ENGINE
02

CONTENTS

page

1.6L & 1.8L Engine Mechanical **02-1**

2.0L Engine Mechanical **02-76**

2.4L Engine Mechanical **02-149**

1.6L & 1.8L ENGINE MECHANICAL

GENERAL INFORMATION 02-3
- Description 02-3
- Operation 02-3
- Specifications 02-3
- Special Tools 02-7
- Lubrication System 02-10

DIAGNOSIS & TESTING 02-13
- Engine Performance Diagnostics 02-13
- Engine Mechanical Diagnostics 02-14
- Cylinder Compression Pressure Test 02-16
- Cylinder Head Gasket Test 02-16

ON-VEHICLE SERVICE 02-17

Accessory Drive Belt 02-17
- Removal & Installation 02-17

Air Cleaner Element 02-18
- Removal & Installation 02-18

Air Cleaner Housing 02-18
- Removal & Installation 02-18

Cylinder Head Cover 02-19
- Removal & Installation 02-19

Camshaft 02-20
- Removal & Installation 02-20

Cylinder Head 02-23
- Removal & Installation 02-23

Front Crankshaft Oil Seal 02-25
- Removal & Installation 02-25

Rear Crankshaft Oil Seal 02-27
- Removal & Installation 02-27

Engine Mounts 02-29
- Removal & Installation - Left Mount 02-29
- Removal & Installation - Right Mount 02-30
- Removal & Installation - Front Mount 02-30
- Removal & Installation - Rear Mount 02-31

Engine Assembly 02-31
- Removal & Installation 02-31

Engine Timing Belt 02-38
- Removal & Installation 02-38

Exhaust Manifold 02-41
- Removal & Installation 02-41

Intake Manifold 02-43
- Removal & Installation 02-43

Idler Pulley 02-45
- Removal & Installation 02-45

Oil Filter 02-46
- Removal & Installation 02-46

Oil Pan 02-47
- Removal & Installation 02-47

Oil Pump 02-48
- Removal & Installation 02-48

Oil Strainer 02-49
- Removal & Installation 02-49

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ENGINE UNIT REPAIR 02-50

Engine Block 02-50
- Specifications 02-50
- Disassembly 02-50
- Inspection 02-52
- Assembly 02-52

Pistons 02-53
- Specifications 02-53
- Disassembly 02-54
- Inspection 02-55
- Assembly 02-57

Connecting Rods 02-58
- Specifications 02-58
- Disassembly 02-58
- Inspection 02-59
- Assembly 02-59

Crankshaft 02-60
- Specifications 02-60
- Disassembly 02-60
- Inspection 02-61
- Assembly 02-62

CYLINDER HEAD UNIT REPAIR 02-63

Cylinder Head 02-63
- Specifications 02-63
- Disassembly 02-63
- Inspection 02-65
- Assembly 02-65

Camshaft 02-66
- Specifications 02-66
- Disassembly 02-67
- Inspection 02-67
- Assembly 02-69

Valve & Valve Guides 02-70
- Specifications 02-70
- Disassembly 02-70
- Inspection 02-71
- Assembly 02-72

Valve Springs 02-73
- Specifications 02-73
- Disassembly 02-73
- Inspection 02-74
- Assembly 02-75

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GENERAL INFORMATION

Description

The 1.6L & 1.8L in-line four cylinder engines have the following features:

- Dual overhead camshafts
- Four valves per cylinder
- Aluminum cylinder head
- Cast iron cylinder block (1.8L Engine)
- Aluminum cylinder block (1.6L Engine)

Operation

The 1.6L & 1.8L engines utilize 4 valve-per-cylinder and a dual overhead camshaft design. The engines use an individual coil ignition system. The 1.6L engine uses an aluminum cylinder block, and the 1.8L engine is made of cast iron. The bearing caps are integrated into the lower cylinder block assembly. An aluminum oil pan bolts to the bottom of the lower cylinder block. The camshafts are mounted in the cylinder head and act against valve tappets to open and close the valves. The camshafts are driven off the front of the cylinder head by one timing belt. The belt is driven by a sprocket that is located on the crankshaft. The piston assembly is an aluminum piston with a cast iron connecting rod.

The aluminum cylinder head contains dual overhead camshafts with 4 valve-per-cylinder construction. The valves are arranged in two in-line banks. The cylinder head incorporates powdered metal valve guides and seats. The cylinder head is sealed to the block using a multi-layer steel head gasket and retaining bolts.

Specifications

1.6L Engine Specifications

DESCRIPTION	SPECIFICATION
Type	In-Line OHV, DOHC
Number of Cylinders	4
Compression Ratio	10.5:1
Compression Pressure	10 - 15 bar
Max. Compression Pressure Variation Between Cylinders	25%
Stroke	77.5 mm
Bore	81 mm
Displacement	1597 cc
Firing Order	1-3-4-2

1.8L Engine Specifications

DESCRIPTION	SPECIFICATION
Type	In-Line OHV, DOHC
Number of Cylinders	4
Compression Ratio	10.5:1
Compression Pressure	10 - 15 bar
Max. Compression Pressure Variation Between Cylinders	25%
Stroke	89.5 mm
Bore	81 mm
Displacement	1845 cc
Firing Order	1-3-4-2

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Mechanical Specifications

DESCRIPTION	ITEM	STANDARD	LIMIT
Engine Oil Pressure	Lower Idle Speed (800 ± 50 RPM)	1.2 - 1.5 bar	-
	High Idle Speed (2000 RPM)	3.2 - 3.5 bar	-
	High Speed (4000 RPM)	3.7 ± 0.5 bar	-
Engine Block Clearance	Surface Distortion	-	0.15 mm
	Inner Diameter	81.000 - 81.010 mm	-
	Out-Of-Round	-	< 0.008 mm
	Taper	-	< 0.01 mm
Piston Ring Groove Clearance	First Ring	0.04 - 0.08 mm	-
	Second Ring	0.0251 - 0.01 mm	-
Piston Ring End Gap Clearance	First Ring	0.2 - 0.4 mm	0.8 mm
	Second Ring	0.4 - 0.6 mm	1.0 mm
Piston To Piston Pin Clearance	-	0.002 - 0.013 mm	-
Piston Diameter	-	80.946 - 80.964 mm	-
Ring Groove Clearance	First Ring	0.04 - 0.08 mm	-
	Second Ring	0.01 - 0.0251 mm	-
Connecting Rod Radial Clearance	-	0.016 - 0.051 mm	-
Connecting Rod Axial Clearance	-	0.002 - 0.013 mm	-
Diameter Of Crankshaft Main Journals	-	53.981 - 54 mm	-
Diameter Of Crankshaft Rod Journals	-	47.884 - 47.9 mm	-
Out-Of-Round Maximum Of Crankshaft Main Journals	-	-	< 0.008 mm
Axial Clearance Of Crankshaft	-	0.07 - 0.265 mm	-
Radial Clearance Of Crankshaft	-	0.0035 - 0.034 mm	-
Coaxality Crankshaft Main Journal	-	-	< 0.005 mm
Thrust Washer Thickness	-	2.4 - 2.405 mm	-
Oil Clearance Of Crankshaft Rod and Main Journals	-	0.022 mm	0.058 mm
Cylinder Head Flatness	-	-	< 0.04 mm
Intake Valve Deflection	-	-	< 0.02 mm
Exhaust Valve Deflection	-	-	< 0.04 mm
Spring Height	-	47.7 mm	-
Spring Height At 620 Newtons Of Pressure	-	32.0 mm	-

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DESCRIPTION	ITEM	STANDARD	LIMIT
Intake Cam Lobe Height	-	37.15 mm	-
Exhaust Cam Lobe Height	-	37.05 mm	-
Camshaft Journal #1 Outer Diameter	-	31.934 - 31.95 mm	-
Camshaft Journal #2, #3, #4, #5, Outer Diameter	-	23.947 - 23.96 mm	-
Camshaft Cam Bearing #1 Inner Diameter	-	32 - 32.025 mm	-
Camshaft Cam Bearing #2, #3, #4, #5, Inner Diameter	-	24 - 24.021 mm	-
Camshaft Journal #1 Clearance	-	0.05 - 0.091 mm	-
Camshaft Journal #2, #3, #4, #5 Clearance	-	0.04 - 0.074 mm	-
Intake Camshaft Axial Clearance	-	0.15 - 0.20 mm	-
Exhaust Camshaft Axial Clearance	-	0.15 - 0.20 mm	-
Intake Valve Guide Clearance	-	0.012 - 0.043 mm	-
Exhaust Valve Guide Clearance	-	0.032 - 0.063 mm	-
Valve Outer Diameter	Intake Valve	5.98 ± 0.008 mm	-
	Exhaust Valve	5.96 ± 0.008 mm	-
Valve Guide Inner Diameter	Intake Valve	5.4 ± 0.1 mm	-
	Exhaust Valve	5.4 ± 0.1 mm	-
Fringe Thickness On Top Of Valve	Intake Valve	0.3 ± 0.15 mm	-
	Exhaust Valve	0.3 ± 0.15 mm	-
Valve Tilt Angle	Intake Valve	65°	-
	Exhaust Valve	68°	-
Valve Height	Intake Valve	107.998 mm	-
	Exhaust Valve	106.318 mm	-

Torque Specifications

CAUTION:
When torquing a fastener in two steps, DO NOT use a torque wrench for the second step.

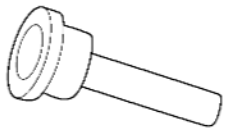
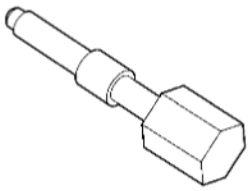
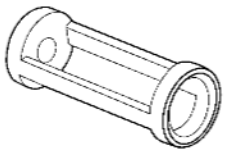
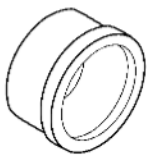
DESCRIPTION	TORQUE (N·m)
Accessory Drive Belt Tensioner Pulley Bolt	35
Camshaft Bearing Cap Bolts	11
Clutch Pressure Plate Bolts	25
Connecting Rod Cap Bolts	1st Step: Tighten the bolts to 25 N·m 2nd Step: Tighten the bolts an additional 90°
Crankshaft Holder	28
Crankshaft Main Bearing Cap Bolts	1st Step: Tighten the bolts to 45 N·m 2nd Step: Tighten the bolts an additional 180°

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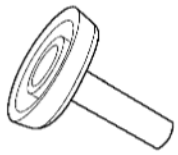
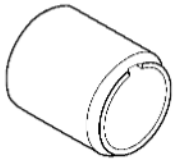
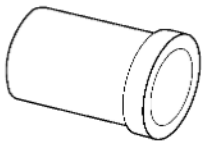
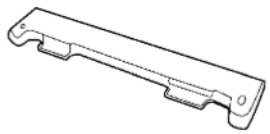
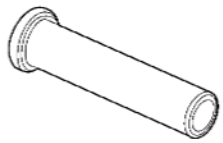
DESCRIPTION	TORQUE (N·m)
Crankshaft Timing Belt Pulley Bolt	1st Step: Tighten the bolt to 130 N·m 2nd Step: Tighten the bolt an additional 65°
Crankshaft Vibration Damper Bolts	25
Cylinder Head Cover Bolts	11
Cylinder Head Bolts	1st Step: Tighten the bolt to 40 ± 5 N·m 2nd Step: Tighten the bolt an additional 90 ± 5° 3rd Step: Tighten the bolt an additional 90 ± 5°
Dipstick Bracket Bolts	11
Drive Plate Bolts (automatic transaxle)	75
Engine Left Mount Bolt	70
Engine Right Mount Bolt	70
Engine Front Mount Bolt	60
Engine Rear Mount Bolt	60
Engine To Transaxle Bolts	80
Exhaust Manifold Nuts	25
Exhaust Manifold Heat Shield Bolts	15
Exhaust Camshaft Timing Belt Pulley Bolt	120
Flywheel Bolts (manual transaxle)	75
Fuel Rail Bracket Bolts	11
Idler Pulley Bolt	40
Intake Camshaft Timing Belt Pulley Bolt	120
Intake Manifold Bolts	10
Intake Manifold Nuts	11
Intake Manifold Bracket Bolts	25
Lower Idler Pulley Bolt	45
Lower Cylinder Block Bolts	23
Oil Filter	25
Oil Pan Bolts	18
Oil Drain Plug	40
Oil Strainer Bolts	18
Oil Pump Bolts	11 (Apply with Loctite 5910 Thread-Locker)
Rear Timing Cover Bolts	7
Timing Belt Upper Cover Bolts	11
Timing Belt Lower Cover Bolts	11
Timing Belt Tensioner Assembly	27
Timing Belt Tensioner Pulley Bolt	30
Throttle Body Bolts	11
Upper Idler Pulley Bolt	45

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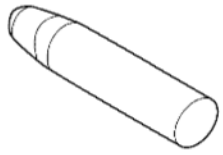
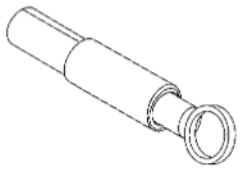
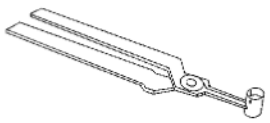
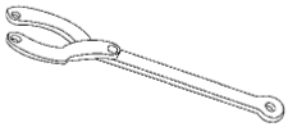
Special Tools

Right Engine Mount Bolt Remover CH-20001	 besm020079
Camshaft Seal Installer CH-20002	 besm020001
Crankshaft Holder CH-20003	 besm020009
Valve Spring Compressor Adaptor CH-20004	 besm020080
Rear Crankshaft Oil Seal Installer CH-20005	 besm020003

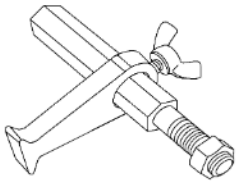
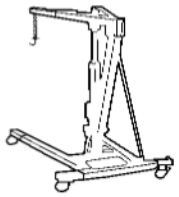
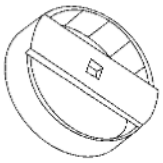
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Rear Crankshaft Oil Seal Guide CH-20006	 besm020002
Front Crankshaft Seal Installer CH-20007	 besm020004
Front Crankshaft Seal Guide CH-20008	 besm020005
Camshaft Holder CH-20010	 besm020008
Valve Seal Installer CH-20011	 besm020081

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Valve Stem Seal Installer Guide CH-20012	 besm020006
Valve Seal Remover CH-20013	 besm020082
Valve Keeper Installer CH-20017	 besm020084
Valve Spring Compressor CH-20018	 besm020007
Crankshaft Belt Pulley Fixture CH-20019	 besm020085

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Flywheel Fixture CH-20043	 ltsm020211
Engine Hoist	 besm020010
Oil Filter Remover CH-10003	 besm020087

Lubrication System

The engine lubrication system operates as follows:

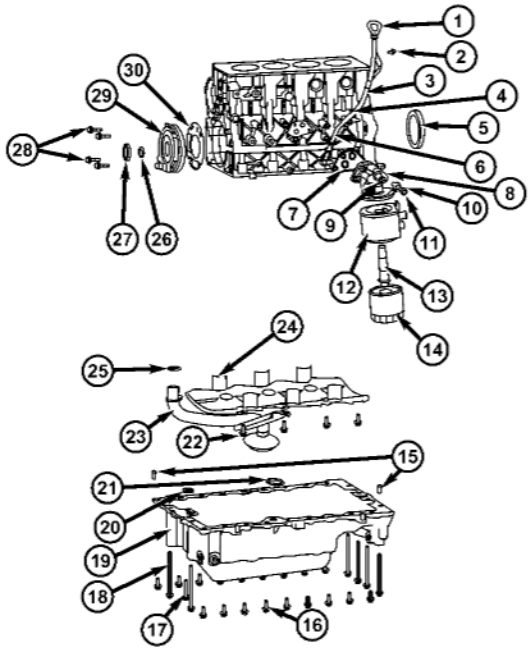
- Oil is drawn into the oil pump through the oil pump strainer tube in the sump of the oil pan.
- Oil is pumped through the oil filter on the cylinder block.
- Oil enters the main oil gallery where it is distributed to the crankshaft main journals and to the cylinder head.
- From the main journals, the oil is routed through cross-drilled passages in the crankshaft to lubricate the connecting rod bearings. Controlled leakage through the crankshaft main bearings and connecting rod bearings is slung radially outward to cool and lubricate the cylinder walls as well as the entire connecting rod, piston and piston ring assembly.
- The engine lubrication system is a full-flow filtration, pressure feed type. The oil pump body is mounted to the engine block. The pump inner rotor is driven by the crankshaft.

Engine Oil Pressure Specifications

Lower Idle Speed (800 ± 50 RPM)	1.2 - 1.5 bar
High Idle Speed (2000 RPM)	3.2 - 3.5 bar
High Speed (4000 RPM)	3.7 ± 0.5 bar

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Engine Lubrication System Exploded View

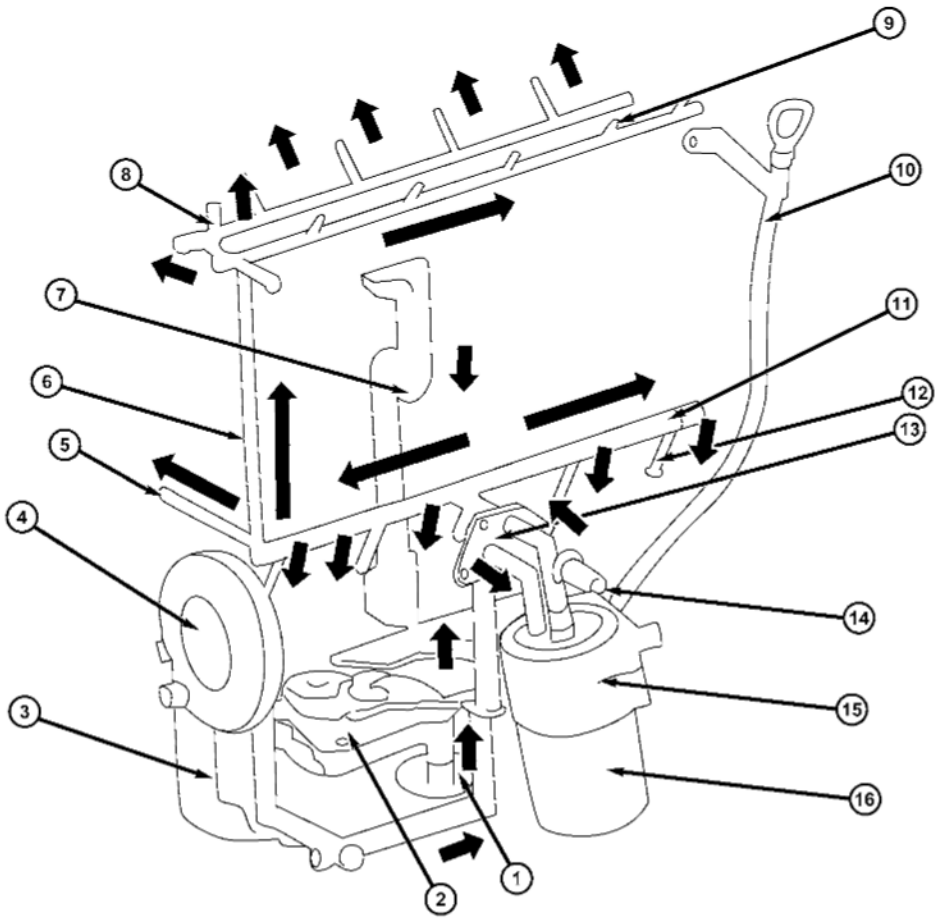


ltsm020161

1 - Oil Dipstick	16 - Oil Pan Bolt
2 - Oil Dipstick Bolt	17 - Oil Pan Bolt
3 - Oil Dipstick Bracket	18 - Oil Pan Bolt
4 - Oil Dipstick Guide	19 - Oil Pan
5 - Crankshaft Rear Oil Seal	20 - O-Ring
6 - O-Ring	21 - O-Ring
7 - Oil Filter Bracket Gasket	22 - Oil Pump Strainer Bolt
8 - Oil Filter Bracket	23 - Oil Pump Strainer
9 - Pressure-Relief Plunger	24 - Baffle Plate
10 - Flange Bolt	25 - O-Ring
11 - Flange Bolt	26 - O-Ring
12 - Oil Cooler	27 - Crankshaft Front Oil Seal
13 - Oil Filter Connector	28 - Oil Pump Bolt
14 - Oil Filter	29 - Oil Pump Assembly
15 - Dowel Pin	30 - Oil Pump Assembly Gasket

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Engine Oil Flow Diagram



besm020088

1 - Oil Pump Strainer	9 - To Middle Bearing Cap
2 - Baffle Plate	10 - Oil Dipstick
3 - Oil Pan	11 - To Crankcase
4 - Oil Pump	12 - Crankcase Pipe
5 - Turbocharger Inlet Oil Passage (if equipped)	13 - Oil Filter Bracket
6 - To Cylinder Head	14 - Oil Pressure Switch
7 - Oil Return Passage	15 - Oil Cooler
8 - To Front Bearing Cap	16 - Oil Filter

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DIAGNOSIS & TESTING

Engine Performance Diagnostics

CONDITION	POSSIBLE CAUSE	CORRECTION
Engine Does Not Start	1. Weak battery. 2. Corroded or loose battery connections. 3. Faulty starter. 4. Faulty coil(s) or control unit. 5. Incorrect spark plug gap. 6. Contamination in fuel system. 7. Faulty fuel pump. 8. Incorrect timing.	1. Test battery. Charge or replace if necessary. 2. Clean and tighten battery connections. Apply a coat of light mineral grease to terminals. 3. Test starting system. Check for codes. (Refer to Appropriate Diagnostic Information) 4. Test and replace if needed. (Refer to Appropriate Diagnostic Information) 5. Set gap. 6. Clean system and replace fuel filter. 7. Test fuel pump and replace as needed. (Refer to Appropriate Diagnostic Information) 8. Check for a skipped timing belt.
Engine Stalls Or Idles Rough	1. Idle speed too low. 2. Incorrect fuel mixture. 3. Intake manifold leakage. 4. Faulty ignition coil(s).	1. Test minimum air flow. (Refer to Appropriate Diagnostic Information) 2. (Refer to Appropriate Diagnostic Information) 3. Inspect intake manifold, manifold gasket, and vacuum hoses. 4. Test and replace if necessary. (Refer to Appropriate Diagnostic Information)
Engine Loss Of Power	1. Dirty or incorrectly gapped spark plugs. 2. Contamination in fuel system. 3. Faulty fuel pump. 4. Incorrect valve timing. 5. Leaking cylinder head gasket. 6. Low compression. 7. Burned, warped, excessive clearance, or pitted valves. 8. Plugged or restricted exhaust system. 9. Faulty ignition coil(s). 10. Burned spark plugs.	1. Clean spark plugs and set gap. 2. Clean system and replace fuel filter. 3. Test and replace if necessary. (Refer to Appropriate Diagnostic Information) 4. Correct valve timing. 5. Replace cylinder head gasket. 6. Test compression of each cylinder. 7. Replace valves. 8. Perform exhaust restriction test. Install new parts. 9. Test and replace if necessary. (Refer to Appropriate Diagnostic Information) 10. Replace spark plugs.

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CONDITION	POSSIBLE CAUSE	CORRECTION
Engine Miss On Acceleration	1. Dirty or incorrectly gapped spark plugs. 2. Contamination in fuel system. 7. Burned, warped, excessive clearance, or pitted valves. 4. Faulty ignition coil(s).	1. Clean spark plugs and set gap. 2. Clean fuel system and replace fuel filter. 3. Replace valves. 4. Test and replace if necessary. (Refer to Appropriate Diagnostic Information)
Engine Miss At High Speed	1. Dirty or incorrect spark plug gap. 2. Faulty ignition coil(s). 3. Dirty fuel injector(s). 4. Contamination in fuel system.	1. Clean spark plugs and set gap. 2. Test and replace if necessary. (Refer to Appropriate Diagnostic Information) 3. Test and replace if necessary. (Refer to Appropriate Diagnostic Information) 4. Clean system and replace fuel filter.

Engine Mechanical Diagnostics

CONDITION	POSSIBLE CAUSE	CORRECTION
Valve Train Noise	1. High or low oil level in crankcase. 2. Thin or diluted oil. 3. Thick oil. 4. Low oil pressure. 5. Worn cam lobe. 6. Worn valve guides. 7. Excessive runout of valve seats on valve faces.	1. Check and correct engine oil level. 2. Change oil to correct viscosity. 3. Change engine oil and filter. 4. Check and correct engine oil level. 5. Install new camshaft. 6. Replace cylinder head. 7. Grind valve seats and replace valves.
Connecting Rod Noise	1. Insufficient oil supply. 2. Low oil pressure. 3. Thin or diluted oil. 4. Excessive bearing clearance. 5. Connecting rod journal out-of-round. 6. Connecting rod out-of-round. 7. Misaligned connecting rods. 8. Connecting rod nuts loose.	1. Check engine oil level. 2. Check engine oil level. Inspect oil pump relief valve and spring. 3. Change oil to correct viscosity. 4. Measure bearings for correct clearance. Repair if necessary. 5. Replace crankshaft or grind surface. 6. Replace connecting rod. 7. Replace bent connecting rods. 8. Tighten the connecting rod nuts.
Main Bearing Noise	1. Insufficient oil supply. 2. Low oil pressure. 3. Thin or diluted oil. 4. Excessive bearing clearance. 5. Excessive end play. 6. Crankshaft journal out-of-round or worn. 7. Loose flywheel or torque converter.	1. Check engine oil level. 2. Check engine oil level. Inspect oil pump. 3. Change oil to correct viscosity. 4. Measure bearings for correct clearance. Repair if necessary. 5. Check thrust bearing for wear on flanges. 6. Replace crankshaft or grind journals. 7. Tighten to correct torque.

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CONDITION	POSSIBLE CAUSE	CORRECTION
Oil Pressure Drop	1. Low oil level. 2. Faulty oil pressure sending unit. 3. Low oil pressure. 4. Clogged oil filter. 5. Thin or diluted oil. 6. Excessive bearing clearance.	1. Check engine oil level. 2. Install new sending unit. 3. Check sending unit and main bearing oil clearance. 4. Install new oil filter. 5. Change oil to correct viscosity. 6. Measure bearings for correct clearance.
Oil Leaks	1. Misaligned or deteriorated gaskets. 2. Loose fastener, broken or porous metal part. 3. Misaligned or deteriorated cup or threaded plug.	1. Replace gasket. 2. Tighten, repair or replace the part. 3. Replace if necessary.
Oil Consumption Or Spark Plugs Fouled	1. PCV system malfunction. 2. Worn, scuffed or broken rings. 3. Carbon in oil ring slots. 4. Rings fitted too tightly in grooves. 5. Worn valve guide(s). 6. Valve stem seal(s) worn or damaged.	1. Check system and repair if necessary. 2. Hone cylinder bores. Install new rings. 3. Install new rings. 4. Remove rings and check grooves. If groove is not proper width, replace piston. 5. Replace cylinder head. 6. Replace seal(s).

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Cylinder Compression Pressure Test

- The result of a cylinder compression pressure test can be utilized to diagnose several engine malfunctions.
- Ensure the battery is completely charged and the engine starter motor is in good operating condition. Otherwise the indicated compression pressures may not be valid for diagnostic purposes.
  - Check engine oil level and add oil if necessary.
  - Disconnect the spark plug wires.
  - Remove all spark plugs from engine (as spark plugs are being removed, check electrodes for abnormal firing indicators fouled, hot, oily, etc.).
  - Record cylinder number of each spark plug for future reference.
  - Disconnect fuel injector electrical connectors.
  - Be sure throttle blade is fully open during the compression check.
  - Insert compression pressure adaptor or the equivalent into each spark plug hole in cylinder head.
  - Crank engine until maximum pressure is reached on gauge. Record each cylinder pressure.
  - Compression should not be less than 1000 kPa and not vary more than 25 percent from cylinder to cylinder.
  - If one or more cylinders have abnormally low compression pressures, repeat the compression test.
  - If the same cylinder or cylinders repeat an abnormally low reading on the second compression test, it could indicate the existence of a problem with the cylinder in question.

NOTE :
The recommended compression pressures are to be used only as a guide to diagnosing engine problems. An engine should not be disassembled to determine the cause of low compression unless some malfunction is present.

Cylinder Head Gasket Test

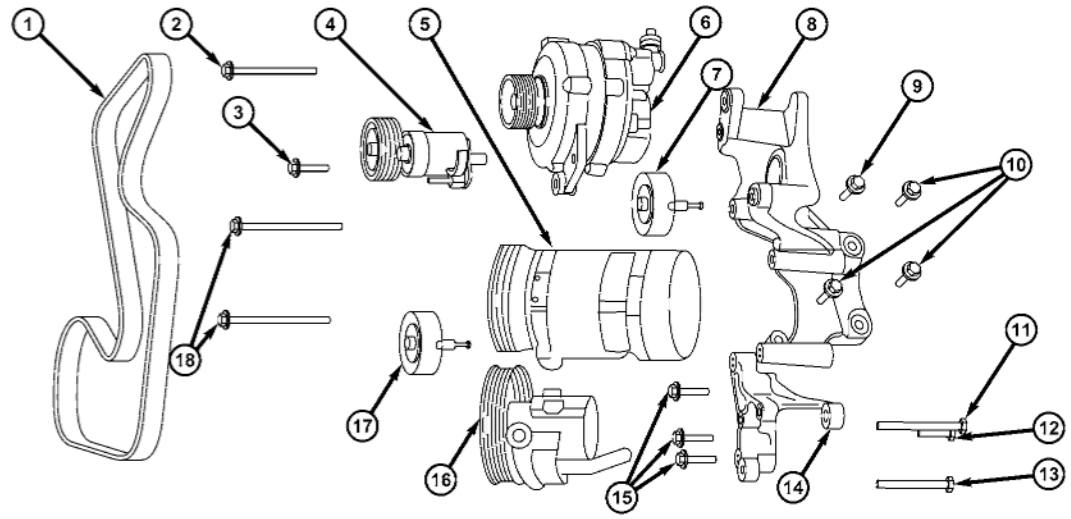
- A cylinder head gasket leak can be located between adjacent cylinders, between a cylinder and the adjacent water jacket or from an oil passage to the exterior of the engine.
- Possible indications of the cylinder head gasket leaking between adjacent cylinders are:
  - Loss of engine power
  - Engine misfiring
  - Poor fuel economy
- Possible indications of the cylinder head gasket leaking between a cylinder and an adjacent water jacket are:
  - Engine overheating
  - Loss of coolant
  - Excessive steam (white smoke) emitting from exhaust
  - Coolant foaming

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ON-VEHICLE SERVICE

Accessory Drive Belt

Removal & Installation



1 - Drive Belt	10 - Generator Bracket Bolts
2 - Generator Bolt	11 - Power Steering Pump Bolt
3 - Tensioner Pulley Bolt	12 - Power Steering Pump Bolt
4 - Tensioner	13 - Power Steering Pump Bolt
5 - Compressor	14 - Power Steering Pump Bracket
6 - Generator	15 - Power Steering Pump Bracket Bolts
7 - Idler Pulley	16 - Power Steering Pump
8 - Generator Bracket	17 - Idler Pulley
9 - Generator Bracket Bolt	18 - Compressor Bolts

WARNING!

Inspect the drive belt only when the engine is stopped.

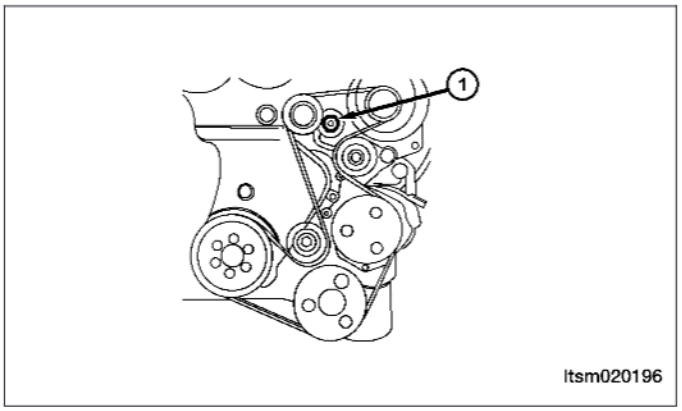
1. While using a suitable tool and securely holding the hexagonal portion of the drive belt tensioner, rotate the pulley counterclockwise to loosen the drive belt.

WARNING!

Avoid placing hands near the drive belt tensioner while it is being held.

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2. Remove the drive belt.
3. Remove accessory drive belt tensioner pulley bolt (1) if necessary.
   (Tighten: Accessory drive belt tensioner pulley bolt to 35 N·m)

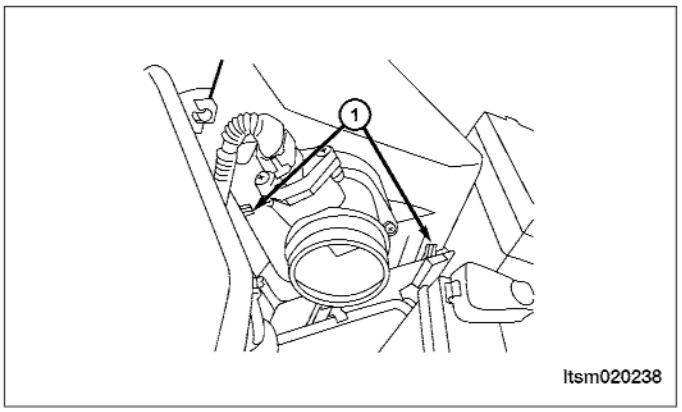


4. Installation is in the reverse order of removal.

Air Cleaner Element

Removal & Installation

1. Unhook the air cleaner case side clips (1) and raise the air cleaner case (upper).



2. Remove the air cleaner element.
3. Install a new air cleaner element.
4. Installation is in the reverse order of removal.

Installation Notes:

- If necessary, clean the inside of the air cleaner housing before installing new air cleaner element.

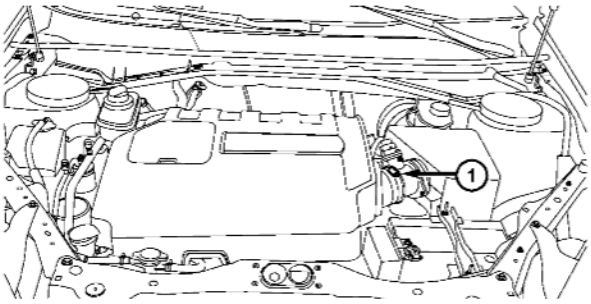
Air Cleaner Housing

Removal & Installation

1. Disconnect the negative battery cable.
2. Disconnect the air flow sensor electrical connector (1.8L Engine).

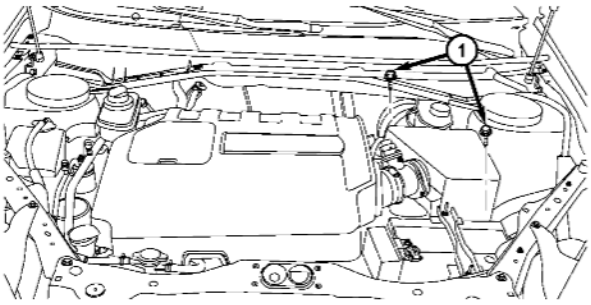
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3. Loosen the clamp (1) between the air intake air hose and the air cleaner and remove the intake air hose.



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4. Remove the screws (1) securing the air cleaner housing to its base.



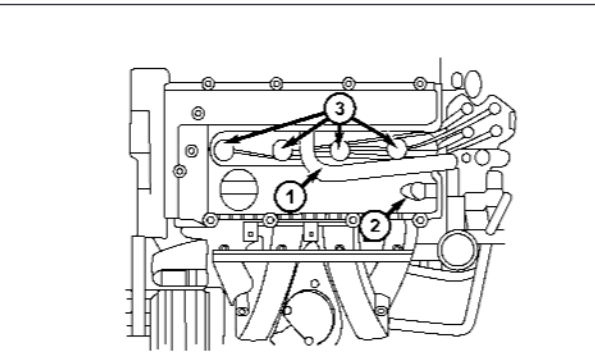
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5. Remove the air cleaner housing.
6. Remove the air cleaner base.
7. Installation is in the reverse order of removal.

Cylinder Head Cover

Removal & Installation

1. Disconnect the negative battery cable.
2. Remove the engine cover.
3. Use compressed air to blow dirt and debris off the cylinder head cover prior to removal.
4. Disconnect the camshaft position sensor electrical connector.
5. Remove the camshaft position sensor (2) and set it aside.
6. Remove the spark plug wires (3) and set them aside.
7. Remove the PCV hose (1) from cylinder head cover.

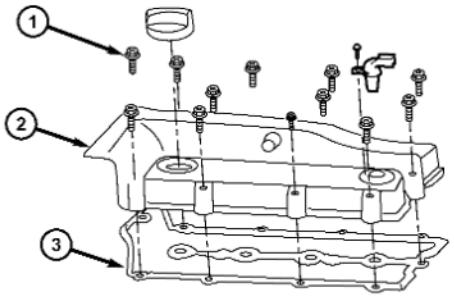


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8. Remove the cylinder head cover bolts (1).
   (Tighten: Cylinder head cover bolts to 11 N·m)
9. Remove the cylinder head cover (2) from the cylinder head.
10. Remove the cylinder head cover gasket (3).
11. Installation is in the reverse order of removal.

NOTE :
Install a new cylinder head cover gasket during installation.



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Camshaft

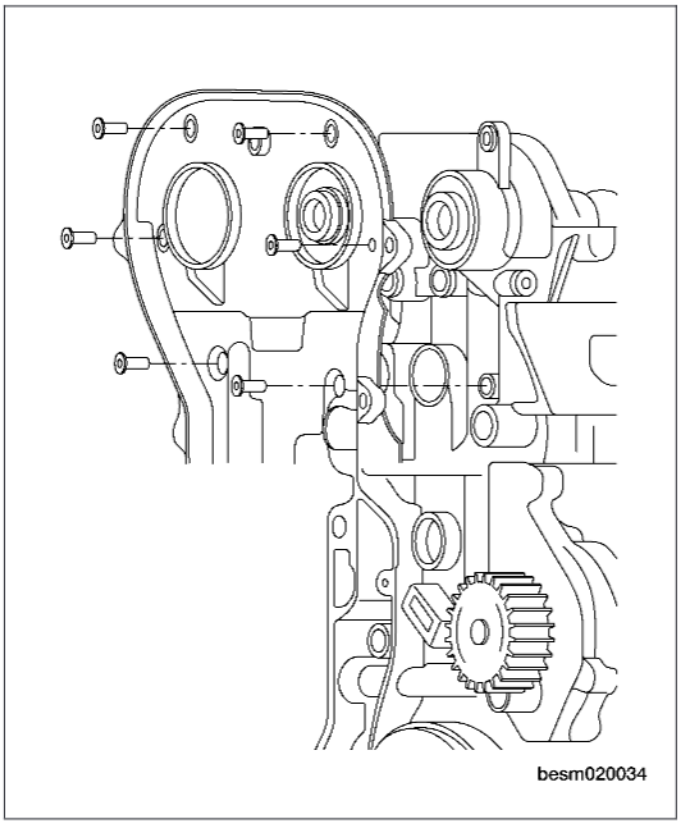
Removal & Installation

NOTE :
The following special tools are required to perform the repair procedure:
- CH-20002 - Camshaft Seal Installer
- CH-20010 - Camshaft Holder

1. Remove the accessory drive belt (See Accessory Drive Belt Removal & Installation in Section 02 Engine).
2. Remove the engine timing belt (See Engine Timing Belt Removal & Installation in Section 02 Engine).
3. Remove the cylinder head cover (See Cylinder Head Cover Removal & Installation in Section 02 Engine).
4. Remove the intake or exhaust camshaft timing belt pulley.
   (Tighten: Camshaft timing belt pulley bolt to 120 N·m)

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5. Remove the rear timing cover of the timing pulley. (Tighten: Rear timing cover bolts to 7 N·m)


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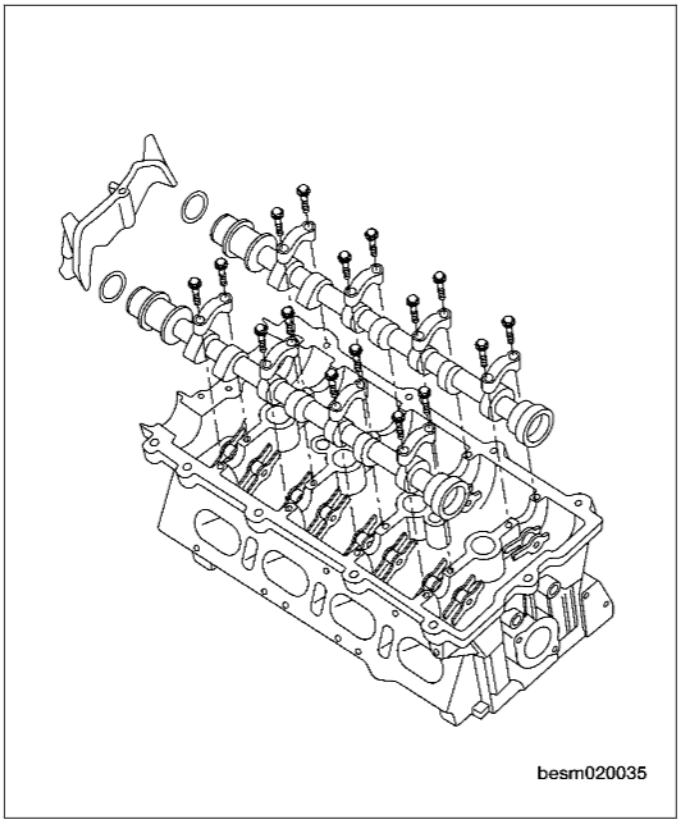
6. Remove the camshaft bearing cap bolts. (Tighten: Camshaft bearing cap bolts to 11 N·m)

   NOTE: Equally loosen camshaft bearing cap bolts in several steps.

7. Remove the camshaft bearing caps and place them in proper order.

   NOTE: The camshaft bearing caps are marked for identification.

8. Remove the camshafts and then remove the camshaft seals.


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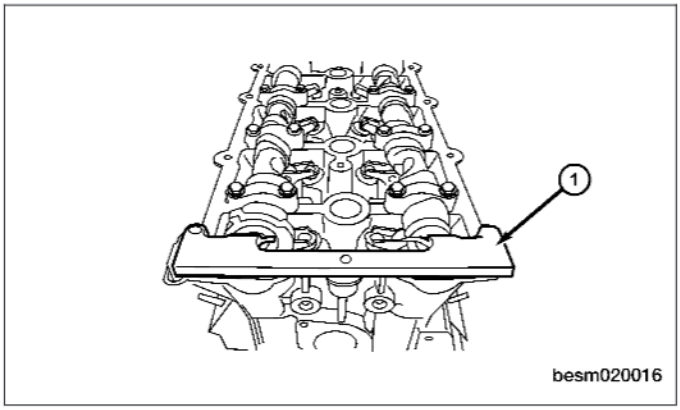
9. Installation is in the reverse order of removal.

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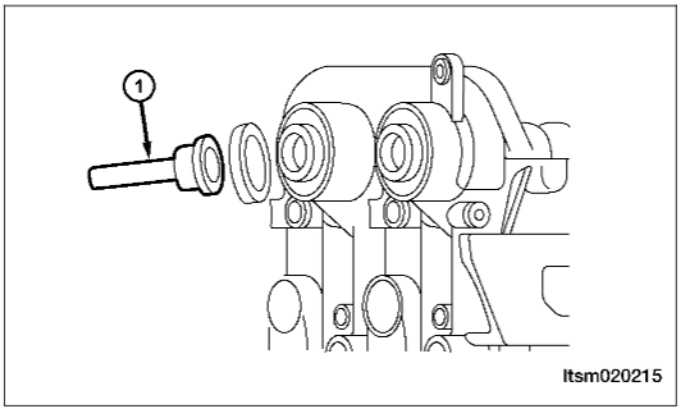
Installation Notes:

- Use special tool CH-20010 (1), to install the camshaft holder to hold the camshafts in place.

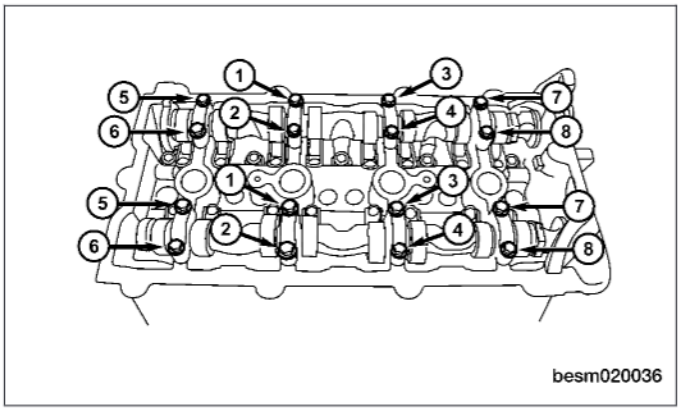
NOTE :
The camshaft holder will prevent the camshafts from rotating in either direction.



- Use special tool CH-20002 (1), to install the camshaft seal.
- Install the intake and exhaust camshaft bearing caps in the proper order.
- Slowly tighten bolts to the specified torque.



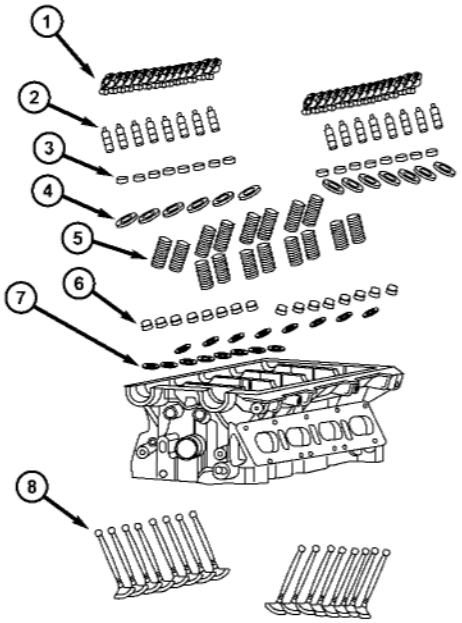
- Follow the torque sequence as shown.



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Cylinder Head

Removal & Installation



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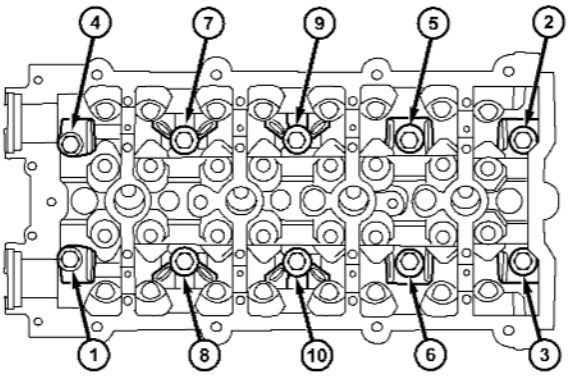
1 - Rocker Arms	5 - Valve Springs
2 - Hydraulic Tappets	6 - Valve Oil Seals
3 - Valve Keepers	7 - Valve Spring Lower Retainers
4 - Valve Spring Upper Retainers	8 - Valves

NOTE :
Replacement cylinder head comes complete with valves, seals, springs, retainers, keepers, and camshafts.

1. Remove engine timing belt (See Engine Timing Belt Removal & Installation in Section 02 Engine).
2. Remove the cylinder head cover (See Cylinder Head Cover Removal & Installation in Section 02 Engine).
3. Remove the camshafts (See Camshaft Removal & Installation in Section 02 Engine).
4. Remove intake manifold (See Intake Manifold Removal & Installation in Section 02 Engine).
5. Remove exhaust manifold (See Exhaust Manifold Removal & Installation in Section 02 Engine).
6. Remove water pipe and thermostat assembly.

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7. Remove the cylinder head bolts in the order shown.



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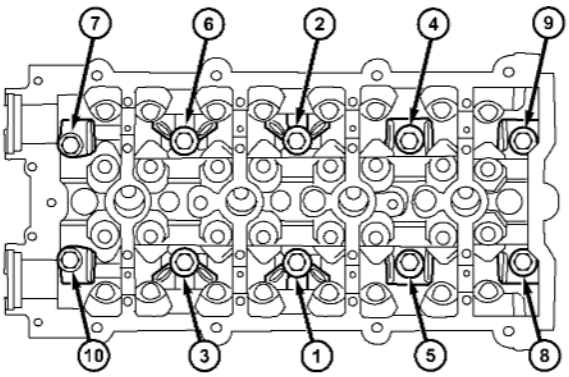
8. Remove cylinder head gasket.
9. Installation is in the reverse order of removal.

Installation Notes:

- Ensure cylinder head bolt holes in the block are clean, dry (free of residual oil or coolant), and threads are not damaged.
- The cylinder head bolts should not be reused. The new bolts should be examined before use. If the bolts are stretched, the bolts should be replaced.
- Position the new cylinder head gasket on the engine block with the part number facing up. Ensure gasket is seated over the locating dowels in the block.
- Before installing the bolts, the threads should be lightly coated with engine oil.

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- Install the cylinder head bolts in the order shown.
- Torque the cylinder head bolts in the following three step sequence:
  - 1st Step: Tighten the bolt to 40 ± 5 N·m
  - 2nd Step: Tighten the bolt an additional 90 ± 5°
  - 3rd Step: Tighten the bolt an additional 90 ± 5°



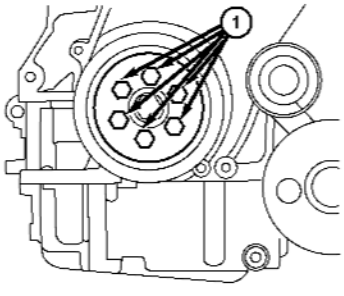
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Front Crankshaft Oil Seal

Removal & Installation

NOTE :
The following special tools are required to perform the repair procedure:
- CH-20007 - Front Crankshaft Seal Installer
- CH-20008 - Front Crankshaft Seal Guide
- CH-20019 - Crankshaft Belt Pulley Fixture

1. Remove the accessory drive belt (See Accessory Drive Belt Removal & Installation in Section 02 Engine).
2. Remove the crankshaft vibration damper bolts (1). (Tighten: Crankshaft vibration damper bolts to 25 N·m)

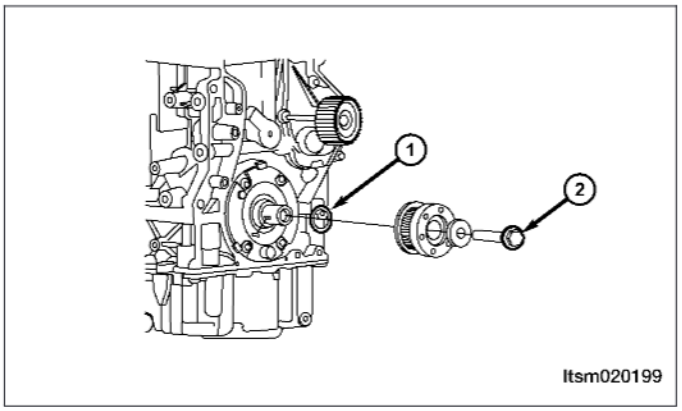


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3. Remove the engine timing belt (See Engine Timing Belt Removal & Installation in Section 02 Engine).

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4. Remove the crankshaft timing belt pulley bolt (2) from the crankshaft.
   (Tighten: Crankshaft timing belt pulley bolt to 130 N·m and an additional 65°)
5. Remove the key-way from the crankshaft.
6. Use an appropriate tool and remove the front crankshaft oil seal (1).

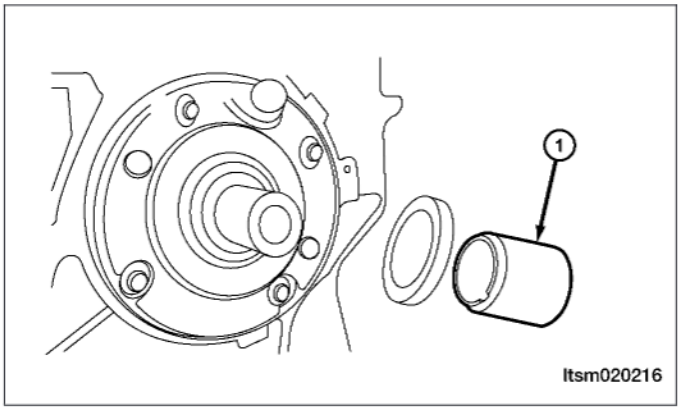


CAUTION:
Be careful not to damage the front cover seal surface while removing the seal.

7. Installation is in the reverse order of removal.

Installation Notes:

- Lubricate the new front seal with engine oil prior to assembly.
- Use the front crankshaft seal installer CH-20008 (1), to install the new seal.



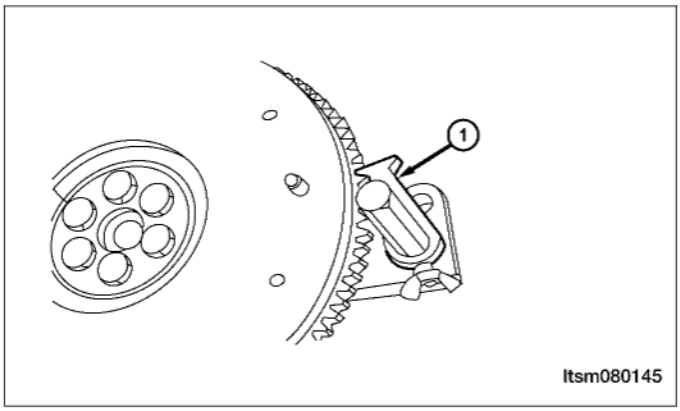
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Rear Crankshaft Oil Seal

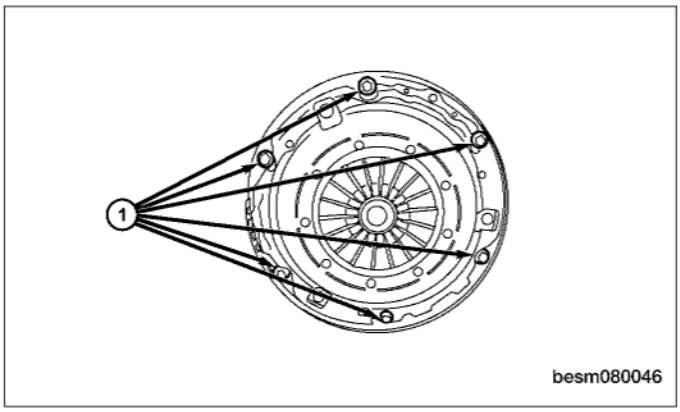
Removal & Installation

NOTE :
The following special tools are required to perform the repair procedure:
- CH-20005 - Rear Crankshaft Oil Seal Installer
- CH-20006 - Rear Crankshaft Oil Seal Guide
- CH-20043 - Flywheel Fixture

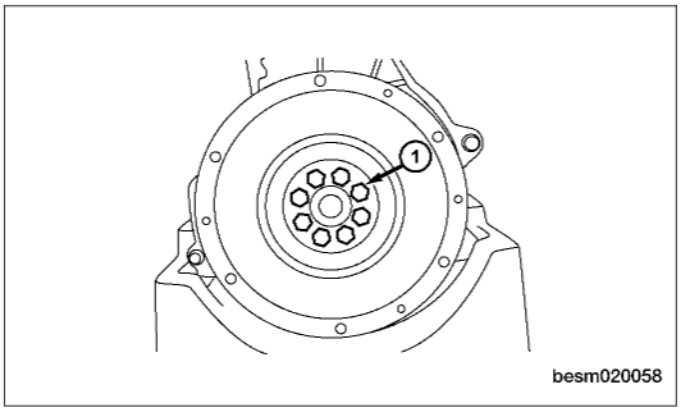
1. Remove the transaxle assembly (See Transaxle Assembly Removal & Installation in Section 08 Transaxle & Transfer Case).
2. Using special tool CH-20043 (1), hold the flywheel.



3. Remove the clutch pressure plate retaining bolts (1) and then remove the clutch pressure plate.
   (Tighten: Clutch pressure plate bolts to 25 N·m)



4. Remove the flywheel bolts (1) and then remove the flywheel.
   (Tighten: Flywheel bolts to 75 N·m)

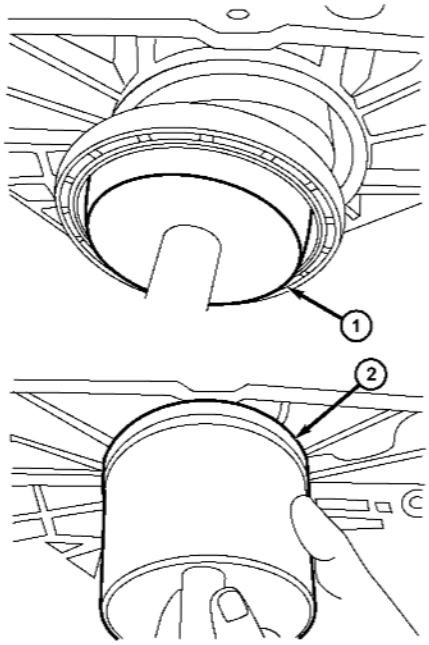


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5. Remove the rear oil seal using a suitable tool.
6. Installation is in the reverse order of removal.

Installation Notes:

- When installing seal, lubricate seal guide with clean engine oil.
- Position the seal over the rear crankshaft seal guide.
- Use special tool CH-20005 (2) CH-20006 (1), to install the rear crankshaft oil seal.
- Ensure that the lip of the seal is facing toward the crankcase during installation.



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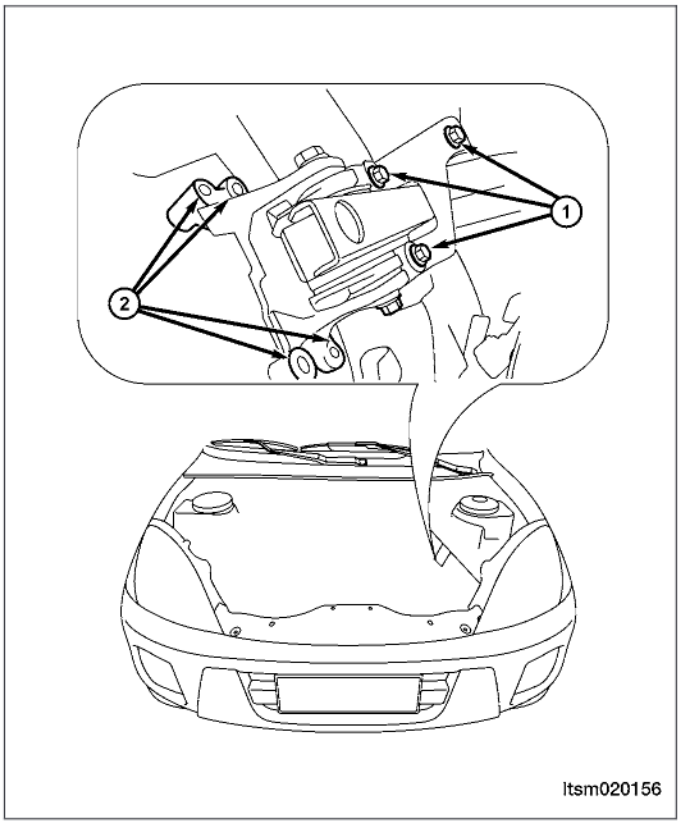
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Engine Mounts

Removal & Installation - Left Mount

NOTE :
The following special tools are required to perform the repair procedure:
- Engine Hoist

1. Disconnect the negative battery cable.
2. Support the engine with the engine hoist.
3. Remove the air cleaner housing (See Air Cleaner Housing Removal & Installation in Section 02 Engine).
4. Remove the air cleaner housing base tray.
5. Remove the engine left mount retaining bolts (2) and remove the engine left mount bracket bolts (1). (Tighten: Engine left mount bolts to 70 N·m)
6. Installation is in the reverse order of removal.

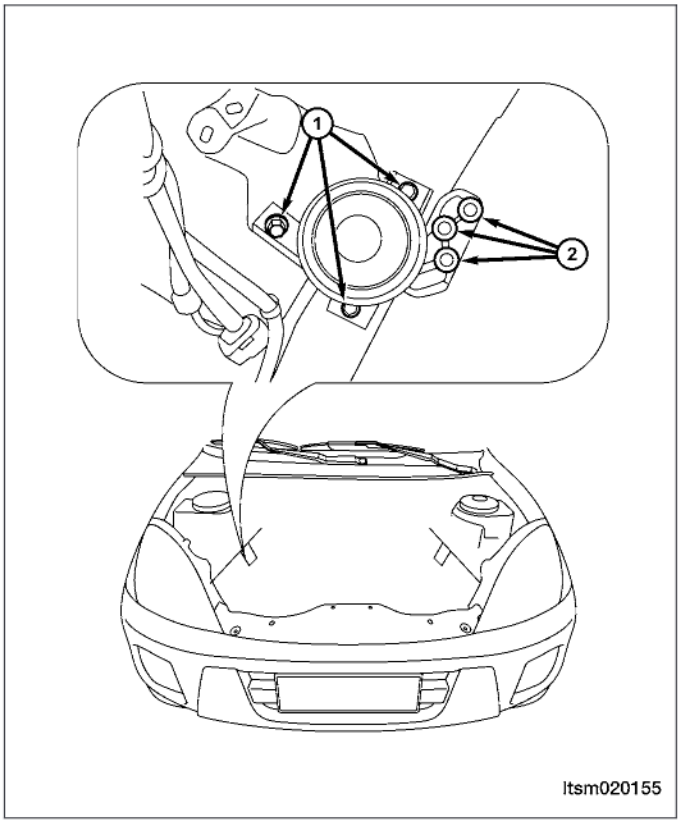


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Removal & Installation - Right Mount

NOTE :
The following special tools are required to perform the repair procedure:
- Engine Hoist

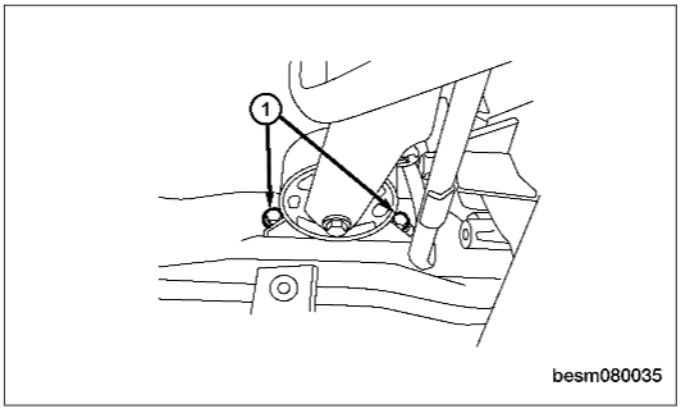
1. Disconnect the negative battery cable.
2. Support the engine with the engine hoist.
3. Remove the engine right mount retaining bolts (2) and remove the engine right mount bracket bolts (1).
   (Tighten: Engine right mount bolts to 70 N·m)
4. Installation is in the reverse order of removal.



Removal & Installation - Front Mount

NOTE :
The following special tools are required to perform the repair procedure:
- Engine Hoist

1. Disconnect the negative battery cable.
2. Support the engine with the engine hoist.
3. Remove the bolts (1) securing the front engine mount.
   (Tighten: Engine front mount bolts to 60 N·m)
4. Installation is in the reverse order of removal.

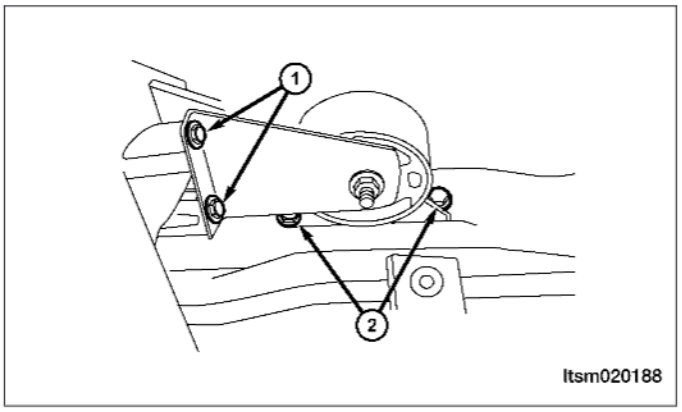


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Removal & Installation - Rear Mount

NOTE :
The following special tools are required to perform the repair procedure:
- Engine Hoist

1. Disconnect the negative battery cable.
2. Support the engine with the engine hoist.
3. Remove the engine rear mount retaining bolts (2) and remove the engine rear mount bracket bolts (1).
   (Tighten: Engine rear mount bolts to 60 N·m)
4. Installation is in the reverse order of removal.



Engine Assembly

Removal & Installation

NOTE :
The following special tools are required to perform the repair procedure:
- CH-20001 - Right Engine Mount Bolt Remover
- Engine Hoist

NOTE :
The engine is removed with the transaxle as an assembly.

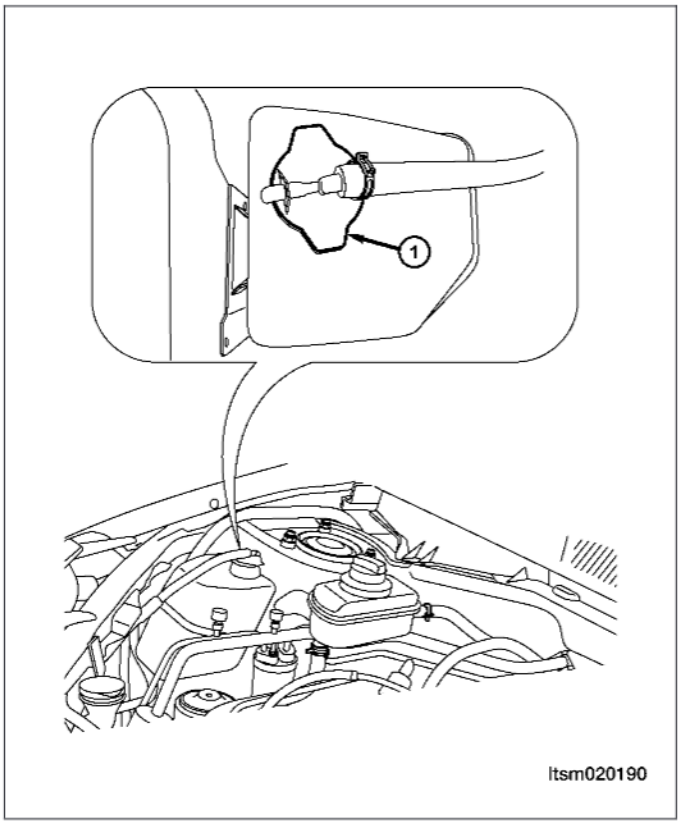
1. Remove the vehicle hood.
2. Remove the negative battery cable from the engine.
3. Remove the engine cover.
4. Remove the battery, battery hold downs, and battery tray (See Battery Removal & Installation in Section 05 Starting & Charging).
5. Discharge air conditioning system (See A/C System Evacuation and Recharge in Section 13 Heating & Air Conditioning).
6. Drain the cooling system (See Cooling System Draining and Filling in Section 06 Cooling).

WARNING!

Always allow the engine to cool before opening the cooling system. Do not loosen the coolant pressure relief cap when the engine is operating or the cooling system is hot. The cooling system is under pressure; steam and hot liquid can come out forcefully when the cap is loosened slightly. Failure to follow these instructions may result in serious personal injury.

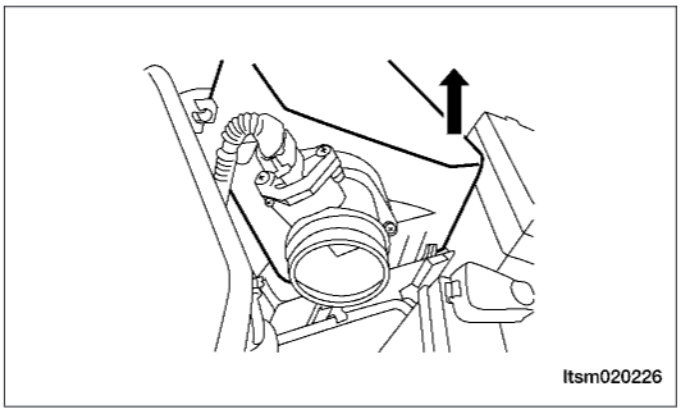
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7. Remove coolant reservoir (1).



8. Remove the coolant fan & radiator assembly (See Coolant Fan & Radiator Assembly Removal & Installation in Section 06 Cooling).
9. Remove the starter motor wiring.
10. Relieve the fuel pressure (See Fuel Pressure Relief Procedure in Section 04 Fuel Delivery).
11. Disconnect and remove the fuel line at the fuel rail.
12. Remove the air inlet hose and the air cleaner case assembly.

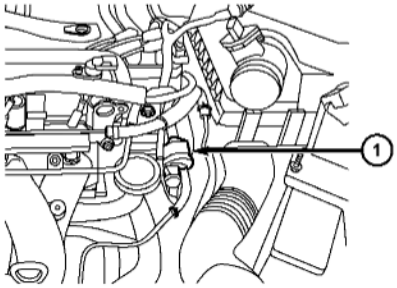
    NOTE: For 1.8L engine, disconnect the air flow sensor electrical connector.



13. Remove the ground cable bolt from the cylinder head.

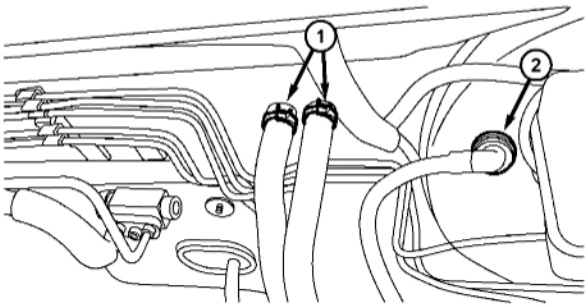
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14. Disconnect and remove the following electrical connectors:
    - Coolant temperature sensor
    - Camshaft position sensor
    - Ignition coil
    - Four fuel injectors
    - Intake manifold air pressure sensor (1.6L)
    - Air flow sensor (1.8L)
    - Carbon canister solenoid valve
    - Throttle body control
    - A/C compressor
    - Oil pressure sensor
    - Power steering pump pressure switch
    - Generator
15. Remove the pipe from the canister control valve (1).



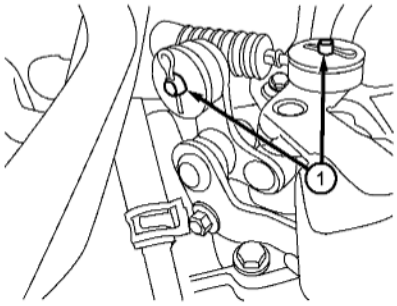
ltsm020235

16. Disconnect the heater hoses (1) on the vehicle.
17. Remove the vacuum line from the brake booster (2).
18. Remove the dipstick.



besm020025

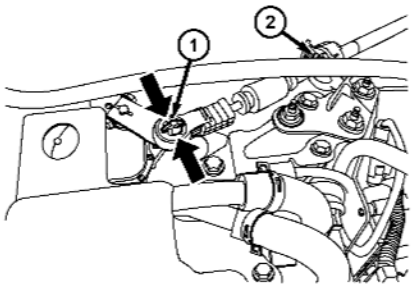
19. If equipped with a manual transaxle remove the transaxle shift cable (1).



besm080051

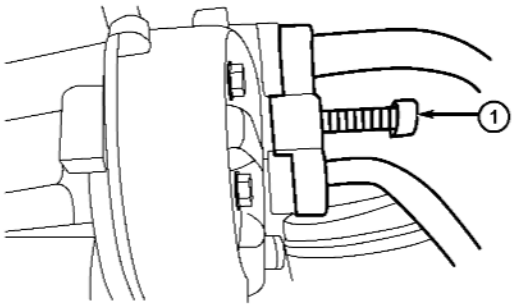
cardiagn.com

20. If equipped with an automatic transaxle, remove the transaxle shift cable (1) and the transaxle shift cable clamp (2).
21. Remove the hydraulic pipe from the clutch slave cylinder.



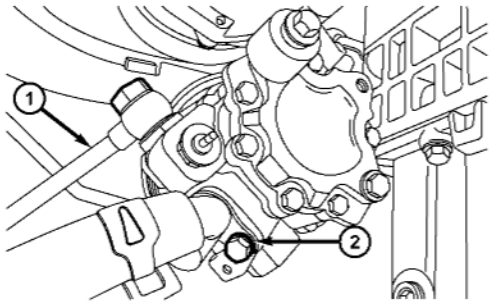
ltsm080186

22. Remove the A/C compressor line bolt (1) from the A/C compressor.
(Tighten: A/C compressor line bolts to 20 N·m)
NOTE: After removing the A/C lines, plug the A/C lines to prevent any debris from entering the A/C system.



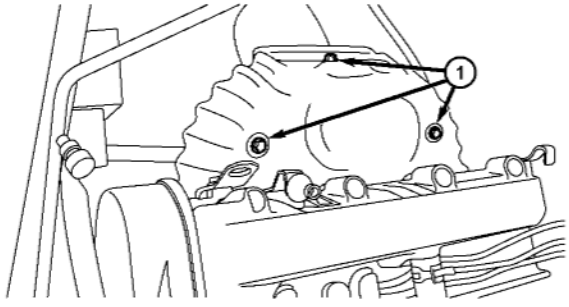
vism130017

23. Remove the high pressure line (1) and low pressure line (2) from the power steering pump (drain fluid from lines).
(Tighten: High pressure line to power steering pump 40 ± 5 N·m)
(Tighten: Low pressure line to power steering pump 40 ± 5 N·m)



besm110011

24. Remove the exhaust manifold heat shield bolts (1) and then remove heat shield.
(Tighten: Exhaust manifold heat shield bolts to 15 N·m)

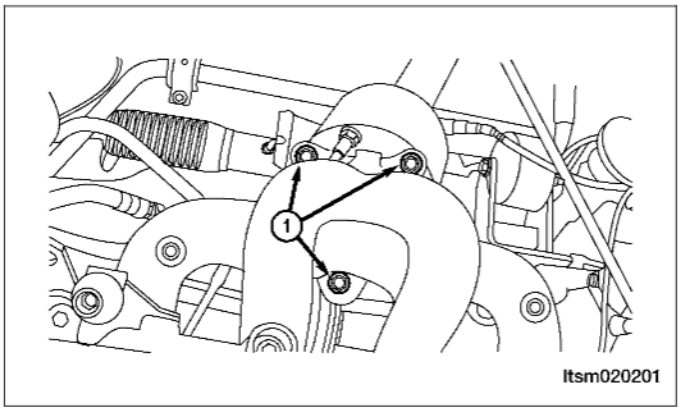


besm020078

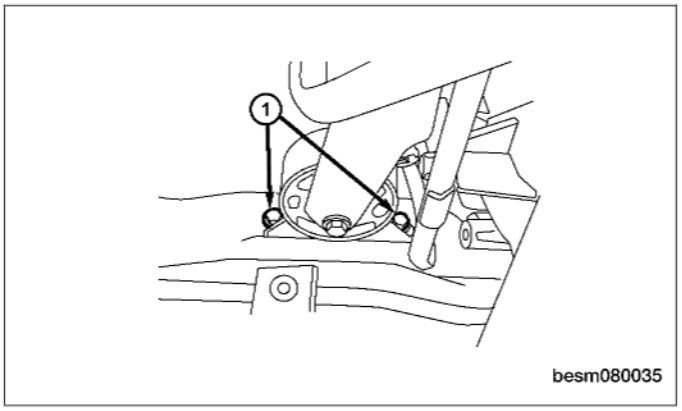
25. Disconnect the upstream and downstream oxygen sensor connectors.

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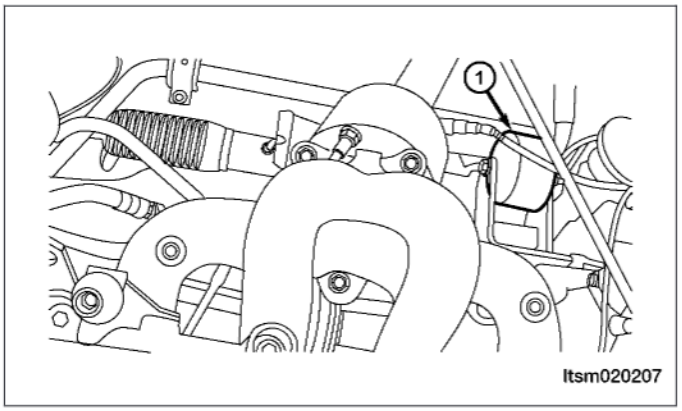
26. Remove the catalytic converter to exhaust manifold bolts (1).



27. Raise and support the vehicle.
28. Remove the front axle shaft (See Front Axle Shaft Removal & Installation in Section 09 Driveline & Axle).
29. Drain the engine oil.
30. Lower the vehicle and install engine lift chain hangers.
31. Remove the bolts (1) securing the front engine mount.
(Tighten: Engine front mount bolt to 60 N·m)

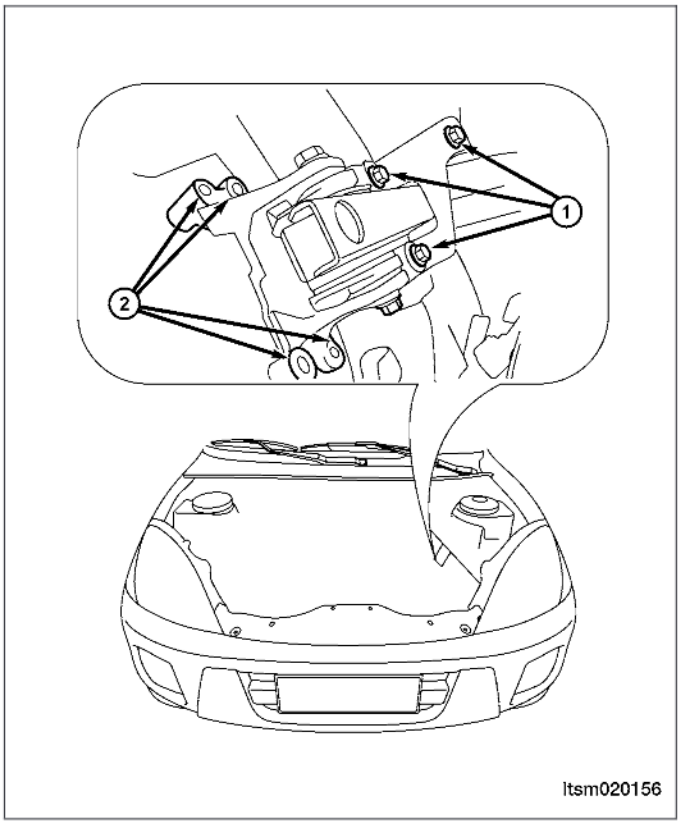


32. Remove the bolts (1) securing the rear engine mount.
(Tighten: Engine rear mount bolt to 60 N·m)

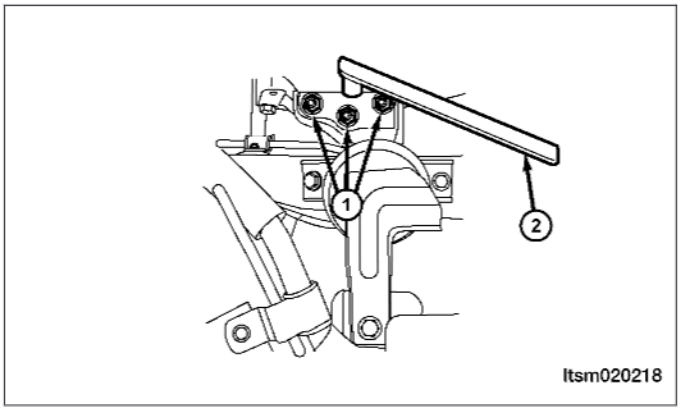


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33. Remove the left transaxle mount bolts (2) and the transaxle mount bracket retaining bolts (1).
(Tighten: Left transaxle mount bolt to 70 N·m)



34. Using special tool CH-20001 (2), remove the three bolts (1) securing the right engine mount.
(Tighten: Engine right mount bolt to 70 N·m)



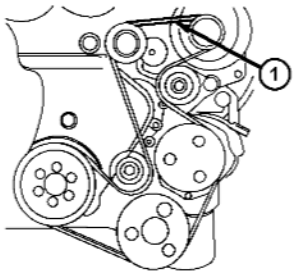
35. Verify all components between the engine and vehicle are disconnected.
36. Remove the front sub-frame (See Front Sub-Frame Removal & Installation in Section 10 Suspension).
37. Hoist the engine from vehicle.

