

Zenith 416 Gamma

Engine Mechanical Manual

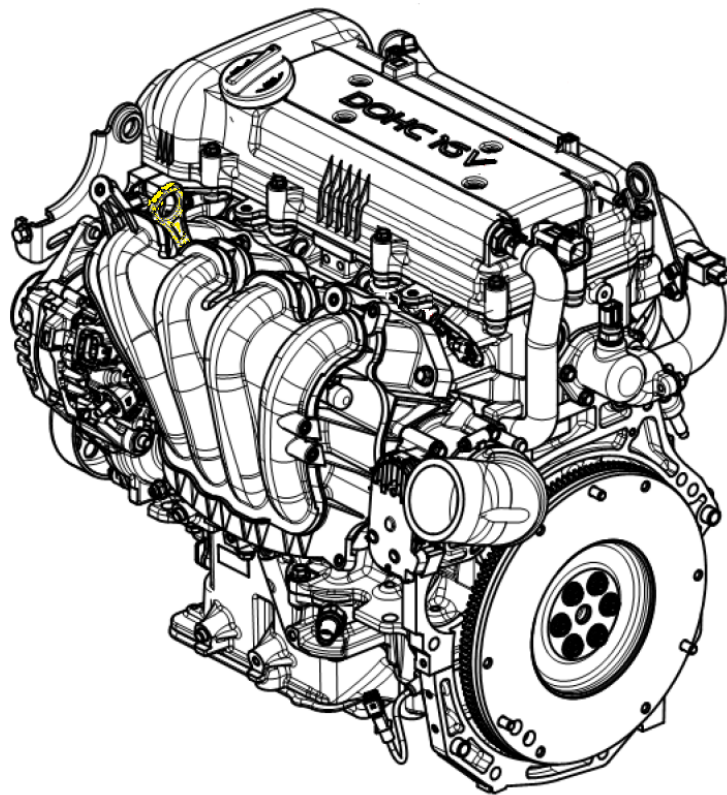


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Content in this manual was provided from many resources, much of which was sourced Courtesy of KIA MOTORS AMERICA, INC. Translations were modified to provide as much clarity as possible.

Technical Specifications

Description		Specifications	Limit
General			
Type		In-line, DOHC	
Number of cylinders		4	
Bore		77mm (3.0315in)	
Stroke		85.44mm (3.3638in)	
Total displacement		1,591 cc (97.09 cu.in)	
Compression ratio		10.5 : 1	
Firing order		1-3-4-2	
Valve timing			
Intake valve	Opens	ATDC 10°/BTDC 40°	
	Closes	ABDC 63°/ABDC 13°	
Exhaust valve	Opens	BBDC 40°	
	Closes	ATDC 3°	
Cylinder head			
Flatness of gasket surface		Less than 0.05mm (0.0020in)	
Camshaft			
Cam height	Intake	43.85mm (1.726in)	
	Exhaust	42.85mm (1.687in)	
Journal outer diameter (Intake, Exhaust)		22.964 - 22.980mm (0.9041 - 0.9047in)	
Camshaft cap oil clearance		0.027 - 0.058mm (0.0011 - 0.0023in)	0.1mm (0.0039in)
End play		0.10 - 0.20mm (0.0039 - 0.0079in)	
Valve			
Valve length	Intake	93.15mm (3.6673in)	
	Exhaust	92.6mm (3.6457in)	
Stem outer diameter	Intake	5.465 - 5.480mm (0.2152 - 0.2157in)	
	Exhaust	5.458 - 5.470mm (0.2149 - 0.2154in)	
Face angle		45.25° ~ 45.75°	
Thickness of valve head (margin)	Intake	1.1mm (0.0433in)	0.8mm (0.0315in)
	Exhaust	1.26mm (0.0496in)	1.0mm (0.0394in)
Valve stem to valve guide clearance	Intake	0.020 - 0.047mm (0.0008 - 0.0019in)	0.10mm (0.0039in)
	Exhaust	0.030 - 0.054mm (0.0012 - 0.0021in)	0.15mm (0.0059in)
Valve guide			
Length	Intake	40.3 - 40.7mm (1.5866 - 1.6024in)	
	Exhaust	40.3 - 40.7mm (1.5866 - 1.6024in)	
Valve spring			
Free length		44.0mm (1.7323in)	
Out of squareness		Less than 1.5°	
Cylinder block			
Cylinder bore		77.00 - 77.03mm (3.0315 - 3.0327in)	
Flatness of gasket surface		Less than 0.05mm (0.0020in) / Less than 0.02mm (0.0008in) 100mm×100mm	
Piston			
Piston outer diameter		76.97 - 77.00mm (3.0303 - 3.0315in)	
Piston to cylinder clearance		0.020 - 0.040mm (0.0008 - 0.0016in)	

Technical Specifications (continued)

Ring groove width	No. 1 ring groove	1.22 - 1.24mm (0.0480 - 0.0488in)	1.26mm (0.0496in)
	No. 2 ring groove	1.22 - 1.24mm (0.0480 - 0.0488in)	1.26mm (0.0496in)
	Oil ring groove	2.01 - 2.03mm (0.0791 - 0.0799in)	2.05mm (0.0807in)
Piston ring			
Side clearance	No.1 ring	0.03 - 0.07mm (0.0012 - 0.0028in)	0.1 mm (0.0039in)
	No.2 ring	0.03 - 0.07mm (0.0012 - 0.0028in)	0.1 mm (0.0039in)
	Oil ring	0.06 - 0.15mm (0.0024 - 0.0059in)	0.2 mm (0.0079in)
End gap	No. 1 ring	0.14 - 0.28mm (0.0055 - 0.0110in)	0.30mm (0.0118in)
	No. 2 ring	0.30 - 0.45mm (0.0118 - 0.0177in)	0.50mm (0.0197in)
	Oil ring	0.20 - 0.70mm (0.0079 - 0.0276in)	0.80mm (0.0315in)
Piston pin			
Piston pin outer diameter		18.001 - 18.006mm (0.7087 - 0.7089in)	
Piston pin hole inner diameter		18.016 - 18.021mm (0.7093 - 0.7095in)	
Piston pin hole clearance		0.010 - 0.020mm (0.0004 - 0.0008in)	
Connecting rod small end hole inner diameter		17.974 - 17.985mm (0.7076 - 0.7081in)	
Piston pin press-in load		500 - 1,500 kg (1,102 - 3,306 lb)	
Connecting rod			
Connecting rod big end inner diameter		45.000 - 45.018mm (1.7717 - 1.7724in)	
Connecting rod bearing oil clearance		0.018 - 0.036mm (0.0007 - 0.0014in)	0.060mm (0.0024in)
Side clearance		0.10 - 0.25mm (0.0039 - 0.0098in)	0.35m (0.0138in)
Crankshaft			
Main bearing oil clearance	No. 1, 2, 3, 4, 5	0.006 - 0.024mm (0.0002 - 0.0009in)	0.05mm (0.0020in)
End play		0.05 - 0.25mm (0.0020 - 0.0098in)	0.3mm (0.0118in)
Engine oil			
Oil quantity	Total	3.7L (3.91US qt, 3.26Imp qt)	When replacing a short engine or a block assembly
	Oil pan	3.0L (3.17US qt, 2.64Imp qt)	
	Drain and refill	3.3L (3.49US qt, 2.90Imp qt)	Including oil filter
Oil quality	Recommendation	5W-20/GF4&SM	If not available, refer to the recommended API or ILSAC classification and SAE viscosity number.
	Classification	API SL, SM or above ILSAC GF3, GF4 or above	Satisfy the requirement of the API or ILSAC classification.
	SAE viscosity grade	Recommended SAE viscosity number	Refer to the "Lubrication System"
Oil pressure (at 1000rpm)		100kPa (1.0kg/cm ² , 14.5psi) or above	Oil temperature in oil pan : 110±2 °C (230±36 °F)
Cooling system			
Cooling method		Forced circulation with water pump	
Coolant quantity		6.5L (6.86US qt., 5.71Imp qt.)	

Technical Specifications (continued)

Thermostat	Type	Wax pellet type	
	Opening temperature	$82 \pm 1.5^{\circ}\text{C}$ ($179.6 \pm 2.7^{\circ}\text{F}$)	
	Full opening temperature	95°C (203°F)	
Radiator cap	Main valve opening pressure	93.16 - 122.58kpa (0.95 - 1.25kgf/cm ² , 13.51 - 17.78psi)	
	Vacuum valve opening pressure	MAX. 6.86 kpa(0.07kgf/cm ² , 1.00 psi)	
Water temperature sensor			
Type		Thermister type	
Resistance	20°C (68°F)	2.45±0.14 kΩ	
	80°C (176°F)	0.3222 kΩ	

Cylinder Head Removal

REPAIR PROCEDURES

Removal

Engine removal is not required for this procedure.

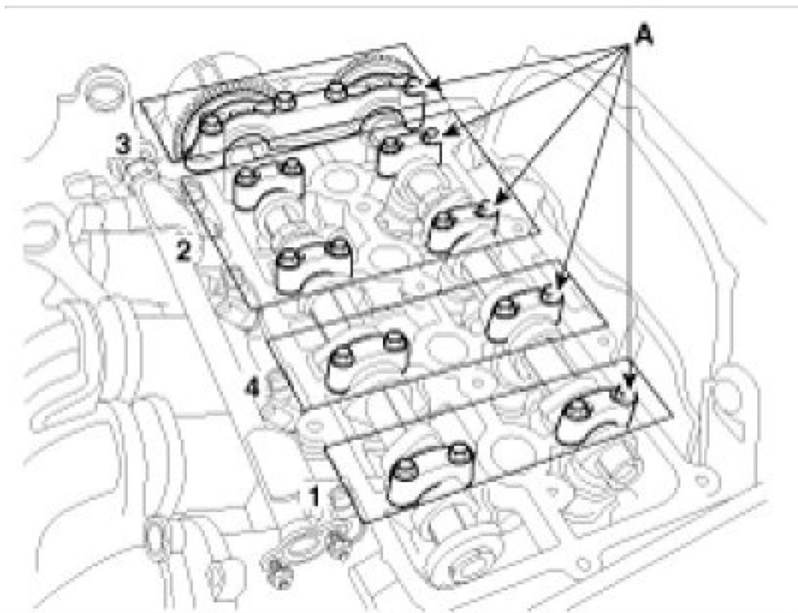
CAUTION:

- To avoid damaging the cylinder head, wait until the engine coolant temperature drops below normal temperature before removal.
- When handling a metal gasket, take care not to fold the gasket or damage the contact surface of the gasket.
- To avoid damage, unplug the wiring connectors carefully while holding the connector portion.

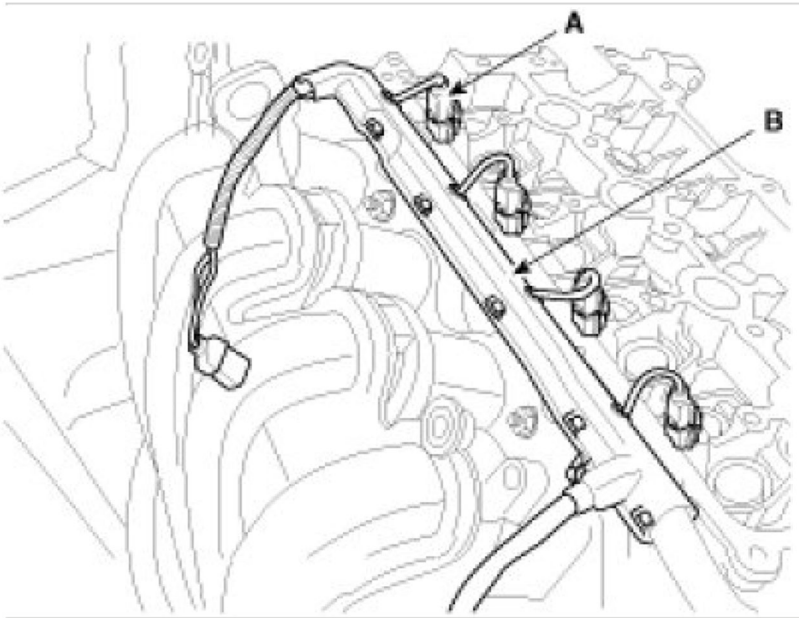
NOTE:

- Mark all wiring and hoses to avoid misconnection.
- Turn the crankshaft pulley so that the No. 1 piston is at top dead center.

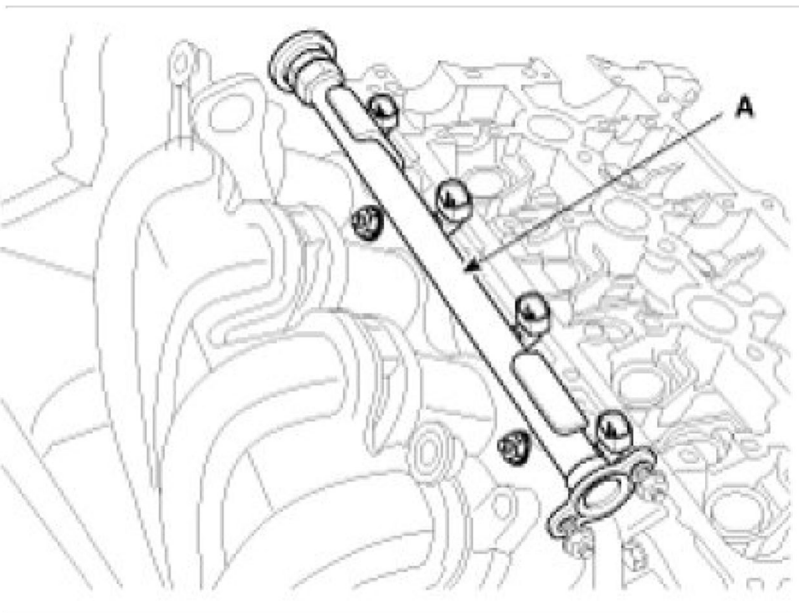
1. Remove the timing chain.
2. Remove the camshaft bearing caps(A) with the order below.



3. Remove the injector connectors(A) and the harness bracket(B).



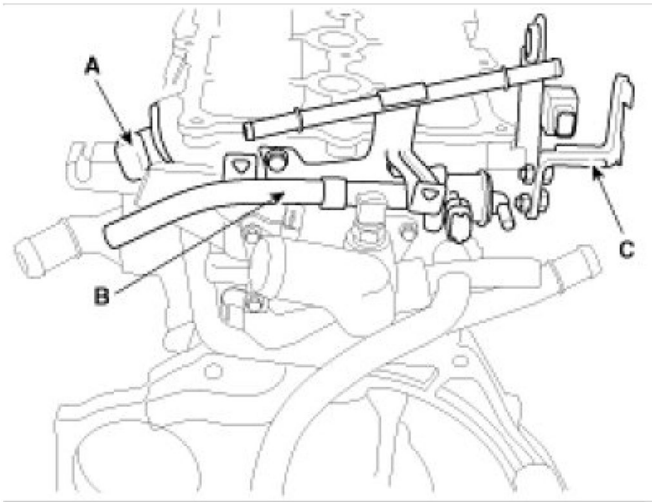
4. Remove the fuel rail (A).



5. Remove the exhaust manifold assembly.

6. Remove the intake manifold module assembly.

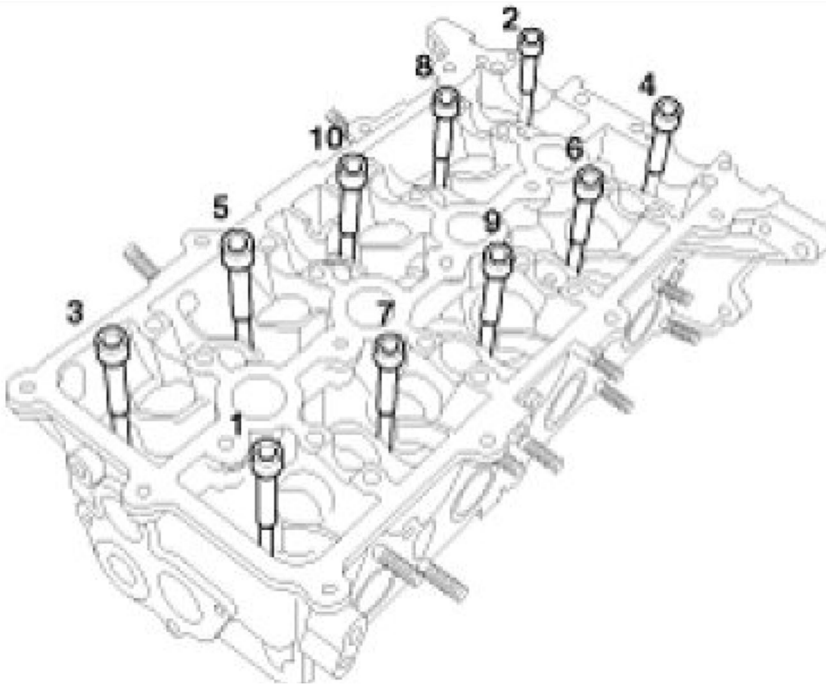
7. Disconnect the camshaft position sensor (CMP) connector(A) and remove the purge control solenoid valve (PCSV bracket(B) and the module hanger bracket(C).



8. Remove the water temperature control assembly and the oil control valve (OCV).

9. Remove the cylinder head bolts, then remove the cylinder head.

(1) Uniformly loosen and remove the 10, cylinder head bolts, in several passes, in the sequence shown.



CAUTION:

Head warpage or cracking could result from removing bolts in an incorrect order.

(2) Lift the cylinder head from the cylinder block and put the cylinder head on wooden blocks.

CAUTION:

Be careful not to damage the contact surfaces of the cylinder head and cylinder block.

Cylinder Head Disassembly

Disassembly

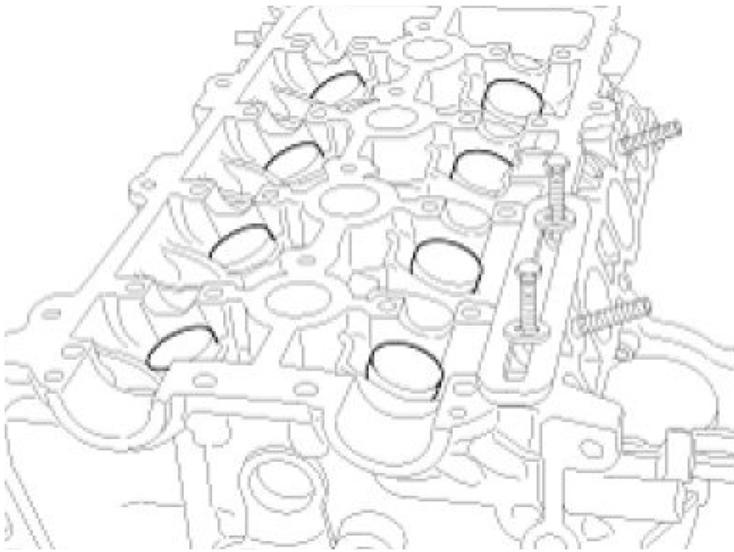
NOTE:

Identify MLA (Mechanical lash adjuster), valves, valve springs as they are removed so that each component can be reinstalled in its original position.

1. Remove the MLAs(A).

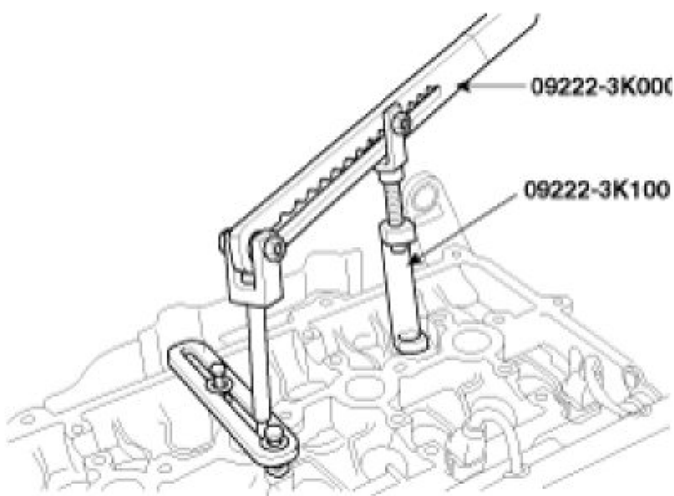
CAUTION:

When removing MLAs, mark all the MLAs for their rearrangement.



2. Remove the valves.

(1) Using the SST (09222-3K000, 09222-3K100 or equivalent), compress the valve spring and remove the retainer lock.



(2) Remove the spring retainer.

(3) Remove the valve spring.

(4) Remove the valve.

(5) Remove the valve stem seal.

(6) Using a magnetic finger, remove the spring seat.

CAUTION:

Do not reuse valve stem seals.

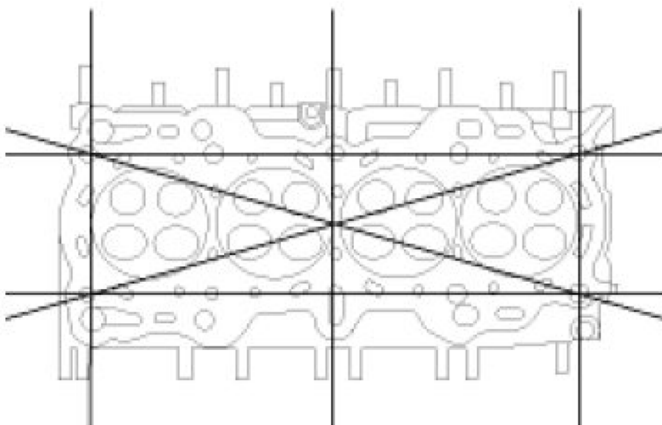
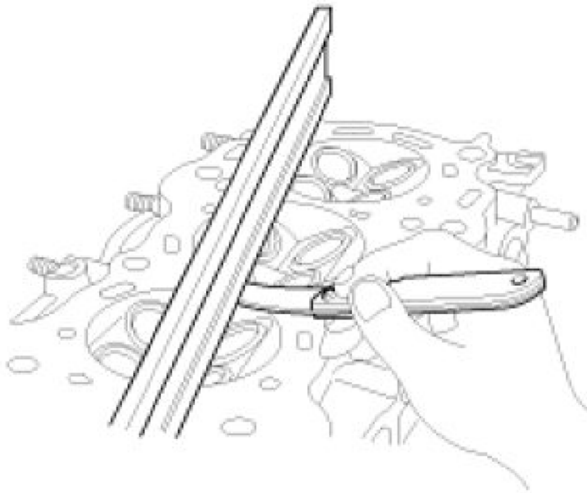
Cylinder Head Inspection

Inspection

Cylinder Head

1. Inspect for flatness. Using a precision straight edge and feeler gauge, measure the surface contacting the cylinder block and the manifolds for warpage.

Flatness of cylinder head gasket surface



Standard: Less than 0.05mm (0.0020in)

Inspect for cracks.

Check the combustion chamber, intake ports, exhaust ports and cylinder block surface for cracks. If cracked, replace the cylinder head.

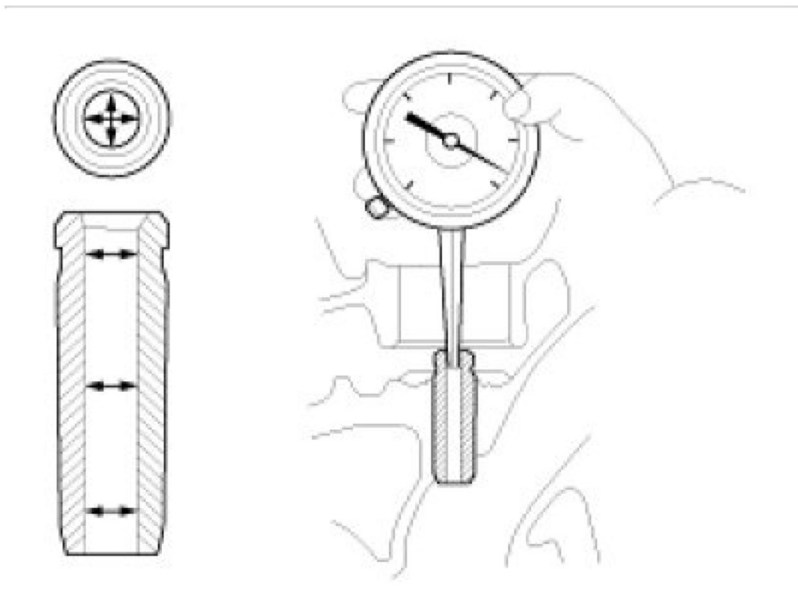
Valve and Valve Spring

1. Inspect the valve stems and valve guides.

(1) Using a caliper gauge, measure the inner diameter of valve guide.

