GENESIS COUPE(BK) > 2013 > G 3.8 GDI > Engine Mechanical System

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			11.5:1	
Firing order			1-2-3-4-5-6	
Valve timing				
Intake	Opens(ATDC)		10°	
	Closes(ABDC)		78°	
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 (1.8583in.)	
		Exhaust	45.8mm (1.8031in.)	
	RH Camshaft	Intake	47.2mm (1.8583in.)	
		Exhaust	45.8mm (1.8031in.)	
		Intake	No.1: 27.964 ~ 27.978mm (1.1009 ~ 1.1015in.) No.2,3,4: 23.954 ~ 23.970mm(0.9430 ~	

Journal outer diameter	LH, RH camshaft		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		45.5mm (1.7913in.)	
Load		19.3±0.8kg/34.0mm (42.7±1.8 lb/1.3386in.)	
		41.5±1.3kg/24.2mm (91.5±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	1.23 ~ 1.25mm (0.0484 ~ 0.0492in.)	1.26mm (0.0496in.)
	No. 2 ring groove	1.23 ~ 1.25mm (0.0484 ~ 0.0492in.)	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	0.02 ~ 0.065mm (0.0008 ~ 0.0026in.)	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 ~ 0.47mm (0.0126 ~ 0.0185in.)	0.7mm (0.0275in.)
	Oil ring	0.2 ~ 0.5mm (0.0078 ~ 0.0196in.)	0.8mm (0.0315in.)
Piston pin			
Piston pin outer diameter		21.097 ~ 22.000mm (0.8306 ~ 0.8661in.)	
Piston pin hole inner diameter		22.004 ~ 22.010mm (0.8662 ~ 0.8665in.)	
Piston pin hole clearance		0.004 ~ 0.013mm (0.00016 ~ 0.00051in.)	
Connecting rod small end inner diameter		22.005 ~ 22.016mm (0.8663 ~ 0.8667in.)	
Connecting rod small end hole clearance		0.005 ~ 0.019mm (0.0002 ~ 0.0007in.)	
Connecting rod			
Connecting rod big end inner diameter		58.000 ~ 58.018mm(2.2834 ~2.2842in.)	
Connecting rod bearing oil clearance		0.044 ~ 0.062mm (0.0017 ~ 0.0024in.)	
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		5.0 ~ 5.5 bar	
Engine oil			
Oil quantity	Total	6.5L (6.87US.qt, 5.72lmp.qt, 1.72 US.gal)	Total engine oil
	Oil pan	6.0L (6.34US.qt, 5.28lmp.qt, 1.58 US.gal)	
	Drain and refill	5.7L (6.02US.qt, 5.01lmp.qt, 1.50 US.gal)	Including oil filter
Oil grade	Recommendation	5W-20 / GF4 & SM 5W-30 / ACEA A5	If not abailable, refer to the recommended API or ILSAC or ACEA clasification and SAE viscosity number
	Classification	API SL, SM or above ILSAC GF3, GF4 or above ACEA A3, A5 or above	Satisfy the requirement of the API or ILSAC or ACEA clasification
	SAE viscosity grade	Recommended SAE viscosity number	Refer to the "Lubrication System"
Oil pressure (at 1000rpm)		130kPa (1.22kg/cm², 18.77psi) or above	Oil temperature in oil pan : 110±2°C (230±36°F)
Cooling system			
Cooling method		Forced circulation with water pump	
Coolant quantity		MT : 9.0L (9.5US.qt, 7.9lmp.qt, 2.4 US.gal) AT : 8.8L (9.3US.qt, 7.7lmp.qt, 2.3 US.gal)	
Thermostat	Type	Wax pellet type	
	Opening temperature	82±2°C (179.6±3.6°F)	
	Fully opened temperature	95°C (203°F)	
	Full lift	10mm (0.3937in.) MIN	
	Main valve opening pressure	93.16 ~ 122.58kpa (0.95 ~ 1.25kg/cm², 13.51	

Radiator cap	pressure	~ 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
Engine Mounting				
Engine mounting insulator to engine mounting support bracket fixing nut	2	63.7 ~ 83.3	6.5 ~ 8.5	47.0 ~ 61.5
Engine mounting support bracket to cylinder block fixing bolt	8	49.0 ~ 63.7	5.0 ~ 6.5	36.2 ~ 47.0
Timing system				
Drive belt idler bolt	1	53.9 ~ 57.9	5.5 ~ 5.9	39.8 ~ 42.7
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
Crankshaft pulley bolt	1	284.4 ~ 304.0	29.0 ~ 31.0	209.8 ~ 224.2
Timing chain cover bolt A	16	18.6 ~ 21.6	1.9 ~ 2.2	13.7 ~ 15.9
Timing chain cover bolt B	2	24.5 ~ 26.5	2.5 ~ 2.7	18.1 ~ 19.5
Timing chain cover bolt C	2	58.8 ~ 68.6	6.0 ~ 7.0	43.4 ~ 50.6
Timing chain cover bolt D	3	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
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
Timing chain cam to cam guide bolt	4	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Cylinder head				
Ignition coil bolt (LH/RH)	6	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Spark plug (LH/RH)	6	14.7 ~ 24.5	1.5 ~ 2.5	10.8 ~ 18.1
Cylinder head cover bolt (LH/RH)	38	[4.9~5.9] + [9.8~11.8]	[0.5~0.6] + [1.0~1.2]	[3.6~4.3] + [7.2~8.7]

CVVT bolt (LH/RH)	4	64.7 ~ 76.5	6.6 ~ 7.8	47.7 ~ 56.4
Camshaft bearing cap bolt (LH/RH)	32	[5.9] + [9.8~11.8]	[0.6] + [1.0~1.2]	[4.3] + [7.2~8.7]
Cylinder head bolt (LH/RH)	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 (RH rear)	2	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Engine hanger bolt (LH)	1	44.1 ~ 53.6	4.5 ~ 5.5	32.5 ~ 39.8
Engine hanger bolt (RH)	2	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Exhaust OCV(oil control valve) bolt (LH/RH)	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Intake OCV(oil control valve) bolt (LH/RH)	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Fuel pump adapter bolt	4	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
High pressure fuel pump bolt	2	12.7 ~ 14.7	1.3 ~ 1.5	9.4 ~ 10.8
Cylinder block				
Connecting rod bolt	12	[27.5~31.3] + [68~72°]	[2.8~3.2] + [68~72°]	[20.2~23.1] + [68~72°]
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
Plug bolt	1	83.4 ~ 102.9	8.5 ~ 10.5	61.5 ~ 75.9
Oil jet bolt	3	27.5 ~ 31.3	2.8 ~ 3.2	20.2 ~ 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
Knock sensor bolt (LH/RH)	2	15.7 ~ 23.5	1.6 ~ 2.4	11.6 ~ 17.4
Drive plate bolt	8	71.5 ~ 75.5	7.3 ~ 7.7	52.8 ~ 55.7
Flywheel bolt	8	71.5 ~ 75.5	7.3 ~ 7.7	52.8 ~ 55.7
Dual mass flywheel (DMF)	8	71.5 ~ 75.5	7.3 ~ 7.7	52.8 ~ 55.7
Upper oil pan bolt	18	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Lubrication system				
Oil drain bolt	1	34.3 ~ 44.1	3.5 ~ 4.5	25.3 ~ 32.5
Oil pump bolt	3	20.6 ~ 22.6	2.1 ~ 2.3	15.2 ~ 16.6
Oil filter body bolt	4	19.6 ~ 21.6	2.0 ~ 2.2	14.5 ~ 15.9
Oil filter cap	1	34.3	3.5	25.3
Oil level gauge & water inlet pipe bolt	1	18.6 ~ 22.6	1.9 ~ 2.3	13.7 ~ 16.6

Lower oil pan bolt	13	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
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 sprocket bolt	1	18.6 ~ 21.6	1.9 ~ 2.2	13.7 ~ 15.9
Cooling system				
Water pump bolt A	3	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Water pump bolt B	1	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Water pump bolt C	1	21.6 ~ 26.5	2.2 ~ 2.7	15.9 ~ 19.5
Water pump bolt D	1	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Water pump bolt E	1	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Water pump bolt F	1	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Water pump 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	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Water temp. control bolt	2	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Water center pipe bolt	1	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Water outlet pipe bolt	1	19.6 ~ 23.5	2.0 ~ 2.4	14.5 ~ 17.4
Water in/outlet pipe to water temp. control bolt	2	19.6 ~ 23.5	2.0 ~ 2.4	14.5 ~ 17.4
Intake and exhaust system				
Intake air hose clamp bolt	1	2.9 ~ 4.9	0.3 ~ 0.5	2.2 ~ 3.6
Air cleaner assembly bolt	3	7.8 ~ 9.8	0.8 ~ 1.0	5.8 ~ 7.2
Intake manifold bolt	8	[3.9~5.9] + [26.5~31.4]	[0.4~0.6] + [2.7~3.2]	[2.9~4.3] + [19.5~23.1]
Surge tank long bolt	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Surge tank short bolt	4	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Surge tank nut	2	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Exhaust manifold nut (LH/RH)	16	49.0 ~ 53.9	5.0 ~ 5.5	36.2 ~ 39.8
Heat protector bolt (LH/RH)	6	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Exhaust manifold stay bolt (LH/RH)	4	34.3 ~ 41.2	3.5 ~ 4.2	25.3 ~ 30.4
Muffler nut	16	39.2 ~ 58.8	4.0 ~ 6.0	28.9 ~ 43.4

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. Disconnect the LH/RH ignition coil connectors and then remove the ignition coils. (Refer to Engine Electrical System - "Ignition System")
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)
   Difference between each cylinder :
   98kPa (1.0kg/cm², 14psi) or less

   (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.

   Tightening torque:
   14.7 ~ 24.5 N.m (1.5 ~ 2.5 kgf.m, 10.8 ~ 18.1 lb-ft)
7. Install the ignition coils and ignition connectors.

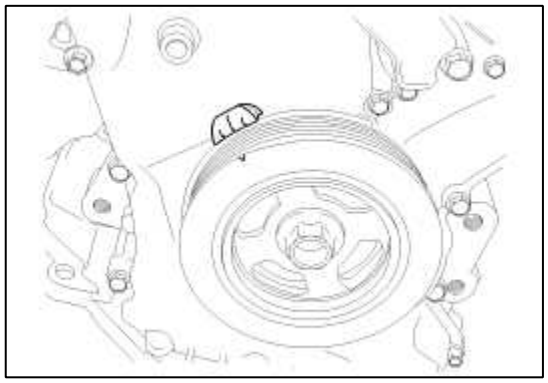
   Tightening torque:
   9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)
8. Install the surge tank. (Refer to Intake and exhaust system in this group)

Valve Clearance Inspection And Adjustment

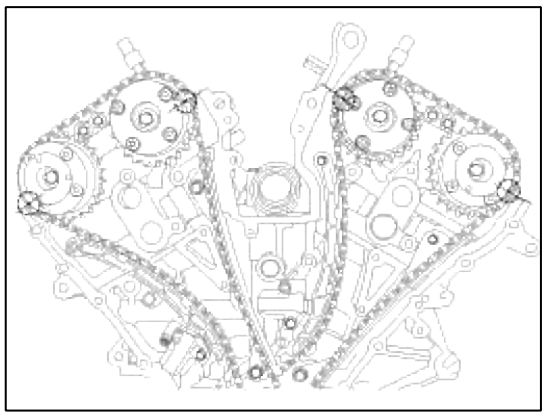
NOTE

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 air cleaner assembly. (Refer to Intake and exhaust system in this goup)
3. Remove the surge tank. (Refer to Intake and exhaust system in this group)
4. Remove the cylinder head cover. (Refer to Timing system in this group)
5. 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.



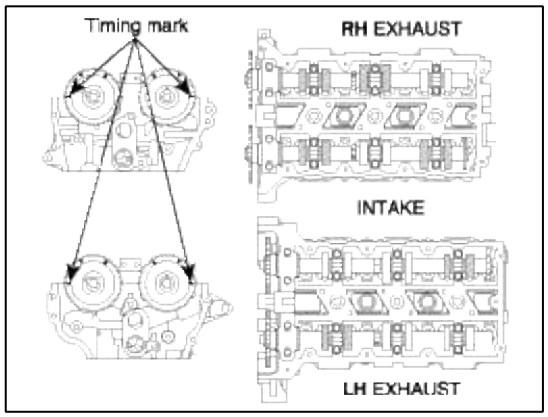
   (2) Check that the mark of the camshaft timing sprockets are in straight line on the cylinder head surface as shown in the illustration.
   If not, turn the crankshaft clockwise one revolution (360°).



NOTE

Do not rotate engine counterclockwise.

6. 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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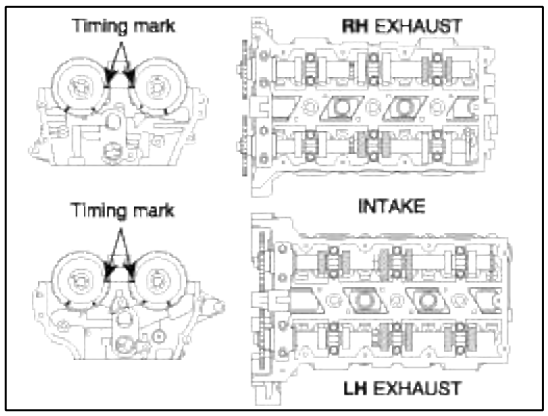
   (2) Turn the crankshaft pulley clockwise one revolution (360°) and align the groove with timing mark "T" of the lower timing chain cover.

   (3) With No.4 cylinder at TDC inspect clearances only the valves shown in diagram below. (Refer to procedure step 1.)

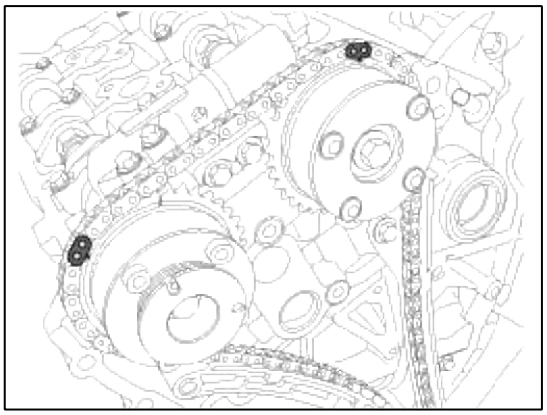


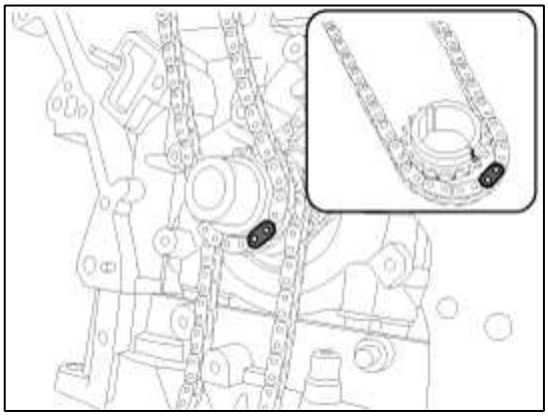
7. Adjust the intake and exhaust valve clearance.
   (1) Set the No.1 cylinder to the TDC/compression.

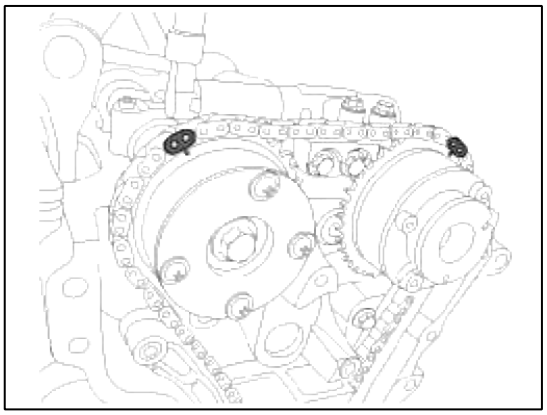
(2) Remove the timing chain. (Refer to timing system in this goup)

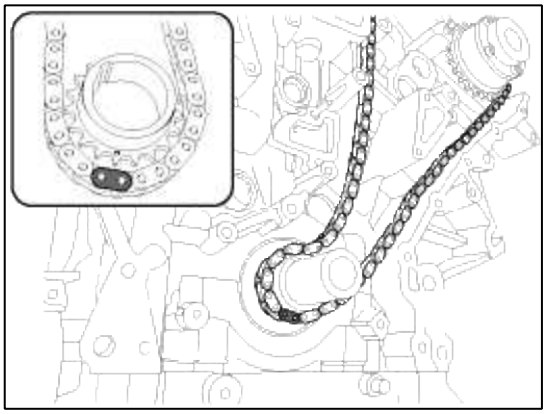
NOTE

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.

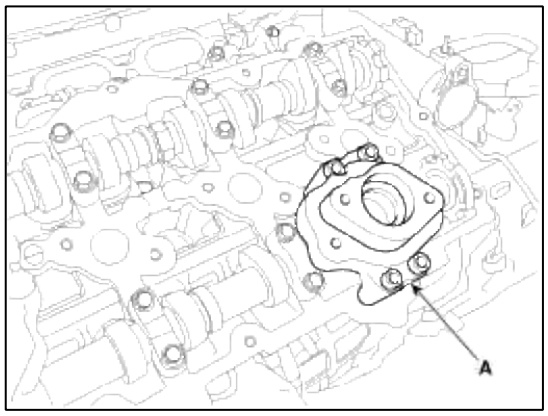




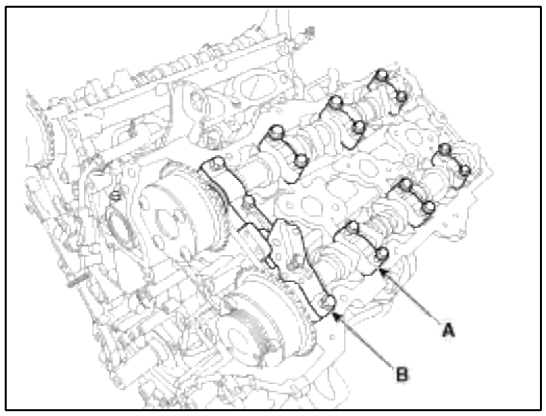


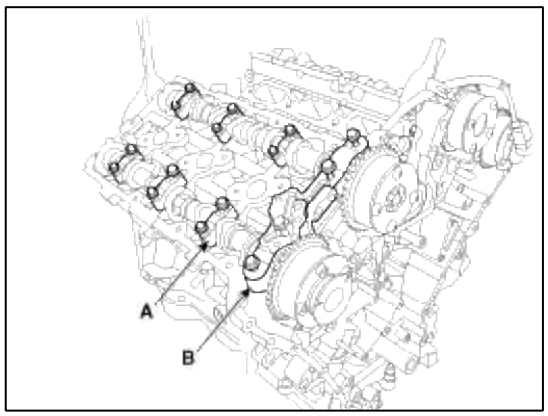


(3) Remove the fuel pump adapter (A).

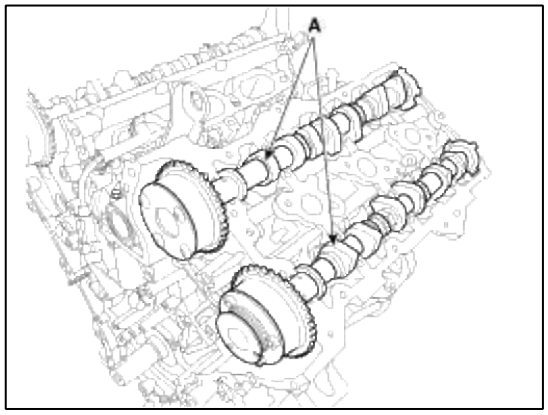


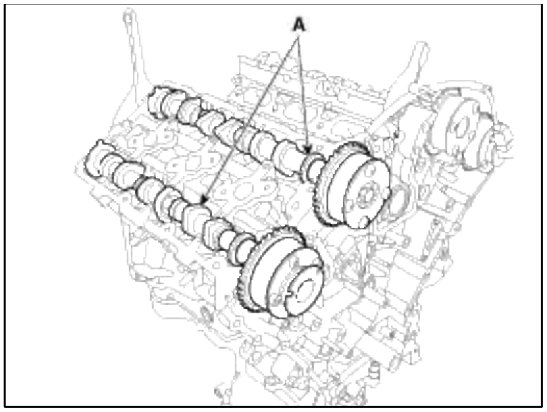
(4) Remove the LH/RH camshaft bearing cap (A) and thrust bearing cap (B).





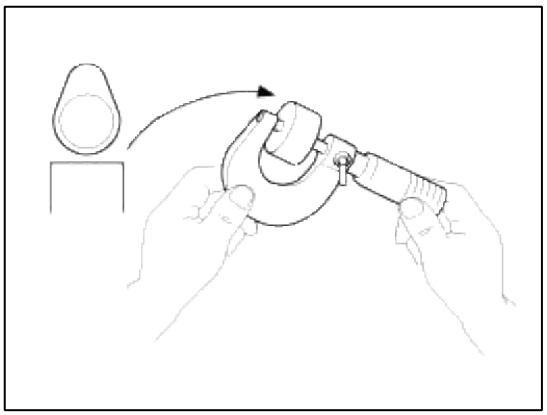
(5) Remove the LH/RH camshaft assembly (A).





(6) Remove the tappets.

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



(8) 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.)]

(9) 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.)

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

NOTE

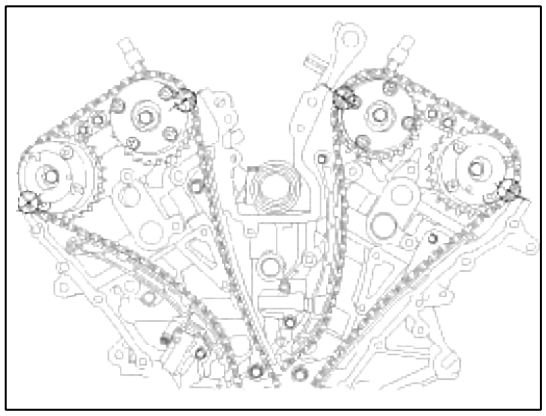
Apply engine oil at the selected tappet on the periphery and top surface.

(11) Install the intake and exhaust camshaft.

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

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

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



(15) 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

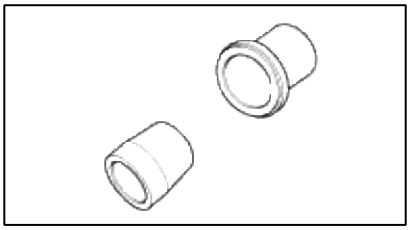
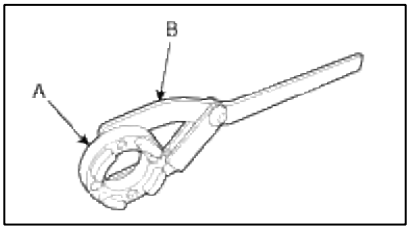
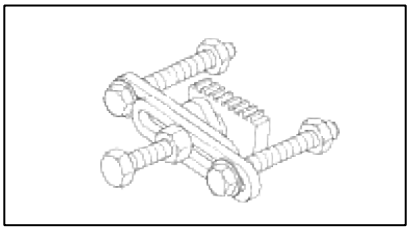
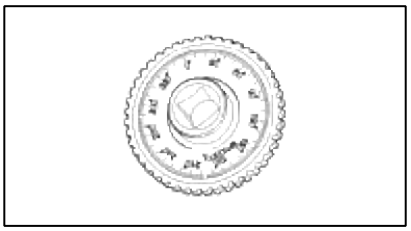
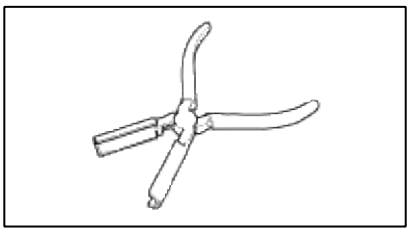
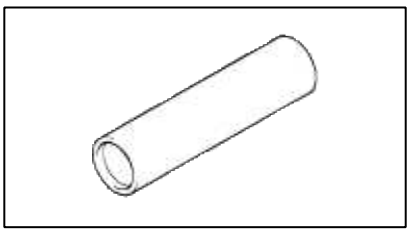
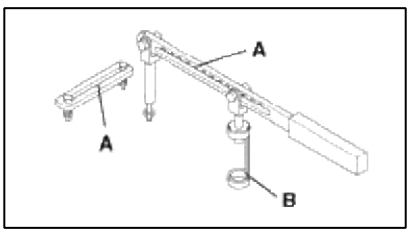
Symptom	Suspect area	Remedy
Engine misfire with abnormal internal lower engine noises.	Worn crankshaft bearings. Loose or damaged engine drive plate.	Replace the crankshaft and bearings as required. Repair or replace the drive plate as required.
	Worn piston rings. (Oil consumption may or may not cause 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	Worn valves, guides and/or valve stem oil seals.	Repair or replace as required.

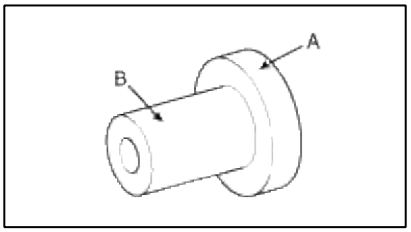
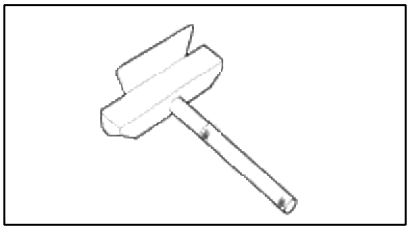
consumption.	Worn piston rings. (Oil consumption may or may not cause the engine to misfire)	• Inspect the cylinder for a loss of compression. • Repair or replace as required.
Engine noise on start-up, but only lasting a few seconds.	Incorrect oil viscosity.	• Drain the oil. • Install the correct viscosity oil.
	NOTE Minor engine clatter sound immediately upon cold start for very brief period may be normal.	
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

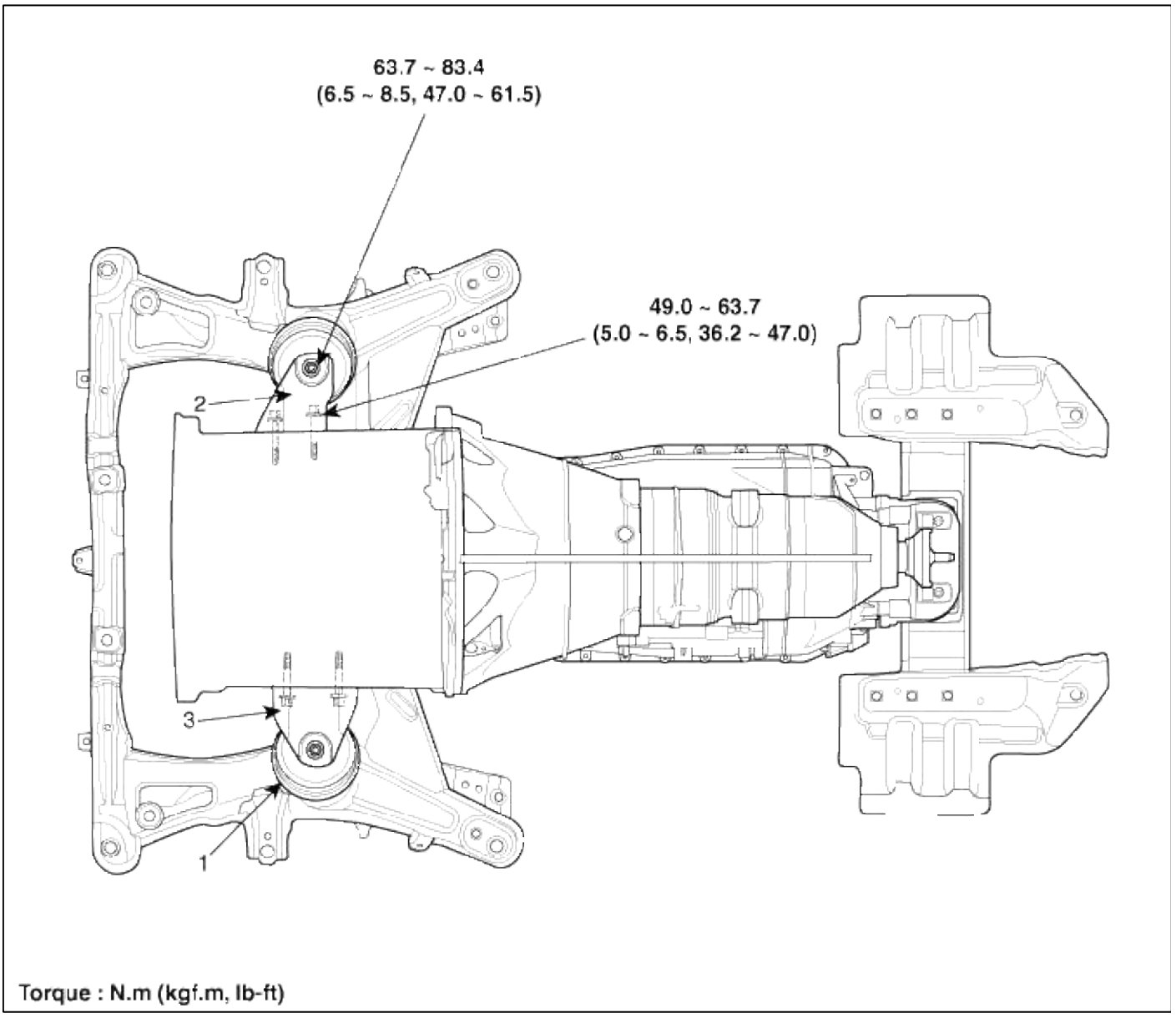
Special Service Tools

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)
Ring gear 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) (09222-3K100)		Removal and installation of the intake or exhaust valves A : 09222-3K000 B : 09222-3K100 (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



1. Engine mounting insulator 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

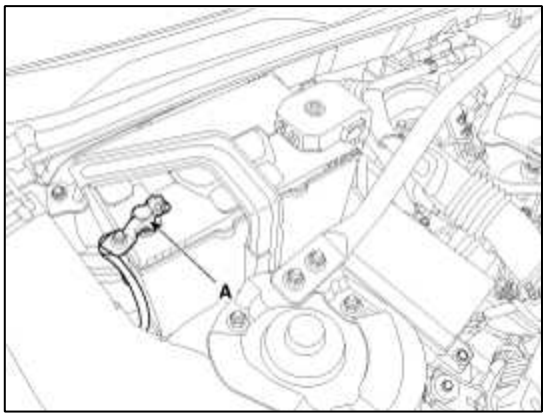
- Use fender covers to avoid damaging painted surfaces.
- To avoid damage, unplug the wiring connectors carefully while holding the connector portion.

NOTE

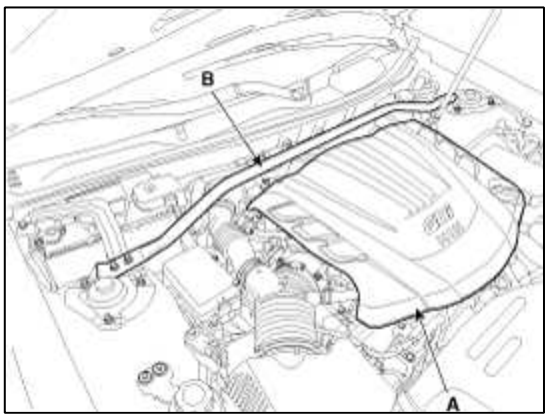
- Mark all wiring and hoses to avoid misconnection.
- For release the fuel system pressure before remove the engine assembly, start the engine without fuel pump relay. And then turn off the ignition switch after engine stops.

1. Remove the transmission before removing the engine. (Refer to Manual/Automatic Transmission System)
2. Disconnect the battery negative cable (A).

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



3. Remove the engine cover (A).
4. Remove the strut bar (B).

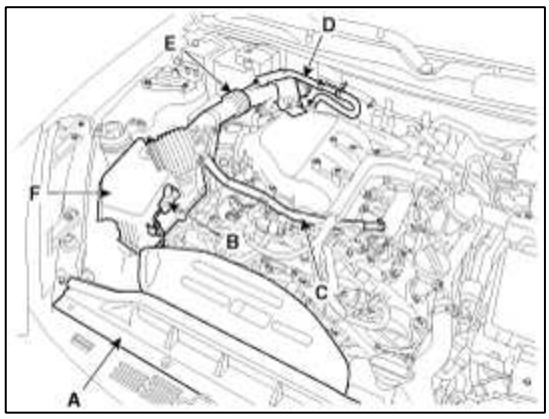


5. Loosen the drain plug and drain the engine coolant.

> WARNING
>
> 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.

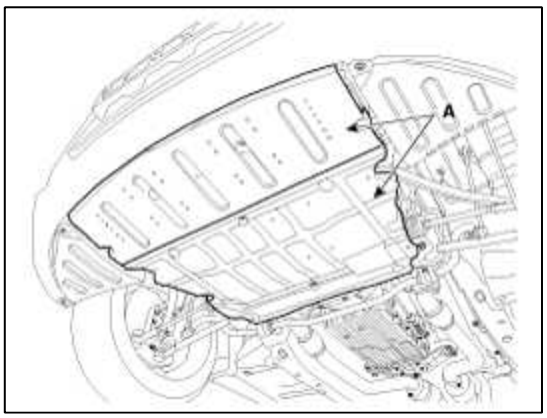
6. After recovering refrigerant, remove the high & low pressure pipe. (Refer to Heating,Ventilation, Air Conditioning - "Compressor")
7. Remove the intake air hose and air cleaner assembly.
   (1) Remove the air duct (A).
   (2) Disconnect the Barometric Pressure Sensor(BPS) connector (B).
   (3) Disconnect the breather hose (C).
   (4) Disconnect the vacuum hose (D).
   (5) Remove the intake air hose (E) and air cleaner assembly (F).

Tightening torque
Hose clamp bolt :
2.9 ~ 4.9 N.m (0.3 ~ 0.5 kgf.m, 2.2 ~ 3.6 lb-ft)
Air cleaner assembly bolts :
7.8 ~ 9.8 N.m (0.8 ~ 1.0 kgf.m, 5.8 ~ 7.2 lb-ft)

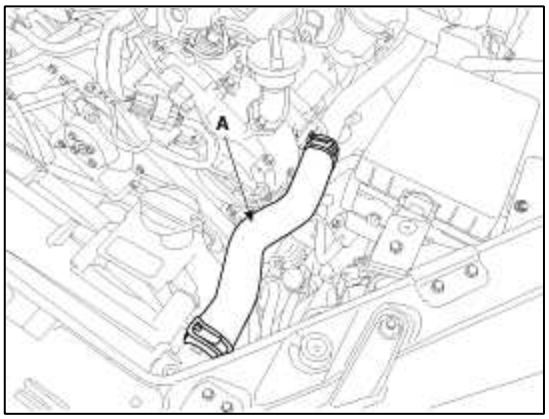


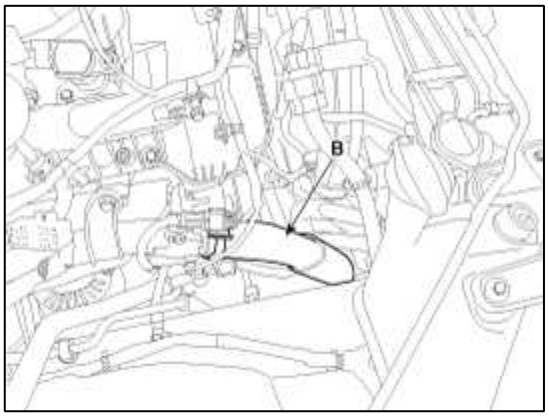
8. Remove the front wheels.
9. Remove the under covers. (A)

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

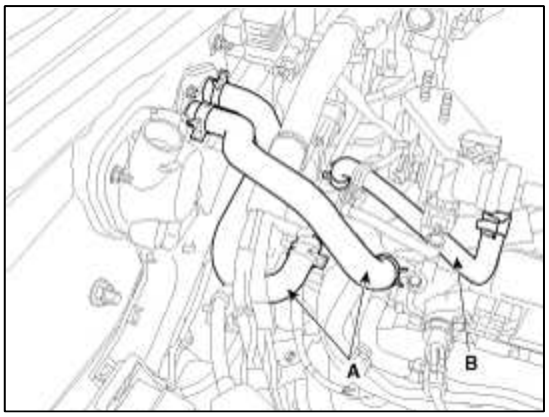


10. Remove the radiator upper hose (A) and lower hose (B).



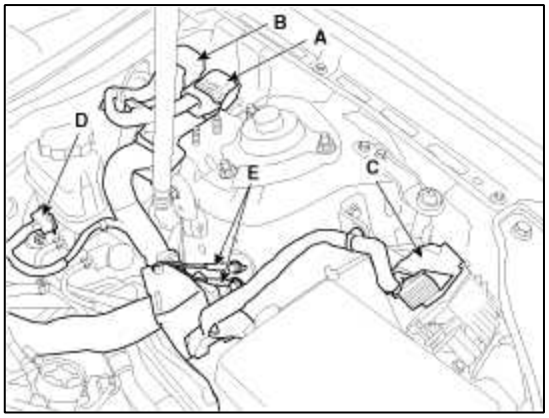


11. Disconnect the ATF cooler hoses. (Refer to Automatic Transaxle System - "Automatic Transaxle System ")
12. Disconnect the heater hoses (A).
13. Disconnect the PCSV hose (B).

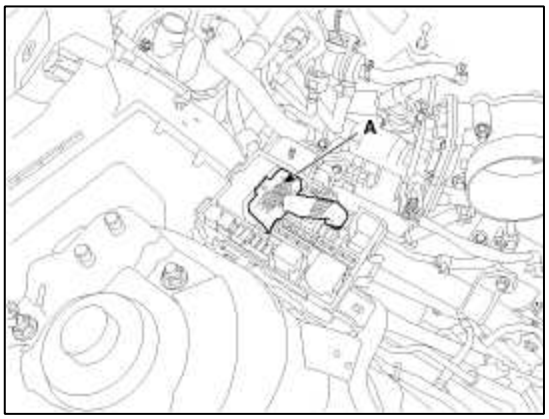


14. Disconnect the ECM connector (A), TCM connector (B), IDB connector (C), brake fluid level switch connector (D) and the ground (E).

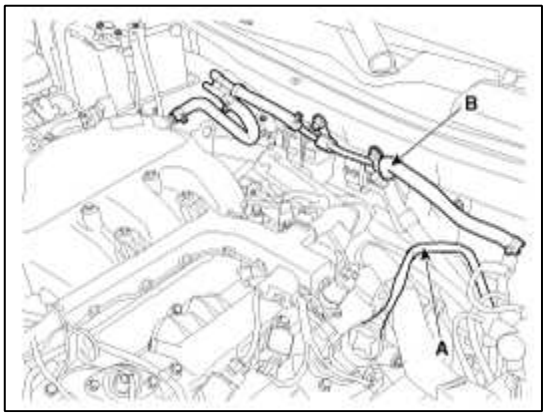
Tightening torque
Gound (E) :
10.8 ~ 13.7 N.m (1.1 ~ 1.4 kgf.m, 7.9 ~ 10.1 lb-ft)



15. Disconnect the wiring (A) from the fuse box.

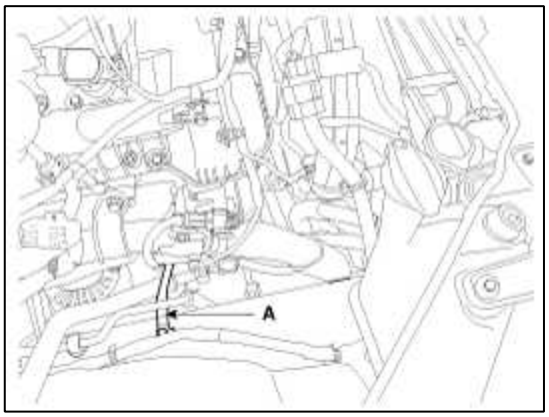


16. Disconnect the fuel hose (A). (Refer to Fuel System - "High Pressure Fuel Pump")
17. Disconnect the brake booster vacuum hose (B).



18. Disconnect the engine ground line (A).

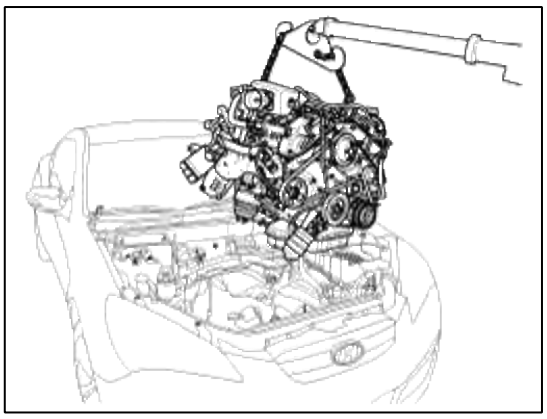
Tightening torque :
10.8 ~ 13.7N.m (1.1 ~ 1.4kgf.m, 8.0 ~ 10.1lb-ft)



19. Remove the cooling fan. (Refer to Cooling System in this group)
20. Remove the oil hose fro the power steering pump. (Refer to Steering System - "Power Steering Oil pump")
21. Disconnect the steering gear box. (Refer to Steering System - "Power Steering Gear Box")
22. Remove the engine mounting bracket nut.

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

23. Remove the hood. (Refer to Body - "Hood")
24. Remove the engine assembly by lifting the engine jack.



CAUTION

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

Installation

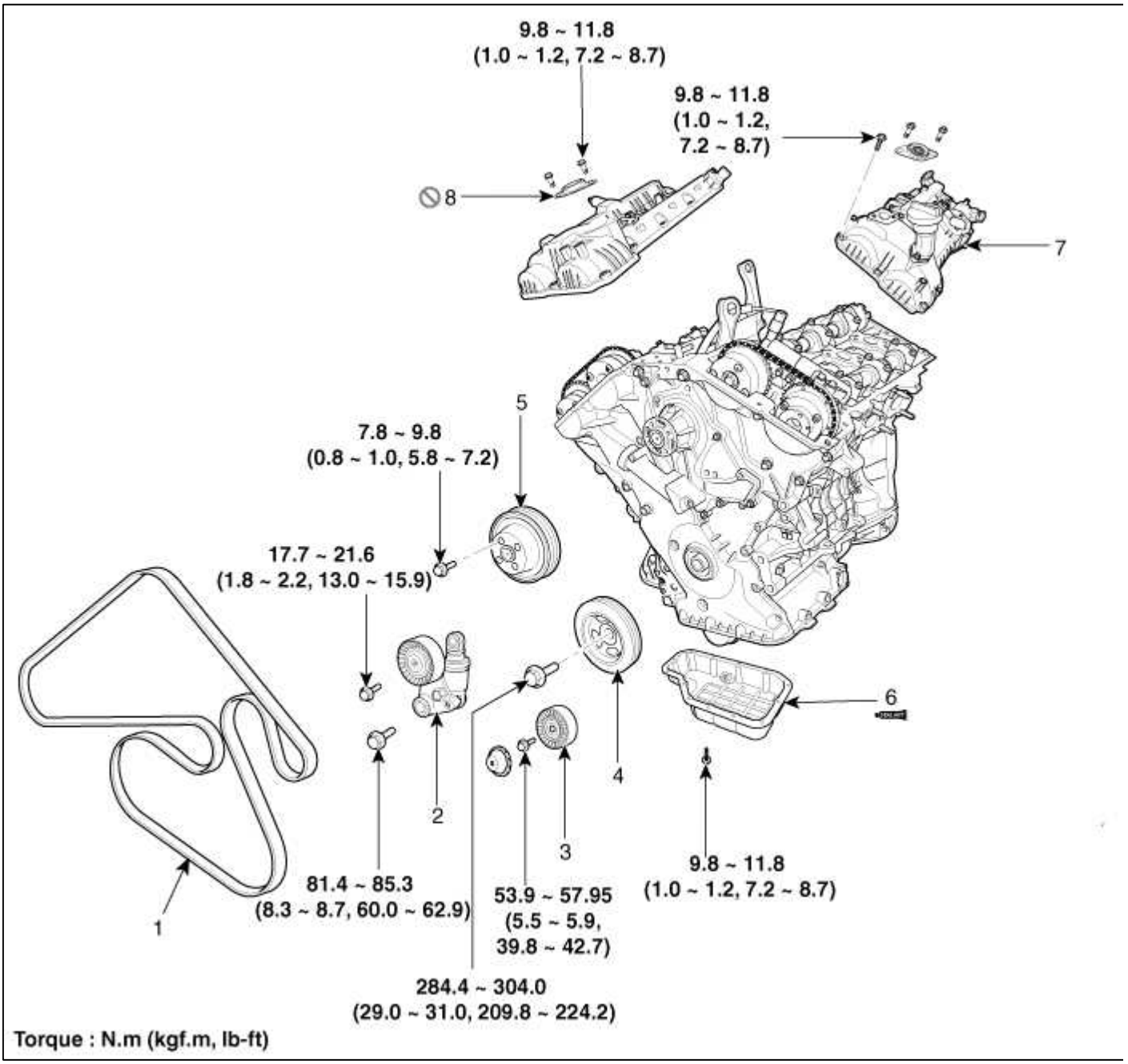
Installation is in the reverse order of removal.
Perform the following :

- 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.

