Engine Mechanical - 1.4L (LUV)

Specifications

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Air Conditioning Compressor Bracket Bolts	22 N•m	16 lb ft
Camshaft Actuator	50 N•m + 60 degrees	37 lb ft + 60 degrees
Camshaft Bearing Cap Bolts	8 N•m	71 lb in
Camshaft Cover Bolts	8 N•m	71 lb in
Camshaft Position Actuator Solenoid Valve	8 N•m	71 lb in
Camshaft Position Sensor Bolt	6 N•m	53 lb in
Camshaft Sprocket Bolt	50 N•m + 60 degrees (1)	37 lb ft + 60 degrees (1)
Catalytic Converter Bracket to Cylinder Block	22 N•m	16 lb ft
Catalytic Converter to Bracket	22 N•m	16 lb ft
Catalytic Converter to Turbocharger (V-clamp)	13 N•m	115 lb in
Connecting Rod Bearing Cap	25 N•m + 45 degrees (1)	18 lb ft + 45 degrees (1)
Crankshaft Balancer Bolt	150 N•m + 45 degrees + 15 degrees (1)	111 lb ft + 45 degrees + 15 degrees (1)
Crankshaft Bearing Tie Plate Bolts (M6)	10 N•m + 60 degrees + 15 degrees (1)	89 lb in + 60 degrees + 15 degrees (1)
Crankshaft Bearing Tie Plate Bolts (M8)	25 N•m + 60 degrees + 15 degrees (1)	18 lb ft + 60 degrees + 15 degrees (1)
Crankshaft Position Sensor Bolt	8 N•m	71 lb in
Cylinder Head Bolts	35 N•m + 180 degrees (1)	26 lb ft + 180 degrees (1)
Drive Belt Tensioner Bolt M8	22 N•m	16 lb ft
Drive Belt Tensioner Bolt M10	55 N•m	41 lb ft
Engine Cooling Thermostat Housing Bolts	8 N•m	71 lb in
Engine Front Cover Bolts M10	35 N•m	26 lb ft
Engine Front Cover Bolts M6	8 N•m	71 lb in
Engine Mount Bracket Bolts	60 N•m + 45–60 degrees (1)	44 lb ft + 45–60 degrees (1)
Engine Mount Right Side to Body	62 N•m	46 lb ft
Engine Mount Right Side to Engine Mount Bracket	50 N•m + 60–75 degrees (1)	37 lb ft + 60–75 degrees (1)
Engine Oil Filter Cap	25 N•m	18 lb ft
Exhaust Manifold Heat Shield Bolts	8 N•m	71 lb in
Flywheel Bolts (Two-Mass)	60 N•m + 45 degrees + 15 degrees (1)	44 lb ft + 45 degrees + 15 degrees (1)
Fuel Injection Rail to Intake Manifold	6 N•m	53 lb in
Generator to Cylinder Block and Engine Cover	35 N•m	26 lb ft
Ignition Coil Bolts	8 N•m	71 lb in
Intake Manifold Bolt	20 N•m	15 lb ft
Knock Sensor	20 N•m	15 lb ft
Oil Cooler Coolant Inlet Pipe to Oil Cooler	10 N•m	89 lb in
Oil Cooler to Engine Block	20 N•m	15 lb ft
Oil Cooler to Oil Filter Assembly (only bolts serviceable)	10 N•m	89 lb in
Oil Filler Plug to Engine Front Cover (M18)	30 N•m	22 lb ft

Fastener Tightening Specifications (cont'd)

Application	Specification	
	Metric	English
Oil Filter Assembly to Block	20 N•m	15 lb ft
Oil Gallery Plug in Engine Front Cover (M22)	60 N•m	44 lb ft
Oil Pan Bolt	10 N•m	89 lb in
Oil Pan Drain Plug	14 N•m	124 lb in
Oil Pressure Indicator	20 N•m	15 lb ft
Oil Pressure Relief Valve	50 N•m	37 lb ft
Oil Pump Cover Bolts	8 N•m	71 lb in
Oil Pump Housing Plug (M10)	10 N•m	89 lb in
Oxygen Sensor to Exhaust Manifold	42 N•m	31 lb ft
Oxygen Sensor to Exhaust Front Pipe	42 N•m	31 lb ft
Piston Oil Nozzles to Block	25 N•m	18 lb ft
Spark Plugs	25 N•m	18 lb ft
Starter Bolts	25 N•m	18 lb ft
Throttle Body Bolts	9 N•m	80 lb in
Timing Chain Guide	8 N•m	71 lb in
Timing Chain Tensioner	8 N•m	71 lb in
Timing Chain Tensioner Shoe	20 N•m	15 lb ft
Turbocharger Coolant Feed Pipe to Engine Block	30 N•m	22 lb ft
Turbocharger Coolant Feed Pipe to Turbocharger (Quick Fitting)	20 N•m	15 lb ft
Turbocharger Coolant Return Pipe to Turbocharger (Quick Fitting)	20 N•m	15 lb ft
Turbocharger Oil Feed Pipe to Oil Cooler/Filter	8 N•m	71 lb in
Turbocharger Oil Feed Pipe to Turbocharger	30 N•m	22 lb ft
Turbocharger Oil Return Pipe to Turbocharger	8 N•m	71 lb in
Turbocharger to Cylinder Head	8 N•m (1)	71 lb in (1)
Water Outlet	8 N•m	71 lb in
Water Pump Housing Bolts	8 N•m	71 lb in
Water Pump Drain Plug	15 N•m	11 lb ft
Water Pump Pulley Bolts	22 N•m	16 lb ft
1 = Use NEW Fastener.		

Engine Mechanical Specifications

Application	Specification	
	Metric	English
General Data		
Engine Type	4-Cylinder Inline	
Displacement	1364 ccm	83.24 cu in
Bore	72.5 mm	2.854 in
Stroke	82.6 mm	3.3 in
Compression Ratio	9.5:1	
Number of Valves	16	
Maximum Power @ engine speed KW/RPM	105 KW /4900	
Maximum Torque @ engine speed N•m / RPM / lb ft / RPM	200 N•m / 1850	148 lb ft / 4000

Engine Mechanical Specifications (cont'd)

Application	Specification	
	Metric	English
Engine Block		
Cylinder Bore Diameter Standard	72.492 mm – 72.508 mm	2.8540 in – 2.8546 in
Cylinder Bore Diameter Oversize 0.5	72.992 mm – 73.008 mm	2.8737 in – 2.8743 in
Piston, Piston Rings and Piston Pins		
Piston Diameter Standard	72.453 mm – 72.467 mm	2.8525 in – 2.8530 in
Piston Diameter Oversize 0.5	72.953 mm – 72.967 mm	2.8722 in – 2.8727 in
Piston Clearance to Bore	0.025 mm –0.055 mm	0.001 in – 0.0022 in
Piston – Upper Compression Ring Thickness	1.17 mm – 1.195 mm	0.0461 in 0.047 in
Piston – Upper Compression Ring Ring Gap	0.25 mm – 0.4 mm	0.0098 in – 0.0157 in
Piston – Upper Compression Ring Side Clearance	0.025 mm – 0.07 mm	0.001 in – 0.0028 in
Piston – Lower Compression Ring Thickness	1.17 mm – 1.195 mm	0.0461 in 0.047 in
Piston – Lower Compression Ring Ring Gap	0.4 mm – 0.6 mm	0.0157 in – 0.0236 in
Piston – Lower Compression Ring Side Clearance	0.025 mm – 0.07 mm	0.001 in – 0.0028 in
Piston – Oil Ring Thickness	1.92 mm – 2 mm	0.0756 in – 0.0787 in
Piston – Oil Ring Ring Gap	0.25 mm – 0.75 mm	0.0098 in – 0.0295 in
Piston – Oil Ring Side Clearance	0.04 mm – 0.12 mm	0.0016 in – 0.0047 in
Piston Pin Bore Diameter	18.006 mm – 18.012 mm	0.7089 in – 0.7091 in
Piston Pin Outer Diameter	17.995 mm – 18 mm	0.7085 in – 0.7087 in
Piston Pin Length	48 mm	1.8898 in
Piston Pin Clearance to Piston Bore	0.005 mm – 0.010 mm	0.0002 in – 0.00039 in
Piston Pin Clearance to Conrod Bore	0.010 mm – 0.018 mm	0.0039 in – 0.00070 in
Crankshaft		
Crankshaft Bearing Journal Standard Diameter (brown or green)	50.004 mm –50.017 mm	1.9687 in – 1.9692 in
Crankshaft Bearing Journal Undersize 0.25 Diameter (brown/blue or green/blue)	49.754 mm –49.767 mm	1.9588 in – 1.9593 in
Crankshaft Bearing Journal Undersize 0.5 Diameter (brown/white or green/white)	49.504 mm –49.517 mm	1.949 in – 1.9495 in
Crankshaft Bearing Journal Width Standard	23.000 mm –23.052 mm	0.9055 in – 0.9076 in
Crankshaft Bearing Journal Width Undersize 0.25	23.200 mm –23.252 mm	0.9134 in – 0.9154 in
Crankshaft Bearing Journal Width Undersize 0.4	23.400 mm –23.452 mm	0.9213 in – 0.9233 in
Crankshaft Bearing Mark 328N (brown) – Thickness	1.989 mm –1.995 mm	0.0783 in – 0.0785 in
Crankshaft Bearing Mark 329N (green) – Thickness	1.995 mm –2.001 mm	0.0785 in – 0.0788 in
Crankshaft Bearing Mark 330N – Thickness Undersize 0.25 (brown/blue)	2.114 mm – 2.120 mm	0.0832 in – 0.0835 in
Crankshaft Bearing Mark 331 – Thickness Undersize 0.25 (green/blue)	2.120 mm – 2.126 mm	0.0835 in – 0.0837 in
Crankshaft Bearing Mark 332 – Thickness Undersize 0.5 (brown/white)	2.239 mm – 2.245 mm	0.0881 in – 0.0884 in
Crankshaft Bearing Mark 332 – Thickness Undersize 0.5 (green/white)	2.245 mm – 2.251 mm	0.0884 in – 0.0886 in
Crankshaft Bearing Clearance	0.007 mm – 0.031 mm	0.0003 in – 0.0012 in
Crankshaft Bearing Clearance Axial	0.100 mm – 0.202 mm	0.0039 in – 0.008 in
Crankshaft Bearing Out Of Round	0.03 mm	0.0012 in
Connecting Rod Bearing Journal Diameter Standard	42.971 mm – 42.987 mm	1.6918 in – 1.6924 in
Connecting Rod Bearing Journal Diameter Undersize 0.25 (blue)	42.721 mm –42.737 mm	1.6819 in – 1.6826 in
Connecting Rod Bearing Journal Diameter Undersize 0.5 (white)	42.471 mm –42.487 mm	1.6721 in – 1.6727 in
Connecting Rod Bearing Thickness Standard	1.490 mm – 1.500 mm	0.0587 in – 0.0591 in
Connecting Rod Bearing Thickness Undersize 0.25	1.615 mm – 1.625 mm	0.0636 in – 0.064 in
Connecting Rod Bearing Thickness Undersize 0.5	1.740 mm – 1.750 mm	0.0685 in – 0.0689 in

Engine Mechanical Specifications (cont'd)

Application	Specification	
	Metric	English
Connecting Rod Bearing Diameter Standard (upper and lower)	1.490 mm – 1.500 mm	0.0587 in – 0.0591 in
Connecting Rod Bearing Diameter Undersize 0.25 (upper and lower)	1.615 mm – 1.625 mm	0.0636 in – 0.064 in
Connecting Rod Bearing Diameter Undersize 0.5 (upper and lower)	1.740 mm – 1.750 mm	0.0685 in – 0.0689 in
Connecting Rod Bearing Clearance	0.013 mm – 0.061 mm	0.0005 in – 0.0024 in
Cylinder Head		
Cylinder Head – Intake Valve Seat Width	1.4 mm – 1.8 mm	0.0551 in – 0.0709 in
Cylinder Head – Exhaust Valve Seat Width	1 mm –1.4 mm	0.0394 in – 0.0551 in
Cylinder Head – Valve Seat Angle	90° 30'	
Cylinder Head – Valve Seat Angle Adjustment Upper	110°	
Cylinder Head — Valve Seat Angle Adjustment Lower	60°	
Cylinder Head – Intake Valve Guide Inner Diameter Standard	4.991 mm – 5.007 mm	0.1965 in – 0.1971 in
Cylinder Head – Intake Valve Guide Inner Diameter + 0.075	5.066 mm – 5.082 mm	0.1994 in – 0.2001 in
Cylinder Head – Intake Valve Guide Inner Diameter 0.150	5.141 mm –5.157 mm	0.2024 in – 0.203 in
Cylinder Head – Exhaust Valve Guide Inner Diameter Standard	4.991 mm – 5.007 mm	0.1965 in – 0.1971 in
Cylinder Head – Exhaust Valve Guide Inner Diameter + 0.075	5.066 mm – 5.082 mm	0.1994 in – 0.2001 in
Cylinder Head – Exhaust Valve Guide Inner Diameter + 0.150	5.141 mm – 5.157 mm	0.2024 in – 0.203 in
Cylinder Head – Valve Guide Length	38.7 mm – 39.3 mm	1.5236 in – 1.5472 in
Cylinder Head – Surface Flatness (max) – Block Deck – longitude	0.05 mm	0.00197 in
Cylinder Head – Surface Flatness (max) – Block Deck – transverse	0.03 mm	0.00118 in
Valve Train		
Intake Valve Length Standard	92.9 mm	3.6575 in
Exhaust Valve Length Standard	92.7 mm	3.6496 in
Intake Valve Stem Diameter Standard	4.950 mm – 4.965 mm	0.1949 in – 0.1955 in
Exhaust Valve Stem Diameter Standard	4.930 mm – 4.945 mm	0.1941 in – 0.1947 in
Intake Valve Stem Diameter + 0.075	5.025 mm – 5.040 mm	0.1978 in – 0.1984 in
Exhaust Valve Stem Diameter + 0.075	5.005 mm – 5.020 mm	0.197 in – 0.1976 in
Intake Valve Stem Diameter + 0.150	5.100 mm – 5.115 mm	0.2008 in – 0.2014 in
Exhaust Valve Stem Diameter + 0.150	5.080 mm – 5.095 mm	0.2 in – 0.2006 in
Intake Valve Disc Diameter	27.9 mm – 28.1 mm	1.0984 in – 1.1063 in
Exhaust Valve Disc Diameter	24.9 mm – 25.1	0.9803 in — 0.9882 in
Valve Spring Height Free	40 mm	1.5748 in
Valve Spring Height Under Load – Valve open	21.5 mm	0.8465 in
Valve Spring Height Under Load – Valve closed	30 mm	1.1811 in
Valve Clearance to Guide Intake	0.026 mm – 0.057 mm	0.001 in – 0.0022 in
Valve Clearance to Guide Exhaust	0.046 mm – 0.077 mm	0.0015 in – 0.003 in
Engine Oil		
Quality	Dexos I	
Filling – With New Oil Filter	4 L	4.25 Quarts
Viscosity	5W–30	
Oil Pressure @ Idle Speed	150 kpa	22 psi
Oil Pressure @ 3000 rpm – 3500 rpm	380 kpa – 650 kpa	55 psi – 94 psi
Oil Pump		
Axial Clearance Vane Rotor to Cover	0.01 mm	0.0004 in
Axial Clearance Vane to Cover	0.09 mm	0.0036 in

Engine Mechanical Specifications (cont'd)

Application	Specification	
	Metric	English
Axial Clearance Vane Ring to Cover	0.04 mm	0.0016 in
Axial Clearance Slide to Cover	0.08 mm	0.0031 in
Axial Clearance Slide Seal to Cover	0.09 mm	0.0036 in
Radial Clearance Vane to Vane Rotor	0.05 mm	0.002 in
Radial Clearance Vane to Slide	0.2 mm	0.008 in

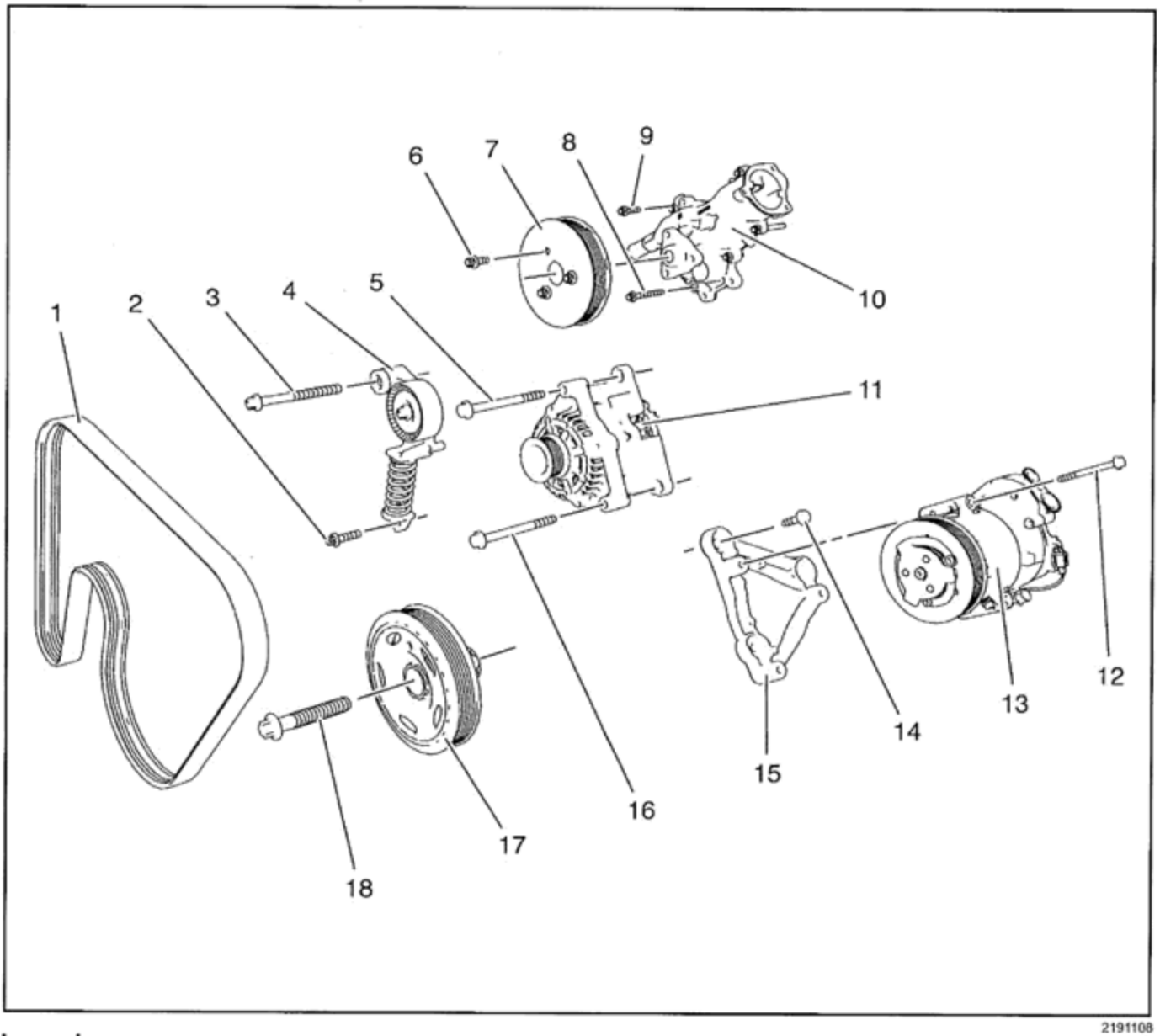
Adhesives, Fluids, Lubricants, and Sealers

Application	Type of Material	GM Part Number
Bolt Connections	Screw Locking Compound	Refer to electronic parts catalog
Engine Oil	DEXOS II, 0-W30, 0-W40, 5-W30 and 5-W40	Refer to electronic parts catalog
First Camshaft Bearing Cap	Surface Sealant	Refer to electronic parts catalog
Oil Pan	Oil Pan Sealant	Refer to electronic parts catalog
Oxygen Sensor	Assembly Paste	Refer to electronic parts catalog
Seal Rings	Silicon Grease	Refer to electronic parts catalog

Component Locator

Disassembled Views

Accessory Drive Components

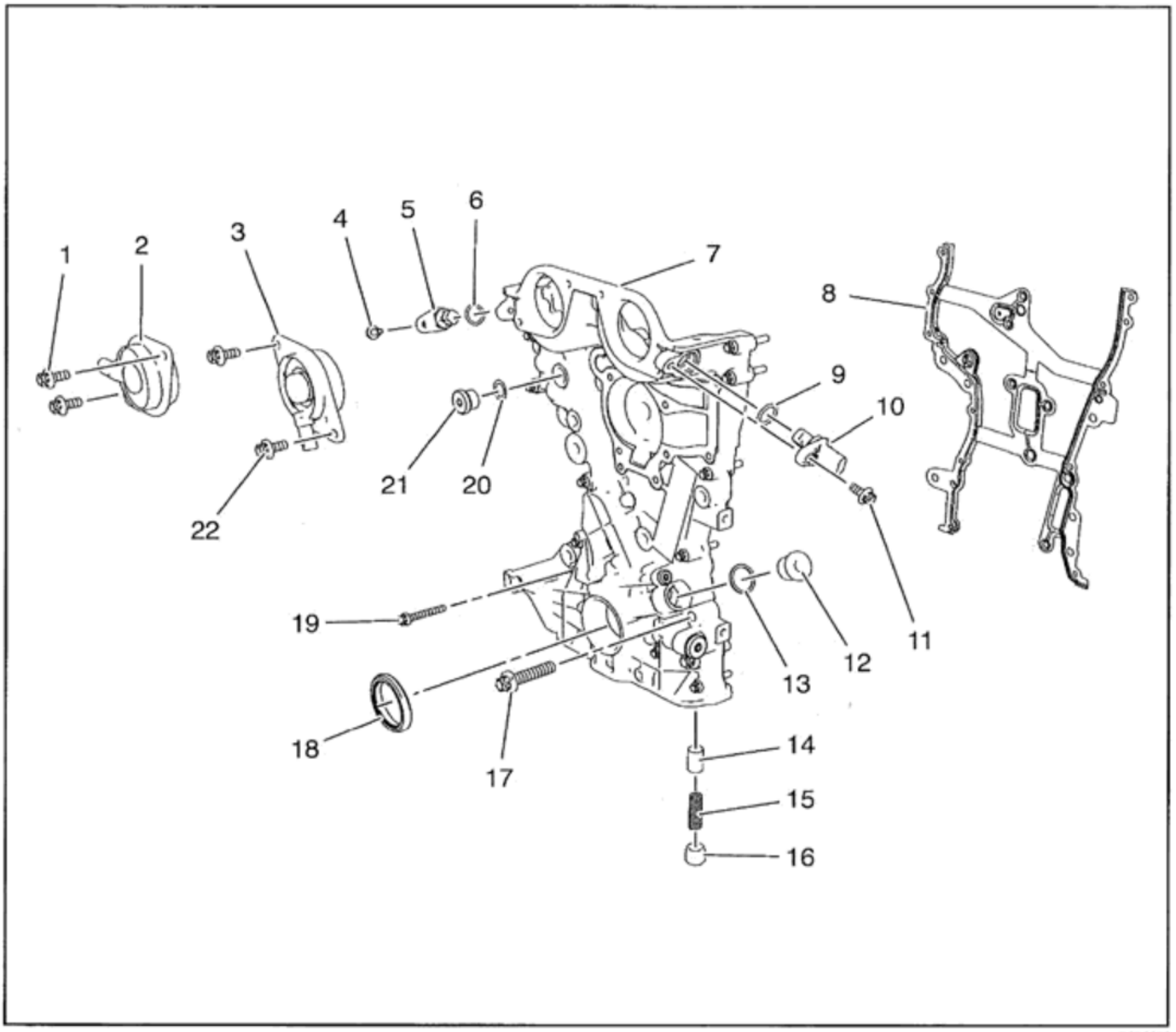


2191108

Legend

(1) Generator And Air Conditioning Compressor Belt
(2) Drive Belt Tensioner Bolt (short)
(3) Drive Belt Tensioner Bolt (long)
(4) Drive Belt Tensioner
(5) Upper Generator Bolt
(6) Water Pump Pulley Bolt
(7) Water Pump Pulley
(8) Water Pump Bolt (Long)
(9) Water Pump Bolt (Short)
(10) Water Pump
(11) Generator
(12) Air Conditioning Compressor Bolt
(13) Air Conditioning Compressor
(14) Air Conditioning Compressor Bracket Bolt
(15) Air Conditioning Compressor Bracket
(16) Lower Generator Bolt
(17) Crankshaft Balancer
(18) Crankshaft Balancer Bolt

Engine Front Cover And Oil Pump Assembly (1 of 2)

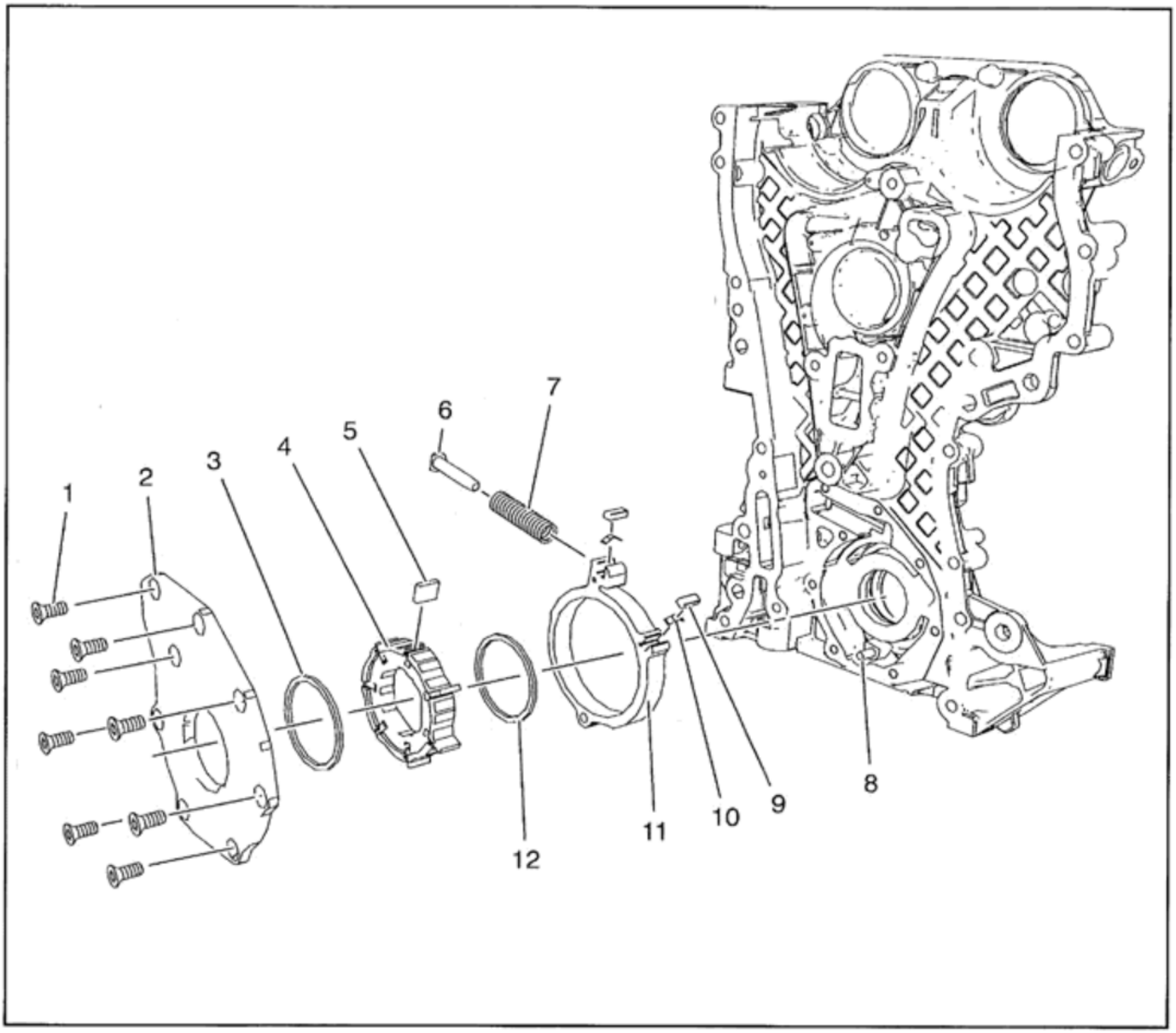


2191109

Legend

(1) Camshaft Position Actuator Solenoid Valve Bolt
(2) Intake Camshaft Position Actuator Solenoid Valve
(3) Exhaust Camshaft Position Actuator Solenoid Valve
(4) Intake Camshaft Position Sensor Bolt
(5) Intake Camshaft Position Sensor
(6) Intake Camshaft Position Sensor Seal Ring
(7) Engine Front Cover
(8) Engine Front Cover Gasket
(9) Exhaust Camshaft Position Sensor Seal Ring
(10) Exhaust Camshaft Position Sensor
(11) Exhaust Camshaft Position Sensor Bolt
(12) Engine Front Cover Oil Gallery Plug
(13) Engine Front Cover Oil Gallery Plug Seal Ring
(14) Oil Pressure Relief Valve Piston
(15) Oil Pressure Relief Valve Spring
(16) Oil Pressure Relief Valve Plug
(17) Engine Front Cover Bolt (M10)
(18) Crankshaft Front Oil Seal
(19) Engine Front Cover Bolt (M6)
(20) Water Drain Plug Seal Ring
(21) Water Drain Plug
(22) Exhaust Camshaft Position Actuator Solenoid Valve Bolt

Engine Front Cover And Oil Pump Assembly (2 of 2)

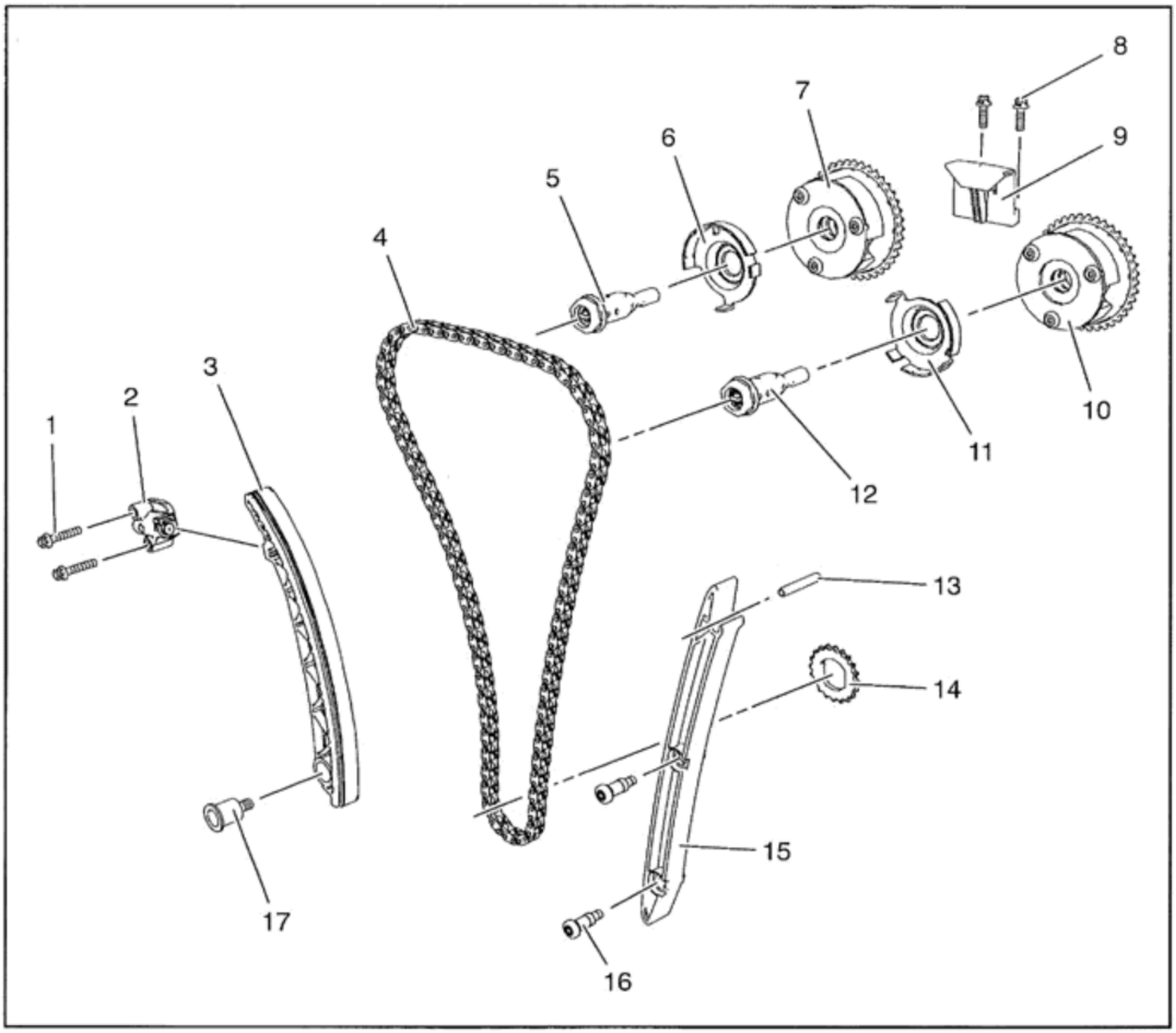


2191111

Legend

(1) Oil Pump Cover Bolt
(2) Oil Pump Cover
(3) Oil Pump Vane Ring
(4) Oil Pump Vane Rotor
(5) Oil Pump Vane
(6) Oil Pump Slide Spring Pin
(7) Oil Pump Slide Spring
(8) Oil Pump Slide Pivot Pin
(9) Oil Pump Slide Seal
(10) Oil Pump Slide Seal Spring
(11) Oil Pump Slide
(12) Oil Pump Vane Ring

Timing Chain Components

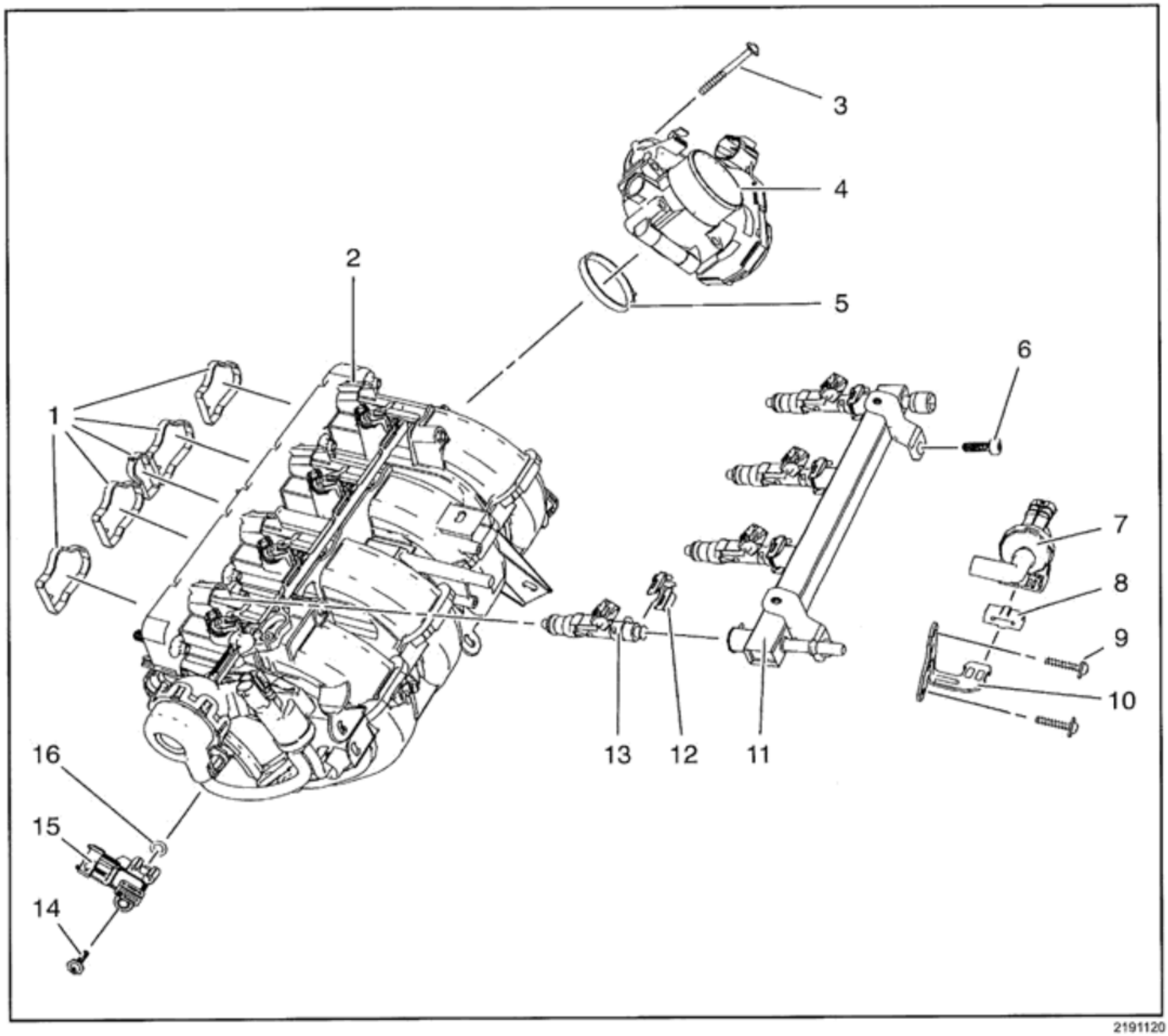


2191118

Legend

(1) Timing Chain Tensioner Bolt
(2) Timing Chain Tensioner
(3) Timing Chain Tensioner Shoe
(4) Camshaft Timing Chain
(5) Intake Camshaft Sprocket Bolt (With Actuator)
(6) Intake Camshaft Position Sensor Exciter Wheel
(7) Intake Camshaft Sprocket (With Position Actuator)
(8) Upper Timing Chain Guide Bolt
(9) Upper Timing Chain Guide
(10) Exhaust Camshaft Sprocket (With Position Actuator)
(11) Exhaust Camshaft Position Sensor Exciter Wheel
(12) Exhaust Camshaft Sprocket Bolt (With Actuator)
(13) Timing Chain Guide Pivot Pin
(14) Crankshaft Sprocket
(15) Timing Chain Guide Right Side
(16) Timing Chain Guide Bolt
(17) Timing Chain Tensioner Shoe Bolt

Intake Manifold Assembly– 1.4L LDD

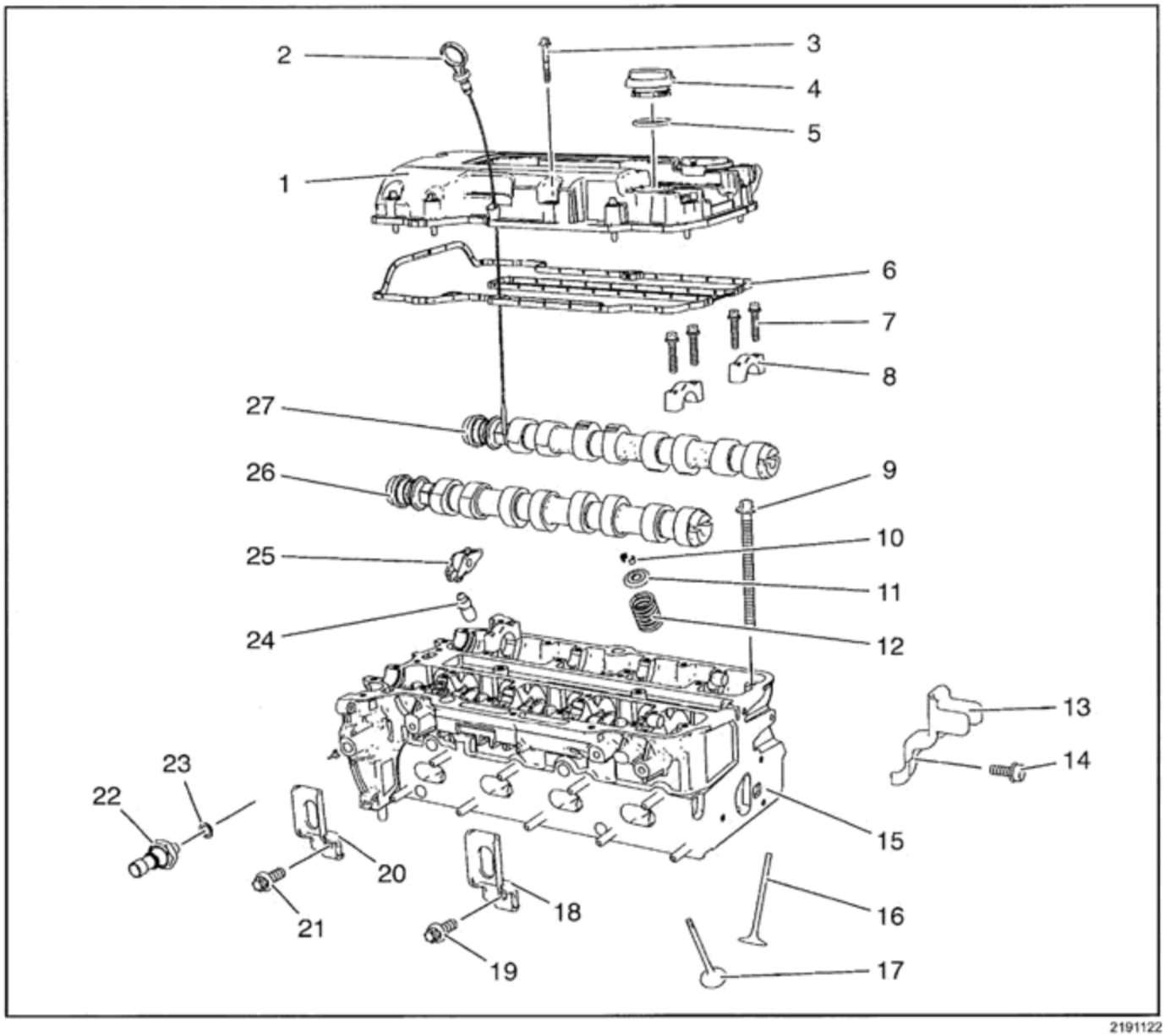


2191120

Legend

(1) Intake Manifold Sealings
(2) Intake Manifold (With Intake Manifold Runner and Intake Manifold Runner Valve)
(3) Throttle Body Bolt
(4) Throttle Body
(5) Throttle Body Seal Ring
(6) Fuel Injection Fuel Rail Bolt
(7) Evaporative Emission Canister Purge Solenoid Valve
(8) Evaporative Emission Canister Purge Solenoid Valve Rubber
(9) Evaporative Emission Canister Purge Solenoid Valve Bracket Bolt
(10) Evaporative Emission Canister Purge Solenoid Valve Bracket
(11) Fuel Injection Fuel Rail
(12) Fuel Injector Retainer Clamp
(13) Fuel Injector
(14) Manifold Absolute Pressure Sensor Bolt
(15) Manifold Absolute Pressure Sensor
(16) Manifold Absolute Pressure Sensor Seal Ring

Cylinder Head Assembly

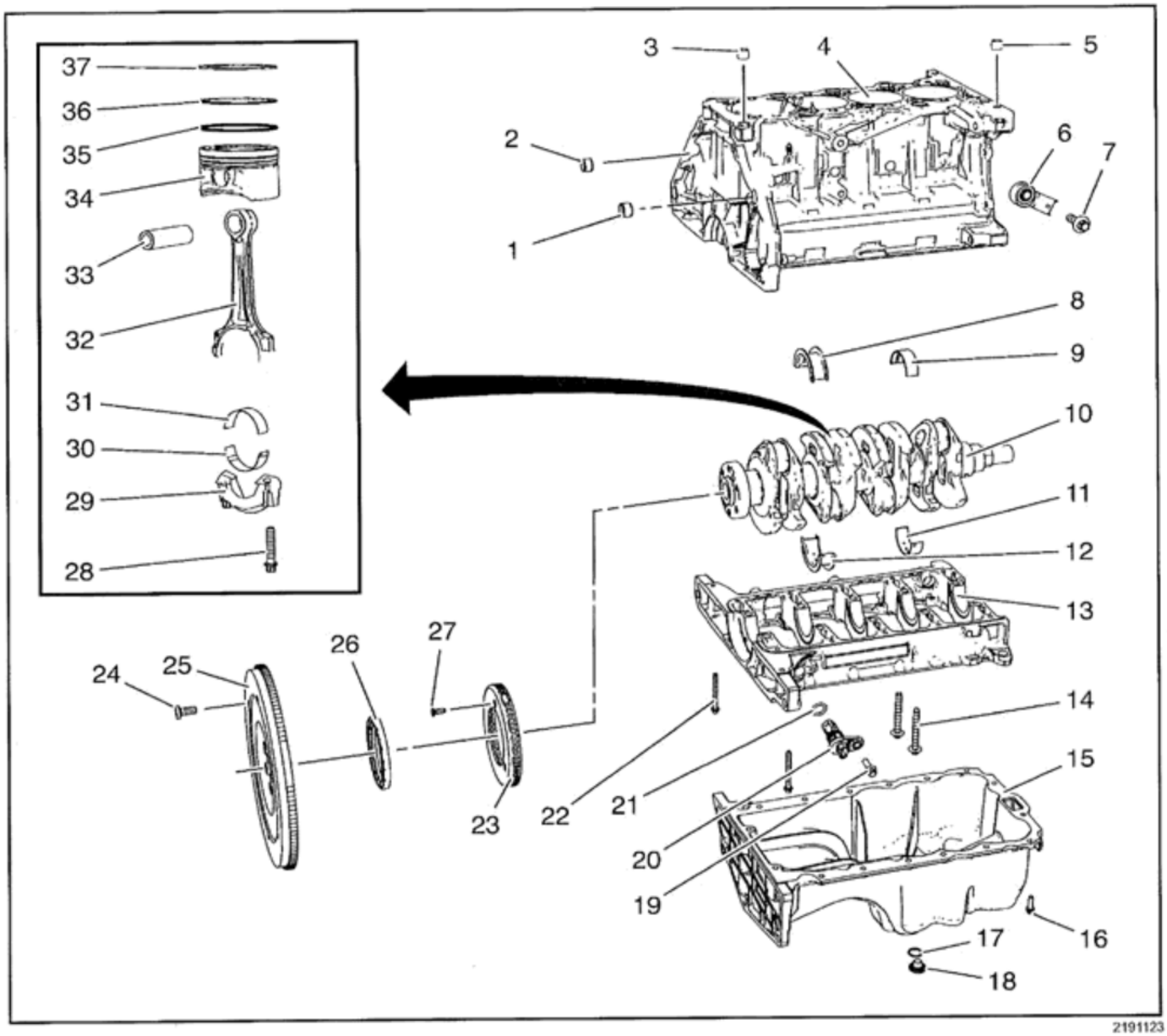


2191122

Legend

(1) Camshaft Cover
(2) Oil Level Indicator
(3) Camshaft Cover Bolt
(4) Oil Filler Cap
(5) Oil Filler Cap Seal Ring
(6) Camshaft Cover Gasket
(7) Camshaft Bearing Cap Bolt
(8) Camshaft Bearing Cap
(9) Cylinder Head Bolt
(10) Valve Keys
(11) Valve Spring Retainer
(12) Valve Spring
(13) Engine Lift Bracket Left Side
(14) Engine Lift Bracket Bolt
(15) Cylinder Head
(16) Intake Valve
(17) Exhaust Valve
(18) Engine Lift Bracket
(19) Engine Lift Bracket Bolt
(20) Engine Lift Bracket
(21) Engine Lift Bracket Bolt
(22) Oil Pressure Indicator Switch (only for 1.4L LDD)
(23) Oil Pressure Indicator Switch Seal Ring (only for 1.4L LDD)
(24) Hydraulic Valve Lash Adjuster
(25) Hydraulic Valve Lash Adjuster Arm
(26) Exhaust Camshaft
(27) Intake Camshaft

Engine Block Assembly– 1.4L LDD



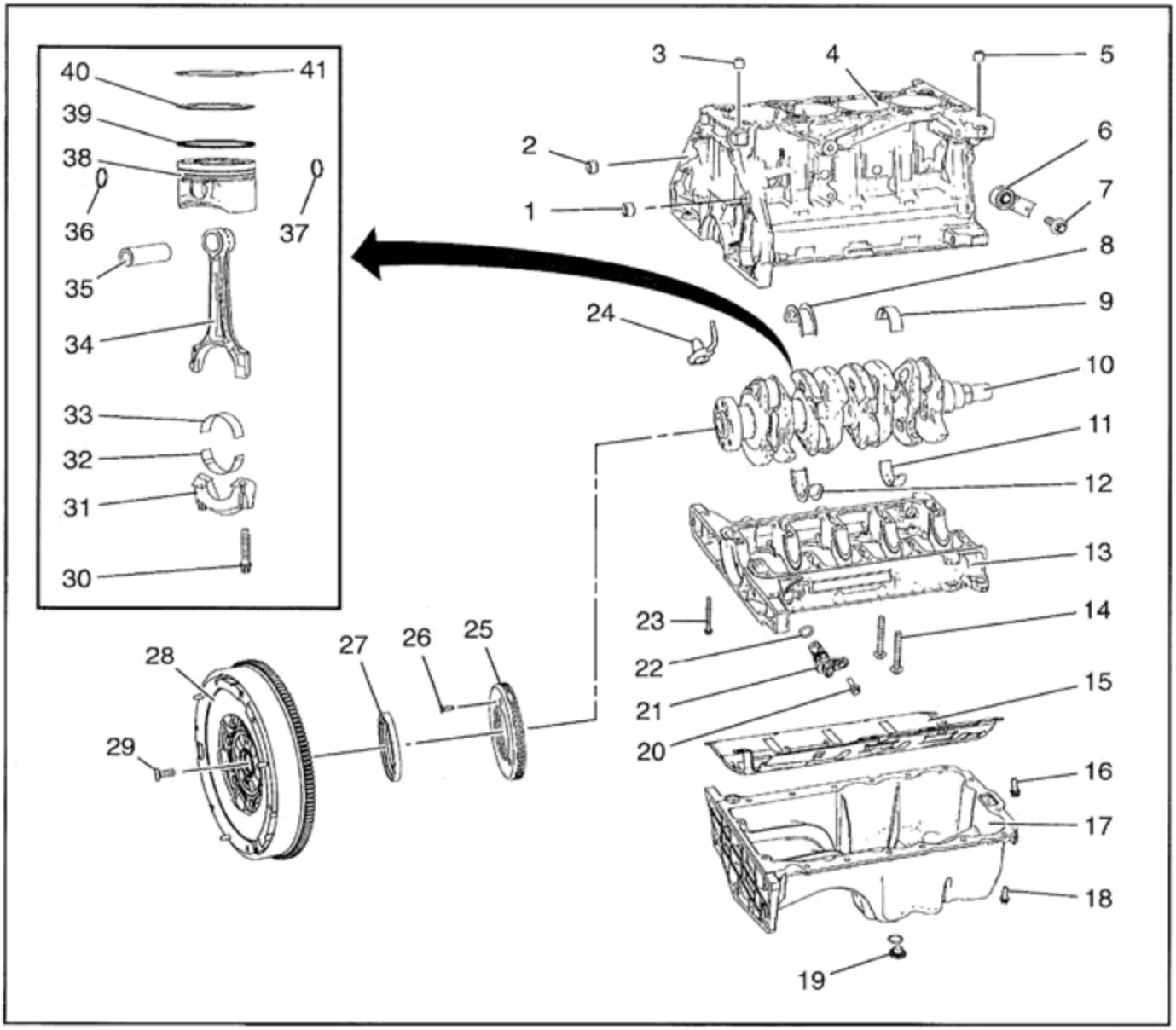
2191123

Legend

(1) Transmission Guide Sleeve
(2) Transmission Guide Sleeve
(3) Cylinder Head Guide Sleeve
(4) Engine Block
(5) Cylinder Head Guide Sleeve
(6) Knock Sensor
(7) Knock Sensor Bolt
(8) Upper Crankshaft Thrust Bearing
(9) Upper Crankshaft Bearing
(10) Crankshaft
(11) Lower Crankshaft Bearing
(12) Lower Crankshaft Thrust Bearing
(13) Crankshaft Bearing Cap Tie Plate
(14) Crankshaft Bearing Cap Tie Plate Bolt (M10)
(15) Oil Pan
(16) Oil Pan Bolt
(17) Oil Pan Drain Plug Seal Ring
(18) Oil Pan Drain Plug
(19) Crankshaft Position Sensor Bolt
(20) Crankshaft Position Sensor
(21) Crankshaft Position Sensor Seal Ring
(22) Crankshaft Bearing Cap Tie Plate Bolt (M8)
(23) Crankshaft Position Sensor Reluctor Ring
(24) Flywheel Bolt
(25) Engine Flywheel
(26) Crankshaft Rear Oil Seal
(27) Crankshaft Position Sensor Reluctor Ring Bolt
(28) Connecting Rod Bearing Cap Bolt
(29) Connecting Rod Bearing Cap
(30) Lower Connecting Rod Bearing
(31) Upper Connecting Rod Bearing
(32) Connecting Rod
(33) Piston Pin

(34) Piston
(35) Piston Oil Ring (With oil Ring Spacer)
(36) Lower Compression Ring
(37) Upper Compression Ring

Engine Block Assembly– 1.4L LUH and LUJ



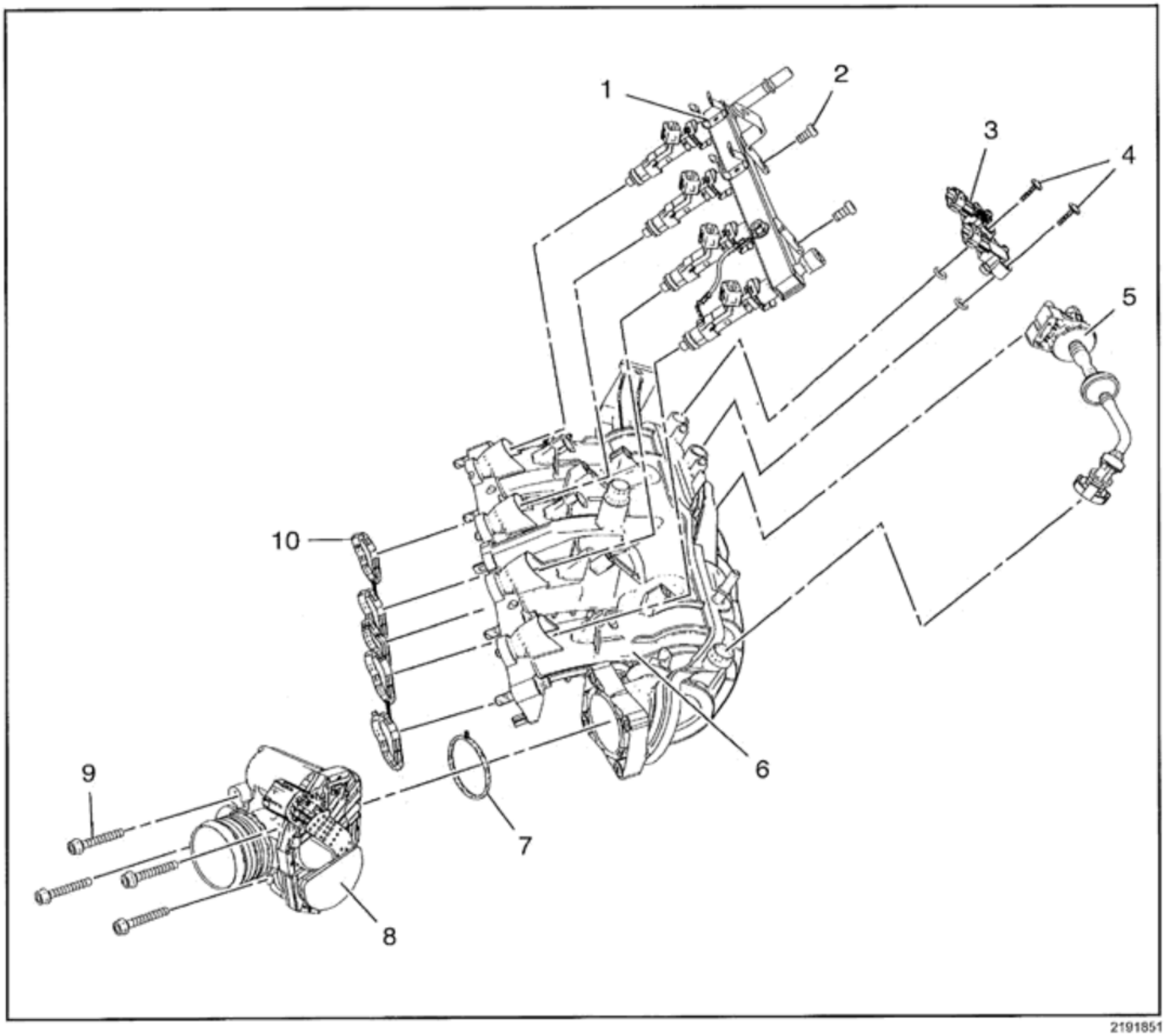
2191836

Legend

(1) Transmission Guide Sleeve
(2) Transmission Guide Sleeve
(3) Cylinder Head Guide Sleeve
(4) Cylinder Head
(5) Cylinder Head Guide Sleeve
(6) Knock Sensor
(7) Knock Sensor Bolt
(8) Upper Crankshaft Thrust Bearing
(9) Upper Crankshaft Bearing
(10) Crankshaft
(11) Lower Crankshaft Bearing
(12) Lower Crankshaft Thrust Bearing
(13) Crankshaft Bearing Cap Tie Plate
(14) Crankshaft Bearing Cap Tie Plate Bolt (M10)
(15) Oil Pan Baffle
(16) Oil Pan Baffle Bolt
(17) Oil Pan
(18) Oil Pan Bolt
(19) Oil Pan Drain Plug
(20) Crankshaft Position Sensor Bolt
(21) Crankshaft Position Sensor
(22) Crankshaft Position Sensor Seal Ring
(23) Crankshaft Bearing Cap Tie Plate Bolt (M8)
(24) Piston Oil Nozzle
(25) Crankshaft Position Sensor Reluctor Ring
(26) Crankshaft Position Sensor Reluctor Ring Bolt
(27) Crankshaft Rear Oil Seal
(28) Engine Flywheel (Two-Mass)
(29) Engine Flywheel Bolt

(30) Connecting Rod Bearing Cap Bolt
(31) Connecting Rod Bearing Cap
(32) Lower Connecting Rod Bearing
(33) Upper Connecting Rod Bearing
(34) Connecting Rod
(35) Piston Pin
(36) Piston Pin Retainer
(37) Piston Pin Retainer
(38) Piston
(39) Piston Oil Ring (With Oil Ring Spacer)
(40) Lower Compression Ring
(41) Upper Compression Ring

Intake Manifold Assembly– 1.4L LUH and LUJ

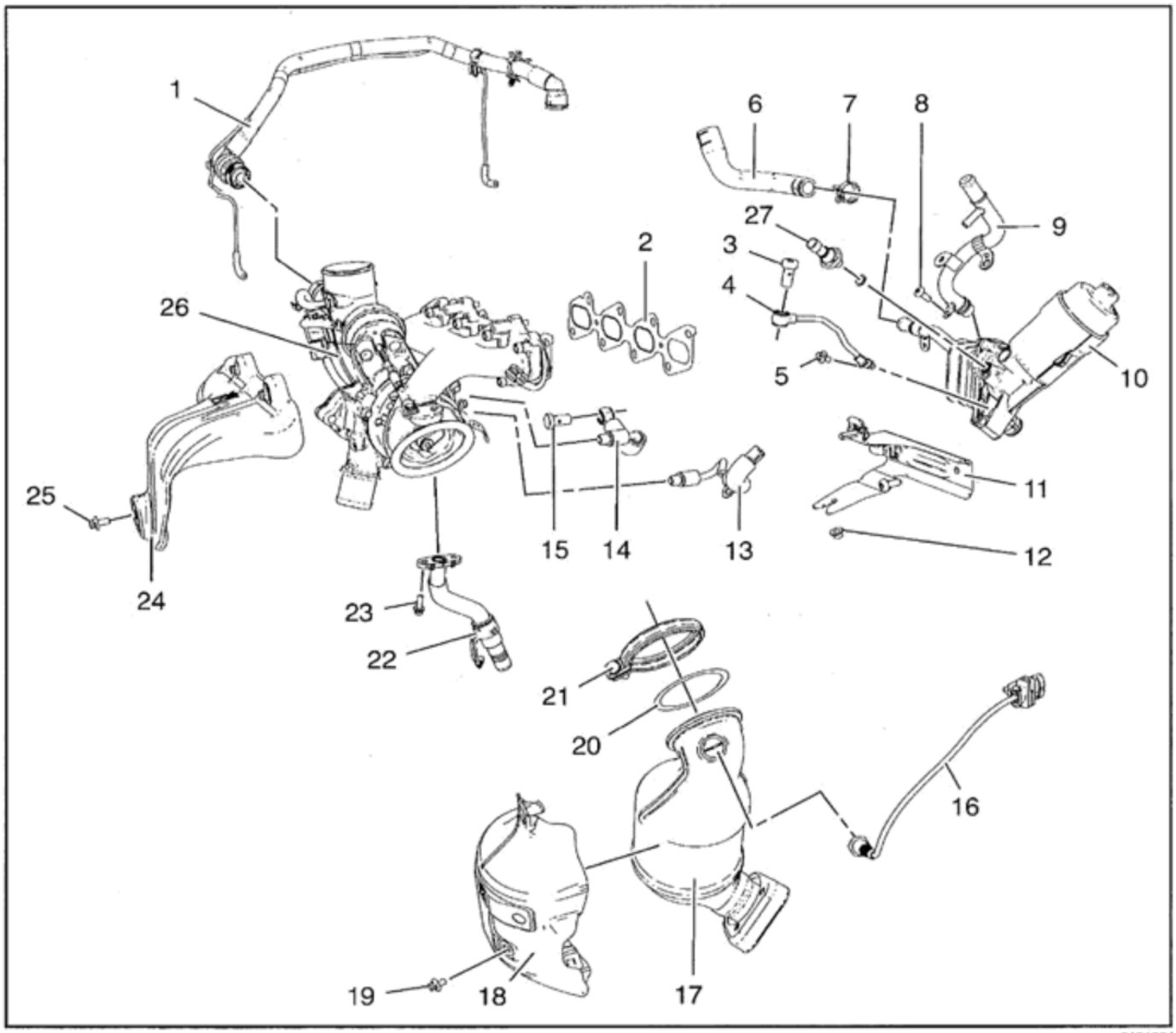


2191851

Legend

(1) Fuel Injector Fuel Rail
(2) Fuel Injector Fuel Rail Bolt
(3) Manifold Absolute Pressure Sensor
(4) Manifold Absolute Pressure Sensor Bolt
(5) Evaporative Emission Canister Purge Solenoid Valve
(6) Intake Manifold
(7) Throttle Body Seal Ring
(8) Throttle Body
(9) Throttle Body Bolt
(10) Intake Manifold Gasket

Exhaust Side– 1.4L LUH and LUJ



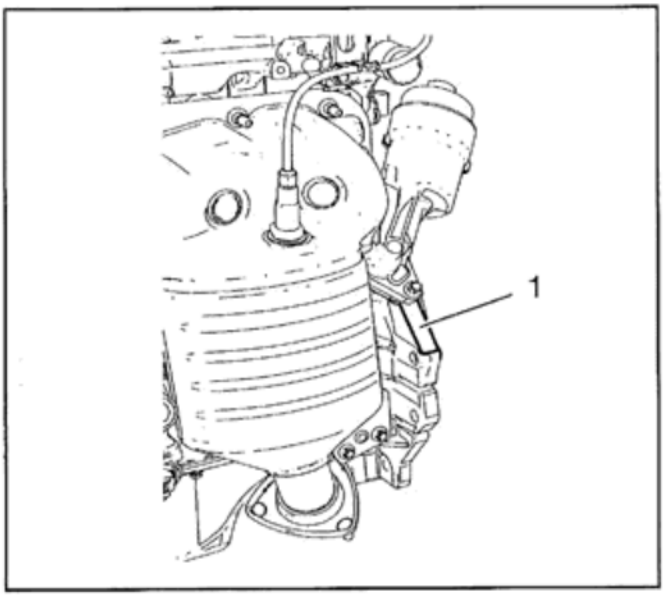
2191854

Legend

(1) Positive Crankcase Ventilation Pipe Assembly
(2) Exhaust Manifold Gasket
(3) Turbo Charger Oil Feed Pipe Hollow Screw
(4) Turbo Charger Oil Feed Pipe
(5) Turbo Charger Oil Feed Pipe Bolt
(6) Oil Cooler Coolant Outlet Hose
(7) Oil Cooler Coolant Outlet Hose Clamp
(8) Oil Cooler Coolant Feed Pipe Bolt
(9) Oil Cooler Coolant Feed Pipe
(10) Engine Oil Cooler Assembly
(11) Catalytic Converter Bracket
(12) Catalytic Converter to Catalytic Converter Bracket Nut
(13) Turbocharger Coolant Return Pipe
(14) Turbocharger Coolant Feed Pipe
(15) Turbocharger Coolant Feed Pipe Hollow Screw
(16) Heated Oxygen Sensor 1
(17) Catalytic Converter
(18) Catalytic Converter Heat Shield
(19) Catalytic Converter Heat Shield Bolt
(20) Catalytic Converter Seal
(21) Catalytic Converter V-Clamp
(22) Turbocharger Oil Return Pipe
(23) Turbocharger Oil Return Pipe Bolt
(24) Exhaust Manifold Heat Shield
(25) Exhaust Manifold Heat Shield Bolt
(26) Turbocharger (with Exhaust Manifold)
(27) Engine Oil Pressure Switch

Engine Identification

Engine Number



2191130

Note: The engine identification number must be stamped to the cylinder block in case of engine replacement.

The engine number is stamped to the engine block (1).

Diagnostic Information and Procedures

Symptoms - Engine Mechanical

Strategy Based Diagnostics

Perform a *Diagnostic System Check - Vehicle on page 6-66*.

All diagnosis on a vehicle should follow a logical process. Strategy based diagnostics is a uniform approach for repairing all systems. The diagnostic flow may always be used in order to resolve a system condition. The diagnostic flow is the place to start when repairs are necessary.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the engine.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Inspect for the correct oil level, proper oil viscosity, and correct filter application.
- Verify the exact operating conditions under which the concern exists. Note factors such as engine RPM, ambient temperature, engine temperature, amount of engine warm-up time, and other specifics.
- Compare the engine sounds, if applicable, to a known good engine and make sure you are not trying to correct a normal condition.

Intermittent

Test the vehicle under the same conditions that the customer reported in order to verify the system is operating properly.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- *Base Engine Misfire without Internal Engine Noises on page 9-774*
- *Base Engine Misfire with Abnormal Internal Lower Engine Noises on page 9-775*
- *Base Engine Misfire with Abnormal Valve Train Noise on page 9-776*
- *Base Engine Misfire with Coolant Consumption on page 9-776*
- *Base Engine Misfire with Excessive Oil Consumption on page 9-776*
- *Engine Noise on Start-Up, but Only Lasting a Few Seconds on page 9-774*
- *Upper Engine Noise, Regardless of Engine Speed on page 9-777*
- *Lower Engine Noise, Regardless of Engine Speed on page 9-777*
- *Engine Noise Under Load on page 9-774*
- *Engine Will Not Crank - Crankshaft Will Not Rotate on page 9-778*
- *Engine Compression Test on page 9-778*
- *Oil Consumption Diagnosis on page 9-773*
- *Oil Pressure Diagnosis and Testing on page 9-771*
- *Drive Belt Chirping, Squeal, and Whine Diagnosis on page 9-779*
- *Drive Belt Rumbling and Vibration Diagnosis on page 9-781*
- *Drive Belt Falls Off and Excessive Wear Diagnosis on page 9-782*

Oil Pressure Diagnosis and Testing

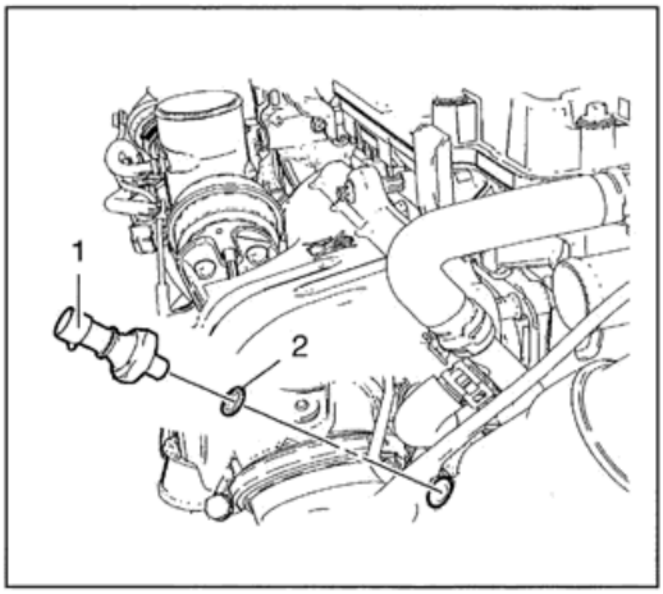
Special Tools

- *EN-498-B* Oil Pressure Gauge
- *EN-498-3* Adapter

For equivalent regional tools, refer to *Special Tools on page 9-927*.

Removal Procedure

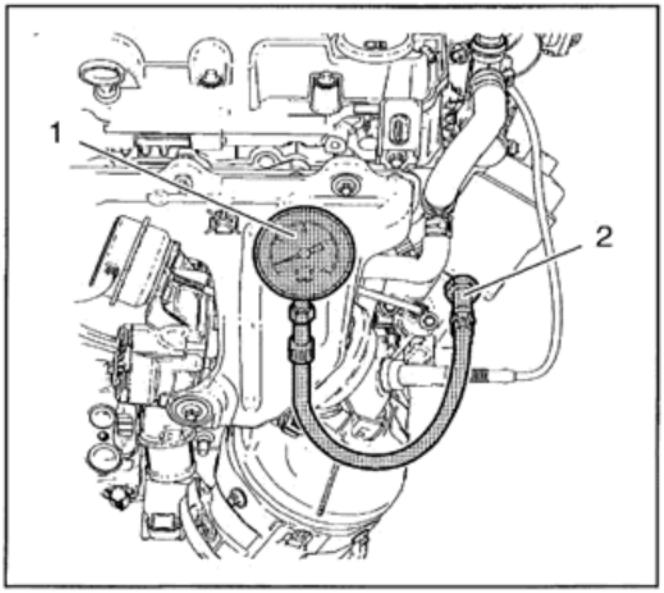
1. Disconnect the oil pressure indicator switch wiring harness plug.



2191866

2. Remove the oil pressure indicator switch (1) and the oil pressure indicator switch seal ring (2).

Measuring Procedure



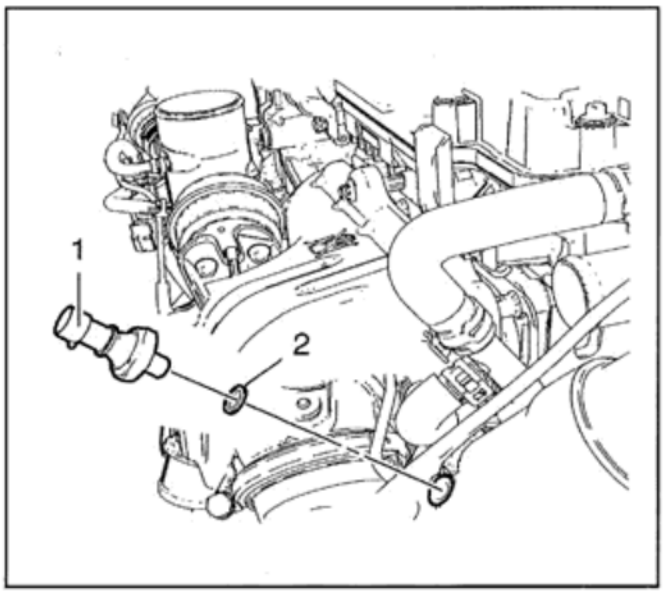
2191867

1. Install *EN-498-B* gauge (1) along with *EN-498-3* adapter (2).
2. Start Engine.

Note: The oil temperature should be between **80°C (176°F)**and **100°C (212°)**.

3. Measure the oil pressure:
   - The oil pressure at idle speed should be **150 kpa (22 psi)**.
   - The oil pressure between **3000 – 3500 rpm**should be **380 – 650 kpa (55 – 94 psi)**.
4. Stop engine.
5. If the engine oil pressure is below specifications, inspect the engine for 1 or more of the following conditions:
   - Oil pump worn or dirty. Refer to *Oil Pump Replacement on page 9-824* and *Engine Front Cover and Oil Pump Cleaning and Inspection on page 9-892*.
   - Oil suction gallery clogged or dirty. Refer to *Oil Pan Cleaning and Inspection on page 9-897*
   - Cracked, porous, or restricted oil galleries.
   - Oil pressure relief valve malfunction.
6. Remove *EN-498-B* gauge and *EN-498-3* adapter.

Installation Procedure



2191866

1. Install the oil pressure indicator switch (1) and a NEW oil pressure indicator switch seal ring (2).

Caution: Refer to *Fastener Caution on page 0-8*.

2. Tighten the oil pressure indicator switch to **20** N•m **(15 lb ft)**.

Oil Leak Diagnosis

Step	Action	Yes	No
DEFINITION: You can repair most fluid leaks by first, visually locating the leak, repairing or replacing the component, or by resealing the gasket surface. Once the leak is identified, determine the cause of the leak. Repair the leak and the cause of the leak.			
1	1. Operate the vehicle until it reaches normal operating temperature. Refer to *Engine Mechanical Specifications on page 9-756*. 2. Park the vehicle on a level surface over a large sheet of paper or other clean surface. 3. Wait 15 minutes. 4. Inspect for drippings. Are drippings present?	Go to *Step 2*	System OK
2	Can you identify the type of fluid and the approximate location of the leak?	Go to *Step 10*	Go to *Step 3*
3	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Inspect for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to *Step 10*	Go to *Step 4*
4	1. Completely clean the entire engine and surrounding components. 2. Operate the vehicle for several miles at normal operating temperature and at varying speeds. 3. Park the vehicle on a level surface over a large sheet of paper or other clean surface. 4. Wait 15 minutes. 5. Identify the type of fluid and the approximate location of the leak. Can you identify the type of fluid and the approximate location of the leak?	Go to *Step 10*	Go to *Step 5*
5	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Inspect for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to *Step 10*	Go to *Step 6*
6	1. Completely clean the entire engine and surrounding components. 2. Apply an aerosol-type powder, for example, baby powder or foot powder, to the suspected area. 3. Operate the vehicle for several miles at normal operating temperature and at varying speeds. 4. Identify the type of fluid and the approximate location of the leak from the discolorations in the powder surface. Can you identify the type of fluid and the approximate location of the leak?	Go to *Step 10*	Go to *Step 7*

Oil Leak Diagnosis (cont'd)

Step	Action	Yes	No
7	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Inspect for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to *Step 10*	Go to *Step 8*
8	Identify the type of fluid and the approximate location of the leak. Can you identify the type of fluid and the approximate location of the leak?	Go to *Step 10*	Go to *Step 9*
9	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Inspect for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to *Step 10*	System OK
10	1. Inspect the engine for mechanical damage. Special interest should be shown to the following areas: • Higher than recommended fluid levels • Higher than recommended fluid pressures • Plugged or malfunctioning fluid filters or pressure bypass valves • Plugged or malfunctioning engine ventilation system • Improperly tightened or damaged fasteners • Cracked or porous components • Improper sealants or gaskets, where required • Improper sealant or gasket installation • Damaged or worn gaskets or seals • Damaged or worn sealing surfaces 2. Inspect the engine for customer modifications. Is there mechanical damage or customer modifications to the engine?	Go to *Step 11*	System OK
11	Repair or replace all damaged or modified components. Did you complete the repair?	Go to *Step 1*	—

Oil Consumption Diagnosis

Checks	Causes
The causes of excessive oil consumption may include the following conditions:	
Preliminary	• External oil leaks. • Incorrect oil level or improper reading of the oil level indicator. With the vehicle on a level surface, run the engine for a few minutes, allow adequate drain down time (2–3 minutes) and check for the correct engine oil level. • Improper oil viscosity. Refer to the vehicle owners manual and use the recommended SAE grade and viscosity for the prevailing temperatures. • Continuous high speed driving and/or severe usage. • Crankcase ventilation system restrictions or malfunctioning components. • Worn valve guides and/or valve stems. • Worn, missing or improperly installed valve stem oil seals. • Piston rings broken, worn, not seated properly. Allow adequate time for the rings to seat.

Oil Consumption Diagnosis (cont'd)

Checks	Causes
	Replace worn piston rings as necessary. • Piston and rings improperly installed or miss-fitted to the cylinder bore.

Engine Noise Under Load

Cause	Correction
Low oil pressure	Insufficient or poor oil supply to components. 1. Perform oil pressure test. 2. Repair or replace all damaged components.
Loose torque converter bolts	1. Inspect the torque converter bolts and flywheel. 2. Repair or replace all damaged components.
Loose and/or damaged flywheel	1. Inspect the flywheel and flywheel attaching bolts. 2. Repair or replace all damaged components.
Excessive piston-to-cylinder bore clearance	1. Inspect the piston rings for low ring tension, broken or worn rings, inspect cylinder bore. 2. Repair or replace all damaged components.
Excessive crankshaft thrust bearing clearance	1. Inspect the crankshaft end play and crankshaft thrust bearings. 2. Repair or replace all damaged components.
Excessive crankshaft bearing clearance	1. Inspect the crankshaft bearings and crankshaft journals. 2. Repair or replace all damaged components.

Engine Noise on Start-Up, but Only Lasting a Few Seconds

Cause	Correction
Incorrect oil filter without anti-drainback feature	Install the correct oil filter.
Incorrect oil viscosity	Drain the engine oil and replace with the correct viscosity oil.
High stationary hydraulic lash adjuster (SHLA), valve lifter, leak down rate	Replace the SHLAs, valve lifters, as required.
Worn crankshaft thrust bearing	• Inspect the thrust bearing and crankshaft. • Repair or replace as required.
Damaged or faulty oil filter by-pass valve	• Inspect the oil filter by-pass valve for proper operation. • Repair or replace as required.

Base Engine Misfire without Internal Engine Noises

Condition	Action
Abnormalities (severe cracking, bumps or missing areas) in the accessory drive belt. Also worn, damaged, or misaligned accessory drive components or excessive pulley runout.	Abnormalities in the accessory drive belt and/or components may cause engine RPM variations, noises similar to a faulty lower engine and also lead to a misfire condition. A misfire code may be present without an actual misfire condition. 1. Inspect the accessory drive components. 2. Repair or replace all damaged components.
Loose and/or damaged crankshaft pulley	A misfire code may be present without an actual misfire condition. 1. Inspect crankshaft pulley and pulley bolt. 2. Repair or replace all damaged components.
Loose torque converter bolts	A misfire code may be present without an actual misfire condition. 1. Inspect torque converter bolts and flywheel. 2. Repair or replace all damaged components.

Base Engine Misfire without Internal Engine Noises (cont'd)

Condition	Action
Loose and/or damaged flywheel	A misfire code may be present without an actual misfire condition. 1. Inspect flywheel and flywheel attaching bolts. 2. Repair or replace all damaged components.
Restricted exhaust system	A severe restriction in the exhaust flow can cause significant loss of engine performance and may set a misfire code. Possible causes of restrictions include collapsed or dented pipes, plugged mufflers and/or catalytic converters. Repair or replace all damaged components.
Air in fuel system	1. Inspect fuel filter, fuel system for leaks and/or restrictions. 2. Repair or replace all damaged components.
Bent and/or worn valve bridge and finger-follower	1. Inspect valve bridge and valve finger-follower. 2. Repair or replace all damaged components.
Sticking valve	Carbon on the valve stem or valve seat may cause the valve to stick. 1. Inspect valves and valve guides. 2. Repair or replace all damaged components.
Damaged or misaligned timing gears	1. Inspect timing gears. 2. Replace all damaged components.
Worn or faulty camshaft lobes	1. Inspect camshaft lobes. 2. Repair or replace all damaged components.
Excessive piston-to-cylinder bore clearance	1. Perform compression tests. 2. Inspect the piston, piston rings and cylinder bore. 3. Repair or replace all damaged components.
Faulty cylinder head gaskets and/or cracking or other damage to the cylinder heads and engine block cooling system passages. (Coolant consumption may or may not cause the engine to overheat.)	1. Perform compression tests. 2. Inspect the piston, piston rings and cylinder bore. 3. Repair or replace all damaged components.

Base Engine Misfire with Abnormal Internal Lower Engine Noises

Condition	Actions
Abnormalities (server cracking, bumps or missing areas) in the accessory drive belt	Abnormalities in the accessory drive belt and/or components may cause engine RPM variations, noises similar to faulty lower engine and also lead to a misfire condition. A misfire code may be present without an actual misfire condition. 1. Inspect the accessory drive components. 2. Repair or replace all damaged components.
Worn, damaged, or misaligned accessory drive components or excessive pulley runout	A misfire code may be present without an actual misfire condition. 1. Inspect the accessory drive components. 2. Repair or replace all damage components.
Loose and/or damaged crankshaft pulley	A misfire code may be present without an actual misfire condition. 1. Repair or replace all damaged components. 2. Inspect crankshaft pulley and pulley bolt.
Loose torque converter bolts	A misfire code may be present without an actual misfire condition. 1. Inspect torque converter bolts and flywheel. 2. Repair or replace all damaged components.
Loose and/or damaged flywheel	A misfire code may be present without an actual misfire condition. 1. Inspect flywheel and flywheel attaching bolts. 2. Repair or replace all damaged components.
Excessive piston-to-cylinder bore clearance	1. Perform cylinder leak down and compression tests. 2. Inspect the piston, piston rings and cylinder bore. 3. Repair or replace all damaged components.

Base Engine Misfire with Abnormal Internal Lower Engine Noises (cont'd)

Condition	Actions
Excessive crankshaft thrust bearing clearance	Severely worn thrust surfaces on the crankshaft and/or thrust bearing may permit for and aft movement of the crankshaft and create a misfire code without an actual misfire condition. 1. Inspect the crankshaft end play and crankshaft thrust bearings. 2. Repair or replace all damaged.

Base Engine Misfire with Abnormal Valve Train Noise

Condition	Action
Loose, worn or damaged valve bridge and finger-follower	1. Inspect valve bridge and finger-follower. 2. Repair or replace all damaged components.
Broken valve springs	1. Inspect valve springs. 2. Repair or replace all damaged components.
Sticking valve	Carbon on the valve stem or valve seat may cause the valve to stick. 1. Inspect valves and valve guides. 2. Repair or replace all damaged components.
Worn or faulty camshaft lobes	1. Inspect camshaft lobes. 2. Repair or replace all damaged components.

Base Engine Misfire with Coolant Consumption

Inspection	Action
DEFINITION: Base engine misfire with coolant consumption	
Preliminary Inspection	Verify that there are no external coolant leaks.
Isolate Affected Cylinders	• Cylinder balance test with scan tool • Cooling system pressurization • Inspection of glow plugs • Compression test
EGR System Inspection	• Inspect EGR valve and intake system for evidence of coolant leakage. • Replace the EGR cooler if any problem is found.
Cylinder Head Gasket Leakage	• Remove cylinder heads of the affected cylinder bank and inspect for damage. • Replace components as necessary.
Cylinder Head or Engine Block Damage	• Inspect the cylinder head for cracks. • Inspect the cylinder block for damage. • Inspect the cylinder block to head mating surface for straightness. • Replace components as necessary.

Base Engine Misfire with Excessive Oil Consumption

Condition	Action
Worn valve guides	1. Inspect the valves and valve guides. 2. Repair or replace all damaged components.
Worn valve stem oil seals	1. Inspect the valve stem oil seals. 2. Repair or replace all damaged components.
Excessive piston-to-cylinder bore clearance	1. Perform compression tests to determine the cause. 2. Inspect the piston rings for low ring tension, broken or worn rings. 3. Inspect cylinder bore. 4. Repair or replace all damaged components.

Upper Engine Noise, Regardless of Engine Speed

Condition	Action
Low oil pressure	Insufficient or poor oil supply to valve train. 1. Perform oil pressure test. 2. Repair or replace all damaged components.
Improper lubrication to the valve finger-follower	1. Inspect valve finger-follower, valve bridge, valve finger follower lifter, oil pump and engine block oil galleries. 2. Repair or replace all damaged components.
Worn or damaged valve finger-follower	1. Inspect valve bridge and finger-follower. 2. Repair or replace all damaged components.
Sticking valve	Carbon on the valve stem or valve seat may cause the valve to stick. 1. Inspect valves and valve guides. 2. Repair or replace all damaged components.
Worn or faulty camshaft lobes	1. Inspect camshaft lobes. 2. If damaged replace camshaft and all valve finger-followers.
Damaged or misaligned timing gears	1. Inspect timing gears. 2. Replace all damaged components.

Lower Engine Noise, Regardless of Engine Speed

Condition	Action
Worn accessory drive components (abnormalities such as severe cracking, bumps or missing areas in the accessory drive belt and/or misalignment of the system components.)	1. Inspect the accessory drive components. 2. Repair or replace all damaged components.
Low oil pressure	Insufficient or poor oil supply to crankshaft and connecting rod bearings. 1. Perform oil pressure test. 2. Repair or replace all damaged components.
Leaking and/or sticking fuel injection nozzle (A stuck fuel injection nozzle can cause a noise similar to a damaged piston, rod or rod bearing.)	1. Inspect the cylinder balance with scan tool to help locate the cylinder that is the source of the noise. 2. If you cannot locate the cylinder that is the source of the noise, diagnose the engine for mechanical damage. 3. If it has been determined that the fuel injection nozzle is causing the noise, replace the fuel injection nozzle.
Loose and/or damaged crankshaft pulley	1. Inspect crankshaft pulley and pulley bolt. 2. Repair or replace all damaged components.
Loose torque converter bolts	1. Inspect torque converter bolts and flywheel. 2. Repair or replace all damaged components.
Loose and/or damaged flywheel	1. Inspect flywheel and flyweel attaching bolts. 2. Repair or replace all damaged components.
Excessive piston pin-to-bore clearance	1. Inspect the piston, piston pin, and the connecting rod. 2. Repair or replace all damaged components.
Misaligned or bent connecting rod	1. Inspect connecting rod and connecting rod bearings. 2. Repair or replace all damaged components.
Excessive connecting rod bearing clearance	1. Inspect the connecting rod bearings, connecting rods, crankshaft and crankshaft journals. 2. Repair or replace all damaged components.
Excessive crankshaft bearing clearance	1. Inspect the crankshaft bearings and crankshaft journals. 2. Repair or replace all damaged components.

Engine Will Not Crank - Crankshaft Will Not Rotate

Cause	Correction
Seized accessory drive system component	1. Inspect the accessory drive system components. 2. Repair or replace all damaged components.
Hydraulically locked cylinder • Coolant/antifreeze in cylinder • Oil in cylinder • Fuel in cylinder	1. Inspect for broken head gasket(s). 2. Inspect for cracked engine block or cylinder head. 3. Inspect for a sticking fuel injector.
Seized automatic transmission torque converter	1. Remove the engine assembly. The torque converter bolts are not accessible with the engine installed to the transmission. 2. Rotate the crankshaft at the pulley.
Seized manual transmission	1. Disengage the clutch. 2. Rotate crankshaft at the pulley.
Material in cylinder • Broken valve • Piston material • Foreign material	1. Inspect the cylinder for damaged components and/or foreign materials. 2. Repair or replace as required.
Seized crankshaft or connecting rod bearing	1. Inspect the crankshaft and connecting rod bearings. 2. Repair as required.
Bent or broken connecting rod	1. Inspect the connecting rods. 2. Repair as required.
Broken crankshaft	1. Inspect the crankshaft. 2. Repair as required.

Engine Compression Test

Special Tools

EN-48248 Cylinder Compression Pressure Gauge

For equivalent regional tools, refer to *Special Tools on page 9-927*.

Removal Procedure

1. Remove the throttle body assembly. Refer to *Throttle Body Assembly Replacement on page 9-253*.
2. Remove the spark plugs. Refer to *Spark Plug Replacement on page 9-281*.
3. Remove the relay holder cover.
4. Remove the fuel pump relay.

Note: The engine cranking time for the compression test should be less then 10 seconds and at 30 second intervals.

5. Crank the engine with the starter motor for 5 seconds to remove any foreign substances from the cylinders.
6. Prior to taking a compression reading, verify the cranking speed is greater than 300 RPM. If the cranking speed is below 300 RPM, repair the slow cranking speed condition before continuing with the compression test.
7. Install *EN-48248* gauge in the spark plug bore for the cylinder that is being checked.
8. Using the vehicle's starter motor, rotate or crank the engine for 4 compression strokes, puffs, for the cylinder being tested.
9. Observe the compression gauge and note the reading as the compression test is being performed. A normal cylinder reading will be indicated if compression builds up quickly and evenly to the specified level. An abnormal reading will be indicated if compression is low on the first compression stroke, starts increasing on the following compression strokes but does not reach the specified level.
10. Record the compression reading for the cylinder just tested.
11. Repeat steps for all remaining cylinders. All 4 cylinders must be tested to obtain valid test results. Record the readings.
12. The maximum pressure differential should not exceed **100 kPa (14.5 psi)**.
13. The nominal cylinder compression value is
    - for natural aspirated engines **1300 kPa – 1500 kPa (188.5 psi – 217.6 psi)**.
    - for turbo engines **1200 kPa – 1400 kPa (174 psi – 203.1 psi)**.

Installation Procedure

1. Install the fuel pump relay.
2. Install the relay holder cover.
3. Install the spark plugs. Refer to *Spark Plug Replacement on page 9-281*.
4. Install the throttle body assembly. Refer to *Throttle Body Assembly Replacement on page 9-253*.

Drive Belt Chirping, Squeal, and Whine Diagnosis

Diagnostic Aids

- A chirping or squeal noise may be intermittent due to moisture on the drive belts or the pulleys. It may be necessary to spray a small amount of water on the drive belts in order to duplicate the customers concern. If spraying water on the drive belt duplicates the symptom, cleaning the belt pulleys may be the probable solution.
- If the noise is intermittent, verify the accessory drive components by varying their loads making sure they are operated to their maximum capacity. An overcharged A/C system, power steering system with a pinched hose or wrong fluid, or a generator failing are suggested items to inspect.
- A chirping, squeal or whine noise may be caused by a loose or improper installation of a body or suspension component. Other items of the vehicle may also cause the noise.
- The drive belts will not cause a whine noise.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

2. The noise may not be engine related. This step is to verify that the engine is making the noise. If the engine is not making the noise do not proceed further with this table.
3. The noise may be an internal engine noise. Removing the drive belts one at a time and operating the engine for a brief period will verify the noise is related to the drive belt. When removing the drive belt the water pump may not be operating and the engine may overheat. Also DTCs may set when the engine is operating with the drive belts removed.
4. Inspect all drive belt pulleys for pilling. Pilling is the small balls or pills or it can be strings in the drive belt grooves from the accumulation of rubber dust.
6. Misalignment of the pulleys may be caused from improper mounting of the accessory drive component, incorrect installation of the accessory drive component pulley, or the pulley bent inward or outward from a previous repair. Test for a misaligned pulley using a straight edge in the pulley grooves across two or three pulleys. If a misaligned pulley is found refer to that accessory drive component for the proper installation procedure for that pulley.
10. Inspecting of the fasteners can eliminate the possibility that a wrong bolt, nut, spacer, or washer was installed.
12. Inspecting the pulleys for being bent should include inspecting for a dent or other damage to the pulleys that would prevent the drive belt from not seating properly in all of the pulley grooves or on the smooth surface of a pulley when the back side of the belt is used to drive the pulley.
14. This test is to verify that the drive belt tensioner operates properly. If the drive belt tensioner is not operating properly, proper belt tension may not be achieved to keep the drive belt from slipping which could cause a squeal noise.
15. This test is to verify that the drive belt is not too long, which would prevent the drive belt tensioner from working properly. Also if an incorrect length drive belt was installed, it may not be routed properly and may be turning an accessory drive component in the wrong direction.
16. Misalignment of the pulleys may be caused from improper mounting of the accessory drive component, incorrect installation of the accessory drive component pulley, or the pulley bent inward or outward from a previous repair. Test for a misaligned pulley using a straight edge in the pulley grooves across two or three pulleys. If a misaligned pulley is found refer to that accessory drive component for the proper installation procedure for that pulley.
17. This test is to verify that the pulleys are the correct diameter or width. Using a known good vehicle compare the pulley sizes.
19. Replacing the drive belt when it is not damaged or there is not excessive pilling will only be a temporary repair.

Drive Belt Chirping, Squeal, and Whine Diagnosis

Step	Action	Yes	No
Caution: Do not use belt dressing on the drive belt. Belt dressing causes the breakdown of the composition of the drive belt. Failure to follow this recommendation will damage the drive belt. DEFINITION: The following items are indications of chirping: • A high pitched noise that is heard once per revolution of the drive belt or a pulley. • Chirping may occur on cold damp start-ups and will subside once the vehicle reaches normal operating temp. DEFINITION: The following items are indications of drive belt squeal: • A loud screeching noise that is caused by a slipping drive belt. This is unusual for a drive belt with multiple ribs. • The noise occurs when a heavy load is applied to the drive belt, such as an air conditioning compressor engagement snapping the throttle, or slipping on a seized pulley or a faulty accessory drive component. DEFINITION: The following items are indications of drive belt whine: • A high pitched continuous noise. • The noise may be caused by an accessory drive component failed bearing.			
1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to *Step 2*	Go to *Symptoms - Engine Mechanical on page 9-770*

Drive Belt Chirping, Squeal, and Whine Diagnosis (cont'd)

Step	Action	Yes	No
2	Verify that there is a chirping, squeal or whine noise. Does the engine make the chirping squeal or whine noise?	Go to *Step 3*	Go to Diagnostic Aids
3	1. Remove the drive belt. If the engine has multiple drive belts, remove the belts one at a time and perform the test below each time a belt is removed. 2. Operate the engine for no longer than 30–40 seconds. 3. Repeat this test if necessary by removing the remaining belt(s). Does the chirping, squeal or whine noise still exist?	Go to *Symptoms - Engine Mechanical on page 9-770*	Go to *Step 4*
4	If diagnosing a chirping noise, inspect for severe pilling exceeding 1/3 of the belt groove depth. If diagnosing a squeal or whine noise, proceed to *Step 13*. Do the belt grooves have pilling?	Go to *Step 5*	Go to *Step 6*
5	Clean the drive belt pulleys with a suitable wire brush. Did you complete the repair?	Go to *Step 20*	Go to *Step 6*
6	Inspect for misalignment of the pulleys. Are any of the pulleys misaligned?	Go to *Step 7*	Go to *Step 8*
7	Replace or repair any misaligned pulleys. Did you complete the repair?	Go to *Step 20*	Go to *Step 8*
8	Inspect for bent or cracked brackets. Did you find any bent or cracked brackets?	Go to *Step 9*	Go to *Step 10*
9	Replace any bent or cracked brackets. Did you complete the repair?	Go to *Step 20*	Go to *Step 10*
10	Inspect for improper, loose or missing fasteners. Did you find the condition?	Go to *Step 11*	Go to *Step 12*
11	**Caution:** Refer to *Fastener Caution on page 0-8*. 1. Tighten any loose fasteners. Refer to *Fastener Tightening Specifications on page 9-755*. 2. Replace any improper or missing fasteners. Did you complete the repair?	Go to *Step 20*	Go to *Step 12*
12	Inspect for a bent pulley. Did you find the condition?	Go to *Step 18*	Go to *Step 19*
13	Inspect for an accessory drive component seized bearing or a faulty accessory drive component. Did you find and correct the condition? If diagnosing a whine noise and the condition still exist, proceed to Diagnostic Aids.	Go to *Step 20*	Go to *Step 14*
14	Test the drive belt tensioner for proper operation. Did you find and correct the condition?	Go to *Step 20*	Go to *Step 15*
15	Inspect for the correct drive belt length. Did you find and correct the condition?	Go to *Step 20*	Go to *Step 16*
16	Inspect for misalignment of a pulley. Did you find and correct the condition?	Go to *Step 20*	Go to *Step 17*
17	Inspect for the correct pulley size. Did you find and correct the condition?	Go to *Step 20*	Go to Diagnostic Aids
18	Replace the bent pulley. Did you complete the repair?	Go to *Step 20*	Go to *Step 19*
19	Replace the drive belt. Refer to *Symptoms - Engine Mechanical on page 9-770*. Did you complete the repair?	Go to *Step 20*	Go to Diagnostic Aids
20	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to *Step 3*

Drive Belt Rumbling and Vibration Diagnosis

Diagnostic Aids

The accessory drive components can have an affect on engine vibration. Vibration from the engine operating may cause a body component or another part of the vehicle to make rumbling noise. Vibration can be caused by, but not limited to the A/C system over charged, the power steering system restricted or the incorrect fluid, or an extra load on the generator. To help identify an intermittent or an improper condition, vary the loads on the accessory drive components.

The drive belt may have a rumbling condition that can not be seen or felt. Sometimes replacing the drive belt may be the only repair for the symptom.

If replacing the drive belt, completing the diagnostic table, and the noise is only heard when the drive belts are installed, there might be an accessory drive component with a failure. Varying the load on the different accessory drive components may aid in identifying which component is causing the rumbling noise.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

2. This test is to verify that the symptom is present during diagnosing. Other vehicle components may cause a similar symptom.
3. This test is to verify that one of the drive belts is causing the rumbling noise or vibration. Rumbling noise may be confused with an internal engine noise due to the similarity in the description. Remove only one drive belt at a time if the vehicle has multiple drive belts. When removing the drive belts the water pump may not be operating and the engine may overheat. Also DTCs may set when the engine is operating with the drive belts removed.
4. Inspecting the drive belts is to ensure that they are not causing the noise. Small cracks across the ribs of the drive belt will not cause the noise. Belt separation can be recognized at the edge of the belt or felt as a lump in the belt.
5. Small amounts of pilling is normal condition and acceptable. When the pilling is severe the drive belt does not have a smooth surface for proper operation.
9. Inspecting of the fasteners can eliminate the possibility that the wrong bolt, nut, spacer, or washer was installed.
11. This step should only be performed if the water pump is driven by the drive belt. Inspect the water pump shaft for being bent. Also inspect the water pump bearings for smooth operation and excessive play. Compare the water pump with a known good water pump.
12. Accessory drive component brackets that are bent, cracked, or loose may put extra strain on that accessory component causing it to vibrate.

Drive Belt Rumbling and Vibration Diagnosis

Step	Action	Yes	No
DEFINITION: The following items are indications of drive belt rumbling: • A low pitch tapping, knocking, or thumping noise heard at or just above idle. • Heard once per revolution of the drive belt or a pulley. • Rumbling may be caused from: – Pilling, the accumulation of rubber dust that forms small balls (pills) or strings in the drive belt pulley groove – The separation of the drive belt – A damaged drive belt. DEFINITION: The following items are indications of drive belt vibration: • The vibration is engine-speed related. • The vibration may be sensitive to accessory load.			
1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to *Step 2*	Go to *Symptoms - Engine Mechanical on page 9-770*
2	Verify that there is a rumbling noise or that the vibration is engine related. Does the engine make the rumbling noise or vibration?	Go to *Step 3*	Go to Diagnostic Aids
3	1. Remove the drive belt. If the engine has multiple drive belts, remove the belts one at a time and perform the test below each time a belt is removed. 2. Operate the engine for no longer than 30–40 seconds. 3. Repeat this test if necessary by removing the remaining belt(s). Does the rumbling or vibration still exist?	Go to *Symptoms - Engine Mechanical on page 9-770*	Go to *Step 4*
4	Inspect the drive belts for wear, damage, separation, sections of missing ribs, and debris build-up. Did you find any of these conditions?	Go to *Step 7*	Go to *Step 5*

Drive Belt Rumbling and Vibration Diagnosis (cont'd)

Step	Action	Yes	No
5	Inspect for severe pilling of more than 1/3 of the drive belt pulley grooves. Did you find severe pilling?	Go to *Step 6*	Go to *Step 7*
6	1. Clean the drive belt pulleys using a suitable wire brush. 2. Reinstall the drive belts. Did you correct the condition?	Go to *Step 8*	Go to *Step 7*
7	Install a new drive belt. Did you complete the replacement?	Go to *Step 8*	Go to *Step 9*
8	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to *Step 9*
9	Inspect for improper, loose or missing fasteners. Did you find any of these conditions?	Go to *Step 10*	Go to *Step 11*
10	**Caution:** Refer to *Fastener Caution on page 0-8.* 1. Tighten any loose fasteners. Refer to *Fastener Tightening Specifications on page 9-755.* 2. Replace improper or missing fasteners. Did you complete the repair?	Go to *Step 12*	Go to *Step 11*
11	Inspect for bent or cracked brackets. Did you find and correct the condition?	Go to *Step 12*	Go to Diagnostic Aids
12	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to *Step 3*

Drive Belt Falls Off and Excessive Wear Diagnosis

Diagnostic Aids

If the drive belt repeatedly falls off the drive belt pulleys, this is because of pulley misalignment.

An extra load that is quickly applied on released by an accessory drive component may cause the drive belt to fall off the pulleys. Verify the accessory drive components operate properly.

If the drive belt is the incorrect length, the drive belt tensioner may not keep the proper tension on the drive belt.

Excessive wear on a drive belt is usually caused by an incorrect installation or the wrong drive belt for the application.

Minor misalignment of the drive belt pulleys will not cause excessive wear, but will probably cause the drive belt to make a noise or to fall off.

Excessive misalignment of the drive belt pulleys will cause excessive wear but may also make the drive belt fall off.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

2. This inspection is to verify the condition of the drive belt. Damage may of occurred to the drive belt when the drive belt fell off. The drive belt may of been damaged, which caused the drive belt to fall off. Inspect the belt for cuts, tears or sections of ribs missing.
4. Misalignment of the pulleys may be caused from improper mounting of the accessory drive component, incorrect installation of the accessory drive component pulley, or the pulley bent inward or outward from a previous repair. Test for a misaligned pulley using a straight edge in the pulley grooves across two or three pulleys. If a misaligned pulley is found refer to that accessory drive component for the proper installation procedure of that pulley.
5. Inspecting the pulleys for being bent should include inspecting for a dent or other damage to the pulleys that would prevent the drive belt from not seating properly in all of the pulley grooves or on the smooth surface of a pulley when the back side of the belt is used to drive the pulley.
6. Accessory drive component brackets that are bent or cracked will let the drive belt fall off.
7. Inspecting of the fasteners can eliminate the possibility that a wrong bolt, nut , spacer, or washer was installed. Missing. loose, or the wrong fasteners may cause pulley misalignment from the bracket moving under load. Over tightening of the fasteners may cause misalignment of the accessory component bracket.
13. The inspection is to verify the drive belt is correctly installed on all of the drive belt pulleys. Wear on the drive belt may be caused by mis-positioning the drive belt by one groove on a pulley.
14. The installation of a drive belt that is two wide or two narrow will cause wear on the drive belt. The drive belt ribs should match all of the grooves on all of the pulleys.

15. This inspection is to verify the drive belt is not contacting any parts of the engine or body while the engine is operating. There should be sufficient clearance when the drive belt accessory drive components load varies. The drive belt should not come in contact with an engine or a body component when snapping the throttle.

Drive Belt Falls Off and Excessive Wear Diagnosis

Step	Action	Yes	No
DEFINITION: The drive belt falls off the pulleys or may not ride correctly on the pulleys. DEFINITION: Wear at the outside ribs of the drive belt due to an incorrectly installed drive belt.			
1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to *Step 2*	Go to *Symptoms - Engine Mechanical on page 9-770*
2	If diagnosing high wear, proceed to *Step 13*. If diagnosing a drive belt that falls off, inspect for a damaged drive belt. Did you find the condition?	Go to *Step 3*	Go to *Step 4*
3	Install a new drive belt. Refer to *Drive Belt Replacement on page 9-784*. Does the drive belt continue to fall off?	Go to *Step 4*	System OK
4	Inspect for misalignment of the pulleys. Did you find and repair the condition?	Go to *Step 12*	Go to *Step 5*
5	Inspect for a bent or dented pulley. Did you find and repair the condition?	Go to *Step 12*	Go to *Step 6*
6	Inspect for a bent or a cracked bracket. Did you find and repair the condition?	Go to *Step 12*	Go to *Step 7*
7	Inspect for improper, loose or missing fasteners. Did you find loose or missing fasteners?	Go to *Step 8*	Go to *Step 9*
8	**Caution:** Refer to *Fastener Caution on page 0-8*. 1. Tighten any loose fasteners. Refer to *Fastener Tightening Specifications on page 9-755*. 2. Replace improper or missing fasteners. Does the drive belt continue to fall off?	Go to *Step 9*	System OK
9	Test the drive belt tensioner for operating correctly. Does the drive belt tensioner operate correctly?	Go to *Step 11*	Go to *Step 10*
10	Replace the drive belt tensioner. Refer to *Drive Belt Tensioner Replacement on page 9-786*. Does the drive belt continue to fall off?	Go to *Step 11*	System OK
11	Inspect for failed drive belt idler and drive belt tensioner pulley bearings. Did you find and repair the condition?	Go to *Step 12*	Go to Diagnostic Aids
12	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to *Step 2*
13	Inspect the drive belt for the proper installation. Refer to *Drive Belt Replacement on page 9-784*. Did you find this condition?	Go to *Step 16*	Go to *Step 14*
14	Inspect for the proper drive belt. Did you find this condition?	Go to *Step 16*	Go to *Step 15*
15	Inspect for the drive belt rubbing against a bracket, hose, or wiring harness. Did you find and repair the condition?	Go to *Step 17*	Go to Diagnostic Aids
16	Replace the drive belt. Refer to *Drive Belt Replacement on page 9-784*. Did you complete the replacement?	Go to *Step 17*	—
17	Operate the system in order to verify the repair. Did you correct the condition?	System OK	—

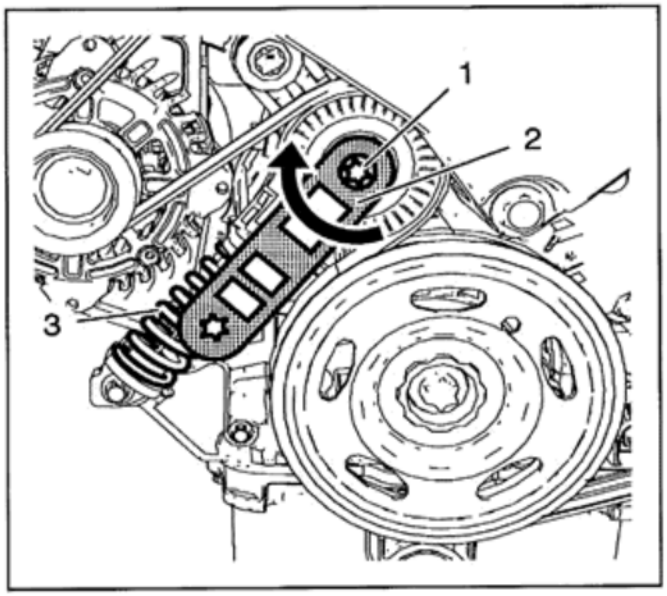
Drive Belt Tensioner Diagnosis

Special Tools

EN-48488 Holding Wrench

For equivalent regional tools, refer to *Special Tools on page 9-927*.

1. Diagnosis consists of a function check on the automatic belt tensioner and a visual check on the belt and the components linked to the belt.



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2. Install the *EN-48488* wrench (2) to the drive belt tensioner pulley bolt (1).
3. Apply tension to the drive belt tensioner spring (3) by moving the drive belt tensioner pulley clockwise.
4. Allow the drive belt tensioner to slide back slowly and thereby inspect the drive belt tensioner mechanism for practicability.

Repair Instructions - On Vehicle

Drive Belt Replacement

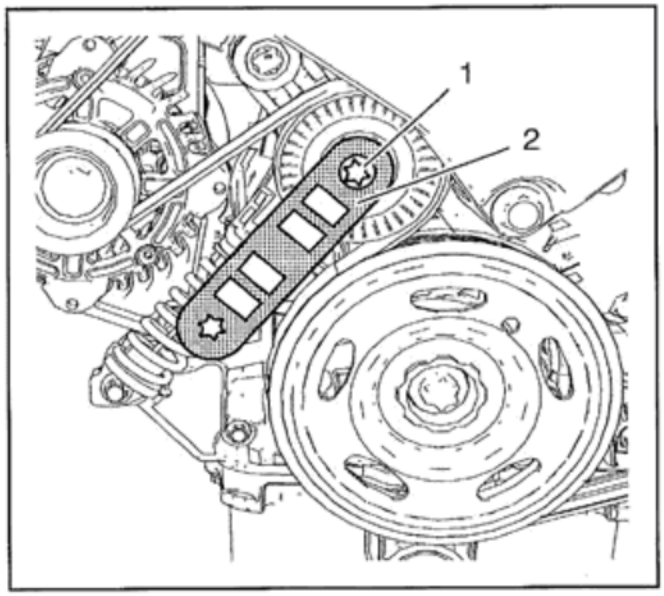
Special Tools

- *EN-48488* Holding Wrench
- *EN-955* Locking Pin

For equivalent regional tools, refer to *Special Tools on page 9-927*.

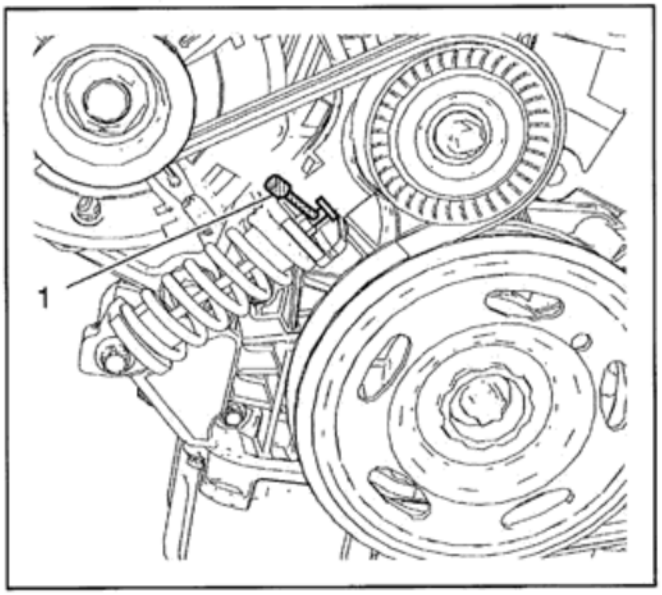
Removal Procedure

1. Remove the right front wheelhouse liner extension. Refer to *Front Wheelhouse Liner Inner Front Extension Replacement (Left Side) on page 3-147* or *Front Wheelhouse Liner Inner Front Extension Replacement (Right Side, LUV) on page 3-148* or *Front Wheelhouse Liner Inner Front Extension Replacement (Right Side, LWE, LUW) on page 3-149*.
2. Install the engine support fixture. Refer to *Engine Support Fixture on page 9-854*.
3. Remove the engine mount bracket. Refer to *Engine Mount Bracket Replacement - Right Side on page 9-789*.



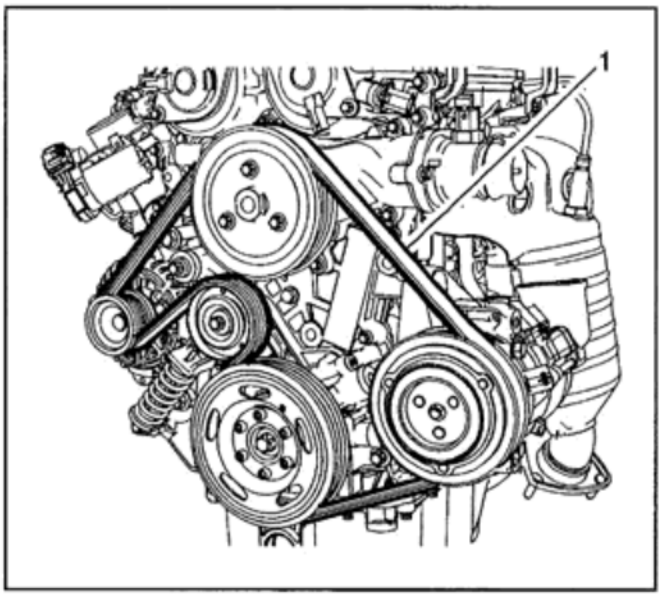
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4. Install *EN-48488* holding wrench (2) to the drive belt tensioner (1).