Valve guide inner diameter:

5.500 - 5.512mm (0.2165 - 0.2170in)

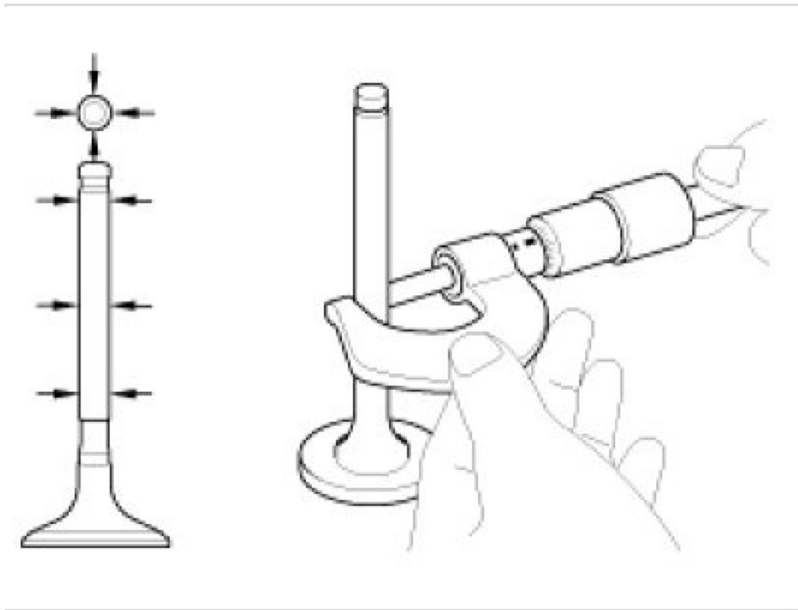


(2) Using a micrometer, measure the outer diameter of valve stem.

Valve stem outer diameter

Intake: 5.465 - 5.480mm (0.2152 - 0.2157in)

Exhaust: 5.458 - 5.470mm (0.2149 - 0.2154in)



(3) Subtract the valve stem outer diameter measurement from the valve guide inner diameter measurement.

Valve stem- to-guide clearance

Intake: 0.020 - 0.047mm (0.0008 - 0.0019in)

Exhaust: 0.030 - 0.054mm (0.0012 - 0.0021in)

If the clearance is greater than specification, replace the valve or the cylinder head.

2. Inspect the valves.

(1) Check the valve is ground to the correct valve face angle.

(2) Check that the surface of valve for wear.

If the valve face is worn, replace the valve.

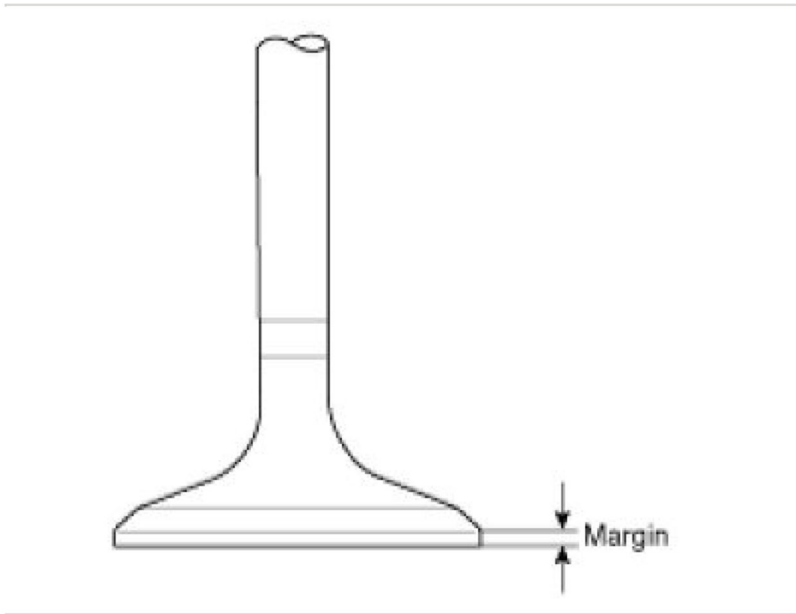
(3) Check the valve head margin thickness.

If the margin thickness is less than minimum, replace the valve.

Margin Standard

Intake: 1.1mm (0.0433in)

Exhaust: 1.26mm (0.0496in)



(4) Check the length of valve.

Valve length Standard

Intake: 93.15mm (3.6673 in)

Exhaust: 92.60mm (3.6457 in)

(5) Check the surface of valve stem tip for wear. If the valve stem tip is worn, replace the valve.

3. Inspect the valve seats.

(1) Check the valve seat for evidence of overheating and improper contact with the valve face. If the valve seat is worn, replace the cylinder head.

(2) Check the valve guide for wear. If the valve guide is worn, replace the cylinder head.

4. Inspect the valve springs.

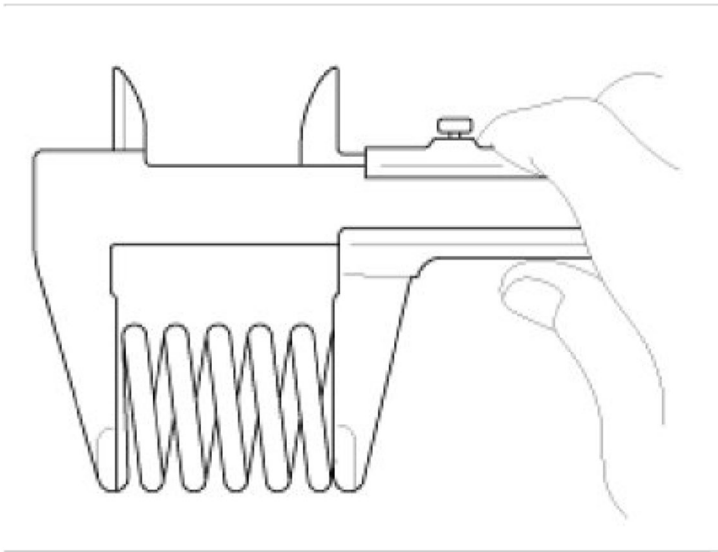
(1) Using a steel square, measure the out-of-square of valve spring.

(2) Using a vernier caliper, measure the free length of valve spring.

Valve spring Standard

Free height: 44mm (1.7323in)

Out of square: Less than 1.5°



Camshaft

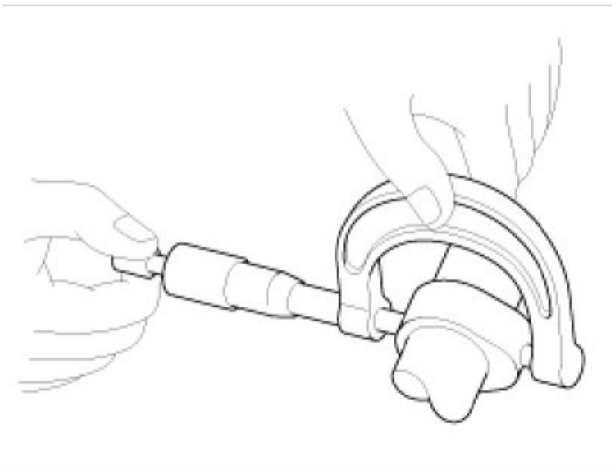
1. Inspect the camheight.

Using a micrometer, measure the cam height.

Cam height

Intake: 43.85mm (1.7264in)

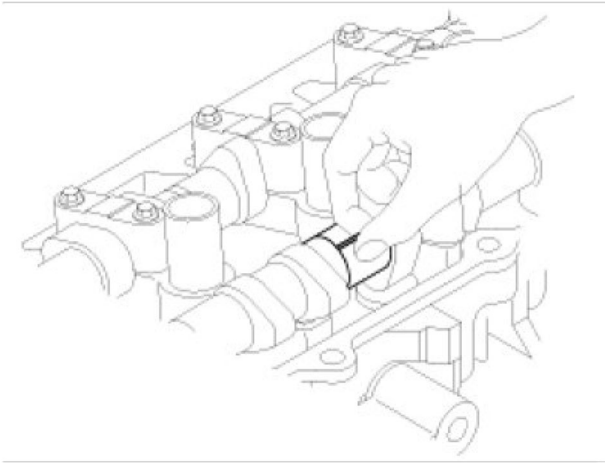
Exhaust: 42.85mm (1.6870in)



If the cam lobe height is less than specified, replace the camshaft.

2. Inspect the camshaft journal clearance.

- (1) Clean the bearing caps and camshaft journals.
- (2) Place the camshafts on the cylinder head.
- (3) Lay a strip of plastic gage across each of the camshaft journal.



(4) Install the bearing caps and tighten the bolts with specified torque.

Tightening torque:

M6 bolts: 11.8 - 13.7Nm (1.2 - 1.4kgf.m, 8.7 - 10.1lb-ft)

M8 bolts: 18.6 - 22.6Nm (1.9 - 2.3 kgf.m, 13.7 - 16.6lb-ft)

CAUTION:

Do not turn the camshaft.

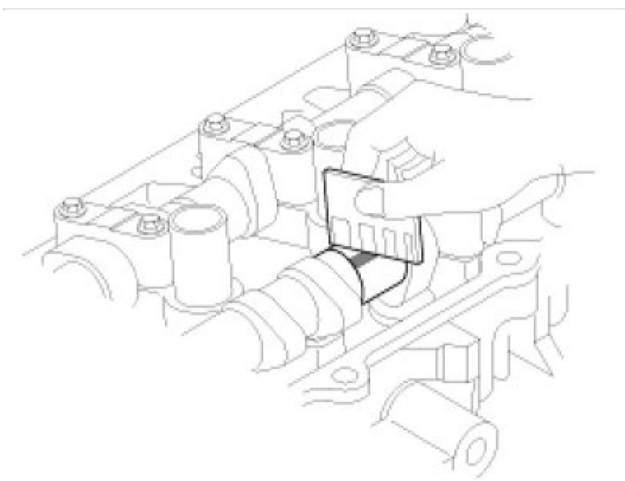
(5) Remove the bearing caps.

(6) Measure the plastic gage at its widest point.

Bearing oil clearance

Standard: 0.027 - 0.058mm (0.0011 - 0.0023in)

Limit: 0.1mm (0.0039in)



If the oil clearance is greater than specified, replace the camshaft. If necessary, replace the bearing caps and cylinder head as a set.

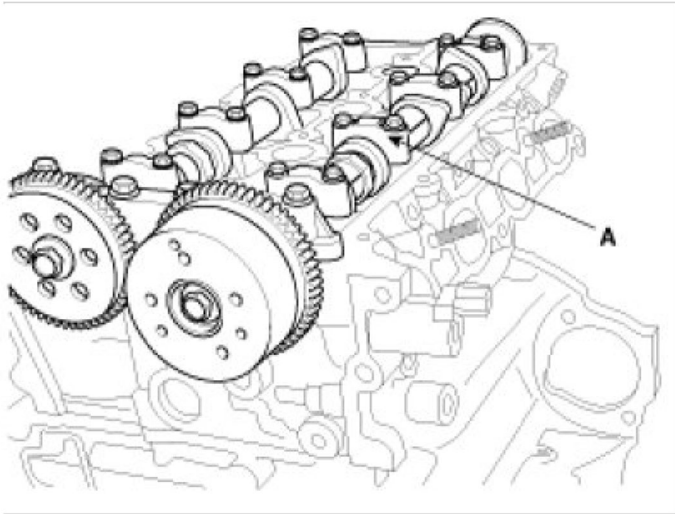
3. Inspect the camshaft end play.

(1) Install the camshafts.

(2) Using a dial indicator, measure the end play while moving the camshaft back and forth.

Camshaft end play

Standard: 0.1 - 0.2mm (0.0039 - 0.0079in)



If the end play is greater than specified, replace the camshaft. If necessary, replace the bearing caps and cylinder head as a set.

(3) Remove the camshafts.

Continuous Variable Valve Timing (CVVT) Assembly

1. Inspect the Continuous variable valve timing (CVVT) assembly.

(1) Fix the Continuous variable valve timing (CVVT) with its camshaft in a vice.

(2) Check that the CVVT assembly will not turn. If it is not turned, it is in normal condition.

(3) Apply vinyl tape to all the parts except the one hole

(4) Using an air gun, apply the pressure, 147.10kpa (1.5kg/cm², 21.33psi) in the hole. This makes the lock pin in maximum retarded state released.

NOTE:

- Wrap it with a shop towel to prevent oil splash.
- After releasing the pin, you can turn the CVVT assembly by hand.
- If there is air leakage, the pin will not release.

(5) Under the condition of (3), turn the CVVT assembly to the advance angle side with your hand.

A. Depending on the air pressure, the CVVT assembly will turn to the advance side.

B. Also, under the condition that the pressure can be hardly applied because of the air leakage from the port, there may be the case that the lock pin could be hardly released.

(6) Except the position where the lock pin meets at the maximum delay angle, let the CVVT assembly turn back and forth and check the movable range and that there is no disturbance.

Standard: Movable smoothly in the range about 25°

(7) Turn the CVVT assembly with your hand counterclockwise and lock it at the maximum delay angle position.

Cylinder Head Reassembly

Reassembly NOTE:

- Thoroughly clean all parts to be assembled.
- Before installing the parts, apply fresh engine oil to all sliding and rotating surface.
- Replace oil seals with new ones.

1. Install the valves.

1) Install the spring seats.

2) Using the SST (09222 - 2B100), push in a new oil seal.

NOTE:

Do not reuse old valve stem oil seals.

Incorrect installation of the seal could result in oil leakage past the valve guides.

CAUTION:

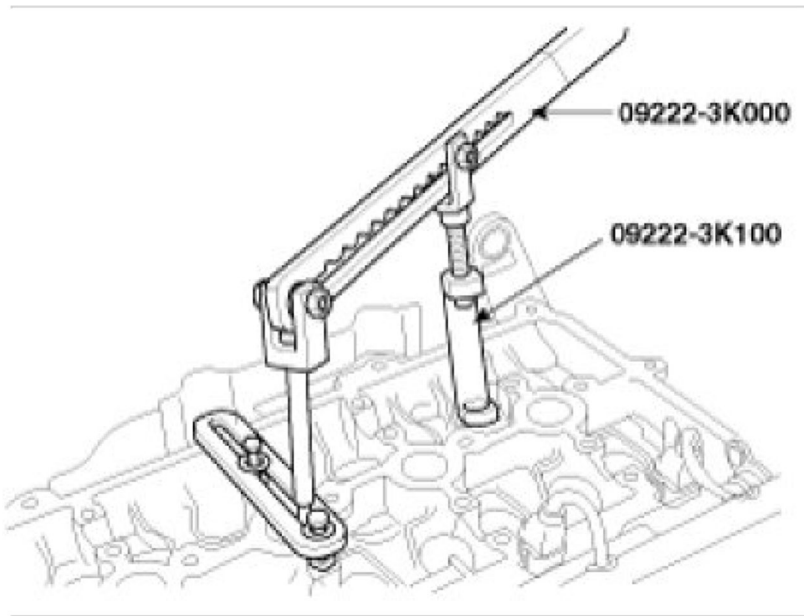
Intake valve stem seals are different from exhaust seals in type. Do not reassemble one in the other's places. (3) Install the valve, valve spring and spring retainer, after applying engine oil at the end of each valve.

NOTE:

When installing valve springs, the enamel coated side should face the valve spring retainer.

2. Using the SST (09222 - 3K000, 09222 - 3K100), compress the spring and install the retainer locks.

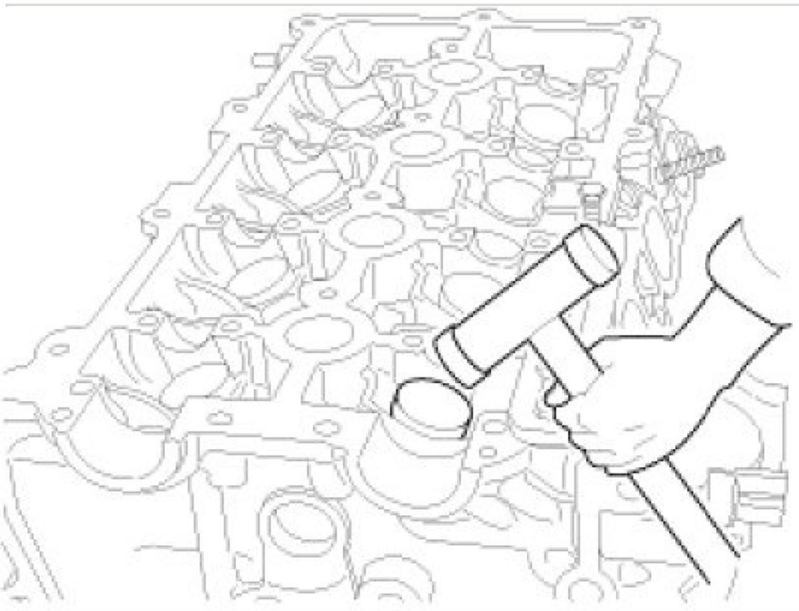
After installing the valves, ensure that the retainer locks are correctly in place before releasing the valve spring compressor.



CAUTION:

When installing the SST, use the torque, 1.2kgf.m or less.

3. Lightly tap the end of each valve stem two or three times with the wooden handle of a hammer to ensure proper seating of the valve and retainer lock.



4. Install the MLA (Mechanical lash adjusters). Check that the MLA rotates smoothly by hand.

NOTE:

All the MLAs should be installed in its original position.

Cylinder Head Installation

Installation

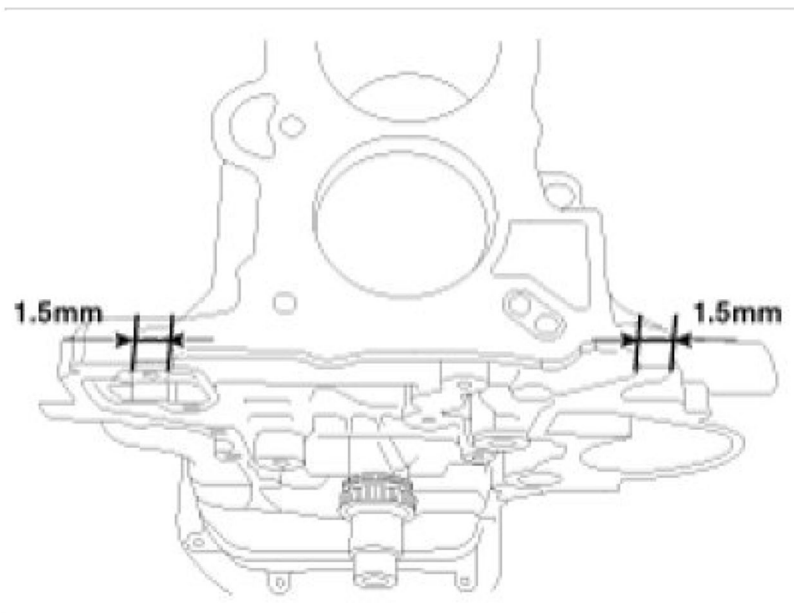
NOTE:

- Thoroughly clean all parts to be assembled.
- Always use a new cylinder head and manifold gasket.
- Always use a new cylinder head bolt.
- The cylinder head gasket is a metal gasket. Take care not to bend it.
- Rotate the crankshaft, set the No.1 piston at TDC.

1. Install the cylinder head assembly.

(1) Before installing, remove the hardened sealant from the cylinder block and cylinder head surface.

(2) Before installing the cylinder head gasket, apply sealant on the upper surface of the cylinder block and reassemble the gasket within five minutes.

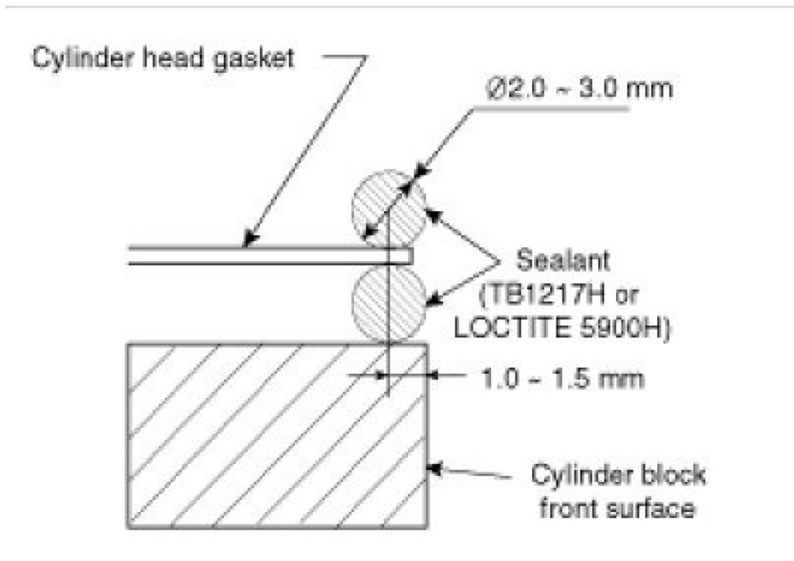


NOTE:

Refer to the illustration for applying sealant.

Use Specification: TB 1217H or LOCTITE 5900H

Width:	2.0 ~ 3.0mm	0.0787 ~ 0.1181in
Position:	1.0 ~ 1.5mm	0.0394 ~ 0.0591in



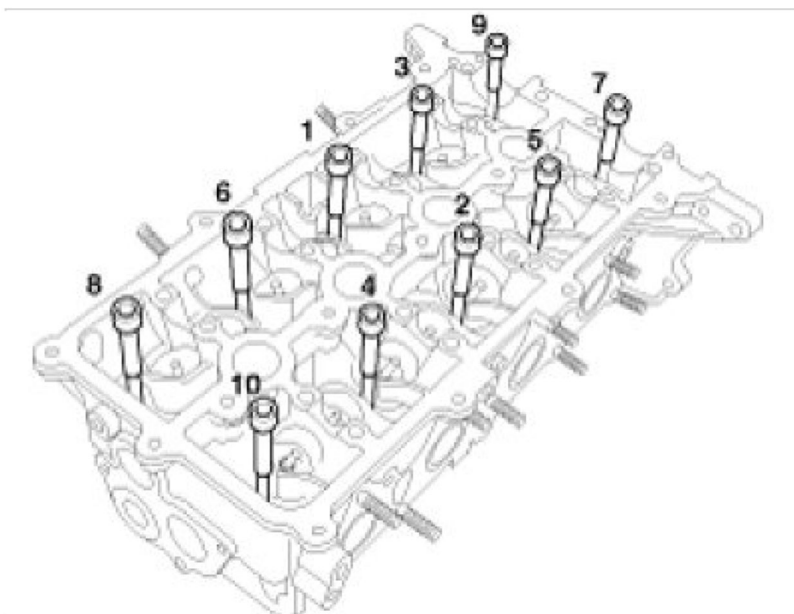
(3) After installing the cylinder head gasket on the cylinder block, apply sealant on the upper surface of the cylinder head gasket and reassemble in five minutes.

2. Place the cylinder head carefully not to damage the gasket.
3. Install the cylinder head bolts with washers.

(1) Tighten the 10, cylinder head bolts, in several passes, in the sequence shown.

Tightening torque:

1st step:	17.7 ~ 21.6 N.m (1.8 ~ 2.2 kgf.m, [13.0 ~ 15.9 lb-ft])
2nd step:	90°~95°
3rd step:	100°~105°



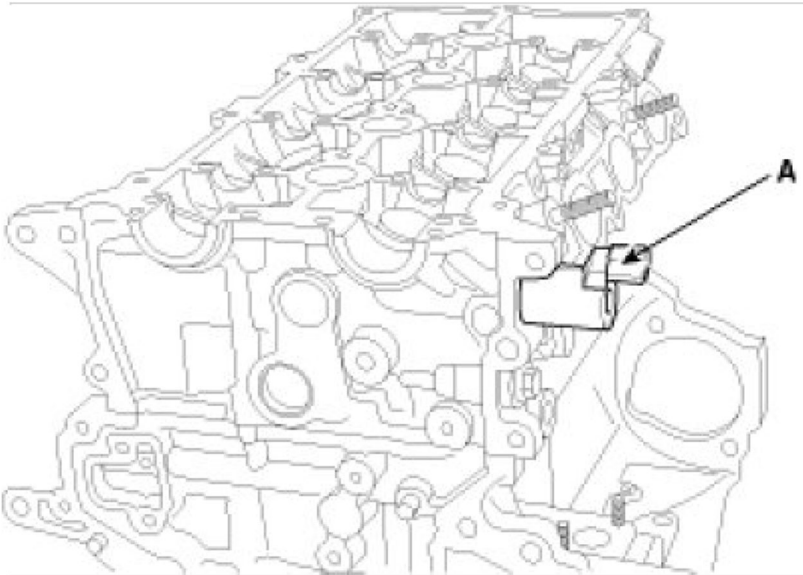
CAUTION:

Always use new cylinder head bolts.