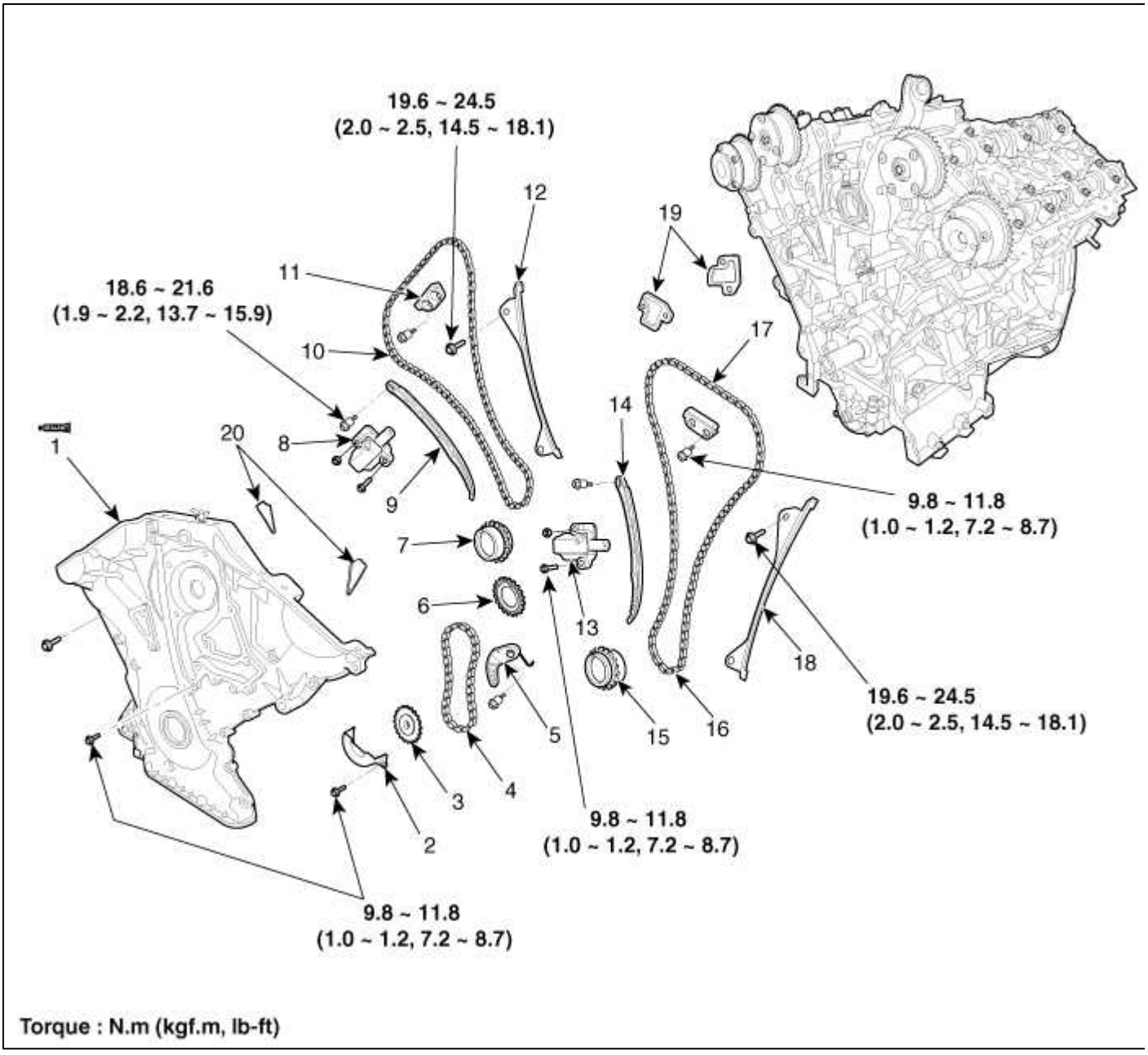
- After assembling the fuel line, turn on the ignition switch (do not operate the starter) so that the fuel pump runs for approximately two seconds and fuel line pressurizes.
- Repeat this operation two or three times, then check for fuel leakage at any point in the fuel line.
- Refill a radiator and 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 2. Drive belt tensioner 3. Idler 4. Crank shaft pulley	5. Water pump pulley 6. Oil pan 7. Cylinder head cover 8. Exhaust camshaft oil control valve (OCV) cap



1. Timing chain cover 2. Oil pump chain cover 3. Oil pump sprocket 4. Oil pump chain 5. Oil pump tensioner assembly 6. Crankshaft oil pump sprocket 7. Crankshaft RH chain sprocket	8. RH Timing chain auto tensioner 9. RH Timing chain tensioner arm 10. RH Timing chain 11. RH cam to cam guide 12. RH Timing chain guide 13. LH Timing chain auto tensioner 14. LH Timing chain tensioner arm	15. Crankshaft LH chain sprocket 16. LH Timing chain 17. LH cam to cam guide 18. LH Timing chain guide 19. Tensioner adapter 20. Gasket

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

Removal

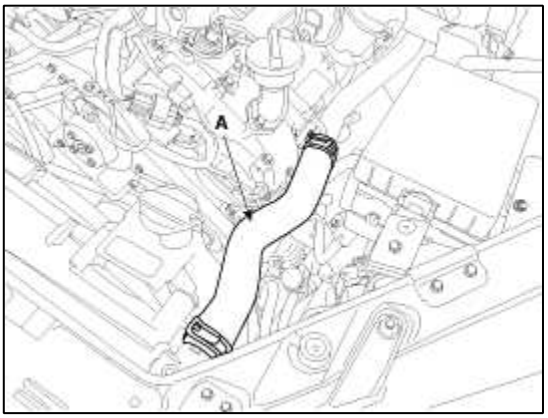
CAUTION

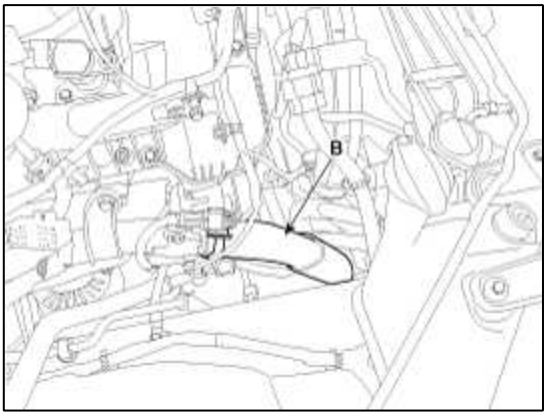
- Use fender covers to avoid damaging painted surfaces.
- To avoid damage, unplug the wiring connectors carefully while holding the connector portion.

NOTE

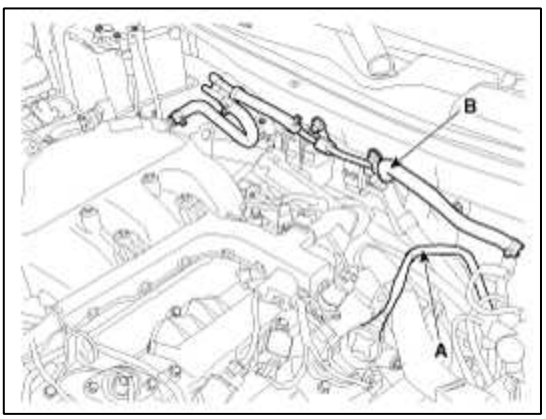
- Mark all wiring and hoses to avoid misconnection.
- Turn the crankshaft pulley so that the No.1 piston is at top dead center.

1. Disconnect the battery negative cable.
2. Loosen the drain plug and drain the engine coolant.
3. Remove the intake air hose and air cleaner assembly. (Refer to Intake And Exhaust System in this group)
4. Remove the radiator upper hose (A) and lower hose (B).



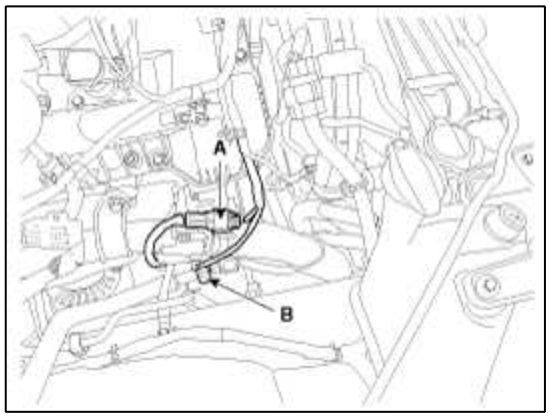


5. Disconnect the fuel hose (A). (Refer to FL group - "High Pressure Fuel Pump")
6. Disconnect the brake booster vacuum hose (B).

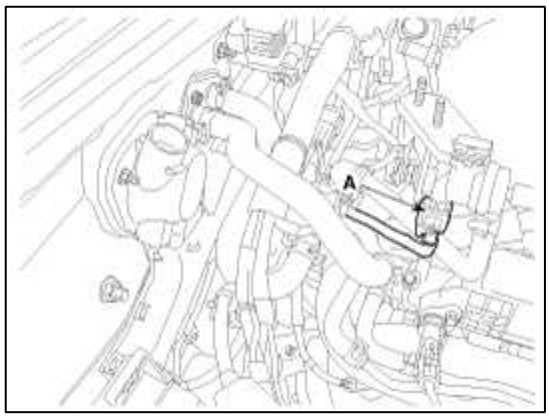


7. Remove the cooling fan. (Refer to Cooling System in this goup)
8. Disconnect the engine wiring harness connectors and hoses.
   (1) RH knock sensor connector (A)

(2) Power steering switch connector (B)



(3) PCSV connector (A)



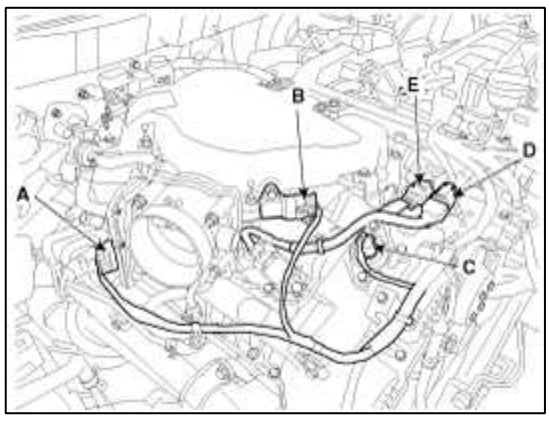
(4) ETC connector (A)

(5) MAP sensor connector (B)

(6) RH exhaust camshaft oil control valve (OCV) connector (C)

(7) RH ignition connector (D)

(8) RH injector connector (E)



(9) LH exhaust camshaft oil contrl valve (OCV) connector (A)

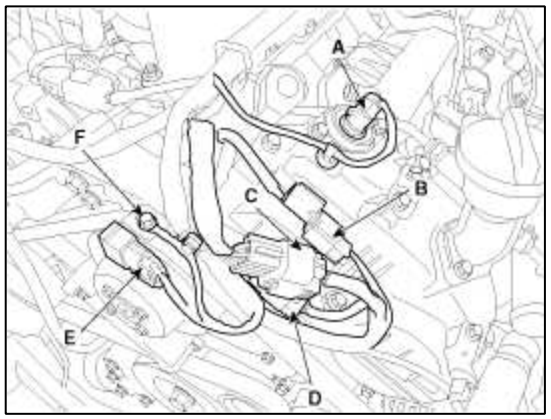
(10) Oil pressure connector (B)

(11) LH injector connector (C)

(12) LH/RH intake camshaft oil control valve connector (D)

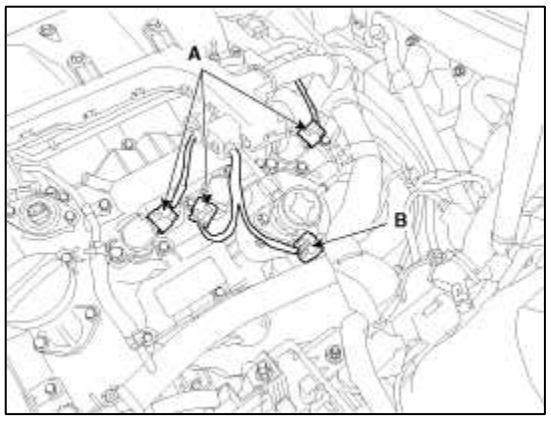
(13) Ignition coil condenser connector (E)

(14) Grounbg line (F)



(15) LH ignition coil connector (A)

(16) Fuel pressure control valve (B)



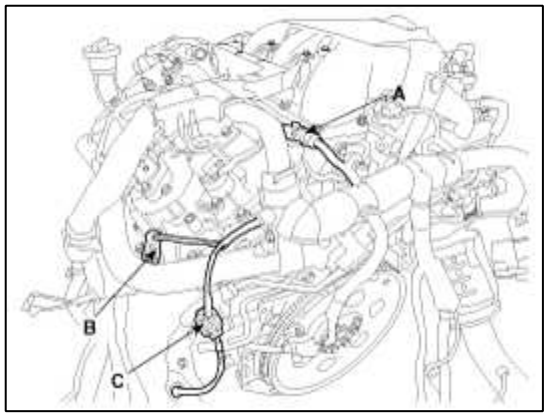
(17) LH intake camshaft position sensor (CMPS) connector (A)

(18) LH exhaust camshaft position sensor (CMPS) connector (B)

(19) LH front oxygen sensor connector (C)

(20) Crankshaft position sensor connector

(21) LH knock sensor connector



(22) Water temperature sensor connector (A)

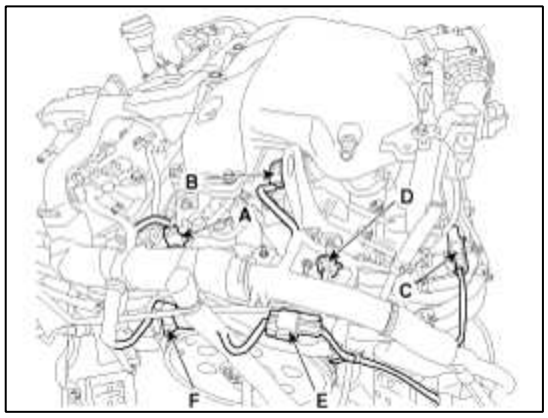
(23) RH intake camshaft position sensor (CMPS) connector (B)

(24) RH exhaust camshaft position sensor (CMPS) connector (C)

(25) Oil temperature sensor connector (D)

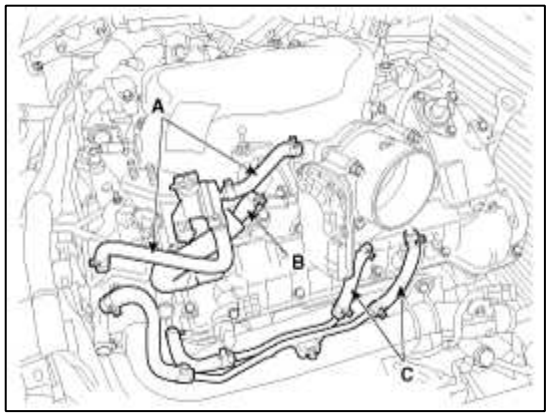
(26) RH front oxygen sensor connector (E)

(27) Ignition coil condenser connector (F)

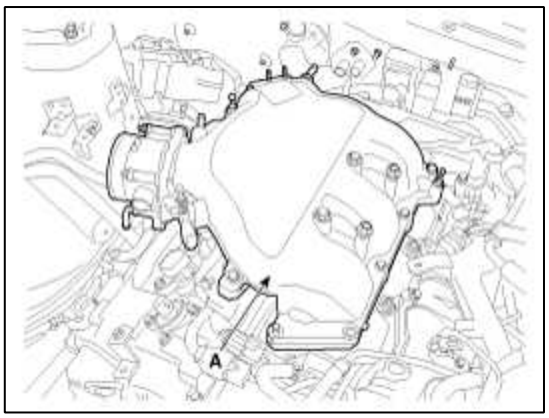


(28) PCSV hose (A), PCV hose (B)

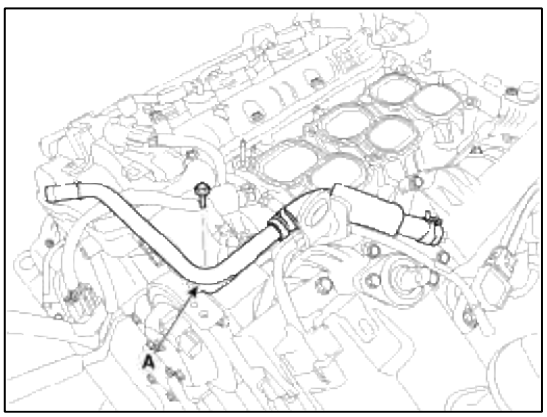
(29) Throttle body water hose (C)



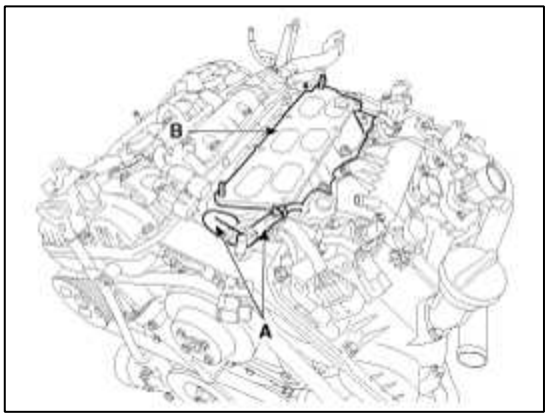
9. Remove the surge tank assembly (A).



10. Remove the breather pipe & hose (A).



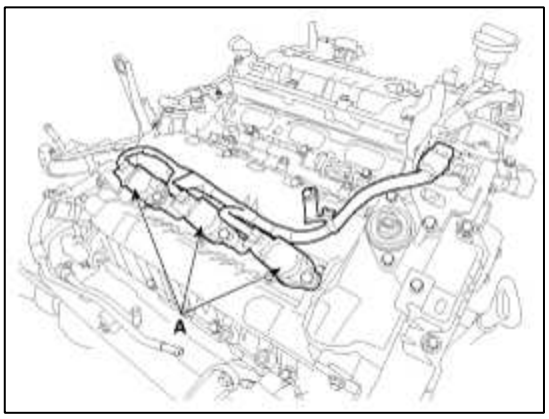
11. Disconnect the water hose & pipe (A) and then remove the intake manifold (B).



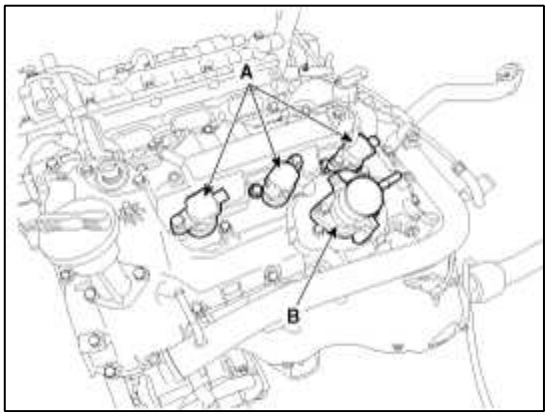
CAUTION

- 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.

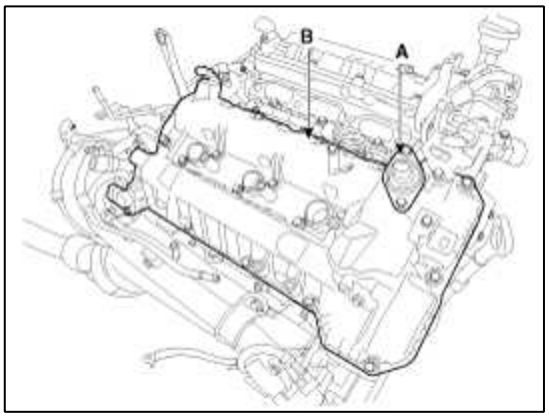
12. Remove the high pressure fuel pipe. (Refer to FL group - "High Pressure Fuel Pump")
13. Remove the RH ignition coils (A) and the wiring.



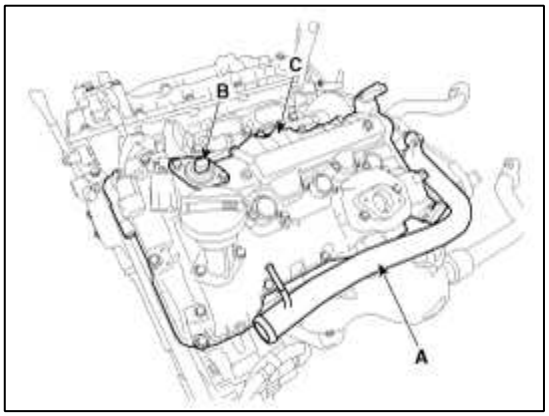
14. Remove the LH ignition coils (A) and the wiring.
15. Remove the fuel pump (B) and the roller tappet (C). (Refer to FL group - "High Pressure Fuel Pump")



16. Remove the LH cylinder head cover (B) after remove the OCV cap (A).



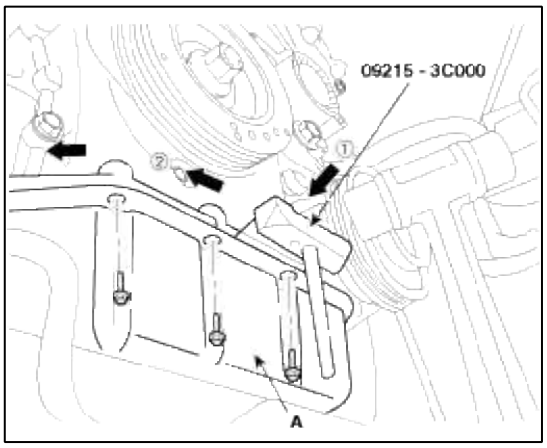
17. Disconnect th water outlet pipe (A).
18. Remove the RH cylinder head cover (C) after remove the OCV cap (B).



NOTE

Cover the cylinder head with a clean woven stuff or vinyl cover to prevent foreign materials from entering.

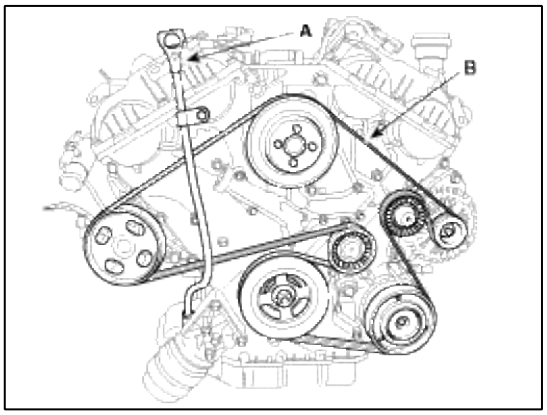
19. Drain the engine oil. (Refer to Lubrication system in this group)
20. Remove the lower oil pan (A).
    Insert the blade of SST(09215-3C000) between the upper oil pan and lower oil pan. Cut off applied sealer and remove the lower oil pan.



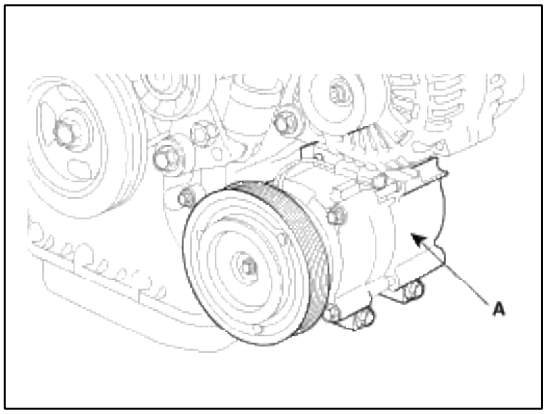
NOTE

- 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.

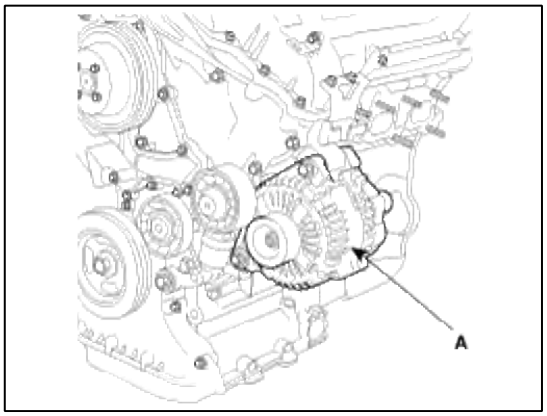
21. Remove the drive belt (B) after removing the oil level gauge (A).



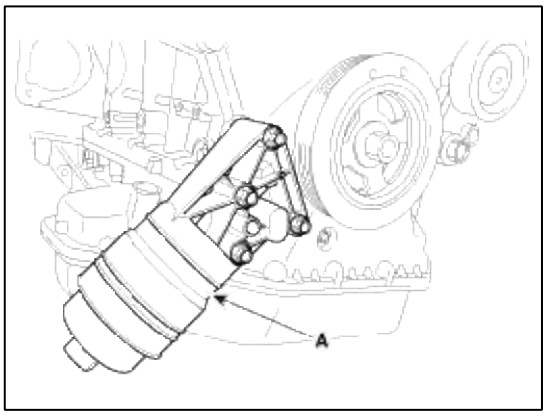
22. Remove the air conditioner compressor (A). (Refer to Heating,Ventilation, Air Conditioning - "Compressor")



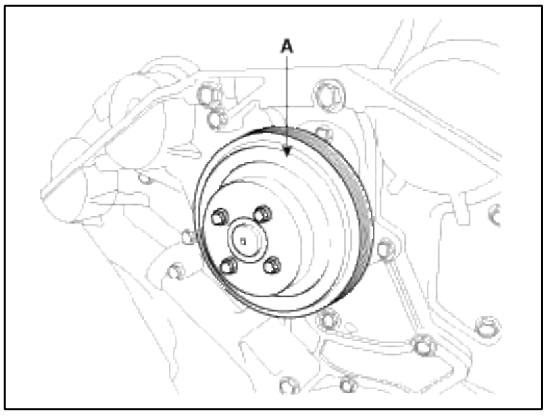
23. Remove the alternator (A). (Refer to Engine Electrical System - "Alternator")



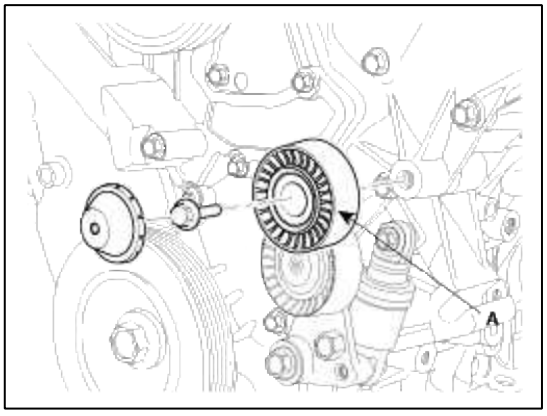
24. Remvoe the oil filter body (A).



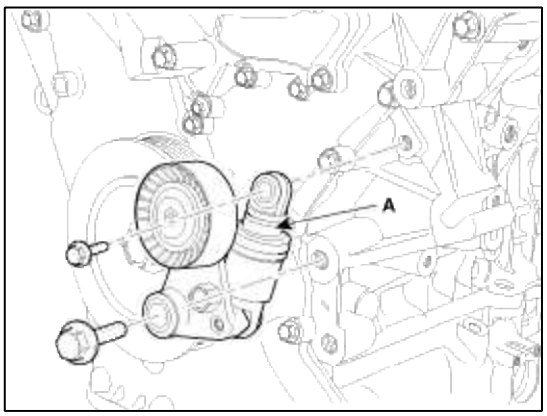
25. Remove the water pump pulley (A).



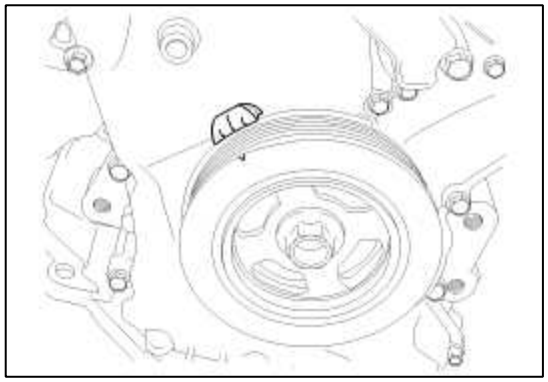
26. Remove the drive belt idler (A).



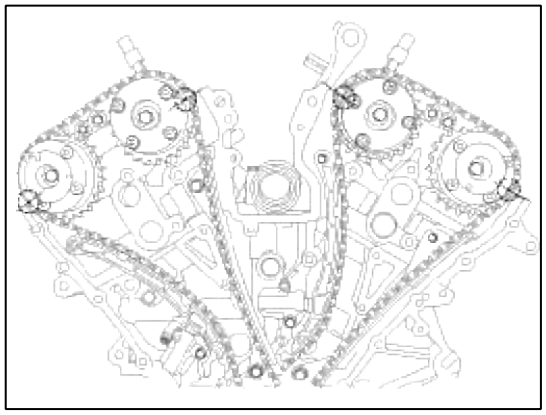
27. Remove the drive belt auto tensioner (A).



28. 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.

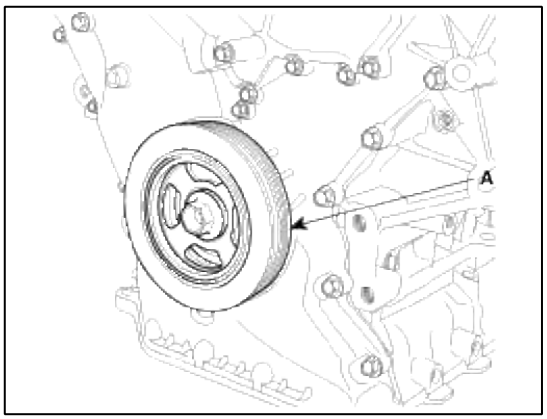


    (2) Check that the mark of the camshaft timing sprockets are in straight line on the cylinder head surface as shown in the illustration. If not, turn the crankshaft clockwise one revolution (360°).

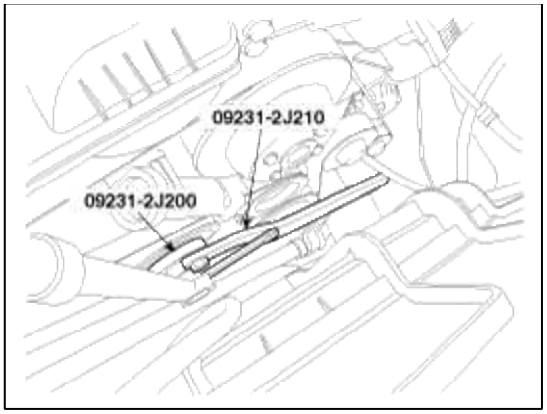


> NOTE
>
> Do not rotate engine counterclockwise.

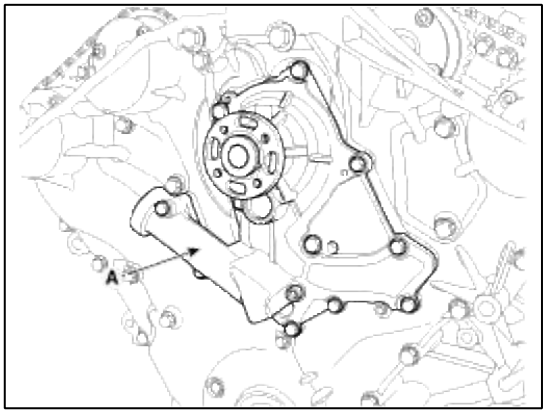
29. Remove the crankshaft pulley (A).

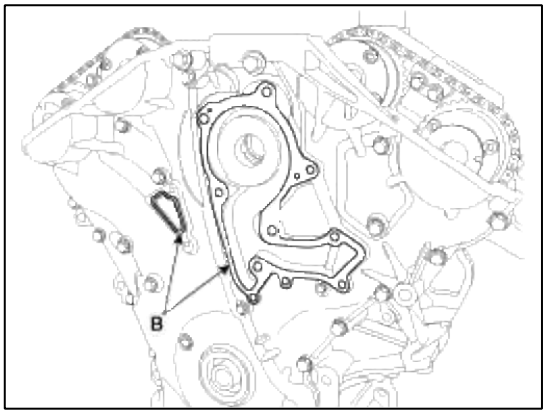


> NOTE
>
> Use the SST(09231-2J210, 09231-2J200) fix the crankshaft pulley.

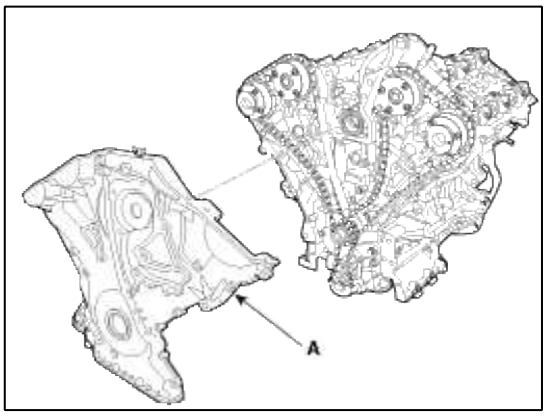


30. Remove the water pump (A) and the gaskets (B).





31. Remove the timing chain cover (A).

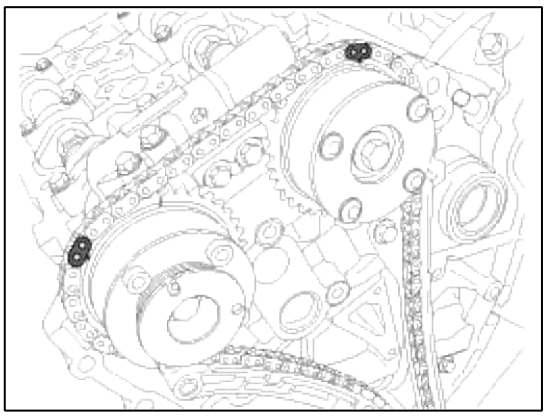


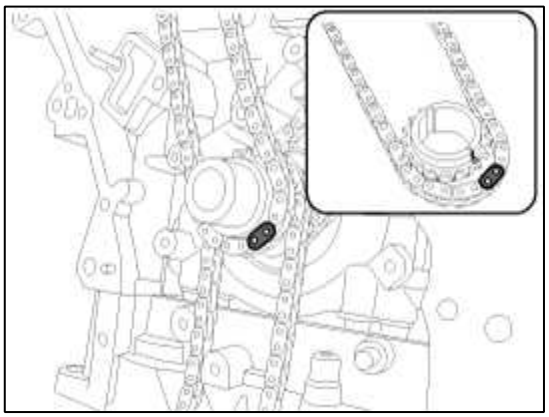
CAUTION

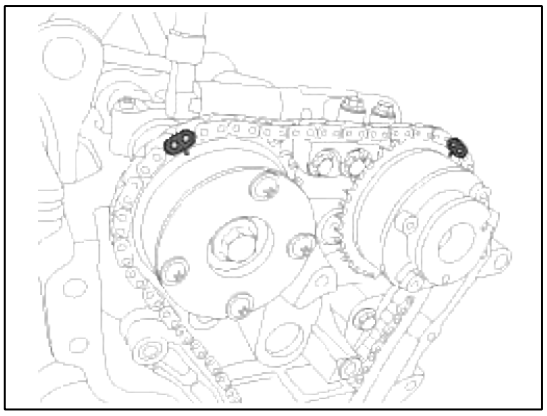
Be careful not to damage the contact surfaces of cylinder block, cylinder head and timing chain cover.

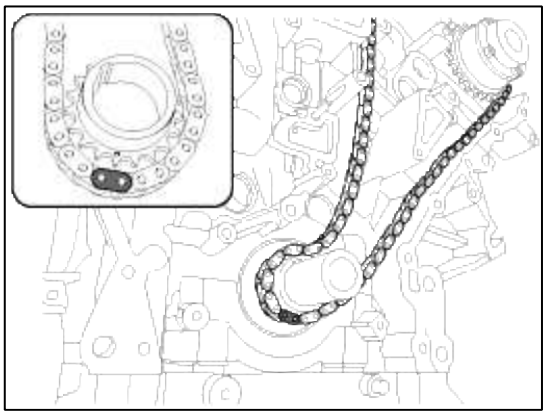
NOTE

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.

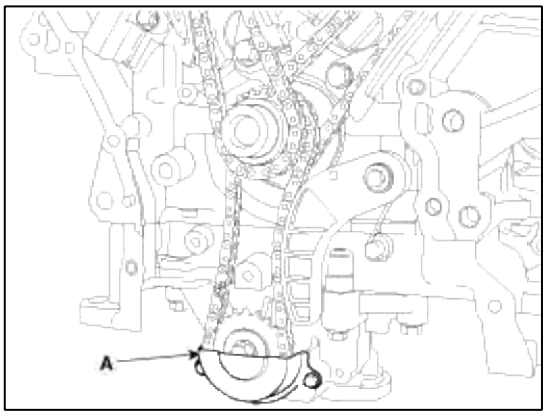




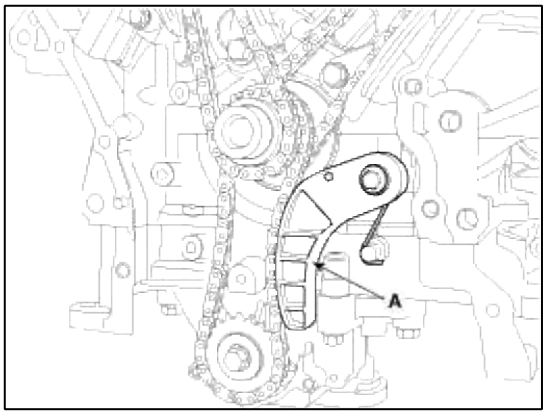




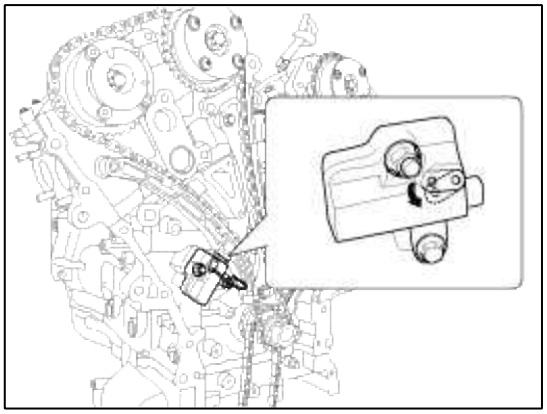
32. Remove the oil pump chain cover (A).



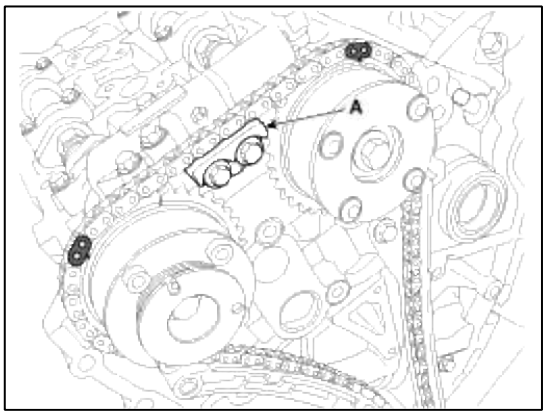
33. Remove the oil pump chain tensioner assembly (A).



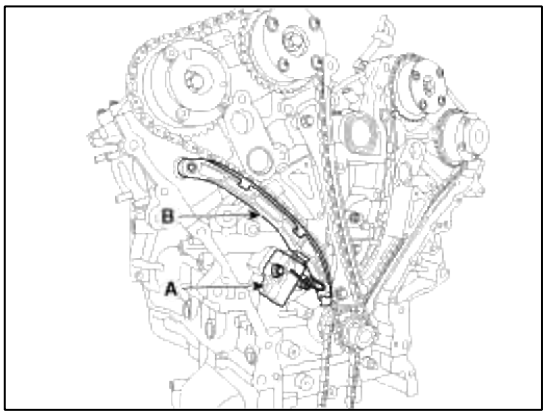
34. Release the ratchet using a thin rod.
    Compress the piston and then insert a stopper pin into the hole on the ratchet to hold the compressed piston.



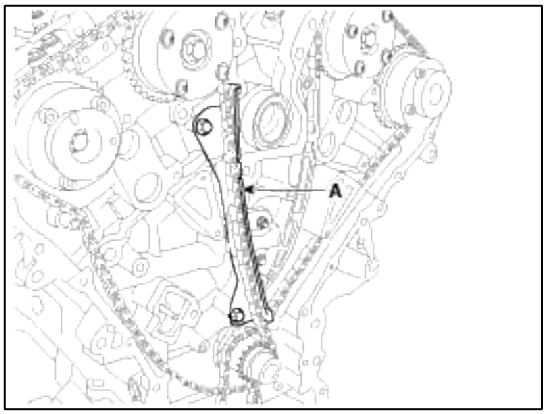
35. Remove the RH timing chain cam to cam guide (A).



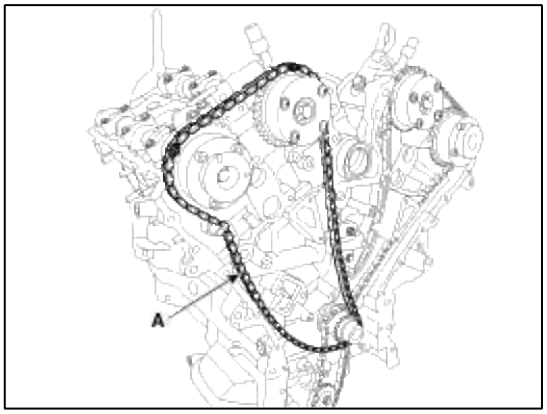
36. Remove the RH timing chain auto tensioner (A) and the RH timing chain tensioner arm (B).



