Engine Mechanical System > General Information > Specifications

Specifications

Description			Specifications	Limit
General				
Type			V-type, DOHC	
Number of cylinders			6	
Bore			96mm(3.7795in.)	
Stroke			87.0mm(3.4252in.)	
Total displacement			3,778cc(230.55cu.in.)	
Compression ratio			10.4	
Firing order			1-2-3-4-5-6	
Valve timing				
Intake	Opens(ATDC)		10°(3.8L)	
	Closes(ABDC)		74°	
Exhaust	Opens(BBDC)		52°	
	Closes(ATDC)		0°	
Cylinder head				
Flatness of gasket surface			Less than 0.05mm (0.0019in.) [Less than 0.02mm (0.0008in.) / 150x150]	
Flatness of manifold mounting	Intake		Less than 0.1mm(0.0039in.) [Less than 0.03mm(0.001in.) / 110x110]	
	Exhaust		Less than 0.1mm(0.0039in.) [Less than 0.03mm(0.001in.) / 110x110]	
Camshaft				
Cam height	LH Camshaft	Intake	47.2mm (1.8582in.)	
		Exhaust	45.8mm (1.8031in.)	
	RH Camshaft	Intake	47.2mm (1.8582in.)	
		Exhaust	45.8mm (1.8031in.)	
Journal outer diameter	LH, RH camshaft	Intake	No.1: 27.964 ~ 27.978mm (1.1009 ~ 1.1015in.) No.2,3,4: 23.954 ~ 23.970mm(0.9430 ~ 0.9437in.)	
		Exhaust	No.1: 27.964 ~ 27.978mm(1.1009 ~ 1.1015in.) No.2,3,4: 23.954 ~ 23.970mm(0.9430 ~ 0.9437in.)	
Bearing oil clearance	LH, RH camshaft	Intake	No.1: 0.027 ~ 0.057mm (0.0011 ~ 0.0022in.) No.2,3,4: 0.030 ~ 0.067mm (0.0012 ~ 0.0026in.)	
		Exhaust	No.1: 0.027 ~ 0.057mm (0.0011 ~ 0.0022in.) No.2,3,4: 0.030 ~ 0.067mm (0.0012 ~ 0.0026in.)	
End play			0.02 ~ 0.18mm (0.0008 ~ 0.0071in.)	

Valve			
Valve length	Intake	105.27mm(4.1445in.)	
	Exhaust	105.50mm (4.1535in.)	
Stem outer diameter	Intake	5.465 ~ 5.480mm (0.2151 ~ 0.2157in.)	
	Exhaust	5.458 ~ 5.470mm (0.2149 ~ 0.2153in.)	
Face angle		45.25° ~ 45.75°	
Thickness of valvehead(margin)	Intake	1.56 ~ 1.86mm (0.06142 ~ 0.07323in.)	
	Exhaust	1.73 ~ 2.03mm (0.06811 ~ 0.07992in.)	
Valve stem to valve guide clearance	Intake	0.020 ~ 0.047mm (0.00078 ~ 0.00185in.)	0.07mm (0.00275in.)
	Exhaust	0.030 ~ 0.054mm (0.00118 ~ 0.00212in.)	0.09mm (0.00354in.)
Valve guide			
Inner diameter	Intake	5.500 ~ 5.512mm (0.2165 ~ 0.2170in.)	
	Exhaust	5.500 ~ 5.512mm (0.2165 ~ 0.2170in.)	
Length	Intake	41.8 ~ 42.2mm (1.6457 ~ 1.6614in.)	
	Exhaust	41.8 ~ 42.2mm (1.6457 ~ 1.6614in.)	
Valve seat			
Width of seat contact	Intake	1.15 ~ 1.45mm(0.05118 ~ 0.05709in.)	
	Exhaust	1.35 ~ 1.65mm(0.05315 ~ 0.06496in.)	
Seat angle	Intake	44.75° ~ 45.20°	
	Exhaust	44.75° ~ 45.20°	
Valve spring			
Free length		43.86mm (1.7267in.)	
Load		19.3±0.8kg/34.0mm (42.7±1.8 lb/1.3386in.)	
		42.3±1.3kg/24.2mm (93.2±2.9 lb/0.9527in.)	
Out of squareness		Less than 1.5°	
MLA			
MLA outer diameter	Intake	34.964 ~ 34.980mm (1.3765 ~ 1.3772in.)	
	Exhaust	34.964 ~ 34.980mm (1.3765 ~ 1.3772in.)	
Cylinder head tappet bore inner diameter	Intake	35.000 ~ 35.025mm (1.3779 ~ 1.3789in.)	
	Exhaust	35.000 ~ 35.025mm (1.3779 ~ 1.3789in.)	
MLA to tappet bore clearance	Intake	0.020 ~ 0.061mm (0.0008 ~ 0.0024in.)	0.07mm (0.0027in.)
	Exhaust	0.020 ~ 0.061mm (0.0008 ~ 0.0024in.)	0.07mm (0.0027in.)
Valve clearance (At 20°C [68°F])			
Intake		0.17 ~ 0.23mm (0.0067 ~ 0.0090in.)	0.10 ~ 0.30mm (0.0039 ~ 0.0118in.)
Exhaust		0.27 ~ 0.33mm (0.0106 ~ 0.0129in.)	0.20 ~ 0.40mm (0.0078 ~ 0.0157in.)

Cylinder block			
Cylinder bore		96.00 ~ 96.03mm (3.7795 ~ 3.7807in.)	
Flatness of gasket surface		Less than 0.05mm (0.0019in.) [Less than 0.02mm (0.0008in.) / 150x150]	
Piston			
Piston outer diameter		95.96 ~ 95.99mm(3.7779 ~ 3.7791in.)	
Piston to cylinder clearance		0.03 ~ 0.05mm(0.0012 ~ 0.0020in.)	
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 ~ 0.0027in.)	0.1mm (0.004in.)
	No. 2 ring	0.03 ~ 0.07mm (0.0012 ~ 0.0027in.)	0.1mm (0.004in.)
	Oil ring	0.06 ~ 0.15mm (0.0024 ~ 0.0059in.)	0.2mm (0.008in.)
End gap	No. 1 ring	0.17 ~ 0.32mm (0.0067 ~ 0.0126in.)	0.6mm (0.0236in.)
	No. 2 ring	0.32 ~ 0.52mm (0.0126 ~ 0.0204in.)	0.7mm (0.0275in.)
	Oil ring	0.20 ~ 0.70mm (0.0078 ~ 0.0275in.)	0.8mm (0.0315in.)
Piston pin			
Piston pin outer diameter		21.997 ~ 22.000mm (0.8660 ~ 0.8661in.)	
Piston pin hole inner diameter		22.004 ~ 22.010mm (0.8663 ~ 0.8665in.)	
Piston pin hole clearance		0.004 ~ 0.013mm (0.00015~ 0.00051in.)	
Connecting rod small end inner diameter		22.007 ~ 22.018mm (0.8664 ~ 0.8668in.)	
Connecting rod small end hole clearance		0.007 ~ 0.021mm (0.00027~ 0.00082in.)	
Connecting rod			
Connecting rod big end inner diameter		58.000 ~ 58.018mm(2.2834 ~2.2842in.)	
Connecting rod bearing oil clearance		0.038 ~ 0.056mm (0.0015 ~ 0.0022in.)	
Side clearance		0.1 ~ 0.25mm (0.0039 ~ 0.0098in.)	
Crankshaft			
Main journal outer diameter		68.942 ~ 68.960mm (2.7142 ~ 2.7149in.)	
Pin journal outer diameter		54.954 ~ 54.972mm (2.1635 ~ 2.1642in.)	
Main bearing oil clearance		0.022 ~ 0.040mm (0.0008 ~ 0.0016in.)	
End play		0.10 ~ 0.28mm (0.0039 ~ 0.0110in.)	
Oil pump			
Relief valve opening pressure		500 ~ 600kPa (5.09 ~ 6.11kgf/cm², 72.51 ~ 87.02psi)	
Engine oil			
Oil quantity	Total	6.0L (6.34US qt, 5.28Imp qt)	When replacing a short engine or a block assembly

	Oil pan	5.5L (5.81US qt, 4.84Imp qt)	
	Drain and refill	5.2L (5.49US qt, 4.58Imp qt)	Including oil filter
Oil grade	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)		130kPa (1.32kg/cm², 18.77psi) or above	Oil temperature in oil pan : 110±2°C (230±36°F)
Cooling system			
Cooling method		Forced circulation with cooling fan	
Coolant quantity		9.0L (9.50US qt, 7.91Imp qt)	
Thermostat	Type	Wax pellet type	
	Opening temperature	82±2°C (179.6±35.6°F)	
	Fully opened temperature	95°C (203°F)	
	Full lift	10mm (0.3937in.) MIN	
Radiator cap	Main valve opening pressure	93.16 ~ 122.58kpa (0.95 ~ 1.25kg/cm², 13.51 ~ 17.78psi)	
	Vacuum valve opening pressure	0 ~ 6.86 kpa (0 ~ 0.07kg/cm², 0 ~ 0.99psi)	
Water temperature sensor			
Type		Thermister type	
Resistance	20°C (68°F)	2.31 ~ 2.59KΩ	
	80°C(176°F)	0.3222 KΩ	

Tightening Torques

Item	Quantity	Nm	kgf.m	lb-ft
Crankshaft pulley bolt	1	284.4 ~ 304.0	29.0 ~ 31.0	209.8 ~ 224.2
Timing chain cover bolt B	17	18.6 ~ 21.6	1.9 ~ 2.2	13.7 ~ 15.9
Timing chain cover bolt C	4	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Timing chain cover bolt D	2	58.8 ~ 68.6	6.0 ~ 7.0	43.4 ~ 50.6
Timing chain cover bolt F	2	24.5 ~ 26.5	2.5 ~ 2.7	18.1 ~ 19.5

Timing chain cover bolt G	4	21.6 ~ 23.5	2.2 ~ 2.4	15.9 ~ 17.4
Timing chain cover bolt H	1	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Timing chain cover bolt I	1	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Timing chain cover bolt J	1	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Timing chain cover bolt K	4	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Timing chain cover bolt L	1	21.6 ~ 26.5	2.2 ~ 2.7	15.9 ~ 19.5
Timing chain auto tensioner bolt	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Timing chain auto tensioner nut	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Timing chain auto tensioner arm bolt	2	18.6 ~ 21.6	1.9 ~ 2.2	13.7 ~ 15.9
Timing chain guide bolt	4	19.6 ~ 24.5	2.0 ~ 2.5	14.5 ~ 18.1
Oil pump chain cover bolt	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Oil pump chain tensioner bolt	1	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Oil pump chain guide bolt	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Oil pump chain sprocket bolt	1	18.6 ~ 21.6	1.9 ~ 2.2	13.7 ~ 15.9
Lower oil pan bolt	13	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Drive belt auto tensioner bolt(M12)	1	81.4 ~ 85.3	8.3 ~ 8.7	60.0 ~ 62.9
Drive belt auto tensioner bolt(M8)	1	17.7 ~ 21.6	1.8 ~ 2.2	13.0 ~ 15.9
Drive belt idler bolt	1	53.9 ~ 57.9	5.5 ~ 5.9	39.8 ~ 42.7
OCV(oil control valve) bolt	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Cylinder head bolt	16	(37.3~41.2) + (118~122°) + (88~92°)	(3.8~4.2) + (118~122°) + (88~92°)	(27.5~30.4) + (118~122°) + (88~92°)
Cylinder head bolt	1	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
CVVT & cam sprocket bolt	4	64.7 ~ 76.5	6.6 ~ 7.8	47.7 ~ 56.4
Camshaft bearing cap bolt	32	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Cylinder head cover bolt	38	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Connecting rod bearing bolt	12	(22.6~26.5) + (98~102°)	(2.3~2.7) + (98~102°)	(16.6~19.5) + (98~102°)
Main bearing cap inner bolt(M11)	8	49.0 + 90°	5.0 + 90°	36.2 + 90°
Main bearing cap outer bolt(M8)	8	19.6 + 120°	2.0 + 120°	14.5 + 120°
Main bearing cap side bolt(M8)	8	29.4 ~ 31.4	3.0 ~ 3.2	21.7 ~ 23.1
Rear oil seal case bolt	6	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Baffle plate bolt	6	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Upper oil pan bolt	16	19.6 ~ 21.6	2.0 ~ 2.2	14.5 ~ 15.9
Knock sensor bolt	2	15.7 ~ 23.5	1.6 ~ 2.4	11.6 ~ 17.4
Drive plate bolt	8	71.54 ~ 75.46	7.3 ~ 7.7	52.80 ~ 55.69
Oil filter cap	1	31.4 ~ 38.2	3.2 ~ 3.9	23.1 ~ 28.2
Oil drain bolt	1	34.3 ~ 44.1	3.5 ~ 4.5	25.3 ~ 32.5
Oil pump bolt	3	19.6 ~ 23.5	2.0 ~ 2.4	14.5 ~ 17.4

Oil filter assembly bolt	4	19.6 ~ 21.6	2.0 ~ 2.2	14.5 ~ 15.9
Bell housing cover bolt	1	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Oil cover bolt	4	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Air vent hose bolt	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Water pump bolt(Timing chain cover bolt L)	1	21.6 ~ 26.5	2.2 ~ 2.7	15.9 ~ 19.5
Water pump bolt(Timing chain cover bolt K)	4	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Water pump bolt(Timing chain cover bolt G)	4	21.6 ~ 23.5	2.2 ~ 2.4	15.9 ~ 17.4
Water pump pulley bolt	4	7.8 ~ 9.8	0.8 ~ 1.0	5.8 ~ 7.2
Water temp. control nut	4	19.6 ~ 23.5	2.0 ~ 2.4	14.5 ~ 17.4
Water temp. control bolt	2	19.6 ~ 23.5	2.0 ~ 2.4	14.5 ~ 17.4
Water inlet fitting bolt	3	16.7 ~ 19.6	1.7 ~ 2.0	12.3 ~ 14.5
Air vent pipe bolt	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Intake manifold bolt	6	26.5 ~ 31.4	2.7 ~ 3.2	19.5 ~ 23.1
Intake manifold nut	2	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Surge tank bolt (M8 × 28)	4	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Surge tank bolt (M6 × 106)	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Surge tank nut (M8)	2	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Breather pipe bolt	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Surge tank stay bolt (M10 × 20)	2	27.5 ~ 31.4	2.8 ~ 3.2	20.3 ~ 23.1
Exhaust manifold nut	16	39.2 ~ 44.1	4.0 ~ 4.5	28.9 ~ 32.6
Heat protector bolt	6	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Front muffler nut	8	39.2 ~ 58.8	4.0 ~ 6.0	28.9 ~ 43.4
Center muffler nut	8	39.2 ~ 58.8	4.0 ~ 6.0	28.9 ~ 43.4
Main muffler nut	8	39.2 ~ 58.8	4.0 ~ 6.0	28.9 ~ 43.4
Air cleaner assembly bolt	2	7.8 ~ 9.8	0.8 ~ 1.0	5.8 ~ 7.2
Intake air hose clamp bolt	1	1.9 ~ 2.9	0.2 ~ 0.3	1.4 ~ 2.2

Engine Mechanical System > General Information > Repair procedures

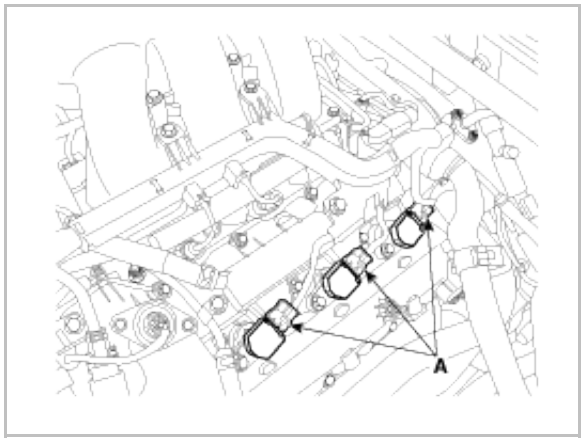
Inspection

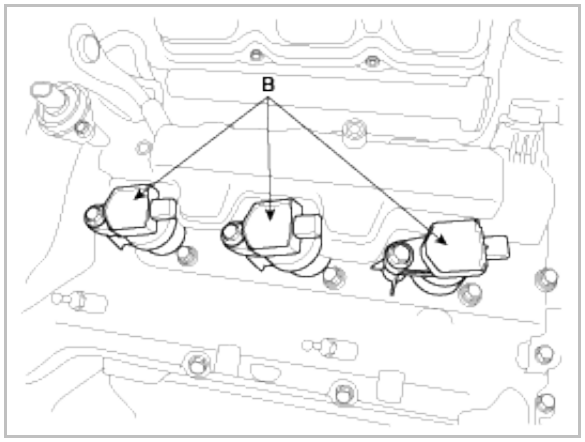
Compression Pressure

NOTE

If the there is lack of power, excessive oil consumption or poor fuel economy, measure the compression pressure.

1. Warm up engine until the normal operating temperature(80~95°C(176-203°F)).
2. Remove the surge tank. (Refer to Intake and exhaust system in this group)
3. Remove the ignition coil connectors (A) and ignition coils (B).





4. Remove the spark plugs.
   Using a 16mm plug wrench, remove the 6 spark plugs.
5. Check cylinder compression pressure.
   (1) Insert a compression gauge into the spark plug hole.
   (2) Fully open the throttle.
   (3) Crank the engine over 7 times to measure compression pressure.

> **NOTE**
> Always use a fully charged battery to obtain engine speed of 250 rpm or more.

   (4) Repeat step 1) though 3) for each cylinder.

> **NOTE**
> This measurement must be done in as short a time as possible.

Compression pressure :
1,029kPa (10.5kgf/cm², 149psi) (250~400 rpm)
Minimum pressure :
882kPa (9.0kgf/cm², 128psi)

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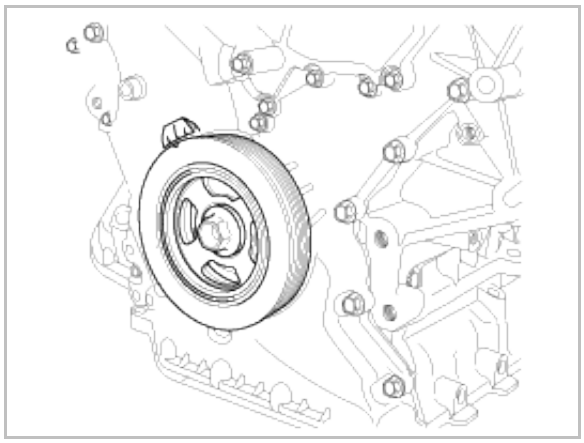
   (5) If the cylinder compression in 1 or more cylinders is low, pour a small amount of engine oil into the cylinder through the spark plug hole and repeat step 1) through 3) for cylinders with low compression.
      A. If adding oil helps the compression, it is likely that the piston rings and/or cylinder bore are worn or damaged.
      B. If pressure stays low, a valve may be sticking or seating is improper, or there may be leakage past the gasket.

6. Reinstall the spark plugs.
7. Install the ignition coils and ignition connectors.
8. Install the surge tank. (Refer to Intake and exhaust system in this group)

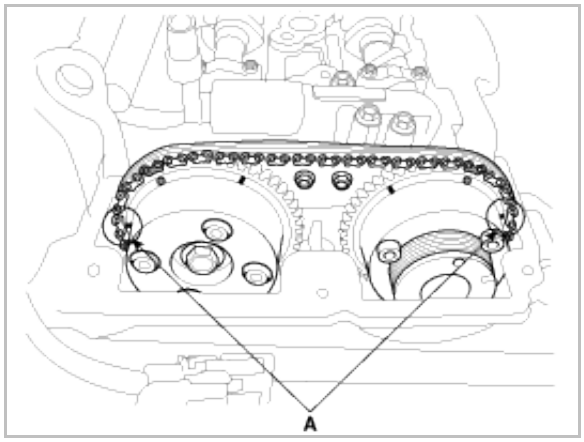
Valve Clearance Inspection And Adjustment

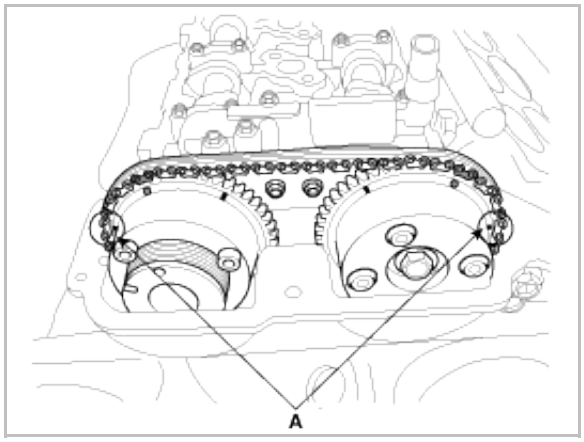
> **NOTE**
>
> Inspect and adjust the valve clearance when the engine is cold (Engine coolant temperature : 20°C(68°F)) and cylinder head is installed on the cylinder block.

1. Remove the engine cover.
2. Remove the engine side cover.
3. Remove air cleaner assembly.
4. Remove the surge tank. (Refer to Intake and exhaust system in this group)
5. Remove the cylinder head cover. (Refer to Timing system in this group)
6. Set No.1 cylinder to TDC/compression.
   (1) Turn the crankshaft pulley clockwise and align its groove with the timing mark "T" of the lower timing chain cover.



   (2) Check that the mark (A) of the camshaft timing sprockets are in straight line on the cylinder head surface as shown in the illustration.
   If not, turn the crankshaft clockwise one revolution (360°).

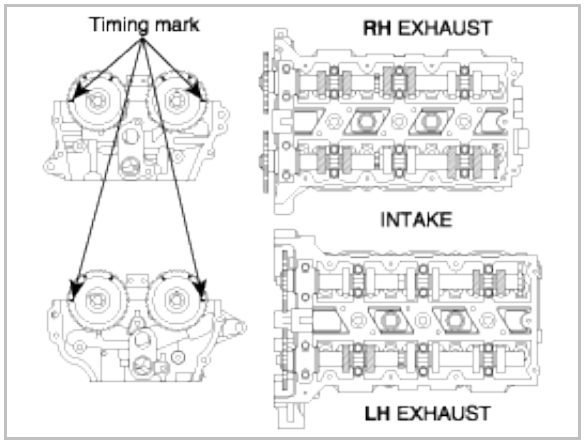




NOTE

Do not rotate engine counterclockwise.

7. Inspect the valve clearance.
   (1) With No.1 cylinder at TDC inspect clearances only on the valves shown in diagram below.



Measurement method.

A. Using a thickness gauge, measure the clearance between the tappet and the base circle of camshaft.
B. Record the out-of-specification valve clearance measurements. They will be used later to determine the required replacement adjusting tappet.

Valve clearance
Specification
Engine coolant temperature : 20°C [68°F]
Limit
Intake : 0.10 ~ 0.30mm (0.0039 ~ 0.0118in.)
Exhaust : 0.20 ~ 0.40mm (0.0078 ~ 0.0157in.)

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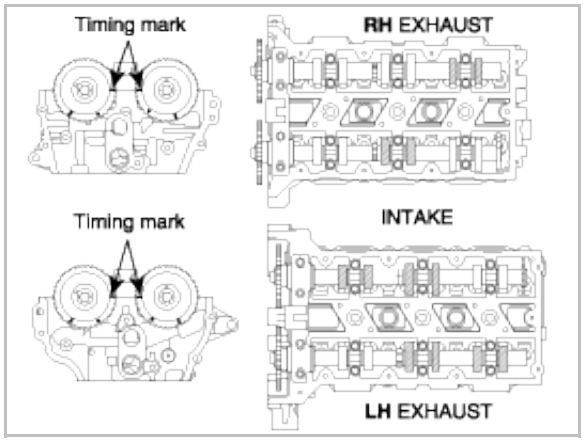
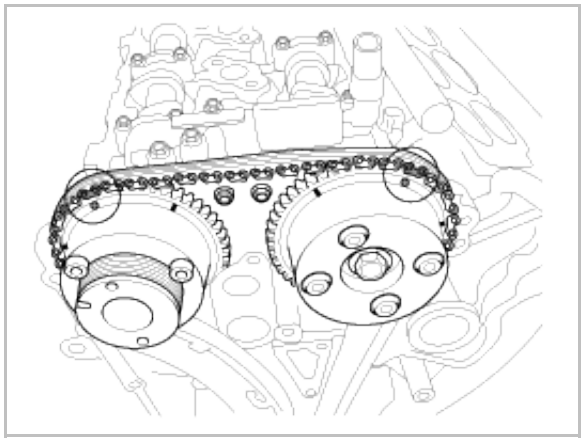
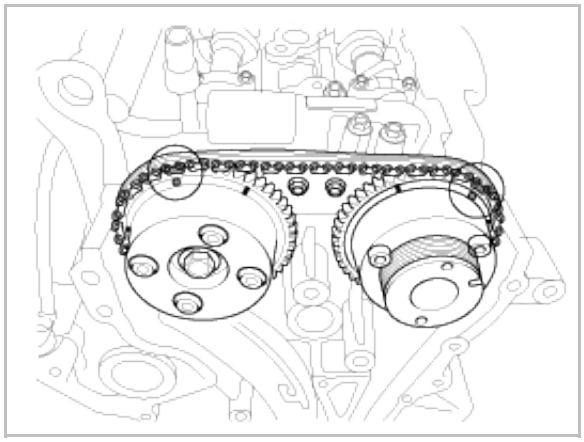
   (2) Turn the crankshaft pulley clockwise one revolution (360°) and align the groove with timing mark "T" of the lower timing chain cover.
   (3) With No.4 cylinder at TDC inspect clearances only the valves shown in diagram below. (Refer to procedure step 1.)

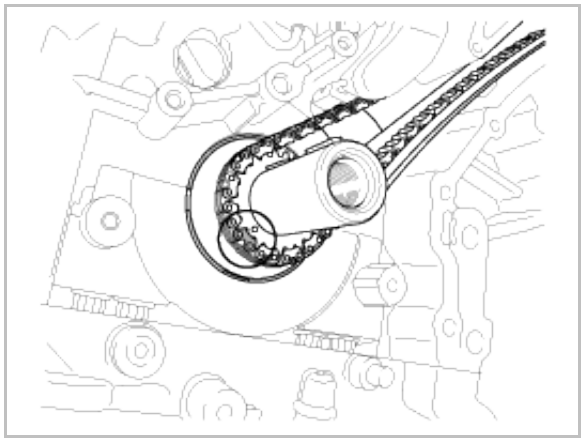


8. Adjust the intake and exhaust valve clearance.
   (1) Set the No.1 cylinder to the TDC/compression.
   (2) Remove the timing chain.

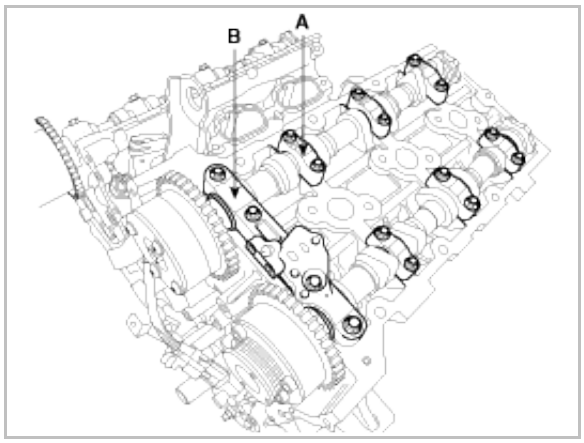
> **NOTE**
>
> Before removing the timing chain, mark the RH/LH timing chain with an identification based on the location of the sprocket because the identification mark on the chain for TDC (Top Dead Center) can be erased.

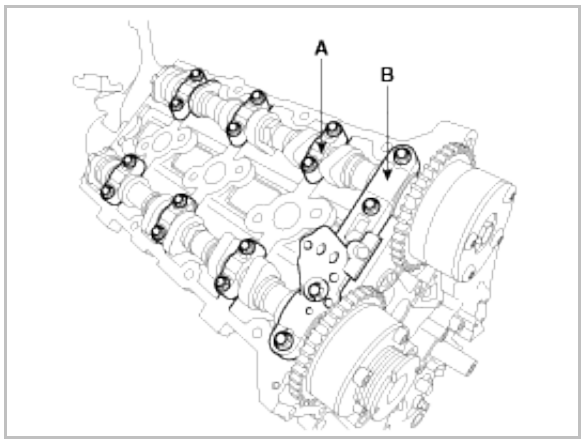




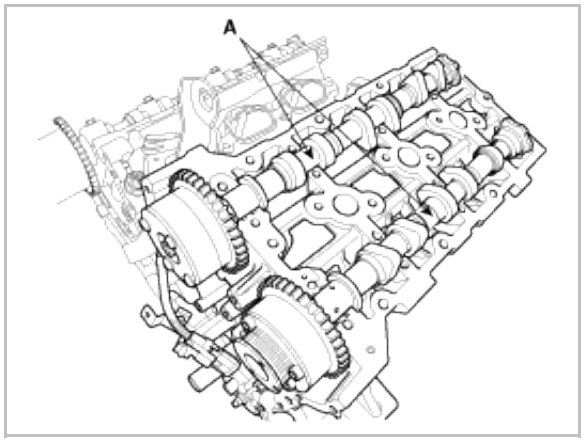


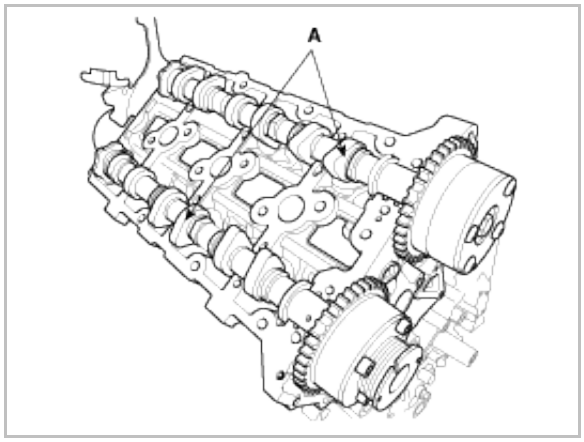
(3) Remove the LH/RH camshaft bearing cap (A) and thrust bearing cap (B).





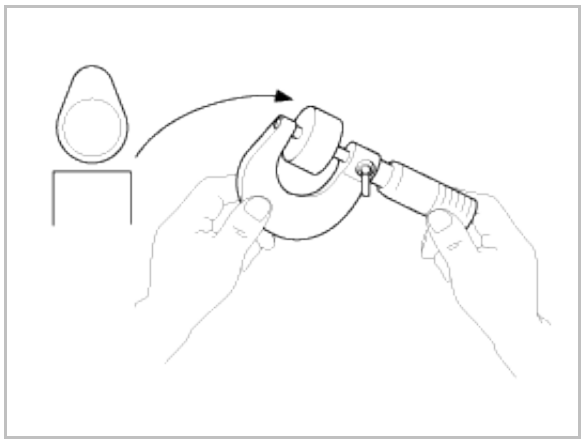
(4) Remove the LH/RH camshaft assembly (A).





(5) Remove the MLA.

(6) Measure the thickness of the removed tappet using a micrometer.



(7) Calculate the thickness of a new tappet so that the valve clearance comes within the specified value.

T : Thickness of removed tappet
A : Measured valve clearance
N : Thickness of new tappet
Intake : N = T + [A - 0.20mm(0.0079in.)]
Exhaust : N = T + [A - 0.30mm (0.0118in.)]

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(8) Select a new tappet with a thickness as close as possible to the calculated value.

NOTE

Shims are available in 41size increments of 0.015mm (0.0006in.) from 3.00mm (0.118in.) to 3.600mm (0.1417in.)

(9) Place a new tappet on the cylinder head.

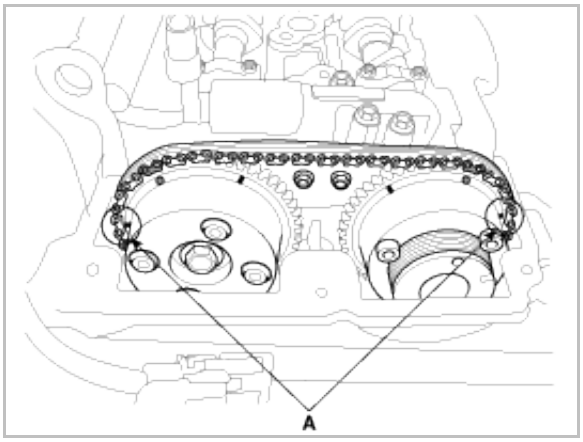
> **NOTE**
>
> Apply engine oil at the selected tappet on the periphery and top surface.

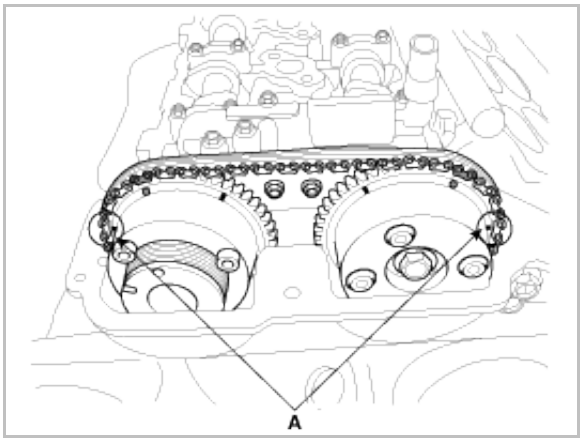
(10) Install the intake and exhaust camshaft.

(11) Install the bearing caps. (Refer to Cylinder head assembly in this Group)

(12) Install the timing chain. (Refer to Timing system in this Group)

(13) Turn the crankshaft two turns in the operating direction (clockwise) and realign crankshaft sprocket and camshaft sprocket timing marks (A).





(14) Recheck the valve clearance.

Valve clearance (Engine coolant temperature : 20°C [68°F])
[Specification]
Intake : 0.17 ~ 0.23mm (0.0067 ~ 0.0090in.)
Exhaust : 0.27 ~ 0.33mm (0.0106 ~ 0.0129in.)

Engine Mechanical System > General Information > Troubleshooting

Troubleshooting

Symptom	Suspect area	Remedy
Engine misfire with abnormal internal lower engine noises.	Worn crankshaft bearings. Loose or damaged engine drive plate.	Replace the crankshaft and bearings as required. Repair or replace the drive plate as

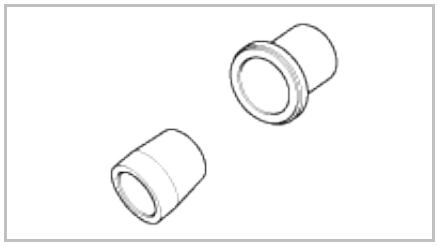
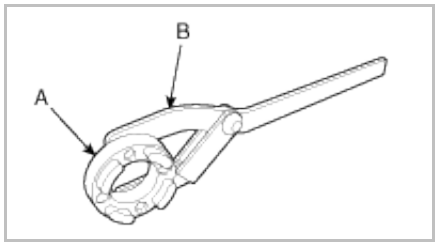
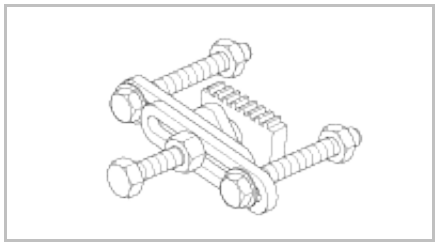
		required.
	Worn piston rings. (Oil consumption may or may not cause the engine to misfire.)	Inspect the cylinder for a loss of compression. Repair or replace as required.
	Worn crankshaft thrust bearings	Replace the crankshaft and bearings as required.
Engine misfire with abnormal valve train noise.	Stuck valves. (Carbon buildup on the valve stem)	Repair or replace as required.
	Excessive worn or mis-aligned timing chain.	Replace the timing chain and sprocket as required.
	Worn camshaft lobes.	Replace the camshaft and valve lifters.
Engine misfire with coolant consumption.	• Faulty cylinder head gasket and/or cranking or other damage to the cylinder head and engine block cooling system • Coolant consumption may or may not cause the engine to overheat.	• Inspect the cylinder head and engine block for damage to the coolant passages and/or a faulty head gasket. • Repair or replace as required.
Engine misfire with excessive oil consumption.	Worn valves, guides and/or valve stem oil seals.	Repair or replace as required.
	Worn piston rings. (Oil consumption may or may not cause the engine to misfire)	• Inspect the cylinder for a loss of compression. • Repair or replace as required.
Engine noise on start-up, but only lasting a few seconds.	Incorrect oil viscosity.	• Drain the oil.•Install the correct viscosity oil.
	Worn crankshaft thrust bearing.	• Inspect the thrust bearing and crankshaft. • Repair or replace as required.
Upper engine noise,regardless of engine speed.	Low oil pressure.	Repair or replace as required.
	Broken valve spring.	Replace the valve spring.
	Worn or dirty valve lifters.	Replace the valve lifters.
	Stretched or broken timing chain and/or damaged sprocket teeth.	Replace the timing chain and sprockets.
	Worn timing chain tensioner, if applicable.	Replace the timing chain tensioner as required.
	Worn camshaft lobes.	• Inspect the camshaft lobes. • Replace the timing camshaft and valve lifters as required.
	Worn valve guides or valve stems.	Inspect the valves and valve guides, then repair as required.
	Stuck valves. Carbon on the valve stem or valve seat may cause the valve to stay open.	Inspect the valves and valve guides, then repair as required.
	Worn drive belt, idler, tensioner and bearing.	Replace as required.

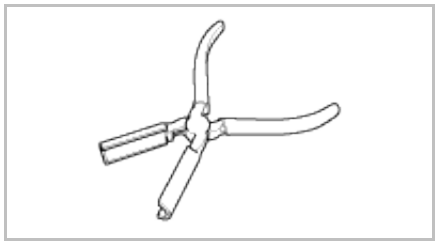
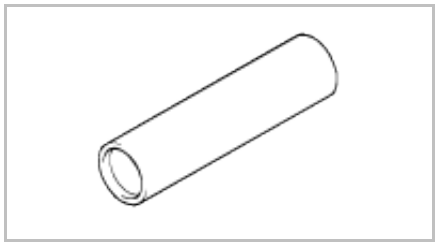
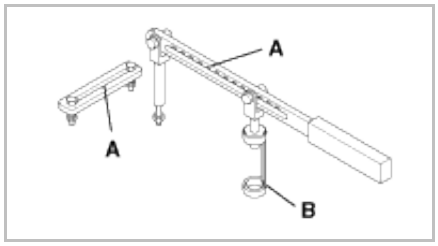
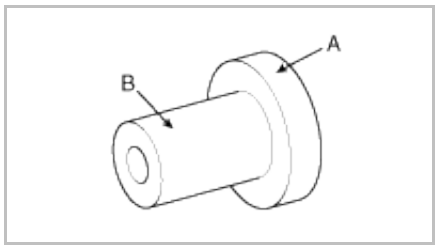
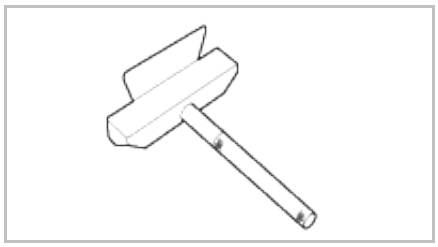
Lower engine noise,regardless of engine speed.	Low oil pressure.	Repair as required.
	Loose or damaged drive plate.	Repair or replace the drive plate.
	Damaged oil pan, contacting the oil pump screen.	• Inspect the oil pan. • Inspect the oil pump screen. • Repair or replace as required.
	Oil pump screen loose, damaged or restricted.	• Inspect the oil pump screen. • Repair or replace as required.
	Excessive piston-to-cylinder bore clearance.	• Inspect the piston, piston pin and cylinder bore. • Repair as required.
	Excessive piston pin-to-piston clearance.	• Inspect the piston, piston pin and the connecting rod. • Repair or replace as required.
	Excessive connecting rod bearing clearance	Inspect the following components and repair as required. • The connecting rod bearings. • The connecting rods. • The crankshaft pin journals.
	Excessive crankshaft bearing clearance.	Inspect the following components, and repair as required. • The crankshaft bearings. • The crankshaft main journals. • The cylinder block.
	Incorrect piston, piston pin and connecting rod installation	• Verify the piston pins and connecting rods are installed correctly. • Repair as required.
Engine noise under load.	Low oil pressure	Repair or replace as required.
	Excessive connecting rod bearing clearance .	Inspect the following components and repair as required : • The connecting rod bearings. • The connecting rods. • The crankshaft.
	Excessive crankshaft bearing clearance.	Inspect the following components, and repair as required. • The crankshaft bearings. • The crankshaft main journals. • The cylinder block.
Engine will not crank-crankshaft will not rotate.	Hydraulically locked cylinder. • Coolant/antifreeze in cylinder. • Oil in cylinder. • Fuel in cylinder.	1. Remove spark plugs and check for fluid. 2. Inspect for broken head gasket. 3. Inspect for cracked engine block or cylinder head. 4. Inspect for a sticking fuel injector and/or leaking fuel regulator.

	Broken timing chain and/or timing chain and/or timing chain gears.	1. Inspect timing chain and gears. 2. Repair as required.
	Material in cylinder. • Broken valve • Piston material • Foreign material	1. Inspect cylinder for damaged components and/or foreign materials. 2. Repair or replace as required.
	Seized crankshaft or connecting rod bearings.	1. Inspect crankshaft and connecting rod bearing. 2. Repair as required.
	Bent or broken connecting rod.	1. Inspect connecting rods. 2. Repair as required.
	Broken crankshaft.	1. Inspect crankshaft. 2. Repair as required.

Engine Mechanical System > General Information > Special Service Tools

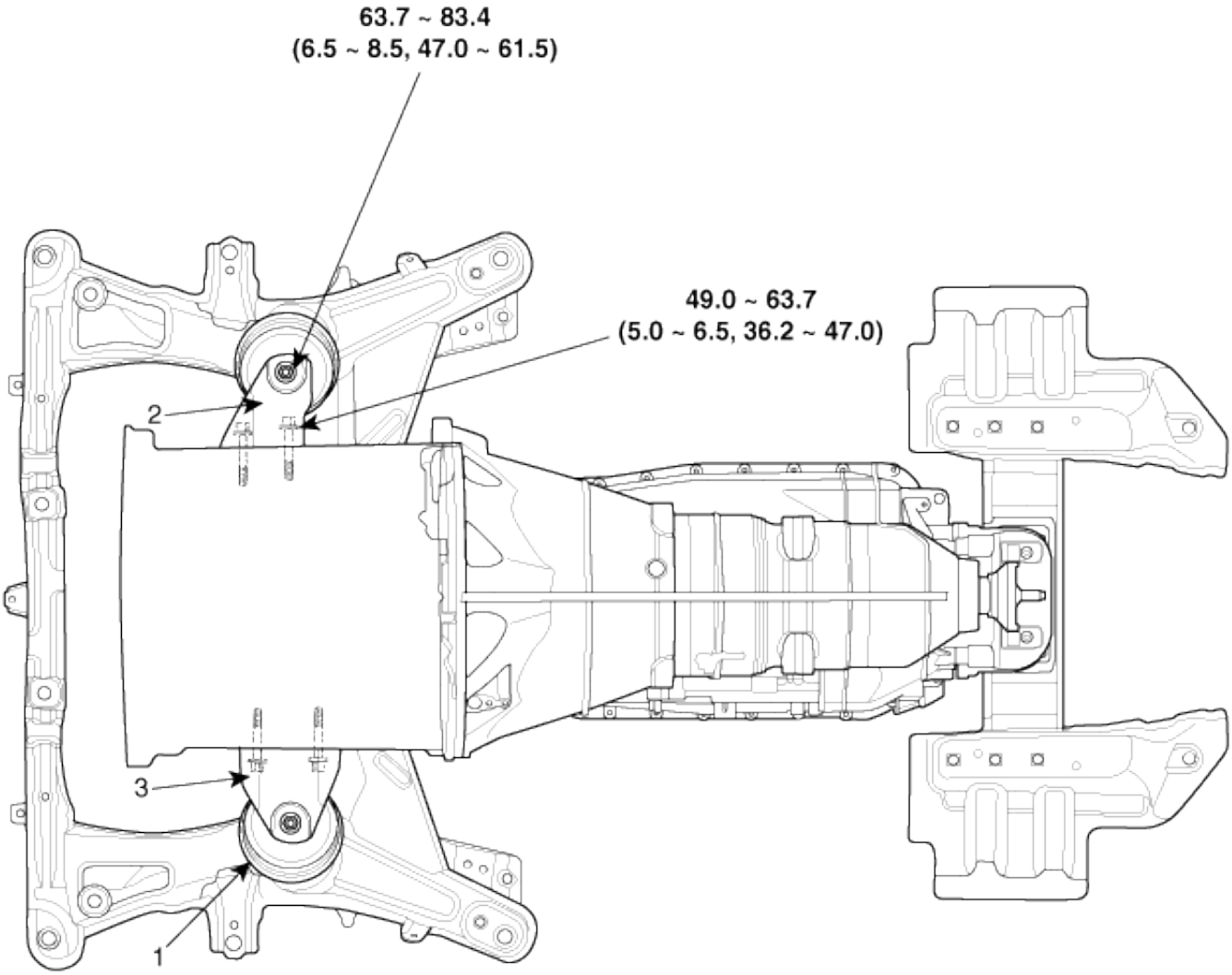
Special Service Tools

Tool (Number and name)	Illustration	Use
Crankshaft front oil seal installer (09231-3C100)		Installation of the front oil seal
Crankshaft pulley adapter holder (09231-2J210) Crankshaft pulley adapter (09231-2J200)		Removal and installation of the crankshaft pulley. (In vehicle use) A : 09231-2J200 B : 09231-2J210 (holder)
Flywheel stopper (09231-2B100)		Removal and installation of the flywheel and crankshaft pulley (Engine disassembly)
Torque angle adapter (09221-4A000)		Installation of bolts & nuts needing an angular method

Valve stem seal remover (09222-29000)		Removal of the valve stem seal
Valve stem seal installer (09222-3C100)		Installation of the valve stem seal
Valve spring compressor & holder (09222-3K000) (09222-3C300)		Removal and installation of the intake or exhaust valves A : 09222-3K000 B : 09222-3C300 (holder)
Crankshaft rear oil seal installer (09231-3C200) (09231-H1100)		Installation of the crankshaft rear oil seal A : 09231-3C200 B : 09231-H1100
Oil pan remover (09215-3C000)		Removal of oil pan

Engine Mechanical System > Engine And Transmission Assembly > Engine Mounting > Components and Components Location

Components



Torque : N.m (kgf.m, lb-ft)

1. Engine mounting bracket 2. Engine support bracket (RH)	3. Engine support bracket (LH)

Engine Mechanical System > Engine And Transmission Assembly > Engine And Transmission Assembly > Repair procedures

Removal

CAUTION

- Use fender covers to avoid damaging painted surfaces.
- To avoid damage, unplug the wiring connectors carefully while holding the connector portion.

WARNING

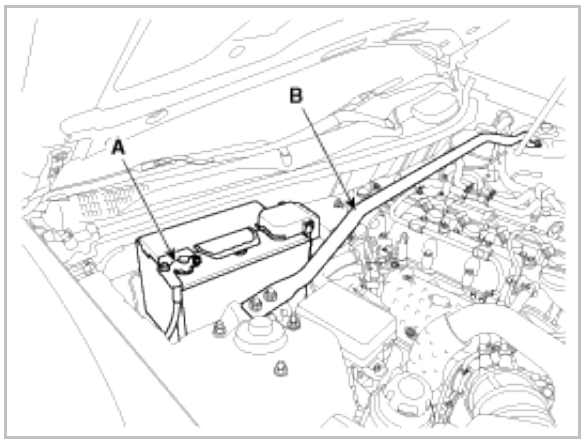
For release the fuel pressure, start the engine and wait until fuel in fuel line is exhausted. After the engine stop

turn the ignition switch OFF.

NOTE

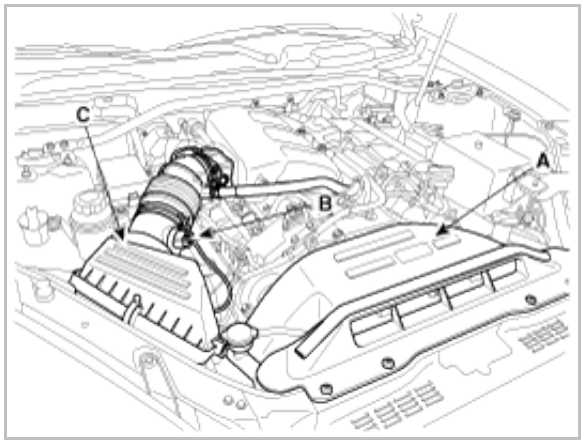
• Mark all wiring and hoses to avoid misconnection.

1. Disconnect the battery negative cable (A).
2. Remove the transmission before removing the engine. (Refer to AT group)
3. Remove the strut bar (B).

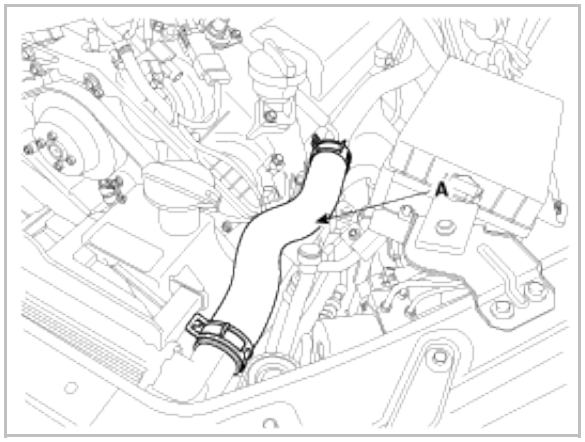


4. Loosen the drain plug and drain the engine coolant.
5. After recovering refrigerant, remove the high & low pressure pipe. (Refer to HA group)
6. Remove the air duct (A).
7. Remove the air cleaner assembly (C) after removing the AFS connector (B).

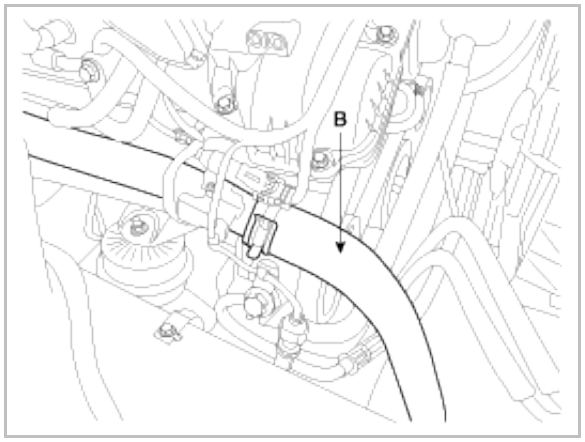
Tightening torque :
Bolt : 7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)
Clamp : 2.9 ~ 4.9N.m (0.3 ~ 0.5kgf.m, 2.2 ~ 3.6lb-ft)



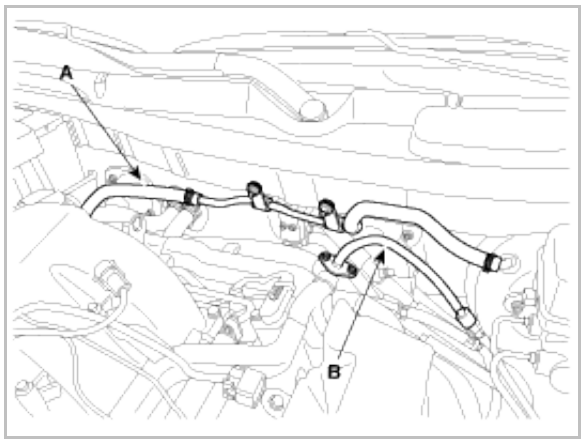
8. Remove the radiator upper hose (A).



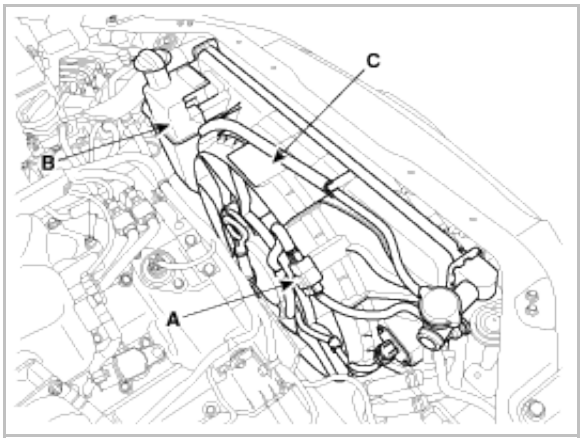
9. Remove the radiator lower hose (A).



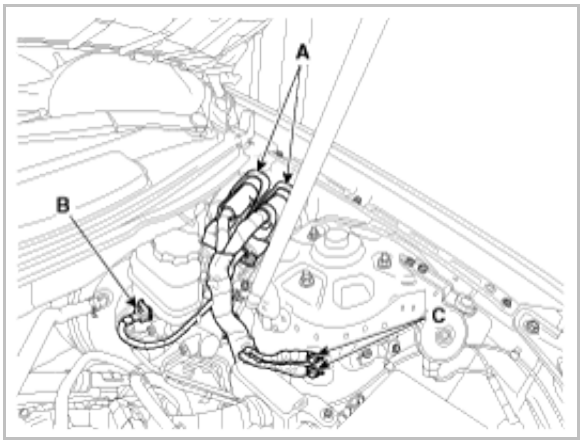
10. Disconnect the fuel hoses (B) and brake vacuum hose (A).



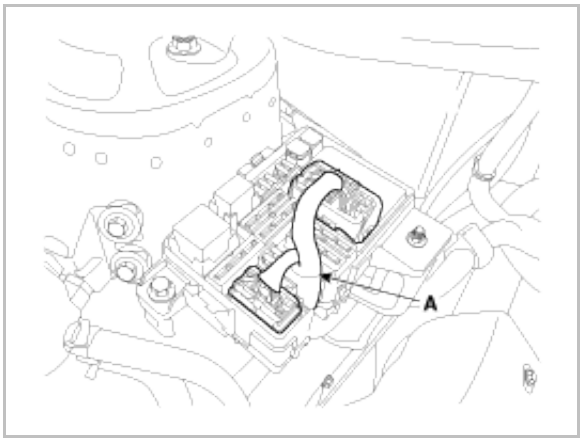
11. Remove the cooling fan.
    (1) Remove the cooling fan connector (A).
    (2) Remove the reservoir tank (B).
    (3) Remove the fan assembly (C).