Install the oil control valve (OCV)(A).

Tightening torque:

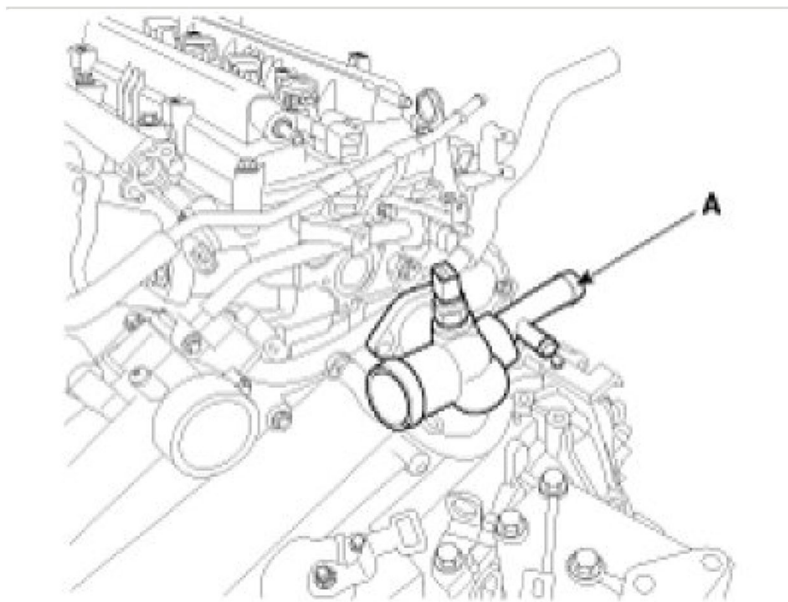
9.8 - 11.8 N.m (1.0 - 1.2 kgf.m, 7.2 - 8.7 lb-ft)



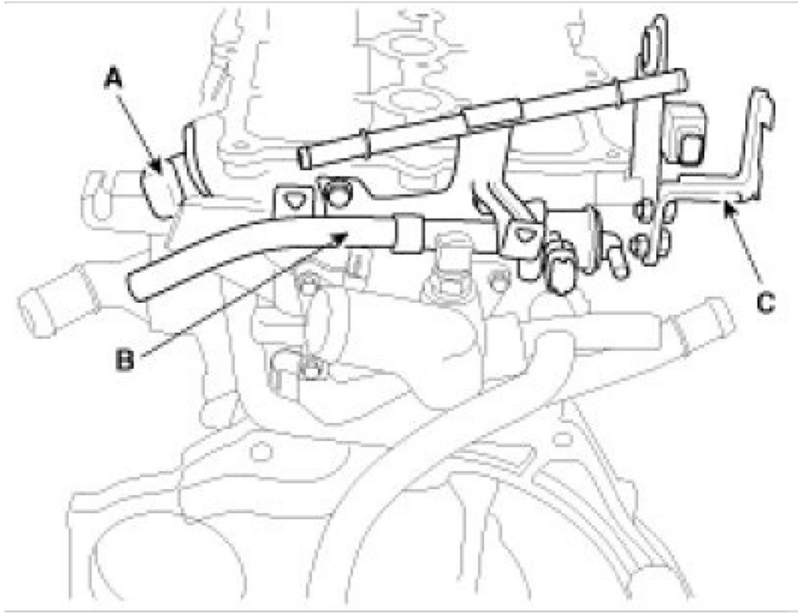
4. Install the water temperature control assembly(A).

Tightening torque:

9.8 - 11.8N.m (1.0 - 1.2kgf.m, 7.2 - 8.7lb-ft)



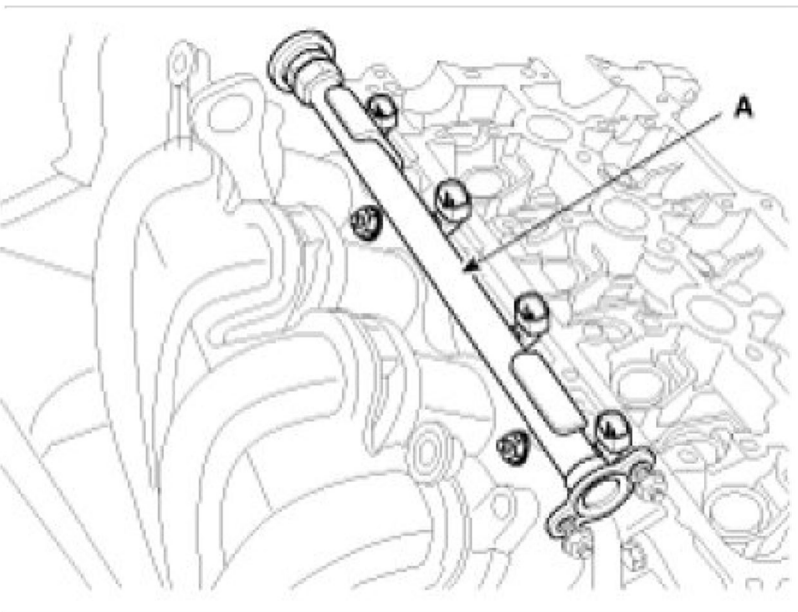
5. Connect the camshaft position sensor (CMP) connector(A) and install the purge control solenoid valve (PCSV) bracket [if equipped] (B) and the module hanger bracket (C).



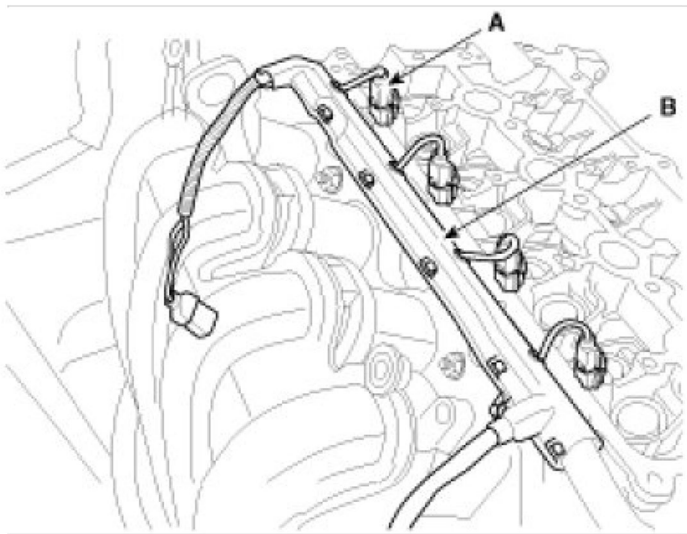
6. Install the intake manifold module assembly.
7. Install the exhaust manifold assembly.
8. Install the delivery pipe assembly(A).

Tightening torque:

19.6 - 24.5N.m (2.0 - 2.5kgf.m, 14.4 - 18.0lb-ft)



9. Install the injector connector(A) and harness bracket(B).



10. Install the camshafts.
 - (1) Before installing, apply engine oil on journals.

CAUTION:

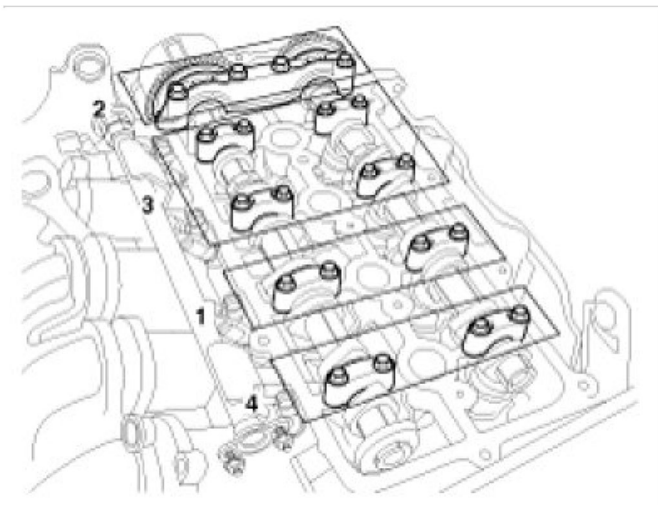
Do not make oil flow down to the front side of the cylinder head.

- (2) After installing, check the valve clearance.
11. Install the camshaft bearing caps with the order below.

Tightening torque:

M6 bolts - 11.8 - 13.7N.m (1.2 - 1.4kgf.m, 8.7 - 10.1lb-ft)

M8 bolts - 18.6 - 22.6N.m (1.9 - 2.3kgf.m, 13.7 - 16.6lb-ft)

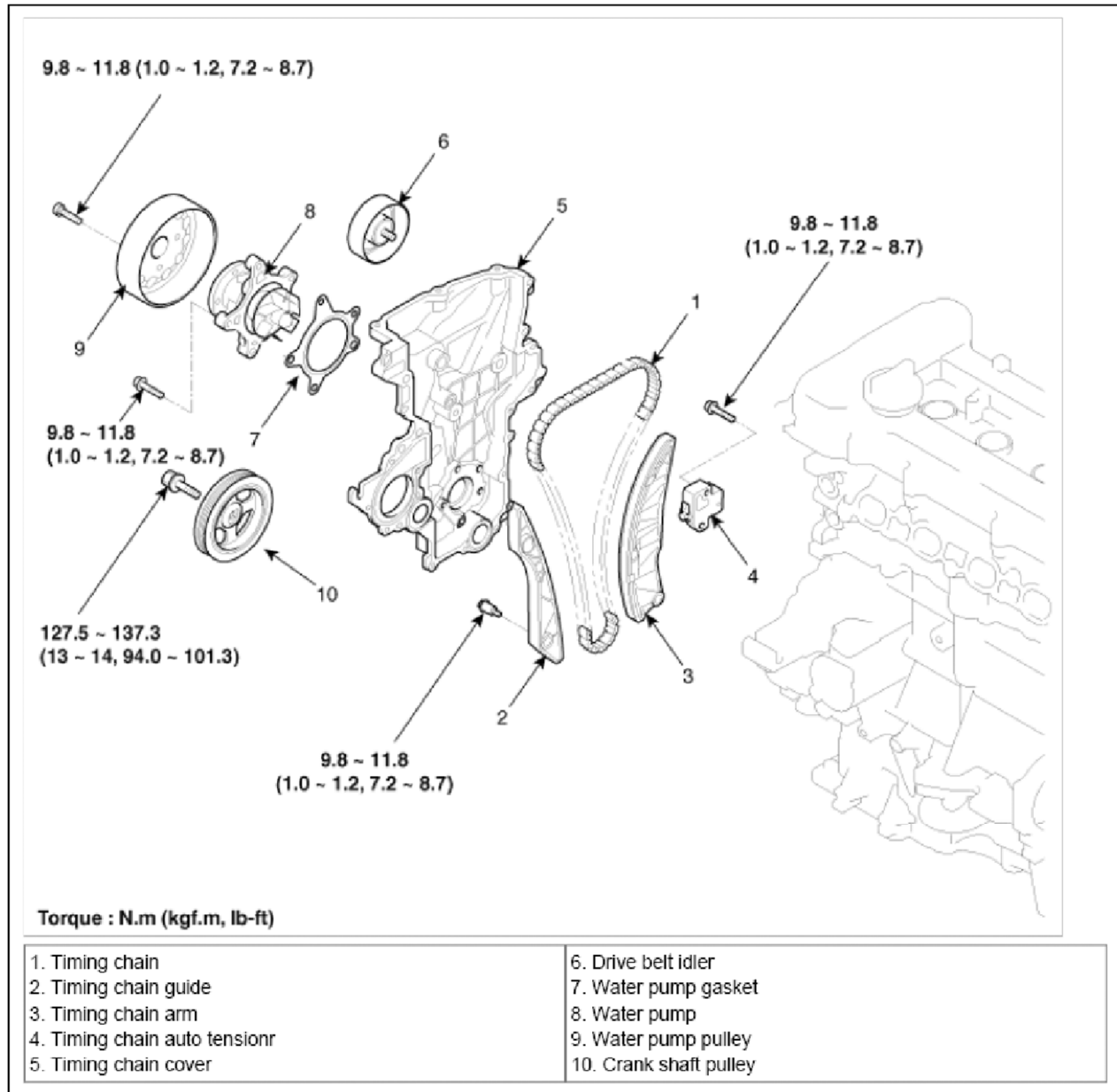


12. Install the intake and exhaust manifold.
13. Install the timingchain.

Timing Chain and Water Pump

Components and Component Locations

Fig 1: Timing System Replacement Components with Torque Specifications



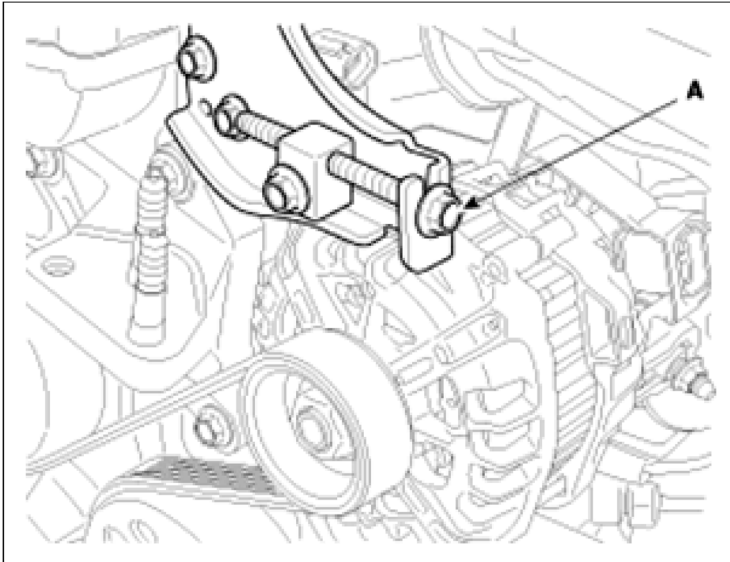
Courtesy of KIA MOTORS AMERICA, INC.

Repair Procedures

Engine removal is not required for this procedure.

1. Loosen the water pump pulley bolt and the drive idler mounting bolt.
2. Loosen the alternator tension adjusting bolt (A) to loosen tension.

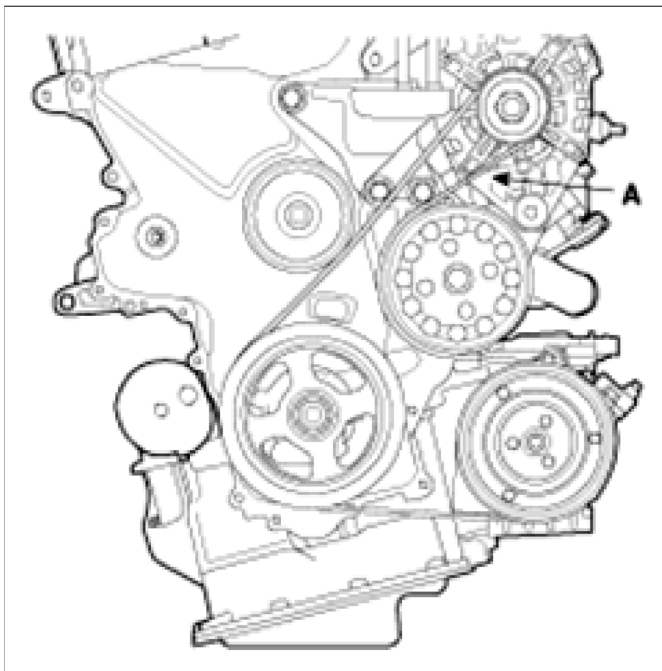
Fig 2: Identifying Alternator Tension Adjusting Bolt



Courtesy of KIA MOTORS AMERICA, INC.

3. Remove the alternator drive belt

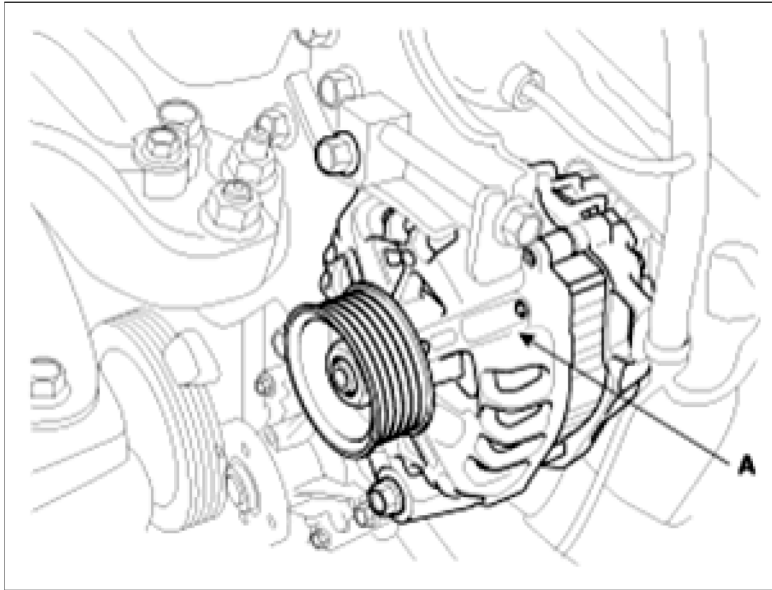
(A) Fig 3: Alternator Drive Belt



Courtesy of KIA MOTORS AMERICA, INC.

4. Remove the alternator (A). (Refer to Alternator)

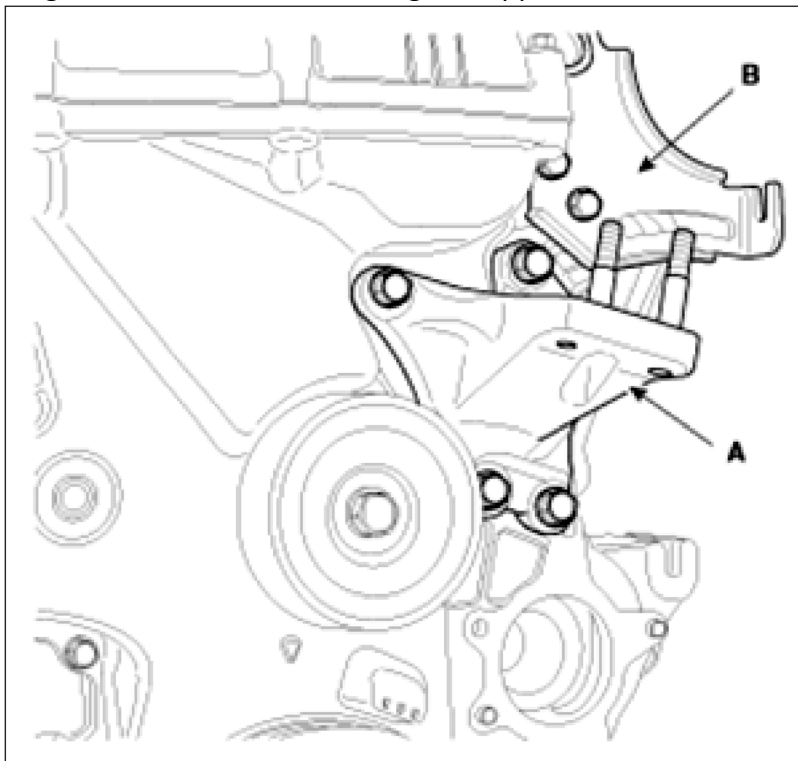
Fig 4: Alternator



Courtesy of KIA MOTORS AMERICA, INC.

5. Remove the alternator bracket (B).
6. Remove the engine support bracket (A).

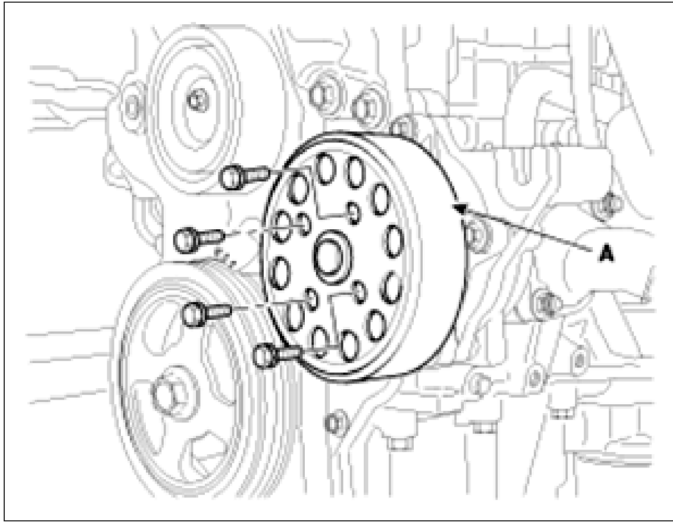
Fig 5: Alternator Bracket & Engine Support Bracket



Courtesy of KIA MOTORS AMERICA, INC.

7. Remove the water pump pulley (A).

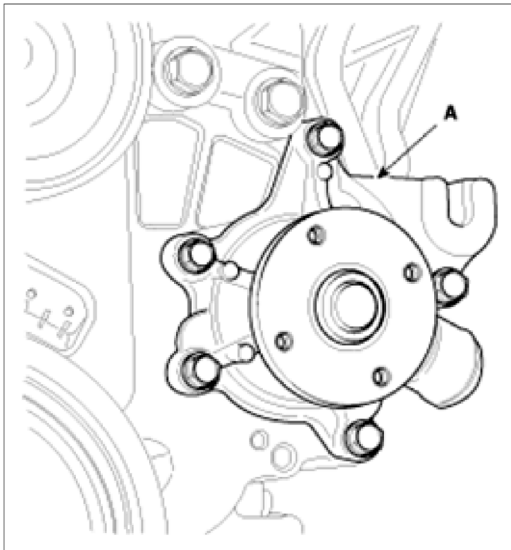
Fig 6: Water Pump Pulley



Courtesy of KIA MOTORS AMERICA, INC.

8. Remove the water pump (A).

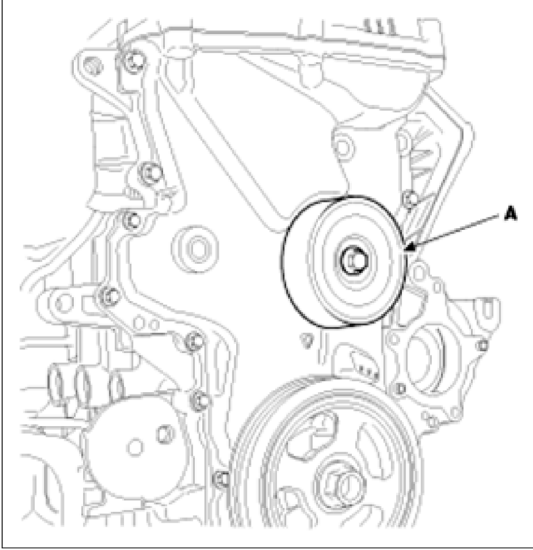
Fig 8: Water Pump



Courtesy of KIA MOTORS AMERICA, INC.

9. Remove the drive belt idler (A).

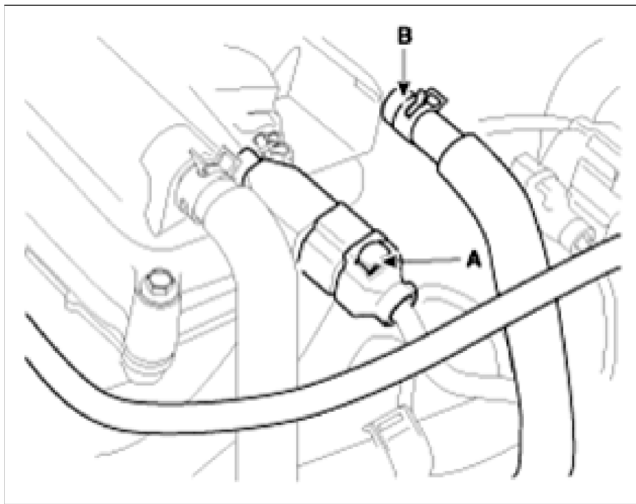
Fig 9: Drive Belt Idler



Courtesy of KIA MOTORS AMERICA, INC.