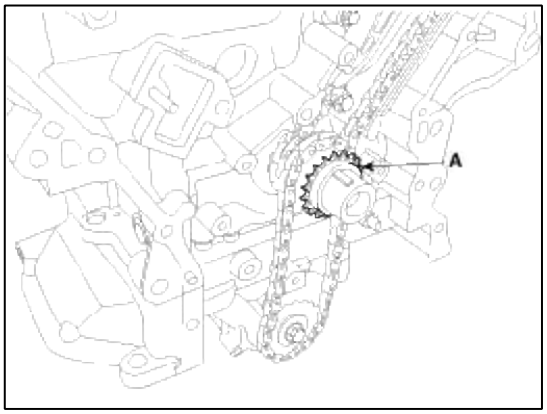
37. Remove the RH timing chain guide (A).



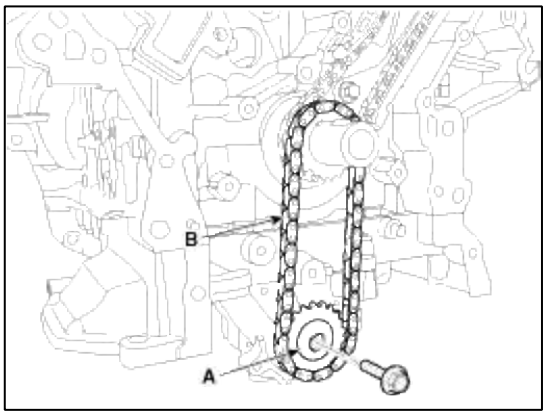
38. Remove the RH timing chain (A).



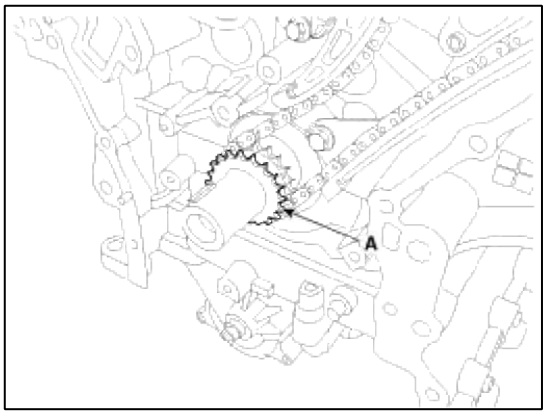
39. Remove the crankshaft RH timing chain sprocket (A).



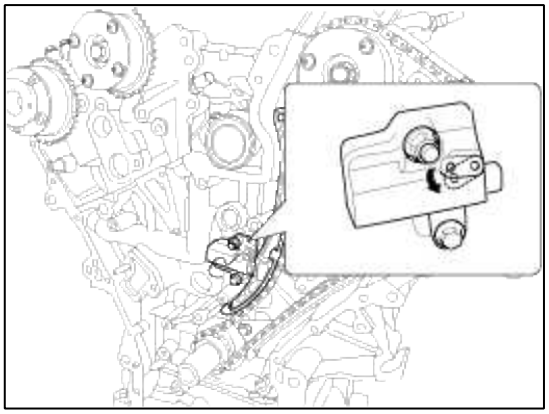
40. Remove the oil pump chain sprocket (A) and oil pump chain (B).



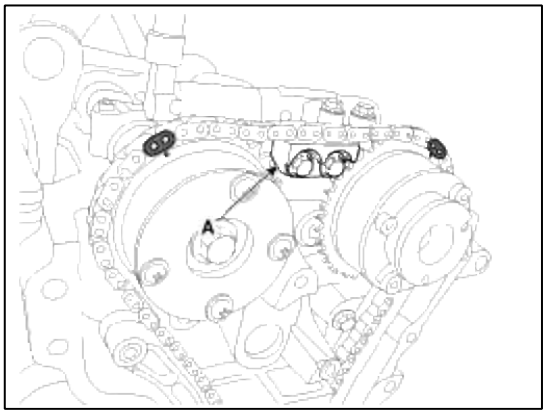
41. Remove the crankshaft oil pump chain sprocket (A).



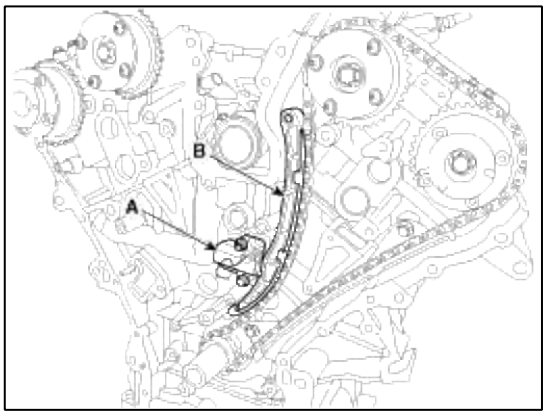
42. Release the ratchet using a thin rod.
    Compress the piston and then insert a stopper pin into the hole on the ratchet to hold the compressed piston.



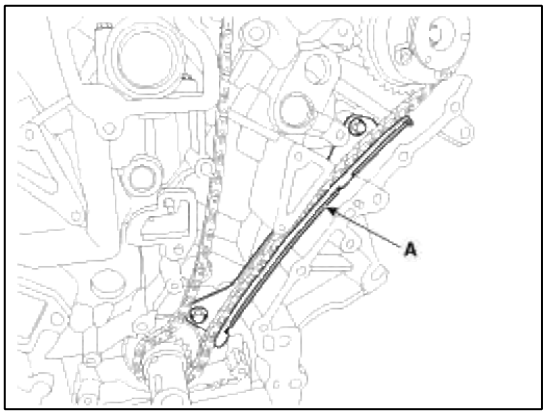
43. Remove the LH timing chain cam to cam guide (A).



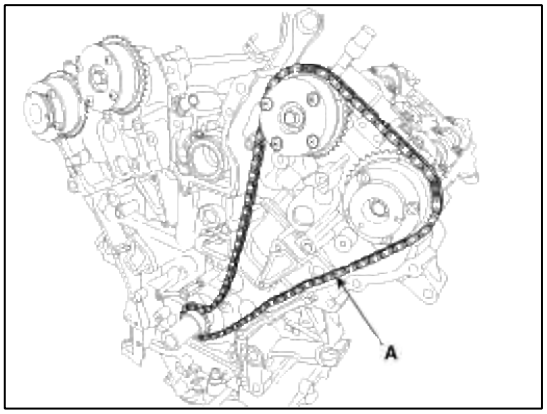
44. Remove the LH timing chain auto tensioner (A) and LH timing chain tensioner arm (B).



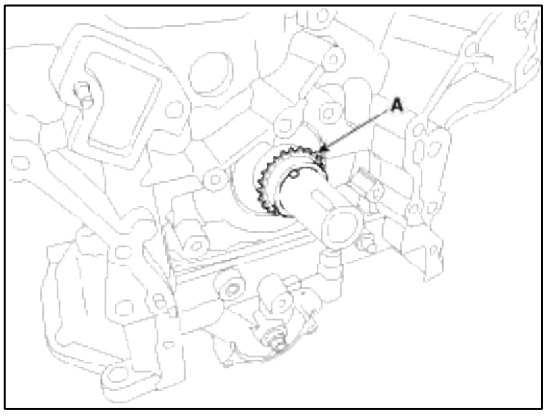
45. Remove the LH timing chain guide (A).



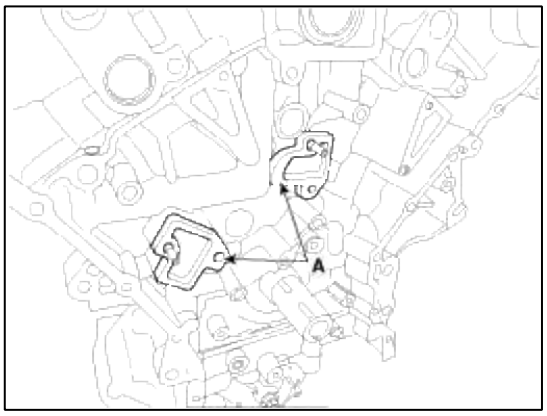
46. Remove the timing chain (A).



47. Remove the crankshaft LH timing chain sprocket (A).



48. Remove the tensioner adapter assembly (A).



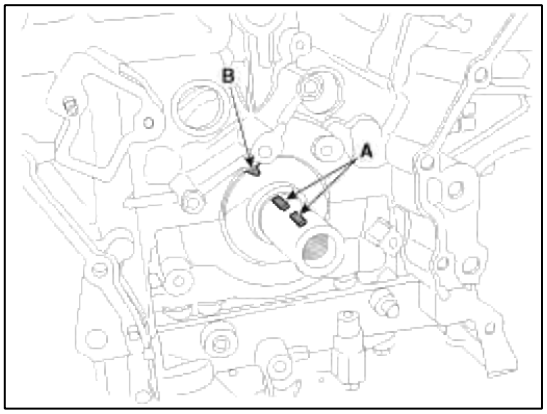
Inspection

Sprockets, Chain Tensioner, Chain Guide, Chain Tensioner Arm

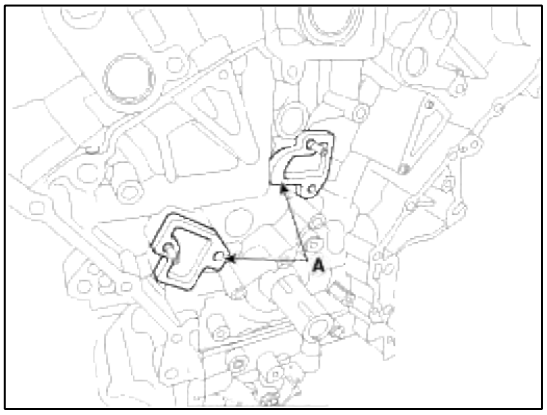
1. Check the camshaft sprocket and crankshaft sprocket for abnormal wear, cracks, or damage. Replace as necessary.
2. Inspect the tensioner arm and chain guide for abnormal wear, cracks, or damage. Replace as necessary.
3. Check that the tensioner piston moves smoothly when the ratchet pawl is released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

Installation

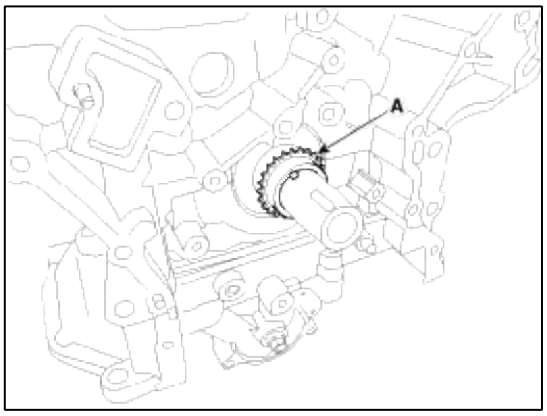
1. The key (A) of crankshaft should be aligned with the timing mark (B) of cylinder block. As a result of this, the piston of No.1 cylinder is placed at the top dead center on compression stroke.



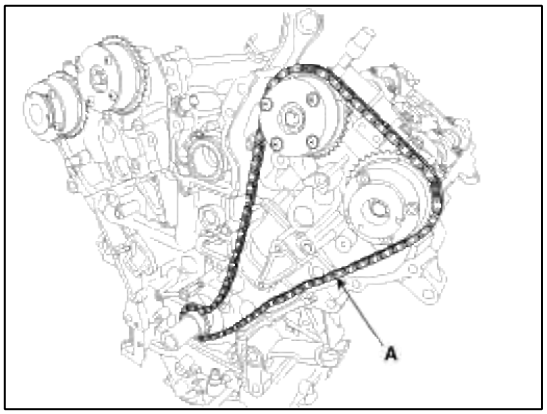
2. Install the tensioner adapter assembly (A).

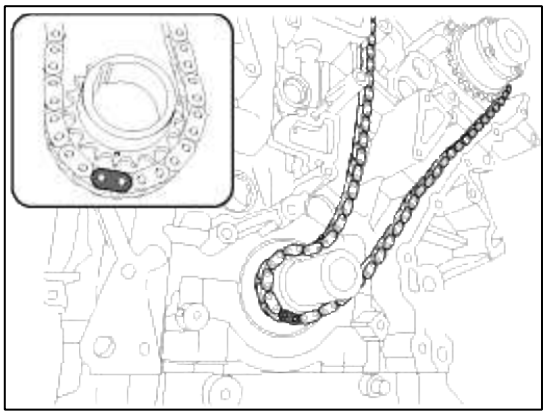


3. Install the crankshaft LH timing chain sprocket (A).



4. Install the LH timing chain (A).



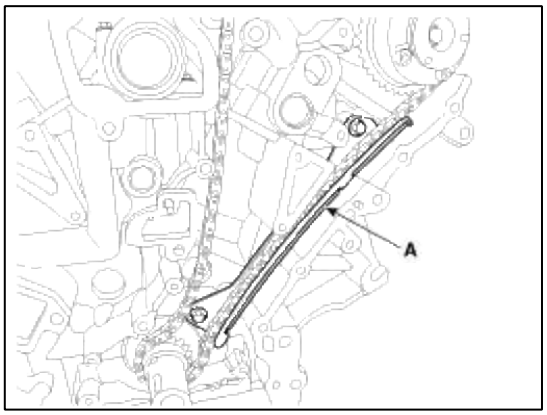


NOTE

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.

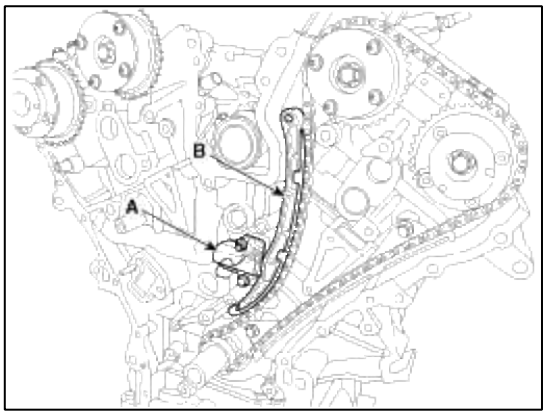
5. Install the LH timing chain guide (A).

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



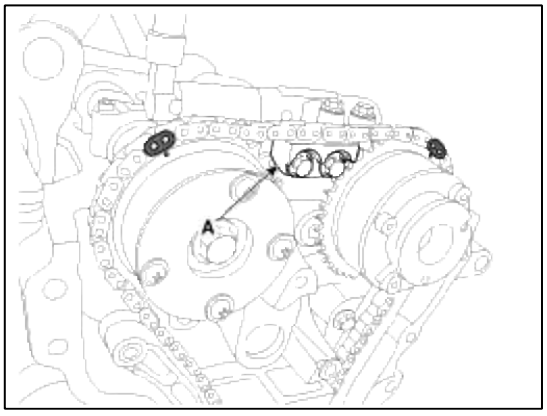
6. Install the LH timing chain tensioner arm (B) and LH timing chain auto tensioner (A).

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)

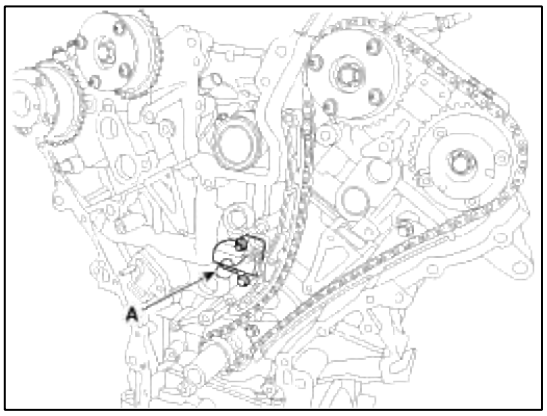


7. Install the LH timing chain cam to cam guide (A).

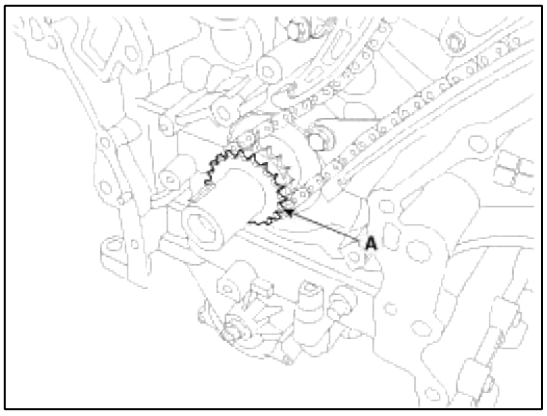
Tightening torque :
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)



8. Remove the tensioner stopper pin (A).

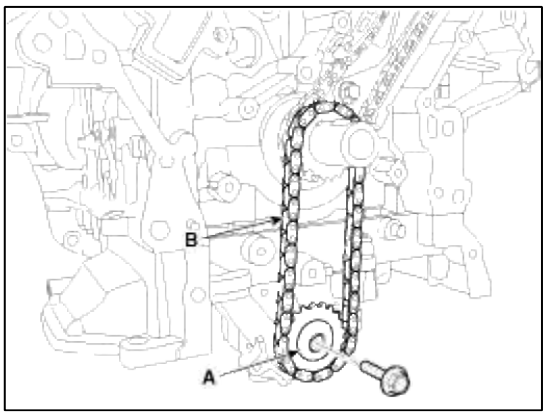


9. Install the crankshaft oil pumpchain sprocket (A).

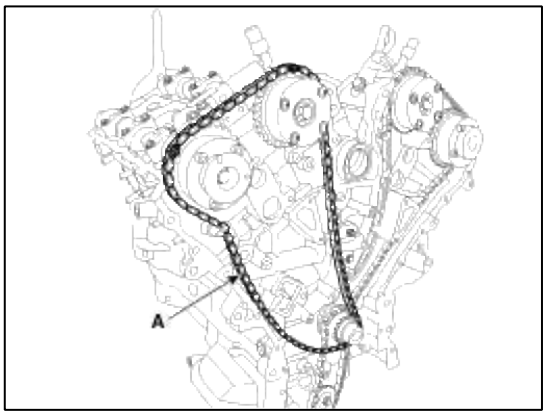


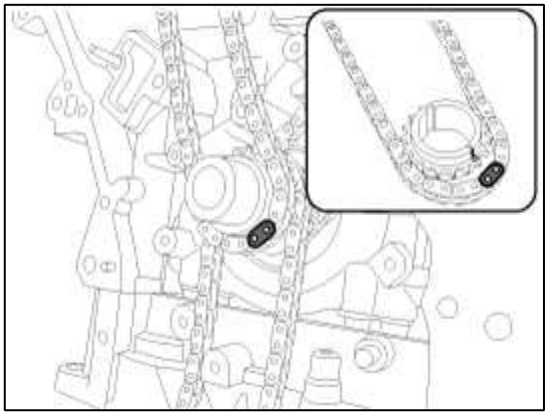
10. Install the oil pump chain sprocket (A) with oil pump chain (B).

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



11. Install the RH timing chain (A).



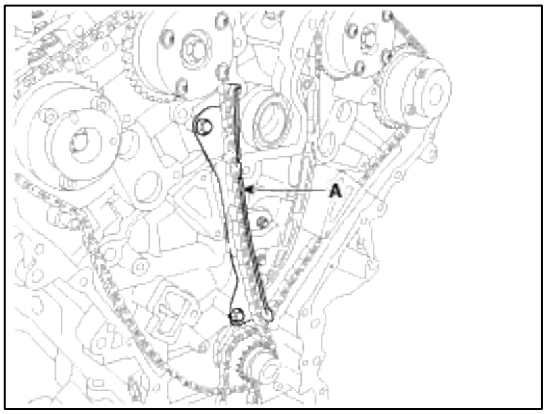


NOTE

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.

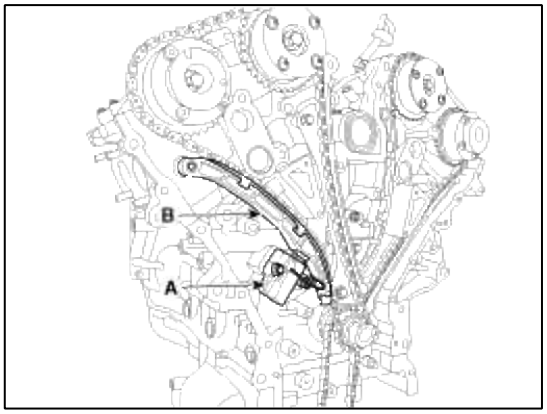
12. Install the RH timing chain guide (A).

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



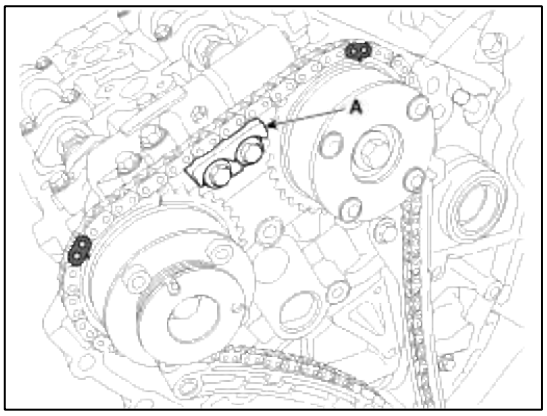
13. Install the RH timing chain tensioner arm (B) and RH timing chain auto tensioner (A).

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)

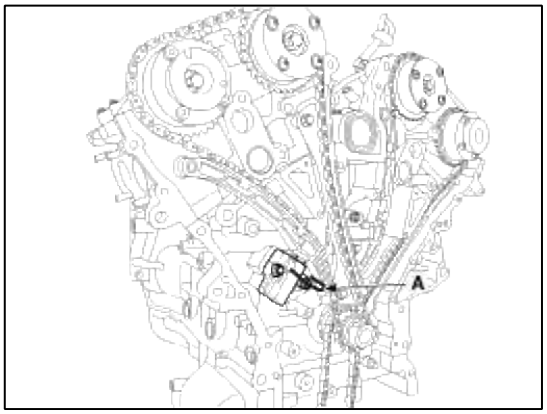


14. Install the RH timing cam to cam guide (A).

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

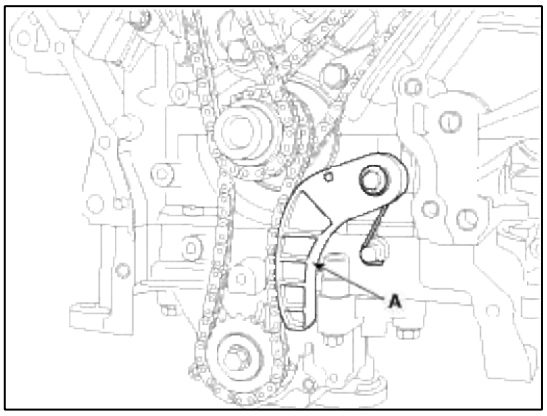


15. Remove the tensioner stopper pin (A).



16. 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)

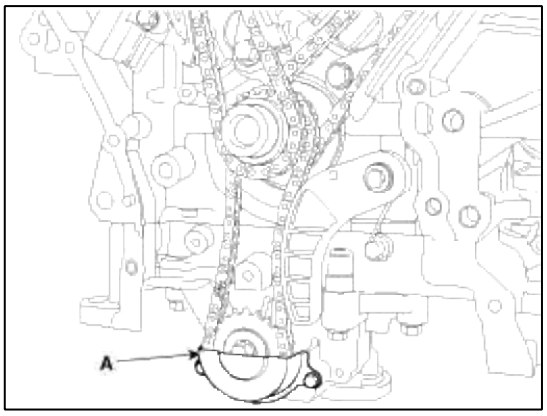


NOTE

The hook of tensioner must be around the guide.

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

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



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

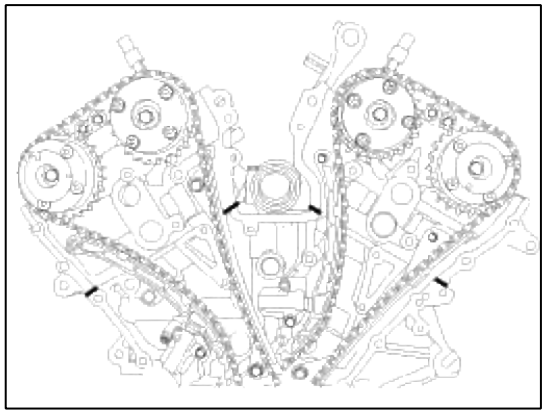
NOTE

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.

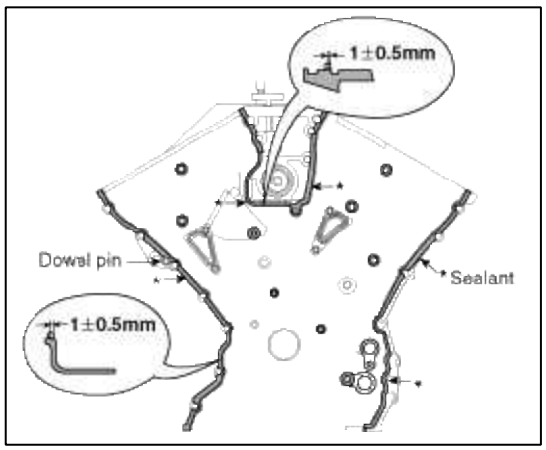
19. Install the timing chain cover.
    (1) The sealant locations on chain cover and on counter parts (cylinder head, cylinder block, and lower oil pan) must be free of engine oil and etc.

(2) Before assembling the timing chain cover, the liquid sealant TB 1217H (Hyundai Gray RTV) 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.)



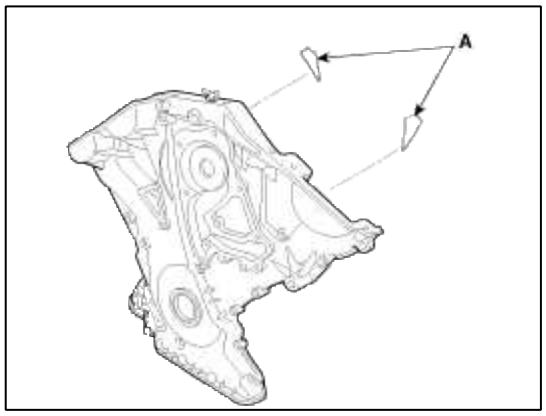
(3) After applying liquid sealant TB 1217H (Hyundai Gray RTV) on timing chain cover. The part must be assembled within 5 minutes after sealant was applied.
Sealant should be applied without discontinuity.



NOTE

- Fill the T-joint area (6EA*) with sealant.
- Apply sealant all around the dawel pin hole (2EA).

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



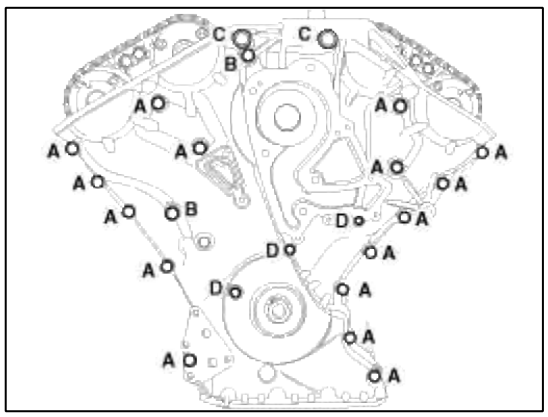
NOTE

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 to be in exact position.

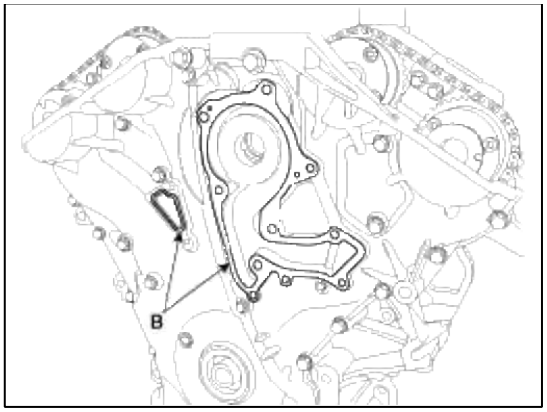
Tightening torque

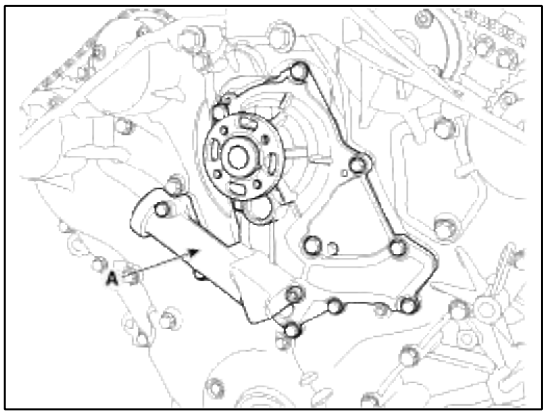
A (16EA) :
18.6 ~ 21.6N.m (1.9 ~ 2.2kgf.m, 13.7 ~ 15.9lb-ft)
B (2EA) :
24.5 ~ 26.5N.m (2.5 ~ 2.7kgf.m, 18.1 ~ 19.5lb-ft)
C (2EA) :
58.8 ~ 68.6N.m (6.0 ~ 7.0kgf.m, 43.4 ~ 50.6lb-ft)
D (3EA) :
9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)



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

20. Install the water pump.
Install the new gaskets (B) and then install the water pump (A).



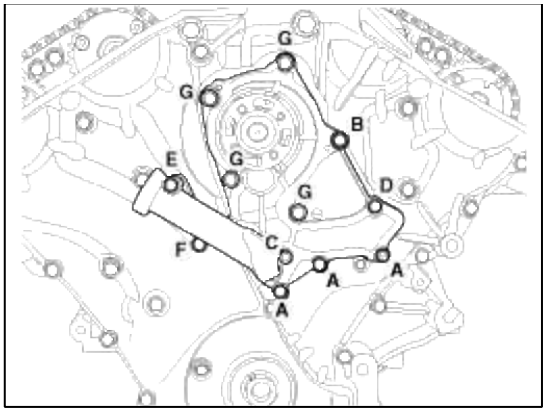


NOTE

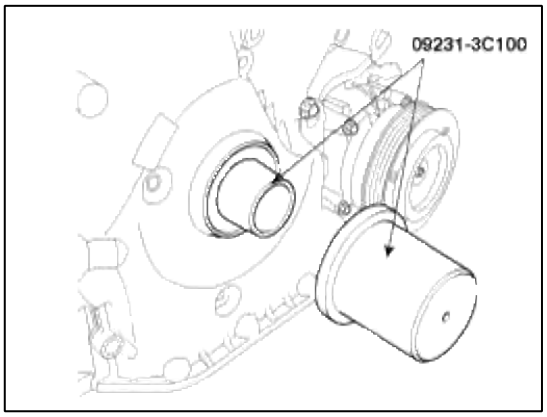
- Clean the contact face before assemble.
- Always use a new seal bolt (Bolt C) and the gaskets.

Tightening torque

A (3EA) :
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)
B (1EA) :
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)
C (1EA) :
19.6 ~ 26.5N.m (2.0 ~ 2.7kgf.m, 14.5 ~ 19.5lb-ft)
D (1EA) :
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)
E (1EA) :
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)
F (1EA) :
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)
G (4EA) :
19.6 ~ 23.5N.m (2.0 ~ 2.4kgf.m, 14.5 ~ 17.4lb-ft)

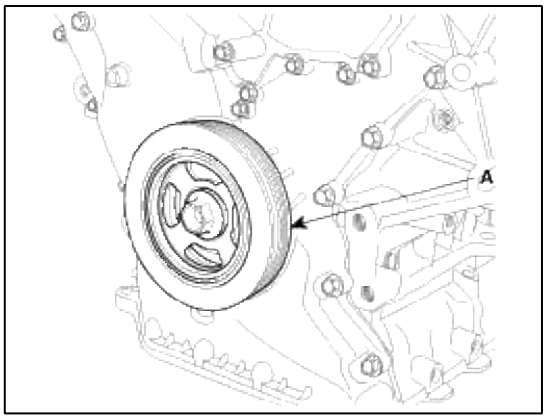


21. Using SST(09231-3C100), install timing chain cover oil seal.



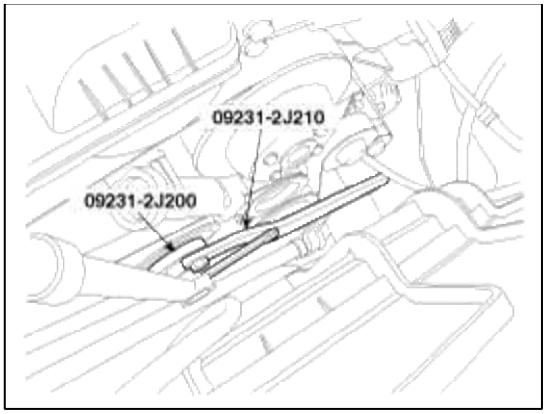
22. Install the crankshaft pulley (A).

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



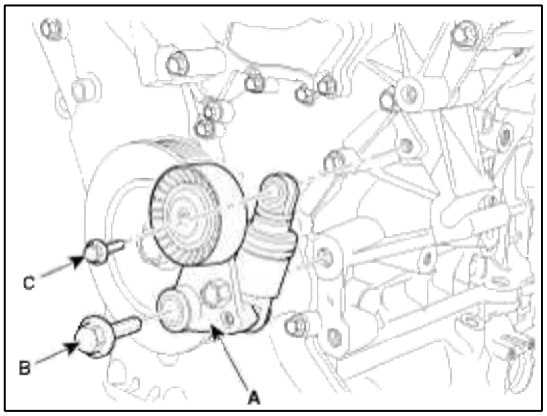
NOTE

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



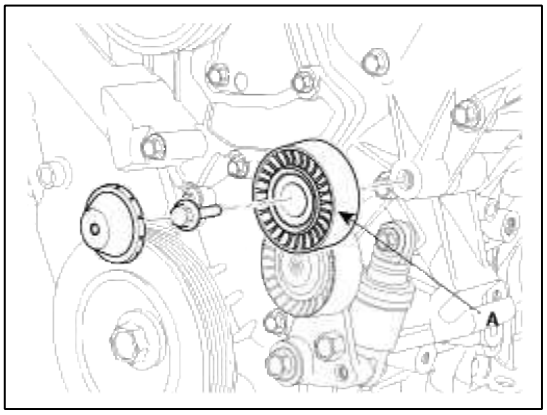
23. Install the drive belt auto tensioner (A).

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)



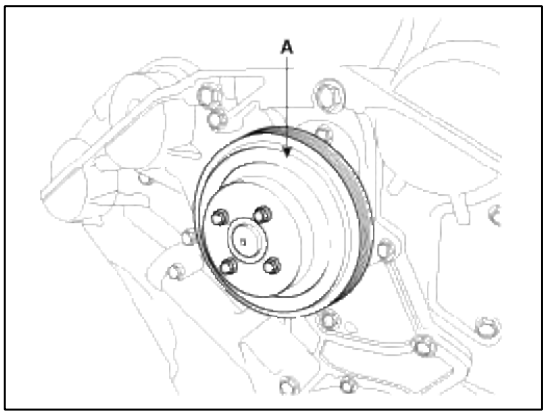
24. Install the drive belt idler (A).

Tightening torque :
53.9 ~ 57.9N.m (5.5 ~ 5.9kgf.m, 39.8 ~ 42.7lb-ft)



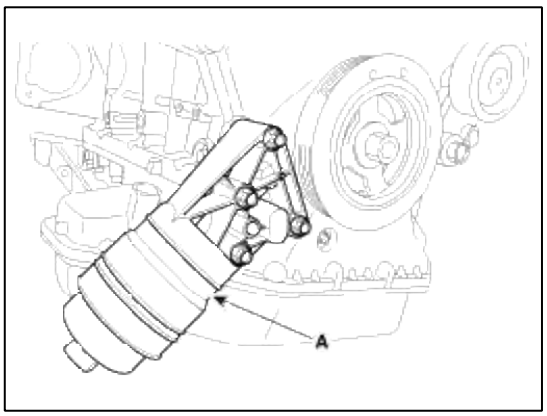
25. Install the water pump pulley (A).

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

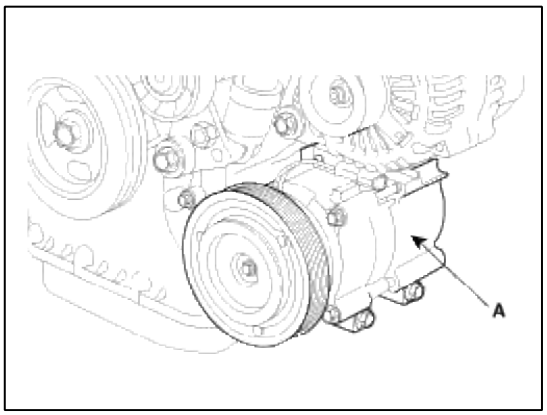


26. Install the oil filter body (A).

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

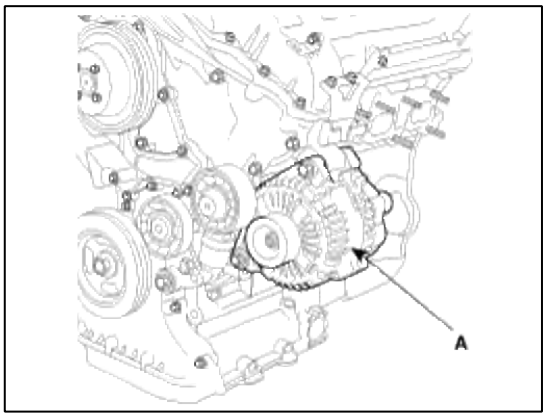


27. Install the air conditioner compressor (A). (Refer to Heating,Ventilation, Air Conditioning - "Compressor")



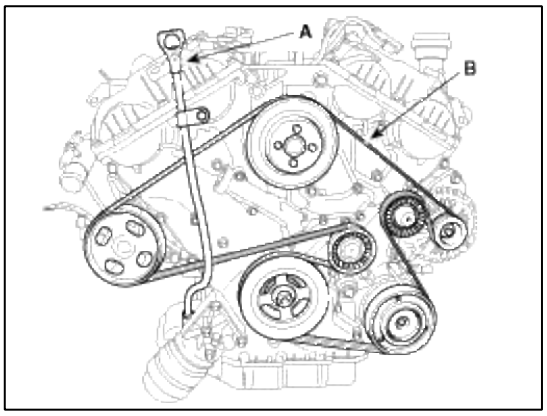
28. Install the alternator (A). (Refer to Engine Electrical System - "Alternator")

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



29. Install the drive belt (B).
30. Install the oil level gauge (A).

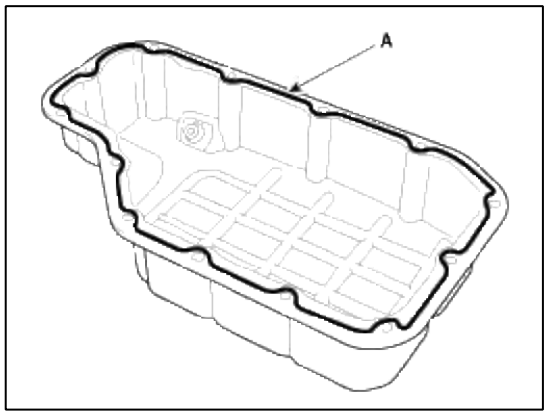
Tightening torque :
18.6 ~ 22.6N.m (1.9 ~ 2.3kgf.m, 13.7 ~ 16.6lb-ft)



31. 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 (Hyundai Gray RTV) 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.)

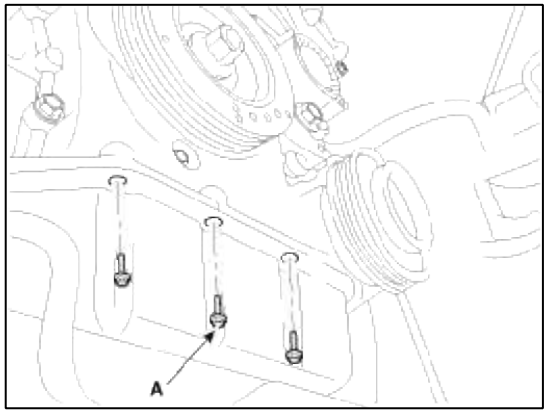


CAUTION

- 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)



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

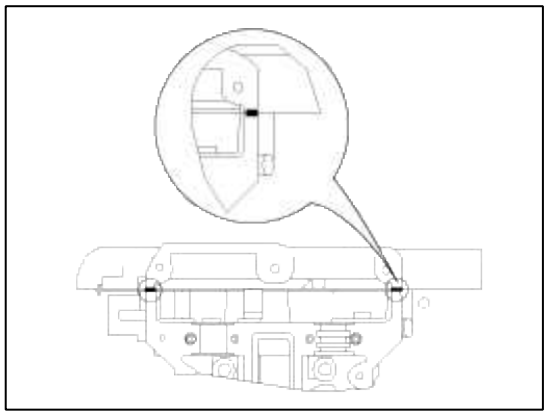
CAUTION

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

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

(2) After applying sealant TB 1217H (Hyundai Gray RTV), it should be assembled within 5 minutes.

Bead width : 2.5mm(0.1in.)



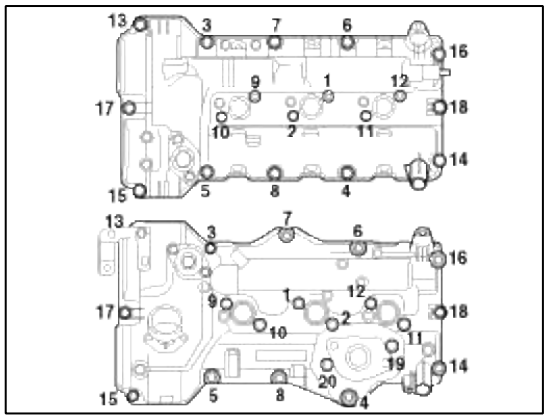
(3) The firing and/or blow out test should not be performed within 30 minutes after the cylinder head cover was assembled.

(4) 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.



(5) Install the exhaust OCV cap.