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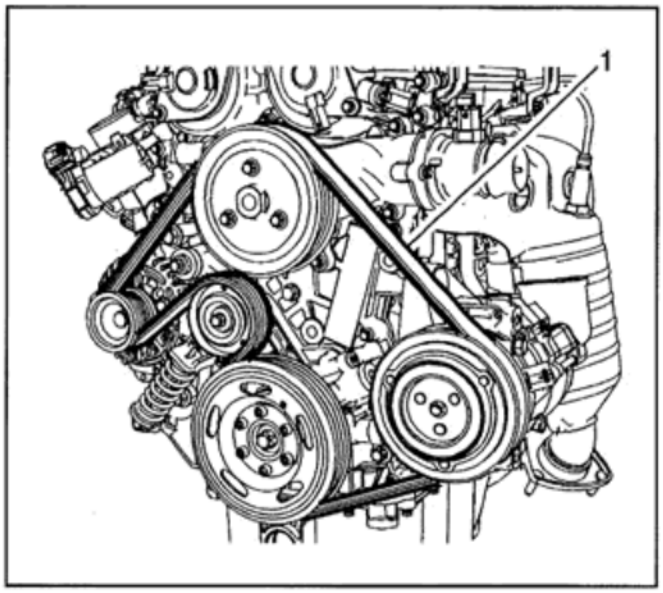
5. Move the drive belt tensioner clockwise until the drive belt tensioner can be fixed with *EN-955* locking pin (1).
6. Remove the *EN-48488* holding wrench.



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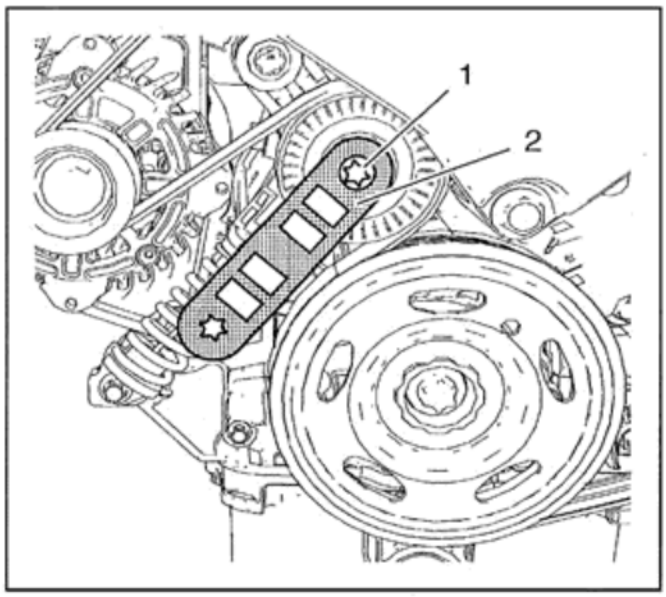
7. Remove the drive belt (1).

Installation Procedure



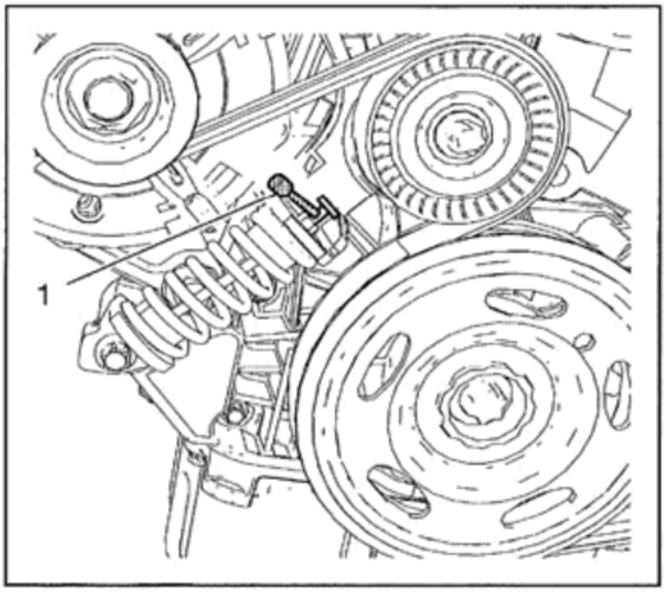
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1. Install the drive belt (1).



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2. Install the *EN-48488* holding wrench (2) to the drive belt tensioner (1).



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3. Move the drive belt tensioner clockwise until *EN-955* locking pin (1) can be removed.
4. Allow the tensioner to slide back slowly.
5. Remove the *EN-48488* holding wrench.
6. Install the engine mount bracket. Refer to *Engine Mount Bracket Replacement - Right Side on page 9-789*.
7. Install the right front wheelhouse liner extension. Refer to *Front Wheelhouse Liner Inner Front Extension Replacement (Left Side) on page 3-147* or *Front Wheelhouse Liner Inner Front Extension Replacement (Right Side, LUV) on page 3-148* or *Front Wheelhouse Liner Inner Front Extension Replacement (Right Side, LWE, LUW) on page 3-149*.
8. Remove the engine support fixture. Refer to *Engine Support Fixture on page 9-854*.

Drive Belt Tensioner Replacement

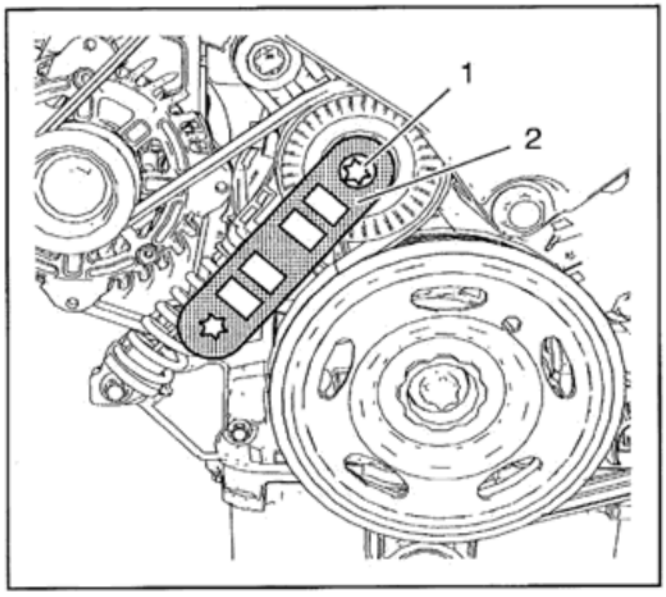
Special Tools

- *EN-955* Locking Pin
- *EN-48488* Holding Wrench

For equivalent regional tools, refer to *Special Tools on page 9-927*.

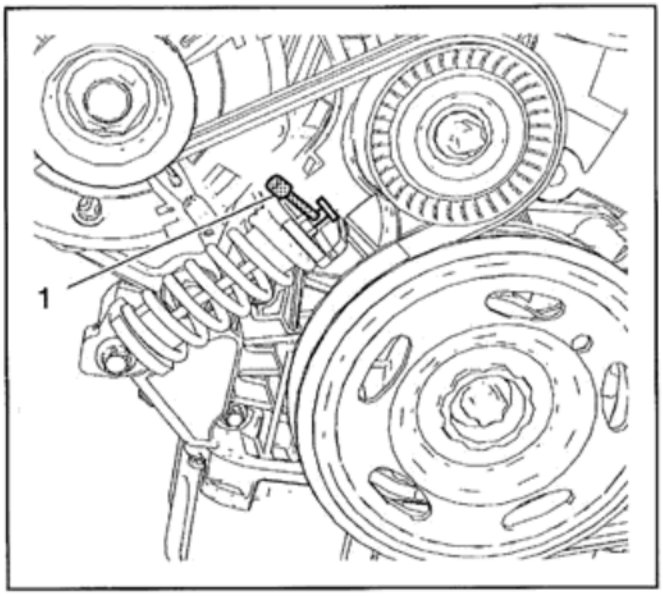
Removal Procedure

1. Remove the right front wheelhouse liner extension. Refer to *Front Wheelhouse Liner Inner Front Extension Replacement (Left SIde) on page 3-147* or *Front Wheelhouse Liner Inner Front Extension Replacement (Right Side, LUV) on page 3-148* or *Front Wheelhouse Liner Inner Front Extension Replacement (Right SIde, LWE, LUW) on page 3-149*
2. Install the engine support fixture. Refer to *Engine Support Fixture on page 9-854*.
3. Remove the engine mount bracket. Refer to *Engine Mount Bracket Replacement - Right Side on page 9-789*.



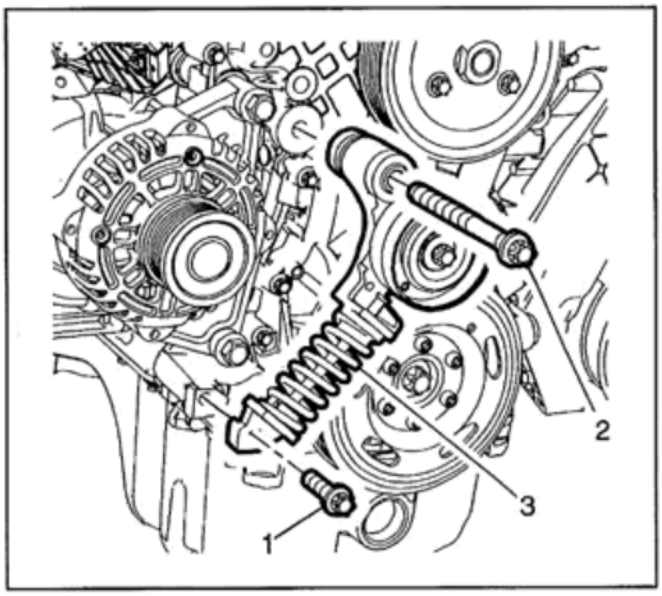
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4. Install the *EN-48488* holding wrench (2) to the drive belt tensioner (1).



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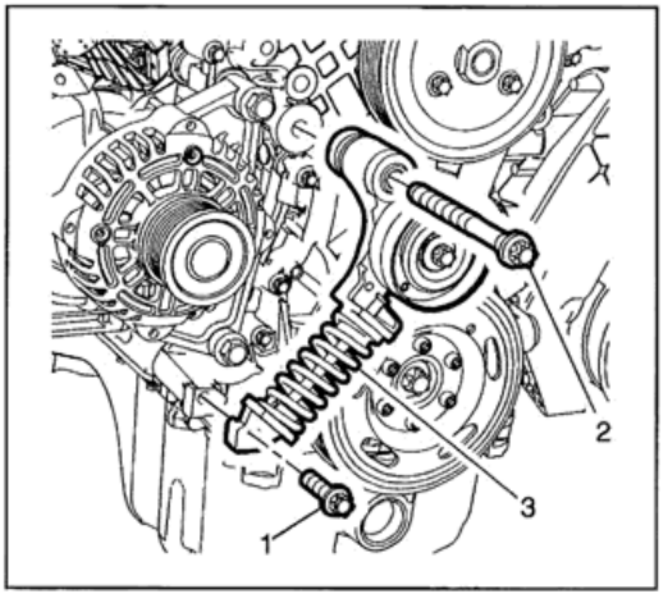
5. Move the drive belt tensioner clockwise until the drive belt tensioner can be fixed with *EN-955* locking pin (1).
6. Remove the *EN-48488* holding wrench.
7. Remove the drive belt.
8. Repeat steps 4 and 5 in order to remove the *EN-955* locking pin from the drive belt tensioner.



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9. Remove the lower drive belt tensioner bolt (1).
10. Remove the upper drive belt tensioner bolt (2).
11. Remove the drive belt tensioner (3).

Installation Procedure

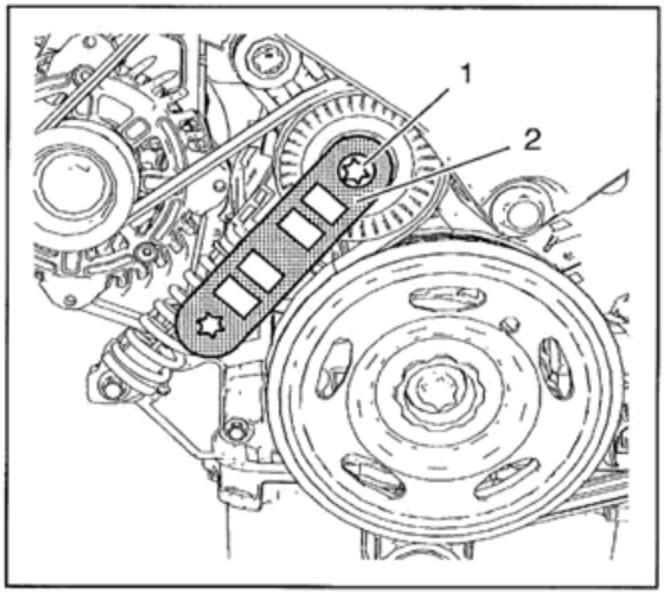


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1. Install the drive belt tensioner (3).
2. Install the lower drive belt tensioner bolt (1).
3. Install the upper drive belt tensioner bolt (2).

Caution: Refer to *Fastener Caution on page 0-8*.

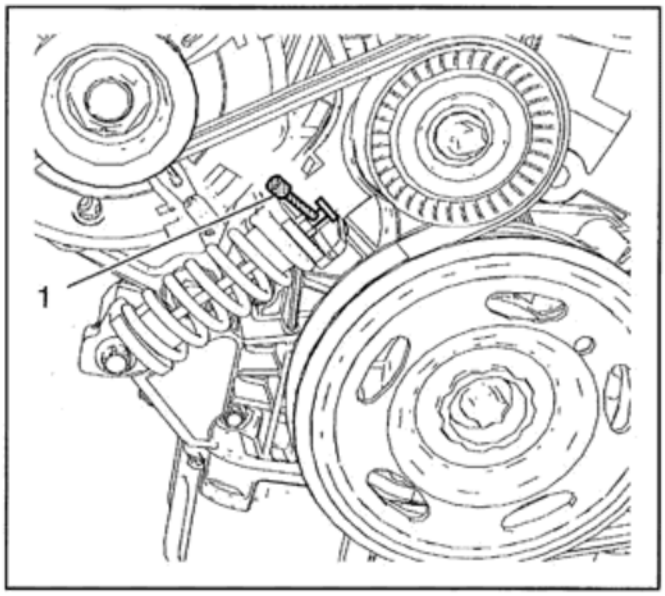
4. Tighten the lower drive belt tensioner bolt (1) to **22 N•m (16 lb ft)**.
5. Tighten the upper drive belt tensioner bolt (2) to **55 N•m (41 lb ft)**.



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Note: Engine mount bracket is removed.

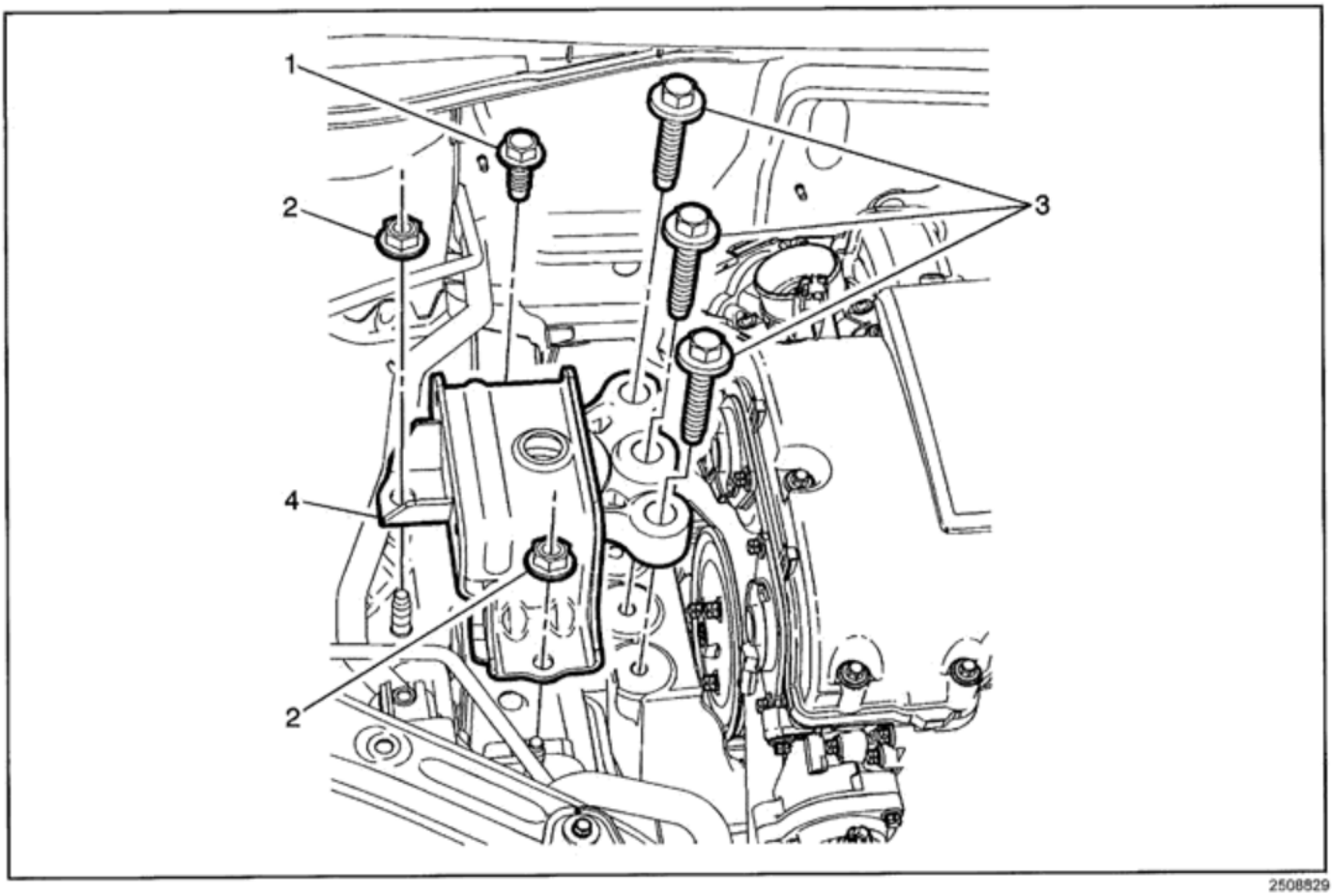
6. Install the *EN-48488* holding wrench (2) to drive belt tensioner (1).



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7. Move the drive belt tensioner clockwise until the drive belt tensioner can be fixed with *EN-955* locking pin (1).
8. Install the drive belt.
9. Move the drive belt tensioner clockwise until *EN-955* locking pin can be removed.
10. Allow the tensioner to slide back slowly.
11. Remove the *EN-48488* holding wrench.
12. Install the engine mount bracket. Refer to *Engine Mount Bracket Replacement - Right Side on page 9-789*.
13. Install the right front wheelhouse liner extension. Refer to *Front Wheelhouse Liner Inner Front Extension Replacement (Left SIde) on page 3-147* or *Front Wheelhouse Liner Inner Front Extension Replacement (Right Side, LUV) on page 3-148* or *Front Wheelhouse Liner Inner Front Extension Replacement (Right SIde, LWE, LUW) on page 3-149*.
14. Remove the engine support fixture. Refer to *Engine Support Fixture on page 9-854*.

Engine Mount Replacement - Right Side

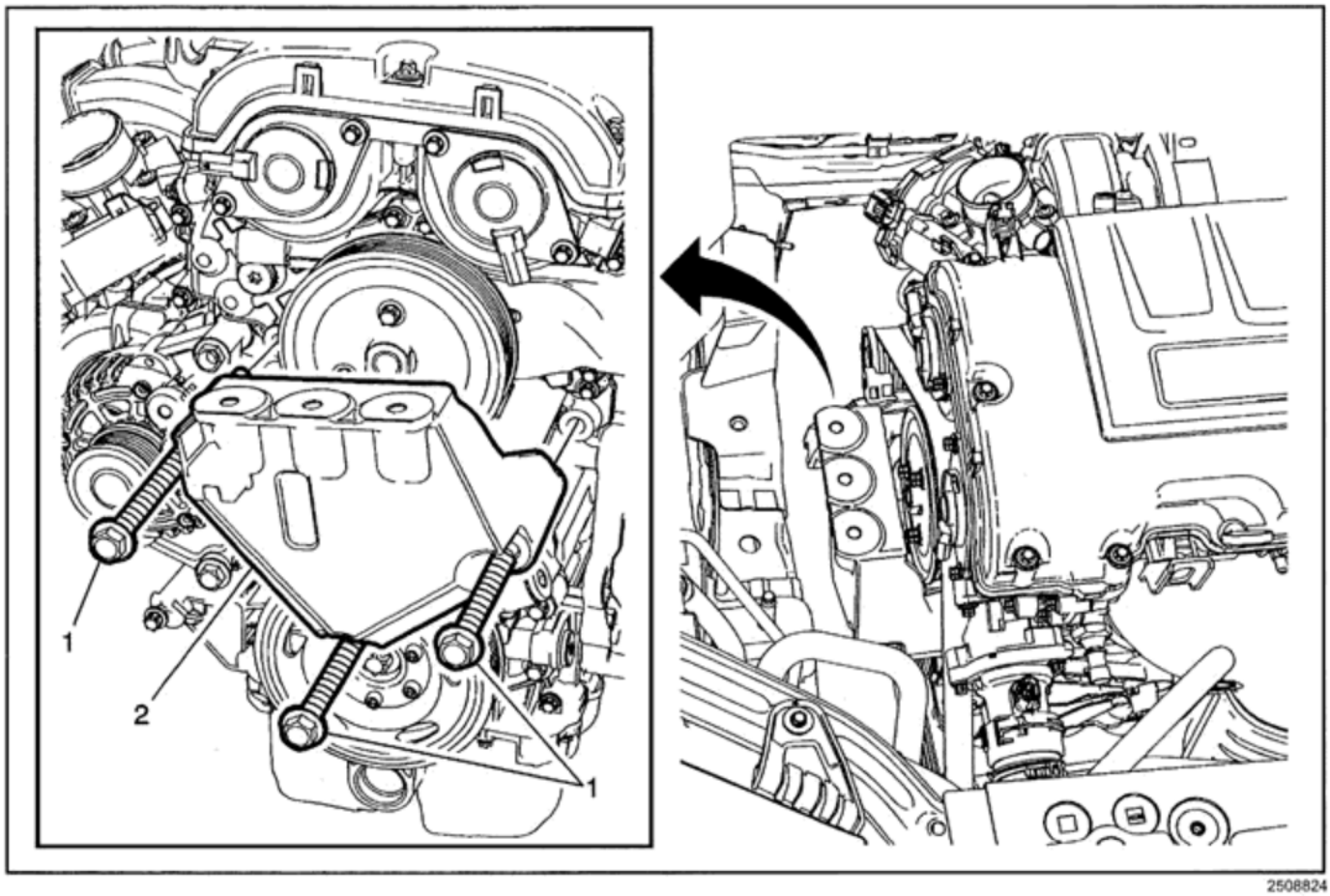


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Engine Mount Replacement - Right Side

Callout	Component Name
Preliminary Procedures 1. Remove the air cleaner assembly. Refer to *Air Cleaner Assembly Replacement on page 9-290*. 2. Install the engine support fixture. Refer to *Engine Support Fixture on page 9-854*. 3. Prior to removing the mount, mark the mount location using spray paint or a marker for correct positioning during installation.	
1	Engine Mount Bolt (Qty: 1) **Caution:** Refer to *Fastener Caution on page 0-8*. **Tighten** 62 N•m (46 lb ft)
2	Engine Mount Nut (Qty: 2) **Tighten** 62 N•m (46 lb ft)
3	Engine Mount Bracket to Mount Bolt (Qty: 3) **Procedure** Ensure to use a NEW bolt whenever the mount is removed. . **Tighten** 50 N•m+ 60° to 75° (37 lb ft + 60° to 75°) **Special Tools** *EN-470-B* Angular Torque Wrench For equivalent regional tools, refer to *Special Tools on page 9-927*
4	Engine Mount

Engine Mount Bracket Replacement - Right Side

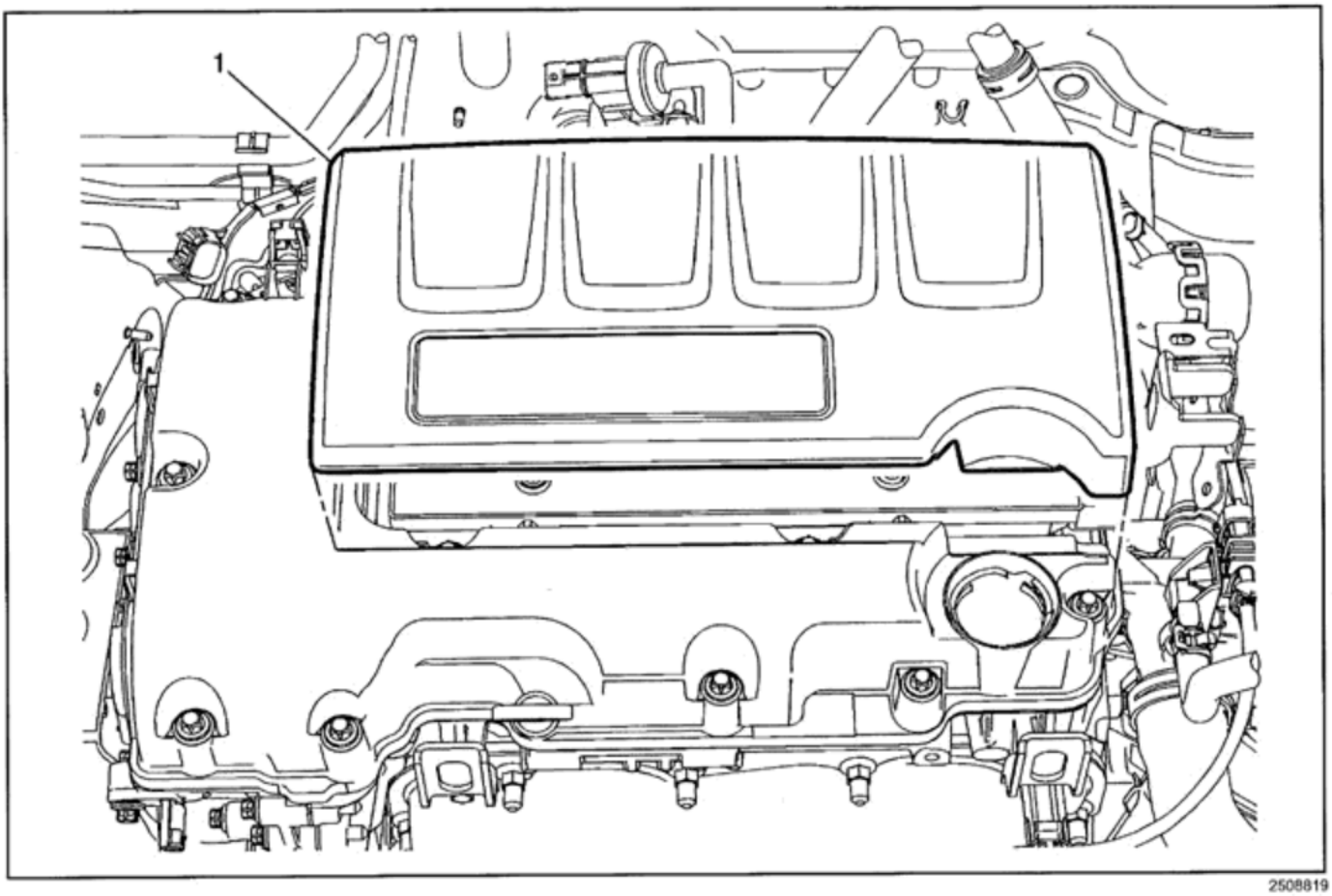


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Engine Mount Bracket Replacement - Right Side

Callout	Component Name
Preliminary Procedures 1. Remove the engine mount. Refer to *Engine Mount Replacement - Right Side on page 9-788.* 2. Remove the front wheelhouse front liner if necessary. Refer to *Front Wheelhouse Liner Replacement (Rear) on page 3-151* or *Front Wheelhouse Liner Replacement (Front) on page 3-150.*	
1	Engine Mount Bracket Fastener (Qty: 3) **Caution:** This component uses torque-to-yield bolts. When servicing this component do not reuse the bolts, New torque-to-yield bolts must be installed. Reusing used torque-to-yield bolts will not provide proper bolt torque and clamp load. Failure to install NEW torque-to-yield bolts may lead to engine damage. **Caution:** Refer to *Fastener Caution on page 0-8.* **Procedure** Raise and lower the engine as needed to access the bolts. **Tighten** 62 N•m (46 lb ft)
2	Engine Mount Bracket

Engine Cover Replacement



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Engine Cover Replacement

Callout	Component Name
1	Engine Cover **Procedure** Use a suitable tool to first unclip the front of the cover, then rotate the cover backward and pull upward to remove.

Intake Manifold Replacement

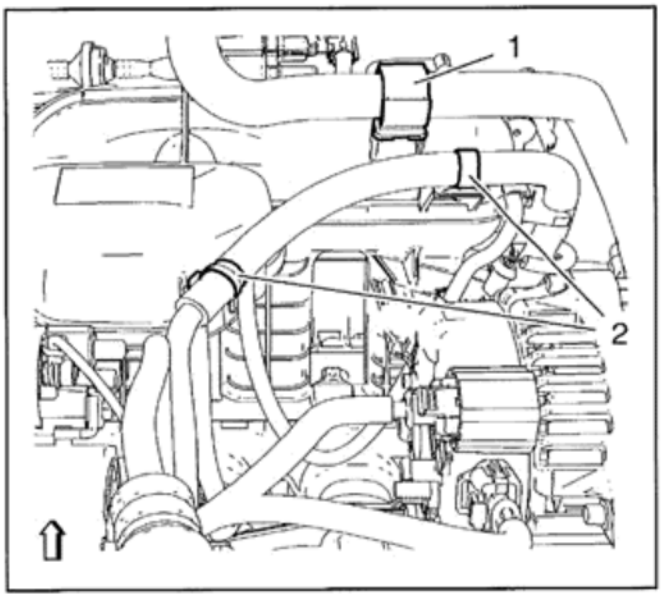
Special Tools

- *EN-34730–91* Pressure Tester
- *EN-6015* Closure Plugs

For equivalent regional tools, refer to *Special Tools on page 9-927*

Removal Procedure

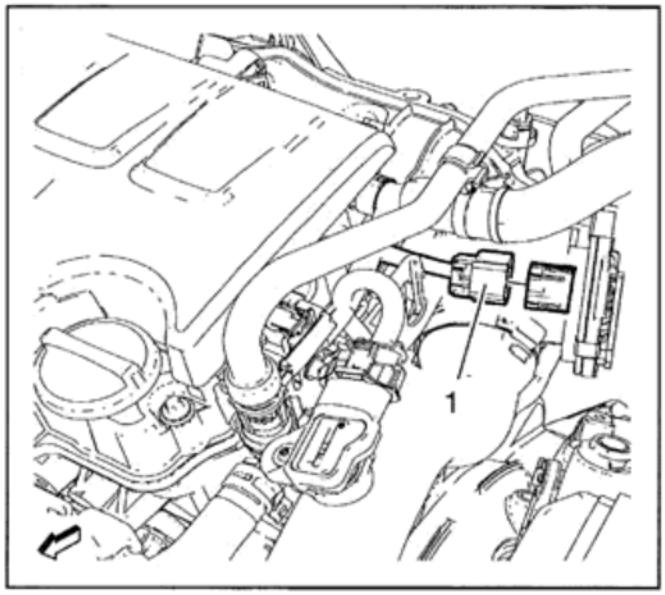
1. Disconnect the battery negative cable. Refer to *Battery Negative Cable Disconnection and Connection on page 9-713*.
2. Remove the engine sight shield.



2192267

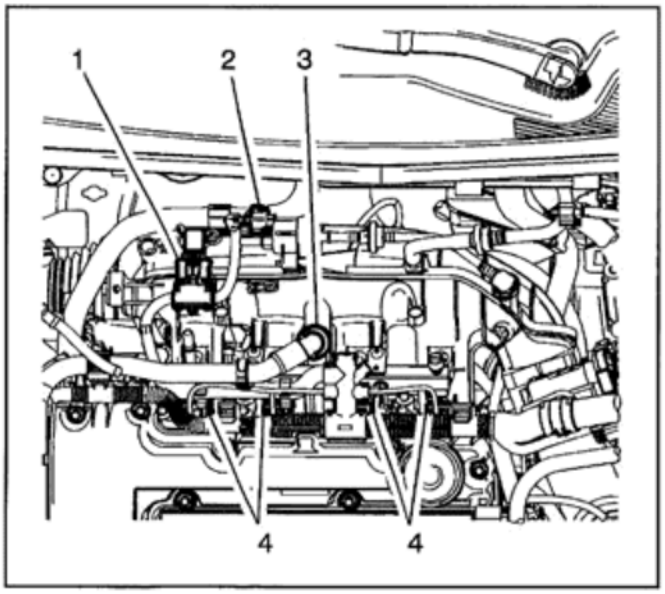
3. Unclip the heater outlet hose from retainer clip (1).

4. Unclip the engine control module wiring harness from 2 retainer clips (2).
5. Lower the vehicle.
6. Remove the charge air cooler outlet air hose from the throttle body. Refer to *Charge Air Cooler Outlet Air Hose Replacement on page 9-293.*



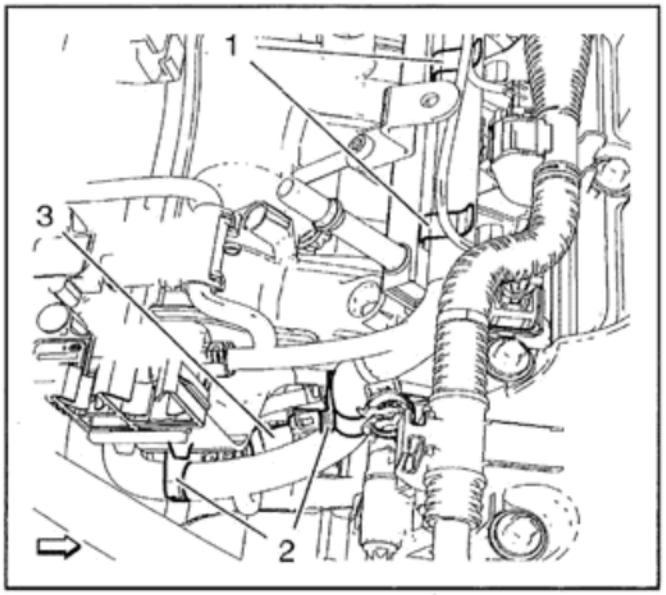
2191969

7. Disconnect the throttle body wiring harness plug (1).



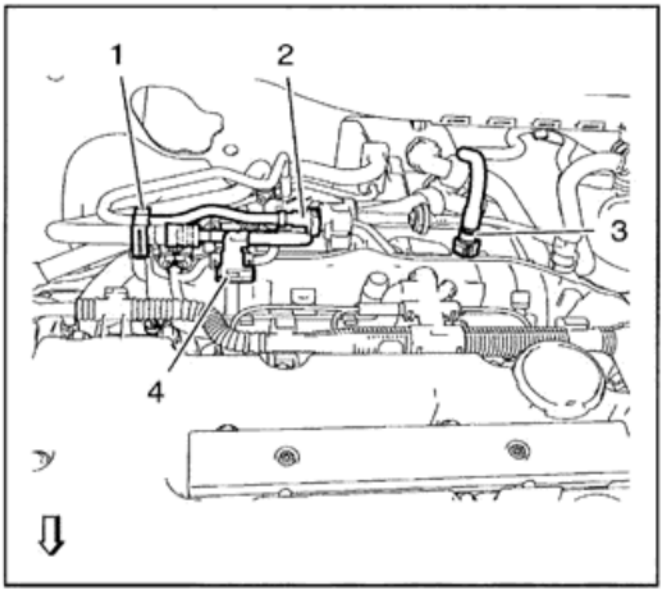
2613070

8. Disconnect the evaporative emission canister purge solenoid valve wiring harness plug (2).
9. Disconnect the manifold absolute pressure sensor wiring harness plug (1).
10. Disconnect the 4 fuel injector wiring harness plugs (4).
11. Unclip the engine control module wiring harness from the camshaft cover.
12. Disconnect the PCV hose (3).



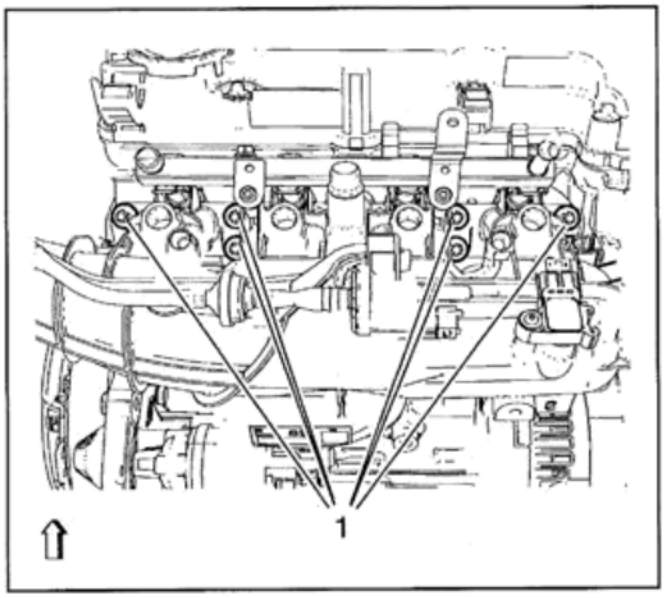
2192266

13. Disconnect the turbocharger wastegate regulator solenoid valve wiring harness plug (3).
14. Unclip the engine control module wiring harness from 2 intake manifold retainer clips (2) and from 2 fuel injection rail retainer clips (1).
15. Relieve the fuel system pressure. Refer to *Fuel Pressure Relief on page 9-253.*



2192264

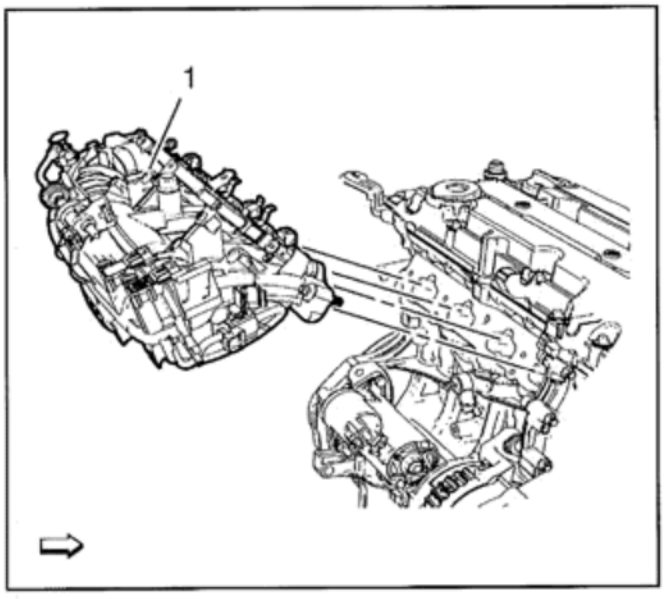
16. Remove the fuel feed pipe (4) from fuel injector rail.
17. Unclip the fuel feed pipe from retainer clip (1).
18. Remove the fuel ventilation pipe (2) from evaporative emission canister purge solenoid valve.
19. Unclip the fuel ventilation pipe from retainer clip (1).
20. Close the vents with the *EN-6015* closure plugs.
21. Disconnect the brake booster vacuum pipe (3) from the intake manifold.



2192268

Note: The intake manifold bolts remain in intake manifold.

22. Remove the 6 intake manifold bolts (1).

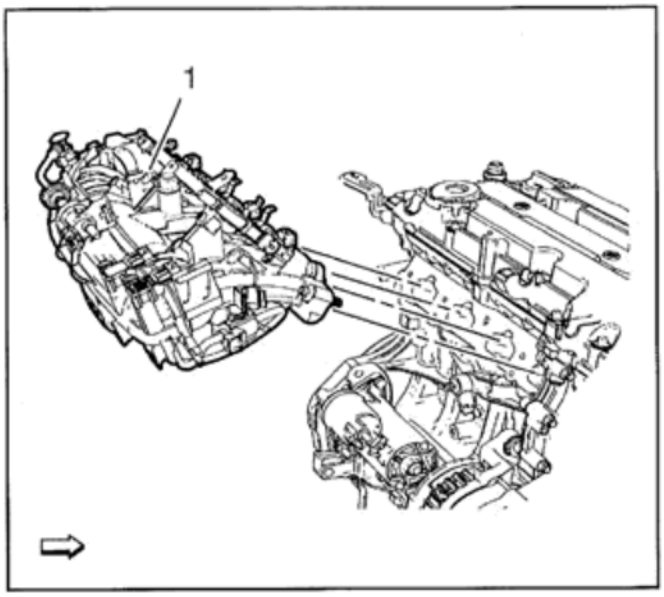


2192269

23. Remove the intake manifold (1) and the intake manifold gasket.
24. Transfer parts from intake manifold as necessary. Refer to *Intake Manifold Disassemble on page 9-888* and *Intake Manifold Assemble on page 9-889*.

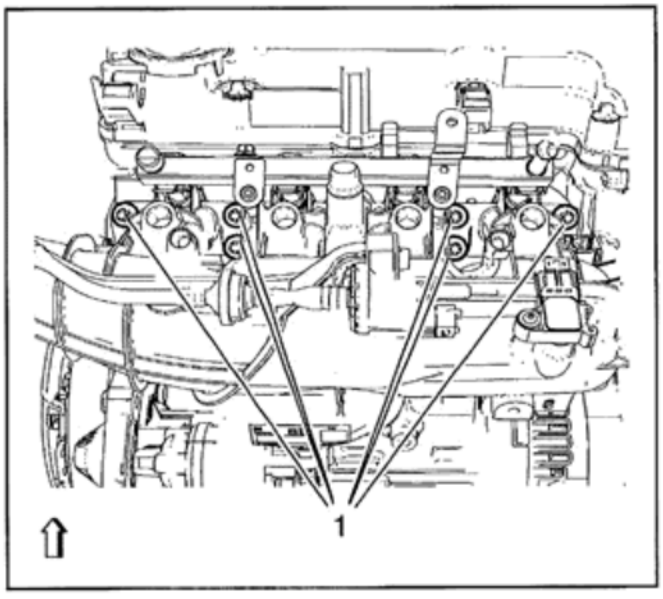
Installation Procedure

1. Clean the sealing surfaces.



2192269

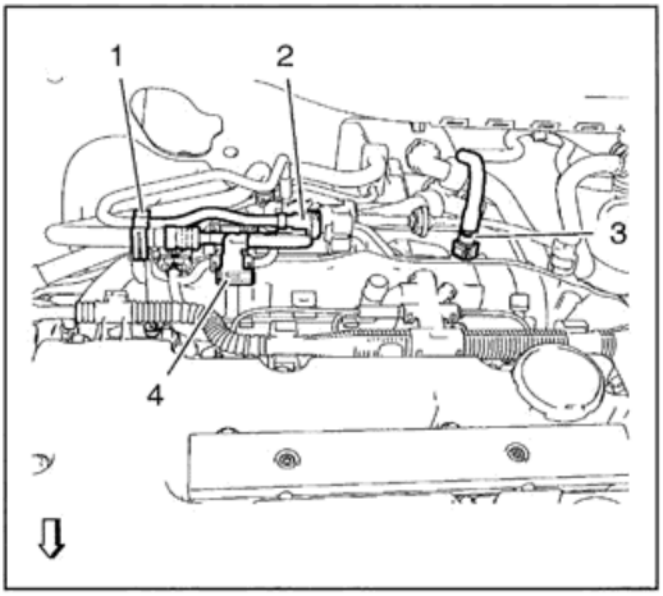
2. Install the intake manifold (1) along with a NEW intake manifold gasket.



2192268

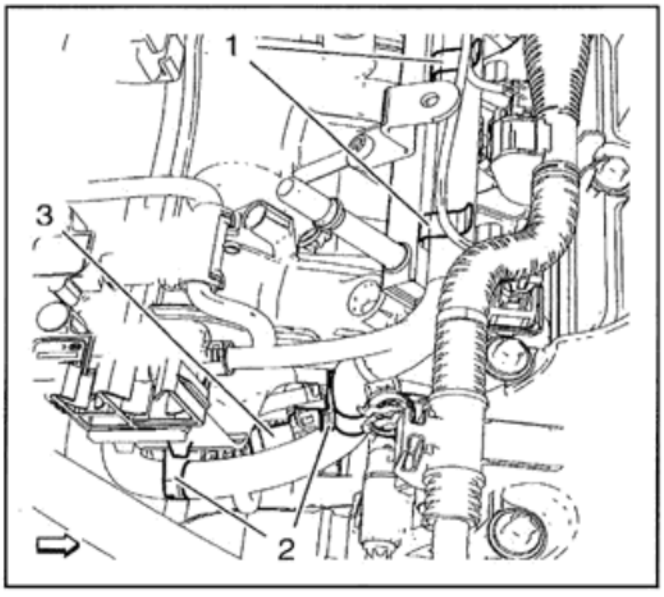
Caution: Refer to *Fastener Caution on page 0-8*.

3. Install the 6 intake manifold bolts (1) and tighten to **20 N·m (15 lb ft)**.



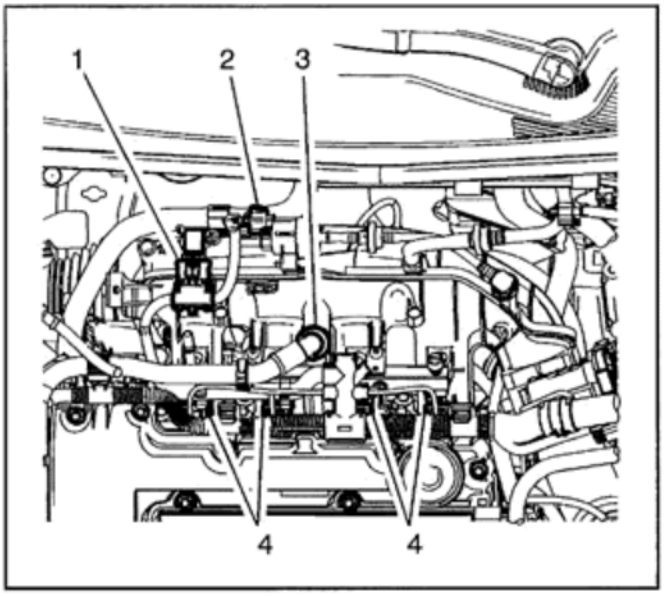
2192264

4. Connect the fuel ventilation pipe (2) to the evaporative emission canister purge solenoid valve.
5. Clip in the fuel ventilation pipe to the retainer clip (1).
6. Connect the fuel feed pipe (4) to the injector rail.
7. Clip in the fuel feed pipe to the retainer clip (1).
8. Connect the brake booster vacuum pipe (3) to the intake manifold.



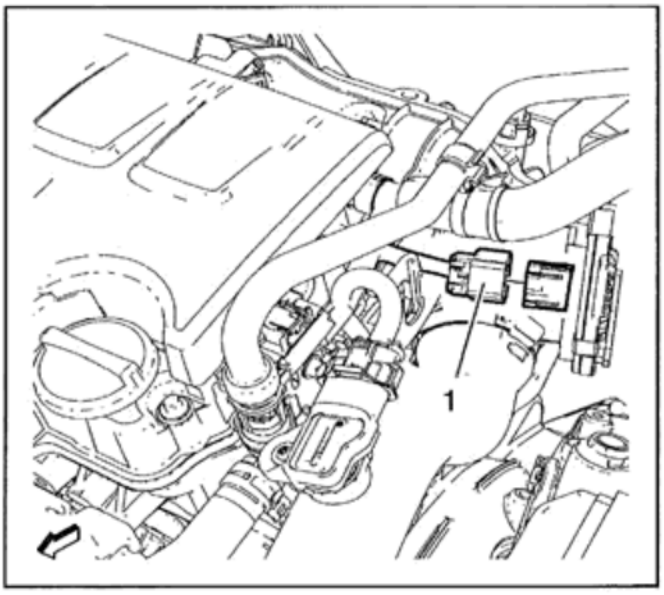
2192266

9. Connect the turbocharger wastegate regulator solenoid valve wiring harness plug (3).
10. Clip in the engine control module wiring harness to 2 intake manifold retainer clips (2) and from 2 fuel injection rail retainer clips (1).



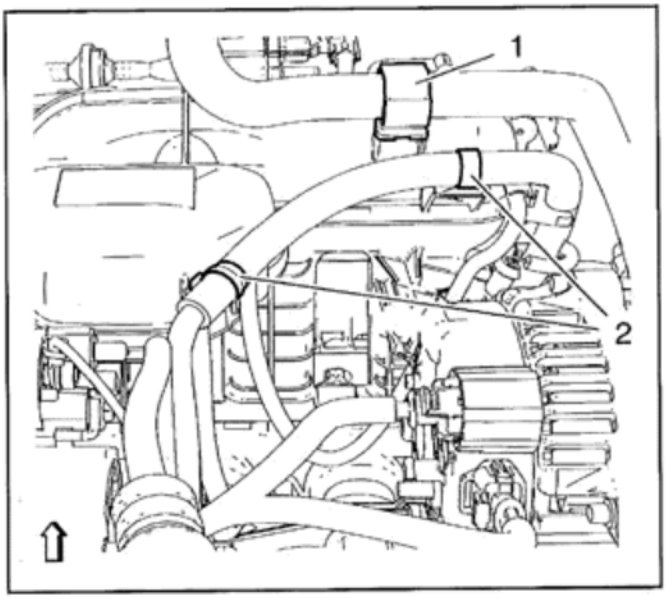
2613070

11. Clip in the engine control module wiring harness to the camshaft cover.
12. Connect the 4 fuel injector wiring harness plugs (4).
13. Connect the manifold absolute pressure sensor wiring harness plug (1) .
14. Disconnect the evaporative emission canister purge solenoid valve wiring harness plug (2).
15. Connect the PCV hose (3).



2191969

16. Connect the throttle body wiring harness plug (1).
17. Install the charge air cooler outlet air hose to the throttle body. Refer to *Charge Air Cooler Outlet Air Hose Replacement on page 9-293*.
18. Raise and support the vehicle.



2192267

19. Clip in the heater outlet hose to retainer clip (1).
20. Clip in the engine control module wiring harness to 2 retainer clips (2).
21. Install the engine sight shield.
22. Connect the battery negative cable. Refer to *Battery Negative Cable Disconnection and Connection on page 9-713*.

Camshaft Timing Chain Replacement

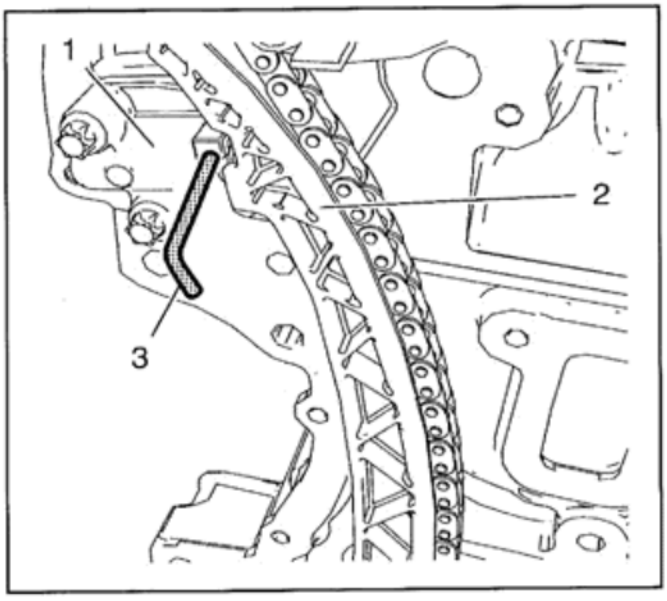
Special Tools

EN-955 Locking Pin

For equivalent regional tools. Refer to *Special Tools on page 9-927*.

Removal Procedure

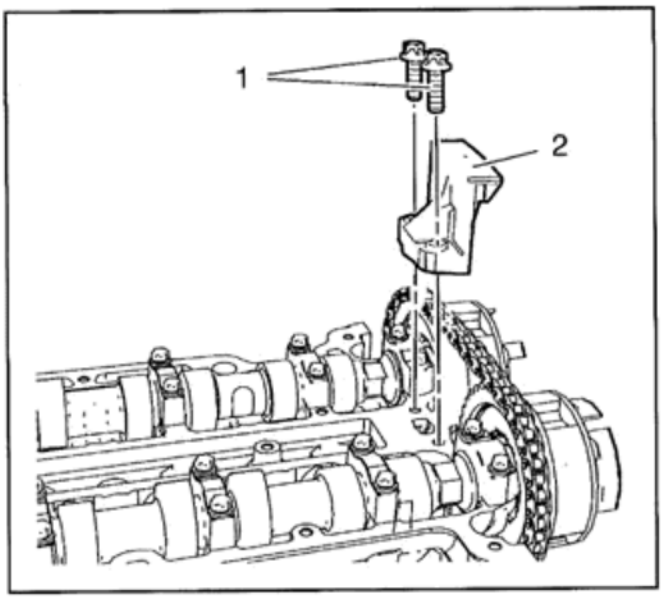
1. Remove the engine front cover. Refer to *Engine Front Cover with Oil Pump Replacement on page 9-821*.



2190679

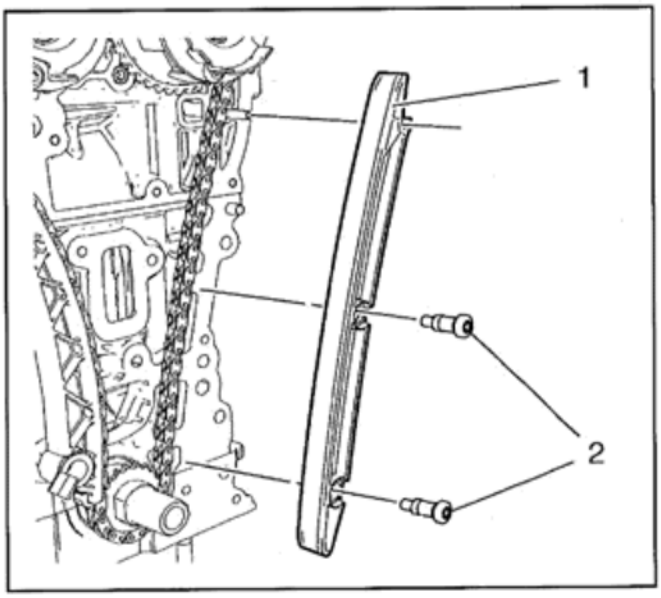
Note: If EN-955 fixing pin can not be inserted, compress the timing chain tensioner further with the aid of a flat bladed tool to allow complete insertion of the pin.

2. Push the timing chain (2) in direction to the timing chain tensioner (1) and install the *EN-955* pin (3).



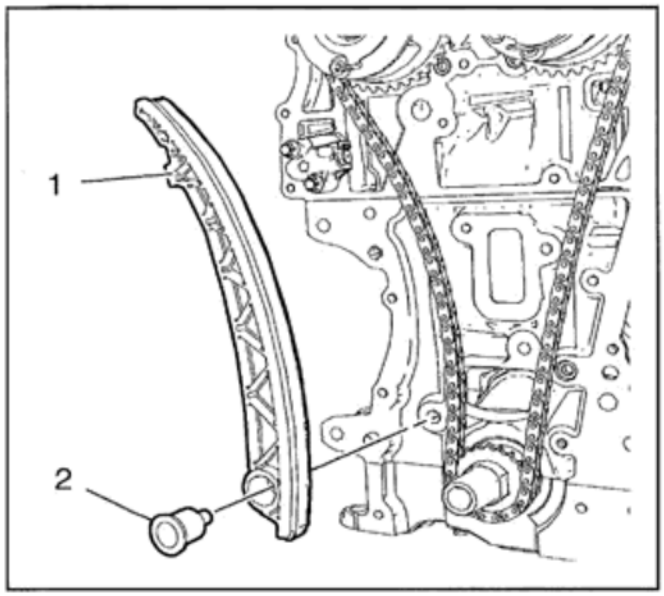
2190676

3. Remove the two upper timing chain guide bolts (1).
4. Remove the upper timing chain guide (2).



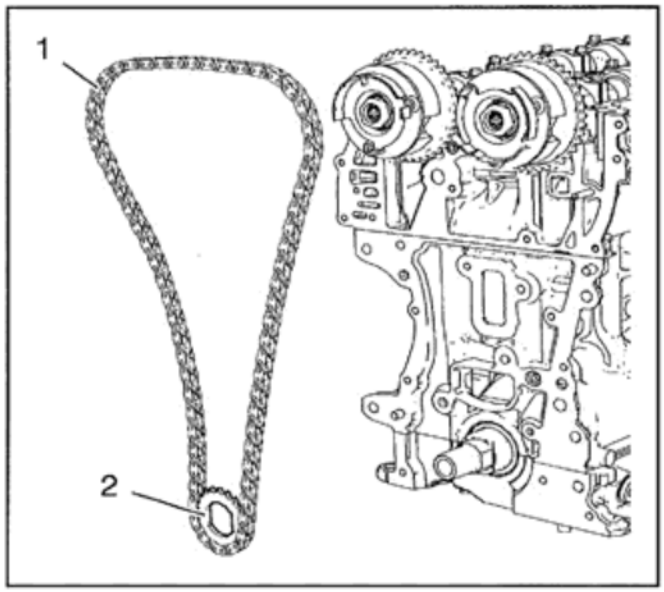
2190677

5. Remove the two timing chain guide right side bolts (2).
6. Remove the timing chain guide right side (1).



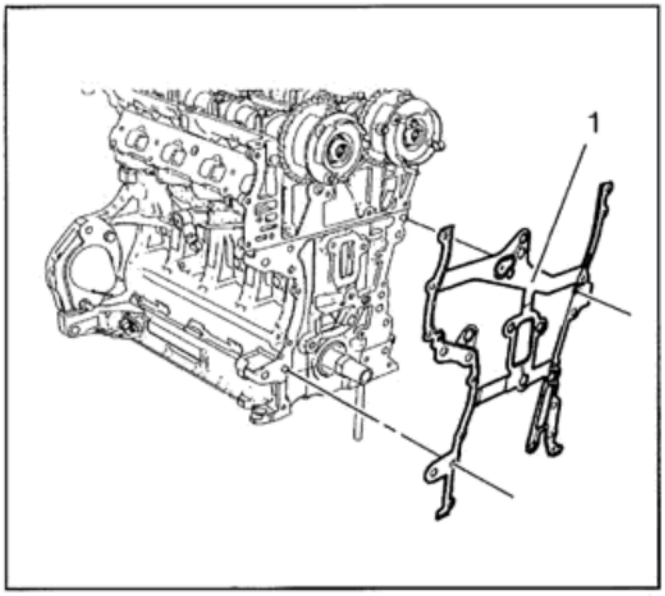
2190678

7. Remove the timing chain tensioner shoe bolt (2).
8. Remove the timing chain tensioner shoe (1).



2190675

9. Remove the timing chain (1) and crankshaft sprocket (2) together as a unit.

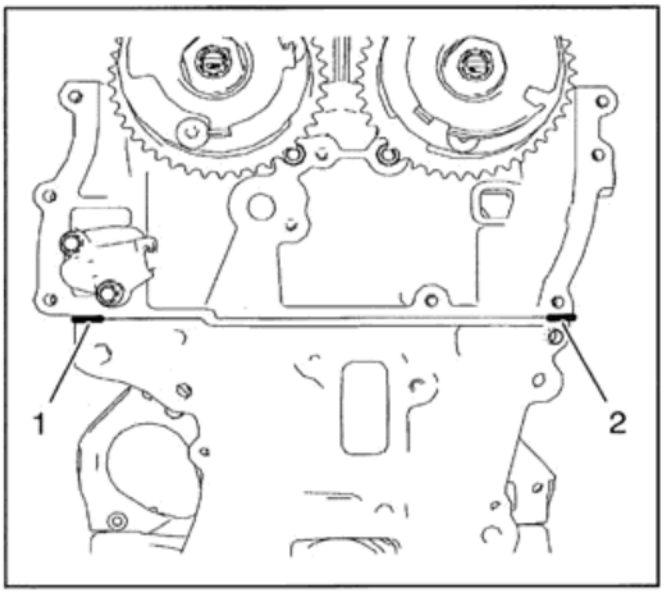


2190693

10. Remove the engine front cover gasket (1).

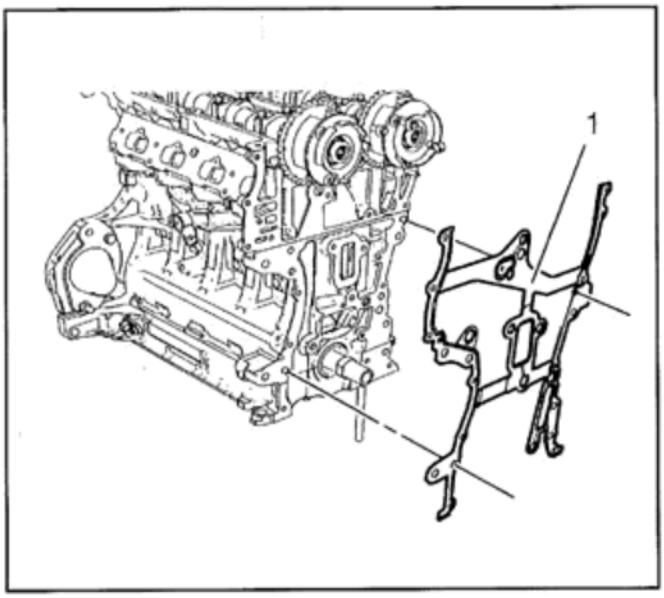
Installation Procedure

1. Clean the engine front cover sealing surfaces on engine block and cylinder head.



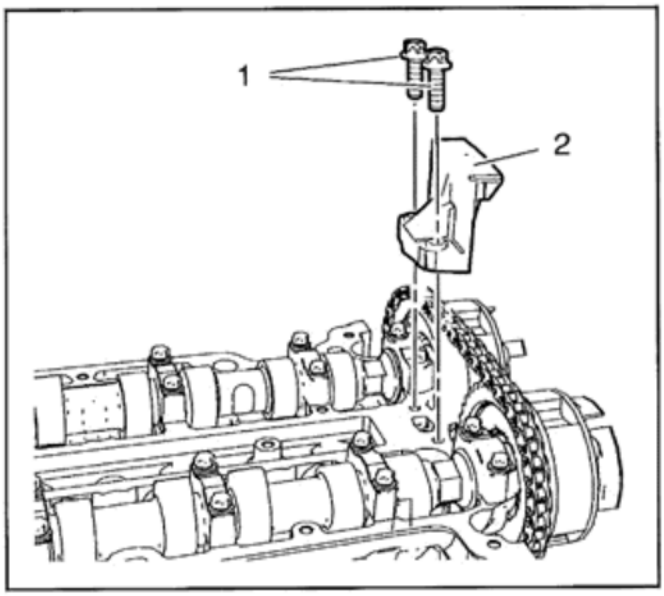
2190694

2. Apply a 2 mm (0.0787 in) bead of RTV sealant the areas shown above (1, 2).



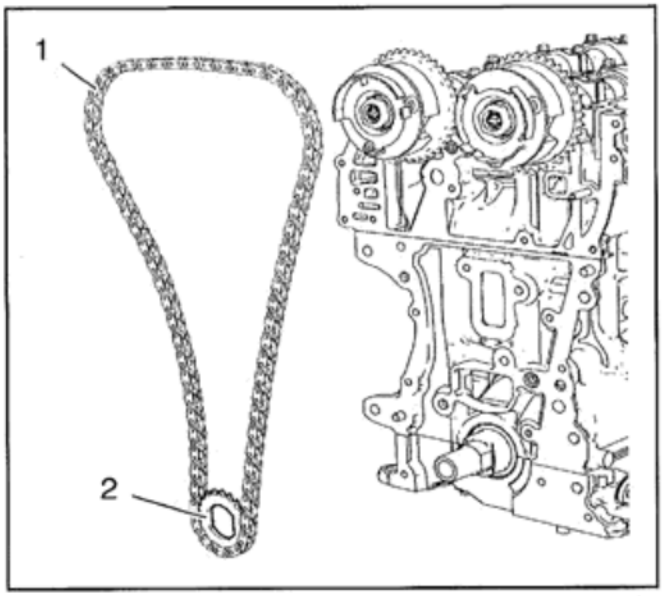
2190693

3. Install the engine front cover gasket (1).



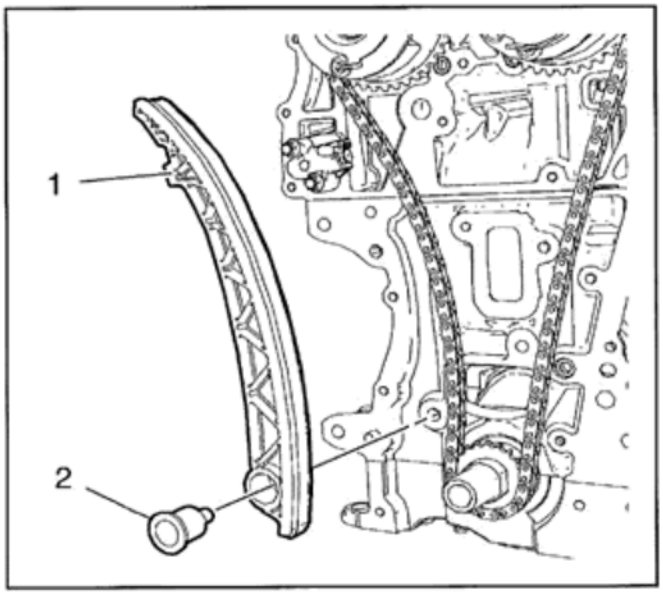
2190676

4. Install the two upper timing chain guide bolts (1) and tighten to 8 N•m (71 lb in).
5. Install the upper timing chain guide (2).



2190675

6. Install the timing chain (1) and crankshaft sprocket (2) together as a unit.

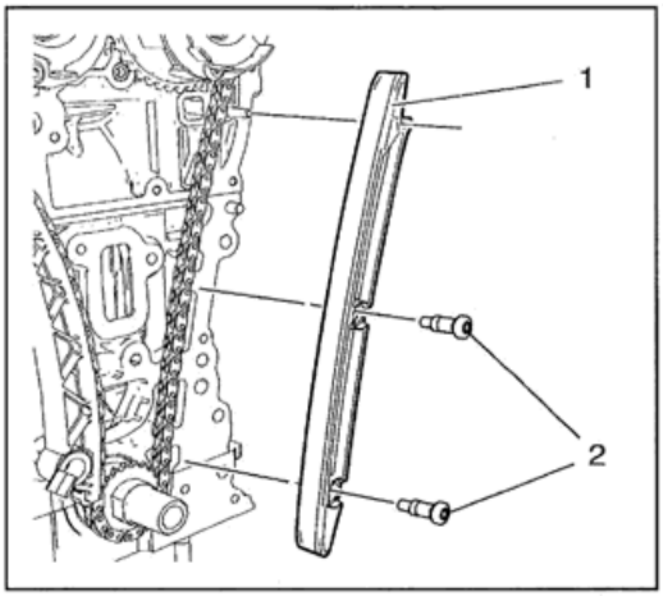


2190678

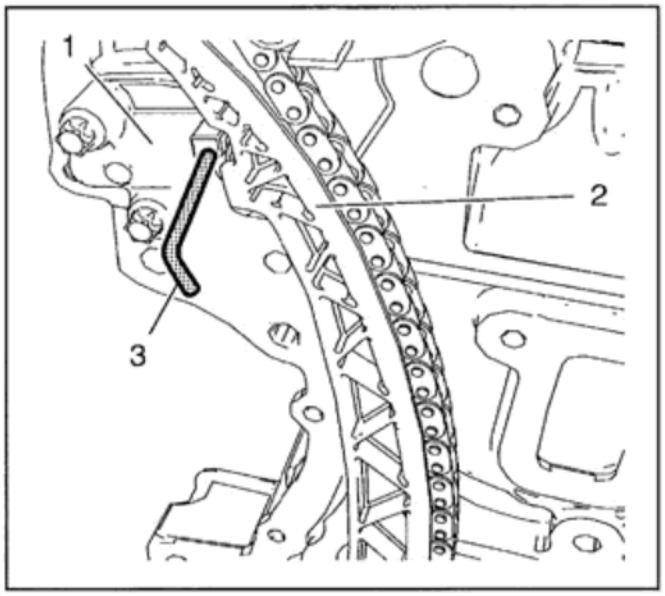
7. Install the timing chain tensioner shoe (1).

Caution: Refer to *Fastener Caution on page 0-8*.

8. Install the timing chain tensioner shoe bolt (2) and tighten to **20** N•m **(15 lb ft)**.



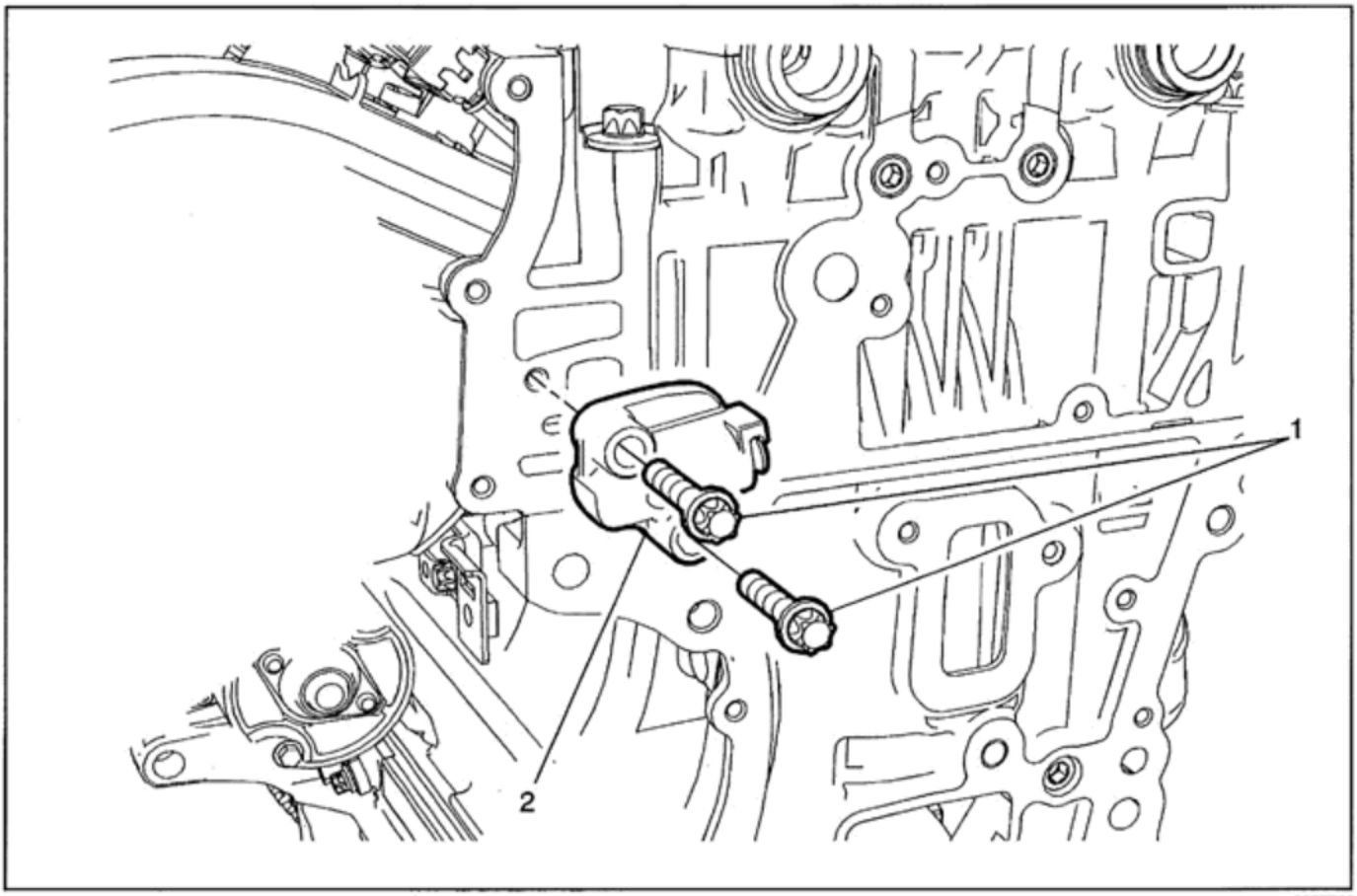
2190677



2190679

9. Install the timing chain guide right side (1).
10. Install the timing chain guide right side bolts (2) and tighten to **8 N•m (71 lb in)**.
11. Push the timing chain (2) in direction of the timing chain tensioner (1) and remove *EN-955* pin (3).
12. Install the engine front cover. Refer to *Engine Front Cover with Oil Pump Replacement on page 9-821*.

Timing Chain Tensioner Replacement

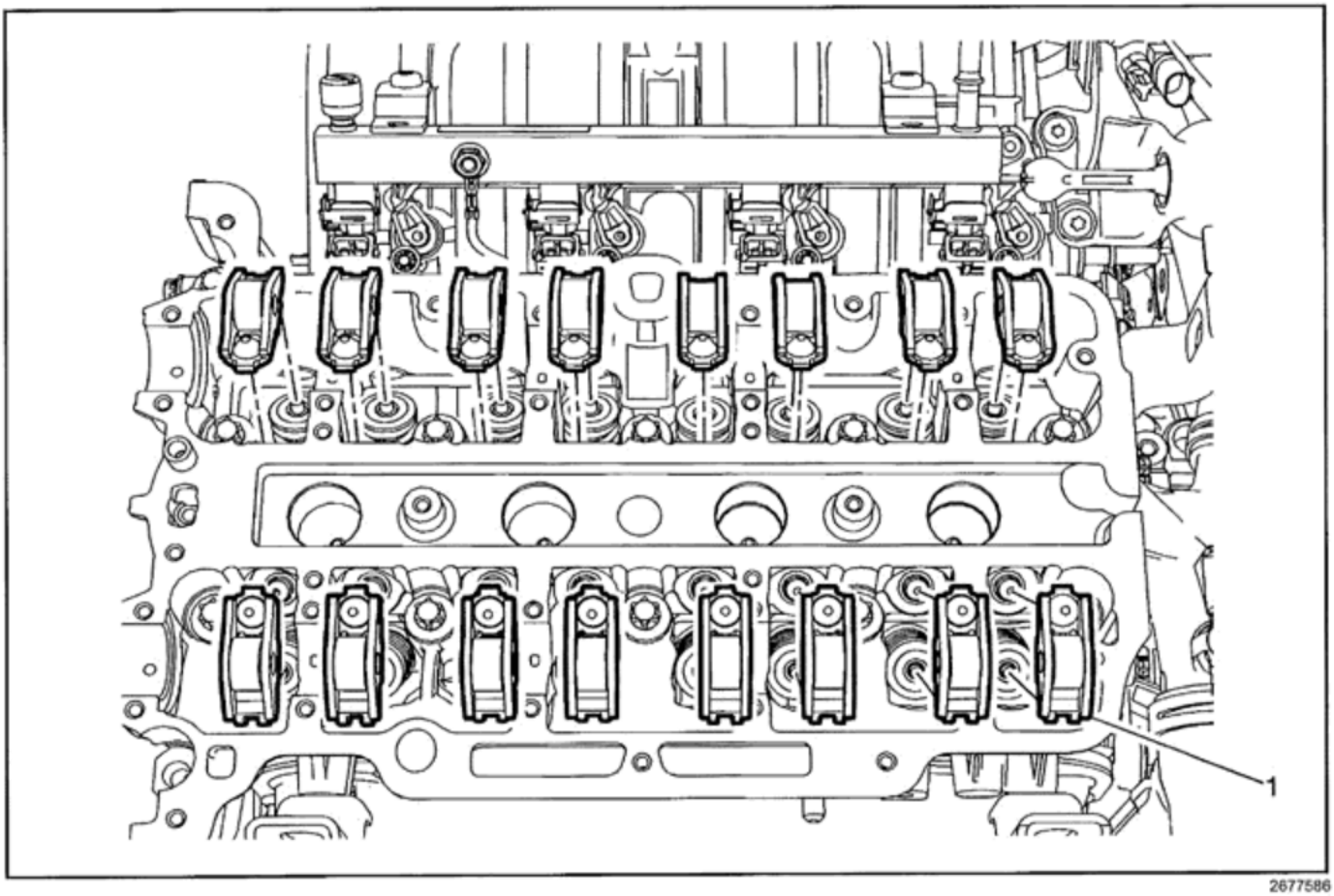


2677589

Timing Chain Tensioner Replacement

Callout	Component Name
Preliminary Procedure Remove the camshaft timing chain . Refer to *Camshaft Timing Chain Replacement on page 9-794*.	
1	Timing Chain Tensioner Fastener (Qty: 2) **Caution:** Refer to *Fastener Caution on page 0-8*. **Tighten** 8 N•m (71 lb in)
2	Timing Chain Tensioner

Hydraulic Valve Lash Adjuster Arm Replacement

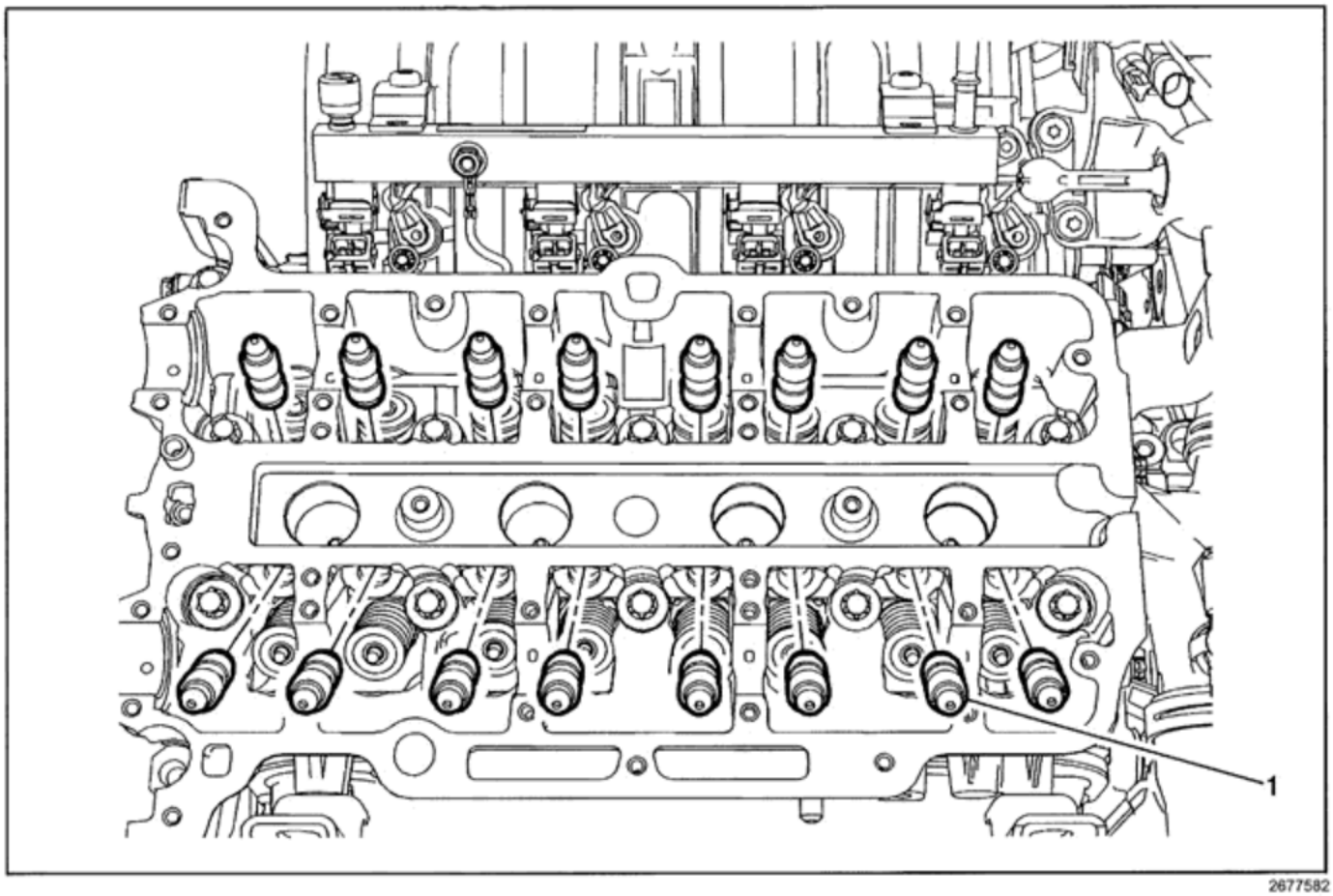


2677586

Hydraulic Valve Lash Adjuster Arm Replacement

Callout	Component Name
Preliminary Procedures 1. Remove the intake camshaft. Refer to *Intake Camshaft Replacement on page 9-851*. 2. Remove the exhaust camshaft. Refer to *Exhaust Camshaft Replacement on page 9-852*.	
1	Hydraulic Valve Lash Adjuster Arms **Procedure** 1. Mark the hydraulic valve lash adjuster arms upon removal to ensure installation is in the correct position. 2. Lubricate the hydraulic valve lash adjuster arms with engine oil before installing the arms.

Hydraulic Valve Lash Adjuster Replacement



2677582

Hydraulic Valve Lash Adjuster Replacement

Callout	Component Name
Preliminary Procedures Remove the hydraulic valve lash adjuster arms. Refer to *Hydraulic Valve Lash Adjuster Arm Replacement on page 9-798*.	
1	Hydraulic Valve Lash Adjuster **Procedure** 1. Mark the hydraulic valve lash adjuster upon removal to ensure installation is in the correct position. 2. Lubricate the hydraulic valve lash adjuster with engine oil before installation.

Camshaft Intake and Exhaust Sprocket Replacement

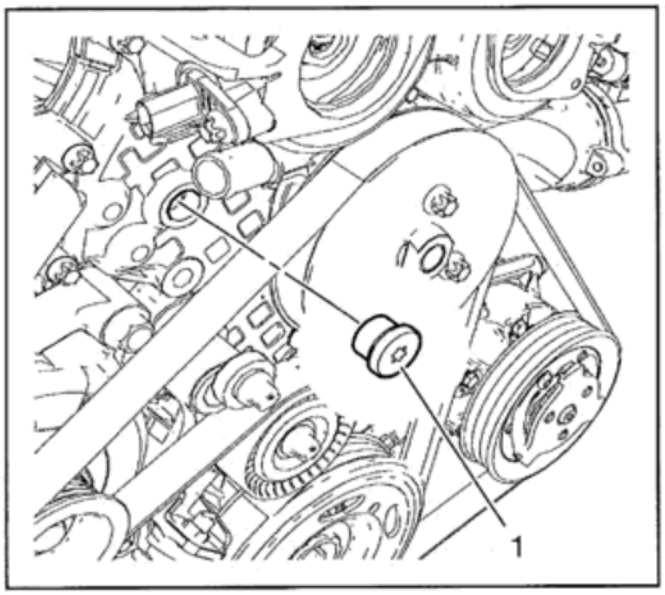
Special Tools

EN-955 Locking Pin

For equivalent regional tools, refer to *Special Tools on page 9-927*.

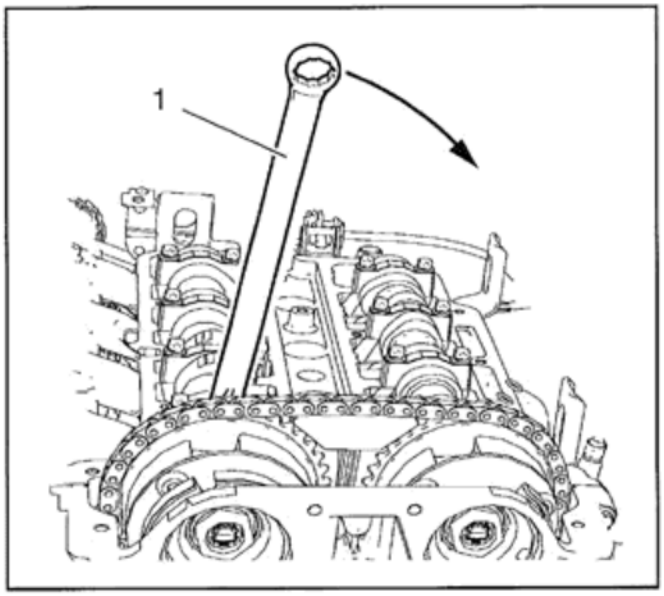
Removal Procedure

1. Remove the air cleaner assembly. Refer to *Air Cleaner Assembly Replacement on page 9-290*.
2. Remove the camshaft cover. Refer to *Camshaft Cover Replacement on page 9-850*.
3. Remove both camshaft position actuator solenoid valves. Refer to *Camshaft Position Actuator Solenoid Valve Replacement on page 9-282*.
4. Adjust the engine to TDC. Refer to *Camshaft Timing Chain Adjustment on page 9-857*.



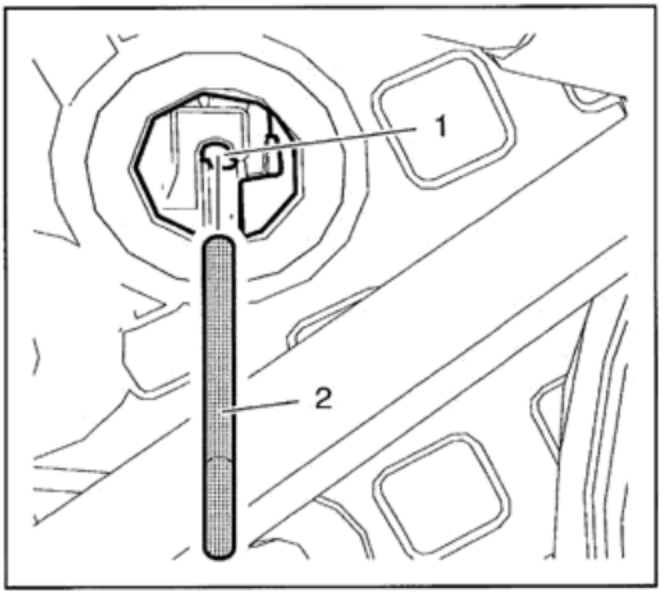
2191145

5. Remove the timing chain tensioner plug (1) from the engine front cover.



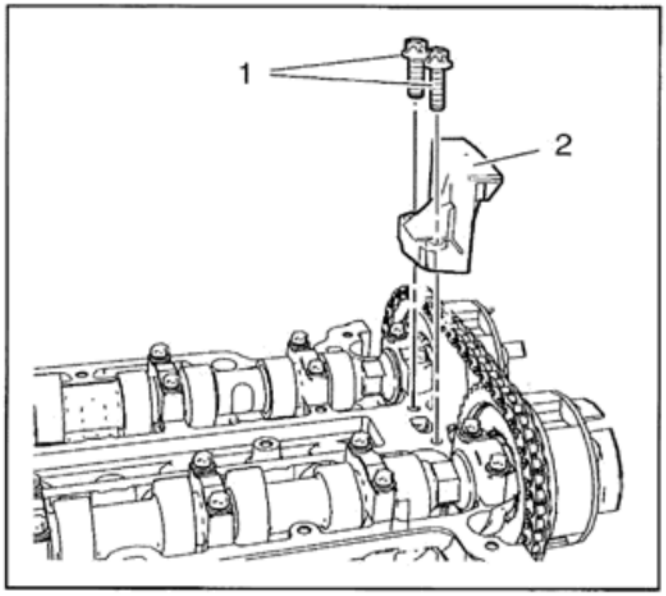
2191147

6. Install a wrench (1) on the cast hexagonal portion of the intake camshaft, rotate the camshaft toward the exhaust camshaft in order to apply tension.



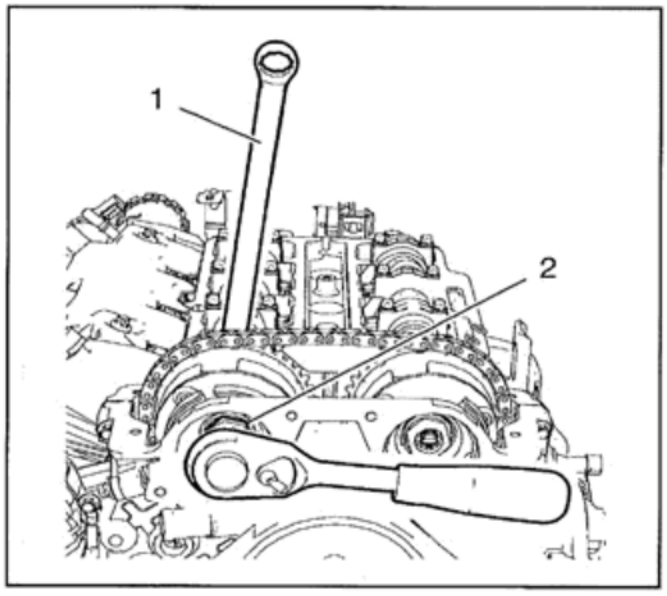
2191146

7. Install *EN-955* pin (2) to the timing chain tensioner bore (1) to secure it in place.
8. Remove the wrench from intake camshaft.



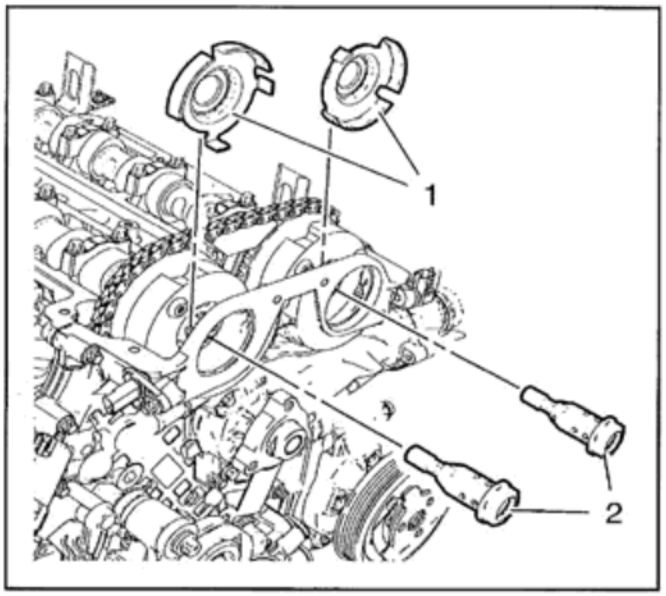
2190676

9. Remove the upper timing chain guide bolts (1).
10. Remove the upper timing chain guide (2).



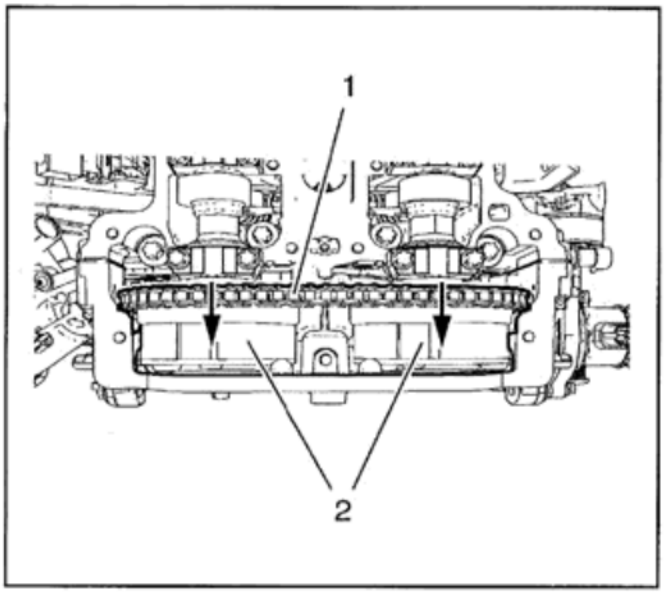
2191371

11. Loosen the intake camshaft sprocket bolt (2) while holding up the hexagon of the intake camshaft with a wrench (1).
12. Loosen the exhaust camshaft sprocket bolt while holding up the hexagon of the exhaust camshaft with a wrench.



2191382

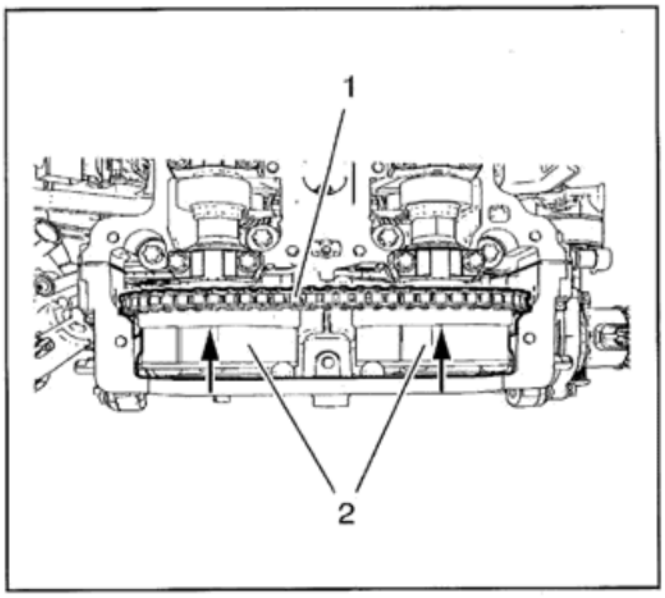
13. Remove and DISCARD the camshaft sprocket bolts (2) and the camshaft position exciter wheels (1).



2191378

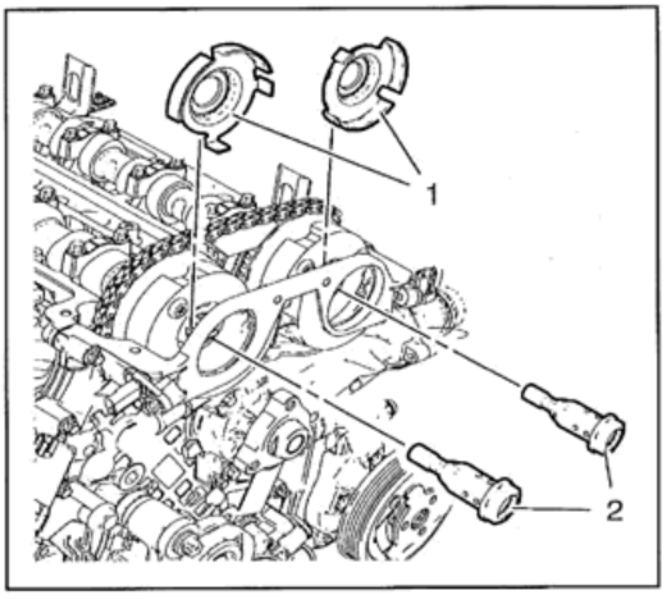
14. Remove the camshaft sprockets (2) and timing chain (1) as one unit.
15. Remove the intake and exhaust camshaft sprocket.
16. Allow the chain to rest on the front cover.

Installation Procedure



2191431

1. Install the camshaft sprockets (2) and timing chain (1) as one unit.



2191382

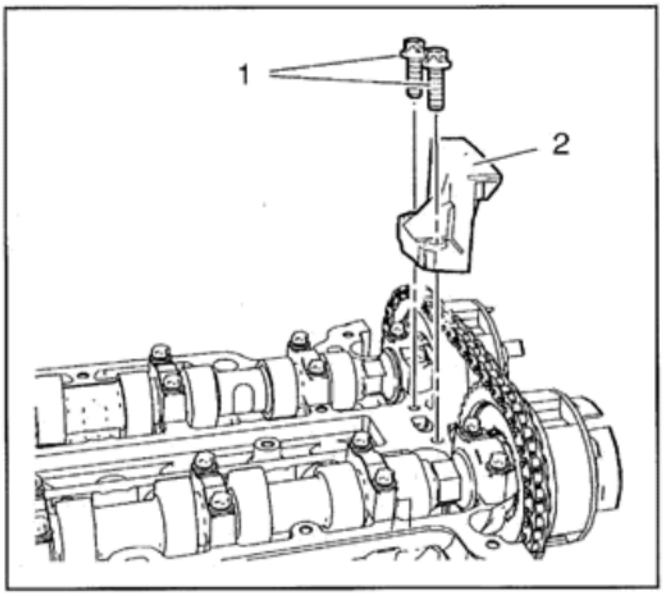
2. Install the camshaft position exciter wheels (1).

Caution: Refer to *Fastener Caution on page 0-8*.

3. Install the NEW camshaft sprocket bolts (2) and tighten to **50 N•m (37 lb ft) plus 60 degrees**.
4. Remove the *EN-955* pin to apply tension to the timing chain .

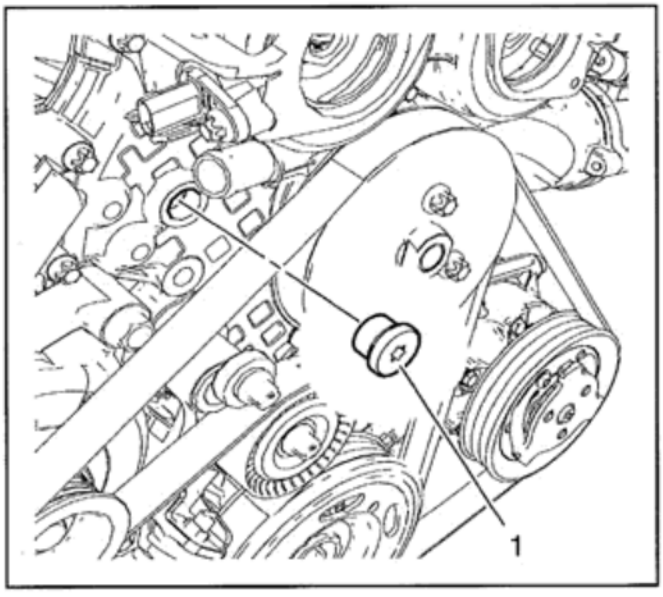
Note: Engine must be adjusted to TDC.

5. Adjust the camshaft timing chain. Refer to *Camshaft Timing Chain Adjustment on page 9-857*.



2190876

6. Install the upper timing chain guide (2).
7. Install the upper timing chain guide bolts (1) and tighten to **8 N•m (71 lb in)**.



2191145

8. Install the timing chain tensioner plug (1) and tighten to **50 N•m (37 lb ft)**.
9. Install both camshaft position actuator solenoid valves. Refer to *Camshaft Position Actuator Solenoid Valve Replacement on page 9-282*.
10. Install the camshaft cover. Refer to *Camshaft Cover Replacement on page 9-850*.
11. Install the air cleaner assembly. Refer to *Air Cleaner Assembly Replacement on page 9-290*.
12. Check and correct engine oil level.

Cylinder Head Replacement

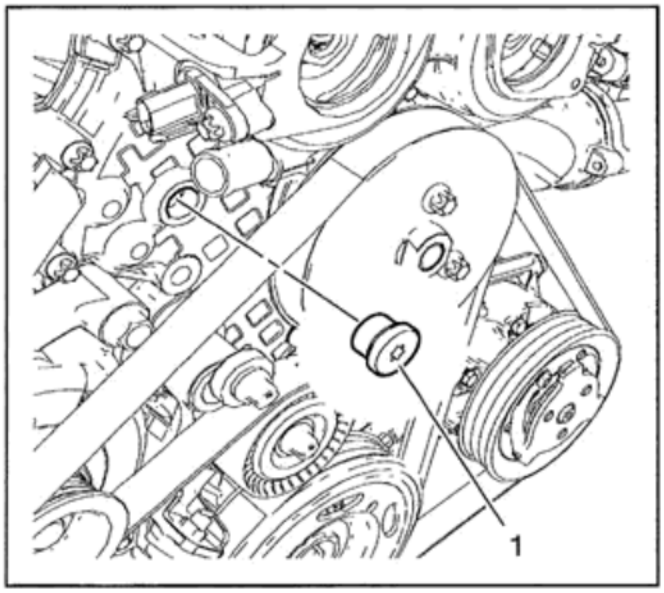
Special Tools

- *EN-470-B* Angular Torque Wrench
- *EN-955* Fixing Pin
- *EN-953–A* Fixing Tool

For equivalent regional tools, refer to *Special Tools on page 9-927*.

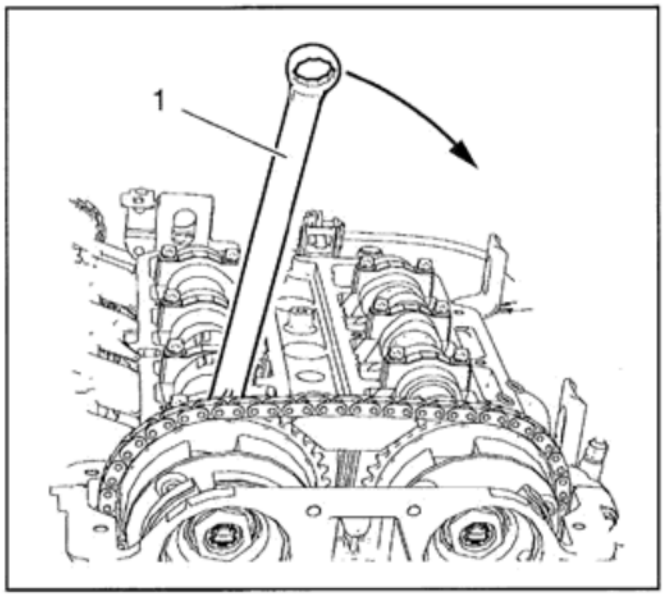
Removal Procedure

1. Disconnect battery negative cable. Refer to *Battery Negative Cable Disconnection and Connection on page 9-713*.
2. Remove the exhaust manifold and turbocharger as an assembly. Refer to *Turbocharger Replacement on page 9-843*.
3. Remove the intake manifold. Refer to *Intake Manifold Replacement on page 9-790*.
4. Remove the water outlet. Refer to *Water Outlet Replacement (LUV) on page 9-666*.
5. Remove the camshaft position actuator solenoid valve intake and exhaust. Refer to *Camshaft Position Actuator Solenoid Valve Replacement on page 9-282*.
6. Adjust the engine to TDC. Refer to *Camshaft Timing Chain Inspection on page 9-855*.



2191145

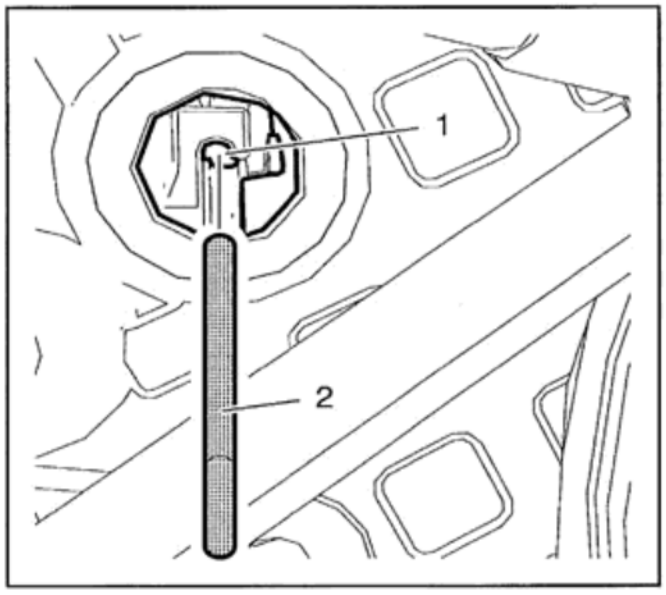
7. Remove the timing chain tensioner plug (1) from the engine front cover.



2191147

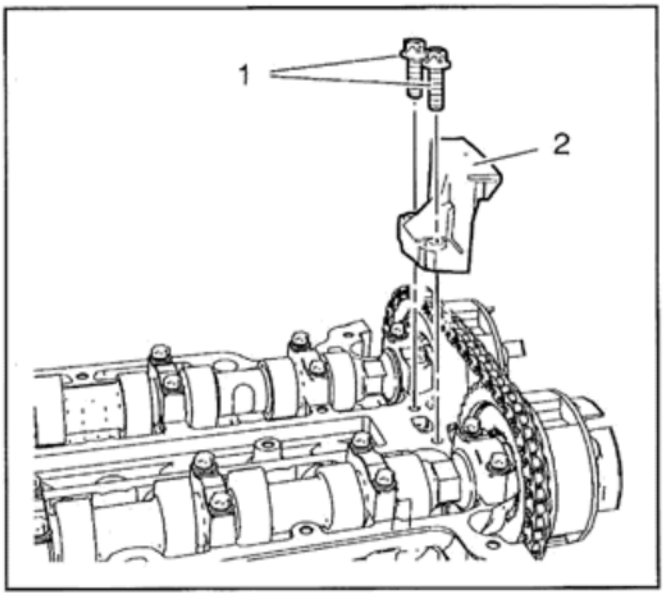
Note: Remove and reinstall the EN-953-A fixing tool for this step.

8. Install a wrench (1) on the cast hexagonal portion of the intake camshaft, rotate the camshaft toward the exhaust camshaft in order to apply tension.



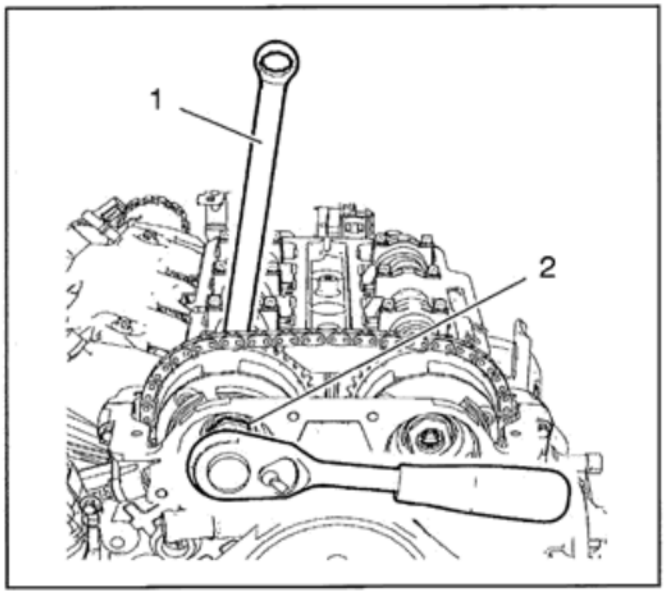
2191146

9. Install *EN-955–10* pin (2) to the timing chain tensioner bore (1) to secure it in place.
10. Remove the wrench from intake camshaft.



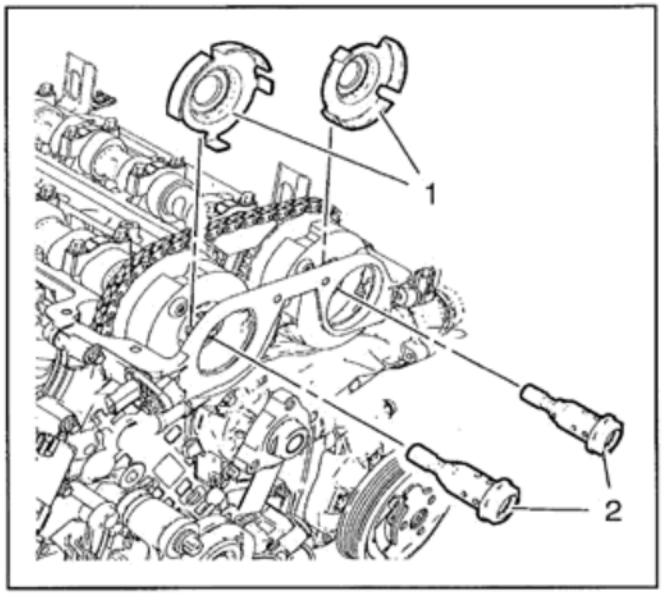
2190676

11. Remove the upper timing chain guide bolts (1).
12. Remove the upper timing chain guide (2).



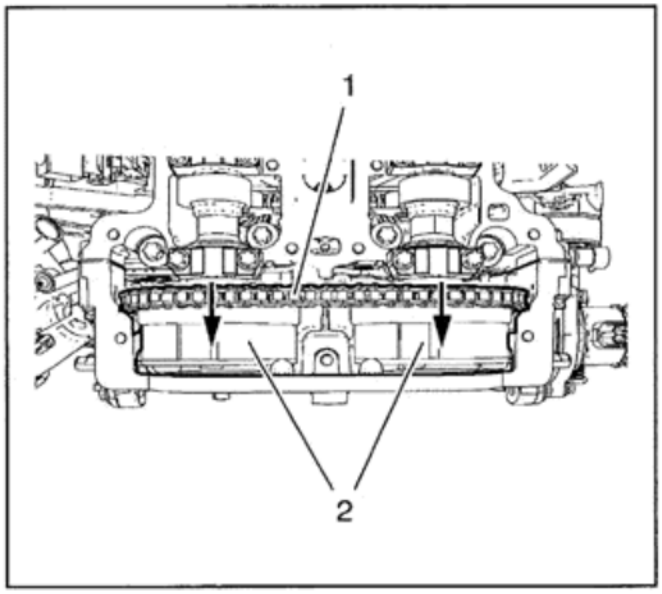
2191371

13. Loosen the intake camshaft sprocket bolt (2) while holding up the hexagon of the intake camshaft with a wrench (1).
14. Loosen the exhaust camshaft sprocket bolt while holding up the hexagon of the exhaust camshaft with a wrench.



2191382

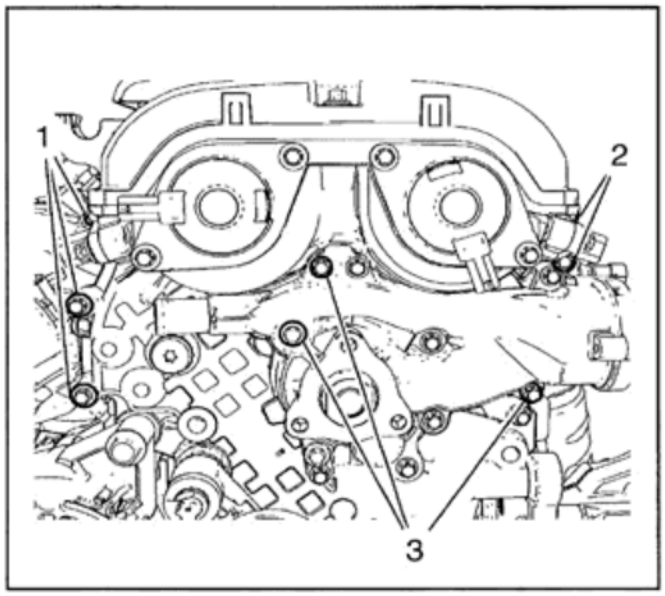
15. Remove and DISCARD the camshaft sprocket bolts (2) and the camshaft position exciter wheels (1).
16. Remove the both camshaft position sensors. Refer to *Camshaft Position Sensor Replacement on page 9-285*.



2191376

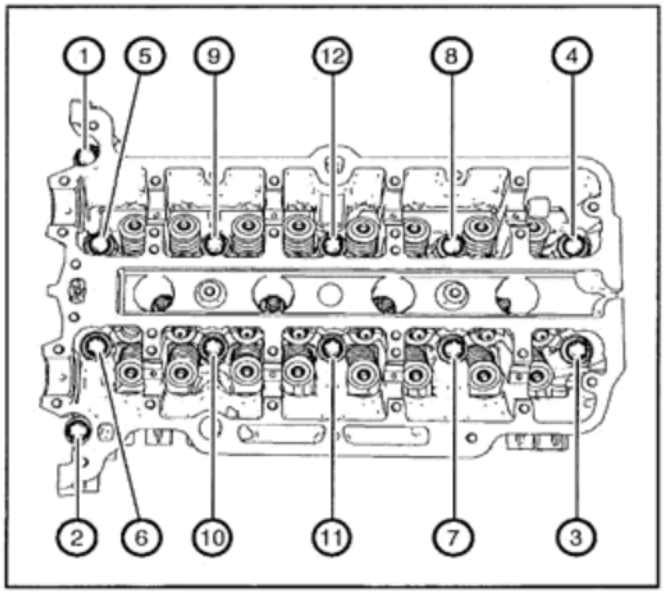
17. Remove the camshaft sprockets (2) and timing chain (1) as one unit.
18. Allow the camshaft sprockets (2) and timing chain (1) rest on the front cover. Do NOT remove sprockets or chain.
19. Install the engine support fixture. Refer to *Engine Support Fixture on page 9-854*.
20. Remove the engine mount bracket. Refer *Engine Mount Bracket Replacement - Right Side on page 9-789*.
21. Remove the drive belt. Refer to *Drive Belt Replacement on page 9-784*.

22. Remove the water pump pulley. Refer to *Water Pump Pulley Replacement (LUV) on page 9-670* or *Water Pump Pulley Replacement (LUW) on page 9-671*.



