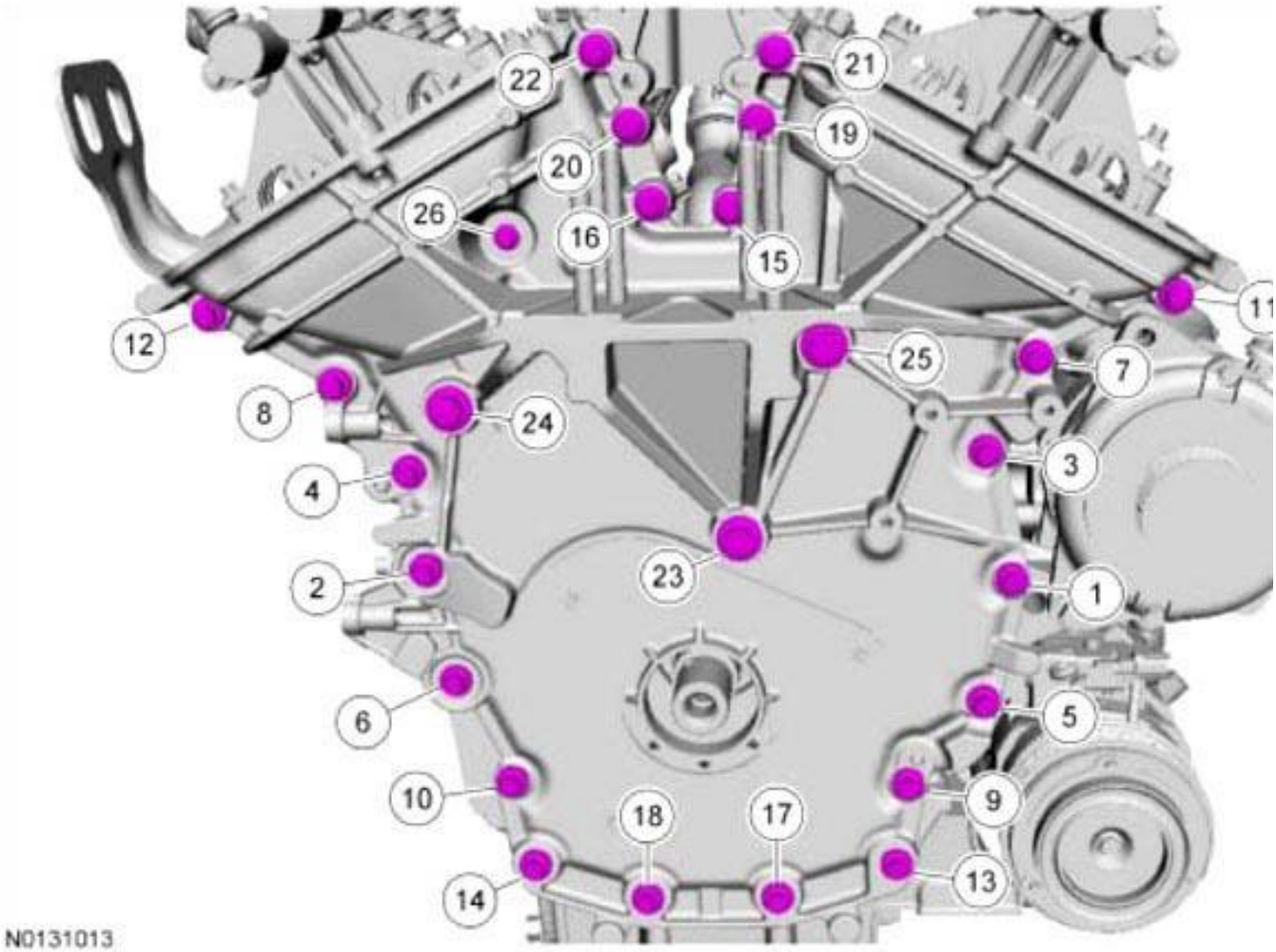
60. Remove the **EOP** switch.

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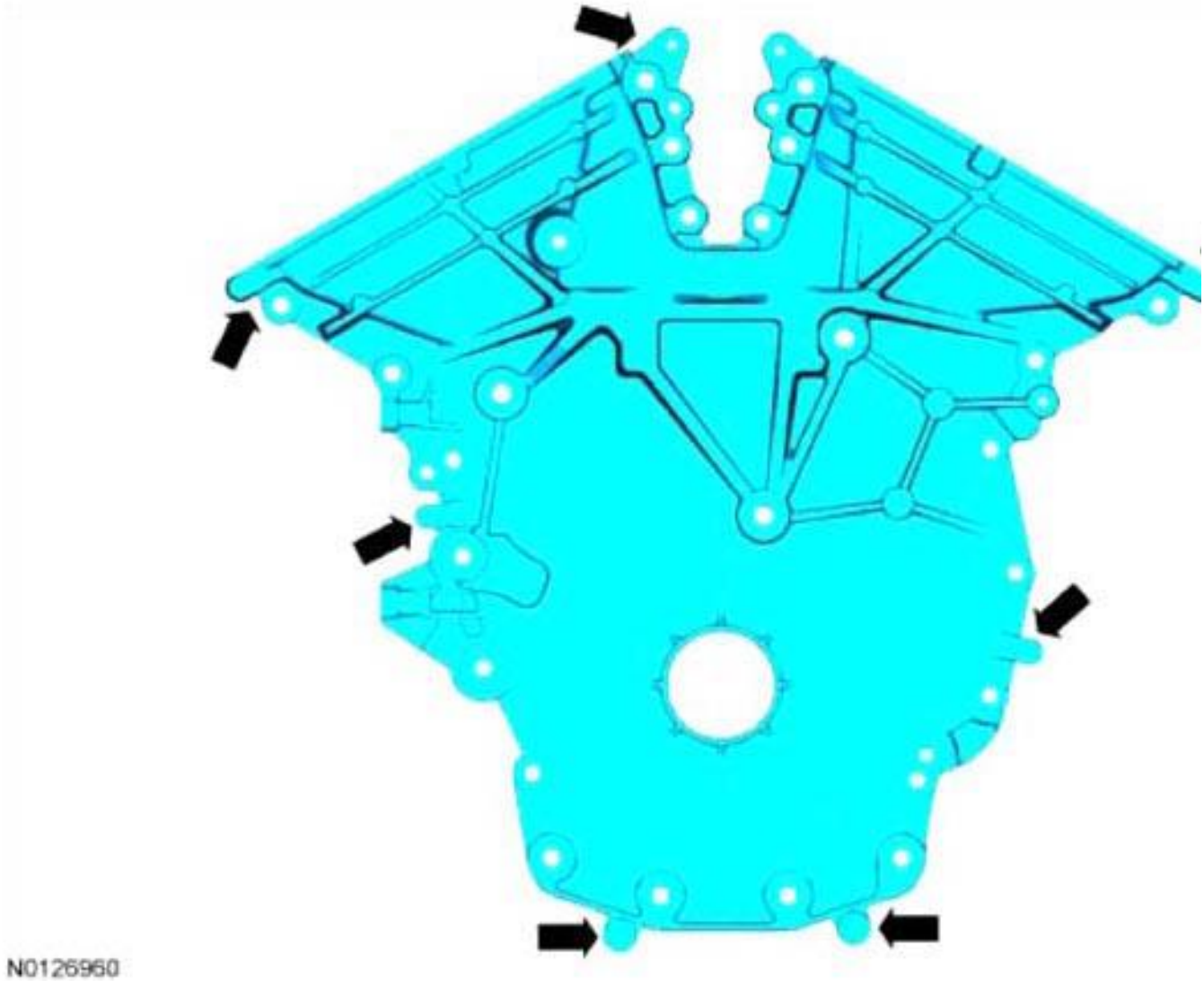
61. Remove the 26 front cover bolts.

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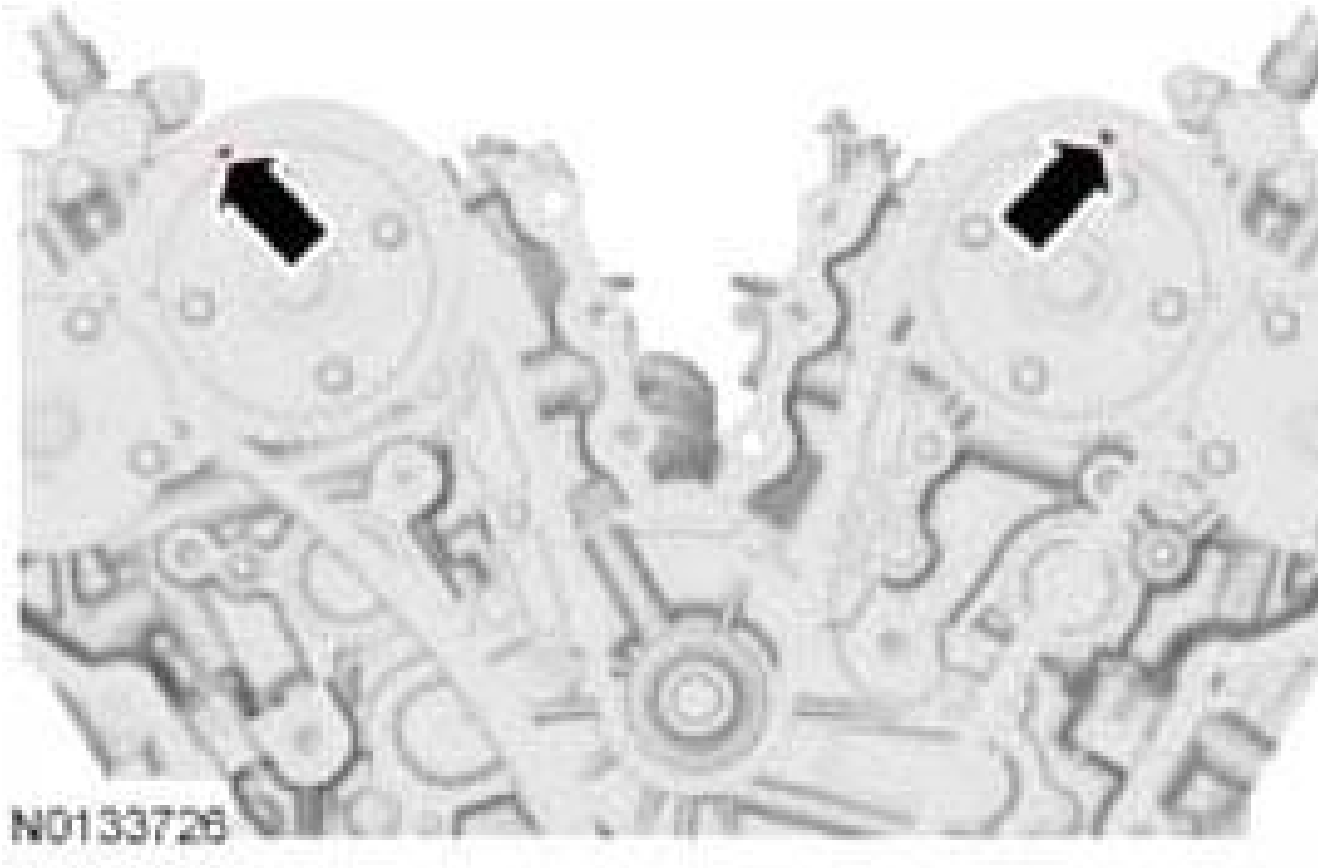
62. Using a suitable pry tool, locate the 7 pry pads shown in illustration and pry the engine front cover loose and remove.

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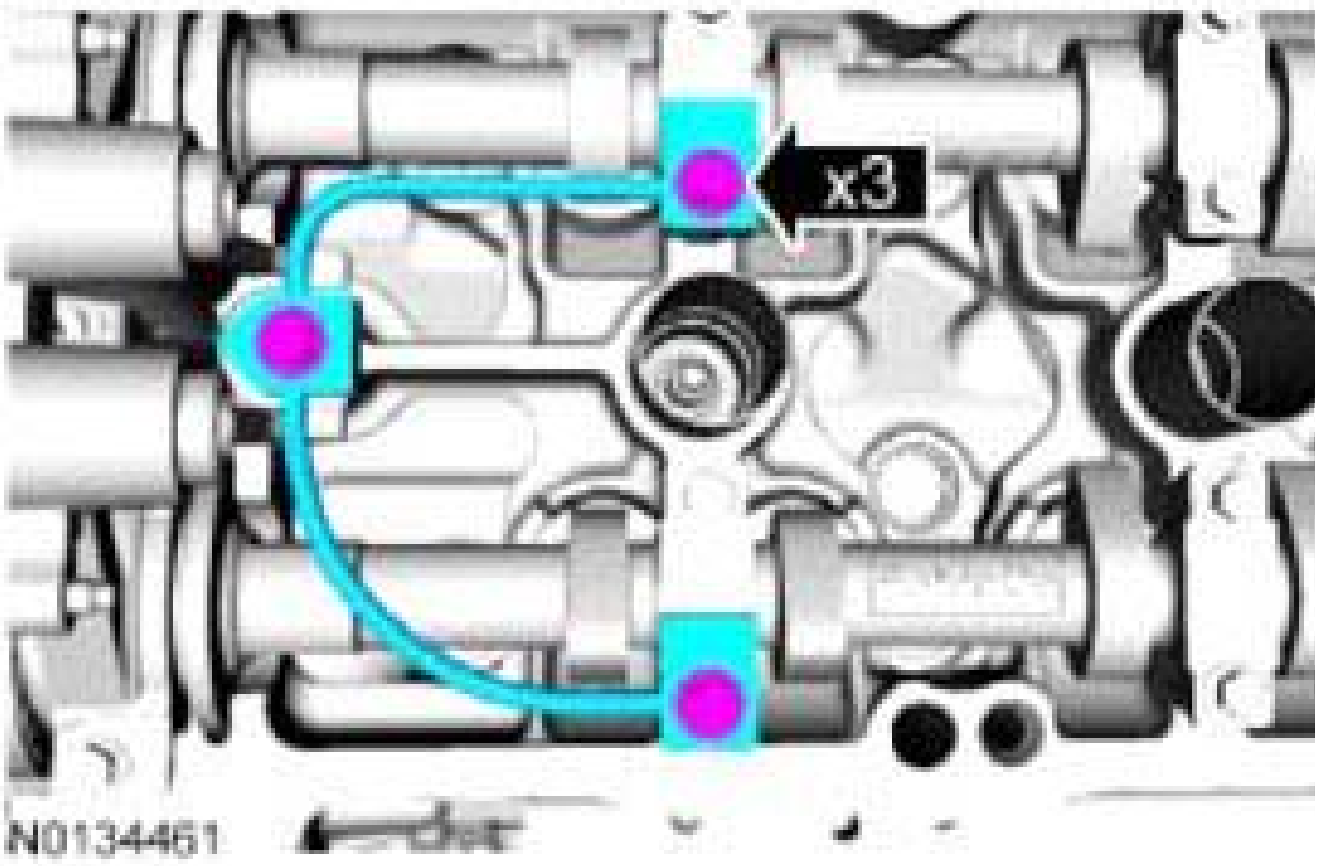
63. Rotate the crankshaft clockwise and align the timing marks on the intake **VCT** assemblies as shown in illustration.

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64. Remove the 3 bolts and the LH valve train oil tube.

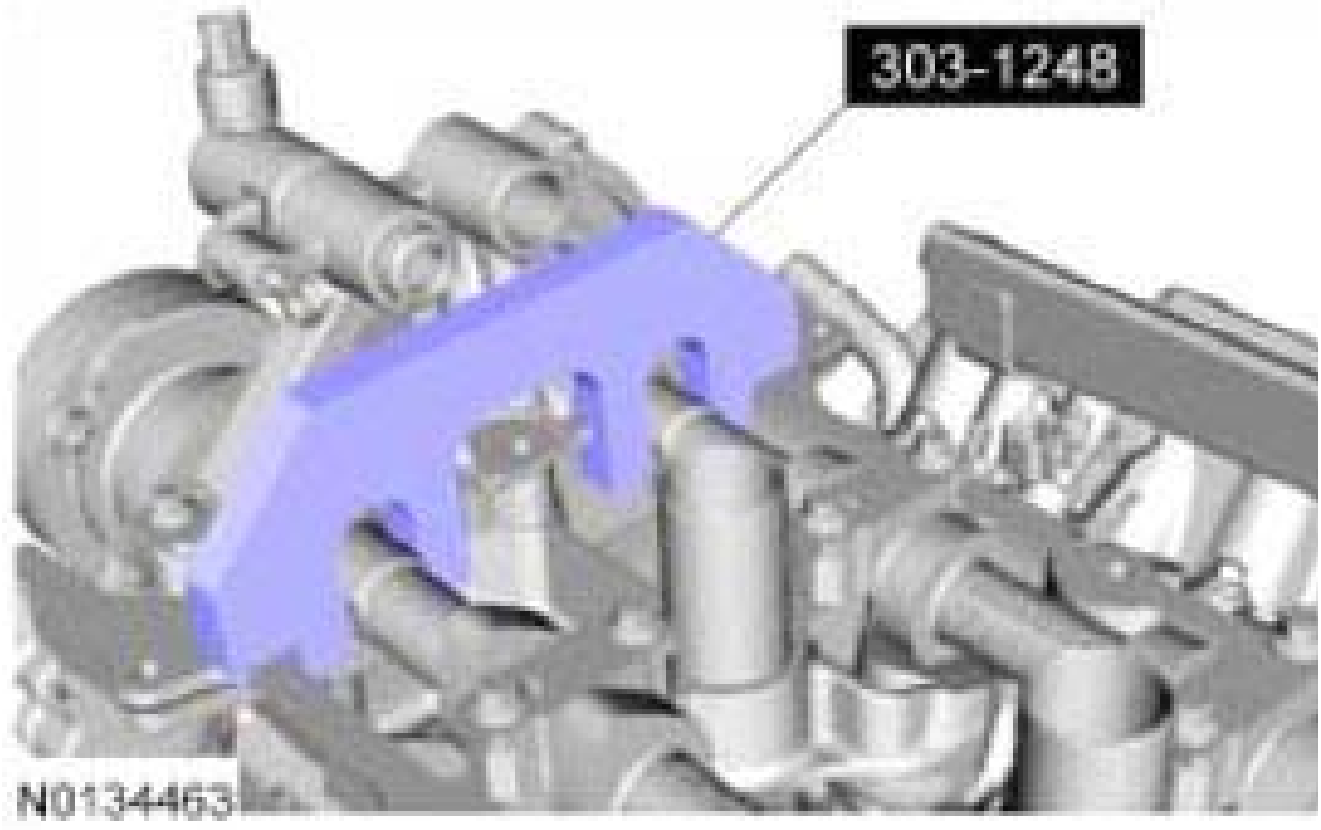
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65. **NOTE: The Camshaft Holding Tool will hold the camshafts in the TDC position.**

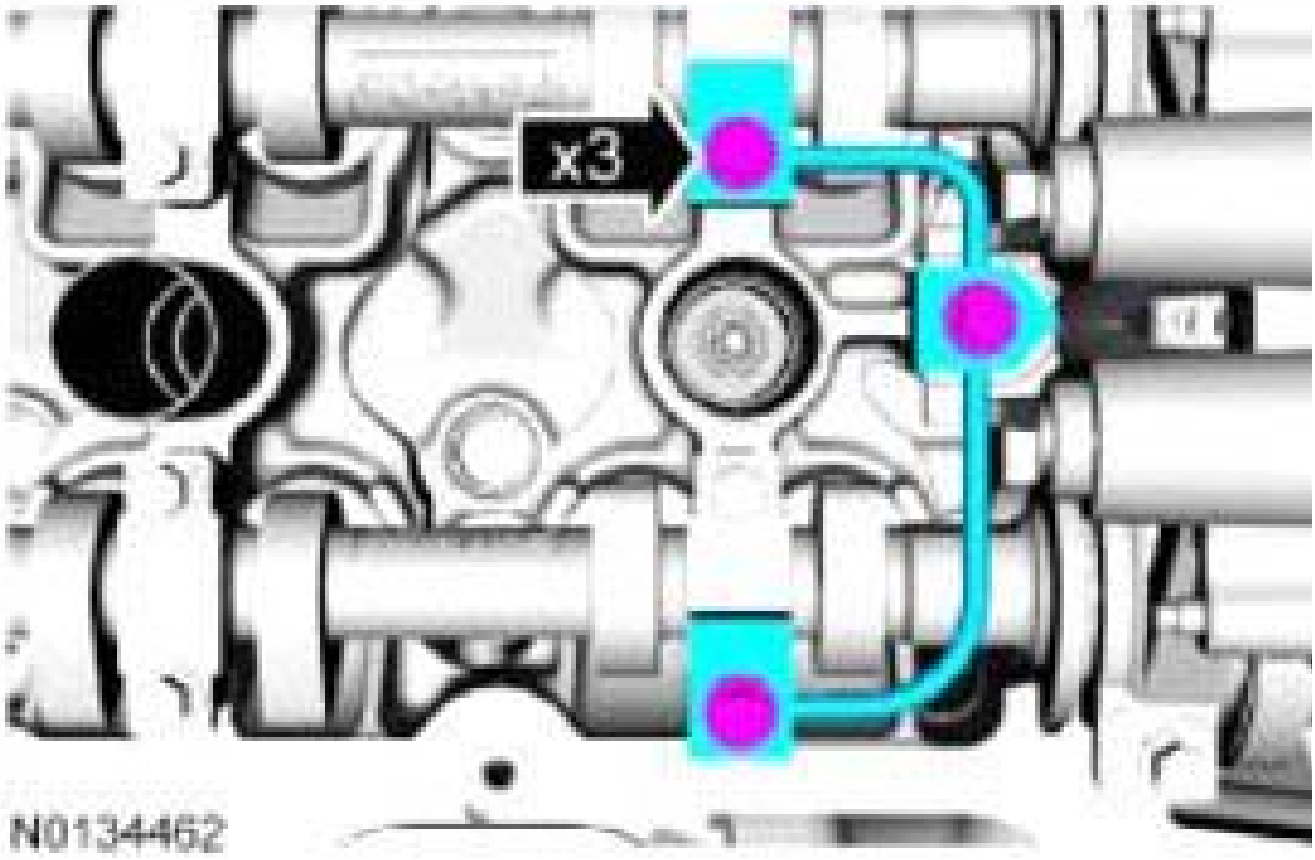
Install the Camshaft Holding Tool onto the flats of the LH camshafts.

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66. Remove the 3 bolts and the RH valve train oil tube.

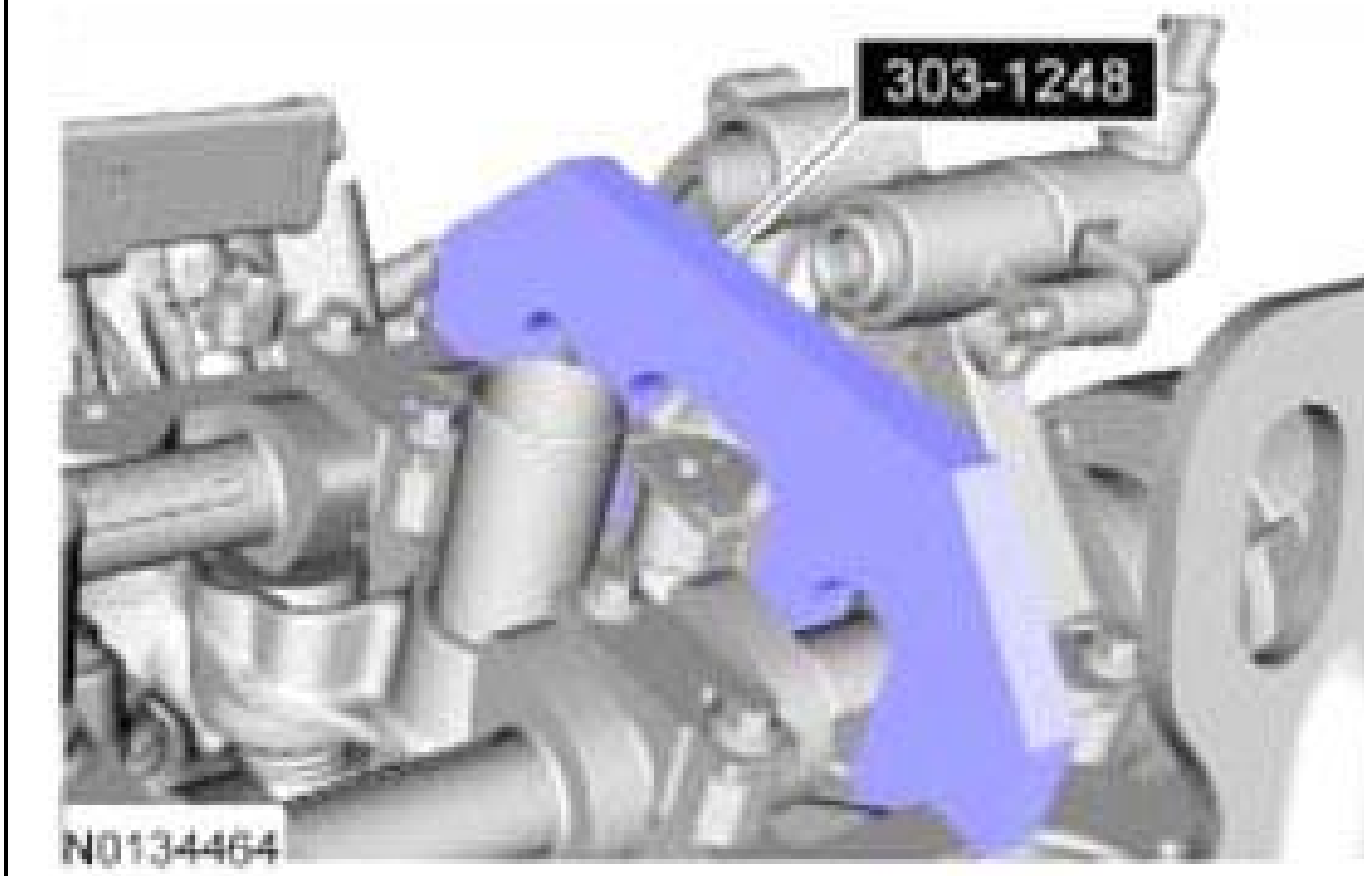
 © 2011 Mitchell Repair Information Company, LLC.



67. **NOTE: The Camshaft Holding Tool will hold the camshafts in the TDC position.**

Install the Camshaft Holding Tool onto the flats of the RH camshafts.

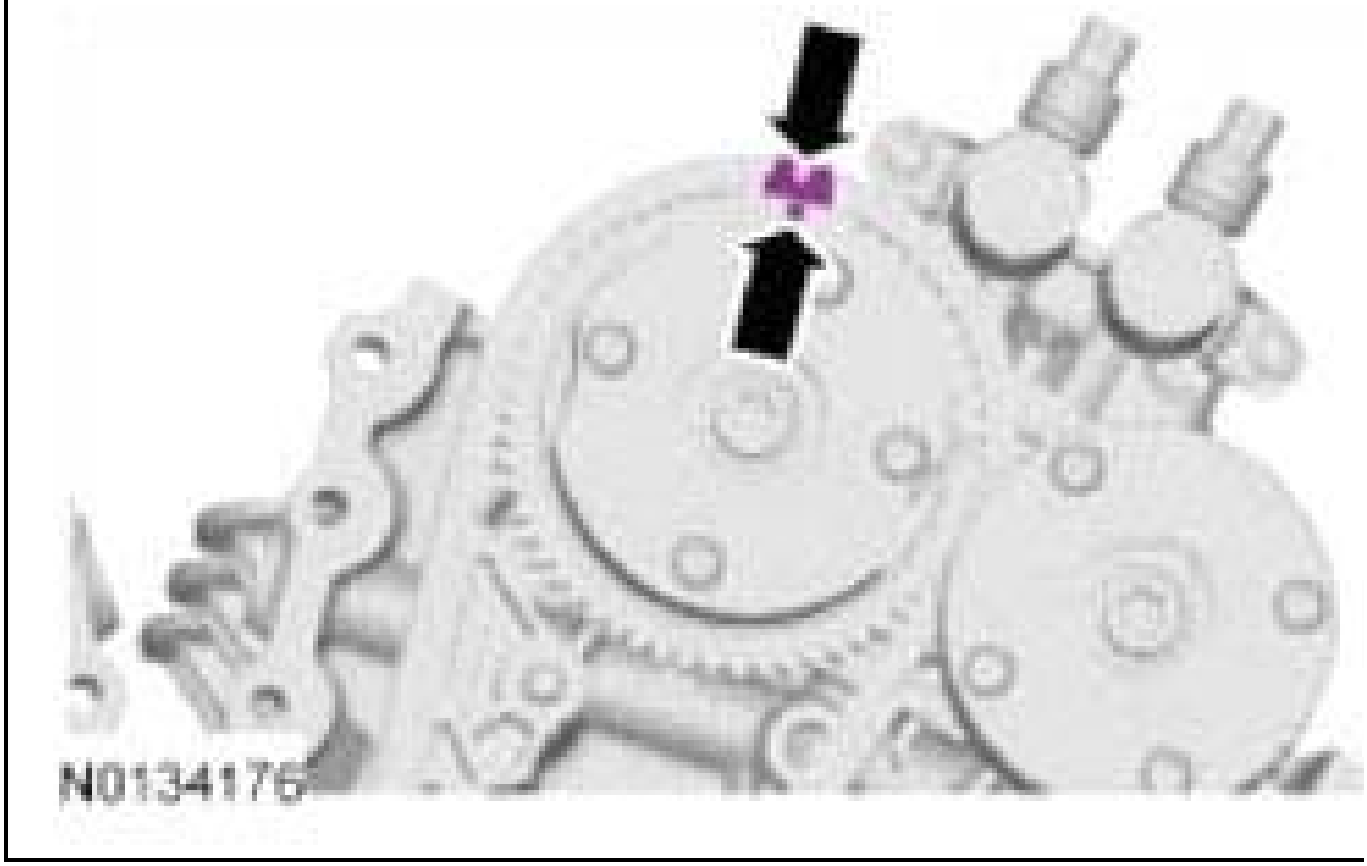
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68. **NOTE: The following 3 steps are for primary timing chains that the colored links are not visible.**

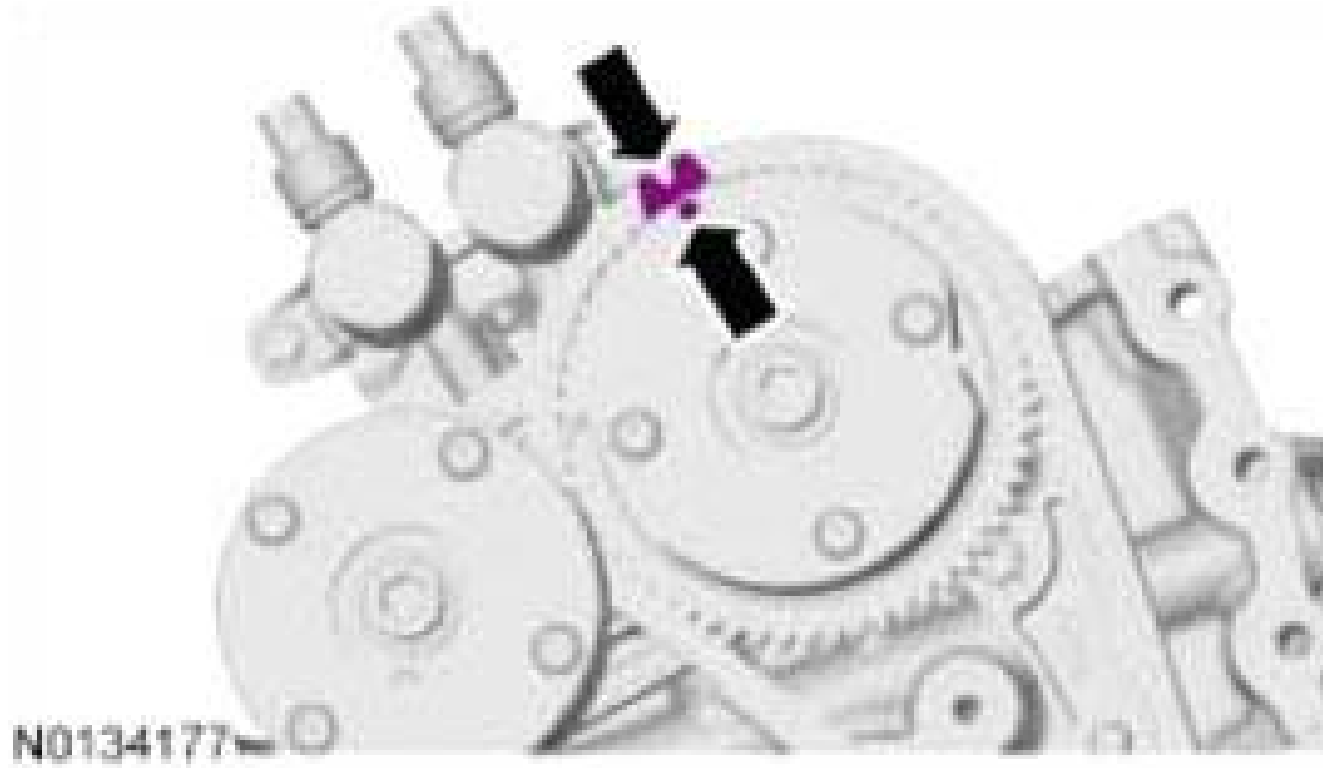
Mark the timing chain link that aligns with the timing mark on the LH intake **VCT** assembly as shown in illustration.

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69. Mark the timing chain link that aligns with the timing mark on the RH intake **VCT** assembly as shown in illustration.

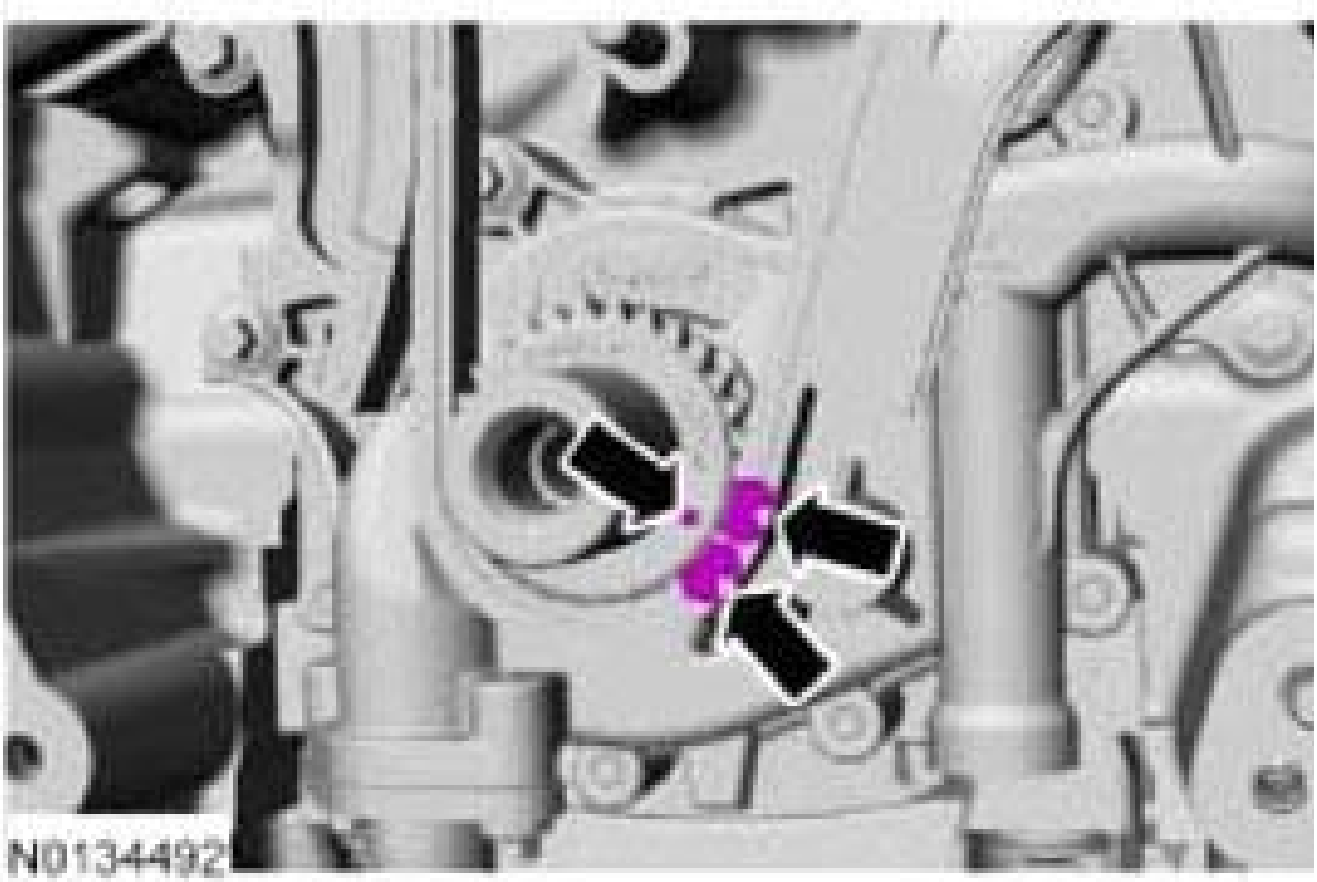
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NOTE: The crankshaft sprocket timing mark should be between the 2 colored links.

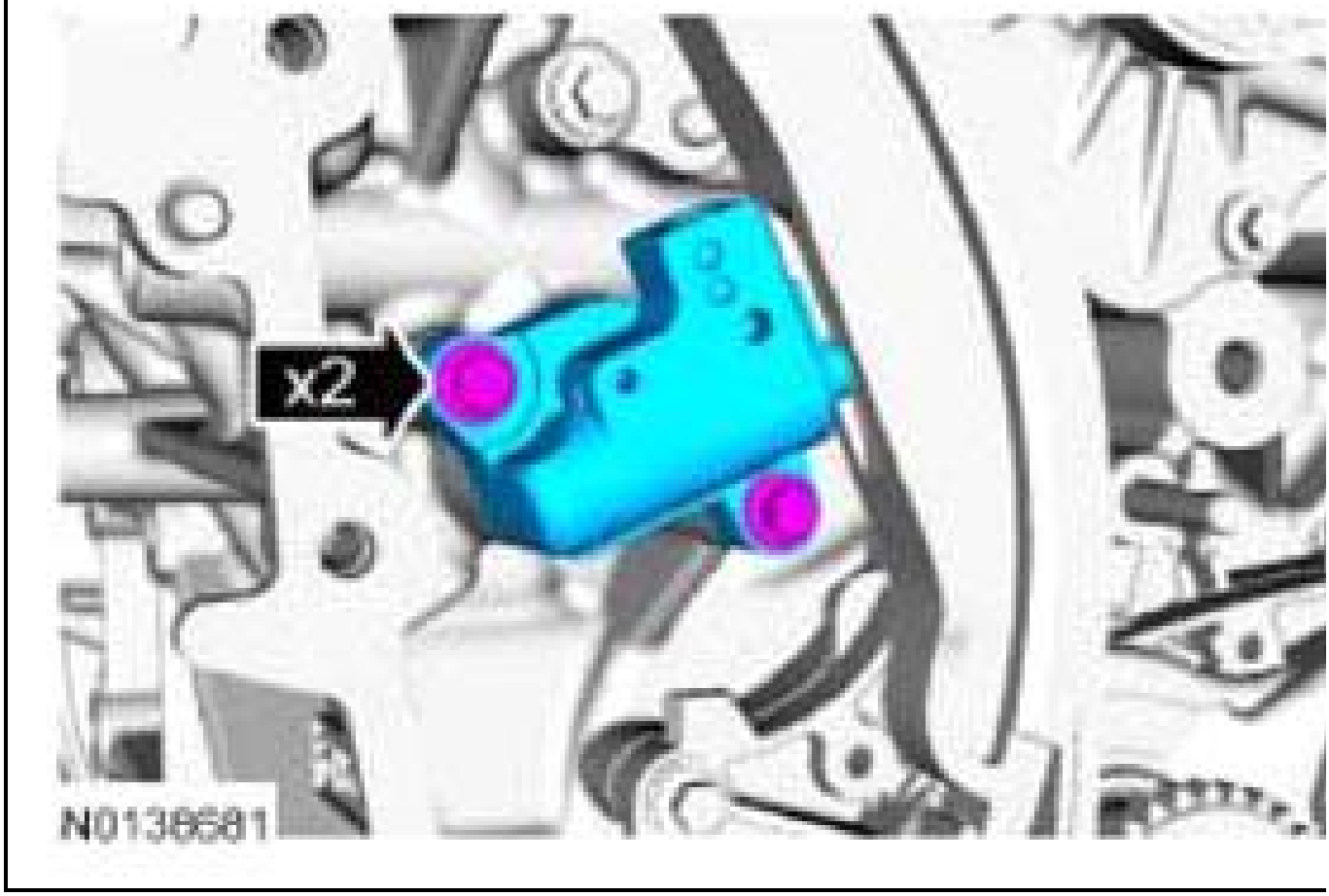
70. Mark the 2 timing chain links that align with the timing mark on the crankshaft sprocket as shown in illustration.

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71. Remove the 2 bolts and the primary timing chain tensioner.

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72. Remove the primary timing chain tensioner arm.

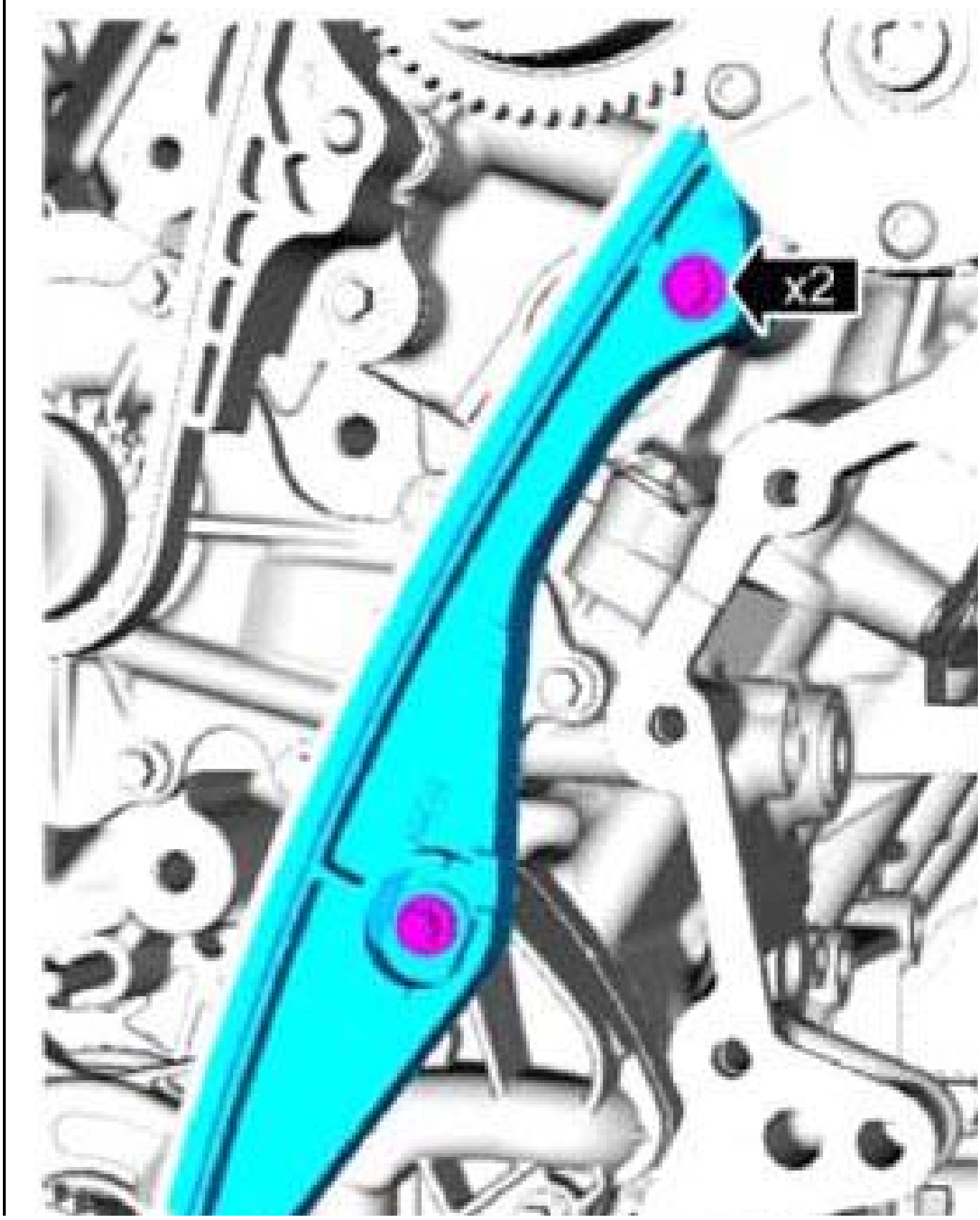
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73. Remove the 2 bolts and the lower LH primary timing chain guide.

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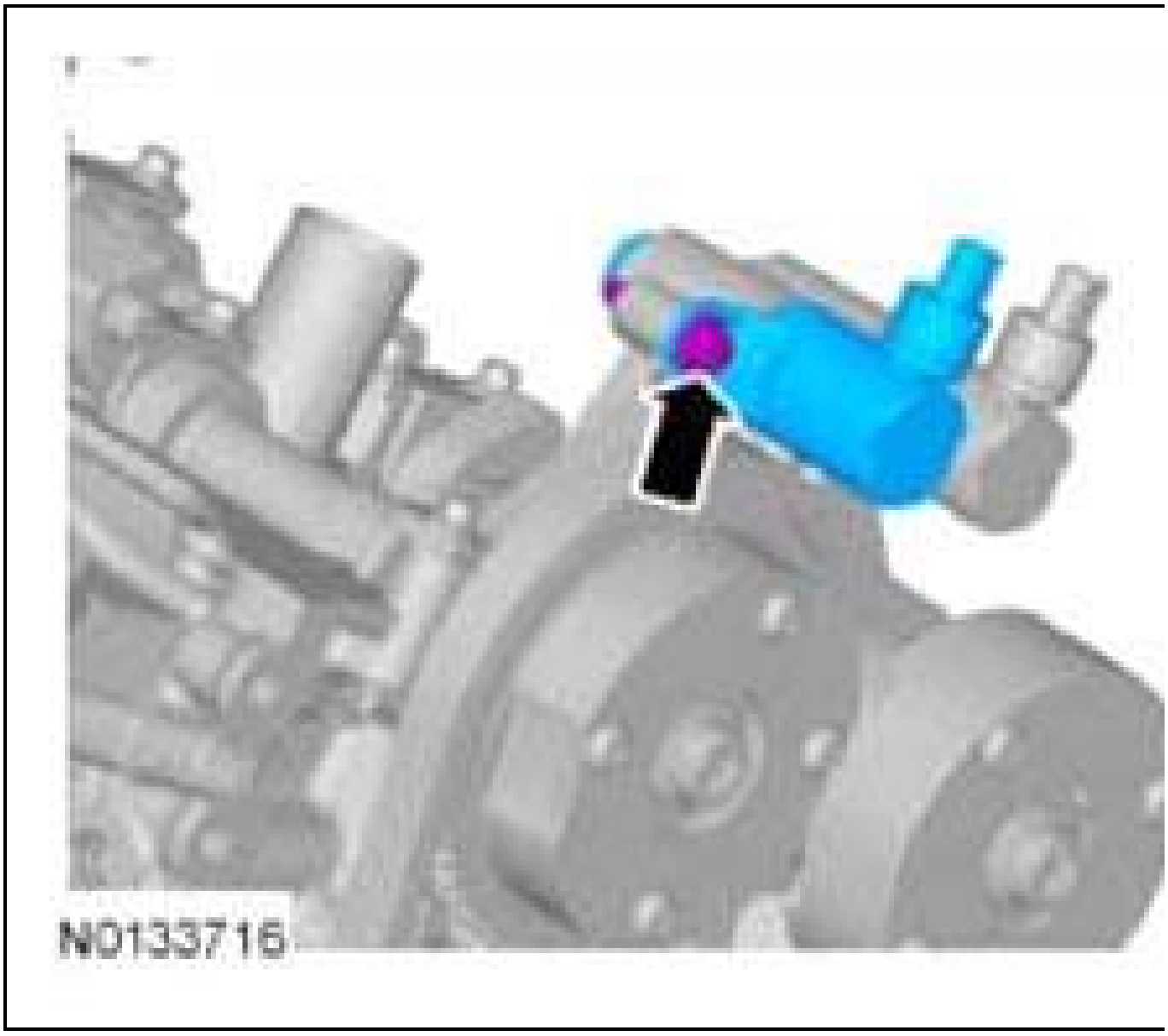
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74. **NOTE: Removal of the VCT oil control solenoid will aid in the removal of the primary timing chain.**

NOTE: A slight twisting motion will aid in the removal of the VCT oil control solenoid.

NOTE: Keep the VCT oil control solenoid clean of dirt and debris.

Remove the bolt and the LH intake **VCT** oil control solenoid.



75. **NOTE: Removal of the VCT oil control solenoid will aid in the removal of the**

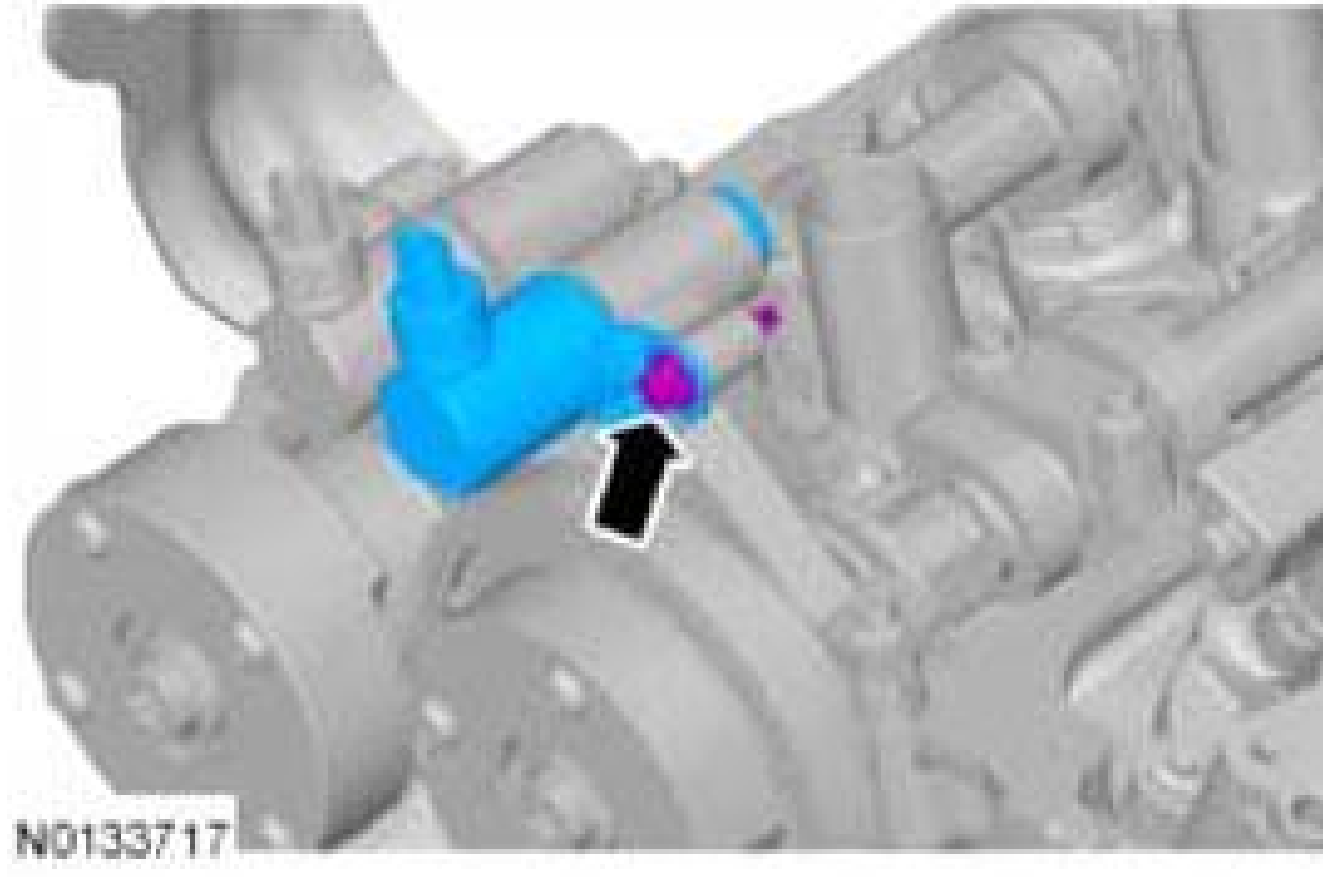
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75. **primary timing chain.**

NOTE: A slight twisting motion will aid in the removal of the VCT oil control solenoid.

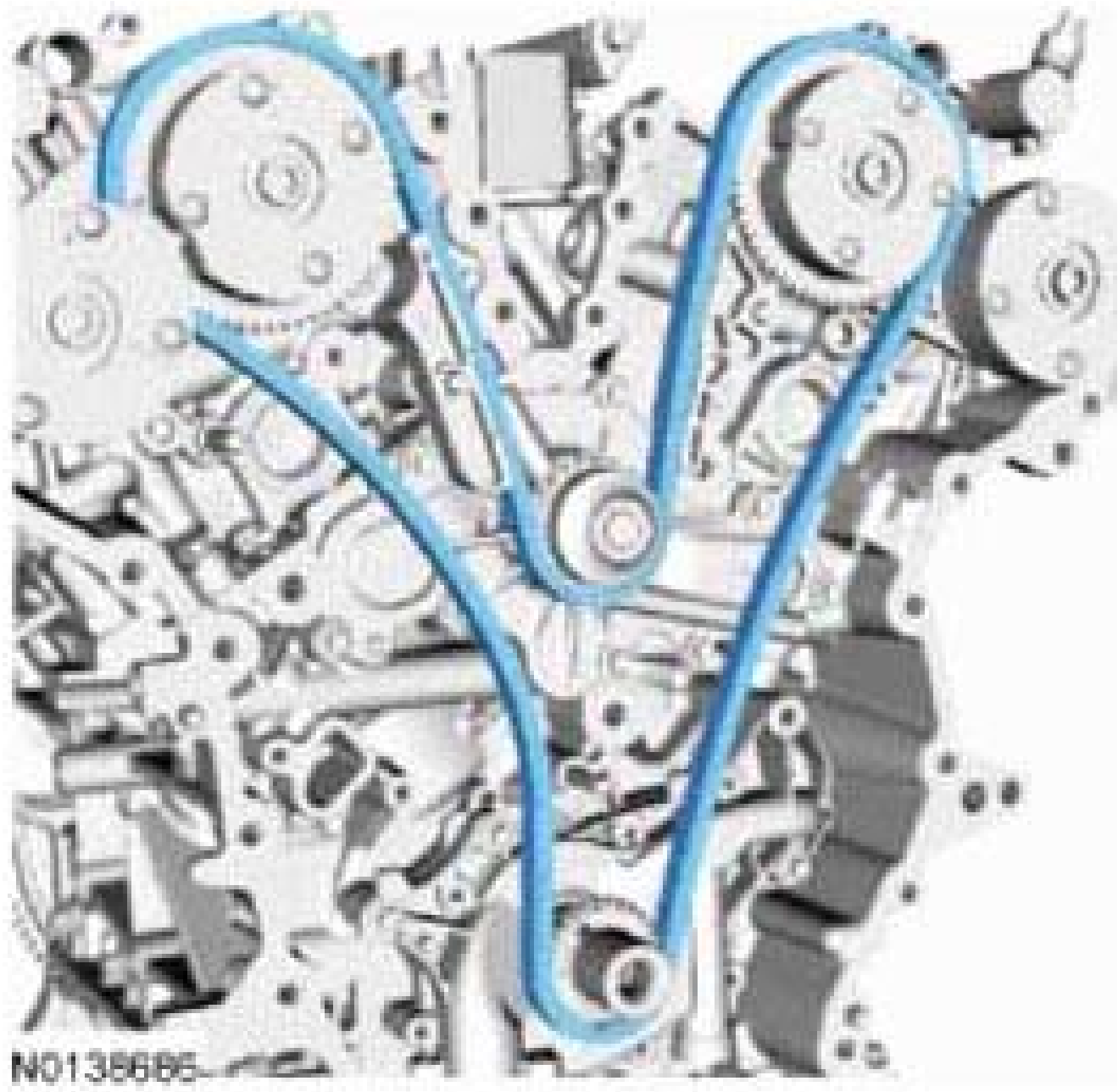
NOTE: Keep the VCT oil control solenoid clean of dirt and debris.

Remove the bolt and the RH intake **VCT** oil control solenoid.



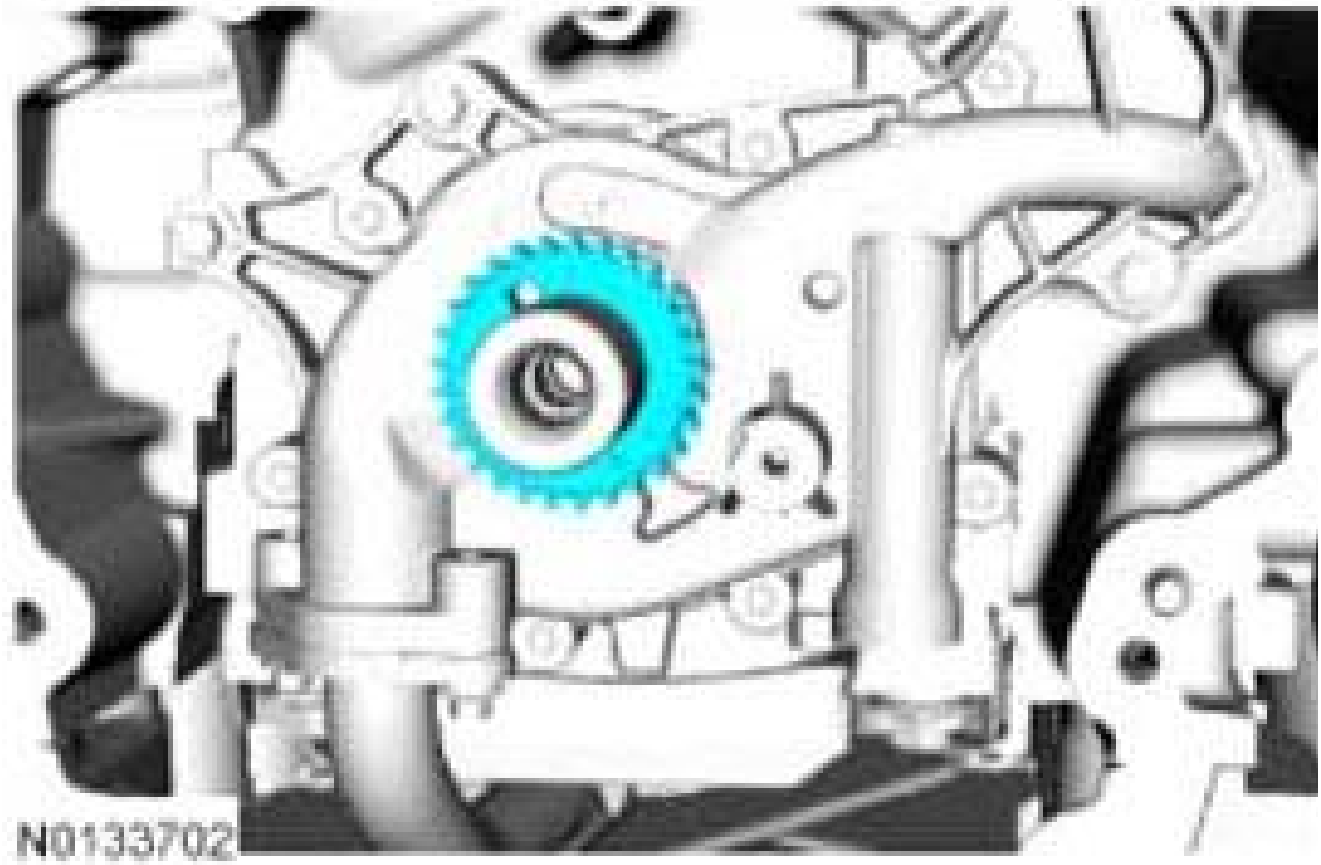
76. Remove the primary timing chain.

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77. Remove the crankshaft timing chain sprocket.

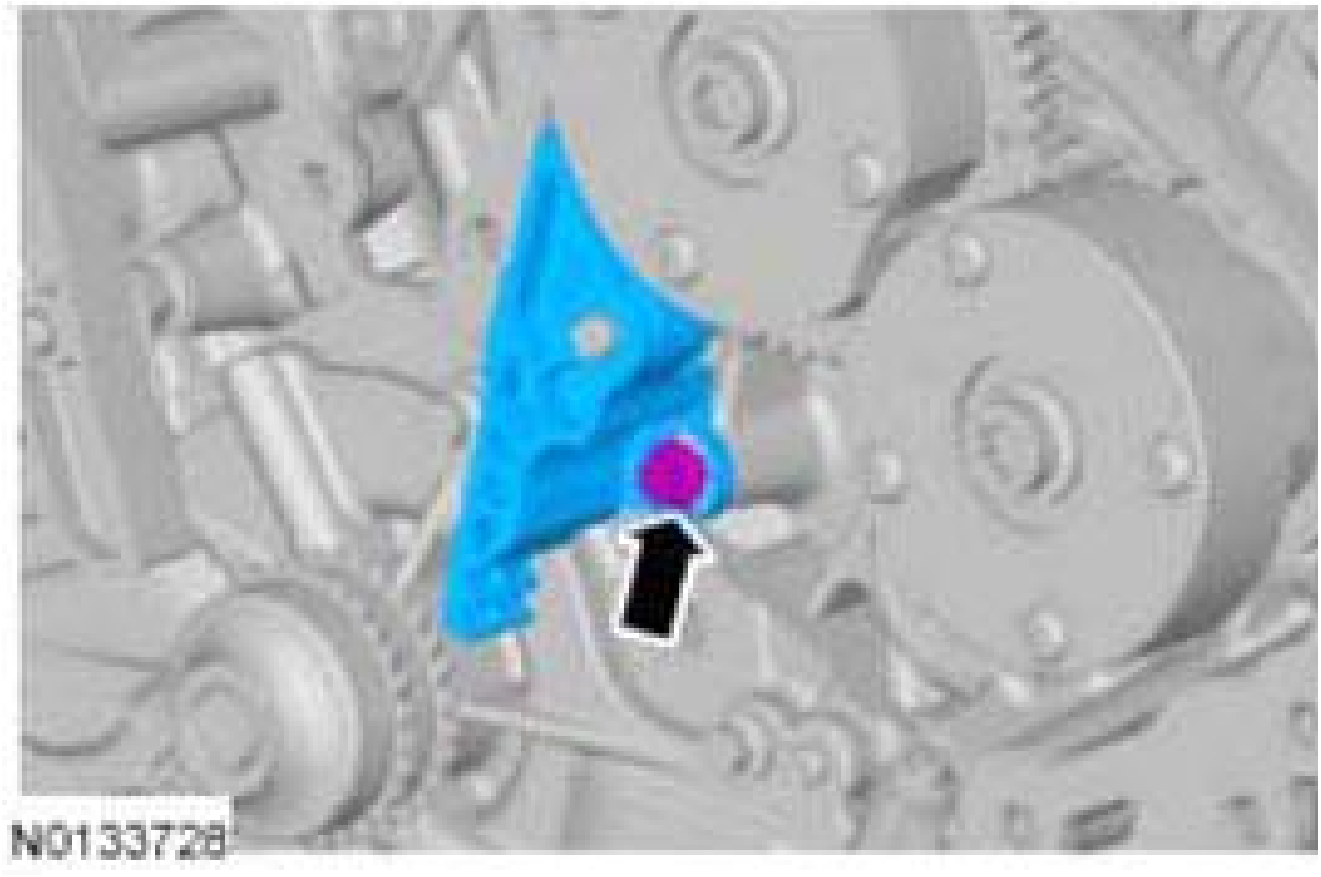
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78. **NOTE: Do not use power tools to remove the bolt or damage to the LH primary timing chain guide may occur.**

Remove the bolt and the upper LH primary timing chain guide

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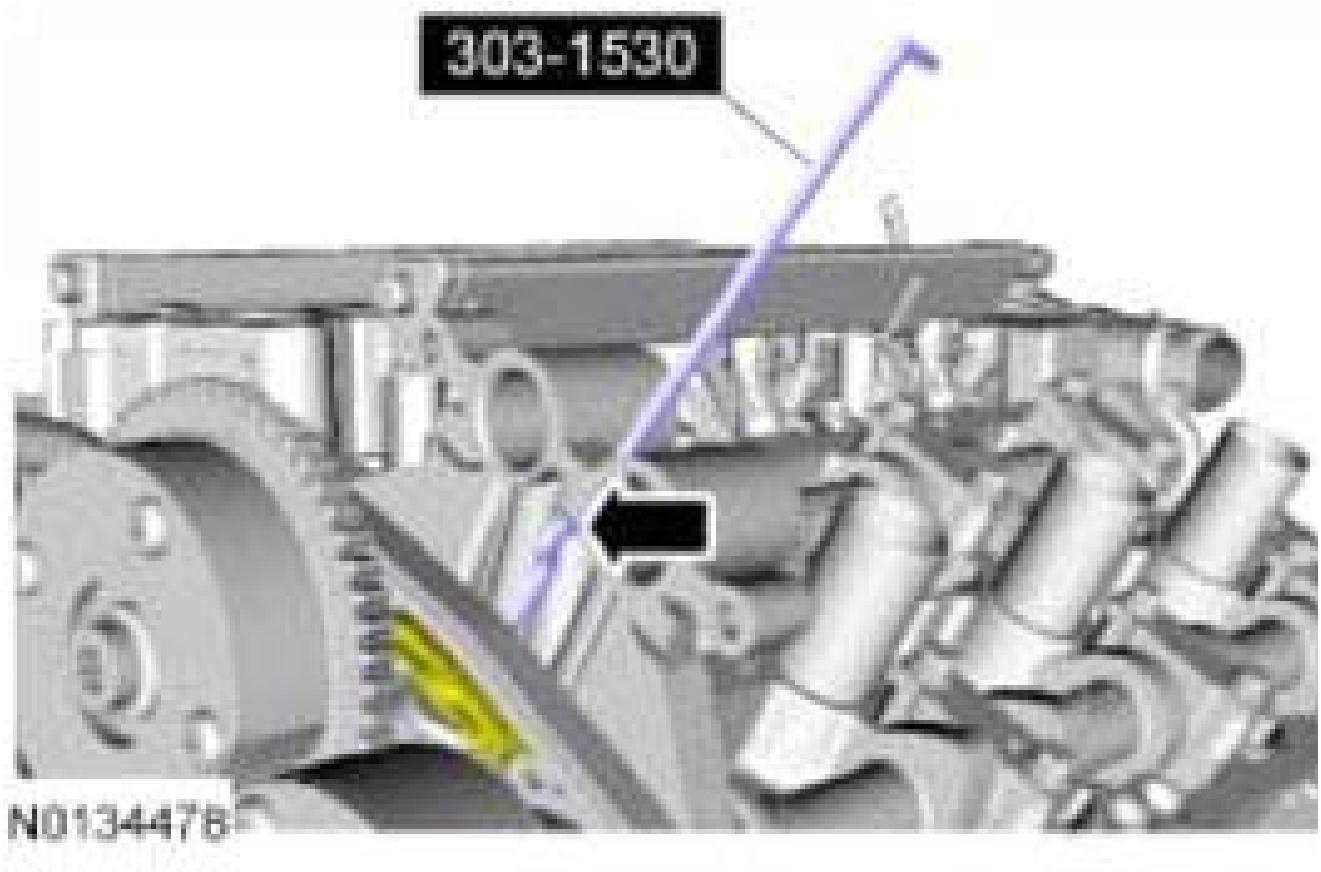


79. **NOTE: The 2 VCT oil control solenoids are removed for clarity.**

NOTE: The Secondary Chain Hold Down is inserted through a hole in the top of the mega cap.

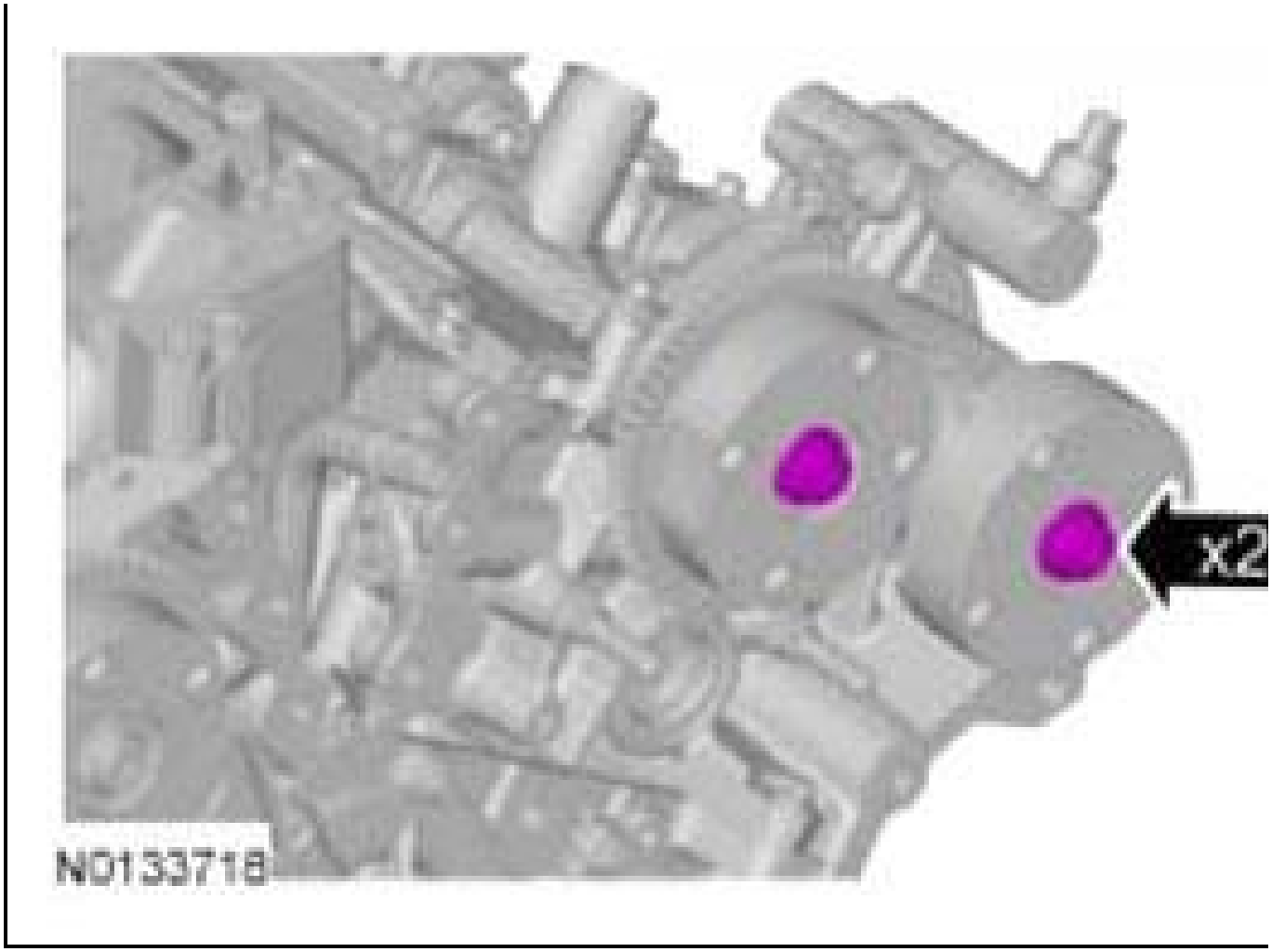
Compress the LH secondary timing chain tensioner and install the Secondary Chain Hold Down in the hole on the rear of the secondary timing chain tensioner guide and let it hold against the mega cap to retain the tensioner in the collapsed position.

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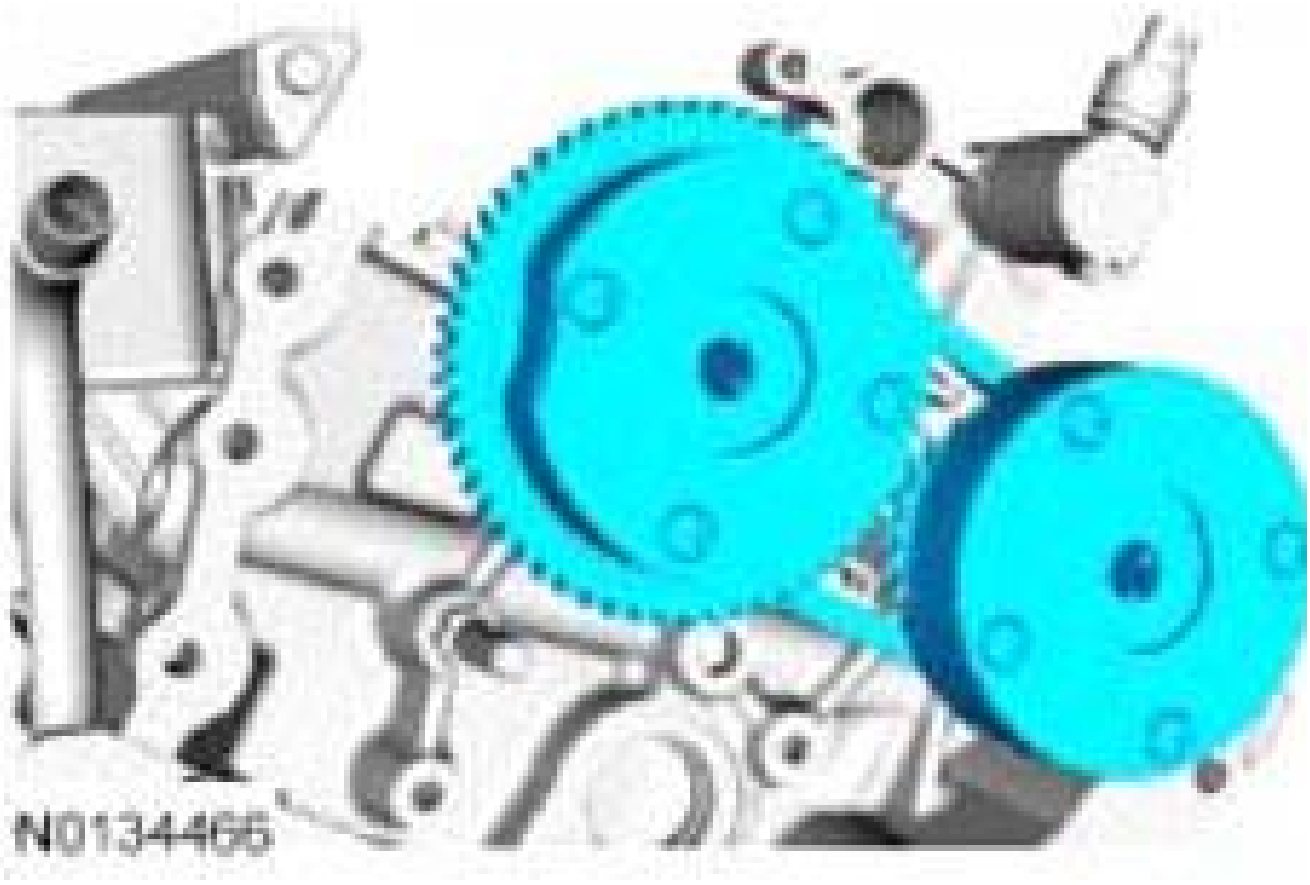
80. Remove and discard the 2 LH **VCT** assembly bolts.

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81. Remove the 2 LH **VCT** assemblies and secondary timing chain.

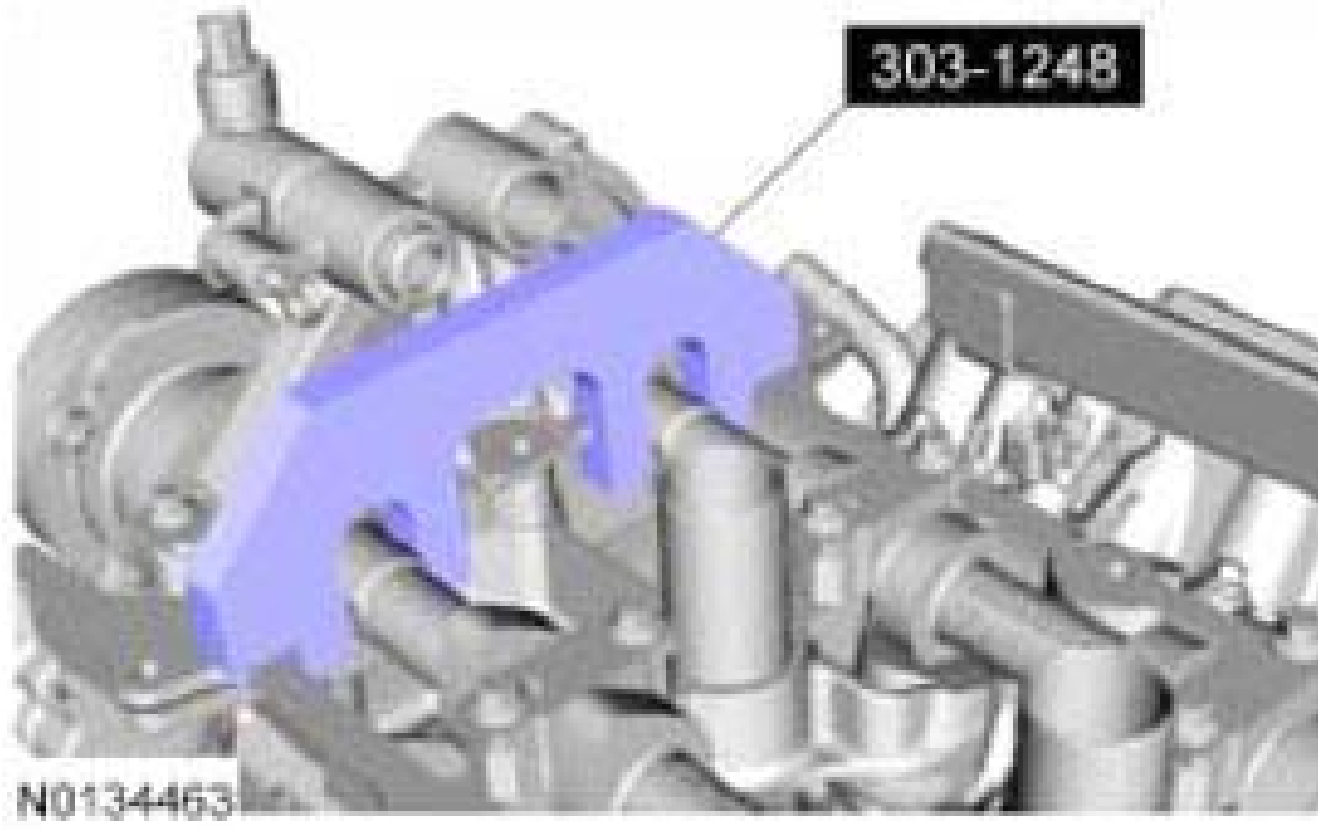
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82. **NOTE: When the 303-1248 is removed, valve spring pressure may rotate the LH camshafts approximately 3 degrees to a neutral position.**

Remove 303-1248 from the LH camshafts.

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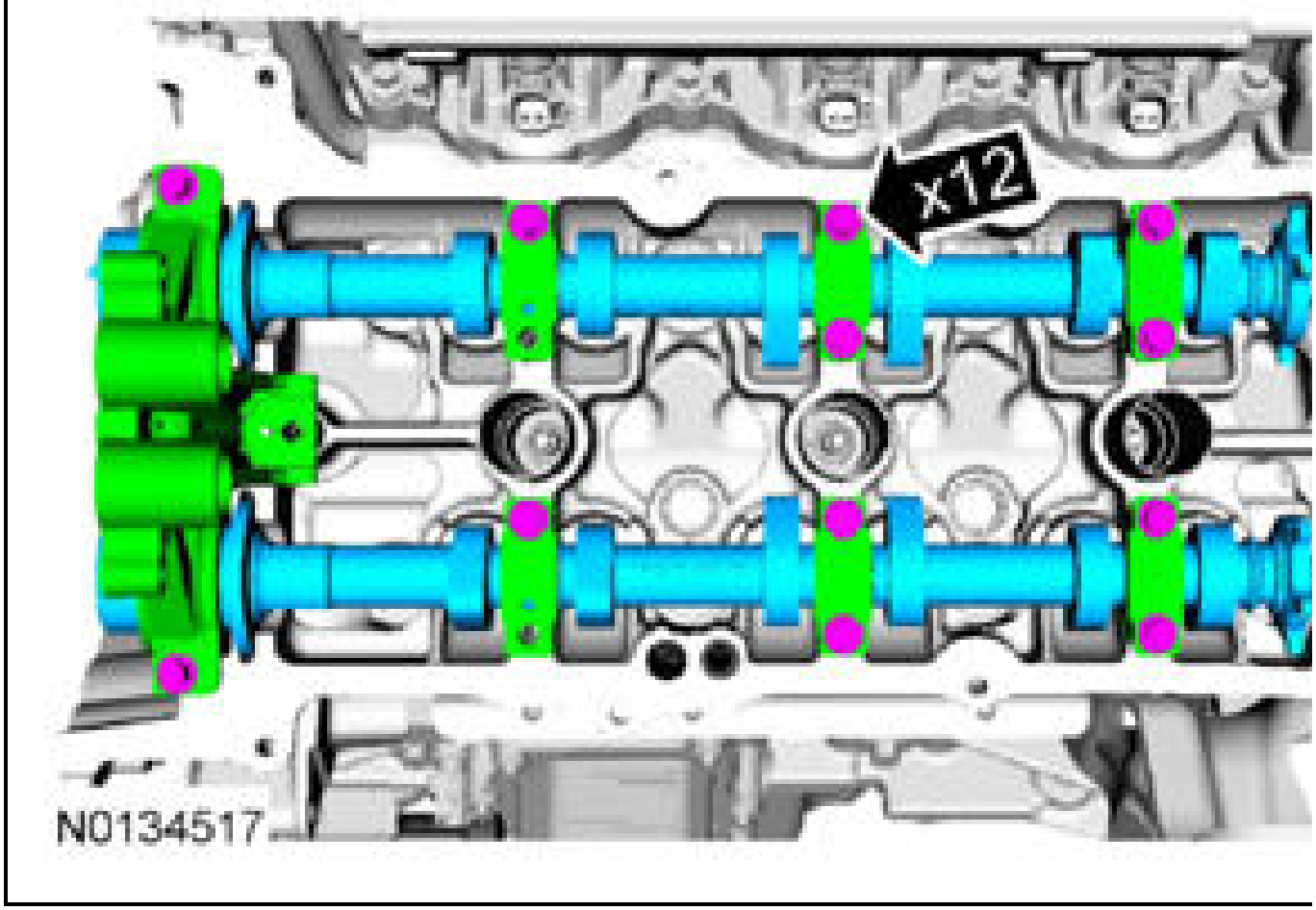


83. **NOTE: Cylinder head camshaft bearing caps are numbered to verify that they are assembled in their original positions.**

NOTE: Mark the exhaust and intake camshafts for installation into their original locations.

Remove the 12 bolts, 6 camshaft caps, mega cap and the LH camshafts.

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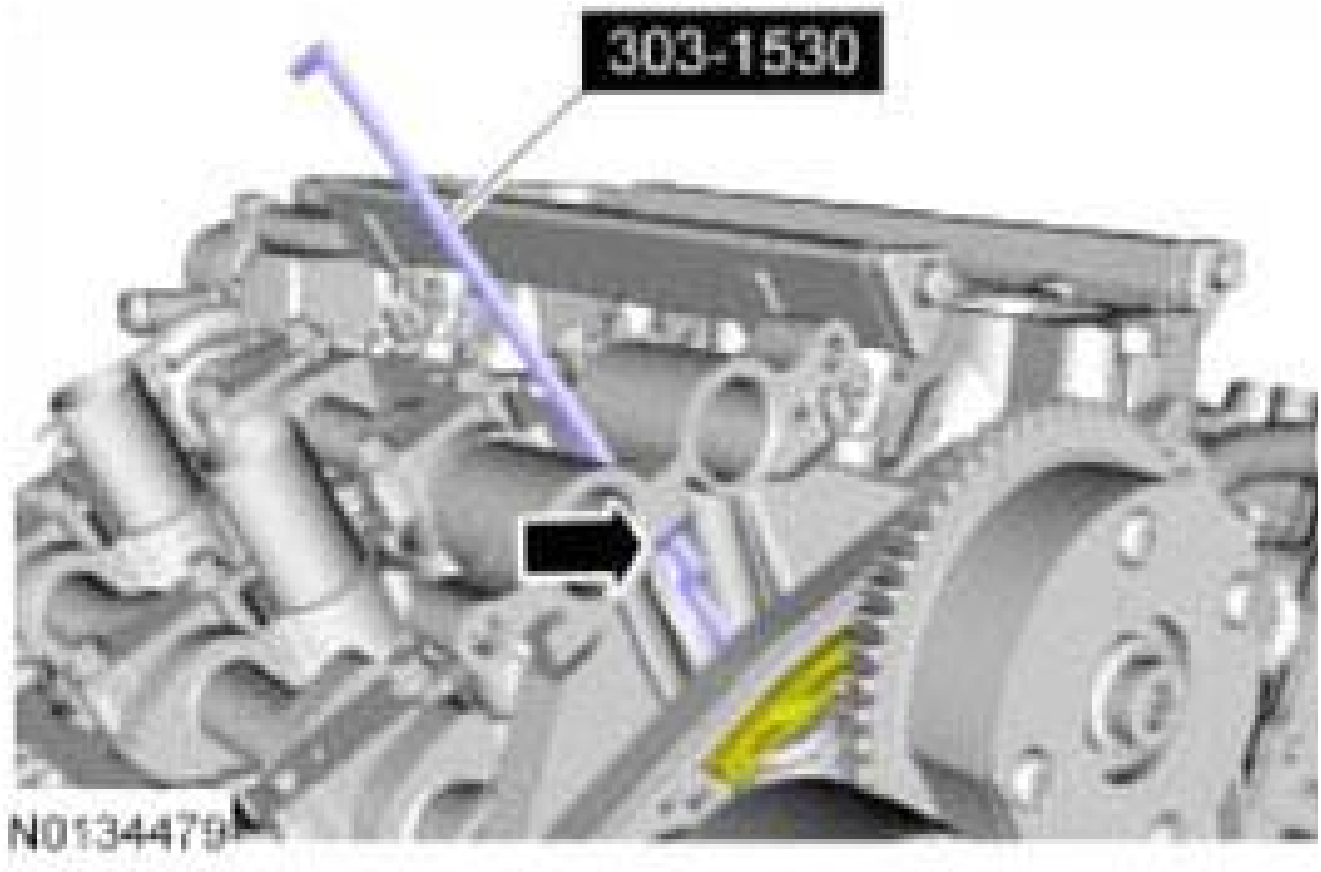


84. **NOTE: The 2 VCT oil control solenoids are removed for clarity.**

NOTE: The Secondary Chain Hold Down is inserted through a hole in the top of the mega cap.

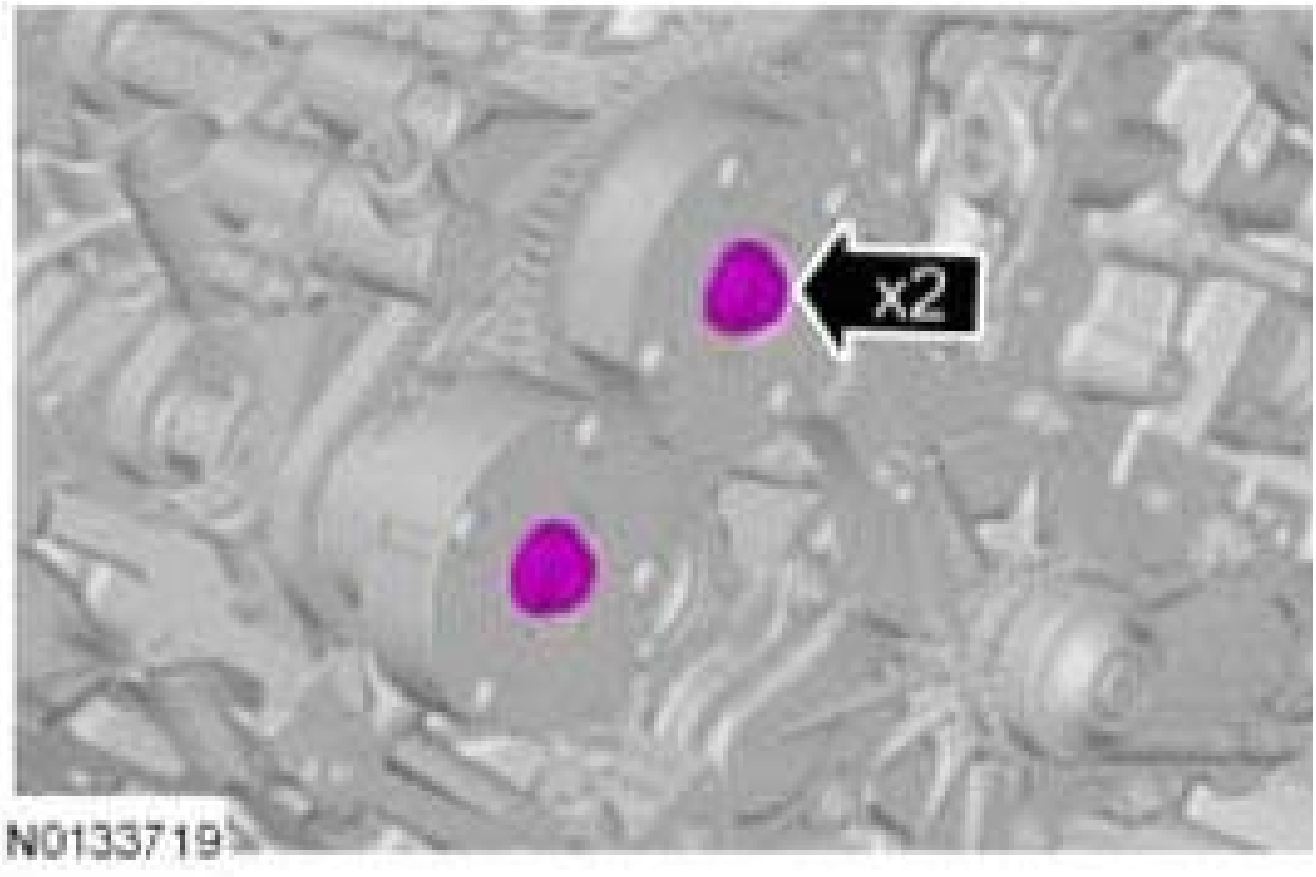
Compress the RH secondary timing chain tensioner and install the Secondary Chain Hold Down in the hole on the rear of the secondary timing chain tensioner guide and let it hold against the mega cap to retain the tensioner in the collapsed position.

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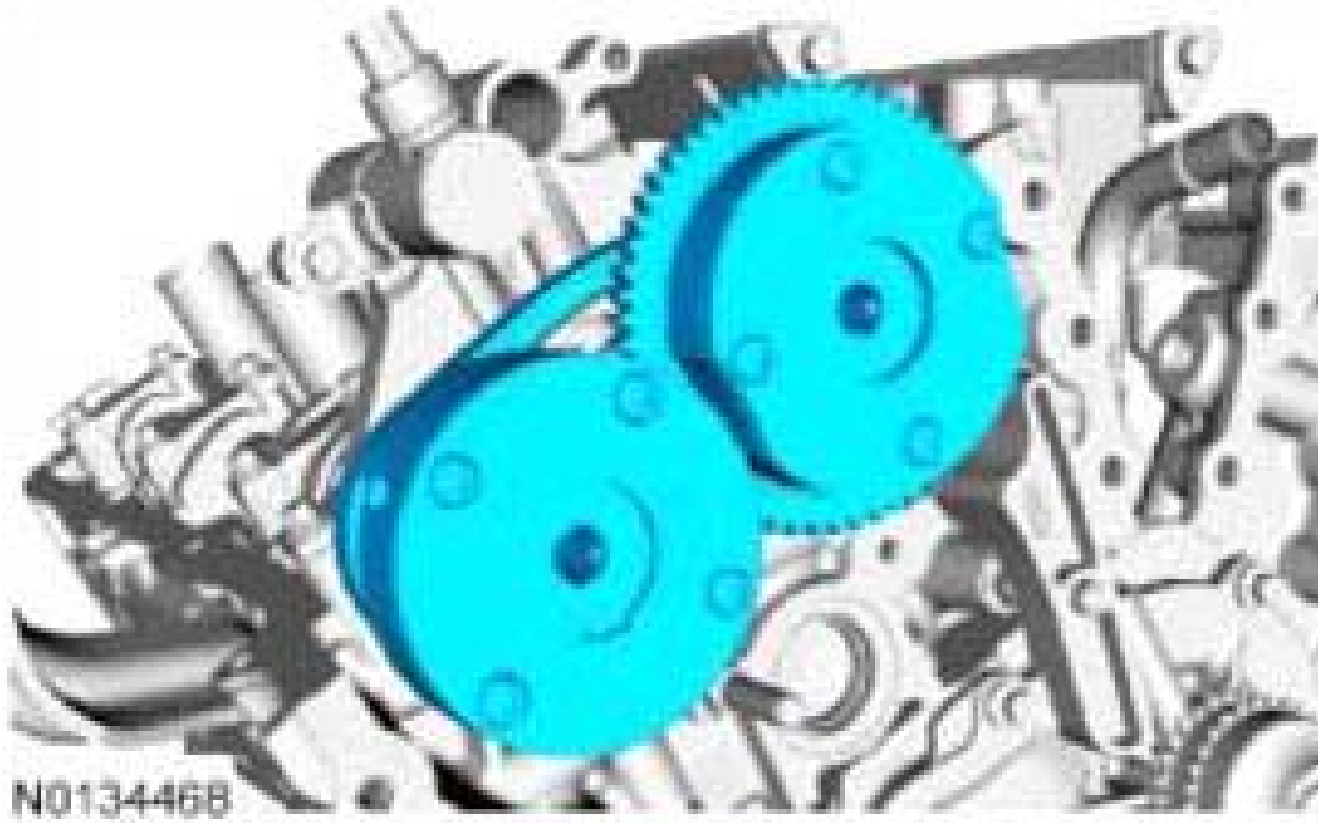
85. Remove and discard the 2 RH **VCT** assembly bolts.

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86. Remove the 2 RH **VCT** assemblies and secondary timing chain.

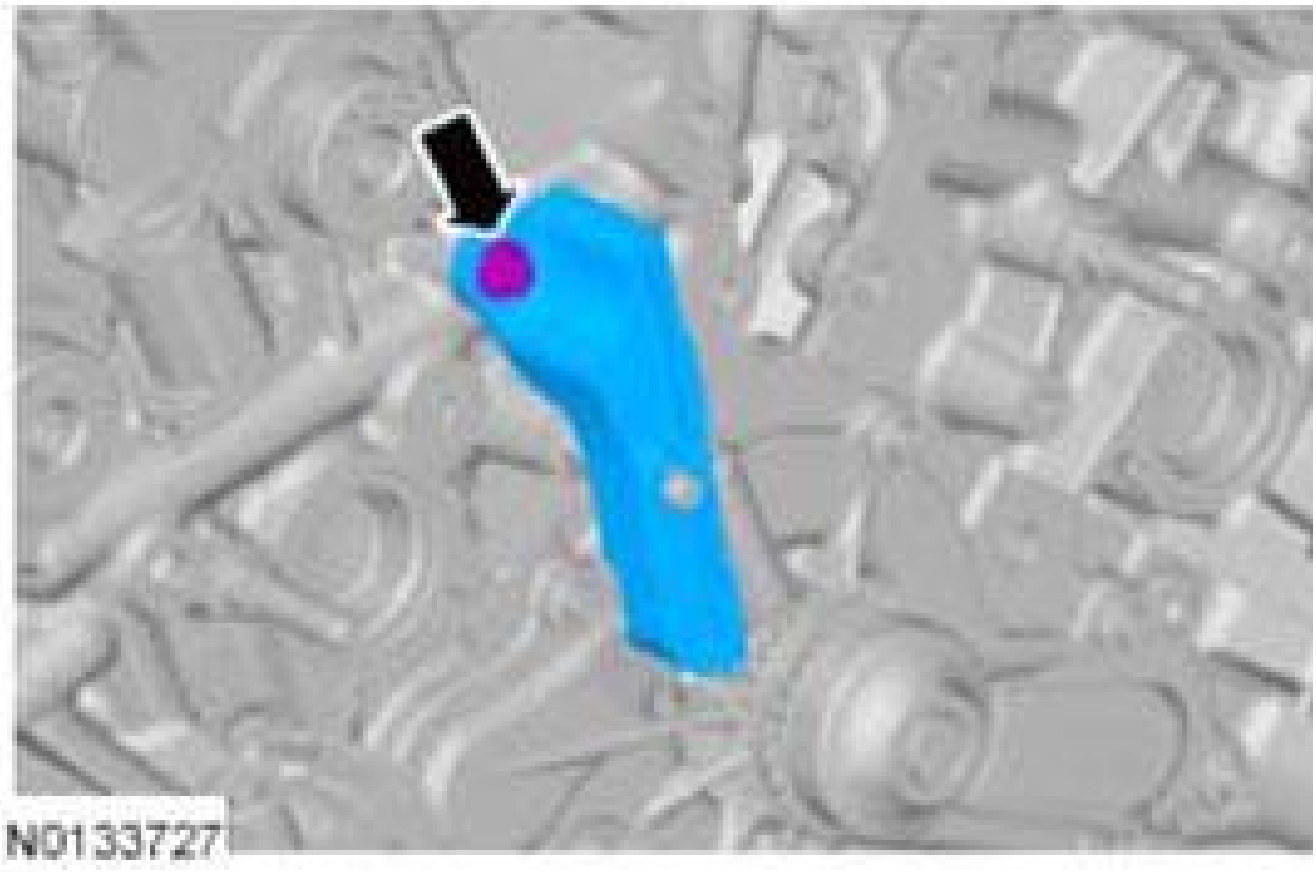
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87. **NOTE: Do not use power tools to remove the bolt or damage to the RH primary timing chain guide may occur.**

Remove the bolt and the RH primary timing chain guide.

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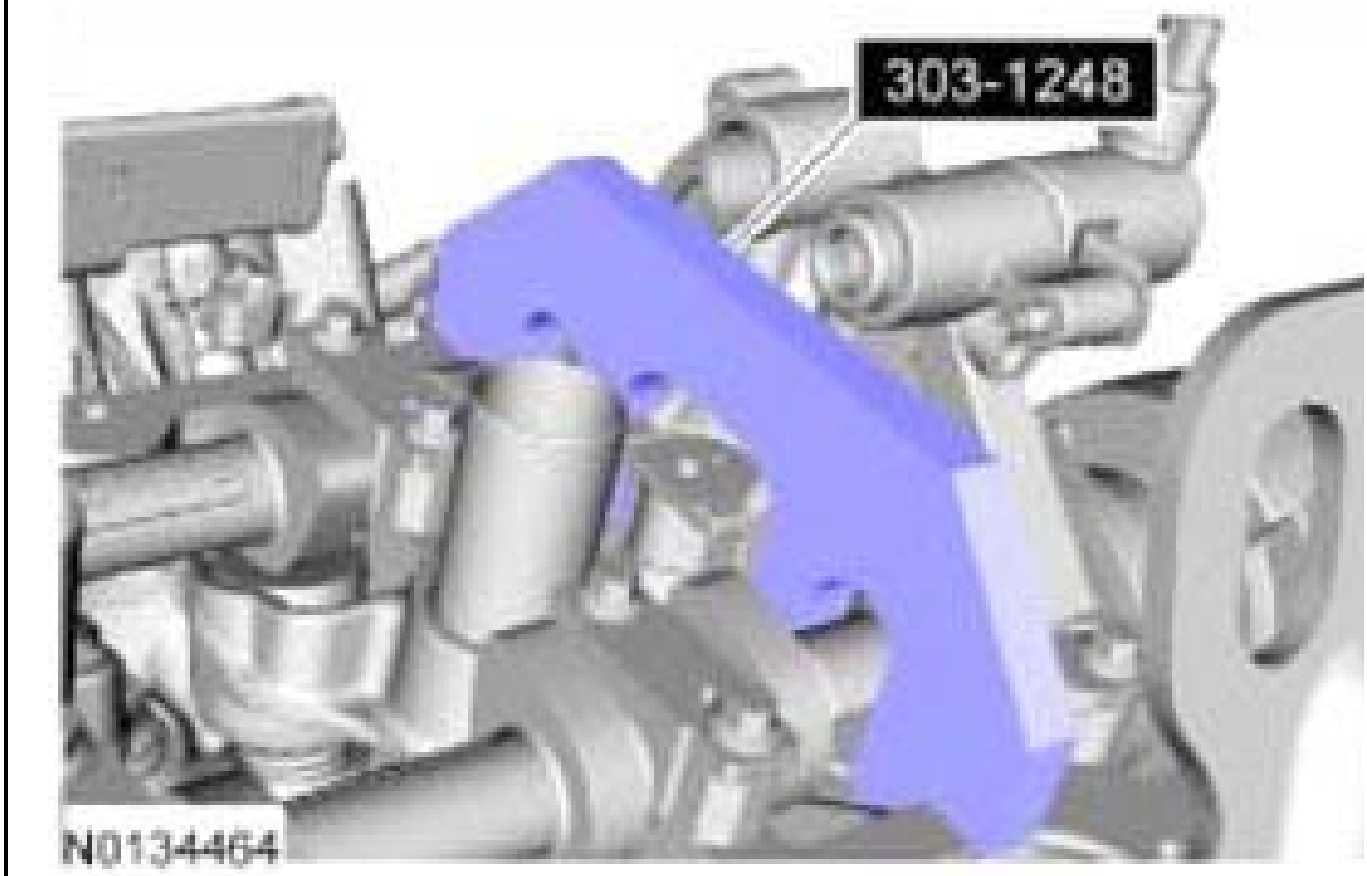


88.

NOTE: **When the 303-1248 is removed, valve spring pressure may rotate the RH camshafts approximately 3 degrees to a neutral position.**

NOTE: **Remove 303-1248 from the RH camshafts.**

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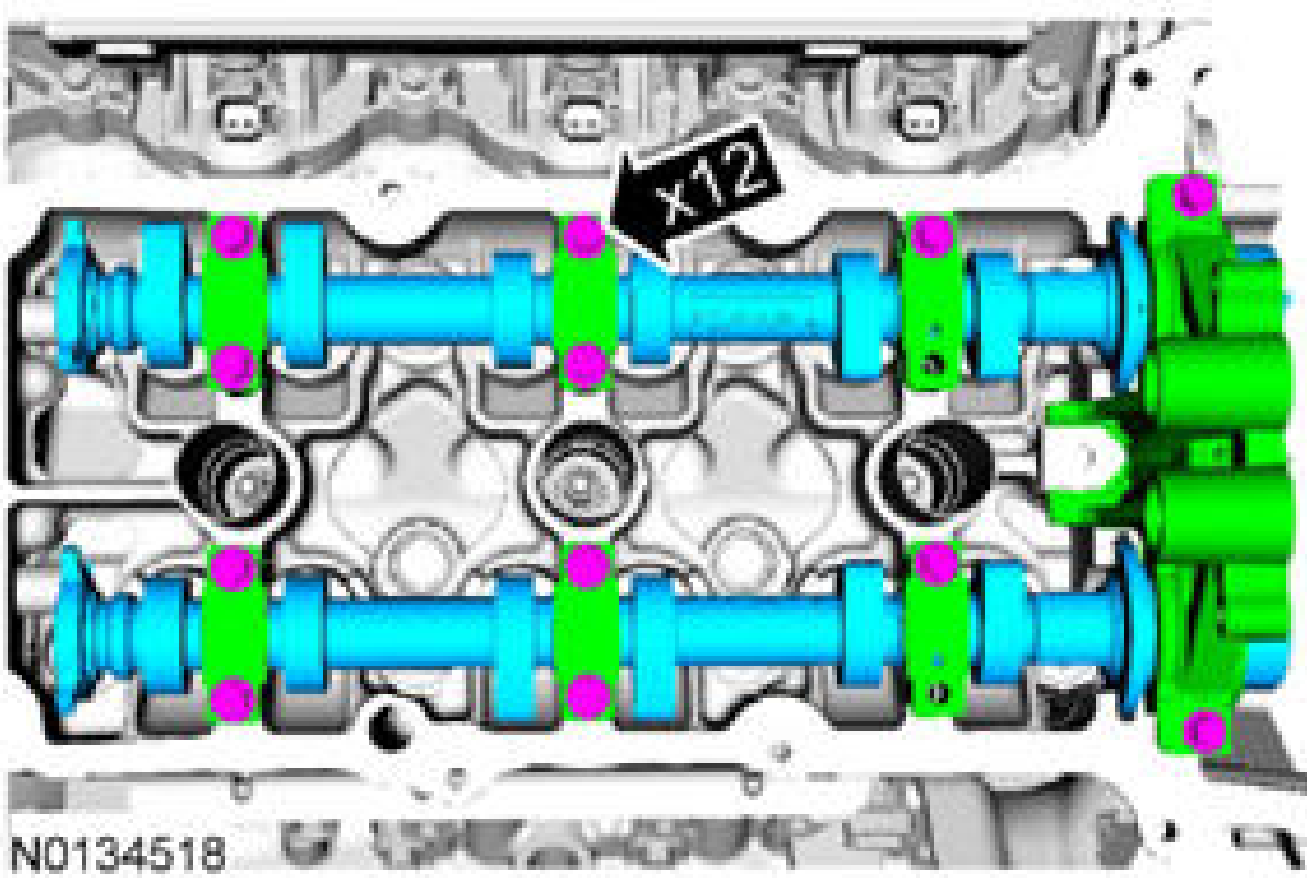


89. **NOTE: Cylinder head camshaft bearing caps are numbered to verify that they are assembled in their original positions.**

NOTE: Mark the exhaust and intake camshafts for installation into their original locations.

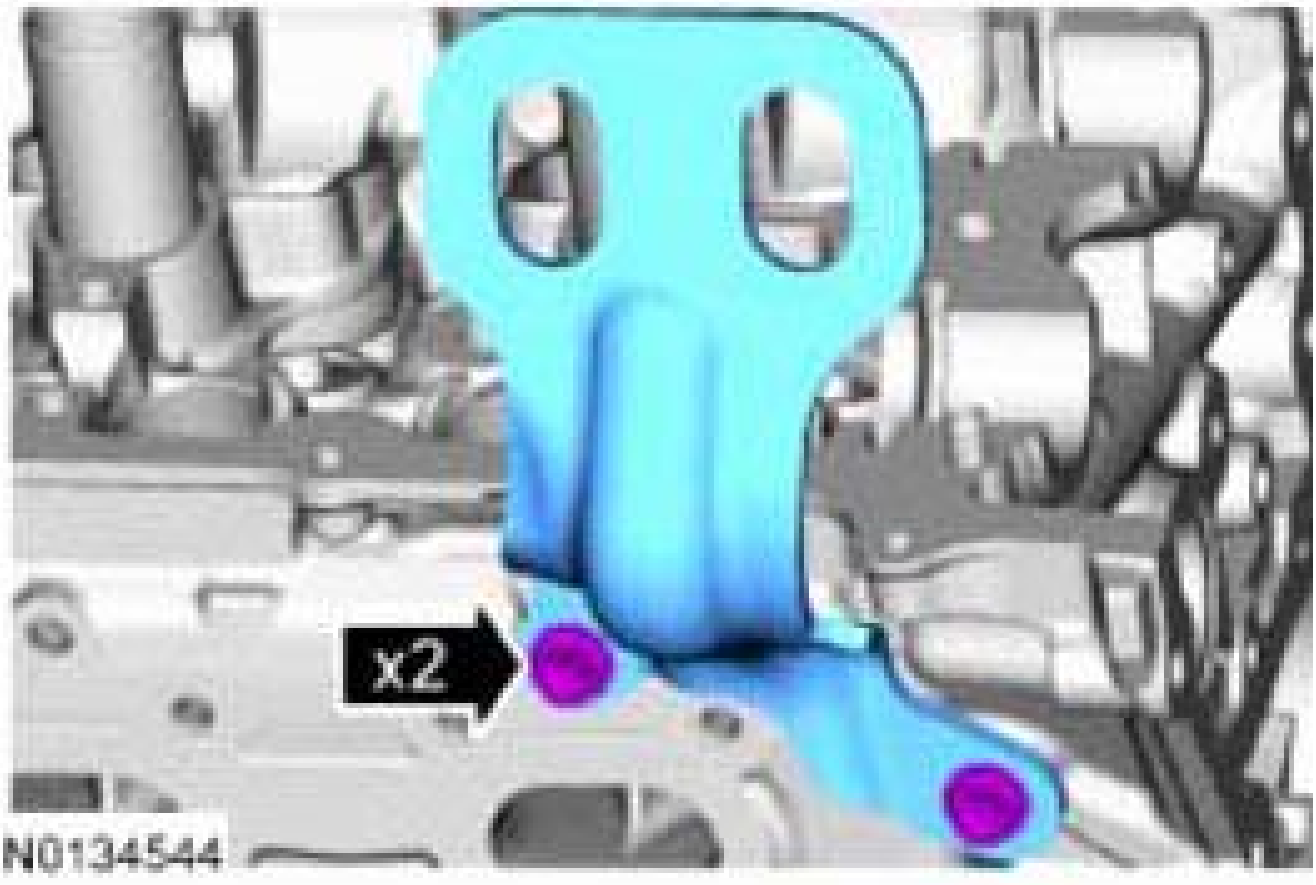
Remove the 12 bolts, 6 camshaft caps, mega cap and the RH camshafts.