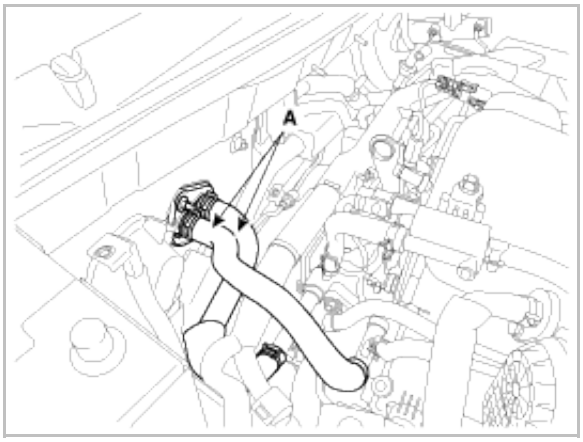
12. Remove the oil hose from the power steering pump. (Refer to ST group)
13. Disconnect the ECM connector (A), brake oil level sensor connector (B) and ground (C).



14. Remove the alternator cable. (Refer to EE group)
15. Disconnect the wirings (A) from the fuse box.



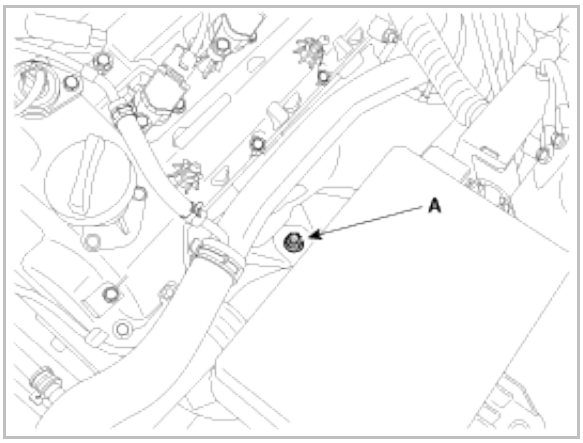
16. Remove the heater hoses (A).



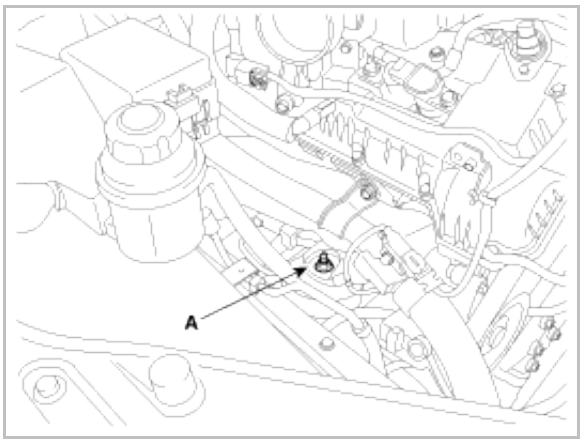
17. Remove the engine mounting bracket nut (A).

Tightening torque :
66.7 ~ 83.4N.m (6.8 ~ 8.5kgf.m, 49.2 ~ 61.5lb-ft)

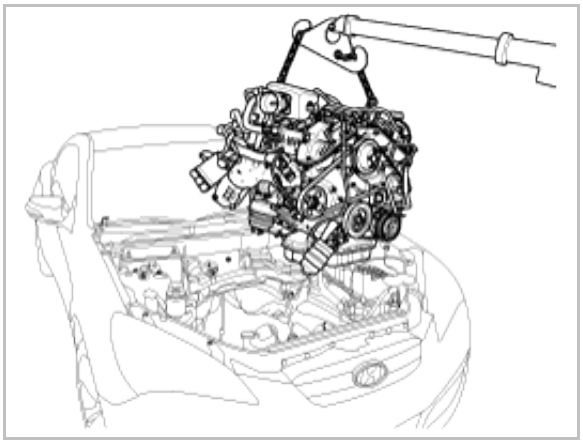
[LH]



[RH]



18. Remove the hood. (Refer to BD group)
19. Remove the engine assembly by lifting the engine jack.



CAUTION

- When removing the engine assembly, be careful not to damage any surrounding parts or body components.

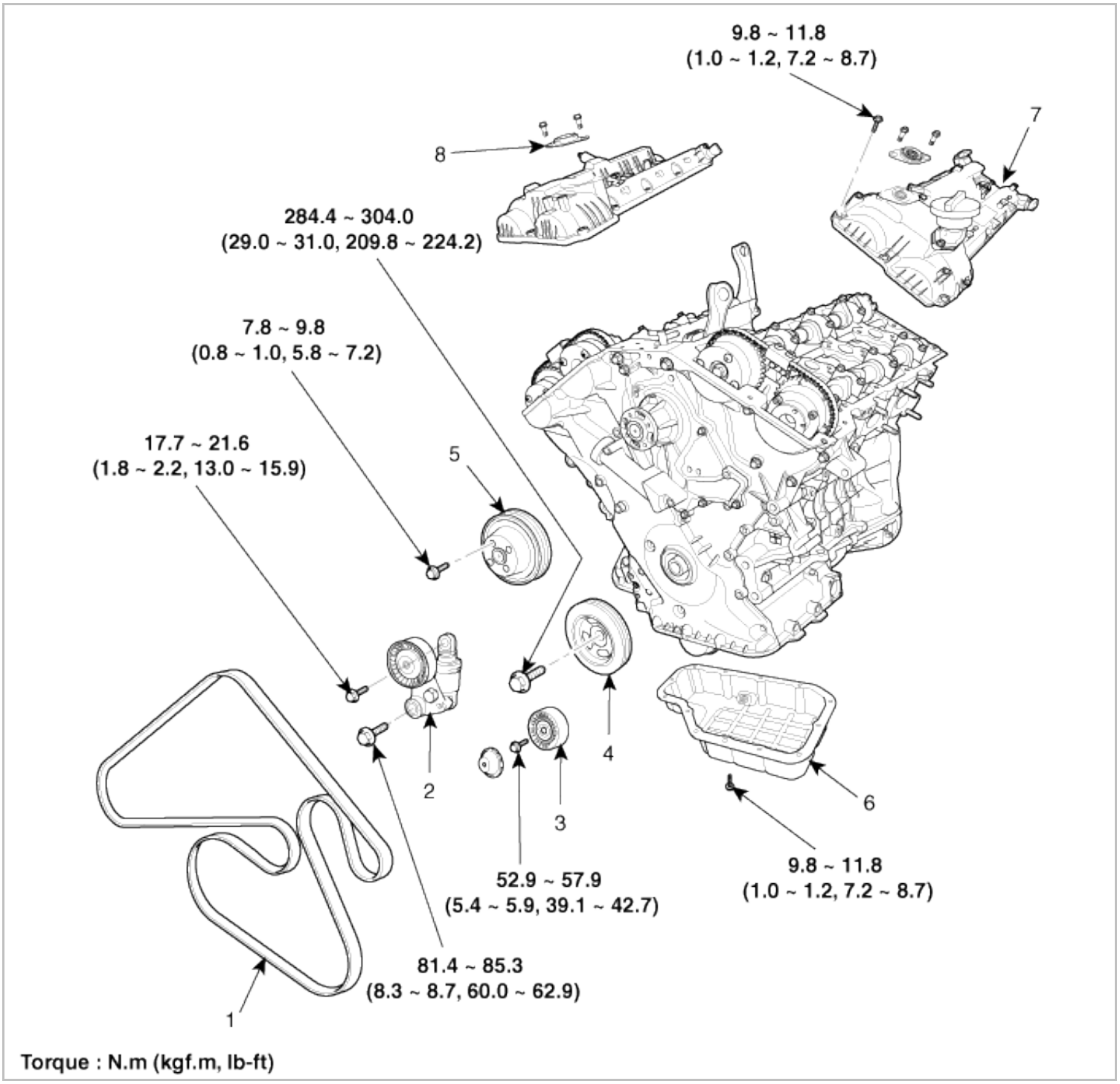
Installation

Installation is in the reverse order of removal.
Perform the following :

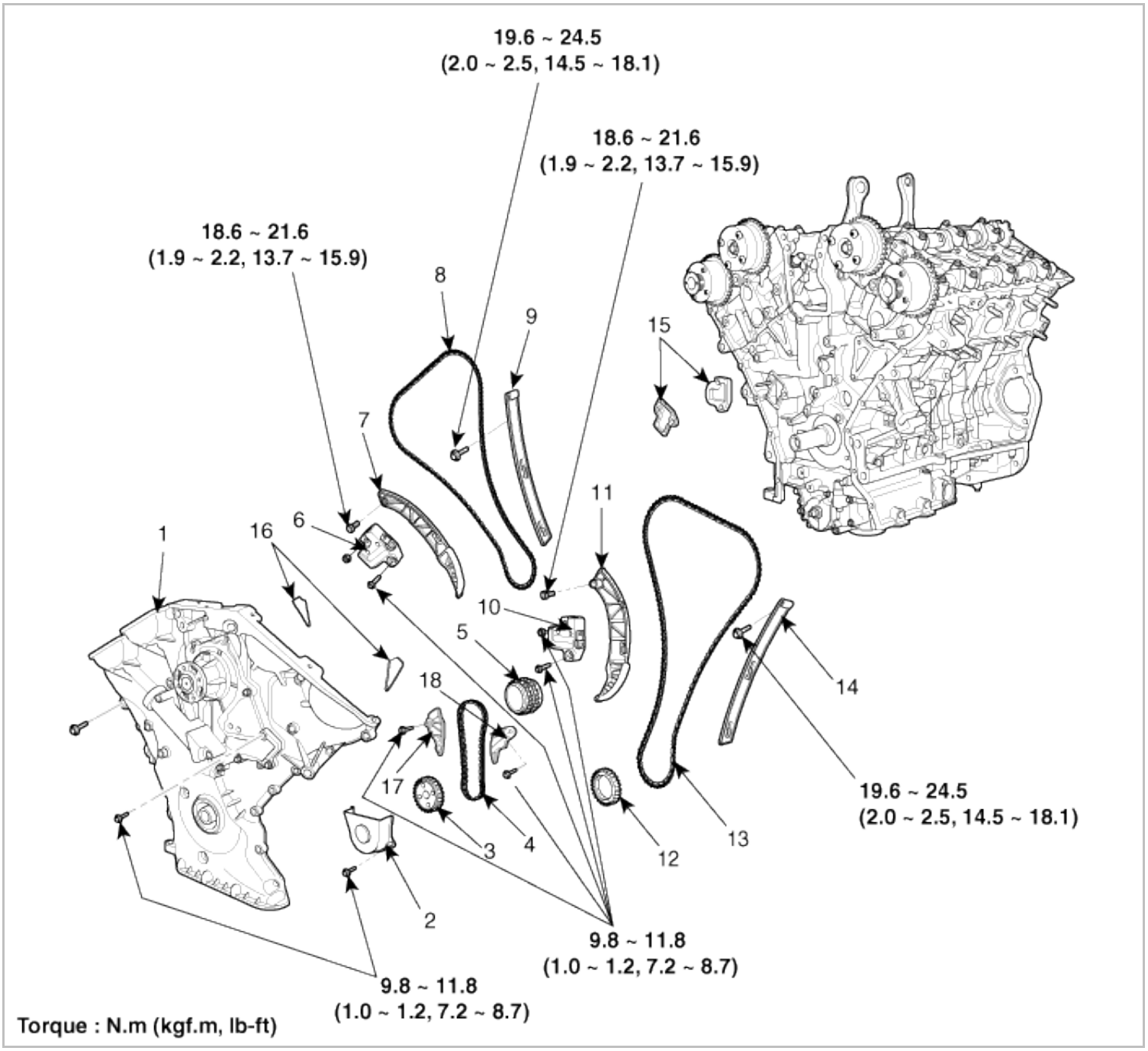
- Adjust a shift cable.
- Refill engine with engine oil.
- Refill a transmission with fluid.
- Clean battery posts and cable terminals with sandpaper. Reassemble, then apply grease to prevent corrosion.
- Inspect for fuel leakage.
- After assembling the fuel line, turn on the ignition switch (do not operate the starter) so that the fuel pump runs for approximately two seconds and fuel line pressurizes.
- Repeat this operation two or three times, then check for fuel leakage at any point in the fuel line.
- Refill a radiator and a reservoir tank with engine coolant.
- Bleed air from the cooling system.
- Start engine and let it run until it warms up. (until the radiator fan operates 3 or 4 times.)
- Turn Off the engine. Check the level in the radiator, add coolant if needed. This will allow trapped air to be removed from the cooling system.
- Put radiator cap on tightly, then run the engine again and check for leaks.

Engine Mechanical System > Timing System > Timing Chain > Components and Components Location

Components



1. Drive belt	5. Water pump pulley
2. Drive belt tensioner	6. Oil pan
3. Idler	7. Cylinder head cover
4. Crank shaft pulley	8. OCV cap



1. Timing chain cover	7. Timing chain tensioner arm	13. Timing chain
2. Oil pump chain cover	8. Timing chain	14. Timing chain guide
3. Oil pump sprocket	9. Timing chain guide	15. Tensioner adapter
4. Oil pump chain	10. Timing chain auto tensioner	16. Gasket
5. Crankshaft sprocket	11. Timing chain tensioner arm	17. Oil pump chain guide
6. Timing chain auto tensioner	12. Crankshaft sprocket	18. Oil pump tensioner assembly

Engine Mechanical System > Timing System > Timing Chain > Repair procedures

Removal

CAUTION

- Use fender covers to avoid damaging painted surfaces.

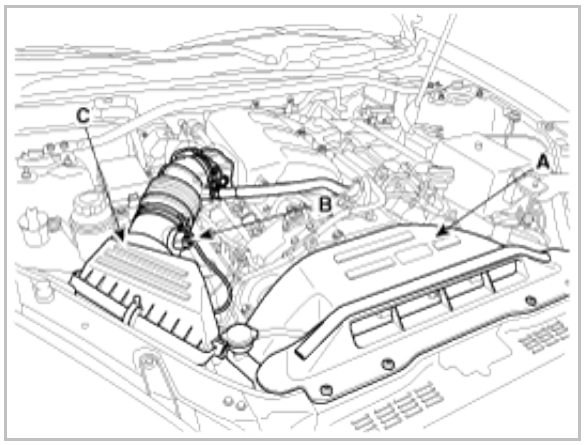
• To avoid damage, unplug the wiring connectors carefully while holding the connector portion.

NOTE

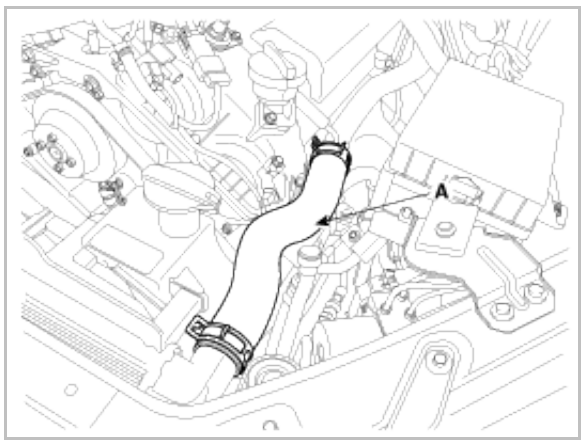
• Mark all wiring and hoses to avoid misconnection.
• Turn the crankshaft pulley so that the No.1 piston is at top dead center.

1. Disconnect the battery negative cable.
2. Loosen the drain plug and drain the engine coolant.
3. Remove the engine cover.
4. After recovering refrigerant, remove the high & low pressure pipe. (Refer to HA group)
5. Remove the air duct (A).
6. Remove the air cleaner assembly (C) after removing the AFS connector (B).

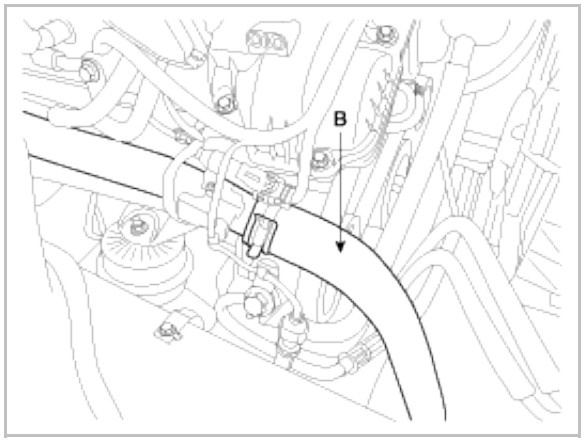
Tightening torque :
Bolt : 7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)
Clamp : 2.9 ~ 4.9N.m (0.3 ~ 0.5kgf.m, 2.2 ~ 3.6lb-ft)



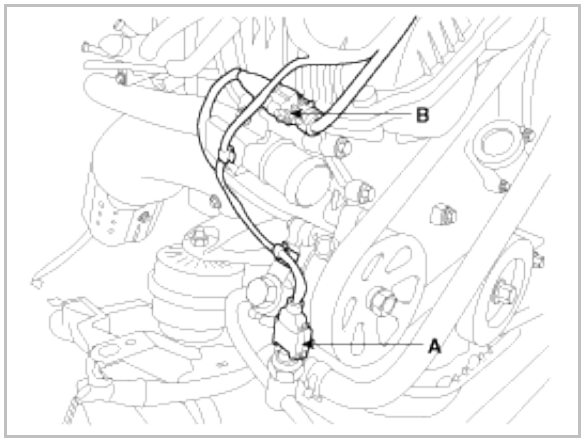
7. Remove the radiator upper hose (A).



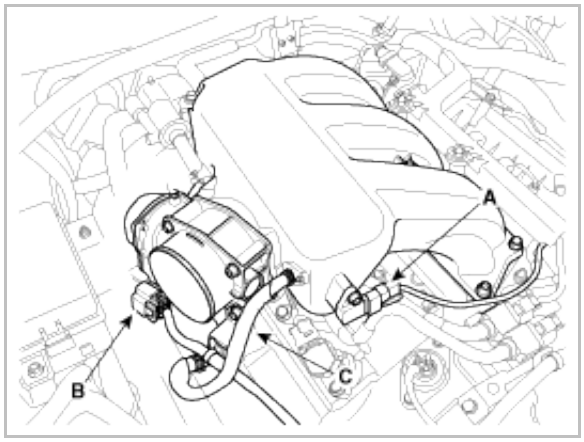
8. Remove the radiator lower hose (A).



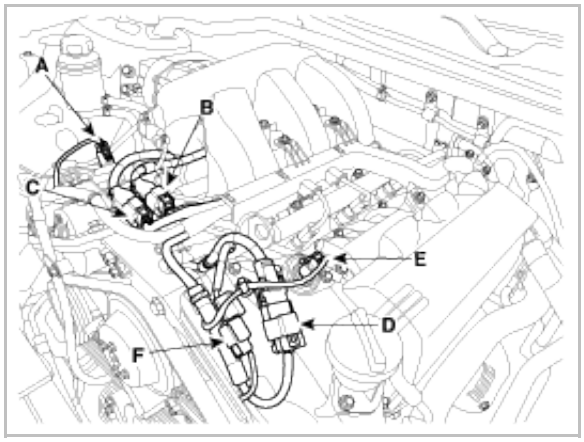
9. Disconnect the engine wiring connectors.
   (1) Disconnect the power steering oil pressure switch connector(A) and RH knock sensor connector(B).



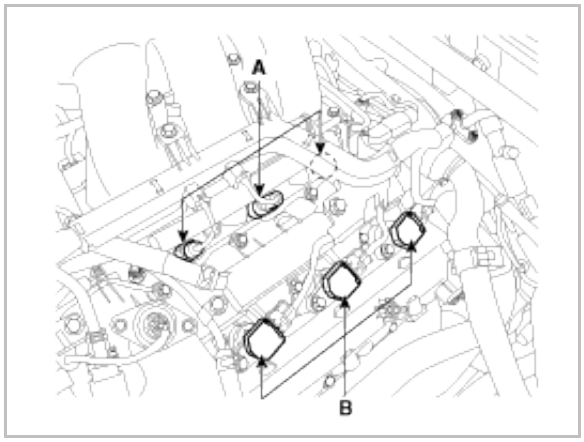
   (2) Disconnect the MAP sensor connector (A), ETC connector (B) and PVC hose (C).



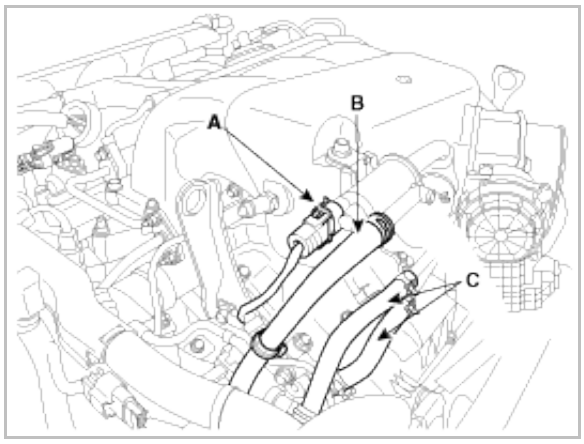
   (3) Disconnect the RH exhaust OCV connector (A), RH injector connector (B) and RH ignition coil connector (C), LH/RH intake OCV connector (D) and LH exhaust OCV connector (E), Oil pressure switch connector (F).



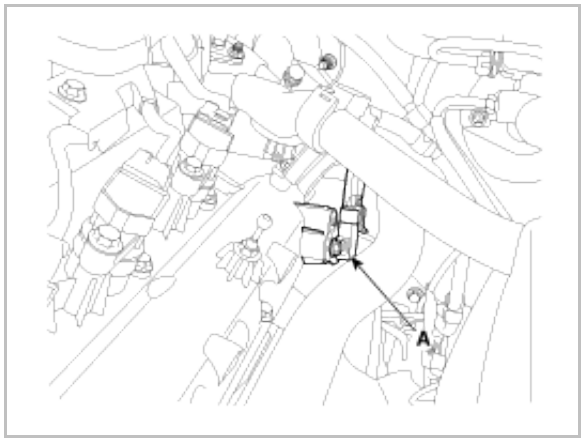
(4) Disconnect the LH injector connector (A) and LH ignition coil connector (B).



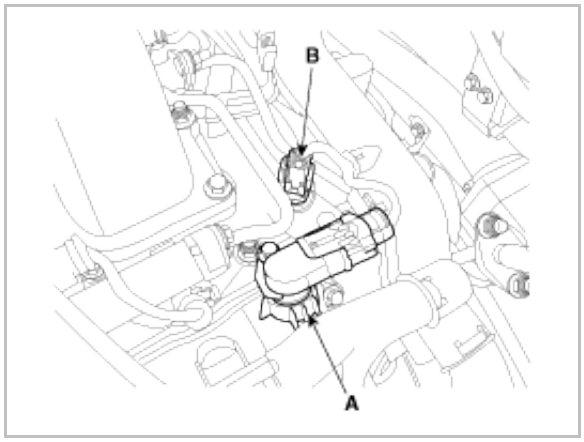
(5) Disconnect the PCSV connector (A), PCSV hose (B) and throttle body coolant hoses (C).



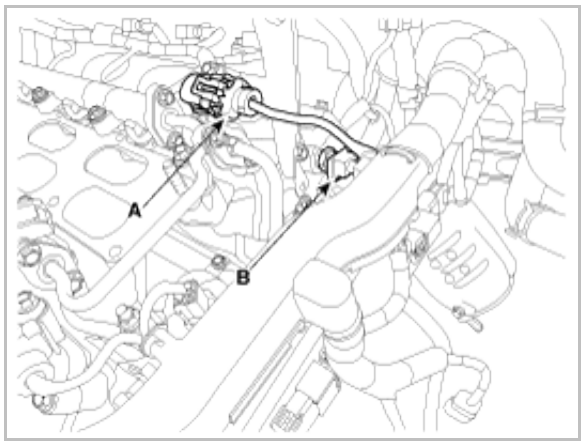
(6) Disconnect the LH exhaust CMP sensor connector (A).



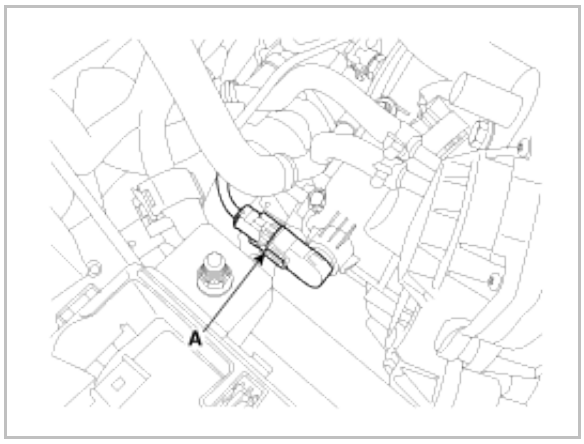
(7) Disconnect the LH intake CMP sensor connector (A) and water temperature sensor connector (B).



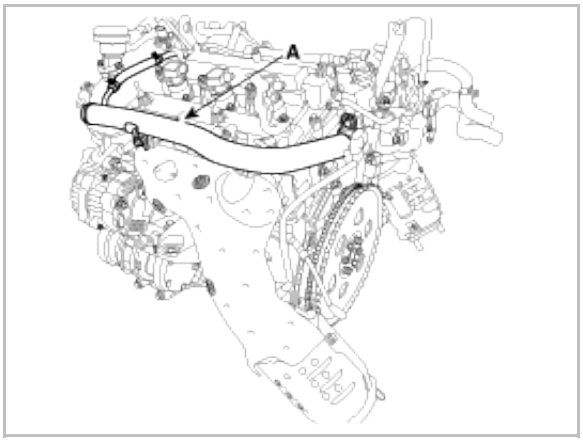
(8) Disconnect the RH intake CMP sensor connector (A) and oil temperature sensor connector (B).



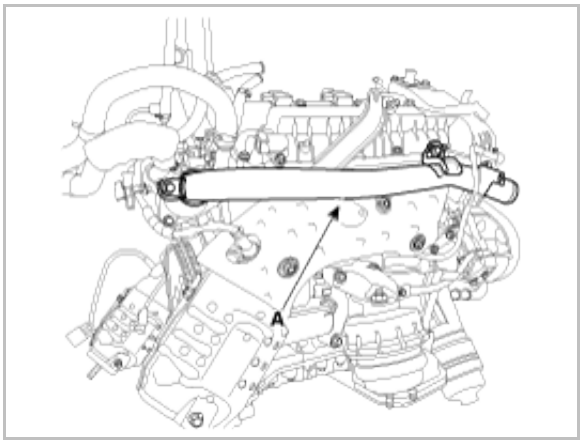
(9) Disconnect the RH exhaust CMP sensor connector (A).



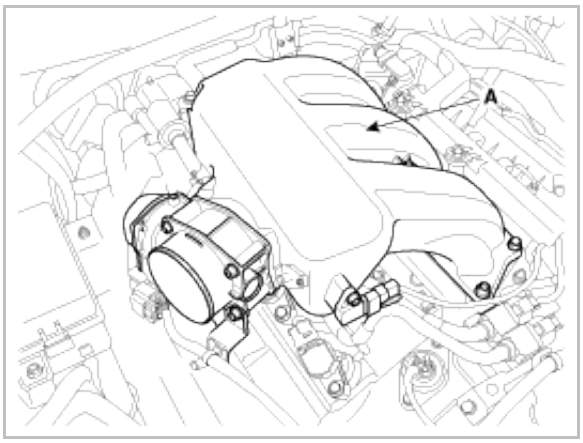
10. Remove the LH side coolant pipe and hose (A).



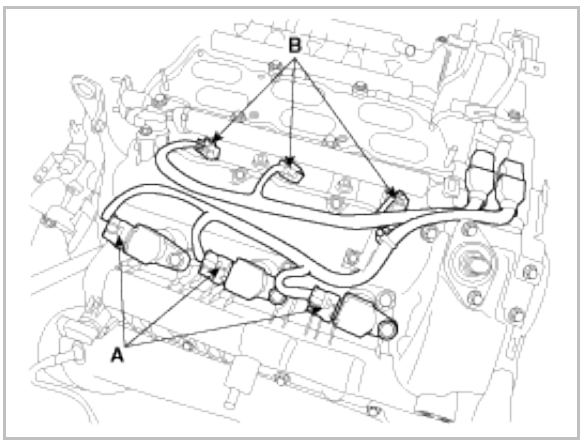
11. Remove the RH side coolant pipe(A).



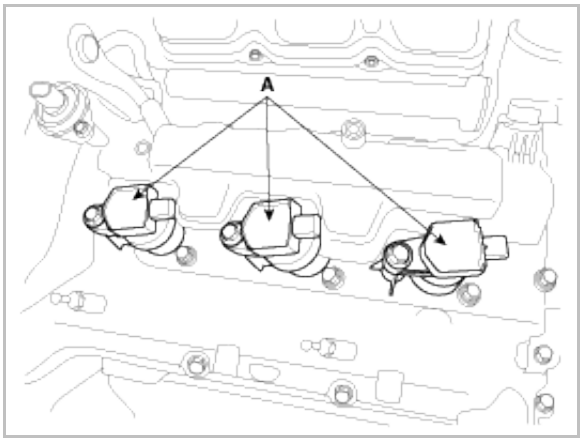
12. Remove the surge tank (A).

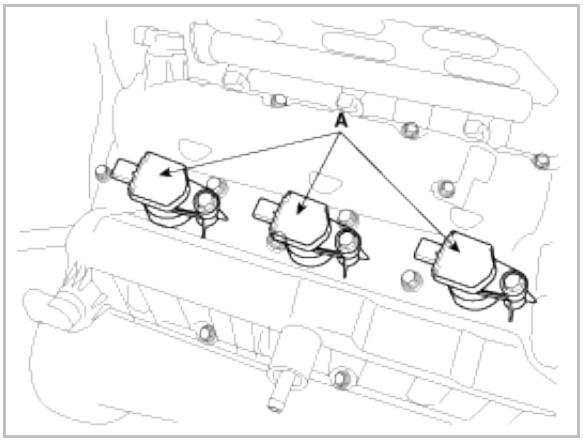


13. Disconnect the RH ignition coil connector (A) and the injector connector (B).

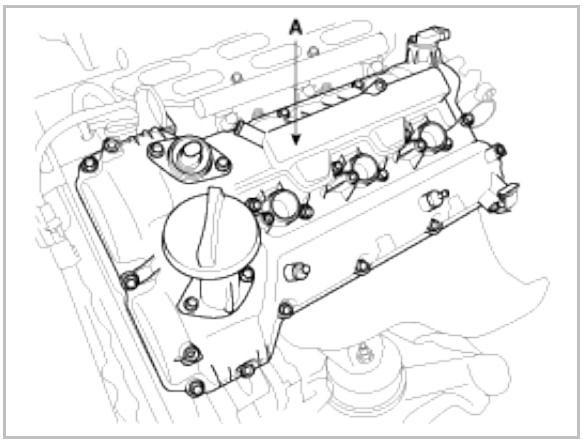


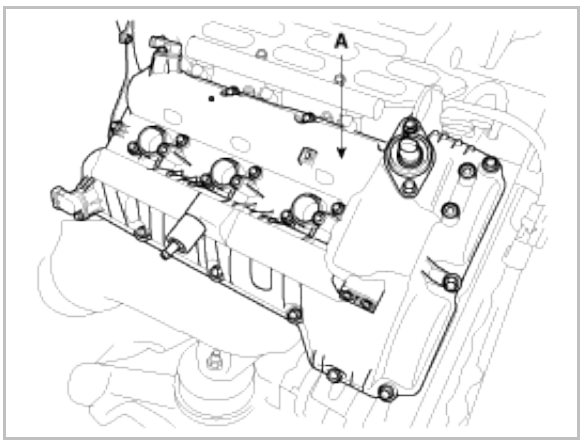
14. Remove the LH/RH ignition coils (A).



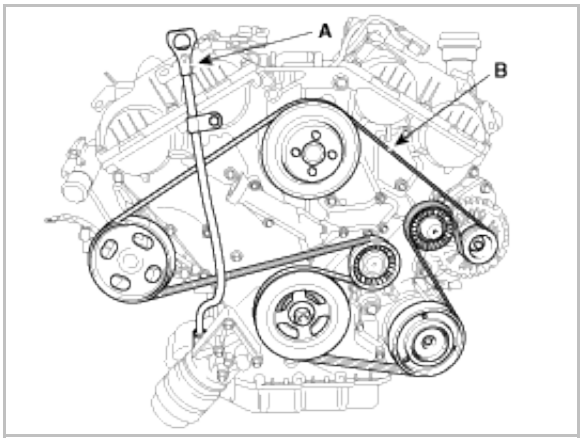


15. Remove the LH/RH cylinder head cover (A).

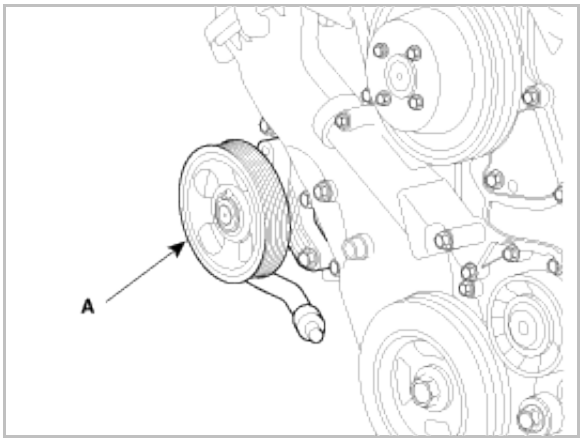




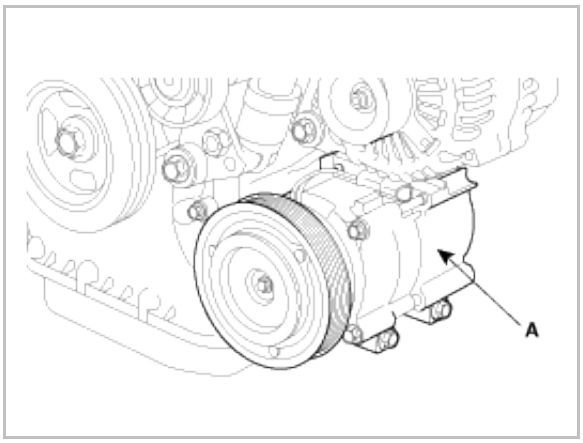
16. Remove the drive belt (B) after removing the oil level gauge tube (A).



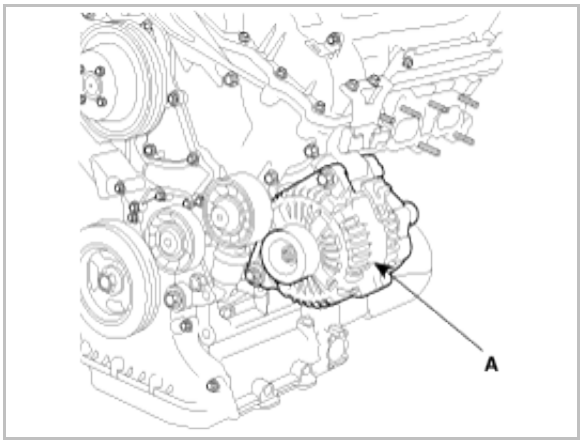
17. Remove the power steering pump (A). (Refer to ST group)



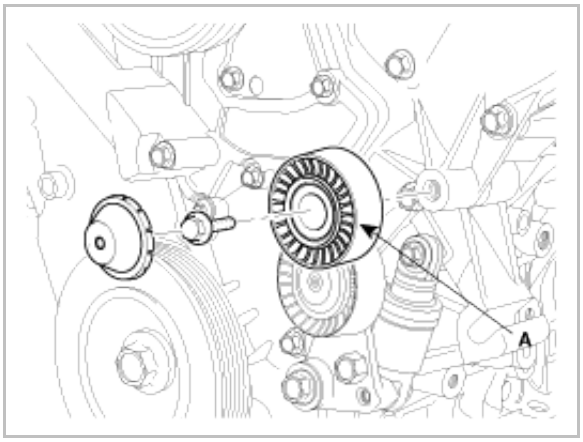
18. Remove the air conditioner compressor (A). (Refer to HA group)



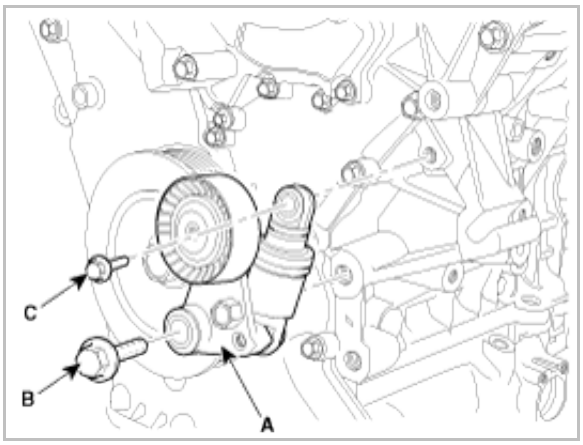
19. Remove the alternator (A). (Refer to EE group)



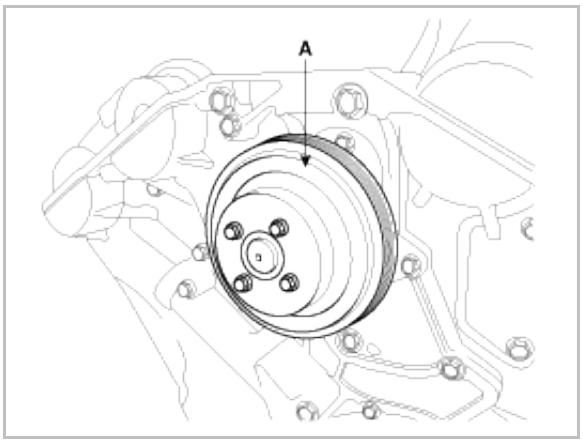
20. Remove the drive belt idler (A).



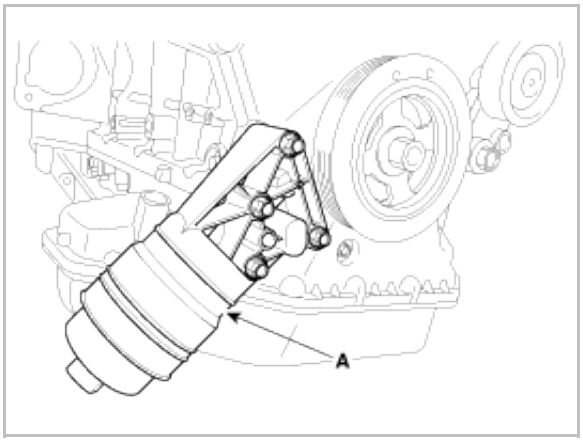
21. Remove the drive belt auto tensioner (A).



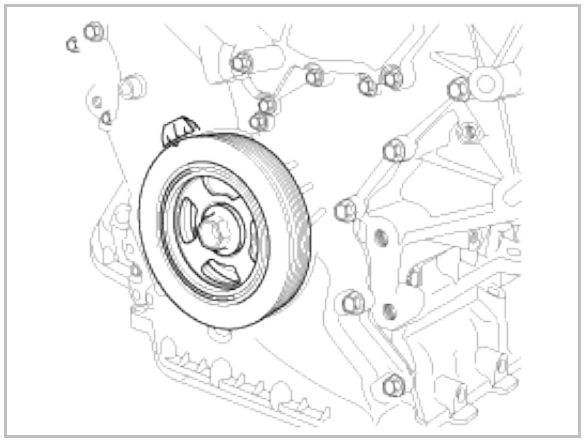
22. Remove the water pump pulley (A).



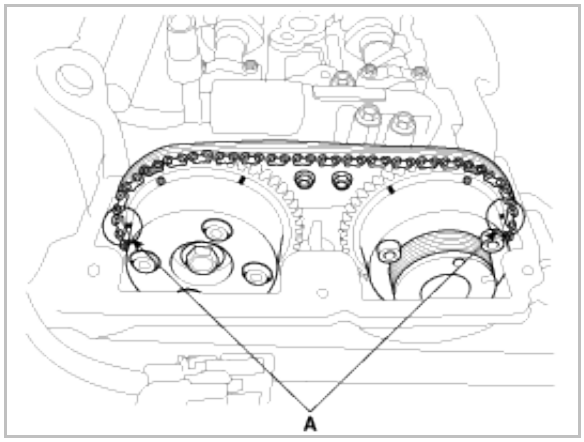
23. Remove the oil filter body (A).

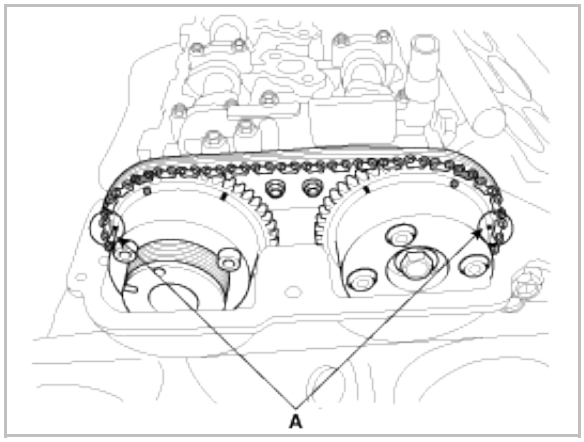


24. Set No.1 cylinder to TDC/compression.
    (1) Turn the crankshaft pulley clockwise and align its groove with the timing mark "T" of the lower timing chain cover.



    (2) Check that the mark (A) of the camshaft timing sprockets are in straight line on the cylinder head surface as shown in the illustration. If not, turn the crankshaft clockwise one revolution (360°).

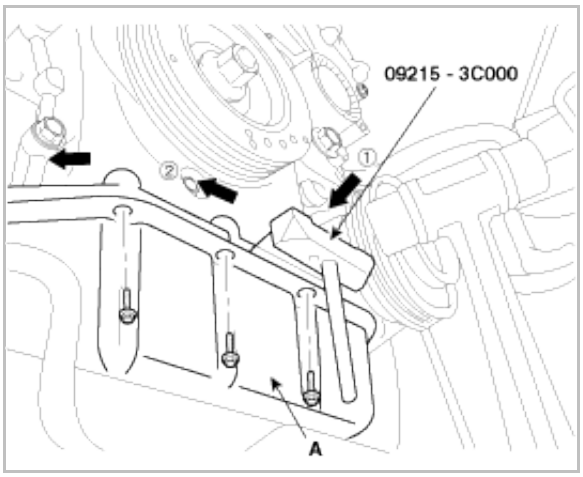




NOTE

Do not rotate engine counterclockwise.

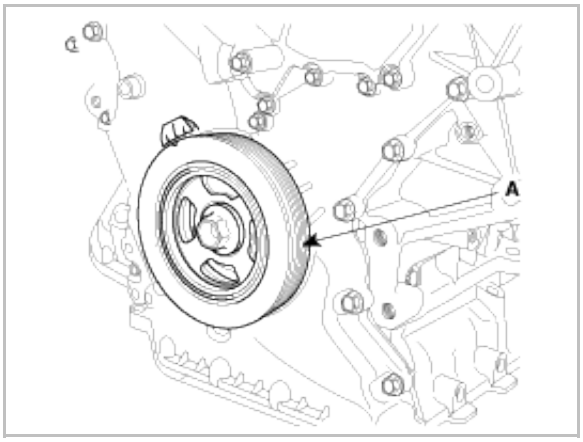
25. Remove the lower oil pan (A).
    Insert the blade of SST(09215-3C000) between the upper oil pan and lower oil pan. Cut off applied sealer and remove the lower oil pan.



NOTE

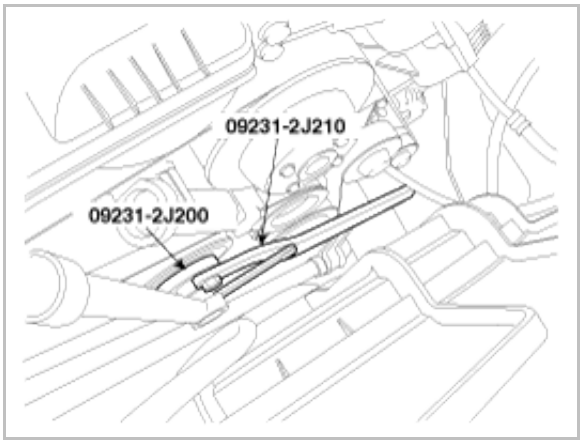
- Insert the SST between the oil pan and the ladder frame by tapping it with a plastic hammer in the direction of arrow.
- After tapping the SST with a plastic hammer along the direction of arrow around more than 2/3 edge of the oil pan, remove it from the ladder frame.
- Do not turn over the SST abruptly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

26. Remove the crankshaft pulley (A).



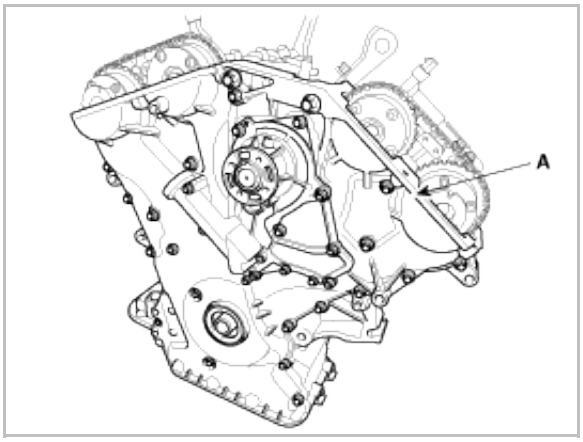
NOTE

• Use the SST(09231-2J210, 09231-2J200) to fix the crankshaft pulley.



27. Remove the water vent hose (A) from the timing chain cover.

28. Remove the timing chain cover (A).

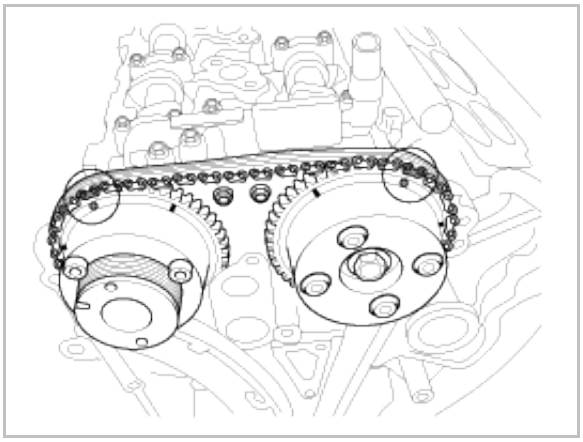


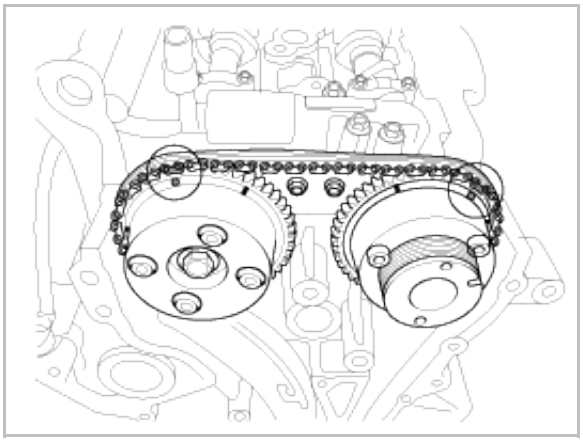
CAUTION

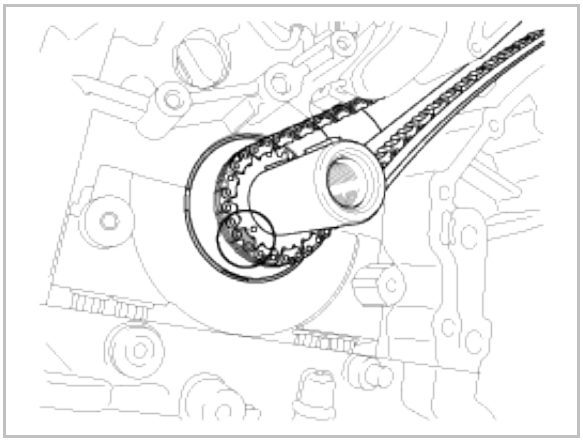
- Be careful not to damage the contact surfaces of cylinder block, cylinder head and timing chain cover.

NOTE

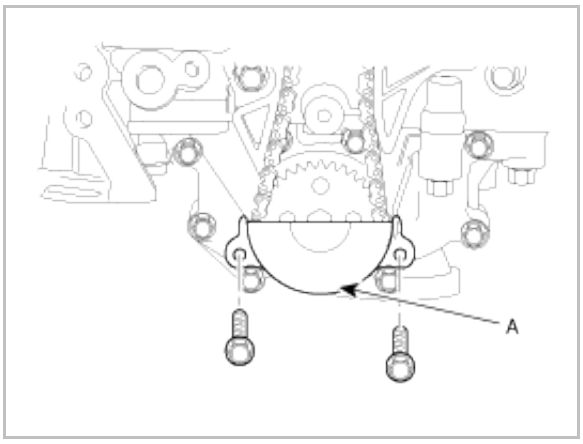
- Before removing the timing chain, mark the RH/LH timing chain with an identification based on the location of the sprocket because the identification mark on the chain for TDC (Top Dead Center) can be erased.



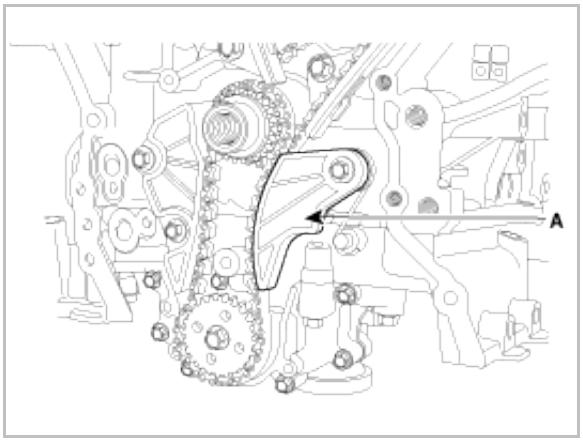




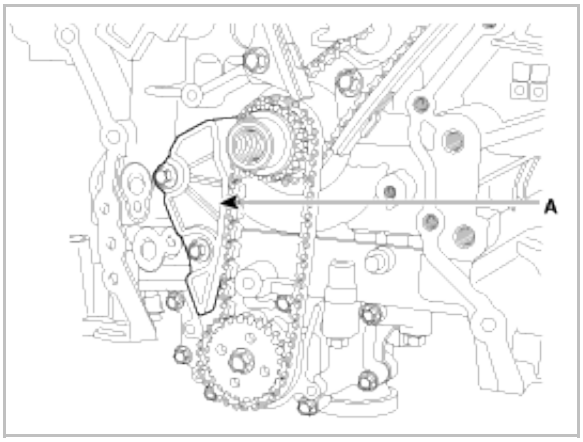
29. Remove the oil pump chain cover (A).



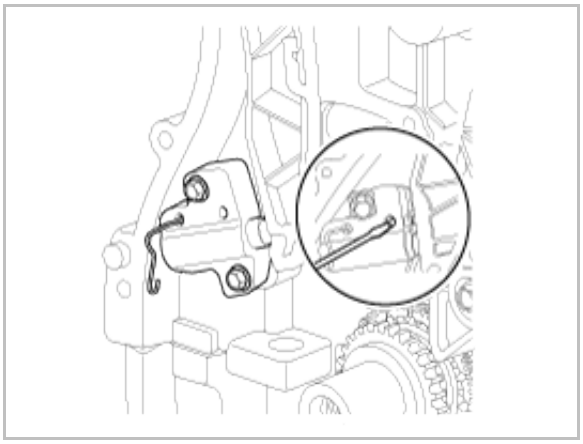
30. Remove the oil pump chain tensioner assembly (A).



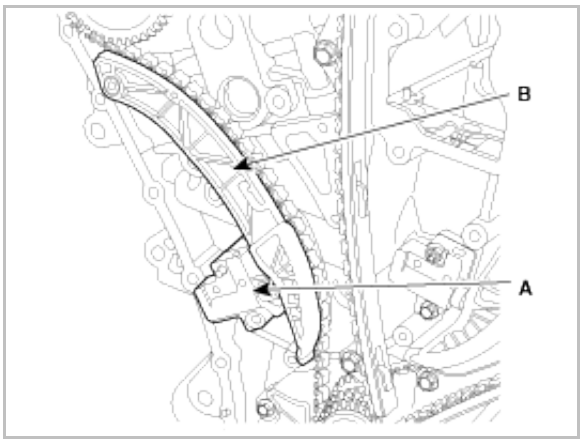
31. Remove the oil pump chain guide (A).



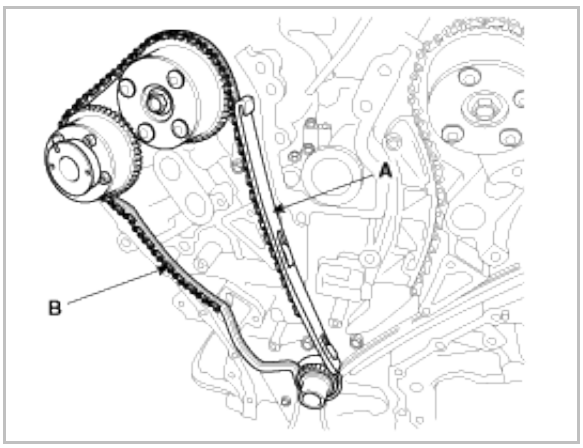
32. Install a set pin after compressing the RH timing chain tensioner.



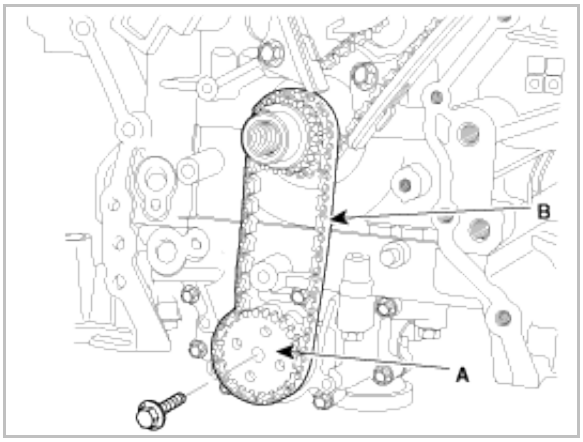
33. Remove the RH timing chain auto tensioner (A) and the RH timing chain tensioner arm (B).



