General Information

Specifications

Description			Specifications	Limit
General				
Type			V-type, DOHC	
Number of cylinders			6	
Bore			96mm(3.7795in)	
Stroke			87.0mm(3.4252in)	
Total displacement			3,778cc(230.55cu.in.)	
Compression ratio			10.4	
Firing order			1-2-3-4-5-6	
Idle RPM			710 RPM	
Valve timing				
Intake	Opens(ATDC)		10˚	
	Closes(ABDC)		62˚	
Exhaust	Opens(BBDC)		42˚	
	Closes(ATDC)		6˚	
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	46.8mm(1.8425in.)	
		Exhaust	45.8mm (1.8031in.)	
	RH Camshaft	Intake	46.8mm(1.8425in.)	
		Exhaust	45.8mm (1.8031in.)	
Journal outer diameter	LH, RHcamshaft	Intake	No.1: 27.964 ~ 27.978mm (1.1009 ~ 1.1015in.) No.2,3,4: 23.954 ~ 23.970mm (0.9430 ~ 0.9437in.)	
		Exhaust	No.1: 27.964 ~ 27.978mm (1.1009 ~ 1.1015in.) No.2,3,4: 23.954 ~ 23.970mm (0.9430 ~ 0.9437in.)	
Bearing oil clearance	LH, RHcamshaft	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.)	

Description		Specifications	Limit
Valve			
Valve length	Intake	105.27mm(4.1445in.)	
	Exhaust	105.50mm (4.1535in.)	
Stem outer diameter	Intake	5.465 ~ 5.480mm (0.2151 ~ 0.2157in.)	
	Exhaust	5.458 ~ 5.470mm (0.2149 ~ 0.2153in.)	
Face angle		45.25° ~ 45.75°	
Thickness of valvehead(margin)	Intake	1.56 ~ 1.86mm(0.06142 ~ 0.07323in.)	
	Exhaust	1.73 ~ 2.03mm(0.06811 ~ 0.07992in.)	
Valve stem to valve guide clearance	Intake	0.020 ~ 0.047mm (0.00078 ~ 0.00185in.)	0.07mm (0.00275in.)
	Exhaust	0.030 ~ 0.054mm (0.00118 ~ 0.00212in.)	0.09mm (0.00354in.)
Valve guide			
Inner diameter	Intake	5.500 ~ 5.512mm (0.2165 ~ 0.2170in.)	
	Exhaust	5.500 ~ 5.512mm (0.2165 ~ 0.2170in.)	
Length	Intake	41.8 ~ 42.2mm (1.6457 ~ 1.6614in.)	
	Exhaust	41.8 ~ 42.2mm (1.6457 ~ 1.6614in.)	
Valve seat			
Width of seat contact	Intake	1.15 ~ 1.45mm(0.05118 ~ 0.05709in.)	
	Exhaust	1.35 ~ 1.65mm(0.05315 ~ 0.06496in.)	
Seat angle	Intake	44.75° ~ 45.20°	
	Exhaust	44.75° ~ 45.20°	
Valve spring			
Free length		43.86mm (1.7267in.)	
Load		19.3±0.8kg/34.0mm (42.7±1.8 lb/1.3386in.)	
		42.3±1.3kg/24.2mm (93.3±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			

Description		Specifications	Limit
Intake		0.17 ~ 0.23mm (0.0067 ~ 0.0090in.)	0.10 ~ 0.30mm (0.0039~0.0118in.)
Exhaust		0.27 ~ 0.33mm (0.0106 ~ 0.0129in.)	0.20 ~ 0.40mm (0.0078~0.0157in.)
Cylinder block			
Cylinder bore		96.00 ~ 96.03mm (3.7795 ~ 3.7807in.)	
Flatness of gasket surface		Less than 0.05mm (0.0019in.) [Less than 0.02mm (0.0008in.) / 150x150]	
Piston			
Piston outer diameter		95.96 ~ 95.99mm(3.7779 ~ 3.7791in.)	
Piston to cylinder clearance		0.03 ~ 0.05mm(0.0012 ~ 0.0020in.)	
Ring groove width	No. 1 ring groove	1.22 ~ 1.24mm (0.0480 ~ 0.0488in.)	1.26mm(0.0496in.)
	No. 2 ring groove	1.22 ~ 1.24mm (0.0480 ~ 0.0488in.)	1.26mm(0.0496in.)
	Oil ring groove	2.01 ~ 2.03mm (0.0791 ~ 0.0799in.)	2.05mm(0.0807in.)
Piston ring			
Side clearance	No. 1 ring	0.03 ~ 0.07mm (0.0012 ~ 0.0027in.)	0.1mm (0.004in.)
	No. 2 ring	0.03 ~ 0.07mm (0.0012 ~ 0.0027in.)	0.1mm (0.004in.)
	Oil ring	0.06 ~ 0.15mm (0.0024 ~ 0.0059in.)	0.2mm (0.008in.)
End gap	No. 1 ring	0.17 ~ 0.32mm (0.0067 ~ 0.0126in.)	0.6mm (0.0236in.)
	No. 2 ring	0.32 ~ 0.47mm (0.0126 ~ 0.0185in.)	0.7mm (0.0275in.)
	Oil ring	0.20 ~ 0.70mm (0.0078 ~ 0.0275in.)	0.8mm (0.0315in.)
Piston pin			
Piston pin outer diameter		23.001 ~ 23.006mm (0.9055 ~ 0.9057in.)	
Piston pin hole inner diameter		23.016 ~ 23.021mm (0.9061 ~ 0.9063in.)	
Piston pin hole clearance		0.01 ~ 0.02mm (0.0004 ~ 0.0008in.)	
Connecting rod small end inner diameter		22.974 ~ 22.985mm (0.9045 ~ 0.9049in.)	
Connecting rod small end hole clearance		-0.032 ~ -0.016mm (-0.0012 ~ 0.0006in.)	
Connecting rod			
Connecting rod big end inner diameter		58.000 ~ 58.018mm(2.2834 ~2.2842in.)	
Connecting rod bearing oil clearance		0.038 ~ 0.056mm (0.0015 ~ 0.0022in.)	
Side clearance		0.1 ~ 0.25mm (0.0039 ~ 0.0098in.)	
Crankshaft			
Main journal outer diameter		68.942 ~ 68.960mm (2.7142 ~ 2.7149in.)	
Pin journal outer diameter		54.954 ~ 54.972mm (2.1635 ~ 2.1642in.)	
Main bearing oil clearance		0.022 ~ 0.040mm (0.0008 ~ 0.0016in.)	
End play		0.10 ~ 0.28mm (0.0039 ~ 0.0110in.)	

Description		Specifications	Limit
Oil pump			
Relief valve opening pressure		450 ~ 550kPa (4.59 ~ 5.61kgf/cm²,65.28 ~ 79.79psi)	
Engine oil			
Oil quantity	Total	6.0L(6.34US qt, 5.28Imp qt)	When replacing a short engine or a block assembly
	Oil pan	5.5L(5.81US qt, 4.84Imp qt)	
	Drain and refill	5.2L(5.49US qt, 4.58Imp qt)	Including oil filter
Oil grade	Recommendation	5W-20/GF4&SM	If not available, refer to the recommended API or ILSAC classification and SAE viscosity number.
	Classification	API SL, SM or above ILSAC GF3, GF4 or above	Satisfy the requirement of the API or ILSAC classification.
	SAE viscosity grade	Recommended SAE viscosity number	Refer to the "Lubrication System"
Oil pressure (at 1000rpm)		130kPa (1.32kg/cm², 18.77psi) or above	Oil temperature in oil pan : 110±2°C (230±36°F)
Cooling system			
Cooling method		Forced circulation with electrical fan	
Coolant quantity		8.5~10.5L(8.98~11.10U.S.qts,7.48~9.24Imp.qts)	
Thermostat	Type	Wax pellet type	
	Opening temperature	82±2°C (179.6±35.6°F)	
	Fully opened temperature	95°C (203°F)	
	Full lift	10mm (0.3937in.) MIN	
Radiator cap	Main valve opening pressure	93.16 ~ 122.58kpa (0.95 ~ 1.25kg/cm², 13.51 ~ 17.78psi)	
	Vacuum valve opening pressure	0.98 ~ 4.90 kpa (0.01 ~ 0.05kg/cm², 0.14 ~ 0.71 psi)	
Water temperature sensor			
Type		Thermister type	
Resistance	20°C (68°F)	2.31 ~ 2.59KΩ	
	80°C(176°F)	0.3222 KΩ	

Tightening Torques

Item	Quantity	Nm	kgf.m	lb-ft
Crankshaft pulley bolt	1	284.2 ~ 303.8	29.0 ~ 31.0	209.76 ~ 224.22
Timing chain cover bolt B	17	18.62 ~ 21.56	1.9 ~ 2.2	13.74 ~ 15.91
Timing chain cover bolt C	4	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Timing chain cover bolt D	1	58.80 ~ 68.80	6.0 ~ 7.0	43.40 ~ 50.63
Timing chain cover bolt E	1	58.80 ~ 68.80	6.0 ~ 7.0	43.40 ~ 50.63
Timing chain cover bolt F	2	24.50 ~ 26.46	2.5 ~ 2.7	18.08 ~ 19.53
Timing chain cover bolt G	4	21.56 ~ 23.52	2.2 ~ 2.4	15.91 ~ 17.36
Timing chain cover bolt H	1	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Timing chain cover bolt I	1	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Timing chain cover bolt J	1	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Cam to cam guide bolt	4	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Timing chain auto tensioner bolt	2	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Timing chain auto tensioner nut	2	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Timing chain guide bolt	4	19.60 ~ 24.50	2.0 ~ 2.5	14.17 ~ 18.08
Oil pump chain cover bolt	3	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Oil pump chain tensioner bolt	1	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Oil pump chain guide bolt	2	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Oil pump chain sprocket bolt	1	18.62 ~ 21.56	1.9 ~ 2.2	13.74 ~ 15.91
Lower oil pan bolt	13	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
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	17.64 ~ 21.56	1.8 ~ 2.2	13.02 ~ 15.91
Drive belt idler bolt	1	53.90 ~ 57.82	5.5 ~ 5.9	39.78 ~ 42.67
OCV(oil control valve) bolt	2	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Cylinder head bolt	16	(37.3~41.2) + (118~122°) + (88~92°)	(3.8~4.2) + (118~122°) + (88~92°)	(27.5~30.4) + (118~122°) + (88~92°)
Cylinder head bolt	1	18.62 ~ 23.52	1.9 ~ 2.4	13.74 ~ 17.36
CVVT & exhaust cam sprocket bolt	4	64.68 ~ 76.44	6.6 ~ 7.8	47.74 ~ 56.42
Camshaft bearing cap bolt	32	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Cylinder head cover bolt	38	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Connecting rod bearing bolt	12	(17.7~21.6) + (88~92°)	(1.8~2.2) + (88~92°)	(13.0~15.9) + (88~92°)
Main bearing cap inner bolt(M11)	8	49.00 + 90°	5.0 + 90°	36.16 + 90°
Main bearing cap outer bolt(M8)	8	19.60 + 120°	2.0 + 120°	14.46 + 120°
Main bearing cap side bolt(M8)	6	29.40 ~ 31.36	3.0 ~ 3.2	21.70 ~ 23.14