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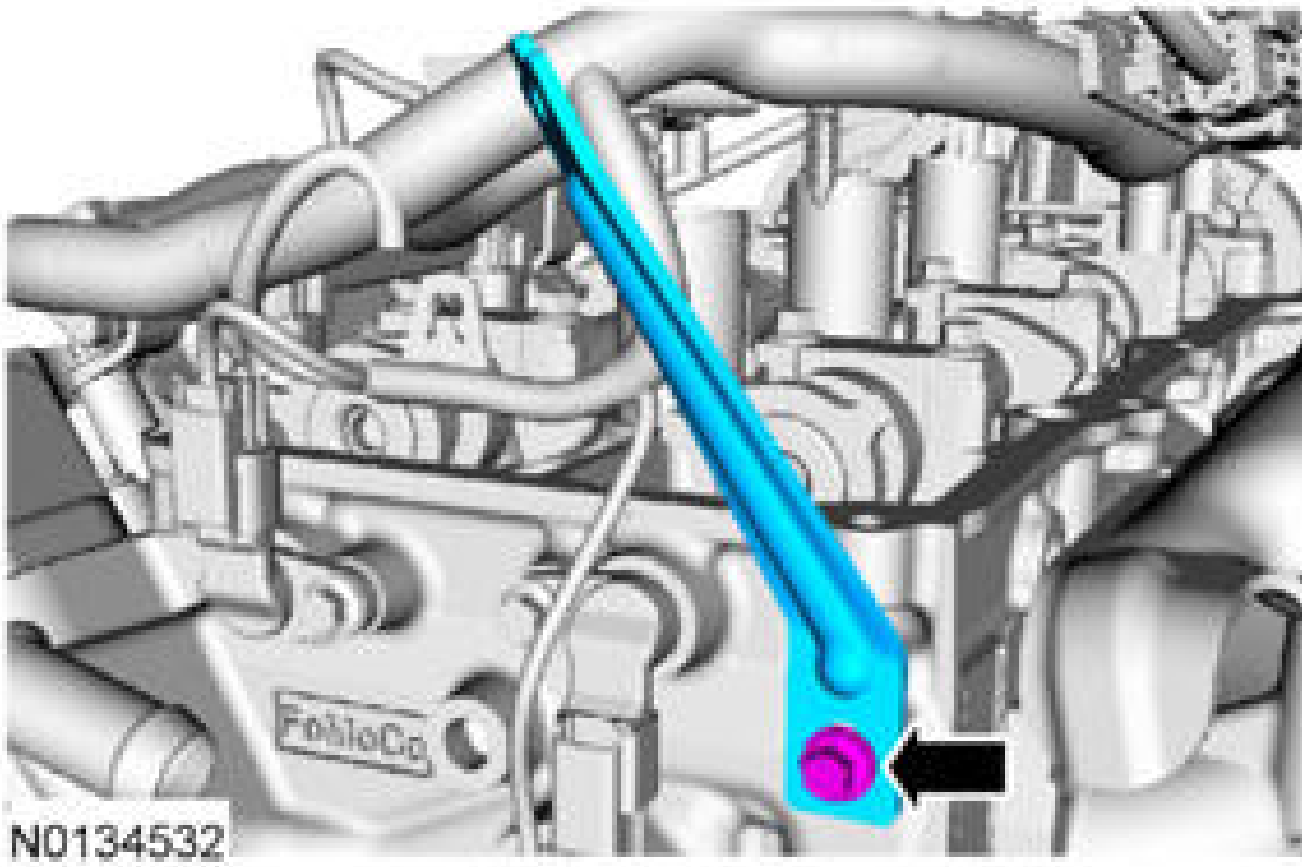
90. Remove the 2 bolts and the engine lifting eye.

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91. **NOTE: Index-mark the location of the bracket on the cylinder head for installation. Remove the bolt and the upper intake manifold bracket.**

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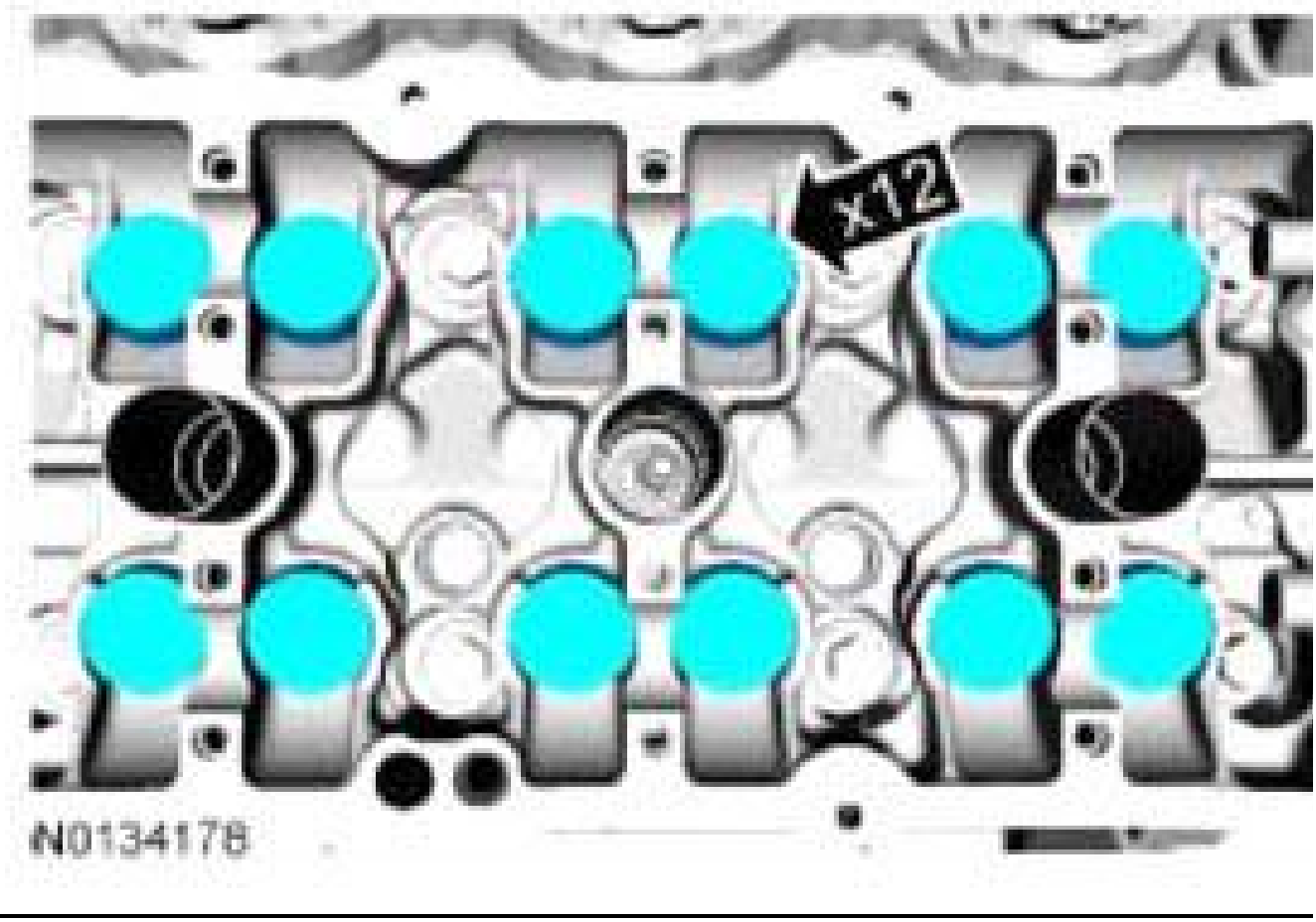
92.

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

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

Remove the valve tappets from the cylinder heads.

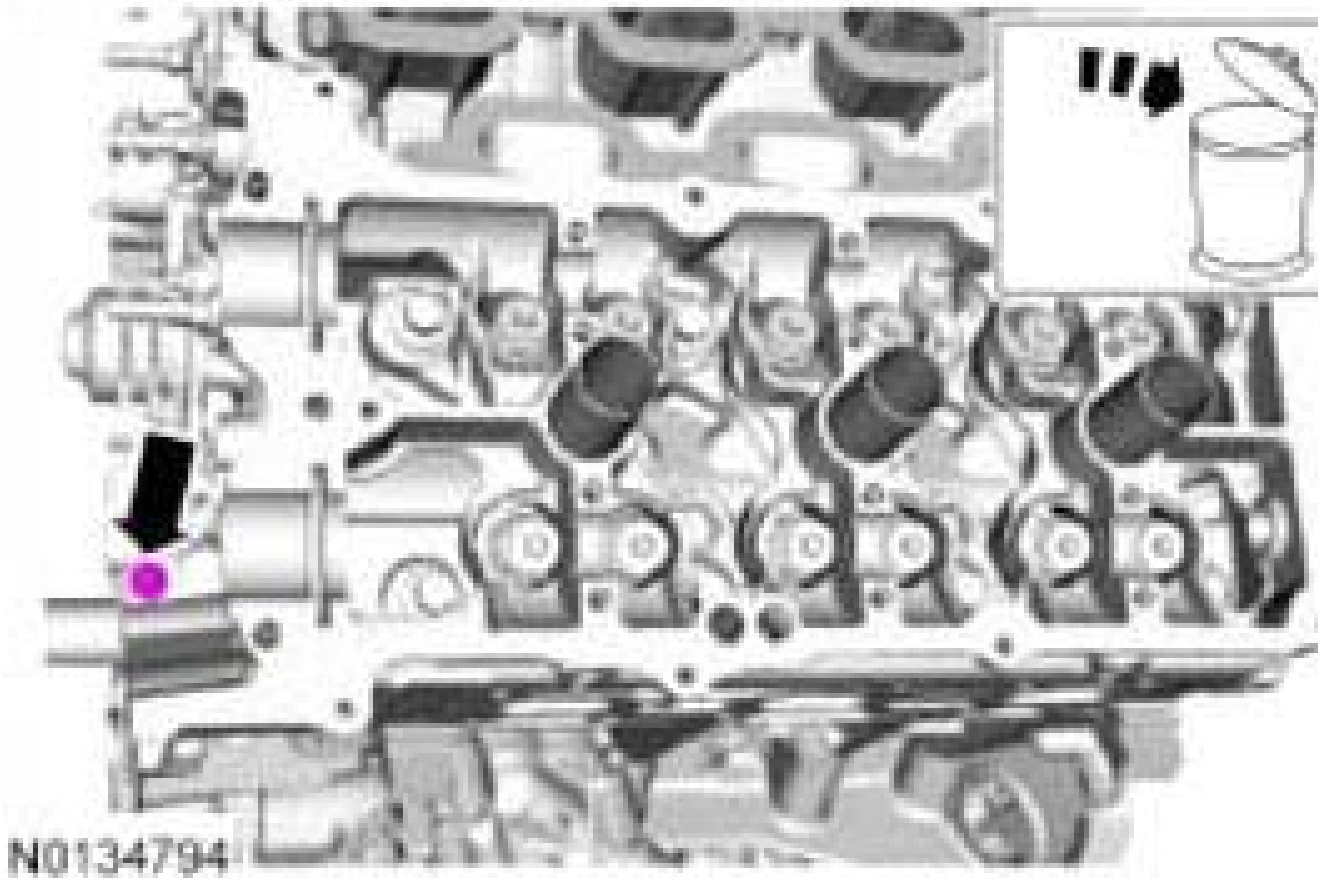
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93. **NOTE: LH shown in illustration, RH similar.**

Remove and discard the M6 bolt from each cylinder head.

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94.

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

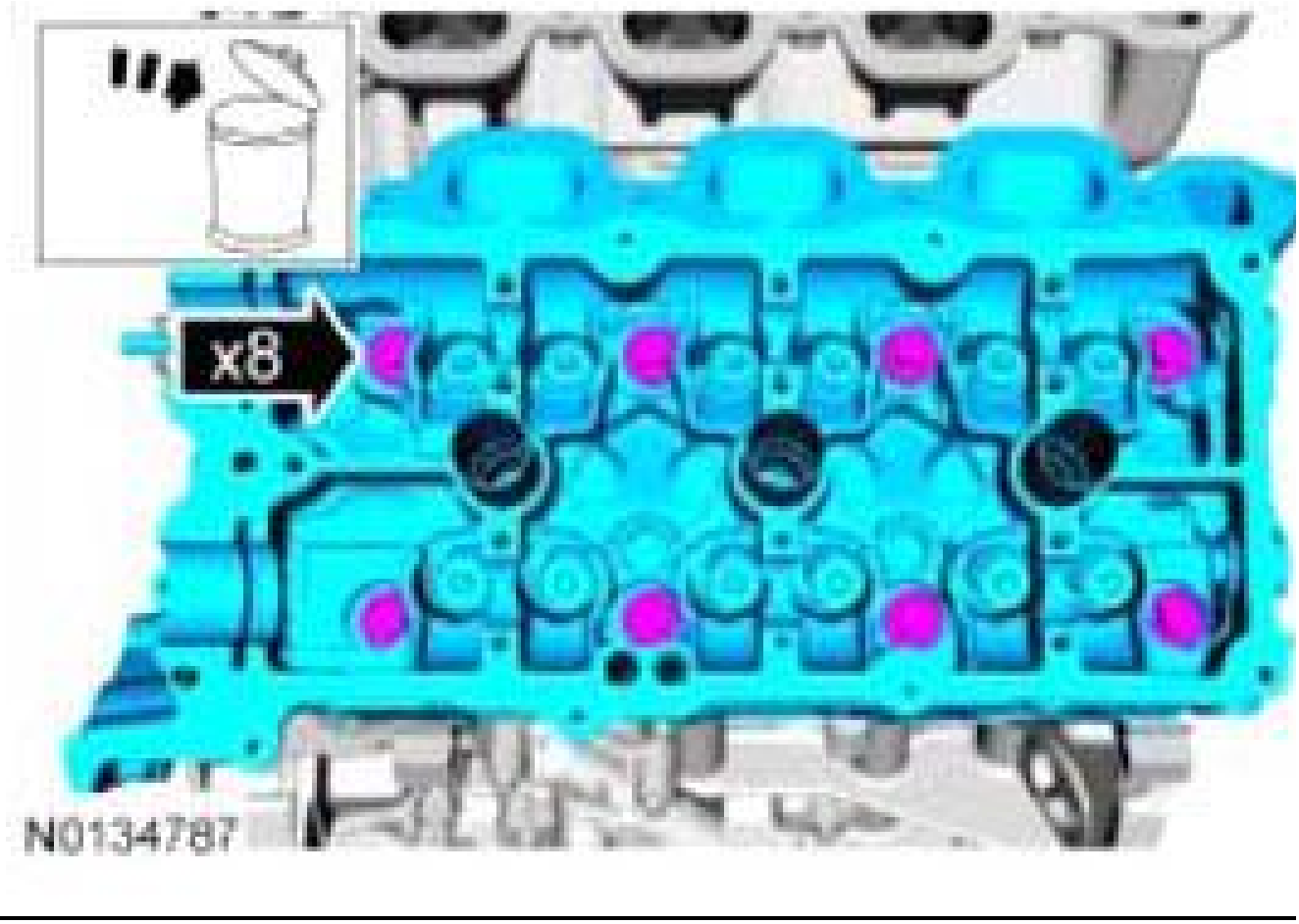
NOTE: **Aluminum surfaces are soft and can be scratched easily. Never place the cylinder head gasket surface, unprotected, on a bench surface.**

NOTE: **The cylinder head bolts must be discarded and new bolts must be installed. They are tighten-to-yield designed and cannot be reused.**

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

Remove and discard the 8 bolts from each cylinder head. Remove the cylinder heads. Discard the cylinder head gaskets.

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95.

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

NOTE: **Observe all warnings or cautions and follow all application directions contained on the packaging of the silicone gasket remover and the metal surface prep.**

NOTE: **If there is no residual gasket material present, metal surface prep can be used to clean and prepare the surfaces. Clean the cylinder head-to-cylinder block mating surfaces of both the cylinder heads and the cylinder block in the following sequence. Remove any large deposits of silicone or gasket material with a plastic scraper.**

Apply silicone gasket remover, following package directions, and allow to set for several minutes. Apply metal surface prep, following package directions, to remove any remaining traces of oil or coolant and to prepare the surfaces to bond with the new gasket.

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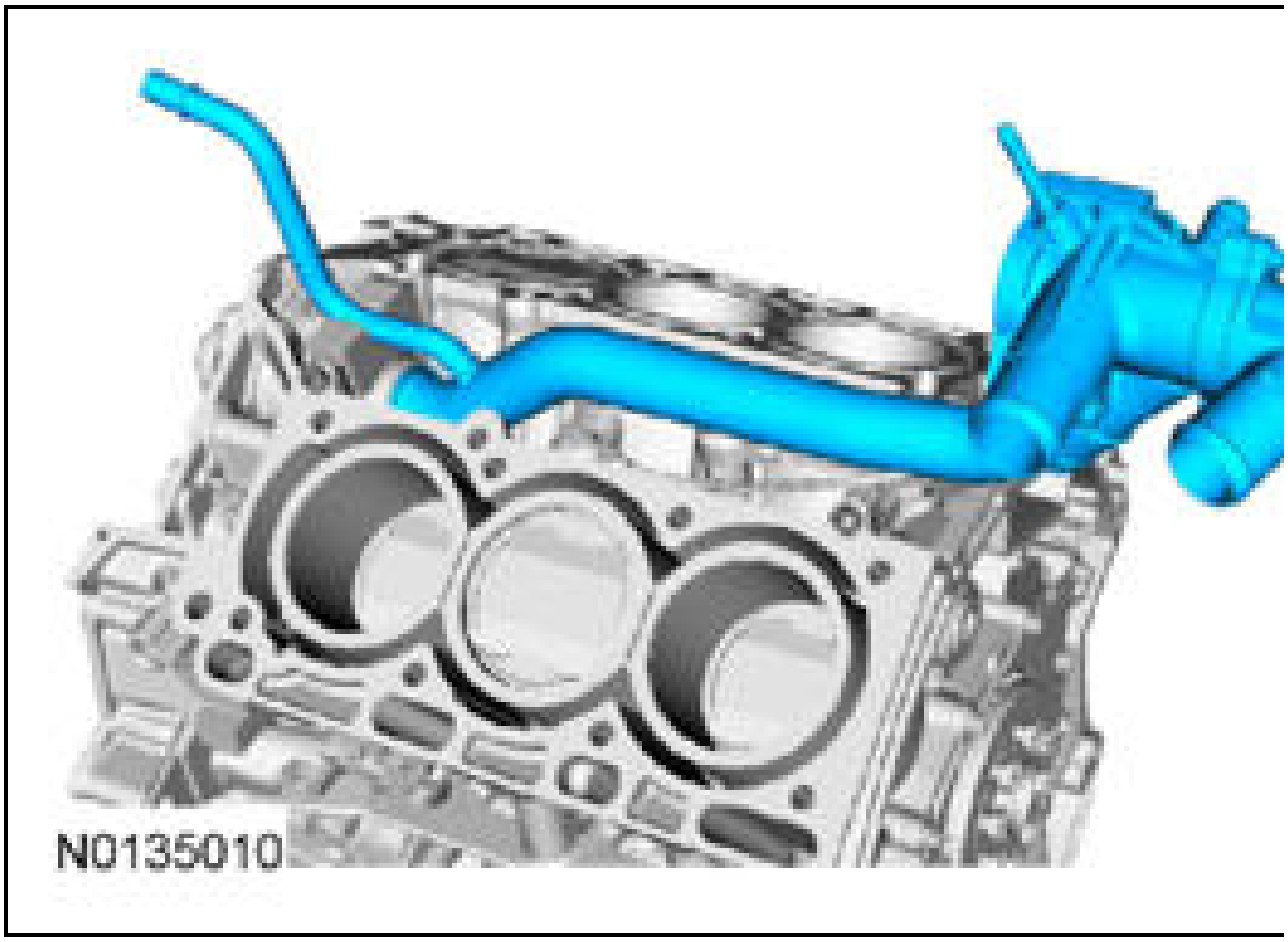
- Remove the silicone gasket remover with a plastic scraper. A second application of silicone gasket remover may be required if residual traces of silicone or gasket material remain.
- Do not attempt to make the metal shiny. Some staining of the metal surfaces is normal. Make sure the 2 locating dowel pins are seated correctly in the cylinder block.

96. Support the cylinder head on a bench with the head gasket side up. Check the cylinder head distortion and the cylinder block distortion.

97. **NOTE: Cylinder heads removed for clarity.**

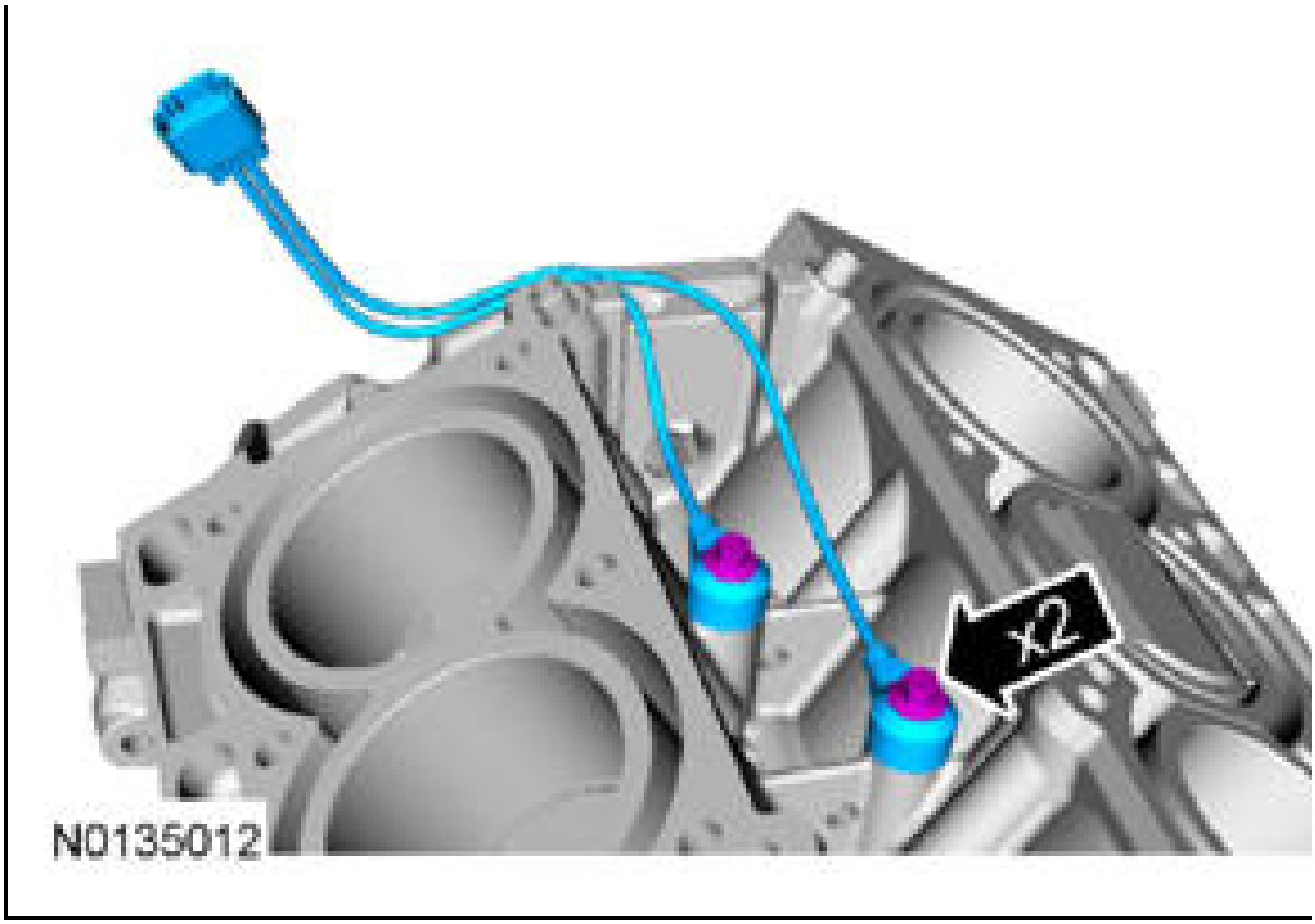
Remove the coolant inlet tube and thermostat assembly.

- Remove and discard the O-ring seal.



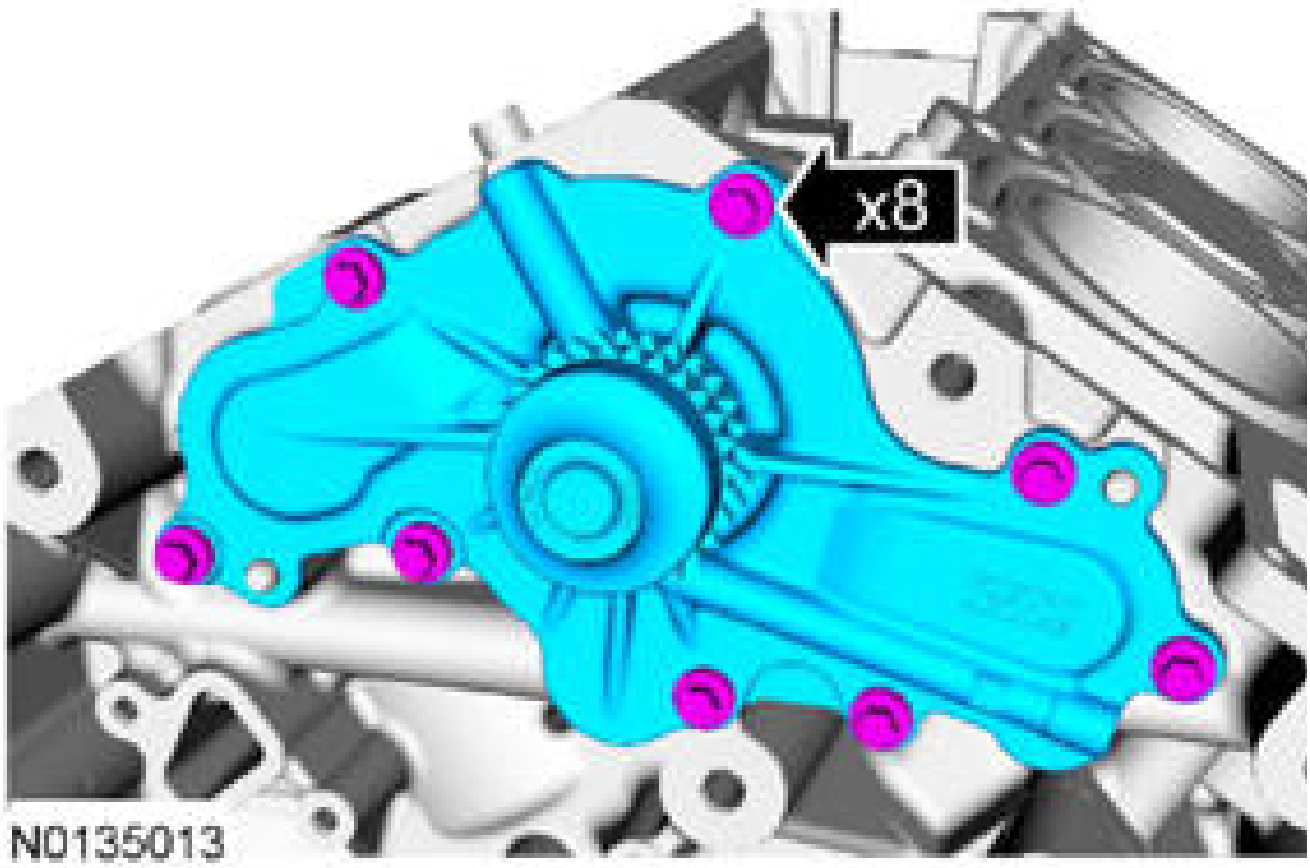
98. Remove the 2 bolts and the KS.

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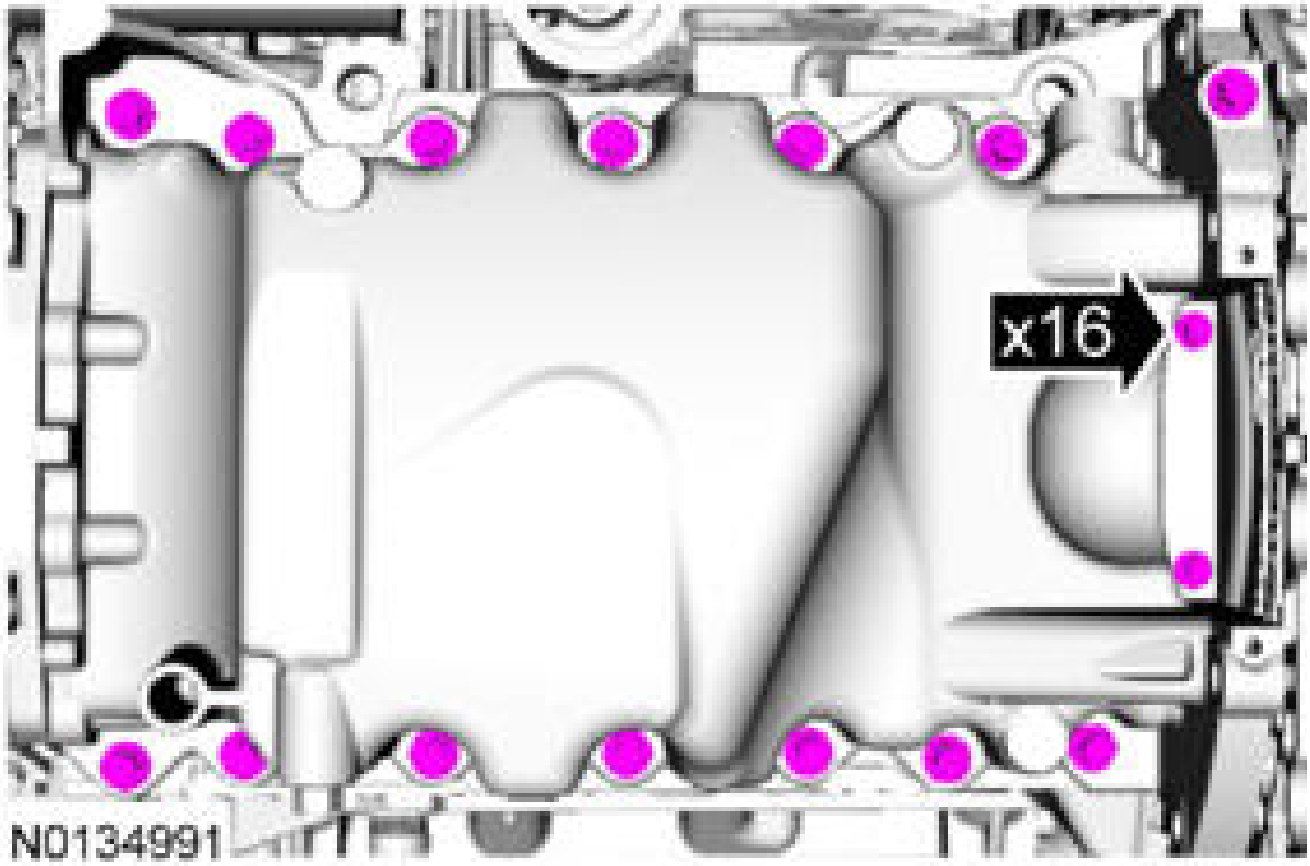
99. Remove the 8 bolts and the coolant pump.

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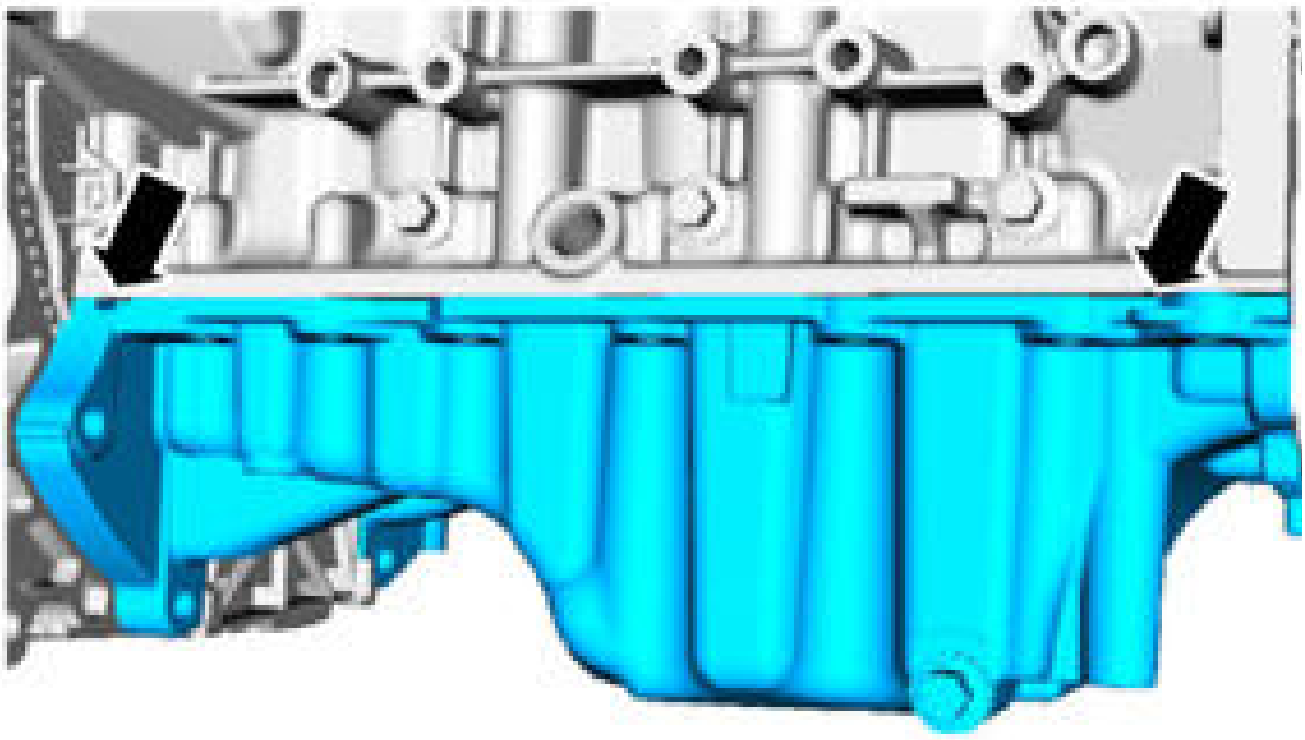
100. Remove the 16 oil pan bolts.

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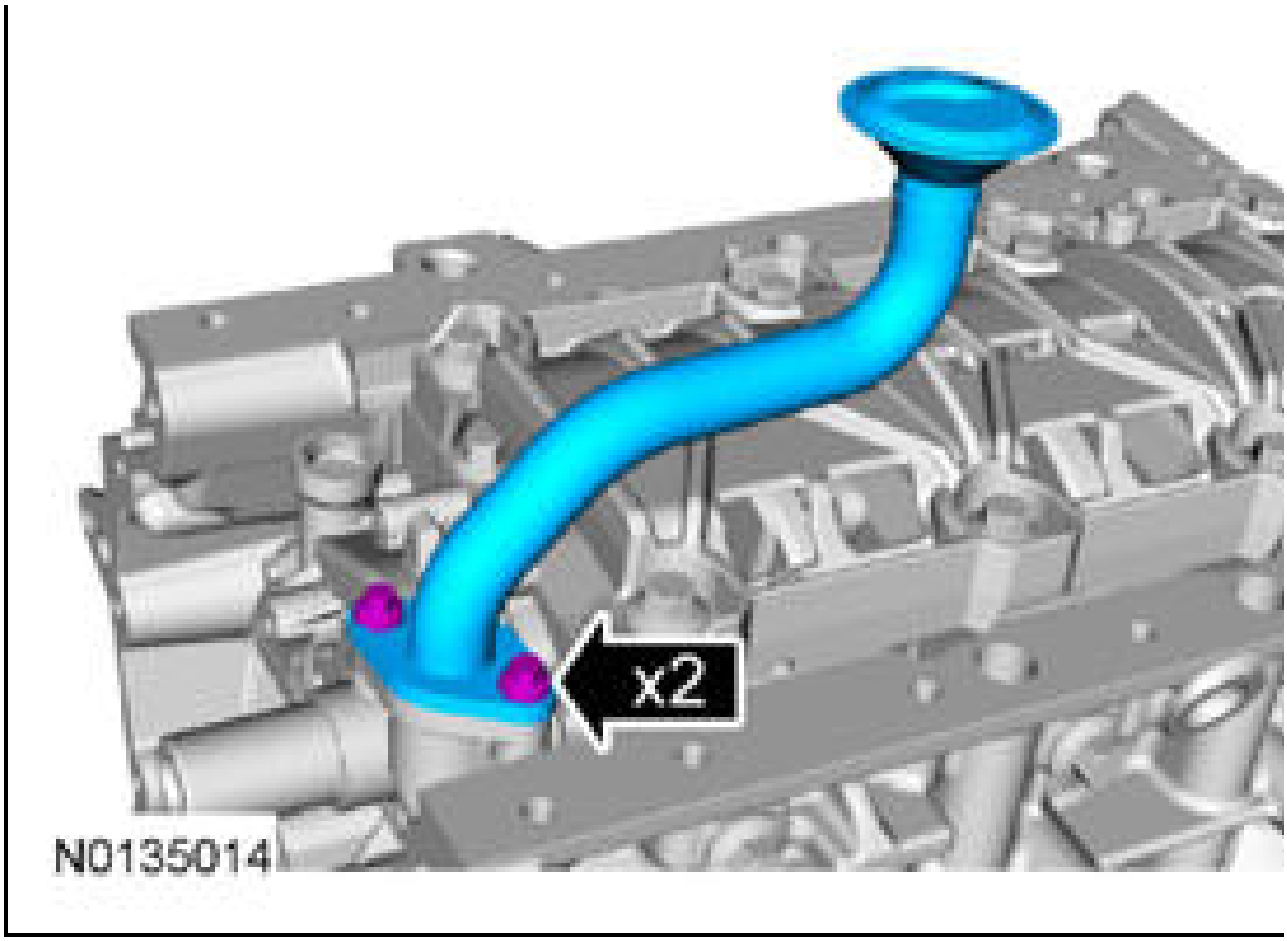
101. Using a suitable pry tool, locate the pry pads and pry the oil pan loose and remove.

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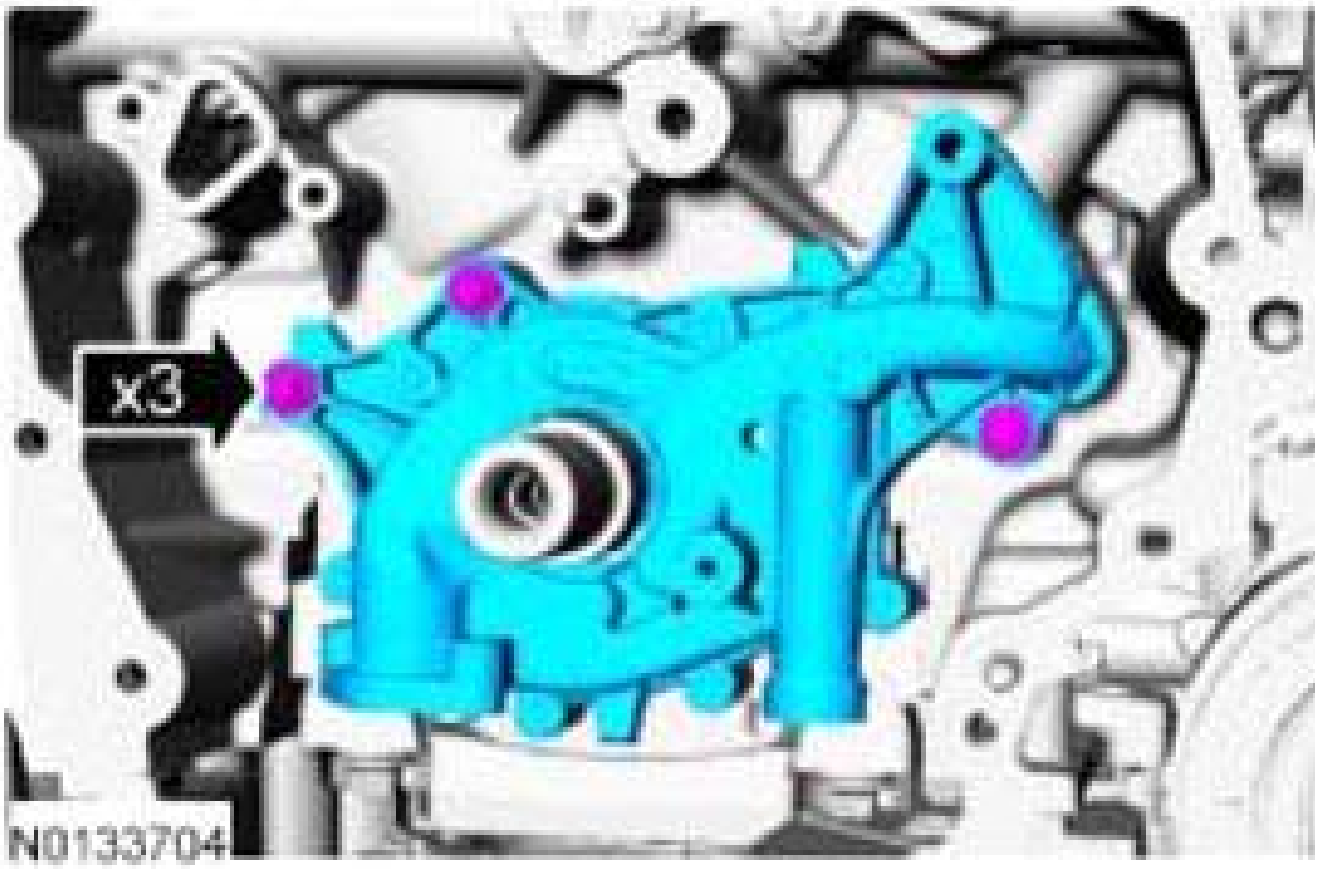
102. Remove the 2 bolts and the oil pump screen and pickup tube.
    - Discard the O-ring seal.

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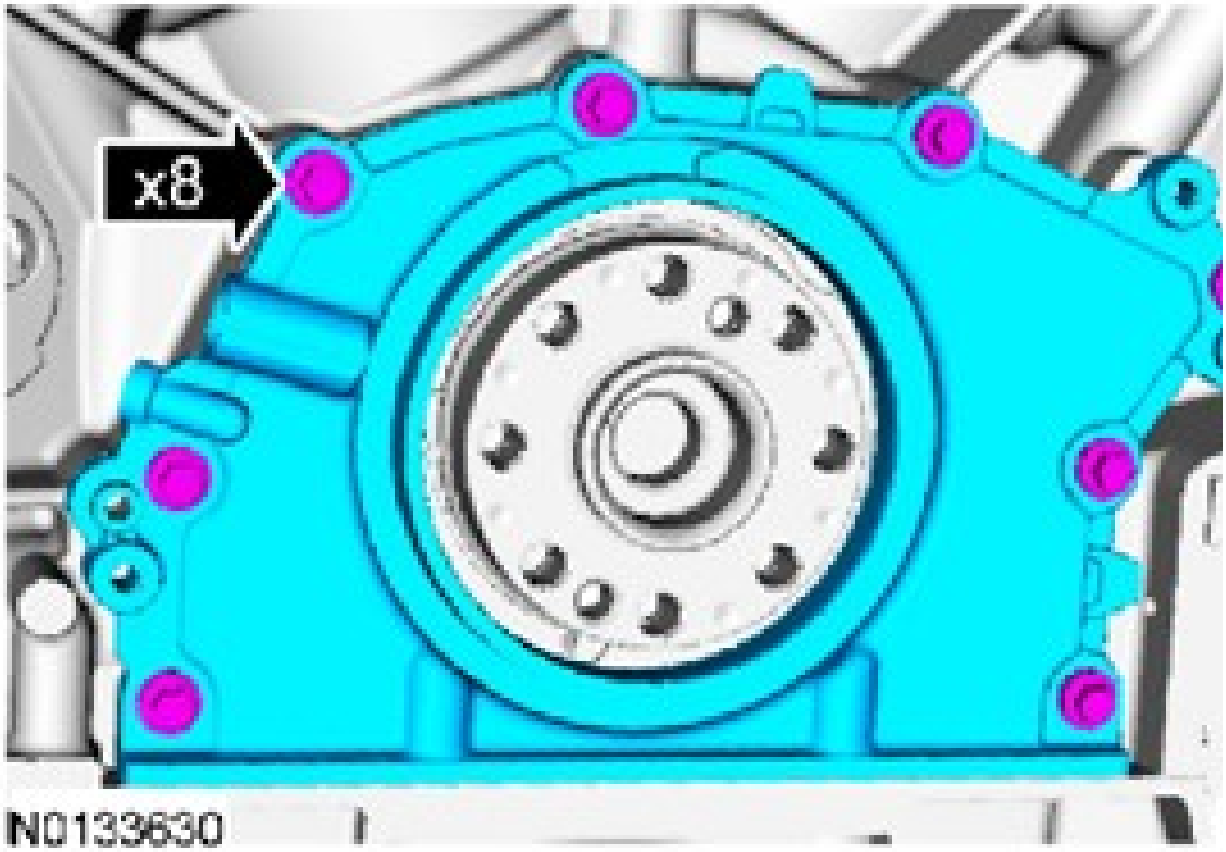
103. Remove the 3 bolts and the oil pump.

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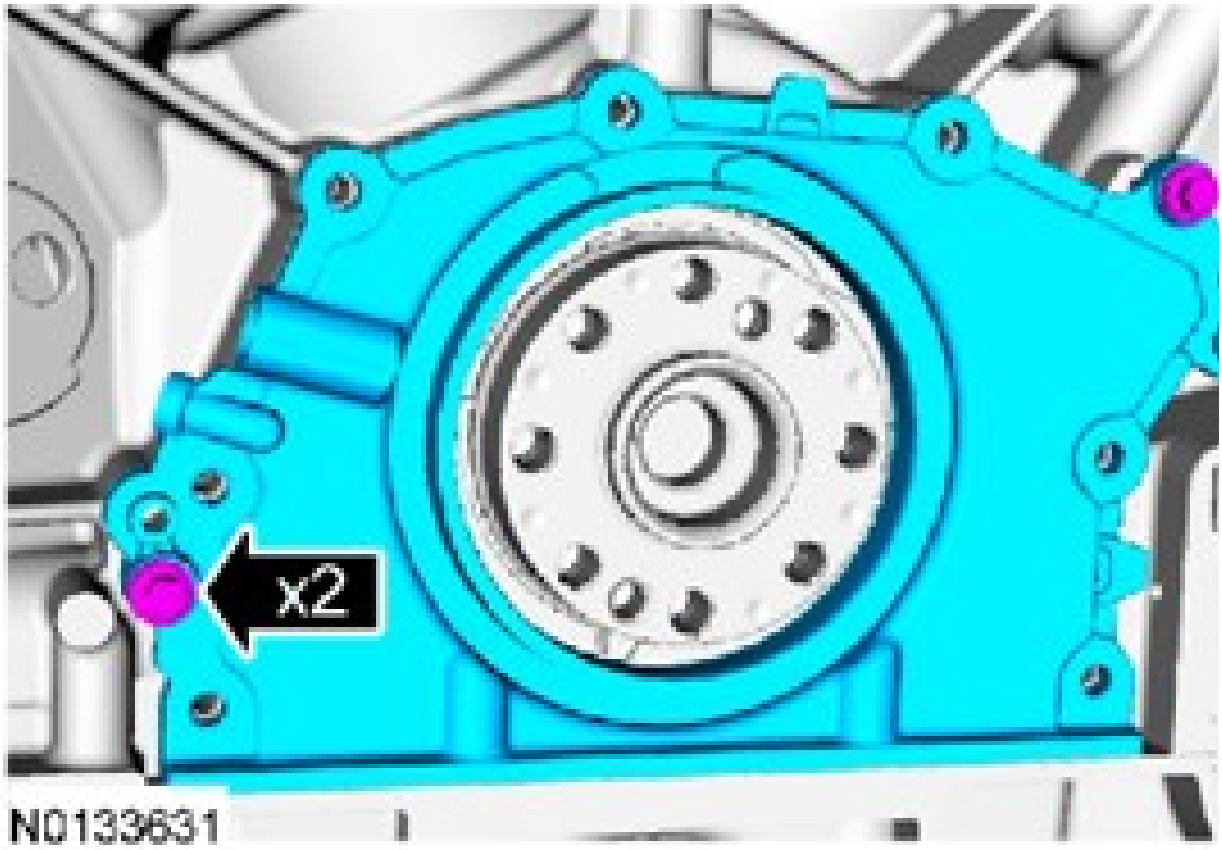
104. Remove the 8 crankshaft rear seal retainer bolts.
    - If equipped with a stamped steel rear seal retainer plate (late build), remove and discard the plate and seal.

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105. If equipped with a cast aluminum rear seal retainer plate (early build), install the 2 M6 oil pan bolts (finger-tight) into the 2 threaded holes in the crankshaft rear seal retainer.
    - Alternately tighten the 2 bolts one turn at a time until the crankshaft rear seal retainer-to-cylinder block seal is released.
    - Remove the crankshaft rear seal retainer plate.

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NOTE: **Only use a 3M™ Roloc® Bristle Disk (2-in white, part number 07528) to clean the engine front cover, oil pan and crankshaft rear seal retainer plate. Do not use metal scrapers, wire brushes or any other power abrasive disk to clean the engine front cover, oil pan and crankshaft rear seal retainer plate. These tools cause scratches and gouges that make leak paths.**

106.

Clean the engine front cover, oil pan and crankshaft rear seal retainer plate using a 3M Roloc® Bristle Disk (2 inch, white, part number 07528) in a suitable tool turning at the recommended speed of 15,000 rpm. Thoroughly wash the engine front cover, oil pan and crankshaft rear seal retainer plate to remove any foreign material, including any abrasive particles created during the cleaning process.

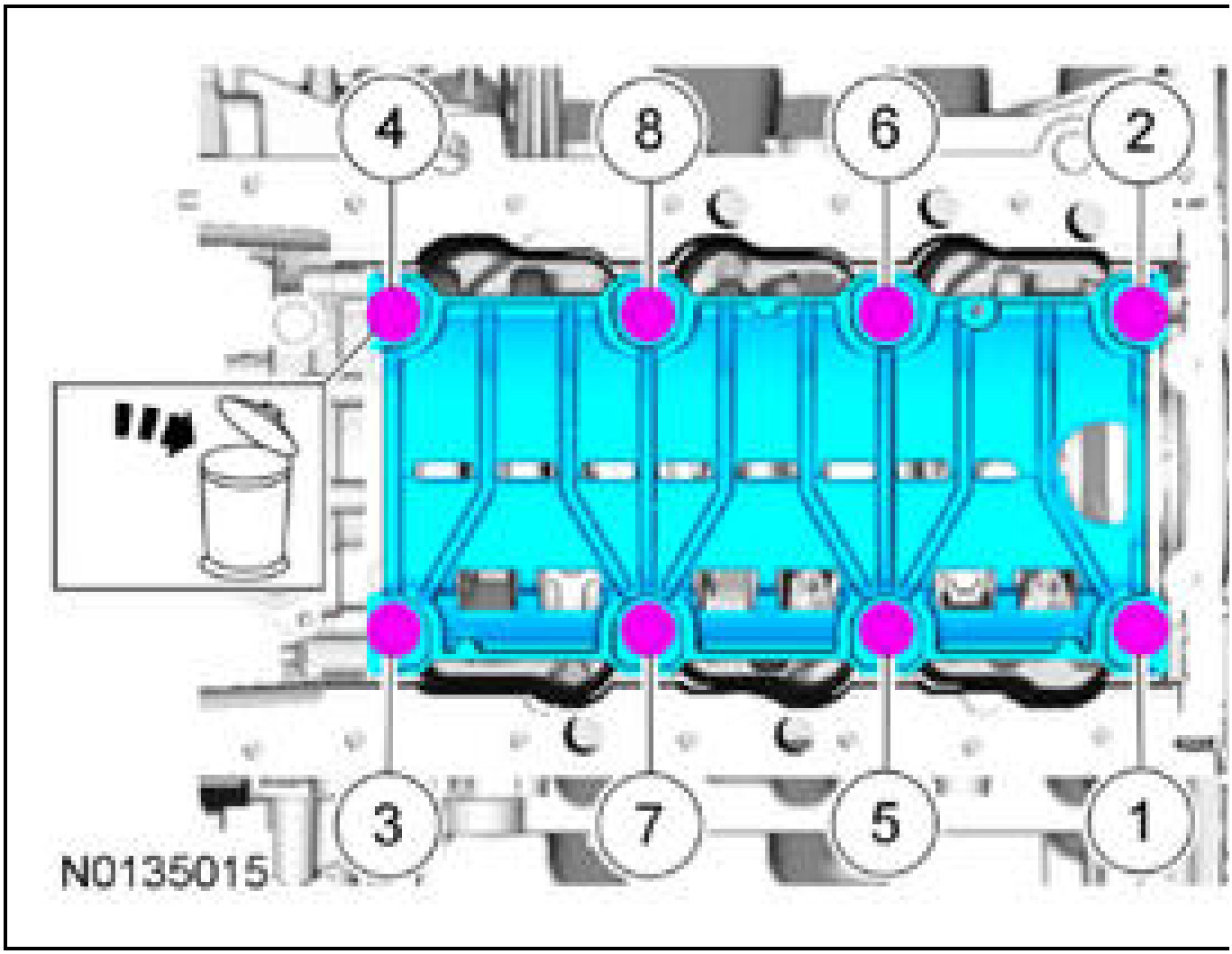
107. Before removing the pistons, inspect the top of the cylinder bores. If necessary, remove the ridge or carbon deposits from each cylinder using an abrasive pad or equivalent, following manufacturer's instructions.

NOTE: **The main bearing cap support brace bolts must be discarded and new bolts must be installed. They are a tighten-to-yield design and cannot be reused.**

108.

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Remove the bolts in the sequence shown in illustration. Remove the main bearing cap support brace. Discard the bolts.



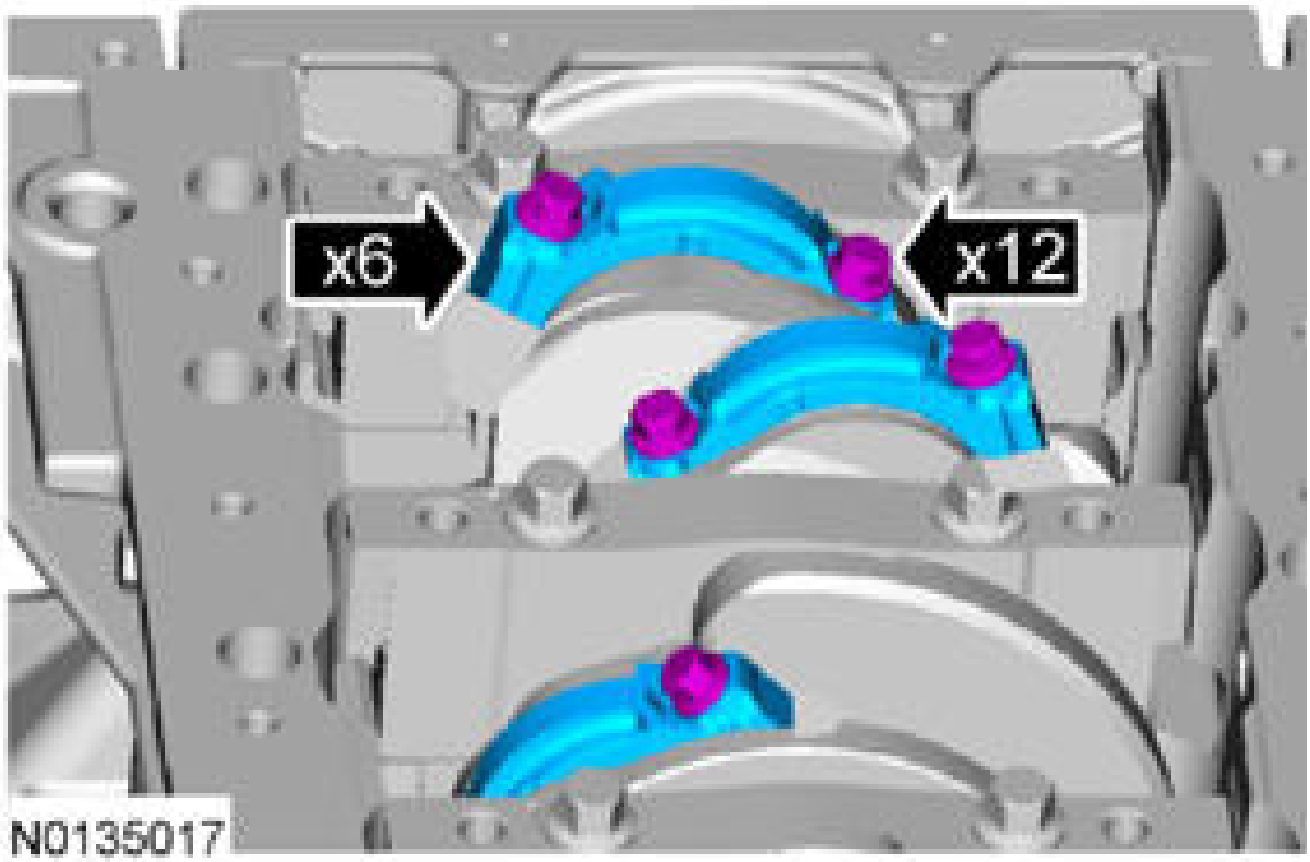
109.

NOTE: **The connecting rod cap bolts are a torque-to-yield design. The original connecting rod cap bolts will be used when measuring the connecting rod large end bore during assembly. The connecting rod cap bolts will be discarded after measurement.**

NOTE: **Clearly mark the position and orientation of the connecting rods, connecting rod caps and connecting rod bearings for reassembly.**

Remove the connecting rod cap bolts and cap.

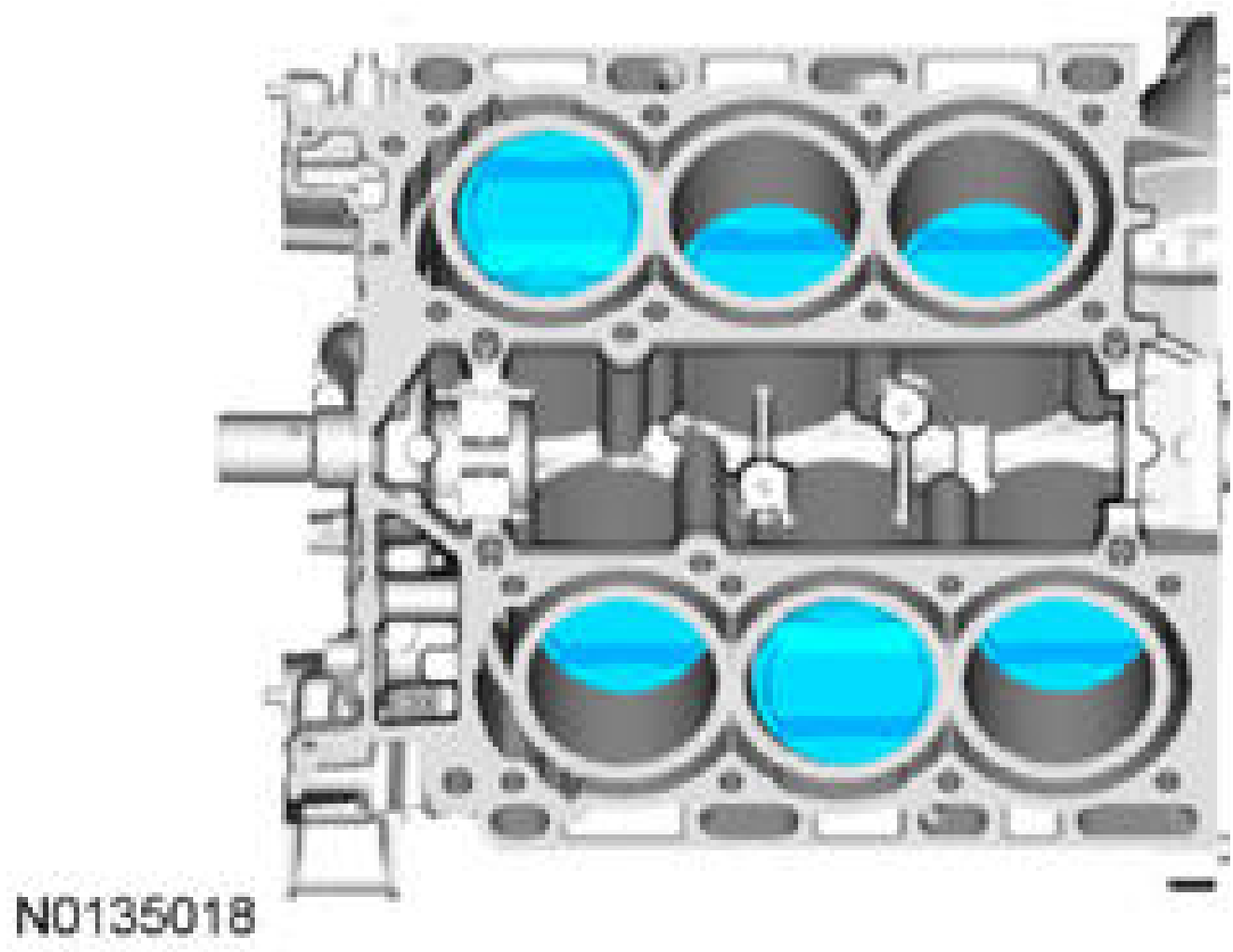
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110. **NOTE: Do not scratch the cylinder walls or crankshaft journals with the connecting rod.**

Remove the piston/rod assembly from the engine block.

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111. Repeat the previous 2 steps until all the piston/rod assemblies are removed from the engine block.

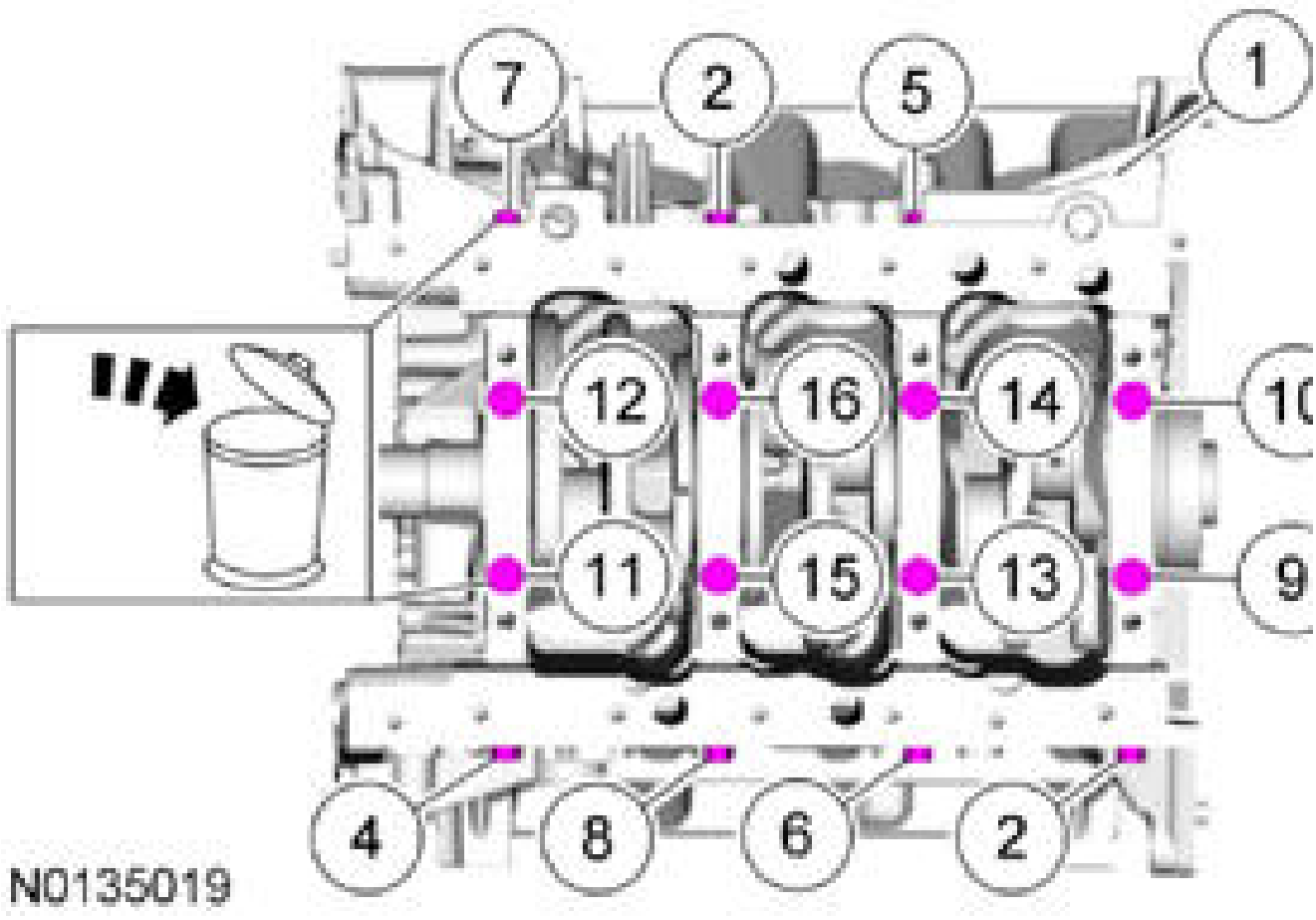
112.

NOTE: **The 8 main bearing cap side bolts and the 8 main bearing cap bolts must be discarded and new bolts must be installed. They are a tighten-to-yield design and cannot be reused.**

NOTE: **Clearly mark the position and orientation of the main bearing caps for reassembly.**

Remove the 8 main bearing cap side bolts and the 8 main bearing cap bolts in the sequence shown in illustration. Discard the bolts.

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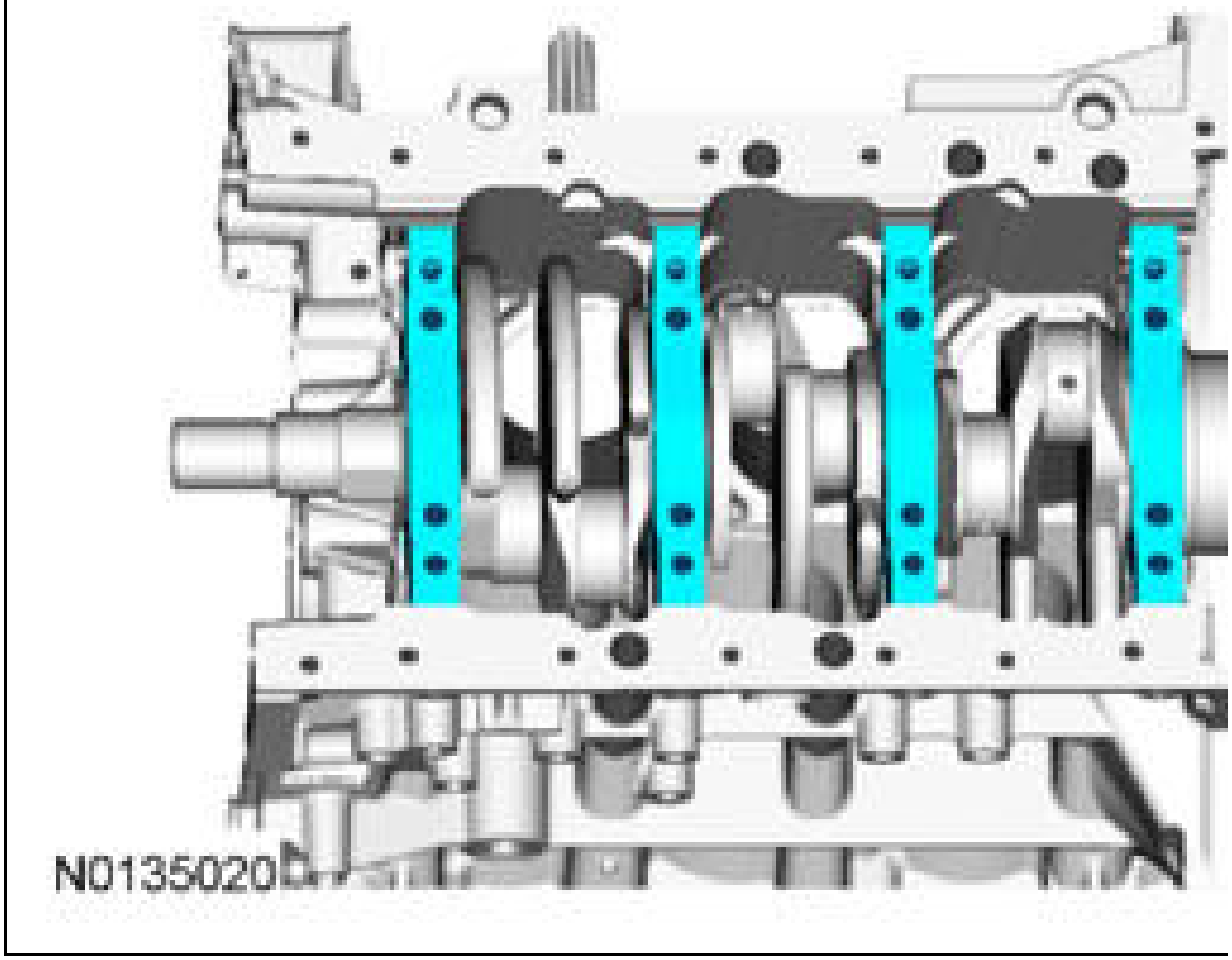
113.

NOTE: **If the main bearings are being reused, mark them for correct position and orientation for reassembly.**

NOTE: **Note the position of the thrust washer on the outside of the No. 4 rear main bearing cap.**

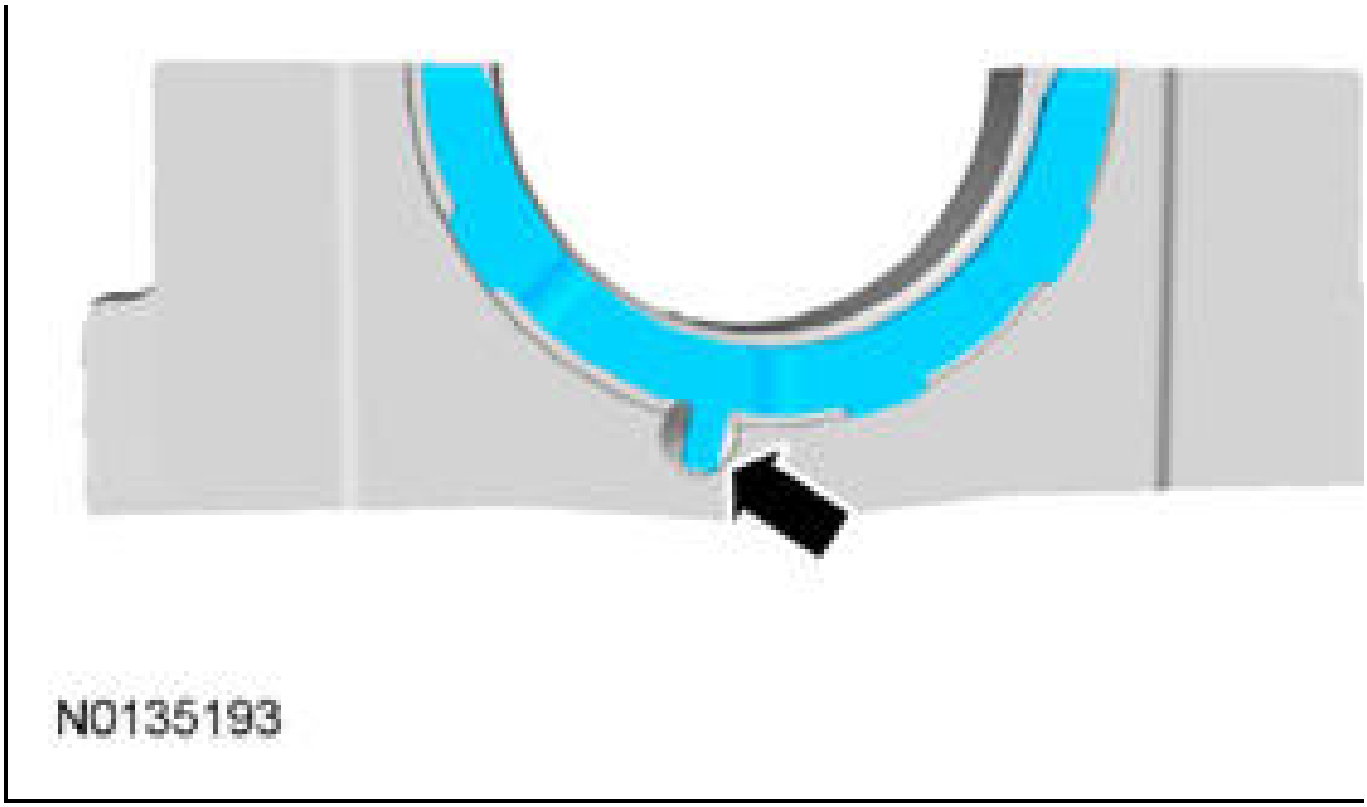
Remove the 4 main bearing caps.

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114. Remove the lower crankshaft thrust washer from the back side of the No. 4 rear main bearing cap.

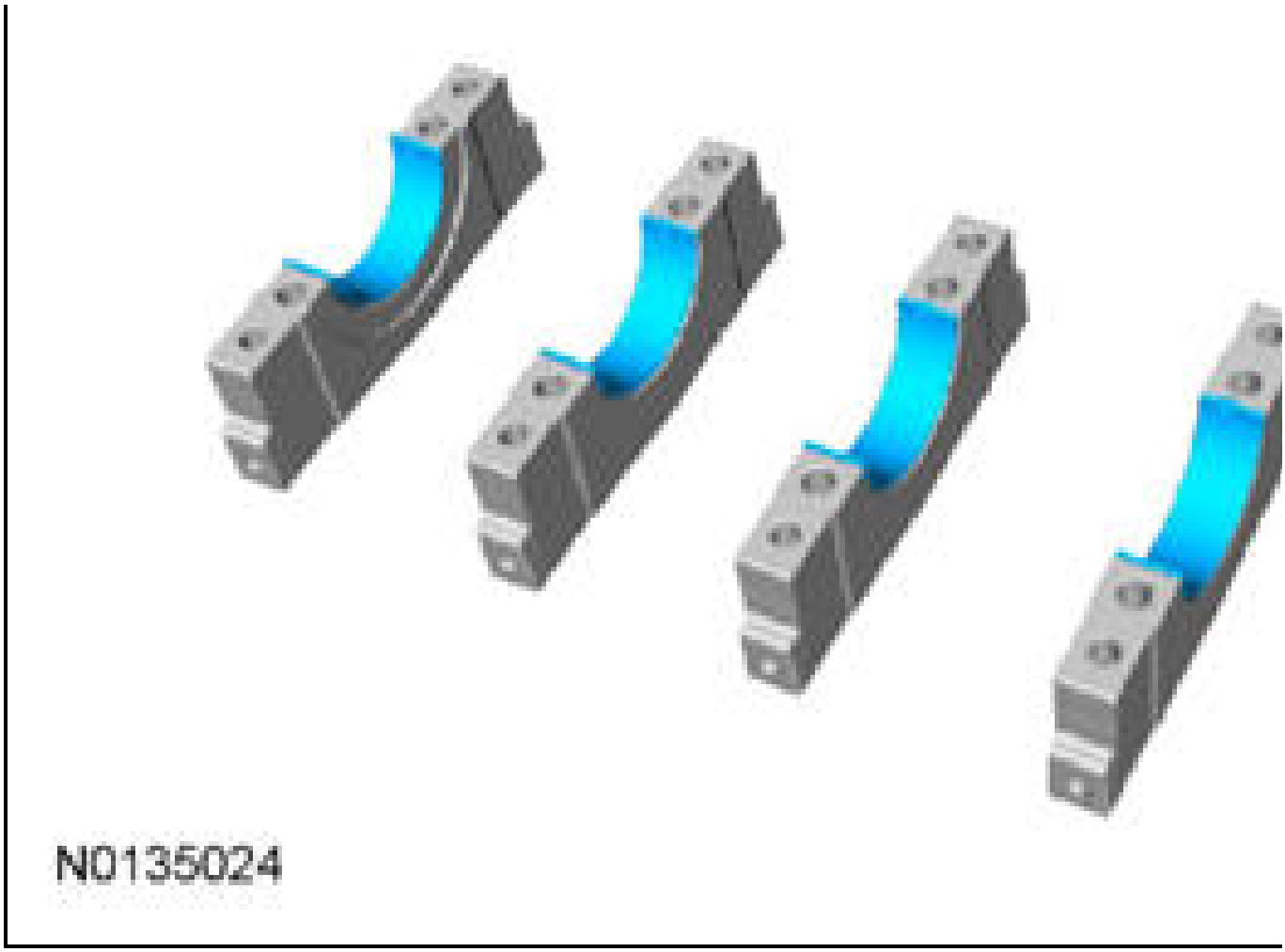
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NOTE: **If the main bearings are being reused, mark them for correct position and orientation for reassembly.**

115. Remove the 4 crankshaft main bearings from the main bearing caps.

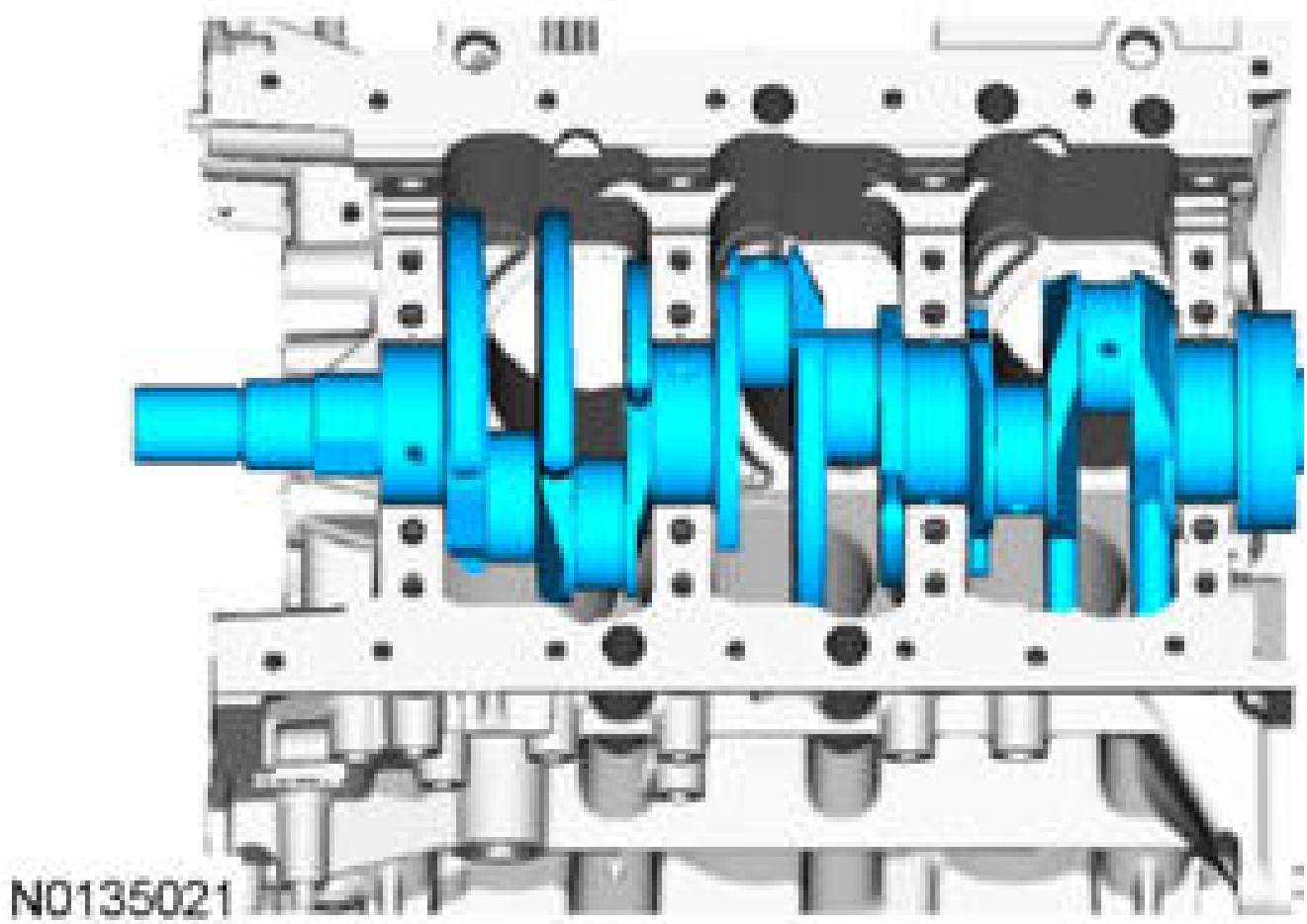
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NOTE: **Note the position of the 2 thrust washers on the inside and outside of the rear main bearing bulkhead.**

116. Remove the crankshaft.

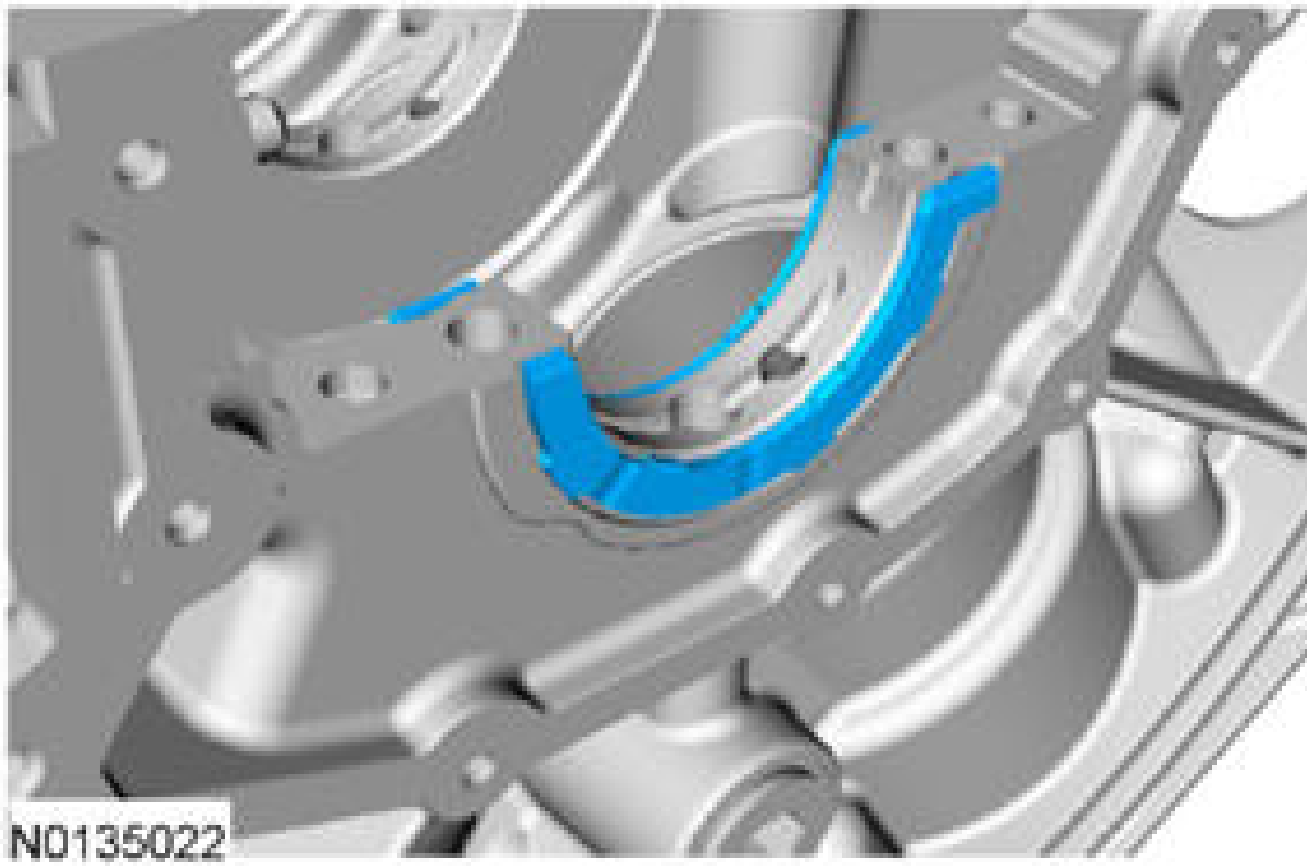
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117. **NOTE: Inside shown in illustration, outside similar.**

Remove the 2 crankshaft thrust bearings from the rear main bearing bulkhead.

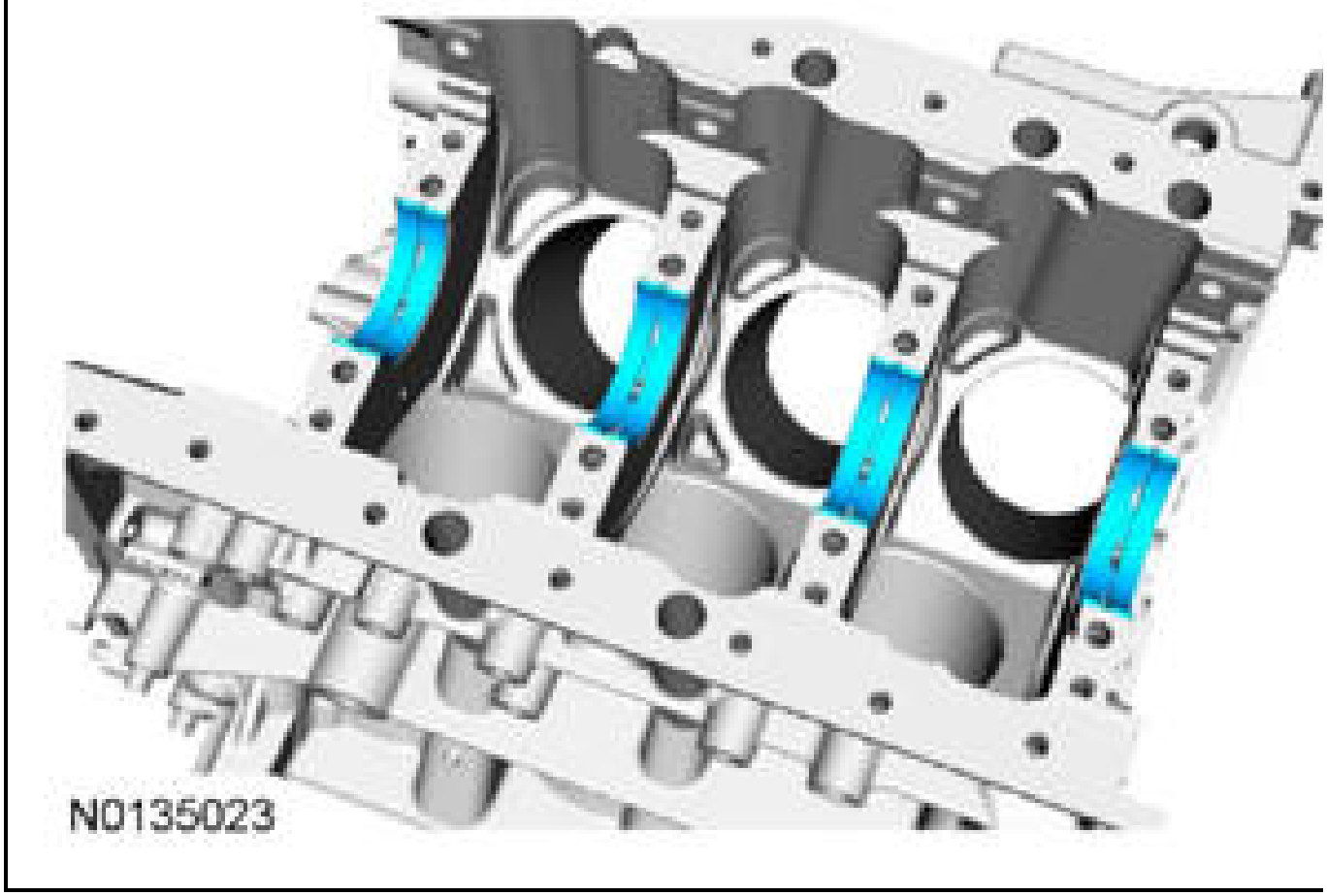
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NOTE: **If the main bearings are being reused, mark them for correct position and orientation for reassembly.**

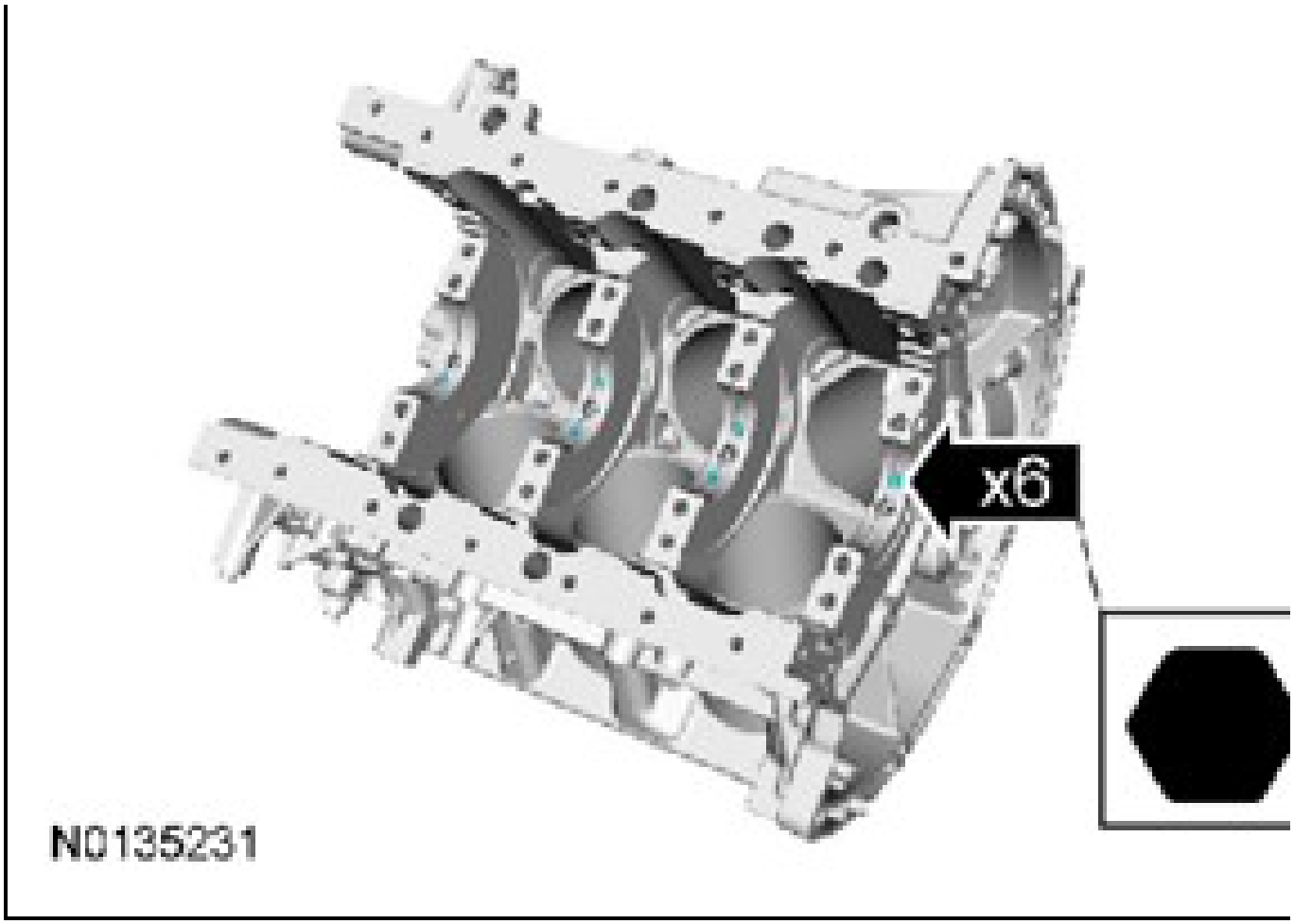
118. Remove the 4 crankshaft main bearings from the cylinder block.

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119. Using a hexagonal screwdriver, remove the 6 piston oil cool valves.

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120. Inspect the cylinder block, bearing cap support brace, pistons and connecting rods.

NOTE: Place clean, lint-free shop towels over exposed engine cavities. Carefully remove the towels so foreign material is not dropped into the engine. Any foreign material (including any material created while cleaning gasket surfaces) that enters the oil passages or the oil pan, may cause engine failure.

121.

NOTE: Do not use wire brushes, power abrasive discs or 3M Roloc® Bristle Disk (2-in white part number 07528) to clean the sealing surfaces. These tools cause scratches and gouges that make leak paths. They also cause contamination that will cause premature engine failure. Remove all traces of the gasket.

Clean the sealing surfaces of the cylinder block in the following sequence.

- Remove any large deposits of silicone or gasket material.
- Apply silicone gasket remover and allow to set for several minutes.
- Remove the silicone gasket remover.

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- A second application of silicone gasket remover may be required if residual traces of silicone or gasket material remain.
- Apply metal surface prep to remove any remaining traces of oil or coolant and to prepare the surfaces to bond. Do not attempt to make the metal shiny. Some staining of the metal surfaces is normal.

Assembly

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

NOTE: The engine is equipped with a cast aluminum (early build) or stamped steel (late build) crankshaft rear seal retainer plate. If the engine is equipped with a stamped steel plate, the seal and plate must be removed as an assembly and discarded.

NOTE: Assembly of the engine requires various inspections/measurements of the engine components (engine block, crankshaft, connecting rods, pistons and piston rings). These inspections/measurements will aid in determining if the engine components will require replacement. REFER to ENGINE SYSTEM - GENERAL INFORMATION .

NOTE: The Wheel Hub Bearing Cup Installer is used to install the VCT solenoid seals.

NOTE: Refer to exploded view(s) and any Warnings, Notices, Notes, Materials, Specifications, and Special Tools. Items in the exploded views may not be listed in order of removal.

1. Using a hexagonal screwdriver, install the 6 piston oil cool valves.
   - Tighten to 4 Nm (35 lb-in).

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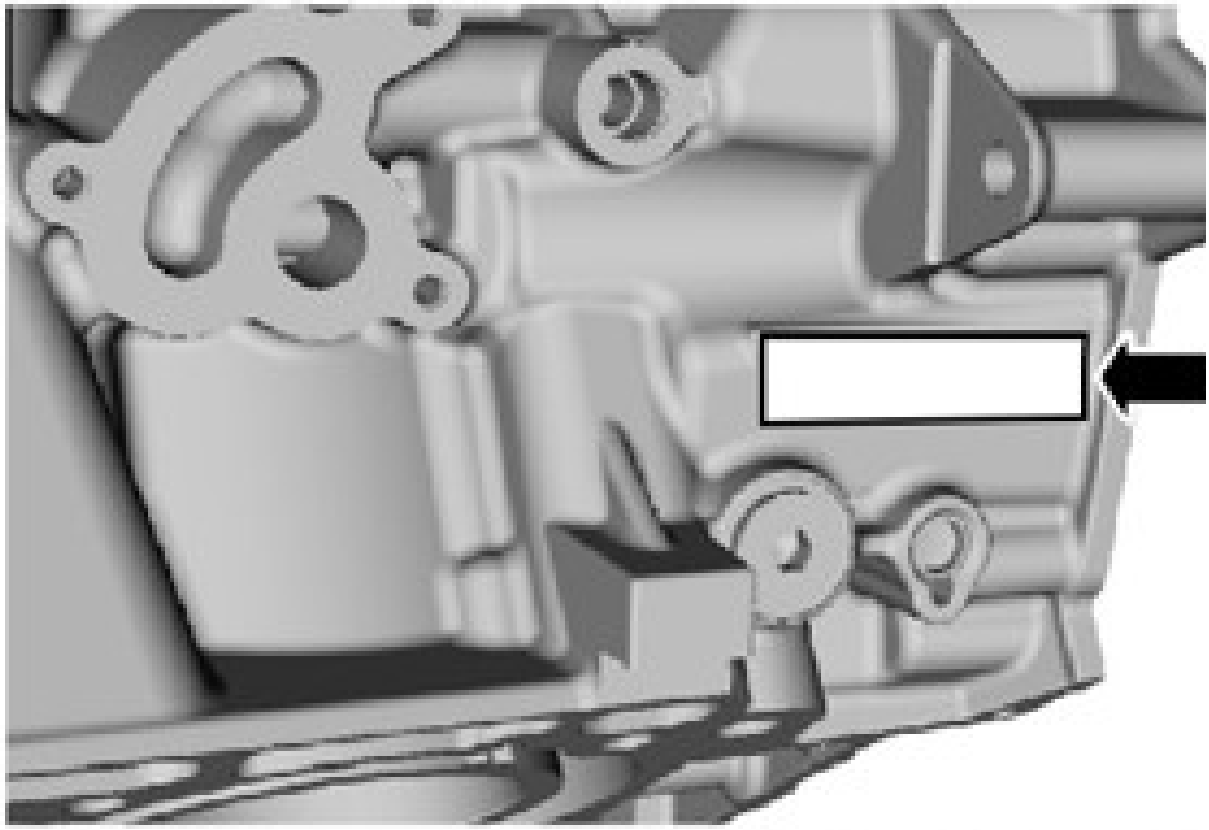


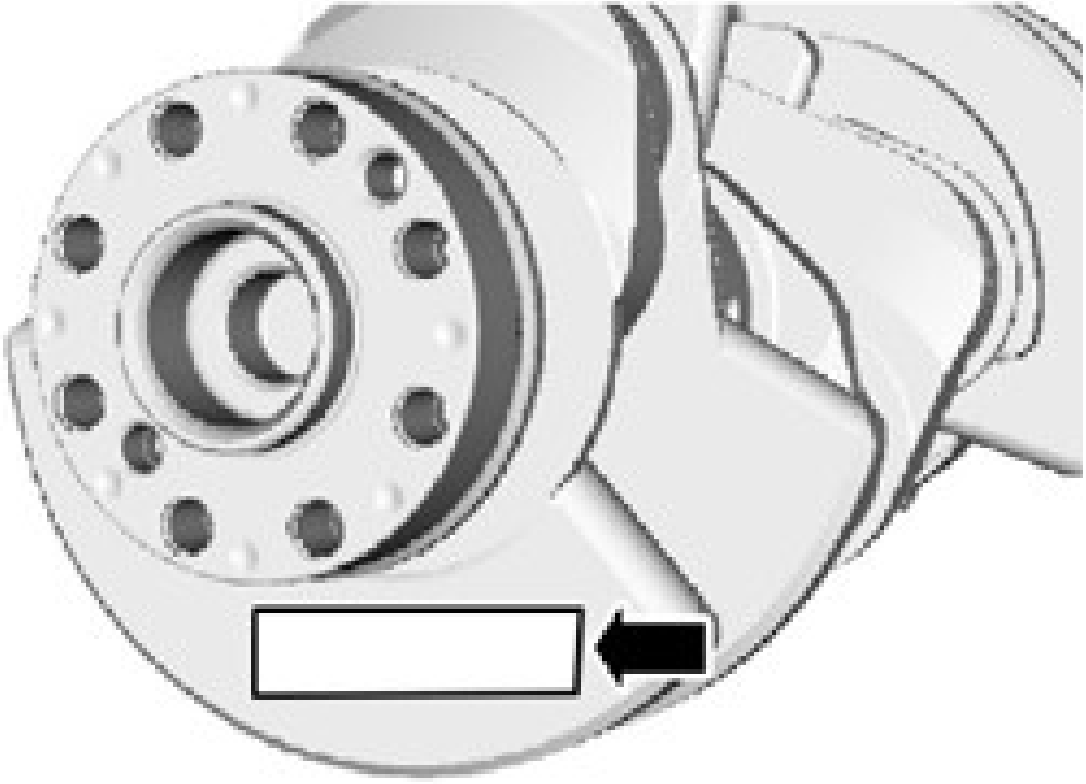
2. **NOTE: This procedure is for selecting bearings using a new crankshaft.**

Select the crankshaft main bearings for each crankshaft journal.

- Read the code on the crankshaft flange.
- Read the code on the cylinder block face.
- The first letter after the first asterisk makes up the code for main No. 1 and the next letter for main No. 2. The first letter after the second asterisk makes up the code for main No. 3 and the last letter for main No. 4.

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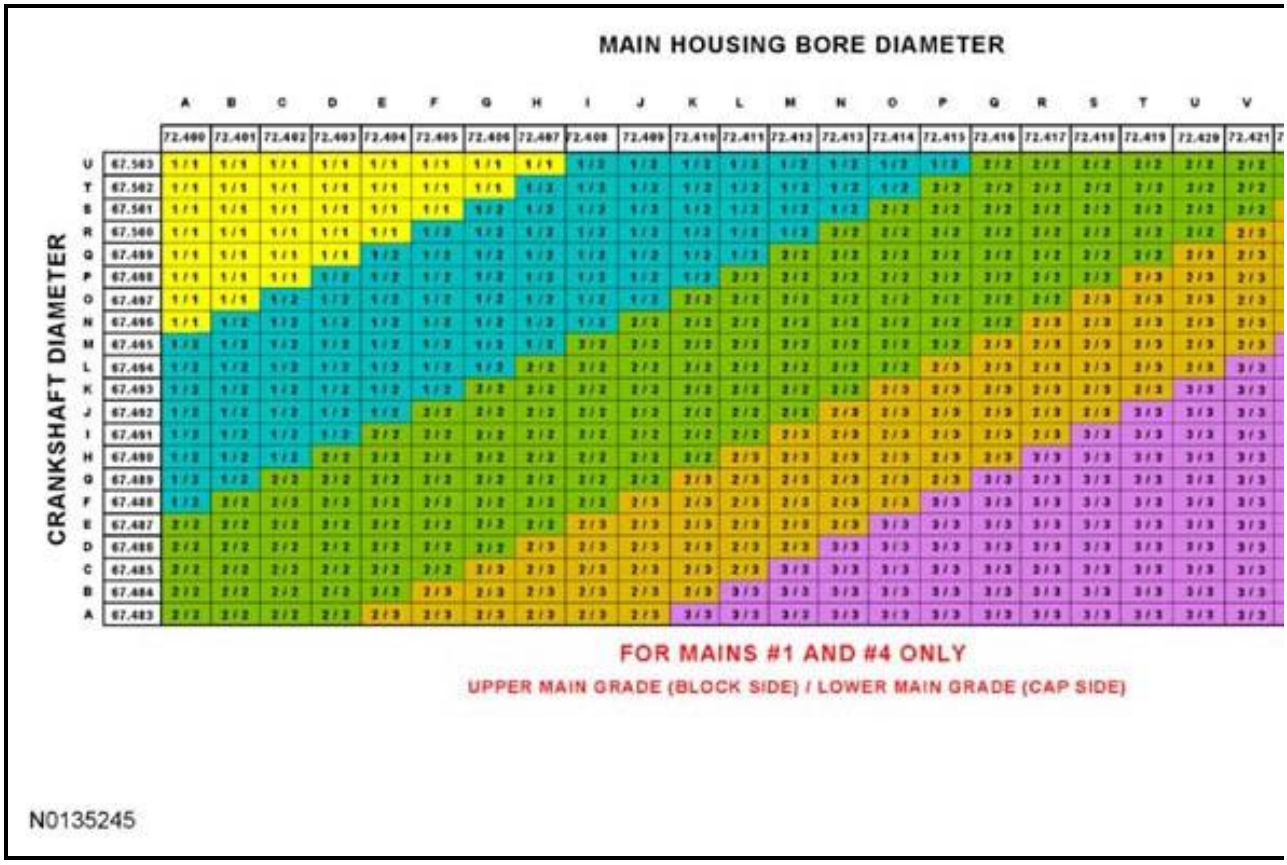


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3. **NOTE: This chart is for selecting main bearings 1 and 4 only, the remaining bearings will be selected using a different chart in the next step.**

Using the data recorded earlier and the Bearing Select Fit Chart, Standard Bearings, determine the required bearing grade for main bearings 1 and 4.

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

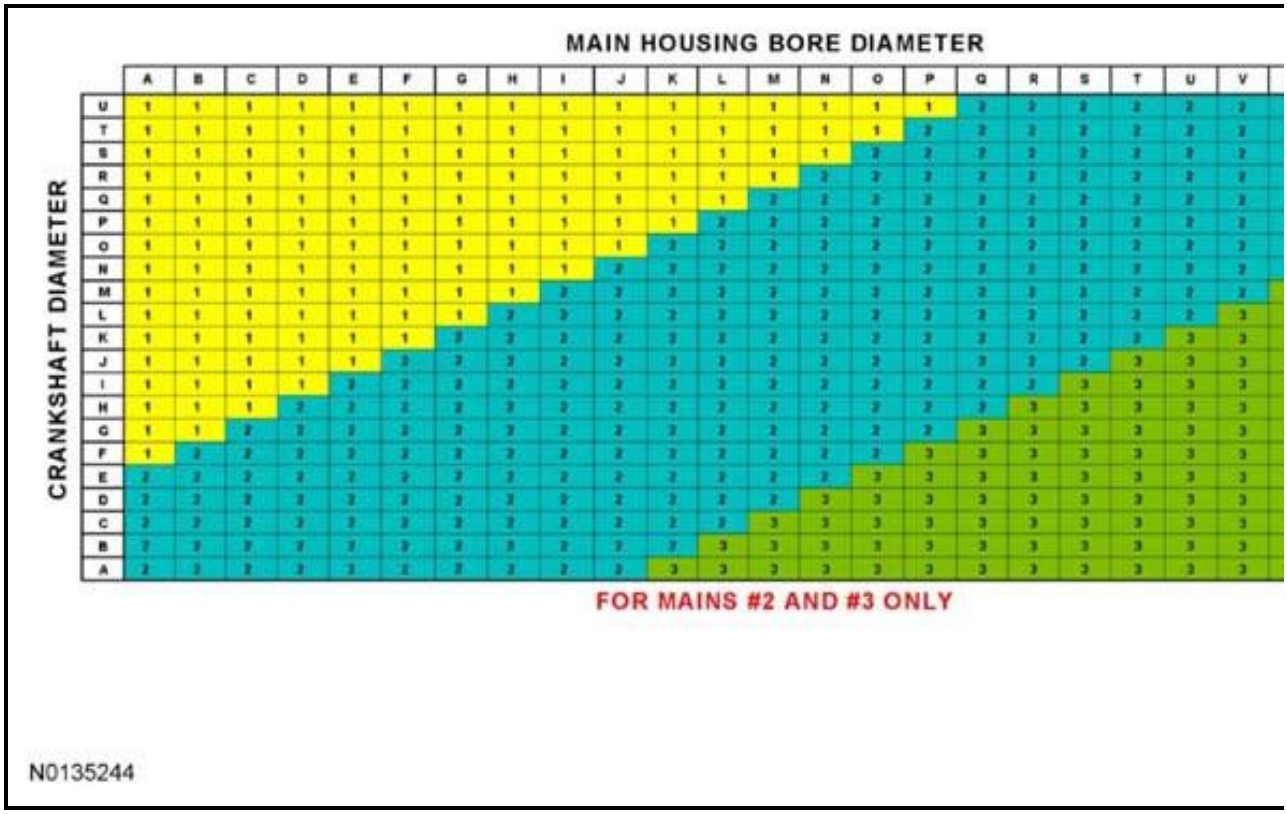


4. **NOTE: This chart is for selecting main bearings 2 and 3 only.**

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

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



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

Using the original connecting rod cap bolts, install the connecting rod caps and bolts. Tighten the bolts in 3 stages.