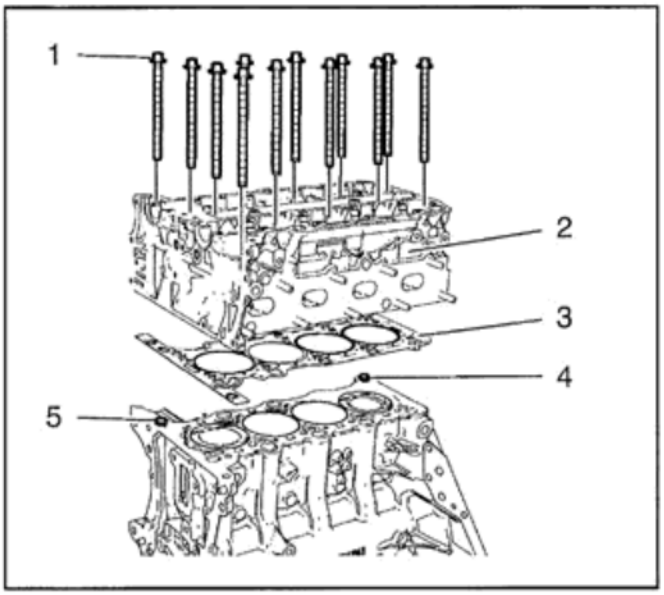
2191417

23. Remove 5 engine front cover bolts (1, 2).
24. Remove 3 water pump bolts (3).
25. Install engine mount bracket. Refer to *Engine Mount Bracket Replacement - Right Side on page 9-789*.
26. Install engine mount. Refer to *Engine Mount Replacement - Right Side on page 9-788*.
27. Remove engine support fixture. Refer *Engine Support Fixture on page 9-854*.



2190736

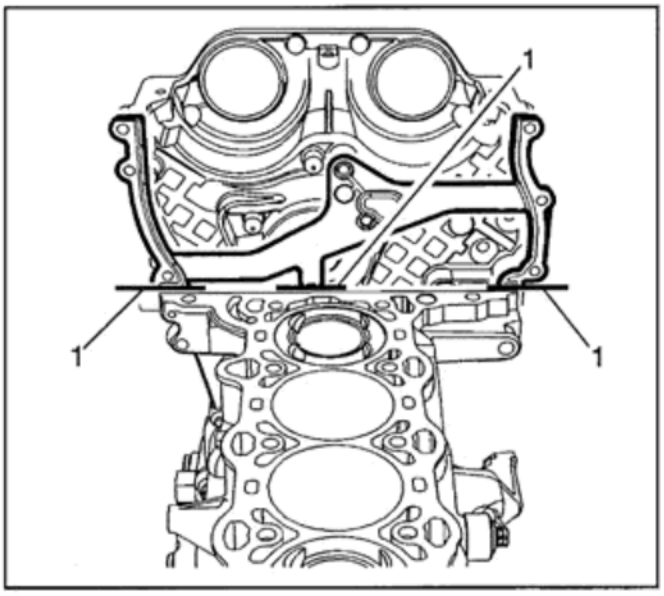
28. Loosen the 12 cylinder head bolts in the sequence as shown above. Use the following procedure:
    - First pass: Loosen the cylinder head bolts 90 degrees.
    - Final pass: Loosen the cylinder head bolts 180 degrees.



2190737

Note: Do not damage the guide sleeves (4, 5).

29. Remove and DISCARD the 12 cylinder head bolts (1).
30. With the aid of an assistant, lift the timing chain side of the cylinder head assembly slightly in direction of the transmission.
31. Remove the cylinder head (2).
32. Remove the cylinder head gasket (3) and discard the gasket.



2421387

33. With the cylinder head out of vehicle, bend the top third of the engine front cover gasket (1) back and forth until snaps off at the breaking point.

34. Remove the assembly parts from cylinder head:
    - Remove the EN-953-A fixing tool
    - Remove the intake camshaft. Refer to *Intake Camshaft Removal on page 9-872*.
    - Remove the exhaust camshaft. Refer to *Exhaust Camshaft Removal on page 9-872*.
    - Remove the hydraulic valve lash adjuster arms. Refer to *Hydraulic Valve Lash Adjuster Arm Removal on page 9-873*.
    - Remove the hydraulic valve lash adjusters. Refer to *Hydraulic Valve Lash Adjuster Removal on page 9-873*.
    - Remove the spark plug. Refer to *Spark Plug Replacement on page 9-281*.
    - Remove the engine oil pressure indicator switch.
    - Remove the timing chain tensioner. Refer to *Timing Chain Tensioner Removal on page 9-871*.
    - Remove the 3 engine lift brackets.
35. For disassembly of the cylinder head. Refer to *Cylinder Head Disassemble on page 9-876*.
36. Clean and inspect the cylinder head. Refer to *Cylinder Head Cleaning and Inspection on page 9-877*.
37. Transfer parts as necessary.

Installation Procedure

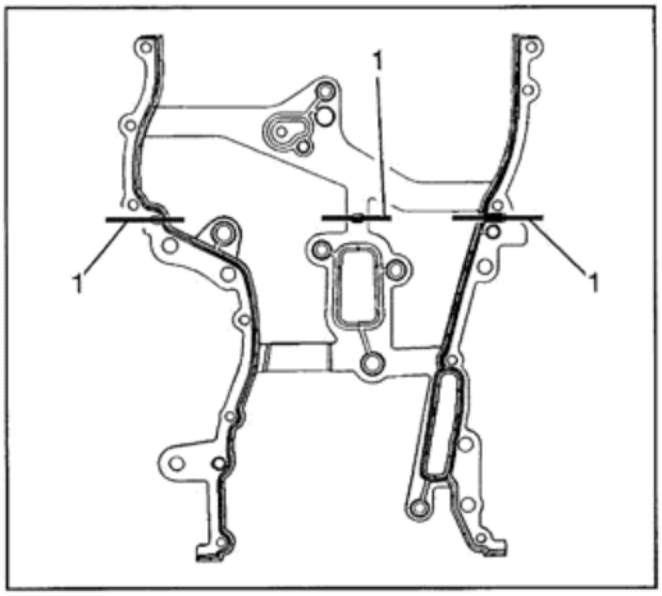
1. For assembly of the cylinder head. Refer to *Cylinder Head Assemble on page 9-880*.

Caution: Refer to *Fastener Caution on page 0-8*.

2. Install the cylinder head assembly parts:
    - Install the 3 engine lift bracket bolts and tighten to**22 N•m (16 lb ft)**.
    - Install the timing chain tensioner. Refer to *Timing Chain Tensioner Installation on page 9-904*.
    - Install the engine oil pressure indicator switch and tighten to **20 N•m (15 lb ft)**
    - Install the spark plug. Refer to *Spark Plug Replacement on page 9-281*.
    - Install the hydraulic valve lash adjusters. Refer to *Hydraulic Valve Lash Adjuster Installation on page 9-902*.
    - Install the hydraulic valve lash adjuster arms. Refer to *Hydraulic Valve Lash Adjuster Arm Installation on page 9-902*.
    - Install the exhaust camshaft. Refer to *Exhaust Camshaft Installation on page 9-903*.
    - Install the intake camshaft. Refer to *Intake Camshaft Installation on page 9-902*.
    - Install the *EN-953-A* fixing tool.

Note: Adjust the camshafts by means of the hexagon and a spanner.

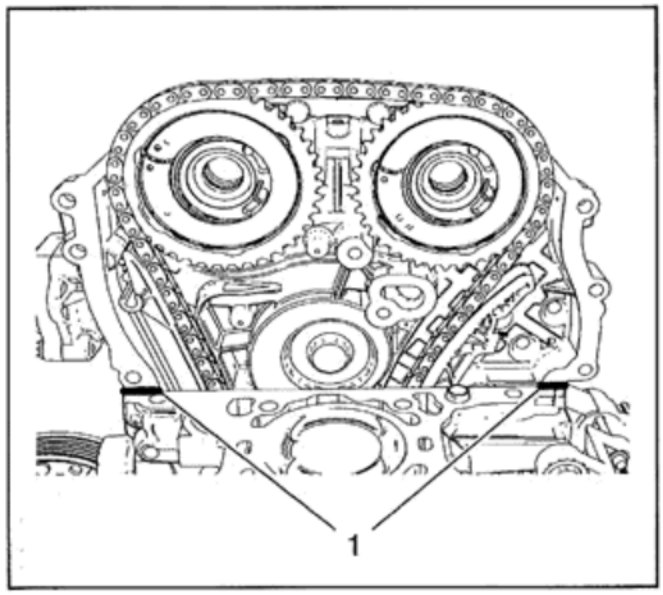
3. Clean sealing surfaces of engine front cover and engine block from grease and old gasket material.



2421388

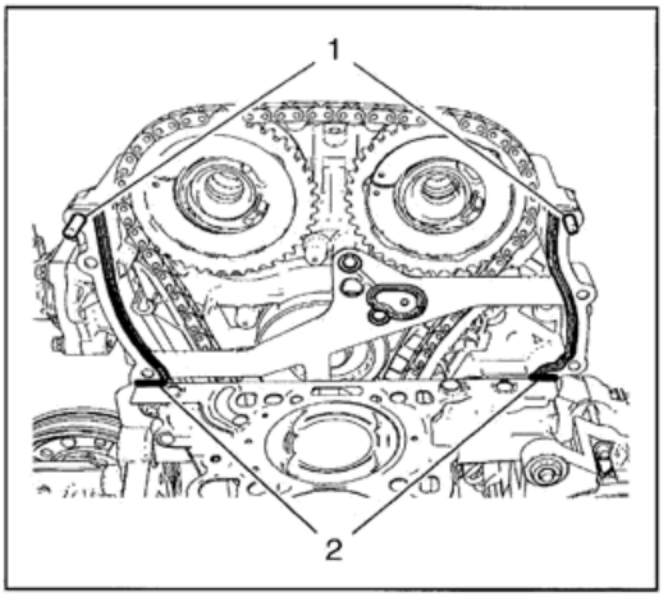
Note: The engine front cover gasket comes as a complete unit.

4. Before installation the of the new front cover gasket, bend the top third of the engine front cover gasket (1) back and forth until snaps off at the breaking point.



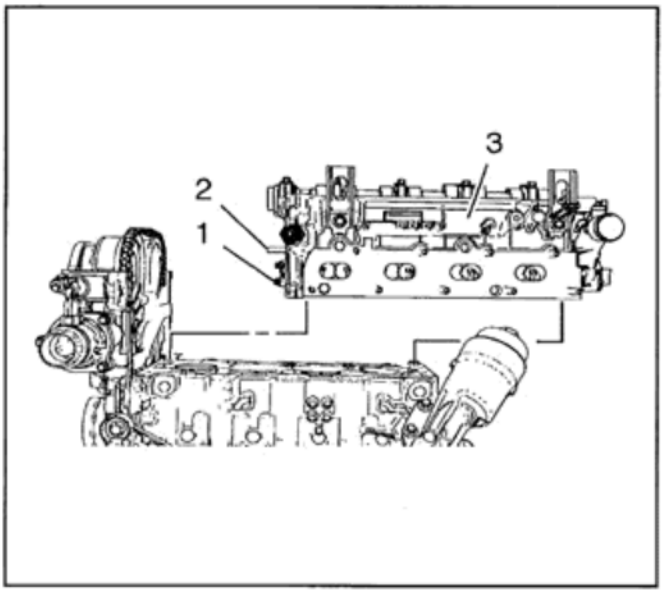
2191385

5. Apply a 2 mm (0.0787 in) bead of RTV sealant to the areas shown (1).
6. Install a NEW cylinder head gasket. The marking "Top" should point to the cylinder head.



2191409

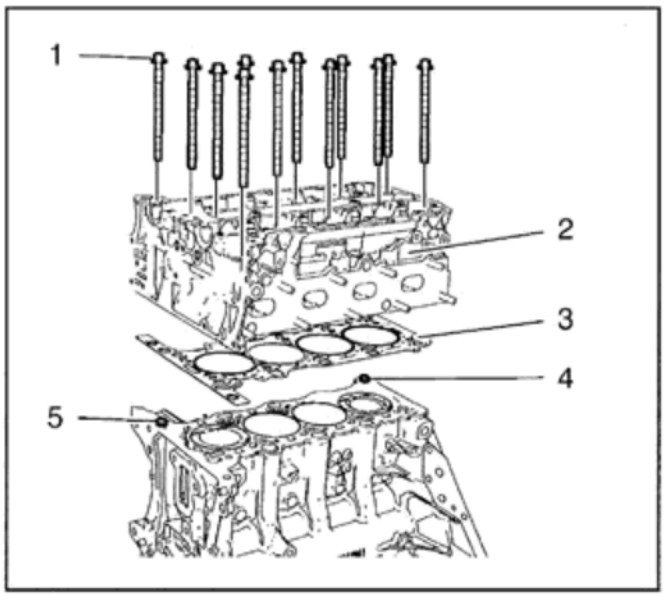
7. Install engine front cover bolts (1) in order to guide the NEW upper engine front cover gasket.
8. Apply a 2 mm (0.0787 in) bead of RTV sealant to the areas shown (2).



2191411

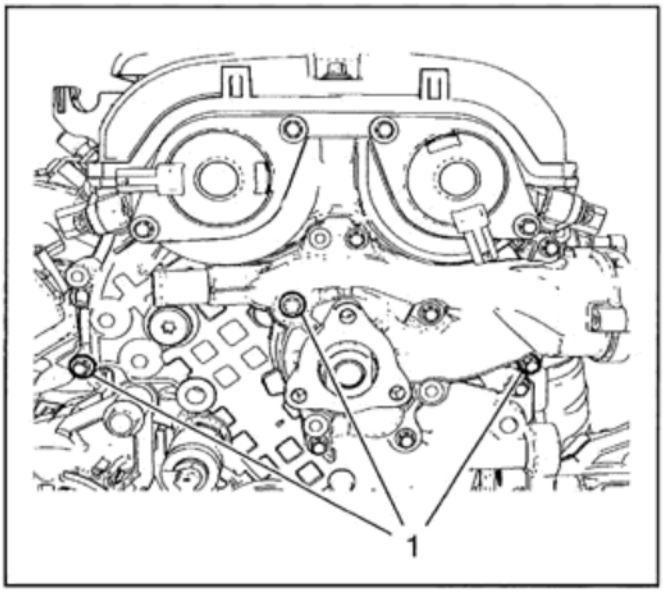
Note: A second mechanic is required.

9. Guide the timing chain guide pin (2) to the timing chain guide and the timing chain tensioner (1) with the installed fixing pin through the timing chain tensioner plug bore in engine front cover.



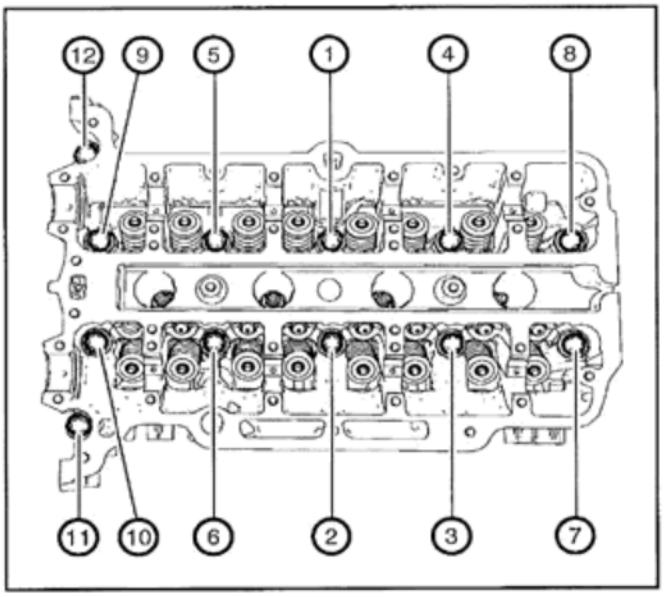
2190737

10. Install the cylinder head (2).
11. Loosely install 12 NEW cylinder head bolts (1).



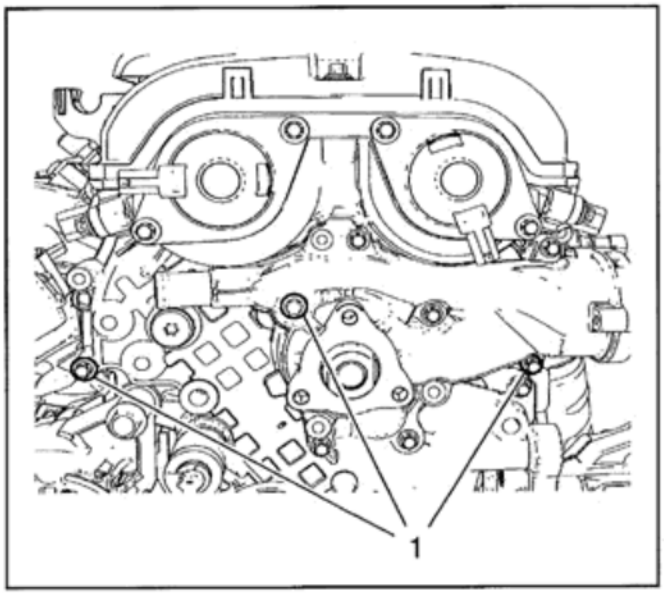
2191422

12. Adjust the cylinder head to the engine front cover. Use a rubber mallet.
13. Position the engine front cover to cylinder head by installing 3 bolts (1).
14. Tighten the 3 bolts (1) to **8 N•m (71 lb in)**.



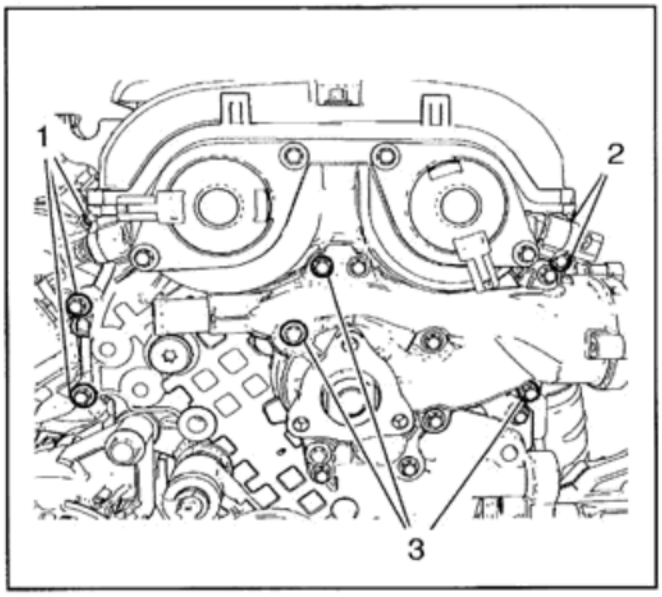
2190738

15. Tighten the cylinder head bolts in the sequence as shown and in the following order.
    - Tighten the cylinder head bolts to **35** N•m **(26 lb ft)**.
    - Tighten the cylinder head bolts an additional 180°. Use *EN-470-B* wrench.



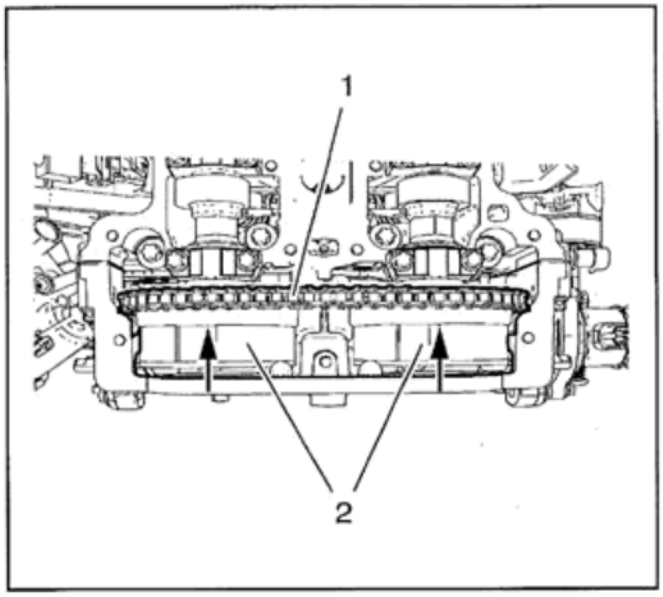
2191422

16. Loosen the bolts from engine front cover (1).



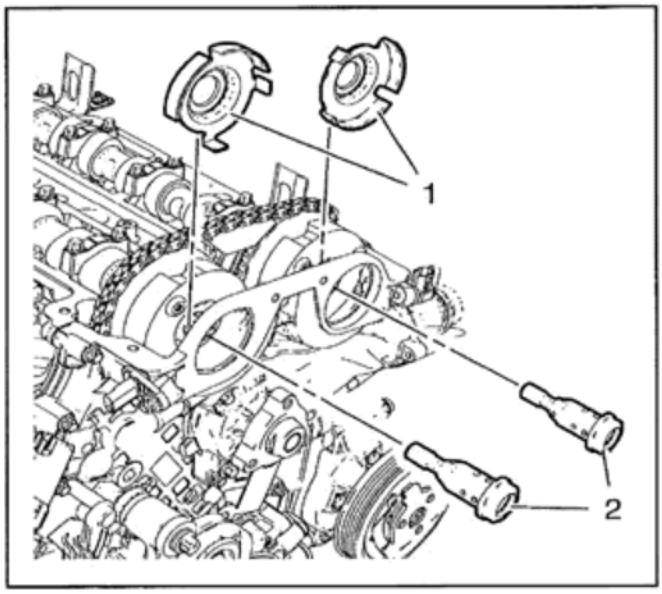
2191417

17. Install the remaining bolts to engine front cover and water pump.
18. Tighten the engine front cover bolts (1, 2) to **8** N•m **(71 lb in)**.
19. Tighten the water pump bolts (3) to **8** N•m **(71 lb in)**.
20. Install the engine support fixture. Refer to *Engine Support Fixture on page 9-854*.
21. Remove the engine mount bracket. Refer to *Engine Mount Bracket Replacement - Right Side on page 9-789*.
22. Install the water pump pulley. Refer to *Water Pump Pulley Replacement (LUV) on page 9-670* or *Water Pump Pulley Replacement (LUW) on page 9-671*.
23. Install the drive belt. Refer to *Drive Belt Replacement on page 9-784*.
24. Install engine mount bracket. Refer to *Engine Mount Bracket Replacement - Right Side on page 9-789*.
25. Install the engine mount. Refer to *Engine Mount Replacement - Right Side on page 9-788*.
26. Remove the engine support fixture. Refer to *Engine Support Fixture on page 9-854*.



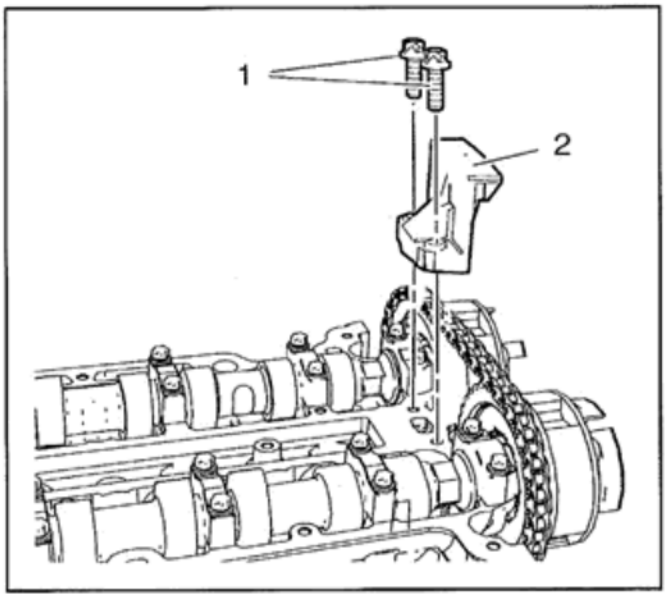
2191431

27. Install the camshaft sprockets (2) and timing chain (1) as one unit.



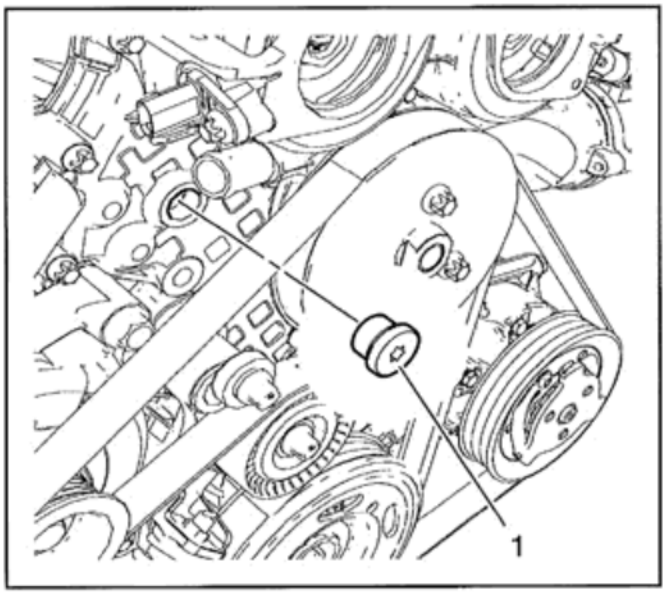
2191382

28. Install the camshaft position exciter wheels (1).
29. Install the NEW camshaft sprocket bolts (2) and tighten to **50** N•m **(37 lb ft) plus 60 degrees**.
30. Install the both camshaft position sensors. Refer to *Camshaft Position Sensor Replacement on page 9-285*.
31. Remove the *EN-955-10* pin to apply tension to the timing chain.
32. Adjust the camshaft timing chain. Refer to *Camshaft Timing Chain Inspection on page 9-855*.



2190676

33. Install the upper timing chain guide (2).
34. Install the upper timing chain guide bolts (1) and tighten to **8** N•m **(71 lb in)**.



2191145

Caution: Refer to *Component Fastener Tightening Caution on page 0-8*.

35. Install the timing chain tensioner plug and tighten to **50** N•m **(37 lb ft)**.
36. Install the camshaft position actuator solenoid valve intake and exhaust. Refer to *Camshaft Position Actuator Solenoid Valve Replacement on page 9-282*.
37. Install the exhaust manifold and turbocharger as an assembly. Refer to *Turbocharger Replacement on page 9-843*.
38. Install the Intake manifold. Refer to *Intake Manifold Replacement on page 9-790*.
39. Fill coolant fluid. Refer to *Cooling System Draining and Filling on page 9-628*.

40. Connect battery negative cable. Refer to *Battery Negative Cable Disconnection and Connection on page 9-713*.
41. Check and correct the engine oil.
42. Test the vehicle using the following procedure:
    42.1. Crank the engine several times. Listen for any unusual noises or evidence that parts are binding.
    42.2. Start the engine and listen for unusual noises.
    42.3. Check the vehicle oil pressure gauge or light and confirm that the engine has acceptable oil pressure.
    42.4. Run the engine speed at about 1,000 RPM until the engine has reached normal operating temperature.
    42.5. Listen for sticking lifter and other unusual noises.
    42.6. Inspect for fuel, oil and/or coolant leaks while the engine is running.
43. Inspect for coolant, oil, gas or exhaust leaks.

Oil Pan Replacement

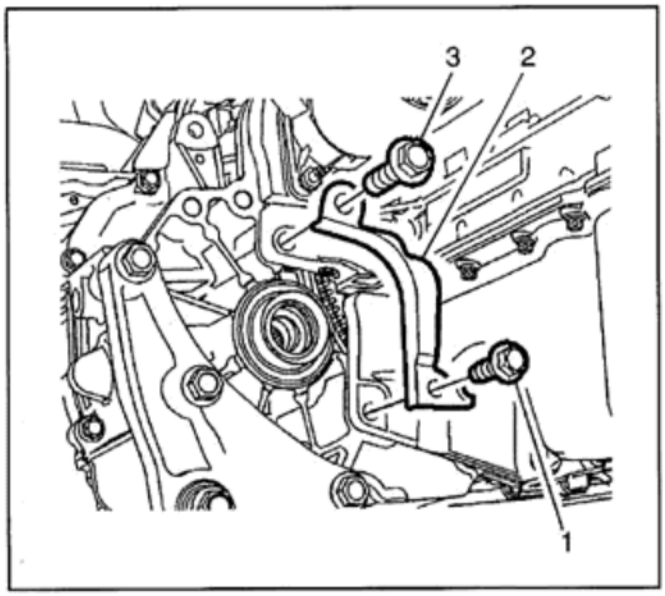
Special Tools

EN-49980 Guidance Pins

For equivalent regional tools, refer to *Special Tools on page 9-927*.

Removal Procedure

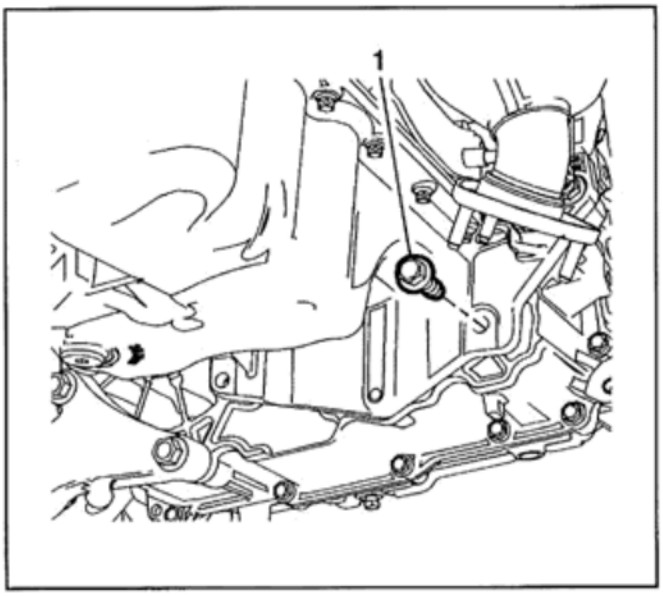
1. Remove the right front wheelhouse liner extension. Refer to *Front Wheelhouse Liner Inner Front Extension Replacement (Left Side) on page 3-147* or *Front Wheelhouse Liner Inner Front Extension Replacement (Right Side, LUV) on page 3-148* or *Front Wheelhouse Liner Inner Front Extension Replacement (Right Side, LWE, LUW) on page 3-149*.
2. Remove the oil filter and drain the engine oil. Refer to *Engine Oil and Oil Filter Replacement on page 9-840*.
3. Remove the front insulator cover. Refer to *Front Compartment Front Insulator Cover Replacement on page 3-157*.
4. Remove the front exhaust pipe. Refer to *Exhaust Front Pipe Replacement (LUV,LUW) on page 9-738*.



2610007

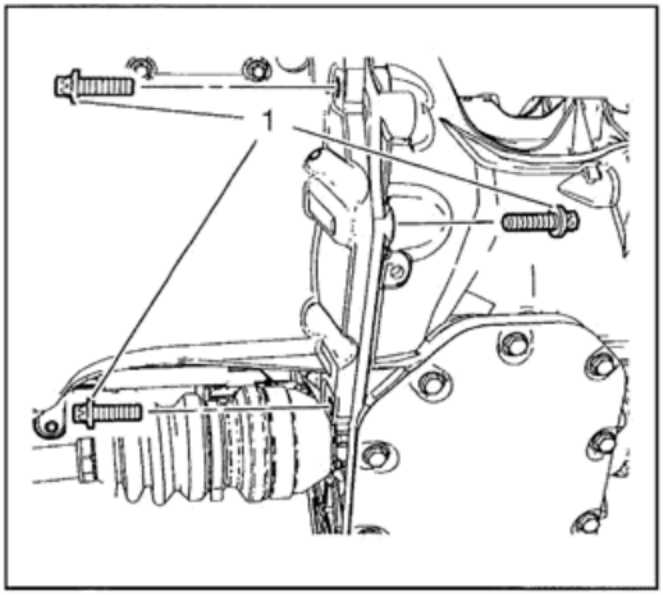
Note: The intermediate shaft is shown removed for visual purposes only.

5. If equipped with an automatic transmission, remove the oil pan to automatic transmission bolts (1, 3) and automatic transmission converter cover (2).



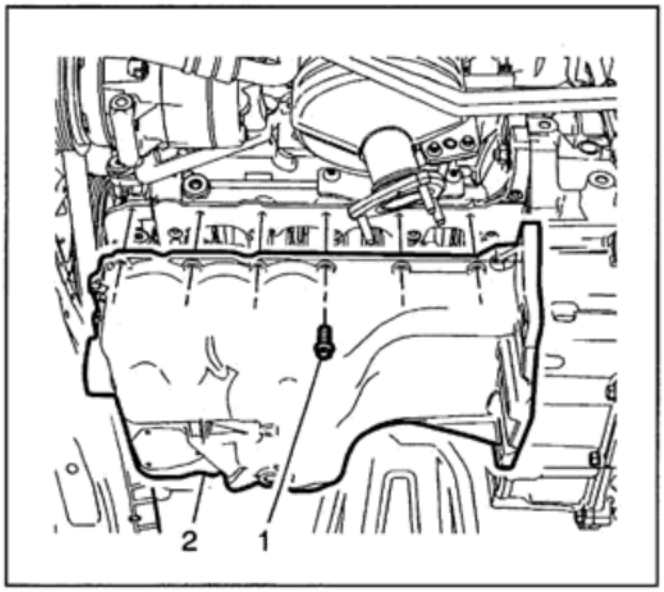
2511147

6. Remove the oil pan to automatic transmission bolts (1) .



2191495

7. If equipped with manual transmission, remove the 3 manual transmission to oil pan bolts (1).

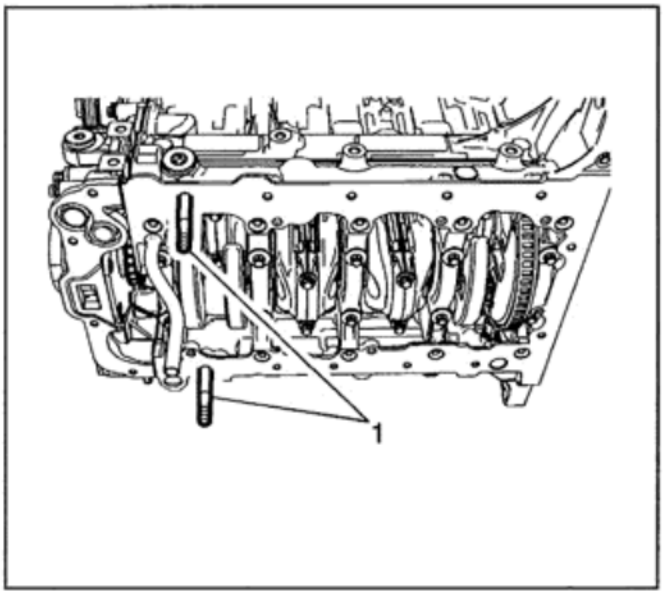


2511148

8. Remove the oil pan bolts (1) and oil pan.

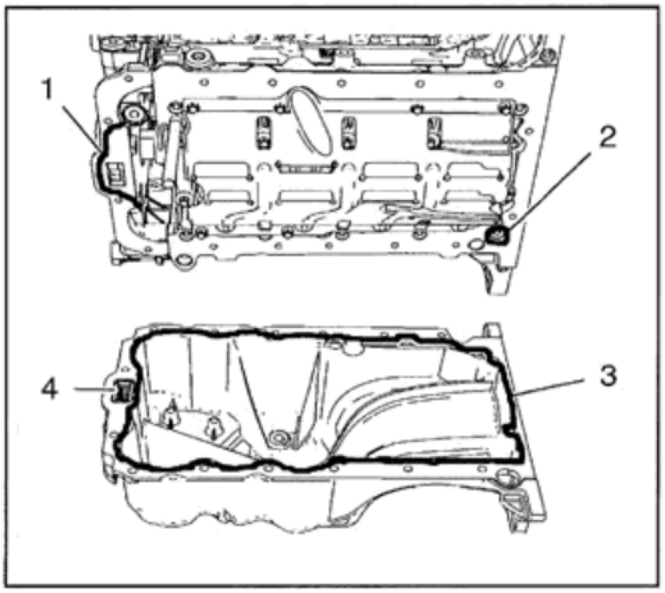
Installation Procedure

1. Clean the sealing surface of crankshaft bearing cap tie plate and the groove in the engine front cover from old gasket material, oil, dirt and grease.



2400331

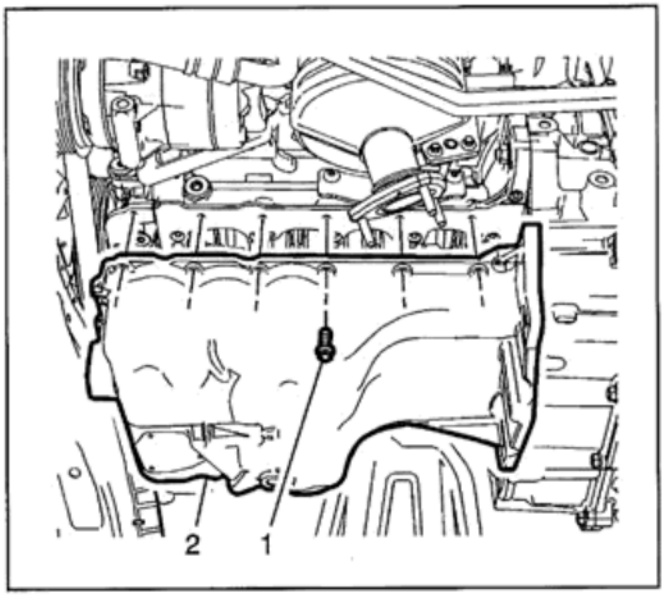
2. Install the 2 *EN-49980* guidance pins (1) to the shown oil pan screw bores.



2190369

Note: The sealing bead should be applied close to the inner edge of the oil pan. Take care that the oil suction gallery (4) will not get contaminated with sealing compound or dirt.

3. Apply **2 mm (0.0787 in)** thickness of sealing compound (3, 2, 1).

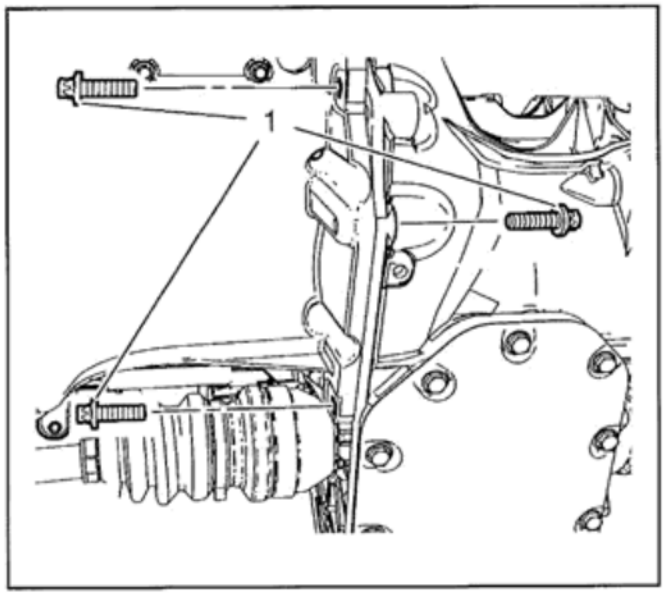


2511148

Caution: Refer to *Fastener Caution on page 0-8.*

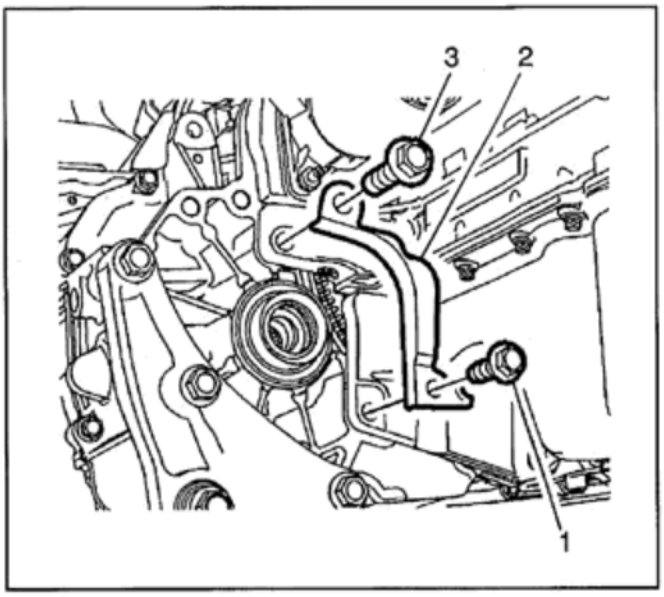
Note: The complete installation procedure of the oil pan should be done in 10 minutes.

4. Loosely install the oil pan bolts (1) in all but the guidance pin locations.
5. Remove the *EN-49980* guidance pins and install the remaining oil pan bolts.
6. Tighten the oil pan bolts to **10** N•m **(89 lb in)**.



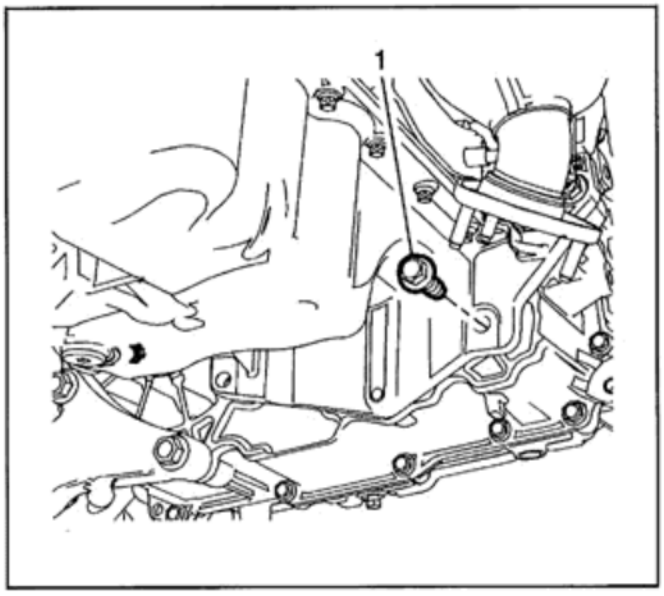
2191495

7. If equipped with manual transmission, install the 3 manual transmission to oil pan bolts (1) and tighten to **40** N•m **(30 lb ft)**.



2610007

8. If equipped with an automatic transmission, install and the automatic transmission converter cover (2) and tighten the cover to automatic transmission bolt (1) to **40** N•m **(30 lb ft)** and automatic transmission bolt (3) to **60** N•m **(44 lb ft)**.

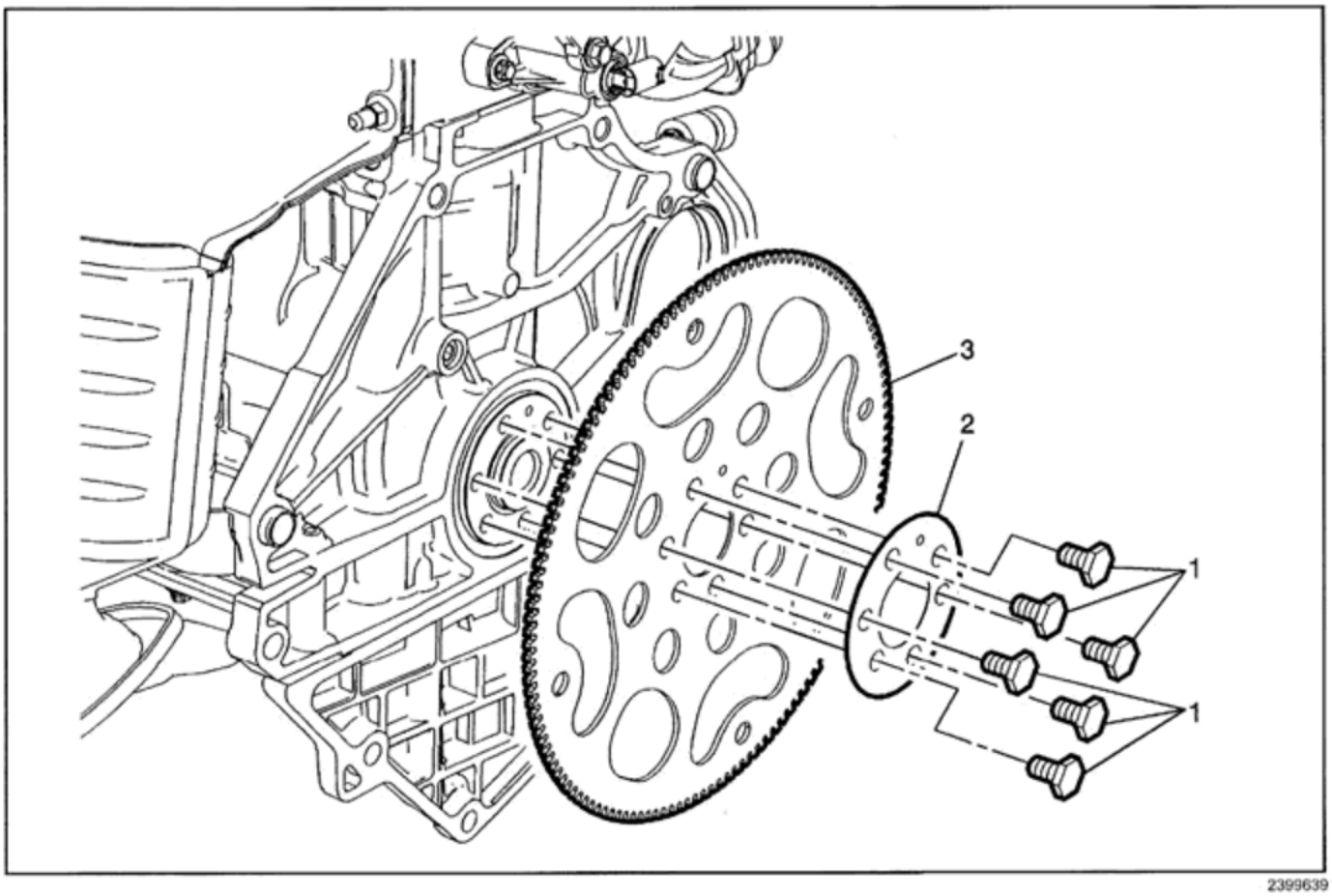


2511147

9. Install the oil pan to automatic transmission bolts (1), and tighten to **40** N•m **(30 lb ft)**.
10. Install a NEW oil filter and fill the engine with oil. Refer to *Engine Oil and Oil Filter Replacement on page 9-840.*
11. Install the exhaust pipe. Refer to *Exhaust Front Pipe Replacement (LUV,LUW) on page 9-738.*
12. Install the front insulator cover. Refer to *Front Compartment Front Insulator Cover Replacement on page 3-157.*

13. Install the right front wheelhouse liner extension. Refer to *Front Wheelhouse Liner Inner Front Extension Replacement (Left Side) on page 3-147* or *Front Wheelhouse Liner Inner Front Extension Replacement (Right Side, LUV) on page 3-149* or *Front Wheelhouse Liner Inner Front Extension Replacement (Right Side, LWE, LUW) on page 3-149*.

Automatic Transmission Flex Plate Replacement



2399639

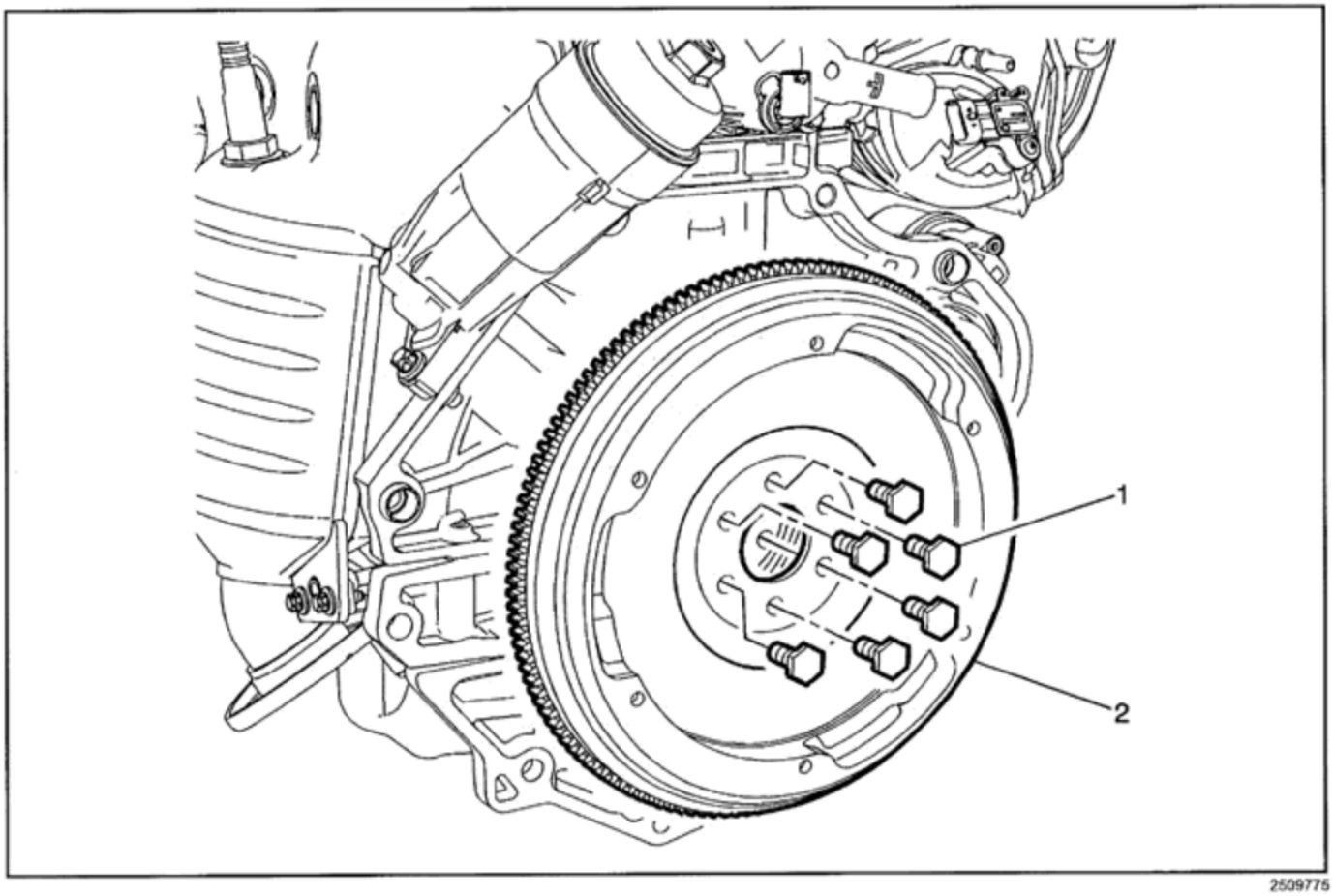
Automatic Transmission Flex Plate Replacement

Callout	Component Name
Preliminary Procedure Remove the transmission. Refer to *Transmission Replacement (With 1.6L or 1.8L Engine) on page 17-221* or *Transmission Replacement (With 1.2L or 1.4L Engine) on page 17-218*. **Special Tools** • *EN-470-B* Angular Torque Wrench • *EN-49979* Crankshaft Shock Mount Retainer For equivalent regional tools, refer to *Special Tools on page 9-927*.	
1	Automatic Transmission Flex Plate Fastener (Qty: 6) **Caution:** Refer to *Fastener Caution on page 0-8*. **Procedure** Ensure to use a NEW fastener whenever the automatic transmission flex plate is removed. **Tighten** • 35 N•m (26 lb ft) • Tighten the bolt an additional 30 degrees, and one more pass at 15 degrees using *EN-470-B* wrench.
2	Flex Plate
3	Automatic Transmission Flex Plate

Automatic Transmission Flex Plate Replacement (cont'd)

Callout	Component Name
	Procedure Inspect the automatic transmission flex plate for the following: 1. Stress cracks around the flex plate. 2. Cracks at welded areas that retain the ring gear onto the flex plate. 3. Damaged or missing ring gear teeth. 4. Do not attempt to repair the welded areas that retain the ring gear to the automatic transmission flex plate. Install a new flex plate.

Engine Flywheel Replacement



2509775

Engine Flywheel Replacement

Callout	Component Name
	Preliminary Procedures 1. Remove the transmission. Refer to *Transmission Replacement on page 17-586.* 2. Remove the clutch pressure and driven plate. Refer to *Clutch Pressure and Driven Plate Replacement (1.4L) on page 17-416* or *Clutch Pressure and Driven Plate Replacement (1.8L) on page 17-419.* **Special Tools** • *EN-652* Flywheel Holder. • *EN-470-B* Angular Torque Wrench. For equivalent regional tools, refer to *Special Tools on page 9-1145.*
1	Flywheel Fastener (Qty: 6) **Caution:** Refer to *Fastener Caution on page 0-8.* **Procedure** Ensure to use a NEW fastener whenever the flywheel is removed.

Engine Flywheel Replacement (cont'd)

Callout	Component Name
	Tighten • First pass tighten bolts to 35 N•m (26 lb ft) • Second pass 30 degrees. • Final pass 15 degrees.
2	Flywheel **Procedure** Inspect the engine flywheel for the following: 1. Stress cracks around the engine flywheel. 2. Cracks at welded areas that retain the ring gear onto the engine flywheel. 3. Damaged or missing ring gear teeth. 4. Do not attempt to repair the welded areas that retain the ring gear to the engine flywheel plate. Install a new engine flywheel.

Crankshaft Balancer Replacement

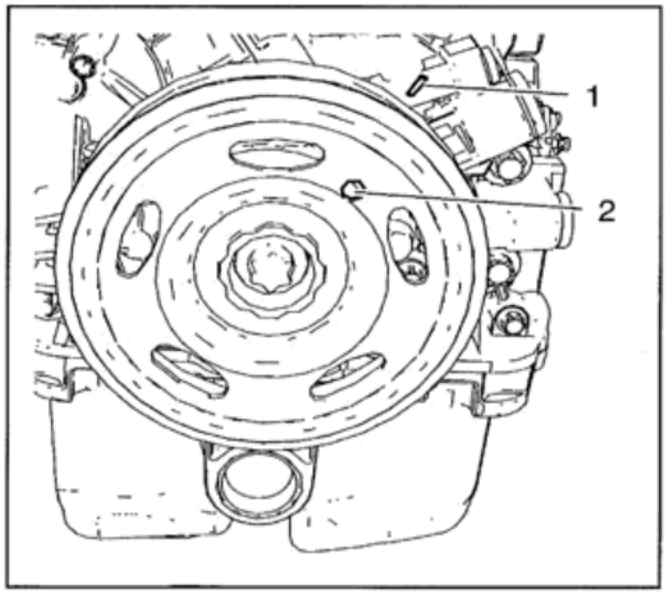
Special Tools

- *EN-470–B* Angular Torque Wrench
- *EN-49979* Crankshaft Shock Mount Retainer

For equivalent regional tools, refer to *Special Tools on page 9-927*.

Removal Procedure

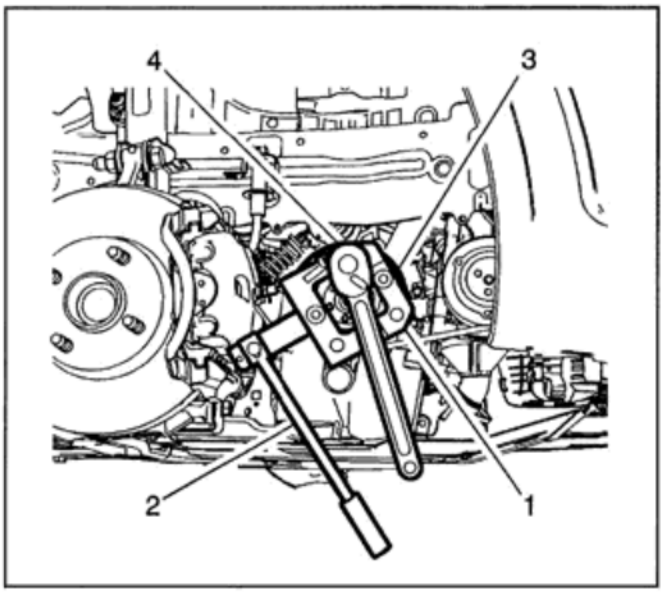
1. Raise and support the vehicle. Refer to *Lifting and Jacking the Vehicle on page 1-31*.
2. Remove front wheelhouse liner extension right side. Refer to *Front Wheelhouse Liner Inner Front Extension Replacement (Left Side) on page 3-147* or *Front Wheelhouse Liner Inner Front Extension Replacement (Right Side, LUV) on page 3-148* or *Front Wheelhouse Liner Inner Front Extension Replacement (Right Side, LWE, LUW) on page 3-149*.
3. Remove the drive belt. Refer to *Drive Belt Replacement on page 9-784*.
4. Place collecting basin underneath.



2190614

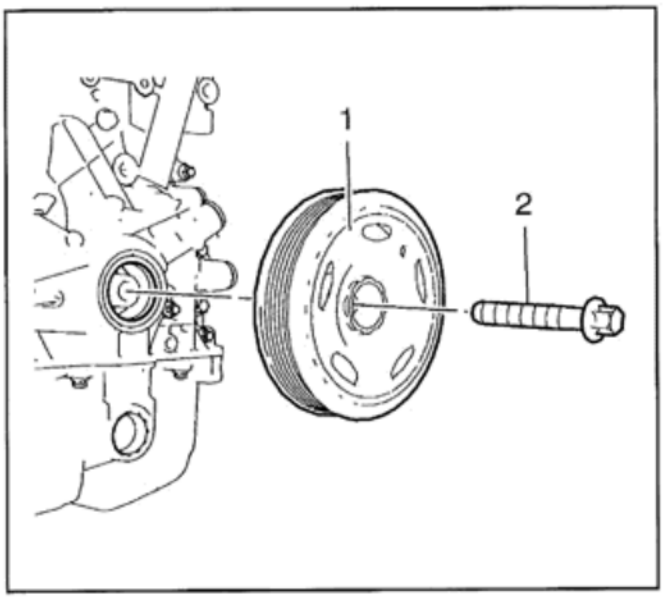
Note: The crankshaft balancer can be incorrectly installed 180° from the required position. Be sure to note the location of the alignment hole on the crankshaft balancer prior to removing the crankshaft balancer from the engine.

5. Rotate the engine clockwise until the bore (2) in the crankshaft balancer aligns with the mark (1) on the engine front cover.



2571647

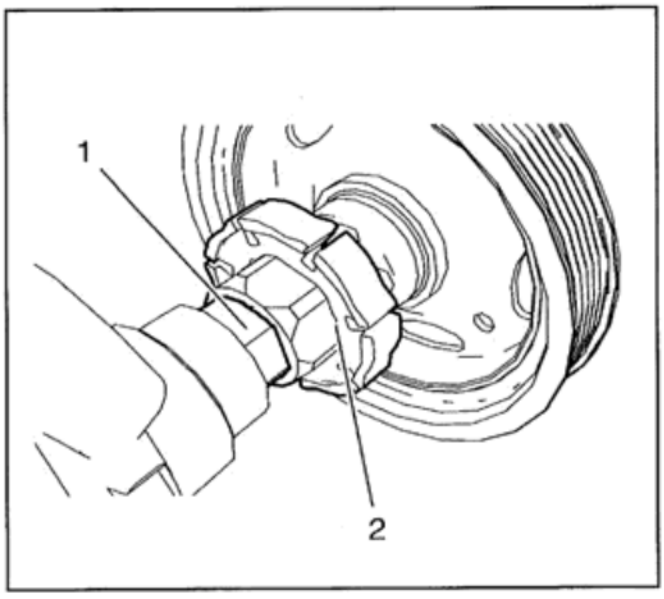
6. Install EN-49979 crankshaft shock mount retainer (1) to suitable tool (2).
7. Loosen the crankshaft balancer bolt (4) while holding the crankshaft balancer (3).



2190552

8. Remove and DISCARD the crankshaft balancer bolt (2).
9. Remove the crankshaft balancer (1).

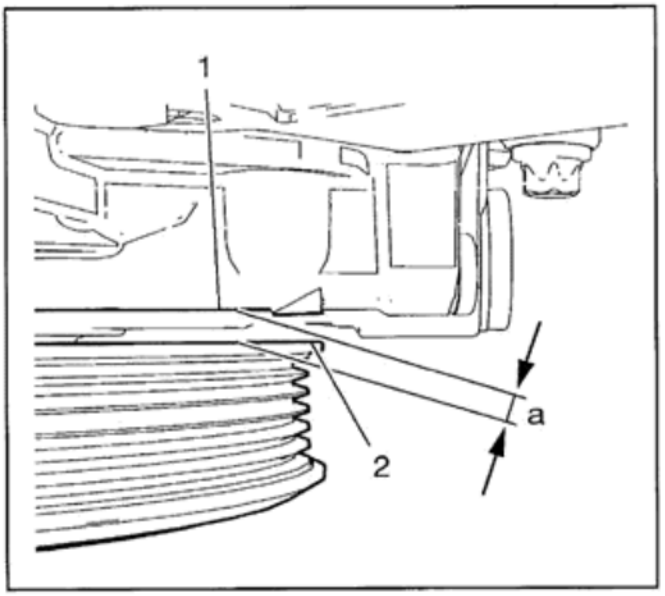
Installation Procedure



2190553

Note: The crankshaft balancer flange must fit to the hexagon of the oil pump rotor (2) and to the two-flats of the crankshaft (1). The TDC markings on crankshaft balancer and engine front cover must match.

1. Install the crankshaft balancer carefully by pressing into position.

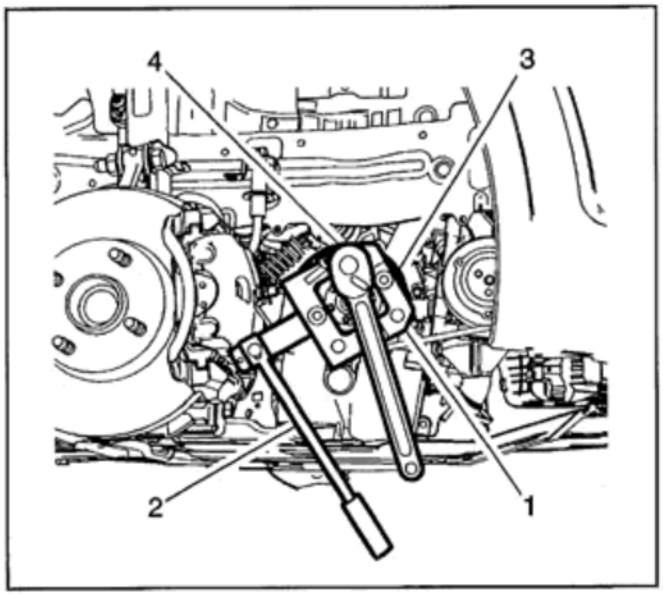


2190555

2. Measure the distance (a) between the crankshaft balancer (2) and the mark on the engine front cover (1). The distance (a) should be **5.5 mm (0.21654 in)**.

Note: Never re-use the crankshaft balancer bolt.

3. Install a NEW crankshaft balancer bolt.



2571647

Caution: Refer to *Fastener Caution on page 0-8*.

Caution: Refer to *Torque-to-Yield Fastener Caution on page 0-10*.

4. Tighten the crankshaft balancer bolt (4) to 150 N•m (111 lb ft) while holding the crankshaft balancer (3) with EN-49979 crankshaft shock mount retainer (1) and suitable tool (2). Use EN-470-B wrench .
5. Tighten the crankshaft balancer bolt to an additional **60°**.
6. Install the drive belt. Refer to *Drive Belt Replacement on page 9-784*.

7. Install the front wheelhouse liner extension right side. Refer to *Front Wheelhouse Liner Inner Front Extension Replacement (Left Side) on page 3-147* or *Front Wheelhouse Liner Inner Front Extension Replacement (Right Side, LUV) on page 3-148* or *Front Wheelhouse Liner Inner Front Extension Replacement (Right Side, LWE, LUW) on page 3-149*.
8. Lower the vehicle.
9. Check and correct engine oil level.

Crankshaft Front Oil Seal Replacement

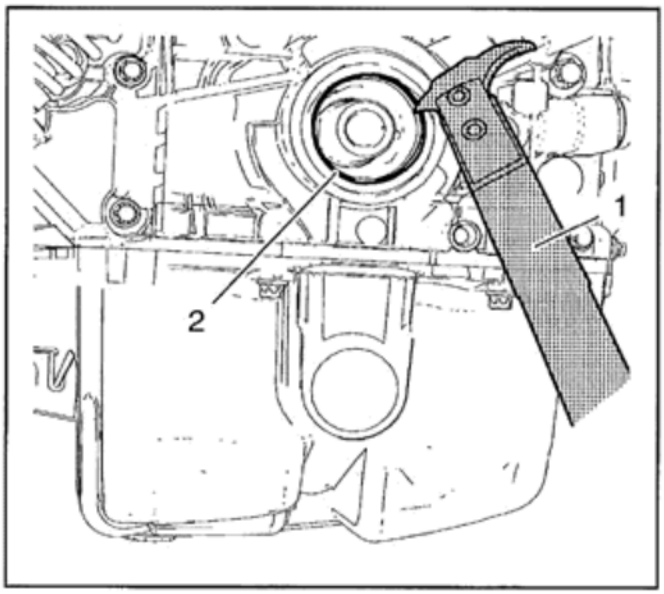
Special Tools

- *EN-960* Installer
- *EN-45000* Remover Oil seal

For equivalent regional tools, refer to *Special Tools on page 9-927*.

Removal Procedure

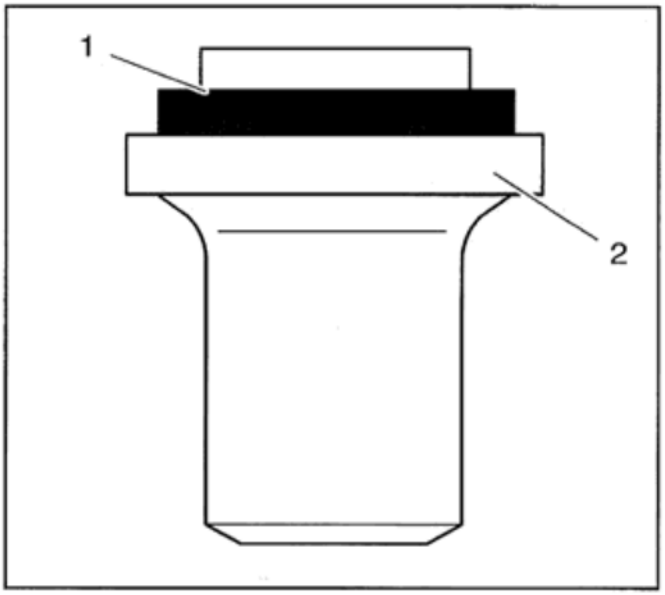
1. Remove the crankshaft balancer. Refer to *Crankshaft Balancer Replacement on page 9-815*.
2. Place a drain pan underneath the front crankshaft seal area.



2191464

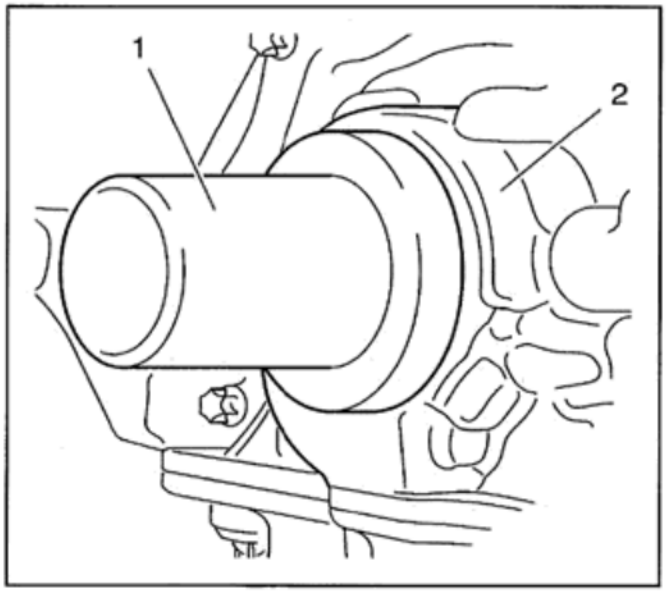
3. Remove crankshaft front oil seal (2) from engine front cover. Use *EN-45000* remover (1).

Installation Procedure



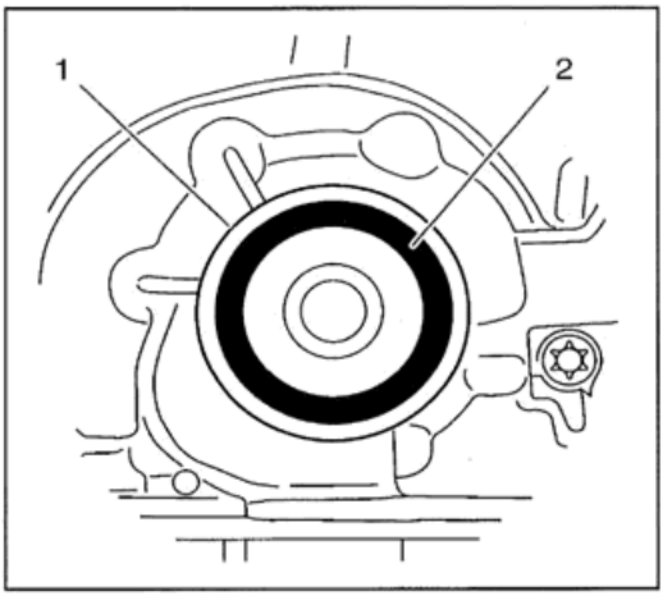
2191466

1. Install NEW crankshaft front oil seal (1) to *EN-960* installer (2).



2191465

2. Install crankshaft front oil seal by means of *EN-960* installer (1) to engine front cover (2).



2191467

3. Ensure that crankshaft front oil seal (2) is flush with engine front cover (1).
4. Install crankshaft balancer. Refer to *Crankshaft Balancer Replacement on page 9-815.*
5. Remove the drain pan.
6. Check and correct engine oil level.

Crankshaft Rear Oil Seal Replacement

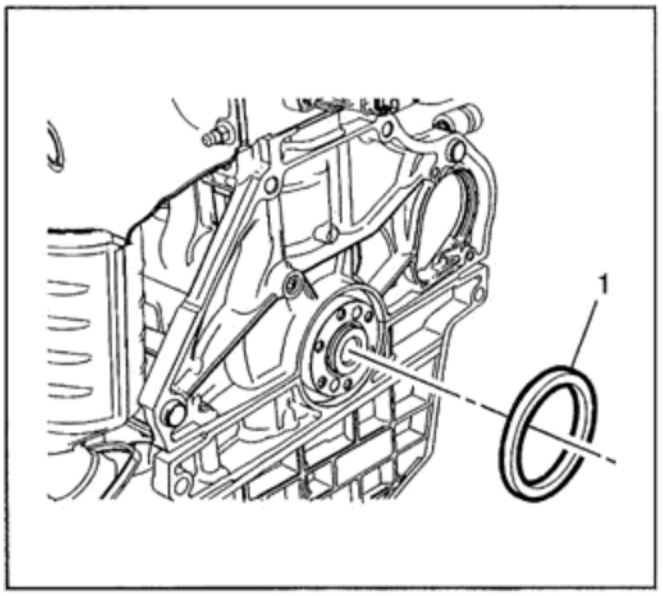
Special Tools

EN-658 Rear Main Seal Installer

For equivalent regional tools, refer to *Special Tools on page 9-927.*

Removal Procedure

1. If equipped with automatic transmission remove the flex plate. Refer to *Automatic Transmission Flex Plate Replacement on page 9-813.*
2. If equipped with manual transmission remove the engine flywheel. Refer to *Engine Flywheel Replacement on page 9-814*

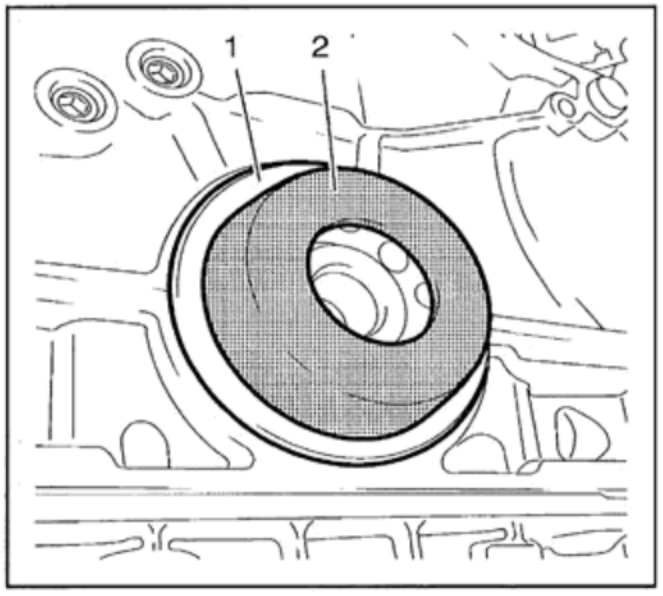


2399622

Note: Do not damage the outside diameter of the crankshaft or chamber with any tool.

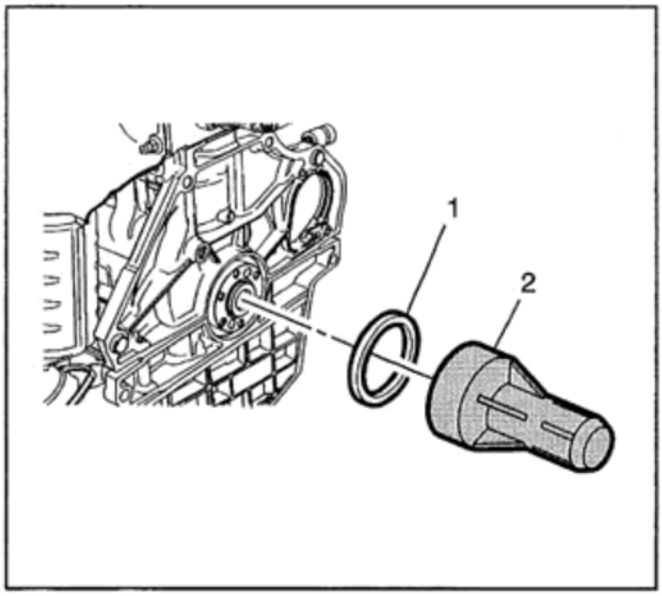
3. Using a flat-bladed tool, remove the rear crankshaft oil seal (1).

Installation Procedure



2190821

1. Install the crankshaft rear oil seal (1) with *EN-658* installer (2).



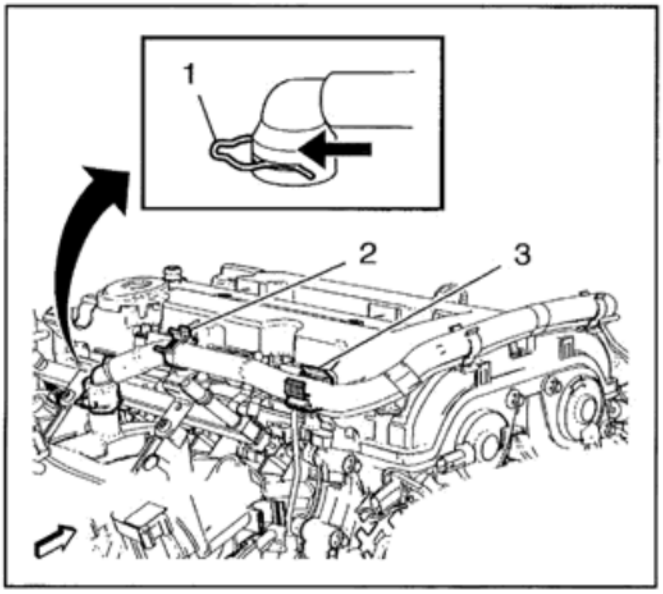
2399604

2. Using the *EN-658* installer (2) , install a NEW crankshaft real oil seal (1).
3. If equipped with automatic transmission install the flex plate. Refer to *Automatic Transmission Flex Plate Replacement on page 9-813*.
4. If equipped with manual transmission install the engine flywheel. Refer to *Engine Flywheel Replacement on page 9-814*

Positive Crankcase Ventilation Hose/ Pipe/Tube Replacement

Removal Procedure

1. Remove the air cleaner outlet duct. Refer to *Air Cleaner Outlet Duct Replacement on page 9-288*.

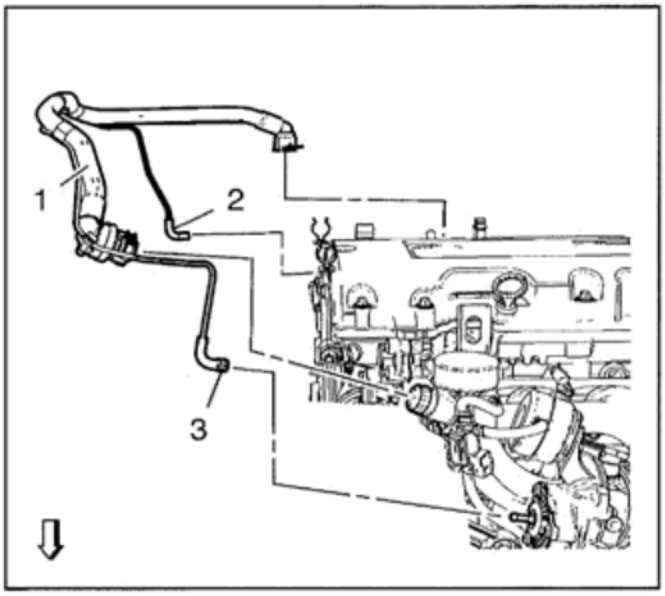


2191938

2. Open the 2 positive crankcase ventilation pipe retainer clips (2) and (3).

Note: Move retainer clamp (1) in direction of the arrow.

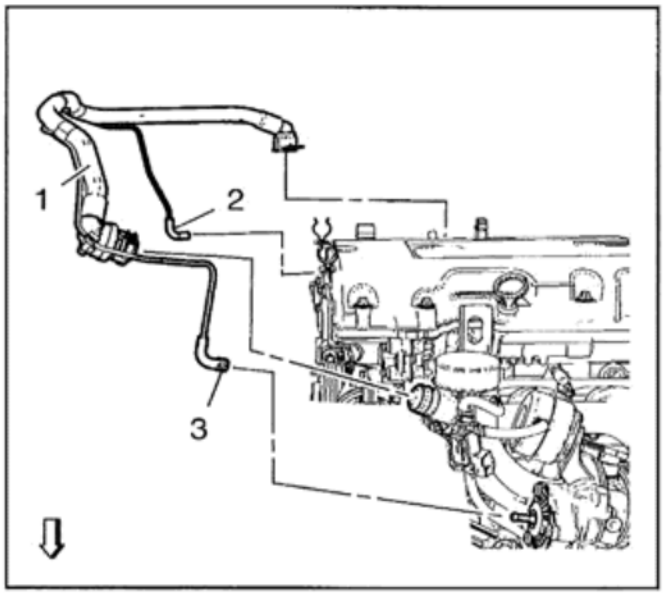
3. Remove the positive crankcase ventilation pipe from the intake manifold.



2191937

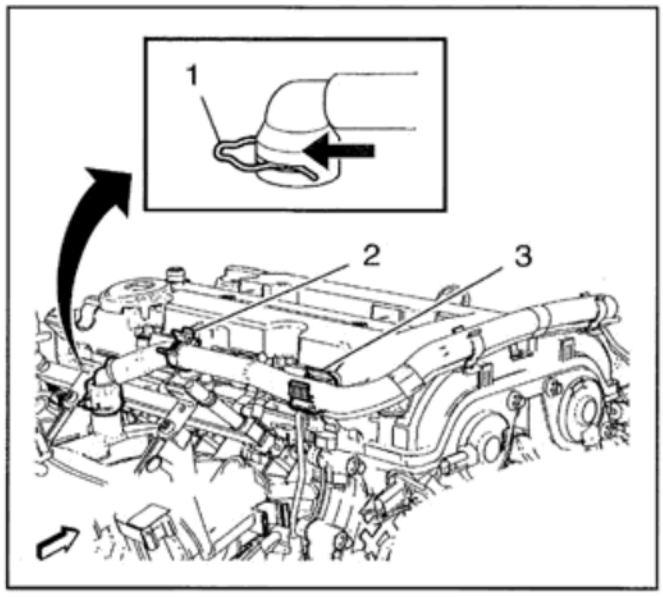
4. Loosen the charger air bypass valve pipe clamp (3).
5. Remove the charger air bypass valve pipe from turbocharger.
6. Remove the charger air bypass valve pipe (2) from turbo charger wastegate regulator solenoid valve.
7. Disconnect the positive crankcase ventilation pipe from turbocharger.
8. Unclip and remove the positive crankcase ventilation pipe assembly (1) from the camshaft cover retainer clips.

Installation Procedure



2191937

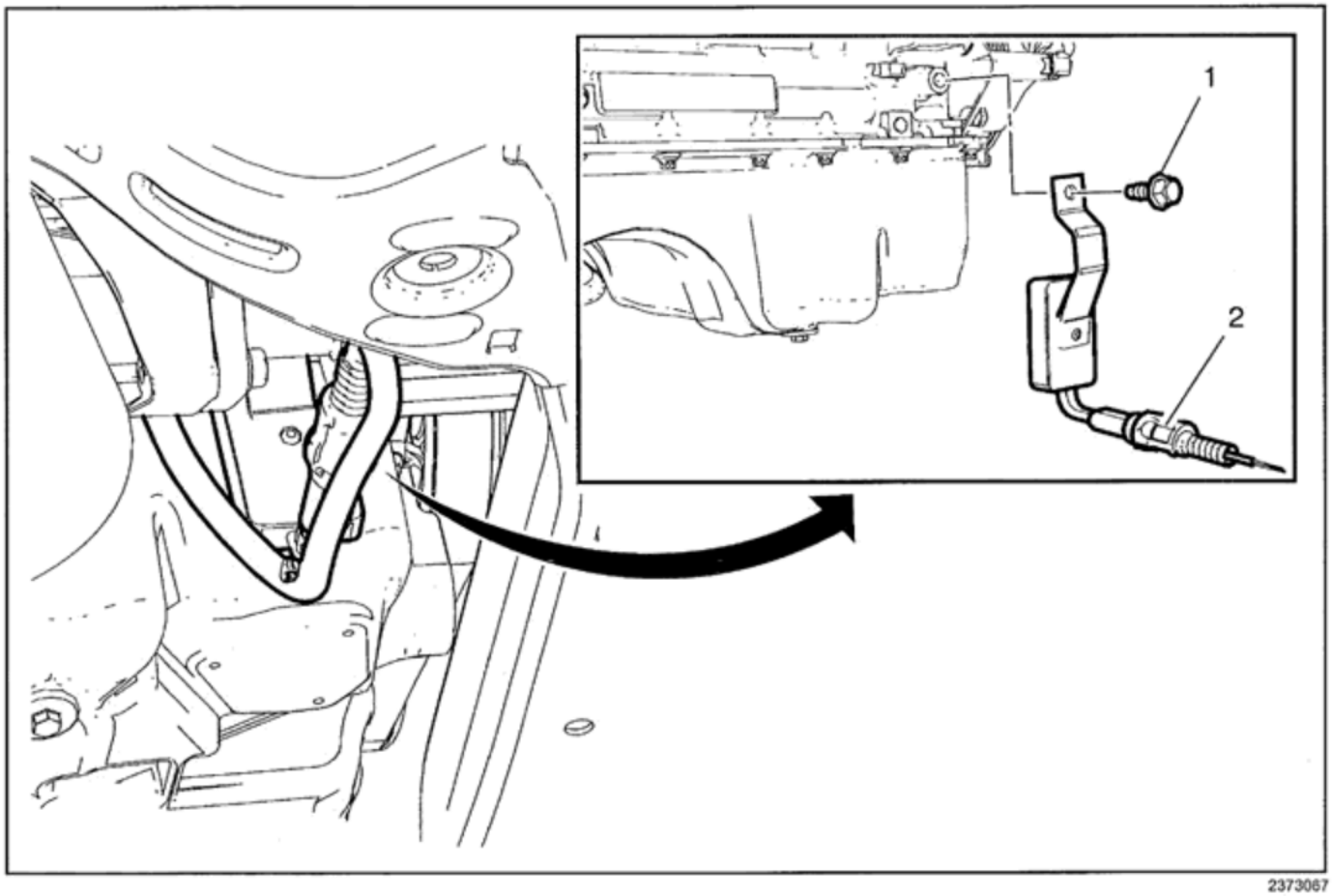
1. Install the positive crankcase ventilation pipe assembly (1) to the camshaft cover retainer clips.
2. Connect the positive crankcase ventilation pipe to turbocharger.
3. Install the charger air bypass valve pipe (2) to turbo charger wastegate regulator solenoid valve.
4. Install the charger air bypass valve pipe to turbocharger.
5. Fasten the charger air bypass valve pipe clamp (3).



2191938

6. Install the positive crankcase ventilation pipe to the intake manifold and fix with retainer clamp (1).
7. Clip in the positive crankcase ventilation pipe to the 2 retainer clips (2) and (3).
8. Install the air cleaner outlet duct. Refer to *Air Cleaner Outlet Duct Replacement on page 9-288*.

Engine Oil Heater Replacement



2373067

Engine Oil Heater Replacement

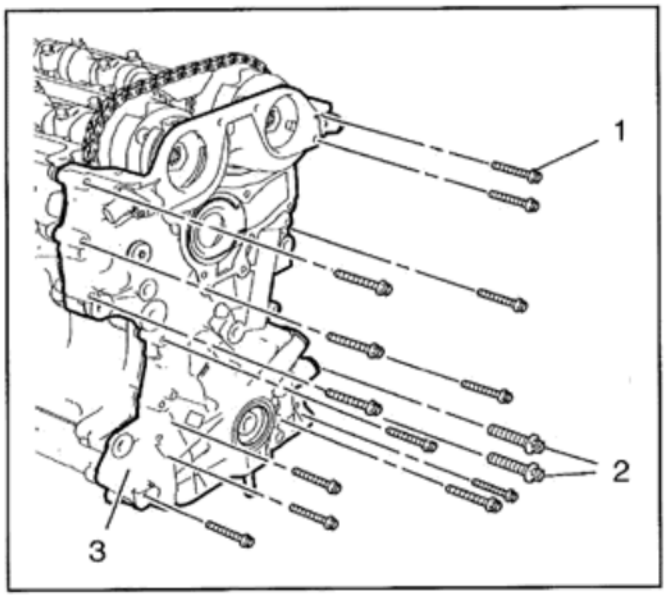
Callout	Component Name
Preliminary Procedures 1. Raise and support the vehicle. Refer to *Lifting and Jacking the Vehicle on page 1-31* 2. If equipped, remove the front insulator cover. Refer to *Front Compartment Front Insulator Cover Replacement on page 3-157*.	
1	Engine Oil Heater Bolt **Caution:** Refer to *Fastener Caution on page 0-8*. **Tighten** 40 N•m (30 lb ft)
2	Engine Oil Heater **Procedure** Disconnect the electrical connector.

Engine Front Cover with Oil Pump Replacement

Removal Procedure

1. Disconnect the battery negative cable. Refer to *Battery Negative Cable Disconnection and Connection on page 9-713*.
2. Set the engine to TDC. Refer to *Camshaft Timing Chain Inspection on page 9-855*.
3. Raise and support the vehicle. Refer to *Lifting and Jacking the Vehicle on page 1-31*.
4. Remove the front wheelhouse liner extension, right side. Refer to *Front Wheelhouse Liner Inner Front Extension Replacement (Left Side) on page 3-147* or *Front Wheelhouse Liner Inner Front Extension Replacement (Right Side, LUV) on page 3-148* or *Front Wheelhouse Liner Inner Front Extension Replacement (Right Side, LWE, LUW) on page 3-149*.
5. Remove the air conditioning compressor. Refer to *Air Conditioning Compressor Replacement (LDE, LUW, LWE) on page 10-16* or *Air Conditioning Compressor Replacement (LUV) on page 10-17*.

6. Remove the air conditioning compressor bracket. Refer to *Air Conditioning Compressor Bracket Removal on page 9-864*.
7. Remove the crankshaft balancer. Refer to *Crankshaft Balancer Replacement on page 9-815*.
8. Remove the oil pan. Refer to *Oil Pan Replacement on page 9-810*.
9. Lower vehicle.
10. Remove the drive belt tensioner. Refer to *Drive Belt Tensioner Replacement on page 9-786*.
11. Remove the generator from above. Refer to *Generator Replacement (LUV) on page 9-726* or *Generator Replacement (LUW) on page 9-727*.
12. Remove the water pump pulley and the water pump. Refer to *Water Pump Replacement (LUV) on page 9-672* or *Water Pump Replacement (LUW) on page 9-673*.
13. Remove the camshaft position actuator solenoid valves. Refer to *Camshaft Position Actuator Solenoid Valve Removal on page 9-868*.
14. Loosen the camshaft sprocket bolts until the camshaft position exciter wheels are free to rotate. Refer to *Camshaft Timing Chain Adjustment on page 9-857*.

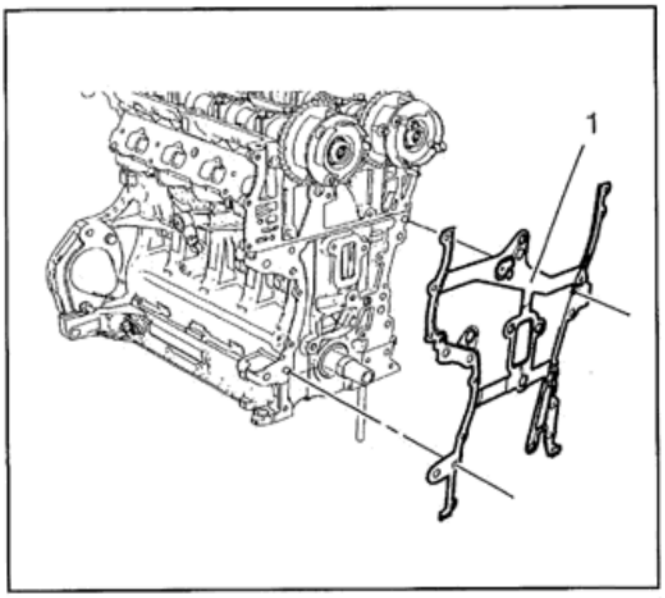


2190667

15. Remove the 13 engine front cover bolts M6 (1).
16. Remove the 2 engine front cover bolts M10 (2).
17. Remove the engine front cover (3).

Note: Removal of timing chain is necessary to get access to engine front cover gasket.

18. Remove the camshaft timing chain. Refer to *Camshaft Timing Chain Replacement on page 9-794*.

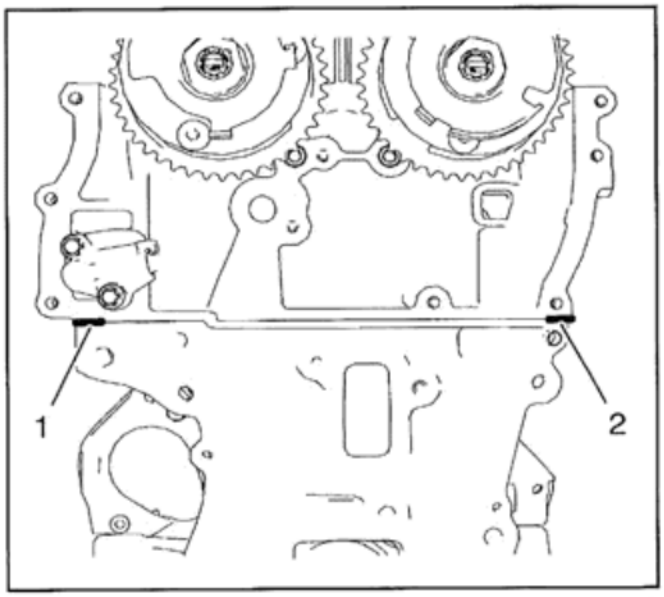


2190693

19. Remove the engine front cover gasket (1).
20. Remove the intake and exhaust camshaft position sensors from the engine front cover. Refer to *Camshaft Position Sensor Replacement on page 9-285*.

Installation Procedure

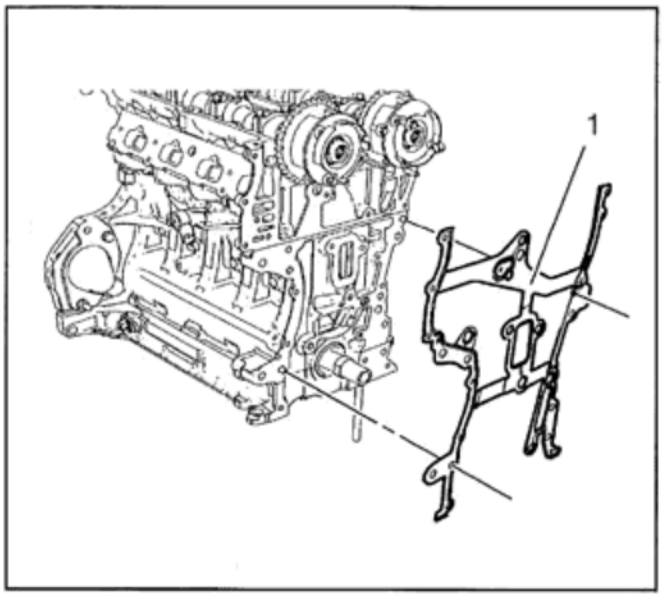
1. Install the intake and exhaust camshaft position sensors to the engine front cover. Refer to *Camshaft Position Sensor Replacement on page 9-285*.
2. Clean the engine front cover sealing surfaces on engine block and cylinder head.



2190694

Note: The thickness of the sealing bead should be **2 mm (0.0787 in)**.

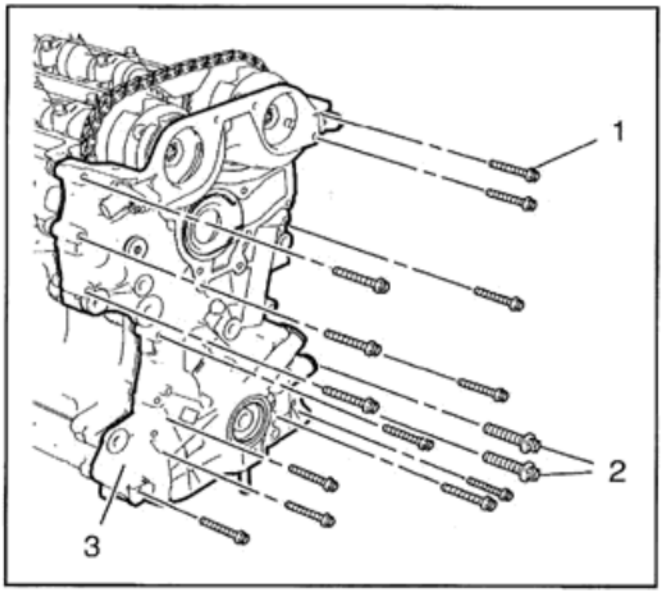
3. Apply sealing compound to the shown areas (1) and (2). Refer to *Adhesives, Fluids, Lubricants, and Sealers on page 9-759*.



2190693

Note: Mind the guide sleeves.

4. Install a NEW engine front cover gasket (1).
5. Install the timing chain. Refer to *Camshaft Timing Chain Replacement on page 9-794*.



2190667

Note: Mind the guide sleeves when installing the engine front cover. The complete installation procedure of the engine front cover should not take longer than 10 minutes.

6. Install the engine front cover (3).
7. Install the 13 engine front cover bolts M6 (1).
8. Install the 2 engine front cover bolts M10 (2).

Caution: Refer to *Fastener Caution on page 0-8*.

9. Tighten the 13 engine front cover bolts M6 to **8 N•m (71 lb in)**.
10. Tighten the 2 engine front cover bolts M10 to **35 N•m (26 lb ft)**.

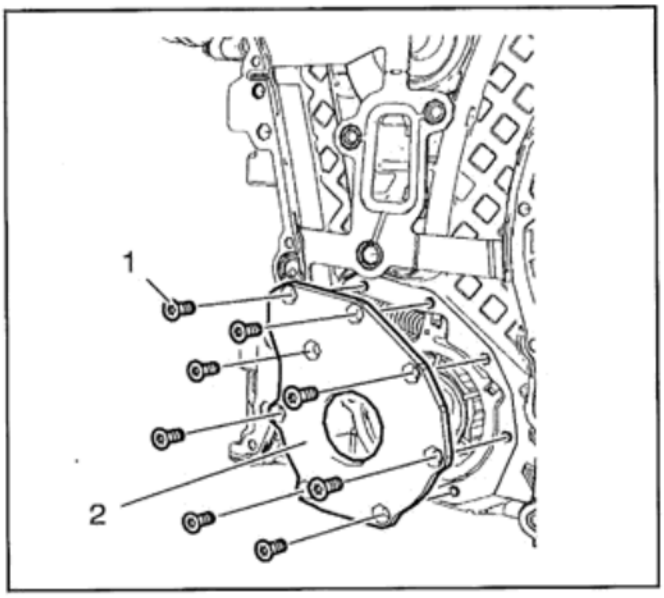
Note: Engine should be adjusted and fixed in TDC position.

11. Tighten the camshaft sprockets, install the upper timing chain guide and remove all special tools. Refer to *Camshaft Timing Chain Adjustment on page 9-857*.
12. Install the 2 camshaft position actuator solenoid valves. Refer to *Camshaft Position Actuator Solenoid Valve Replacement on page 9-282*.
13. Install the water pump and the water pump pulley. Refer to *Water Pump Replacement (LUV) on page 9-672* or *Water Pump Replacement (LUW) on page 9-673*.
14. Install the generator from above. Refer to *Generator Replacement (LUV) on page 9-726* or *Generator Replacement (LUW) on page 9-727*.
15. Install the drive belt tensioner. Refer to *Drive Belt Tensioner Replacement on page 9-786*.
16. Install the air conditioning compressor bracket. Refer to *Air Conditioning Compressor Bracket Installation on page 9-914*.
17. Install the air conditioning compressor. Refer to *Air Conditioning Compressor Replacement (LDE, LUW, LWE) on page 10-16* or *Air Conditioning Compressor Replacement (LUV) on page 10-17*.
18. Install the crankshaft balancer. Refer to *Crankshaft Balancer Replacement on page 9-815*.
19. Install the drive belt. Refer to *Drive Belt Replacement on page 9-784*.
20. Install the engine mount bracket. Refer to *Engine Mount Bracket Replacement - Right Side on page 9-789*.
21. Install the engine mount. Refer to *Engine Mount Replacement - Right Side on page 9-788*.
22. Install the camshaft cover. Refer to *Camshaft Cover Replacement on page 9-850*.
23. Install the air cleaner assembly. Refer to *Air Cleaner Assembly Replacement on page 9-290*.
24. Raise the vehicle.
25. Install the oil pan. Refer to *Oil Pan Replacement on page 9-810*.
26. Install the front wheelhouse liner extension, right side. Refer to *Front Wheelhouse Liner Inner Front Extension Replacement (Left Side) on page 3-147* or *Front Wheelhouse Liner Inner Front Extension Replacement (Right Side, LUV) on page 3-148* or *Front Wheelhouse Liner Inner Front Extension Replacement (Right Side, LWE, LUW) on page 3-149*.
27. Lower the vehicle.
28. Connect the battery negative cable. Refer to *Battery Negative Cable Disconnection and Connection on page 9-713*.
29. Fill up engine oil. Refer to *Engine Oil and Oil Filter Replacement on page 9-840*.

Oil Pump Replacement

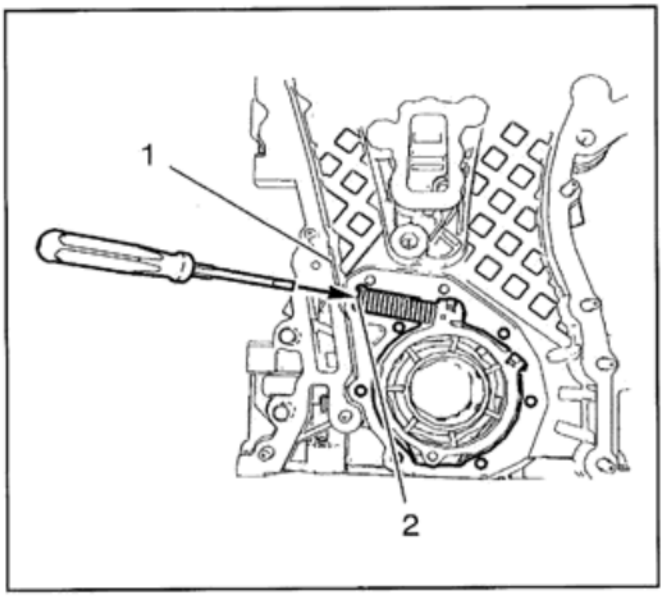
Removal Procedure

1. Remove the engine front cover. Refer to *Engine Front Cover with Oil Pump Replacement on page 9-821.*



2191037

2. Remove the 8 oil pump cover bolts (1).
3. Remove the oil pump cover (2).

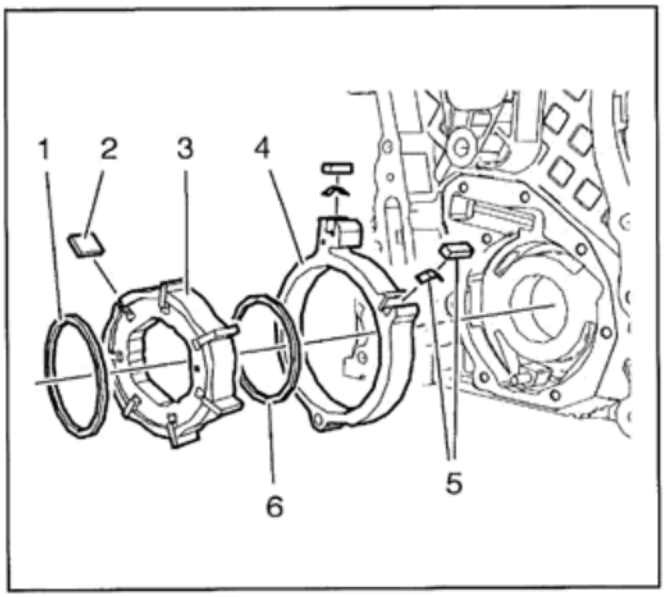


2191038

Warning: Before removing the spring, cover the spring with a towel to prevent the spring from flying and possibly causing damage or personal injury.

Note: Insert the screw driver between the oil pump slide spring windings (2).

4. Protect the engine front cover edge (1) with a suitable piece of plastic.
5. Compress the oil pump slide spring with a screw driver and remove the oil pump slide spring in conjunction with the oil pump slide spring pin.



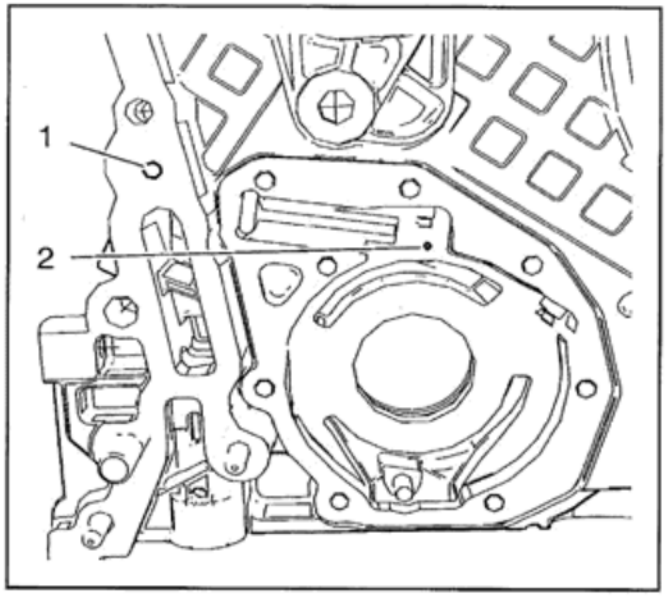
2191039

Note: Keep the oil pump components in order to aid in installation.

6. Remove the oil pump components in the following order:
   - 6.1. Outer oil pump vane ring (1).
   - 6.2. Oil pump vane rotor (3) and the 7 oil pump vanes (2).
   - 6.3. Inner oil pump vane ring (6).
   - 6.4. Oil pump slide (4) and the 2 oil pump slide seals with the 2 oil pump slide seal springs (5).

Cleaning And Inspection Procedure

1. Inspect the engine front cover for cracks, scratches and damage.
2. Inspect the oil pump cover and the engine front cover for flatness.
3. Inspect the oil pump vanes, the oil pump vane rotor, the oil pump vane rings and the oil pump slide for localized flatting.
4. Inspect the oil pump slide pivot pin for firm seat.



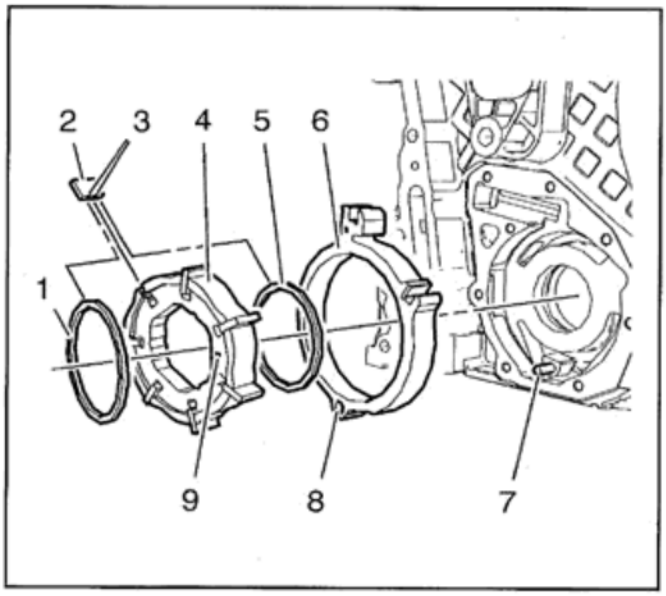
2191041

Warning: Wear safety glasses when using compressed air in order to prevent eye injury.

Caution: To ensure proper engine lubrication, clean clogged or contaminated oil galleries in an approved solvent and with compressed air. Failure to clean oil galleries may cause engine damage.

5. Clean the oil galleries with solvent and compressed air. Blow compressed air from bore (2) to bore (1).

Installation Procedure



2191079

Note: Oil pump slide spring pin, oil pump slide spring and slide seal and slide seal spring can be ordered as single parts. All other oil pump components can only be ordered as a replacement kit.

1. Install the oil pump components in the following order:

Note: The bore (8) in the oil pump slide must fit smooth-running and without clearance to the oil pump slide pivot pin (7).

1.1. Install the oil pump slide (6).

1.2. Install the inner oil pump vane ring (5).

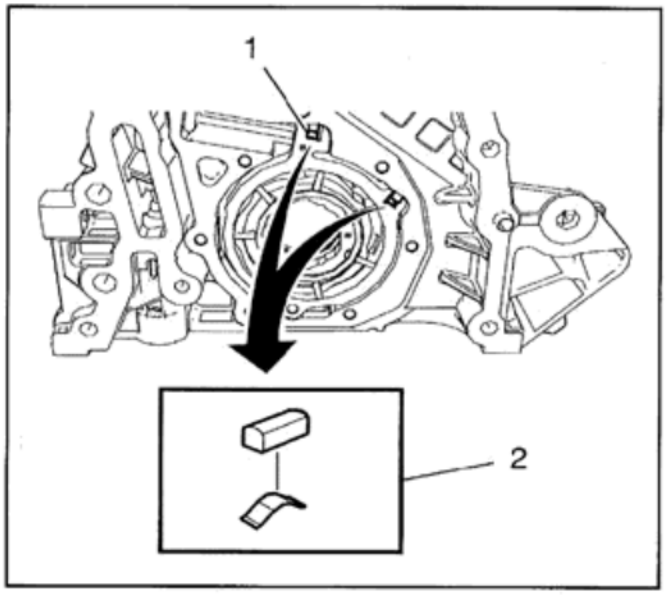
Note: Ensure the mark (9) of the oil pump vane rotor (4) points to the oil pump cover.

1.3. Install the oil pump vane rotor (4).

Note: Ensure the flats (3) on the oil pump vanes (2) point to the oil pump vane rotor.

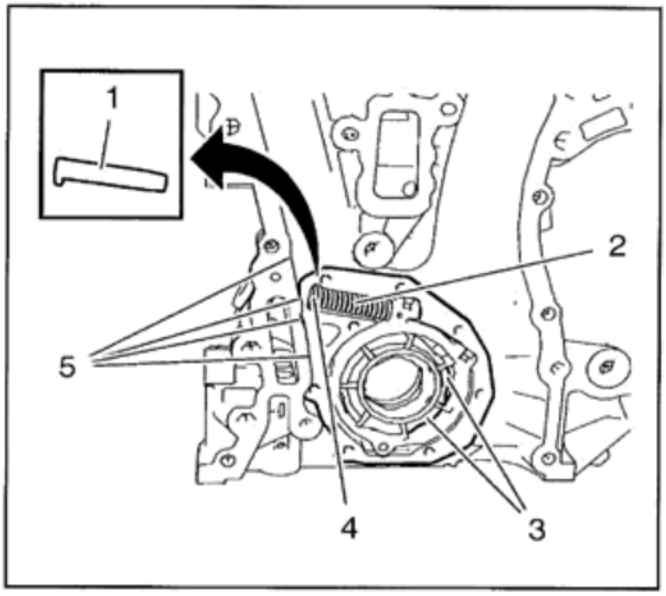
1.4. Install the 7 oil pump vanes (2).

1.5. Install the outer oil pump vane ring (1).



2191049

2. Install the 2 oil pump slide seals and the 2 oil pump slide seal springs (2) in the position as shown to the 2 grooves (1) of the oil pump slide.

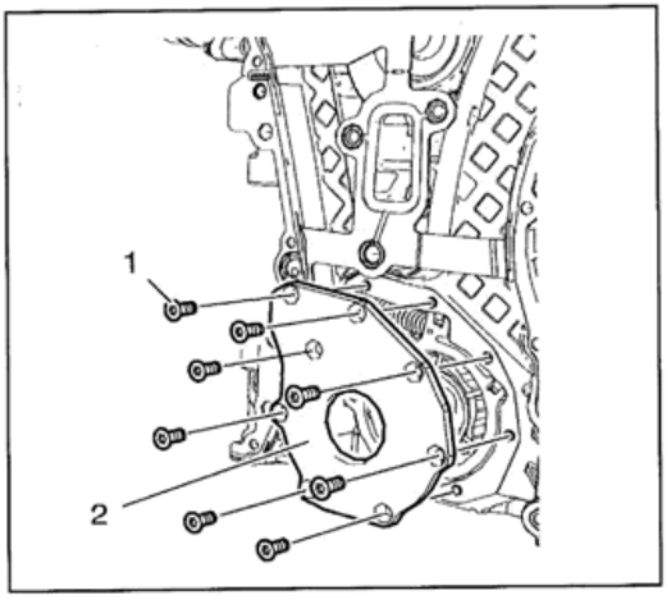


2191052

3. Protect the engine front cover edge (5) with a suitable piece of plastic.

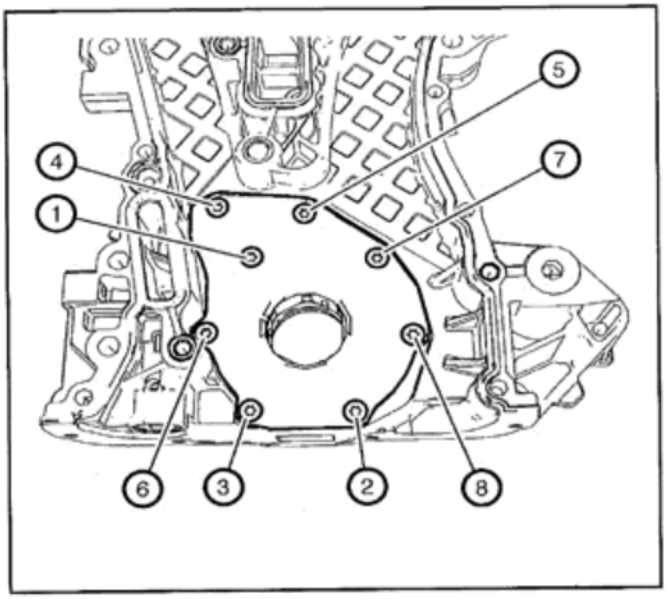
Note: The length of the removed oil pump slide spring (2) should be **76.5 mm (3.0118 in)** for naturally aspirated engines and **61 mm (2.4016 in)** for turbo engines.

4. Install the oil pump slide spring pin (1) in conjunction with the oil pump slide spring (4). Use a screwdriver to compress the oil pump slide spring. The flat side of oil pump slide spring pin must face upwards.
5. Lubricate the oil pump vanes, the oil pump vane rotor, the oil pump slide spring and the chambers (3) with engine oil.
6. Inspect the oil pump slide spring mechanism for proper function.
7. Measure the oil pump axial and radial clearances and compare with the specified values. Refer to *Engine Front Cover and Oil Pump Cleaning and Inspection on page 9-892*.