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Item	Quantity	Nm	kgf.m	lb-ft
Oil drain cover bolt	6	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Rear oil seal case bolt	6	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Baffle plate bolt	12	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Upper oil pan bolt	16	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Knock sensor bolt	2	15.68 ~ 23.52	1.6 ~ 2.4	11.57 ~ 17.36
Drive plate bolt cap	8	71.54 ~ 75.46	7.3 ~ 7.7	52.80 ~ 55.69
Oil filter cap		24.50	2.5	18.08
Oil drain bolt cap	1	34.30 ~ 44.10	3.5 ~ 4.5	25.31 ~ 32.55
Oil pump bolt	3	20.6 ~ 22.6	2.1 ~ 2.3	15.2 ~ 16.6
Oil filter body bolt	10	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Oil filter body cover bolt	11	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Water vent hose bolt(Timing chain cover bolt L)	2	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Water pump bolt(Timing chain cover bolt K)	1	21.56 ~ 26.46	2.2 ~ 2.7	15.91 ~ 19.53
Water pump bolt	4	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Water pump pulley bolt	4	7.84 ~ 9.80	0.8 ~ 1.0	5.78 ~ 7.23
Water temp. control nut	4	19.6 ~ 23.52	2.0 ~ 2.4	14.5 ~ 17.36
Water temp. control bolt	2	19.6 ~ 23.52	2.0 ~2.4	14.5 ~ 17.36
Water inlet pipe bolt	3	16.66 ~ 19.60	1.7 ~ 2.0	12.30 ~ 14.47
Air vent pipe bolt	2	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Intake manifold bolt	6	26.5 ~ 31.4	2.7 ~ 3.2	19.5 ~ 23.1
Intake manifold nut	2	18.62 ~ 23.52	1.9 ~ 2.4	13.74 ~ 17.36
Surge tank bolt (M8 × 25)	3	18.62 ~ 23.52	1.9 ~ 2.4	13.74 ~ 17.36
Surge tank bolt (M6 × 106)	2	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Surge tank nut	1	18.62 ~ 23.52	1.9 ~ 2.4	13.74 ~ 17.36
Breather pipe bolt	2	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Surge tank bracket bolt rear (M10 × 18)	2	27.44 ~ 31.36	2.8 ~ 3.2	20.25 ~ 23.14
Surge tank bracket bolt front (M8 × 16)	2	18.62 ~ 23.52	1.9 ~ 2.4	13.74 ~ 17.36
ETC bracket bolt	2	15.68 ~ 25.48	1.6 ~ 2.6	11.57 ~ 18.80
Exhaust manifold nut	16	39.20 ~ 44.10	4.0 ~ 4.5	28.93 ~ 32.55
Heat proctor bolt	8	16.66 ~ 21.56	1.7 ~ 2.2	12.30 ~ 15.91
Front muffler	2	39.20 ~ 58.80	4.0 ~ 6.0	28.93 ~ 43.40

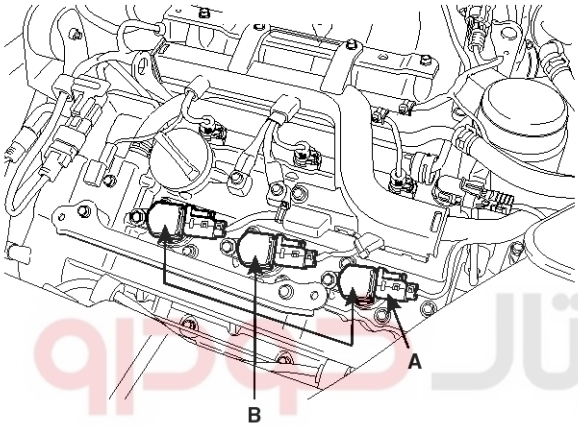
Compression Pressure Inspection

NOTICE

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

1. Warm up and stop engine.

   Allow the engine to warm up to normal operating temperature.
2. Remove the surge tank.
3. Remove the ignition coil connectors(A) and ignition coils(B).



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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) After 7 times of cranking the engine, measure the compression pressure.

      NOTICE

      Always use a fully charged battery to obtain engine speed of 250 rpm or more.
   4) Repeat steps 1) through 3) for each cylinder.

      NOTICE

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

Compression pressure :
1,225kPa (12.5kgf/cm², 177psi)
Minimum pressure :
1,078kPa (11.0kgf/cm², 156psi)

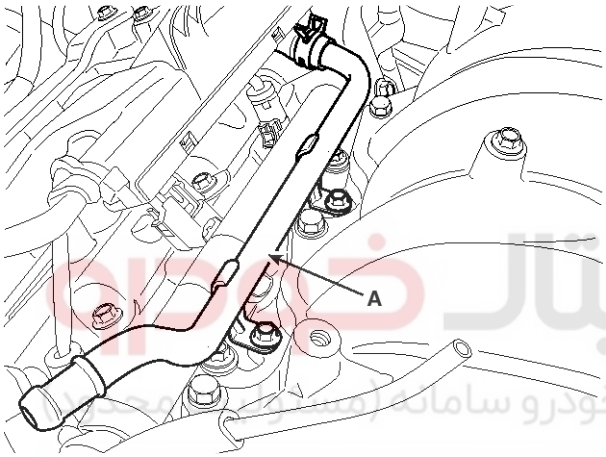
   5) If the cylinder compression in 1 or more cylinders is low, pour a small amount of engine oil into the cylinder through the spark plug hole and repeat steps (1) through (3) for cylinders with low compression.
      - If adding oil helps the compression, it is likely that the piston rings and/or cylinder bore are worn or damaged.
      - If pressure stays low, a valve may be sticking or seating is improper, or there may be leakage past the gasket.
6. Reinstall the spark plugs.
7. Install the ignition coil and ignition coil connectors.
8. Install the surge tank.

Valve Clearance Inspection And Adjustment

NOTICE

Inspect and adjust the valve clearance when the engine is cold (Engine coolant temperature : 20˚C) and cylinder head is installed on the cylinder block.

1. Remove the engine cover.
2. Remove air cleaner assembly.
3. Remove the surge tank.
4. Remove the cylinder head cover.
   1) Disconnect the ignition coil connector and remove the ignition coil.
   2) Disconnect the breather pipe assembly(A) from the intake manifold.



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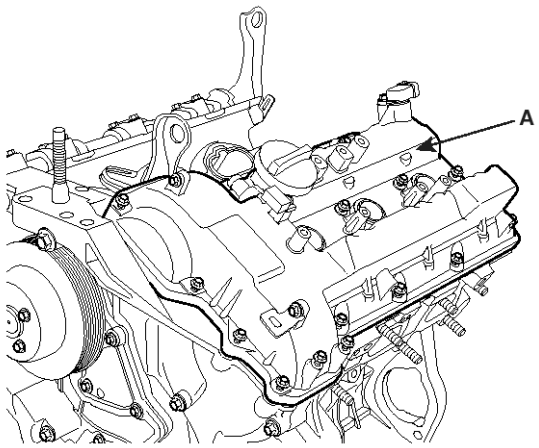
   3) Loosen the cylinder head cover bolts and then remove the cover(A) and gasket.



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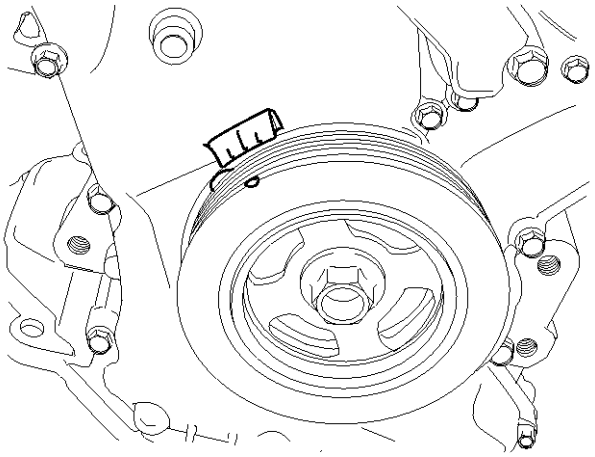
5. Set No.1 cylinder to TDC/compression.
   1) Turn the crankshaft pulley and align its groove with the timing mark "T" of the lower timing chain cover.



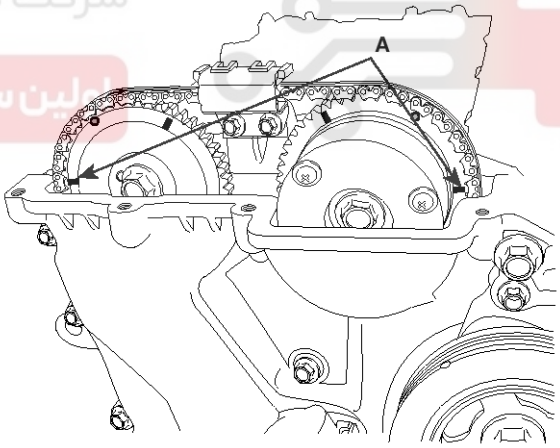
KDRF108A

   2) Check that the mark(A) of the camshaft timing sprockets are in straight line on the cylinder head surface as shown in the illustration.

   If not, turn the crankshaft one revolution (360˚)

NOTICE

Do not rotate engine counterclockwise



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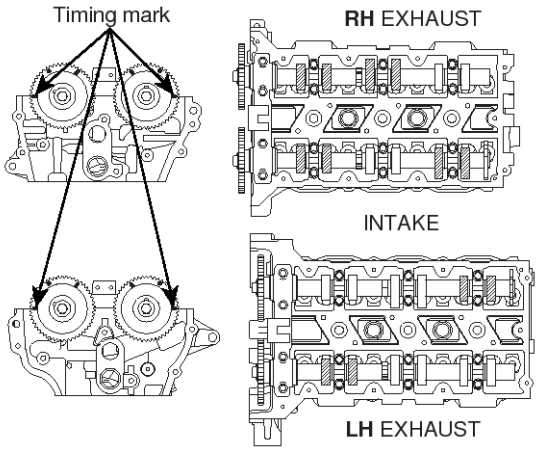
6. Inspect the valve clearance.
   1) Check only the valve indicated as shown. [No. 1 cylinder : TDC/Compression] measure the valve clearance.



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Measurement method.

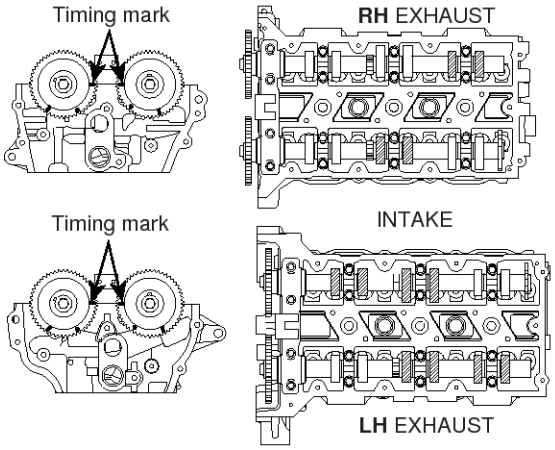
- · Using a thickness gauge, measure the clearance between the tappet and the base circle of camshaft.
- · Record the out-of-specification valve clearance measurements. They will be used later to determine the required replacement adjusting tappet.