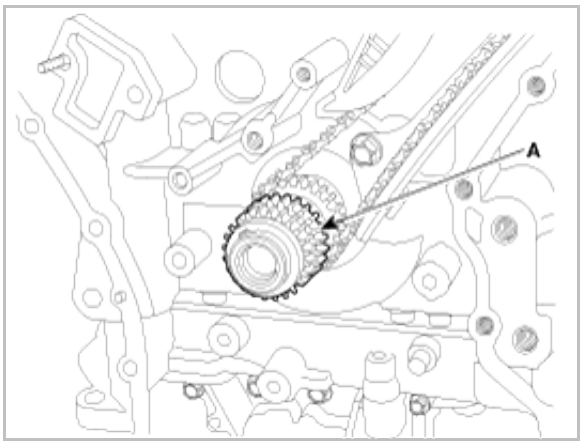
34. Remove the RH timing chain guide (A) and RH timing chain (B).



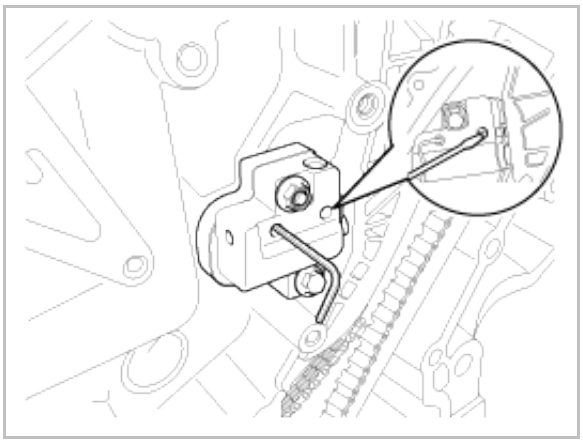
35. Remove the oil pump chain sprocket (A) and oil pump chain (B).



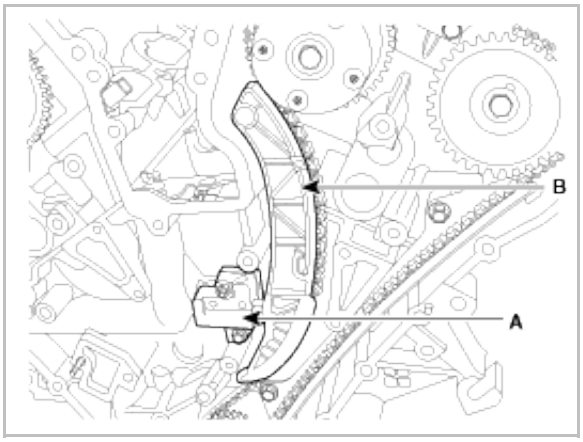
36. Remove the crankshaft sprocket (A) (O/P & RH camshaft drive).



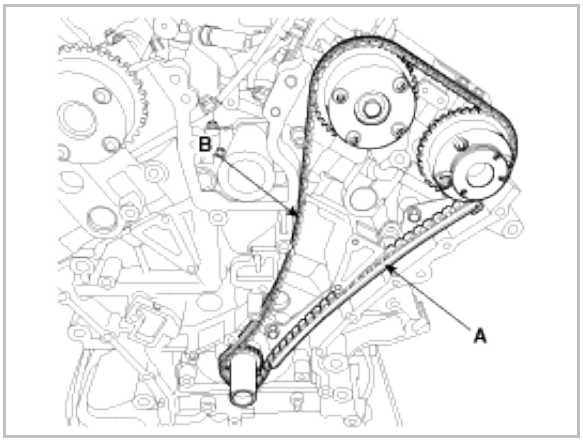
37. Install a set pin after compressing the LH timing chain tensioner.



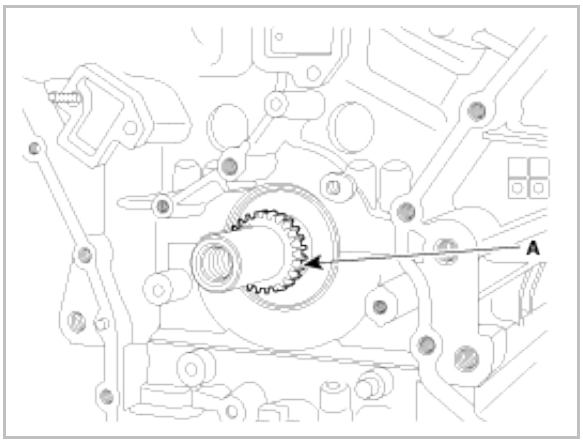
38. Remove the LH timing chain auto tensioner (A) and LH timing chain tensioner arm (B).



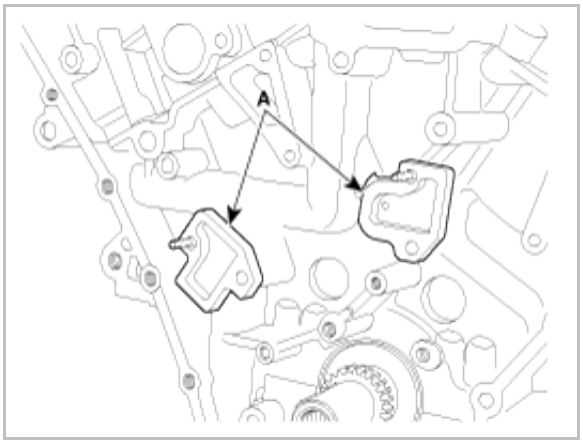
39. Remove the LH timing chain guide (A) and LH timing chain (B).



40. Remove the crankshaft sprocket (A). (LH camshaft drive).



41. Remove the tensioner adapter assembly (A).



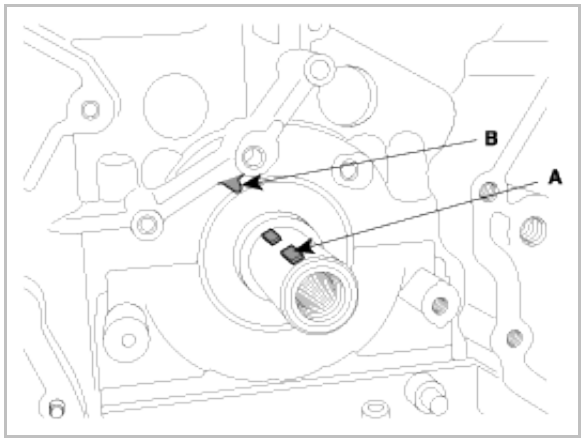
Inspection

Sprockets, Chain Tensioner, Chain Guide, Chain Tensioner Arm

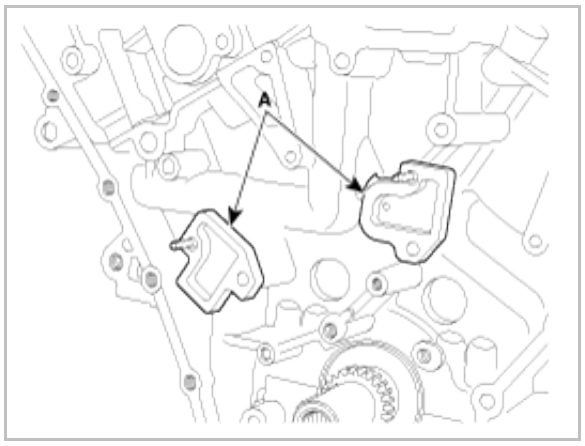
1. Check the camshaft sprocket and crankshaft sprocket for abnormal wear, cracks, or damage. Replace as necessary.
2. Inspect the tensioner arm and chain guide for abnormal wear, cracks, or damage. Replace as necessary.
3. Check that the tensioner piston moves smoothly when the ratchet pawl is released with thin rod.

Installation

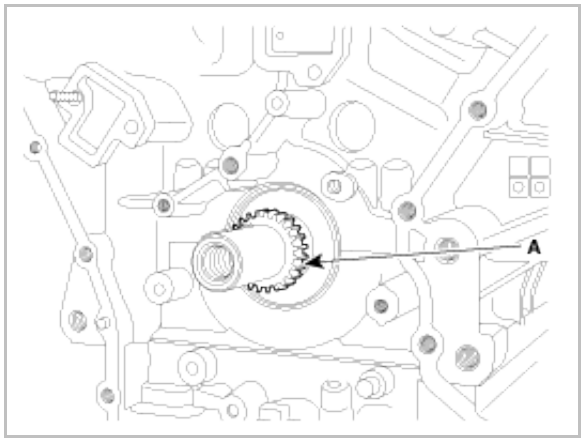
1. The key (A) of crankshaft should be aligned with the timing mark (B) of timing chain cover. As a result of this, the piston of No.1 cylinder is placed at the top dead center on compression stroke.



2. Install the tensioner adapter assembly (A).

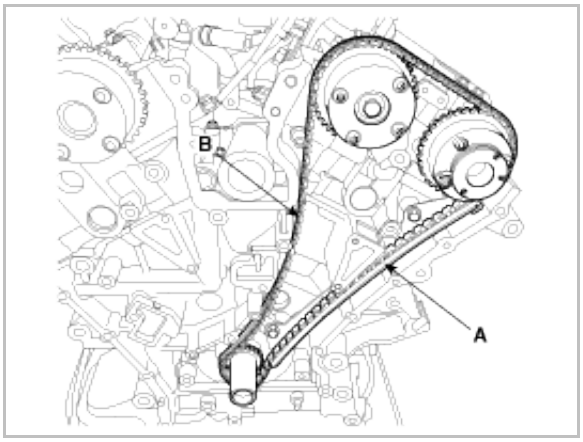


3. Install the crankshaft sprocket (A). (LH camshaft drive).



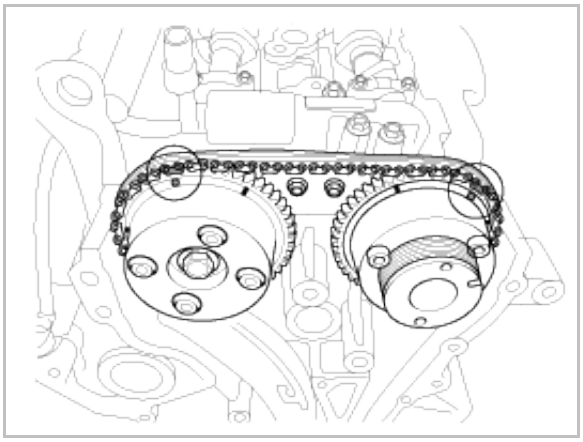
4. Install the LH timing chain guide (A) and LH timing chain (B).

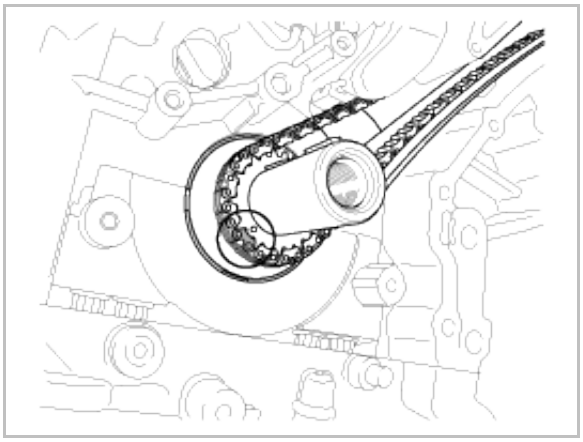
Tightening torque :
19.6 ~ 24.5N.m (2.0 ~ 2.5kgf.m, 14.5 ~ 18.1lb-ft)



NOTE

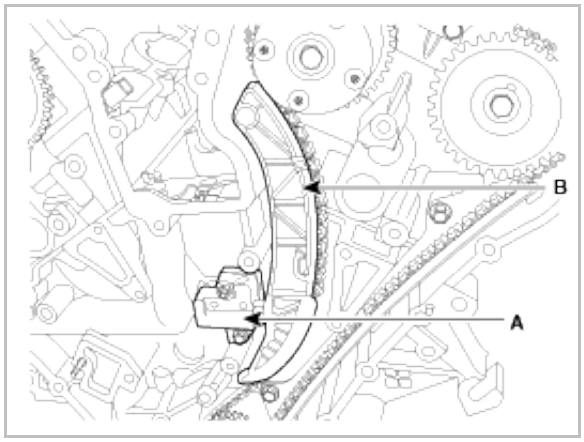
To install the timing chain with no slack between each shaft (cam, crank), follow the below procedure.
Crankshaft sprocket → Timing chain guide → Exhaust camshaft sprocket → Intake camshaft sprocket.
The timing mark of each sprockets should be matched with timing mark (color link) of timing chain at installing timing chain.



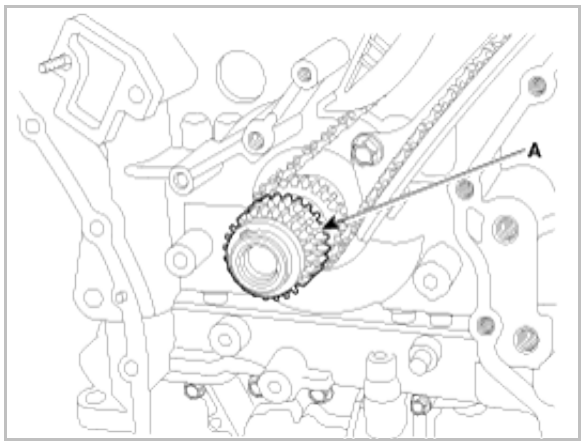


5. Install the LH timing chain tensioner arm (B) and LH timing chain auto tensioner (A).

Tightening torque
A : 9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)
B : 18.6 ~ 21.6N.m (1.9 ~ 2.2kgf.m, 13.7 ~ 15.9lb-ft)

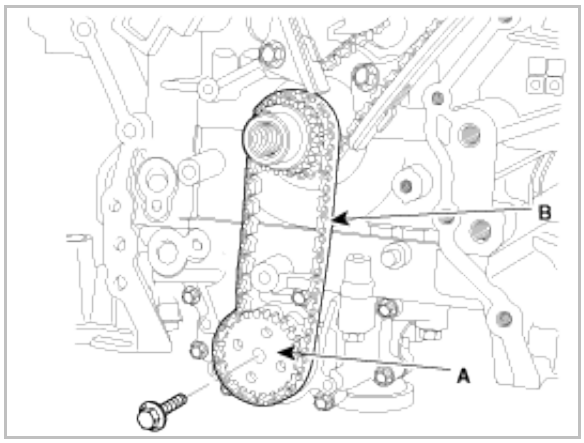


6. Install the crankshaft sprocket (A) (O/P & RH camshaft drive).



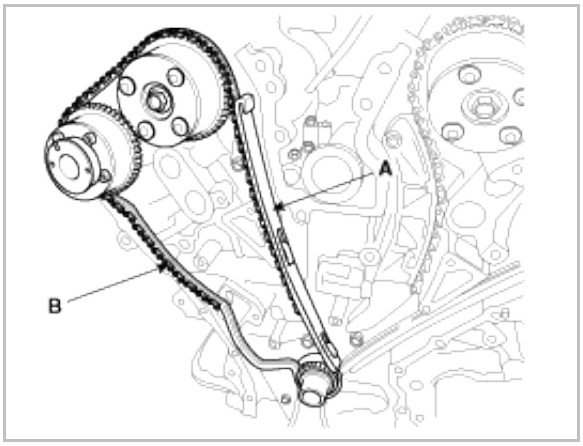
7. Install the oil pump chain sprocket (A) and oil pump chain (B).

Tightening torque :
18.6 ~ 21.6N.m (1.9 ~ 2.2kgf.m, 13.7 ~ 15.9lb-ft)



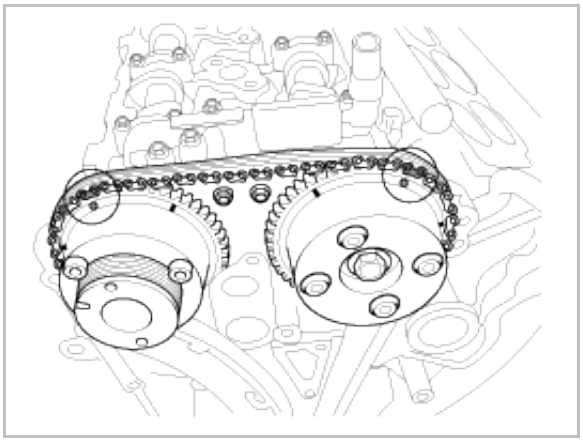
8. Install the RH timing chain guide (A) and RH timing chain (B).

Tightening torque :
A : 19.6 ~ 24.5N.m (2.0 ~ 2.5kgf.m, 14.5 ~ 18.1lb-ft)



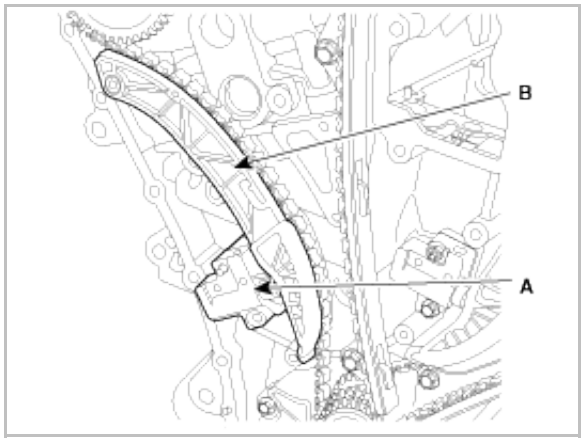
NOTE

To install the timing chain with no slack between each shaft (cam, crank), follow the below procedure.
Crankshaft sprocket →Timing chain guide → Intake camshaft sprocket → Exhaust camshaft sprocket.
The timing mark of each sprockets should be matched with timing mark (color link) of timing chain at installing timing chain.



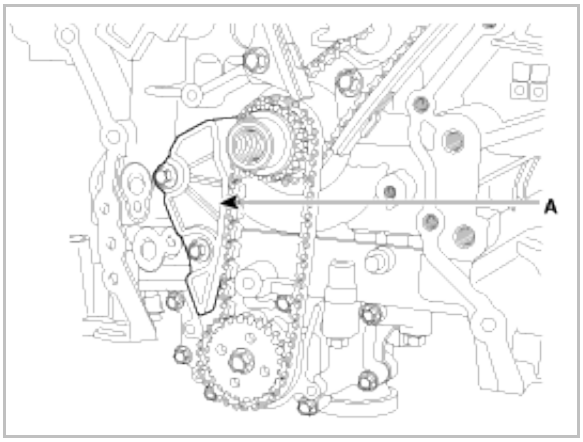
9. Install the RH timing chain tensioner arm (B) and RH timing chain auto tensioner (A).

Tightening torque
A : 9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)
B : 18.6 ~ 21.6N.m (1.9 ~ 2.2kgf.m, 13.7 ~ 15.9lb-ft)



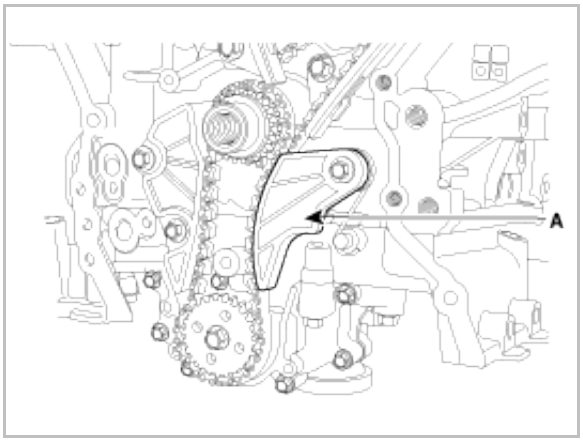
10. Install the oil pump chain guide (A).

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

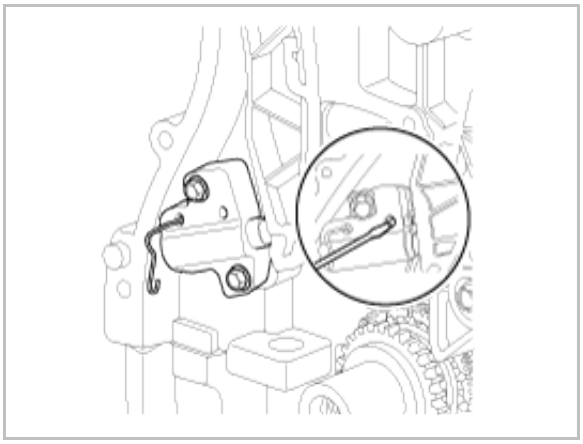


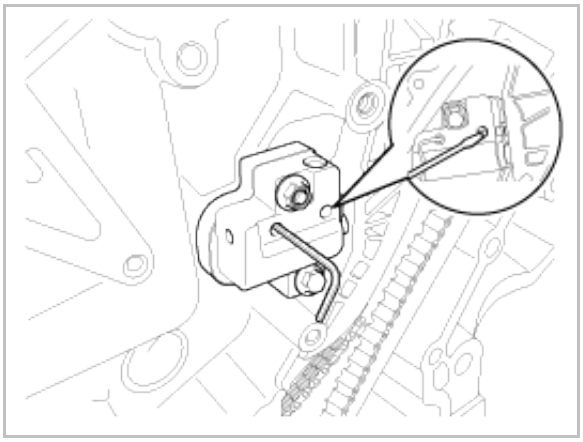
11. Install the oil pump chain tensioner assembly (A).

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



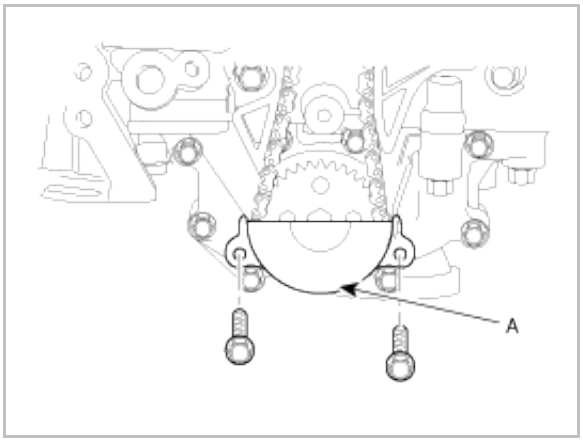
12. Pull out the pins of hydraulic tensioner (LH & RH).





13. Install the oil pump chain cover (A).

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



14. After rotating the crankshaft 2 revolutions in regular direction (clockwise viewed from front), confirm the timing mark.

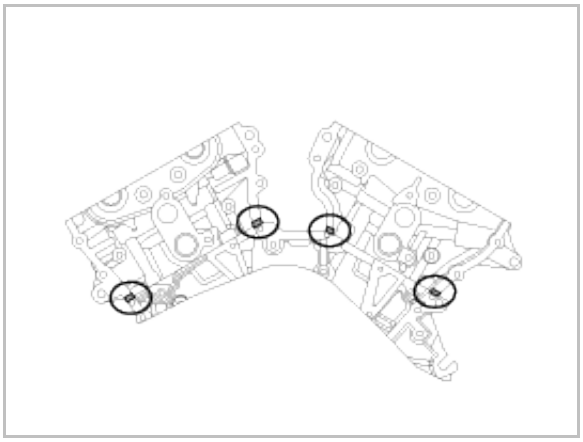
NOTE

Always turn the crankshaft clockwise.
Turning the crankshaft counter clockwise before building up oil pressure in the hydraulic timing chain tensioner may result in the chain disengaging from the sprocket teeth.

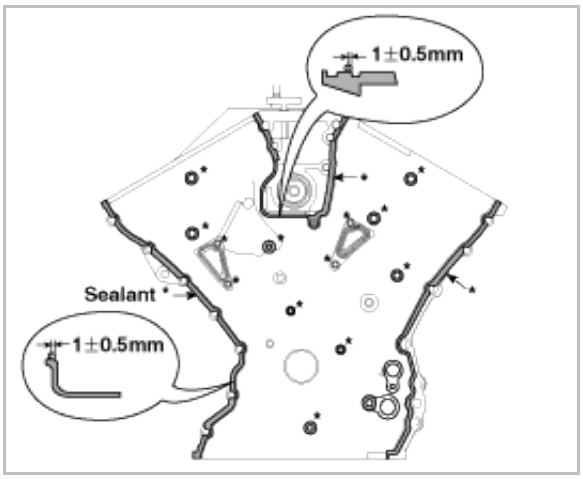
15. Install the timing chain cover.
    (1) The sealant locations on chain cover and on counter parts (cylinder head, cylinder block, and lower oil pan) must be free of engine oil and etc.
    (2) Before assembling the timing chain cover, the liquid sealant TB 1217H should be applied on the gap between

cylinder head and cylinder block.
The part must be assembled within 5 minutes after sealant was applied.

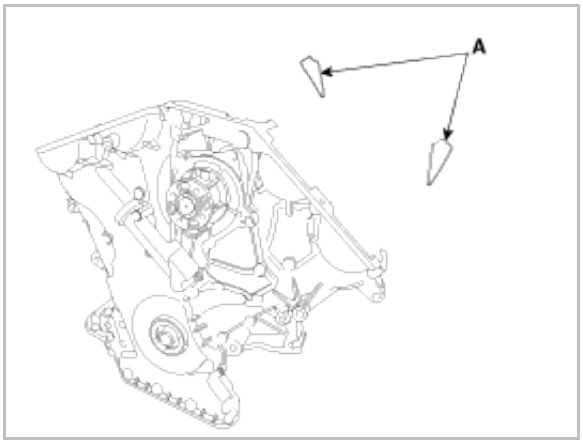
Bead width : 2.5mm(0.1in.)



(3) After applying liquid sealant TB1217H on timing chain cover. The part must be assembled within 5 minutes after sealant was applied.
Sealant should be applied without discontinuity.



(4) Install the new gasket (A) to the timing chain cover.



NOTE

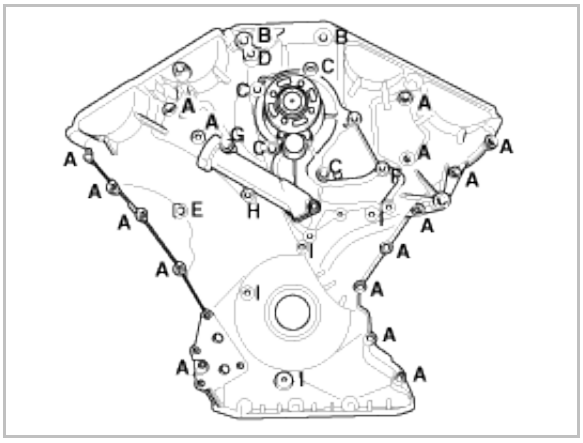
During timing cover installation, care not to take off applied sealant on the timing cover by contact with other parts.

(5) The dowel pins on the cylinder block and holes on the timing chain cover should be used as a reference in

order to assemble the timing chain cover (A) to be in exact position.

Tightening torque

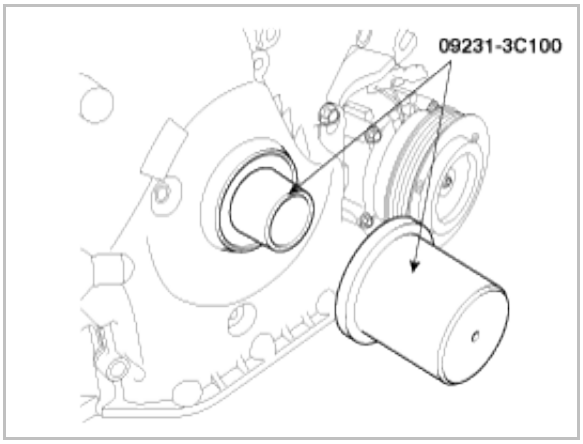
A(16) :
18.62 ~ 25.49N.m (1.9 ~ 2.6kgf.m, 13.74 ~ 18.80lb-ft)
F(1) :
9.80 ~ 11.76N.m (1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)
B(2) :
58.80 ~ 68.80N.m (6.0 ~ 7.0kgf.m, 43.40 ~ 50.63lb-ft)
D(1) :
24.50 ~ 26.46N.m (2.5 ~ 2.7kgf.m, 18.08 ~ 19.53lb-ft)
C(4) :
21.56 ~ 23.52N.m (2.2 ~ 2.4kgf.m, 15.91 ~ 17.36lb-ft)
G(1) :
9.80 ~ 11.76N.m (1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)
H(1) :
9.80 ~ 11.76N.m (1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)
I(4) :
9.80 ~ 11.76N.m (1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)
E(1) :
24.50 ~ 26.46N.m (2.5 ~ 2.7kgf.m, 18.08 ~ 19.53lb-ft)



(6) The firing and/or blow out test should not be performed within 30 minutes after the timing chain cover was assembled.

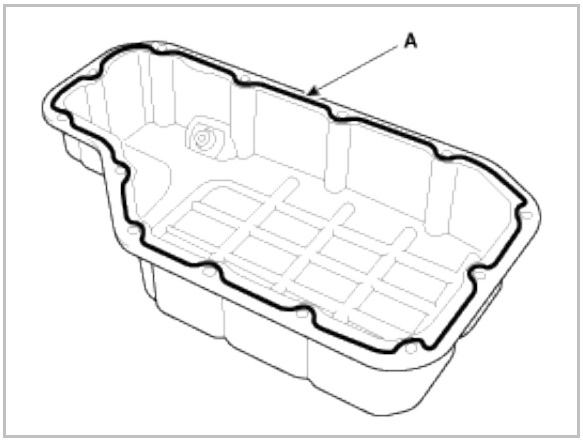
16. Install the water vent hose (A) to the timing chain cover.

17. Using SST(09231-3C100), install timing chain cover oil seal.



18. Install the lower oil pan (A).
    (1) Using a gasket scraper, remove all the old packing material from the gasket surfaces.
    (2) Before assembling the oil pan, the liquid sealant TB 1217H should be applied on oil pan. The part must be assembled within 5 minutes after the sealant was applied.

Bead width : 2.5mm(0.1in.)

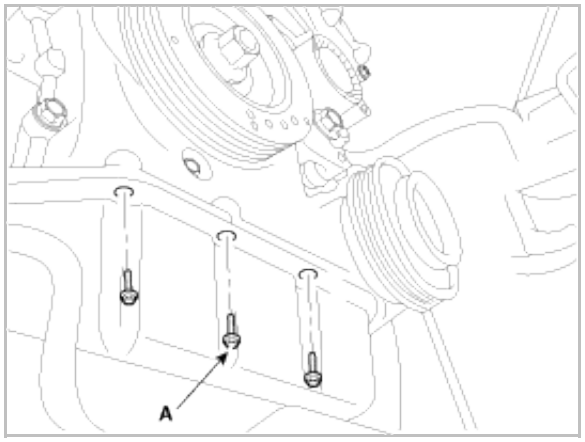


CAUTION

- Clean the sealing face before assembling two parts.
- Remove harmful foreign matters on the sealing face before applying sealant.
- When applying sealant gasket, sealant must not be protruded into the inside of oil pan.
- To prevent leakage of oil, apply sealant gasket to the inner threads of the bolt holes.

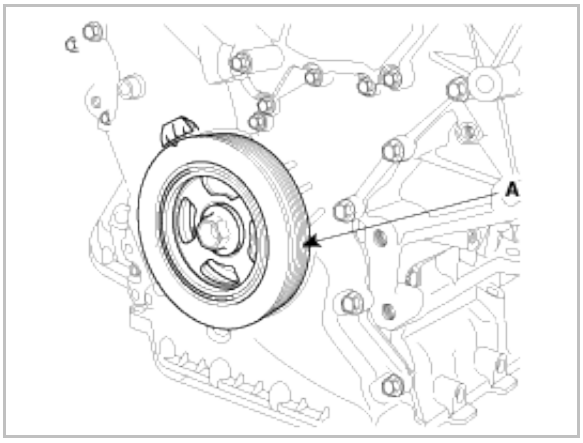
    (3) Install the oil pan (A).
    Uniformly tighten the bolts in several passes.

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



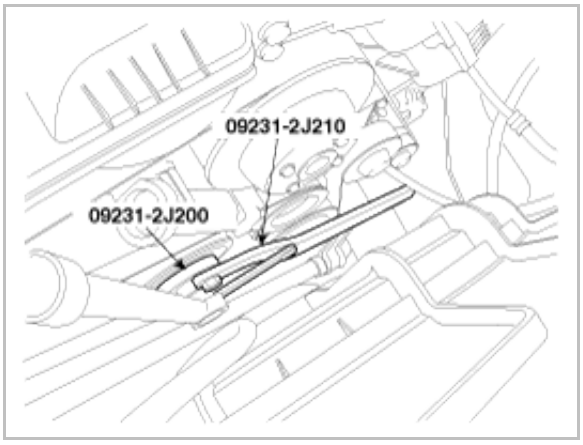
19. Install the crankshaft pulley (A).

Tightening torque :
284.4 ~304.0N.m (29.0~31.0kgf.m, 209.8~224.2lb-ft)



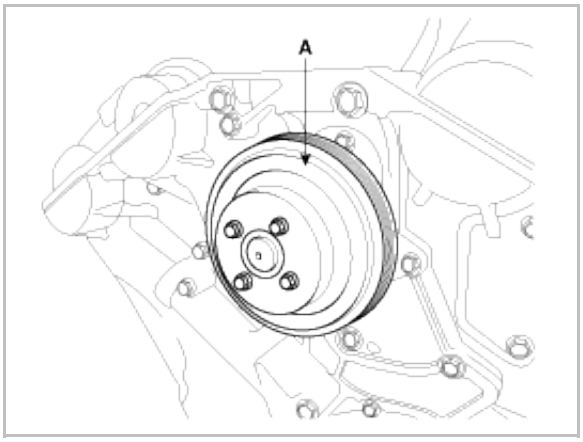
NOTE

- Use the SST(09231-2J210, 09231-2J200) to install the crankshaft pulley bolt.



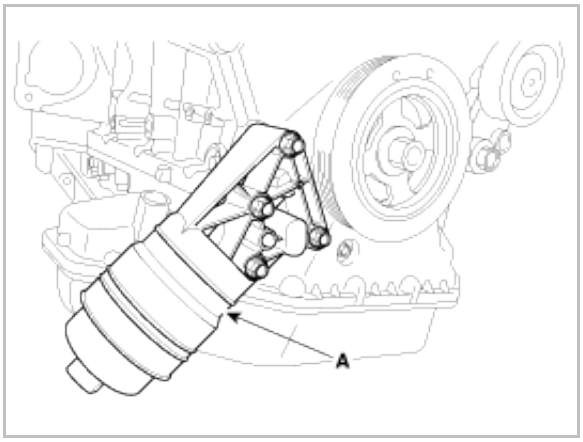
20. Install the water pump pulley (A).

Tightening torque :
7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)



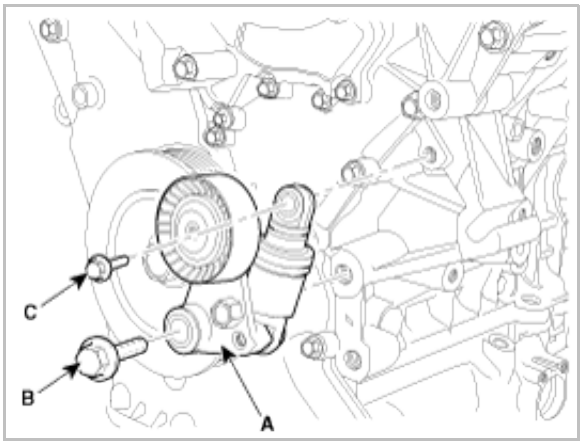
21. Install the oil filter assembly (A).

Tightening torque
19.6 ~ 21.56N.m (2.0 ~ 2.2kgf.m, 14.4 ~ 15.9lb-ft)



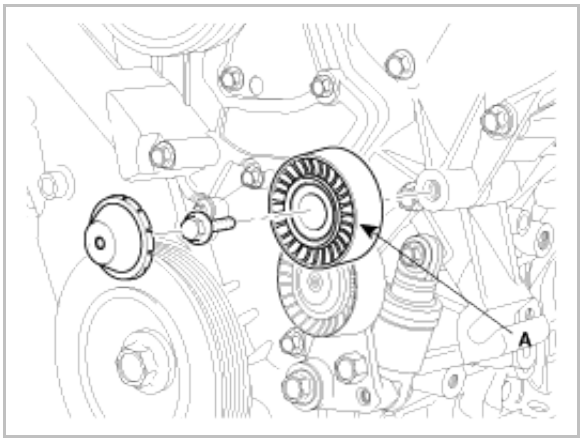
22. Install the drive belt auto tensioner (A).

Tightening torque
Bolt (B) :
81.4 ~ 85.3N.m (8.3 ~ 8.7kgf.m, 60.0 ~ 62.9lb-ft)
Bolt (C) :
17.7 ~ 21.6N.m (1.8 ~ 2.2kgf.m, 13.0 ~ 15.9lb-ft)



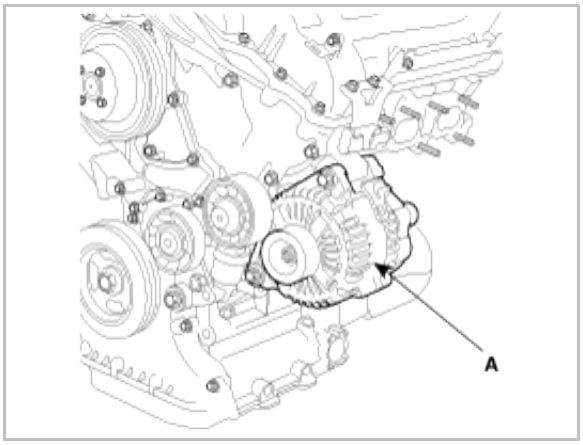
23. Install the drive belt idler (A).

Tightening torque :
52.9 ~ 57.9N.m (5.4 ~ 5.9kgf.m, 39.1 ~ 42.7lb-ft)

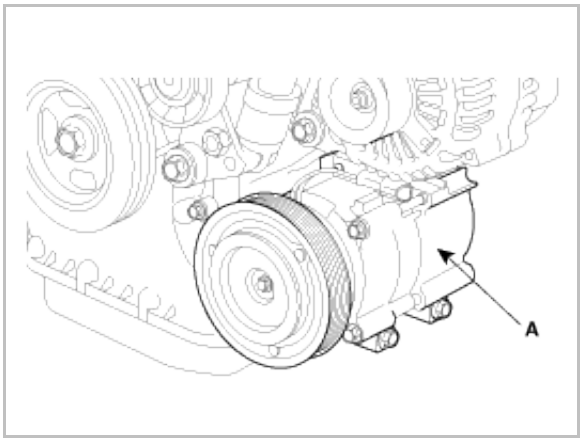


24. Install the alternator (A). (Refer to EE group)

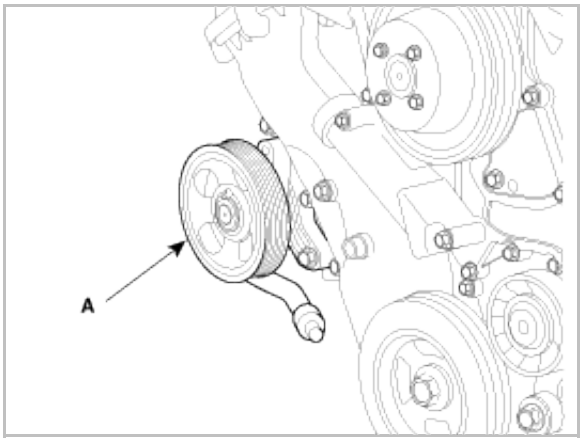
Tightening torque :
26.5 ~ 33.3N.m (2.7 ~ 3.4kgf.m, 19.5 ~ 24.6lb-ft)



25. Install the air conditioner compressor (A). (Refer to HA group)

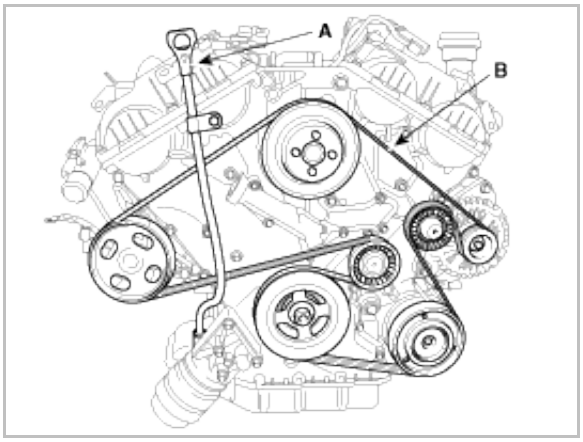


26. Install the power steering pump (A). (Refer to ST group)



27. Install the drive belt (A).

Tightening torque :
18.6 ~ 22.5N.m (1.9 ~ 2.3kgf.m, 13.7 ~ 16.6lb-ft)

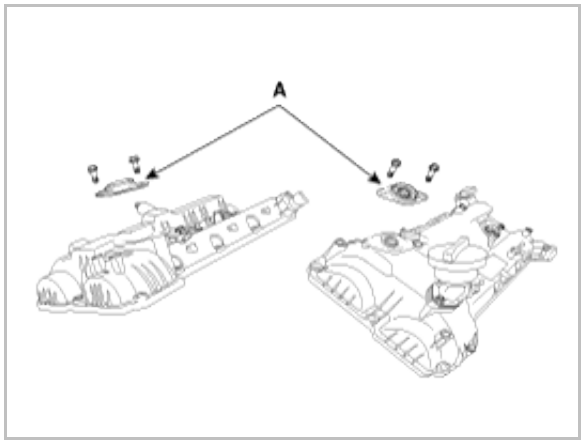


28. Install the LH/RH cylinder head cover (A).

NOTE

- Install the cylinder head cover under the exhaust OCV cap is removed.
- To prevent engine oil leakage, surely install the new exhaust OCV cap after installing the cylinder head cover.

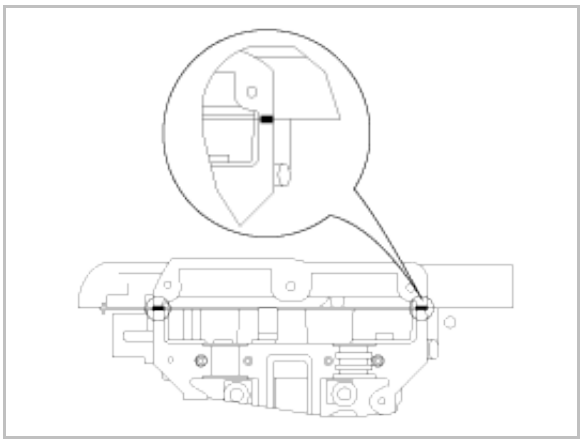
(1) Remove the exhaust OCV cap (A) from the cylinder head cover.



(2) The hardening sealant located on the upper area between timing chain cover and cylinder head should be removed before assembling cylinder head cover.

(3) After applying sealant(TB1217H), it should be assembled within 5 minutes.

Bead width : 2.5mm(0.1in.)



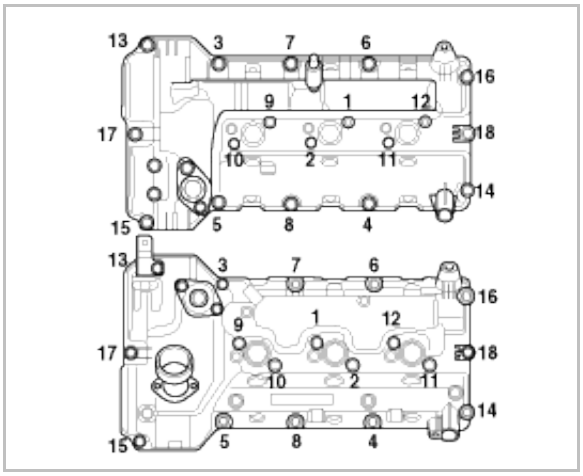
(4) The firing and/or blow out test should not be performed within 30 minutes after the cylinder head cover was assembled.

(5) Install the cylinder head cover bolts as following method.

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

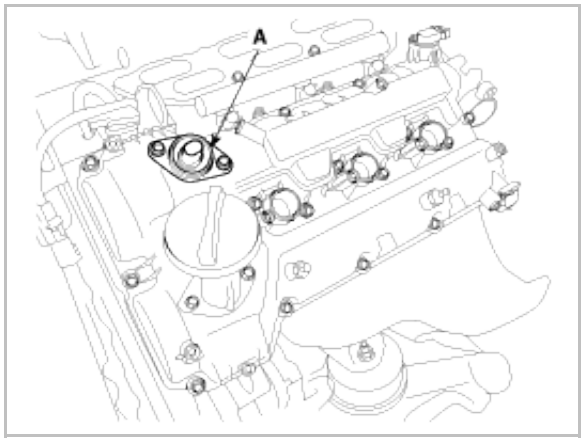
CAUTION

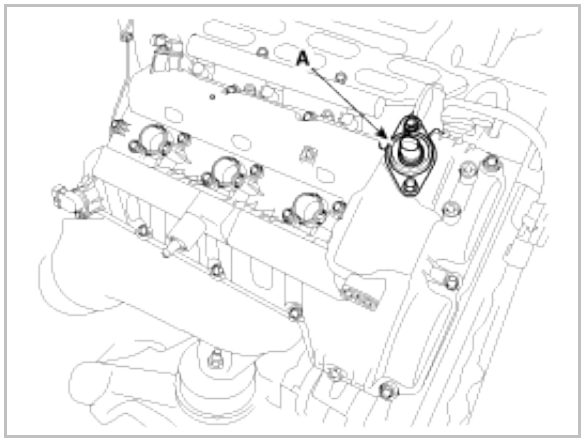
Do not reuse cylinder head cover gasket.



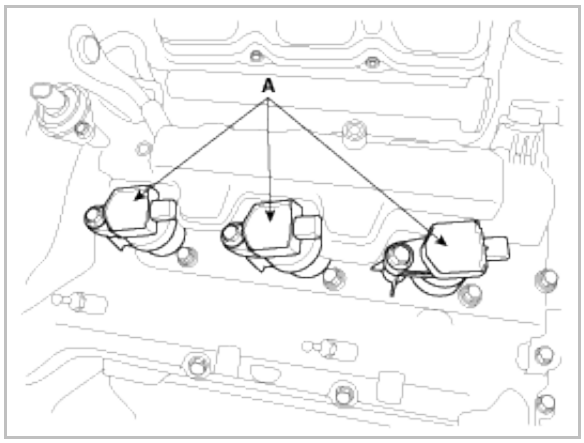
(6) Install the new exhaust OCV cap (A).

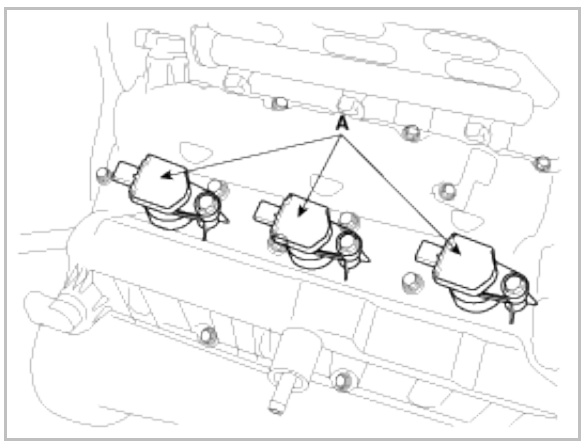
Tightening torque :
9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)



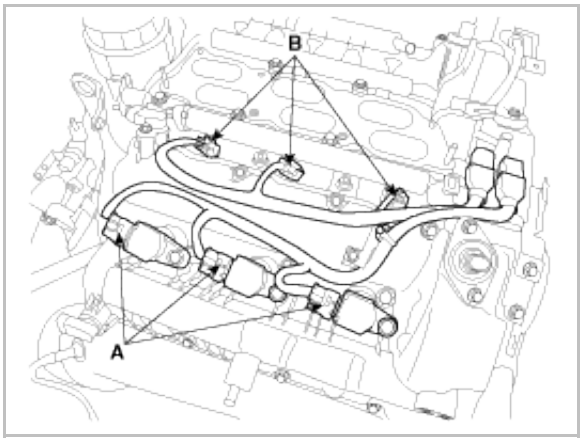


29. Install the LH/RH ignition coils (A).



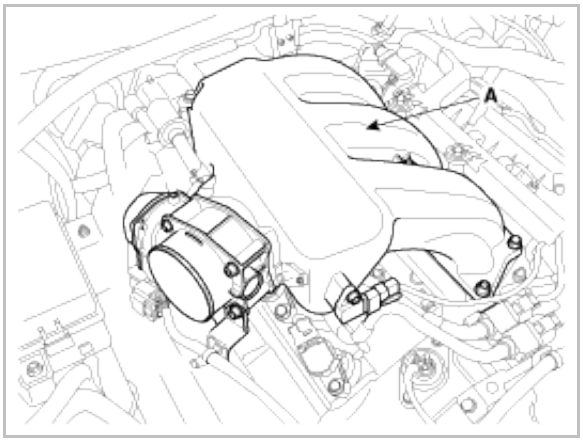


30. Connect the RH ignition coil connector (A) and the injector connector (B).



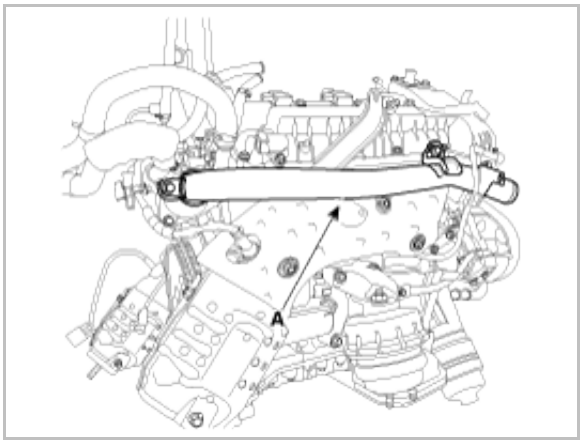
31. Install the surge tank assembly (A).

Tightening torque :
18.6 ~ 23.5N.m (1.9 ~ 2.4kgf.m,13.7 ~ 17.3lb-ft)



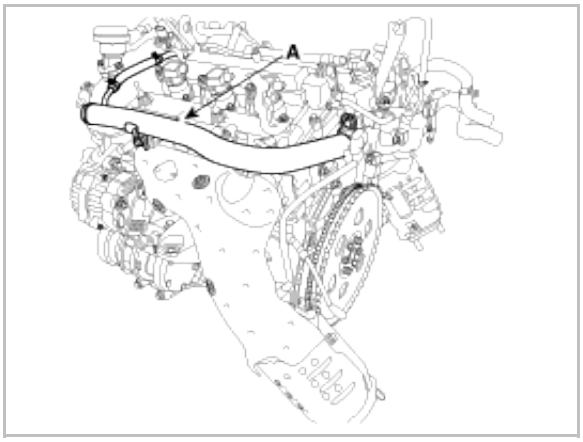
32. Install the RH side coolant pipe (A).

Tightening torque :
19.6 ~ 23.5N.m (2.0 ~ 2.4kgf.m, 14.5 ~ 17.4lb-ft)

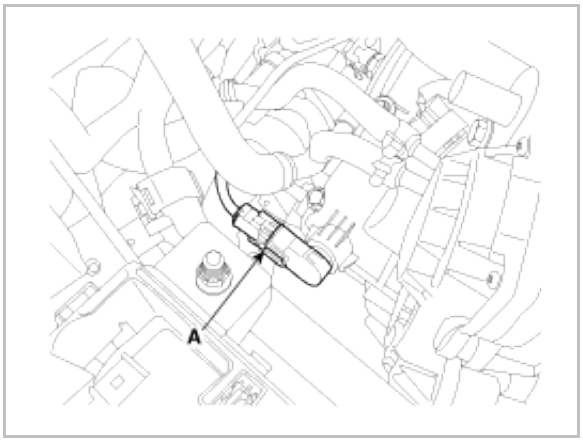


33. Install the LH side coolant pipe and hose (A).

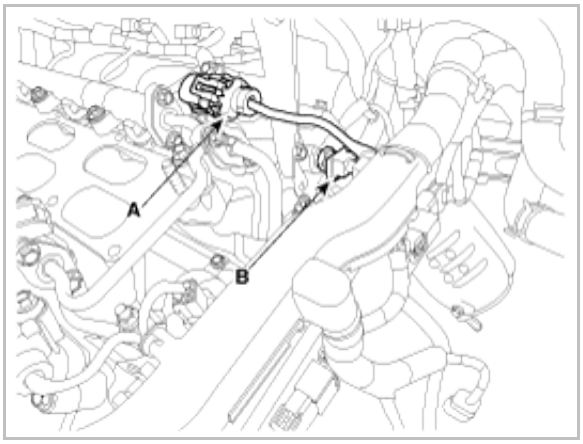
Tightening torque
19.6 ~ 23.5Nm (2.0 ~ 2.4kgf.m, 14.5 ~ 17.4lb-ft)



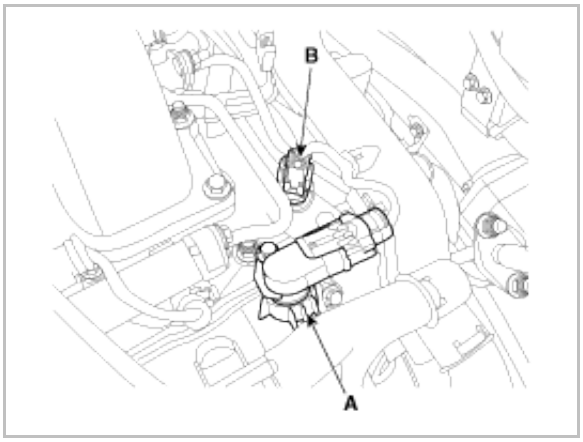
34. Connect the engine wiring connectors.
    (1) Connect the RH exhaust CMP sensor connector (A).



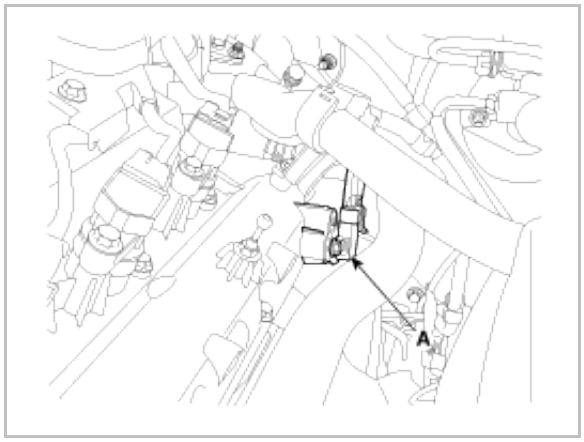
    (2) Connect the RH intake CMP sensor connector (A) and oil temperature sensor connector (B).