CAUTION:
Verify all electrical connectors are disconnected prior to engine/transaxle removal.

38. Separate the engine and transaxle.

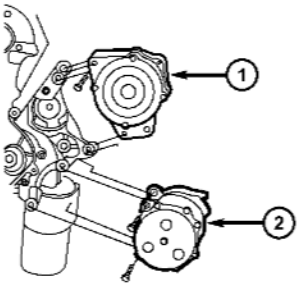
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39. Remove the accessory drive belt (1) (See Accessory Drive Belt Removal & Installation in Section 02 Engine).



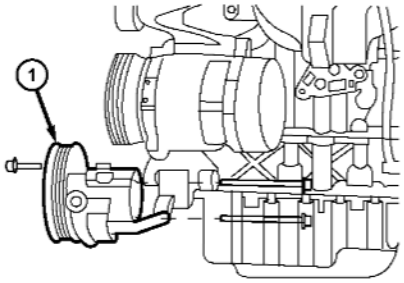
ltsm020200

40. Remove the generator (1) from the bracket (See Generator Removal & Installation in Section 05 Starting & Charging).
41. Remove the A/C compressor pipe.
42. Remove the A/C compressor (2) (See A/C Compressor Removal & Installation in Section 13 Heating & Air Conditioning).



besm020029

43. Remove the power steering pump (1) with the piping connected and set the pump aside. Secure the pump with wire.



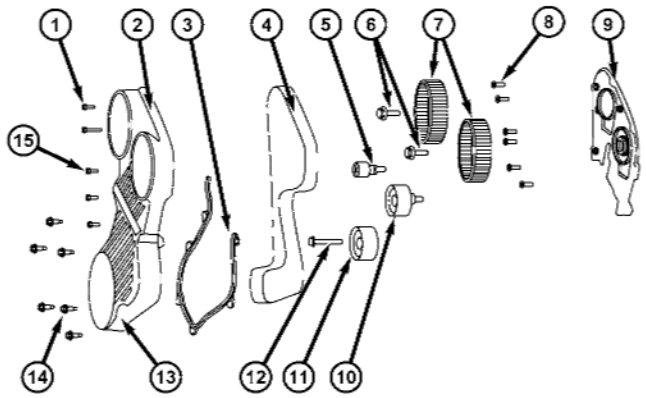
besm020028

44. Installation is in the reverse order of removal.

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Engine Timing Belt

Removal & Installation



ltsm020162

1 - Timing Belt Upper Cover Bolt	9 - Rear Timing Cover
2 - Timing Belt Upper Cover	10 - Idler Pulley
3 - Timing Belt Cover Gasket	11 - Tensioner Pulley
4 - Timing Belt	12 - Tensioner Pulley Bolt
5 - Timing Belt Touch Pulley	13 - Timing Belt Lower Cover
6 - Camshaft Bolt	14 - Timing Belt Lower Cover Bolt
7 - Camshaft	15 - Timing Belt Upper Cover Bolt
8 - Rear Timing Cover Bolt	

NOTE :
The following special tools are required to perform the repair procedure:
- CH-20001 - Right Engine Mount Bolt Remover
- CH-20003 - Crankshaft Holder
- CH-20010 - Camshaft Holder
- Engine Hoist

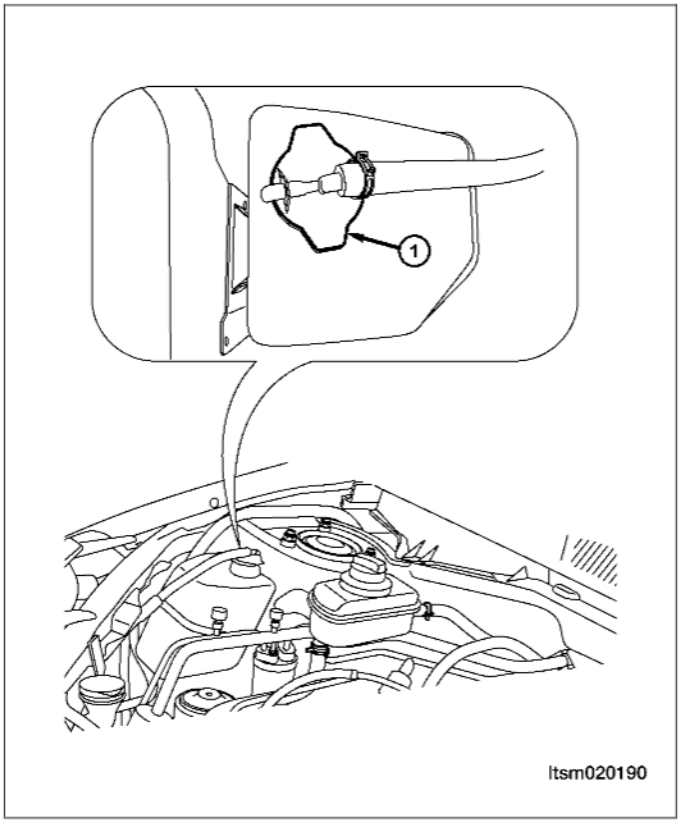
1. Release the coolant system pressure.

WARNING!

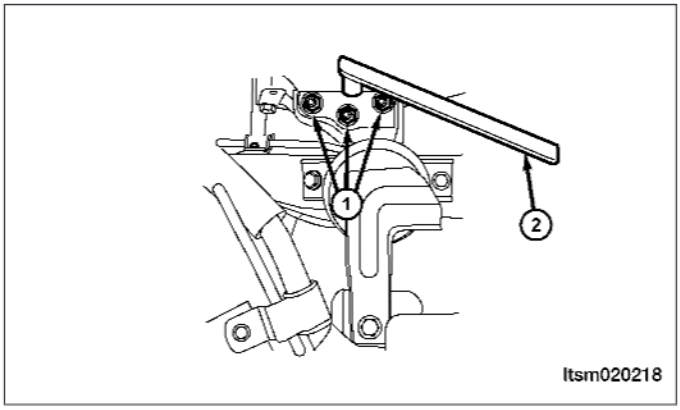
Always allow the engine to cool before opening the cooling system. Do not loosen the coolant pressure relief cap when the engine is operating or the cooling system is hot. The cooling system is under pressure; steam and hot liquid can come out forcefully when the cap is loosened slightly. Failure to follow these instructions may result in serious personal injury.

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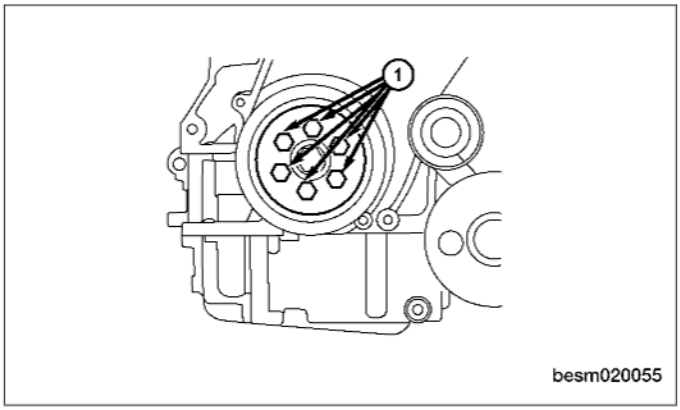
2. Remove the coolant reservoir (1) and set aside.



3. Attach an engine hoist and support the engine using an engine hoist.
4. Using special tool CH-20001 (2), remove the engine right mount bolts (1) and bracket.
(Tighten: Engine right mount bolts to 70 N·m)

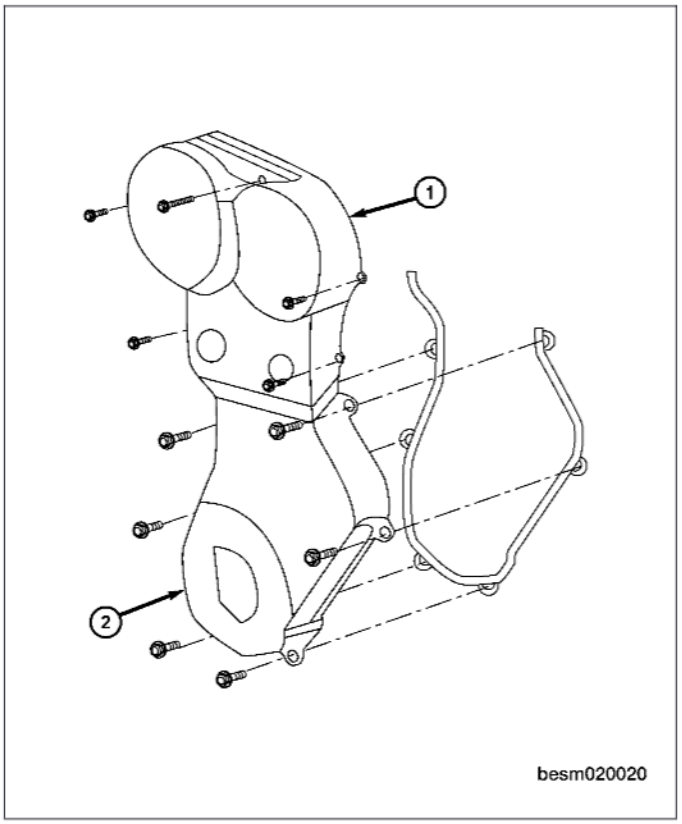


5. Remove the accessory drive belt (See Accessory Drive Belt Removal & Installation in Section 02 Engine).
6. Remove the crankshaft vibration damper bolts (1).
(Tighten: Crankshaft vibration damper bolts to 25 N·m)

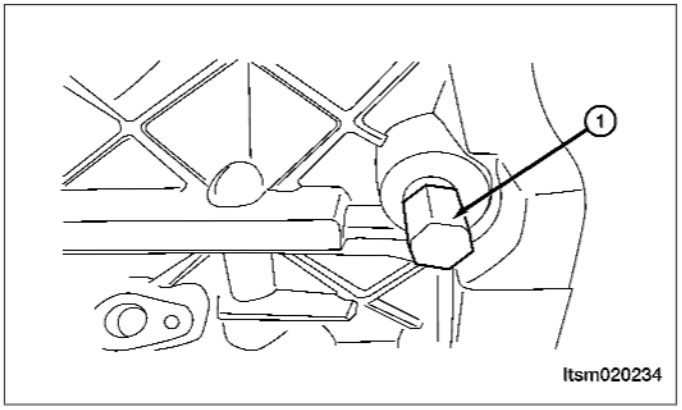


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7. Remove the timing belt upper cover (1) and timing belt lower cover (2).
   (Tighten: Timing belt upper cover bolts to 11 N·m)
   (Tighten: Timing belt lower cover bolts to 11 N·m)

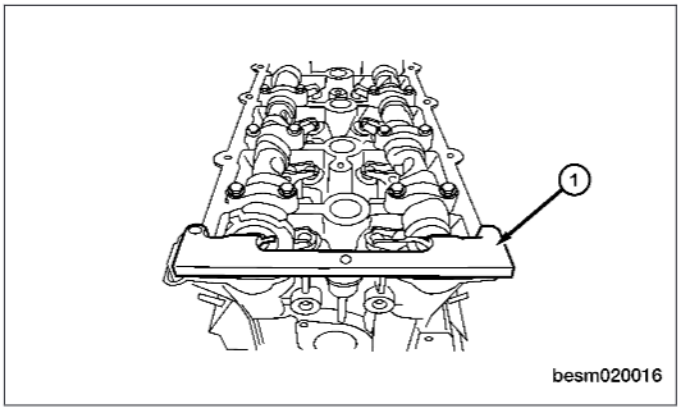


8. Remove the cylinder head cover (See Cylinder Head Cover Removal & Installation in Section 02 Engine).
9. Remove the plug in the cylinder block.
10. Using special tool CH-20003 (1), install the crankshaft holder into the cylinder block and rotate the crankshaft until the crankshaft tool completely holds the crankshaft in place.
    (Tighten: Crankshaft holder to 28 N·m)
    NOTE: The crankshaft holder will prevent the crankshaft from rotating in either direction.



11. Using special tool CH-20010 (1), install the camshaft holder to hold the camshafts in place.
    NOTE: The camshaft holder will prevent the camshafts from rotating in either direction.

CAUTION: Rotating the camshafts or crankshaft with timing components loosened or removed can cause seriou damage to the valves or pistons.

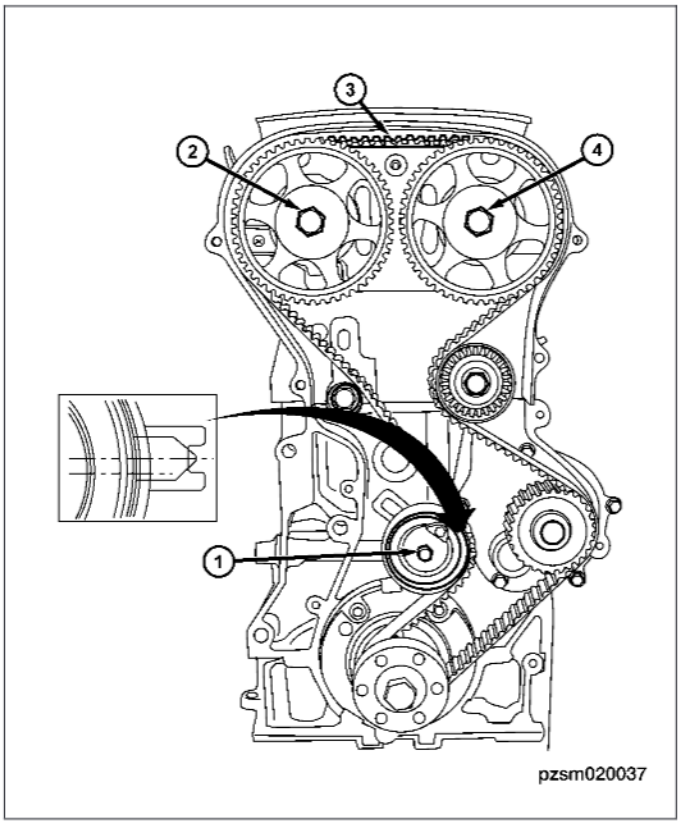


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12. Loosen the bolt of the timing belt tensioner pulley (1), remove the pulley.
    (Tighten: Timing belt tensioner pulley bolt to 30 N·m)
13. Remove the timing belt (3).
14. Installation is in the reverse order of removal.

Installation Notes:

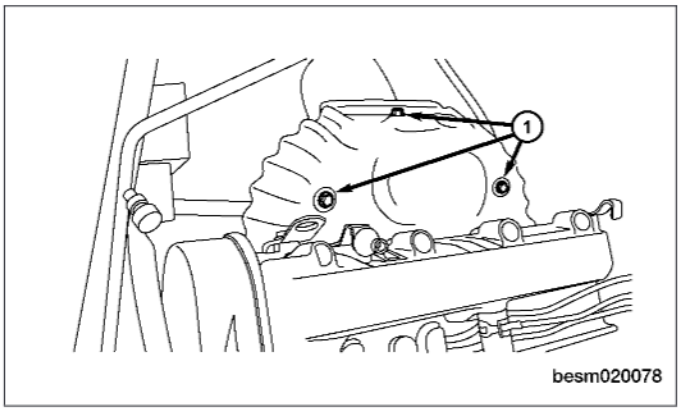
- Install the timing belt and rotate the tensioner pulley with an Allen wrench in order to apply tension to the belt and align the finger pointer of the tensioner to the middle of the U-slot opening. Tighten the tensioner pulley bolt (1) to 30 N·m, then tighten the intake and exhaust camshaft pulley bolts (2, 4) to 120 N·m.



Exhaust Manifold

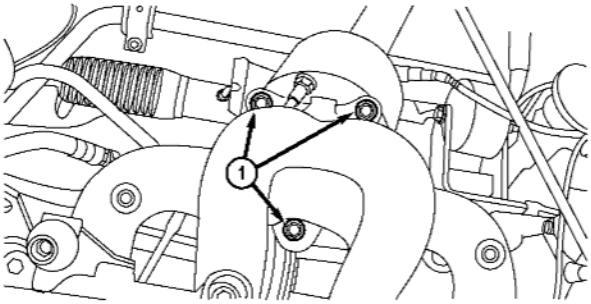
Removal & Installation

1. Remove the engine cover.
2. Remove the bolts (1) attaching the exhaust manifold heat shield.
   (Tighten: Exhaust manifold heat shield bolts to 15 N·m)
3. Remove the exhaust manifold heat shield.



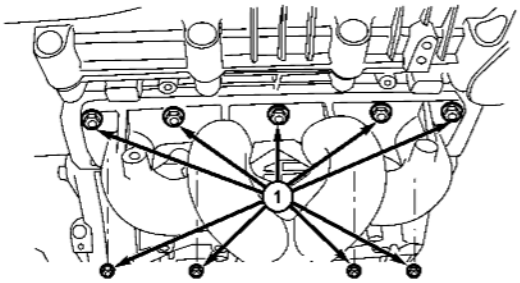
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4. Remove the three bolts (1) securing the exhaust manifold to the catalytic converter assembly.
5. Disconnect the catalytic converter assembly from the manifold.



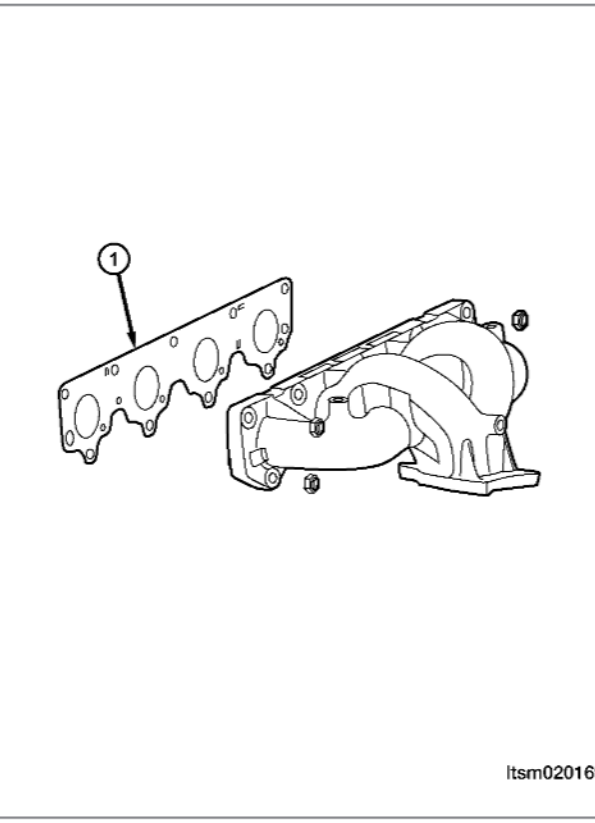
ltsm020201

6. Remove the exhaust manifold nuts (1).
(Tighten: Exhaust manifold nuts to 25 N·m)



besm020033

7. Remove and discard manifold gasket (1).



ltsm020169

8. Installation is in the reverse order of removal.

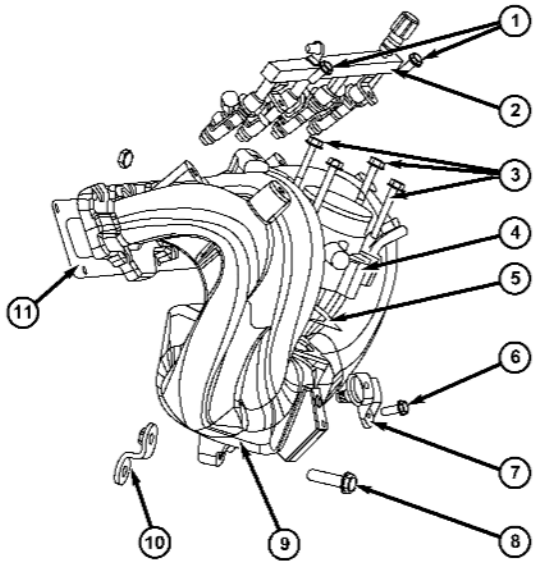
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Installation Notes:

- Clean all surfaces of manifold and cylinder head.
- Install a new exhaust manifold gasket during installation.

Intake Manifold

Removal & Installation



ltsm020164

1 - Fuel Rail Bolt	7 - Air Intake Pressure Temperature Sensor
2 - Fuel Rail	8 - Intake Manifold Bolt
3 - Electronic Throttle Control Actuator Bolt	9 - Intake Manifold
4 - Electronic Throttle Control Actuator	10 - Intake Manifold Bracket
5 - Electronic Throttle Control Actuator Gasket	11 - Intake Manifold Gasket
6 - Air Intake Pressure Temperature Sensor Bolt	

1. Disconnect the negative battery cable.
2. Remove the engine cover.
3. Drain the cooling system (See Cooling System Draining and Filling in Section 06 Cooling).

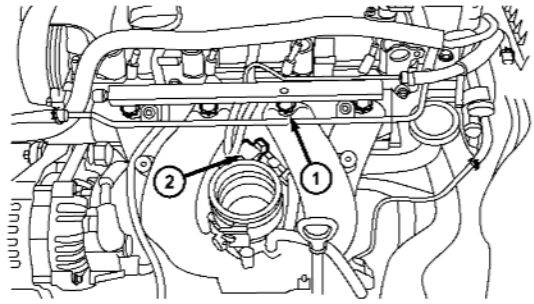
WARNING!

Always allow the engine to cool before opening the cooling system. Do not loosen the coolant pressure relief cap when the engine is operating or the cooling system is hot. The cooling system is under pressure; steam and hot liquid can come out forcefully when the cap is loosened slightly. Failure to follow these instructions may result in serious personal injury.

4. Remove the coolant fan & radiator assembly (See Coolant Fan & Radiator Assembly Removal & Installation in Section 06 Cooling).

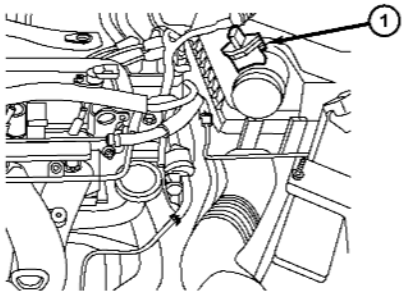
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5. Disconnect the four fuel injector electrical connectors (1).
6. Disconnect the throttle body control electrical connector (2).



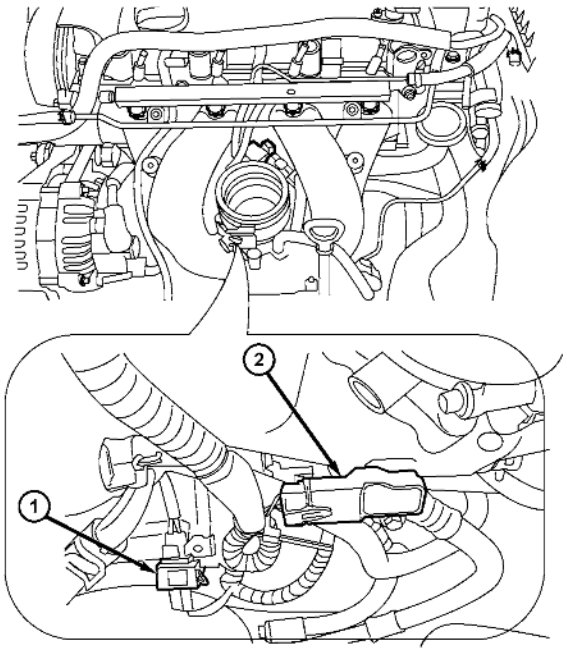
ltsm020221

7. Disconnect the air flow sensor electrical connector (1) (1.8L engine).



ltsm020204

8. Disconnect the air pressure sensor electrical connector (1) (1.6L engine).
9. Remove MAP sensor (2) from intake manifold.

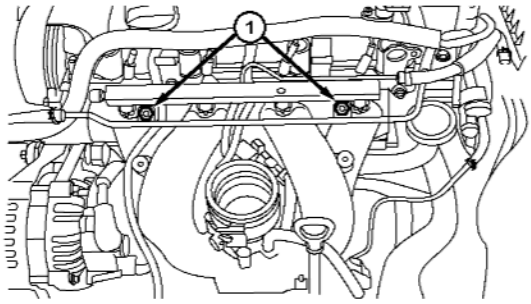


ltsm020227

10. Loosen the clamp between the air intake hose and the air cleaner.
11. Loosen the clamp between the air intake hose and the throttle body and then remove the intake pipe.
12. Loosen the clamp on the PCV hose and then disconnect the PCV hose.

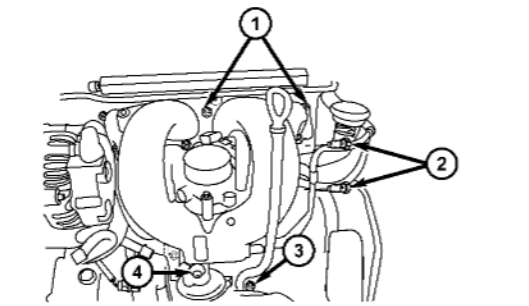
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13. Remove the fuel rail bracket bolts (1).
(Tighten: Fuel rail bracket bolts to 11 N·m)



ltsm020222

14. Remove the fuel rail with the fuel injectors and set aside.
15. Remove the screws securing the vacuum valve bracket to the intake manifold.
16. Set aside the vacuum valve and pipe.
17. Disconnect intake manifold electrical harness, and vacuum hose.
18. Remove the bolts (2) & (3) securing the engine oil dipstick to intake manifold. Remove the dipstick.
(Tighten: Dipstick bracket bolts to 11 N·m)
19. Disconnect the oil pressure switch connect (4).
20. Remove the nuts (1) securing the intake manifold to cylinder head.
(Tighten: Intake manifold nuts to 11 N·m)



ltsm020223

21. Installation is in the reverse order of removal.

Installation Notes:

- Clean all surfaces of manifold and cylinder head.
- Install a new intake manifold gasket during installation.
- Install new O-rings on the fuel injectors.

Idler Pulley

Removal & Installation

1. While using a suitable tool and securely holding the hexagonal portion of the drive belt tensioner, rotate the pulley counterclockwise to loosen the drive belt.

WARNING!
Avoid placing hands near the drive belt tensioner while it is being held.

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2. Remove the drive belt.

Upper Accessory Drive Belt Idler Pulley (1)

- Remove the bolt and the upper accessory drive belt idler pulley.

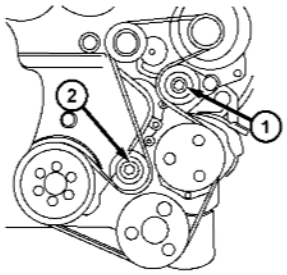
(Tighten: Upper idler pulley bolt to 45 N·m)

Lower Accessory Drive Belt Idler Pulley (2)

- Remove the bolt and the lower accessory drive belt idler pulley.

(Tighten: Lower idler pulley bolt to 45 N·m)

3. Installation is in the reverse order of removal.



Itsm020203

Oil Filter

Removal & Installation

NOTE :

The following special tools are required to perform the repair procedure:

- CH-10003 - Oil Filter Remover

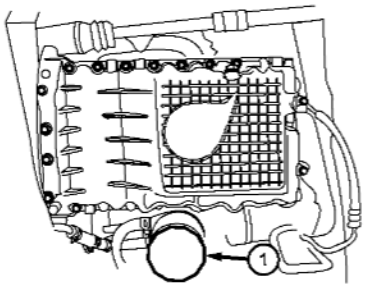
WARNING!

Prolonged and repeated contact with engine oil will harm your skin. If engine oil is spilled on your skin, wash it off immediately with water. In addition, used engine oil contains potentially harmful contaminants which may cause skin cancer. Always use adequate skin protection when performing vehicle service.

CAUTION:

When servicing the oil filter, install the special tool against the base of the filter to avoid deforming the filter.

1. Using special tool CH-10003 oil filter remover, remove the oil filter (1).
   (Tighten: Oil filter to 25 N·m)
   CAUTION: When removing the oil filter, ensure that the oil filter gasket is not stuck to the engine. The oil filter gasket must be removed from the engine before installing the new oil filter.



Itsm020206

2. Installation is in the reverse order of removal.

Installation Notes:

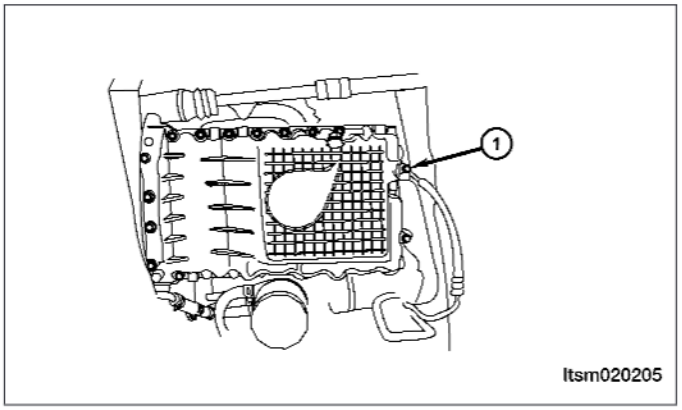
- Clean the surface, and verify the oil filter does not leak.

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Oil Pan

Removal & Installation

1. Remove the oil dipstick.
2. Raise and support the vehicle.
3. Remove the oil pan drain plug and drain the engine oil.
   (Tighten: Oil pan drain plug to 40 N·m)

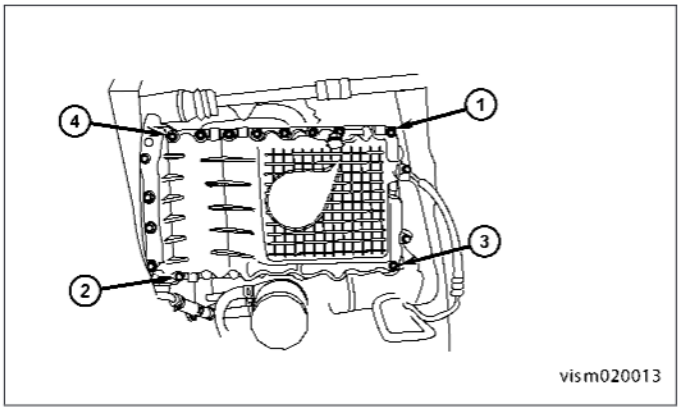


NOTE :
Do not pry on cylinder block to remove oil pan.

4. Remove oil pan bolts (1).
   (Tighten: Oil pan bolts to 18 N·m)
5. Using a putty knife, loosen seal around oil pan.
6. Remove the oil pan.
7. Installation is in the reverse order of removal.

Installation Notes:

- Oil pan sealing surfaces must be free of grease or oil.
- Install the four oil pan corner bolts in the sequence shown (1-2-3-4).
- Install the remaining oil pan bolts.
- Torque all the oil pan bolts to the proper specification.

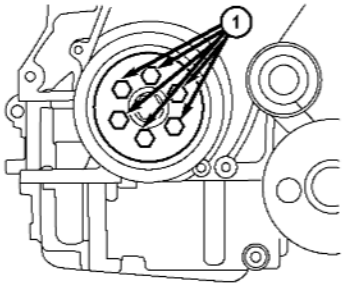


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Oil Pump

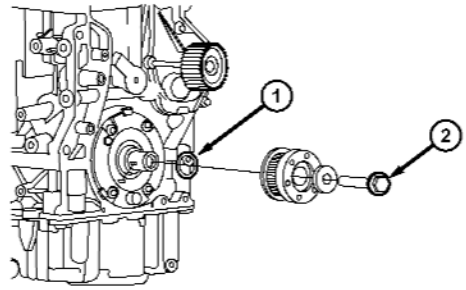
Removal & Installation

1. Remove the accessory drive belt (See Accessory Drive Belt Removal & Installation in Section 02 Engine).
2. Remove the crankshaft vibration damper retaining bolts (1).
   (Tighten: Crankshaft vibration damper bolts to 25 N·m)



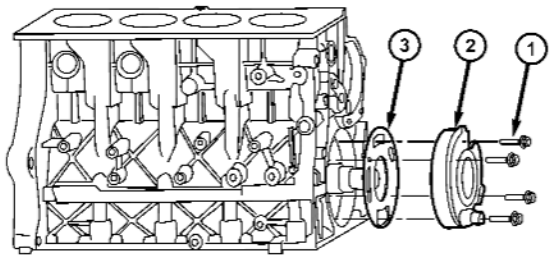
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3. Remove the engine timing belt (See Engine Timing Belt Removal & Installation in Section 02 Engine).
4. Remove the crankshaft timing belt pulley bolt (2) from the crankshaft.
   (Tighten: Crankshaft timing belt pulley bolt to 130 N·m and an additional 65°)
5. Remove the key-way from the crankshaft.
6. Using an appropriate tool, remove the front crankshaft oil seal (1).



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7. Remove the four oil pump bolts (1).
   (Tighten: Oil pump bolts to 11 N·m)
8. Remove the oil pump (2) using a suitable tool.
9. Remove the oil pump gasket (3).



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10. Installation is in the reverse order of removal.

Installation Notes:

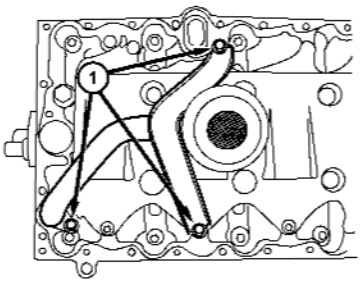
- Before installing, prime the new oil pump. Fill the oil pump with engine oil and rotate the oil pump.
- Replace the oil pump gasket.

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Oil Strainer

Removal & Installation

1. Raise and support the vehicle.
2. Remove the oil pan (See Oil Pan Removal & Installation in Section 02 Engine).
3. Remove the oil strainer retaining bolts (1).
   (Tighten: Oil strainer bolts to 18 N·m)



4. Carefully remove the oil strainer.
5. Installation is in the reverse order of removal.

Installation Notes:

- Install new O-rings on the oil strainer pipe.

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Engine Block

Specifications

Torque Specifications

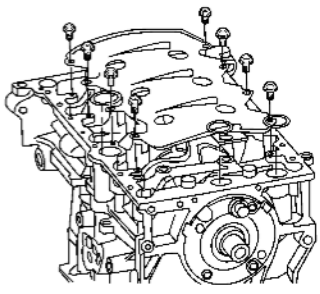
DESCRIPTION	TORQUE (N·m)
Connecting Rod Cap Bolts	1st Step: Tighten the bolt to 25 N·m 2nd Step: Tighten the bolt an additional 90°
Main Bearing Cap Bolts	1st Step: Tighten the bolt to 45 N·m 2nd Step: Tighten the bolt an additional 180°
Lower Cylinder Block Bolts	23

Clearance Specifications

DESCRIPTION	SPECIFICATION (mm)
Surface Distortion Limit	0.15
Inner Diameter Standard	81
Out-Of-Round	< 0.008
Taper	< 0.01

Disassembly

1. Remove the oil pan and then remove oil baffle.
2. Remove the oil strainer.

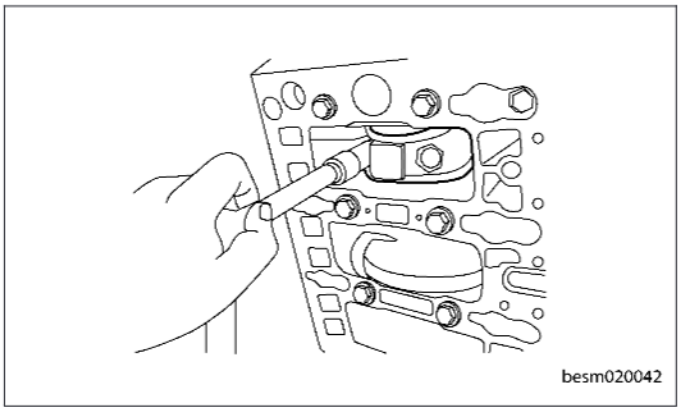

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3. For each connecting rod/piston assembly to be removed, rotate the crankshaft to the bottom dead center position for each cylinder.

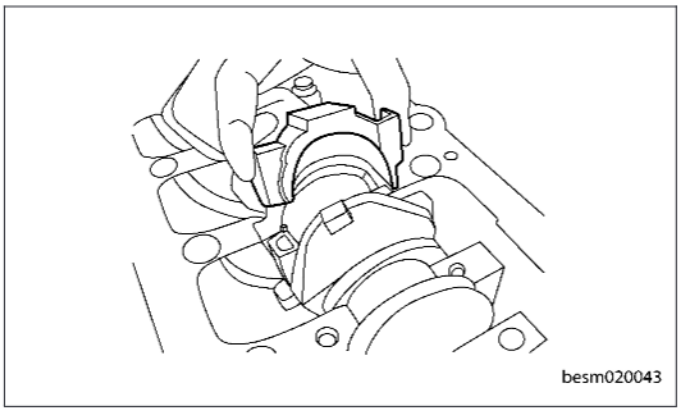
NOTE :
Before removing the connecting rod/piston assembly, check the connecting rod side clearance.

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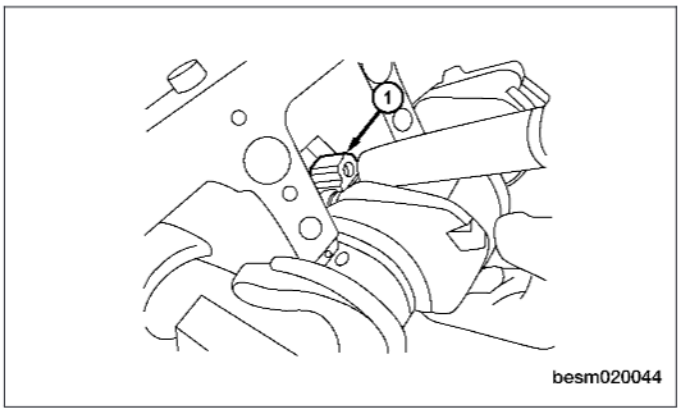
4. Remove the connecting rod retaining bolts.


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5. Remove the connecting rod bearing cap.

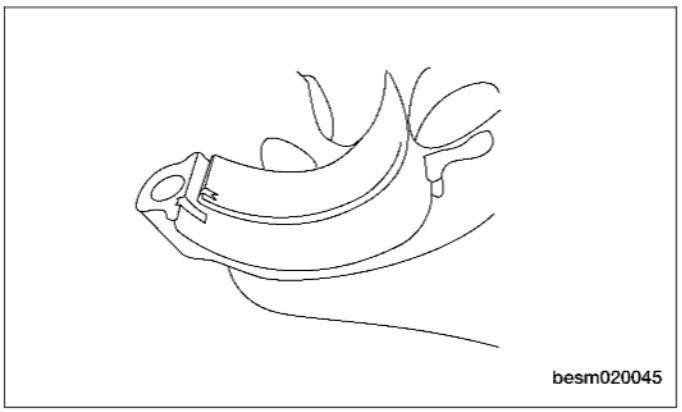

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6. Using a hammer handle or similar tool, push the connecting rod/piston assembly (1) out through the top of the cylinder block.



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7. Remove the connecting rod bearings (See Connecting Rod Removal & Installation in Section 02 Engine).


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CAUTION: When removing the connecting rod side bearings, note the installation position. Keep them in the correct order.

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8. Installation is in the reverse order of removal.

Inspection

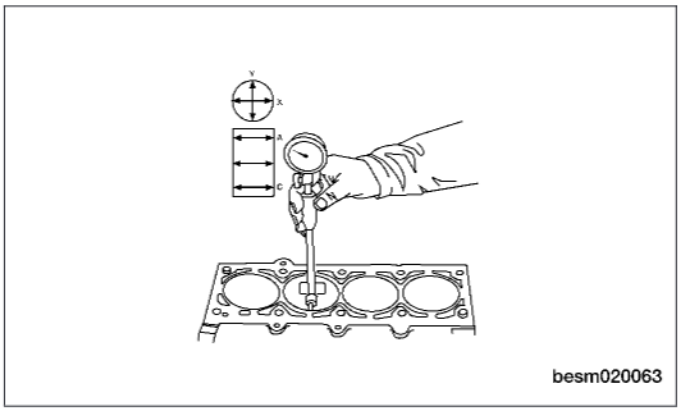
NOTE :
All measurements should be taken with the engine block at room temperature, 21°C.

Engine Block

- Clean cylinder block thoroughly and check all core hole plugs for evidence of leaking.
- Examine block and cylinder bores for cracks or fractures.
- Check block deck surfaces for flatness. Deck surface must be within service limit of 0.050 mm.

Cylinder Bore

- The cylinder walls should be checked for out-of-round and taper with cylinder indicator or equivalent. If the cylinder walls are badly scuffed or scored, the cylinder block should be replaced, and new pistons and rings fitted.
- Measure the cylinder bore at three levels in directions X and Y. Top measurement should be 10 mm down and bottom measurement should be 10 mm up from bottom of bore.



CYLINDER BORE	
All Cylinders	81.000 - 81.010 mm

Assembly

NOTE :
Cleanliness is extremely important during the engine assembly procedure. Any foreign material, including any material created while cleaning gasket surfaces, that enters the oil passages, coolant passages or the oil pan can cause engine failure.

NOTE :
Assemble all components in their original position.

1. Install the pistons to the connecting rods.
2. Using a piston ring expander, install the piston rings.
3. Assemble all components in the reverse order of disassembly.

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Pistons

Specifications

Clearance Specifications - Pistons

DESCRIPTION	SPECIFICATION (mm)
Surface Distortion Limit	0.15
Inner Diameter Standard	81
Out-Of-Round	< 0.008
Taper	< 0.01

Clearance Specifications - Piston Ring Groove

DESCRIPTION	SPECIFICATION (mm)
First Ring	0.04 - 0.08
Second Ring	0.01 - 0.0251

Clearance Specifications - Piston Ring End Gap

DESCRIPTION	SPECIFICATION	LIMIT
First Ring End Gap	0.2 - 0.4 mm	0.8 mm
Second Ring End Gap	0.4 - 0.6 mm	1.0 mm

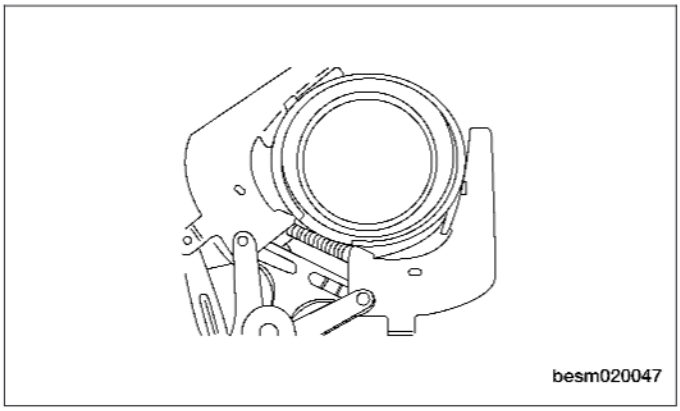
Clearance Specifications - Piston to Piston Pin

DESCRIPTION	SPECIFICATION (mm)
Piston To Piston Pin	0.002 - 0.013

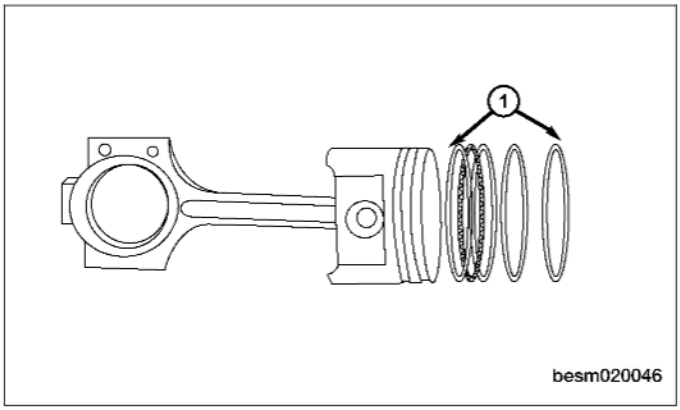
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Disassembly

- Piston Ring Removal
  - Using a suitable ring expander, remove upper and intermediate piston rings.
  - Remove the upper oil ring side rail, lower oil ring side rail and then oil ring expander from piston.
  - Clean ring grooves of any carbon deposits.

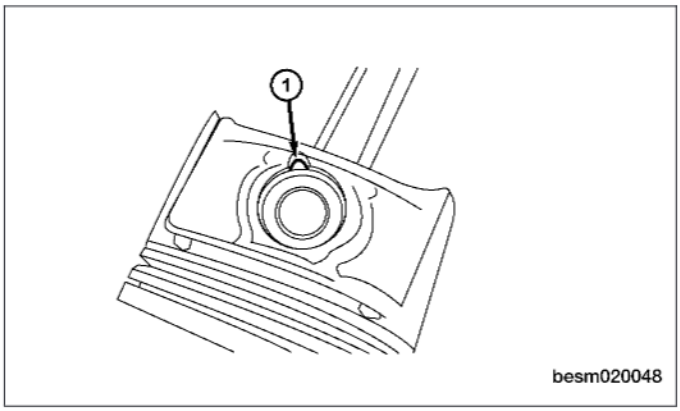

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CAUTION:
Before removing the piston rings (1), check the piston ring side clearance. Be careful to mark the location of the piston rings if they are to be reused.



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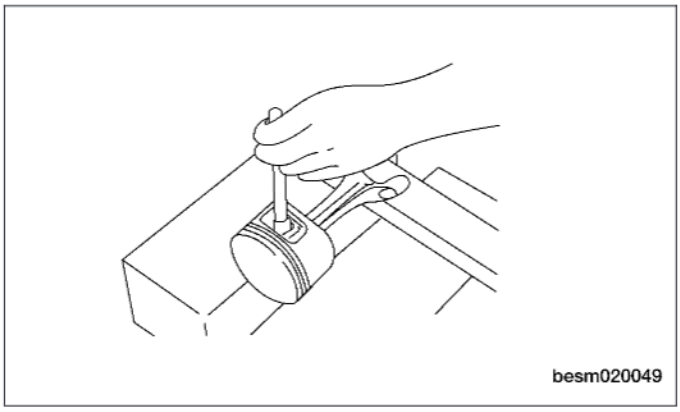
- Piston Pin Snap Ring Removal
  - Using snap ring pliers, remove the snap ring (1).
  - Heat the pistons if necessary.



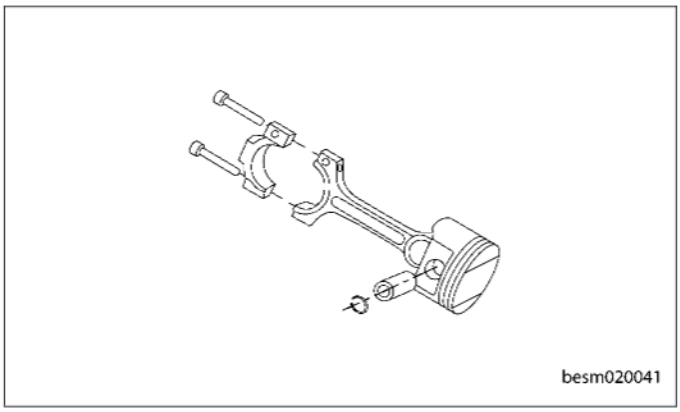
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- Piston Pin Removal
  - Push out the piston pin with a suitable tool.

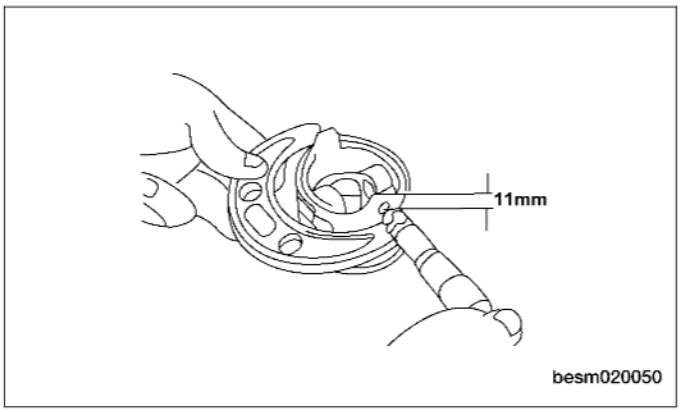


- Connecting Rod & Piston Disassembly
  - Remove the piston from the connecting rod.



Inspection

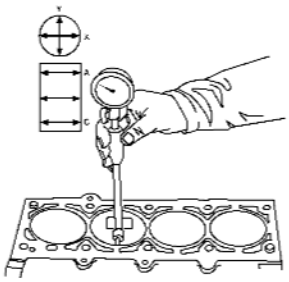
Check the piston diameter.



PISTON DIAMETER	
All Pistons	80.946 - 80.964 mm

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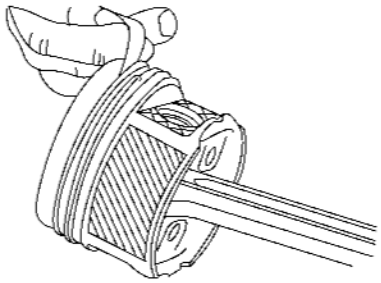
Check the inner diameter of each cylinder bore (See Cylinder Bore Inspection in Section 02 Engine).



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CYLINDER BORE	
All Cylinders	81.000 - 81.010 mm

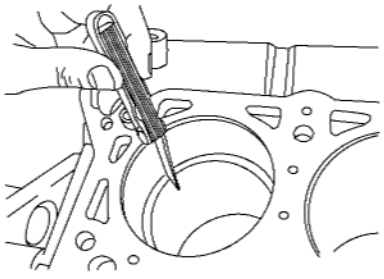
Check piston ring to groove side clearance.
- Clean the ring slot using a suitable tool.
- Measure piston ring to groove side clearance.



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RING GROOVE CLEARANCE	
First Ring	0.04 - 0.08 mm
Second Ring	0.01 - 0.0251 mm

- Wipe the cylinder bore clean. Insert ring and push down with piston to ensure it is square in the bore. The ring gap measurement must be made with the ring positioned at least 13 mm from bottom of cylinder bore and below the bottom of the oil ring travel where the cylinder bore has minimal wear. Check gap with feeler gauge.

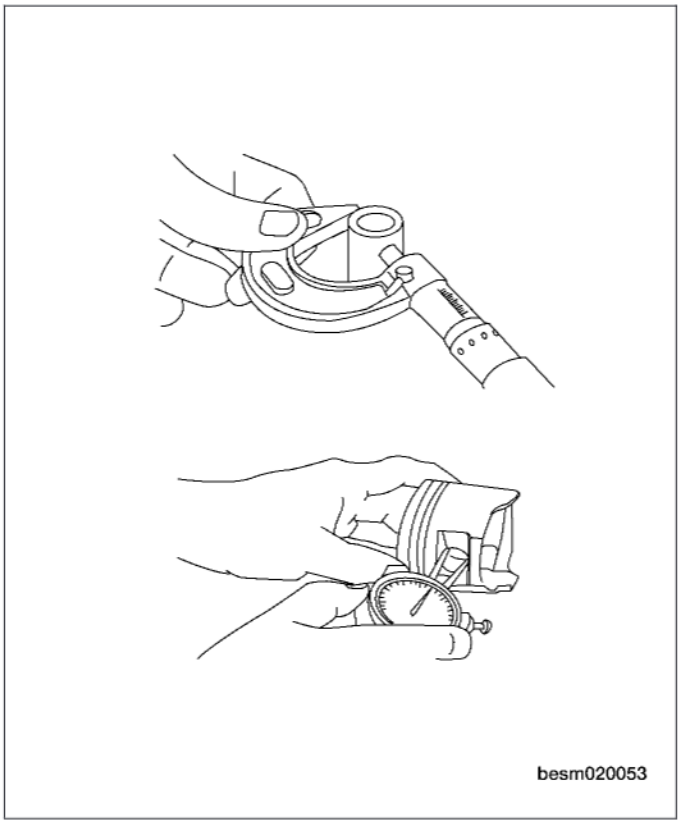


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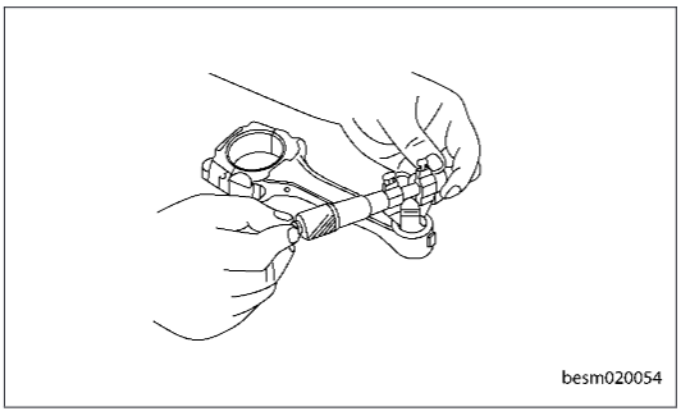
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RING END GAP CLEARANCE		
First Ring	0.2 - 0.4 mm	0.8 mm
Second Ring	0.4 - 0.6 mm	1.0 mm

- Check the diameter of the piston pin bore.
- Check the outer diameter of the piston pin.



- Check the inner diameter of connecting rod (small end).



PISTON PIN CLEARANCE	
Piston and Piston Pin	0.002 - 0.013 mm

Assembly

1. Install the piston to the connecting rod. Assemble the components in their original positions.
2. Using a piston ring expander, install the piston rings. Assemble the components in their original positions.
3. Assemble all components in the reverse order of disassembly.

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Connecting Rods

Specifications

Torque Specifications

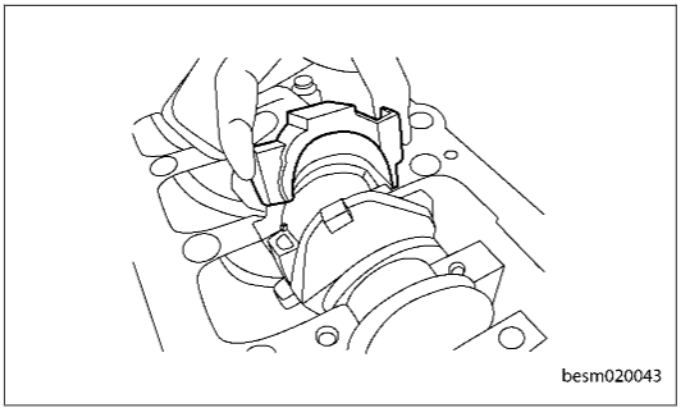
DESCRIPTION	TORQUE (N·m)
Connecting Rod Bolts	1st Step: Tighten bolts to 25 N·m 2nd Step: Tighten the connecting rod bolts an additional 90°

Clearance Specifications

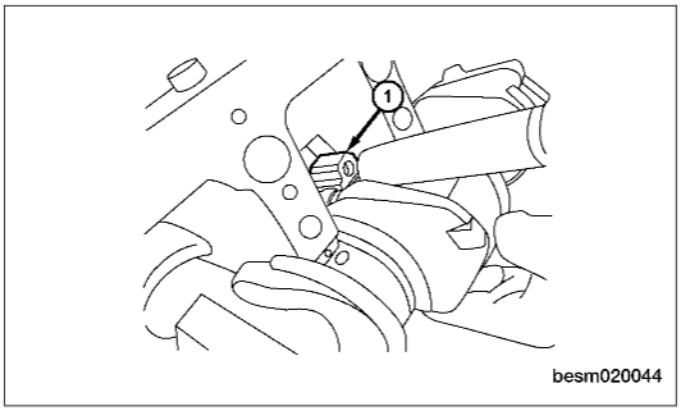
DESCRIPTION	SPECIFICATION (mm)
Connecting Rod Radial Clearance	0.016 - 0.051
Connecting Rod Axial Clearance	0.002 - 0.013

Disassembly

1. Remove the connecting rod cap bolts.
2. Remove the connecting rod bearing cap.


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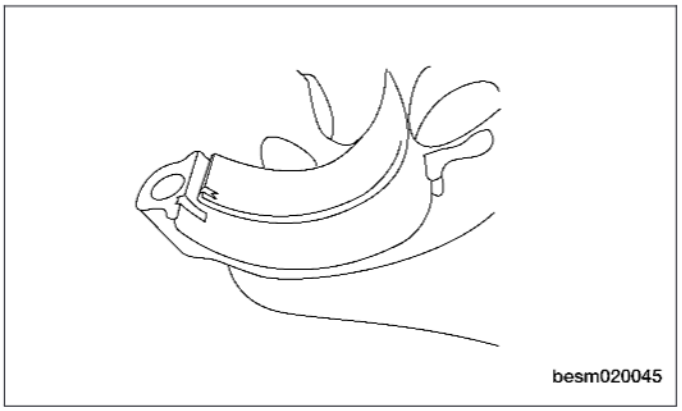
3. Using a hammer handle or similar tool, push the piston and connecting rod assembly (1) out through the cylinder head side of the engine block.
   NOTE: Before removing the piston and connecting rod assembly, check the connecting rod side clearance.



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4. Remove the connecting rod bearings.
   CAUTION: When removing the connecting rod side bearings, note the installation position. Keep them in the correct order.


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Inspection

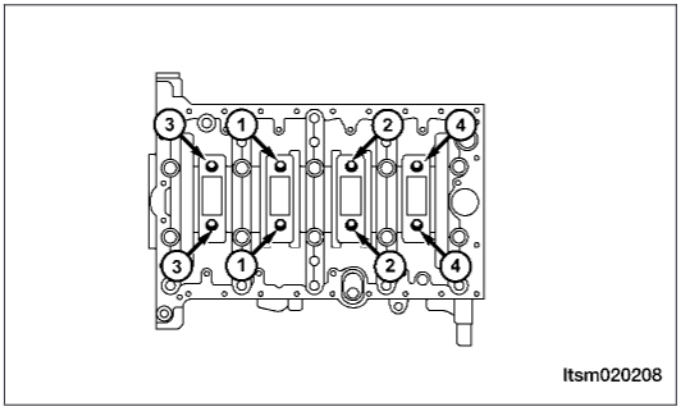
- Check the radial clearance of connecting rod bearing.

CONNECTING ROD RADIAL CLEARANCE	
Radial Clearance	0.016 - 0.051 mm

Assembly

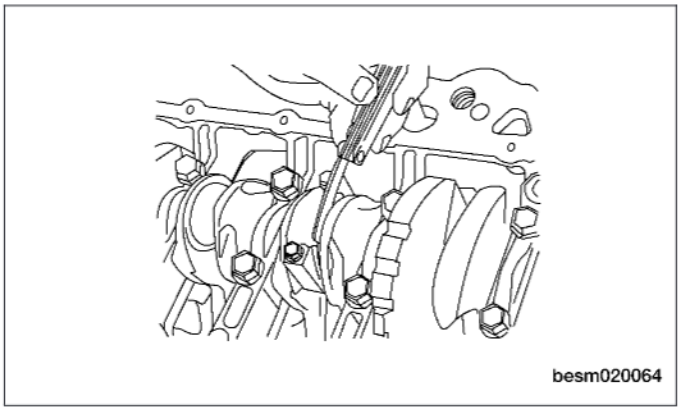
NOTE :
The rod bolts should not be reused.

1. Before installing the NEW rod bolts, the threads and under the bolt head should be oiled with clean engine oil.
2. Install each bolt finger tight, then alternately tighten each bolt to assemble the cap properly.
3. Tighten the connecting rod bolts using the two step torque-turn method:
   - 1st Step: Tighten bolts to 25 N·m
   - 2nd Step: Tighten the connecting rod bolts an additional 90°



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4. Using a feeler gauge check connecting rod side clearance.
   - Check axial clearance of connecting rod.


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Crankshaft

Specifications

Torque Specifications

DESCRIPTION	TORQUE (N·m)
Main Bearing Cap Bolts	1st Step: Tighten the bolt to 45 N·m 2nd Step: Tighten the bolt an additional 180°
Lower Cylinder Block Bolts	23

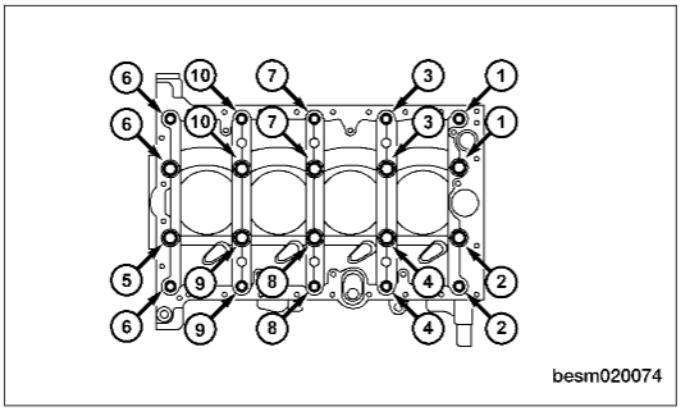
Clearance Specifications

DESCRIPTION	SPECIFICATION (mm)
Diameter of Crankshaft Main Journals	53.981 - 54
Diameter of Crankshaft Rod Journals	47.884 - 47.9
Out-of-Round Maximum of Crankshaft Main Journals	0.008
Axial Clearance of Crankshaft	0.07 - 0.265
Radial Clearance of Crankshaft	0.0035 - 0.034
Coaxality Crankshaft Main Journal	0.05
Thrust Washer Thickness	2.4 - 2.405

Disassembly

1. Remove the front crankshaft oil seal (See Front Crankshaft Oil Seal Removal & Installation in Section 02 Engine).
2. Remove the rear crankshaft oil seal (See Rear Crankshaft Oil Seal Removal & Installation in Section 02 Engine).
3. Remove the pistons with connecting rod assemblies.
4. Remove the lower cylinder block bolts in the sequence shown.

   NOTE: Before loosening the lower cylinder block bolts, measure the crankshaft side clearance.



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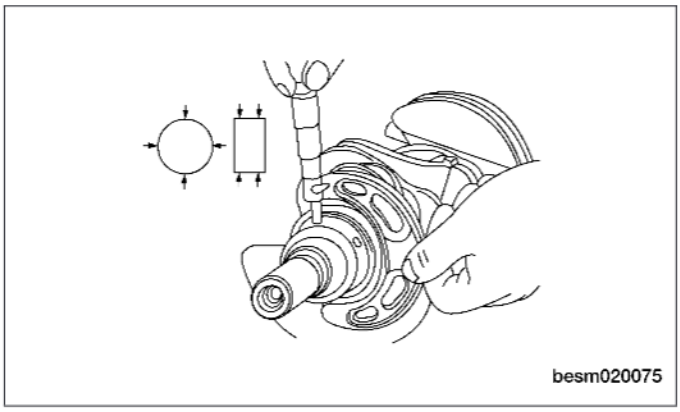
5. Remove the lower cylinder block.
6. Remove the crankshaft.
7. Remove the main bearings and thrust bearings from the cylinder block and lower cylinder block.

   NOTE: If reusing the bearings, identify and number the bearings so that they are assembled in the same position and direction.

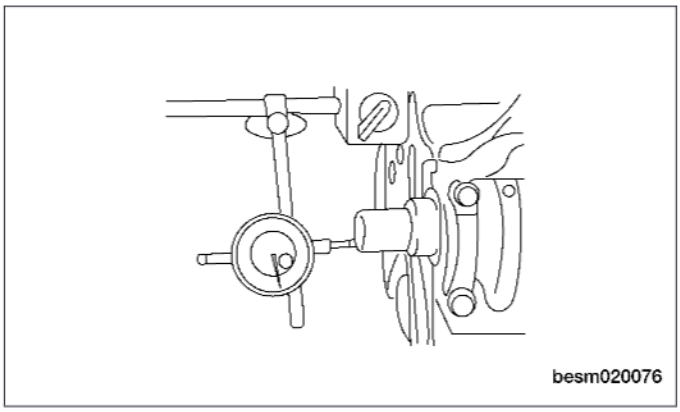
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Inspection

- The crankshaft main journals should be checked for excessive wear, roundness and scoring. Limits of roundness on any crankshaft main journals should be held to 0.008 mm. Limits of roundness on any crankshaft rod journals should be held to 0.005 mm. DO NOT nick crank pin or bearing fillets. Limits of out of round on any crankshaft journals should be held to 0.005 mm.

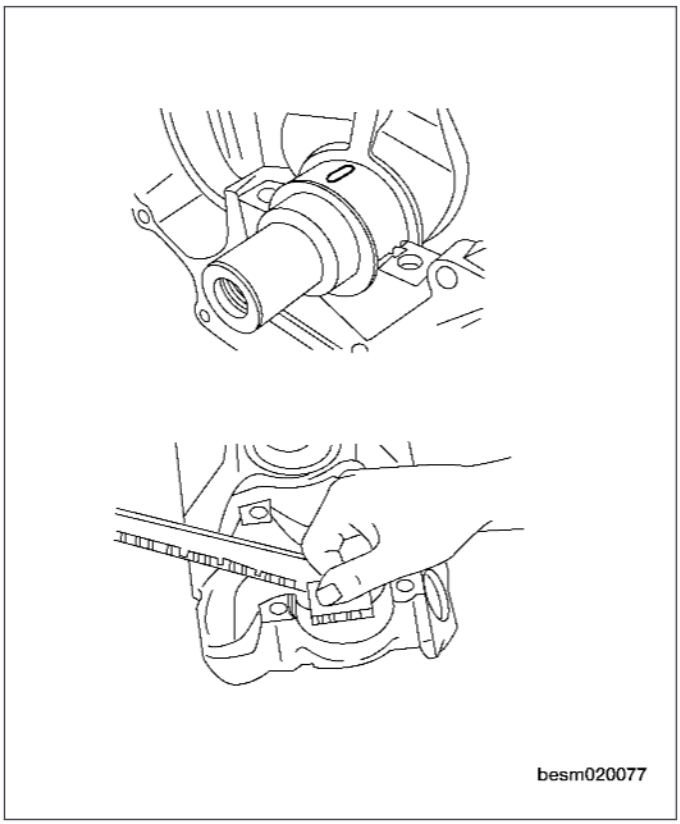

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- Check the axial clearance after installation. Standard of axial clearance should be 0.07 mm. Limits of axial clearance should be held to 0.265 mm.


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- Clean the journal and bearing.
- Install the crankshaft.
- Cut the plastic-gauge to the same width as the bearing, and then put it onto the crankshaft journal to make it parallel with the central line of the crankshaft.
- Install the main bearing cap carefully, and tighten the bolts to the specified torque.
- Remove the main bearing cap.
- Measure the oil clearance with the plastic-gauge.
  - Standard oil clearance of crankshaft rod and main journals should be 0.022 mm
  - Limits of oil clearance of crankshaft rod and main journals should be 0.058 mm

Standard oil clearance of crankshaft main journal should be 0.022 mm. Limits of oil clearance of crankshaft main journal should be 0.058 mm.


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Assembly

1. Install the main bearings and thrust bearings to the upper cylinder block and lower cylinder block.
   NOTE: Identify and number the bearings, if reusing them, so that they are assembled in the same position and direction.
2. Assemble the crankshaft and main bearings in the reverse order of disassembly.

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CYLINDER HEAD UNIT REPAIR

Cylinder Head

Specifications

Torque Specifications

DESCRIPTION	TORQUE (N·m)
Cylinder Head Bolts	1st Step: Tighten the bolt to 40 ± 5 N·m 2nd Step: Tighten the bolt an additional 90 ± 5° 3rd Step: Tighten the bolt an additional 90 ± 5°
Cylinder Head Cover Bolts	11

Clearance Specifications

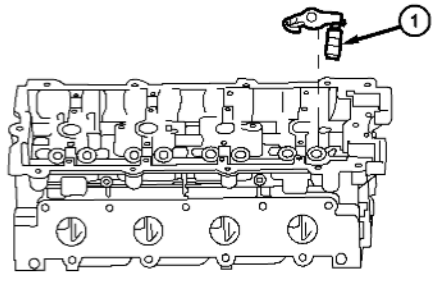
DESCRIPTION	SPECIFICATION (mm)
Cylinder Head Flatness	0.04
Intake Valve Deflection	0.02
Exhaust Valve Deflection	0.04
Spring Height	47.7

Disassembly

NOTE :
The following special tools are required to perform the repair procedure:
- CH-20011 - Valve Seal Installer
- CH-20012 - Valve Stem Seal Installer Guide
- CH-20013 - Valve Seal Remover
- CH-20017 - Valve Keeper Installer
- CH-20018 - Valve Spring Compressor

NOTE :
Replacement cylinder head comes complete with valves, seals, springs, retainers, keepers, tappets, and camshafts.

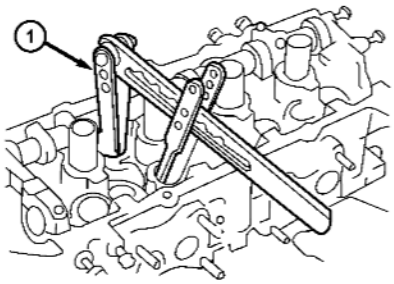
1. Remove camshafts.
2. Remove the hydraulic tappet assembly (1).



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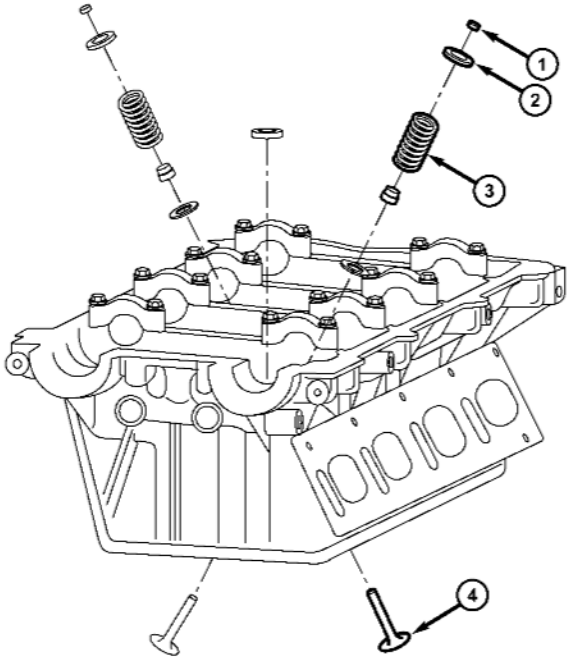
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3. Using the special tool CH-20018 (1), compress the valve spring.



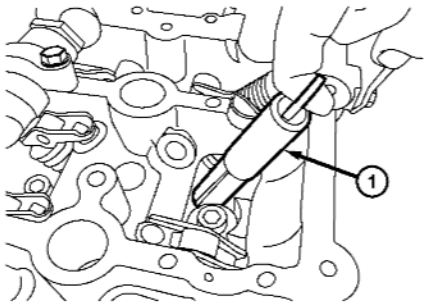
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4. Remove the valve keeper (1), valve spring retainer (2) and valve spring (3).
5. Push the valve stem from the cylinder head and remove the valve (4).



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6. Using special tool CH-20013 (1), remove the valve oil seal.



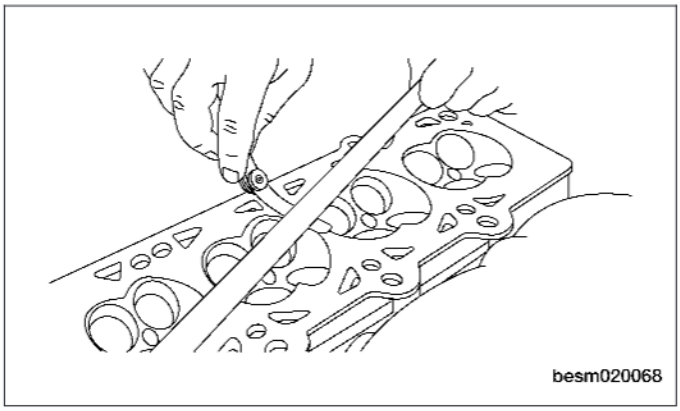
ltsm020225

7. Remove the valve guide.
8. Remove the spark plugs.

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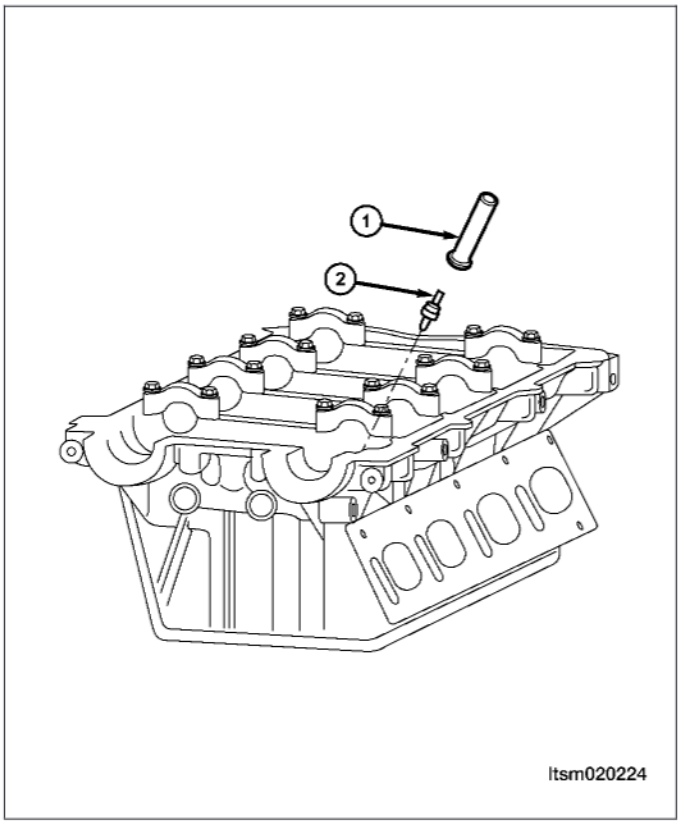
Inspection

- Cylinder head must be flat within 0.04 mm.
- Inspect camshaft bearing journals for scoring.
- Remove carbon and varnish deposits from inside of valve guides with a valve guide cleaner.
- Verify the valve tappets move freely in their bores, and that they have been rotating.
- Check the valve guide height.


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Assembly

1. Install new valve guide if necessary.
2. Install new valve seat if necessary.
3. Using special tool CH-20011 (1) and CH-20012 (2), install the new valve oil seal.

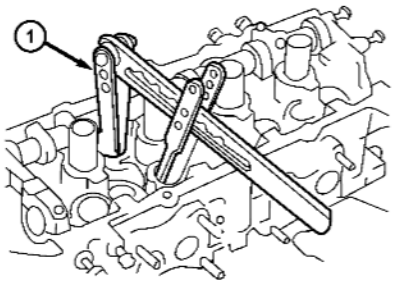


ltsm020224

4. Install the valves into the cylinder head (larger diameter on intake side).
5. Install the valve springs.
6. Install the valve spring retainers.

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7. Using valve spring compressor CH-20018 (1), compress the valve springs.
8. Install the valve keepers.



besm020067

9. Strike the valve stem lightly with a plastic hammer after installation to verify proper assembly.
10. Install valve tappets in the head.
11. Install the camshafts.

Installation Notes:

- Coat the valve oil seal with engine oil.

Camshaft

Specifications

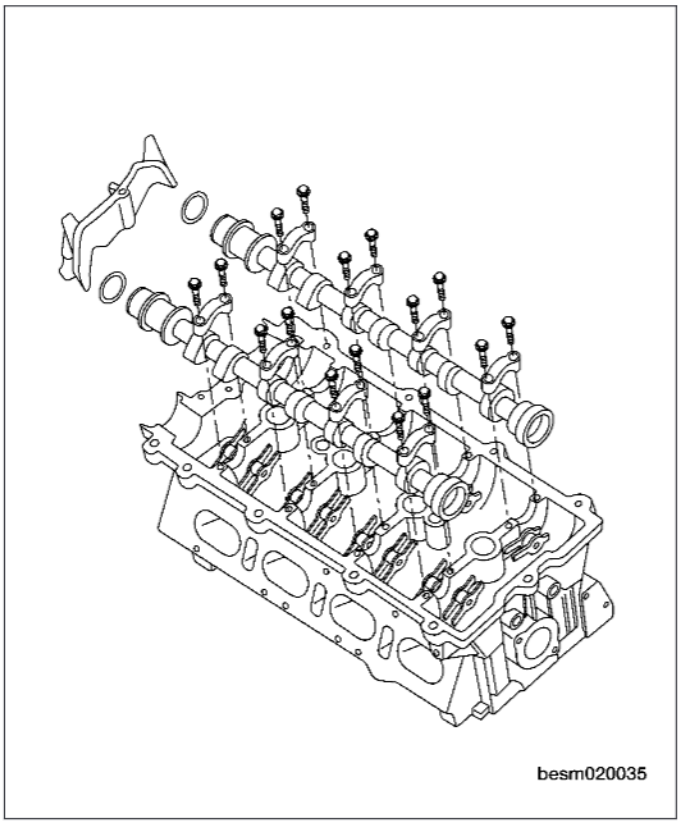
Camshaft Specifications

DESCRIPTION	SPECIFICATION (mm)
Intake Cam Lobe Height	37.15
Exhaust Cam Lobe Height	37.05
Journal #1 Outer Diameter	31.934 - 31.95
Journal #2, #3, #4, #5, Outer Diameter	23.947 - 23.96
Cam Bearing #1 Inner Diameter	32 - 32.025
Cam Bearing #2, #3, #4, #5, Inner Diameter	24 - 24.021
Journal #1 Clearance	0.05 - 0.091
Journal #2, #3, #4, #5 Clearance	0.04 - 0.074
Intake Camshaft Axial Clearance	0.15 - 0.20
Exhaust Camshaft Axial Clearance	0.15 - 0.20

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Disassembly

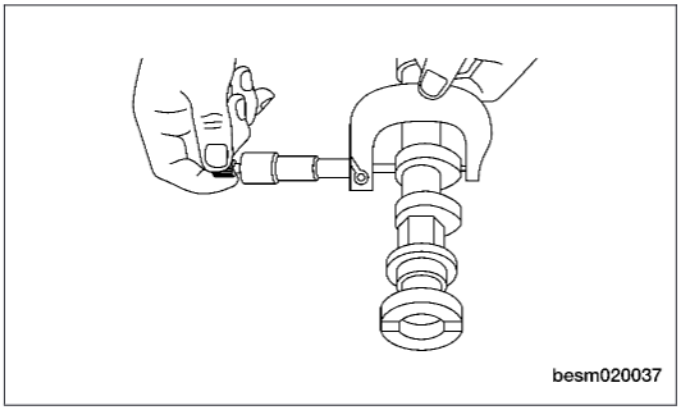
1. Remove the camshaft bearing cap bolts.
   NOTE: Equally loosen camshaft bearing cap bolts in several steps.


besm020035

2. Remove the camshaft bearing caps and place them in proper order.
   NOTE: The camshaft bearing caps are marked for identification.
3. Remove the camshafts and then remove the camshaft seals.

Inspection

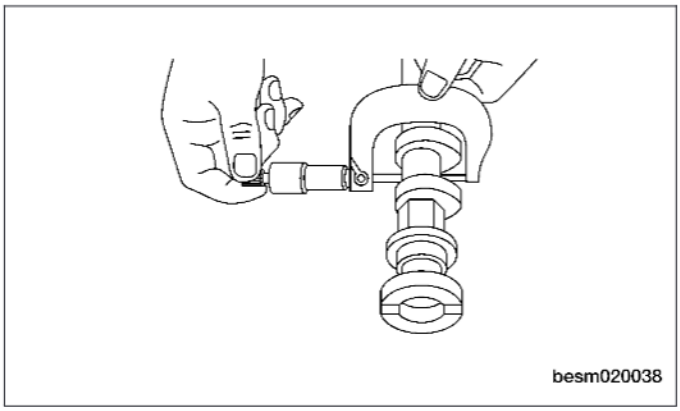
- Measure the camshaft cam lobe height.
- If wear is beyond the limit, replace the camshaft.