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

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

NOTICE
Do not rotate engine counterclockwise

   3) Check only valves indicated as shown. [NO. 4 cylinder : TDC/compression]. Measure the valve clearance. (Refer to procedure step1))

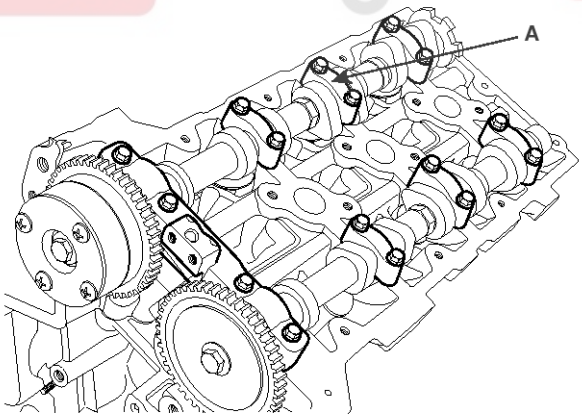


EDRF022A

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

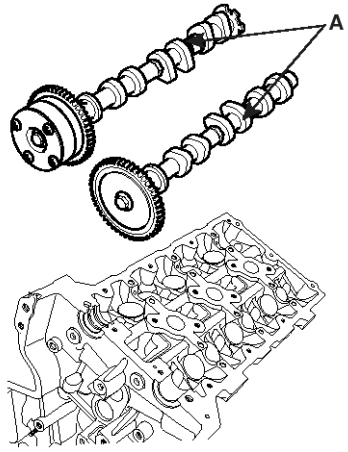
NOTICE
Before removing the timing chain, mark the RH/LH timing chain with an identification based on the location of the sproket because the identification mark on the chain for TDC(Top Dead Center) can be erased.

   3) Remove the camshaft bearing caps(A).



KDRF196A

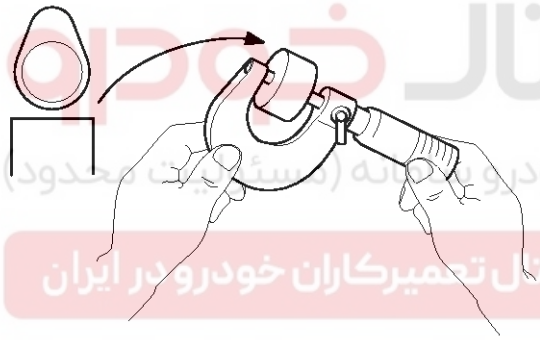
4) Remove the camshaft assembly(A).



KDRF197A

5) Remove MLAs.

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



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

Valve clearance(Engine coolant temperature: 20˚C[68˚F])
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.)]

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

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

9) Place a new tappet on the cylinder head.

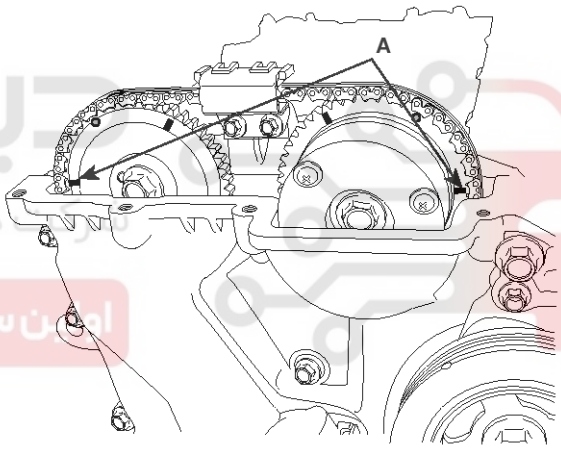
NOTICE
Apply engine oil at the selected tappet on the periphery and top surface.

10) Install the intake and exhaust camshaft.

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

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

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



KDRF113A

14) Recheck the valve clearance.

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

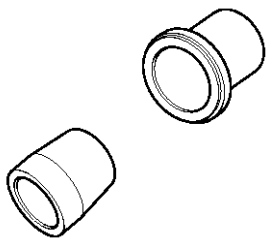
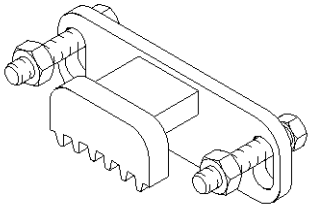
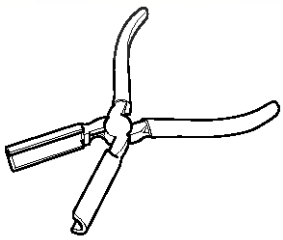
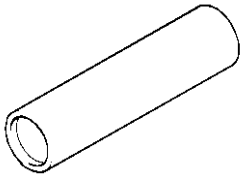
Troubleshooting

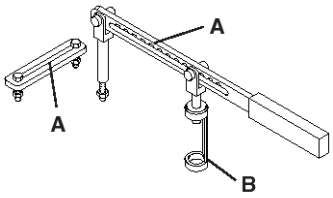
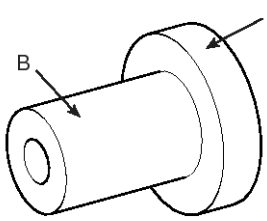
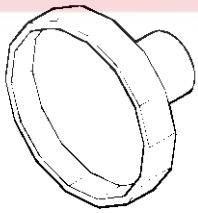
Symptom	Suspect area	Remedy
Engine misfire with abnormal internal lower engine noises.	Worn crankshaft bearings. Loose or damaged engine drive plate.	Replace the crankshaft and bearings as required. Repair or replace the drive plate as required.
	Worn piston rings. (Oil consumption may or may not cause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

Symptom	Suspect area	Remedy
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.

Symptom	Suspect area	Remedy
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.

Special Service Tools

Tool (Number and name)	Illustration	Use
Crankshaft front oil seal installer (09231-3C100)	 KDRF233A	Installation of the front oil seal
Flywheel stopper (09231-3C300)	 KCRF030D	Removal and installation of the flywheel and crankshaft pulley.
Torque angle adapter (09221-4A000)	 LCAC030A	Installation of bolts & nuts needing an angular method
Valve stem seal remover (09222-29000)	 KDRF232A	Removal of the valve stem seal
Valve stem seal installer (09222-3C100)	 LCAC030D	Installation of the valve stem seal

Tool (Number and name)	Illustration	Use
Valve spring compressor & holder (09222-3K000) (09222-3C300)	 ECRF003A	Removal and installation of the intake or exhaust valves A : 09222-3K000 B : 09222-3C300 (holder)
Crankshaft rear oil seal installer (09231-3C200) (09231-H1100)	 ACRF003A	Installation of the crankshaft rear oil seal A : 09231-3C200 B : 09231-H1100
Oil pan remover (09215-3C000)	 KDRF219A	Removal of oil pan
Oil filter wrench (09263-3C100)	 B6327000	Removal and installation of the oil filter

Engine And Transaxle Assembly

Removal

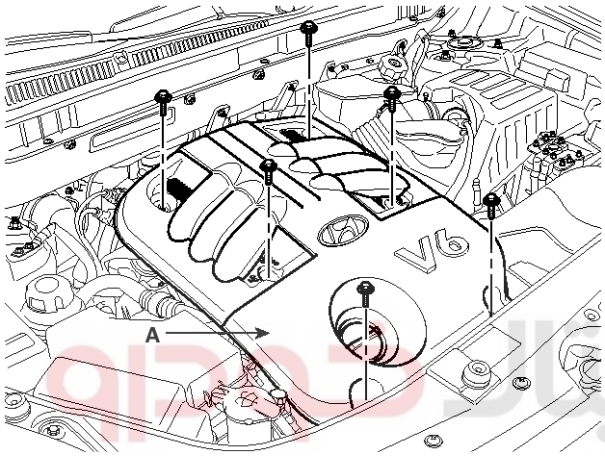
CAUTION

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

NOTICE

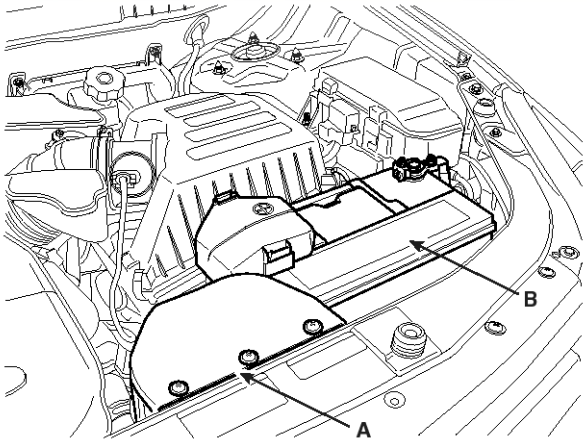
- *Mark all wiring and hoses to avoid misconnection.*

1. Remove the engine cover(A).



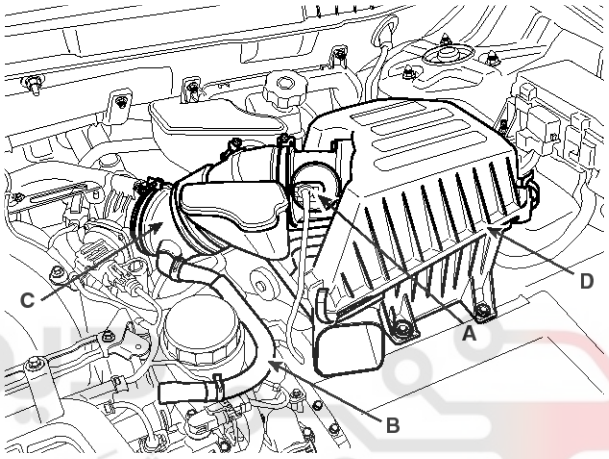
SENM17002L

2. Remove the air duct(A).
3. Disconnect the neagative terminal from the battery(B).



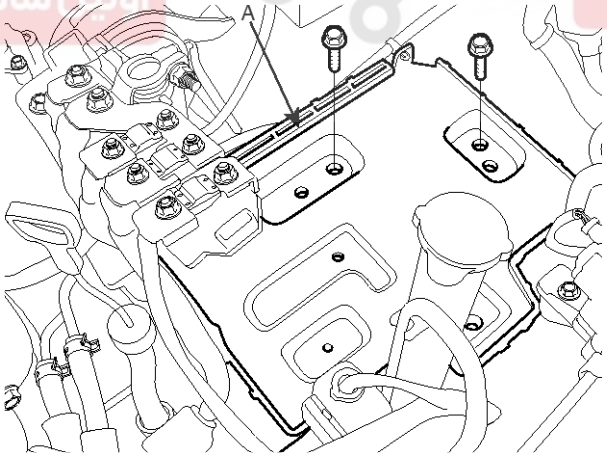
SENM17003L

4. Recover refrigerant and remove the high & low pressure pipe. (Refer to Air conditioner compressor in HA Group)
5. Remove the intake air hose and air cleaner assembly.
   1) Disconnect the AFS connector(A).
   2) Disconnect the breather hose(B) from air cleaner hose.
   3) Remove the intake air hose(C) and air cleaner body(D).



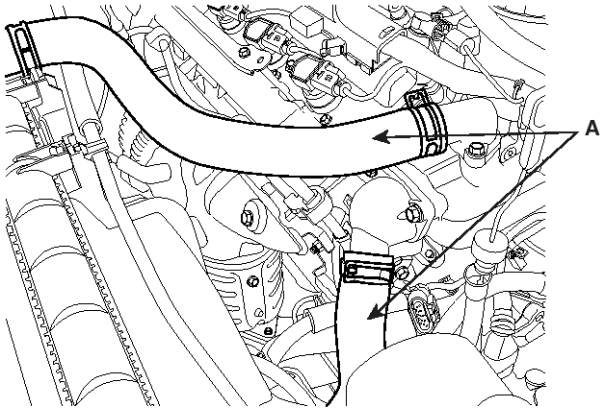
SENM17004L

6. Remove the battery tray(A).



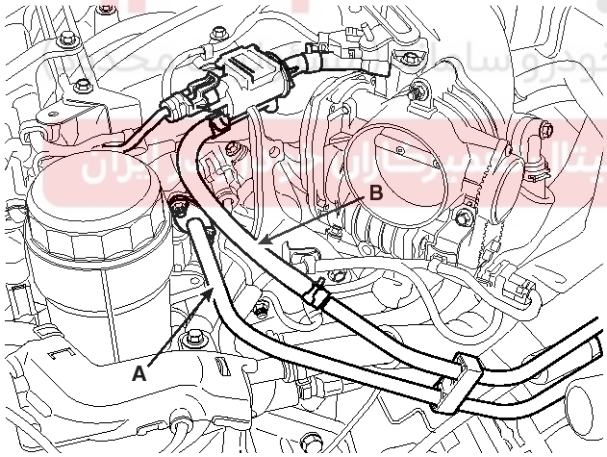
SGHAT7005N

7. Remove the front wheels.
8. Remove the under cover.
9. Drain the engine coolant.
   Remove the radiator cap to speed draining.
10. Remove the upper radiator hose and lower radiator hose(A).