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

33. Install the other parts reverse order of removal.

34. Connect the battery negative cable.

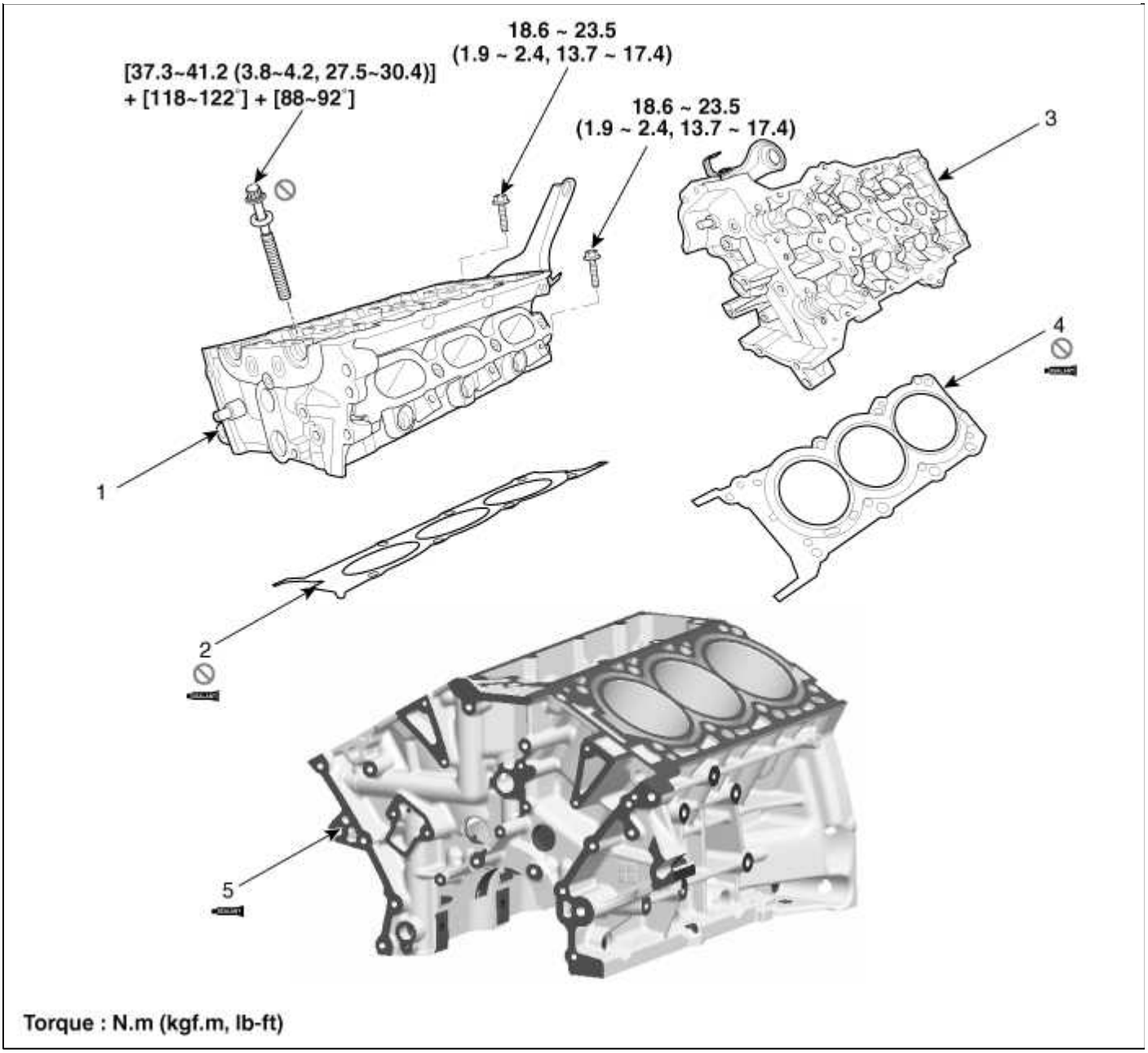
Tightening torque :
7.8 ~ 9.8 N.m (0.8 ~ 1.0 kgf.m, 5.8 ~ 7.2 lb-ft)

NOTE

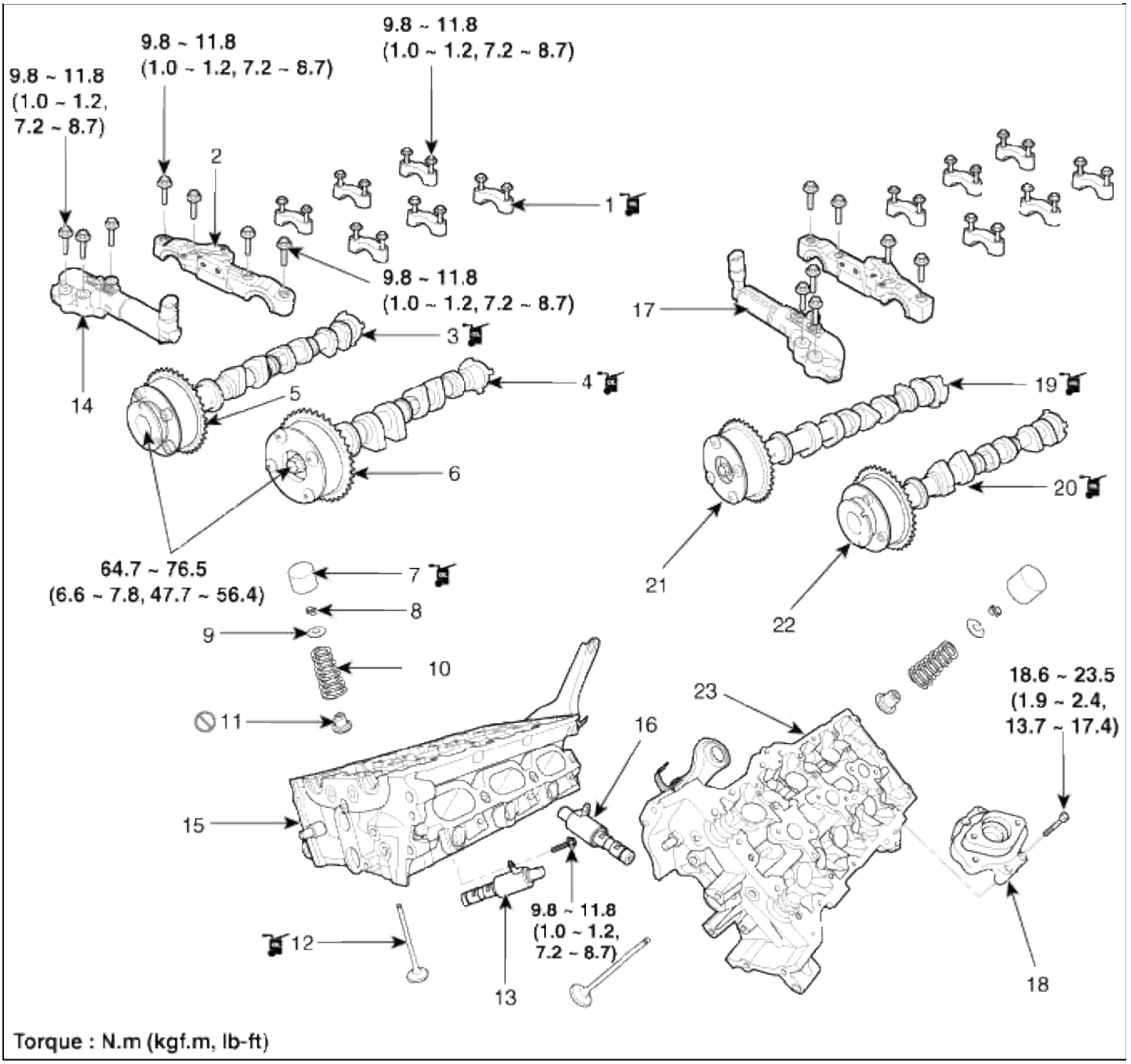
- Refill engine oil.
- Clean the battery posts and cable terminals with sandpaper. Assemble and then apply grease to prevent corrosion.
- Inspect for fuel leakage.
- After assembling the fuel line, turn on the ignition switch (do not operate the starter) so that the fuel pump runs for approximately two 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



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



1. Camshaft bearing cap	9. Retainer	17. LH exhaust camshaft OCV
2. Camshaft thrust bearing cap	10. Valve spring	18. Fuel pump bracket
3. RH exhaust camshaft	11. Valve stem seal	19. LH intake camshaft
4. RH intake camshaft	12. Valve	20. LH exhaust camshaft
5. RH exhaust CVVT assembly	13. RH exhaust camshaft OCV	21. LH intake CVVT assembly
6. RH intake CVVT assembly	14. RH intake camshaft OCV	22. LH exhaust CVVT assembly
7. Mechanical lash adjuster (MLA)	15. RH cylinder head	23. LH cylinder head
8. Retainer lock	16. LH intake camshaft OCV	

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

Removal

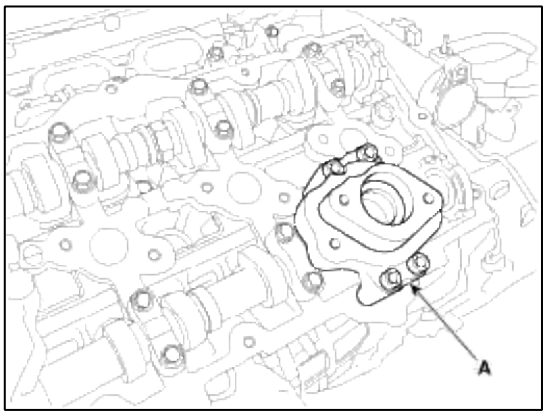
CAUTION

- 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.

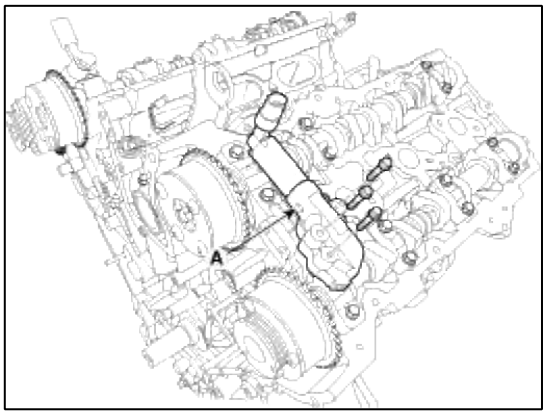
NOTE

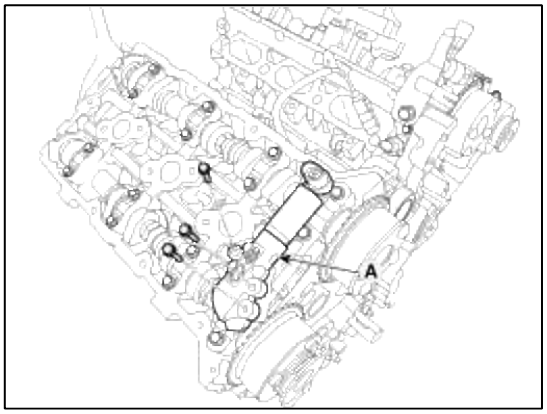
- Mark all wiring and hoses to avoid misconnection.
- Turn the crankshaft pulley so that the No. 1 piston is at top dead center.

1. Remove the intake and exhaust manifolds. (Refer to Intake and exhaust system in this group)
2. Remove the timing chain. (Refer to Timing system in this group)
3. Disconnect the heater hoses and then remove the water temperature control assembly. (Refer to Cooling system in this group)
4. Remove the injector & rail assembly. (Refer to Fuel System - "Delivery Pipe")
5. Remove the fuel pump adapter (A).

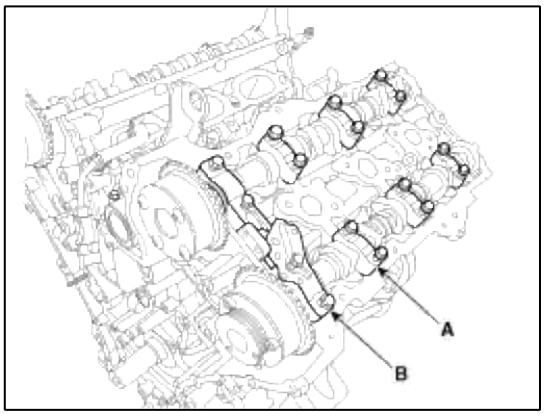


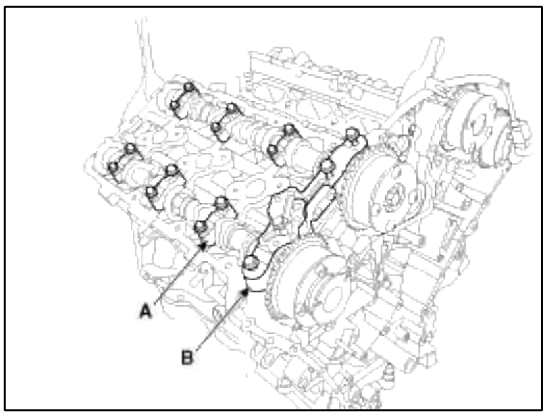
6. Remove the LH/RH exhaust camshaft oil control valve(OCV) (A).



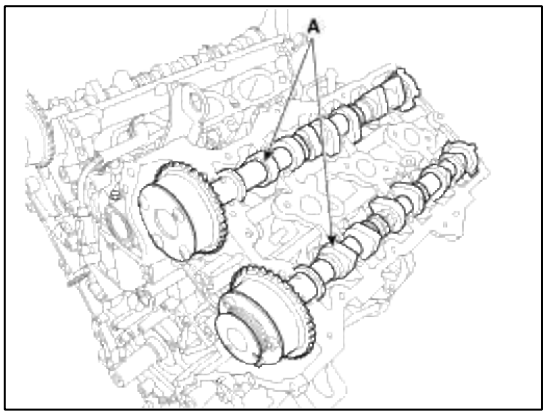


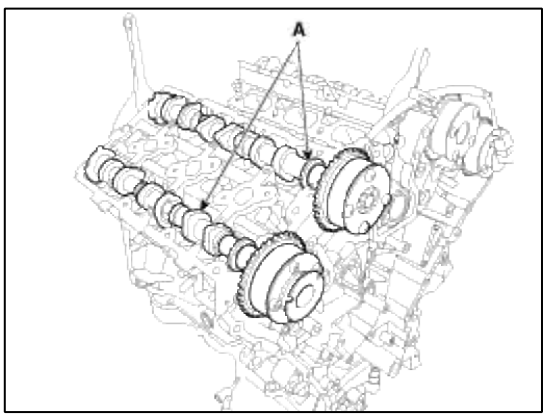
7. Remove the LH/RH camshaft bearing cap (A) and thrust bearing cap (B).





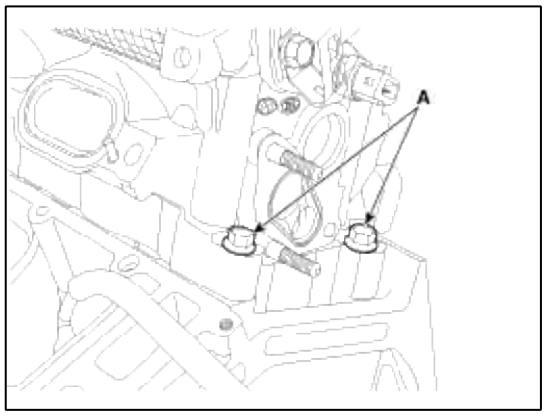
8. Remove the LH/RH camshaft assembly (A).



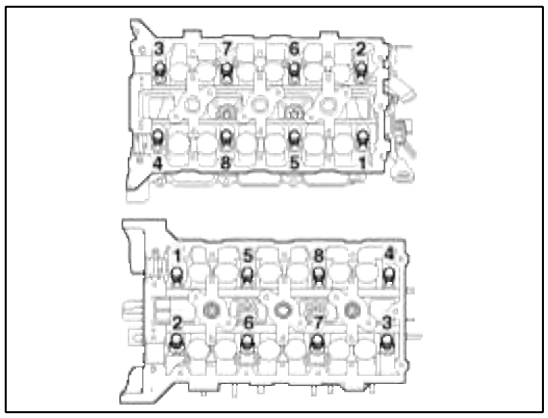


9. Remove the cylinder head.

(1) Remove the RH cylinder head rear bolts (A).



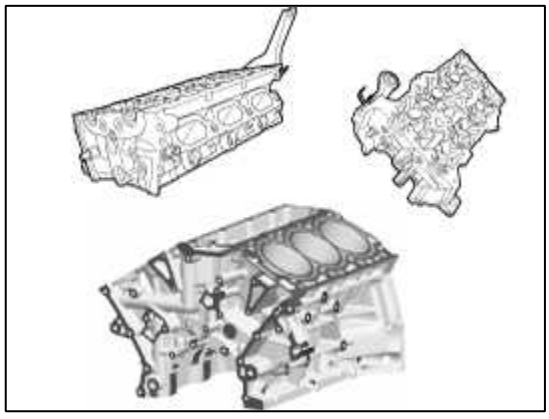
(2) Uniformly loosen and remove the cylinder head bolts, in several passes, in the sequence shown.



CAUTION

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

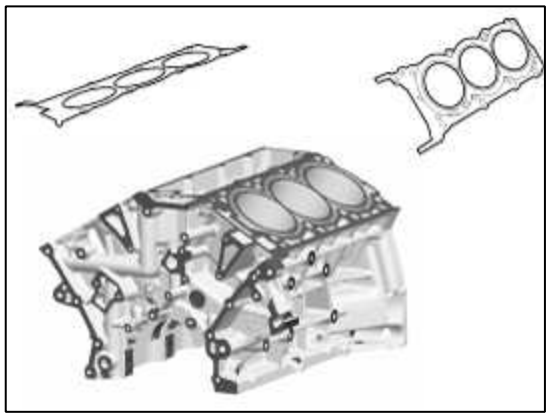
(3) Lift the cylinder head from the dowels on the cylinder block and place the cylinder head on wooden blocks on a bench.



CAUTION

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

(4) Remove the LH/RH cylinder head gaskets.

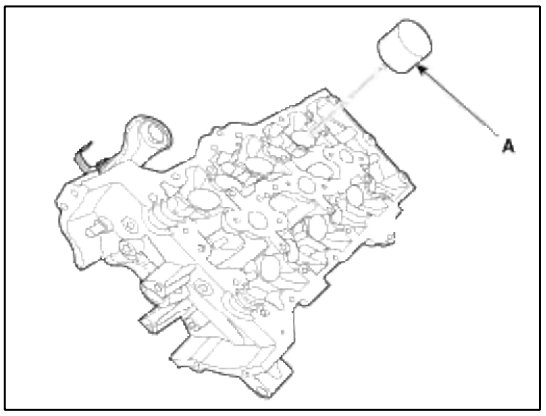


Disassembly

NOTE

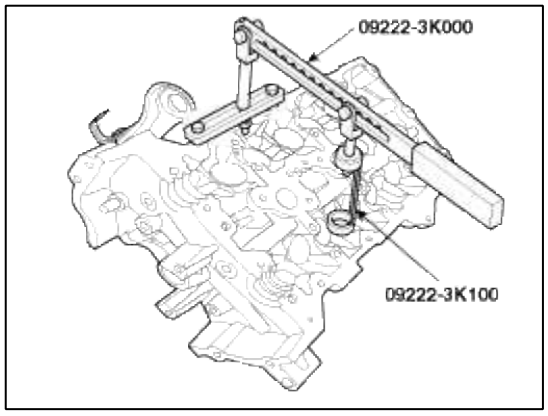
Identify MLA, valves and valve springs as they are removed so that each item can be reinstalled in its original position.

1. Remove the MLAs(A).



2. Remove the valves.

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

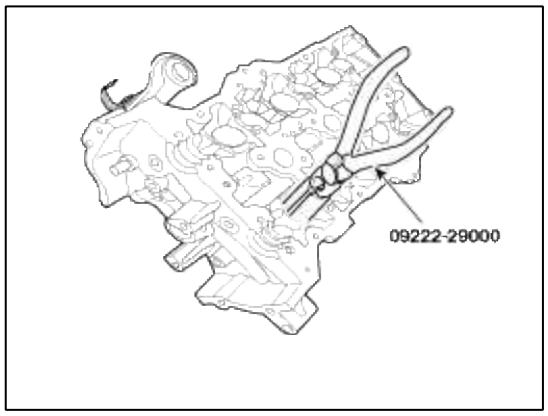


(2) Remove the spring retainer.

(3) Remove the valve spring.

(4) Remove the valve.

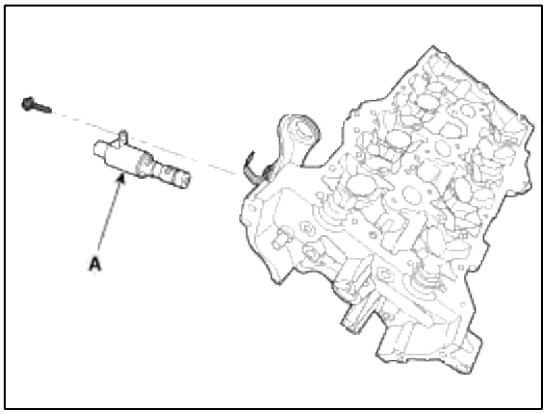
(5) Using the SST(09222-29000), remove the valve stem seal.

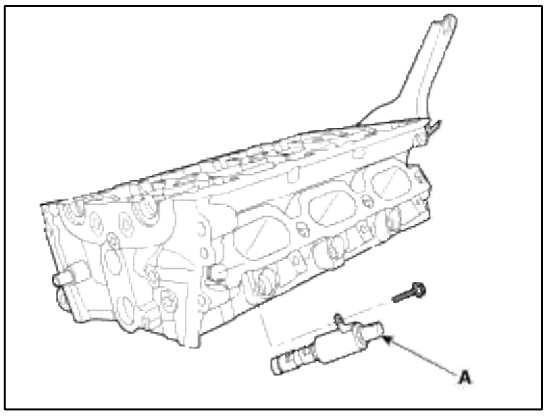


NOTE

Do not reuse old valve stem seals.

3. Remove the LH/RH intake OCV(A).



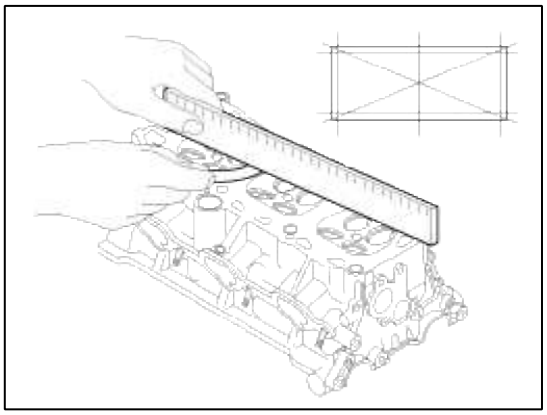


Inspection

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 0.03mm(0.001in)/110x110

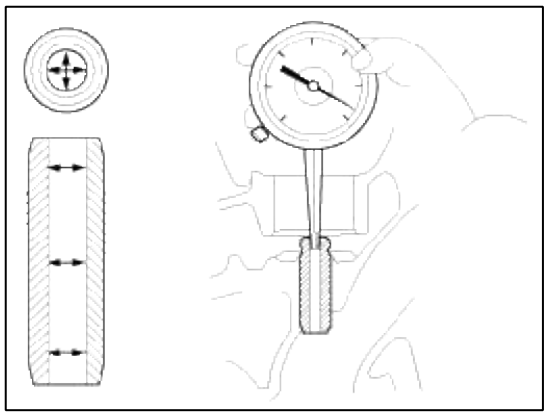


2. Inspect for cracks.
   Check the combustion chamber, intake ports, exhaust ports and cylinder block surface for cracks. If cracked, replace the cylinder head.

Valve And Valve Spring

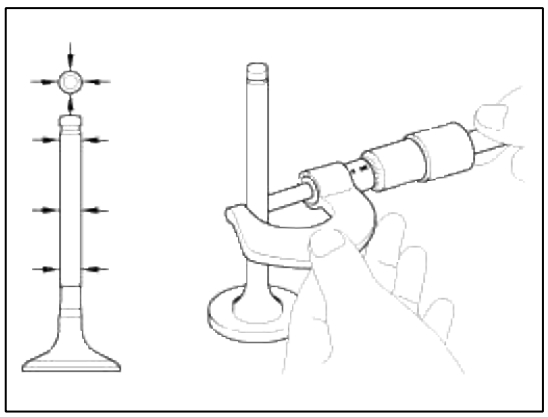
1. Inspect valve stems and valve guides.
   (1) Using a caliper gauge, measure the inside diameter of the valve guide.

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.)

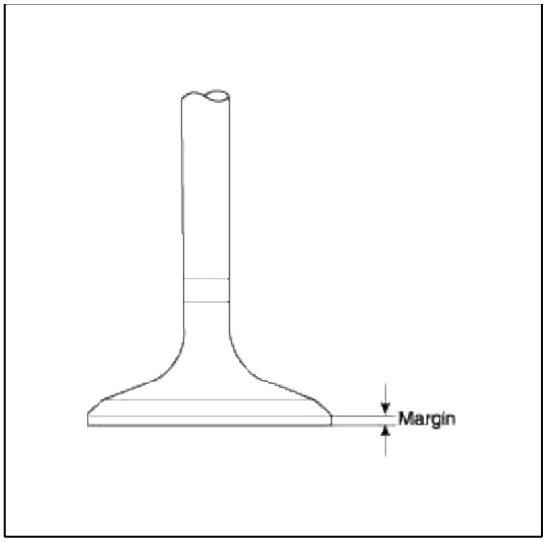


(3) Subtract the valve stem diameter measurement from the valve guide inside diameter measurement.

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.)



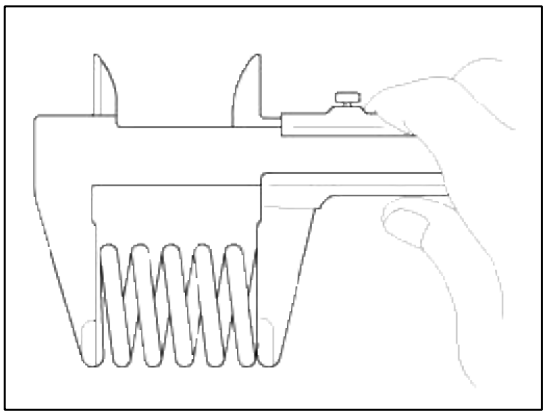
(4) Check the valve length.

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 : 45.5mm (1.7913in.)
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.)

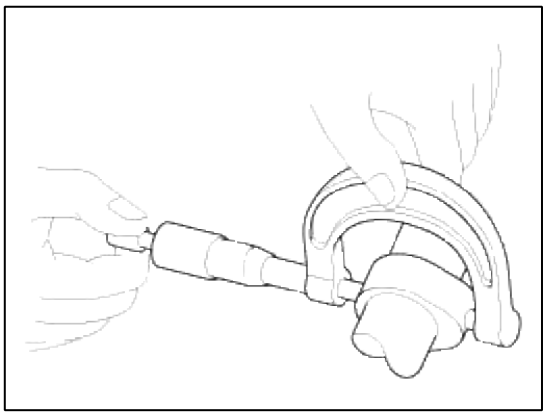
3. Subtract MLA outside diameter measurement from tappet bore inside diameter measurement.

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

Camshaft

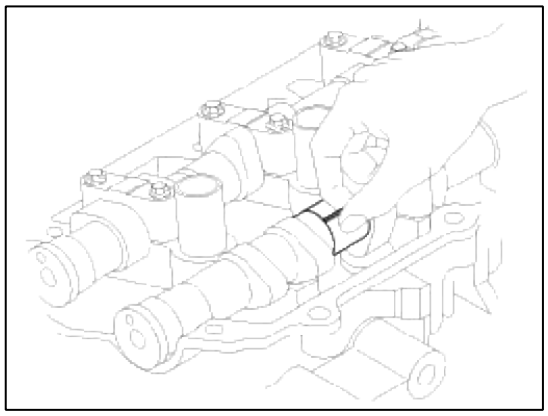
1. Inspect cam lobes.
   Using a micrometer, measure the cam lobe height.

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



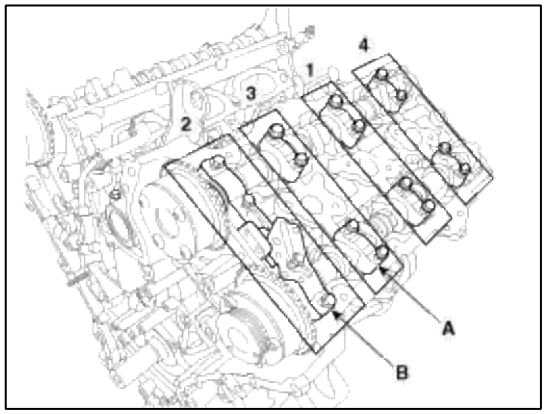
   If the cam lobe height is less than standard, replace the camshaft.
2. Inspect the camshaft journal clearance.
   (1) Clean the bearing caps and camshaft journals.
   (2) Place the camshafts on the cylinder head.

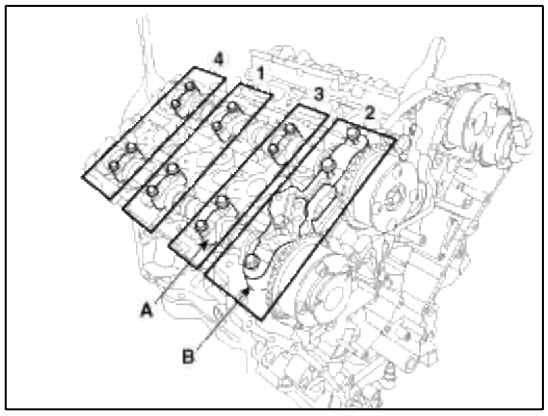
(3) Lay a strip of plastigage across each of the camshaft journals.



(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)





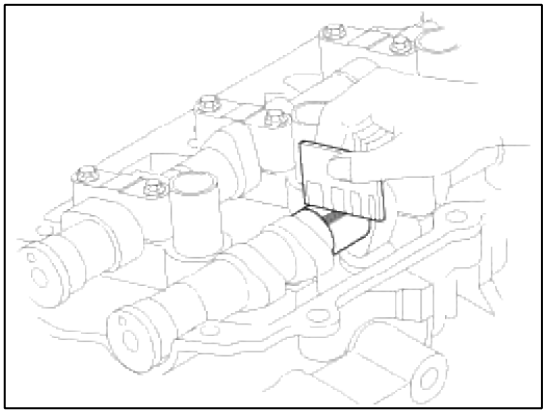
CAUTION

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 : 0.027 ~ 0.057mm (0.0010 ~ 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.

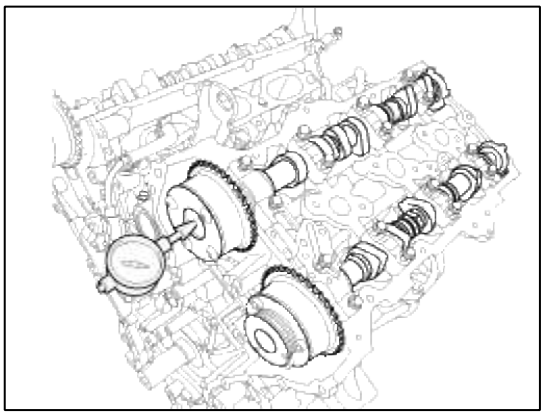
(8) Remove the camshafts.

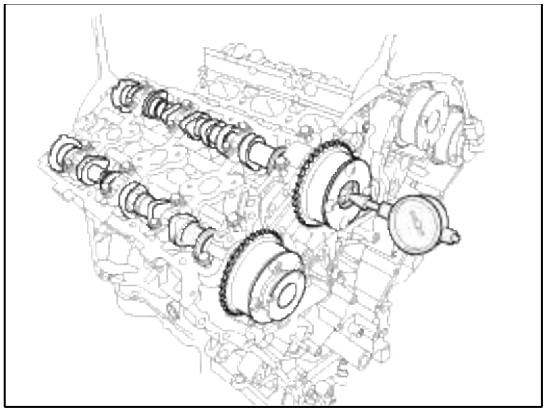
3. Inspect the camshaft end play.

(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.

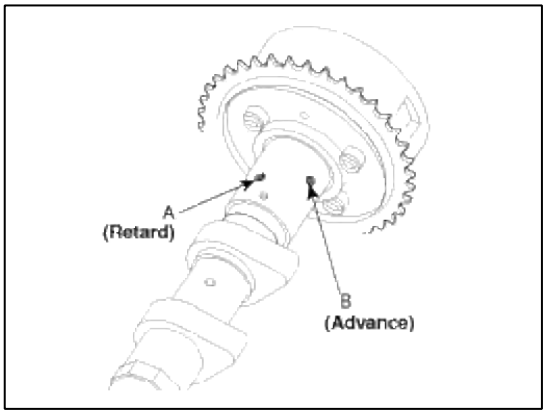
CVVT Assembly

1. Inspect the CVVT assembly.

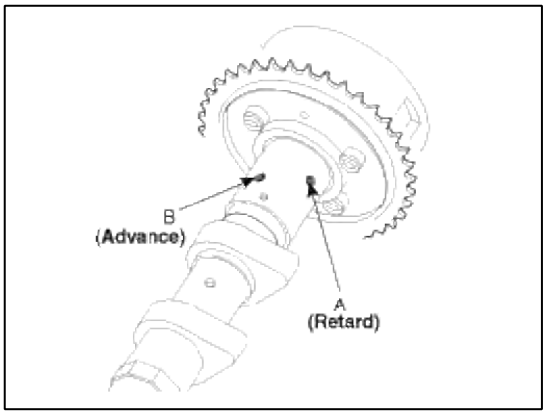
(1) Check that the CVVT assembly will not turn.

(2) Apply vinyl tape to the retard hole except the one indicated by the arrow in the illustration.

[Intake]



[Exhaust]

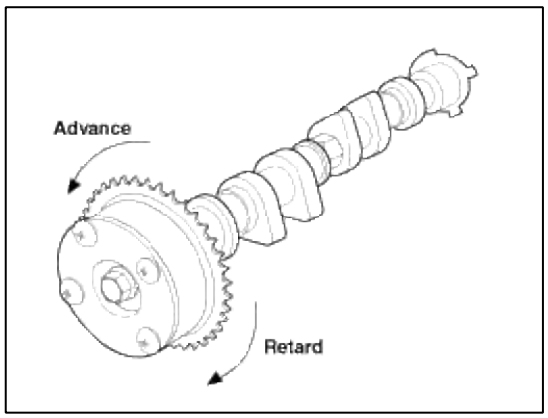


(3) Wrap tape around the tip of the air gun and apply air of approx. 150kpa(1.5kgf/cm², 21psi) to the port of the camshaft.
(Perform this in order to release the lock pin for the maximum delay angle locking.)

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 25°

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

Reassembly

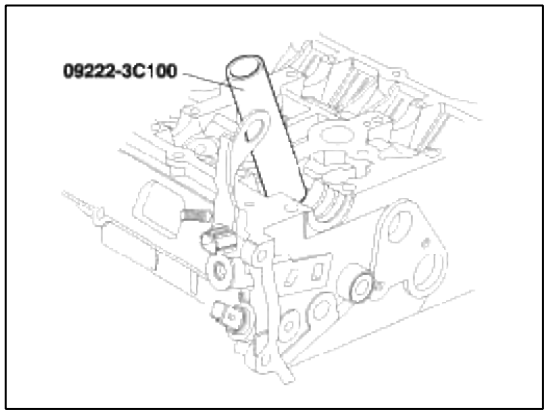
NOTE

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 valve stem seal.

NOTE

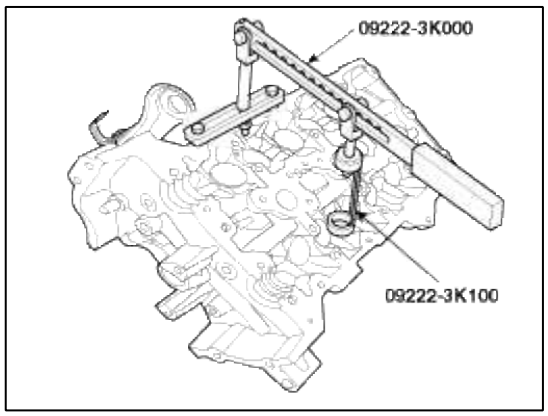
Do not reuse old valve stem seals.
Incorrect installation of the seal could result in oil leakage past the valve guides.



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

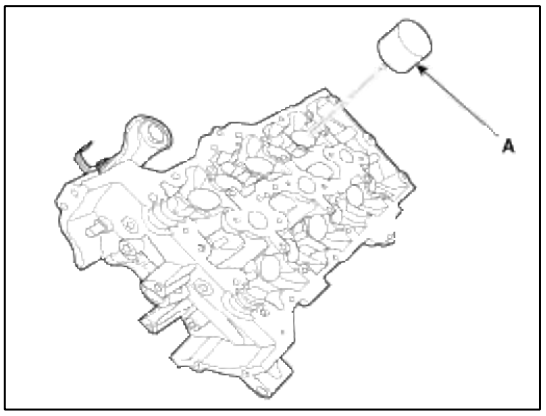
> NOTE
>
> Place valve springs so that the side coated with enamel faces toward the valve spring retainer and then install the retainer.

(3) Using the SST(09222 - 3K000, 09222-3K100), compress the spring and install the retainer locks. After installing the valves, ensure that the retainer locks are correctly in place before releasing the valve spring compressor.



(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.

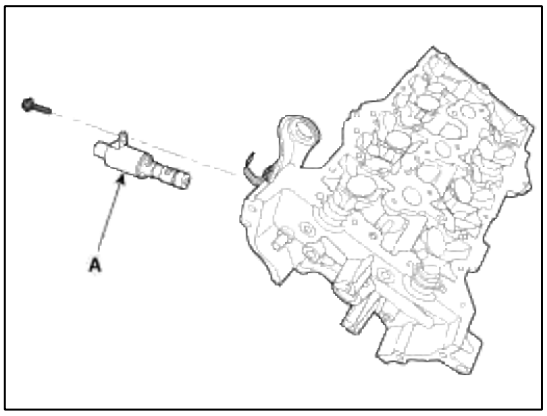
2. Install the MLAs.
Check that the MLA rotates smoothly by hand.

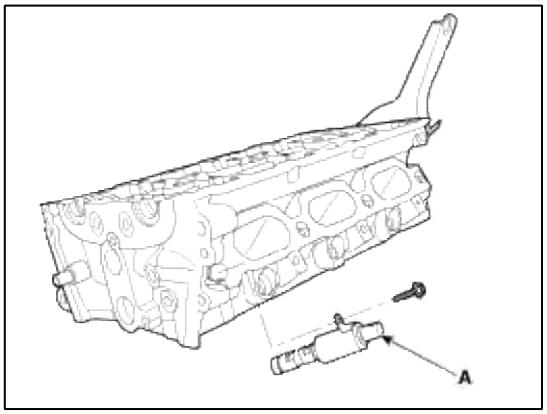


> NOTE
>
> MLA can be reinstalled in its original position.

3. Install the LH/RH intake oil control valve(OCV) (A).

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





NOTE

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

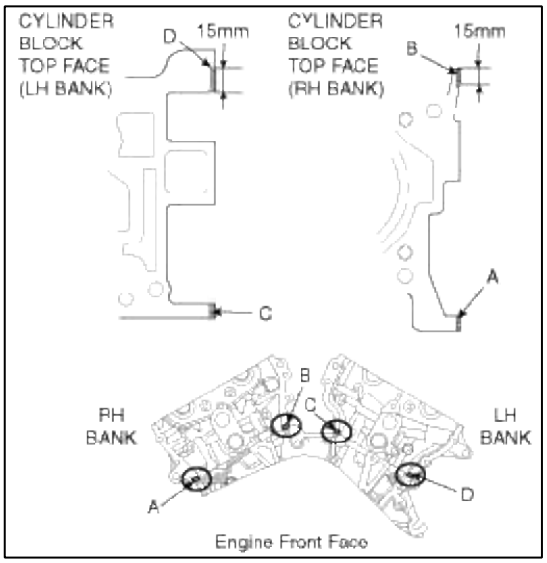
Installation

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.

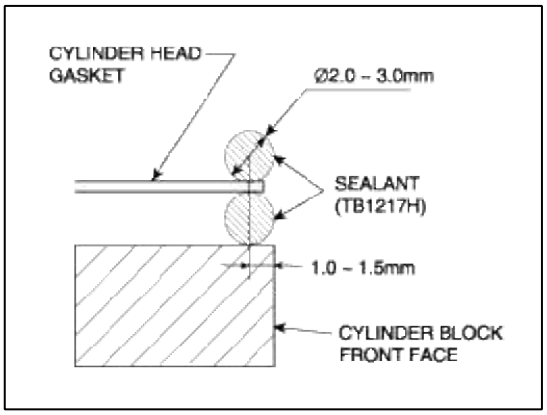
B. Apply sealant on cylinder block top face before assembling cylinder head gaskets.
The part must be assembled within 5 minutes after sealant was applied.



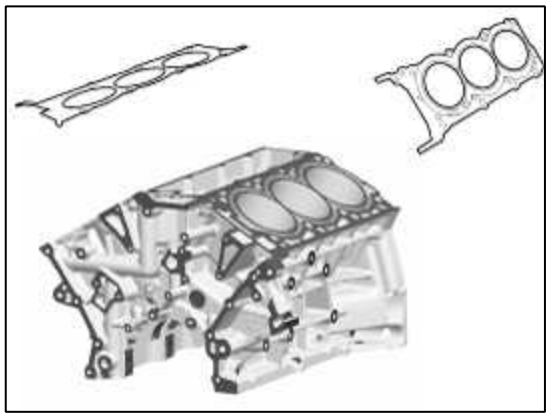
NOTE

Refer to below illustration to apply the sealant.

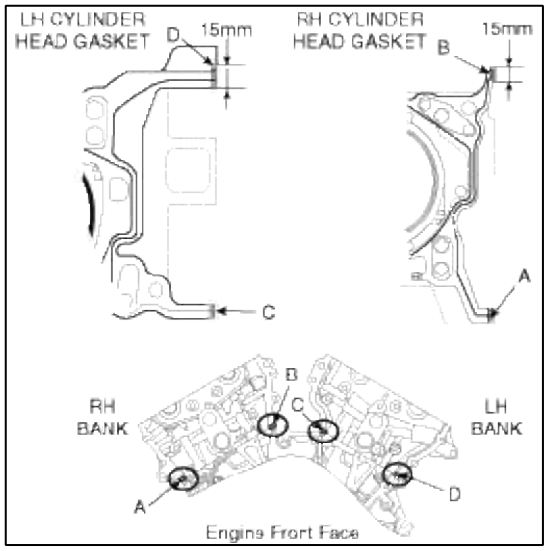
Bead width :
2.0~3.0 mm (0.078 ~ 0.118 in.)
Sealant locations :
1.0~1.5mm (0.039 ~ 0.059 in.) from block surface
Recommended sealant :
Liquid sealant TB 1217H (Hyundai Gray RTV)



C. Apply sealant on cylinder head gaskets after assembling cylinder head gaskets on cylinder block.

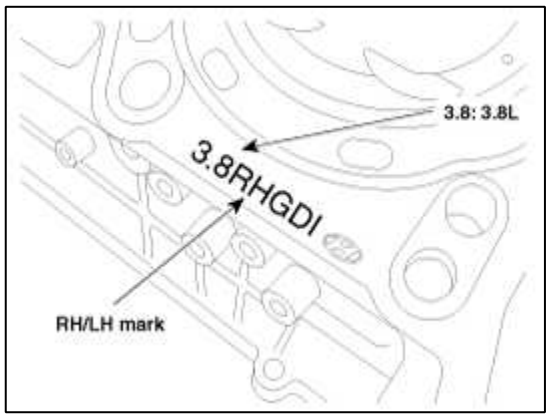


The part must be assembled within 5 minutes after sealant was applied.



NOTE

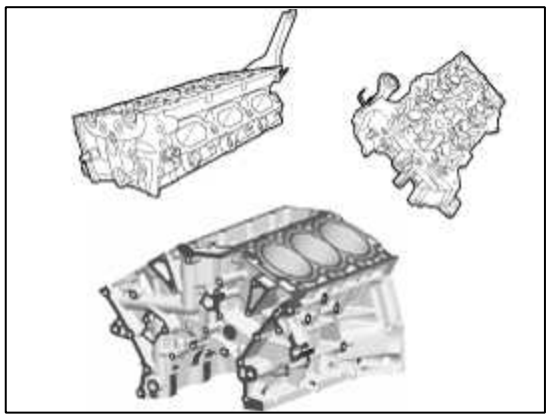
Be careful of the installation direction.



D. Install the cylinder head.

NOTE

Remove the extruded sealant after assembling cylinder heads.