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CAMSHAFT CAM LOBE HEIGHT	
Intake Cam Lobe Height	37.15 mm
Exhaust Cam Lobe Height	37.05 mm

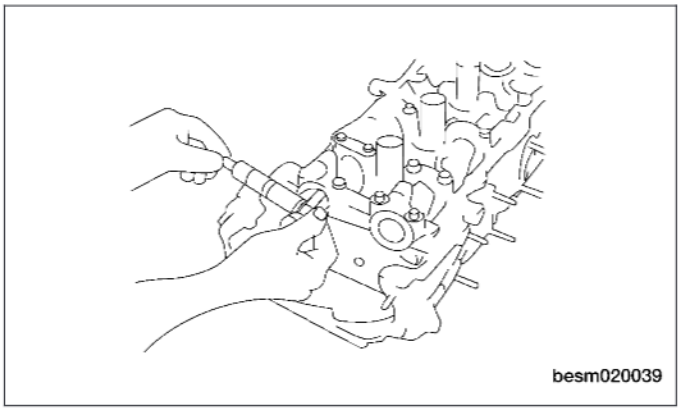
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- Measure the outer diameter of the camshaft journal.



OUTER DIAMETER OF CAMSHAFT JOURNAL	
Journal #1 Outer Diameter	31.934 - 31.95 mm
Journal #2, #3, #4, #5, Outer Diameter	23.947 - 23.96 mm

- Measure the inner diameter of the camshaft bearing.



INNER DIAMETER OF CAMSHAFT BEARING	
Cam Bearing #1 Inner Diameter	32 - 32.025 mm
Cam Bearing #2, #3, #4, #5, Inner Diameter	24 - 24.021 mm

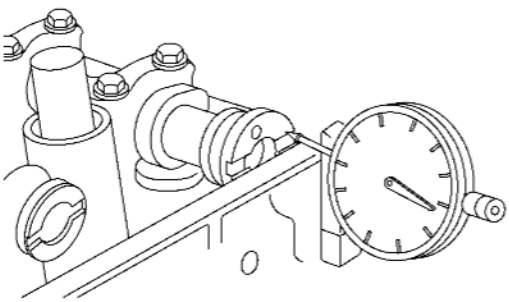
- Calculation of camshaft journal clearance

Journal clearance = (inner diameter of camshaft bearing) - (outer diameter of camshaft journal)

CAMSHAFT JOURNAL CLEARANCE	
Journal #1 Clearance	0.05 - 0.091 mm
Journal #2, #3, #4, #5 Clearance	0.04 - 0.074 mm

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- Measure the axial clearance of camshaft.



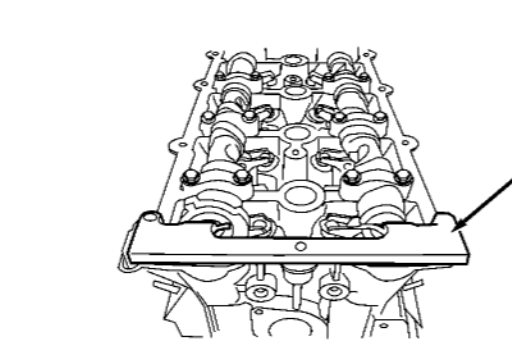
besm020070

CAMSHAFT AXIAL CLEARANCE	
Intake Camshaft	0.15 - 0.20 mm
Exhaust Camshaft	0.15 - 0.20 mm

Assembly

1. Using special tool CH-20010 (1), install the camshaft holder to hold the camshafts in place.

NOTE :
The camshaft holder will prevent the camshafts from rotating in either direction.

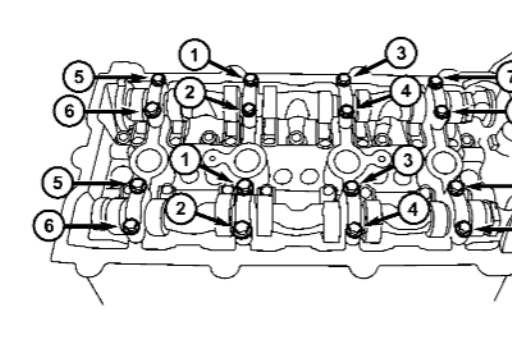


besm020016

2. Installation is in the reverse order of removal.

Installation Notes:

- Install the intake and exhaust camshaft bearing caps in the proper order.
- Slowly tighten bolts to the specified torque.
- Follow the torque sequence as shown.



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Valve & Valve Guides

Specifications

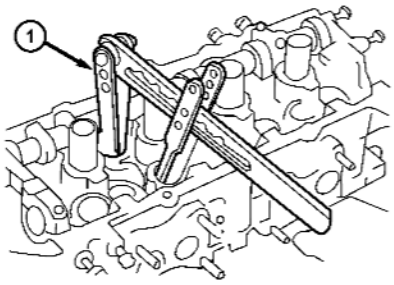
Valve & Valve Guide Specifications

DESCRIPTION	SPECIFICATION (mm)
Intake Valve Deflection	0.02
Exhaust Valve Deflection	0.04
Intake Valve Guide Clearance	0.012 - 0.043
Exhaust Valve Guide Clearance	0.032 - 0.063

Disassembly

NOTE :
The following special tools are required to perform the repair procedure:
- CH-20011 - Valve Seal Installer
- CH-20012 - Valve Stem Seal Installer Guide
- CH-20013 - Valve Seal Remover
- CH-20017 - Valve Keeper Installer
- CH-20018 - Valve Spring Compressor

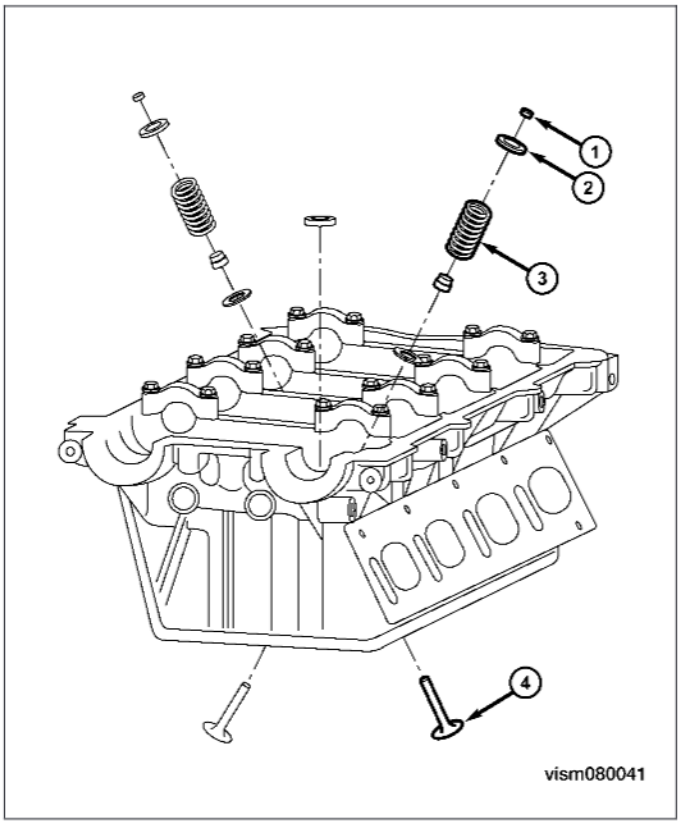
1. Using the special tool CH-20018 (1), compress the valve springs.



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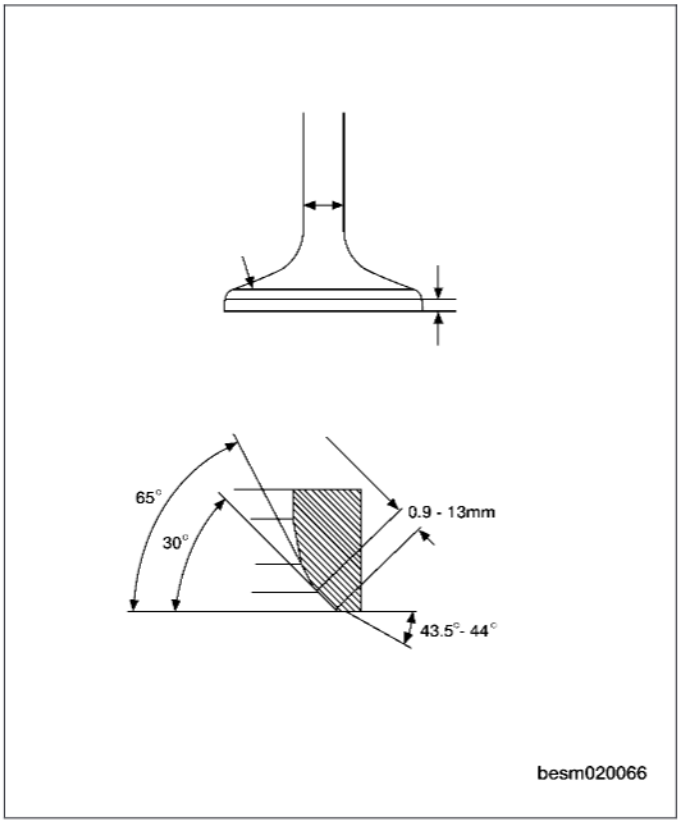
2. Remove the valve keeper (1), valve spring retainer (2) and valve spring (3).
3. Remove valves (4) from the cylinder head.



Inspection

Inspect the valves for the following:

- Clean all valves thoroughly and discard burned, warped and cracked valves.
- Check valve seats and valve faces for damage.
- When reconditioning valves follow the specifications outlined for both intake and exhaust valves.



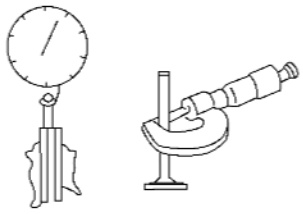
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ITEM		SPECIFICATION (mm)
Valve Outer Diameter	Intake Valve	5.98 ± 0.008
	Exhaust Valve	5.96 ± 0.008
Valve Guide Inner Diameter	Intake Valve	5.4 ± 0.1
	Exhaust Valve	5.4 ± 0.1
Fringe Thickness On Top Of Valve	Intake Valve	0.3 ± 0.15
	Exhaust Valve	0.3 ± 0.15
Valve Tilt Angle	Intake Valve	65°
	Exhaust Valve	68°
Valve Height	Intake Valve	107.998
	Exhaust Valve	106.318

- Measure valve deflection.

VALVE DEFLECTION LIMIT (DIAL GAUGE READING)	
Intake	0.02 mm
Exhaust	0.04 mm

- If it exceeds the limit, check valve to valve guide clearance.
  - Measure valve stem diameter and valve guide inner diameter.
  - Check that clearance is within specification.
  - If it exceeds the limit, replace valve or valve guide.



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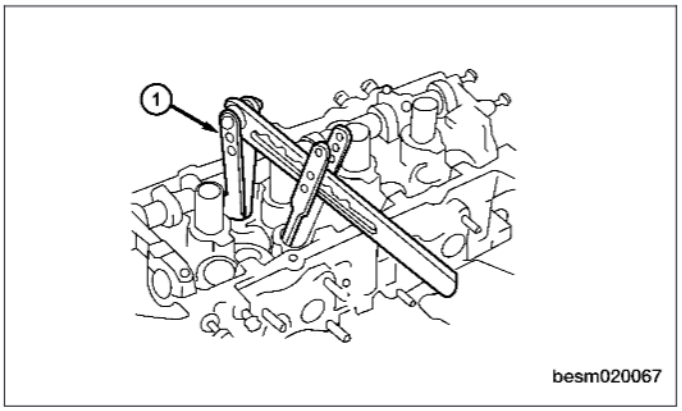
VALVE TO VALVE GUIDE CLEARANCE STANDARD	
Intake	0.012 - 0.043 mm
Exhaust	0.032 - 0.063 mm

Assembly

1. Install the valves into the cylinder head (larger diameter on intake side).
2. Install the valve springs.
3. Install the valve spring retainers.

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4. Using valve spring compressor CH-20018 (1), compress the valve springs.
5. Install the valve keepers.



6. Strike the valve stem lightly with a plastic hammer after installation to verify proper assembly.

Valve Springs

Specifications

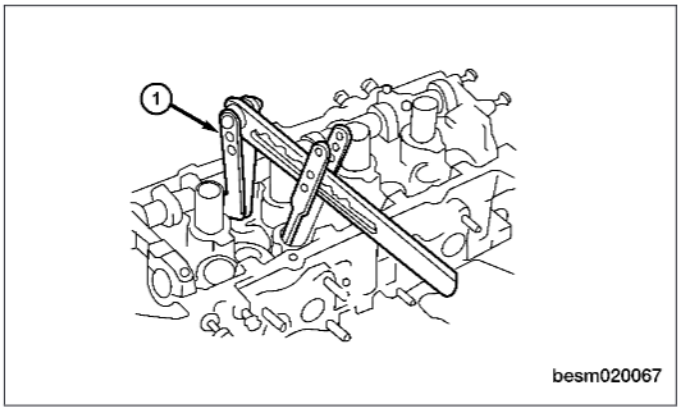
Valve Spring Specifications

DESCRIPTION	SPECIFICATION (mm)
Spring Free Length	47.7
Spring Height At 620 Newtons Of Pressure	32.0

Disassembly

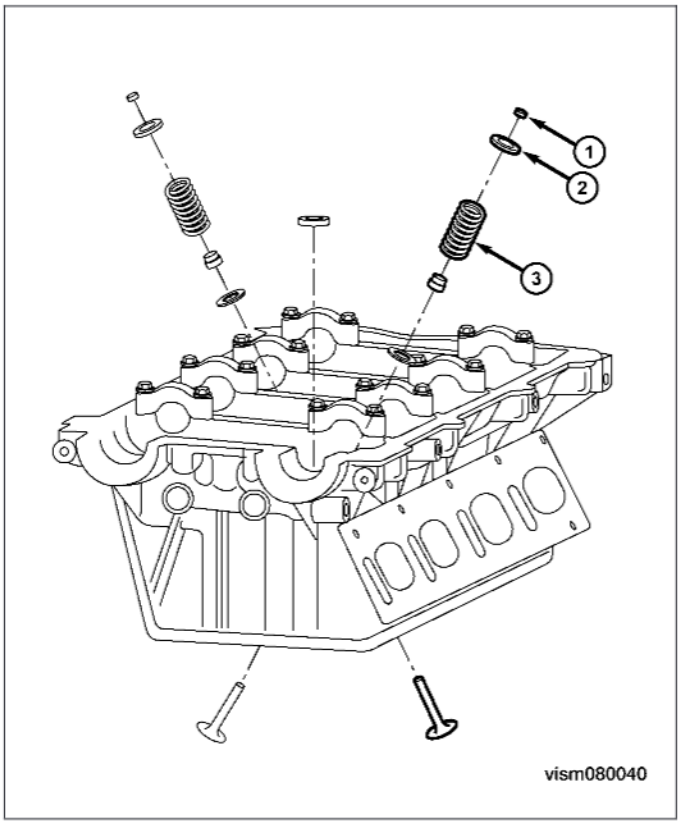
NOTE :
The following special tools are required to perform the repair procedure:
- CH-20011 - Valve Seal Installer
- CH-20012 - Valve Stem Seal Installer Guide
- CH-20013 - Valve Seal Remover
- CH-20017 - Valve Keeper Installer
- CH-20018 - Valve Spring Compressor

1. Using the special tool CH-20018 (1), compress the valve springs.



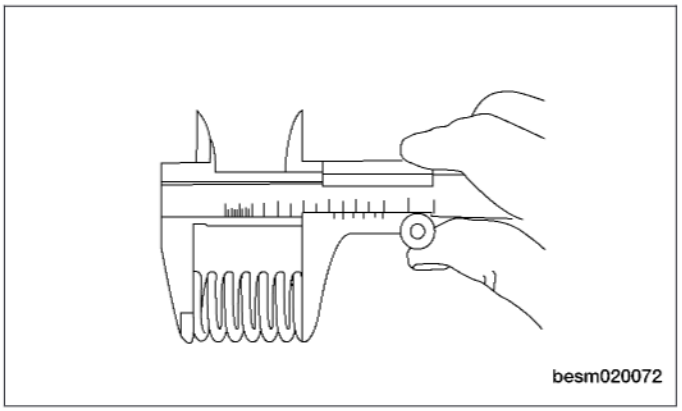
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2. Remove the valve keeper (1), valve spring retainer (2).
3. Remove the valve springs (3) from the cylinder head.



Inspection

- Whenever valves have been removed for inspection, reconditioning or replacement, valve springs should be tested for correct load.
- Discard the springs that do not meet specifications.
- The following specifications apply to both intake and exhaust valve springs.



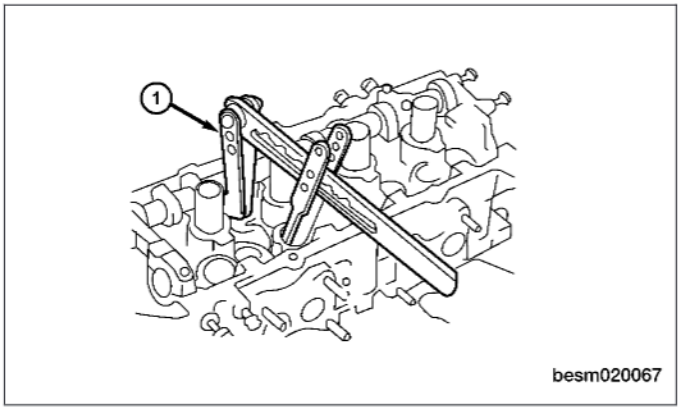
VALVE SPRING LENGTH/HEIGHT	
Spring Free Length	47.7 mm
Spring Height At 620 Newtons Of Pressure	32.0 mm

If it is not within specifications, replace the valve spring.

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Assembly

1. Install the valve springs.
2. Install the valve spring retainers.
3. Using valve spring compressor CH-20018 (1), compress the valve springs.
4. Install the valve keepers.



5. Strike the valve stem lightly with a plastic hammer after installation to verify proper assembly.

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2.0L ENGINE MECHANICAL

GENERAL INFORMATION 02-77
- Description 02-77
- Operation 02-77
- Specifications 02-77
- Special Tools 02-81
- Lubrication System 02-84

DIAGNOSIS & TESTING 02-87
- Engine Performance Diagnostics 02-87
- Engine Mechanical Diagnostics 02-88
- Cylinder Compression Pressure Test 02-90
- Cylinder Head Gasket Test 02-90

ON-VEHICLE SERVICE 02-91

Accessory Drive Belt 02-91
- Removal & Installation 02-91

Air Cleaner Element 02-92
- Removal & Installation 02-92

Air Cleaner Housing 02-93
- Removal & Installation 02-93

Cylinder Head Cover 02-93
- Removal & Installation 02-93

Camshaft 02-94
- Removal & Installation 02-94

Cylinder Head 02-97
- Removal & Installation 02-97

Front Crankshaft Oil Seal 02-99
- Removal & Installation 02-99

Rear Crankshaft Oil Seal 02-100
- Removal & Installation 02-100

Engine Mounts 02-103
- Removal & Installation - Left Mount 02-103
- Removal & Installation - Right Mount 02-104
- Removal & Installation - Front Mount 02-104
- Removal & Installation - Rear Mount 02-105

Engine Assembly 02-105
- Removal & Installation 02-105

Engine Timing Belt 02-112
- Removal & Installation 02-112

Exhaust Manifold 02-115
- Removal & Installation 02-115

Intake Manifold 02-117
- Removal & Installation 02-117

Idler Pulley 02-119
- Removal & Installation 02-119

Oil Filter 02-119
- Removal & Installation 02-119

Oil Pan 02-120
- Removal & Installation 02-120

Oil Pump 02-121
- Removal & Installation 02-121

Oil Strainer 02-122
- Removal & Installation 02-122

ENGINE UNIT REPAIR 02-123

Engine Block 02-123
- Specifications 02-123
- Disassembly 02-123
- Inspection 02-125
- Assembly 02-125

Pistons 02-126
- Specifications 02-126
- Disassembly 02-127
- Inspection 02-128
- Assembly 02-130

Connecting Rods 02-131
- Specifications 02-131
- Disassembly 02-131
- Inspection 02-132
- Assembly 02-132

Crankshaft 02-133
- Specifications 02-133
- Disassembly 02-133
- Inspection 02-134
- Assembly 02-135

CYLINDER HEAD UNIT REPAIR 02-136

Cylinder Head 02-136
- Specifications 02-136
- Disassembly 02-136
- Inspection 02-138
- Assembly 02-138

Camshaft 02-139
- Specifications 02-139
- Disassembly 02-140
- Inspection 02-140
- Assembly 02-142

Valve & Valve Guides 02-143
- Specifications 02-143
- Disassembly 02-143
- Inspection 02-144
- Assembly 02-145

Valve Springs 02-146
- Specifications 02-146
- Disassembly 02-146
- Inspection 02-147
- Assembly 02-148

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Description

The 2.0L in-line four cylinder engine has the following features:

- Dual overhead camshafts
- Four valves per cylinder
- Aluminum cylinder head
- Aluminum cylinder block

Operation

The 2.0L engine utilizes 4 valve-per-cylinders and a dual overhead camshaft design. The engine uses an individual coil ignition system. The cylinder block is made of aluminum and the bearing caps are integrated into the lower cylinder block assembly. An aluminum oil pan bolts to the bottom of the lower cylinder block. The camshafts are mounted in the cylinder head and act against valve tappets to open and close the valves. The camshafts are driven off the front of the cylinder head by one timing belt. The belt is driven by a sprocket that is located on the crankshaft. The piston assembly is an aluminum piston with a cast iron connecting rod.

The aluminum cylinder head contains dual overhead camshafts with 4 valve-per-cylinder construction. The valves are arranged in two in-line banks. The cylinder head incorporates powdered metal valve guides and seats. The cylinder head is sealed to the block using a multi-layer steel head gasket and retaining bolts.

Specifications

2.0L Engine Specifications

DESCRIPTION	SPECIFICATION
Type	In-Line OHV, DOHC
Number of Cylinders	4
Compression Ratio	10:1
Compression Pressure	10 - 15 bar
Max. Compression Pressure Variation Between Cylinders	25%
Stroke	90 mm
Bore	83.5 mm
Displacement	1971 cc
Firing Order	1-3-4-2

Mechanical Specifications

DESCRIPTION	ITEM	STANDARD	LIMIT
Engine Oil Pressure	Lower Idle Speed (800 ± 50 RPM)	1.2 - 1.5 bar	-
	High Idle Speed (2000 RPM)	3.2 - 3.5 bar	-
	High Speed (4000 RPM)	3.7 ± 0.5 bar	-
Engine Block Clearance	Surface Distortion	-	0.15 mm
	Inner Diameter	83.500 - 83.510 mm	-
	Out-Of-Round	-	< 0.008 mm
	Taper	-	< 0.01 mm
Piston Ring Groove Clearance	First Ring	0.04 - 0.08 mm	-
	Second Ring	0.0251 - 0.01 mm	-

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DESCRIPTION	ITEM	STANDARD	LIMIT
Piston Ring End Gap Clearance	First Ring	0.2 - 0.4 mm	0.8 mm
	Second Ring	0.4 - 0.6 mm	1.0 mm
Piston To Piston Pin Clearance	-	0.002 - 0.013 mm	-
Piston Diameter	-	83.451 - 83.469 mm	-
Ring Groove Clearance	First Ring	0.04 - 0.08 mm	-
	Second Ring	0.01 - 0.0251 mm	-
Connecting Rod Radial Clearance	-	0.016 - 0.051 mm	-
Connecting Rod Axial Clearance	-	0.002 - 0.013 mm	-
Diameter Of Crankshaft Main Journals	-	53.981 - 54 mm	-
Diameter Of Crankshaft Rod Journals	-	47.884 - 47.9 mm	-
Out-Of-Round Maximum Of Crankshaft Main Journals	-	-	< 0.008 mm
Axial Clearance Of Crankshaft	-	0.07 - 0.265 mm	-
Radial Clearance Of Crankshaft	-	0.0035 - 0.034 mm	-
Coaxality Crankshaft Main Journal	-	-	< 0.005 mm
Thrust Washer Thickness	-	2.4 - 2.405 mm	-
Oil Clearance Of Crankshaft Rod and Main Journals	-	0.022 mm	0.058 mm
Cylinder Head Flatness	-	-	< 0.04 mm
Intake Valve Deflection	-	-	< 0.02 mm
Exhaust Valve Deflection	-	-	< 0.04 mm
Spring Height	-	47.7 mm	-
Spring Height At 620 Newtons Of Pressure	-	32.0 mm	-
Intake Cam Lobe Height	-	37.15 mm	-
Exhaust Cam Lobe Height	-	37.05 mm	-
Camshaft Journal #1 Outer Diameter	-	31.934 - 31.95 mm	-
Camshaft Journal #2, #3, #4, #5, Outer Diameter	-	23.947 - 23.96 mm	-
Camshaft Cam Bearing #1 Inner Diameter	-	32 - 32.025 mm	-
Camshaft Cam Bearing #2, #3, #4, #5, Inner Diameter	-	24 - 24.021 mm	-
Camshaft Journal #1 Clearance	-	0.05 - 0.091 mm	-
Camshaft Journal #2, #3, #4, #5 Clearance	-	0.04 - 0.074 mm	-

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DESCRIPTION	ITEM	STANDARD	LIMIT
Intake Camshaft Axial Clearance	-	0.15 - 0.20 mm	-
Exhaust Camshaft Axial Clearance	-	0.15 - 0.20 mm	-
Intake Valve Guide Clearance	-	0.012 - 0.043 mm	-
Exhaust Valve Guide Clearance	-	0.032 - 0.063 mm	-
Valve Outer Diameter	Intake Valve	5.98 ± 0.008 mm	-
	Exhaust Valve	5.96 ± 0.008 mm	-
Valve Guide Inner Diameter	Intake Valve	5.4 ± 0.1 mm	-
	Exhaust Valve	5.4 ± 0.1 mm	-
Fringe Thickness On Top Of Valve	Intake Valve	0.3 ± 0.15 mm	-
	Exhaust Valve	0.3 ± 0.15 mm	-
Valve Tilt Angle	Intake Valve	65°	-
	Exhaust Valve	68°	-
Valve Height	Intake Valve	107.998 mm	-
	Exhaust Valve	106.318 mm	-

Torque Specifications

CAUTION:
When torquing a fastener in two steps, DO NOT use a torque wrench for the second step.

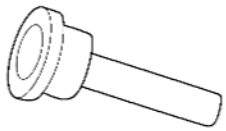
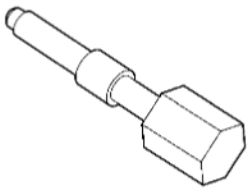
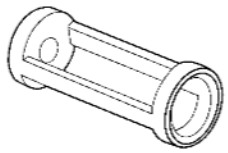
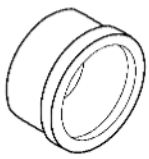
DESCRIPTION	TORQUE (N·m)
Accessory Drive Belt Tensioner Pulley Bolt	35
Camshaft Bearing Cap Bolts	11
Clutch Pressure Plate Bolts	25
Connecting Rod Cap Bolts	1st Step: Tighten the bolt to 25 N·m 2nd Step: Tighten the bolt an additional 90°
Crankshaft Holder	28
Crankshaft Main Bearing Cap Bolts	1st Step: Tighten the bolt to 45 N·m 2nd Step: Tighten the bolt an additional 180°
Crankshaft Timing Belt Pulley Bolt	1st Step: Tighten the bolt to 130 N·m 2nd Step: Tighten the bolt an additional 65°
Crankshaft Vibration Damper Bolts	25
Cylinder Head Cover Bolts	11
Cylinder Head Bolts	1st Step: Tighten the bolt to 40 ± 5 N·m 2nd Step: Tighten the bolt an additional 90 ± 5° 3rd Step: Tighten the bolt an additional 90 ± 5°
Dipstick Bracket Bolts	11
Drive Plate Bolts (automatic transaxle)	75
Engine Left Mount Bolt	70
Engine Right Mount Bolt	70
Engine Front Mount Bolt	60
Engine Rear Mount Bolt	60

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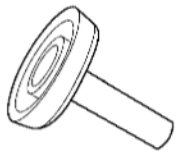
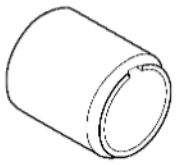
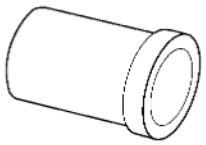
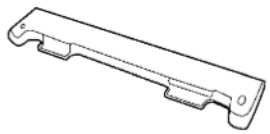
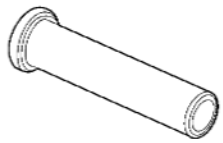
DESCRIPTION	TORQUE (N·m)
Engine To Transaxle Bolts	80
Exhaust Manifold Nuts	25
Exhaust Manifold Heat Shield Bolts	15
Exhaust Camshaft Timing Belt Pulley Bolt	120
Flywheel Bolts (manual transaxle)	75
Fuel Rail Bracket Bolts	11
Idler Pulley Bolt	40
Intake Camshaft Timing Belt Pulley Bolt	120
Intake Manifold Bolts	10
Intake Manifold Nuts	11
Intake Manifold Bracket Bolts	25
Lower Idler Pulley Bolt	45
Lower Cylinder Block Bolts	23
Oil Filter	25
Oil Pan Bolts	18
Oil Drain Plug	40
Oil Strainer Bolts	18
Oil Pump Bolts	11 (Apply with Loctite 5910 Thread-Locker)
Rear Timing Cover Bolts	7
Timing Belt Upper Cover Bolts	11
Timing Belt Lower Cover Bolts	11
Timing Belt Tensioner Assembly	27
Timing Belt Tensioner Pulley Bolt	30
Throttle Body Bolts	11
Upper Idler Pulley Bolt	45

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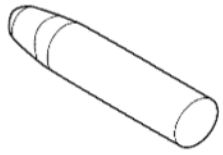
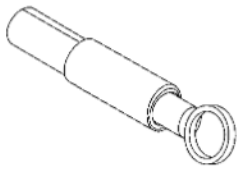
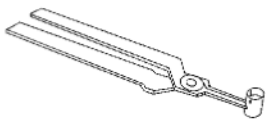
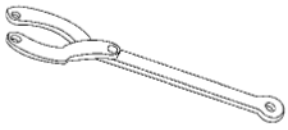
Special Tools

Right Engine Mount Bolt Remover CH-20001	 besm020079
Camshaft Seal Installer CH-20002	 besm020001
Crankshaft Holder CH-20003	 besm020009
Valve Spring Compressor Adaptor CH-20004	 besm020080
Rear Crankshaft Oil Seal Installer CH-20005	 besm020003

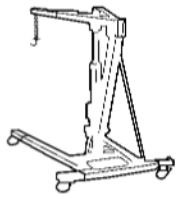
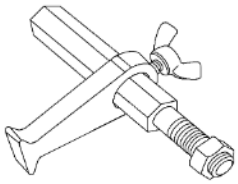
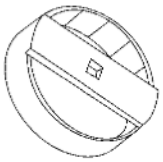
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Rear Crankshaft Oil Seal Guide CH-20006	 besm020002
Front Crankshaft Seal Installer CH-20007	 besm020004
Front Crankshaft Seal Guide CH-20008	 besm020005
Camshaft Holder CH-20010	 besm020008
Valve Seal Installer CH-20011	 besm020081

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Valve Stem Seal Installer Guide CH-20012	 besm020006
Valve Seal Remover CH-20013	 besm020082
Valve Keeper Installer CH-20017	 besm020084
Valve Spring Compressor CH-20018	 besm020007
Crankshaft Belt Pulley Fixture CH-20019	 besm020085

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Engine Hoist	 besm020010
Flywheel Fixture CH-20043	 ltsm020211
Oil Filter Remover CH-10003	 besm020087

Lubrication System

The engine lubrication system operates as follows:

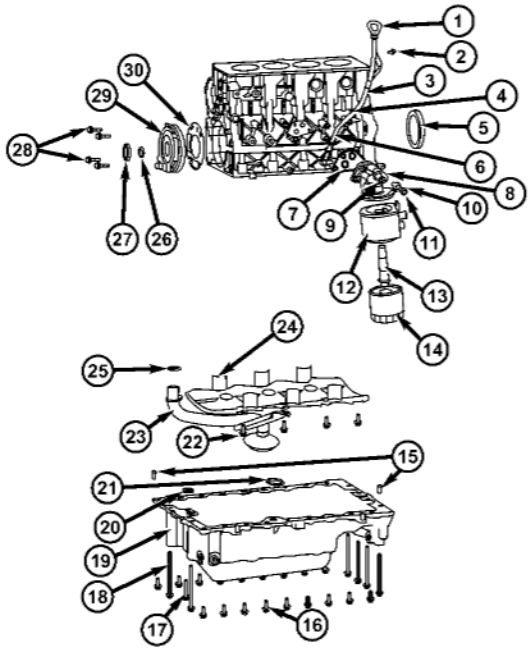
- Oil is drawn into the oil pump through the oil pump strainer tube in the sump of the oil pan.
- Oil is pumped through the oil filter on the cylinder block.
- Oil enters the main oil gallery where it is distributed to the crankshaft main journals and to the cylinder head.
- From the main journals, the oil is routed through cross-drilled passages in the crankshaft to lubricate the connecting rod bearings. Controlled leakage through the crankshaft main bearings and connecting rod bearings is slung radially outward to cool and lubricate the cylinder walls as well as the entire connecting rod, piston and piston ring assembly.
- The engine lubrication system is a full-flow filtration, pressure feed type. The oil pump body is mounted to the engine block. The pump inner rotor is driven by the crankshaft.

Engine Oil Pressure Specifications

Lower Idle Speed (800 ± 50 RPM)	1.2 - 1.5 bar
High Idle Speed (2000 RPM)	3.2 - 3.5 bar
High Speed (4000 RPM)	3.7 ± 0.5 bar

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Engine Lubrication System Exploded View

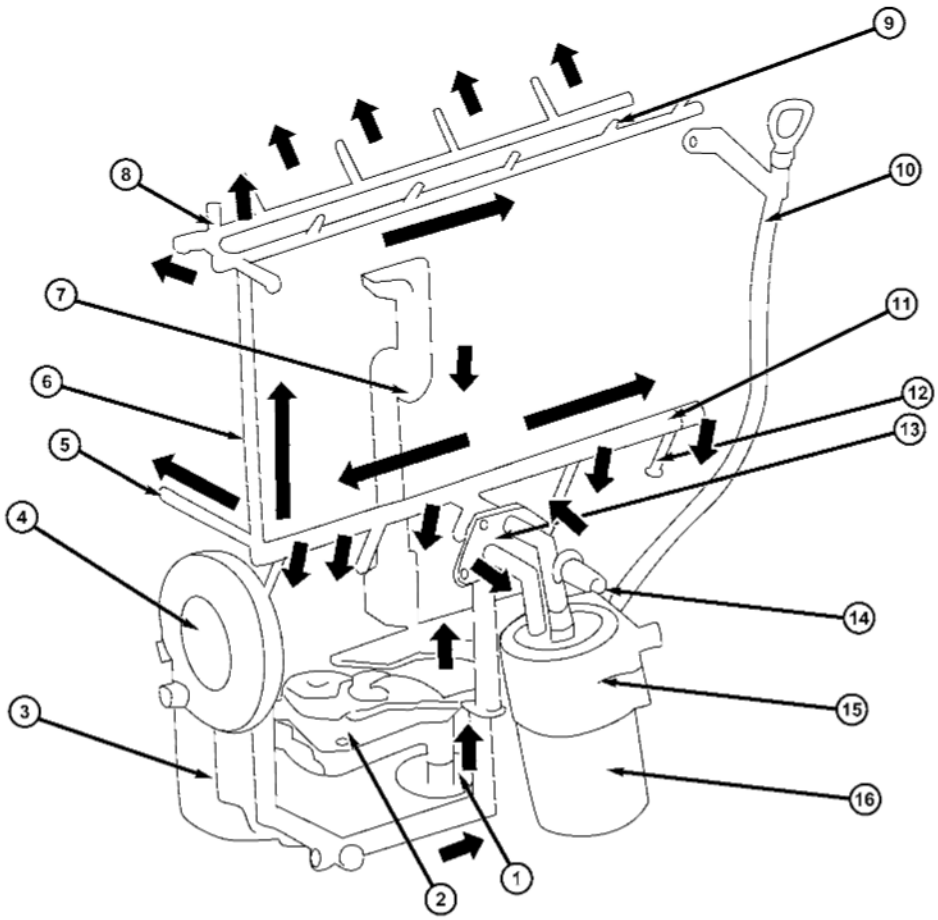


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1 - Oil Dipstick	16 - Oil Pan Bolt
2 - Oil Dipstick Bolt	17 - Oil Pan Bolt
3 - Oil Dipstick Bracket	18 - Oil Pan Bolt
4 - Oil Dipstick Guide	19 - Oil Pan
5 - Crankshaft Rear Oil Seal	20 - O-Ring
6 - O-Ring	21 - O-Ring
7 - Oil Filter Bracket Gasket	22 - Oil Pump Strainer Bolt
8 - Oil Filter Bracket	23 - Oil Pump Strainer
9 - Pressure-Relief Plunger	24 - Baffle Plate
10 - Flange Bolt	25 - O-Ring
11 - Flange Bolt	26 - O-Ring
12 - Oil Cooler	27 - Crankshaft Front Oil Seal
13 - Oil Filter Connector	28 - Oil Pump Bolt
14 - Oil Filter	29 - Oil Pump Assembly
15 - Dowel Pin	30 - Oil Pump Assembly Gasket

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Engine Oil Flow Diagram



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1 - Oil Pump Strainer	9 - To Middle Bearing Cap
2 - Baffle Plate	10 - Oil Dipstick
3 - Oil Pan	11 - To Crankcase
4 - Oil Pump	12 - Crankcase Pipe
5 - Turbocharger Inlet Oil Passage (if equipped)	13 - Oil Filter Bracket
6 - To Cylinder Head	14 - Oil Pressure Switch
7 - Oil Return Passage	15 - Oil Cooler
8 - To Front Bearing Cap	16 - Oil Filter

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DIAGNOSIS & TESTING

Engine Performance Diagnostics

CONDITION	POSSIBLE CAUSE	CORRECTION
Engine Does Not Start	1. Weak battery. 2. Corroded or loose battery connections. 3. Faulty starter. 4. Faulty coil(s) or control unit. 5. Incorrect spark plug gap. 6. Contamination in fuel system. 7. Faulty fuel pump. 8. Incorrect timing.	1. Test battery. Charge or replace if necessary. 2. Clean and tighten battery connections. Apply a coat of light mineral grease to terminals. 3. Test starting system. Check for codes. (Refer to Appropriate Diagnostic Information) 4. Test and replace as needed. (Refer to Appropriate Diagnostic Information) 5. Set gap. 6. Clean system and replace fuel filter. 7. Test fuel pump and replace as needed. (Refer to Appropriate Diagnostic Information) 8. Check for a skipped timing belt.
Engine Stalls Or Idles Rough	1. Idle speed too low. 2. Incorrect fuel mixture. 3. Intake manifold leakage. 4. Faulty ignition coil(s).	1. Test minimum air flow. (Refer to Appropriate Diagnostic Information) 2. (Refer to Appropriate Diagnostic Information) 3. Inspect intake manifold, manifold gasket, and vacuum hoses. 4. Test and replace if necessary. (Refer to Appropriate Diagnostic Information)
Engine Loss Of Power	1. Dirty or incorrectly gapped spark plugs. 2. Contamination in fuel system. 3. Faulty fuel pump. 4. Incorrect valve timing. 5. Leaking cylinder head gasket. 6. Low compression. 7. Burned, warped, excessive clearance, or pitted valves. 8. Plugged or restricted exhaust system. 9. Faulty ignition coil(s). 10. Burned spark plugs.	1. Clean spark plugs and set gap. 2. Clean system and replace fuel filter. 3. Test and replace if necessary. (Refer to Appropriate Diagnostic Information) 4. Correct valve timing. 5. Replace cylinder head gasket. 6. Test compression of each cylinder. 7. Replace valves. 8. Perform exhaust restriction test. Install new parts. 9. Test and replace if necessary. (Refer to Appropriate Diagnostic Information) 10. Replace spark plugs.

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CONDITION	POSSIBLE CAUSE	CORRECTION
Engine Miss On Acceleration	1. Dirty or incorrectly gapped spark plugs. 2. Contamination in fuel system. 7. Burned, warped, excessive clearance, or pitted valves. 4. Faulty ignition coil(s).	1. Clean spark plugs and set gap. 2. Clean fuel system and replace fuel filter. 3. Replace valves. 4. Test and replace if necessary. (Refer to Appropriate Diagnostic Information)
Engine Miss At High Speed	1. Dirty or incorrect spark plug gap. 2. Faulty ignition coil(s). 3. Dirty fuel injector(s). 4. Contamination in fuel system.	1. Clean spark plugs and set gap. 2. Test and replace if necessary. (Refer to Appropriate Diagnostic Information) 3. Test and replace if necessary. (Refer to Appropriate Diagnostic Information) 4. Clean system and replace fuel filter.

Engine Mechanical Diagnostics

CONDITION	POSSIBLE CAUSE	CORRECTION
Valve Train Noise	1. High or low oil level in crankcase. 2. Thin or diluted oil. 3. Thick oil. 4. Low oil pressure. 5. Worn cam lobe. 6. Worn valve guides. 7. Excessive runout of valve seats on valve faces.	1. Check and correct engine oil level. 2. Change oil to correct viscosity. 3. Change engine oil and filter. 4. Check and correct engine oil level. 5. Install new camshaft. 6. Replace cylinder head. 7. Grind valve seats and replace valves.
Connecting Rod Noise	1. Insufficient oil supply. 2. Low oil pressure. 3. Thin or diluted oil. 4. Excessive bearing clearance. 5. Connecting rod journal out-of-round. 6. Connecting rod out-of-round. 7. Misaligned connecting rods. 8. Connecting rod nuts loose.	1. Check engine oil level. 2. Check engine oil level. Inspect oil pump relief valve and spring. 3. Change oil to correct viscosity. 4. Measure bearings for correct clearance. Repair if necessary. 5. Replace crankshaft or grind surface. 6. Replace connecting rod. 7. Replace bent connecting rods. 8. Tighten the connecting rod nuts.
Main Bearing Noise	1. Insufficient oil supply. 2. Low oil pressure. 3. Thin or diluted oil. 4. Excessive bearing clearance. 5. Excessive end play. 6. Crankshaft journal out-of-round or worn. 7. Loose flywheel or torque converter.	1. Check engine oil level. 2. Check engine oil level. Inspect oil pump. 3. Change oil to correct viscosity. 4. Measure bearings for correct clearance. Repair if necessary. 5. Check thrust bearing for wear on flanges. 6. Replace crankshaft or grind journals. 7. Tighten to correct torque.

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CONDITION	POSSIBLE CAUSE	CORRECTION
Oil Pressure Drop	1. Low oil level. 2. Faulty oil pressure sending unit. 3. Low oil pressure. 4. Clogged oil filter. 5. Thin or diluted oil. 6. Excessive bearing clearance.	1. Check engine oil level. 2. Install new sending unit. 3. Check sending unit and main bearing oil clearance. 4. Install new oil filter. 5. Change oil to correct viscosity. 6. Measure bearings for correct clearance.
Oil Leaks	1. Misaligned or deteriorated gaskets. 2. Loose fastener, broken or porous metal part. 3. Misaligned or deteriorated cup or threaded plug.	1. Replace gasket. 2. Tighten, repair or replace the part. 3. Replace if necessary.
Oil Consumption Or Spark Plugs Fouled	1. PCV system malfunction. 2. Worn, scuffed or broken rings. 3. Carbon in oil ring slots. 4. Rings fitted too tightly in grooves. 5. Worn valve guide(s). 6. Valve stem seal(s) worn or damaged.	1. Check system and repair if necessary. 2. Hone cylinder bores. Install new rings. 3. Install new rings. 4. Remove rings and check grooves. If groove is not proper width, replace piston. 5. Replace cylinder head. 6. Replace seal(s).

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Cylinder Compression Pressure Test

- The result of a cylinder compression pressure test can be utilized to diagnose several engine malfunctions.
- Ensure the battery is completely charged and the engine starter motor is in good operating condition. Otherwise the indicated compression pressures may not be valid for diagnostic purposes.
  - Check engine oil level and add oil if necessary.
  - Disconnect the spark plug wires.
  - Remove all spark plugs from engine (as spark plugs are being removed, check electrodes for abnormal firing indicators fouled, hot, oily, etc.).
  - Record cylinder number of each spark plug for future reference.
  - Disconnect fuel injector electrical connectors.
  - Be sure throttle blade is fully open during the compression check.
  - Insert compression pressure adaptor or the equivalent into each spark plug hole in cylinder head.
  - Crank engine until maximum pressure is reached on gauge. Record each cylinder pressure.
  - Compression should not be less than 1000 kPa and not vary more than 25 percent from cylinder to cylinder.
  - If one or more cylinders have abnormally low compression pressures, repeat the compression test.
  - If the same cylinder or cylinders repeat an abnormally low reading on the second compression test, it could indicate the existence of a problem with the cylinder in question.

NOTE :
The recommended compression pressures are to be used only as a guide to diagnosing engine problems. An engine should not be disassembled to determine the cause of low compression unless some malfunction is present.

Cylinder Head Gasket Test

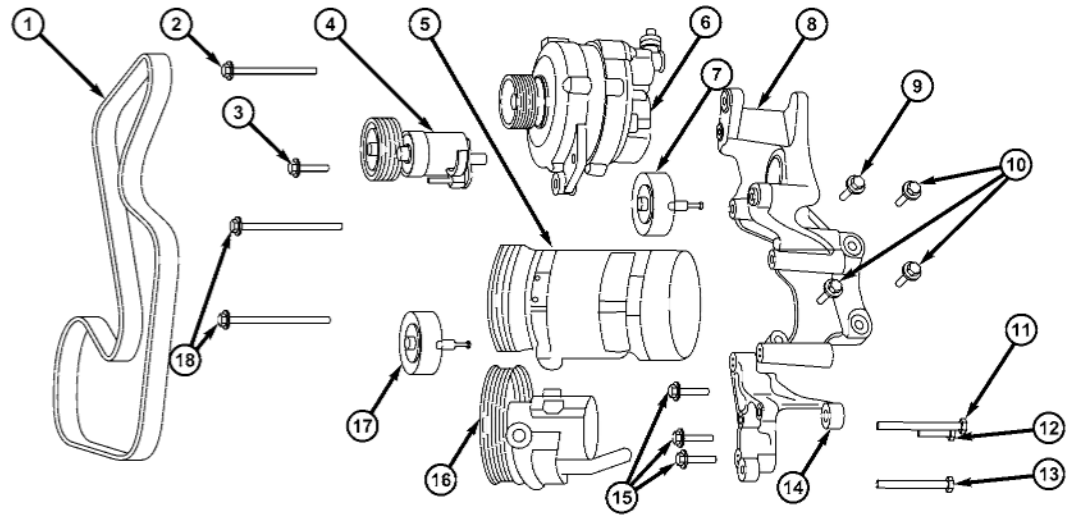
- A cylinder head gasket leak can be located between adjacent cylinders, between a cylinder and the adjacent water jacket or from an oil passage to the exterior of the engine.
- Possible indications of the cylinder head gasket leaking between adjacent cylinders are:
  - Loss of engine power
  - Engine misfiring
  - Poor fuel economy
- Possible indications of the cylinder head gasket leaking between a cylinder and an adjacent water jacket are:
  - Engine overheating
  - Loss of coolant
  - Excessive steam (white smoke) emitting from exhaust
  - Coolant foaming

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ON-VEHICLE SERVICE

Accessory Drive Belt

Removal & Installation



1 - Drive Belt	10 - Generator Bracket Bolt
2 - Generator Bolt	11 - Power Steering Pump Bolt
3 - Tensioner Pulley Bolt	12 - Power Steering Pump Bolt
4 - Tensioner	13 - Power Steering Pump Bolt
5 - Compressor	14 - Power Steering Pump Bracket
6 - Generator	15 - Power Steering Pump Bracket Bolt
7 - Idler Pulley	16 - Power Steering Pump
8 - Generator Bracket	17 - Idler Pulley
9 - Generator Bracket Bolt	18 - Compressor Bolt

WARNING!

Inspect the drive belt only when the engine is stopped.

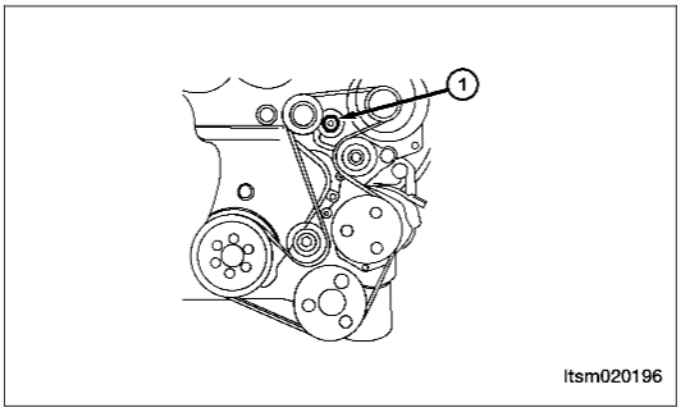
1. While using a suitable tool and securely holding the hexagonal portion of the drive belt tensioner, rotate the pulley counterclockwise to loosen the drive belt.

WARNING!

Avoid placing hands near the drive belt tensioner while it is being held.

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2. Remove the drive belt.
3. Remove accessory drive belt tensioner (1)

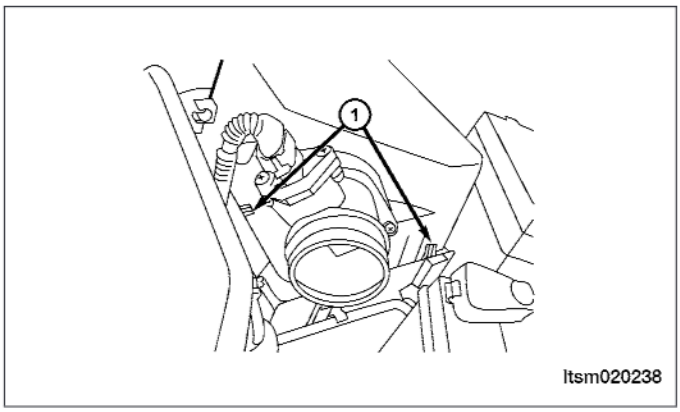


4. Installation is in the reverse order of removal.

Air Cleaner Element

Removal & Installation

1. Unhook the air cleaner case side clips (1) and raise the air cleaner case (upper).



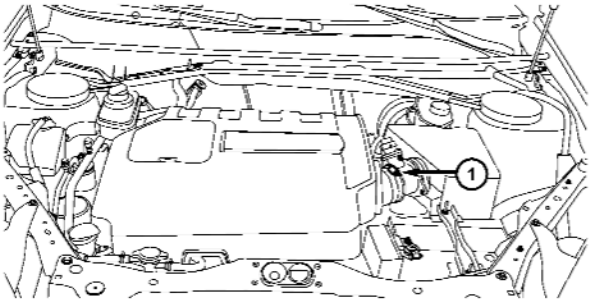
2. Remove the air cleaner element.
3. Install a new air cleaner element.
4. Installation is in the reverse order of removal.

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Air Cleaner Housing

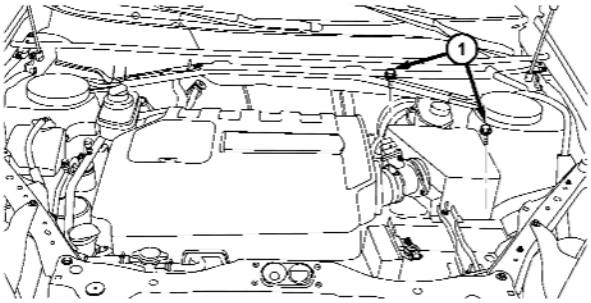
Removal & Installation

1. Disconnect the negative battery cable.
2. Disconnect the air flow sensor electrical connector (1.8L Engine).
3. Loosen the clamp (1) between the air intake air hose and the air cleaner and remove the intake air hose.



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4. Remove the screws (1) securing the air cleaner housing to its base.



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5. Remove the air cleaner housing.
6. Remove the air cleaner base.
7. Installation is in the reverse order of removal.

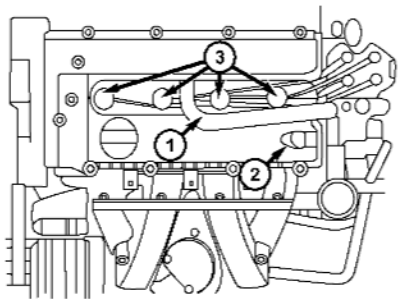
Cylinder Head Cover

Removal & Installation

1. Disconnect the negative battery cable.
2. Remove the engine cover.
3. Use compressed air to blow dirt and debris off the cylinder head cover prior to removal.
4. Disconnect the camshaft position sensor electrical connector.
5. Remove the camshaft position sensor (2) and set it aside.

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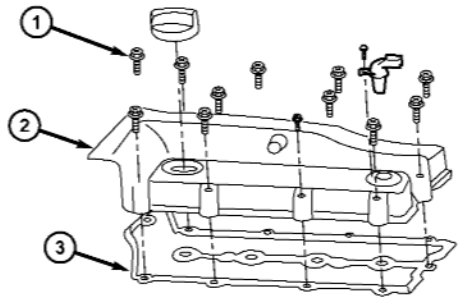
6. Remove the spark plug wires (3) and set them aside.
7. Remove the PCV hose (1) from cylinder head cover.



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8. Remove the cylinder head cover bolts (1).
   (Tighten: Cylinder head cover bolts to 11 N·m)
9. Remove the cylinder head cover (2) from the cylinder head.
10. Remove the cylinder head cover gasket (3).
11. Installation is in the reverse order of removal.

NOTE :
Install a new cylinder head cover gasket during installation.



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Camshaft

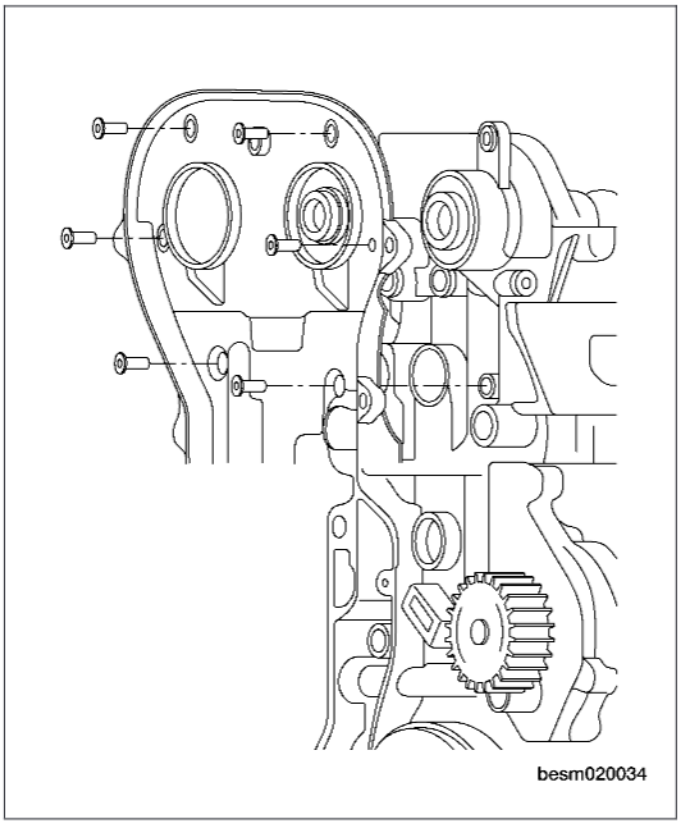
Removal & Installation

NOTE :
The following special tools are required to perform the repair procedure:
- CH-20002 - Camshaft Seal Installer

1. Remove the accessory drive belt (See Accessory Drive Belt Removal & Installation in Section 02 Engine).
2. Remove the engine timing belt (See Engine Timing Belt Removal & Installation in Section 02 Engine).
3. Remove the cylinder head cover (See Cylinder Head Cover Removal & Installation in Section 02 Engine).
4. Remove the intake or exhaust camshaft timing belt pulley.
   (Tighten: Camshaft timing belt pulley bolt to 120 N·m)

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5. Remove the rear timing cover of the timing pulley. (Tighten: Rear timing cover bolts to 7 N·m)


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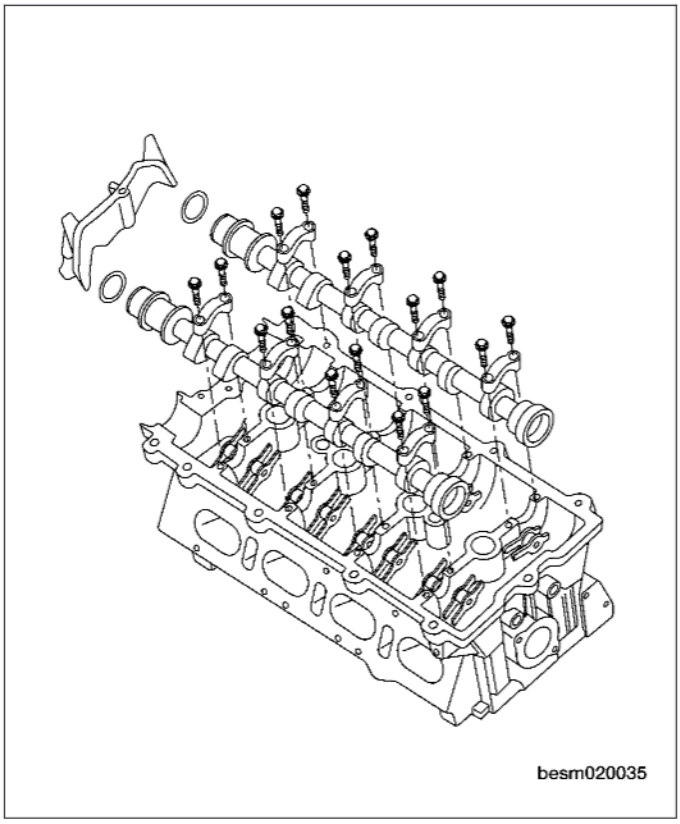
6. Remove the camshaft bearing cap bolts. (Tighten: Camshaft bearing cap bolts to 11 N·m)

   NOTE: Equally loosen camshaft bearing cap bolts in several steps.

7. Remove the camshaft bearing caps and place them in proper order.

   NOTE: The camshaft bearing caps are marked for identification.

8. Remove the camshafts and then remove the camshaft seals.


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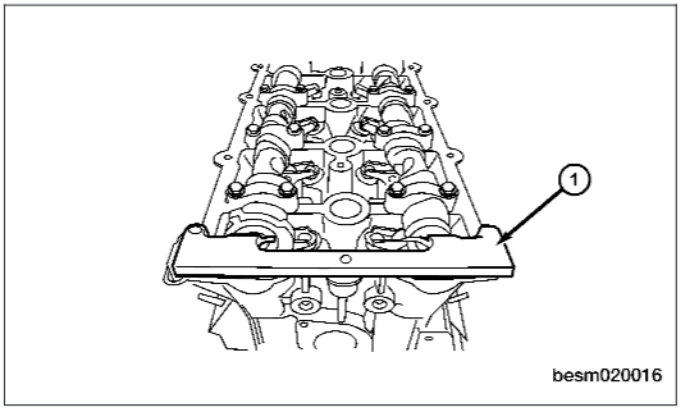
9. Installation is in the reverse order of removal.

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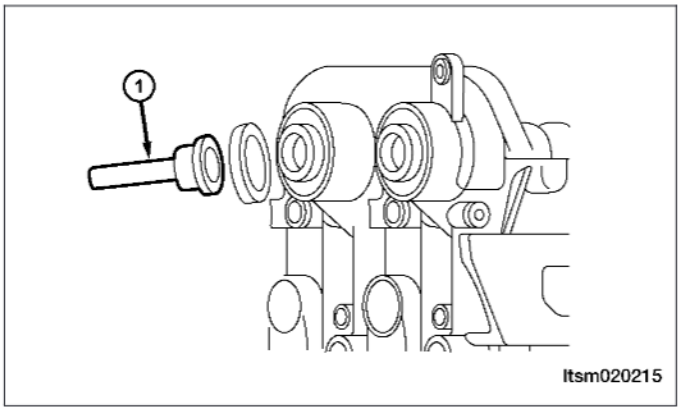
Installation Notes:

- Use special tool CH-20010 (1), to install the camshaft holder to hold the camshafts in place.

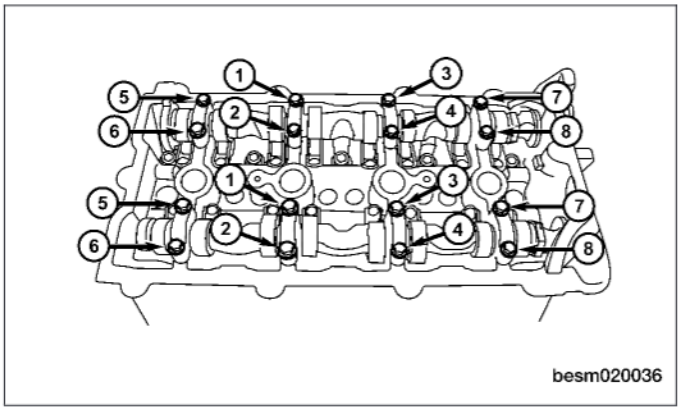
NOTE :
The camshaft holder will prevent the camshafts from rotating in either direction.



- Use special tool CH-20002 (1), to install the camshaft seal.
- Install the intake and exhaust camshaft bearing caps in the proper order.
- Slowly tighten bolts to the specified torque.



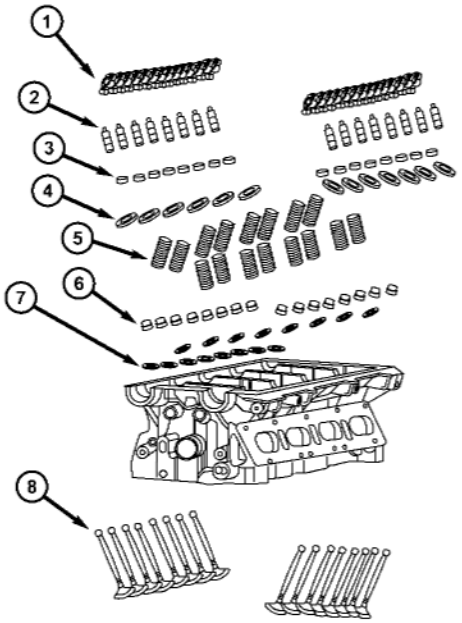
- Follow the torque sequence as shown.



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Cylinder Head

Removal & Installation



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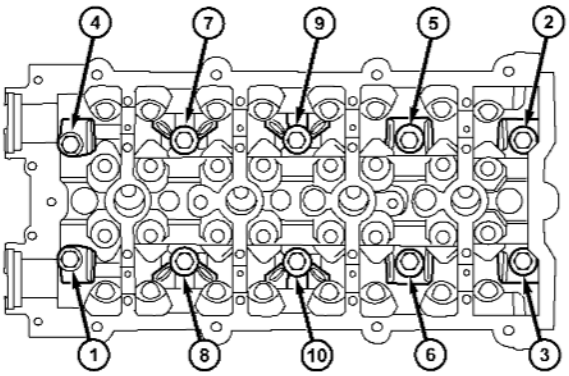
1 - Rocker Arms	5 - Valve Springs
2 - Hydraulic Tappets	6 - Valve Oil Seals
3 - Valve Keepers	7 - Valve Spring Lower Retainers
4 - Valve Spring Upper Retainers	8 - Valves

NOTE :
Replacement cylinder head comes complete with valves, seals, springs, retainers, keepers, and camshafts.

1. Remove engine timing belt (See Engine Timing Belt Removal & Installation in Section 02 Engine).
2. Remove the cylinder head cover (See Cylinder Head Cover Removal & Installation in Section 02 Engine).
3. Remove the camshafts (See Camshaft Removal & Installation in Section 02 Engine).
4. Remove intake manifold (See Intake Manifold Removal & Installation in Section 02 Engine).
5. Remove exhaust manifold (See Exhaust Manifold Removal & Installation in Section 02 Engine).
6. Remove water pipe and thermostat assembly.

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7. Remove the cylinder head bolts in the order shown.



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8. Remove cylinder head gasket.
9. Installation is in the reverse order of removal.

Installation Notes:

- Ensure cylinder head bolt holes in the block are clean, dry (free of residual oil or coolant), and threads are not damaged.
- The cylinder head bolts should not be reused. The new bolts should be examined before use. If the bolts are stretched, the bolts should be replaced.
- Position the new cylinder head gasket on the engine block with the part number facing up. Ensure gasket is seated over the locating dowels in the block.
- Before installing the bolts, the threads should be lightly coated with engine oil.

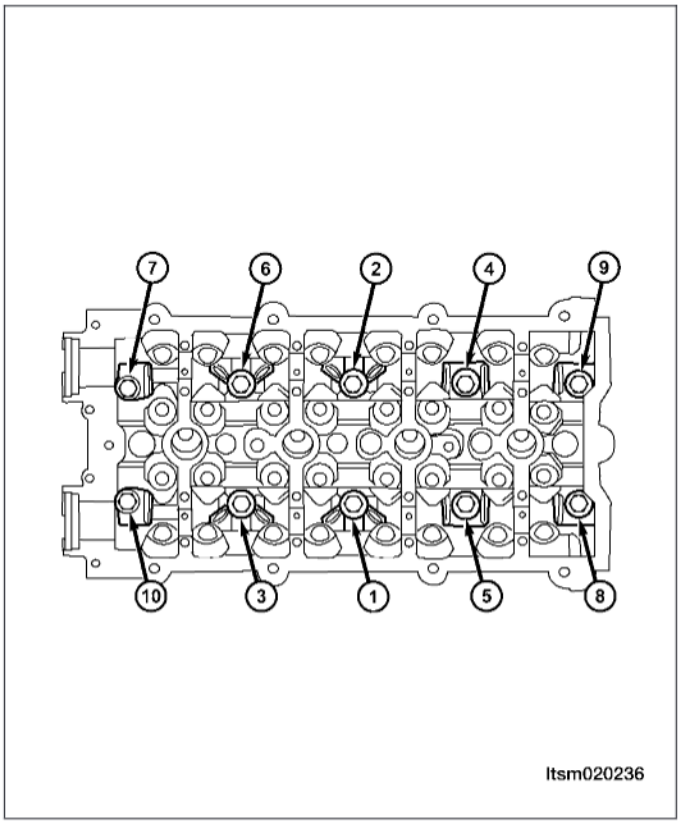
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Install the cylinder head bolts in the order shown. Torque the cylinder head bolts in the following three step sequence:

1st Step: Tighten the bolt to 40 ± 5 N·m

2nd Step: Tighten the bolt an additional 90 ± 5°

3rd Step: Tighten the bolt an additional 90 ± 5°



Front Crankshaft Oil Seal

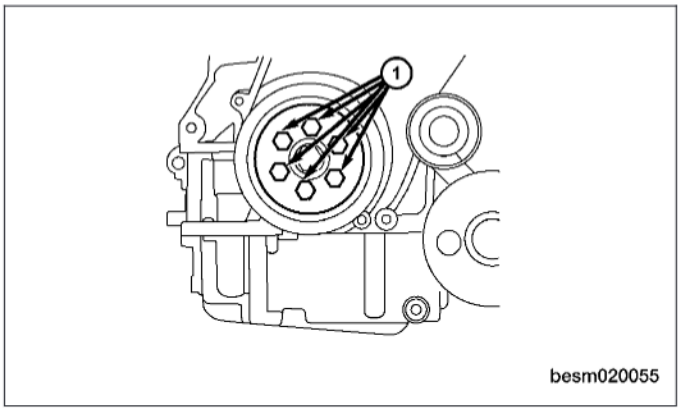
Removal & Installation

NOTE :

The following special tools are required to perform the repair procedure:

- CH-20007 - Front Crankshaft Seal Installer
- CH-20008 - Front Crankshaft Seal Guide
- CH-20019 - Crankshaft Belt Pulley Fixture

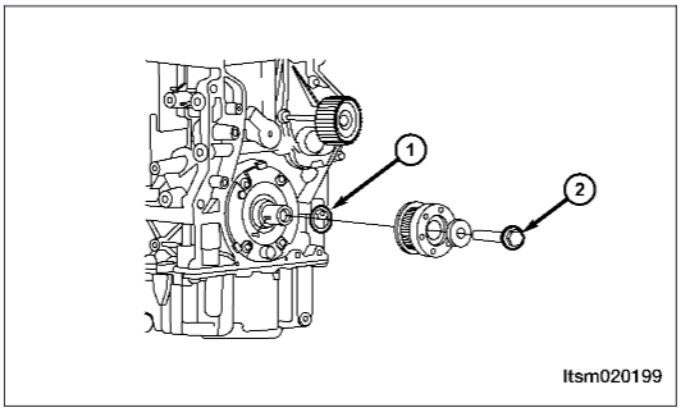
1. Remove the accessory drive belt (See Accessory Drive Belt Removal & Installation in Section 02 Engine).
2. Remove the crankshaft vibration damper bolts (1). (Tighten: Crankshaft vibration damper bolts to 25 N·m)



3. Remove the engine timing belt (See Engine Timing Belt Removal & Installation in Section 02 Engine).

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4. Remove the crankshaft timing belt pulley bolt (2) from the crankshaft.
   (Tighten: Crankshaft timing belt pulley bolt to 130 N·m and an additional 65°)
5. Remove the key-way from the crankshaft.
6. Using an appropriate tool, remove the front crankshaft oil seal (1).



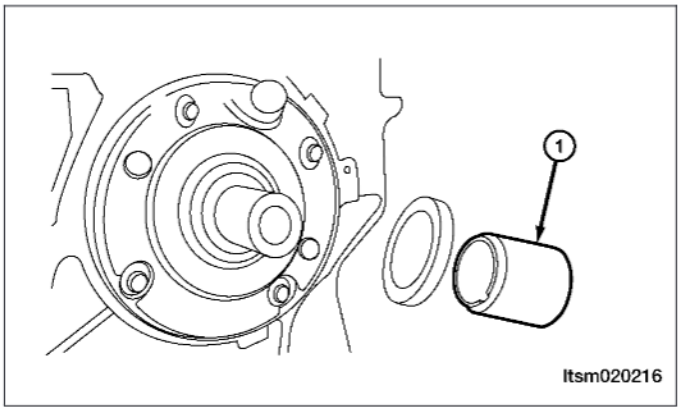
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CAUTION:
Be careful not to damage the front cover seal surface while removing the seal.

7. Installation is in the reverse order of removal.

Installation Notes:

- Lubricate the new front seal with engine oil prior to assembly.
- Use the front crankshaft seal installer CH-20007 (1), to install the new seal.



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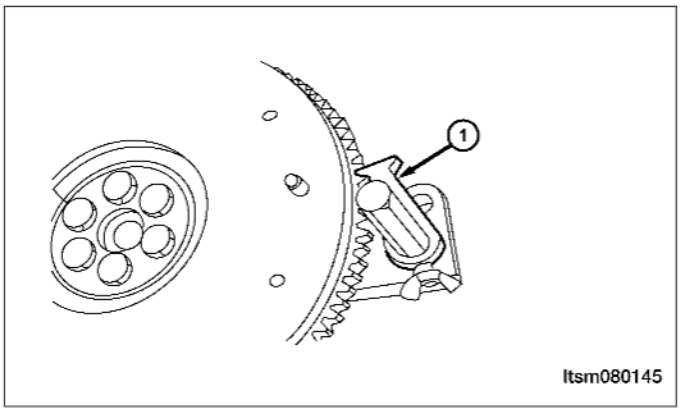
Rear Crankshaft Oil Seal

Removal & Installation

NOTE :
The following special tools are required to perform the repair procedure:

- CH-20005 - Rear Crankshaft Oil Seal Installer
- CH-20006 - Rear Crankshaft Oil Seal Guide
- CH-20043 - Flywheel Fixture

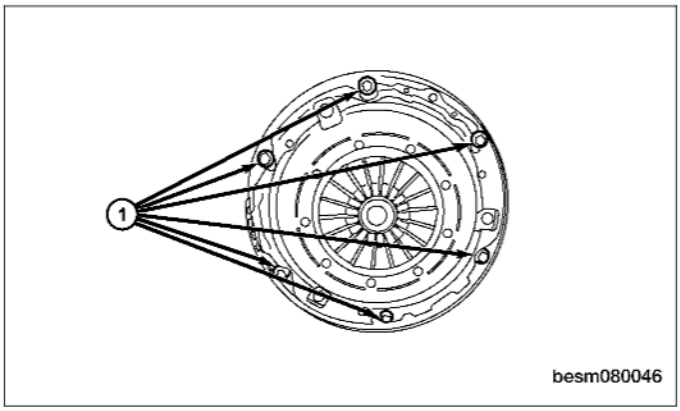
1. Remove the transaxle assembly (See Transaxle Assembly Removal & Installation in Section 08 Transaxle and Transfer Case).
2. Using special tool CH-20043 (1), hold the flywheel.



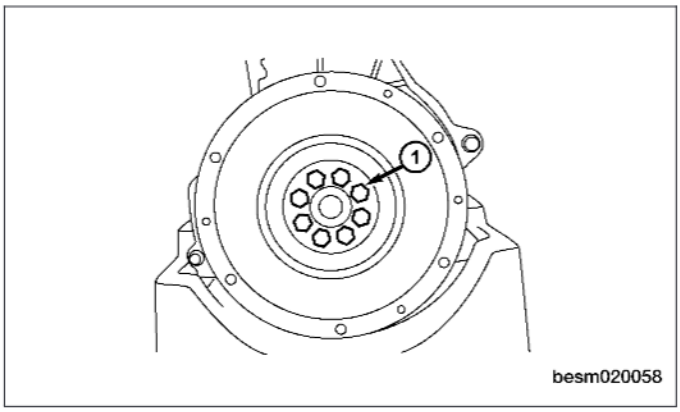
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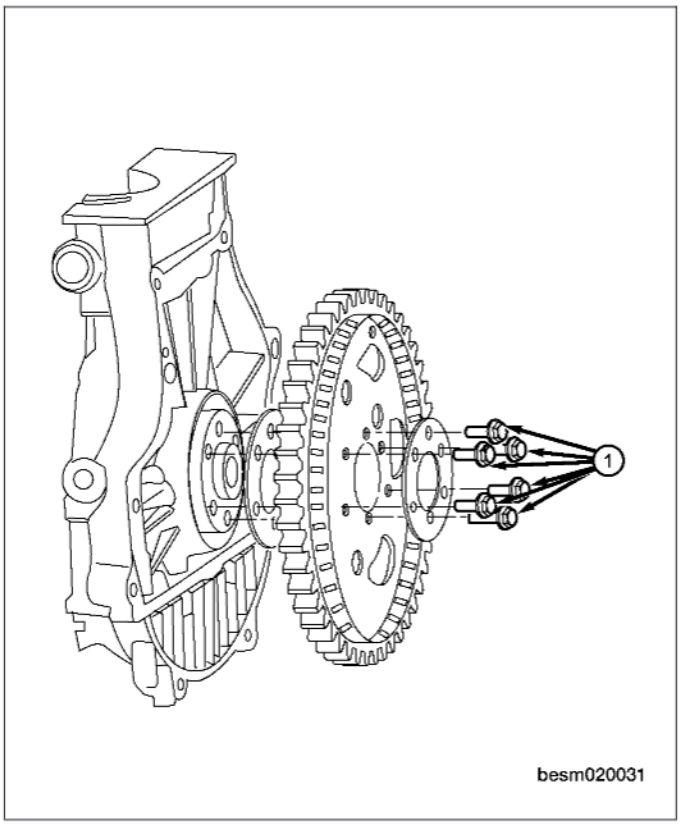
3. If equipped with manual transaxle, remove clutch pressure plate retaining bolts (1) and remove the clutch pressure plate.
   (Tighten: Clutch pressure plate bolts to 25 N·m)



4. If equipped with manual transaxle, remove the flywheel bolts (1) and then remove the flywheel.
   (Tighten: Flywheel bolts to 75 N·m)



5. If equipped with automatic transaxle, remove the drive plate retaining bolts (1) and then remove drive plate.
   (Tighten: Drive plate bolts to 75 N·m)

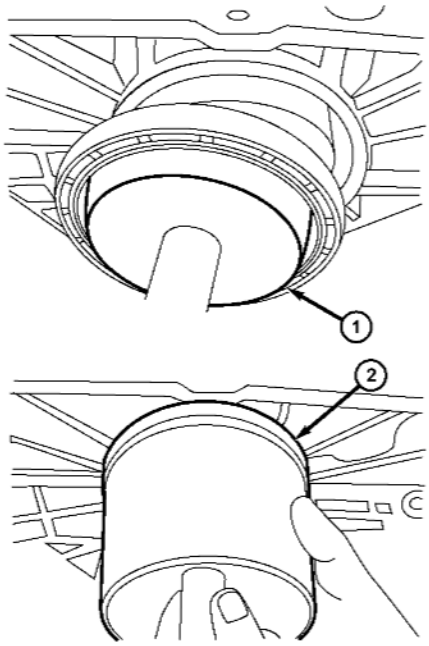


6. Remove the rear oil seal using a suitable tool.
7. Installation is in the reverse order of removal.

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Installation Notes:

- When installing seal, lubricate seal guide with clean engine oil.
- Position the seal over the rear crankshaft seal guide.
- Use special tool CH-20005 (2) and CH-20006 (1), to install the rear crankshaft oil seal.
- Ensure that the lip of the seal is facing toward the crankcase during installation.



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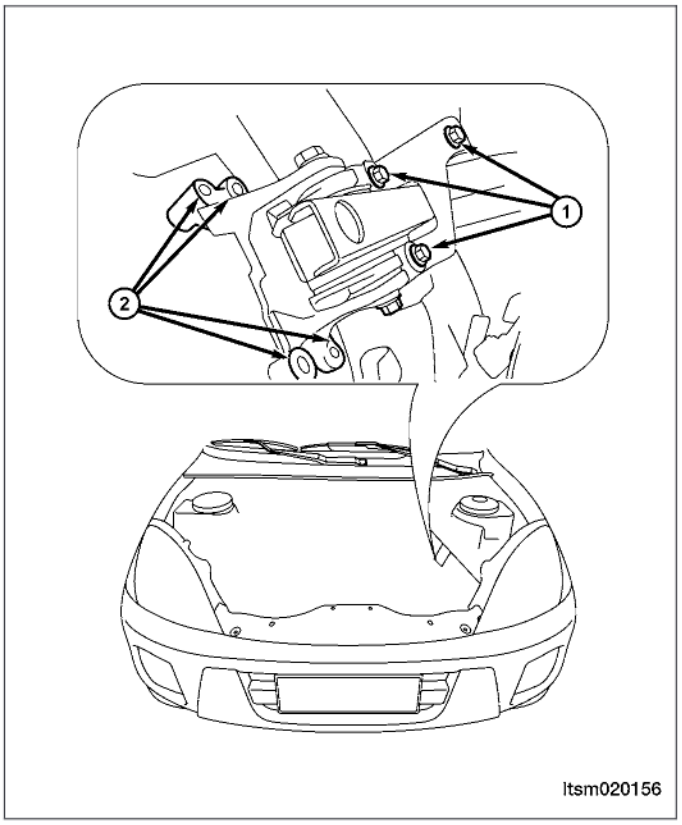
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Engine Mounts

Removal & Installation - Left Mount

NOTE :
The following special tools are required to perform the repair procedure:
- Engine Hoist

1. Disconnect the negative battery cable.
2. Support the engine with the engine hoist.
3. Remove the air cleaner housing. (See Air Cleaner Housing Removal & Installation in Section 02 Engine).
4. Remove the engine left mount retaining bolts (2) and remove the engine left mount bracket bolts (1). (Tighten: Engine left mount bolts to 70 N·m)
5. Installation is in the reverse order of removal.