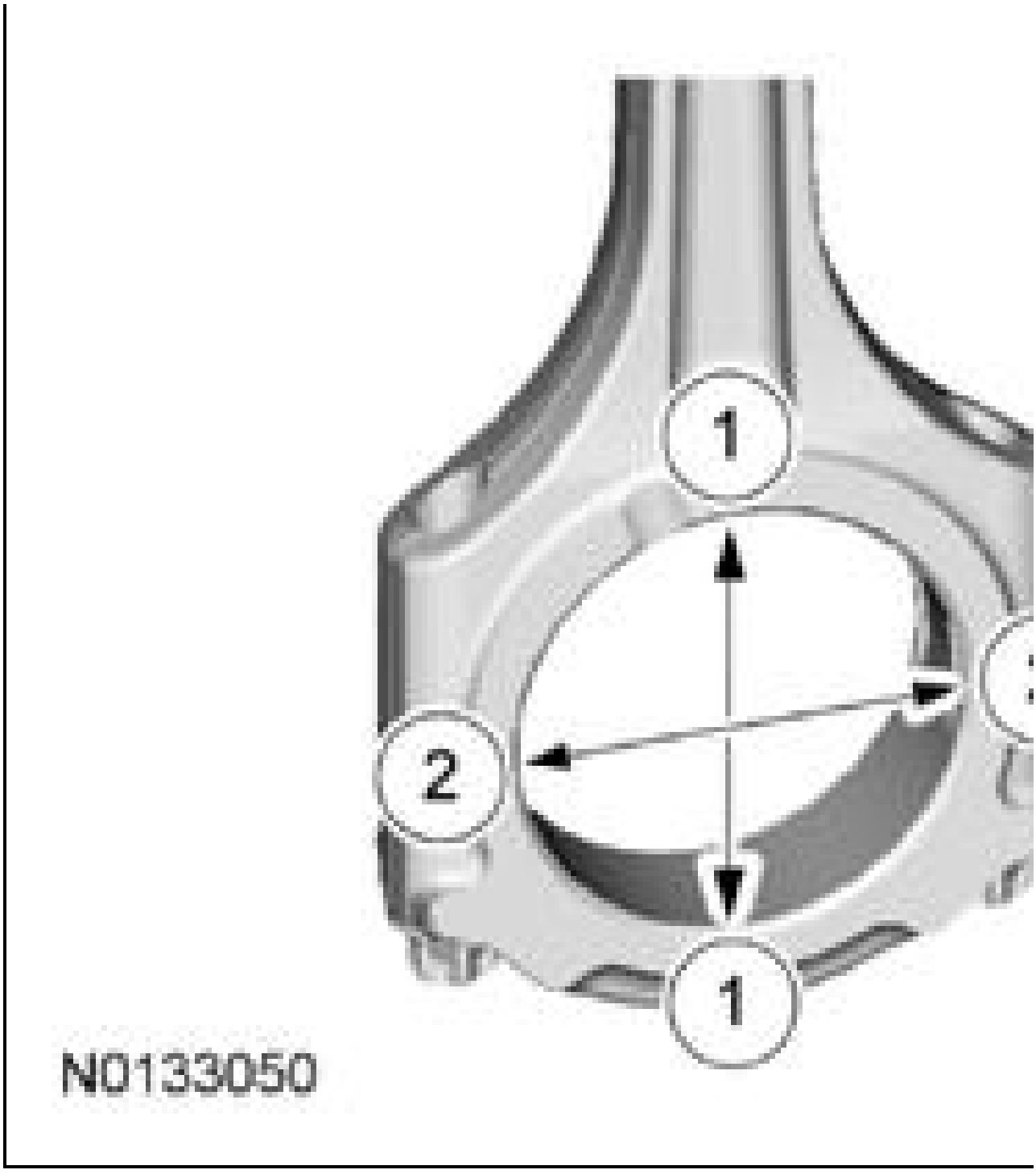
- Stage 1: Tighten to 23 Nm (17 lb-ft).
- Stage 2: Tighten to 43 Nm (32 lb-ft).
- Stage 3: Tighten an additional 90 degrees.

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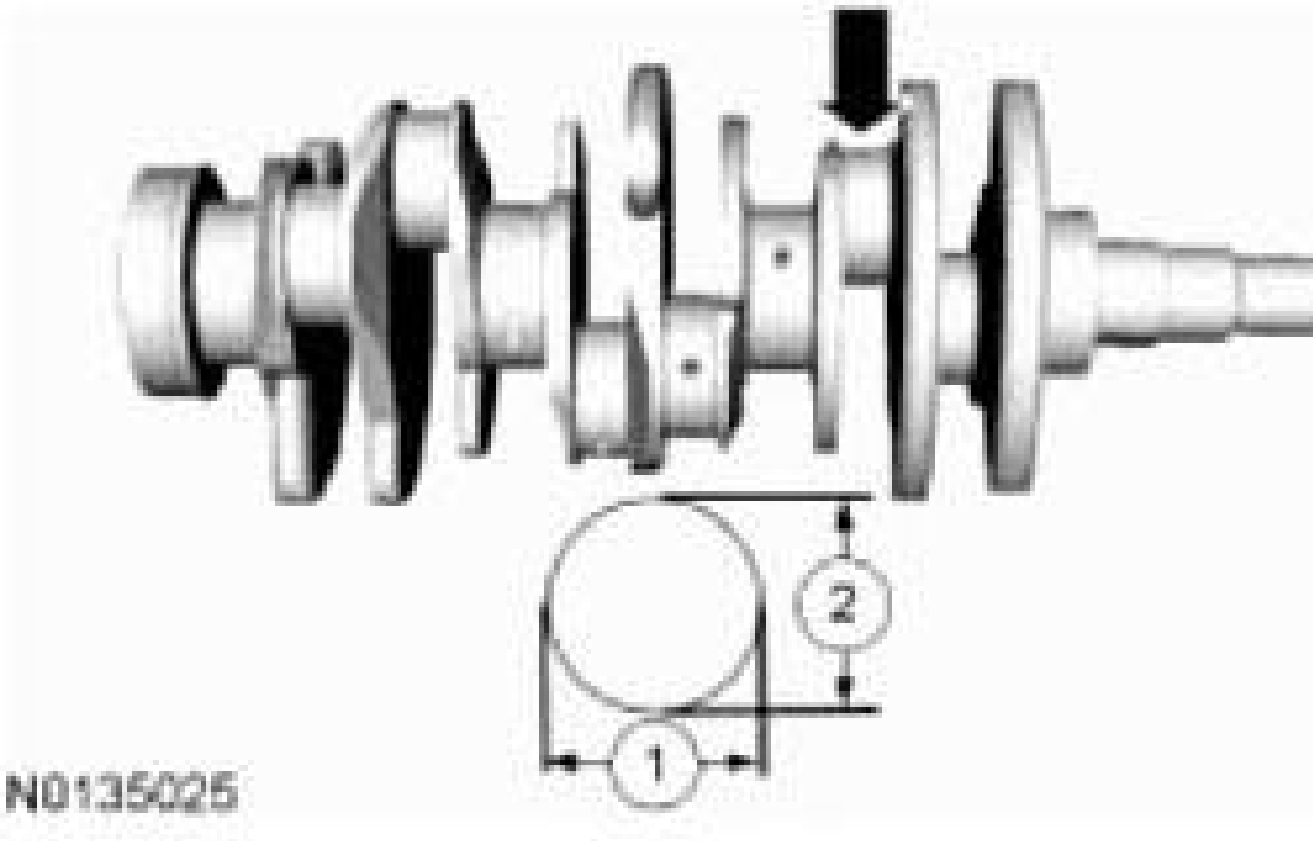
6. Measure the connecting rod large end bore in 2 directions.
    - Remove the bolts and the rod cap.
    - Discard the connecting rod cap bolts.

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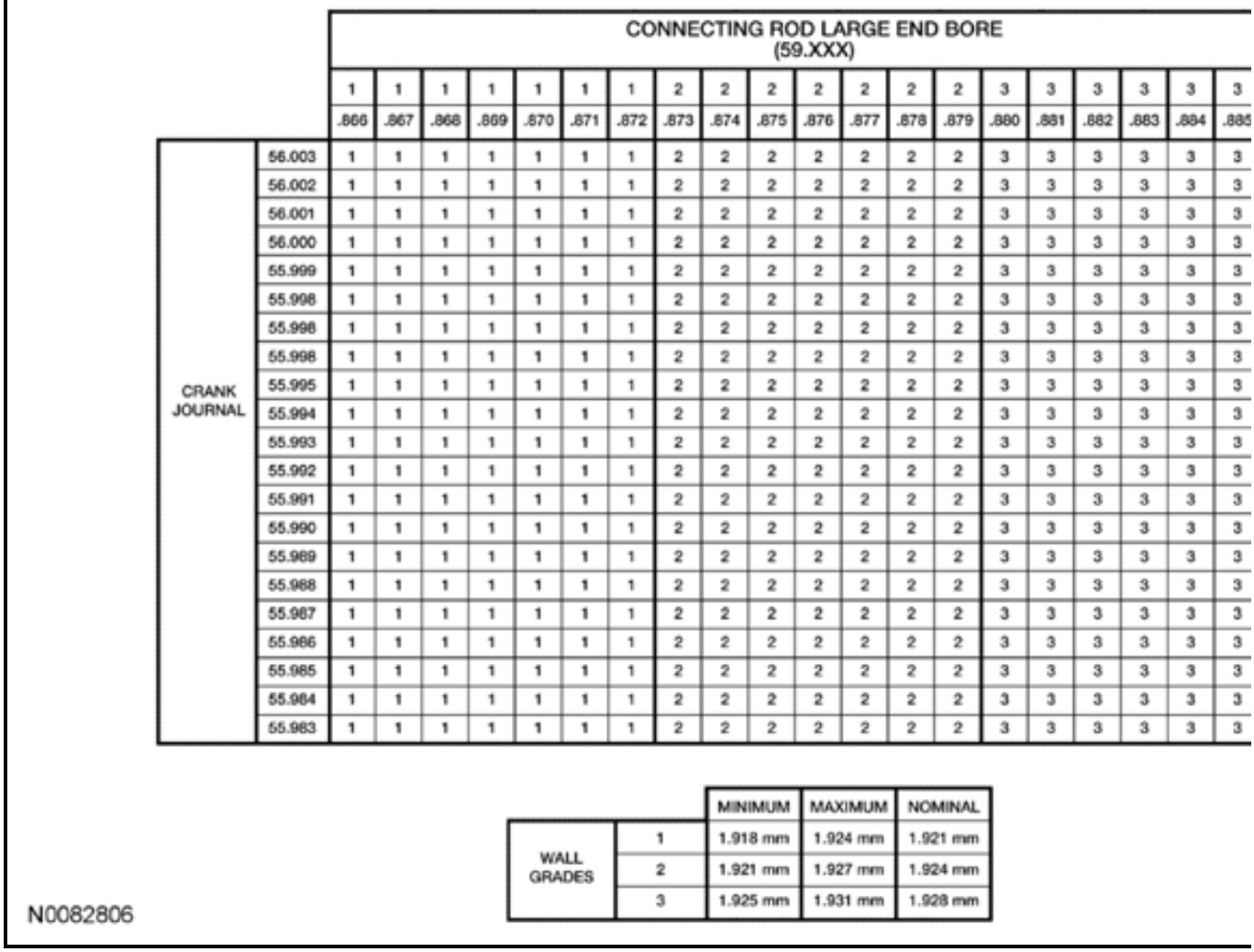
7. Measure each of the crankshaft connecting rod bearing journal diameters in at least 2 directions.

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8. Using the chart, select the correct connecting rod bearings for each crankshaft connecting rod journal.

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		CONNECTING ROD LARGE END BORE (59.XXX)																			
		1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3
		.866	.867	.868	.869	.870	.871	.872	.873	.874	.875	.876	.877	.878	.879	.880	.881	.882	.883	.884	.885
CRANK JOURNAL	56.003	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3
	56.002	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3
	56.001	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3
	56.000	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3
	55.999	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3
	55.998	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3
	55.998	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3
	55.998	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3
	55.995	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3
	55.994	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3
	55.993	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3
	55.992	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3
	55.991	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3
	55.990	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3
	55.989	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3
	55.988	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3
	55.987	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3
	55.986	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3
	55.985	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3
	55.984	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3
	55.983	1	1	1	1	1	1	1	2	2	2	2	2	2	2	3	3	3	3	3	3

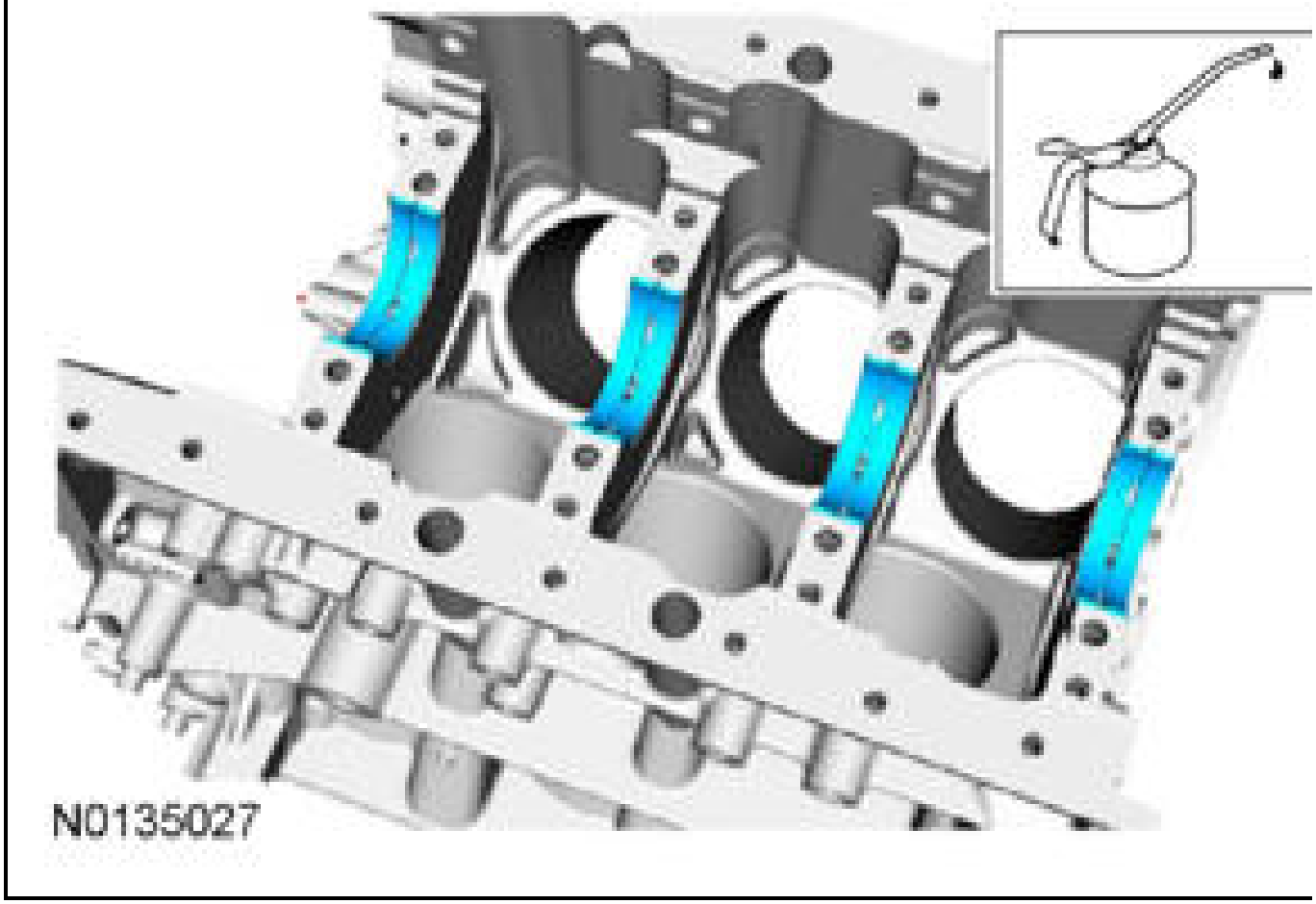
		MINIMUM	MAXIMUM	NOMINAL
WALL GRADES	1	1.918 mm	1.924 mm	1.921 mm
	2	1.921 mm	1.927 mm	1.924 mm
	3	1.925 mm	1.931 mm	1.928 mm

N0082806

NOTE: Before assembling the cylinder block, all sealing surfaces must be free of chips, dirt, paint and foreign material. Also, make sure the coolant and oil passages are clear.

9. Lubricate the upper crankshaft main bearings with clean engine oil and install the 4 crankshaft main bearings in the cylinder block.

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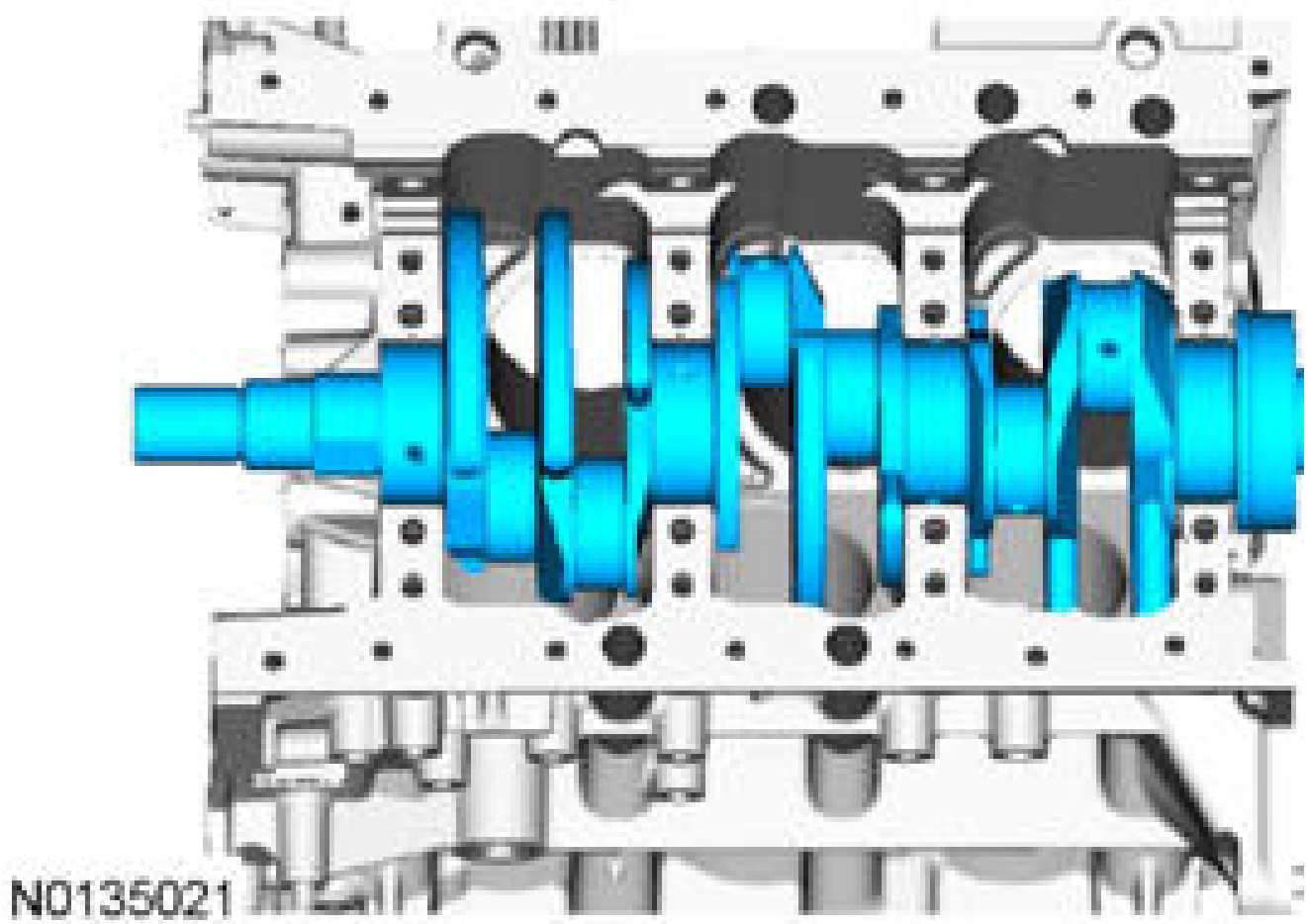


10. **NOTE: Do not install the upper thrust bearings until the crankshaft is installed.**

NOTE: Lubricate the thrust surfaces of the crankshaft with clean engine oil.

Install the crankshaft onto the upper main bearings.

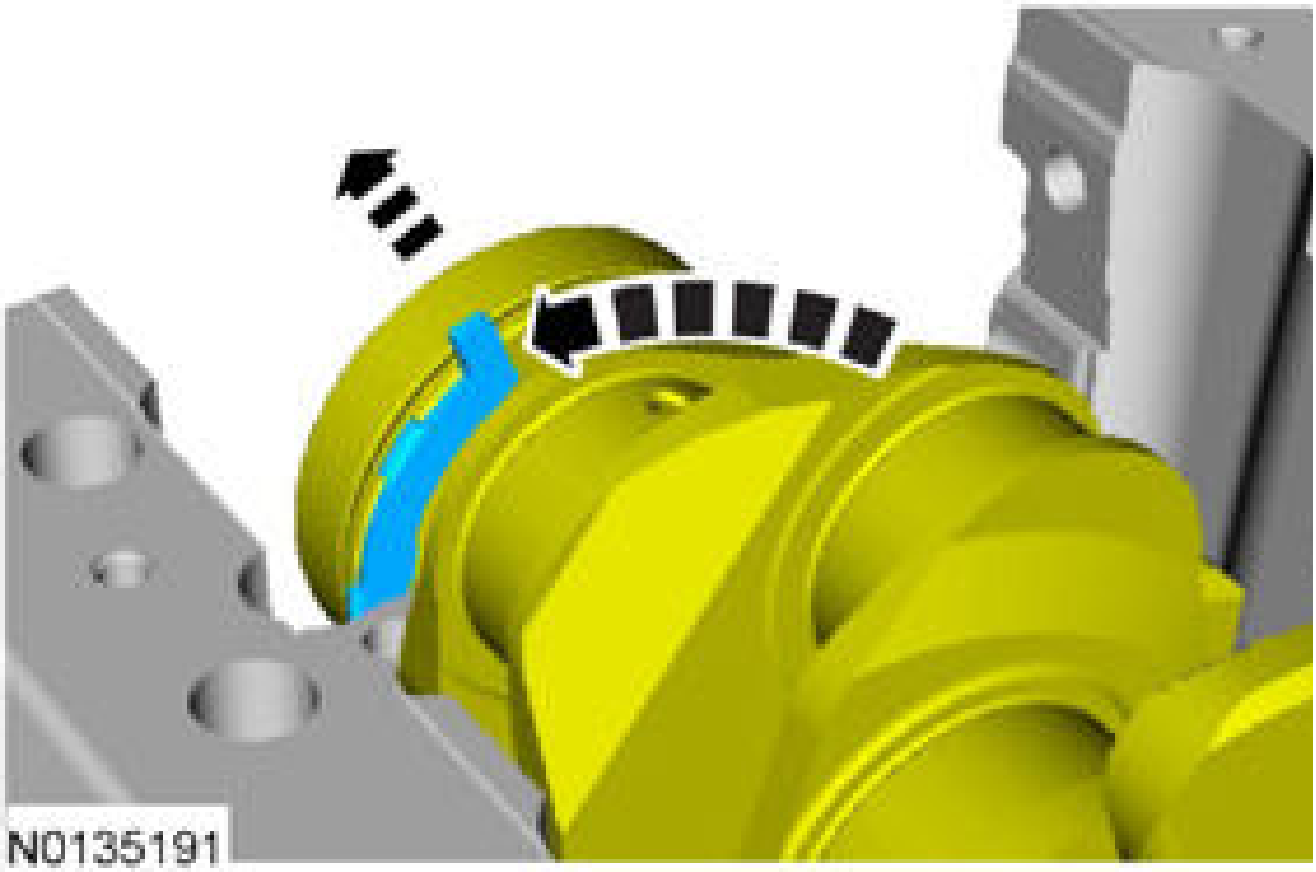
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11. **NOTE: Make sure the side of the thrust washer, with the wide oil grooves, faces the crankshaft thrust surface.**

Push the crankshaft rearward and install the rear crankshaft upper thrust washer at the back of the No. 4 rear bulkhead.

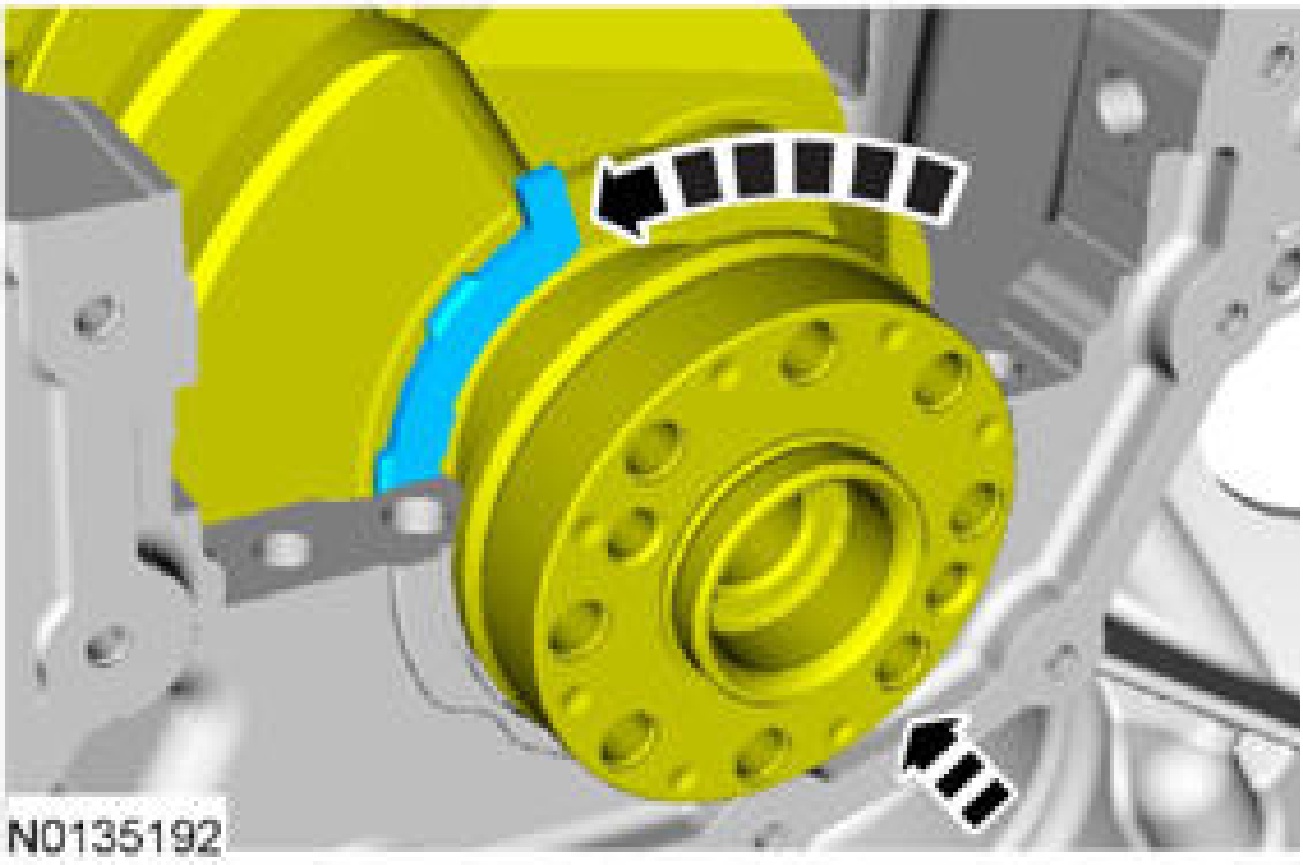
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12. **NOTE: Make sure the side of the thrust washer, with the wide oil grooves, faces the crankshaft thrust surface.**

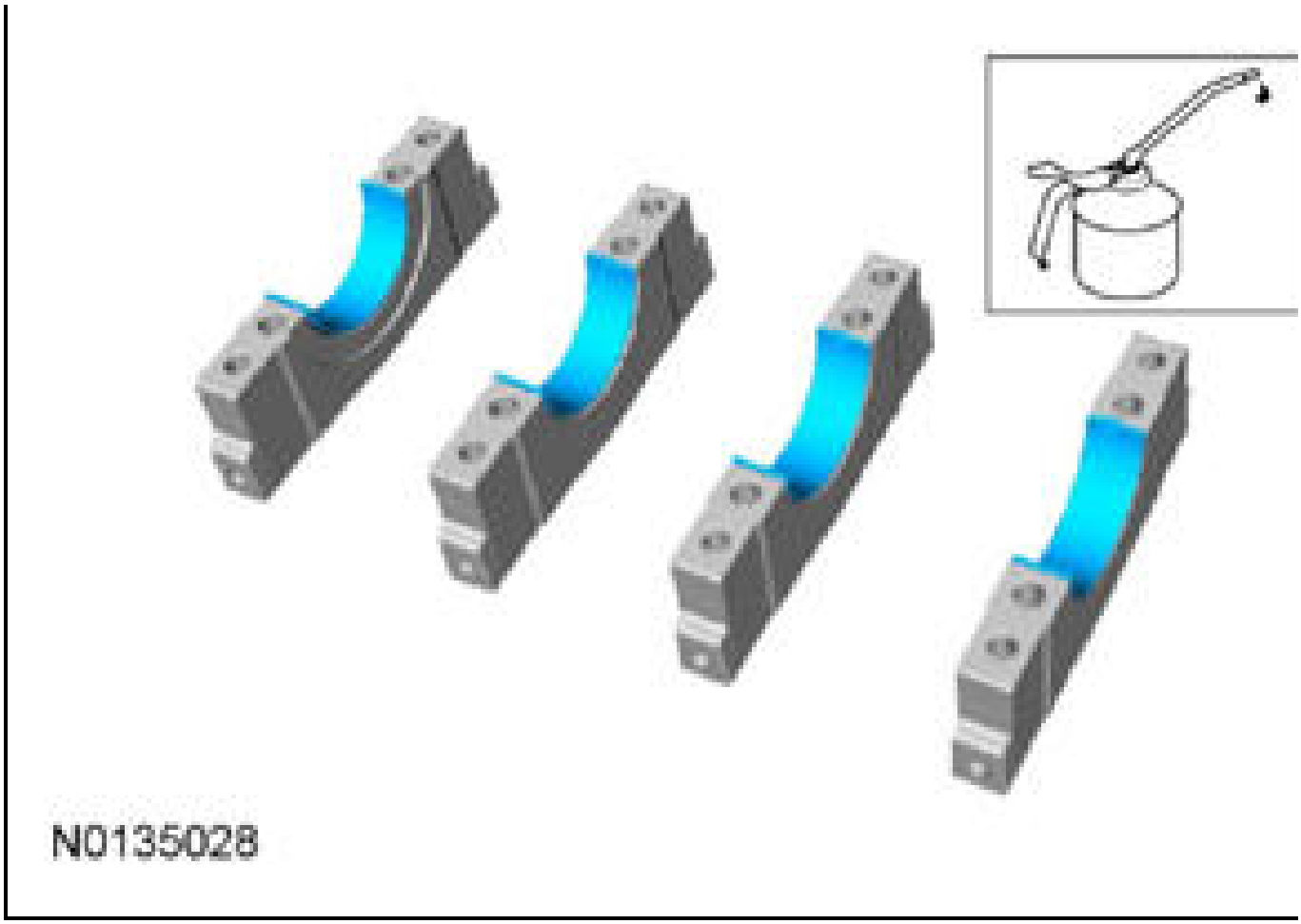
Push the crankshaft forward and install the front crankshaft upper thrust washer at the front of the No. 4 rear bulkhead.

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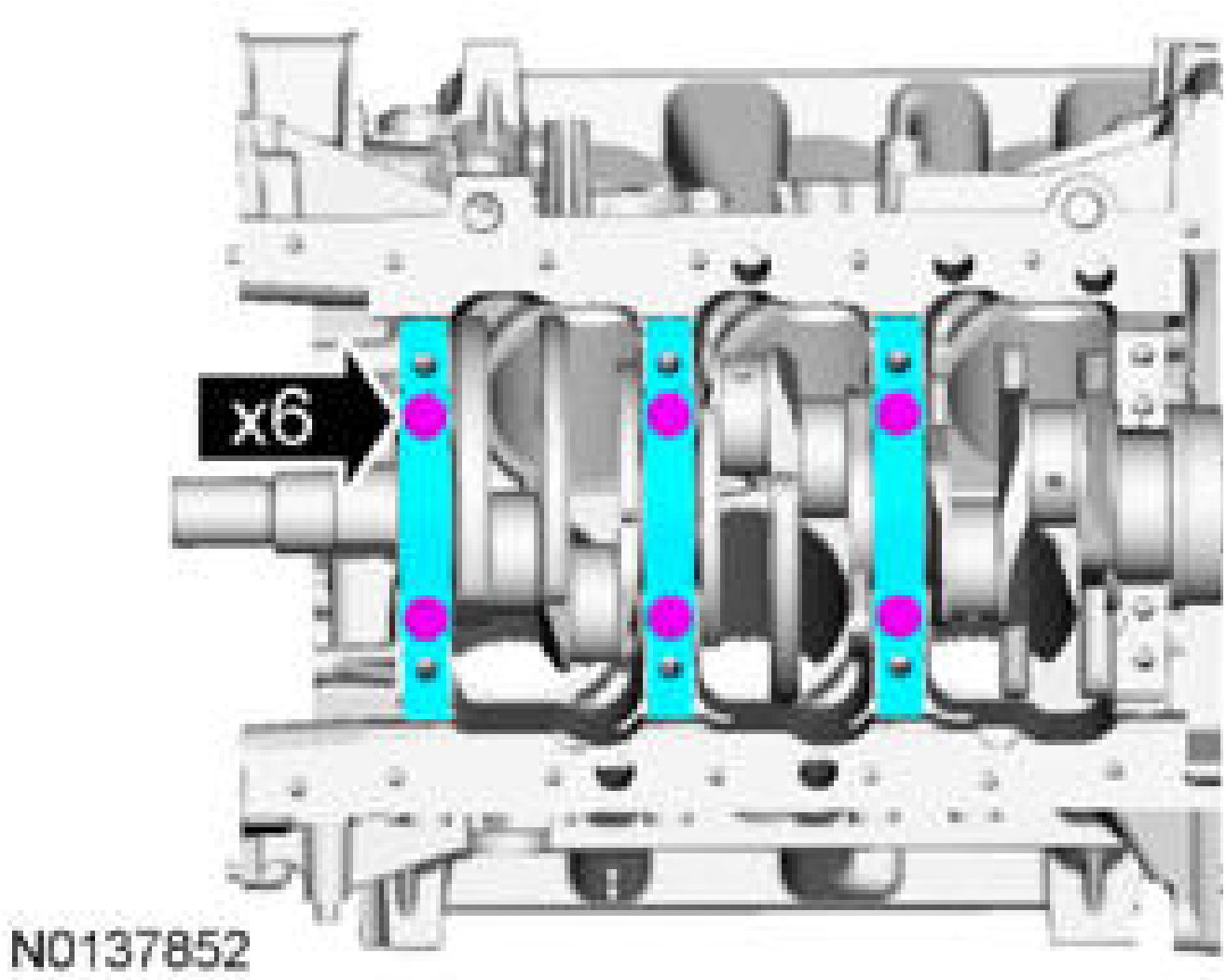
13. Lubricate the crankshaft lower main bearings with clean engine oil and install them into the main bearing caps. Visually check seating and squareness of the bearings to make sure of proper seating in caps.

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14. Position the No. 1, No. 2 and No. 3 main bearing caps on the cylinder block and, keeping the caps as square as possible, alternately draw the caps down evenly using the new bolts until the main bearing caps are seated.

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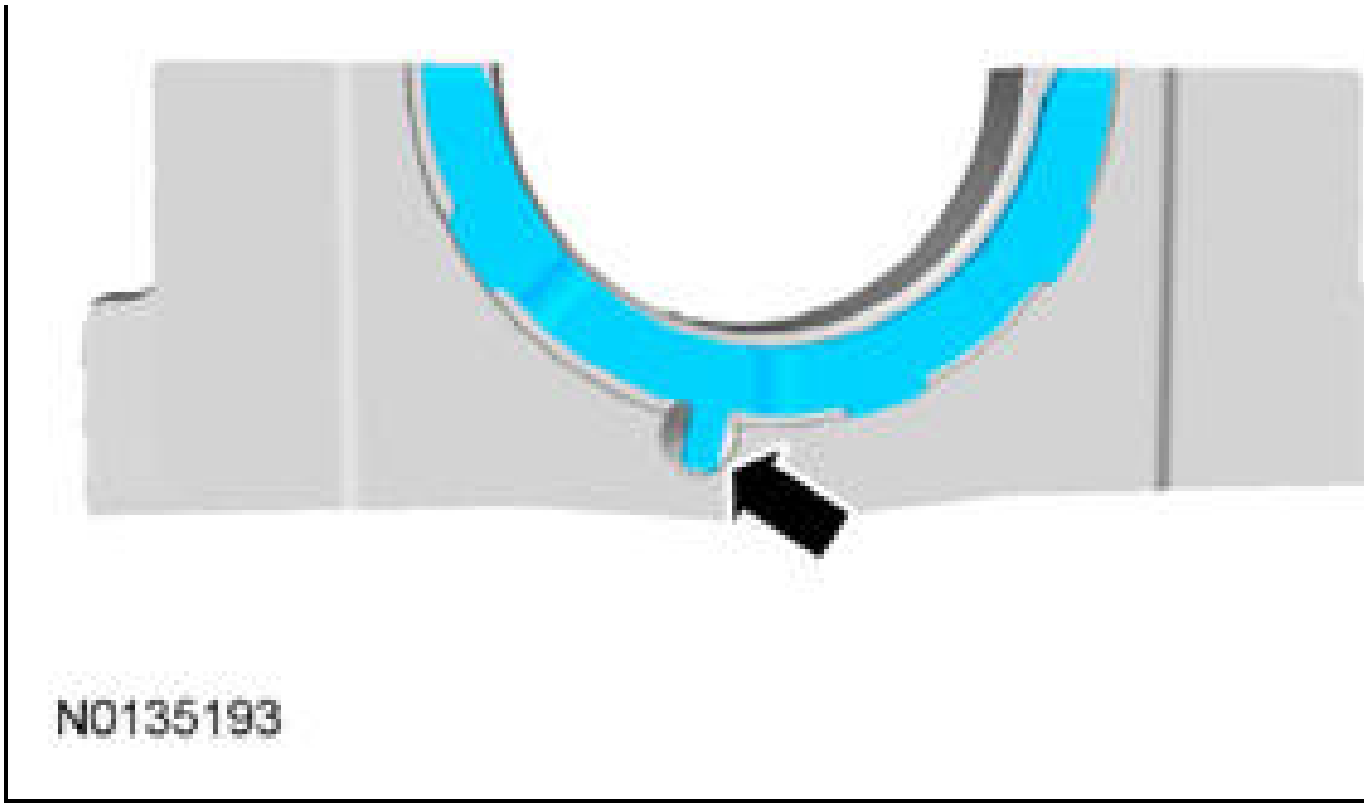
15.

NOTE: **Make sure the side of the thrust washer, with the wide oil grooves, faces the crankshaft thrust surface.**

NOTE: **To aid in assembly, apply petroleum jelly to the back of the crankshaft thrust washer.**

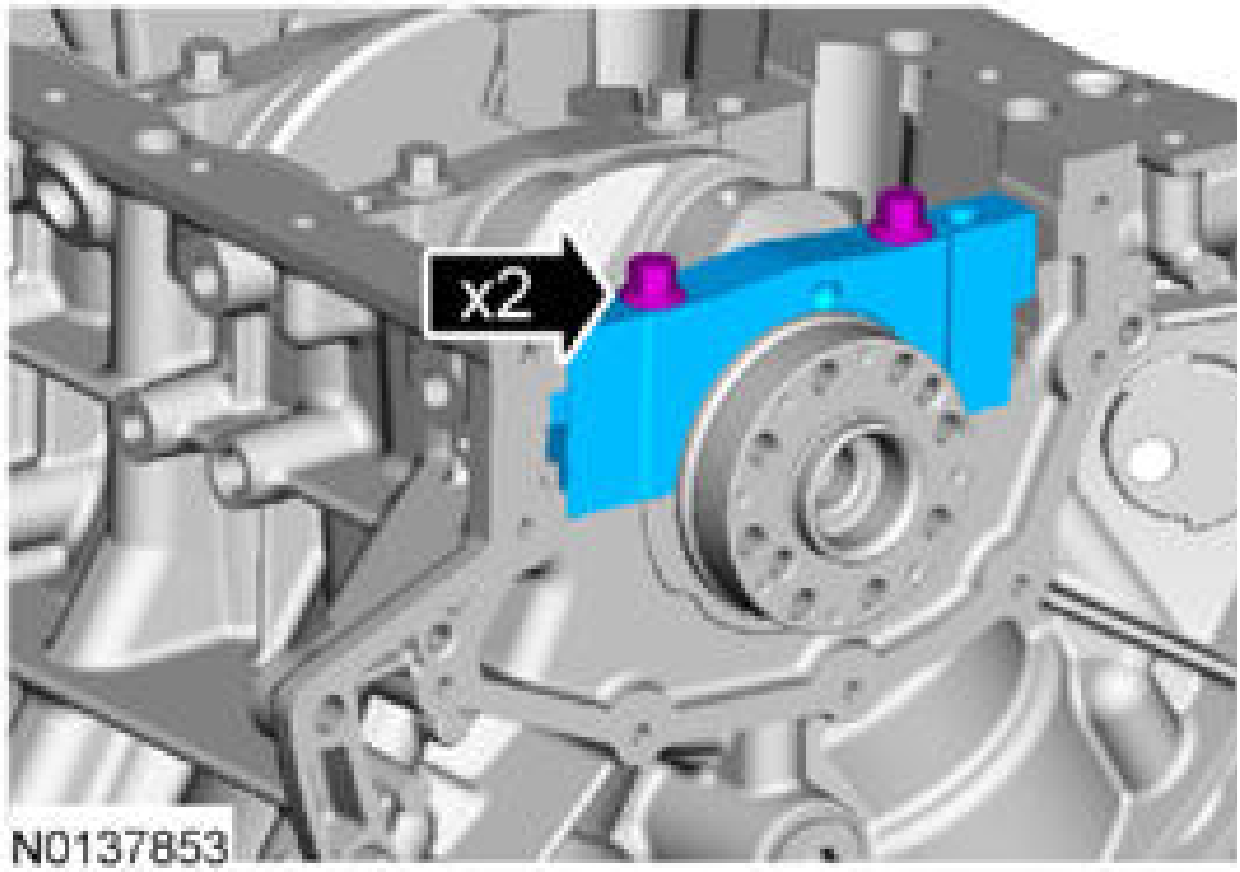
Install the lower crankshaft thrust washer to the back side of the No. 4 rear main bearing cap, with the tab aligned with the cutout in the main bearing cap.

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16. Position main bearing cap No. 4 on the cylinder block and keeping the cap as square as possible, alternately draw the cap down evenly using the new bolts until the main bearing cap is seated.
    - Loosen the No. 4 main bearing cap bolts.

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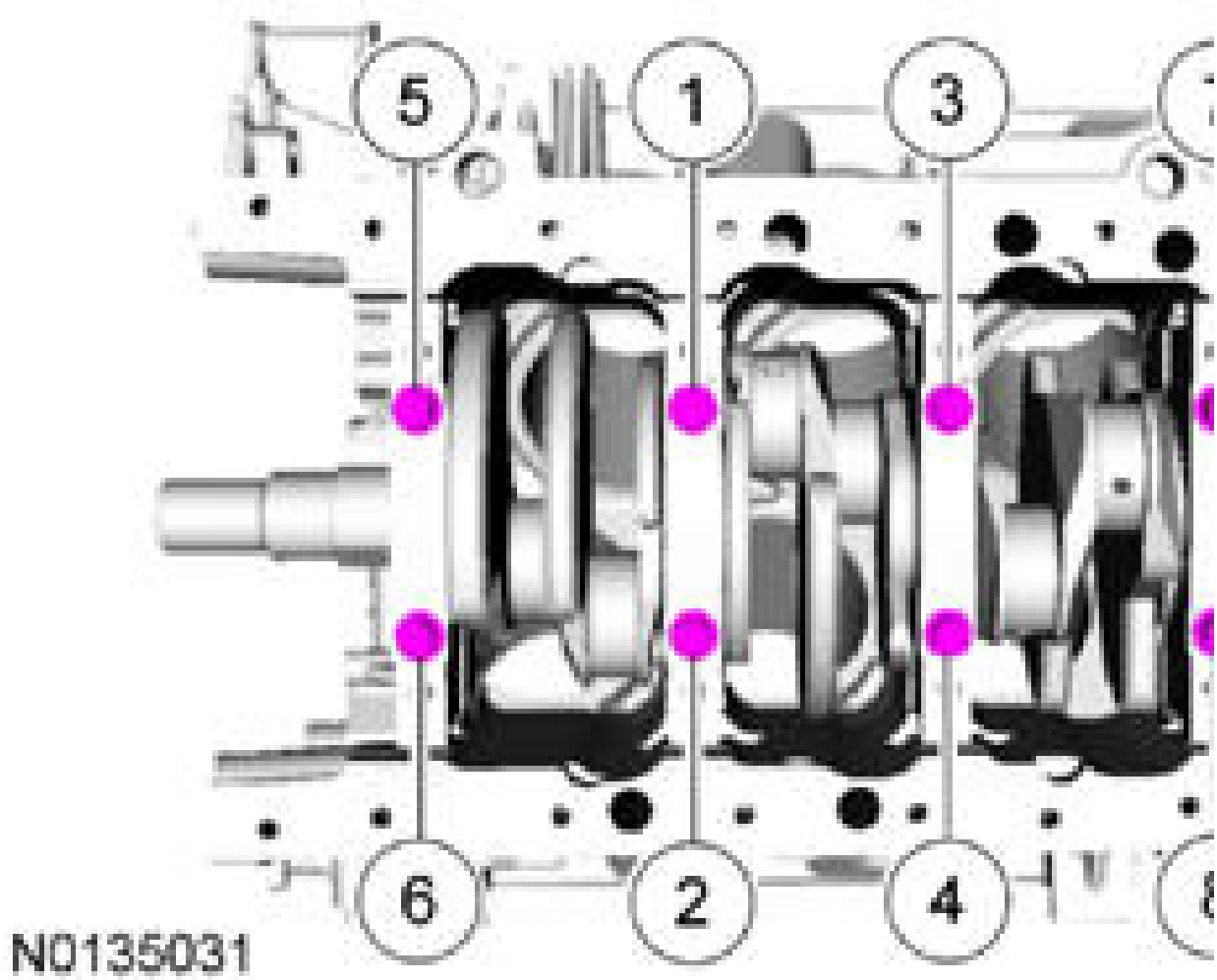


17. **NOTE: While tightening the main bearing vertical bolts, push the crankshaft forward and the No. 4 main bearing cap rearward to seat the crankshaft thrust washers.**

Tighten the main bearing bolts in the sequence shown in illustration in 2 stages.

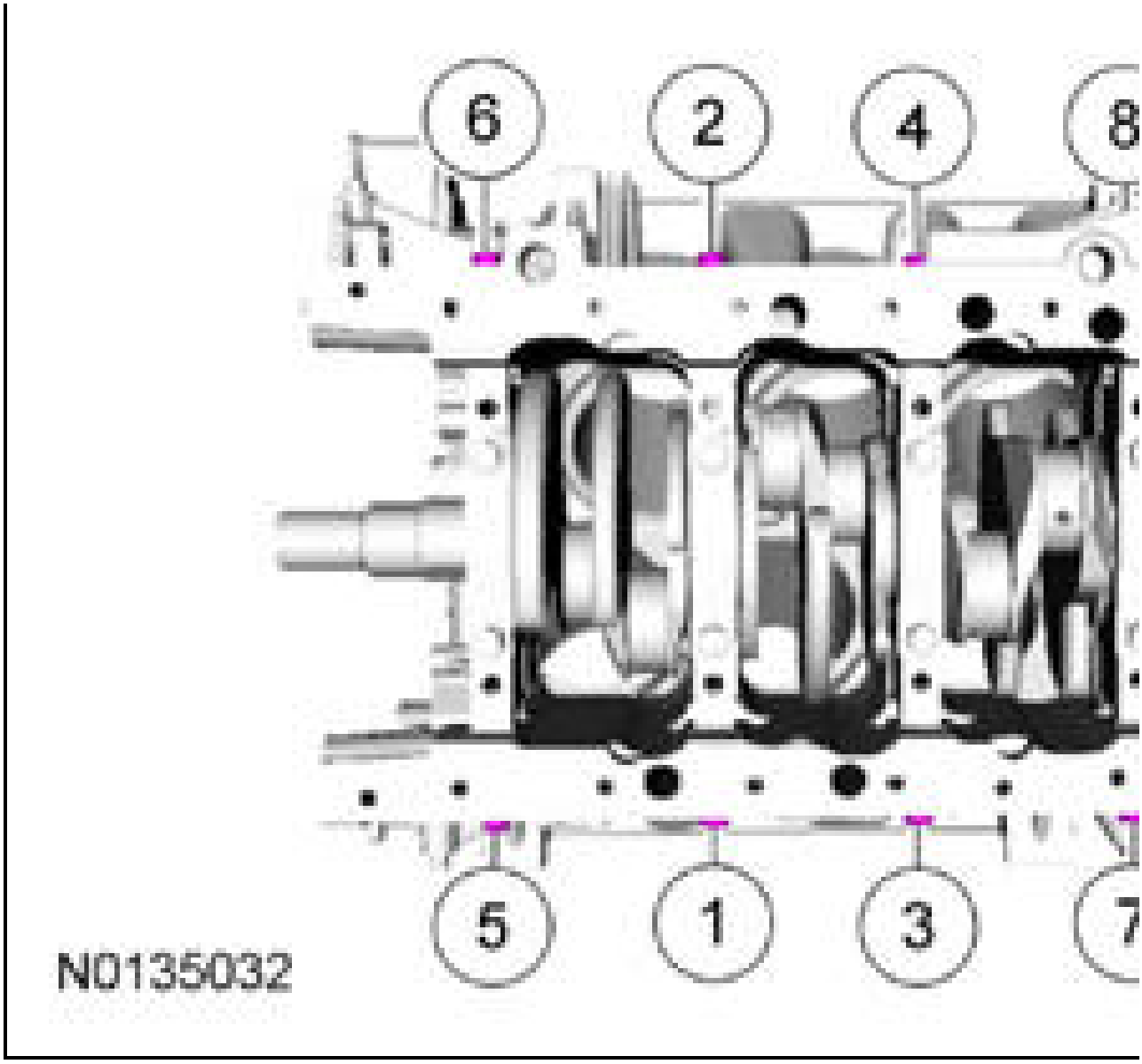
- Stage 1: Tighten fasteners 1 through 8 to 33 Nm (24 lb-ft).
- Stage 2: Tighten fasteners 1 through 8 an additional 135 degrees.

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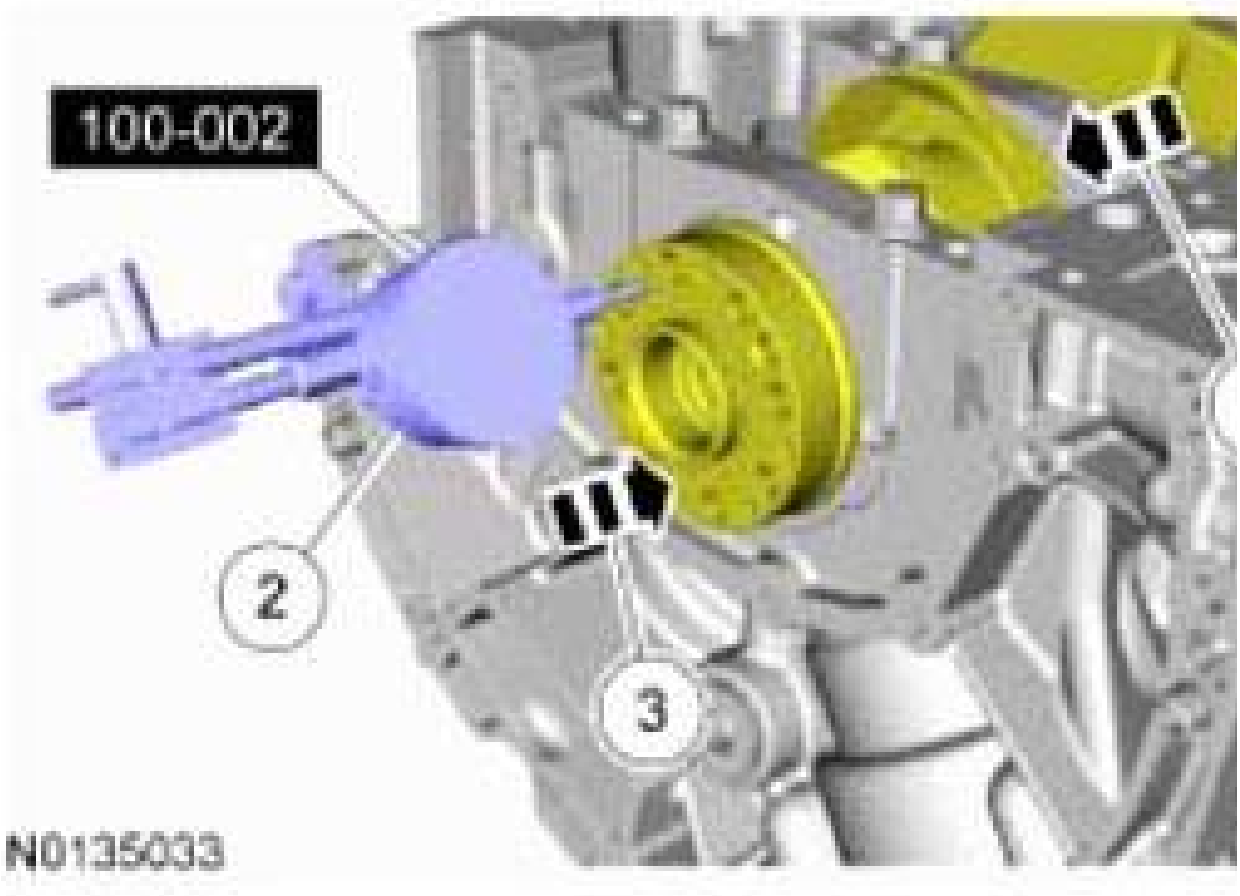
18. Install the new 8 main bearing cap side bolts. Tighten in the sequence shown in illustration in 2 stages.
    - Stage 1: Tighten fasteners 1 through 8 to 24 Nm (18 lb-ft).
    - Stage 2: Tighten fasteners 1 through 8 an additional 180 degrees.

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19. Using 100-002 TOOL-4201-C, measure crankshaft end play.
    - Position the crankshaft to the rear of the cylinder block.
    - Zero 100-002 TOOL-4201-C.
    - Move the crankshaft to the front of the cylinder block. Note and record the crankshaft end play.

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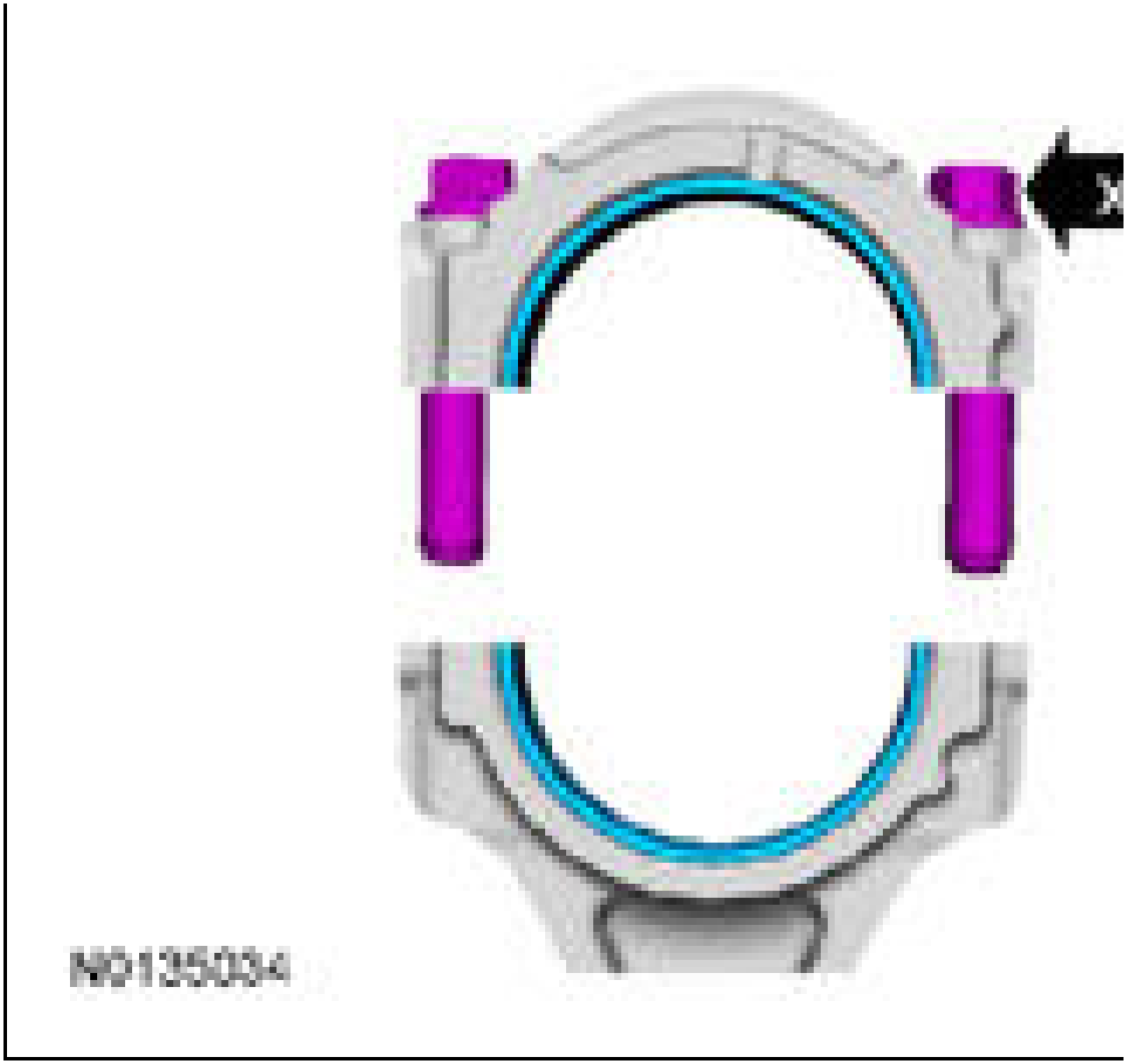


NOTE: **The rod cap installation must keep the same orientation as marked during disassembly or engine damage may occur.**

20. Prepare the connecting rod and cap.

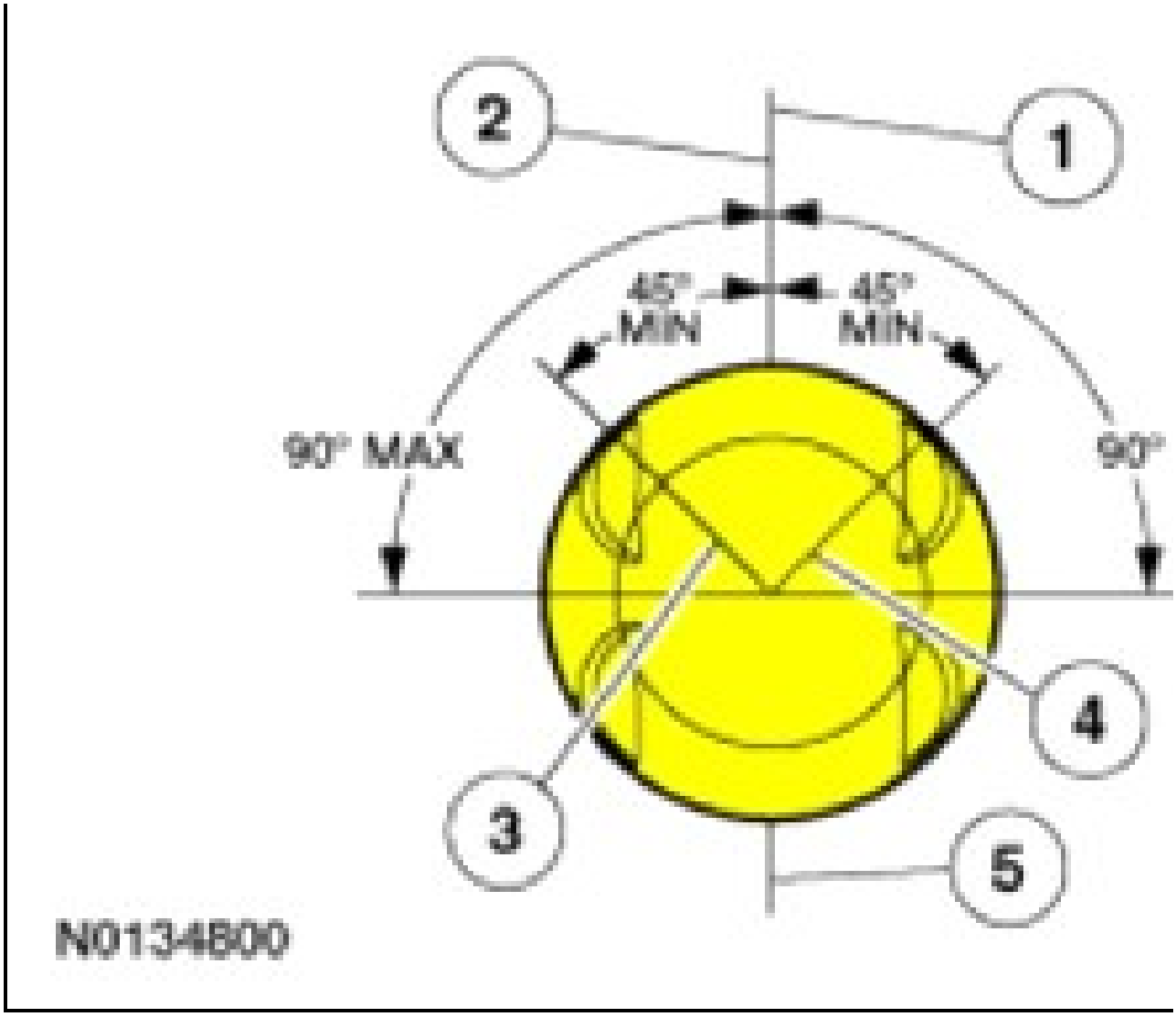
- Insert the new bolts in the rod cap.
- Insert the upper and lower rod bearings into the rod and cap.

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21. Before installing the pistons into the cylinder block, verify proper ring gap location.
    - Center line of the piston parallel to the wrist pin bore.
    - Upper compression ring gap location.
    - Upper oil control segment ring gap location.
    - Lower oil control segment ring gap location.
    - Expander ring and lower compression ring gap location.

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22.

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

NOTE: **The next 3 steps are for all 6 connecting rods, rod caps and pistons. Only 1 connecting rod, rod cap and piston is shown in illustration.**

NOTE: **Lubricate the pistons, piston rings, connecting rod bearings and the entire cylinder bores with clean engine oil.**

NOTE: **Make sure the piston rings are positioned to specifications for installation. For additional information, refer to the PISTON information.**

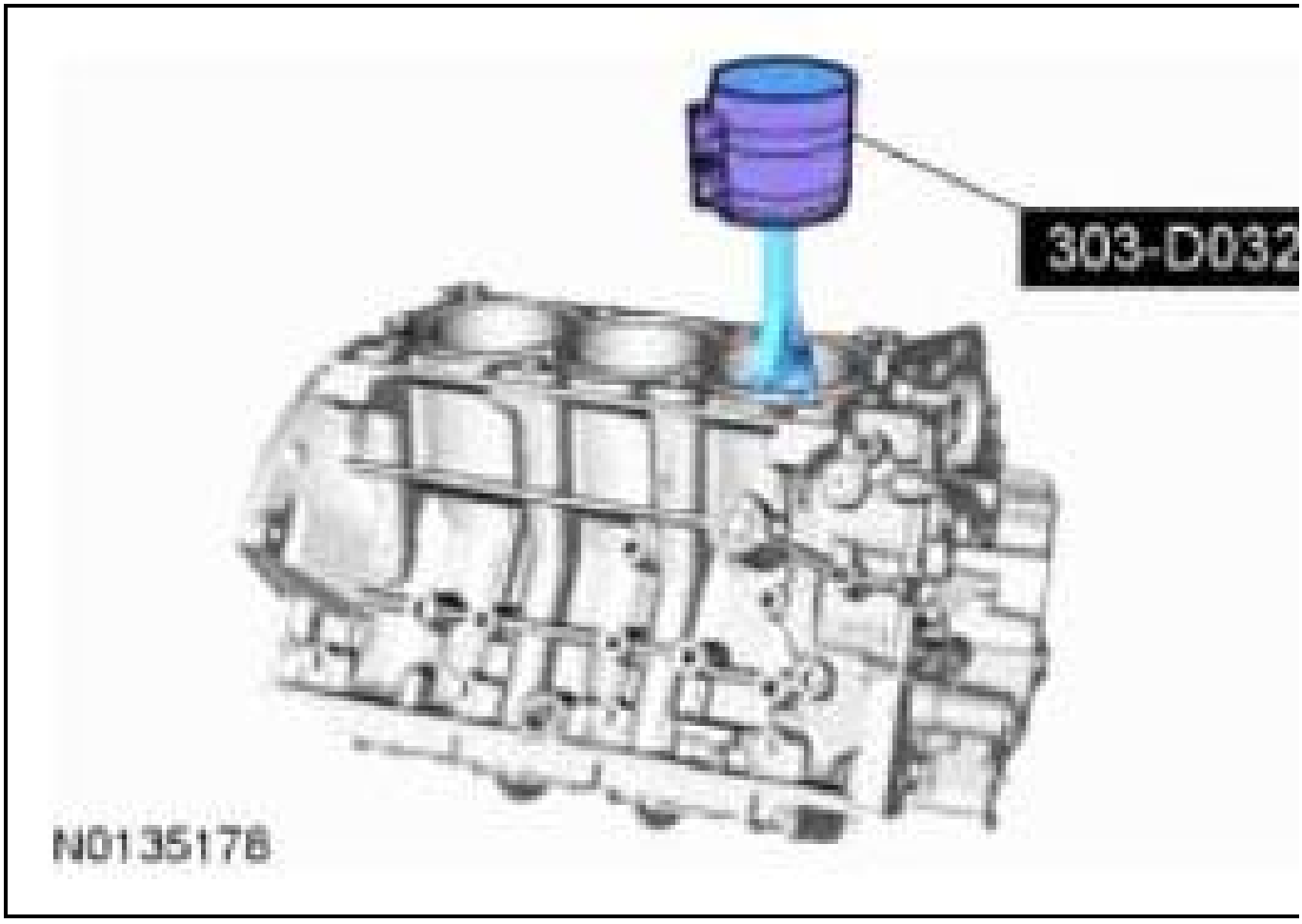
NOTE: **If the piston and or connecting rod are being installed new, the piston rod**

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

NOTE: If the piston and connecting rod are to be reinstalled, they must be installed in the same orientation as disassembled.

Using the Piston Ring Compressor, install the piston and connecting rod assemblies.



23. Seat the connecting rod on the crankshaft journal.

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

24.

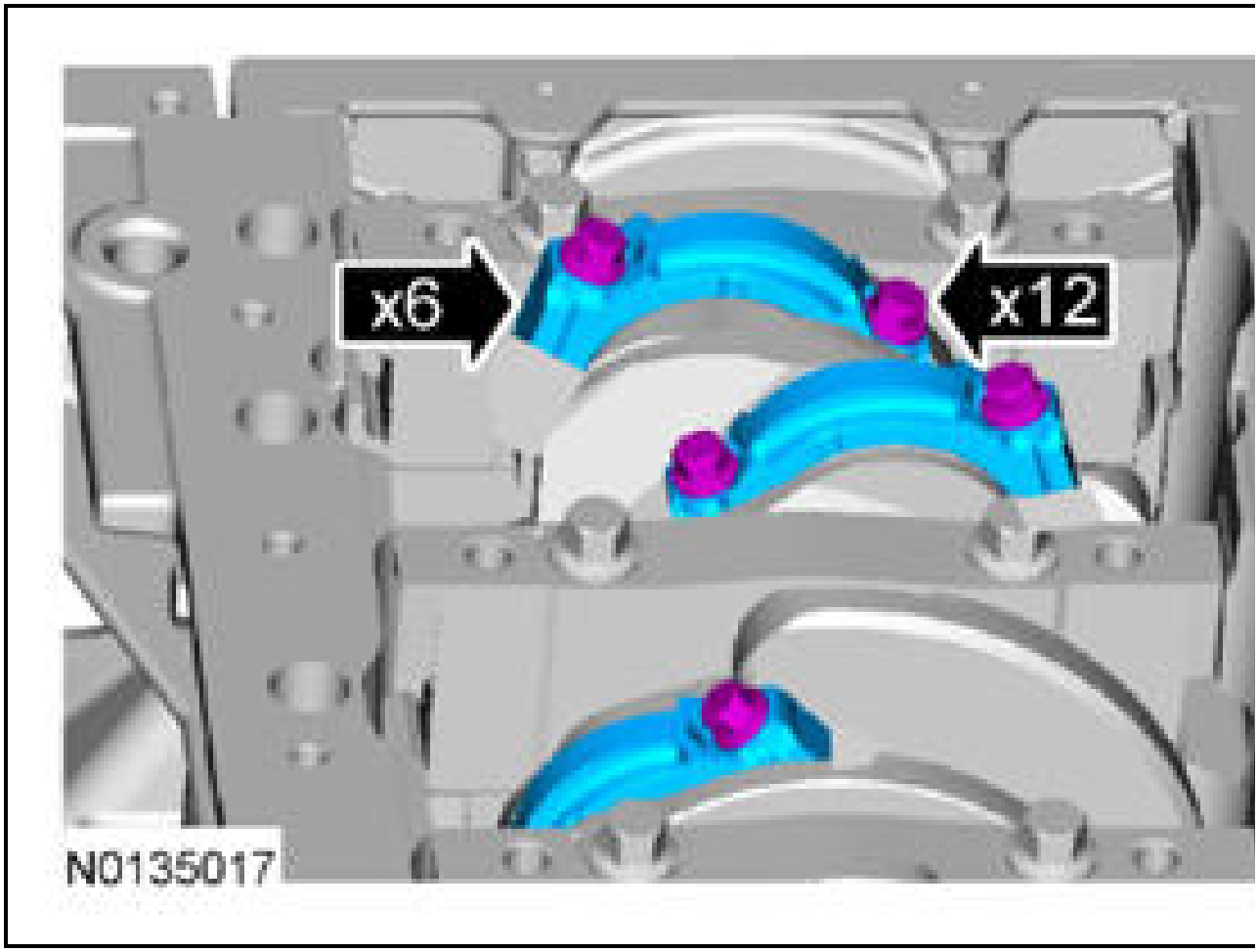
NOTE: After installation of each piston, connecting rod, rod cap and bolts, rotate the crankshaft to verify smooth operation.

Install the connecting rod cap and bolts. Tighten the bolts in 3 stages.

- Stage 1: Tighten to 23 Nm (17 lb-ft).

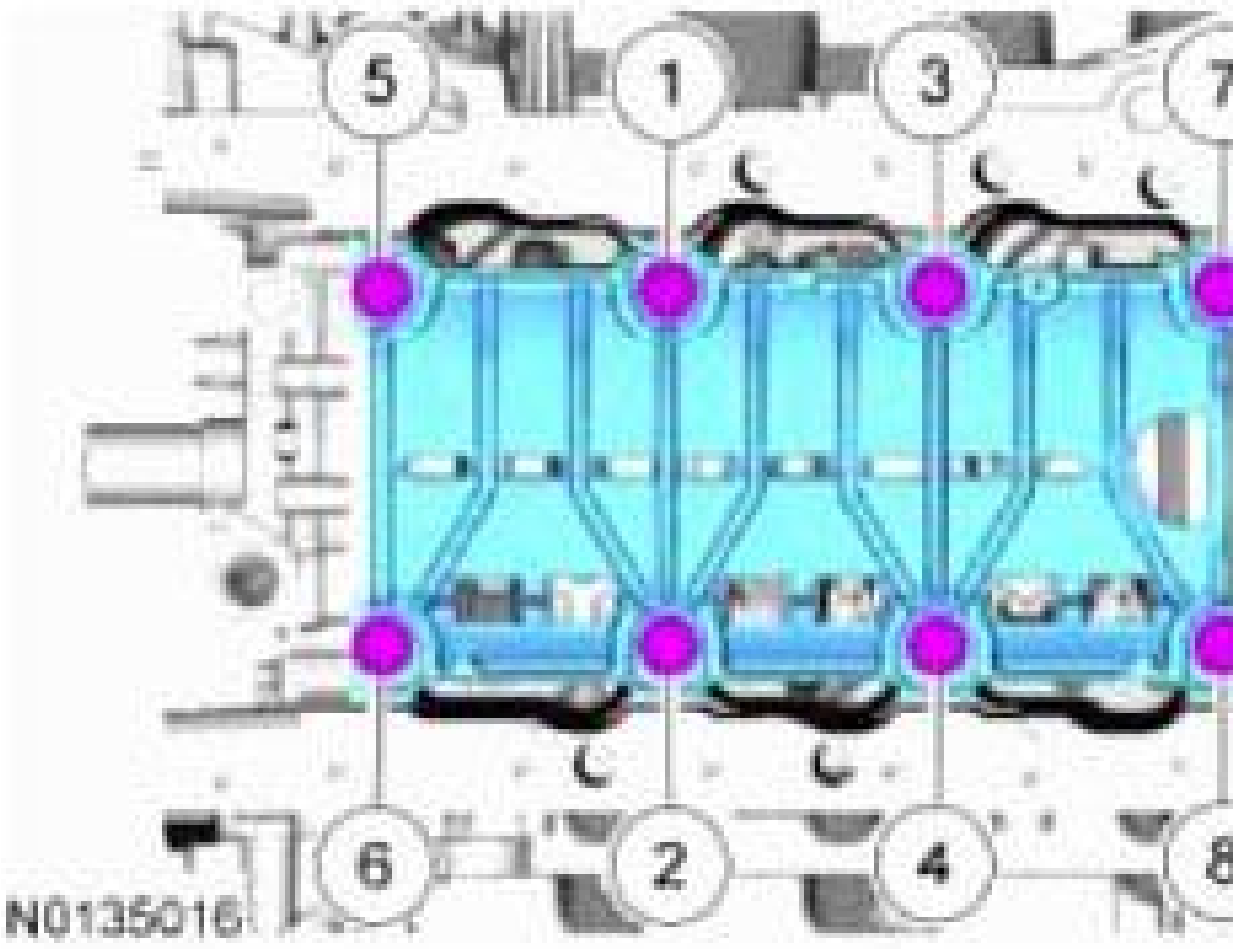
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- Stage 2: Tighten to 43 Nm (32 lb-ft).
- Stage 3: Tighten an additional degrees (90).



25. Repeat the previous 3 steps until all 6 piston, connecting rod and connecting rod cap assemblies are installed.
26. Install the main bearing cap support brace and the new bolts. Tighten in the sequence shown in illustration in 2 steps.
    - Stage 1: Tighten to 20 Nm (177 lb-in).
    - Stage 2: Tighten an additional 180 degrees.

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27.

NOTE: **Failure to use Motorcraft® High Performance Engine RTV Silicone may cause the engine oil to foam excessively and result in serious engine damage.**

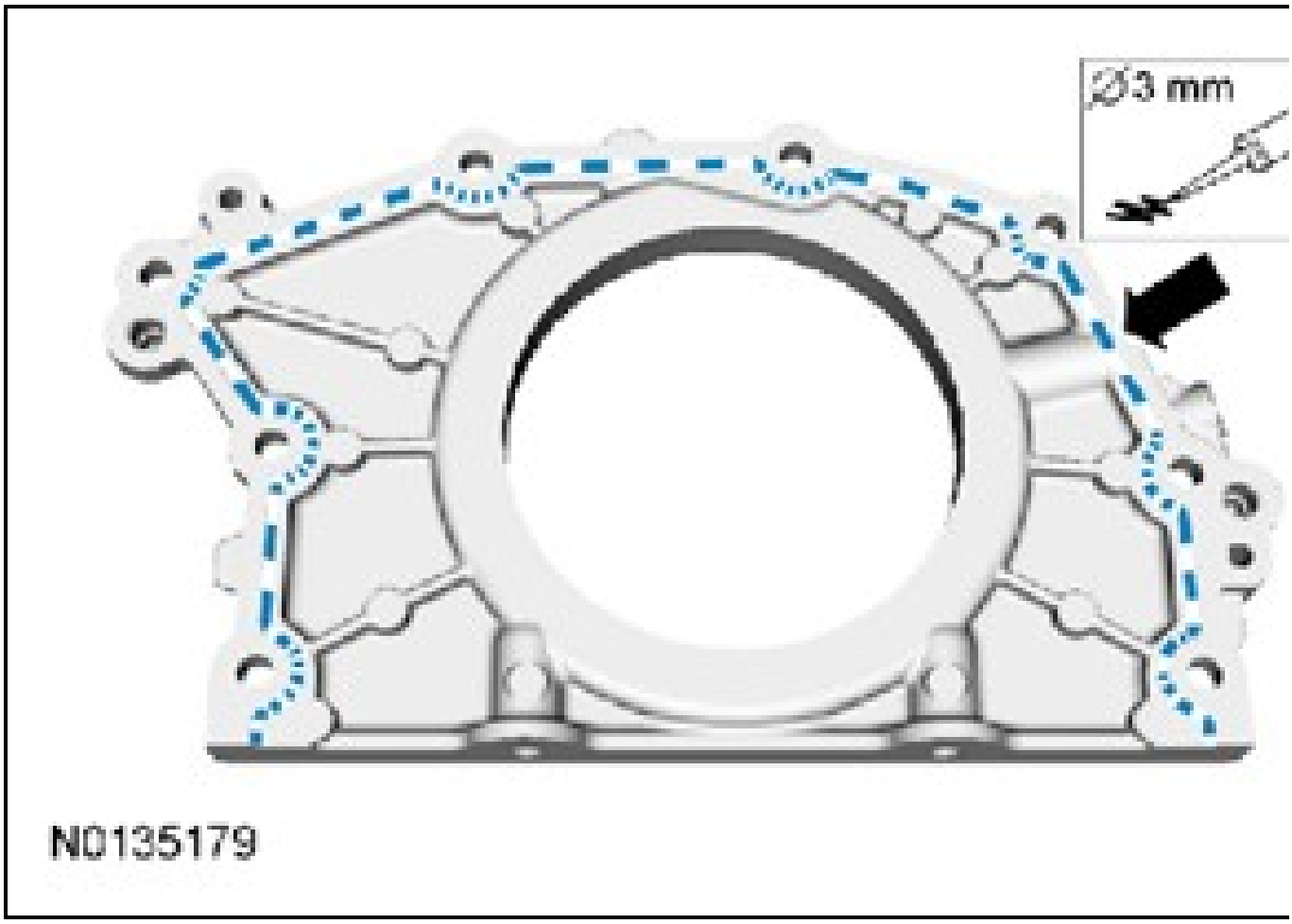
NOTE: **The crankshaft rear seal retainer must be installed and the bolts tightened within 4 minutes of sealant application.**

NOTE: **Cast aluminum (early build) crankshaft rear seal retainer plate shown in illustration, stamped steel (late build) crankshaft rear seal retainer plate is similar.**

NOTE: **The stamped steel (late build) crankshaft rear seal retainer plate comes with the crankshaft rear seal.**

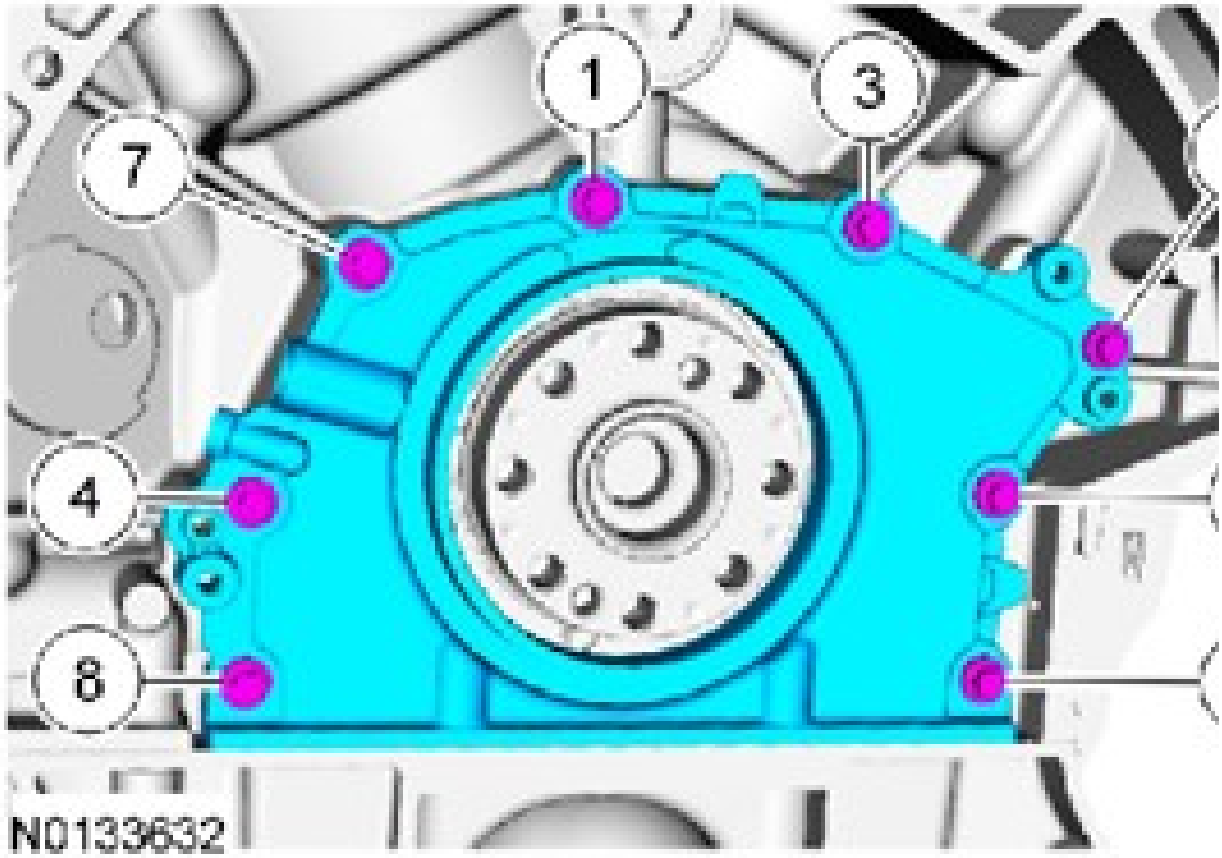
Apply a 3 mm (0.12 in) bead of Motorcraft® High Performance Engine RTV Silicone to the sealing surface of the crankshaft rear seal retainer.

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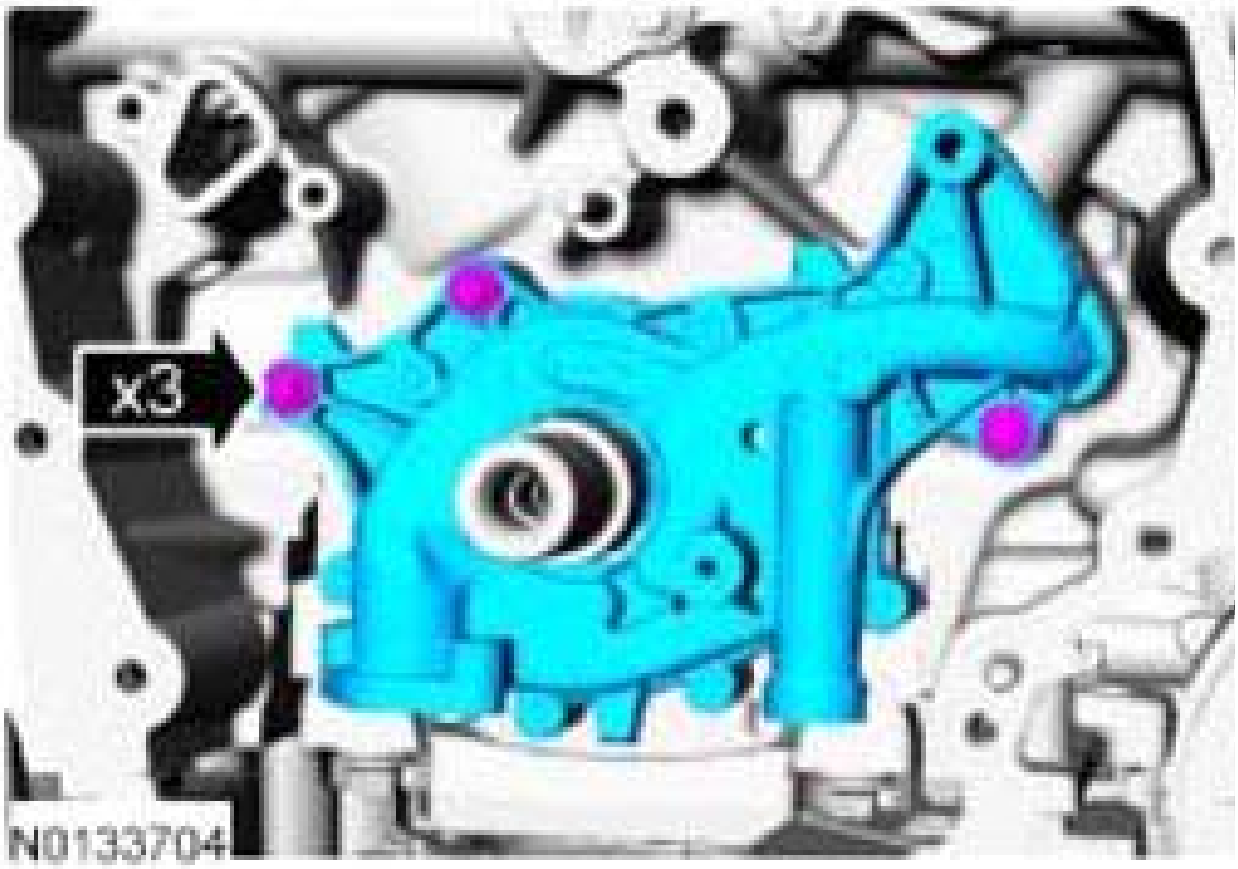
28. Install the crankshaft rear seal retainer and the 8 bolts.
    - Tighten to 10 Nm (89 lb-in).

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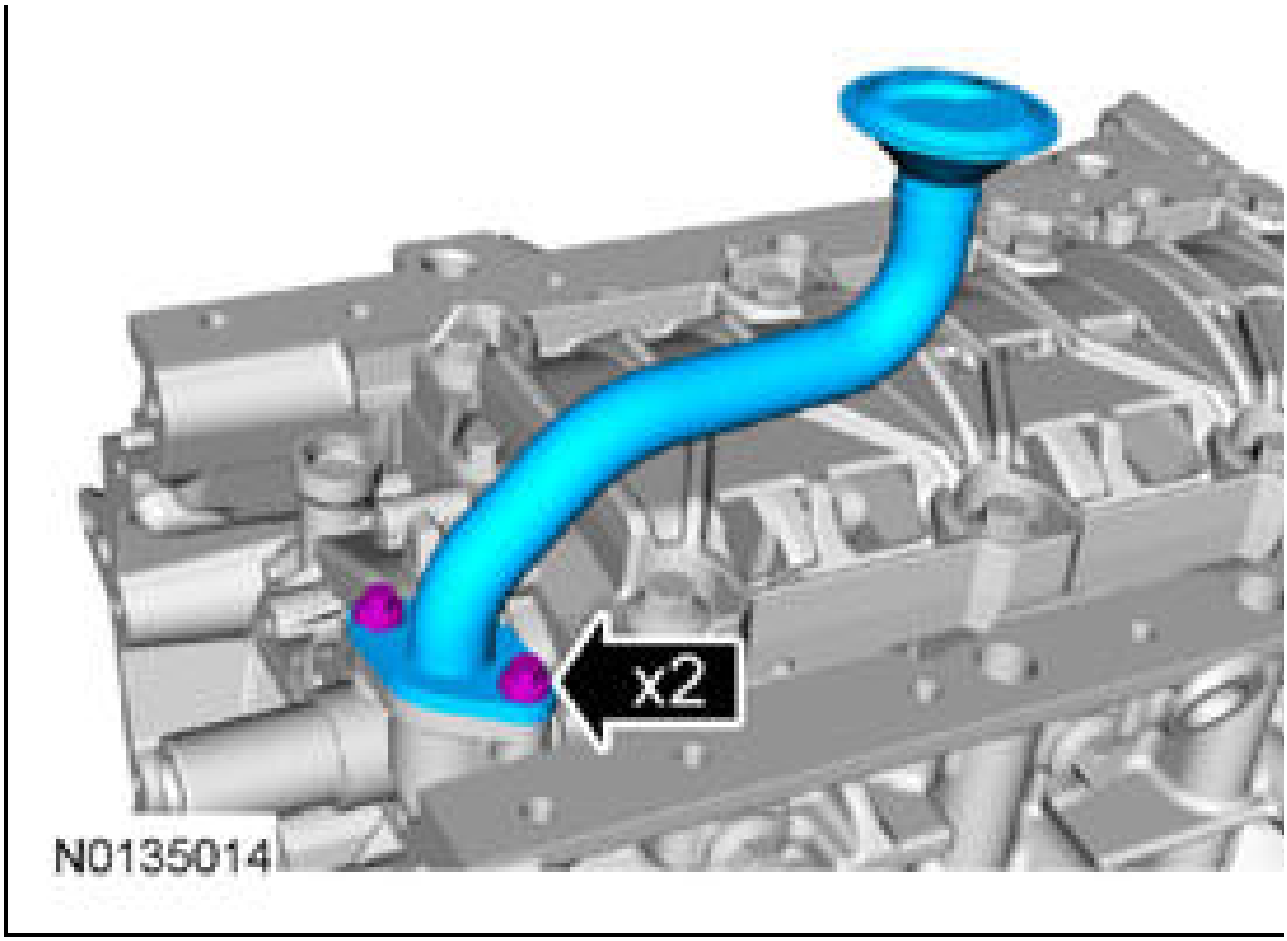
29. Install the oil pump and the 3 bolts.
    - Tighten to 10 Nm (89 lb-in).

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30. Using a new O-ring seal, install the oil pump screen and pickup tube and the 2 bolts.
    - Tighten to 10 Nm (89 lb-in).

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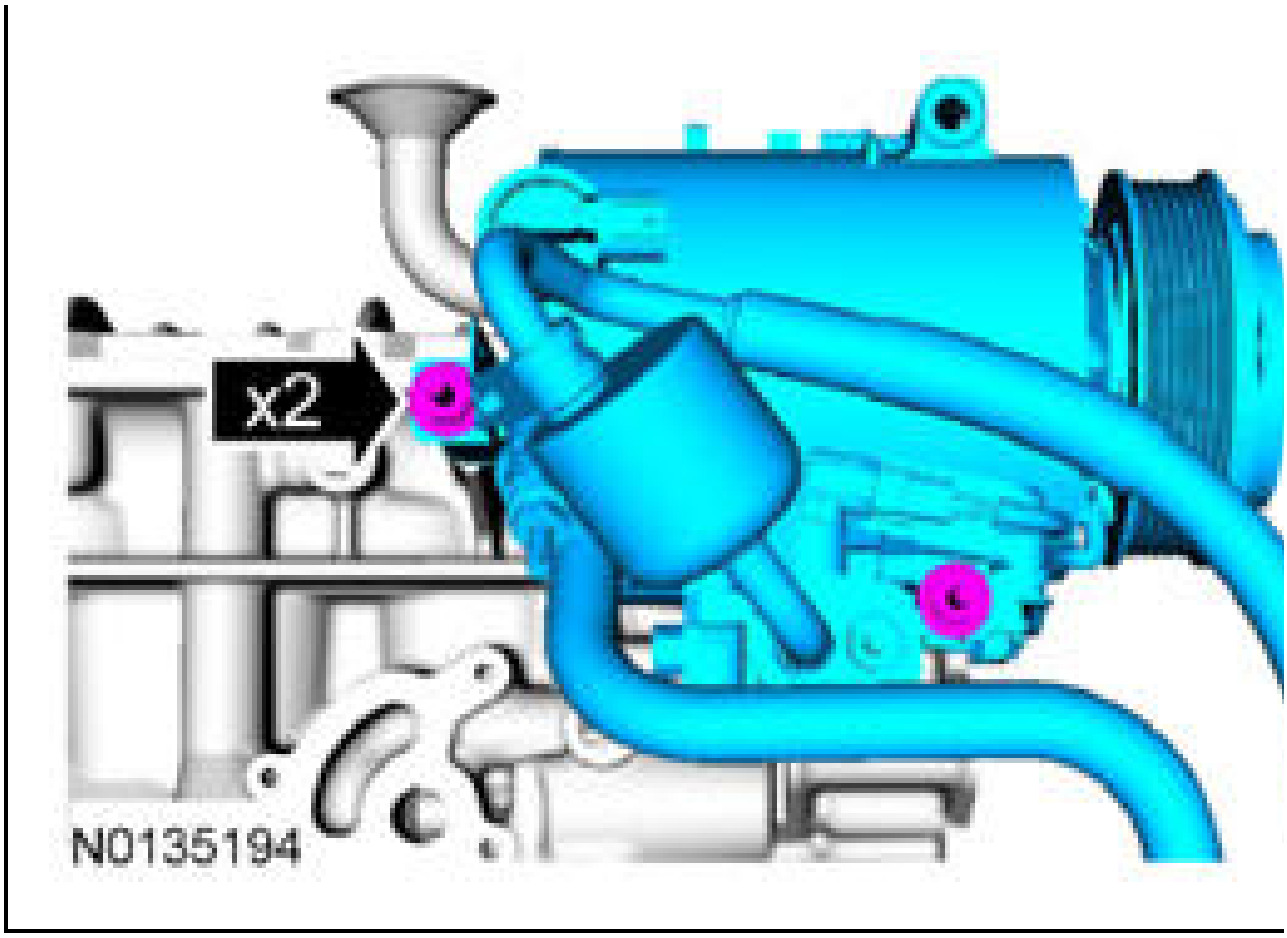


31. **NOTE: The A/C compressor must be installed on the cylinder block and the 2 bolts tightened prior to installing the oil pan.**

Install the A/C compressor and the 2 bolts.

- Stage 1: Tighten to 25 Nm (18 lb-ft).

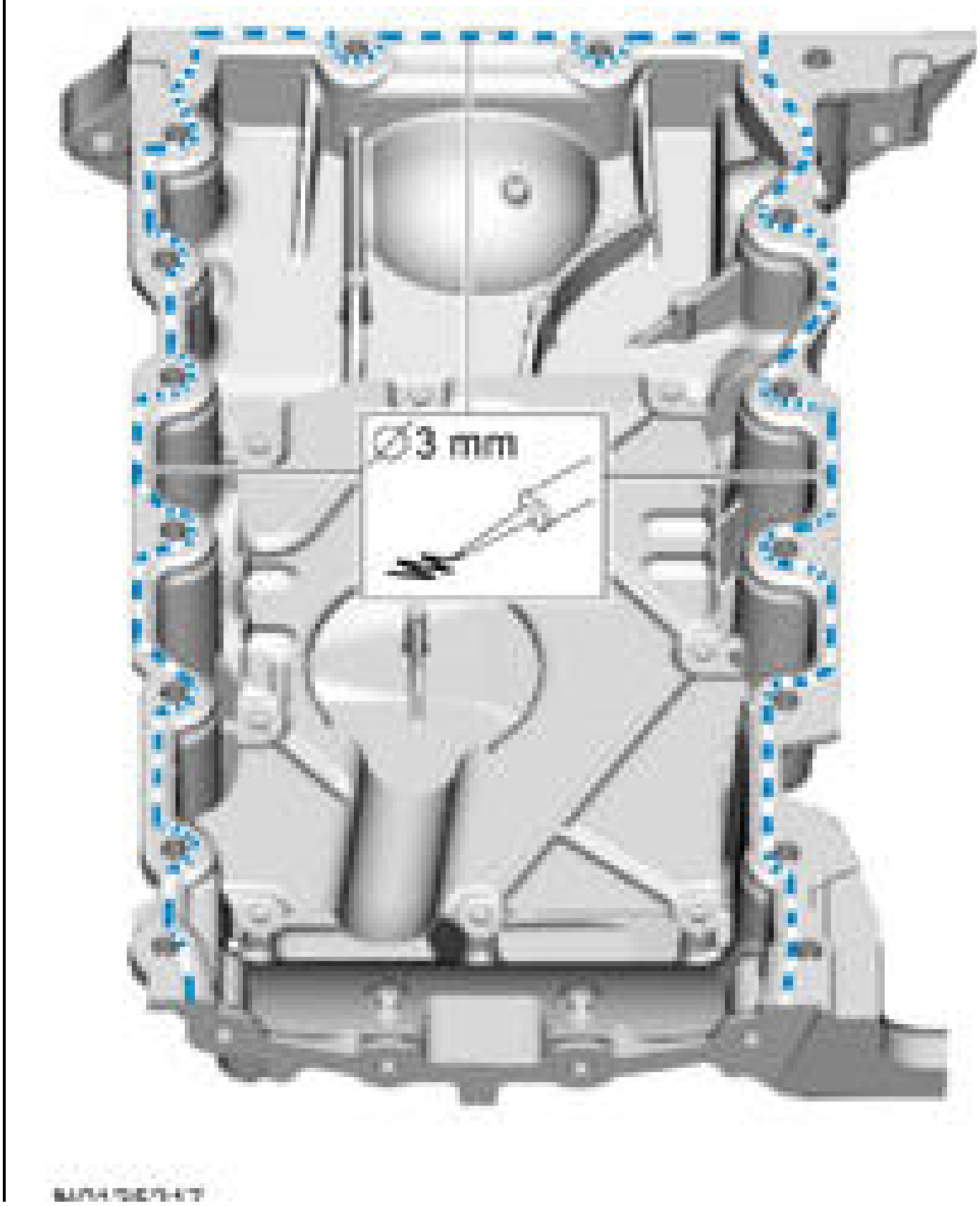
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NOTE: **Failure to use Motorcraft® High Performance Engine RTV Silicone may cause the engine oil to foam excessively and result in serious engine damage.**

32. Apply a 3 mm (0.12 in) bead of Motorcraft® High Performance Engine RTV Silicone to the sealing surface of the oil pan.

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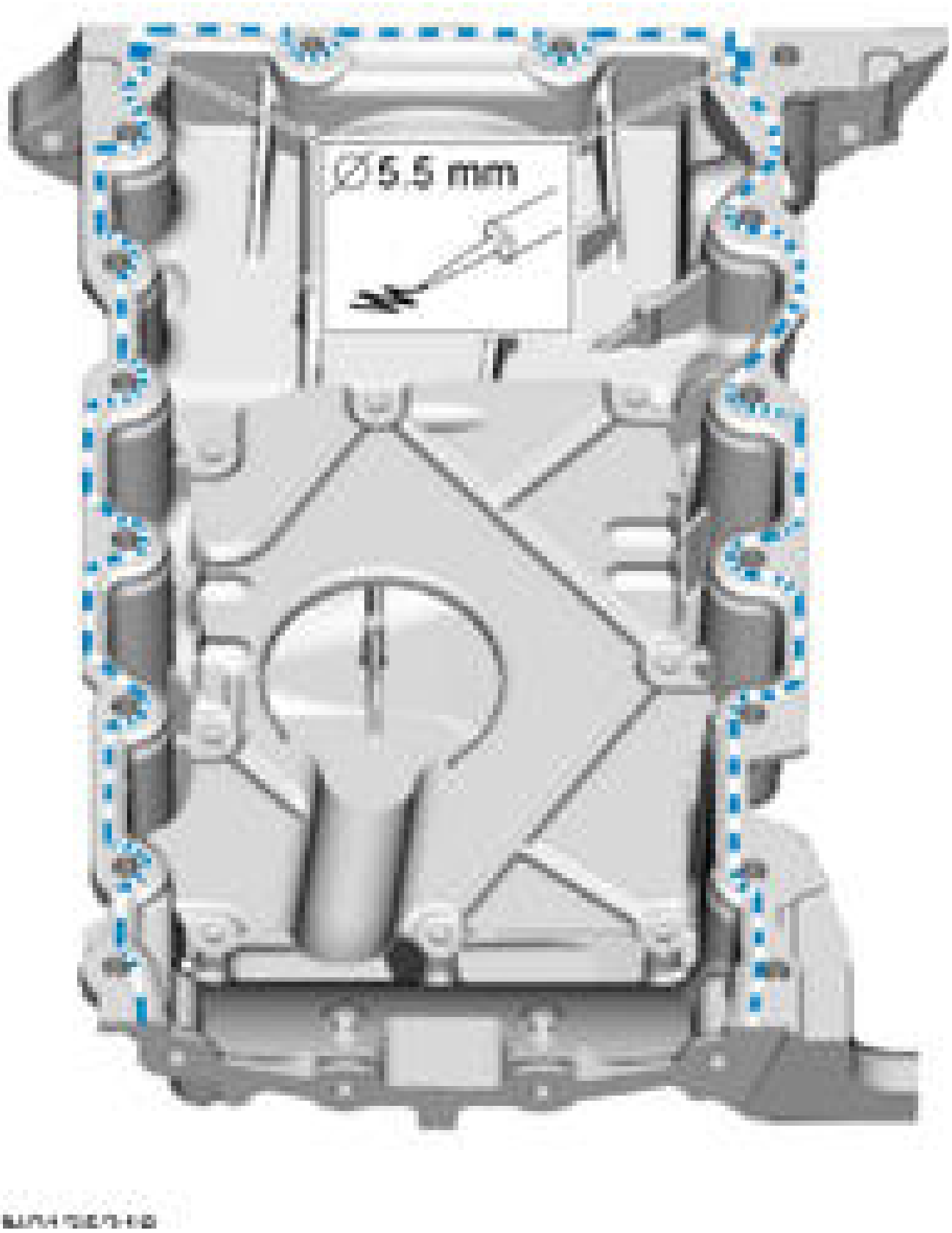
NOTE: **Failure to use Motorcraft® High Performance Engine RTV Silicone may cause the engine oil to foam excessively and result in serious engine damage.**

33.

NOTE: **The oil pan and the 4 specified bolts must be installed and the oil pan aligned to the cylinder block and A/C compressor within 4 minutes of sealant application. Final tightening of the oil pan bolts must be carried out within 60 minutes of sealant application.**

Apply a 5.5 mm (0.22 in) bead of Motorcraft® High Performance Engine RTV Silicone to the 2 crankshaft seal retainer plate-to-cylinder block joint areas on the sealing surface of the oil pan.

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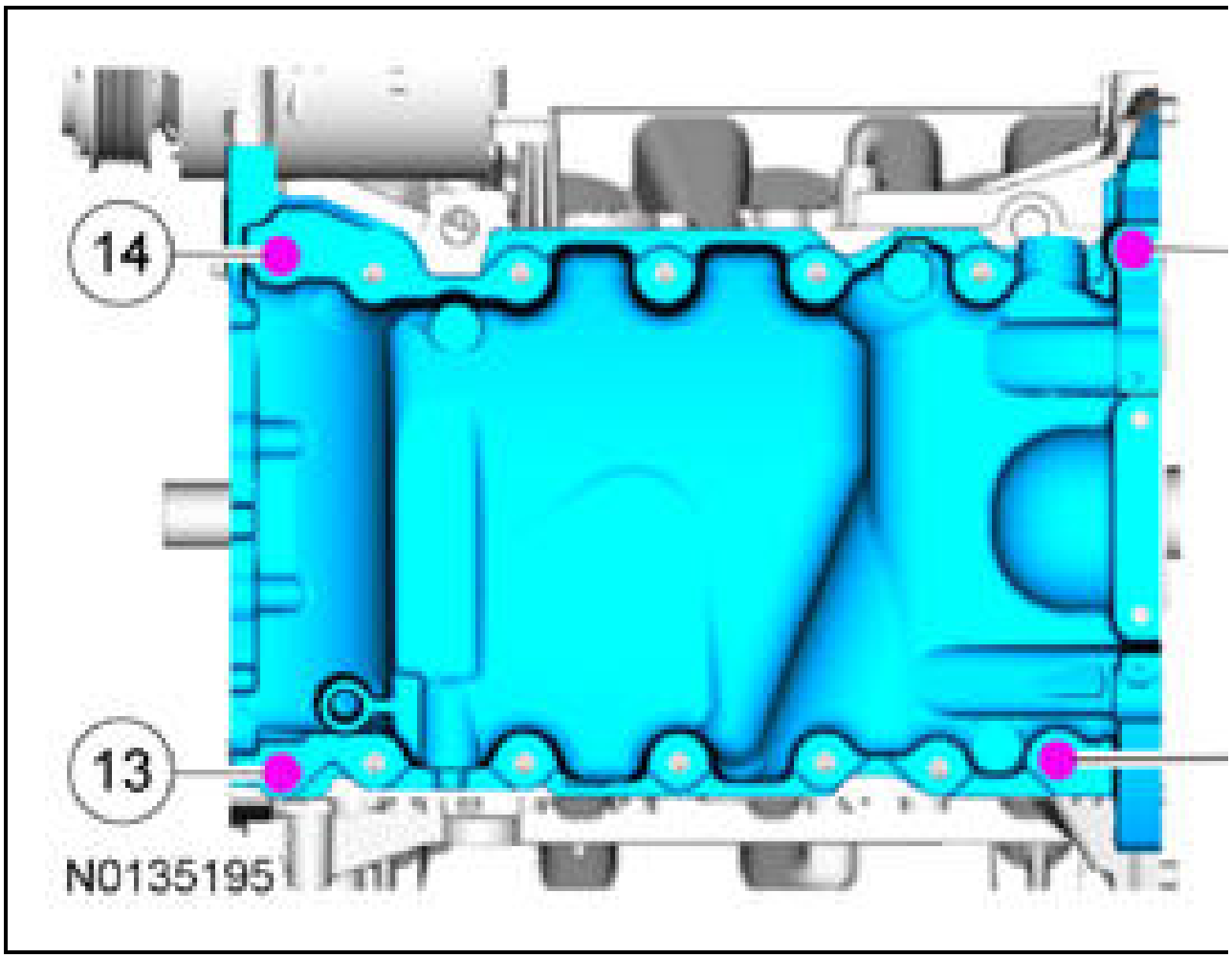


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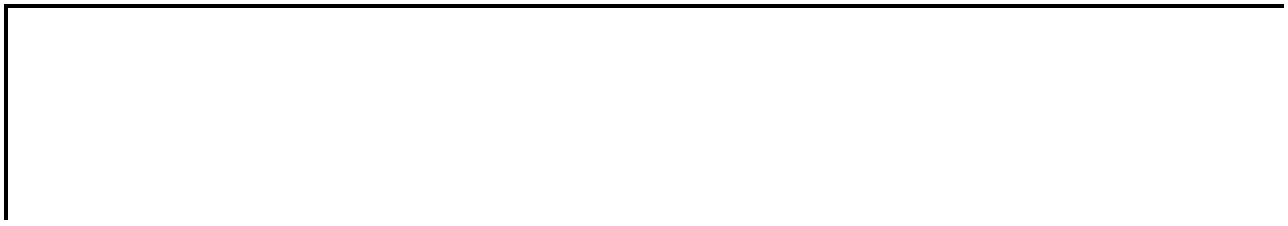
34. **NOTE: The oil pan and the 4 specified bolts must be installed within 4 minutes of the start of sealant application.**

Install the oil pan and bolts 10, 11, 13 and 14.