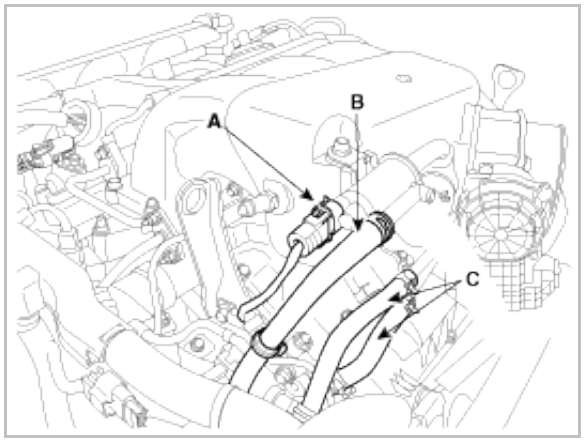
    (3) Connect the LH intake CMP sensor connector (A) and water temperature sensor (B).



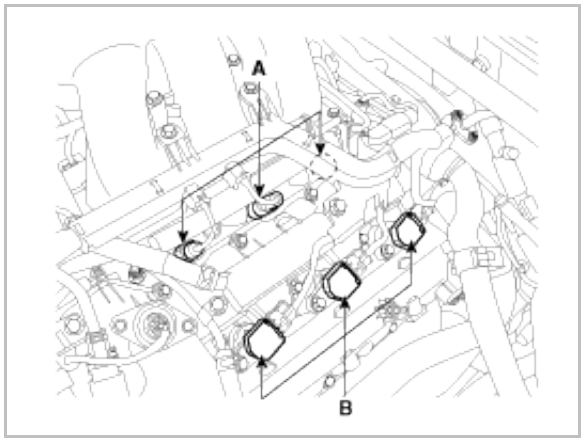
(4) Connect the LH exhaust CMP sensor connector (A).



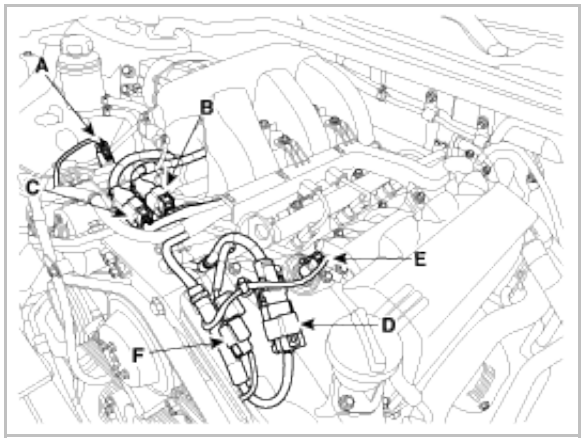
(5) Connect the PCSV hose (B), PCSV connector (A) and throttle body coolant hoses (C).



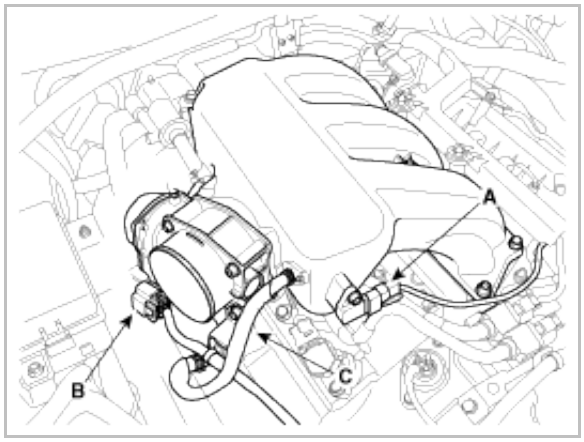
(6) Connect the LH injector connectors (A) and LH ignition coil connectors (B).



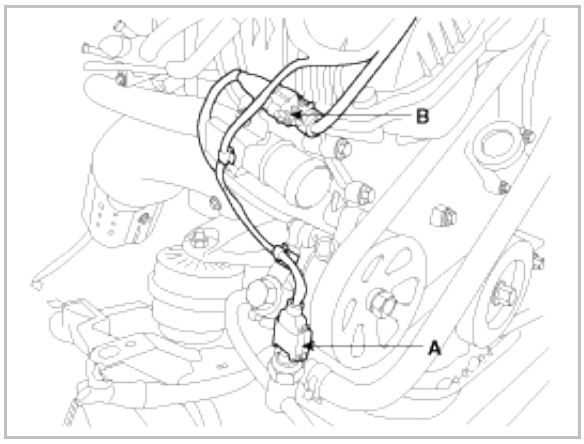
(7) Connect the RH exhaust OCV connector (A), RH inject connector (B), RH ignition coil connector (C), RH/LH intake camshaft OCV connector (D), LH exhaust OCV connector (E) and oil pressure switch connector (F).



(8) Connect the MAP sensor connector (A), ETC connector (B) and PCV hose (C).



(9) Connect the power steering oil pressure switch connector(A) and RH knock sensor connector(B).

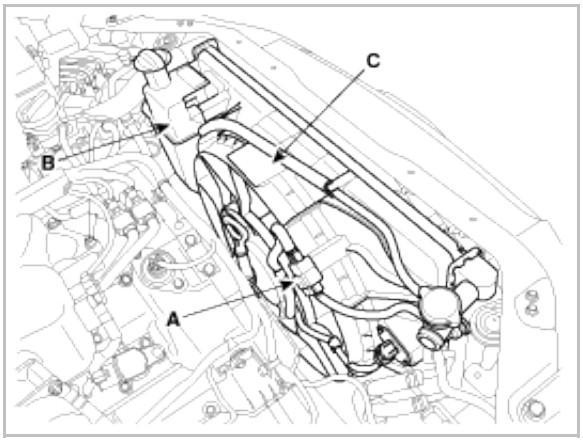


35. Remove the cooling fan.

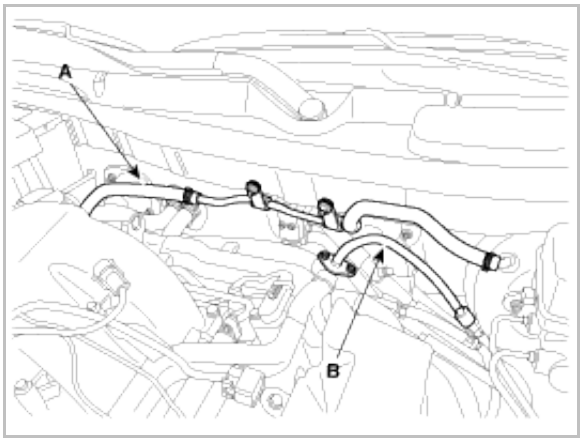
(1) Install the fan assembly (C).

(2) Install the reservoir tank (B).

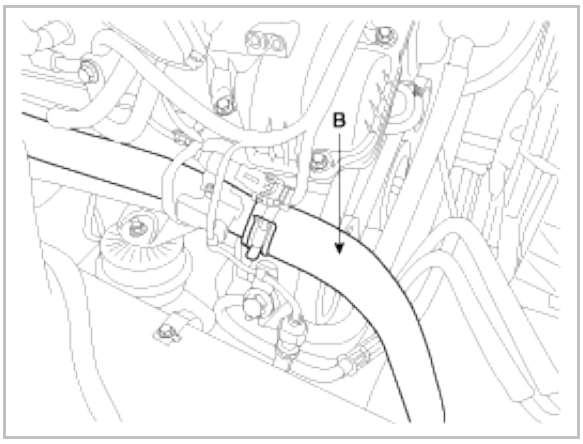
(3) Install the cooling fan connector (A).



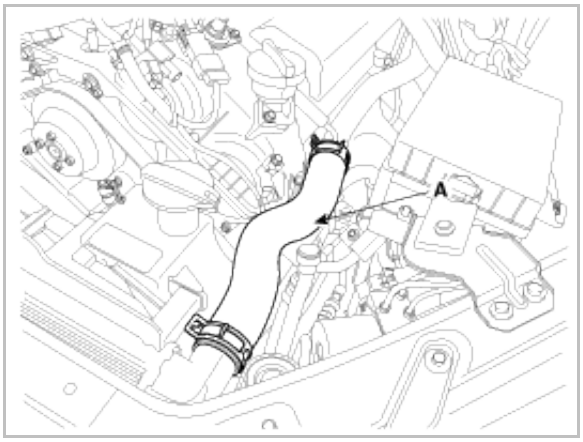
36. Install the fuel hose (B) and brake vacuum hose (A).



37. Install the radiator lower hose (A).



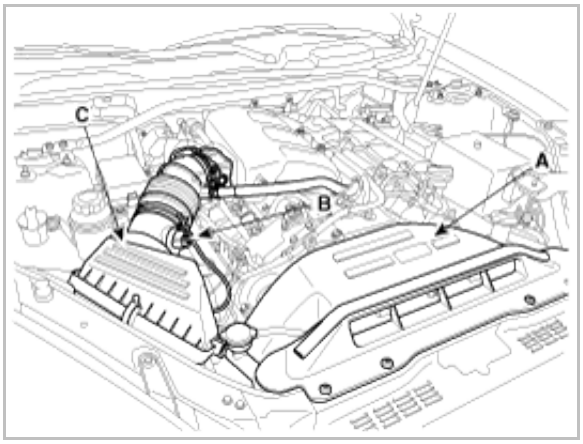
38. Install the radiator upper hose (A).



39. Connect the AFS connector (B) after installing the air cleaner assembly (C).

Tightening torque :
Bolt : 7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)
Clamp : 2.9 ~ 4.9N.m (0.3 ~ 0.5kgf.m, 2.2 ~ 3.6lb-ft)

40. Install the air duct (A).



41. Install the engine cover.

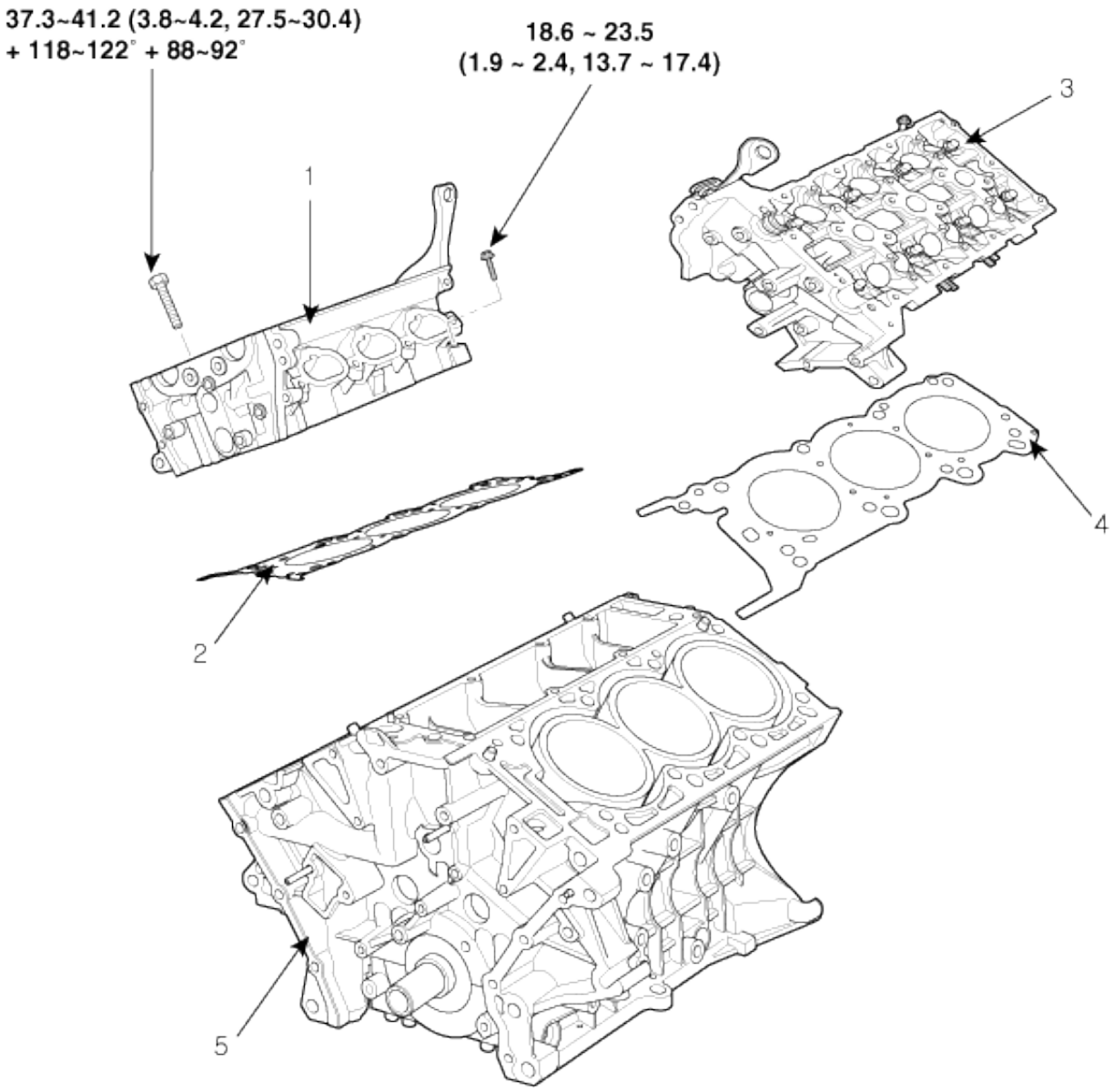
42. Connect the battery negative cable.

NOTE

- Refill engine oil.
- Clean the battery posts and cable terminals with sandpaper. Assemble and then apply grease to prevent corrosion.
- Inspect for fuel leakage.
- After assembling the fuel line, turn on the ignition switch (do not operate the starter) so that the fuel pump runs for approximately two seconds and fuel line pressurizes.
- Repeat this operation two or three times, then check for fuel leakage at any point in the fuel lines.
- Refill radiator and reservoir tank with engine coolant.
- Bleed air from the cooling system.
- Start engine and let it run until it warms up. (Until the radiator fan operates 3 or 4 times.)
- Turn Off the engine. Check the level in the radiator, add coolant if needed. This will allow trapped air to be removed from the cooling system.
- Put radiator cap on tightly, then run the engine again and check for leaks.

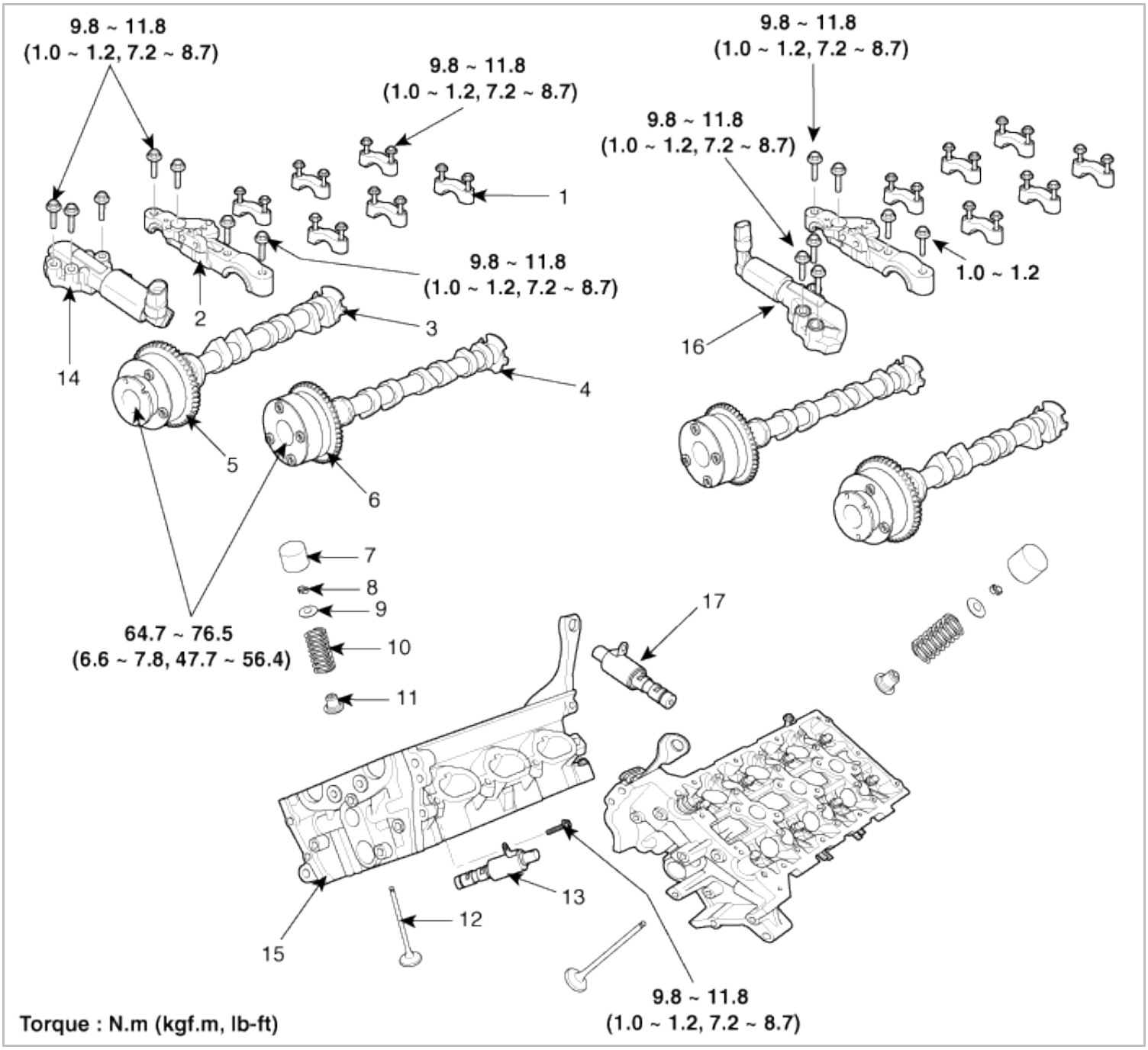
Engine Mechanical System > Cylinder Head Assembly > Cylinder Head > Components and Components Location

Components



Torque : N.m (kgf.m, lb-ft)

1. RH Cylinder head 2. RH Cylinder head gasket 3. LH Cylinder head	4. LH Cylinder head gasket 5. Cylinder block



1. Camshaft bearing cap	7. Mechanical lash adjuster (MLA)	13. Intake camshaft OCV (RH)
2. Camshaft thrust bearing cap	8. Retainer lock	14. Exhaust camshaft OCV (RH)
3. Exhaust camshaft	9. Retainer	15. Cylinder head
4. Intake camshaft	10. Valve spring	16. Exhaust camshaft OCV (LH)
5. Exhaust CVVT assembly	11. Valve stem seal	17. Intake camshaft OCV (LH)
6. Intake CVVT assembly	12. Valve	

Engine Mechanical System > Cylinder Head Assembly > Cylinder Head > Repair procedures

Removal

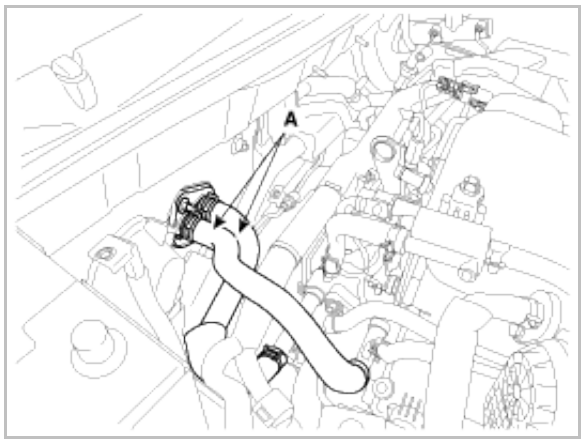
CAUTION

- Use fender covers to avoid damaging painted surfaces.
- To avoid damaging the cylinder head, wait until the engine coolant temperature drops below normal temperature (20°C [68°F]) before removing it.
- 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.

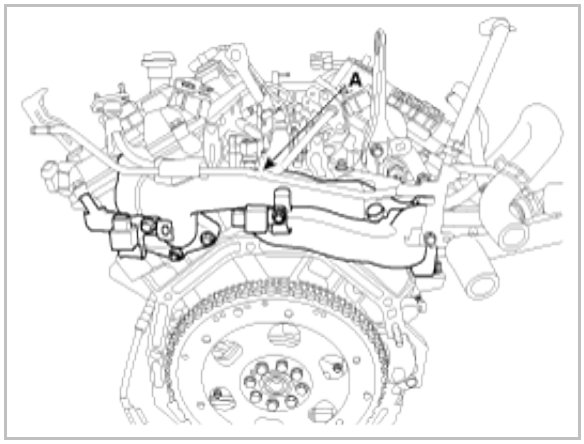
NOTE

- 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. (Refer to Timing system in this group)
2. Disconnect the heater hoses (A).



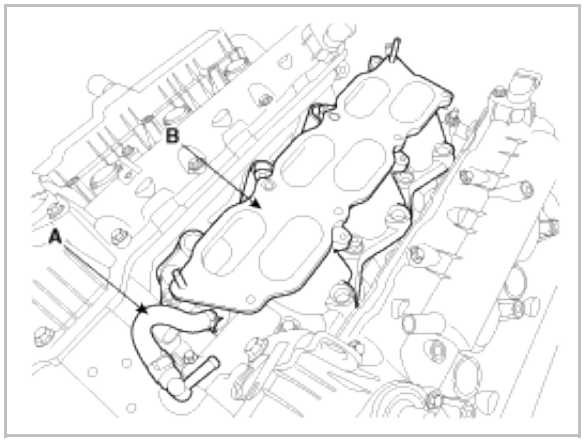
3. Remove the water temperature control assembly (A).



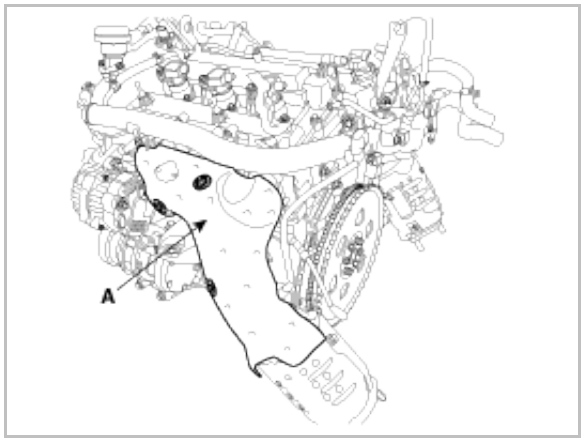
4. Disconnect the air vent hose (A) and then remove the intake the manifold (B).

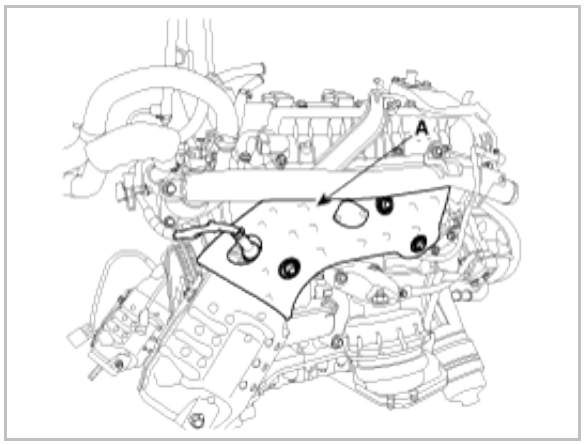
CAUTION

- Be sure to drain the engine coolant before removing the intake manifold.
- If any coolant drained from the cylinder head vent hole has entered the intake port. This can potentially lead to engine trouble.

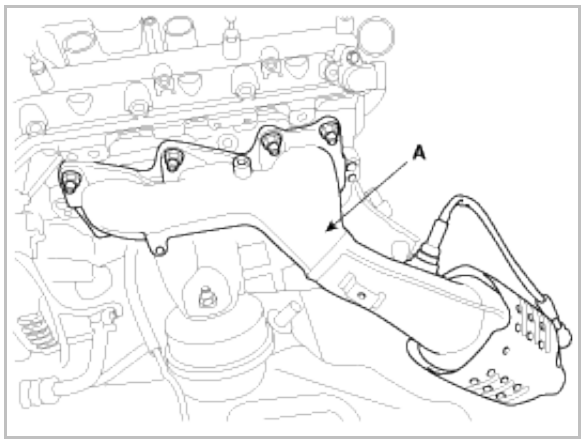


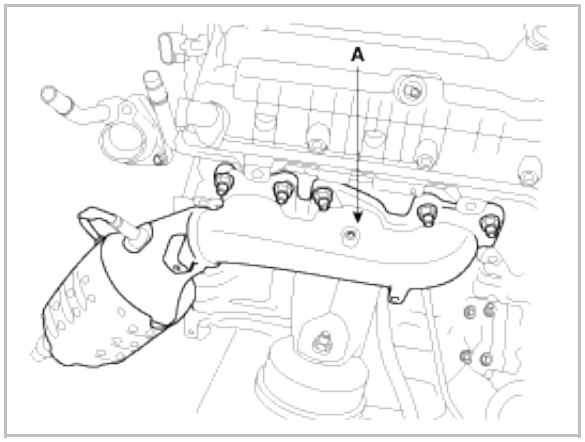
5. Remove the LH/RH exhaust manifold heat protector (A).



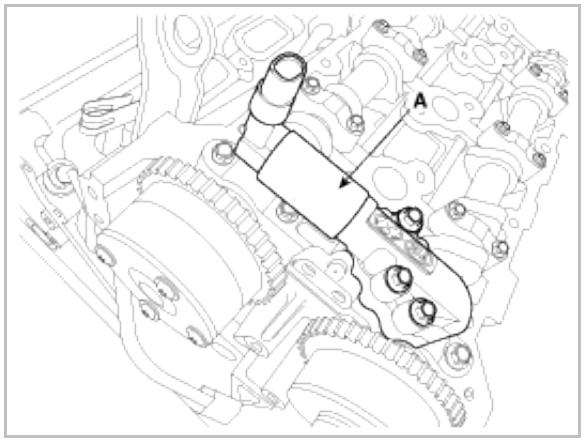


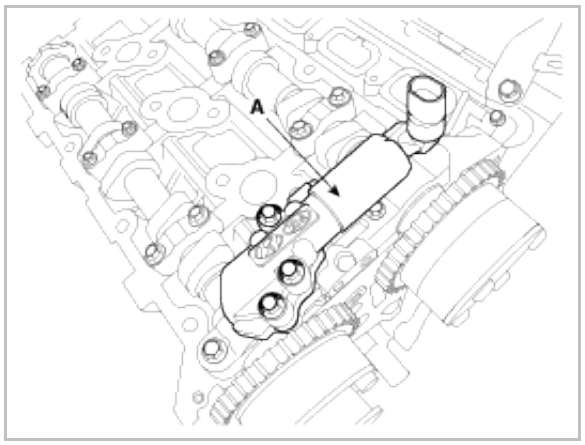
6. Remove the LH/RH exhaust manifold (A).



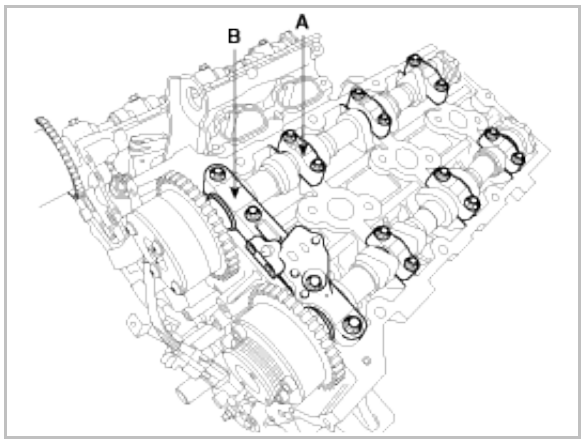


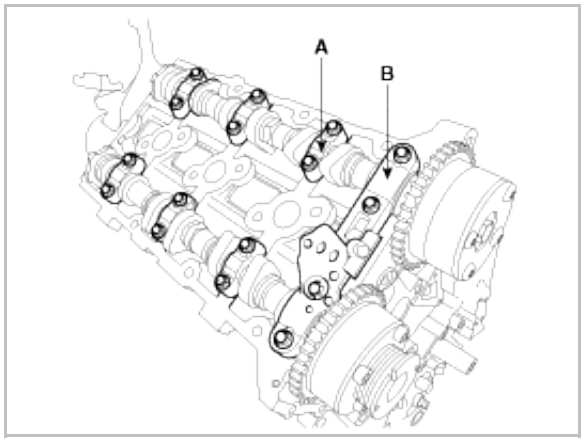
7. Remove the LH/RH exhaust camshaft OCV (A).



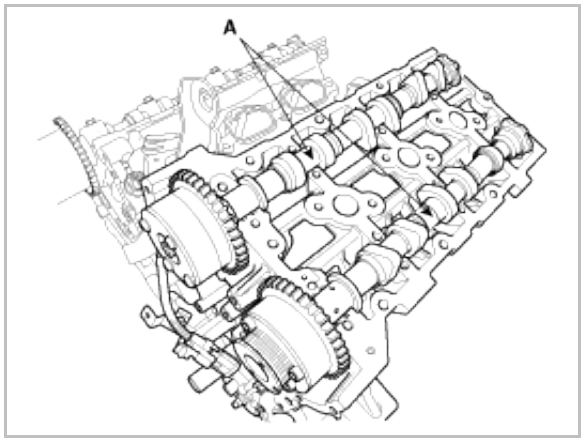


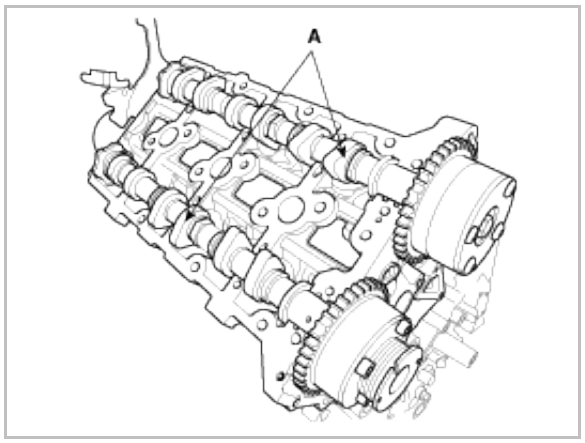
8. Remove the LH/RH camshaft bearing cap (A) and thrust bearing cap (B).



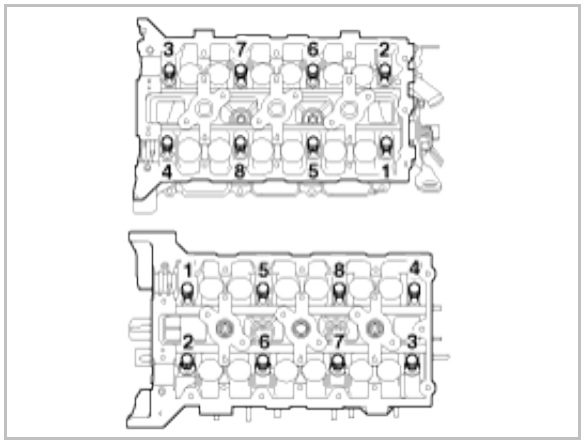


9. Remove the LH/RH camshaft assembly (A).





10. Remove the cylinder head.
    (1) Uniformly loosen and remove the 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 dowels on the cylinder block and place the cylinder head on wooden blocks on a bench.

CAUTION

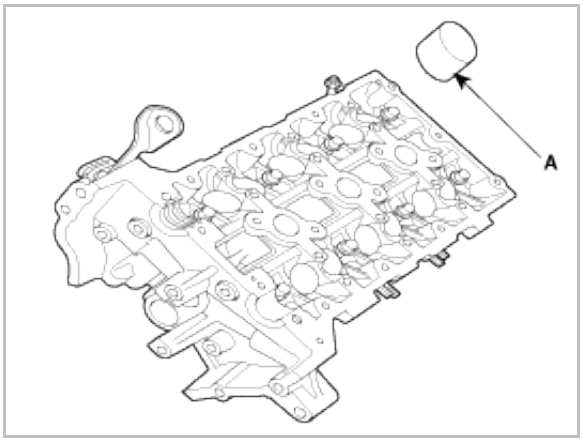
Be careful not to damage the contact surfaces of the cylinder head and cylinder block.

Disassembly

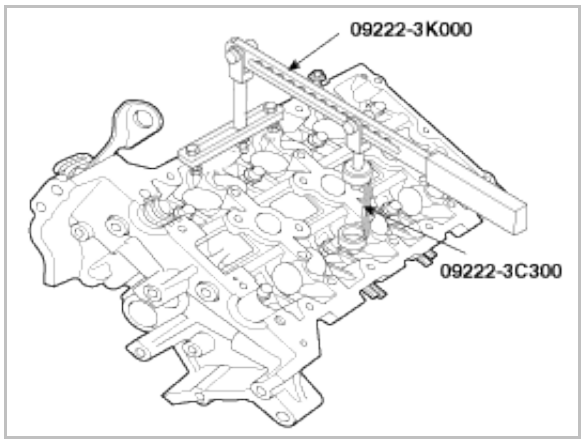
NOTE

Identify MLA, valves and valve springs as they are removed so that each item can be reinstalled in its original position.

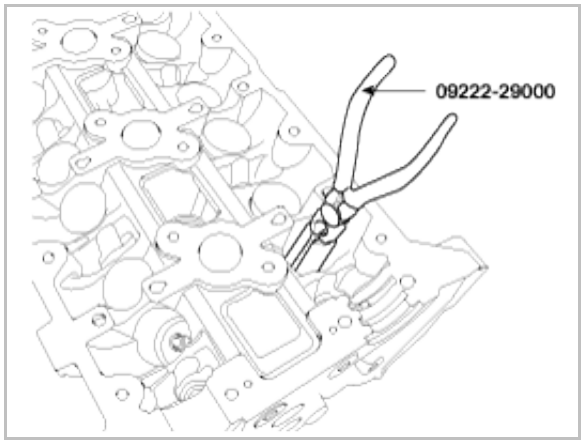
1. Remove the MLAs(A).



2. Remove the valves.
   (1) Using the SST(09222-3K000, 09222-3C300), compress the valve spring and remove retainer lock.



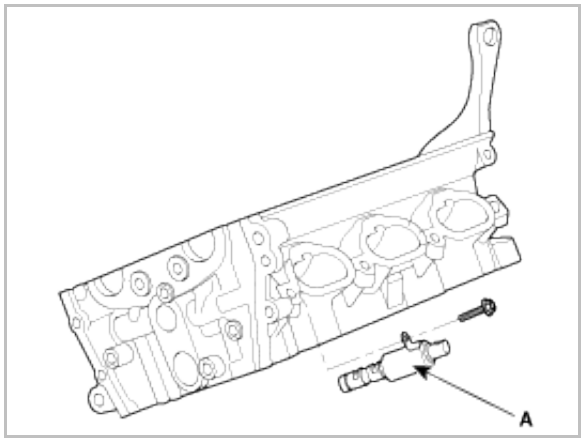
   (2) Remove the spring retainer.
   (3) Remove the valve spring.
   (4) Remove the valve.
   (5) Using the SST(09222-29000), remove the valve stem seal.



NOTE

Do not reuse old valve stem seals.

3. Remove the OCV(A).

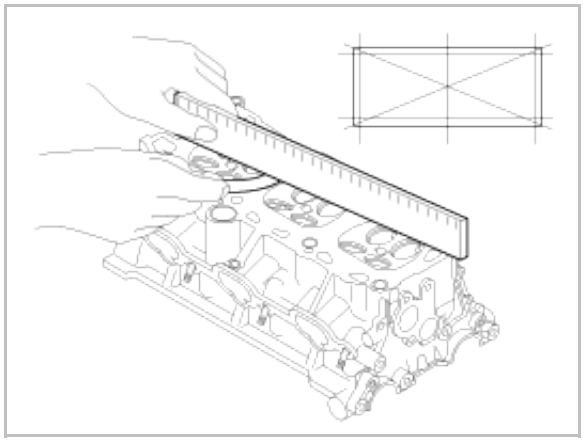


Inspection

Cylinder Head

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

Flatness of cylinder head gasket surface
Standard : Less than 0.05mm(0.002in.)
[Less than 0.02mm(0.0008in.)/150x150]
Flatness of manifold gasket surface
Standard : Less than 0.01mm(0.0004in)/110x110

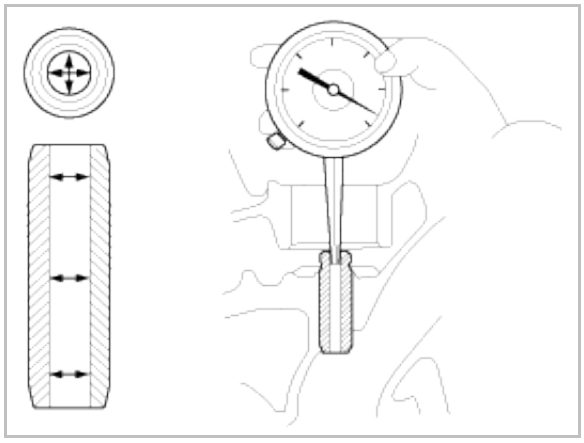


2. Inspect for cracks.
   Check the combustion chamber, intake ports, exhaust ports and cylinder block surface for cracks. If cracked, replace the cylinder head.

Valve And Valve Spring

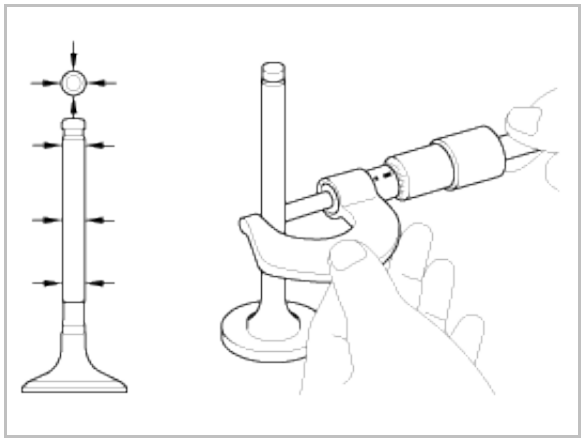
1. Inspect valve stems and valve guides.
   (1) Using a caliper gauge, measure the inside diameter of the valve guide.

Valve guide I.D.
Intake / Exhaust : 5.500 ~ 5.512mm (0.216 ~ 0.217in.)



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

Valve stem O.D.
Intake : 5.465 ~ 5.480mm (0.2151 ~ 0.2157in.)
Exhaust : 5.458 ~ 5.470mm (0.2149 ~ 0.2153in.)

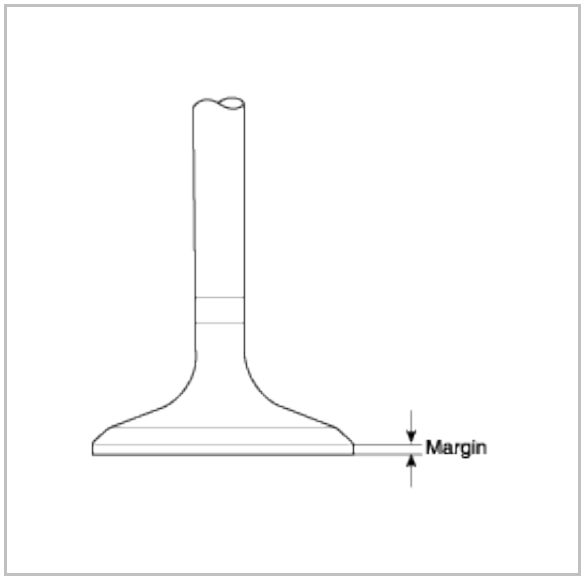


(3) Subtract the valve stem diameter measurement from the valve guide inside diameter measurement.

Valve stem-to-guide clearance
[Standard]
Intake : 0.020 ~ 0.047mm (0.0008 ~ 0.0018in.)
Exhaust : 0.030 ~ 0.054mm (0.0012 ~ 0.0021in.)
[Limit]
Intake : 0.07mm (0.0027in.)
Exhaust : 0.09mm (0.0035in.)

2. Inspect valves.
(1) Check the valve is ground to the correct valve face angle.
(2) Check that the surface of the 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 : 1.56 ~ 1.86mm (0.06142 ~ 0.07323in.)
Exhaust : 1.73 ~ 2.03mm (0.06811 ~ 0.07992in.)



(4) Check the valve length.

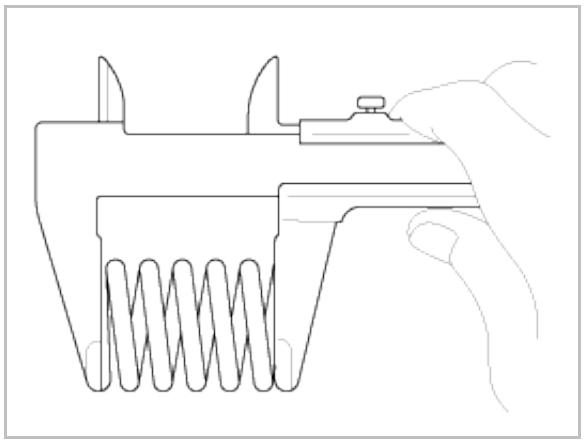
Length
Intake : 105.27mm (4.1445in)
Exhaust : 105.50mm (4.1535in)

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

3. Inspect valve seats
Check the valve seat for evidence of overheating and improper contact with the valve face.
If the valve seat is worn, replace cylinder head.
Before reconditioning the seat, check the valve guide for wear. If the valve guide is worn, replace cylinder head.
Recondition the valve seat with a valve seat grinder or cutter. The valve seat contact width should be within specifications and centered on the valve face.

4. Inspect valve springs.
   (1) Using a steel square, measure the out-of-square of the valve spring.
   (2) Using vernier calipers, measure the free length of the valve spring.

Valve spring
[Standard]
Free height : 43.86mm (1.7267in.)
Out-of-square : 1.5°



MLA

1. Inspect MLAs.
   Using a micrometer, measure the MLA outside diameter.

MLA O.D.
Intake/Exhaust :
34.964 ~ 34.980mm(1.3765 ~ 1.3771in.)

2. Using a caliper gauge, measure MLA tappet bore inner diameter of cylinder head.

Tappet bore I.D.
Intake/Exhaust :
35.000 ~ 35.025mm(1.3779 ~ 1.3789in.)

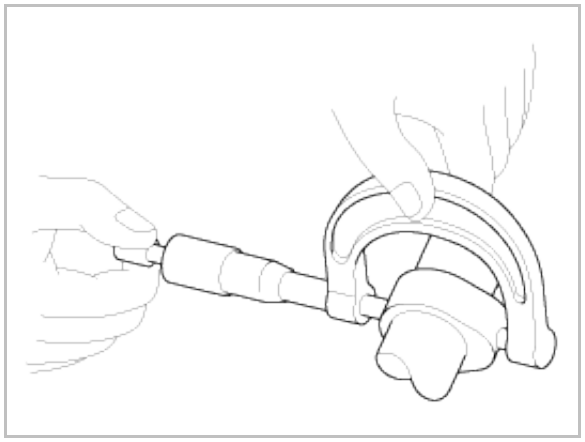
3. Subtract MLA outside diameter measurement from tappet bore inside diameter measurement.

MLA to tappet bore clearance
[Standard]
Intake/Exhaust : 0.020 ~ 0.061mm(0.0008 ~ 0.0024in.)
[Limit]
Intake/Exhaust : 0.07mm(0.0027in.)

Camshaft

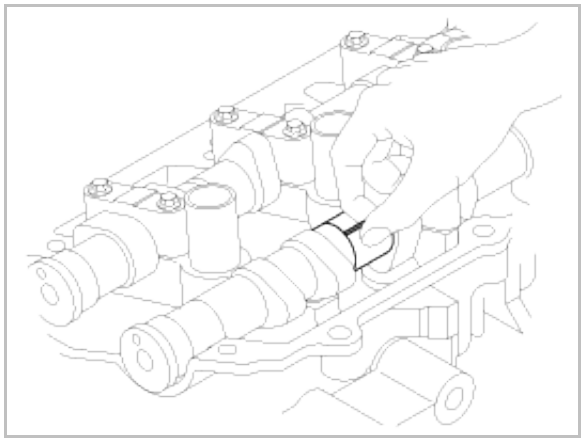
1. Inspect cam lobes.
   Using a micrometer, measure the cam lobe height.

Cam height
[Standard value]
Intake : 47.2mm (1.8582in.)
Exhaust : 45.8mm (1.8031in.)



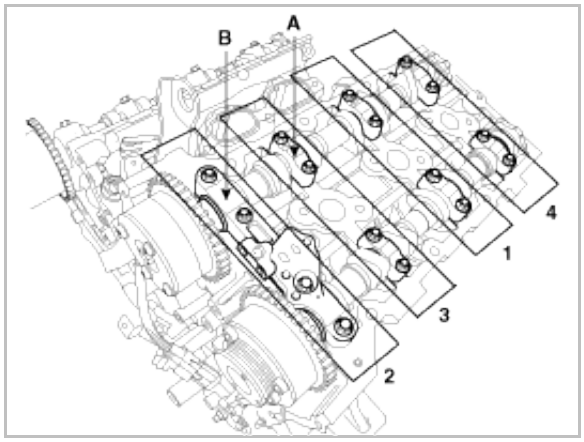
If the cam lobe height is less than standard, replace the camshaft.

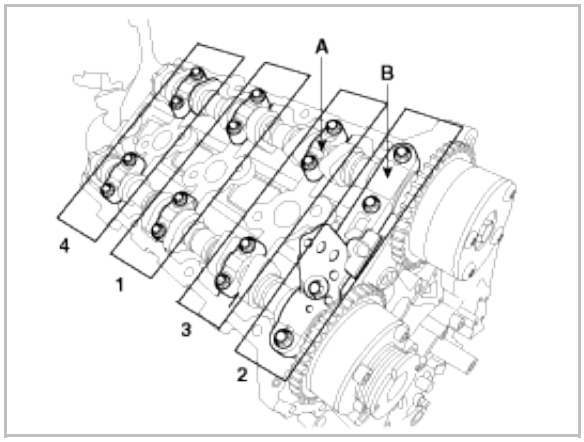
2. Inspect the camshaft journal clearance.
   (1) Clean the bearing caps and camshaft journals.
   (2) Place the camshafts on the cylinder head.
   (3) Lay a strip of plastigage across each of the camshaft journals.



   (4) Install the bearing cap (A) and thrust bearing cap (B) with specified torque.

Tightening torque :
1st step : 5.8N.m (0.6kgf.m, 4.3lb-ft)
2nd step : 9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)





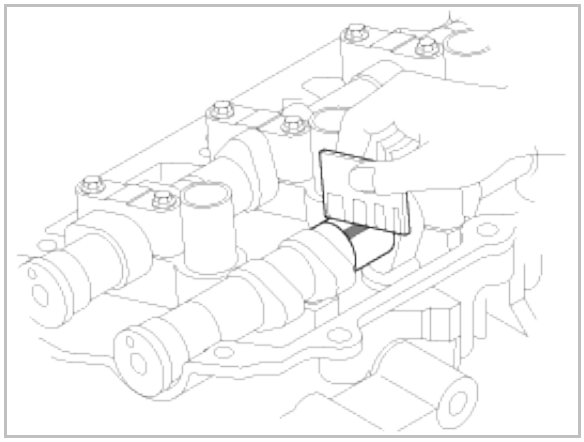
CAUTION

Do not turn the camshaft.

(5) Remove the bearing caps.

(6) Measure the plastigage at its widest point.

Bearing oil clearance
[Standard value]
Intake
No.1 journal : 0.020 ~ 0.057mm (0.0008 ~ 0.0022in.)
No.2,3,4 journal : 0.030 ~ 0.067mm (0.0012 ~ 0.0026in.)
Exhaust
No.1 journal : 0.027 ~ 0.057mm (0.0010 ~ 0.0022in.)
No.2,3,4 journal : 0.030 ~ 0.067mm (0.0012 ~ 0.0026in.)



If the oil clearance is greater than maximum, replace the camshaft. If necessary, replace cylinder head.

(7) Completely remove the plastigage.

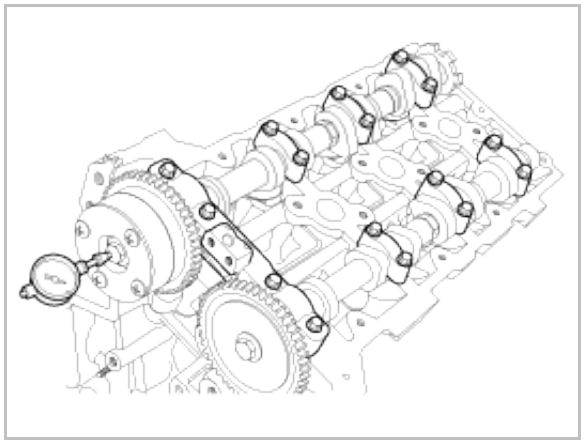
(8) Remove the camshafts.

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 value] : 0.02 ~ 0.18mm(0.0008 ~ 0.0071in.)



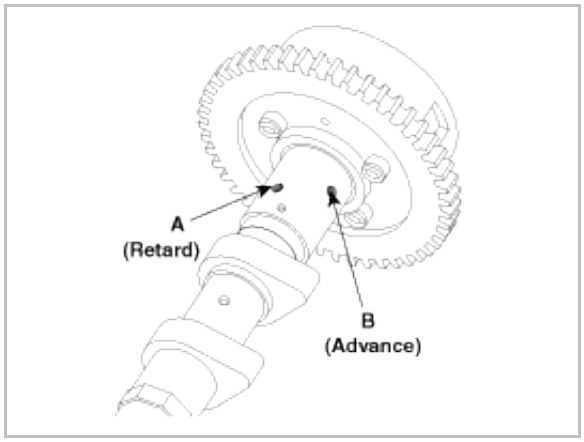
If the end play is greater than maximum, replace the camshaft. If necessary, replace cylinder head.

(3) Remove the camshafts.

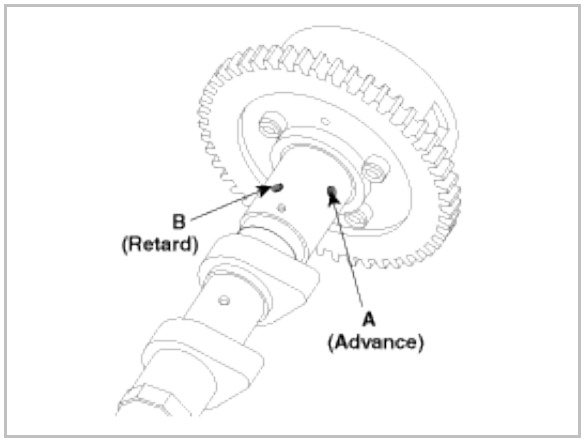
CVVT Assembly

1. Inspect the CVVT assembly.
   (1) Check that the CVVT assembly will not turn.
   (2) Apply vinyl tape to the retard hole except the one indicated by the arrow in the illustration.

[Intake CVVT]



[Exhaust CVVT]

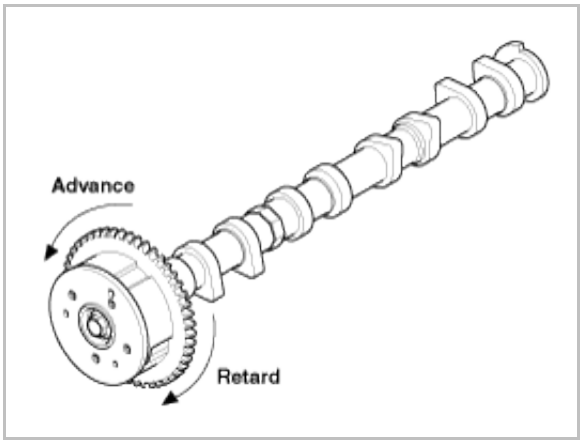


(3) Wrap tape around the tip of the air gun and apply air of approx. 150kpa(1.5kgf/cm², 21psi) to the port of the camshaft.
(Perform this in order to release the lock pin for the maximum delay angle locking.)

NOTE

When the oil splashes, wipe it off with a shop rag.

(4) Under the condition of (3), turn the CVVT assembly to the advance angle side (the arrow marked direction in the illustration) with your hand.
Depending on the air pressure, the CVVT assembly will turn to the advance side without applying force by hand.



(5) 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 interference.

Standard: Movable smoothly in the range about 30°

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

Reassembly

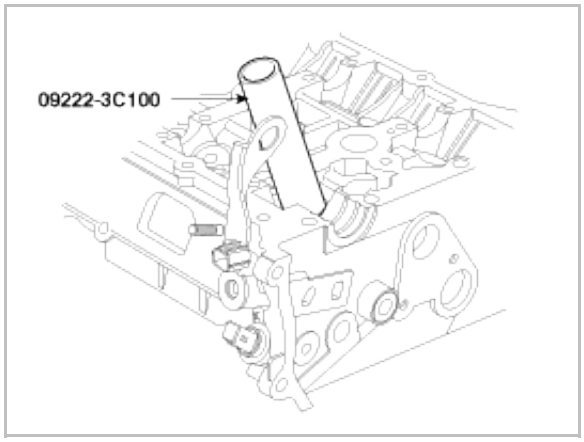
NOTE

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

1. Install the valves.
(1) Using the SST(09222-3C100), push in a new oil seal.

NOTE

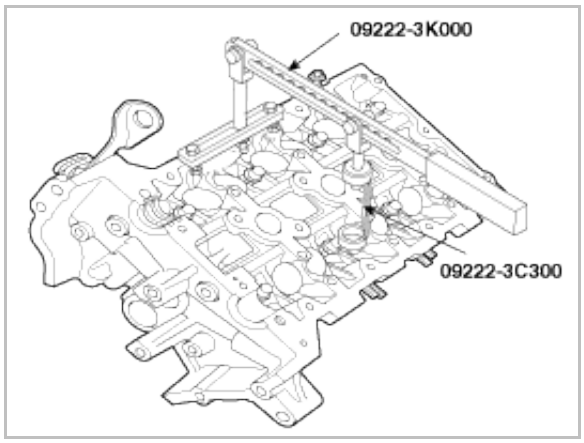
Do not reuse old valve stem seals.
Incorrect installation of the seal could result in oil leakage past the valve guides.



(2) Install the valve, valve spring and spring retainer.