2191037

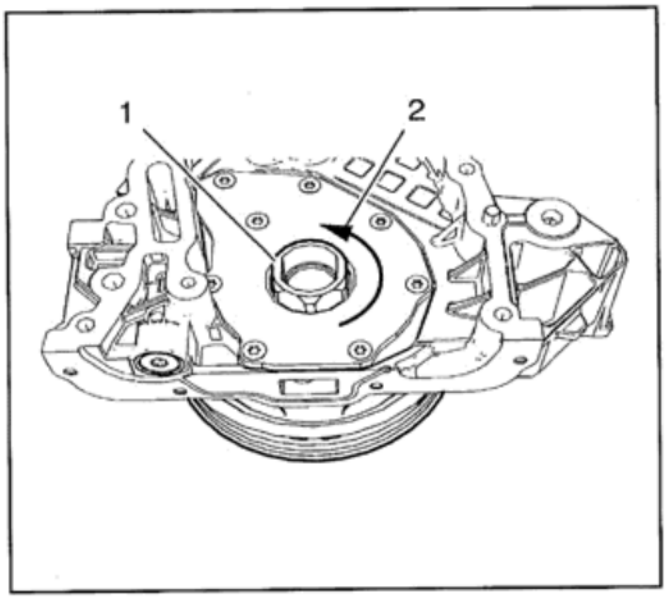
8. Install the oil pump cover (2) and the 8 oil pump cover bolts (1).



2191056

Caution: Refer to *Fastener Caution on page 0-8*

9. Tighten the oil pump cover bolts in a sequence as shown to **8 N•m (71 lb in)**.



2191058

10. Install the crankshaft balancer (1) and rotate in shown direction (2) in order to inspect the function of the oil pump mechanism. Crankshaft balancer should rotate easily.
11. Remove the timing chain and replace the engine front cover gasket. Refer to *Camshaft Timing Chain Replacement on page 9-794*.
12. Install the timing chain. Refer to *Camshaft Timing Chain Replacement on page 9-794*.
13. Install the engine front cover. Refer to *Engine Front Cover with Oil Pump Replacement on page 9-821*.
14. Measure the oil pressure and compare with the specified values. Refer to *Oil Pressure Diagnosis and Testing on page 9-771*.

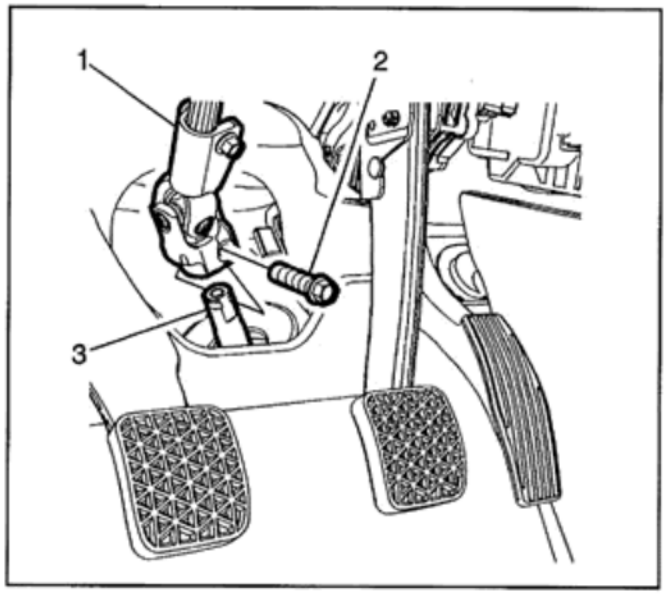
Engine Replacement

Special Tools

EN-48244 Engine Assembly Remove/Install Pallet Supporter

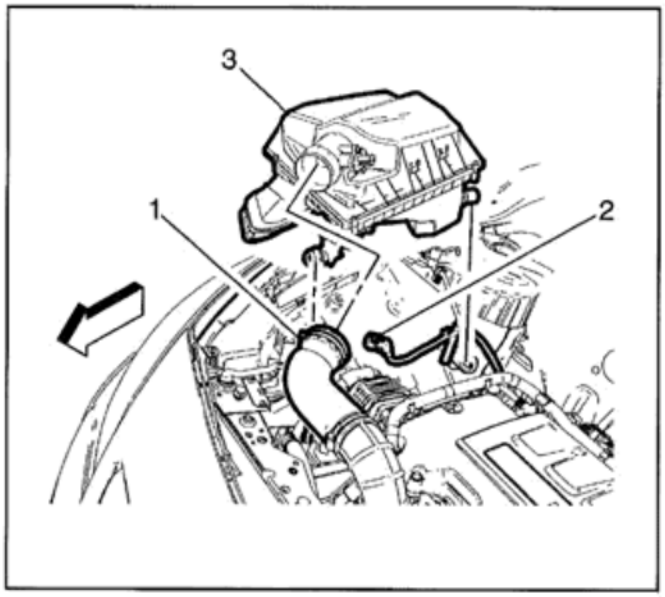
Removal Procedure

1. Remove the battery and battery tray. Refer to *Battery Tray Replacement on page 9-721*.
2. Relieve the fuel system pressure. Refer to *Fuel Pressure Relief on page 9-547*.
3. Recover the refrigerant. Refer to *Refrigerant Recovery and Recharging on page 10-13*.
4. Remove the front tire and wheel assembly. Refer to *Tire and Wheel Removal and Installation on page 16-60*.
5. Remove the front bumper fascia. Refer to *Front Bumper Fascia Replacement on page 3-55*.
6. Drain the cooling system. Refer to *Cooling System Draining and Filling on page 9-628*.



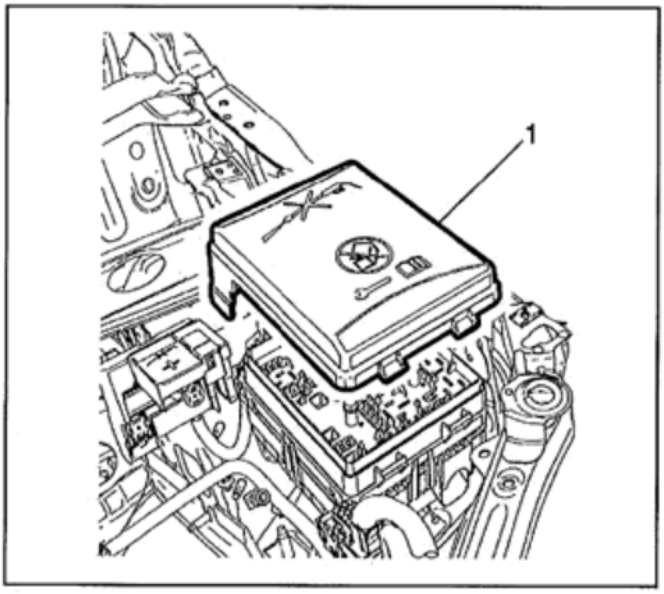
2520388

7. Remove the lower intermediate steering shaft bolt (1) and slide the shaft away from steering column. Refer to *Intermediate Steering Shaft Replacement on page 15-27*.



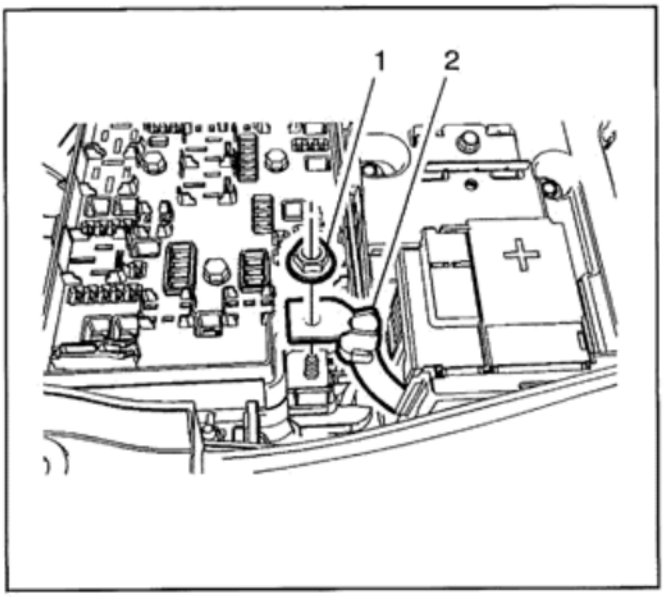
2680251

8. Remove the air cleaner assembly (1). Refer to *Air Cleaner Assembly Replacement on page 9-582*.



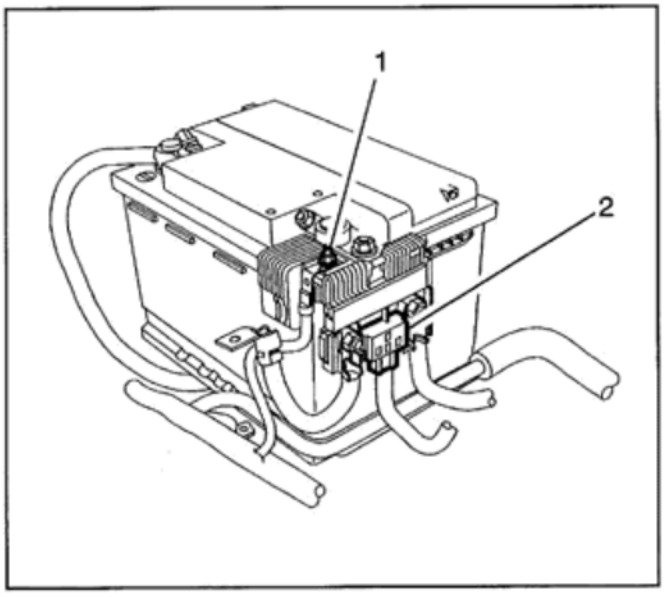
2539745

9. Remove the junction block cover (1).



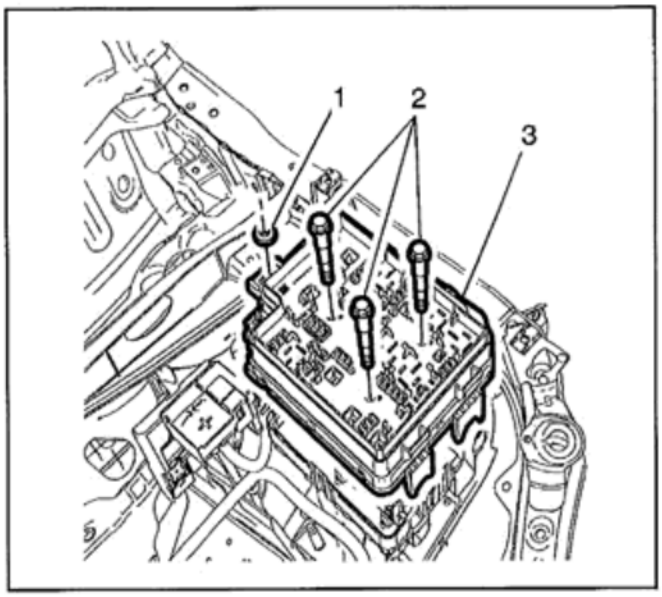
2504689

10. Remove the positive battery cable nut (1) from the junction block.
11. Remove the positive battery cable (2) from the junction block.



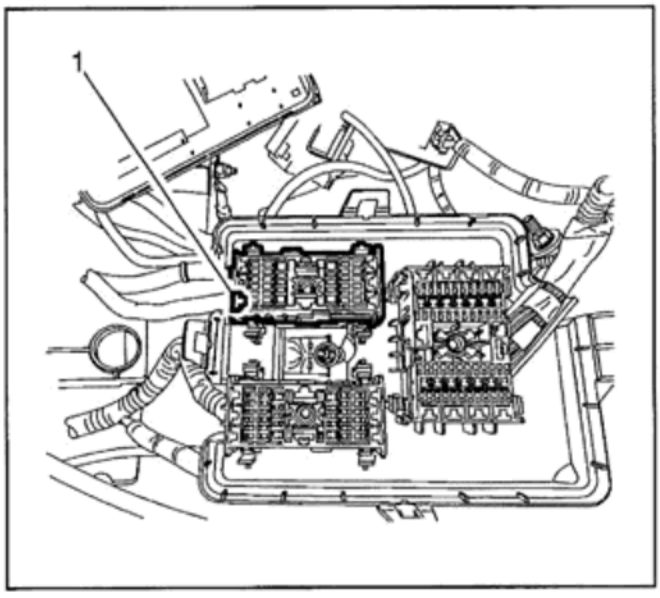
2539751

12. Remove the positive cable nut (1) and battery positive cable, from the battery positive cable junction block.
13. Disconnect the body wiring master harness connector (2), from the battery positive cable junction block.



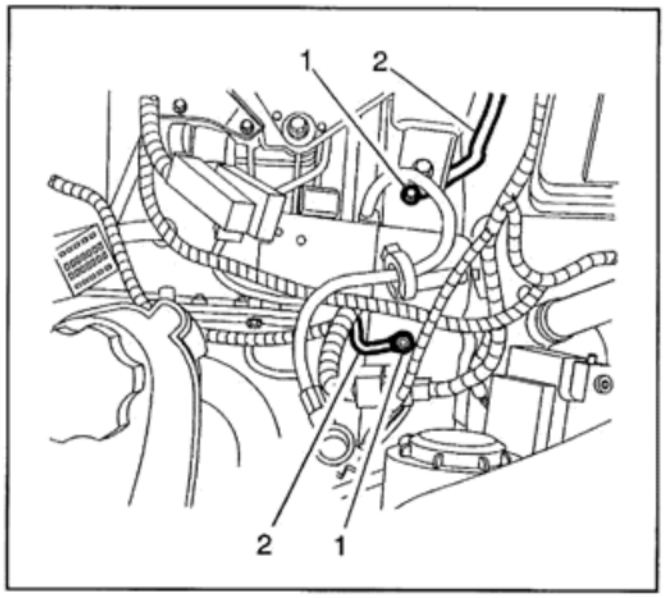
2539757

14. Remove the junction block nut (1).
15. Remove the junction block bolts (2).
16. Disconnect the wiring harness from the junction block base.
17. Remove the junction block (3) from the base.
18. Disconnect the wiring harness plug from the front compartment fuse block.



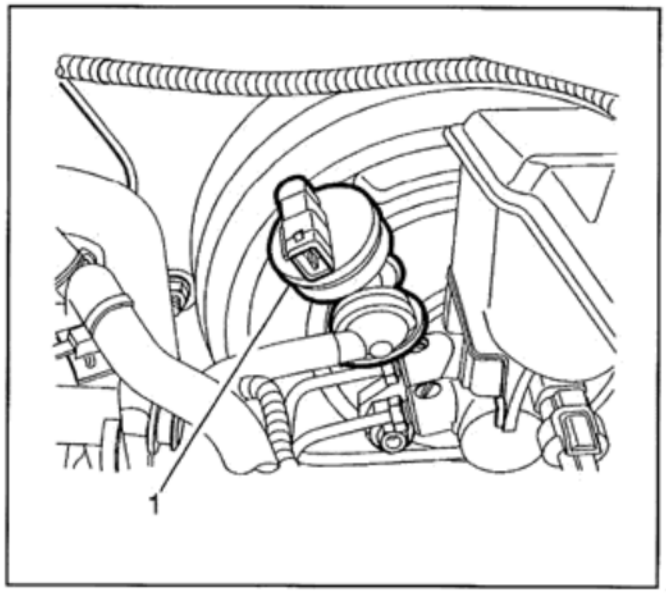
2539762

19. Reposition the wiring harness (1) on top of the engine.



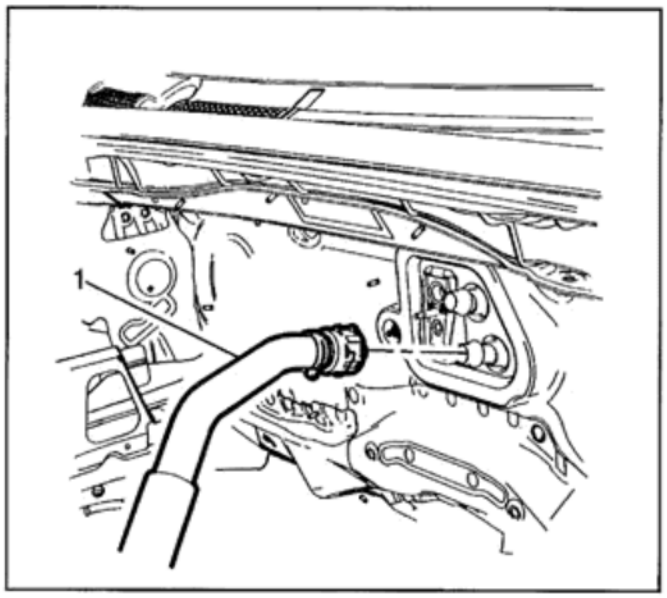
2539765

20. Remove the ground nuts (1) and reposition the wiring harness (2) aside.



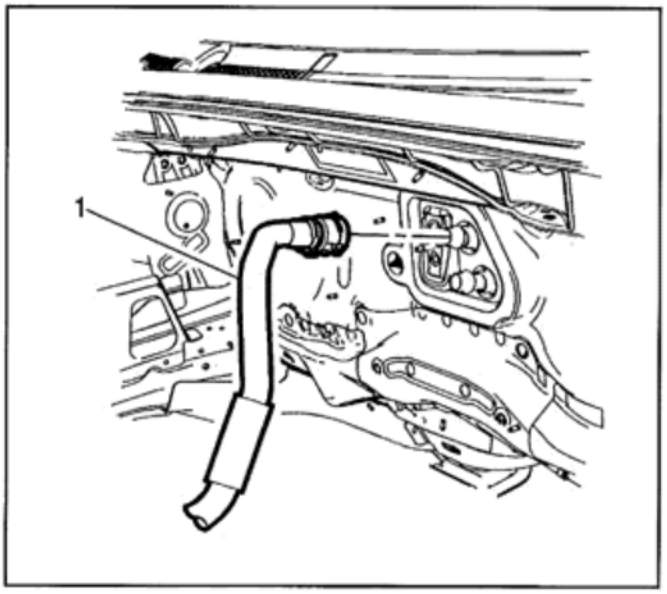
2534615

21. Disconnect the electrical connector and remove the brake booster hose (1) .



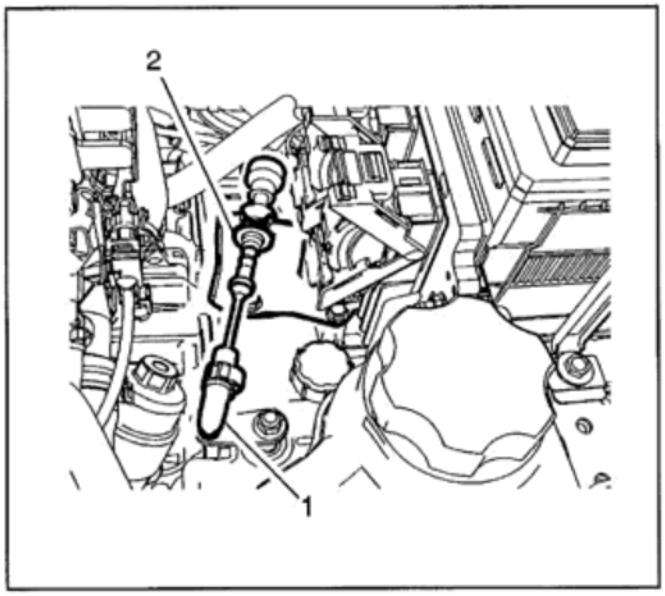
2521422

22. Disconnect the heater inlet hose (1) from the heater core. Refer to *Heater Inlet Hose Replacement (LDE, LUW) on page 10-38* or *Heater Inlet Hose Replacement (LUV) on page 10-38*.



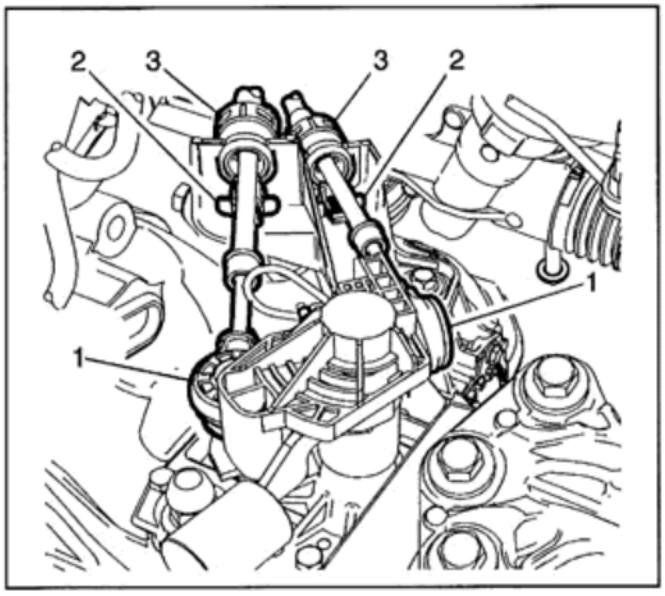
2521427

23. Disconnect the heater outlet hose (1) from the heater core. Refer to *Heater Outlet Hose Replacement (LUV) on page 10-40* or *Heater Outlet Hose Replacement (LDE, LUW) on page 10-40*.



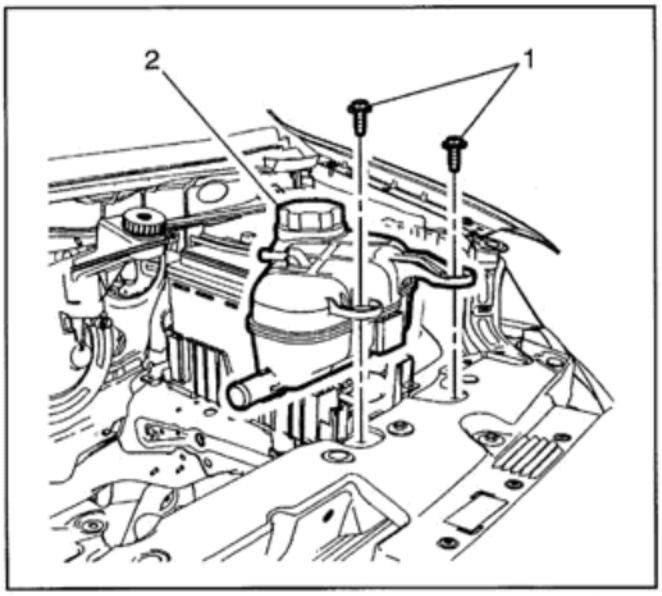
2492632

24. If equipped with an automatic transmission, disconnect the transmission range selector lever cable terminal (1) from the transmission manual shift lever pin.
25. Remove the transmission range selector lever cable (2) from the cable bracket.



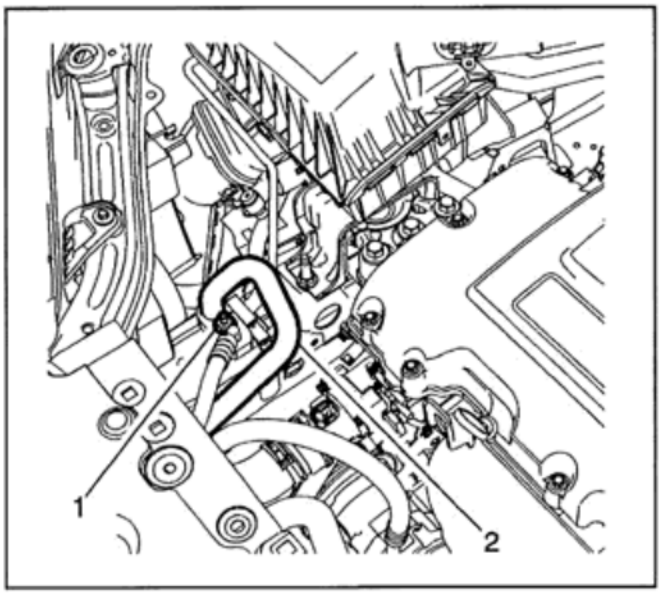
2512882

26. If equipped with manual transmission, disconnect the shift lever and selector lever cable end (1) from the transmission shift lever and selector lever.
27. Pull the cable retainers (2) to release the shift lever and selector lever cable from the shift lever and selector lever cable bracket.
28. Disconnect the shift lever and selector lever cable from the shift lever and selector lever cable bracket.



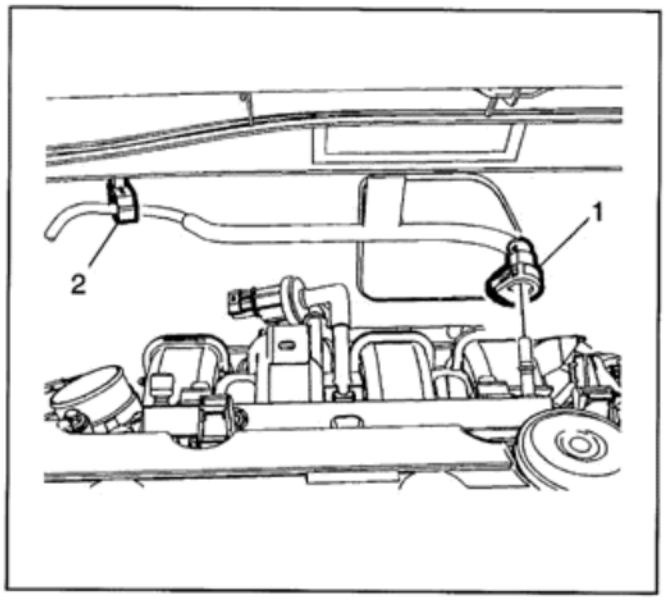
2513642

29. Remove the radiator surge tank (2) and position aside. Refer to *Radiator Surge Tank Replacement on page 9-630*.
30. Disconnect the fan connector.



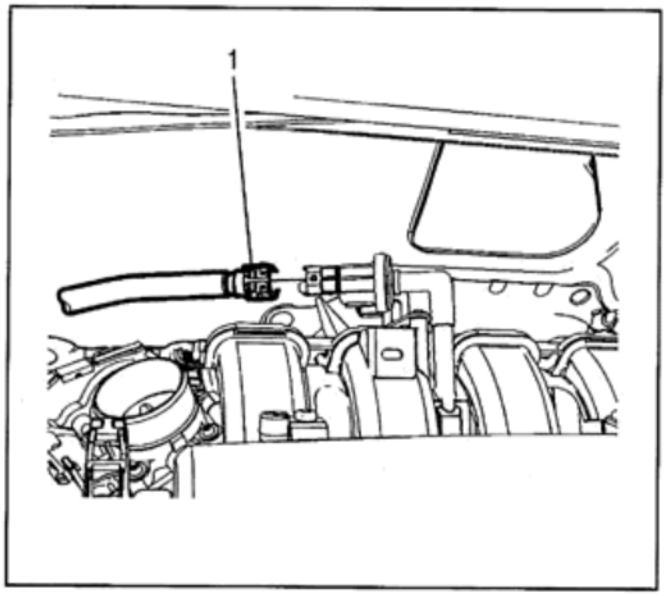
2571891

31. Remove air conditioning compressor and condenser hose nut (1).
32. Remove air conditioning compressor and condenser hose (2) from refrigerant hose.



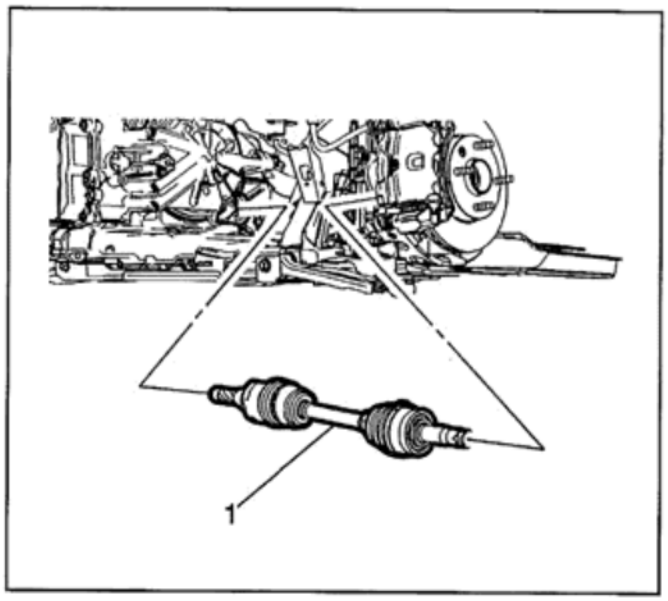
2510861

33. Disconnect the fuel feed pipe (1). Refer to *Plastic Collar Quick Connect Fitting Service on page 9-264*.



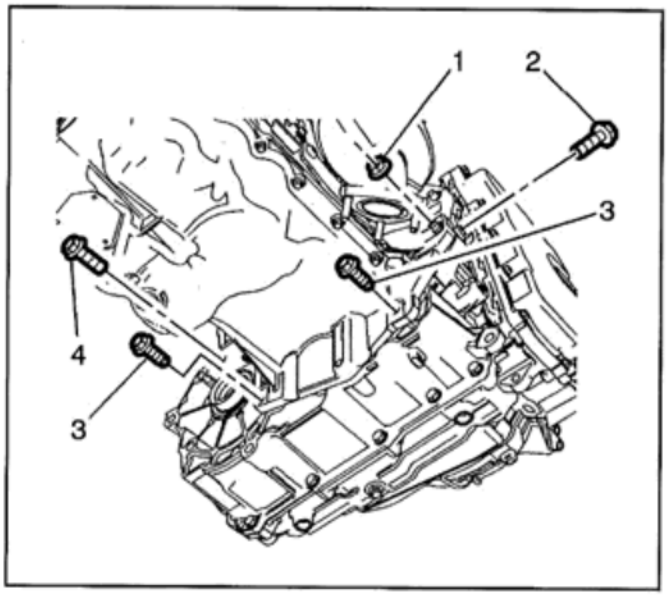
2510688

34. Disconnect the evaporative emission pipe (1). Refer to *Plastic Collar Quick Connect Fitting Service on page 9-264*.



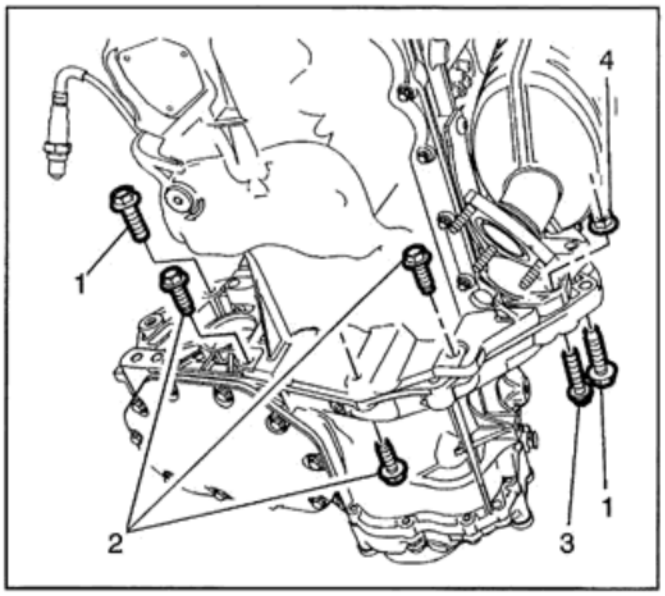
2508569

35. Remove the wheel drive shafts. Refer to *Front Wheel Drive Shaft Replacement on page 7-5*.
36. Remove the front exhaust pipe. Refer to *Exhaust Front Pipe Replacement (LUV,LUW) on page 9-738*.



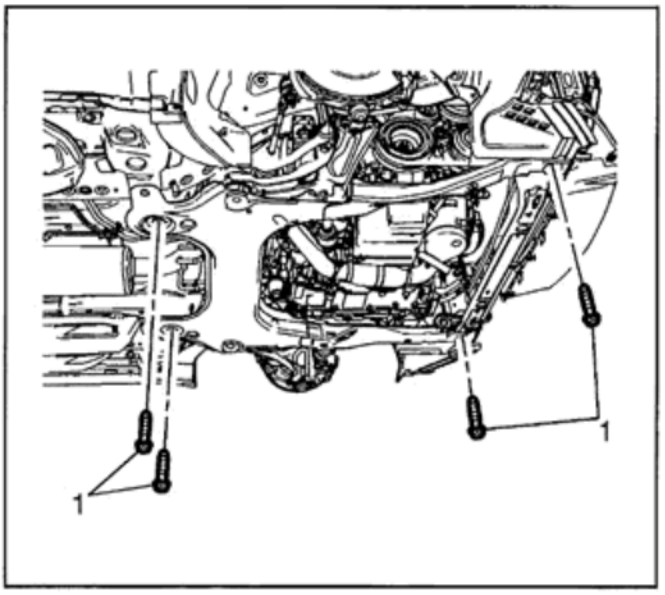
2571892

37. If equipped with an automatic transmission, remove the lower transmission nut (1) and the lower transmission bolts (2, 3, 4).



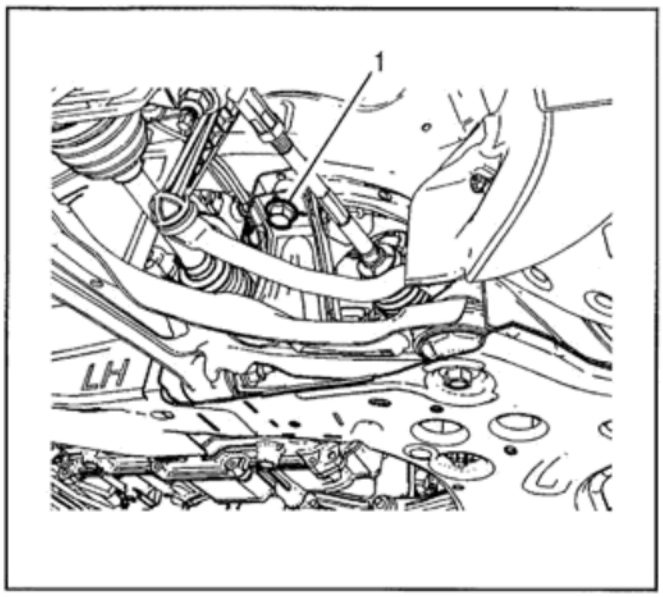
2571894

38. If equipped with manual transmission, remove the lower transmission bolt (3) and nut (4).
39. Remove the lower transmission bolts (1, 2).



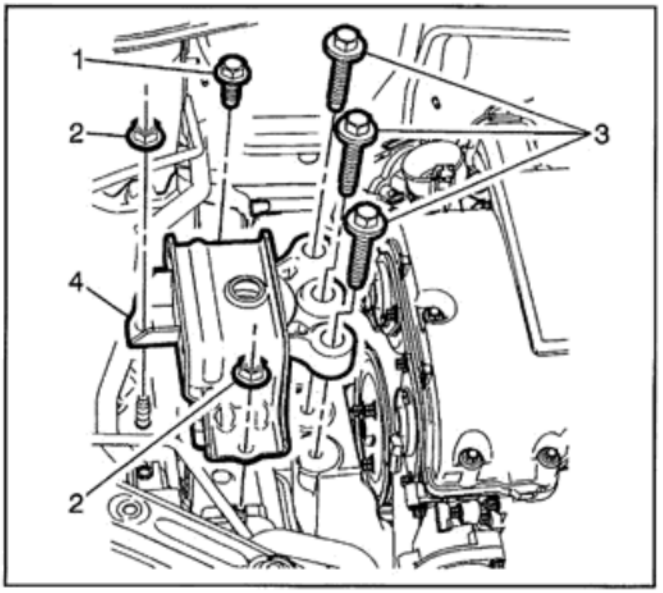
2539788

40. Remove the frame front bolts (1).
41. Position the *EN-48244* engine assembly remove/ install pallet supporter under the powertrain and support with blocks of wood.



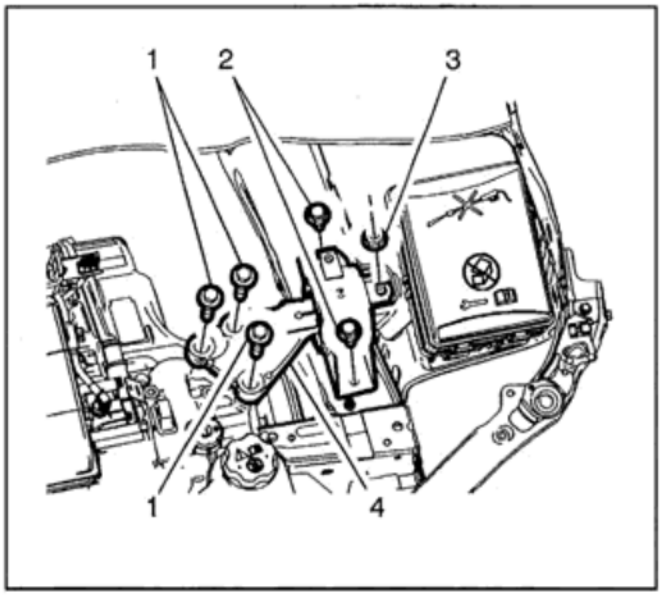
2492995

42. Remove the upper frame suspension retaining bolts (1) on both sides.



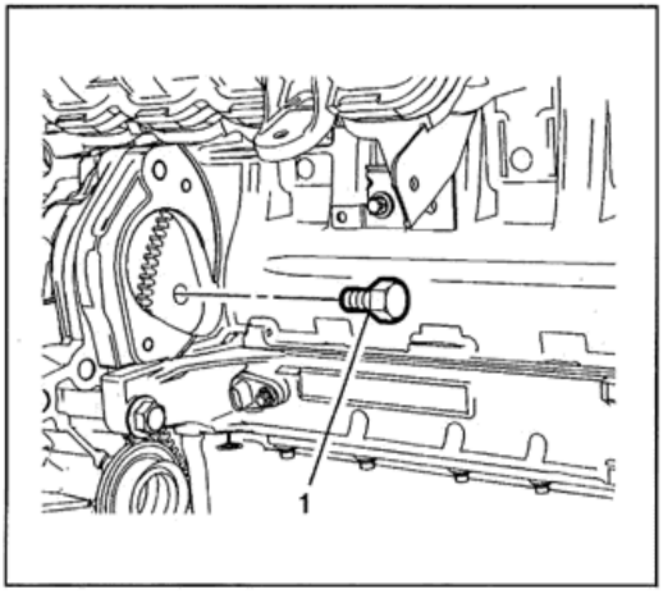
2571896

43. Remove the right side engine mount (4). Refer to *Engine Mount Replacement - Right Side on page 9-788*.



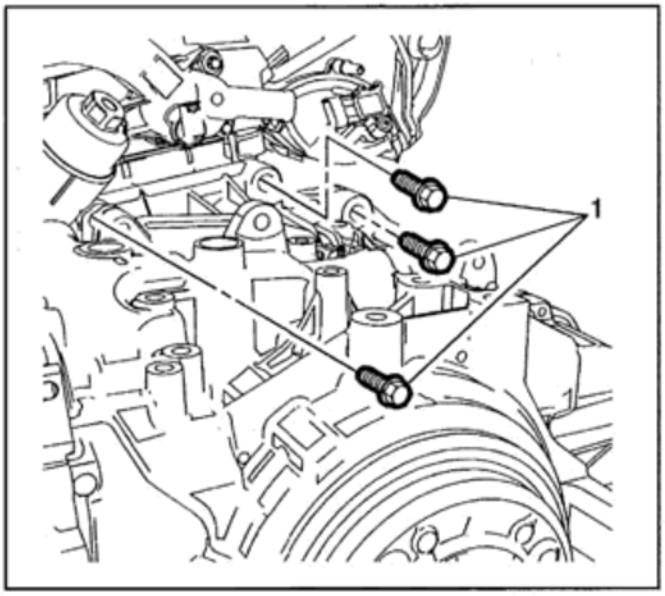
2534715

44. Remove and DISCARD the transmission mount bolts (1) – left side. Refer to *Transmission Mount Replacement - Left Side on page 17-216.*
45. Disconnect any additional electrical connections as necessary.
46. Raise the vehicle until the powertrain is clear for removal.



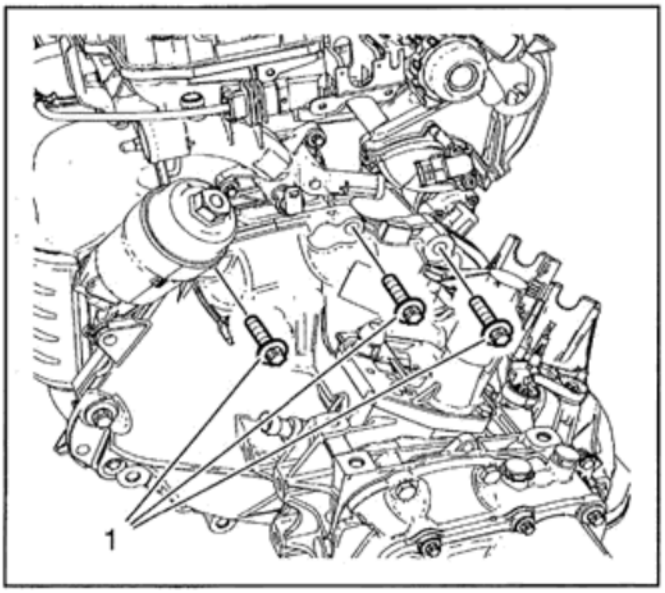
2571901

47. If equipped with an automatic transmission, remove the starter. Refer to *Starter Replacement (LUW) on page 9-722* or *Starter Replacement (LUV) on page 9-724.*
48. Mark the relationship of the flex plate to the torque converter for reassembly.
49. Remove and DISCARD the flex plate to torque converter bolts (1).



2571900

50. If equipped with an automatic transmission, remove the upper transmission to engine bolts (1) and separate the engine and transmission.

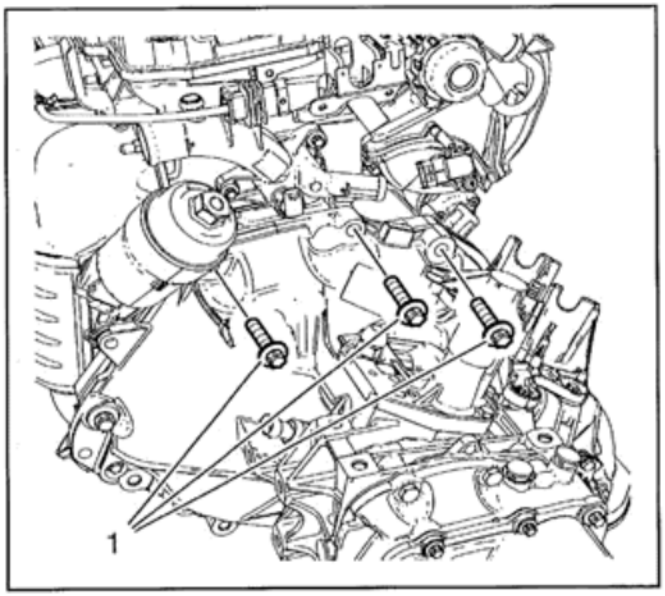


2191679

51. If equipped with manual transmission, remove the upper transmission to engine bolts (1). And separate the engine and transmission.
52. Disconnect any electrical connectors as needed.
53. Transfer parts as necessary.

Installation Procedure

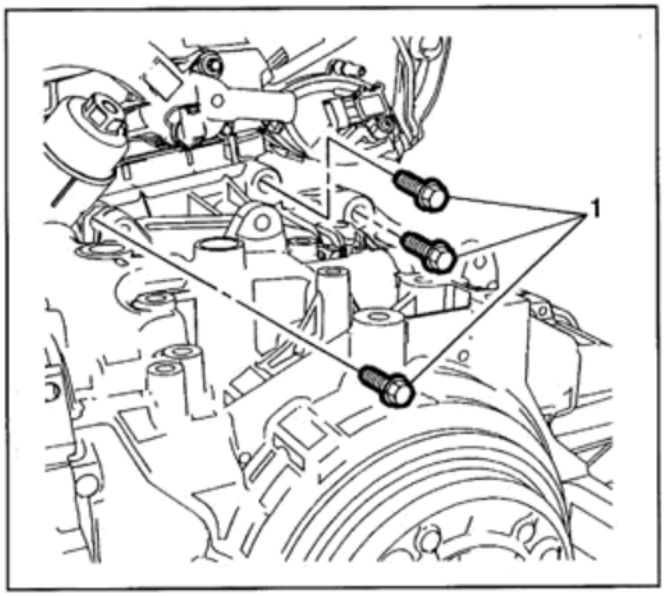
1. Install the transmission to the engine.



2191679

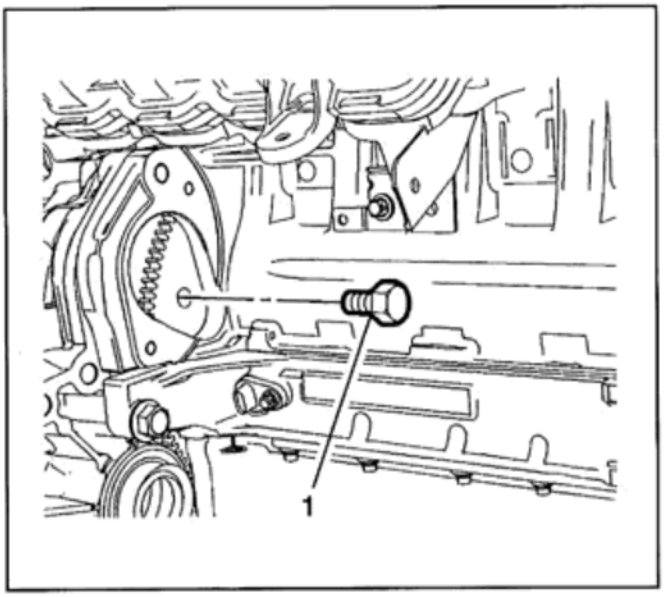
Caution: Refer to *Fastener Caution on page 0-8*.

2. If equipped with a manual transmission, install the upper transmission to engine bolts (1) to **60 N•m (44 lb ft)**.



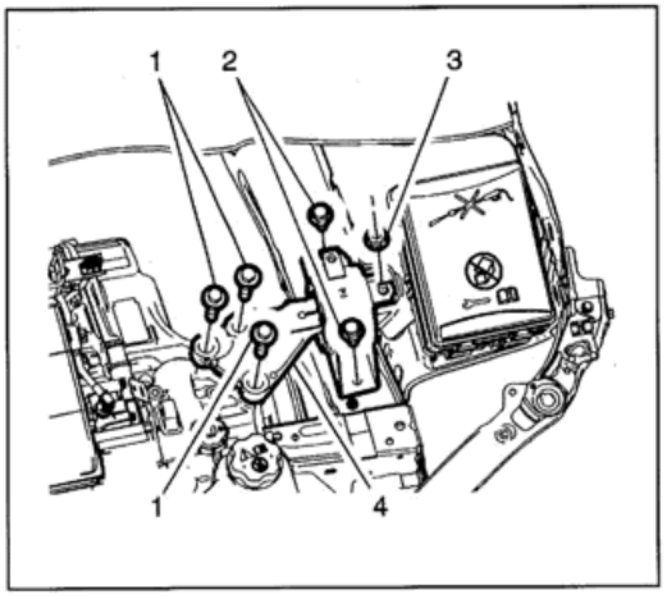
2571900

3. If equipped with automatic transmission, install the upper transmission to engine bolts (1) and tighten to **60 N•m (44 lb ft)**.



2571901

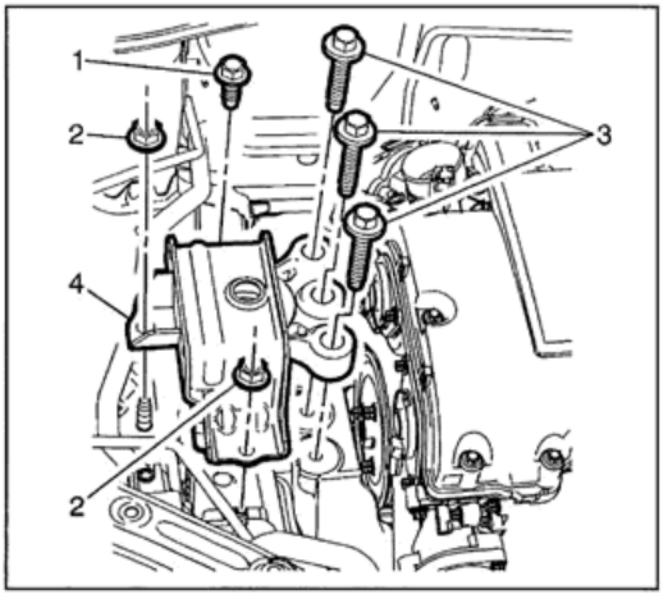
4. If equipped with an automatic transmission, install the torque converter to flex plate bolts (1) and tighten to **60 N•m (44 lb ft)**.
5. Install the starter. Refer to *Starter Replacement (LUW) on page 9-722* or *Starter Replacement (LUV) on page 9-724*.
6. Position the powertrain under the vehicle and slowly lower the body onto the powertrain.



2534715

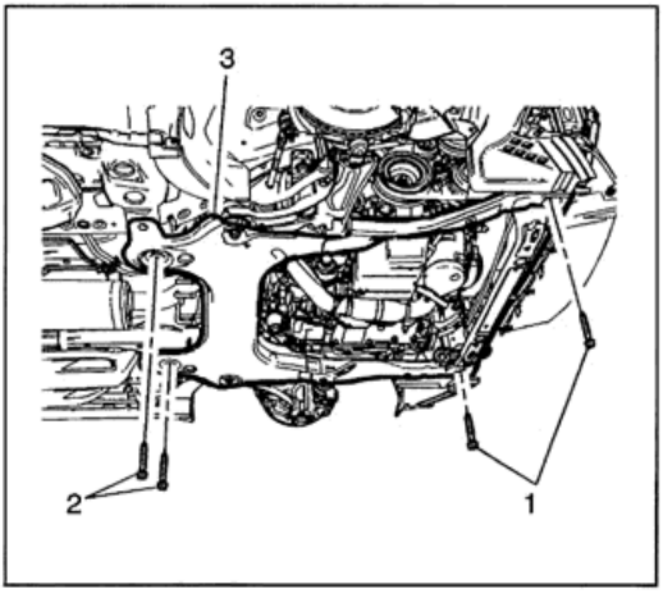
Caution: Refer to *Torque-to-Yield Fastener Caution on page 0-10*.

7. Install the NEW left transmission mount to transmission bolts (1) and tighten to **50 N•m (37 lb ft) plus 70 degrees**.



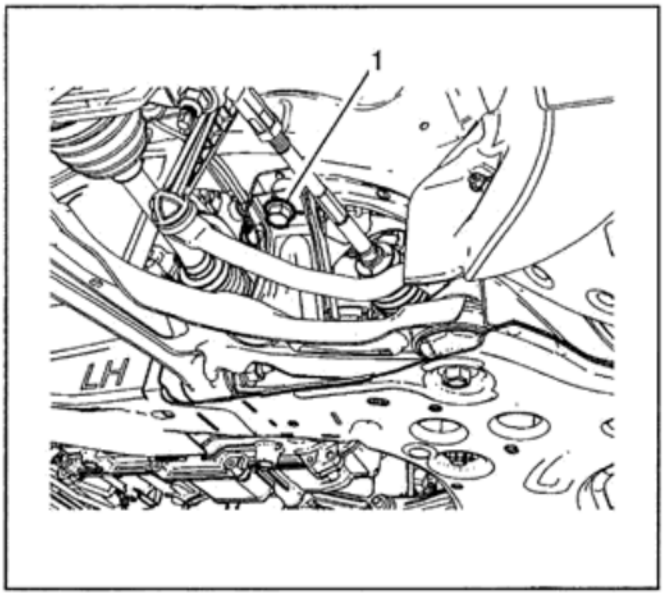
2571895

8. Install the right side engine mount (4). Refer to *Engine Mount Replacement - Right Side on page 9-788*.
9. Connect all previously disconnected electrical connections.



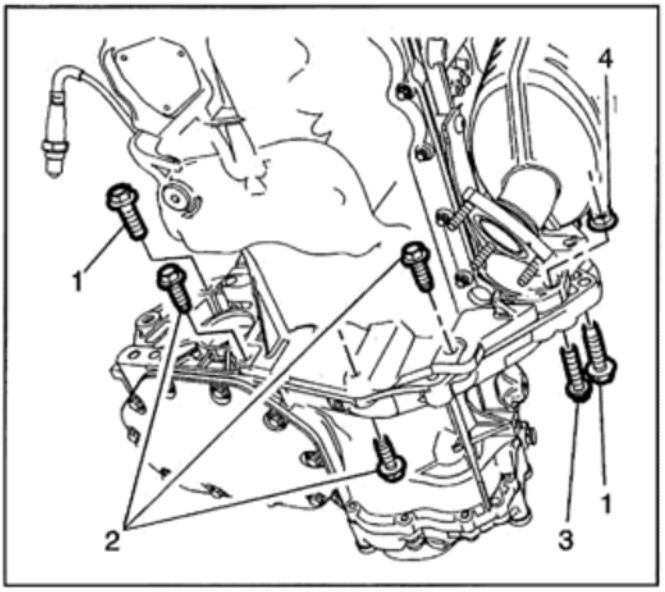
2508892

10. Install the frame (3) rear bolts (2) and front bolts (1), tighten a little bit.
11. Install the frame (3) rear bolts (2) and tighten to **135** N•m **(100 lb ft)**.
12. Install the frame (3) front bolts (1) and tighten to **58** N•m **(43 lb ft)**.



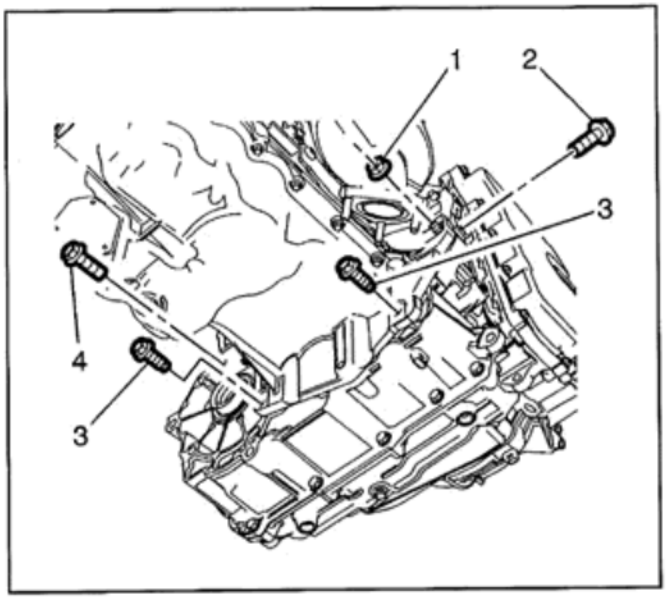
2492995

13. Install the upper frame suspension retaining bolts (1) on both sides and tighten to **135** N•m **(100 lb ft)**.
14. Remove the lift table.



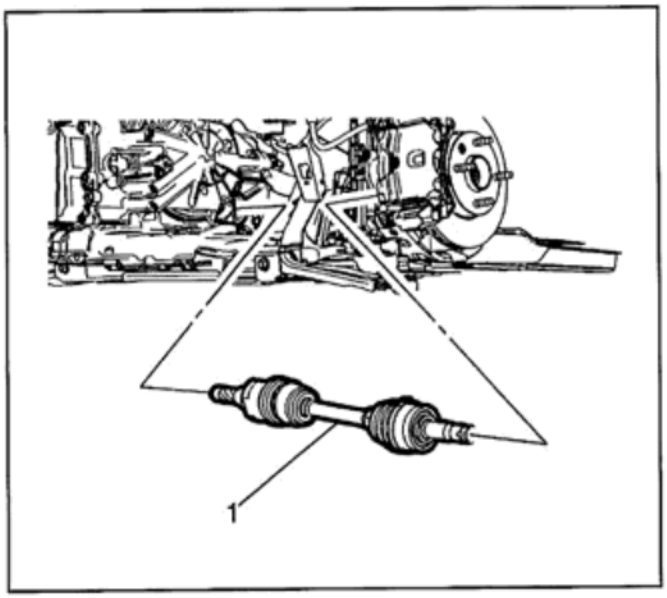
2571894

15. If equipped with manual transmission, install the lower transmission bolts (1) and tighten to **60** N•m **(44 lb ft)**.
16. Install the lower transmission bolts (2) and tighten **40** N•m **(30 lb ft)**.
17. Install the lower transmission bolt (3) and nut (4) and tighten to **40** N•m **(30 lb ft)**.



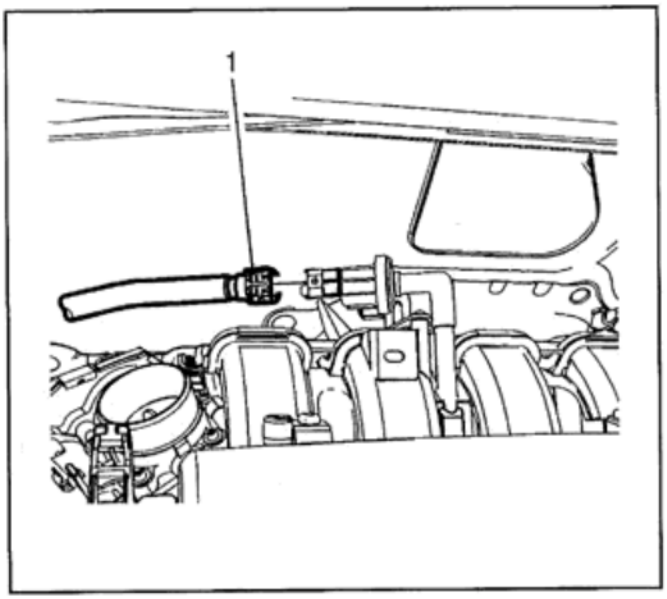
2571892

18. If equipped with an automatic transmission, install the lower transmission bolts (2, 4) and tighten to **60** N•m **(44 lb ft)**.
19. Install the lower transmission bolts (3) and the lower transmission nut (1) and tighten to **40** N•m **(30 lb ft)**.
20. Install the front exhaust pipe. Refer to *Exhaust Front Pipe Replacement (LUV,LUW) on page 9-738*.



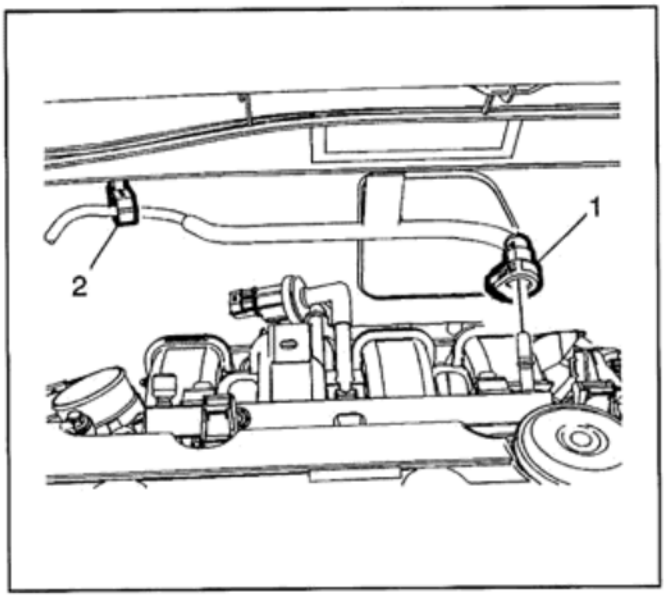
2508569

21. Install the wheel drive shafts. Refer to *Front Wheel Drive Shaft Replacement on page 7-5*.



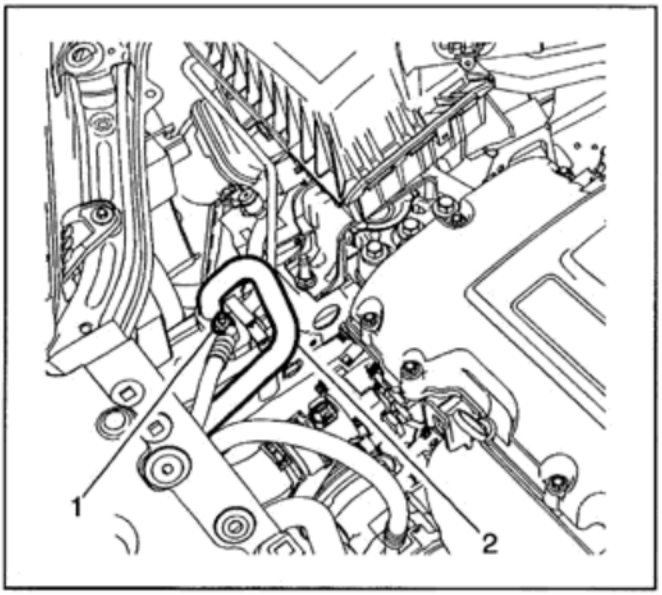
2510688

22. Connect the evaporative emission pipe (1). Refer to *Plastic Collar Quick Connect Fitting Service on page 9-264*.



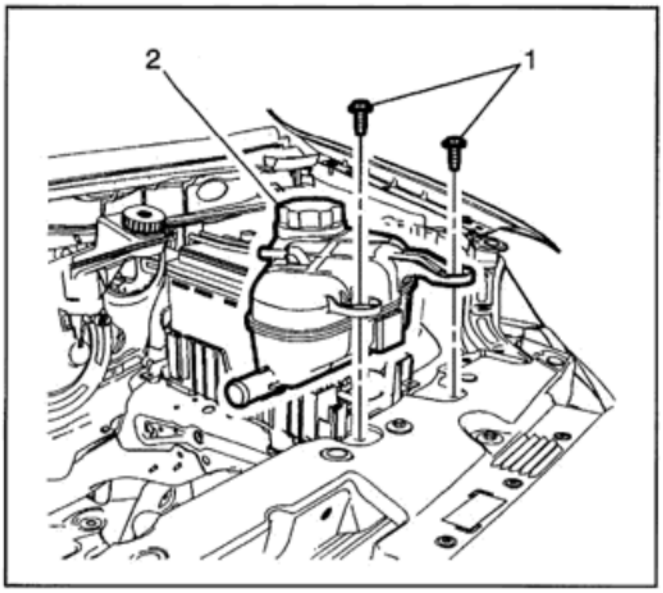
2510661

23. Connect the fuel feed pipe (1). Refer to *Plastic Collar Quick Connect Fitting Service on page 9-264*.



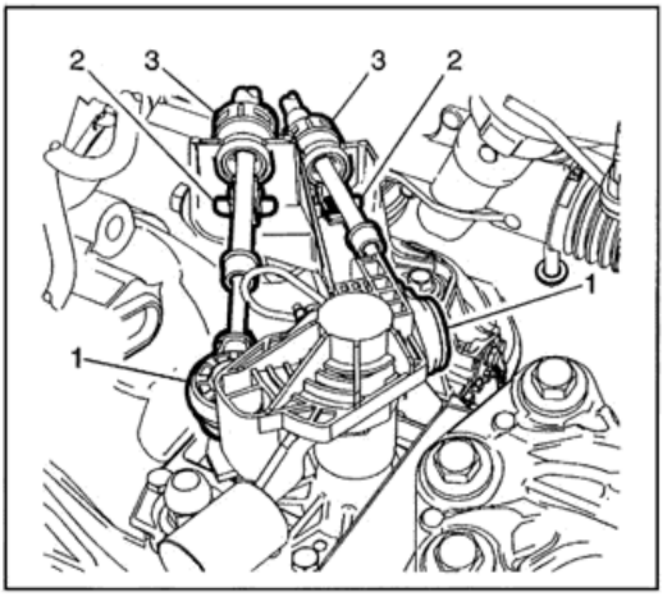
2571891

24. Install air conditioning compressor and condenser hose to the refrigerant hose.
25. Install air conditioning compressor and condenser hose nut (1) tighten nut to **22 N•m (16 lb ft)**.



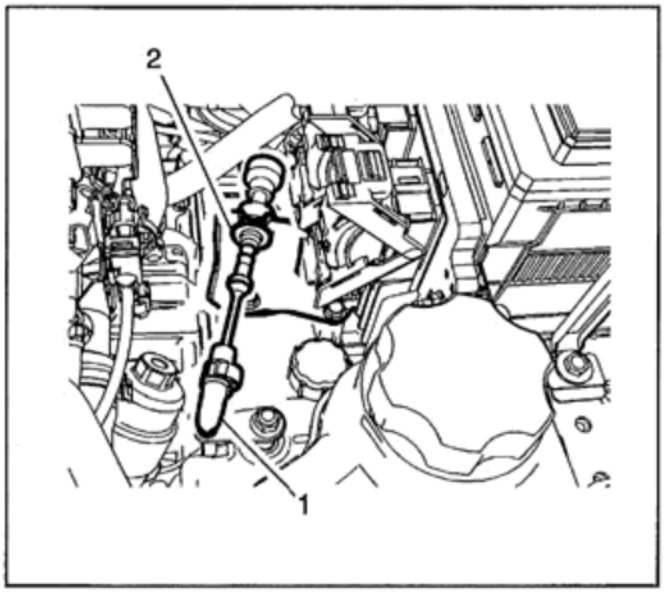
2513642

26. Install the radiator surge tank (2). Refer to *Radiator Surge Tank Replacement on page 9-630.*
27. Connect the fan connector.



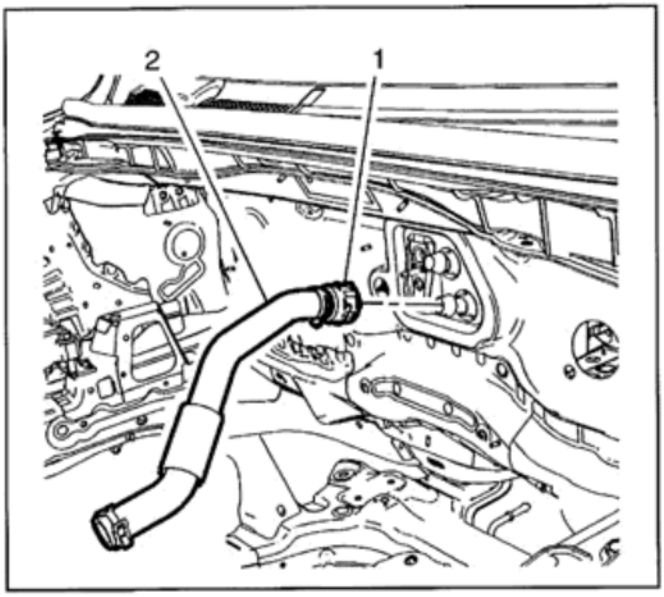
2512882

28. If equipped with manual transmission, Connect the shift lever and selector lever cable end (1) to the transmission shift lever and selector lever.
29. Connect the shift lever and selector lever cable to the shift lever and selector lever cable bracket.
30. Install the cable retainers (2) to the shift lever and selector lever cable bracket.



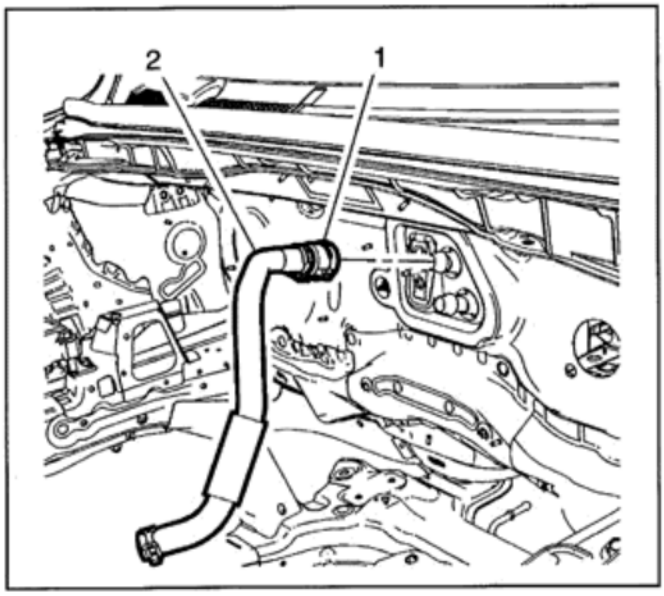
2492632

31. If equipped with automatic transmission, install the transmission range selector lever cable (2) to the cable bracket.
32. Connect the transmission range selector lever cable terminal (1) to the transmission manual shift lever pin.
33. Adjust the automatic transmission range selector lever cable. Refer to *Range Selector Lever Cable Adjustment on page 17-196.*



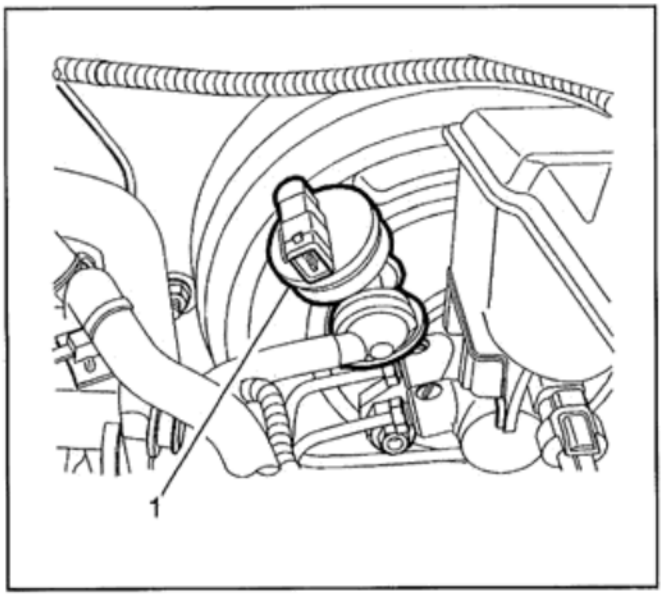
2495311

34. Connect the heater inlet hose (2) from the heater core. Refer to *Heater Inlet Hose Replacement (LDE, LUW) on page 10-38* or *Heater Inlet Hose Replacement (LUV) on page 10-38*.



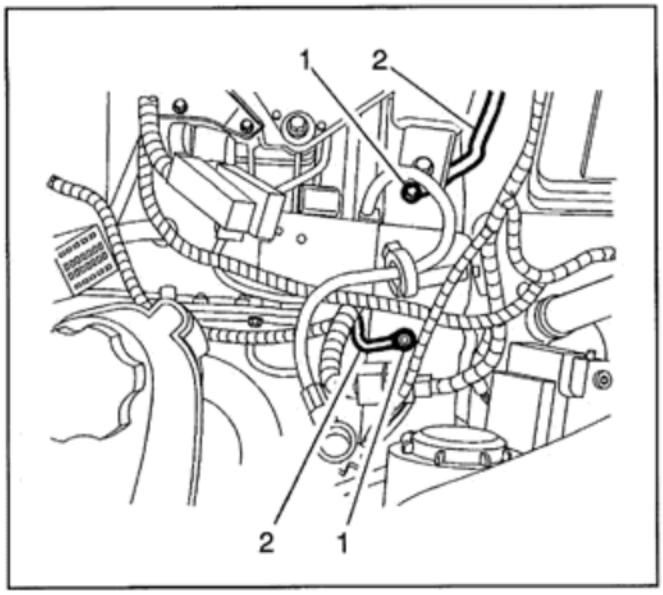
2495305

35. Connect the heater outlet hose (2) from the heater core. Refer to *Heater Outlet Hose Replacement (LUV) on page 10-40* or *Heater Outlet Hose Replacement (LDE, LUW) on page 10-40*.



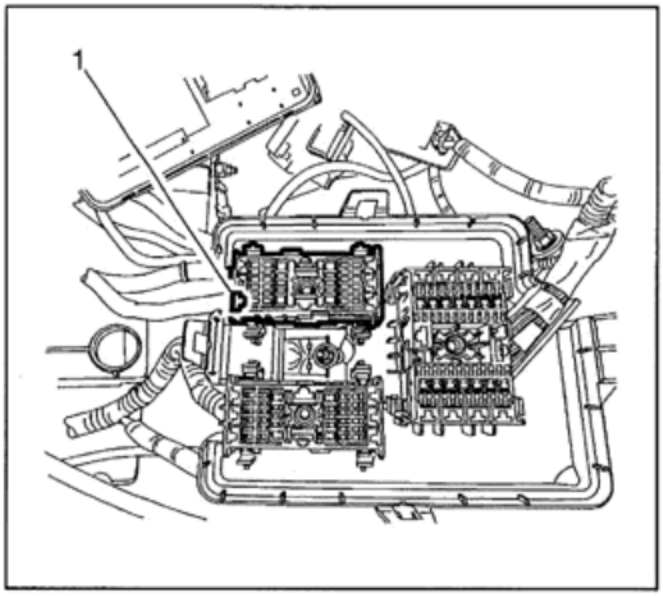
2534615

36. Connect the electrical connector and install the brake booster hose (1).



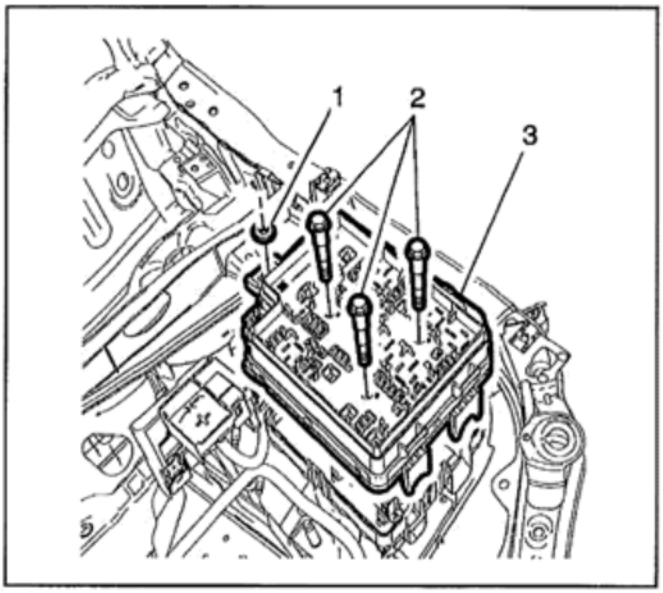
2539765

37. Install the ground nuts (1) and wiring harness (2).



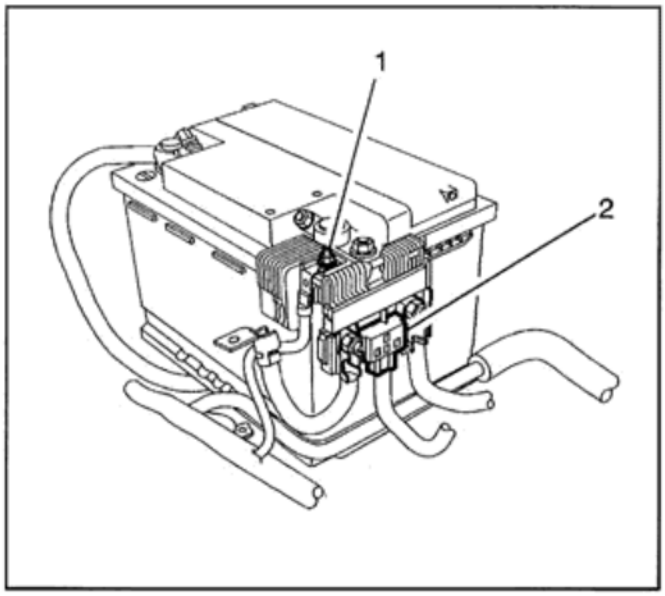
2539762

38. Clip in the wiring harness plugs (1).



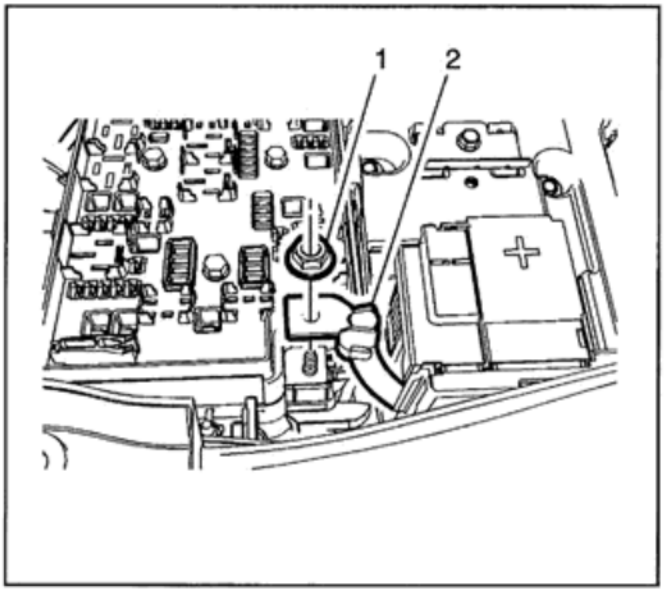
2539757

39. Install the junction block to the base (3).
40. Install the junction block bolts (2) and tighten to **5** N•m **(44 lb in)**.
41. Install the junction block nut (1) and tighten to **5** N•m **(44 lb in)**.



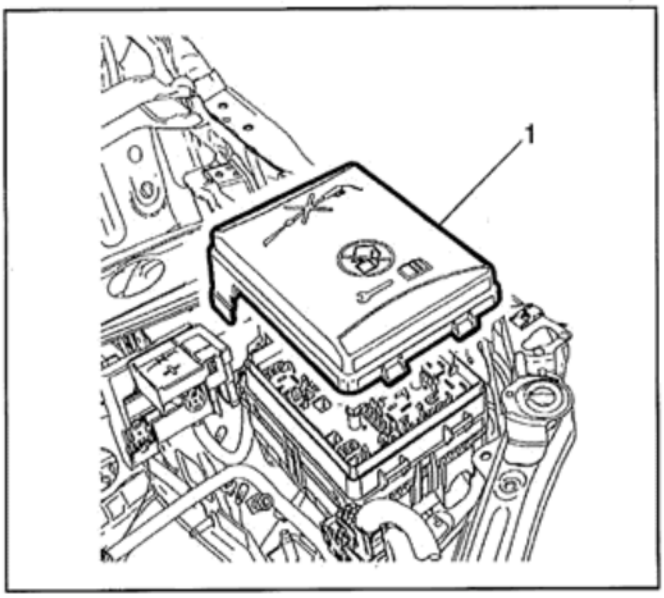
2539751

42. Install the battery positive cable to the battery positive cable junction block and tighten nut (1) to **5** N•m **(44 lb in)**.
43. Connect the body wiring master harness connector (2), to the battery positive cable junction block.



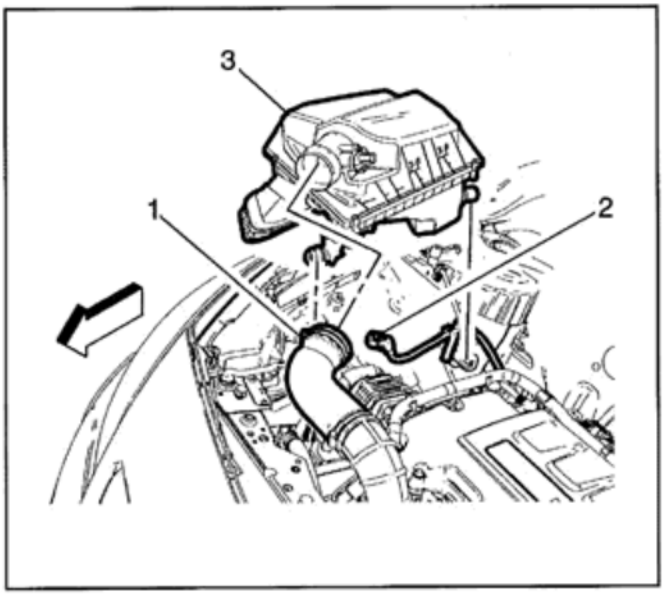
2504689

44. Position the positive battery cable (2) to the junction block.
45. Install the positive battery cable nut (1) and tighten to **7** N•m **(62 lb in)**.



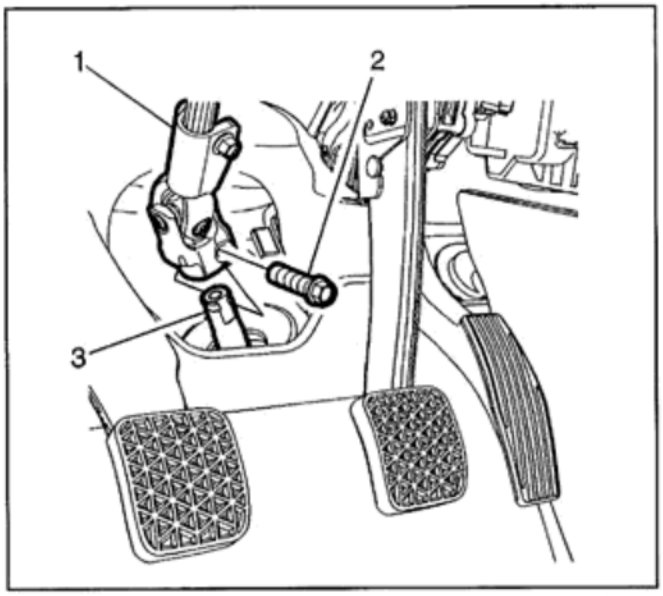
2539745

46. Install the junction block cover (1).



2680251

47. Install the air cleaner assembly (1). Refer to *Air Cleaner Assembly Replacement on page 9-582*.



2520388

48. Install the lower intermediate steering shaft bolt (1). Refer to *Intermediate Steering Shaft Replacement on page 15-27*.
49. Install the battery and battery tray. Refer *Battery Tray Replacement on page 9-721*.
50. Install the front tire and wheel assembly. Refer to *Tire and Wheel Removal and Installation on page 16-60*.
51. Install the front bumper fascia. Refer to *Front Bumper Fascia Replacement on page 3-55*.
52. Evacuate and charge the refrigerant system. Refer to *Refrigerant Recovery and Recharging on page 10-13*.
53. Fill the cooling system. Refer to *Cooling System Draining and Filling on page 9-628*.

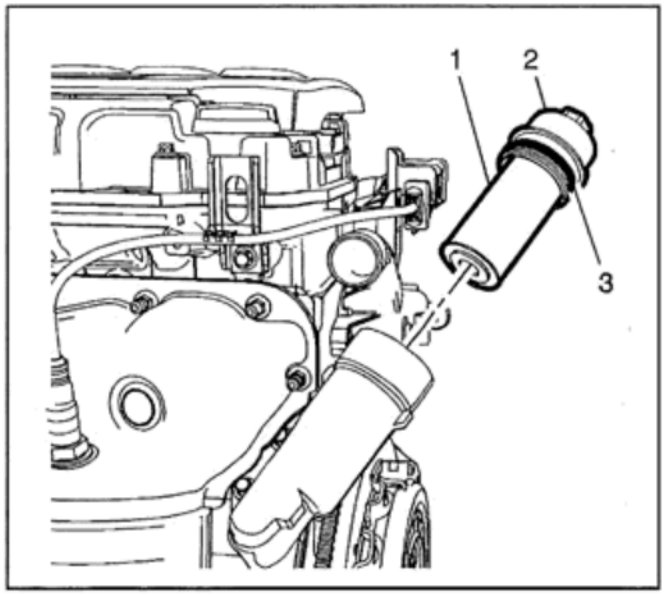
Engine Oil and Oil Filter Replacement

Removal Procedure

1. Open hood.
2. Place a drain pan below the vehicle.

Caution: To prevent damage to oil filter cap ensure proper tool is used. Do not use an open end wrench which may cause damage to filter cap.

3. Using a 24mm socket or closed end wrench loosen oil filter cap. Unscrew filter cap 3 turns and let oil filter and cap assembly drain in housing for 30 seconds.



2852124

Note: Use care when removing engine oil filter cap and filter to minimize fluid spillage. If fluid spillage occurs it must be cleaned with appropriate cleaner.

Note: Inspect oil filter cap for any cracks or damage. If oil filter cap is damaged it must be replaced.

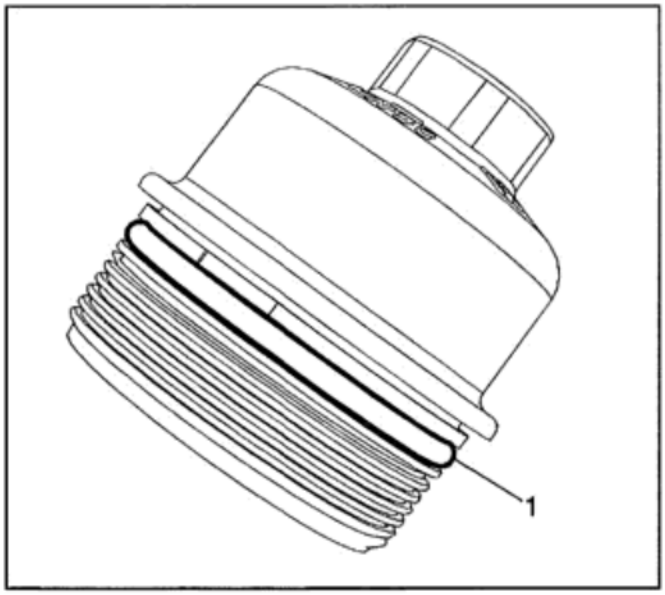
4. Remove the engine oil filter cap (2) with the engine oil filter cap seal ring (3) and the oil filter element (1).
5. Raise and support the vehicle. Refer to *Lifting and Jacking the Vehicle on page 1-31*.
6. Remove the oil pan drain plug and allow the oil to drain into the drain pan.

Installation Procedure

1. Clean the oil pan drain plug thread in the oil pan.
2. Install a NEW seal ring to the oil pan drain plug.

Caution: Refer to *Component Fastener Tightening Caution on page 0-8*.

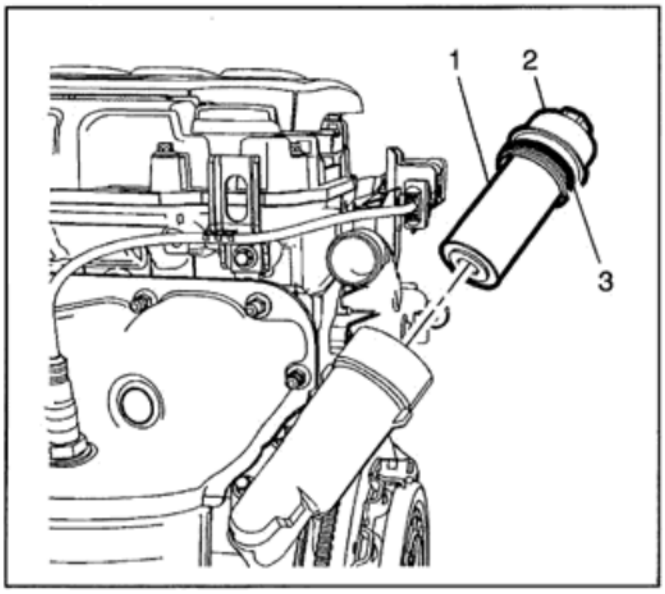
3. Install the oil pan drain plug and tighten to **14** N•m **(10 lb ft)**.
4. Lower the vehicle.



2852132

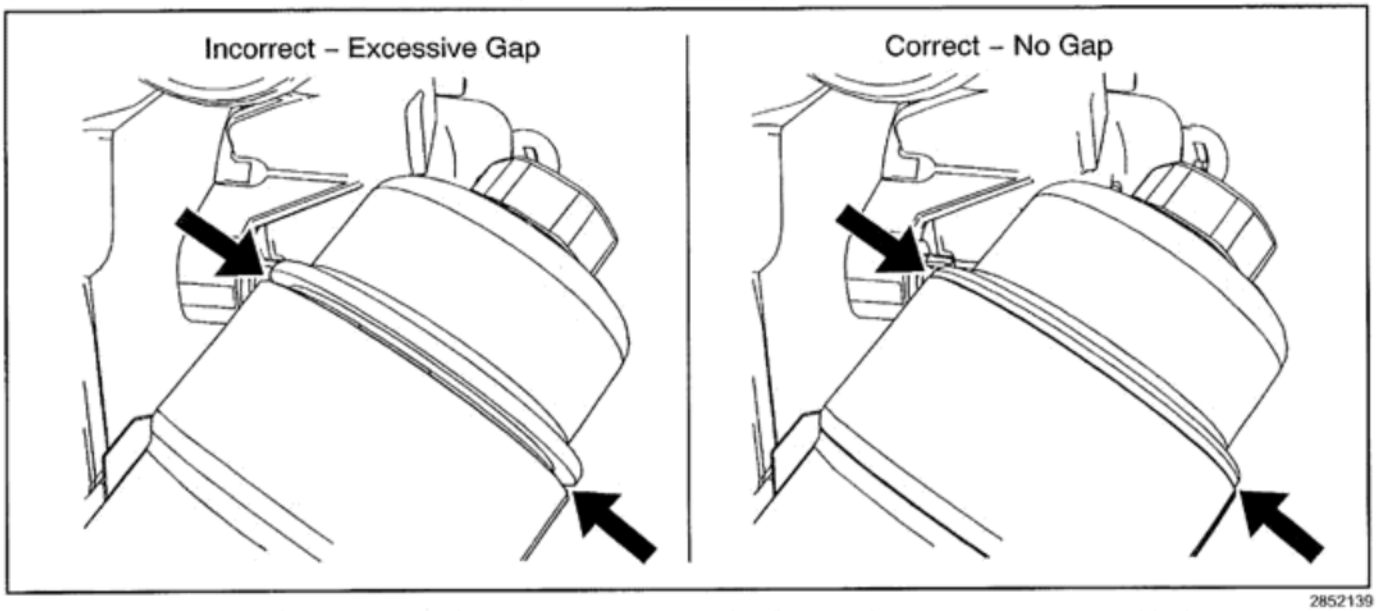
Note: Clean oil filter cap and lubricate the NEW oil filter cap seal ring with clean engine oil. Ensure oil filter cap seal ring is in proper position as shown.

5. Install a NEW oil filter cap seal ring (1).



2852124

6. Install the engine oil filter cap (2) with NEW engine oil filter cap seal ring (3) and NEW oil filter element (1) hand tight.



2852139

Caution: Ensure oil filter cap is completely seated on oil filter housing. If not completely seated an oil leak may occur.

Caution: Over torquing the oil filter cap may cause damage to the oil filter cap resulting in an oil leak.

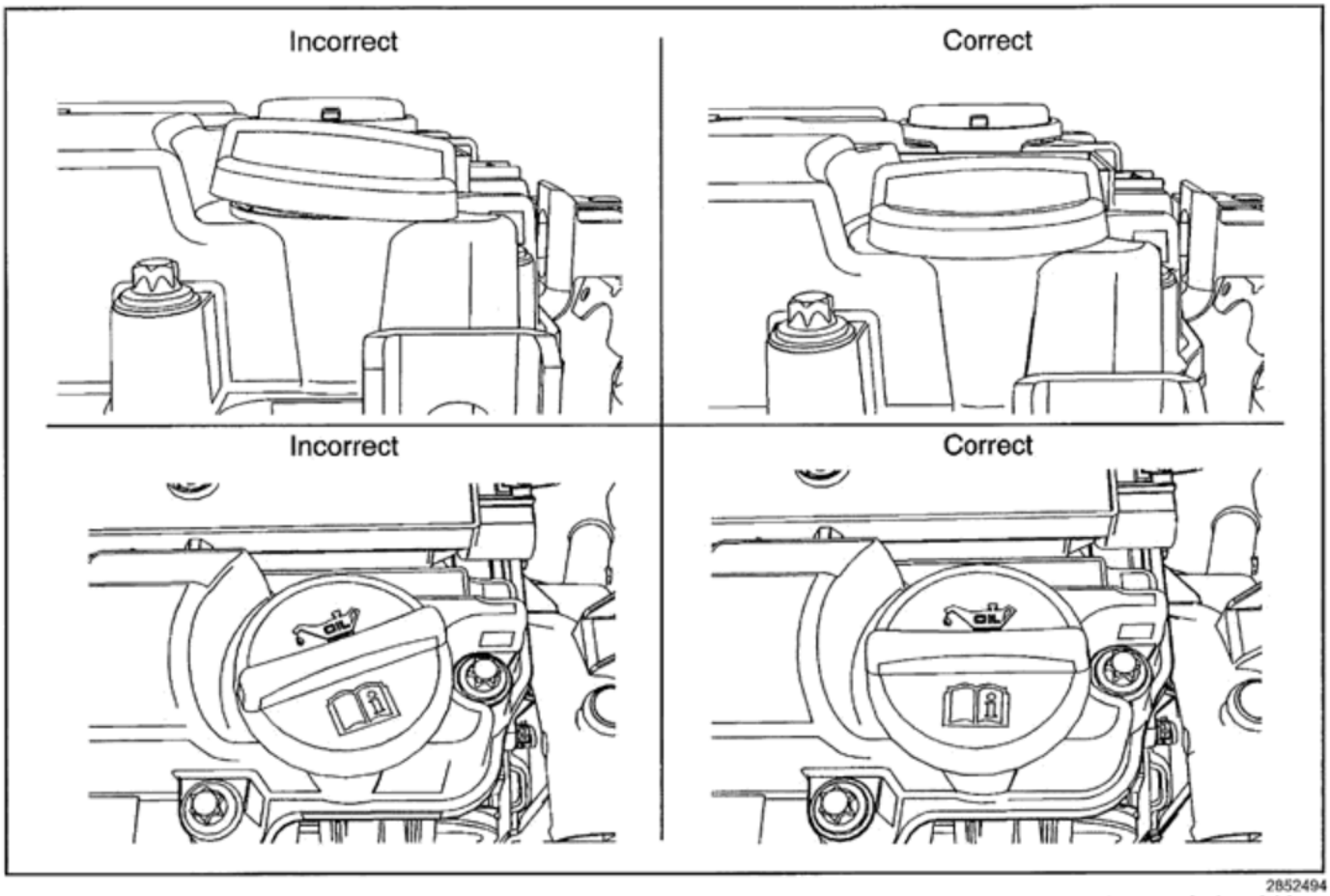
7. Using a 24mm socket or closed end wrench tighten the engine oil filter cap to **25 N•m (18 lb ft)**.

Caution: Using engine oils of any viscosity other than those viscosities recommended could result in engine damage.

Note: Do not overfill the engine with engine oil.

Note: Anytime engine oil is added (top off or oil changes) ensure all engine surfaces are completely free of residual oil. If there is oil on any engine surface clean as necessary.

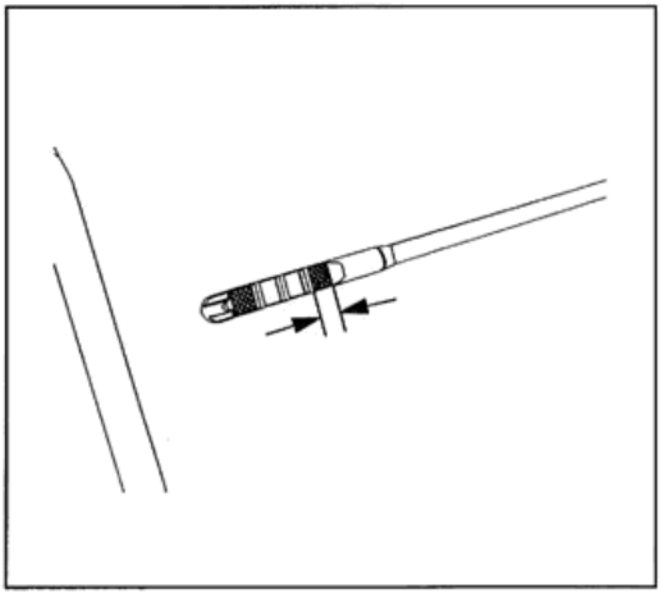
8. Fill engine with NEW oil using Dexos™1 5W-30 specification.



2852494

Note: Oil fill cap must be properly seated and tightened during installation.

9. Install oil fill cap.
10. Start the engine and allow it to run until the oil pressure control indicator goes off. Inspect for any oil leaks around the drain plug, oil filter and oil fill cap.



2852643

11. Inspect the engine oil level. The oil level should be in the cross-hatched section of the oil level indicator as shown.
12. Close hood.
13. Reset the engine oil life system monitor.

Turbocharger Replacement

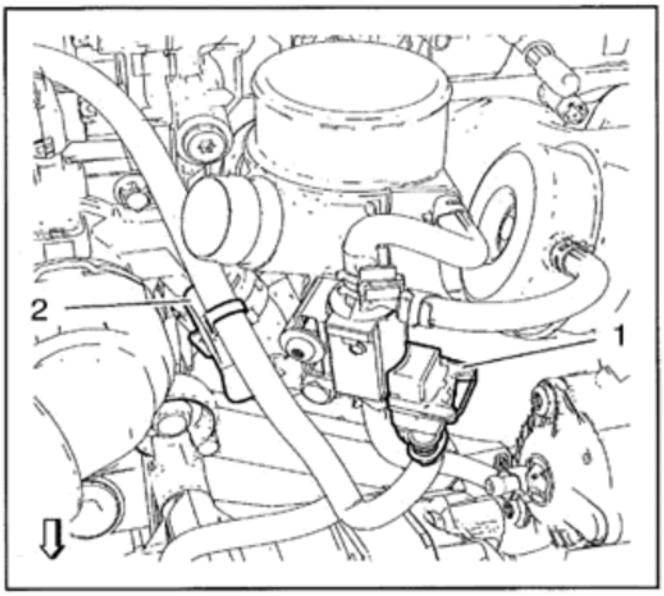
Special Tools

EN-49942 Holding Wrench

For equivalent regional tools, refer to *Special Tools on page 9-927*.

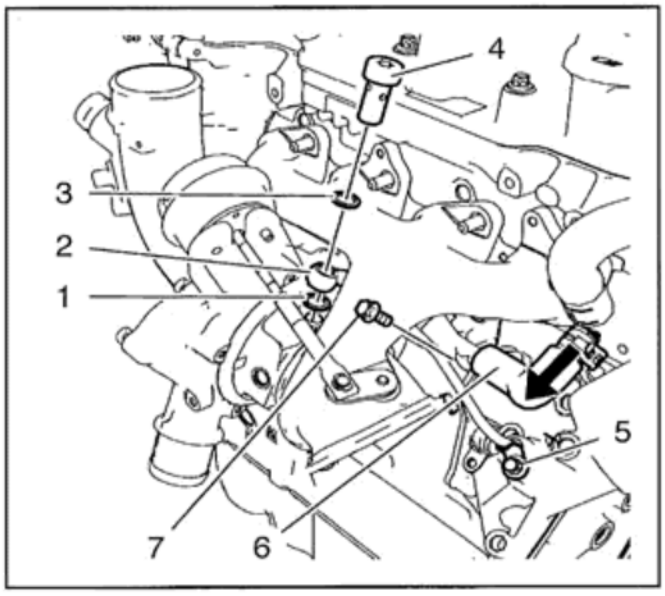
Removal Procedure

1. Disconnect battery negative cable. Refer to *Battery Negative Cable Disconnection and Connection on page 9-713*.
2. Drain the cooling system. Refer to *Cooling System Draining and Filling on page 9-628*.
3. Remove the air cleaner outlet duct. Refer to *Air Cleaner Outlet Duct Replacement on page 9-288*.
4. Disconnect the positive crankcase ventilation pipe from turbocharger. Refer to *Positive Crankcase Ventilation Hose/Pipe/Tube Replacement on page 9-819*.
5. Remove the exhaust manifold heat shield. Refer to *Exhaust Manifold Heat Shield Replacement (LUV) on page 9-749* or *Exhaust Manifold Heat Shield Replacement (LUW) on page 9-750*.



2192219

6. Disconnect the turbocharger wastegate regulator solenoid valve wiring harness connector (1) and unclip wiring harness from retainer clip (2).

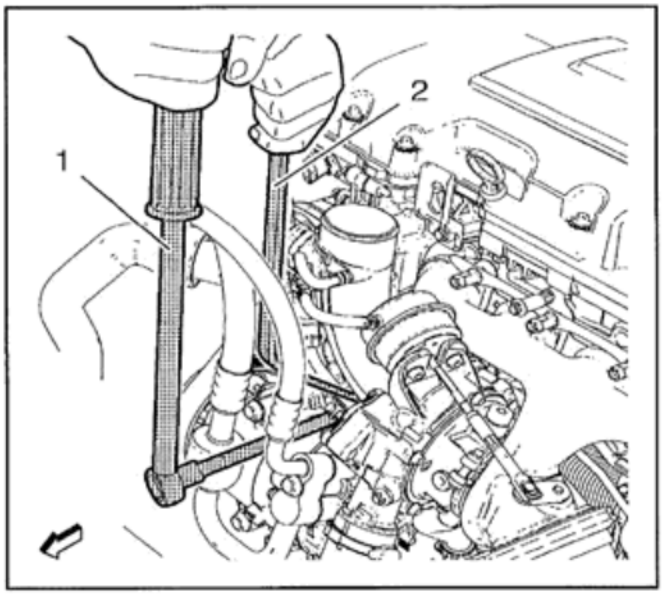


2190428

7. Remove the turbocharger oil feed pipe hollow screw (4).
8. Remove and DISCARD the 2 seal rings (1) and (3).
9. Remove the turbocharger oil feed pipe bolt (5).

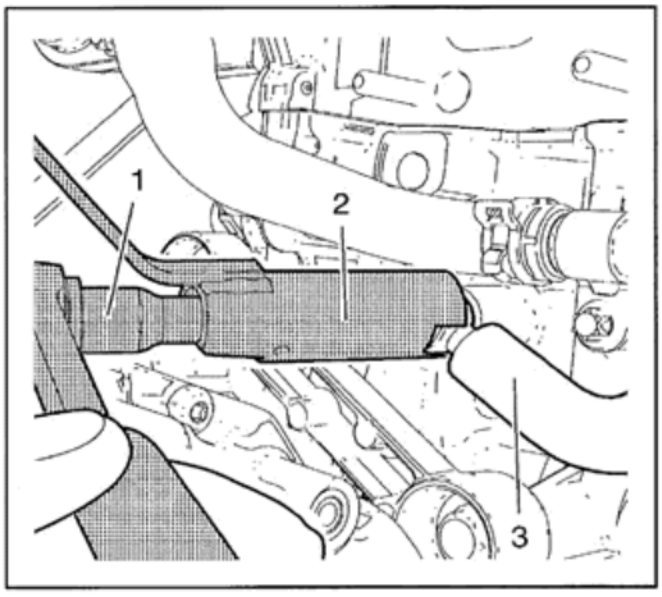
Note: Close the screw bore in the turbocharger in order to avoid contamination.

10. Remove the turbocharger oil feed pipe (2).
11. Loosen the turbocharger coolant return hose clamp and remove the turbocharger coolant return hose (6) from the oil cooler inlet pipe.
12. Remove the turbocharger coolant return pipe bolt (7).
13. Remove the charge air cooler inlet air hose from the turbocharger. Refer to *Charge Air Cooler Inlet Air Hose Replacement on page 9-292*.



2192010

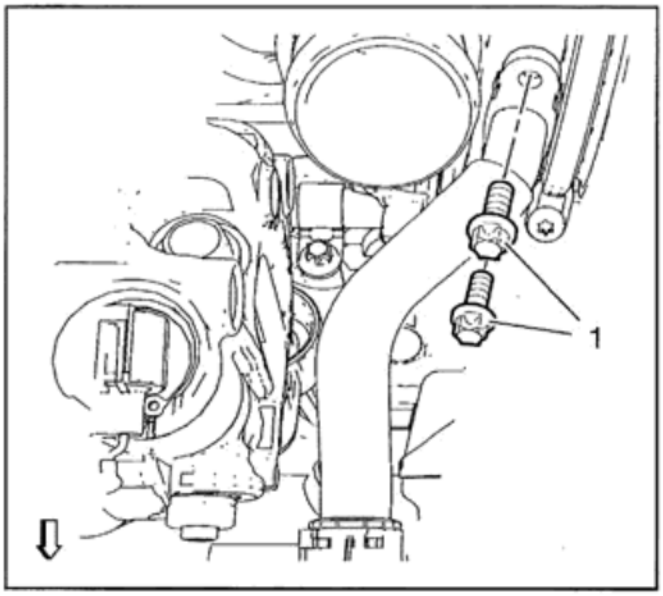
14. Install the *EN-49942* holding wrench (2) to the turbocharger coolant feed pipe. Guide a ratchet wrench (1) along with an extension through *EN-49942* holding wrench to the turbocharger coolant feed pipe hollow screw.



2192009

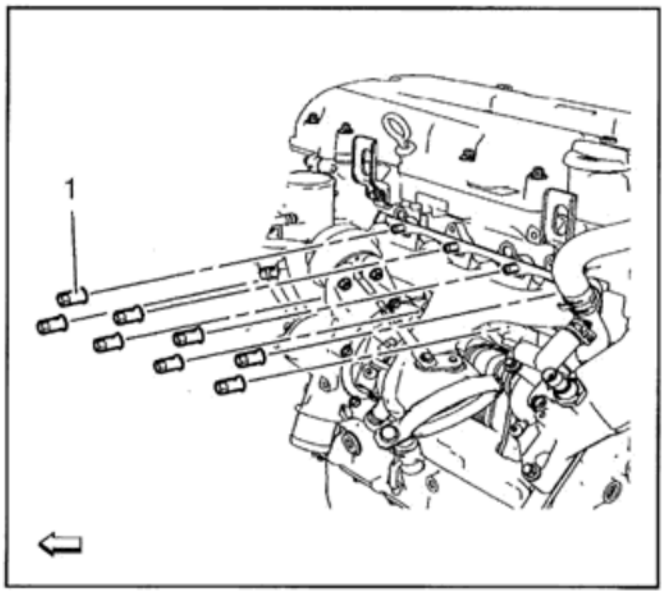
Note: *EN-49942* holding wrench (2) should be installed to turbocharger coolant feed pipe as shown. The holding wrench should be installed to avoid twist of the turbocharger coolant feed pipe during the loosening procedure.

15. Loosen the turbocharger coolant feed pipe hollow screw with ratchet wrench and extension (1).
16. Remove the turbocharger coolant feed pipe hollow screw.
17. Remove and DISCARD the 2 seal rings.
18. Remove the three way warm catalytic converter. Refer to *Catalytic Converter Replacement (LUV) on page 9-742*.



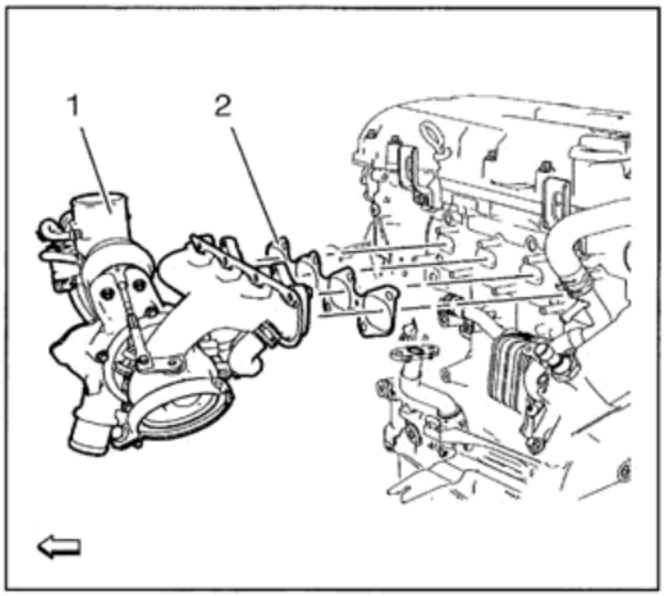
2192221

19. Remove the 2 turbocharger oil return pipe bolts (1) from turbocharger.
20. Remove the turbocharger oil return pipe from the turbocharger.
21. Remove and DISCARD the gasket.



2192236

22. Remove and DISCARD the 8 turbocharger nuts (1).

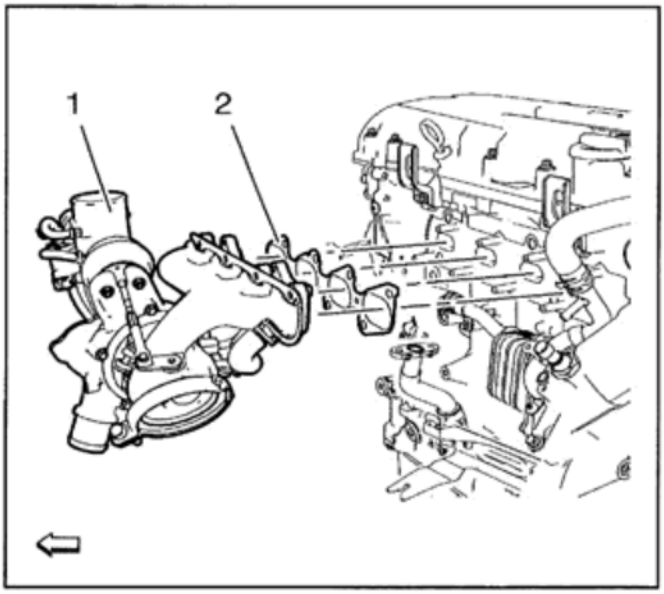


2192371

23. Remove the turbocharger assembly (1).
24. Remove and DISCARD the turbocharger gasket (2).
25. Remove the assembly parts from the turbocharger as necessary. Refer to *Turbocharger Disassemble on page 9-894*.
26. If the turbocharger is being reused, refer to *Turbocharger Cleaning and Inspection on page 9-895*.

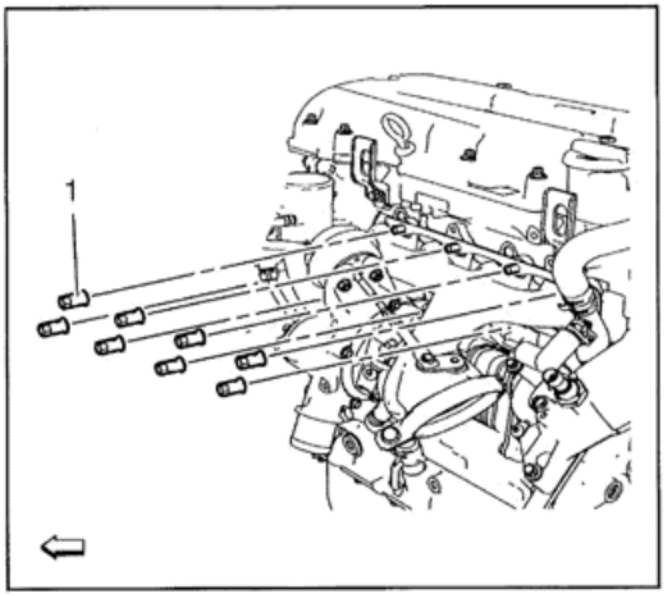
Installation Procedure

1. Install the assembly parts to the turbocharger as necessary. Refer to *Turbocharger Assemble on page 9-895*.
2. Clean the sealing surfaces.



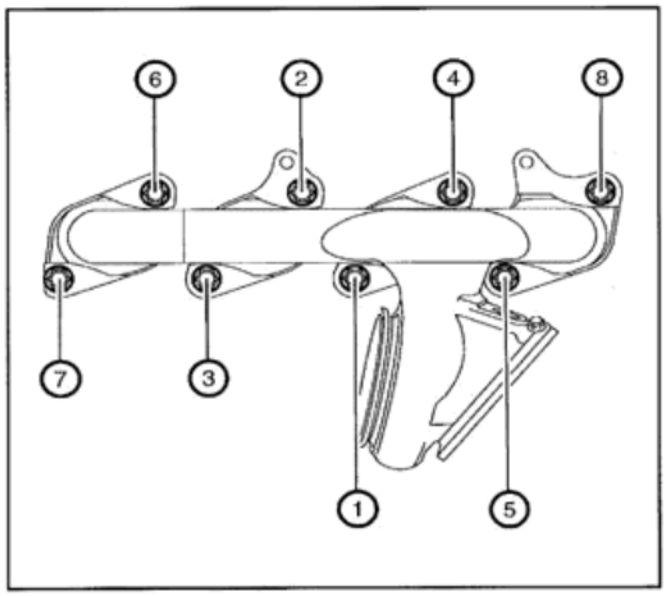
2192371

3. Install a NEW turbocharger gasket.
4. Install the turbocharger assembly (1).



2192236

5. Install the 8 NEW turbocharger nuts (1).

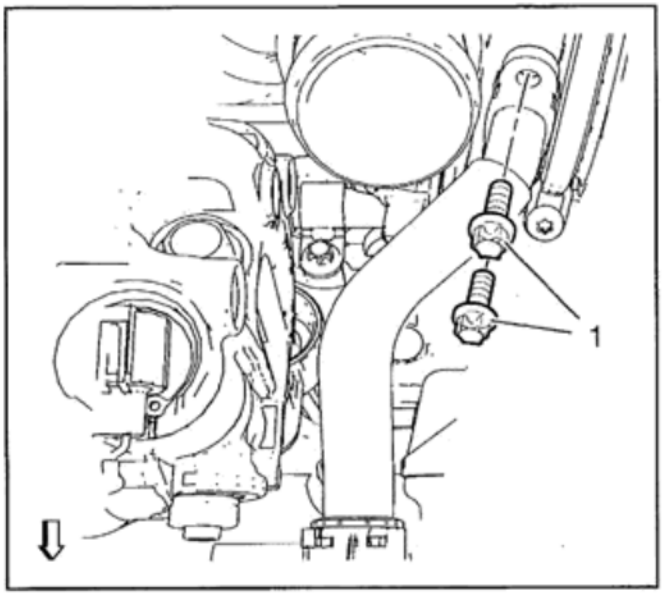


2192286

Caution: Refer to *Fastener Caution on page 0-8*.