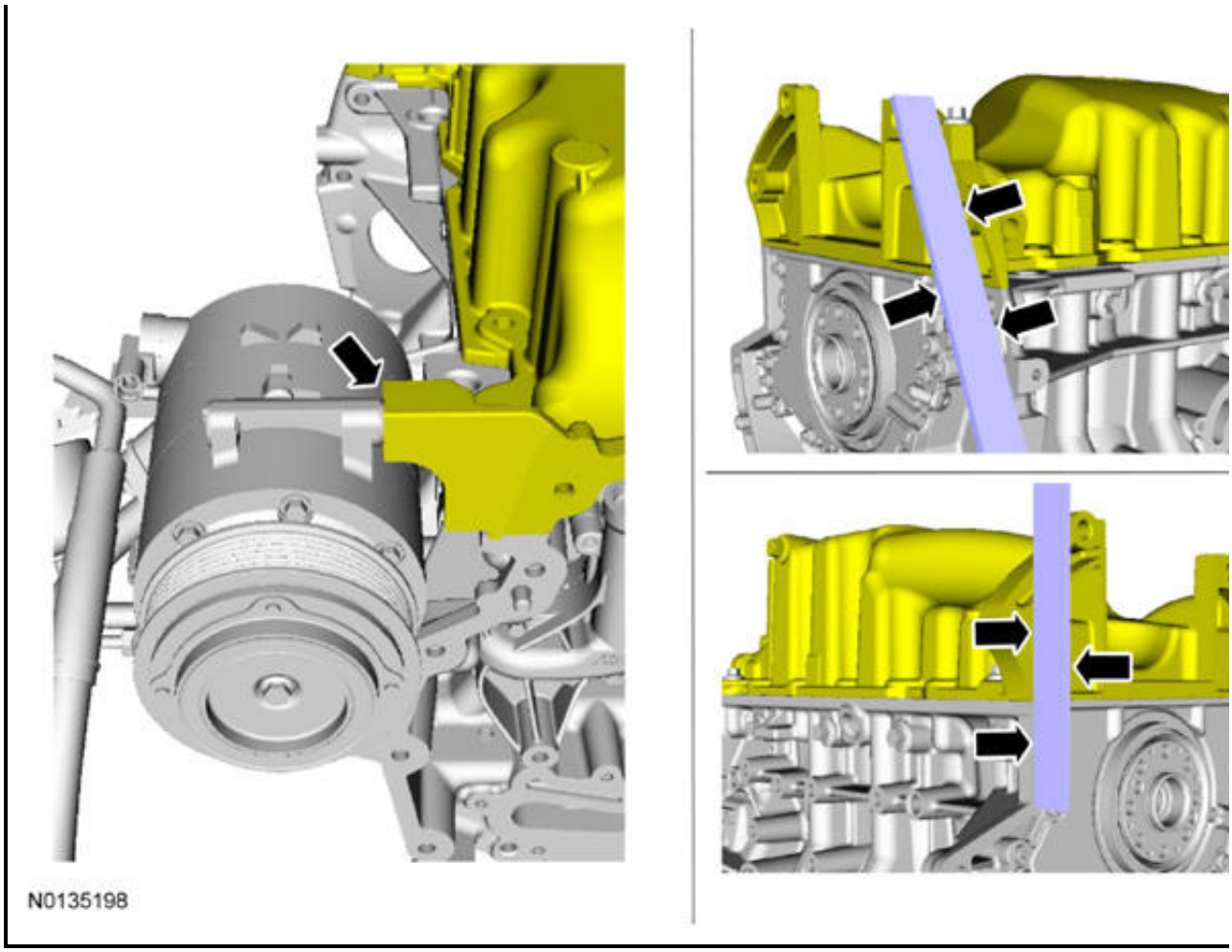
- Stage 1: Tighten to 3 Nm (27 lb-in).
- Stage 2: Loosen the bolts 180 degrees.



35. Align the oil pan to the cylinder block and the A/C compressor.
    - Position the oil pan so the mounting boss is against the A/C compressor and using a straightedge, align the oil pan flush with the rear of the cylinder block at the 2 areas shown in illustration.

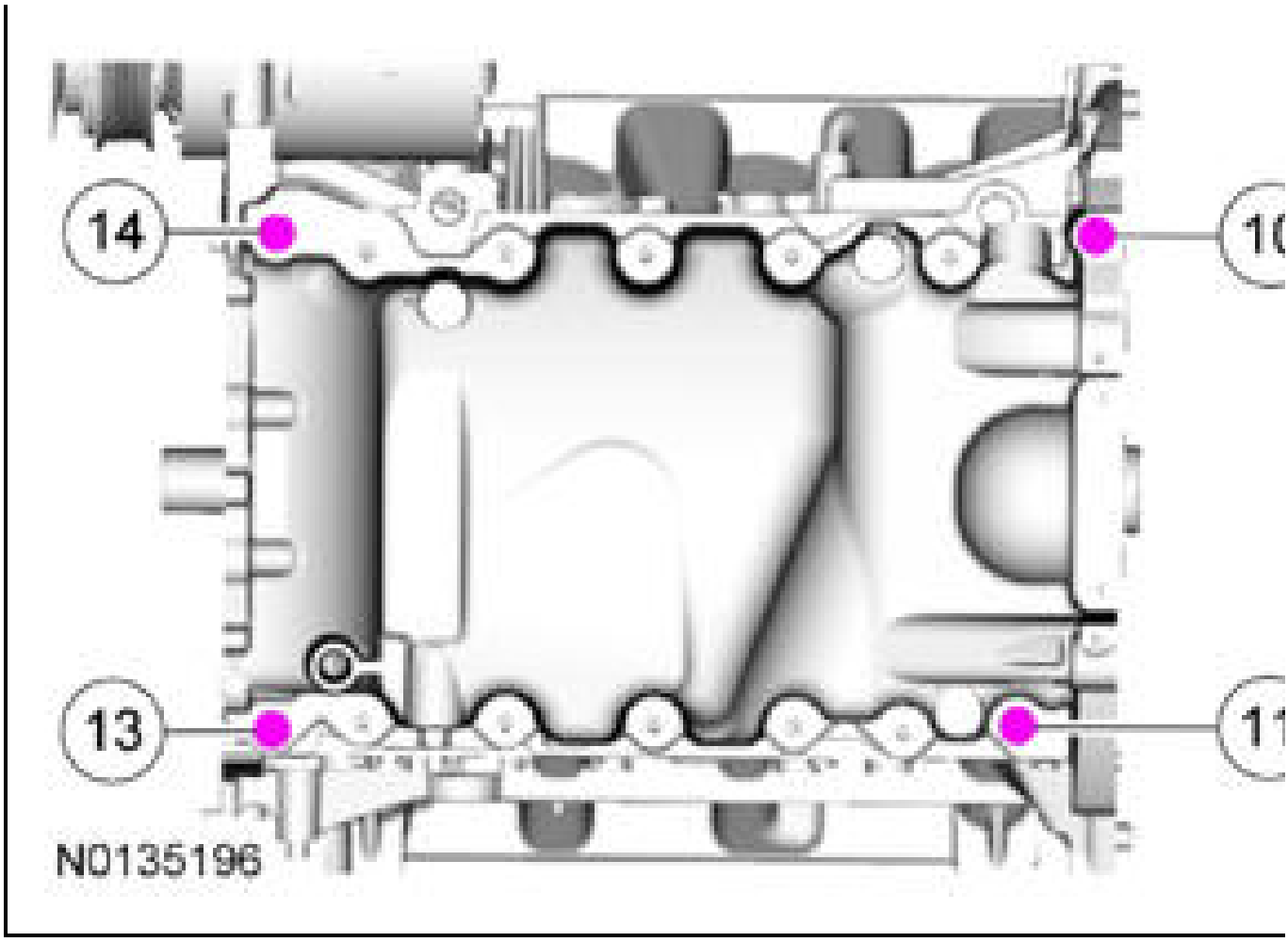


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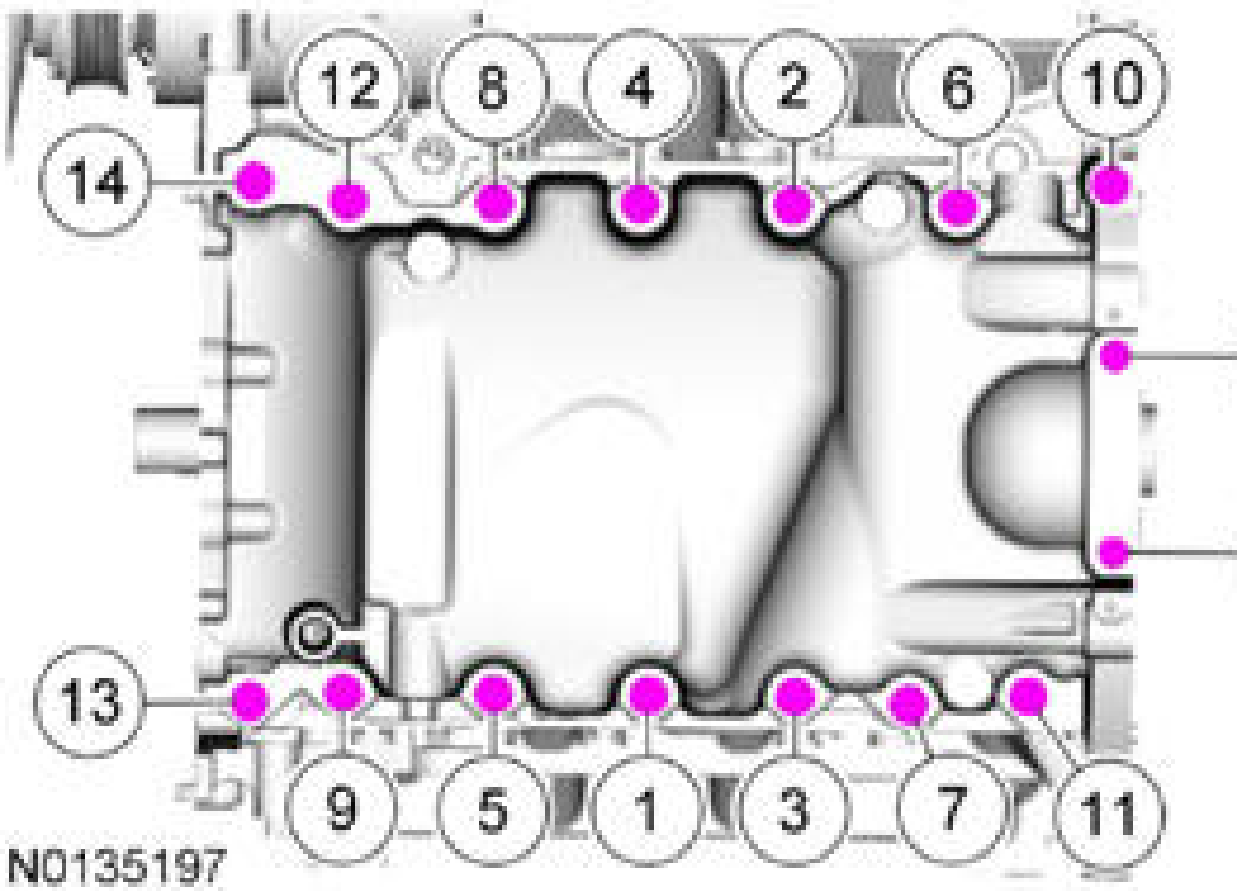
36. Tighten bolts 10, 11, 13 and 14 in the sequence shown in illustration, to 3 Nm (27 lb-in).

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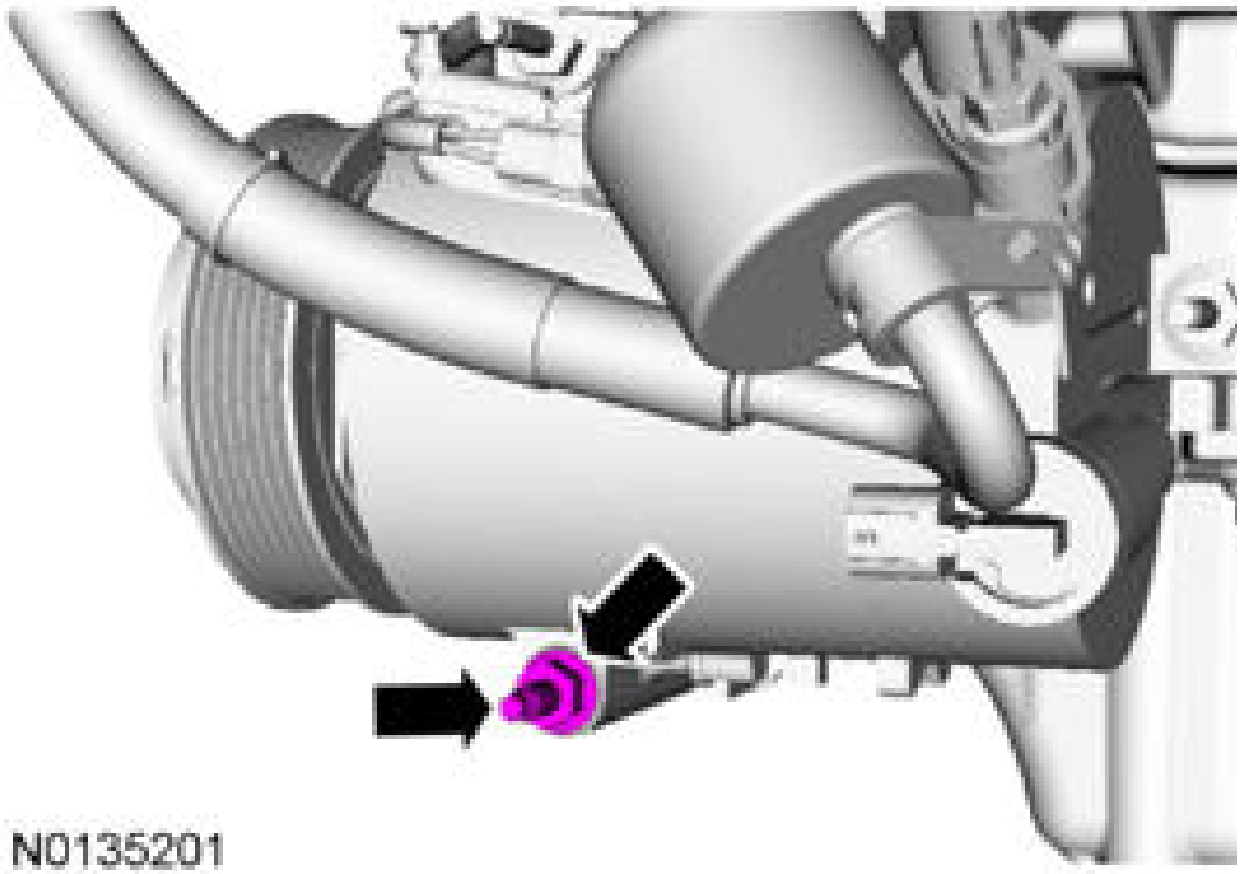
37. Install the remaining oil pan bolts. Tighten all the oil pan bolts in the sequence shown in illustration.
    - Stage 1: Tighten the large bolts (1-14) to 24 Nm (18 lb-ft).
    - Stage 2: Tighten the small bolts (15 and 16) to 10 Nm (89 lb-in).

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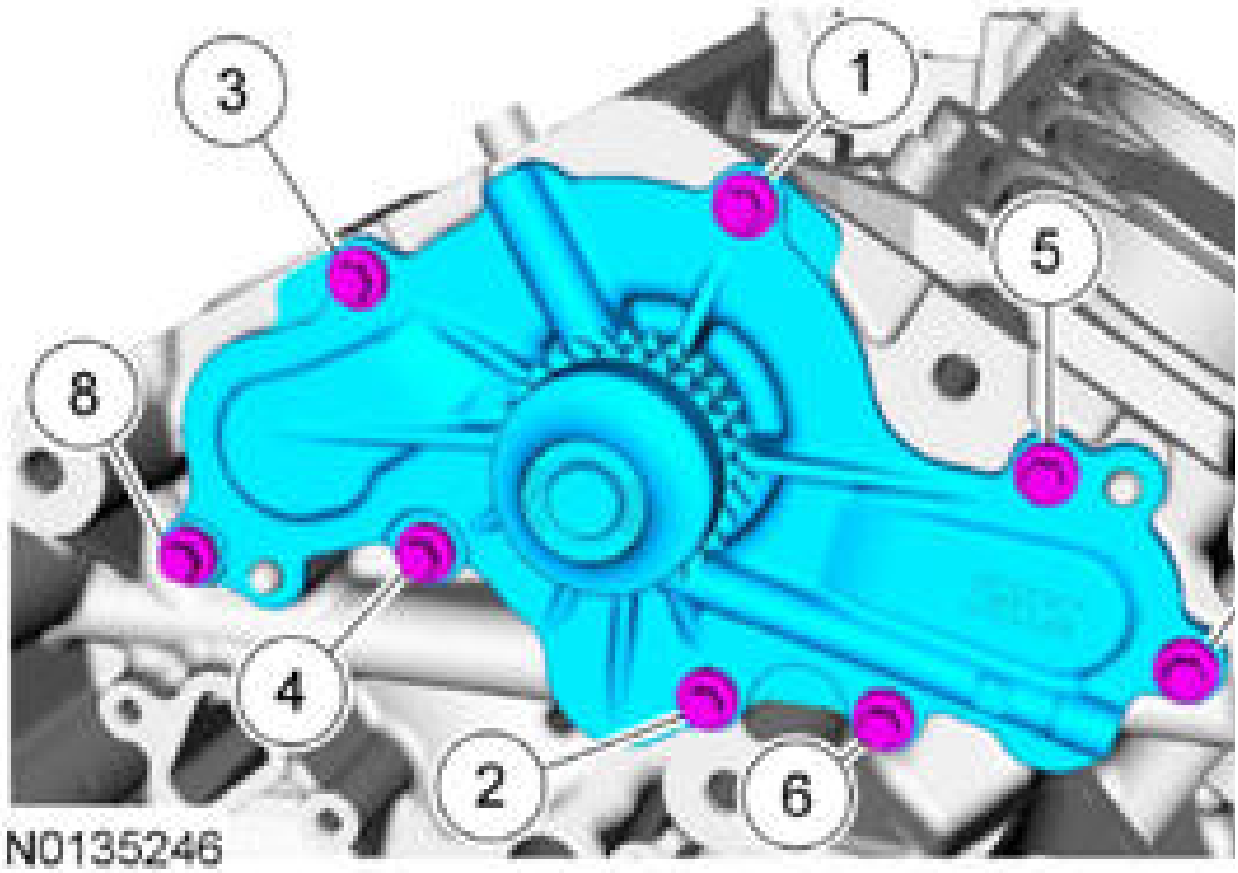
38. Install the A/C compressor mounting stud and nut.
    - Tighten the stud to 9 Nm (80 lb-in) and the nut to 25 Nm (18 lb-ft).

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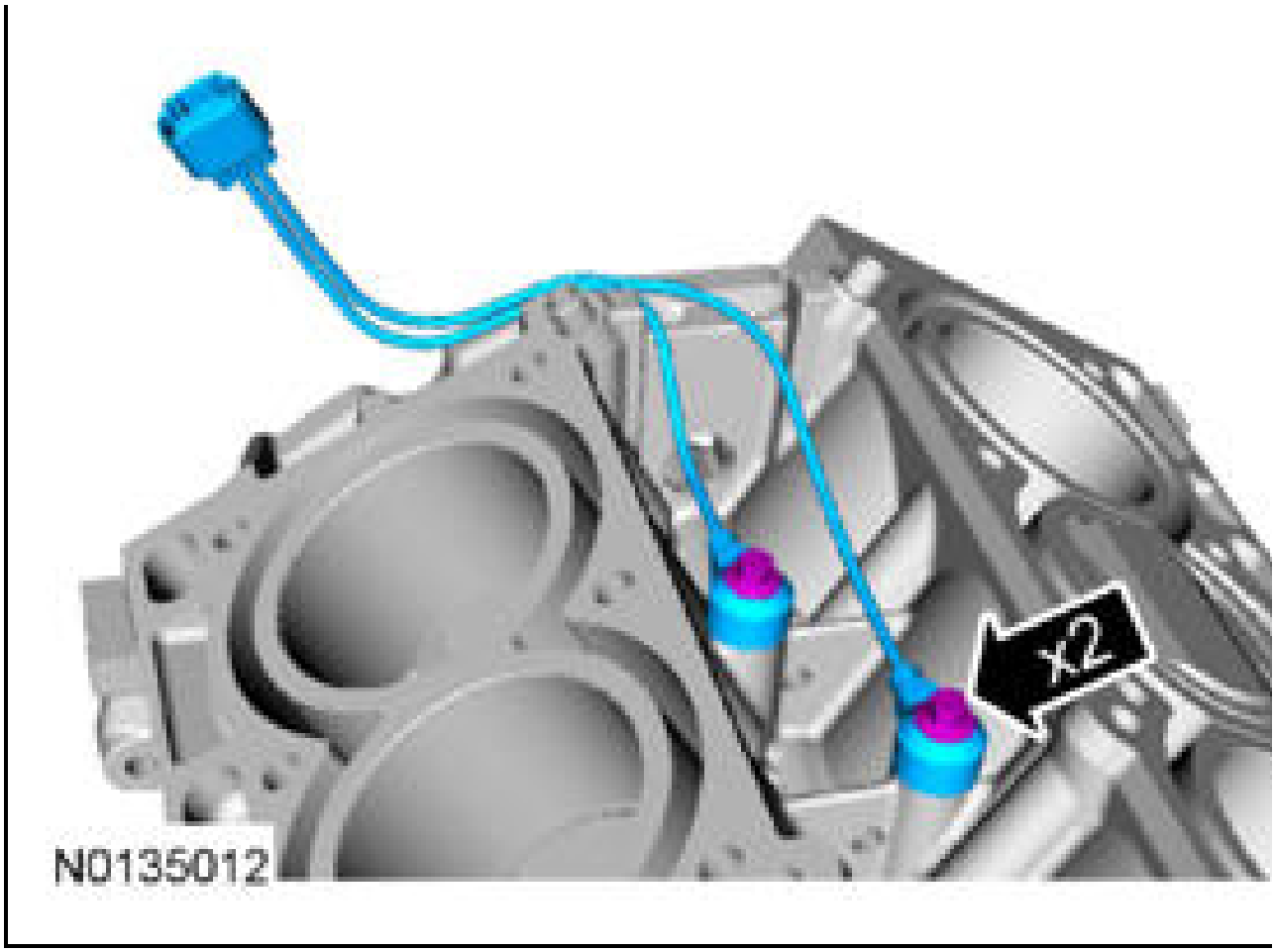
39. Install the coolant pump and the 8 bolts. Tighten in the sequence shown in illustration in 2 stages:
    - Stage 1: Tighten to 10 Nm (89 lb-in).
    - Stage 2: Tighten an additional 45 degrees.

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40. Install the KS and the 2 bolts.
    - Tighten to 20 Nm (177 lb-in).

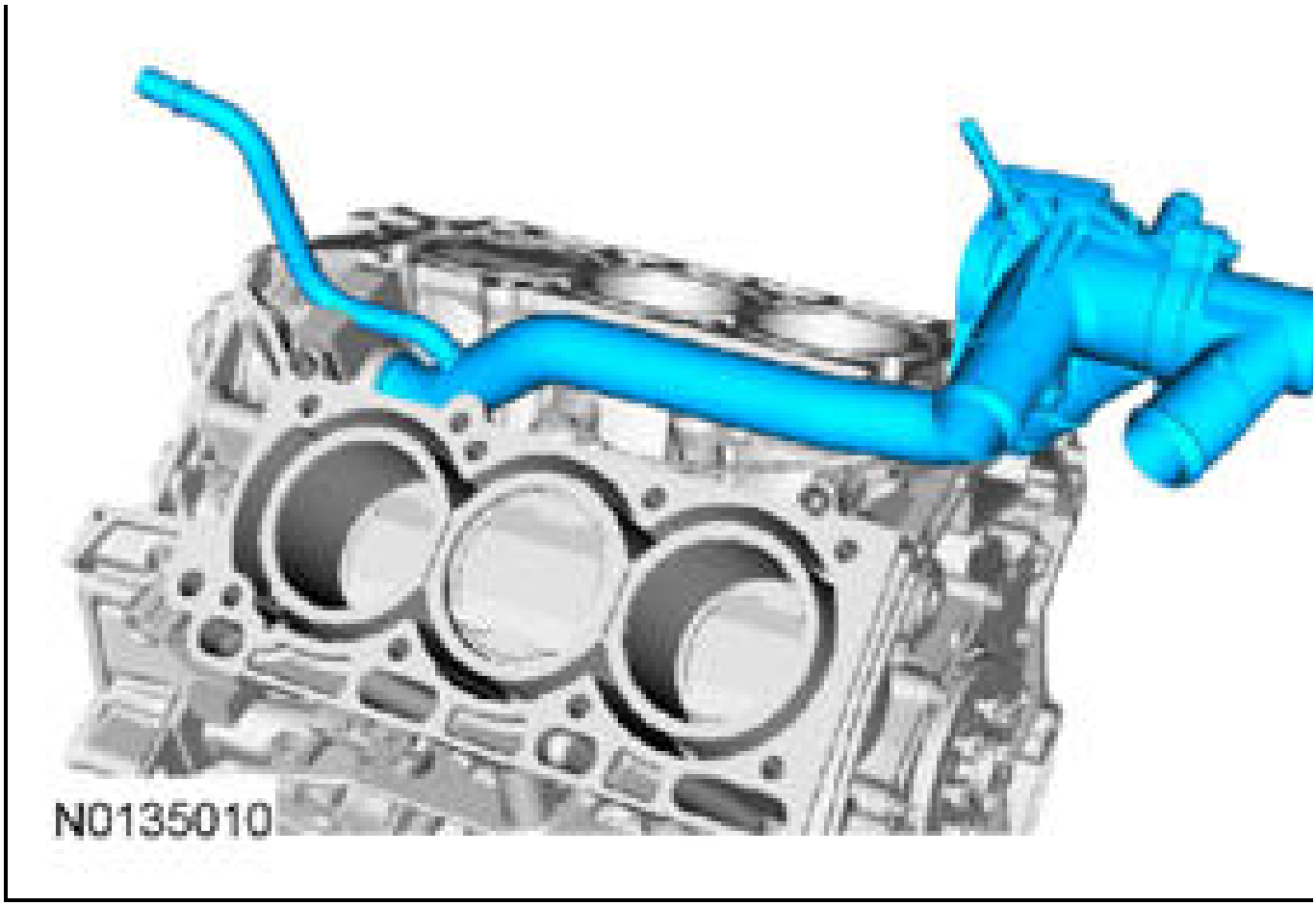
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41. **NOTE: Apply clean engine coolant to the O-ring seal prior to installation.**

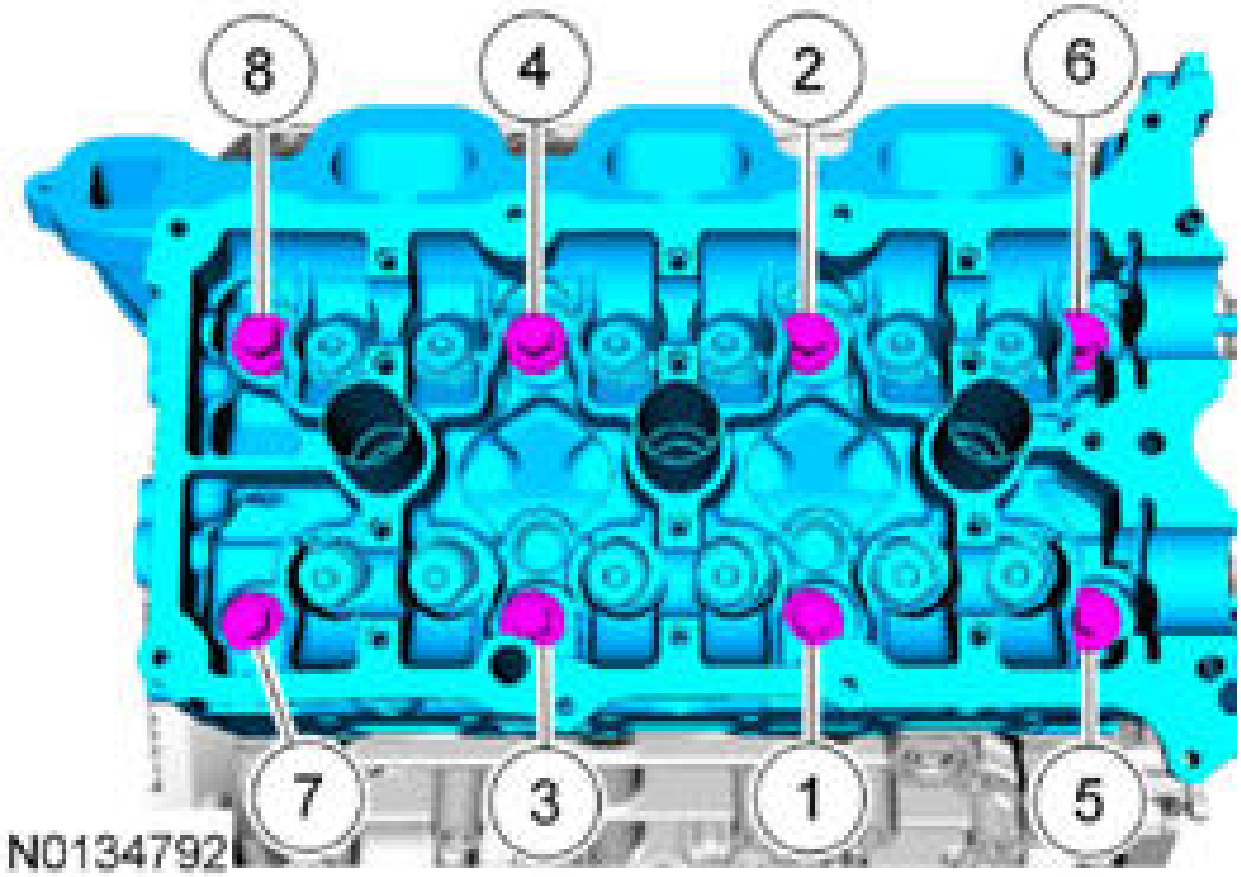
Using a new O-ring seal, install the coolant inlet tube and thermostat assembly.

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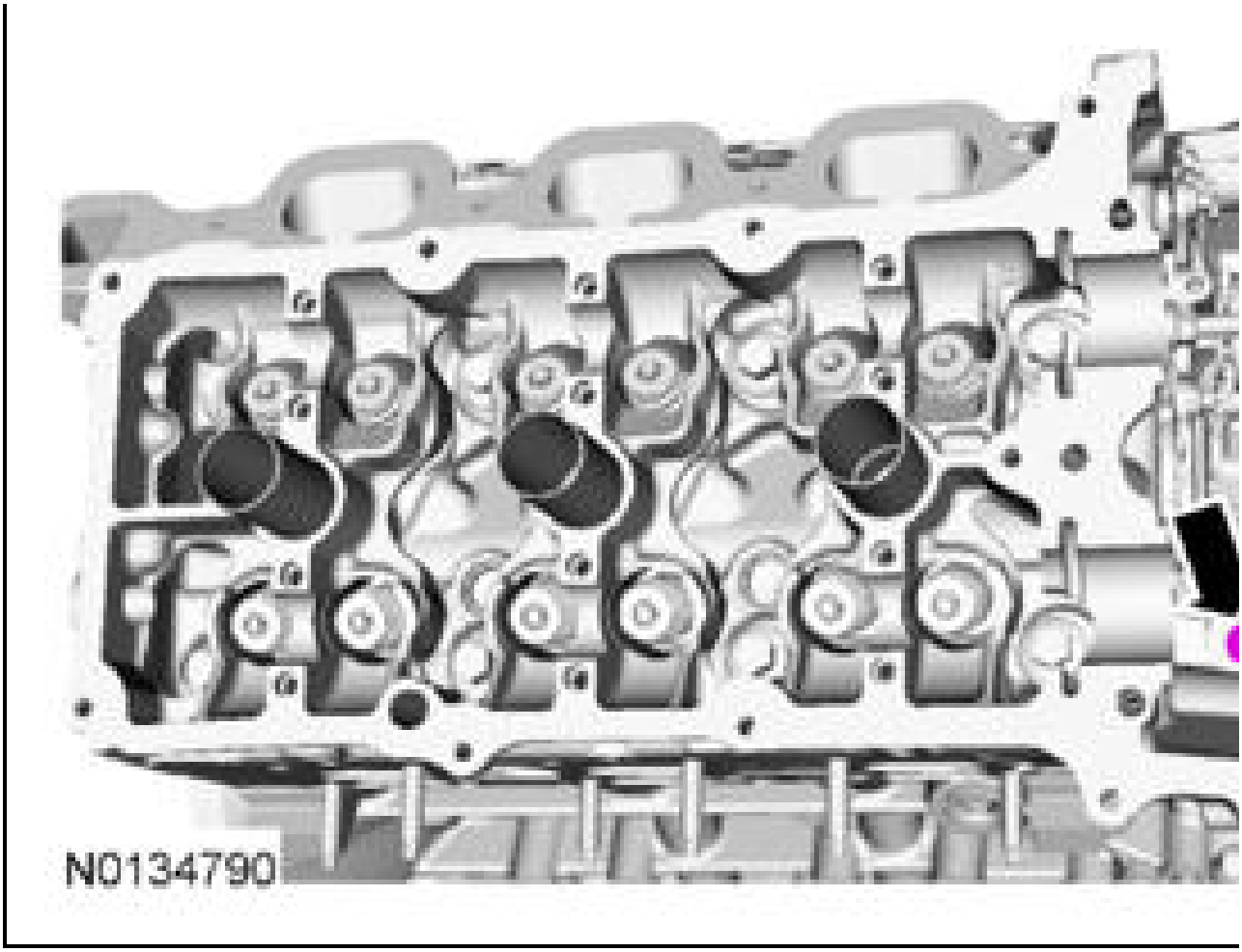
42. Install a new gasket, the RH cylinder head and 8 new bolts. Tighten in the sequence shown in illustration in 5 stages:
    - Stage 1: Tighten to 20 Nm (177 lb-in).
    - Stage 2: Tighten to 35 Nm (26 lb-ft).
    - Stage 3: Tighten 90 degrees.
    - Stage 4: Tighten 90 degrees.
    - Stage 5: Tighten 45 degrees.

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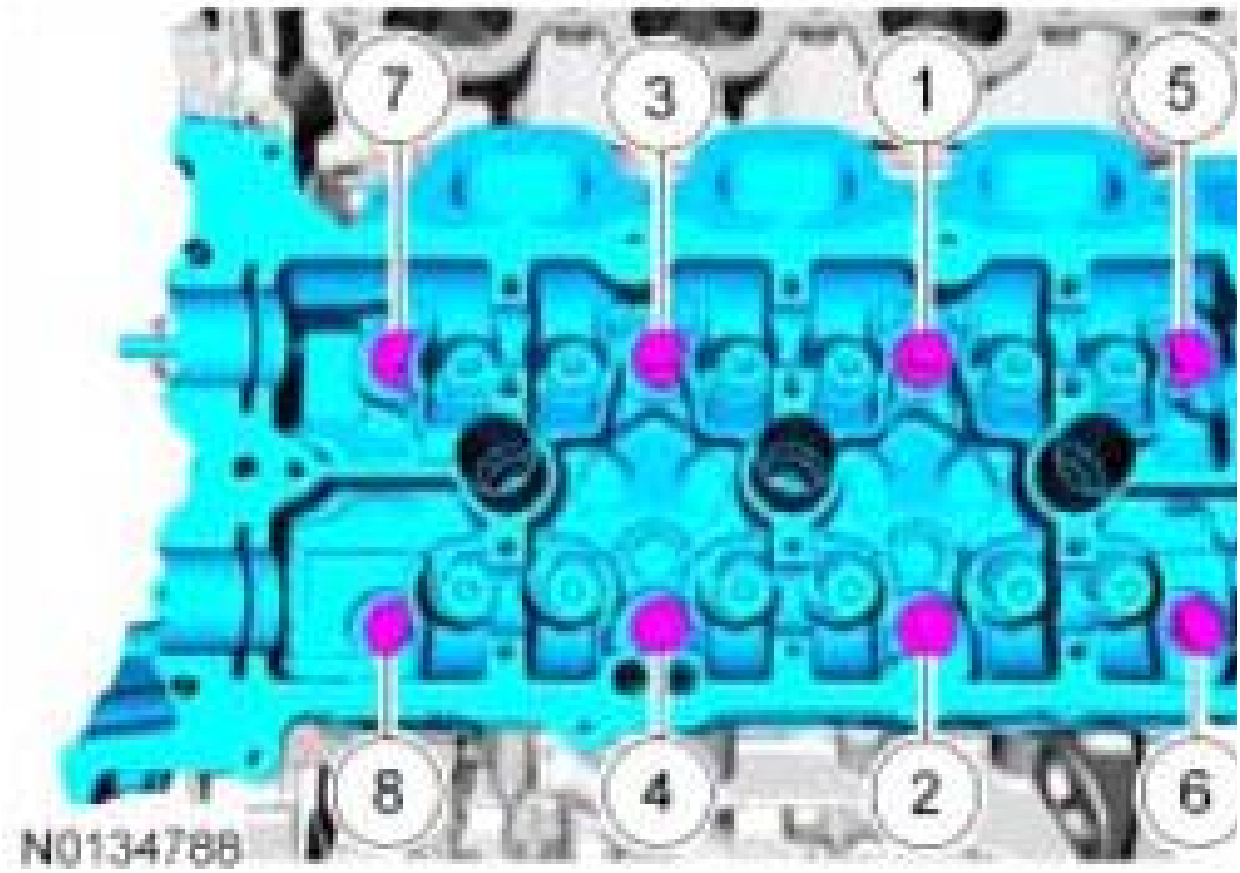
43. Install the bolt.
    - Tighten to 10 Nm (89 lb-in).

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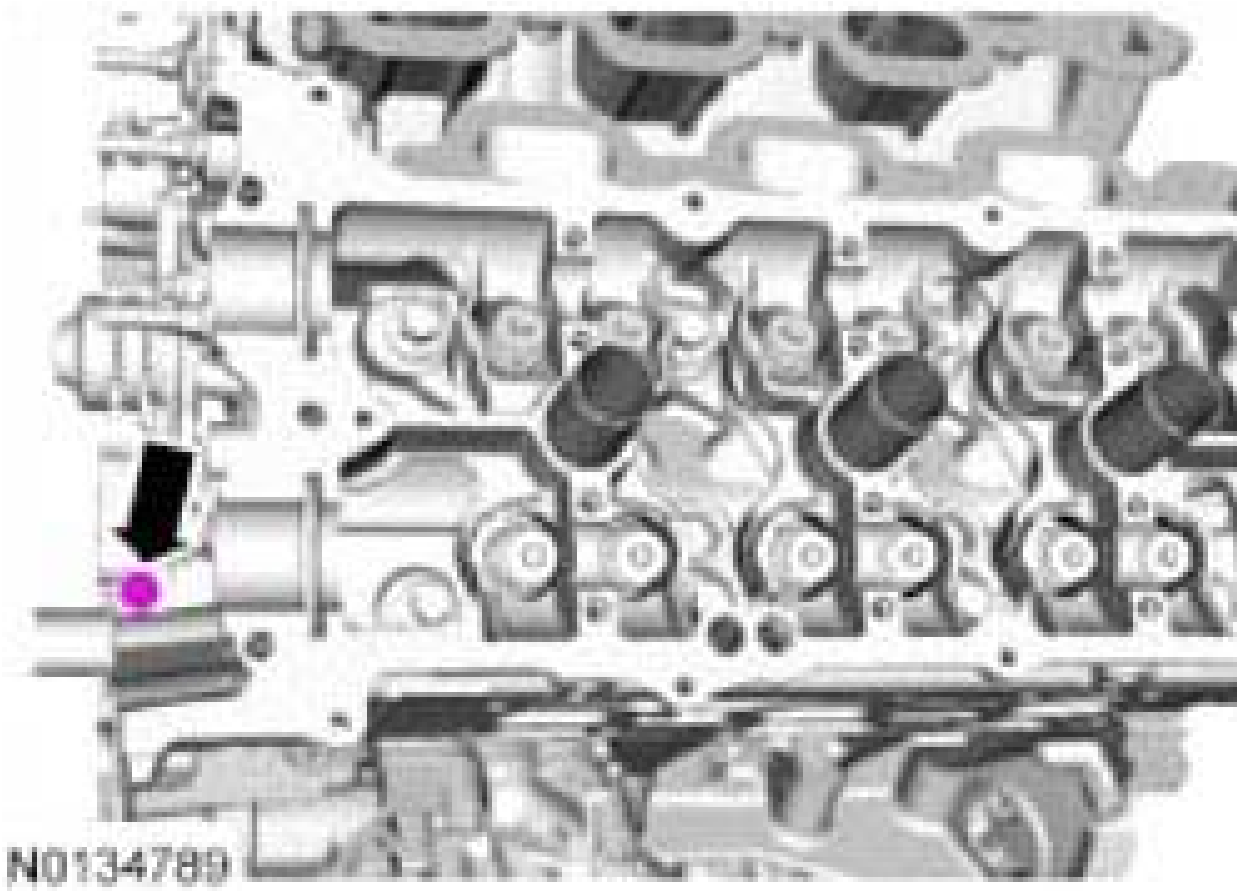
44. Install a new gasket, the LH cylinder head and 8 new bolts. Tighten in the sequence shown in illustration in 5 stages:
    - Stage 1: Tighten to 20 Nm (177 lb-in).
    - Stage 2: Tighten to 35 Nm (26 lb-ft).
    - Stage 3: Tighten 90 degrees.
    - Stage 4: Tighten 90 degrees.
    - Stage 5: Tighten 45 degrees.

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45. Install the bolt.
    - Tighten to 10 Nm (89 lb-in).

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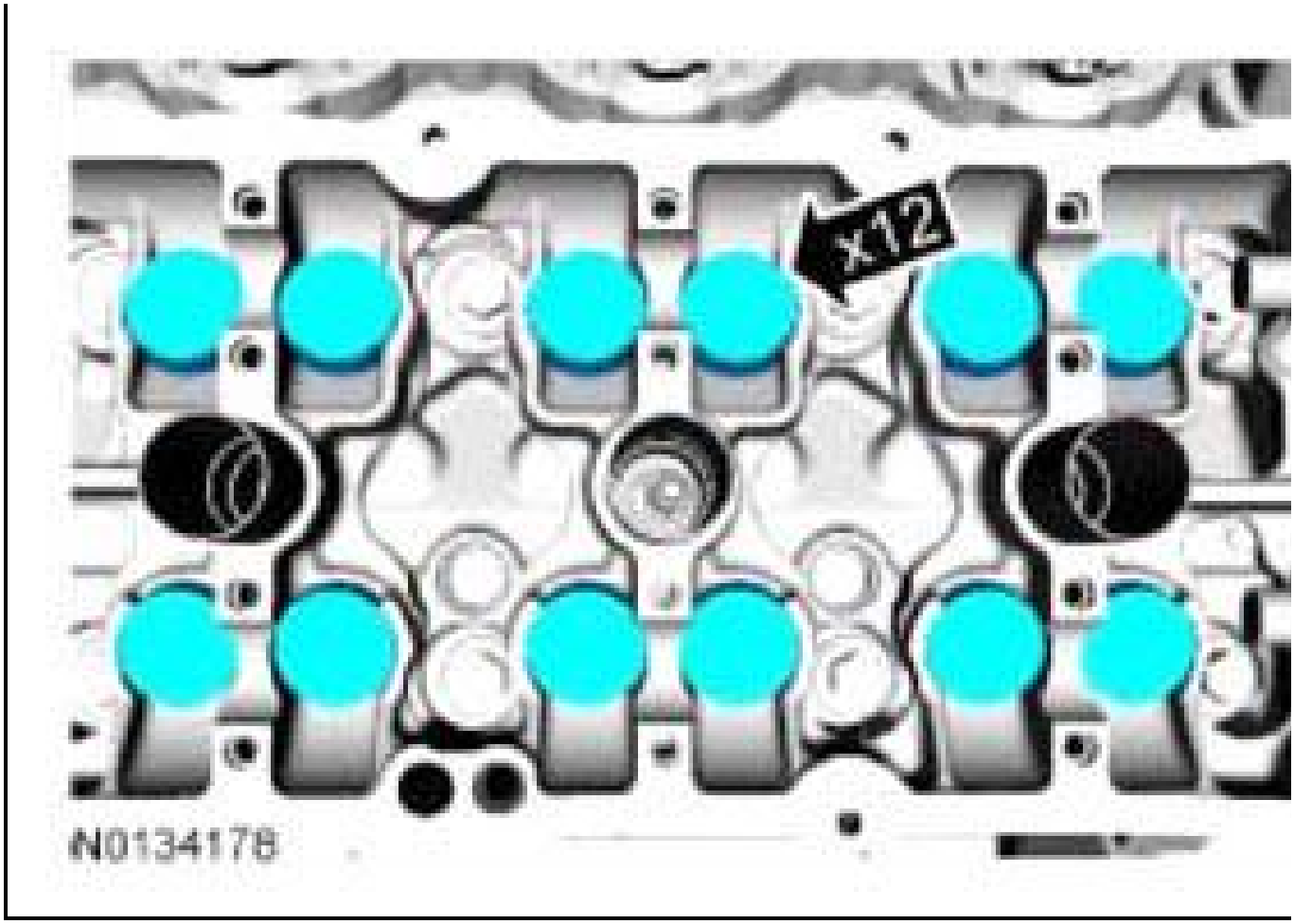
46. **NOTE: The valve tappets must be installed in their original positions.**

NOTE: Coat the valve tappets with clean engine oil prior to installation.

NOTE: LH shown in illustration, RH similar.

Install the valve tappets.

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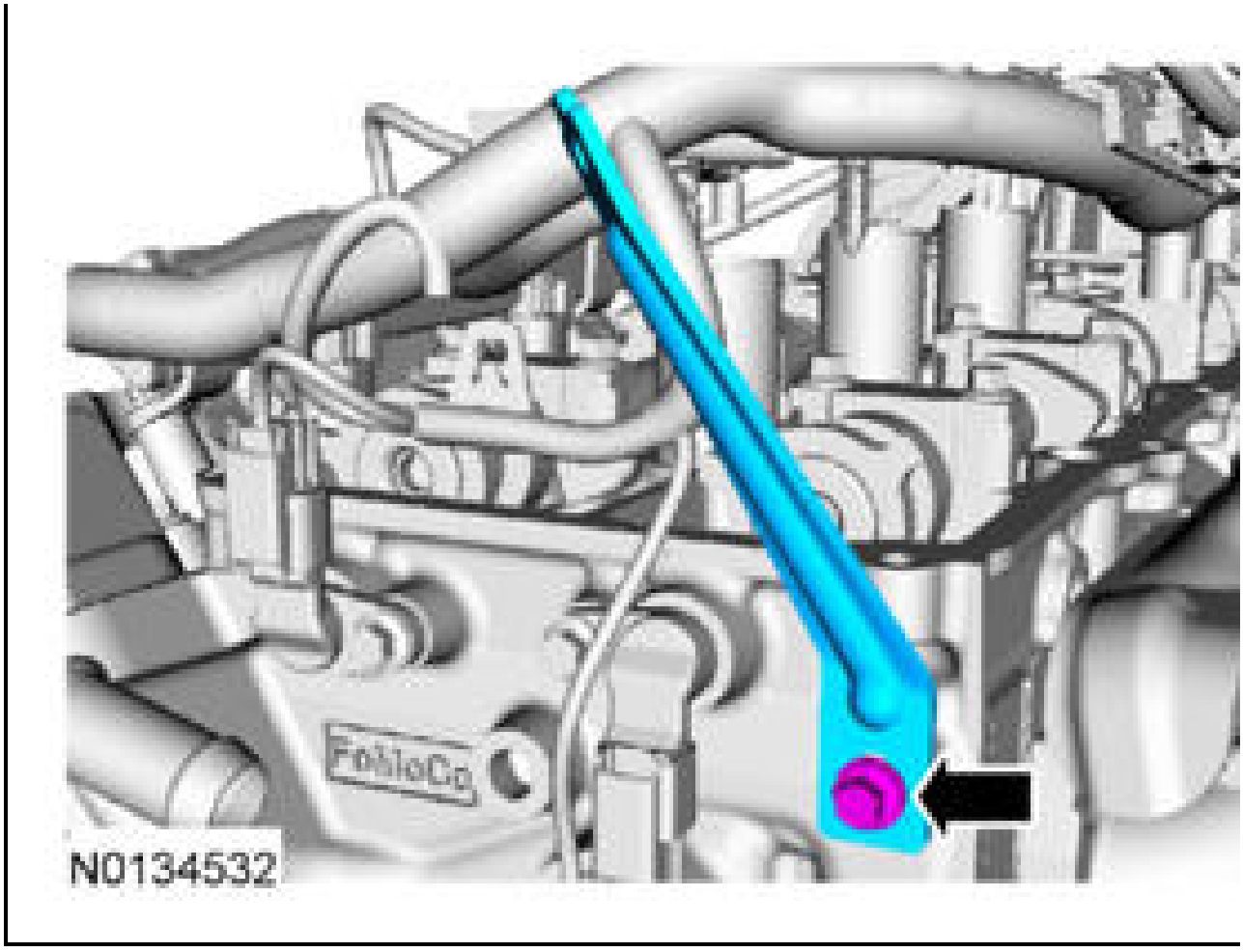


47. **NOTE: Align the bracket with the index mark made during removal.**

Install the upper intake manifold bracket and the bolt.

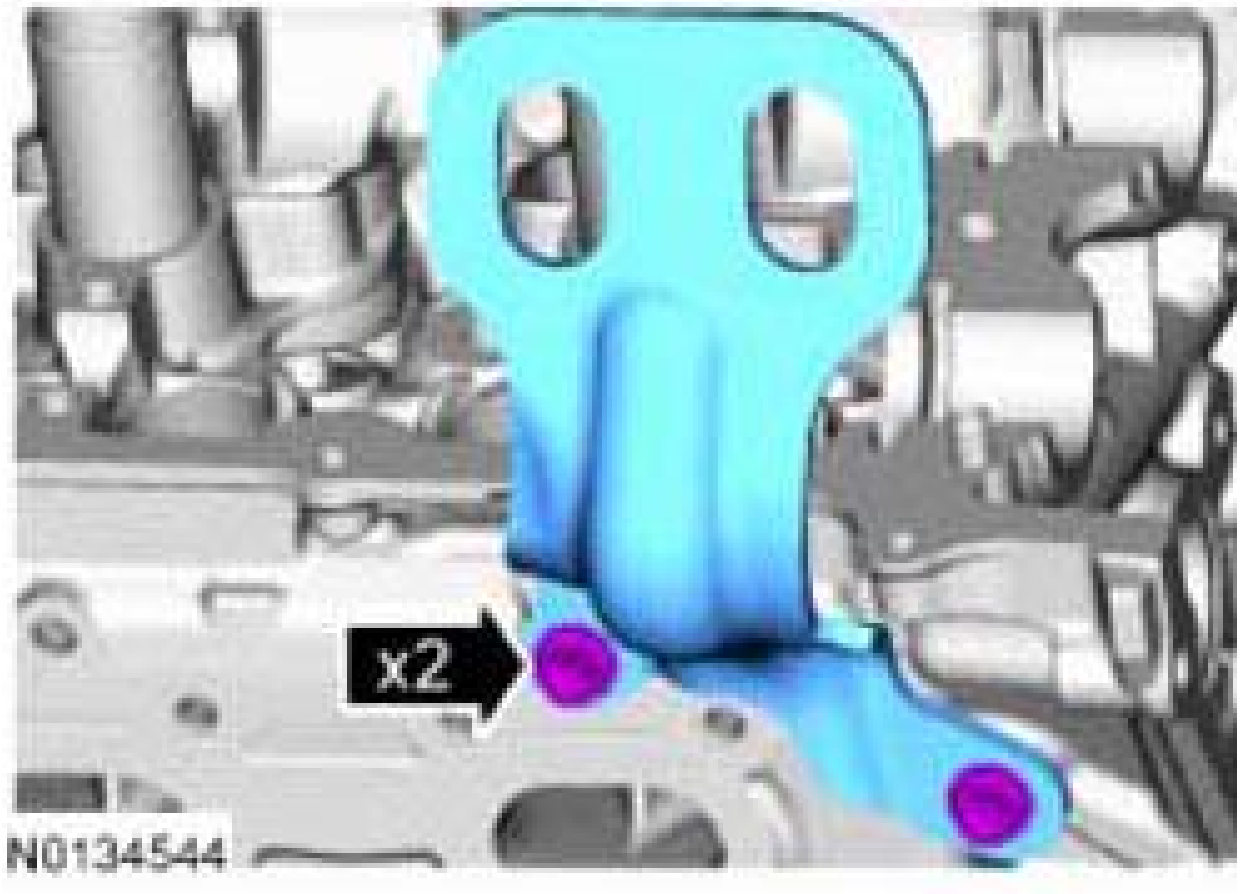
- Tighten to 10 Nm (89 lb-in).

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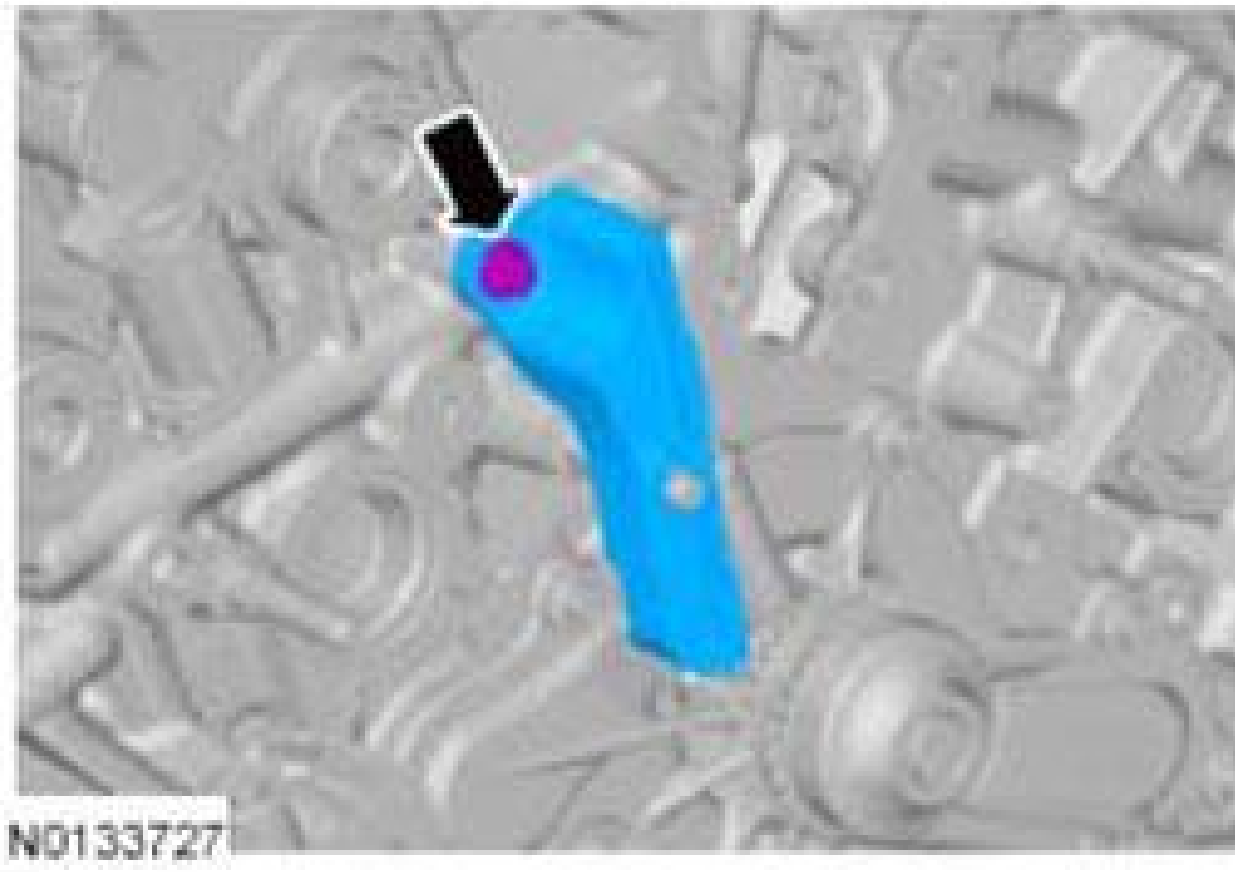
48. Install the engine lifting eye and the 2 bolts.
    - Tighten to 24 Nm (18 lb-ft).

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49. Install the RH primary timing chain guide and the bolt.
    - Tighten to 10 Nm (89 lb-in).

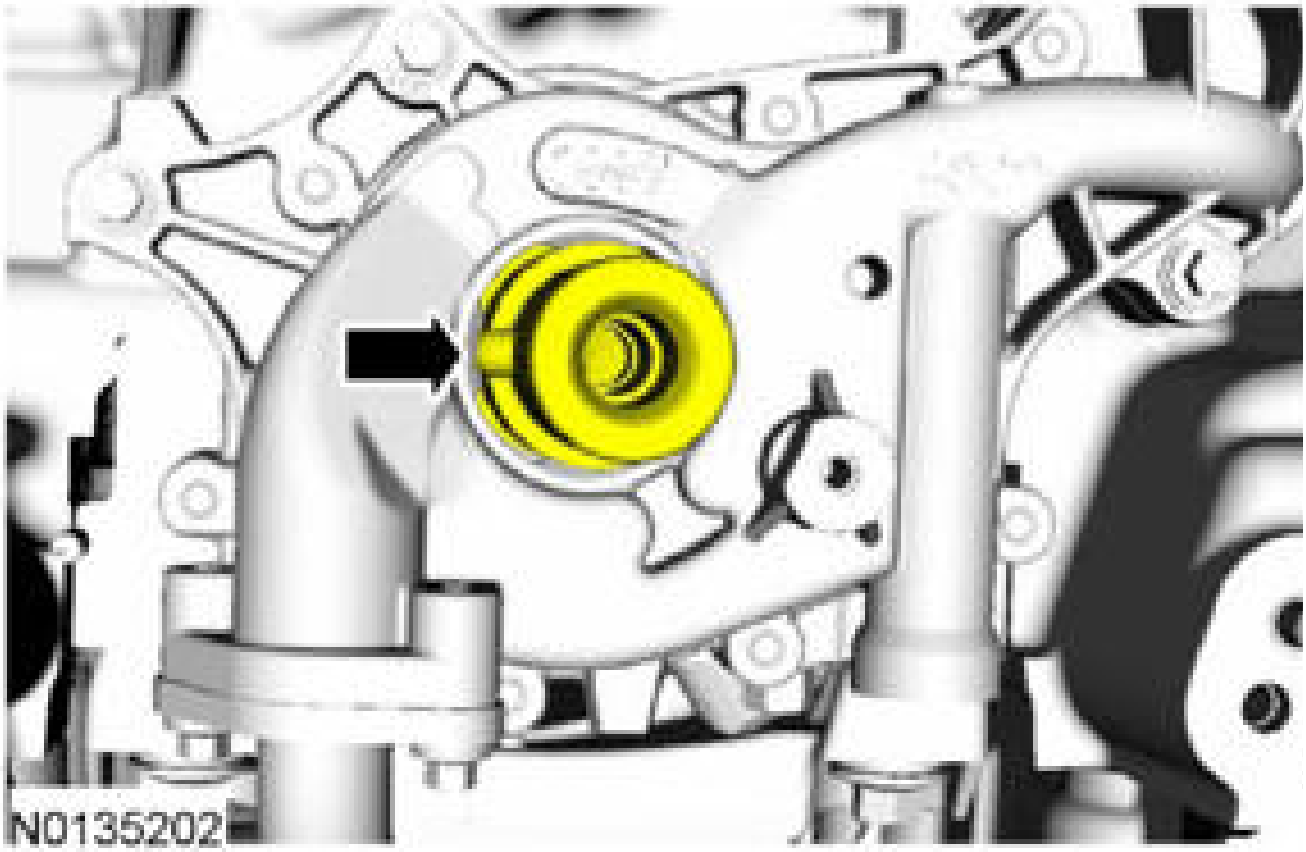
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NOTE: **The crankshaft must remain in the freewheeling position (crankshaft dowel pin at 9 o'clock) until after the camshafts are installed and the valve clearance is checked/adjusted. Do not turn the crankshaft until instructed to do so. Failure to follow this process will result in severe engine damage.**

50. Position the crankshaft dowel pin in the 9 o'clock position.

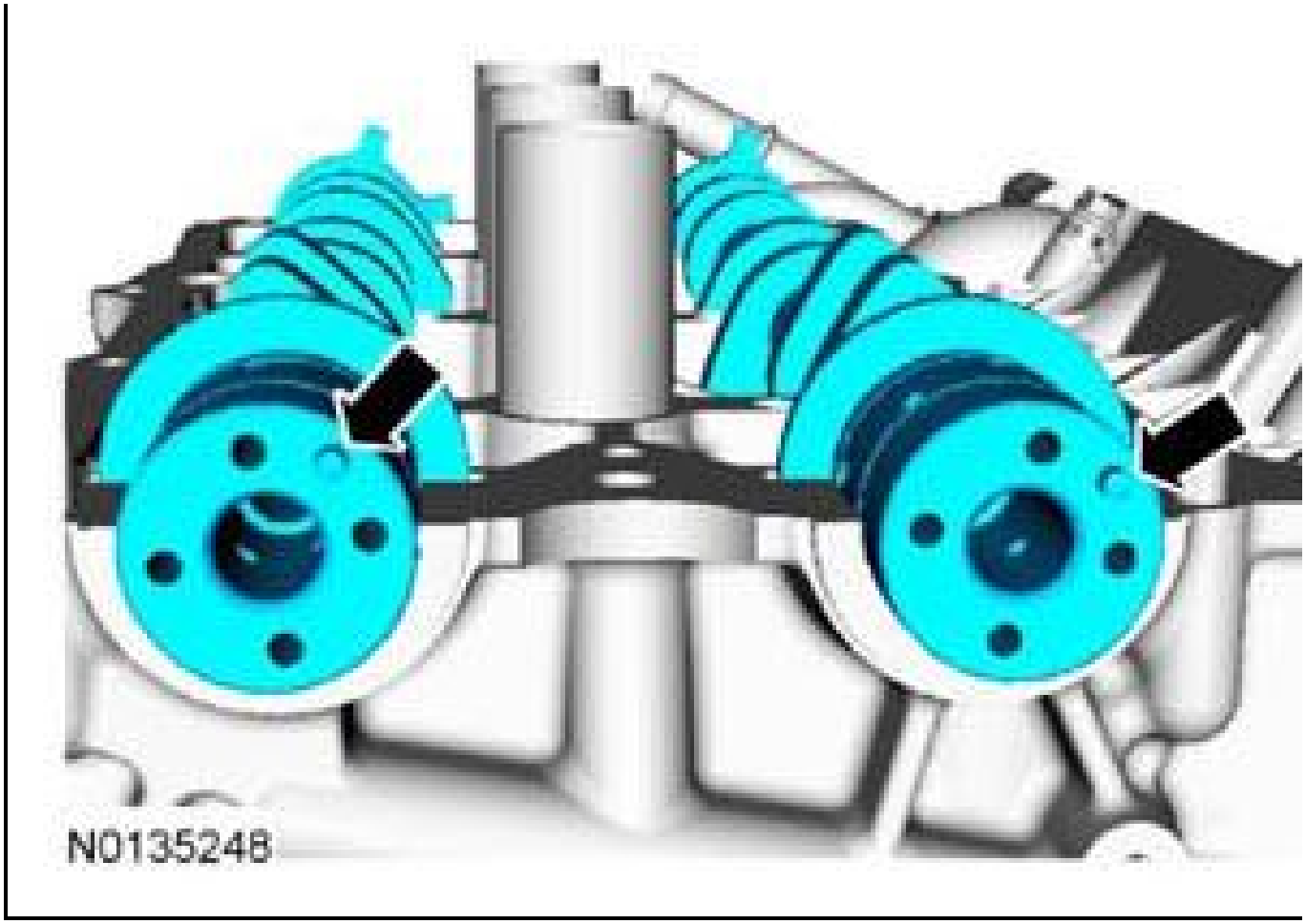
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51. **NOTE: Coat the camshafts with clean engine oil prior to installation.**

Position the camshafts onto the RH cylinder head in the neutral position as shown in illustration.

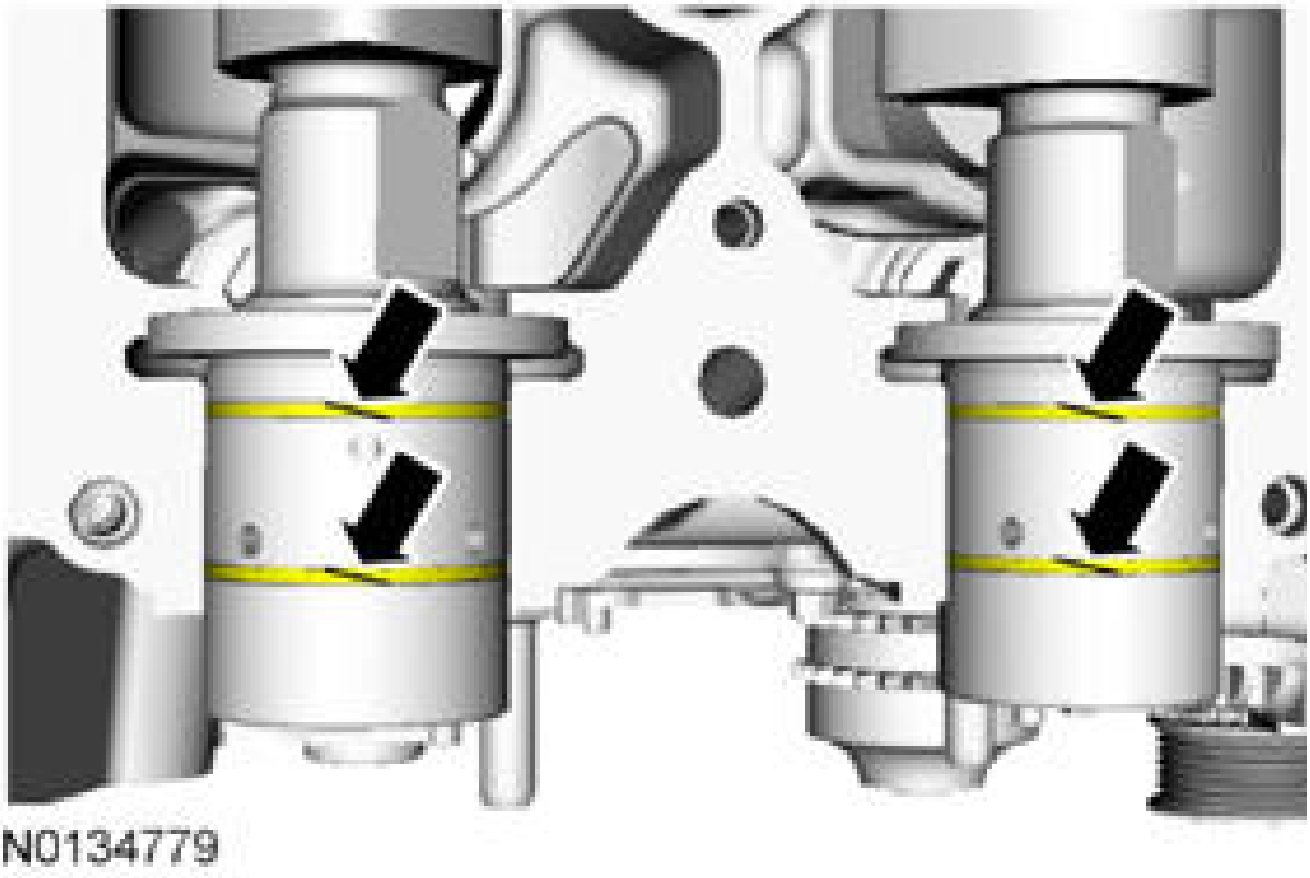
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52. **NOTE: The camshaft seal gaps must be at the 12 o'clock position or damage to the engine may occur.**

Position the 4 camshaft seals gaps as shown in illustration.

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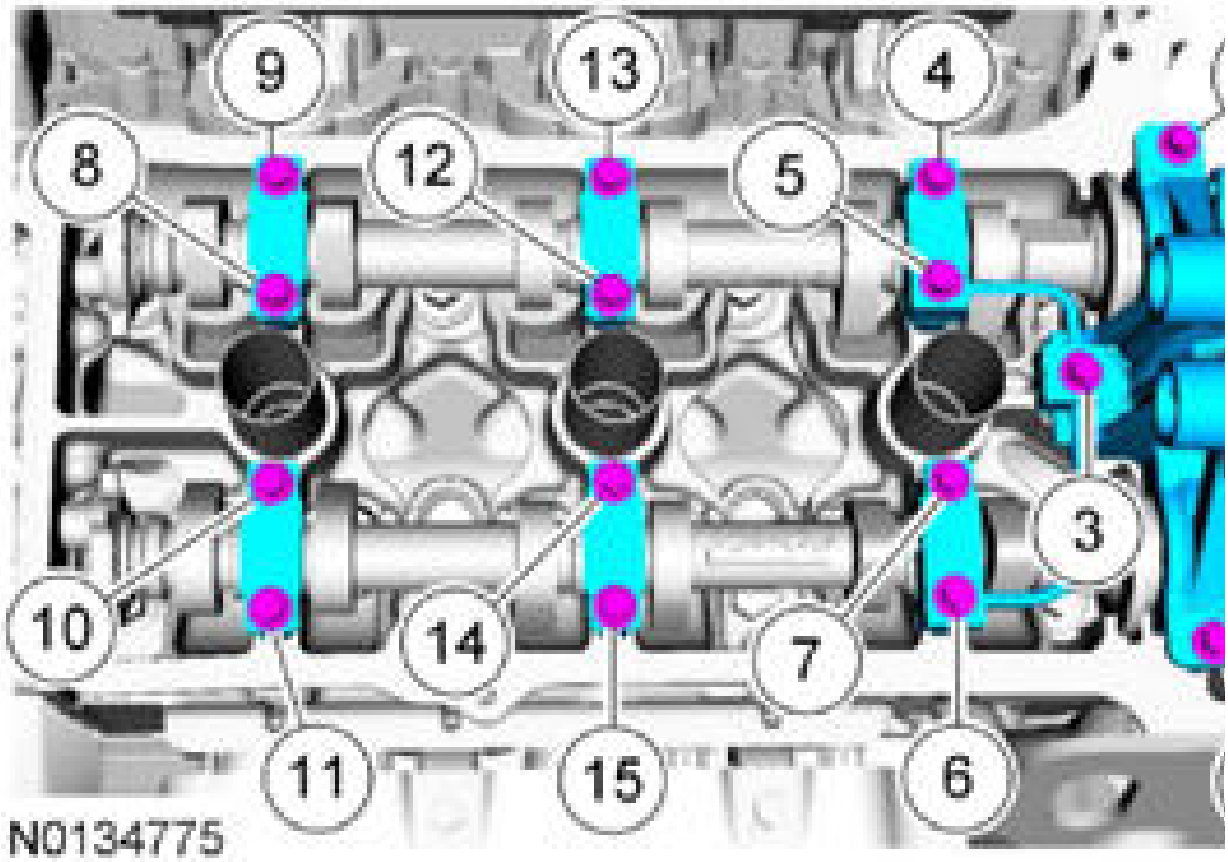


53. **NOTE: Cylinder head camshaft bearing caps are numbered to verify that they are assembled in their original positions.**

Install the 6 camshaft caps, mega cap, valve train oil tube and the 15 bolts in the sequence shown in illustration.

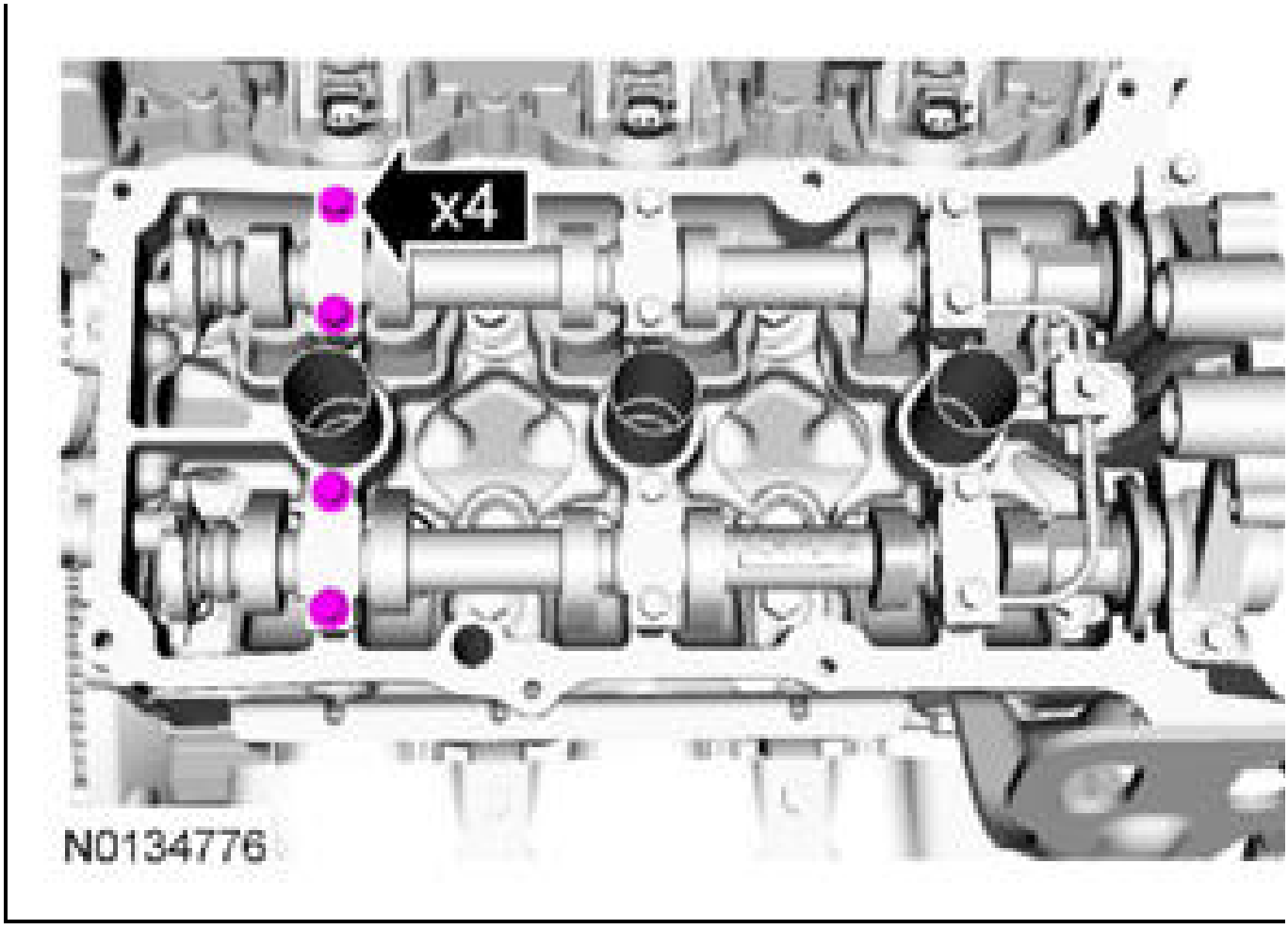
- Tighten to 8 Nm (71 lb-in) then an additional 45 degrees.

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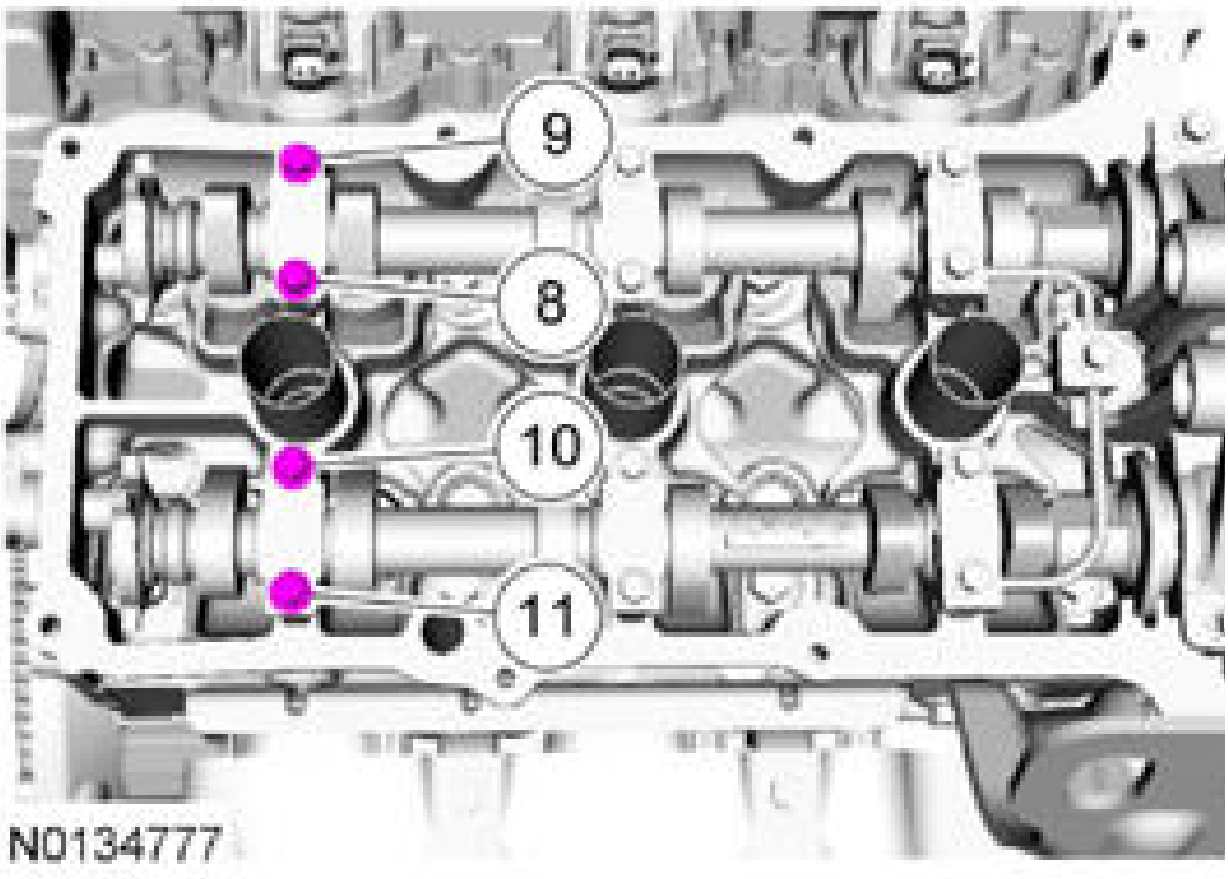
54. Loosen the 4 camshaft caps bolts.

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55. Tighten the 4 camshaft caps bolts in the sequence shown in illustration.
    - Tighten bolts 8, 9, 10 and 11 to 8 Nm (71 lb-in) then an additional 45 degrees.

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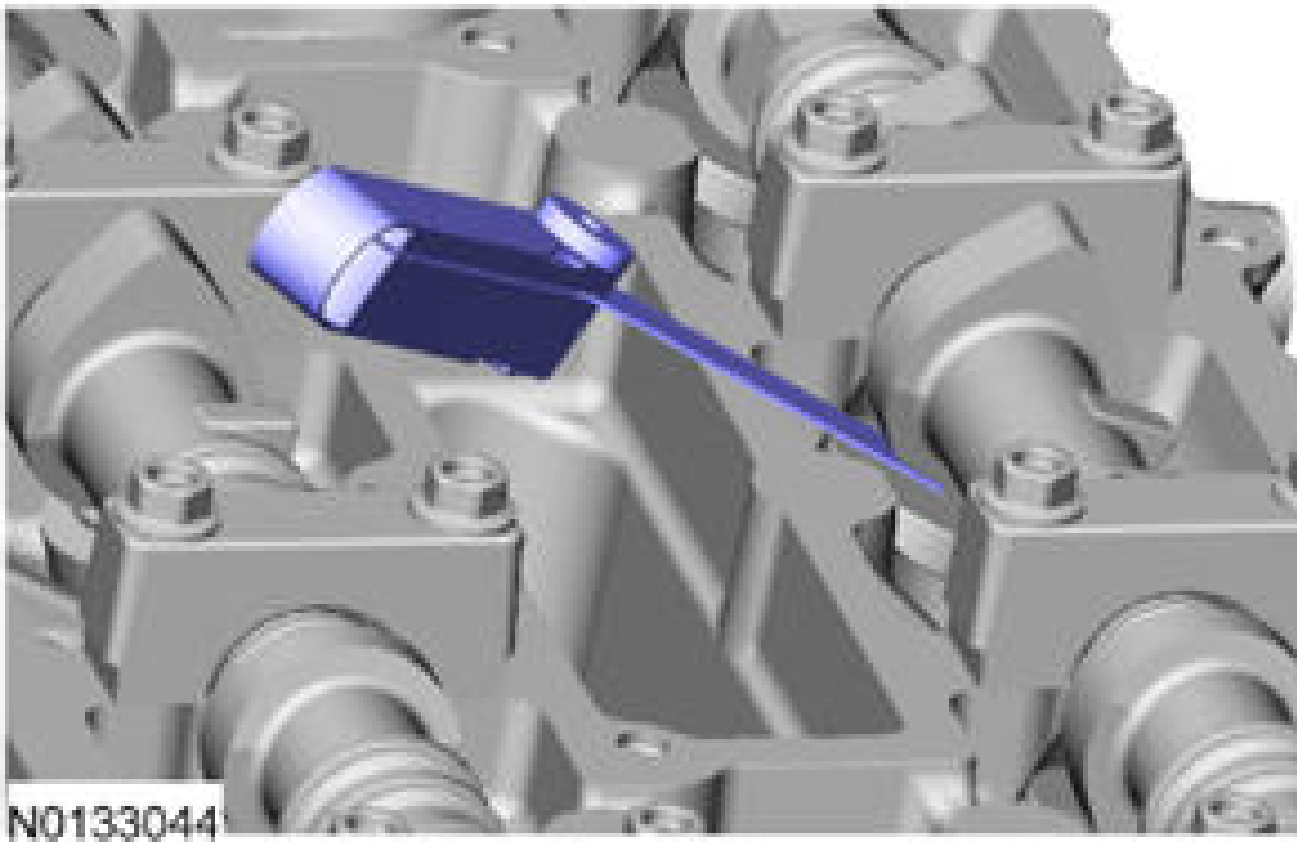
56.

NOTE: If any components are installed new, the engine valve clearance must be checked/adjusted or engine damage may occur.

NOTE: Use a camshaft sprocket bolt to turn the camshafts.

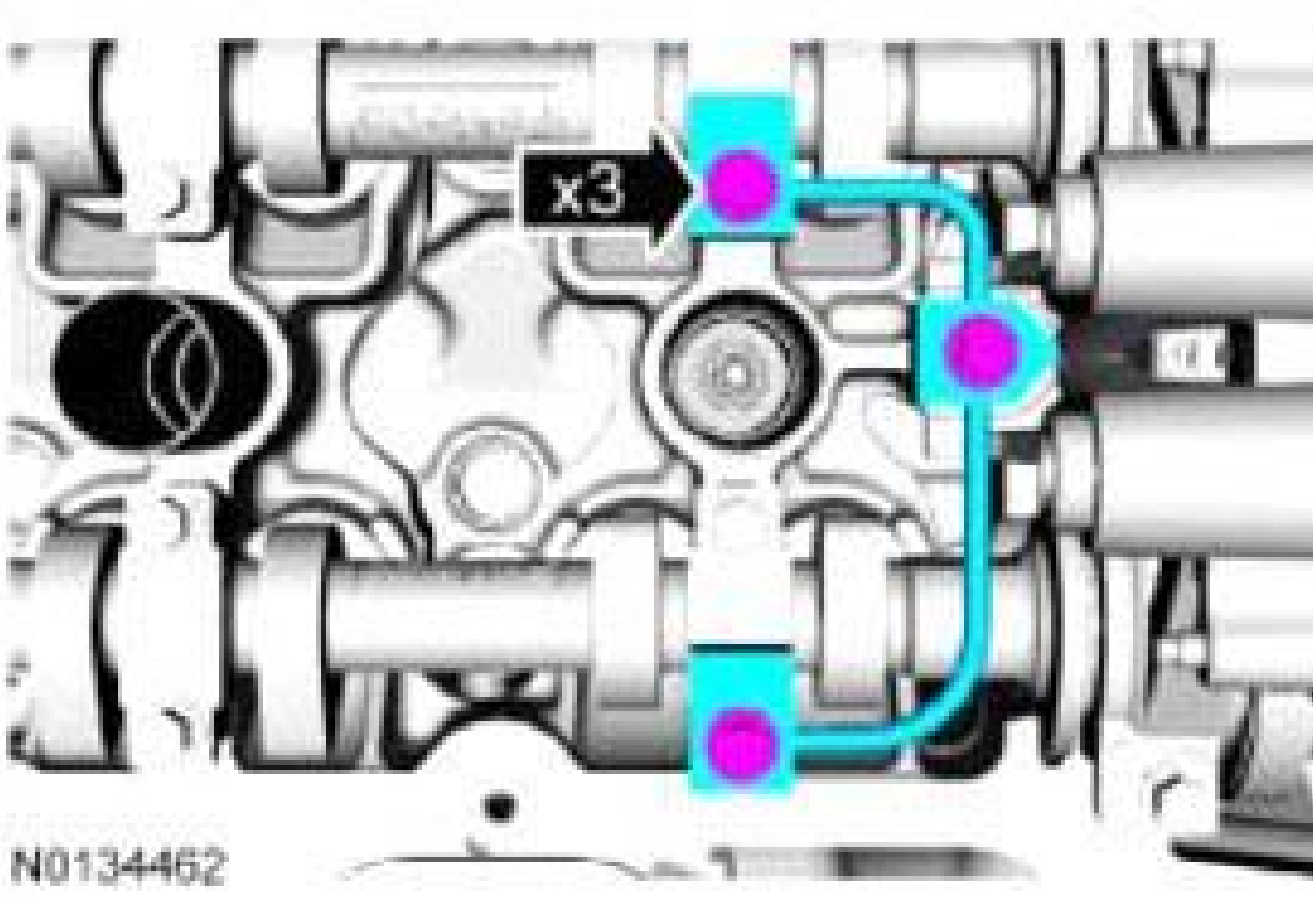
Using a feeler gauge, confirm that the valve tappet clearances are within specification. If valve tappet clearances are not within specification, the clearance must be adjusted by installing new valve tappet (s) of the correct size.

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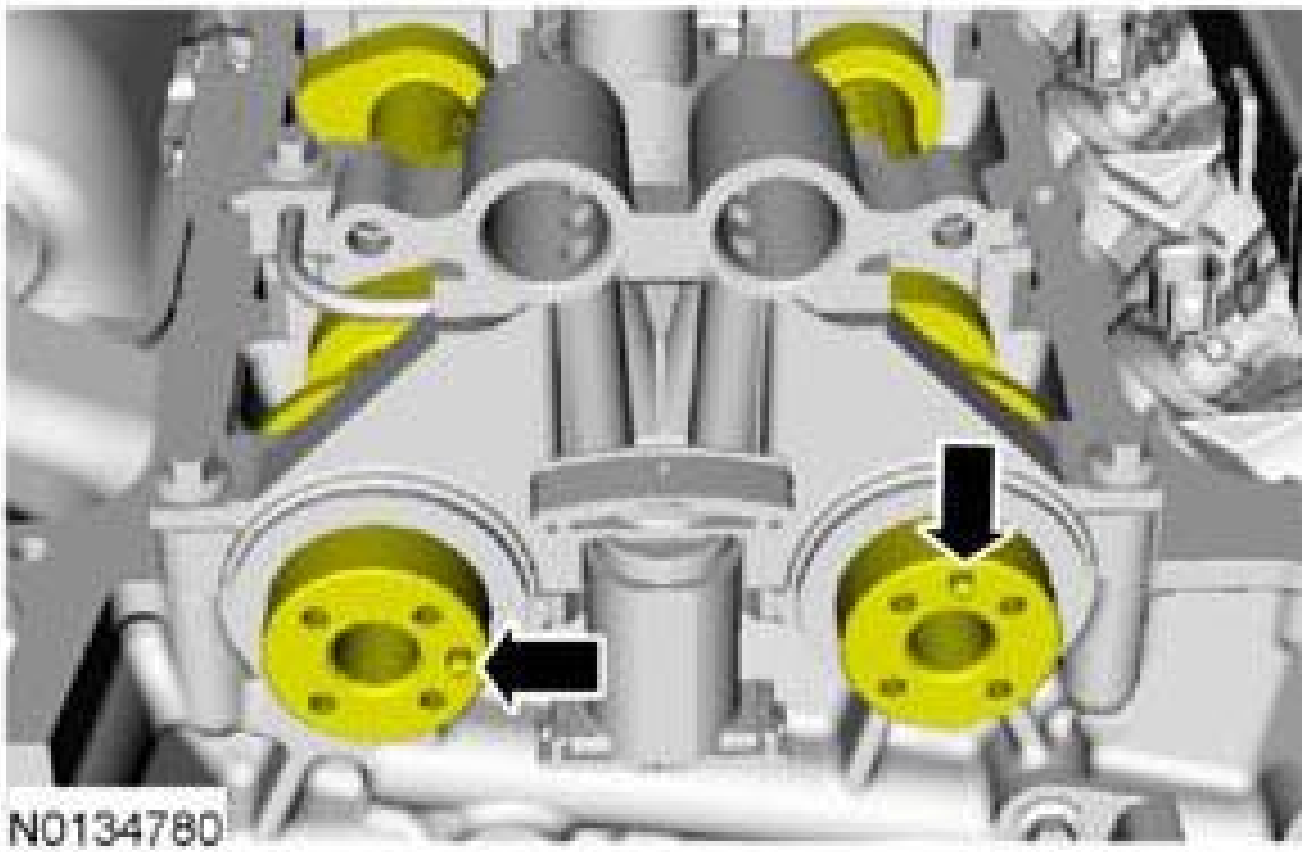
57. Remove the 3 bolts and the RH valve train oil tube.

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58. Rotate the RH camshafts to the **TDC** position as shown in illustration.

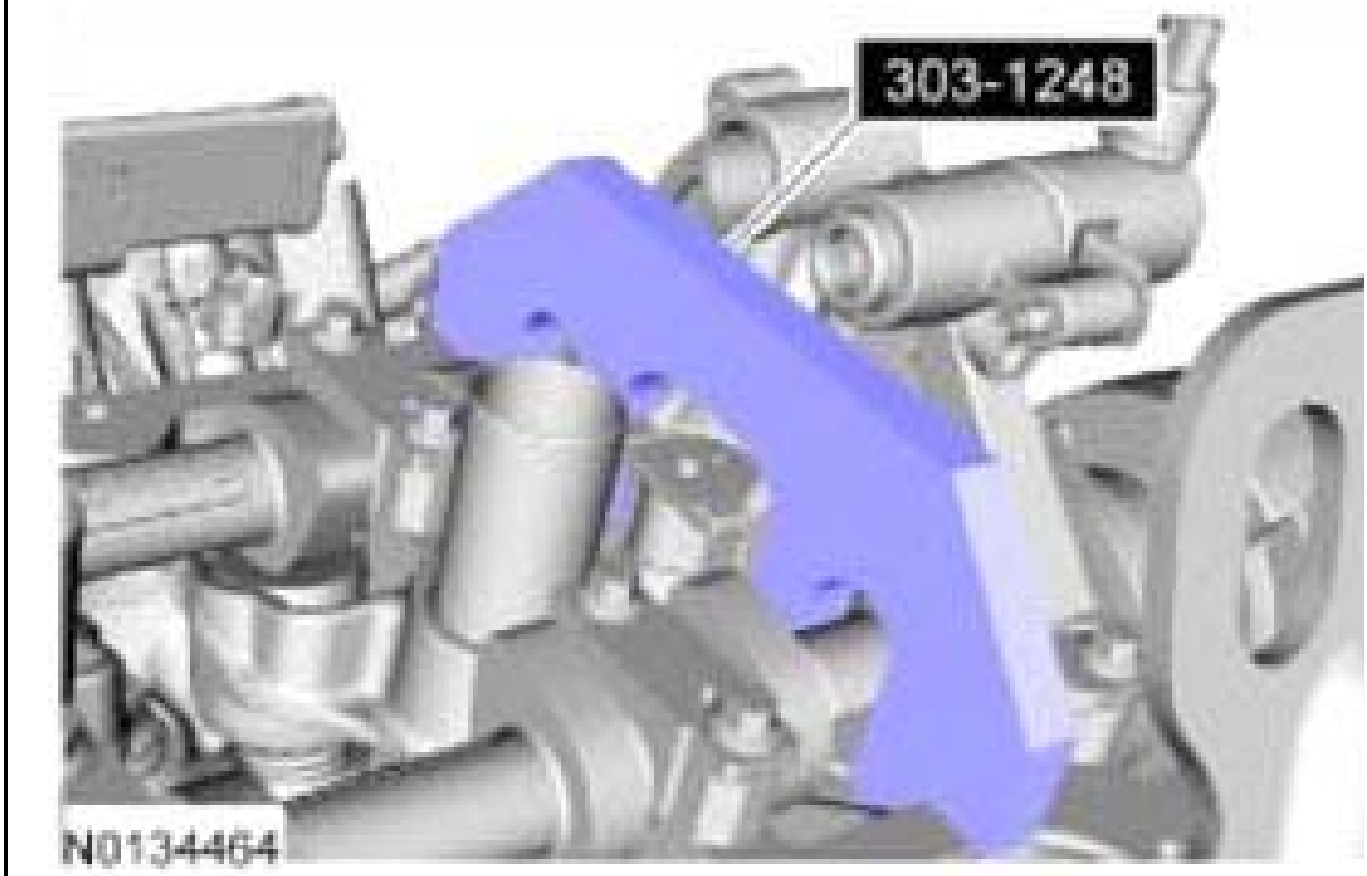
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59. **NOTE: The 303-1248 will hold the camshafts in the TDC position.**

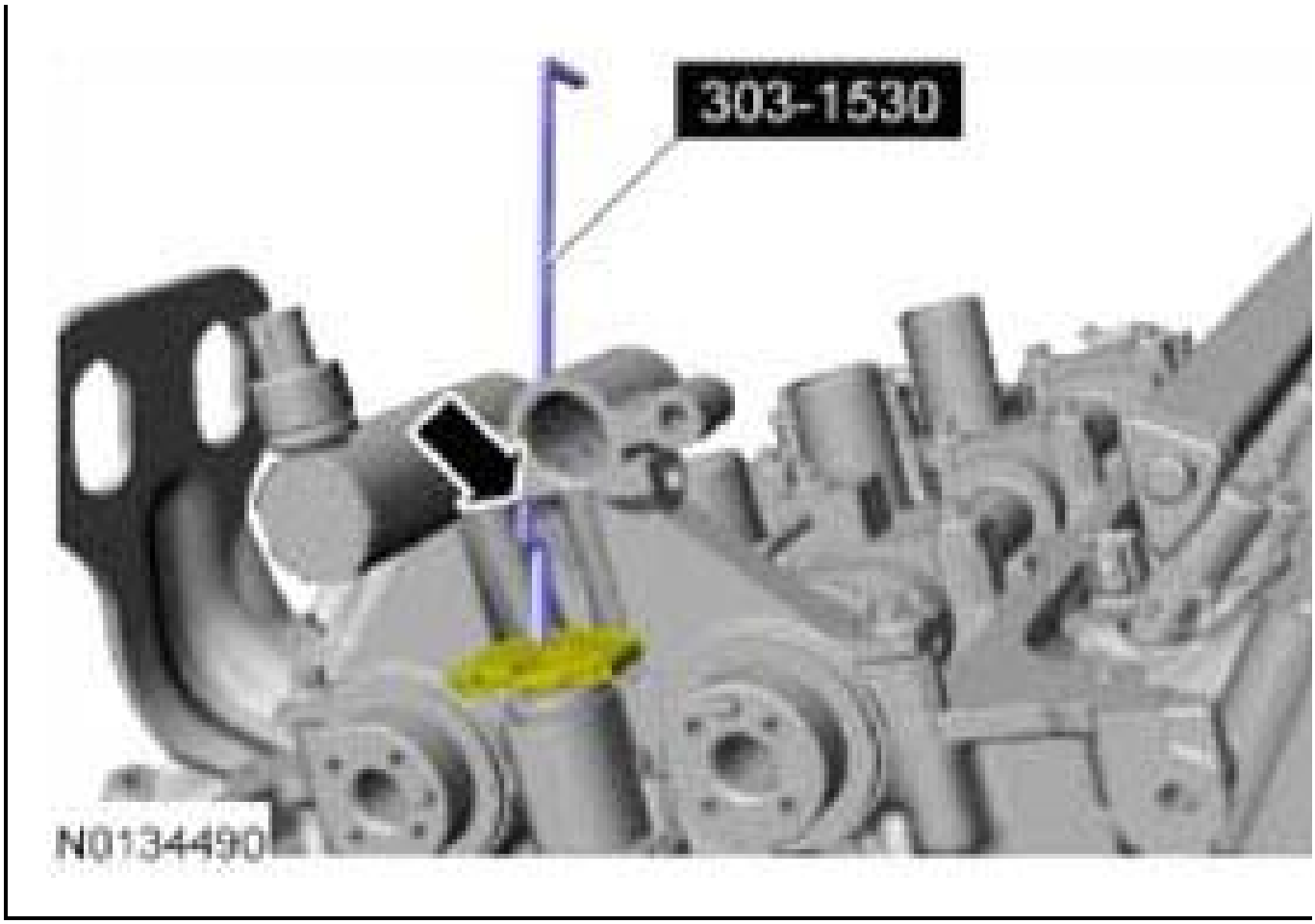
Install 303-1248 onto the flats of the RH camshafts.

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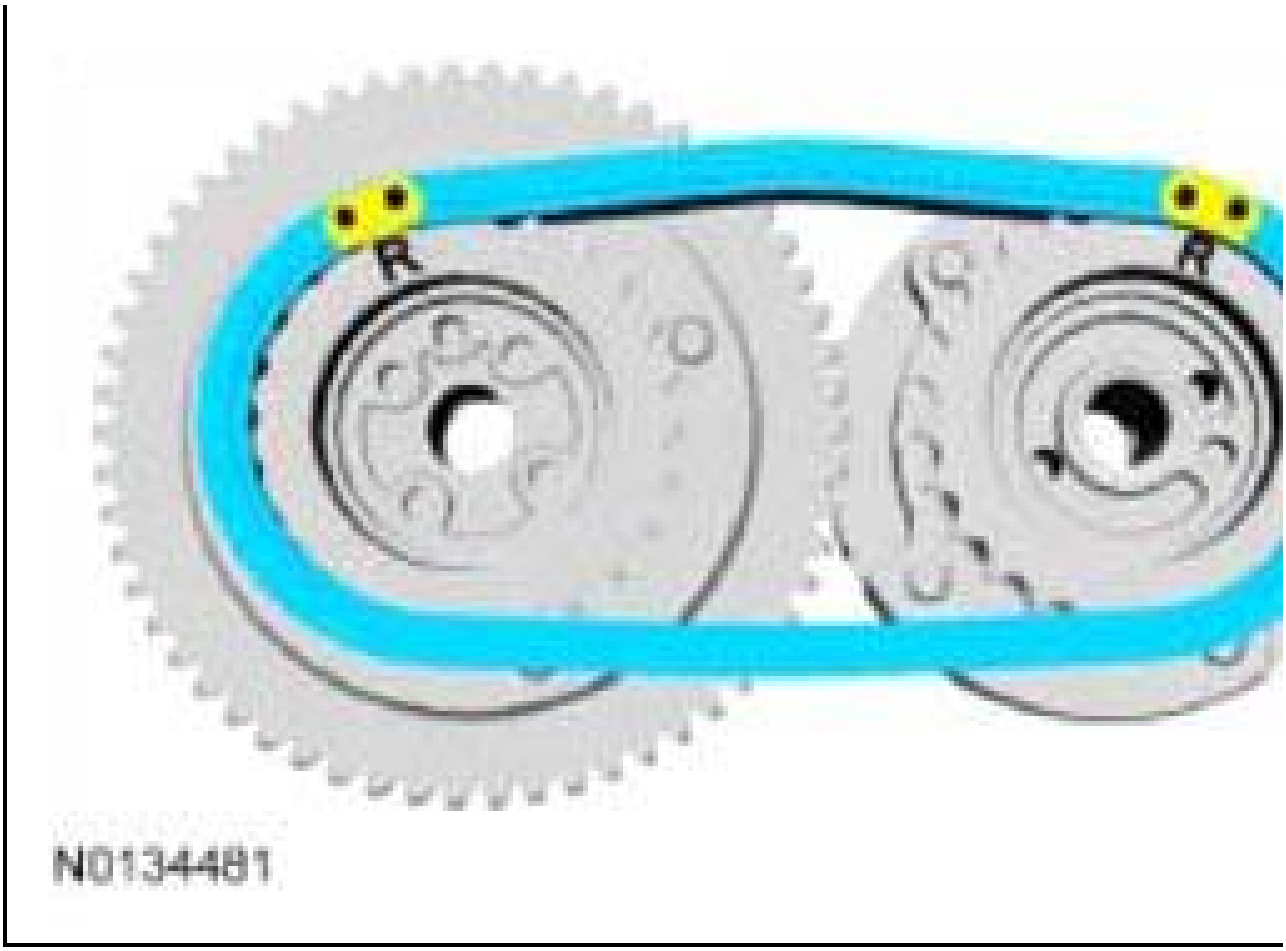
60. Compress the RH secondary timing chain tensioner and install 303-1530 to retain the tensioner in the collapsed position.

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61. Assemble the RH **VCT** assembly, the RH exhaust camshaft sprocket and the RH secondary timing chain.
    - Align the colored links with the timing marks.

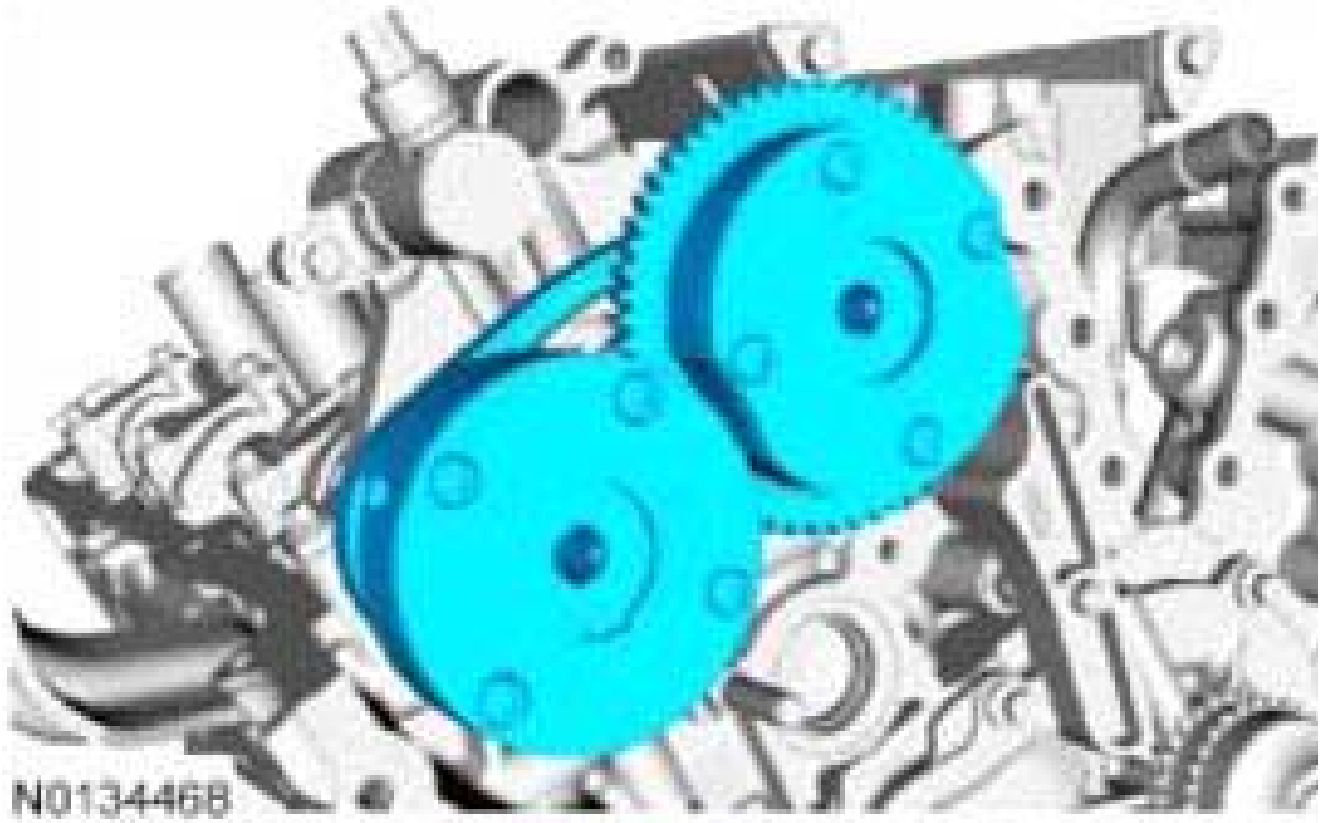
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62. **NOTE: It may be necessary to rotate the camshafts slightly, to install the RH secondary timing assembly.**

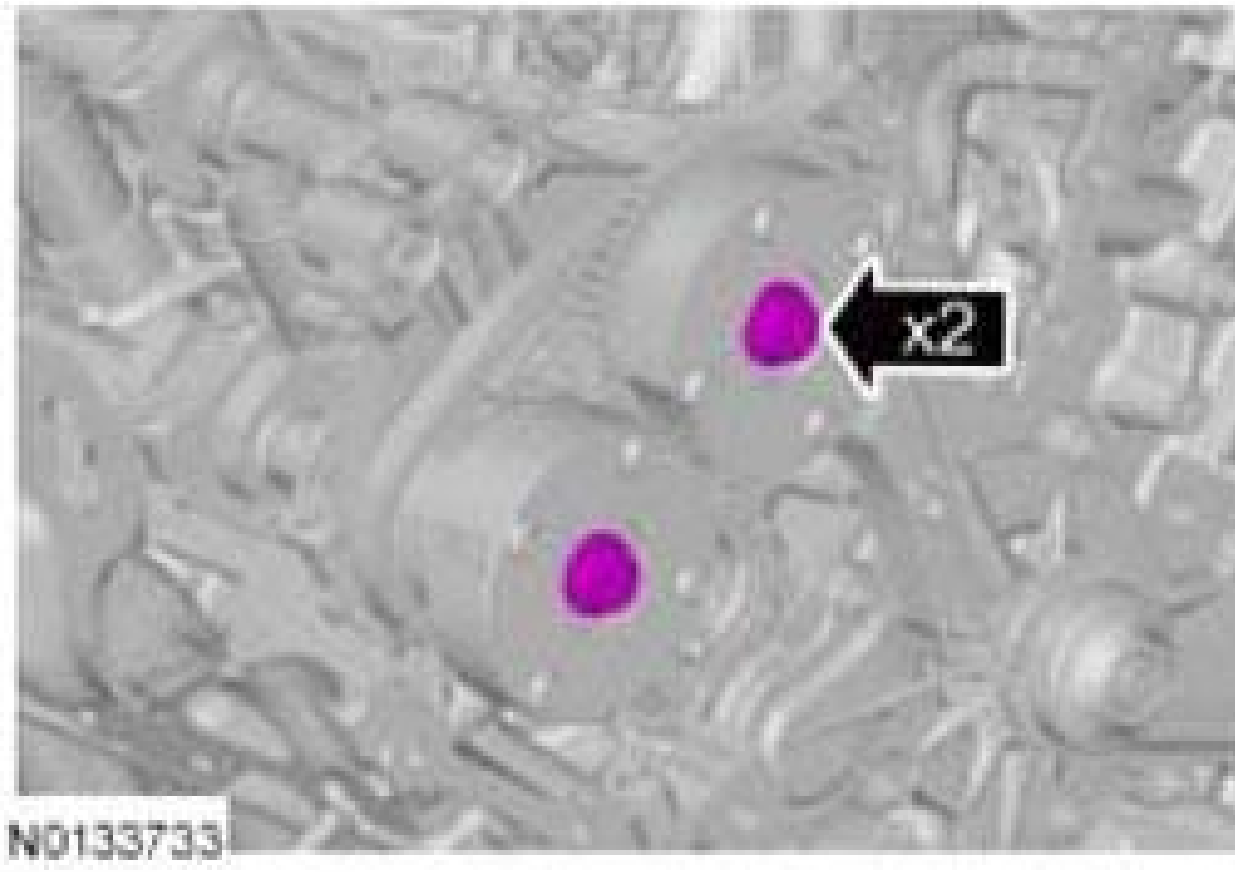
Position the 2 RH **VCT** assemblies and secondary timing chain onto the camshafts by aligning the holes in the **VCT** assemblies with the dowel pins in the camshafts.