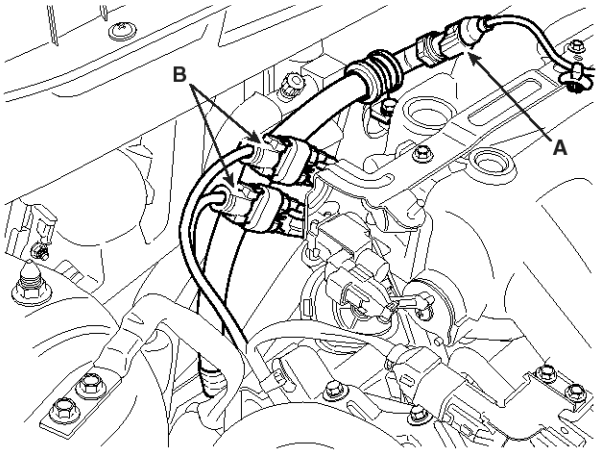
KDRF148A

11. Remove the transaxle oil cooler hose.
12. Remove the fuel hose(A) and PCSV(B) hose.



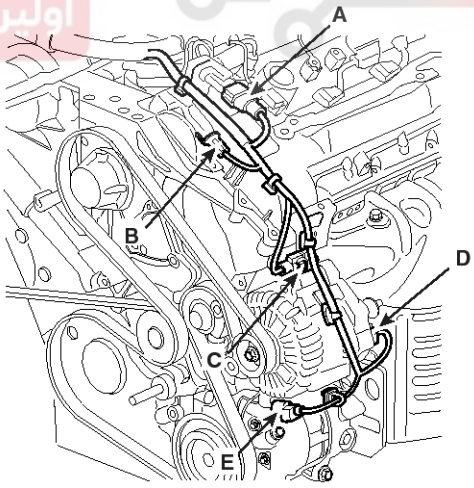
SENM17006L

13. Remove the engine wiring.
    1) Disconnect the RH oxygen sensor connectors(B).
    2) Disconnect the power steering oil pressure sensor connector(A).



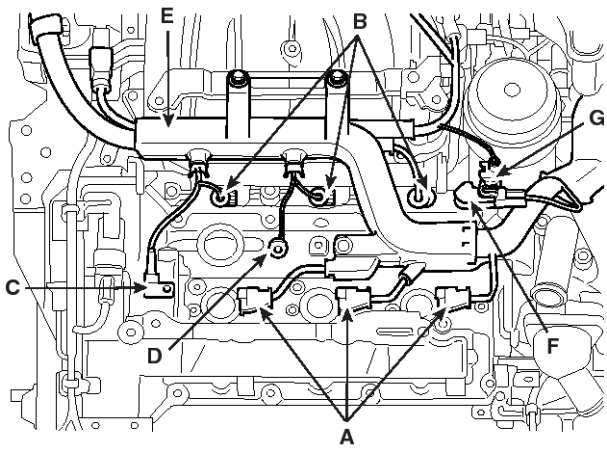
SENM17005L

    3) Disconnect the RH injector connector and the ignition coil connector.
    4) Disconnect the OCV connector(A) and the knock sensor connector(B).
    5) Disconnect the LH front oxygen sensor connector(C).
    6) Disconnect the alternator connector(D) and the air compressor connector(E).



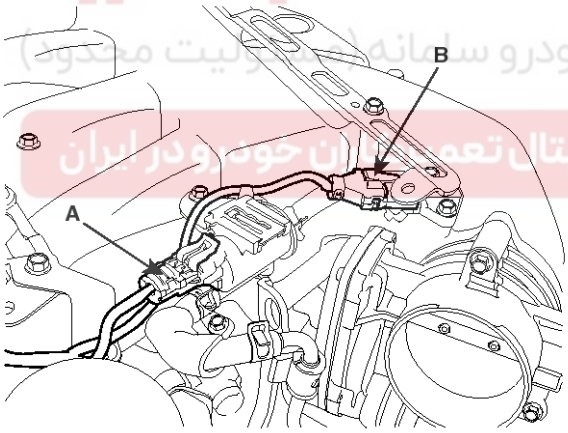
SENM17007L

7) Disconnect the LH ignition coil connector(A), the injector connector(B), the condenser connector(C) and the ground(D), and remove the wiring harness protector(E).
8) Disconnect the LH CMPS(F) and the oil pressure switch connector(G).



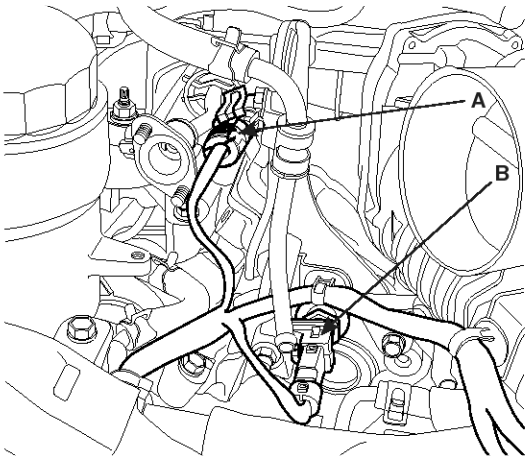
SENM17008L

9) Disconnect the PCSV connector(A) and the MAP sensor connector(B).



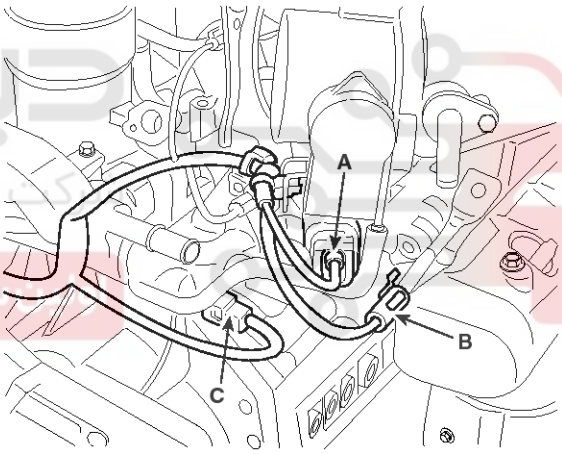
UCBF003A

10) Disconnect the RH CMPS(A) and the OTS connector(B).



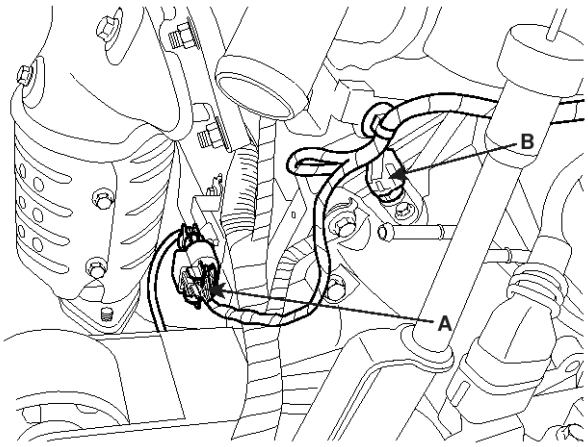
KDRF161A

11) Disconnect the ETC connector(A) and the knock sensor connector(B).
12) Disconnect the ECT sensor connector(C).



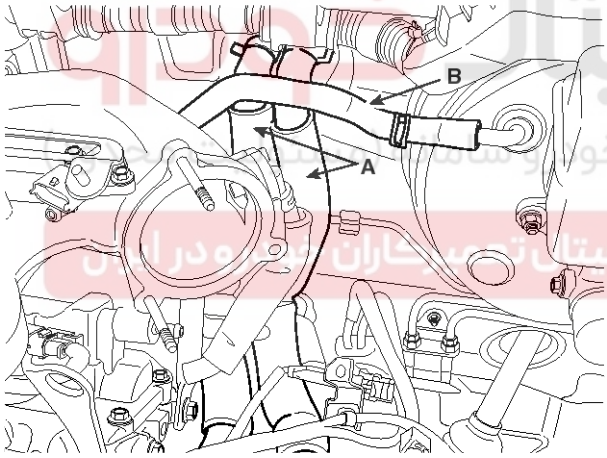
SENM17009L

13) Disconnect the LH rear oxygen sensor connector(A) and the CPS connector(B).



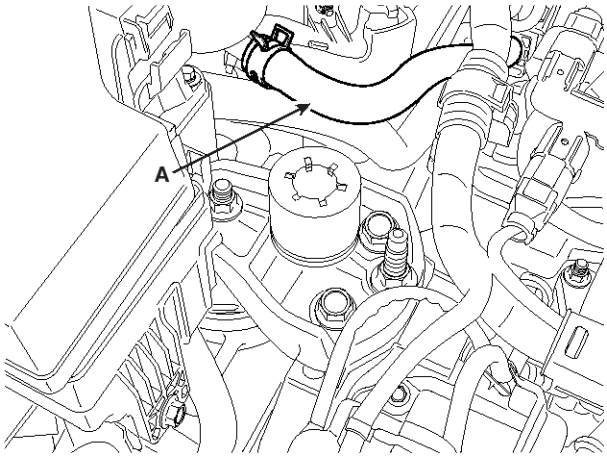
KDRF164A

14. Disconnect the transaxle wire harness connector and remove the transaxle control cable.
15. Remove the heater hose(A).
16. Remove the brake vacuum hose(B).



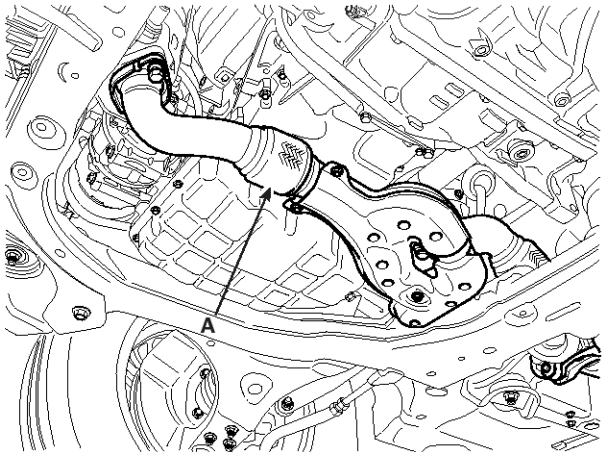
SENM17010L

17. Remove the power steering pump hose(A).



SENM17011L

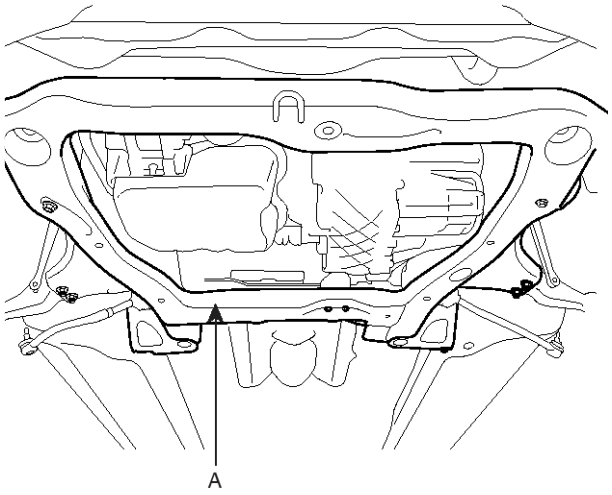
18. Remove the A/C compressor hose.
19. Drain transaxle oil.
20. Remove the lower arm ball joint.
21. Remove the tie rod end ball joint.
22. Remove the stabilizer link.
23. After removing a split pin and nut from the steering bar tie rod, disconnect it.
24. Remove the power steering return hose and drain power steering oil.
25. Remove the front roll stopper mounting bolt.
26. Remove the rear roll stopper mounting bolt.
27. Remove the steering u-joint mounting bolt.
28. Remove the front exhaust pipe(A).