2. Install 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.

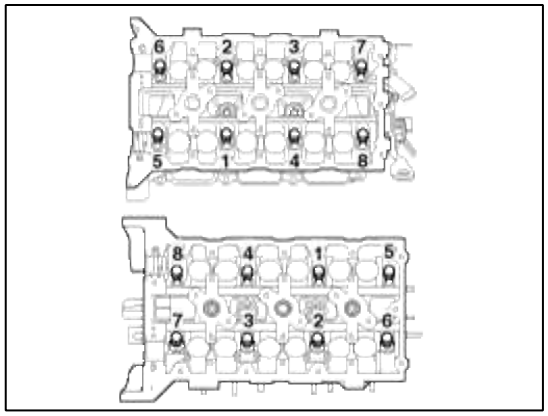
Tightening torque

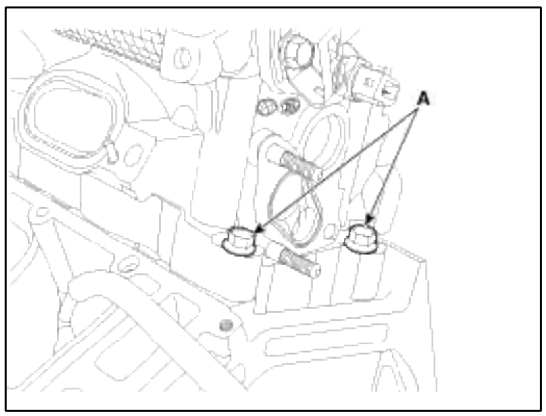
Head bolt:

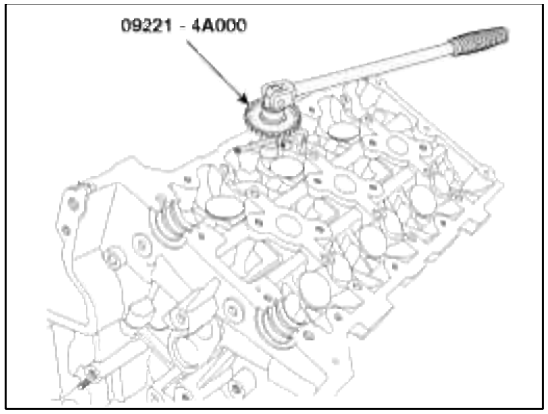
37.3~41.2Nm (3.8~4.2kgf.m, 27.5~30.4lb-ft) + 118~122° + 88~92°

Bolts (A):

18.6 ~ 23.5Nm (1.9 ~ 2.4kgf.m, 13.7 ~ 17.4lb-ft)

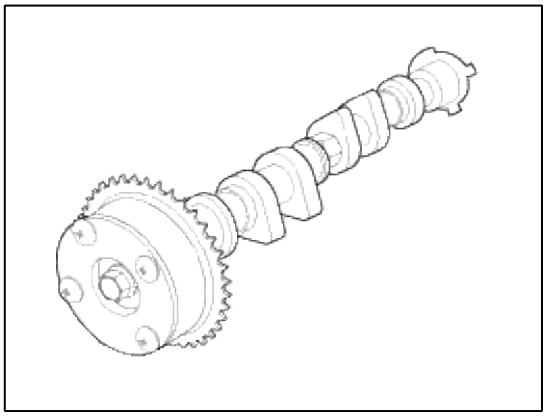






3. Install the CVVT assembly.

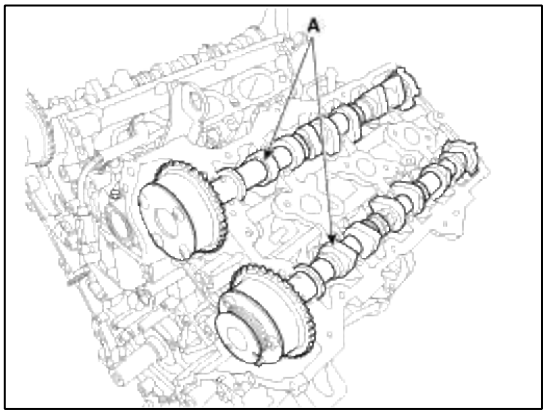
Tightening torque :
64.7 ~ 76.5N.m (6.6 ~ 7.8kgf.m, 47.7 ~ 56.4lb-ft)

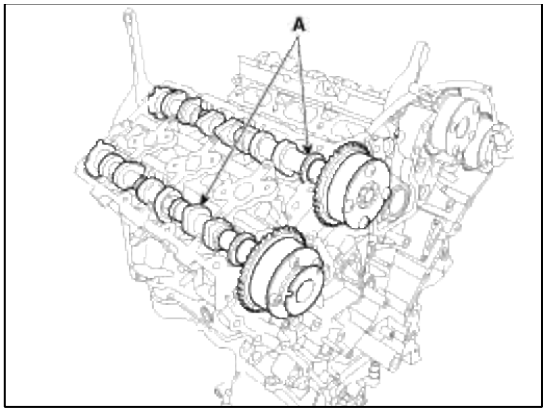


CAUTION

- 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).

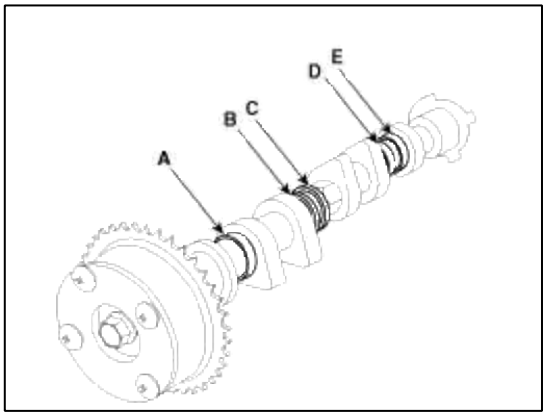




CAUTION

- 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.

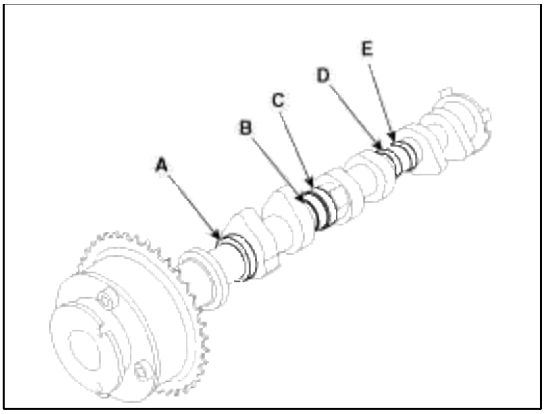
Intake Camshaft



As for camshaft identification, refer to the table below.

Displacement	Outer diameter	
	LH	RH
3.8L	A : 30mm (1.1811in.)	A : 30mm (1.1811in.)
	B : 30mm (1.1811in.)	B : 30mm (1.1811in.)
	C : 30mm (1.1811in.)	C : 30mm (1.1811in.)
	D : 30mm (1.1811in.)	D : 27mm (1.0630in.)
	E : 27mm (1.0630in.)	E : 30mm (1.1811in.)

Exhaust Camshaft

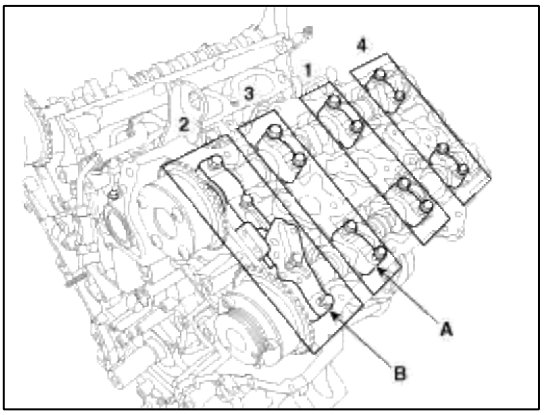


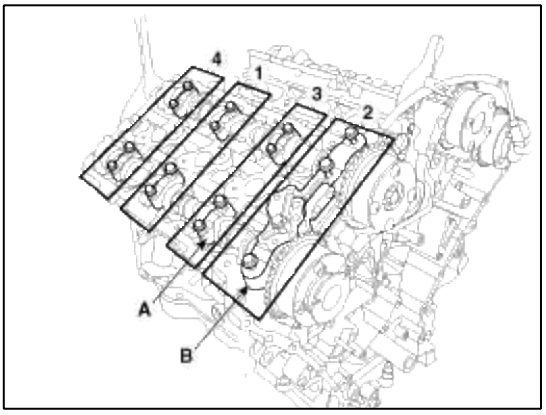
As for camshaft identification, refer to the table below.

Displacement	Outer diameter	
	LH	RH
3.8L	A : -	A : 27mm (1.0630in.)
	B : -	B : 27mm (1.0630in.)
	C : -	C : 30mm (1.1811in.)
	D : -	D : 30mm (1.1811in.)
	E : 31mm (1.2204in.)	E : -

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)



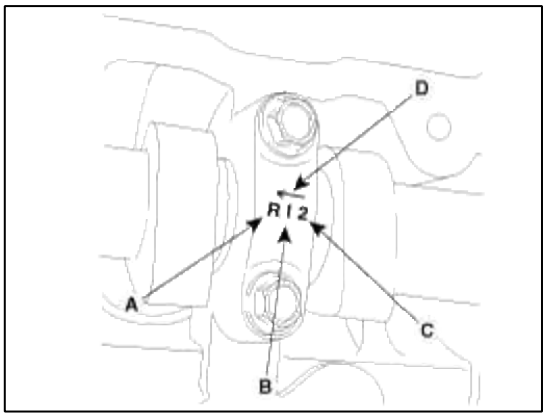


CAUTION

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.



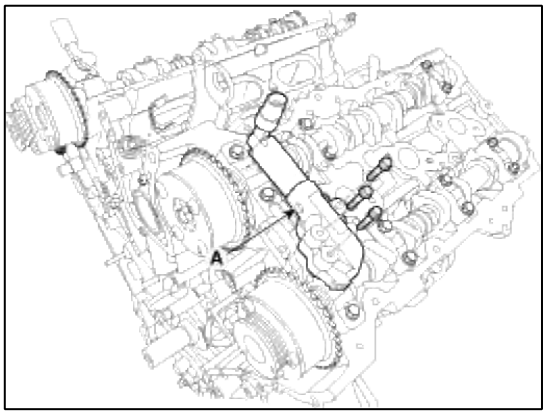
A : L(LH),R(RH)
B : I(Intake), None(Exhaust)
C : Journal number
D : Front mark

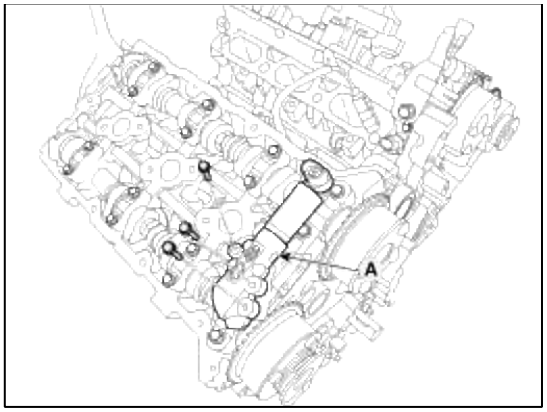
CAUTION

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 oil control valve(OCV) (A).

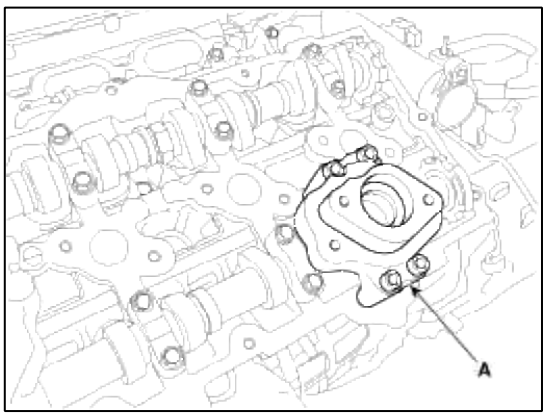
Tightening torque :
9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)





7. Install the fuel pump bracket (A).

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



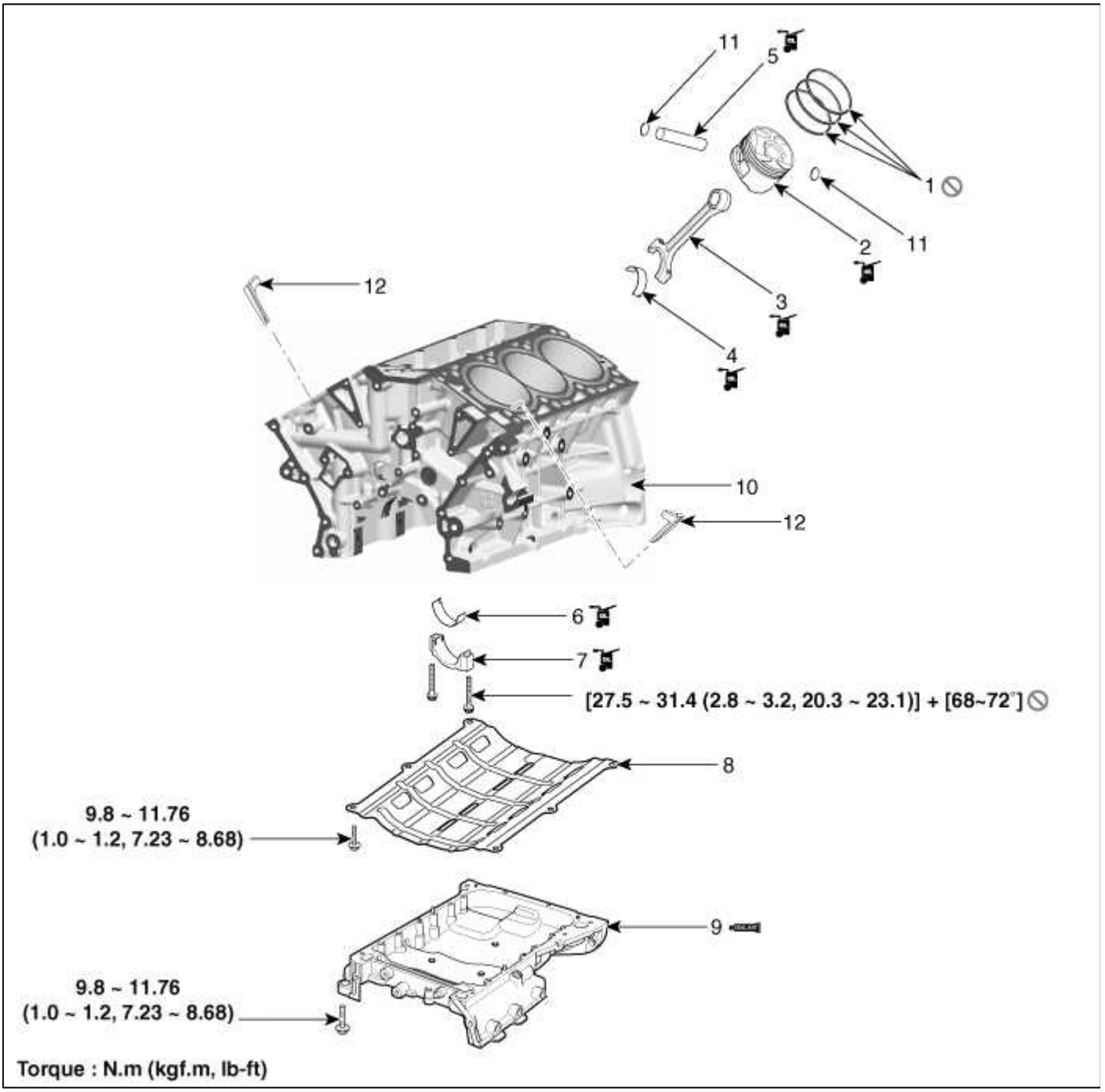
8. Install the water temperature control assembly and then connect the heater hoses. (Refer to Cooling system in this group)
9. Install the timing chain. (Refer to Timing system in this group)
10. Install the cylinder head cover. (Refer to Timing system in this group)
11. Install the intake and exhaust manifolds. (Refer to Intake and exhaust system in this group)

NOTE

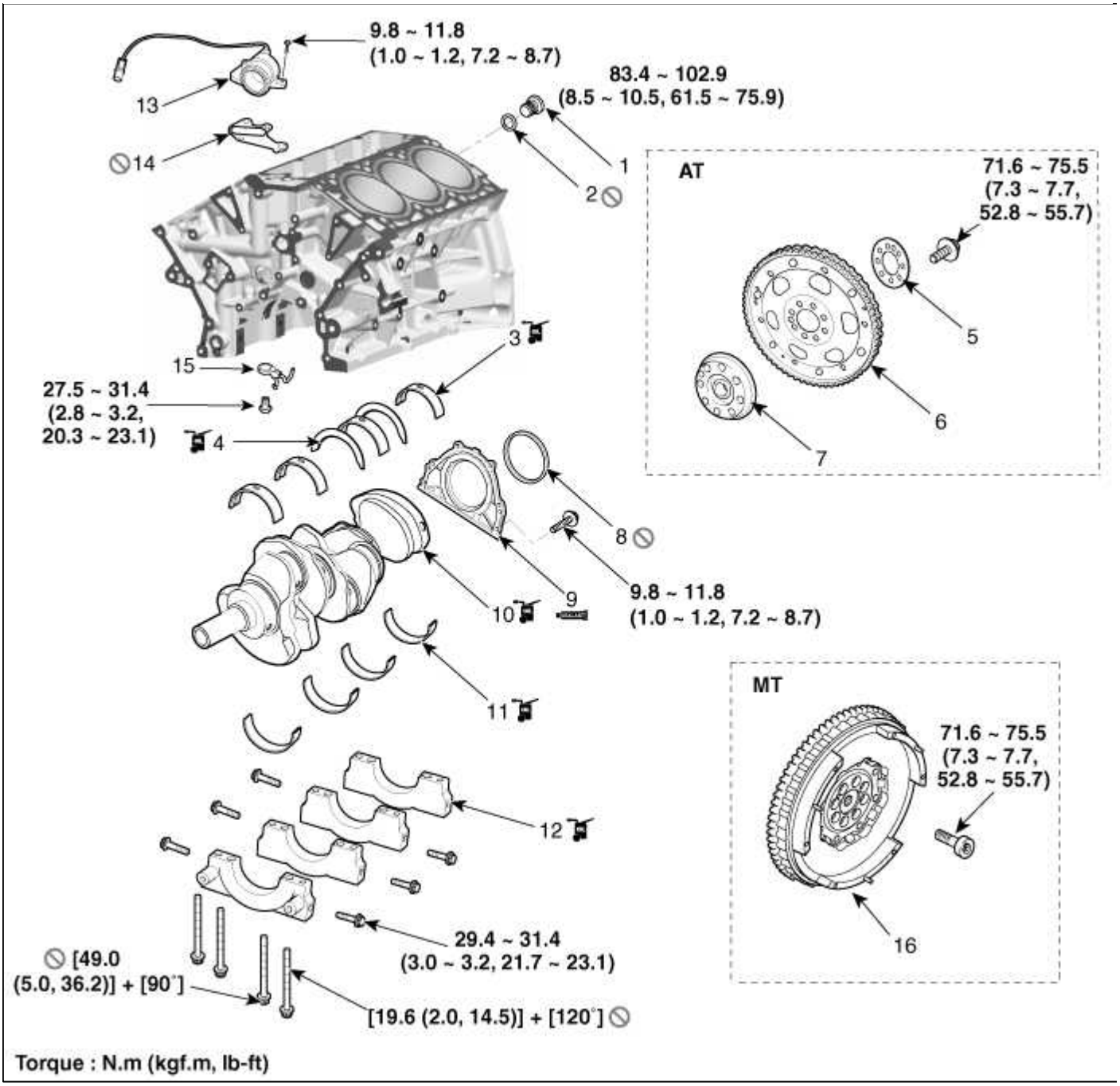
- Refill engine oil.
- Clean the battery posts and cable terminals with sandpaper. Assemble and then apply grease to prevent corrosion.
- Inspect for fuel leakage.
- After assembling the fuel line, turn on the ignition switch (do not operate the starter) so that the fuel pump runs for approximately two 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	12. Water jacket seperator



1. Plug bolt	7. Crankshaft adapter (AT)	13. Oil cover
2. Washer gasket	8. Rear oil seal	14. Oil cover gasket
3. Crank shaft upper bearing	9. Rear oil seal case	15. Piston cooling jet
4. Thrust bearing	10. Crankshaft	16. Dual mass flywheel (DMF) (MT)
5. Adapter plate (AT)	11. Crankshaft lower bearing	
6. Drive plate (AT)	12. Main bearing cap	

Engine Mechanical System > Cylinder Block > Repair procedures

Disassembly

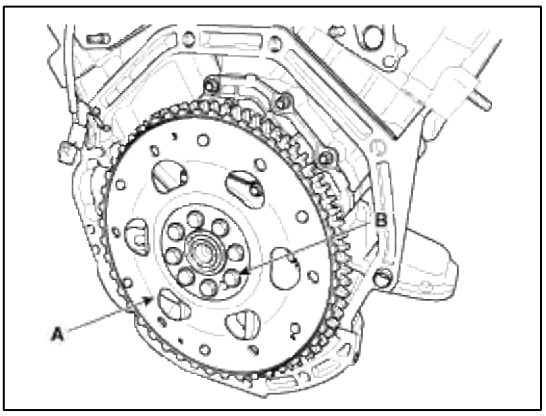
CAUTION

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

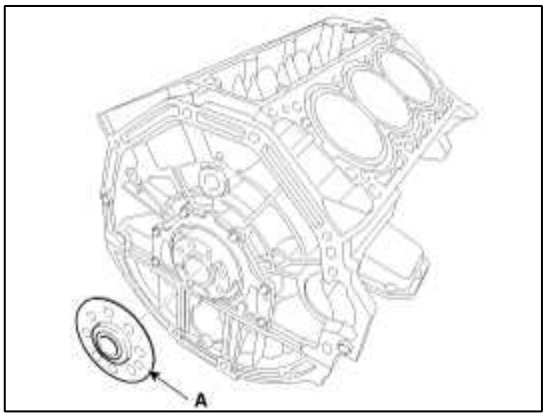
NOTE

- Mark all wiring and hoses to avoid misconnection.
- Inspect the timing belt 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.

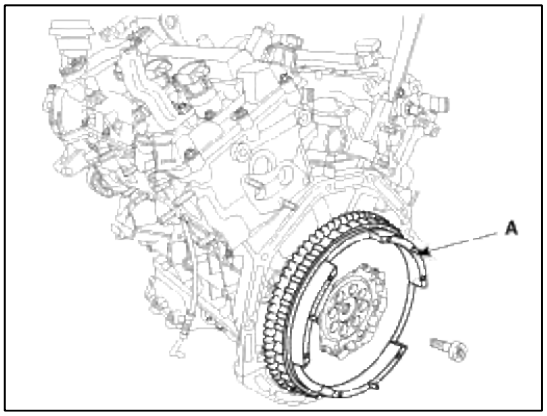
1. Remove the engine assembly from the vehicle. (Refer to Engine and transmission assembly in this group)
2. Install the engine to engine stand for disassembly.
3. Remove the intake manifold and exhaust manifold. (Refer to Intake and exhaust system in this group)
4. Remove the timing chain. (Refer to Timing system in this group)
5. Remove the water temperature control assembly. (Refer to Cooling system in this group)
6. Remove the cylinder head. (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) and adapter plate (B). (AT)



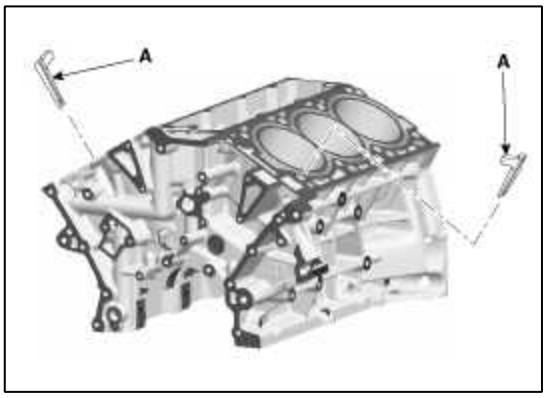
10. Remove the crankshaft adapter (A). (AT)



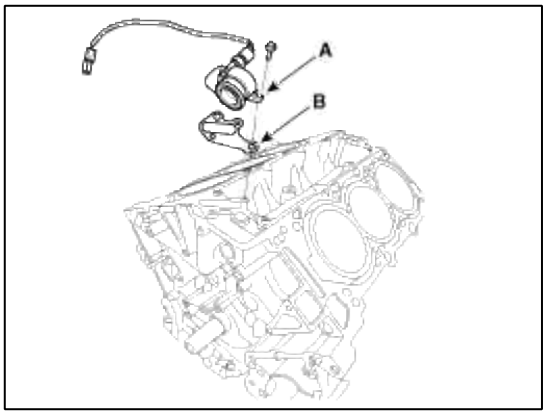
11. Remove the dual mass flywheel (DMF) (A). (MT)



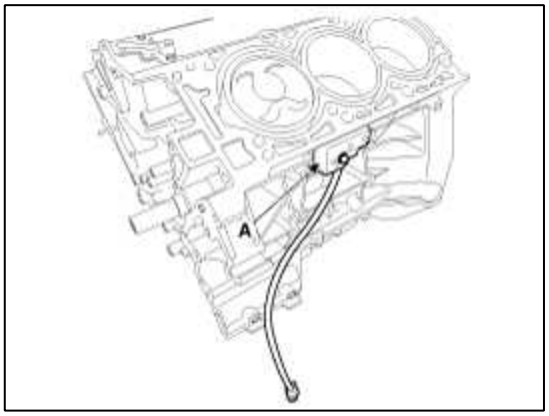
12. Remove the water jacket seperator (A).

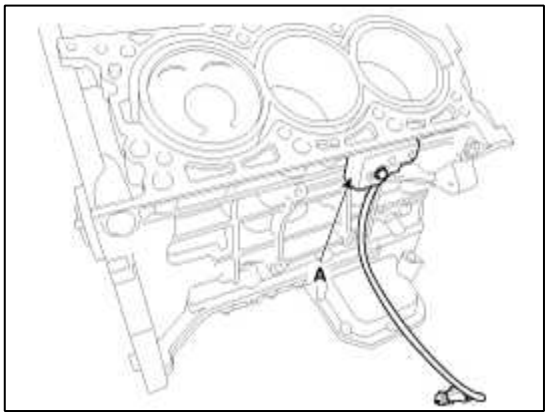


13. Remove the oil cover (A) are the gasket (B).

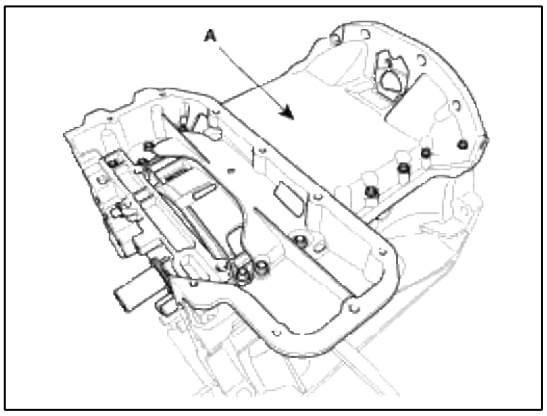


14. Remove the knock sensor (A).

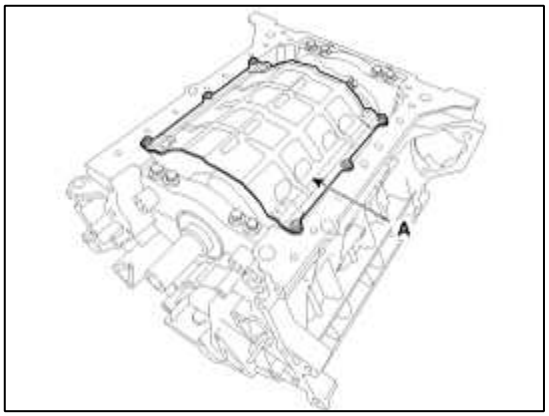




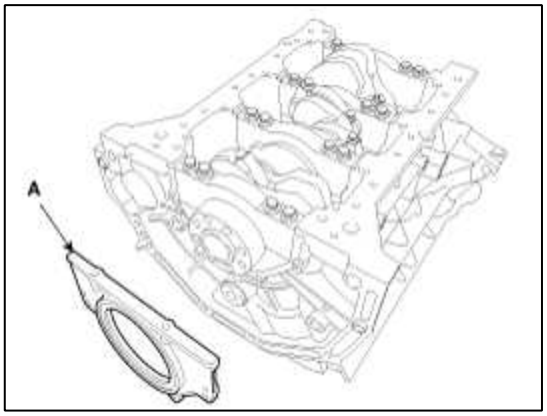
15. Remove the upper oil pan (A).



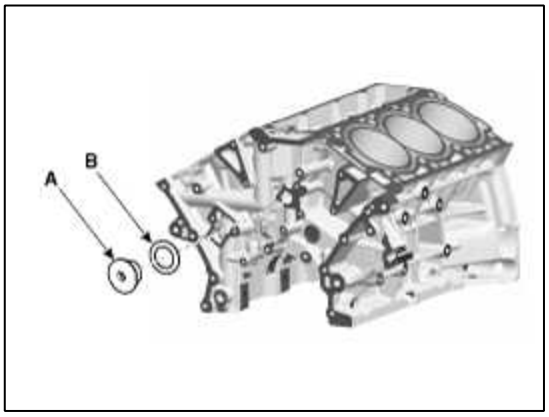
16. Remove the baffle plate (A).



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



18. Remove the plut bolt (A) and the washer gasket (B).

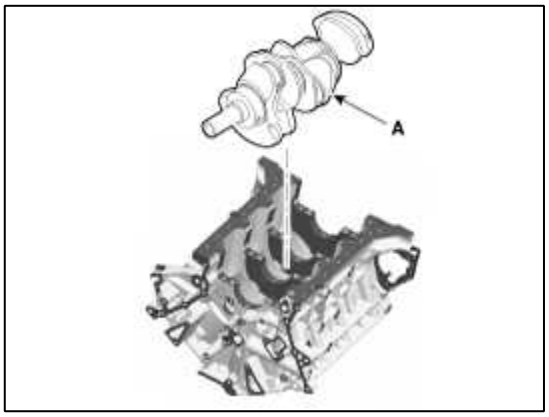


19. Check the connecting rod end play.
20. Check the connecting rod cap oil clearance.

21. 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.

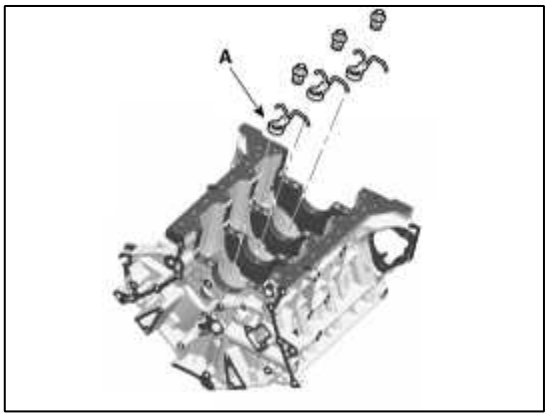
> NOTE
> • Keep the bearings, connecting rod and cap together.
> • Arrange the piston and connecting rod assemblies in the correct order.

22. Remove the crankshaft main bearing cap and check oil clearance.
23. Check the crankshaft end play.
24. 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.

25. Remove the oil jets (A).



26. Remove the piston rings.
    (1) Using a piston ring expander, remove the 2 compression rings.
    (2) Remove oil ring and coil spring by hand.

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

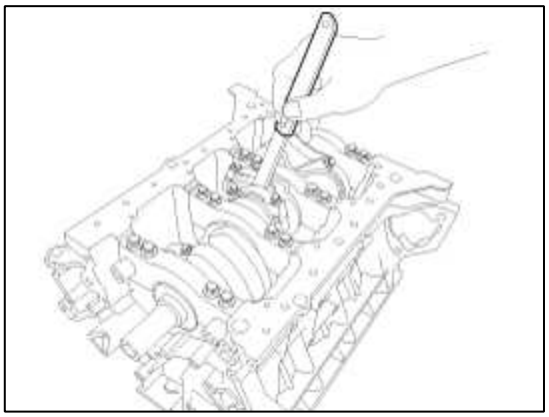
27. Disconnect connecting rod from piston. Remove the snap ring at both ends of piston pin.
    And push the piston pin to seperate from piston and connecting rod.

Inspection

Connecting Rod And Crankshaft

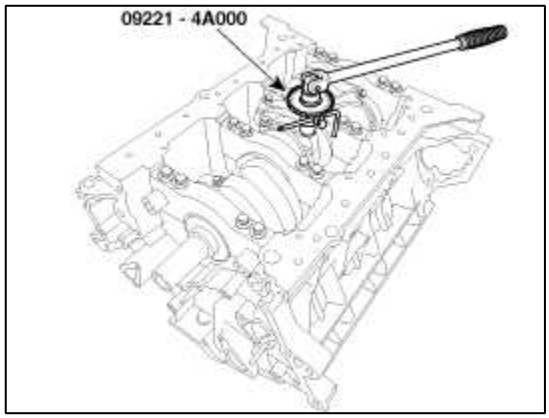
1. Check the connecting rod end play.
   Using a feeler gauge, measure the end play while moving the connecting rod back and forth.

   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 :
   27.5 ~ 31.4N.m (2.8 ~ 3.2kgf.m, 20.3 ~ 23.1 lb-ft) + 68~72°



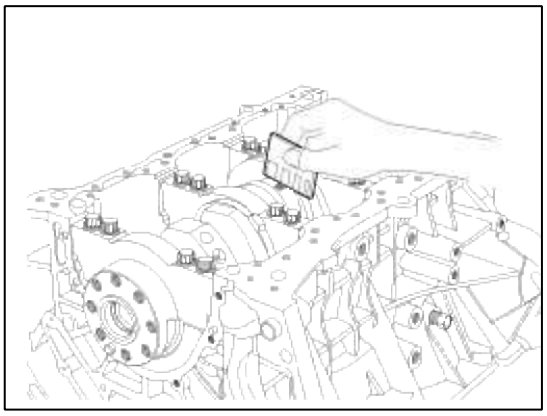
   NOTE

   Do not turn the crankshaft.

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

(8) Measure the plastigage at its widest point.

Standard oil clearance :
0.044 ~ 0.062mm (0.0017 ~ 0.0024in.)



(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.

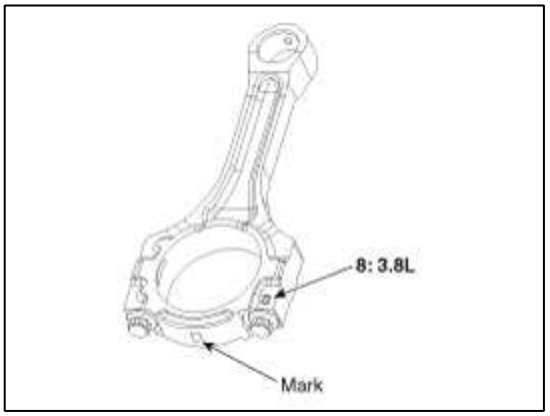
> CAUTION
>
> Do not file, shim, or scrape the bearings or the caps to adjust clearance.

(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

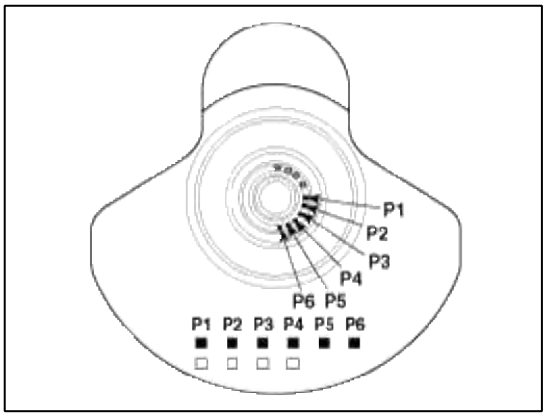


Identification Of Connecting Rod

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

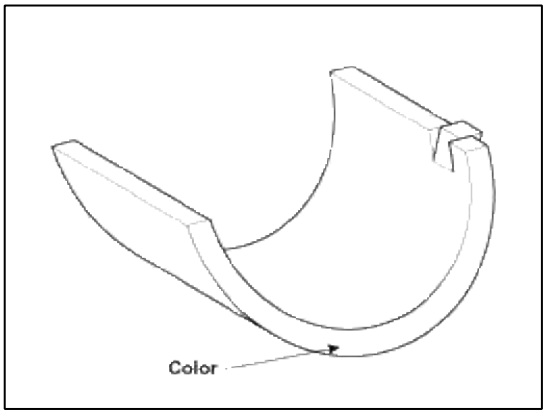
Identification Of Crankshaft



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	1.511 ~ 1.514mm (0.0595 ~ 0.0596in.)
D	BLACK	1.508 ~ 1.511mm (0.0594 ~ 0.0595in.)
C	RED	1.505 ~ 1.508mm (0.0593 ~ 0.0594in.)
B	GREEN	1.502 ~ 1.505mm (0.0591 ~ 0.0593in)
A	YELLOW	1.499 ~ 1.502mm (0.0590 ~ 0.0591in.)

(11) Selection

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

3. Check the crankshaft bearing oil clearance.

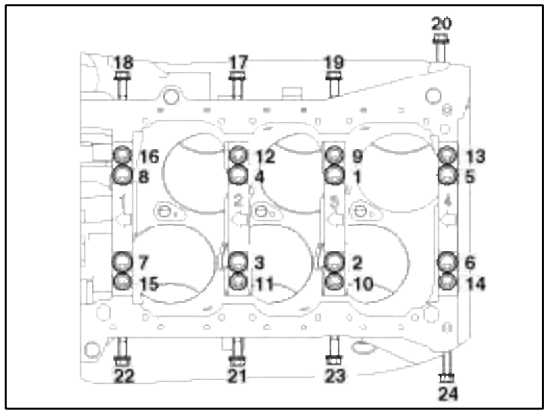
(1) To check main bearing-to-journal oil clearance, remove the main bearing caps and bearing halves.

(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° (No. 1 ~ 8)
19.6Nm(2.0 kgf.m, 14.5lb-ft)+ 120° (No. 9 ~ 16)
29.4 ~ 31.4Nm(3.0 ~ 3.2 kgf.m, 21.7 ~ 23.1lb-ft)
(No. 17 ~ 24)

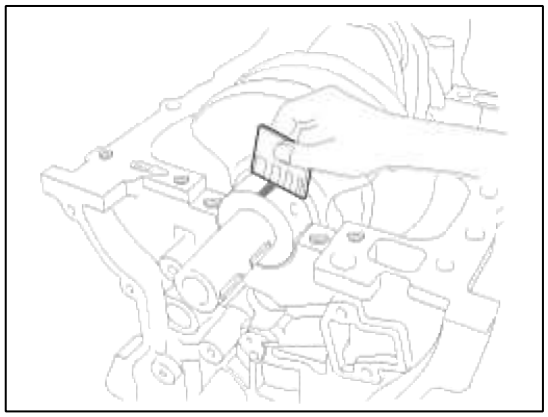


NOTE

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.

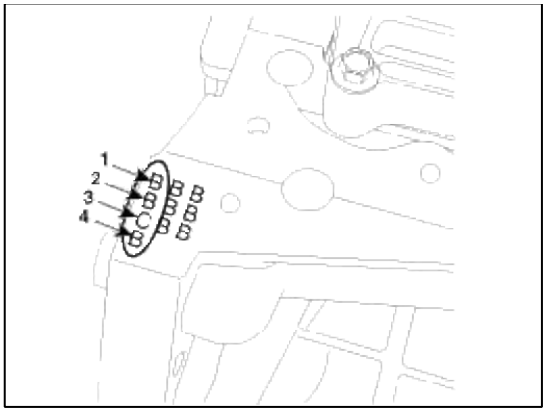
NOTE

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.

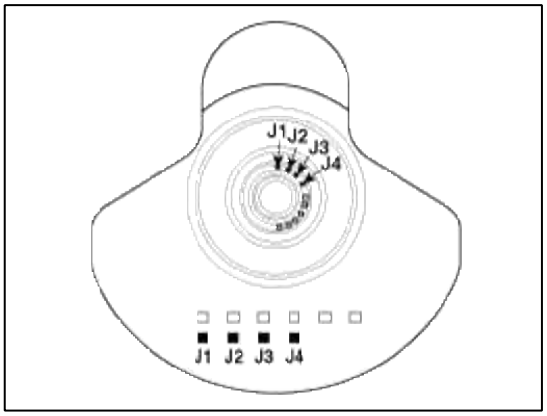


Discrimination Of Cylinder Block

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

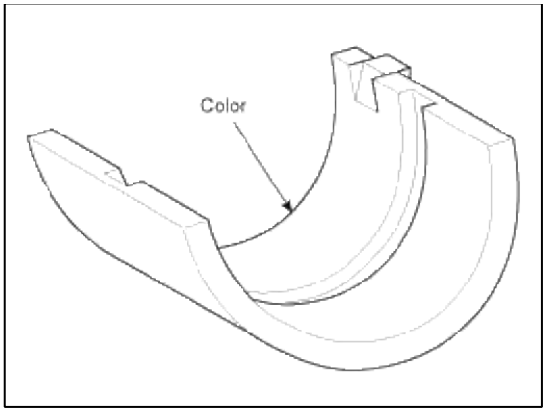
Discrimination Of Crankshaft



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

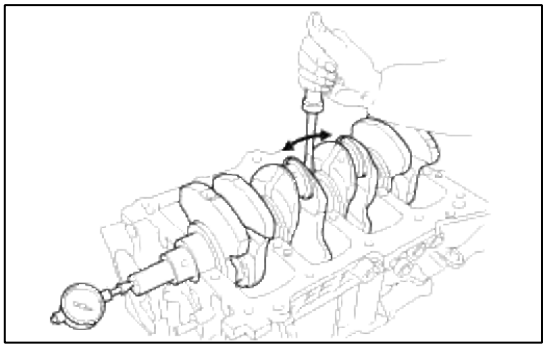
Class	Mark	Thickness Of Bearing
E	BLUE	2.277 ~ 2.280mm (0.0896 ~ 0.0897in.)
D	BLACK	2.274 ~ 2.277mm (0.0895 ~ 0.0896in.)
C	RED	2.271 ~ 2.274mm (0.0894 ~ 0.0895in.)
B	GREEN	2.268 ~ 2.271mm (0.0893 ~ 0.0894in.)
A	YELLOW	2.265 ~ 2.268mm (0.0892 ~ 0.0893in.)

Selection

		Crankshaft Bore Identification Mark		
		a(A)	b(B)	c(C)
Crankshaft Identification Mark	1 or A	A (YELLOW)	B (GREEN)	C (RED)
	2 or B	B (GREEN)	C (RED)	D (BLACK)
	3 or C	C (RED)	D (BLACK)	E (BLUE)

4. 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.)

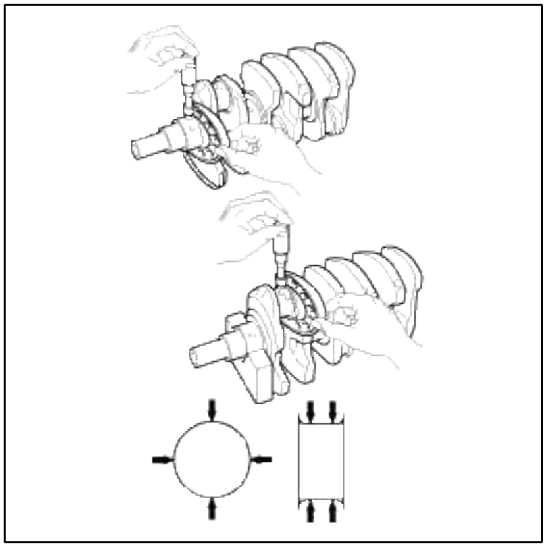


   If the end play is greater than maximum, replace the thrust bearings as a set.

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

5. 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.

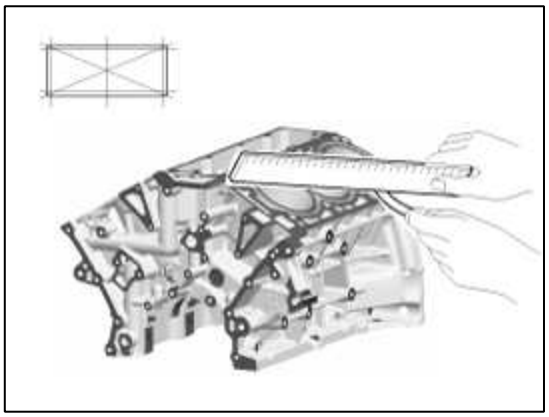
3. Using a connecting rod aligning tool, check the rod for bend and twist. If the measured value is close to the repair limit, correct the rod by a press. Any connecting rod that has been severely bent or distorted should be replaced.