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63. Install the 2 new RH **VCT** bolts and tighten in 4 stages.
    - Stage 1: Tighten to 40 Nm (30 lb-ft).
    - Stage 2: Loosen one full turn.
    - Stage 3: Tighten 25 Nm (18 lb-ft).
    - Stage 4: Tighten an additional 180 degrees.

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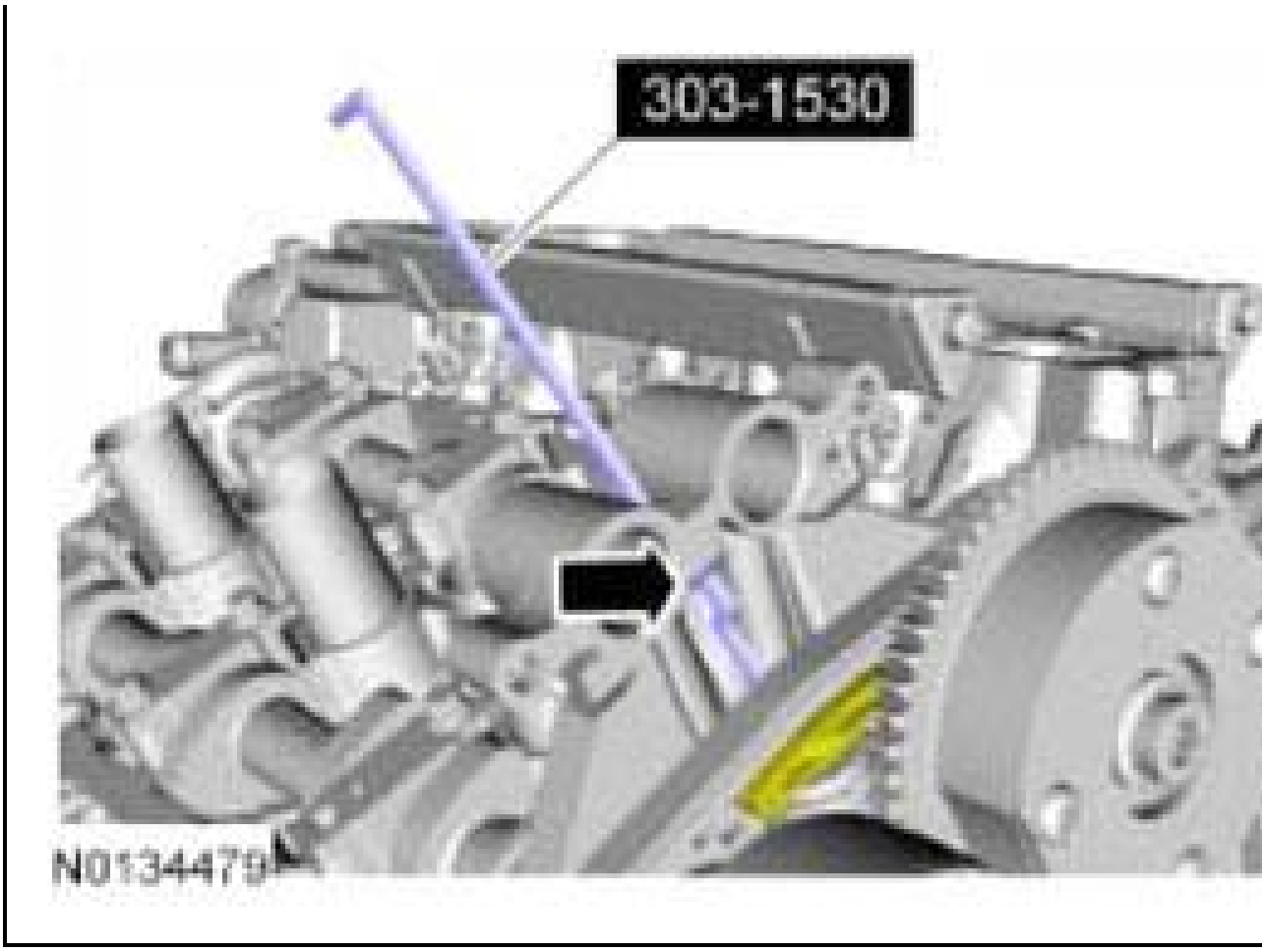


64. **NOTE: The 2 VCT oil control solenoids are removed for clarity.**

Compress the RH secondary timing chain tensioner and remove the Secondary Chain Hold Down.

- Make sure the secondary timing chain is centered on the timing chain tensioner guides.

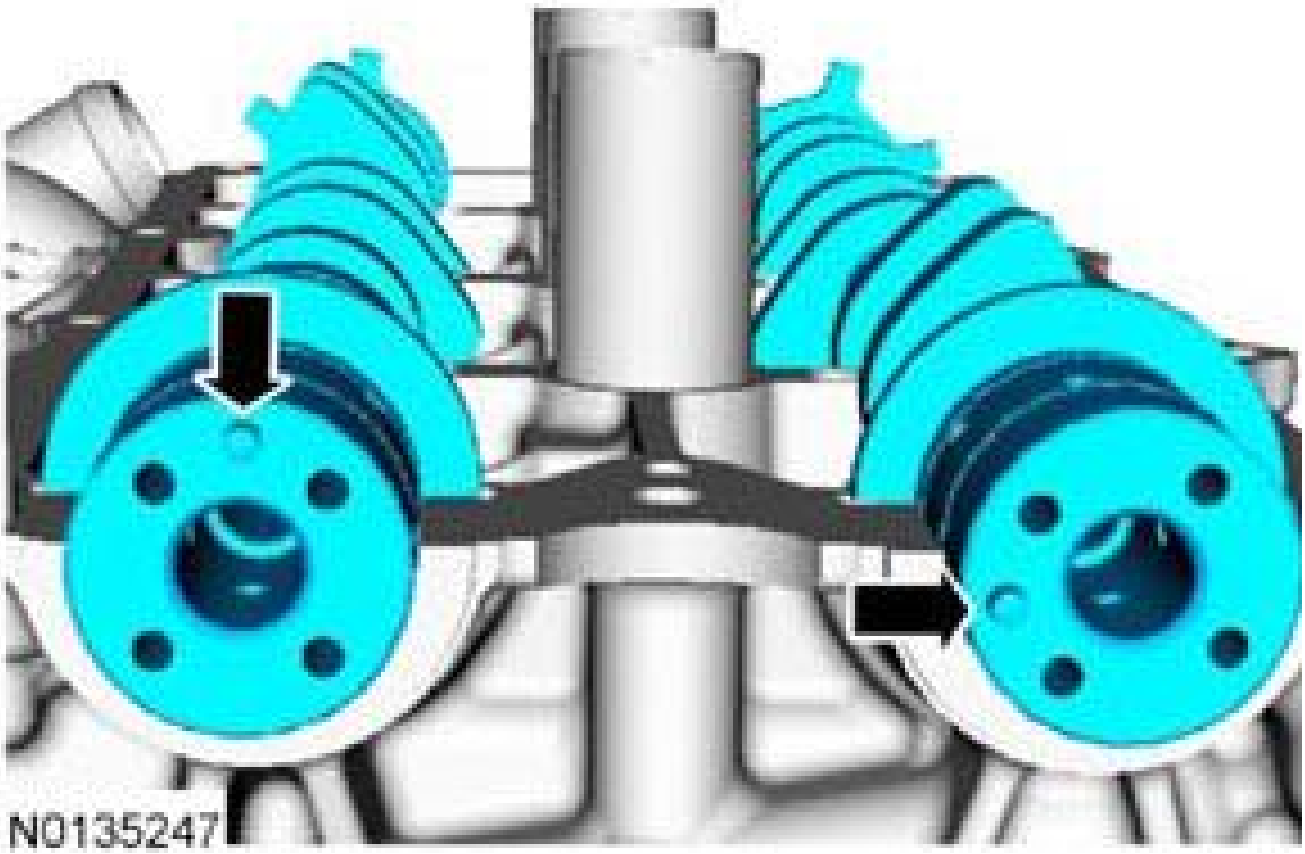
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65. **NOTE: Coat the camshafts with clean engine oil prior to installation.**

Position the camshafts onto the LH cylinder head in the neutral position as shown in illustration.

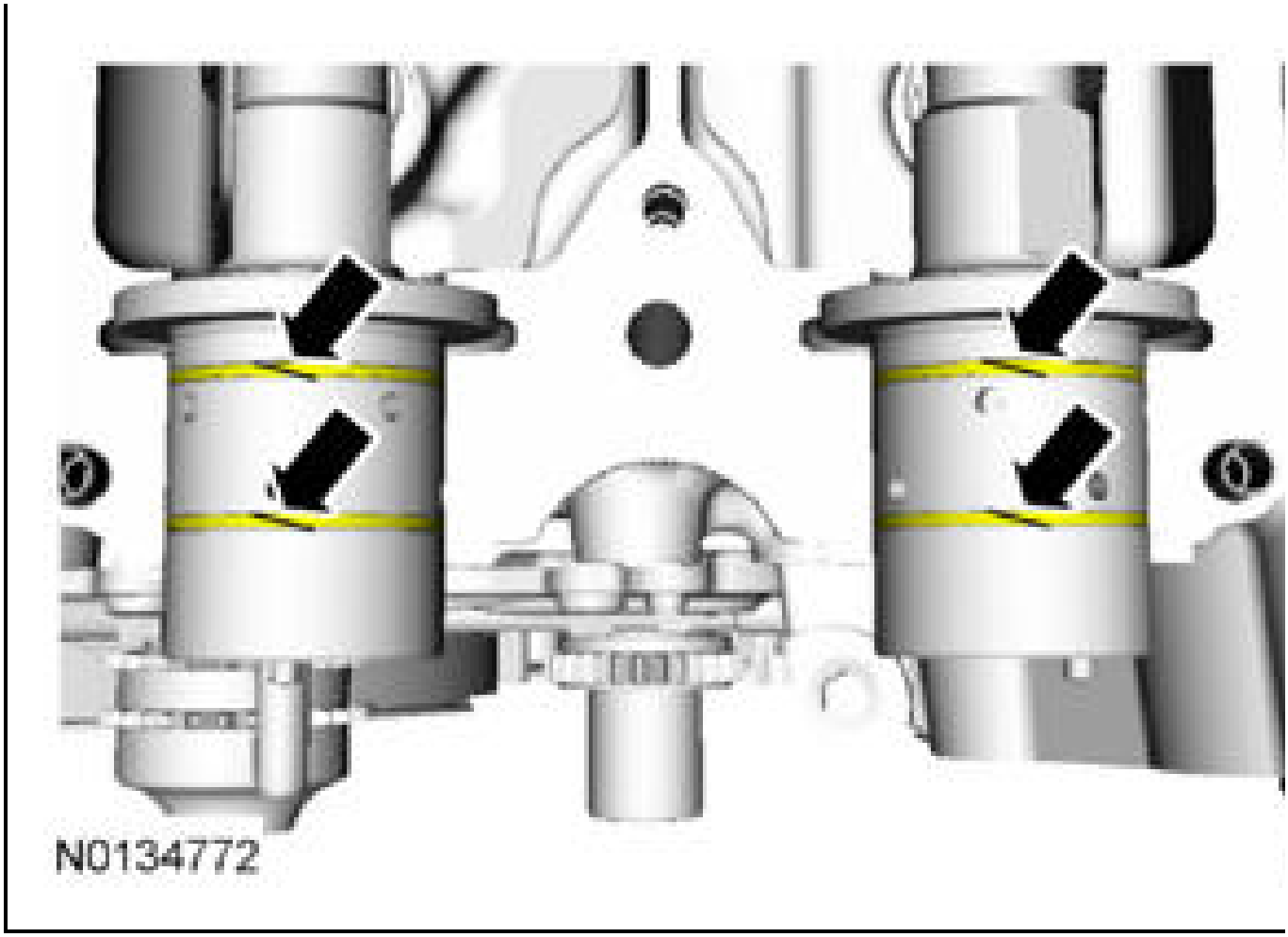
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66. **NOTE: The camshaft seal gaps must be at the 12 o'clock position or damage to the engine may occur.**

Position the 4 camshaft seals gaps as shown in illustration.

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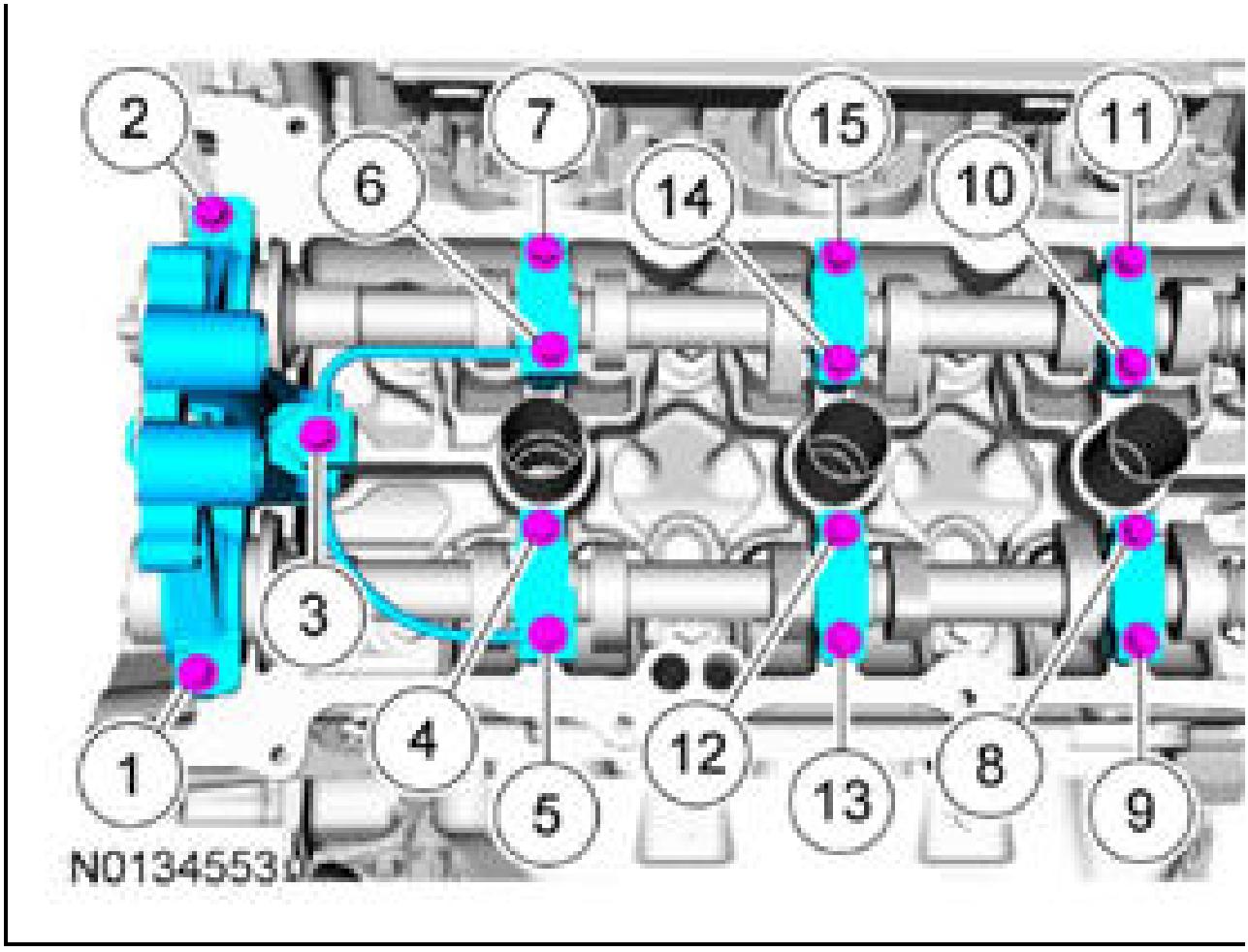


67. **NOTE: Cylinder head camshaft bearing caps are numbered to verify that they are assembled in their original positions.**

Install the 6 camshaft caps, mega cap, valve train oil tube and the 15 bolts in the sequence shown in illustration.

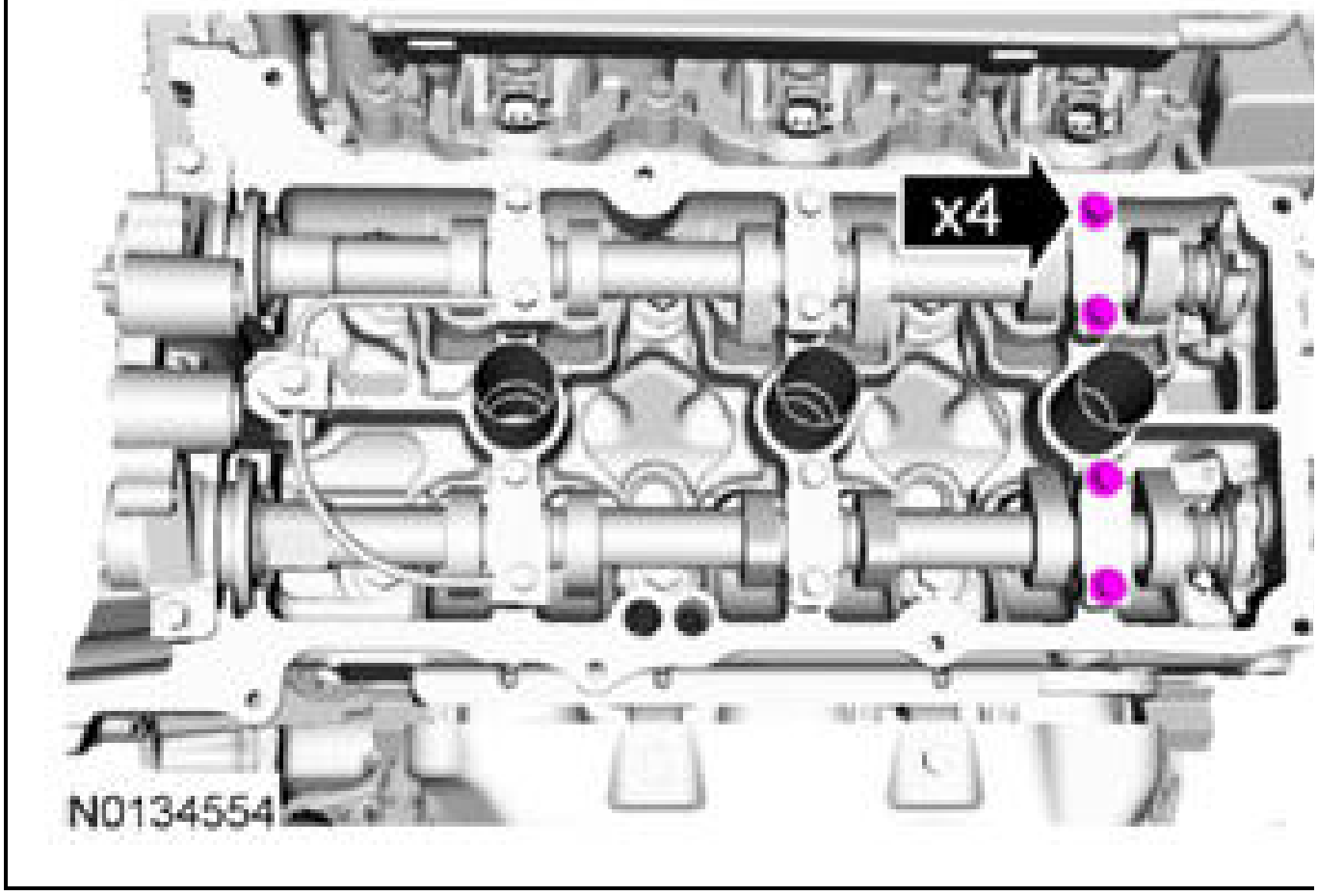
- Tighten to 8 Nm (71 lb-in).

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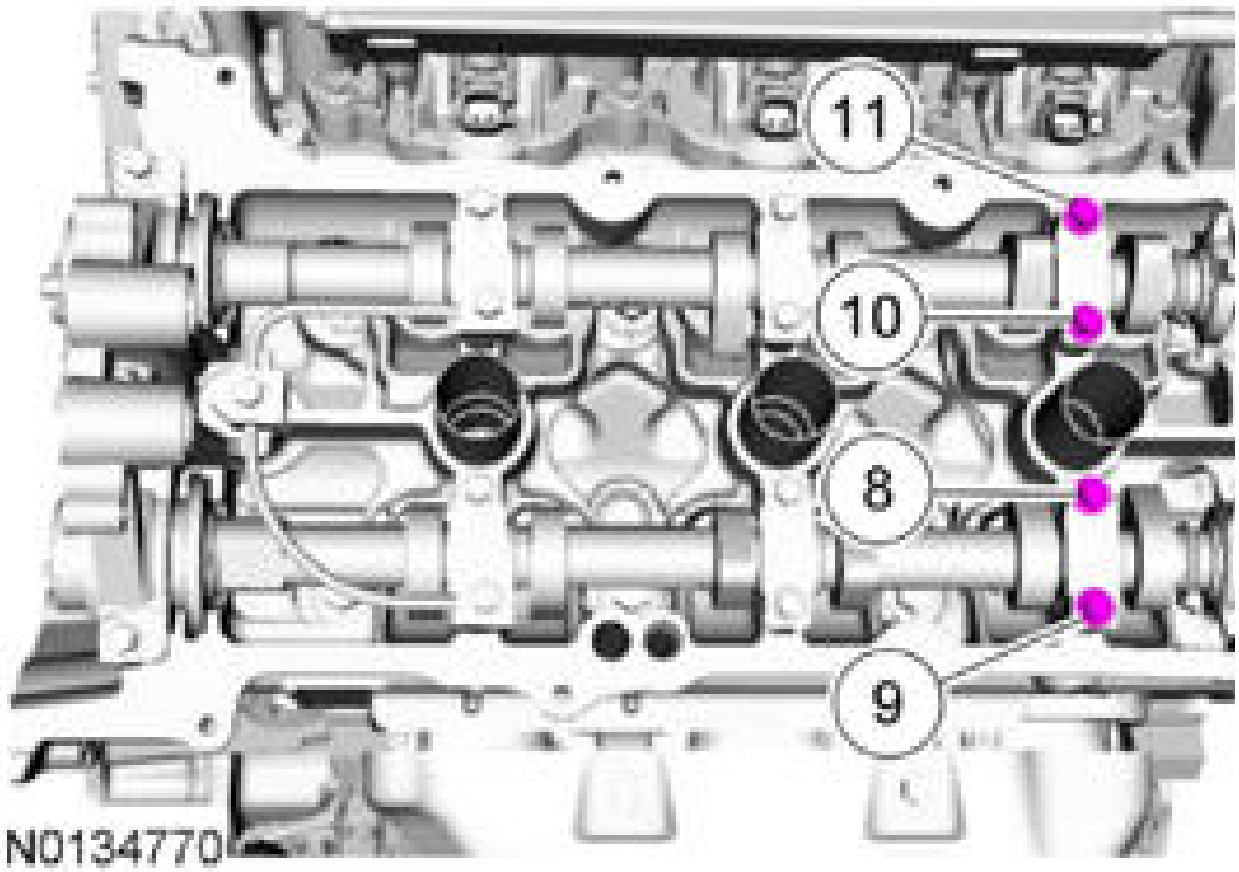
68. Loosen the 4 camshaft caps bolts.

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69. Tighten the 4 camshaft caps bolts in the sequence shown in illustration.
    - Tighten bolts 8, 9, 10 and 11 to 8 Nm (71 lb-in) then an additional 45 degrees.

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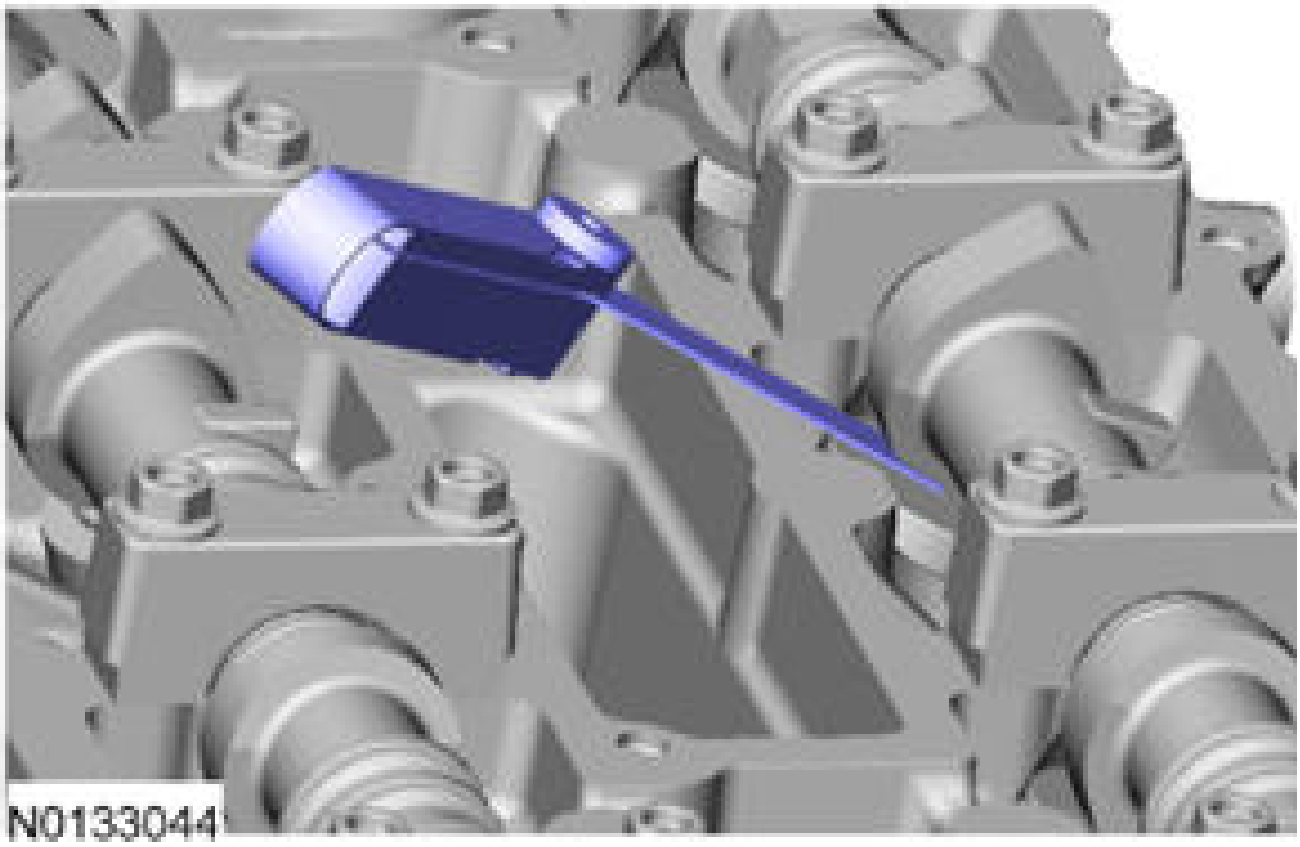
70.

NOTE: If any components are installed new, the engine valve clearance must be checked/adjusted or engine damage may occur.

NOTE: Use a camshaft sprocket bolt to turn the camshafts.

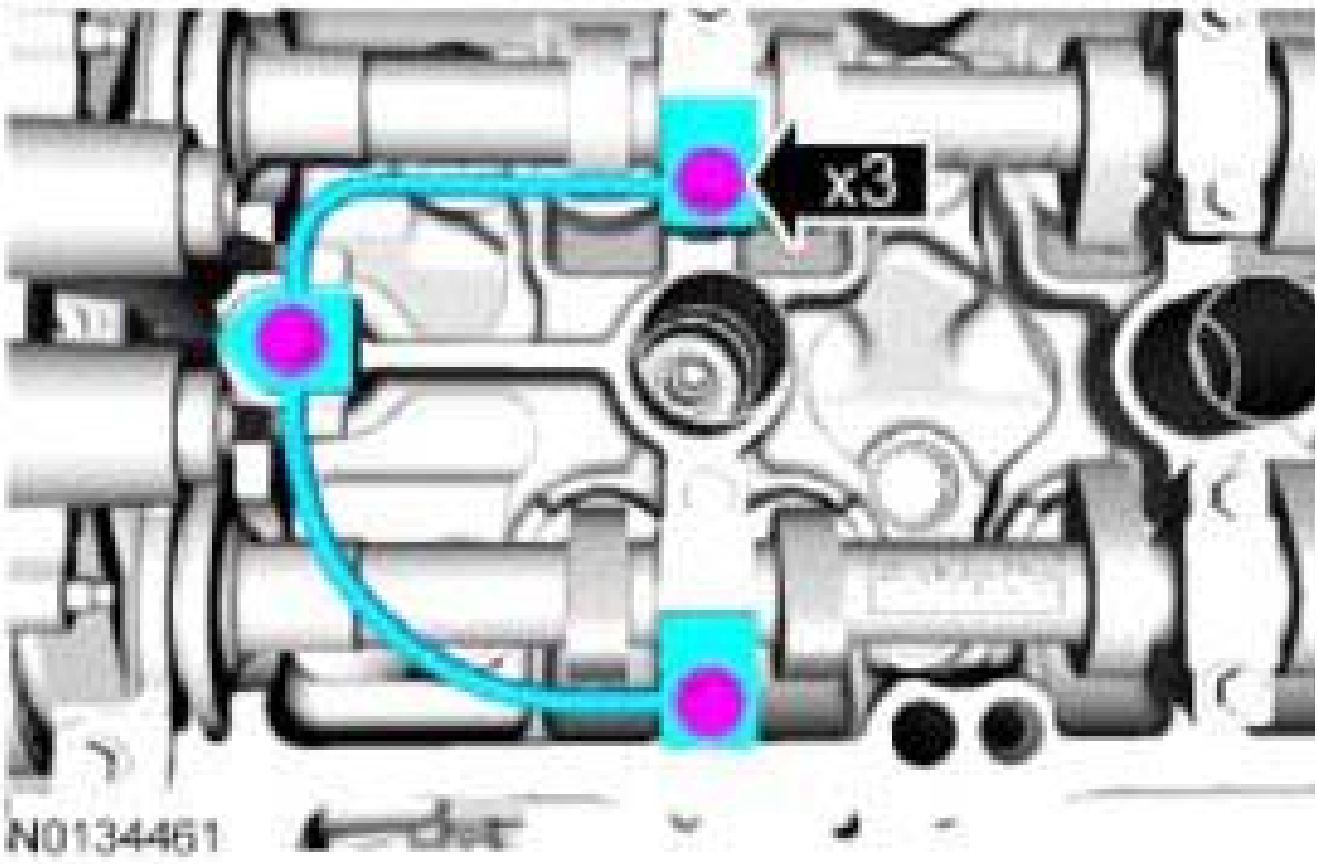
Using a feeler gauge, confirm that the valve tappet clearances are within specification. If valve tappet clearances are not within specification, the clearance must be adjusted by installing new valve tappet (s) of the correct size.

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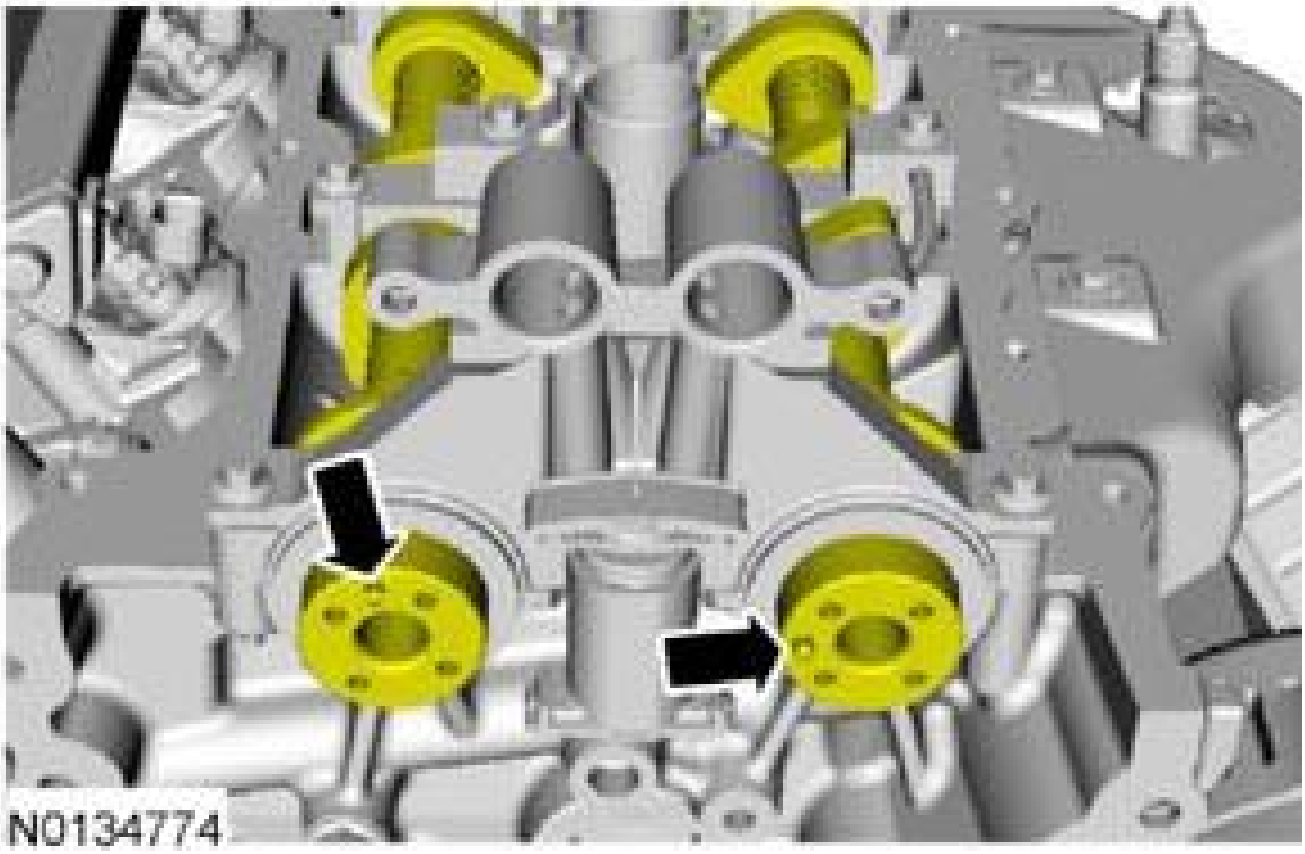
71. Remove the 3 bolts and the LH valve train oil tube.

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72. Rotate the LH camshafts to the **TDC** position as shown in illustration.

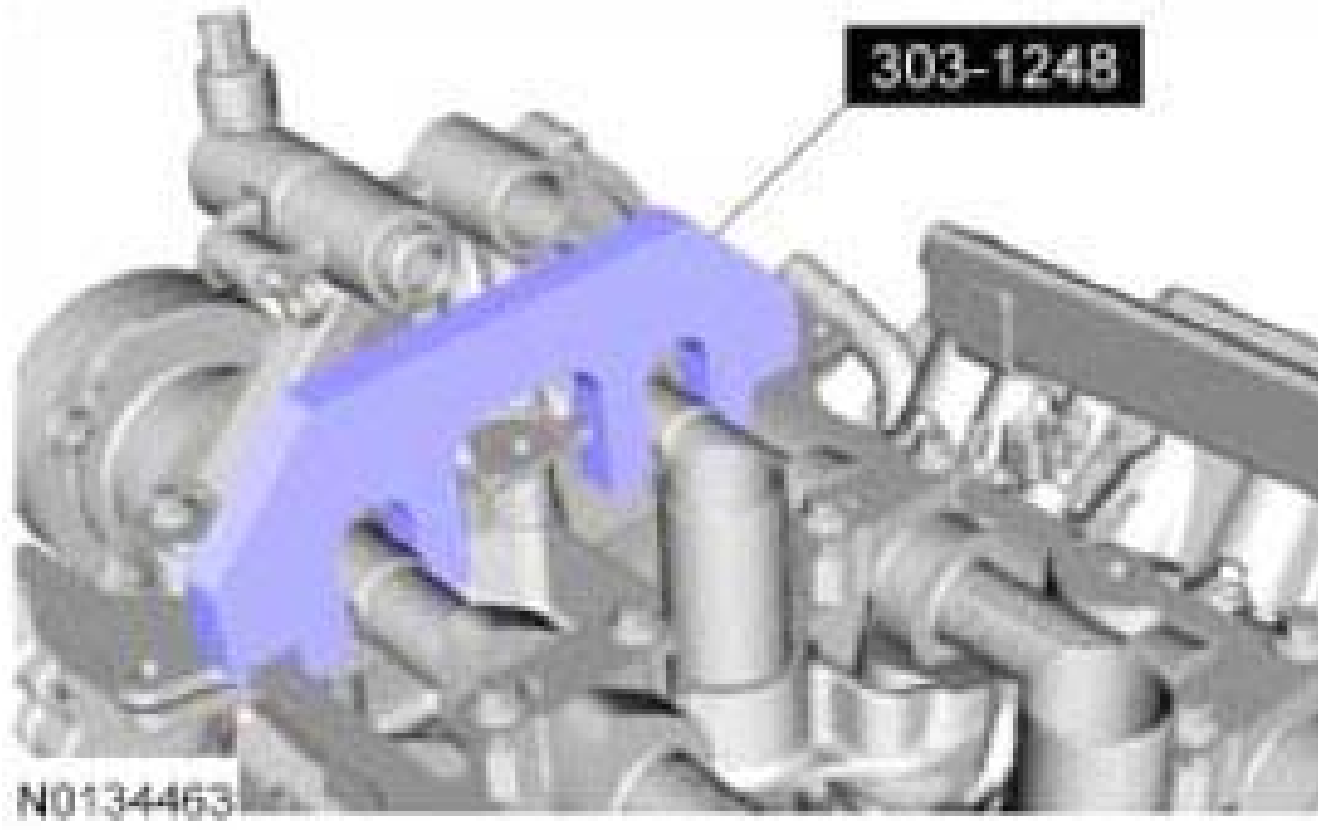
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73. **NOTE: The 303-1248 will hold the camshafts in the TDC position.**

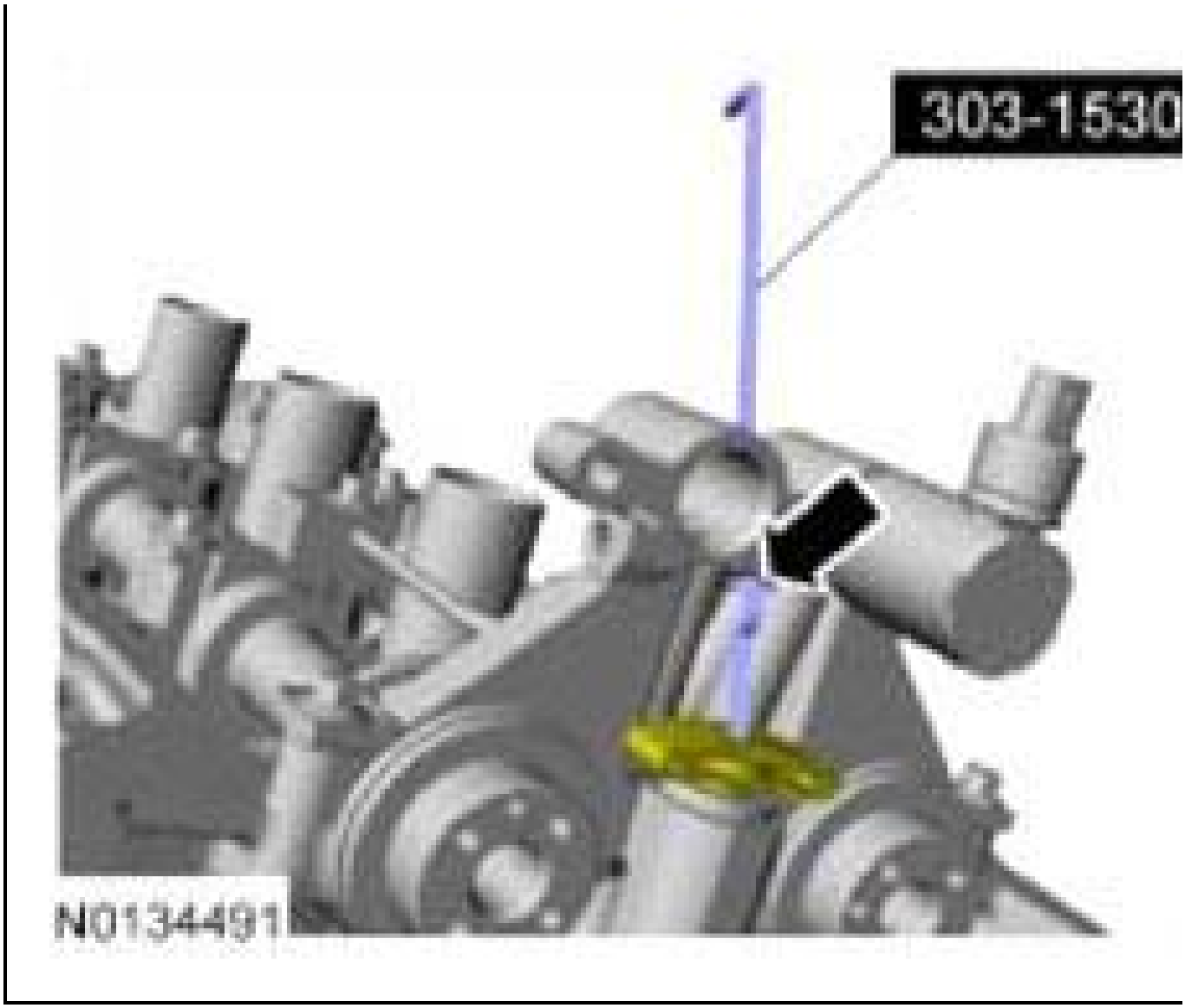
Install 303-1248 onto the flats of the LH camshafts.

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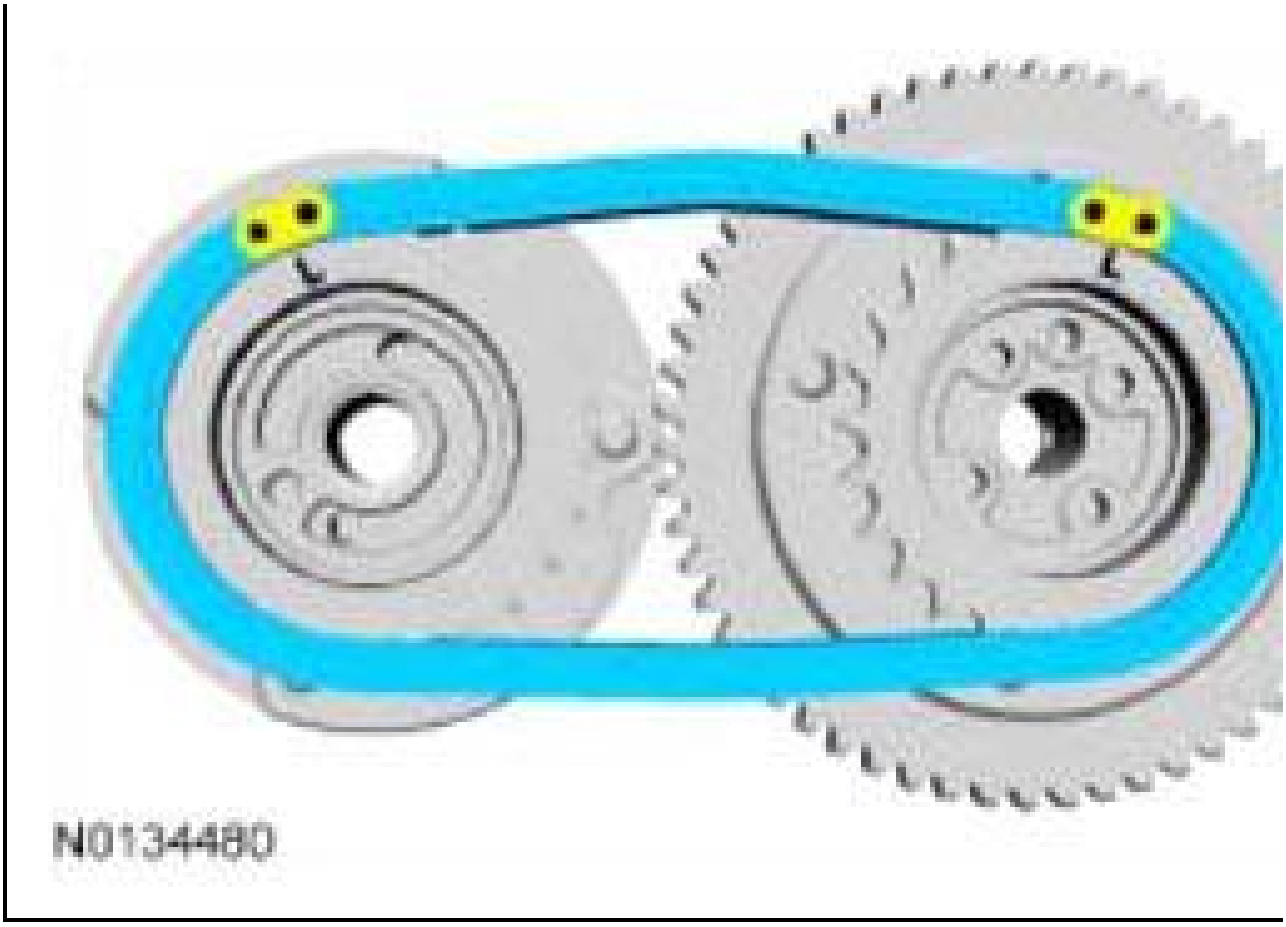
74. Compress the LH secondary timing chain tensioner and install the 303-1530 to retain the tensioner in the collapsed position.

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75. Assemble the 2 LH **VCT** assemblies and the LH secondary timing chain.
    - Align the colored links with the timing marks.

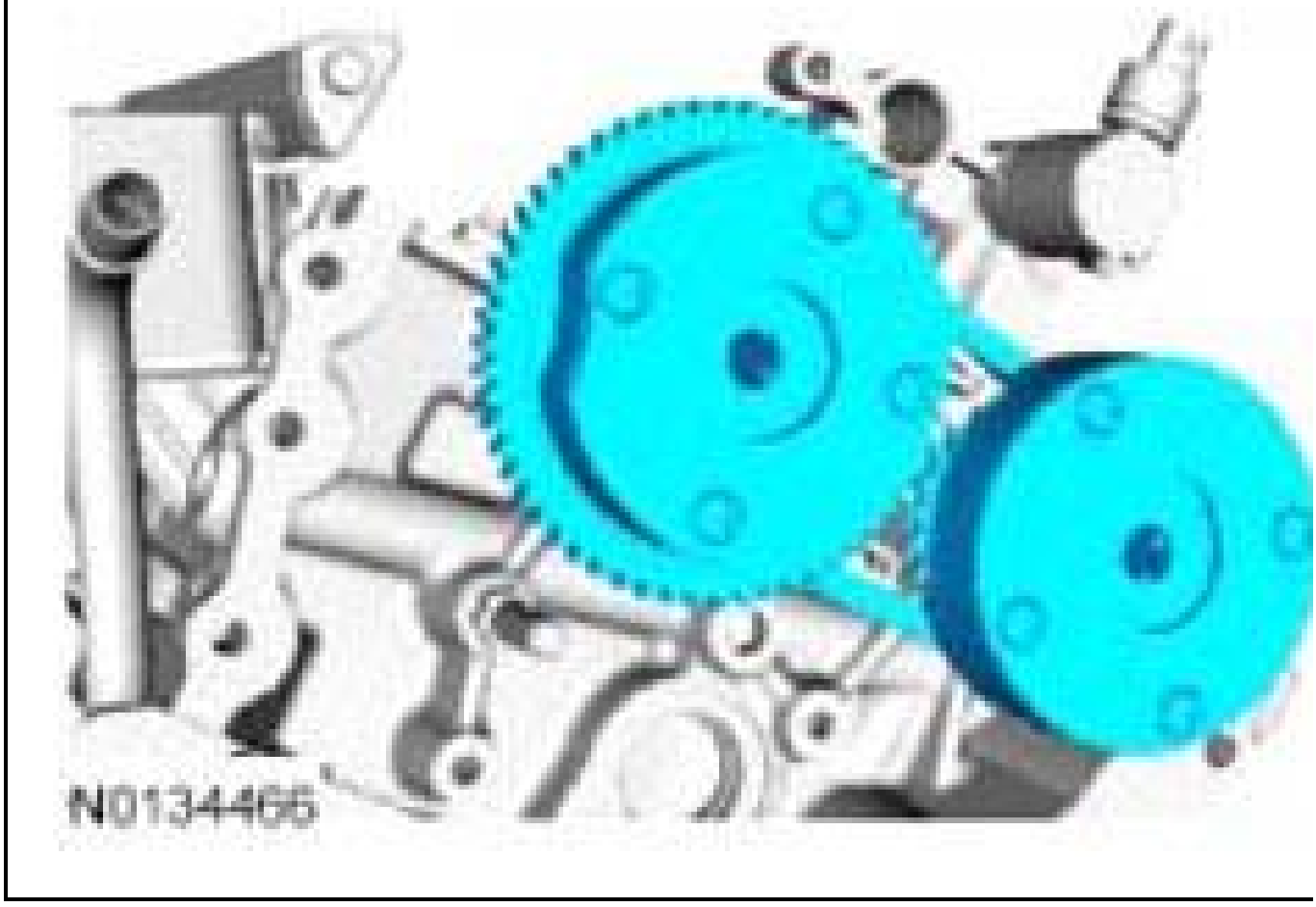
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76. **NOTE: It may be necessary to rotate the camshafts slightly, to install the LH secondary timing assembly.**

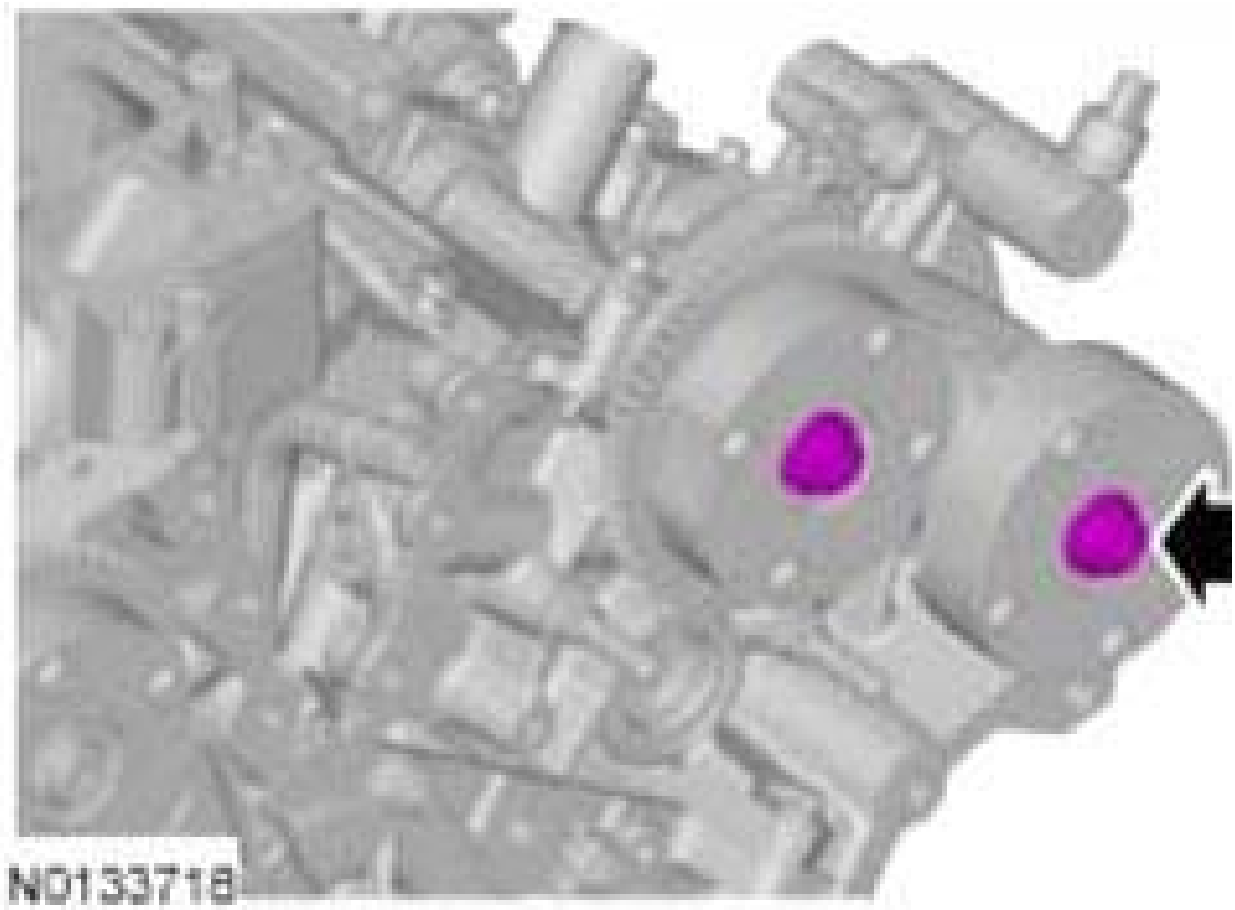
Position the 2 LH **VCT** assemblies and secondary timing chain onto the camshafts by aligning the holes in the **VCT** assemblies with the dowel pins in the camshafts.

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77. Install the 2 new LH **VCT** bolts and tighten in 4 stages.
    - Stage 1: Tighten to 40 Nm (30 lb-ft).
    - Stage 2: Loosen one full turn.
    - Stage 3: Tighten to 25 Nm (18 lb-ft).
    - Stage 4: Tighten an additional 180 degrees.

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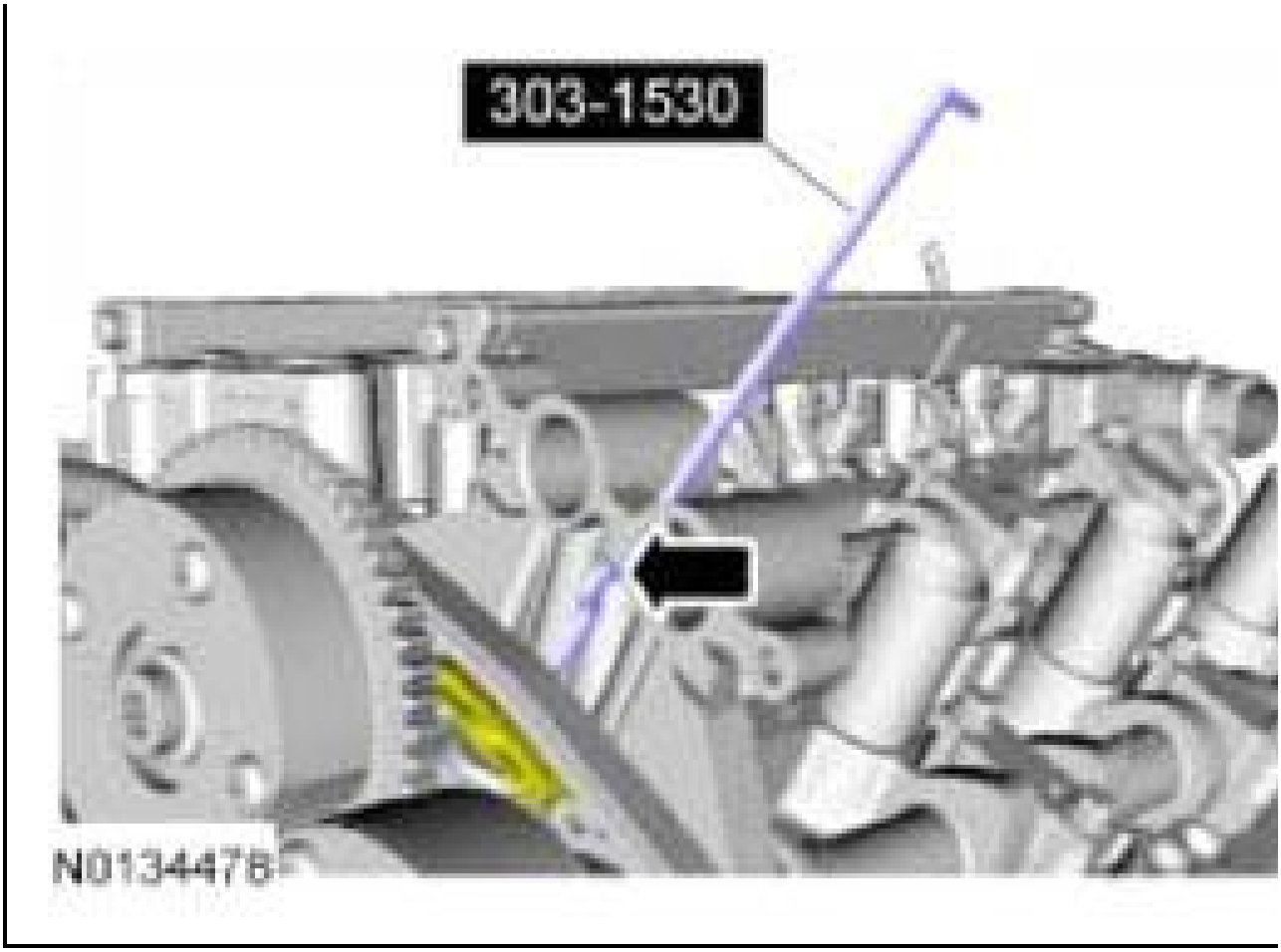


78. **NOTE: The 2 VCT oil control solenoids are removed for clarity.**

Compress the LH secondary timing chain tensioner and remove the 303-1530.

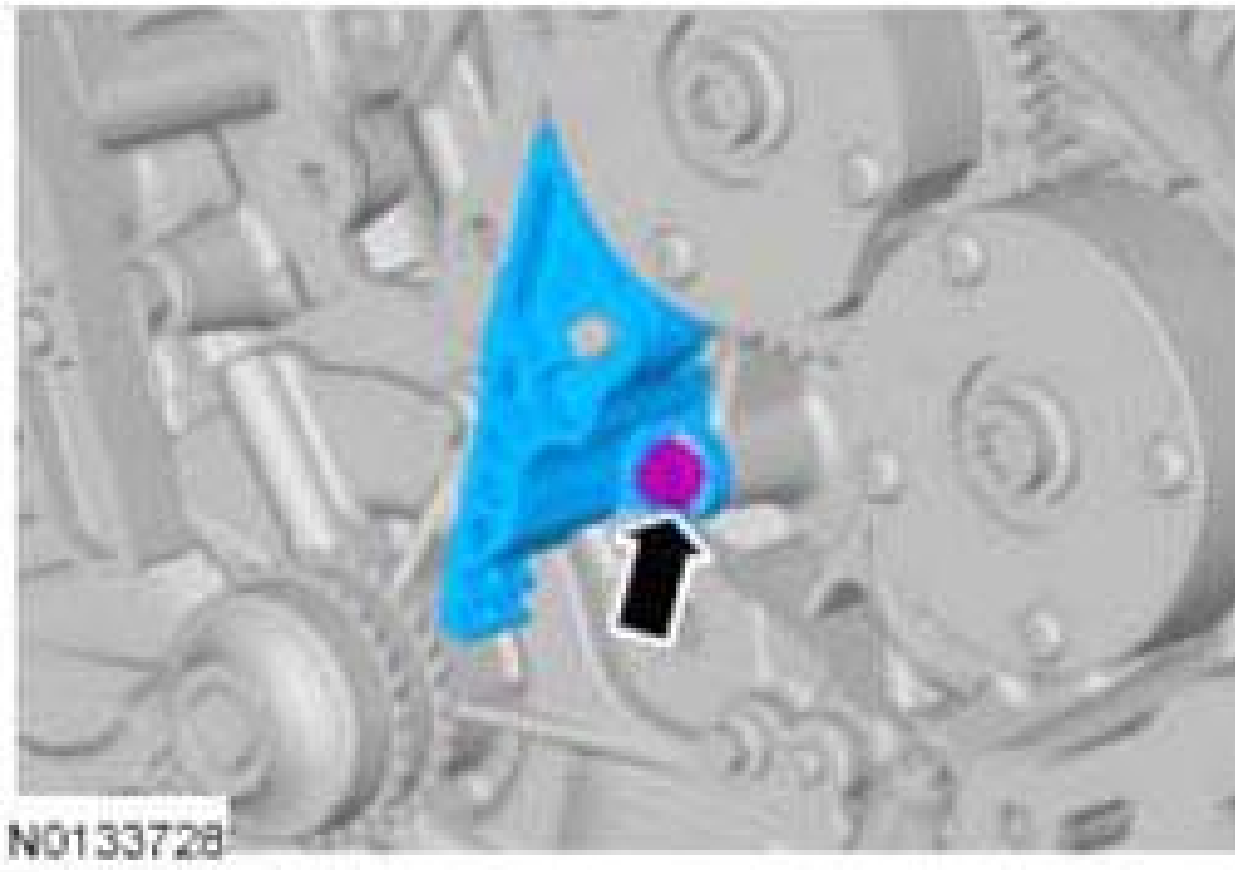
- Make sure the secondary timing chain is centered on the timing chain tensioner guides.

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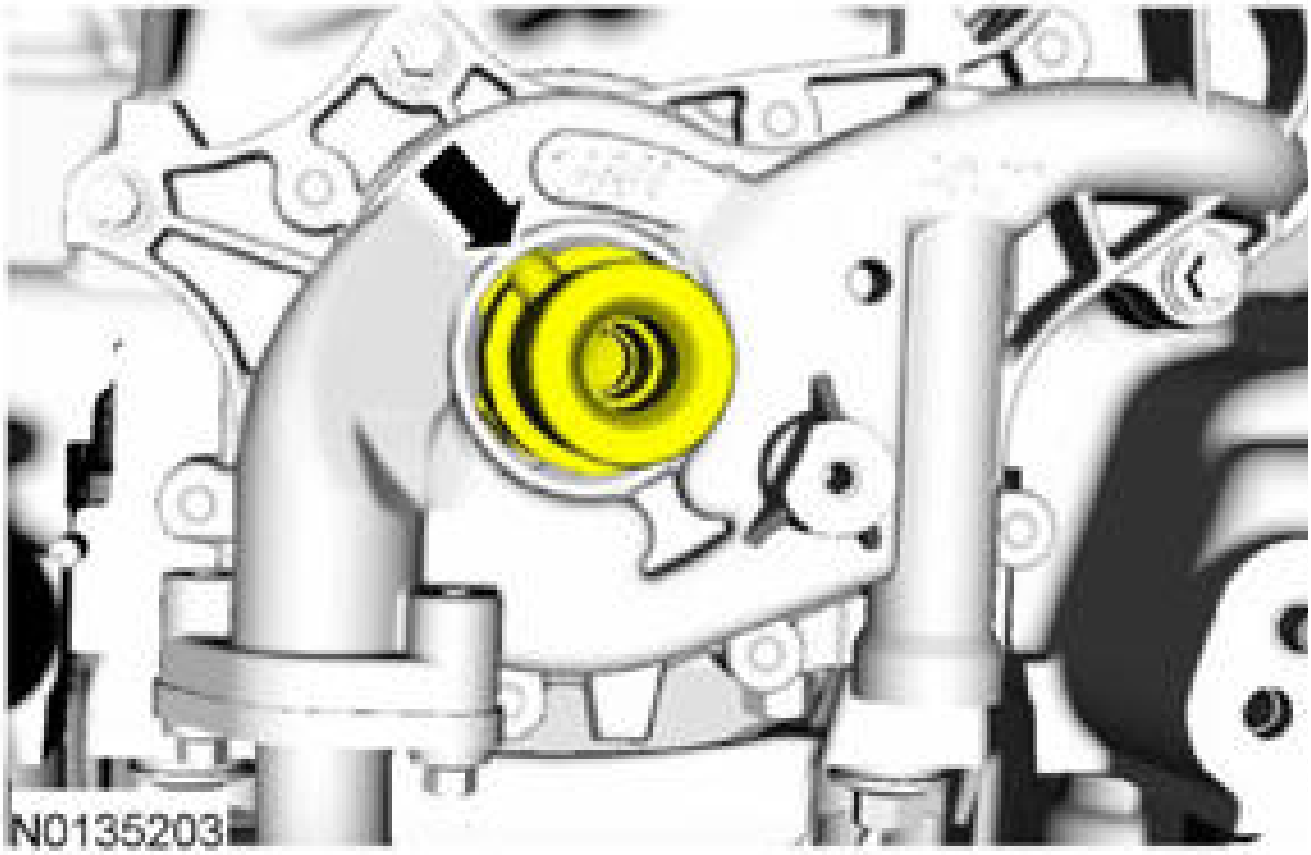
79. Install the LH upper primary timing chain guide and the bolt.
    - Tighten to 10 Nm (89 lb-in).

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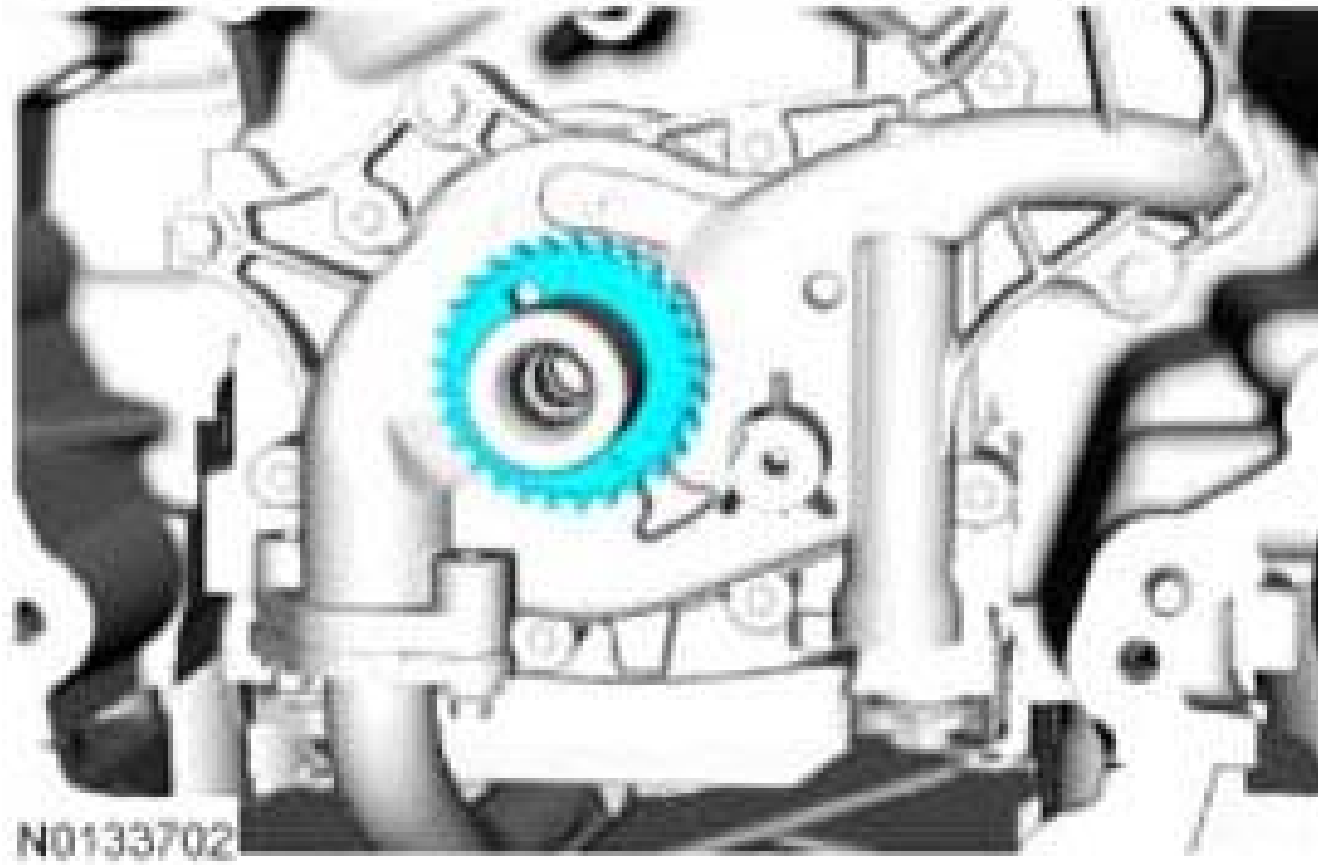
80. Rotate the crankshaft clockwise 60 degrees to the **TDC** position (crankshaft dowel pin at 11 o'clock).

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81. Install the crankshaft timing chain sprocket.

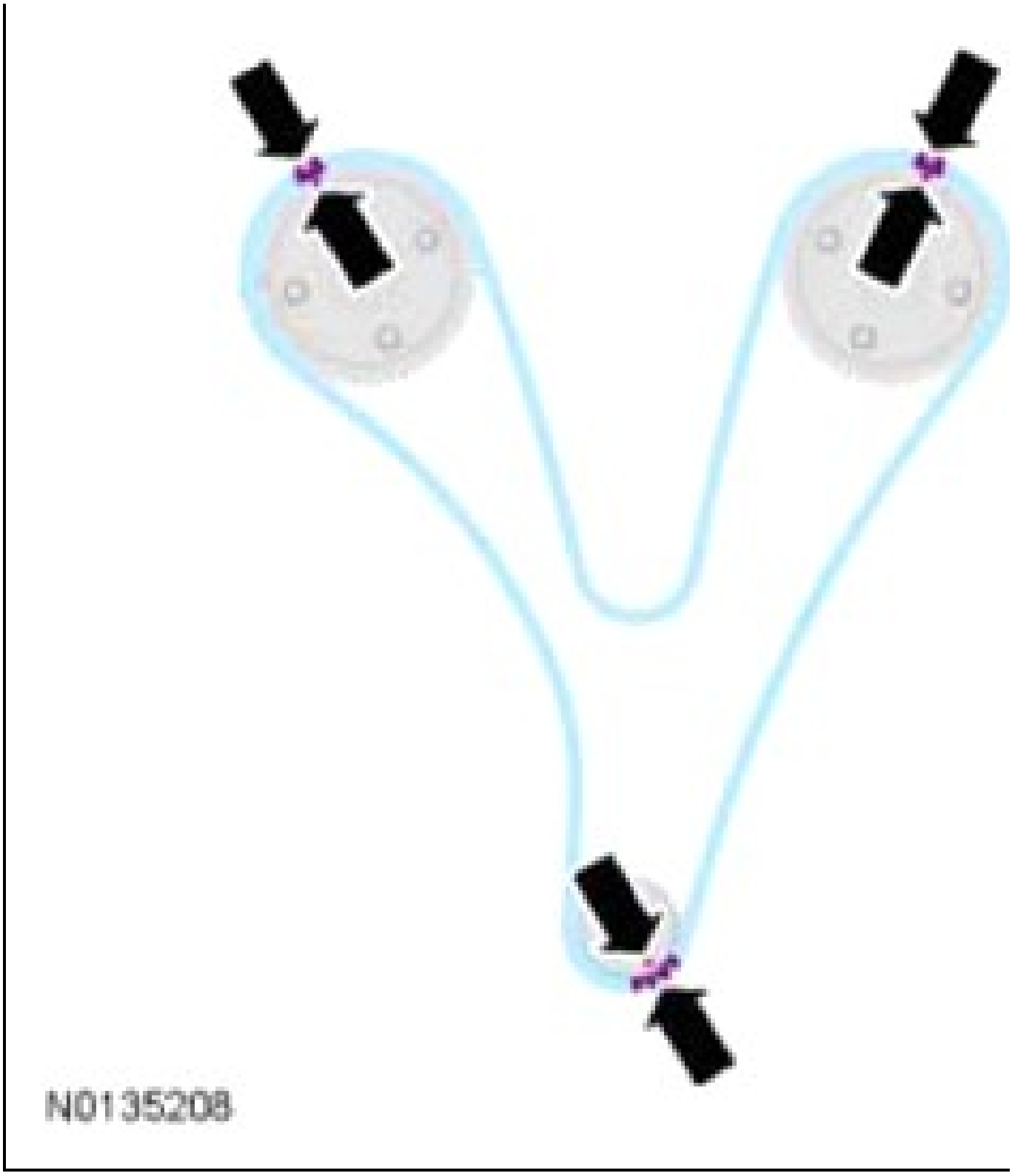
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82. **NOTE: It may be necessary to rotate the camshafts slightly, to align the timing marks.**

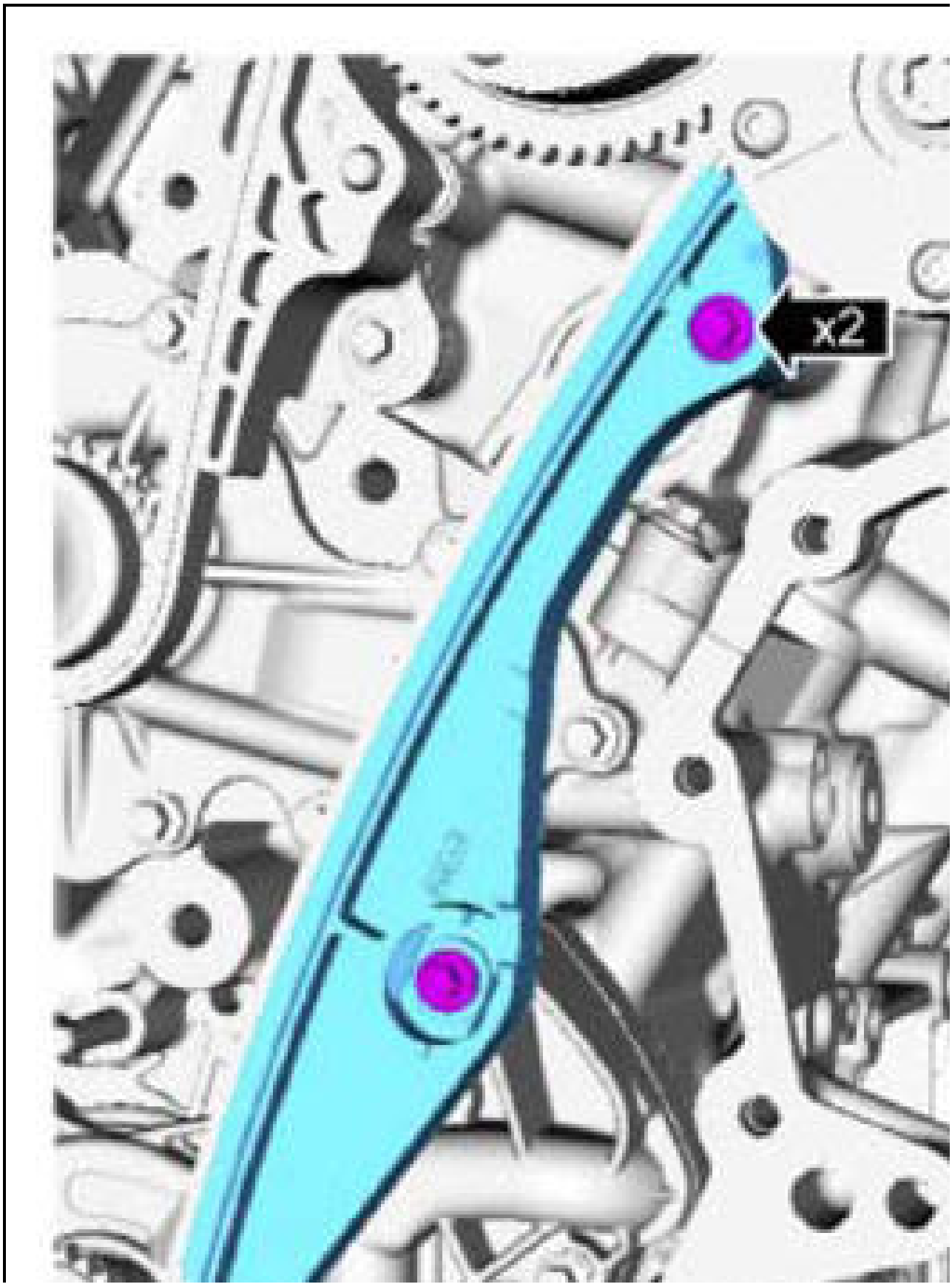
Install the primary timing chain with the colored links aligned with the timing marks on the **VCT** assemblies and the crankshaft sprocket.

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83. Install the lower LH primary timing chain guide and the 2 bolts.
    - Tighten to 10 Nm (89 lb-in).

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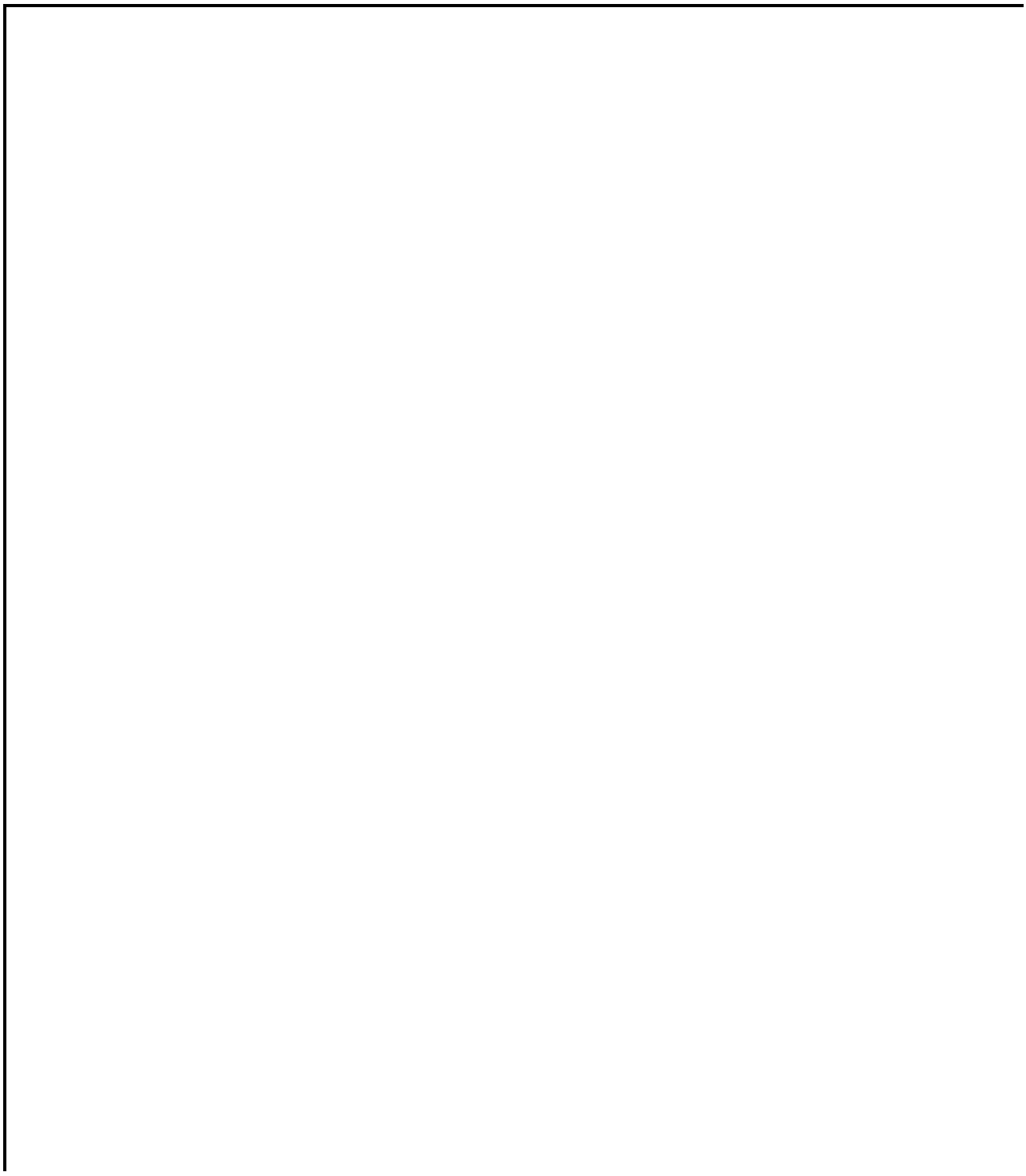
84. Install the primary timing chain tensioner arm.

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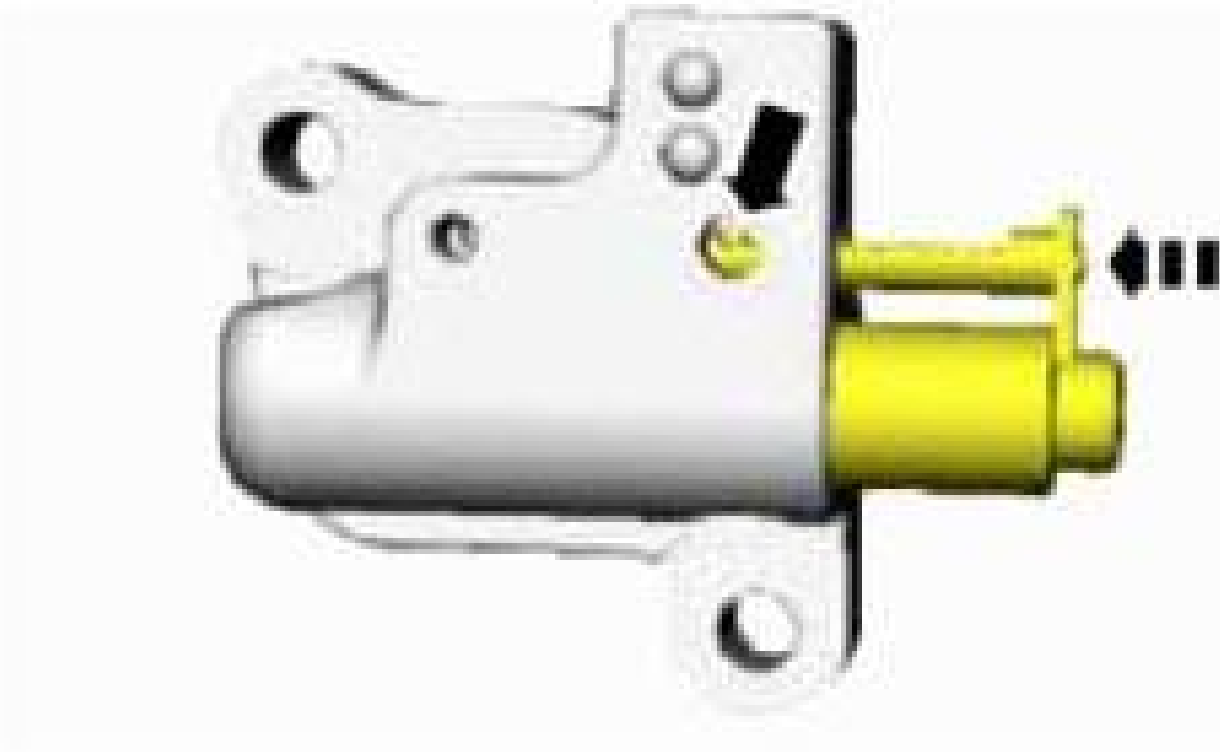


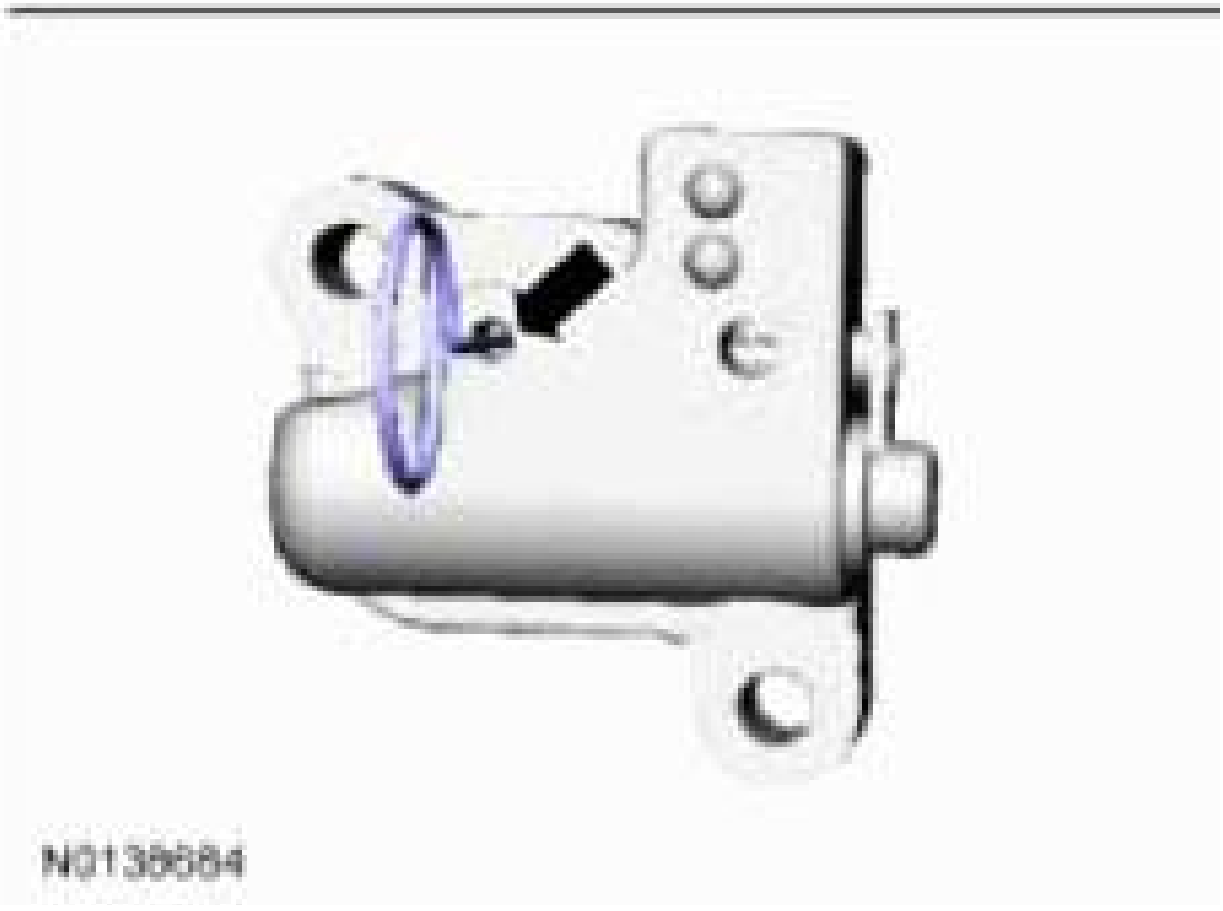
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85. Reset the primary timing chain tensioner.
    - Release the ratchet detent.
    - Using a soft-jawed vise, compress the ratchet plunger.
    - Align the hole in the ratchet plunger with the hole in the tensioner housing.
    - Install a suitable lockpin.



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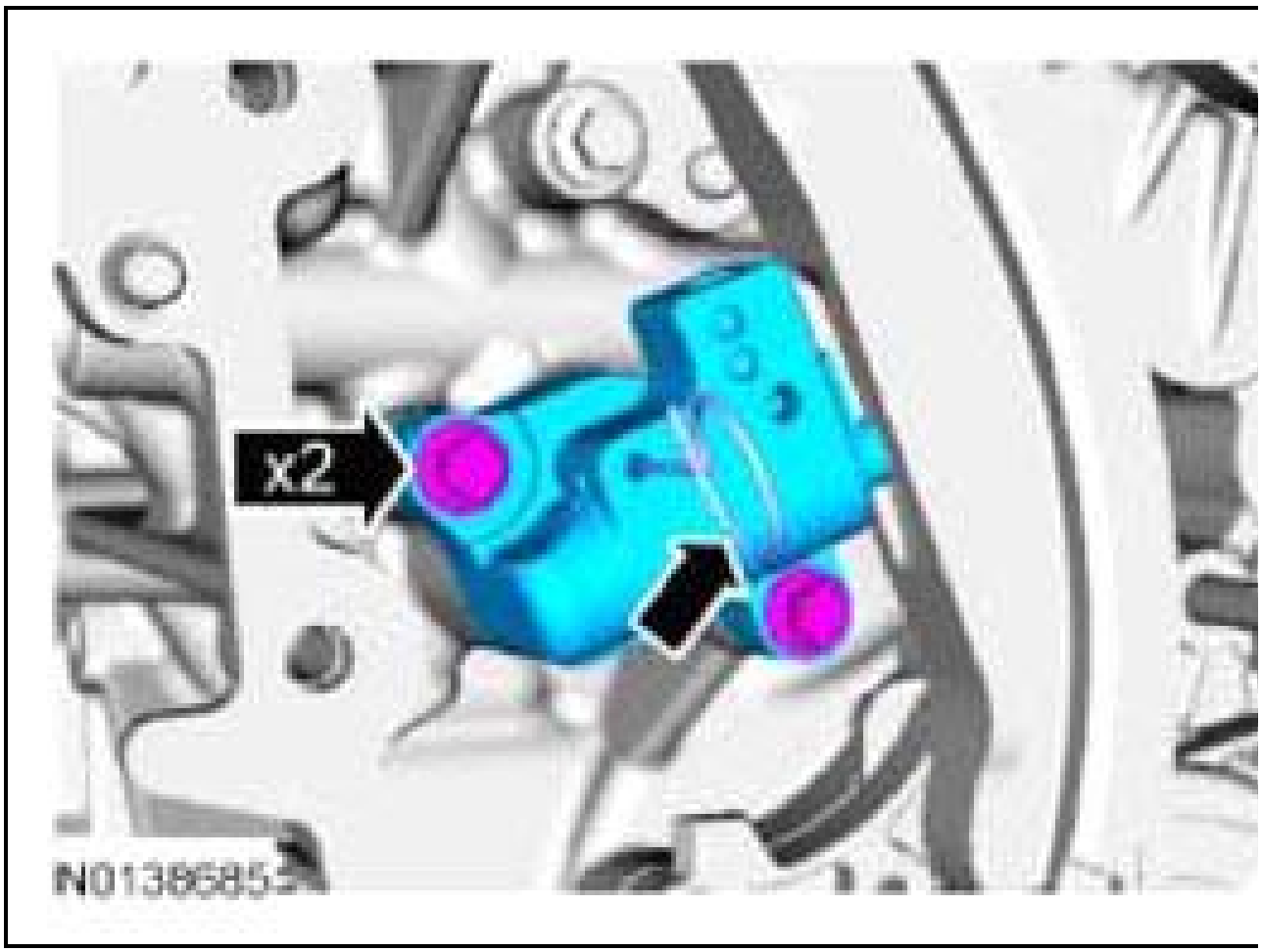


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86. **NOTE: It may be necessary to rotate the camshafts slightly to remove slack from the timing chain to install the tensioner.**

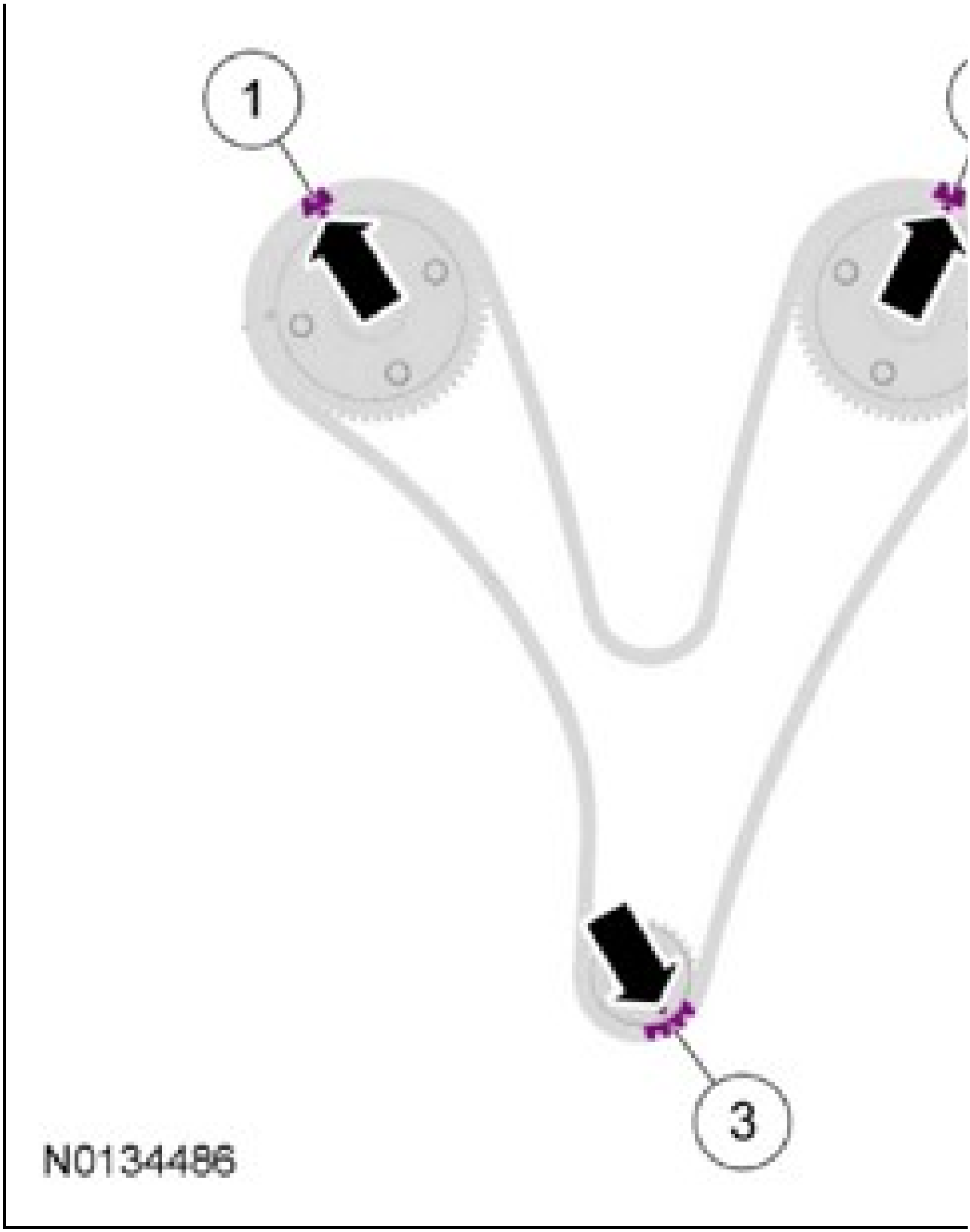
Install the primary tensioner and the 2 bolts.

- Tighten to 10 Nm (89 lb-in).
- Remove the lockpin.



87. As a post-check, verify correct alignment of all timing marks.
    - There are 48 links in between the RH intake **VCT** assembly colored link (1) and the LH intake VCT assembly colored link (2).
    - There are 35 links in between LH intake **VCT** assembly colored link (2) and the 2 crankshaft sprocket links (3).

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88. **NOTE: Do not use excessive force when installing the VCT oil control solenoid.**

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88. **Damage to the mega cap could cause the cylinder head to be inoperable. If difficult to install the VCT oil control solenoid, inspect the bore and VCT oil control solenoid to ensure there are no burrs, sharp edges or contaminants present on the mating surface. Only clean the external surfaces as necessary.**

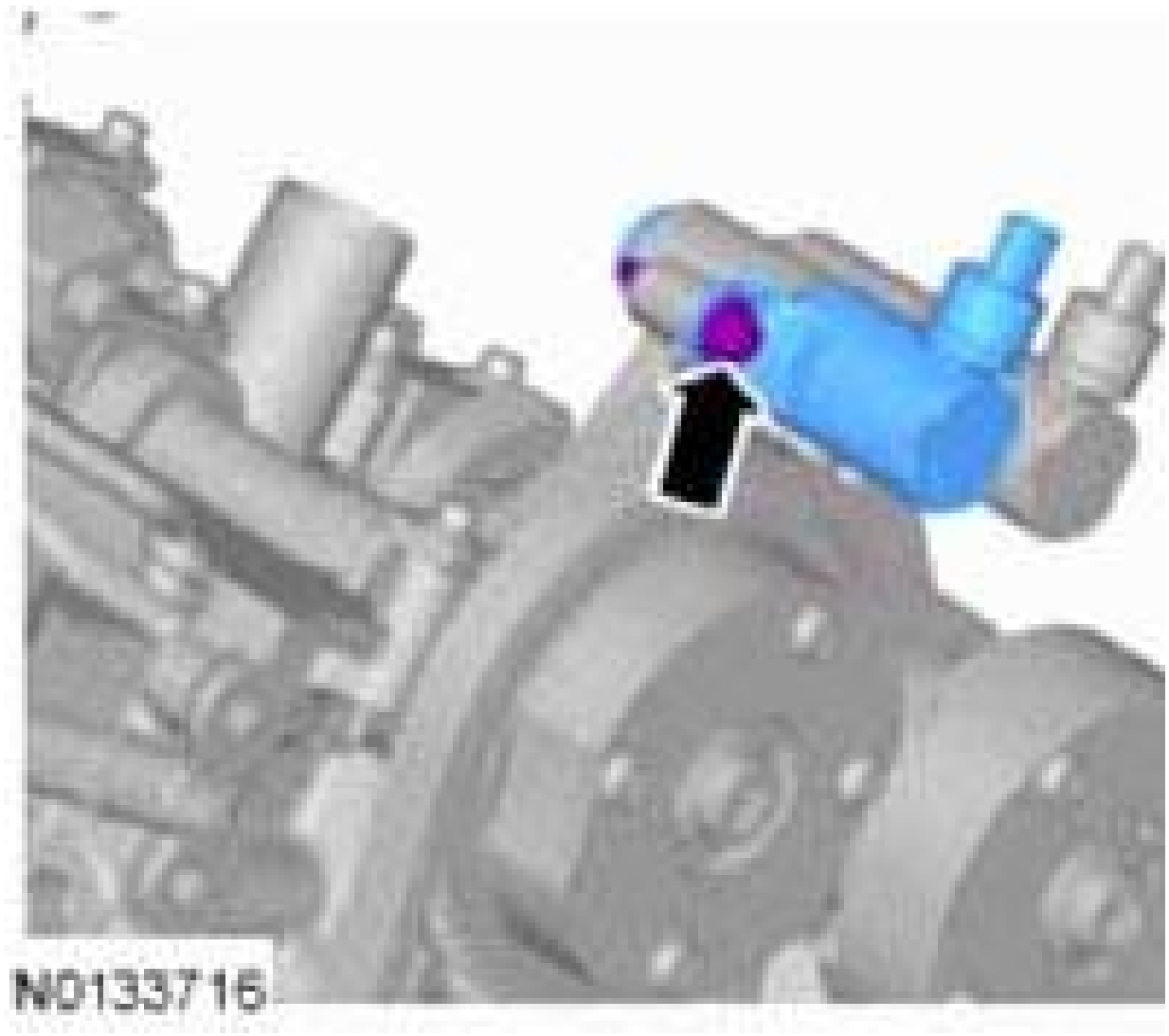
NOTE: A slight twisting motion will aid in the installation of the VCT oil control solenoid.

NOTE: Keep the VCT oil control solenoid clean of dirt and debris.

Install the LH intake **VCT** oil control solenoid and the bolt.

- Tighten to 8 Nm (71 lb-in) then an additional 20 degrees.

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89.

NOTE: **Do not use excessive force when installing the VCT oil control solenoid. Damage to the mega cap could cause the cylinder head to be inoperable. If difficult to install the VCT oil control solenoid, inspect the bore and VCT oil control solenoid to ensure there are no burrs, sharp edges or contaminants present on the mating surface. Only clean the external surfaces as necessary.**

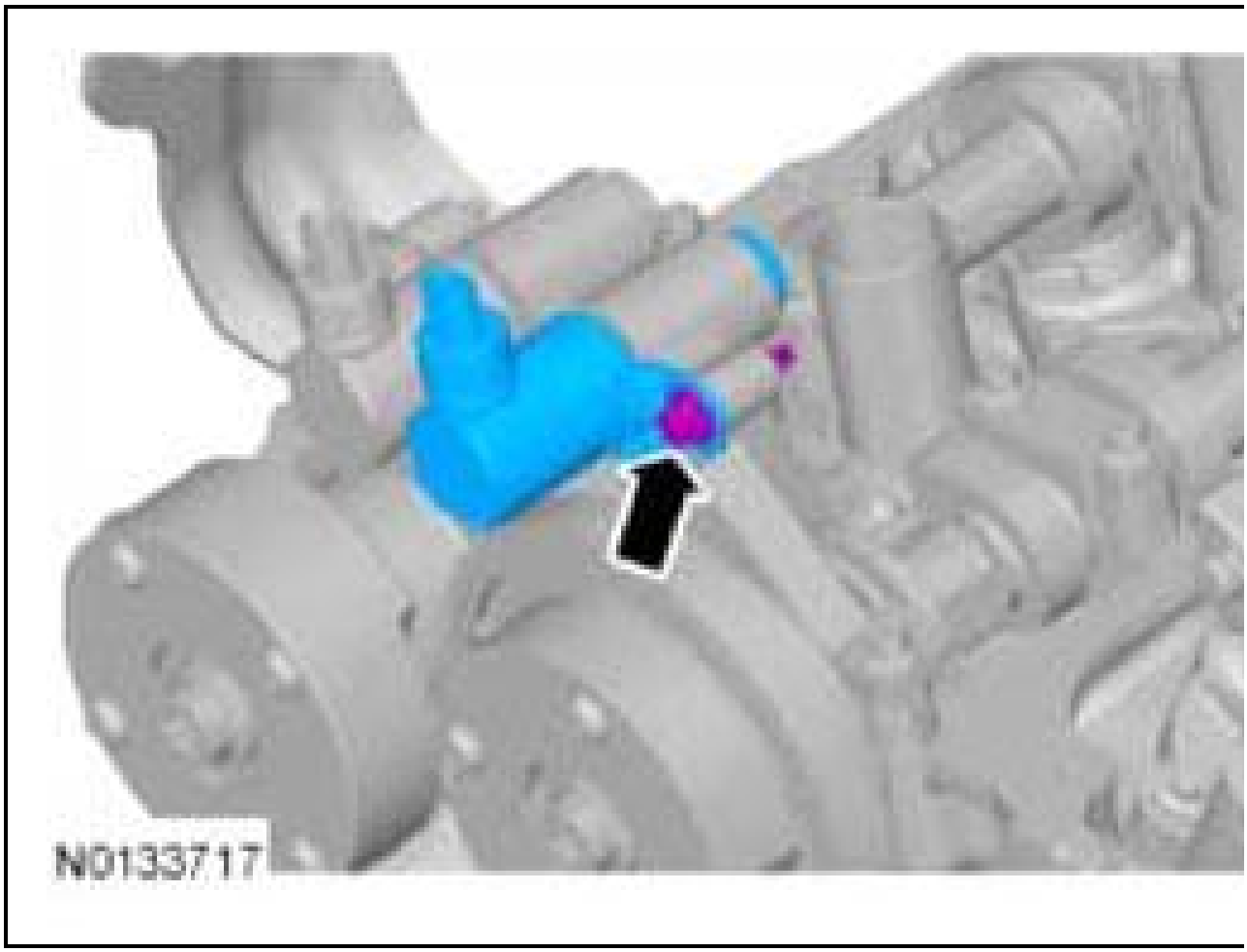
NOTE: **A slight twisting motion will aid in the installation of the VCT oil control solenoid.**

NOTE: **Keep the VCT oil control solenoid clean of dirt and debris.**

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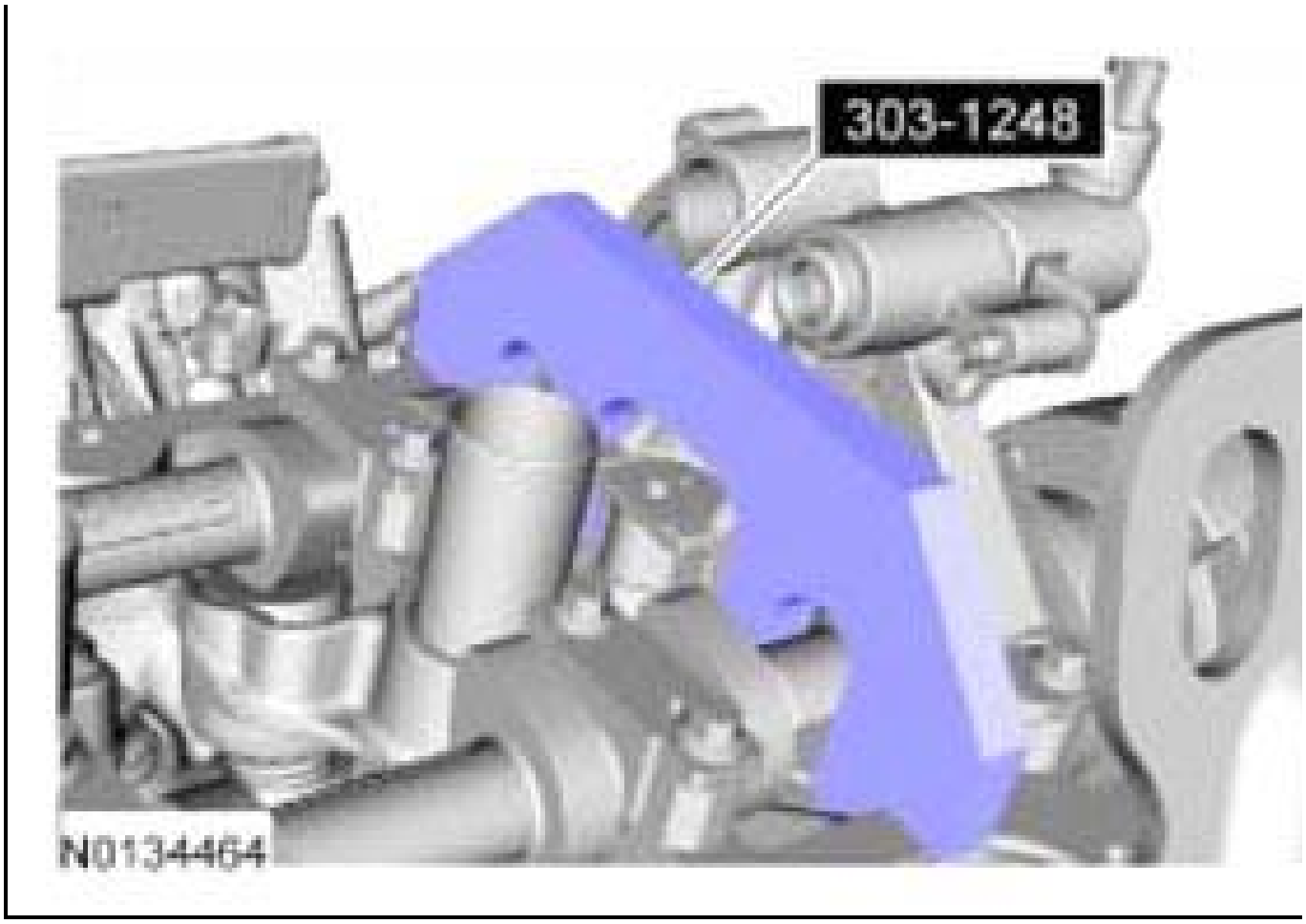
Install the RH intake **VCT** oil control solenoid and the bolt.