10. Disconnect the ignition coil connector (A) and the breather hose (B).

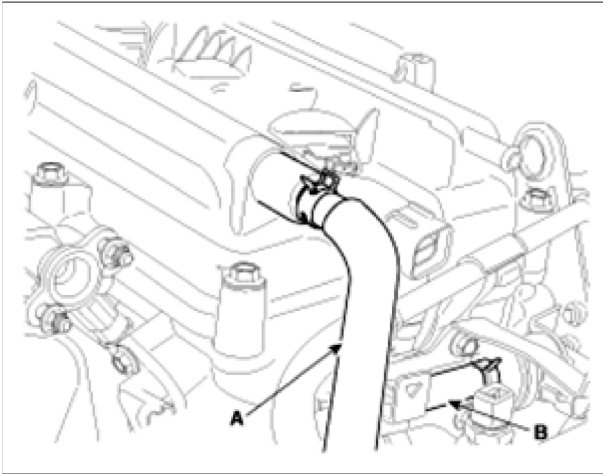
Fig 10: Ignition Coil Connector & Breather Hose



Courtesy of KIA MOTORS AMERICA, INC.

11. Disconnect the positive crankcase ventilation (PCV) hose (A) and PCSV hose (B).

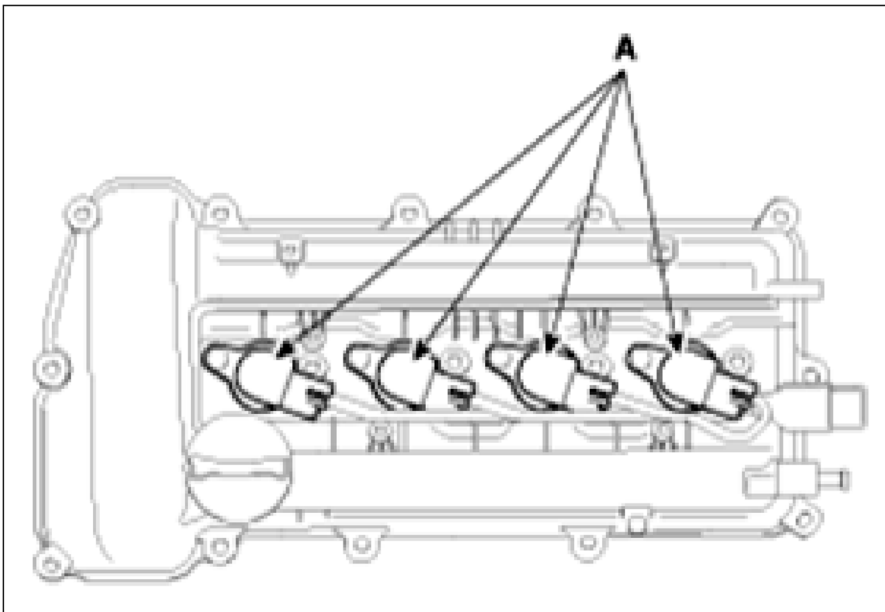
Fig 11: Positive Crankcase Ventilation Hose & PCSV Hose



Courtesy of KIA MOTORS AMERICA, INC.

12. Remove the ignition coils (A).

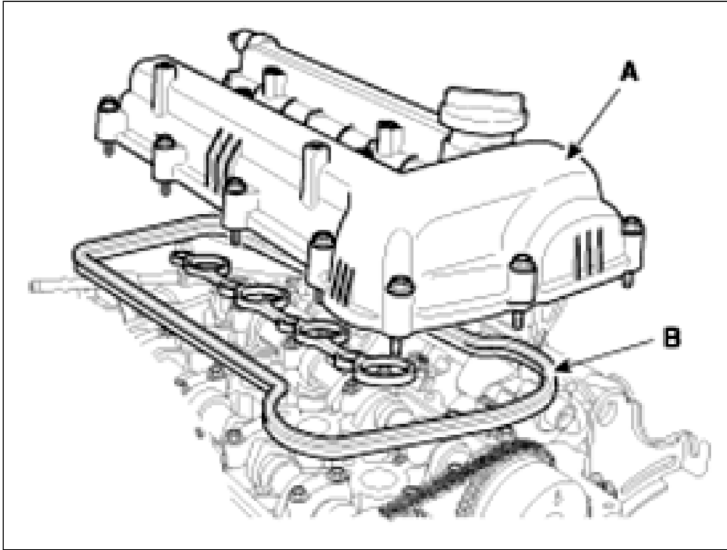
Fig 12: Ignition Coils



Courtesy of KIA MOTORS AMERICA, INC.

13. Remove the cylinder head cover (A) with the gasket (B).

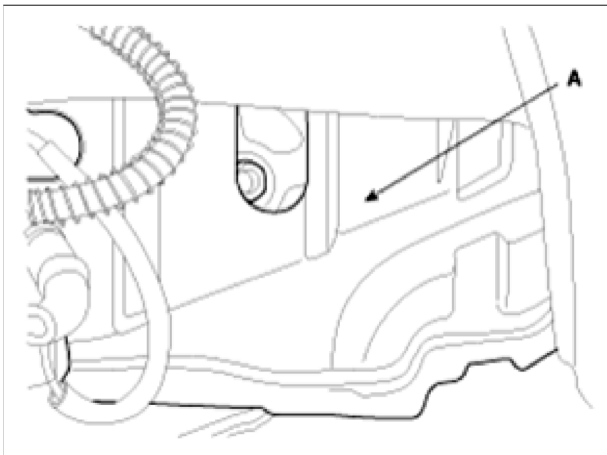
Fig 13: *Identifying Cylinder Head Cover & Gasket*



Courtesy of KIA MOTORS AMERICA, INC.

14. Remove side cover.

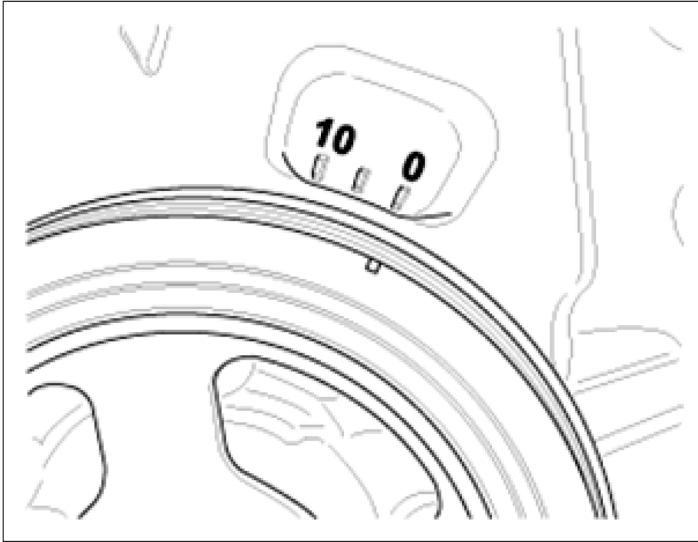
Fig 14: Side Cover



Courtesy of KIA MOTORS AMERICA, INC.

15. Turn the crankshaft pulley clockwise and align its groove with the timing mark of the timing chain cover.

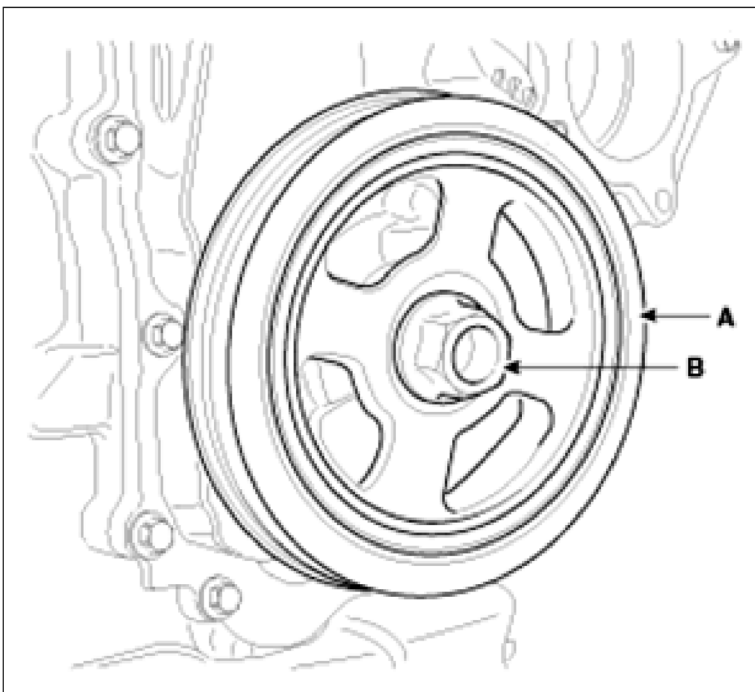
Fig 15: Aligning Groove of Crankshaft Pulley with Timing Mark on Cover



Courtesy of KIA MOTORS AMERICA, INC.

16. Remove the crankshaft bolt (B) and crankshaft pulley (A).

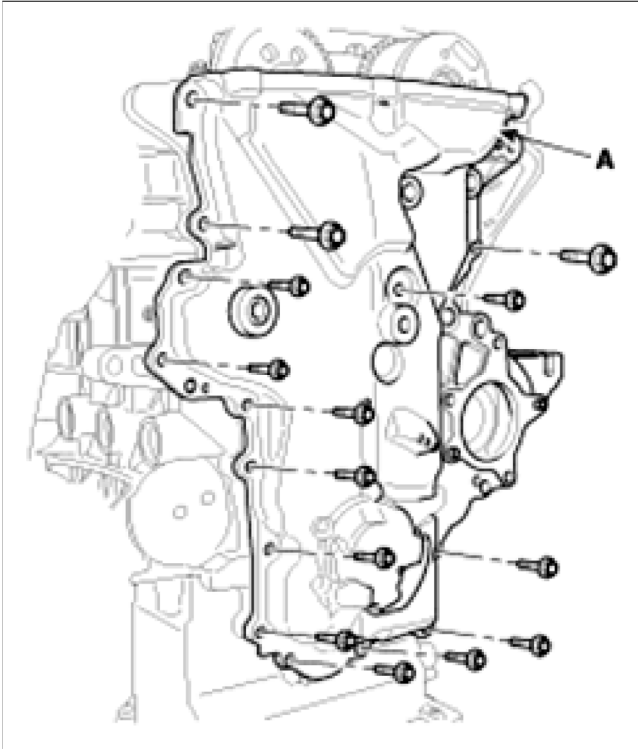
Fig 16: Crankshaft Bolt & Crankshaft Pulley



Courtesy of KIA MOTORS AMERICA, INC.

17. Remove the timing chain cover (A).

Fig 17: Timing Chain Cover



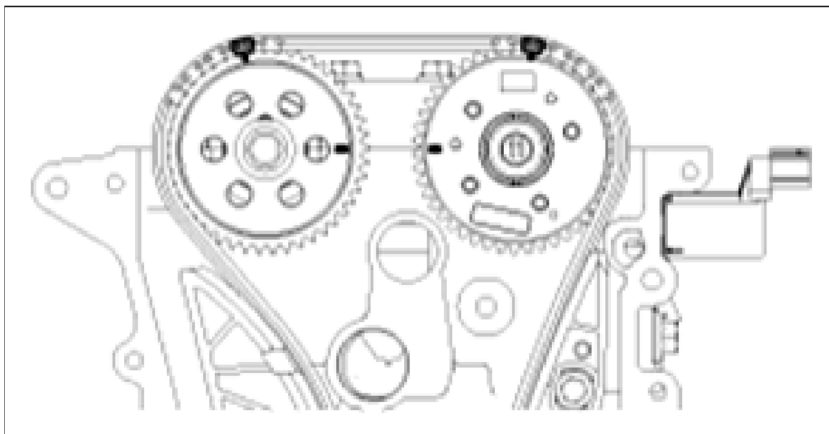
Courtesy of KIA MOTORS AMERICA, INC.

18. Align the timing marks of the camshaft sprocket with the upper surface of the cylinder head to make No. 1 cylinder be positioned at TDC.

1. Check the dowel pin of the crankshaft for facing upside of the engine at this moment.

CAUTION: Put paint marks on the timing chain links (3 places) that meet with the timing marks of the camshaft sprockets and the crankshaft sprocket.

Fig 18: Aligning Timing Marks

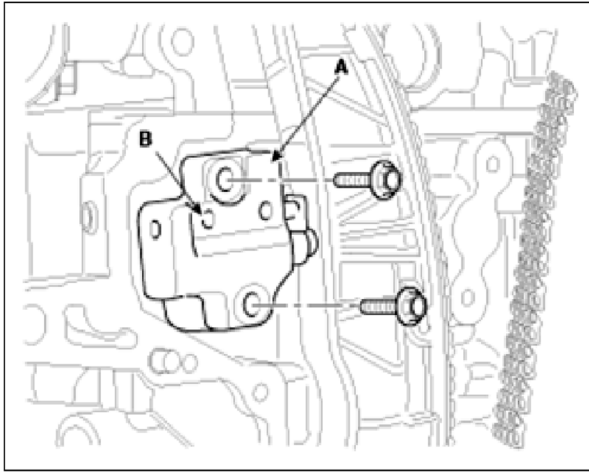


Courtesy of KIA MOTORS AMERICA, INC.

19. Remove the hydraulic tensioner (A).

CAUTION: Before removing the tensioner, fix the piston of the tensioner with a pin through the hole (B) at TDC.

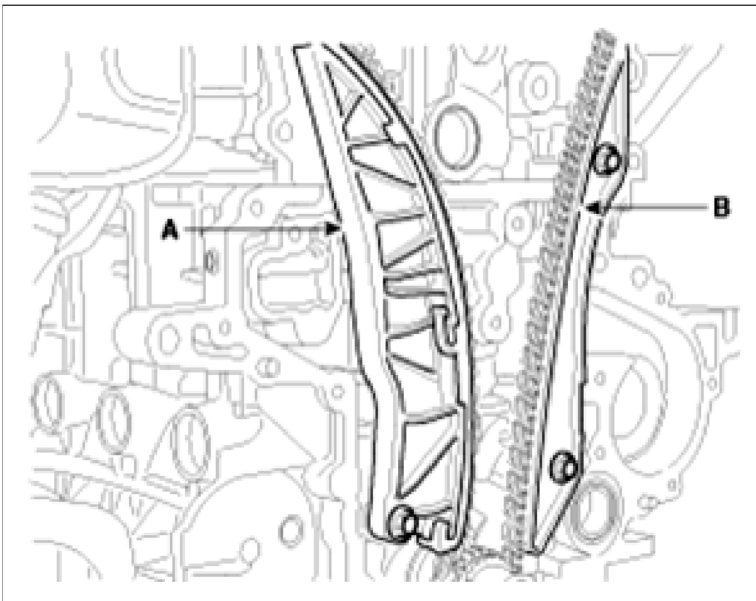
Fig 19: Hvdraulic Tensioner & Hole



Courtesy of KIA MOTORS

20. Remove the timing chain tensioner arm (A) and guide (B).

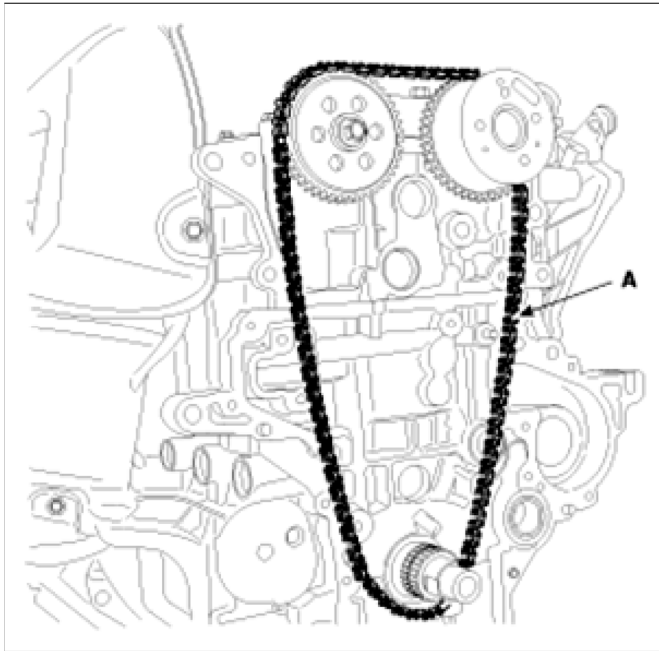
Fig 20: Timing Chain Tensioner Arm & Guide



Courtesy of KIA MOTORS AMERICA, INC.

21. Remove the timing chain (A).

Fig 21: Timing Chain



Courtesy of KIA MOTORS AMERICA, INC.

Inspection

Sprockets, Hydraulic Tensioner, Chain Guide, Tensioner Arm

1. Check the camshaft sprocket, crankshaft sprocket teeth for abnormal wear, cracks, or damage. Replace if necessary.
2. Check a contact surface of the chain tensioner arm and guide for abnormal wear, cracks, or damage. Replace if necessary.
3. Check the hydraulic tensioner for its piston stroke and ratchet operation. Replace if necessary.

Belt, Idler, Pulley

1. Check the idler for excessive oil leakage, abnormal rotation, or vibration. Replace if necessary.
2. Check belt for maintenance and abnormal wear of V-ribbed part. Replace if necessary.
3. Check the pulleys for vibration in rotation, oil or dust deposit of V-ribbed part. Replace if necessary.

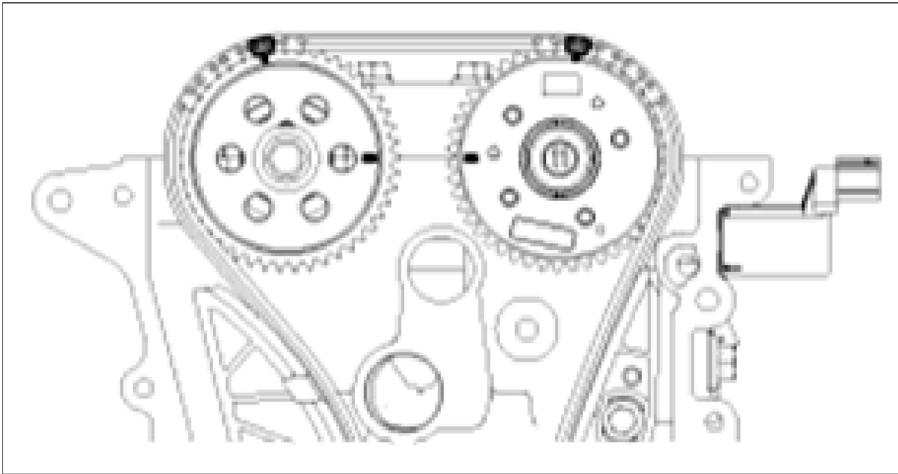
NOTE:

1. Do not bend, twist, or turn the timing belt inside out.
2. Do not allow the timing belt to come into contact with oil, water and steam.

Installation

1. Align the timing marks of the camshaft sprocket with the upper surface of the cylinder head to make No. 1 cylinder be positioned at TDC.

Fig 22: Aligning Timing Marks



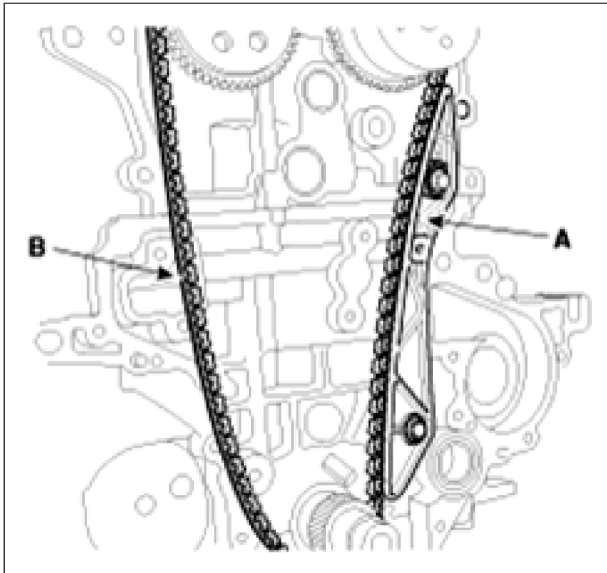
Courtesy of KIA MOTORS AMERICA, INC.

1. Check the dowel pin of the crankshaft for facing upside of the engine at this moment.
2. Install the timing chain guide (A).

Tightening torque:

9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)

Fig 23: Timing Chain Guide



Courtesy of KIA MOTORS AMERICA, INC.

3. When installing a timing chain, align the timing marks on the sprockets with paint marks of the chain.

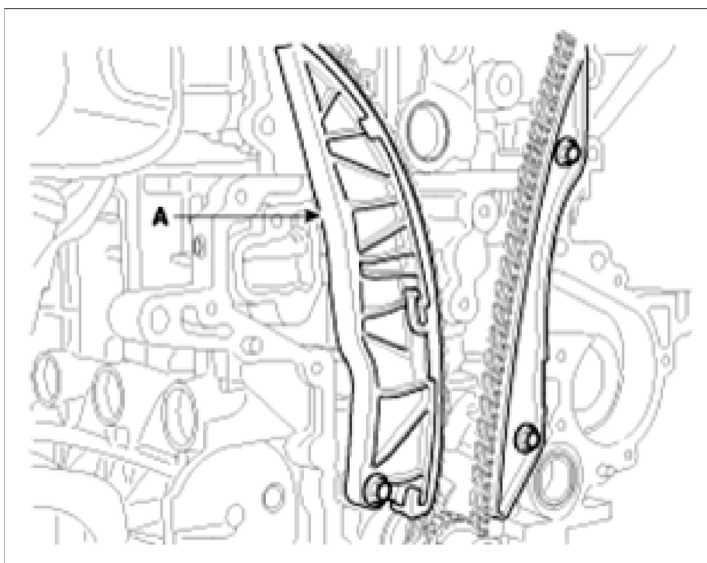
Order: Crankshaft sprocket → Timing chain guide → Intake camshaft sprocket → Exhaust camshaft sprocket.

2. Install the chain tensioner arm (A).

Tightening torque:

9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)

Fig 24: Chain Tensioner Arm



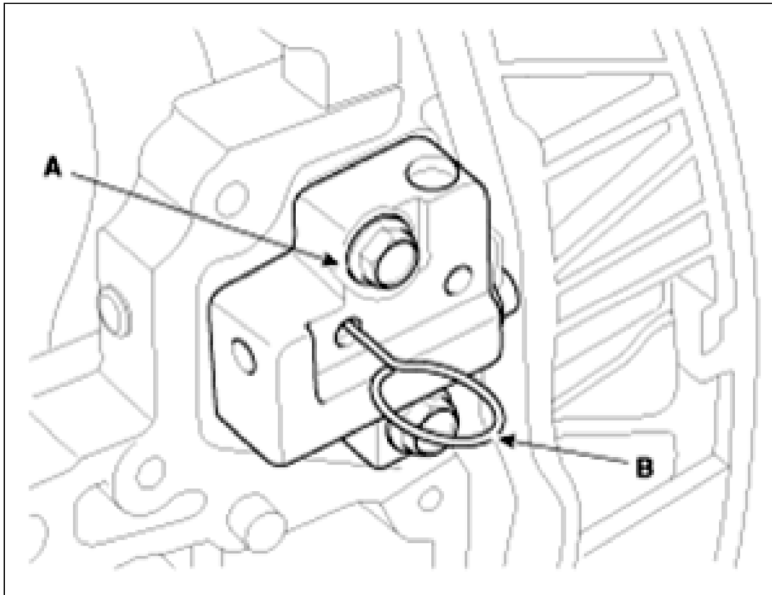
Courtesy of KIA MOTORS AMERICA, INC.

3. Install the hydraulic tensioner (A) and remove the pin (B).

Tightening torque:

9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)

Fig 25: Hydraulic Tensioner & Pin

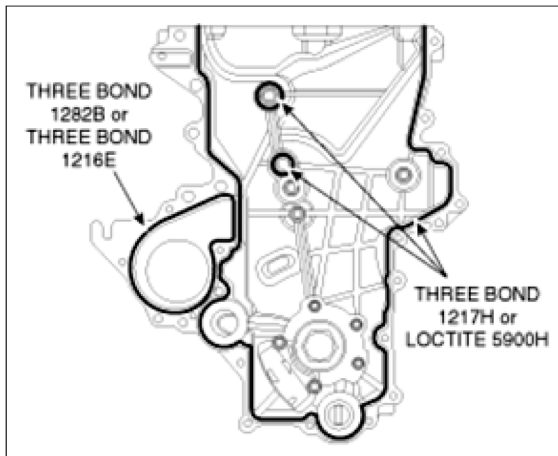


Courtesy of KIA MOTORS AMERICA, INC.

NOTE: Recheck the top dead center (TDC) marks on the crankshaft and camshaft.