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.

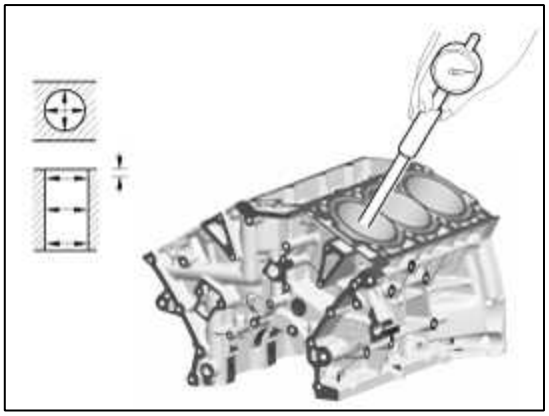
Flatness of cylinder block gasket surface
Standard : Less than 0.05mm(0.0020 in.),
Less than 0.02mm(0.0008in.) / 150 x 150



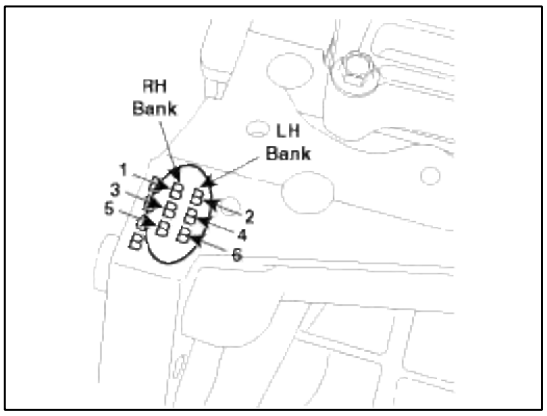
4. Inspect cylinder bore diameter
   Visually check the cylinder for vertical scratchs.
   If deep scratches are present, replace the cylinder block.

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 :
[3.0L / 3.3L] 92.00 ~ 92.03mm (3.6220 ~ 3.6232in.)
[3.8L] 96.00 ~ 96.03mm (3.7795 ~ 3.7807in.)



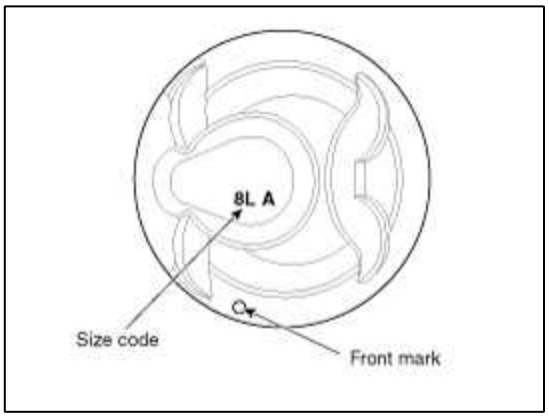
6. Check the cylinder bore size code on the cylinder block.



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.)

Maximum limit size : 96.28mm (3.7906in.)

7. Check 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.)

Boring Cylinder

1. Oversize pistons should be selected according to the largest bore cylinder.

Identification Mark	Size
0.1	0.1 mm (0.004 in)
0.25	0.25 mm (0.010 in)

NOTE

The size of piston is stamped on top of the piston.

2. Measure the outside diameter of the piston to be used.
3. According to the measured O.D(Outer Diameter), calculate the new bore size.

New bore size = piston O.D + 0.03 to 0.05mm (0.0012 to 0.0020in) (clearance between piston and cylinder) - 0.01mm (0.0004in) (honing margin.)

4. Bore each of the cylinders to the calculated size.

CAUTION

To prevent distortion that may result from temperature rise during honing, bore the cylinder holes in the firing order.

5. Hone the cylinders, finishing them to the proper dimension (piston outside diameter + gap with cylinder).

6. Check the clearance between the piston and cylinder.

Standard : 0.03 ~ 0.05mm (0.0012 ~ 0.0020in)

NOTE

When boring the cylinders, finish all of the cylinders to the same oversize. Do not bore only one cylinder to the oversize.

Piston And Rings

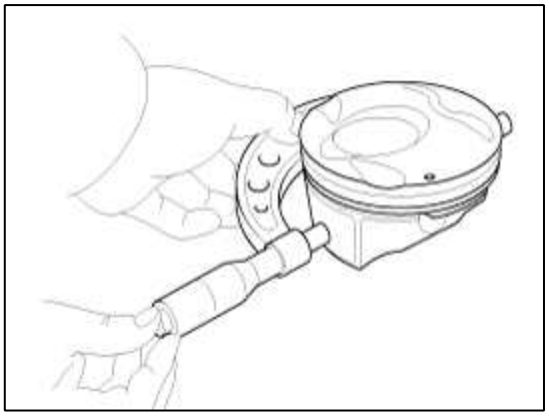
1. Clean piston
   (1) Using a gasket scraper, remove the carbon from the piston top.
   (2) Using a groove cleaning tool, clean the piston ring grooves.
   (3) Using solvent and a brush, thoroughly clean the piston.

   NOTE

   Do not use a wire brush.

2. The standard measurement of the piston outside diameter is taken 12mm (0.4724in.) from the bottom of the piston.

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

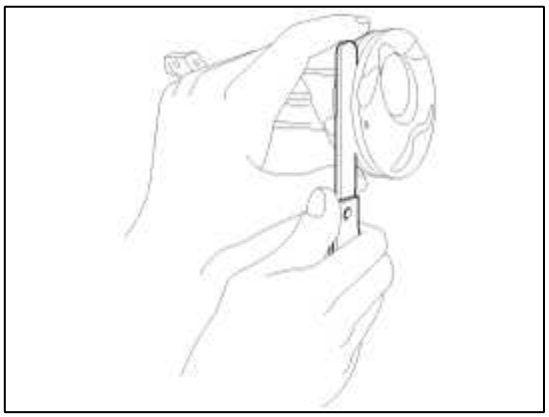


3. Calculate the difference between the cylinder bore diameter and the piston diameter.

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

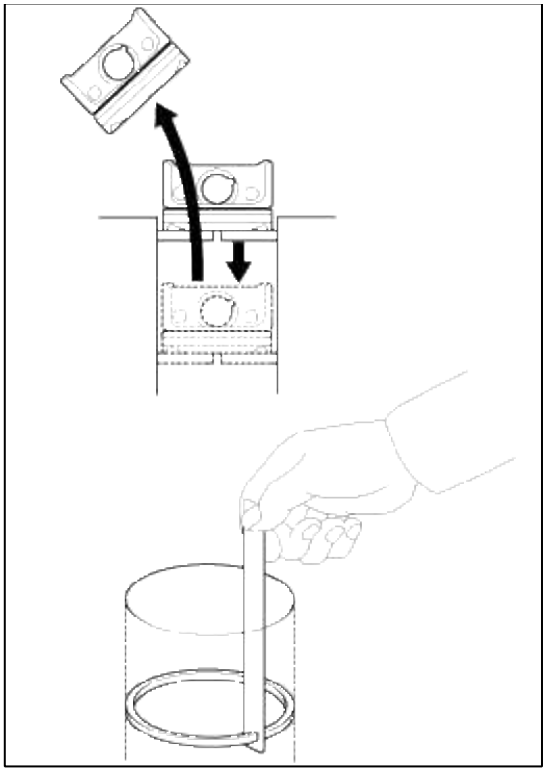
4. Inspect the piston ring side clearance.
   Using a feeler gauge, measure the clearance between new piston ring and the wall of the ring groove.

Piston ring side clearance
Standard
No.1 : 0.04 ~ 0.08mm (0.0016 ~ 0.0031in.)
No.2 : 0.04 ~ 0.08mm (0.0016 ~ 0.0031in.)
Oil ring : 0.02~0.065mm (0.0008~0.0026in.)
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.

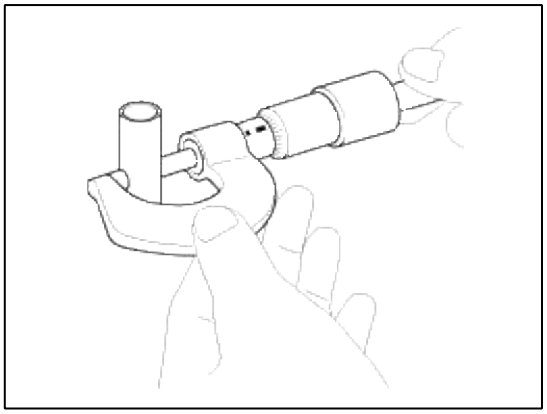
Piston ring end gap
Standard
No.1 : 0.17 ~ 0.32mm (0.0067 ~ 0.0126in.)
No.2 : 0.32~0.047mm (0.0126~0.0185in.)
Oil ring : 0.2~0.5mm (0.0078~0.0196in.)
Limit
No.1 : 0.6mm (0.0236in.)
No.2 : 0.7mm (0.0275in.)
Oil ring : 0.8mm (0.0315in.)



Piston Pins

1. Measure the diameter of the piston pin.

Piston pin diameter :
21.097 ~ 22.000mm (0.8305 ~ 0.8661in.)



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

Piston pin-to-piston clearance :
0.004 ~ 0.013mm (0.00016 ~ 0.00051in.)

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

Piston pin-to-connecting rod interference :
0.005 ~ 0.019mm (0.0002 ~ 0.0007in.)

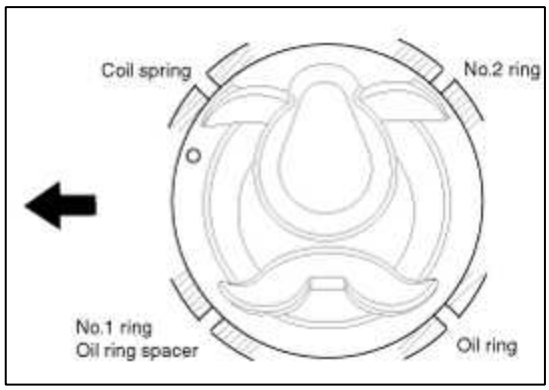
Reassembly

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.

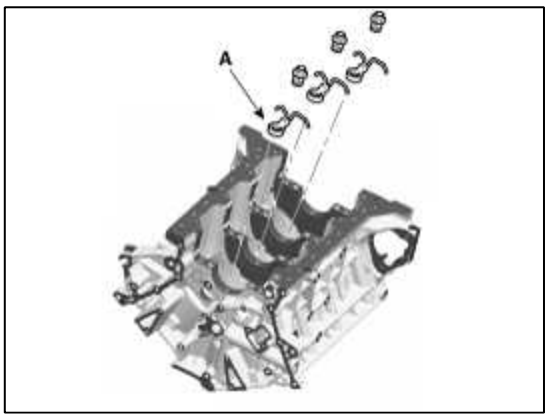
1. Assemble the piston and the connecting rod.
   (1) Install the piston pin with snap ring 2EA and check the snap ring assembly throughly.
   (2) The piston front mark and the connecting rod front mark must face the timing belt side of the engine.

2. Install the piston rings.
   (1) Install the 2 oil rings and coil spring by hand.
   (2) Using a piston ring expander, install the 2 compression rings with the code mark facing upward.
   (3) Position the piston rings so that the ring ends are as shown.

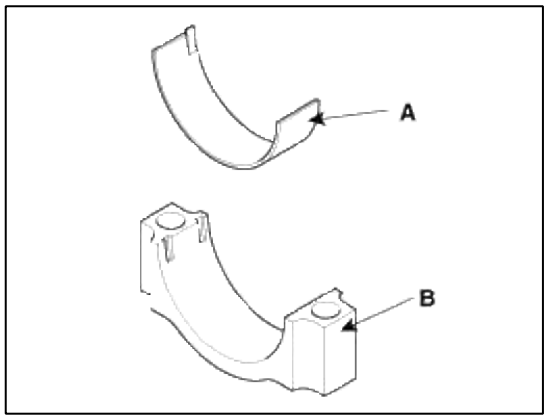


3. Install the oil jets (A).

Tightening torque :
27.5 ~ 31.4N.m (2.8 ~ 3.2kgf.m, 20.3 ~ 23.1 lb-ft)



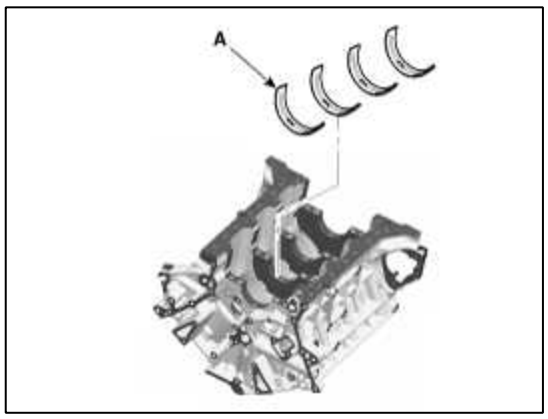
4. Install the connecting rod bearings.
   (1) Align the bearing claw with the groove of the connecting rod or connecting rod cap.
   (2) Install the bearings(A) in the connecting rod and connecting rod cap(B).



5. Install the main bearings.

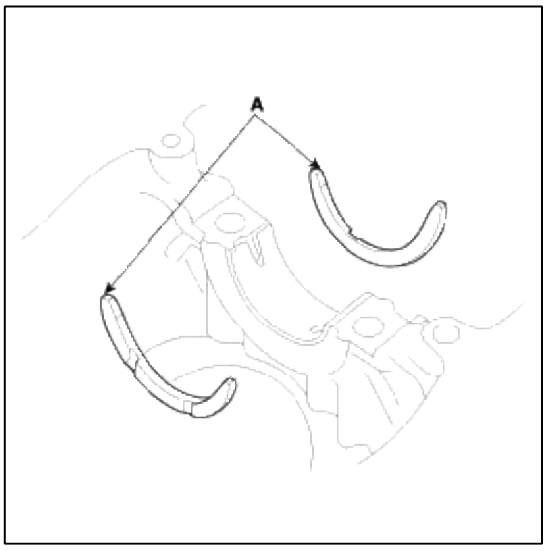
> NOTE
>
> Upper bearings have an oil groove of oil holes; Lower bearings do not.

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

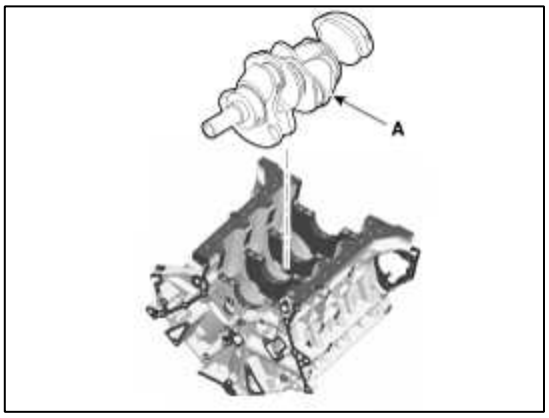


   (2) Align the bearing claw with the claw groove of the main bearing cap, and push in the 4 lower bearings.

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.

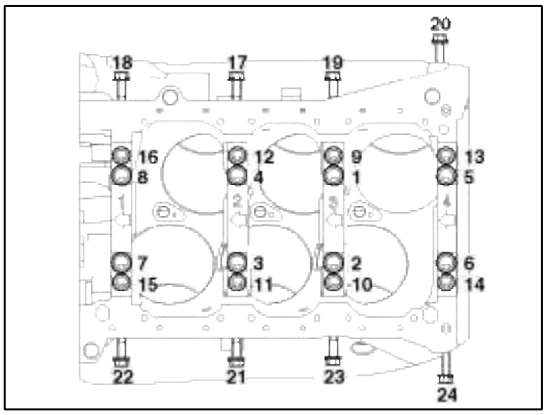


8. Place the main bearing caps on cylinder block.
9. Install the main bearing cap bolts.
   (1) Install and uniformly tighten the bearing cap bolts, in several passes, in the sequence shown.

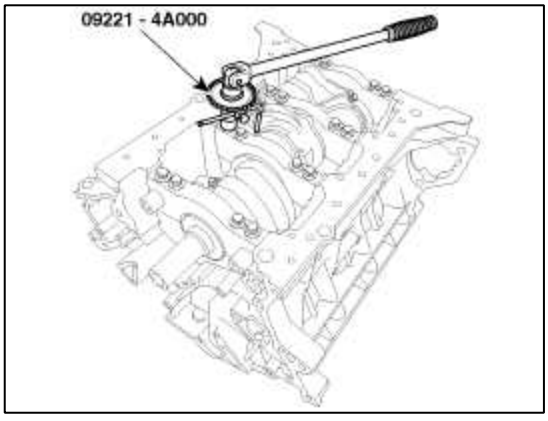
Tightening torque
Main bearing cap bolt
49.0N.m (5.0 kgf.m, 36.2lb-ft) + 90° (1 ~ 8)
19.6N.m (2.0 kgf.m, 14.5lb-ft) + 120° (9 ~ 16)
29.4 ~ 31.4N.m (3.0 ~ 3.2 kgf.m, 21.7 ~ 23.1lb-ft)
(17 ~ 24)

NOTE

- Always use new main bearing cap bolts.
- If any of the 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.

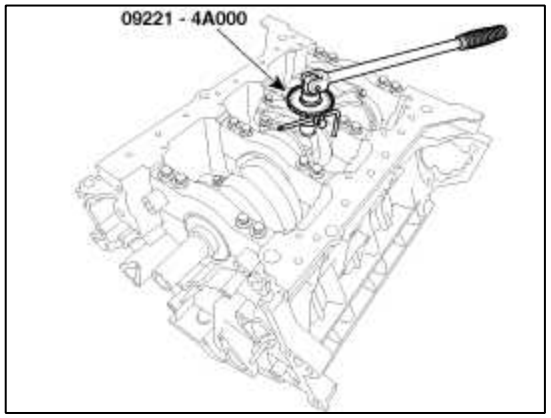
(1) Install the ring compressor, check that the bearing is securely in place, then position the piston in the cylinder, and tap it in using the wooden handle of a hammer.

(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.

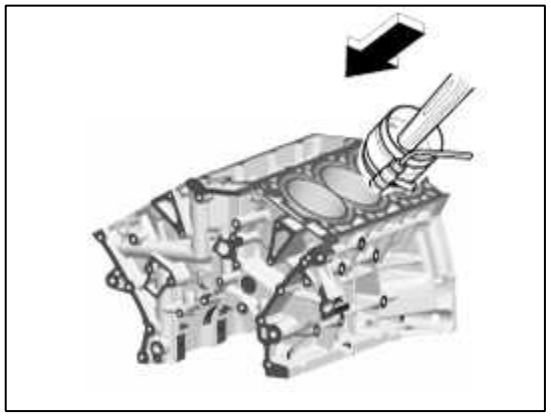
Tightening torque :
27.5 ~ 31.4N.m (2.8 ~ 3.2kgf.m, 20.3 ~ 23.1 lb-ft) + 68~72°

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



NOTE

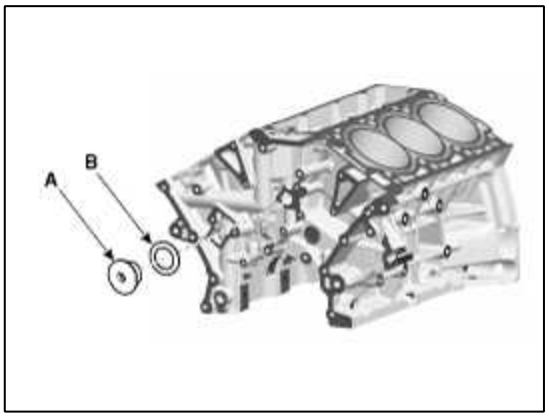
- Always use new connecting rod bearing cap bolts.
- Maintain downward force on the ring compressor to prevent the rings from expanding before entering the cylinder bore.



12. Check the connecting rod end play.

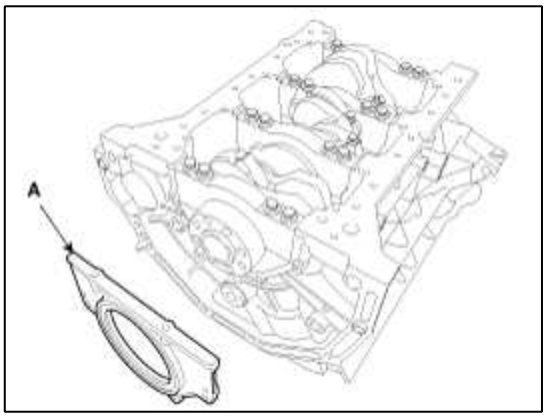
13. Install the plug bolt (A) and the washer gasket (B).

Tightening torque :
83.4 ~ 102.9N.m (8.5 ~ 10.5kgf.m, 61.5 ~ 75.9lb-ft)



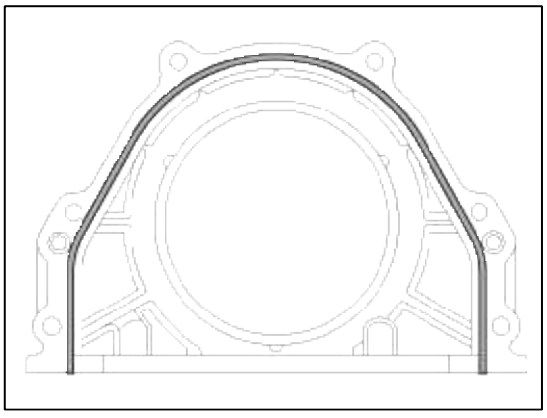
14. Install the rear oil seal case(A).

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

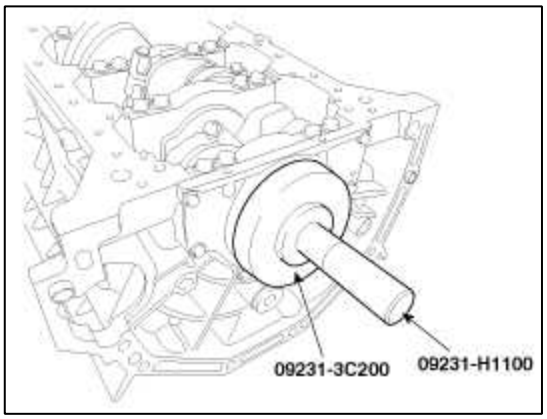


NOTE

- 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 TB 1217H (Hyundai Gray RTV) 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.

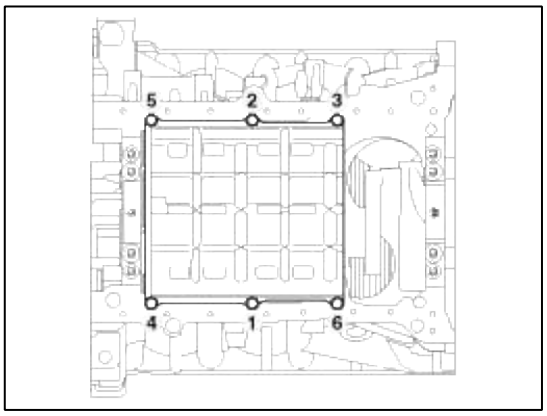


15. Using the SST(09231-3C200, 09231-H1100), install rear oil seal.



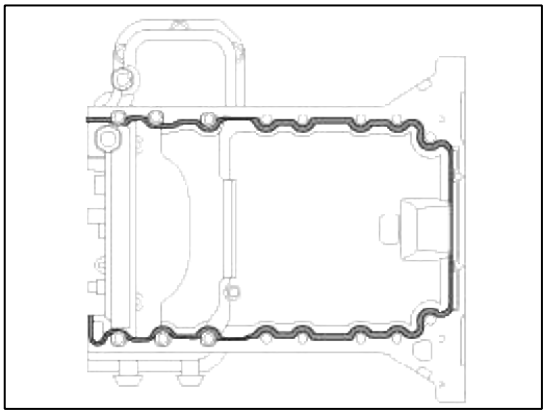
16. Install the baffle plate.
    Install and uniformly tighten the baffle plate bolts, in several passes, in the sequence shown.

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



17. 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 TB 1217H (Hyundai Gray RTV) 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.)

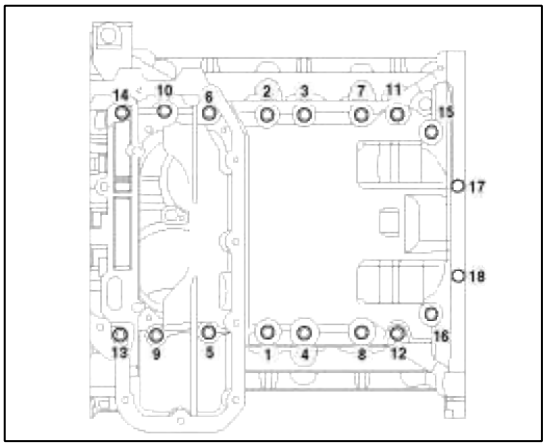


NOTE

- 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.

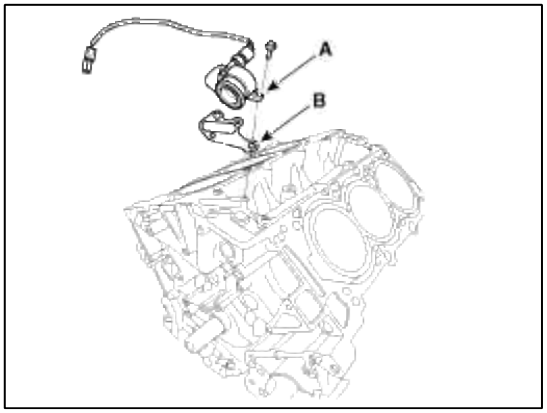
C. Install the upper oil pan.
Uniformly tighten the bolts in several passes.

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



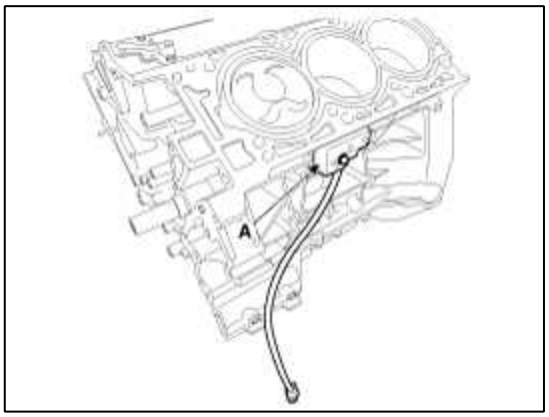
18. Install the oil cover (A) and new gasket (B).

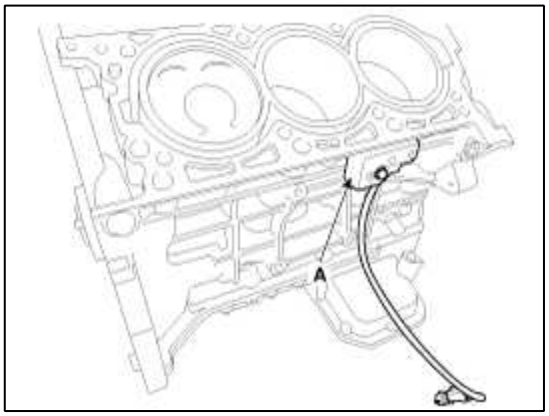
Tightening torque :
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)



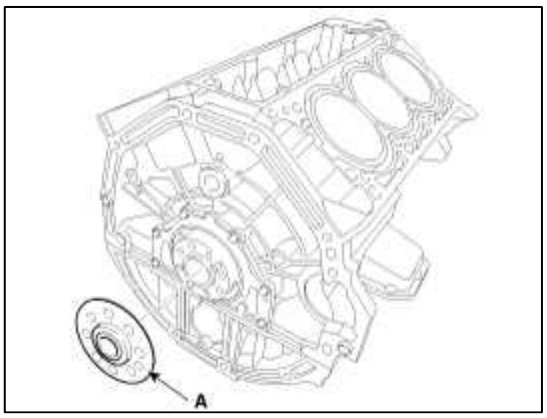
19. Install the knock sensor(A).

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



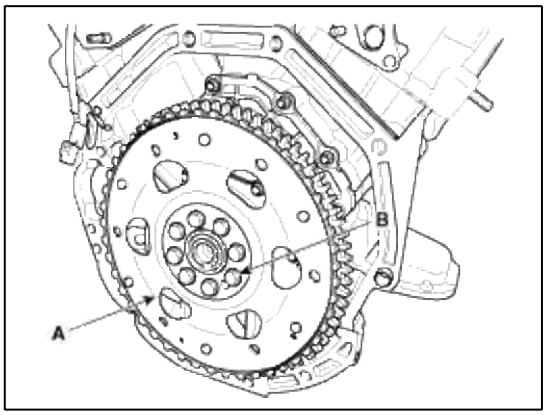


20. Install the crankshaft adapter (A). (AT)



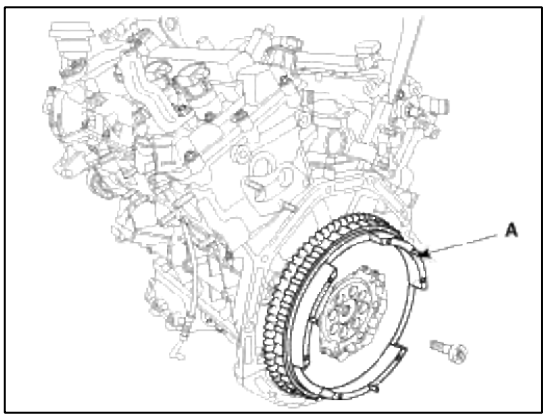
21. Install the drive plate (A) and adapter plate (B). (AT)

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

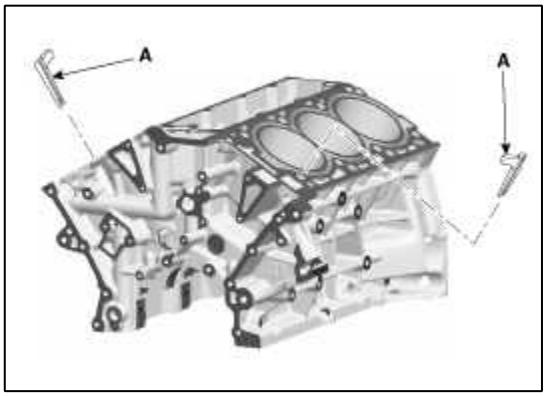


22. Install the dual mass flywheel (DMF) (A). (MT)

Tightening torque :
71.5 ~ 75.5N.m (7.3 ~ 7.7kgf.m, 52.8 ~ 55.7lb-ft)

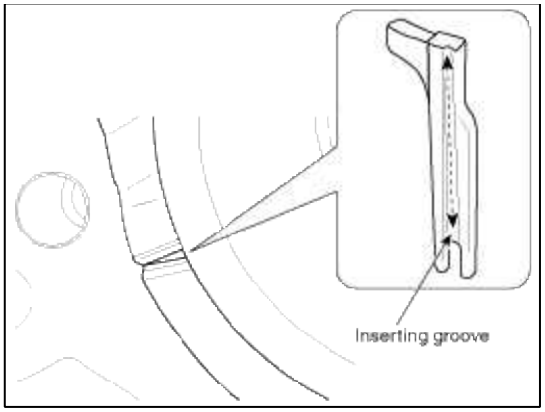


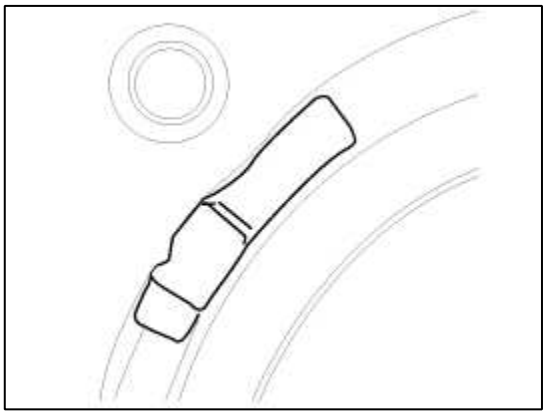
23. Install the #1, #2 cylinder bore water jacket seperator (A).



NOTE

Insert the seperator align with block inner side protrusion, and it must be located under the cylinder head installing surface.





24. Install the oil filter assembly. (Refer to Lubrication system in this group)
25. Install the oil pump. (Refer to Lubrication system in this group)
26. Install the cylinder head. (Refer to Cylinder head in this group)
27. Install the water temperature control assembly. (Refer to Cooling system in this group)
28. Install the timing chain. (Refer to Timing system in this group)
29. Install the intake manifold and exhaust manifold. (Refer to Intake and exhaust system in this group)
30. 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

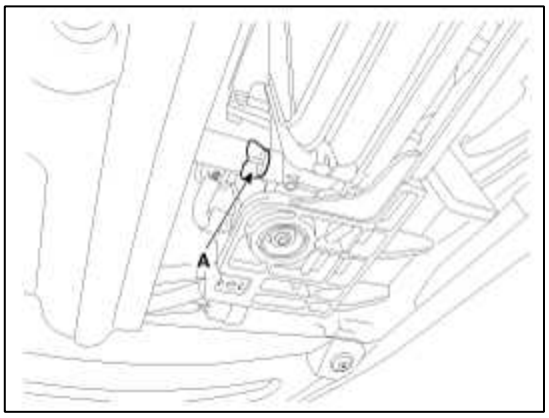
Never remove the radiator cap when the engine is hot. Serious scalding could be caused by hot fluid under high pressure escaping from the radiator.

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 (A), 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 (55~60%) (except for North America, Europe and China : 45~50%) 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 55% (except for North America, Europe and China : 45%) minimum.
>   Coolant concentrations less than 55% (except for North America, Europe and China : 45%) 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.

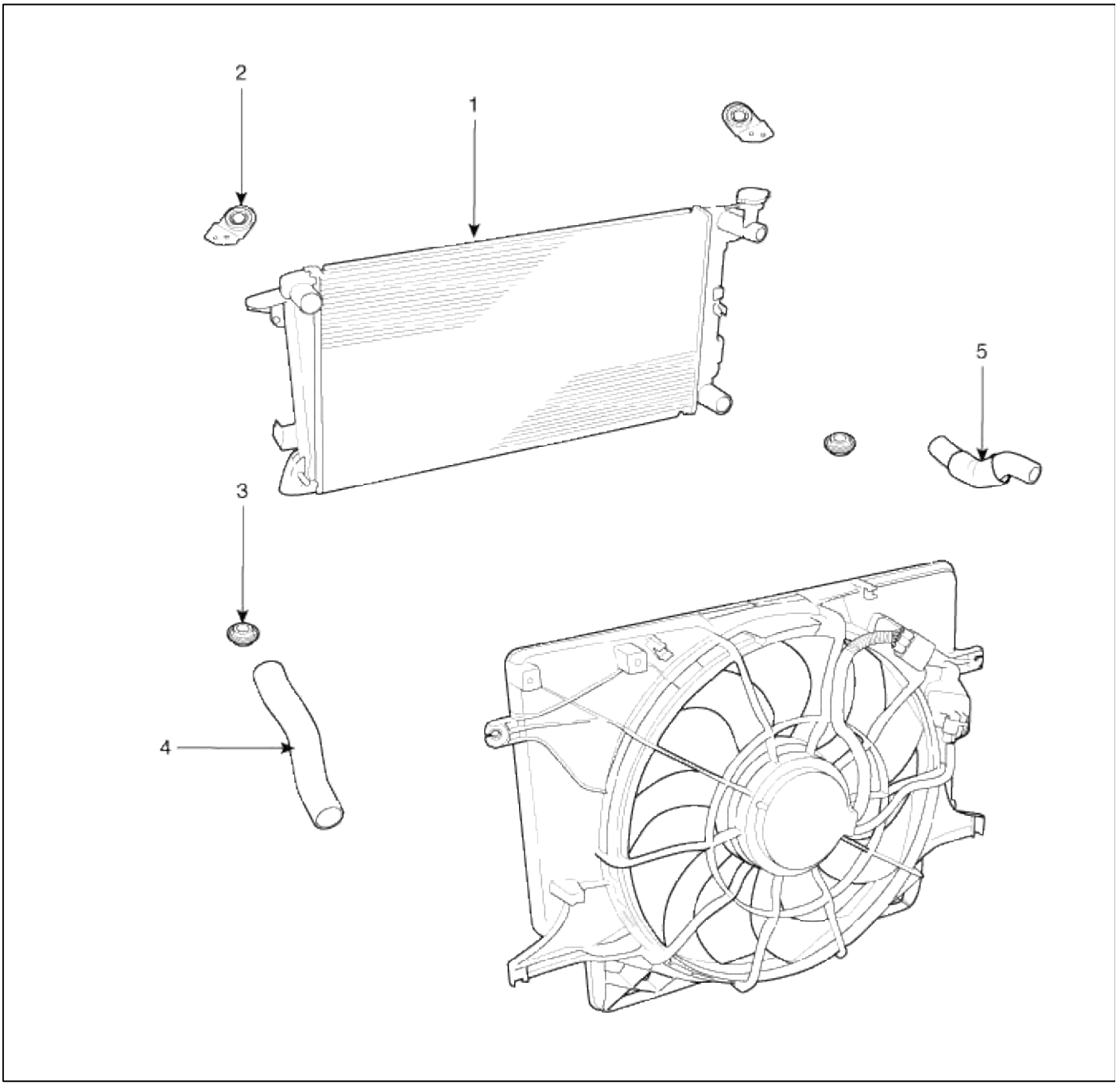
NOTE

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 :
MT : 9.0L (9.5US.qt, 7.9lmp.qt, 2.4 US.gal)
AT : 8.8L (9.3US.qt, 7.7lmp.qt, 2.3 US.gal)

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

Components

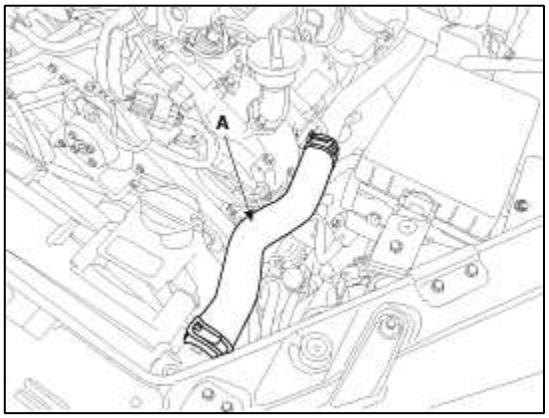


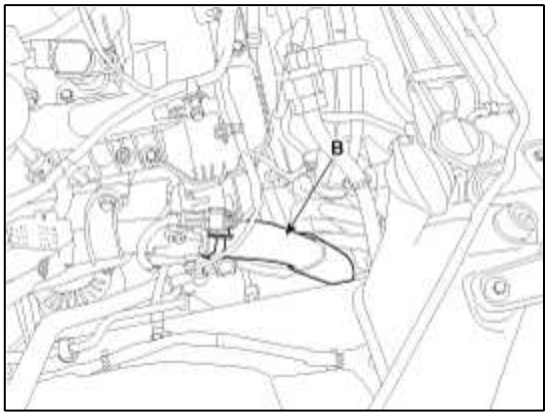
1. Radiator assembly 2. Radiator upper mounting bracket 3. Lower mounting insulator	4. Radiator upper hose 5. Radiator lower hose

Engine Mechanical System > Cooling System > Radiator > Repair procedures

Removal and Installation

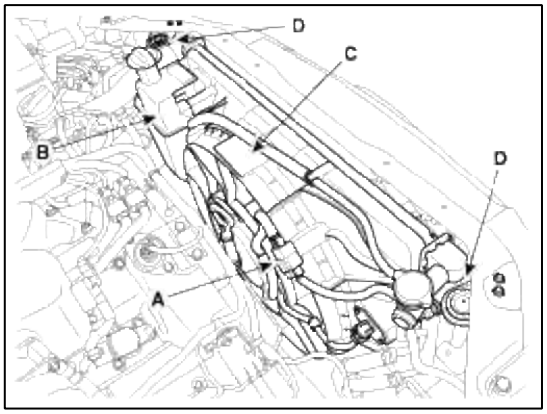
1. Disconnect the battery negative cable.
2. Loosen the drain plug and drain the engine coolant.
3. Remove the air cleaner assembly. (Refer to Engine And Transmission Assembly in this group)
4. Remove the radiator upper hose (A) and radiator lower hose (B).





5. Disconnect the ATF cooler hoses. (Refer to AT group)

6. 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.

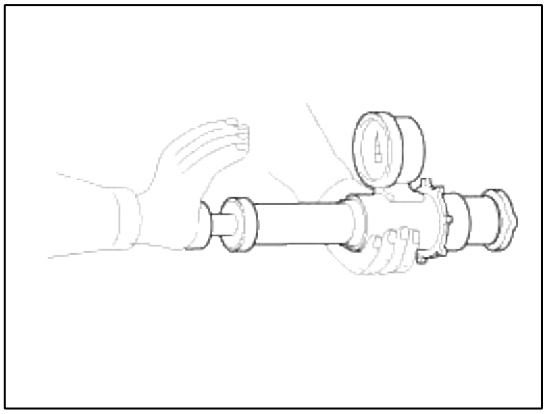


7. Installation is reverse order of removal.
8. Connect the fan motor connector.
9. Install the radiator upper hose & lower hose, and connect the ATF cooler hoses.
10. Fill the radiator with coolant and check for leaks.

Inspection

Cap Testing

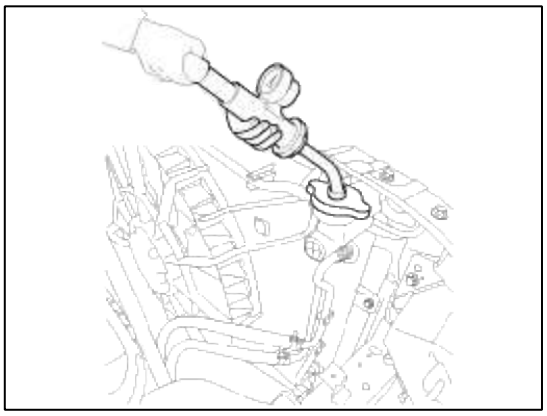
1. Remove the radiator cap, wet its seal with engine coolant, then install it to pressure tester.



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.