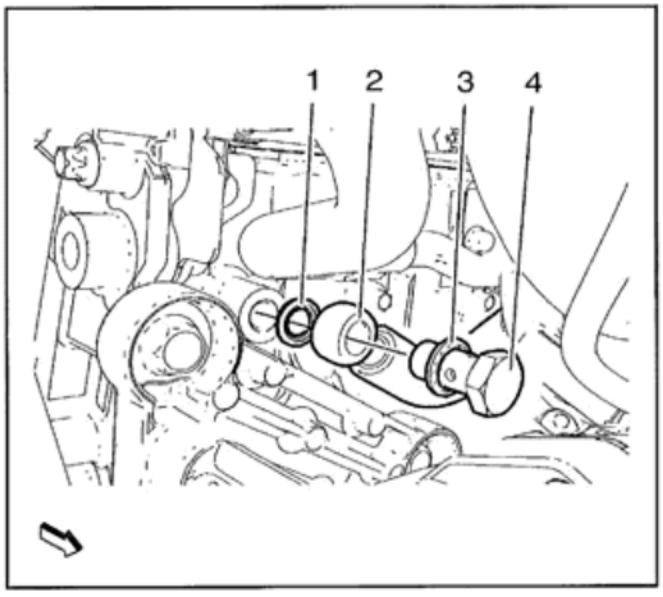
Caution: Refer to *Torque-to-Yield Fastener Caution on page 0-10*.

6. Tighten the 8 turbocharger nuts in a sequence as shown to **8 N•m (71 lb in)**.
7. Repeat the tightening procedure to ensure a proper fastening of the turbocharger nuts.



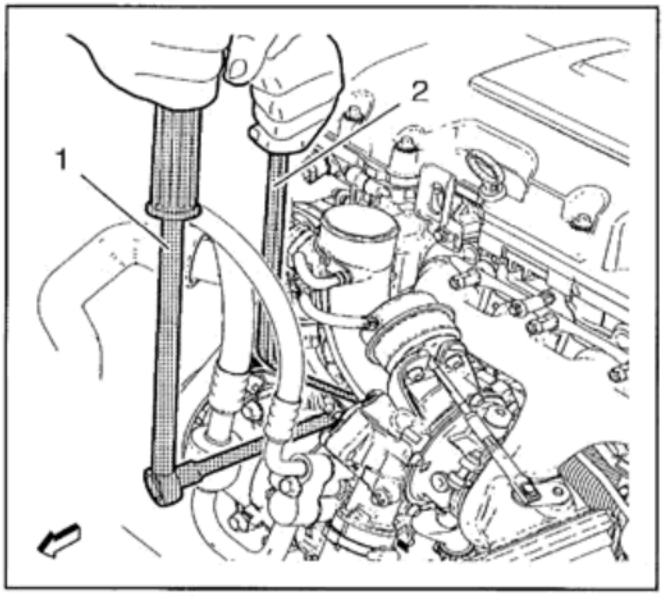
2192221

8. Install a NEW gasket and the 2 turbocharger oil return pipe bolts (1) and tighten to **8 N•m (71 lb in)**.
9. Install the three way warm up catalytic converter. Refer to *Catalytic Converter Replacement (LUV) on page 9-742*.



2192246

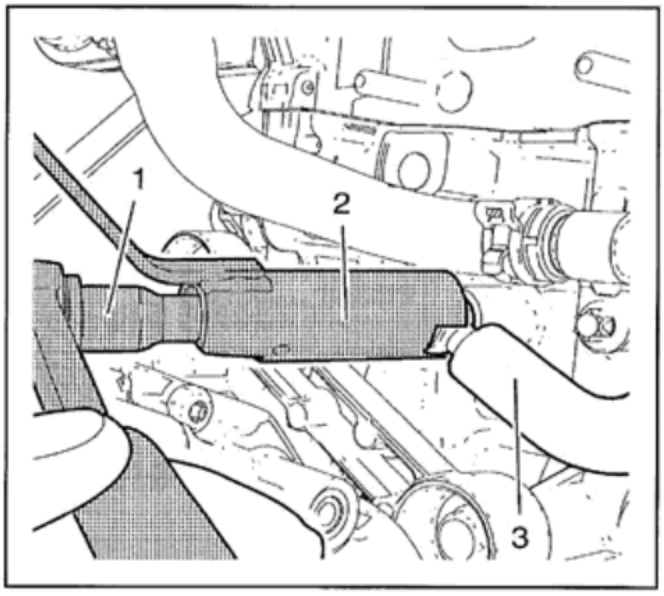
10. Install the turbocharger coolant feed pipe to the engine block. Use the following procedure:
    - Install a NEW seal ring (3) to the turbocharger coolant feed pipe hollow screw (4).
    - Install the turbocharger coolant feed pipe hollow screw along with the seal ring to the turbocharger coolant feed pipe (2).
    - Install a NEW seal ring (1) to the turbocharger coolant feed pipe hollow screw.
    - Install the turbocharger coolant feed pipe hollow screw along with the turbocharger coolant feed pipe and the 2 seal rings to the engine.



2192010

Note: The *EN-49942* holding wrench should be installed in a perpendicular position as shown to ensure a proper installation position of the turbocharger coolant feed pipe.

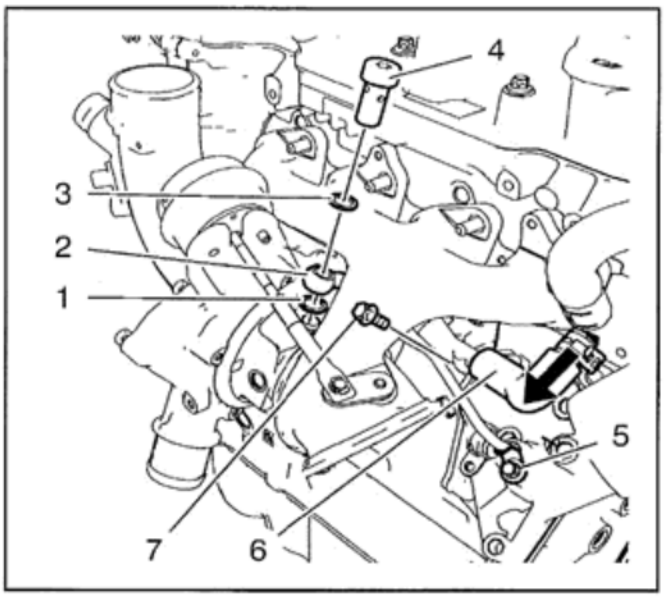
11. Install the *EN-49942* holding wrench (2) to the turbocharger coolant feed pipe. Guide a ratchet wrench (1) along with an extension through *EN-49942* holding wrench to the turbocharger coolant feed pipe hollow screw.



2192009

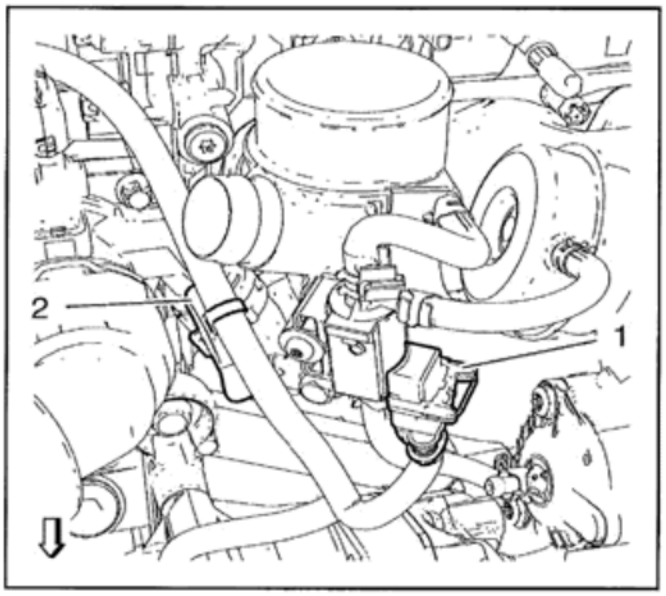
Note: *EN-49942* holding wrench (2) should be installed to the turbocharger coolant feed pipe as shown. The holding wrench should be installed to avoid twist of the turbocharger coolant feed pipe during the fastening procedure.

12. Tighten the turbocharger coolant feed pipe hollow screw with ratchet wrench and extension (1) to **30** N•m **(22 lb ft)**.
13. Install the charge air cooler inlet air hose to the turbocharger. Refer to *Charge Air Cooler Inlet Air Hose Replacement on page 9-292*.



2190428

14. Install the turbocharger coolant return pipe bolt (7) and tighten to **8** N•m **(71 lb in)**.
15. Install the turbocharger coolant return hose (6) to the oil cooler inlet pipe.
16. Install the turbocharger coolant return hose clamp.
17. Install the turbocharger oil feed pipe (2) to the oil cooler and the turbocharger.
18. Install the turbocharger oil feed pipe bolt (5).
19. Install the turbocharger oil feed pipe hollow screw (4) along with the 2 NEW seal rings (1) and (3) and tighten to **30** N•m **(22 lb ft)**.
20. Tighten the turbocharger oil feed pipe bolt to **10** N•m **(89 lb in)**.



2192219

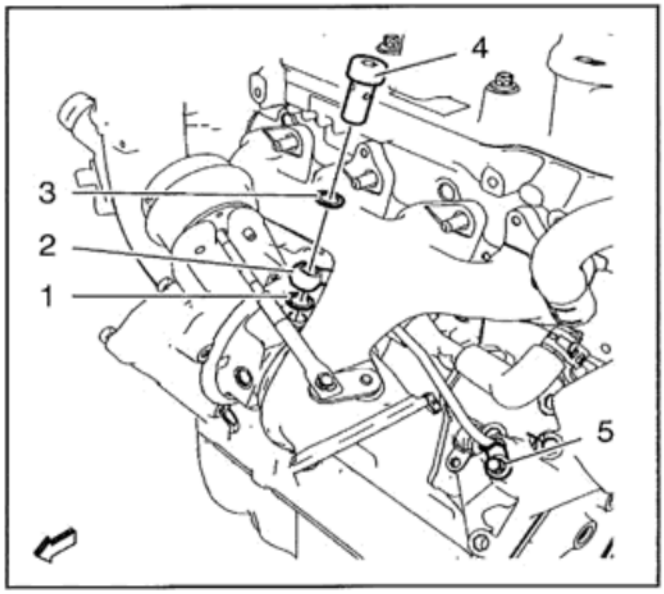
21. Connect the turbocharger wastegate regulator solenoid valve wiring harness connector (1) and clip in wiring harness to retainer clip (2).

22. Install the exhaust manifold heat shield. Refer to *Exhaust Manifold Heat Shield Replacement (LUV) on page 9-749* or *Exhaust Manifold Heat Shield Replacement (LUW) on page 9-750*.
23. Connect the positive crankcase ventilation pipe to the turbocharger. Refer to *Positive Crankcase Ventilation Hose/Pipe/Tube Replacement on page 9-819*.
24. Install the air cleaner outlet duct. Refer to *Air Cleaner Outlet Duct Replacement on page 9-288*.
25. Connect battery negative cable. Refer to *Battery Negative Cable Disconnection and Connection on page 9-713*.
26. Fill the cooling system. Refer to *Cooling System Draining and Filling on page 9-628*.

Turbocharger Oil Feed Pipe Replacement

Removal Procedure

1. Open the hood.
2. Disconnect battery negative cable. Refer to *Battery Negative Cable Disconnection and Connection on page 9-713*.
3. Remove the exhaust manifold heat shield. Refer to *Exhaust Manifold Heat Shield Replacement (LUV) on page 9-749* or *Exhaust Manifold Heat Shield Replacement (LUW) on page 9-750*.

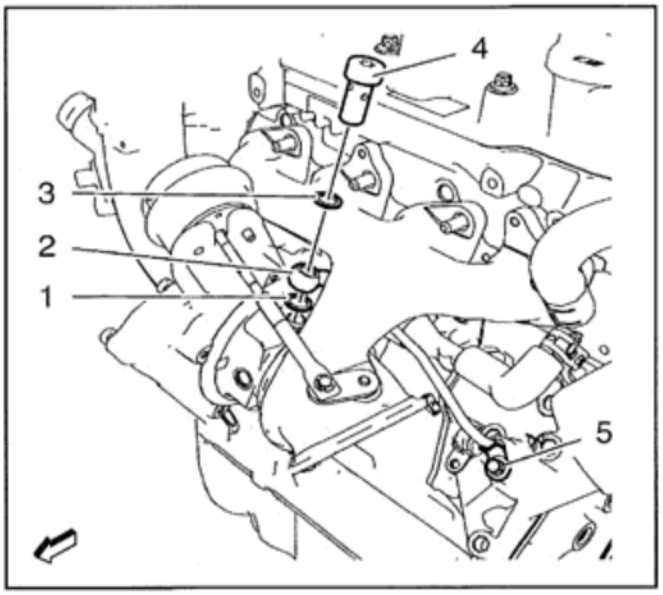


2192280

4. Remove the turbocharger oil feed pipe bolt (5).
5. Remove the turbocharger oil feed pipe hollow screw (4) and the 2 seal rings (1) and (3).
6. Remove the turbocharger oil feed pipe (2) and the rubber seal ring.

Installation Procedure

1. Clean the sealing surfaces.



2192280

2. Install the turbocharger oil feed pipe (2) along with a NEW rubber seal ring.
3. Install the turbocharger oil feed pipe hollow screw (4) and 2 NEW seal rings (1) and (3).

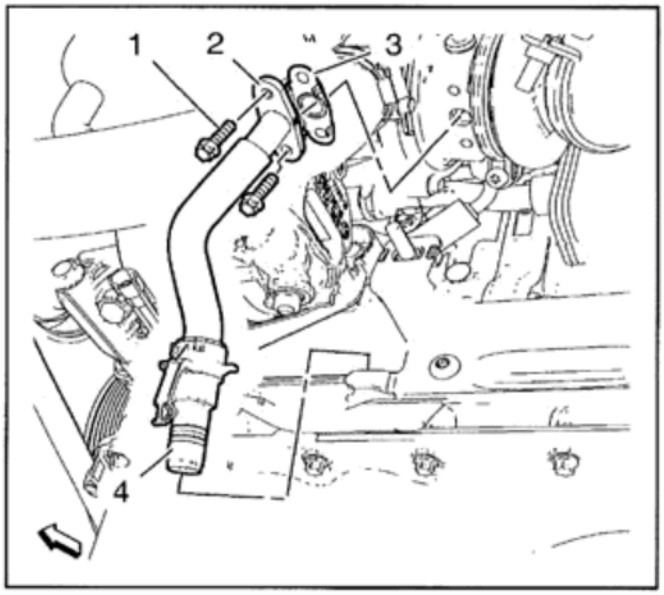
Caution: Refer to *Fastener Caution on page 0-8*.

4. Install the turbocharger oil feed pipe bolt (5) and tighten to **10 N•m (89 lb in)**.
5. Tighten the turbocharger oil feed pipe hollow screw to **30 N•m (22 lb ft)**.
6. Install the exhaust manifold heat shield. Refer to *Exhaust Manifold Heat Shield Replacement (LUV) on page 9-749* or *Exhaust Manifold Heat Shield Replacement (LUW) on page 9-750*.
7. Connect battery negative cable. Refer to *Battery Negative Cable Disconnection and Connection on page 9-713*.
8. Close the hood.

Turbocharger Oil Return Pipe Replacement

Removal procedure

1. Remove the drivetrain and front suspension frame skid plate, if equipped. Refer to*Drivetrain and Front Suspension Frame Skid Plate Replacement on page 3-143.*



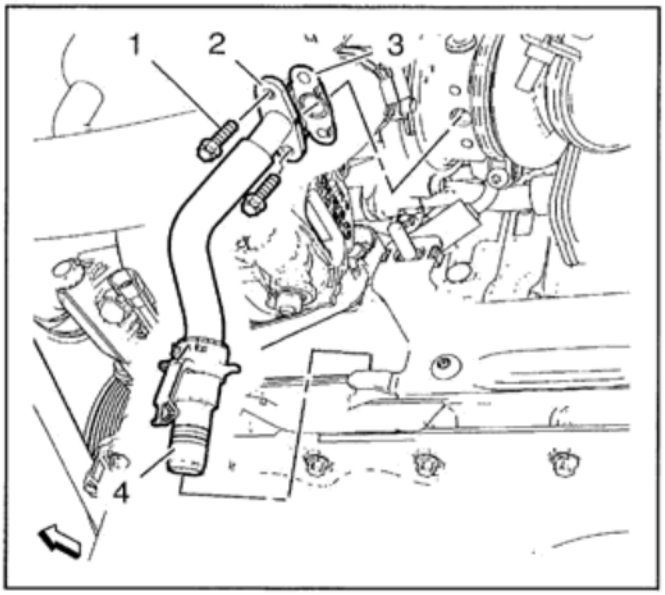
2192288

Note: Simplified Graphic. DO NOT remove the warm up three way catalytic converter.

2. Remove the 2 turbocharger oil return pipe bolts (1).
3. Place a drain pan below the vehicle.
4. Release the turbocharger oil return pipe connector (4) and disconnect the turbocharger oil return pipe from the engine block.
5. Remove the turbocharger oil return pipe (2) and the gasket (3).

Installation Procedure

1. Clean the sealing surfaces.



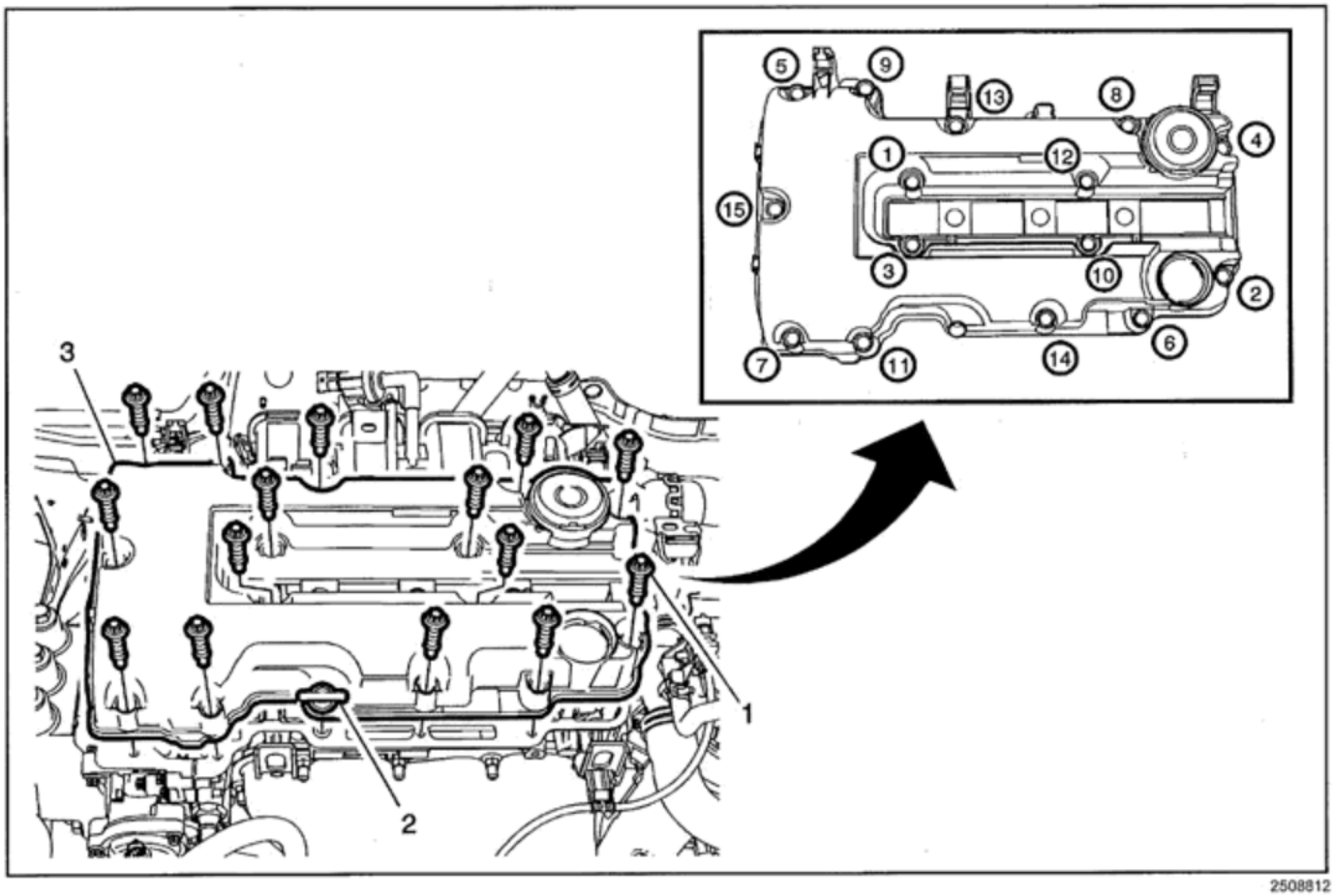
2192288

2. Install the turbocharger oil return pipe (2) in compound with a NEW gasket (3) and connect to the engine block.

Caution: Refer to *Fastener Caution on page 0-8.*

3. Install the 2 turbocharger oil return pipe bolts (1) and tighten to **8 N•m (71 lb in)**.
4. Lower the vehicle.
5. Check engine oil level.
6. Install the drivetrain and front suspension frame skid plate, if equipped. Refer to*Drivetrain and Front Suspension Frame Skid Plate Replacement on page 3-143.*

Camshaft Cover Replacement



2508812

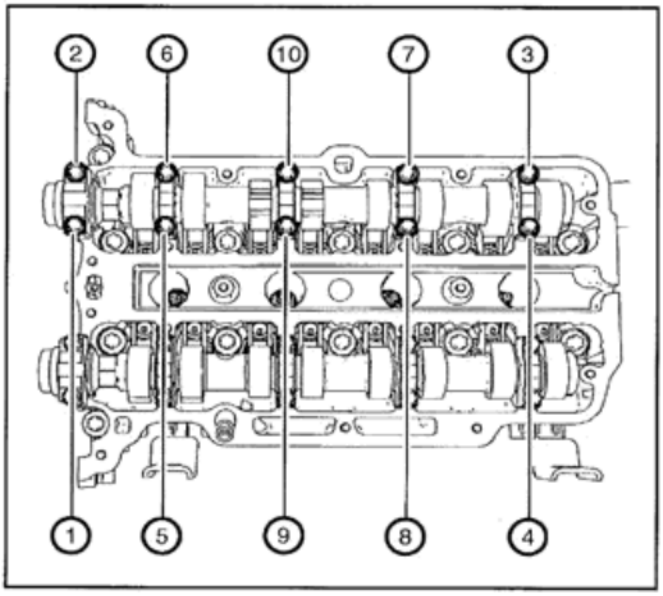
Camshaft Cover Replacement

Callout	Component Name
Preliminary Procedure Remove the ignition coil. Refer to *Ignition Coil Replacement on page 9-277*.	
1	Camshaft Cover Fastener (Qty: 15) **Caution:** Refer to *Fastener Caution on page 0-8*. **Procedure** Ensure to follow the tighten sequence shown. **Tighten** 8 N•m (71 lb in)
2	Oil Level Indicator **Tip:** Remove the oil level indicator from camshaft cover.
3	Camshaft Cover **Procedure** 1. Remove or reposition the clips as necessary. 2. Do not reuse the camshaft gasket. Also use a new gasket whenever removing or replacing camshaft cover. 3. Disconnect electrical connector as necessary. 4. Transfer components as necessary.

Intake Camshaft Replacement

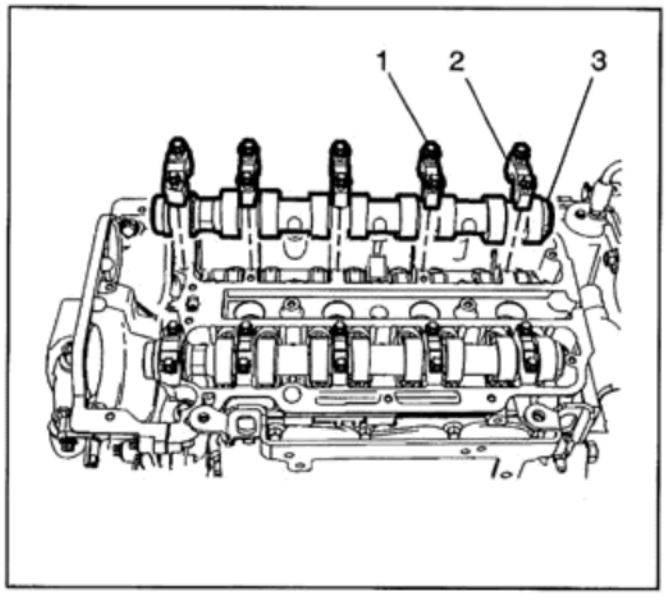
Removal Procedure

1. Remove the camshaft intake and exhaust sprocket. Refer to *Camshaft Intake and Exhaust Sprocket Replacement on page 9-800*.



2190728

2. Remove the camshaft bearing cap bolts in sequence shown. Ensure to remove the bolts one turn at a time until there is no spring tension pushing on the camshaft.

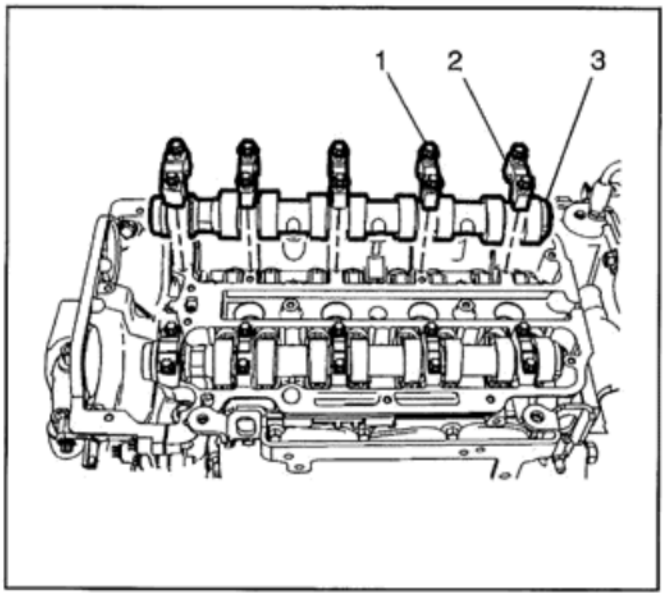


2403116

Note: Mark the camshafts bearing caps and the camshaft upon removal to ensure installation is in the correct position.

3. Remove the camshaft bearing cap bolts (1).
4. Remove the camshaft bearing caps (2).
5. Remove the intake camshaft (3).

Installation Procedure



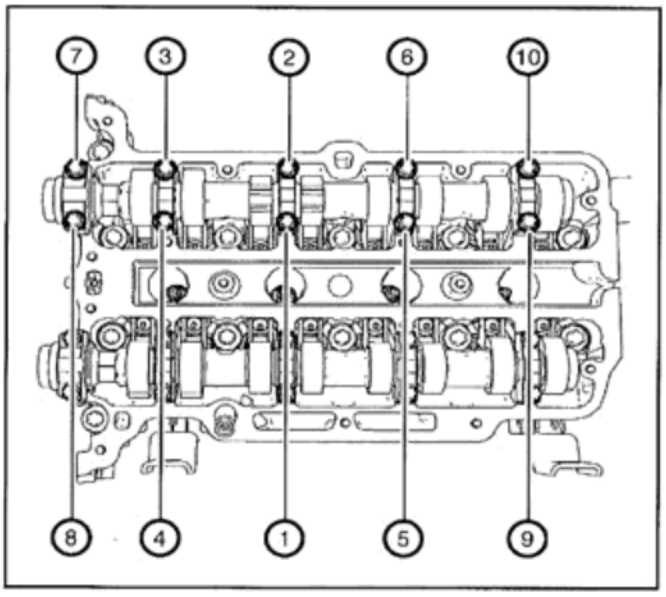
2403116

Note: Ensure that the camshaft sealing rings are in place in the camshaft grooves. Camshaft sealing rings must be in place below the surface of the camshaft journal in order to avoid being pinched between the cylinder head and the camshaft caps.

1. Lubricate the camshaft and camshaft bearing caps with engine oil.
2. Install the intake camshaft (3).
3. Install the camshaft bearing caps (2).

Caution: Refer to *Fastener Caution on page 0-8*.

4. Install the camshaft bearing cap bolts and tighten the bolts hand tight (1).



2190731

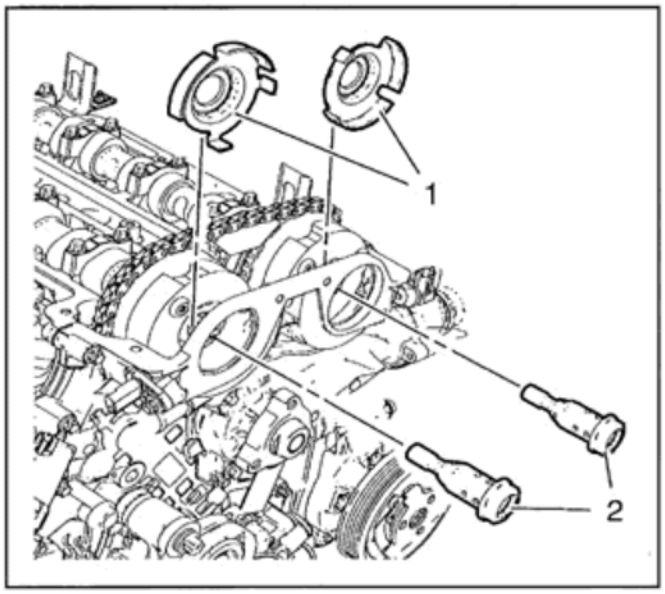
5. Install and tighten the camshaft bearing cap bolts one turn at a time in sequence as shown to **8 N•m (71 lb in)**.

6. Install the camshaft intake and exhaust sprocket. Refer to *Camshaft Intake and Exhaust Sprocket Replacement on page 9-800.*

Exhaust Camshaft Replacement

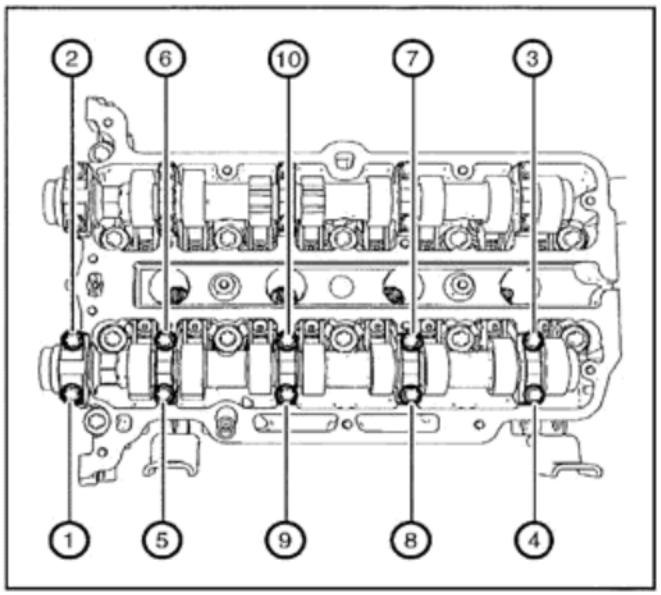
Removal Procedure

1. Remove the camshaft intake and exhaust sprocket. Refer to *Camshaft Intake and Exhaust Sprocket Replacement on page 9-800.*



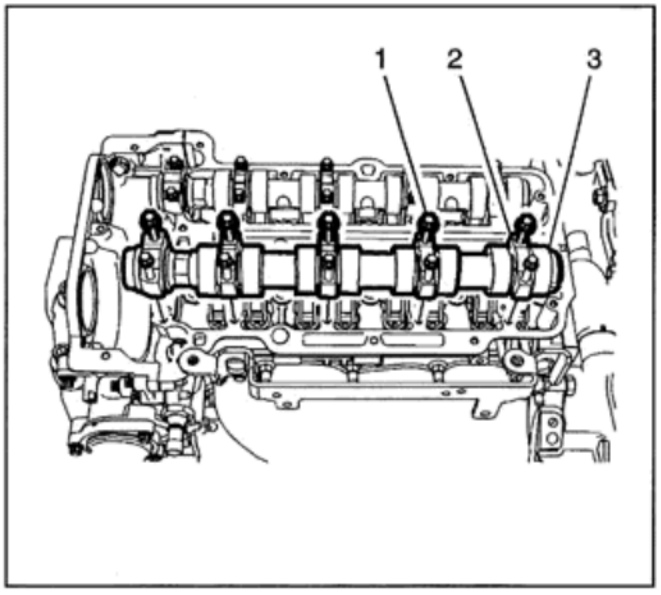
2191382

2. Remove and DISCARD the camshaft sprocket bolts (2) and the camshaft position exciter wheels (1).
3. Allow the both camshaft sprockets with the timing chain to rest on the engine front cover.



2190732

4. Remove the camshaft bearing cap bolts in sequence shown. Ensure to remove the bolts one turn at a time until there is no spring tension pushing on the camshaft.

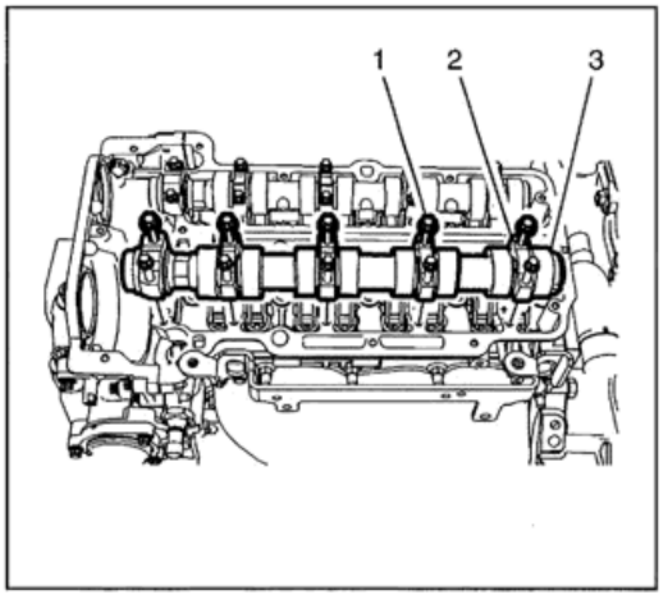


2403118

Note: Mark the camshafts upon removal to ensure installation is in the correct position.

5. Remove the camshaft bearing cap bolts (1).
6. Remove the camshaft bearing caps (2).
7. Remove the exhaust camshaft (3).

Installation Procedure



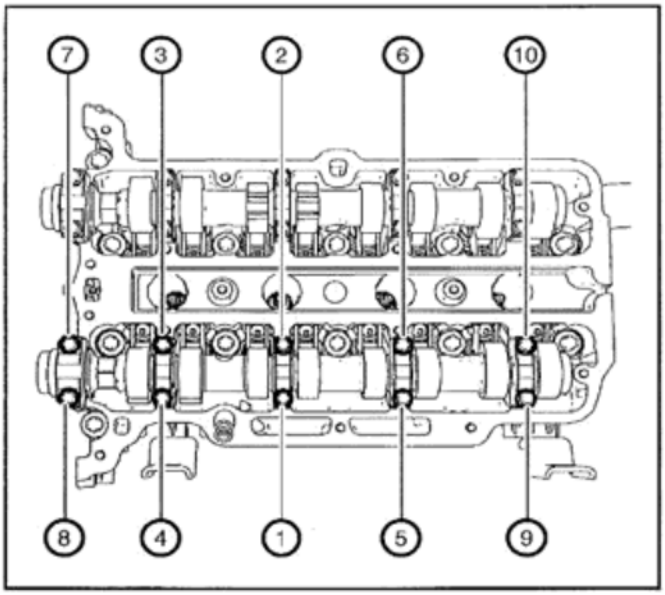
2403118

Note: Ensure that the camshaft sealing rings are in place in the camshaft grooves. Camshaft sealing rings must be in place below the surface of the camshaft journal in order to avoid being pinched between the cylinder head and the camshaft caps.

1. Lubricate camshaft and camshaft bearing caps with engine oil.
2. Install the exhaust camshaft (3).
3. Install the camshaft bearing caps (2).

Caution: Refer to *Fastener Caution on page 0-8*.

4. Install the camshaft bearing cap and hand tighten the bolts (1).

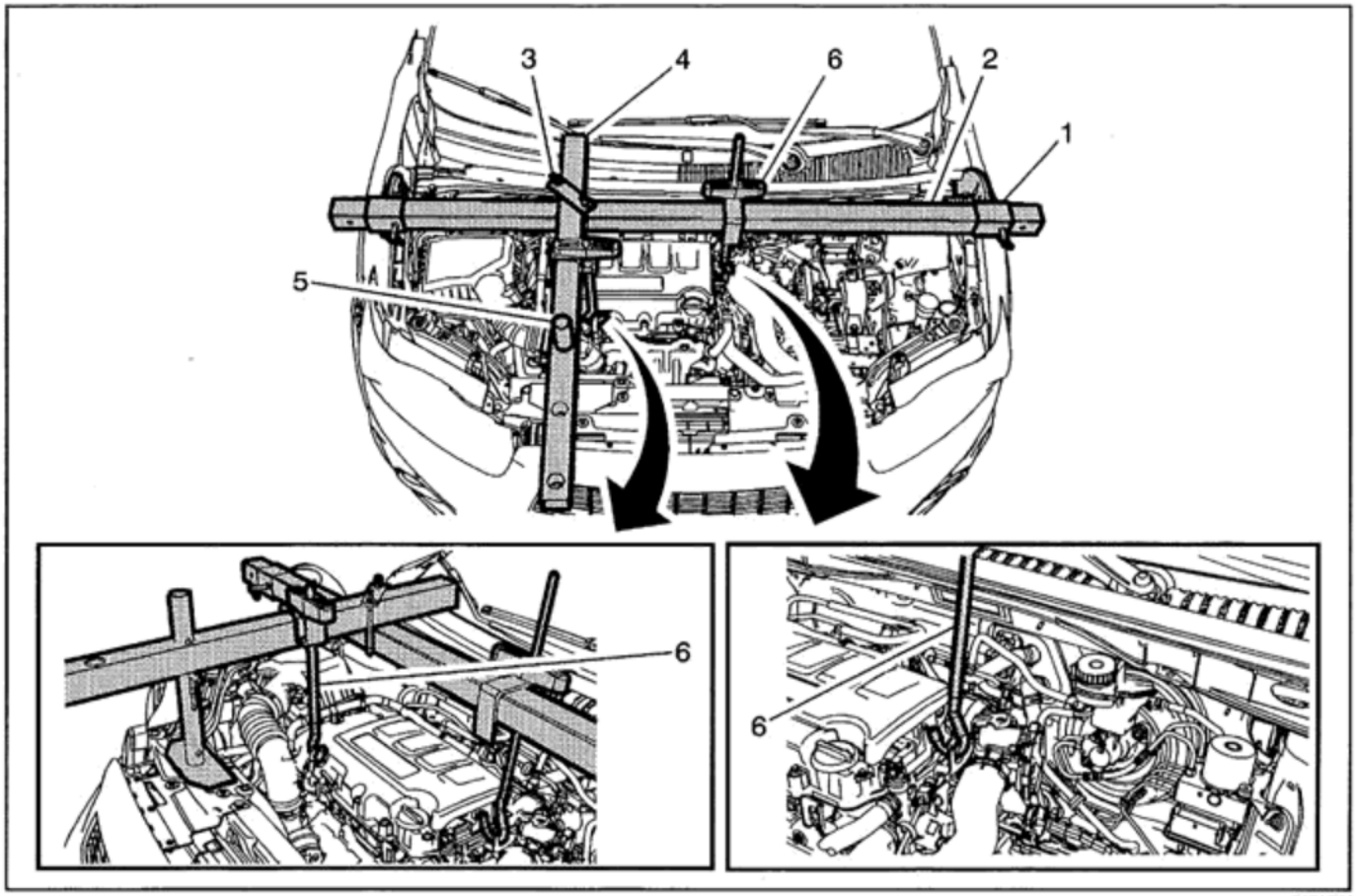


2190734

5. Install and tighten the camshaft bearing cap bolts one turn at a time in sequence as shown **8 N•m (71 lb in)**.
6. Install the camshaft intake and exhaust sprocket. Refer to *Camshaft Intake and Exhaust Sprocket Replacement on page 9-800*.

Repair Instructions - Off Vehicle

Engine Support Fixture



2673751

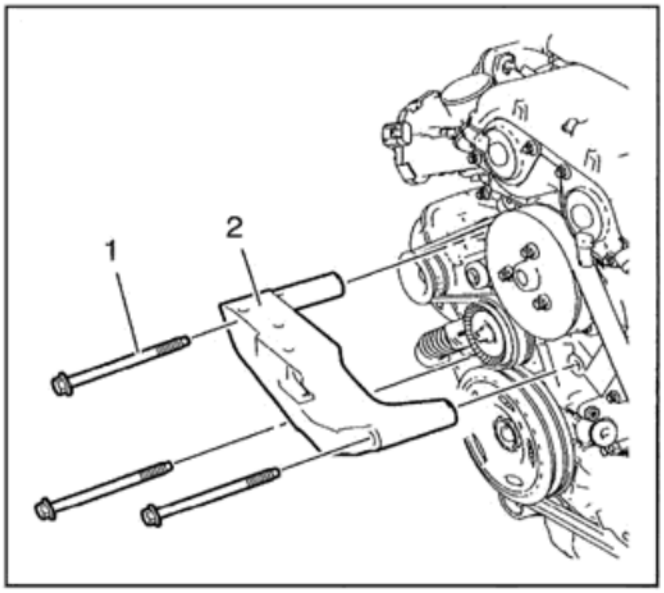
Engine Support Fixture

Callout	Component Name
Preliminary Procedure Remove the radiator opening upper cover. Refer to *Front Opening Upper Cover Replacement on page 3-40* **Special Tools** • *EN-28467-300* Engine Support Fixture Adapter • *J-28467-518* Main Support Beam • *J-28467-1A* Cross Bracket • *J-28467-5A* Strut Tower Support Assembly • *J-28467-2A* Radiator Tube Shelf Assembly • *J-36857* Engine Lift Bracket • *J-28467-8A* Hook Assembly For equivalent regional tools, refer to *Special Tools on page 9-927*.	
1	Engine Support Fixture Adapter Leg (Qty: 2) **Procedure** Install the bracket to fender frame. Do not install on top of fender lip.
2	Main Support Beam
3	Cross Bracket
4	Strut Tower Support Assembly **Procedure** Adjust the length of the strut tower support assembly.
5	Radiator Tube Shelf Assembly

Engine Support Fixture (cont'd)

Callout	Component Name
6	Hook Assembly **Procedure** Use a grade 10.9 bolt to install the engine lift bracket. **Tip:** If the engine is not equipped with engine lift bracket, install J-36857 in place.

Engine Mount Bracket Removal



2190464

1. Remove the 3 engine mount bracket bolts (1).
2. Remove the engine mount bracket (2).

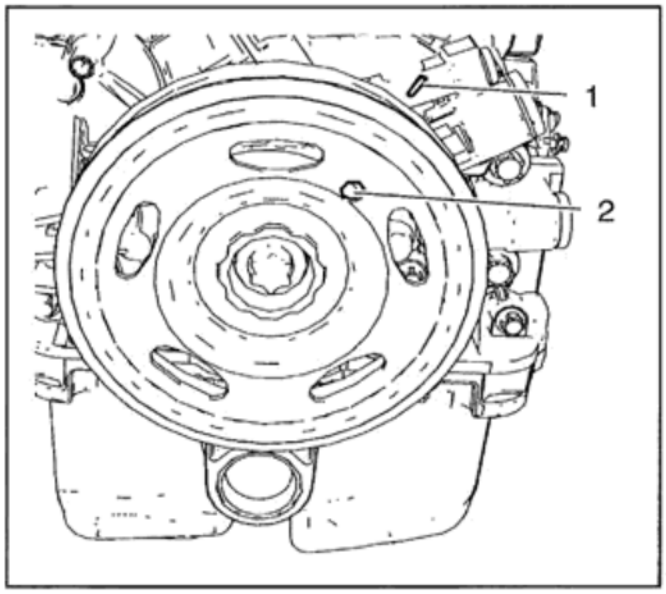
Camshaft Timing Chain Inspection

Special Tools

- *EN-952* Fixing Pin
- *EN-953-A* Fixing Tool
- *EN-49977-100* Transmitter Disc Fixation

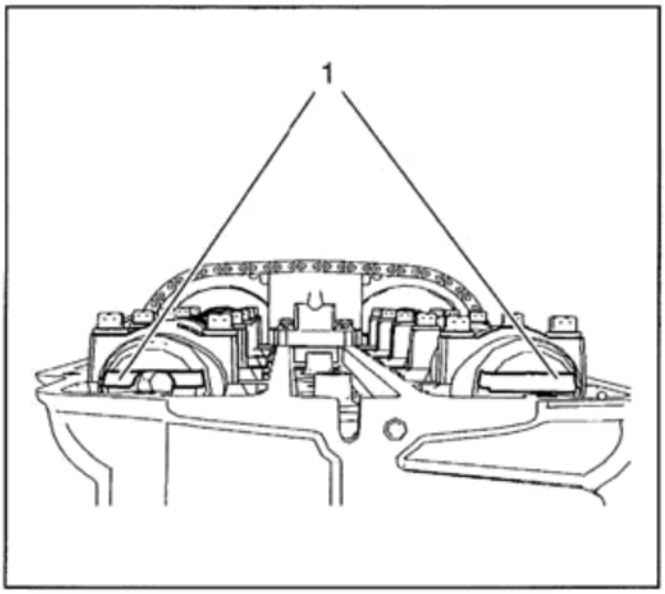
For equivalent regional tools, refer to *Special Tools on page 9-927*.

1. Remove the ignition coil. Refer to *Ignition Coil Replacement on page 9-277*.
2. Remove the camshaft cover. Refer to *Camshaft Cover Replacement on page 9-850*.



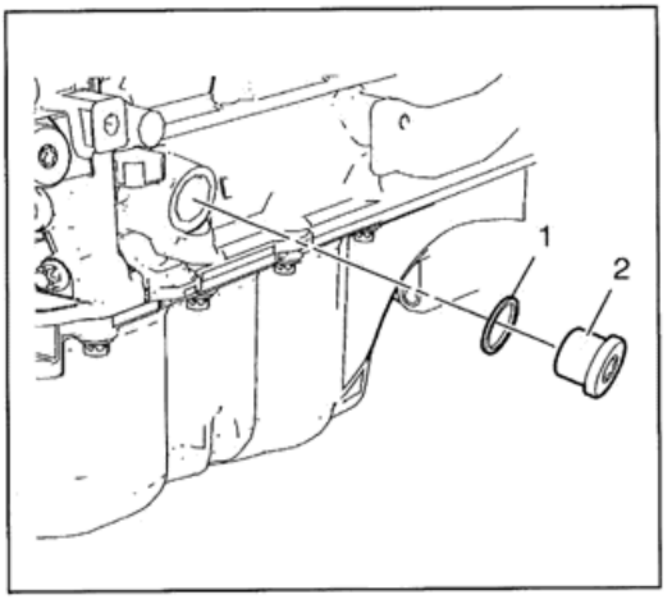
2190614

3. Remove the right front wheelhouse liner. Refer to *Front Wheelhouse Liner Replacement (Rear) on page 3-151* or *Front Wheelhouse Liner Replacement (Front) on page 3-150*
4. Rotate the engine clockwise until the bore (2) in the crankshaft balancer aligns with the mark (1) on the engine front cover.



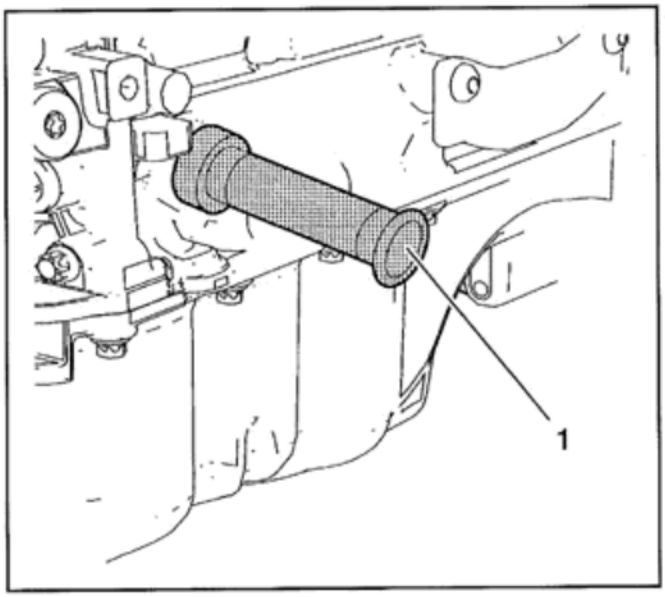
2190634

5. Examine that the camshaft grooves (1) are visible as shown. If the camshaft grooves are not visible rotate the crankshaft 360°.



2190611

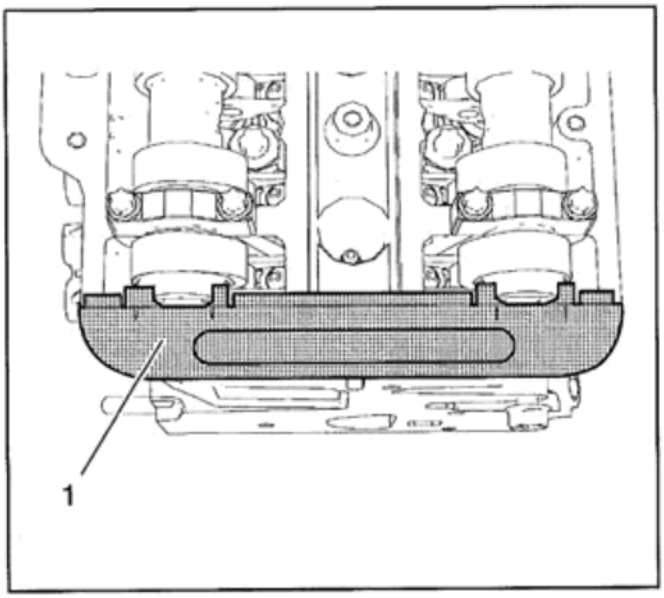
6. Remove the crankshaft bearing cap tie plate hole plug (2) and the seal ring (1).



2190612

Caution: To ensure proper crankshaft top dead center (TDC) alignment, the retention pin should fit easily through the bore in the crankshaft tie plate and into the crankshaft. Binding of the retention pin could affect proper engine timing.

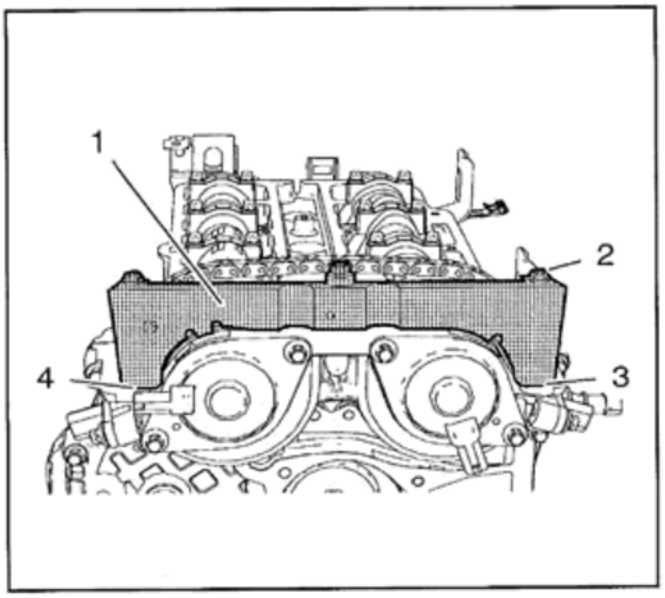
7. Install *EN-952* fixing pin (1) to hold the crankshaft in TDC position.



2190610

Note: The fixing tool should be installed completely to both camshaft grooves without high effort.

8. Install *EN-953-A* fixing tool (1) to the camshafts.



2190623

Note: A wrong installation position is possible. Make sure that the fixation tool is installed without clearance to the cylinder head in areas (3) and (4).

9. Install *EN-49977-100* transmitter disc fixation (1) to inspect the correct position of the camshaft position exciter wheels.
10. Tighten the bolts (2) of *EN-49977-100* transmitter disc fixation.
11. If *EN-953-A* fixing tool or *EN-49977-100* transmitter disc fixation can not be installed, refer to *Camshaft Timing Chain Adjustment on page 9-857*.
12. Remove *EN-49977-100* transmitter disc fixation.
13. Remove *EN-953-A* fixing tool.
14. Remove *EN-952* fixing pin.

Caution: Refer to *Fastener Caution on page 0-8*.

15. Install crankshaft bearing cap tie plate hole plug and seal ring and tighten to **40** N•m **(30 lb ft)**.
16. Install the right front wheelhouse liner. Refer to *Front Wheelhouse Liner Replacement (Rear) on page 3-151* or *Front Wheelhouse Liner Replacement (Front) on page 3-150*
17. Install the camshaft cover. Refer to *Camshaft Cover Installation on page 9-909*.
18. Install the ignition coil. Refer to *Ignition Coil Installation on page 9-910*.

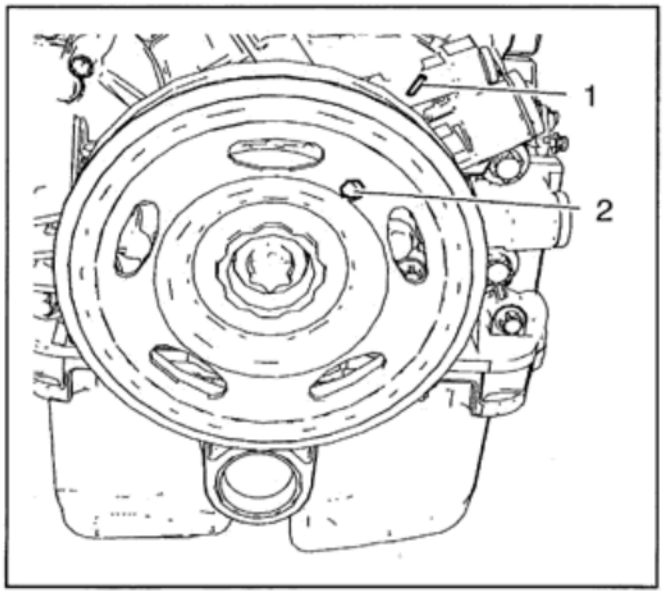
Camshaft Timing Chain Adjustment

Special Tools

- *EN-952* Fixing Pin
- *EN-953–A* Fixing Tool
- *EN-49977–100* Fixation Sensor Discs

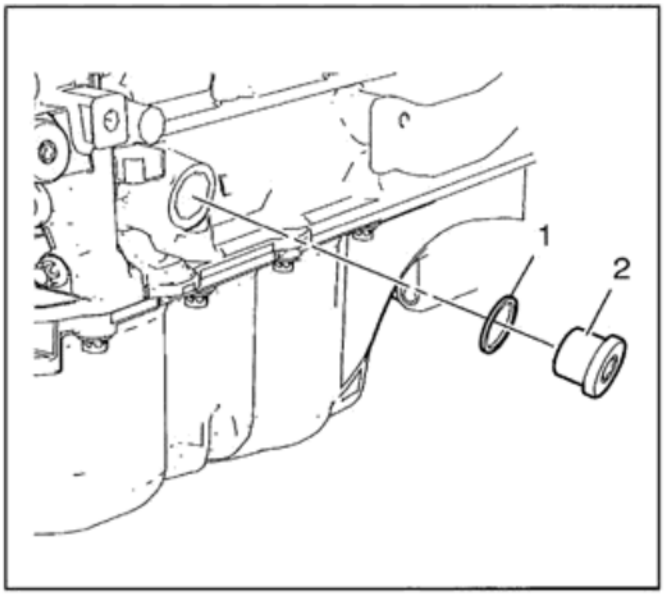
For equivalent regional tools, refer to *Special Tools on page 9-927*.

1. Remove the ignition coil. Refer to *Ignition Coil Replacement on page 9-277*.
2. Remove the camshaft cover. Refer to *Camshaft Cover Replacement on page 9-850*.
3. Remove the camshaft position actuator solenoid valves. Refer to *Camshaft Position Actuator Solenoid Valve Replacement on page 9-282*.
4. Remove the right front wheelhouse liner. Refer to *Front Wheelhouse Liner Replacement (Rear) on page 3-151* or *Front Wheelhouse Liner Replacement (Front) on page 3-150*.



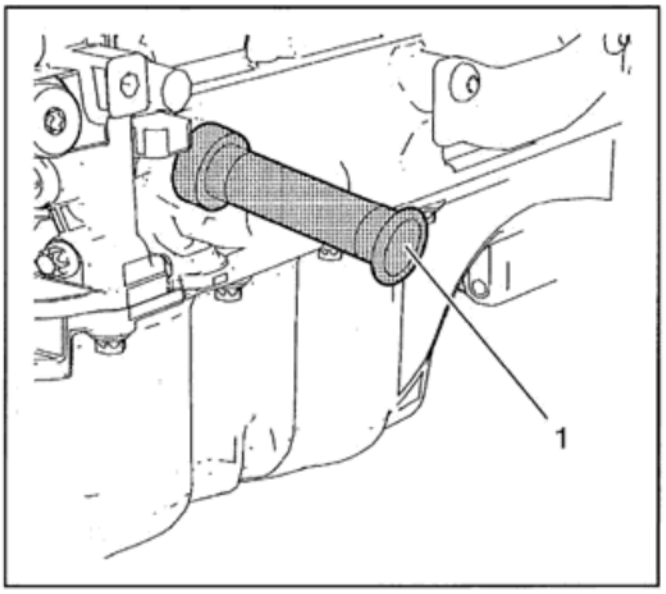
2190614

5. Rotate the engine clockwise until the bore (2) in the crankshaft balancer aligns with the mark (1) on the engine front cover.



2190611

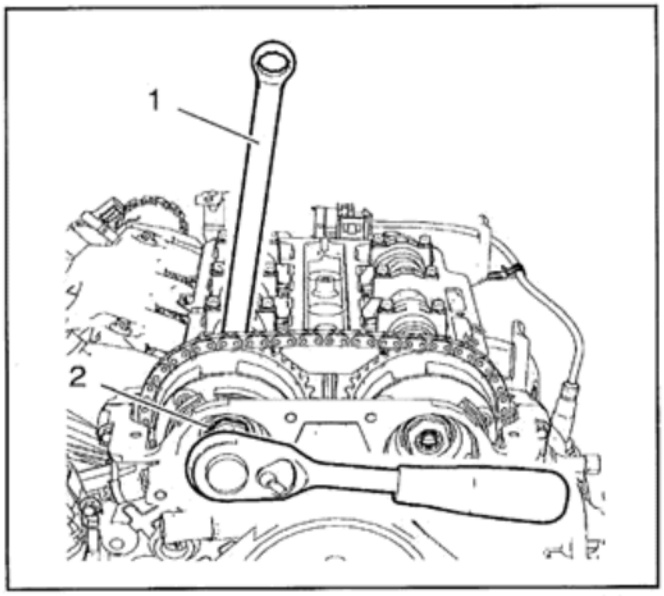
6. Remove the crankshaft bearing cap tie plate hole plug (2) and the seal ring (1).



2190612

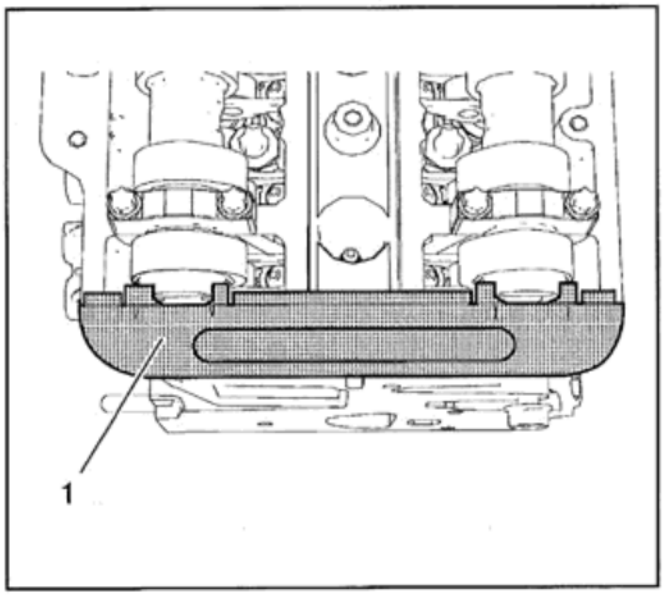
Caution: To ensure proper crankshaft top dead center (TDC) alignment, the retention pin should fit easily through the bore in the crankshaft tie plate and into the crankshaft. Binding of the retention pin could affect proper engine timing.

7. Install the *EN-952* fixing pin (1) to hold the crankshaft in TDC position.



2191148

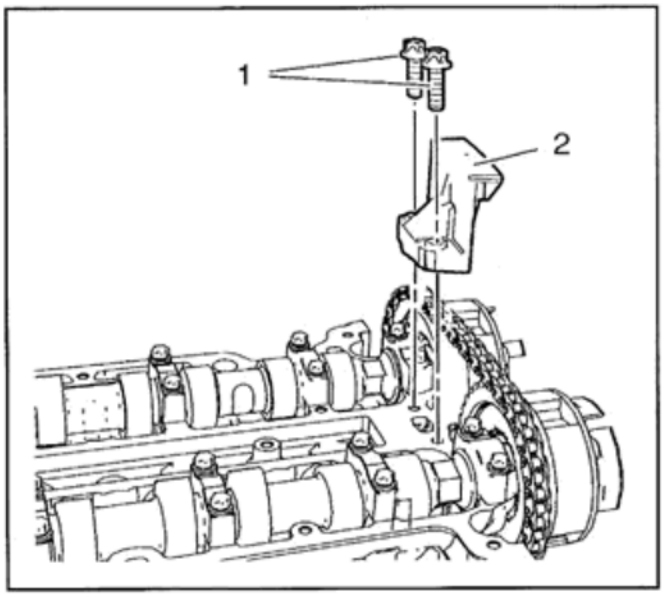
8. Loosen the intake camshaft sprocket bolt (2) while holding the hexagon of the intake camshaft with a wrench (1) until the camshaft position exciter wheel is clearly rotatable.
9. Loosen the exhaust camshaft sprocket bolt while holding the hexagon of the exhaust camshaft with a wrench until the camshaft position exciter wheel is clearly rotatable.



2190610

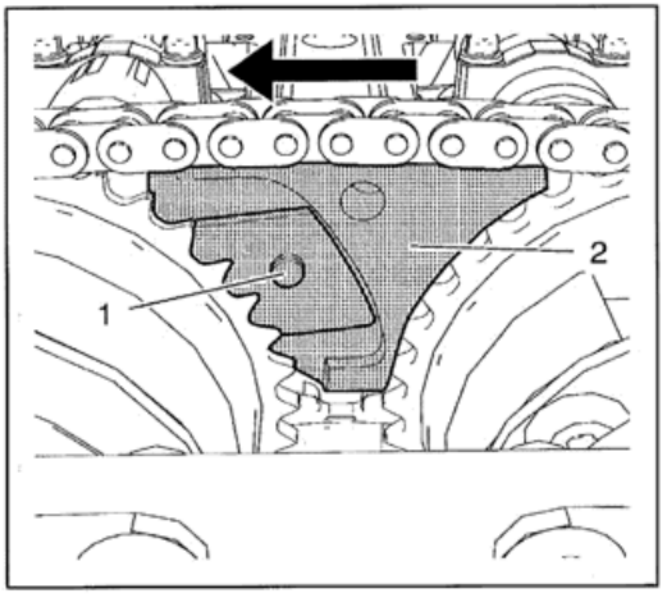
Note: The fixing tool should be installed completely to both camshaft grooves without high effort.

10. Adjust the camshafts so that the *EN-953–A* fixing tool (1) can be installed.



2190576

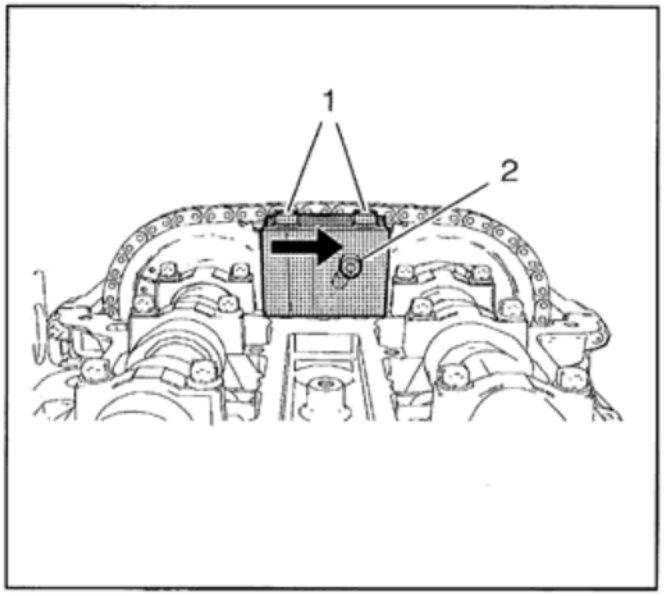
11. Remove the 2 upper timing chain guide bolts (1).
12. Remove the upper timing chain guide (2).



2190710

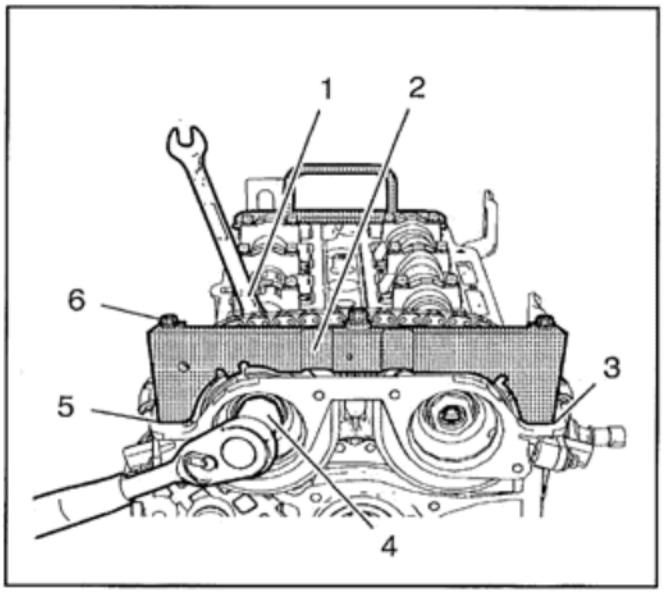
Note: Push the fixing tool in the direction of the arrow to ensure it engages without clearance.

13. Install the *EN-49977–200* fixing tool (2) and adjust the gearing of the fixing tool so it engages with the intake camshaft sprocket gearing (1).



2190712

14. Tighten the 2 fastening bolts (1) of the *EN-49977–200* fixing tool while pushing the fixing tool in direction of the arrow.
15. Tighten the adjuster bolt (2).



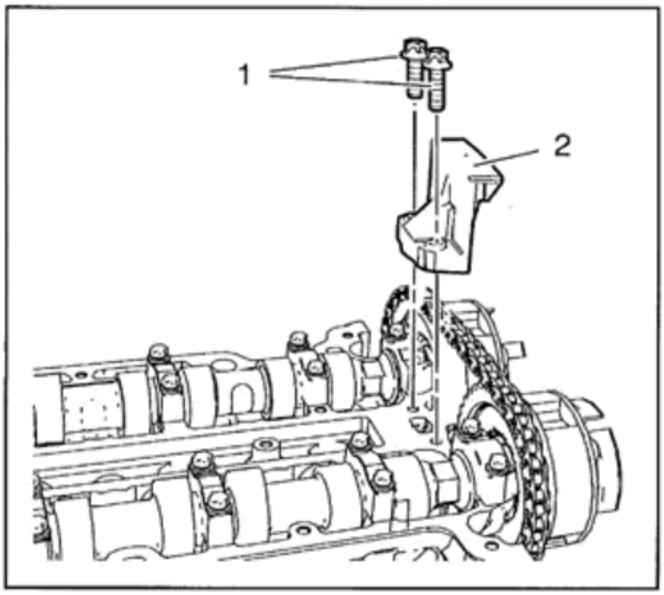
2190709

Note: A wrong installation position is possible. Make sure that the fixation tool is installed without clearance to the cylinder head in areas (3) and (5).

16. Install the *EN-49977–100* fixation (2) to find and hold the camshaft position exciter wheels in the correct position.
17. Tighten the 2 fastening bolts (6) of the *EN-49977–100* fixation.

Caution: Refer to *Fastener Caution on page 0-8*.

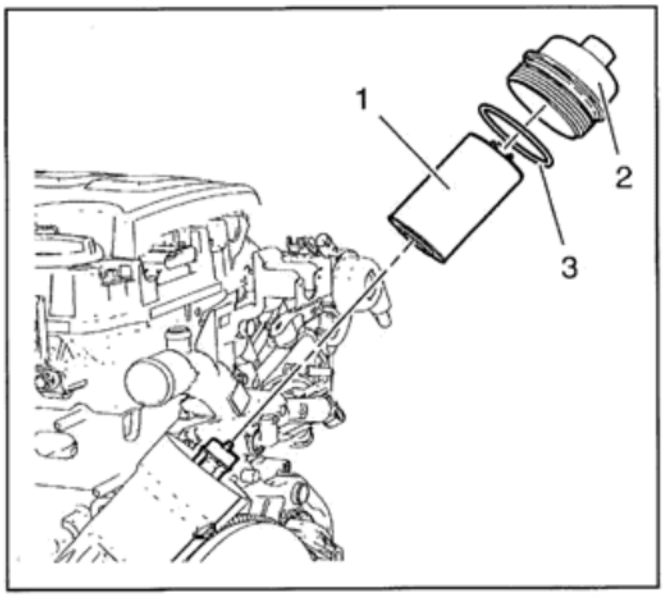
18. Tighten the intake camshaft sprocket bolt (4) while holding the hexagon (1) of the intake camshaft to **50** N•m **(37 lb ft)**.
19. Tighten the intake camshaft sprocket bolt (4) while holding the hexagon (1) of the intake camshaft an additional **60°**.
20. Tighten the exhaust camshaft sprocket bolt while holding the hexagon of the exhaust camshaft to **50** N•m **(37 lb ft)**.
21. Tighten the exhaust camshaft sprocket bolt while holding the hexagon of the exhaust camshaft an additional **60°**.
22. Remove the *EN-49977–100* fixation and the *EN-49977–200* fixing tool.



2190676

23. Install the upper timing chain guide (2).
24. Install the 2 upper timing chain guide bolts (1) and tighten to **8** N•m **(71 lb in)**.
25. Remove the *EN-953–A* fixing tool.
26. Remove the *EN-952* fixing pin.
27. Rotate the crankshaft for **720°** and check the engine timing again. Repeat the adjustment procedure if necessary.
28. Install the crankshaft bearing cap tie plate hole plug and seal ring and tighten to **40** N•m **(30 lb ft)**.
29. Install the right front wheelhouse liner. Refer to *Front Wheelhouse Liner Replacement (Rear) on page 3-151* or *Front Wheelhouse Liner Replacement (Front) on page 3-150*
30. Install the camshaft position actuator solenoid valves. Refer to *Camshaft Position Actuator Solenoid Valve Replacement on page 9-282*.
31. Install the camshaft cover. Refer to *Camshaft Cover Replacement on page 9-850*.
32. Install the ignition coil. Refer to *Ignition Coil Replacement on page 9-277*.

Draining Fluids and Oil Filter Removal

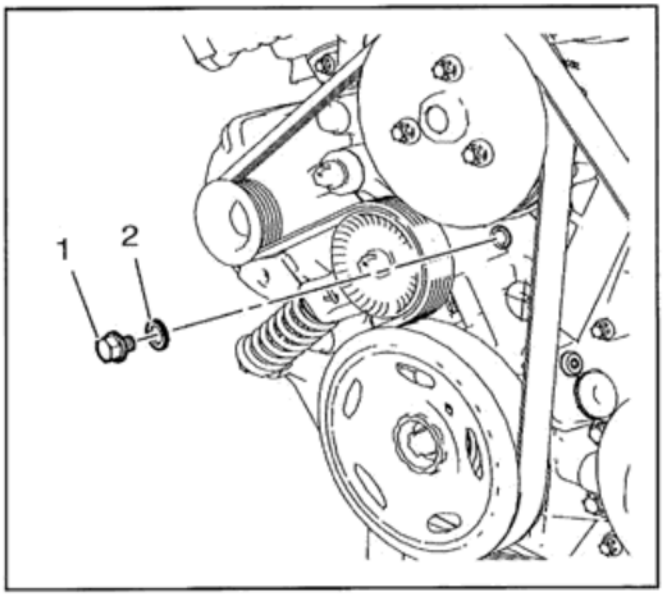


2190433

1. Remove the engine oil filter cap (2) along with the engine oil filter cap seal ring (3) and the oil filter element (1).
2. Remove the oil pan drain plug and allow the oil to drain out.

Caution: Refer to *Fastener Caution on page 0-8.*

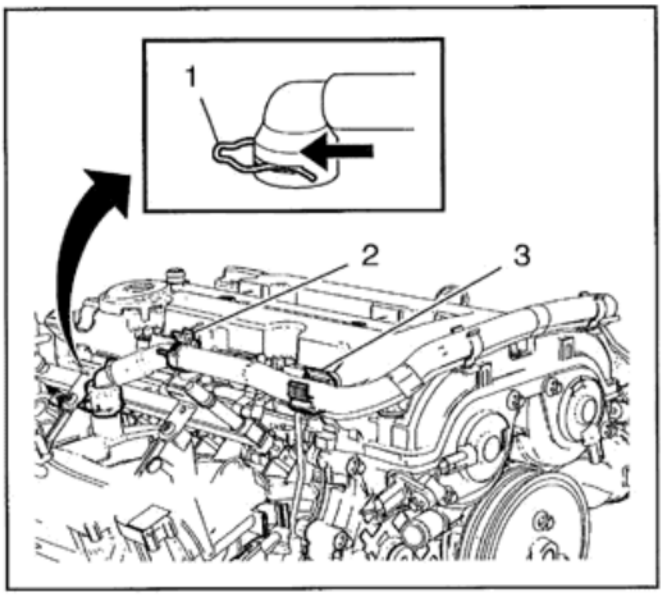
3. Install the oil pan drain plug and a NEW seal ring and tighten to **14 N•m (124 lb in)**.
4. Install the engine oil filter cap along with a NEW engine oil filter cap seal ring and a NEW oil filter element.
5. Tighten the engine oil filter cap to **25 N•m (18 lb ft)**.



2190440

6. Remove the water pump drain plug (1) and the water pump drain plug seal ring (2) and allow the remaining coolant to drain out.
7. Install the water pump drain plug and a NEW seal ring and tighten to **15 N•m (11 lb ft)**.

Positive Crankcase Ventilation Pipe Removal

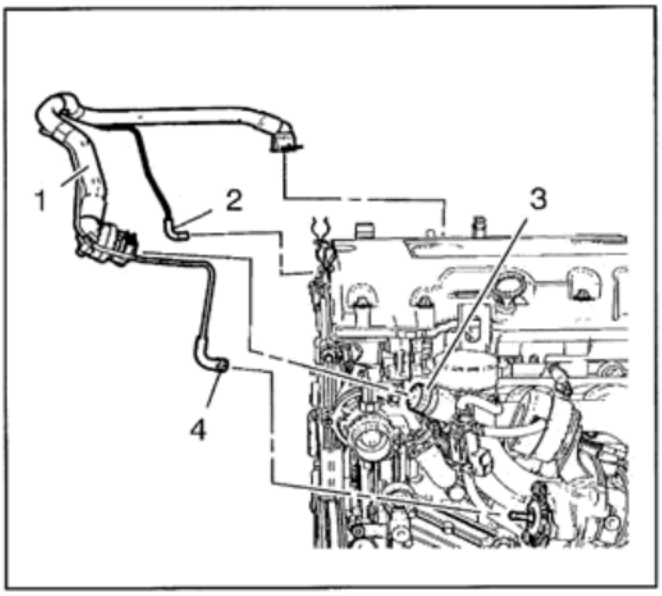


2190425

1. Open the 2 positive crankcase ventilation pipe retainer clips (2) and (3).

Note: Move retainer clamp (1) in direction of the arrow.

2. Remove the positive crankcase ventilation pipe from the intake manifold.

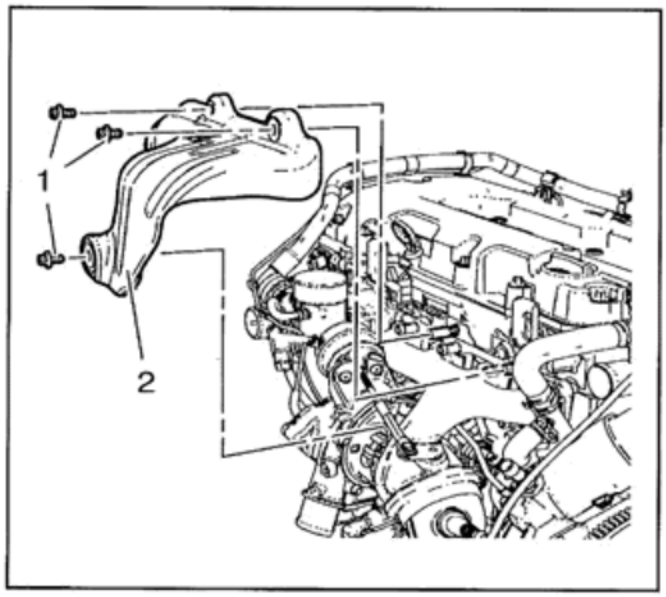


2190426

3. Loosen the charger air bypass valve pipe clamp (4).
4. Remove the charger air bypass valve pipe from turbocharger.
5. Remove the charger air bypass valve pipe (2) from turbo charger waste regulator solenoid valve.

6. Disconnect the positive crankcase ventilation pipe from turbocharger (3).
7. Unclip and remove the positive crankcase ventilation pipe assembly (1) from the camshaft cover retainer clips.

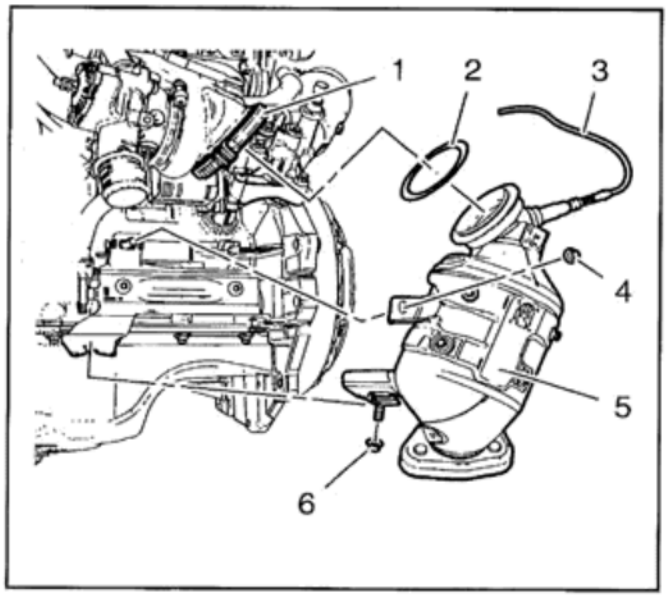
Exhaust Manifold Heat Shield Removal



2190424

1. Remove the 3 exhaust manifold heat shield bolts (1) and the washers.
2. Remove the exhaust manifold heat shield (2).

Warm Up Three-Way Catalytic Converter Removal



2190423

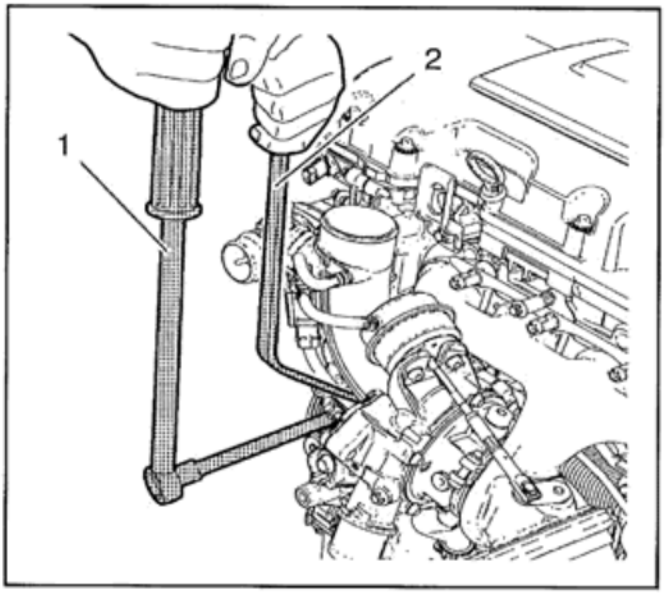
1. Disconnect the heated oxygen sensor wiring harness (3) from retainer clip.
2. Remove the 2 catalytic converter to catalytic converter bracket nuts (4) and (6).
3. Loosen the three way warm up catalytic converter V-clamp (1).
4. Remove the three way warm up catalytic converter (5) and the catalytic converter seal (2).

Turbocharger Removal

Special Tool

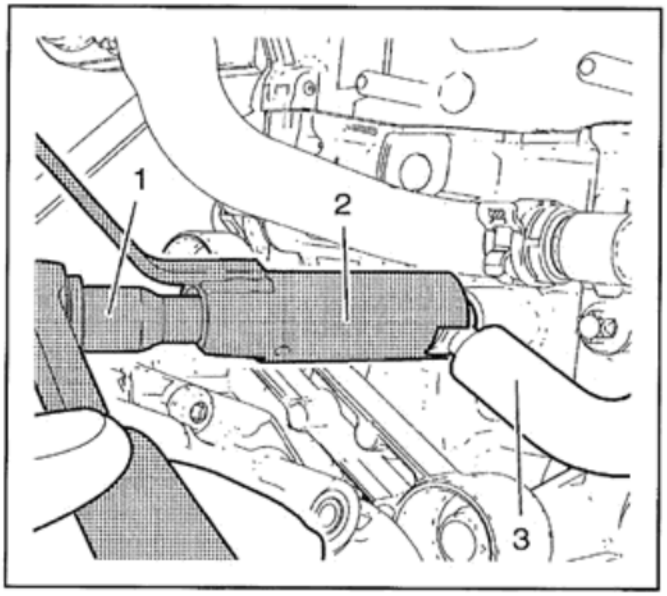
EN-49942 Holding Wrench

For equivalent regional tools, refer to *Special Tools on page 9-927*.



2192012

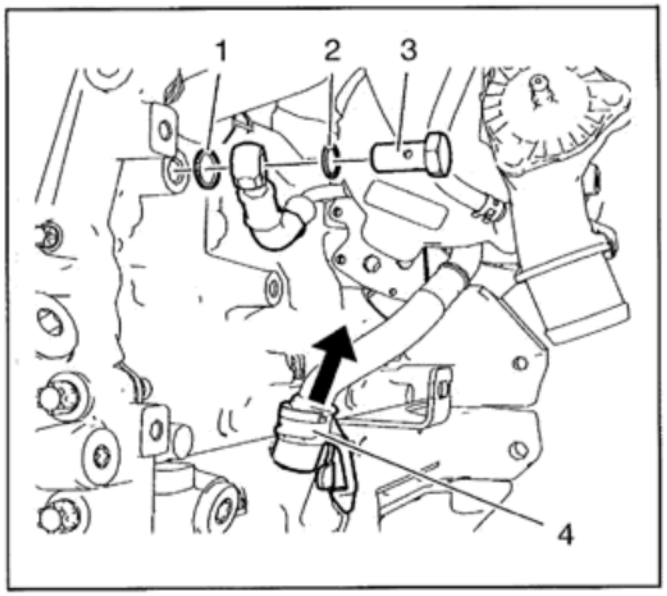
1. Install the *EN-49942* holding wrench (2) to the turbocharger coolant feed pipe. Guide a ratchet wrench (1) along with an extension through *EN-49942* holding wrench to the turbocharger coolant feed pipe hollow screw.



2192009

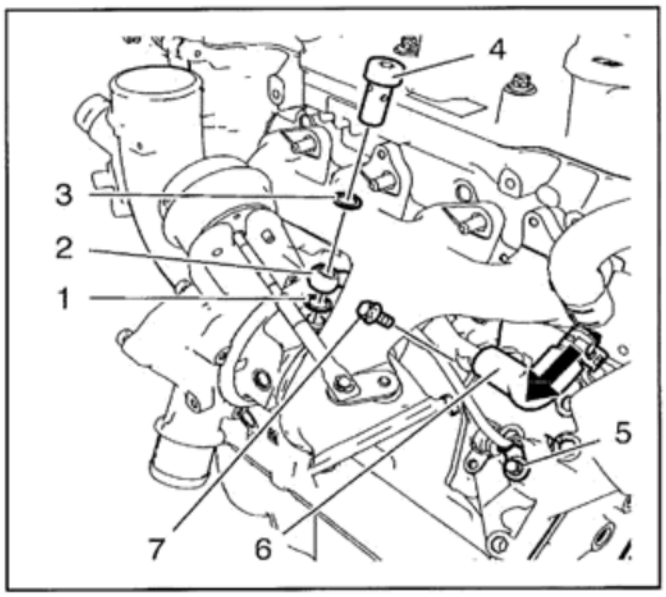
Note: *EN-49942* holding wrench (2) should be installed to turbocharger coolant feed pipe as shown. The holding wrench should be installed to avoid twist of the turbocharger coolant feed pipe during the loosening procedure.

2. Loosen the turbocharger coolant feed pipe hollow screw with ratchet wrench and extension (1).



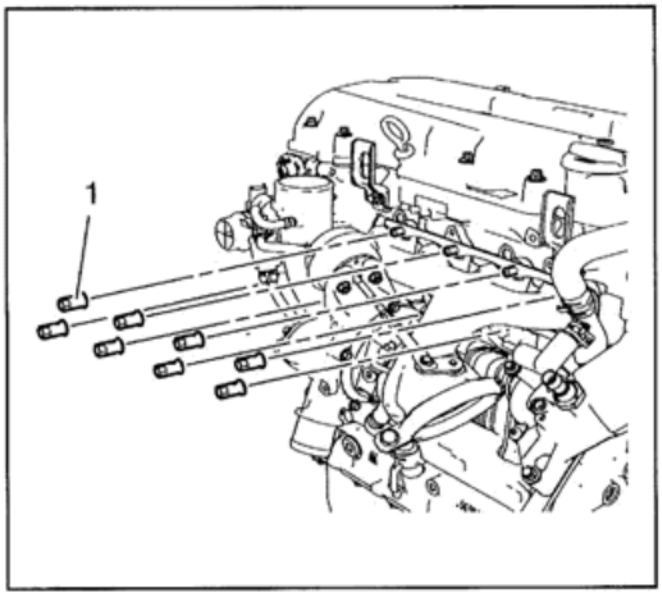
2190427

3. Remove the turbocharger coolant feed pipe hollow screw (3) and the 2 seal rings (1) and (2).
4. Disconnect the turbocharger oil return pipe (4) from the engine block.



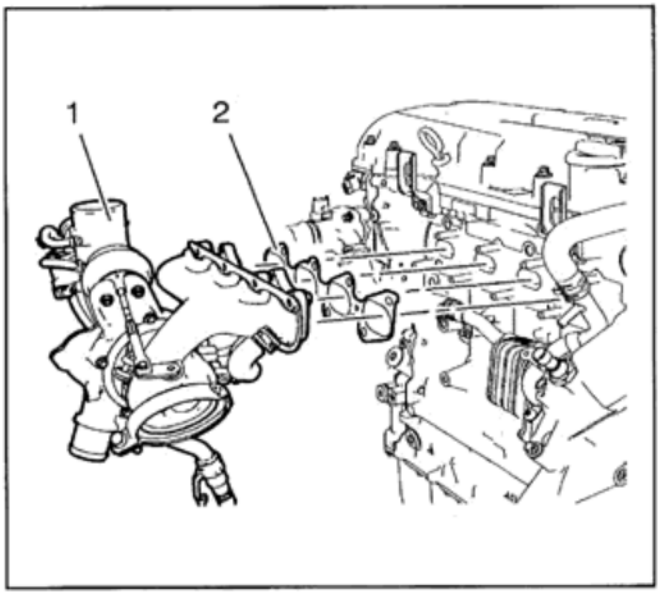
2190428

5. Remove the turbocharger oil feed pipe bolt (5) from the oil cooler.
6. Remove the turbocharger oil feed pipe hollow screw (4) and the 2 seal rings (1) and (3) and close the screw bore in the turbocharger.
7. Remove the turbocharger oil feed pipe (2) and the rubber seal ring.
8. Disconnect the turbocharger coolant return hose (6) from the oil cooler coolant inlet pipe and remove the turbocharger coolant return pipe bolt (7) from the oil cooler.



2190429

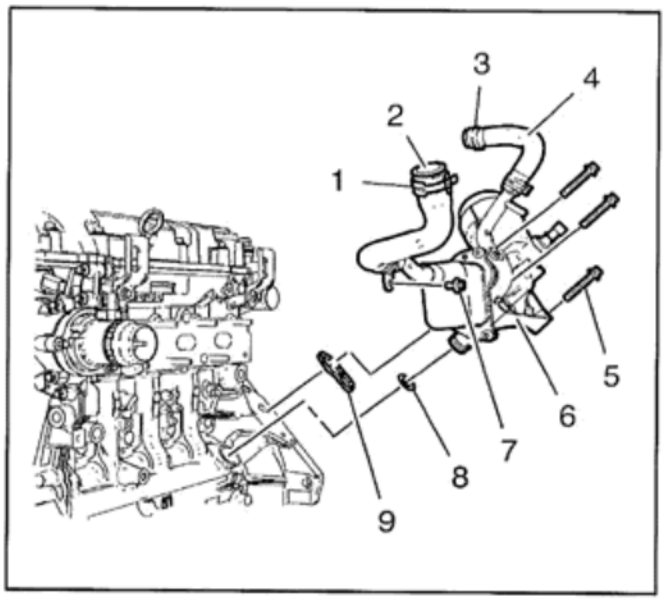
9. Remove the 8 turbocharger nuts (1).



2190430

10. Remove the turbocharger assembly (1) and the turbocharger gasket (2).

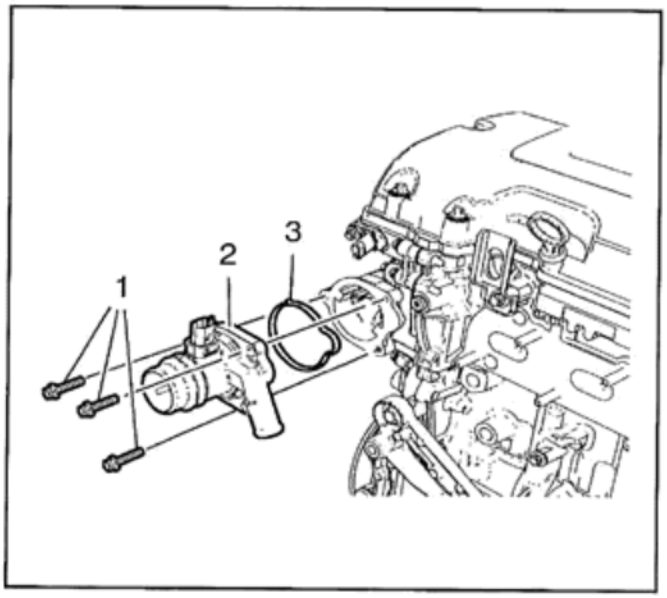
Engine Oil Cooler Removal



2191862

1. Remove the oil cooler coolant outlet hose clamp (1).
2. Remove the oil cooler coolant outlet hose (2) from engine coolant thermostat housing.
3. Remove the oil cooler coolant inlet hose clamp (3).
4. Remove the oil cooler coolant inlet hose (4) from water outlet.
5. Remove the oil cooler coolant outlet pipe bolt (7).
6. Remove the 3 oil cooler bolts (5).
7. Remove the engine oil cooler assembly (6) and the 2 oil cooler sealings (8) and (9).

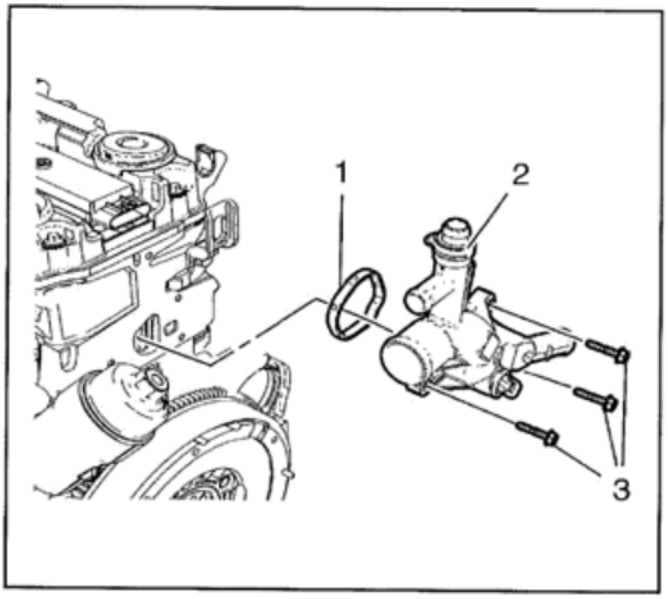
Engine Coolant Thermostat Housing Removal



2191834

1. Remove the 3 engine coolant thermostat housing bolts (1).
2. Remove the engine coolant thermostat housing (2) and the engine coolant thermostat housing seal ring (3).

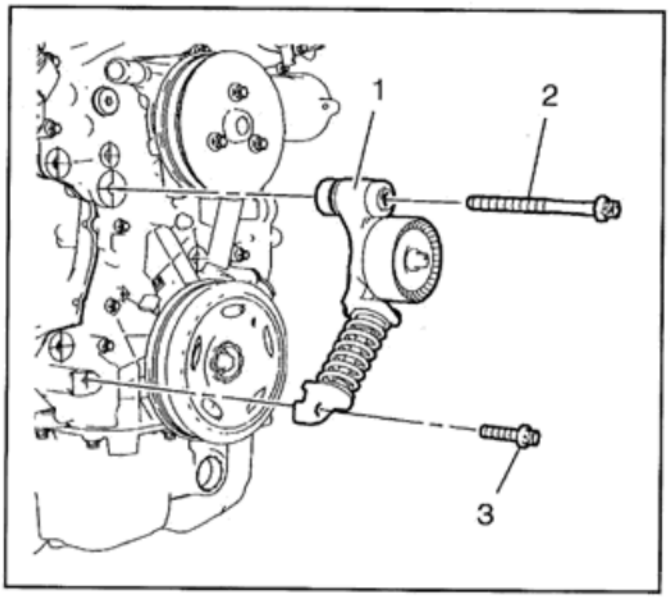
Water Outlet Removal



2191835

1. Remove the 3 water outlet bolts (3).
2. Remove the water outlet (2) and the water outlet seal ring (1).

Drive Belt Tensioner Removal

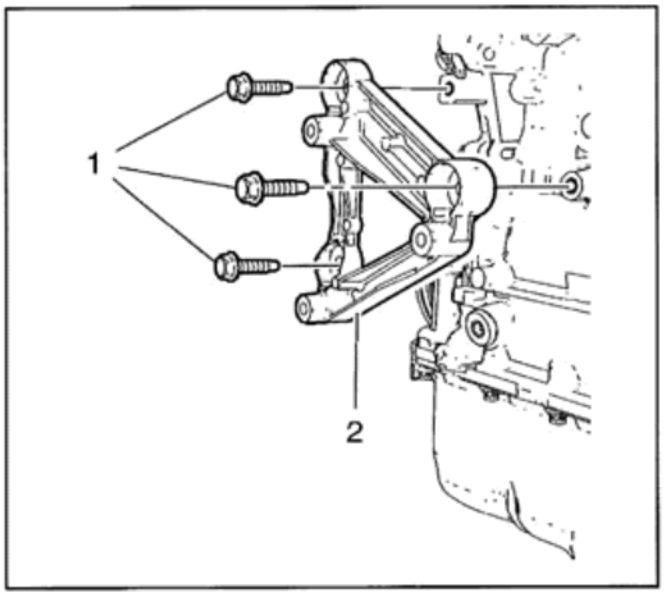


2190385

Caution: The drive belt tensioner must always be in a pre-tensioned state and must never be free from tension. If the drive belt tensioner is free from the belt tension, it must always stay fixed with an appropriate locking pin. Failure to follow this instruction will lead to a damage of the drive belt tensioner.

1. Remove the upper drive belt tensioner bolt (2).
2. Remove the lower drive belt tensioner bolt (3).
3. Remove the drive belt tensioner (1).

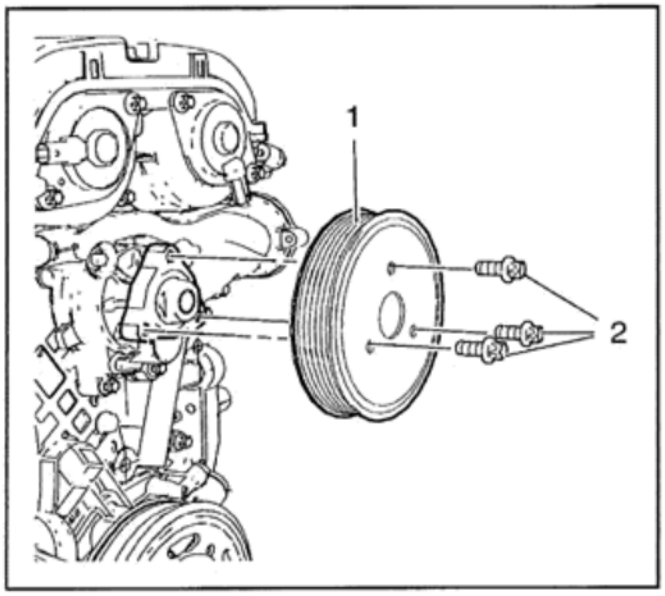
Air Conditioning Compressor Bracket Removal



2190353

1. Remove the 3 air conditioning compressor bracket bolts (1).
2. Remove the air conditioning compressor bracket (2).

Water Pump Pulley Removal



2190373

1. Loosen the 3 water pump pulley bolts (2) while holding up the water pump pulley hub with a wrench.
2. Remove the 3 water pump pulley bolts (2).
3. Remove the water pump pulley (1).

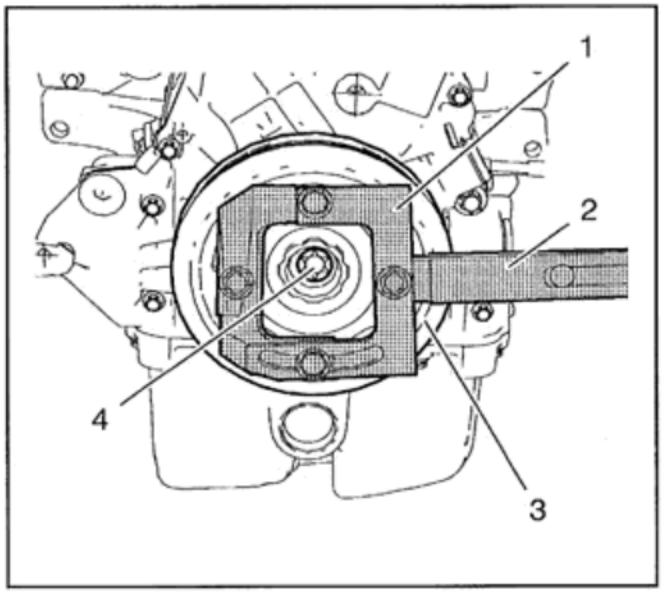
Crankshaft Balancer Removal

Special Tools

- *EN-956-1* Extension
- *EN-49979* Crankshaft Shock Mount Retainer

For equivalent regional tools, refer to *Special Tools on page 9-927*.

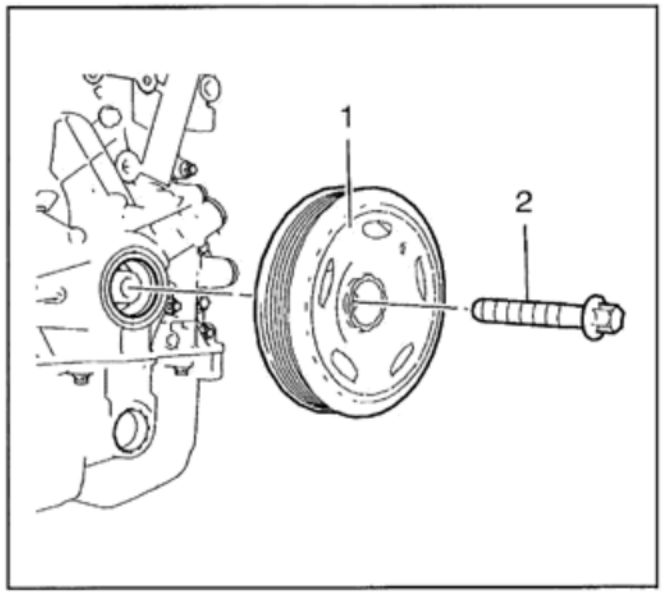
1. Install *EN-49979* retainer to *EN-956-1* extension.



2190546

Note: The crankshaft balancer can be incorrectly installed 180° from the required position. Be sure to note the location of the alignment hole on the crankshaft balancer prior to removing the crankshaft balancer from the engine.

2. Loosen the crankshaft balancer bolt (4) while fixing the crankshaft balancer (3) with *EN-49979* retainer (1) and *EN-956-1* extension (2).

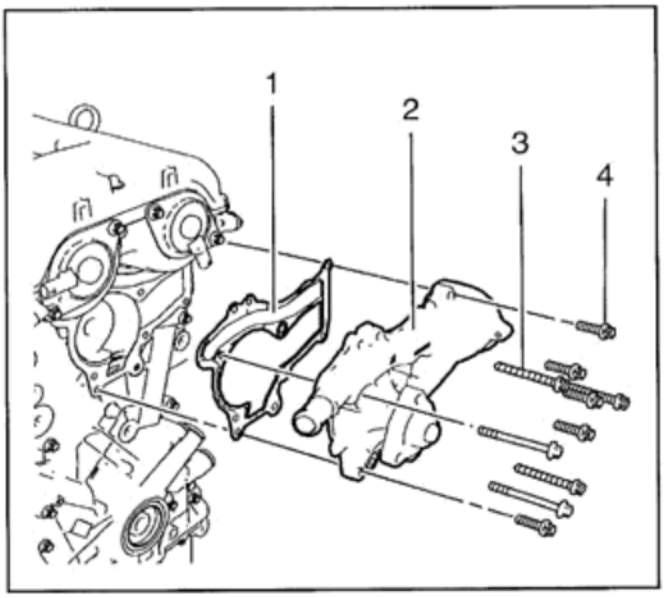


2190552

3. Remove and DISCARD the crankshaft balancer bolt (2).

4. Remove the crankshaft balancer (1).

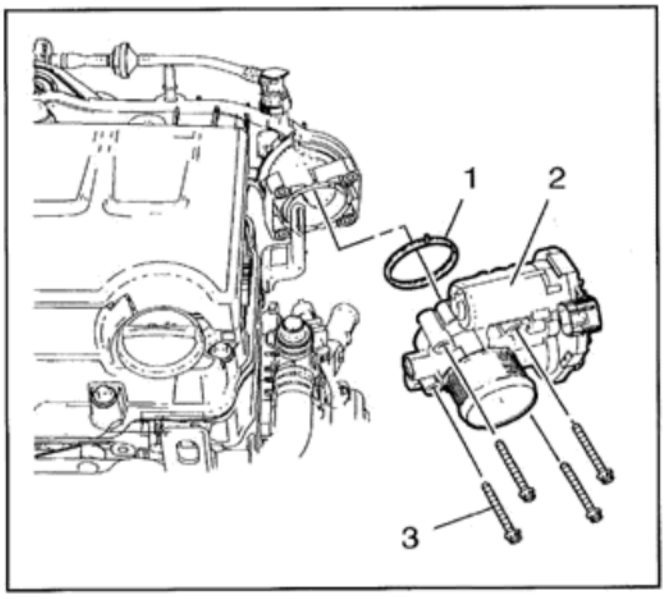
Water Pump Removal



2190389

1. Remove the 5 short water pump bolts (4) and the 5 long water pump bolts (3).
2. Remove the water pump (2).
3. Remove the water pump gasket (1).

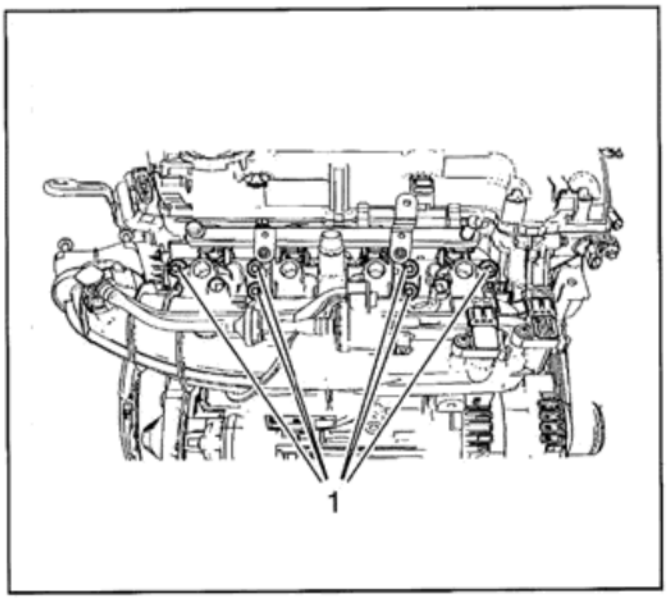
Throttle Body Removal



2191887

1. Remove the 4 throttle body bolts (3).
2. Remove the throttle body (2) and the throttle body seal ring (1).

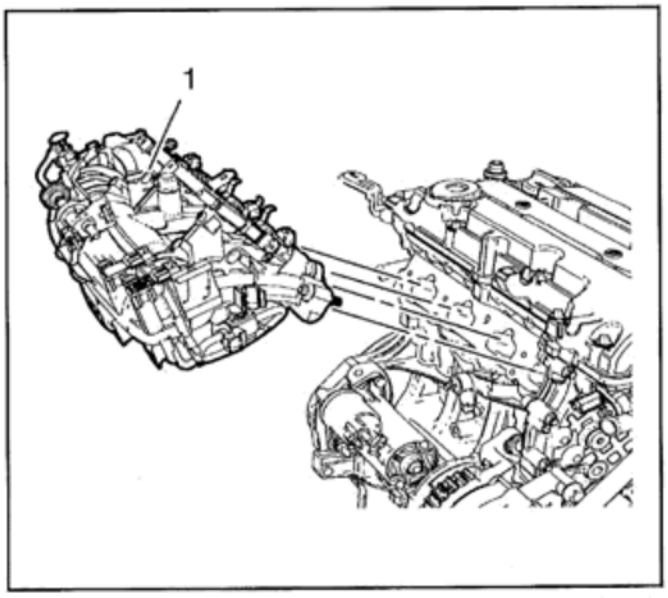
Intake Manifold Removal



2191842

Note: Intake manifold bolts remain in intake manifold screw bores.

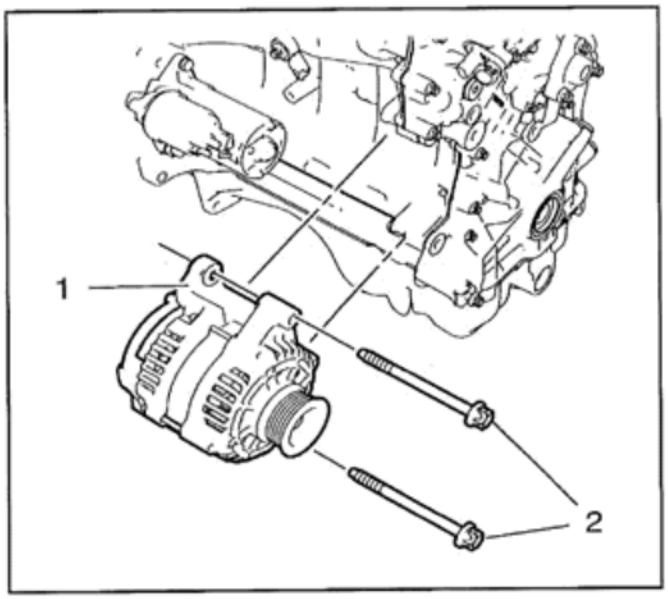
1. Remove the 6 intake manifold bolts (1).



2191843

2. Remove the intake manifold (1) along with the intake manifold gasket.

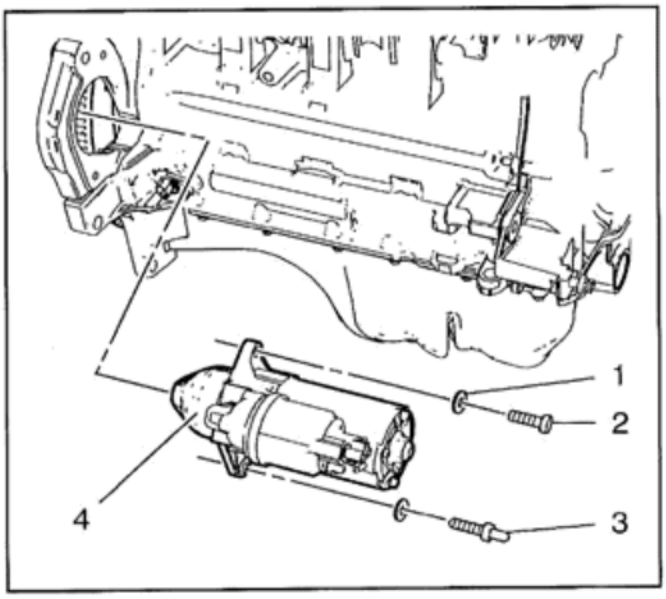
Generator Removal



2190617

1. Remove the 2 generator bolts (2).
2. Remove the generator (1).

Starter Removal



2190618

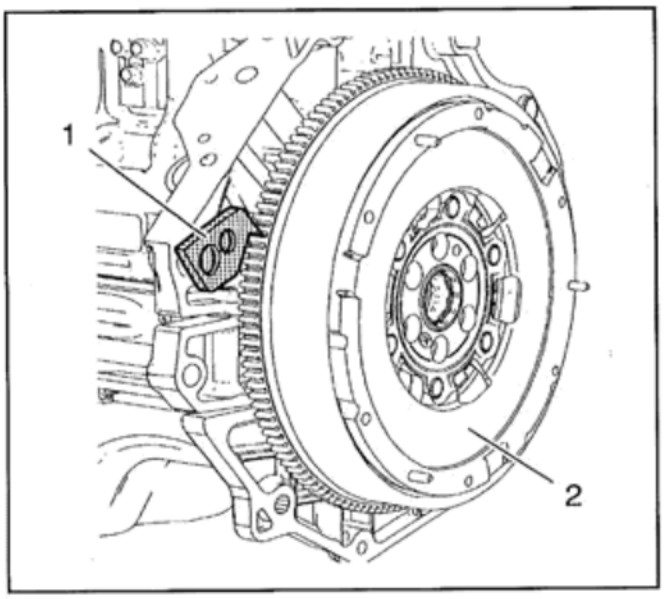
1. Remove the upper starter bolt (2) and if equipped the washer (1).
2. Remove the lower starter bolt stud (3) and if equipped the washer.
3. Remove the starter (4).

Engine Flywheel Removal

Special Tools

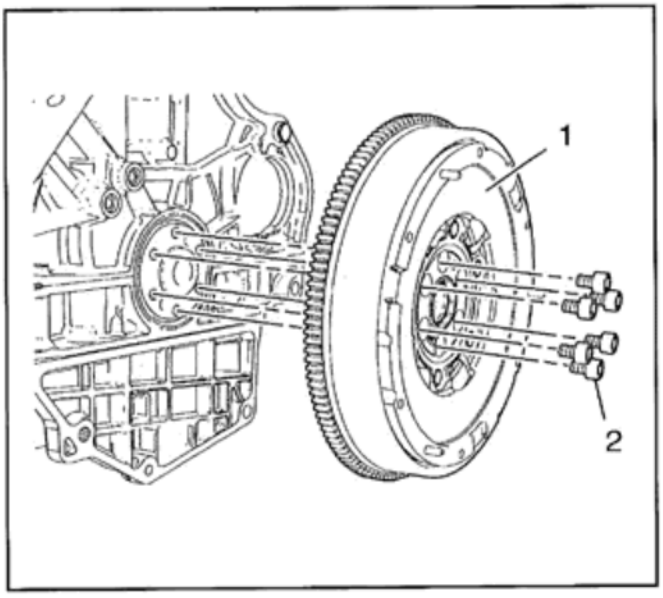
EN-652 Flywheel Holder

For equivalent regional tools, refer to *Special Tools on page 9-927*.