SENM17012L

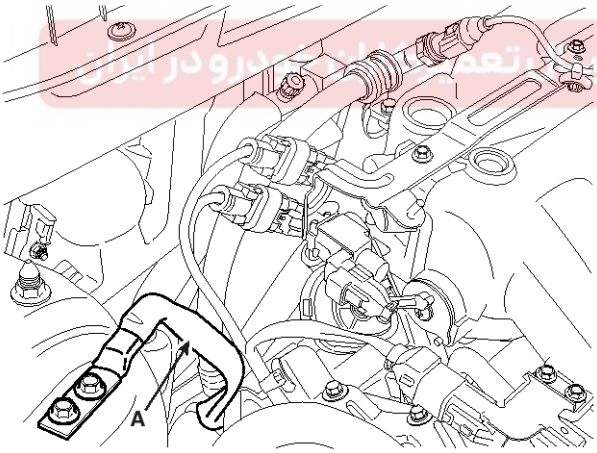
29. Supporting the cross member(A) with a jack, remove the stay with the mounting bolts.

Tightening torque :
137.3~156.9Nm (14.0~16.0kgf.m, 101.3~115.7lb-ft)



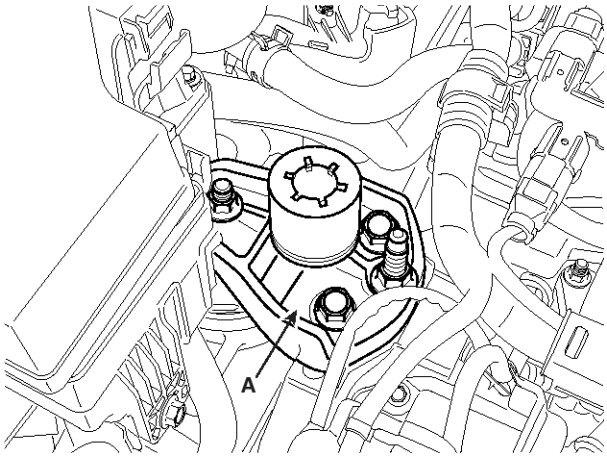
KMRE009R

30. Remove the drive shafts from transaxle.
31. Install a jack for supporting the engine and transaxle assembly.
32. Disconnet the ground cable(A) from the engine mounting bracket.



SENM17300L

33. Remove the engine mounting bracket(A).



SENM17301L

34. Remove the transaxle mounting bracket.
35. Remove the engine and transaxle assembly by lifting vehicle.

NOTICE
When removing the engine and transaxle 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 the shift cable.
- Refill an engine with engine oil.
- Refill a transaxle with fluid.
- Refill a radiator with engine coolant.
- Bleed air from the cooling system with the heater valve open.
- Clean the battery posts and cable terminals with sandpaper assemble them, 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.

Engine Mounting

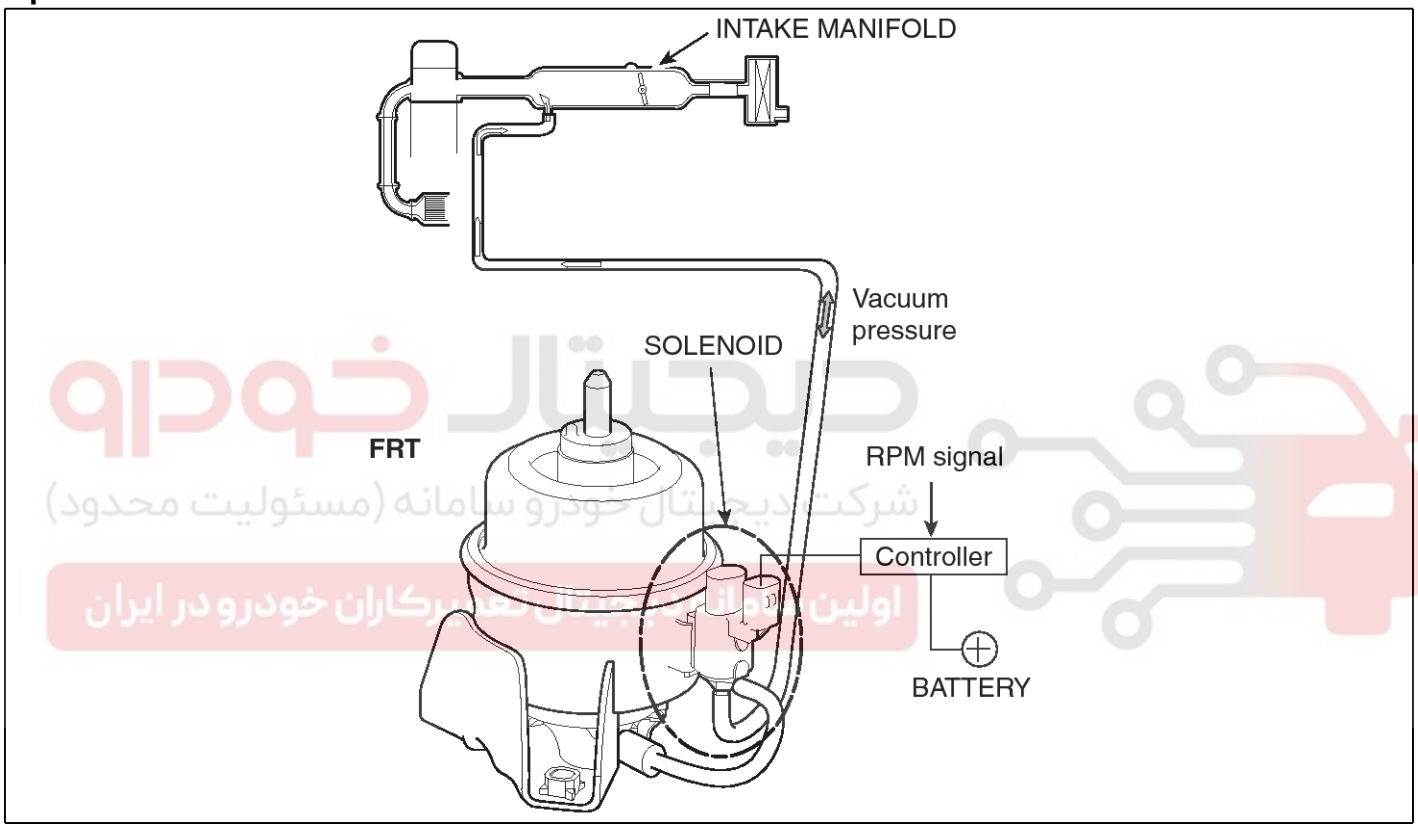
Description

Semi-active mounting(it can also be called 'Electronic Controlled Mounting(ECM)') , unlike hydraulic mountings before, is a controllable hydraulic mounting which gives a high damping value in driving and also reduce viblation with a low damping value and a spring coefficient at idle.

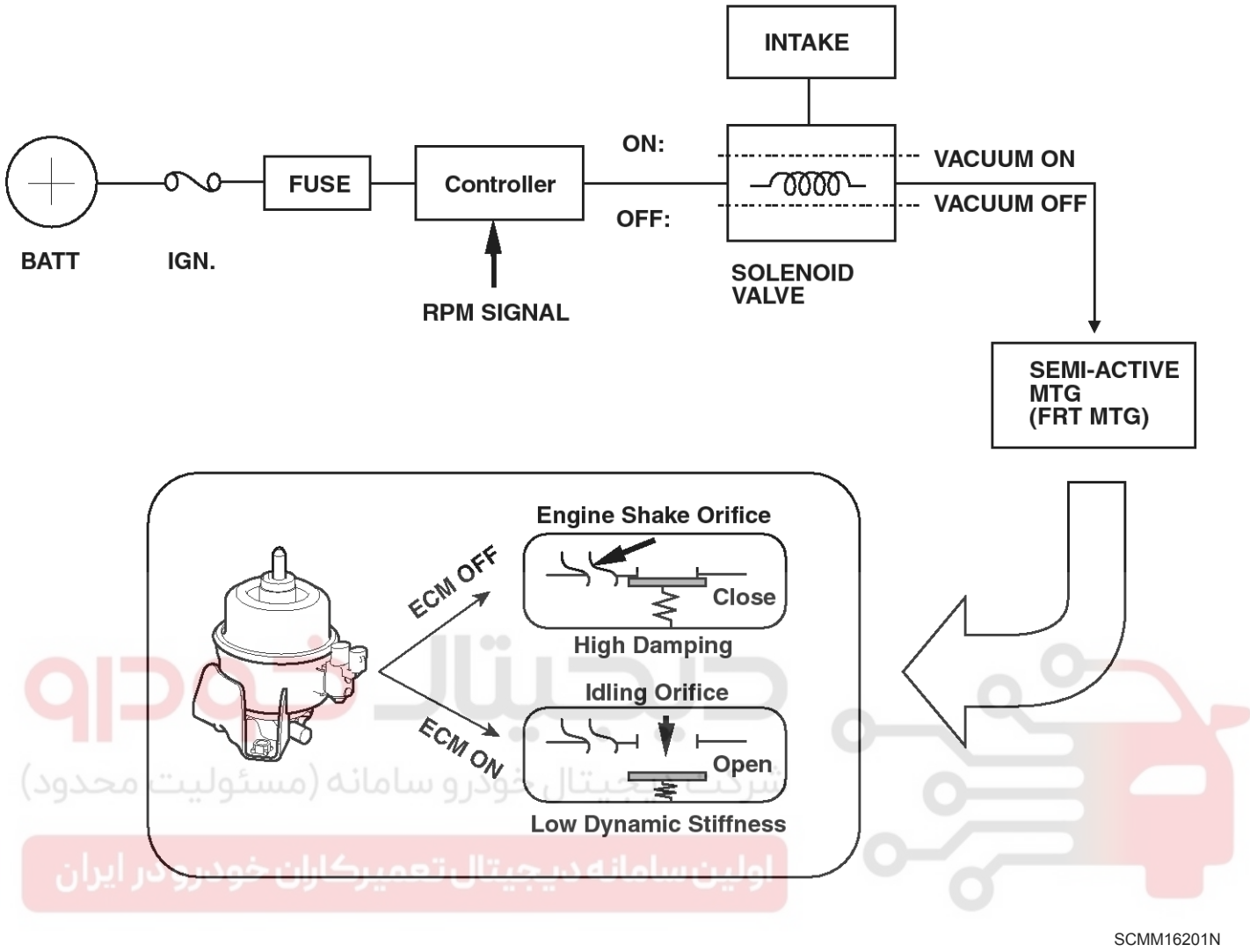
This system is composed of a control module, solenoid valve and a diaphragm for ON/OFF in it.