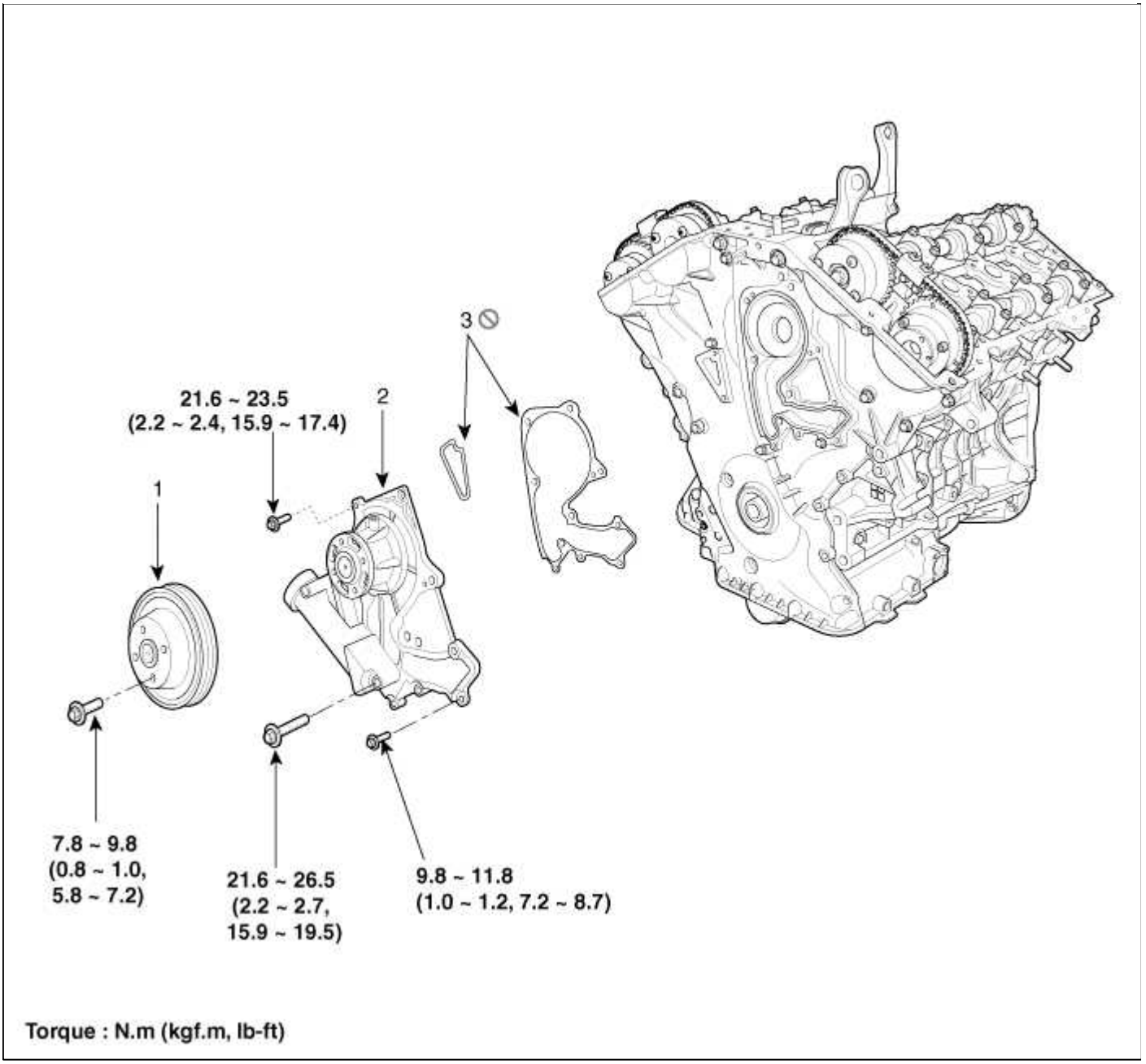


2. Apply a pressure of 93 ~ 123kPa (0.95 ~ 1.25kgf/cm², 14 ~ 19psi).
3. Inspect for engine coolant leaks and a drop in pressure.
4. If the pressure drops, check hoses, the radiator and the water pump for leakage. If there is no leakage, inspect the heater core, the cylinder block and the cylinder head.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

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

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

Components



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

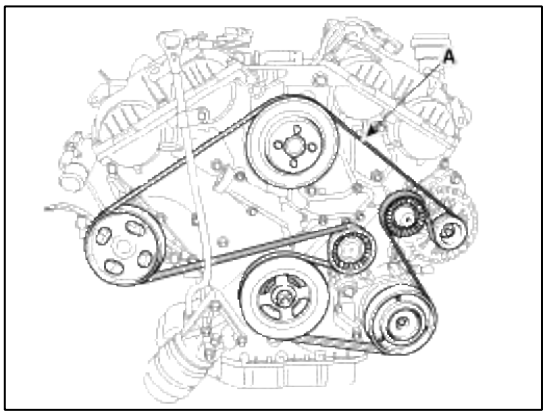
Engine Mechanical System > Cooling System > Water pump > Repair procedures

Removal

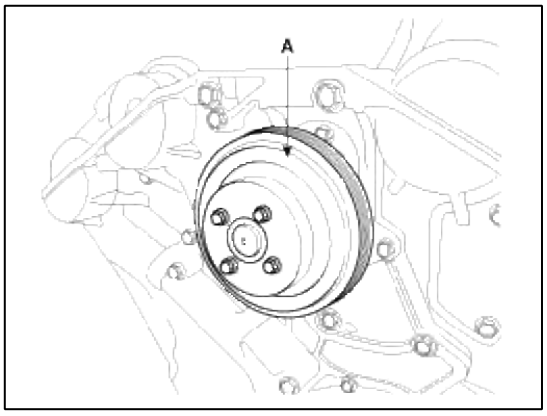
1. Loosen the drain plug, and drain the engine coolant.

> WARNING
>
> 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.

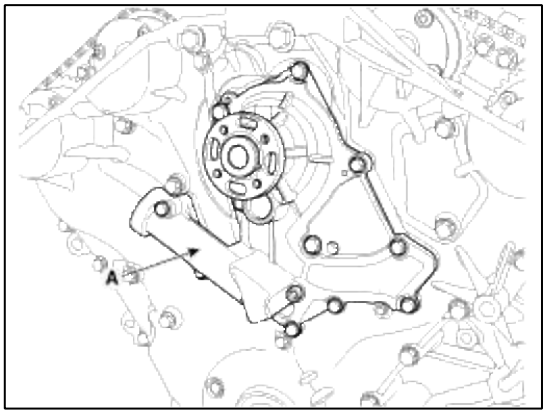
2. Remove the drive belt (A).

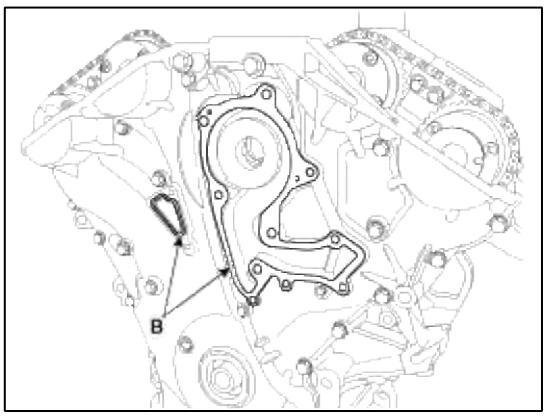


3. Remove the drive belt (A).



4. Remove the water pump (A) and the gaskets (B).





Inspection

1. Check each part for cracks, damage or wear, and replace the coolant pump assembly if necessary.
2. Check the bearing for damage, abnormal noise and sluggish rotation, and replace the coolant pump assembly if necessary.

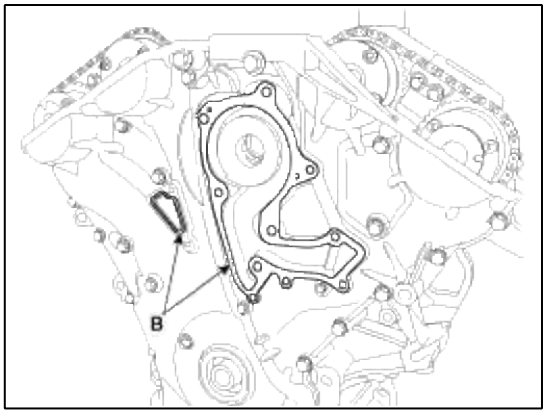
3. Check for coolant leakage. If coolant leaks from hole, the seal is defective. Replace the coolant pump assembly.

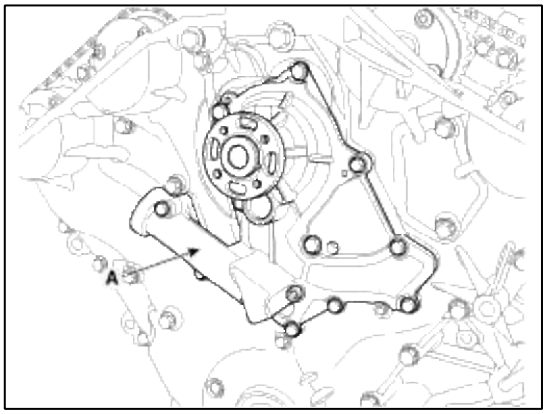
NOTE

A small amount of "weeping" from the bleed hole is normal.

Installation

1. Install the water pump (A) with the new gaskets (B).

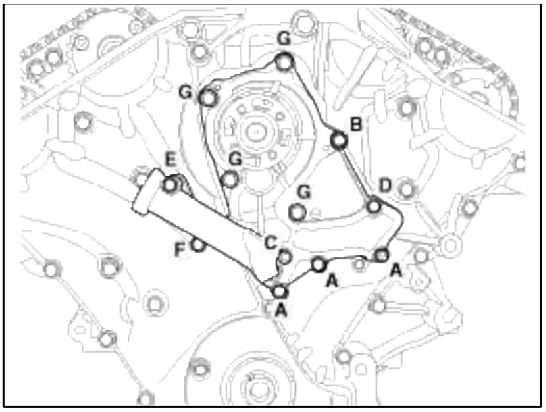




NOTE

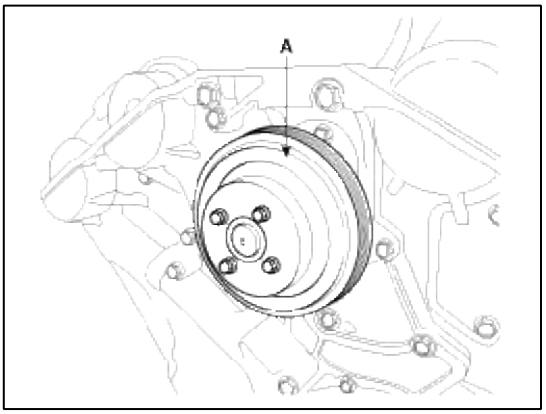
- Clean the contact face before assemble.
- Always use a new gaskets.

Tightening torque
A(3EA) : 9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)
B(1EA): 9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)
C(1EA): 21.6 ~ 26.5N.m (2.2 ~ 2.7kgf.m, 15.9 ~ 19.5lb-ft)
D(1EA): 9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)
E(1EA): 9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)
F(1EA): 9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)
G(4EA) :21.6 ~ 23.5N.m (2.2 ~ 2.4kgf.m, 15.9 ~ 17.4lb-ft)

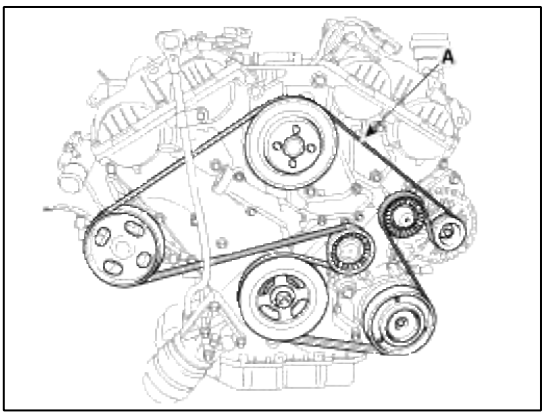


2. Install the water pump pulley (A).

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



3. Install the drive belt (A).



4. Fill the radiator with coolant and check for leaks.

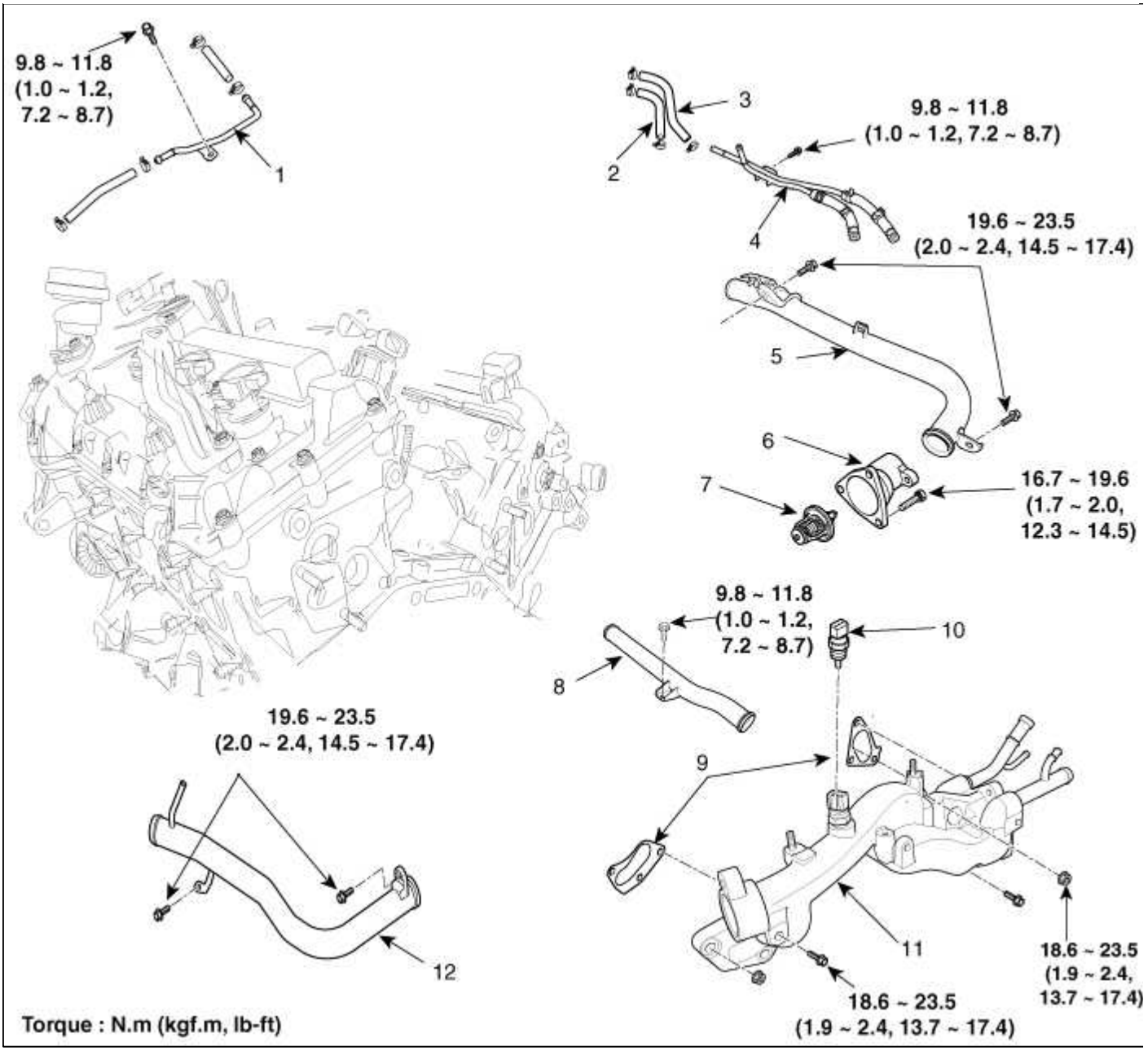
Engine Mechanical System > Cooling System > Water pump > Troubleshooting

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 > Water Temperature Control Assembly > Components and Components Location

Components



1. Water vent hose & pipe	7. Thermostat
2. Throttle body coolant hose A	8. Center pipe
3. Throttle body coolant hose B	9. Gasket
4. Throttle body coolant hose & pipe	10. Water temperature sensor (ECT)
5. RH coolant pipe	11. Water temperature control assembly
6. Coolant inlet parting	12. LH coolant pipe

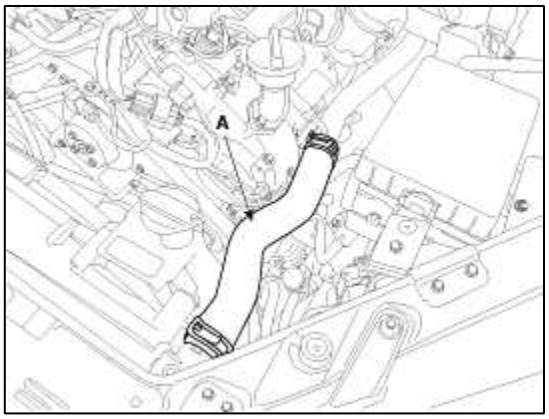
Engine Mechanical System > Cooling System > Water Temperature Control Assembly > Repair procedures

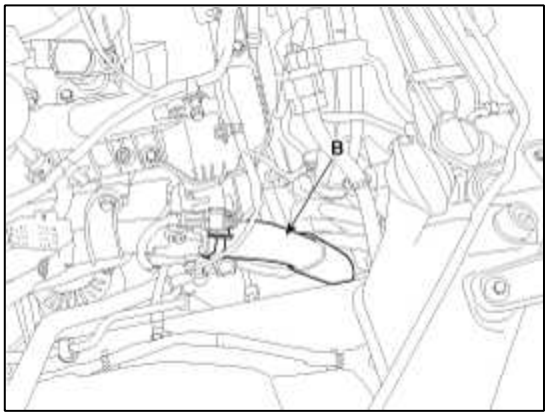
Removal

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

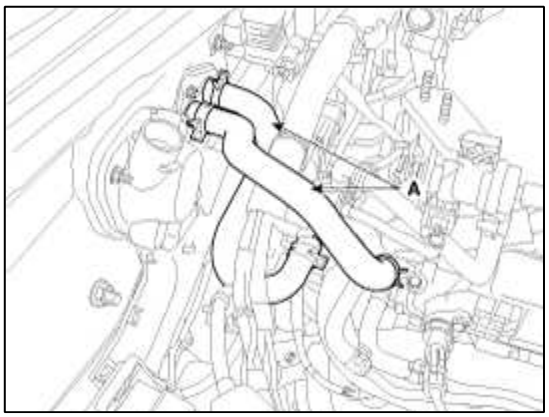
> WARNING
>
> Never remove the radiator cap when the engine is hot. Serious scalding could be caused by hot fluid under high pressure escaping from the radiator.

2. 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.
3. Remove the radiator upper hose (A) and radiator lower hose (B).

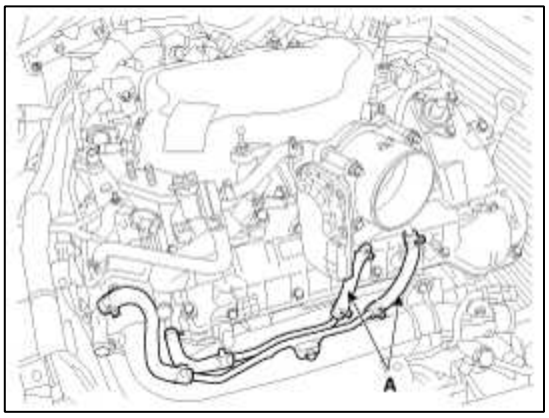




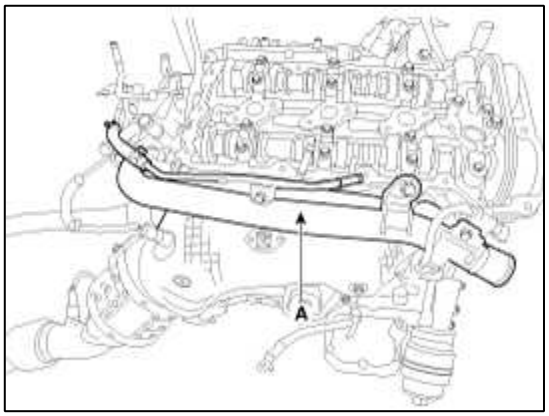
4. Disconnect the heater hoses (A).



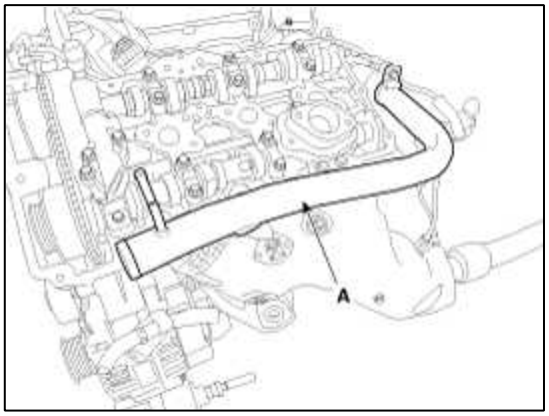
5. Remove the throttle body coolant hose & pipe (A).



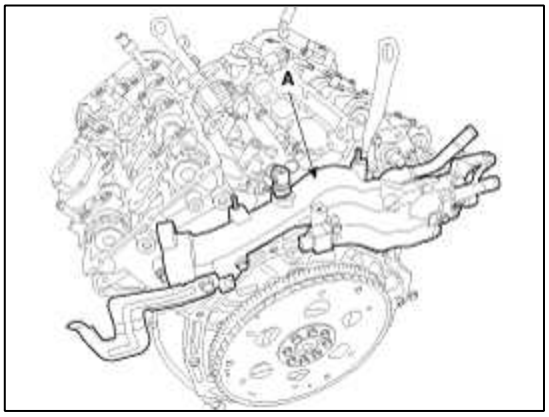
6. Remove the water inlet pipe & hose (A).



7. Remove the water outlet pipe (A).



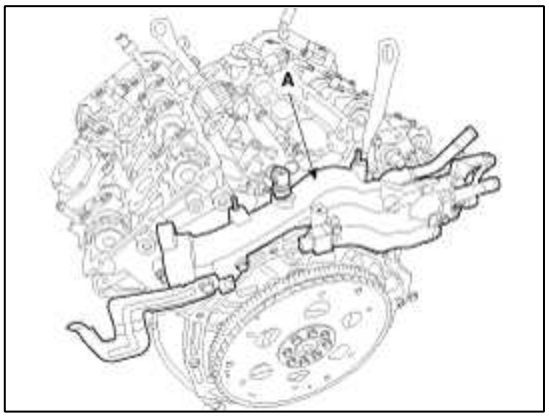
8. Remove the water temperature control assembly (A) and the gaskets.



Installation

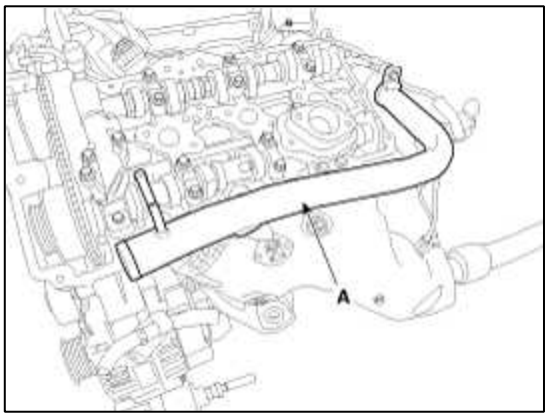
1. Install the water temperature control assembly (A) with a new gasket.

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



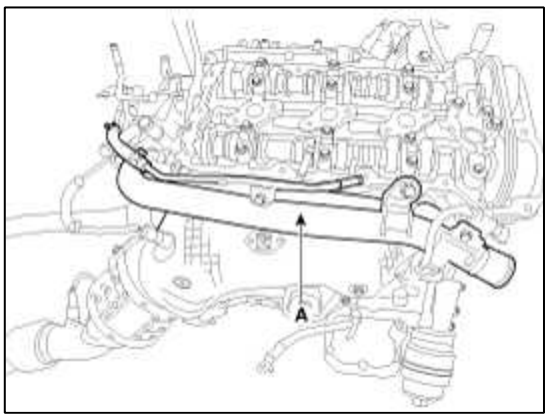
2. Install the water outlet pipe (A).

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



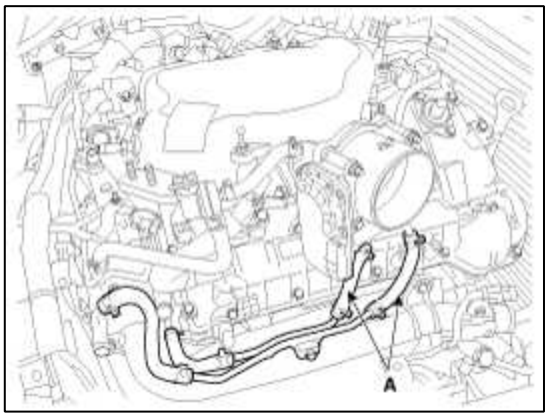
3. Install the water inlet pipe & hose (A).

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

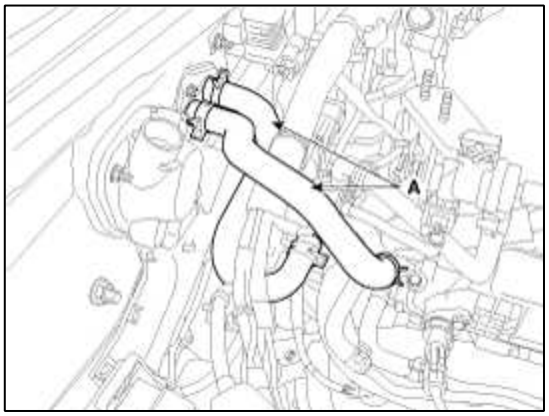


4. Install the throttle body coolant hose & pipe (A).

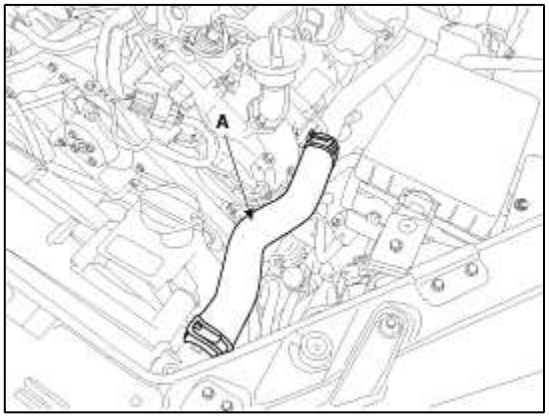
Tightening torque :
9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)

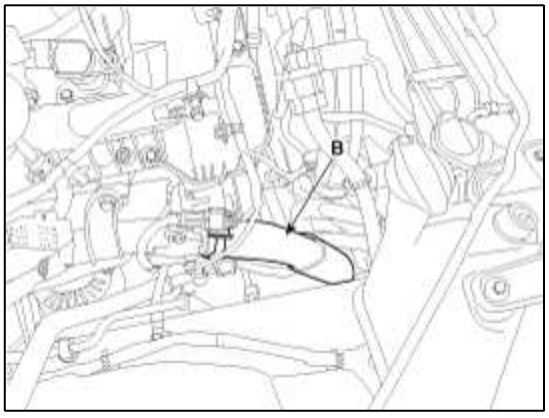


5. Connect the heater hoses (A).



6. Install the radiator upper hose (A) and radiator lower hose (B).





7. Install the air cleaner assembly. (Refer to Engine And Transmission Assembly in this group)
8. Fill the engine coolant.

9. Start the engine and check for leaks.
10. Recheck the coolant level.

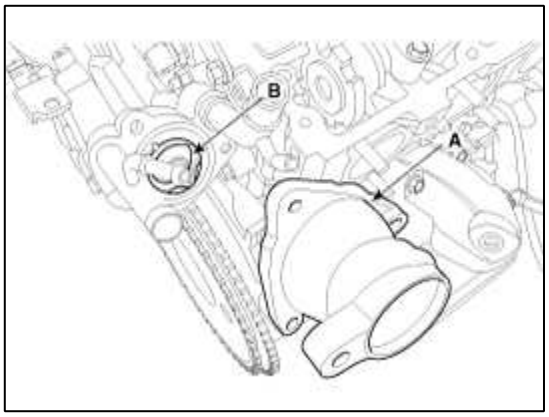
Engine Mechanical System > Cooling System > Thermostat > Repair procedures

Removal

NOTE

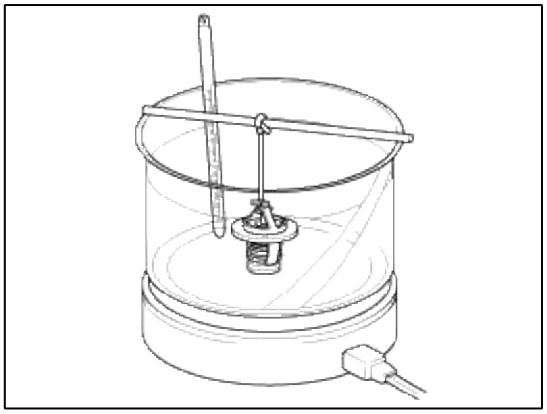
Removal of the thermostat would have an adverse effect, causing a lowering of cooling efficiency. Do not remove the thermostat, even if the engine tends to overheat.

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



Inspection

1. Immerse the thermostat in water and gradually heat the water.



2. Check the valve opening temperature.

Valve opening temperature:
82 ± 1.5°C (179.6 ± 2.7°F)
Full opening temperature: 95°C (203°F)

If the valve opening temperature is not as specified, replace the thermostat.

3. Check the valve lift.

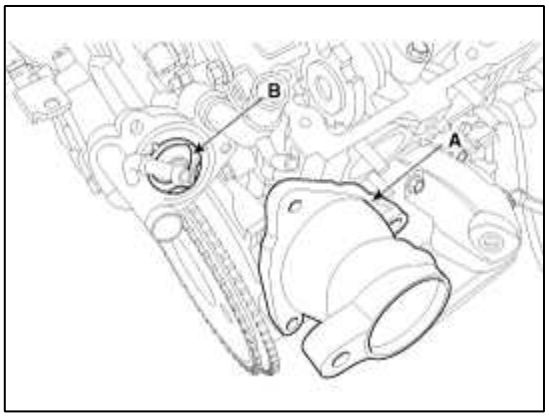
Valve lift : 10mm (0.3937in.) or more at 95°C (203°F)

If the valve lift is not as specified, replace the thermostat.

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 for damage	• Check gasket or seal for damage	• Replace gaskets and 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 > Engine Oil > Repair procedures

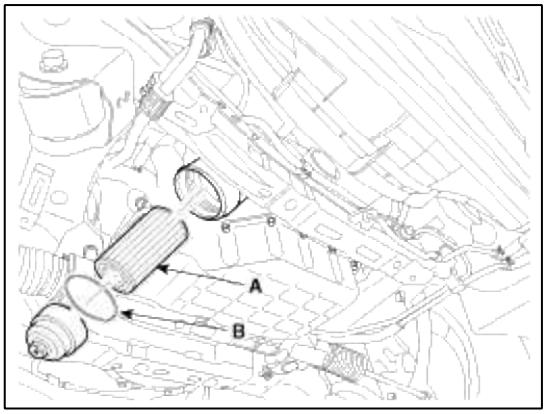
Replacement

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 fully 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).



   (6) Apply clean engine oil to the new O-rings.
   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 :
34.3N.m (3.5kgf.m, 25.3lb-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 : 6.5L (6.87US.qt, 5.72lmp.qt, 1.72 US.gal)
Oil pan : 6.0L (6.34US.qt, 5.28lmp.qt, 1.58 US.gal)
Drain and refill including oil filter :
5.7L (6.02US.qt, 5.01lmp.qt, 1.50 US.gal)

CAUTION

- Fill the crankcase to about half the capacity and then fill the remainder after waiting.
- Do not fill oil over the 'F' line, checking the level with the oil level gauge. frequently to ensure no overfilling.

   (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.

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

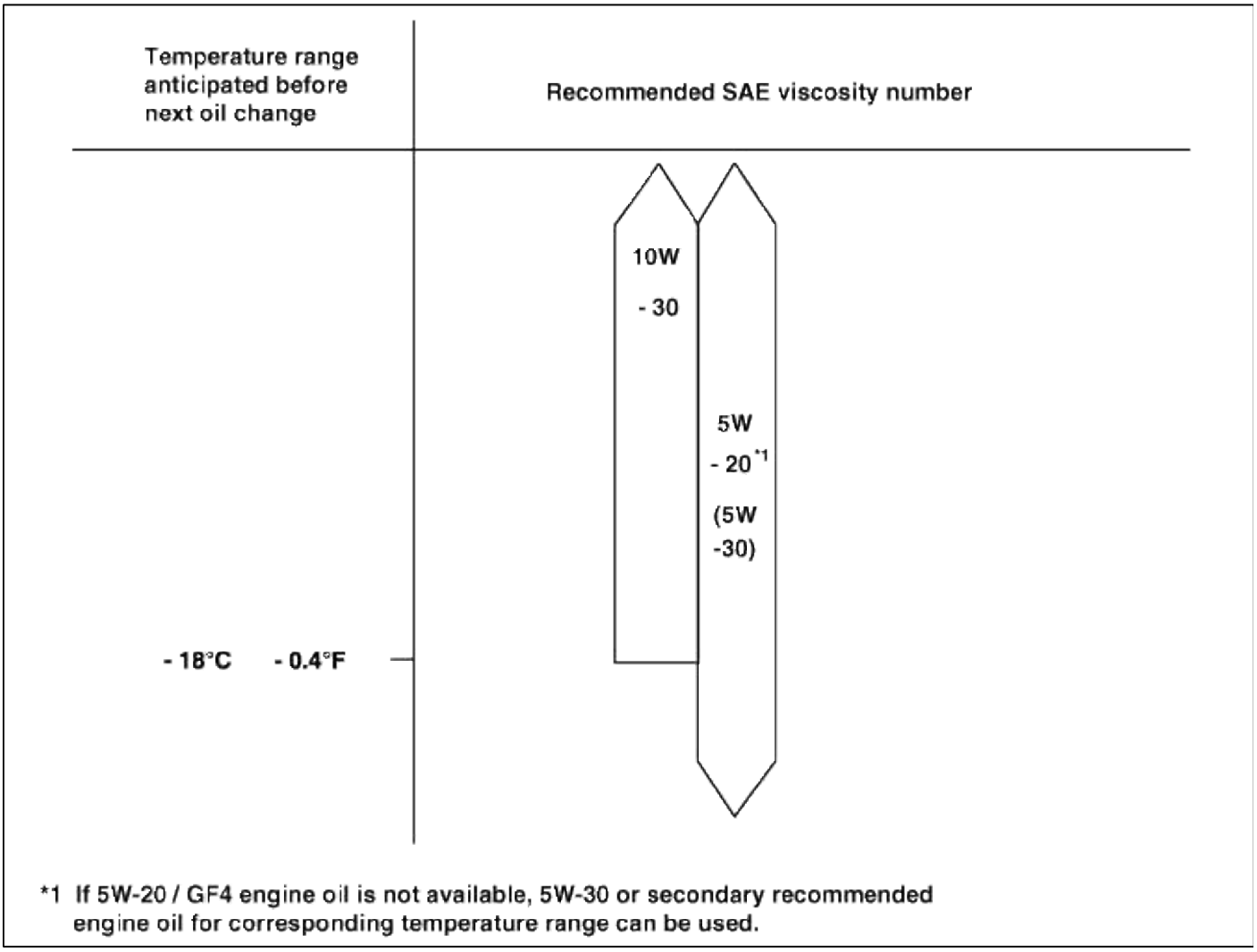
Recommendation : 5W-20 / GF&SM, 5W-30 / ACEA A5 (If not available, refer to the recommended ACEA, API or ILSAC classification)

API classification : SL, SM or above

ILSAC classification : GF3, GF4 or above

ACEA Classification : A3, A5 or above

SAE viscosity grade : Refer to the recommended SAE viscosity number.



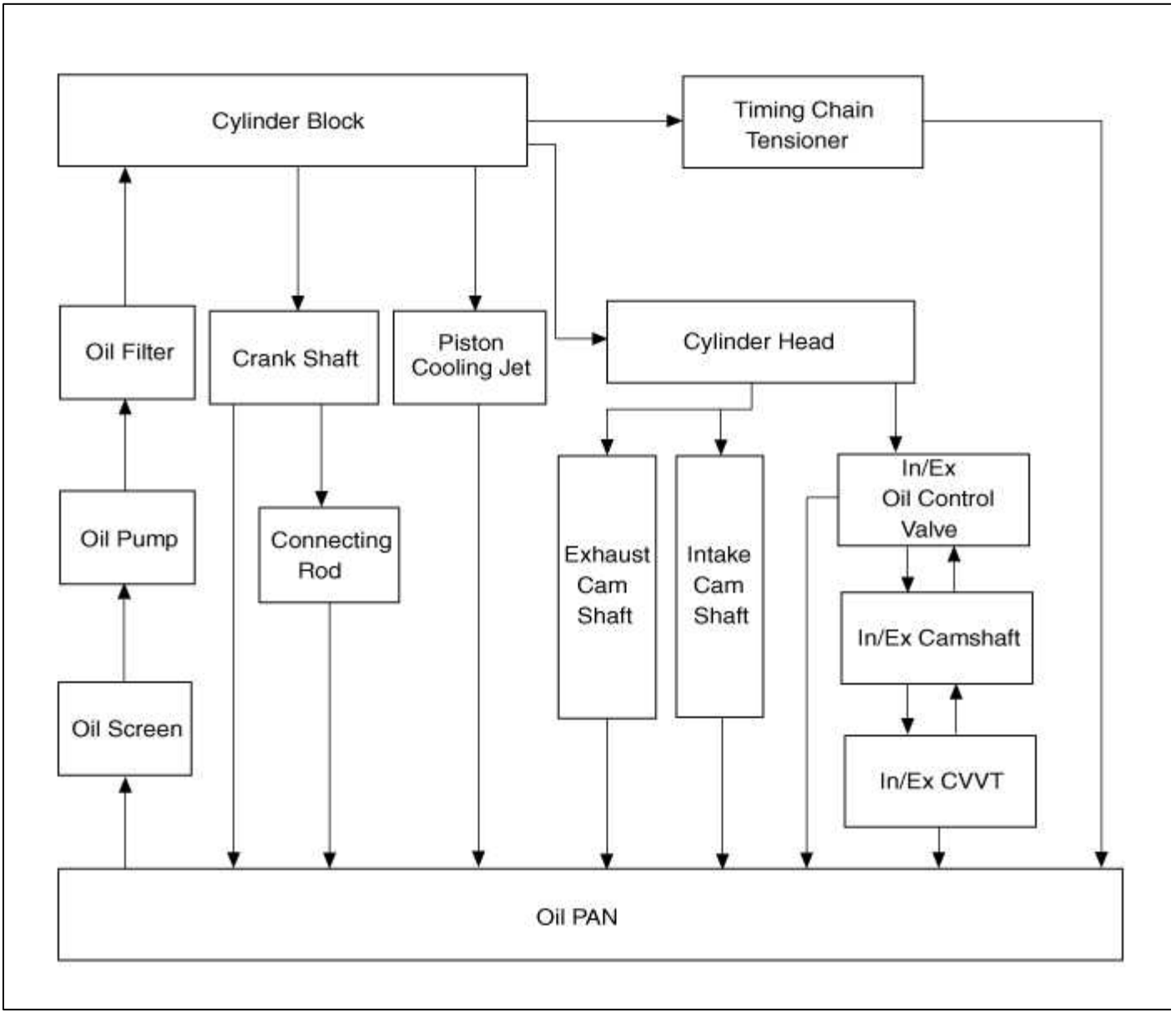
NOTE

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

1. Satisfy the requirement of the ACEA, 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 ACEA, API or ILSAC service classification on the container should not be used.

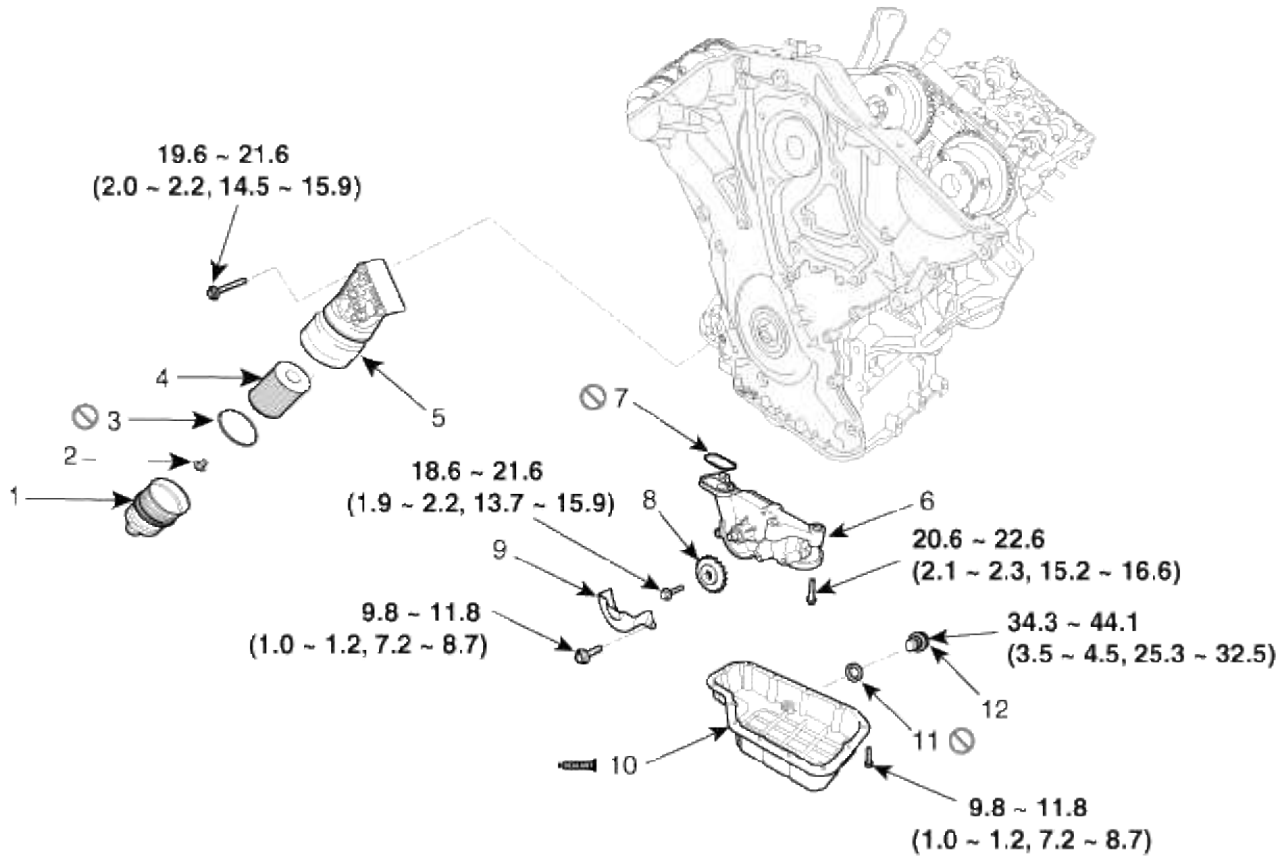
Engine Mechanical System > Lubrication System > Engine Oil > Flow Diagram

Engine Oil Flow Diagram



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

Components



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

1. Oil filter cap	5. O-ring	9. Oil pump chain cover
2. Relief valve	6. Oil pump	10. Lower oil pan
3. Oil filter element	7. O-ring	11. Oil drain plug gasket
4. Oil filter body	8. Oil pump sprocket	12. Oil drain plug

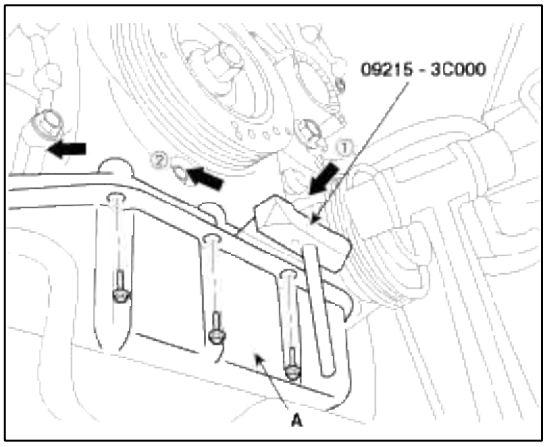
Engine Mechanical System > Lubrication System > Oil Pump > Repair procedures

Removal

Oil Pump

1. Drain the engine oil.

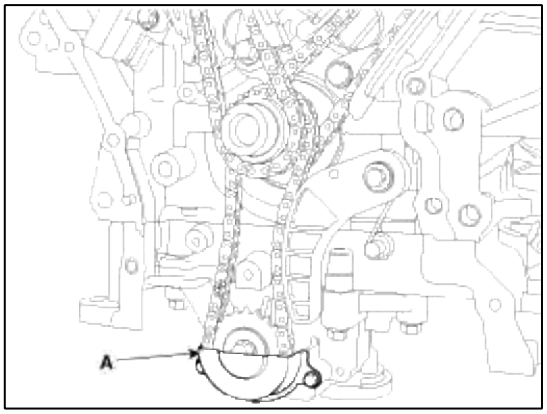
2. Remove the lower oil pan (A).
   Insert the blade of SST(09215-3C000) between the upper oil pan and lower oil pan. Cut off applied sealer and remove the lower oil pan.