4. Install the timing chain cover (A).
1. Before installing, remove the hardened sealant from the cylinder block and ladder frame surface.
2. Apply the liquid gasket (TB 1217H or LOCTITE 5900H) on the surface between the cylinder head and the cylinder block.

Width: 3 ~ 5mm (0.1181~0.1969in.) Fig 26: Applying Liquid Gasket Between Cylinder Head & Cylinder Block



Courtesy of KIA MOTORS AMERICA, INC.

3. Apply the liquid gasket, THREE BOND 1282B or THREE BOND 1216E on the water pump contact parts of the timing chain cover and THREE BOND 1217H or LOCTITE 5900H on the rest parts. Reassemble the cover (A) within 5 minutes.

Width: 3.5 ~ 4.5 mm (0.1378 ~ 0.1772 in.)

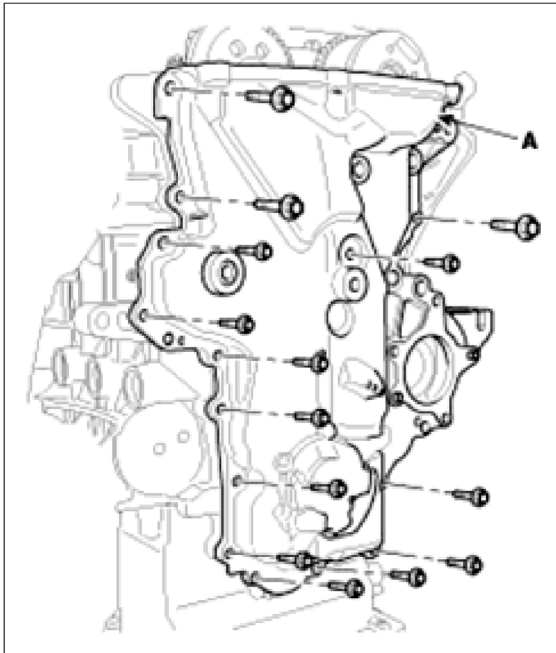
CAUTION: *Thoroughly remove oil or dust from the surface.*

4. Align the dowel pin of the cylinder block and the holes of the oil pump.

Tightening torque:

12mm bolts	18.6 ~ 23.5 N.m (1.9 ~ 2.4 kgf.m, 13.7 ~ 17.4 lb ft)
10mm bolts	9.8 ~ 11.8 Nm (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb ft)

Fig 27: Timing Chain Cover

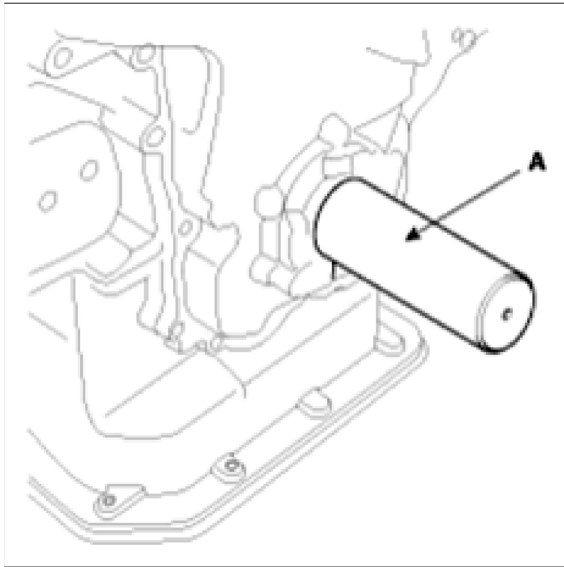


Courtesy of KIA MOTORS AMERICA, INC.

CAUTION: *After the installation, do not crank engine or apply pressure on the cover for half an hour.*

5. Using the SST (09455-21200), reassemble the timing chain cover oil seal (A).

Fig 28: Timing Chain Cover Oil Seal



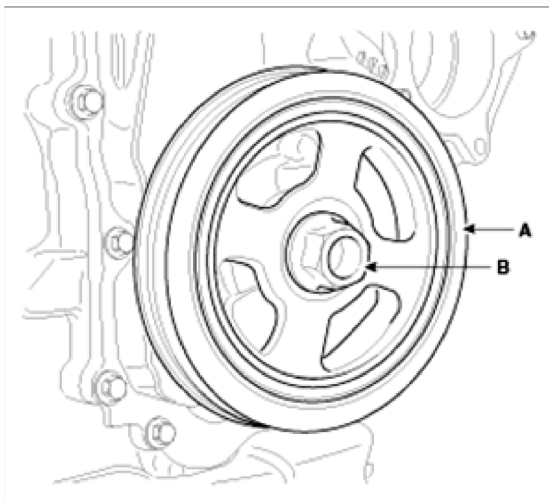
Courtesy of KIA MOTORS AMERICA, INC.

6. Install the crankshaft pulley (A).

Tightening torque:

127.5 ~ 137.3N.m (13.0 ~ 14.0kgf.m, 94.0 ~ 101.3lb-ft)

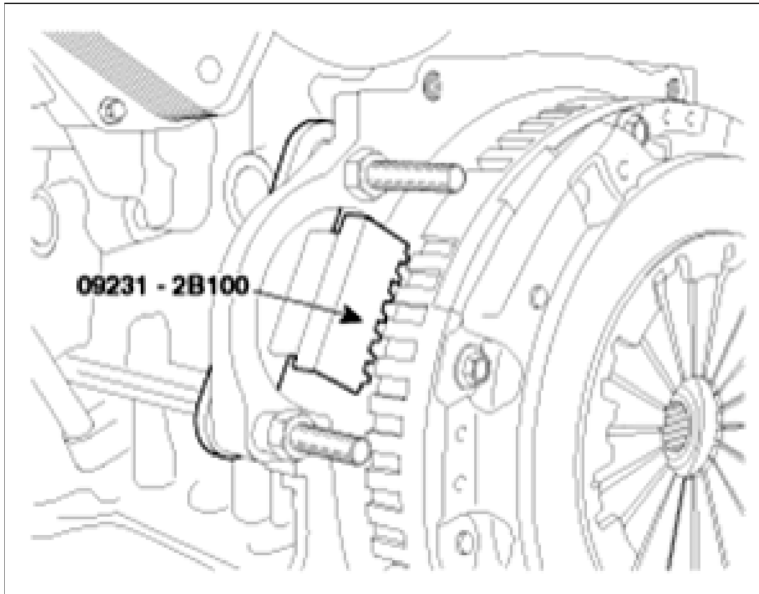
Fig 29: Identifying Crankshaft Pulley & Bolt



Courtesy of KIA MOTORS AMERICA, INC.

NOTE: When installing the pulley, remove the starter and fix the SST (09231-2B100).

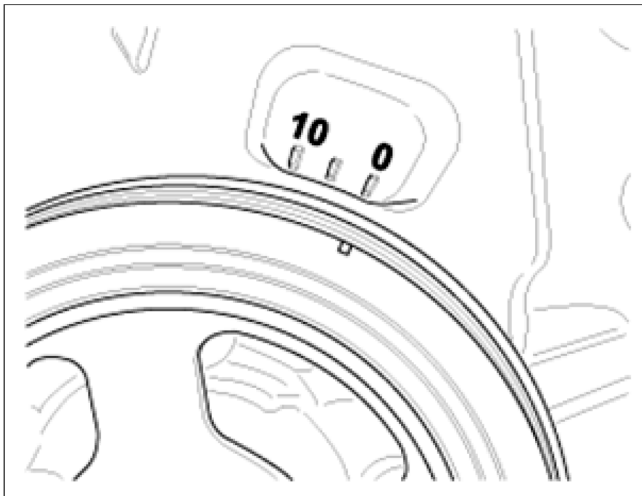
Fig 30: Removing Starter & Attaching SST When Installing Pulley



Courtesy of KIA MOTORS AMERICA, INC.

NOTE: When installing the pulley, the groove on the pulley should be positioned outside.

Fig 31: Positioning Groove on Pulley



Courtesy of KIA MOTORS AMERICA, INC.

7. Install side cover.

Tightening torque:

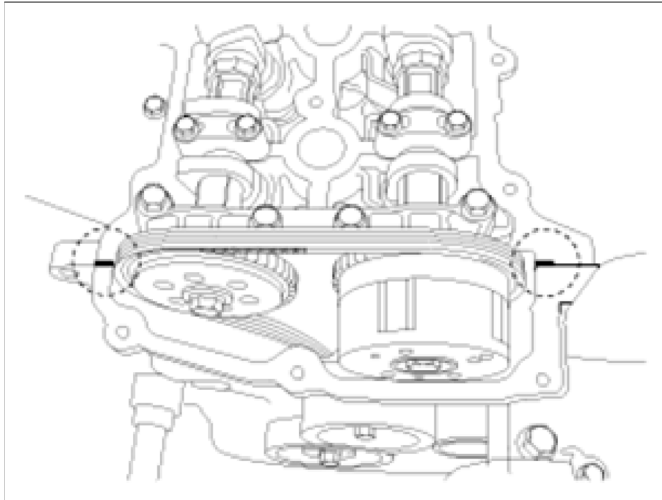
8.8 ~ 10.8 N.m (0.9 ~ 1.1 kgf.m, 6.5 ~ 8.0 lb-ft)

8. Before installing the cylinder head cover, remove oil, dust or hardened sealant from the timing chain cover and the cylinder head upper surface.

- After applying the liquid gasket, THREE BOND 1217H or LOCTITE 5900H on the cylinder head cover, reassemble the cover within five minutes.

Width: 2.0 ~ 2.5mm (0.0787~0.0984in.)

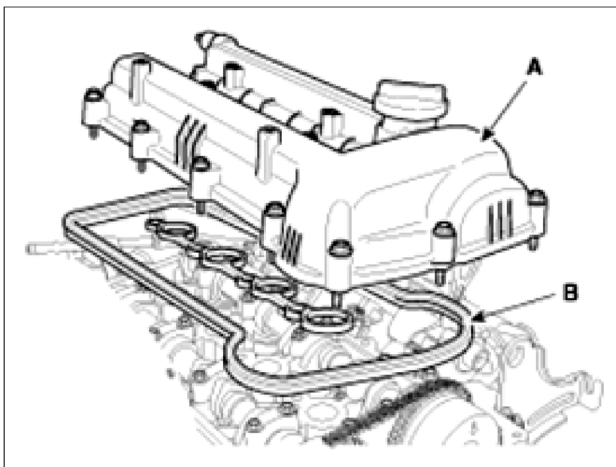
Fig 32: Applying Liquid Gasket on Cylinder Head Cover



Courtesy of KIA MOTORS AMERICA, INC.

- Install the cylinder head cover (A) with a new gasket (B).

Fig 33: Cylinder Head Cover & Gasket



Courtesy of KIA MOTORS AMERICA, INC.

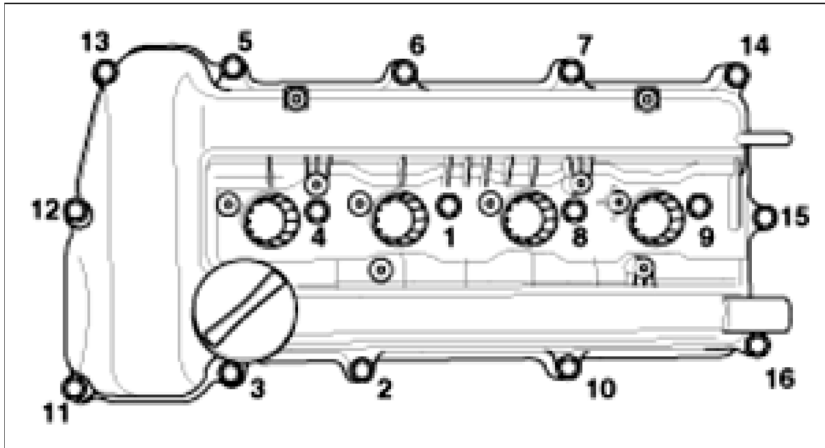
CAUTION: Do not reuse the gasket.

- Tighten the cylinder head cover bolts (A) with the order and steps.

Tightening torque:

1st step	3.9 ~ 5.9N.m (0.4 ~ 0.6kgf.m, 2.9 ~ 4.3lb ft)
2nd step	7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb ft)

Fig 34: Tightening Sequence of Cylinder Head Cover Bolts



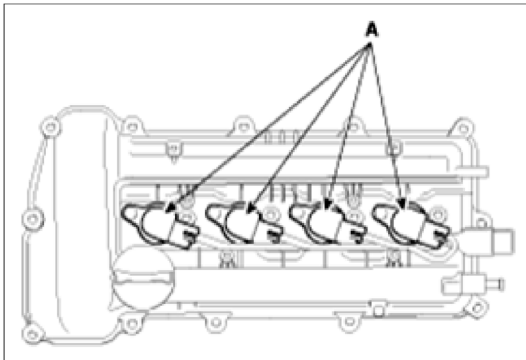
Courtesy of KIA MOTORS AMERICA, INC.

12. Install the ignition coils (A).

Tightening torque:

9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)

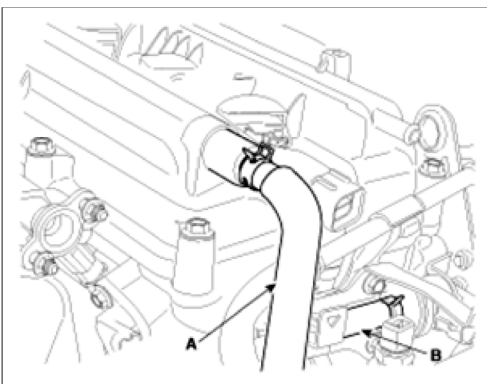
Fig 35: Ignition Coils



Courtesy of KIA MOTORS AMERICA, INC.

13. Install the positive crankcase ventilation (PCV) hose (A) and the positive and PCSV hose (B).

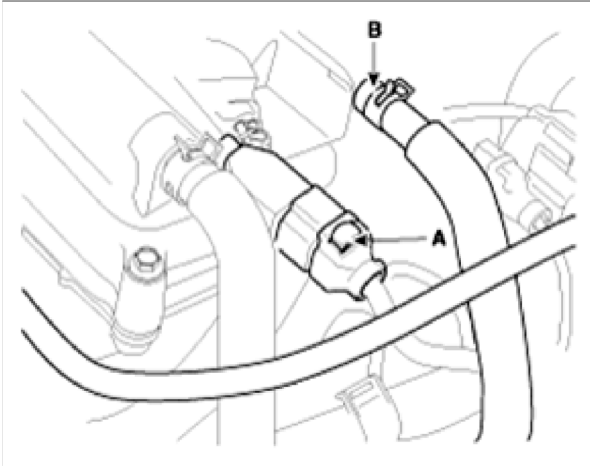
Fig 36: Positive Crankcase Ventilation Hose & PCSV Hose



Courtesy of KIA MOTORS AMERICA, INC.

14. Connect the ignition coil connector (A) and the breather hose (B).

Fig 37: Ignition Coil Connector & Breather Hose



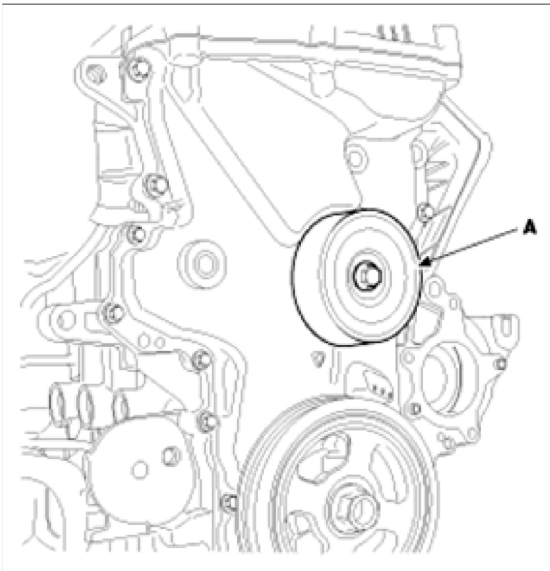
Courtesy of KIA MOTORS AMERICA, INC.

15. Install the drive belt idler (A).

Tightening torque:

42.2 ~ 53.9 N.m (4.3 ~ 5.5 kgf.m, 31.1 ~ 39.8 lb-ft)

Fig 38: Drive Belt Idler



Courtesy of KIA MOTORS AMERICA, INC.

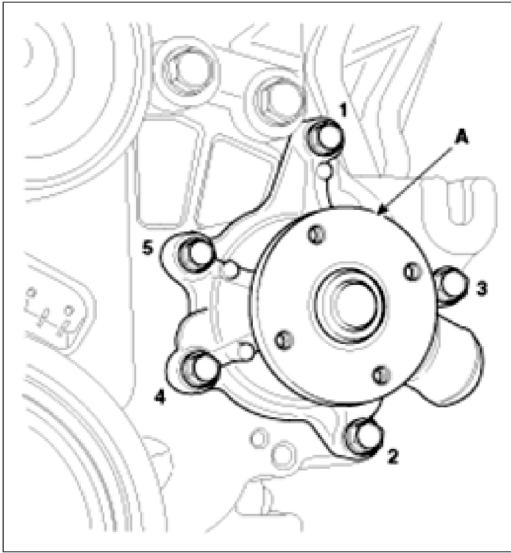
16. Install the water pump (A) with a gasket.

Tighten bolts with the order shown in Fig

39. Tightening torque:

9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)

Fig 39: Tightening Sequence of Water Pump Bolts



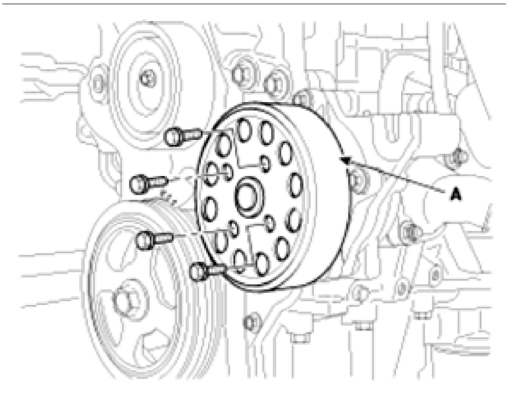
Courtesy of KIA MOTORS AMERICA, INC.

17. Install the water pump pulley (A).

Tightening torque:

9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)

Fig 40: Water Pump Pulley



Courtesy of KIA MOTORS AMERICA, INC.

CAUTION: Tighten the bolts diagonally.

18. Install the engine support bracket (A).

Tightening torque:

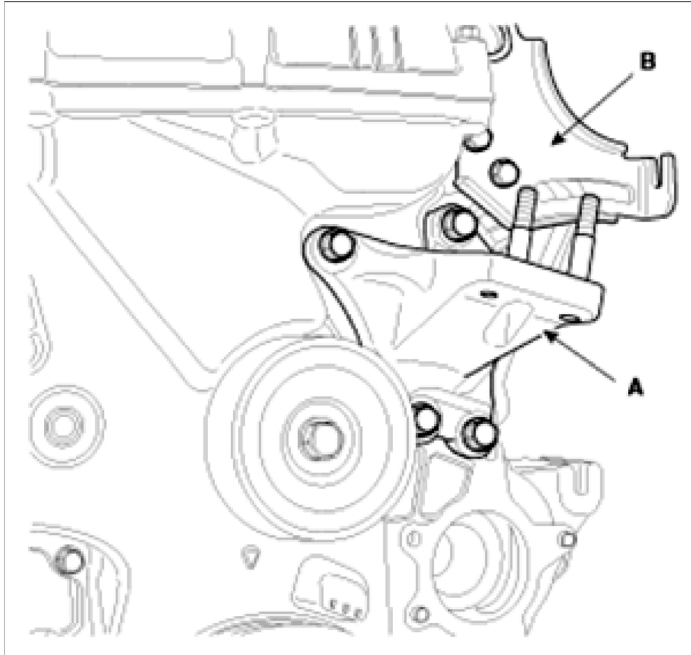
29.4 ~ 41.2 N.m (3.0 ~ 4.2 kgf.m, 21.7 ~ 30.4 lb-ft)

19. Install the alternator bracket (B).

Tightening torque:

19.6 ~ 26.5 N.m (2.0 ~ 2.7 kgf.m, 14.5 ~ 19.5 lb-ft)

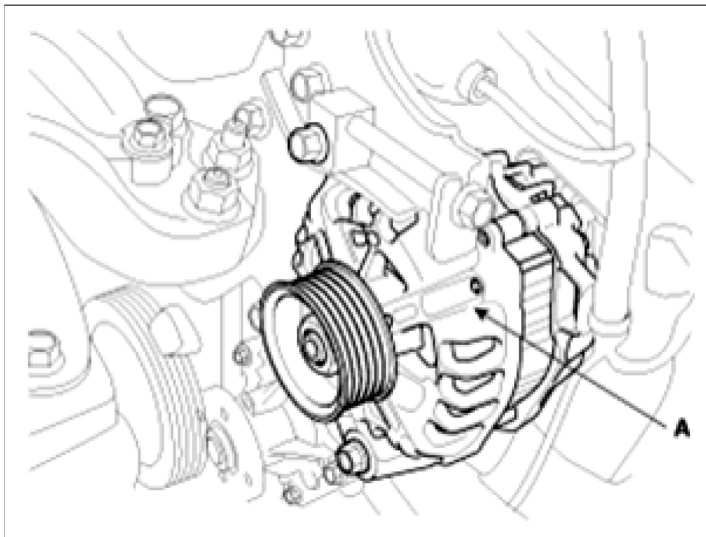
Fig 41: Engine Support Bracket & Alternator Bracket



Courtesy of KIA MOTORS AMERICA, INC.

20. Install the alternator (A) and pre-tighten the mounting bolts.

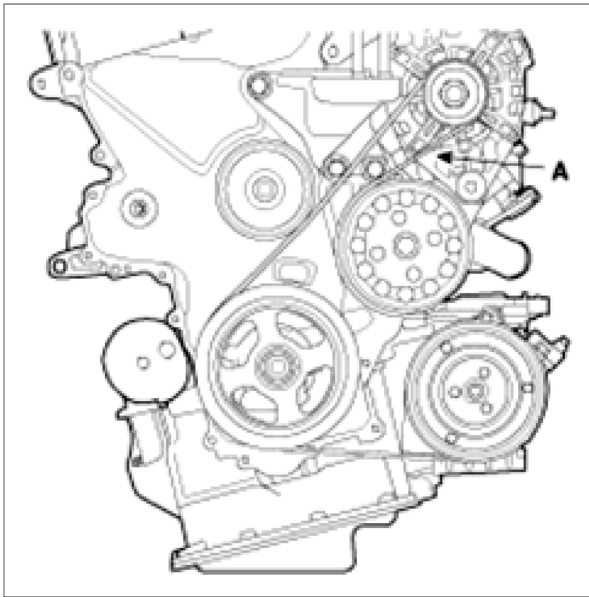
Fig 43: Alternator & Mounting Bolts



Courtesy of KIA MOTORS AMERICA, INC.

21. Install the drive belt (A).

Fig 44: Engine Drive Belt Routing Diagram



Courtesy of KIA MOTORS AMERICA, INC.

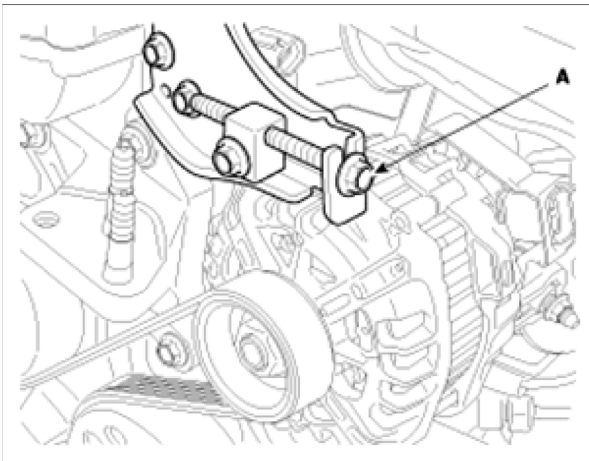
22. Adjust tension by tightening the alternator tension adjust bolt (A). (Refer to DRIVE BELT TENSION MEASUREMENT AND ADJUSTMENT)

Tension

New belt: 882.6 ~ 980.7N (90 ~ 100kg, 198.4 ~ 220.5lb)

Used belt: 637.4 ~ 735.5N (65 ~ 75kg, 143.3 ~ 165.3lb)

Fig 45: Alternator Tension Adjust Bolt



Courtesy of KIA MOTORS AMERICA, INC.