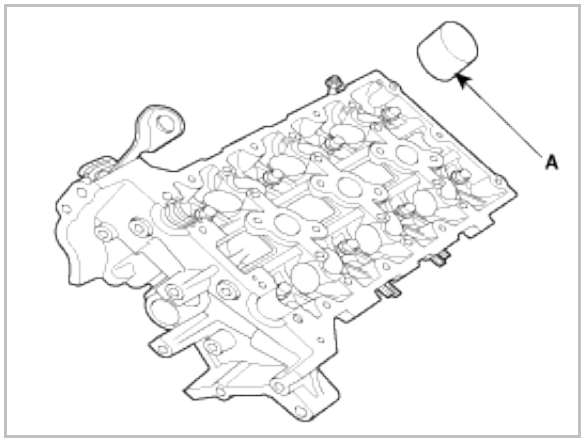
> **NOTE**
>
> Place valve springs so that the side coated with enamel faces toward the valve spring retainer and then install the retainer.

(3) Using the SST(09222 - 3K000, 09222-3C300), 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.



(4) 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.

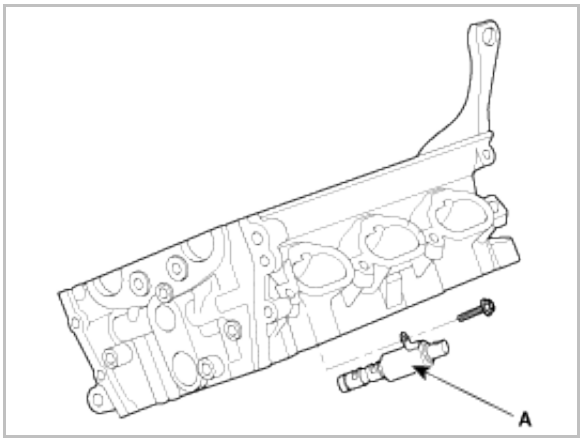
2. Install the MLAs.
Check that the MLA rotates smoothly by hand.



> **NOTE**
>
> MLA can be reinstalled in its original position.

3. Install the OCV(A).

Tightening torque
9.80 ~ 11.76Nm(1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)



NOTE

- Install OCV with gray colored connector into LH bank.
- Install OCV with black colored connector into RH bank.

CAUTION

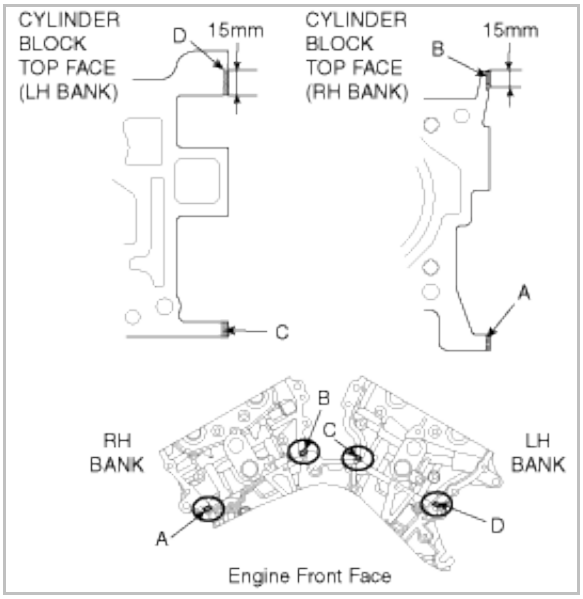
- Do not reuse the OCV when dropped.
- Keep the OCV clean.
- Do not hold the OCV sleeve during servicing.
- When the OCV is installed on the engine, do not move the engine while holding the OCV yoke.

Installation

NOTE

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

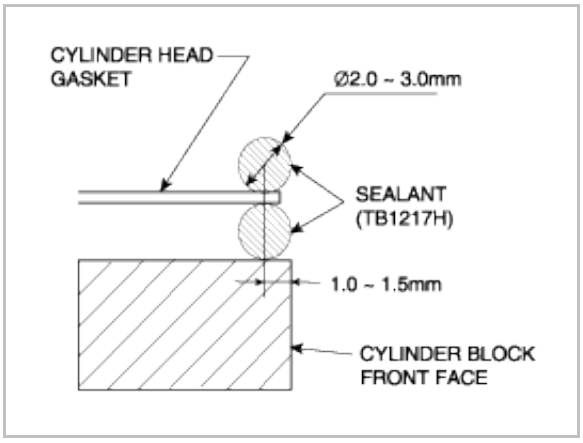
1. Install the cylinder head.
   A. The sealant locations on cylinder head and cylinder block must be free of engine oil and ETC.
   B. Apply sealant on cylinder block top face before assembling cylinder head gaskets.
      The part must be assembled within 5 minutes after sealant was applied.



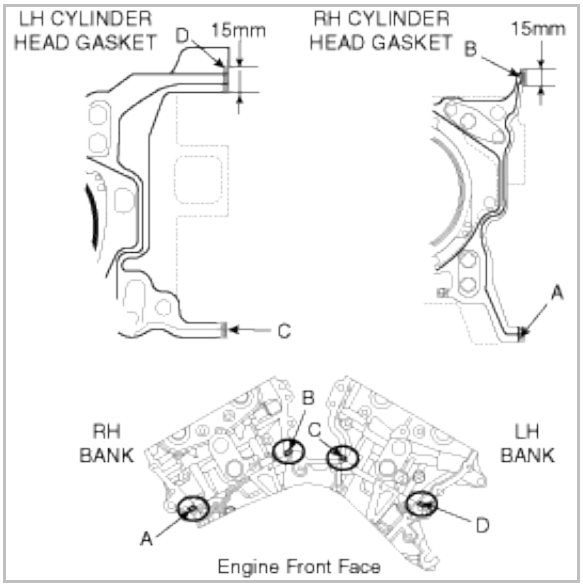
NOTE

Refer to below illustration to apply the sealant.

Bead width :
2.0~3.0 mm (0.078 ~ 0.118 in.)
Sealant locations :
1.0~1.5mm (0.039 ~ 0.059 in.) from block surface
Recommended sealant : Liquid sealant TB1217H

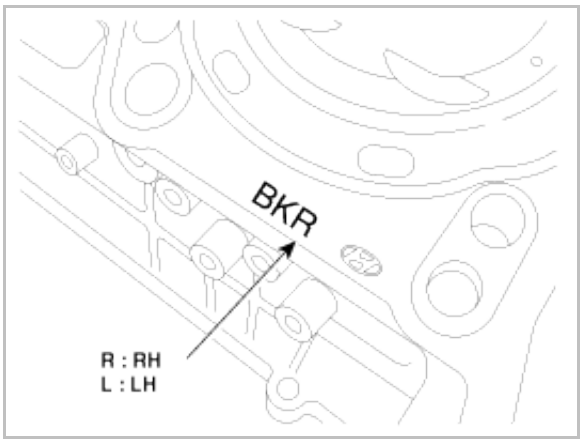


C. Apply sealant on cylinder head gaskets after assembling cylinder head gaskets on cylinder block.
The part must be assembled within 5 minutes after sealant was applied.



NOTE

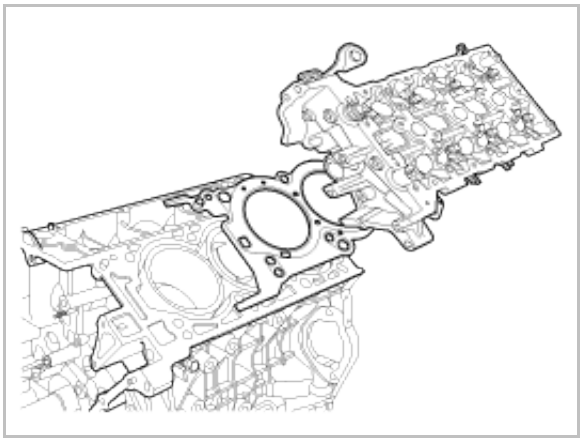
Be careful of the installation direction.



D. Install the cylinder head.

NOTE

Remove the extruded sealant after assembling cylinder heads.



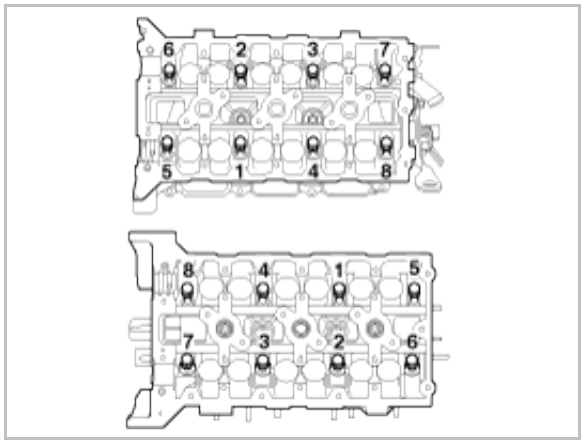
2. Install the cylinder head bolts.

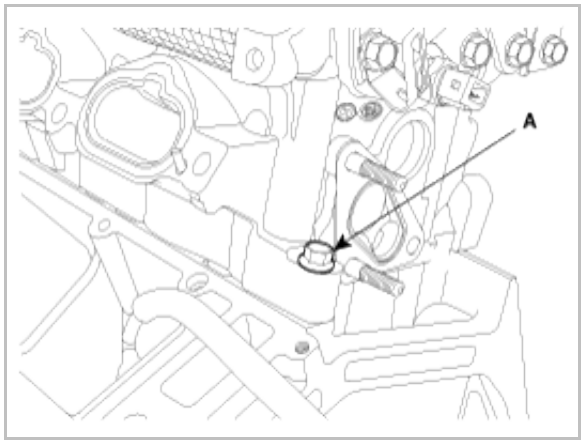
(1) Do not apply engine oil on the threads and under the heads of the cylinder head bolts.

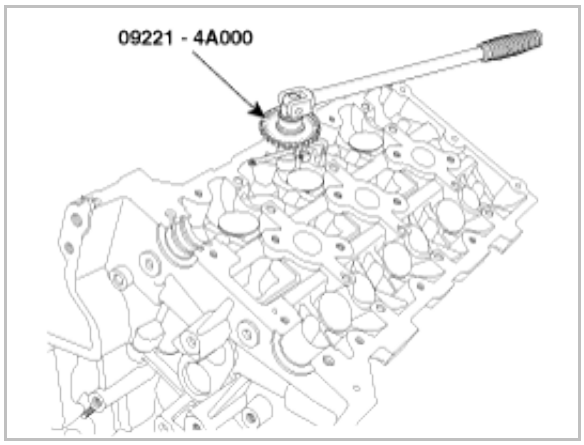
(2) Using SST(09221-4A000), install and tighten the cylinder head bolts and plate washers, in several passes, in the

sequence shown.

Tightening torque
Head bolt: 37.3~41.2Nm (3.8~4.2kgf.m, 27.5~30.4lb-ft) + 118~122° + 88~92°
Bolt (A):18.6 ~ 23.5Nm (1.9 ~ 2.4kgf.m, 13.7 ~ 17.4lb-ft)

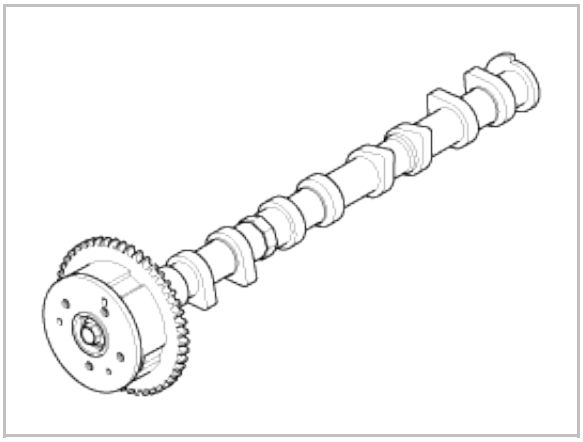






3. Install the CVVT assembly.

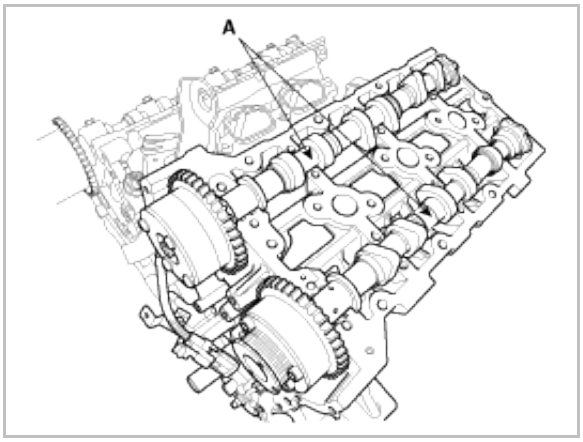
Tightening torque :
64.7 ~ 76.5N.m (6.6 ~ 7.8kgf.m, 47.7 ~ 56.4lb-ft)

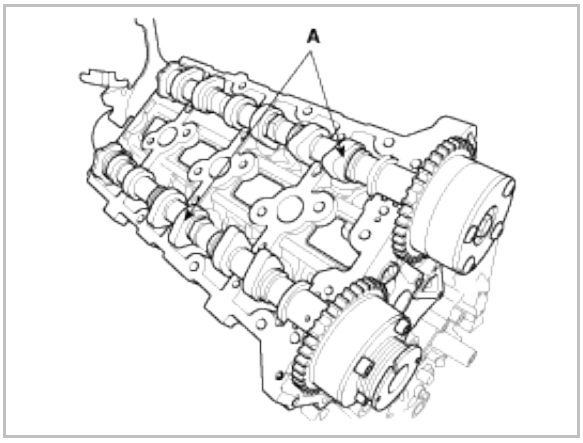


CAUTION

- Install camshaft-inlet to dowel pin of CVVT assembly.
  At this time, attend not to be installed to oil hole of camshaft-inlet.
- Hold the hexagonal head wrench portion of the camshaft with a vise, and install the bolt and CVVT assembly.
- Do not rotate CVVT assembly when camshaft is installed to dowel pin of CVVT assembly.

4. Install the LH/RH camshaft assembly (A).

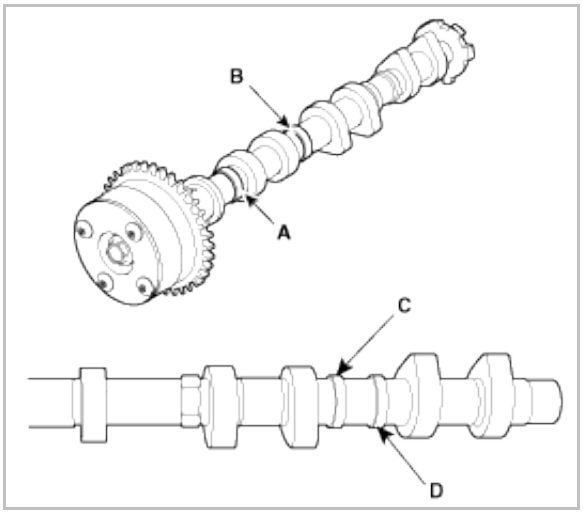




CAUTION

- Apply a light coat of engine oil on camshaft journals.
- Assemble the key groove of camshaft rear side to the same level of head top surface.
- Be careful the right, left bank, intake, exhaust side before assembling.

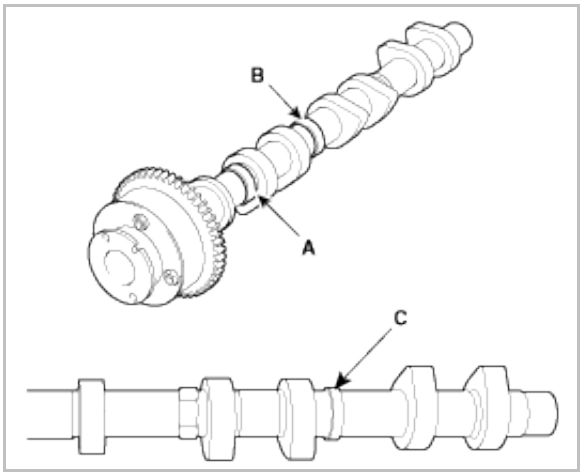
Intake Camshaft



As for camshaft identification, refer to the table below.

Displacement	Outer diameter	
	LH	RH
Intake camshaft	A : 27mm (1.0630in.)	A : 27mm (1.0630in.)
	B : 27mm (1.0630in.)	B : 27mm (1.0630in.)
	C : 30mm (1.1811in.)	C : 27mm (1.0630in.)
	D : 27mm (1.0630in.)	D : 30mm(1.1811in.)

Exhaust Camshaft



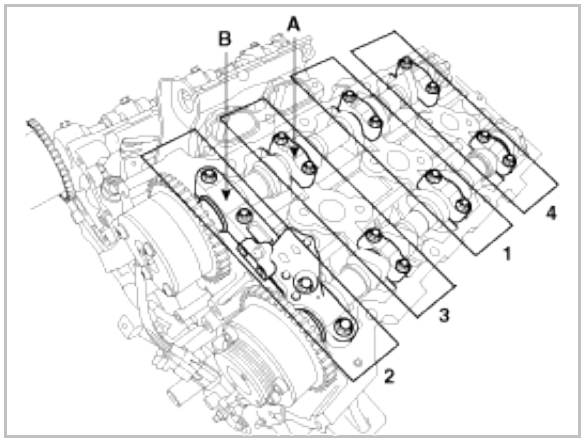
As for camshaft identification, refer to the table below.

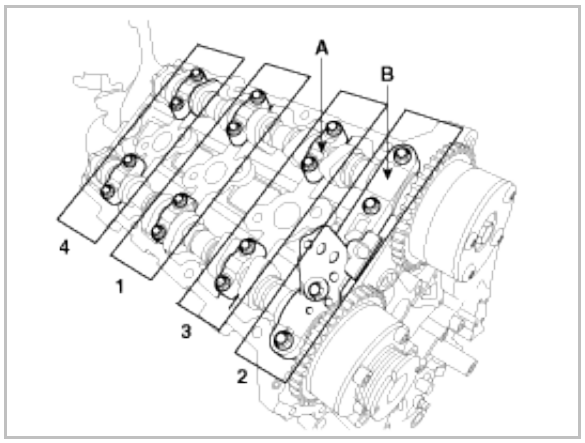
Displacement	Outer diameter	
	LH	RH
Exhaust camshaft	A : 27mm (1.0630in.)	A : 27mm (1.0630in.)
	B : 27mm (1.0630in.)	B : 27mm (1.0630in.)
	C : 27mm (1.0630in.)	C : 30mm (1.1811in.)

5. Install the LH/RH camshaft bearing cap (A) and thrust bearing cap (B).

Tightening torque

1st step : 5.8N.m (0.6kgf.m, 4.3lb-ft)
2nd step : 9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)



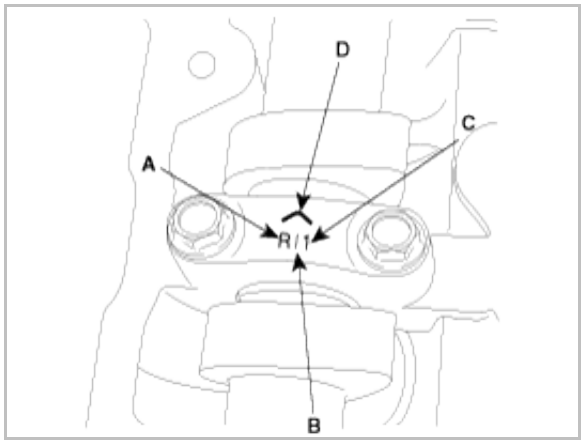


CAUTION

Be sure to install the thrust bearing cap bolts and the bearing cap bolts in the correct place.

NOTE

Be careful the right, left bank, intake, exhaust side before assembling.



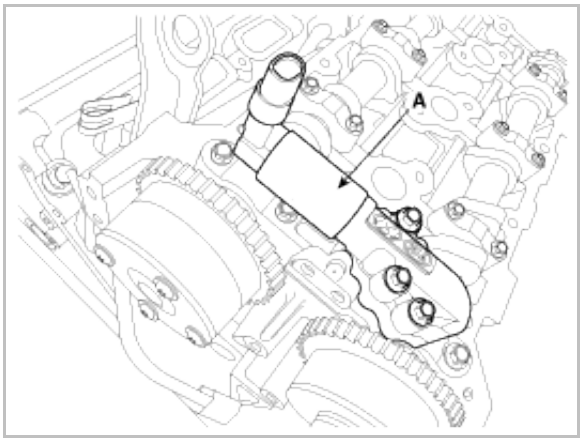
A : L(LH),R(RH)
B : I(Intake), None(Exhaust)
C : Journal number
D : Front mark

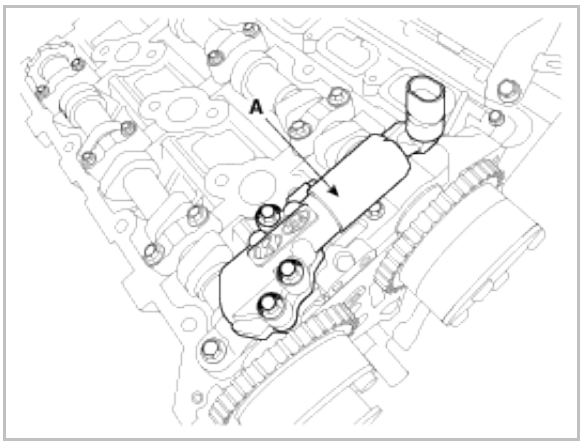
CAUTION

Rotate the crankshaft not to contact the valves to the pistons by making the pistons below 10mm(0.3937in.) from the top of cylinder block.

6. Install the LH/RH exhaust camshaft OCV (A).

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



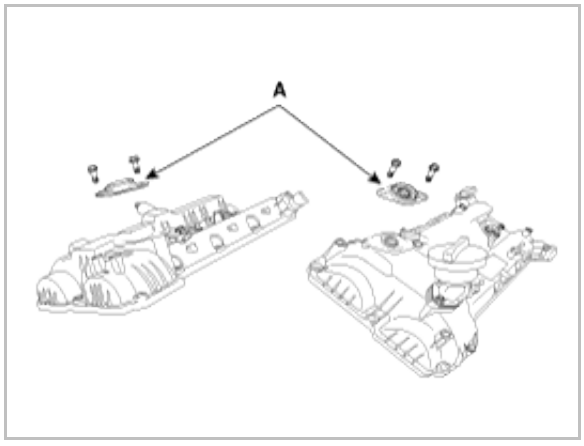


7. Install the LH/RH cylinder head cover (A).

NOTE

- Install the cylinder head cover under the exhaust OCV cap is removed.
- To prevent engine oil leakage, surely install the new exhaust OCV cap after installing the cylinder head cover.

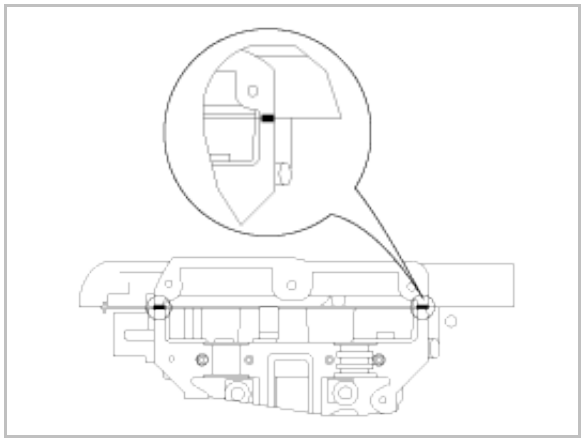
(1) Remove the exhaust OCV cap (A) from the cylinder head cover.



(2) The hardening sealant located on the upper area between timing chain cover and cylinder head should be removed before assembling cylinder head cover.

(3) After applying sealant(TB1217H), it should be assembled within 5 minutes.

Bead width : 2.5mm(0.1in.)



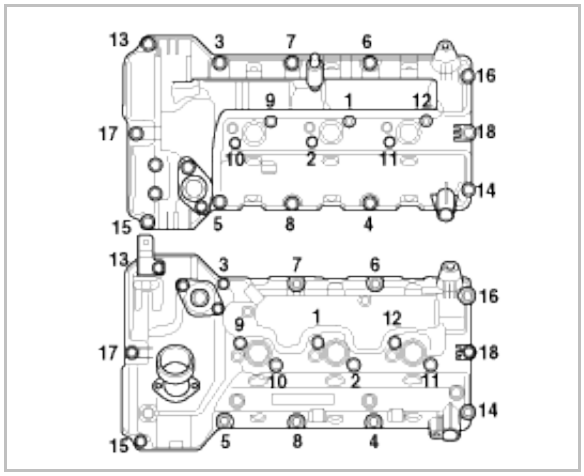
(4) The firing and/or blow out test should not be performed within 30 minutes after the cylinder head cover was assembled.

(5) Install the cylinder head cover bolts as following method.

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

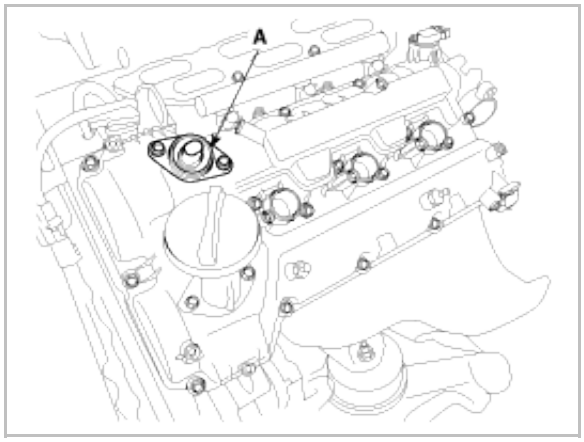
CAUTION

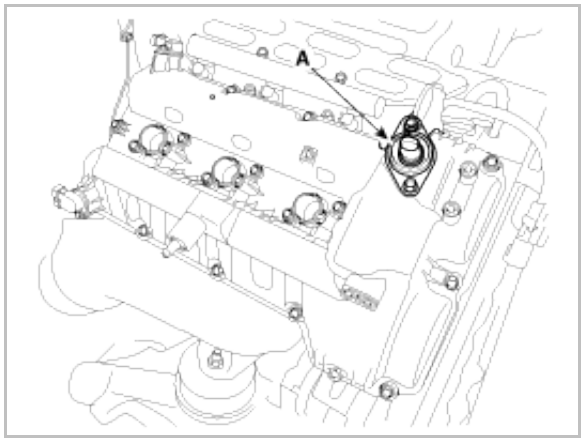
Do not reuse cylinder head cover gasket.



(6) Install the new exhaust OCV cap (A).

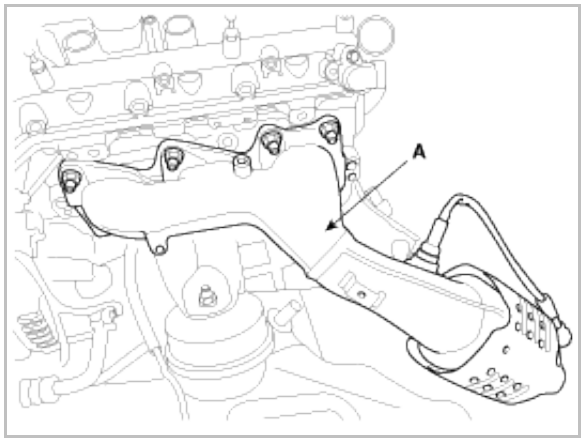
Tightening torque :
9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)

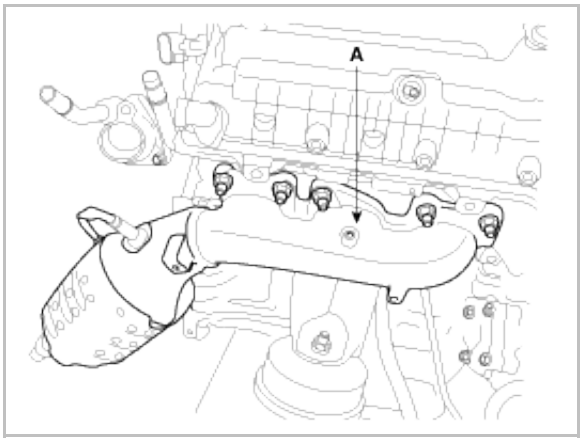




8. Install the LH/RH exhaust manifold (A) with a new gasket.

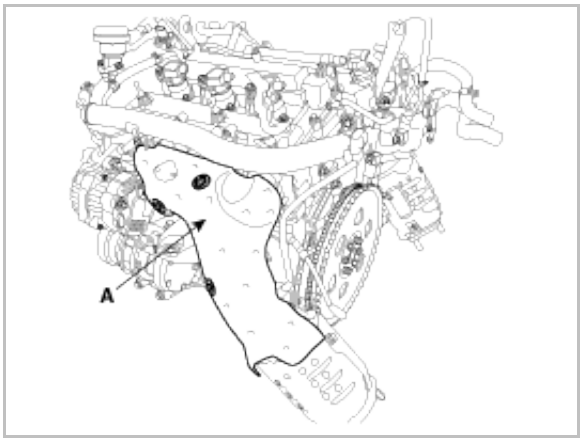
Tightening torque :
39.2 ~ 44.1N.m (4.0 ~ 4.5kgf.m, 28.9 ~ 32.5lb-ft)

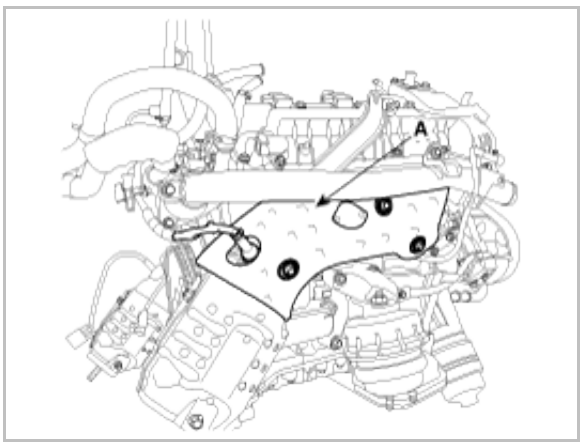




9. Install the LH/RH exhaust manifold heat protector (A).

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





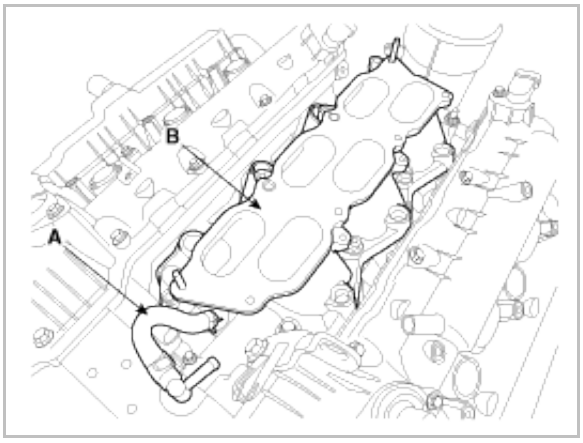
10. Install the intake the manifold (B) with a new gasket, and connect the water vent hose (A).

CAUTION

- Be sure to drain the engine coolant before removing the intake manifold.
- If any coolant drained from the cylinder head vent hole has entered the intake port. This can potentially lead to engine trouble.

Tightening torque
Step 1: 3.9 ~ 5.9N.m (0.4 ~ 0.6kgf.m, 2.9 ~ 4.3lb-ft)
Step 2:

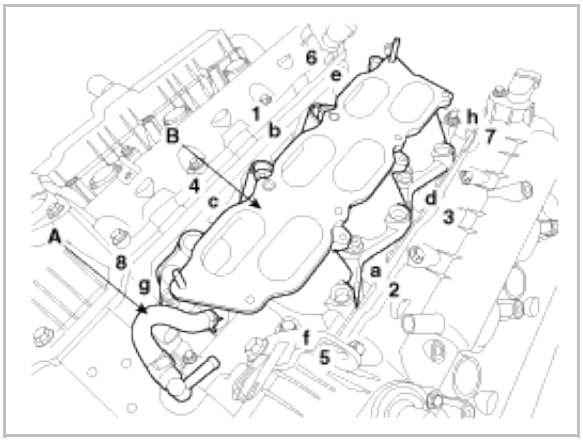
Nut-18.62 ~ 23.52N.m (1.9~2.4kgf.m, 13.74~17.36lb-ft)
Bolt -26.5 ~ 31.4 N.m (2.7 ~ 3.2 kgf.m, 19.5 ~ 23.1lb-ft)
Step 3: Repeat 2nd step twice or more.



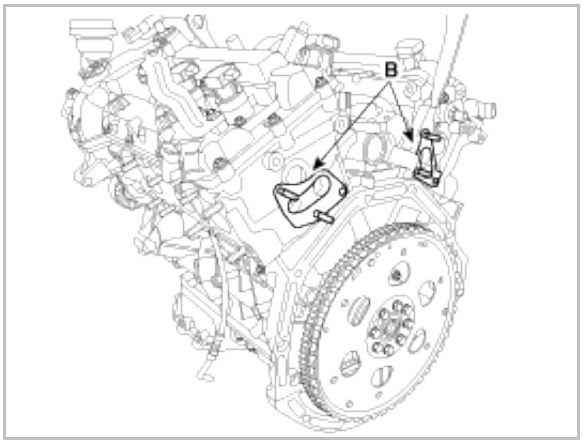
a - h : 1st step order
1 ~ 8 : 2nd step order

NOTE

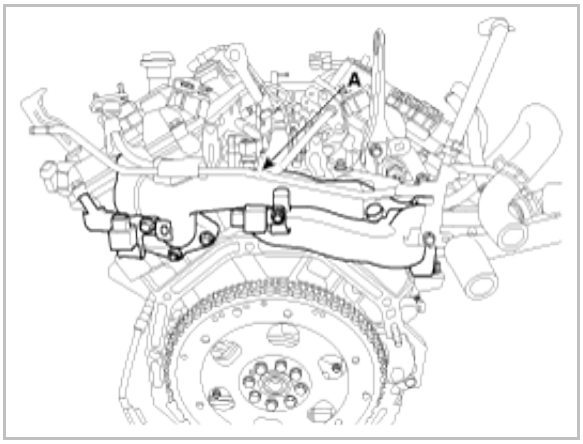
Confirm the manifold gasket identification mark (LH, RH) and be careful of the installation direction.



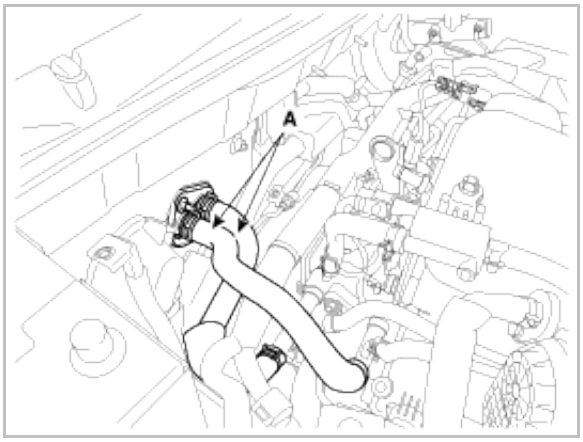
11. Install the water temperature control assembly (A) after installing a new gasket (B).



Tightening torque :
19.6 ~ 23.5Nm (2.0 ~ 2.4kgf.m, 14.5 ~ 17.4lb-ft)



12. Connect the heater hoses (A).



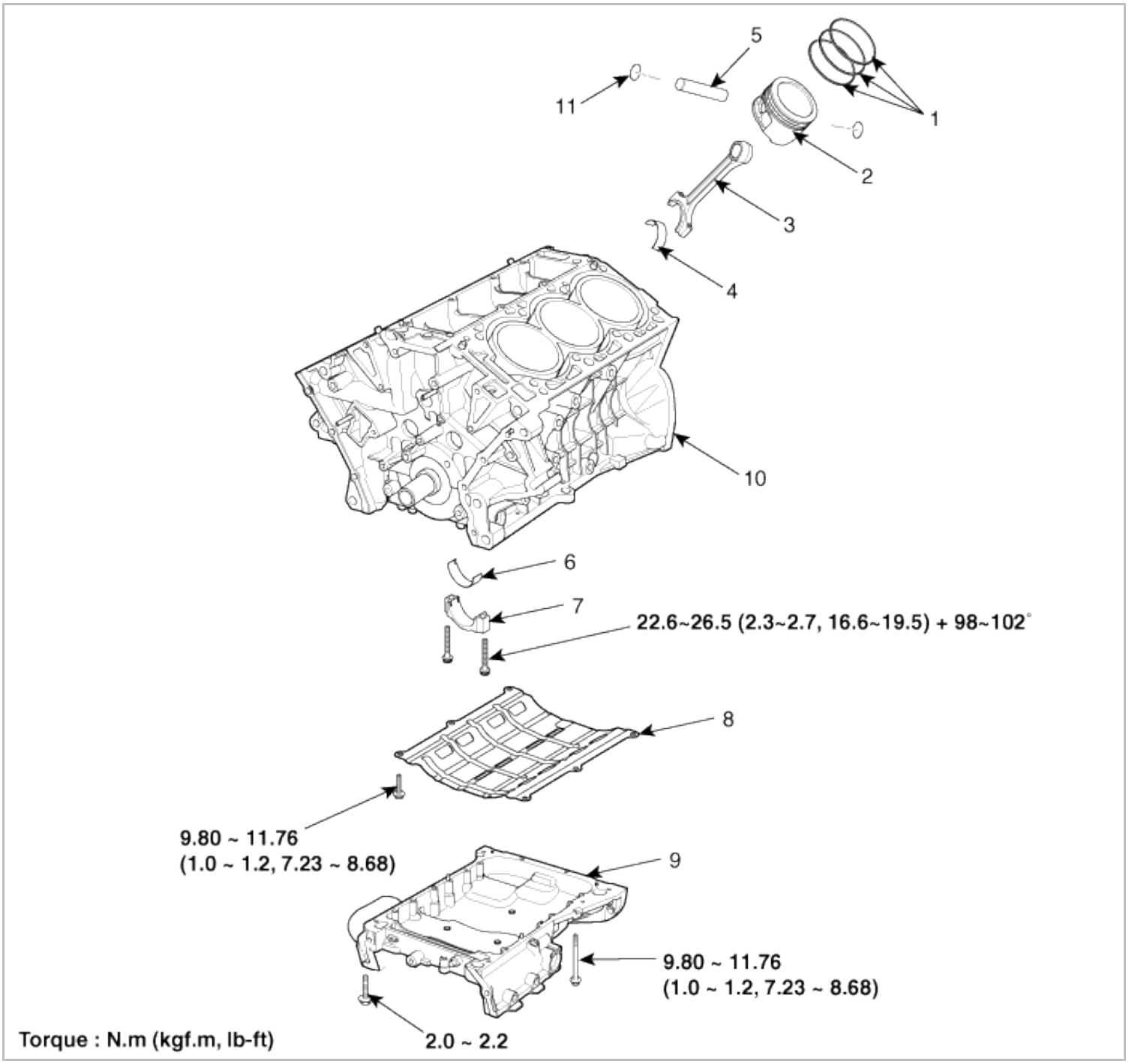
13. Install the timing chain. (Refer to Timing system in this group)

NOTE

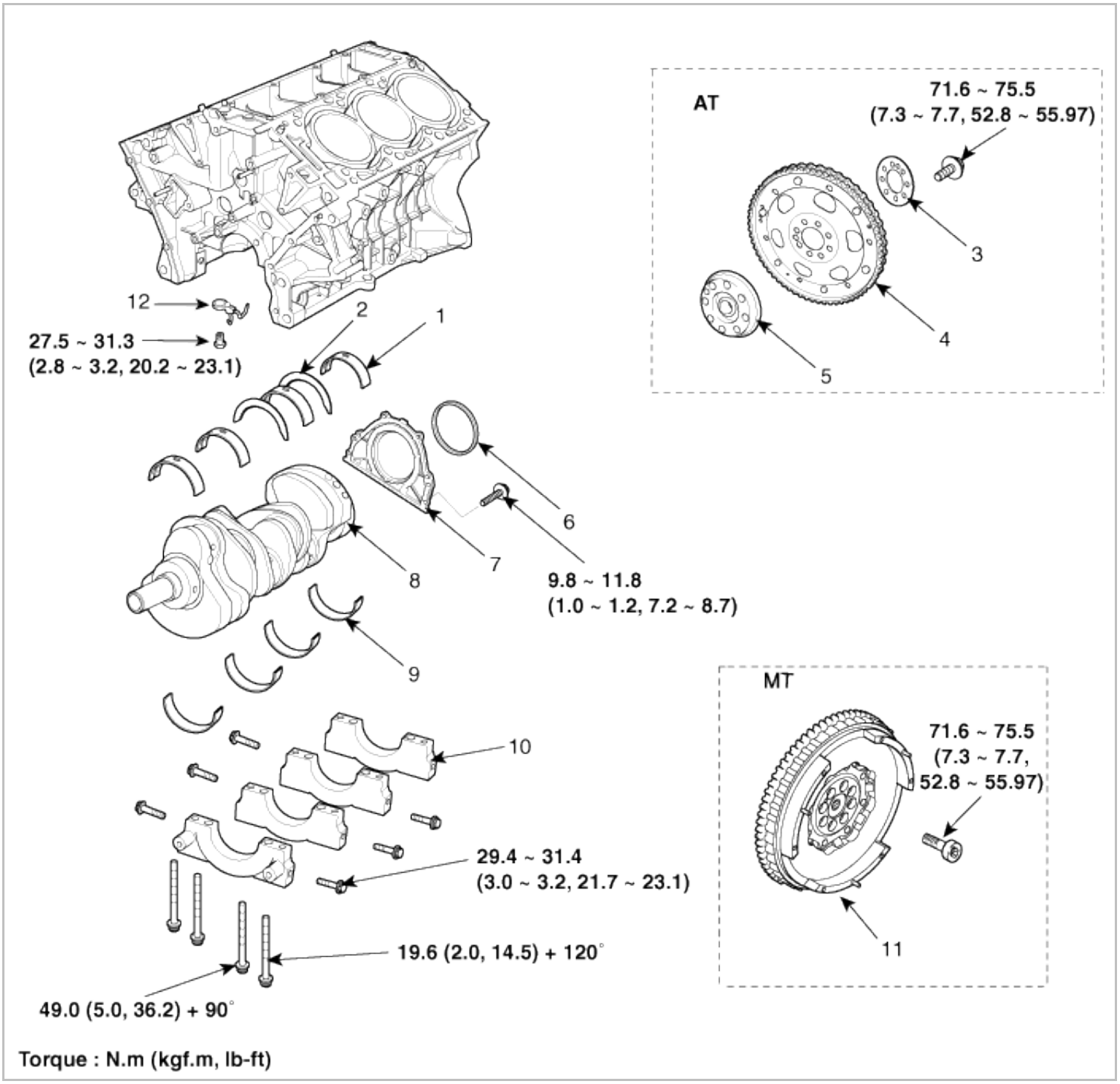
- Refill engine oil.
- Clean the battery posts and cable terminals with sandpaper. Assemble and then apply grease to prevent corrosion.
- Inspect for fuel leakage.
- After assembling the fuel line, turn on the ignition switch (do not operate the starter) so that the fuel pump runs for approximately two seconds and fuel line pressurizes.
- Repeat this operation two or three times, then check for fuel leakage at any point in the fuel lines.
- Refill radiator and reservoir tank with engine coolant.
- Bleed air from the cooling system.
- Start engine and let it run until it warms up. (Until the radiator fan operates 3 or 4 times.)
- Turn Off the engine. Check the level in the radiator, add coolant if needed. This will allow trapped air to be removed from the cooling system.
- Put radiator cap on tightly, then run the engine again and check for leaks.

Engine Mechanical System > Cylinder Block > Components and Components Location

Components



1. Piston ring	5. Piston pin	9. Upper oil pan
2. Piston	6. Connecting rod lower bearing	10. Cylinder block
3. Connecting rod	7. Connecting rod bearing cap	11. Snap ring
4. Connecting rod upper bearing	8. Baffle plate	



1. Crank shaft upper bearing	5. Crank shaft adapter	9. Crankshaft lower bearing
2. Thrust bearing	6. Rear oil seal	10. Main bearing cap
3. Adapter plate	7. Rear oil seal case	11. Dual mass flywheel [MT]
4. Drive plate	8. Crankshaft	12. Piston cooling jet

Engine Mechanical System > Cylinder Block > Repair procedures

Disassembly

CAUTION

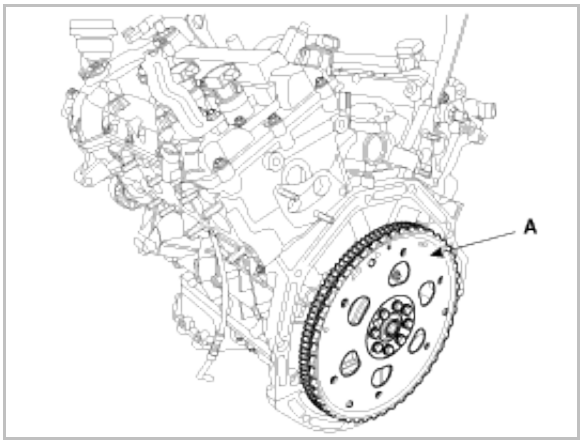
- Use fender covers to avoid damaging painted surfaces.

• To avoid damage, unplug the wiring connectors carefully while holding the connector portion.

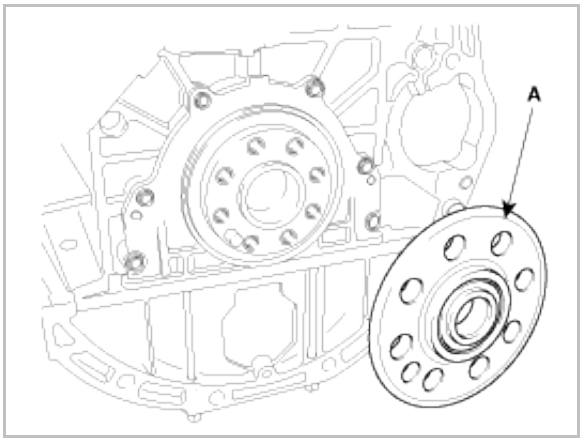
NOTE

• Mark all wiring and hoses to avoid misconnection.
• Inspect the timing chain before removing the cylinder head.
• Turn the crankshaft pulley so that the No.1 piston is at top dead center.
• Engine removal is required for this procedure.

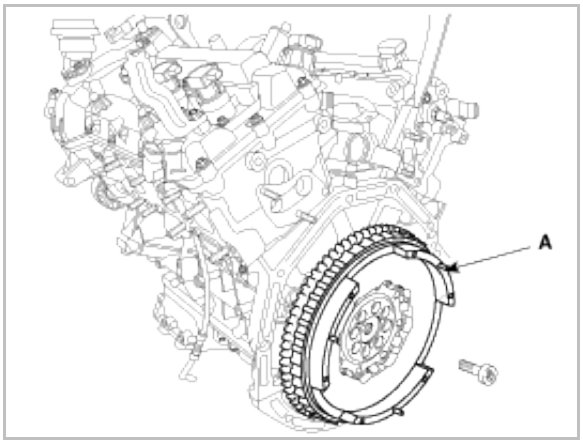
1. Remove the engine assembly from the vehicle. (Refer to Engine and transmission assembly in this group)
2. Install the engine to engine stand for disassembly.
3. Remove the intake manifold and exhaust manifolds. (Refer to Intake and exhaust system in this group)
4. Remove the timing chains. (Refer to Timing system in this group)
5. Remove the water temperature control assembly. (Refer to Cooling system in this group)
6. Remove the cylinder heads. (Refer to Cylinder head in this group)
7. Remove the oil pump. (Refer to Lubrication system in this group)
8. Remove the oil filter assembly. (Refer to Lubrication system in this group)
9. Remove the drive plate (A). (AT only)



10. Remove the crankshaft adapter (A). (AT only)



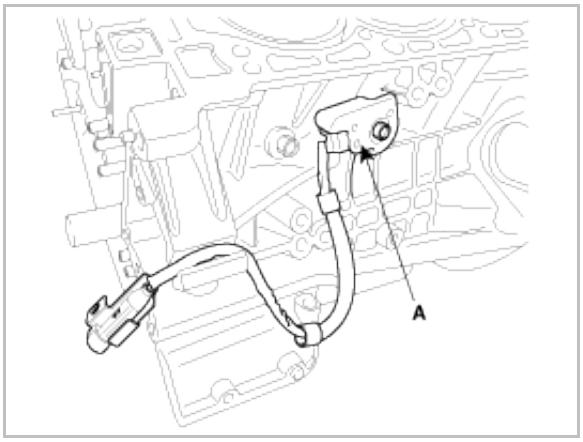
11. Remove the DMF (A). (MT only)

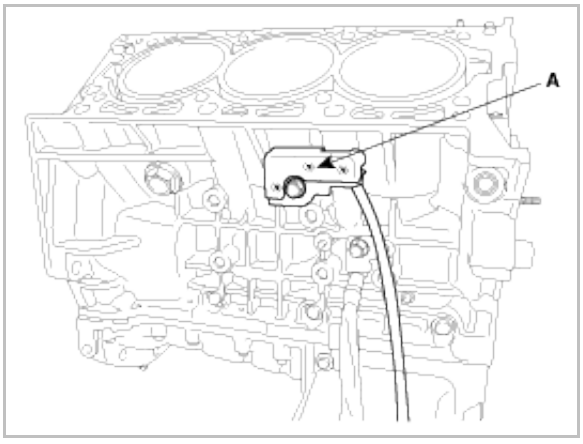


NOTE

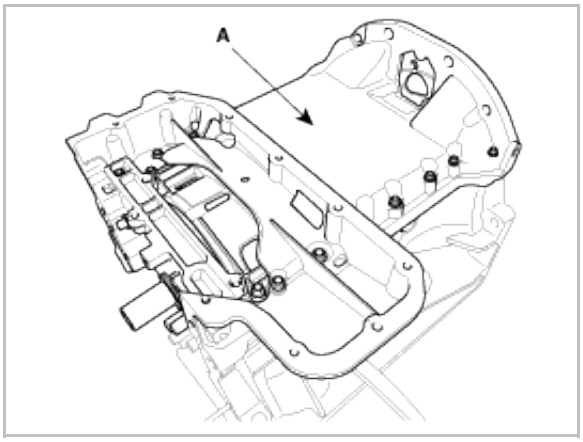
A form of "★" socket (12-gon) is needed to remove the DMF bolt.

12. Remove the knock sensors (A).

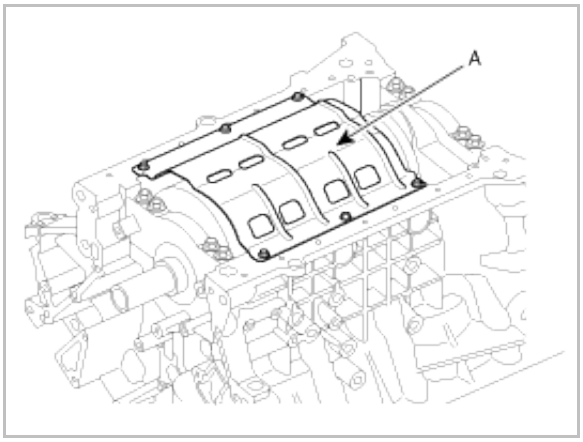




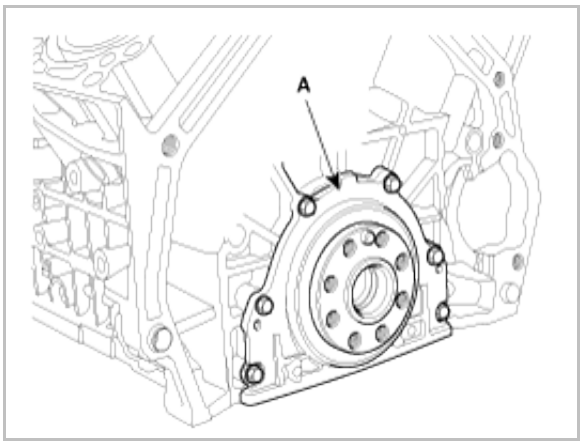
13. Remove the upper oil pan (A).



14. Remove the baffle plate (A).



15. Remove the rear oil seal case (A).



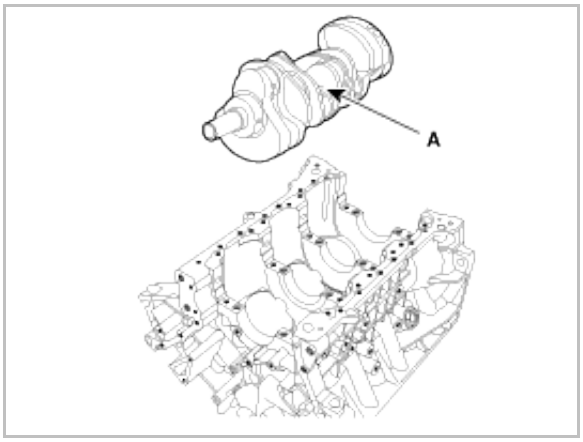
16. Check the connecting rod end play.
17. Check the connecting rod cap oil clearance.
18. Remove the piston and connecting rod assemblies.
    (1) Using a ridge reamer, remove all the carbon from the top of the cylinder.
    (2) Push the piston, connecting rod assembly and upper bearing through the 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.

19. Check the crankshaft end play.

20. Remove the crankshaft main bearing cap and check oil clearance.
21. Lift the crankshaft (A) out of engine, being careful not to damage journals.

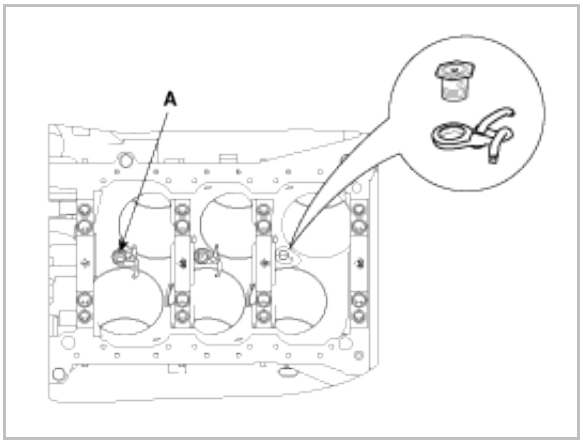


> **NOTE**
>
> Arrange the main bearings and thrust bearings in the correct order.

22. 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 piston and piston pin as a set.
23. Remove the piston rings.
    (1) Using a piston ring expander, remove the 2 compression rings.
    (2) Remove 2 side rails and the spacer by hand.

> **NOTE**
>
> Arrange the piston rings in the correct order only.