- Tighten to 8 Nm (71 lb-in) then an additional 20 degrees.



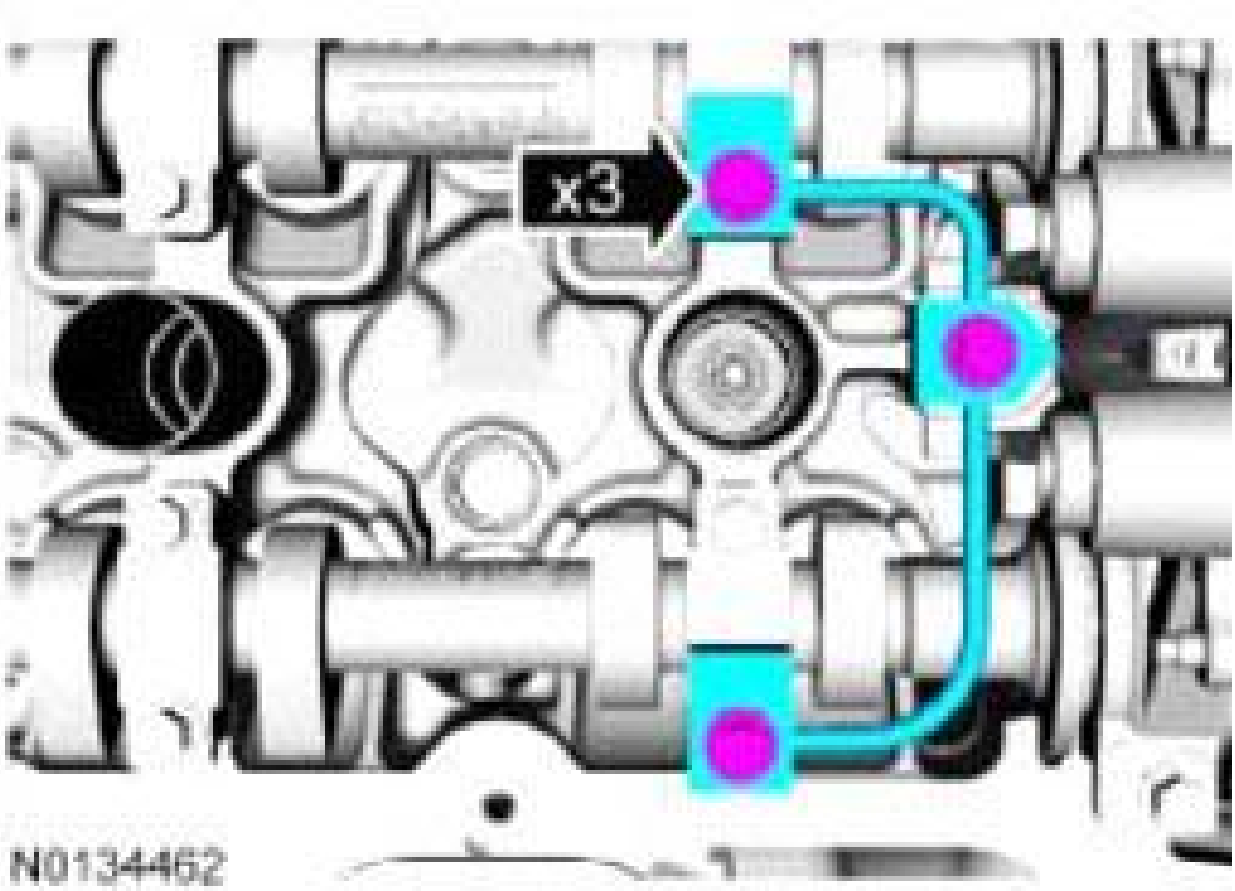
90. Remove the RH 303-1248.

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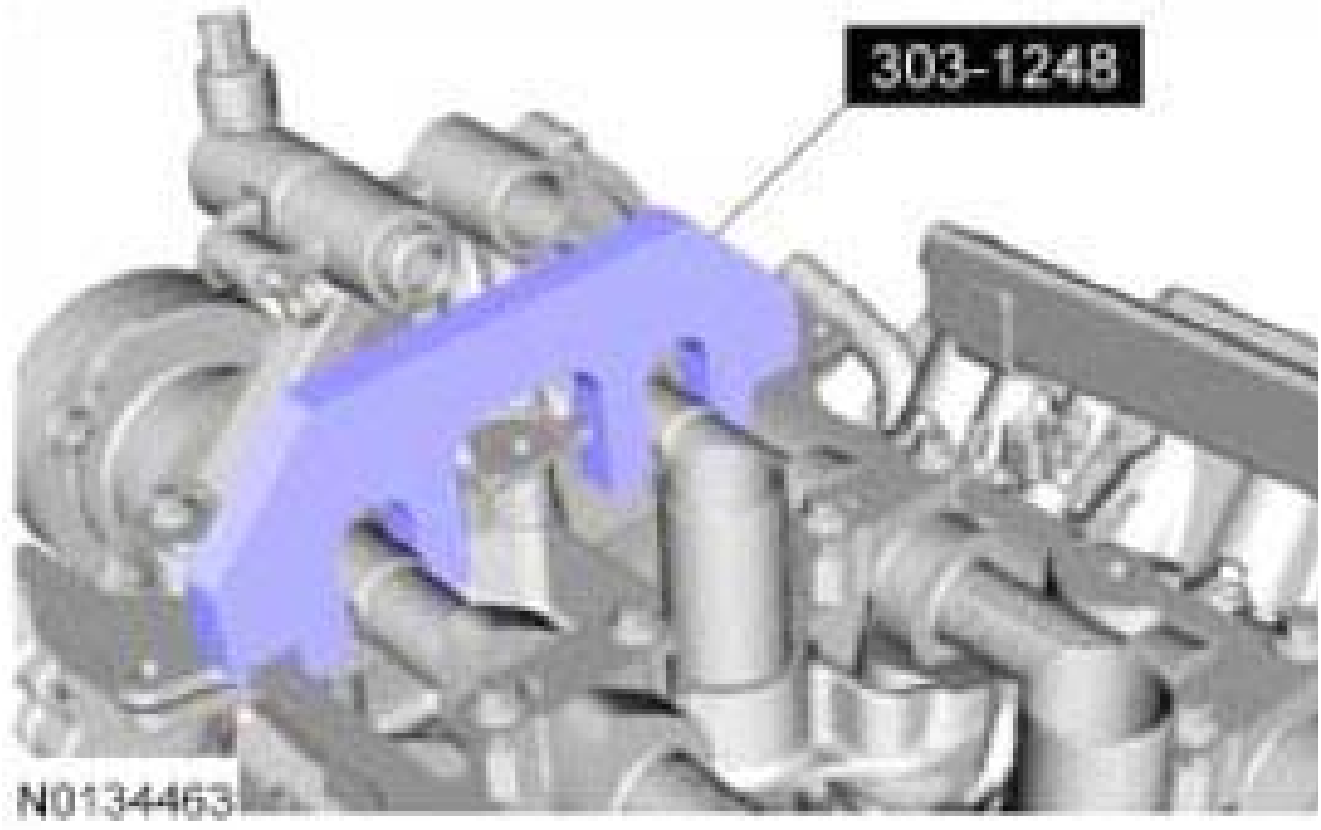
91. Install the RH valve train oil tube and the 3 bolts and tighten in 2 stages.
    - Stage 1: Tighten to 8 Nm (71 lb-in).
    - Stage 2: Tighten an additional 45 degrees.

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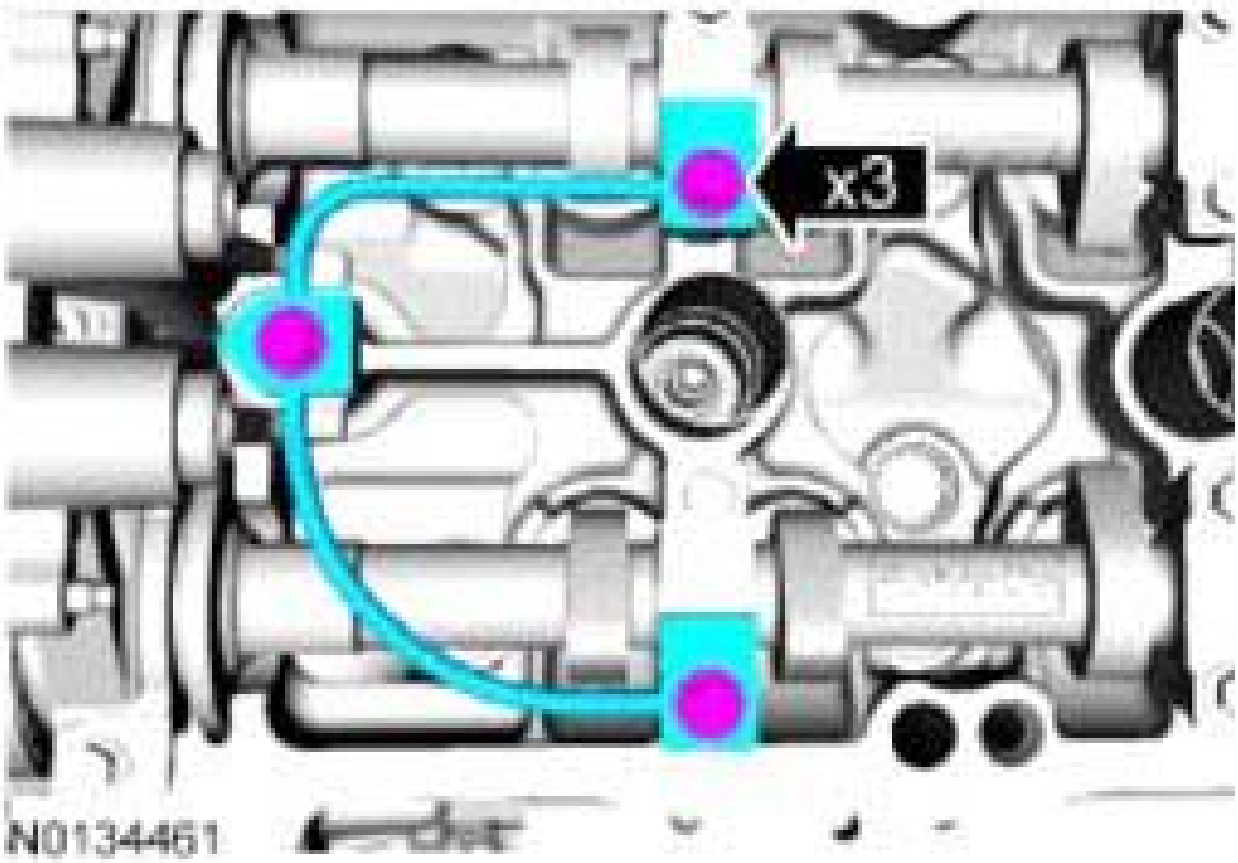
92. Remove the LH 303-1248.

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93. Install the LH valve train oil tube and the 3 bolts and tighten in 2 stages.
    - Stage 1: Tighten to 8 Nm (71 lb-in).
    - Stage 2: Tighten an additional 45 degrees.

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94.

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

NOTE: **Do not use wire brushes, power abrasive discs or 3M Roloc® Bristle Disk (2-in white part number 07528) to clean the sealing surfaces of engine block, cylinder heads, and oil pan. These tools can cause contamination that will cause premature engine failure. Remove all traces of the gasket.**

Clean the sealing surfaces of the cylinder heads, the cylinder block and the oil pan in the following sequence.

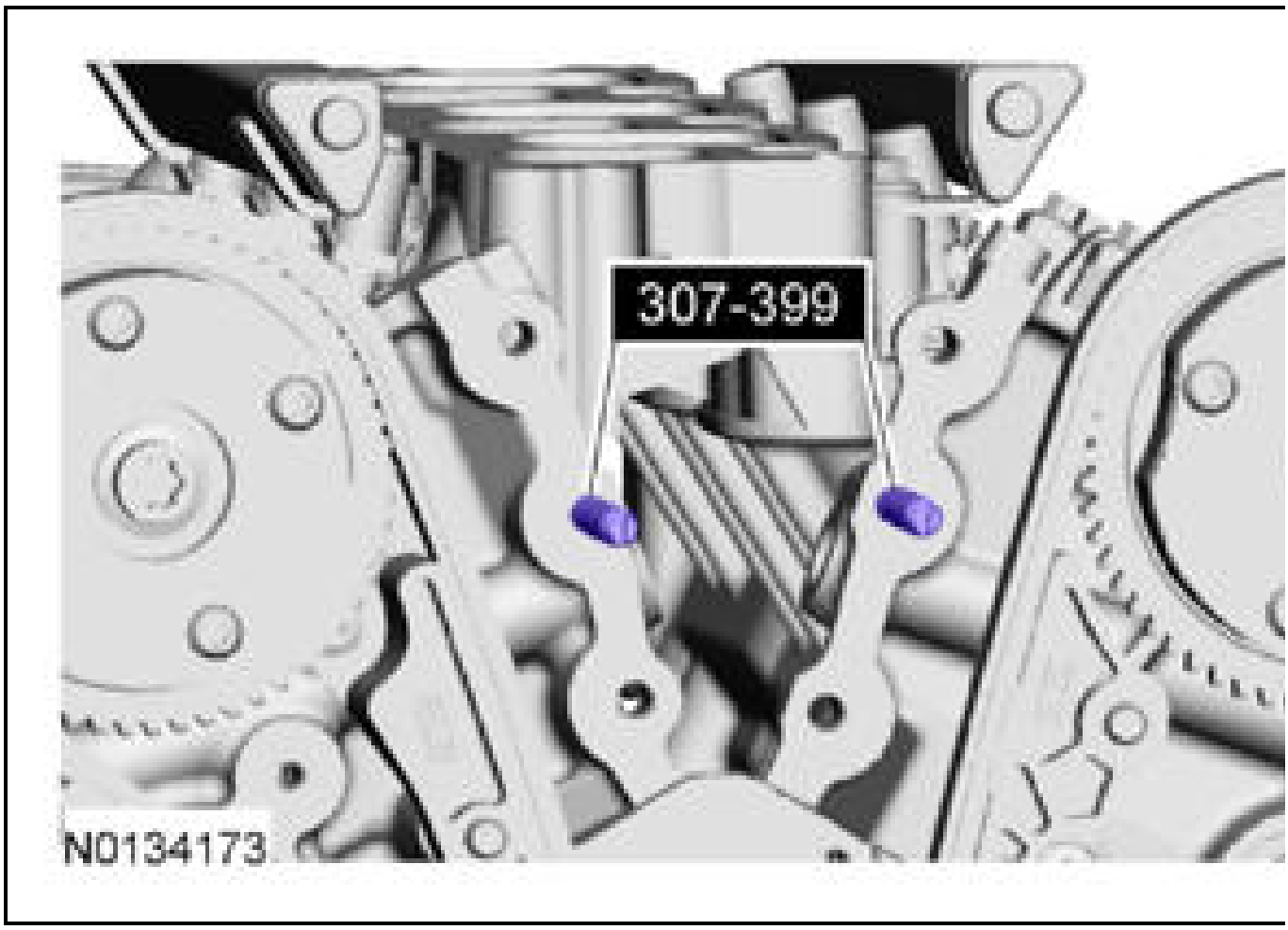
- Remove any large deposits of silicone or gasket material.
- Apply Motorcraft® Silicone Gasket Remover and allow to set for several minutes.
- Remove the Motorcraft® Silicone Gasket Remover. A second application of Motorcraft® Silicone Gasket Remover may be required if residual traces of silicone or gasket material remain.

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- Apply Motorcraft® Metal Surface Prep to remove any remaining traces of oil or coolant and to prepare the surfaces to bond. Do not attempt to make the metal shiny. Some staining of the metal surfaces is normal.

95. **NOTE: Make sure the 2 locating dowel pins are seated correctly in the cylinder block.**

Install 307-399.



96. **NOTE: Failure to use Motorcraft® High Performance Engine RTV Silicone may cause the engine oil to foam excessively and result in serious engine damage.**

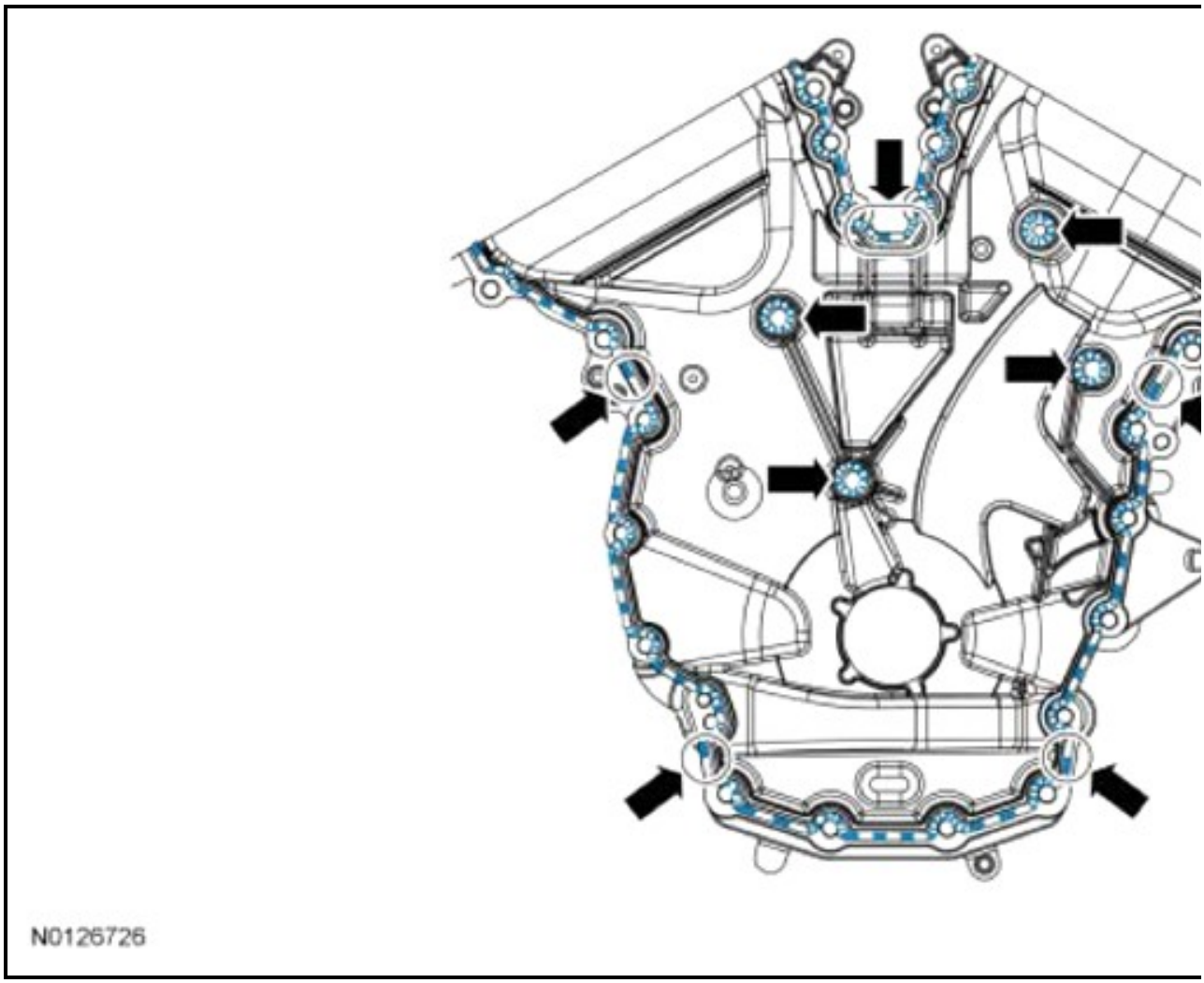
NOTE: The engine front cover and bolts 7, 8, 15, 17, 18, 21 and 22 must be installed within 4 minutes of the initial sealant application. The remainder of the engine front cover bolts must be installed and tightened within 35 minutes of the initial sealant application. If the time limits are exceeded, the sealant must be removed, the sealing area cleaned and sealant

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reapplied. To clean the sealing area, use Motorcraft® Silicone Gasket Remover and Motorcraft® Metal Surface Prep. Failure to follow this procedure can cause future oil leakage.

Apply a 3 mm (0.1181 in) bead of Motorcraft® High Performance Engine RTV Silicone to the sealing surface of the front cover.

- Apply a 5.5 mm (0.22 in) bead of Motorcraft® High Performance Engine RTV Silicone to the oil pan-to-cylinder block joint and the cylinder head-to-cylinder block joint areas of the engine front cover in 5 places as indicated.

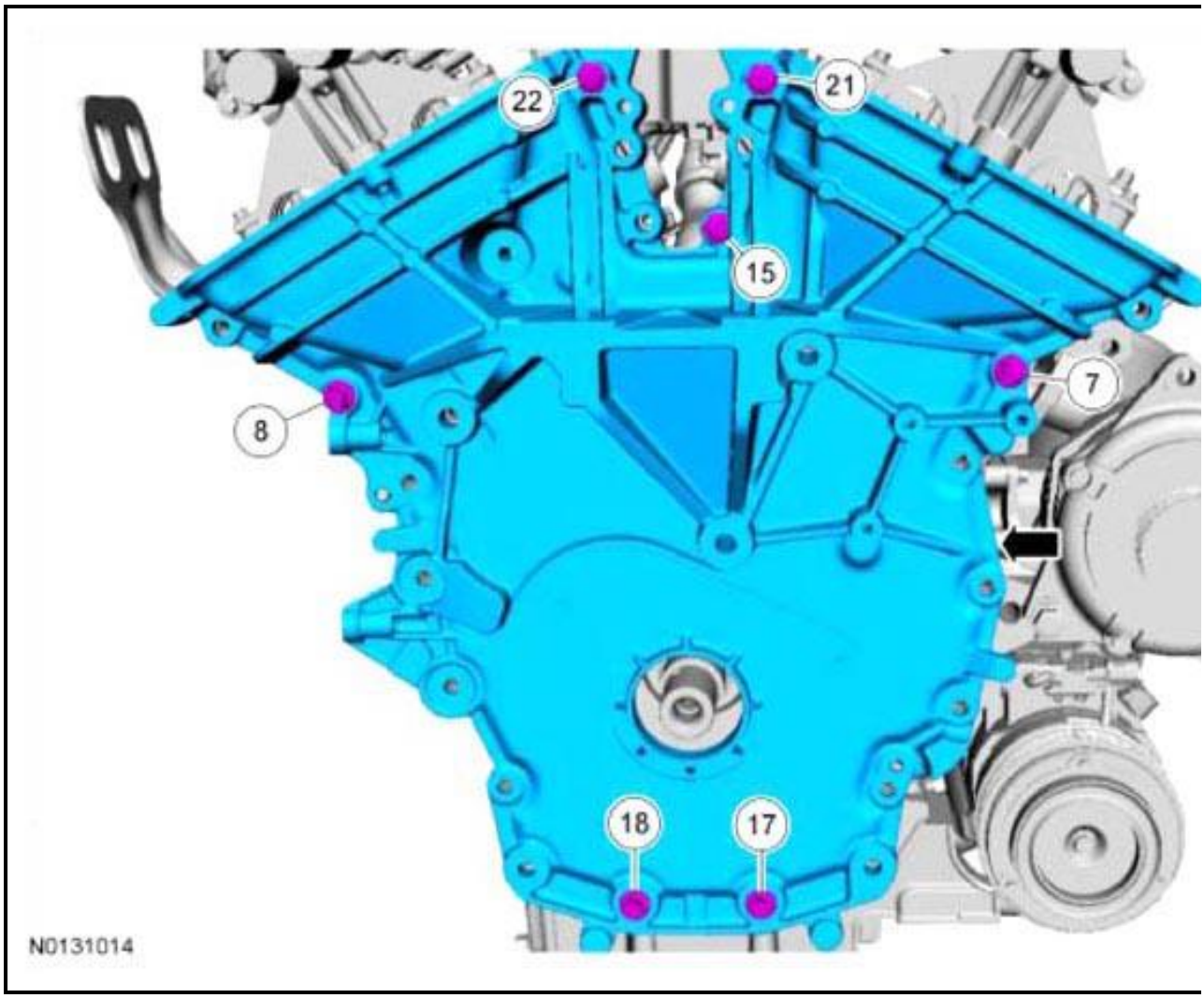


97. **NOTE: Make sure the 2 locating dowel pins are seated correctly in the cylinder block.**

Install the engine front cover and bolts 7, 8, 15, 17, 18, 21 and 22.

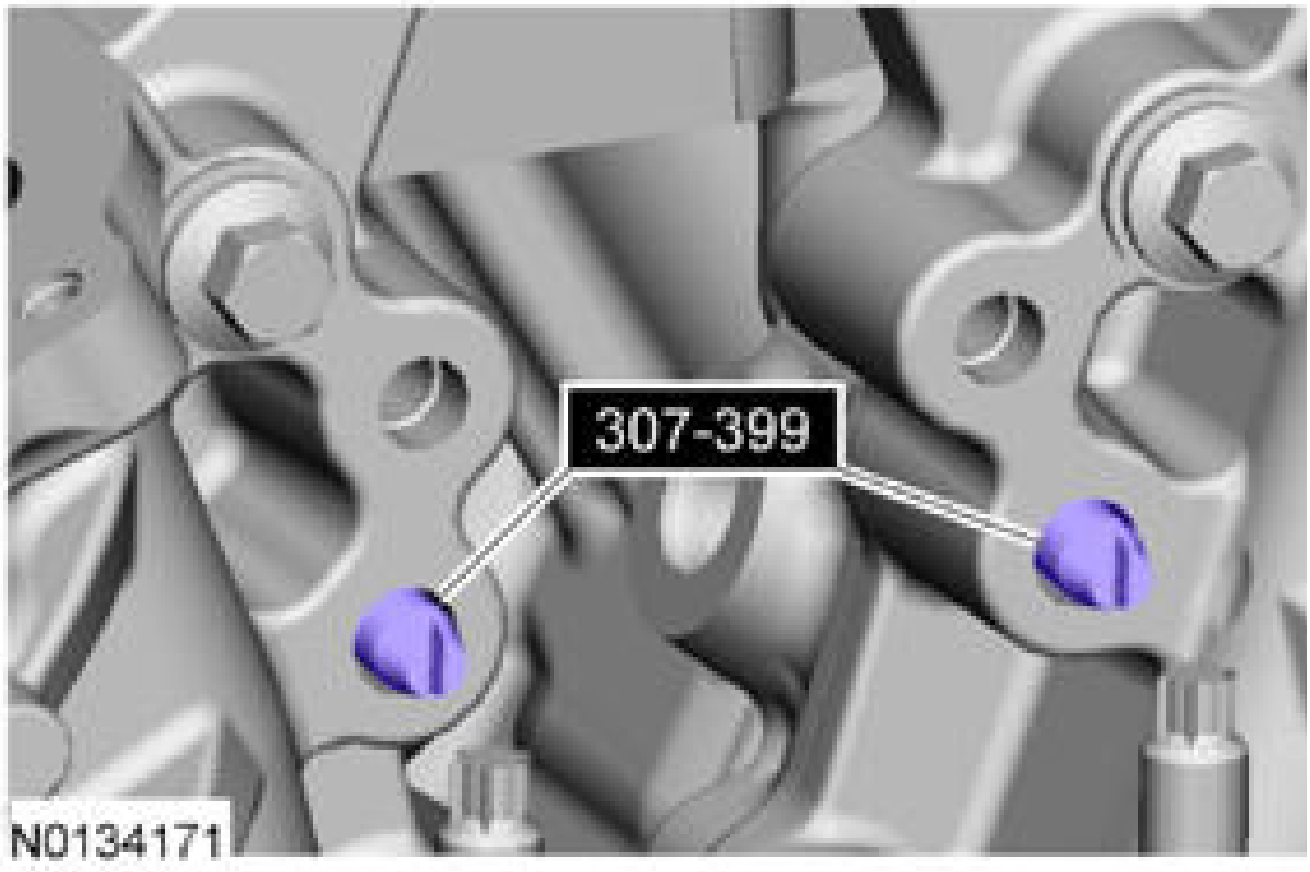
- Tighten in sequence shown in illustration to 3 Nm (27 lb-in).

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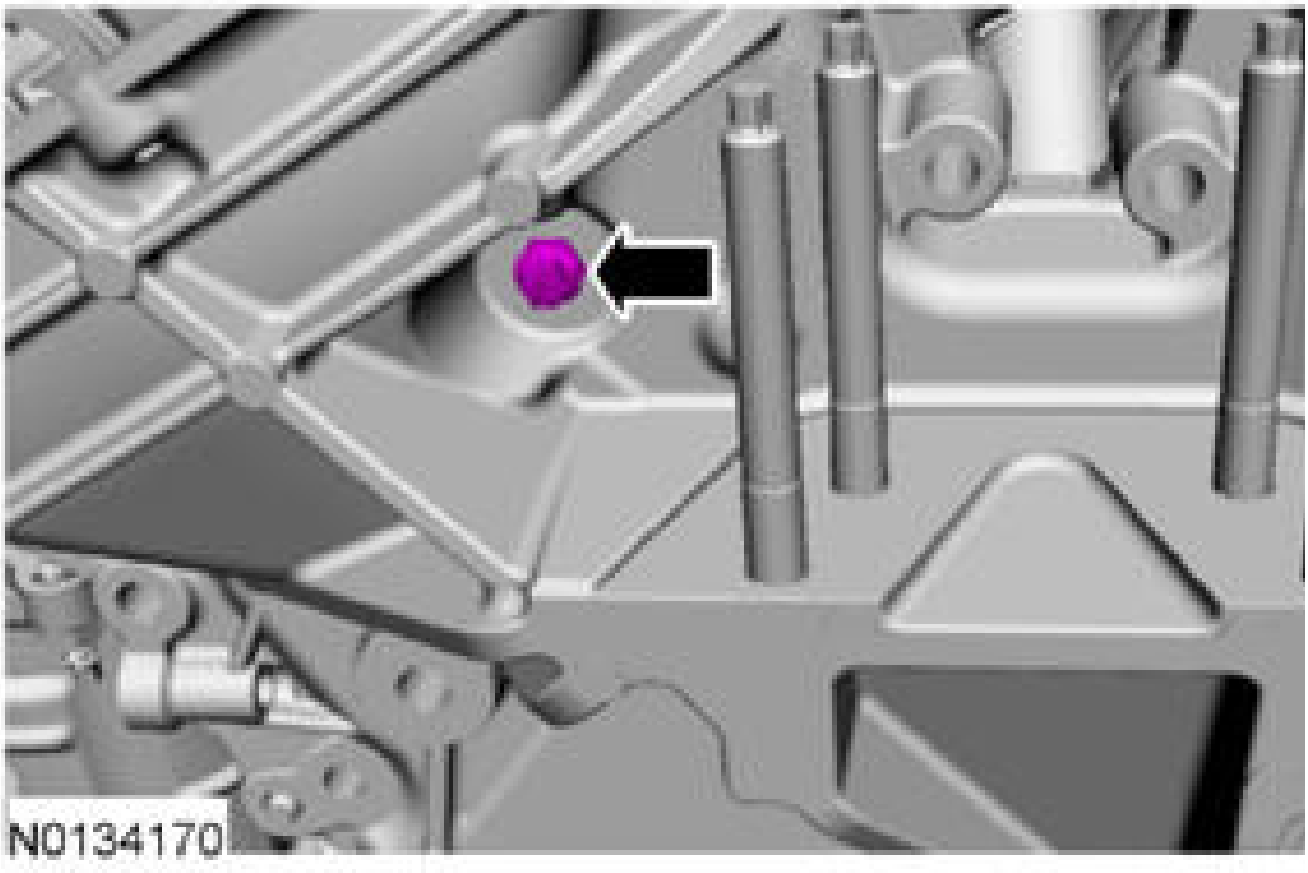
98. Remove 307-399.

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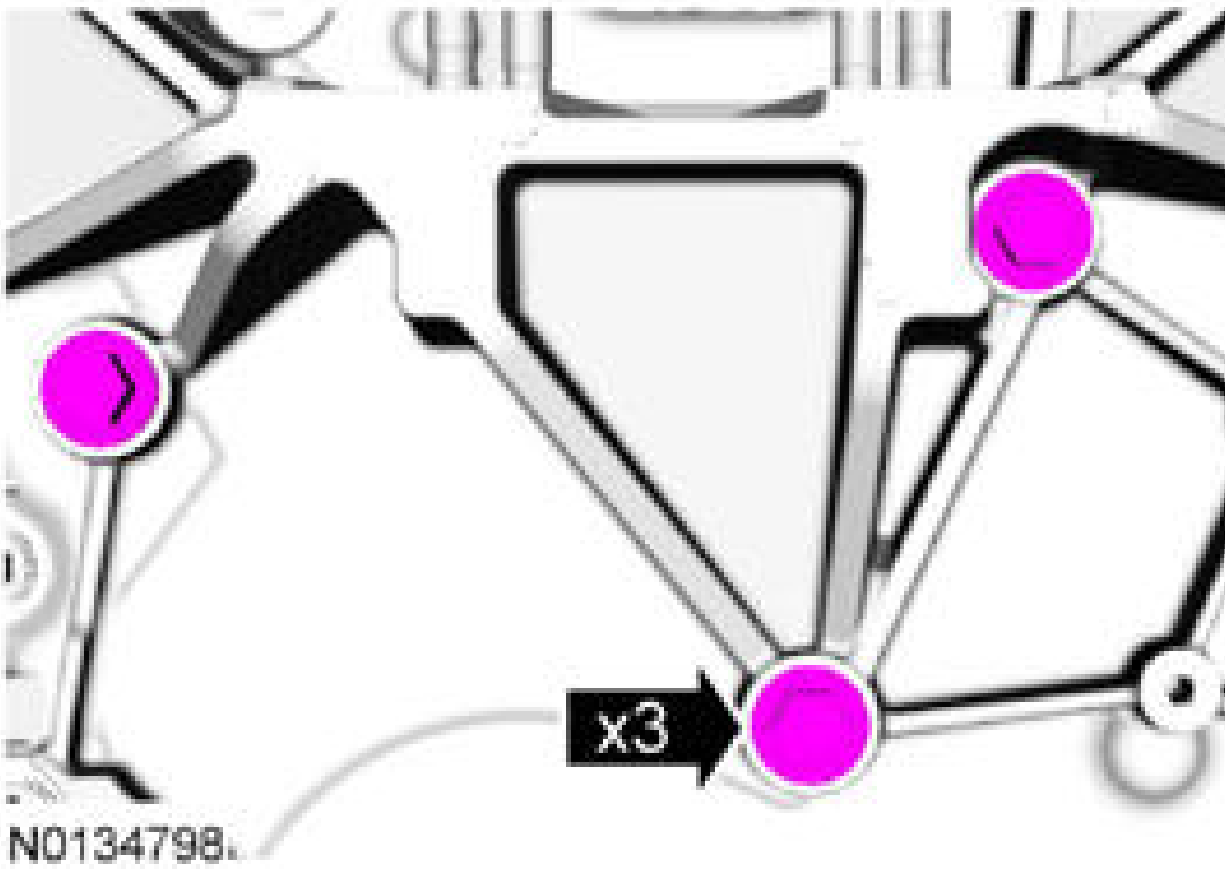
99. Install the M6 engine front cover bolt. Do not tighten at this time.

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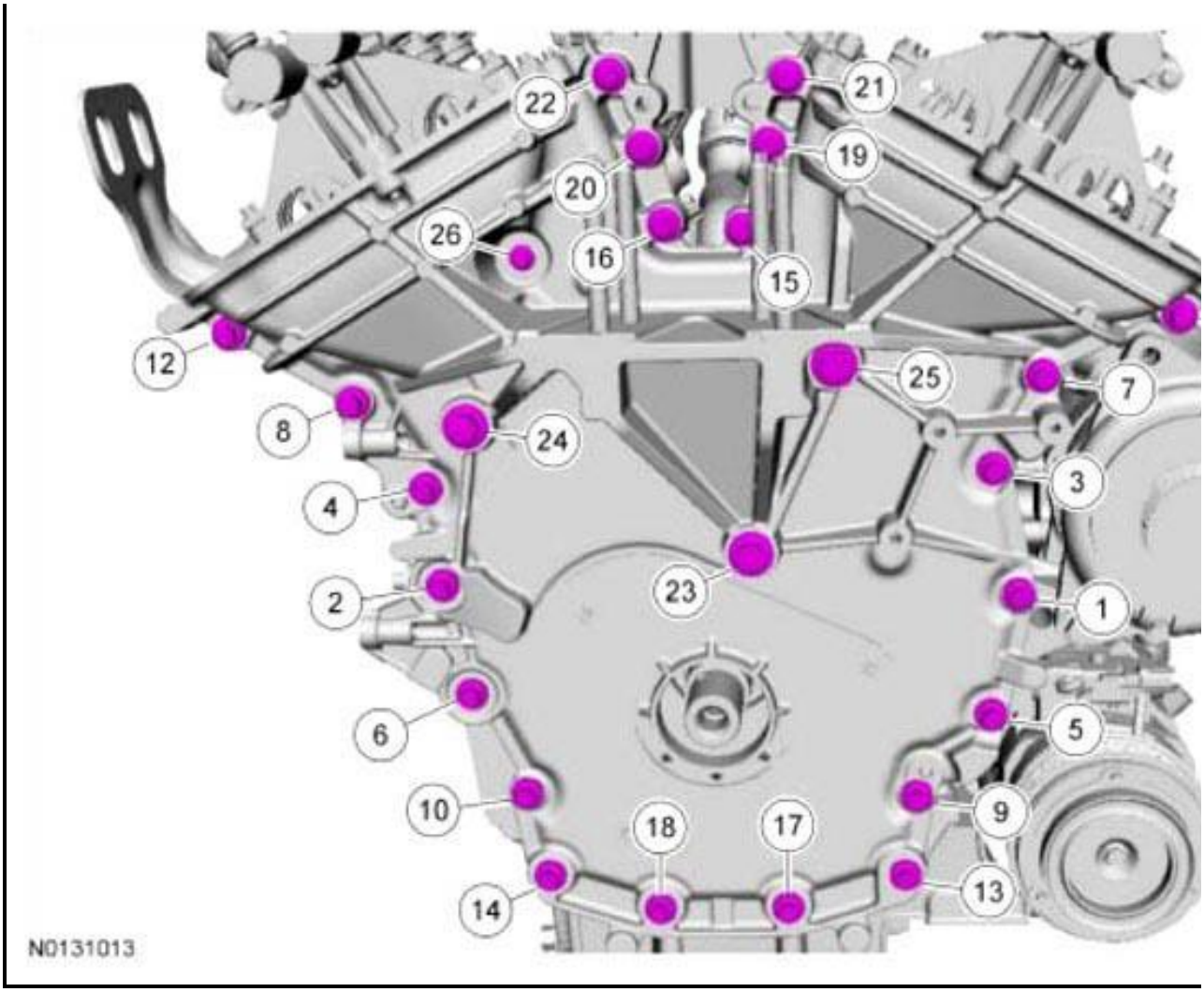
100. Install the 3 upper M10 engine front cover bolts.
    - Do not tighten the bolts at this time.

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101. Install the remaining engine front cover bolts. Tighten all of the engine front cover bolts in the sequence shown in illustration in 7 stages.
    - Stage 1: Tighten bolts 1 thru 22 to 10 Nm (89 lb-in).
    - Stage 2: Tighten bolts 23 thru 25 to 15 Nm (133 lb-in).
    - Stage 3: Tighten bolt 26 to 10 Nm (89 lb-in).
    - Stage 4: Loosen bolt 26 one full turn.
    - Stage 5: Tighten bolts 23 thru 25 to 30 Nm (22 lb-ft) plus an additional 90 degrees.
    - Stage 6: Tighten bolts 1 thru 22 to 20 Nm (177 lb-in) plus an additional 45 degrees.
    - Stage 7: Tighten bolt 26 to 10 Nm (89 lb-in) plus an additional 45 degrees.

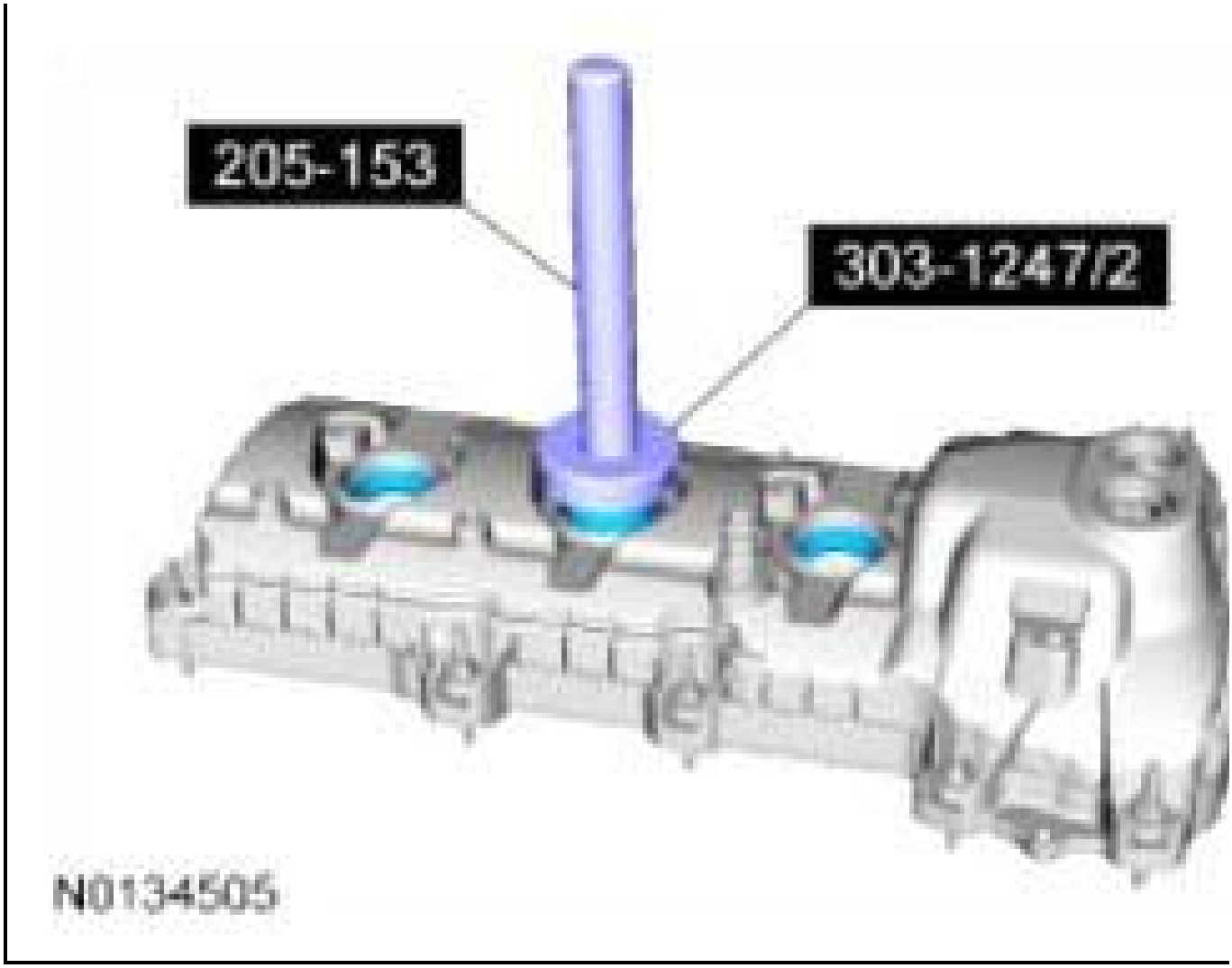
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102. **NOTE: Installation of new seals is only required if damaged seals were removed.**

Using 303-1247/2 and 205-153 T80T-4000-W install the new spark plug tube seal(s).

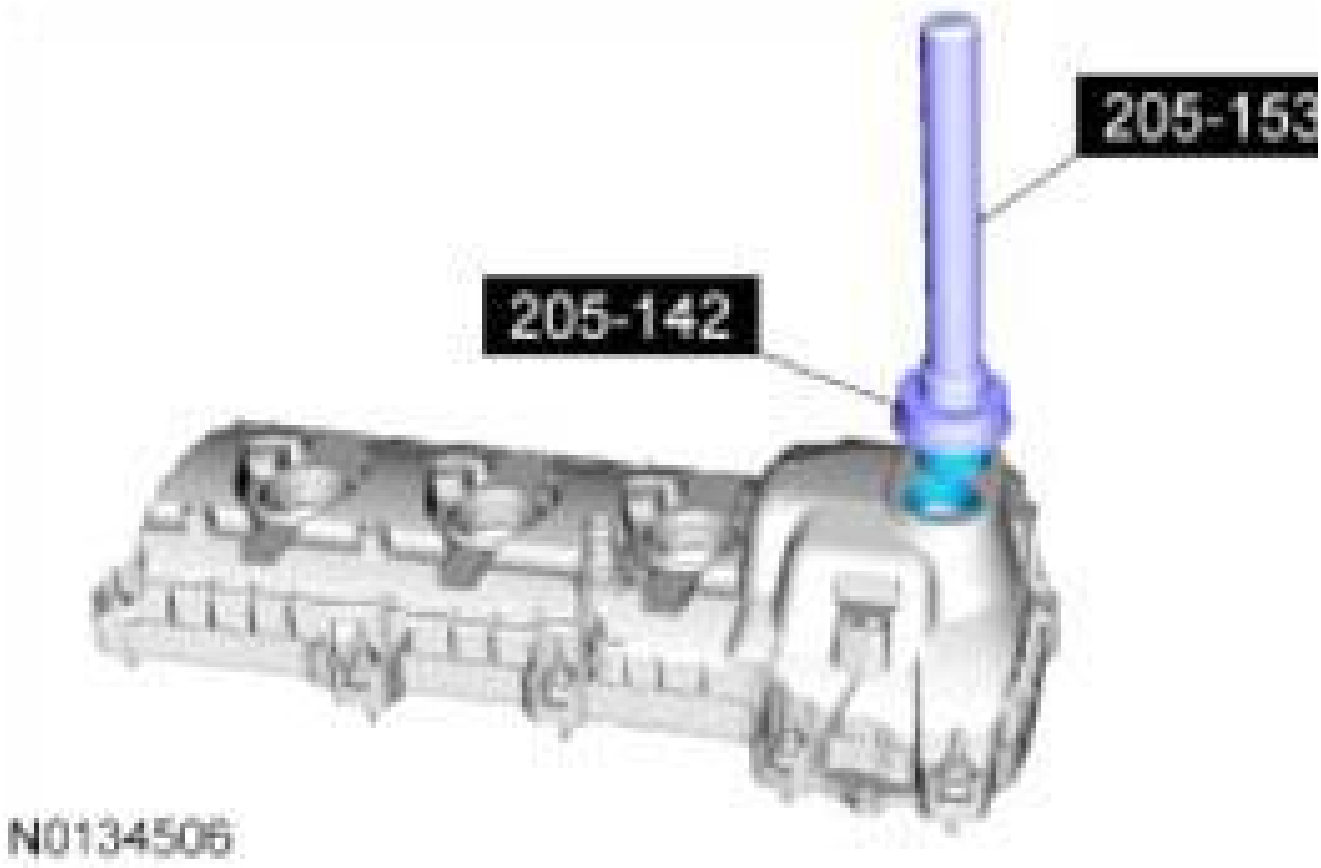
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103. **NOTE: Installation of new seals is only required if damaged seals were removed.**

Using 205-142 T80T-4000-J and 205-153 T80T-4000-W install the new **VCT** seal(s).

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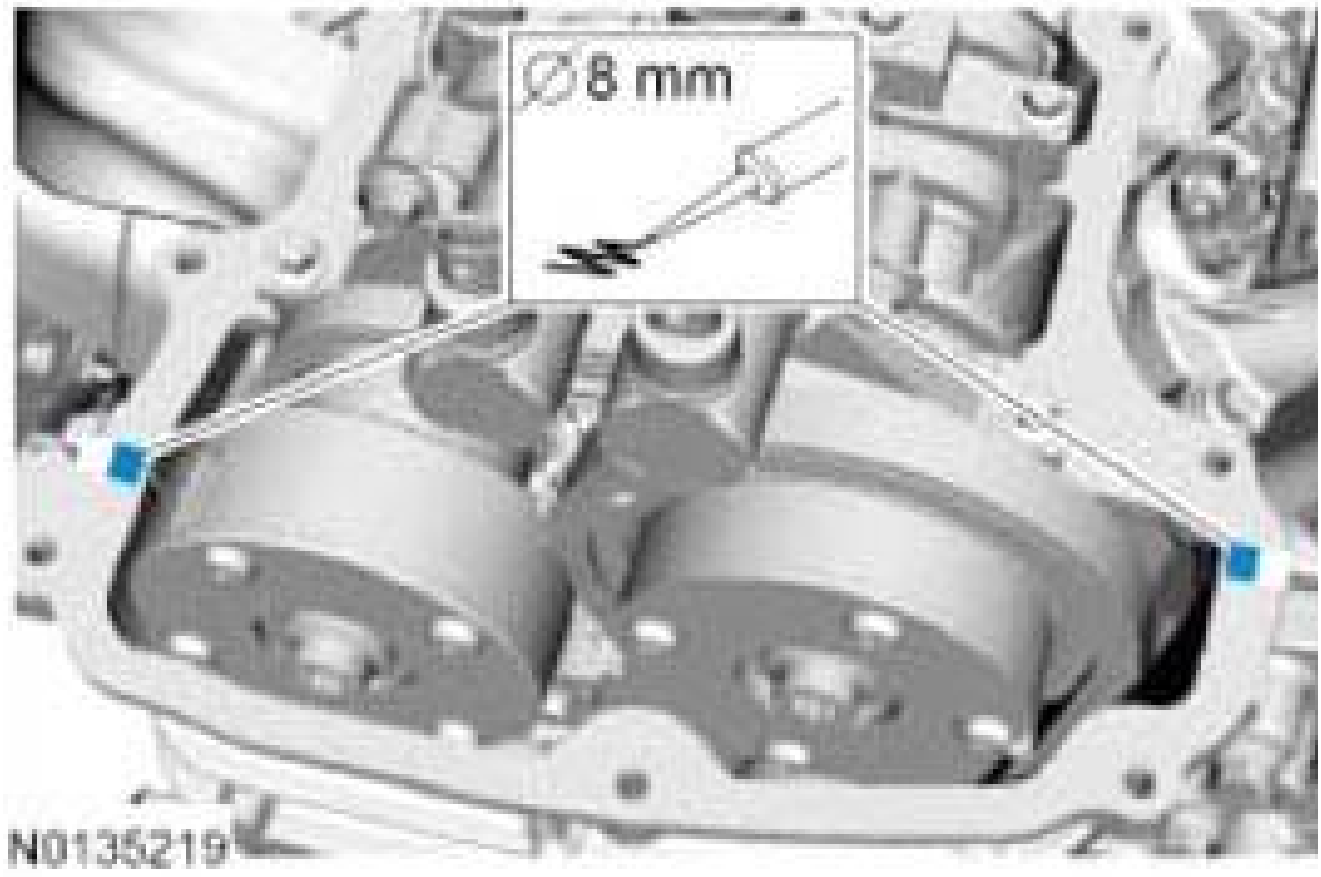
104.

NOTE: **Failure to use Motorcraft® High Performance Engine RTV Silicone may cause the engine oil to foam excessively and result in serious engine damage.**

NOTE: **If the valve cover is not installed and the fasteners tightened within 4 minutes, the sealant must be removed and the sealing area cleaned. To clean the sealing area, use Motorcraft® Silicone Gasket Remover and Motorcraft® Metal Surface Prep. Failure to follow this procedure can cause future oil leakage.**

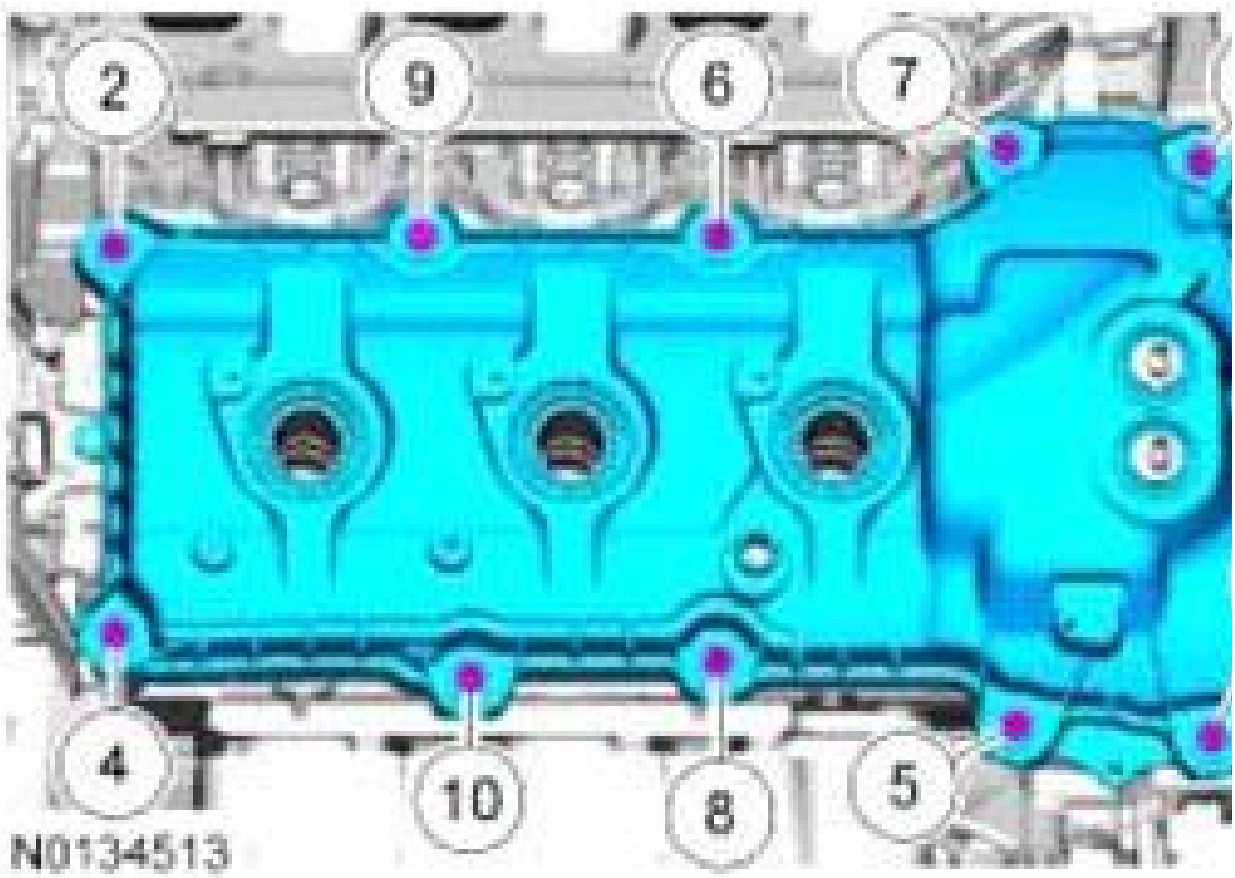
Apply an 8 mm (0.315 in) bead of Motorcraft® High Performance Engine RTV Silicone to the engine front cover-to-Right Hand (RH) cylinder head joints.

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105. Using a new gasket, install the RH valve cover and tighten the 3 bolts and 8 stud bolts.
    - Tighten in the sequence shown in illustration to 10 Nm (89 lb-in).

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106. Make sure the **VCT** seals in the valve cover are below the top of the **VCT** oil control solenoid electrical connector or the **VCT** seal may leak oil.

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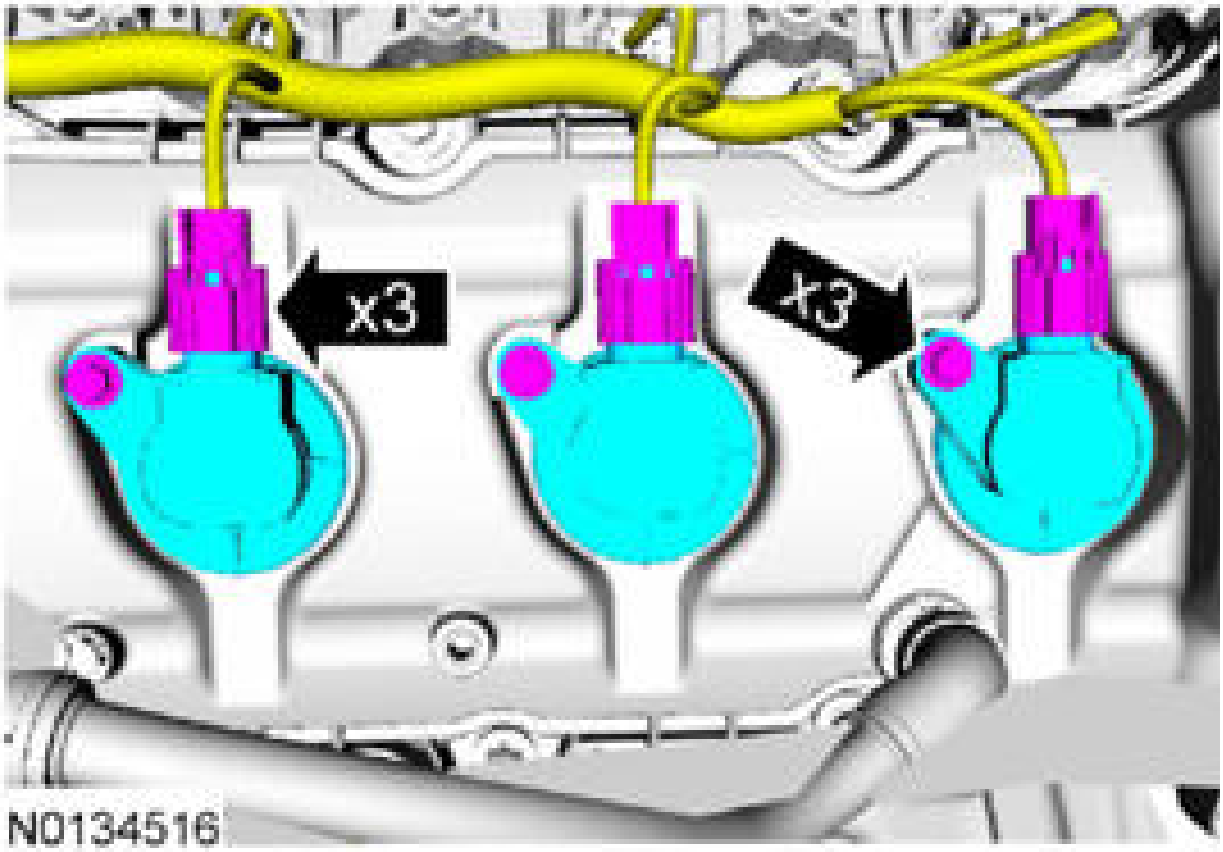


107. **NOTE: Apply a small amount of dielectric grease to the inside of the ignition coil-on-plug boots before attaching to the spark plugs.**

Install the 3 RH coil-on-plugs and the 3 bolts.

- Tighten to 7 Nm (62 lb-in).

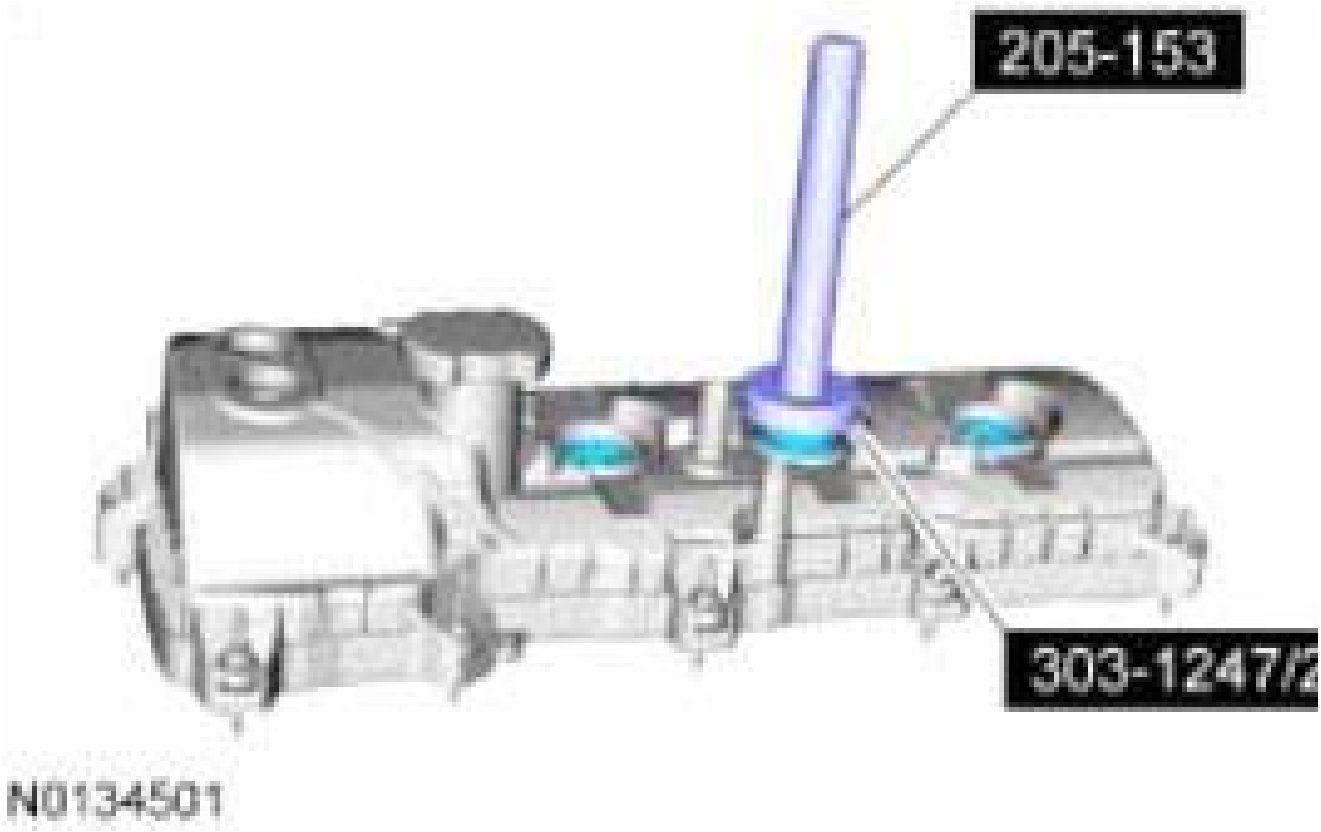
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108. **NOTE: Installation of new seals is only required if damaged seals were removed.**

Using 303-1247/2 and 205-153 T80T-4000-W install the new spark plug tube seal(s).

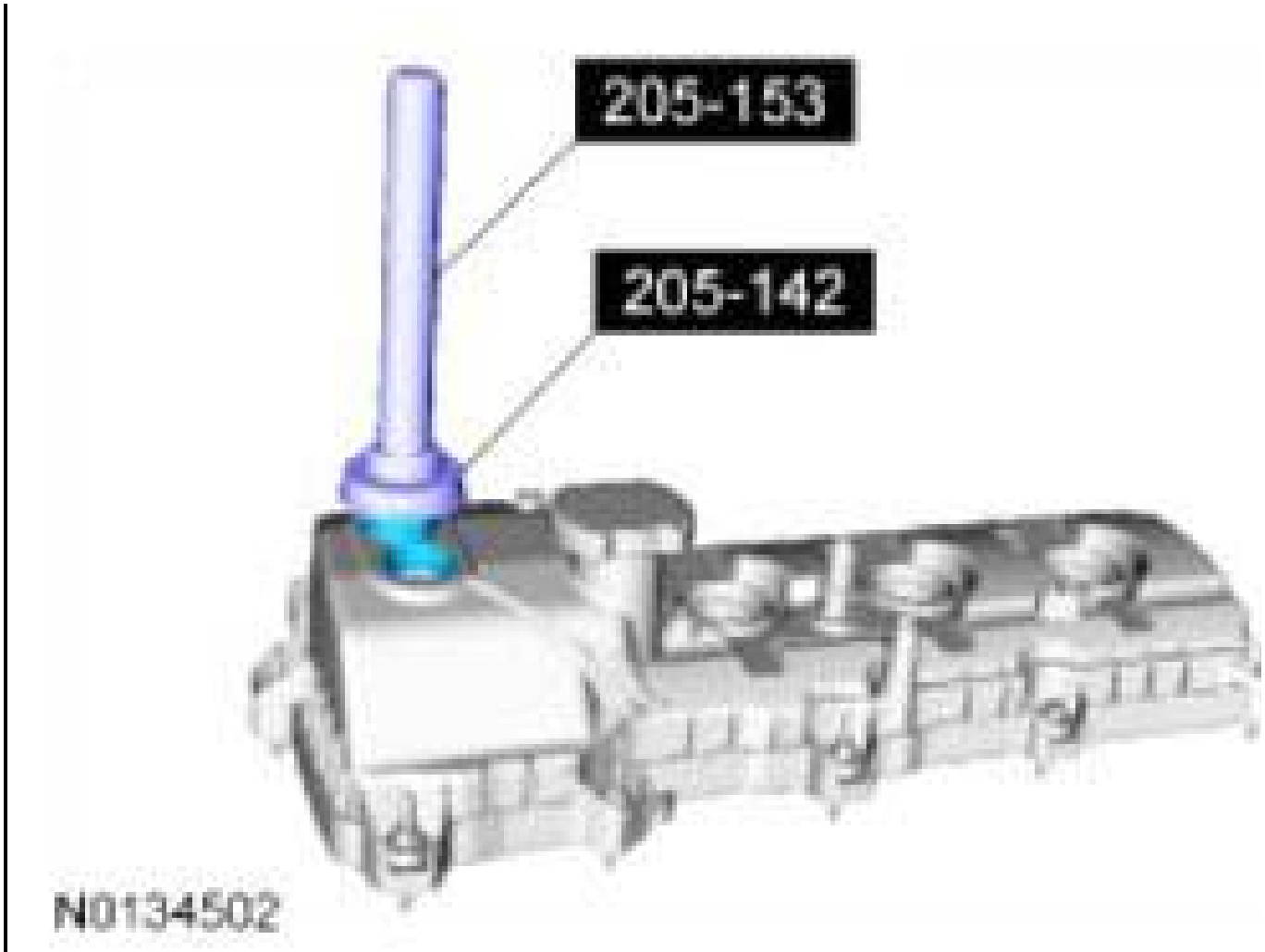
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109. **NOTE: Installation of new seals is only required if damaged seals were removed.**

Using 205-142 T80T-4000-J and 205-153 T80T-4000-W install the new **VCT** seal(s).

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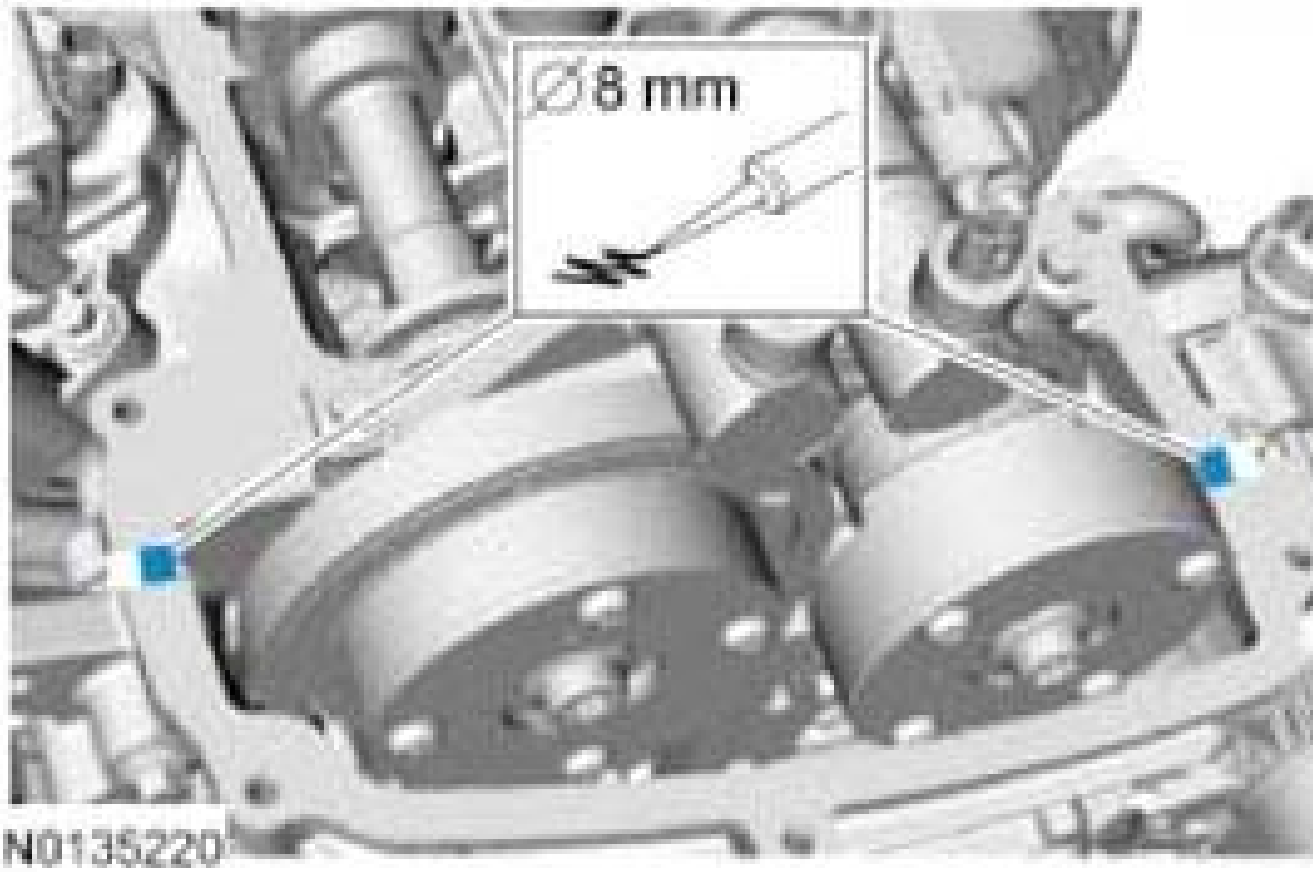
NOTE: **Failure to use Motorcraft® High Performance Engine RTV Silicone may cause the engine oil to foam excessively and result in serious engine damage.**

110.

NOTE: **If the valve cover is not installed and the fasteners tightened within 4 minutes, the sealant must be removed and the sealing area cleaned. To clean the sealing area, use Motorcraft® Silicone Gasket Remover and Motorcraft® Metal Surface Prep. Failure to follow this procedure can cause future oil leakage.**

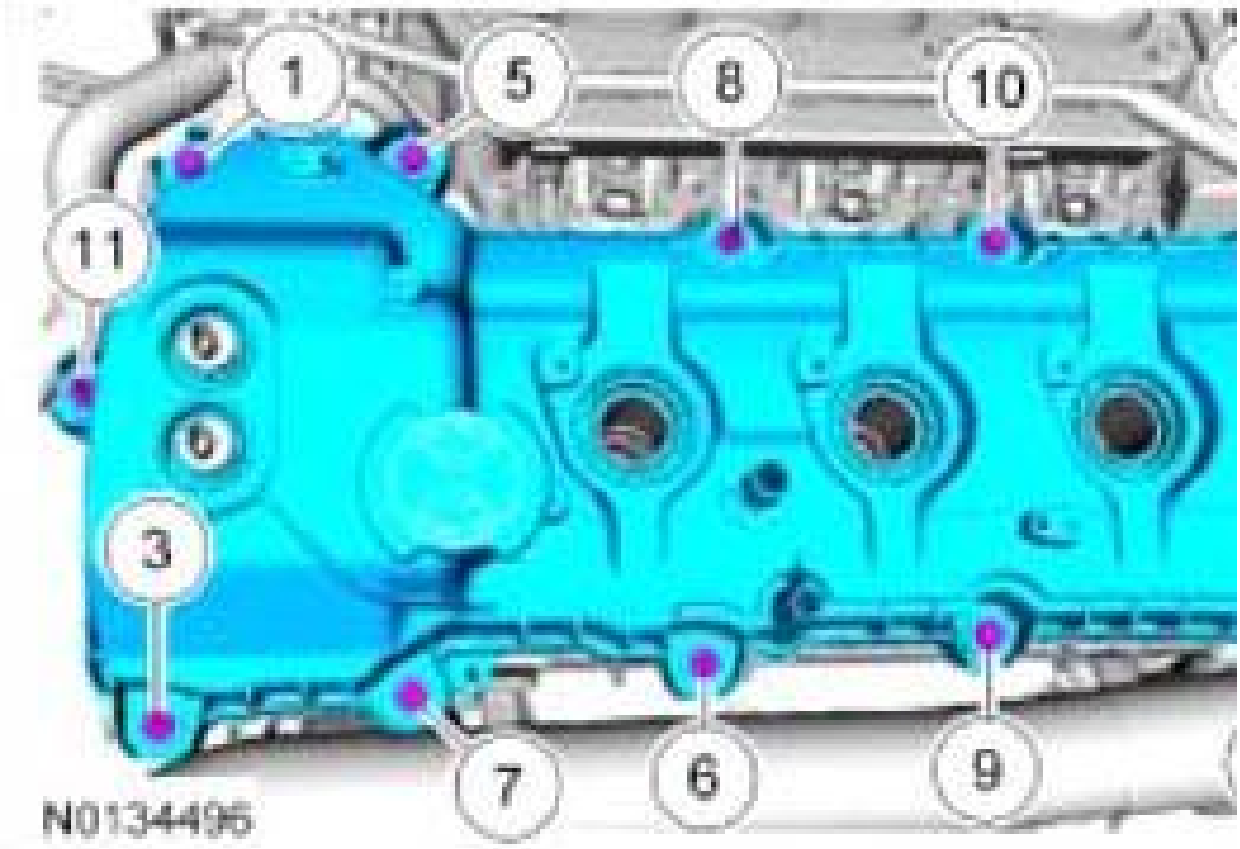
Apply an 8 mm (0.315 in) bead of Motorcraft® High Performance Engine RTV Silicone to the engine front cover-to-Left Hand (LH) cylinder head joints.

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111. Using a new gasket, install the LH valve cover and tighten the 4 bolts and 7 stud bolts.
    - Tighten in the sequence shown in illustration to 10 Nm (89 lb-in).

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112. Make sure the **VCT** seals in the valve cover are below the top of the **VCT** oil control solenoid electrical connector or the **VCT** seal may leak oil.

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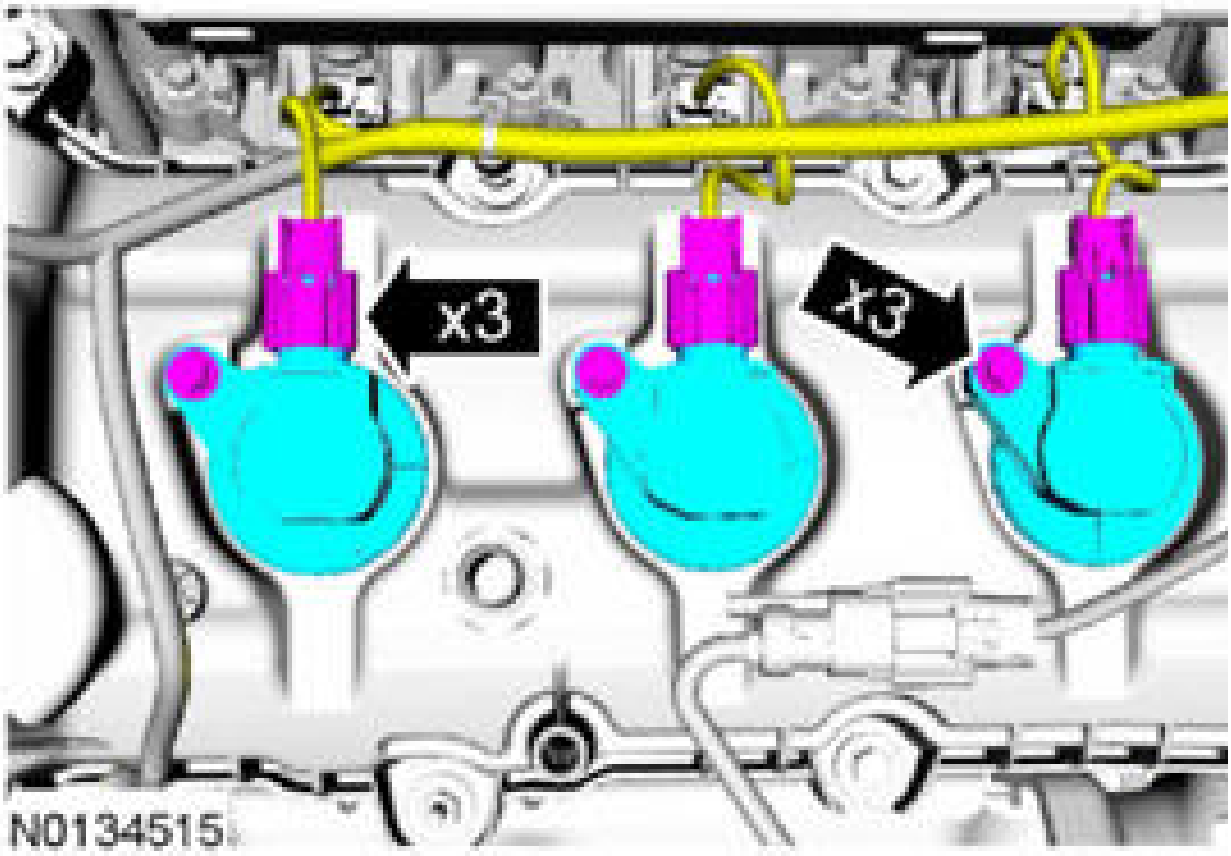


113. **NOTE: Apply a small amount of dielectric grease to the inside of the ignition coil-on-plug boots before attaching to the spark plugs.**

Install the 3 LH coil-on-plugs and the 3 bolts.

- Tighten to 7 Nm (62 lb-in).

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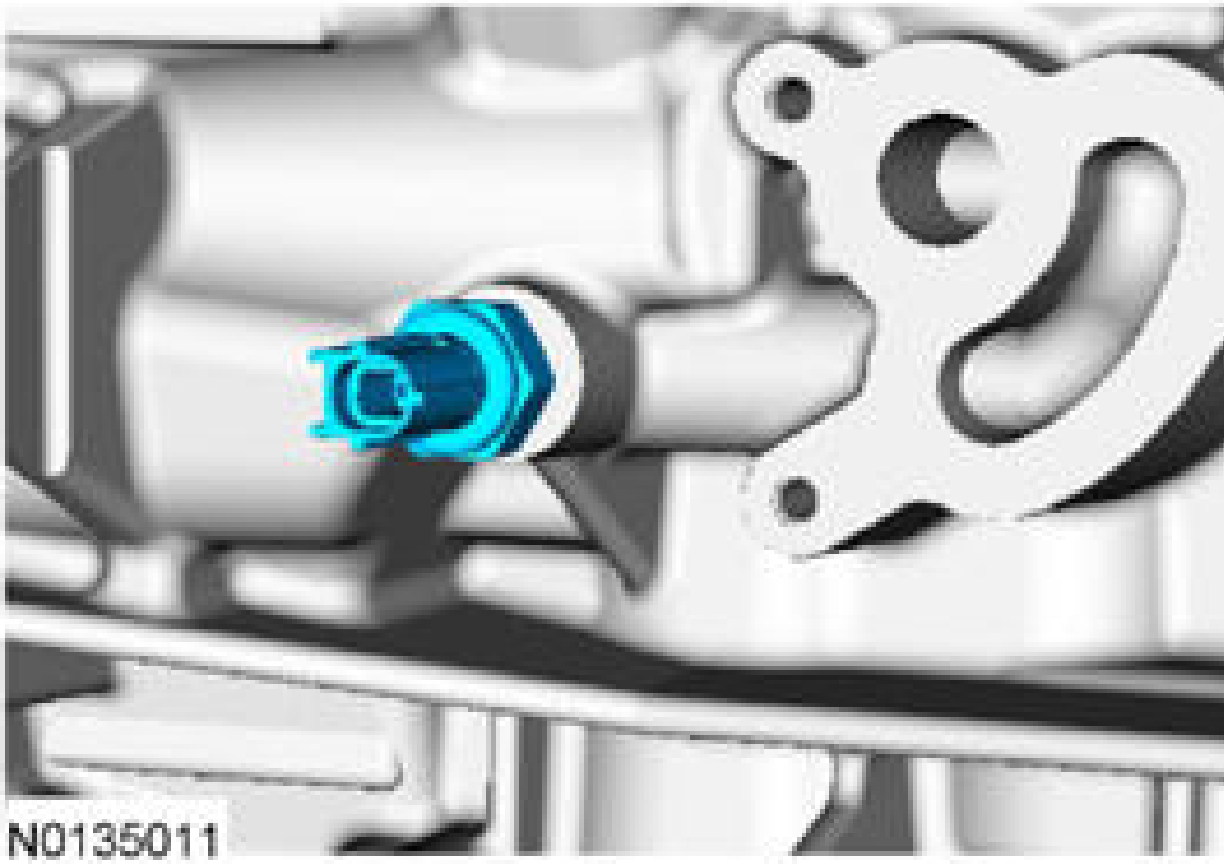


114. **NOTE: Apply Thread Sealant with PTFE to the EOP switch threads.**

Install the EOP switch.

- Tighten to 14 Nm (124 lb-in) plus an additional 180 degrees.

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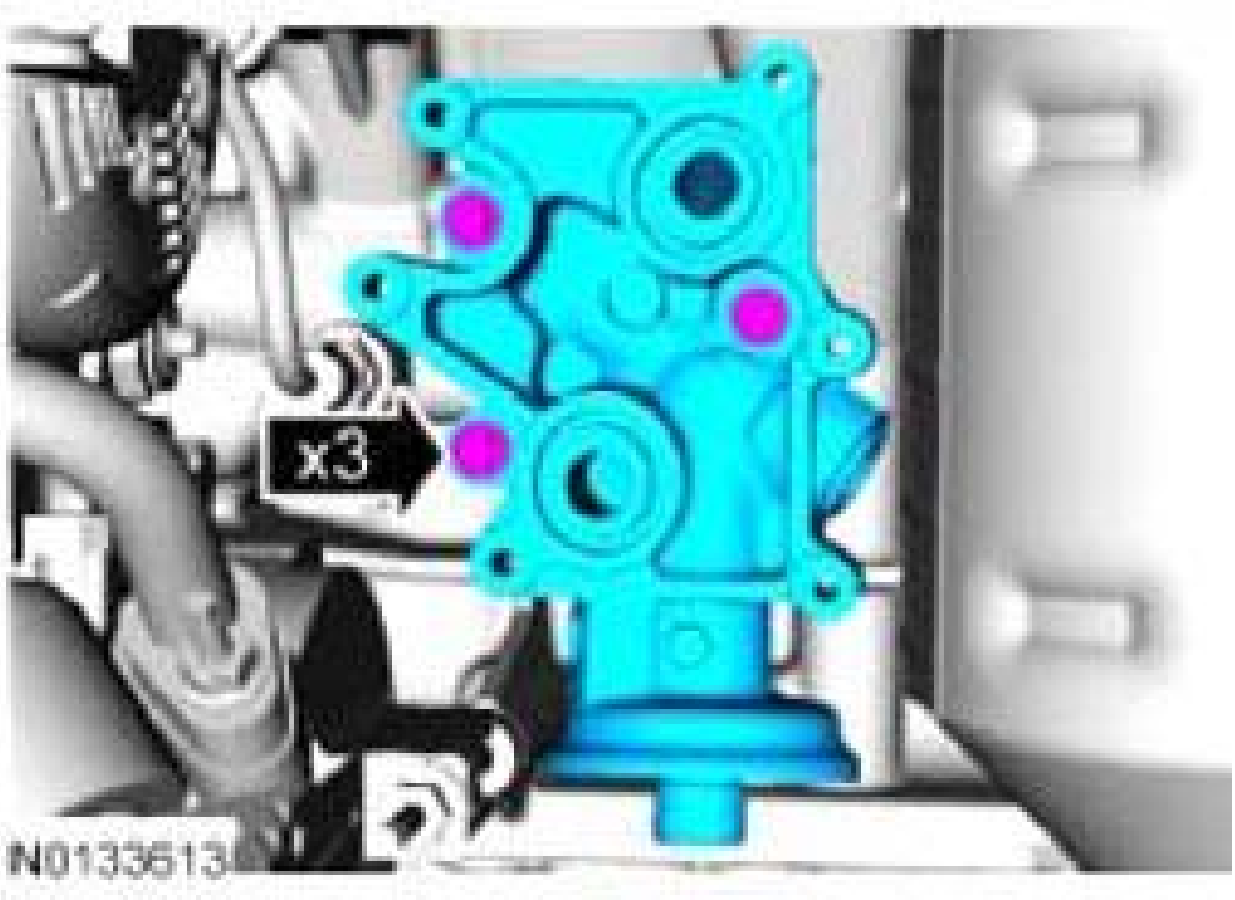


NOTE: **Oil filter adapter with oil cooler shown in illustration, oil filter adapter without oil cooler similar.**

115. Using a new gasket, install the oil filter adapter and the 3 bolts.

- Tighten to 10 Nm (89 lb-in) plus an additional 45 degrees.

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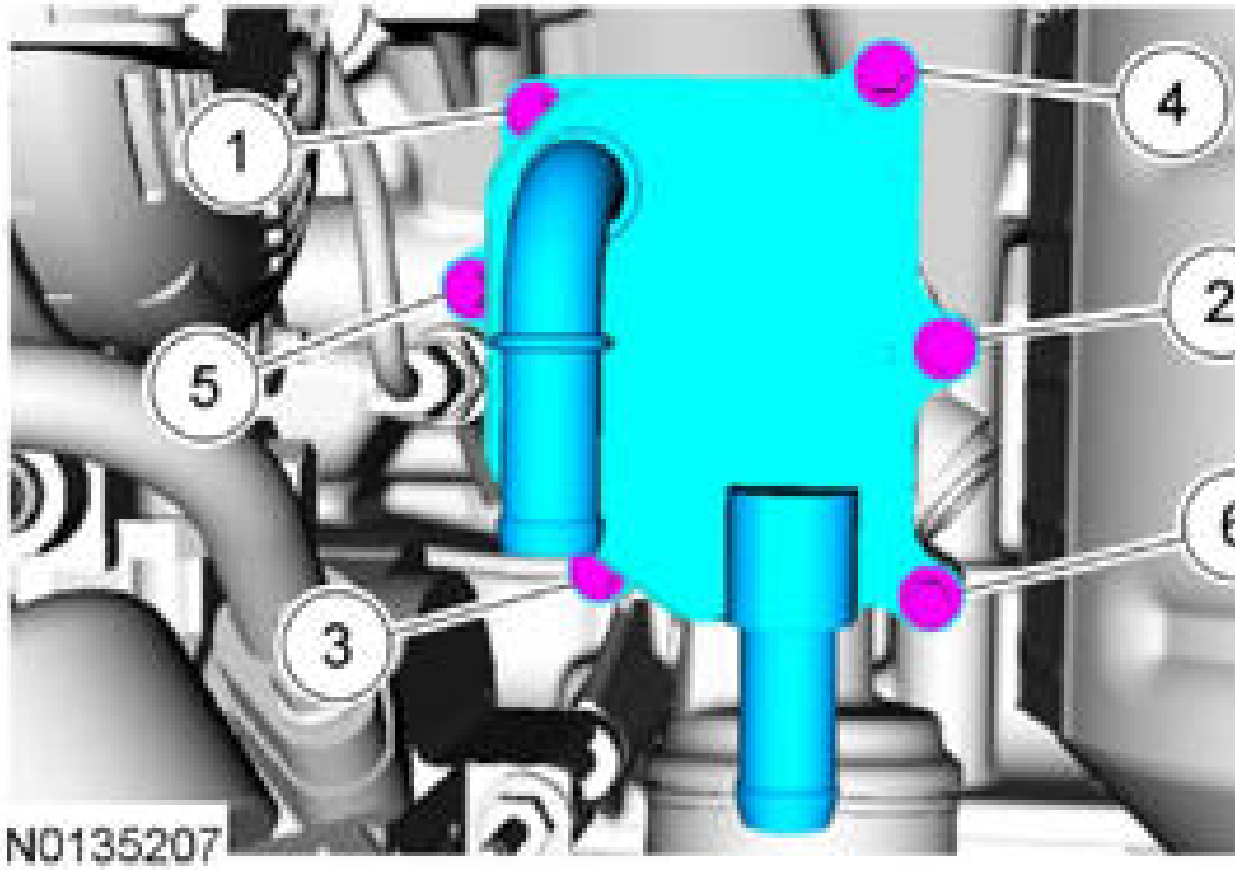


NOTE: A new oil cooler must be installed or severe damage to the engine may occur.

116. If equipped, install a new oil cooler, new gaskets and the 6 bolts.

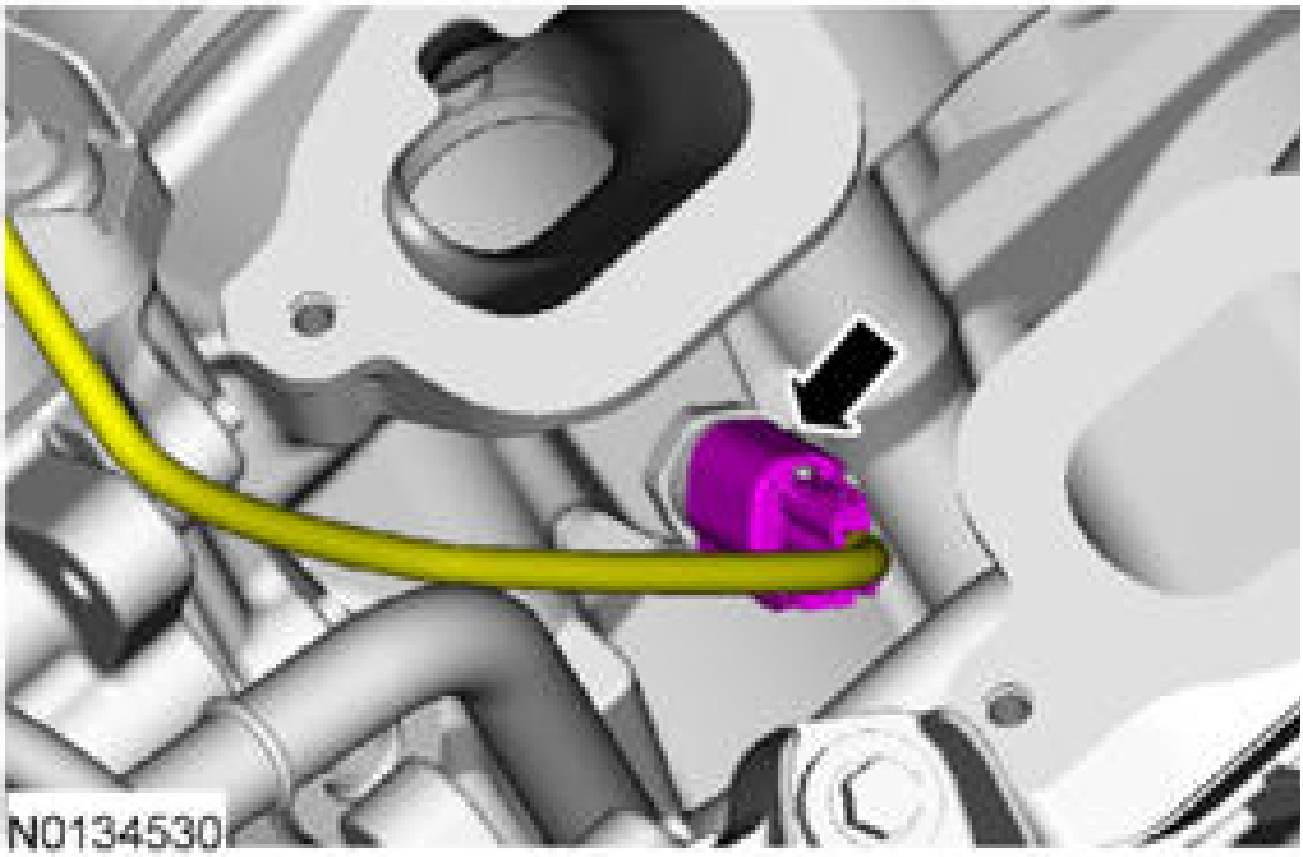
- Tighten in the sequence shown in illustration to 10 Nm (89 lb-in).

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117. Install and connect the **CHT** sensor jumper harness.

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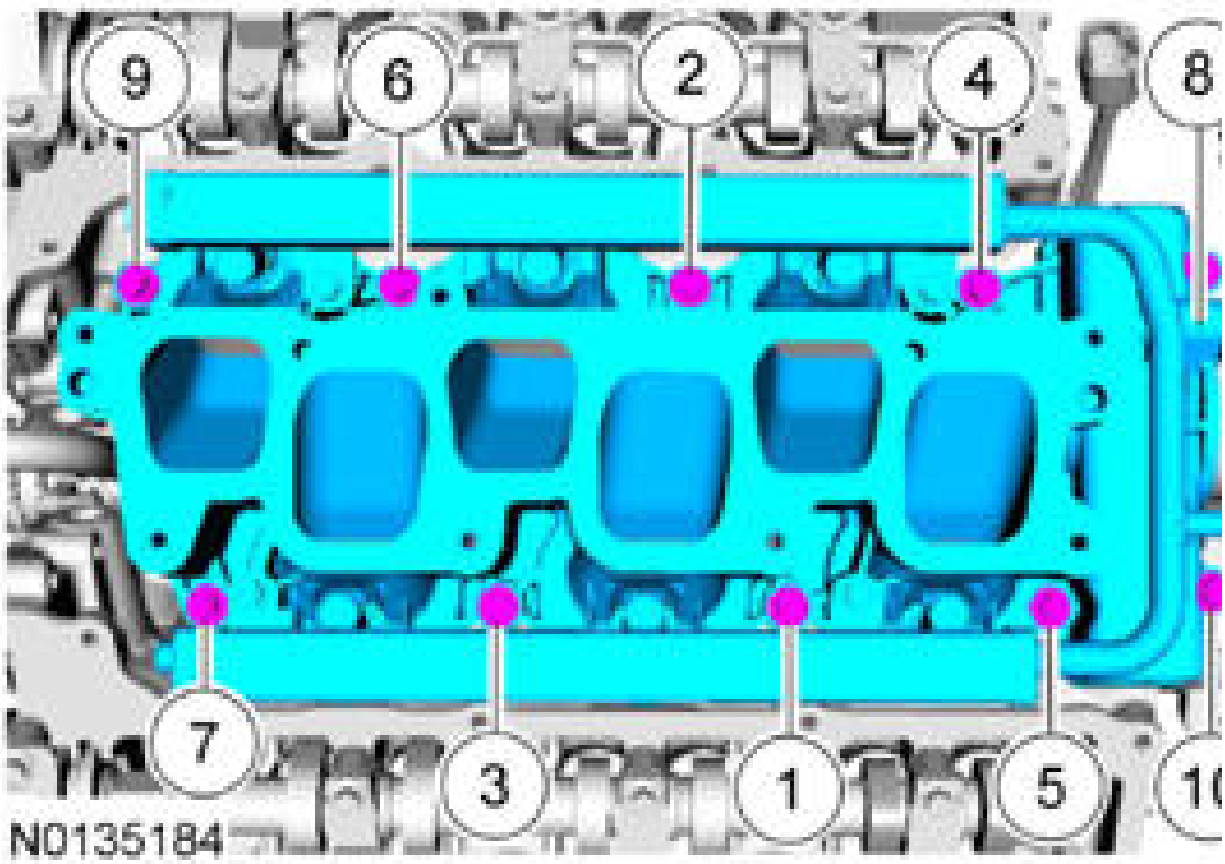
NOTE: **If the engine is repaired or replaced because of upper engine failure, typically including valve or piston damage, check the intake manifold for metal debris. If metal debris is found, install a new intake manifold. Failure to follow these instructions can result in engine damage.**

118.

Using new intake manifold and thermostat housing gaskets, install the lower intake manifold and the 10 bolts.

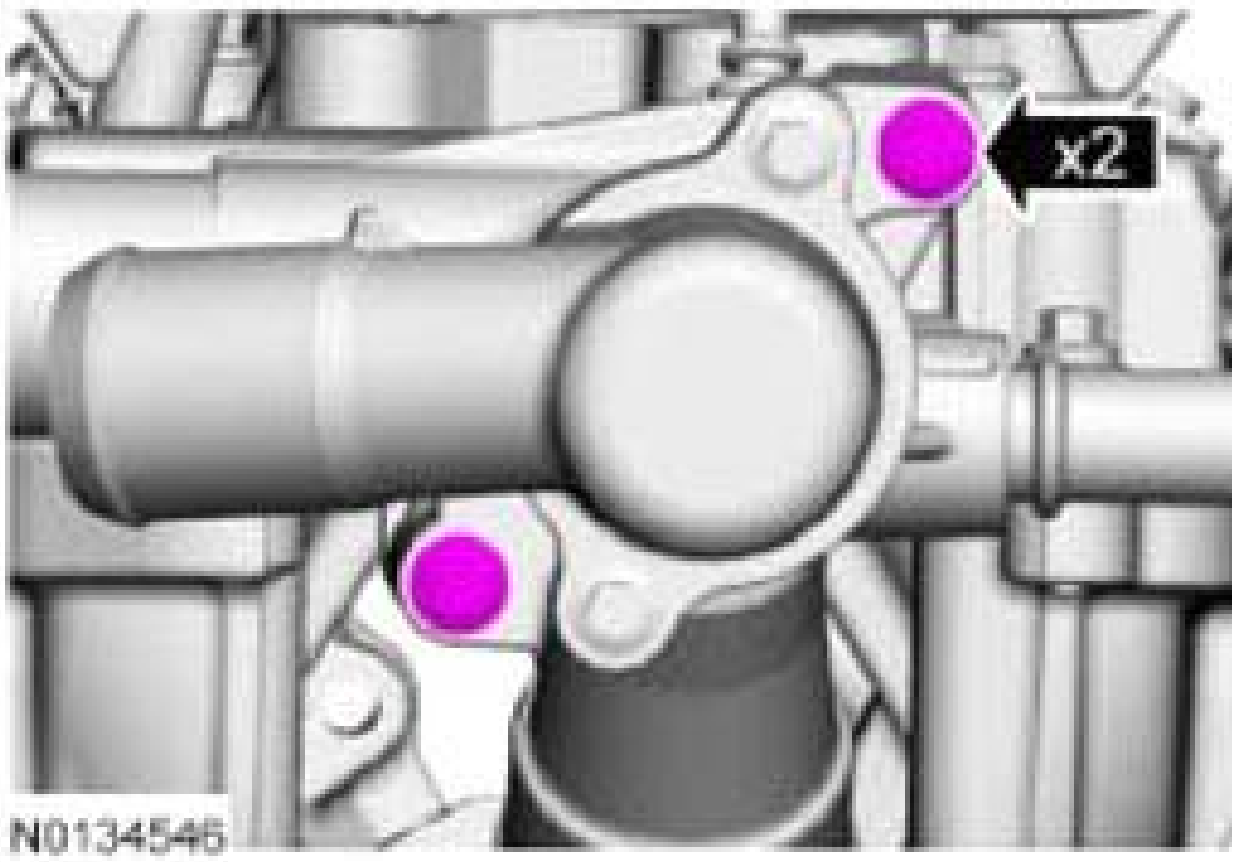
- Tighten in the sequence shown in illustration to 10 Nm (89 lb-in).

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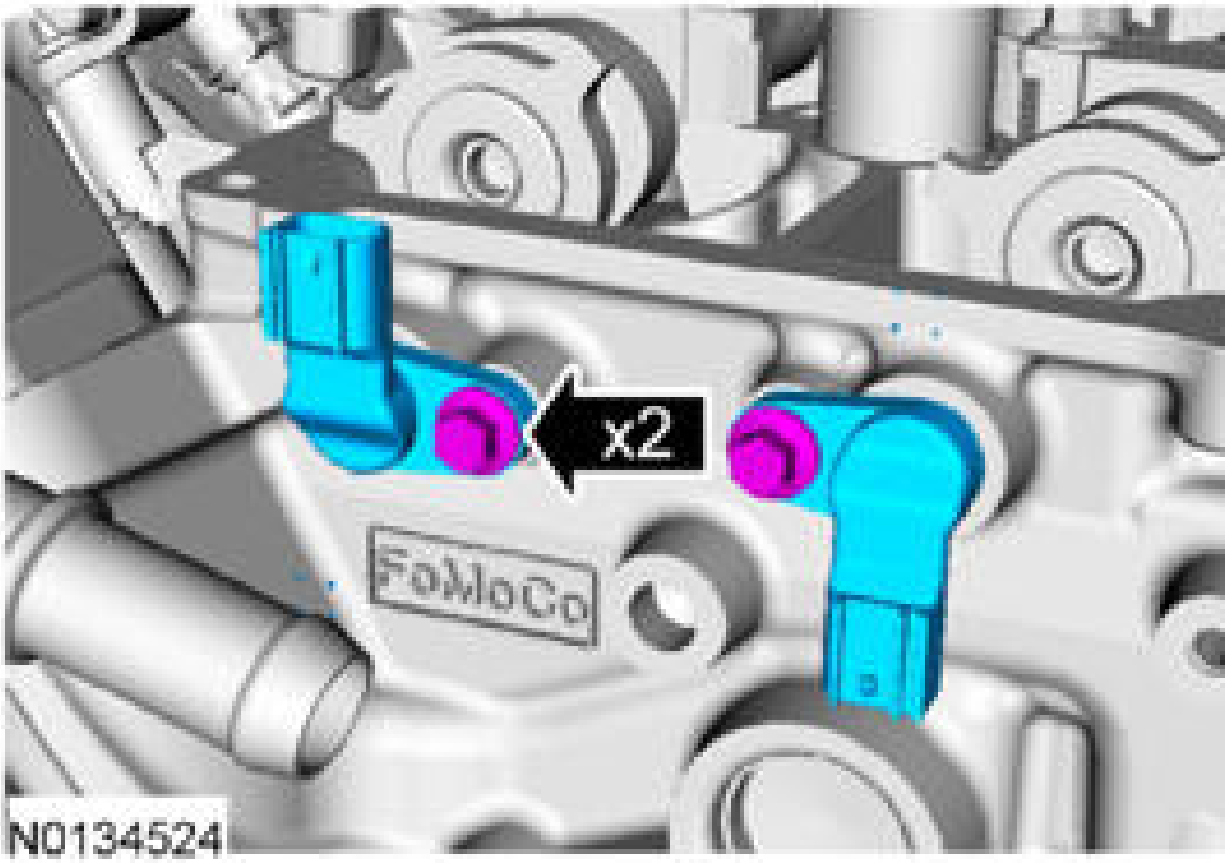
119. Install the 2 thermostat housing-to-lower intake manifold bolts.
    - Tighten to 10 Nm (89 lb-in).

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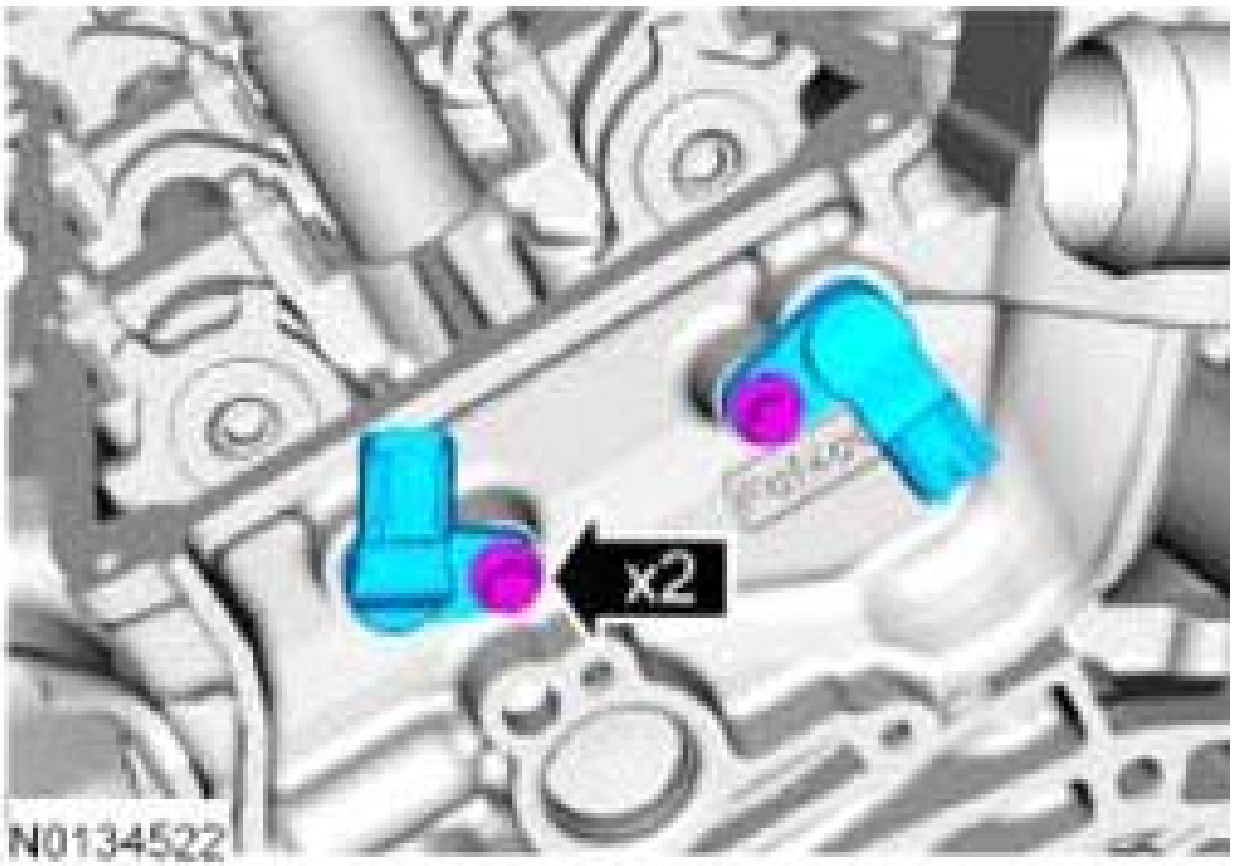
120. Install the 2 bolts and the 2 LH CMP sensors.
    - Tighten to 10 Nm (89 lb-in).