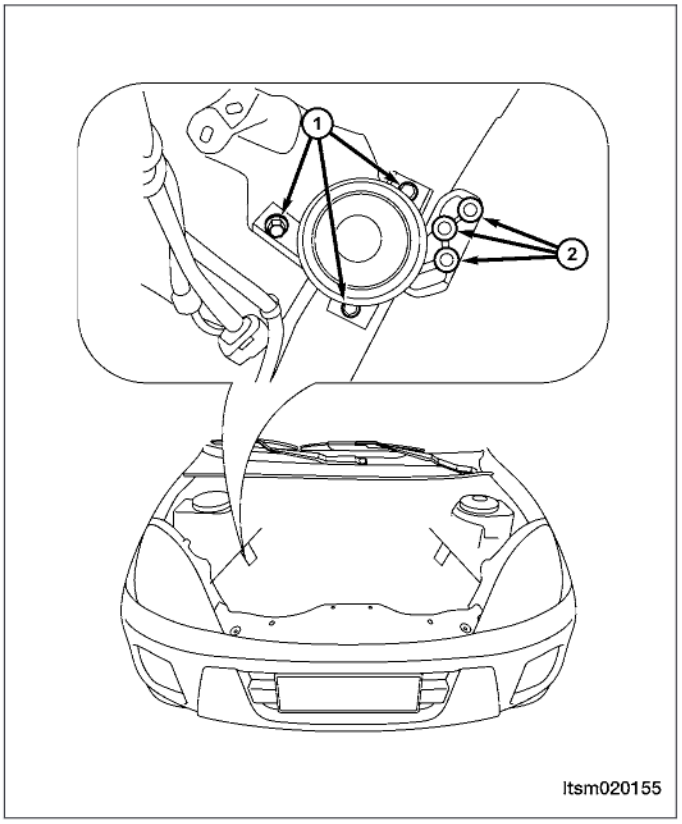


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Removal & Installation - Right Mount

NOTE :
The following special tools are required to perform the repair procedure:
- Engine Hoist

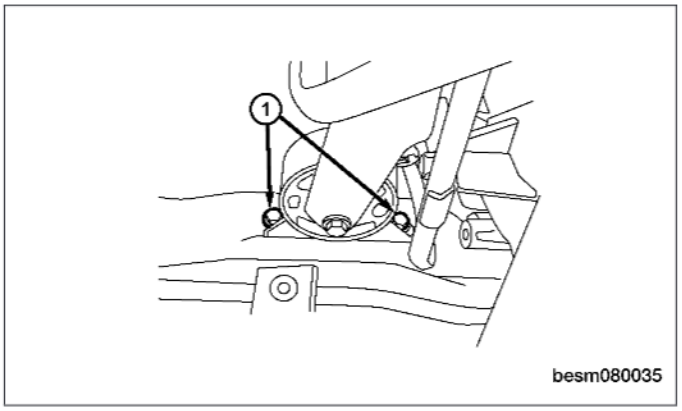
1. Disconnect the negative battery cable.
2. Support the engine with the engine hoist.
3. Remove the engine right mount retaining bolts (2) and remove the engine right mount bracket bolts (1).
   (Tighten: Engine right mount bolts to 70 N·m)
4. Installation is in the reverse order of removal.



Removal & Installation - Front Mount

NOTE :
The following special tools are required to perform the repair procedure:
- Engine Hoist

1. Disconnect the negative battery cable.
2. Support the engine with the engine hoist.
3. Remove the bolts (1) securing the front engine mount.
   (Tighten: Engine front mount bolts to 60 N·m)
4. Installation is in the reverse order of removal.

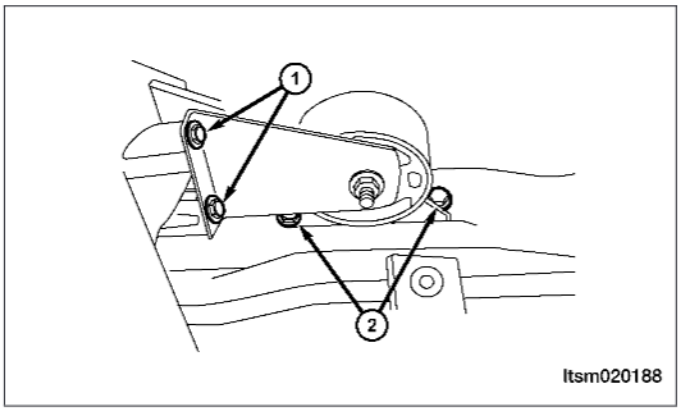


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Removal & Installation - Rear Mount

NOTE :
The following special tools are required to perform the repair procedure:
- Engine Hoist

1. Disconnect the negative battery cable.
2. Support the engine with the engine hoist.
3. Remove the engine rear mount retaining bolts (2) and remove the engine rear mount bracket bolts (1).
   (Tighten: Engine rear mount bolts to 60 N·m)
4. Installation is in the reverse order of removal.



Engine Assembly

Removal & Installation

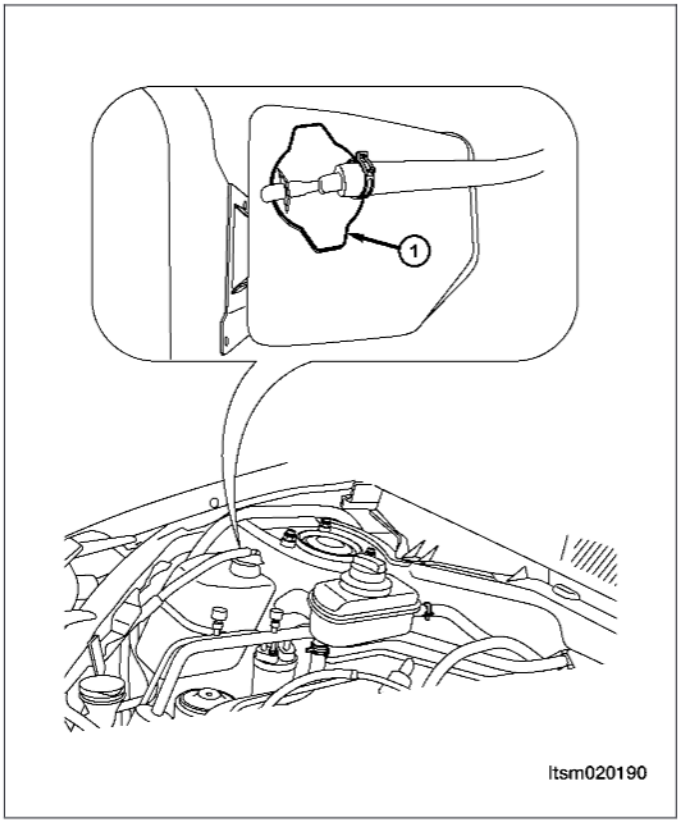
NOTE :
The following special tools are required to perform the repair procedure:
- CH-20001 - Right Engine Mount Bolt Remover
- Engine Hoist

NOTE :
The engine is removed with the transaxle as an assembly.

1. Remove the vehicle hood.
2. Remove the negative battery cable from the engine.
3. Remove the engine cover.
4. Remove the battery, battery hold downs, and battery tray (See Battery Removal & Installation in Section 05 Starting & Charging).
5. Discharge air conditioning system (See A/C System Evacuation and Recharge in Section 13 Heating & Air Conditioning).

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6. Drain the cooling system (See Cooling System Draining and Filling in Section 06 Cooling).

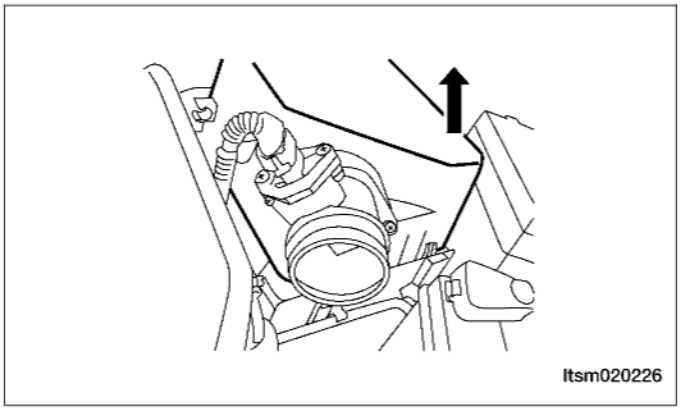


WARNING!

Always allow the engine to cool before opening the cooling system. Do not loosen the coolant pressure relief cap when the engine is operating or the cooling system is hot. The cooling system is under pressure; steam and hot liquid can come out forcefully when the cap is loosened slightly. Failure to follow these instructions may result in serious personal injury.

7. Remove the coolant fan & radiator assembly (See Coolant Fan & Radiator Assembly Removal & Installation in Section 06 Cooling).
8. Remove the starter motor wiring.
9. Relieve the fuel pressure (See Fuel Pressure Relief Procedure in Section 04 Fuel Delivery).
10. Disconnect and remove the fuel line at the fuel rail.
11. Remove the air inlet hose and the air cleaner case assembly.

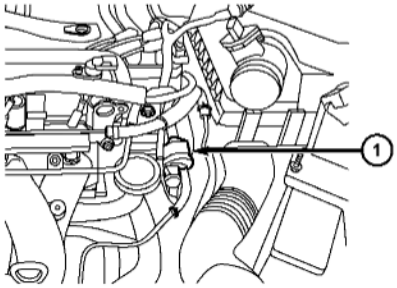
    NOTE: For 1.8L engine, disconnect the air flow sensor electrical connector.



12. Remove the ground cable bolt from the cylinder head.

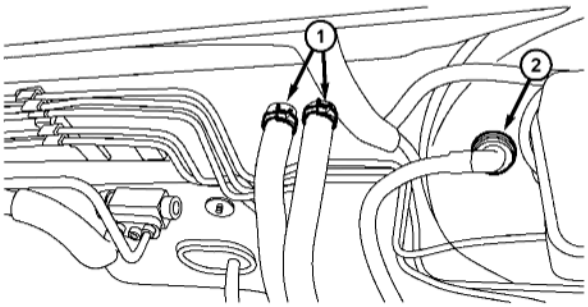
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13. Disconnect and remove the following electrical connectors:
    - Coolant temperature sensor
    - Camshaft position sensor
    - Ignition coil
    - Four fuel injectors
    - Intake manifold air pressure sensor (1.6L)
    - Air flow sensor (1.8L)
    - Carbon canister solenoid valve
    - Throttle body control
    - A/C compressor
    - Oil pressure sensor
    - Power steering pump pressure switch
    - Generator
14. Remove the pipe from the canister control valve (1).



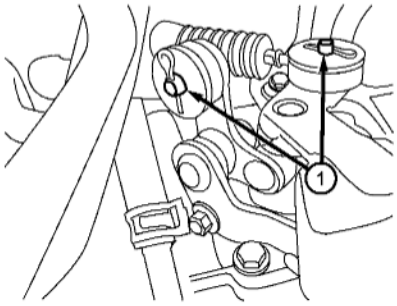
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15. Disconnect the heater hoses (1) on the vehicle.
16. Remove the vacuum line from the brake booster (2).
17. Remove the dipstick.



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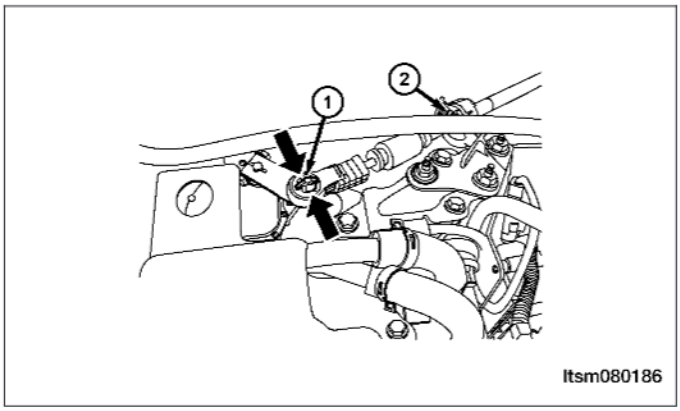
18. If equipped with a manual transaxle remove the transaxle shift cable (1).
19. Remove the hydraulic pipe from the clutch slave cylinder.



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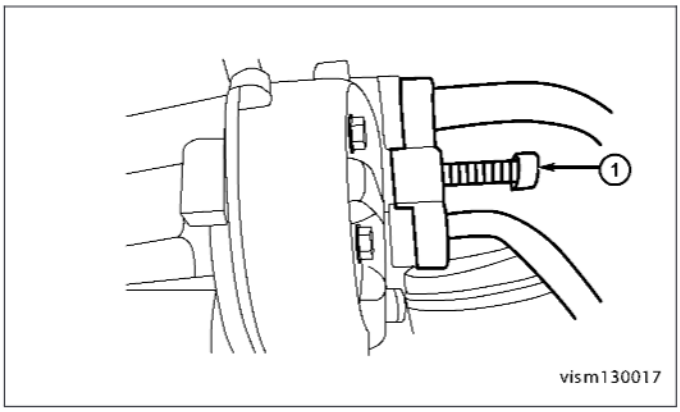
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20. If equipped with an automatic transaxle remove the transaxle shift cable (1) and the shift cable clamp (2).

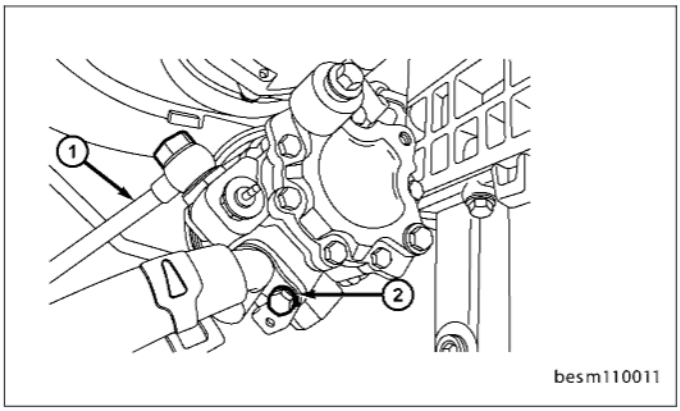


21. Remove the A/C compressor line bolt (1) from the A/C compressor.
(Tighten: A/C compressor line bolts to 20 N·m)

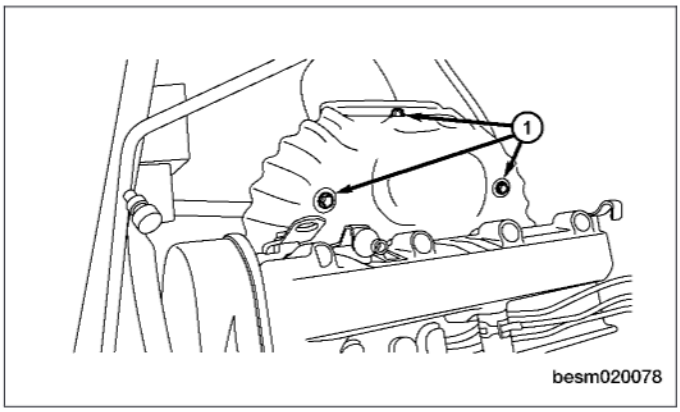
NOTE :
After removing the A/C lines, plug the A/C lines to prevent any debris from entering the A/C system.



22. Remove the high pressure line (1) and low pressure line (2) from the power steering pump (drain fluid from lines).
(Tighten: High pressure line to power steering pump 40 ± 5 N·m)
(Tighten: Low pressure line to power steering pump 40 ± 5 N·m)



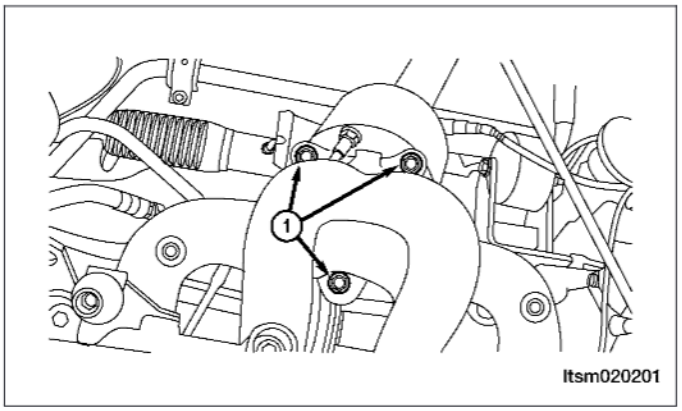
23. Remove the exhaust manifold heat shield bolts (1) and then remove heat shield.
(Tighten: Exhaust manifold heat shield bolts to 15 N·m)



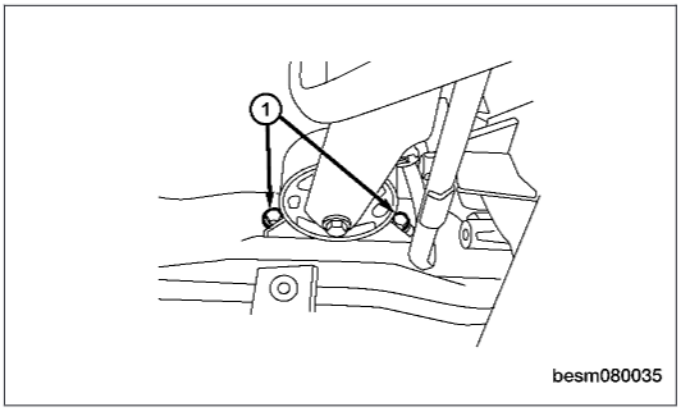
24. Disconnect the upstream and downstream oxygen sensor connectors.

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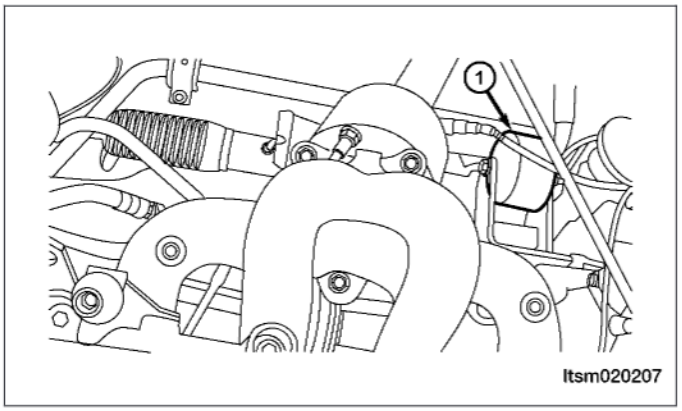
25. Remove the catalytic converter to exhaust manifold bolts (1).



26. Raise and support the vehicle.
27. Remove the front axle shaft (See Front Axle Shaft Removal & Installation in Section 09 Driveline & Axle).
28. Drain the engine oil.
29. Lower the vehicle and install engine lift chain hangers.
30. Remove the bolts (1) securing the front engine mount.
    (Tighten: Engine front mount bolt to 60 N·m)

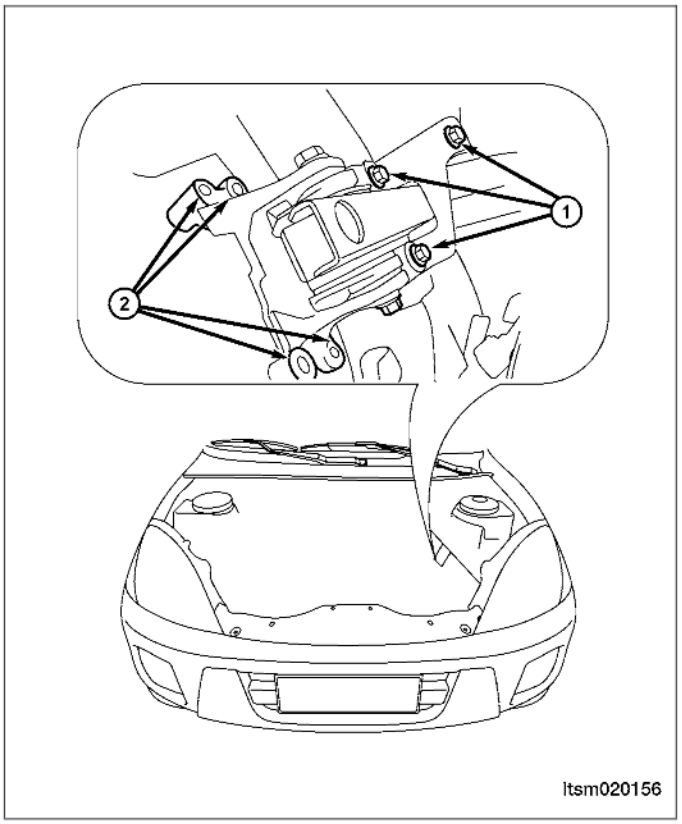


31. Remove the bolts (1) securing the rear engine mount.
    (Tighten: Engine rear mount bolt to 60 N·m)

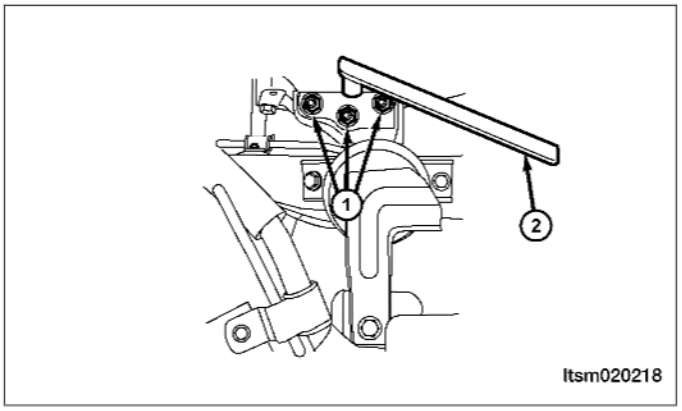


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32. Remove the left transaxle mount bolts (2) and the transaxle mount bracket retaining bolts (1).
(Tighten: Left transaxle mount bolt to 70 N·m)



33. Using special tool CH-20001 (2), remove the three bolts (1) securing the right engine mount.
(Tighten: Engine right mount bolt to 70 N·m)



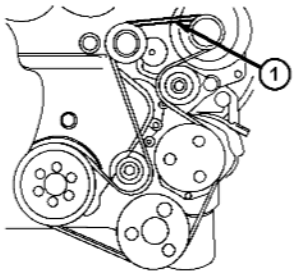
34. Verify all components between the engine and vehicle are disconnected.
35. Remove the front sub-frame (See Front Sub-Frame Removal & Installation in Section 10 Suspension).
36. Hoist the engine from vehicle.

CAUTION:
Verify all electrical connectors are disconnected prior to engine/transaxle removal.

37. Separate engine and transaxle.

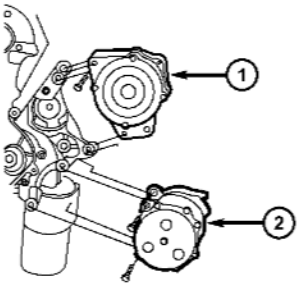
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38. Remove the accessory drive belt (1) (See Accessory Drive Belt Removal & Installation in Section 02 Engine).



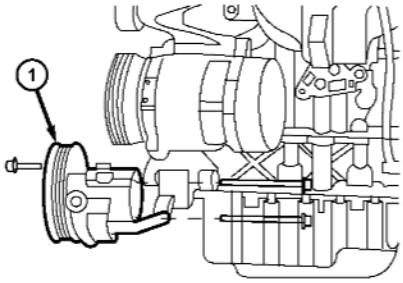
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39. Remove the generator (1) from the bracket (See Generator Removal & Installation in Section 05 Starting & Charging).
40. Remove the A/C compressor pipe.
41. Remove the A/C compressor (2) (See A/C Compressor Removal & Installation in Section 13 Heating & Air Conditioning).



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42. Remove the power steering pump (1) with piping connected and set aside with wire.



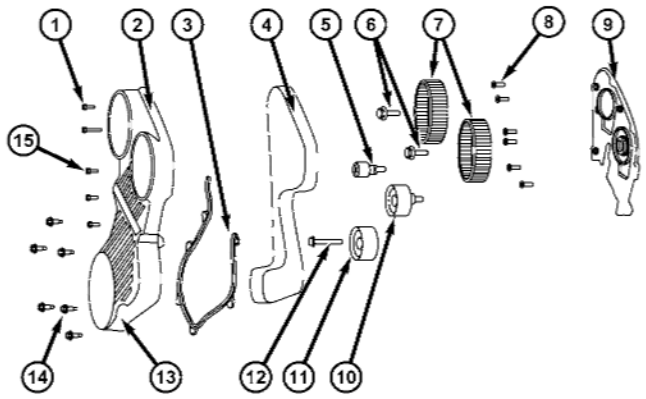
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43. Installation is in the reverse order of removal.

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Engine Timing Belt

Removal & Installation



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1 - Timing Belt Upper Cover Bolt	9 - Rear Timing Cover
2 - Timing Belt Upper Cover	10 - Idler Pulley
3 - Timing Belt Cover Gasket	11 - Tensioner Pulley
4 - Timing Belt	12 - Tensioner Pulley Bolt
5 - Timing Belt Touch Pulley	13 - Timing Belt Lower Cover
6 - Camshaft Bolt	14 - Timing Belt Lower Cover Bolt
7 - Camshaft	15 - Timing Belt Upper Cover Bolt
8 - Rear Timing Cover Bolt	

NOTE :
The following special tools are required to perform the repair procedure:
- CH-20001 - Right Engine Mount Bolt Remover
- CH-20003 - Crankshaft Holder
- CH-20010 - Camshaft Holder
- Engine Hoist

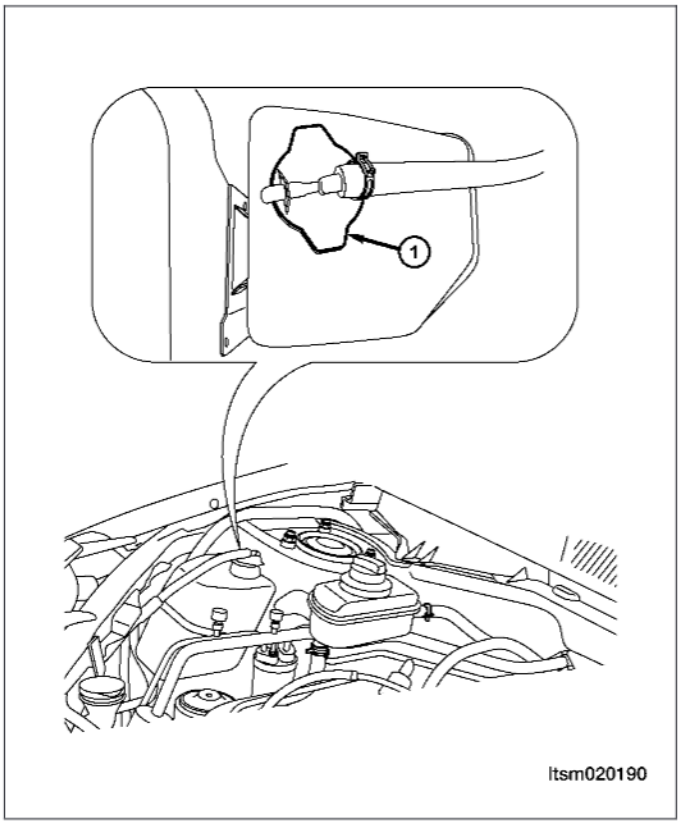
1. Release the coolant system pressure.

WARNING!

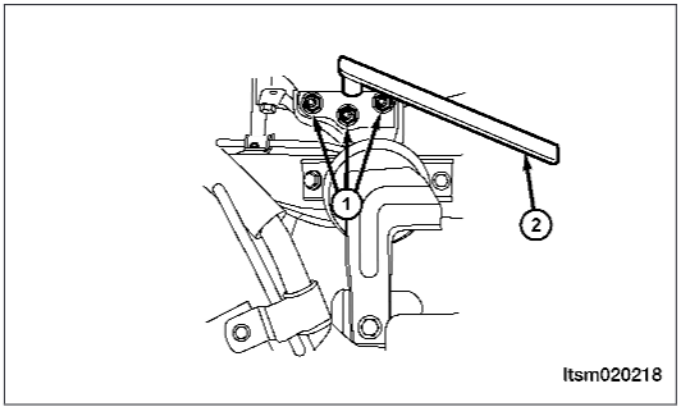
Always allow the engine to cool before opening the cooling system. Do not loosen the coolant pressure relief cap when the engine is operating or the cooling system is hot. The cooling system is under pressure; steam and hot liquid can come out forcefully when the cap is loosened slightly. Failure to follow these instructions may result in serious personal injury.

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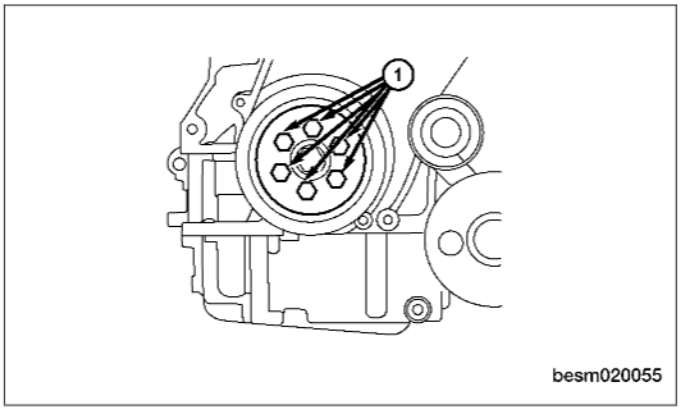
2. Remove the coolant reservoir (1) and set aside.



3. Attach an engine hoist and support the engine using an engine hoist.
4. Using special tool CH-20001 (2), remove the engine right mount bolts (1) and bracket.
(Tighten: Engine right mount bolts to 70 N·m)

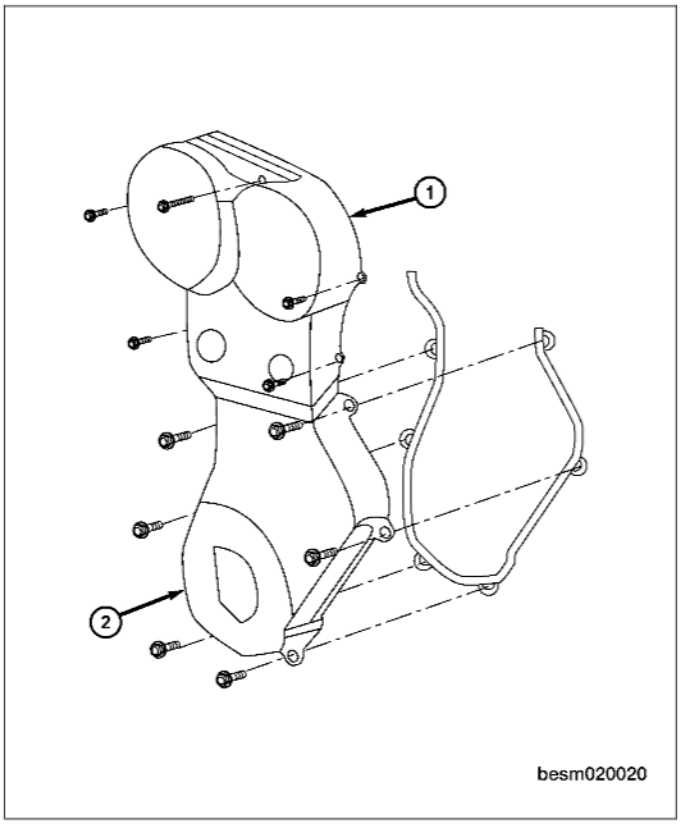


5. Remove the accessory drive belt (See Accessory Drive Belt Removal & Installation in Section 02 Engine).
6. Remove the crankshaft vibration damper bolts (1).
(Tighten: Crankshaft vibration damper bolts to 25 N·m)

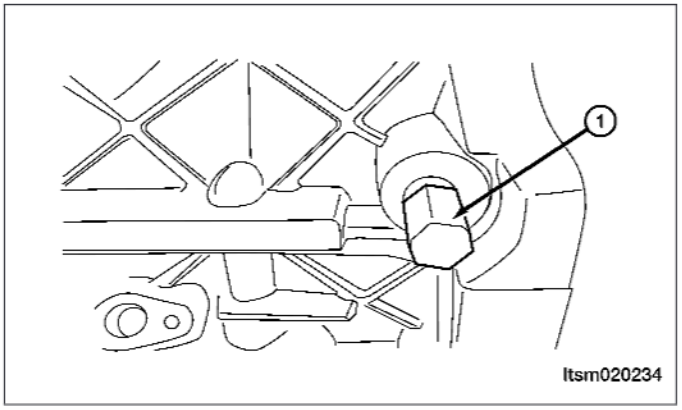


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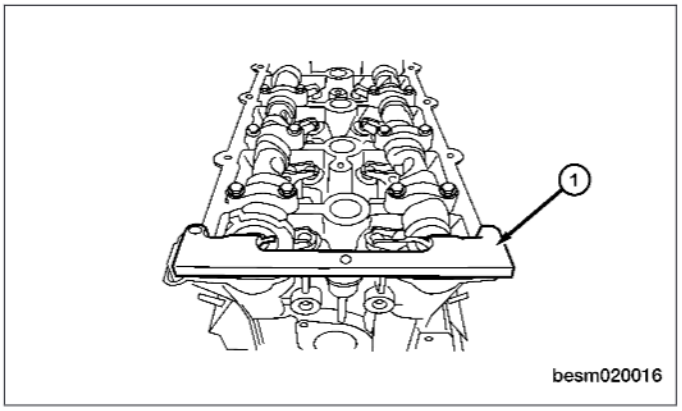
7. Remove the timing belt upper cover (1) and timing belt lower cover (2).
   (Tighten: Timing belt upper cover bolts to 11 N·m)
   (Tighten: Timing belt lower cover bolts to 11 N·m)



8. Remove the cylinder head cover (See Cylinder Head Cover Removal & Installation in Section 02 Engine).
9. Remove the plug in the cylinder block.
10. Using special tool CH-20003 (1), install the crankshaft holder into the cylinder block and rotate the crankshaft until the crankshaft tool completely holds the crankshaft in place.
    (Tighten: Crankshaft holder to 28 N·m)
    NOTE: The crankshaft holder will prevent the crankshaft from rotating in either direction.



11. Using special tool CH-20010 (1), install the camshaft holder to hold the camshafts in place.
    NOTE: The camshaft holder will prevent the camshafts from rotating in either direction.



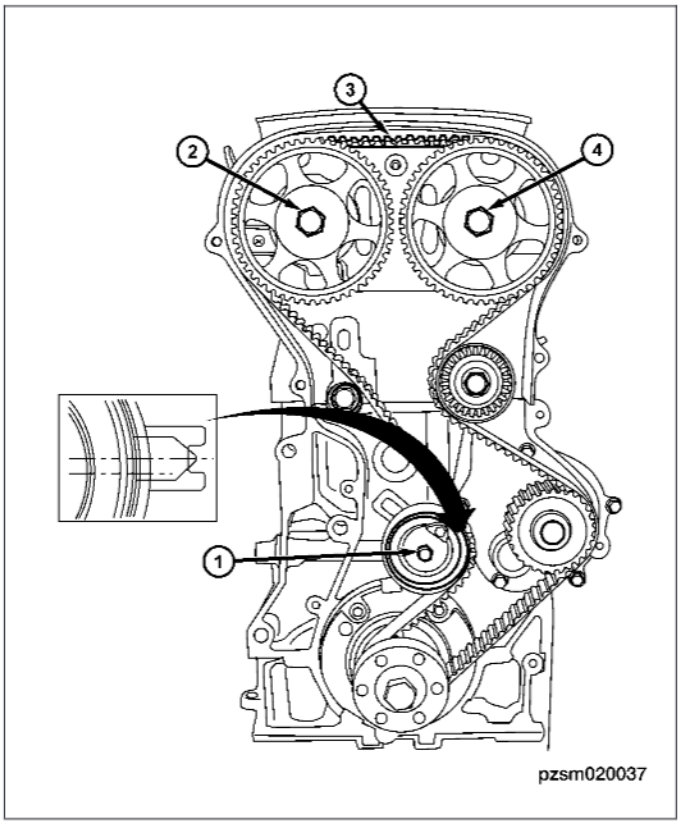
CAUTION: Rotating the camshafts or crankshaft with timing components loosened or removed can cause serious damage to the valves or pistons.

02
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12. Loosen the bolt of the timing belt tensioner pulley (1), remove the pulley.
    (Tighten: Timing belt tensioner pulley bolt to 30 N·m)
13. Remove the timing belt (3).
14. Installation is in the reverse order of removal.

Installation Notes:

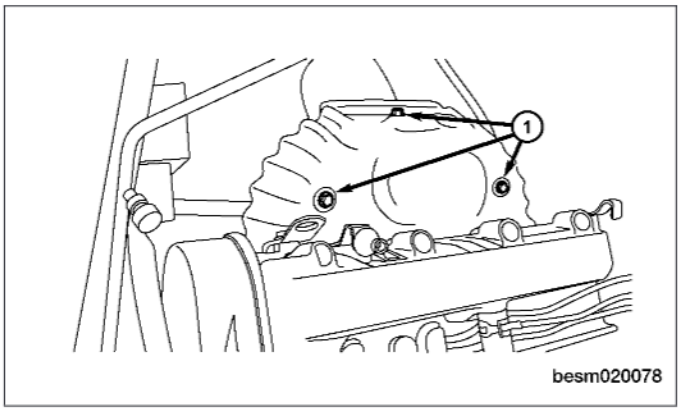
- Install the timing belt and rotate the tensioner pulley with an Allen wrench in order to apply tension to the belt and align the finger pointer of the tensioner to the middle of the U-slot opening. Tighten the tensioner pulley bolt (1) to 30 N·m, then tighten the intake and exhaust camshaft pulley bolts (2 & 4) to 120 N·m.



Exhaust Manifold

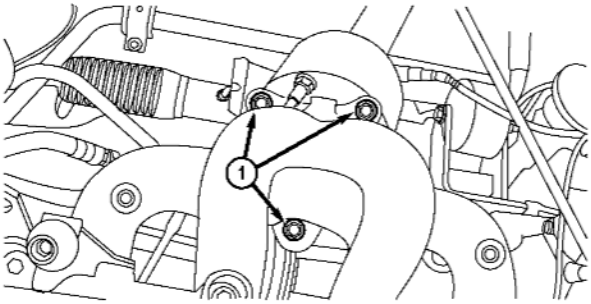
Removal & Installation

1. Remove the engine cover.
2. Remove the bolts (1) attaching the exhaust manifold heat shield.
   (Tighten: Exhaust manifold heat shield bolts to 15 N·m)
3. Remove the exhaust manifold heat shield.



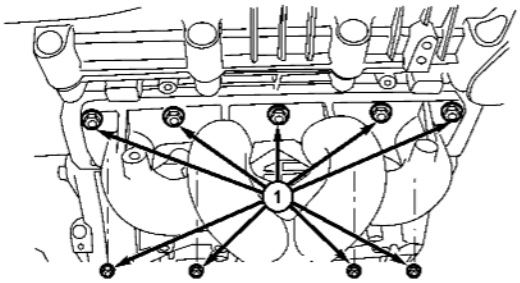
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4. Remove the three bolts (1) securing the exhaust manifold to the catalytic converter assembly.
5. Disconnect the catalytic converter assembly from the manifold.



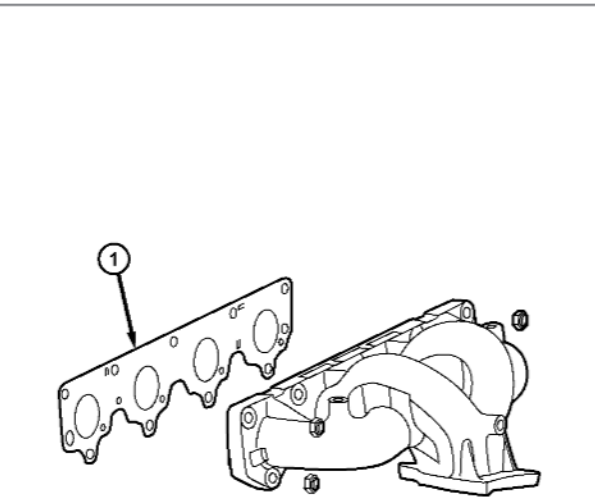
ltsm020201

6. Remove the exhaust manifold nuts (1).
(Tighten: Exhaust manifold nuts to 25 N·m)



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7. Remove the exhaust manifold.
8. Remove and discard manifold gasket (1).



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9. Installation is in the reverse order of removal.

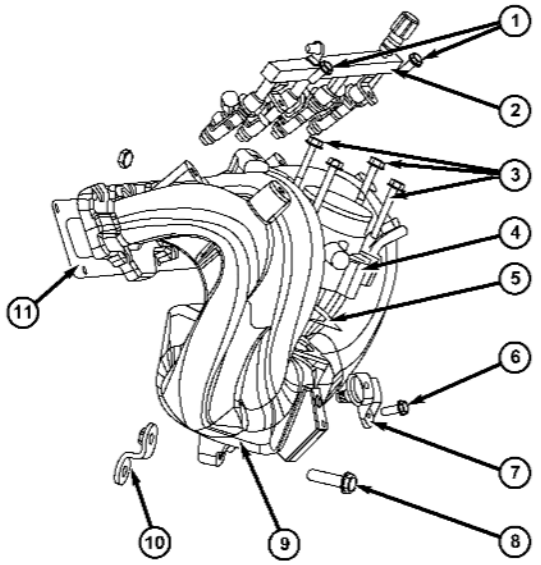
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Installation Notes:

- Clean all surfaces of manifold and cylinder head.
- Install a new exhaust manifold gasket during installation.

Intake Manifold

Removal & Installation



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1 - Fuel Rail Bolt	7 - Air Intake Pressure Temperature Sensor
2 - Fuel Rail	8 - Intake Manifold Bolt
3 - Electronic Throttle Control Actuator Bolt	9 - Intake Manifold
4 - Electronic Throttle Control Actuator	10 - Intake Manifold Bracket
5 - Electronic Throttle Control Actuator Gasket	11 - Intake Manifold Gasket
6 - Air Intake Pressure Temperature Sensor Bolt	

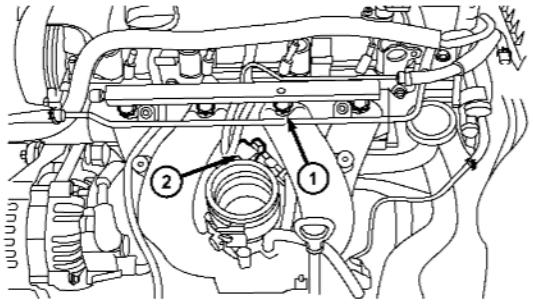
1. Disconnect the negative battery cable.
2. Remove the engine cover.
3. Drain the cooling system (See Cooling System Draining and Filling in Section 06 Cooling).

WARNING!

Always allow the engine to cool before opening the cooling system. Do not loosen the coolant pressure relief cap when the engine is operating or the cooling system is hot. The cooling system is under pressure; steam and hot liquid can come out forcefully when the cap is loosened slightly. Failure to follow these instructions may result in serious personal injury.

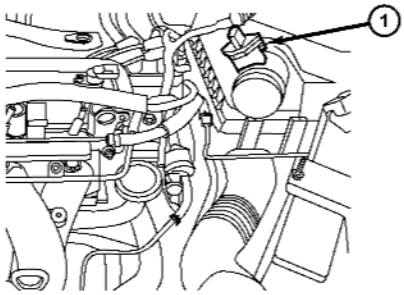
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4. Disconnect the four fuel injector electrical connectors (1).
5. Disconnect the throttle body control electrical connector (2).



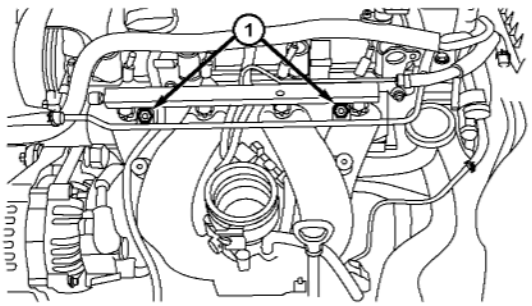
ltsm020221

6. Disconnect the air flow sensor electrical connector (1).



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7. Loosen the clamp between the air intake hose and the air cleaner.
8. Loosen the clamp between the air intake hose and the throttle body and then remove the intake pipe.
9. Loosen the clamp on the PCV hose and then disconnect the PCV hose.
10. Remove the fuel rail bracket bolts (1).
(Tighten: Fuel rail bracket bolts to 11 N·m)



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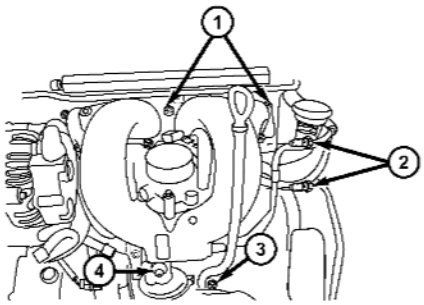
11. Remove the fuel rail with the fuel injectors and set aside.
12. Remove the fuel injector O-rings.

NOTE :
Install new O-rings on the fuel injectors.

13. Remove the screws securing the vacuum valve bracket to the intake manifold.
14. Set aside the vacuum valve and pipe.
15. Disconnect intake manifold electrical harness, and vacuum hose.

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16. Remove the bolts (2) & (3) securing the engine oil dipstick to intake manifold. Remove the dipstick. (Tighten: Dipstick bracket bolts to 11 N·m)
17. Disconnect the oil pressure switch connector (4).
18. Remove the nuts (1) securing the intake manifold to cylinder head.
    (Tighten: Intake manifold nuts to 11 N·m)
    NOTE: Replace the manifold gasket.



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19. Installation is in the reverse order of removal.

Installation Notes:

- Clean all surfaces of manifold and cylinder head.
- Install a new intake manifold gasket during installation.
- Install new O-rings on the fuel injectors.

Idler Pulley

Removal & Installation

1. While using a suitable tool and securely holding the hexagonal portion of the drive belt tensioner, rotate the pulley counterclockwise to loosen the drive belt.

WARNING!
Avoid placing hands near the drive belt tensioner while it is being held.

2. Remove the drive belt.

Upper Accessory Drive Belt Idler Pulley (1)

- Remove the bolt and the upper accessory drive belt idler pulley.

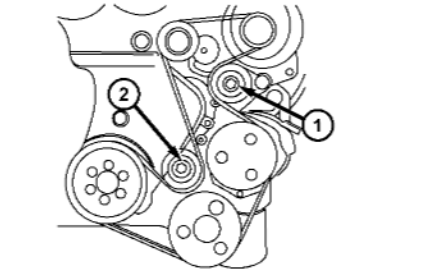
(Tighten: Upper idler pulley bolt to 45 N·m)

Lower Accessory Drive Belt Idler Pulley (2)

- Remove the bolt and the lower accessory drive belt idler pulley.

(Tighten: Lower idler pulley bolt to 45 N·m)

3. Installation is in the reverse order of removal.



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Oil Filter

Removal & Installation

NOTE :
The following special tools are required to perform the repair procedure:

- CH-10003 - Oil Filter Remover

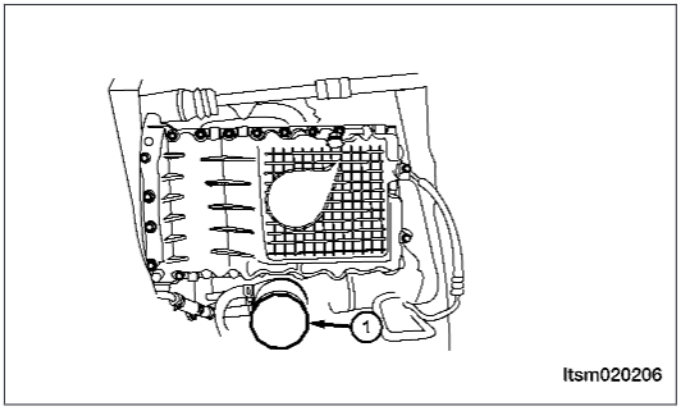
CAUTION:
When servicing the oil filter, avoid deforming the filter by installing the special tool against the base of the filter.

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WARNING!

Prolonged and repeated contact with engine oil will harm your skin. If engine oil is spilled on your skin, wash it off immediately with water. In addition, used engine oil contains potentially harmful contaminants which may cause skin cancer. Always use adequate skin protection when performing vehicle service.

1. Using special tool CH-10003 oil filter remover, remove the oil filter (1).
   (Tighten: Oil filter to 25 N·m)
   CAUTION: When removing the oil filter, ensure that the oil filter gasket is not stuck to the engine. The oil filter gasket must be removed from the engine before installing the new oil filter.



2. Installation is in the reverse order of removal.

Installation Notes:

- Clean all surfaces, and verify the oil filter does not leak.

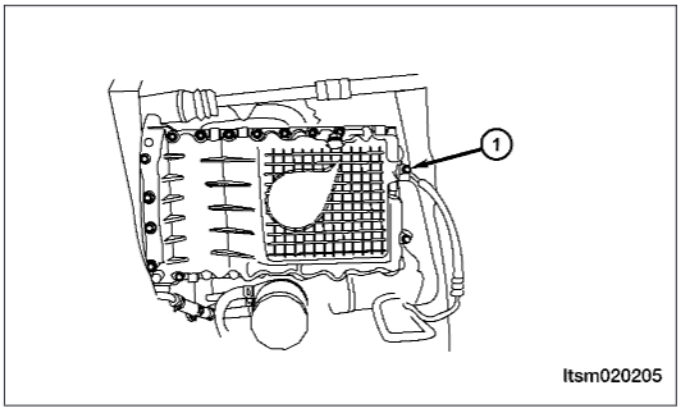
Oil Pan

Removal & Installation

1. Remove the oil dipstick.
2. Raise and support the vehicle.
3. Remove the oil pan drain plug and drain the engine oil.
   (Tighten: Oil pan drain plug to 40 N·m)

NOTE :
Do not pry on cylinder block to remove oil pan.

4. Remove oil pan bolts (1).
   (Tighten: Oil pan bolts to 18 N·m)

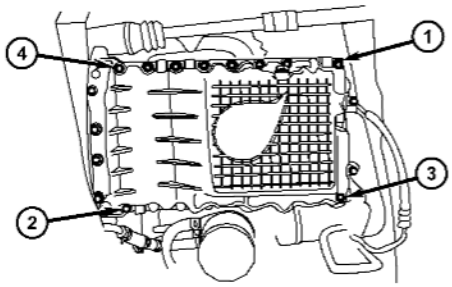


5. Using a putty knife, loosen seal around oil pan.
6. Remove the oil pan.
7. Installation is in the reverse order of removal.

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Installation Notes:

- Oil pan sealing surfaces must be free of grease or oil.
- Install the four oil pan corner bolts in the sequence shown (1-2-3-4).
- Install the remaining oil pan bolts.
- Torque all the oil pan bolts to the proper specification.

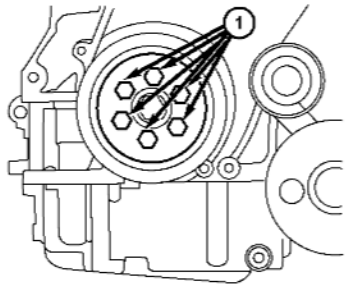


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Oil Pump

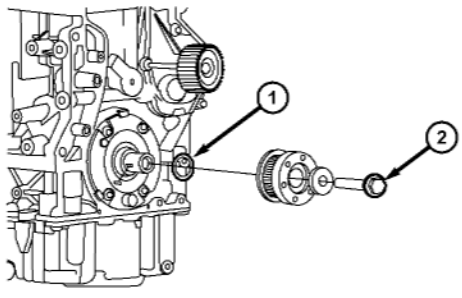
Removal & Installation

1. Remove the accessory drive belt (See Accessory Drive Belt Removal & Installation in Section 02 Engine).
2. Remove the crankshaft vibration damper retaining bolt (1).
   (Tighten: Crankshaft vibration damper bolts to 25 N·m)



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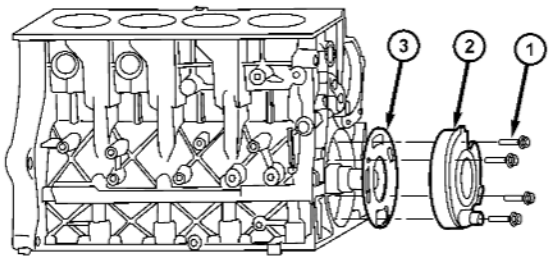
3. Remove the engine timing belt (See Engine Timing Belt Removal & Installation in Section 02 Engine).
4. Remove the crankshaft timing belt pulley bolt (2) from the crankshaft.
   (Tighten: Crankshaft timing belt pulley bolt to 130 N·m and an additional 65°)
5. Remove the key-way from the crankshaft.
6. Using an appropriate tool, remove the front crankshaft oil seal (1).



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7. Remove the four oil pump bolts (1).
   (Tighten: Oil pump bolts to 11 N·m)
8. Remove the oil pump (2) using a suitable tool.
9. Remove the oil pump gasket (3).



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10. Installation is in the reverse order of removal.

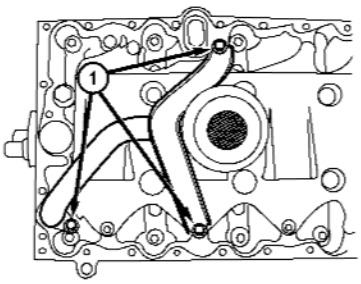
Installation Notes:

- Before installing, prime the new oil pump. Fill the oil pump with engine oil and rotate the oil pump.
- Replace the oil pump gasket.

Oil Strainer

Removal & Installation

1. Raise and support the vehicle.
2. Remove the oil pan (See Oil Pan Removal & Installation in Section 02 Engine).
3. Remove the oil strainer retaining bolts (1).
   (Tighten: Oil strainer bolts to 18 N·m)



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4. Carefully remove the oil strainer.
5. Installation is in the reverse order of removal.

Installation Notes:

- Install new O-rings on the oil strainer pipe.

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Engine Block

Specifications

Torque Specifications

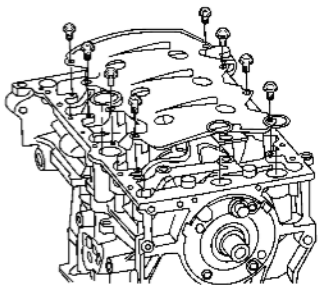
DESCRIPTION	TORQUE (N·m)
Connecting Rod Cap Bolts	1st Step: Tighten the bolt to 25 N·m 2nd Step: Tighten the bolt an additional 90°
Main Bearing Cap Bolts	1st Step: Tighten the bolt to 45 N·m 2nd Step: Tighten the bolt an additional 180°
Lower Cylinder Block Bolts	23

Clearance Specifications

DESCRIPTION	SPECIFICATION (mm)
Surface Distortion Limit	0.15
Inner Diameter Standard	84
Out-Of-Round	< 0.008
Taper	< 0.01

Disassembly

1. Remove the oil pan and then remove oil baffle.
2. Remove the oil strainer.

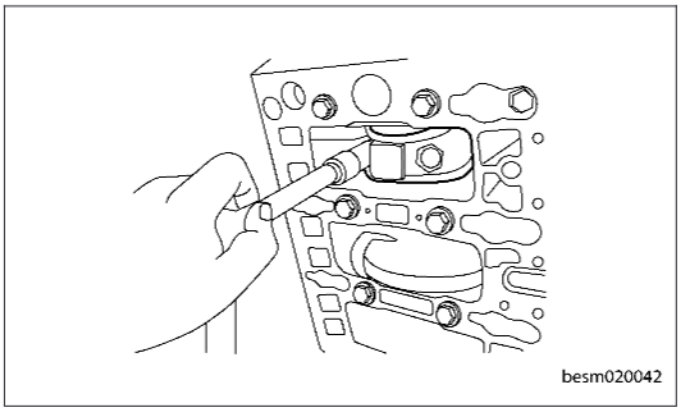

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3. For each connecting rod/piston assembly to be removed, rotate the crankshaft to the bottom dead center position for each cylinder.

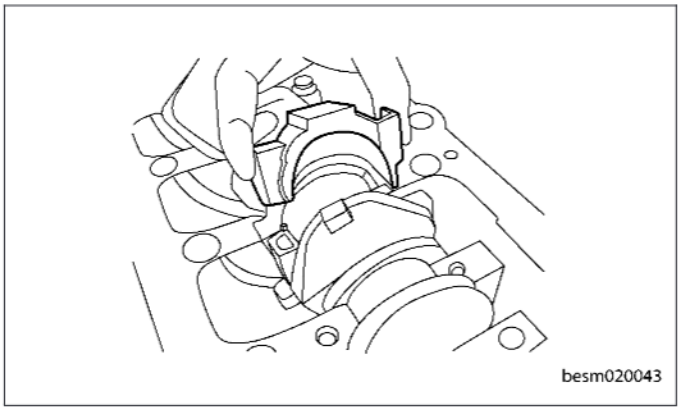
NOTE :
Before removing the connecting rod/piston assembly, check the connecting rod side clearance.

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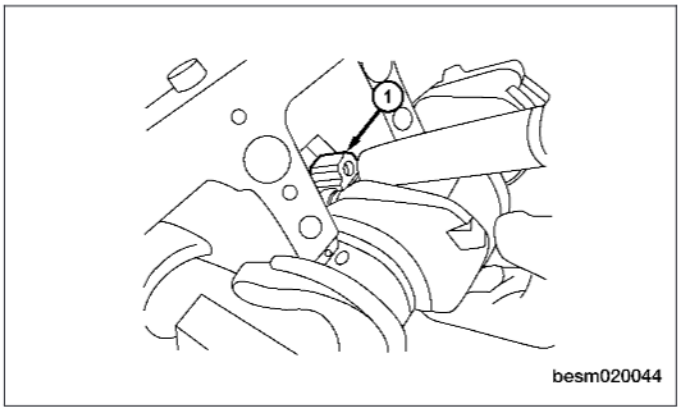
4. Remove the connecting rod retaining bolts.


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5. Remove the connecting rod bearing cap.

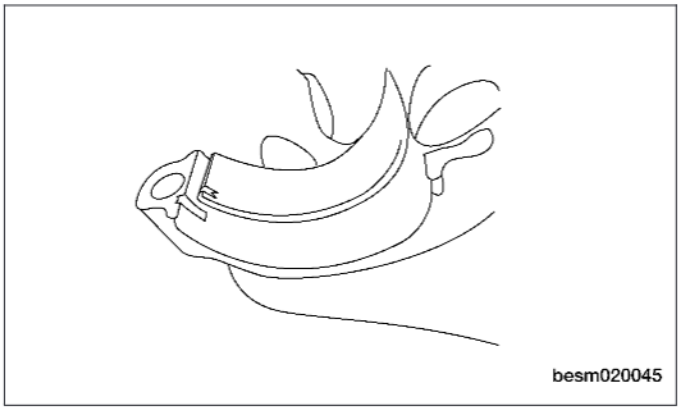

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6. Using a hammer handle or similar tool, push the connecting rod/piston assembly (1) out through the top of the cylinder block.



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7. Remove the connecting rod bearings (See Connecting Rod Removal & Installation in Section 02 Engine).
CAUTION: When removing the connecting rod side bearings, note the installation position. Keep them in the correct order.


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8. Installation is in the reverse order of removal.

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Inspection

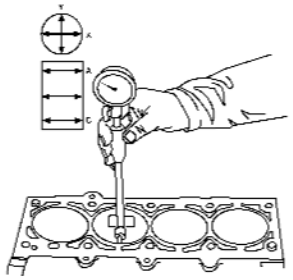
NOTE :
All measurements should be taken with the engine block at room temperature, 21°C.

Engine Block

- Clean cylinder block thoroughly and check all core hole plugs for evidence of leaking.
- Examine block and cylinder bores for cracks or fractures.
- Check block deck surfaces for flatness. Deck surface must be within service limit of 0.050 mm.

Cylinder Bore

- The cylinder walls should be checked for out-of-round and taper with cylinder indicator or equivalent. If the cylinder walls are badly scuffed or scored, the cylinder block should be replaced, and new pistons and rings fitted.
- Measure the cylinder bore at three levels in directions X and Y. Top measurement should be 10 mm down and bottom measurement should be 10 mm up from bottom of bore.



CYLINDER BORE	
All Cylinders	83.500 - 83.510 mm

Assembly

NOTE :
Cleanliness is extremely important during the engine assembly procedure. Any foreign material, including any material created while cleaning gasket surfaces, that enters the oil passages, coolant passages or the oil pan can cause engine failure.

NOTE :
Assemble all components in their original position.

1. Install the pistons to the connecting rods.
2. Using a piston ring expander, install the piston rings.
3. Assemble all components in the reverse order of disassembly.

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Pistons

Specifications

Clearance Specifications - Pistons

DESCRIPTION	SPECIFICATION (mm)
Surface Distortion Limit	0.15
Inner Diameter Standard	84
Out-Of-Round	< 0.008
Taper	< 0.01

Clearance Specifications - Piston Ring Groove

DESCRIPTION	SPECIFICATION (mm)
First Ring	0.04 - 0.08
Second Ring	0.01 - 0.0251

Clearance Specifications - Piston Ring End Gap

DESCRIPTION	SPECIFICATION	LIMIT
First Ring End Gap	0.2 - 0.4 mm	0.8 mm
Second Ring End Gap	0.4 - 0.6 mm	1.0 mm

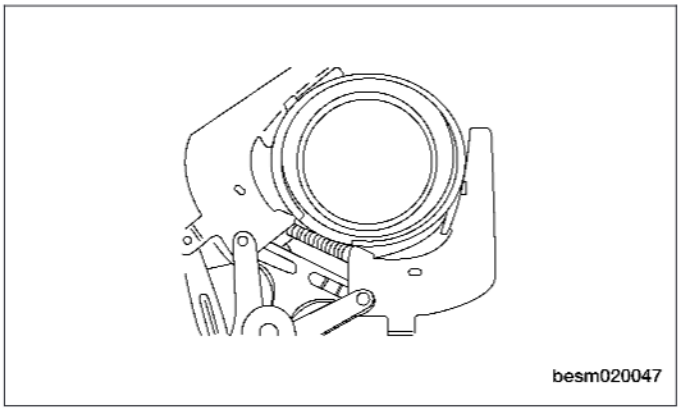
Clearance Specifications - Piston to Piston Pin

DESCRIPTION	SPECIFICATION (mm)
Piston To Piston Pin	0.002 - 0.013

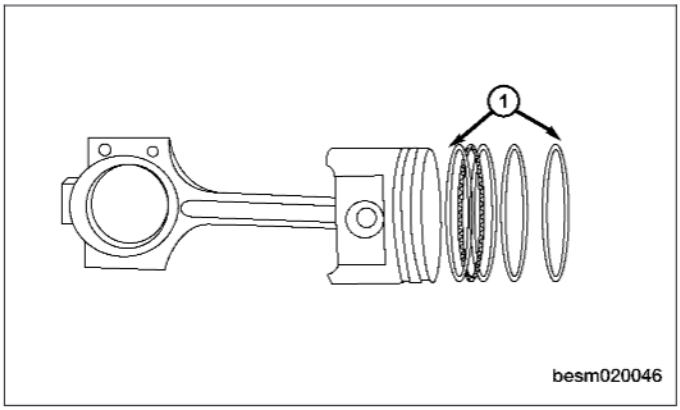
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Disassembly

- Piston Ring Removal
  - Using a suitable ring expander, remove upper and intermediate piston rings.
  - Remove the upper oil ring side rail, lower oil ring side rail and then oil ring expander from piston.
  - Clean ring grooves of any carbon deposits.

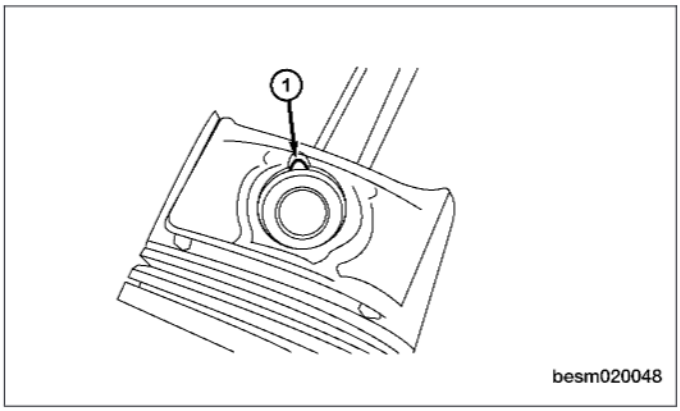

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CAUTION:
Before removing the piston rings (1), check the piston ring side clearance. Be careful to mark the location of the piston rings if they are to be reused.



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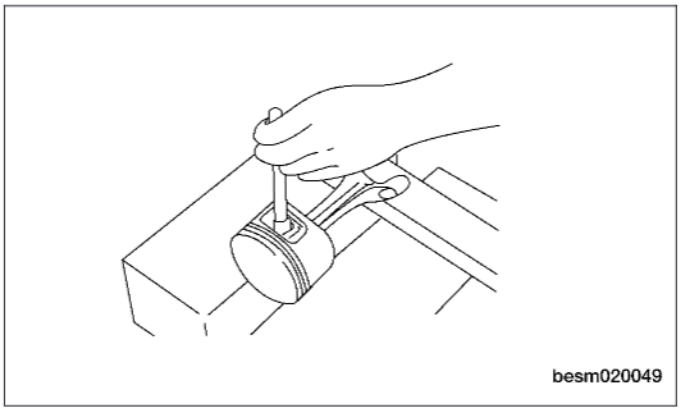
- Piston Pin Snap Ring Removal
  - Using snap ring pliers, remove the snap ring (1).
  - Heat the pistons if necessary.



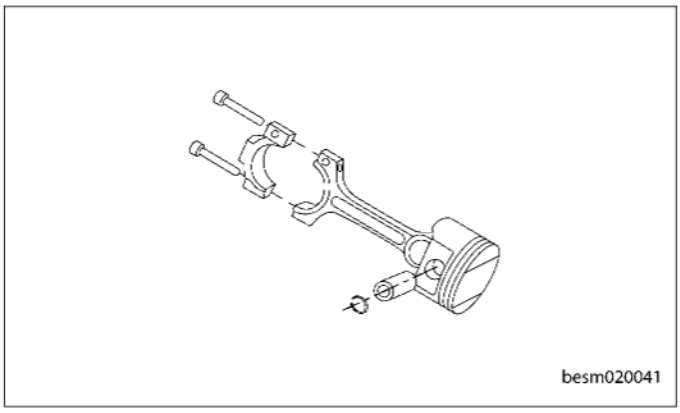
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- Piston Pin Removal
  - Push out the piston pin with a suitable tool.

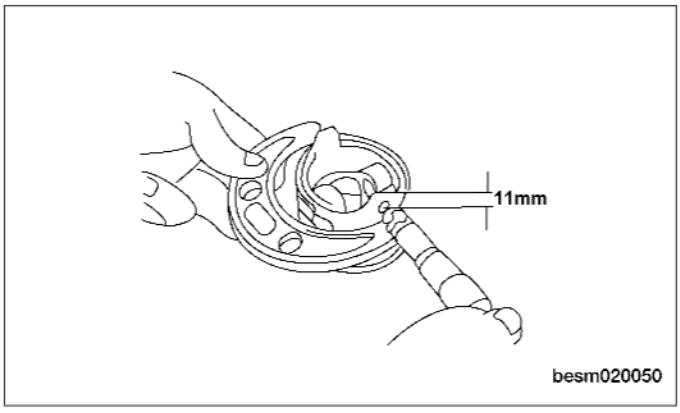

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- Connecting Rod & Piston Disassembly
  - Remove the piston from the connecting rod.


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Inspection

- Check the piston diameter.

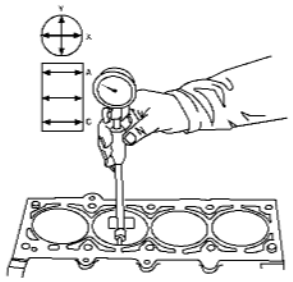


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PISTON DIAMETER	
All Pistons	83.451 - 83.469 mm

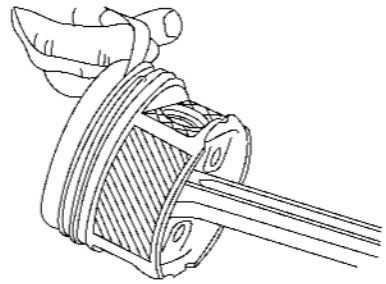
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- Check the inner diameter of each cylinder bore (See Cylinder Bore Inspection in Section 02 Engine).


besm020063

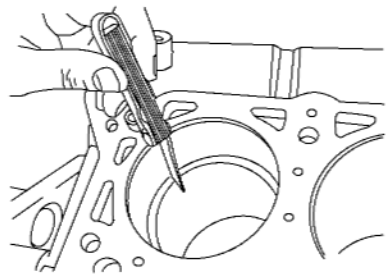
CYLINDER BORE	
All Cylinders	83.500 - 83.510 mm

- Check piston ring to groove side clearance.
  - Clean the ring slot using a suitable tool.
  - Measure piston ring to groove side clearance.


besm020051

RING GROOVE CLEARANCE	
First Ring	0.04 - 0.08 mm
Second Ring	0.01 - 0.0251 mm

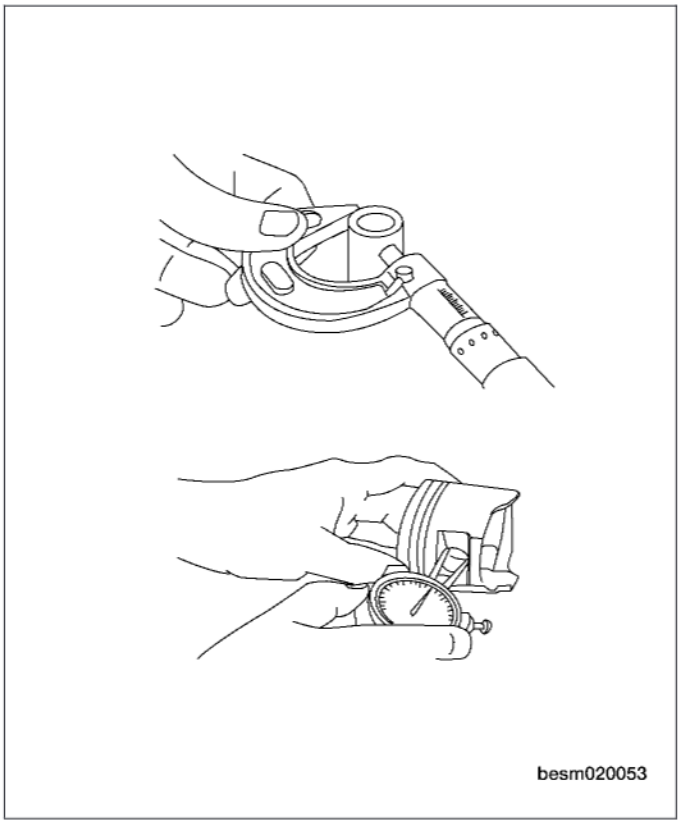
- Wipe the cylinder bore clean. Insert ring and push down with piston to ensure it is square in the bore. The ring gap measurement must be made with the ring positioned at least 13 mm from bottom of cylinder bore and below the bottom of the oil ring travel where the cylinder bore has minimal wear. Check gap with feeler gauge.


besm020052

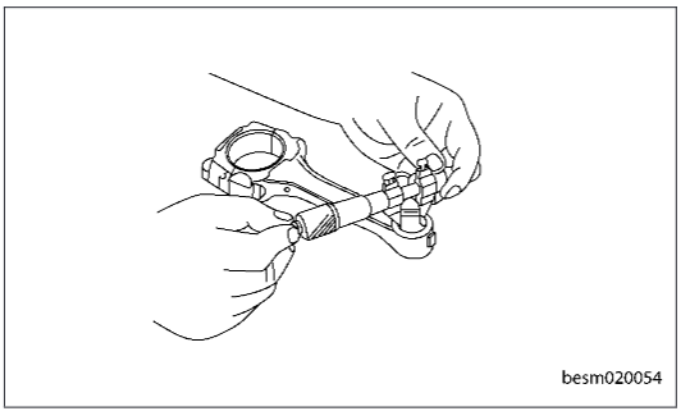
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RING END GAP CLEARANCE		
First Ring	0.2 - 0.4 mm	0.8 mm
Second Ring	0.4 - 0.6 mm	1.0 mm

- Check the diameter of the piston pin bore.
- Check the outer diameter of the piston pin.



- Check the inner diameter of connecting rod (small end).



PISTON PIN CLEARANCE	
Piston and Piston Pin	0.002 - 0.013 mm

Assembly

1. Install the piston to the connecting rod. Assemble the components in their original positions.
2. Using a piston ring expander, install the piston rings. Assemble the components in their original positions.
3. Assemble all components in the reverse order of disassembly.

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Connecting Rods

Specifications

Torque Specifications

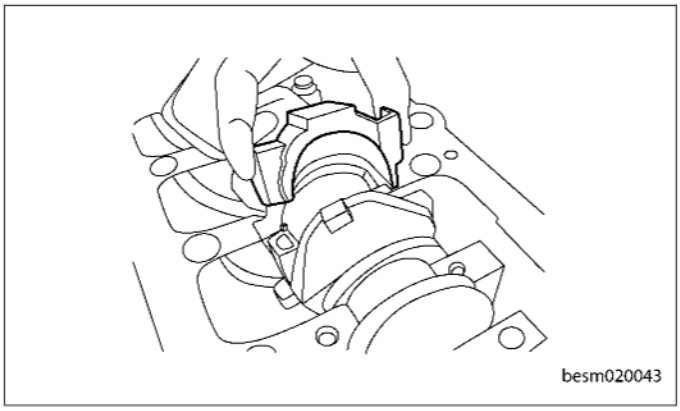
DESCRIPTION	TORQUE (N·m)
Connecting Rod Bolts	1st Step: Tighten bolts to 25 N·m 2nd Step: Tighten the connecting rod bolts an additional 90°

Clearance Specifications

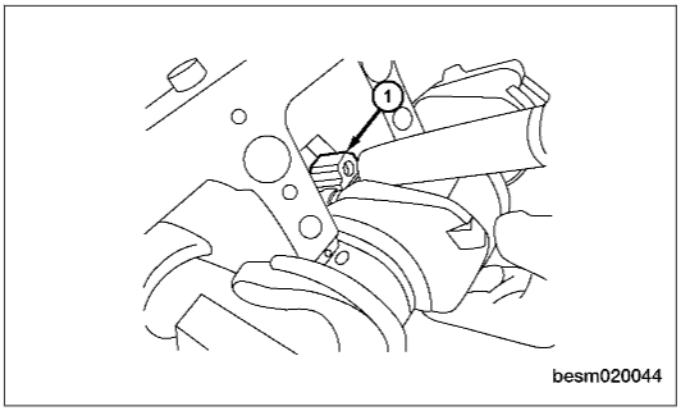
DESCRIPTION	SPECIFICATION (mm)
Connecting Rod Radial Clearance	0.016 - 0.051
Connecting Rod Axial Clearance	0.002 - 0.013

Disassembly

1. Remove the connecting rod cap bolts.
2. Remove the connecting rod bearing cap.


besm020043

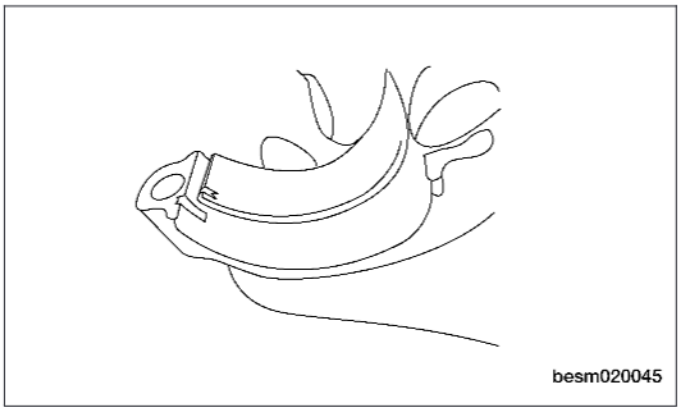
3. Using a hammer handle or similar tool, push the piston and connecting rod assembly (1) out through the cylinder head side of the engine block.
   NOTE: Before removing the piston and connecting rod assembly, check the connecting rod side clearance.



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4. Remove the connecting rod bearings.
   CAUTION: When removing the connecting rod side bearings, note the installation position. Keep them in the correct order.


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Inspection

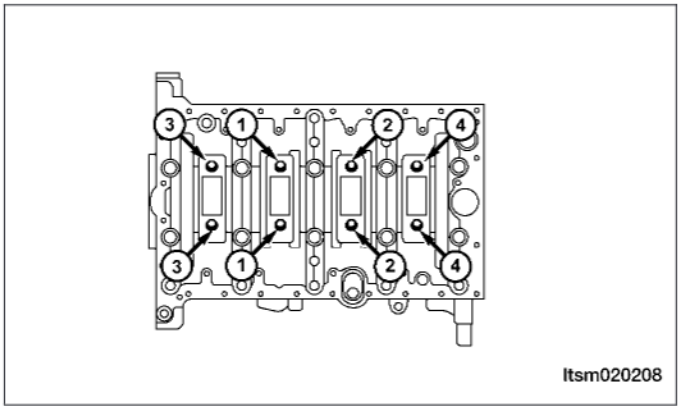
- Check the radial clearance of connecting rod bearing.

CONNECTING ROD RADIAL CLEARANCE	
Radial Clearance	0.016 - 0.051 mm

Assembly

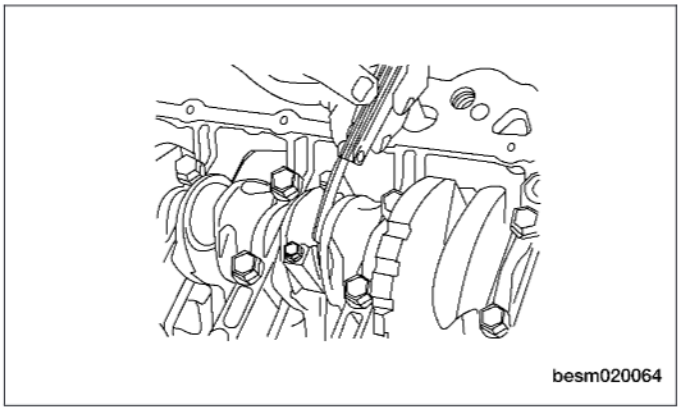
NOTE :
The rod bolts should not be reused.

1. Before installing the NEW rod bolts, the threads and under the bolt head should be oiled with clean engine oil.
2. Install each bolt finger tight, then alternately tighten each bolt to assemble the cap properly.
3. Tighten the connecting rod bolts using the two step torque-turn method:
   - 1st Step: Tighten bolts to 25 N·m
   - 2nd Step: Tighten the connecting rod bolts an additional 90°



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4. Using a feeler gauge check connecting rod side clearance.
   - Check axial clearance of connecting rod.