2191832

1. Install *EN-652* holder (1) to hold the engine flywheel (2).



2191833

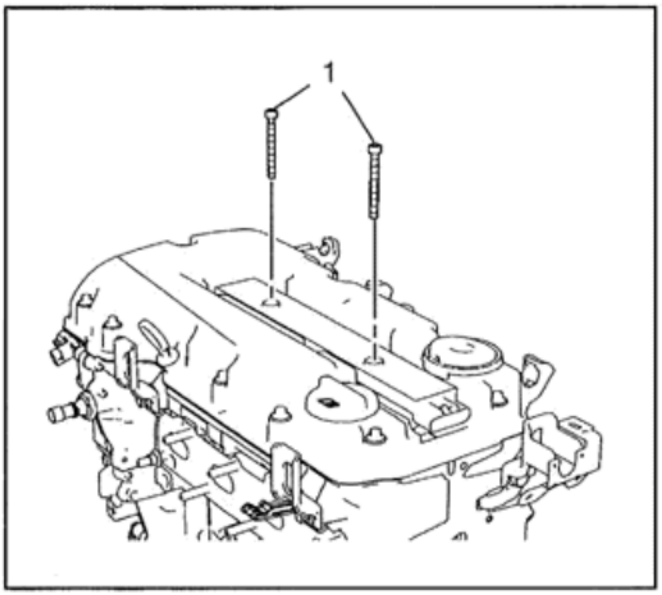
2. Remove and DISCARD the 6 engine flywheel bolts (2).
3. Remove the engine flywheel (1).

Ignition Coil Removal

Special Tools

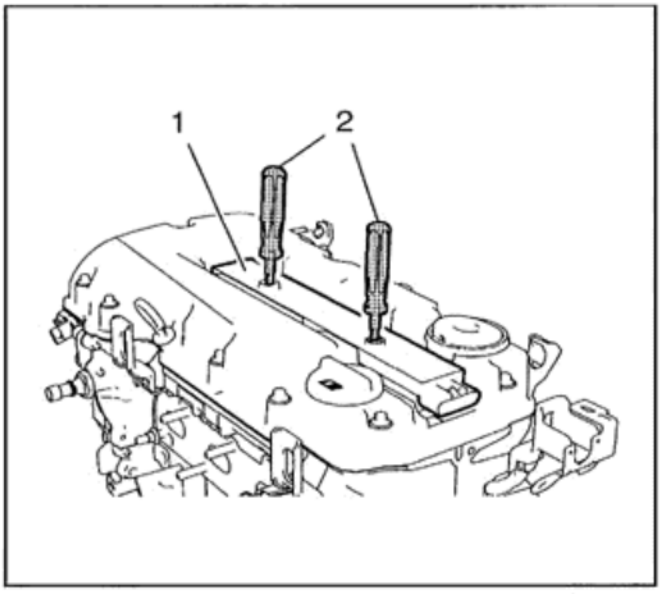
EN-6009 Remover and Installer Ignition Module

For equivalent regional tools, refer to *Special Tools on page 9-927.*



2190645

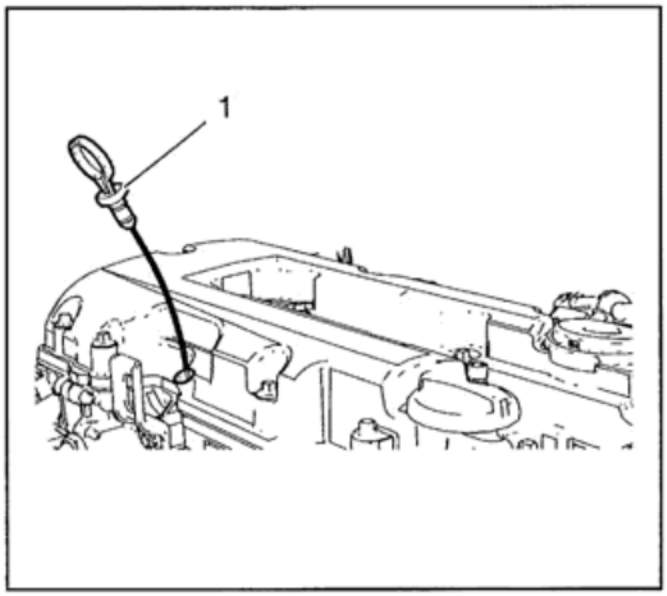
1. Remove the 2 ignition coil bolts (1).



2190646

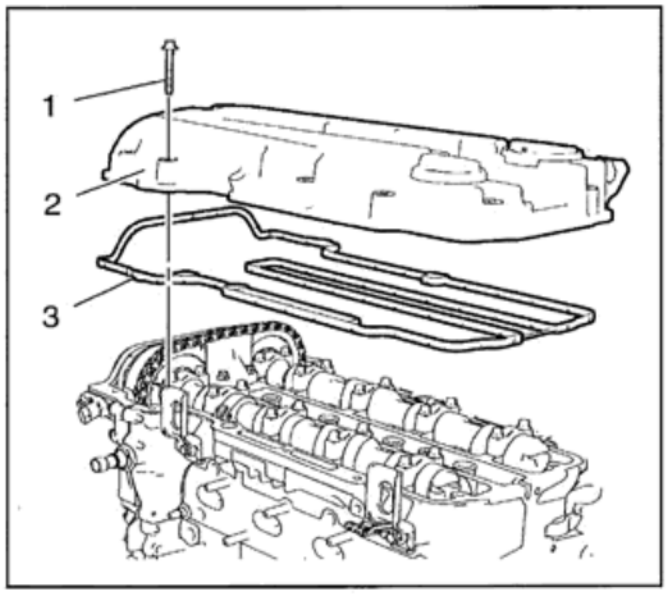
2. Install *EN-6009* remover and installer (2) and remove the ignition coil (1).

Camshaft Cover Removal



2190647

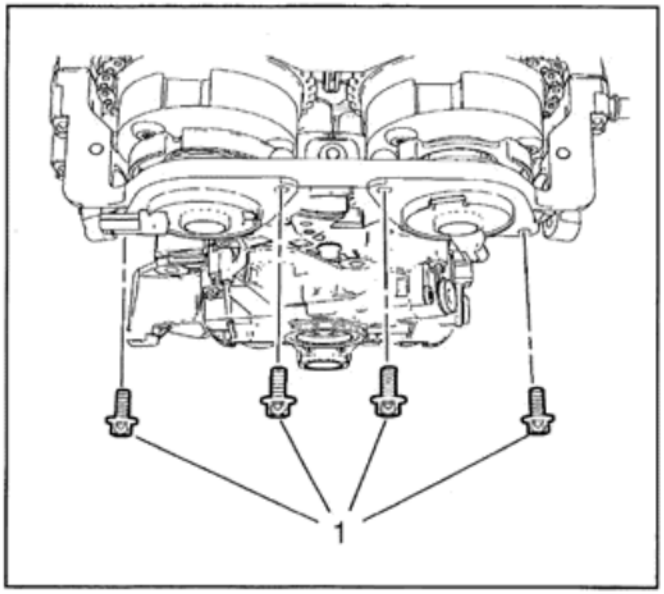
1. Remove the oil level indicator (1).



2190620

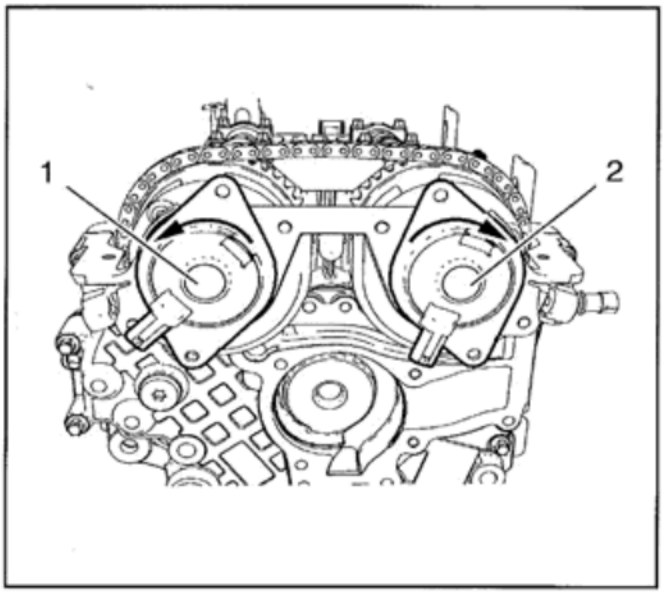
2. Remove the 15 camshaft cover bolts (1).
3. Remove the camshaft cover (2) and the camshaft cover gasket (3).

Camshaft Position Actuator Solenoid Valve Removal



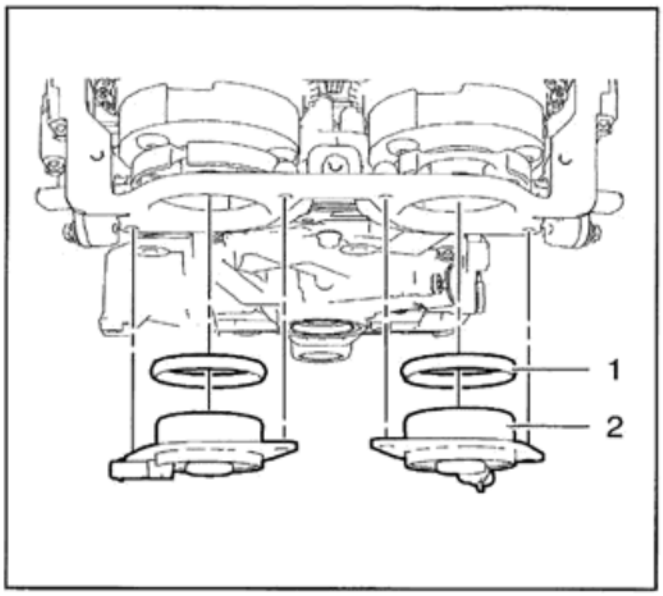
2191735

1. Remove the 4 camshaft position actuator solenoid valve bolts (1).



2191733

2. Move the intake camshaft position actuator solenoid valve (1) carefully counter clockwise in the position shown.
3. Move the exhaust camshaft position actuator solenoid valve (2) carefully clockwise in the position shown.

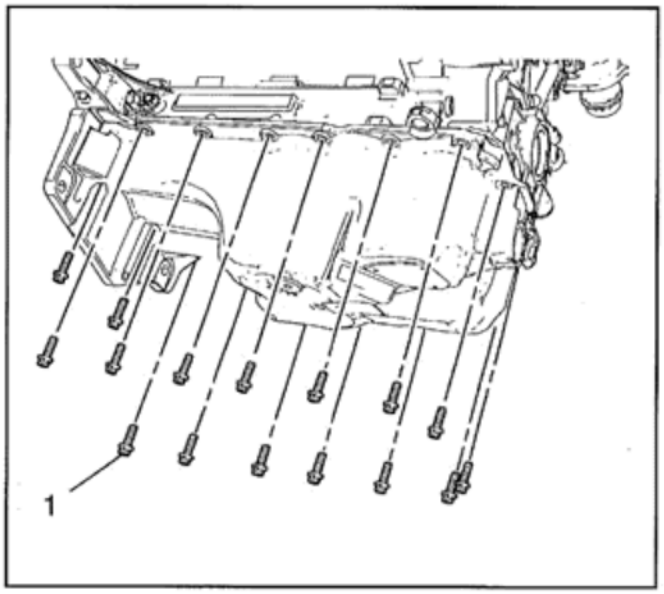


2190650

Caution: The camshaft position actuator solenoid valves must be kept parallel to the engine front cover during removal and installation. The camshaft position actuator solenoid valves can be damaged if they become wedged or stuck during this process.

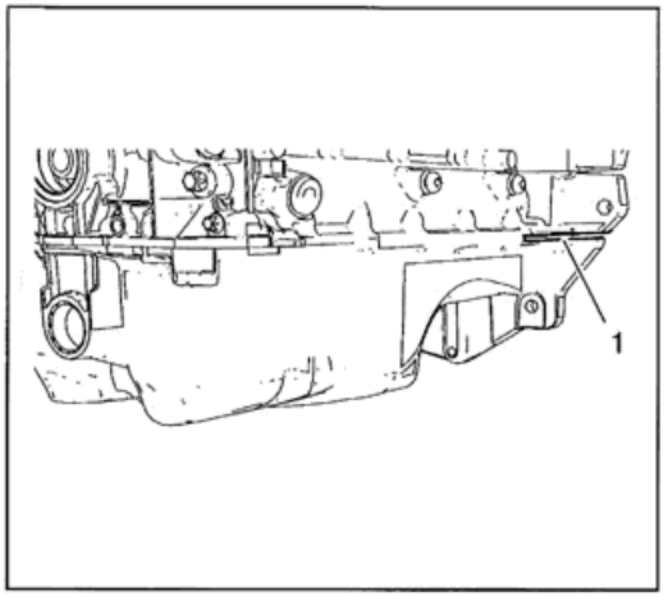
4. Carefully remove the 2 camshaft position actuator solenoid valves (2) and the seal rings (1).

Oil Pan Removal



2190370

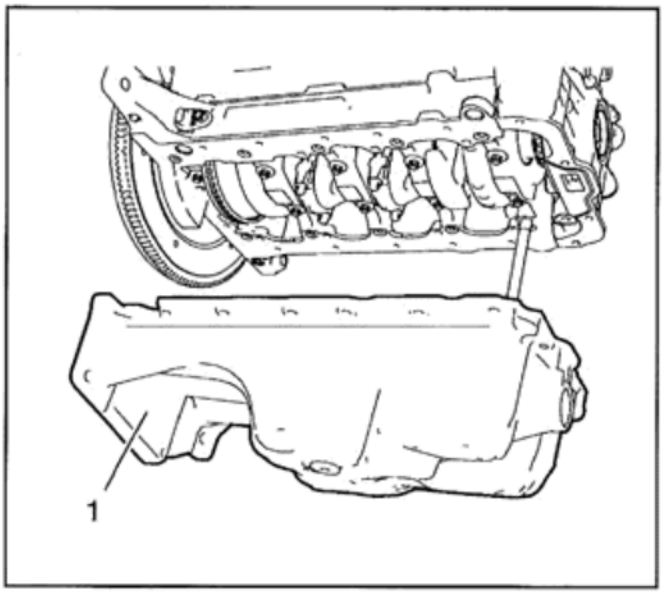
1. Remove the 16 oil pan bolts (1).



2190659

Caution: Pry the oil pan carefully in order to prevent damage to the transaxle case or the oil pan sealing surfaces.

2. Place a suitable prying tool to the area shown (1) and carefully pry the oil pan loose.

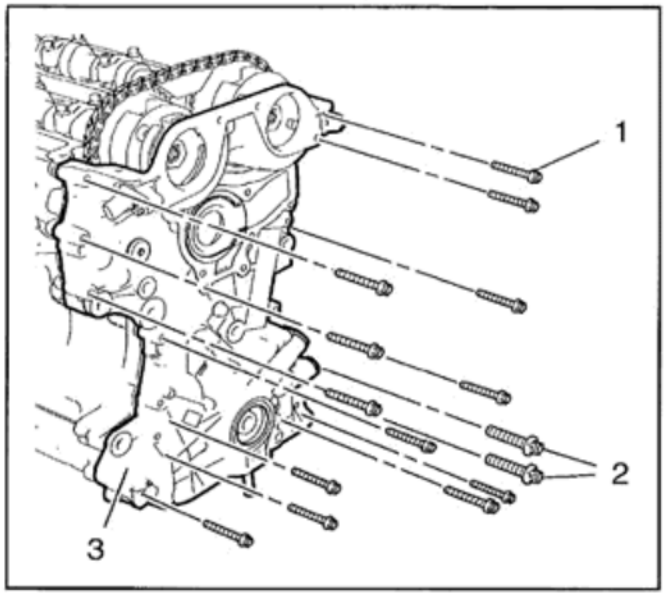


2190661

3. Remove the oil pan (1).

Engine Front Cover and Oil Pump Removal

1. Set engine to TDC. Refer to *Camshaft Timing Chain Inspection on page 9-855*.



2190667

2. Remove the 13 engine front cover bolts M6 (1).
3. Remove the 2 engine front cover bolts M10 (2).
4. Remove the engine front cover.

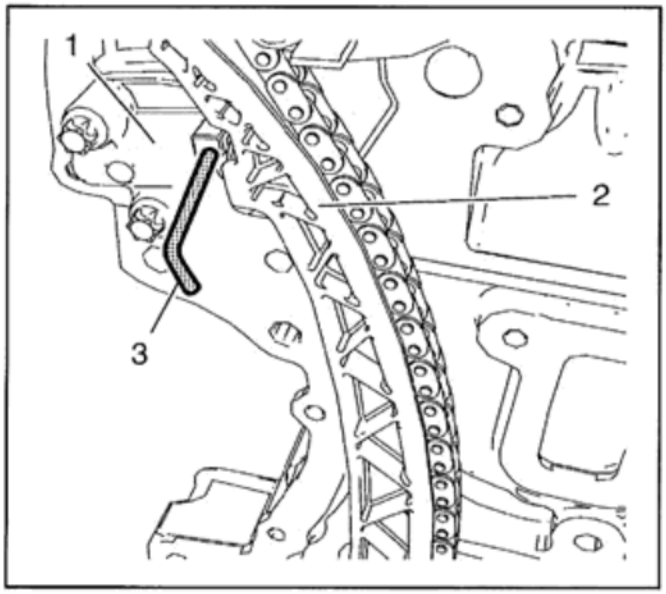
Camshaft Timing Chain Removal

Special Tools

- *EN-952* Fixing Pin
- *EN-953-A* Fixing Tool
- *EN-955-10* Fixing Pin from *EN-955* Kit

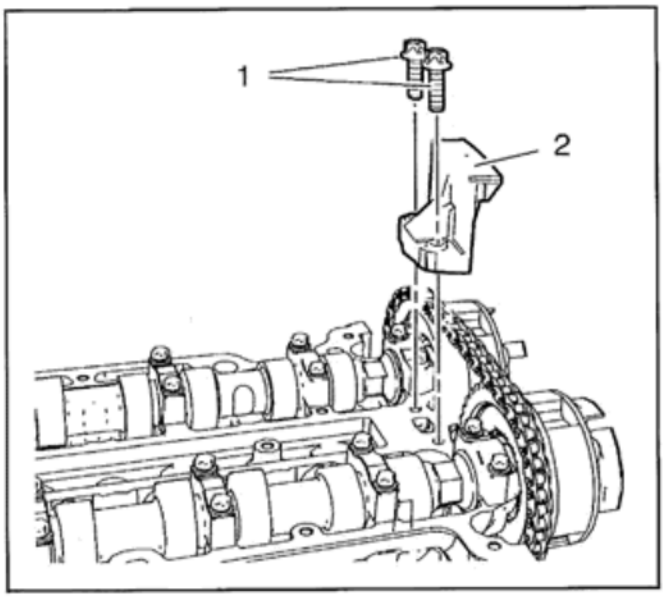
For equivalent regional tools, refer to *Special Tools on page 9-927*.

1. The engine should be adjusted to TDC.
2. The crankshaft should be fixed with *EN-952* fixing pin.
3. The camshaft should be fixed with *EN-953-A* fixing tool.



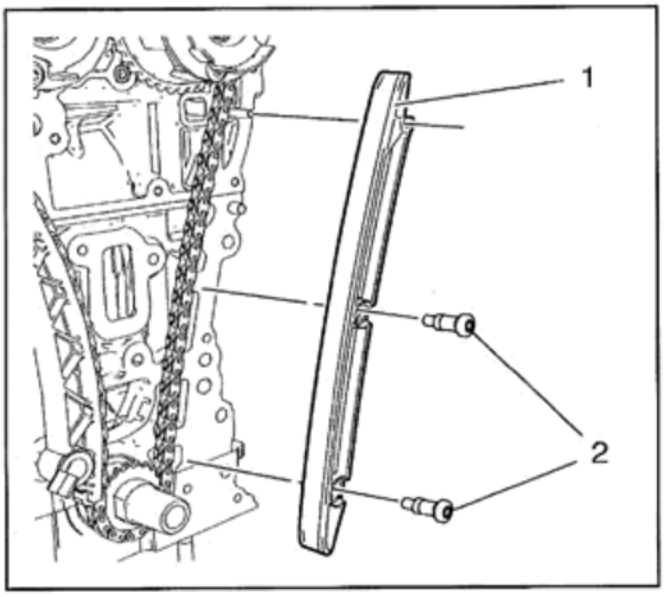
2190679

4. Push the timing chain (2) in direction to the timing chain tensioner (1) and fix the tensioner with *EN-955-10* fixing pin (3).



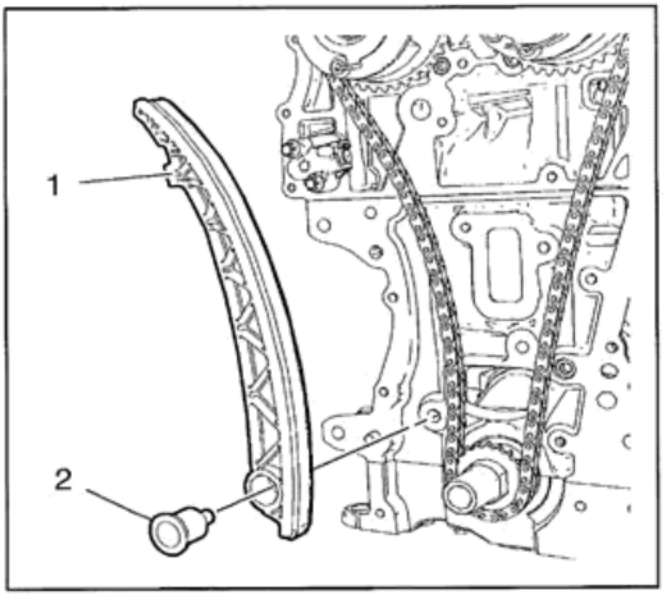
2190676

5. Remove the 2 upper timing chain guide bolts (1).
6. Remove the upper timing chain guide (2).



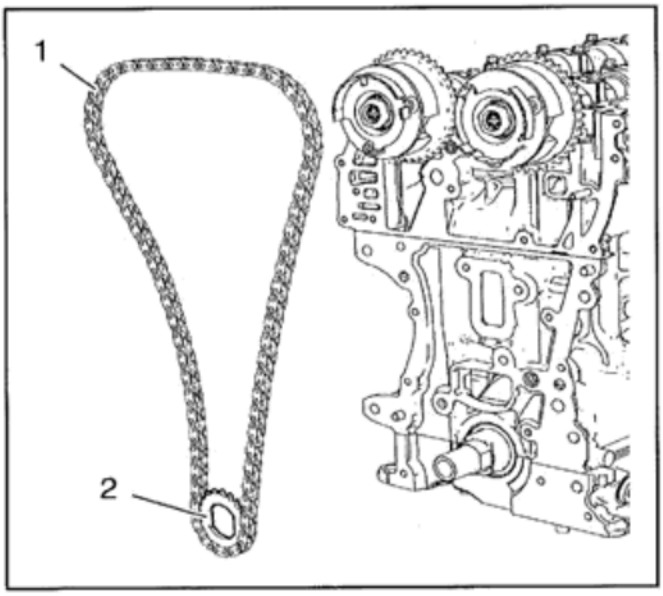
2190677

7. Remove the 2 timing chain guide right side bolts (2).
8. Remove the timing chain guide right side (1).



2190678

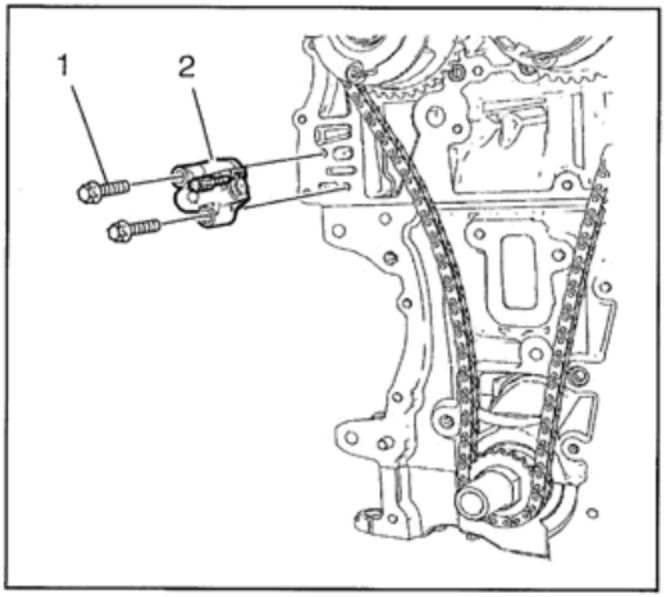
9. Remove the timing chain tensioner shoe bolt (2).
10. Remove the timing chain tensioner shoe (1).



2190675

11. Remove the timing chain (1) in compound with the crankshaft sprocket (2).

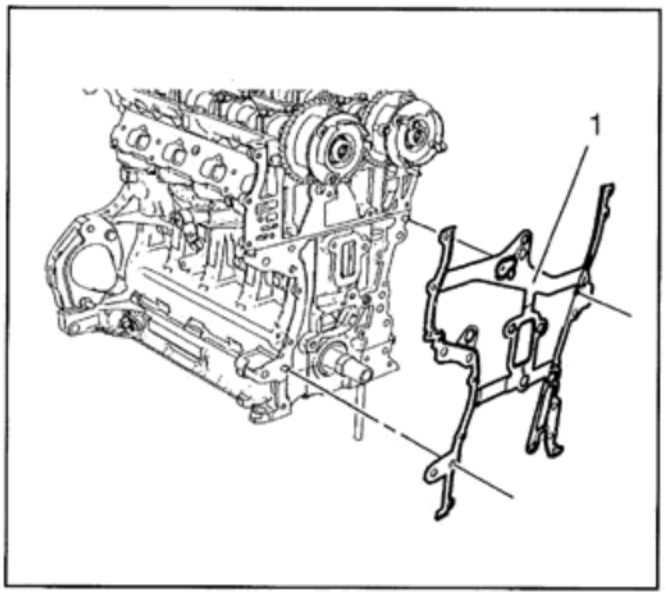
Timing Chain Tensioner Removal



2190684

1. Remove the 2 timing chain tensioner bolts (1).
2. Remove the timing chain tensioner (2).

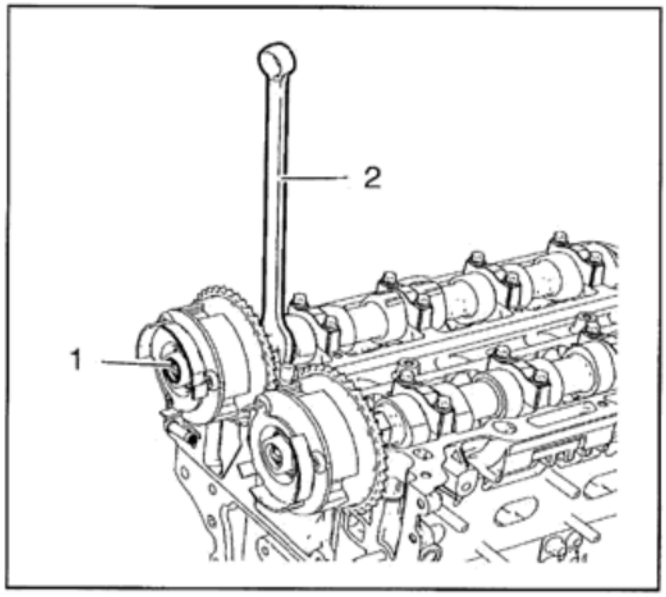
Engine Front Cover Gasket Removal



2190693

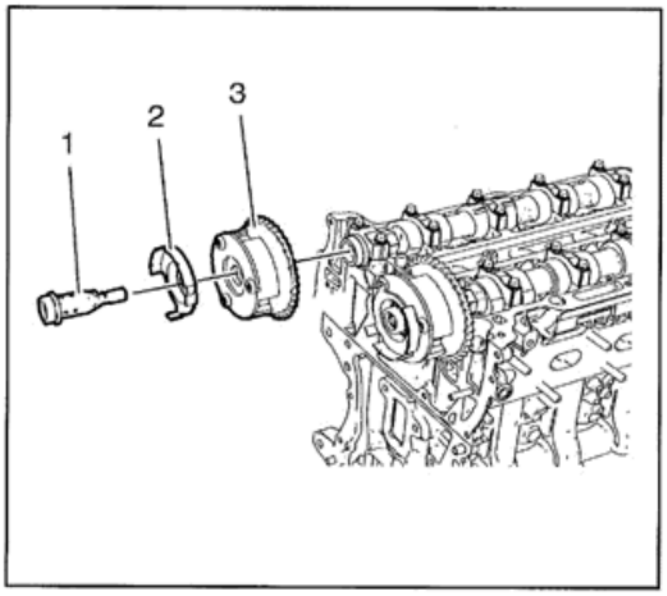
Remove and DISCARD the engine front cover gasket (1).

Camshaft Sprocket Removal



2190719

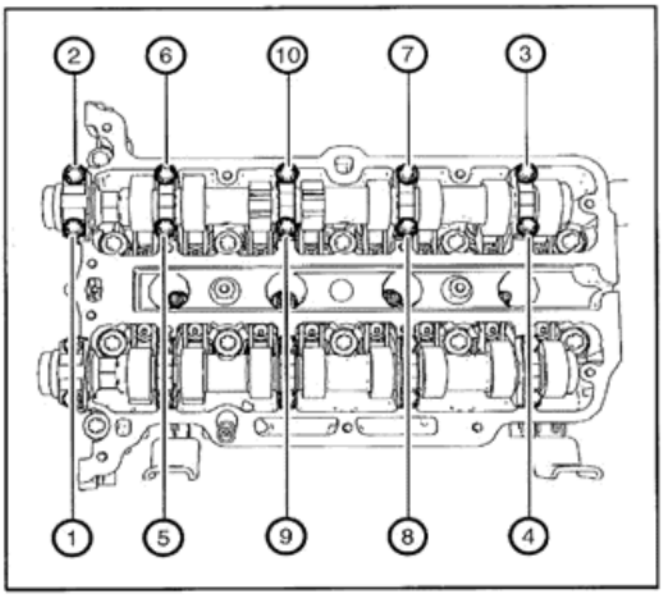
1. Loosen the intake camshaft sprocket bolt (1) while holding the hexagon of intake camshaft (2) with a wrench.



2190718

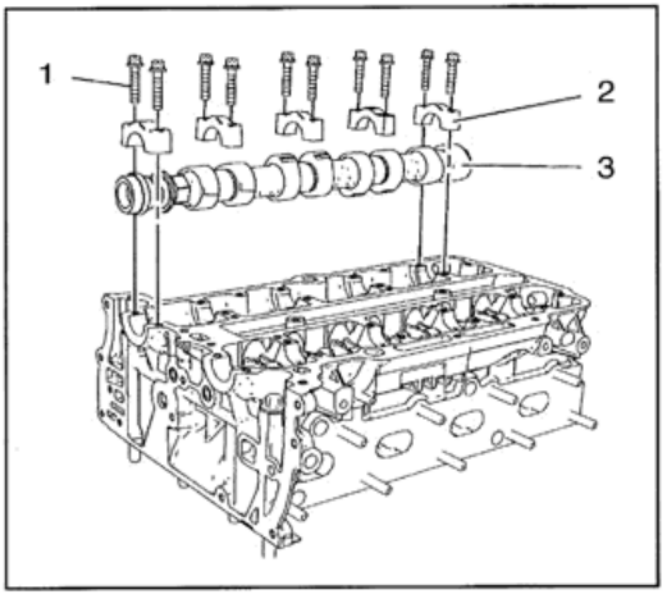
2. Remove the intake camshaft sprocket bolt (1) and the intake camshaft position exciter wheel (2).
3. Remove the intake camshaft sprocket (3).
4. Loosen the exhaust camshaft sprocket bolt while holding the hexagon of exhaust camshaft with a wrench.
5. Remove the exhaust camshaft sprocket bolt and the exhaust camshaft position exciter wheel.
6. Remove the exhaust camshaft sprocket.

Intake Camshaft Removal



2190728

1. Remove the camshaft bearing cap bolts in a spiral sequence as shown one turn at a time until there is no spring tension pushing on the camshaft.

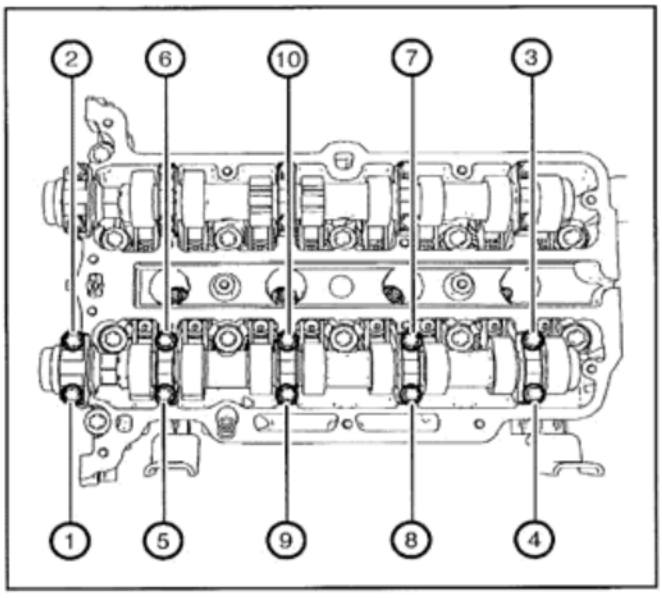


2190730

Note: Mind the markings on the camshaft bearing caps to ensure they will be installed in the same position.

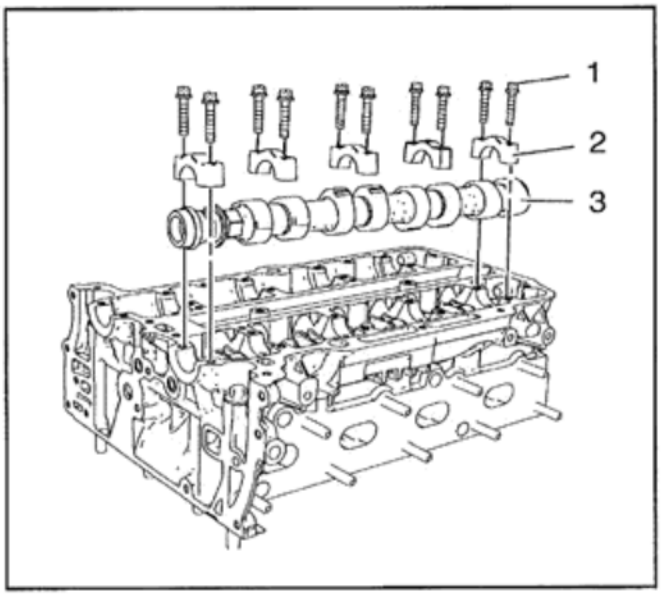
2. Remove the 10 camshaft bearing cap bolts (1).
3. Remove the 5 camshaft bearing caps (2).
4. Remove the intake camshaft (3).

Exhaust Camshaft Removal



2190732

1. Remove the camshaft bearing cap bolts in a spiral sequence as shown one turn at a time until there is no spring tension pushing on the camshaft.

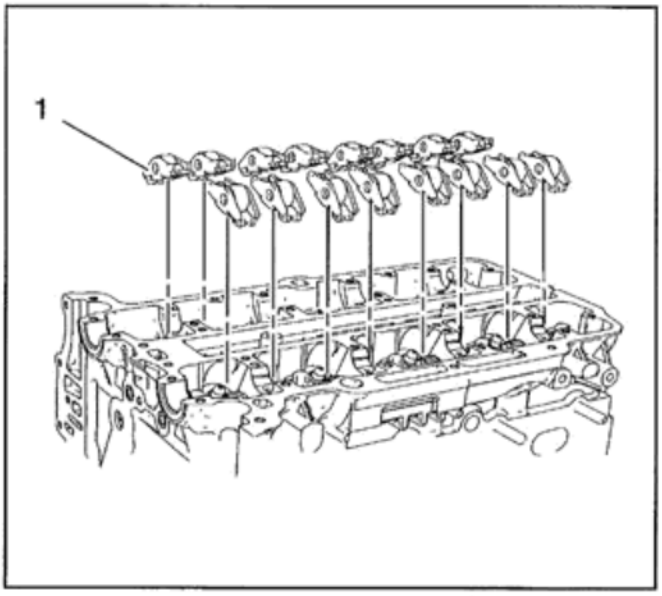


2190733

Note: Mind the markings on the camshaft bearing caps to ensure they will be installed in the same position.

2. Remove the 10 camshaft bearing cap bolts (1).
3. Remove the 5 camshaft bearing caps (2).
4. Remove the exhaust camshaft (3).

Hydraulic Valve Lash Adjuster Arm Removal

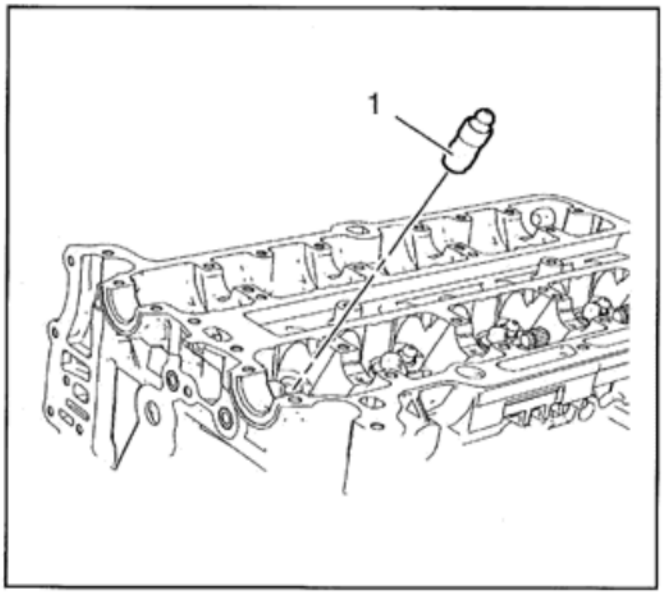


2190735

Note: Mind the installation position of the hydraulic valve lash adjuster arms.

Remove the 16 hydraulic valve lash adjuster arms (1).

Hydraulic Valve Lash Adjuster Removal

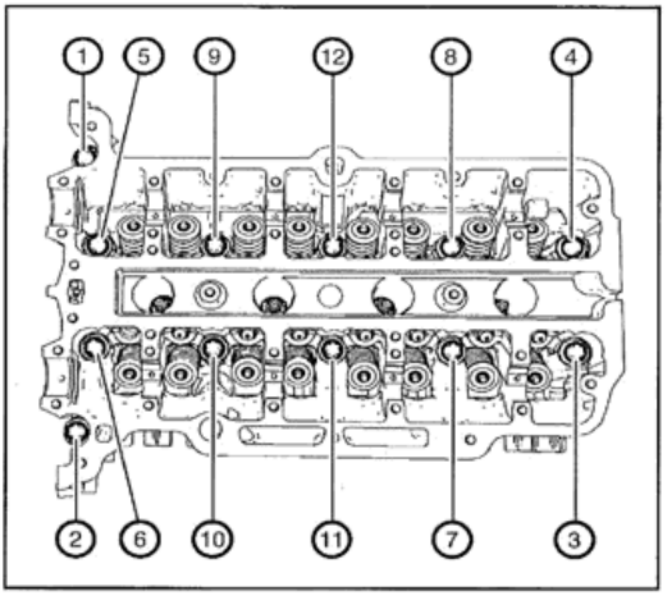


2190767

Note: Mind the installation position of the hydraulic valve lash adjusters.

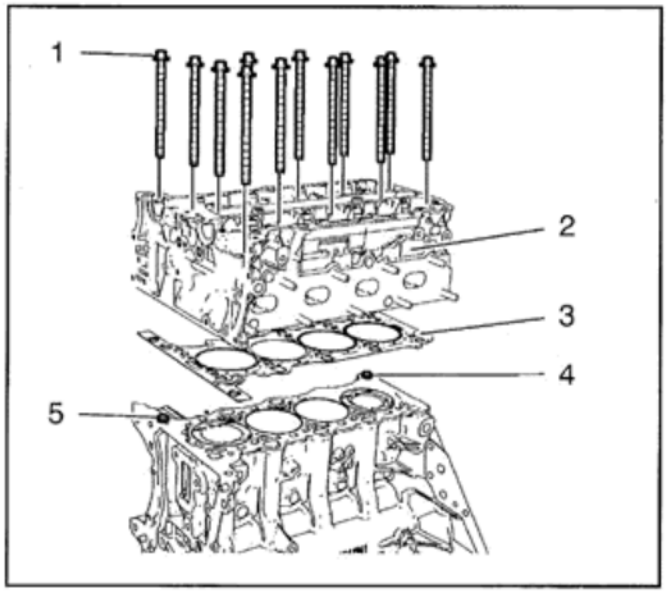
Remove the 16 hydraulic valve lash adjusters (1).

Cylinder Head Removal



2190736

1. Loosen the 12 cylinder head bolts in the sequence as shown. Use the following procedure:
   1.1. Loosen the cylinder head bolts 90 degrees.
   1.2. Loosen the cylinder head bolts 180 degrees.

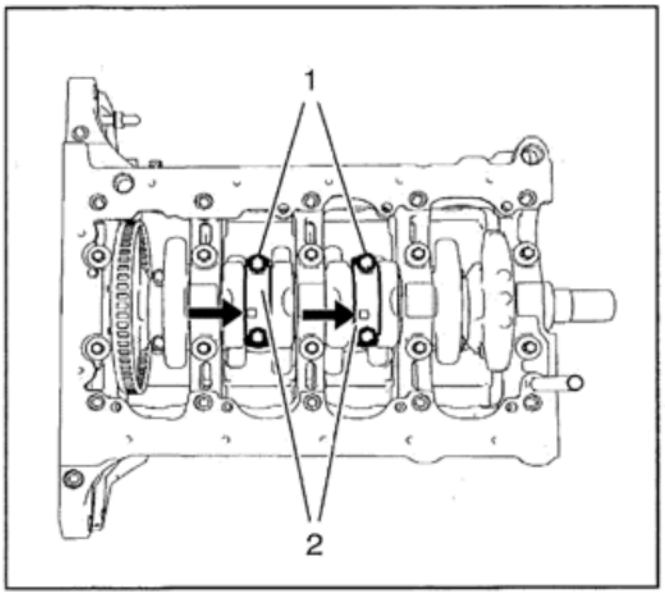


2190737

Note: Do not damage the guide sleeves (4) and (5).

2. Remove the 12 cylinder head bolts (1).
3. Remove the cylinder head (2).
4. Remove the cylinder head gasket (3).

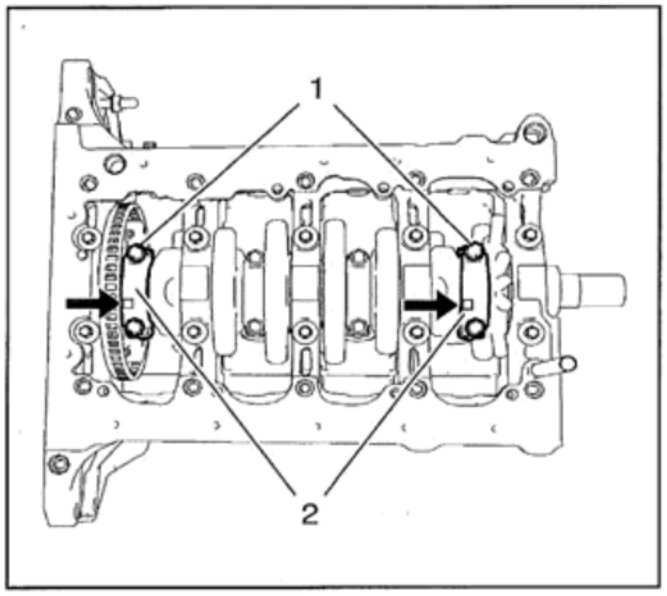
Piston, Connecting Rod, and Bearing Removal



2190741

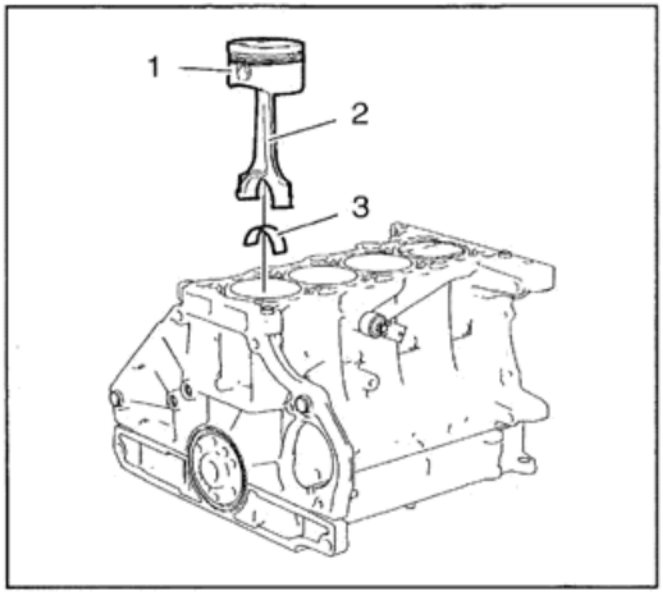
Note: Mark the installation position of the connecting rod bearing caps. The connecting rod bearings and bearing caps must not be interchanged with other connecting rods.

1. Remove the 4 connecting rod bearing cap bolts (1) of cylinder 2 and 3.
2. Remove the 2 connecting rod bearing caps (2) and the 2 connecting rod bearings of cylinder 2 and 3.
3. Rotate the crankshaft 180 degrees.



2190742

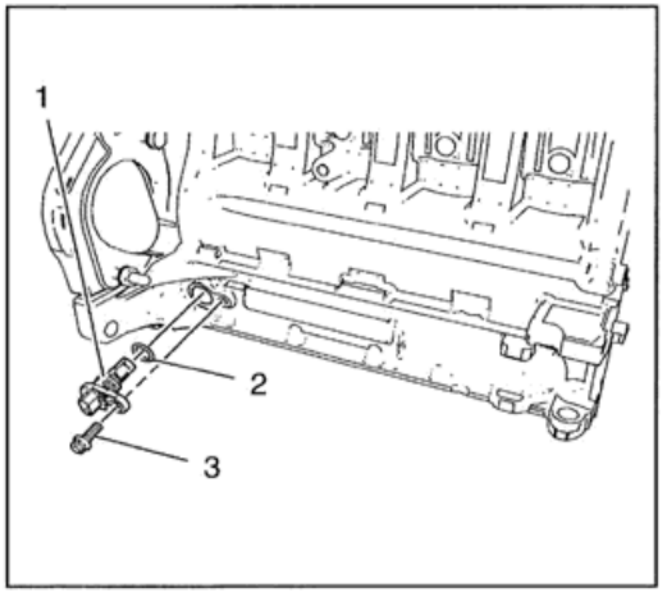
4. Remove the 4 connecting rod bearing cap bolts (1) of cylinder 1 and 4.
5. Remove the 2 connecting rod bearing caps (2) and the 2 connecting rod bearings of cylinder 1 and 4.



2190743

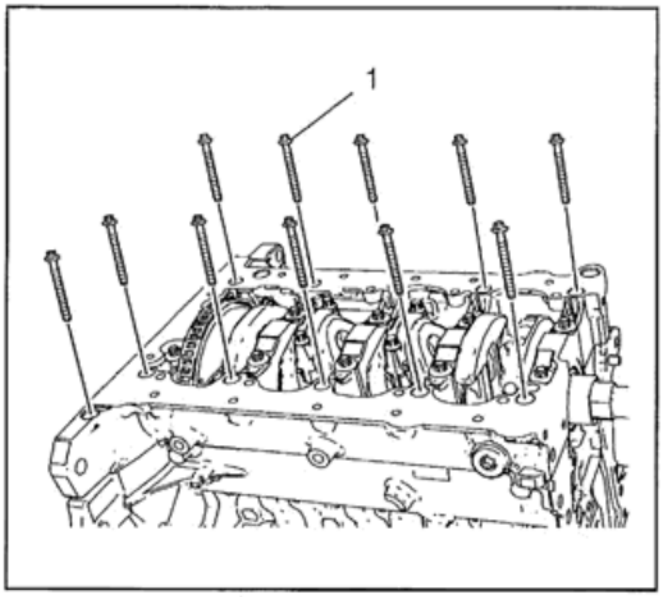
6. Remove the 4 pistons (1) and connecting rods (2) and the 4 upper connecting rod bearings (3) from the cylinder block.

Crankshaft and Bearing Removal



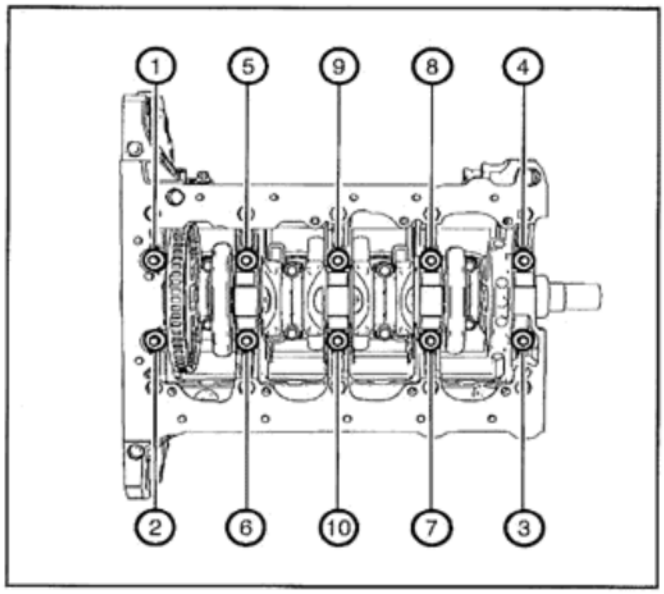
2190746

1. Remove the crankshaft position sensor bolt (3).
2. Remove the crankshaft position sensor (1) and the crankshaft position sensor seal ring (2).



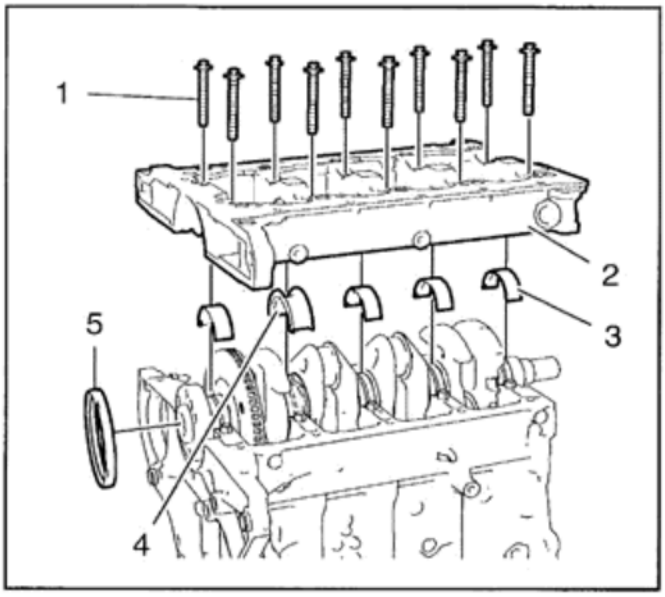
2190355

3. Remove the 12 outer crankshaft bearing cap tie plate bolts (1).



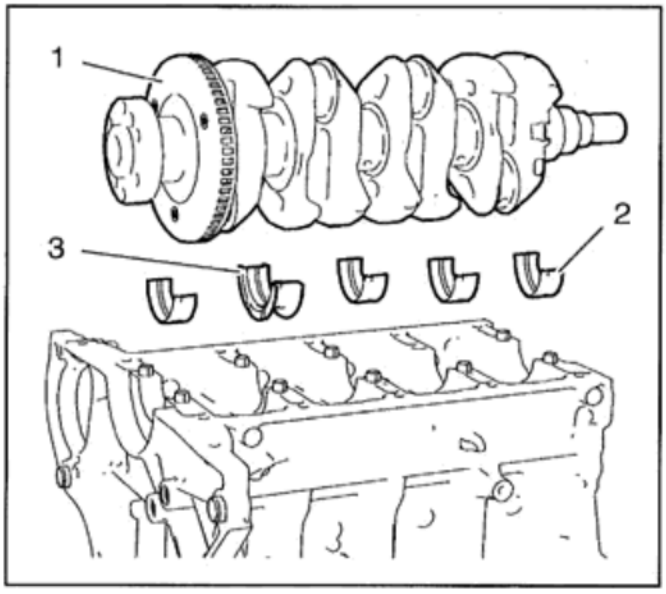
2190356

4. Loosen the 10 inner crankshaft bearing cap tie plate bolts in a sequence as shown.



2190744

5. Remove and DISCARD the 10 crankshaft bearing cap tie plate bolts (1)
   Remove the crankshaft bearing cap tie plate (2).
6. Remove the 4 lower crankshaft bearings (3) an the lower crankshaft thrust bearing (4).
7. Remove the crankshaft rear oil seal (5).



2190745

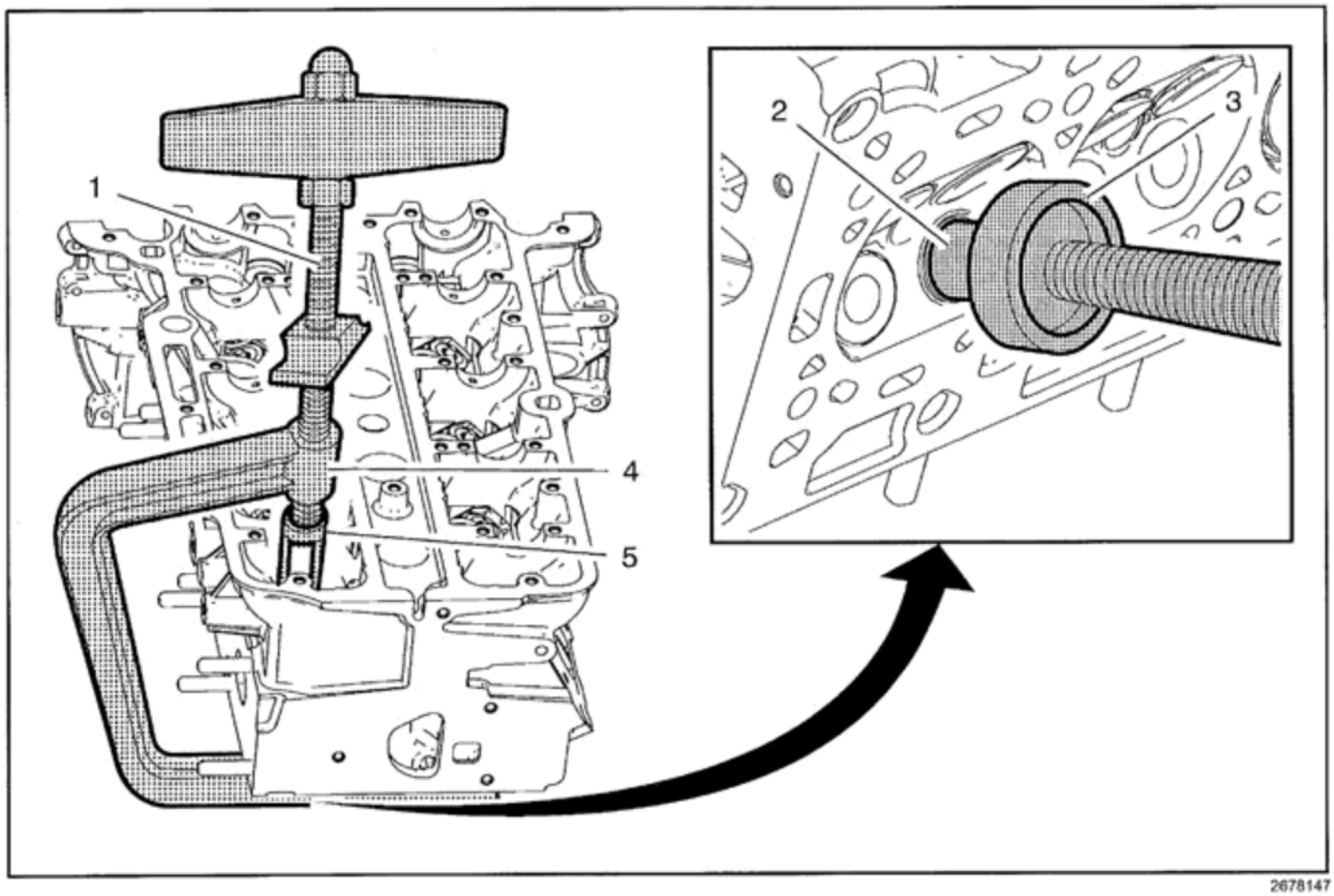
8. Remove the crankshaft (1), the 4 upper crankshaft bearings (2) and the upper crankshaft thrust bearing (3).

Cylinder Head Disassemble

Special Tools

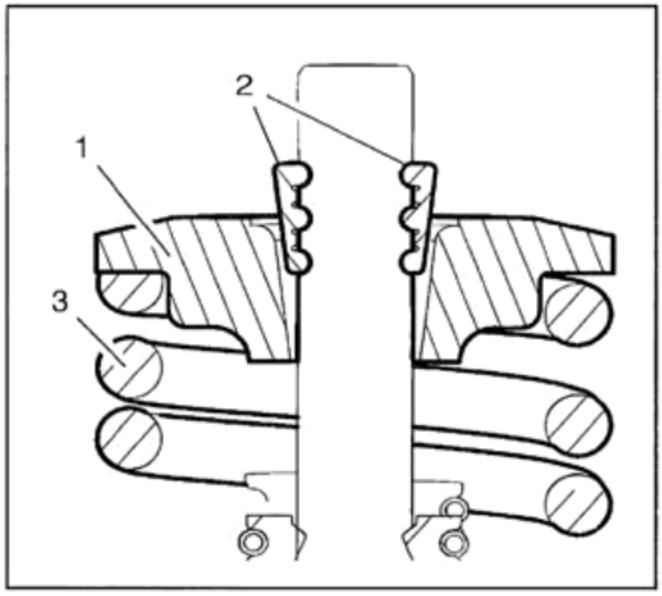
- *EN-840* Pliers/Remover
- *EN-8062* Valve Spring Compressor
- *EN-8062-5* Adapter
- *EN-50717-2* Compressor Assembly of *EN-50717* Kit

For equivalent regional tools, refer to *Special Tools on page 9-927*.



2678147

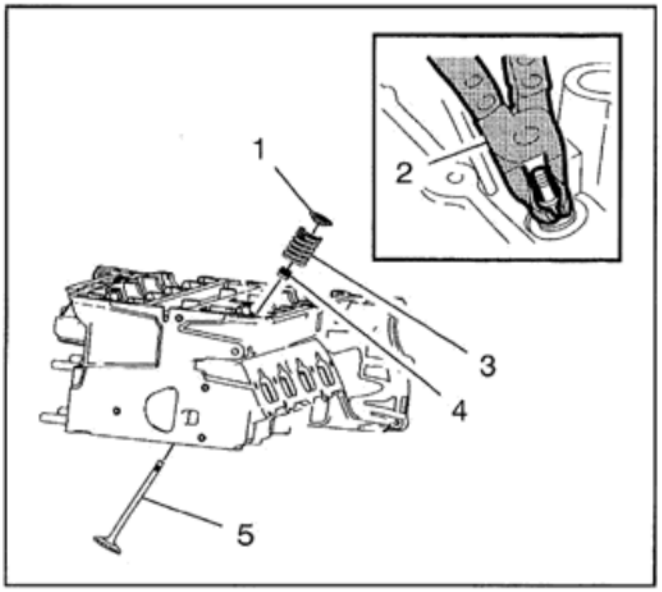
1. Install the *EN-50717–2* assembly (1) to the *EN-8062* compressor (4).
2. Install the *EN-8062–5* adapter (3) to the *EN-8062* compressor.
3. Install the compressor assembly to the cylinder head, so that the adapter (5) of the *EN-50717–2* assembly (1) contacts the valve spring retainer properly and the *EN-8062–5* adapter (3) contacts the valve disc (2). Prefix the *EN-8062* compressor (4).



2678153

Warning: Valve springs can be tightly compressed. Use care when removing the retainers and plugs. Personal injury could result.

4. Apply pressure to the *EN-50717–2* assembly to push down the vale spring retainer (1) and compress the valve spring (3) until the valve keys (2) are free from tension. Carefully remove the valve keys.



2678154

5. Slowly and carefully loosen the *EN-50717–2* assembly until the valve spring is entirely expanded.
6. Remove the compressor assembly from the cylinder head.
7. Remove the valve spring retainer (1) and the valve spring (3).
8. Remove and DISCARD the valve stem oil seal (4), using the *EN-840* pliers (2).
9. Remove the valve (5).

Note: Ensure that the valve train components are kept together and identified in order for proper installation in their original position.

10. Repeat the procedure with the remaining valves.
11. In case of re-using the cylinder head, refer to *Cylinder Head Cleaning and Inspection on page 9-877*.

Cylinder Head Cleaning and Inspection

Special Tools

- *EN-6216* Gauge
- *EN-6216-200/300/400* Gauge Instruments

For equivalent regional tools refer to *Special Tools on page 9-927*.

Cleaning Procedure

1. Remove any old thread sealant, gasket material or sealant.
2. Clean all cylinder head surfaces with non-corrosive sealant.

Warning: Refer to Safety Glasses Warning on page 0-5.

3. Blow out all the oil galleries using compressed air.
4. Remove any carbon deposits from the combustion chamber.

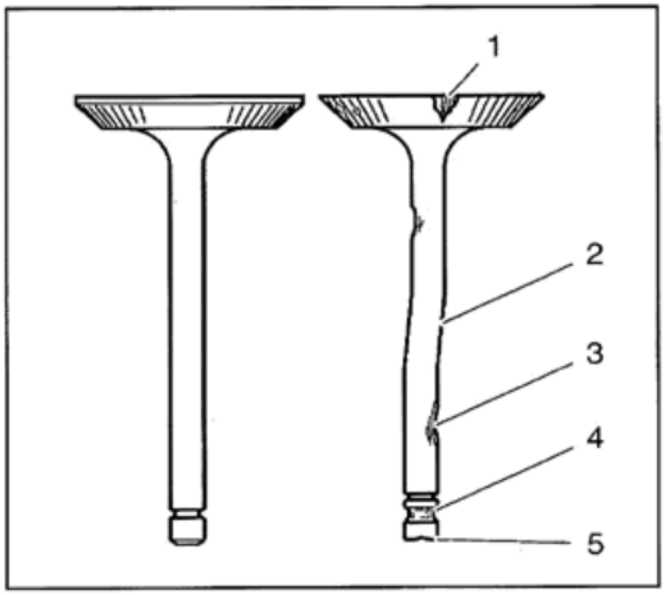
Visual Inspection

1. Inspect the cylinder head camshaft bearing surfaces for the following conditions:
   - Excessive scoring or pitting
   - Discoloration from overheating
   - Deformation from excessive wear
   - If the camshaft bearing journals appear to be scored or damaged, you must replace the cylinder head. DO NOT machine the camshaft bearing journals.
2. If any of the above conditions exist on the camshaft bearing surfaces, replace the cylinder head.
3. Inspect the cylinder head for the following:
   - Cracks, damage or pitting in the combustion chambers.
   - Debris in the oil galleries – Continue to clean the galleries until all debris is removed.
   - Coolant leaks or damage to the deck face sealing surface – If coolant leaks are present, measure the surface war page as described under cylinder head measurement – deck flatness inspection.
   - Damage to any gasket surfaces.
   - Burnt or eroded areas in the combustion chamber.
   - Cracks in the exhaust ports and combustion chambers.
   - External cracks in the water passages.
   - Restrictions in the intake or exhaust passages.

- Restrictions in the cooling system passages.
- Rusted, damaged or leaking core plugs.

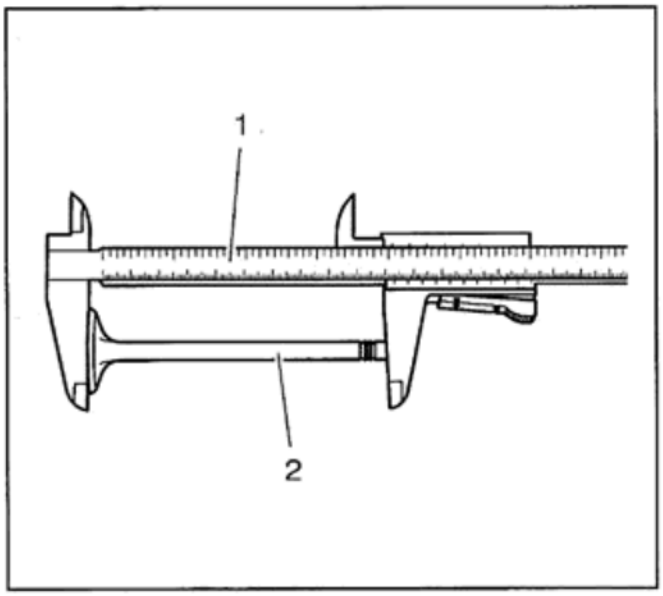
4. If the cylinder head is cracked or damaged, it must be replaced. No welding or patching of the cylinder head is allowed.

Valve Inspection And Measurement



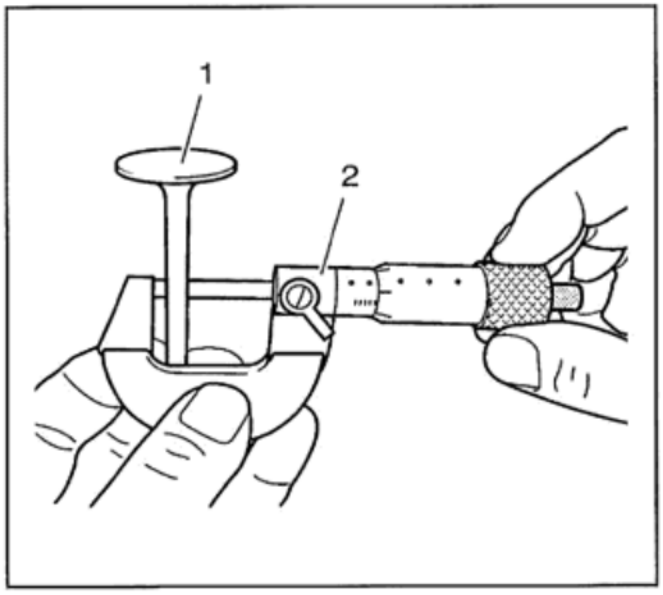
2189690

1. Clean the valves of carbon and oil. Carbon can be removed with a wire brush.
2. Inspect the valves for the following conditions:
   2.1. Inspect the valve faces for burning and cracking (1). If pieces are broken, replace the valve and inspect the corresponding piston and cylinder head area for damage.
   2.2. Inspect the valve for straightness and distortion (2). Distorted valve must be replaced.
   2.3. Inspect the valve stem for wear (3).
   2.4. Inspect the valve key grooves for chipping and wear (5). Replace the valve if chipped or worn.



2189668

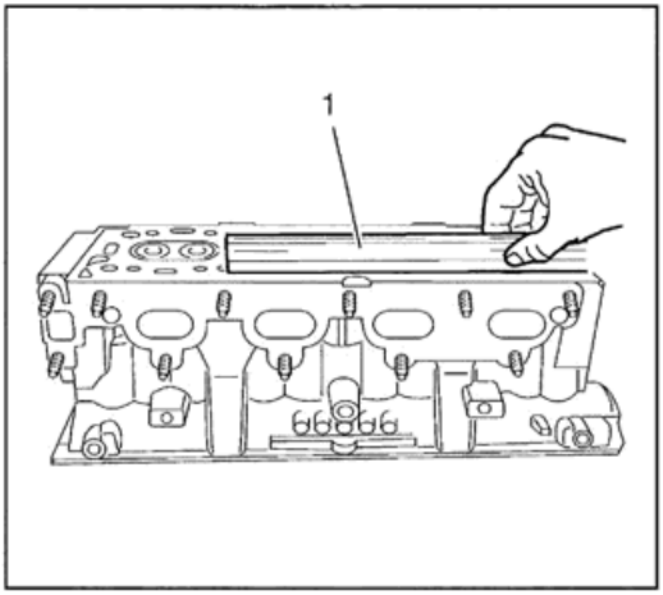
3. Measure the valve length (2). Use a slide gauge (1). Refer to *Engine Mechanical Specifications on page 9-756* to find the permitted values.



2189667

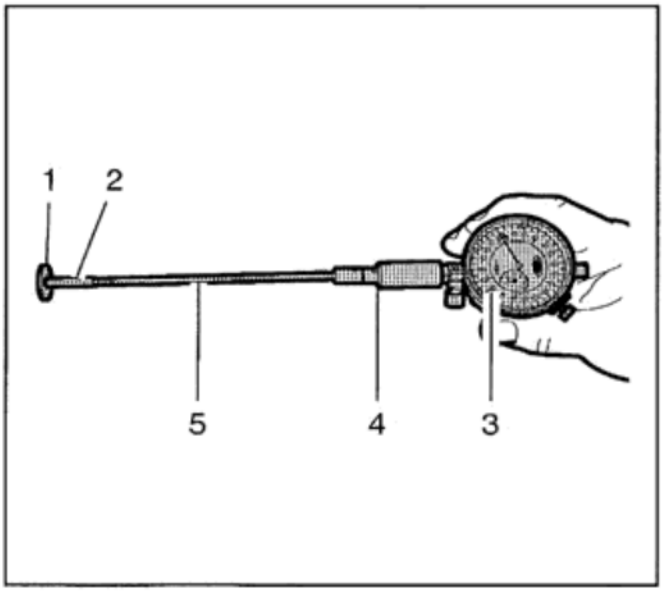
4. Measure the valve stem diameter. Use a micrometer gauge (2). Refer to *Engine Mechanical Specifications on page 9-756* to find the permitted values. Note the measurement results.

Cylinder Head Measurement



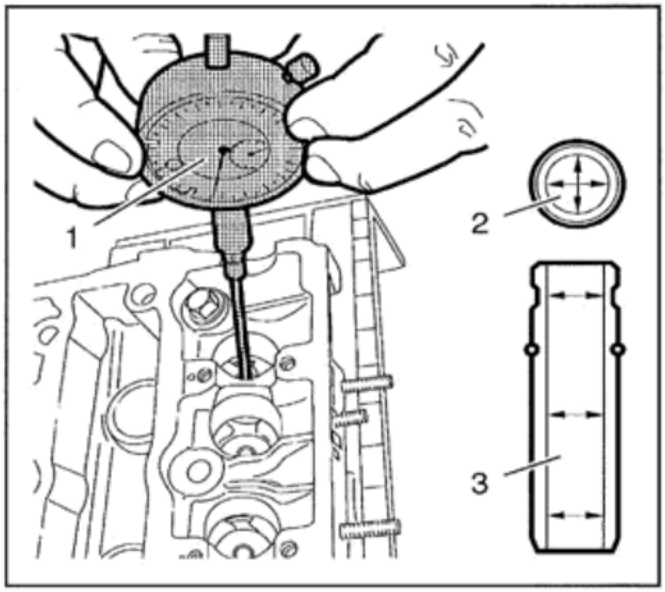
2189666

1. Inspect the cylinder head sealing surface for flatness. Use a straightedge (1). Refer to *Engine Mechanical Specifications on page 9-756* to find the permitted values. If the measurement does not show the permitted values, replace the cylinder head. Machining is NOT allowed.



2189672

2. Prepare the gauge for valve stem to guide clearance measurement. Assemble the *EN-6216* gauge and the *EN-6216-200/300/400* gauge instruments as followed:
   2.1. Install the extension (5) to the support (4).
   2.2. Install the inside caliper (2) to the extension (5).
   2.3. Install the gauge (3) to the support (4) and pretension to **1 mm (0.0394 in)**.
   2.4. Install the calibration washer (1) as shown to justify the gauge.
   2.5. Adjust the gauge to **0 mm (0 in)** by rotating the instrument dial.
   2.6. Cautious remove the calibration washer (1).



2189673

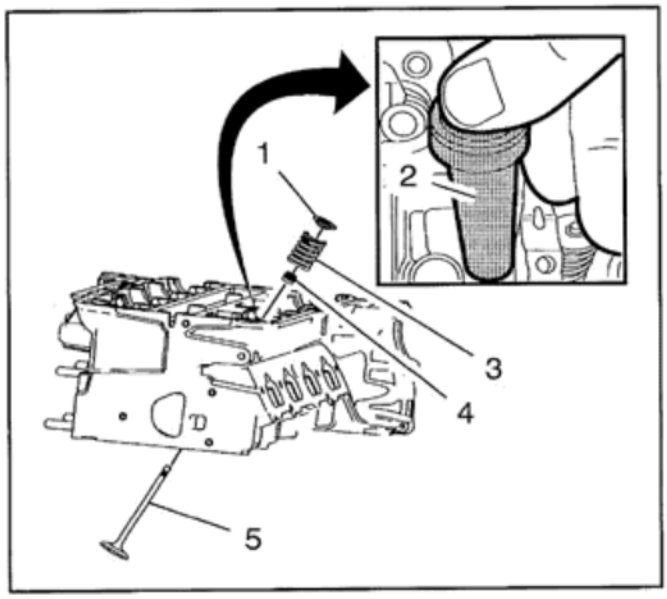
3. Measure the valve guide inner diameter (2) as shown in different areas (3). Use *EN-6216* gauge (1) and gauge instruments. Note the measurement results. Refer to *Engine Mechanical Specifications on page 9-756* to find the permitted values.
4. Substract the valve stem diameter from valve guide inner diameter to calculate the valve stem to guide clearance. Refer to *Engine Mechanical Specifications on page 9-756* to find the permitted values.
5. Turn the cylinder head upside down.

Cylinder Head Assemble

Special Tools

- *EN-958* Valve Stem Seal Installer
- *EN-8062* Valve Spring Compressor
- *EN-8062-5* Adapter
- *EN-50717-2* Compressor Assembly of *EN-50717* Kit

For equivalent regional tools, refer to *Special Tools on page 9-927*.

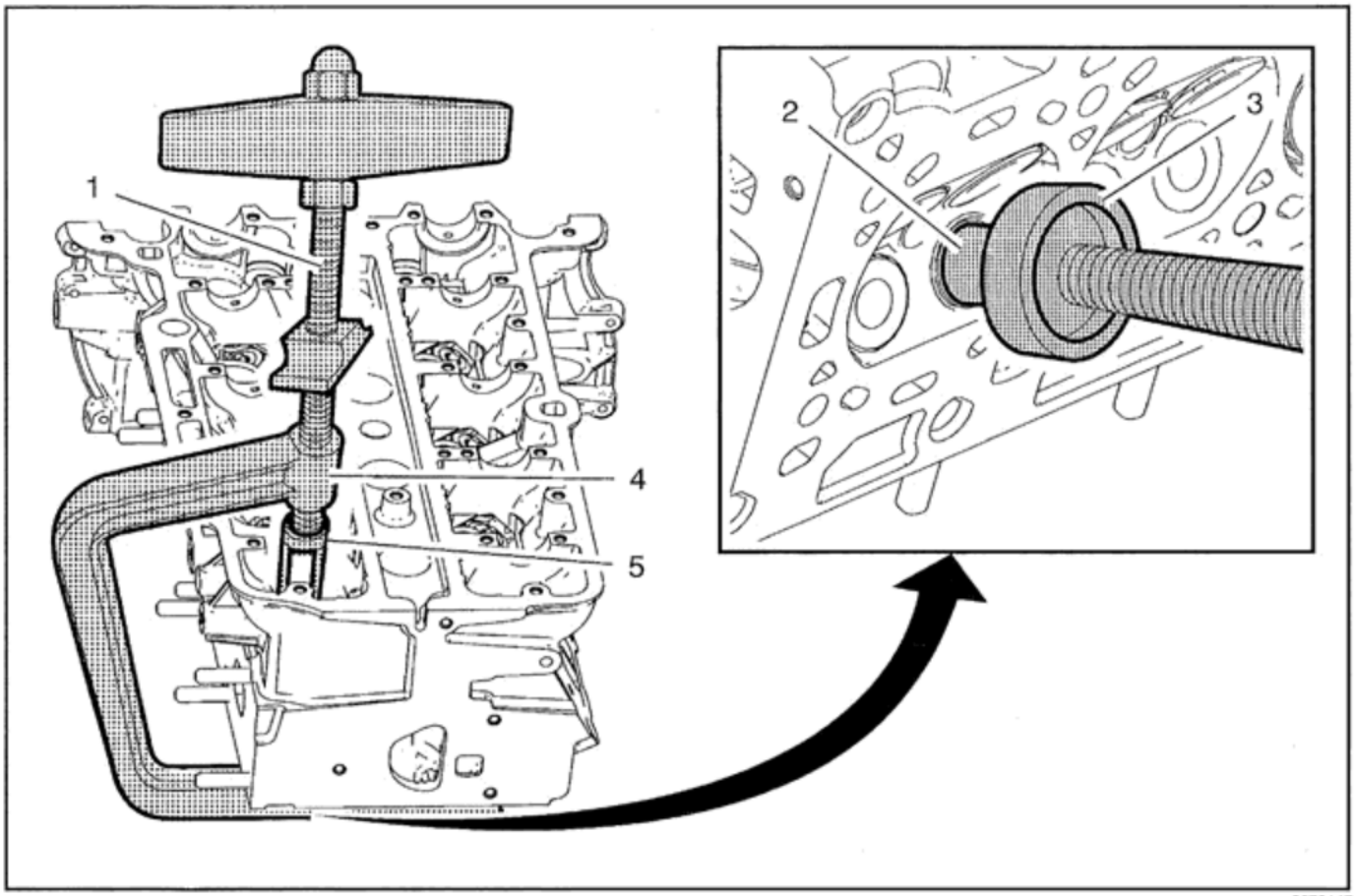


2678156

1. Lubricate the valve stem and the valve guide with clean engine oil.

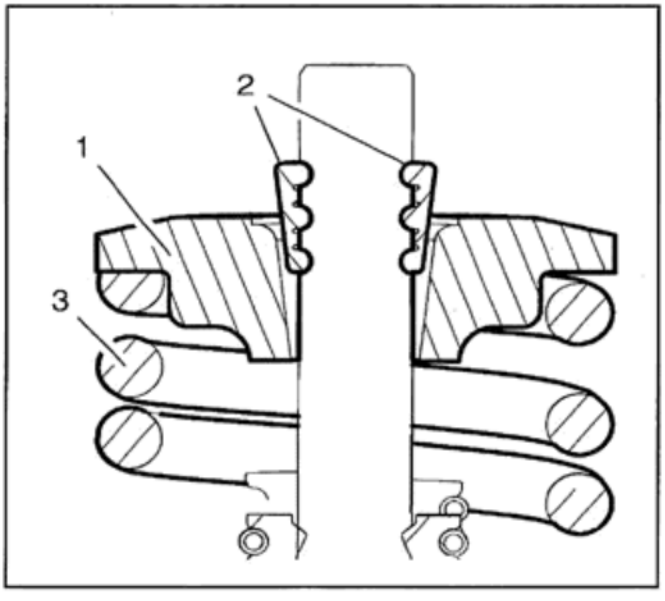
Note: Ensure all valve train components will be installed in their original position.

2. Install the valve (5).
3. Install the NEW valve stem oil seal (4), using the *EN-958* installer (2).
4. Loosely install the valve spring (3) and the valve spring retainer (1).



2678147

5. Install the *EN-50717–2* assembly (1) to the *EN-8062* compressor (4).
6. Install the *EN-8062–5* adapter (3) to the *EN-8062* compressor.
7. Install the compressor assembly to the cylinder head, so that the adapter (5) of the *EN-50717–2* assembly (1) contacts the valve spring retainer properly and the *EN-8062–5* adapter (3) contacts the valve disc (2). Prefix the *EN-8062* compressor (4).

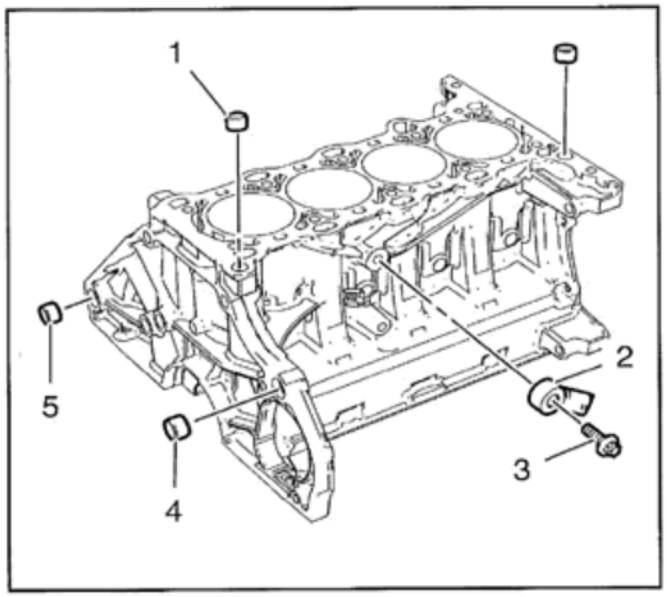


2678153

Caution: The valve stem keys must correctly seat in the valve spring cap. Engine damage may occur by not installing properly.

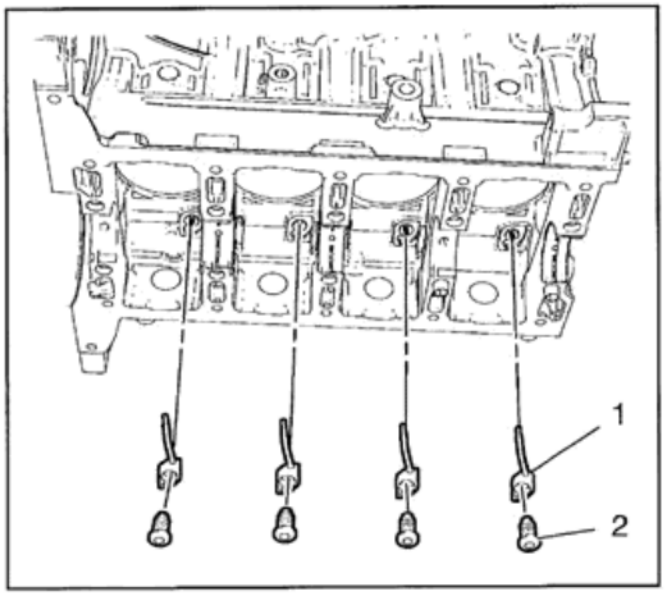
8. Apply pressure to the *EN-50717–2* assembly to push down the vale spring retainer (1) and compress the valve spring (3) until the valve keys (2) can be inserted. Carefully insert the valve keys then, so that they are proper installed to the valve stem grooves.
9. Carefully release the tension from the *EN-50717–2* assembly.
10. Inspect the valve keys and valve spring retainers for proper seat.
11. Remove the compressor assembly from the cylinder head.
12. Repeat the procedure with the remaining valves.

Engine Block Disassemble



2190941

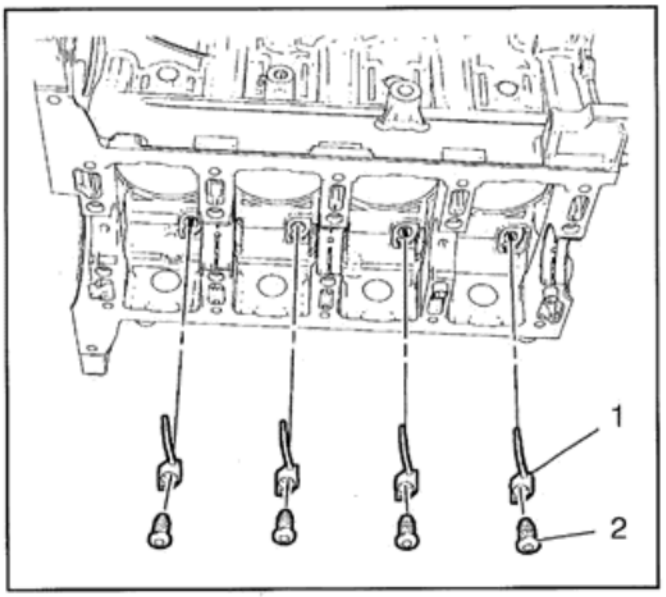
1. Remove the knock sensor bolt (3).
2. Remove the knock sensor (2).
3. Remove the 2 cylinder head guide sleeves (1). Use suitable pliers.
4. Remove the 2 transmission guide sleeves (4) and (5). Use suitable pliers.



2191859

5. Remove the 4 piston oil nozzle bolts (2).
6. Remove the 4 piston oil nozzles (1).

Engine Block Assemble

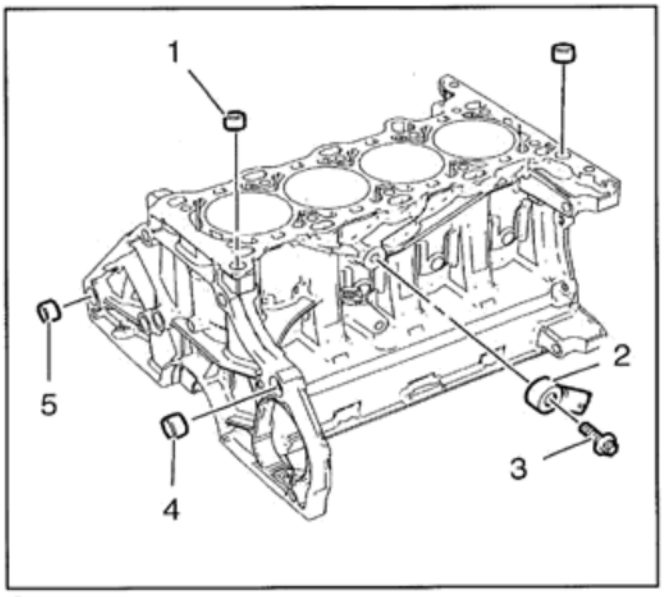


2191859

1. Install the 4 piston oil nozzles (1).

Caution: Refer to *Fastener Caution on page 0-8*.

2. Install the 4 piston oil nozzle bolts (2) and tighten to **25 N•m (18 lb ft)**.



2190941

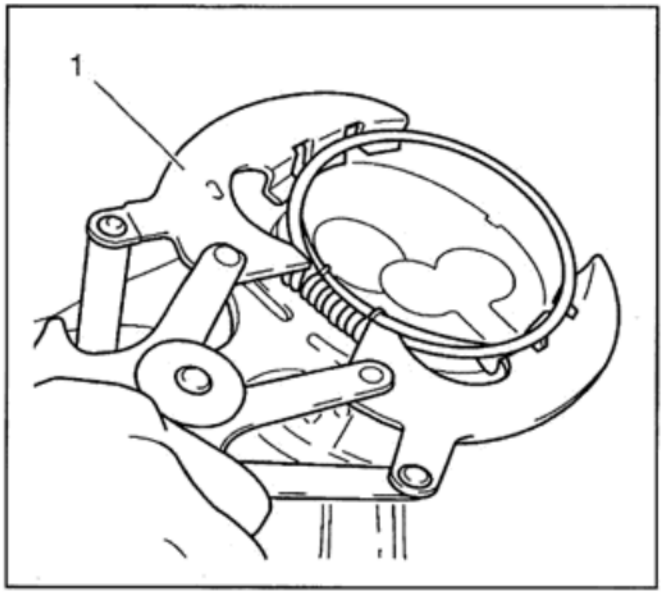
3. Install the knock sensor (2).
4. Install the knock sensor bolt (3) and tighten to **20 N•m (15 lb ft)**.
5. Install the 2 cylinder head guide sleeves (1). Use a rubber mallet.
6. Install the 2 transmission guide sleeves (4) and (5). Use a rubber mallet.

Piston and Connecting Rod Disassemble

Special Tool

EN-49941 Remover / Installer Piston Retainer Ring

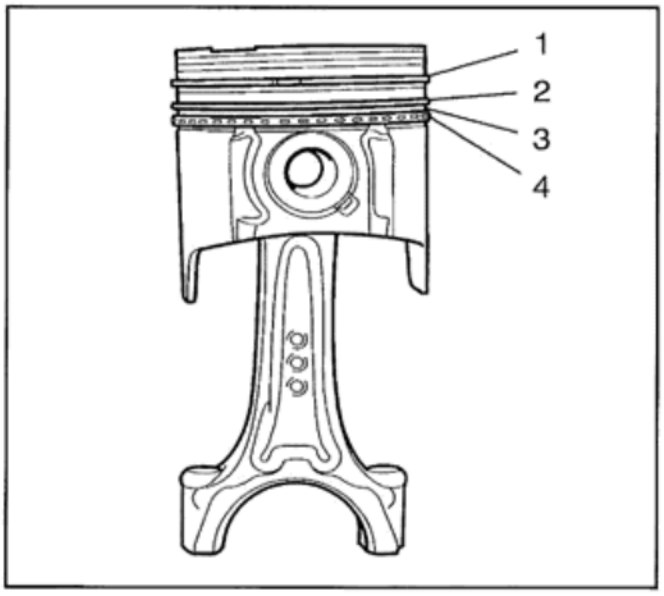
For equivalent regional tools, refer to *Special Tools on page 9-927*.



2189594

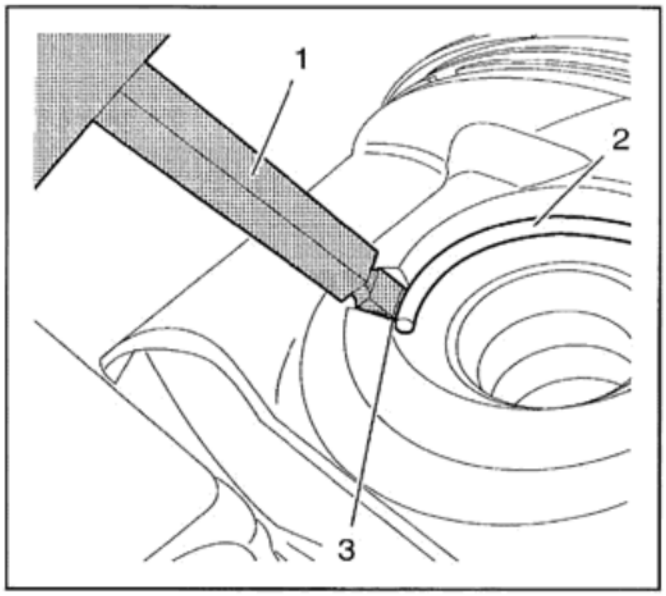
Warning: Handle the piston carefully. Worn piston rings are sharp and may cause bodily injury.

1. Remove the piston rings. Use piston ring pliers (1)



2189595

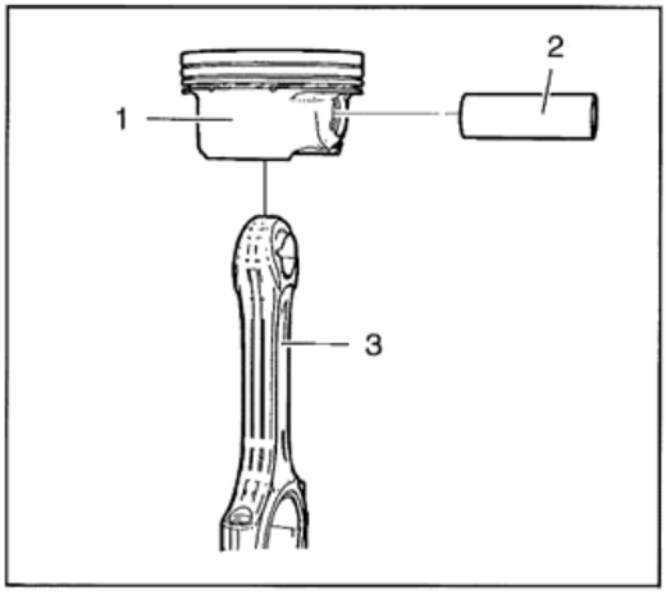
2. The piston rings are ordered as followed:
   - Upper compression ring (1)
   - Lower compression ring (2)
   - Oil rings and oil ring spacer (3) and (4)
3. Install the piston and connecting rod assembly to a bench vise. Use aluminium braces



2191896

Warning: Use extreme care when removing snap rings. Always wear adequate eye protection in order to avoid personal injury.

4. Apply the *EN-49941* remover (1) in the notch (3) to the piston pin retainer (2) and remove it.



2191898

5. Remove the piston pin (2) and the connecting rod (3) from the piston (1).

Piston, Connecting Rod, and Bearing Cleaning and Inspection

Special Tools

EN-470-B Angular Torque Wrench

For equivalent regional tools, refer to *Special Tools on page 9-927*.

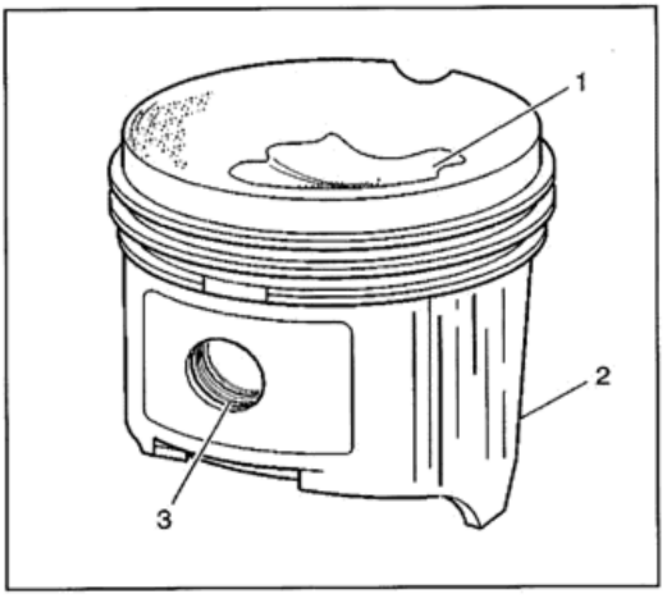
Visual Inspection And Cleaning Procedure

Connecting Rod

Warning: Wear safety glasses when using compressed air in order to prevent eye injury.

1. Clean the connecting rods in solvent and dry with compressed air.
2. Inspect the connecting rod for the following:
   - Signs of being twisted, bent, nicked or cracked
   - Scratches or abrasion on the connecting rod bearing seating surfaces

Piston

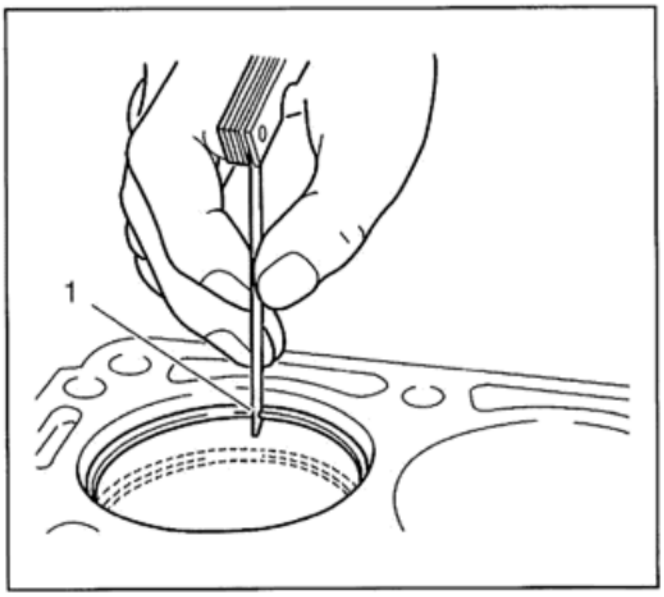


156168

1. Clean the piston with a cleaning solvent. DO NOT wire brush any parts of the piston.
2. Clean the piston ring grooves.
3. Inspect the piston on the following:
   - Cracked ring lands, skirts or pin bosses
   - Ring grooves for nicks
   - Eroded areas on the top of the piston (1)
   - Scuffed or damaged skirts (2)
   - Worn piston pin bores (3)
4. If there is any excessive wear, replace the piston.
5. Measure the clearance between piston pin and piston bore.

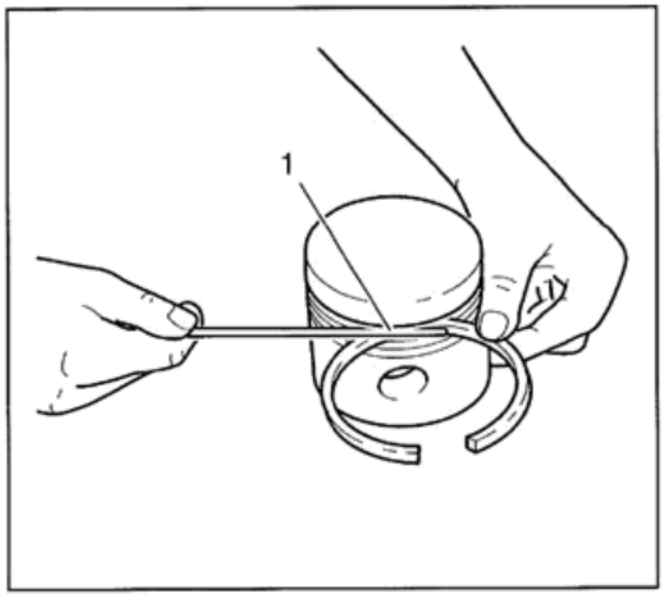
Piston And Connecting Rod Measurement Procedure

Piston Ring Clearance



2189596

1. Install the piston rings to the cylinder as shown (1) and measure the piston ring end gap. Compare the measurements with those provided below:
   - The upper compression ring end gap should be 0.4–0.6 mm (0.0157–0.0236 in).
   - The lower compression ring end gap should be 0.4–0.6 mm (0.0157–0.0236 in).
   - The oil ring end gap should be 0.2–0.9 mm (0.0079–0.0354 in).
2. If the clearance is greater than the provided specifications, the piston rings must be replaced.



2189597

3. Measure the piston ring side clearance as shown (1). Compare the measurements with those provided below:
   - The upper compression ring side clearance should be 0.025–0.07 mm (0.001–0.0028 in).
   - The lower compression ring side clearance should be 0.025–0.07 mm (0.001–0.0028 in).
   - The oil ring side clearance should be 0.04–0.12 mm (0.0016–0.0047 in).
4. If the clearance is greater than the provided specifications, replace the piston rings.
5. If the clearance is still to great, replace the pistons.

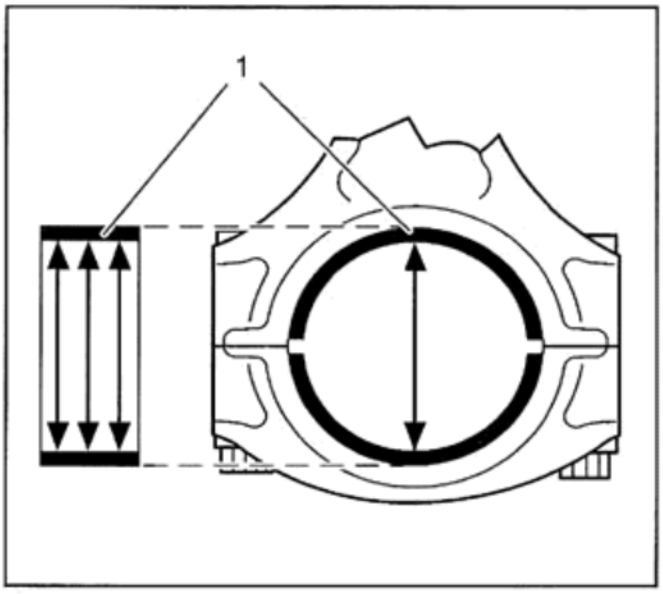
Connecting Rod Bearing Clearance (With Micrometer Gauge Internal Measuring Device)

1. Install the connecting bearings and the connecting rod bearing caps.
2. Tighten the connecting rod bearing cap bolts in the following sequence:

Caution: Refer to *Fastener Caution on page 0-8*

Note: The old bolts can be reused for the measuring procedure.

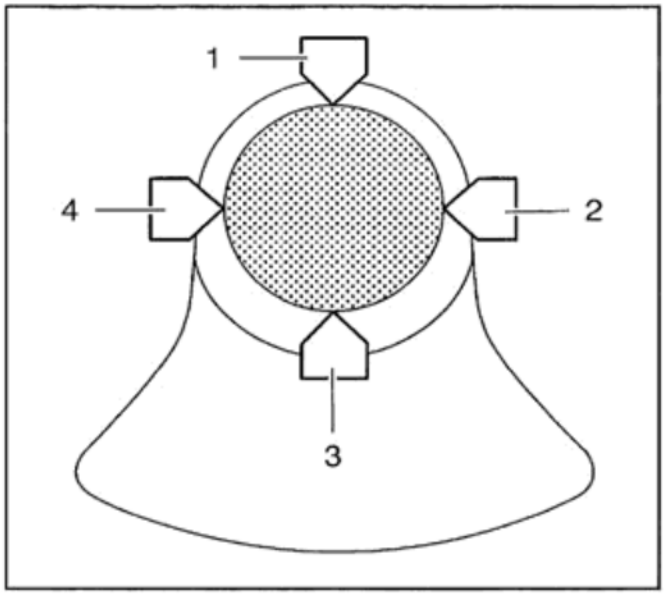
2.1. Tighten the connecting rod bearing cap bolts to **10 N•m (89 lb in)**.
2.2. Tighten the bolts to an additional 60 degrees using *EN-470-B* wrench.
2.3. Tighten the bolts to an additional 15 degrees using *EN-470-B* wrench.



2189741

3. Measure the connecting rod bearing diameters at 3 points as shown (1). Use a internal measuring device.
4. Calculate the average connecting rod inner diameter.

   Formula: 1. result + 2. result + 3. result / 3



2189634

5. Measure the connecting rod journal diameter at 2 points between (1) and (3) and between (2) and (4). Use a micrometer gauge.
6. Calculate the average connecting rod journal diameter.

   Formula: 1. result + 2. result / 2.
7. Substract the average connecting rod journal diameter from the average connecting rod bearing diameter in order to determine the connecting rod bearing clearance.

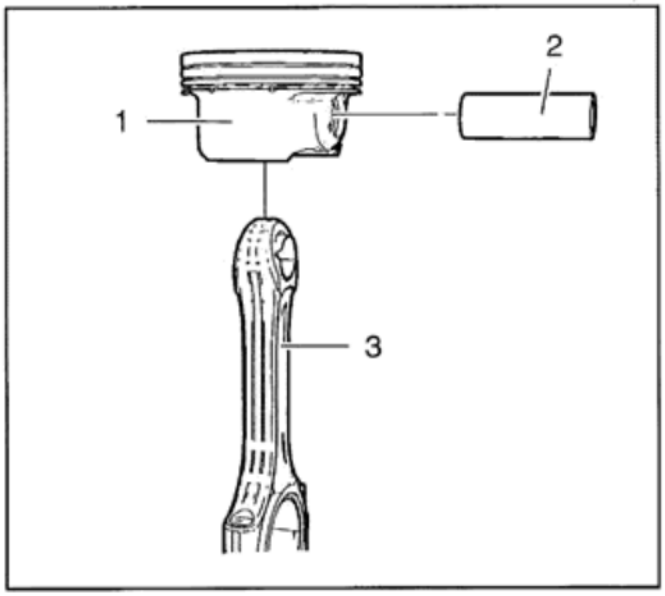
   The clearance should be **0.013–0.061 mm (0.0005–0.0024 in)**.

Piston and Connecting Rod Assemble

Special Tools

EN-49941 Remover / Installer Piston Retainer Ring

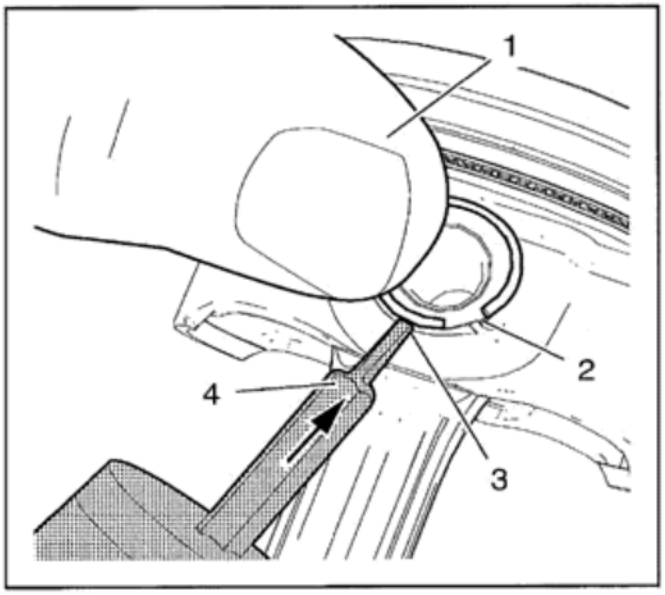
For equivalent regional tools, refer to *Special Tools on page 9-927*.



2191898

Note: Lubricate the piston pin with clean engine oil.

1. Install the connecting rod (3) and the piston pin (2) to the piston (1).
2. Install the piston and connecting rod assembly to a bench vise. Use aluminium braces.



2191892

Warning: Use extreme care when removing snap rings. Always wear adequate eye protection in order to avoid personal injury.

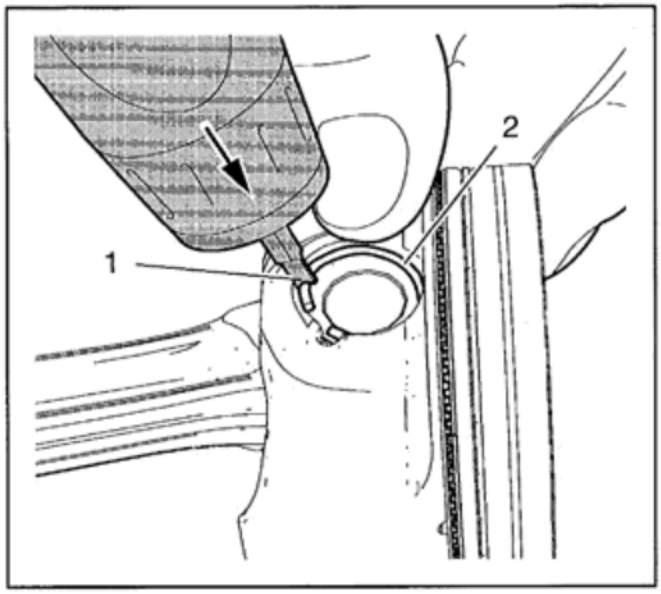
Warning: Use care when removing or installing the piston retainer ring. Ensure the EN-49941 remover/ installer is installed properly onto the retainer ring and that hands and fingers are kept clear from the front of the tool. Otherwise, bodily injury may occur.

Note: Notch (2) on right side.

3. Place the piston pin retainer in the piston pin retainer groove so that the ring gap lays on the notch (2).
4. Push the piston pin retainer down with the thumb in the shown position (1) and hold.

Note: The *EN-49941* installer should be applied in a perpendicular position to the piston pin retainer.

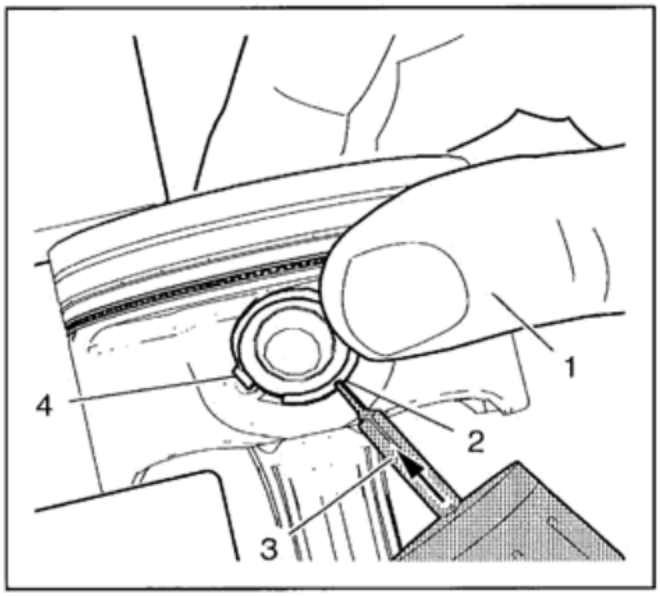
5. Apply the *EN-49941* installer (4) to the piston pin retainer in the position shown (3) and push in direction of the arrow while pushing down with the thumb.



2191894

Note: Push the piston pin retainer down in the position shown (2).

6. Move the *EN-49941* installer (1) carefully to the position shown while pushing in direction of the arrow until the piston pin retainer engages in the piston pin retainer groove.
7. Push down the piston ring retainer to get a proper seat in the groove.



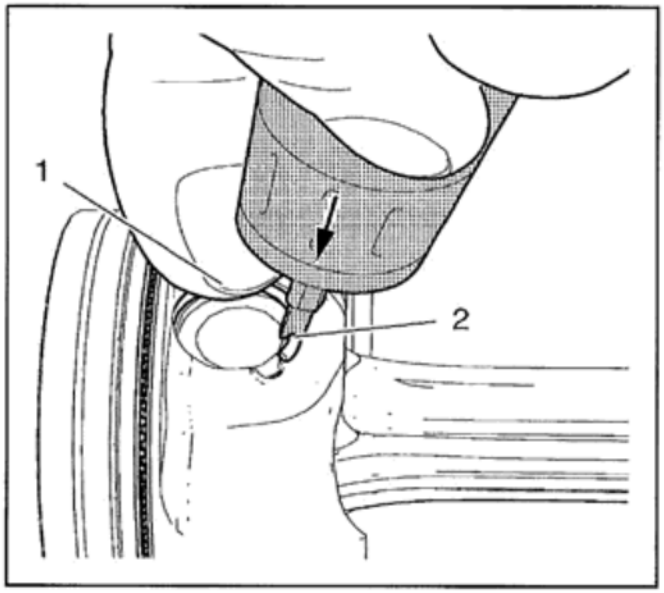
2191889

Note: Notch (4) on left side. *EN-49941* installer should be used with left hand.

8. Place the piston pin retainer in the piston pin retainer groove so that the ring gap lays on the notch (4).
9. Push the piston pin retainer down with the thumb in the position shown (1) and hold.

Note: The *EN-49941* installer should be applied in a perpendicular position to the piston pin retainer.

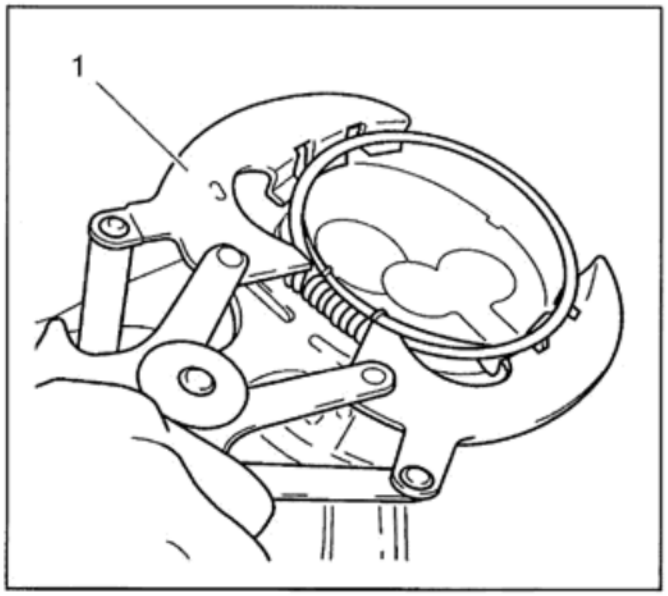
10. Apply the *EN-49941* installer (3) to the piston pin retainer in the position shown (2) and push in direction of the arrow while pushing down with the thumb.



2191893

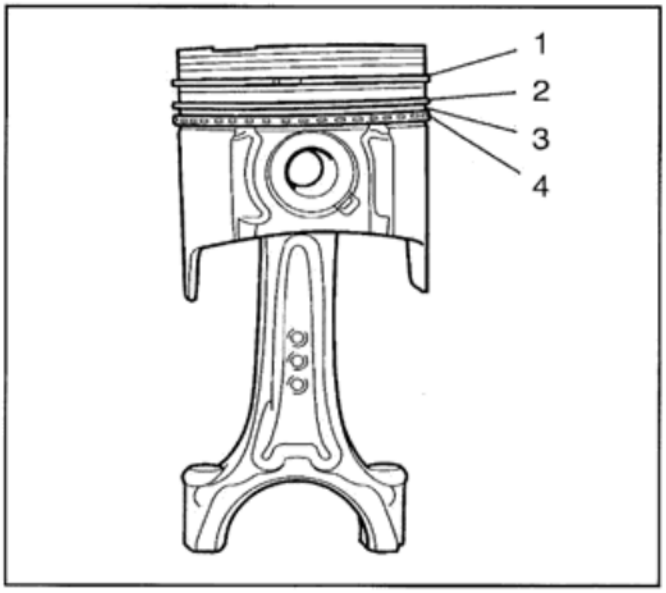
Note: Push the piston pin retainer down in the position shown (1).

11. Move the *EN-49941* installer (2) carefully to the position shown while pushing in direction of the arrow until the piston pin retainer engages in the piston pin retainer groove.
12. Push down the piston ring retainer to get a proper seat in the groove.
13. Remove the piston and connecting rod assembly from the bench vise.