24. Disconnect connecting rod from piston. Remove th snap ring installed at both ends of piston pin. And push the piston pin to separate piston and connectingrod.
25. Remove the piston cooling jet (A).

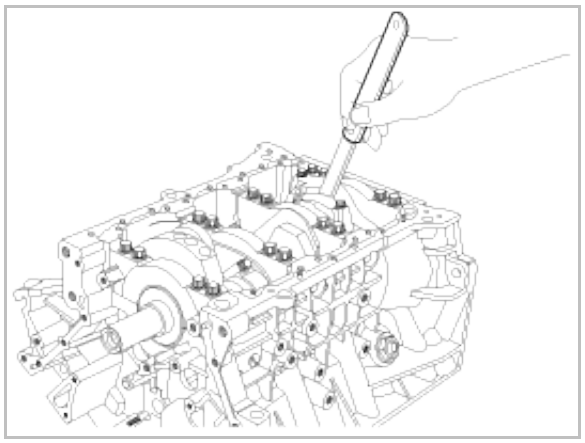


Inspection

Connecting Rod And Crankshaft

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

Standard end play : 0.1~ 0.25mm(0.004 ~ 0.010in.)



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 matchmarks on the connecting rod and cap are aligned to ensure correct reassembly.

(2) Remove 2 connecting rod cap bolts.

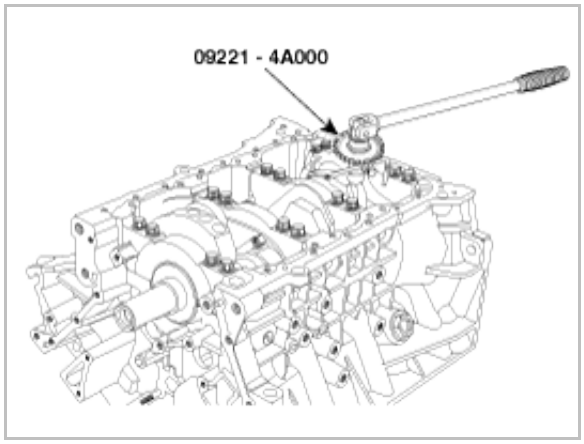
(3) Remove the connecting rod cap and bearing half.

(4) Clean the crank pin and bearing.

(5) Place plastigage across the crank pin.

(6) Reinstall the bearing half and cap, and torque the bolts.

Tightening torque
22.6~26.5Nm (2.3~2.7kgf.m, 16.6~19.5lb-ft) + 98~102°



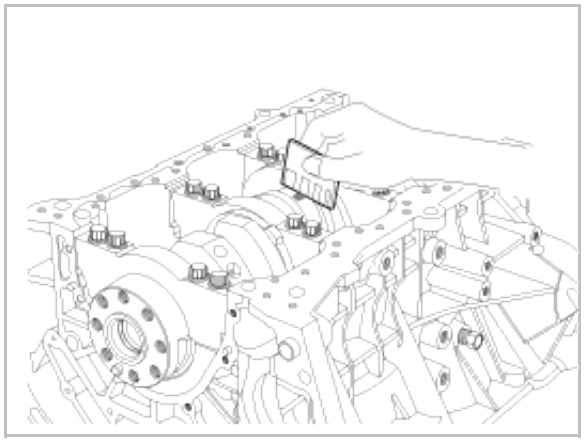
NOTE

Do not turn the crankshaft.

(7) Remove 2 bolts, connecting rod cap and bearinghalf.

(8) Measure the plastigage at its widest point.

Standard oil clearance
0.038 ~ 0.056mm(0.0015 ~ 0.0022in.)



(9) If the plastigage measures too wide or too narrow, remove the upper half of the bearing, install a new, complete bearing with the same color mark (select the color as shown in the next column), and recheck the clearance.

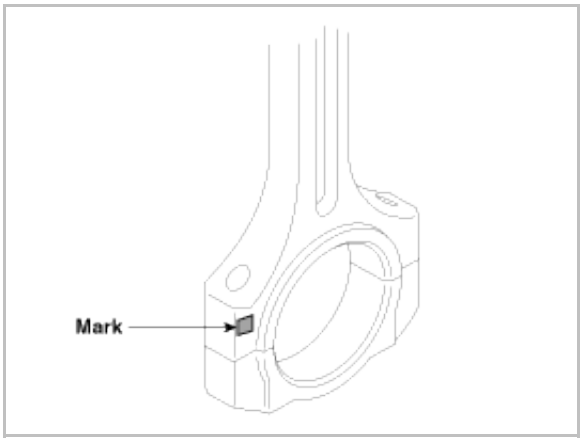
> **CAUTION**
>
> Do not file, shim, or scrape the bearings or the caps to adjust clearance.

(10) If the plastigage shows the clearance is still incorrect, try the next larger or smaller bearing (the color listed above or below that one), and check clearance again.

> **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.

Connecting Rod Mark Location



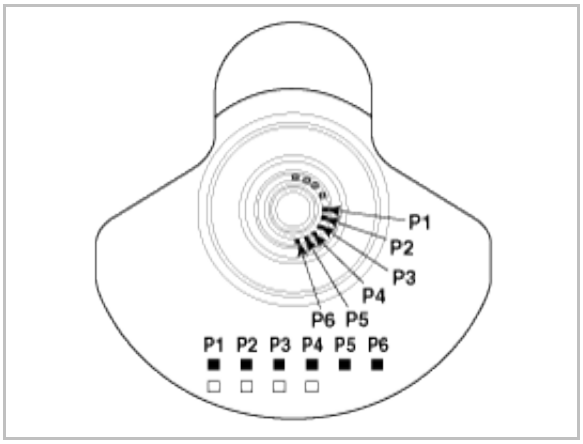
Identification Of Connecting Rod

Class	Mark	Inside Diameter
0	a	58.000 ~ 58.006mm (2.2834 ~ 2.2837in.)
1	b	58.006 ~ 58.012mm (2.2837 ~ 2.2839in.)
2	c	58.012 ~ 58.018mm

		(2.2839 ~ 2.2842in.)

Crankshaft Pin Mark Location

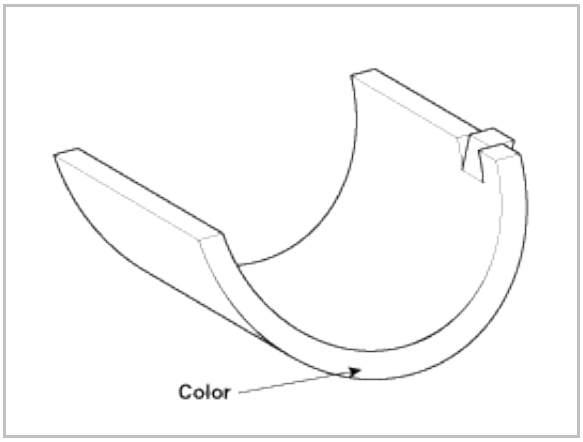
Identification Of Crankshaft



Discrimination Of Crankshaft

Class	Mark	Outside Diameter Of Pin
I	1 or A	54.966 ~ 54.972mm (2.1640 ~ 2.1642in.)
II	2 or B	54.960 ~ 54.966mm (2.1638 ~ 2.1640in.)
III	3 or C	54.954 ~ 54.960mm (2.1635 ~ 2.1638in.)

Place Of Identification Mark (Connecting Rod Bearing)



Identification Of Connecting Rod Bearing

Class	Mark	Thickness Of Bearing
E	Blue	1.514 ~ 1.517mm (0.0596 ~ 0.0597in.)
D	Black	1.511 ~ 1.514mm (0.0595 ~ 0.0596in.)
C	Brown	1.508 ~ 1.511mm (0.0594 ~ 0.0595in.)

B	Green	1.505 ~ 1.508mm (0.0593 ~ 0.0594in.)
A	Yellow	1.502 ~ 1.505mm (0.0591 ~ 0.0593in)

(11) Selection

Connecting Rod Bearing		Connecting Rod Identification Mark		
		0(a)	1(b)	2(c)
Crankshaft Indentification Mark	1 or A	A (YELLOW)	B (GREEN)	C (BROWN)
	2 or B	B (GREEN)	C (BROWN)	D (BLACK)
	3 or C	C (BROWN)	D (BLACK)	E (BLUE)

3. Check the connecting rod.
   (1) When reinstalling, check the cylinder numbers on the connecting rods and the caps. When installing a new connecting rod, the notches for bearing fixing on the connecting rods and caps should face the same direction.
   (2) If one or both edge of the connecting rod thrust surface is damaged, replace the rod. If the inner surface of the rod is damaged or rough, also replace it.
   (3) Using a connecting rod aligner, measure the bent or torsion of the rod. If the measurement is near the specification, adjust the rod with a press. If the rod is bent or twisted excessily, replace it.

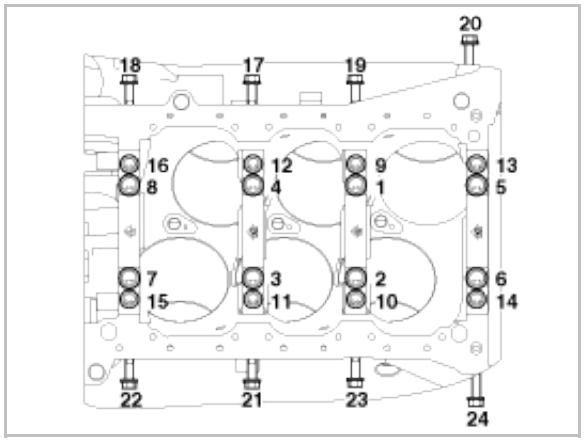
Bending : 0.05mm/100mm(0.0020in./3.9370in.)
Torsion : 0.1mm/100mm(0.0039in./3.9370in.)

NOTE

When assembling the rod without a bearing, there should be no difference.
Connectingrod bearing width of the BK lambda RS engine is 16mm(0.63in).

4. Check the crankshaft bearing oil clearance.
   (1) To check main bearing-to-journal oil clearance, remove the main bearing caps and bearing halves.
   (2) Clean each main journal and bearing half with a clean shop tower.
   (3) Place one strip of plastigage across each main journal.
   (4) Reinstall the bearings and caps, then torque the bolts.

Tightening torque
49.0Nm(5.0 kgf.m, 36.2lb-ft) + 90° : (1 ~ 8)
19.6Nm(2.0 kgf.m, 14.5lb-ft)+ 120° : (9 ~ 16)
29.4 ~ 31.4Nm(3.0 ~ 3.2 kgf.m, 21.7 ~ 23.1lb-ft) : (17 ~ 24)

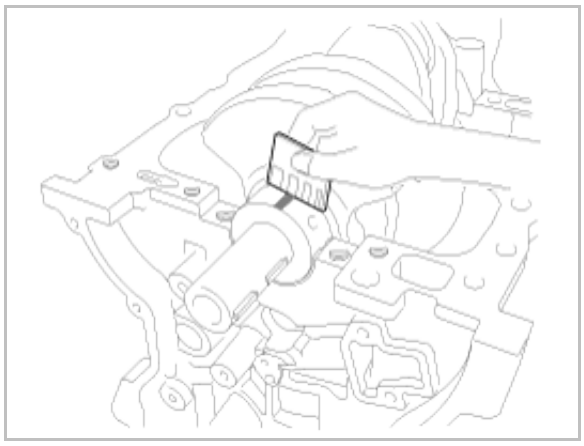


NOTE

Do not turn the crankshaft.

(5) Remove the cap and bearing again, and measure the widest part of the plastigage.

Standard oil clearance
0.022 ~ 0.040mm (0.0009 ~ 0.0016in.)



(6) If the plastigage measures too wide or too narrow, remove the upper half of the bearing, install a new, complete bearing with the same color mark (select the color as shown in the next column), and recheck the clearance.

CAUTION

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

(7) If the plastigage shows the clearance is still incorrect, try the next larger or smaller bearing (the color listed above or below that one), and check clearance again.

NOTE

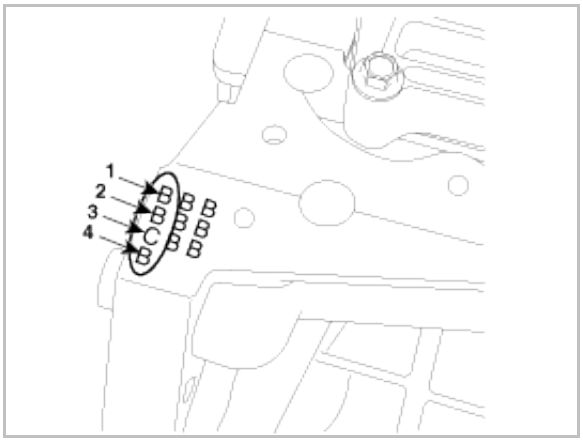
If the proper clearance cannot be obtained by using the appropriate larger or smaller bearings, replace the crankshaft and start over.

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.

Crankshaft bore mark location

Letters have been stamped on the block as a mark for the size of each of the 4 main journal bores.
Use them, and the numbers or bar stamped on the crank (marks for main journal size), to choose the correct bearings.

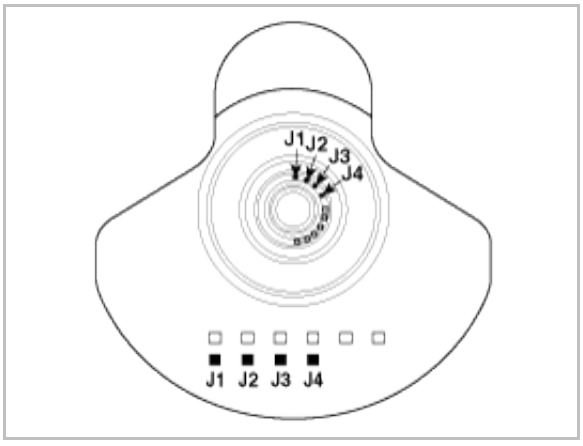


Discrimination Of Cylinder Block

Class	Mark	Inside Diameter
a	A	73.500 ~ 73.506mm (2.8937 ~ 2.8939in.)
b	B	73.506 ~ 73.512mm (2.8939 ~ 2.8942in.)
c	C	73.512 ~ 73.518mm (2.8942 ~ 2.8944in.)

Crankshaft Journal Mark Location

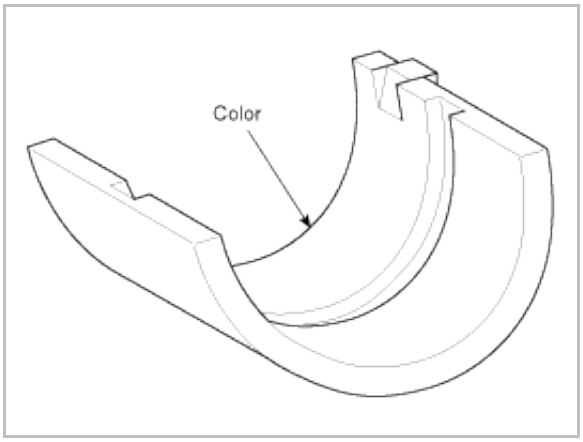
Discrimination Of Crankshaft



Discrimination Of Crankshaft

Class	Mark	Outside Diameter Of Journal
I	1 or A	68.954 ~ 68.960mm (2.7147 ~ 2.7150in.)
II	2 or B	68.948 ~ 68.954mm (2.7145 ~ 2.7147in.)
III	3 or C	68.942 ~ 68.948mm (2.7142 ~ 2.7145in.)

Place Of Identification Mark (Crankshaft Bearing)



Discrimination Of Crankshaft Bearing

Class	Mark	Thickness Of Bearing
E	Blue	2.277 ~ 2.280mm (0.0896 ~ 0.0897in.)
D	Black	2.274 ~ 2.277mm (0.0895 ~ 0.0896in.)
C	Brown	2.271 ~ 2.274mm (0.0894 ~ 0.0895in.)
B	Green	2.268 ~ 2.271mm (0.0893 ~ 0.0894in.)
A	Yellow	2.265 ~ 2.268mm (0.0892 ~ 0.0893in.)

Selection

Crankshaft Main Bearing		Crankshaft Bore Identification Mark		
		a(A)	b(B)	c(C)
Crankshaft Identification Mark	1 or A	A (Yellow)	B (Green)	C (Brown)
	2 or B	B (Green)	C (Brown)	D (Black)
	3 or C	C (Brown)	D (Black)	E (Blue)

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

Standard end play
0.10 ~ 0.28mm (0.0039 ~ 0.0110in.)

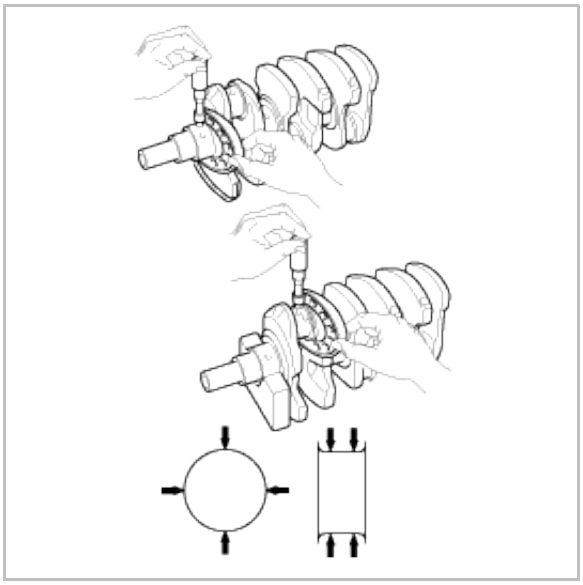
If the end play is greater than maximum, replace the thrust bearings as a set.

Thrust bearing thickness
2.41 ~ 2.45mm(0.0949 ~ 0.0964in.)

6. Inspect main journals and crank pins

Using a micrometer, measure the diameter of each main journal and crank pin.

Main journal diameter :
68.942 ~ 68.960mm (2.7142 ~ 2.7149in.)
Crank pin diameter :
54.954 ~ 54.972mm (2.1635 ~ 2.1642in.)



Connecting Rods

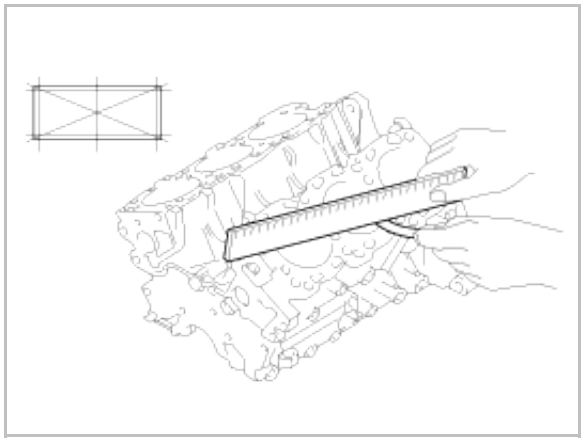
1. When reinstalling, make sure that cylinder numbers put on the connecting rod and cap at disassembly match. When a new connecting rod is installed, make sure that the notches for holding the bearing in place are on the same side.
2. Replace the connecting rod if it is damaged on the thrust faces at either end. Also 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 (0.0020 in./3.94 in.) or less
Allowable twist of connecting rod :
0.1mm / 100mm (0.0039 in./3.94 in.) or less

Cylinder Block

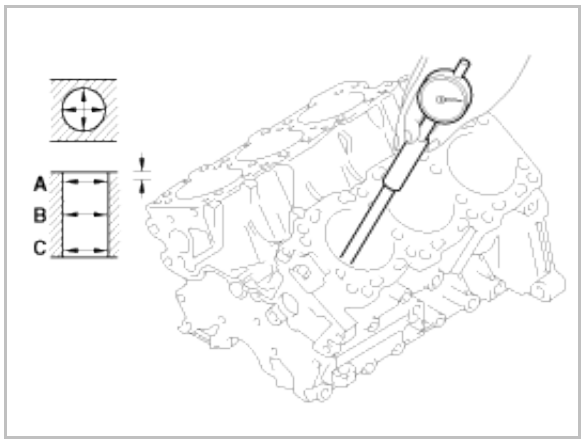
1. Remove the gasket material.
   Using a gasket scraper, remove all the gasket material from the top surface of the cylinder block.
2. Clean the cylinder block
   Using a soft brush and solvent, thoroughly clean the cylinder block.
3. Inspect the top surface of the cylinder block for flatness.
   Using 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(0.0020 in.),
Less than 0.02mm(0.0008in.) / 150 x 150

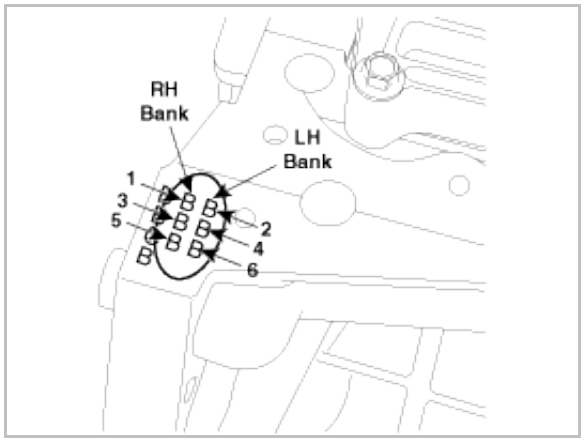


4. Inspect cylinder bore diameter
   Visually check the cylinder for vertical scratchs.
   If deep scratches are present, replace the cylinder block.
5. Inspect cylinder bore diameter
   Using a cylinder bore gauge, measure the cylinder bore diameter at position in the thrust and axial directions.

Standard diameter
96.00 ~ 96.03mm (3.7795 ~ 3.7807in.)



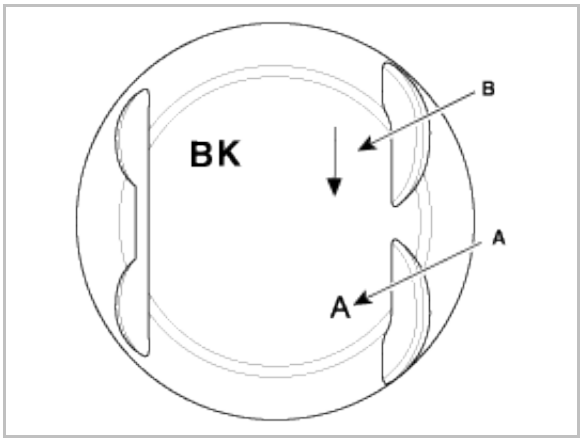
6. Check the cylinder bore size code on the cylinder block.



Class	Size code	Cylinder bore inner diameter
A	A	96.00~96.01mm (3.7795~3.7799in.)
B	B	96.01~96.02mm (3.7799~3.7803in.)

C	C	96.02~96.03mm (3.7803~3.7807in.)

7. Check the "BK" mark, the piston size code(A) and the front mark(B) on the piston top face.



Class	Size code	Piston outer diameter
A	A	95.96~95.97mm (3.7779~3.7783in.)
B	B	95.97~95.98mm (3.7783~3.7787in.)
C	C	95.98~95.99mm (3.7787~3.7791in.)

8. Select the piston related to cylinder bore class.

Clearance : 0.03 ~ 0.05mm(0.0012 ~ 0.0020in.)

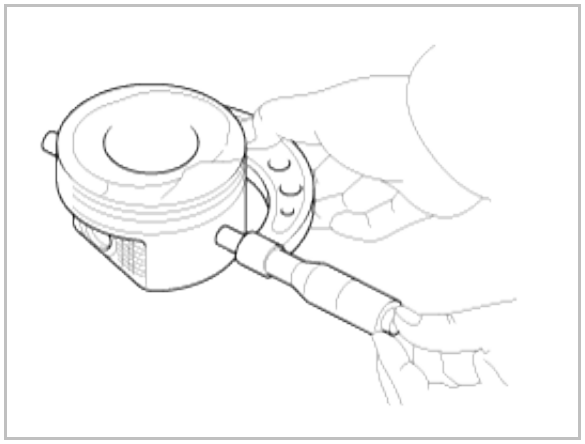
Piston And Rings

1. Clean piston
   (1) Using a gasket scraper, remove the carbon from the piston top.
   (2) Using a groove cleaning tool, 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 16 mm (0.6299 in.) from the bottom of the piston.

Standard diameter
95.96 ~ 95.99mm (3.7779 ~ 3.7791in.)

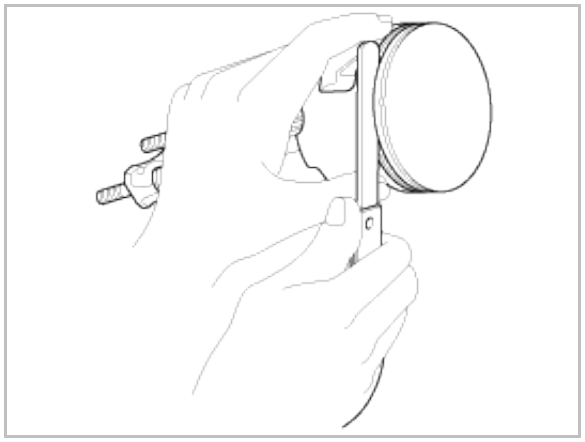


3. Calculate the difference between the cylinder bore diameter and the piston diameter.

Piston-to-cylinder clearance
0.03 ~ 0.05mm (0.0012 ~ 0.0020in.)

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

Piston ring side clearance
Standard
No.1 : 0.03 ~ 0.07mm (0.0012 ~ 0.0027in.)
No.2 : 0.03 ~ 0.07mm (0.0012 ~ 0.0027in.)
Oil ring : 0.06 ~ 0.15mm (0.0024 ~ 0.0059in.)
Limit
No.1 : 0.1mm (0.004in.)
No.2 : 0.1mm (0.004in.)
Oil ring : 0.2mm (0.008in.)

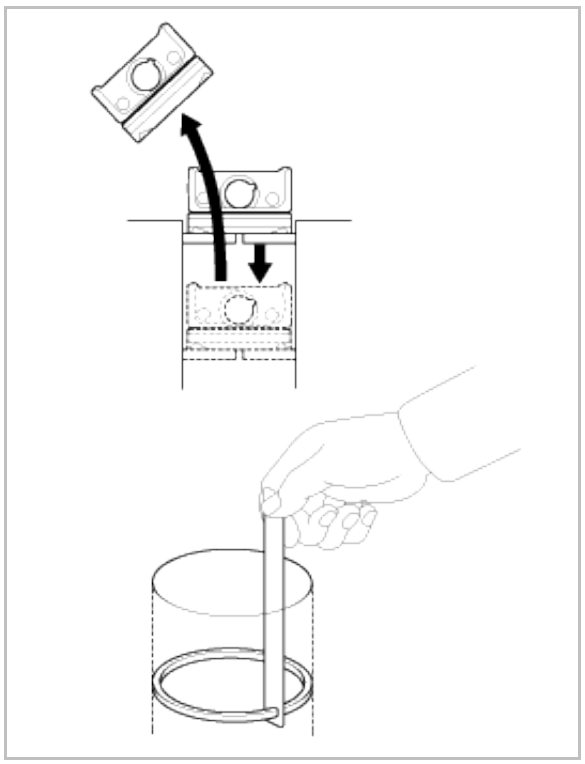


If the clearance is greater than maximum, replace the piston.

5. Inspect 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 ring. If the gap is too large, recheck the cylinder bore diameter against the wear limits. If the bore is over the service limit, the cylinder block must be replaced.

Piston ring end gap
Standard
No.1 : 0.17 ~ 0.32mm (0.0067 ~ 0.0126in.)
No.2 : 0.32 ~ 0.52mm (0.0126 ~ 0.0204in.)

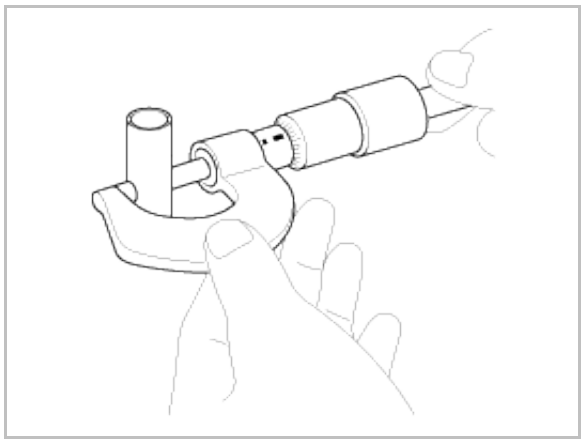
Oil ring : 0.20 ~ 0.70mm (0.0079 ~ 0.0275in.)
Limit
No.1 : 0.6mm (0.0236in.)
No.2 : 0.7mm (0.0275in.)
Oil ring : 0.8mm (0.0315in.)



Piston Pins

1. Measure the diameter of the piston pin.

Piston pin diameter
21.997 ~ 22.000mm (0.8660 ~ 0.8661in.)



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

Piston pin-to-piston clearance
0.004 ~ 0.013mm (0.00015 ~ 0.00051in.)

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

Piston pin-to-connecting rod interference

0.007 ~ 0.021mm (0.00027 ~ 0.00082in.)

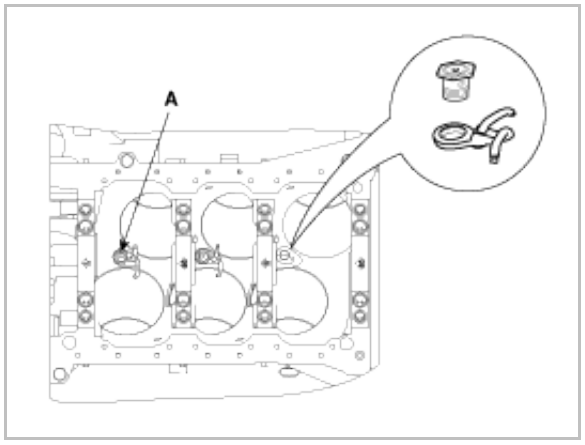
Reassembly

NOTE

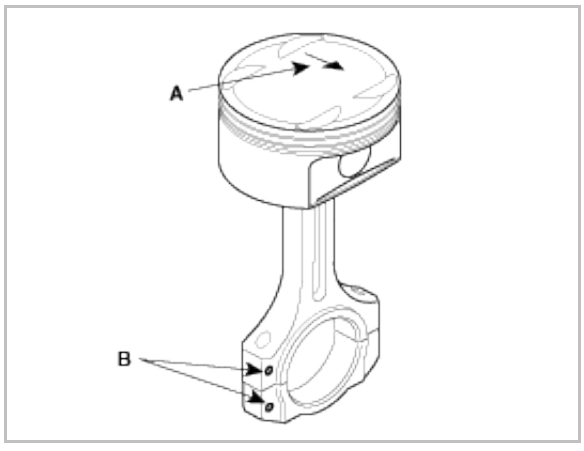
- Thoroughly clean all parts to be assembled.
- Before installing the parts, apply fresh engine oil to all sliding and rotating surfaces.
- Replace all gaskets, O-rings and oil seals with new parts.

1. Install the cooling jet (A).

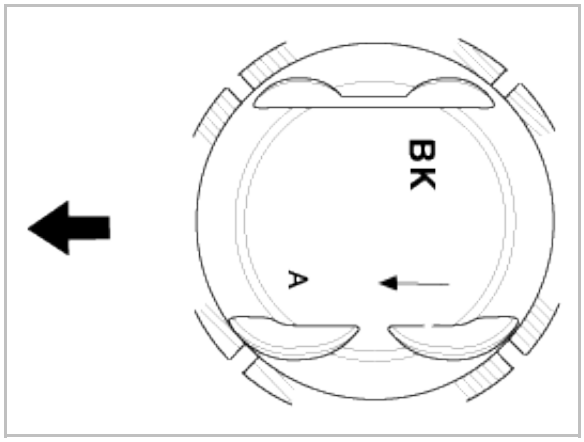
Tightening torque :
27.4~31.4N.m (2.8~3.2kgf.m, 20.2~23.1lb.ft)



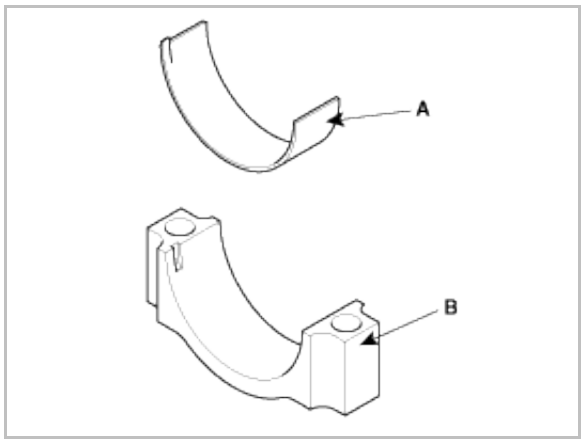
2. Assemble the piston and the connecting rod.
   (1) Use a hydraulic press for installation.
   (2) The piston front mark (A) and the connecting rod front mark (B) must face the timing belt side of the engine.



3. Install the piston rings.
   (1) Install the oil ring spacer 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.



4. Install the connecting rod bearings.
   (1) Align the bearing claw with the groove of the connecting rod or connecting rod cap.
   (2) Install the bearings(A) in the connecting rod and connecting rod cap(B).

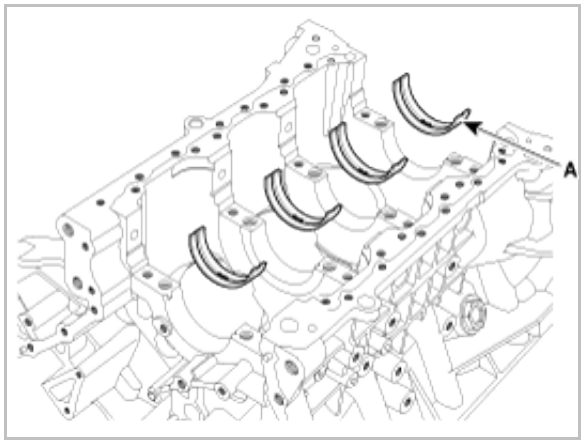


> **NOTE**
>
> When reassembling the connecting rods and the caps, ensure the front marks on them and the number of cylinder.

5. Install the main bearings.

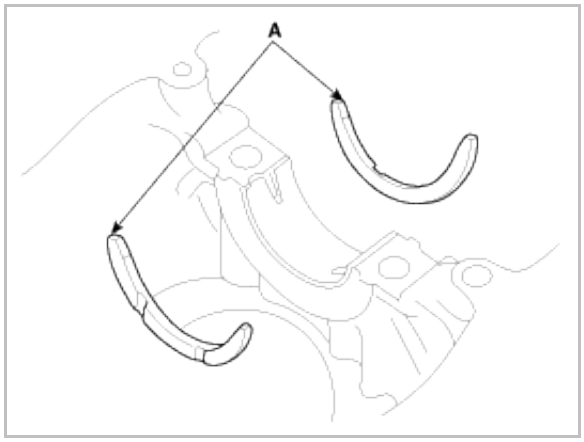
> **NOTE**
>
> Upper bearings have an oil groove of oil holes; Lower bearings do not.

   (1) Align the bearing claw with the claw groove of the cylinder block, push in the 4 upper bearings(A).

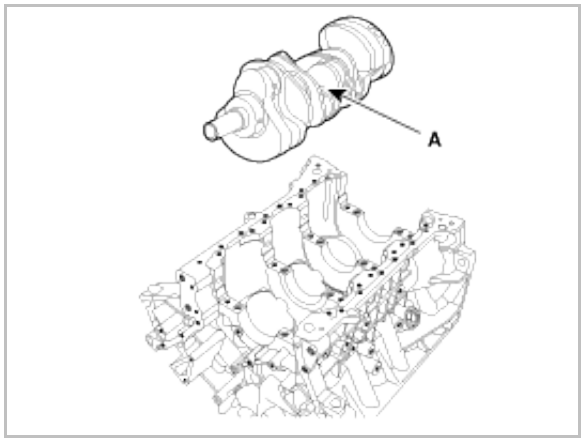


   (2) Align the bearing claw with the claw groove of the main bearing cap, and push in the 4 lower bearings.

6. Install the thrust bearings.
   Install the 2 thrust bearings(A) under the No.3 journal position of the cylinder block with the oil grooves facing outward.



7. Place the crankshaft(A) on the cylinder block.

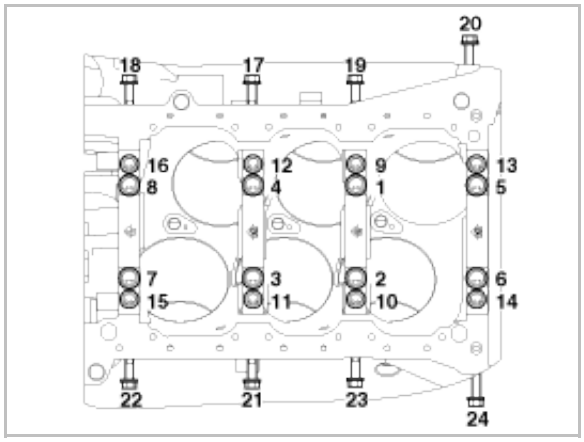


8. Place the main bearing caps on cylinder block.
9. Install the main bearing cap bolts.
   (1) Install and uniformly tighten the bearing cap bolts, in several passes, in the sequence shown.

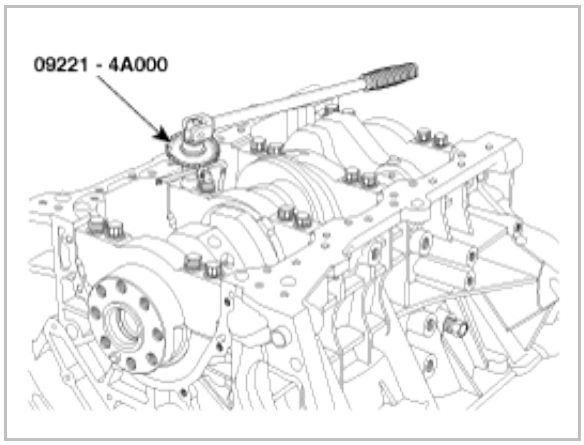
Tightening torque
Main bearing cap bolt
49.0N.m (5.0 kgf.m, 36.2lb-ft) + 90° (1 ~ 8)
19.6N.m (2.0 kgf.m, 14.5lb-ft) + 120° (9 ~ 16)
29.4 ~ 31.4N.m (3.0 ~ 3.2 kgf.m, 21.7 ~ 23.1lb-ft) (17 ~ 24)

NOTE

- Always use new main bearing cap bolts.
- If any of the side bearing cap bolts are broken or deformed, replace it.



Use the SST(09221-4A000), install main bearing cap bolts.



(2) Check that the crankshaft turns smoothly.

10. Check crankshaft end play.
11. Install the piston and connecting rod assemblies.

NOTE

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

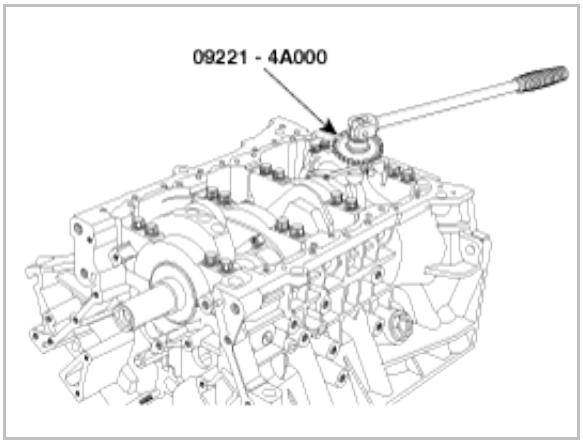
(1) Install the ring compressor, check that the bearing is securely in place, then position the piston in the cylinder, and tap it in using the wooden handle of a hammer.

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

(3) Apply engine oil to the bolt threads. Install the rod caps with bearings, and torque the bolts.

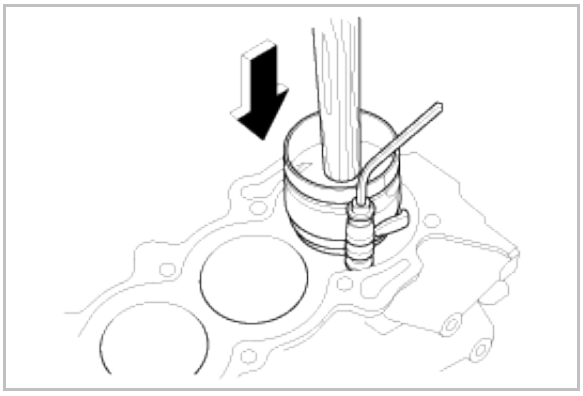
Tightening torque
22.6~26.5Nm (2.3~2.7kgf.m, 16.6~19.5lb-ft) + 98~102°

Use SST(09221-4A000), install connecting rod bearing cap bolts.



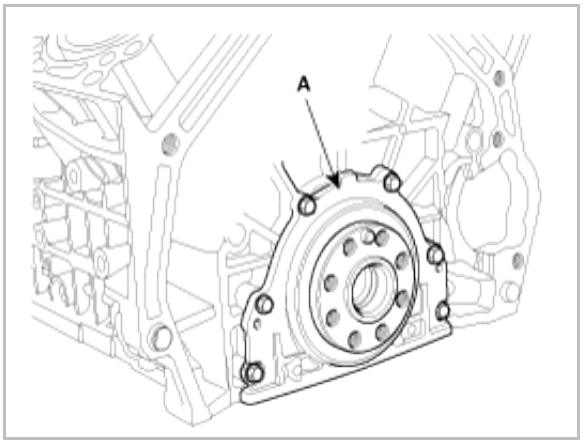
NOTE

- Always use new connecting rod bearing cap bolts.
- Maintain downward force on the ring compressor to prevent the rings from expanding before entering the cylinder bore.



12. Check the connecting rod end play.
13. Install the rear oil seal case(A).

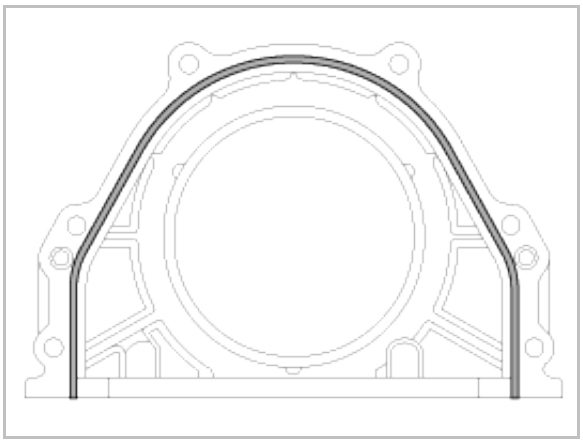
Tightening torque
9.8 ~ 11.8Nm (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)



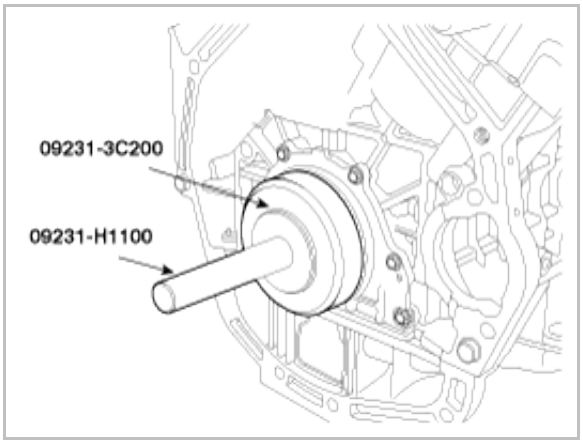
NOTE

- Clean the sealing face before assembling two parts.
- Remove harmful foreign materials on the sealing face before applying sealant
- Before assembling rear oil seal case, the liquid sealant TB1217H should be applied to the rear oil seal

case.
- The part must be assembled within 5 minutes after sealant was applied.
- Apply sealant to the inner threads of the bolt holes.

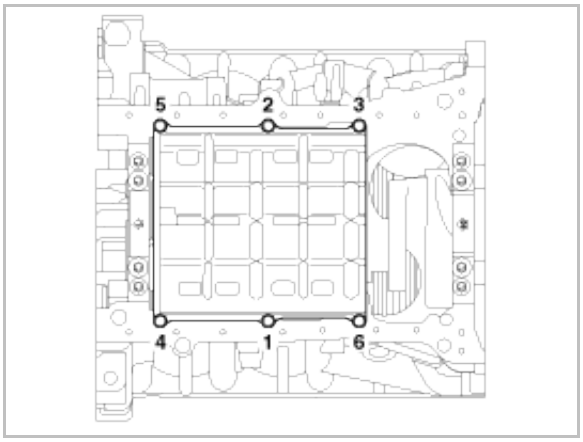


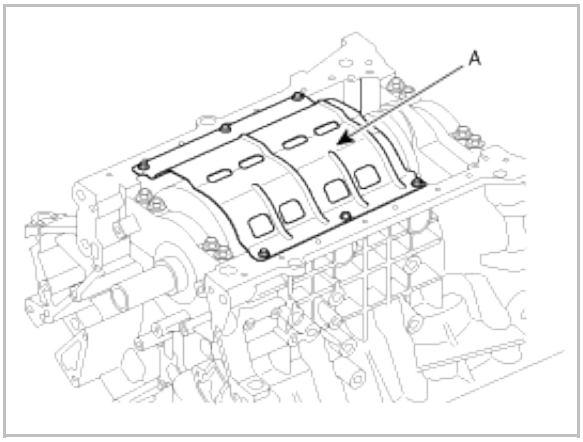
14. Using the SST(09231-3C200, 09231-H1100), install rear oil seal.



15. Install the baffle plate.
Install and uniformly tighten the baffle plate bolts, in several passes, in the sequence shown.

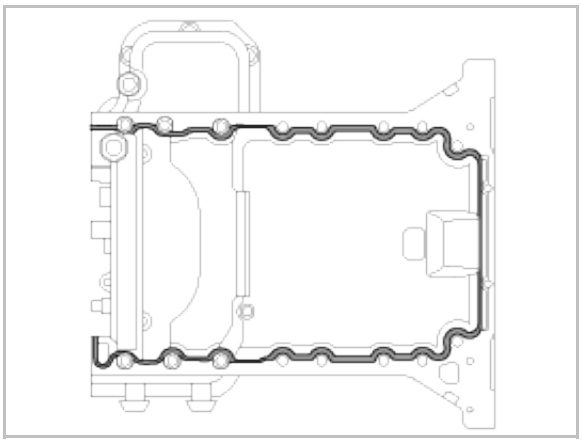
Tightening torque
9.8 ~ 11.8Nm (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)





16. Install the upper oil pan.
    A. Using a gasket scraper, remove all the old packing material from the gasket surfaces.
    B. Before assembling the oil pan, the liquid sealant TB1217H should be applied on upper oil pan.
    The part must be assembled within 5 minutes after the sealant was applied.

Bead width : 2.5mm(0.1in.)

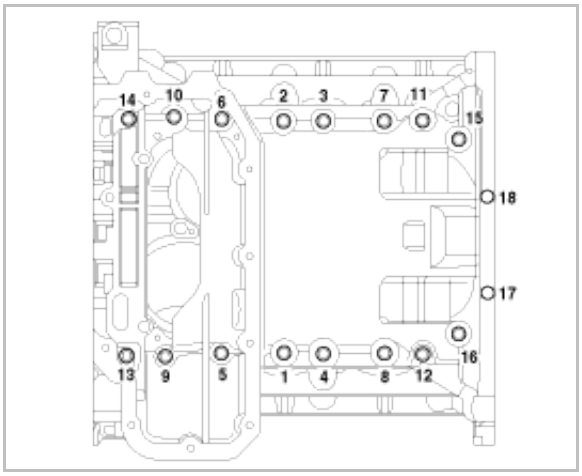


NOTE

- Clean the sealing face before assembling two parts.
- Remove harmful foreign materials on the sealing face before applying sealant
- When applying sealant gasket, sealant must not protrude into the inside of oil pan.
- To prevent leakage of oil, apply sealant gasket to the inner threads of the bolt holes.

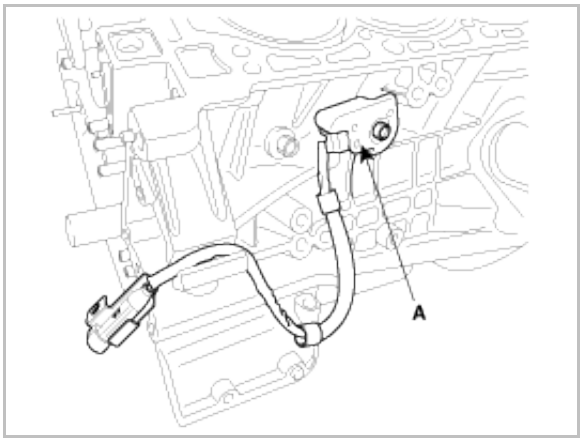
    C. Install the upper oil pan.
    Uniformly tighten the bolts in several passes.

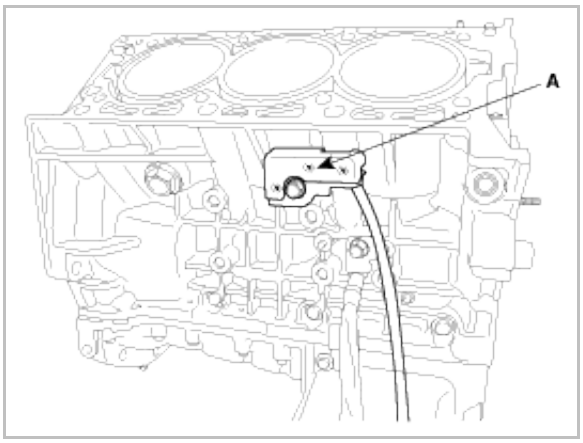
Tightening torque
9.8 ~ 11.8Nm (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)



17. Install the knock sensors (A).

Tightening torque
15.7 ~ 23.5Nm (1.6 ~ 2.4kgf.m, 11.6 ~ 17.3lb-ft)





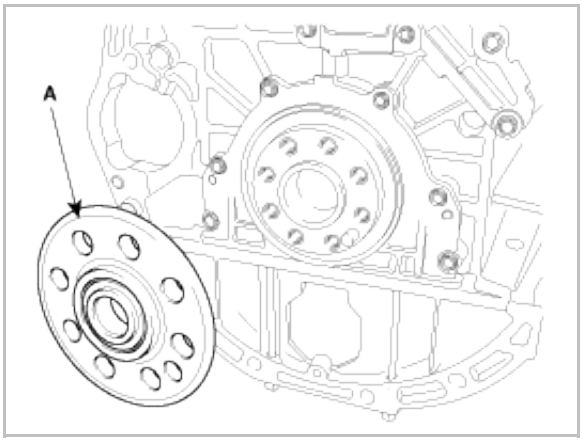
18. Install the DMF. (MT only)

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

NOTE

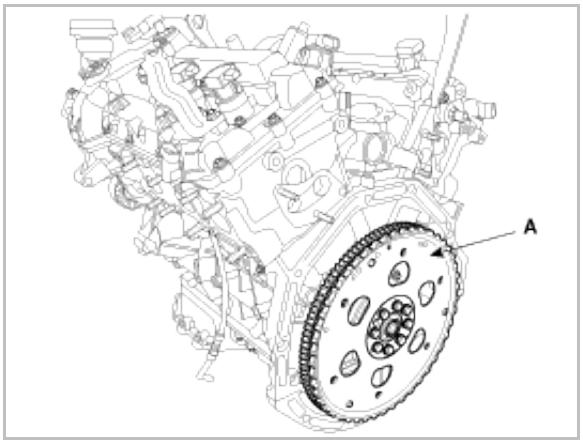
A from of "★" socket (12-gon) is needed to install the DMF bolt.

19. Install the crankshaft adapter (A). (AT only)



20. Install the drive plate (A). (AT only)

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



21. Install the oil filter assembly. (Refer to Lubrication system in this group)
22. Install the oil pump. (Refer to Lubrication system in this group)
23. Install the cylinder heads. (Refer to Cylinder head in this group)
24. Install the water temperature control assembly. (Refer to Cooling system in this group)
25. Install the timing chains. (Refer to Timing system in this group)
26. Install the intake manifold and exhaust manifolds. (Refer to Intake and exhaust system in this group)
27. Install the engine assembly to the vehicle. (Refer to Engine and transmission assembly in this group)

Engine Mechanical System > Cooling System > Coolant > Repair procedures

Replacement And Air Bleeding

CAUTION

Never remove the radiator cap when the engine is hot. Serious scalding could be caused by hot fluid under high pressure escaping from the radiator.

NOTE

When pouring engine coolant, be sure to shut the relay box lid and not to let coolant spill on the electrical parts or the paint. If any coolant spills, rinse it off immediately.

1. Make sure the engine and radiator are cool to the touch.
2. Remove the radiator cap.
3. Loosen the drain plug, and drain the coolant.
4. Tighten the radiator drain plug securely.
5. Remove, drain and reinstall the reservoir. Fill the tank halfway to the MAX mark with water, then up to the MAX mark with antifreeze.
6. Fill the radiator with water through the radiator cap and tighten the cap.

> **NOTE**
>
> To most effectively bleed the air, pour the water slowly and press on the upper / lower radiator hoses.

7. Start the engine and allow to come to normal operating temperature. Wait for the cooling fans to turn on several times. Accelerate the engine to aid in purging trapped air. Shut engine off.
8. Wait until the engine is cool.
9. Repeat steps 1 to 8 until the drained water runs clear.
10. Fill fluid mixture with coolant and water(5 : 5) (Tropical region – 4:6) slowly through the radiator cap. Push the upper/lower hoses of the radiator so as bleed air easily.

> **NOTE**
>
> - Use only genuine antifreeze/coolant.
> - For best corrosion protection, the coolant concentration must be maintained year-round at 35% minimum. Coolant concentrations less than 35% may not provide sufficient protection against corrosion or freezing.
> - Coolant concentrations greater then 60% will impair cooling efficiency and are not recommended.

> **CAUTION**
>
> - Do not mix different brands of antifreeze/coolants.
> - Do not use additional rust inhibitors or antirust products; they may not be compatible with the coolant.