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Crankshaft

Specifications

Torque Specifications

DESCRIPTION	TORQUE (N·m)
Main Bearing Cap Bolts	1st Step: Tighten the bolt to 45 N·m 2nd Step: Tighten the bolt an additional 180°
Lower Cylinder Block Bolts	23

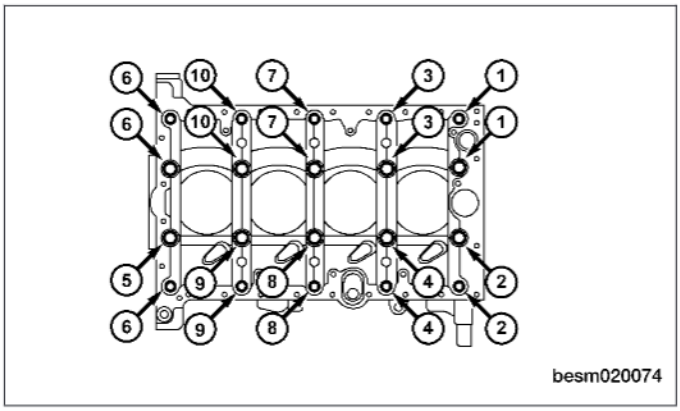
Clearance Specifications

DESCRIPTION	SPECIFICATION (mm)
Diameter of Crankshaft Main Journals	53.981 - 54
Diameter of Crankshaft Rod Journals	47.884 - 47.9
Out-of-Round Maximum of Crankshaft Main Journals	0.008
Axial Clearance of Crankshaft	0.07 - 0.265
Radial Clearance of Crankshaft	0.0035 - 0.034
Coaxality of Crankshaft Main Journals	0.05
Thrust Washer Thickness	2.4 - 2.405

Disassembly

1. Remove the front crankshaft oil seal (See Front Crankshaft Oil Seal Removal & Installation in Section 02 Engine).
2. Remove the rear crankshaft oil seal (See Rear Crankshaft Oil Seal Removal & Installation in Section 02 Engine).
3. Remove the pistons with connecting rod assemblies.
4. Remove the lower cylinder block bolts in the sequence shown.

   NOTE: Before loosening the lower cylinder block bolts, measure the crankshaft side clearance.



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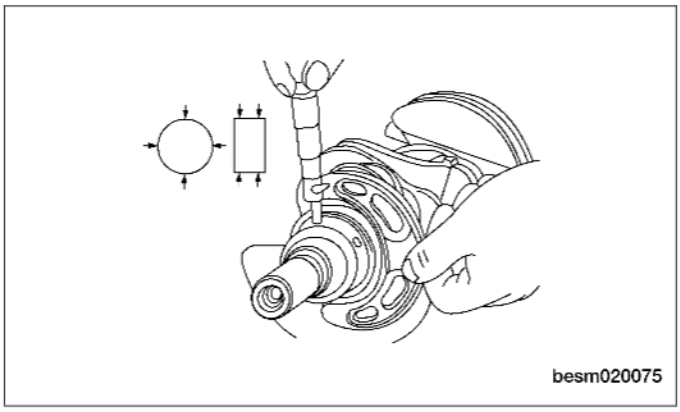
5. Remove the lower cylinder block.
6. Remove the crankshaft.
7. Remove the main bearings and thrust bearings from the cylinder block and lower cylinder block.

   NOTE: If reusing the bearings, identify and number the bearings so that they are assembled in the same position and direction.

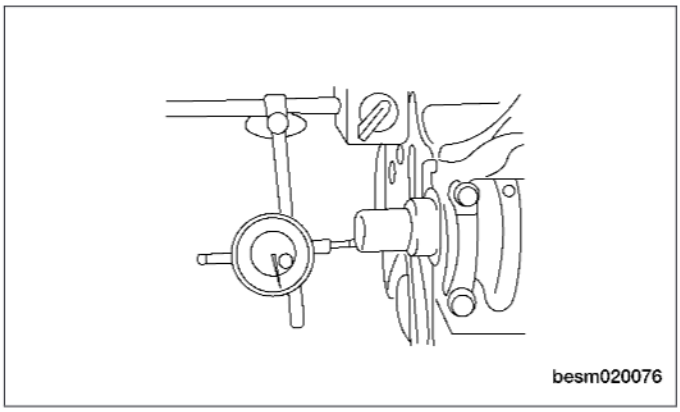
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Inspection

- The crankshaft main journals should be checked for excessive wear, roundness and scoring. Limits of roundness on any crankshaft main journals should be held to 0.008 mm. Limits of roundness on any crankshaft rod journals should be held to 0.005 mm. DO NOT nick crank pin or bearing fillets. Limits of out of round on any crankshaft journals should be held to 0.005 mm.

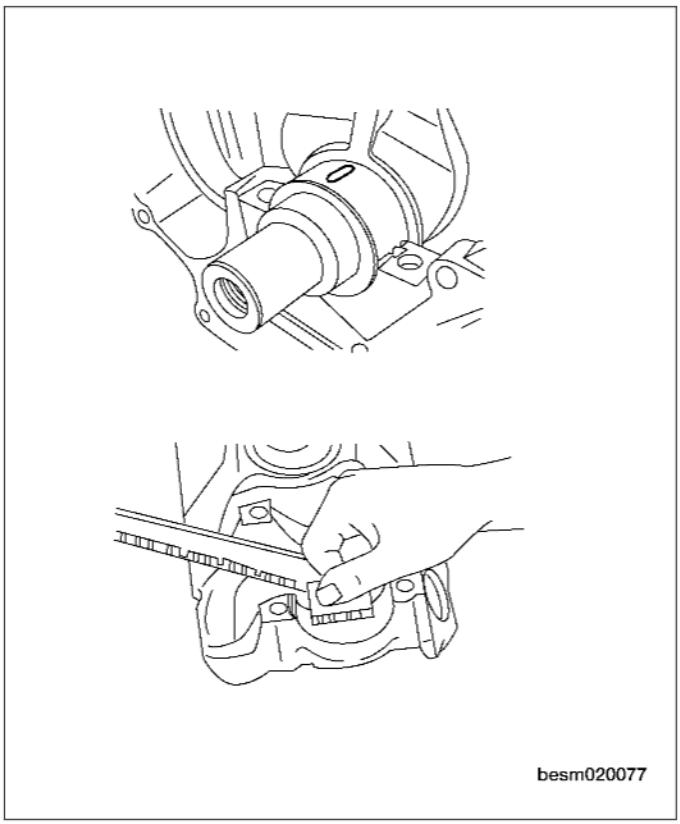

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- Check the axial clearance after installation. Standard of axial clearance should be 0.07 mm. Limits of axial clearance should be held to 0.265 mm.


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- Oil Clearance of crankshaft main journal
  - Clean the journal and bearing.
  - Install the crankshaft.
  - Cut the plastic-gauge to the same width as the bearing, and then put it onto the crankshaft journal to make it parallel with the central line of the crankshaft.
  - Install the main bearing cap carefully, and tighten the bolts to the specified torque.
  - Remove the main bearing cap.
  - Measure the oil clearance with the plastic-gauge.

Standard oil clearance of crankshaft main journal should be 0.022 mm. Limits of oil clearance of crankshaft main journal should be 0.058 mm.


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Assembly

1. Install the main bearings and thrust bearings to the upper cylinder block and lower cylinder block.
   NOTE: Identify and number the bearings, if reusing them, so that they are assembled in the same position and direction.
2. Assemble the crankshaft and main bearings in the reverse order of disassembly.

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CYLINDER HEAD UNIT REPAIR

Cylinder Head

Specifications

Torque Specifications

DESCRIPTION	TORQUE (N·m)
Cylinder Head Bolts	1st Step: Tighten the bolt to 40 ± 5 N·m 2nd Step: Tighten the bolt an additional 90 ± 5° 3rd Step: Tighten the bolt an additional 90 ± 5°
Cylinder Head Cover Bolts	11

Clearance Specifications

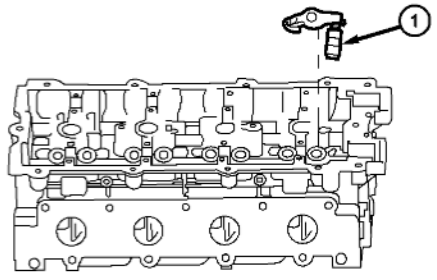
DESCRIPTION	SPECIFICATION (mm)
Cylinder Head Flatness	0.04
Intake Valve Deflection	0.02
Exhaust Valve Deflection	0.04
Spring Height	47.7

Disassembly

NOTE :
The following special tools are required to perform the repair procedure:
- CH-20010 - Camshaft Holder
- CH-20011 - Valve Seal Installer
- CH-20012 - Valve Stem Seal Installer Guide
- CH-20013 - Valve Seal Remover
- CH-20017 - Valve Keeper Installer
- CH-20018 - Valve Spring Compressor

NOTE :
Replacement cylinder head comes complete with valves, seals, springs, retainers, keepers, tappets, and camshafts.

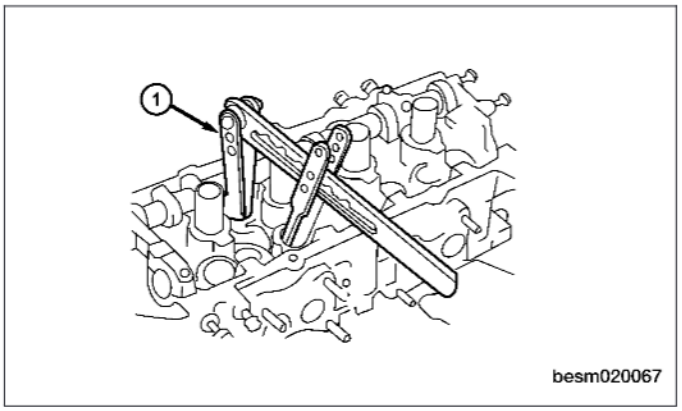
1. Remove camshafts (See Camshaft Removal & Installation in Section 02 Engine).
2. Remove the hydraulic tappet assembly (1).



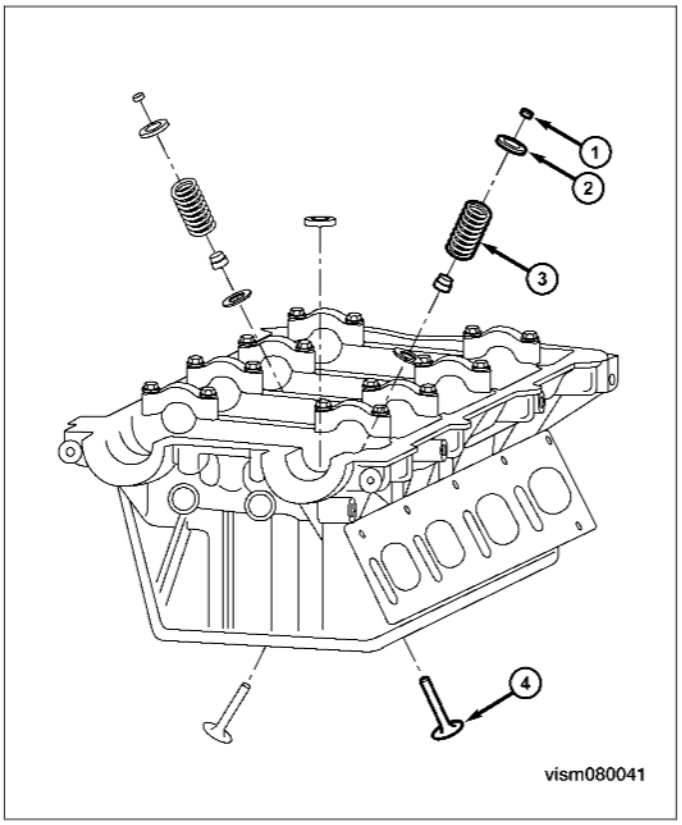
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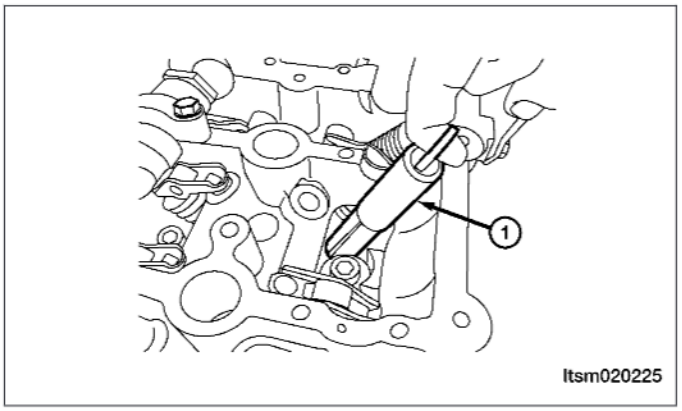
3. Using the special tool CH-20018 (1), compress the valve spring.



4. Remove the valve keeper (1), valve spring retainer (2) and valve spring (3).
5. Push the valve stem from the cylinder head and remove the valve (4).



6. Using special tool CH-20013 (1), remove the valve oil seal.



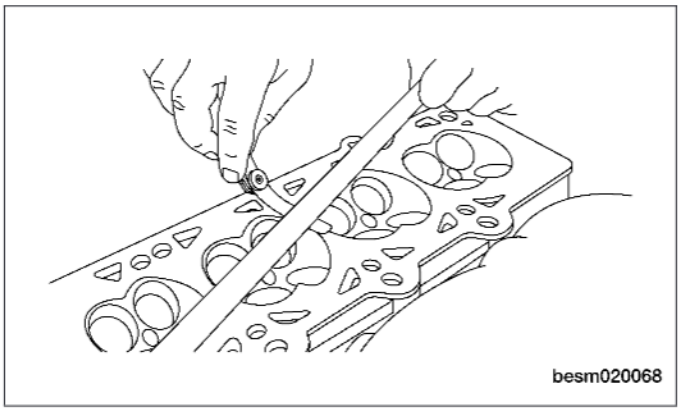
7. Remove the valve guide.
8. Remove the spark plugs.

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Inspection

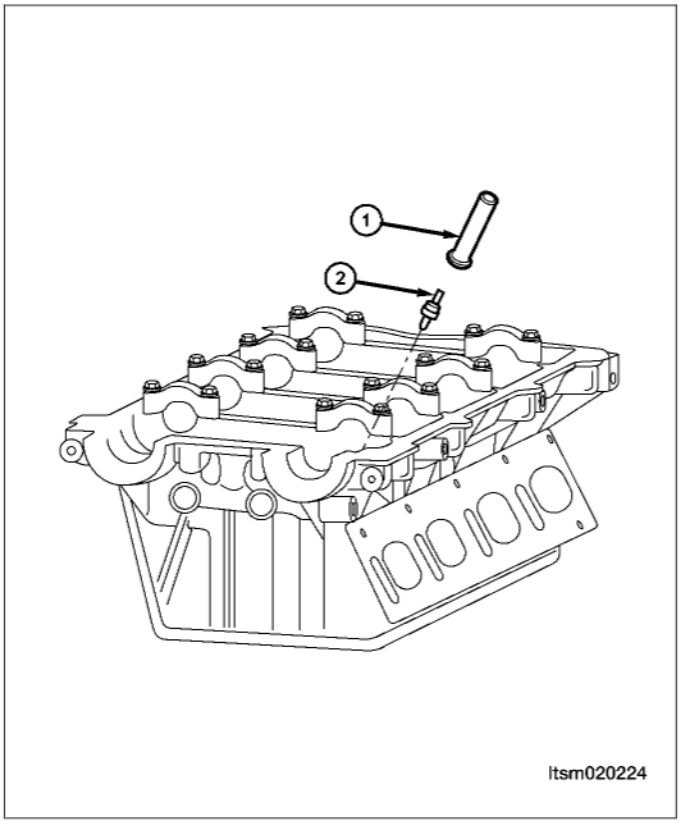
Inspect the cylinder head for the following:

- Cylinder head must be flat within 0.04 mm.
- Inspect camshaft bearing journals for scoring.
- Remove carbon and varnish deposits from inside of valve guides with a valve guide cleaner.
- Verify the valve tappets move freely in their bores, and that they have been rotating.
- Check the valve guide height.


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Assembly

1. Install new valve guide if necessary.
2. Install new valve seat if necessary.
3. Using special tool CH-20011 (1) and CH-20012 (2), install the new valve oil seal.

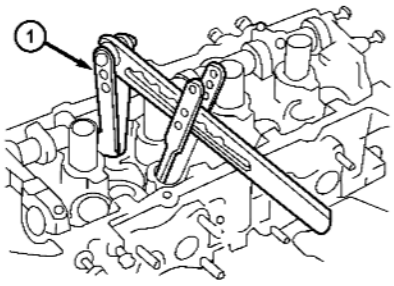


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4. Install the valves into the cylinder head (larger diameter on intake side).
5. Install the valve springs.
6. Install the valve spring retainers.

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7. Using a valve spring compressor CH-20018 (1), compress the valve springs.
8. Install the valve keepers.



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9. Strike the valve stem lightly with a plastic hammer after installation to verify proper assembly.
10. Install valve tappets in the head.
11. Install the camshafts.

Installation Notes:

- Coat the valve oil seal with engine oil.

Camshaft

Specifications

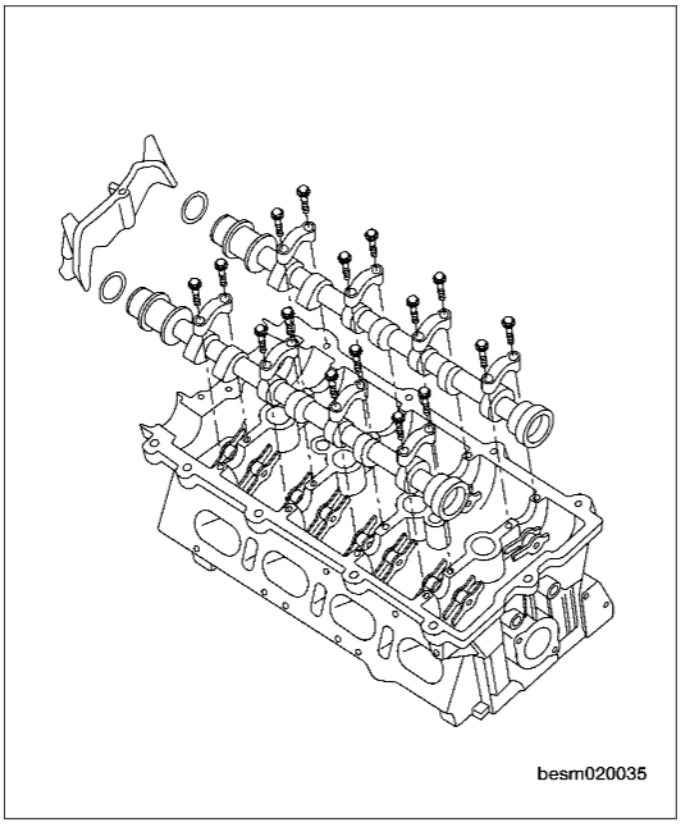
Camshaft Specifications

DESCRIPTION	SPECIFICATION (mm)
Intake Cam Lobe Height	37.15
Exhaust Cam Lobe Height	37.05
Journal #1 Outer Diameter	31.934 - 31.95
Journal #2, #3, #4, #5, Outer Diameter	23.947 - 23.96
Cam Bearing #1 Inner Diameter	32 - 32.025
Cam Bearing #2, #3, #4, #5, Inner Diameter	24 - 24.021
Journal #1 Clearance	0.05 - 0.091
Journal #2, #3, #4, #5 Clearance	0.04 - 0.074
Intake Camshaft Axial Clearance	0.15 - 0.20
Exhaust Camshaft Axial Clearance	0.15 - 0.20

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Disassembly

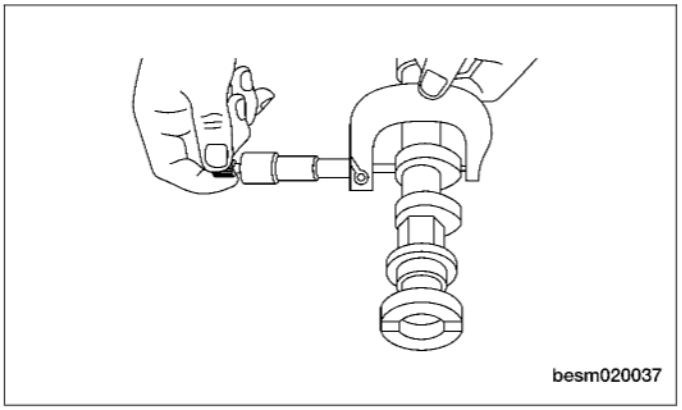
1. Remove the camshaft bearing caps bolts.
   NOTE: Equally loosen camshaft bearing cap bolts in several steps.


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2. Remove the camshaft bearing caps and place them in proper order.
   NOTE: The camshaft bearing caps are marked for identification.
3. Remove the camshafts and then remove the camshaft seals.

Inspection

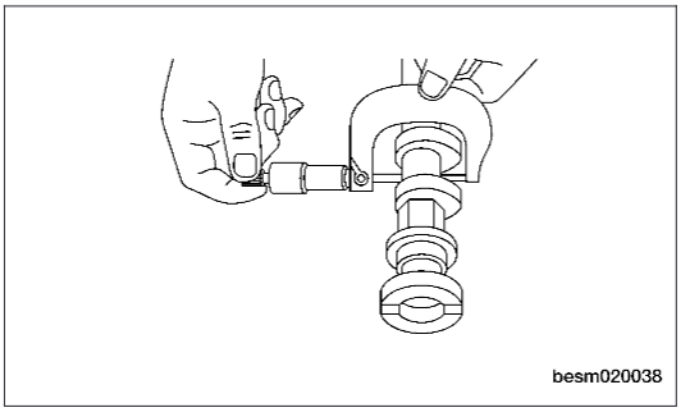
Inspect the camshaft for the following:
- Measure the camshaft cam lobe height.
- If wear is beyond the limit, replace the camshaft.


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CAMSHAFT CAM LOBE HEIGHT	
Intake Cam Lobe Height	37.15 mm
Exhaust Cam Lobe Height	37.05 mm

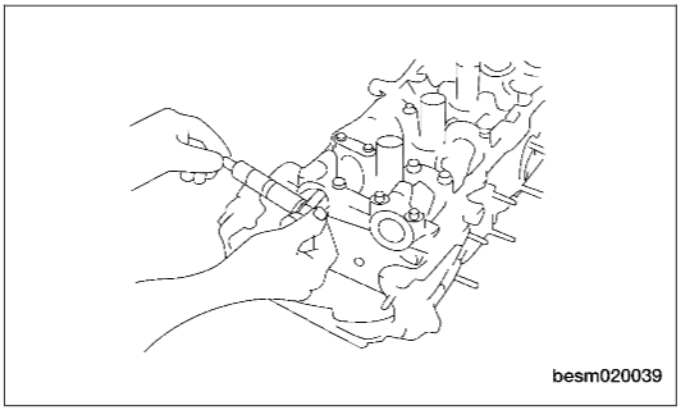
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- Measure the outer diameter of the camshaft journal.



OUTER DIAMETER OF CAMSHAFT JOURNAL	
Journal #1 Outer Diameter	31.934 - 31.95 mm
Journal #2, #3, #4, #5, Outer Diameter	23.947 - 23.96 mm

- Measure the inner diameter of the camshaft bearing.



INNER DIAMETER OF CAMSHAFT BEARING	
Cam Bearing #1 Inner Diameter	32 - 32.025 mm
Cam Bearing #2, #3, #4, #5, Inner Diameter	24 - 24.021 mm

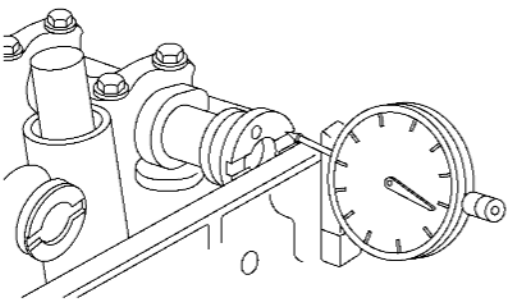
- Calculation of camshaft journal clearance

Journal clearance = (inner diameter of camshaft bearing) - (outer diameter of camshaft journal)

CAMSHAFT JOURNAL CLEARANCE	
Journal #1 Clearance	0.05 - 0.091 mm
Journal #2, #3, #4, #5 Clearance	0.04 - 0.074 mm

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- Measure the axial clearance of camshaft.



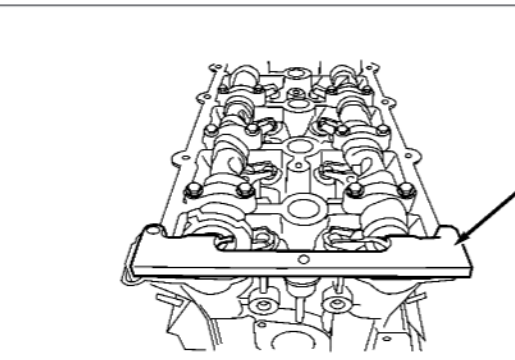
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CAMSHAFT AXIAL CLEARANCE	
Intake Camshaft	0.15 - 0.20 mm
Exhaust Camshaft	0.15 - 0.20 mm

Assembly

1. Using special tool CH-20010 (1), install the camshaft holder to hold the camshafts in place.

NOTE :
The camshaft holder will prevent the camshafts from rotating in either direction.

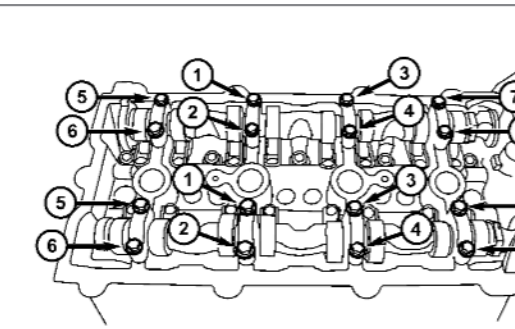


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2. Installation is in the reverse order of removal.

Installation Notes:

- Install the intake and exhaust camshaft bearing caps in the proper order.
- Slowly tighten bolts to the specified torque.
- Follow the torque sequence as shown.



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Valve & Valve Guides

Specifications

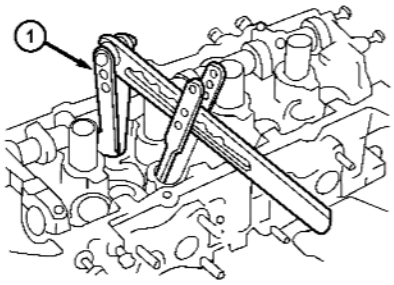
Valve & Valve Guide Specifications

DESCRIPTION	SPECIFICATION (mm)
Intake Valve Deflection	0.02
Exhaust Valve Deflection	0.04
Intake Valve Guide Clearance	0.012 - 0.043
Exhaust Valve Guide Clearance	0.032 - 0.063

Disassembly

NOTE :
The following special tools are required to perform the repair procedure:
- CH-20011 - Valve Seal Installer
- CH-20012 - Valve Stem Seal Installer Guide
- CH-20013 - Valve Seal Remover
- CH-20017 - Valve Keeper Installer
- CH-20018 - Valve Spring Compressor

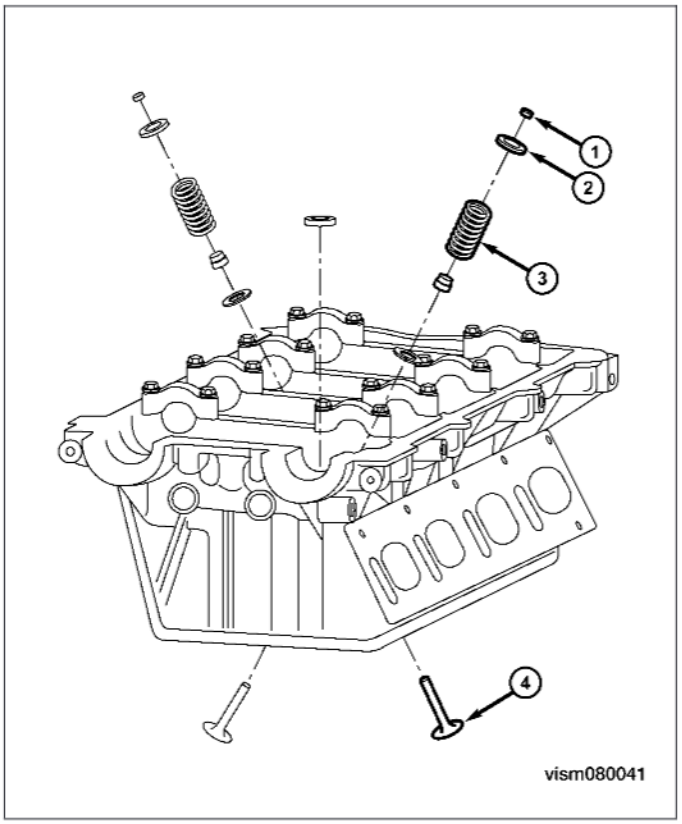
1. Using the special tool CH-20018 (1), compress the valve springs.



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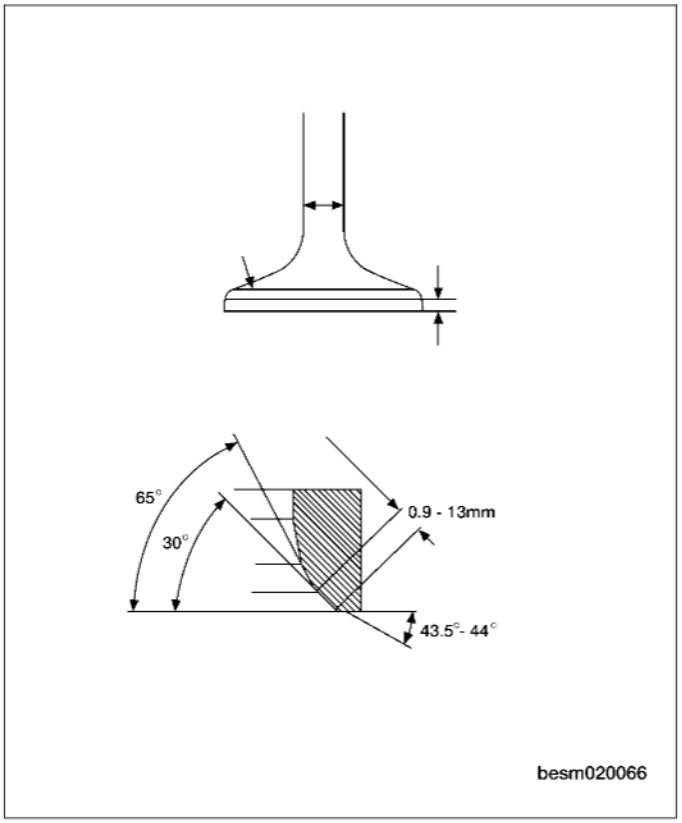
2. Remove the valve keeper (1), valve spring retainer (2) and valve spring (3).
3. Remove valves (4) from the cylinder head.



Inspection

Inspect the valves for the following:

- Clean all valves thoroughly and discard burned, warped and cracked valves.
- Check valve seats and valve faces for damage.
- When reconditioning valves follow the specifications outlined for both intake and exhaust valves.



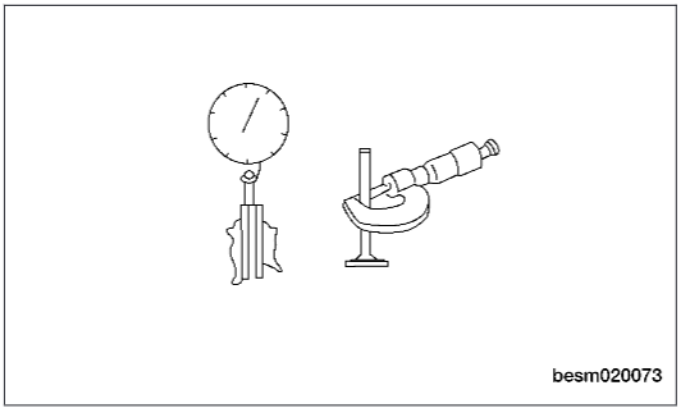
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ITEM		SPECIFICATION (mm)
Valve Outer Diameter	Intake Valve	5.98 ± 0.008
	Exhaust Valve	5.96 ± 0.008
Valve Guide Inner Diameter	Intake Valve	5.4 ± 0.1
	Exhaust Valve	5.4 ± 0.1
Fringe Thickness On Top Of Valve	Intake Valve	0.3 ± 0.15
	Exhaust Valve	0.3 ± 0.15
Valve Tilt Angle	Intake Valve	65°
	Exhaust Valve	68°
Valve Height	Intake Valve	107.998
	Exhaust Valve	106.318

- Measure valve deflection.

VALVE DEFLECTION LIMIT (DIAL GAUGE READING)	
Intake	0.02 mm
Exhaust	0.04 mm

- If it exceeds the limit, check valve to valve guide clearance.
  - Measure valve stem diameter and valve guide inner diameter.
  - Check that clearance is within specification.
  - If it exceeds the limit, replace valve or valve guide.



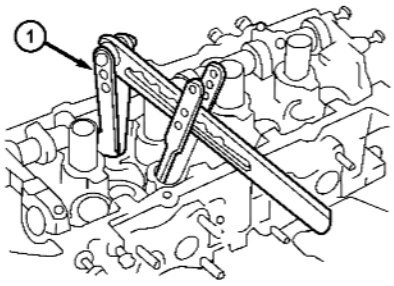
VALVE TO VALVE GUIDE CLEARANCE STANDARD	
Intake	0.012 - 0.043 mm
Exhaust	0.032 - 0.063 mm

Assembly

1. Install the valves into the cylinder head (larger diameter on intake side).
2. Install the valve springs.
3. Install the valve spring retainers.

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4. Using valve spring compressor CH-20018 (1), compress the valve springs.
5. Install the valve keepers.



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6. Strike the valve stem lightly with a plastic hammer after installation to verify proper assembly.

Valve Springs

Specifications

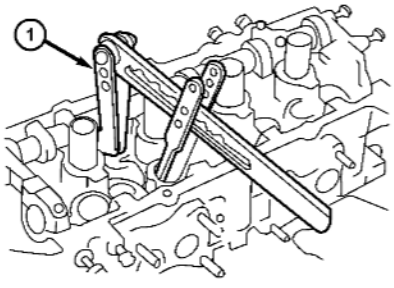
Valve Spring Specifications

DESCRIPTION	SPECIFICATION (mm)
Spring Free Length	47.7
Spring Height At 620 Newtons Of Pressure	32.0

Disassembly

NOTE :
The following special tools are required to perform the repair procedure:
- CH-20011 - Valve Seal Installer
- CH-20012 - Valve Stem Seal Installer Guide
- CH-20013 - Valve Seal Remover
- CH-20017 - Valve Keeper Installer
- CH-20018 - Valve Spring Compressor

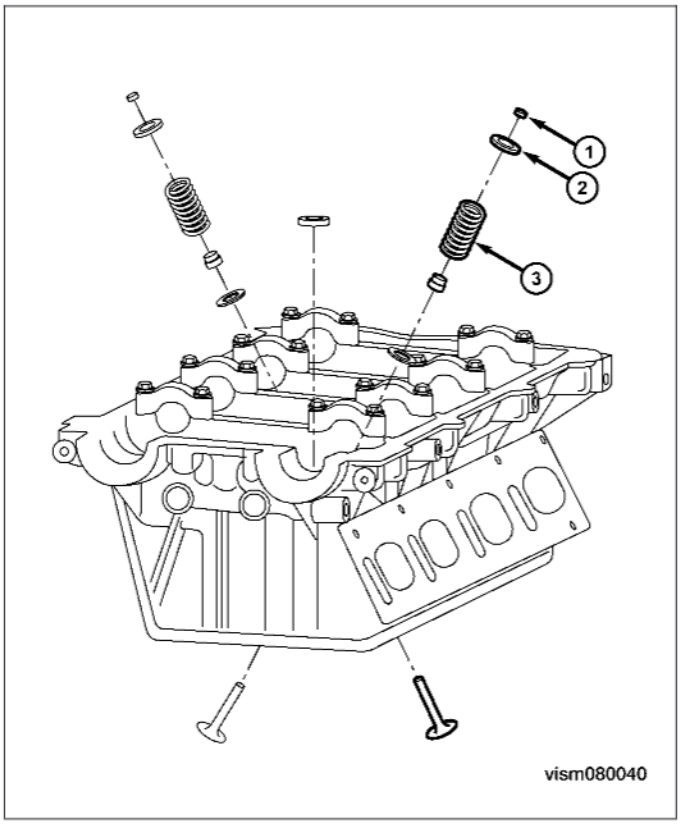
1. Using the special tool CH-20018 (1), compress the valve springs.



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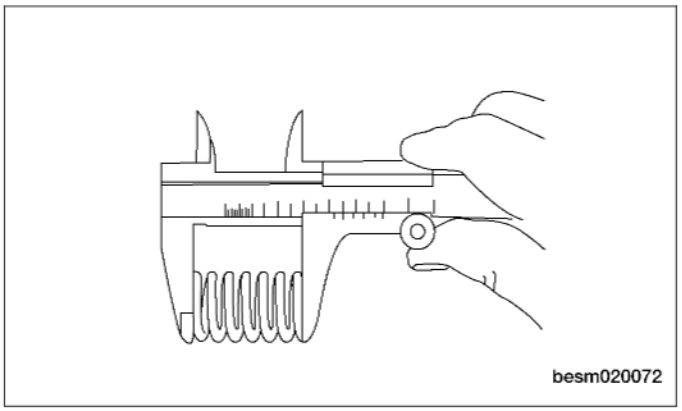
2. Remove the valve keeper (1), valve spring retainer (2).
3. Remove the valve springs (3) from the cylinder head.



Inspection

Inspect the valve springs for the following:

- Whenever valves have been removed for inspection, reconditioning or replacement, valve springs should be tested for correct load.
- Discard the springs that do not meet specifications.
- The following specifications apply to both intake and exhaust valve springs.



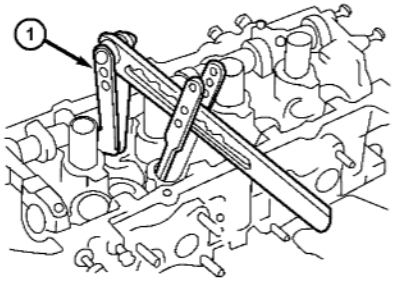
VALVE SPRING LENGTH/HEIGHT	
Spring Free Length	47.7 mm
Spring Height At 620 Newtons Of Pressure	32.0 mm

If it is not within specifications, replace the valve spring.

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Assembly

1. Install the valve springs.
2. Install the valve spring retainers.
3. Using a valve spring compressor CH-20018 (1), compress the valve springs.
4. Install the valve keepers.



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5. Strike the valve stem lightly with a plastic hammer after installation to verify proper assembly.

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2.4L ENGINE MECHANICAL

GENERAL INFORMATION 02-151
- Description 02-151
- Operation 02-151
- Specifications 02-151
- Special Tools 02-154
- Lubrication System 02-160

DIAGNOSIS & TESTING 02-163
- Engine Performance Diagnostics 02-163
- Engine Mechanical Diagnostics 02-164
- Cylinder Compression Pressure Test 02-165
- Cylinder Head Gasket Test 02-166
- Engine Oil Pressure Test 02-166

ON-VEHICLE SERVICE 02-167

Accessory Drive Belt 02-167
- Removal & Installation 02-167

Air Cleaner Element 02-168
- Removal & Installation 02-168

Air Cleaner Housing 02-169
- Removal & Installation 02-169

Cylinder Head Cover 02-170
- Removal & Installation 02-170

Camshaft 02-171
- Removal & Installation 02-171

Cylinder Head 02-175
- Removal & Installation 02-175

Front Crankshaft Oil Seal 02-177
- Removal & Installation 02-177

Rear Crankshaft Oil Seal 02-179
- Removal & Installation 02-179

Engine Mounts 02-181
- Removal & Installation - Left Mount 02-181
- Removal & Installation - Right Mount 02-182
- Removal & Installation - Front Mount 02-182
- Removal & Installation - Rear Mount 02-183

Engine Assembly 02-183
- Removal & Installation 02-183

Engine Timing Belt 02-189
- Removal & Installation 02-189
- Inspection 02-194

Timing Belt Automatic Tensioner 02-196
- Removal & Installation 02-196
- Inspection 02-197

Upper Balance Shaft Timing Belt 02-198
- Removal & Installation 02-198

Exhaust Manifold 02-200
- Removal & Installation 02-200

Intake Manifold 02-201
- Removal & Installation 02-201

Upper Balance Shaft 02-204
- Removal & Installation 02-204
- Upper Balance Shaft Bearing Replacement 02-207

Lower Balance Shaft 02-208
- Removal & Installation 02-208
- Lower Balance Shaft Bearing Replacement 02-211

Oil Filter 02-212
- Removal & Installation 02-212

Oil Pan 02-213
- Removal & Installation 02-213

Oil Pump 02-215
- Removal & Installation 02-215

Oil Strainer 02-216
- Removal & Installation 02-216

ENGINE UNIT REPAIR 02-217

Engine Block 02-217
- Specifications 02-217
- Disassembly 02-218
- Inspection 02-220
- Assembly 02-220

Pistons 02-221
- Specifications 02-221
- Disassembly 02-222
- Inspection 02-224
- Assembly 02-226

Connecting Rods 02-229
- Specifications 02-229
- Disassembly 02-229
- Inspection 02-230
- Assembly 02-231

Crankshaft 02-233
- Specifications 02-233
- Disassembly 02-234
- Inspection 02-236
- Assembly 02-237

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CYLINDER HEAD UNIT REPAIR 02-241

Cylinder Head 02-241
- Specifications 02-241
- Disassembly 02-241
- Inspection 02-242
- Assembly 02-242

Camshaft 02-243
- Specifications 02-243
- Disassembly 02-244
- Camshaft 02-245
- Hydraulic Adjusters 02-245
- Rocker Arms 02-246

Valve & Valve Guides 02-246
- Specifications 02-246
- Disassembly 02-247
- Valves 02-248
- Valve Guides 02-250
- Valve Seats 02-251
- Assembly 02-252

Valve Springs 02-252
- Specifications 02-252
- Disassembly 02-253
- Inspection 02-254
- Assembly 02-255

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GENERAL INFORMATION

Description

The 2.4L in-line four cylinder engine has the following features:

- Single overhead camshaft
- Four valves per chamber cylinder head design
- Aluminum cylinder head
- Cast iron cylinder block

Operation

The 2.4L engine utilizes 4 valves-per-cylinder and a single-overhead-camshaft design. The engine uses an individual coil ignition system and multi-point sequential injection. The cylinder block is made of cast iron and the bearing caps are integrated into the lower cylinder block assembly. A cast iron oil pan is located at the bottom of the lower cylinder block. The camshaft is mounted in the cylinder head and acts against the valve tappets to open and close the valves. The camshaft is driven off the front of the cylinder head by the timing belt. The belt is driven by a sprocket that is located on the crankshaft. The piston assembly is an aluminum piston with a cast iron connecting rod.

The aluminum cylinder head contains a single overhead camshaft with 4 valves-per-cylinder construction. The valves are arranged in two in-line banks. The cylinder head incorporates powdered metal valve guides and seats. The cylinder head is sealed to the block using a multi-layer steel head gasket and retaining bolts.

Specifications

2.4L General Engine Specifications

DESCRIPTION	SPECIFICATION
Type	In-Line, OHV, SOHC
Number of Cylinders	4
Compression Ratio	9:1
Output Power (kw)	95 / 5500 RPM
Stroke	100 mm
Cylinder Diameter	86.5 mm
Displacement	2351 cc
Firing Order	1-3-4-2
Max Torque (N·m)	198.1

2.4L Mechanical Specifications

ITEM			STANDARD	LIMIT
Engine Timing Belt	Tensioner Arm Protrusion		12	-
	Tensioner Arm Depression (98-196 N)		≤1	-
Camshaft	Cam Height	Air-In	37.50	37.00
		Air-Out	36.99	36.49
	Shaft Diameter		45.0	-
Cylinder Head	Lower Surface Flatness		0.03	0.2
	Surface Grinding Limit* Total Grinding of Cylinder Block and Cylinder Head		-	0.2
	Full Height		119.9 - 120.1	-

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ITEM			STANDARD	LIMIT
Valve	Edge Thickness	Air-In	1.0	0.5
		Air-Out	1.2	0.7
	Valve Rod Diameter		6.0	-
	Crest Clearance Between Valve Rod and Guide	Air-In	0.02 - 0.05	0.10
		Air-Out	0.03 - 0.07	0.15
	Inclination Angle		45° - 45.5°	-
	Height	Air-In	112.30	111.80
		Air-Out	114.11	113.61
Valve Spring	Free Height		51.0	50.0
	Pre-Loading Force/Operation Height km/mm		27.2/44.2	-
	Center Line		≤2°	≤4°
Valve Guide	Valve Margin		0.9 - 1.3	-
	Internal Diameter		6.0	-
	External Diameter		11.0	-
	Depression Depth		14.0	-
	Valve Stem Height		49.3	49.8
Engine Oil Pump	Side Clearance	Driving Gear	0.08 - 0.14	-
		Driven Gear	0.06 - 0.12	-
Piston	Piston Clearance		0.02 - 0.04	-
Piston Ring	Lateral Clearance	No.1 Ring	0.02 - 0.06	0.1
		No.2 Ring	0.02 - 0.06	0.1
	End Clearance	No.1 Ring	0.25 - 0.35	0.8
		No.2 Ring	0.40 - 0.55	0.8
		Oil Ring	0.10 - 0.40	1.0
Piston Pin	External Diameter		22.0	-
	Depressing Force (Kg)		755 - 1750	-
	Depressing Force (Kg)		Room Temperature	-
Connecting Rod	Big End Clearance		0.10 - 0.25	0.4
Crankshaft	Axial Clearance		0.05 - 0.18	0.25
	Main Journal Diameter		57	-
	Connecting Journal Diameter		45	-
	Main Journal Oil Clearance		0.02 - 0.04	0.1
Cylinder Block	Upper Surface Flatness		0.05	0.1
	Upper Surface Grinding Limit		-	*0.2
Cylinders	Cylinder Out-of-Round		0.01	-
Cylinder Head	Replacement Valve Guides	0.25 O.S.	11.25 - 11.27	-
		0.50 O.S.	11.50 - 11.52	-
	Intake Valve Replacement Valve Seats	0.30 O.S.	34.435 -34.455	-
		0.60 O.S.	34.735 - 34.755	-
	Exhaust Valve Replacement Valve Seats	0.30 O.S.	31.935 - 31.955	-
		0.60 O.S.	32.235 - 32.255	-

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Torque Specifications

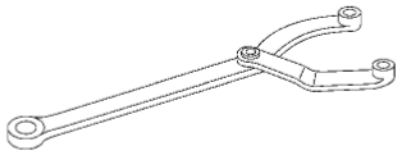
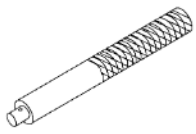
CAUTION:
When torquing a fastener in two steps, DO NOT use a torque wrench for the second step.

DESCRIPTION	TORQUE (N·m)
Alternator Adjusting Bolt	10
Alternator Bracket Bolt	24
Alternator Center Nut	45
Camshaft Position Sensor Bracket	14
Camshaft Position Sensor	10
Camshaft Position Sensor Cylinder	22
Crank Belt Gear	25
Ignition Coil	10
Locking Bolt	22
Spark Piston	25
Water Pump Belt Gear	9
Timing Belt Automatic Tensioner Bolt	24
Belt Gear of Balance Axle	46
Central Belt Wheel Bolt	36
Lower Balance Shaft Bolt	55
Timing Belt Cover Bolts	11
Tensioner Wheel Bolt	49
Tensioner Arm Bolt	22
Tensioner Bracket	49
Timing Belt Indicator	09
Timing Belt Rear Cover	11
Upper Balance Shaft Tensioner Bolt	19
Camshaft Pulley Bolt	90
Crankshaft Pulley Bolt	120
Connecting Bolt of Outflow Pipe	20
EGR Valve	22
Exhaust Manifold Nut (M8)	30
Exhaust Manifold Nut (M10)	50
Fuel Pressure Regulator	9
Fuel Return Pipe	09
Injector and Distribution Pipe	12
Intake Manifold Bolt	20
Intake Manifold Bracket	14
Thermostat Housing Bolt	24
Water Pump Bolts	14
Rocker Cover Bolt	4
Rocker and Camshaft Assembly Bolt	32
Trust Bearing Cover Bolt	19

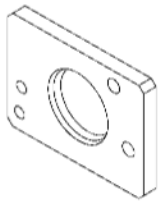
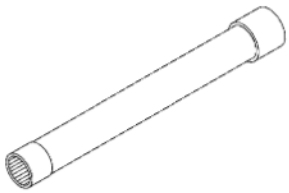
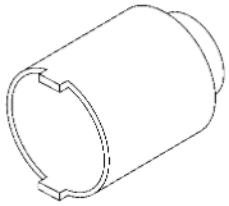
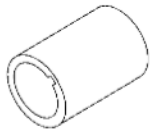
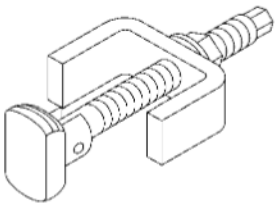
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DESCRIPTION	TORQUE (N·m)
Cylinder Head Bolts	1st Step: Tighten the bolt to 78 N·m 2nd Step: Completely loosen the bolt 3rd Step: Retighten the bolt to 20 N·m 4th Step: Tighten the bolt an additional 90° 5th Step: Finish tightening the bolt an additional 90°
Engine Oil Pump Cover Bolt	16
Front Cover Bolts	24
Flange Bolt	37
Oil Pan Drain Plug	45
Oil Pan	18
Oil Pressure Switch	10
Oil Pressure Relief Plug	45
Oil Plug	24
Oil Strainer Screw Bolts	19
Oil Filter Adapter Bolts	19
Connecting Rod Nuts	1st Step: Tighten the nuts to 20 N·m 2nd Step: Tighten the nuts an additional 90°-100°
Flywheel Bolts	135
Oil Seal Cover Screw Bolts	11
Crankshaft Main Bearing Bolts	1st Step: Tighten the bolts to 25 N·m 2nd Step: Tighten the bolts an additional 90°-100°

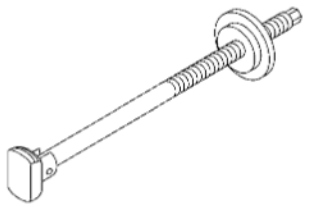
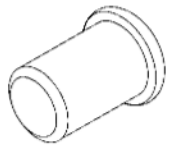
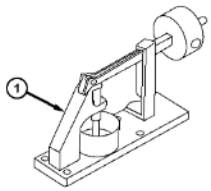
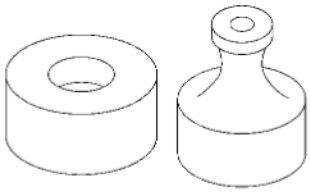
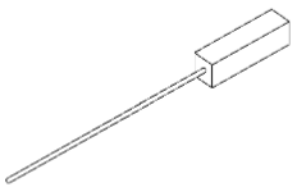
Special Tools

Camshaft Pulley Spanner Wrench MB-990767	 ltsm020004
Driver Handle MB-990938	 ltsm020026

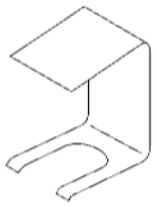
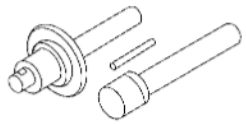
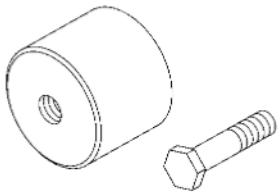
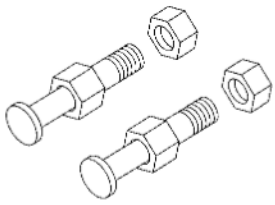
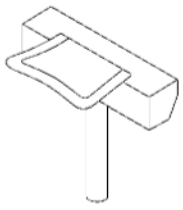
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Balance Shaft Bearing Puller Limiter MB-991603	 ltsm020020
Cylinder Cover Bolt Spanner MB-991654	 ltsm020011
Plug Spanner MD-998162	 ltsm020016
Crankshaft Front Oil Seal Duct MD-998285	 ltsm020023
Balance Shaft Bearing Puller MD-998371	 ltsm020018

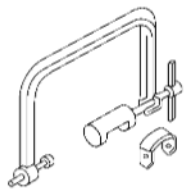
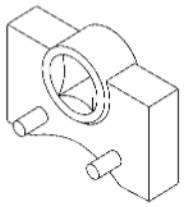
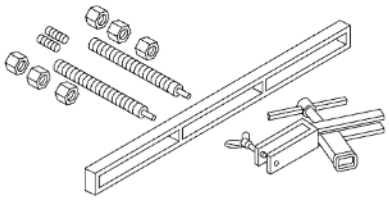
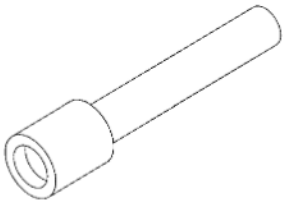
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Balance Shaft Bearing Puller MD-998372	 ltsm020019
Crankshaft Front Oil Seal Installer MD-998375	 ltsm020022
Hydraulic Adjuster Leak Tester MD-998440	 ltsm020159
Hydraulic Adjuster Keeper MD-998441	 ltsm020158
Hydraulic Adjuster Wiring MD-998442	 ltsm020010

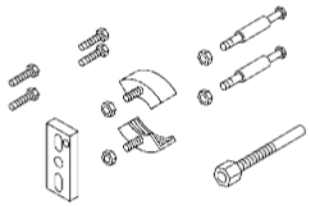
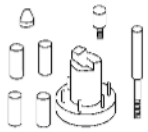
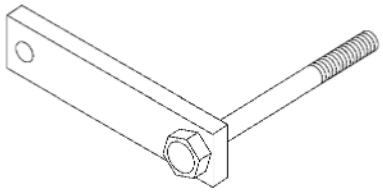
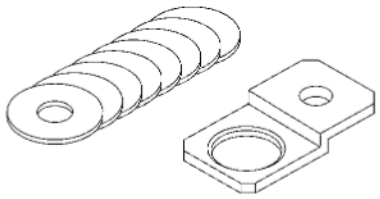
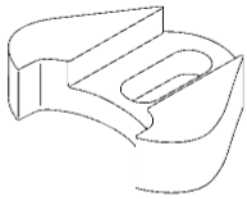
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Hydraulic Adjuster Keeper MD-998443	 Itsm020008
Balance Shaft Bearing Installer MD-998705	 Itsm020021
Camshaft Oil Seal Installer MD-998713	 Itsm020009
Pin For Belt Gear MD-998719	 Itsm020005
Oil Pan Remover MD-998727	 Itsm020014

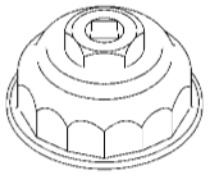
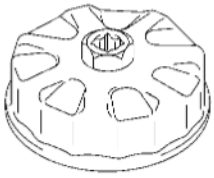
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Valve Spring Compressor MD-998735	 ltsm020157
Automatic Tensioner Socket MD-998767	 ltsm020007
Valve Spring Compressor MD-998772	 ltsm020012
Valve Oil Seal Installer MD-998774	 ltsm020013
Crankshaft Rear Oil Seal Installer MD-998776	 ltsm020027

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Crankshaft Pulley Puller MD-998778	 Itsm020002
Piston Disassembling and Assembling Tool MD-998780	 Itsm020025
Flywheel Holder MD-998781	 Itsm020001
Plug Spanner Fixer MD-998783	 Itsm020017
Upper Balance Shaft Pulley Holder MD-998785	 Itsm020003

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Oil Filter Wrench MB-991828	 ltsm020036
Oil Filter Wrench MB-991396	 ltsm020055

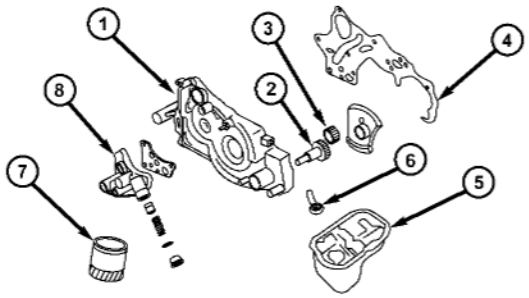
Lubrication System

The engine lubrication system operates as follows:

- Oil is drawn into the oil pump through the oil pump strainer tube in the sump of the oil pan.
- Oil is pumped through the oil filter to the cylinder block.
- Oil enters the main oil gallery where it is distributed to the crankshaft main journals and to the cylinder head.
- From the main journals, the oil is routed through cross-drilled passages in the crankshaft to lubricate the connecting rod bearings. Controlled leakage through the crankshaft main bearings and connecting rod bearings is slung radially outward to cool and lubricate the cylinder walls as well as the entire connecting rod, piston and piston ring assembly.
- The lubrication system is a fully force-fed, full-flow filtration type. The oil pump is a gear type which is driven by the crankshaft via the timing belt.

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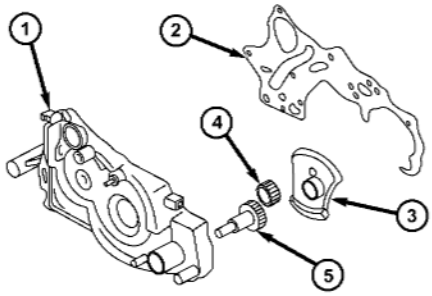
Oiling System



Itsm020045

1 - Engine Front Cover	5 - Oil Pan
2 - Oil Pump Driving Gear	6 - Oil Strainer
3 - Oil Pump Driven Gear	7 - Oil Filter
4 - Oil Pump Cover	8 - Oil Filter Adaptor

Oil Pump

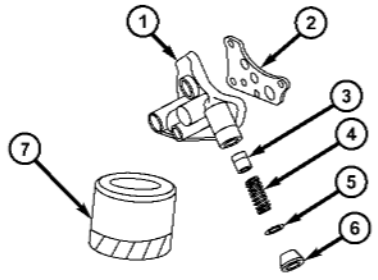


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1 - Front End Cover	4 - Oil Pump Driven Gear
2 - Front End Cover Pad	5 - Oil Pump Driving Gear
3 - Oil Pump Rear Cover	

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Oil Filter and Oil Filter Adaptor



Itsm020047

1 - Oil Filter Adaptor	5 - Spacer
2 - Gasket	6 - Plug Screw
3 - Pressure Limiting Valve Plunger	7 - Oil Filter
4 - Spring	

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DIAGNOSIS & TESTING

Engine Performance Diagnostics

CONDITION	POSSIBLE CAUSES	CORRECTION
Engine Does Not Start	1. Weak battery. 2. Corroded or loose battery connections. 3. Faulty starter. 4. Faulty coil(s) or control unit. 5. Incorrect spark plug gap. 6. Contamination in fuel system. 7. Faulty fuel pump. 8. Incorrect timing.	1. Test battery. Charge or replace if necessary. 2. Clean and tighten battery connections. Apply a coat of light mineral grease to terminals. 3. Test starting system. Check for codes. (Refer to Appropriate Diagnostic Information) 4. Test and replace as needed. (Refer to Appropriate Diagnostic Information) 5. Set gap. 6. Clean system and replace fuel filter. 7. Test fuel pump and replace as needed. (Refer to Appropriate Diagnostic Information) 8. Check for a skipped timing belt.
Engine Stalls Or Idles Rough	1. Idle speed too low. 2. Incorrect fuel mixture. 3. Intake manifold leakage. 4. Faulty ignition coil(s).	1. Test minimum air flow. (Refer to Appropriate Diagnostic Information) 2. (Refer to Appropriate Diagnostic Information) 3. Inspect intake manifold, manifold gasket, and vacuum hoses. 4. Test and replace if necessary. (Refer to Appropriate Diagnostic Information)
Engine Loss Of Power	1. Dirty or incorrectly gapped spark plugs. 2. Contamination in fuel system. 3. Faulty fuel pump. 4. Incorrect valve timing. 5. Leaking cylinder head gasket. 6. Low compression. 7. Burned, warped, excessive clearance, or pitted valves. 8. Plugged or restricted exhaust system. 9. Faulty ignition coil(s). 10. Burned spark plugs.	1. Clean spark plugs and set gap. 2. Clean system and replace fuel filter. 3. Test and replace if necessary. (Refer to Appropriate Diagnostic Information) 4. Correct valve timing. 5. Replace cylinder head gasket. 6. Test compression of each cylinder. 7. Replace valves. 8. Perform exhaust restriction test. Install new parts. 9. Test and replace if necessary. (Refer to Appropriate Diagnostic Information) 10. Replace spark plugs.

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CONDITION	POSSIBLE CAUSES	CORRECTION
Engine Miss On Acceleration	1. Dirty or incorrectly gapped spark plugs. 2. Contamination in fuel system. 7. Burned, warped, excessive clearance, or pitted valves. 4. Faulty ignition coil(s).	1. Clean spark plugs and set gap. 2. Clean fuel system and replace fuel filter. 3. Replace valves. 4. Test and replace if necessary. (Refer to Appropriate Diagnostic Information)
Engine Miss At High Speed	1. Dirty or incorrect spark plug gap. 2. Faulty ignition coil(s). 3. Dirty fuel injector(s). 4. Contamination in fuel system.	1. Clean spark plugs and set gap. 2. Test and replace if necessary. (Refer to Appropriate Diagnostic Information) 3. Test and replace if necessary. (Refer to Appropriate Diagnostic Information) 4. Clean system and replace fuel filter.

Engine Mechanical Diagnostics

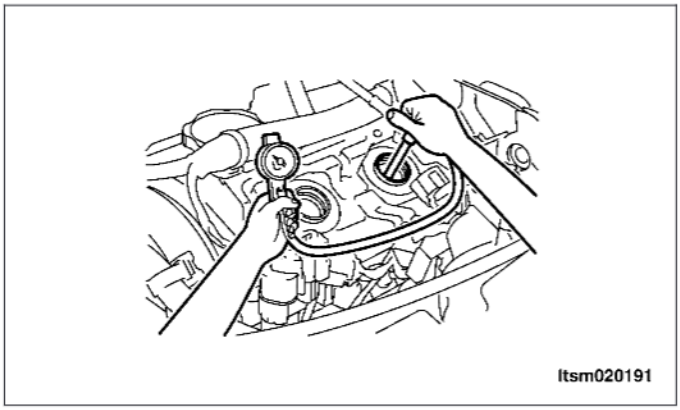
CONDITION	POSSIBLE CAUSES	CORRECTION
Valve Train Noise	1. High or low oil level in crankcase. 2. Thin or diluted oil. 3. Thick oil. 4. Low oil pressure. 5. Worn cam lobe. 6. Worn valve guides. 7. Excessive runout of valve seats on valve faces.	1. Check and correct engine oil level. 2. Change oil to correct viscosity. 3. Change engine oil and filter. 4. Check and correct engine oil level. 5. Install new camshaft. 6. Replace cylinder head. 7. Grind valve seats and replace valves.
Connecting Rod Noise	1. Insufficient oil supply. 2. Low oil pressure. 3. Thin or diluted oil. 4. Excessive bearing clearance. 5. Connecting rod journal out-of-round. 6. Connecting rod out-of-round. 7. Misaligned connecting rods. 8. Connecting rod nuts loose.	1. Check engine oil level. 2. Check engine oil level. Inspect oil pump relief valve and spring. 3. Change oil to correct viscosity. 4. Measure bearings for correct clearance. Repair if necessary. 5. Replace crankshaft or grind surface. 6. Replace connecting rod. 7. Replace bent connecting rods. 8. Tighten the connecting rod nuts.
Main Bearing Noise	1. Insufficient oil supply. 2. Low oil pressure. 3. Thin or diluted oil. 4. Excessive bearing clearance. 5. Excessive end play. 6. Crankshaft journal out-of-round or worn. 7. Loose flywheel or torque converter.	1. Check engine oil level. 2. Check engine oil level. Inspect oil pump. 3. Change oil to correct viscosity. 4. Measure bearings for correct clearance. Repair if necessary. 5. Check thrust bearing for wear on flanges. 6. Replace crankshaft or grind journals. 7. Tighten to correct torque.

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CONDITION	POSSIBLE CAUSES	CORRECTION
Oil Pressure Drop	1. Low oil level. 2. Faulty oil pressure sending unit. 3. Low oil pressure. 4. Clogged oil filter. 5. Thin or diluted oil. 6. Excessive bearing clearance.	1. Check engine oil level. 2. Install new sending unit. 3. Check sending unit and main bearing oil clearance. 4. Install new oil filter. 5. Change oil to correct viscosity. 6. Measure bearings for correct clearance.
Oil Leaks	1. Misaligned or deteriorated gaskets. 2. Loose fastener, broken or porous metal part. 3. Misaligned or deteriorated cup or threaded plug.	1. Replace gasket. 2. Tighten, repair or replace the part. 3. Replace if necessary.
Oil Consumption Or Spark Plugs Fouled	1. PCV system malfunction. 2. Worn, scuffed or broken rings. 3. Carbon in oil ring slots. 4. Rings fitted too tightly in grooves. 5. Worn valve guide(s). 6. Valve stem seal(s) worn or damaged.	1. Check system and repair if necessary. 2. Hone cylinder bores. Install new rings. 3. Install new rings. 4. Remove rings and check grooves. If groove is not proper width, replace piston. 5. Replace cylinder head. 6. Replace seal(s).

Cylinder Compression Pressure Test

- The result of a cylinder compression pressure test can be utilized to diagnose several engine malfunctions.
- Ensure the battery is completely charged and the engine starter motor is in good operating condition. Otherwise the indicated compression pressures may not be valid for diagnostic purposes.
  - Check engine oil level and add oil if necessary.
  - Disconnect the spark plug wires.
  - Remove all spark plugs from engine (as spark plugs are being removed, check electrodes for abnormal firing indicators fouled, hot, oily, etc.).
  - Record cylinder number of each spark plug for future reference.
  - Disconnect fuel injector electrical connectors.
  - Be sure throttle blade is fully open during the compression check.
  - Insert compression pressure adaptor or the equivalent into each spark plug hole in cylinder head.
  - Crank engine until maximum pressure is reached on gauge. Record each cylinder pressure.
  - Compression should not be less than 880 kPa and not vary more than 25 percent from cylinder to cylinder.
  - If one or more cylinders have abnormally low compression pressures, repeat the compression test.
  - If the same cylinder or cylinders repeat an abnormally low reading on the second compression test, it could indicate the existence of a problem with the cylinder in question.



NOTE :
The recommended compression pressures are to be used only as a guide to diagnosing engine problems. An engine should not be disassembled to determine the cause of low compression unless some malfunction is present.

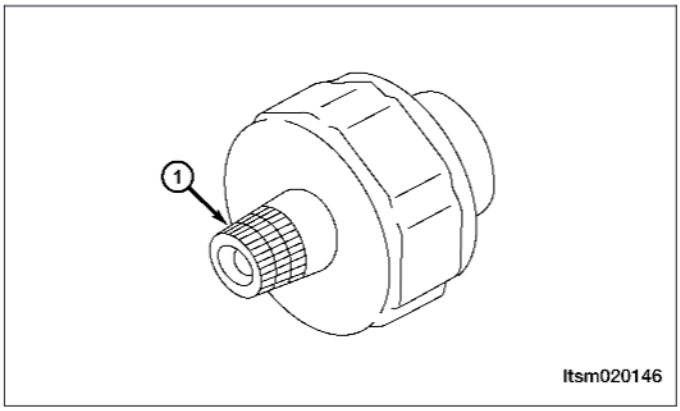
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Cylinder Head Gasket Test

- A cylinder head gasket leak can be located between adjacent cylinders, between a cylinder and the adjacent water jacket or from an oil passage to the exterior of the engine.
- Possible indications of the cylinder head gasket leaking between adjacent cylinders are:
  - Loss of engine power
  - Engine misfiring
  - Poor fuel economy
- Possible indications of the cylinder head gasket leaking between a cylinder and an adjacent water jacket are:
  - Engine overheating
  - Loss of coolant
  - Excessive steam (white smoke) emitting from exhaust
  - Coolant foaming

Engine Oil Pressure Test

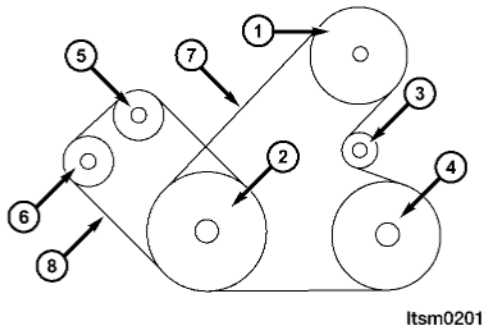
1. Check the engine oil level.
2. Disconnect the oil pressure switch electrical connector.
3. Remove the oil pressure switch.
4. Install the mechanical oil pressure gauge.
5. Start the engine and warm to normal operating temperature.
6. After the engine has been warmed up, check that the oil pressure is within the specifications.
   - Standard Oil Pressure: At 750 ± 50 RPM: 0.8 MPa
7. Stop the engine.
8. Remove the oil pressure gauge.
9. Apply the specified sealant to the thread (1) of oil pressure switch.
10. Install the oil pressure switch (Tighten: Oil pressure switch to 10 ± 2 N·m).



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Accessory Drive Belt

Removal & Installation



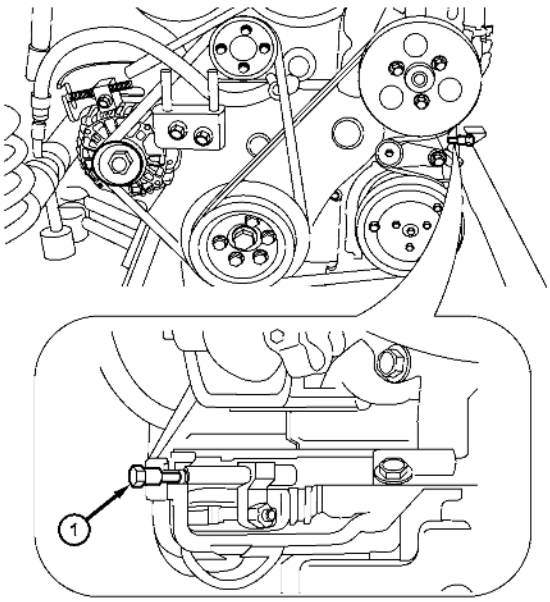
Itsm020176

1 - Power Steering Pump	5 - Coolant Pump Pulley
2 - Crankshaft Pulley	6 - Generator Pulley
3 - Idler Pulley	7 - A/C Compressor Belt
4 - A/C Compressor	8 - Generator Belt

WARNING!

Inspect the drive belt only when the engine is stopped.

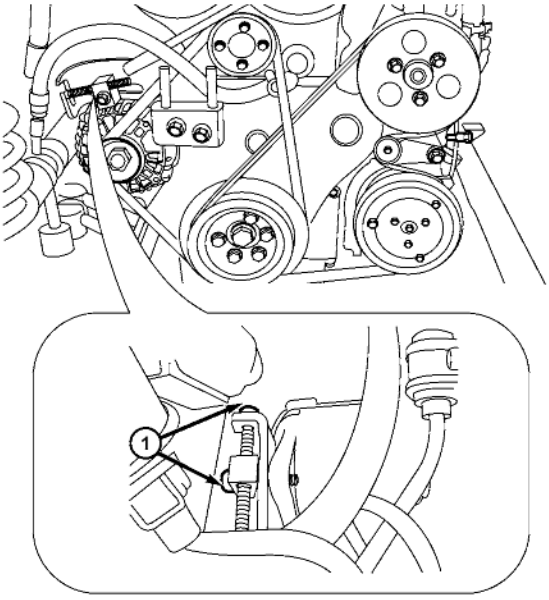
1. Loosen the power steering pump adjustment bolt (1).



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2. Remove the A/C compressor belt.
3. Loosen the generator adjustment bolts (1).
4. Remove the generator belt.
5. Installation is in the reverse order of removal.

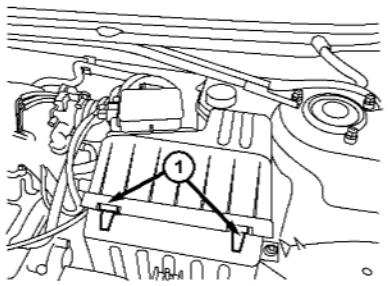


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Air Cleaner Element

Removal & Installation

1. Loosen the air cleaner case side clamps (1) and raise the air cleaner case (upper).
2. Remove the air cleaner element.
3. Installation is in the reverse order of removal.



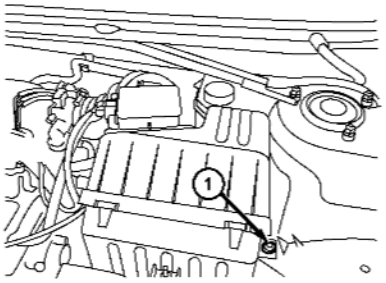
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Air Cleaner Housing

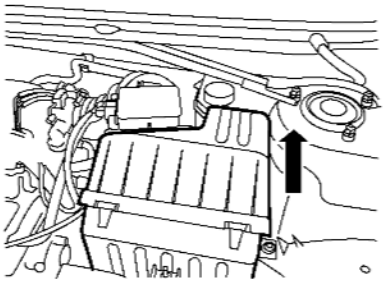
Removal & Installation

1. Disconnect the negative battery cable.
2. Disconnect the air flow sensor electrical connector.
3. Loosen the clamp between the air intake hose and the air cleaner.
4. Remove the retaining bolt (1), securing the air cleaner housing to its base.
   (Tighten: Air cleaner housing retaining bolts to 10 N·m)



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5. Remove the air cleaner housing.


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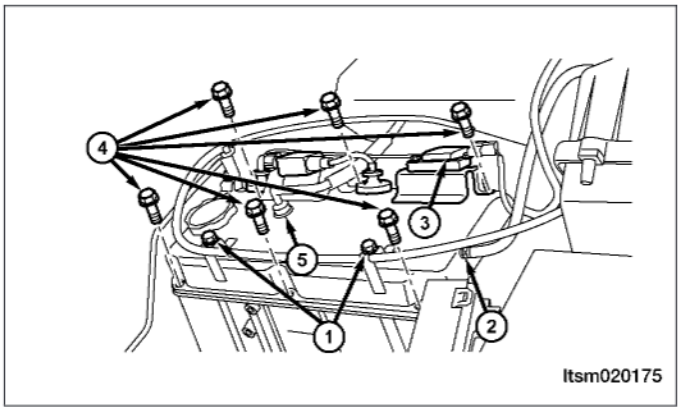
6. Installation is in the reverse order of removal.

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Cylinder Head Cover

Removal & Installation

1. Disconnect the negative battery cable.
2. Remove the accelerator cable bracket bolts (1). (Tighten: Accelerator cable bracket bolts to 10 N·m)
3. Remove the accelerator cable.
4. Remove the air flow hose clamp (2) and disconnect the air flow hose.
5. Remove the spark plug wires (3) and set them aside (See Spark Plug Wire Removal & Installation in Section 03 Electronic Engine Controls).
6. Remove the PCV tube (5).
7. Remove the cylinder head cover bolts (4). (Tighten: Cylinder head cover bolts to 11 N·m)



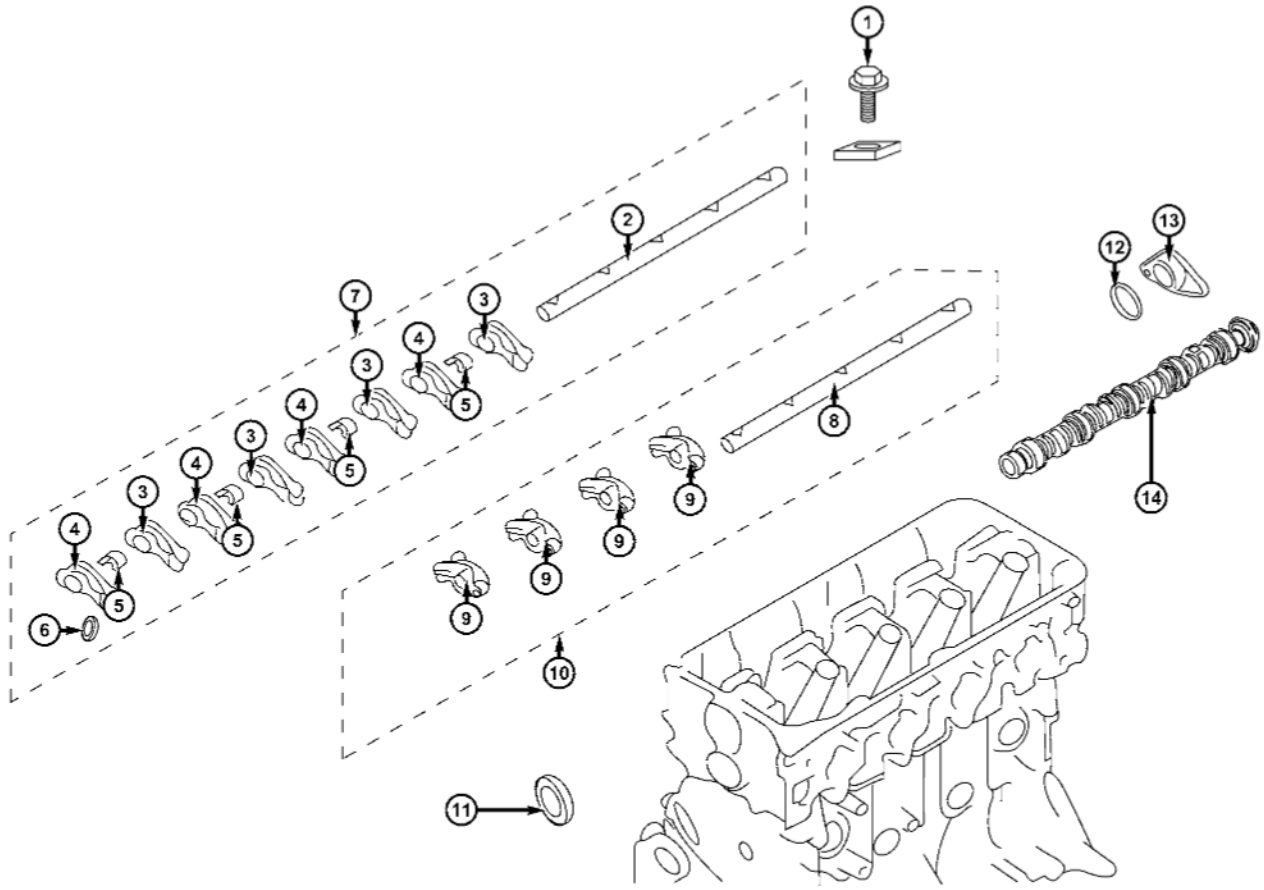
8. Remove the cylinder head cover from the cylinder head.
9. Remove the cylinder head cover gasket if necessary.
10. Installation is in the reverse order of removal.

NOTE :
Install a new cylinder head cover gasket during installation.