2189594

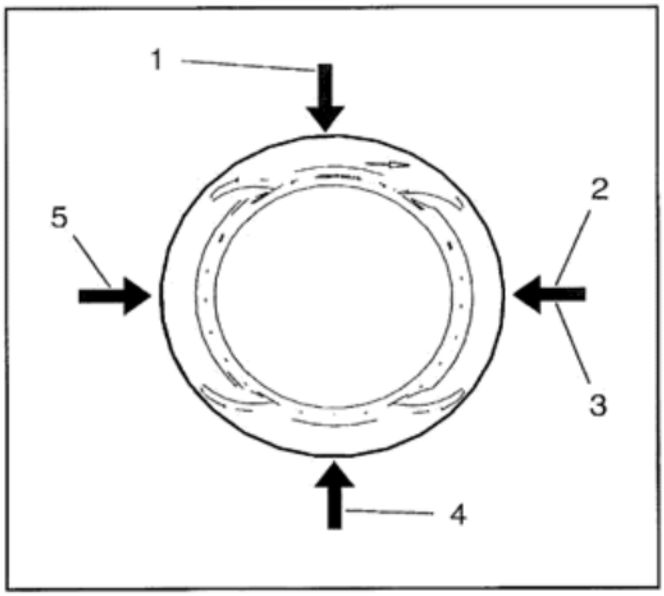
14. Install the piston rings. Use piston ring pliers (1).



2189595

Note: Mind the TOP marking on the piston rings.

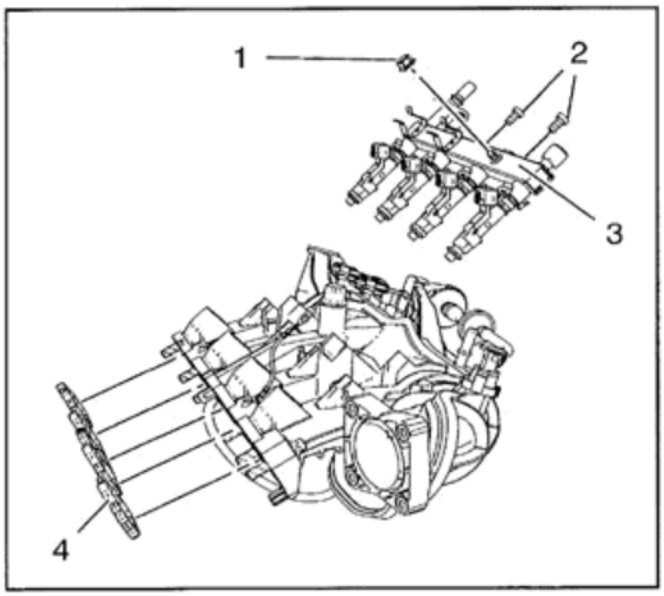
15. The piston rings must be ordered as followed:
    - Upper compression ring (1)
    - Lower compression ring (2)
    - Piston oil ring with spacer (3), (4)



2192328

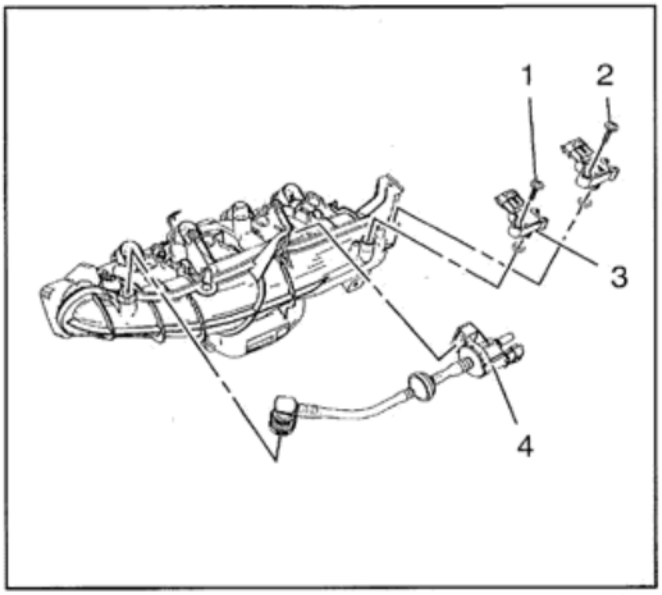
16. The piston ring joints must be positioned 90 degrees to each other.
    - Upper compression ring joint (2)
    - Lower compression ring joint (5)
    - Oil ring joint, upper part (1)
    - Oil ring joint, lower part (4)
    - Oil ring spacer joint (3)

Intake Manifold Disassemble



2191856

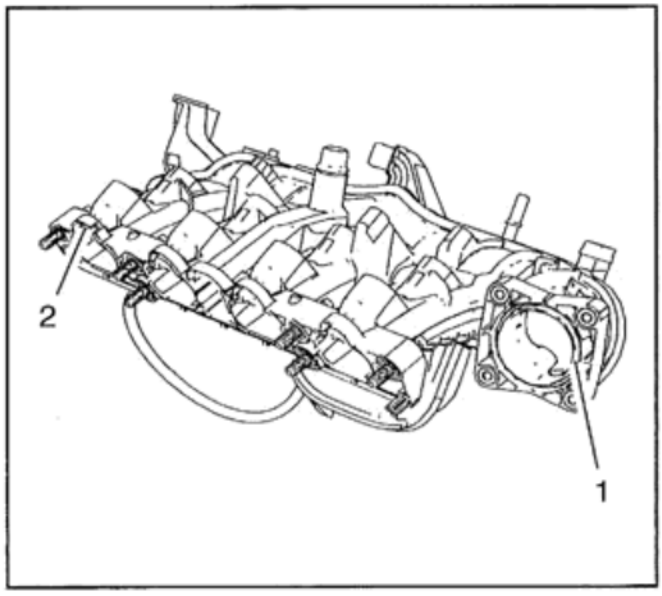
1. Remove the fuel injection rail ground cable nut (1).
2. Remove the 2 fuel injection rail bolts (2).
3. Remove the fuel injection fuel rail assembly (3).
4. Remove the intake manifold gasket (4).



2191857

5. Remove the 2 manifold absolute pressure sensor bolts (1).
6. Remove the 2 manifold absolute pressure sensors (2).
7. Remove the evaporative emission canister purge solenoid valve (3).

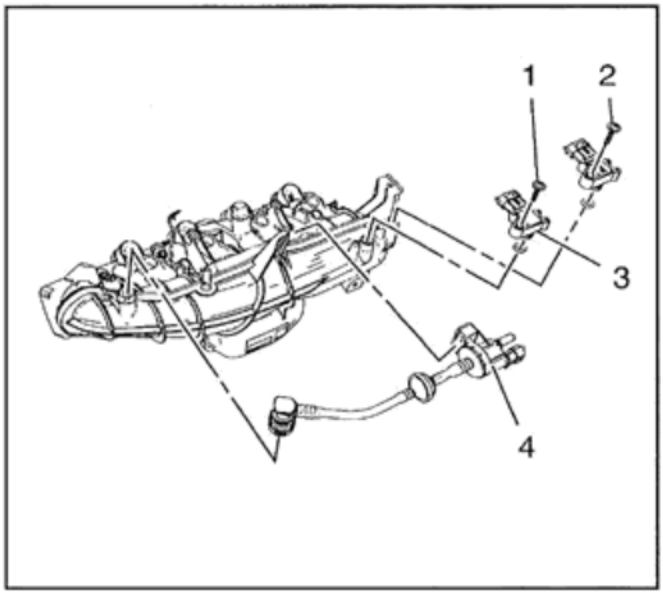
Intake Manifold Cleaning and Inspection



2372991

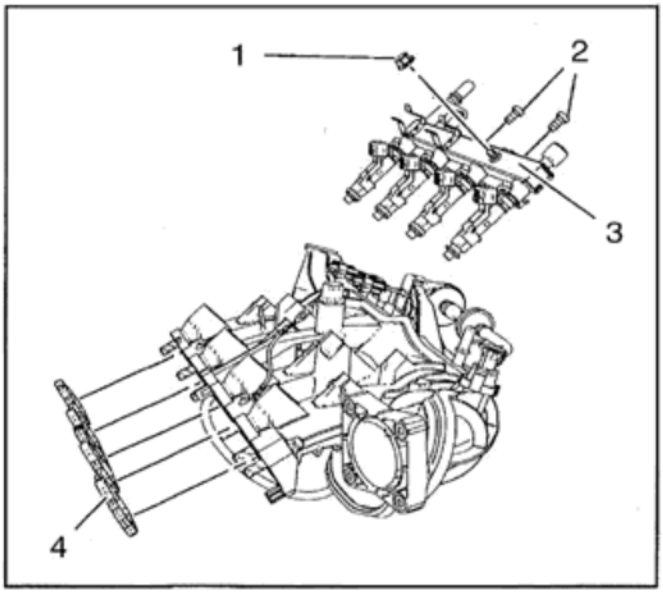
1. Clean the sealing surfaces (1) and (2).
2. Inspect the intake manifold for cracks and fractures.

Intake Manifold Assemble



2191857

1. Install the evaporative emission canister purge solenoid valve (3).
2. Install the 2 manifold absolute pressure sensors (2).
3. Install the 2 manifold absolute pressure sensor bolts (1) and tighten.



2191856

4. Install the fuel injection fuel rail assembly (3).

Caution: Refer to *Fastener Caution on page 0-8*.

5. Install the 2 fuel injection rail bolts (2) and tighten to **8 N•m (71 lb in)**.
6. Install the fuel injection rail ground cable nut (1) and tighten.
7. Install a NEW intake manifold gasket (4).

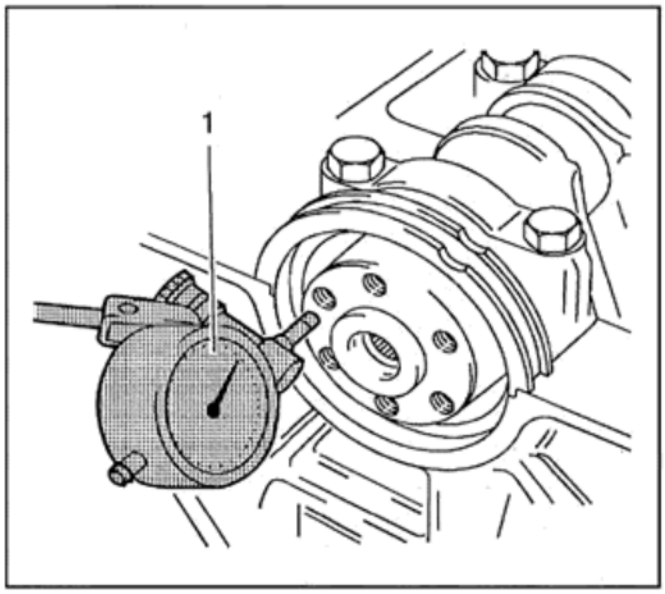
Crankshaft and Bearing Cleaning and Inspection

Special Tools

- *EN-470–B* Angular Torque Wrench
- *GE-571-B* Dial Gauge

For equivalent regional tools, refer to *Special Tools on page 9-927*.

Crankshaft End Play, Check

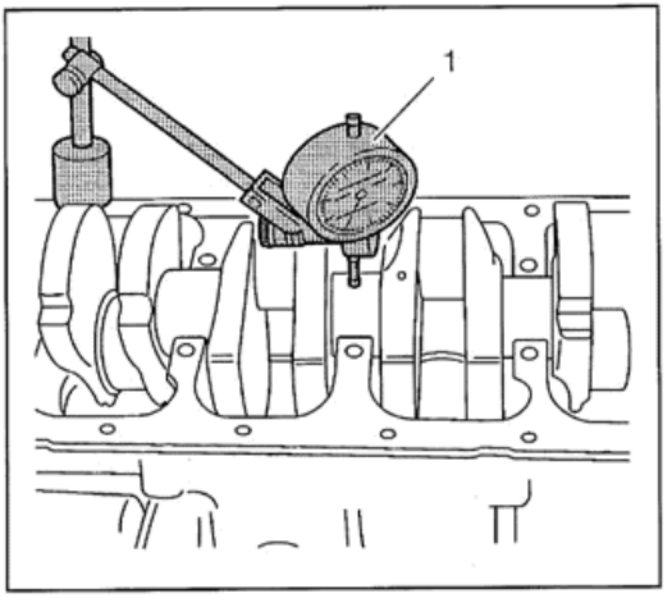


2190913

Note: Crankshaft attached with crankshaft bearing caps.

1. Install the *GE-571-B* gauge (1).
   - Install the holder on the front of the engine block.
   - Place the dial gauge plunger against the crankshaft and adjust.
2. Measure the longitudinal play of the crankshaft.
   - Move the crankshaft in the longitudinal direction.
   - Permissible crankshaft end play **0.100–0.202 mm (0.0039–0.0080 in)**.
3. Remove the *GE-571-B* gauge.

Crankshaft Out-of-Round, Check

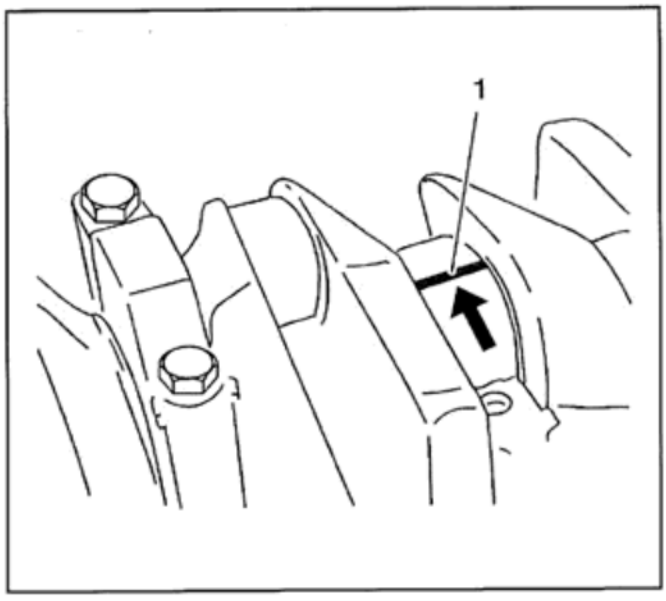


2190919

Note: Crankshaft removed.

1. Insert the crankshaft in the engine block.
2. Install the *GE-571-B* gauge (1).
   - Attach holder to the engine block.
   - Place the dial gauge plunger against the crankshaft bearing journal and adjust.
3. Check the rotational play of the crankshaft.
   - Turn the crankshaft evenly.
   - Maximum permissible rotational play **0.03 mm (0.001 in)**.
4. Remove the *GE-571-B* gauge.

Check Crankshaft Bearing Clearance (With Plastigage)

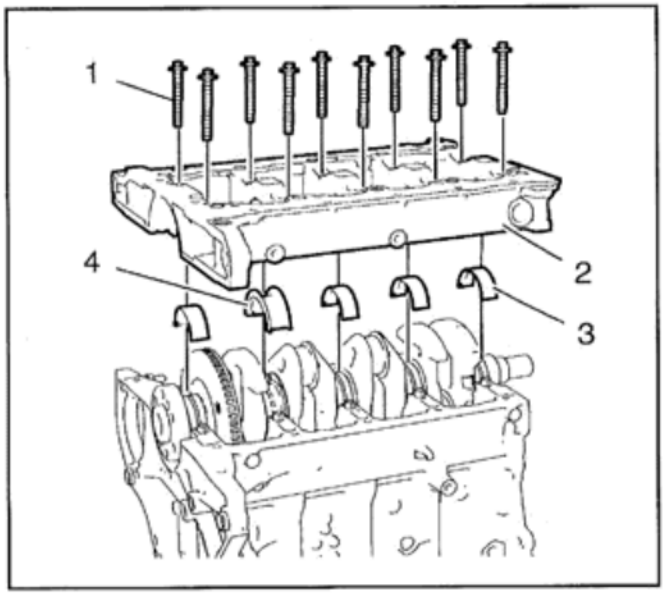


2190912

Note:

- Crankshaft removed.
- Do not rotate the crankshaft.

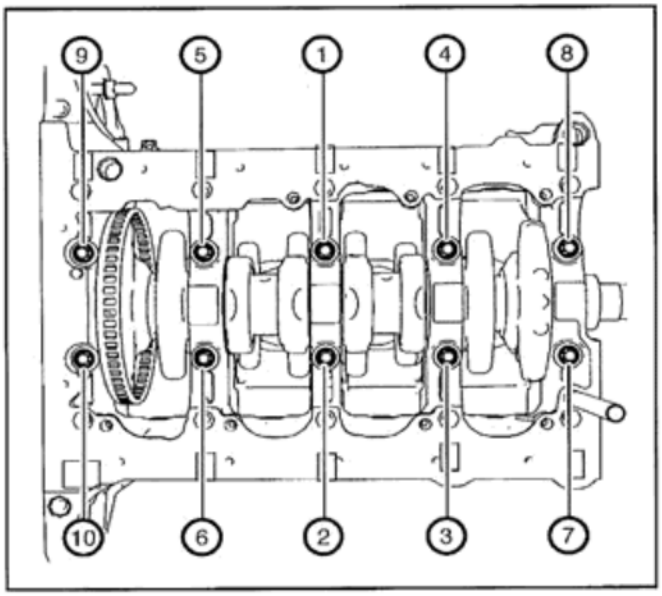
1. Lay out plastigage.
   Lay out plastigage (flexible plastic thread) around the entire width of the crankshaft bearing journal (1).



2190818

Note: The bolts can be reused for checking the crankshaft bearing play.

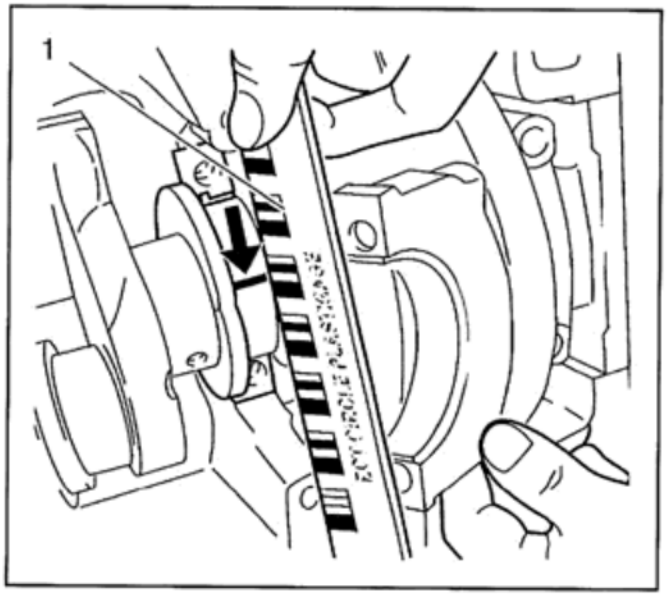
2. Install the 4 lower crankshaft bearings (3) and the lower crankshaft thrust bearing (4).
3. Install the crankshaft bearing cap tie plate (2).
4. Install the 10 inner crankshaft bearing cap tie plate bolts (1).



2190747

Caution: Refer to *Fastener Caution on page 0-8.*

5. Tighten the 10 inner crankshaft bearing cap tie plate bolts in a sequence as shown and in the following order:
   5.1. Tighten the inner crankshaft bearing cap tie plate bolts to **25 N•m (18 lb ft)**.
   5.2. Tighten the inner crankshaft bearing cap tie plate bolts an additional **60°**. Use *EN-470–B* wrench.
   5.3. Tighten the inner crankshaft bearing cap tie plate bolts an additional **15°**. Use *EN-470–B* wrench.
6. Remove the crankshaft bearing cap tie plate bolts and the crankshaft bearing cap tie plate.



2190914

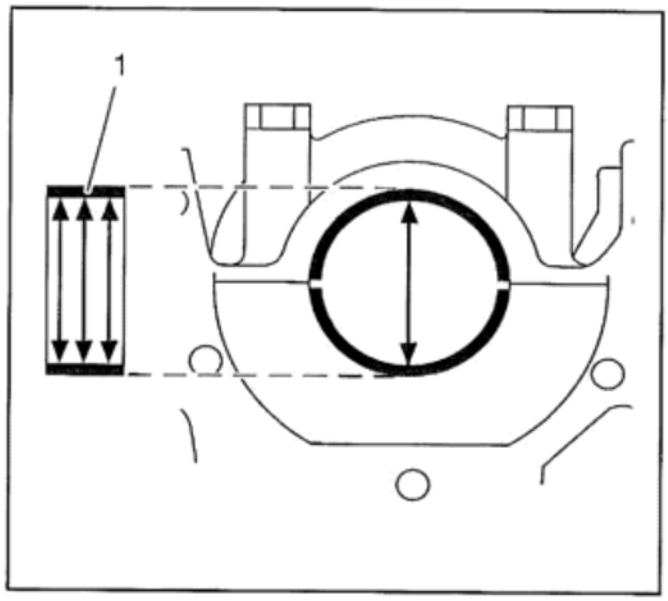
Note: When reading the value, do not confuse millimeters and inches on the measuring scale.

7. Measure the crankshaft bearing play.
   - Compare the width of the flattened plastic thread (arrow) to the measuring scale (1).
   - The crankshaft bearing play should be **0.007–0.031 mm (0.00028–0.00122 in)**.

Check Crankshaft Bearing Clearance (With Micrometer Gauge Internal Measuring Device)

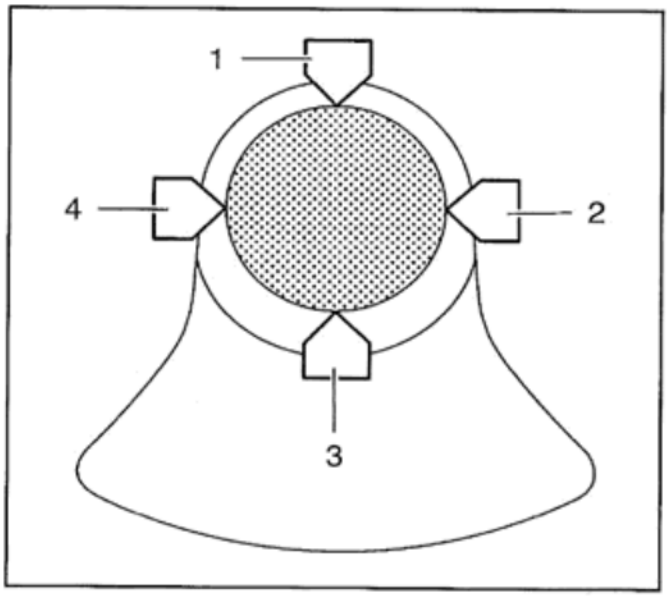
Note: The bolts can be reused for checking the crankshaft bearing play.

1. Install and tighten the crankshaft bearing cap tie plate and the crankshaft bearings as shown above.



2189635

2. Measure the crankshaft bearing diameter at 3 points.
   Measure in areas as shown (1) with an internal measuring device.
   Calculate the average crankshaft bearing diameter.
   Formula: 1. result + 2. result + 3. result / 3.



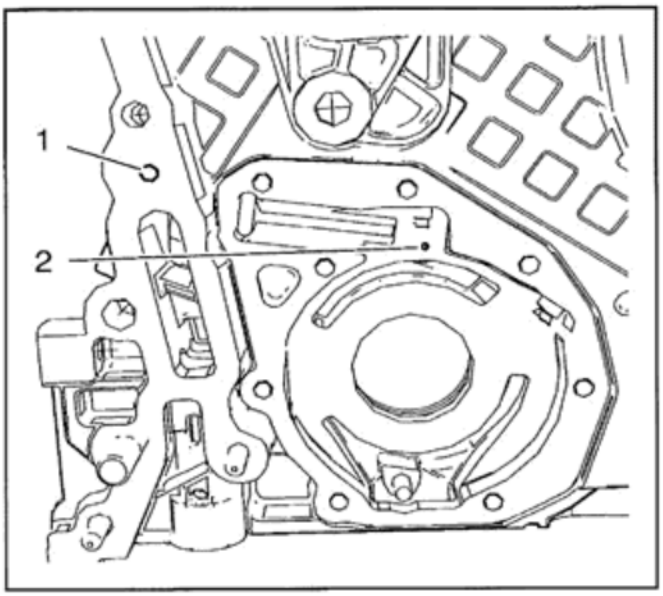
2189634

3. Measure the crankshaft bearing journal diameter at 2 points between (1) and (3) and between (2) and (4) with the micrometer gauge.
4. Calculate the average crankshaft bearing journal diameter.
   Formula: 1. result + 2. result / 2.
5. Determine the crankshaft bearing play.
   Calculation formula: average crankshaft bearing diameter minus average crankshaft bearing journal diameter.
6. The crankshaft bearing play should be **0.007–0.031 mm (0.00028–0.00122 in)**.

Engine Front Cover and Oil Pump Cleaning and Inspection

Engine Front Cover Cleaning Procedure

1. Clean the engine front cover sealing surface.



2191041

Warning: Wear safety glasses when using compressed air in order to prevent eye injury.

Caution: To ensure proper engine lubrication, clean clogged or contaminated oil galleries in an approved solvent and with compressed air. Failure to clean oil galleries may cause engine damage.

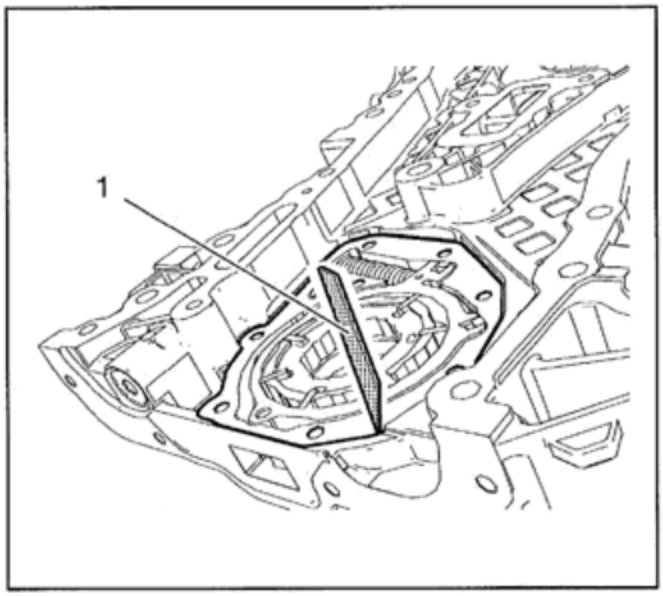
2. Clean the shown oil gallery with solvent and compressed air. Blow compressed air from bore (2) to bore (1).

Engine Front Cover Visual Inspection

Inspect the engine front cover for cracks, scratches and damage.

Oil Pump Visual Inspection and Measurement

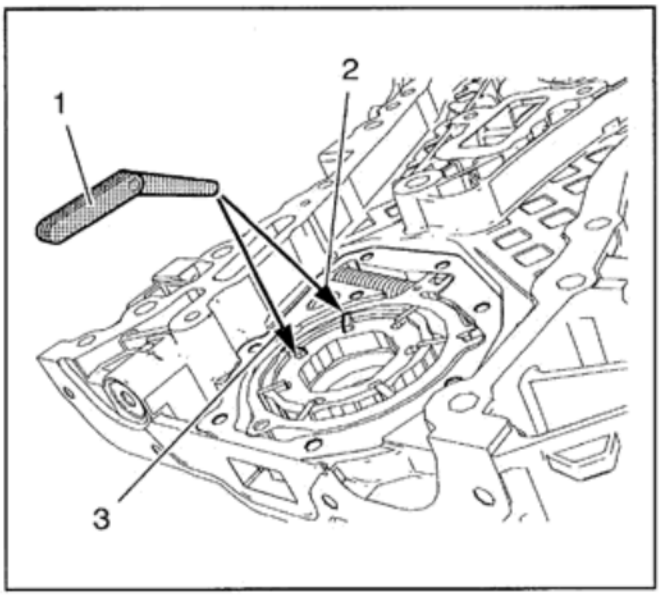
1. Inspect the oil pump cover and the engine front cover for flatness.
2. Inspect the oil pump vanes, the oil pump vane rotor, the oil pump vane rings and the oil pump slide for localized flatting.
3. Inspect the oil pump slide pivot pin for firm seat.



2191042

Note: Oil pump components are installed.

4. Measure the oil pump axial clearances. Use a straight edge (1) and a feeler gauge.
   - 4.1. The maximal axial clearance between engine front cover and oil pump vane rotor should be 0.1 mm (0.004 in).
   - 4.2. The maximal axial clearance between engine front cover and oil pump vane should be 0.09 mm (0.0035 in).
   - 4.3. The maximal axial clearance between engine front cover and oil pump vane ring should be 0.4 mm (0.016 in).
   - 4.4. The maximal axial clearance between engine front cover and oil pump slide should be 0.08 mm (0.0031 in).
   - 4.5. The maximal axial clearance between engine front cover and oil pump slide seal should be 0.09 mm (0.0035 in).

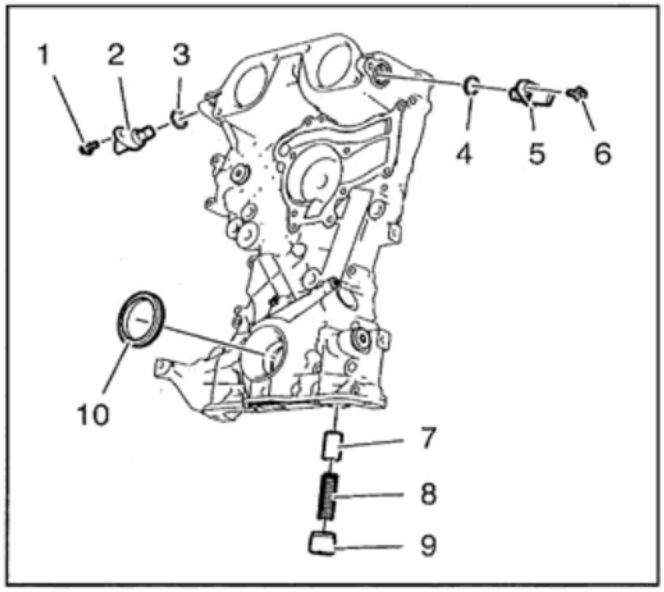


2191044

5. Measure the oil pump radial clearance. Use a feeler gauge (1). Measure the clearance between oil pump vane rotor and oil pump vane (3).
   The maximal clearance should be 0.05 mm (0.002 in).
6. Measure the clearance between oil pump vane and oil pump slide (2).
   The maximal clearance should be 0.2 mm (0.008 in).

Engine Front Cover and Oil Pump Disassemble

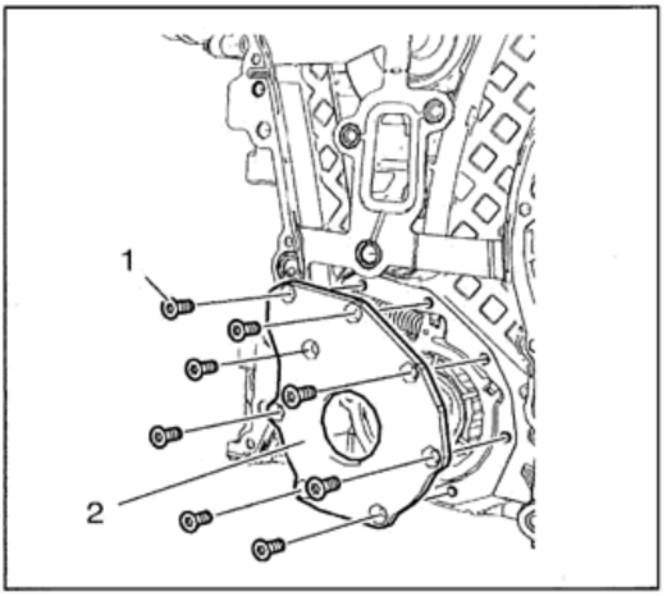
Engine Front Cover Disassemble



2191036

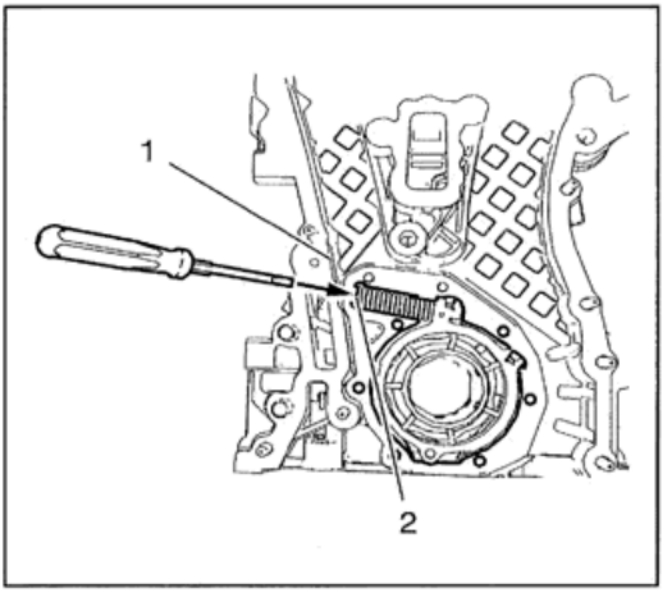
1. Remove the intake camshaft position sensor bolt (1).
2. Remove the intake camshaft position sensor (2) and the seal ring (3).
3. Remove the exhaust camshaft position sensor bolt (6).
4. Remove the exhaust camshaft position sensor (5) and the seal ring (4).
5. Remove the oil pressure relief valve (7, 8 and 9)
6. Remove the crankshaft front oil seal (10).

Oil Pump Removal



2191037

1. Remove the 8 oil pump cover bolts (1).
2. Remove the oil pump cover (2).

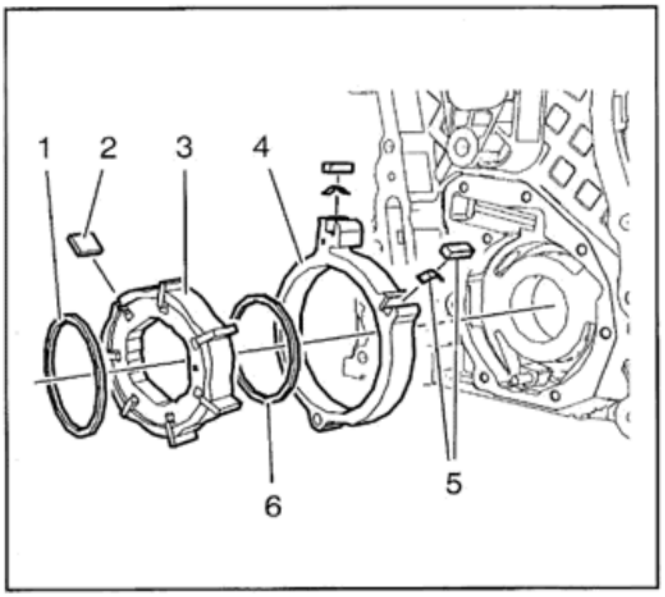


2191038

Warning: Before removing the spring, cover the spring with a towel to prevent the spring from flying and possibly causing damage or personal injury.

Note: Position a screw driver between the oil pump slide spring windings (2).

3. Protect the engine front cover edge (1) with a suitable piece of plastic.
4. Compress the oil pump slide spring with a screw driver and remove the oil pump slide spring along with the oil pump slide spring pin.



2191039

Note: Mind the installation position of the oil pump components.

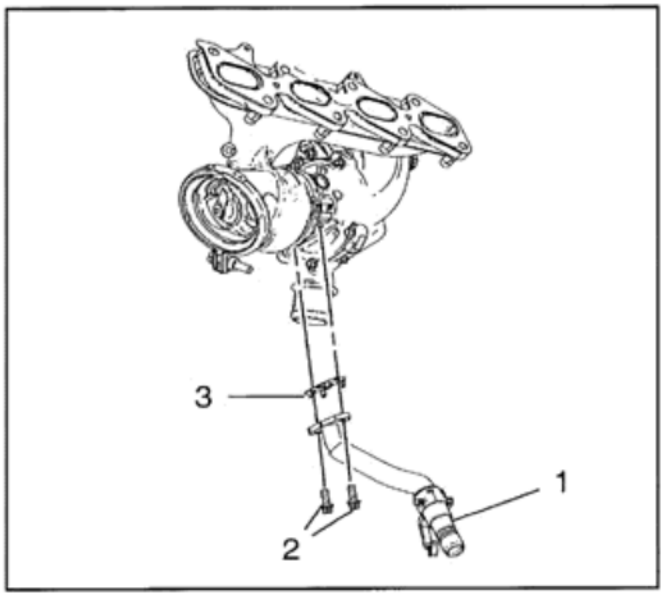
5. Remove the oil pump components in the following order:
   5.1. Outer oil pump vane ring (1).
   5.2. Oil pump vane rotor (3) and the 7 oil pump vanes (2).
   5.3. Inner oil pump vane ring (6).
   5.4. Oil pump slide (4) and the 2 oil pump slide seals with the 2 oil pump slide seal springs (5).

Turbocharger Disassemble

Special Tool

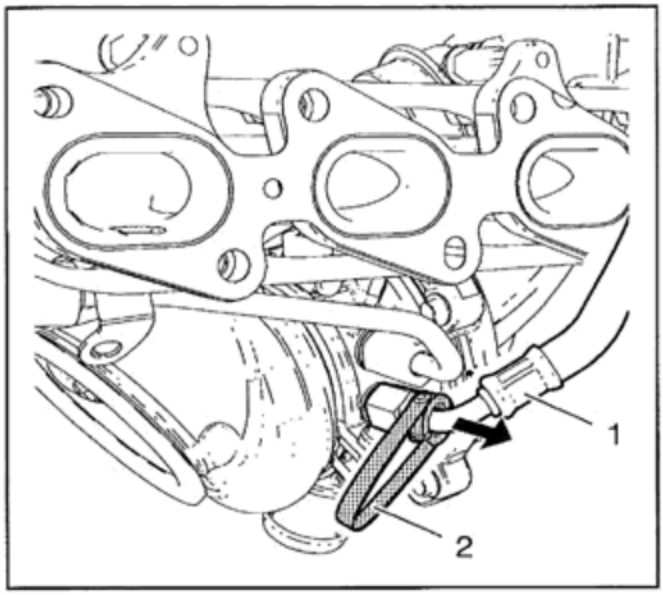
EN-49940 Remover Quick Connector

For equivalent regional tools, refer to *Special Tools on page 9-927*.



2191928

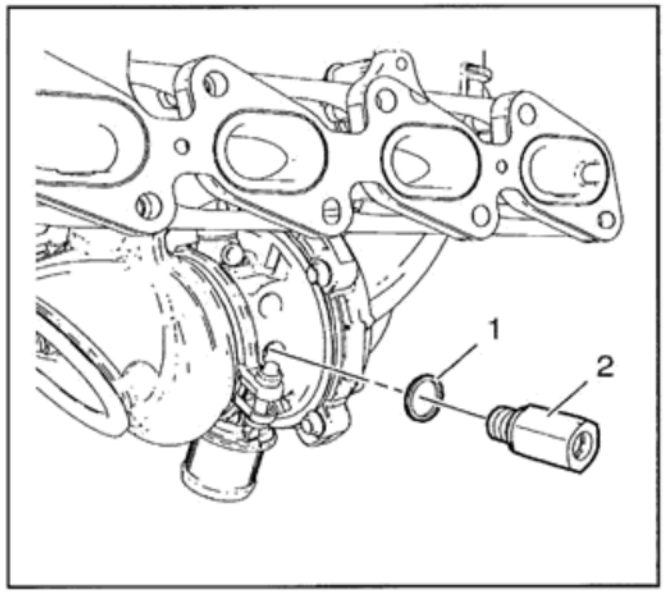
1. Remove the 2 turbocharger oil return pipe bolts (2).
2. Remove the turbocharger oil return pipe (1) and the sealing (3) from the turbocharger.



2192344

Note: The quick fitting connectors should be always replaced when the turbocharger coolant pipes are removed

3. Install the *EN-49940* remover (2) to the turbocharger coolant feed pipe (1) and the quick fitting connector as shown.
4. Compress the *EN-49940* remover and remove the turbocharger coolant feed pipe direction of the arrow.



2192345

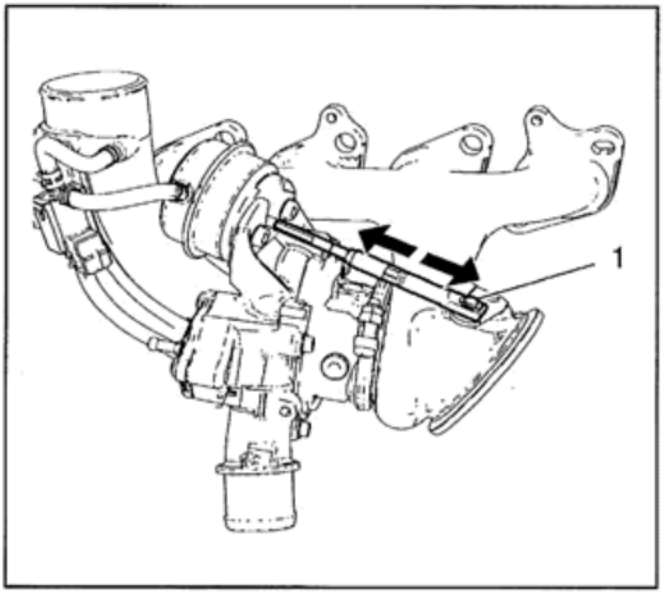
5. Remove the quick fitting connector (2) and the seal ring (1).
6. Use the same procedure for the turbocharger coolant return pipe and the turbocharger coolant return pipe quick fitting connector.

Turbocharger Cleaning and Inspection

Cleaning Procedure

1. Clean all sealing surfaces.
2. Clean all threads if necessary.

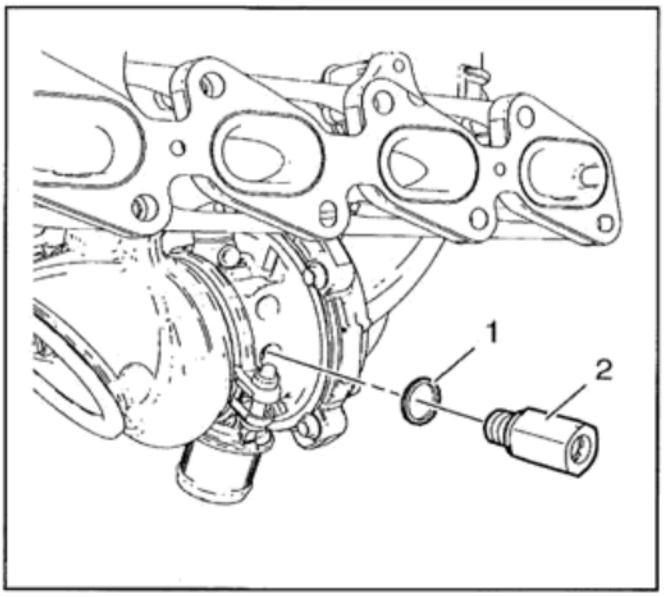
Inspection Procedure



2192355

1. Inspect the wastegate regulator mechanism (1) for functionality.
2. Inspect the turbine blades for damage or foreign material.
3. Inspect the turbocharger wastegate regulator vacuum hoses for damage.
4. Inspect the exhaust manifold and the turbocharger for cracks or other damage.
5. Inspect the exhaust manifold mating surface for flatness.

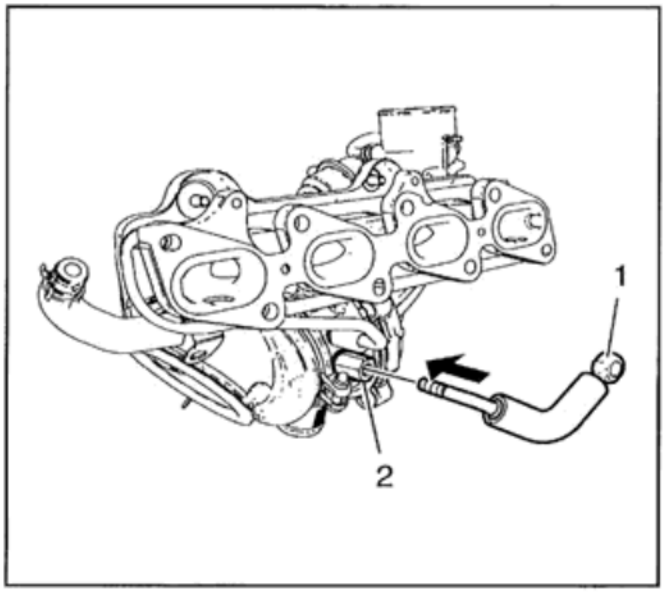
Turbocharger Assemble



2192345

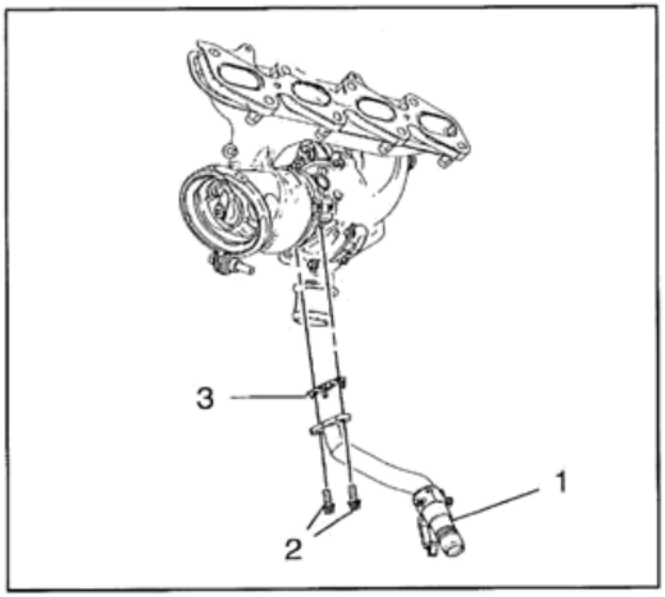
Caution: Refer to *Fastener Caution on page 0-8*.

1. Install the NEW quick fitting connector (2) and a NEW seal ring (1) to the turbocharger and tighten to **20** N•m **(15 lb ft)**.



2192343

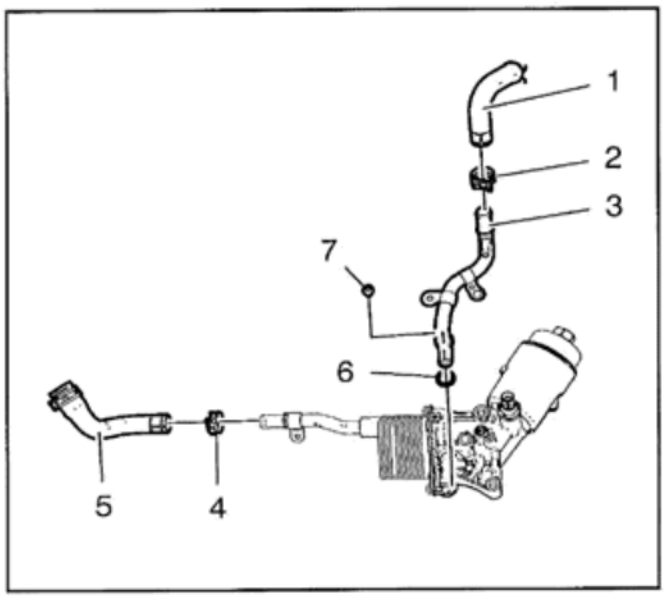
2. Inspect the turbocharger coolant pipes for ridges and damage.
3. Install the turbocharger coolant feed pipe (1) to the quick fitting connector (2) by pushing in direction of the arrow until an audible click is heard.
4. Use the same procedure for the turbocharger coolant return pipe and the turbocharger coolant return pipe quick fitting connector.



2191928

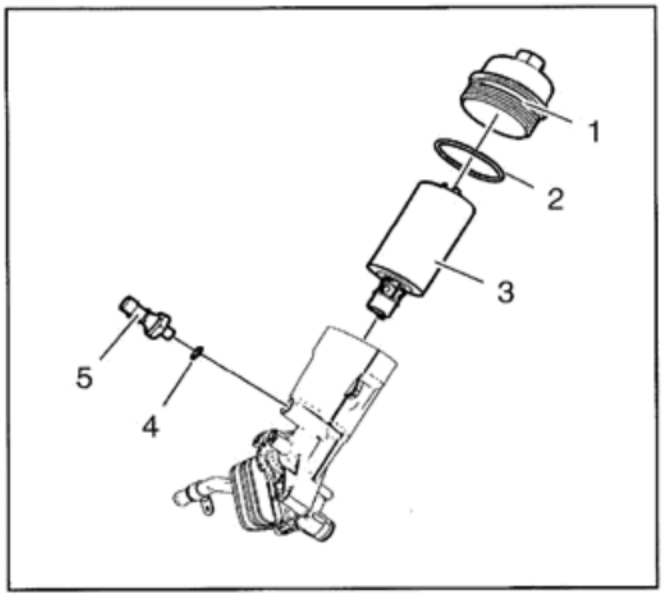
5. Install the turbocharger oil return pipe (1) and a NEW sealing (3) to the turbocharger.
6. Install the 2 turbocharger oil return pipe bolts (2) and tighten to **8** N•m **(71 lb in)**.

Engine Oil Cooler Disassemble



2191943

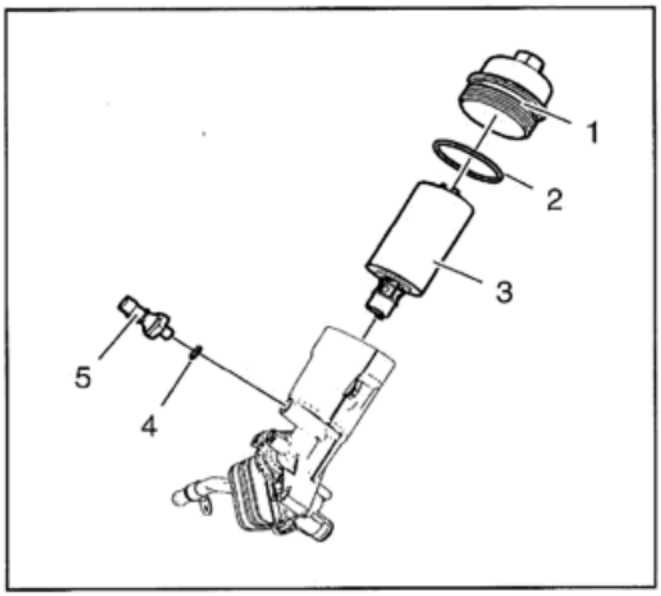
1. Remove the oil cooler coolant inlet hose clamp (2).
2. Remove the oil cooler coolant inlet hose (1).
3. Remove the oil cooler coolant inlet pipe bolt (7)
4. Remove the oil cooler coolant inlet pipe (3) and the seal ring (6).
5. Remove the oil cooler coolant outlet hose clamp (4).
6. Remove the oil cooler coolant outlet hose (5).



2191944

7. Remove the engine oil pressure indicator switch (5) and the seal ring (4).
8. Remove the engine oil filter cap (1) along with the seal ring (2) and the oil filter element (3).

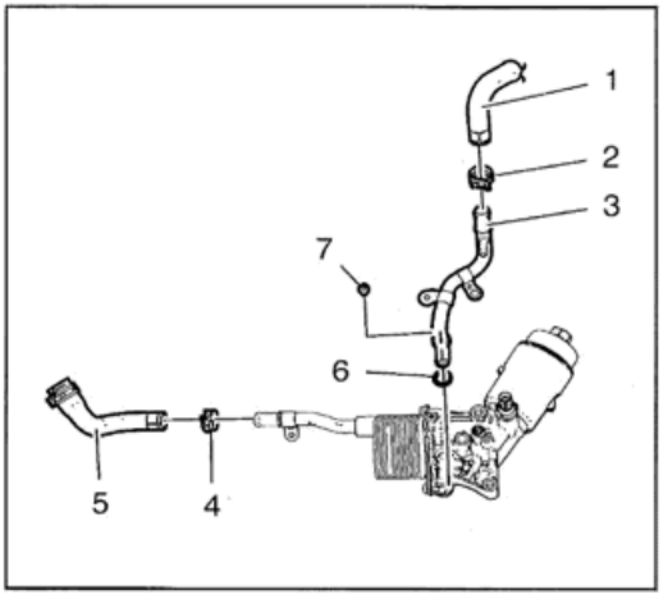
Engine Oil Cooler Assemble



2191944

Caution: Refer to *Fastener Caution on page 0-8*.

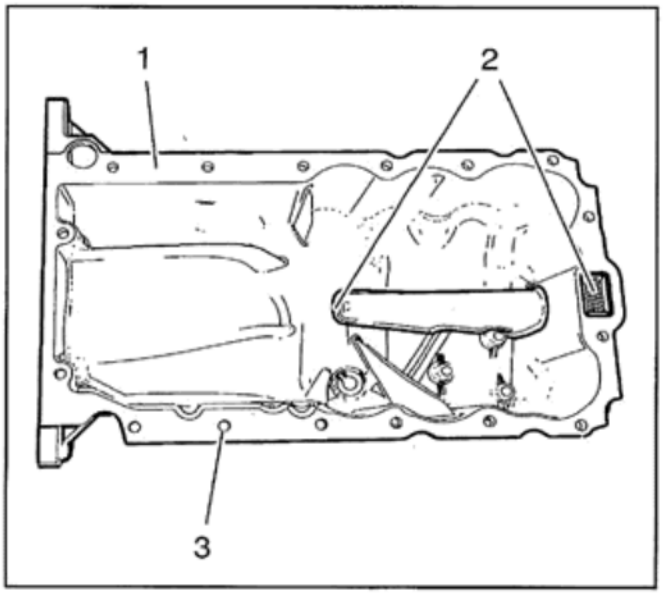
1. Install the engine oil filter cap (1) along with a NEW seal ring (2) and a NEW oil filter element (3) and tighten to **25** N•m **(18 lb ft)**.
2. Install the engine oil pressure indicator switch (5) and NEW seal ring (4) and tighten to **20** N•m **(15 lb ft)**.



2191943

3. Install the oil cooler coolant outlet hose (5)
4. Install the oil cooler coolant outlet hose clamp (4).
5. Install the oil cooler coolant inlet pipe (3) and a NEW seal ring (6).
6. Install the oil cooler coolant inlet pipe bolt (7) and tighten to **10 N·m (89 lb in)**.
7. Install the oil cooler coolant inlet hose (1).
8. Install oil cooler coolant inlet hose clamp (2).

Oil Pan Cleaning and Inspection



2191020

Warning: Wear safety glasses when using compressed air in order to prevent eye injury.

Caution: To ensure proper engine lubrication, clean clogged or contaminated oil galleries in an approved solvent and with compressed air. Failure to clean oil galleries may cause engine damage.

1. Clean the oil suction gallery (2) with compressed air. Be sure to remove all dirt and old gasket material from the suction gallery (2).
2. Remove all remaining old gasket material from sealing surface (1) and screw bores (3).
3. Clean the sealing surfaces from dirt and grease.
4. Inspect the sealing surface for cracks and damage.

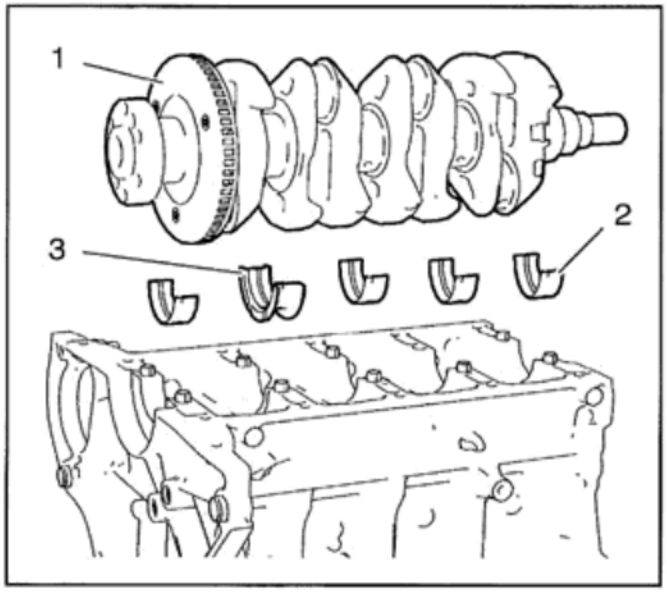
Crankshaft and Bearing Installation

Special Tools

- *EN-235-6* Installer from *EN-235-D* Kit.
- *EN-470–B* Angular Torque Wrench
- *EN-658-1* Installer from *EN-658* Kit.

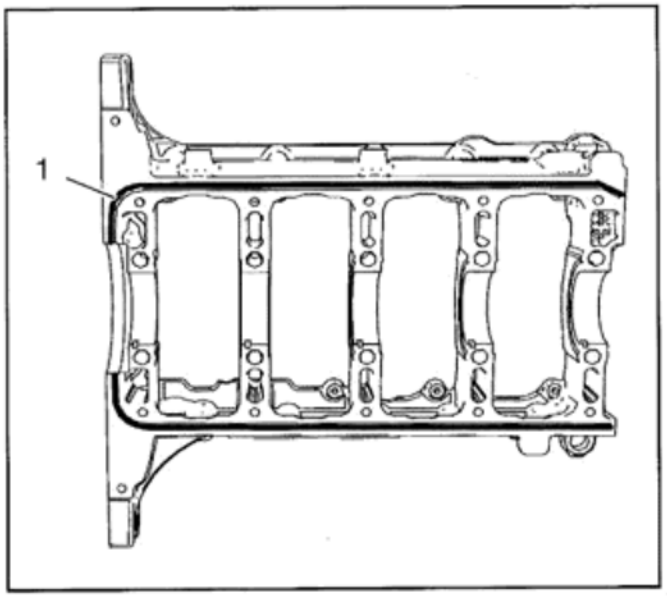
For equivalent regional tools, refer to *Special Tools on page 9-927*.

1. Lubricate crankshaft, crankshaft bearings and crankshaft bearing cap tie plate with engine oil.



2190745

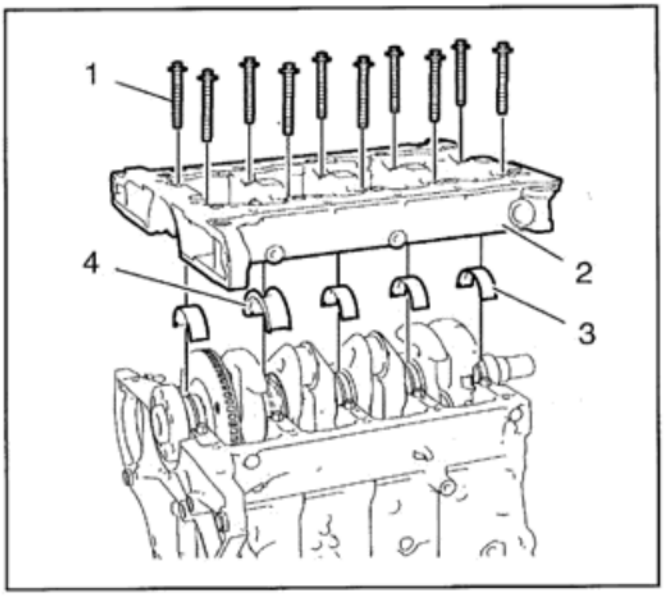
2. Install the 4 upper crankshaft bearings (2) and the crankshaft thrust bearing (3).
3. Install the crankshaft (1).



2190820

Note: The thickness of the sealing bead should be **2 mm (0.0787 in)**.

4. Apply sealing compound (1) to the outer rim of the groove on the crankshaft bearing cap tie plate. Refer to *Adhesives, Fluids, Lubricants, and Sealers on page 9-759*.



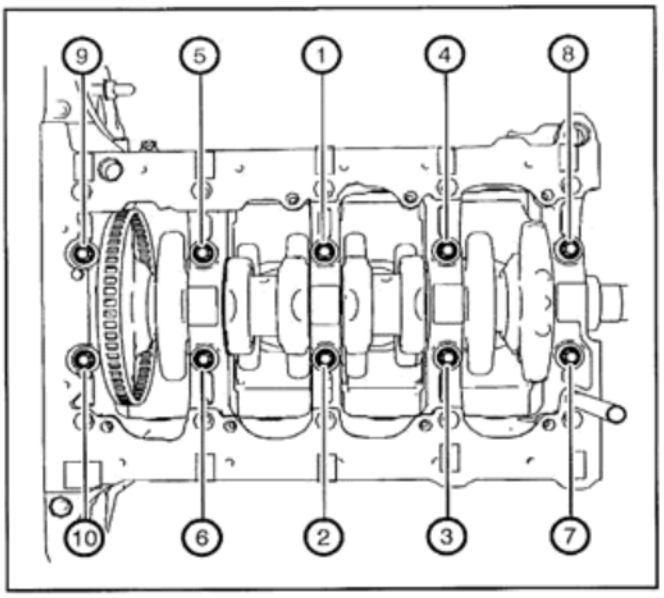
2190818

Note: The complete installation procedure should not take longer than 10 minutes.

5. Install the 4 lower crankshaft bearings (3) and the lower crankshaft thrust bearing (4).
6. Install the crankshaft bearing cap tie plate (2).

Note: Do not reuse the old bolts.

7. Install the 10 NEW inner crankshaft bearing cap tie plate bolts (1).

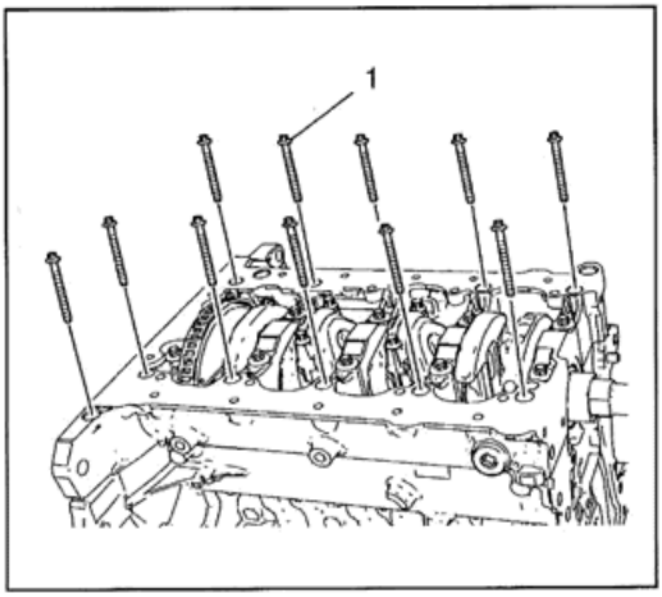


2190747

Caution: Refer to *Fastener Caution on page 0-8*.

Caution: Refer to *Torque-to-Yield Fastener Caution on page 0-10*.

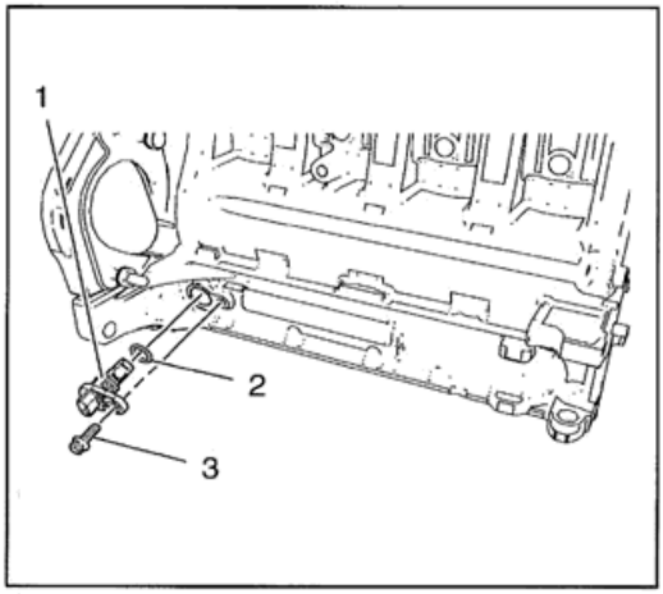
8. Tighten the 10 inner crankshaft bearing cap tie plate bolts in the sequence shown and to the following specifications:
   8.1. Tighten the inner crankshaft bearing cap tie plate bolts to **25 N•m (18 lb ft)**.
   8.2. Tighten the inner crankshaft bearing cap tie plate bolts an additional 60 degrees. Use *EN-470–B* wrench.
   8.3. Tighten the inner crankshaft bearing cap tie plate bolts an additional 15 degrees. Use *EN-470–B* wrench.



2190355

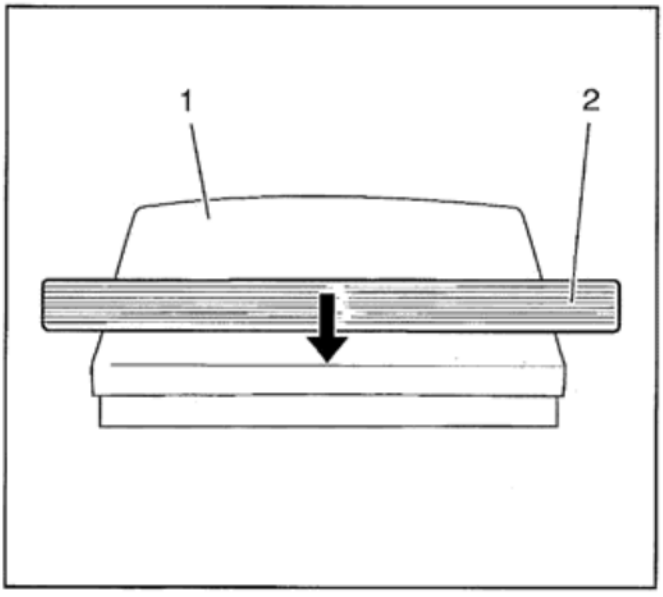
Note: Do not reuse the old bolts.

9. Install the 12 NEW outer crankshaft bearing cap tie plate bolts (1) and tighten to the following specification:
   9.1. Tighten the outer crankshaft bearing cap tie plate bolts to **10** N•m **(89 lb in)**.
   9.2. Tighten the outer crankshaft bearing cap tie plate bolts an additional 60 degrees. Use *EN-470–B* wrench.
   9.3. Tighten the outer crankshaft bearing cap tie plate bolts an additional 15 degrees. Use *EN-470–B* wrench.



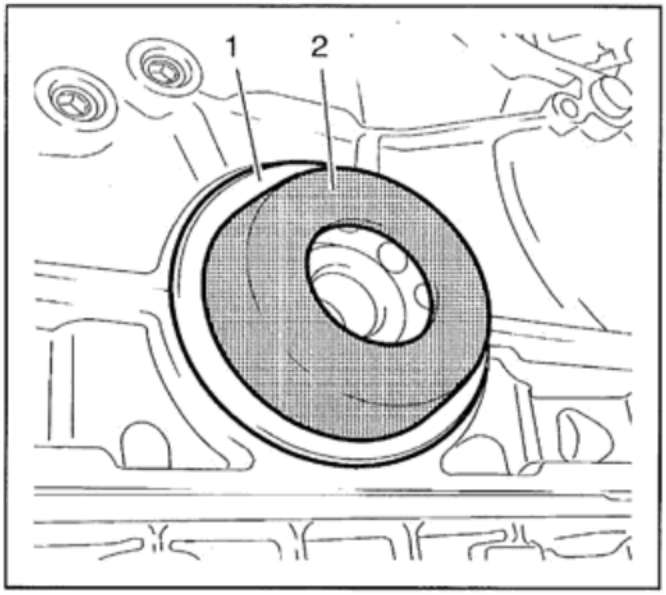
2190746

10. Install the crankshaft position sensor (1) and a NEW crankshaft position sensor seal ring (2).
11. Install the crankshaft position sensor bolt (3) and tighten to **8** N•m **(71 lb in)**.



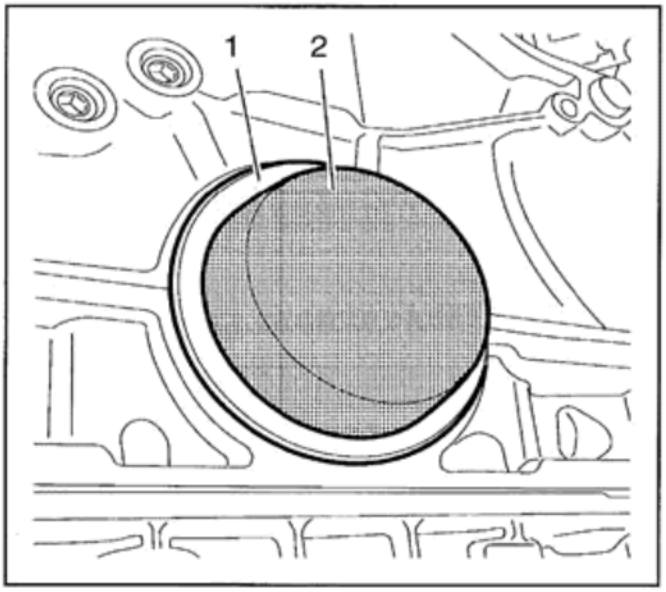
2757896

12. Slide the crankshaft rear oil seal (2) across the *EN-235-6* installer (1) contained in *EN-235-D* kit.



2190821

13. Install the crankshaft rear oil seal (1) with *EN-235-6* installer (2) to the crankshaft.



2750534

Note: Ensure that the crankshaft rear oil seal fits proper.

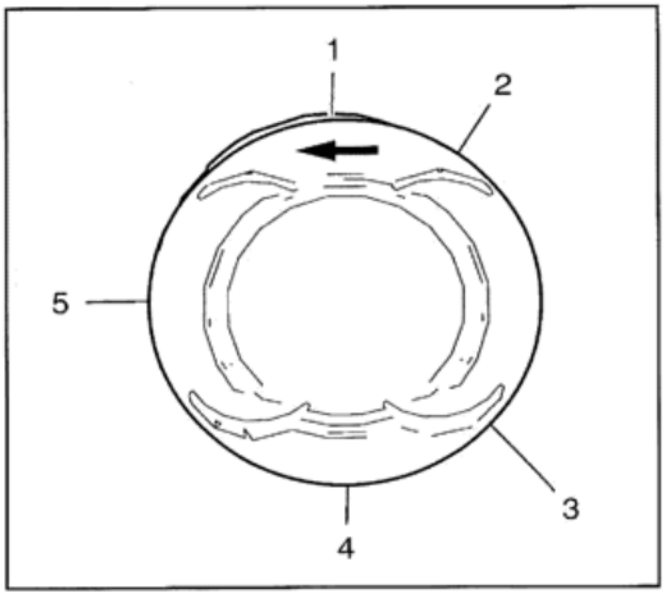
14. Use *EN-658-1* installer (2) to strike the crankshaft rear oil seal (1)

Piston, Connecting Rod, and Bearing Installation

Special Tools

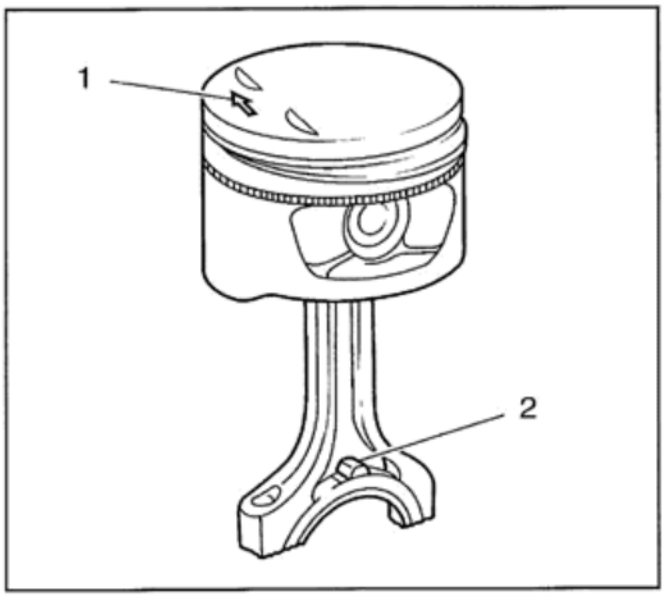
EN-470-B Angular Torque Wrench

For equivalent regional tools, refer to *Special Tools on page 9-927*.



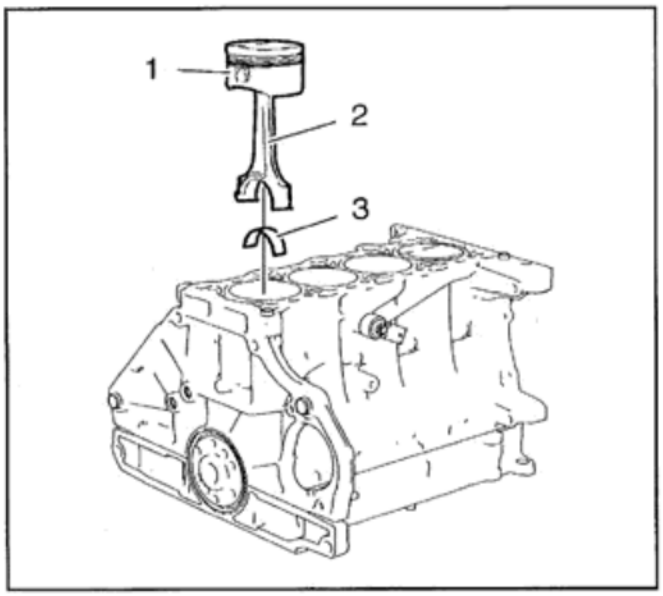
2190817

1. Adjust the piston ring joints as follows:
   1.1. Upper compression ring (1).
   1.2. Lower compression ring (4).
   1.3. Oil rings (2) or (3).
   1.4. Oil ring spacer (5).



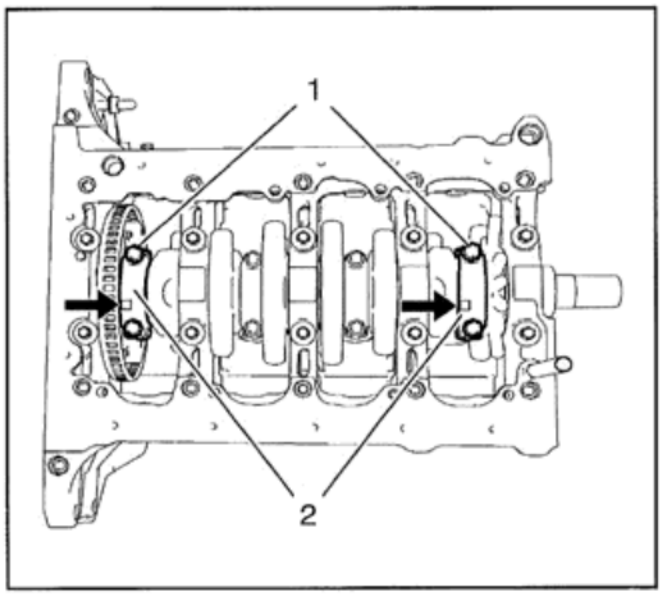
2190813

2. The arrow (1) on the piston head must point to the timing side.
3. The markings on the connecting rods (2) must point to the transmission side.



2190743

4. Install a piston ring compressor to compress the piston rings.
5. Install the pistons (1) in along with connecting rods (2) and upper connecting rod bearings (3) to the engine block and to the crankshaft.



2190742

Note: The flarings (arrows) on the connecting rod bearing caps must point to the transmission side. The connecting rod bearing caps must be installed in their original position.

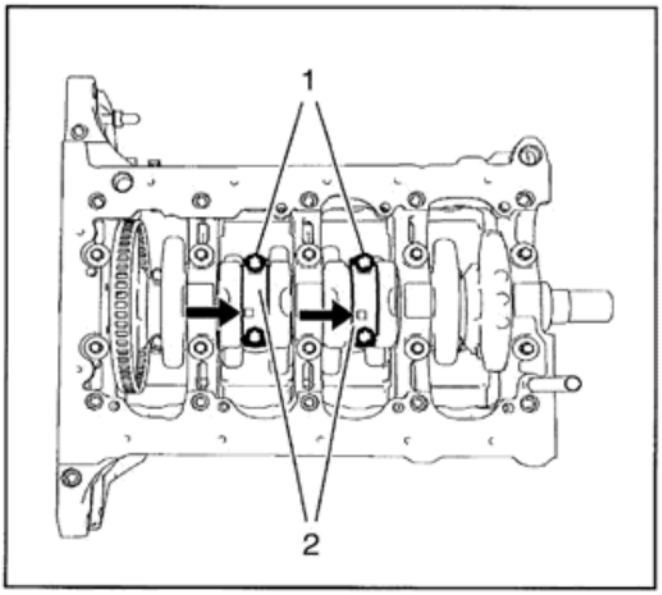
6. Install the 2 connecting rod bearings and the 2 connecting rod bearing caps (2) of cylinder 1 and 4.

Caution: Refer to *Fastener Caution on page 0-8*.

Caution: Refer to *Torque-to-Yield Fastener Caution on page 0-10*.

Note: Do not reuse the old bolts.

7. Install the 4 NEW connecting rod bearing cap bolts (1) and tighten in the following sequence:
   7.1. Tighten the connecting rod bearing cap bolts to **25 N•m (18 lb ft)**.
   7.2. Tighten the connecting rod bearing cap bolts an additional 45 degrees. Use *EN-470 B* wrench.
8. Rotate the crankshaft 180 degrees.



2190741

Note: The flarings (arrows) on the connecting rod bearing caps must point to the transmission side. The connecting rod bearing caps must be installed in their original position.

9. Install the 2 connecting rod bearings and the 2 connecting rod bearing caps (2) of cylinder 3 and 2.

Note: Do not reuse the old bolts.

10. Install the 4 NEW connecting rod bearing cap bolts (1) and tighten in the following sequence:
    10.1. Tighten the connecting rod bearing cap bolts to **25 N•m (18 lb ft)**.
    10.2. Tighten the connecting rod bearing cap bolts an additional 45 degrees. Use *EN-470–B* wrench.

Cylinder Head Installation

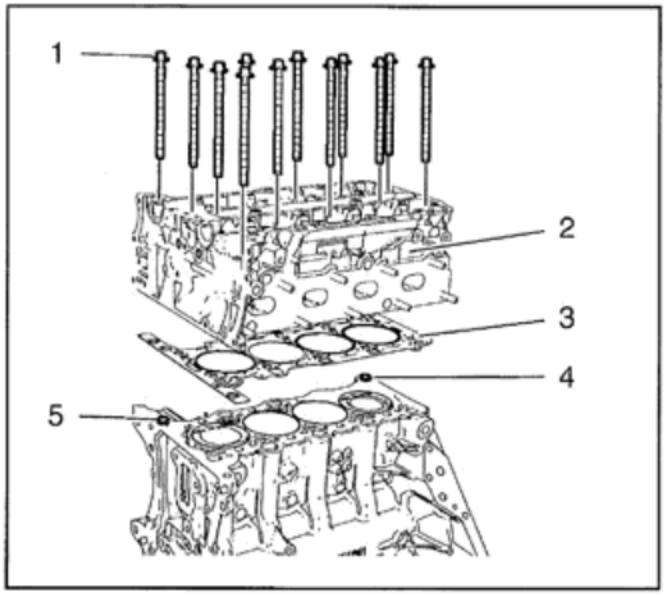
Special Tools

EN-470–B Angular Torque Wrench.

For equivalent regional tools, refer to *Special Tools on page 9-927*.

Warning: Wear safety glasses when using compressed air in order to prevent eye injury.

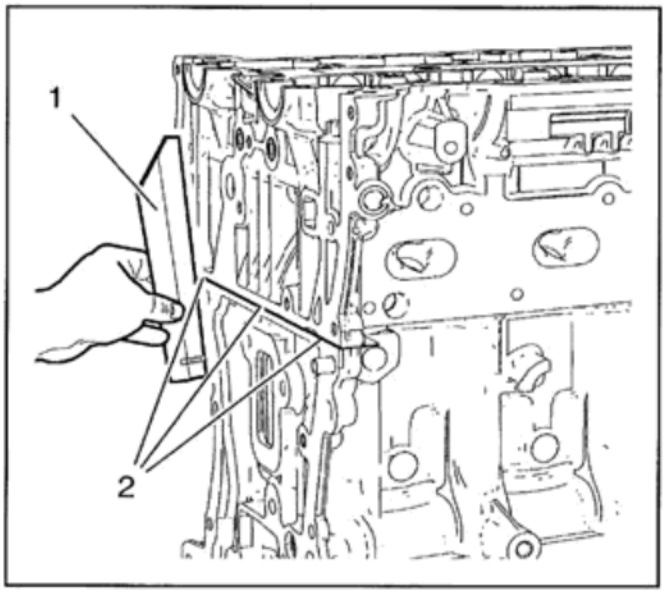
1. Clean the sealing surfaces and remove dirt and old gasket material from thread bores, water galleries and oil galleries.



2190737

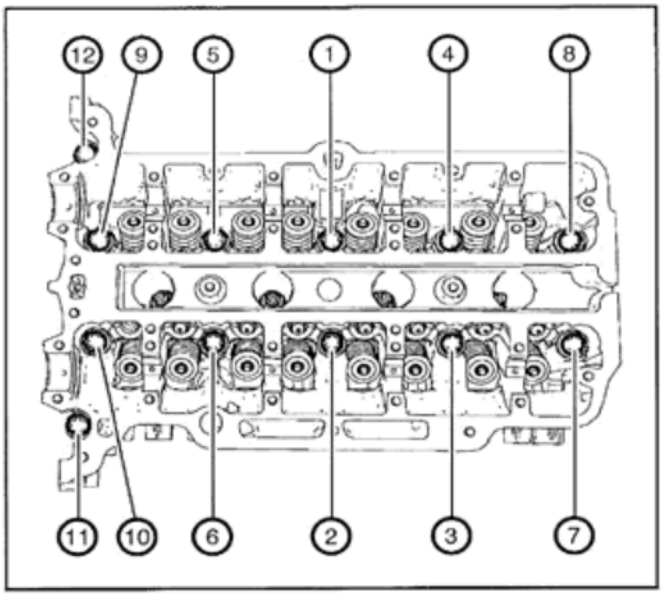
Note: Mind the guide sleeves (4) and (5).

2. Install a NEW cylinder head gasket (3). The marking "Top" should point to the cylinder head.
3. Install the cylinder head (2).
4. Install 12 NEW cylinder head bolts (1) and hand tighten.



2191829

5. Lay a straight edge (1) against the engine block and cylinder head. Adjust the transition in area (2) until there is no clearance between cylinder head and straight edge, using a rubber mallet.



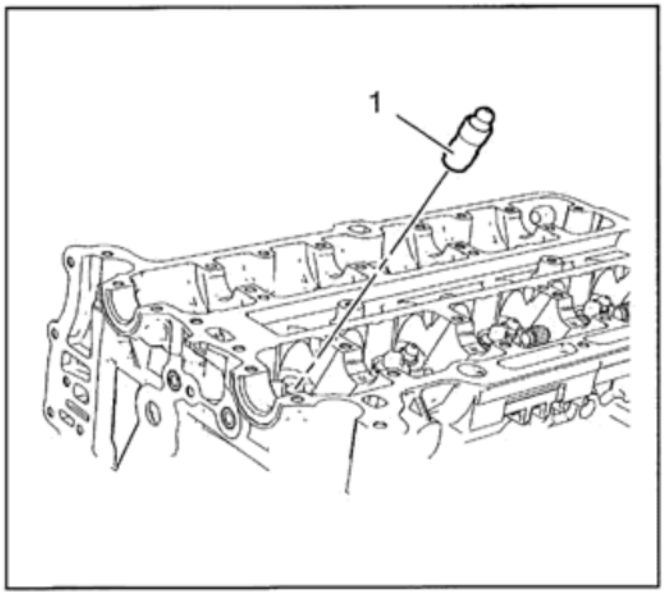
2190738

Caution: Refer to *Fastener Caution on page 0-8*

Caution: Refer to *Torque-to-Yield Fastener Caution on page 0-10.*

6. Tighten the cylinder head bolts in the sequence shown and to the following specifications:
   6.1. Tighten the cylinder head bolts to **35 N•m (26 lb ft)**.
   6.2. Tighten the cylinder head bolts an additional 180 degrees. Use *EN-470–B* wrench.

Hydraulic Valve Lash Adjuster Installation

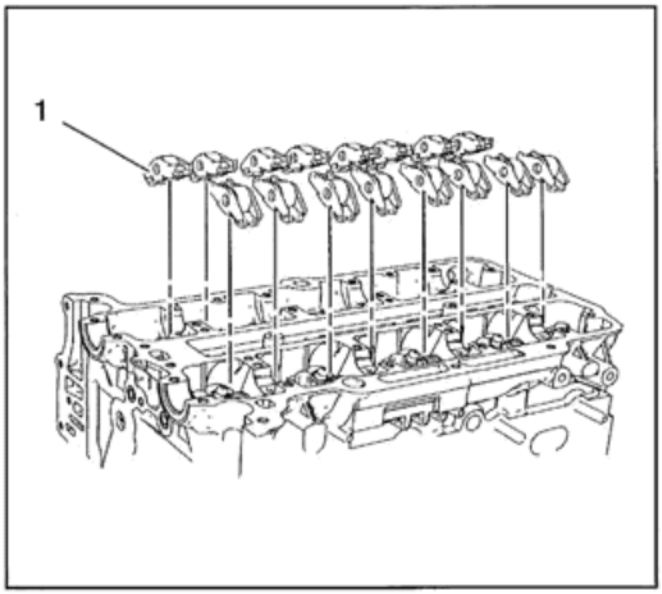


2190767

Note: Mind the installation position of the hydraulic valve lash adjusters.

1. Lubricate the hydraulic valve lash adjusters with engine oil.
2. Install the 16 hydraulic valve lash adjusters (1).

Hydraulic Valve Lash Adjuster Arm Installation

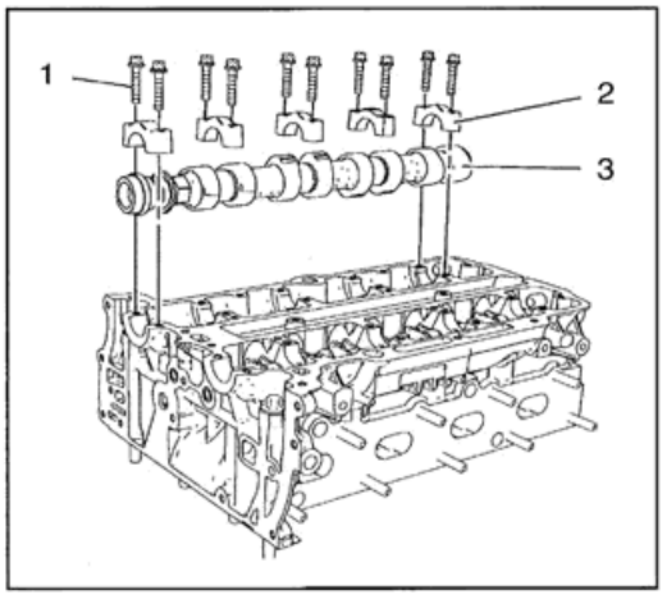


2190735

Note: Hydraulic valve lash adjuster arms should be installed in their original position.

1. Lubricate the hydraulic valve lash adjuster arms with engine oil.
2. Install the 16 hydraulic valve lash adjuster arms (1).

Intake Camshaft Installation

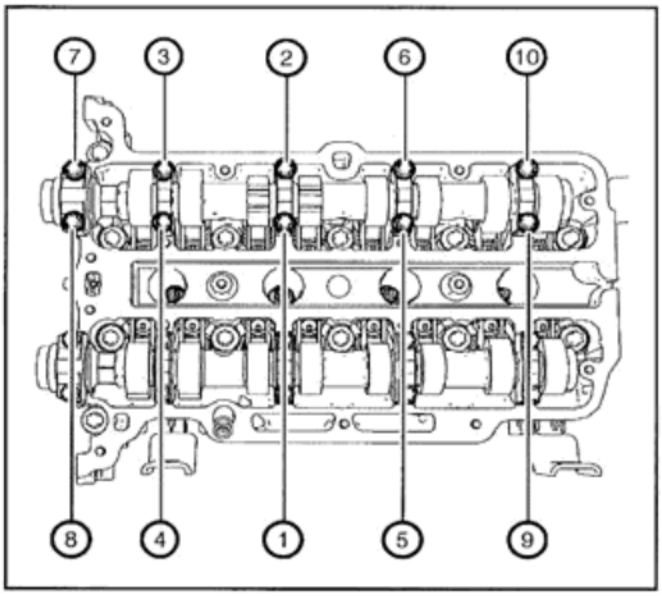


2190730

Note: Mind the markings on the camshaft bearing caps. Camshaft bearing caps should be installed in their original position.

1. Lubricate camshaft and camshaft bearing caps with engine oil.
2. Install the intake camshaft (3).
3. Install the 5 camshaft bearing caps (2).

4. Install the 10 camshaft bearing cap bolts (1) and handtighten.



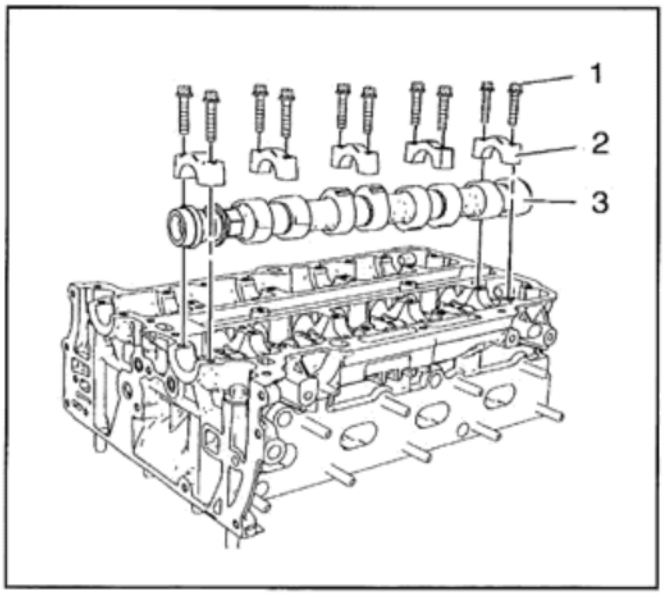
2190731

Caution: Refer to *Fastener Caution on page 0-8.*

Note: Tighten the camshaft bearing cap bolts one turn at a time in order to avoid shape distortion of the camshaft.

5. Tighten the camshaft bearing cap bolts one turn at a time and in a spiral sequence as shown to **8 N•m (71 lb in)**.

Exhaust Camshaft Installation

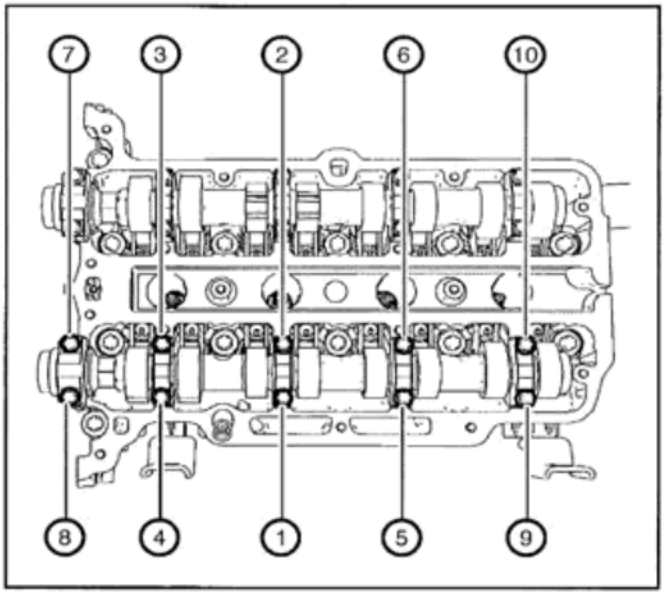


2190733

Note: Mind the markings on the camshaft bearing caps. Camshaft bearing caps should be installed in their original position.

1. Lubricate camshaft and camshaft bearing caps with engine oil.
2. Install the exhaust camshaft (3).
3. Install the 5 camshaft bearing caps (2).

4. Install the 10 camshaft bearing cap bolts (1) and handtighten.



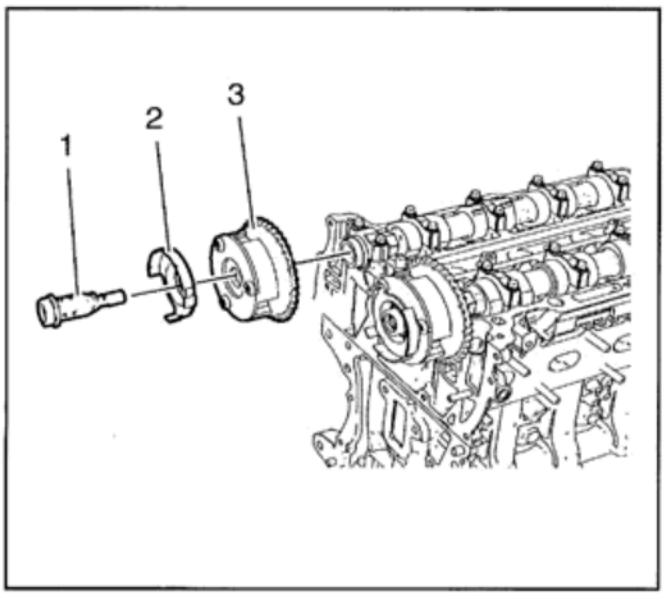
2190734

Caution: Refer to *Fastener Caution on page 0-8.*

Note: Tighten the camshaft bearing cap bolts one turn at a time in order to avoid shape distortion of the camshaft.

5. Tighten the camshaft bearing cap bolts one turn at a time and in a spiral sequence as shown to **8 N•m (71 lb in)**.

Camshaft Sprocket Installation



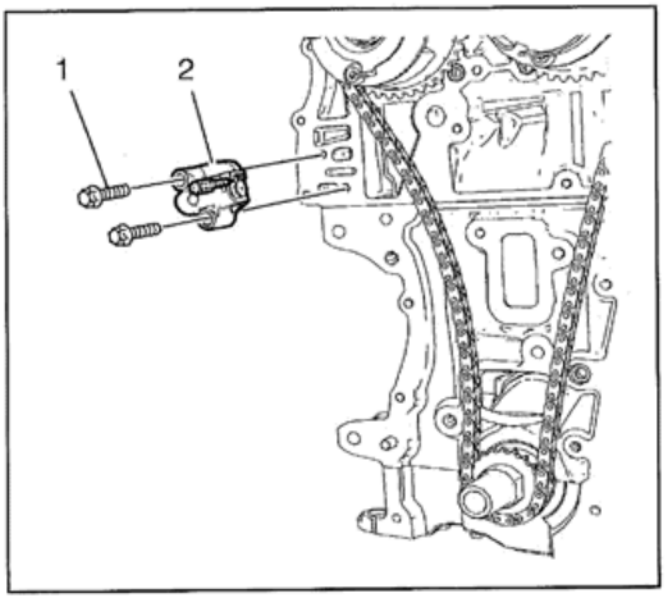
2190718

1. Install the intake camshaft sprocket (3).
2. Install the intake camshaft position sensor exciter wheel (2) and the intake camshaft sprocket bolt (1), but do not tighten yet.
3. Install the exhaust camshaft sprocket.

Note: Tightening of camshaft sprocket bolts will be done after the engine front cover installation.

4. Install the exhaust camshaft position sensor exciter wheel and the exhaust camshaft sprocket bolt, but do not tighten yet.

Timing Chain Tensioner Installation



2190684

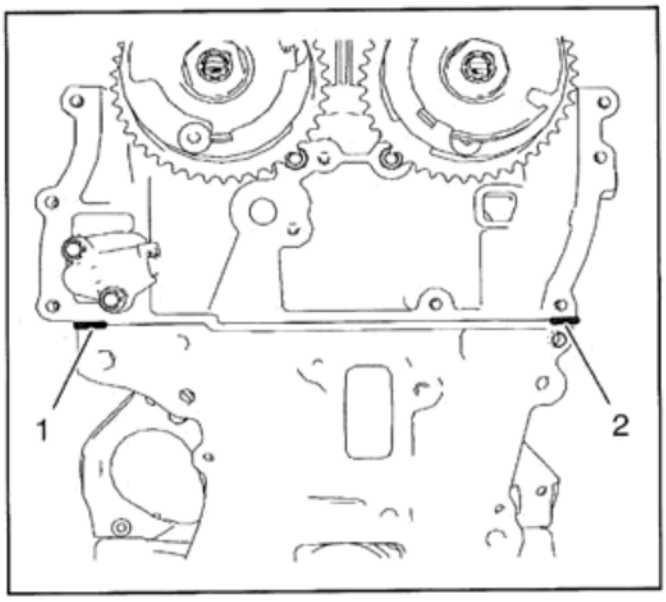
1. Install the timing chain tensioner (2).

Caution: Refer to *Fastener Caution on page 0-8*.

2. Install the 2 timing chain tensioner bolts (1) and tighten to **8 N•m (71 lb in)**.

Engine Front Cover Gasket Installation

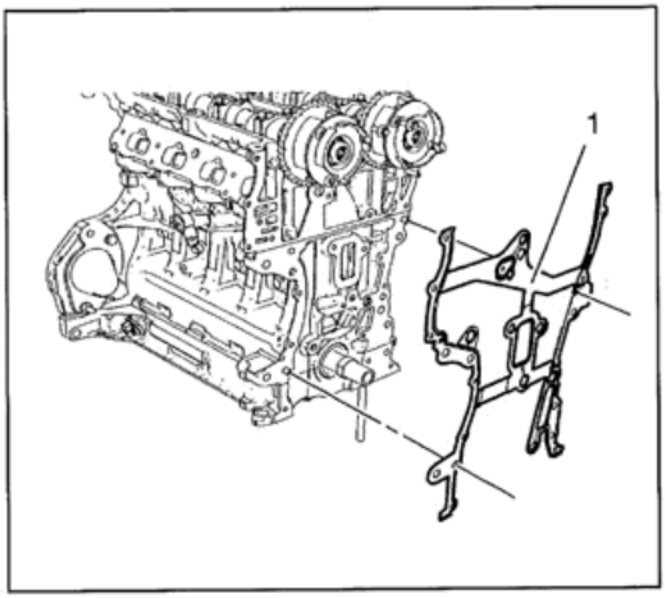
1. Clean the sealing surfaces and remove all remains of old sealing compound material.



2190694

Note: The thickness of the sealing bead should be 2 mm (0.0787 in).

2. Apply sealing compound to the shown areas (1) and (2). Refer to *Adhesives, Fluids, Lubricants, and Sealers on page 9-759*.



2190693

Note: Mind the guide sleeves.

3. Install the NEW engine front cover gasket (1).
4. Install the timing chain. Refer to *Camshaft Timing Chain Installation on page 9-904*.

Note: The complete installation procedure should not take longer than 10 minutes.

5. Install the engine front cover. Refer to *Engine Front Cover and Oil Pump Installation on page 9-906*.

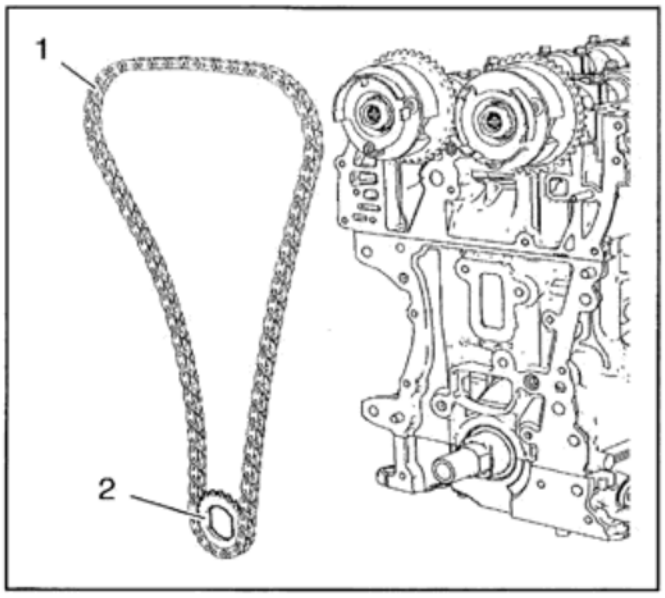
Camshaft Timing Chain Installation

Special Tools

- *EN-952* Fixing Pin
- *EN-953-A* Fixing Tool
- *EN-955-10* Fixing Pin from *EN-955* Kit

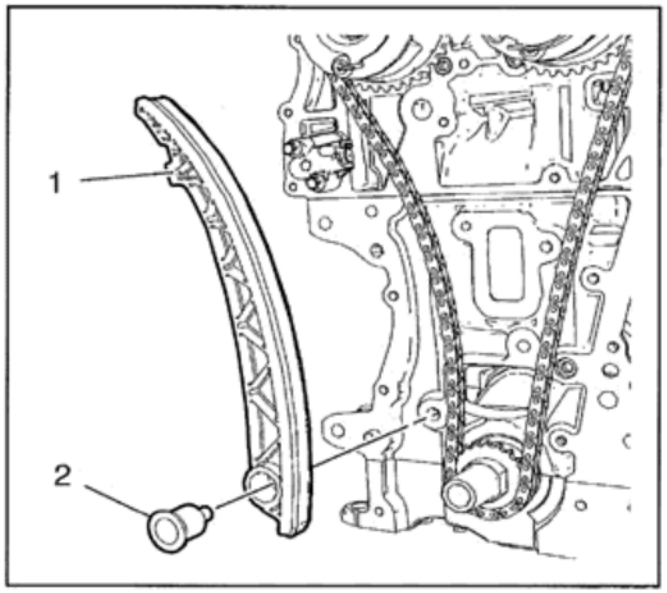
For equivalent regional tools, refer to *Special Tools on page 9-927*.

1. The engine should be adjusted to TDC.
2. The crankshaft should be locked with *EN-952* fixing pin.
3. The camshaft should be locked with *EN-953-A* fixing tool.



2190675

4. Install the timing chain (1) along with the crankshaft sprocket (2).

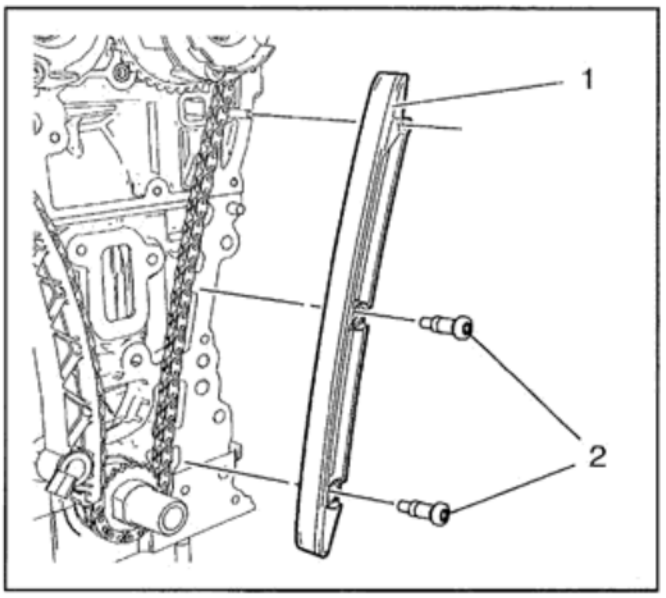


2190678

5. Install the timing chain tensioner shoe (1).

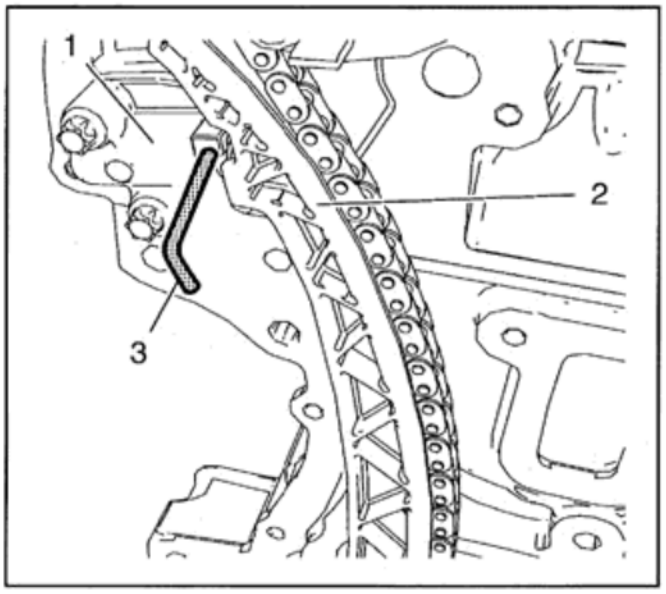
Caution: Refer to *Fastener Caution on page 0-8*.

6. Install the timing chain tensioner shoe bolt (2) and tighten to **20 N•m (15 lb ft)**.



2190677

7. Install the timing chain guide right side (1).
8. Install the 2 timing chain guide right side bolts (2) and tighten to **8 N•m (71 lb in)**.



2190679

9. Push the timing chain (2) in direction to the timing chain tensioner (1) and remove the *EN-955-10* fixing pin (3).

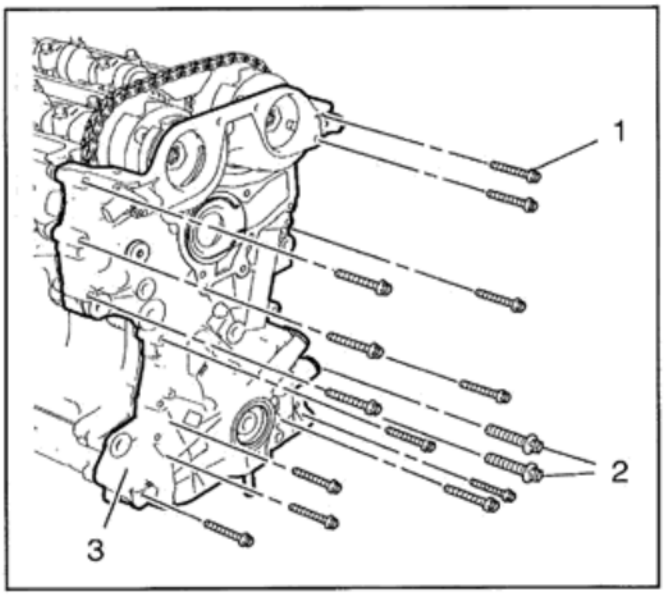
The upper timing chain guide will be installed after the installation of the engine front cover and the fastening of the camshaft sprockets.

Engine Front Cover and Oil Pump Installation

Special Tools

- *EN-952* Fixing Pin
- *EN-953-A* Fixing Tool
- *EN-49977-100* Transmitter Disc Fixation
- *EN-49977-200* Fixing Tool

For equivalent regional tools, refer to *Special Tools on page 9-927*.



2190667

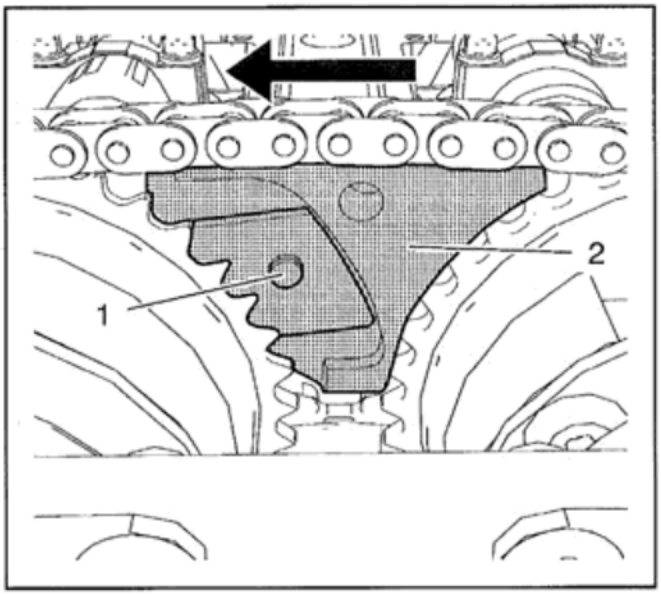
Note: Mind the guide sleeves when installing engine front cover.

1. Install the engine front cover (3).
2. Install the 13 engine front cover bolts M6 (1).
3. Install the 2 engine front cover bolts M10 (2).

Caution: Refer to *Fastener Caution on page 0-8*.

4. Tighten the 13 engine front cover bolts M6 to **8 N•m (71 lb in)**.
5. Tighten the 2 engine front cover bolts M10 to **35 N•m (26 lb ft)**.

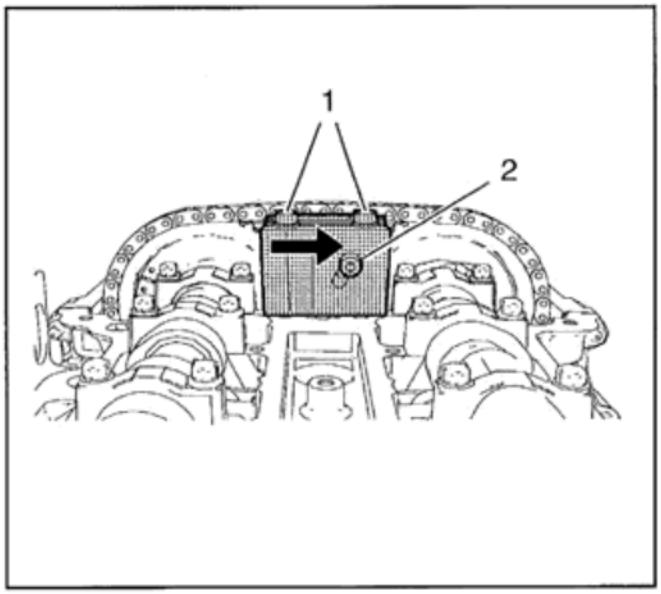
Camshaft Sprocket Fastening



2190710

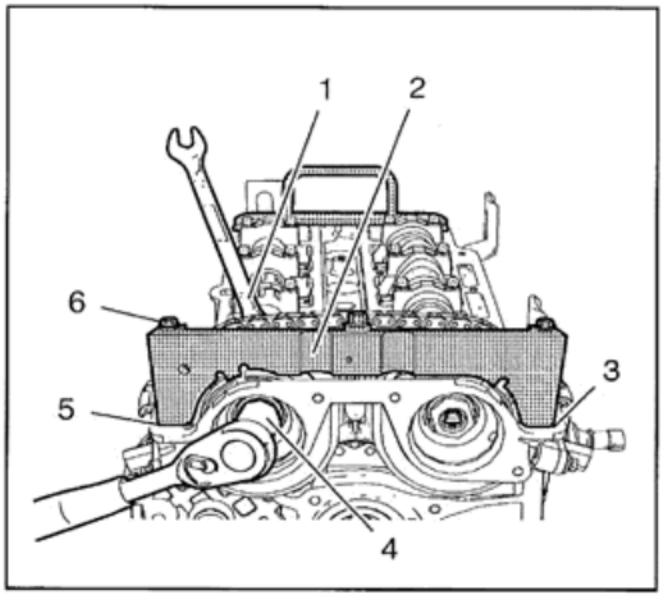
Note: Push the fixing tool in the direction of the arrow to ensure it fully engages.

1. Install *EN-49977-200* fixing tool (2) and ensure that the gearing of the fixing tool engages with the intake camshaft sprocket gearing (1).



2190712

2. Tighten the 2 fastening bolts (1) of *EN-49977-200* fixing tool while pushing the fixing tool in direction of the arrow.
3. Tighten the adjuster bolt (2).



2190709

Note: A wrong installation position is possible. Make sure that the holding tool is fully installed to the cylinder head in areas (3) and (5).

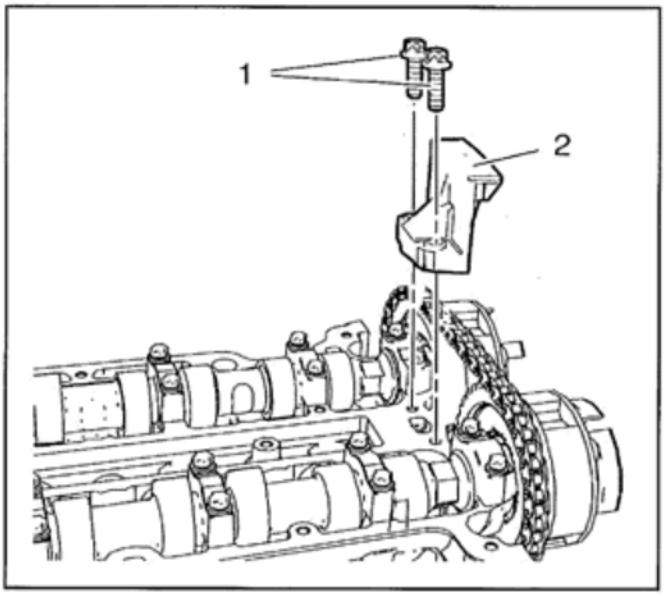
4. Install *EN-49977–100* transmitter disc holder (2) to find and hold the correct position of the camshaft position exciter wheels.
5. Tighten the fastening bolts (6) of *EN-49977-100* transmitter disc holder.

Caution: Refer to *Fastener Caution on page 0-8*.

Caution: Refer to *Torque-to-Yield Fastener Caution on page 0-10*.