At idle, the control module receives a RPM signal and give it to the solenoid valve. As the valve opens or closes, vacuum pressure in the intake system goes to the diaphragm for opening the orifice. By opening the orifice, the mounting has a low damping value and a low spring coefficient for reducing viblation.

Operation



SENM17200L



SCMM16201N

ECM: Electronic Controlled Mounting

System	Condition		Solenoid Valve Relay	Voltage
Semi-active engine mount or Electronic Controlled Mounting(ECM)	After ignition switch is ON	~ 880RPM	ON(idle)	9V ~
		880~1040RPM	Hold the previous state.	2~9V
		1040PRM ~	OFF(driving)	~ 2V
	Ignition switch is OFF		OFF	

Troubleshooting

The engine vibrates excessively when idling.

Check idle speed:
Warm up the engine to mornal operating temperature (the cooling fan comes on).

Is the idle speed less than 880rpm?

NO → Adjust the idle speed to the regulation spec.

YES

Check the front mounting control system:

1. Fully depress the brake pedal and shift the transaxle in 'D' range.

2. Have an assistant connect and disconnect the 2P connector from the front mount control solenoid valve.

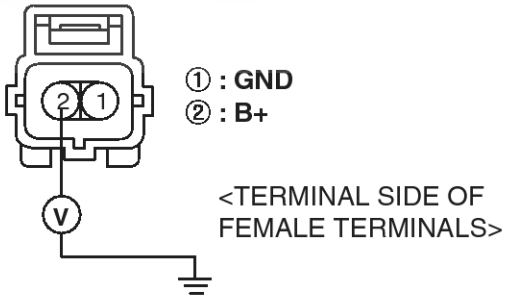
Is there a noticeable change in idle smoothness when the

YES → Reconnect the 2P connector to the solenoid valve. (The front mounting control system is OK).

NO

Test the front mount control solenoid valve wire:

1. Shift to 'N' or 'P' position.
2. Disconnect the 2P connector from the enfine mount control solenoid valve.
3. Measure voltage between the power terminal and body ground.



Is there battery voltage?

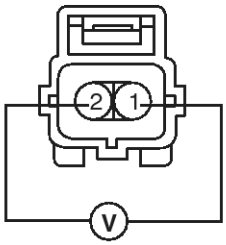
NO → - Repair open in power wire between the connector and the fuse.
- Check or replace relay or fuse.

YES

SENM17201L

Test the front mount control solenoid valve wire:

1. Measure voltage betweem the terminals of the connector.



<TERMINAL SIDE OF FEMALE TERMINALS>

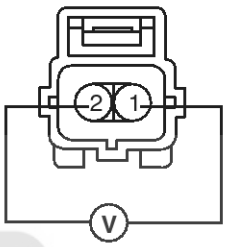
Is there battery voltage?

NO → - Repair open betweem the terminals of the connector.
- If the wire is OK, check the input/output signals to the controller and substitute a known-good controller and recheck.

YES

Test the front mount control solenoid valve wire:

1. Raise the engine speed above 1040rpm.
2. Measure voltage betweem the terminals of the connector.



<TERMINAL SIDE OF FEMALE TERMINALS>

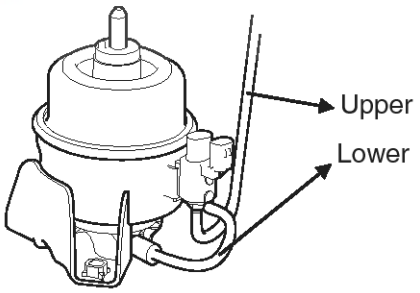
Is there battery voltage?

YES → - Repair short in ground wire between the controller and the connector.
- If the wire is OK, check the input signal to the controller and substitute a known-good controller and recheck.

NO

Test the front mount and vacuum hose:

1. Disconnect the lower vacuum hose from the front mount solenoid valve, and connect a vacuum pump/gauge to the hose.
2. Apply vacuum(more than 350mmHg) for 20 senconds.

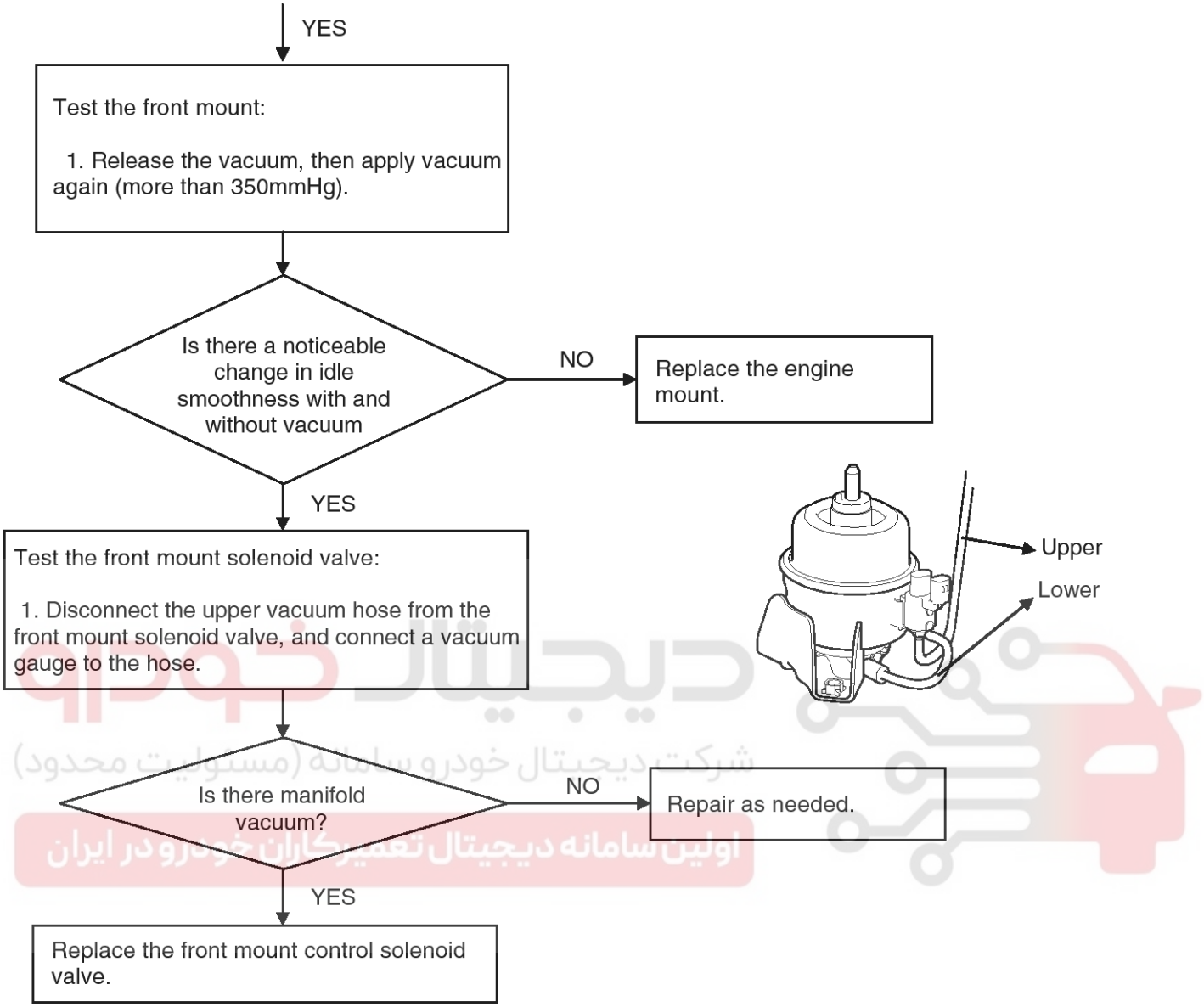


Does the engine mount hold vacuum?

NO → - Replace the vacuum hose.
- Replace the engine mount.