23. Tighten the alternator mounting bolts.

Tightening torque:

12mm bolt	19.6 ~ 26.5 N.m (2.0 ~ 2.7 kgf.m, 14.5 ~ 19.5 lb ft)
14mm bolt	29.4 ~ 41.2 N.m (3.0 ~ 4.2 kgf.m, 21.7 ~ 30.4 lb ft)

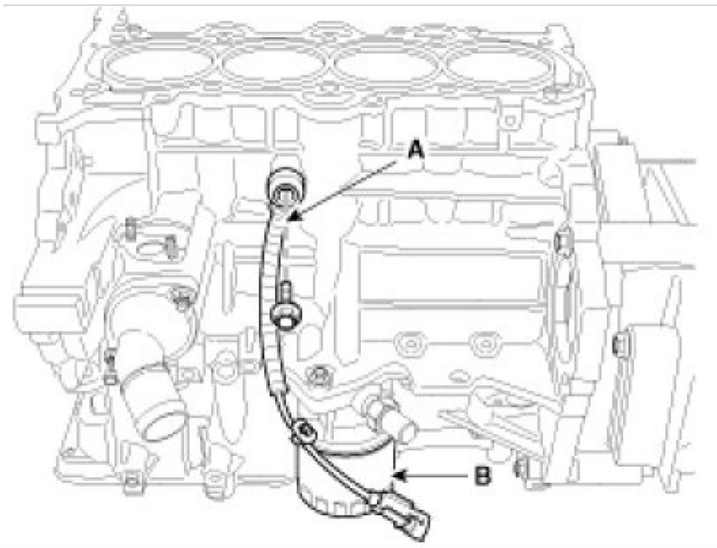
Engine Overhaul

Engine Block Disassembly

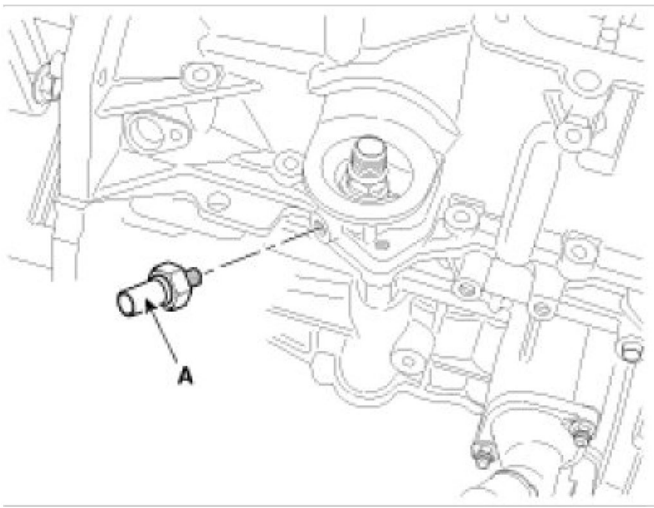
Disassembly

Engine removal from the equipment is required for this procedure.

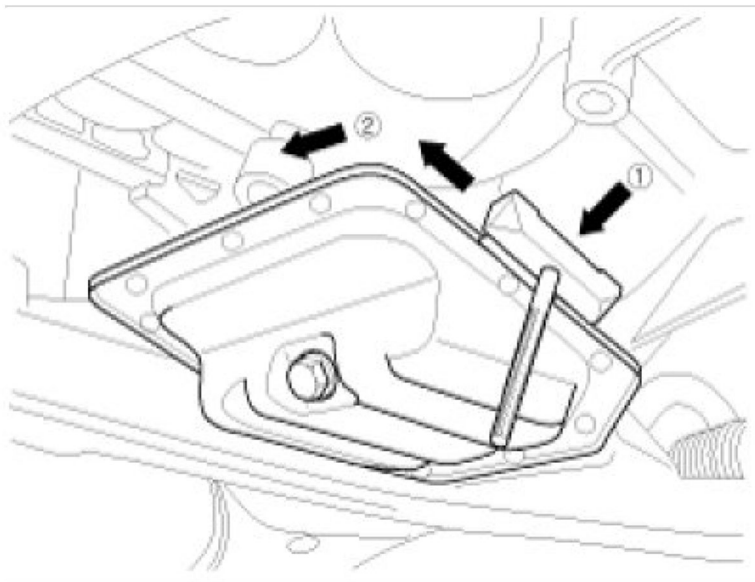
1. M/T: Remove the fly wheel.
2. A/T: Remove the drive plate.
3. Use an engine stand for disassembly.
4. Remove the timingchain.
5. Remove the cylinderhead.
6. Remove the oil level gauge tube.
7. Remove the knock sensor(A) and the oil filter(B).



8. Remove the oil pressure switch(A).



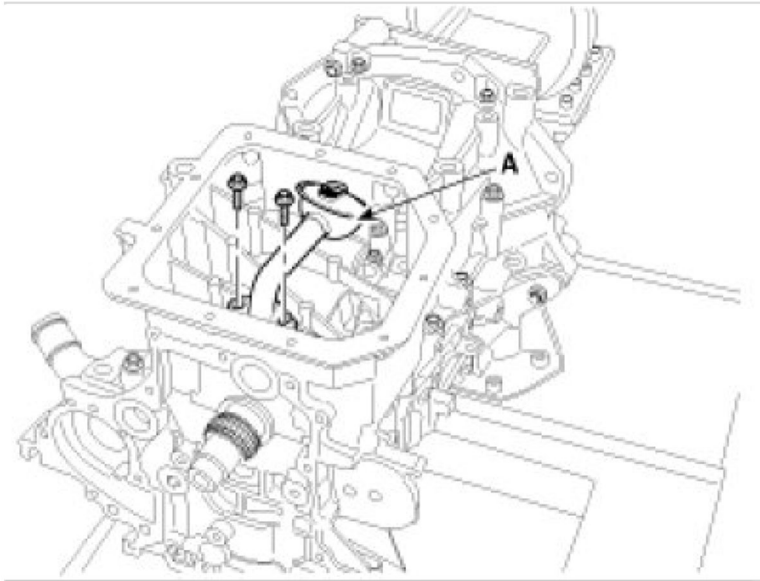
9. Using the SST (09215-3C000), remove the oil pan (A).



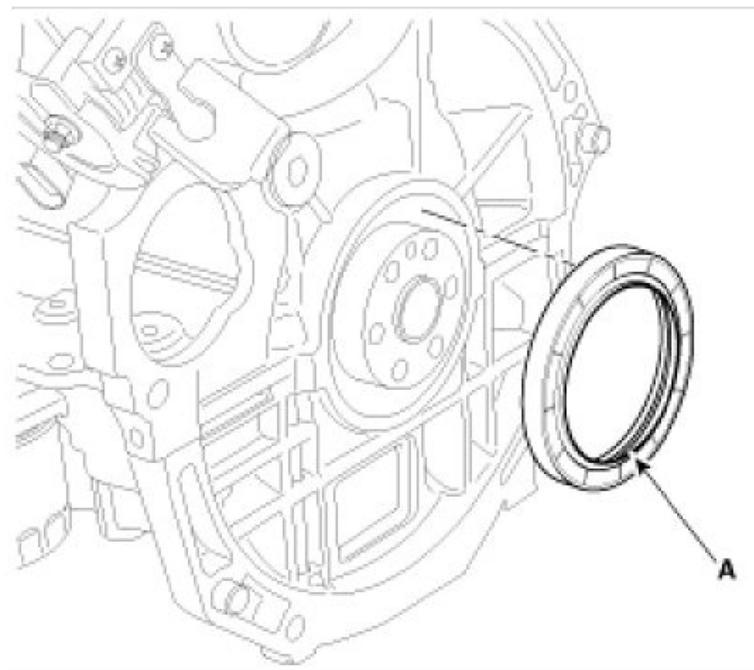
CAUTION:

- Insert the SST between the oil pan and the ladder frame by tapping it with a plastic hammer in the direction of 1 arrow.
- After tapping the SST with a plastic hammer along the direction of 2 arrow around more than 2/3 edge of the oil pan, remove it from the ladder frame.
- Do not turn over the SST abruptly without tapping. It is result in damage of the SST.

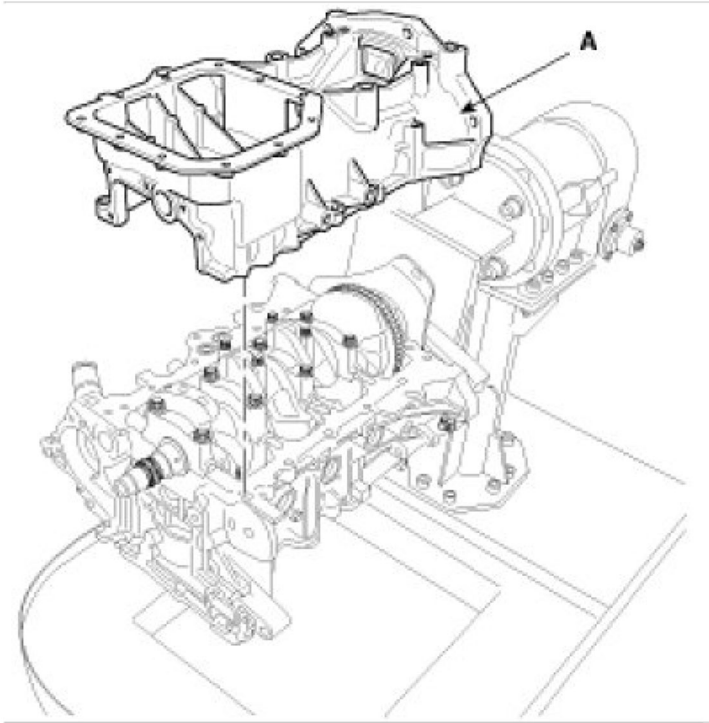
10. Remove the oilscreen(A).



11. Remove the rear oil seal(A).



12. Remove the ladderframe(A).



13. Check the connecting rod end play.

14. Remove the connecting rod caps and check oil clearance.

15. Remove the piston and connecting rod assemblies.

(1) Using a ridge reamer, remove all the carbon from the top of the cylinder.

(2) Push the piston, connecting rod assembly and upper bearing through the top of the cylinder block.

NOTE:

- Keep the bearings, connecting rod and cap together.
- Arrange the piston and connecting rod assemblies in the correct order.

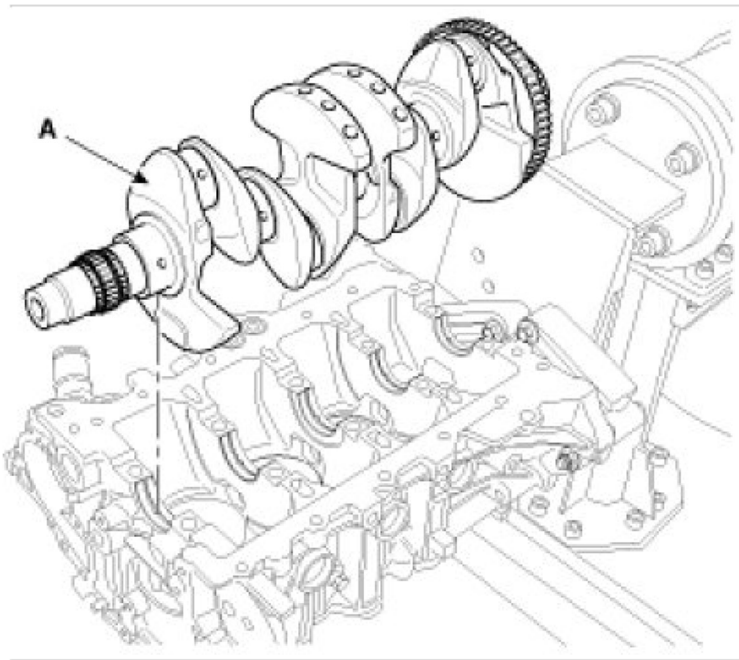
16. Remove the crankshaft bearing cap and check oil clearance.

17. Check the crankshaft end play.

18. Lift the crankshaft(A) out of the engine, being careful not to damage journals.

NOTE:

Arrange the main bearings and thrust bearings in the correct order.



19. Check fit between piston and piston pin.
Try to move the piston back and forth on the piston pin.
If any movement is felt, replace the piston and pin as a set.
20. Remove the piston rings.
 - (1) Using a piston ring expander, remove the 2 compression rings.
 - (2) Remove the 2 side rails and oil ring by hand.

NOTE:

Arrange the piston rings in the correct order only.

21. Remove the connecting rod from the piston. Using a press, remove the piston pin from piston. (Press-in load: 500-1,500kg (1,102-3,306lb))

Cylinder Block Inspection

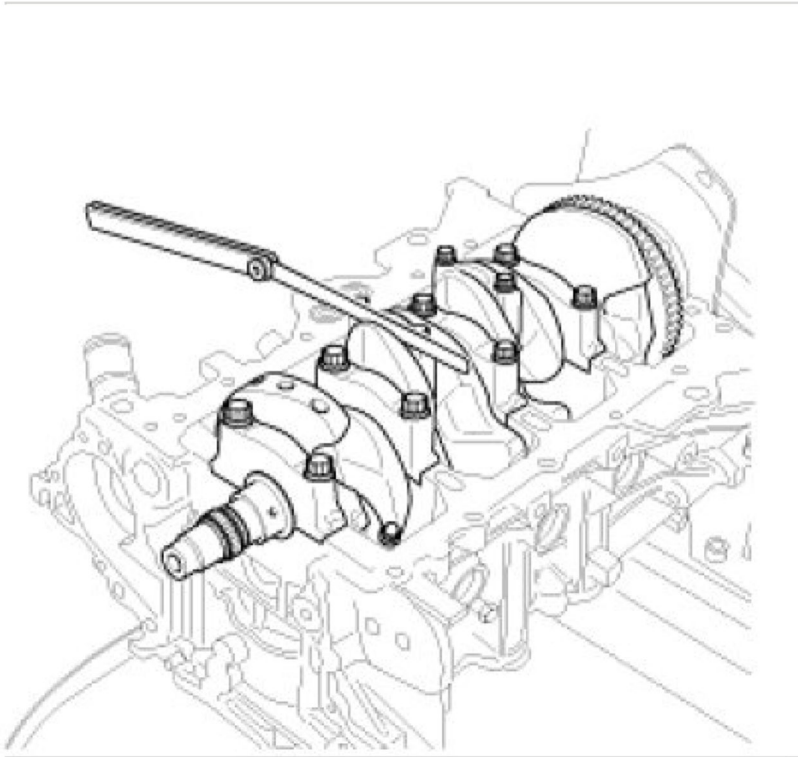
Connecting Rod and Crankshaft

1. Check the connecting rod end play.
Using feeler gauge, measure the end play while moving the connecting rod back and forth.

End play

Standard: 0.1 - 0.25mm (0.0039 - 0.0098in)

Maximum: 0.35mm (0.0138in)



- A.** If out-of-tolerance, install a new connecting rod.
- B.** If still out-of-tolerance, replace the crankshaft.

2. Check the connecting rod bearing oil clearance.

- (1) Check the match marks on the connecting rod and cap are aligned to ensure correct reassembly.
- (2) Remove the 2 connecting rod cap bolts.
- (3) Remove the connecting rod cap and lower bearing.
- (4) Clean the crankshaft pin journal and bearing.
- (5) Place a Plastic gage across the crankshaft pin journal.
- (6) Reinstall the lower bearing and cap and tighten the bolts. Do not reuse the bolts.

Tightening torque:

17.7 - 21.6N.m (1.8 - 2.2kgf.m, 13.0 - 15.9lb-ft) + 88 - 92°

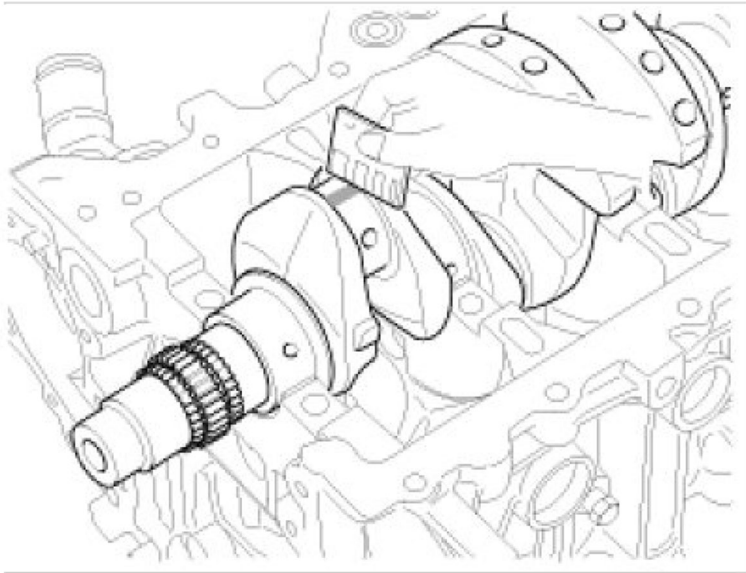
NOTE:

Do not turn the crankshaft.

- (7) Remove the 2 bolts, connecting rod cap and lower bearing.
- (8) Measure the plastic gage at its widest point.

Standard oil clearance

0.032 - 0.052mm (0.0013 - 0.0020in)



(9) If the measurement from the plastic gage is too wide or too narrow, remove the upper and lower bearing and then install new bearings with the same color mark. Recheck the oil clearance.

CAUTION:

Do not file, shim, or scrape the bearings or the caps to adjust clearance.

(10) If the plastic gage shows the clearance is still incorrect, try the next larger or smaller bearing. Recheck the oil clearance.

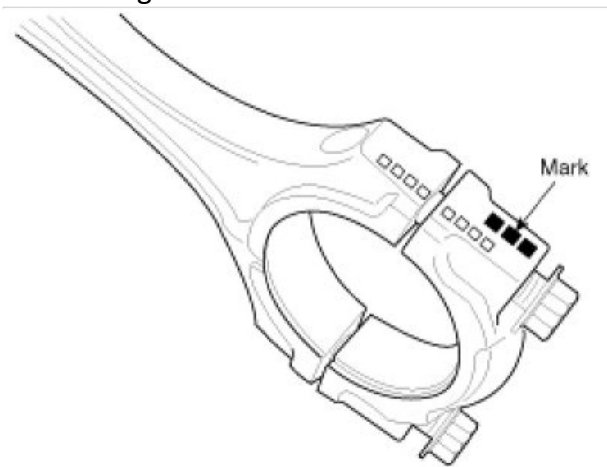
NOTE:

If the proper clearance cannot be obtained by using the appropriate larger or smaller bearings, replace the crankshaft and recheck.

CAUTION:

If the marks are indecipherable because of an accumulation of dirt and dust, do not scrub them with a wire brush or scraper. Clean them only with solvent or detergent.

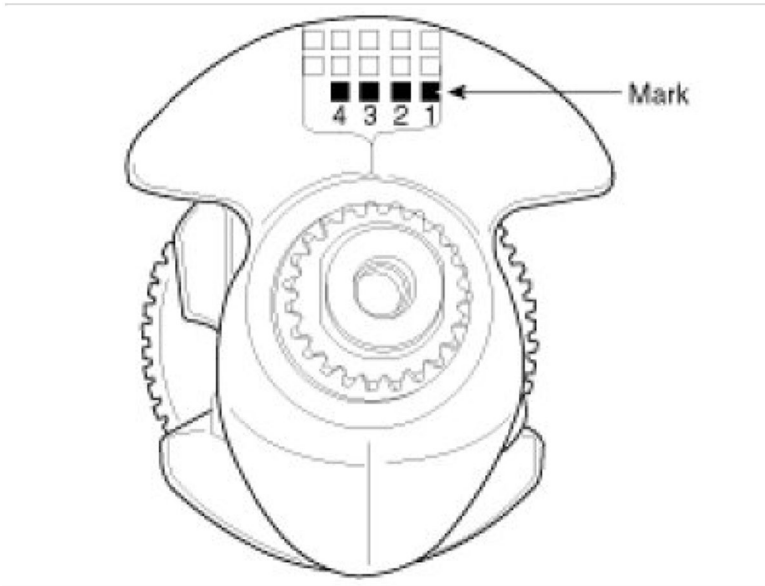
Connecting Rod Mark Location



Connecting Rod

Mark	Connecting rod big-end inner diameter
A, 0	45.000 - 45.006mm (1.7717 - 1.7719in)
B, 00	45.006 - 45.012mm (1.7719 - 1.7721in)
C, 000	45.012 - 45.018mm (1.7721 - 1.7724in)

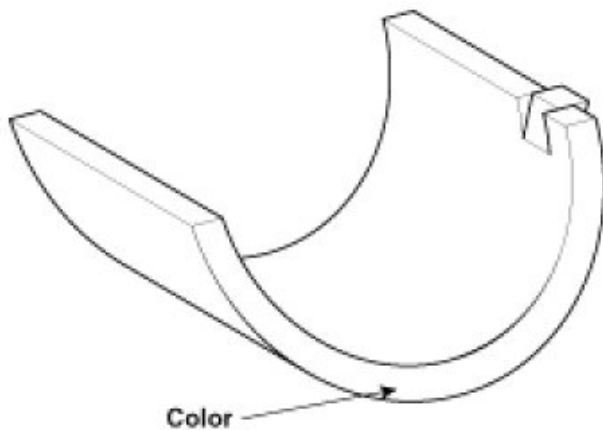
Crankshaft Pin Diameter Mark Location



Crankshaft Pin Diameter

Mark	Crankshaft pin outer diameter
1	41.972 - 41.966mm (1.6524 - 1.6522in)
2	41.966 - 41.960mm (1.6522 - 1.6520in)
3	41.960 - 41.954mm (1.6520 - 1.6517in)

Connecting Rod Bearing Color Location



Connecting Rod Bearing Description

Mark	Color	Connecting rod bearing thickness
A	Blue	1.514 - 1.517mm (0.0596 - 0.0597in)
B	Black	1.511 - 1.514mm (0.0595 - 0.0596in)
C	None	1.508 - 1.511mm (0.0594 - 0.0595in)
D	Green	1.505 - 1.508mm (0.0593 - 0.0594in)
E	Red	1.502 - 1.505mm (0.0591 - 0.0593in)

(11) Select the bearing by using selection table.

Connecting Rod Bearing Selection Table

		Connecting rod mark		
		A, 0	B, 00	C, 000
Crank shaft pin journal mark	1	E (Red)	D (Green)	C (None)
	2	D (Green)	C (None)	B (Black)
	3	C (None)	B (Black)	A (Blue)

3. Check the connecting rods.

(1) When reinstalling, make sure that cylinder numbers put on the connecting rod and cap at disassembly match. When a new connecting rod is installed, make sure that the notches for holding the bearing in place are on the same side.

(2) Replace the connecting rod if it is damaged on the thrust faces at either end. If step wear or a severely rough surface of the inside diameter of the small end is apparent, the rod must be replaced as well.

(3) Using a connecting rod aligning tool, check the rod for bend and twist. If the measured value is close to the repair limit, correct the rod by a press. Any connecting rod that has been severely bent or distorted should be replaced.

Allowable bend of connecting rod:

0.05mm / 100mm (0.0020in / 3.94in) or

less Allowable twist of connecting rod:

0.1mm / 100mm (0.0039in / 3.94in) or less

NOTE:

When the connecting rods are installed without bearings, there should be no difference on sides surface.

4. Check the crankshaft bearing oil clearance.

(1) To check main bearing-to-journal oil clearance, remove the main bearing caps and lower bearings.

(2) Clean each main journal and lower bearing with a clean shop towel.

(3) Place one strip of plastic gage across each main journal.

(4) Reinstall the lower bearings and caps, then tighten the bolts.

Tightening torque:

1st - 17.7 - 21.6N.m (1.8 - 2.2kgf.m, 13.0 - 15.9lb-ft)

2nd - 88° ~ 92°

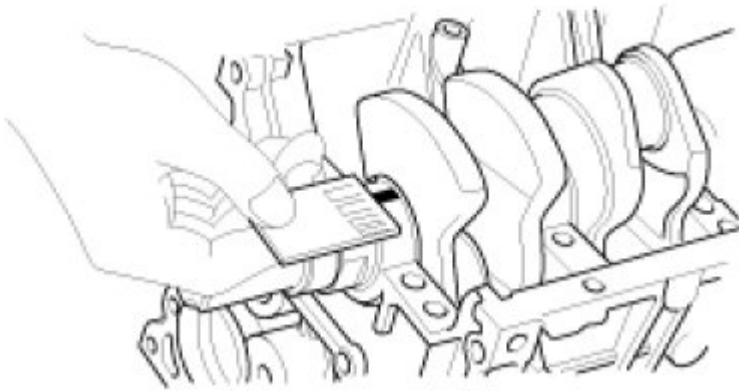
NOTE:

Do not turn the crankshaft.