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Camshaft

Removal & Installation



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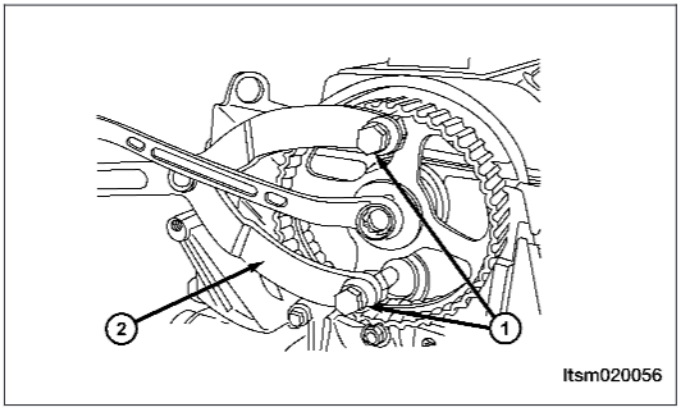
1 - Rocker Shaft Retaining Bolt	8 - Exhaust Rocker Arm Shaft
2 - Intake Rocker Arm Shaft	9 - Rocker Arm
3 - Rocker Arm	10 - Rocker Arm and Rocker Shaft
4 - Rocker Arm	11 - Camshaft Oil Seal
5 - Rocker Shaft Spring	12 - O-Ring
6 - Hydraulic Adjuster	13 - Camshaft Thrust Plate
7 - Rocker Arm and Rocker Shaft	14 - Camshaft

NOTE :
The following special tools are required to perform the repair procedure:
- MD-998719 - Camshaft Belt Gear Holder
- MD-990767 - Camshaft Belt Gear Holder
- MD-998443 - Hydraulic Post Keeper

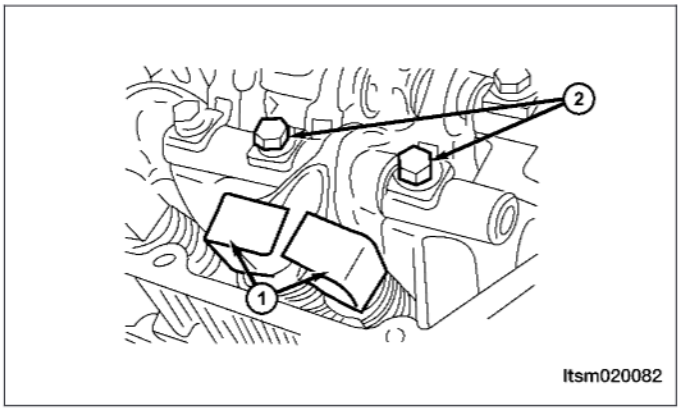
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- MD-998442 - Hydraulic Post Wiring
- MD-998713 - Camshaft Oil Seal Installer
- MD-998441 - Hydraulic Post Keeper
- MD-998440 - Leak Tester

1. Remove the accessory drive belt (See Accessory Drive Belt Removal & Installation in Section 02 Engine).
2. Remove the engine timing belt (See Engine Timing Belt Removal & Installation in Section 02 Engine).
3. Remove the cylinder head cover (See Cylinder Head Cover Removal & Installation in Section 02 Engine).
4. Using special tools MD-998719 (1) and MB-990767 (2) remove the camshaft timing belt pulley bolt. (Tighten: Camshaft timing belt pulley bolt to 120 N·m)



5. Remove the camshaft timing belt pulley.
6. Remove the intake and exhaust rocker shaft assembly retaining bolts (2). (Tighten: Rocker shaft assembly bolts to 32 N·m)
7. Remove the rocker arm and rocker shaft assemblies.
   CAUTION: Before disassembling the rocker arm and rocker arm shaft assembly, install special tool MD-998443 (1) as shown in the illustration to prevent the hydraulic adjusters from dropping into the cylinder head.



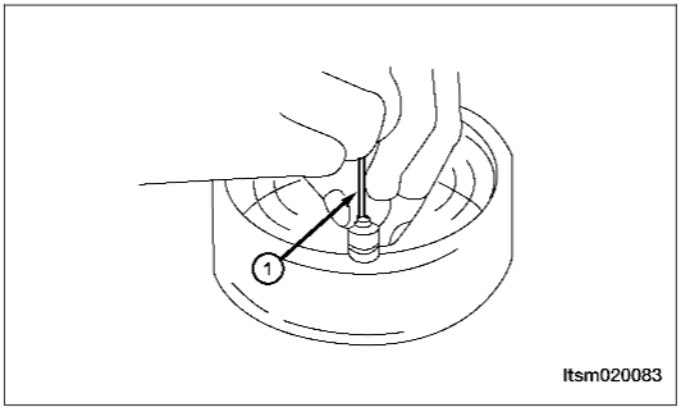
8. Remove the camshaft position sensor electrical connector.
9. Remove the camshaft position sensor. (See Camshaft Position Sensor Removal & Installation in Section 03 Electronic Engine Controls).
10. Remove the camshaft thrust plate retaining bolt. (Tighten: Camshaft thrust plate bolt to 19 ± 3 N·m)
11. Remove the O-ring.
12. Remove the camshaft.
13. Installation is in the reverse order of removal.

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Installation Notes:

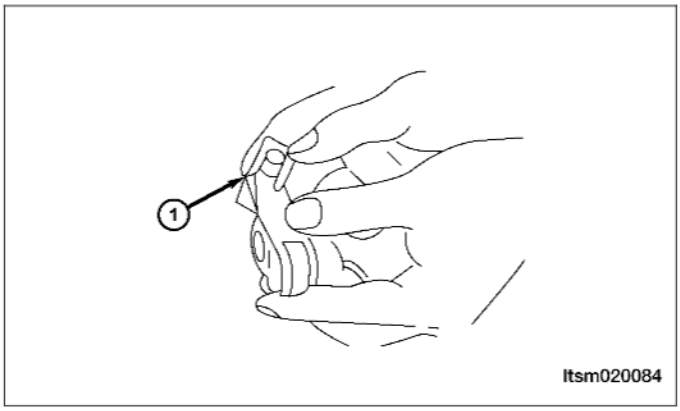
- Use special tool MD-998442 (1), to depress the plunger several times to exhaust all air from the hydraulic adjuster.

CAUTION:
The check ball is especially soft, do not push the check ball too hard or the hydraulic adjuster will be damaged. When using special tool MD-998442 (1) the air will be relieved easily.



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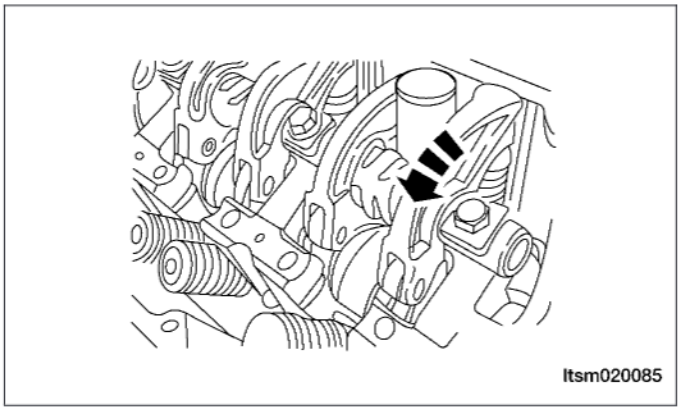
- Insert the hydraulic adjusters into the rocker arms. Insert special tool MD-998443 (1) to prevent dropping the hydraulic adjuster during installation.



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- Assemble the rocker shaft springs to the rocker shafts from the upper side of the shaft. Install the rocker shafts to the cylinder head and install the rocker shaft bolts and hand tighten only.

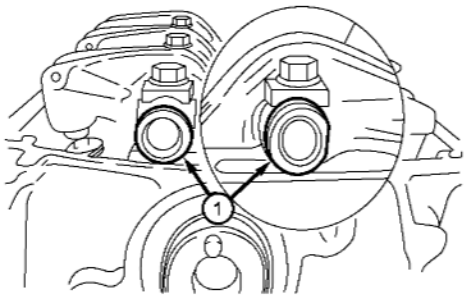
CAUTION:
The rocker shaft springs should be installed first and then install the rocker shaft bolts.


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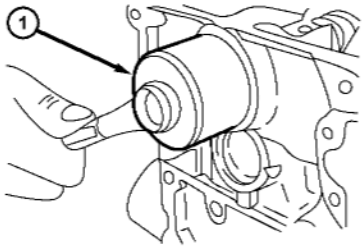
- Make sure that the rocker shafts are installed properly (1) as shown in the illustration.

CAUTION:
The oil hole in the rocker shafts should be aligned with the cylinder head to ensure correct installation position.



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- Using special tool MD-998713 (1), install the camshaft oil seal.

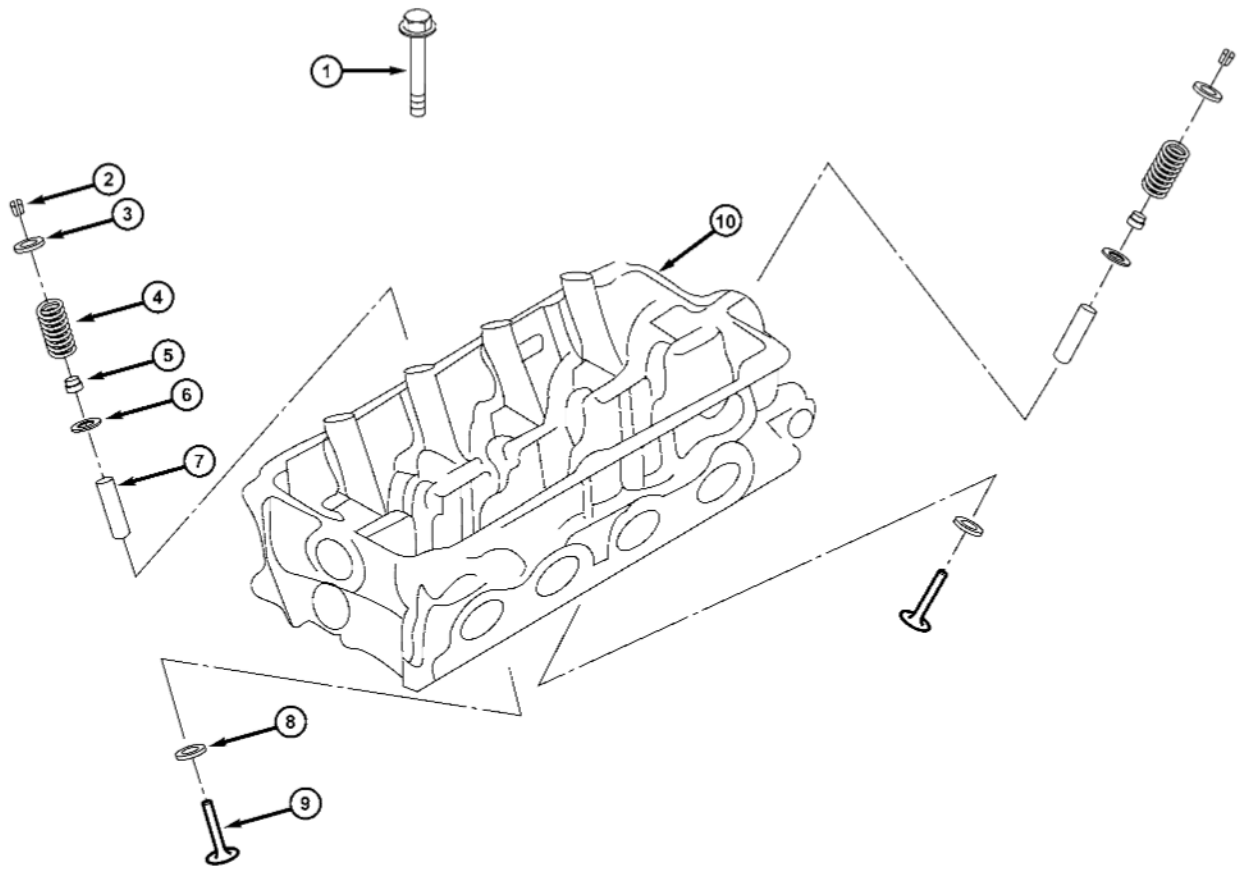


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Cylinder Head

Removal & Installation



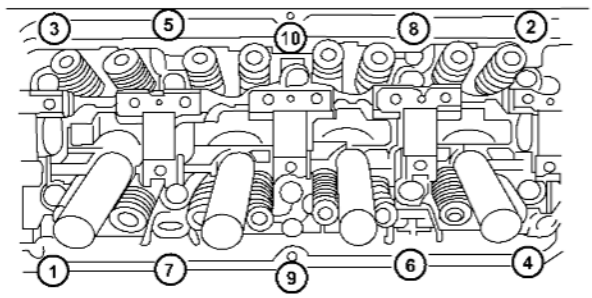
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1 - Cylinder Head Bolt	6 - Lower Valve Spring Retainer
2 - Valve Spring Locks	7 - Valve Guide
3 - Upper Valve Spring Retainer	8 - Valve Seat
4 - Valve Spring	9 - Valve
5 - Valve Oil Seal	10 - Cylinder Head

1. Drain the cooling system (See Cooling System Draining and Filling in Section 06 Cooling).
2. Remove the engine timing belt (See Engine Timing Belt Removal & Installation in Section 02 Engine).
3. Remove the cylinder head cover (See Cylinder Head Cover Removal & Installation in Section 02 Engine).
4. Remove the camshafts (See Camshaft Removal & Installation in Section 02 Engine).
5. Remove the intake manifold (See Intake Manifold Removal & Installation in Section 02 Engine).
6. Remove the exhaust manifold (See Exhaust Manifold Removal & Installation in Section 02 Engine).
7. Remove the water pipe and thermostat assembly.

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8. Remove the cylinder head bolts in the sequence shown.

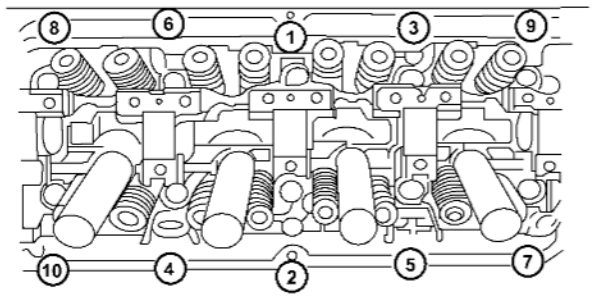


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9. Remove the cylinder head.
10. Remove the cylinder head gasket.
11. Inspect the cylinder head for warp using a straightedge and feeler gauge. Repair the cylinder head if necessary.
12. Installation is in the reverse order of removal.

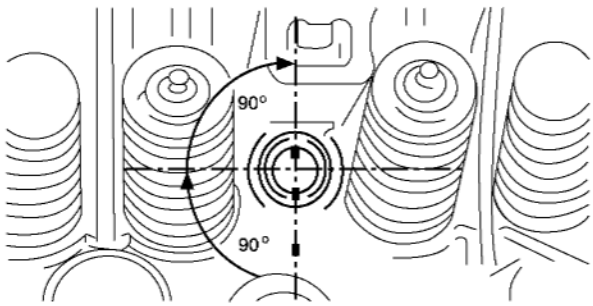
Installation Notes:

- Ensure cylinder head bolt holes in the block are clean, dry (free of residual oil or coolant), and threads are not damaged.
- Do not reuse the cylinder head bolts. The new bolts should be examined before use. If the bolts are stretched, the bolts should be replaced.
- Position the new cylinder head gasket on the engine block with the part number facing up. Ensure gasket is seated over the locating dowels in the block.
- Before installing the bolts, the threads should be lightly coated with engine oil.
- The cylinder head bolts should be installed and torqued in the sequence shown.



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- Tighten the cylinder head bolts in the following sequence.
  - 1st Step: Tighten the bolt to 78 N·m
  - 2nd Step: Completely loosen the bolt
  - 3rd Step: Retighten the bolt to 20 N·m
  - 4th Step: Tighten the bolt an additional 90°
  - 5th Step: Finish tightening the bolt an additional 90°



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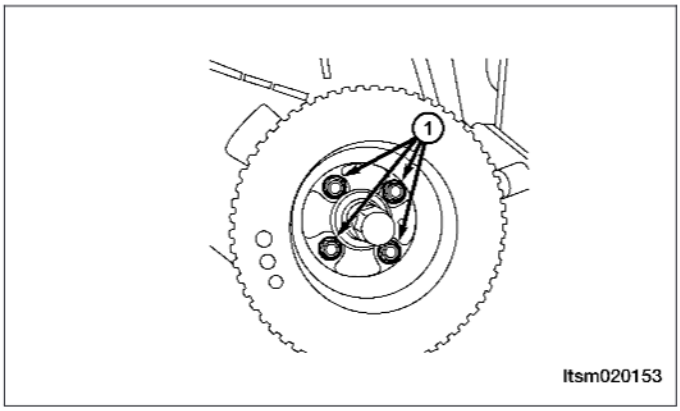
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Front Crankshaft Oil Seal

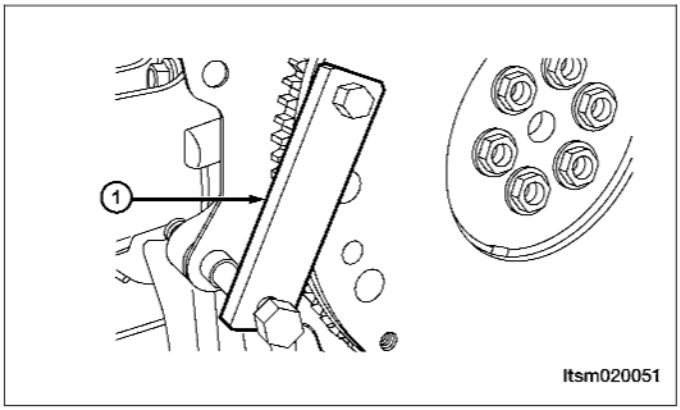
Removal & Installation

NOTE :
The following special tools are required to perform the repair procedure:
- MD-998778 - Crankshaft Belt Gear Puller
- MD-998781 - Flywheel Holder

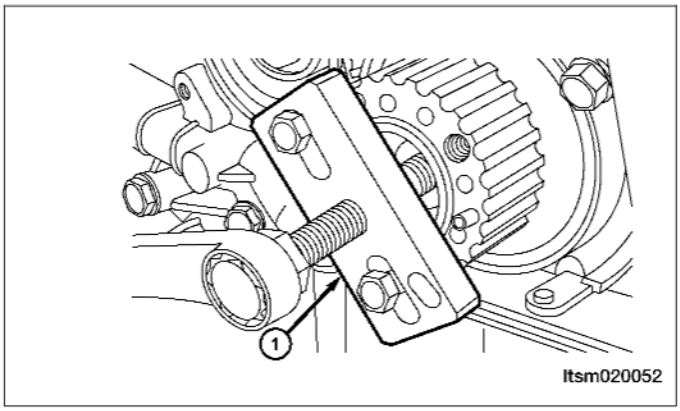
1. Remove the accessory drive belt (See Accessory Drive Belt Removal & Installation in Section 02 Engine).
2. Remove the crankshaft vibration damper bolts (1). (Tighten: Crankshaft vibration damper bolts to 25 N·m)



3. Remove the engine timing belt (See Engine Timing Belt Removal & Installation in Section 02 Engine).
4. Install special tool MD-998781 (1), onto the flywheel.



5. Remove the crankshaft timing belt pulley bolt.
6. Using special tool MD-998778 (1), remove the crankshaft timing belt pulley from the crankshaft.



7. Remove the key-way from the crankshaft.
8. Using an appropriate tool, remove the front crankshaft oil seal.

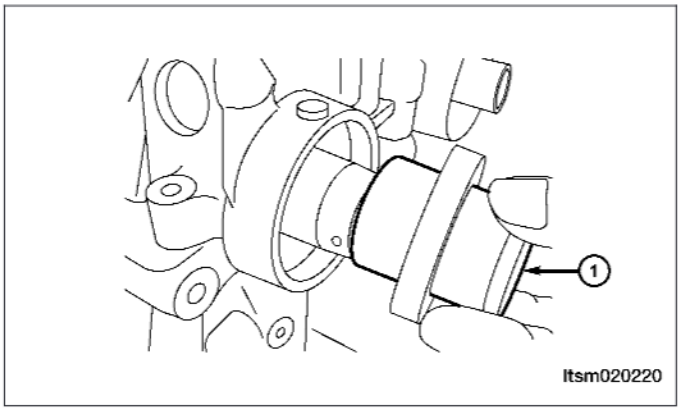
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CAUTION:
Be careful not to damage the front cover seal surface while removing the seal.

9. Installation is in the reverse order of removal.

Installation Notes:

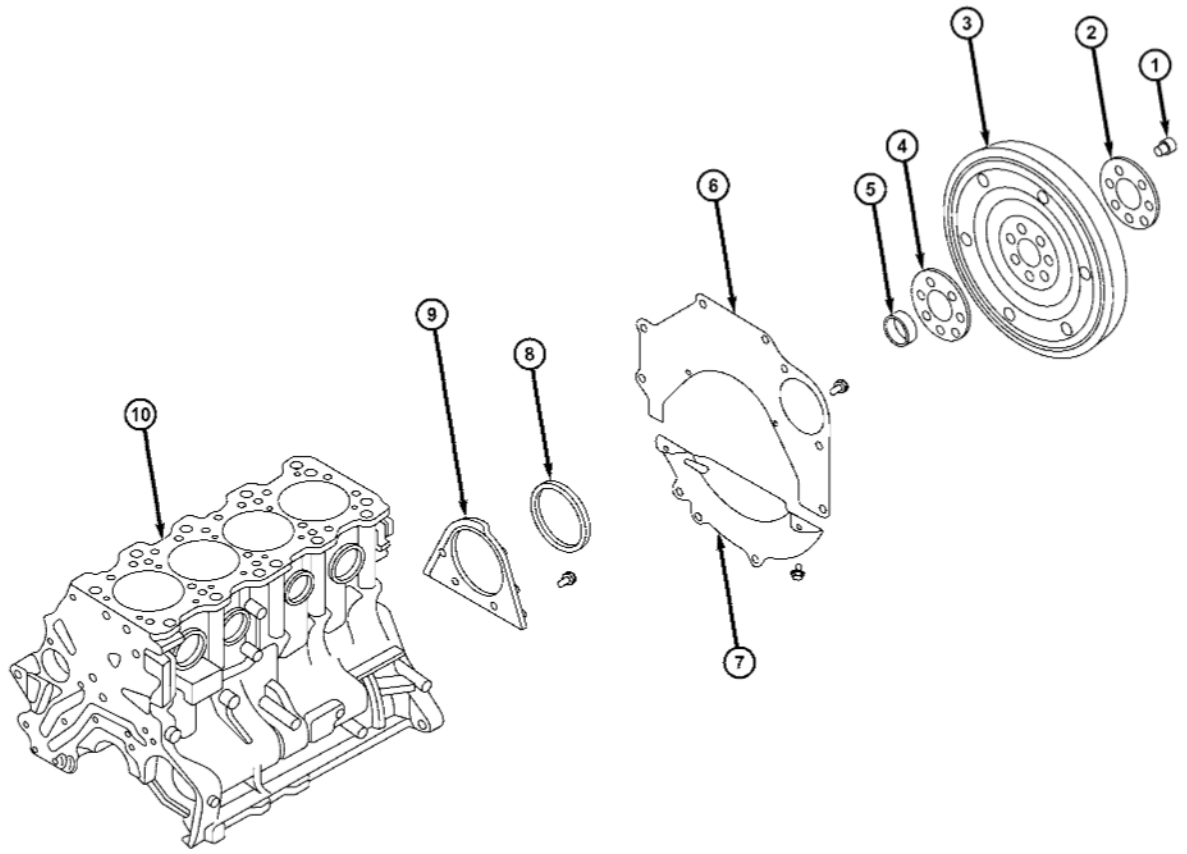
- Lubricate the new front seal with engine oil prior to assembly.
- Use the front crankshaft seal installer MD-998285 (1), to install the new seal.
- Tighten the crankshaft timing belt pulley bolt in the following sequence.
  - 1st step: Tighten the crankshaft timing belt pulley bolt to 130 N·m.
  - 2nd step: Tighten the bolt an additional 65°



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Rear Crankshaft Oil Seal

Removal & Installation



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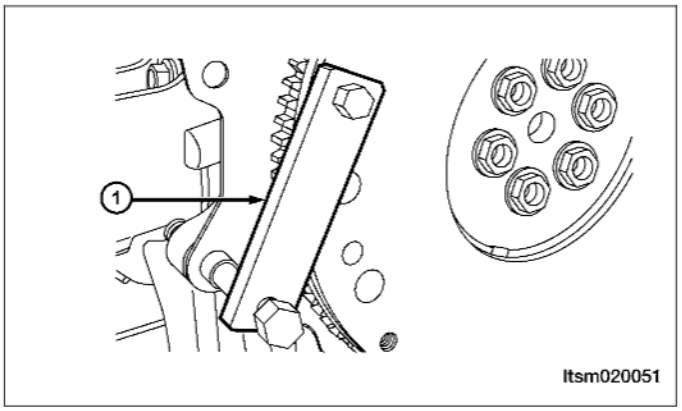
1 - Flywheel Bolt	6 - Rear Engine Plate
2 - Rear Flywheel Flange	7 - Bell Housing Cover
3 - Flywheel	8 - Rear Crankshaft Oil Seal
4 - Front Flywheel Flange	9 - Rear Crankshaft Oil Seal Housing
5 - Crankshaft Bushing	10 - Cylinder Block

NOTE :
The following special tools are required to perform the repair procedure:
- MD-998776 - Crankshaft Rear Oil Seal Installer

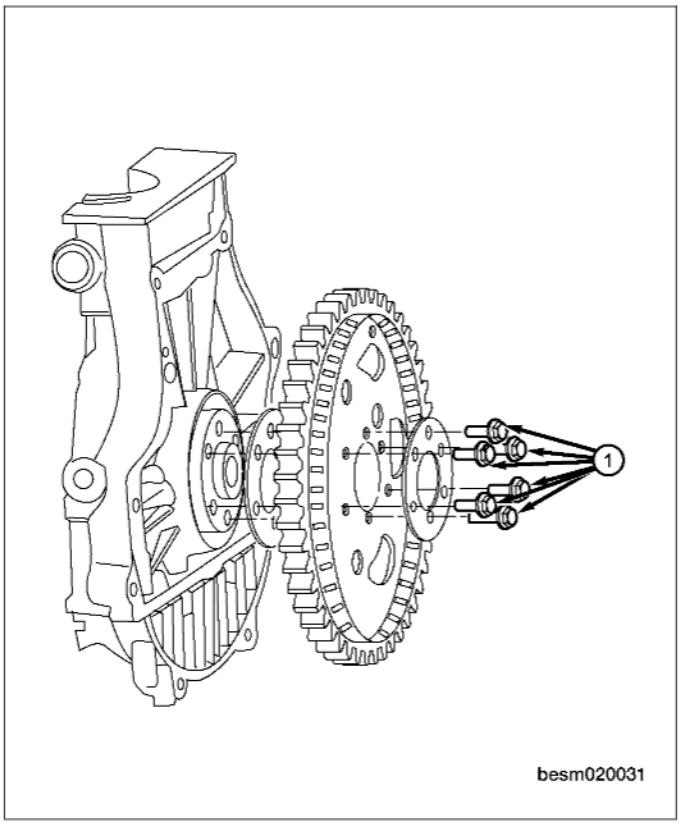
1. Remove the transaxle assembly (See Transaxle Assembly Removal & Installation in Section 08 Transaxle & Transfer Case).

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2. Install special tool MD - 998781 (1), on to the flywheel.



3. If equipped with automatic transaxle, remove the drive plate retaining bolts (1) and then remove the drive plate.
(Tighten: Drive plate bolts to 75 N·m)



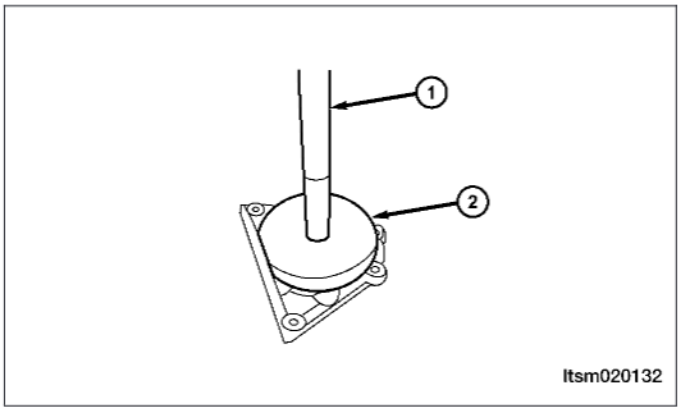
4. Remove the crankshaft rear oil seal using a suitable tool.
5. Installation is in the reverse order of removal.

Installation Notes:

- When installing seal, lubricate seal guide with clean engine oil.
- Position the seal over the rear crankshaft seal guide.

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- Use special tool MD-998776 (2) and MD-990938 (1), to install the rear oil seal.
- Ensure that the lip of the seal is facing toward the crankcase during installation.

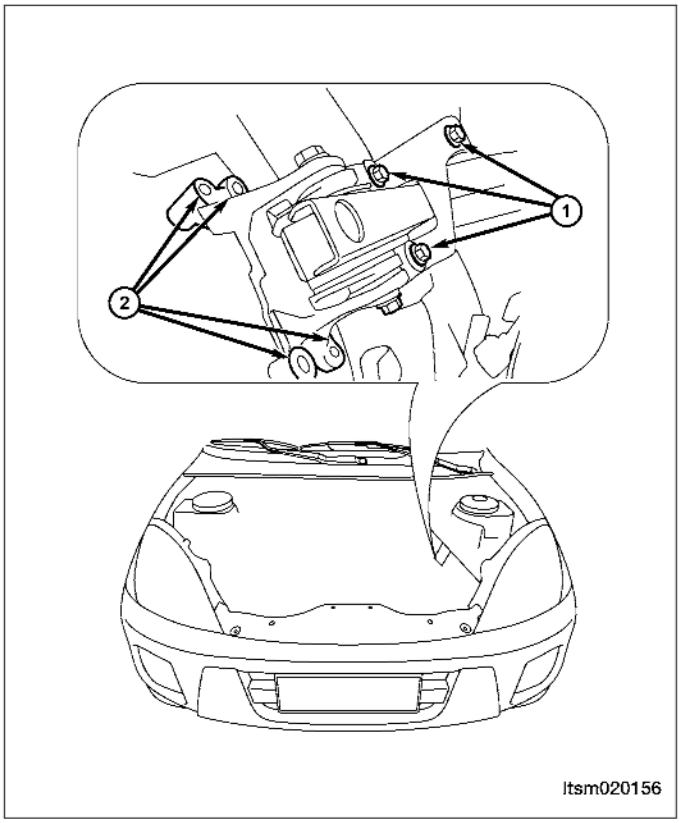


Engine Mounts

Removal & Installation - Left Mount

NOTE :
The following special tools are required to perform the repair procedure:
- Engine Hoist

1. Disconnect the negative battery cable.
2. Remove the air cleaner housing. (See Air Cleaner Housing Removal & Installation in Section 02 Engine).
3. Support the engine with the engine hoist.
4. Remove the engine left mount retaining bolts (2) and remove the engine left mount bracket bolts (1). (Tighten: Engine left mount bolts to 70 N·m)
5. Installation is in the reverse order of removal.

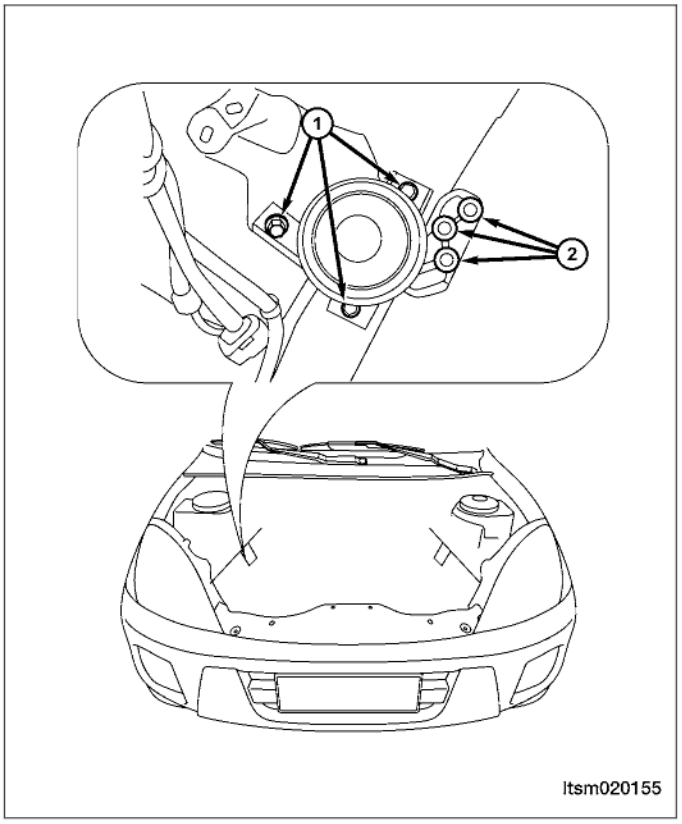


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Removal & Installation - Right Mount

NOTE :
The following special tools are required to perform the repair procedure:
- Engine Hoist

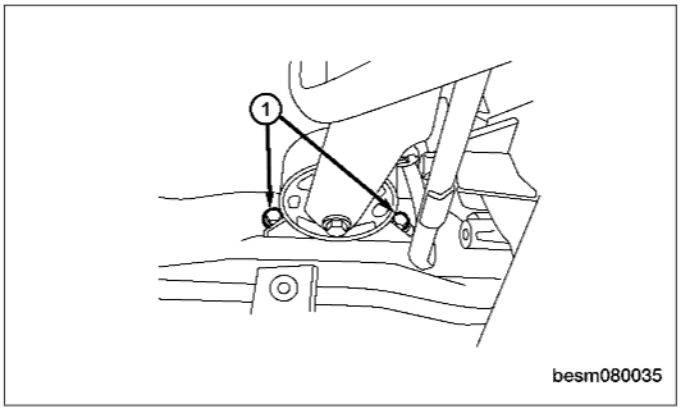
1. Disconnect the negative battery cable.
2. Support the engine with the engine hoist.
3. Remove the engine right mount retaining bolts (2) and remove the engine right mount bracket bolts (1).
   (Tighten: Engine right mount bolts to 70 N·m)
4. Installation is in the reverse order of removal.



Removal & Installation - Front Mount

NOTE :
The following special tools are required to perform the repair procedure:
- Engine Hoist

1. Disconnect the negative battery cable.
2. Support the engine with the engine hoist.
3. Remove the bolts (1) securing the front engine mount.
   (Tighten: Engine front mount bolts to 60 N·m)
4. Installation is in the reverse order of removal.

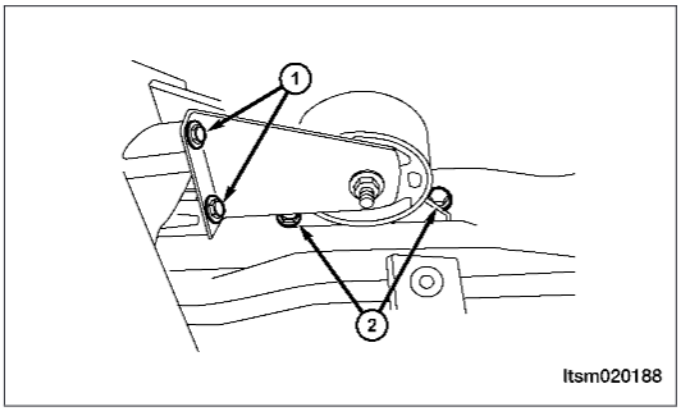


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Removal & Installation - Rear Mount

NOTE :
The following special tools are required to perform the repair procedure:
- Engine Hoist

1. Disconnect the negative battery cable.
2. Support the engine with the engine hoist.
3. Remove the engine rear mount retaining bolts (2) and remove the engine rear mount bracket bolts (1).
   (Tighten: Engine rear mount bolts to 60 N·m)
4. Installation is in the reverse order of removal.



Engine Assembly

Removal & Installation

NOTE :
The following special tools are required to perform the repair procedure:
- Engine Hoist

NOTE :
The engine is removed with the transaxle as an assembly.

1. Relieve the fuel pressure (See Fuel Pressure Relief Procedure in Section 04 Fuel Delivery).
2. Disconnect the negative battery cable.
3. Remove the battery, battery hold downs, and battery tray (See Battery Removal & Installation in Section 05 Starting & Charging).
4. Remove the hood.
5. Discharge air conditioning system (See A/C System Evacuation and Recharge in Section 13 Heating & Air Conditioning).
6. Drain the cooling system (See Cooling System Draining and Filling in Section 06 Cooling).

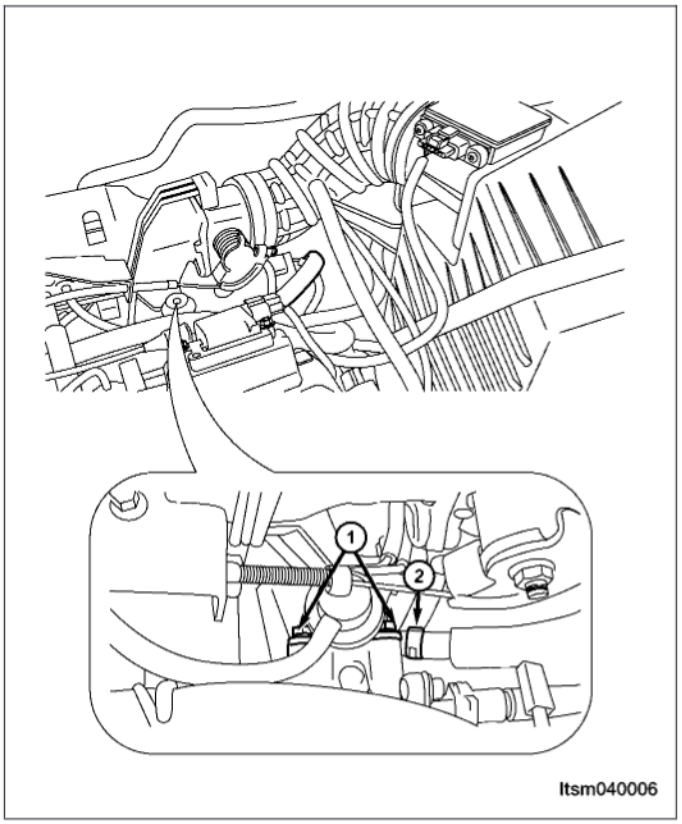
WARNING!

Always allow the engine to cool before opening the cooling system. Do not loosen the coolant pressure relief cap when the engine is operating or the cooling system is hot. The cooling system is under pressure; steam and hot liquid can come out forcefully when the cap is loosened slightly. Failure to follow these instructions may result in serious personal injury.

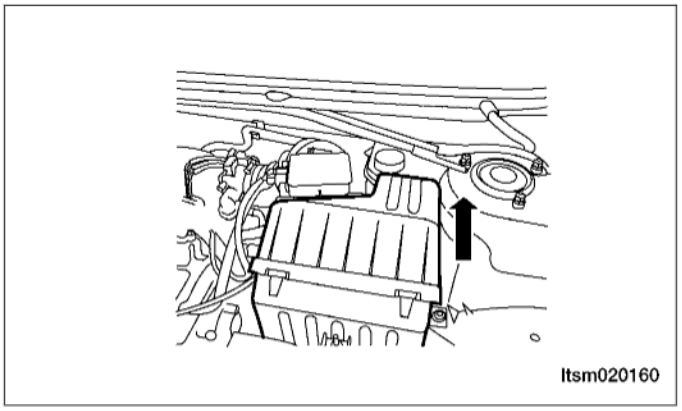
7. Remove the coolant fan & radiator assembly (See Coolant Fan & Radiator Assembly Removal & Installation in Section 06 Cooling).
8. Remove the starter motor wiring.
9. Remove the negative battery cable from the engine.

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10. Disconnect and remove the fuel line (2) at the fuel rail.
11. Remove the fuel pressure regulator retaining bolt (1) and set the fuel pressure regulator aside. (Tighten: Fuel pressure regulator bolt to 9 N·m)



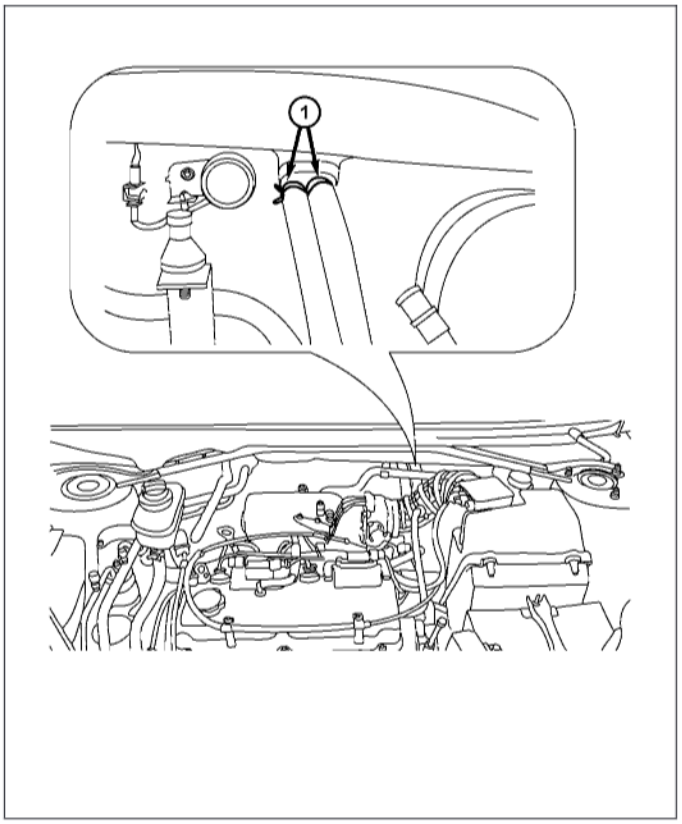
12. Remove the air inlet hose and the air cleaner case assembly.



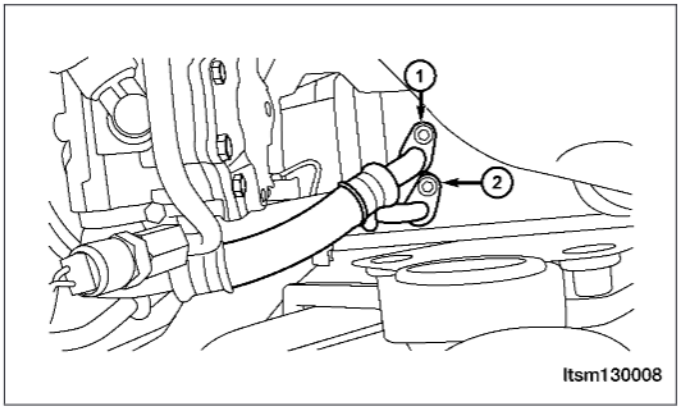
13. Remove the accelerator cable bolt from the cylinder head.
14. Disconnect and remove the following electrical connectors:
    - Coolant temperature sensor
    - Crankshaft position sensor
    - Camshaft position sensor
    - Ignition coil
    - Four fuel injectors
    - Air flow sensor
    - Canister solenoid valve
    - EGR control solenoid valve
    - Throttle position sensor
    - A/C compressor
    - Oil pressure sensor
    - Power steering pump pressure switch
    - Generator
    - Upstream oxygen sensor
    - Knock sensor
    - Idle air control motor

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15. Remove the pipe from the canister control valve.
16. Disconnect the heater hoses (1) on the vehicle.

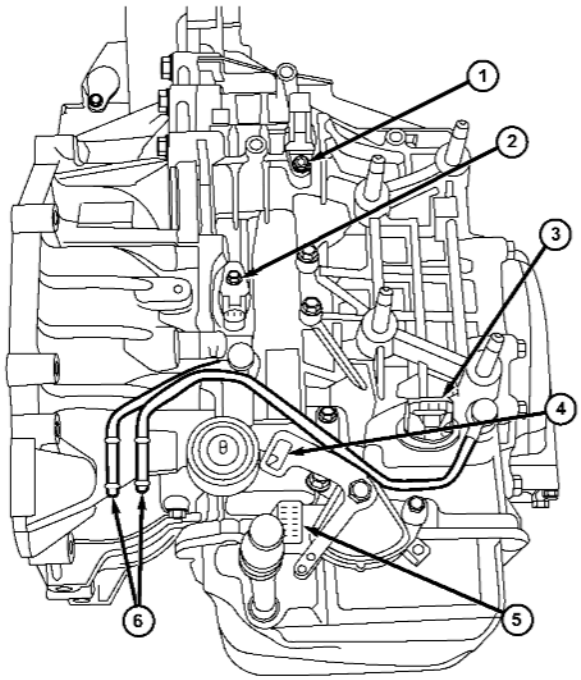


17. Remove the vacuum line from the brake booster.
18. Remove the dipstick.
19. Remove the accessory drive belt (See Accessory Drive Belt Removal & Installation in Section 02 Engine).
20. Remove the A/C compressor high and low pressure pipe bolts (1) & (2).



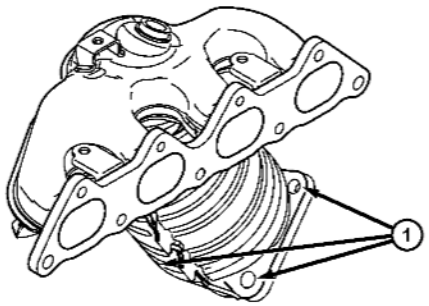
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21. Disconnect the following automatic transaxle electrical connectors:
    - Output shaft sensor (1)
    - Input shaft sensor (2)
    - Electromagnetic valve switch connector (3)
    - Gear switch connector (5)
22. Disconnect the transaxle fluid lines (6) using a suitable tool.
23. Remove the shift cable (4) from the transaxle assembly.



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24. Remove the catalytic converter to exhaust manifold bolts (1).
    (Tighten: Exhaust manifold bolt to 49 ± 5 N·m)

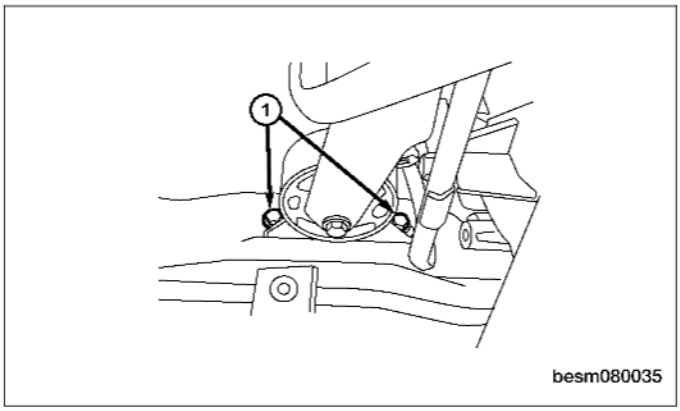


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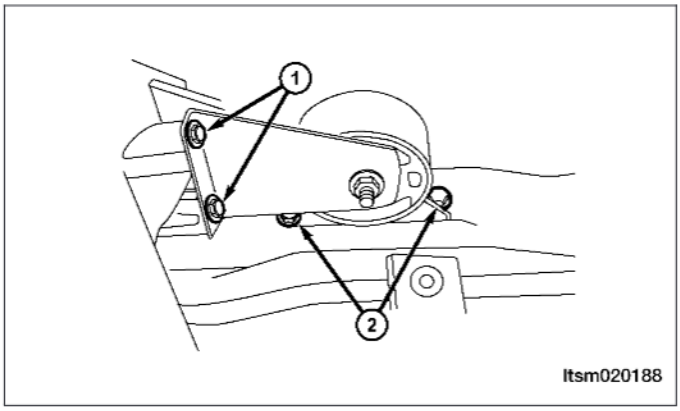
25. Remove the front axle shaft (See Front Axle Shaft Removal & Installation in Section 09 Driveline & Axle).
26. Raise and support the vehicle.
27. Drain the engine oil.
28. Remove the power steering pump fluid line and set aside (See Power steering pump Removal & Installation in Section 11 Steering).
29. Lower the vehicle and install engine lift chain hangers.

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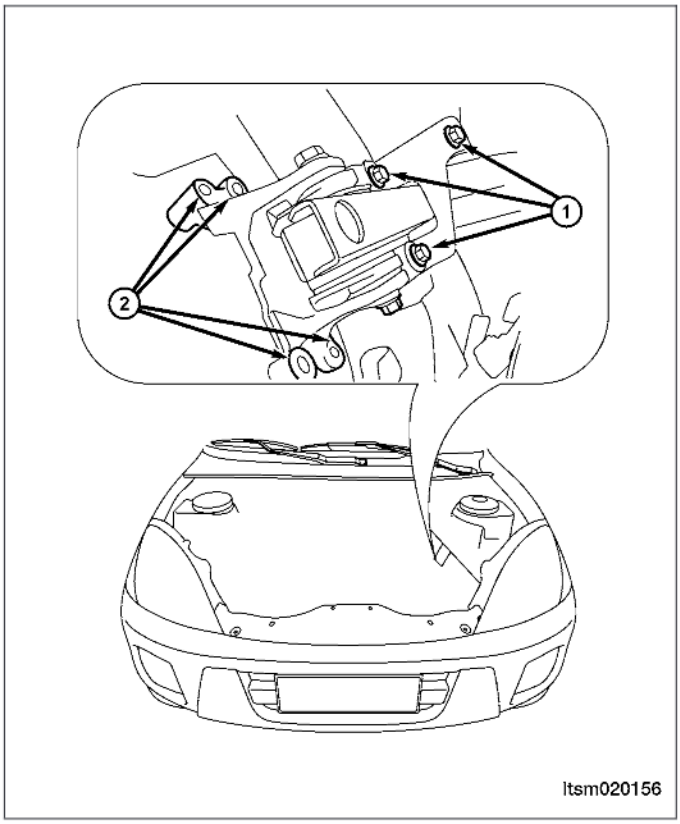
30. Remove the bolts (1) securing the front engine mount.
(Tighten: Engine front mount bolt to 60 N·m)



31. Remove the bolts (2) securing the rear engine mount and the bolts (1) securing the mount bracket.
(Tighten: Engine rear mount bolt to 60 N·m)

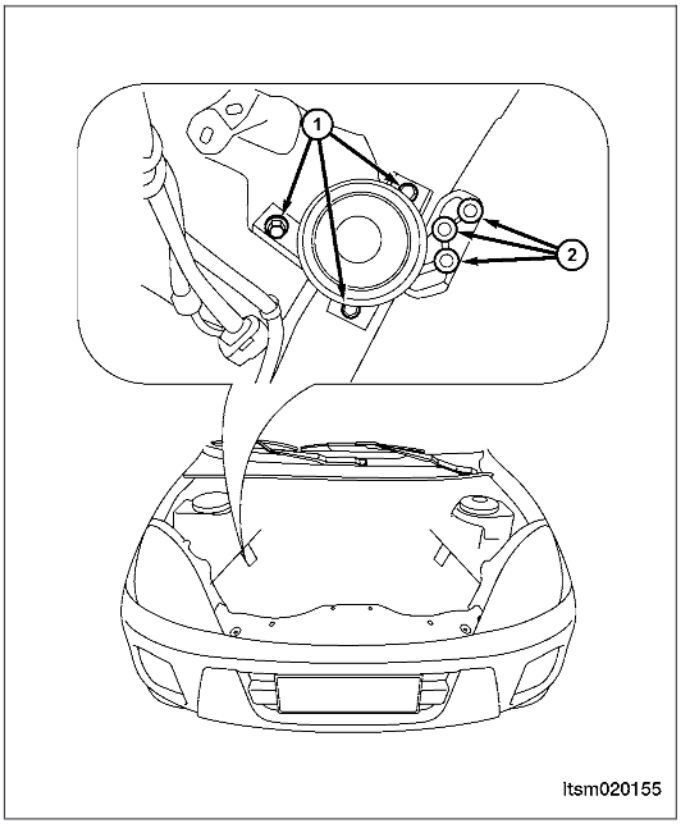


32. Remove the bolts (2) securing the left transaxle mount and the bolts (1) securing the mount bracket.
(Tighten: Left transaxle mount bolt to 70 N·m)



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33. Remove the bolts (2) securing the right engine mount and the bolts (1) securing the mount bracket.
    (Tighten: Engine right mount bolt to 70 N·m)
34. Remove the mount assembly.



35. Verify all components between the engine and vehicle are disconnected.
36. Hoist the engine from vehicle.

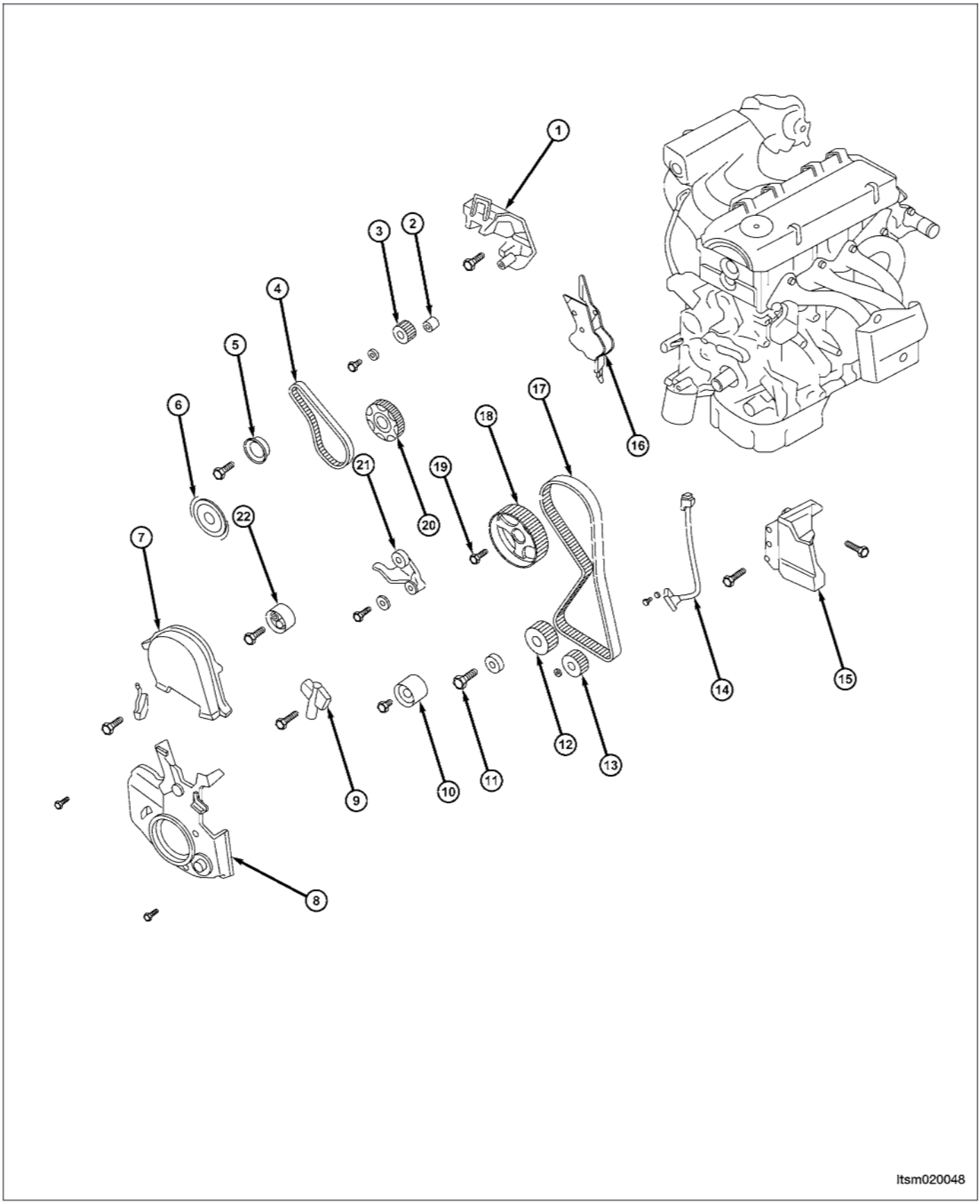
CAUTION:
Verify all electrical connectors are disconnected prior to engine/transaxle removal.

37. Separate engine and transaxle.
    (Tighten: M12×1.75 bolts to 70 ± 5 N·m)
    (Tighten: M10×1.5 bolts to 50 ± 5 N·m)
38. Installation is in the reverse order of removal.

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Engine Timing Belt

Removal & Installation



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1 - Right Engine Mounting Bracket	12 - Crankshaft Timing Belt Pulley
2 - Spacer	13 - Lower Balance Shaft Pulley
3 - Upper Balance Shaft Pulley	14 - Crankshaft Position Sensor
4 - Upper Balance Shaft Timing Belt	15 - Power Steering Bracket
5 - Upper Balance Shaft Timing Belt Tensioner	16 - Timing Belt Rear Cover
6 - Crankshaft Sensing Blade	17 - Timing Belt
7 - Upper Timing Belt Cover	18 - Camshaft Timing Pulley
8 - Lower Timing Belt Cover	19 - Camshaft Pulley Bolt
9 - Timing Belt Automatic Tensioner	20 - Crankshaft Upper Balance Shaft Pulley
10 - Idler Pulley	21 - Tensioner Arm
11 - Crankshaft Bolt	22 - Tensioner Pulley

NOTE :
The following special tools are required to perform the repair procedure:
- MB-990767 - Timing Belt Spanner Wrench
- MD-998785 - Timing Belt Gear Holder
- MD-998767 - Automatic Tensioner Socket

1. Drain the cooling system (See Cooling System Draining and Filling in Section 06 Cooling).

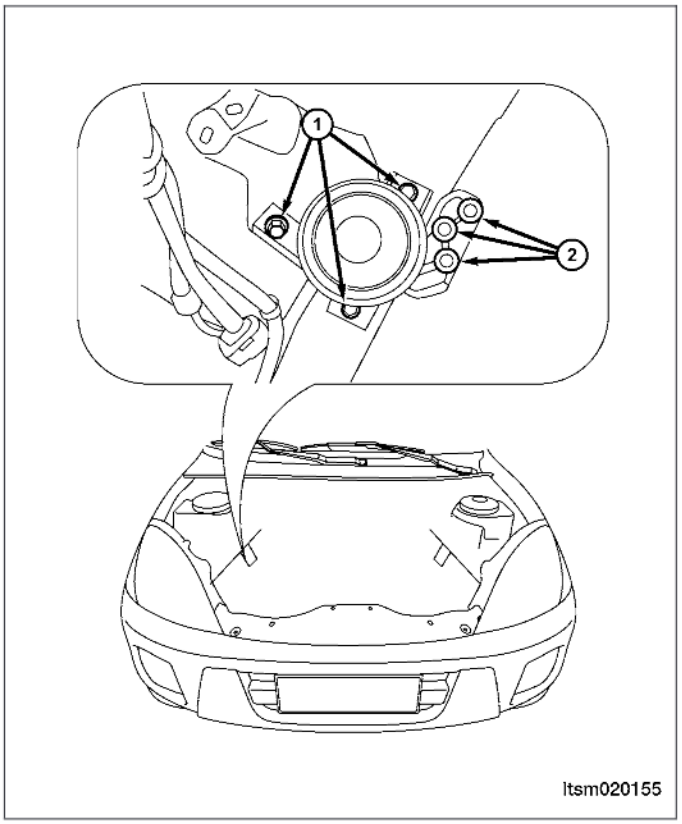
WARNING!

Always allow the engine to cool before opening the cooling system. Do not loosen the coolant pressure relief cap when the engine is operating or the cooling system is hot. The cooling system is under pressure; steam and hot liquid can come out forcefully when the cap is loosened slightly. Failure to follow these instructions may result in serious personal injury.

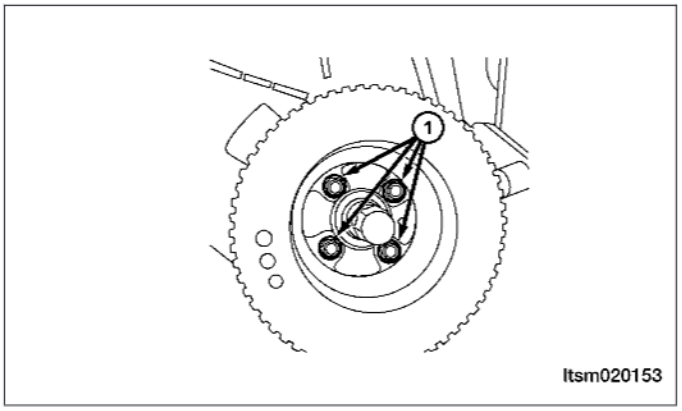
2. Attach an engine hoist to the engine.
3. Raise the engine with the engine hoist, just enough to support the engine.

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4. Remove the engine right mount bolts (2) and the engine right mount bracket bolts (1).
   (Tighten: Engine right mount bolts to 70 N·m)
5. Remove the accessory drive belts (See Accessory Drive Belt Removal & Installation in Section 02 Engine).



6. Remove the crankshaft vibration damper bolts (1).
   (Tighten: Crankshaft vibration damper bolts to 25 N·m)

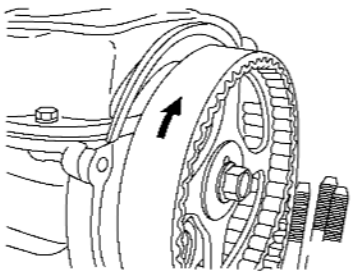


7. Remove the timing belt upper cover.
   (Tighten: Timing belt upper cover bolts to 11 N·m)
8. Remove the timing belt lower cover.
   (Tighten: Timing belt lower cover bolts to 11 N·m)
9. Loosen the timing belt tensioning pulley bolt.
10. Remove the timing belt.

NOTE: Remember the rotation direction of the timing belt in order to avoid any error when reassembling.

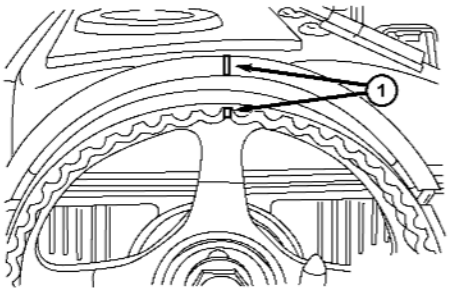
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11. Installation is in the reverse order of removal.

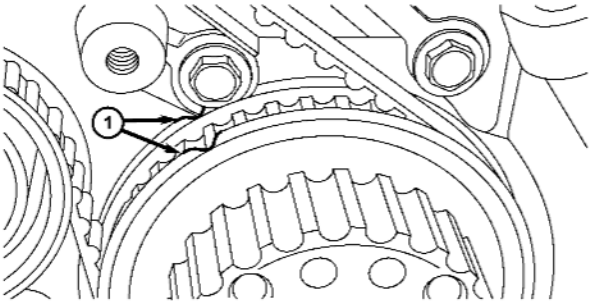


Installation Notes:

- Rotate the camshaft pulley and align the timing marks (1) with the cylinder head cover.

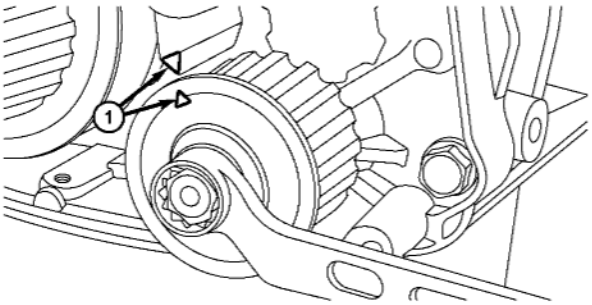


- Rotate the crankshaft pulley and align the timing marks (1) with the front cover.



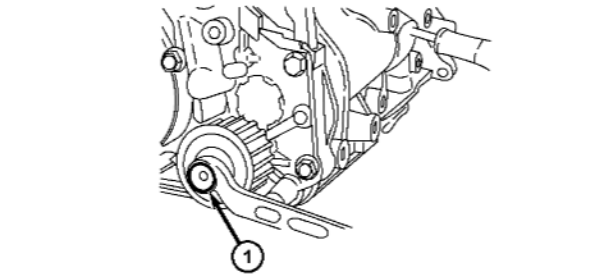
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- Rotate the lower balance shaft pulley and align the timing marks (1) with the front cover.



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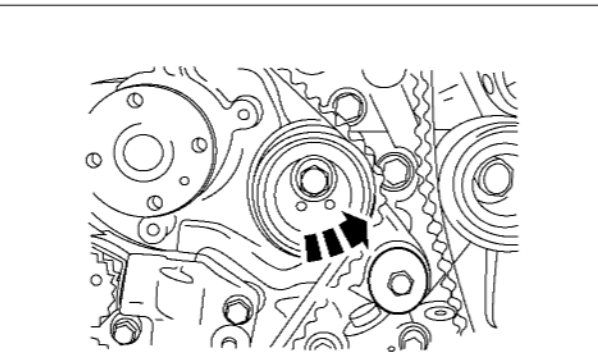
- Remove the plug from the cylinder block and then insert a holder (1) (8 mm diameter) into the hole.



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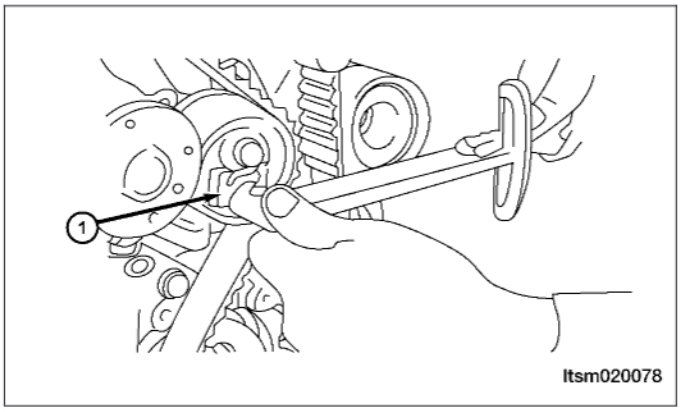
NOTE :
If the holder can be inserted more than 60 mm, then the timing marks are aligned. If the holder could not be inserted more than 20-25 mm, the lower balance shaft pulley should be rotated one revolution and the timing marks should be then be aligned. Keep the holder installed until the installation of the timing belt is complete.

- Make sure all timing marks are aligned properly.
- Install the timing belt.

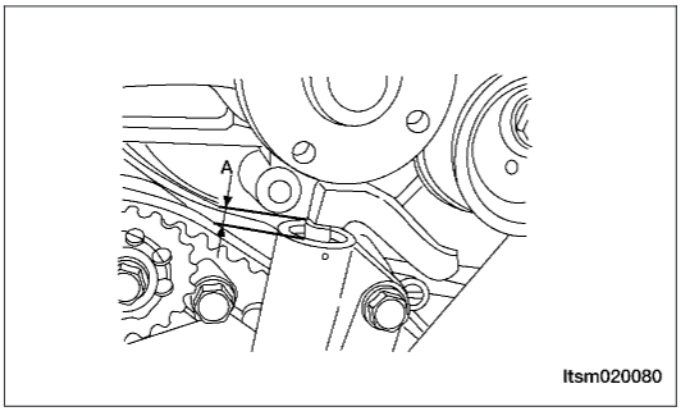

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- Using special tool MD-998767 (1) and a torque wrench, adjust the timing belt tensioner.

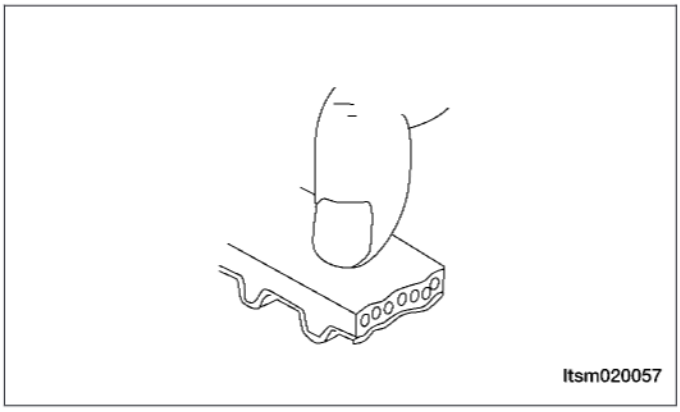


- Measure distance “A” between the tensioner arm and the automatic tensioner.
  - Standard distance is 3.84 mm



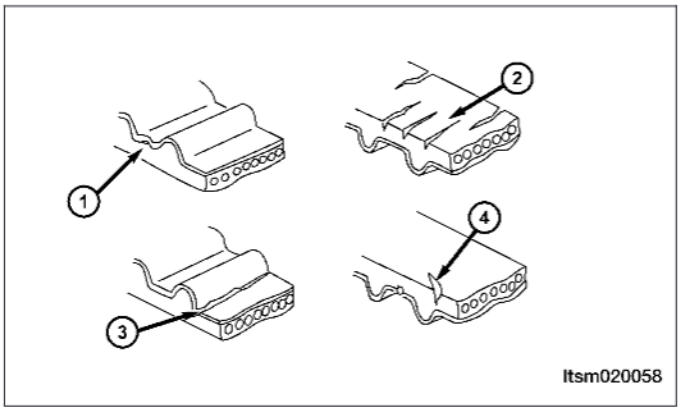
Inspection

1. Inspect the timing belt back rubber for signs of aging and glistening.

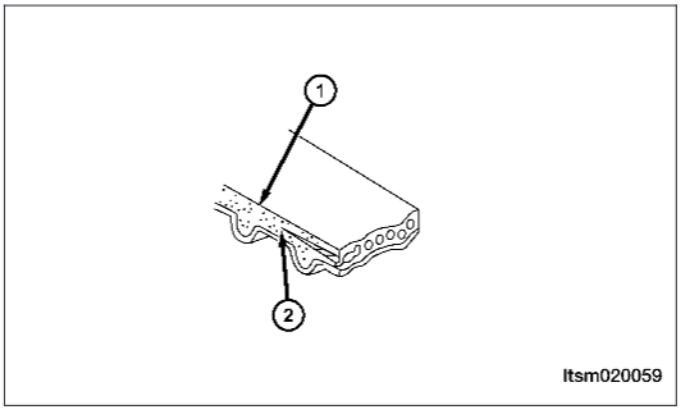


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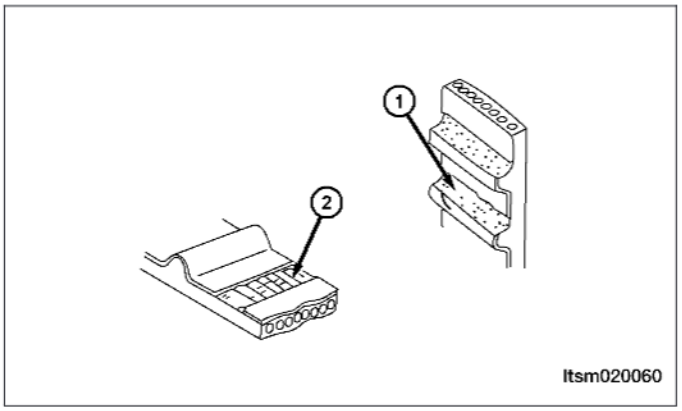
2. Inspect the timing belt for the following:
   - Cracks in the back rubber (1).
   - Cracks and stripping in the canvas (2).
   - Cracks in the grooves (3).
   - Cracks in the side of the belt (4).



3. Inspect the timing belt (1) for abnormal abrasion in the side of the belt (2).



4. Inspect the timing belt for abnormal abrasion (2) or teeth missing (1) from the belt.



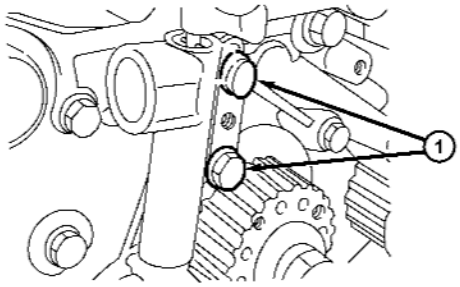
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Timing Belt Automatic Tensioner

Removal & Installation

NOTE :
The following special tools are required to perform the repair procedure:
- MD-998767 - Automatic Tensioner Socket

1. Remove the engine timing belt (See Engine Timing Belt Removal & Installation in Section 02 Engine).
2. Remove the timing belt automatic tensioner bolts (1).
   (Tighten: Timing belt automatic tensioner bolts to 24 N·m)

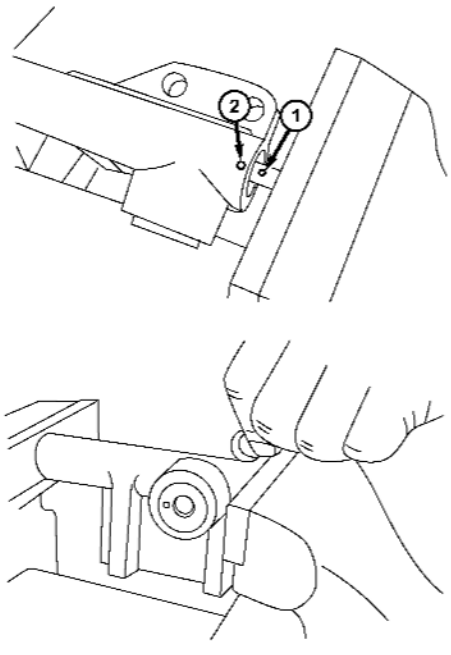


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3. Installation is in the reverse order of removal.

Installation Notes:

- Perform the following to prepare the automatic tensioner for installation:
  - Slowly close the vise jaws until the rod hole (1) and housing hole (2) are aligned.
  - Insert a steel wire (1.4 mm diameter) into the aligned hole.
  - Remove the automatic tensioner from the vise.



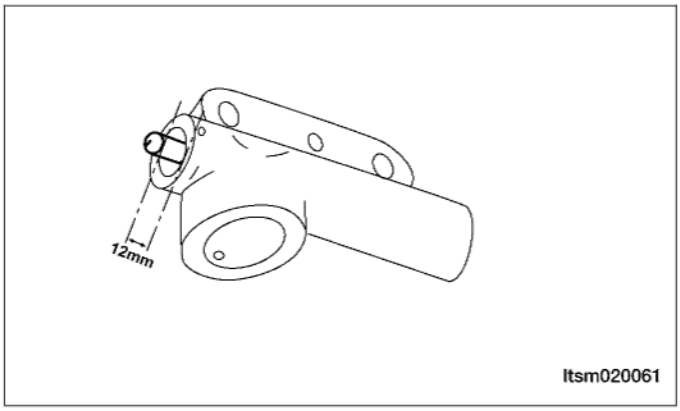
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- The automatic tensioner is now ready to be installed on the engine.

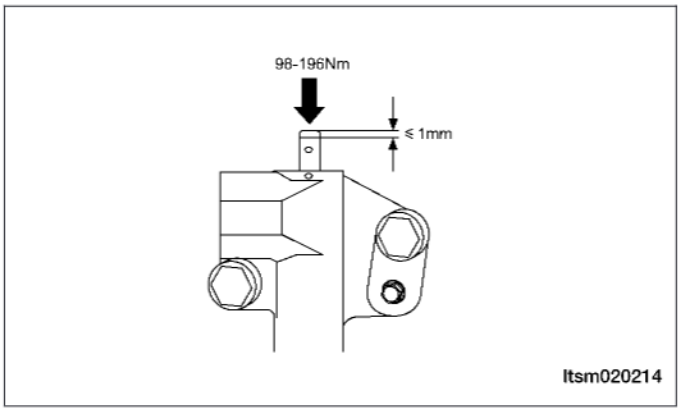
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Inspection

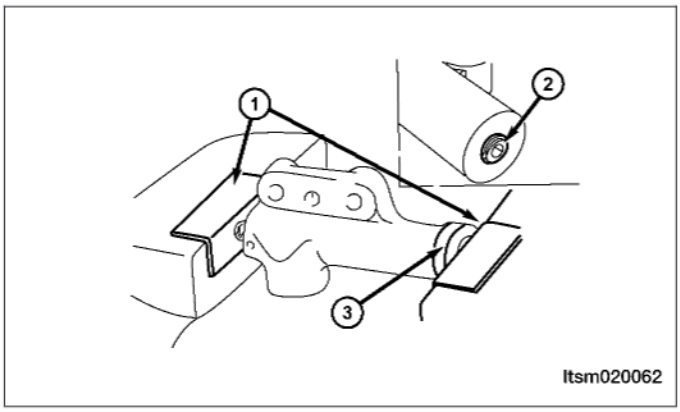
1. Inspect the automatic tensioner for any leaks. Replace the tensioner if any leaks are found.
2. Inspect the automatic tensioner for signs of abrasion at the end of the rod. Replace the tensioner if any abrasions are found.
3. Inspect the length of the rod. If the rod length does not comply with the standard length, replace the tensioner (standard rod length is 12 mm).



4. Using a calibrated force, press the end of the rod using 98 - 196 N·m and measure the rod displacement. If the rod displacement is 1 mm larger than the standard, replace the tensioner (standard measurement is ≤ 1 mm).



5. Assemble the automatic tensioner with a soft jawed vise (1).
   CAUTION: Use an appropriate pad (3) to protect the tensioner bolt (2) from the jaws of the vise.
6. Rotate the handle of the vise to push the rod of the automatic tensioner into the tensioner. If the rod is easy to push in, replace the automatic tensioner. The rod should have some resistance when you push the rod into the tensioner.



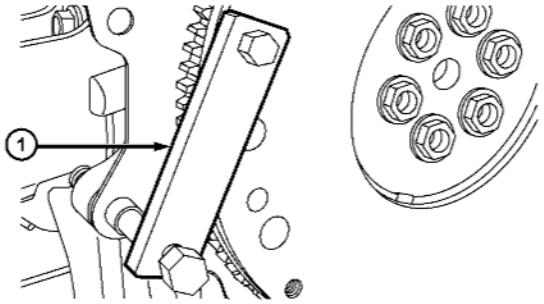
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Upper Balance Shaft Timing Belt

Removal & Installation

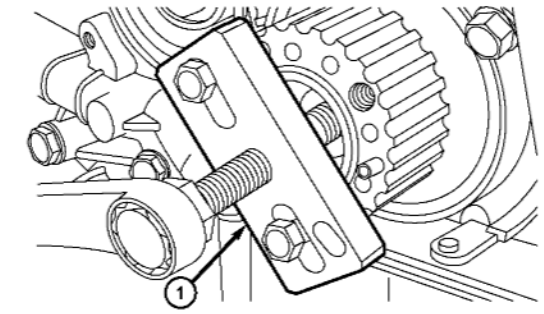
NOTE :
The following special tools are required to perform the repair procedure:
- MD-998778 - Crankshaft Pulley Puller
- MD-998781 - Flywheel Holder
- MD-998785 - Upper Balance Shaft Pulley Holder

1. Remove the engine timing belt (See Engine Timing Belt Removal & Installation in Section 02 Engine).
2. Using special tool MD-998781 (1), attach the tool to the flywheel.



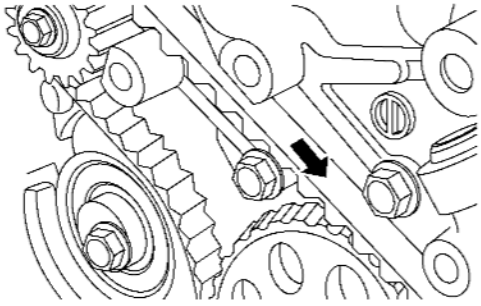
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3. Remove the crankshaft pulley bolt.
   (Tighten: Crankshaft pulley bolt to 120 N·m)
4. Using special tool MD-998778 (1), remove the crankshaft pulley.



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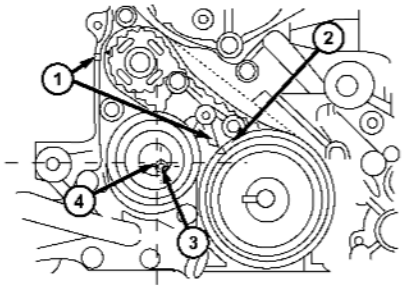
5. Remove the upper balance shaft timing belt.
   NOTE: Remember the rotation direction of the timing belt in order to avoid any error when reassembling.
6. Installation is in the reverse order of removal.


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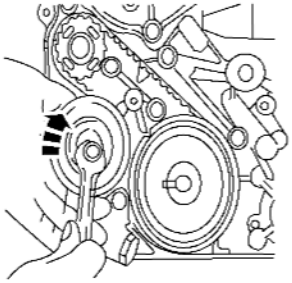
Installation Notes:

- Align the timing marks on the crankshaft pulley (2) and the upper balance shaft pulley with the timing marks on the front engine cover (1).
- Make sure all timing marks are aligned properly.
- Install the timing belt.
- Make sure that the belt tensioner position is as shown (3 & 4).