YES

SENM17202L

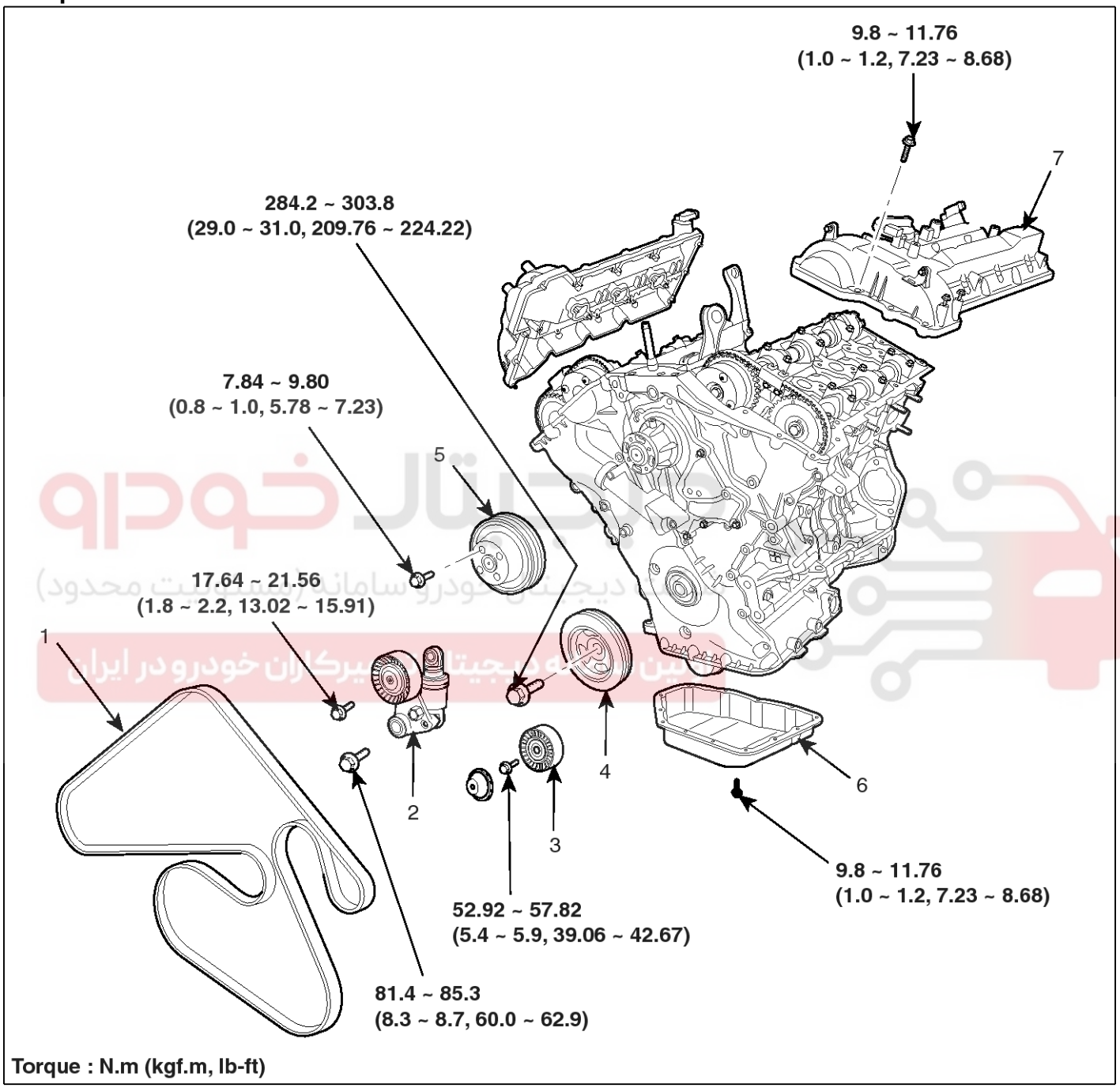


SCMM16204N

Timing System

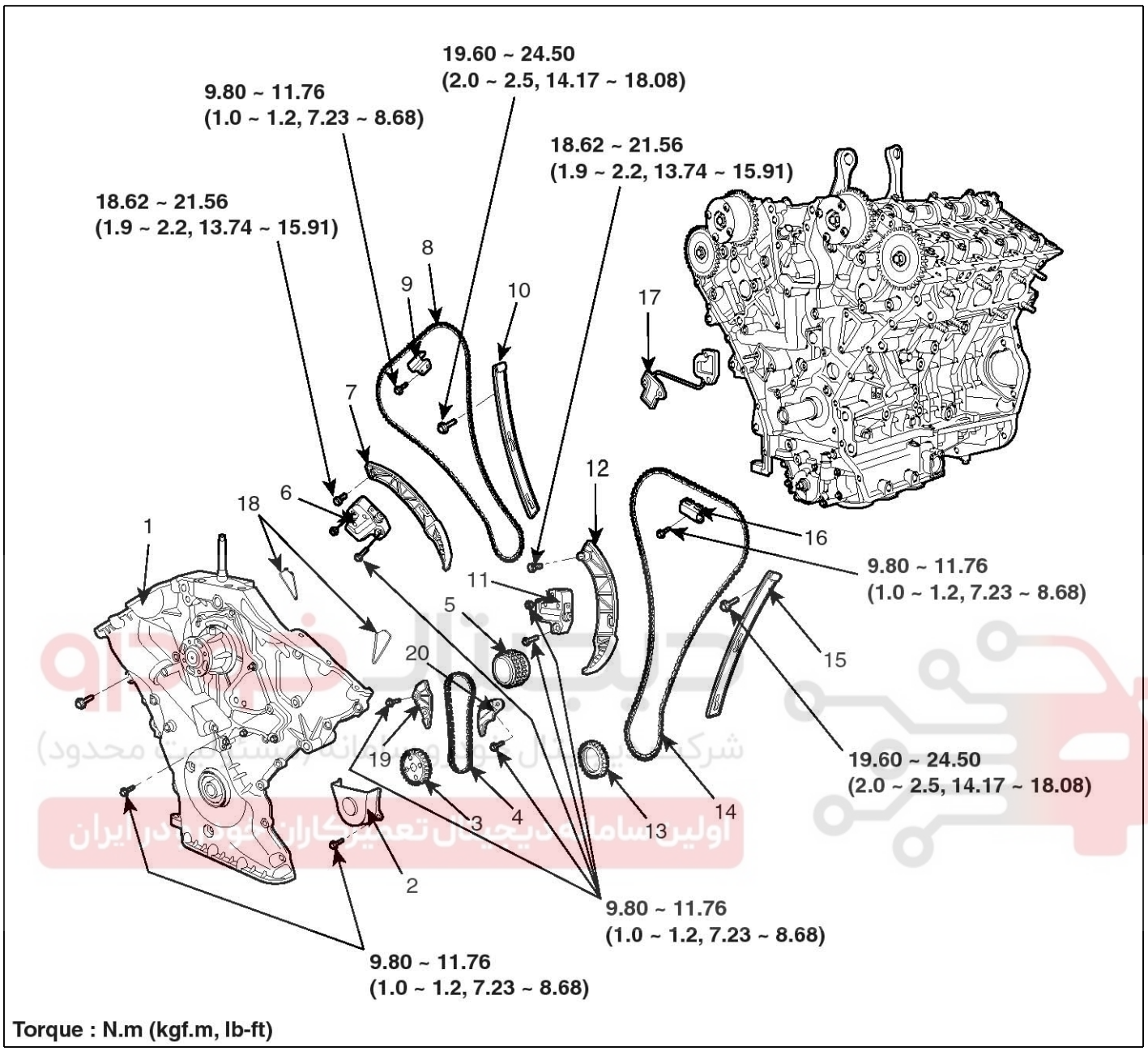
Timing Chain

Components



SENEM9001N

1. Drive belt
2. Drive belt tensioner
3. Idler
4. Damper pulley
5. Water pump pulley
6. Oil pan
7. Cylinder head cover



SENEM9002N

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

Removal

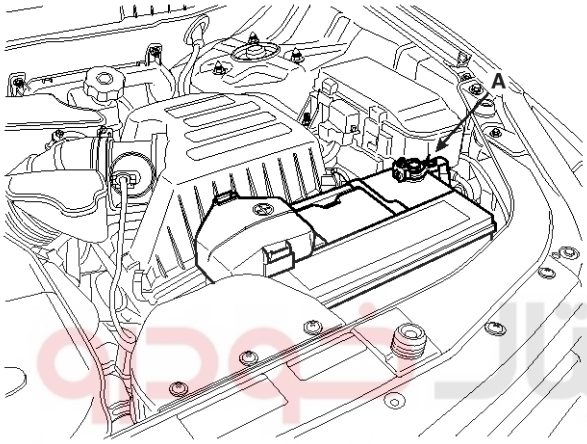
CAUTION

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

NOTICE

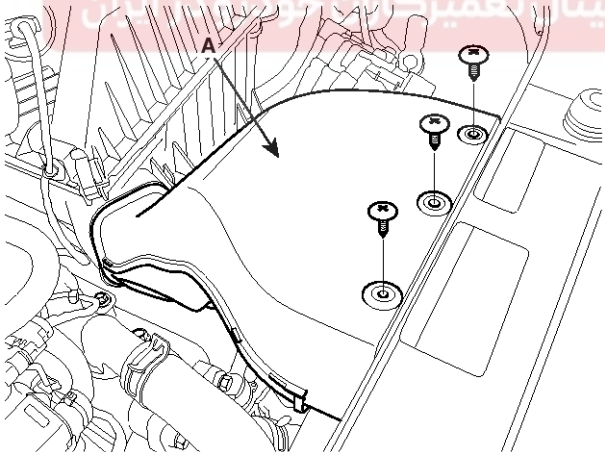
- *Mark all wiring and hoses to avoid misconnection.*
- *Turn the crankshaft pulley so that the No.1 piston is at top dead center.*

1. Disconnect the battery negative cable (A).



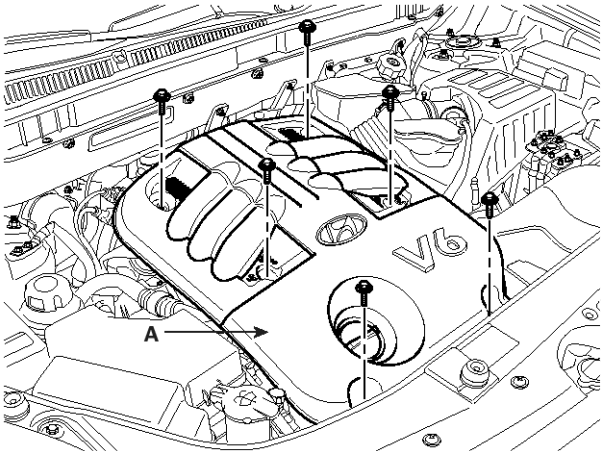
SENEM7100N

2. Remove the air duct (A).



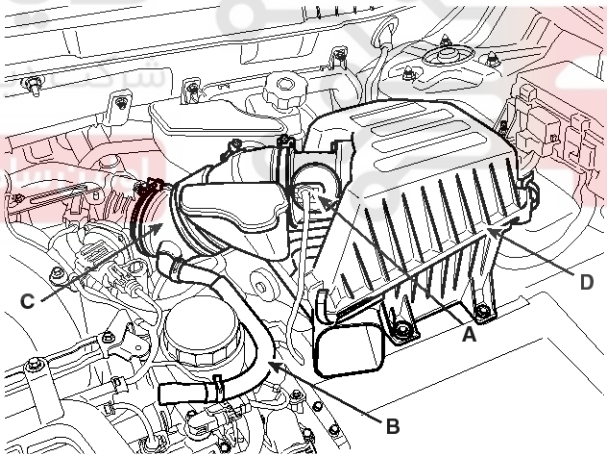
SENM17213L

3. Remove the engine cover (A).



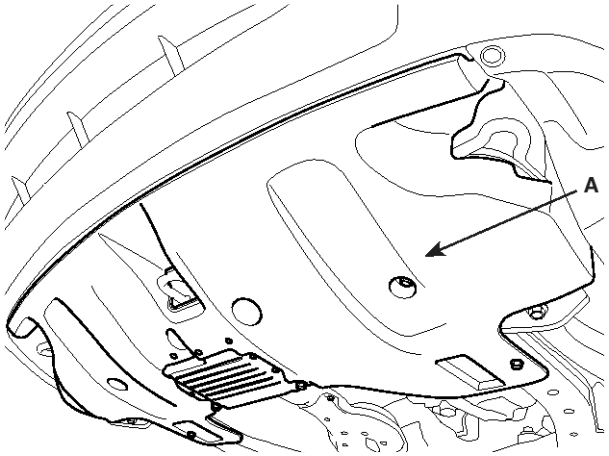
SENM17002L

4. Remove the intake air hose and air cleaner assembly.
   1) Disconnect the AFS connector (A).
   2) Disconnect the breather hose (B) from air cleaner hose.
   3) Remove the intake air hose(C) and air cleaner body (D).



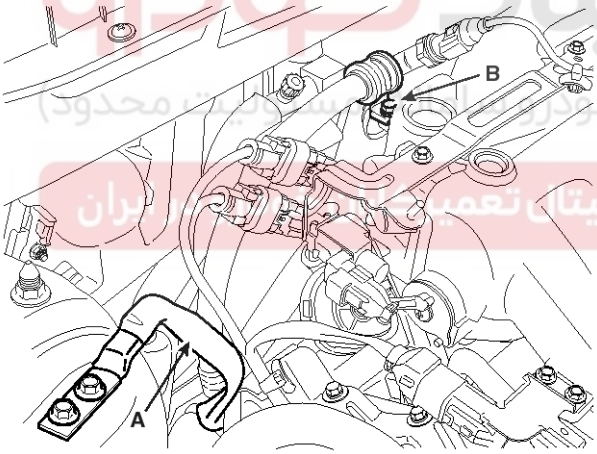
SENM17004L

5. Remove the RH front wheel.
6. Remove the under cover(A).



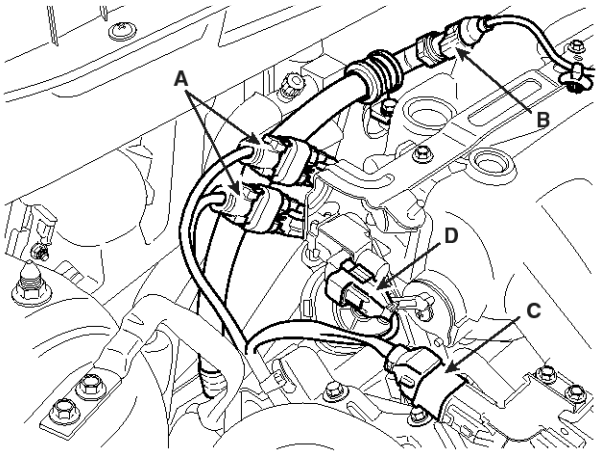
SENEM7101N

7. Remove the side cover.
8. Loosen the drain plug and drain the engine coolant.
9. Drain the engine oil.
10. Disconnect the ground cable (A) and loosen the power steering hose mounting bolt (B).