(5) Remove the cap and lower bearing again and measure the widest part of the plastic gage.

Standard oil clearance:

No.1, 2, 3, 4, 5: 0.021 - 0.042mm (0.0008 - 0.0017in)



(6) If the plastic gage measure is too wide or too narrow, remove the upper and lower bearing and then install a new bearing with the same color mark. Recheck the oil clearance.

CAUTION:

Do not file, shim, or scrape the bearings or the cap to adjust clearance.

(7) If the plastic gage shows the clearance is still incorrect, try the next larger or smaller bearing. Recheck the oil clearance.

NOTE:

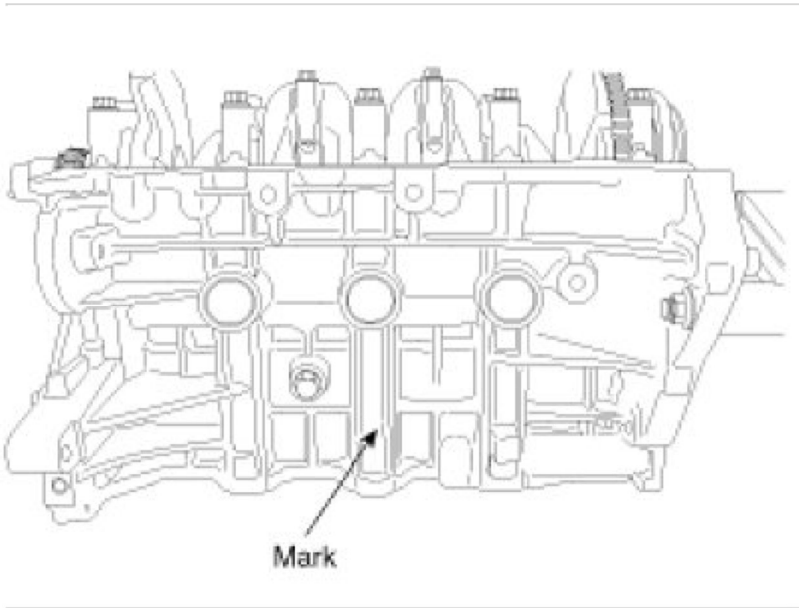
If the proper clearance cannot be obtained by using the appropriate larger or smaller bearings, replace the crankshaft and start over.

CAUTION:

If the marks are indecipherable because of an accumulation of dirt and dust, do not scrub them with a wire brush or scraper. Clean them only with solvent or detergent.

Cylinder block crankshaft journal bore mark location

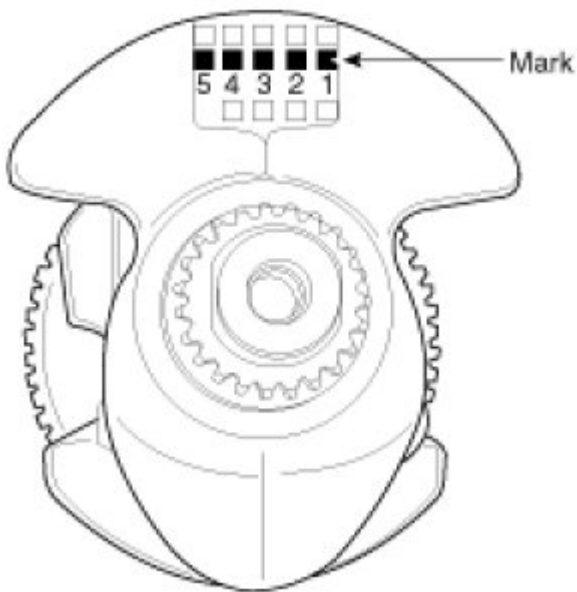
Letters have been stamped on the side surface of the block as a mark for the size of each of the 5 main journal bores. Use them, and the numbers or letters stamped on the crank (marks for main journal size), to choose the correct bearings.



Description of Cylinder Block Crankshaft Journal Bore

Mark	Cylinder block crankshaft journal bore inner diameter
A	52.000 - 52.006mm (2.0472 - 2.0475in)
B	52.006 - 52.012mm (2.0475 - 2.0477in)
C	52.012 - 52.018mm (2.0477 - 2.0479in)

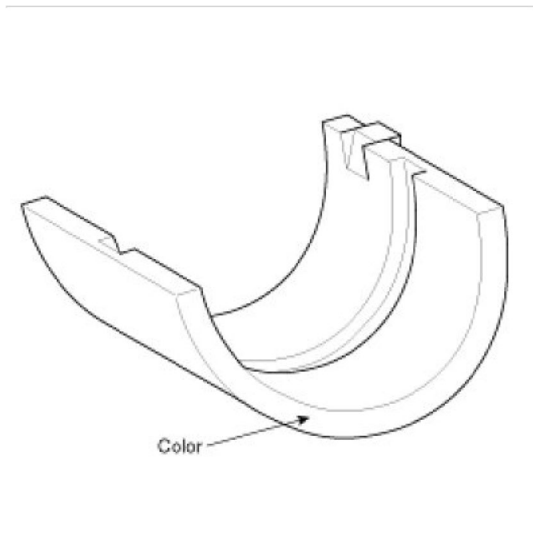
Crankshaft Main Journal Mark Location



Definition of Crankshaft Main Journal

Mark	Crankshaft main journal outer diameter
1	47.960 - 47.954mm (1.8882 - 1.8879in)
2	47.954 - 47.948mm (1.8879 - 1.8877in)
3	47.948 - 47.942mm (1.8877 - 1.8875in)

Crankshaft Main Bearing Color Location



Definition of Crankshaft Main Bearing

Mark	Color	Crankshaft main bearing thickness
		No.1, 2, 3, 4, 5
A	Blue	2.026 - 2.029mm (0.0798 - 0.0799in)
B	Black	2.023 - 2.026mm (0.0796 - 0.0798in)
C	None	2.020 - 2.023mm (0.0795 - 0.0796in)
D	Green	2.017 - 2.020mm (0.0794 - 0.0795in)
E	Red	2.014 - 2.017mm (0.0793 - 0.0794in)

(8) Select the bearing by using selection table.

Crankshaft Main Bearing Selection Table

		Cylinder block crankshaft journal bore mark		
		A	B	C
Crank shaft main journal mark	1	E (Red)	D (Green)	C (None)
	2	D (Green)	C (None)	B (Black)
	3	C (None)	B (Black)	A (Blue)

5. Check the crankshaft end play.

Using a dial indicator, measure the thrust clearance while prying the crankshaft back and forth with a screwdriver.

End play

Standard: 0.05 - 0.25mm (0.0020 - 0.0098in)

Limit: 0.30mm (0.0118in)

If the end play is greater than maximum, replace the center bearing.

Cylinder Block

1. Remove the gasket material.

Using a gasket scraper, remove all the gasket material from the top surface of the cylinder block.

2. Clean the cylinder block

Using a soft brush and solvent, thoroughly clean the cylinder block.

3. Inspect the top surface of cylinder block for flatness.

Using a precision straight edge and feeler gauge, measure the surface contacting the cylinder head gasket for warpage.

Flatness of cylinder block gasket surface

Standard:

Less than 0.05mm (0.0020in)

Less than 0.02mm (0.0008in) - 100mm x t; 100mm



4. Inspect the cylinder bore.

Visually check the cylinder for vertical scratches.

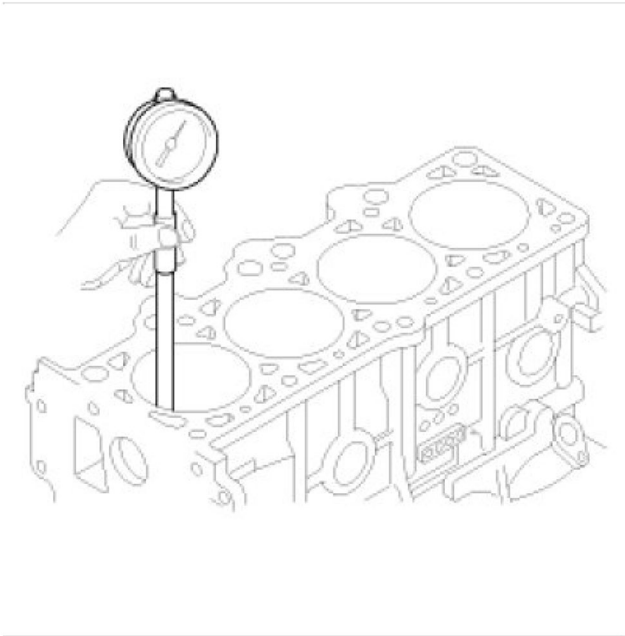
If deep scratches are present, replace the cylinder block.

5. Inspect the cylinder bore diameter.

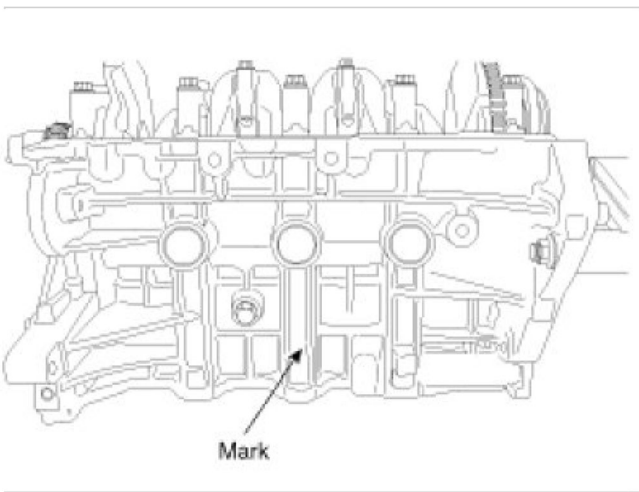
Using a cylinder bore gauge, measure the cylinder bore diameter at position in the thrust and axial direction.

Standard diameter:

77.00 - 77.03mm (3.0315 - 3.0327in)



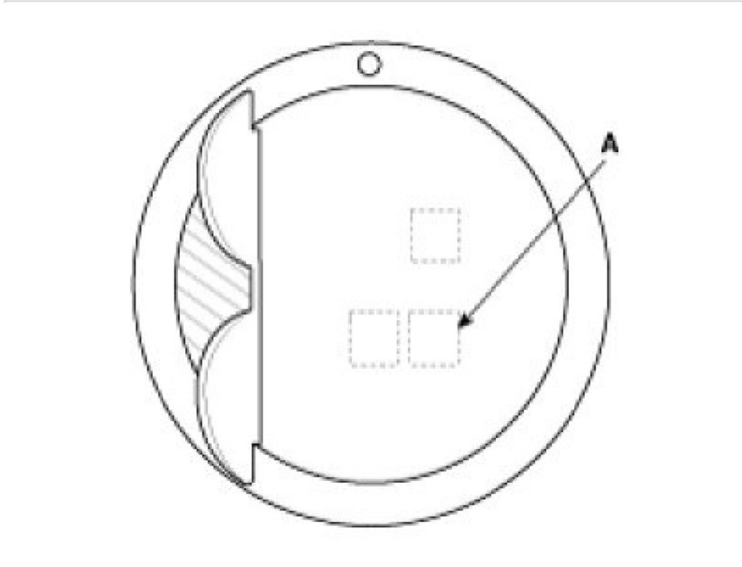
6. Check the cylinder bore size code on the cylinder block side surface.



Cylinder Bore Specifications

Mark	Cylinder bore inner diameter
A	77.00 - 77.01mm (3.0315 - 3.0319in)
B	77.01 - 77.02mm (3.0319 - 3.0323in)
C	77.02 - 77.03mm (3.0323 - 3.0327in)

7. Check the piston size mark(A) on the piston top face.



Piston Outer Diameter

Mark	Piston outer diameter
A	76.97 - 76.98mm (3.0303 - 3.0307in)
B	76.98 - 76.99mm (3.0307 - 3.0311in)
C	76.99 - 77.00mm (3.0311 - 3.0315in)

8. Select the piston related to cylinder bore class.

Piston -to-cylinder clearance:

0.02 - 0.04mm (0.0008 - 0.0016in)

Piston and Piston Rings

1. Clean the piston.

- (1) Using a gasket scraper, remove the carbon from the piston top.
- (2) Using a groove cleaning tool or broken ring, clean the piston ring grooves.
- (3) Using solvent and a brush, thoroughly clean the piston.

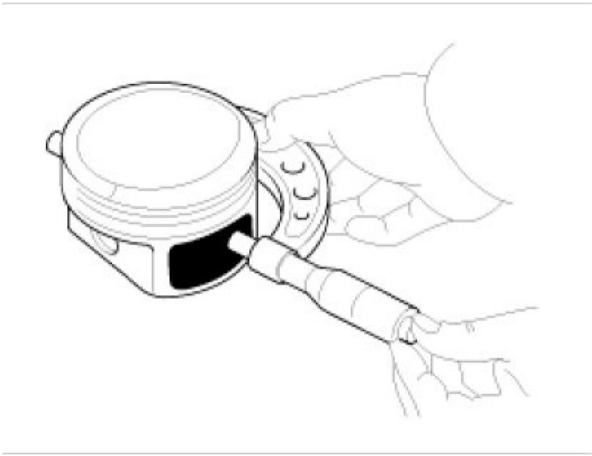
NOTE:

Do not use a wire brush.

2. The standard measurement of the piston outside diameter is taken 33.9mm(1.5697in) from top land of the piston.

Standard diameter:

76.97 - 77.00mm (3.0303 - 3.0315in)



3. Calculate the difference between the cylinder bore inner diameter and the piston outer diameter.

Piston-to-cylinder clearance:

0.02 - 0.04mm (0.0008 - 0.0016in)

4. Inspect the piston ring side clearance.

Using a feeler gauge, measure the clearance between new piston ring and the wall of ring groove.

Piston ring side clearance

No.1 ring: 0.03 - 0.07mm (0.0012 - 0.0028in)

No.2 ring: 0.03 - 0.07mm (0.0012 - 0.0028in)

Oil ring: 0.06 - 0.15mm (0.0024 - 0.0059in)

Limit

No.1 ring: 0.1mm (0.0039in)

No.2 ring: 0.1mm (0.0039in)

Oil ring: 0.2mm (0.0079in)



If the clearance is greater than maximum, replace the piston.

5. Inspect the piston ring end gap.

To measure the piston ring end gap, insert a piston ring into the cylinder bore. Position the ring at right angles to the cylinder wall by gently pressing it down with a piston. Measure the gap with a feeler gauge. If the gap exceeds the service limit, replace the piston rings. If the gap is too large, recheck the cylinder bore inner diameter. If the bore is over the service limit, the cylinder block must be rebored.

Piston ring end gap

Standard

No.1 ring: 0.14 - 0.28mm (0.0079 - 0.0138in)

No.2 ring: 0.30 - 0.45mm (0.0118 - 0.0177in)

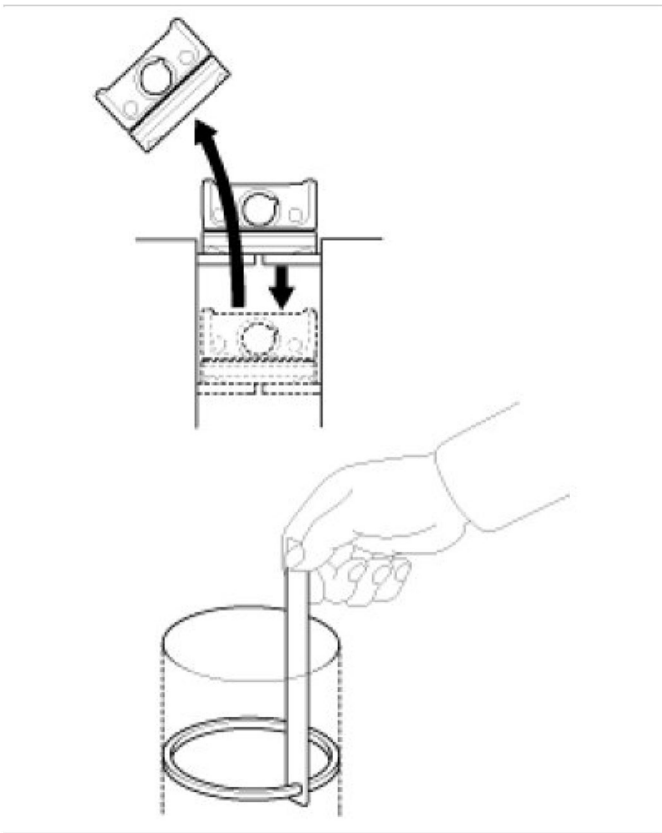
Oil ring: 0.20 - 0.70mm (0.0079 - 0.0276in)

Limit

No.1 ring: 0.3mm(0.0118in)

No.2 ring: 0.5mm(0.0197in)

Oil ring: 0.8mm(0.0315in)



Piston Pins

1. Measure the outer diameter of piston pin

Piston pin diameter:

18.001 - 18.006mm (0.7087 - 0.7089in)



2. Measure the piston pin-to-piston clearance.

Piston pin-to-piston clearance:

0.010 - 0.020mm (0.0004 - 0.0008in)

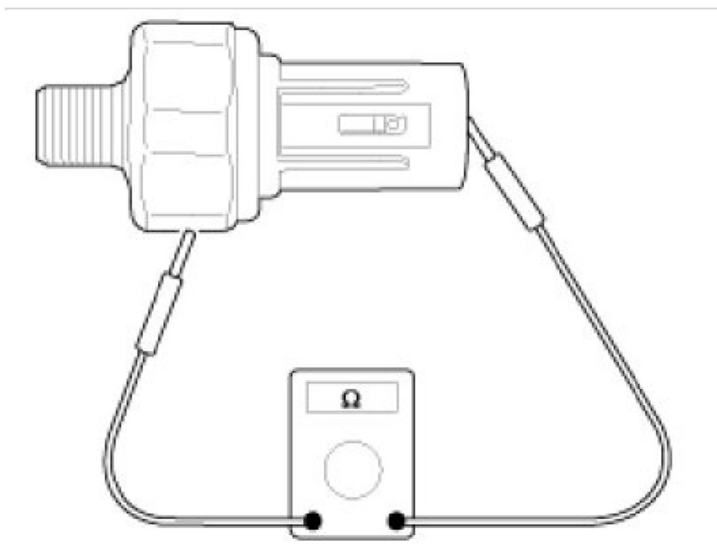
3. Check the difference between the piston pin outer diameter and the connecting rod small end inner diameter.

Piston pin-to-connecting rod interference:

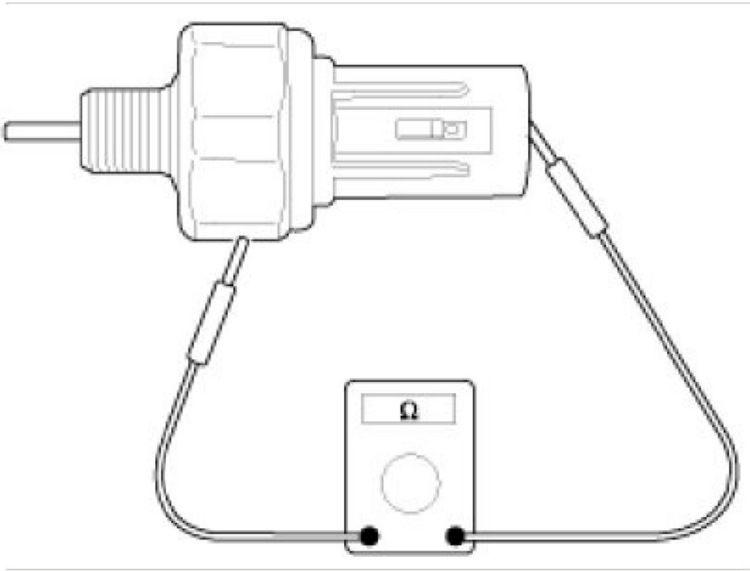
-0.032 ~ -0.016mm (-0.0013 ~ -0.0006in)

Oil Pressure Switch

1. Check the continuity between the terminal and the body with an ohmmeter. If there is no continuity, replace the oil pressure switch.



2. Check the continuity between the terminal and the body when the fine wire is pushed. If there is continuity even when the fine wire is pushed, replace the switch.



3. If there is no continuity when a 49.0kpa (0.5kg/cm², 7.1psi) is applied through the oil hole, the switch is operating properly. Check for air leakage. If air leaks, the diaphragm is broken. Replace it.

Cylinder Block Reassembly

NOTE:

- Thoroughly clean all parts to assembled.
- Before installing the parts, apply fresh engine oil to all sliding and rotating surfaces.
- Replace all gaskets, O-rings and oil seals with new parts.

1. Assemble the piston and connecting rod.

(1) Use a hydraulic press for installation

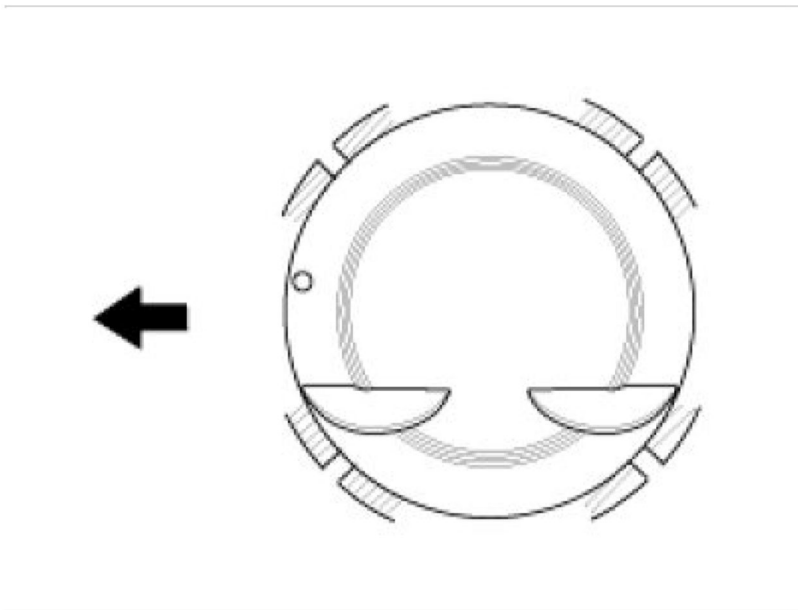
(3) The piston front mark and the connecting rod front mark must face the timing chain side of the engine.



2. Install the piston rings.

(1) Install the oil ring expander and 2 side rails by hand.

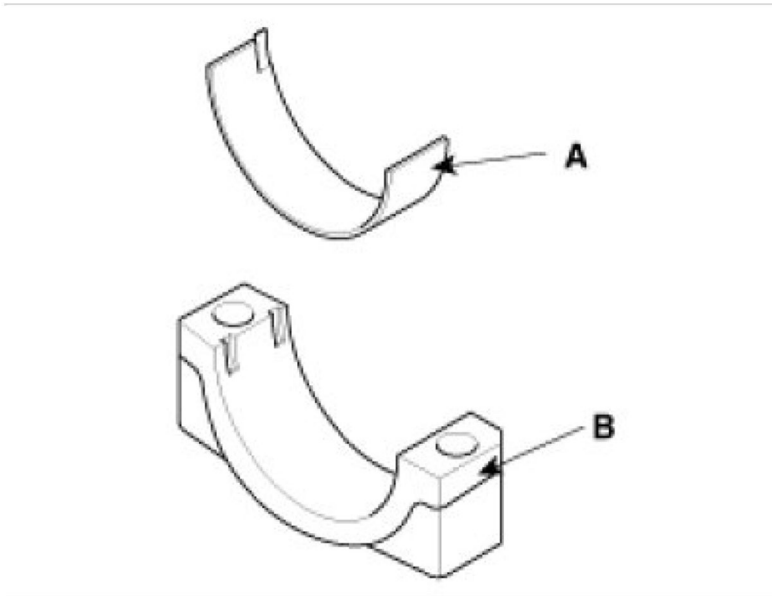
(2) Using a piston ring expander, install the 2 compression rings with the code mark facing upward. **(3)** Position the piston rings so that the ring ends are as shown.



3. Install the connecting rod bearings.

(1) Align the bearing(A) claw with the groove of the connecting rod or connecting rod cap(B).

(2) Install the bearings(A) in the connecting rod and connecting rod cap(B).