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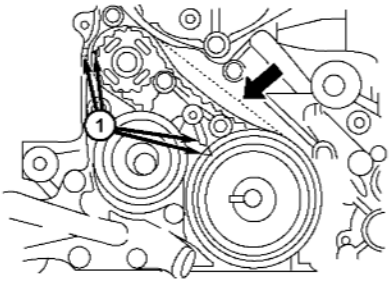
- While applying finger pressure to the belt tensioner in the direction of the arrow, tighten the tensioner bolt to 35 N·m.


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CAUTION:

Do not allow the belt tensioner to move while tightening the bolt, if the tensioner moves it could cause the belt to be overtightened.

- Ensure that the timing marks (1) have not moved, and are still in alignment.
- Press the center of the timing belt with an index finger and measure the belt deflection (standard deflection is 5-7 mm).
- If the belt deflection is not within specifications, adjust if necessary.



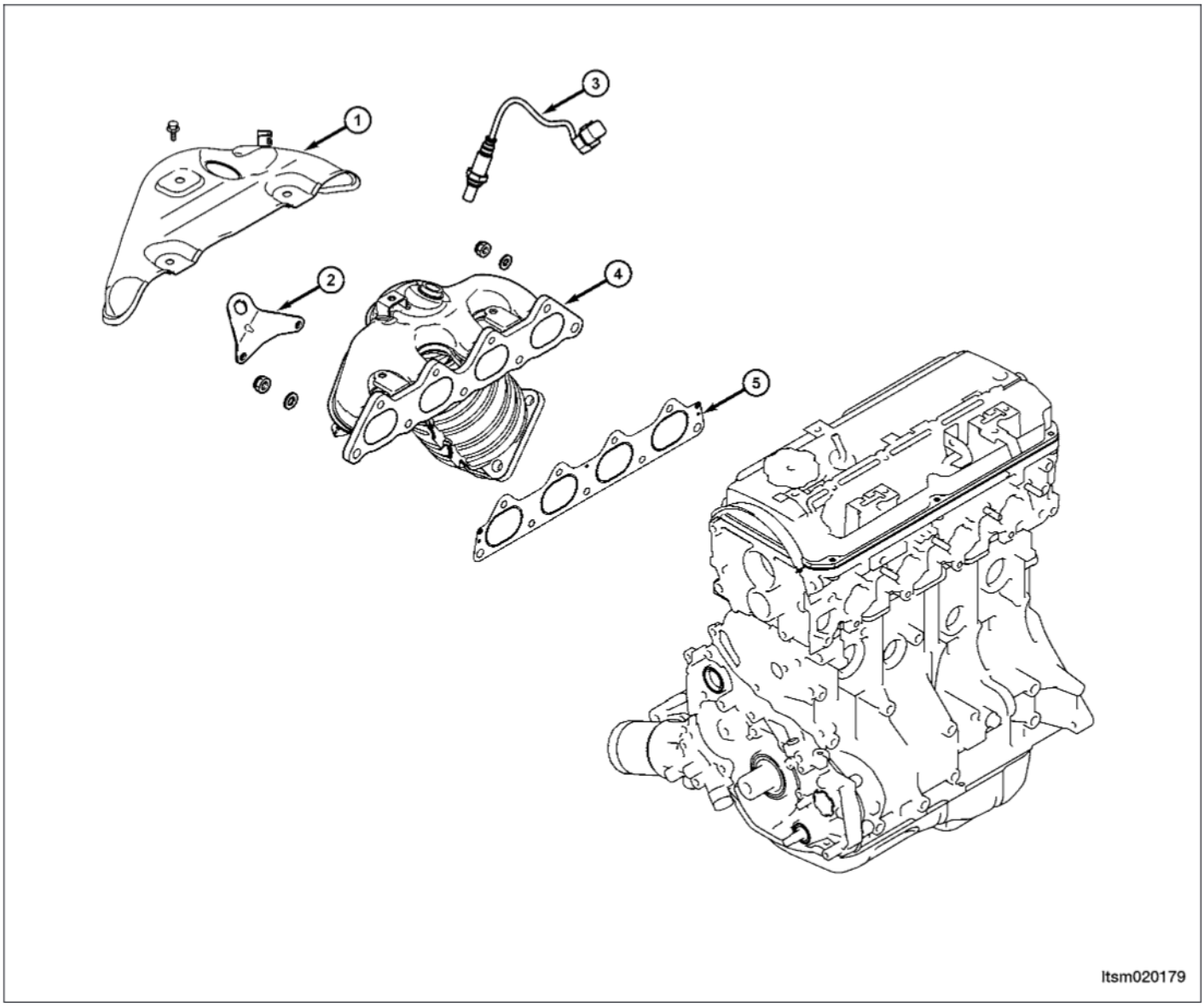
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- Reinstall the engine timing belt (See Engine Timing Belt Removal & Installation in Section 02 Engine).

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Exhaust Manifold

Removal & Installation



1 - Exhaust Manifold Heat Shield	4 - Exhaust Manifold
2 - Engine Hanger	5 - Exhaust Manifold Gasket
3 - Oxygen Sensor	

1. Remove the bolts attaching the exhaust manifold heat shield.
   (Tighten: Exhaust manifold heat shield bolts to 14 N·m)
2. Remove the exhaust manifold heat shield.
3. Remove the three bolts securing the exhaust manifold to the catalytic converter assembly.
   (Tighten: Exhaust manifold to catalytic converter bolts to 49 ± 5 N·m)
4. Disconnect the catalytic converter assembly from the manifold.
5. Remove the exhaust manifold nuts.
   (Tighten: Exhaust manifold nuts to 29 ± 3 N·m)
6. Remove the exhaust manifold from the cylinder head.
7. Remove and discard exhaust manifold gasket.

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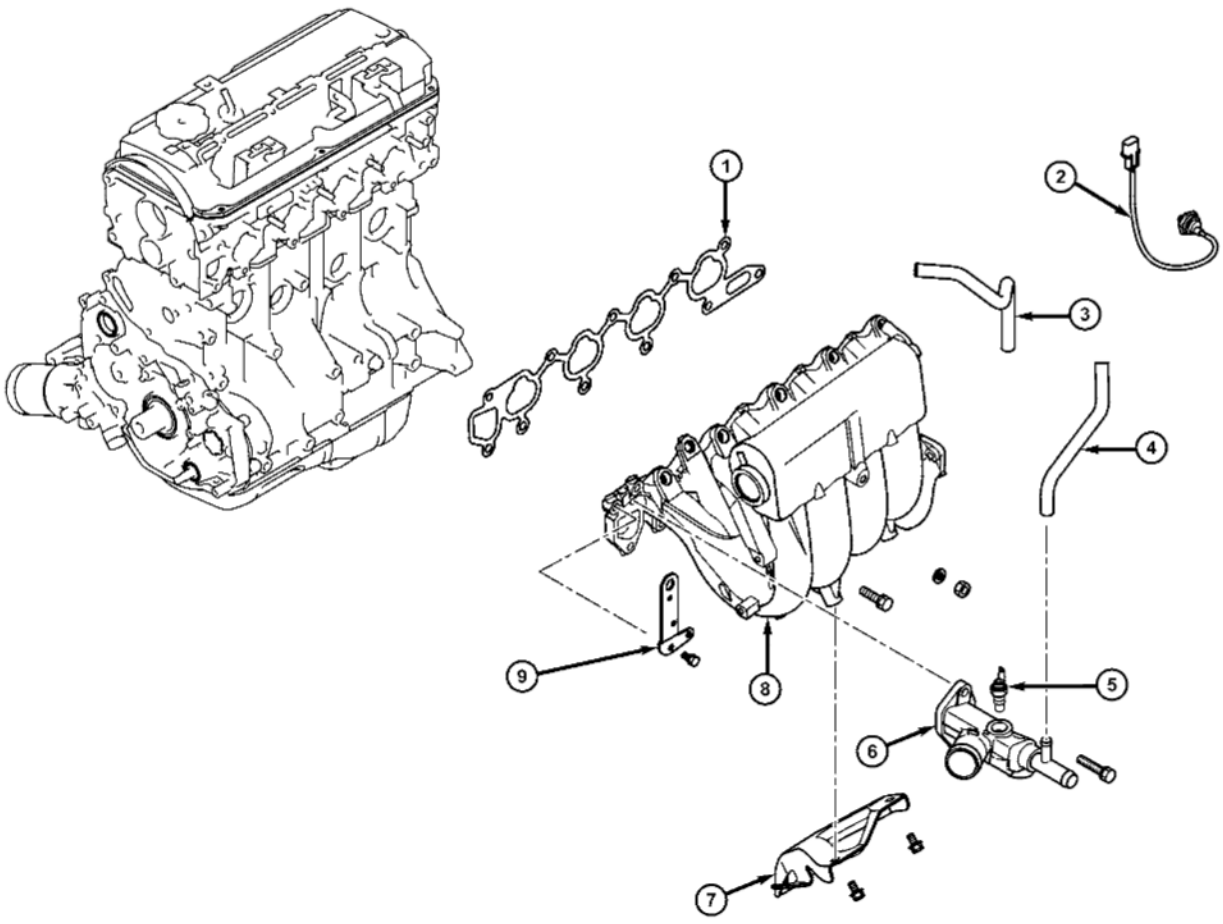
8. Installation is in the reverse order of removal.

Installation Notes:

- Clean all surfaces of manifold and cylinder head.
- Install a new exhaust manifold gasket during installation.

Intake Manifold

Removal & Installation



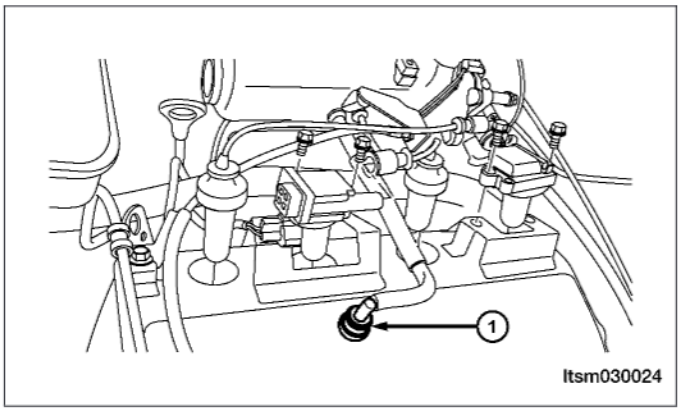
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1 - Inlet Manifold Gasket	6 - Coolant Outlet Fitting
2 - Knock Sensor	7 - Intake Manifold Support Bracket
3 - Coolant Hose	8 - Intake Manifold
4 - Coolant Hose	9 - Engine Hanger
5 - Coolant Temperature Sensor	

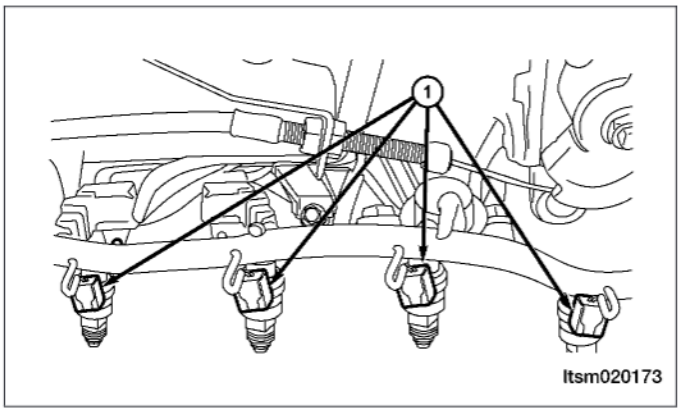
1. Disconnect the negative battery cable.

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2. Remove the accelerator cable retaining bolt from the intake manifold.
   (Tighten: Accelerator cable retaining bolt to 10 N·m)
3. Remove the PCV hose (1).



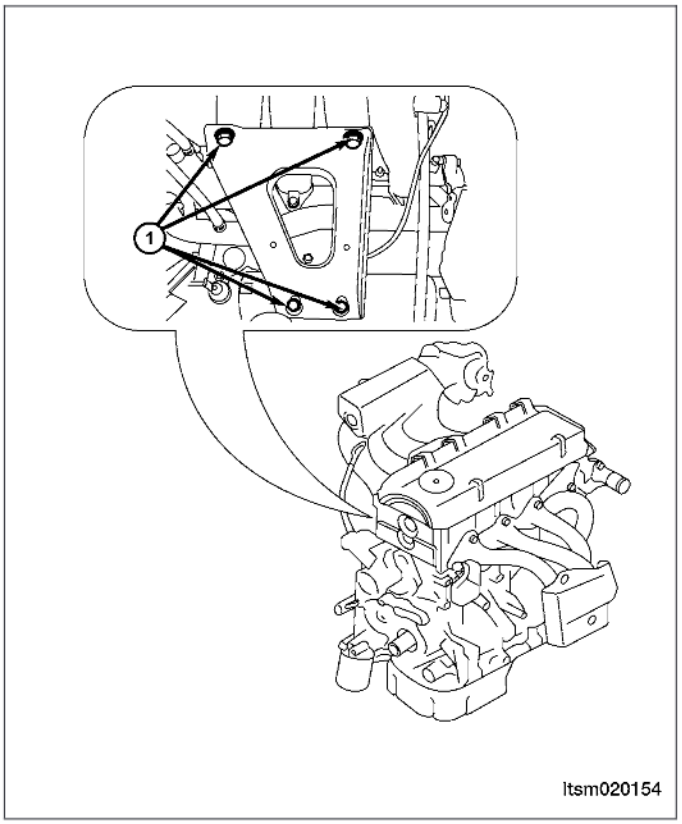
4. Disconnect the four fuel injector electrical connectors (1).



5. Loosen the clamp between the air intake hose and the air cleaner.
6. Loosen the clamp between the air intake hose and the throttle body and then remove the intake pipe.
7. Remove the fuel rail bracket bolts.
   (Tighten: Fuel rail bracket bolts to 11 N·m)
8. Remove the fuel rail with the fuel injectors and set aside.
9. Remove the fuel injector O-rings.
10. Remove the screws securing the vacuum valve bracket to the intake manifold.
11. Set aside the vacuum valve and pipe.
12. Disconnect the intake manifold electrical harness, and vacuum hose.

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13. Remove the intake manifold bracket bolts (1). (Tighten: Intake manifold bracket bolts to 14 ± 1 N·m)



14. Remove the intake manifold retaining nuts. (Tighten: Intake manifold retaining nuts to 49 ± 5 N·m)
15. Remove the intake manifold from the cylinder head.
16. Remove and discard the intake manifold gasket.
17. Installation is in the reverse order of removal.

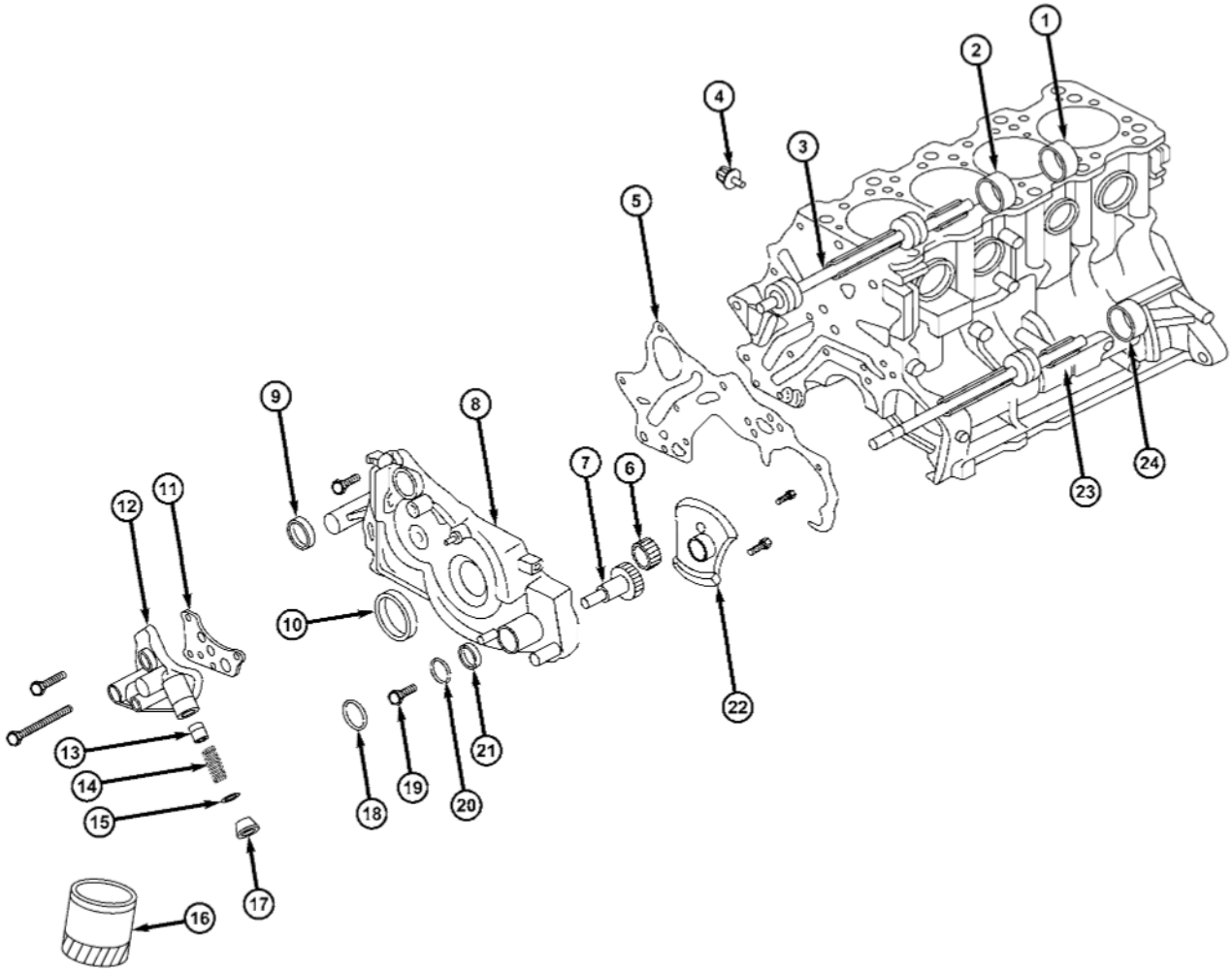
Installation Notes:

- Clean all surfaces of the manifold and cylinder head.
- Install a new intake manifold gasket during installation.
- Install new O-rings on the fuel injectors.

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Upper Balance Shaft

Removal & Installation

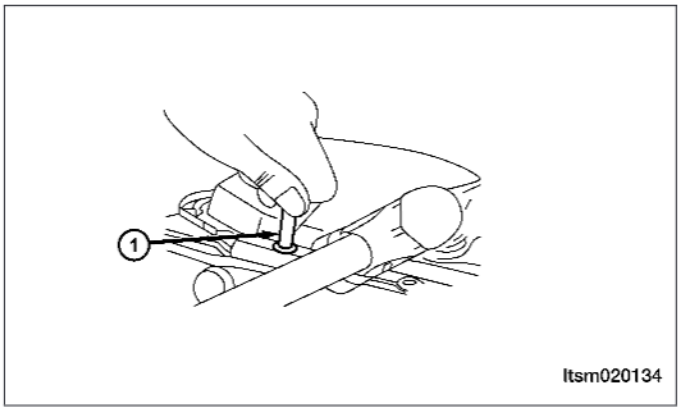


1 - Upper Balance Shaft Rear Bearing	13 - Pressure-Relief Valve
2 - Upper Balance Shaft Front Bearing	14 - Pressure Relief Spring
3 - Upper Balance Shaft	15 - Pressure-Relief Valve Seal
4 - Oil Pressure Switch	16 - Oil Filter
5 - Front Cover Gasket	17 - Pressure Relief Valve Plug
6 - Oil Pump Driven Gear	18 - Plug
7 - Oil Pump Drive Gear	19 - Front Cover Bolt
8 - Front Cover	20 - O-Ring
9 - Upper Balance Shaft Oil Seal	21 - Oil Pump Oil Seal
10 - Crankshaft Front Oil seal	22 - Oil Pump Cover
11 - Oil Filter Adapter Gasket	23 - Lower Balance Shaft
12 - Oil Filter Adapter	24 - Lower Balance Shaft Rear Bearing

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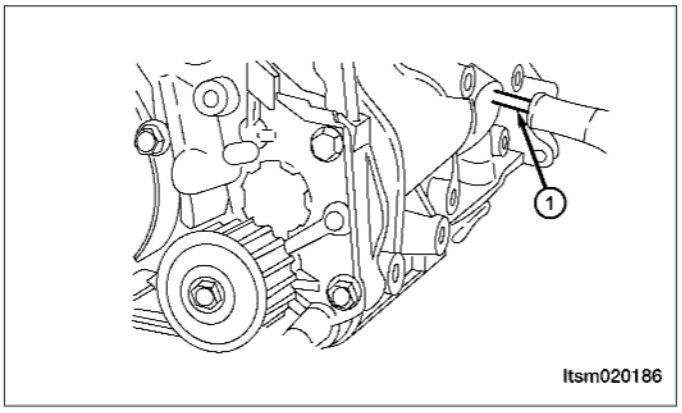
NOTE :
The following special tools are required to perform the repair procedure:
- MB-991603 - Balance Shaft Bearing Puller Limiter
- MD-998162 - Plug Spanner
- MD-998371 - Balance Shaft Bearing Puller
- MD-998372 - Balance Shaft Bearing Puller
- MD-998375 - Crankshaft Front Oil Seal Installer
- MD-998705 - Balance Shaft Bearing Installer
- MD-998727 - Oil Pan Remover
- MD-998783 - Plug Spanner Fixer
- MB-991828 - Oil Filter Wrench
- MB-991396 - Oil Filter Wrench

1. Remove the engine timing belt (See Engine Timing Belt Removal & Installation in Section 02 Engine).
2. Remove the upper balance shaft timing belt (See Upper Balance Shaft Timing Belt Removal & Installation in Section 02 Engine).
3. Raise and support the vehicle.
4. Loosen the oil drain plug and drain the oil.
5. Remove the oil pan retaining bolts.
   (Tighten: Oil pan bolts to 18 N·m)
6. Using special tool MD-998727 (1), remove the oil pan.
   NOTE: Insert the special tool between cylinder block and the oil pan. Do not use a screwdriver or chisel, otherwise the edge of oil pan may be distorted and oil leaks will occur.
7. Remove the oil strainer retaining bolts.
   (Tighten: Oil strainer bolts to 19 N·m)
8. Remove the oil strainer.
9. Remove the oil strainer gasket.



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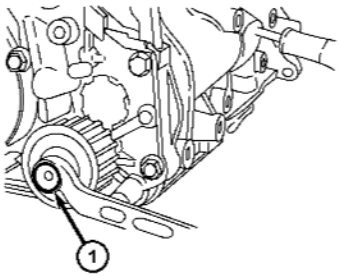
10. Secure the lower balance shaft. Remove the plug from the cylinder block and then insert a holder (1) (8 mm diameter) into the hole.
    NOTE: If the holder can be inserted more than 60 mm, then the timing marks are aligned. If the holder could not be inserted more than 20-25 mm, the lower balance shaft pulley should be rotated one revolution and the timing marks should be then be aligned. Keep the holder installed until the installation of the timing belt is complete.



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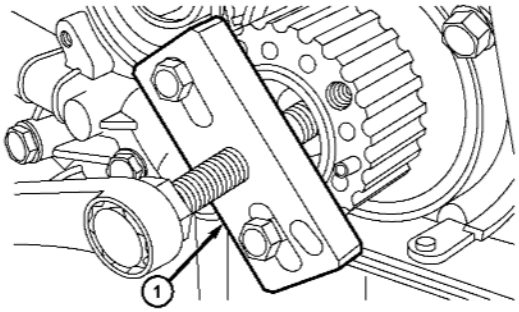
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11. Remove the lower balance shaft bolt (1).
(Tighten: Lower balance shaft bolt to 55 N·m)
12. Remove the lower balance shaft pulley.



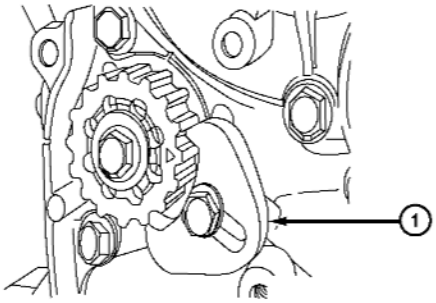
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13. Remove the crankshaft pulley bolt.
(Tighten: Crankshaft pulley bolt to 120 N·m)
14. Using special tool MD-9988778 (1), remove the crankshaft pulley.



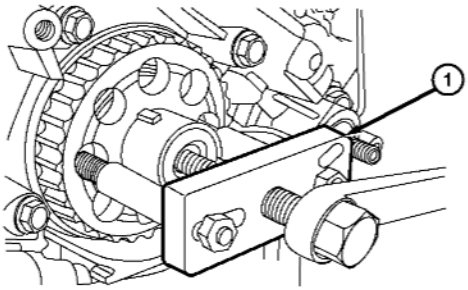
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15. Using special tool MD-9988785 (1), lock the upper balance shaft pulley in place.
16. Remove the upper balance shaft pulley bolt.
(Tighten: Upper balance shaft pulley bolt to 45 N·m)



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17. Using special tool MD-9988778 (1), remove the upper balance shaft pulley.
18. Remove the front cover.
19. Remove the front cover gasket.
20. Remove the upper balance shaft.
21. Remove the upper balance shaft bearings (See Upper Balance Shaft Bearing Replacement in Section 02 Engine).
22. Installation is in the reverse order of removal.



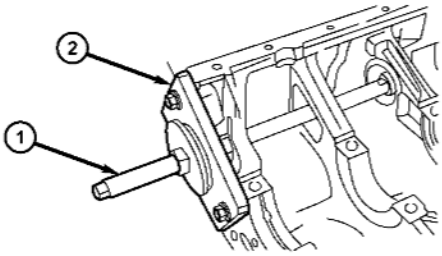
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Upper Balance Shaft Bearing Replacement

1. Using special tool MB-991603 (2) and MD-998372 (1), disassemble the upper balance shaft front and rear bearing from the cylinder block.

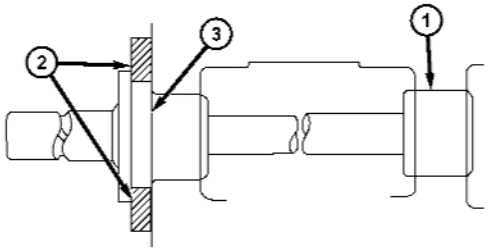
NOTE :
Special tool MB-991603 should be installed on the front of the cylinder block when disassembling the upper balance shaft rear bearing.



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2. Using special tool MB-991603 (2) and MD-998705 (1), install the rear bearing (3).

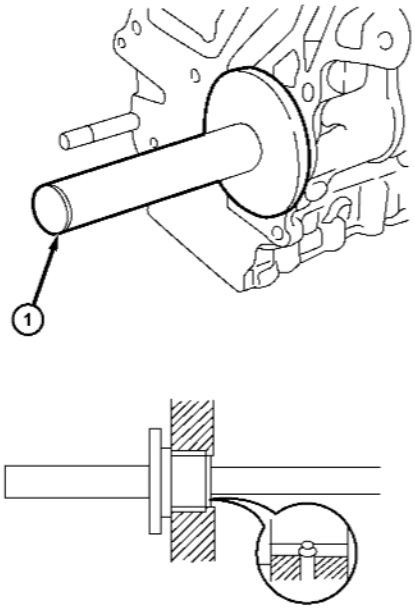
NOTE :
There is NO oil hole in the rear bearing.



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3. Using special tool MD-998705 (1), install the front bearing.

NOTE :
Align the oil holes in the front bearing and the cylinder block.

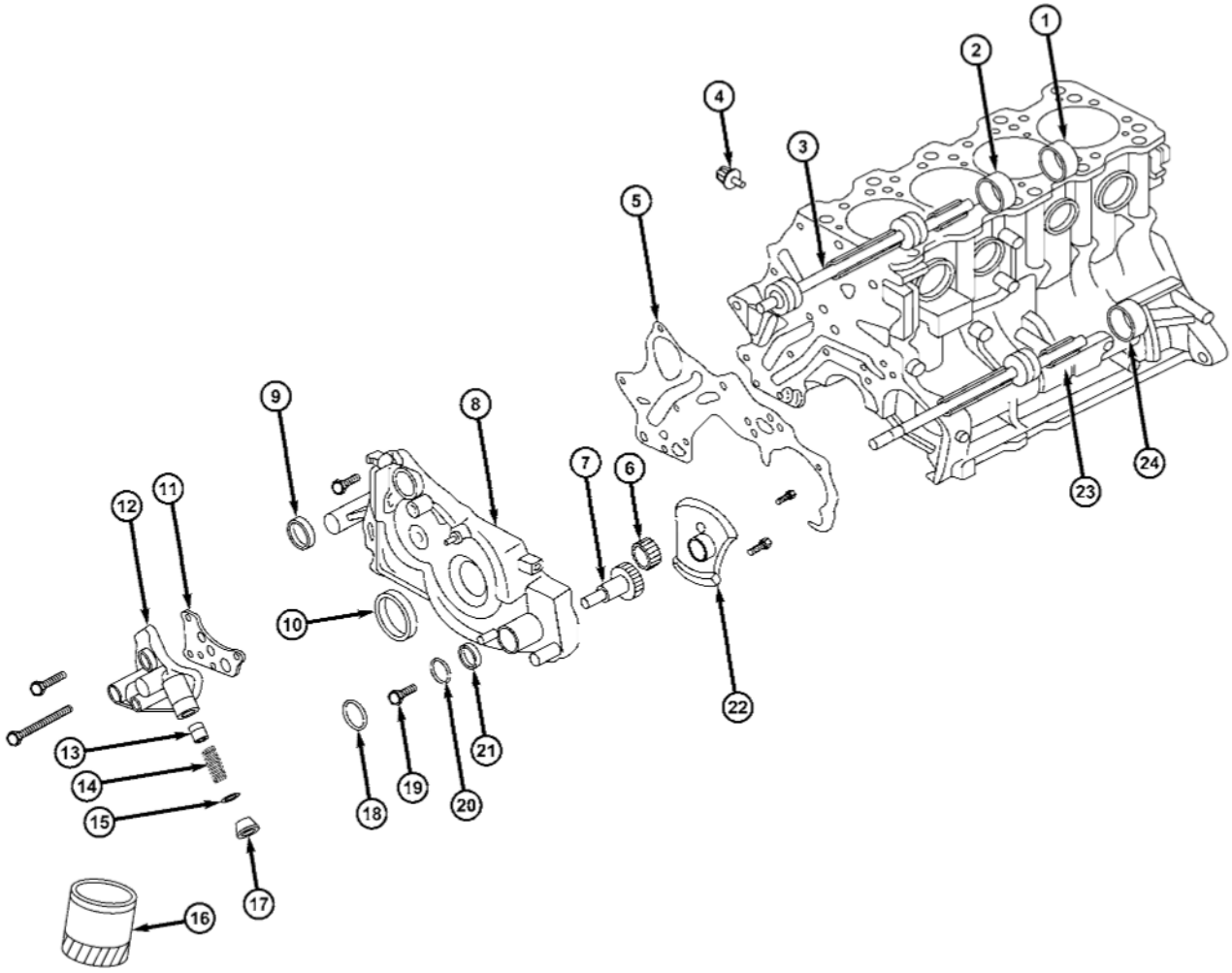


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Lower Balance Shaft

Removal & Installation

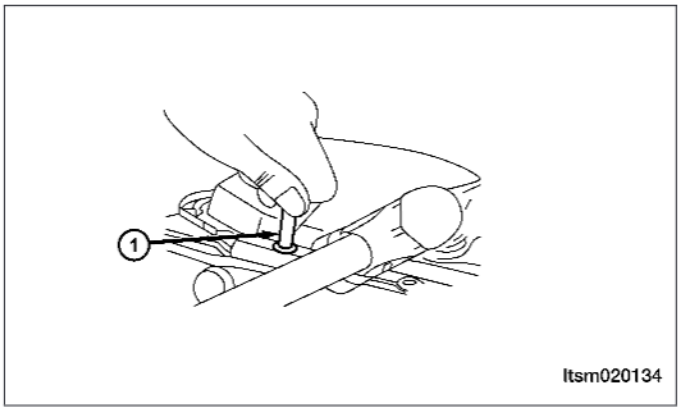


1 - Upper Balance Shaft Rear Bearing	13 - Pressure-Relief Valve
2 - Upper Balance Shaft Front Bearing	14 - Pressure Relief Spring
3 - Upper Balance Shaft	15 - Pressure-Relief Valve Seal
4 - Oil Pressure Switch	16 - Oil Filter
5 - Front Cover Gasket	17 - Pressure Relief Valve Plug
6 - Oil Pump Driven Gear	18 - Plug
7 - Oil Pump Drive Gear	19 - Front Cover Bolt
8 - Front Cover	20 - O-Ring
9 - Upper Balance Shaft Oil Seal	21 - Oil Pump Oil Seal
10 - Crankshaft Front Oil Seal	22 - Oil Pump Cover
11 - Oil Filter Adapter Gasket	23 - Lower Balance Shaft
12 - Oil Filter Adapter	24 - Lower Balance Shaft Rear Bearing

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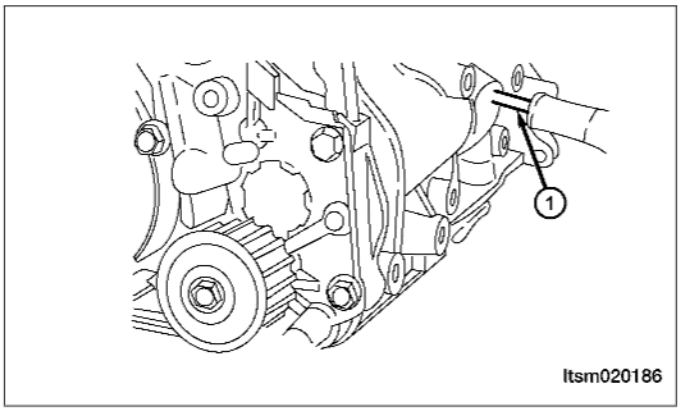
NOTE :
The following special tools are required to perform the repair procedure:
- MD-991603 - Balance Shaft Bearing Puller Limiter
- MD-998162 - Plug Spanner
- MD-998371 - Balance Shaft Bearing Puller
- MD-998372 - Balance Shaft Bearing Puller
- MD-998375 - Crankshaft Front Oil Seal Installer
- MD-998705 - Balance Shaft Bearing Installer
- MD-998727 - Oil Pan Remover
- MD-998783 - Plug Spanner Fixer
- MD-991828 - Oil Filter Wrench
- MD-991396 - Oil Filter Wrench

1. Raise and support the vehicle.
2. Loosen the oil drain plug and drain the oil.
3. Remove the engine timing belt (See Engine Timing Belt Removal & Installation in Section 02 Engine).
4. Remove the upper balance shaft timing belt (See Upper Balance Shaft Timing Belt Removal & Installation in Section 02 Engine).
5. Remove the oil pan retaining bolts.
   (Tighten: Oil pan bolts to 18 N·m)
6. Using special tool MD-998727 (1), remove the oil pan.
   NOTE: Insert the special tool between cylinder block and the oil pan. Do not use a screwdriver or chisel, otherwise the edge of oil pan may be distorted and oil leaks will occur.
7. Remove the oil strainer retaining bolts.
   (Tighten: Oil strainer bolts to 19 N·m)
8. Remove the oil strainer.
9. Remove the oil strainer gasket.



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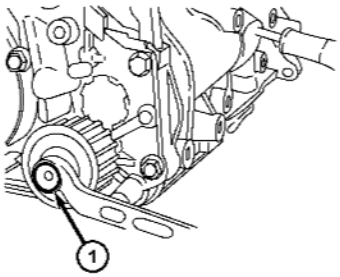
10. Secure the lower balance shaft. Remove the plug from the cylinder block and then insert a holder (1) (8 mm diameter) into the hole.
    NOTE: If the holder can be inserted more than 60 mm, then the timing marks are aligned. If the holder could not be inserted more than 20-25 mm, the lower balance shaft pulley should be rotated one revolution and the timing marks should be then be aligned. Keep the holder installed until the installation of the timing belt is complete.



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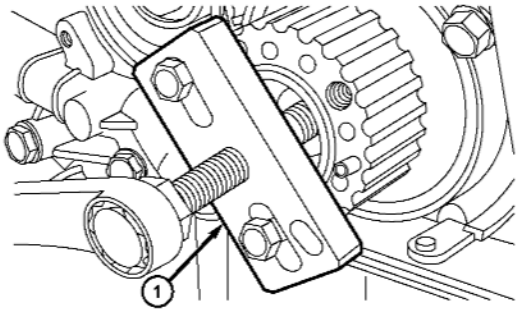
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11. Remove the lower balance shaft bolt (1).
(Tighten: Lower balance shaft bolt to 55 N·m)
12. Remove the lower balance shaft pulley.



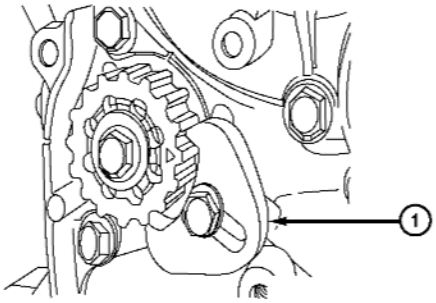
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13. Remove the crankshaft pulley bolt.
(Tighten: Crankshaft pulley bolt to 120 N·m)
14. Using special tool MD-9988778 (1), remove the crankshaft pulley.



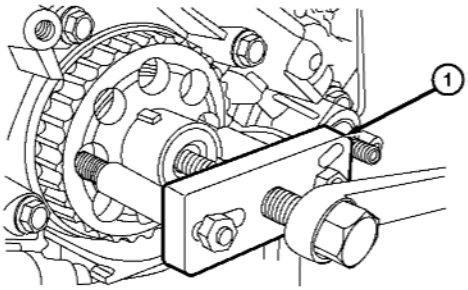
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15. Using special tool MD-9988785 (1), lock the upper balance shaft pulley in place.
16. Remove the upper balance shaft pulley bolt.
(Tighten: Upper balance shaft pulley bolt to 45 N·m)



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17. Using special tool MD-9988778 (1), remove the upper balance shaft pulley.
18. Remove the front cover.
19. Remove the front cover gasket.
20. Remove the lower balance shaft.
21. Remove the lower balance shaft bearings (See Lower Balance Shaft Bearing Replacement in Section 02 Engine).
22. Installation is in the reverse order of removal.

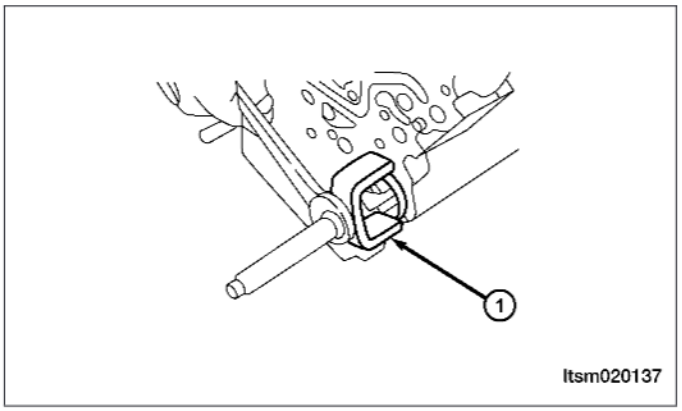


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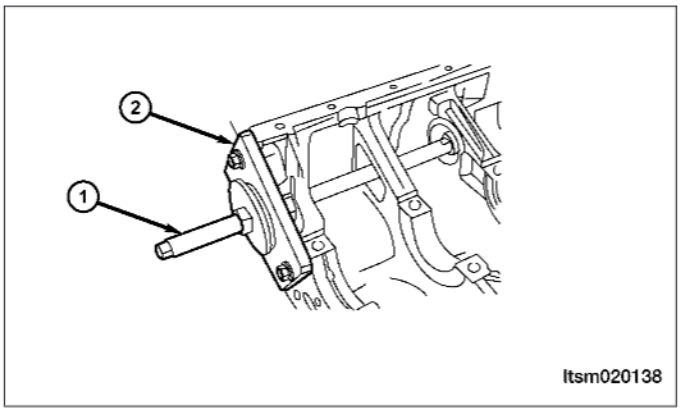
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Lower Balance Shaft Bearing Replacement

1. Using special tool MD-998371 (1), remove the lower balance shaft front bearing from the cylinder block.

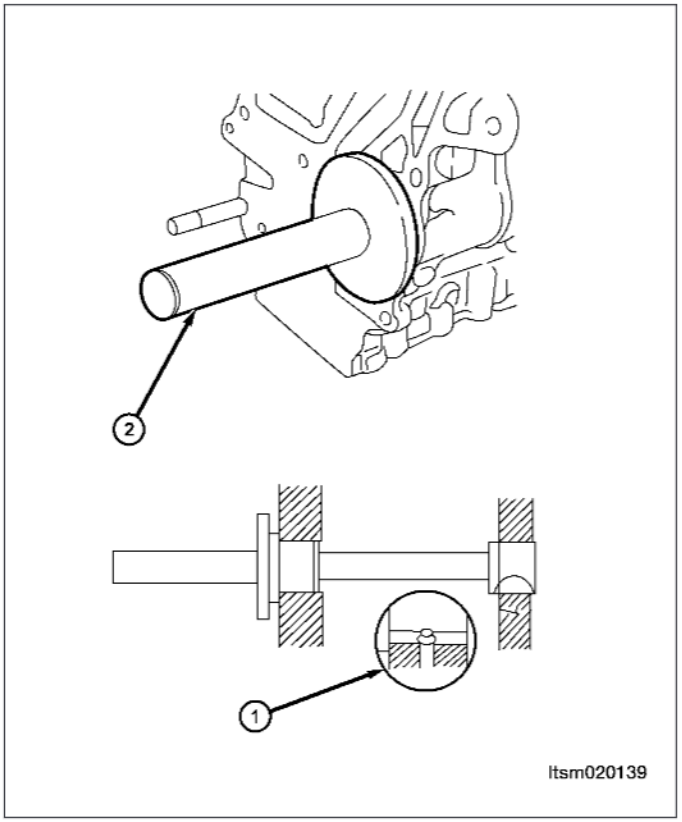


2. Using special tool MD-998705 (1) MD-991603 (2), remove the lower balance shaft rear bearing from the cylinder block.



3. Using special tool MD-998705 (2), install the rear bearing.

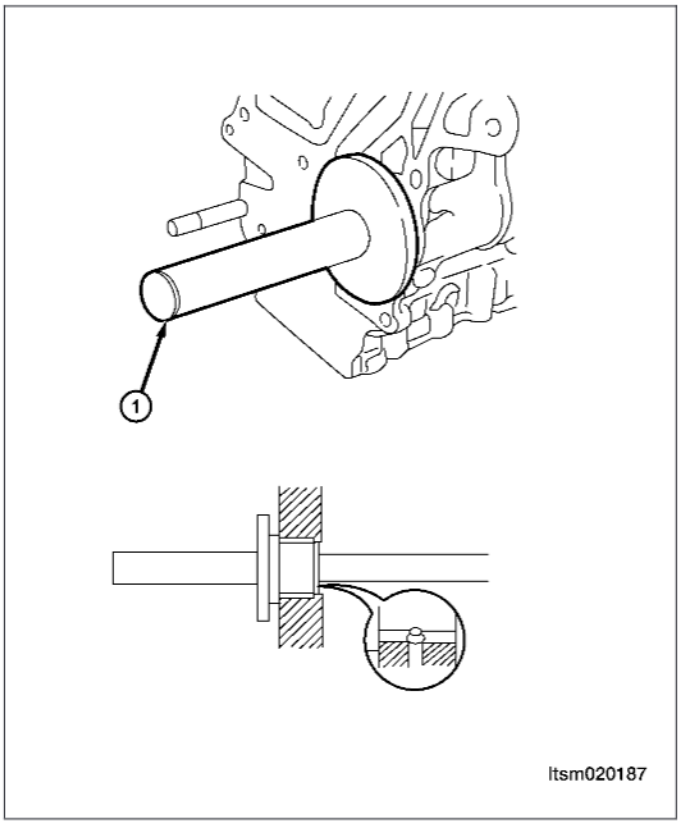
NOTE :
Align the oil holes (1) in the rear bearing and the cylinder block.



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4. Using special tool MD-998705 (1), install the front bearing.

NOTE :
Align the oil holes in the front bearing and the cylinder block.



Oil Filter

Removal & Installation

NOTE :
The following special tools are required to perform the repair procedure:
- MB-991828 - Oil Filter Wrench
- MB-991396 - Oil Filter Wrench

WARNING!

Prolonged and repeated contact with engine oil will harm your skin. If engine oil is spilled on your skin, wash it off immediately with water. In addition, used engine oil contains potentially harmful contaminants which may cause skin cancer. Always use adequate skin protection when performing vehicle service.

CAUTION:
When servicing the oil filter, install the special tool against the base of the filter to avoid deforming the filter.

1. Start the engine and allow it to warm up to normal operating temperature.
2. Stop the engine and remove the engine oil filler cap.
3. Raise and support the vehicle.
4. Remove the oil pan drain plug and drain the oil out of the engine.

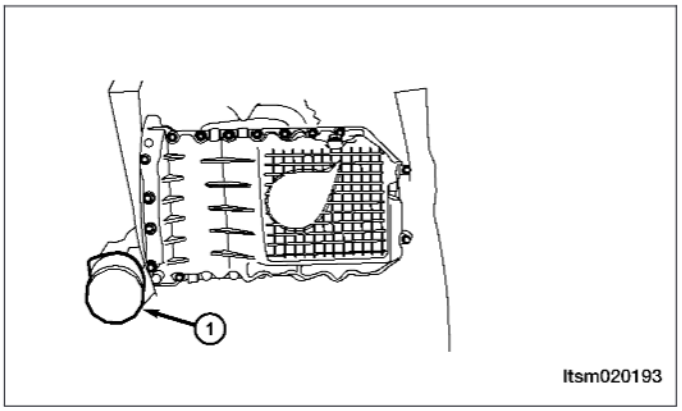
WARNING!

The engine oil is hot and can burn your skin.

5. Remove the under cover.

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6. Using special tool MB-991828 or MB-991396 oil filter wrench, remove the oil filter (1).



CAUTION:
When removing the oil filter, ensure that the oil filter gasket is not stuck to the engine. The oil filter gasket must be removed from the engine before installing the new oil filter.

7. Clean the oil filter bracket side mounting surface.
8. Apply a small amount of engine oil to the O-ring of the new oil filter.
9. Once the O-ring of the oil filter is touching the flange, use special tool MB-991828 or MB-991396 and tighten the oil filter to 16 ± 4 N·m.
10. Install a new drain plug gasket and then install the oil pan drain plug. (Tighten: Oil pan drain plug to 45 N·m)
11. Refill the engine with the specified quantity and grade of engine oil.
12. Install the oil filler cap.
13. Check the engine oil level.

Installation Notes:

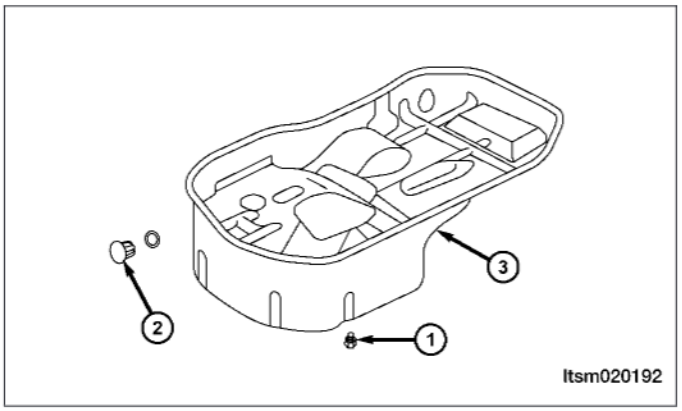
- Clean all surfaces, and verify the oil filter does not leak.

Oil Pan

Removal & Installation

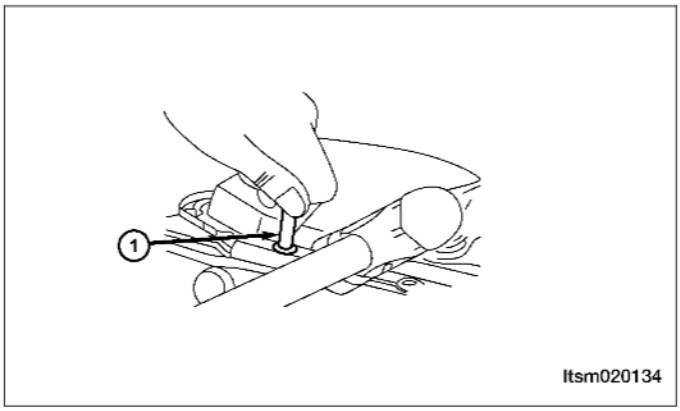
NOTE :
The following special tools are required to perform the repair procedure:
- MD-998727 - Oil Pan Remover

1. Remove the oil dipstick.
2. Raise and support the vehicle.
3. Remove the oil pan drain plug (2) and drain the engine oil.
   (Tighten: Oil pan drain plug to 45 N·m)
4. Remove the oil pan (3) retaining bolts (1).
   (Tighten: Oil pan bolts to 18 N·m)



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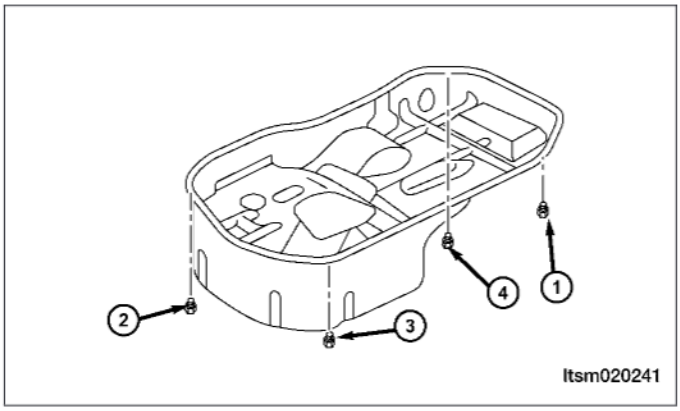
5. Using special tool MD-998727 (1), remove the oil pan.
   NOTE: Insert the special tool between cylinder block and the oil pan. Do not use a screwdriver or chisel, otherwise the edge of oil pan may be distorted and oil leaks will occur.



6. Installation is in the reverse order of removal.

Installation Notes:

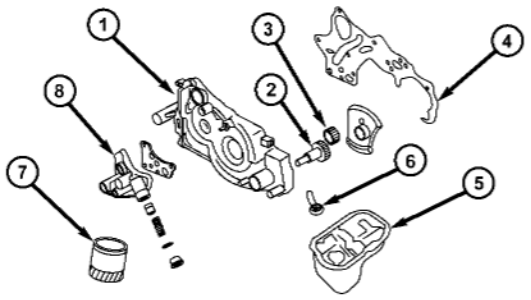
- Oil pan sealing surfaces must be free of grease or oil.
- Install the four oil pan corner bolts in the sequence shown (1-2-3-4).
- Install the remaining oil pan bolts.
- Torque all the oil pan bolts to the proper specification.



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Oil Pump

Removal & Installation



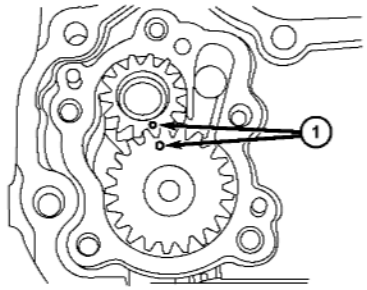
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1 - Engine Front Cover	5 - Oil Pan
2 - Oil Pump Driving Gear	6 - Oil Strainer
3 - Oil Pump Driven Gear	7 - Oil Filter
4 - Oil Pump Rear Cover	8 - Oil Filter Adapter

1. Remove the engine timing belt (See Engine Timing Belt Removal & Installation in Section 02 Engine).
2. Remove the upper balance shaft timing belt (See Upper Balance Shaft Timing Belt Removal & Installation in Section 02 Engine).
3. Remove the oil filter.
4. Remove the oil filter adapter.
   (Tighten: oil filter adapter bolts to 11 N·m)
5. Remove the engine front cover.
6. Remove the oil pump drive gear and the driven gear.
7. Remove the oil pump rear cover.
8. Installation is in the reverse order of removal.

Installation Notes:

- Before installing the new oil pump, prime the oil pump by filling the oil pump with engine oil and rotate the oil pump.
- Align the oil pump timing marks (1).
- Check oil pump side clearance.

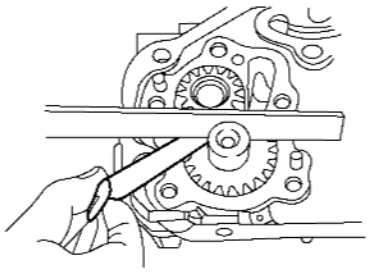


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Oil Pump Clearance Specifications

- Driving Gear: 0.08-0.14 mm
- Driven Gear: 0.06-0.12 mm



Oil Strainer

Removal & Installation

1. Raise and support the vehicle.
2. Remove the oil pan (See Oil Pan Removal & Installation in Section 02 Engine).
3. Remove the oil strainer retaining bolts.
   (Tighten: Oil strainer bolts to 18 N·m)
4. Carefully remove the oil strainer.
5. Installation is in the reverse order of removal.

Installation Notes:

- Install new O-rings on the oil strainer pipe.

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Engine Block

Specifications

Torque Specifications

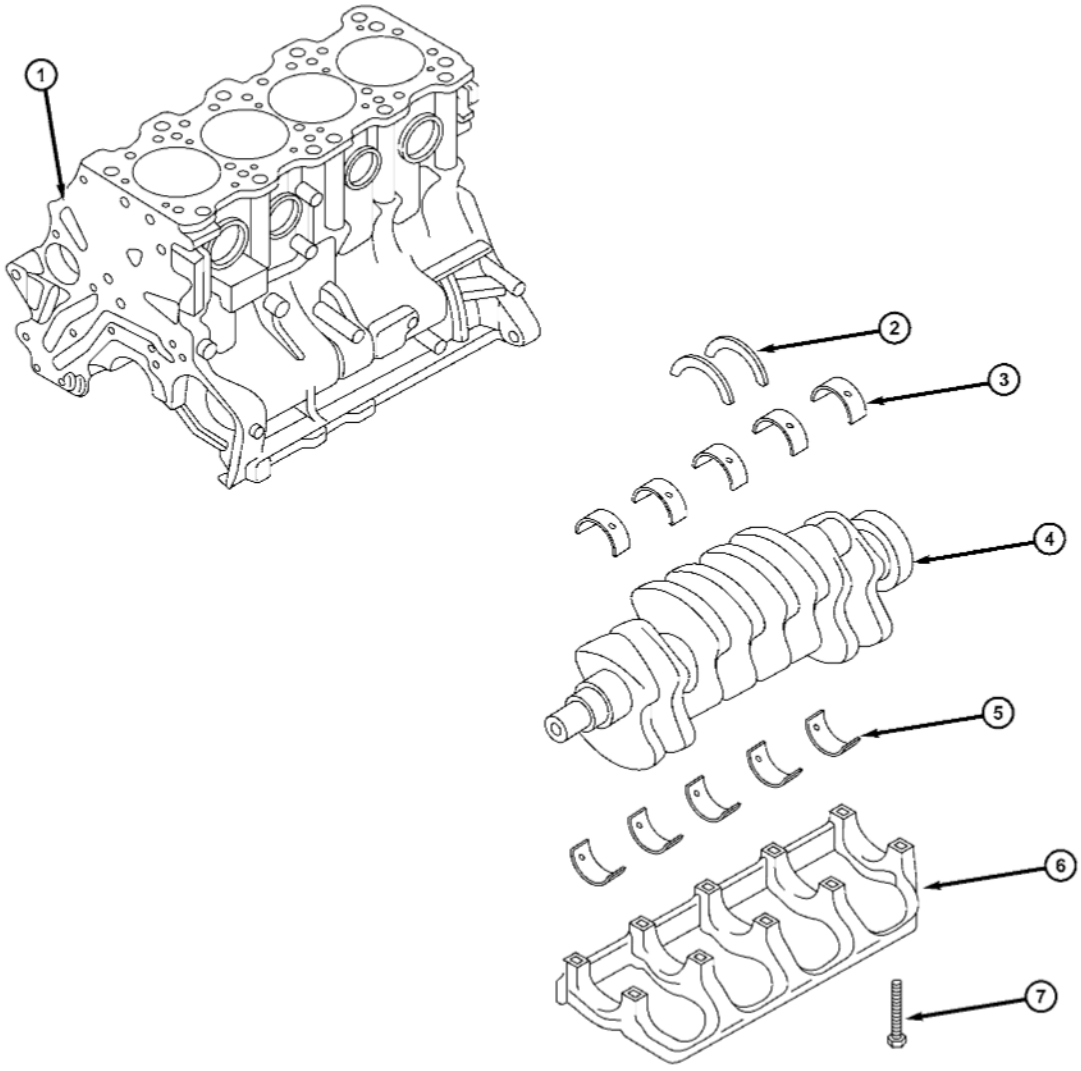
DESCRIPTION	TORQUE (N·m)
Connecting Rod Cap Nuts	1st Step: Tighten the nuts to 20 N·m 2nd Step: Tighten the nuts an additional 90°-100°
Main Bearing Cap Bolts	1st Step: Tighten the bolts to 25 N·m 2nd Step: Tighten the bolts an additional 90°-100°

Clearance Specifications

DESCRIPTION	SPECIFICATION (mm)
Surface Distortion Limit	0.15
Cylinder Diameter Standard	86.50 - 86.53
Out-Of-Round	< 0.008
Taper	< 0.01

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Disassembly



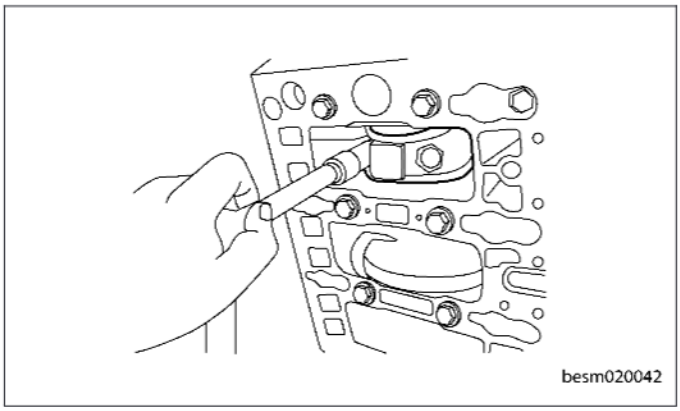
1 - Cylinder Block	5 - Lower Crankshaft Bearing
2 - Crankshaft Thrust Bearing	6 - Bearing Cap
3 - Upper Crankshaft Bearing	7 - Bearing Cap Bolt
4 - Crankshaft	

1. Remove the oil pan.
2. Remove the oil strainer.
3. For each connecting rod/piston assembly to be removed, rotate the crankshaft to the bottom dead center position for each cylinder.

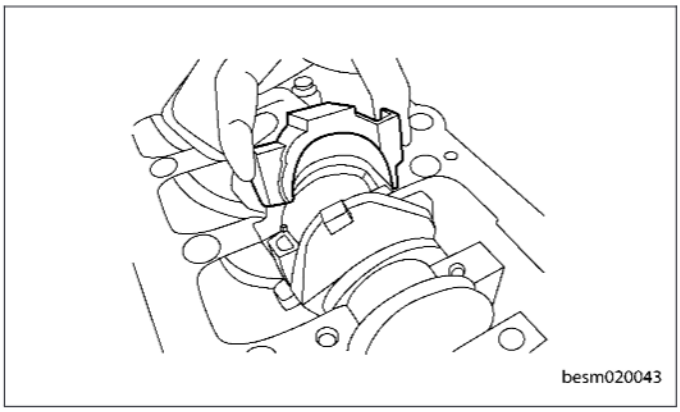
NOTE :
Before removing the connecting rod/piston assembly, check the connecting rod side clearance.

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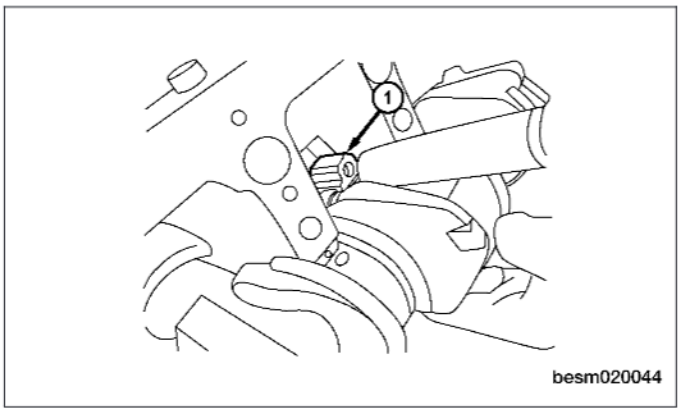
4. Remove the connecting rod retaining bolts.


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5. Remove the connecting rod bearing cap.

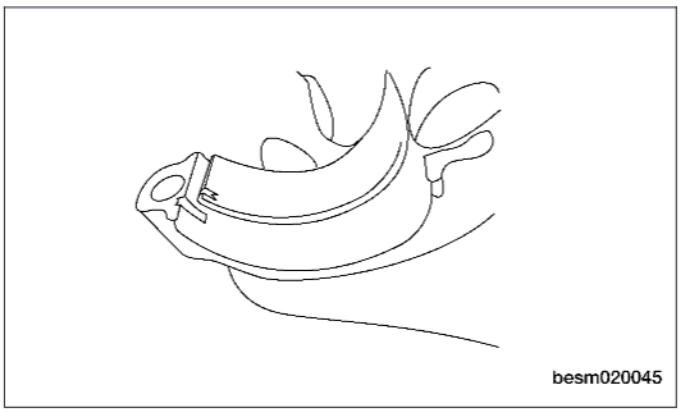

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6. Using a hammer handle or similar tool, push the connecting rod/piston assembly (1) out through the top of the cylinder block.



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7. Remove the connecting rod bearings (See Connecting Rod Removal & Installation in Section 02 Engine).
CAUTION: When removing the connecting rod side bearings, note the installation position. Keep them in the correct order.


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8. Installation is in the reverse order of removal.

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Inspection

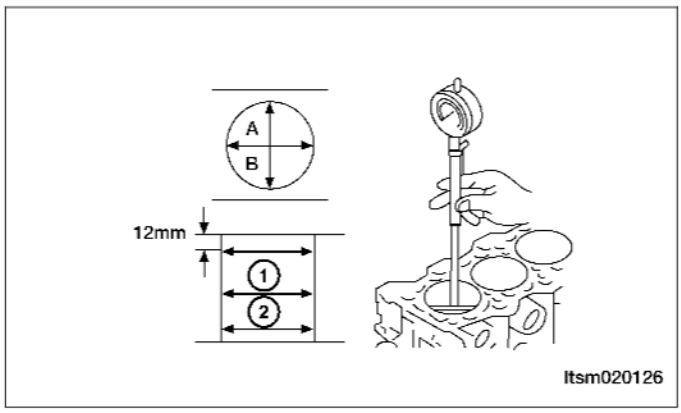
NOTE :
All measurements should be taken with the engine block at room temperature, 21°C.

Engine Block

- Clean cylinder block thoroughly and check all core hole plugs for evidence of leaking.
- Examine block and cylinder bores for cracks or fractures.
- Check block deck surfaces for flatness. Deck surface must be within service limit of 0.050 mm.

Cylinder Bore

- The cylinder walls should be checked for out-of-round and taper with cylinder indicator or equivalent. If the cylinder walls are badly scuffed or scored, the cylinder block should be replaced, and new pistons and rings fitted.
- Measure the cylinder bore at three levels in directions A and B. Top measurement should be 12 mm down and bottom measurement should be 12 mm up from bottom of bore.



CYLINDER BORE	
Cylinder Size	86.50 - 86.53 mm
Cylinder Cylindrically	≤ 0.01 mm

Assembly

NOTE :
Cleanliness is extremely important during the engine assembly procedure. Any foreign material, including any material created while cleaning gasket surfaces, that enters the oil passages, coolant passages or the oil pan can cause engine failure.

NOTE :
Assemble all components in their original position.

1. Install the pistons to the connecting rods.
2. Using a piston ring expander, install the piston rings.
3. Assemble all components in the reverse order of disassembly.

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Pistons

Specifications

Clearance Specifications - Pistons

DESCRIPTION	SPECIFICATION (mm)
Surface Distortion Limit	0.15
Out-Of-Round	< 0.008
Taper	< 0.01

Clearance Specifications - Piston Ring Groove

DESCRIPTION	SPECIFICATION	LIMIT
First Ring	0.02 - 0.06 mm	0.1 mm
Second Ring	0.02 - 0.06 mm	0.1 mm

Clearance Specifications - Piston Ring End Gap

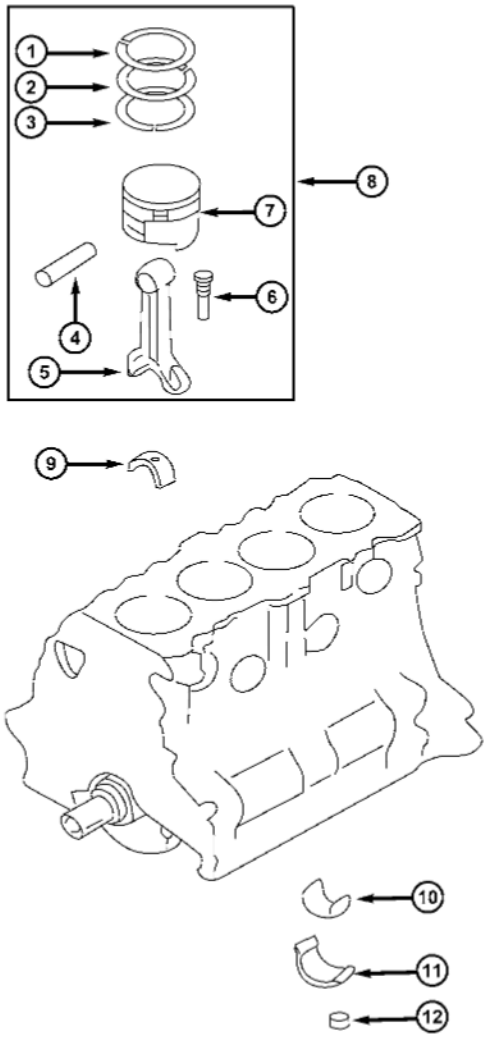
DESCRIPTION	SPECIFICATION	LIMIT
First Ring	0.25 - 0.35 mm	0.8 mm
Second Ring	0.40 - 0.55 mm	0.8 mm
Oil Control Ring	0.10 - 0.40 mm	1.0 mm

Clearance Specifications - Piston to Piston Pin

DESCRIPTION	SPECIFICATION (mm)
Piston To Piston Pin	0.002 - 0.013

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Disassembly



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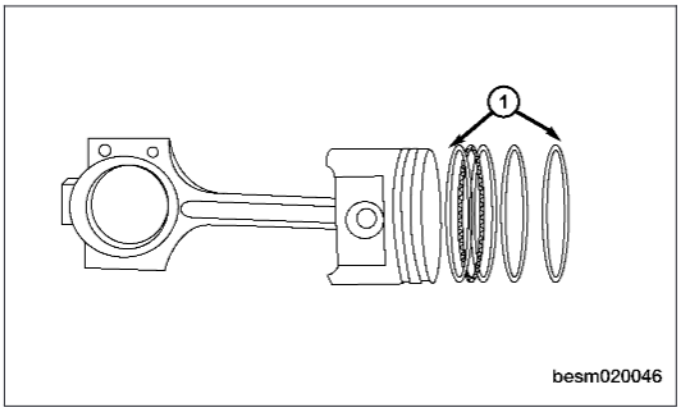
1 - No. 1 Compression Ring	7 - Piston
2 - No. 2 Compression Ring	8 - Piston and Connecting Rod Assembly
3 - Oil Control Ring	9 - Upper Connecting Rod Bearing
4 - Piston Pin	10 - Lower Connecting Rod Bearing
5 - Connecting Rod	11 - Connecting Rod Cap
6 - Connecting Rod Bolt	12 - Connecting Rod Nut

Piston Ring Removal

- Using a suitable ring expander, remove upper and intermediate piston rings.
- Remove the upper oil ring side rail, lower oil ring side rail and then oil ring expander from piston.
- Clean ring grooves of any carbon deposits.

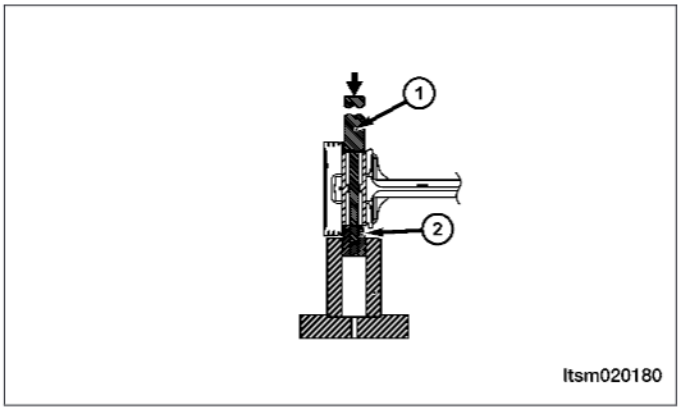
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CAUTION:
Before removing the piston rings (1), check the piston ring side clearance. Be careful to mark the location of the piston rings if they are to be reused.



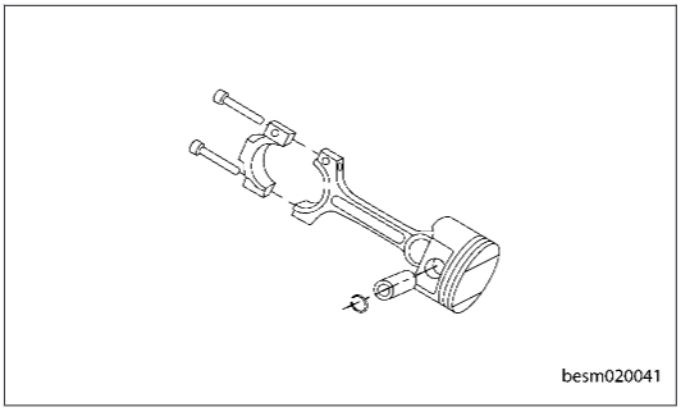
Piston Pin Removal

- Using special tool MD-998780 (1) & (2), remove the piston pin for the pistons.
- Insert the tool push rod into the piston from the notched side.
- Attach the tool guide into the piston and to the push rod.



Connecting Rod & Piston Disassembly

- Connecting Rod & Piston Disassembly.
  - − Remove the piston from the connecting rod.

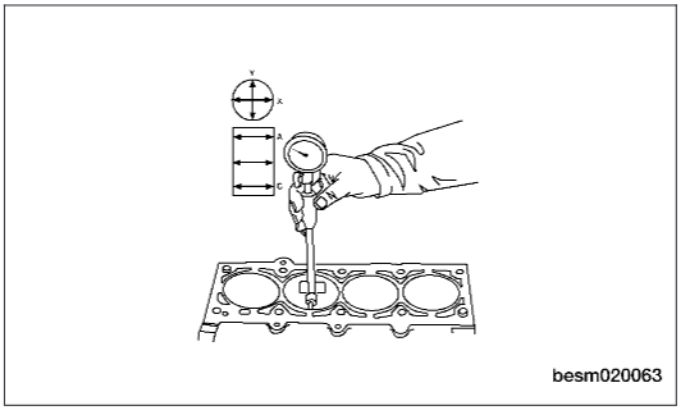


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Inspection

Cylinder Bore

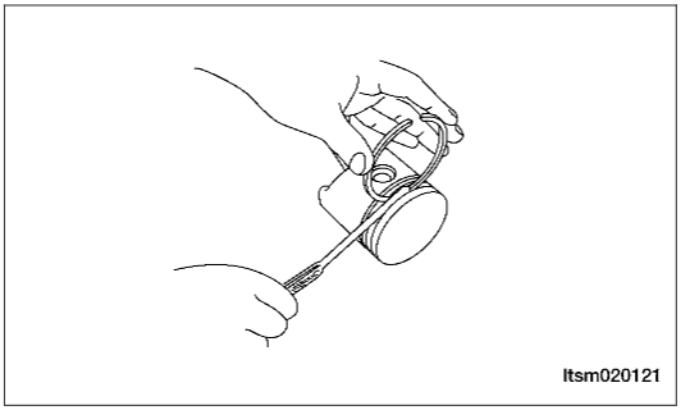
- Check the inner diameter of each cylinder bore (See Cylinder Bore Inspection in Section 02 Engine).



CYLINDER BORE	
All Cylinders	86.50 - 86.53 mm

Ring Groove Side Clearance

- Check piston ring to groove side clearance.
  - Clean the ring slot using a suitable tool.
  - Measure piston ring to groove side clearance.

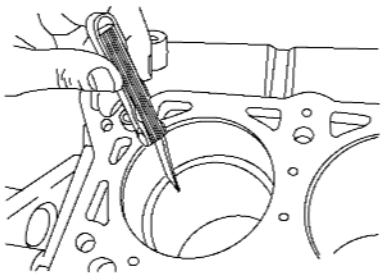


RING GROOVE SIDE CLEARANCE		
DESCRIPTION	SPECIFICATION	LIMIT
First Ring	0.02 - 0.06 mm	0.1 mm
Second Ring	0.02 - 0.06 mm	0.1 mm

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Ring End Gap

- Wipe the cylinder bore clean. Insert ring and push down with piston to ensure it is square in the bore. The ring gap measurement must be made with the ring positioned at least 13 mm from bottom of cylinder bore and below the bottom of the oil ring travel where the cylinder bore has minimal wear. Check gap with feeler gauge.

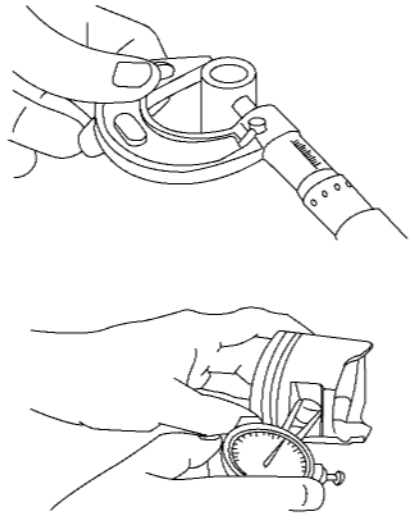


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RING END GAP		
DESCRIPTION	**SPECIFICATION**	**LIMIT**
First Ring	0.25 - 0.35 mm	0.8 mm
Second Ring	0.40 - 0.55 mm	0.8 mm
Oil Control Ring	0.10 - 0.40 mm	1.0 mm

Piston Pin Clearance

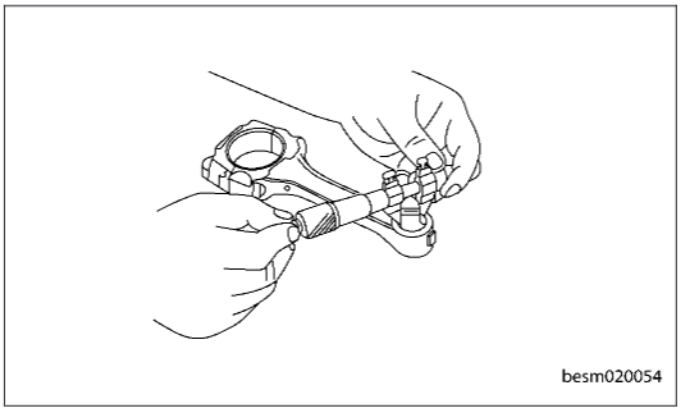
- Check the diameter of the piston pin bore.
- Check the outer diameter of the piston pin.



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- Check the inner diameter of connecting rod (small end).

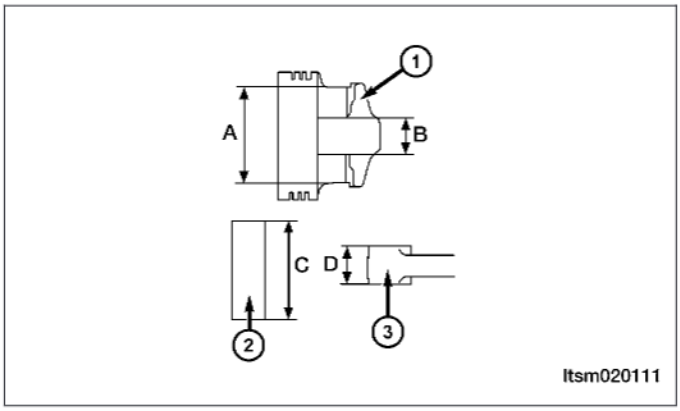


PISTON PIN CLEARANCE	
Piston and Piston Pin	0.002 - 0.013 mm

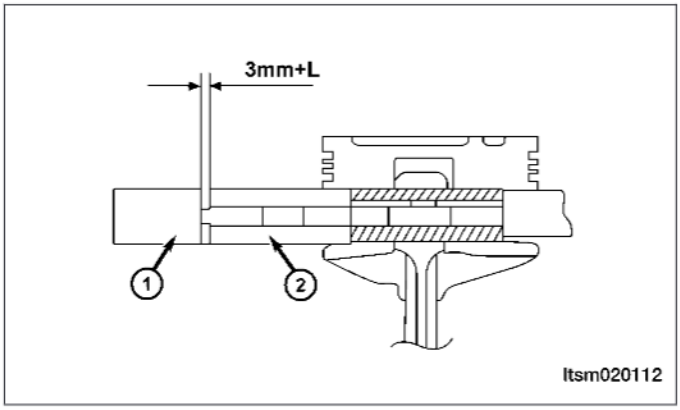
Assembly

Piston Pin Installation

- Measure the following dimensions of each piston (1), piston pin (2) and connecting rod (3).
  - Length of piston pin in hole (A).
  - Width of pin sockets (B).
  - Length of piston pin (C).
  - Width of small end of connecting rod (D).
- Put measured sizes above into following formula to calculate L.
  - L=[(A-C)-(B-D)] / 2



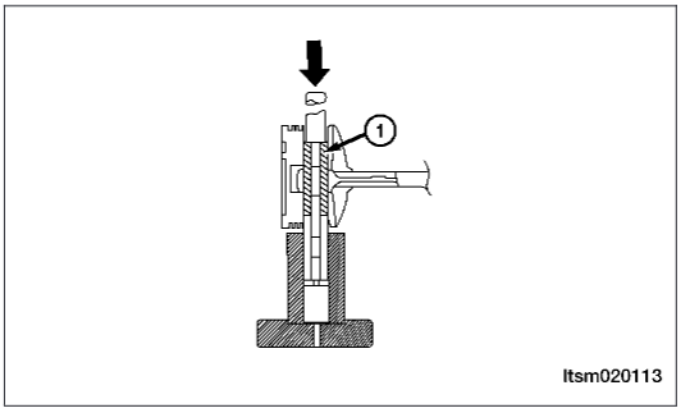
- After inserting the push rod of the special tool into piston pin, install pipe A in the top of the push rod.
- Install forward marks of piston and connecting rod in the same direction.
- Lubricate the external diameter of piston pin with engine oil.
- Through pipe A, insert the push rod, piston pin and pipe component into piston pin hole from the side with the forward mark.
- Screw on guide block B into guide pipe A to gain clearance between guide block A (2) and guide block B (1) equal to the value of Value L (L=[(A-C)-(B-D)] / 2) plus 3 mm.