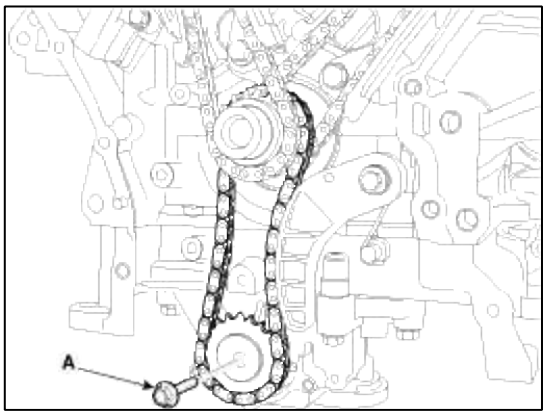
NOTE

- 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.

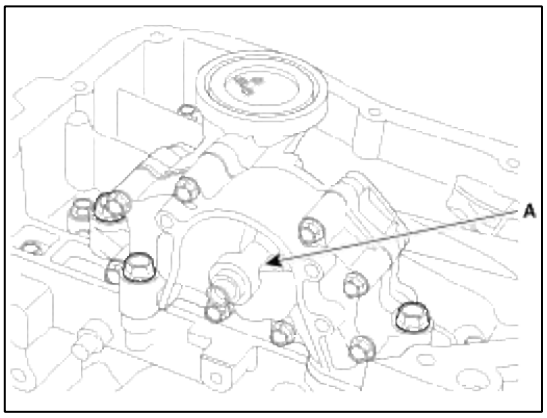
3. Remove the oil pump chain cover (A).



4. Remove the bolt (A) and then seperate the chain with sprocket from the oil pump.

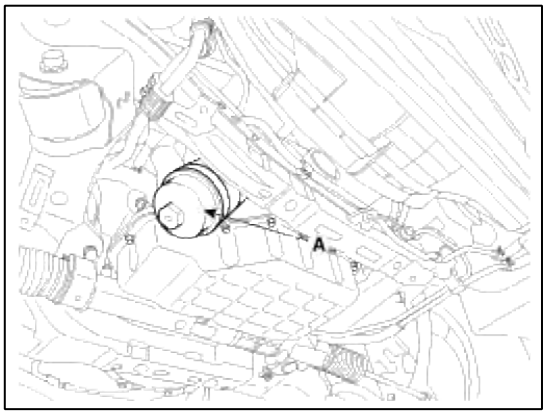


5. Remove the oil pump (A).

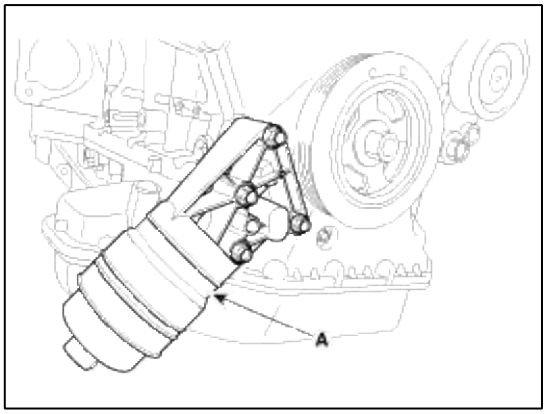


Oil Filter Assembly

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



2. Remove the oil filter body (A).

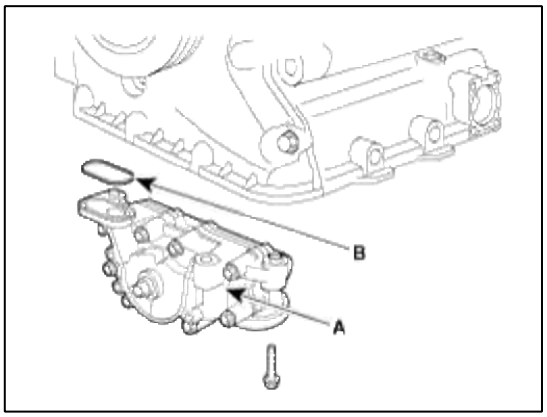


Installation

Oil Pump

1. Install the oil pump (A).

Tightening torque :
20.6 ~ 22.6N.m (2.1 ~ 2.3kgf.m, 15.2 ~ 16.6lb-ft)

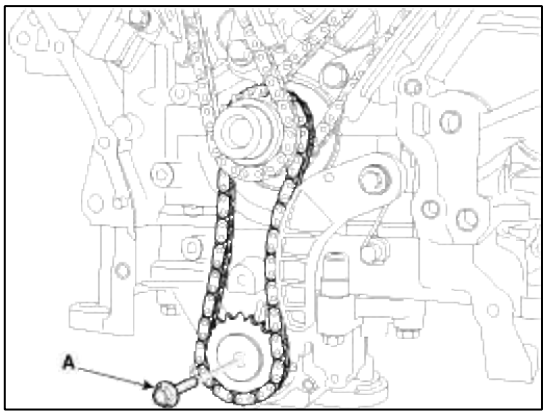


NOTE

Always use a new O-ring (B).

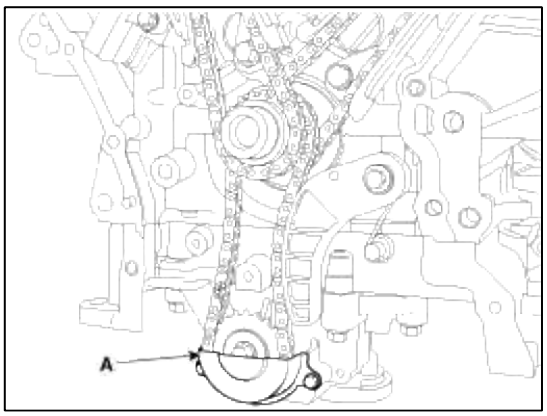
2. Install the oil pump sprocket (A) with oil pump chain to the oil pump.

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



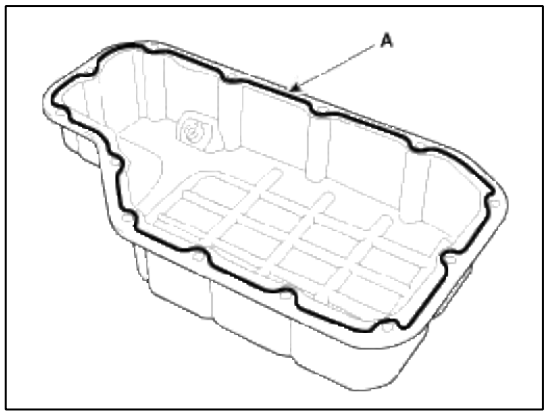
3. Install the oil pump chain cover (A).

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 (Hyundai Gray RTV) 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.)

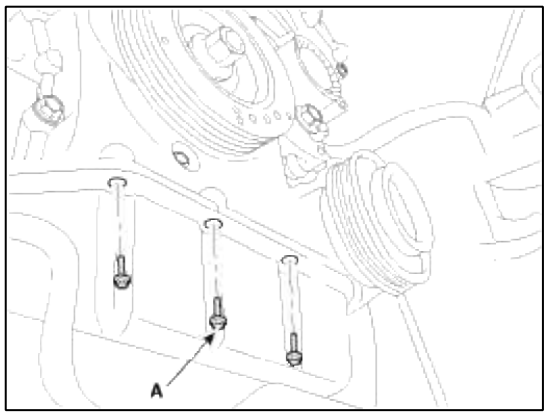


CAUTION

- 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)

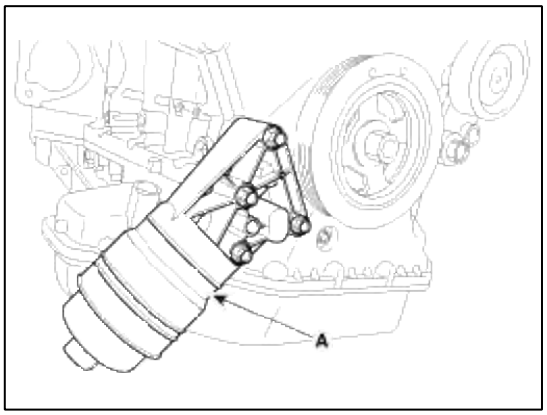


5. After assembly, wait at least 30 minutes before filling the engine with oil.

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)



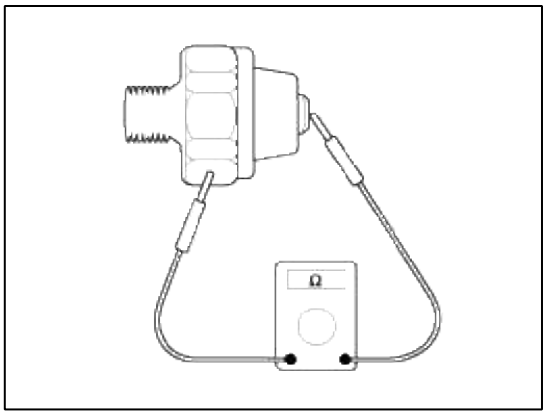
CAUTION

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

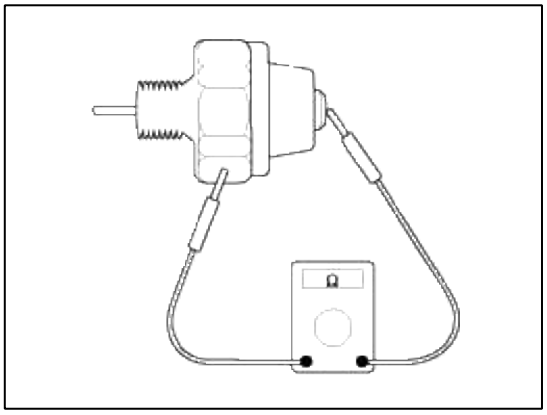
Engine Mechanical System > Lubrication System > Oil Pressure Switch > Repair procedures

Inspection

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

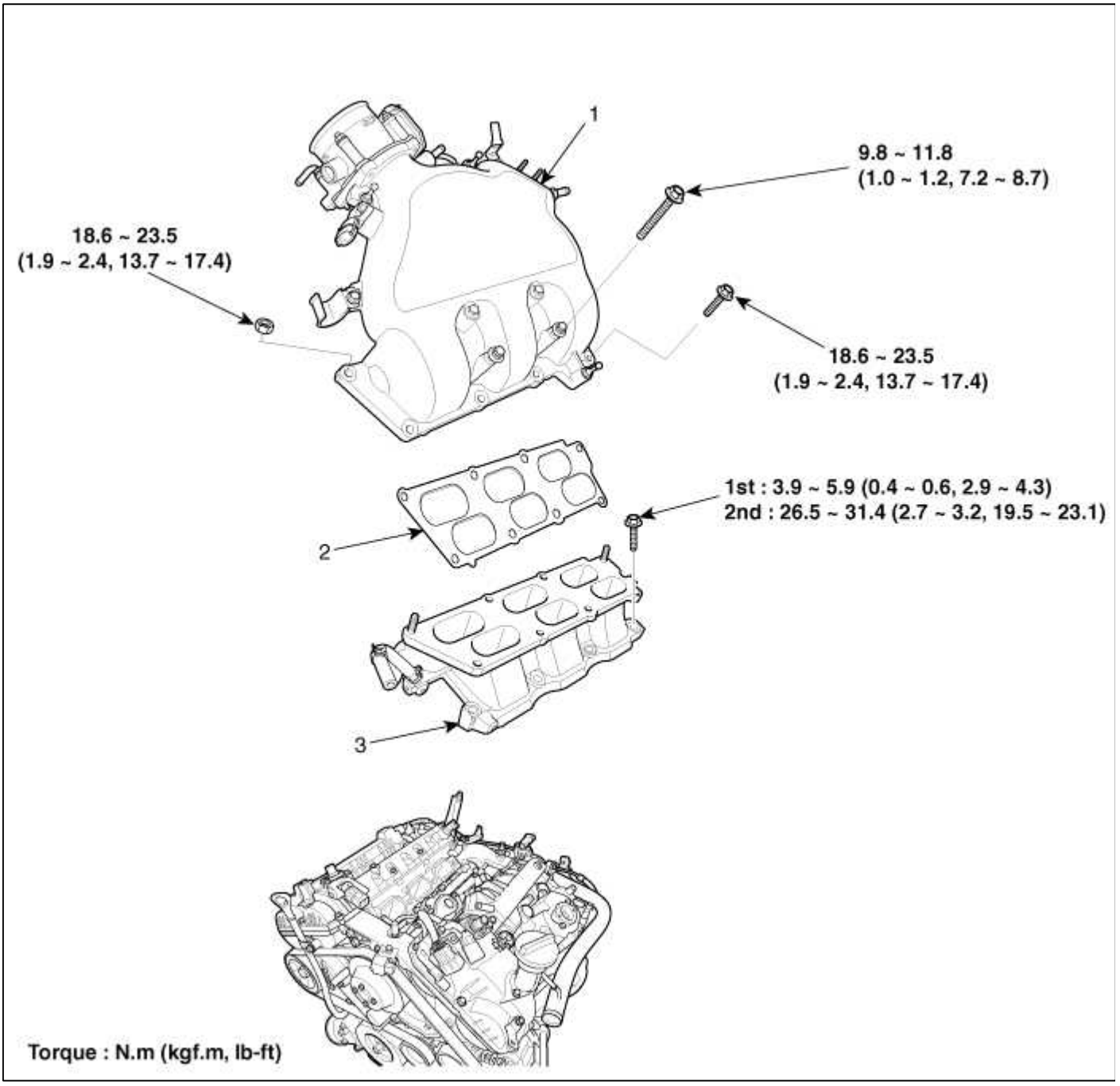


2. Check the continuity between the terminal and the body when the fine wire is pushed. If there is continuity even when the fine wire is pushed, replace the switch.



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

Components



1. Surge tank 2. Surge tank gasket	3. Intake manifold

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

Removal and Installation

CAUTION

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

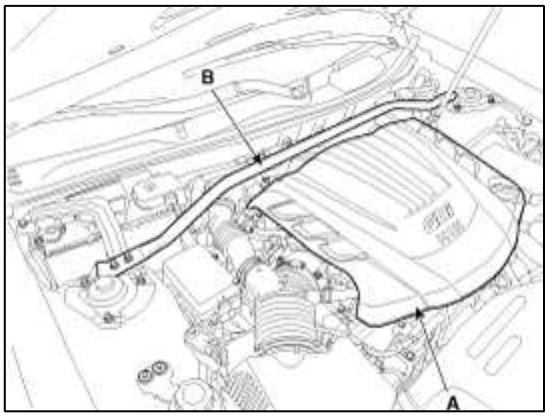
NOTE

Mark all wiring and hoses to avoid misconnection.

1. Disconnect the battery negative cable.

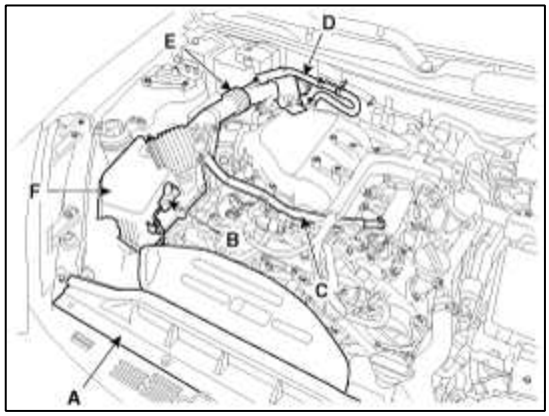
Tightening torque :
7.8 ~ 9.8 N.m (0.8 ~ 1.0 kgf.m, 5.8 ~ 7.2 lb-ft)

2. Remove the engine cover (A).
3. Remove the strut bar (B).

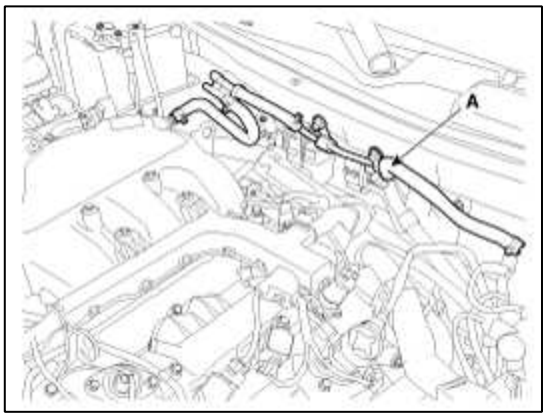


4. Loosen the drain plug and drain the engine coolant.
5. Remove the intake air hose and air cleaner assembly.
   (1) Remove the air duct (A).
   (2) Disconnect the Barometric Pressure Sensor (BPS) connector (B).
   (3) Disconnect the breather hose (C).
   (4) Disconnect the vacuum hose (D).
   (5) Remove the intake air hose (E) and air cleaner assembly (F).

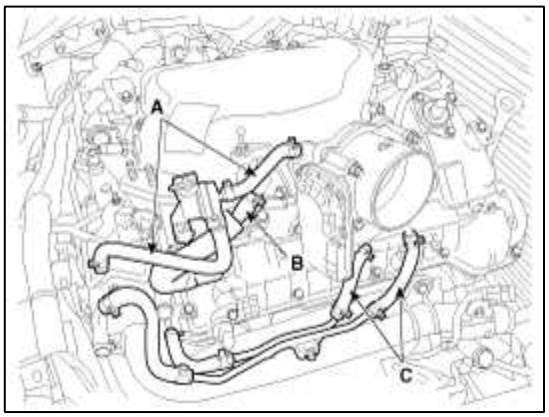
Tightening torque
Hose clamp bolt :
2.9 ~ 4.9 N.m (0.3 ~ 0.5 kgf.m, 2.2 ~ 3.6 lb-ft)
Air cleaner assembly bolts :
7.8 ~ 9.8 N.m (0.8 ~ 1.0 kgf.m, 5.8 ~ 7.2 lb-ft)



6. Disconnect the brake booster vacuum hose (A).

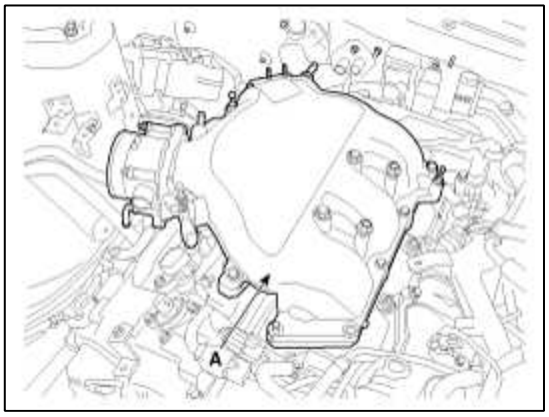


7. Disconnect the engine wiring connectors and harness protector on the surge tank. (Refer to Timing System in this group)
8. Disconnect the purge control solenoid valve (PCSV) hoses (A), positive crankcase ventilation (PCV) and the throttle body coolant hoses (C).



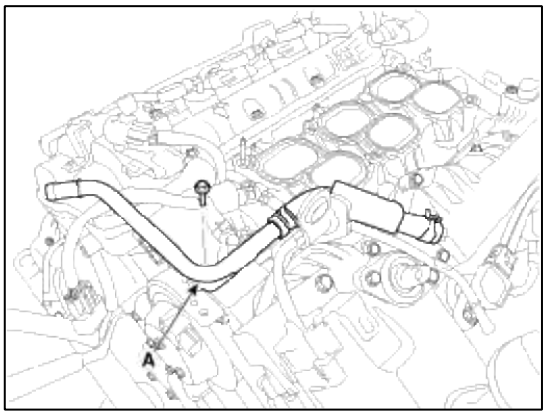
9. Remove the surge tank (A).

Tightening torque
Long bolt (2ea) :
9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)
Short bolt (4ea) :
18.6 ~ 23.5N.m (1.9 ~ 2.4kgf.m, 13.7 ~17.4lb-ft)
Nut (2ea) :
18.6 ~ 23.5N.m (1.9 ~ 2.4kgf.m, 13.7 ~17.4lb-ft)

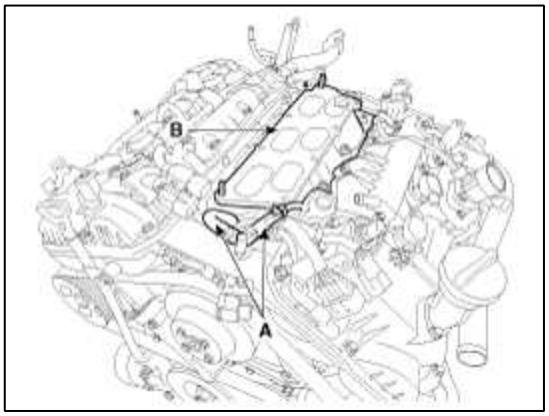


10. Remove the breather pipe & hose (A).

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



11. Disconnect the water hose & pipe (A) and then remove the intake manifold (B).



WARNING

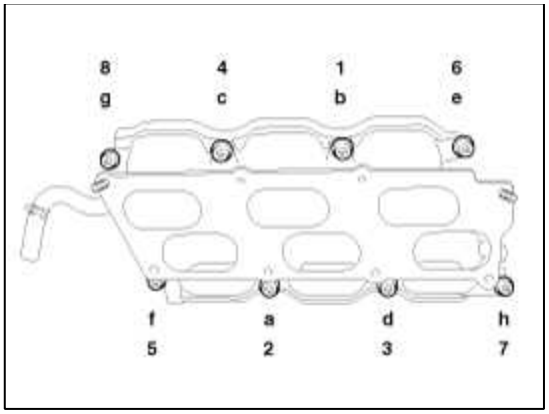
- Be sure to drain the engine coolant before removing the intake manifold.
- If any coolant drained from the cylinder head vent hole has entered the intake port. This can potentially lead to engine trouble.

12. Installation is reverse order of removal.

NOTE

Tighten the intake manifold bolts, in several passes as below.
a~h : 1st step order
1~8 : 2nd step order

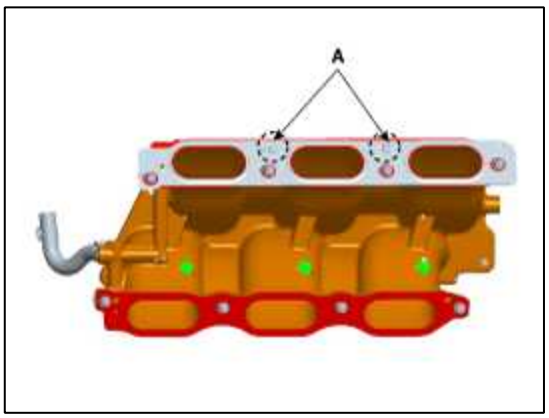
Tightening torque
Step 1 :3.9 ~ 5.9 N.m (0.4 ~ 0.6 kgf.m, 2.9 ~ 4.3 lb-ft)
Step 2 :26.5 ~ 31.4N.m (2.7 ~ 3.2kgf.m, 19.5 ~ 23.1 lb-ft)
Step 3 : Repeat 2nd step twice or more



NOTE

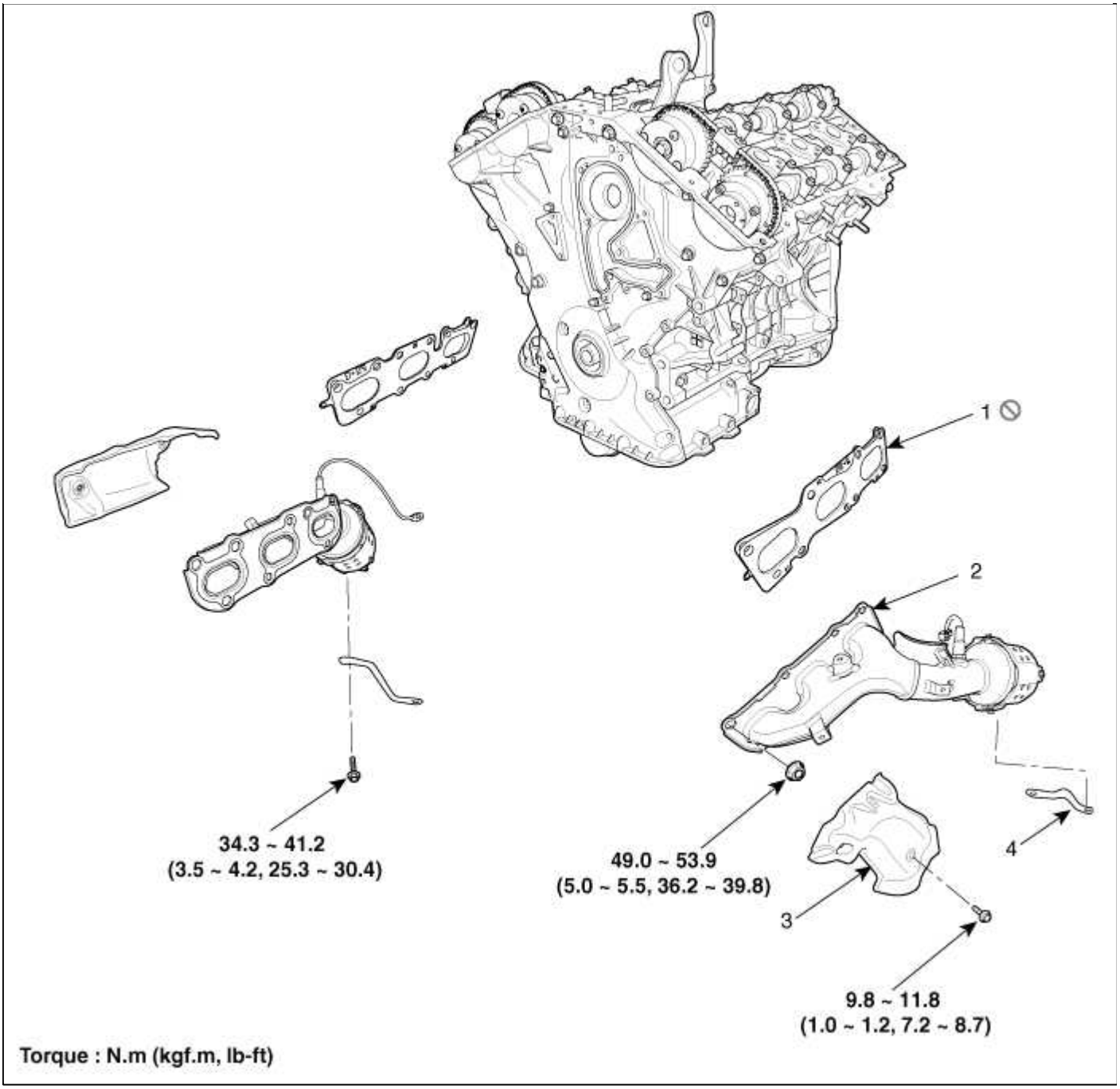
- When installing, replace with new gaskets.
- When replacing the LH gasket, tighten the screw(A) with specified torque.

Tightening torque :
2.9 ~ 3.9 N.m (0.3 ~ 0.4 kgf.m, 2.2 ~ 2.9 lb-ft)



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

Components



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

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

Removal and Installation

CAUTION

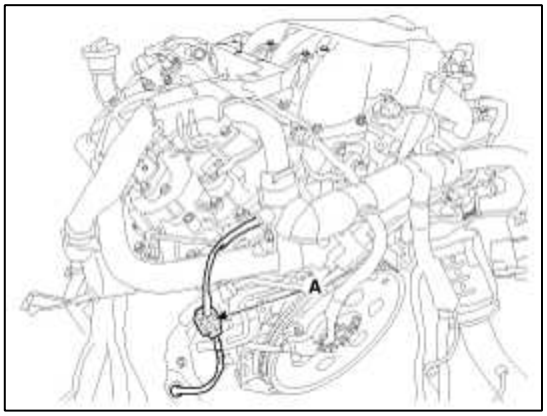
- To avoid damage, unplug the wiring connectors carefully while holding the connector portion.

NOTE

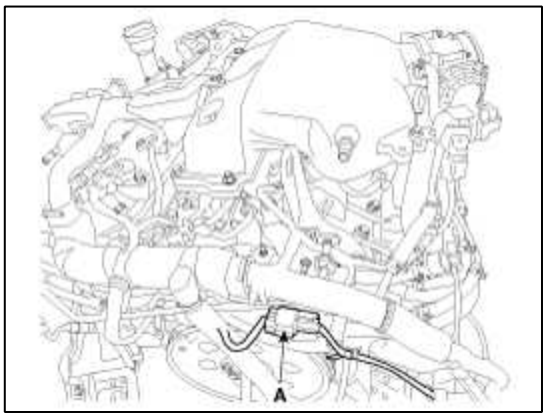
- Mark all wiring and hoses to avoid misconnection.

1. Disconnect the battery negative cable.

2. Loosen the drain plug and drain the engine coolant.
3. Remove the engine cover.
4. Remove the air duct and air cleaner assembly. (Refer to Intake and exhaust system in this group)
5. Remove the radiator upper hose and lower hose. (Refer to Cooling System in this group)
6. Disconnect the LH front oxygen sensor connector (A).

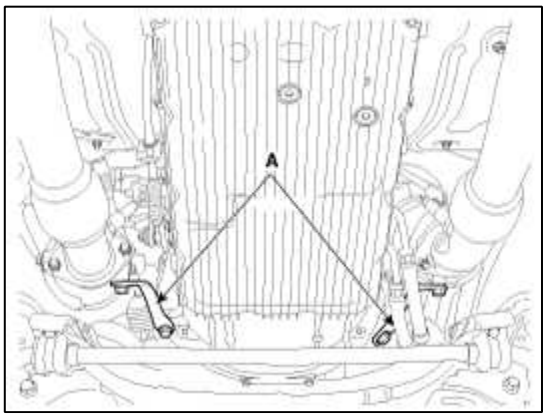


7. Disconnect the RH front oxygen sensor connector (A).



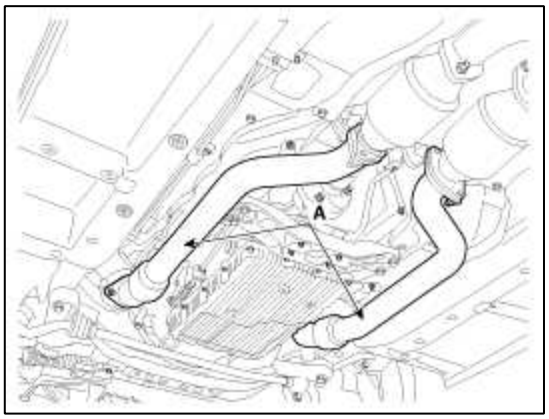
8. Remove the LH/RH exhaust manifold stays (A).

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



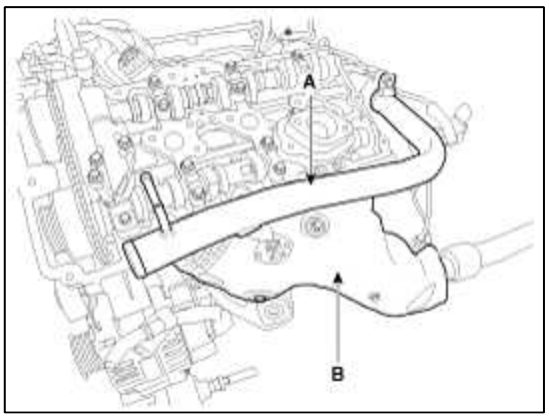
9. Remove the front muffler (A).

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



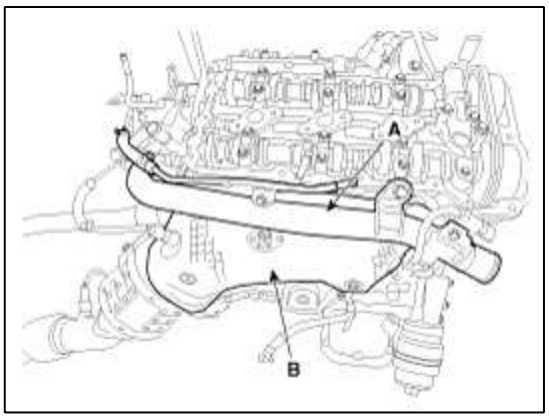
10. Remove the water outlet pipe (A) and the LH exhaust manifold heat protector (B).

Tightening torque
Water inlet pipe bolt :
19.6 ~ 23.5N.m (2.0 ~ 2.4kgf.m, 14.5 ~ 17.4lb-ft)
Heat protector bolts :
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)



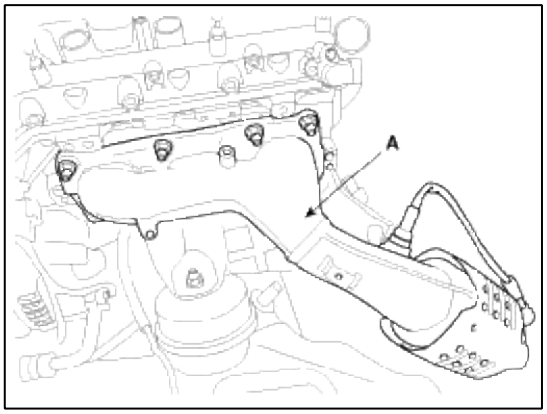
11. Remove the water inlet pipe (A) and the RH exhaust manifold heat protector (B).

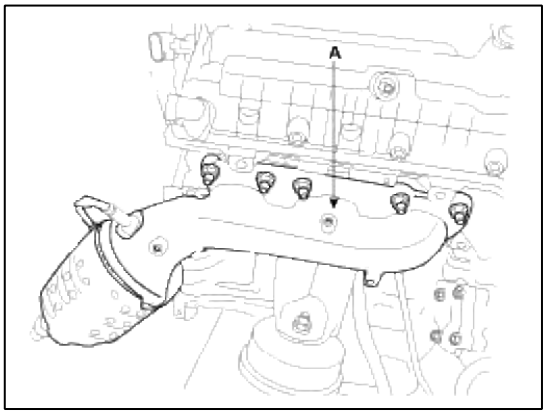
Tightening torque
Water outlet pipe bolt :
19.6 ~ 23.5N.m (2.0 ~ 2.4kgf.m, 14.5 ~ 17.4lb-ft)
Heat protector bolts :
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)



12. Remove the LH/RH exhaust manifolds (A).

Tightening torque :
49.0 ~ 53.9N.m (5.0 ~ 5.5kgf.m, 36.2 ~ 39.8lb-ft)





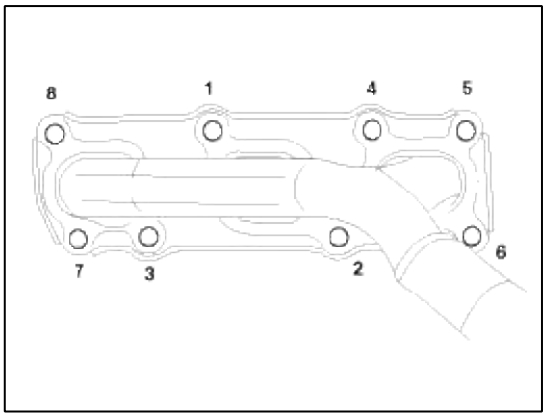
13. Remove the LH/RH exhaust manifold gaskets.

14. Installation is reverse order of removal.

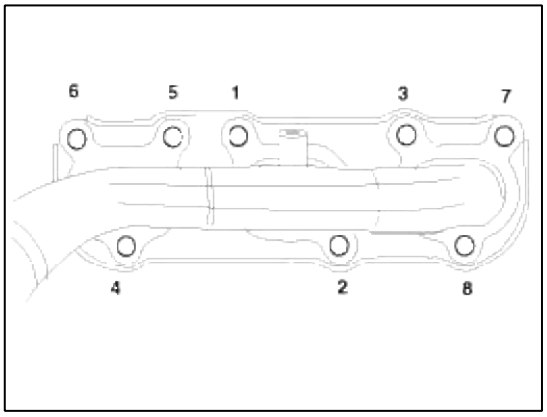
NOTE

When installing the intake manifold, tighten the nuts with pre-torque first and then tighten the nuts with specified torque in the sequence shown.

[LH]

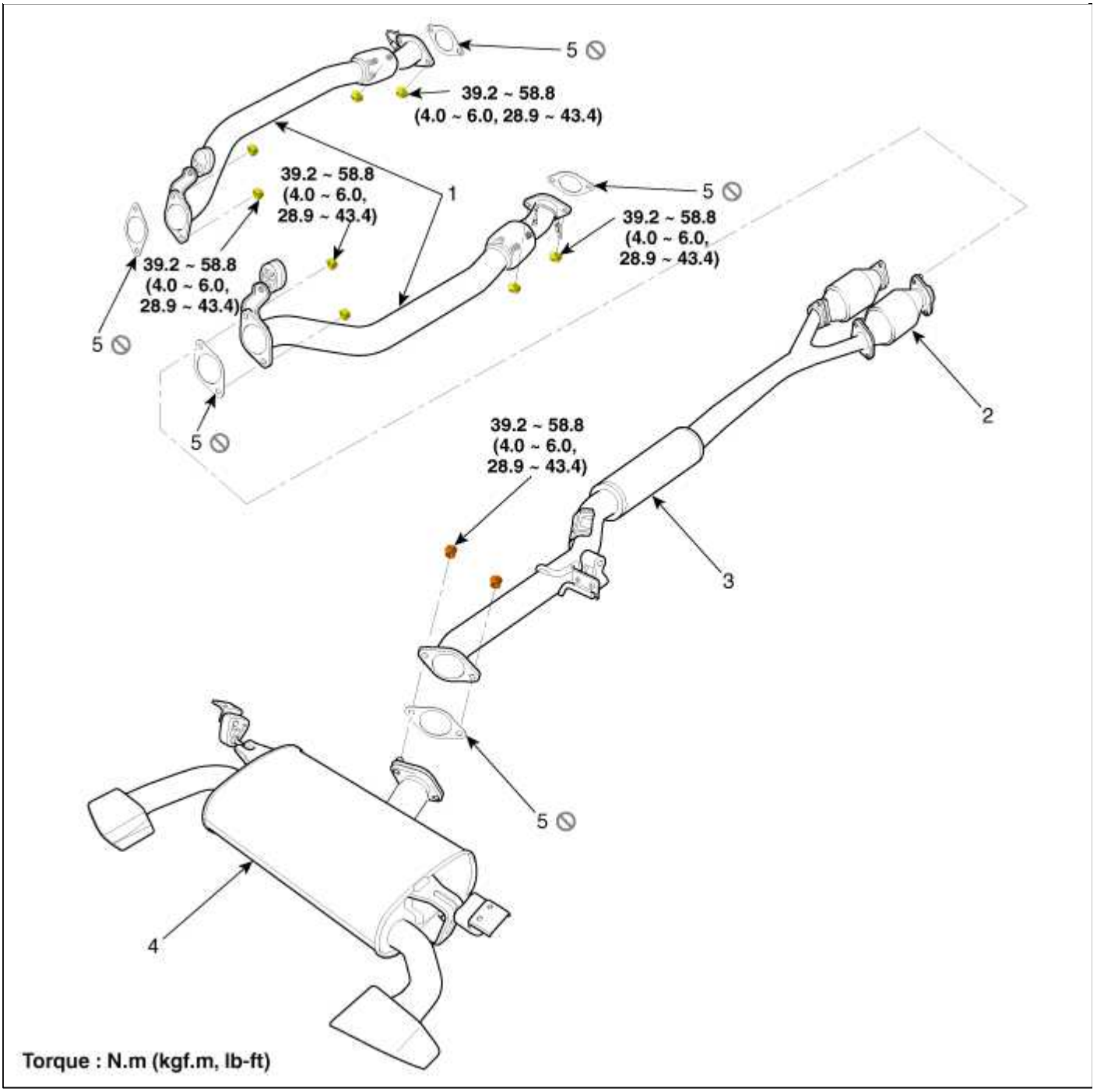


[RH]



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

Components

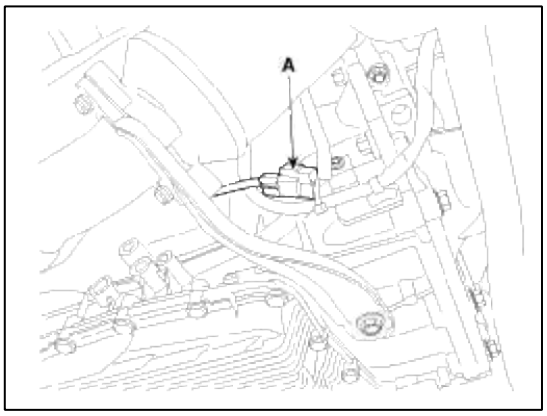


1. Front muffler 2. Catalytic converter	3. Center muffler 4. Main muffler 5. Gasket

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

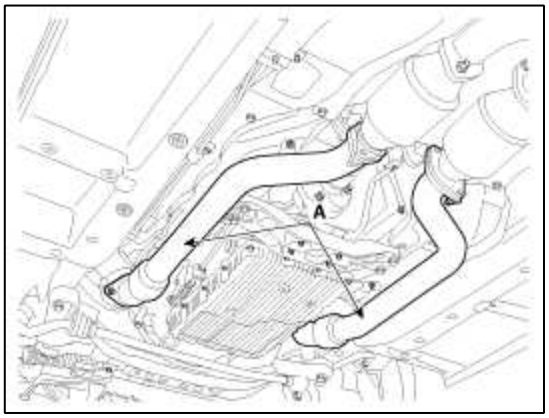
Removal and Installation

1. Disconnect the rear oxygen sensor (HO2S) connector (A) on LH and RH side.



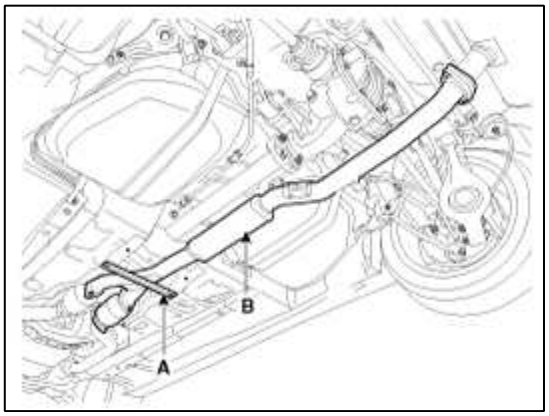
2. Remove the front muffler (A) on LH and RH side.

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

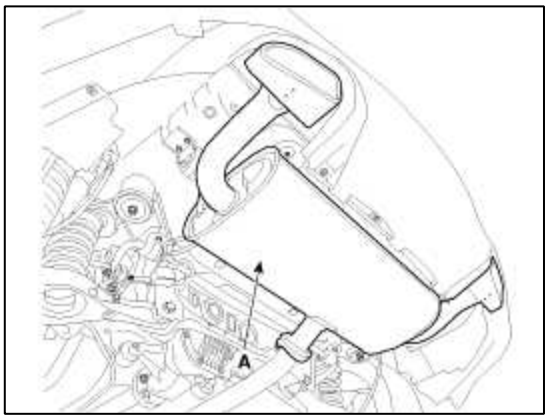


3. Remove the center muffler (B) after removing the tunnel stay (A).

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



4. Remove the main muffler (A).



5. Installation is reverse order of removal.