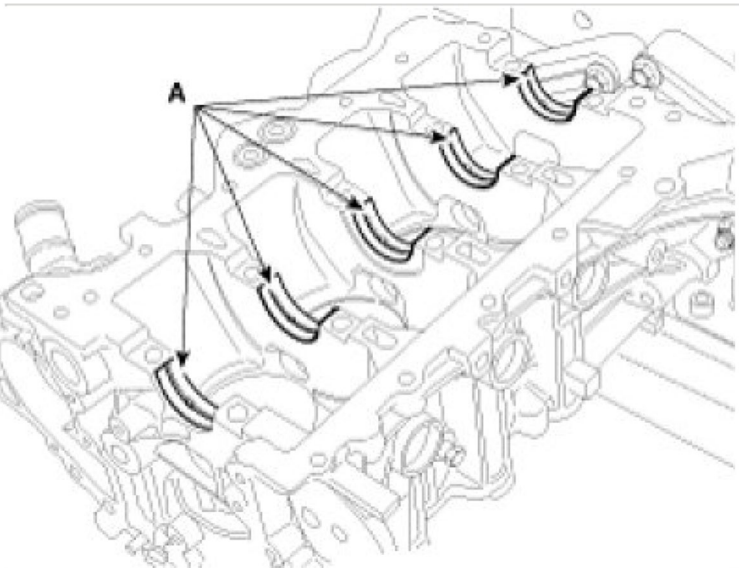


4. Install the crankshaft main bearings.

NOTE:

Upper bearings have an oil groove or oil holes; Lower bearings do not.

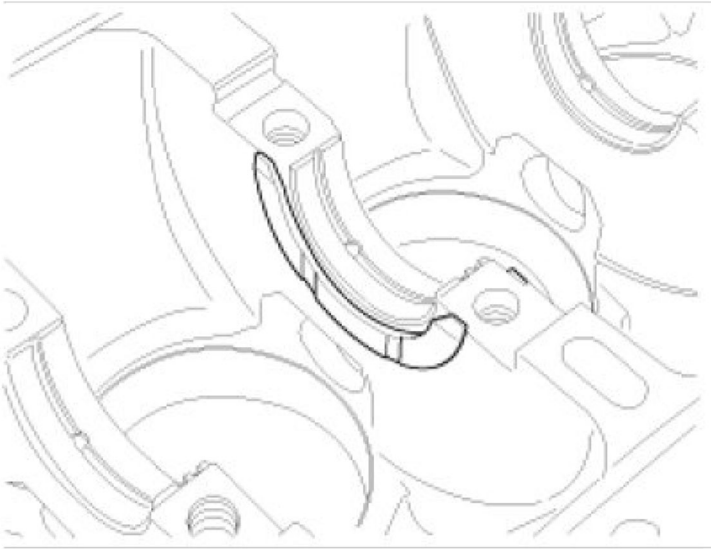
(1) Align the bearing claw with the claw groove of the cylinder block, push in the five upper bearings(A).



(2) Align the bearing claw with the claw groove of the main bearing cap and push in the 5 lower bearings.

5. Install the thrust bearing.

Install the thrust bearing(A) on the No.3 journal position of the cylinder block with the oil grooves facing outward.



6. Place the crankshaft on the cylinder block.
7. Place the main bearing caps on the cylinder block.
8. Install the main bearing cap bolts.

NOTE:

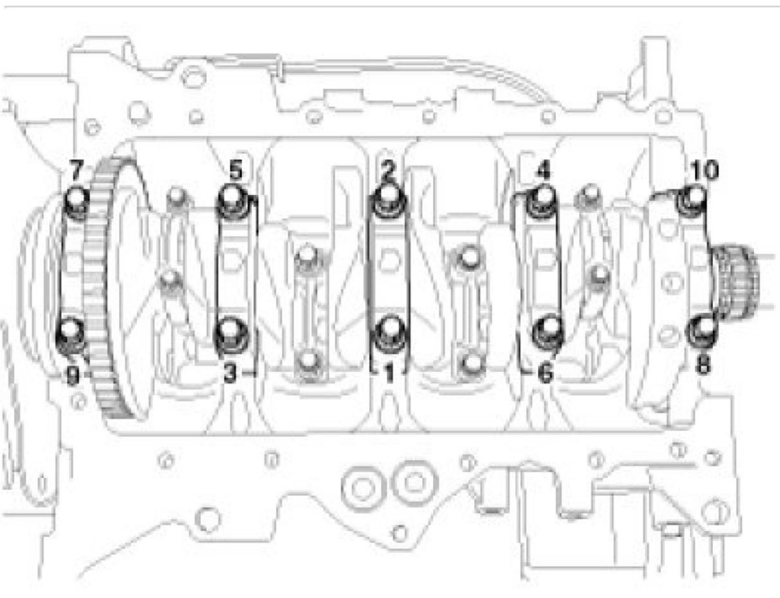
The main bearing cap bolts are tightened in 2 progressive steps. If any of the bearing cap bolts is broken or deformed, replace it.

- (1)** Apply a light coat of engine oil on the threads and under the bearing cap bolts.
- (2)** Install and uniformly tighten the 10 bearing cap bolts, in several passes, in the sequence shown.

Tightening torque:

1st - 17.7 - 21.6N.m (1.8 - 2.2kgf.m, 13.0 - 15.9lb-ft)

2nd - 88° ~ 92°



CAUTION:

Do not reuse the main bearing cap bolts.

(3) Check that the crankshaft turns smoothly.

9. Check the crankshaft end play.

10. Install the piston and connecting rod assemblies.

NOTE:

Before installing the piston, apply a coat of engine oil to the ring grooves and cylinder bores.

(1) Install the ring compressor, check that the rings are securely in place, then position the piston in the cylinder, and tap it in using the wooden handle of a hammer.

(2) Stop after the ring compressor pops free and check the connecting rod-to-crank journal alignment before pushing the piston into place.

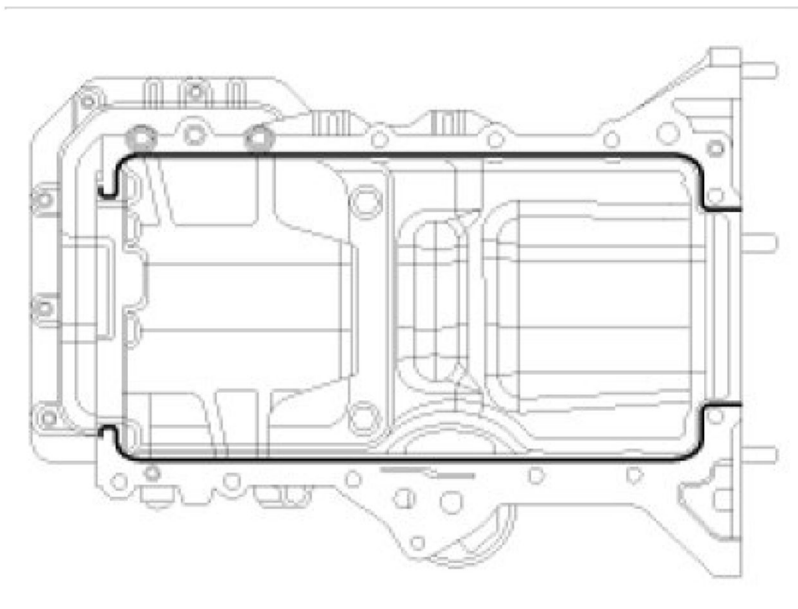
(3) Install the rod caps with bearings and tighten the bolts. (Do not reuse the bolts).

Tightening torque:

1st - 17.7 - 21.8N.m (1.8 - 2.2kgf.m, 13.0 - 15.9lb-ft)

2nd - 88° ~ 92°

11. Apply the sealant on the ladder frame.



NOTE:

- Apply the sealant, THREE-BOND 1217H or LOCTITE 5900H on the ladder frame rail portion and install it within five minutes.

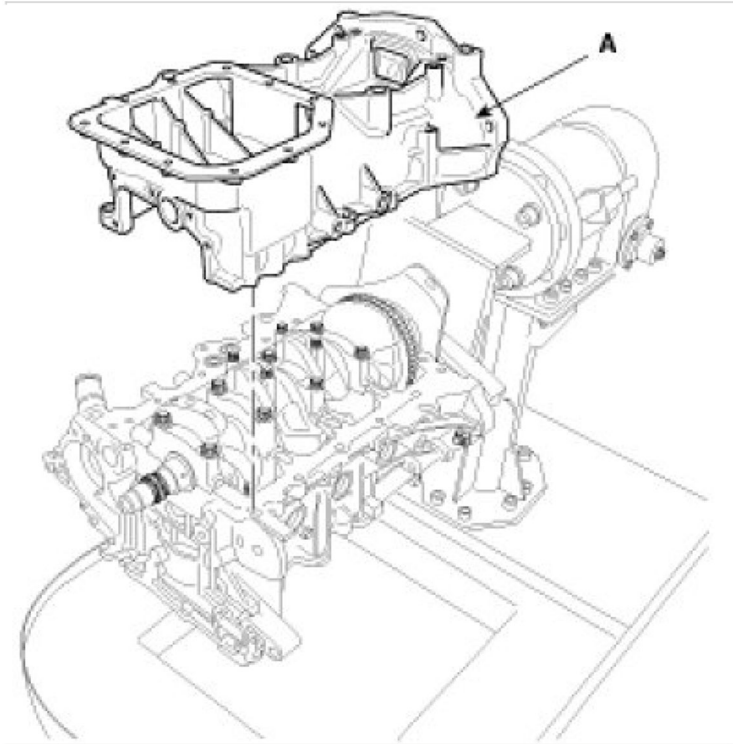
If when sealant is applied to cylinder block bottom position, sealant position to be same with position that is applied to ladder frame rail position.

- Apply sealant along the inner line of the bolt holes.

12. Install the ladderframe(A).

Tightening torque:

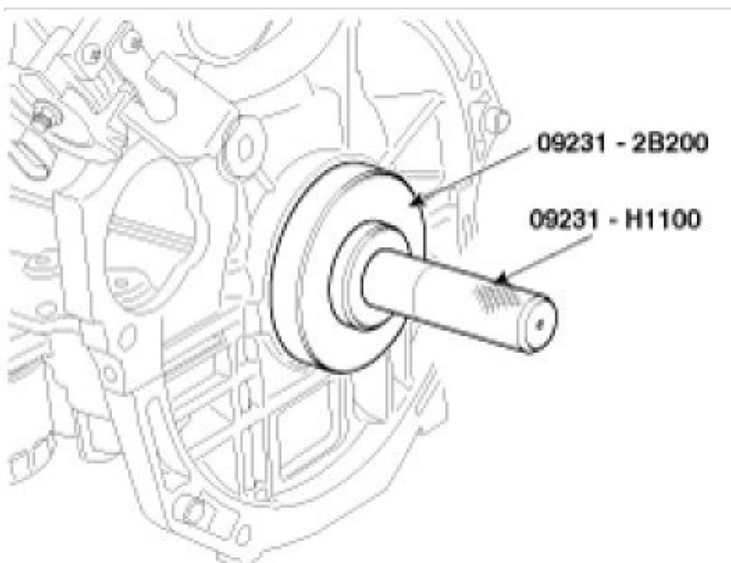
18.6 - 24.2N.m (1.9 - 2.4kgf.m, 13.7 - 17.4lb-ft)



13. Install the rear oil seal.

(1) Apply engine oil to a new oil seal lip.

(2) Using the SST (09231-H1100, 09231-2B200) and a hammer, tap in the oil seal until its surface is flush with the rear oil seal retainer edge.

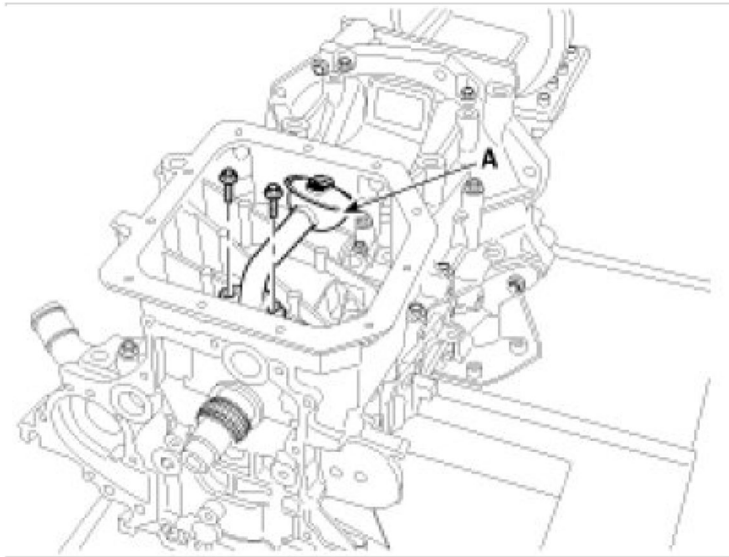


14. Install the oilscreen.

Install a new gasket and oil screen with 2 bolts.

Tightening torque:

19.6 - 26.5N.m (2.0 - 2.7kgf.m, 14.5 - 19.5lb-ft)



15. Install the oilpan.

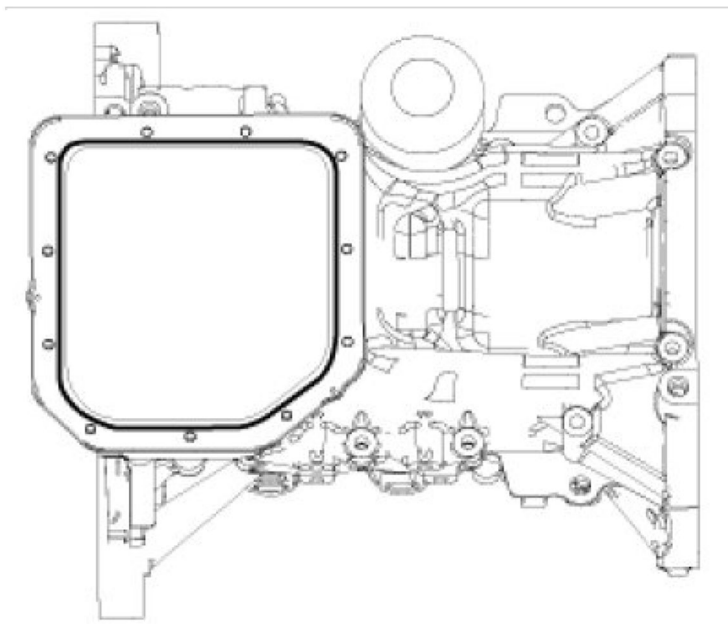
(1) Using a razor blade and gasket scraper, remove all the old packing material from the gasket surfaces.

NOTE:

Check that the mating surfaces are clean and dry before applying liquid gasket.

(2) Apply liquid gasket with the width of 3mm, starting 1mm-away position from the inner rounding of the oil pan rail.

Liquid gasket: TB 1217H or LOCTITE 5900H



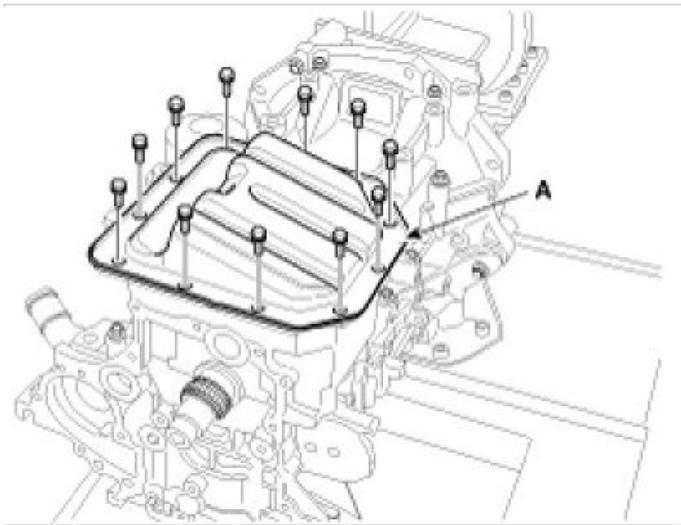
NOTE:

- To prevent leakage of oil, apply liquid gasket to the inner threads of the bolt holes.
- Do not install the parts if five minutes or more have elapsed since applying the liquid gasket. Instead, reapply liquid gasket after removing the residue.
- After assembly, wait at least 30 minutes before filling the engine with oil.

(3) Install the oil pan(A) with the bolts. Uniformly tighten the bolts in several passes.

Tightening torque:

9.8 - 11.8N.m (1.0 - 1.2kgf.m, 7.2 - 8.7lb-ft)

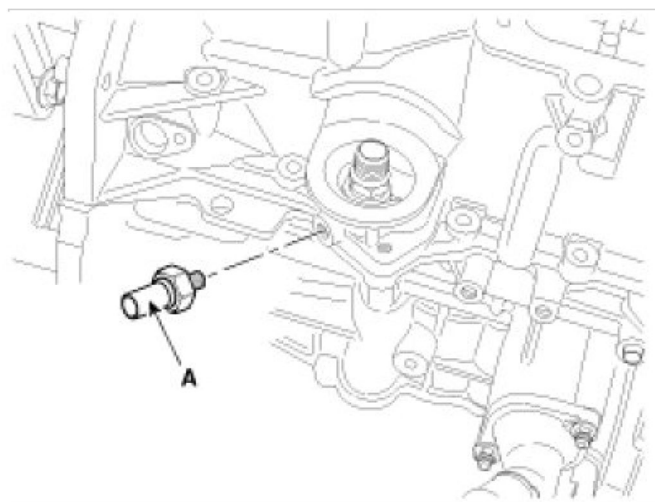


16. Install the oil pressure switch.

- (1)** Apply adhesive to 2 or 3 threads.
(2) Install the oil pressure switch(A).

Tightening torque:

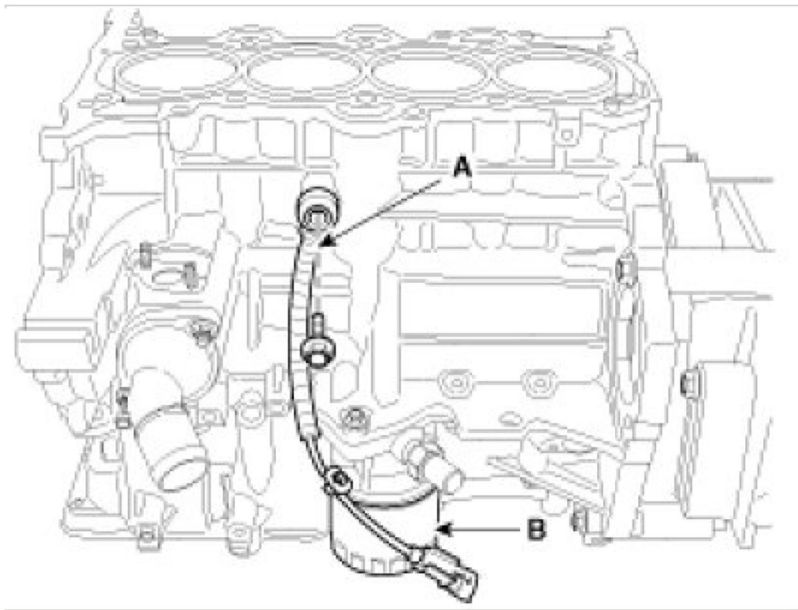
7.8 - 11.8N.m (0.8 - 1.2kgf.m, 5.8 - 8.7lb-ft)



17. Install the knock sensor(A) and the oil filter(B).

Tightening torque:

16.7 - 26.5N.m (1.7 - 2.7kgf.m, 12.3 - 19.5lb-ft)



18. Install the oil level gauge tube.

(1) Install a new O-ring on the oil level gauge tube.

(2) Apply engine oil on the O-ring.

(3) Install the oil level gauge tube with the bolt.

Tightening torque:

9.8 - 11.8N.m (1.0 - 1.2kgf.m, 7.2 - 8.7lb-ft)

19. Install the cylinderhead.

20. Install the timingchain.

21. Remove the engine stand.

22. A/T: install the drive plate.

Tightening torque:

71.6 - 75.5N.m (7.3 - 7.7kgf.m, 52.8 - 55.7lb-ft)

23. M/T: install the fly wheel.

Tightening torque:

71.6 - 75.5N.m (7.3 - 7.7kgf.m, 52.8 - 55.7lb-ft)

24. Install the engine.

Engine Fastener Torque Specifications

Item	Quantity	N.m	kgf.m	lb-ft
Cylinder block				
Engine support bracket bolts (engine side)	4	29.4 - 41.2	3.0 - 4.2	21.7 - 30.4
Ladder frame bolts	13	18.6 - 23.5	1.9 - 2.4	13.7 - 17.4
Connecting rod cap bolt	8	(17.7 - 21.6) + (88 - 92°)	(1.8 - 2.2) + (88 - 92°)	(13.0 - 15.9) + (88 - 92°)
Crankshaft main bearing cap bolt	10	(17.7 - 21.6) + (88 - 92°)	(1.8 - 2.2) + (88 - 92°)	(13.0 - 15.9) + (88 - 92°)
Flywheel bolts(M/T)	6	71.6 - 75.5	7.3 - 7.7	52.8 - 55.7
Drive plate bolts(A/T)	6	71.6 - 75.5	7.3 - 7.7	52.8 - 55.7
Timing chain system				
Timing chain and oil pump assembly cover bolt(M6×20)	10	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7
Timing chain and oil pump assembly cover bolt(M6×38)	1	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7
Timing chain and oil pump assembly cover bolt(M8×22)	3	18.6 - 23.5	1.9 - 2.4	13.7 - 17.4
Idler pulley assembly bolt	1	42.2 - 53.9	4.3 - 5.5	31.1 - 39.8
Timing chain tensioner arm bolt	1	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7
Timing chain guide bolt	2	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7
Crankshaft pulley bolt	1	127.5 - 137.3	13.0 - 14.0	94.0 - 101.3
Timing chain tensioner bolt	2	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7
Cylinder head				
Engine cover bolt	4	7.8 - 11.8	0.8 - 1.2	5.8 - 8.7
Cylinder head cover bolt	16	7.8 - 9.8	0.8 - 1.0	5.8 - 7.2
Camshaft bearing cap bolt(M6)	16	11.8 - 13.7	1.2 - 1.4	8.7 - 10.1
Camshaft bearing cap bolt(M8)	4	18.6 - 22.6	1.9 - 2.3	13.7 - 16.6
Cylinder head bolt	10	(17.7 - 21.6) + (90 - 95°) + (100 - 105°)	(1.8 - 2.2) + (90 - 95°) + (100 - 105°)	(13.0 - 15.9) + (90 - 95°) + (100 - 105°)
Cooling system				
Water pump pulley bolt	4	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7
Water pump bolt	5	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7
Water temperature control assembly mounting bolts	3	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7
Water inlet fitting nut	2	18.6 - 23.5	1.9 - 2.4	13.7 - 17.4
Heater pipe mounting bolts/Nuts(M6)	1	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7
Heater pipe mounting bolt(M8)	2	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7
Engine coolant temperature sensor(ECTS)	1	29.4 - 39.2	3.0 - 4.0	21.7 - 28.9
Lubrication system				
Oil filter	1	11.8 - 15.7	1.2 - 1.6	8.7 - 11.6
Oil pan bolt	11	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7
Oil pan drain plug	1	34.3 - 44.1	3.5 - 4.5	25.3 - 32.5
Oil screen bolt	2	19.6 - 26.5	2.0 - 2.7	14.5 - 19.5
Oil pressure switch	1	14.7 - 21.6	1.5 - 2.2	10.8 - 15.9
Oil level gauge assembly mounting bolt	1	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7
Intake and exhaust system				
Intake manifold and cylinder head mounting nut	5	18.6 - 23.5	1.9 - 2.4	13.7 - 17.4

Engine Fastener Torque Specifications (continued)

Exhaust manifold and cylinder head mounting nut	9	29.4 - 34.3	3.0 - 3.5	21.7 - 25.3
Oxygen sensor mounting	2	39.2 - 49.0	4.0 - 5.0	28.9 - 36.2
Exhaust manifold heat cover	6	16.7 - 21.6	1.7 - 2.2	12.3 - 15.9
Exhaust manifold and cylinder block, ladder frame mounting bolts	4	39.2 - 49.0	4.0 - 5.0	28.9 - 36.2
Air cleaner lower cover mounting	2	7.8 - 9.8	0.8 - 1.0	5.8 - 7.2
Exhaust manifold and catalytic convertor mounting nut	2	43.1 - 45.1	4.4 - 4.6	31.8 - 33.3
Center muffler and main muffler mounting nut	2	39.2 - 58.8	4.0 - 6.0	28.9 - 43.4
Exhaust manifold stay mounting bolts	3	39.2 - 58.8	4.0 - 6.0	28.9 - 43.4