6. Tighten the NEW intake camshaft sprocket bolt (4) while holding the hexagon (1) of the intake camshaft to **50 N•m (37 lb ft)**.
7. Tighten the intake camshaft sprocket bolt (4) while holding the hexagon (1) of the intake camshaft to an additional **60 degrees**.
8. Tighten the NEW exhaust camshaft sprocket bolt while holding the hexagon of the exhaust camshaft to **50 N•m (37 lb ft)**.
9. Tighten the exhaust camshaft sprocket bolt while holding the hexagon of the exhaust camshaft to an additional **60 degrees**.
10. Remove *EN-49977-100* transmitter disc holder and *EN-49977-200* fixing tool.

Upper Timing Chain Guide Installation



2190676

1. Install the upper timing chain guide (2).
2. Install the 2 upper timing chain guide bolts (1) and tighten to **8 N•m (71 lb in)**.
3. Remove *EN-953-A* fixing tool and *EN-952* fixing pin.
4. Install crankshaft bearing cap tie plate hole plug and seal ring and tighten to **50 N•m (37 lb ft)**.

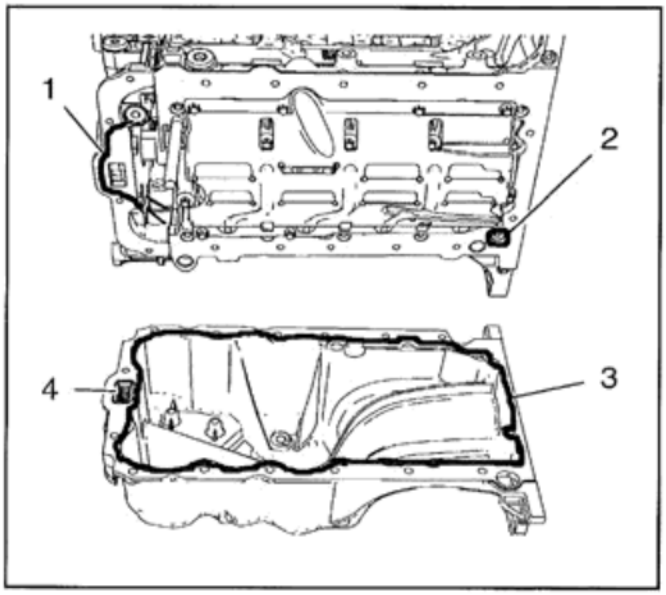
Oil Pan Installation

Special Tools

EN-49980 Guidance Pins

For equivalent regional tools, refer to *Special Tools on page 9-927*.

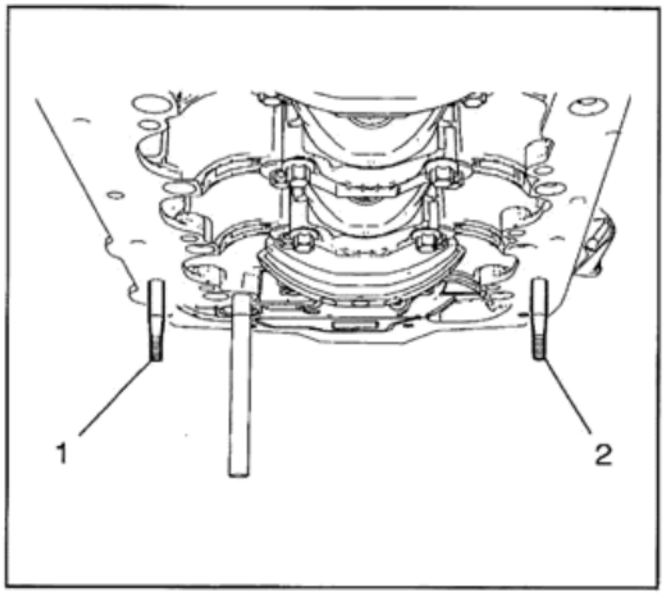
1. Clean the sealing surfaces from old sealing material, dirt, oil and grease.



2190369

Note: The sealing bead should be applied close to the inner edge of the oil pan. Take care that the oil suction gallery (4) will not get contaminated with sealing compound or dirt. The thickness of the sealing bead (3) should be 2 mm (0.0787 in).

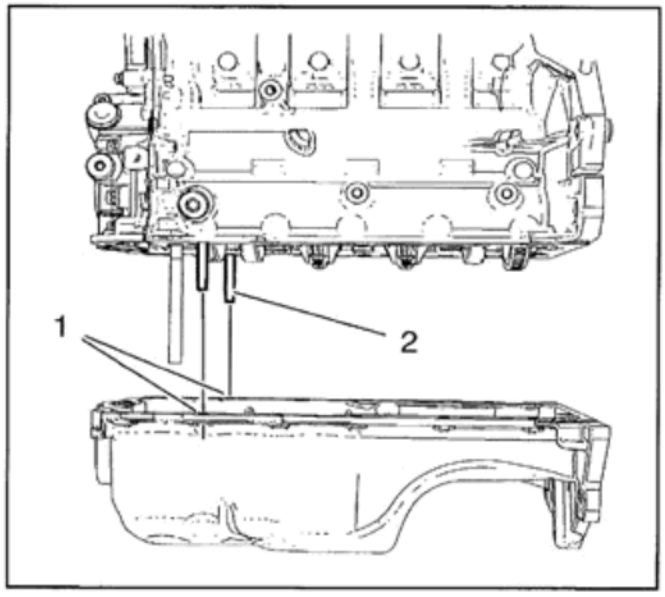
2. Apply sealing compound to the oil pan. Refer to *Adhesives, Fluids, Lubricants, and Sealers on page 9-759.*
3. Apply sealing compound to the groove of the engine front cover (1). Refer to *Adhesives, Fluids, Lubricants, and Sealers on page 9-759.*
4. Apply sealing compound around the screw bore (2) of the crankshaft bearing cap tie plate.



2191029

Note: The complete installation procedure of the oil pan should not take longer than 10 minutes.

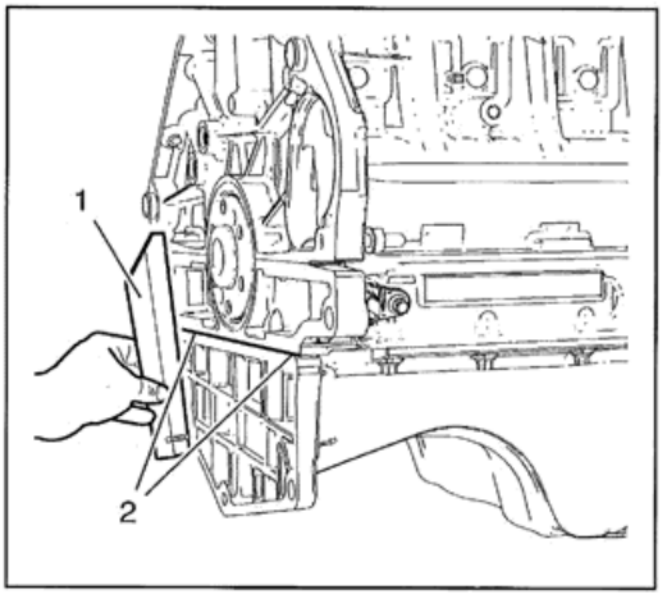
5. Install the 2 *EN-49980* pins (1) and (2) to the shown oil pan screw bores.



2191030

Caution: Use care when installing the oil pan to prevent disruption of the sealing bead. The sealing bead should remain consistent until the oil pan is mated with the engine. An inconsistent sealing bead can cause an insufficient seal and result in engine damage.

6. Carefully install the oil pan. Guide the oil pan with *EN-49980* pins (2) and the equivalent screw bores (1).
7. Hold the oil pan with 4 oil pan bolts.
8. Remove *EN-49980* pins.
9. Install the remaining 12 oil pan bolts and hand tighten.



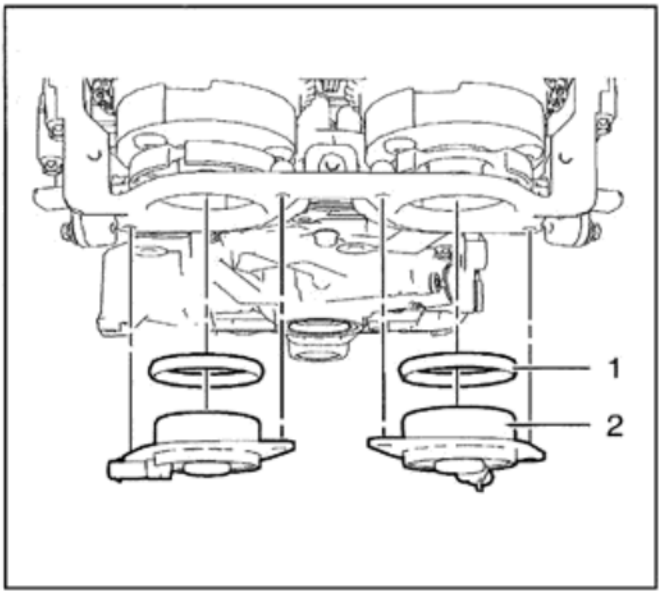
2191830

10. Lay a straight edge (1) against the oil pan and engine block. Using a rubber mallet, adjust the transition in area (2) until there is no clearance between oil pan and the straight edge.

Caution: Refer to *Fastener Caution on page 0-8.*

11. Tighten the 16 oil pan bolts to **10 N•m (89 lb in)**.

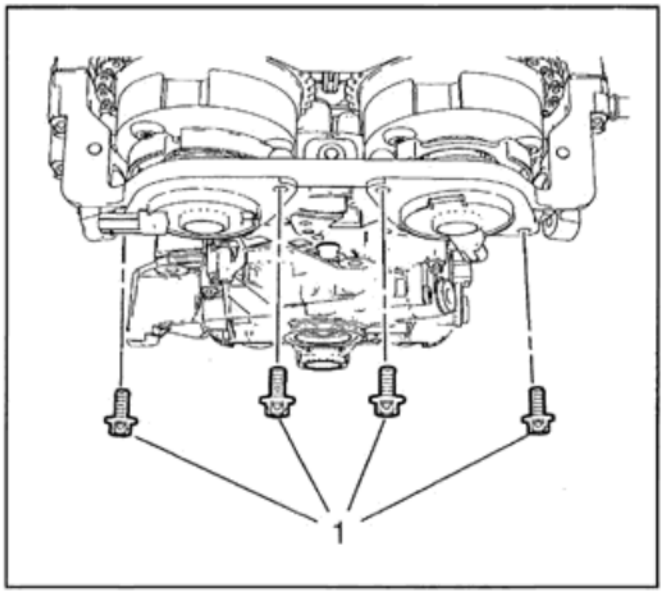
Camshaft Position Actuator Solenoid Valve Installation



2190650

Caution: The camshaft position actuator solenoid valves must be kept parallel to the engine front cover during removal and installation. The camshaft position actuator solenoid valves can be damaged if they become wedged or stuck during this process.

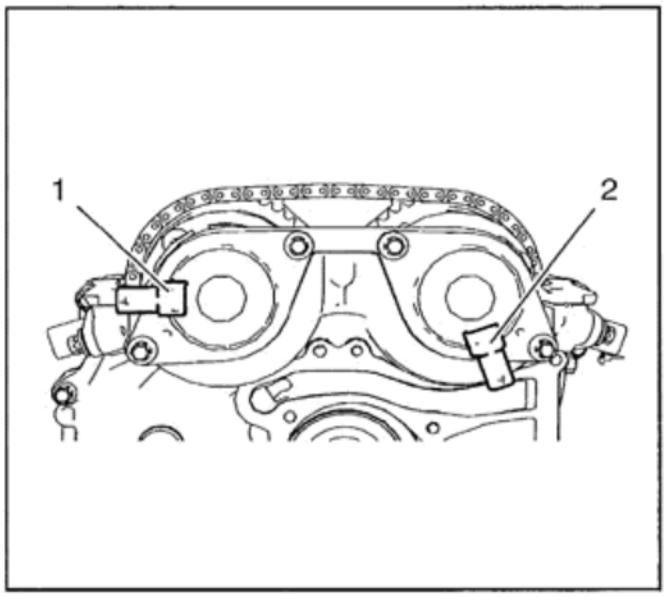
1. Install the 2 camshaft position actuator solenoid valves (2) and the 2 seal rings (1) by carefully and evenly pressing.



2191735

Caution: Refer to *Fastener Caution on page 0-8*

2. Install the 4 camshaft position actuator solenoid valve bolts (1) and tighten to **8 N•m (71 lb in)**.

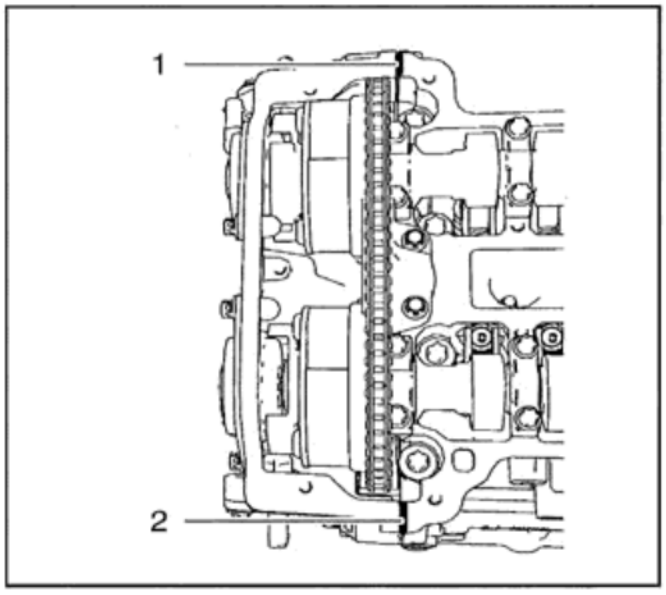


2190651

3. The 2 camshaft position actuator solenoid valves should be installed in the position as shown (1) and (2).

Camshaft Cover Installation

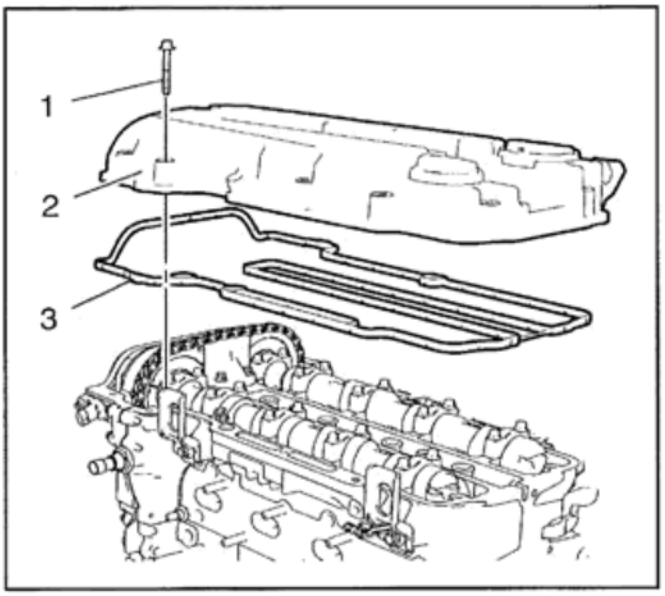
1. Clean the sealing surfaces.



2190649

Note: The thickness of the sealing bead should be 2 mm (0.0787 in).

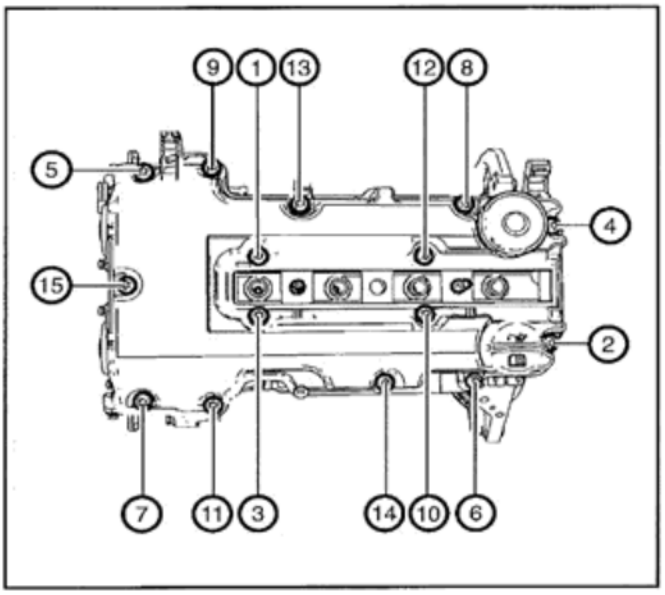
2. Apply sealing compound to areas (1) and (2). Refer to *Adhesives, Fluids, Lubricants, and Sealers on page 9-759*.



2190620

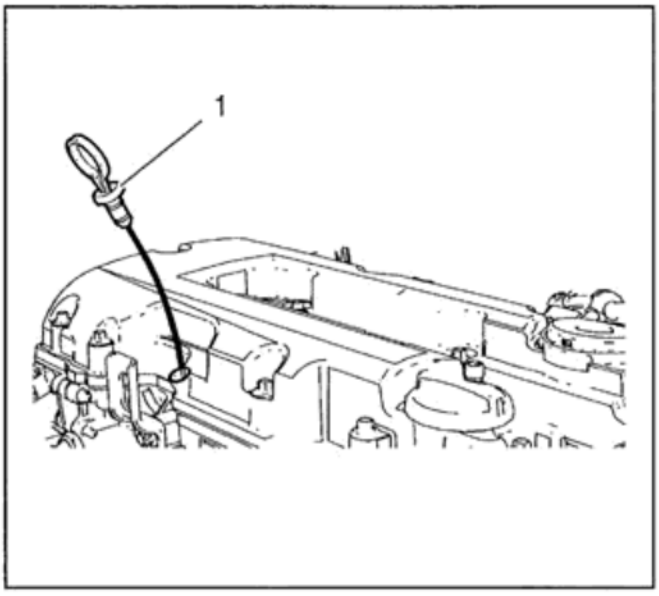
Note: The installation procedure should not take longer than 10 minutes.

3. Install the camshaft cover (2) and a NEW gasket (3).
4. Install the 15 camshaft cover bolts (1).



2190648

5. Tighten the 15 camshaft cover bolts in a sequence as shown to **8 N•m (71 lb in)**.



2190647

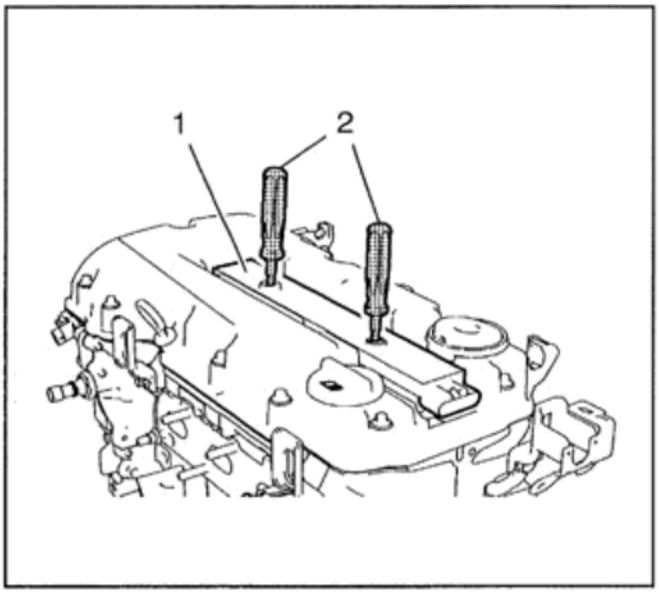
6. Install the oil level indicator (1).

Ignition Coil Installation

Special Tools

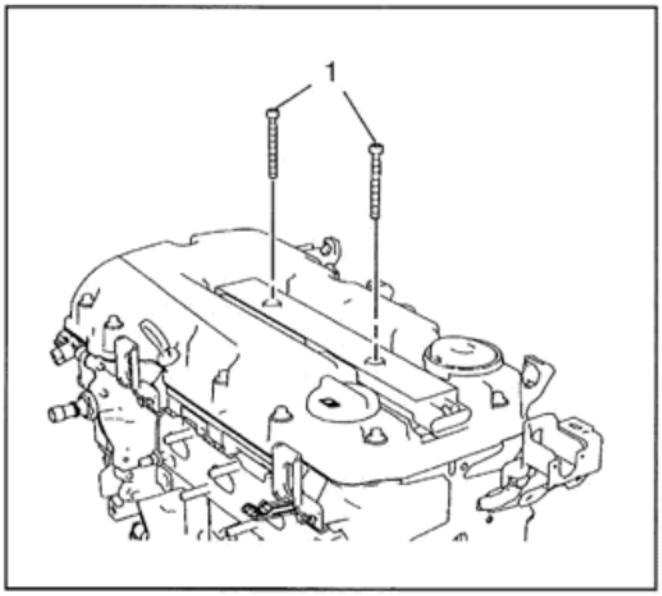
EN-6009 Remover and Installer Ignition Module

For equivalent regional tools, refer to *Special Tools on page 9-927*.



2190646

1. Install the ignition coil (1) and remove *EN-6009* remover and installer (2).



2190645

Caution: Refer to *Fastener Caution on page 0-8*.

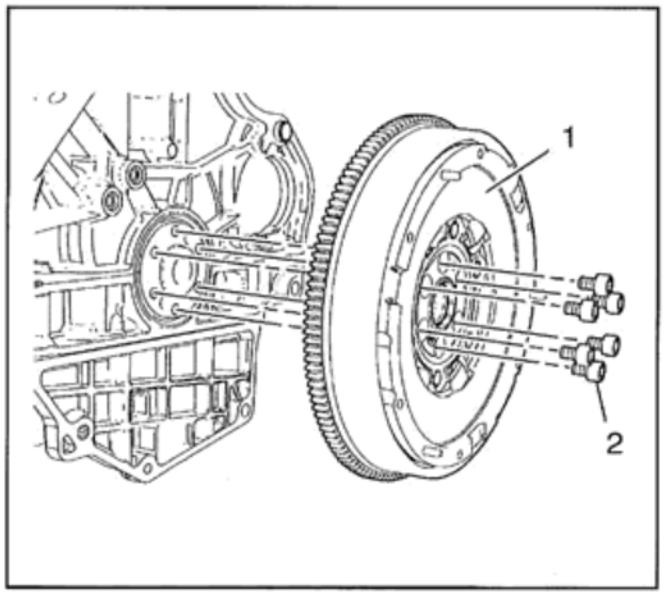
2. Install the 2 ignition coil bolts (1) and tighten to **8 N•m (71 lb in)**.

Engine Flywheel Installation

Special Tools

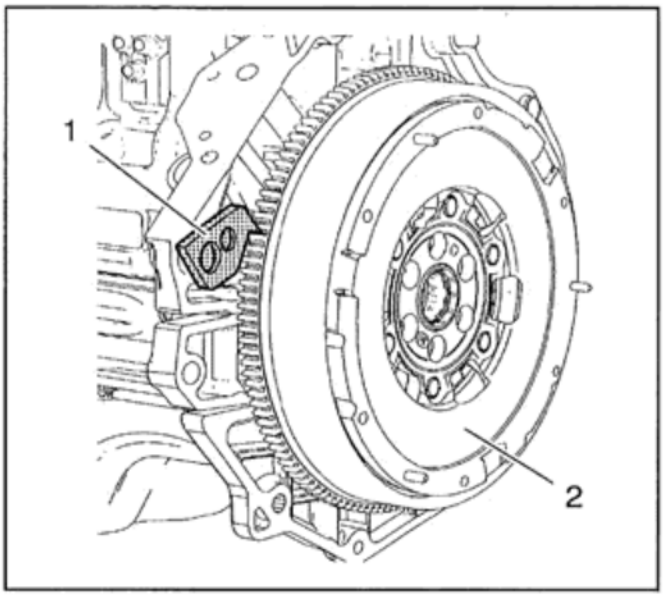
- *EN-470–B* Angular Torque Wrench
- *EN-652* Flywheel Holder

For equivalent regional tools, refer to *Special Tools on page 9-927*.



2191833

1. Install the engine flywheel (1).
2. Install the 6 NEW engine flywheel bolts (2).



2191832

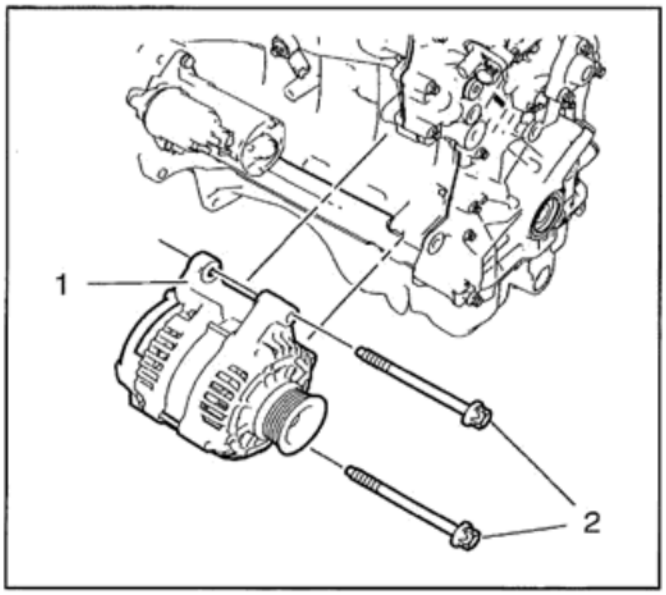
3. Install *EN-652* holder (1) to hold the engine flywheel (2).

Caution: Refer to *Fastener Caution on page 0-8*.

Caution: Refer to *Torque-to-Yield Fastener Caution on page 0-10*.

4. Tighten the 6 engine flywheel bolts in a cross sequence to **60 N•m (44 lb ft)**.
   4.1. Tighten the 6 engine flywheel bolts in a cross sequence to an additional 45 degrees. Use *EN-470–B* wrench.
   4.2. Tighten the 6 engine flywheel bolts in a cross sequence to an additional 15 degrees. Use *EN-470–B* wrench.
5. Remove *EN-652* holder.

Generator Installation



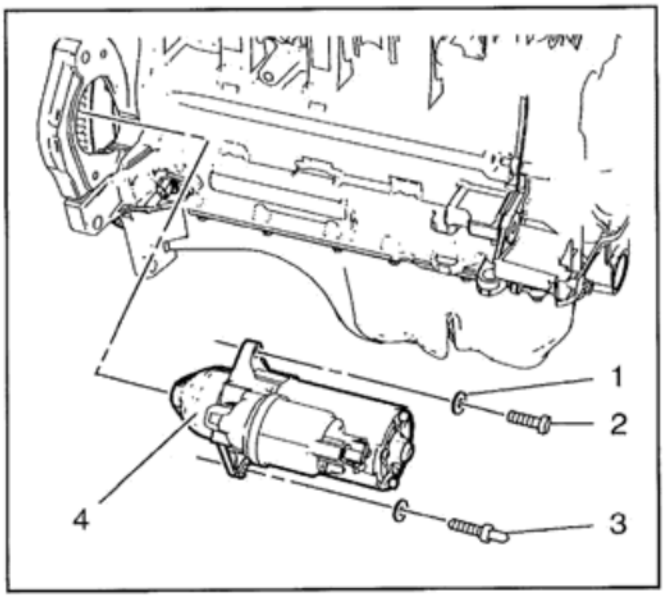
2190617

1. Install the generator (1).

Caution: Refer to *Fastener Caution on page 0-8*.

2. Install the 2 generator bolts (2) and tighten to **35 N•m (26 lb ft)**.

Starter Installation



2190618

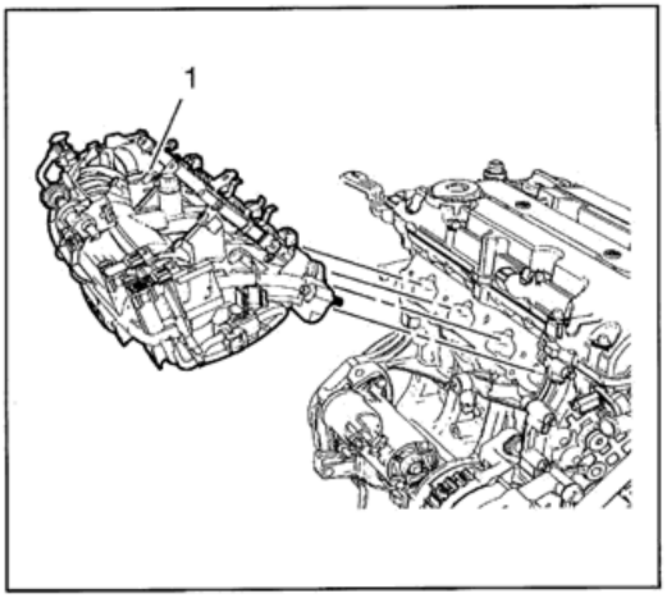
1. Install the starter (4).
2. Install the lower starter bolt stud (3) and if equipped the washer.
3. Install the upper starter bolt (2) and if equipped the washer (1).

Caution: Refer to *Fastener Caution on page 0-8.*

4. Tighten the starter bolt and starter bolt stud to **25 N•m (18 lb ft)**.

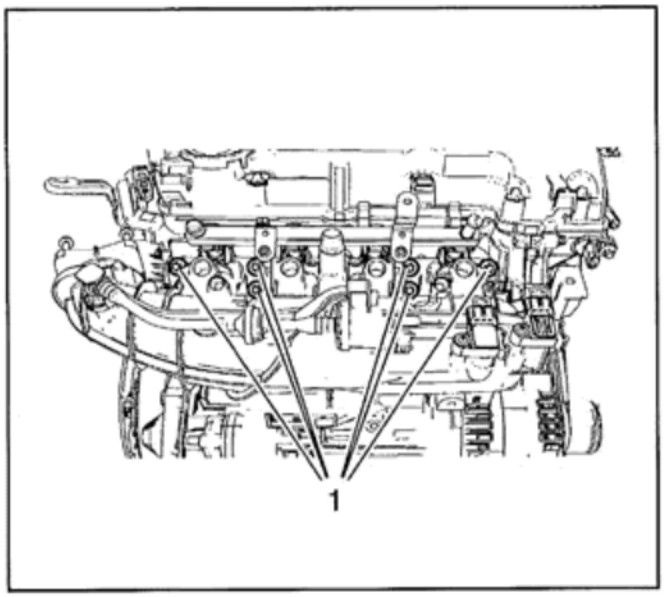
Intake Manifold Installation

1. Clean the sealing surfaces.



2191843

2. Install the intake manifold (1) along with a NEW intake manifold gasket.

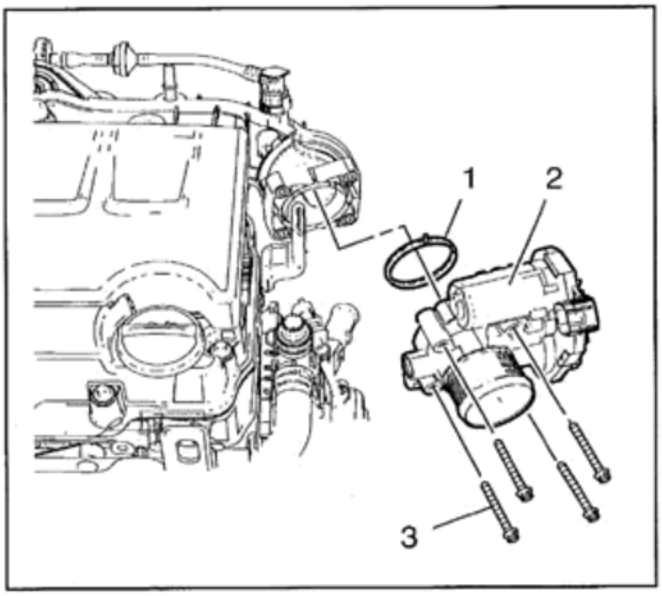


2191842

Caution: Refer to *Fastener Caution on page 0-8.*

3. Install the 6 intake manifold bolts (1) and tighten to **20 N•m (15 lb ft)**.

Throttle Body Installation



2191887

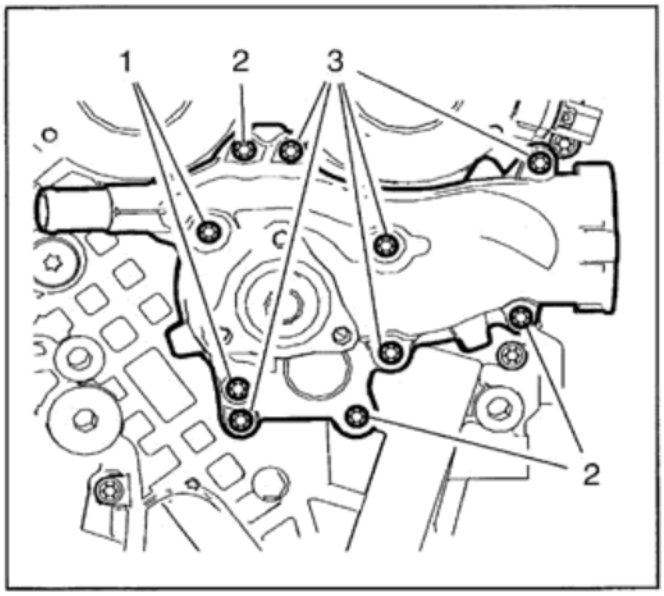
1. Install the throttle body (2) and a NEW throttle body seal ring (1).

Caution: Refer to *Fastener Caution on page 0-8.*

2. Install the 4 throttle body bolts (3) and tighten to **8 N•m (71 lb in)**.

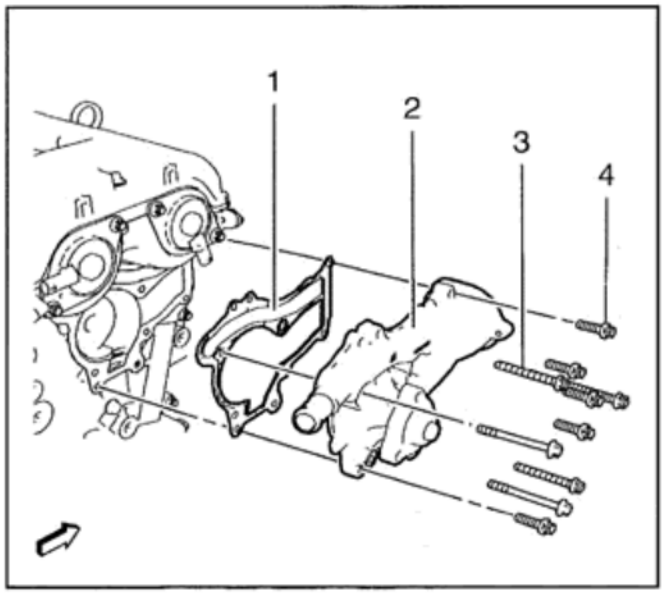
Water Pump Installation

1. Clean the sealing surfaces.



2631338

2. The water pump and engine front cover bolts are located as followed:
   - Engine front cover special bolt without cone end **60 mm (2.362 in)** (1).
   - Engine front cover standard bolt with cone end **52 mm (2.047 in)** (2).
   - Water pump bolt **25 mm (0.984 in)** (3).



2191788

3. Install the water pump (2) and a NEW water pump gasket (1).

Caution: Refer to *Fastener Caution on page 0-8*.

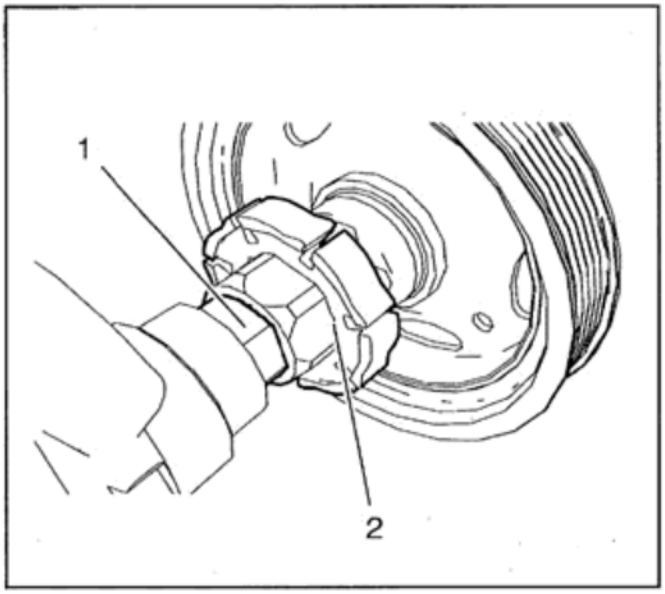
4. Install the 5 water pump bolts (4) and the 5 long engine front cover bolts (3) and tighten in a cross sequence to **8 N•m (71 lb in)**.

Crankshaft Balancer Installation

Special Tools

- *EN-470–B* Angular Torque Wrench
- *EN-956–1* Extension
- *EN-49979* Crankshaft Shock Mount Retainer

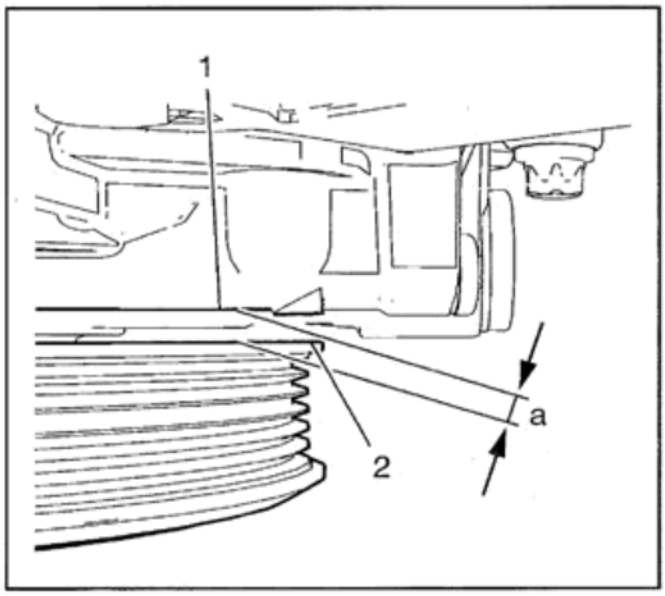
For equivalent regional tools, refer to *Special Tools on page 9-927*.



2190553

Note: The crankshaft balancer flange must fit to the hexagon of the oil pump rotor (2) and to the two-flat of the crankshaft (1).

1. Install the crankshaft balancer by carefully pressing into position.

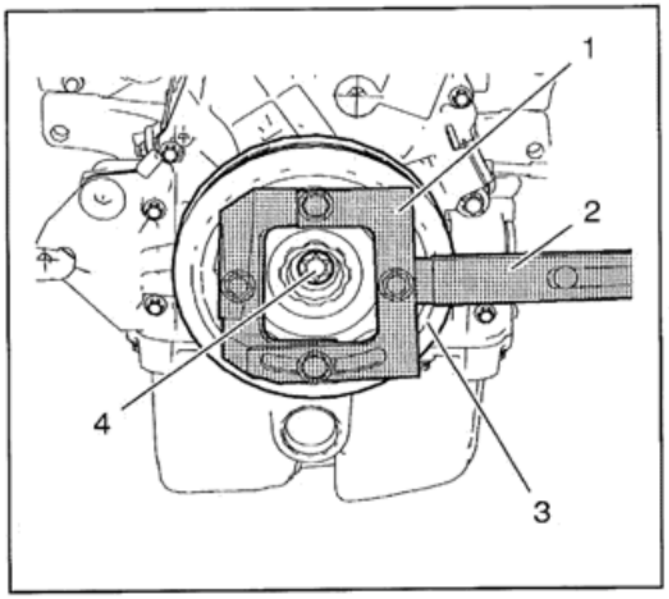


2190555

2. Measure the distance **a** between the crankshaft balancer (2) and the engine front cover (1). The distance **a** should be 5.5 mm (0.21654 in).

Note: Never re-use the crankshaft balancer bolt.

3. Install a NEW crankshaft balancer bolt.



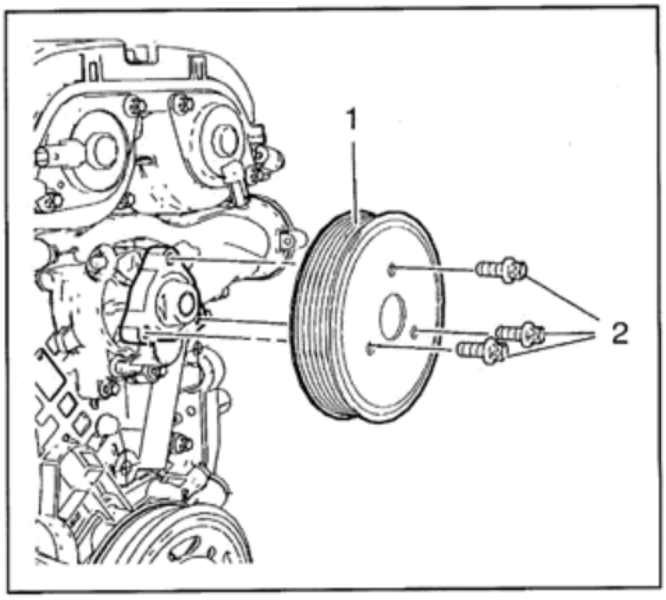
2190546

Caution: Refer to *Fastener Caution on page 0-8.*

Caution: Refer to *Torque-to-Yield Fastener Caution on page 0-10.*

4. Tighten the crankshaft balancer bolt (4) while holding the crankshaft balancer (3) with *EN-49979* retainer (1) and *EN-956–1* extension (2) in the following order:
   4.1. Tighten the crankshaft balancer bolt to **150 N•m (111 lb ft)**.
   4.2. Tighten the crankshaft balancer bolt to an additional 60 degrees, using *EN-470–B* wrench.

Water Pump Pulley Installation



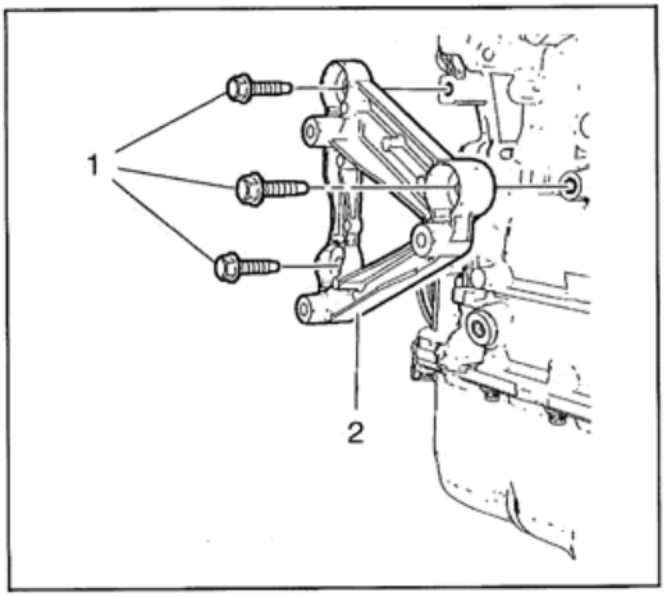
2190373

1. Install the water pump pulley (1).
2. Install the 3 water pump pulley bolts (2).

Caution: Refer to *Fastener Caution on page 0-8.*

3. Tighten the 3 water pump pulley bolts (2) to **22 N•m (16 lb ft)** while holding up the water pump pulley hub with a wrench.

Air Conditioning Compressor Bracket Installation



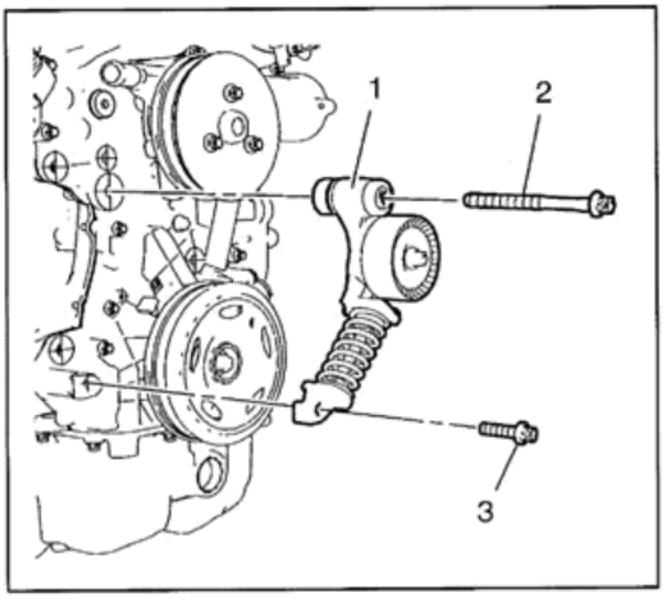
2190353

1. Install the air conditioning compressor bracket (2).

Caution: Refer to *Fastener Caution on page 0-8.*

2. Install the 3 air conditioning compressor bracket bolts (1) and tighten to **22 N•m (16 lb ft)**.

Drive Belt Tensioner Installation



2190385

1. Install the drive belt tensioner (1).
2. Install the upper drive belt tensioner bolt (2).
3. Install the lower drive belt tensioner bolt (3).

Caution: Refer to *Fastener Caution on page 0-8.*

4. Tighten the lower drive belt tensioner bolt (M8) to **22 N•m (16 lb ft)**.
5. Tighten the upper drive belt tensioner bolt to **55 N•m (41 lb ft)**.

Drive Belt Installation

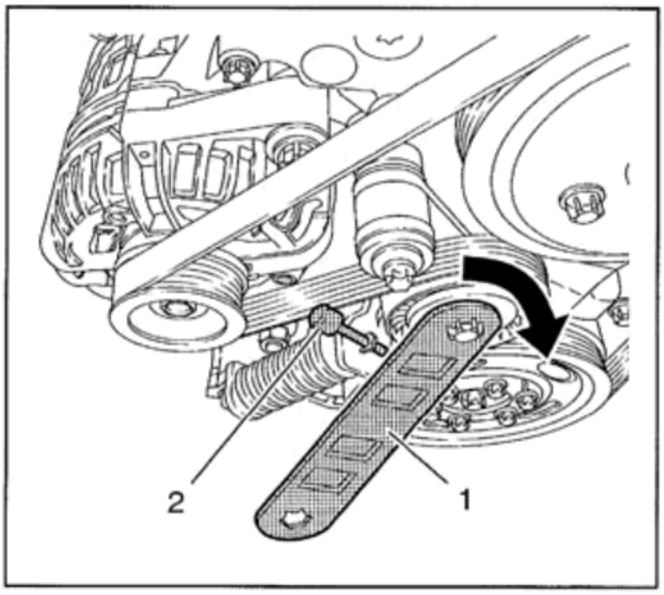
Special Tools

- *EN-955* Locking Pins
- *EN-48488* Holding Wrench

For equivalent regional tools, refer to *Special Tools on page 9-927*.

Note: Ensure that the drive belt tensioner is held with *EN-955–2* locking pin.

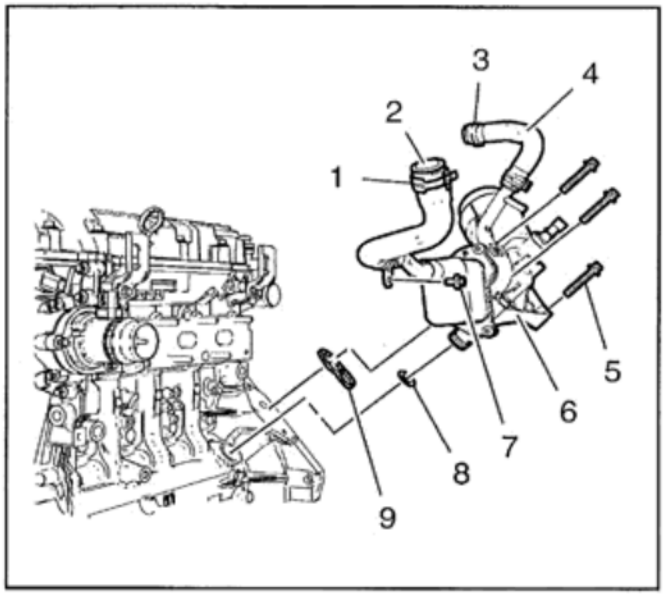
1. Install the drive belt.



2191736

2. Move the drive belt tensioner clockwise until *EN-955–20* locking pin (2) can be removed. Use *EN-48488* wrench (1).
3. Remove *EN-955–20* locking pin (2) from the drive belt tensioner while holding with *EN-48488* wrench (1).
4. Release tension from drive belt tensioner and remove *EN-48488* wrench (1).

Engine Oil Cooler Installation



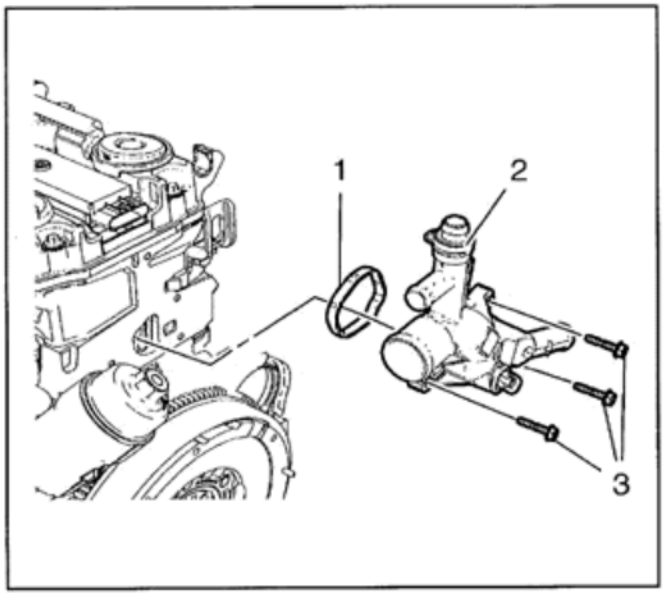
2191862

Note: Lubricate the oil cooler seal (8) with clean engine oil.

1. Install the engine oil cooler assembly (6) along with 2 NEW sealings (8) and (9).
2. Install the 3 oil cooler bolts (5) and tighten to **10 N•m (89 lb in)**.
3. Install the oil cooler coolant outlet pipe bolt (7) and tighten to **10 N•m (89 lb in)**.
4. Install the oil cooler coolant outlet hose (2) to the engine coolant thermostat housing.
5. Install the oil cooler coolant outlet hose clamp (1).
6. Install the oil cooler coolant inlet hose (4) to the water outlet.
7. Install the oil cooler coolant inlet hose clamp (3).

Water Outlet Installation

1. Clean the sealing surfaces.



2191835

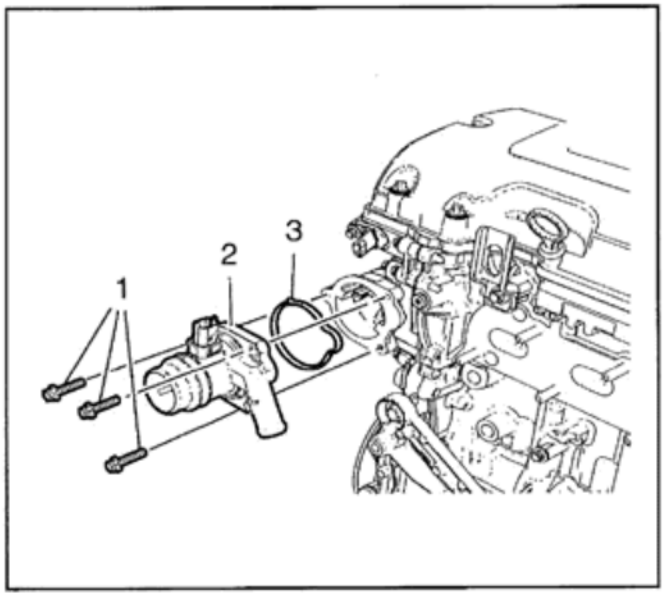
2. Install the water outlet (2) and a NEW water outlet seal ring (1).

Caution: Refer to *Fastener Caution on page 0-8.*

3. Install the 3 water outlet bolts (3) and tighten to **8 N•m (71 lb in).**

Engine Coolant Thermostat Housing Installation

1. Clean the sealing surfaces.



2191834

2. Install the engine coolant thermostat housing (2) and a NEW engine coolant thermostat housing seal ring (3).

Caution: Refer to *Fastener Caution on page 0-8.*

3. Install the 3 engine coolant thermostat housing bolts (1) and tighten to **8 N•m (71 lb in).**

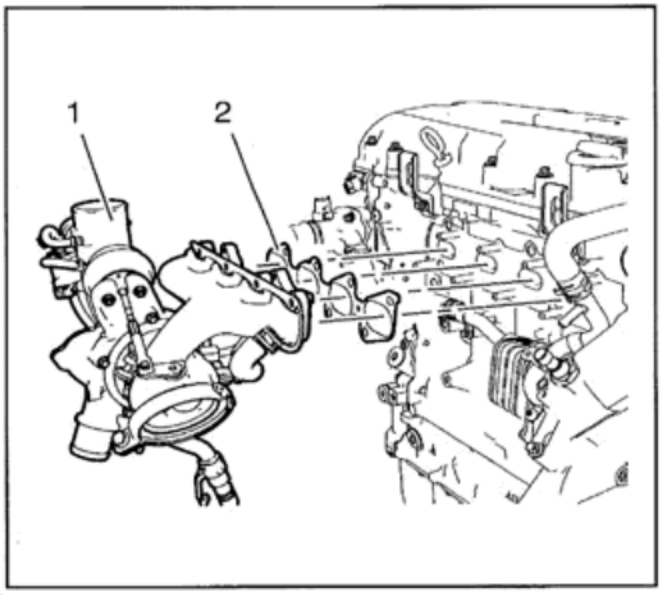
Turbocharger Installation

Special Tool

EN-49942 Holding Wrench

For equivalent regional tools, refer to *Special Tools on page 9-927.*

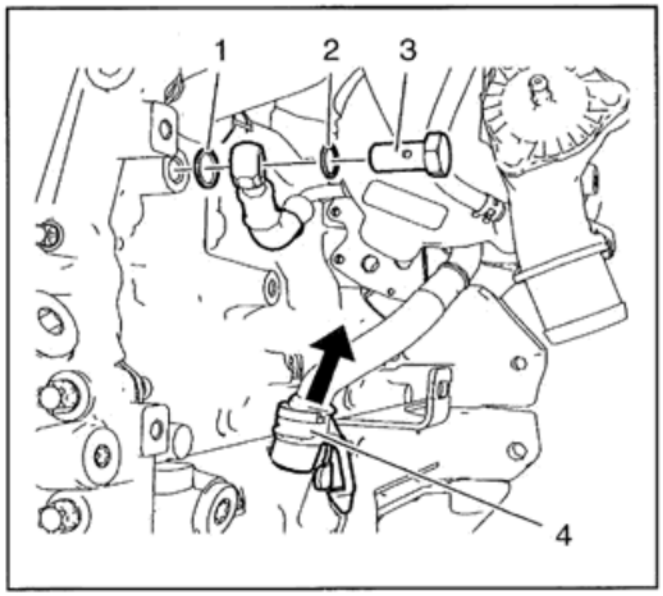
1. Clean the sealing surfaces.
2. Replace the connect fittings on the turbocharger coolant feed pipe and the turbocharger coolant return pipe. Refer to *Turbocharger Disassemble on page 9-894* and *Turbocharger Assemble on page 9-895.*



2190430

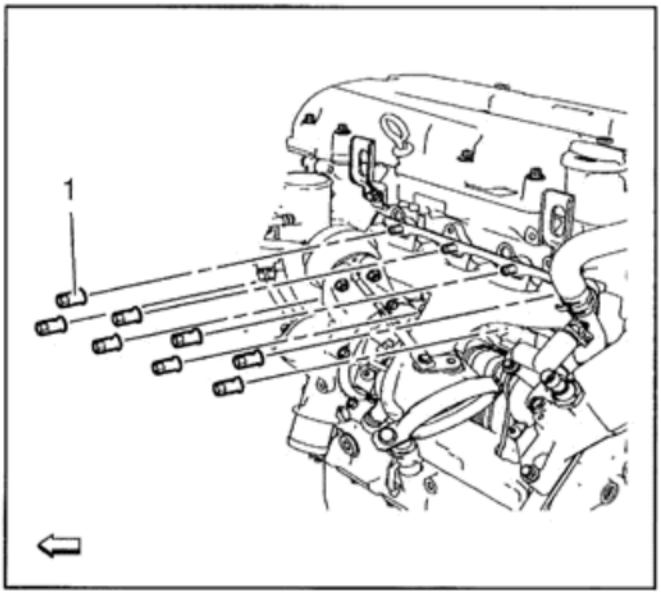
Note: Mind the turbocharger oil return pipe.

3. Install the turbocharger assembly (1) and a NEW turbocharger gasket (2).



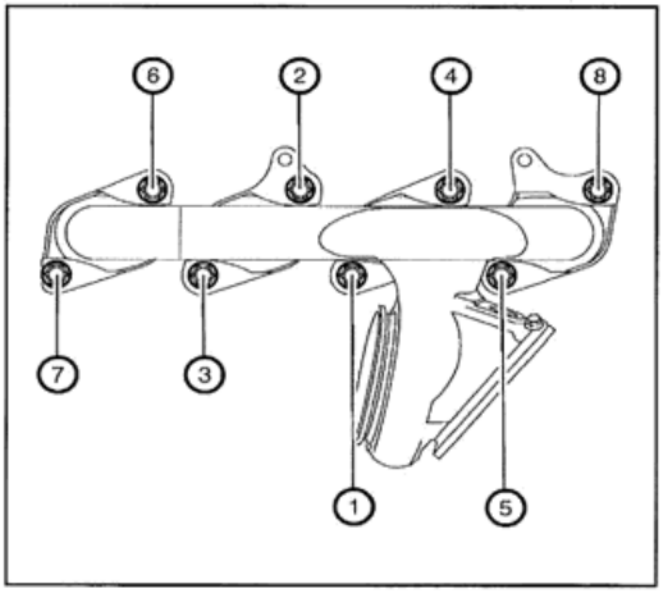
2190427

4. Connect the turbocharger oil return pipe to the engine while installing the turbocharger.
5. Install the turbocharger coolant feed pipe hollow screw along with 2 NEW seal rings (1) and (2).



2192236

6. Install the 8 NEW turbocharger nuts (1).

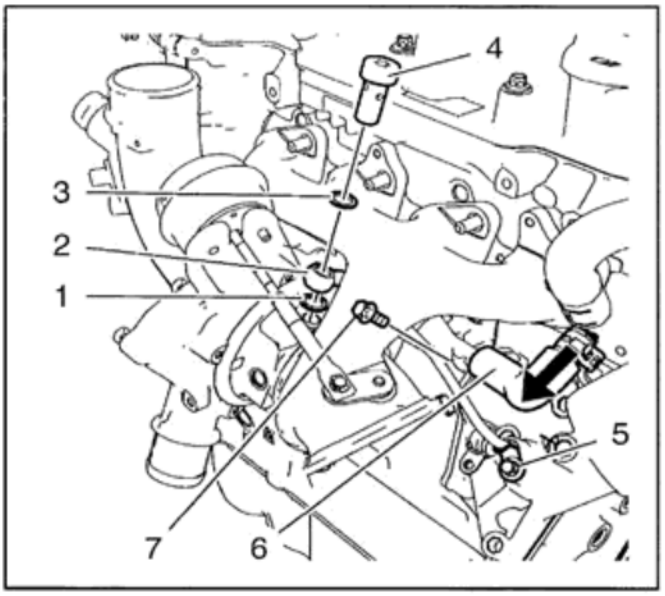


2192286

Caution: Refer to *Fastener Caution on page 0-8*.

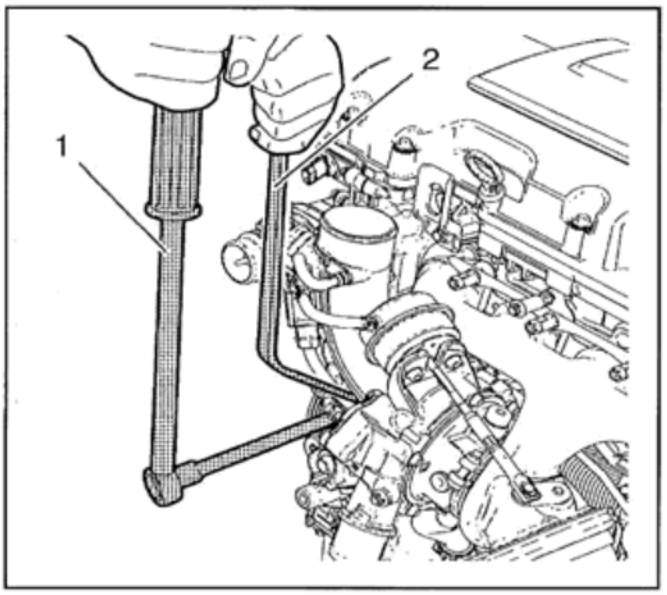
Caution: Refer to *Torque-to-Yield Fastener Caution on page 0-10*.

7. Tighten the 8 turbocharger nuts in a sequence as shown to **8 N•m (71 lb in)**.
8. Repeat the tightening procedure to ensure a proper fastening of the turbocharger nuts.



2190428

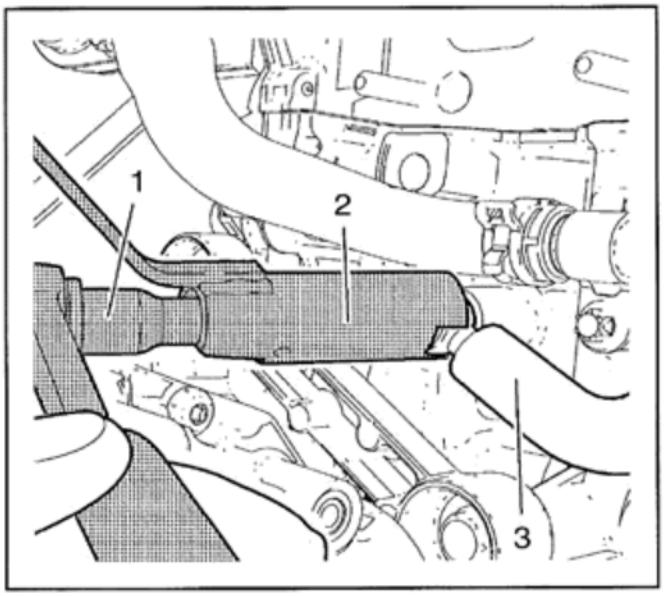
9. Connect the turbocharger coolant return hose (6) to the oil cooler coolant inlet pipe and install the turbocharger coolant return pipe bolt (7) to the oil cooler. Tighten the turbocharger coolant return pipe bolt to **8 N•m (71 lb in)**.
10. Install the turbocharger oil feed pipe (2) along with a NEW rubber seal ring.
11. Install the turbocharger oil feed pipe hollow screw (4) in compound with 2 NEW seal rings (1) and (3).
12. Install the turbocharger oil feed pipe bolt (5) to the oil cooler and tighten to **10 N•m (89 lb in)**.
13. Tighten the turbocharger oil feed pipe hollow screw to **30 N•m (22 lb ft)**.



2192012

Note: The *EN-49942* holding wrench (2) should be installed to turbocharger coolant feed pipe as shown. The holding wrench should be installed to avoid twisting of the turbocharger coolant feed pipe during the fastening procedure.

14. Install the *EN-49942* holding wrench (2) to the turbocharger coolant feed pipe. Guide a ratchet wrench (1) along with an extension through *EN-49942* holding wrench to the turbocharger coolant feed pipe hollow screw.

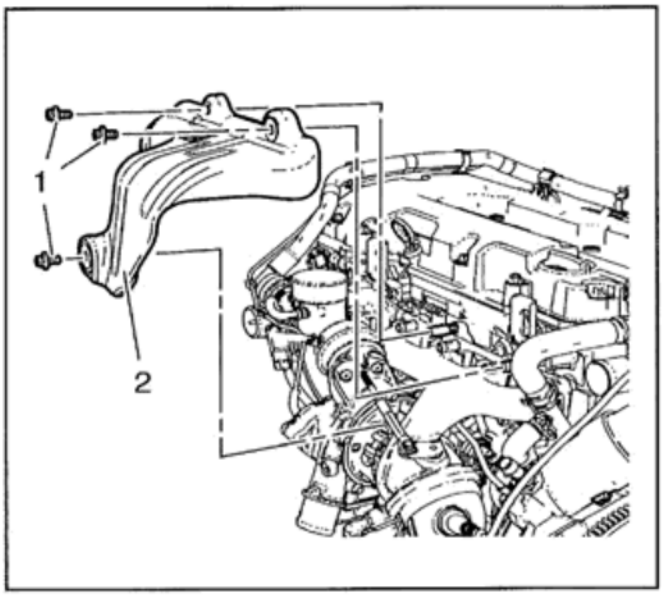


2192009

Note: *EN-49942* holding wrench (2) should be installed to turbocharger coolant feed pipe as shown. The holding wrench should be installed to avoid twist of the turbocharger coolant feed pipe while the fastening procedure.

15. Tighten the turbocharger coolant feed pipe hollow screw with ratchet wrench and extension (1) to **30 N•m (22 lb ft)**.

Exhaust Manifold Heat Shield Installation



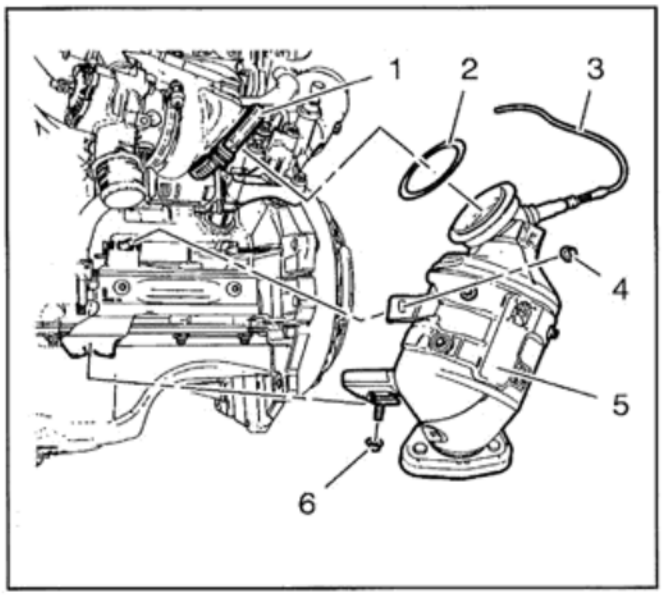
2190424

1. Install the exhaust manifold heat shield (2).

Caution: Refer to *Fastener Caution on page 0-8*.

2. Install the 3 exhaust manifold heat shield bolts (1) and the washers and tighten to **8 N•m (71 lb in)**.

Warm Up Three-Way Catalytic Converter Installation

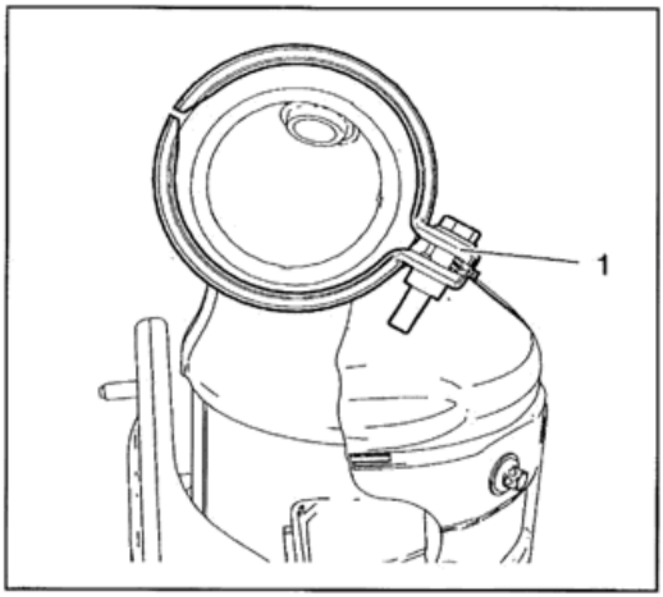


2190423

1. Install the warm up three way catalytic converter (5) to the brackets and the turbocharger. Use a NEW warm up three way catalytic converter seal (2).

Note: Never re-use the V-clamp.

2. Install a NEW warm up three way catalytic converter V-clamp (1).
3. Install the 2 catalytic converter to catalytic converter bracket nuts (4) and (6) and hand tighten.
4. Hand tighten the catalytic converter V-clamp.
5. Connect the heated oxygen sensor wiring harness (3) to retainer clip.



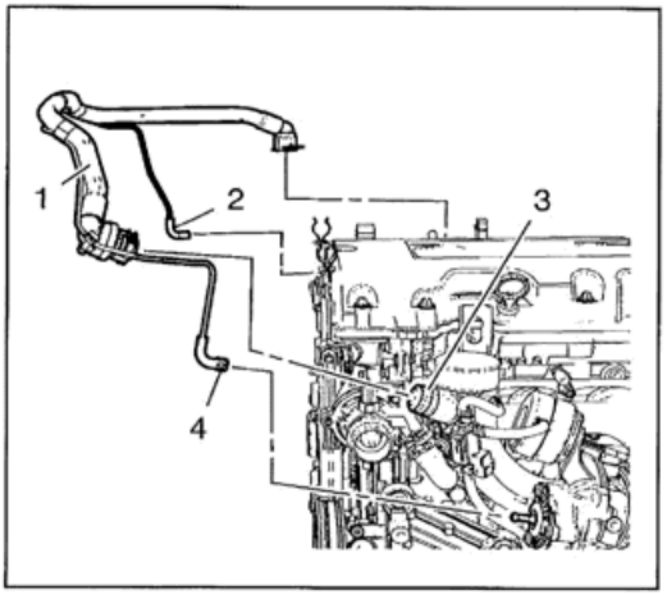
2191860

6. The catalytic converter V-clamp (1) should be installed in the shown position.

Caution: Refer to *Fastener Caution on page 0-8*.

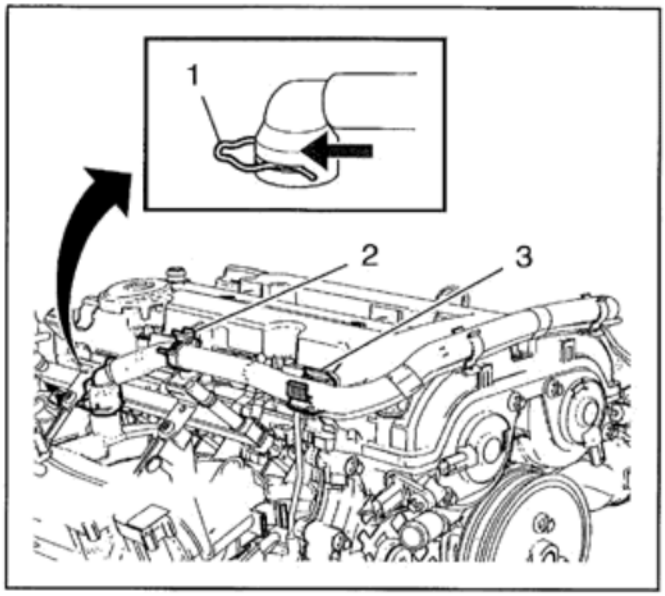
7. Tighten the catalytic converter to catalytic converter bracket nuts to **22 N•m (16 lb ft)**.
8. Tighten the catalytic converter V-clamp to **13 N•m (115 lb in)**.

Positive Crankcase Ventilation Pipe Installation



2190426

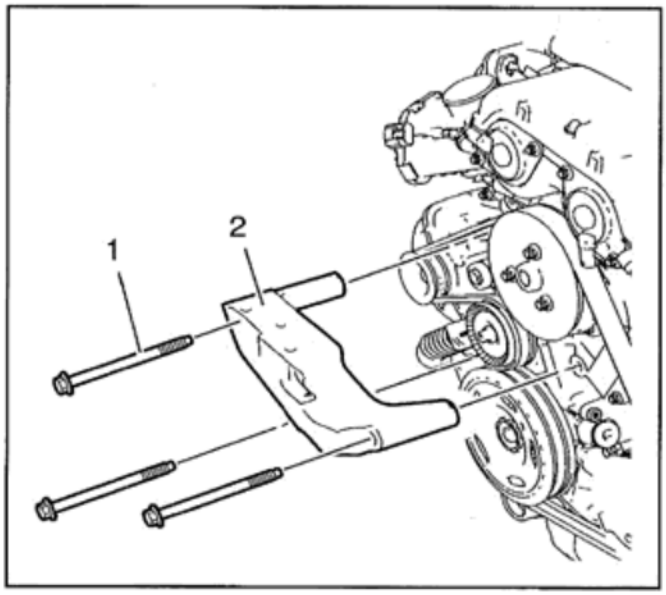
1. Install the positive crankcase ventilation pipe assembly (1) to the camshaft cover retainer clips.
2. Connect the positive crankcase ventilation pipe to turbocharger (3).
3. Install the charger air bypass valve pipe (2) to turbo charger waste regulator solenoid valve.
4. Install the charger air bypass valve pipe to turbocharger.
5. Fasten the charger air bypass valve pipe clamp (4).



2190425

6. Install the positive crankcase ventilation pipe to the intake manifold and fix with retainer clamp (1).
7. Clip in the positive crankcase ventilation pipe to the 2 retainer clips (2) and (3).

Engine Mount Bracket Installation



2190464

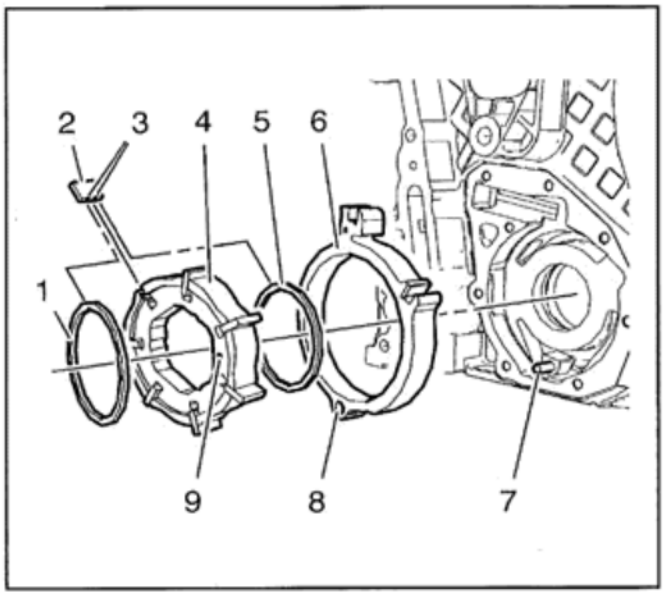
1. Install the engine mount bracket (2).

Caution: Refer to *Fastener Caution on page 0-8*.

2. Install the 3 engine mount bracket bolts and tighten to **60 N•m (45 lb ft) + 45–60°**.

Engine Front Cover and Oil Pump Assemble

Oil Pump Installation



2191079

Note: The oil pump slide spring and pin, as well as the slide seal and slide seal spring can be ordered as single parts. All other oil pump components can only be ordered as a replacement kit.

1. Install the oil pump components in the following order:

Note: The bore (8) in the oil pump slide must fit smooth-running and without clearance to the oil pump slide pivot pin (7).

1.1. Install the oil pump slide (6).

1.2. Install the inner oil pump vane ring (5).

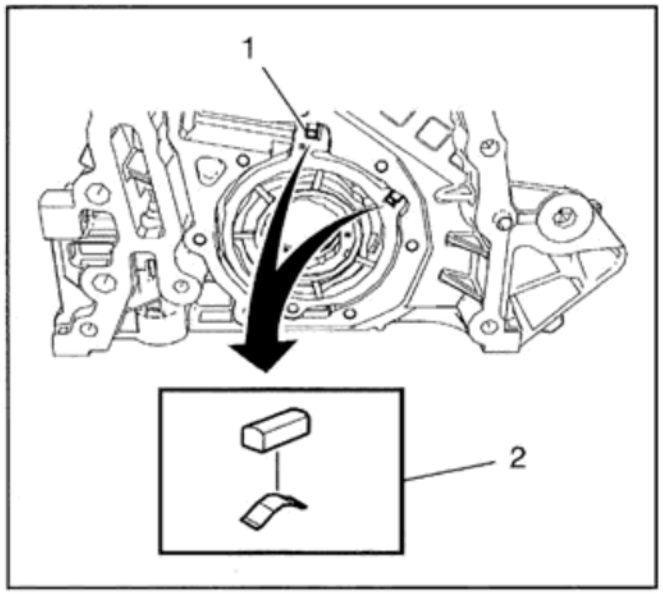
Note: Mind the installation position of the oil pump vane rotor (4). The mark (9) must point to direction of the oil pump cover.

1.3. Install the oil pump vane rotor (4).

Note: Mind the localized flats (3) on the oil pump vanes (2) caused by the oil pump vane rings. The localized flats must point to the oil pump vane rotor.

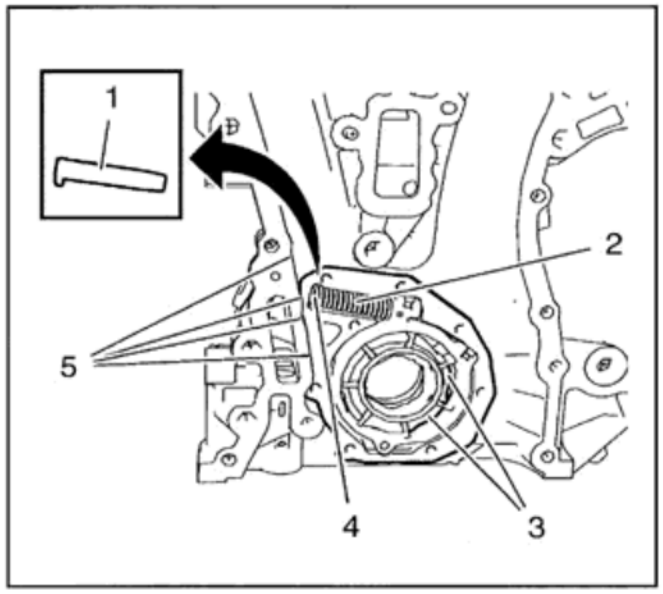
1.4. Install the 6 oil pump vanes (2).

1.5. Install the outer oil pump vane ring (1).



2191049

2. Install the 2 oil pump slide seals and the 2 oil pump slide seal springs (2) in the position as shown to the 2 grooves (1) of the oil pump slide.



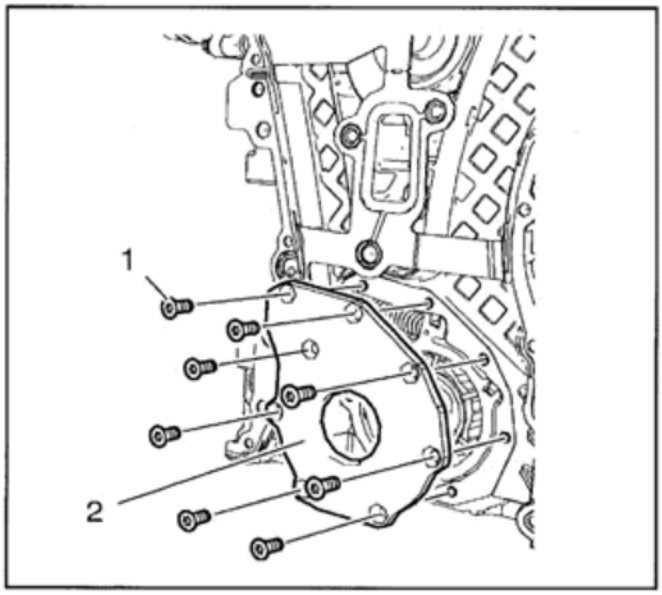
2191052

3. Protect the engine front cover edge (5) with a suitable piece of plastic.

Note: The length of the removed oil pump slide spring (2) should be 76.5 mm (3.0118 in) for suction engines and 61 mm (2.4016 in) for turbo engines.

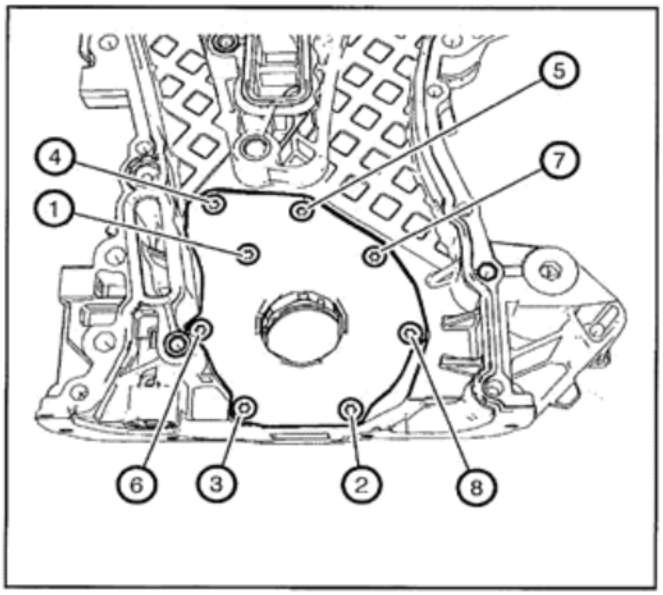
4. Install the oil pump slide spring pin along with the oil pump slide spring (4). Use a screwdriver to compress the oil pump slide spring. The flat side of oil pump slide spring pin must face upwards.

5. Measure the oil pump clearances to ensure a correct installation of the oil pump components. Refer to *Engine Front Cover and Oil Pump Cleaning and Inspection on page 9-892*.
6. Lubricate the oil pump vanes, the oil pump vane rotor, the oil pump slide spring and the area (3) with engine oil.
7. Inspect the oil pump slide spring mechanism for functionality.



2191037

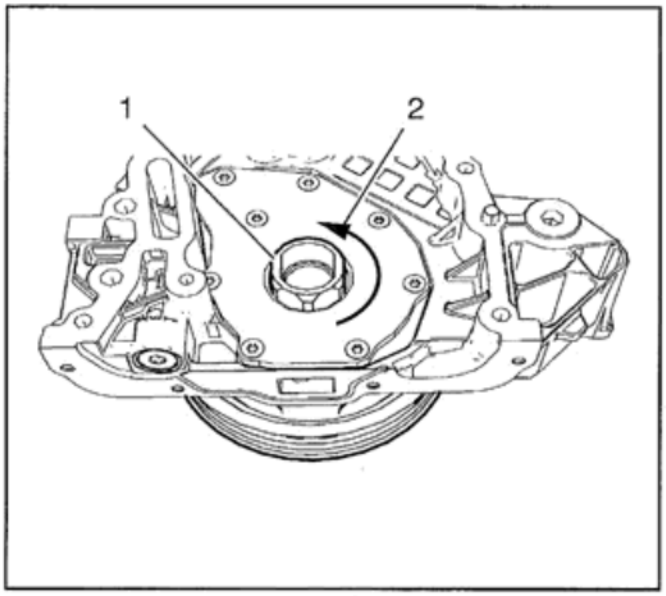
8. Install the oil pump cover (2) and the 8 oil pump cover bolts (1).



2191056

Caution: Refer to *Fastener Caution on page 0-8*.

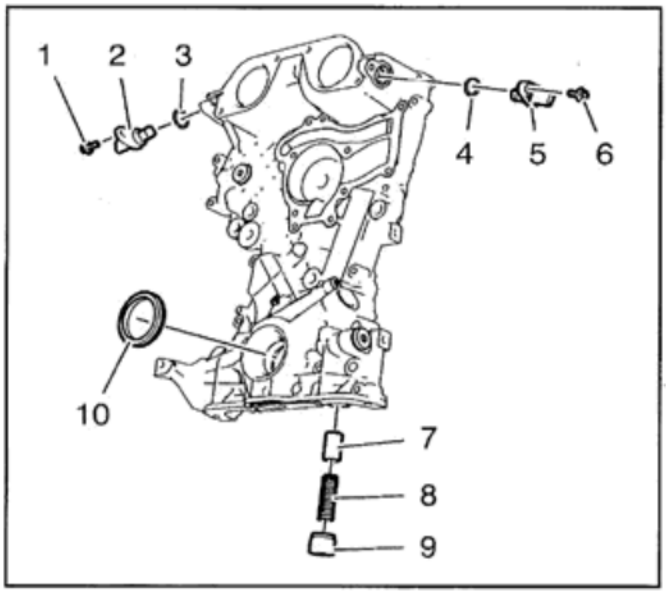
9. Tighten the oil pump cover bolts in a sequence as shown to **8 N•m (71 lb in)**.



2191058

10. Install the crankshaft balancer (1) and rotate in the direction shown (2) in order to inspect the function of the oil pump mechanism. The crankshaft balancer should rotate easily.

Engine Front Cover Assemble



2191036

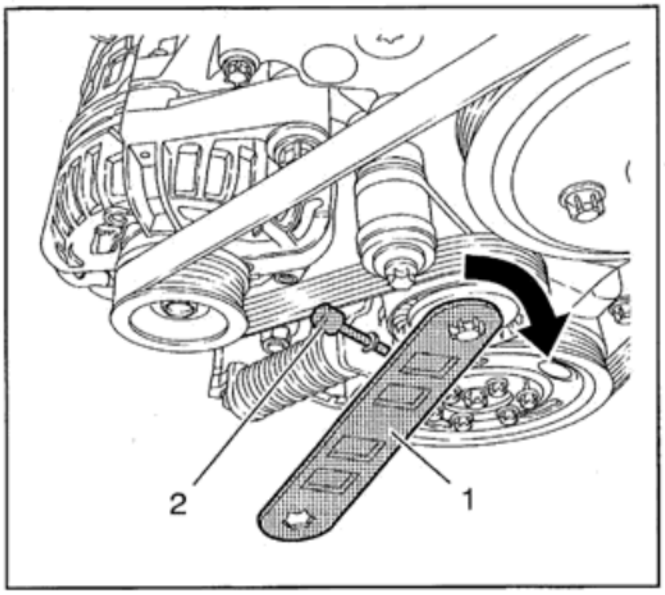
1. Install the crankshaft front oil seal (10).
2. Install the oil pressure relief valve (7), (8) and (9) and tighten to **50 N•m (37 lb ft)**.
3. Install the exhaust camshaft position sensor (5) and the seal ring (4).
4. Install the exhaust camshaft sensor bolt (6) and tighten to **6 N•m (53 lb in)**.
5. Install the intake camshaft position sensor (2) and the seal ring (3).
6. Install the intake camshaft sensor bolt (1) and tighten to **6 N•m (53 lb in)**.

Drive Belt Removal

Special Tools

- *EN-955* Locking Pins
- *EN-48488* Holding Wrench

For equivalent regional tools, refer to *Special Tools on page 9-927*.



2191736

1. Install *EN-48488* wrench (1) to the drive belt tensioner.

Note: The drive belt tensioner must always be in a pre-tensioned state.

2. Move the drive belt tensioner clockwise until the drive belt tensioner can be fixed with the *EN-955–20* locking pin (2).
3. Remove the drive belt.

Engine Block Cleaning and Inspection

Special Tools

EN-8087 Cylinder Bore Gauge

For equivalent regional tool, refer to *Special Tools on page 9-927*.

Cleaning Procedure

1. Remove any old thread sealant, gasket material or sealant.
2. Clean all the following areas with solvent:
   - Sealing surfaces
   - Cooling passages
   - Oil passages
3. Clean all threaded and through holes with solvent.

Warning: Wear safety glasses when using compressed air in order to prevent eye injury.

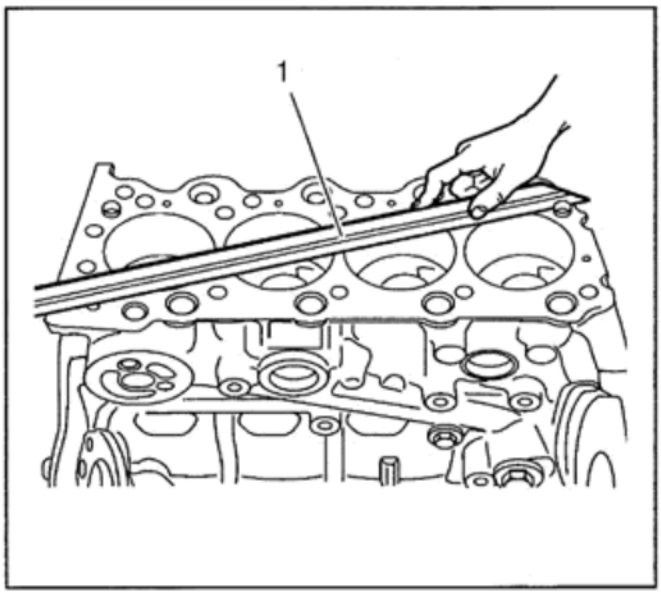
4. Dry the engine block with compressed air.

Visual Inspection

1. Inspect the crankshaft bearings journals for damage or spun bearings. The crankshaft bearing journals are not repairable, if the crankshaft bearing journals are damaged the engine block assembly must be replaced.
2. Inspect all sealing and mating surfaces for damage, repair or replace the engine block assembly if necessary.
3. Inspect all threaded and through holes for damage or excessive debris.
4. Inspect all bolts for damage, if damaged replace with NEW bolts only.
5. Inspect the cylinder walls for cracks or damage. The cylinder sleeves are not serviced separately, if the cylinders are damaged the cylinder block assembly must be replaced.
6. Inspect the engine block for cracks. Do not repair any cracks. If cracks are found, the cylinder block assembly must be replaced.

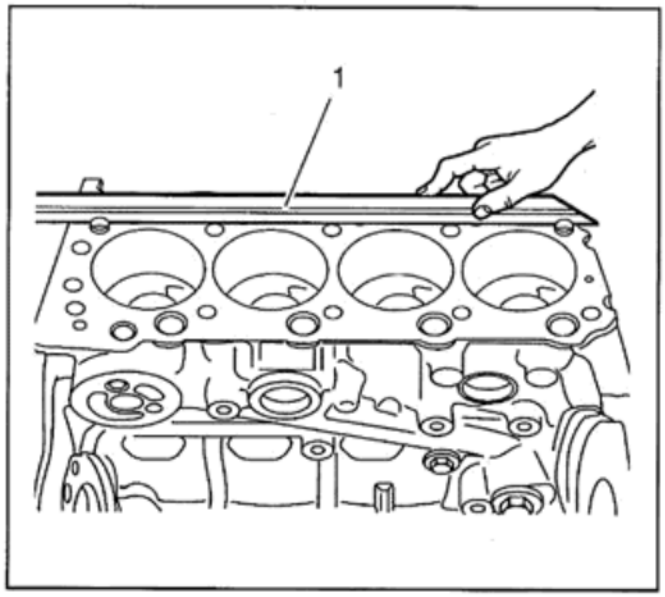
Measuring Procedure

Engine Block Flatness Inspection



2189637

1. Inspect the engine block as shown for distortion. Use a straightedge (1).



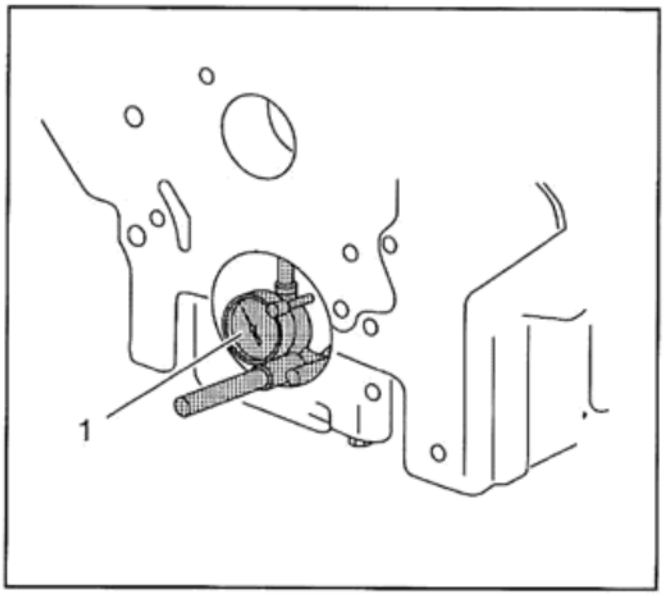
2189636

2. Inspect the engine block as shown for deflection. Use a straightedge (1).

Cylinder bore and crankshaft bearing bore

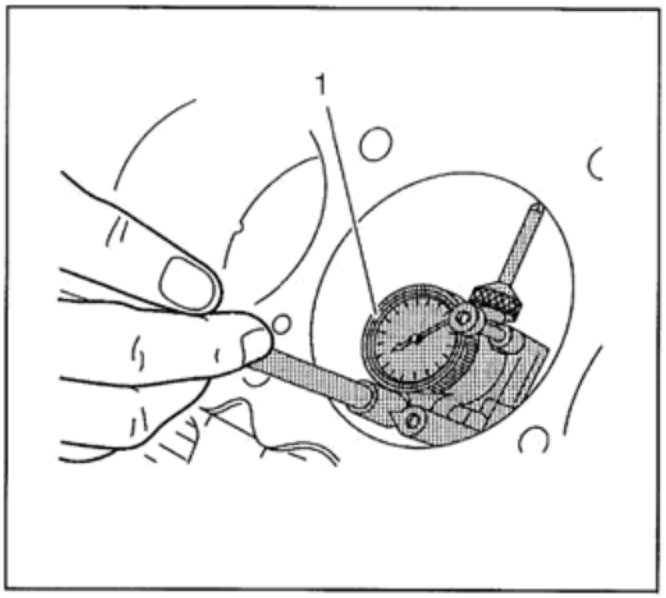
Note: Old bolts can be used for the measuring procedure.

1. Install the crankshaft bearing cap tie plate and tighten.



2026766

2. Inspect the crankshaft main bearing bores. Use the *EN-8087* gauge (1) to measure the bearing bore concentricity and alignment. Refer to *Engine Mechanical Specifications on page 9-756* to find the permitted values.
3. Replace the engine block and crankshaft bearing cap tie plate if the crankshaft bearing bores are out of specification.



2026767

4. Inspect the cylinder bores using the *EN-8087* gauge (1). Inspect for the following items:
   - Wear
   - Taper
   - Runout
   - Ridging
5. Refer to *Engine Mechanical Specifications on page 9-756* to find the permitted values.
6. If the cylinder bores are out of specification, replace the engine block.
7. Remove the crankshaft bearing cap tie plate.

Description and Operation

Engine Component Description

Cylinder Block

The cylinder hollow frame structured in–line 4 cylinder. The block has 5 crankshaft bearings with the thrust bearing located on the third bearing from the front of the engine.

Crankshaft

The crankshaft is a steel crankshaft. It is supported in 5 main journals with main bearings which have oil clearance for lubrication. The 3rd bearing is the thrust bearing which controls the proper axial end play of the crankshaft. A harmonic damper is used to control torsional vibration.

Oil Pump

The engine is equipped with a variable oil pump. The oil pump is integrated into the engine front cover and provides different oil pressure values depending on the engine speed.

Oil Pan

The oil pan is a structural aluminum oil pan with transmission attachment points. The oil suction gallery for the oil pump is integrated into the oil pan.

Piston and Connecting Rod

The pistons are aluminum pistons. The connecting rods are made of fractured steel. The piston pin is floating in piston bore and shrinked in connecting rod.

Cylinder Head

This cylinder head is a double over head camshaft (DOHC) type and has 2 camshafts that open 4 valves per cylinder with hydraulic valve lash adjusters and hydraulic valve lash adjuster arms. The cylinder head is made of cast aluminum alloy for better strength and hardness while remaining light weight. The combustion chamber of the cylinder head is designed for increasing of squish and swirl efficiency to help maximize gasoline combustion efficiency.

Camshaft Drive with Variable Camshaft Timing

A timing chain is used for camshaft drive. There is a tensioner to control the tension of the chain. The engine is equipped with a variable camshaft timing system. The camshaft adjuster will readjust itself depending on the engine speed. The valve timing readjusts to reduce fuel consumption and provide optimal power and torque.

Intake Manifold

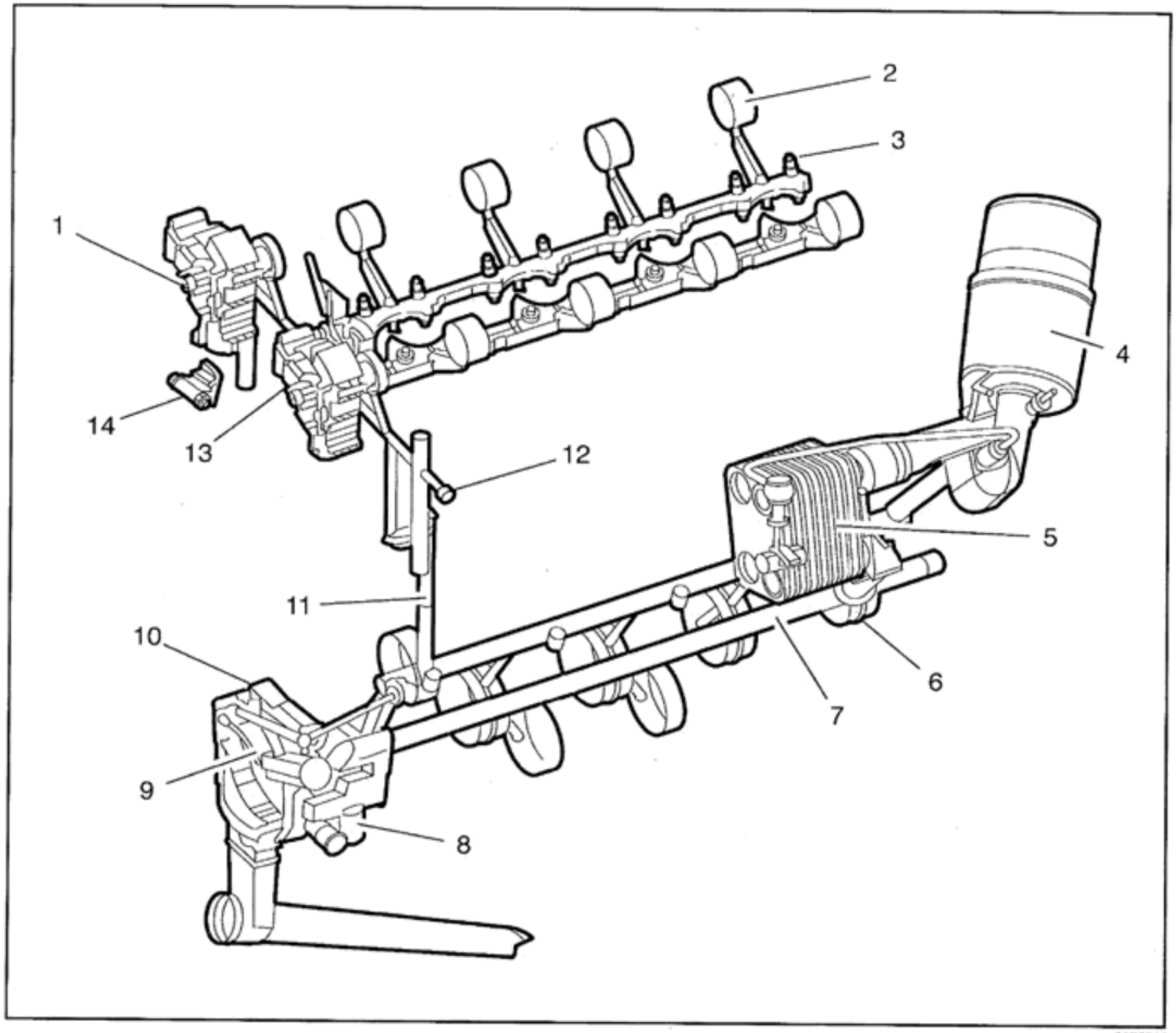
The intake manifold provides the air flow passage to the combustion chambers through the throttle body. The intake manifold along with the throttle body have an effect on engine torque, power, noise, driveability, emission, fuel economy and performance. The intake manifold is made of plastic for better strength with maintaining a light weight.

Turbocharger

The turbocharger consists of turbine and compressor on a common shaft. The shaft bearing is constructed to higher rotation speed and lubricated by engine oil. The turbocharger is water cooled for improved durability. The turbine wheel is driven by exhaust emissions. The compressor wheel compresses the intake air. A bypass valve (Wastegate) regulates the charging pressure for generating a high pressure at low speed as well. At a defined charging pressure it regulates the way of the exhaust emission on bypassing the turbine wheel. The Wastegate valve is controlled pneumatic and electric from the pressure in the intake manifold. The pressure of exhaust emission is reduced by opening the Wastegate thereby reducing the intake pressure.

Lubrication Description

General Lubrication Description



2372786

Oil is applied under pressure to the crankshaft bearings (6), connecting rod bearings (7), camshaft bearings (2) and hydraulic lash adjusters (3). In addition the variable oil pump (9), variable camshaft phaser (1), and hydraulic chain tensioner (14) are supplied with pressurized oil. Oil is sucked from the oil pan through the fixed screen into the variable vane type oil pump. The pump is integrated in the front cover and directly driven by the crankshaft. Also integrated into the front cover is a pressure relieve valve (8) that opens when the oil pressure is too high at a cold start. When that valve is open some oil flows directly into the oil pan. Normally the pressurized oil passes into the engine oil gallery leading through the oil cooler (5) to the oil filter assembly (4). The oil is cleaned by passing the filter from the outer to the inner side of the filter. Then the oil flows into the main oil gallery. A filter by-pass valve in the oil filter ensures continues oil flow in case the oil filter should be restricted by more than 1.7 bar. From the oil filter the oil is distributed to the crankshaft bearings, oil pump displacement control chamber (10) and cylinder head feed (11). The connecting rod bearings are supplied by oil flow passages through the crankshaft connecting the main journals to the rod journals. A groove around each upper main bearing furnishes oil to the drilled crankshaft passages. In the cylinder head the oil is distributed to the variable camshaft phasers, chain tensioner, oil pressure switch (12) and through the restrictor orifice (13) into the camshaft feed oil gallery. From there the hydraulic valve lifters and camshaft bearings are supplied with oil.

Variable Oil Pump Description

The engine is equipped with a variable displacement vane oil pump. It is indirect regulated by the oil pressure out of the main oil gallery. The purpose of this indirect regulation is to keep a defined maximum pressure in the main oil gallery independent of the individual pressure drop between the pump outlet, the main gallery inlet, and the various engine components. The purpose of the variable displacement is to reduce the power consumption of the pump to reduce the overall fuel consumption of the engine. The oil flow of a static displacement oil pump is linear to the speed of the pump. This would lead to a too high oil pressure after a certain engine speed (ca. 1000 rpm at cold oil temperature, ca. 3000 rpm at hot oil temperatures). To reduce that high oil pressure normal pumps have a relieve valve: a portion of the pressurized, already pumped oil is fed back to the intake of the pump. This is waste of power. The oil flow of a Variable Displacement Vane Pump (VDVP) as used in Fam 0 Gen 3 is linear to the speed and to the excentricity of the rotor to the slide. The slide is moveable, so it is possible to reduce the oil flow for a given speed by reducing the excentricity. With a lower flow the oil pressure is reduced; pump oil flow equals now engine oil flow.

Cleanliness and Care

An automobile engine is a combination of many of the following surfaces:

- Machined
- Honed
- Polished
- Lapped

The tolerances of these surfaces are measured in the ten-thousandths of an inch. When you service any internal engine part, cleanliness and care are important. Apply a liberal coating of engine oil to the friction areas during assembly in order to protect and lubricate the surfaces on initial operation. Throughout this section, practice proper cleaning and protection procedures to the machined surfaces and to the friction areas.

Whenever you remove the valve train components, keep the components in order. Follow this procedure in order to install the components in the same locations and with the same mating surfaces as when removed.

Warning: Refer to Battery Disconnect Warning on page 0-4.

Disconnect the negative battery cables before you perform any major work on the engine.

Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant

Pipe Joint Compound

Note: Three types of sealer are commonly used in engines. These are RTV sealer, anaerobic gasket eliminator sealer, and pipe joint compound. The correct sealer and amount must be used in the proper location to prevent oil leaks. DO NOT interchange the 3 types of sealers. Use only the specific sealer or the equivalent as recommended in the service procedure.

- Pipe joint compound is a pliable sealer that does not completely harden. This type sealer is used where 2 non-rigid parts, such as the oil pan and the engine block, are assembled together.
- Do not use pipe joint compound in areas where extreme temperatures are expected. These areas include: exhaust manifold, head gasket, or other surfaces where gasket eliminator is specified.
- Follow all safety recommendations and directions that are on the container. To remove the sealant or the gasket material.
- Apply the pipe joint compound to a clean surface. Use a bead size or quantity as specified in the procedure. Run the bead to the inside of any bolt holes. Do not allow the sealer to enter any blind threaded holes, as it may prevent the bolt from clamping properly.
- Apply a continuous bead of pipe joint compound to one sealing surface. Sealing surfaces to be resealed must be clean and dry.
- Tighten the bolts to specifications. Do not overtighten.

Special Tools and Equipment

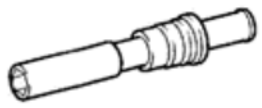
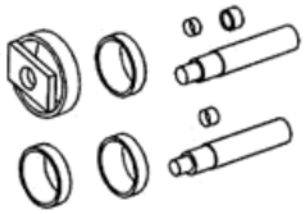
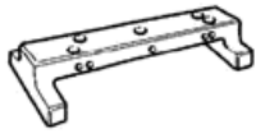
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 2546662	EN-235–D KM-235–D Seal Installer Kit
 2190203	EN-301 KM-301 Measuring Bridge
 1282416	EN-470–B KM-470–B J–45059 Angular Torque Wrench
 1644744	EN-498–B KM-498–B Pressure Gauge

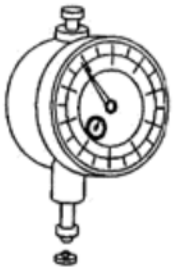
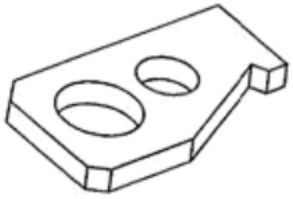
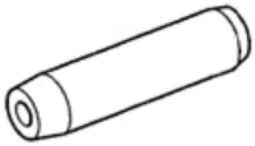
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 1938128	EN-652 DT-652 KM-652 Flywheel Holder
 2750538	EN-658 KM-658 J-35264 Installer
 2026921	EN-663 KM-663 Installer
 1940941	EN-796–A KM-796–A Remover Quick Fitting

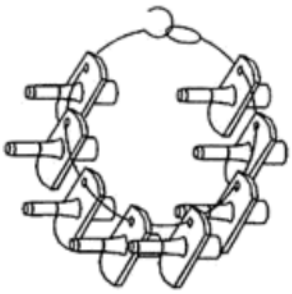
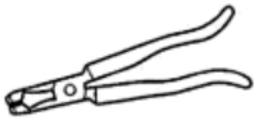
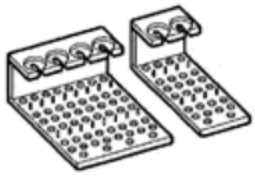
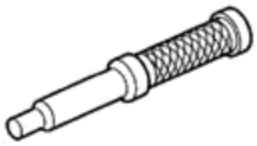
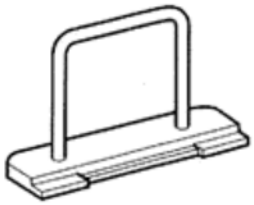
Illustration	Tool Number/Description
 1941086	CH-807 KM-807 Plugs
 2026925	EN-840 KM-840 Pliers / Remover
 2026927	EN-849 KM-849 Assembly Tray
 2191098	EN-952 KM-952 Fixing Tool Crankshaft
 2191099	EN-953–A Fixing Tool Camshaft

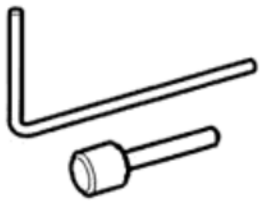
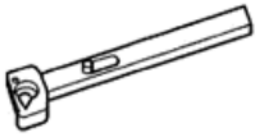
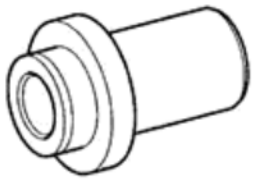
Illustration	Tool Number/Description
 2882903	EN-955 KM-955 Locking Pins
 2026928	EN-956–1 KM-956–1 Extension
 2191101	EN-960 KM-960 Installer
 2028332	EN-6015 KM-6015 Closure Plugs
 2191921	EN-45000 KM-J45000 J-45000 Remover Oil Seal

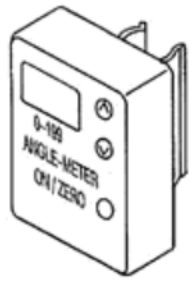
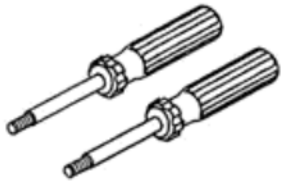
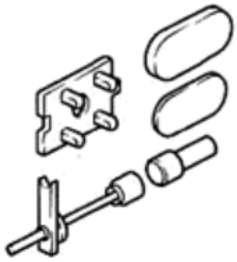
Illustration	Tool Number/Description
 1197696	EN-45059 Angle Meter
 1936461	EN-6009 KM-6009 Remover / Installer
 1937998	EN-6086 MKM-6086 Basic Kit, Spring and Wedge Replacer
 2026885	EN-6167 KM-6167 Adapter Kit
 2026933	EN-6171 KM-6171 Release Tool

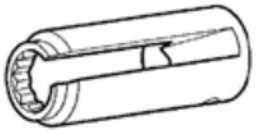
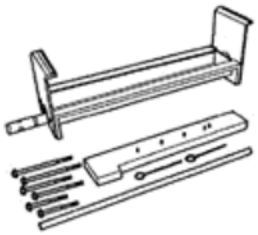
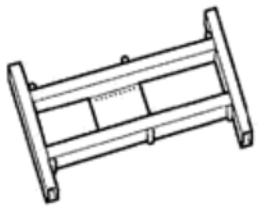
Illustration	Tool Number/Description
 2191102	EN-6179 KM-6179 Installer / Remover
 2026932	EN-6215 KM-6215 Mounting Equipment
 1936492	EN-34730–91 KM-34730–91 J-34730–91 Pressure Tester
 1844742	EN-48248 Cylinder Compression Pressure Gauge
 2028223	CH-904 Base Frame

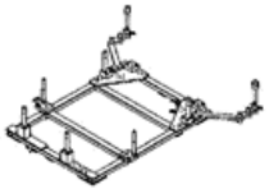
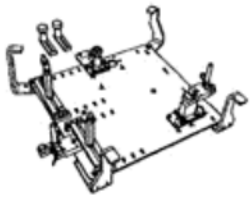
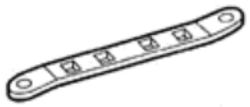
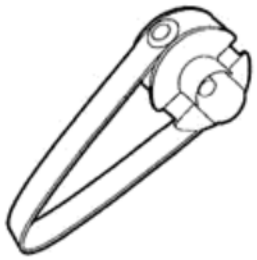
Illustration	Tool Number/Description
 2019089	CH-49289 Centering Frame
 2028289	CH-49290 Engine Support Tool
 2191920	EN-48488 KM-956 Holding Wrench
 2191916	EN-49940 Remover Quick Connector
 2191915	EN-49941 Remover / Installer Piston Retainer Ring

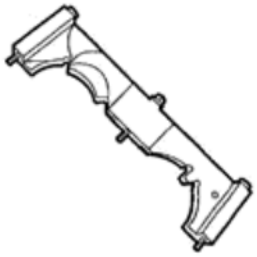
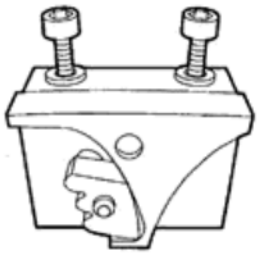
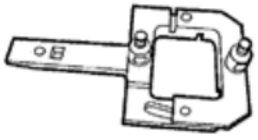
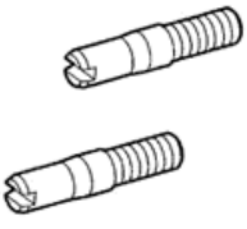
Illustration	Tool Number/Description
 2191917	EN-49942 Holding Wrench
 2191924	EN-49977–100 Fixation Sensor Disks and Camshafts
 2191925	EN-49977–200 Fixing Tool
 2191926	EN-49979 Retainer Shock Mount Crankshaft
 2191941	EN-49980 Guidance Pins Oil Pan

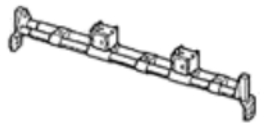
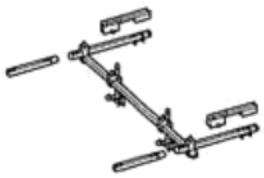
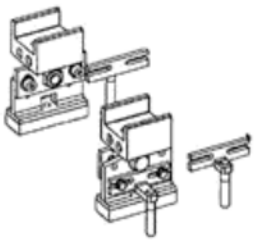
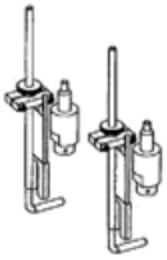
Illustration	Tool Number/Description
 2019126	EN-47649 Engine Bridge
 2019127	EN-47650 Retainer Frame

Illustration	Tool Number/Description
 2027945	EN-47650–300 Adapter
 2027944	EN-47650–200 Front Adapter