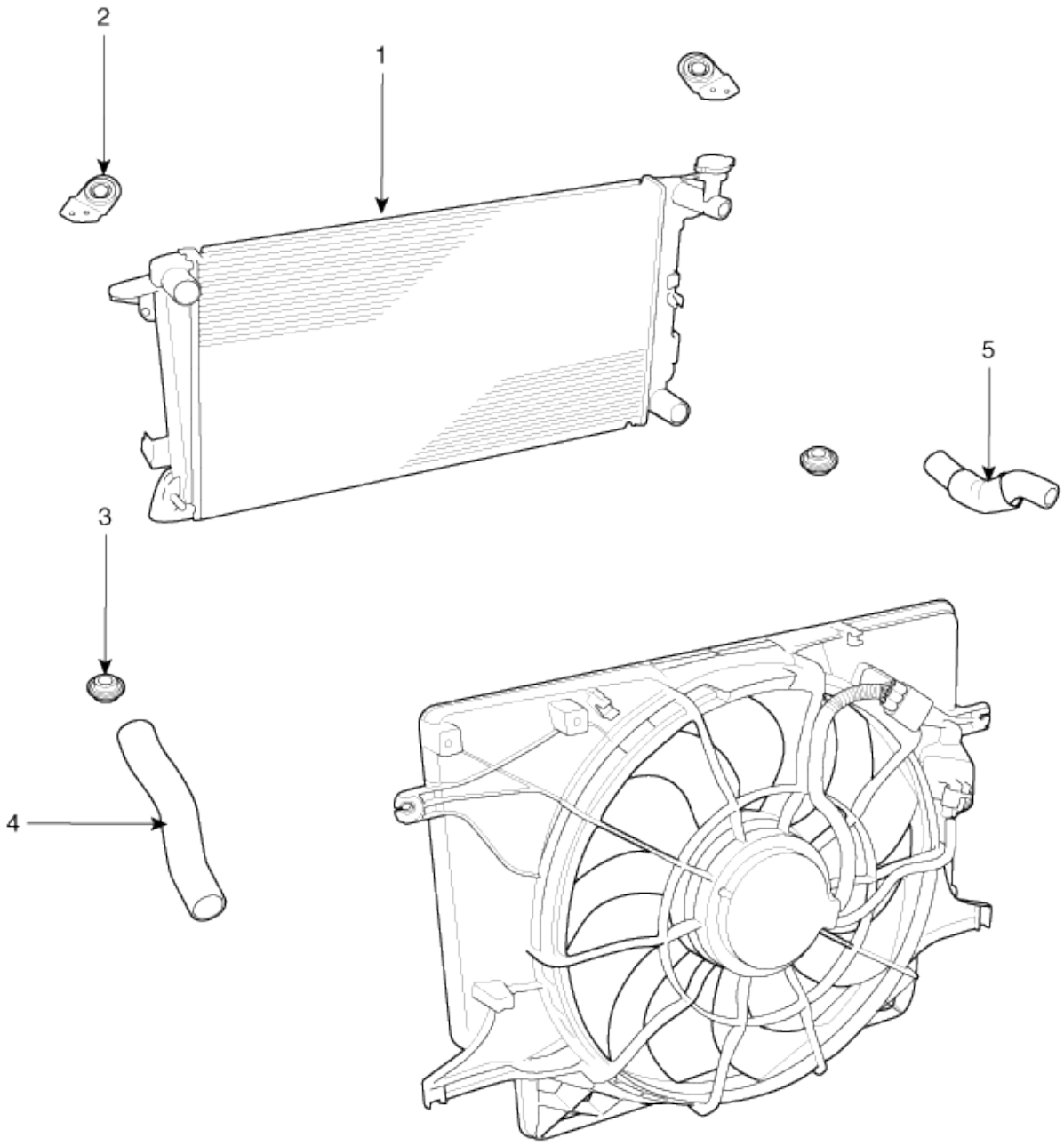
11. Start the engine and run coolant circulates.
12. When the cooling fan operates and coolant circulates, refill coolant through the radiator cap.
13. Repeat step.11 until the cooling fan 3 ~ 5times and bleed air sufficiently out of the cooling system.
14. Install the radiator cap and fill the reservoir tank to the "MAX" line with coolant.
15. Run the vehicle under idle until the cooling fan operates 2 ~ 3 times.
16. Stop the engine and wait coolant gets cool.
17. Repeat 10 to 15 until the coolant level doesn't fall any more, bleed air out of the cooling system.

> **NOTE**
>
> As it is to bleed air out to the cooling system and refill coolant when coolant gets cool completely, recheck the coolant level in the reservoir tank for 2 ~ 3 days after replacing coolant.

Coolant capacity :
9.0L (9.5Us.qts, 7.9Imp.qts)

Engine Mechanical System > Cooling System > Radiator > Components and Components Location

Components



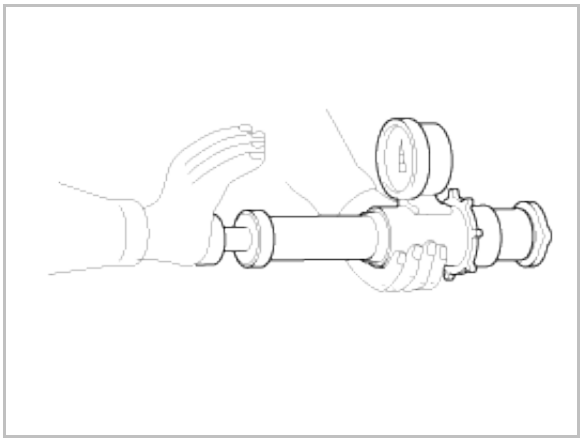
1. Radiator assembly 2. Radiator upper mounting bracket 3. Lower mounting insulator	4. Radiator upper hose 5. Radiator lower hose

Engine Mechanical System > Cooling System > Radiator > Repair procedures

Inspection

Cap Testing

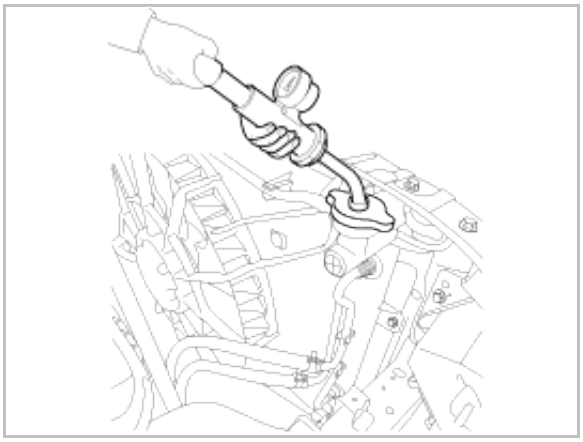
1. Remove the radiator cap, wet its seal with engine coolant, then install it to pressure tester.



2. Apply a pressure of 93 ~ 123kPa (0.95 ~ 1.25kgf/cm², 14 ~ 19psi).
3. Check for a drop in pressure.
4. If the pressure drops, replace the cap.

Radiator Leakage

1. Wait until engine is cool, then carefully remove the radiator cap and fill the radiator with engine coolant, then install a pressure tester on it.



2. Apply a pressure of 93 ~ 123kPa (0.95 ~ 1.25kgf/cm², 14 ~ 19psi).
3. Inspect for engine coolant leaks and a drop in pressure.
4. If the pressure drops, check hoses, the radiator and the water pump for leakage. If there is no leakage, inspect the heater core, the cylinder block and the cylinder head.
5. Remove the tester and reinstall the radiator cap.

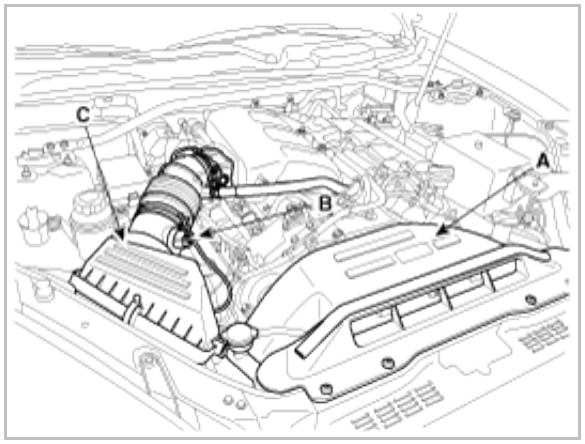
> **NOTE**
>
> Check for engine oil in coolant and/or coolant in engine oil.

Removal

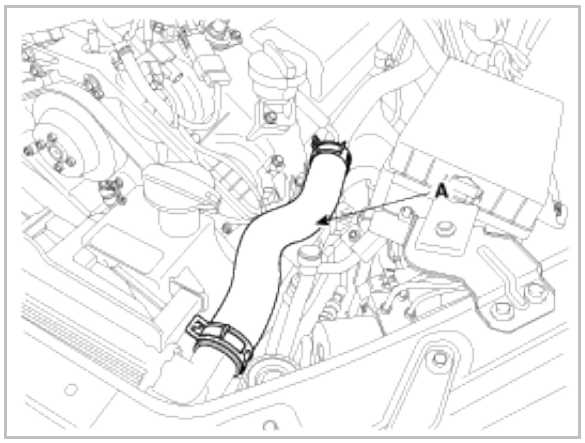
1. Disconnect the battery negative cable
2. Loosen the drain plug and drain the engine coolant.
3. Remove the air duct (A).

4. Remove the air cleaner assembly (C) after removing the AFS connector (B).

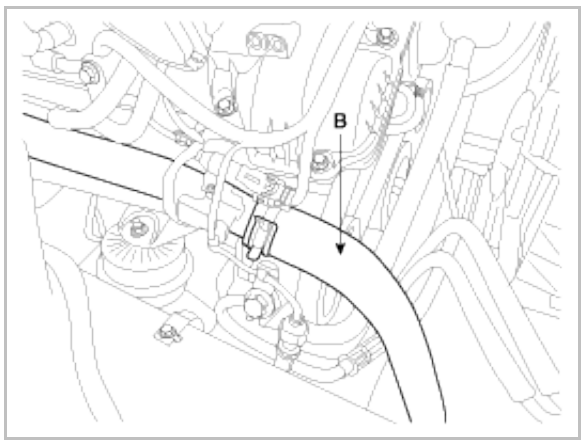
Tightening torque :
Bolt : 7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)
Clamp : 2.9 ~ 4.9N.m (0.3 ~ 0.5kgf.m, 2.2 ~ 3.6lb-ft)



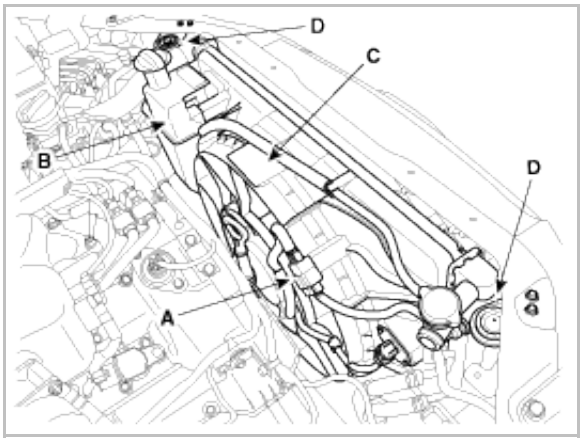
5. Remove the radiator upper hose (A).



6. Remove the radiator lower hose (A).



7. Remove the radiator.
   (1) Remove the cooling fan connector (A).
   (2) Remove the reservoir tank (B).
   (3) Remove the fan assembly (C).
   (4) Remove the radiator upper mounting bracket and radiator from the vehicle.

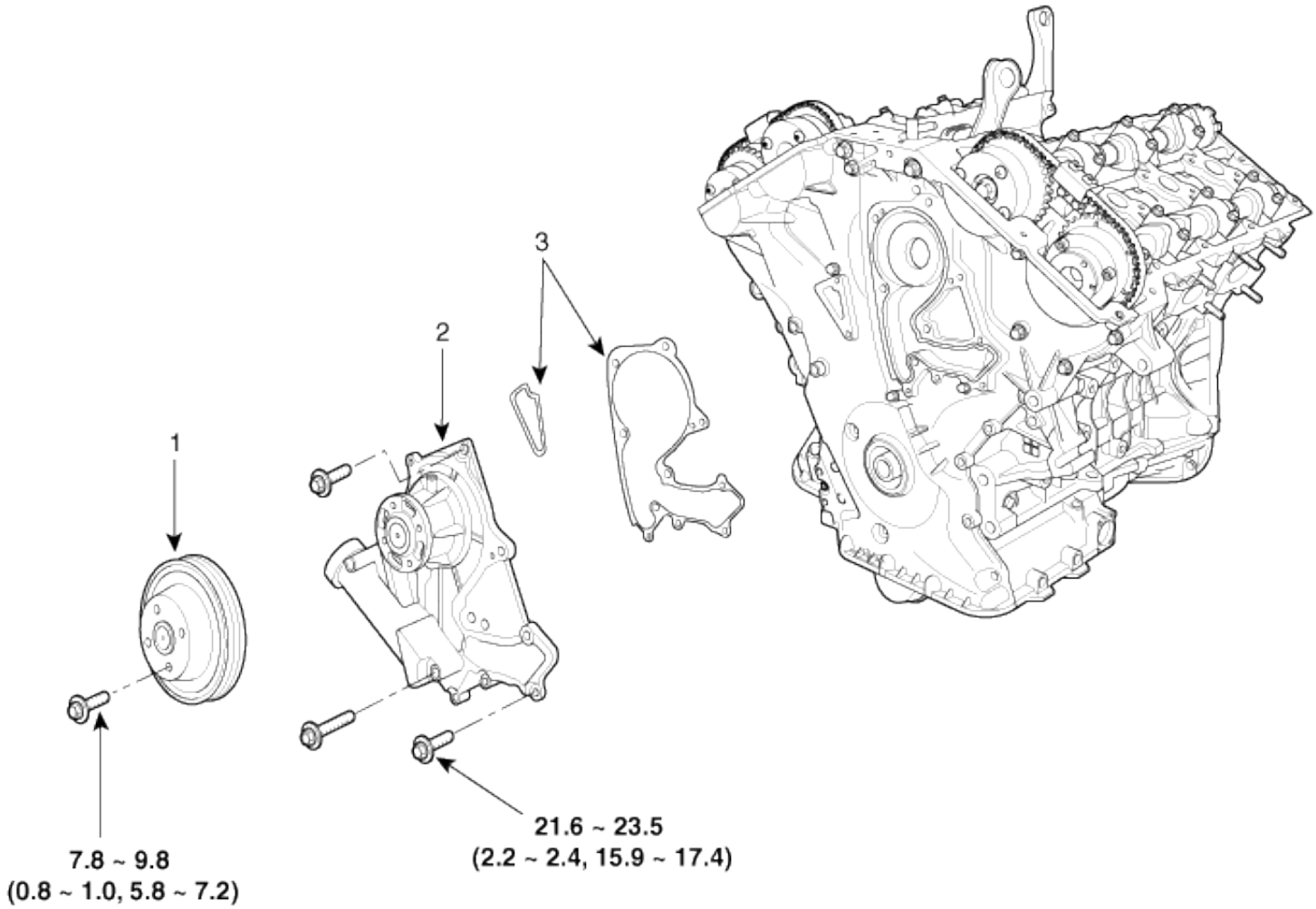


Installation

1. Installation is reverse order of removal.
2. Connect the fan motor connector.
3. Install the radiator upper hose & lower hose, and connect the ATF cooler hoses.
4. Fill the radiator with coolant and check for leaks.

Engine Mechanical System > Cooling System > Water pump > Components and Components Location

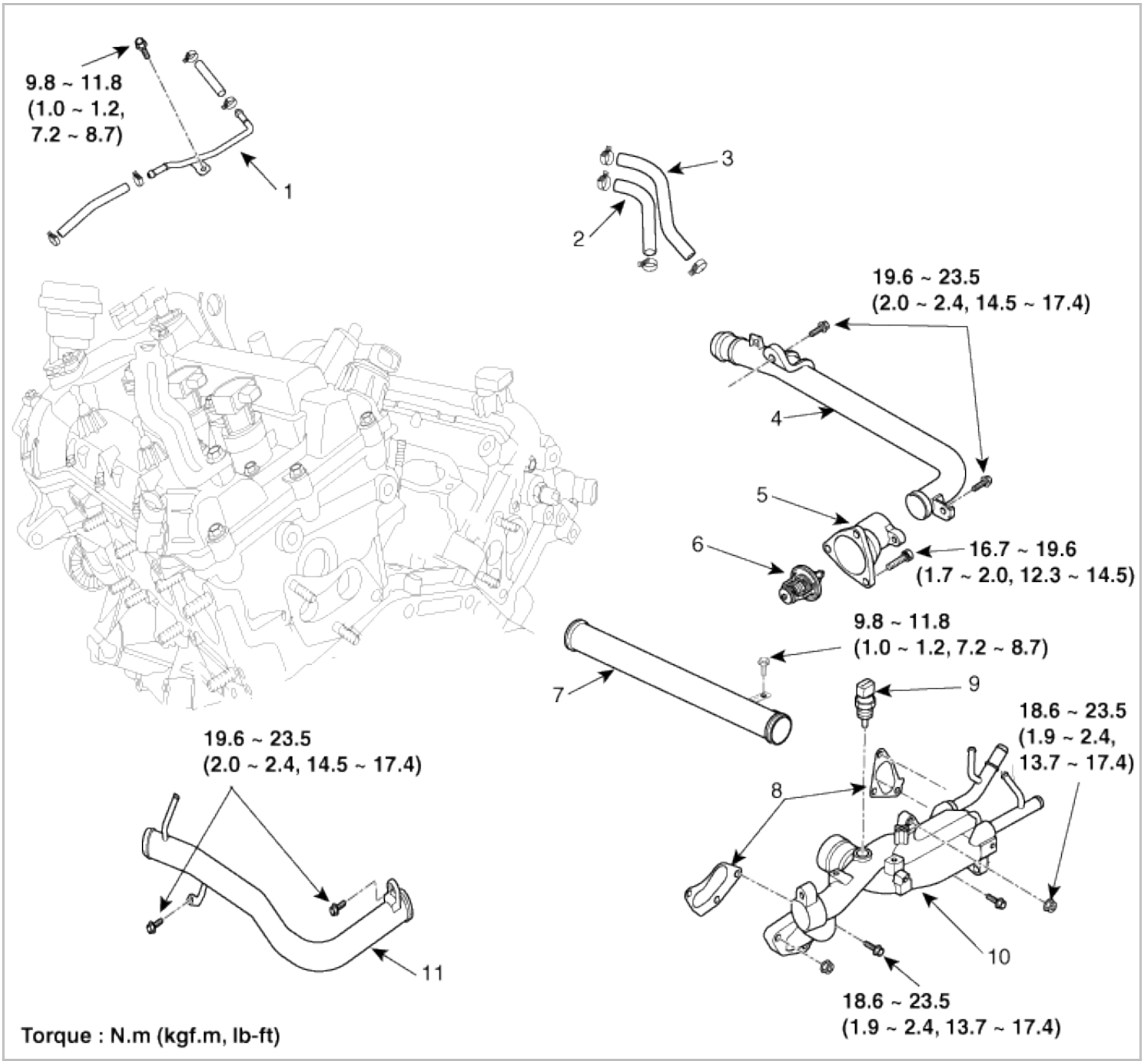
Components



Torque : N.m (kgf.m, lb-ft)

1. Water pump pulley 2. Water pump	3. Water pump gasket

Water Temperature Control Assembly



1. Water vent hose & pipe	7. Center pipe
2. Throttle body coolant hose A	8. Gasket
3. Throttle body coolant hose B	9. Water temperature sensor (ECT)
4. RH coolant pipe	10. Water temperature control assembly
5. Coolant inlet parting	11. LH coolant pipe
6. Thermostat	

Engine Mechanical System > Cooling System > Water pump > Repair procedures

Removal

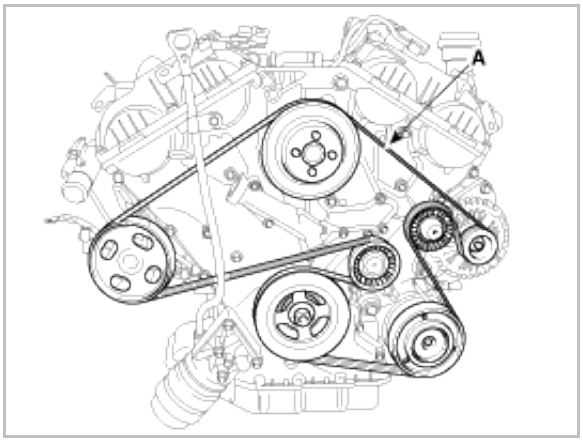
Water Pump

1. Loosen the drain plug, and drain the engine coolant.

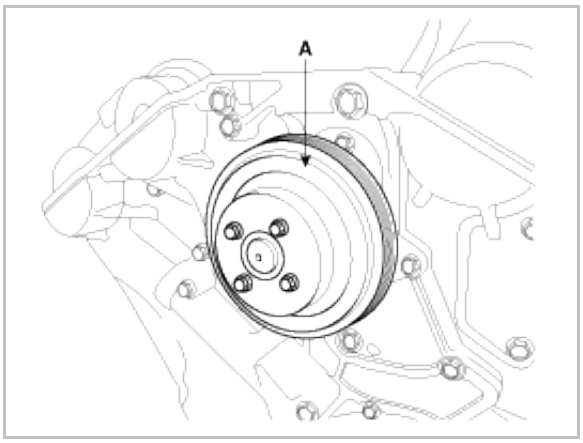
CAUTION

Never remove the radiator cap when the engine is hot. Serious scalding could be caused by hot fluid under high pressure escaping from the radiator.

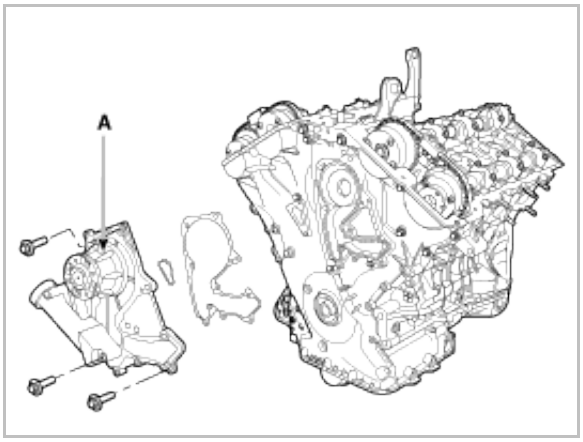
2. Remove the drive belt (A).



3. Remove the water pump pulley (A).

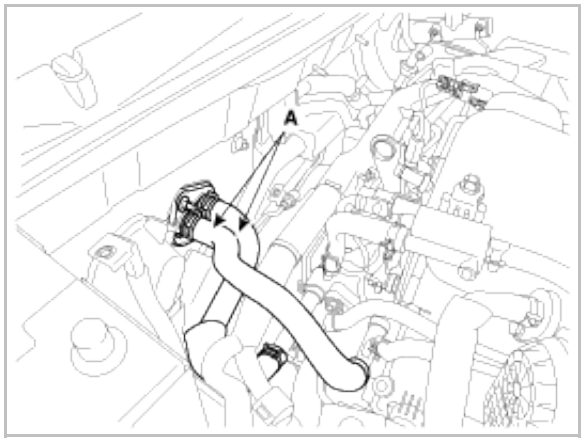


4. Remove the water pump (A).

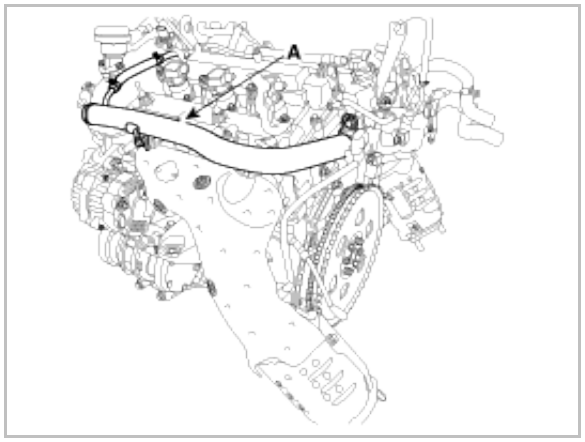


Water Temperature Control Assembly

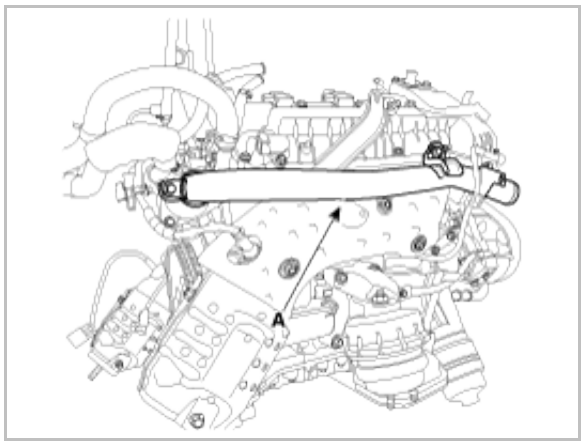
1. Disconnect the heater hoses (A).



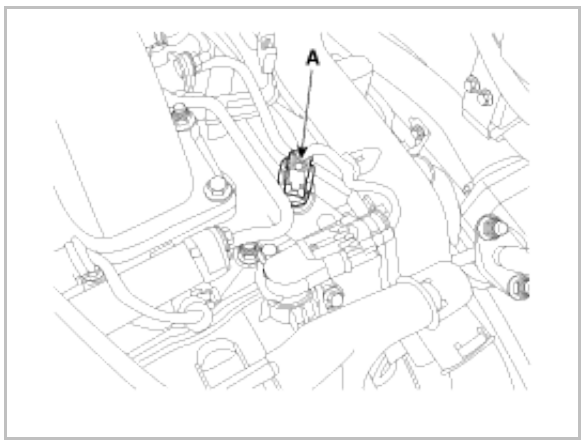
2. Remove the LH side coolant pipe (A) and hose.



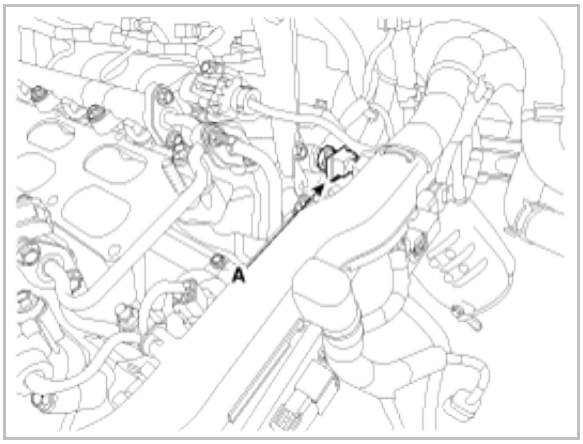
3. Remove the RH side coolant pipe (A).



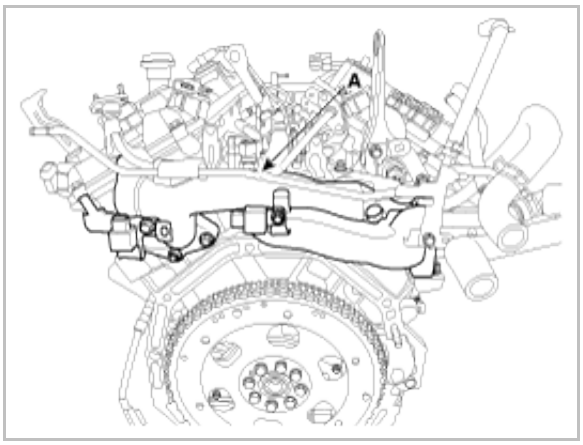
4. Remove the water temperature sensor connector (A).



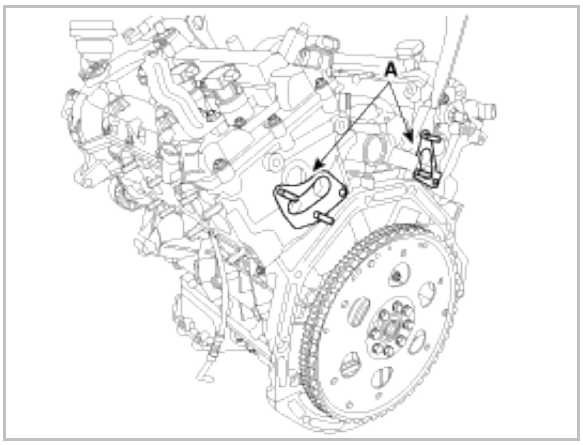
5. Remove the oil temperature sensor connector (A).



6. Remove the water temperature control assembly (A).



7. Remove the water temperature control assembly gaskets (A).



8. Install the water temperature control assembly with new gaskets.
   Installation is reverse order of removal.

Engine Mechanical System > Cooling System > Water pump > Troubleshooting

Troubleshooting

Symptoms		Possible Causes		Remedy
Coolant leakage	• From the bleed hole of the water pump	Visually check	• Check leaks after about ten-minute warming up.	• If coolant still leaks, replace a water pump. • If leakage stops, reuse the

				water pump (Do not replace the pump with a new one).
	• From gaskets or bolts		• Check the tightening of the water pump mounting bolts.	• Retighten the mounting bolts.
			• Check damage of gaskets or inflow of dust.	• Replace the gasket and clean dust off.
	• From outer surface of water pump		• Check the material or any cracks of the water pump.	• Poor material. If any crack found, replace the water pump.
Noise	• From bearings • From mechanical seals • Impeller interference	Inspection with a stethoscope	• After starting the engine, check noise with a stethoscope.	• If there is no noise, reuse the water pump(do not replace it).
				• If there is any noise from the water pump, remove the drive belt and recheck.
		Inspection after removing a drive belt	• After removing a water pump and a drive belt, check noise again.	• If there is noise, reuse the water pump. Check other drive line parts.
				• If there is no noise, replace the water pump with a new one.
		Inspection after removing a water pump	• After removing a water pump and a drive belt, check noise again.	• If there is any interference between them, replace the water pump with a new one.
Overheating	• Damaged impeller • Loosened impeller	Loosened impeller	• Corrosion of the impeller wing	• Check engine coolant. • Poor coolant quality / Maintenance check
			• Impeller seperation from the shaft	• Replace the water pump.

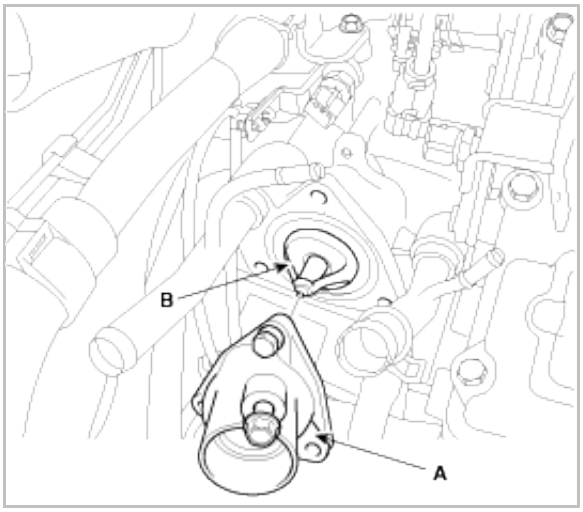
Engine Mechanical System > Cooling System > Thermostat > Repair procedures

Removal

NOTE

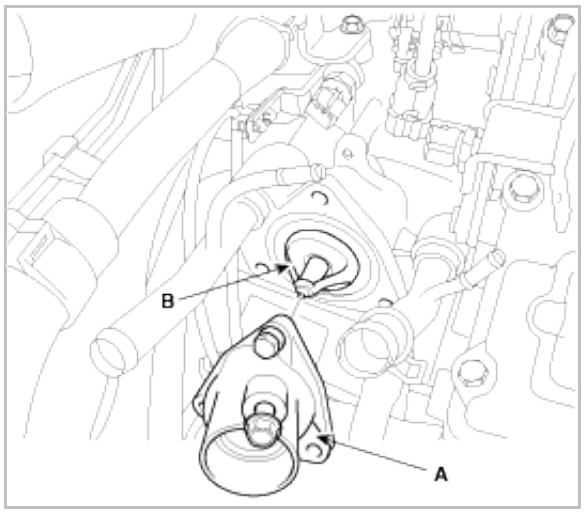
Removal of the thermostat would have an adverse effect, causing a lowering of cooling efficiency. Do not remove the thermostat, even if the engine tends to overheat.

1. Drain engine coolant so its level is below thermostat.
2. Remove the water inlet fitting (A) and the thermostat (B).



Installation

1. Place the thermostat in thermostat housing.
   (1) Install the thermostat with the jiggle valve upward.
   (2) Install a new thermostat (B).



2. Install the water inlet fitting (A).

Tightening torque :
16.7 ~ 19.6N.m (1.7 ~ 2.0kgf.m, 12.3 ~ 14.5lb-ft)

3. Fill with engine coolant.
4. Start engine and check for leaks.

Engine Mechanical System > Cooling System > Thermostat > Troubleshooting

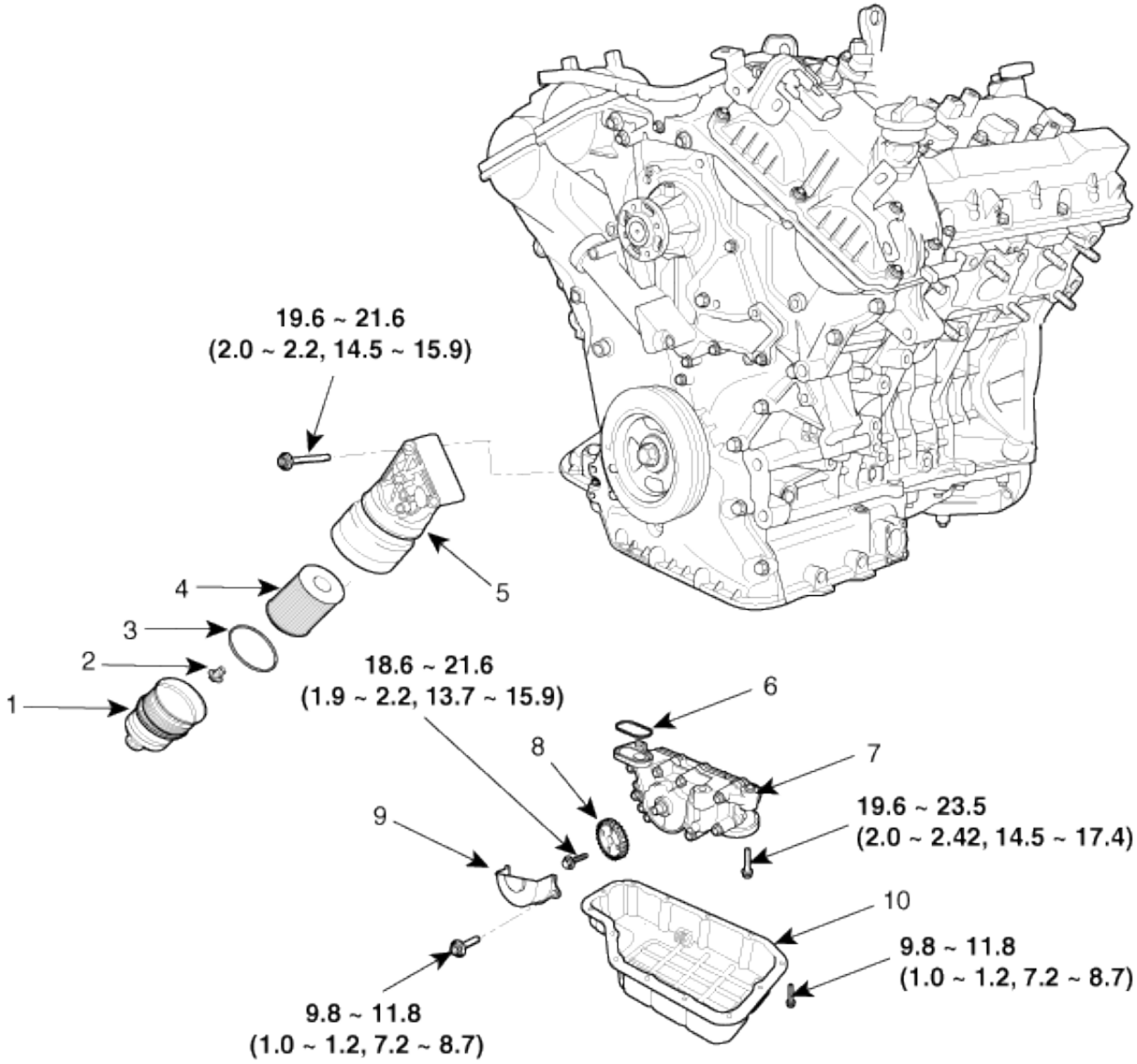
Troubleshooting

Symptoms		Possible Causes		Remedy
Coolant leakage	• From the thermostat gasket	Check the mounting bolts	• Check the torque of the mounting bolts	• Retighten the bolts and check leakage again.
		Check the gasket	• Check gasket or seal for	• Replace gaskets and

		for damage	damage	reuse the thermostat.
Cooled excessively	• Low heater performance (cool air blowed-out) • Thermogauge indicates 'LOW'	Visually check after removing the radiator cap.	• Insufficient coolant or leakage.	• After refilling coolant, recheck.
		GDS check & Starting engine	• Check DTCs • Check connection of the fan clutch or the fan motor. ※ If the fan clutch is always connected, there will be a noise at idle.	• Check the engine coolant sensor, wiring and connectors. • Replace the componants.
		Remove the thermostat and inspect	• Check if there are dusts or chips in the thermostat valve. • Check adherence of the thermostat.	• Clean the thermostat valve and reuse the thermostat. • Replace the thermostat, if it doesn't work properly.
Heated excessively	• Engine overheated • Thermogauge indicates 'HI'	Visually check after removing the radiator cap.	• Insufficient coolant or leakage. ※ Be careful when removing a radiator cap of the overheated vehicle. • Check air in cooling system.	• After refilling coolant, recheck. • Check the cylinder head gaskets for damage and the tightening torque of the mounting bolts.
		GDS check & Starting engine	• Check DTCs • Check the fan motor performance as temperature varies. • Check if the fan clutch slips. • Check the water pump adherence or impeller damaged.	• Check the engine coolant sensor, wiring and connectors. • Check the fan motor, the relay and the connector. • Replace the fan clutch, if it doesn't work properly. • Replace the water pump, if it doesn't work properly.
		Immerse the thermostat in boiling water and inspection.	• After removing the thermostat, check it works properly. ※ Check the thermostat opens at the valve opening temperature.	• Replace the thermostat, if it doesn't work properly.

Engine Mechanical System > Lubrication System > Oil Pump > Components and Components Location

Components



Torque : N.m (kgf.m, lb-ft)

1. Oil filter cap 2. Relief valve 3. O-ring 4. Oil filter element	5. Oil filter body 6. O-ring 7. Oil pump	8. Oil pump sprocket 9. Oil pump chain cover 10. Lower oil pan

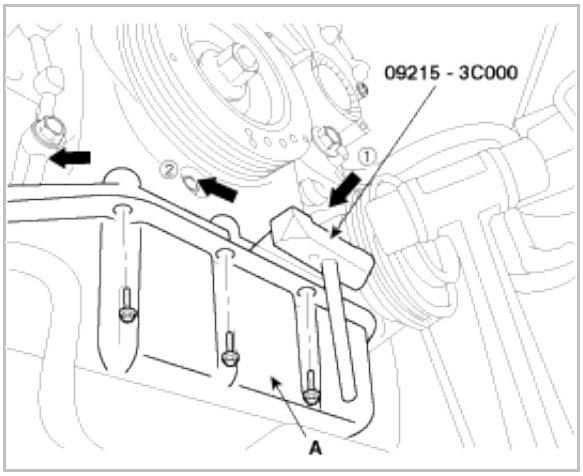
Engine Mechanical System > Lubrication System > Oil Pump > Repair procedures

Removal

Oil Pump

1. Drain the engine oil.
2. Remove the lower oil pan (A).
   Insert the blade of SST(09215-3C000) between the upper oil pan and lower oil pan. Cut off applied sealer and

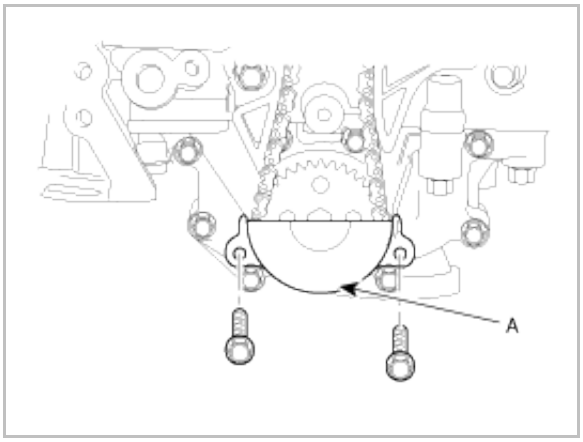
remove the lower oil pan.



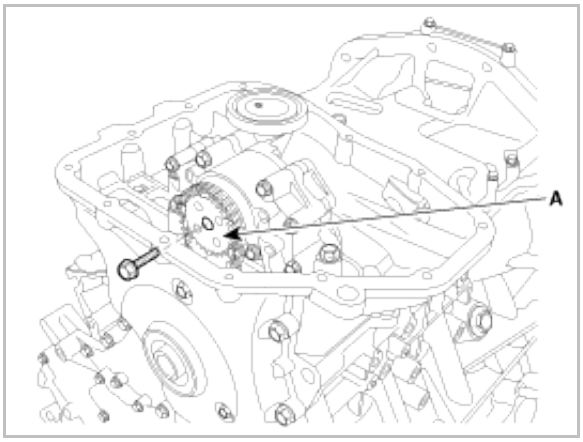
NOTE

- Insert the SST between the oil pan and the ladder frame by tapping it with a plastic hammer in the direction of arrow.
- After tapping the SST with a plastic hammer along the direction of 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 be result in damage of the SST.
- Be careful not to damage the contact surfaces of Upper oil pan and lower oil pan.

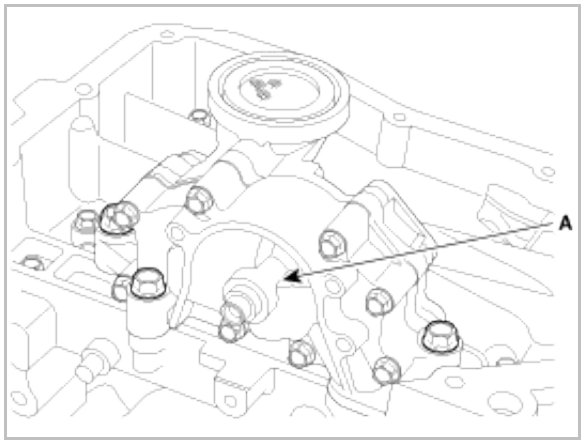
3. Remove the oil pump chain cover (A).



4. Remove the oil pump chain sprocket (A).

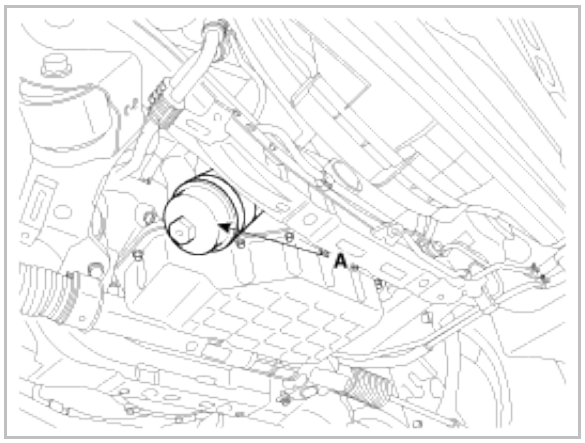


5. Remove the oil pump (A).

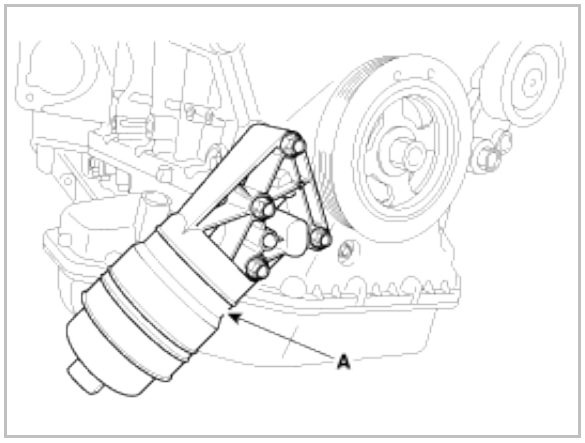


Oil Filter Assembly

1. Wait for 5 minutes after loosening the oil filter cap to drain well the oil in the oil filter.



2. Remove the oil filter body.

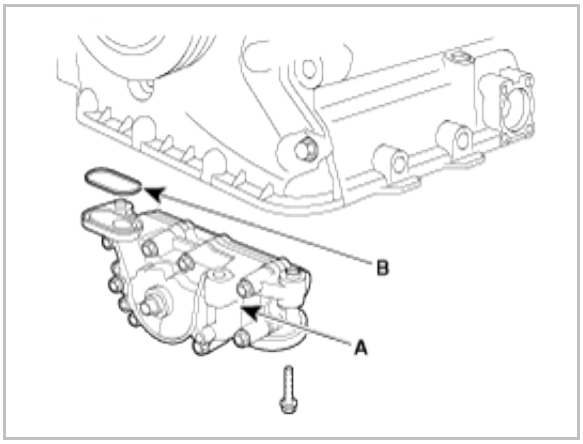


Installation

Oil Pump

1. Install the oil pump (A).

Tightening torque :
19.6 ~ 23.5N.m (2.0 ~ 2.4kgf.m, 14.5 ~ 17.4lb-ft)

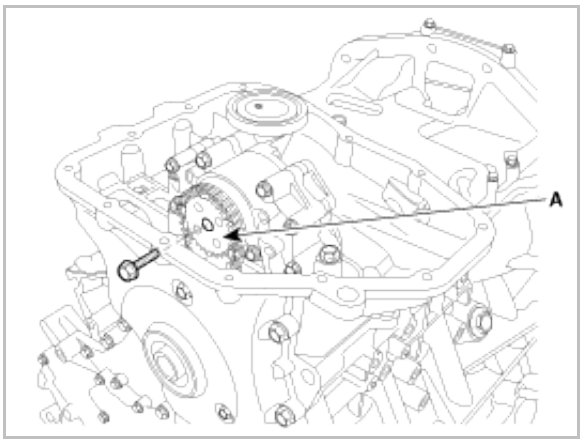


NOTE

Always use a new O-ring (B).

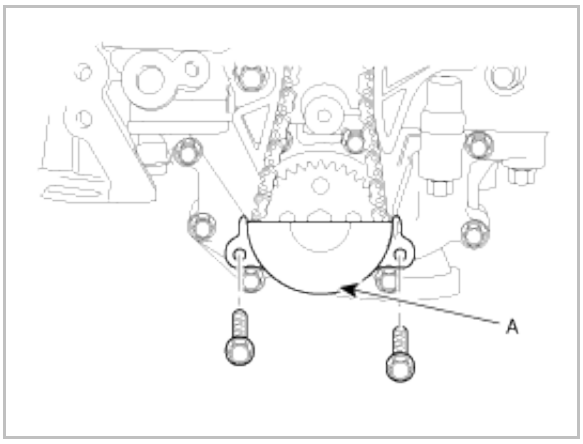
2. Install the oil pump sprocket (A) and the oil pump chain on the oil pump.

Tightening torque :
18.6 ~ 21.6N.m (1.9 ~ 2.2kgf.m, 13.7 ~ 15.9lb-ft)



3. Install the oil pump chain cover (A).

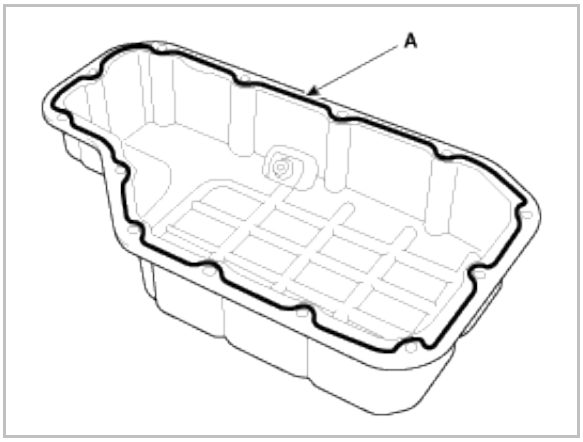
Tightening torque :
9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)



4. Install the lower oil pan (A).
   (1) Using a gasket scraper, remove all the old packing material from the gasket surfaces.

(2) Before assembling the oil pan, the liquid sealant TB 1217H should be applied on oil pan. The part must be assembled within 5 minutes after the sealant was applied.

Bead width : 2.5mm(0.1in.)

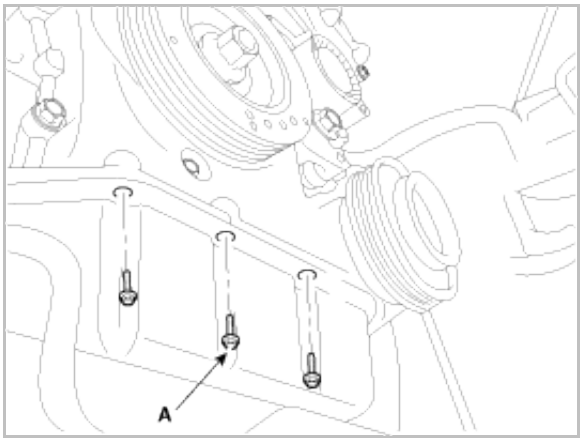


CAUTION

- Clean the sealing face before assembling two parts.
- Remove harmful foreign matters on the sealing face before applying sealant.
- When applying sealant gasket, sealant must not be protruded into the inside of oil pan.
- To prevent leakage of oil, apply sealant gasket to the inner threads of the bolt holes.

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

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

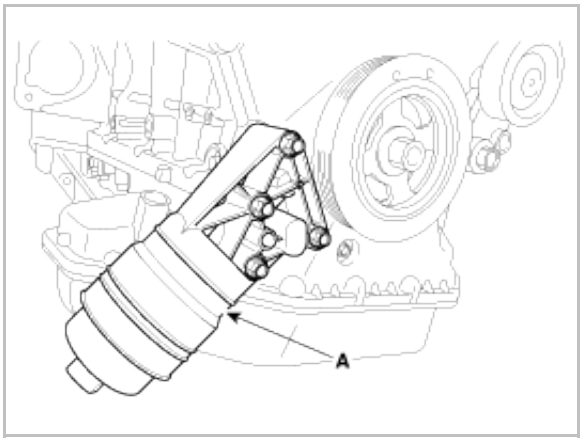


5. After assembly, wait at least 30 minutes before filling the engine with oil.

Oil Filter Assembly

1. Install the oil filter body.

Tightening torque :
19.6 ~ 21.6N.m (2.0 ~ 2.2kgf.m, 14.5 ~15.9lb-ft)



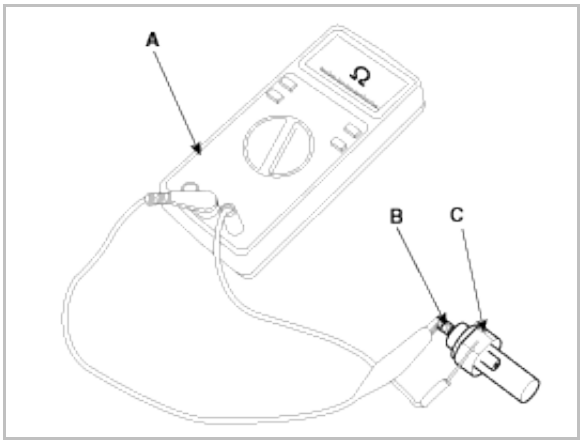
CAUTION

- All rubber gaskets must not be damaged by assembling parts.
- Always use a new oil seal.

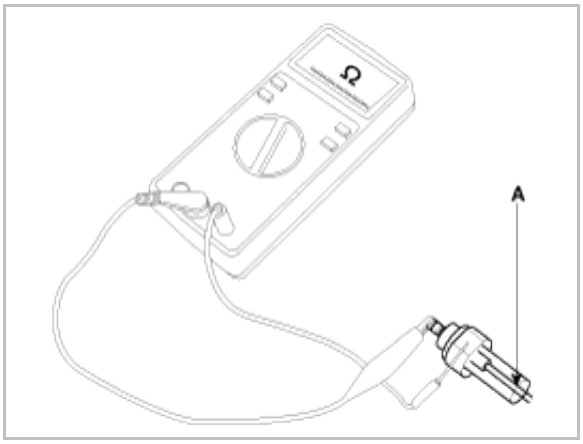
Engine Mechanical System > Lubrication System > Oil Pressure Switch > Repair procedures

Inspection

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



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



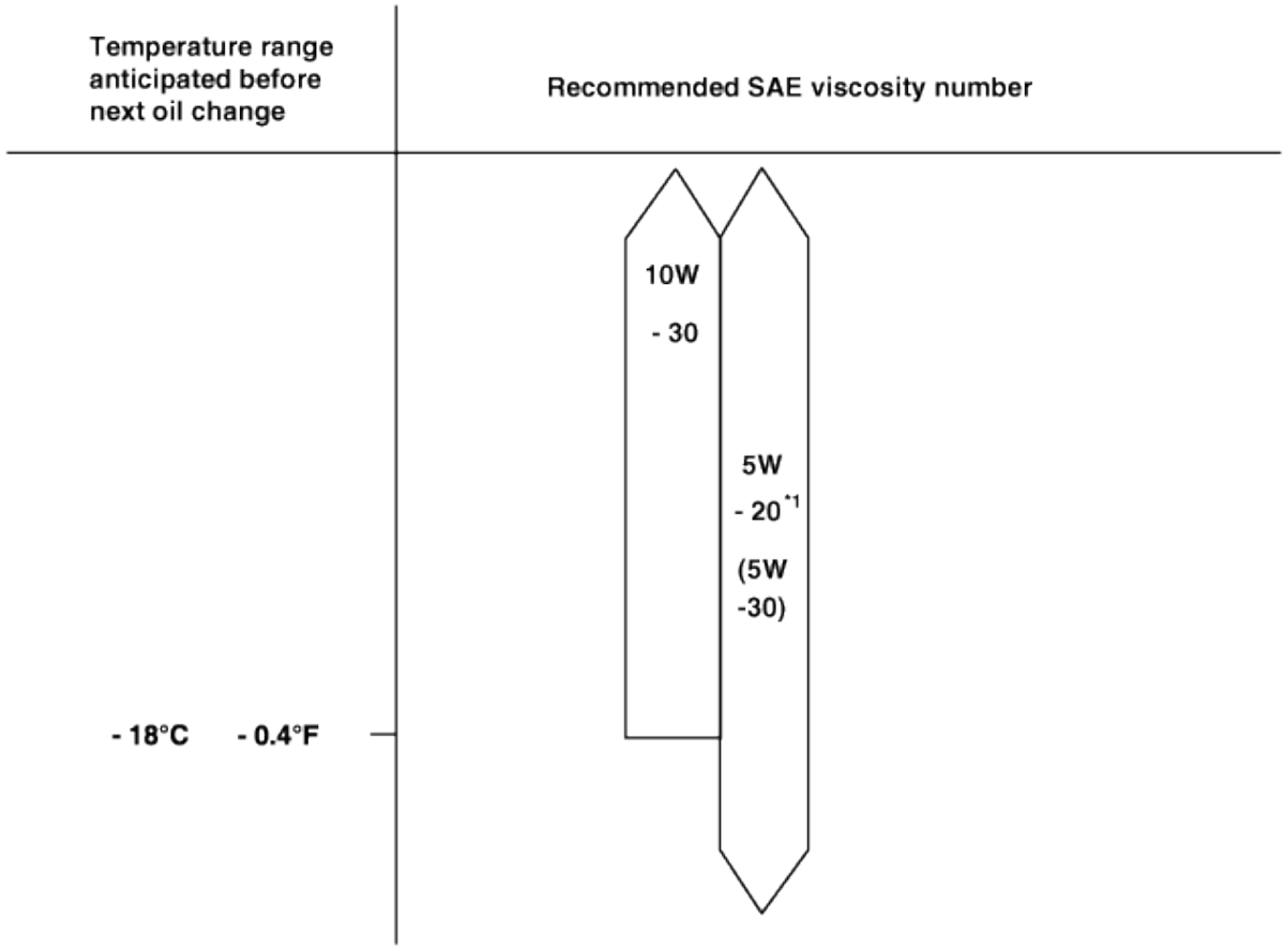
Inspection

1. Check the engine oil quality. Check the oil deterioration, entry of water, discoloring of thinning. If the quality is visibly poor, replace the oil.
2. Check the engine oil level.
   After warming up the engine and then 5 minutes after the engine stop, oil level should be between the “L” and “F” marks in the dipstick.
   If low, check for leakage and add oil up to the “F” mark.