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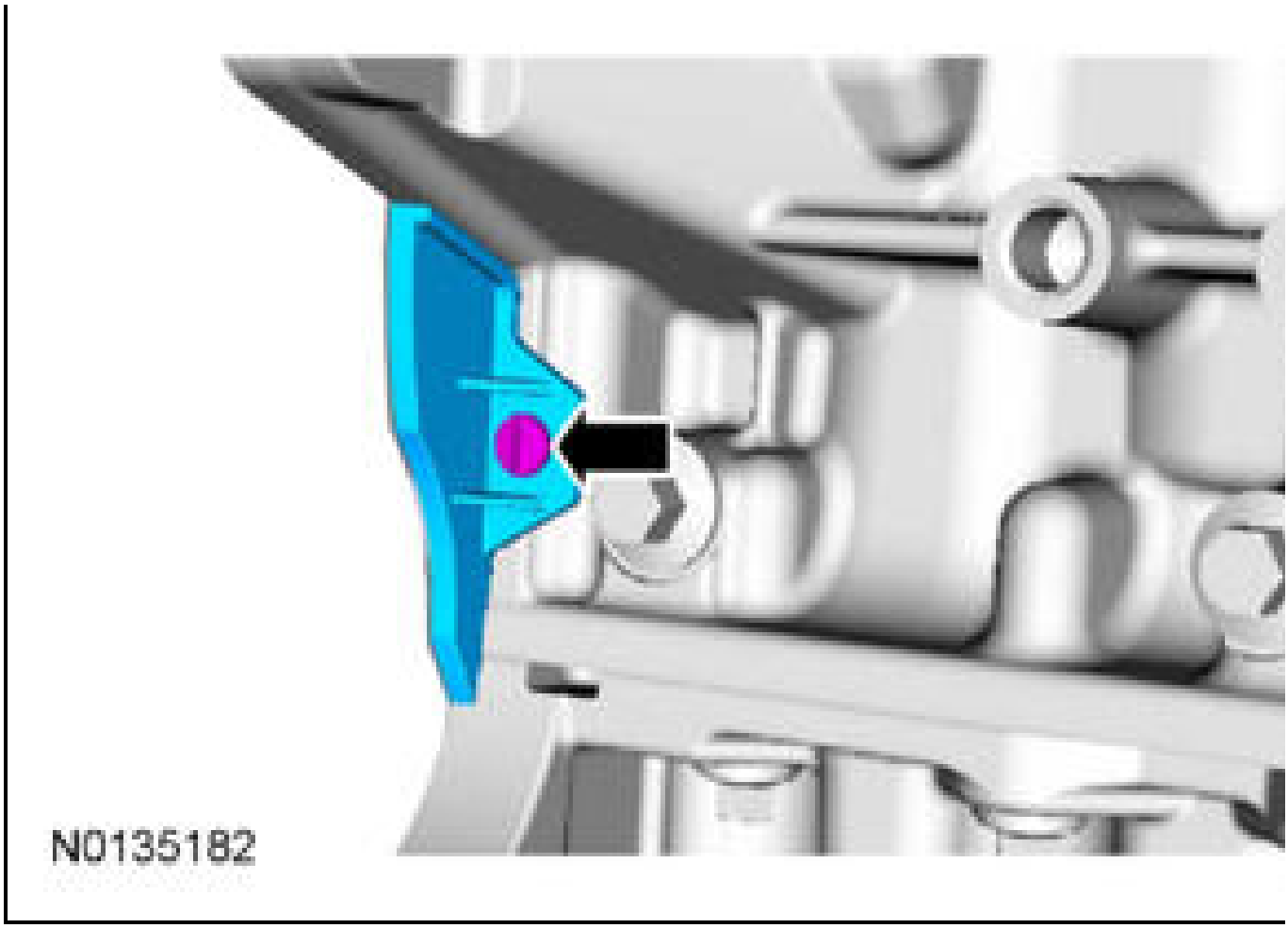
121. Install the 2 bolts and the 2 RH CMP sensors.
    - Tighten to 10 Nm (89 lb-in).

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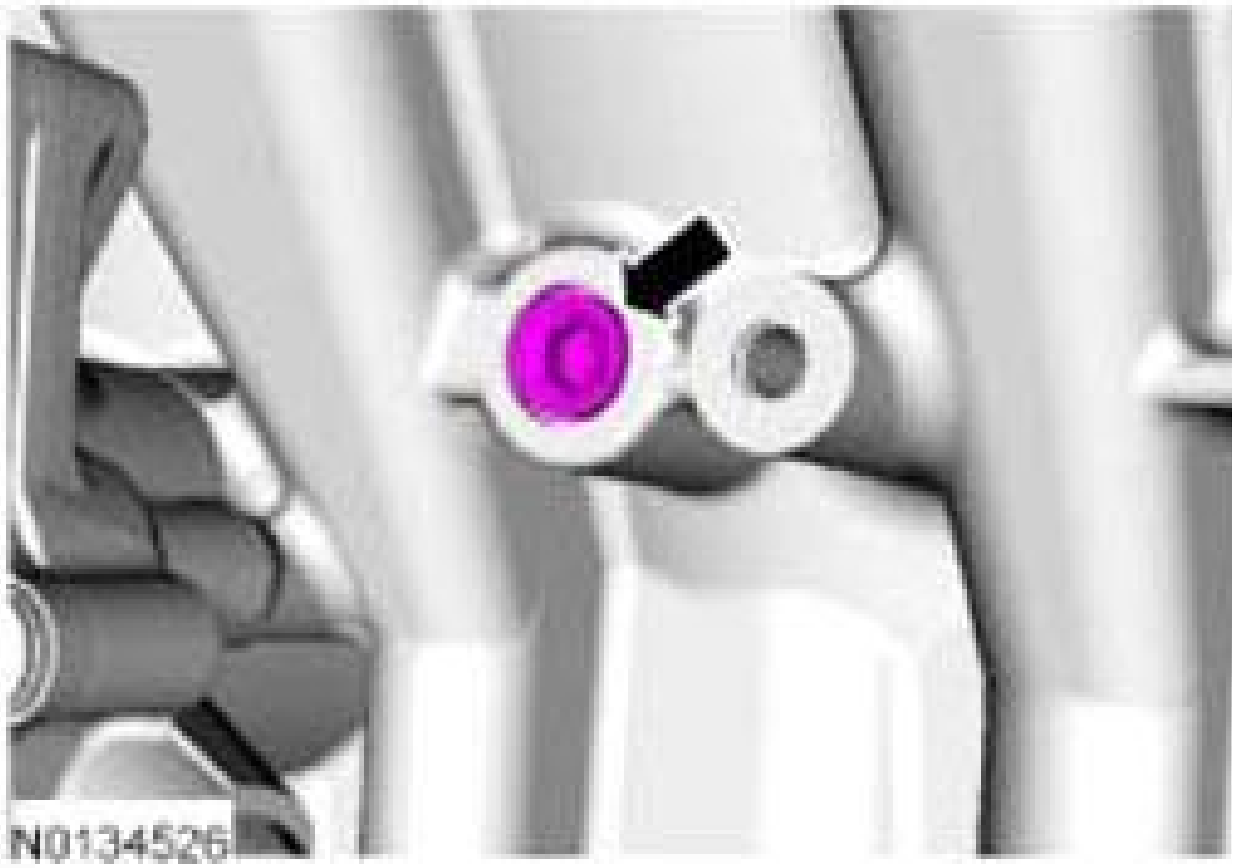
122. Install the cover and the pin-type retainer.

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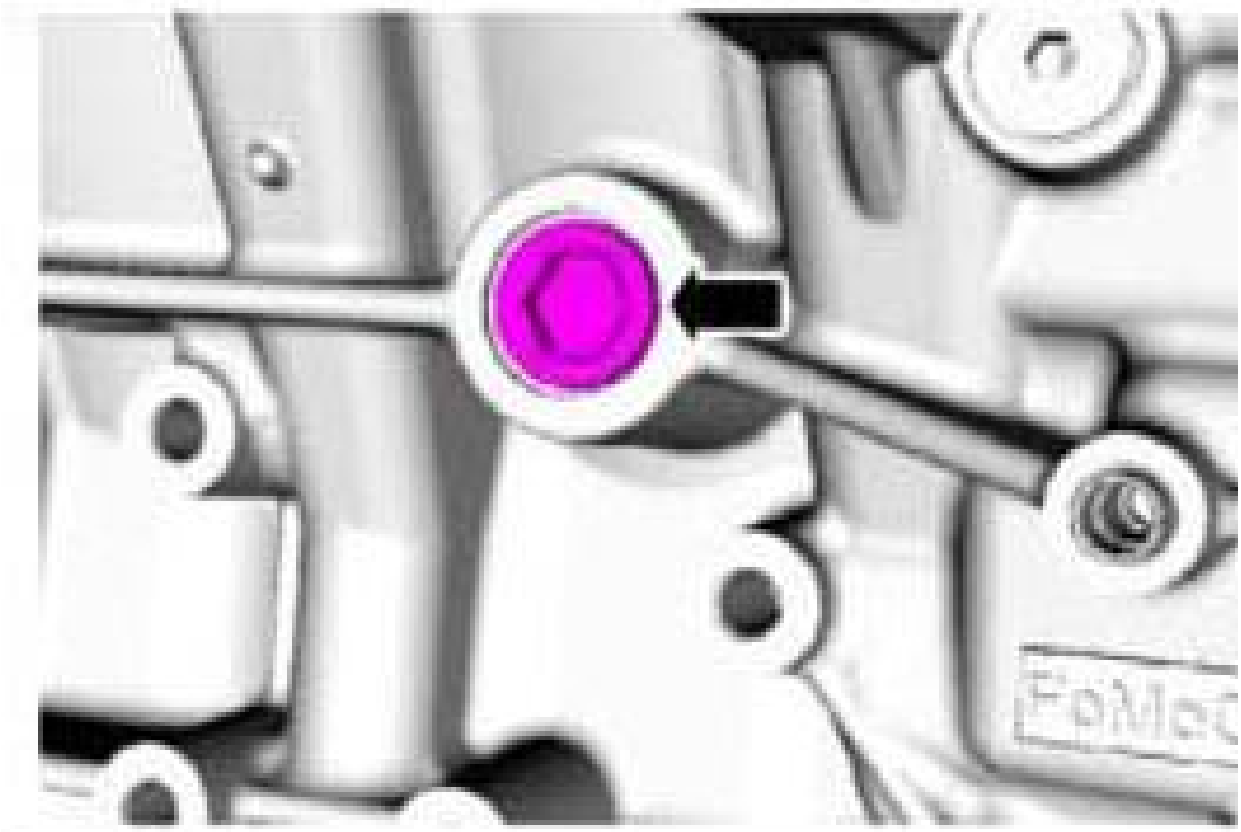
123. Install the LH cylinder block drain plug.
    - Tighten to 16 Nm (142 lb-in) plus an additional 180 degrees.

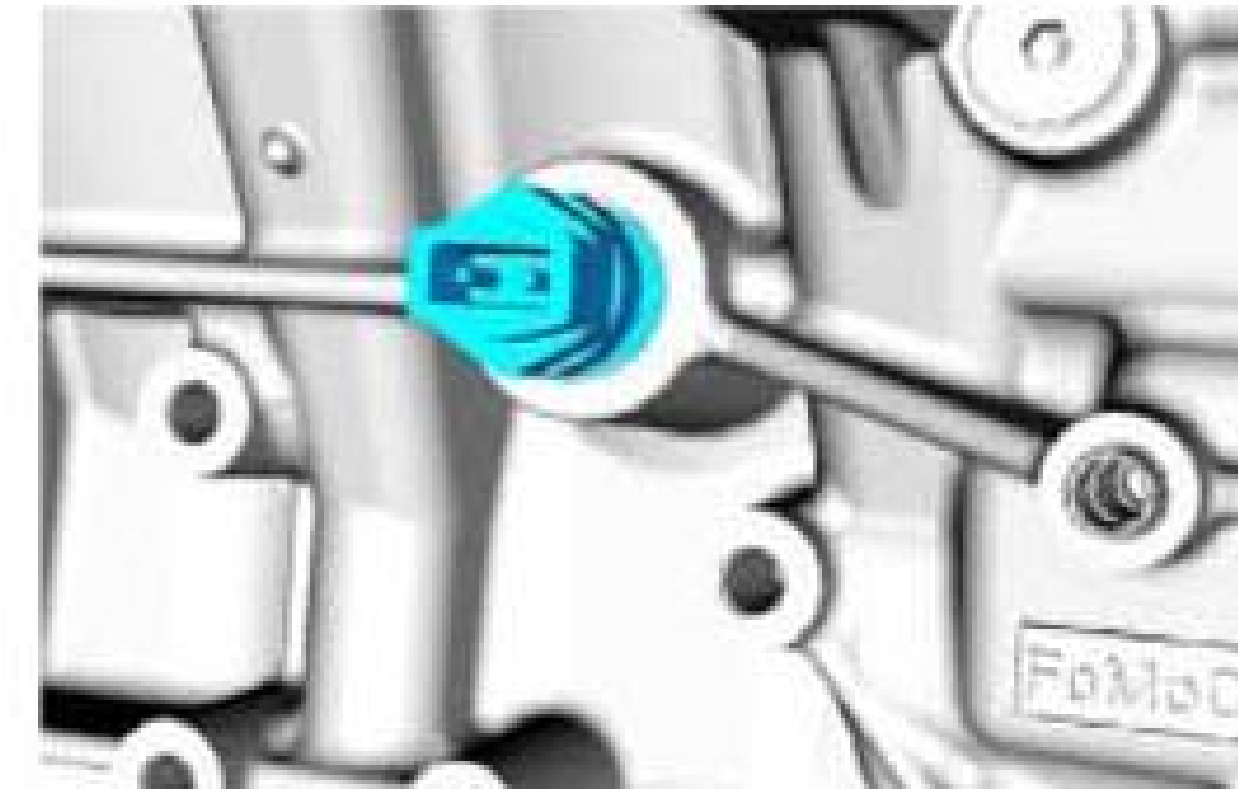
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124. If equipped, install the block heater wiring harness onto the engine.
    - Stage 1: Tighten the cylinder block drain plug to 10 Nm (89 lb-in) plus an additional 180 degrees.
    - Stage 2: Tighten the block heater to 40 Nm (30 lb-ft).

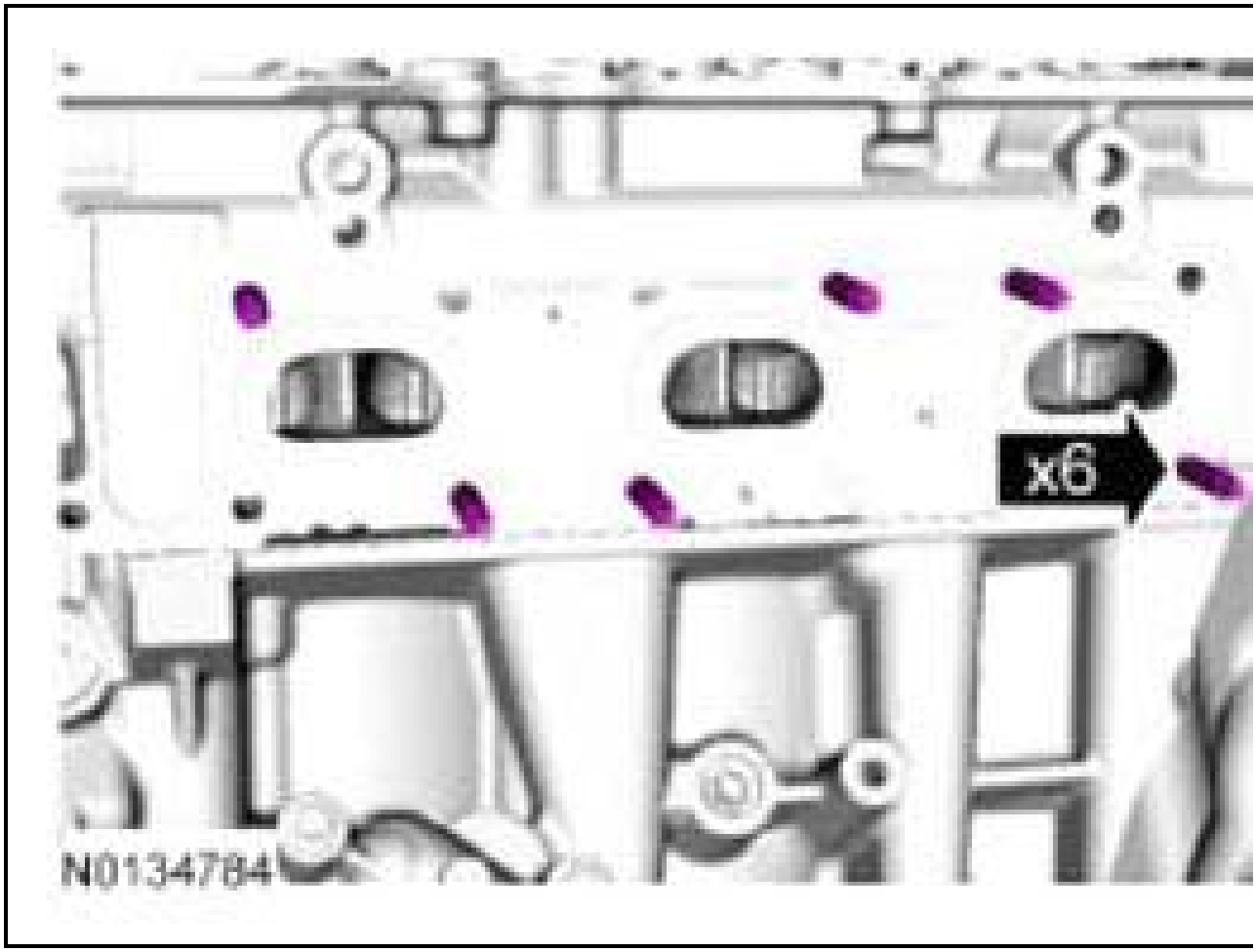
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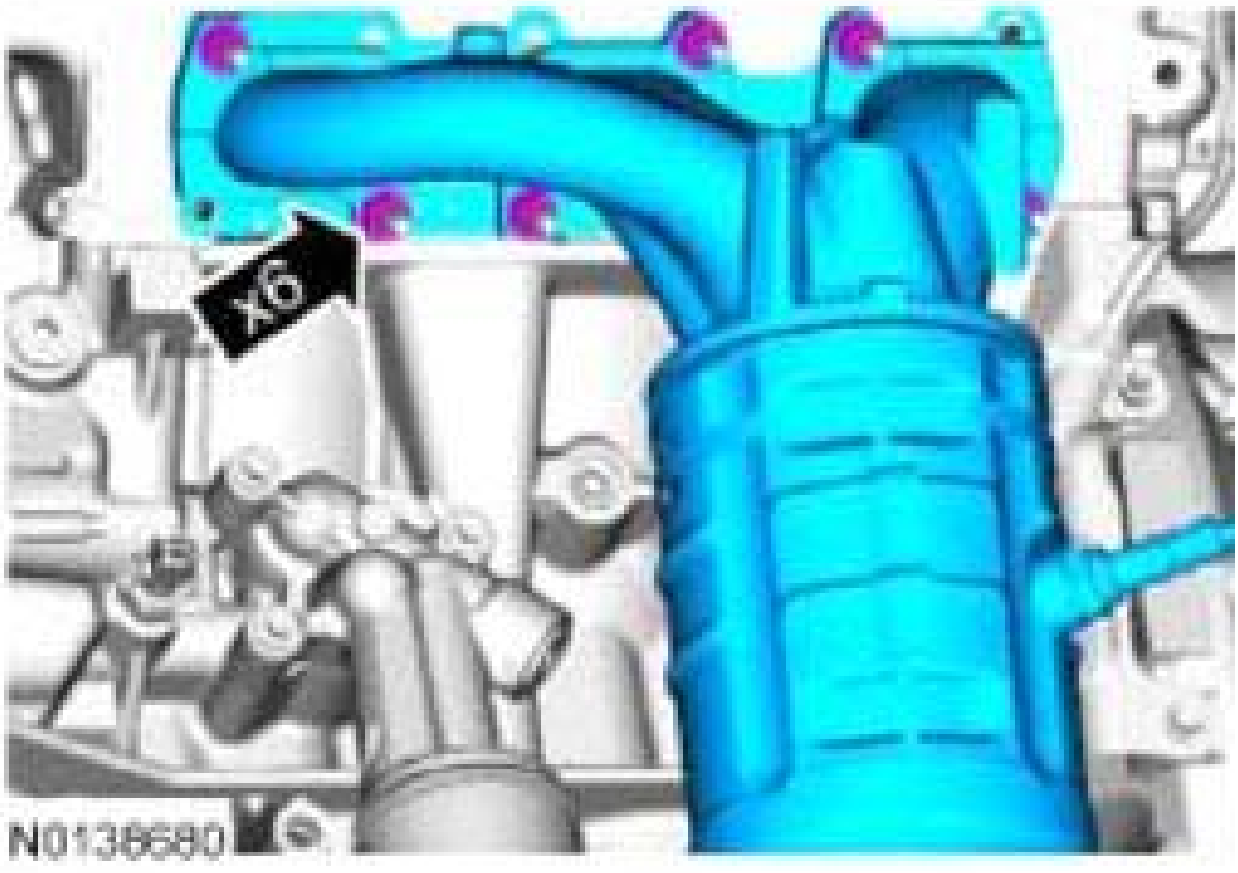
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125. Install 6 new LH exhaust manifold studs.
    - Tighten to 12 Nm (106 lb-in).



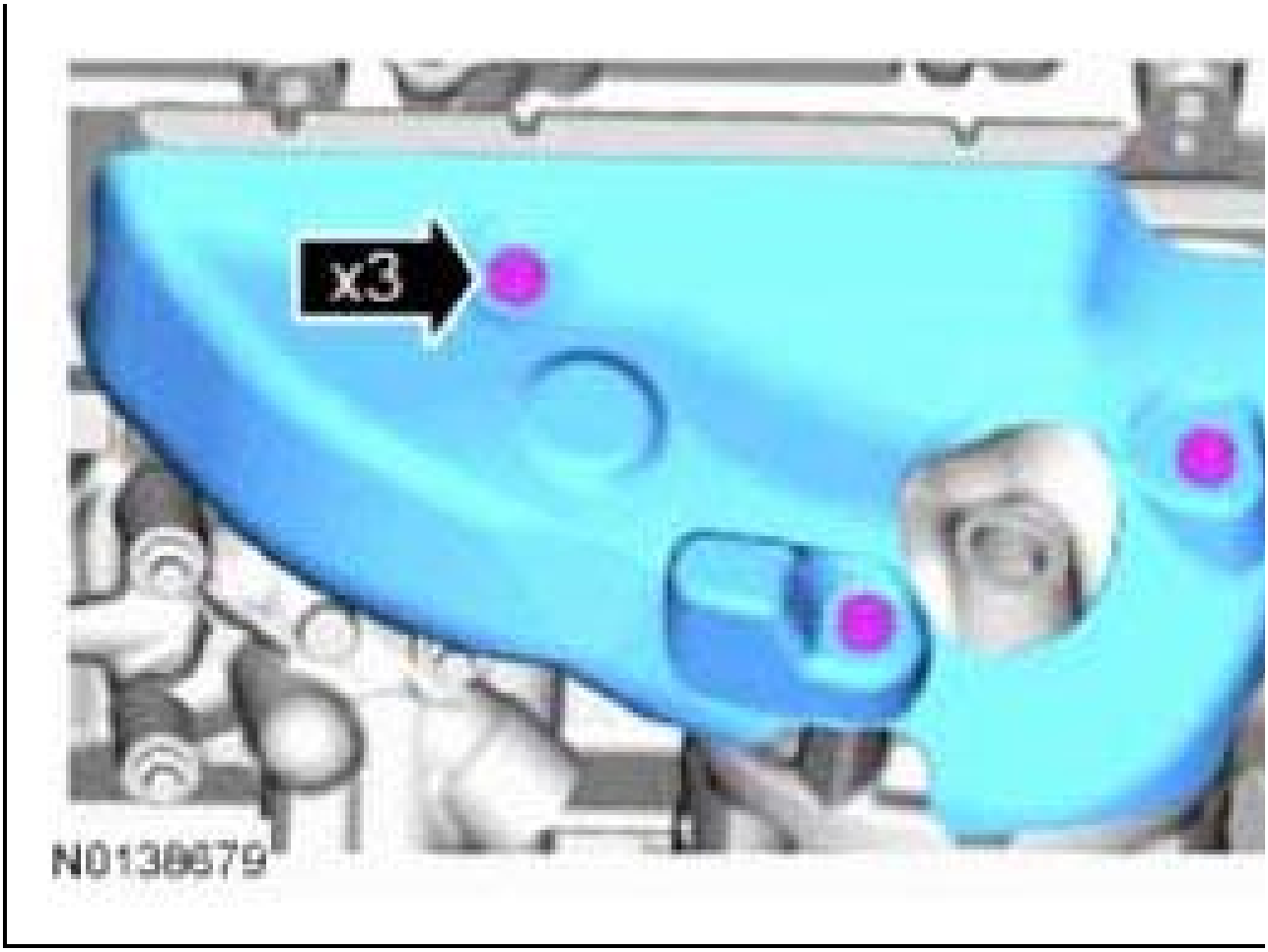
126. Using a new gasket, install the LH catalytic converter and 3 new lower LH catalytic converter manifold-to-cylinder head nuts. Tighten in 2 stages in the sequence shown in illustration:
    - Stage 1: Tighten the 3 lower LH catalytic converter manifold-to-cylinder head nuts to 25 Nm (18 lb-ft).
    - Stage 2: Install the 3 new upper nuts and tighten the upper LH catalytic converter manifold-to-cylinder head nuts to 25 Nm (18 lb-ft).

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127. Install the LH exhaust heat shield and the 3 bolts.
    - Tighten to 12 Nm (106 lb-in).

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NOTE: **Apply High Temperature Nickel Anti-Seize Lubricant to the threads of the HO2S prior to installing.**

128. Install the LH **HO2S** .

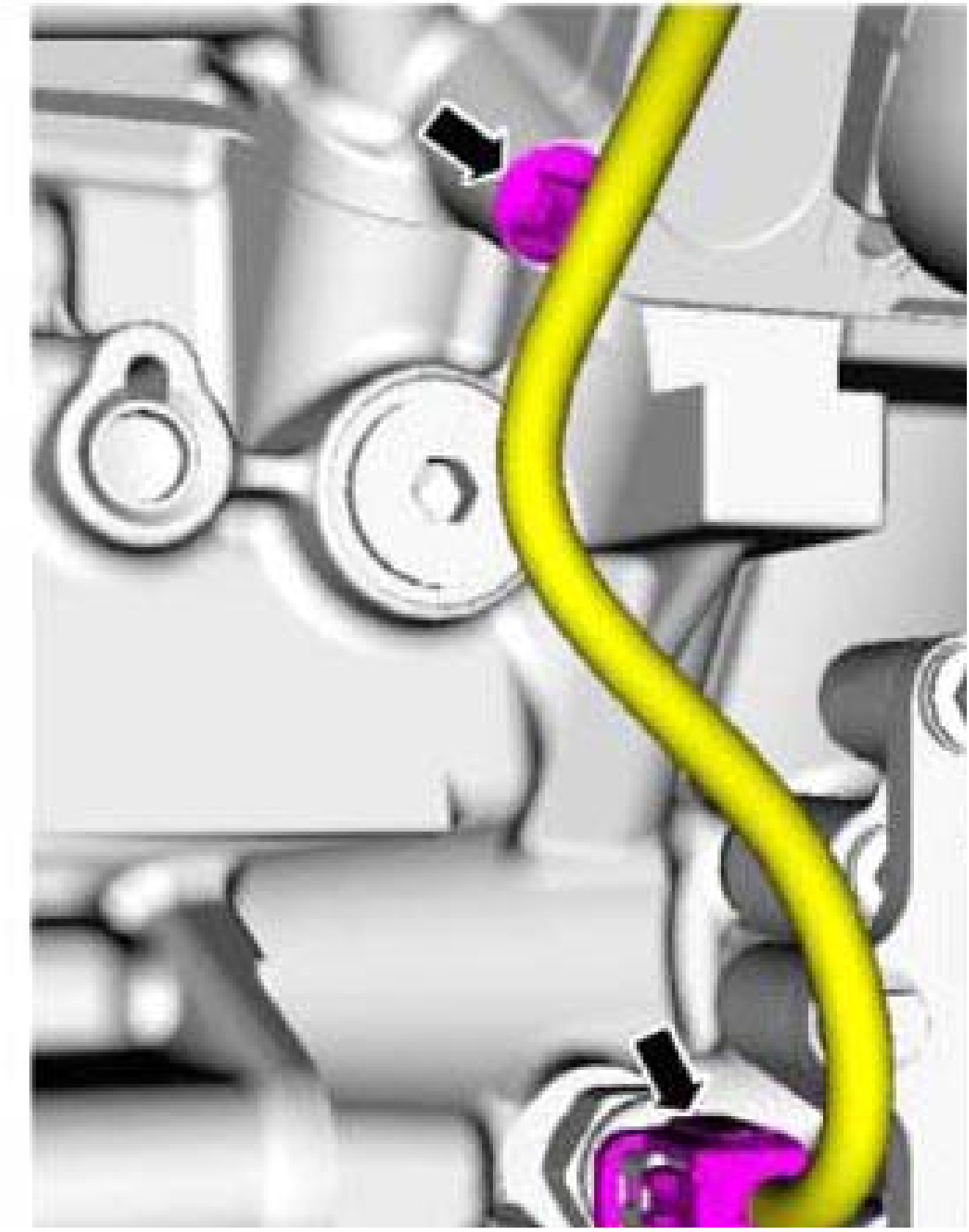
- Tighten to 48 Nm (35 lb-ft).

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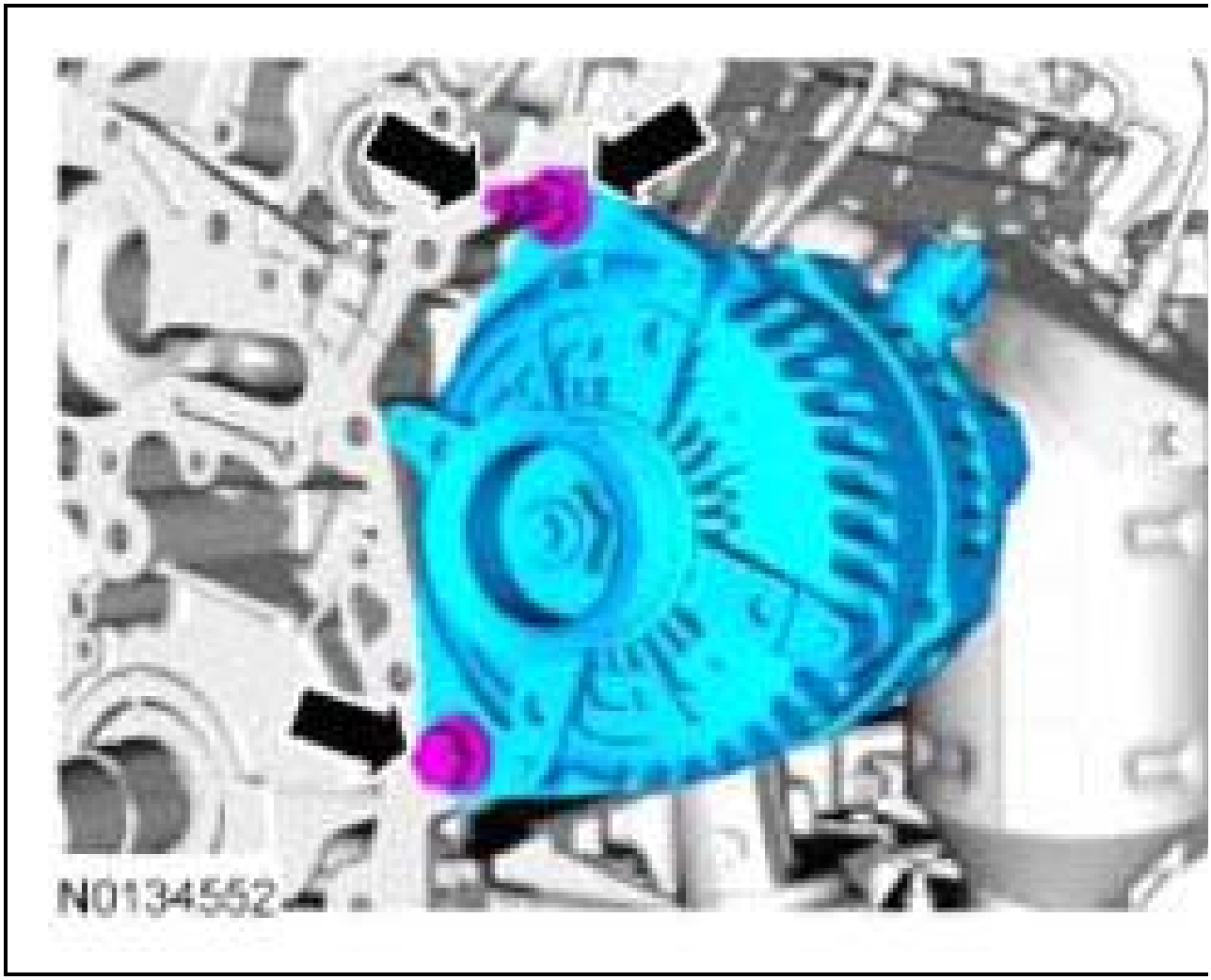
129. Connect the EOP switch electrical connector and the wiring harness pin-type retainer.

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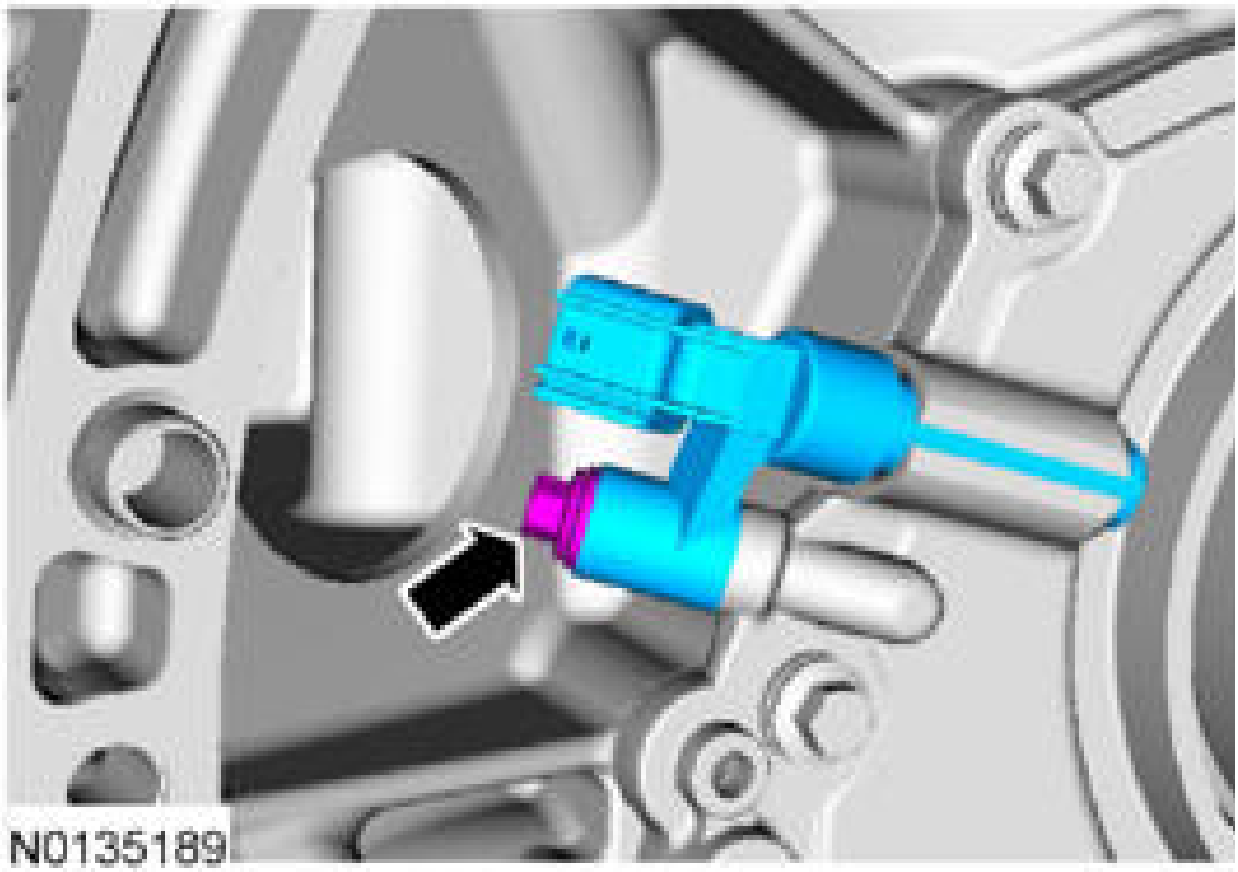
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130. Install the generator stud, generator and the nut and bolt.
    - Tighten the stud to 8 Nm (71 lb-in).
    - Tighten the nut and bolt to 47 Nm (35 lb-ft).



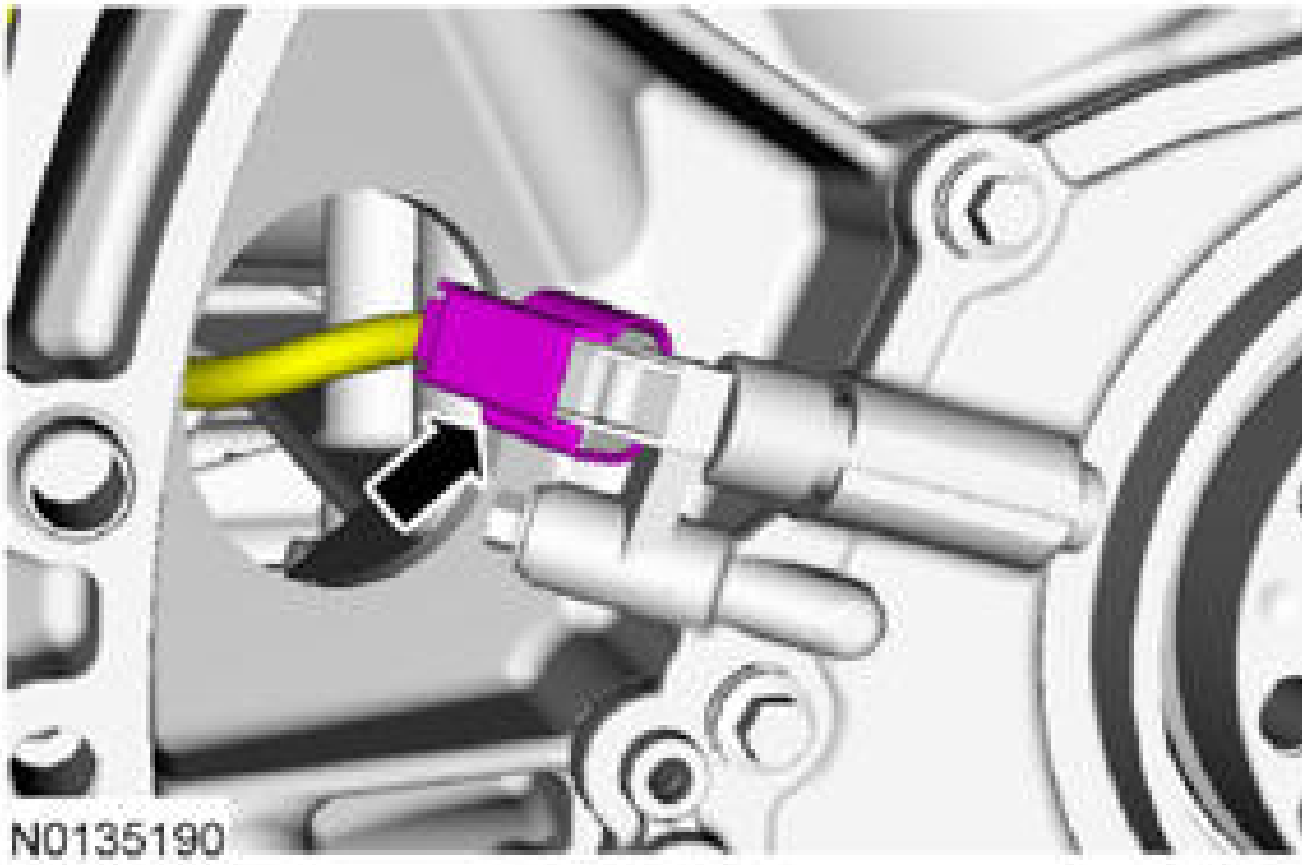
131. Install the CKP sensor and install the bolt.
    - Tighten to 10 Nm (89 lb-in).

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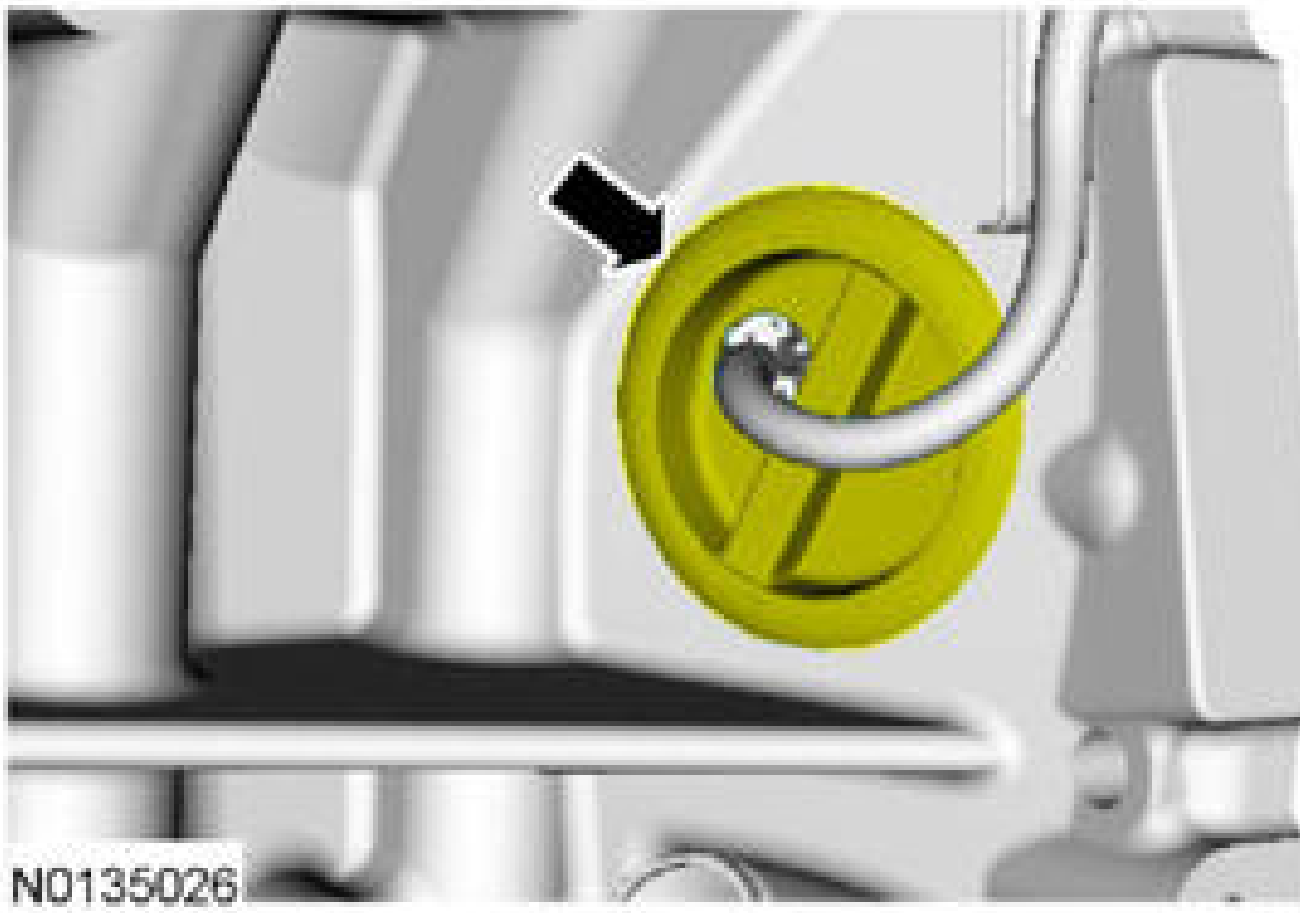
132. Connect the CKP sensor electrical connector.

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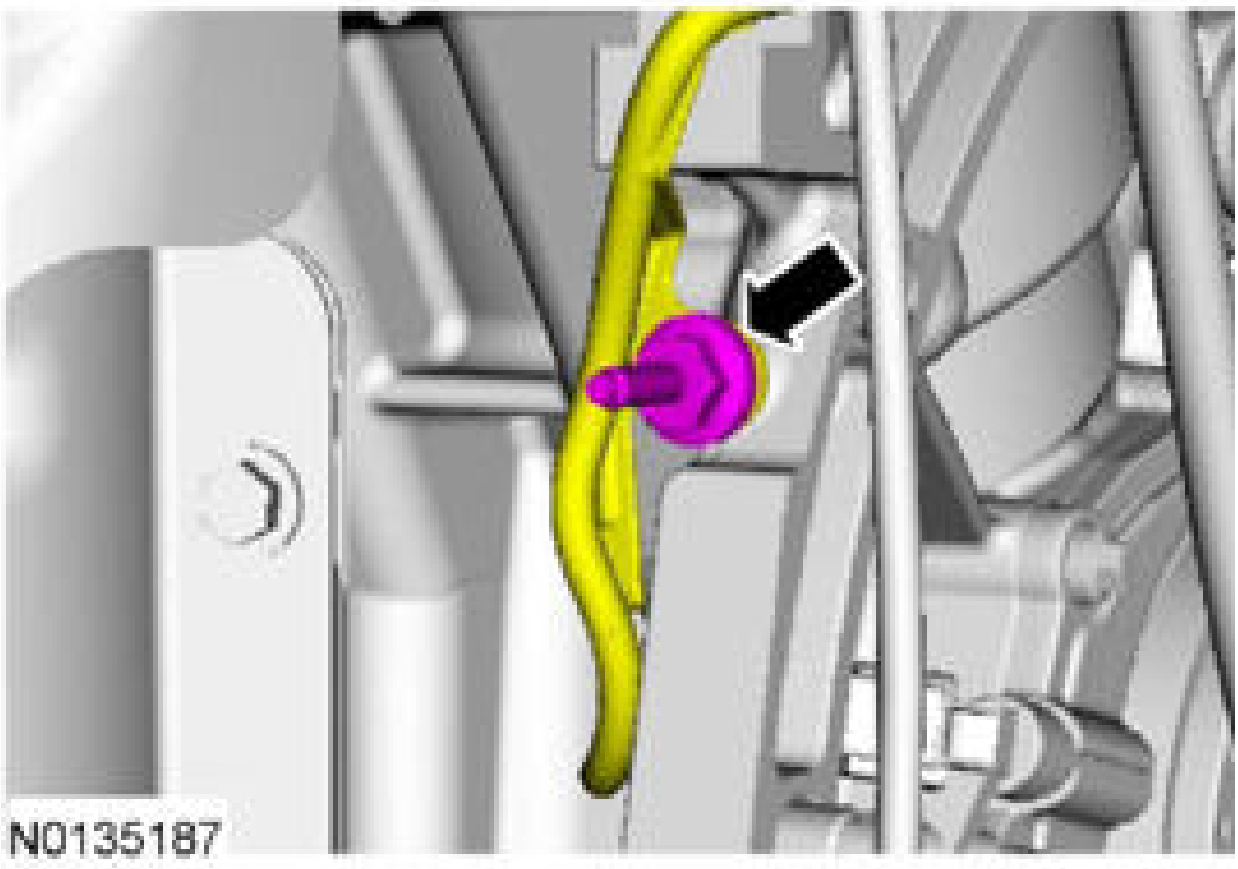
133. Install the wiring harness grommet.

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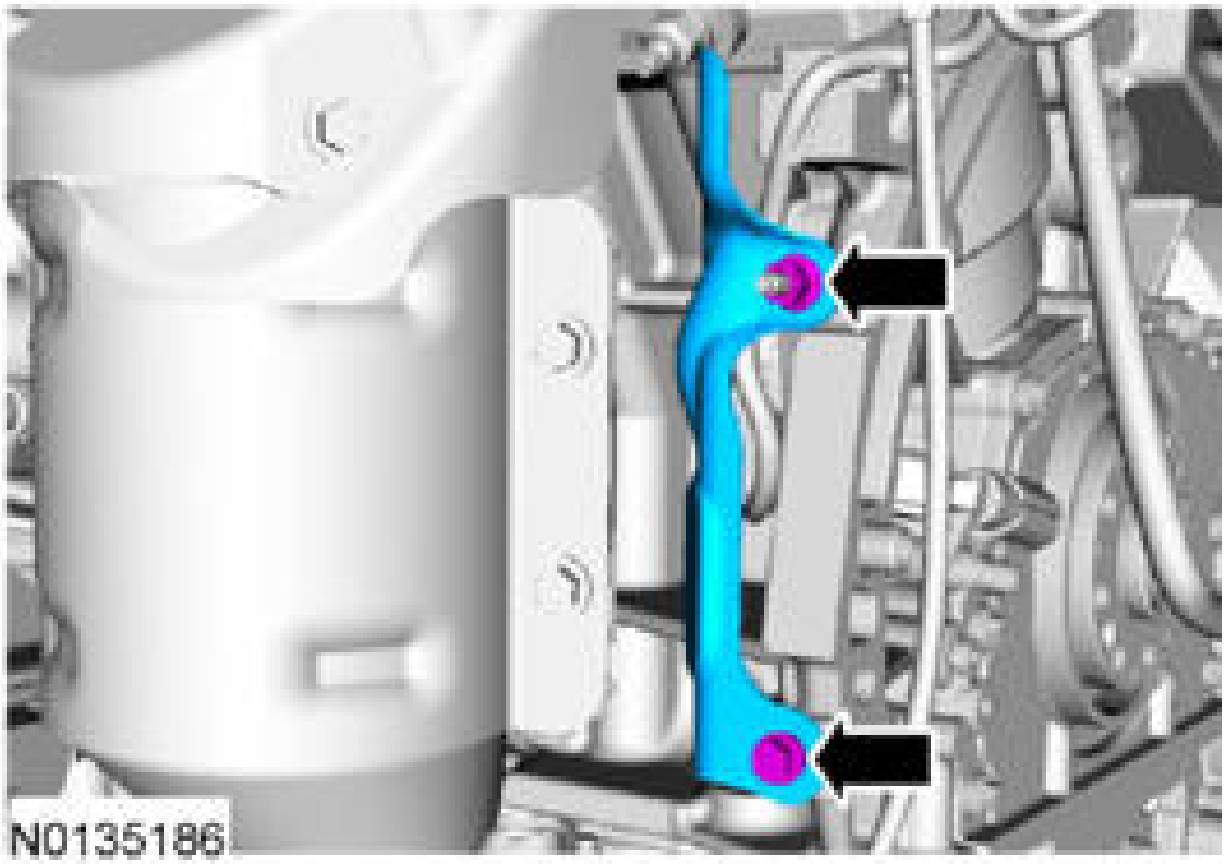
134. Install the wiring harness retainer stud bolt.
    - Tighten to 10 Nm (89 lb-in).

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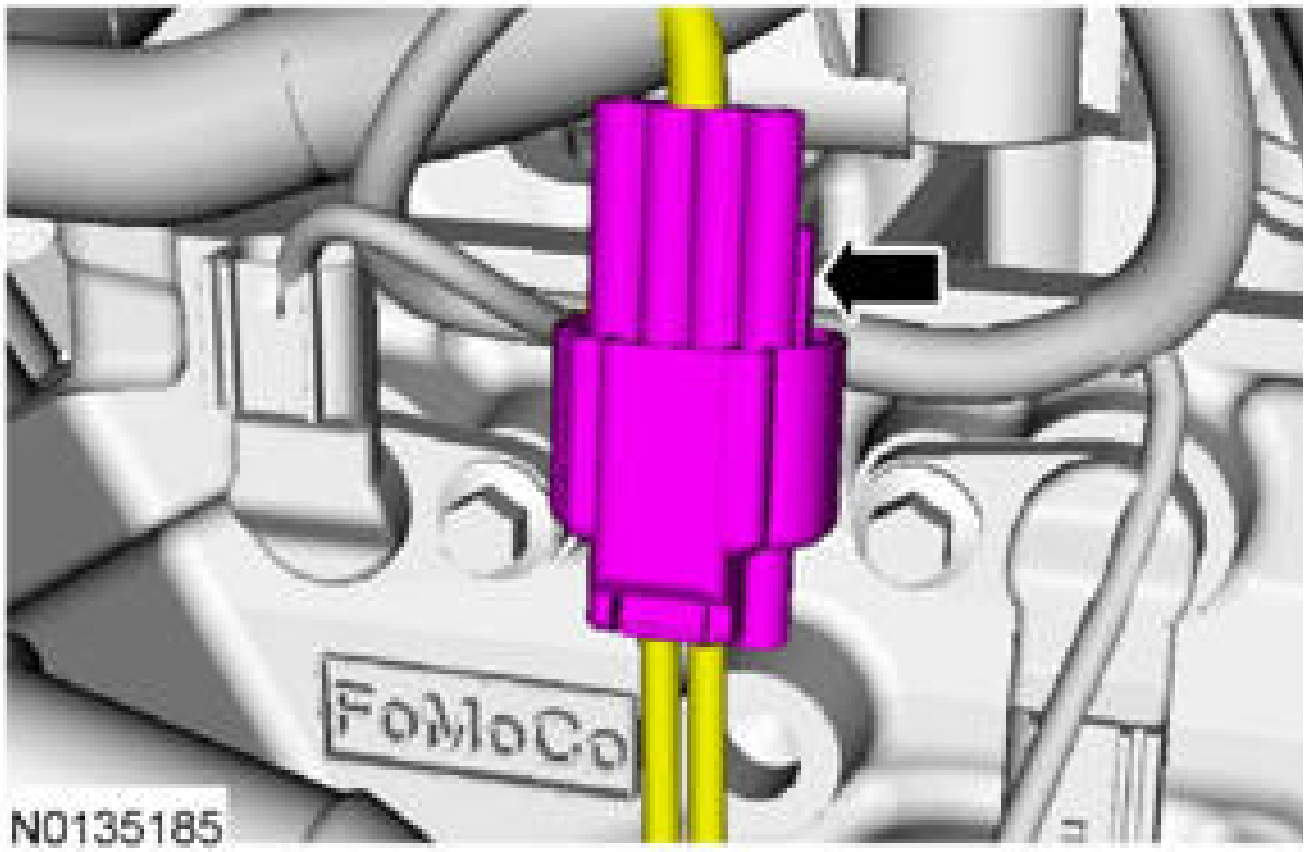
135. Install the heat shield, the nut and the bolt.
    - Tighten to 10 Nm (89 lb-in).

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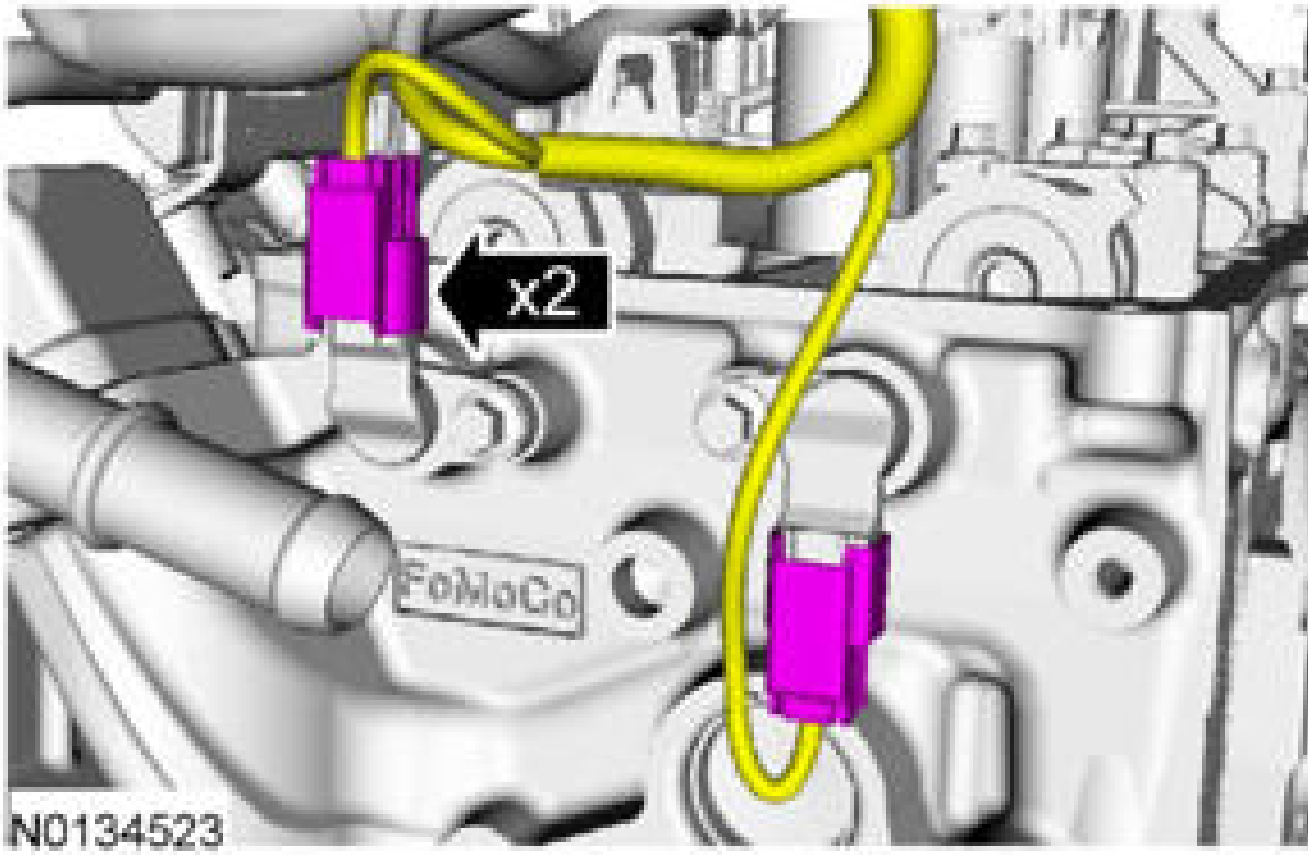
136. Connect the KS electrical connector.

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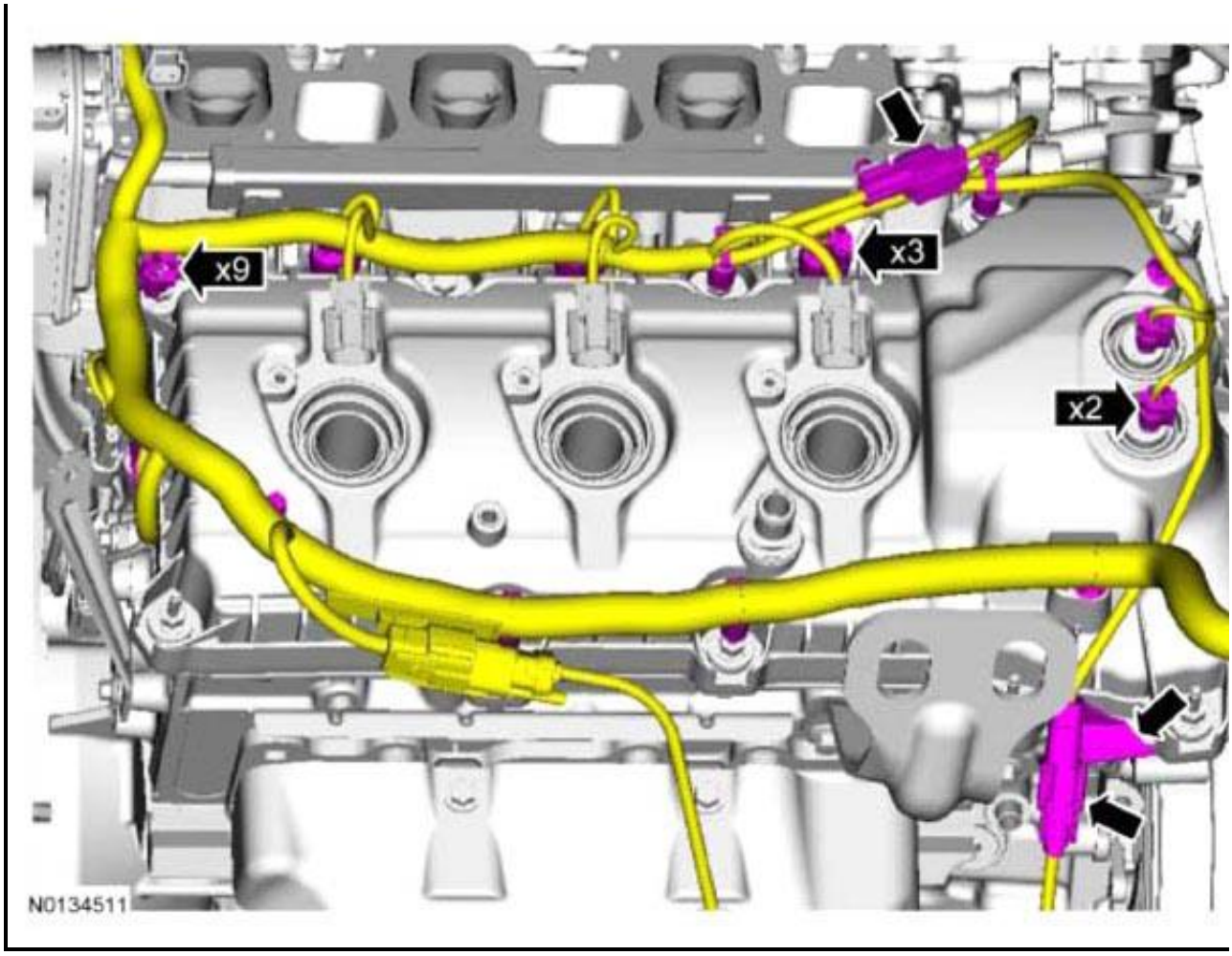
137. Connect the 2 RH CMP sensor electrical connectors.

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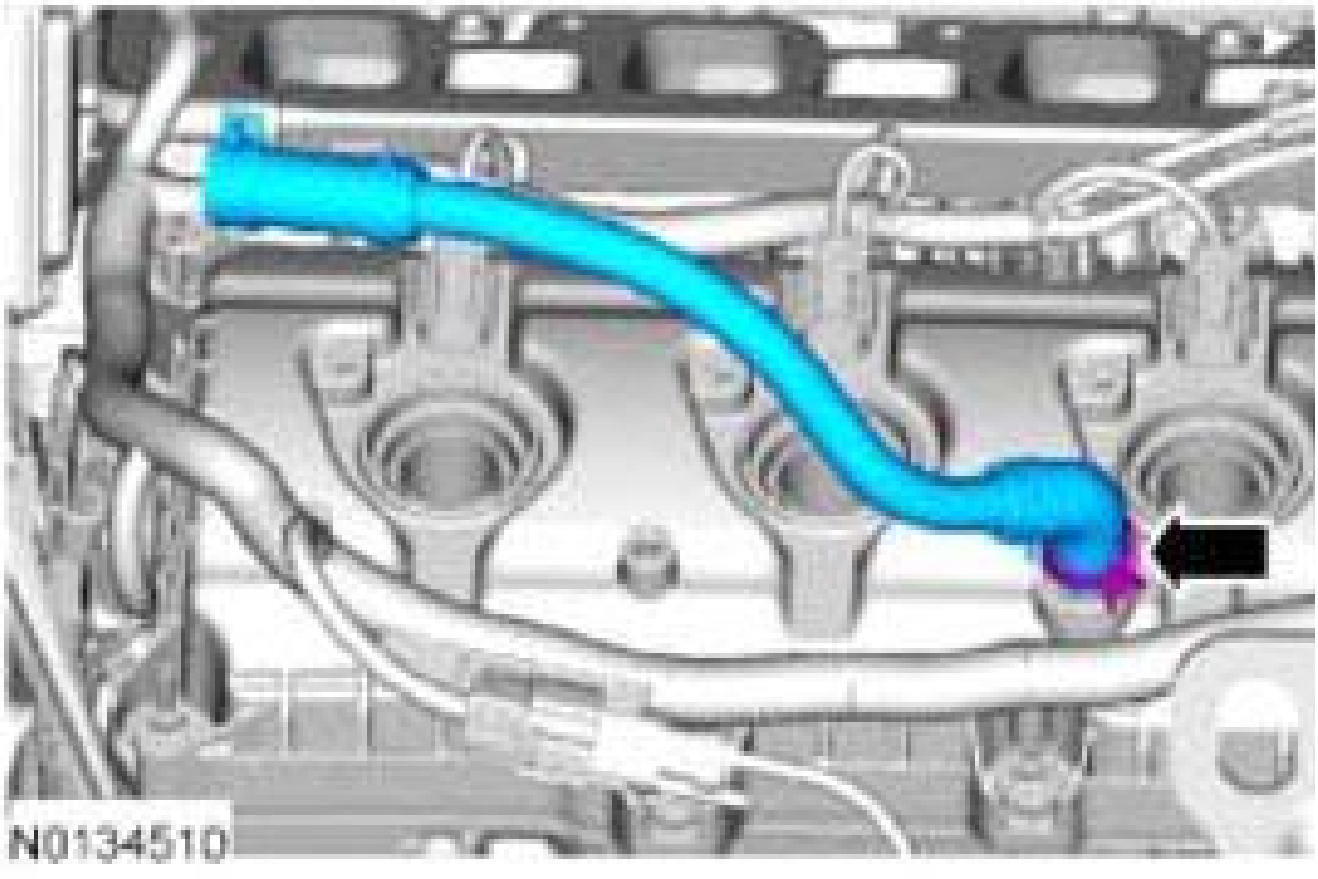
138. Install the engine wiring harness to the RH valve cover.
    - Position the wiring harness and attach the 9 wiring harness retainers to the RH valve cover and stud bolts.
    - Connect the **CHT** sensor wiring harness jumper electrical connector.
    - Connect the 3 fuel injector electrical connectors.
    - Connect and attach the RH **CMS** electrical connector.
    - Connect the 2 **VCT** oil control solenoid electrical connectors.

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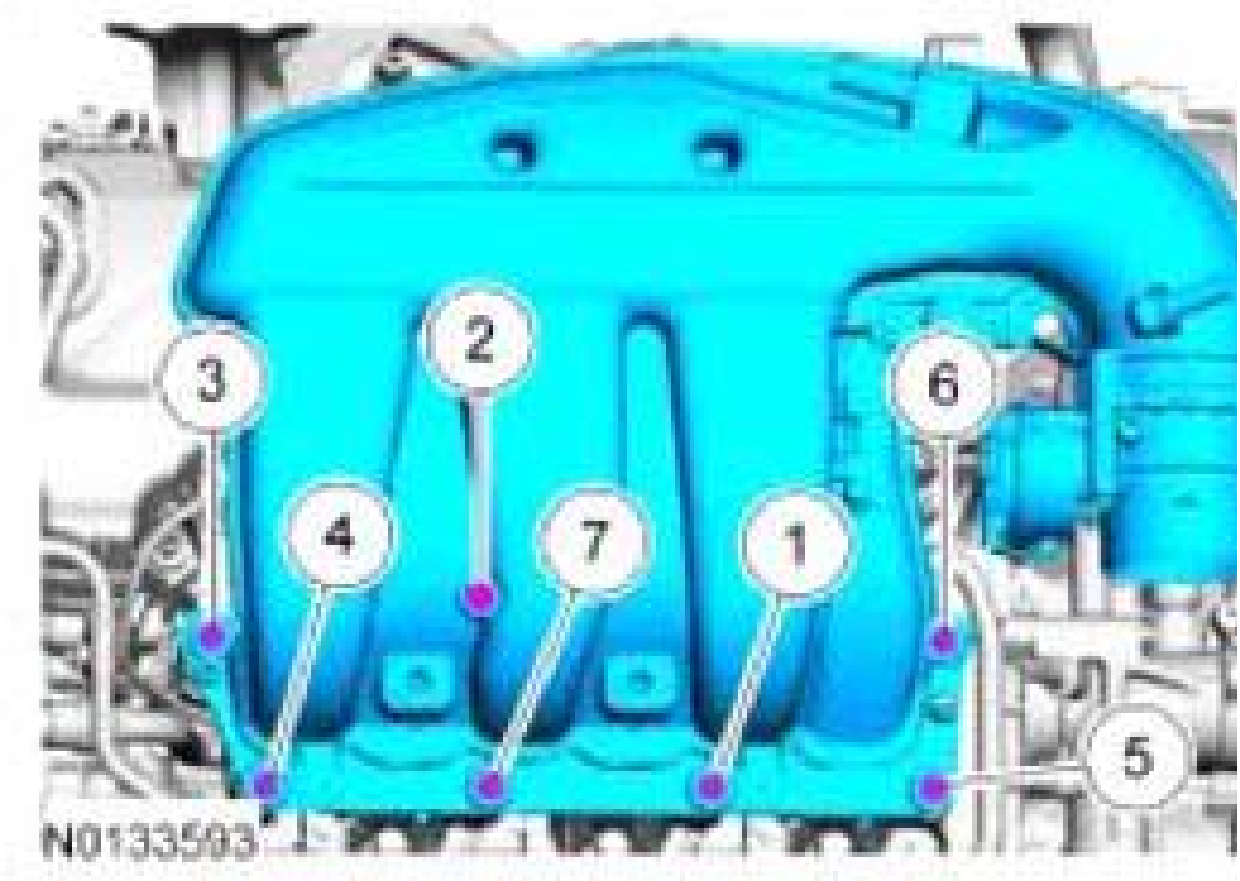
139. Install the **PCV** crankcase vent tube.

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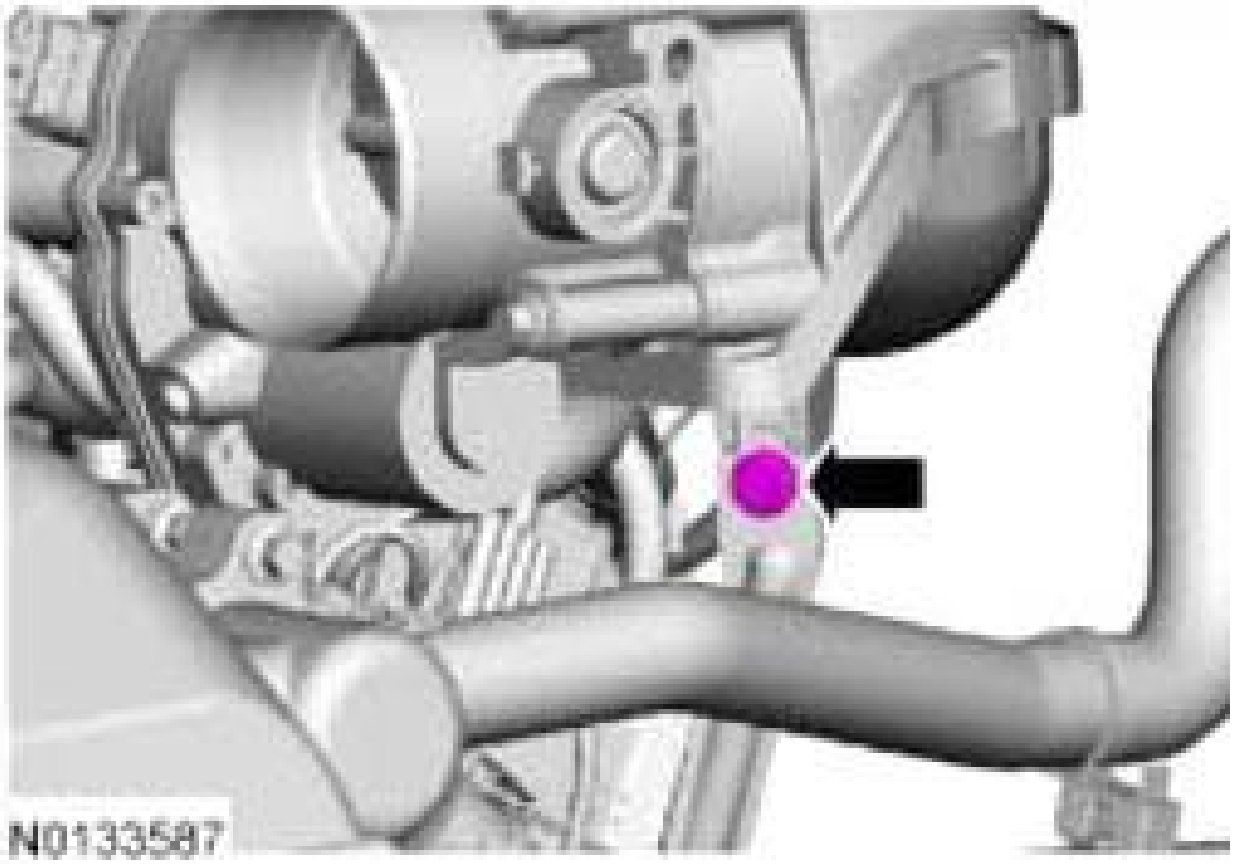
140. Using a new gasket, install the intake manifold and the 7 bolts.
    - Tighten in the sequence shown in illustration in 2 stages.
    - Stage 1: Tighten to 10 Nm (89 lb-in).
    - Stage 2: Tighten an additional 45 degrees.

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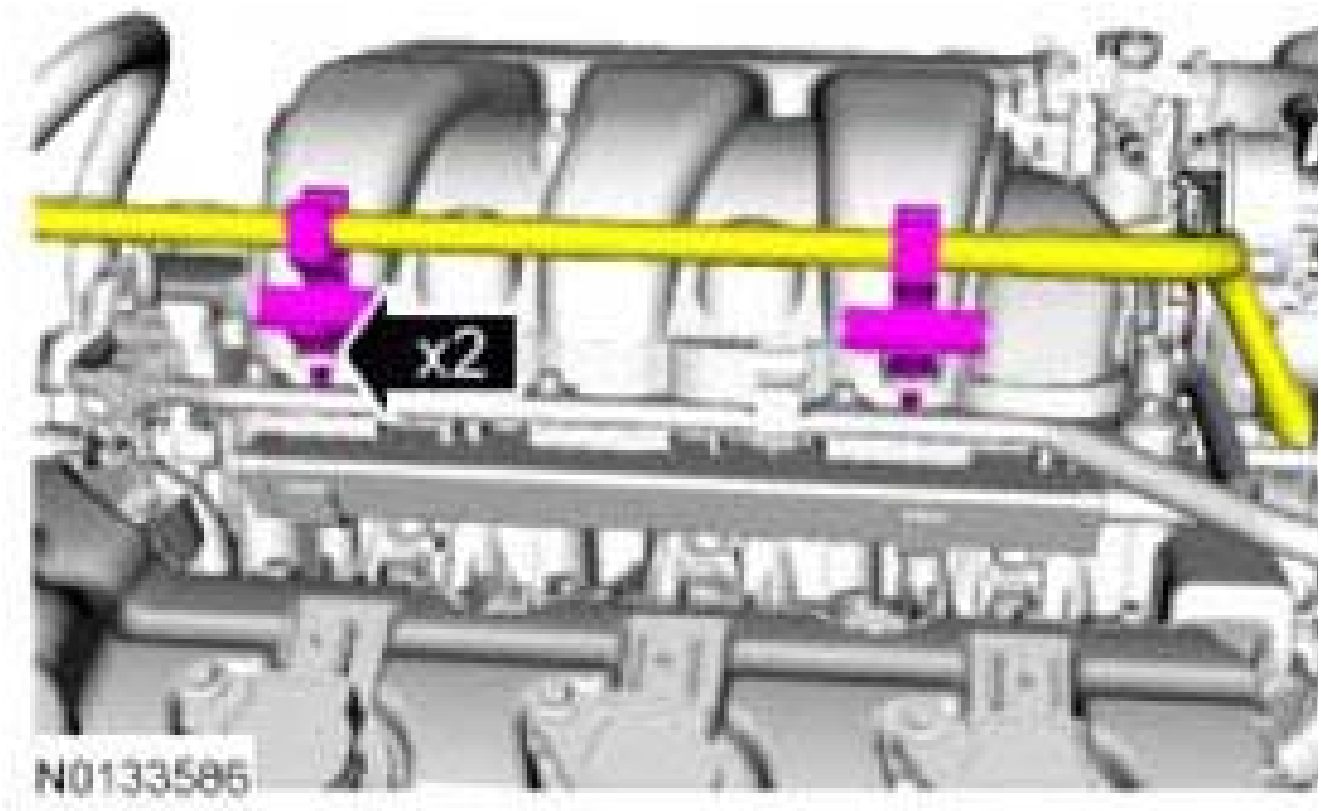
141. Install the upper intake manifold support bolt.
    - Tighten to 10 Nm (89 lb-in).

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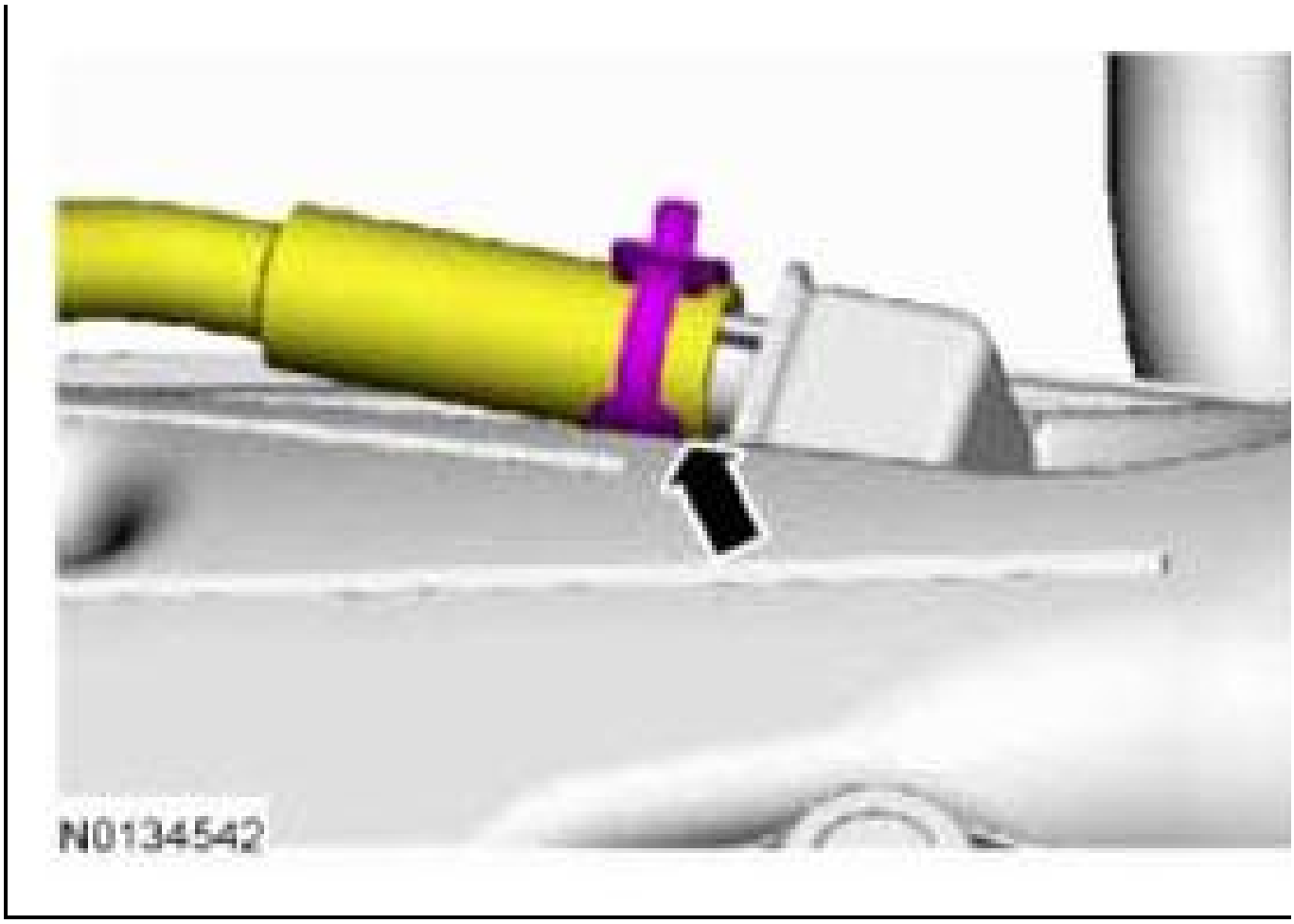
142. Attach the 2 coolant tube retainers to the upper intake manifold.

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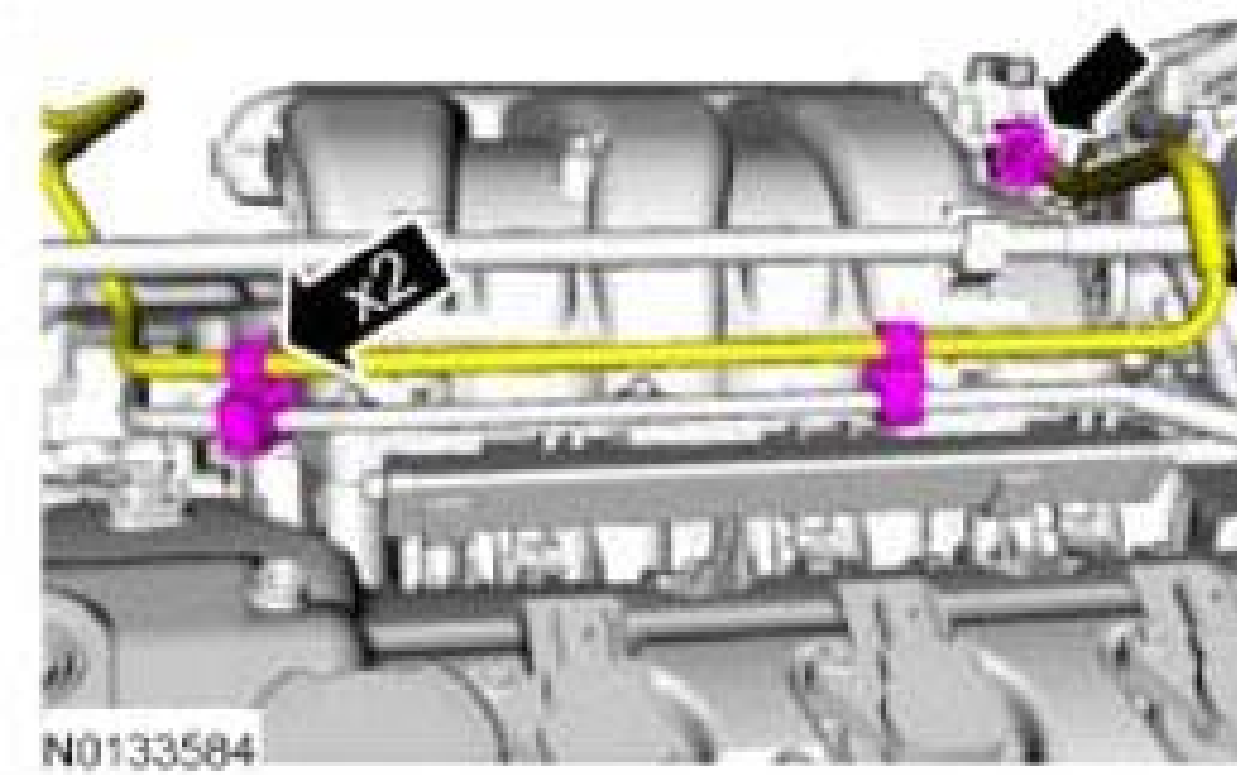
143. Connect the crankcase ventilation hose to the upper intake manifold.

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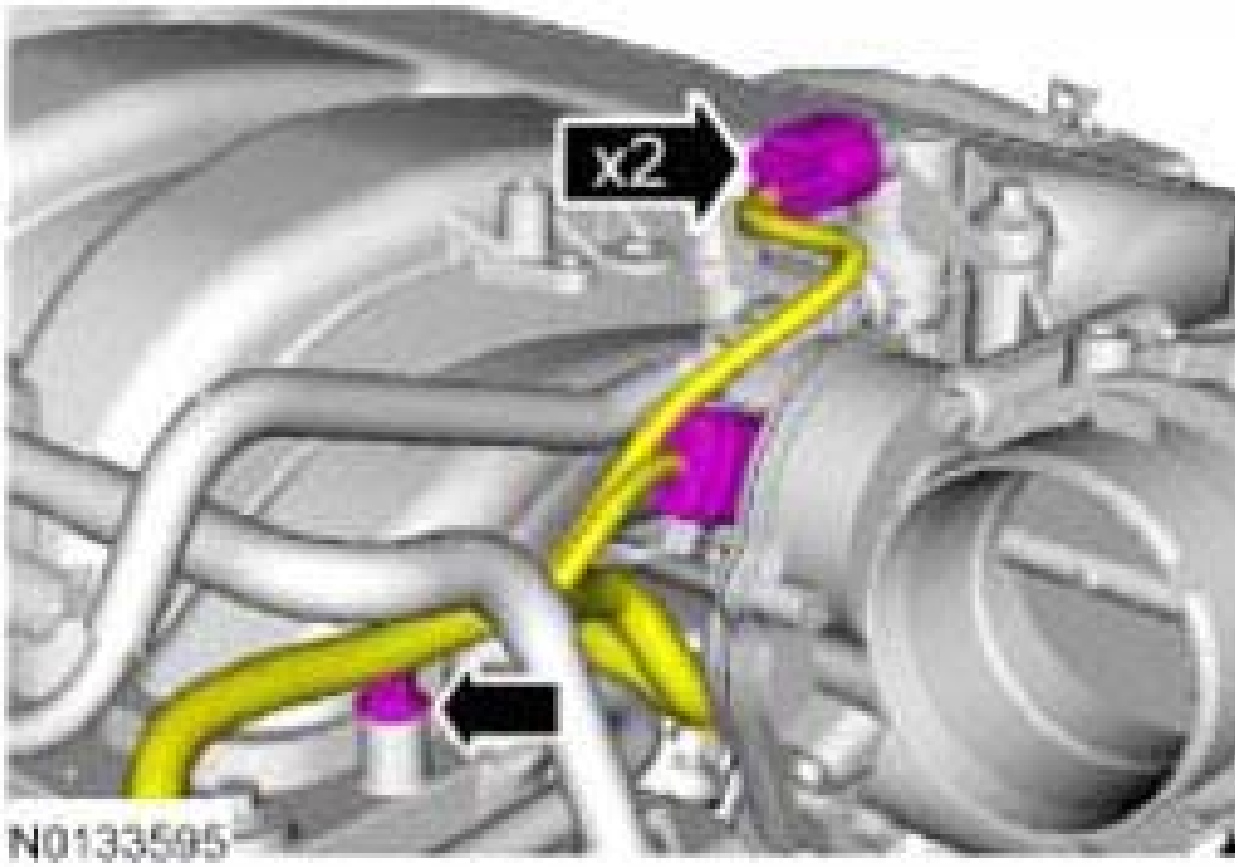
144. Connect the **EVAP** vapor tube to the **EVAP** canister purge valve. REFER to **QUICK CONNECT COUPLING** .
    - Attach the **EVAP** vapor tube to the 2 retainers.

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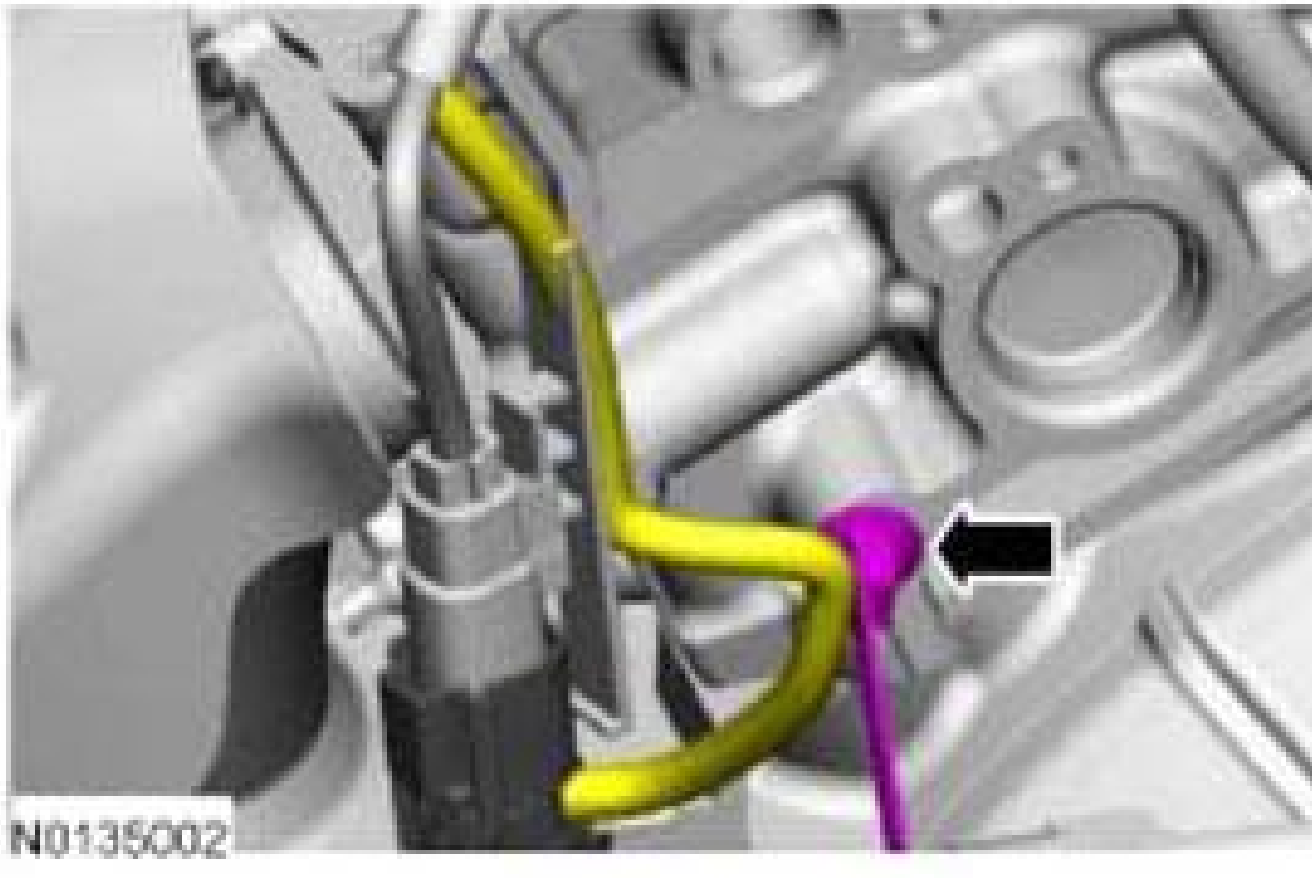
145. Connect the **EVAP** canister purge valve and throttle body electrical connectors.
    - Attach the wiring harness pin-type retainer to the upper intake manifold.

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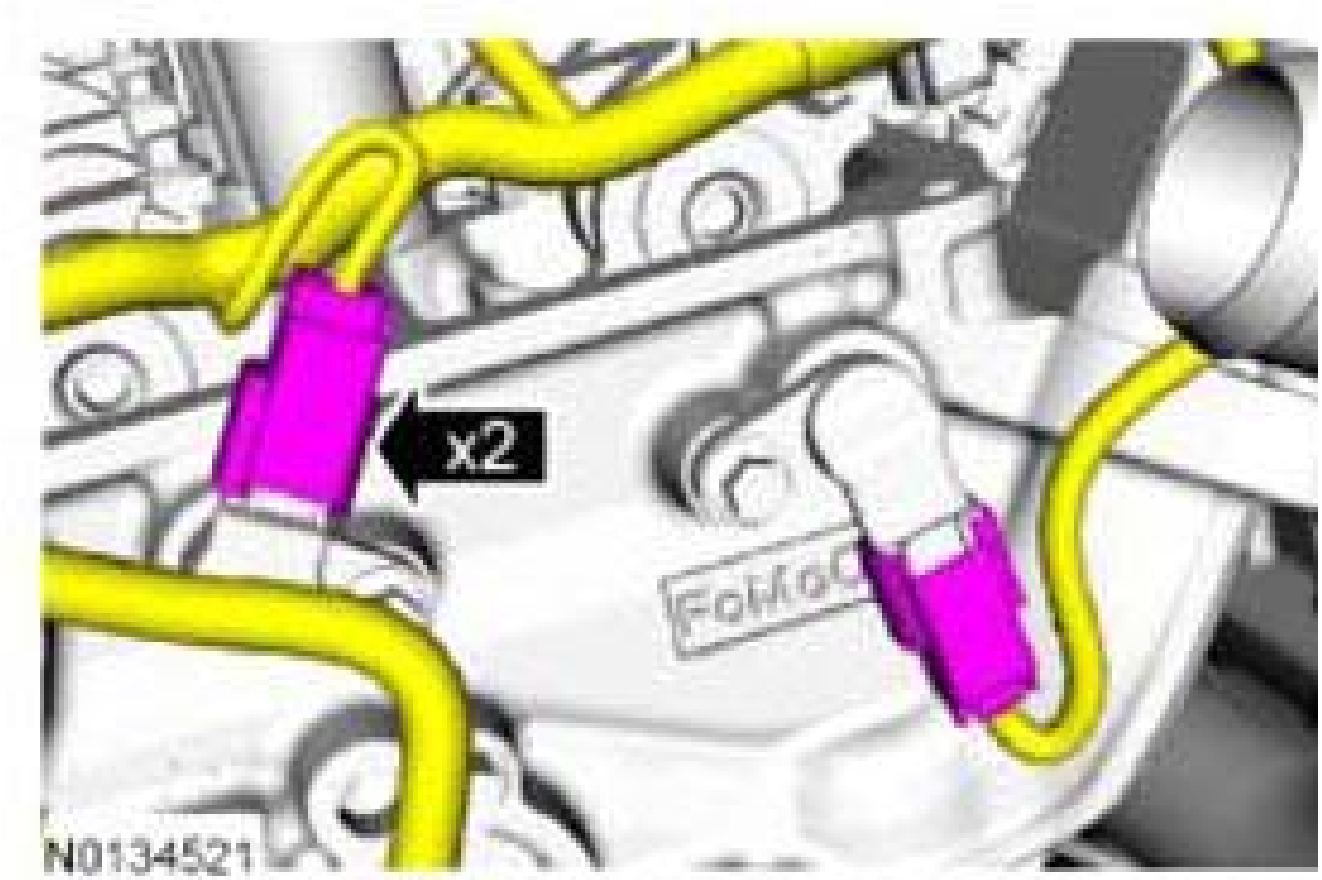
146. Install the wiring harness retainer to the rear of the LH cylinder head.

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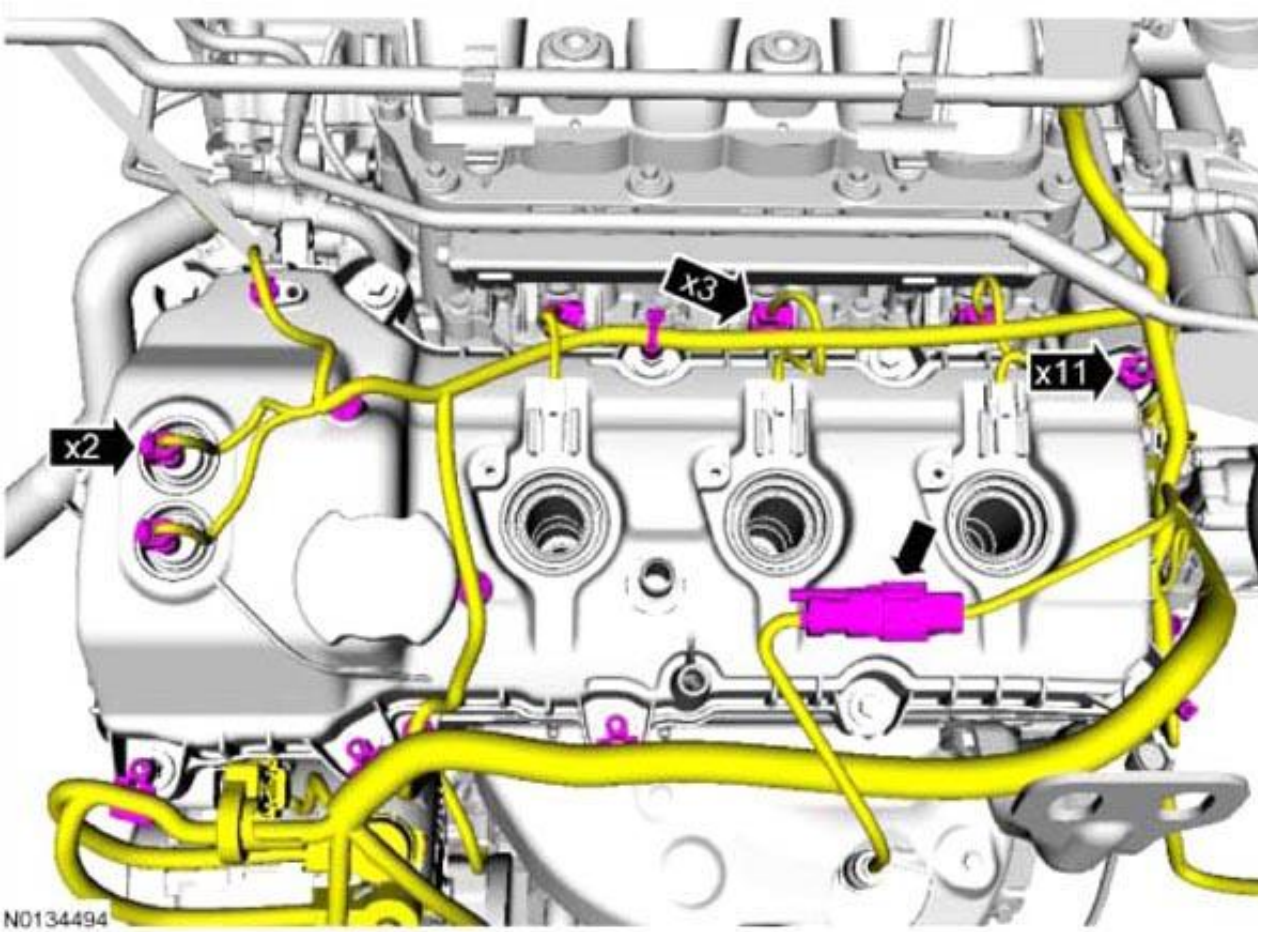
147. Connect the 2 LH CMP sensor electrical connectors.

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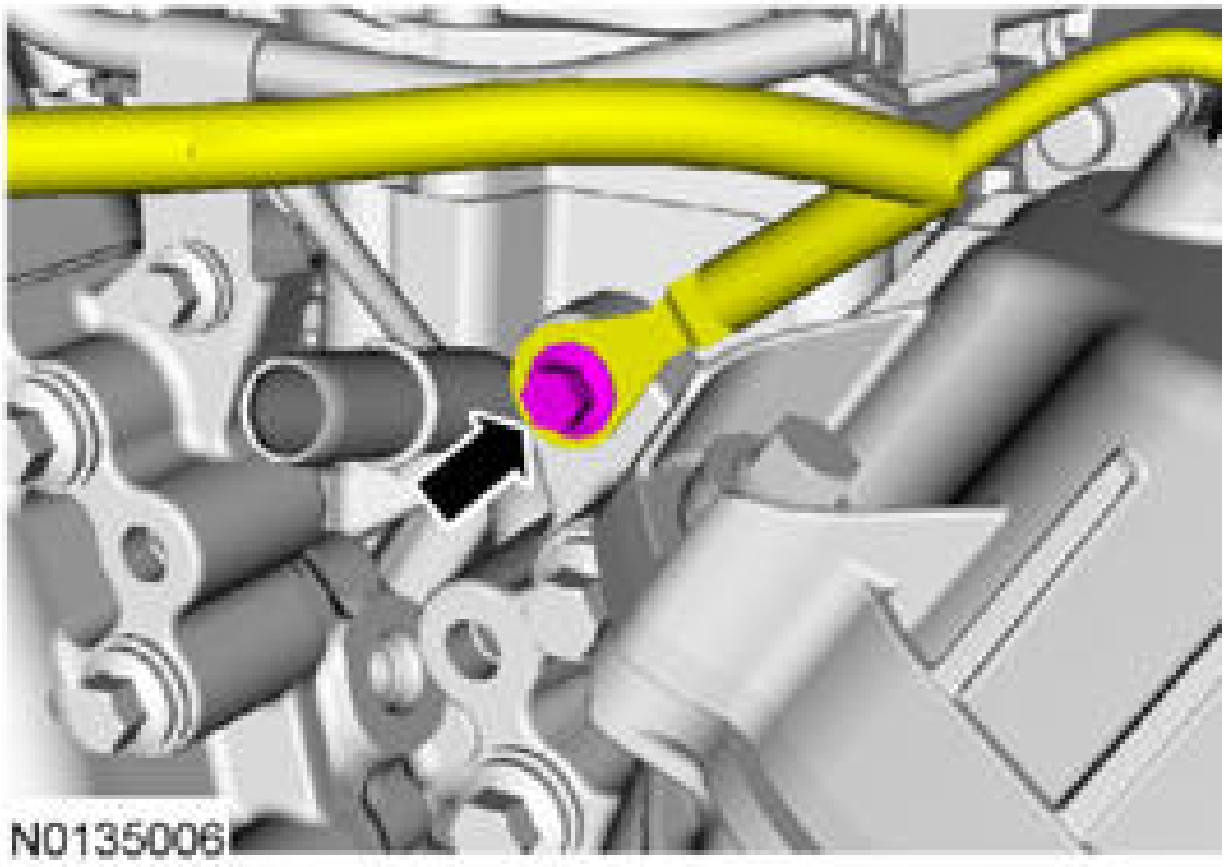
148. Install the engine wiring harness to the LH valve cover.
    - Position the wiring harness and attach the 11 wiring harness retainers to the LH valve cover and stud bolts.
    - Connect the 3 fuel injector electrical connectors.
    - Connect and attach the LH **HO2S** electrical connector.
    - Connect the 2 **VCT** oil control solenoid electrical connectors.

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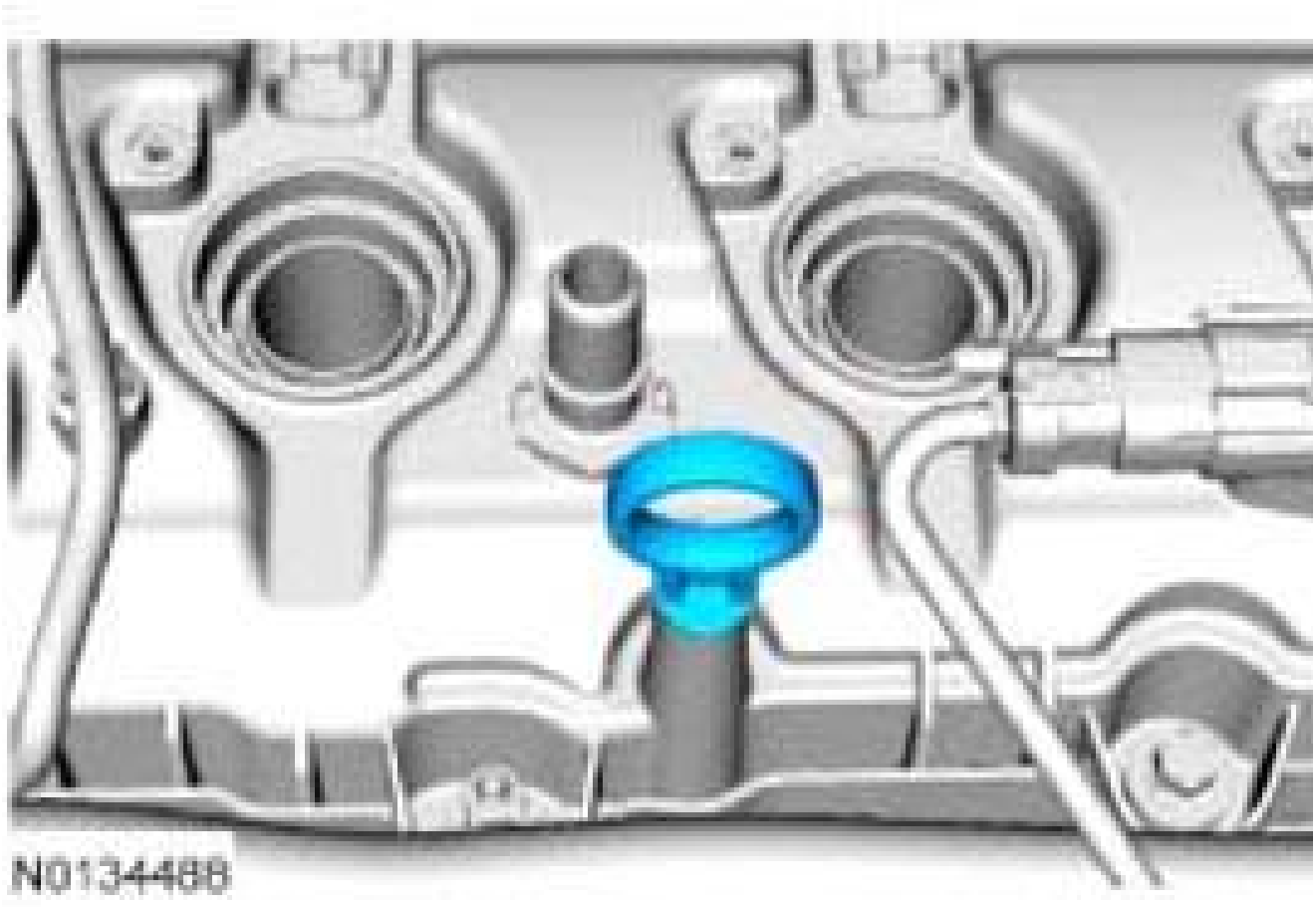
149. Position the wire harness ground to the engine front cover and install the bolt.
    - Tighten to 10 Nm (89 lb-in).

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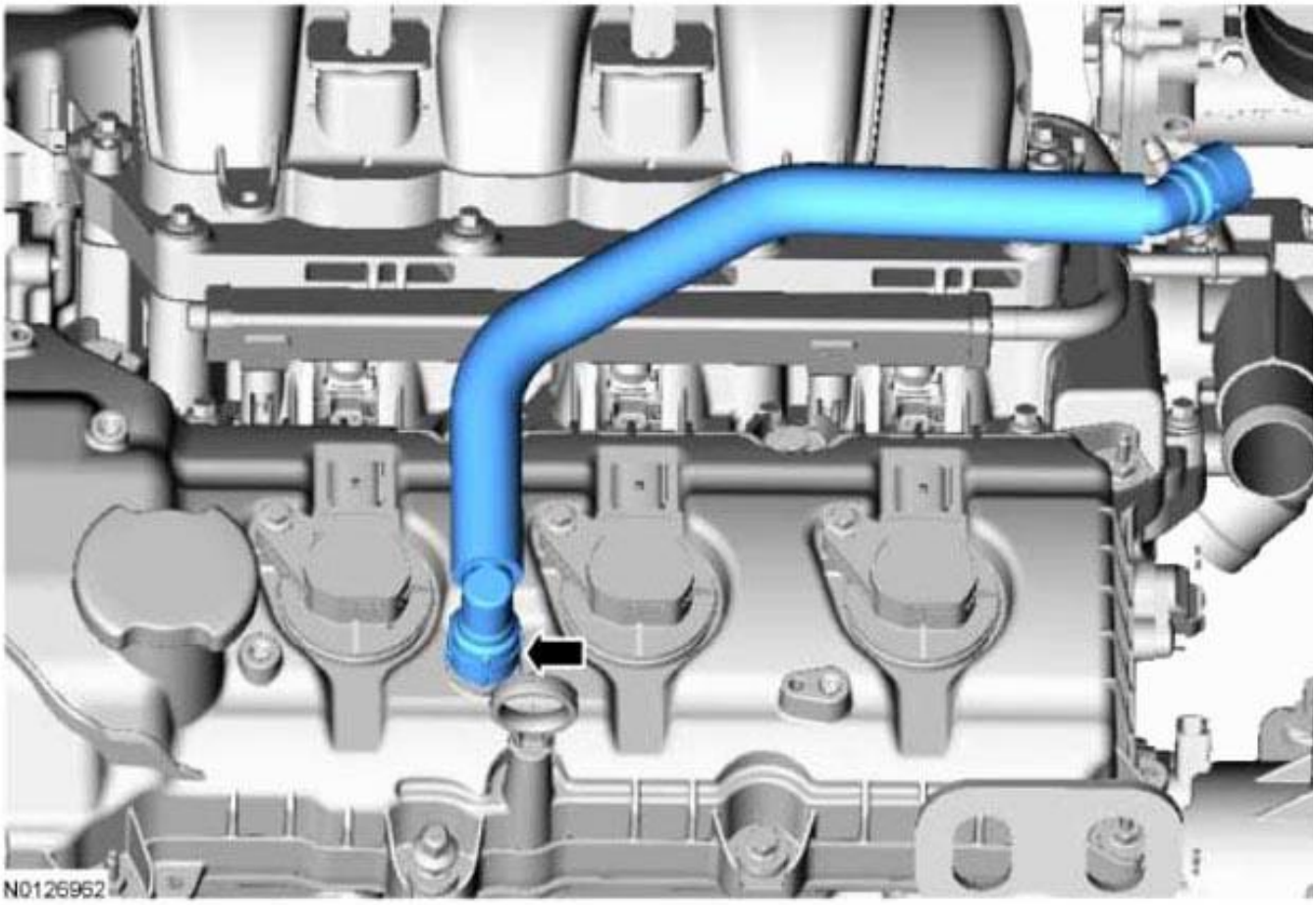
150. Install the oil level indicator.