- Keep the forward mark of piston upward. Install piston and connecting rod in tool base of piston pin installer.

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- Using a press, press the piston pin (1) in under pressure. When the pressure is less than standard value, replace piston pin and piston component and/or replace connecting rod.standard value: 7,350-17,200 Newtons



- Check to make sure the piston can rotate freely.

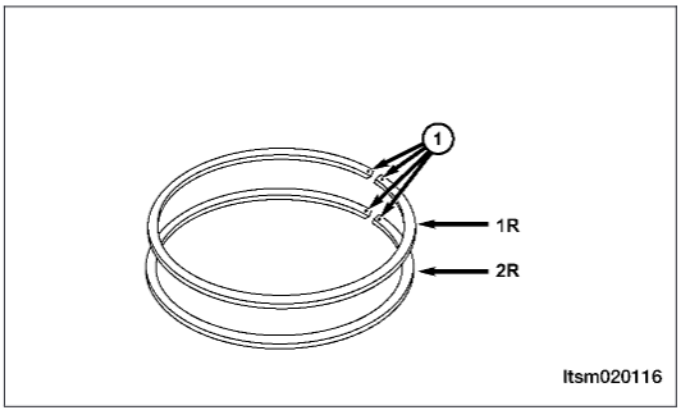
Piston Ring Installation

NOTE :
The compression rings have an identification mark (1) on the top of the ring.

Piston Ring Identification Marks:

- No. 1 Ring - 1R
- No. 2 Ring - 2R

When installing piston ring, keep the mark upwards and towards the top of piston.



- Size markings of pistons shown as the following:

SIZE	IDENTIFICATION
Standard	None
Increase 0.50 mm	50
Increase 1.00 mm	100

CAUTION:
Do not use a piston ring expander to install the oil control rings.

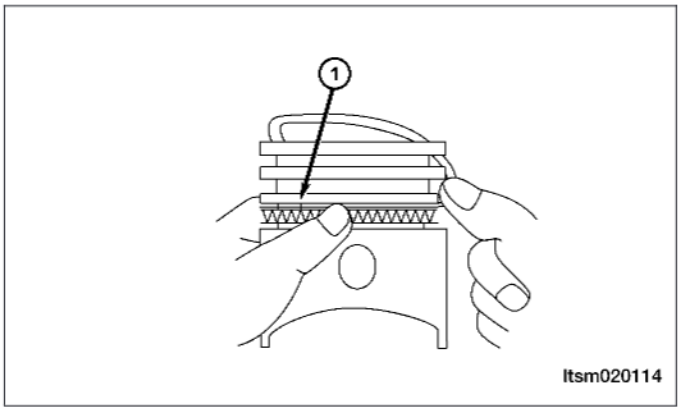
Oil Control Ring Installation

- Install the main ring of oil control ring into oil ring groove.

NOTE :
There is no difference between the upper and lower oil control rings.

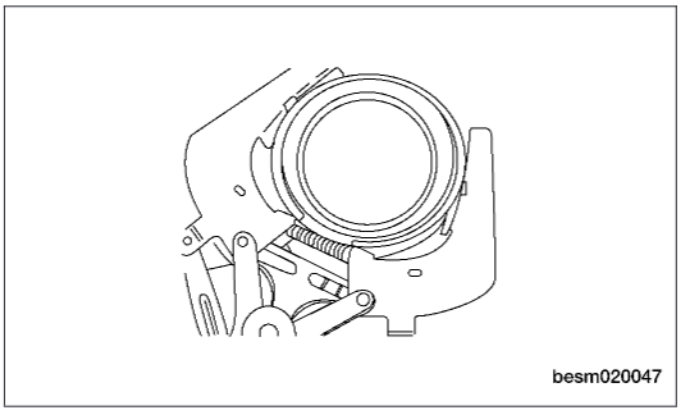
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- Install the bottom oil control ring (1). When installing the ring, force one side of the piston ring into the piston oil ring groove. Then force the ring into oil ring groove with the thumb as shown.
- Install the top oil control ring. When installing the ring, force one side of the piston ring into the piston oil ring groove. Then force the ring into oil ring groove with the thumb as shown.
- Ensure the ring can turn from the left to the right freely after installation.



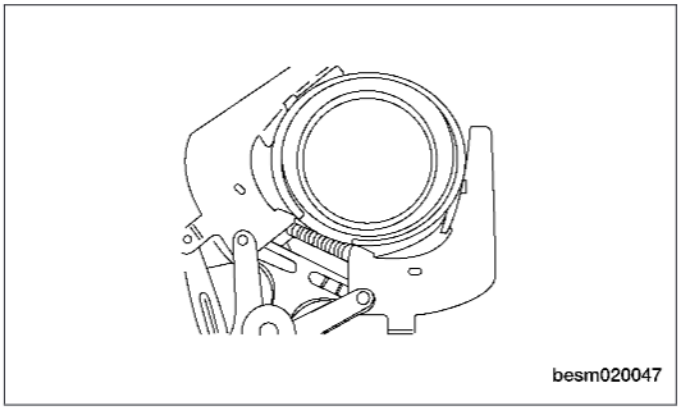
Bottom Compression Ring Installation (2nd Ring)

- Using a piston ring expander, install the bottom compression ring.
- Ensure the ring can turn from the left to the right freely after installation.



Top Compression Ring Installation (1st Ring)

- Using a piston ring expander, install the top compression ring.
- Ensure the ring can turn from the left to the right freely after installation.



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Connecting Rods

Specifications

Torque Specifications

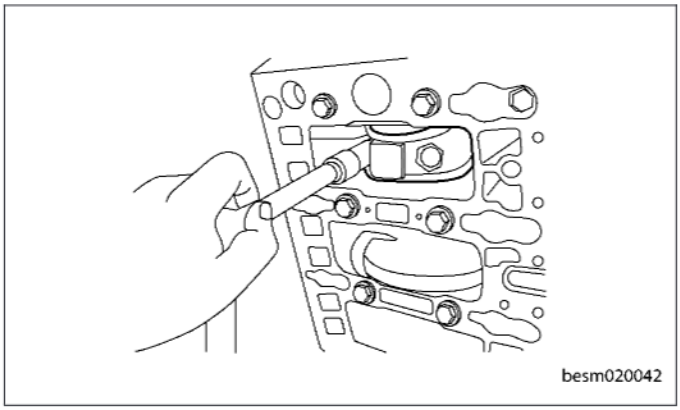
DESCRIPTION	TORQUE (N·m)
Connecting Rod Nuts	1st Step: Tighten the nuts to 20 N·m 2nd Step: Tighten the nuts an additional 90°-100°

Clearance Specifications

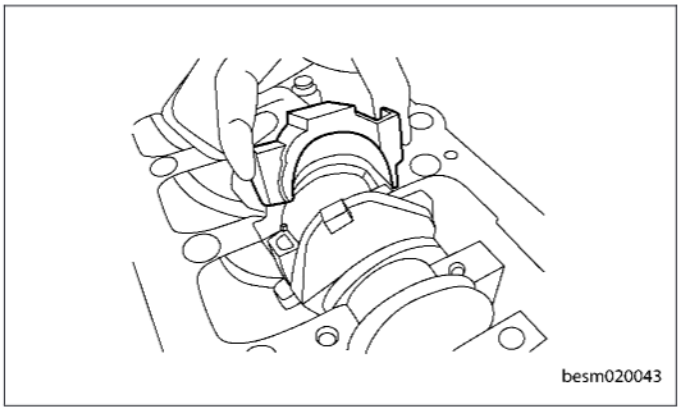
DESCRIPTION	SPECIFICATION (mm)
Connecting Rod Radial Clearance	0.016 - 0.051
Connecting Rod Axial Clearance	0.002 - 0.013

Disassembly

1. Remove the connecting rod cap nuts.

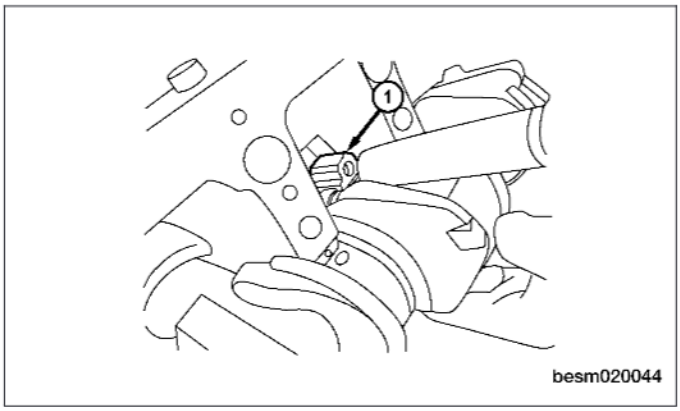


2. Remove the connecting rod bearing cap.



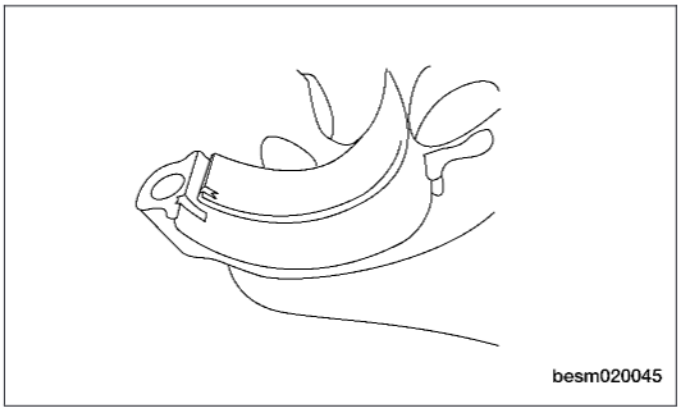
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3. Using a hammer handle or similar tool, push the piston and connecting rod assembly (1) out through the cylinder head side of the engine block.
   NOTE: Before removing the piston and connecting rod assembly, check the connecting rod side clearance.



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4. Remove the connecting rod bearings.
   CAUTION: When removing the connecting rod side bearings, note the installation position. Keep them in the correct order.


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Inspection

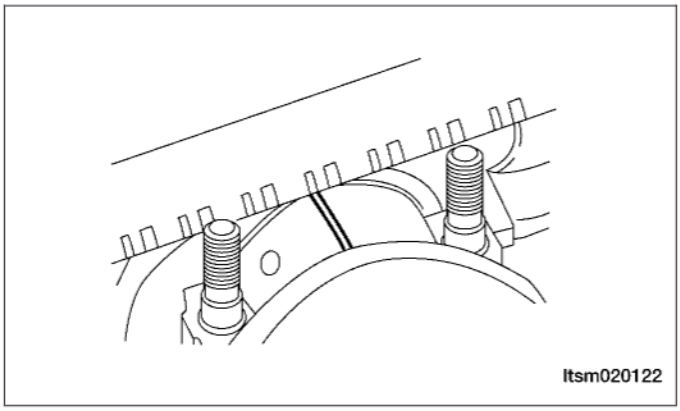
Bearing Radial Clearance

- Check the radial clearance of connecting rod bearing.

CONNECTING ROD RADIAL CLEARANCE	
Radial Clearance	0.016 - 0.051 mm

Bearing Oil Clearance (Plastigauge)

- Check the oil clearance of the connecting rods and crankshaft.
  - Clean all engine oil off of the connecting rod bearing and the crankshaft journal.
  - Cut the plastigauge into lengths as wide as the crankshaft journal.
  - Lay the plastigauge across the crankshaft journal.
  - Carefully install the connecting rod cap.
  - Torque the connecting rod cap nuts to 20 N·m
  - Carefully disassemble the connecting rod cap.
  - Use the measuring rule imprinted on the plastigauge package to measure the width of the widest part of the plastigauge.


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CONNECTING ROD BEARING OIL CLEARANCE	
Standard Clearance	0.02 - 0.05 mm
Maximum Clearance	0.1 mm

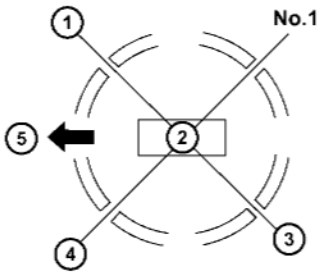
Assembly

NOTE :

- The connecting rod bolts should NOT be reused.
- Before installing the NEW rod bolts, apply clean engine oil to the threads and under the bolt heads.

Piston and Connecting Rod

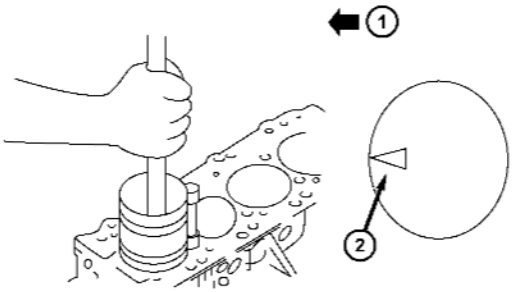
- Oil the piston rings and the side of the piston.
- Position the piston rings in the proper alignment with the piston pin (2):
  - Top Ring (1)
  - Bottom Ring (3)
  - Oil Control Ring (4)
- Install protective coverings over the connecting rod bolts.
- Rotate the crankshaft journal to the lowest position.
- Use a suitable piston ring compressor to insert the piston and connecting rod assembly into cylinder.
- Make sure the forward mark on the top of the piston is facing the front of the engine (5).



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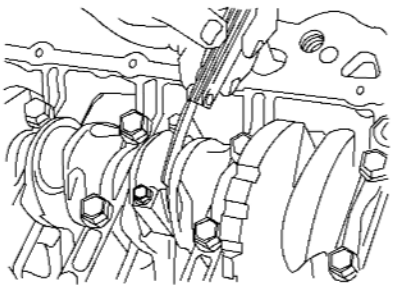
- Using a suitable tool, tap the piston and connecting rod assembly into cylinder.

NOTE :
The piston direction mark (2) should point toward the timing belt side (1).



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- Check the axial clearance of the connecting rods.

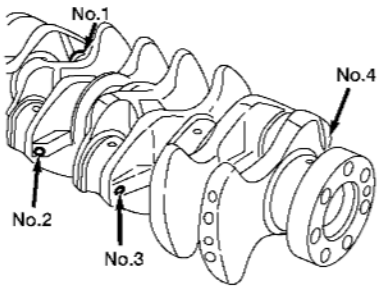

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CONNECTING ROD AXIAL CLEARANCE		
DESCRIPTION	SPECIFICATION	LIMIT
Connecting Rods	0.10 - 0.25 mm	0.4 mm

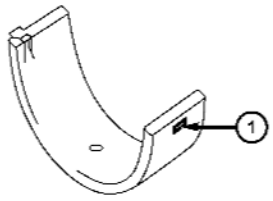
Connecting Rod Bearings

- Perform the following steps when replacing the connecting rod bearings:
  - Measure and record the External Diameter of the connecting rod journals.
  - Use the connecting rod bearing identification table to locate the desired bearing.



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- The bearing will have an identification mark (1) imprinted in the position as shown.



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IDENTIFYING CONNECTING ROD BEARINGS					
Internal Diameter of Connecting Rods (without bearing): 48.000 - 48.015 mm					
Crank Journal			Connecting Rod Bearing		
Group	Identification Color	External Diameter (mm)	Identification Number	Identification Color	Thickness (mm)
1	Yellow	44.995 - 45.000	1	Yellow	1.487 - 1.491
2	None	44.985 - 44.995	2	None	1.491 - 1.495
3	White	44.980 - 44.985	3	Blue	1.495 - 1.499

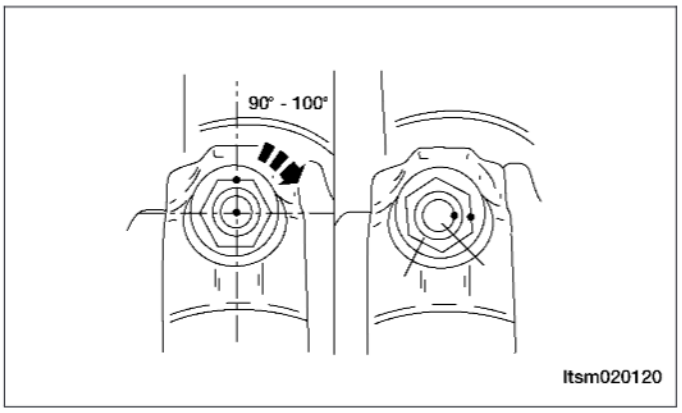
NOTE :
As an example, if the measurement of the external diameter of the connecting rod journal is 44.996 mm, it will be identified as Group 1 in the table. If the crankshaft has been replaced, check the identification color applied to the new crankshaft journal. If the journal is yellow, the crankshaft bearing will be from Group 1, and the connecting rod bearing will be identified as 1.

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Connecting Rod Cap Nuts

- Apply engine oil to the connecting rod bolts.
- Install each connecting rod nut finger tight, then alternately tighten each nut to assemble the cap properly.
- Tighten the connecting rod nuts using the two step torque-turn method:
  - 1st Step: Tighten nuts to 20 N·m
  - 2nd Step: Tighten the connecting rod nuts an additional 90°- 100°

CAUTION:
If the nuts are over tightened (exceed angle of 100°), loosen the nuts and restart the torque sequence from Step 1.



Crankshaft

Specifications

Torque Specifications

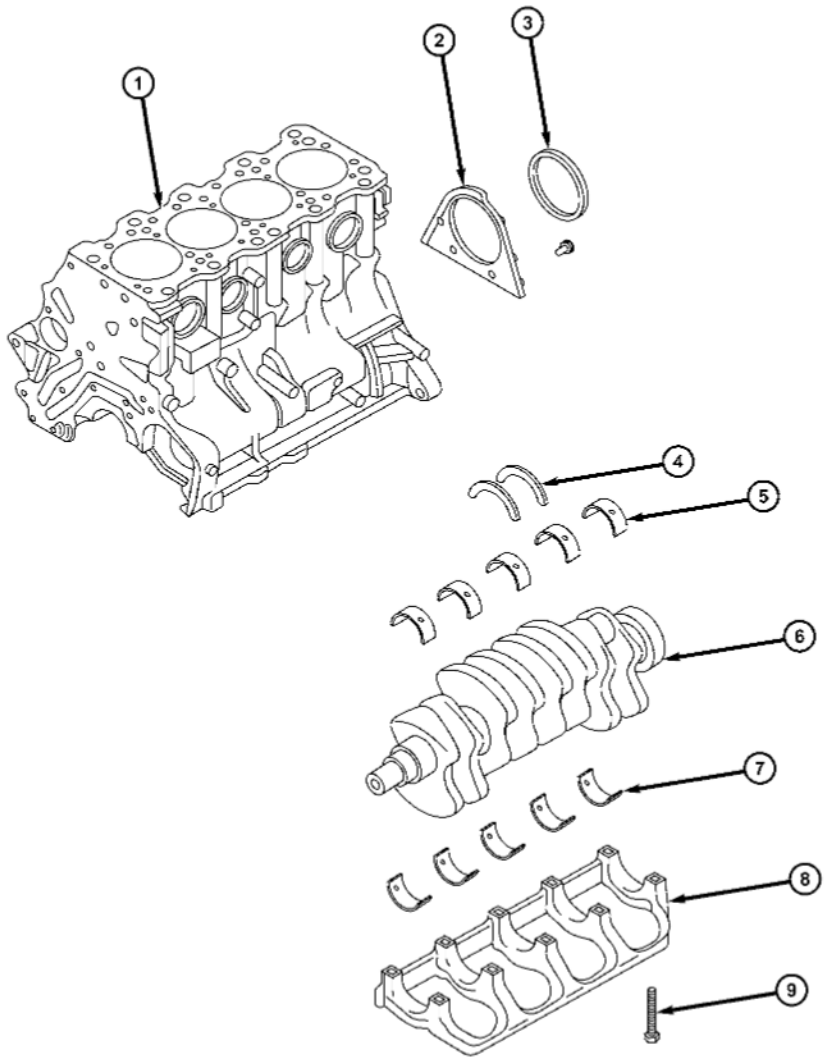
DESCRIPTION	TORQUE (N·m)
Main Bearing Cap Bolts	1st Step: Tighten the bolts to 25 N·m 2nd Step: Tighten the bolts an additional 180°

Clearance Specifications

DESCRIPTION	SPECIFICATION (mm)
Diameter of Crankshaft Main Journals	53.981 - 54
Diameter of Crankshaft Rod Journals	47.884 - 47.9
Out-of-Round Maximum of Crankshaft Main Journals	0.008
Axial Clearance of Crankshaft	0.07 - 0.265
Radial Clearance of Crankshaft	0.0035 - 0.034
Coaxality Crankshaft Main Journal	0.05
Thrust Washer Thickness	2.4 - 2.405

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Disassembly

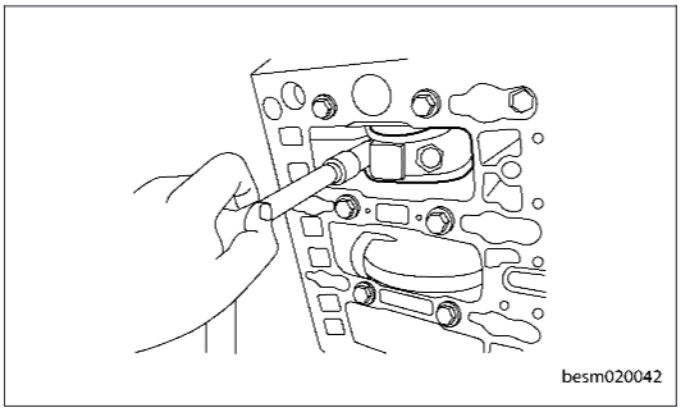


1 - Cylinder Block	6 - Crankshaft
2 - Crankshaft Rear Oil Seal Housing	7 - Lower Crankshaft Bearing
3 - Crankshaft Rear Oil Seal	8 - Bearing Cap
4 - Crankshaft Thrust Bearing	9 - Bearing Cap Bolt
5 - Upper Crankshaft Bearing	

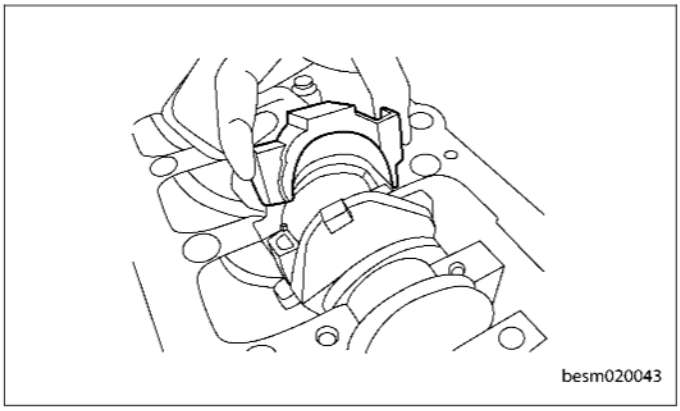
1. Remove the engine front cover.
2. Remove the crankshaft rear oil seal.

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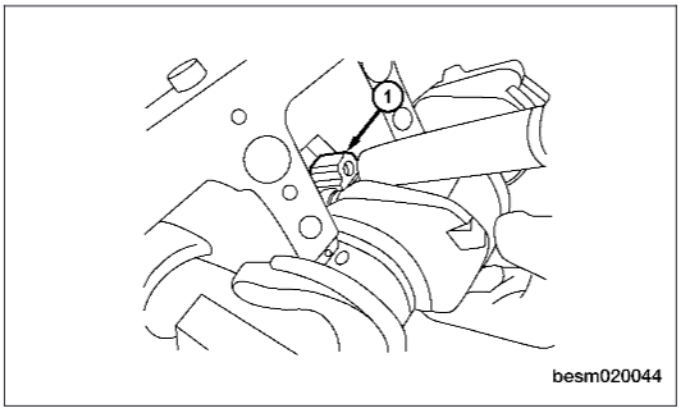
3. Remove the connecting rod cap nuts.


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4. Remove the connecting rod bearing cap.

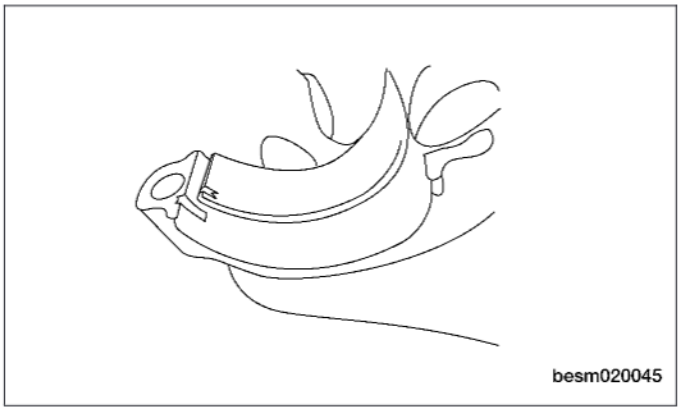

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5. Using a hammer handle or similar tool, push the piston and connecting rod assembly (1) out through the cylinder head side of the engine block.
   NOTE: Before removing the piston and connecting rod assembly, check the connecting rod side clearance.



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6. Remove the connecting rod bearings.
   CAUTION: When removing the connecting rod side bearings, note the installation position. Keep them in the correct order.

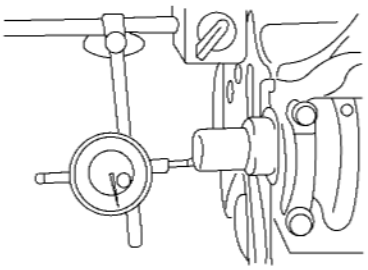

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Inspection

Crankshaft Axial Clearance

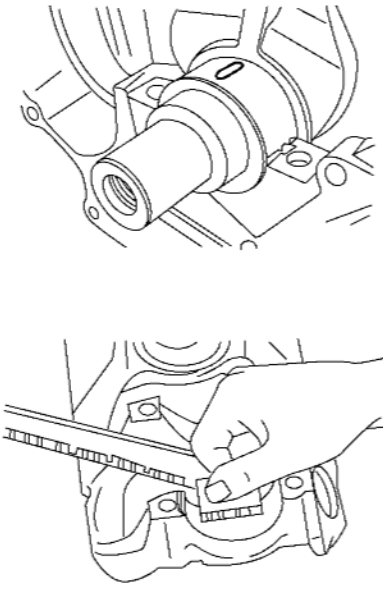
- Check the axial clearance of the crankshaft.


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CRANKSHAFT AXIAL CLEARANCE		
DESCRIPTION	SPECIFICATION	MAXIMUM LIMIT
Crankshaft	0.05 - 0.18 mm	0.25 mm

Crankshaft Bearing Oil Clearance (Plastigauge)

- Check the oil clearance of the crankshaft.
  - Clean all engine oil off of the crankshaft journals.
  - Cut the plastigauge into lengths as wide as the crankshaft journal.
  - Lay the plastigauge across the crankshaft journal.
  - Carefully install the main bearing cap.
  - Torque the main bearing cap to the specified torque.
  - Carefully disassemble the main bearing cap.
  - Use the measuring rule imprinted on the plastigauge package to measure the width of the widest part of the plastigauge.

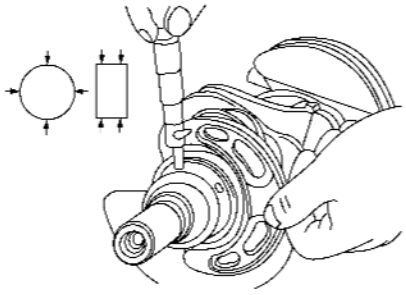

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CRANKSHAFT BEARING OIL CLEARANCE	
Standard Clearance	0.02 - 0.04 mm
Maximum Clearance	0.1 mm

Crankshaft Main Journal Roundness

- The crankshaft main journals should be checked for excessive wear, roundness and scoring. Limits of roundness on any crankshaft main journals should be held to 0.006 mm. Limits of roundness on any crankshaft rod journals should be held to 0.006 mm. DO NOT nick crank pin or bearing fillets. Limits of out of round on any crankshaft journals should be held to 0.006 mm.


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CRANKSHAFT MAIN JOURNALS		
DESCRIPTION	**SPECIFICATION**	**MAXIMUM LIMIT**
Crankshaft Journal Roundness	0.006 mm	0.006 mm

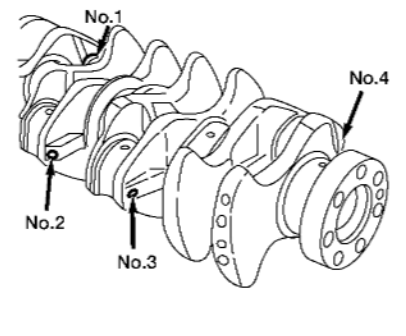
Assembly

NOTE :
Cleanliness is extremely important during the engine assembly procedure. Any foreign material, including any material created while cleaning gasket surfaces, that enters the oil passages, coolant passages or the oil pan can cause engine failure.

Before installing the main bearing bolts, clean the threads and oil the bolts with clean engine oil.

Crankshaft Main Bearings

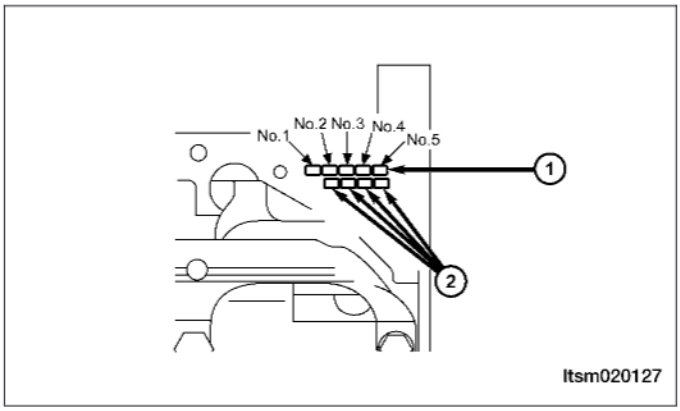
- Perform the following when replacing the crankshaft main bearings:
  - Measure and record the external diameter of the crankshaft main journals.



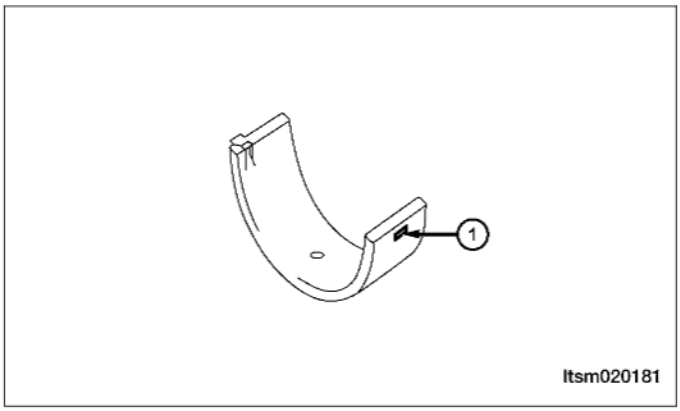
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- Identify the bearing markings (1) & (2) on the cylinder block.



- The bearing will have an identification mark (1) imprinted in the position as shown.

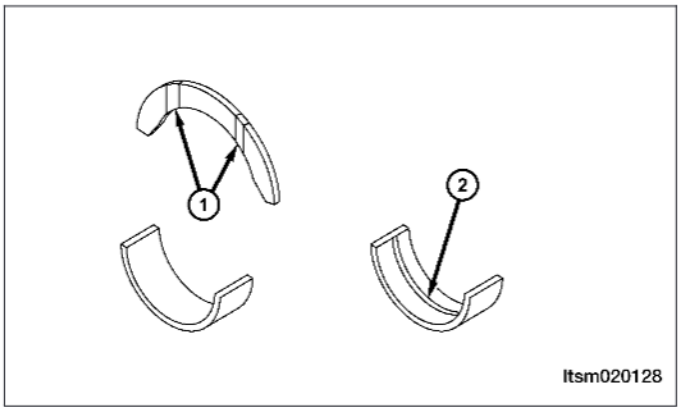


IDENTIFYING CRANKSHAFT MAIN BEARINGS					
Combination of Crankshaft Main Journal and Spindle Bore				Identification mark and color of No. 1, 2, 4, 5 journal bearing	Identification mark and color of No. 3 journal bearing
Crankshaft Main Journal			Identification mark of spindle bore		
Group	Identification Color	External Diameter (mm)			
1	Yellow	56.994 - 57.000	0	Green	Black
			1	Yellow	Green
			2	None	Yellow
2	None	56.988 - 56.994	0	Yellow	Green
			1	None	Yellow
			2	Blue	None
3	White	56.982 - 56.988	0	None	Yellow
			1	Blue	None
			2	Red	Blue

NOTE :
As an example, if the identification color of the crankshaft main journal is yellow and the identification mark of spindle bore is “1”, choose the No. 1,2,4,5 bearing of which identification mark is “2” and identification color is “yellow” and No.3 bearing of which identification mark is “1” and identification color is “green”.

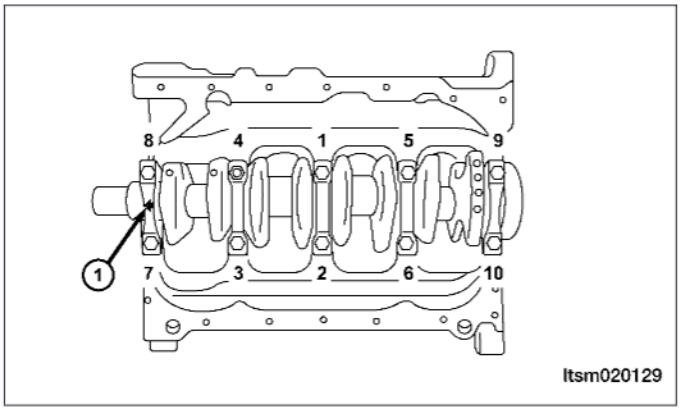
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- Main bearing and thrust bearing installation.
  - Install the main bearings with oil grooves on the cylinder block side.
  - Install the main bearings without oil grooves (2) on the bearing cap.
  - Install the two thrust bearings on crankshaft journal No. 3. Apply clean oil to the surface of thrust bearing.
  - The grooved (1) side of the thrust bearing should face towards the crankshaft.



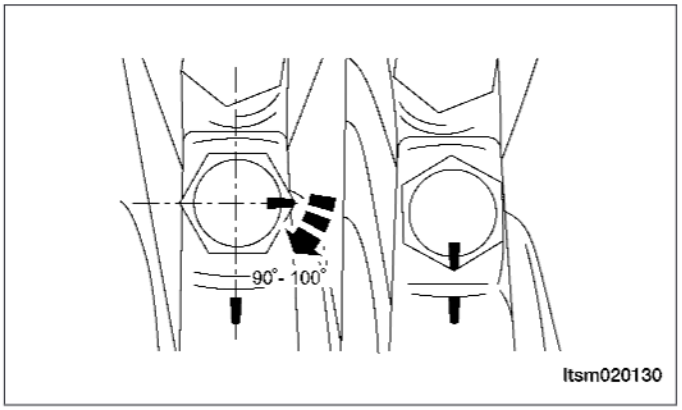
Main Bearing Caps and Bolts

- Install the main bearing caps with the arrow on the main caps (1) facing the front of the engine.
- Install the main bearing cap bolts in the sequence shown.
- Torque the bearing cap bolts in the sequence shown to 25 N·m.



- Tighten the main bearing cap bolts an additional 90°- 100° in the sequence shown.

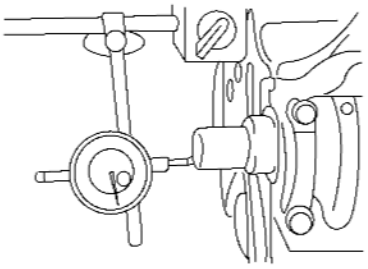
CAUTION:
If the bolts are over tightened (exceed angle of 100°), loosen the bolts and restart the torque sequence from Step 1



- After installing the main bearing caps, assure that the crankshaft rotates smoothly.

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- Inspect the crankshaft axial clearance.
  - If the crankshaft axial clearance exceeds the maximum limit, replace the No.3 crankshaft thrust bearing.


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CRANKSHAFT AXIAL CLEARANCE		
DESCRIPTION	**SPECIFICATION**	**MAXIMUM LIMIT**
Crankshaft	0.05 - 0.18 mm	0.25 mm

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CYLINDER HEAD UNIT REPAIR

Cylinder Head

Specifications

Torque Specifications

DESCRIPTION	TORQUE (N·m)
Cylinder Head Bolts	1st Step: Tighten the bolt to 78 N·m 2nd Step: Completely loosen the bolt 3rd Step: Retighten the bolt to 20 N·m 4th Step: Tighten the bolt an additional 90° 5th Step: Finish tightening the bolt an additional 90°
Cylinder Head Cover Bolts	11 N·m

Clearance Specifications

DESCRIPTION	SPECIFICATION (mm)
Cylinder Head Flatness	0.03
Intake Valve Deflection	0.02
Exhaust Valve Deflection	0.04
Spring Height	51

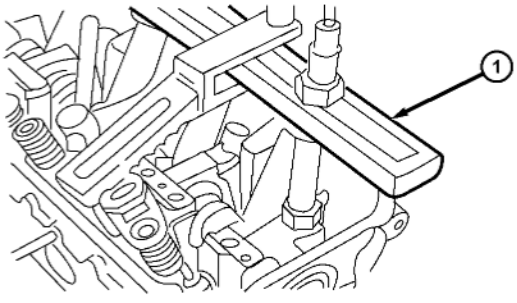
Disassembly

NOTE :
The following special tools are required to perform the repair procedure:

- MD-998772 - Valve Spring Compressor
- MD-998774 - Valve Oil Seal Installer

NOTE :
Replacement cylinder head comes complete with valves, seals, springs, retainers, keepers, tappets, and camshafts.

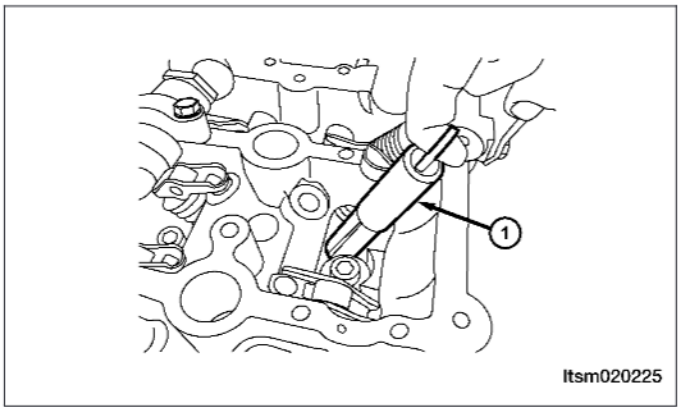
1. Remove camshaft.
2. Using the special tool MD-998772 (1), compress the valve spring.
3. Remove the valve keeper, valve spring retainer and valve spring.
4. Push the valve stem from the cylinder head and remove the valve.



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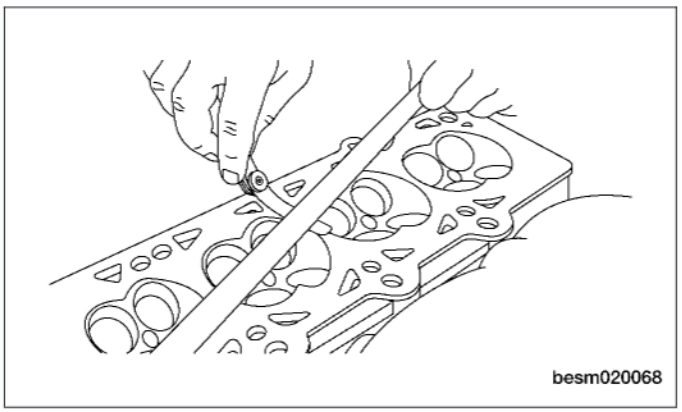
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5. Using special tool CH-20013 (1), Remove the valve oil seal.
6. Remove the valve guide.
7. Remove the spark plugs.



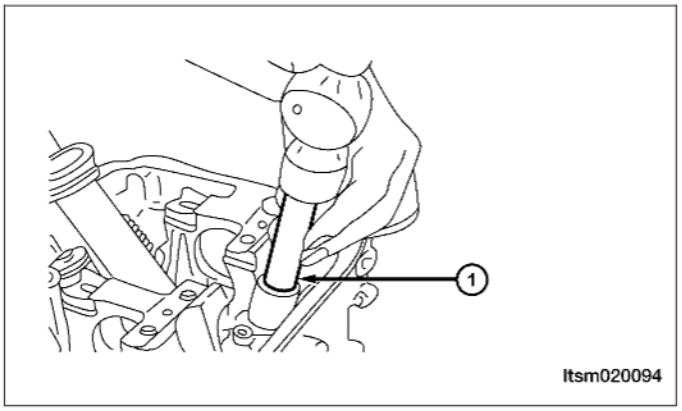
Inspection

- Cylinder head must be flat within 0.03 mm.
- Inspect camshaft bearing journals for scoring.
- Remove carbon and varnish deposits from inside of valve guides with a valve guide cleaner.
- Check the valve guide height.



Assembly

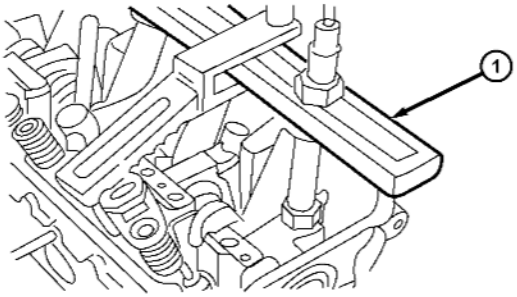
1. Install new valve guide if necessary.
2. Install new valve seat if necessary.
3. Using special tool MD-998774 (1), install the new valve oil seal.



4. Install the valves into the cylinder head (larger diameter on intake side).
5. Install the valve springs.
6. Install the valve spring retainers.

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7. Using valve spring compressor MD-998772 (1), compress the valve springs.
8. Install the valve keepers.
9. Strike the valve stem lightly with a plastic hammer after installation to verify proper assembly.



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Camshaft

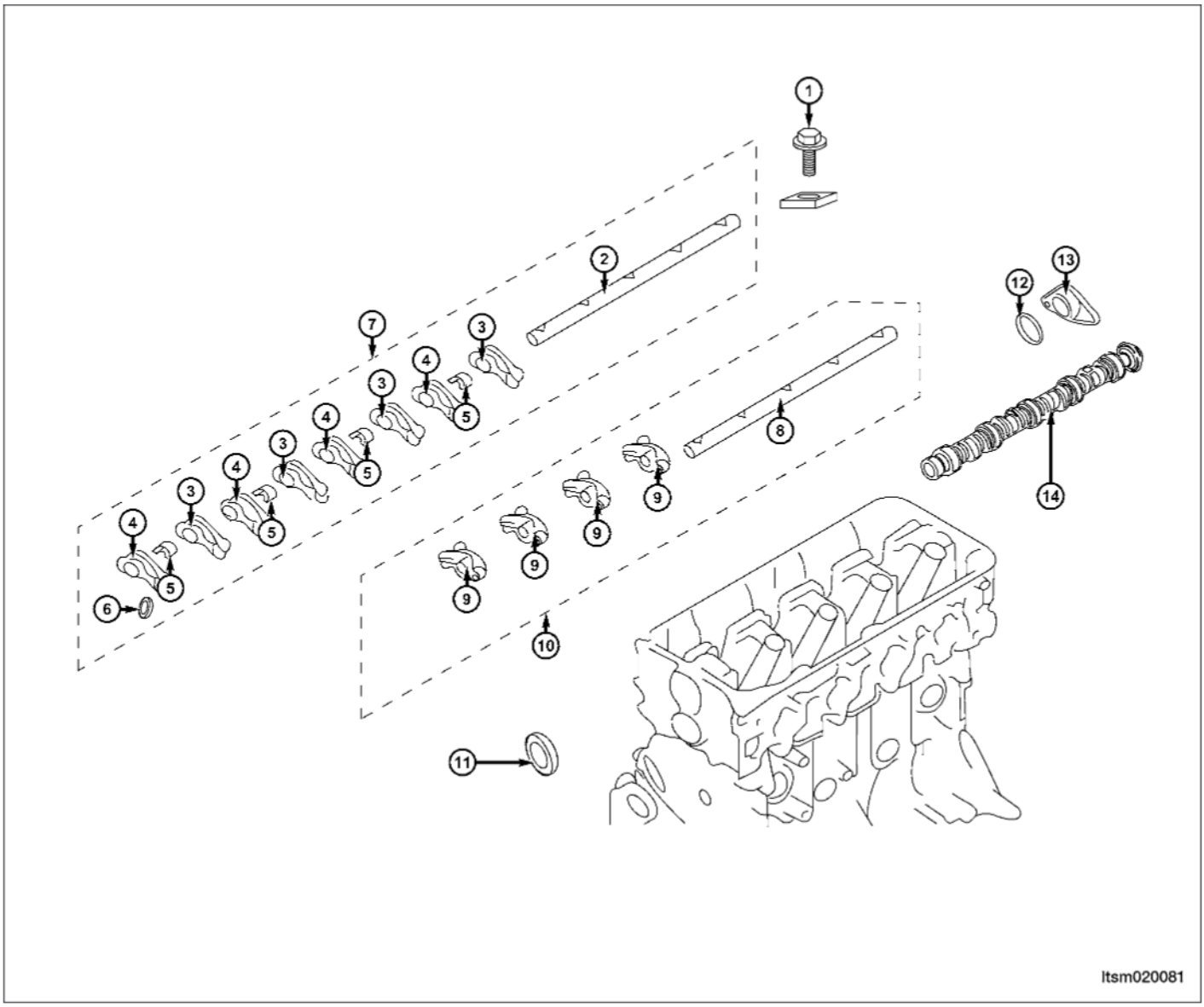
Specifications

Camshaft Specifications

DESCRIPTION	SPECIFICATION	MINIMUM LIMIT
Intake Cam Lobe Height	37.5 mm	37 mm
Exhaust Cam Lobe Height	36.99 mm	36.49 mm

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Disassembly



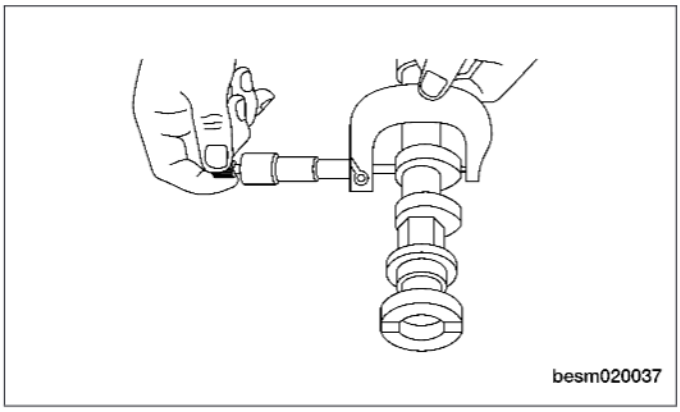
1 - Rocker Shaft Retaining Bolt	8 - Exhaust Rocker Arm Shaft
2 - Intake Rocker Arm Shaft	9 - Rocker Arm
3 - Rocker Arm	10 - Rocker Arm and Rocker Shaft
4 - Rocker Arm	11 - Camshaft Oil Seal
5 - Rocker Shaft Spring	12 - O-Ring
6 - Hydraulic Adjuster	13 - Camshaft Thrust Plate
7 - Rocker Arm and Rocker Shaft	14 - Camshaft

1. Remove the rocker shaft retaining bolt.
2. Remove the rocker arms.
3. Remove the camshaft thrust plate retaining bolts.
4. Remove the camshaft and then remove the camshaft seal.

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Camshaft

- Measure the camshaft cam lobe height.
- If wear is beyond the limit, replace the camshaft.



CAMSHAFT LOBE HEIGHT		
DESCRIPTION	**STANDARD LOBE HEIGHT**	**MINIMUM LOBE HEIGHT**
Intake Cam Lobe Height	37.5 mm	37 mm
Exhaust Cam Lobe Height	36.99 mm	36.49 mm

Hydraulic Adjusters

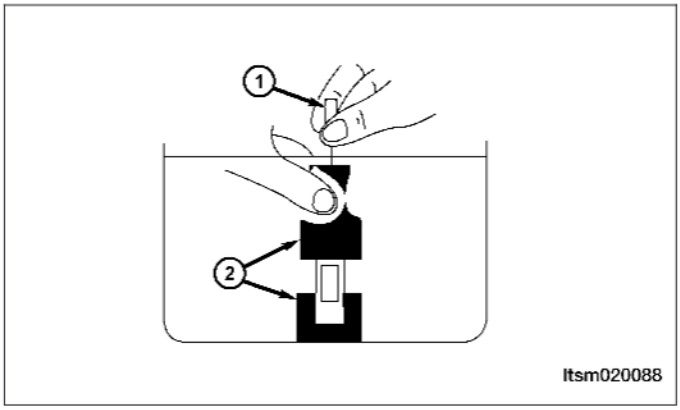
CAUTION:

The hydraulic adjusters are a precision part. There should not be any dust or foreign matter on its surface. Do not disassemble the hydraulic adjusters. It is required to use clean diesel oil to clean the hydraulic adjusters.

- Soak the hydraulic adjusters in clean diesel oil.
- Using special tool MD-998442 (1) and MD-998441 (2), press the steel ball on the inside of the hydraulic adjuster and remove all air by moving the plunger up and down 4-5 times.

NOTE :

Use the special tool and check whether the plunger can be pressed. If it is hard to press the plunger, the hydraulic adjuster is normal. If it is easy to press the plunger, repeat the previous procedure and then check the hydraulic adjuster again. If the plunger is still loose, the hydraulic adjuster should be replaced.

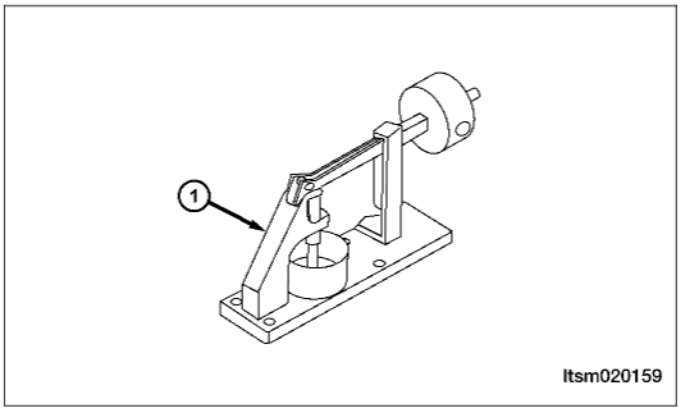


CAUTION:

After the hydraulic adjuster has been prepared, it should be kept erect to avoid the loss of diesel oil.

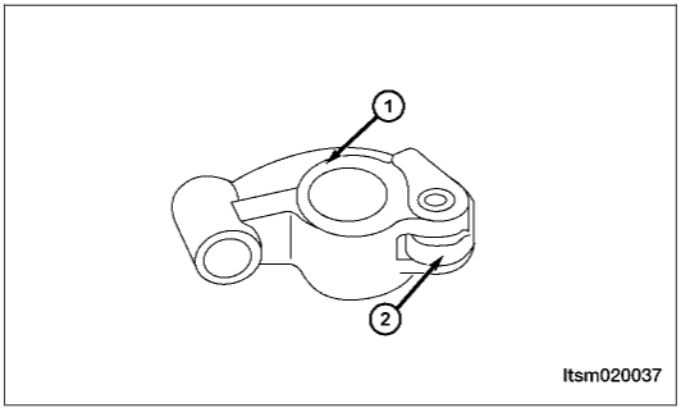
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- Using special tool MD-998440 (1) (return leakage tester), install the hydraulic adjuster.
- After the plunger has moved slightly (0.2 - 0.5 mm), measure the time it takes to move an additional 1.0 mm. If the measurement value is not within specifications, replace the hydraulic adjuster-.Standard Value: 4 - 20 seconds/1 mm (applying diesel oil of 15-20°C)



Rocker Arms

- Inspect the surface of the roller (2) on all rocker arms. If there is any damage, the rocker arm should be replaced.
- Inspect the roller for smooth operation. If the roller does not revolve smoothly or is loose, the rocker arm should be replaced.
- Inspect the internal diameter (1) of the rocker arms. If there is any damage, the rocker arm should be replaced.



Valve & Valve Guides

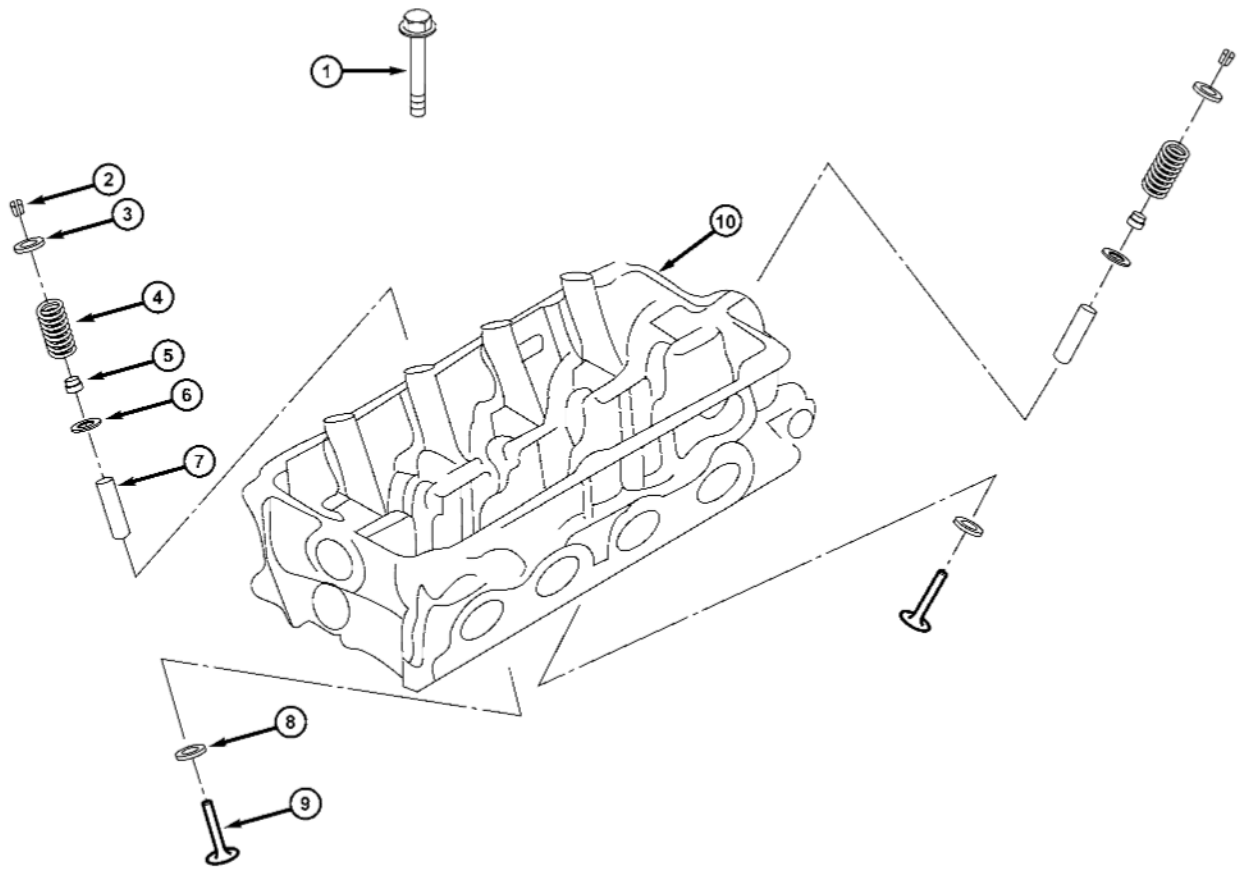
Specifications

Valve & Valve Guide Specifications

DESCRIPTION	SPECIFICATION	LIMIT
Intake Valve Deflection	0.02 mm	0.02 mm
Exhaust Valve Deflection	0.04 mm	0.04 mm
Intake Valve Clearance	0.020 - 0.050 mm	0.10 mm
Exhaust Valve Clearance	0.030 - 0.070 mm	0.15 mm
Intake Valve Edge Thickness	1.0 mm	0.5 mm
Exhaust Valve Edge Thickness	1.2 mm	0.7 mm
Intake Valve Height	112.30 mm	111.80 mm
Exhaust Valve Height	114.11 mm	113.61 mm
Intake Valve Guide Height	49.30 mm	49.80 mm
Exhaust Valve Guide Height	49.30 mm	49.80 mm

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Disassembly

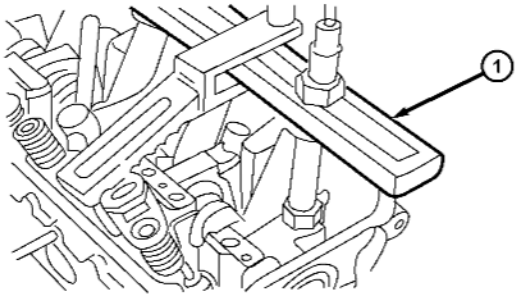


1 - Cylinder Head Bolt	6 - Lower Valve Spring Retainer
2 - Valve Spring Keepers	7 - Valve Guide
3 - Upper Valve Spring Retainer	8 - Valve Seat
4 - Valve Spring	9 - Valve
5 - Valve Oil Seal	10 - Cylinder Head

NOTE :
The following special tools are required to perform the repair procedure:
- MD-998772 - Valve Spring Compressor

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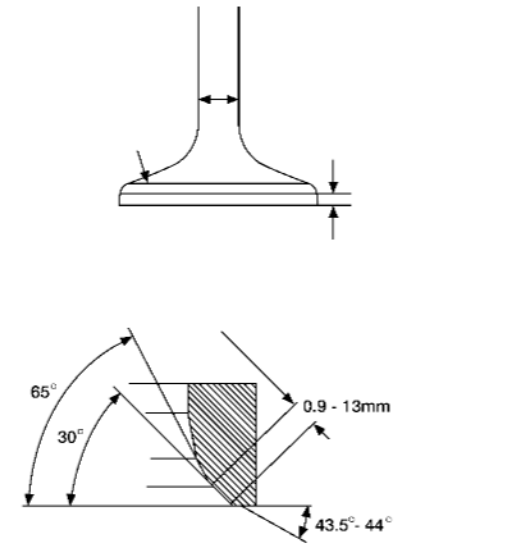
1. Using the special tool MD-998772 (1), compress the valve springs.
2. Remove the valve keeper, valve spring retainer and valve spring.
3. Remove valves from the cylinder head.



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Valves

- Clean all valves thoroughly and discard burned, warped and cracked valves.
- Check valve seats and valve faces for damage.
- When reconditioning valves follow the specifications outlined for both intake and exhaust valves.



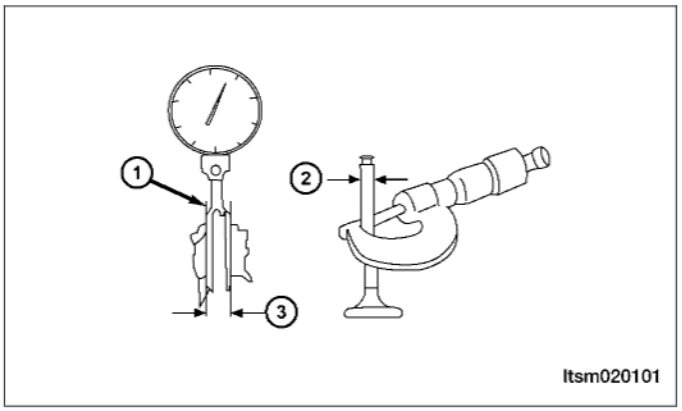
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- Measure valve deflection.

VALVE DEFLECTION LIMIT (DIAL GAUGE READING)	
Intake Valve	0.02 mm
Exhaust Valve	0.04 mm

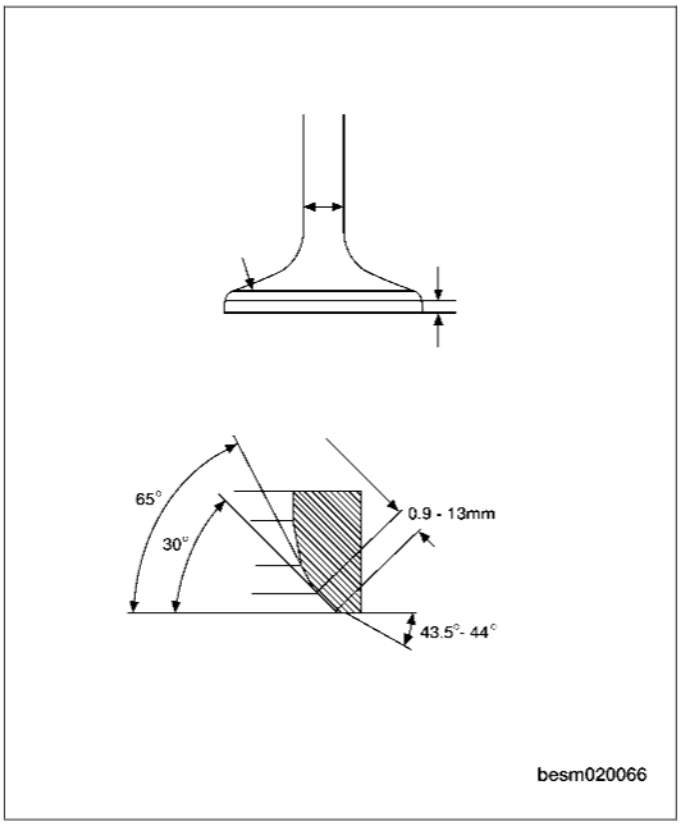
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- If it exceeds the limit, check valve to valve guide clearance (1) .
  - Measure valve stem diameter (2) and valve guide inner diameter (3).
  - Check that clearance is within specification.
  - If it exceeds the limit, replace valve or valve guide.



VALVE TO VALVE GUIDE CLEARANCE		
DESCRIPTION	**SPECIFICATION**	**LIMIT**
Intake Valve Clearance	0.020 - 0.050 mm	0.10 mm
Exhaust Valve Clearance	0.030 - 0.070 mm	0.15 mm

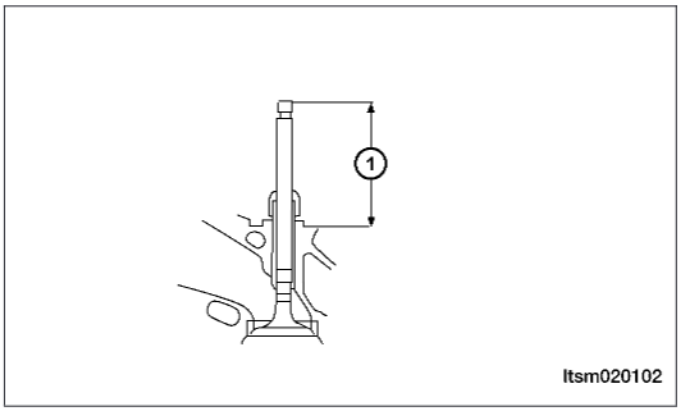
- Check the valve edge thickness and valve contact area. Repair or replace the valve if necessary.



VALVE EDGE THICKNESS		
DESCRIPTION	**SPECIFICATION**	**LIMIT**
Intake Valve Edge Thickness	1.0 mm	0.5 mm
Exhaust Valve Edge Thickness	1.2 mm	0.7 mm

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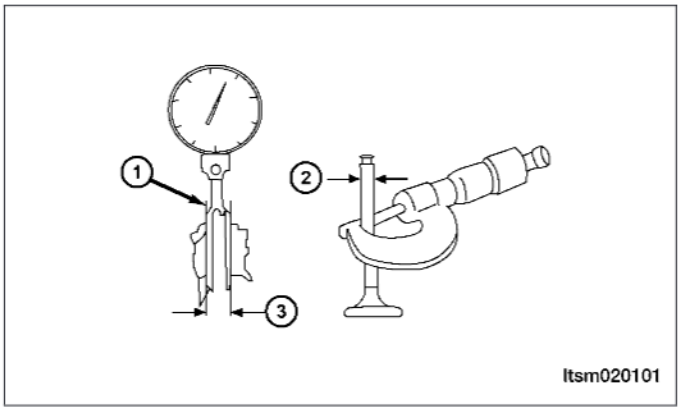
- Measure the total valve height (1). If the valve height is less than the limit value, the valve should be replaced.



VALVE HEIGHT		
DESCRIPTION	SPECIFICATION	LIMIT
Intake Valve Height	112.30 mm	111.80 mm
Exhaust Valve Height	114.11 mm	113.61 mm

Valve Guides

- Check the clearance (1) between the valve guide and the valve stem, if it exceeds the limit, check valve to valve guide clearance.
  - Measure valve stem diameter (2) and valve guide inner diameter (3).
  - Check that clearance is within specification.
  - If it exceeds the limit, replace valve or valve guide.



VALVE TO VALVE GUIDE CLEARANCE		
DESCRIPTION	SPECIFICATION	LIMIT
Intake Valve Clearance	0.020 - 0.050 mm	0.10 mm
Exhaust Valve Clearance	0.030 - 0.070 mm	0.15 mm

Valve Guide Replacement

- Press the original valve guide out of the cylinder head.
- Ream the valve guide hole until the hole diameter is the size of the new enlarged valve guide to be installed.

CAUTION:

When replacing valve guides, do not use a new valve guide that is the same size as the original valve guide.

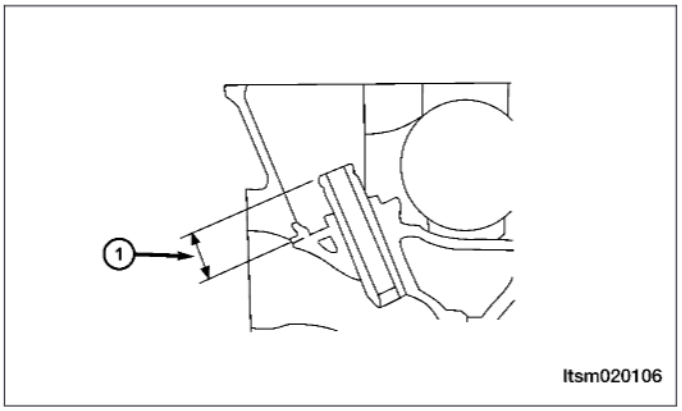
- Enlarge valve guide size 0.05 (11.05 - 11.068 mm)
- Enlarge valve guide size 0.25 (11.25 - 11.268 mm)
- Enlarge valve guide size 0.50 (11.50 - 11.518 mm)

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- Install the new valve guide from the top of the cylinder head as shown in the illustration.
  - Intake valve guide length: 45.5 mm
  - Exhaust valve guide length: 50.5 mm

CAUTION:
The intake and exhaust valves are different lengths, use care when replacing the valve guides to install the correct valve guide.

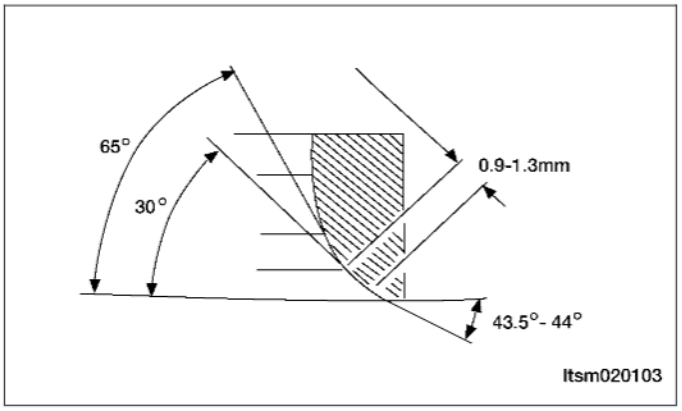
- Install the valve guide to the specified height (1) of 14 mm.



- After installing the valve guide, insert the new valve and check for smooth movement.

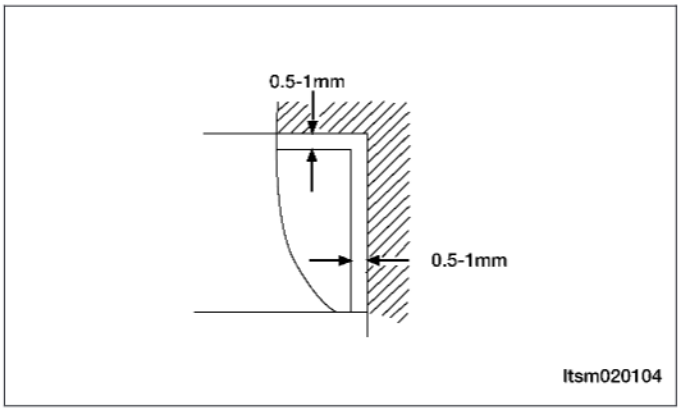
Valve Seats

- Before machining the valve seat, check the clearance between the valve guide and the valve stem. If the clearance is excessive, repair the valve and valve guide if necessary before machining the valve seat.
- Repair the width and angle of the valve seat until the valve seat meets specified values.
- After repairing the valve seat, use valve lapping compound to lap the valves and seats in pairs.



Valve Seat Replacement

- Cut out a portion of the original valve seat and remove the valve seat from the cylinder head.
- Select the replacement valve seat according to the outer diameter of the enlarged valve seat.



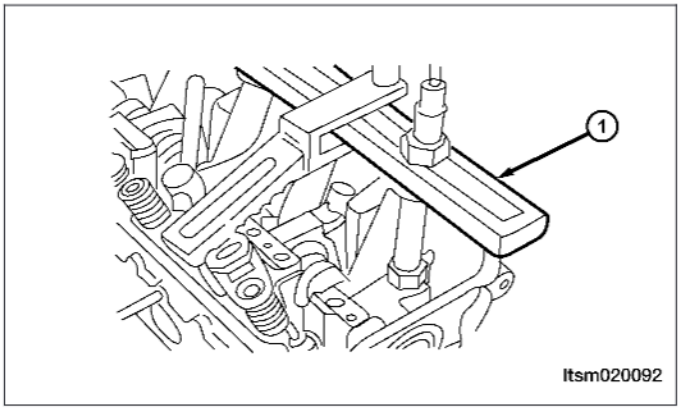
REPLACEMENT VALVE SEAT SIZES		
Intake valve seat	Enlargement size 0.30 mm	34.435 - 34.455 mm
	Enlargement size 0.60 mm	34.735 - 34.755 mm
Exhaust valve seat	Enlargement size 0.30 mm	31.935 - 31.955 mm
	Enlargement size 0.60 mm	32.235 - 32.255 mm

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NOTE :
Before installing the valve seat, heat the cylinder head to the temperature of about 250°, or cool the valve seat in liquid nitrogen in order to install the valve seat.
- Machine the new valve seat and valve to proper specifications.

Assembly

1. Install the valves into the cylinder head (larger diameter on intake side).
2. Using special tool MD-998774, install the new valve oil seal.
3. Install the valve springs.
4. Install the valve spring retainers.
5. Using valve spring compressor MD-998772 (1), compress the valve springs.
6. Install the valve keepers.
7. Strike the valve stem lightly with a plastic hammer after installation to verify proper assembly.



Valve Springs

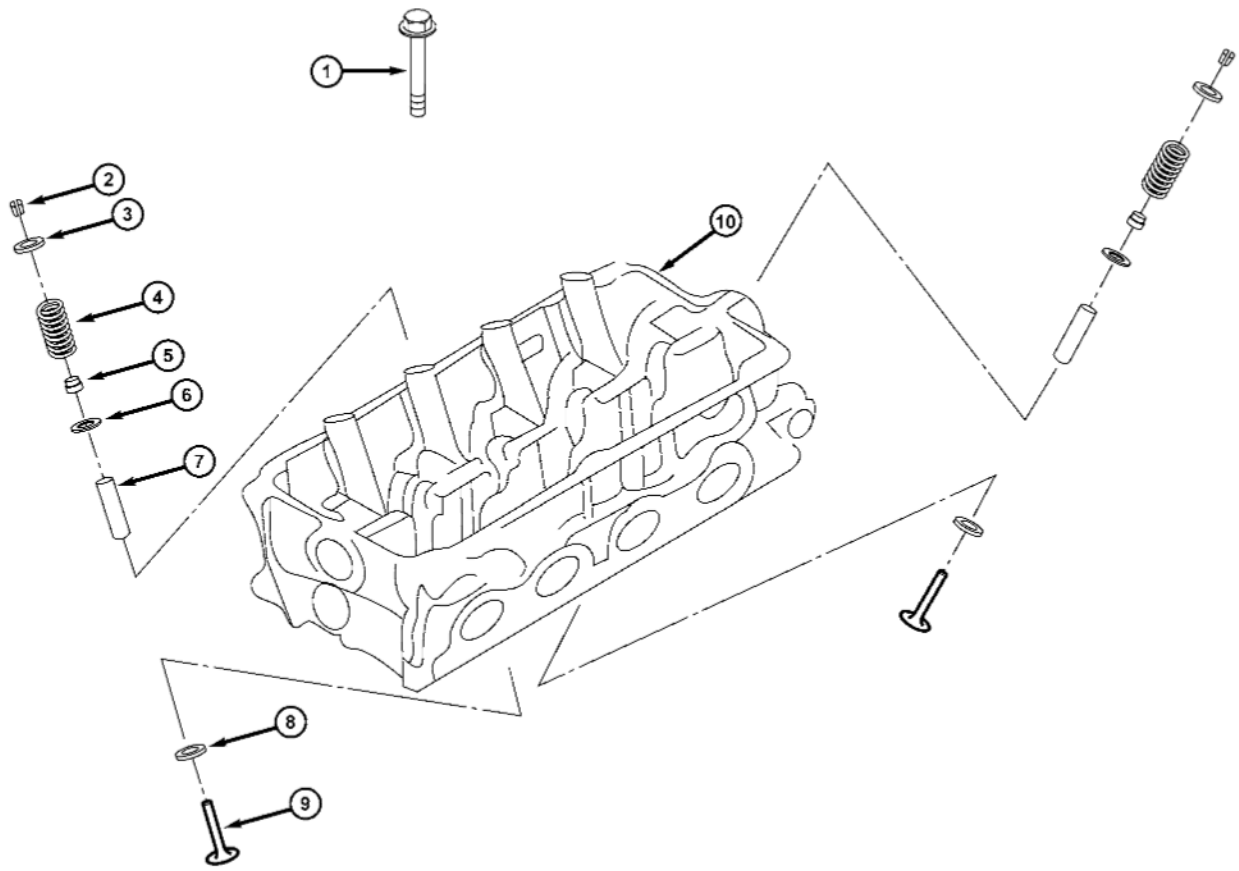
Specifications

Valve Spring Specifications

DESCRIPTION	SPECIFICATION	LIMIT
Spring Free Length	51.0 mm	50.0 mm
Spring Center Line	≤ 2.0°	≤ 4.0°

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Disassembly



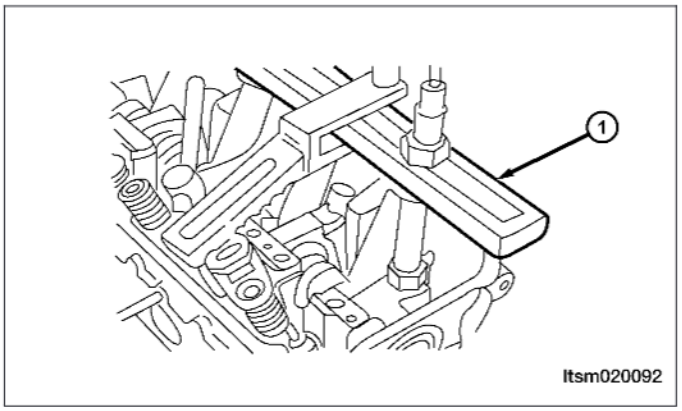
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1 - Cylinder Head Bolt	6 - Lower Valve Spring Retainer
2 - Valve Spring Keepers	7 - Valve Guide
3 - Upper Valve Spring Retainer	8 - Valve Seat
4 - Valve Spring	9 - Valve
5 - Valve Oil Seal	10 - Cylinder Head

NOTE :
The following special tools are required to perform the repair procedure:
- MD-998772 - Valve Spring Compressor

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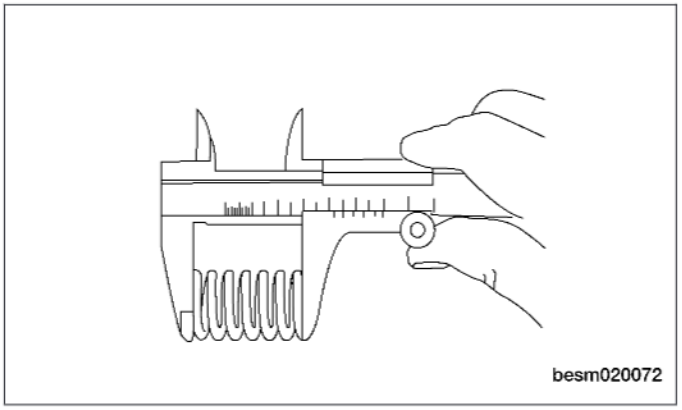
1. Using the special tool MD-998772 (1), compress the valve springs.
2. Remove the valve keeper, valve spring retainer.
3. Remove the valve springs from the cylinder head.



Inspection

NOTE :
Whenever valves have been removed for inspection, reconditioning or replacement, valve springs should be tested for correct load.

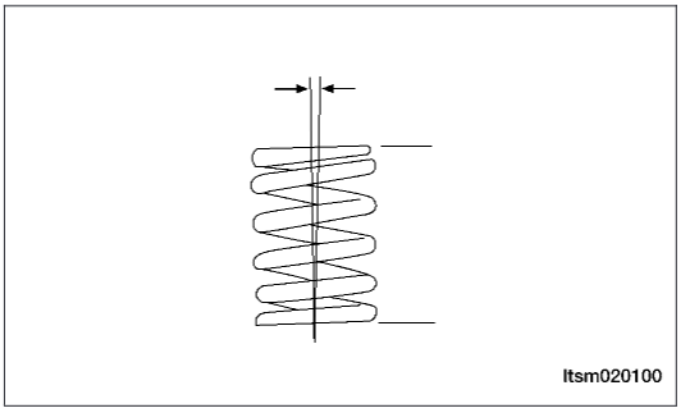
- Check the valve spring length/height. Discard the springs that do not meet specifications.
- The following specifications apply to both intake and exhaust valve springs.



VALVE SPRING LENGTH/HEIGHT		
DESCRIPTION	**SPECIFICATION**	**LIMIT**
Spring Free Length	51.0 mm	50.0 mm

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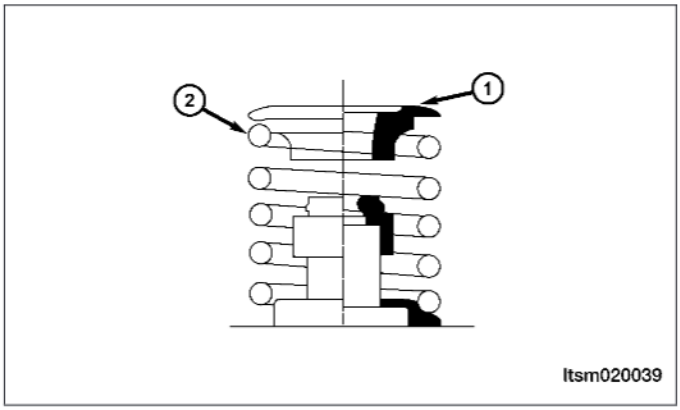
- Check the valve spring center line. Discard the springs that do not meet specifications.
- The following specifications apply to both intake and exhaust valve springs.



VALVE SPRING CENTER LINE		
DESCRIPTION	**SPECIFICATION**	**LIMIT**
Spring Center Line	≤ 2.0°	≤ 4.0°

Assembly

1. Install the valve springs (2).
2. Install the valve spring retainers (1).
3. Using valve spring compressor MD - 998772, compress the valve springs.
4. Install the valve keepers.
5. Strike the valve stem lightly with a plastic hammer after installation to verify proper assembly.



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