> NOTE
>
> Do not fill with engine oil above the “F” mark.

Selection Of Engine Oil

Recommendation : 5W-20/GF4&SM (If not available, refer to the recommended API or ILSAC classificationand SAE viscosity number.)
API classification : SL, SM or above
ILSAC classification : GF3, GF4 or above
SAE viscosity grade : Refer to the recommended SAE viscosity number.



*1 If 5W-20 / GF4 engine oil is not available, 5W-30 or secondary recommended engine oil for corresponding temperature range can be used.

NOTE

For best performance and maximum protection of all types of operation, select only those lubricants which :

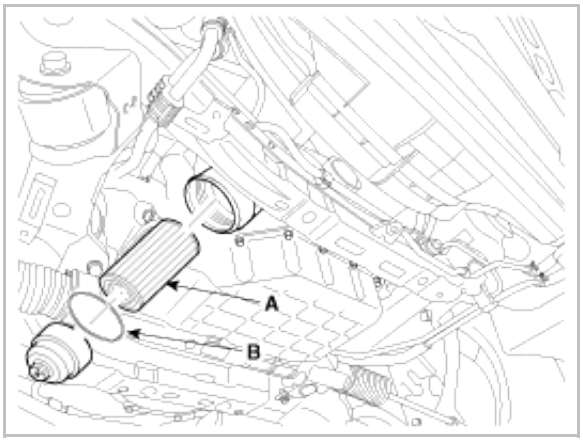
1. Satisfy the requirement of the API or ILSAC classification.
2. Have proper SAE grade number for expected ambient temperature range.
3. Lubricants that do not have both an SAE grade number and API or ILSAC service classification on the container should not be used.

Replacement

CAUTION

- Prolonged and repeated contact with mineral oil will result in the removal of natural fats from the skin, leading to dryness, irritation and dermatitis. In addition, used engine oil contains potentially harmful contaminants which may cause skin cancer.
- Exercise caution in order to minimize the length and frequency of contact of your skin to used oil. Wear protective clothing and gloves. Wash your skin thoroughly with soap and water, or use water-less hand cleaner, to remove any used engine oil. Do not use gasoline, thinners, or solvents.
- In order to preserve the environment, used oil and used oil filter must be disposed of only at designated disposal sites.

1. Park the car on level ground.
   Start the engine and let it warm up.
2. Turn the engine off and open the hood.
   Remove the engine cover.
3. Wait for 5 minutes after loosening the oil filter cap to drain well the oil in the oil filter.
4. Drain engine oil.
   (1) Remove the oil filler cap.
   (2) After lifting the car, remove the oil drain plug and drain oil into a container.
5. Replace the oil filter.
   (1) Disconnect the oil filter cap from the oil filter body.
   (2) Remove the oil filter element.
   (3) Check and clean the oil filter installation surface.
   (4) Check the part number of a new oil filter is same as old one.
   (5) Install a new oil filter element (A) and new O-ring (B).



NOTE

When remove the oil filter element from the oil filter cap, pull the oil filter element upright.

(6) Apply clean engine oil to the new O-ring.
Lightly screw the oil filter cap into place, and tighten it until the O-ring contacts the seat.

(7) Finally tighten it again by specified tightening torque.

Tightening torque :
31.4 ~ 38.2N.m (3.2 ~ 3.9kgf.m, 23.1 ~ 28.2lb-ft)

6. Fill new engine oil.
(1) Install the oil drain plug with a new gasket.

Tightening torque :
34.3 ~ 44.1N.m (3.5 ~ 4.5kgf.m, 25.3 ~ 32.5lb-ft)

(2) Fill with new engine oil, after removing the engine oil level gauge.

Capacity
Total : 6.0 L (6.34 US qt, 5.27 Imp qt)
Oil pan : 5.5 L (5.81 US qt, 4.83 Imp qt)
Drain and refill including oil filter :
5.2 L (4.49 US qt, 4.57 Imp qt)

CAUTION

- Fill a half oil of the total amount first and do the rest again after about one minute later.
- Do not fill oil over the 'F' line, checking the level with the oil level gauge.

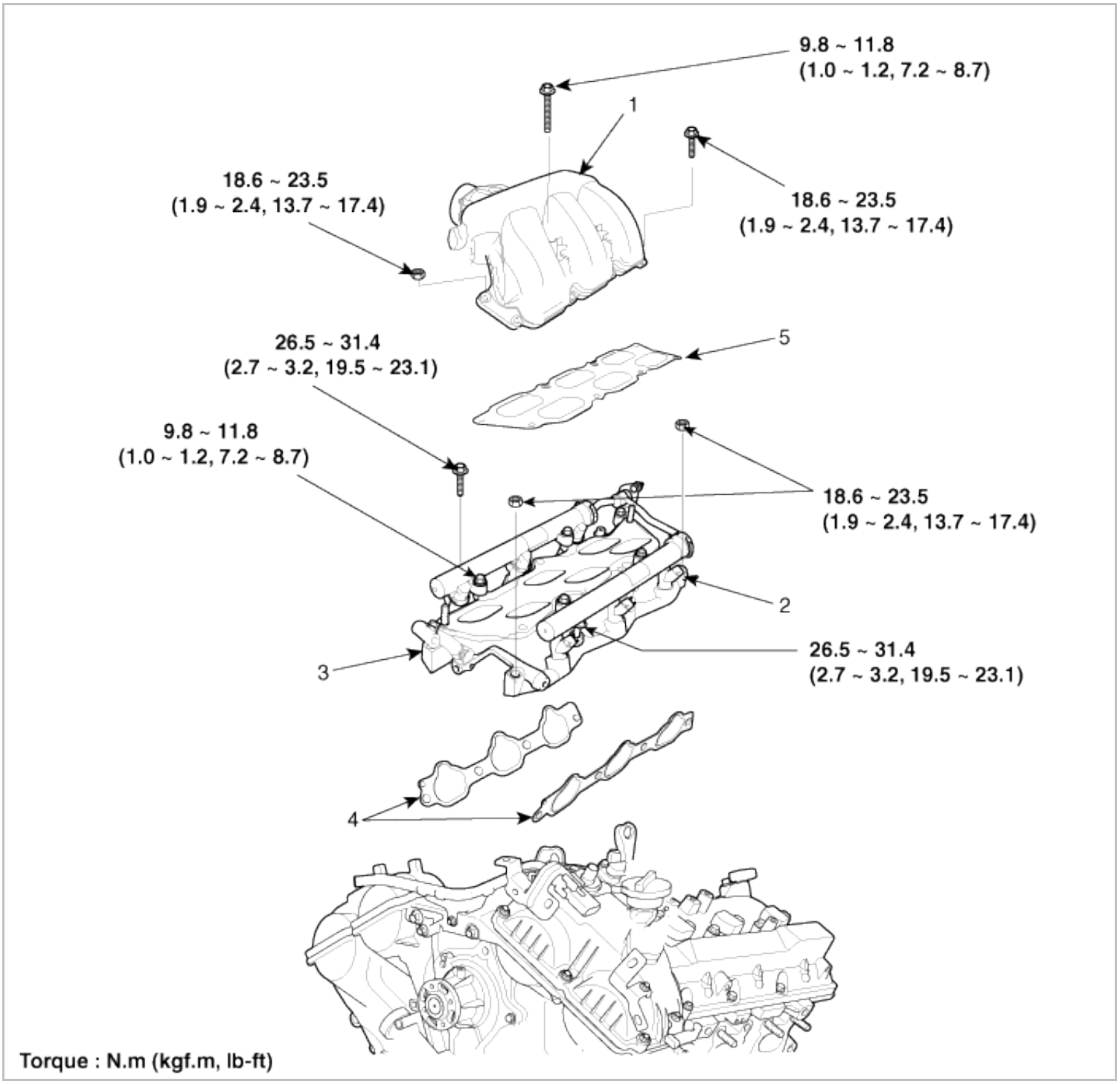
(3) Install the oil filler cap and oil level gauge.

7. Start the engine and check to be sure no oil is leaking from the drain plug or oil filter.

8. Recheck the engine oil level.

Engine Mechanical System > Intake And Exhaust System > Intake Manifold > Components and Components Location

Components



1. Surge tank 2. Delivery pipe	3. Intake manifold 4. Intake manifold gasket 5. Surge tank gasket

Engine Mechanical System > Intake And Exhaust System > Intake Manifold > Repair procedures

Removal

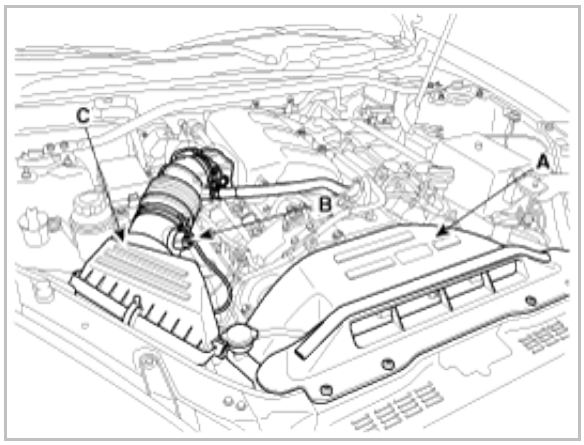
CAUTION

- To avoid damage, unplug the wiring connectors carefully while holding the connector portion.

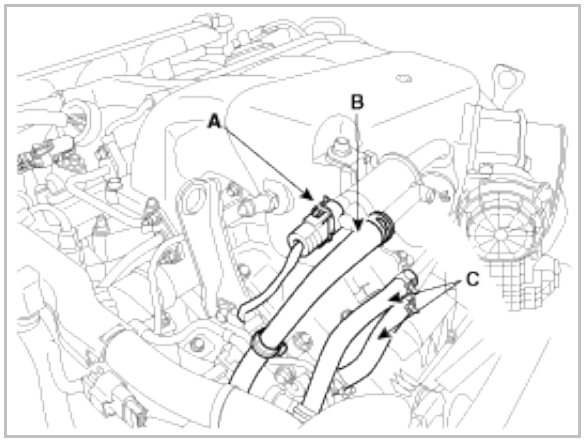
NOTE

- Mark all wiring and hoses to avoid misconnection.

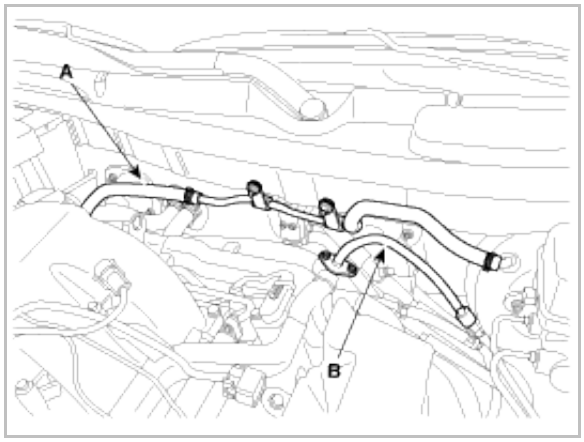
1. Disconnect the battery negative cable.
2. Loosen the drain plug and drain the engine coolant.
3. Remove the air duct (A).
4. Remove the AFS connector (B) and air cleaner assembly (C).



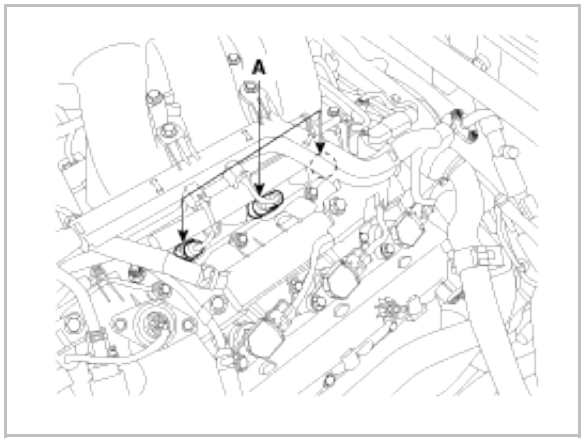
5. Remove the PCSV connector (A), PCSV hose (B) and throttle body coolant hoses (C).



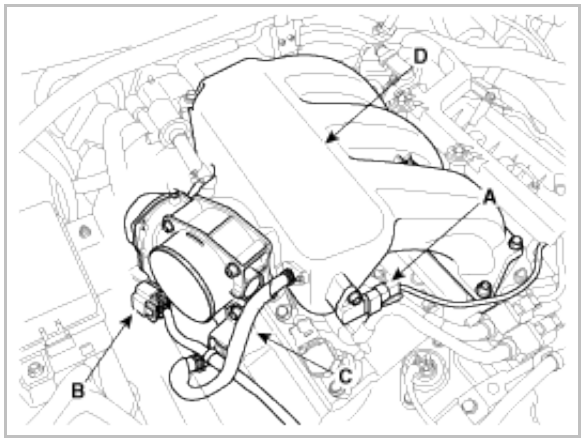
6. Disconnect the brake vacuum hose (A).



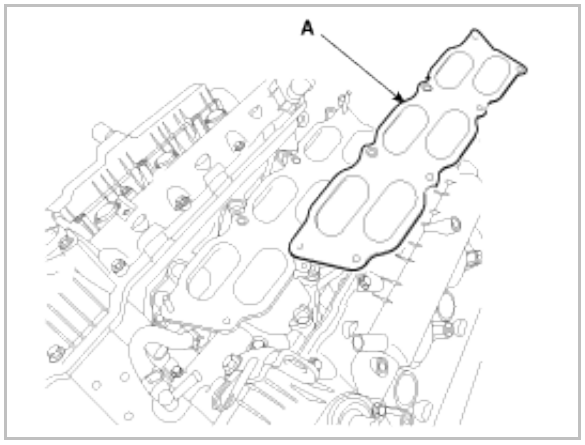
7. Disconnect the LH injector connectors (A).



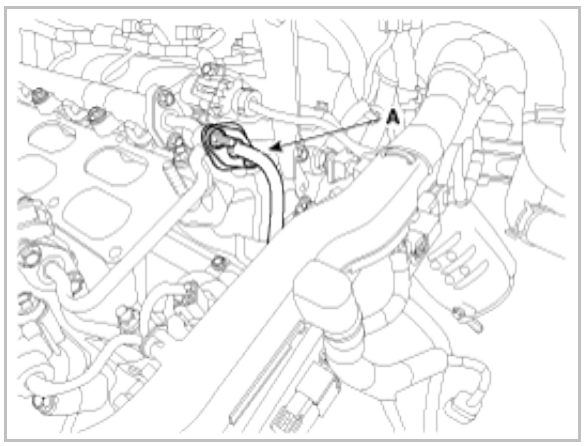
8. Disconnect the MAP sensor connector (A), ETC connector (B), PCV hose (C) and then remove the surge tank (D).



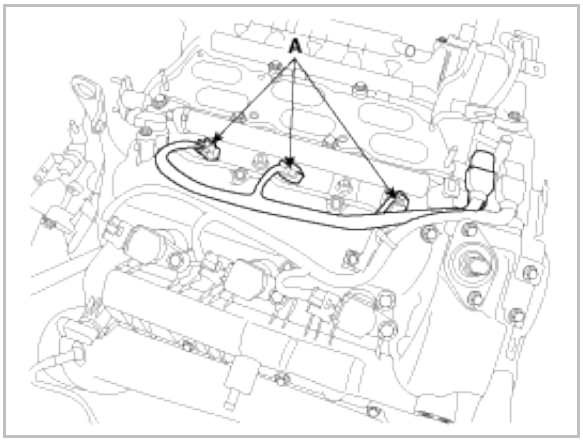
9. Remove the surge tank gasket (A).



10. Remove the fuel hose (A).

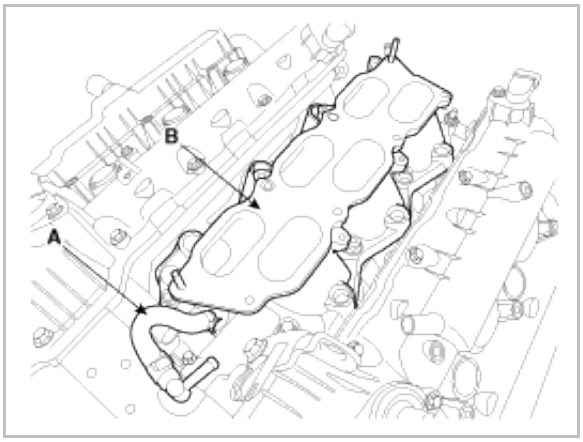


11. Disconnect the RH injector connector (A).



12. Disconnect the water vent hose (A) and then remove the intake the manifold (B).

> **CAUTION**
>
> - Be sure to drain the engine coolant before removing the intake manifold.
> - If any coolant drained from the cylinder head vent hole has entered the intake port. This can potentially lead to engine trouble.

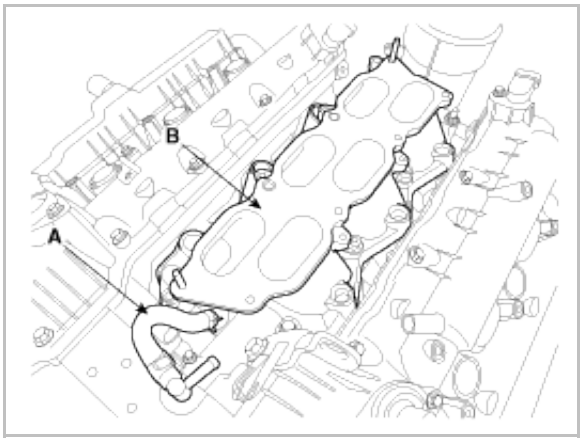


Installation

1. Install the intake the manifold (B) with a new gasket, and connect the water vent hose (A).

> **CAUTION**
>
> - Be sure to drain the engine coolant before removing the intake manifold.
> - If any coolant drained from the cylinder head vent hole has entered the intake port. This can potentially lead to engine trouble.

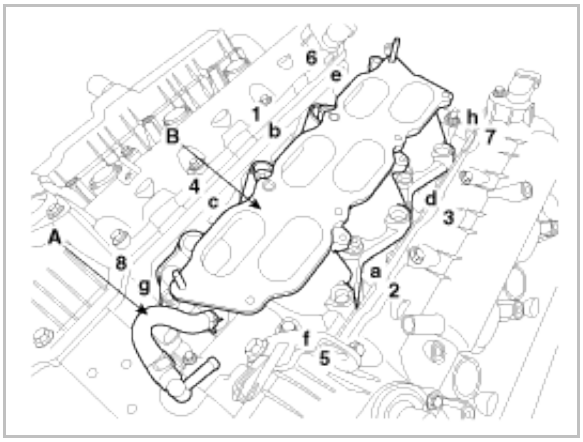
Tightening torque
Step 1: 3.9 ~ 5.9N.m (0.4 ~ 0.6kgf.m, 2.9 ~ 4.3lb-ft)
Step 2:
Nut- 18.62 ~ 23.52N.m (1.9~2.4kgf.m, 13.74~17.36lb-ft)
Bolt -26.5 ~ 31.4N.m (2.7~3.2kgf.m, 19.5~23.1lb-ft)
Step 3: Repeat 2nd step twice or more.



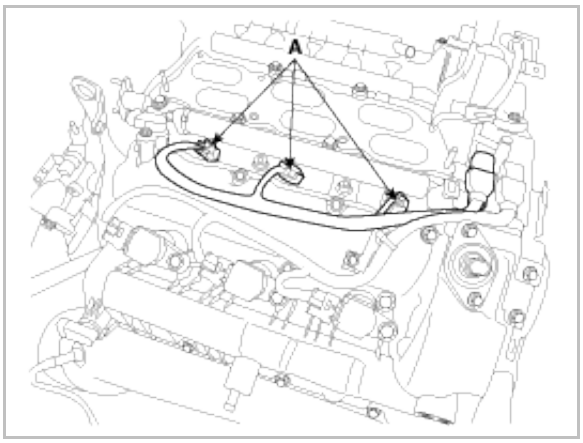
a - h : 1st step order
1 ~ 8 : 2nd step order

NOTE

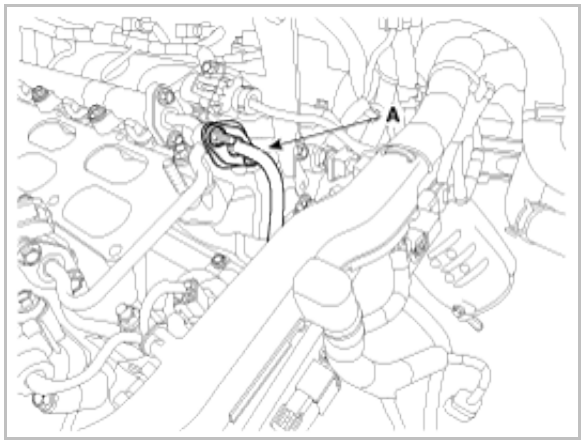
Confirm the manifold gasket identification mark (LH, RH) and be careful of the installation direction.



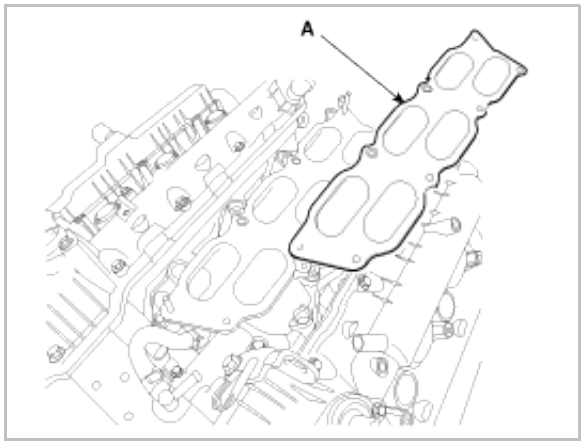
2. Connect the RH injector connector (A).



3. Install the fuel pipe (A) and vacuum pipe (B).

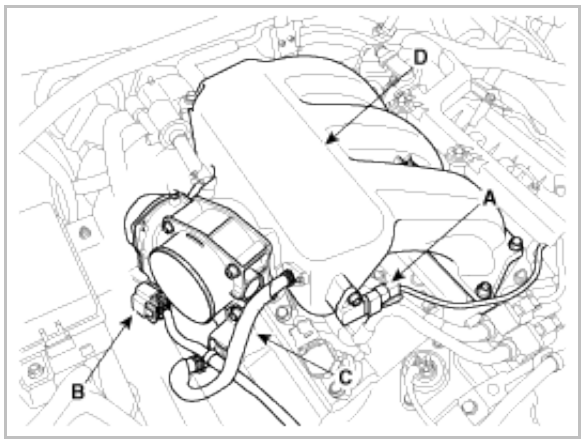


4. Install the new surge tank gasket (A).

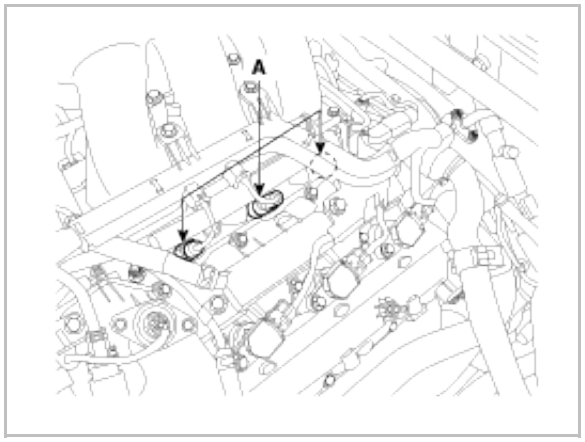


5. Install the surge tank assembly (D), MAP sensor connector (A), ETC connector (B) and PCV hose (C).

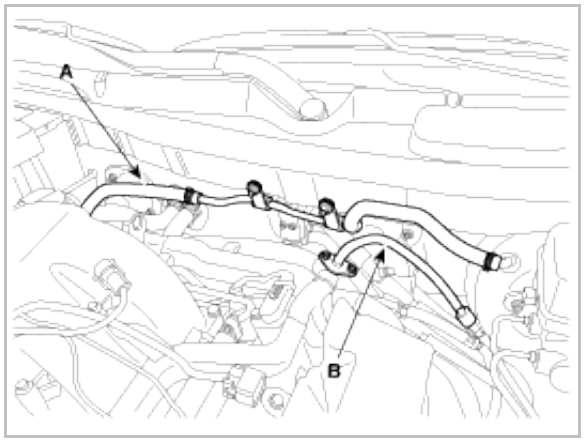
Tightening torque :
18.6 ~ 23.5N.m (1.9 ~ 2.4kgf.m, 13.7 ~17.4lb-ft)



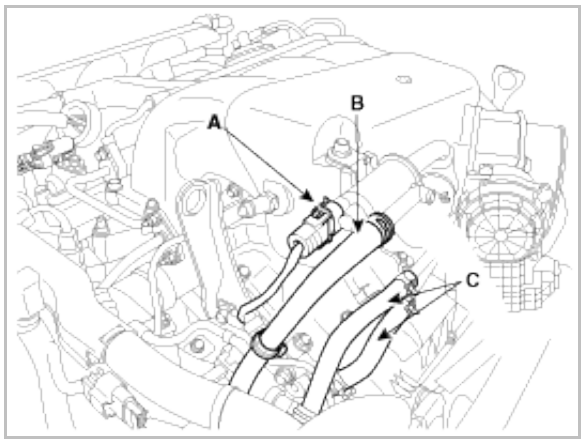
6. Connect the LH injector connectors (A).



7. Connect the brake vacuum hose (A).

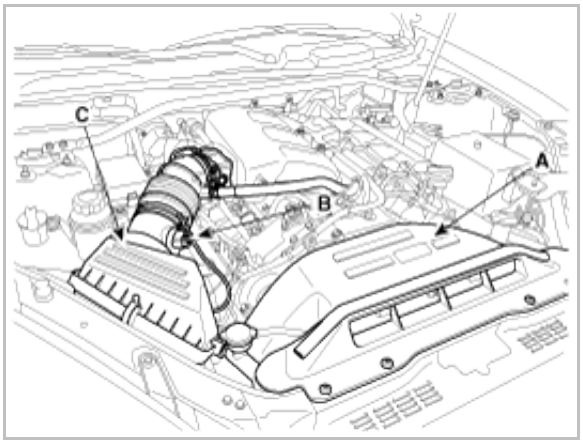


8. Connect the PCSV connector (A), PCSV hose (B) and throttle body coolant hoses (C).



9. Install the air cleaner assembly (C) and connect the AFS connector (B).
10. Install the air duct (A).

Tightening torque :
Bolt : 7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)
Clamp : 2.9 ~ 4.9N.m (0.3 ~ 0.5kgf.m, 2.2 ~ 3.6lb-ft)



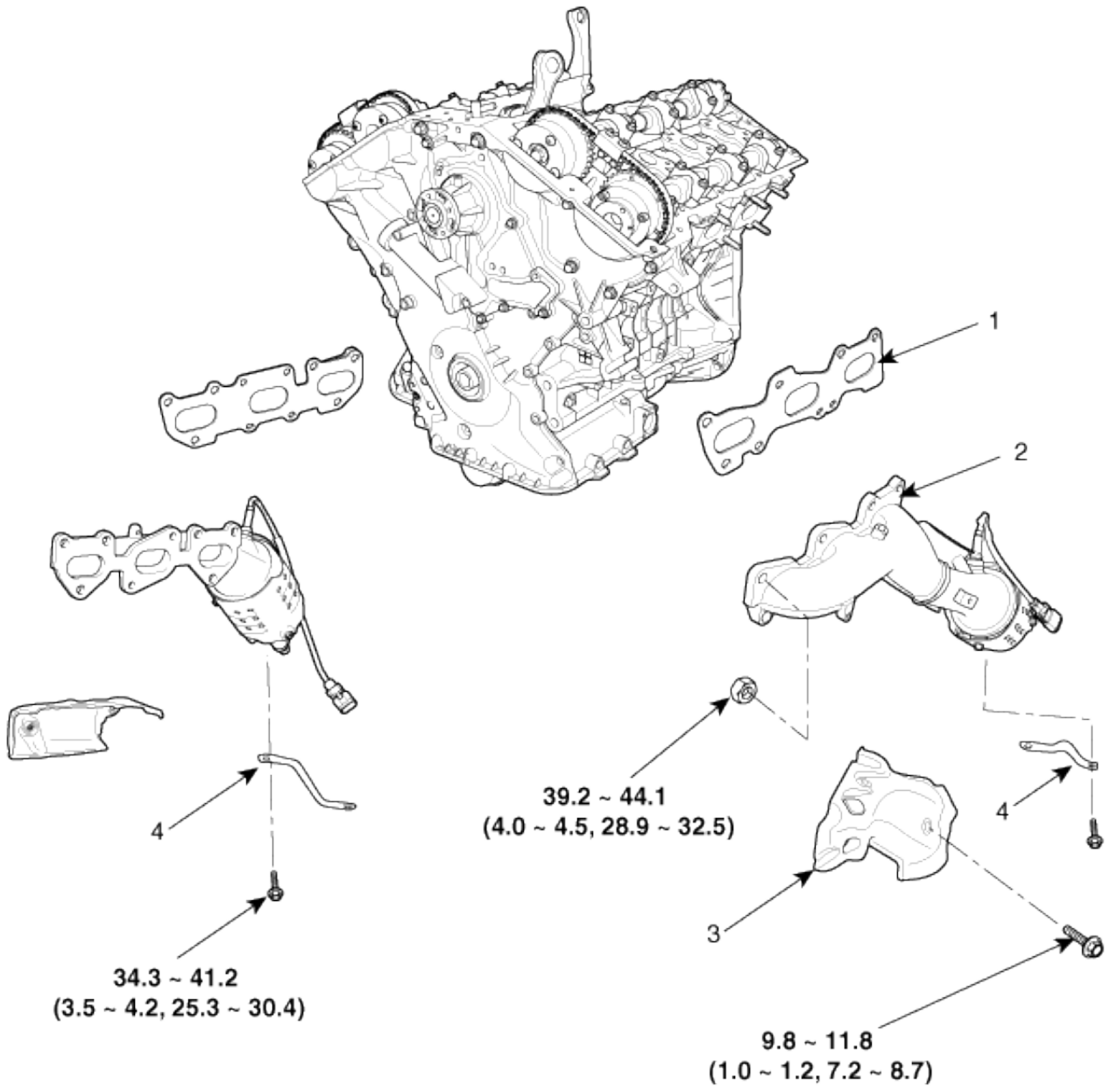
11. Connect the battery negative cable.

NOTE

- Refill engine coolant.
- Refill radiator and reservoir tank with engine coolant.
- Bleed air from the cooling system.
  - Start engine and let it run until it warms up. (Until the radiator fan operates 3 or 4 times.)
  - Turn Off the engine. Check the level in the radiator, add coolant if needed. This will allow trapped air to be removed from the cooling system.
  - Put radiator cap on tightly, then run the engine again and check for leaks.
- Clean the battery posts and cable terminals with sandpaper. Assemble and, then apply grease to prevent corrosion.

Engine Mechanical System > Intake And Exhaust System > Exhaust Manifold > Components and Components Location

Components



Torque : N.m (kgf.m, lb-ft)

1. Gasket 2. Exhaust manifold	3. Heat protector 4. Exhaust manifold stay

Engine Mechanical System > Intake And Exhaust System > Exhaust Manifold > Repair procedures

Removal

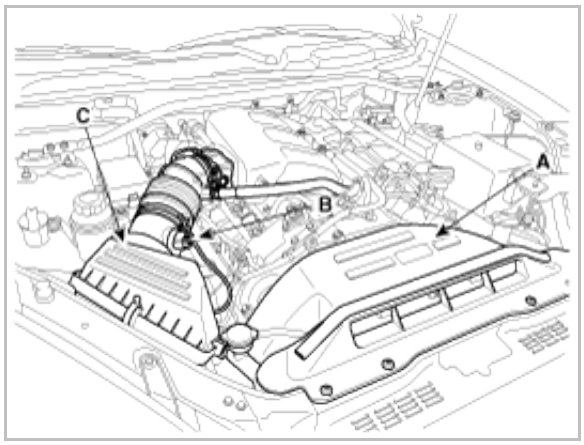
CAUTION

- To avoid damage, unplug the wiring connectors carefully while holding the connector portion.

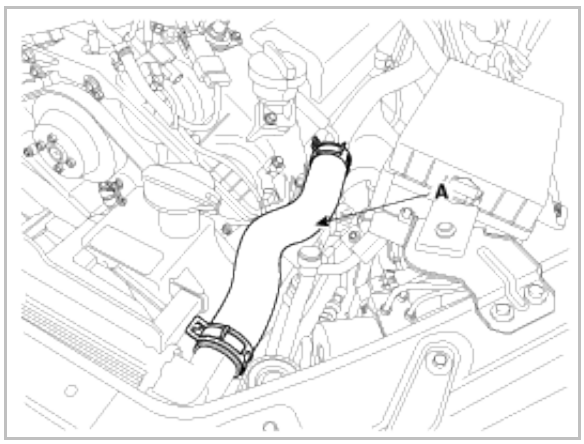
NOTE

• Mark all wiring and hoses to avoid misconnection.

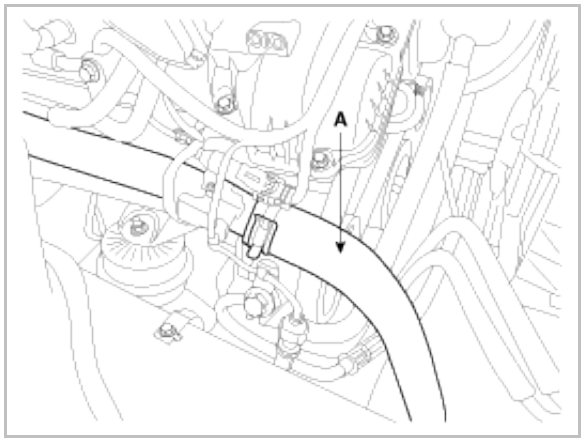
1. Disconnect the battery negative cable.
2. Loosen the drain plug and drain the engine coolant.
3. Remove the air duct (A).
4. Remove the AFS connector (B) and air cleaner assembly (C).



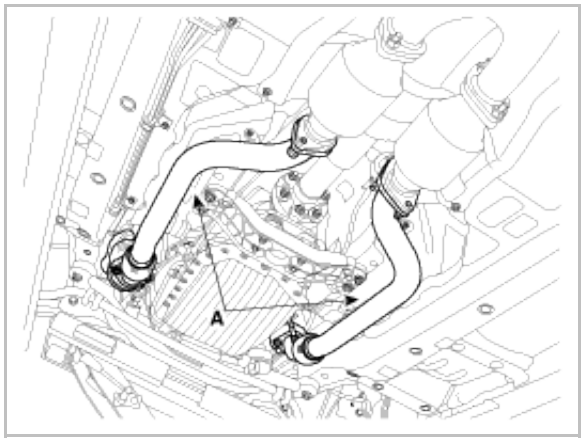
5. Remove the radiator upper hose (A).



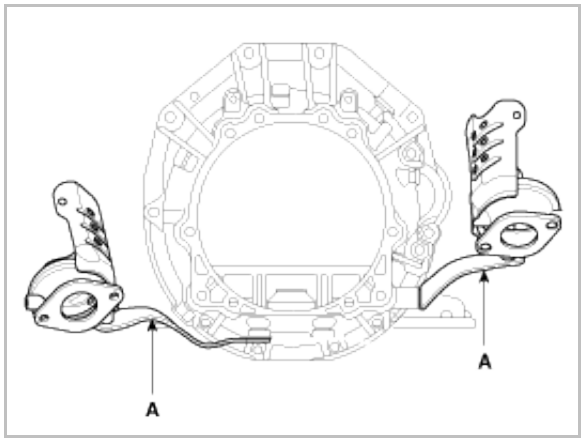
6. Remove the radiator lower hose (A).



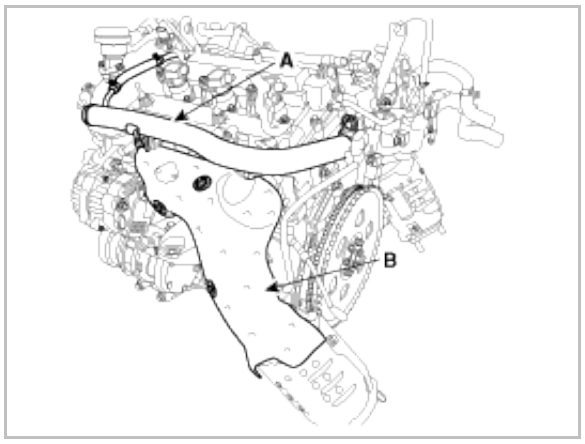
7. Remove the front muffler (A).



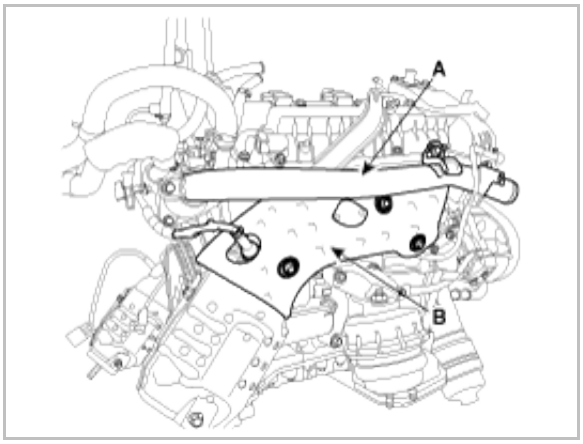
8. Remove the exhaust manifold stays (A).



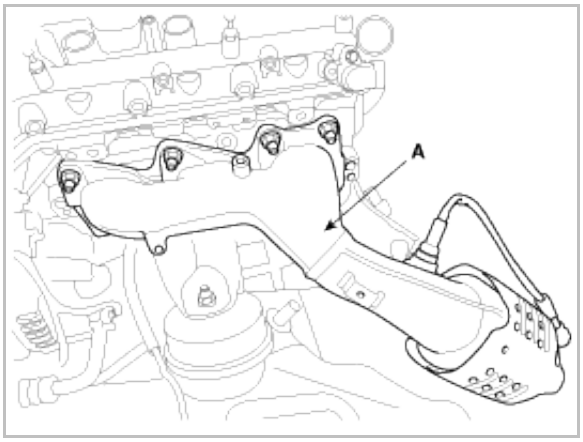
9. Remove the LH side coolant pipe and hose (A) and then remove the exhaust manifold heat protector (B).

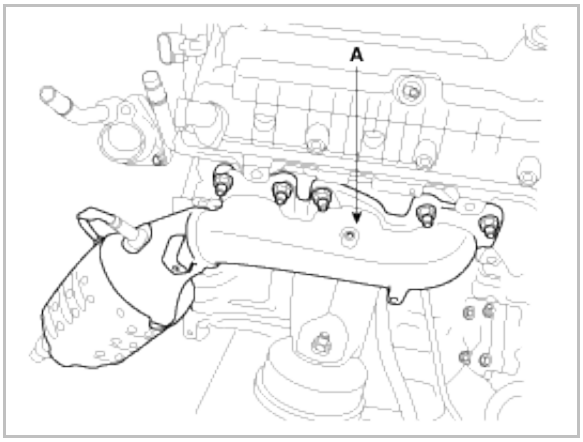


10. Remove the RH side coolant pipe and hose (A) and then remove the exhaust manifold heat protector (B).



11. Remove the LH/RH exhaust manifold (A).

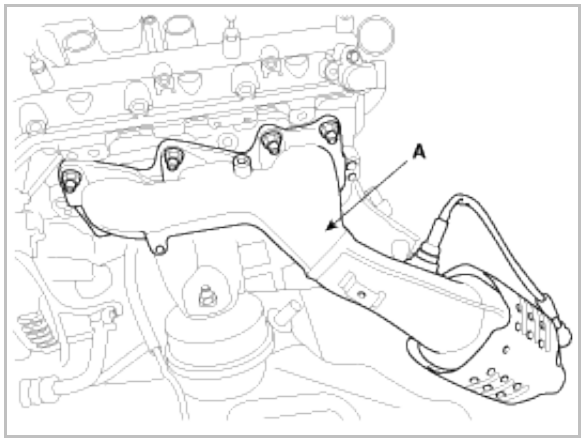


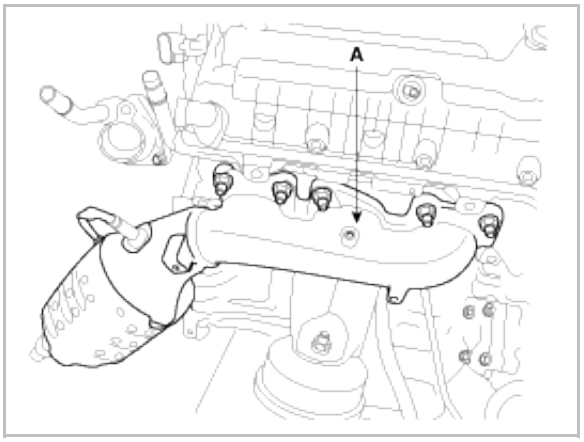


Installation

1. Install the LH/RH exhaust manifold (A).

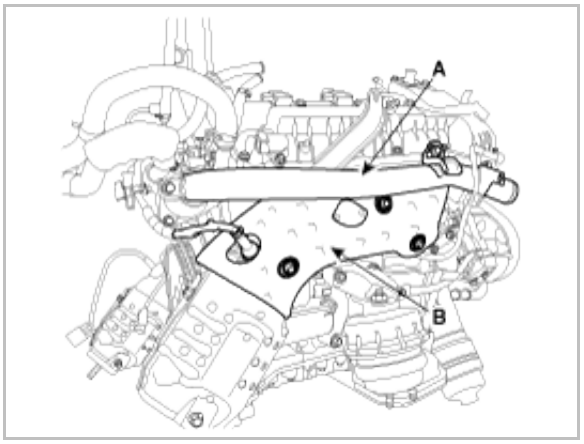
Tightening torque :
39.2 ~ 44.1N.m (4.0 ~ 4.5kgf.m, 28.9 ~ 32.5lb-ft)





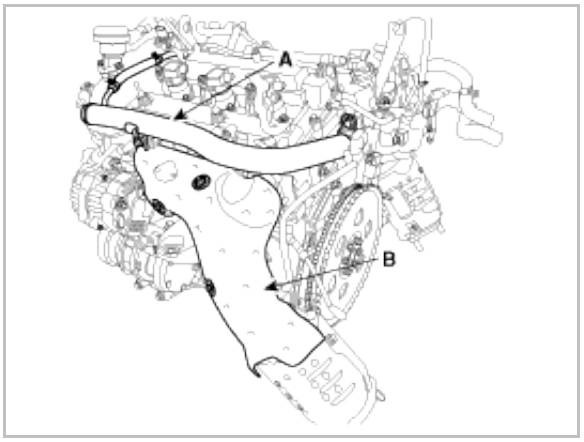
2. Install the RH side the exhaust manifold heat protector (B) and then install the coolant pipe and hose (A).

Tightening torque :
A : 19.6 ~ 23.5N.m (2.0 ~ 2.4kgf.m, 14.5 ~ 17.4lb-ft)
B : 9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)



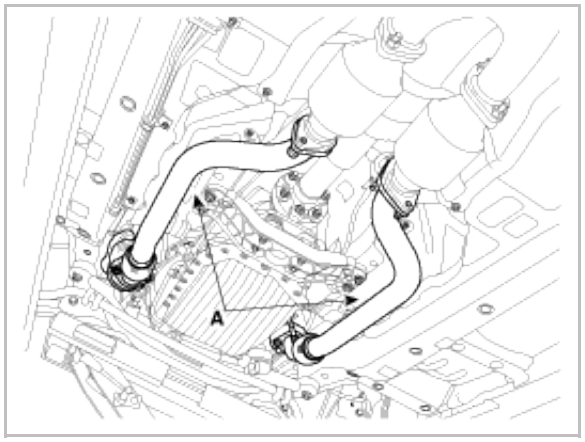
3. Install the LH side the exhaust manifold heat protector (B) and then install the coolant pipe and hose (A).

Tightening torque :
A : 19.6 ~ 23.5N.m (2.0 ~ 2.4kgf.m, 14.5 ~ 17.4lb-ft)
B : 9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)



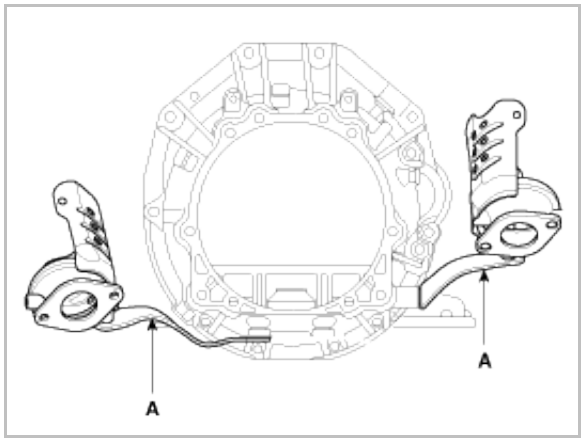
4. Install the front mufler (A).

Tightening torque :
39.2 ~ 58.8N.m (4.0 ~ 6.0kgf.m, 28.9 ~ 43.4lb-ft)

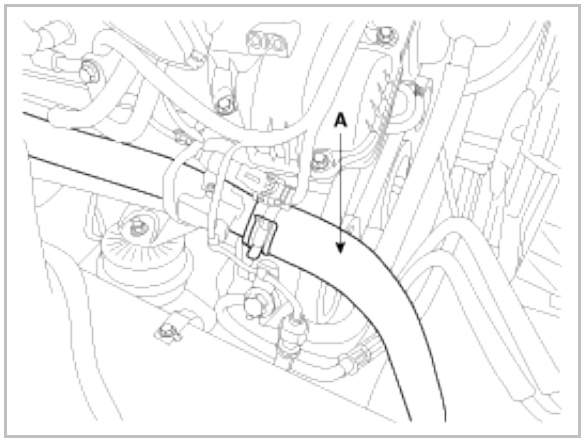


5. Install the exhaust manifold stays (A).

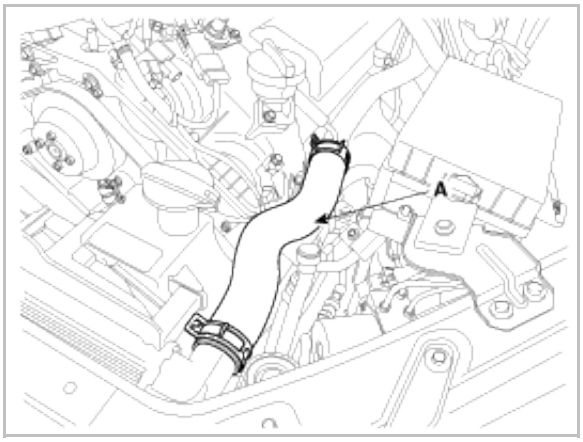
Tightening torque :
34.3 ~ 41.2N.m (3.5 ~ 4.2kgf.m, 25.3 ~ 30.4lb-ft)



6. Install the radiator lower hose(A).

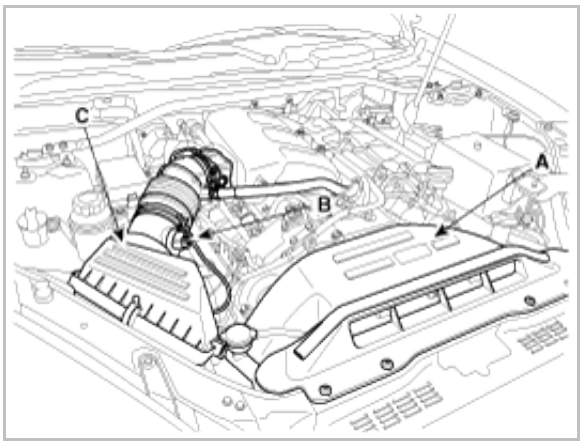


7. Install the radiator upper hose(A).



8. Install the air cleaner assembly (C) and then connect the AFS connector (B).
9. Install the air duct (A).

Tightening torque :
Bolt : 7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)
Clamp : 2.9 ~ 4.9N.m (0.3 ~ 0.5kgf.m, 2.2 ~ 3.6lb-ft)



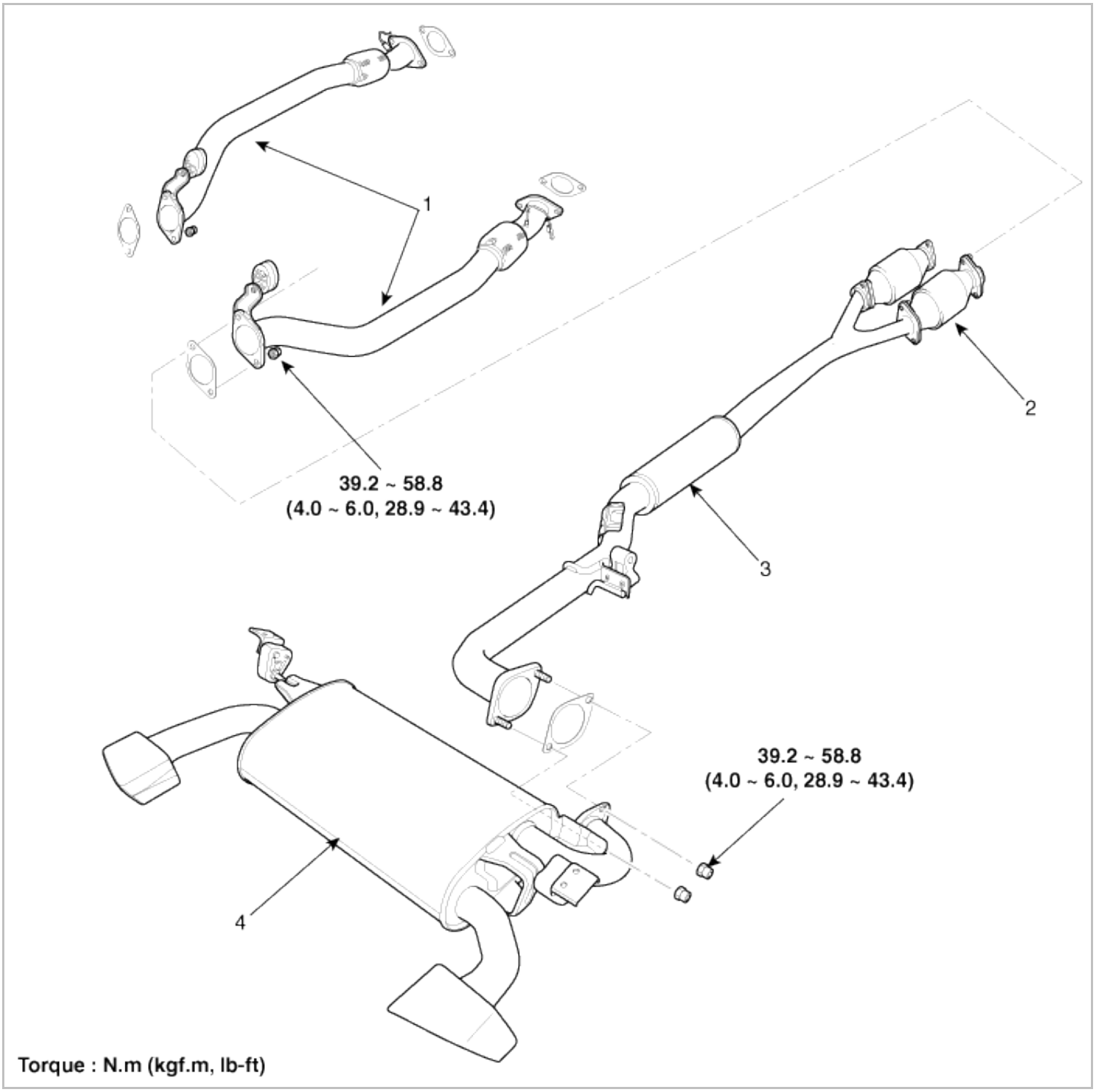
10. Connect the battery negative cable.

NOTE

- Refill engine coolant.
- Refill radiator and reservoir tank with engine coolant.
- Bleed air from the cooling system.
- Start engine and let it run until it warms up. (Until the radiator fan operates 3 or 4 times.)
- Turn Off the engine. Check the level in the radiator, add coolant if needed. This will allow trapped air to be removed from the cooling system.
- Put radiator cap on tightly, then run the engine again and check for leaks.
- Clean the battery posts and cable terminals with sandpaper. Assemble and, then apply grease to prevent corrosion.

Engine Mechanical System > Intake And Exhaust System > Muffler > Components and Components Location

Components



1. Front muffler	3. Center muffler
2. Catalytic converter	4. Main muffler