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151. Install the crankcase vent tube. REFER to **QUICK CONNECT COUPLING** .

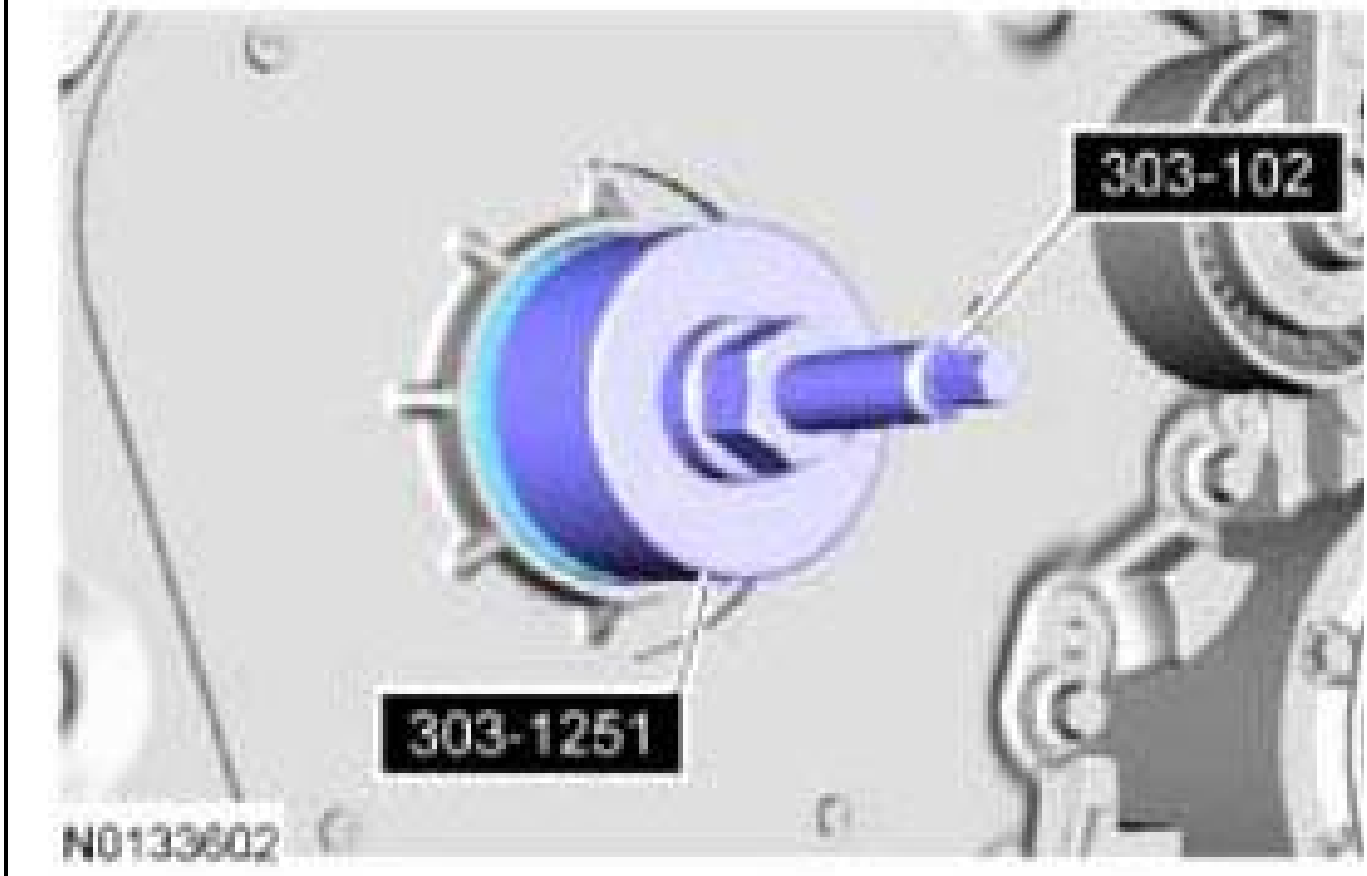
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152. **NOTE: Apply clean engine oil to the crankshaft front seal bore in the engine front cover.**

Using the 303-102 T74P-6316-B and 303-1251, install a new crankshaft front seal.

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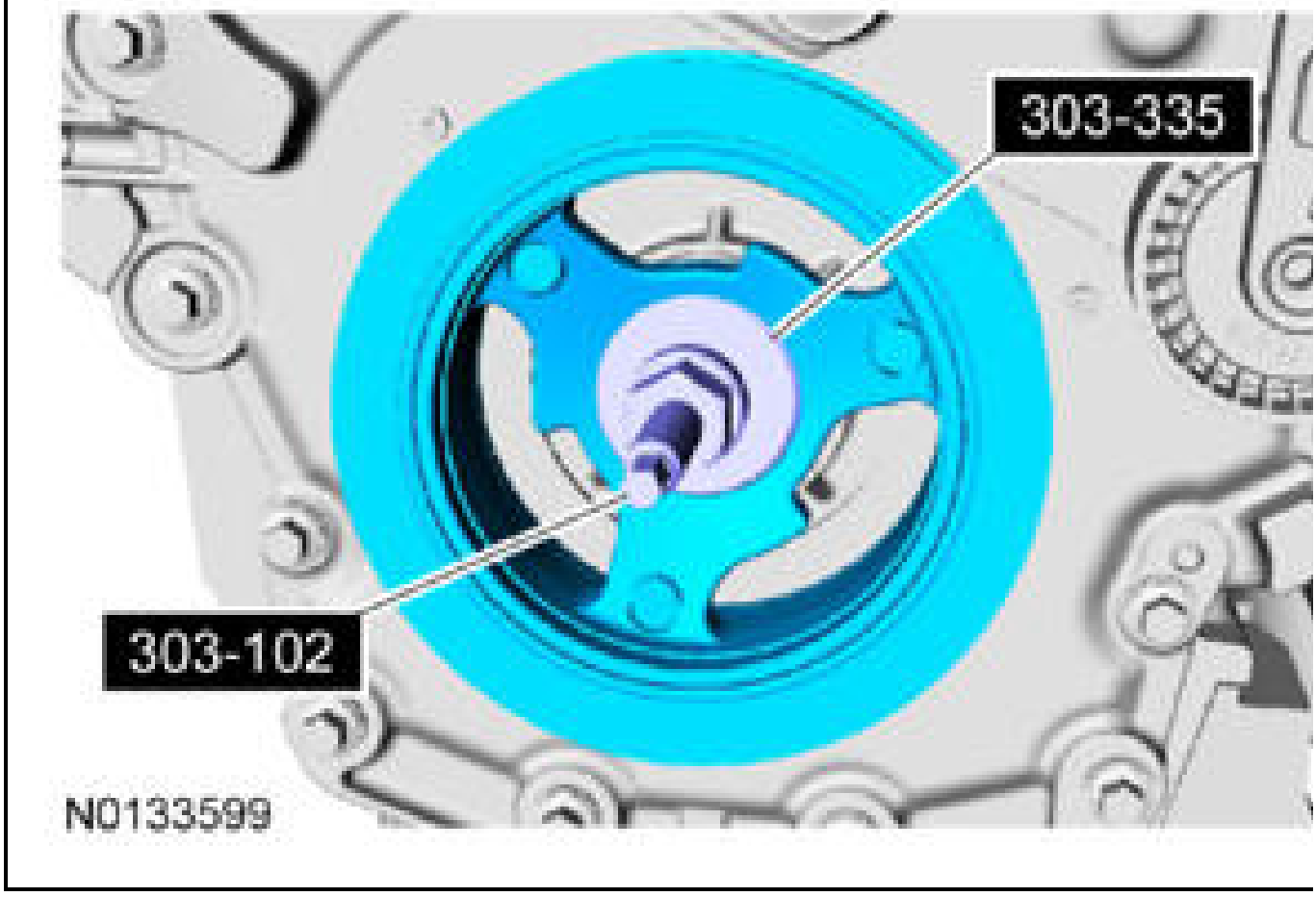


153. **NOTE: Lubricate the crankshaft front seal inner lip with clean engine oil.**

NOTE: Lubricate the outside diameter sealing surfaces with clean engine oil.

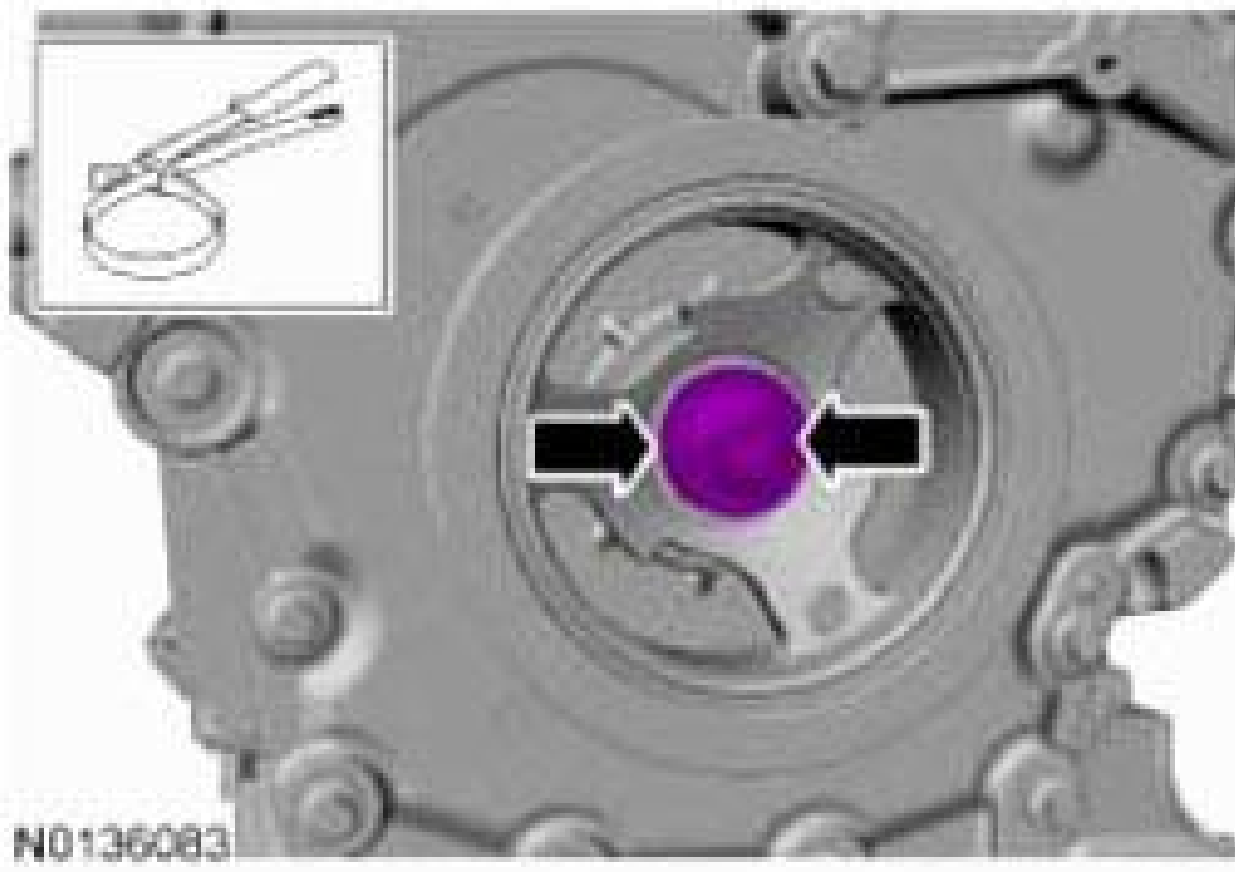
Using the 303-102 T74P-6316-B and 303-335 T88T-6701-A, install the crankshaft pulley.

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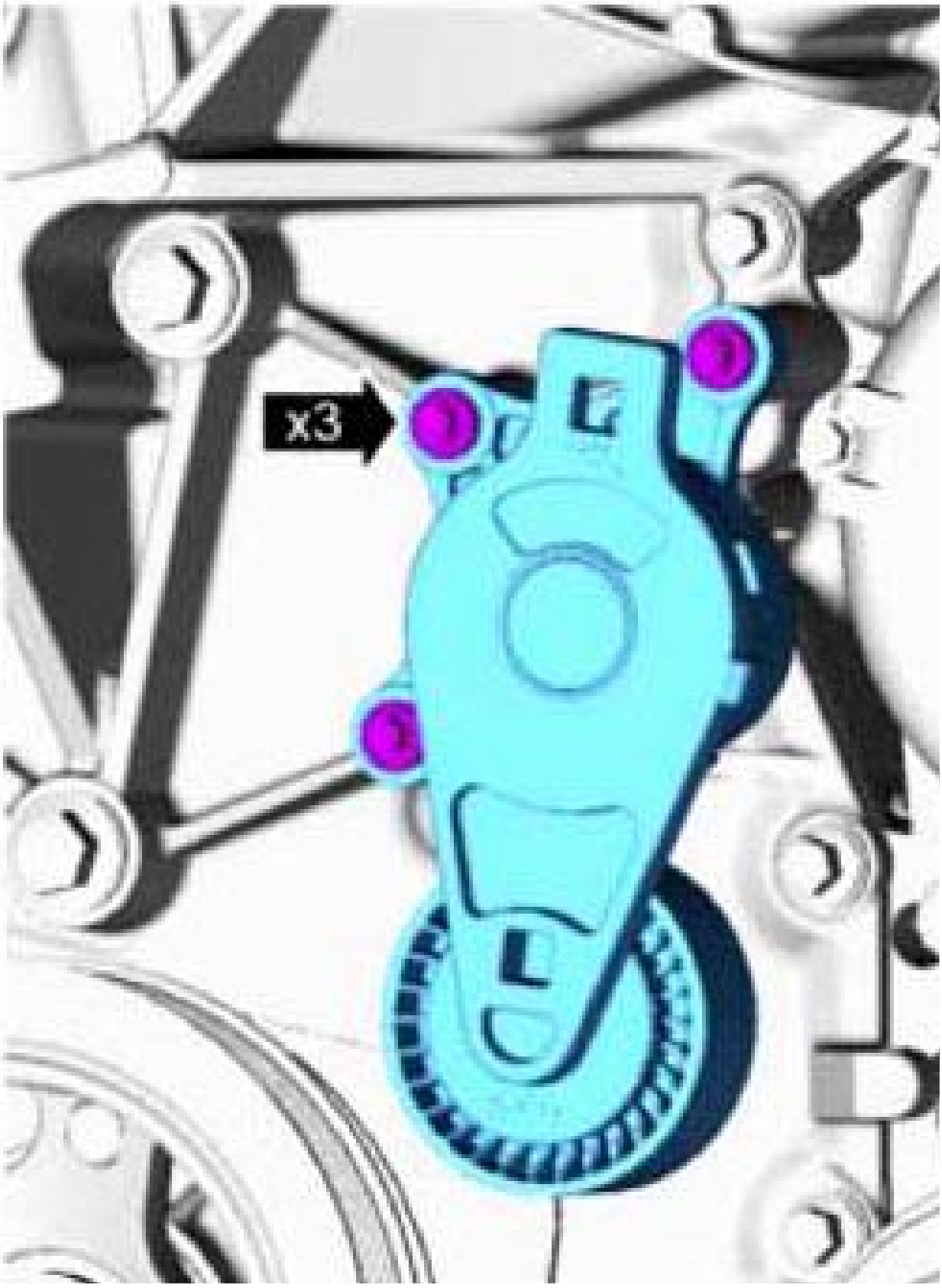
154. Using the 303-D055 D85L-6000-A, install the crankshaft pulley washer and new bolt and tighten in 4 stages.
    - Stage 1: Tighten to 120 Nm (89 lb-ft).
    - Stage 2: Loosen one full turn.
    - Stage 3: Tighten to 50 Nm (37 lb-ft).
    - Stage 4: Tighten an additional 90 degrees.

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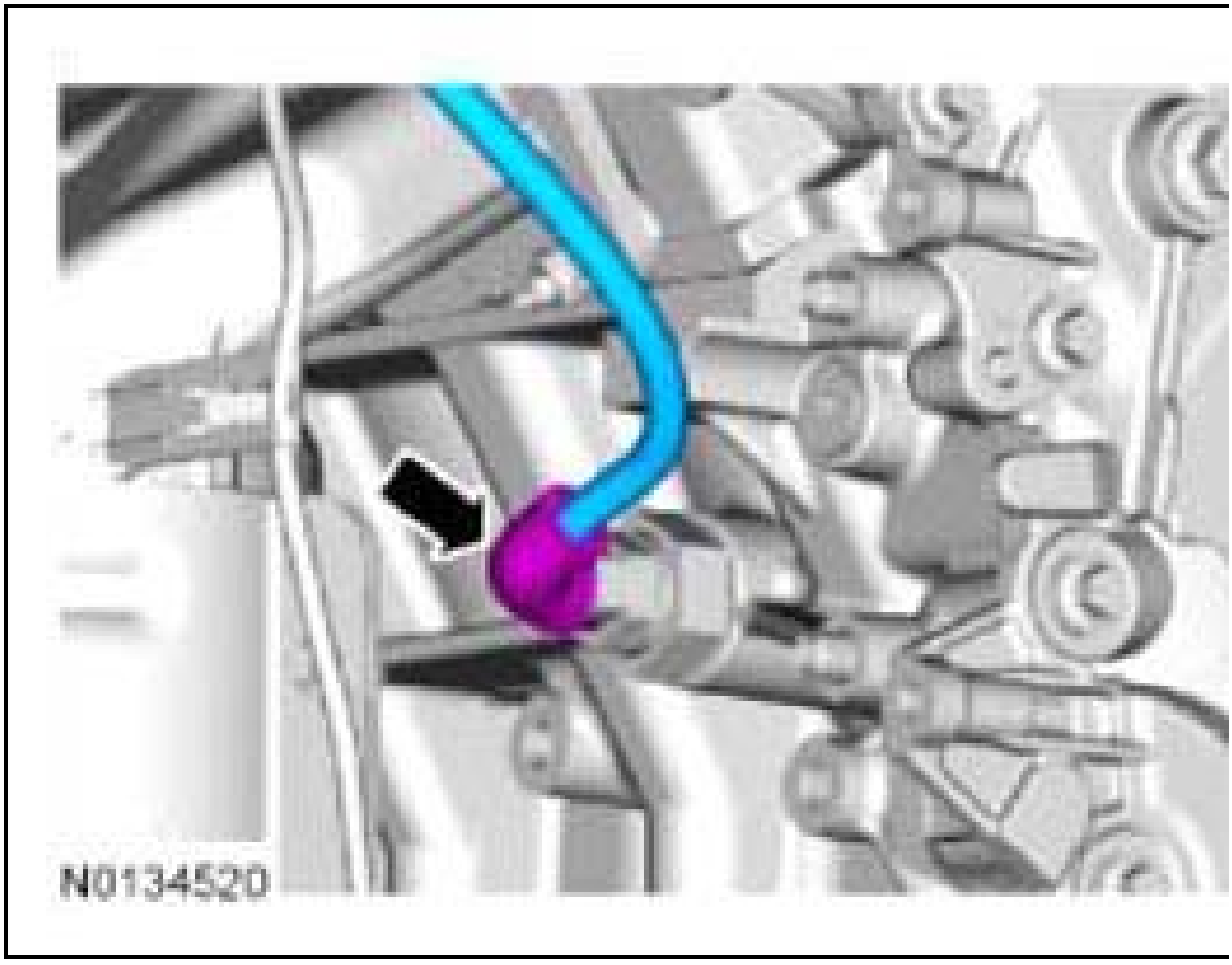
155. Install the accessory drive belt tensioner and the 3 bolts.
    - Tighten to 11 Nm (97 lb-in).

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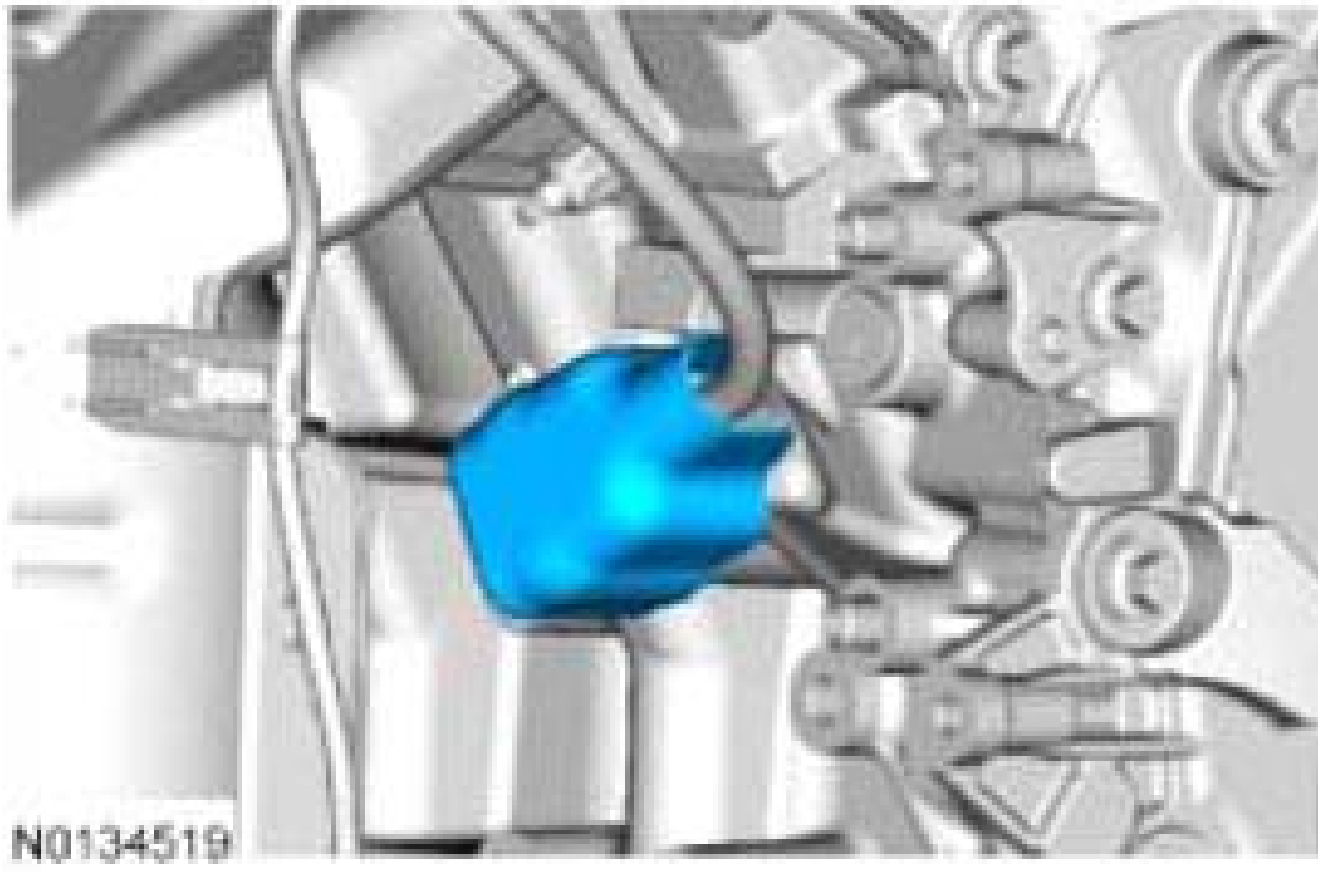
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156. If equipped, position the block heater wiring harness onto the engine and attach all of the harness retainers.
    - Connect the block heater electrical connector.



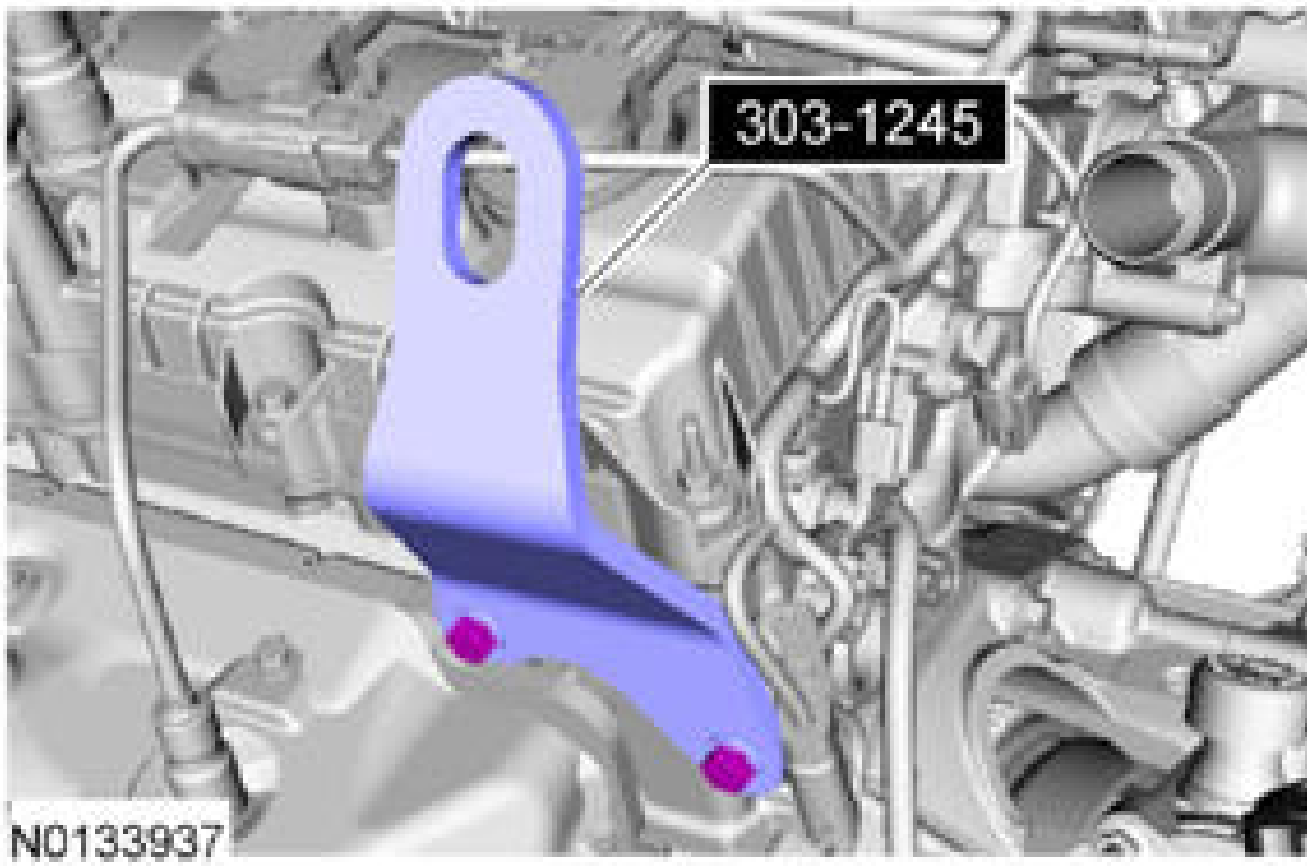
157. If equipped, install the block heater heat shield.

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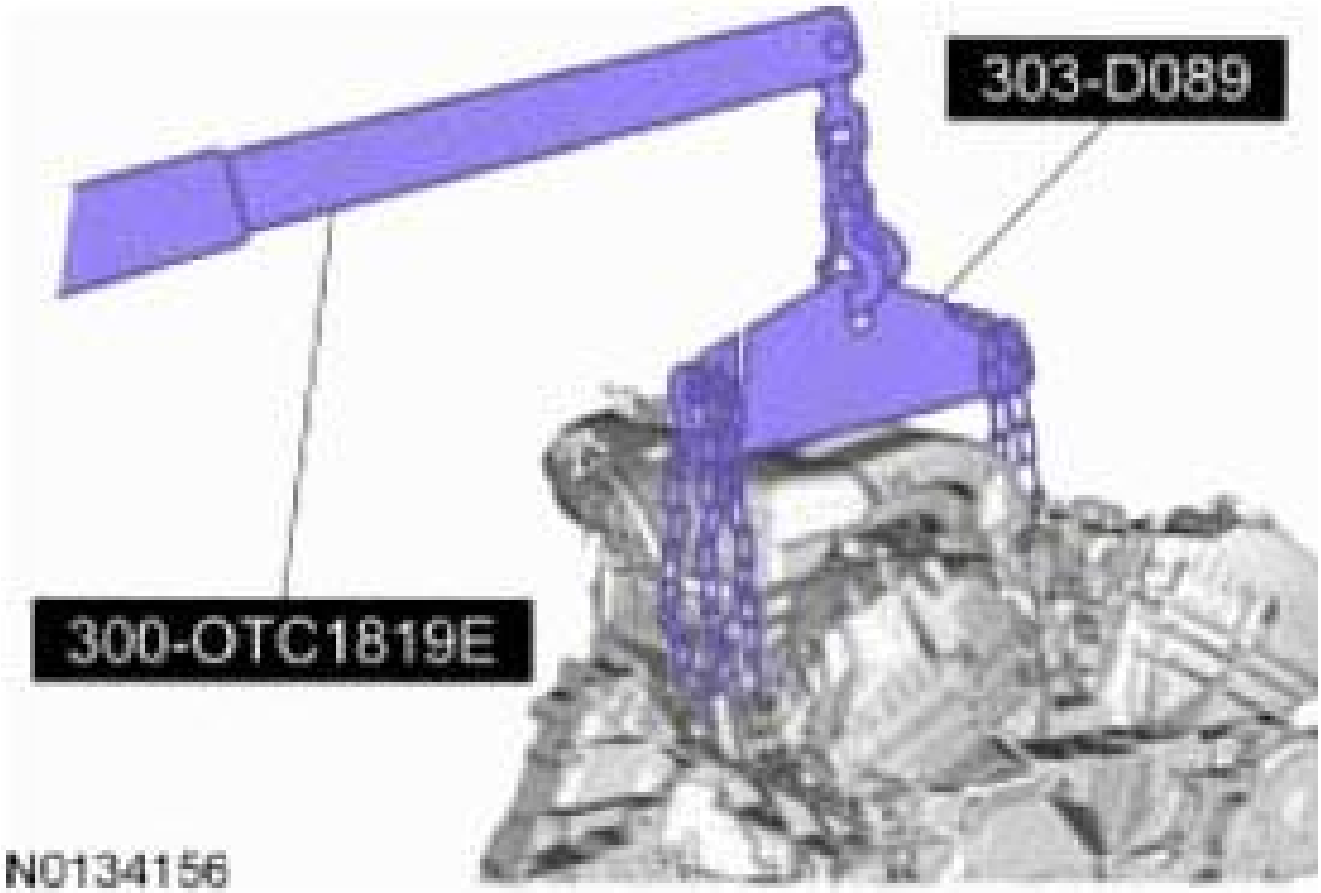
158. Install 303-1245 on the LH cylinder head.

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159. Using 300-OTC1819E and 303-D089 D93P-6001-A3, remove the engine from the stand.

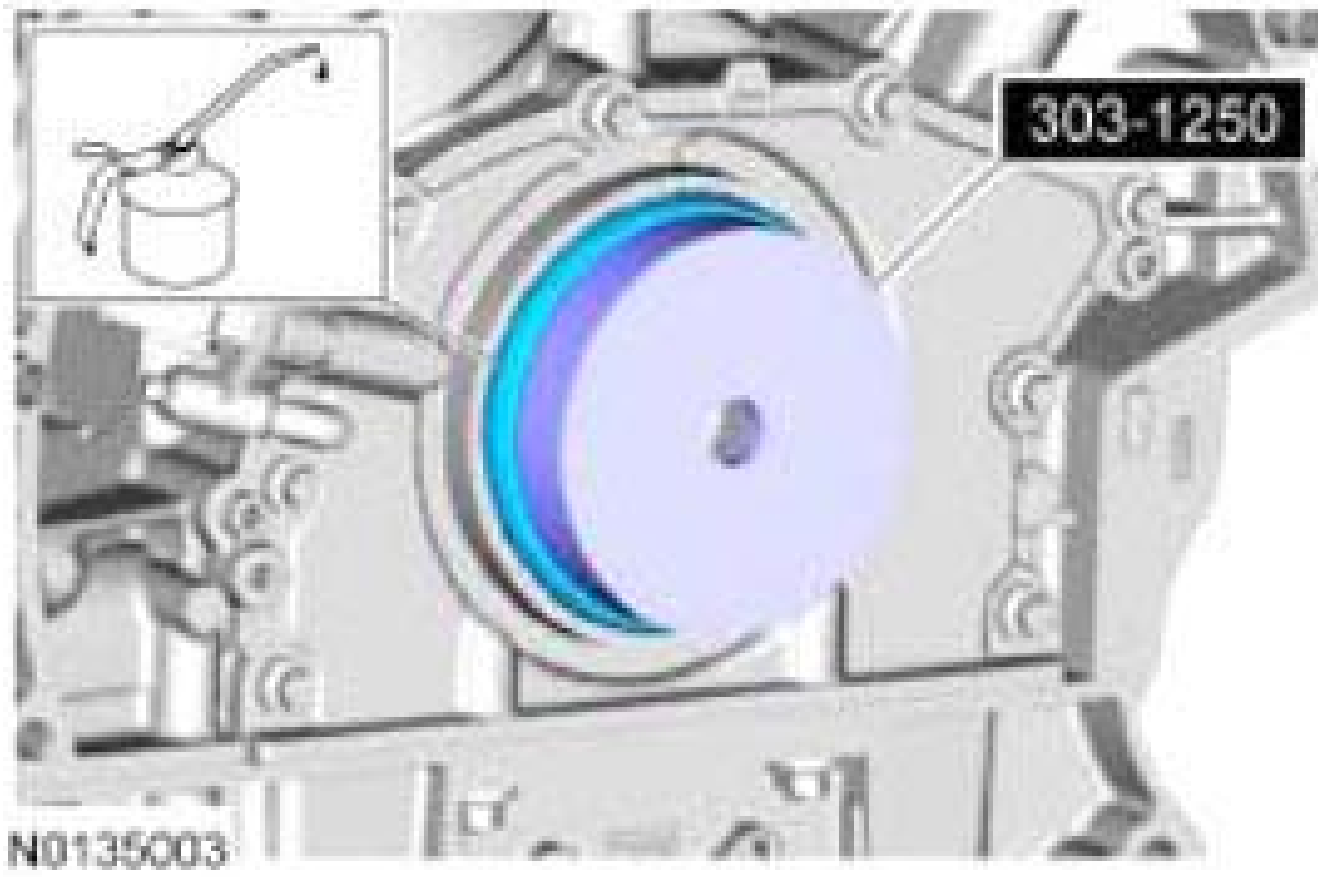
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160. **NOTE: Lubricate the seal lips and bore with clean engine oil prior to installation.**

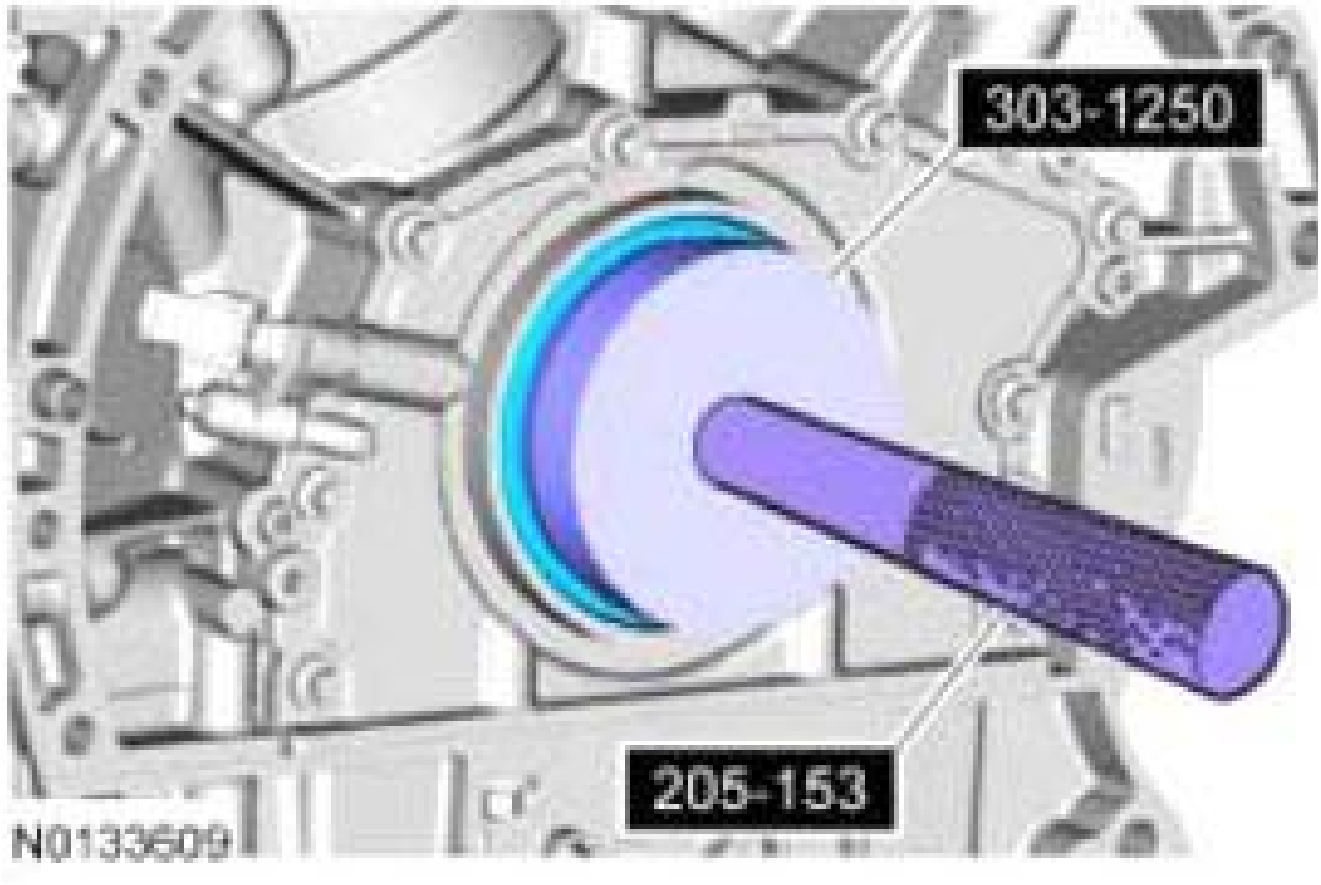
If equipped with a cast aluminum crankshaft rear seal retainer plate (early build), position 303-1250 onto the end of the crankshaft and slide a new crankshaft rear seal onto 303-1250.

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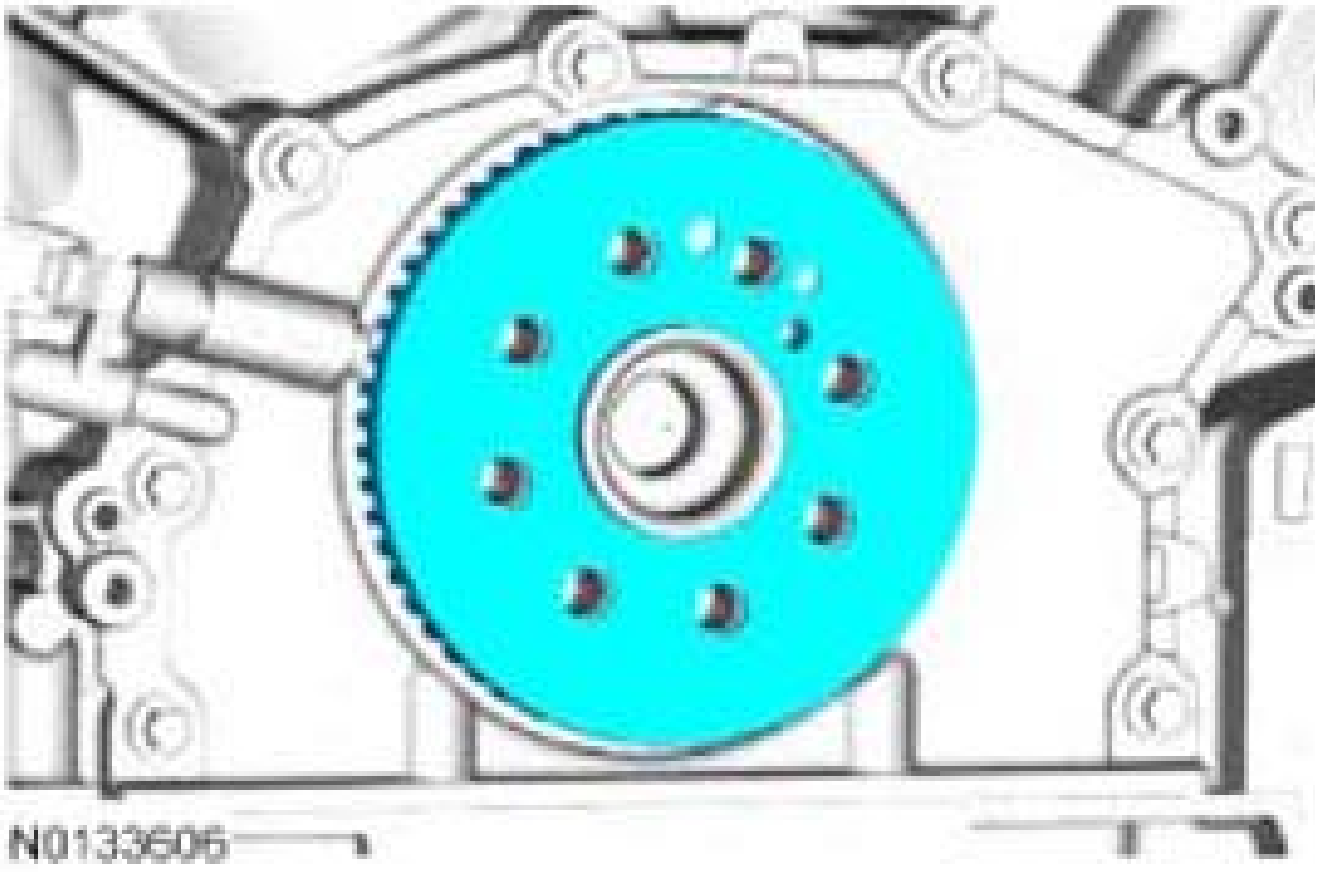
161. If equipped with a cast aluminum crankshaft rear seal retainer plate (early build), using the 303-1250 and 205-153 T80T-4000-W, install the new crankshaft rear seal.

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162. Install the crankshaft sensor ring.

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NOTE: **One of the 8 flexplate holes are offset so the flexplate can only be installed in one position.**

163. Install the flexplate and the 8 bolts.

- Tighten in the sequence shown in illustration to 80 Nm (59 lb-ft).

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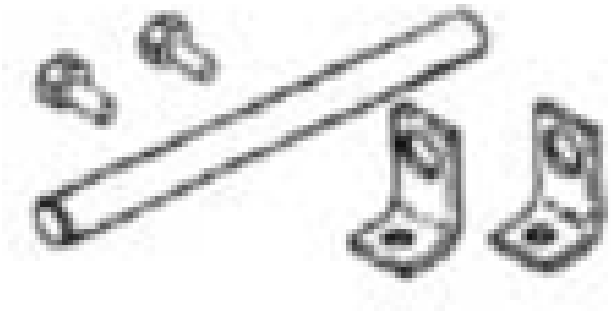
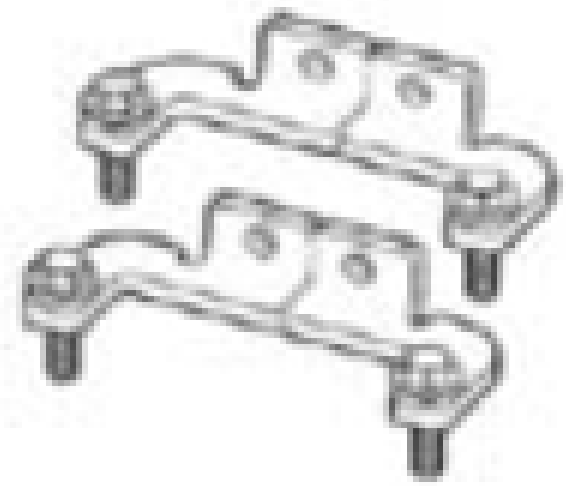
DISASSEMBLY AND ASSEMBLY OF SUBASSEMBLIES

CYLINDER HEAD

SPECIAL TOOL(S) DESCRIPTION

	Compressor, Valve Spring **303-300T87C-6565-A**

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	Compressor, Valve Spring **303-350T89P-6565-A**
	Valve Spring Compressor **303-1249**

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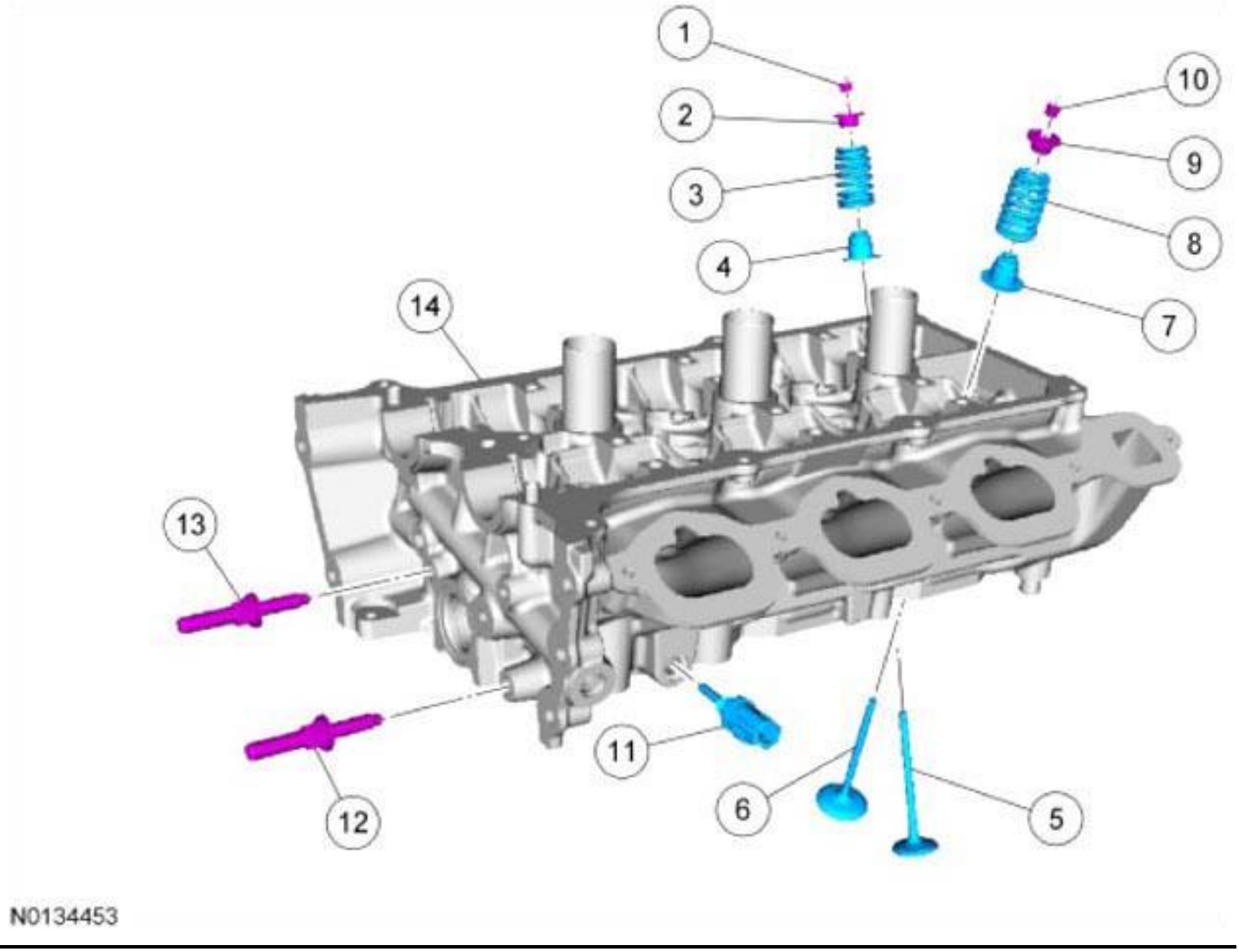
	Installer, Valve Stem Oil Seal **303-470T94P-6510-CH**

MATERIAL SPECIFICATIONS

Item	Specification
Motorcraft® SAE 5W-20 Premium Synthetic Blend Motor Oil (US); Motorcraft® SAE 5W-20 Super Premium Motor Oil (Canada) XO-5W20-QSP (US); CXO-5W20-LSP12 (Canada)	WSSM2C945-A

Exploded View

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Item	Part Number	Description
1	6518	Intake valve spring retainer key (12 required)
2	6514	Intake valve spring retainer (6 required)
3	6513	Intake valve spring (6 required)
4	6571	Intake valve stem seal (6 required)
5	6507	Intake valve (6 required)
6	6505	Exhaust valve (6 required)
7	6571	Exhaust valve stem seal (6 required)
8	6513	Exhaust valve spring (6 required)
9	6514	Exhaust valve spring retainer (6 required)
10	6518	Exhaust valve spring retainer key (12 required)
11	6G004	**CHT** sensor (RH cylinder head only)
12	W714090	Timing chain guide pin (RH cylinder head only)

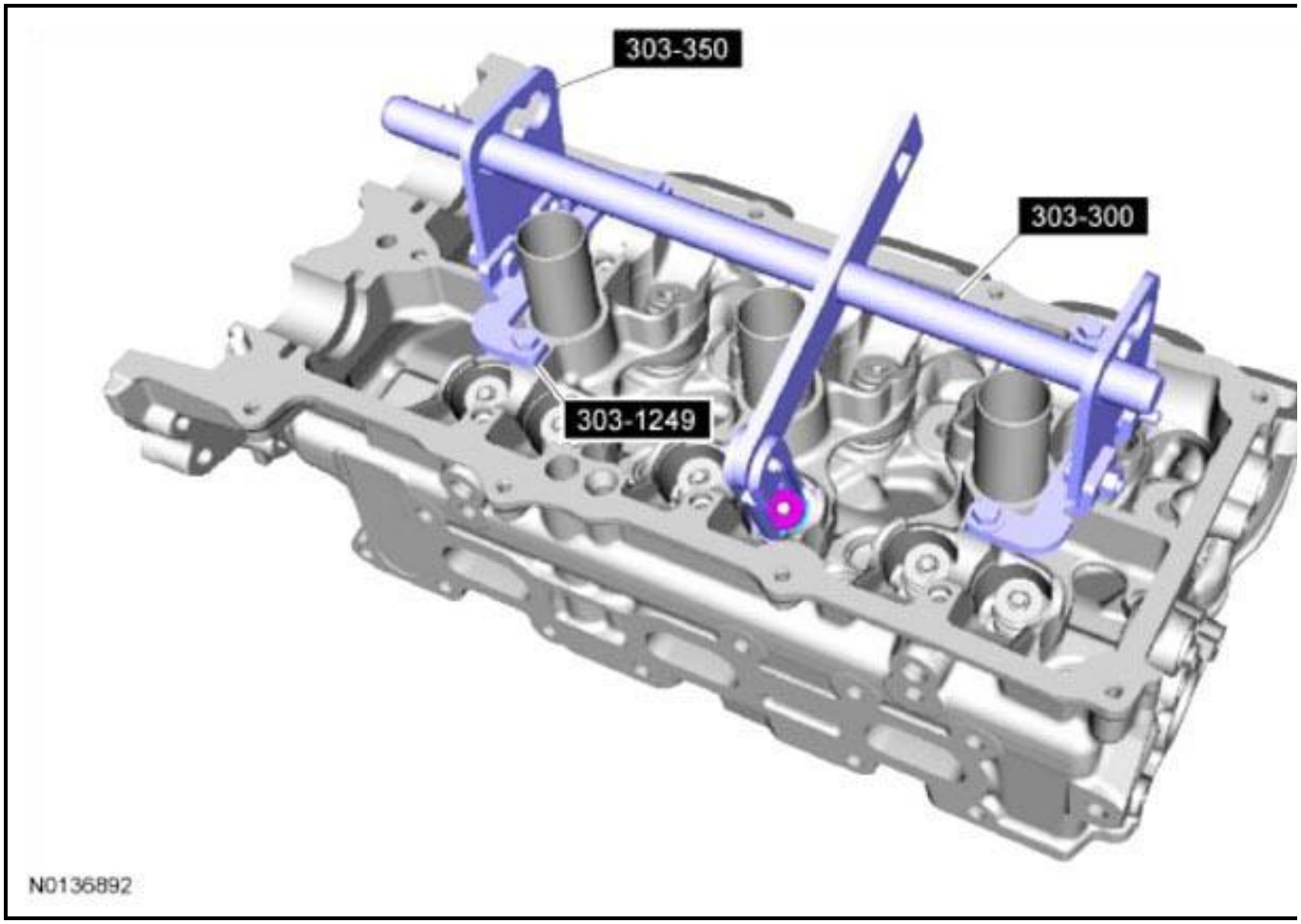
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13	W714090	Timing chain tensioner arm pin (RH cylinder head only)
14	6049	Cylinder head

Disassembly

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

1. Using the 303-300 T87C-6565-A, 303-350 T89P-6565-A and 303-1249, remove the keys, retainer and spring.



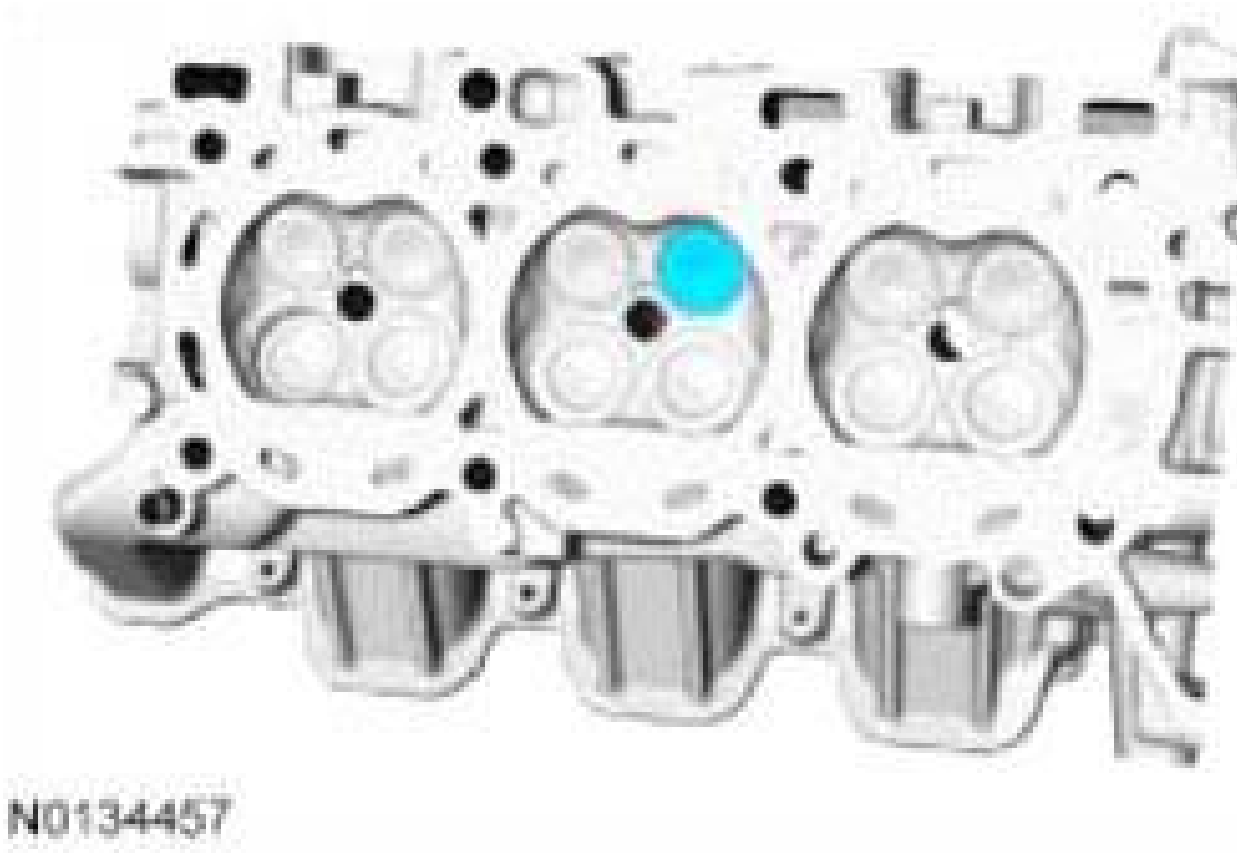
2. Remove and discard the valve stem seal.

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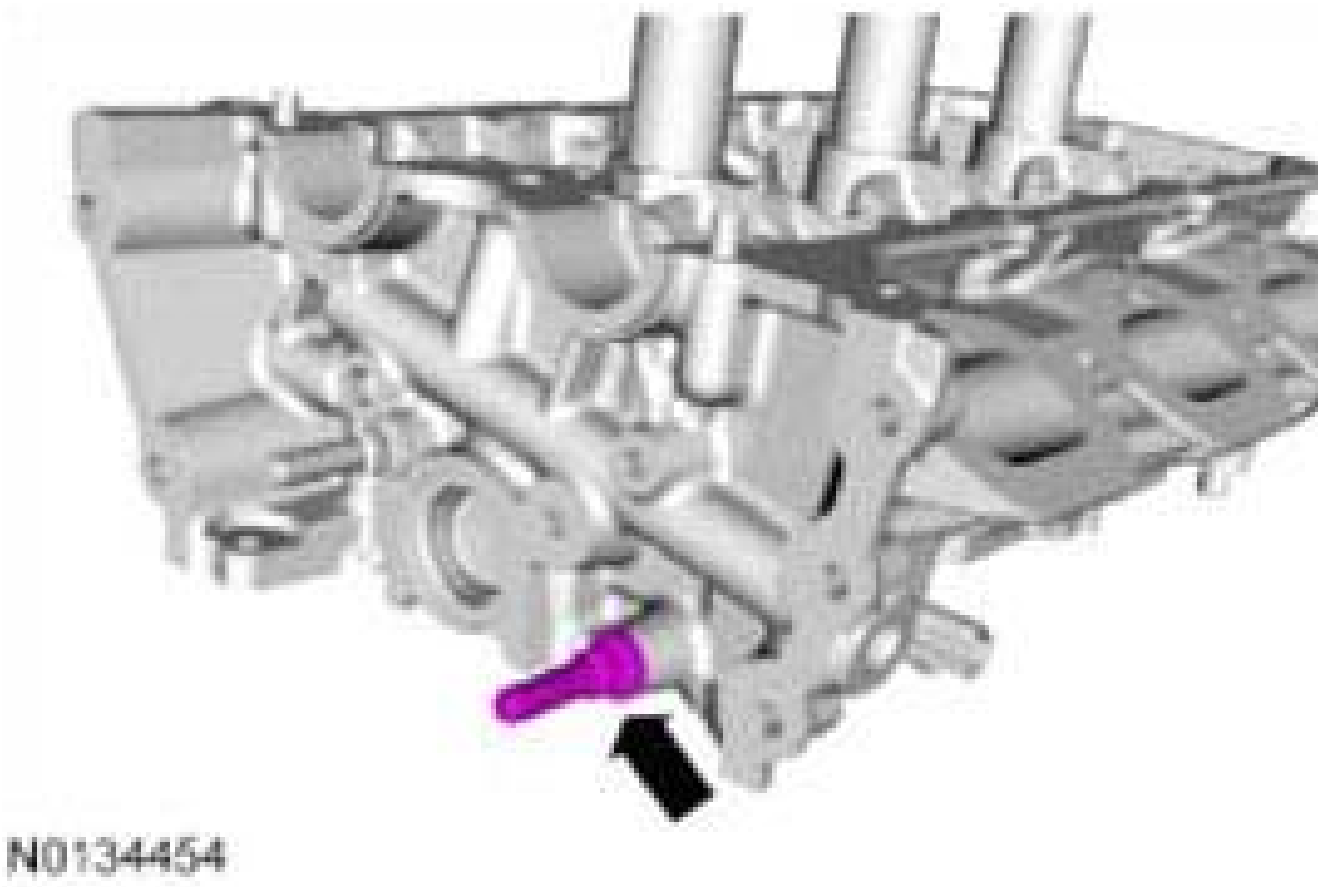
3. Remove the valve from the cylinder head.
    - Repeat the above steps for each valve.

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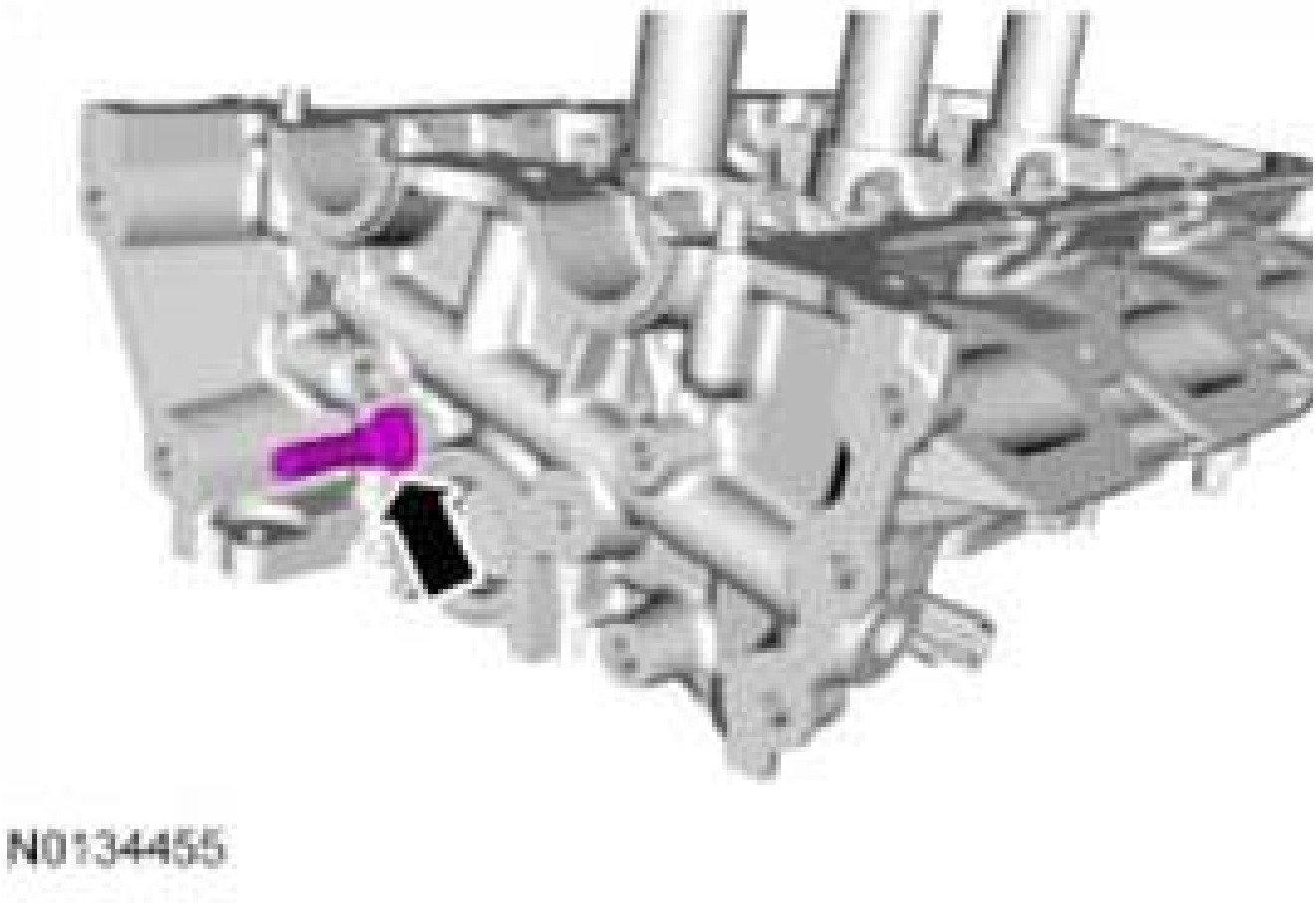
4. Remove the timing chain guide pin.

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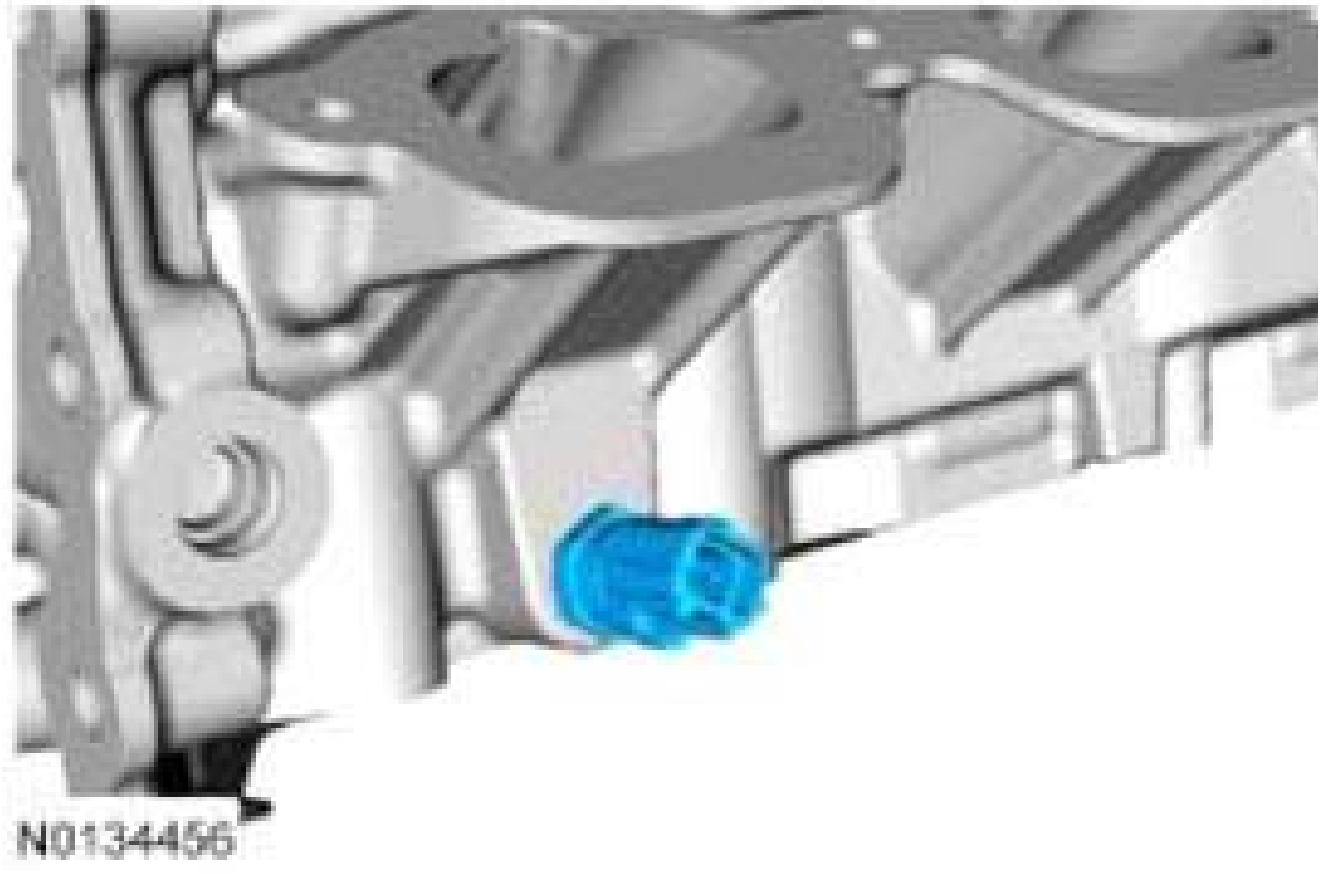
5. Remove the timing chain tensioner arm pin from the RH cylinder head.

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6. Remove and discard the **CHT** sensor from the RH cylinder head.

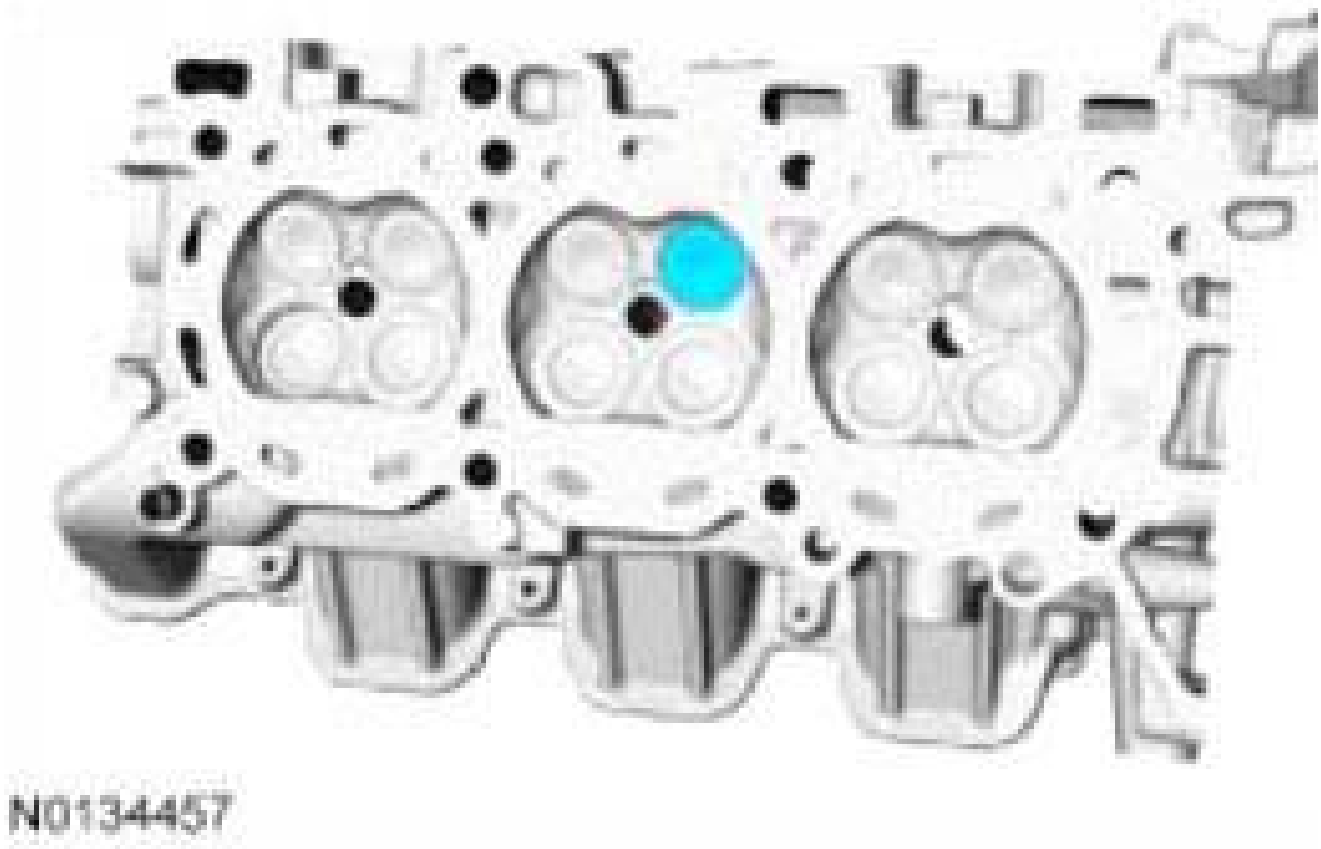
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Assembly

1. Install the valve.

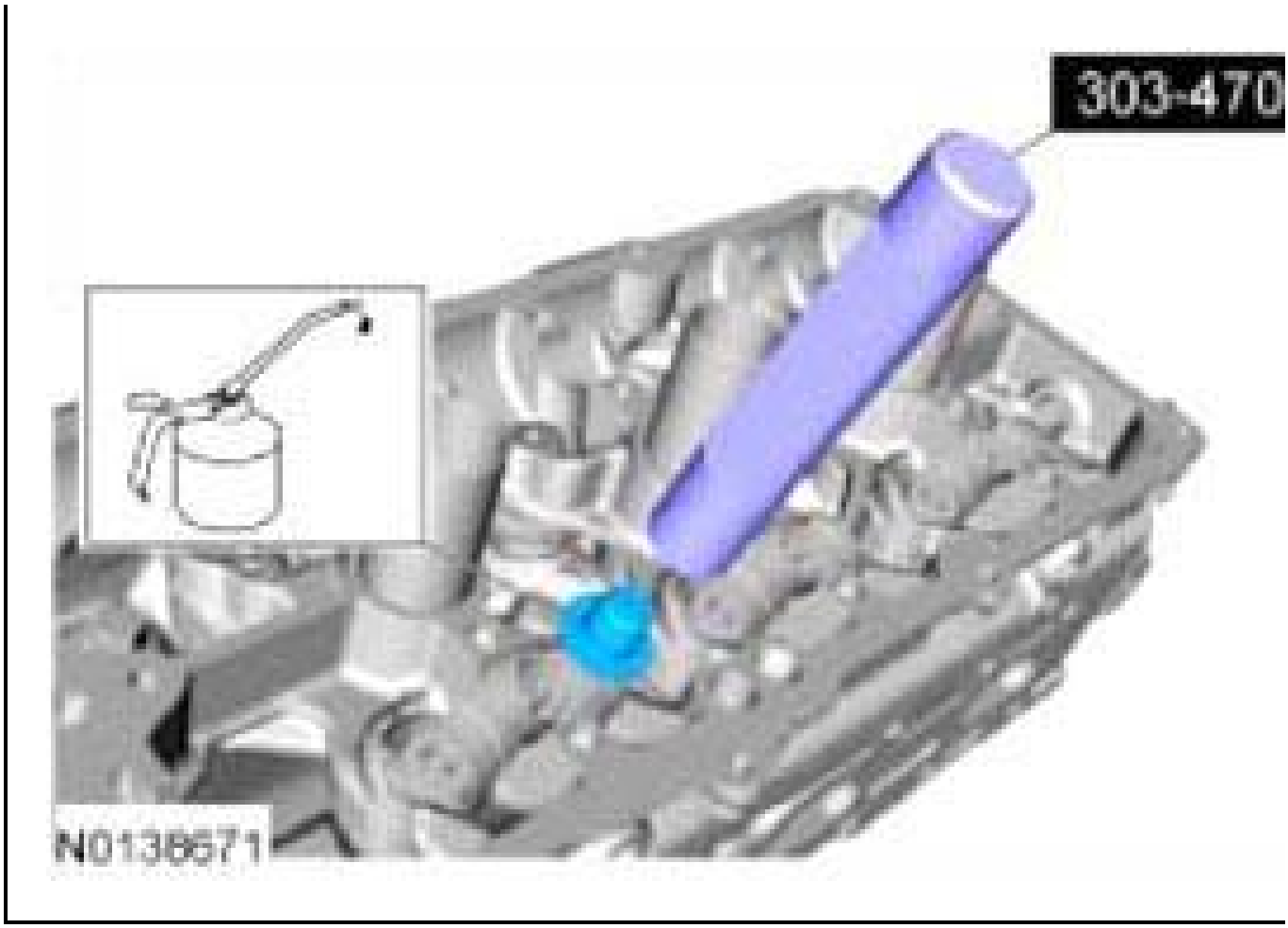
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2. **NOTE: Lubricate the valve stem seal with clean engine oil prior to installation.**

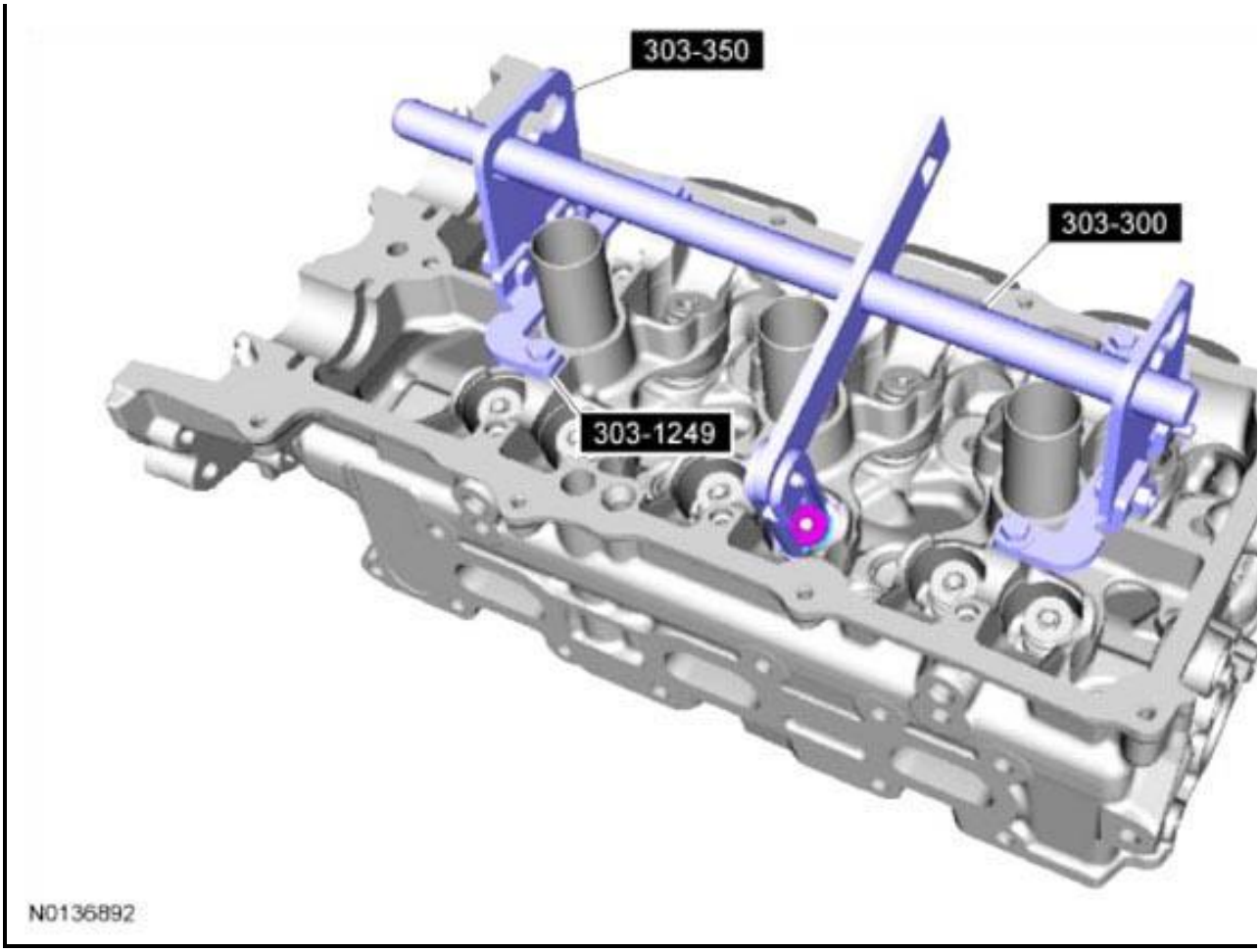
Using the 303-470 T94P-6510-CH, install a new valve stem seal.

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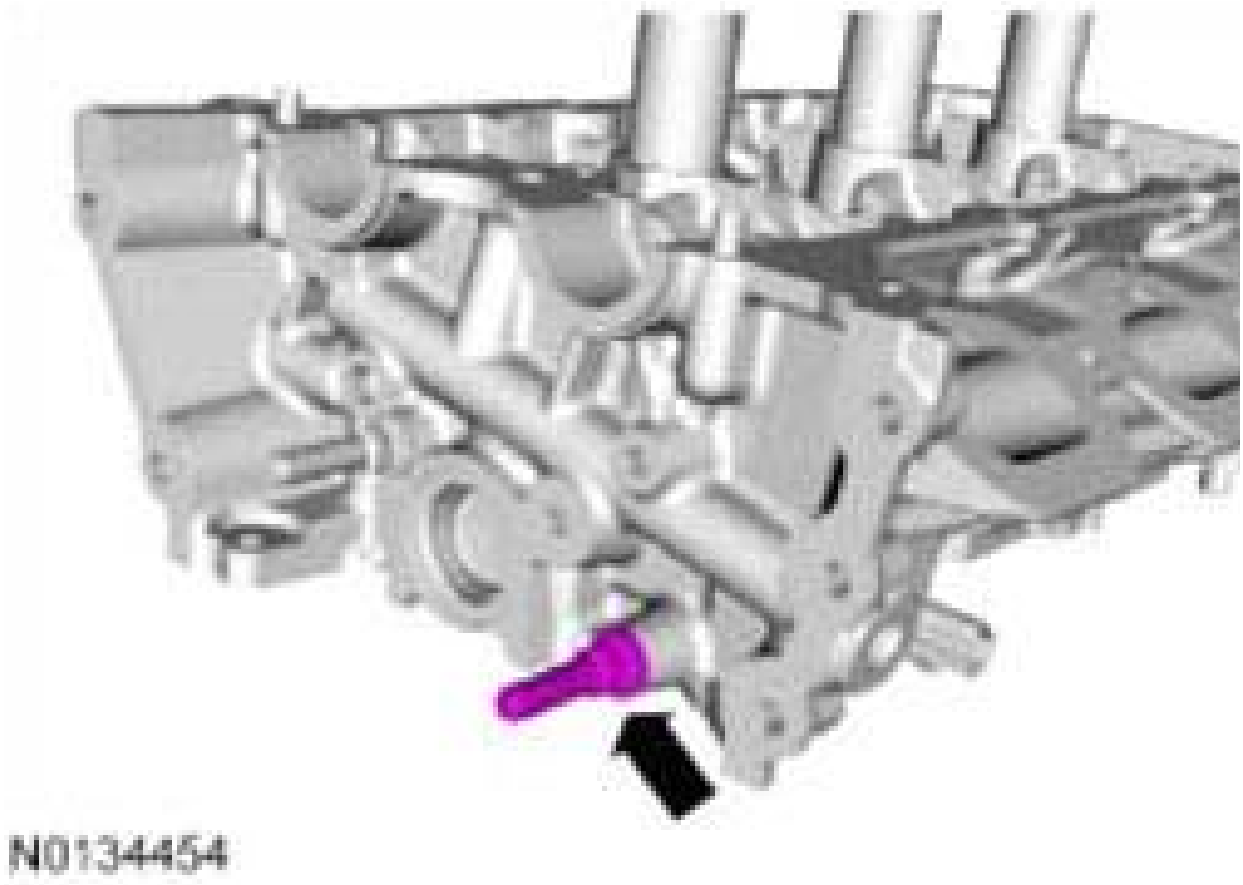
3. Using the 303-300 T87C-6565-A, 303-350 T89P-6565-A and 303-1249, install the valve spring, retainer and key.
    - Repeat the above steps for each valve.

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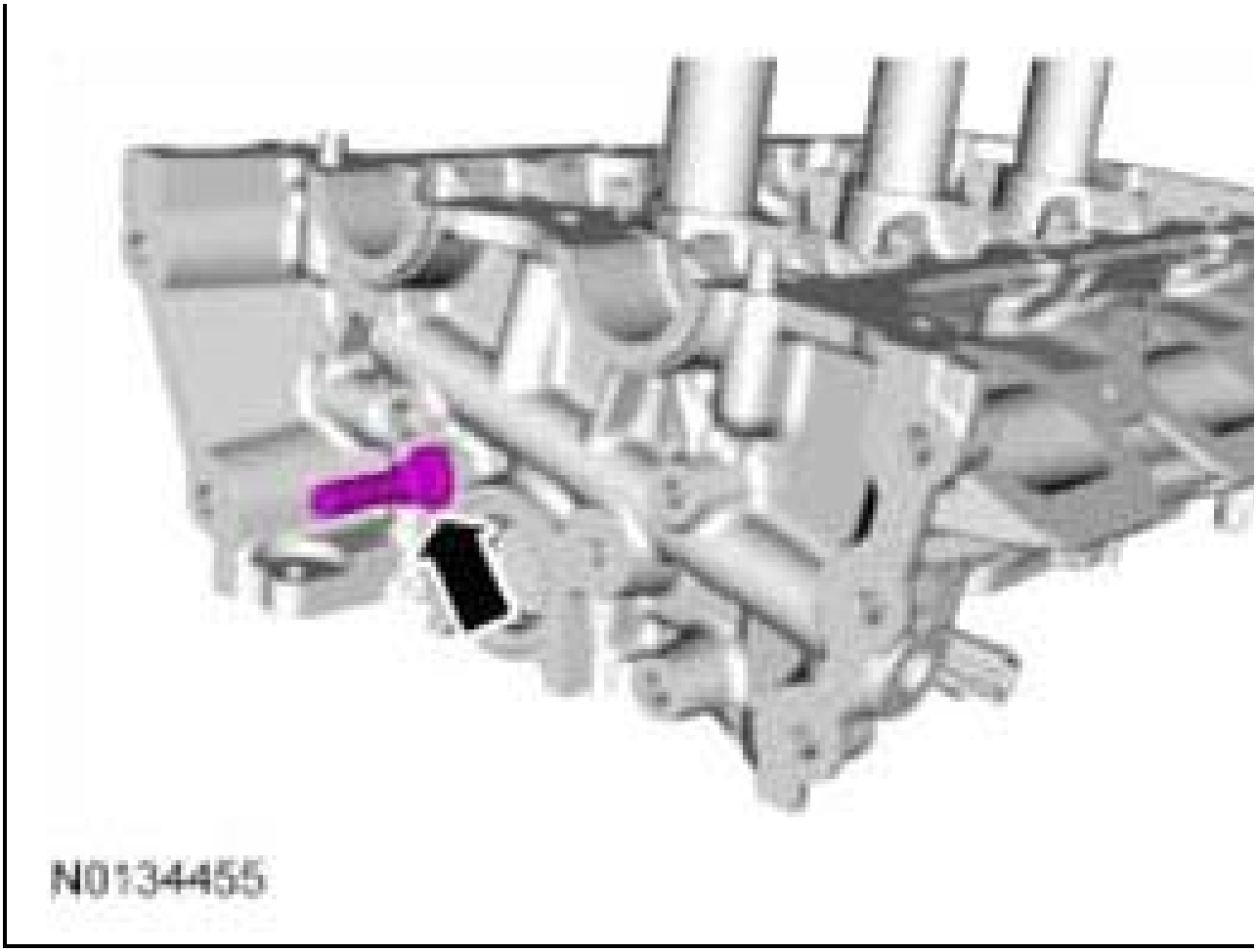
4. Install the timing chain guide pin.
    - Tighten to 10 Nm (89 lb-in).

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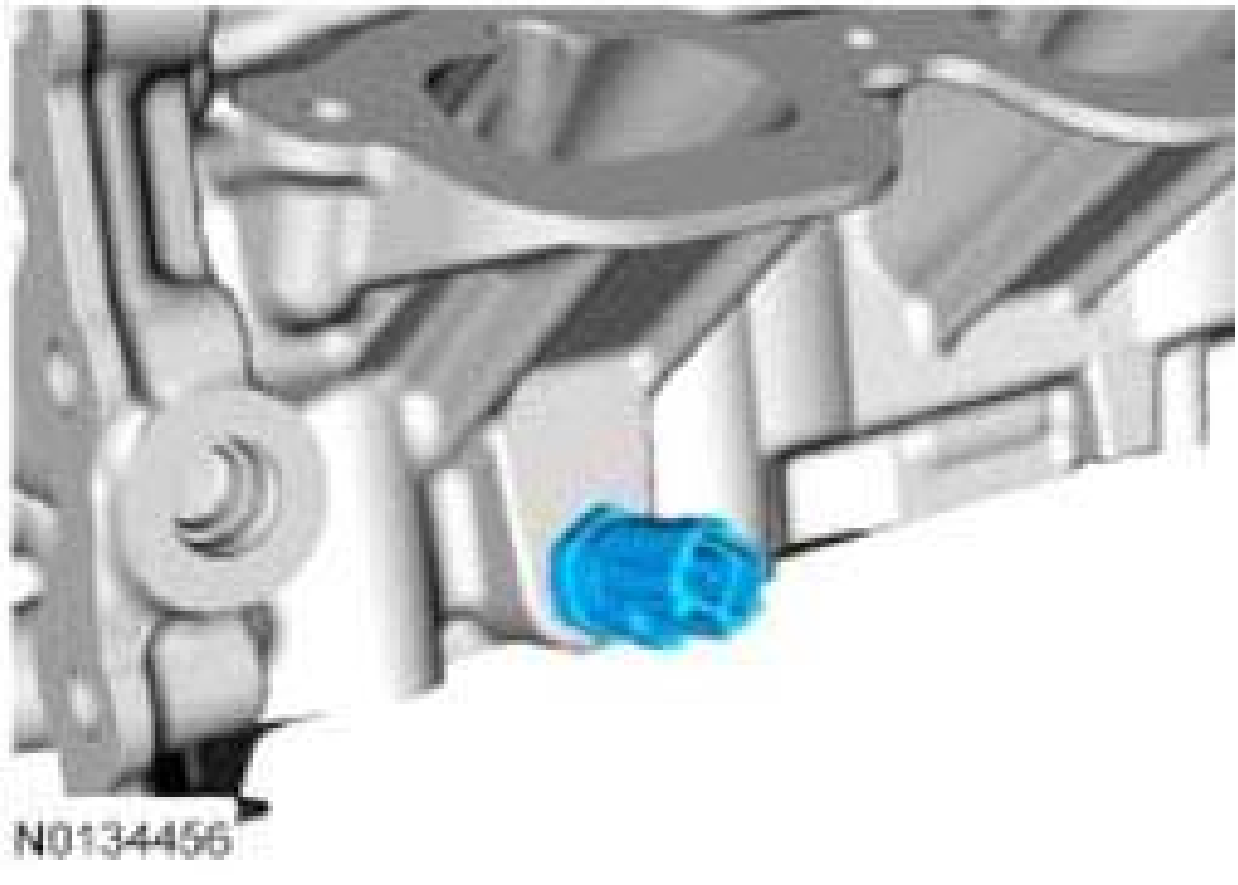
5. Install the timing chain tensioner arm pin on the RH cylinder head.
    - Tighten to 10 Nm (89 lb-in).

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6. Install a new **CHT** sensor in the RH cylinder head.
    - Tighten to 10 Nm (89 lb-in).

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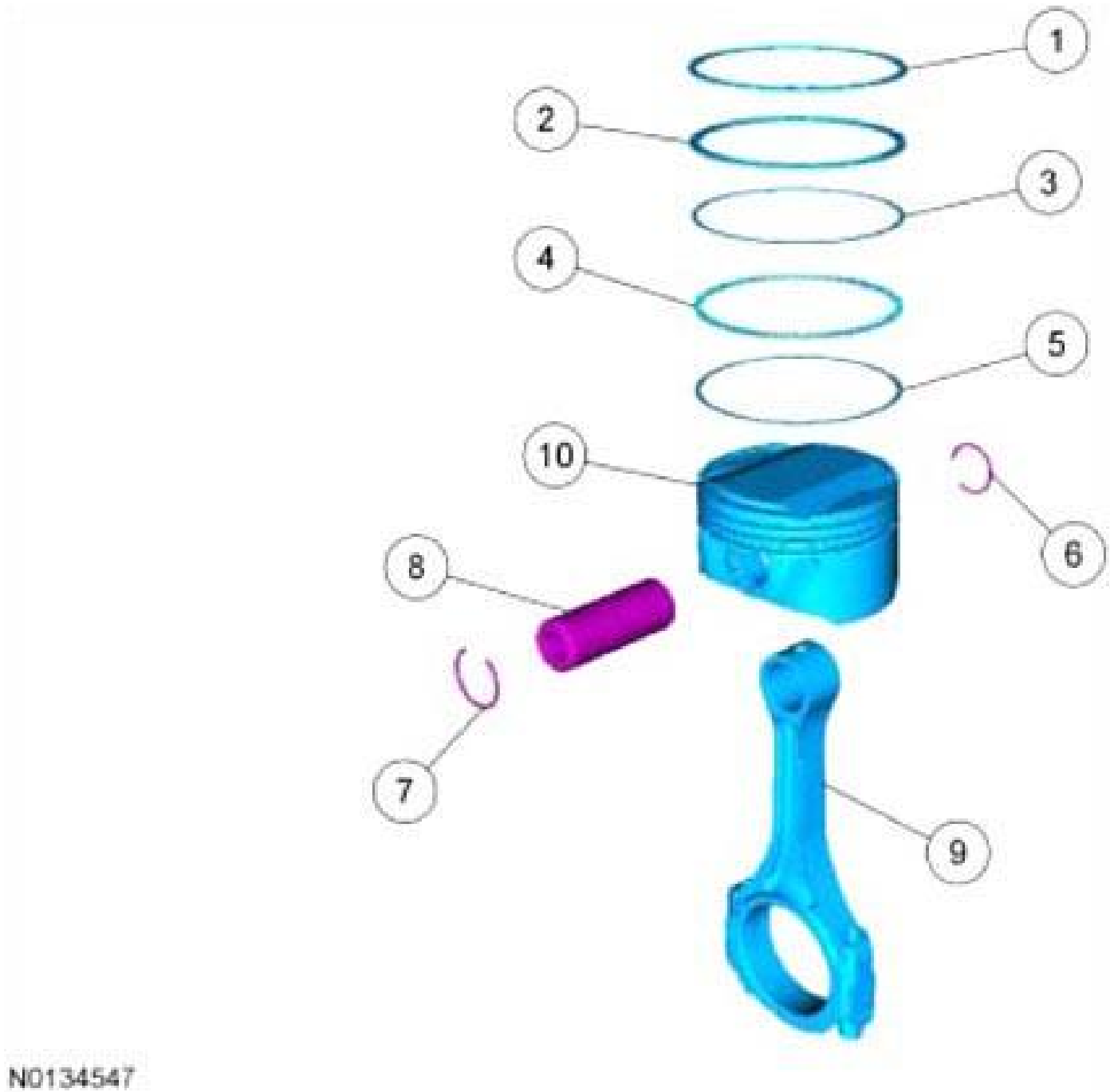
PISTON

MATERIAL SPECIFICATIONS

Item	Specification
Motorcraft® SAE 5W-20 Premium Synthetic Blend Motor Oil (US); Motorcraft® SAE 5W-20 Super Premium Motor Oil (Canada) XO-5W20-QSP (US); CXO-5W20-LSP12 (Canada)	WSSM2C945-A

Exploded View

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Item	Part Number	Description
1	-	Piston compression upper ring (part of 6148)
2	-	Piston compression lower ring (part of 6148)
3	-	Piston oil control upper segment ring (part of 6148)
4	-	Piston oil control spacer (part of 6148)
5	-	Piston oil control lower segment ring (part of 6148)

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6	6140	Piston pin retainer clip
7	6140	Piston pin retainer clip
8	6135	Piston pin
9	6200	Connecting rod
10	6110	Piston

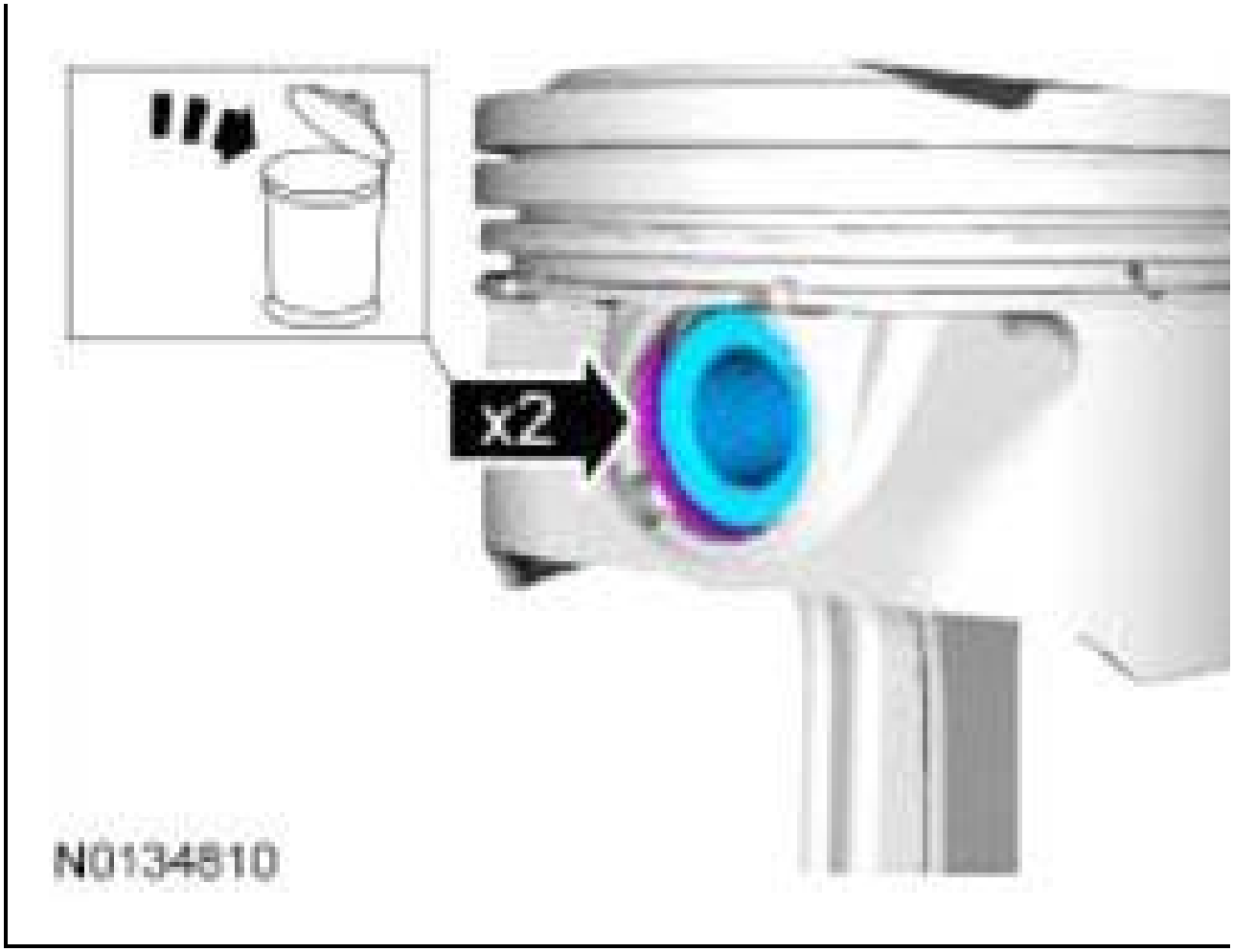
Disassembly

1. Remove the piston rings from the piston.
    - Discard the piston rings.



2. Remove the 2 piston pin retainers and the piston pin.
    - Discard the 2 piston pin retainer clips.

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

3. Separate the piston from the connecting rod.

- Clean and inspect the piston and connecting rod. Refer to **PISTON INSPECTION** , and **CONNECTING ROD CLEANING** .

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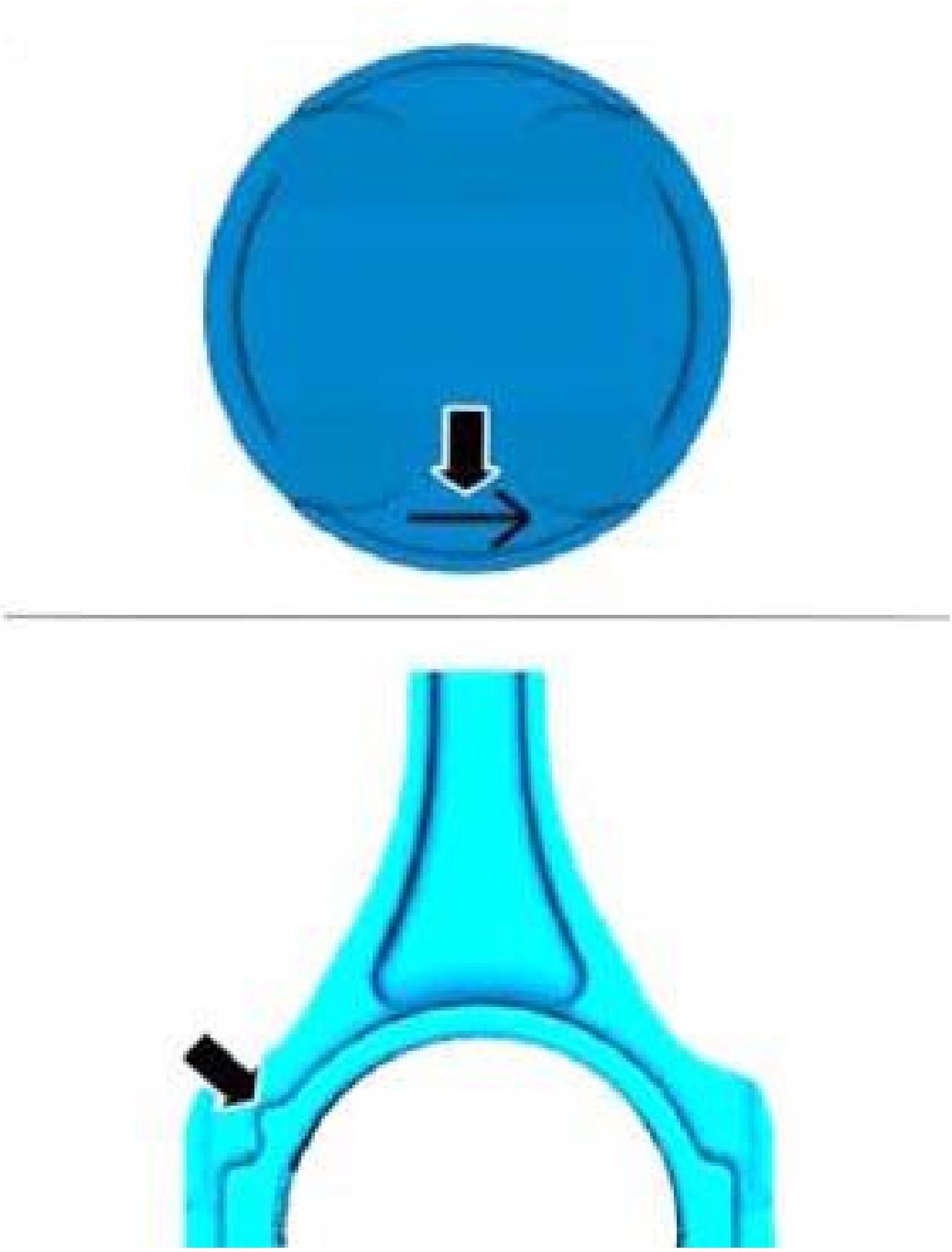


Assembly

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

1. Align the piston-to-connecting rod orientation marks and position the connecting rod in the piston.

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2. **NOTE: Lubricate the piston pin and pin bore with clean engine oil.**

Install the piston pin in the piston and connecting rod assembly.



3. Install the new piston pin retaining clips in the piston.
   - The piston pin retaining clip gap orientation must be toward the top or dome of piston.

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4. **NOTE: Lubricate the piston and the new piston rings with clean engine oil.**

Install the piston rings on the piston.

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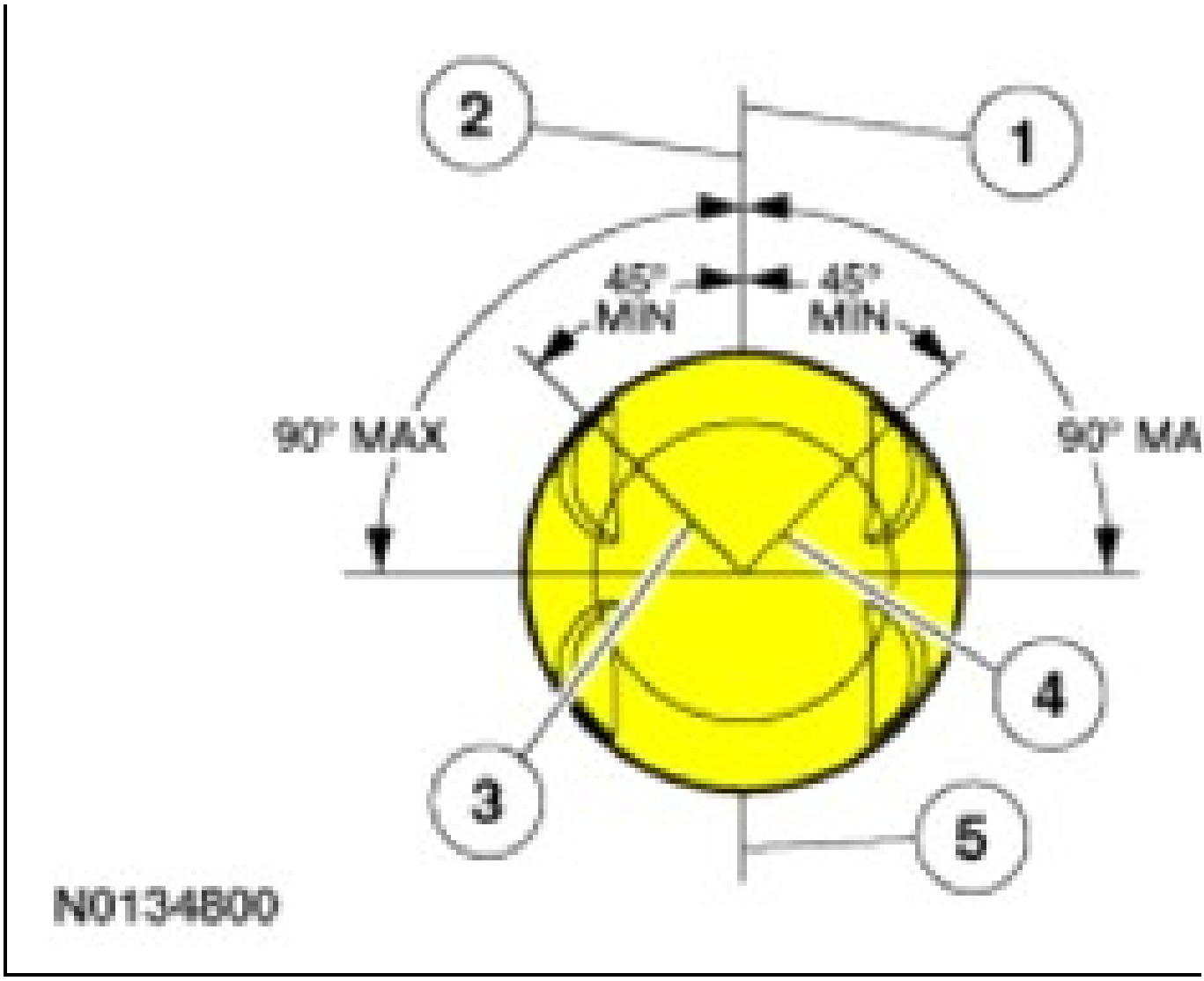


5. **NOTE: The piston compression upper and lower ring should be installed with the "O" mark on the ring face pointing up toward the top of the piston.**

Install the piston rings onto the piston as shown in illustration.

- Center line of the piston parallel to the wrist pin bore
- Upper compression ring gap location
- Upper oil control segment ring gap location
- Lower oil control segment ring gap location
- Expander ring and lower compression ring gap location

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