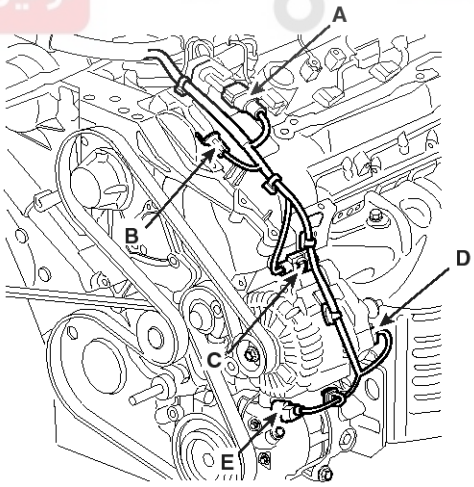
SENEM7102N

11. Remove the surge tank and engine wiring.
    1) Disconnect the RH front and rear oxygen sensor connectors(A), the power steering sensor connector(B), the RH injector harness connector(C) and the VIS solenoid valve connector(D).



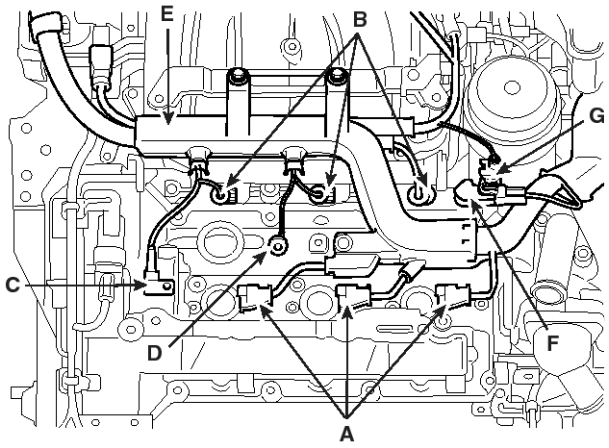
SENM17207L

    2) Disconnect the RH ignition coil connector.
    3) Disconnect the OCV connector (A) and the knock sensor connector (B).
    4) Disconnect the LH front oxygen sensor connector (C).
    5) Disconnect the alternator connector (D) and the air compressor connector (E).



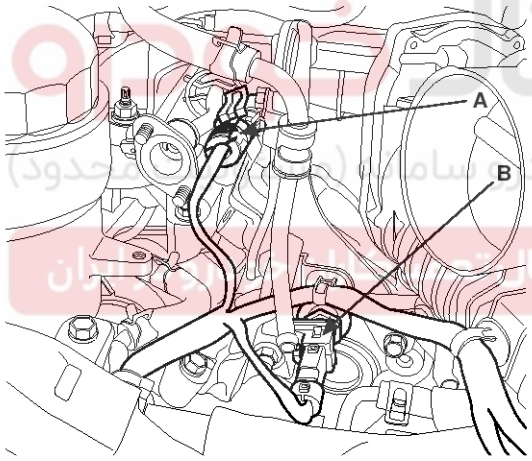
SENM17007L

6) Disconnect the LH ignition coil connector (A), the injector connector (B), the condenser connector (C) and the ground (D), and remove the wiring harness protector (E).



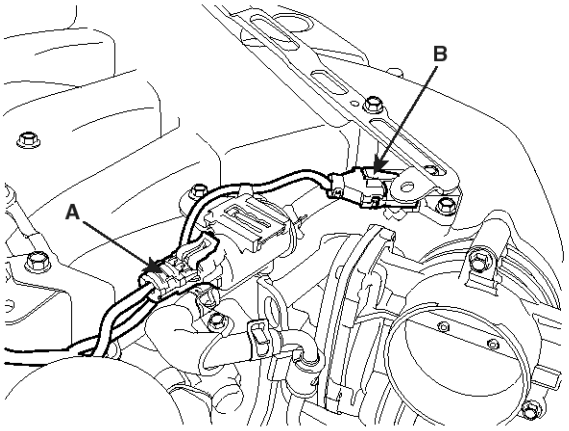
SENM17008L

7) Disconnect the RH CMPS (A) and the OTS connector (B).



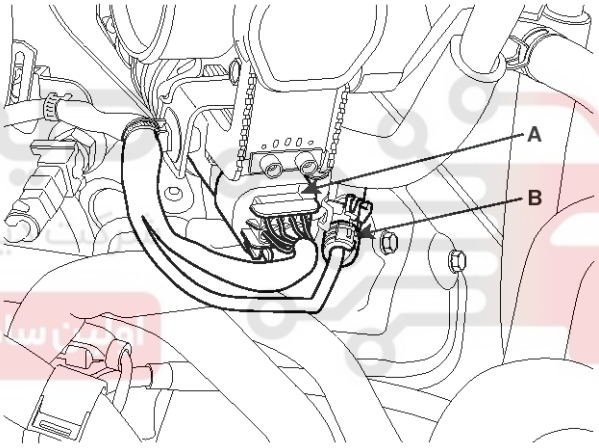
KDRF161A

8) Disconnect the PCSV connector (A), the MAP sensor connector (B) and the PCSV hose.



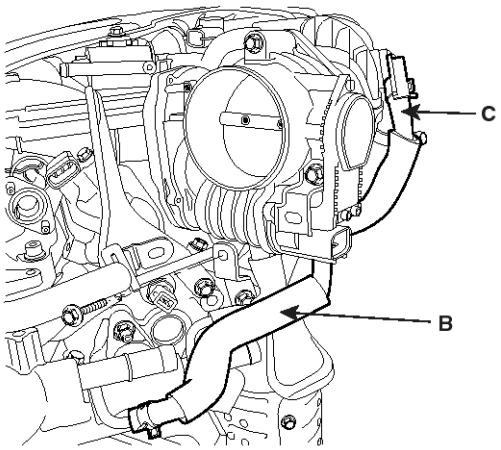
UCBF003A

9) Disconnect the ETC connector (A) and the knock sensor connector (B).



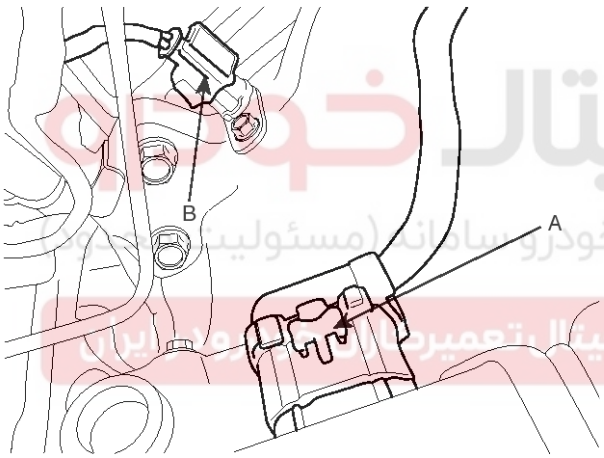
KDRF162A

10) Disconnect the water hoses (B) from ETC and PCV(C) hose.



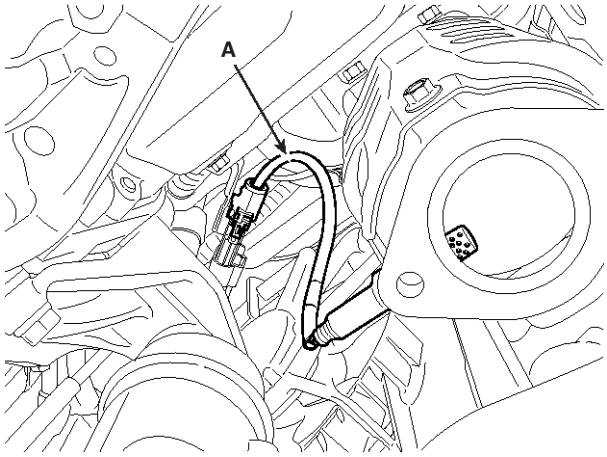
SENM17208L

11) Disconnect the TCU connector(A) and CKP sensor connector(B).



SENEM7105N

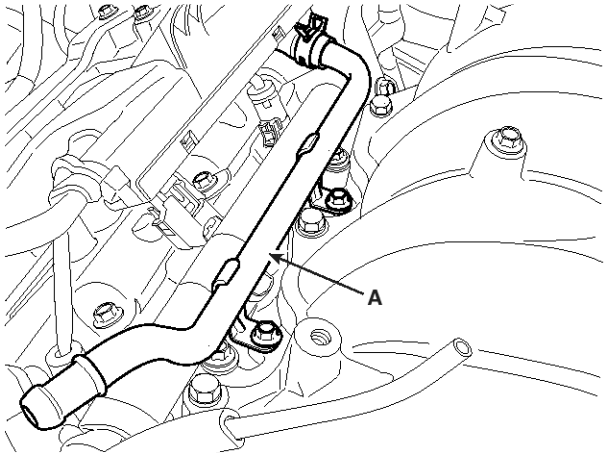
12) Disconnect the LH rear oxygen sensor connector(A).



SENM17020L

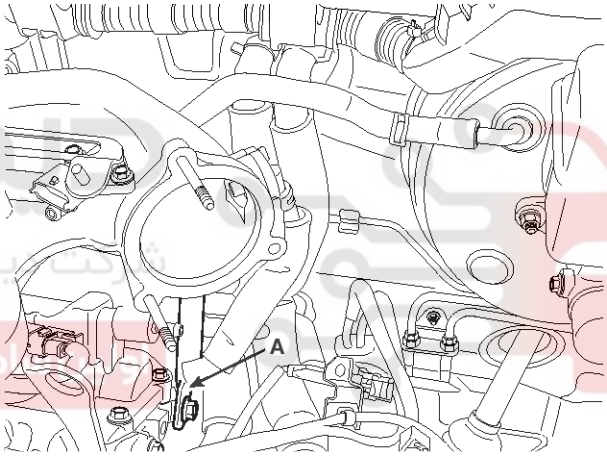
13) Disconnect brake vacuum hose.

14) Remove the breather pipe assembly (A).

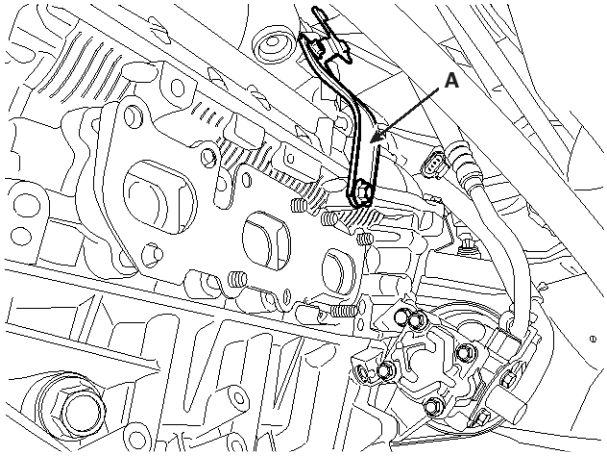


SENM17001L

15) Remove the surge tank stays (A).

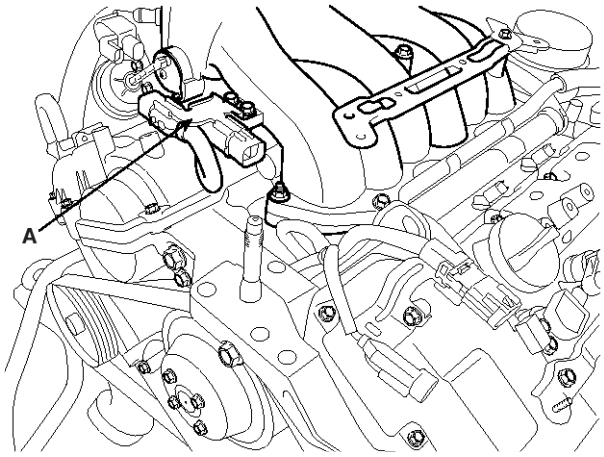


SENM17209L



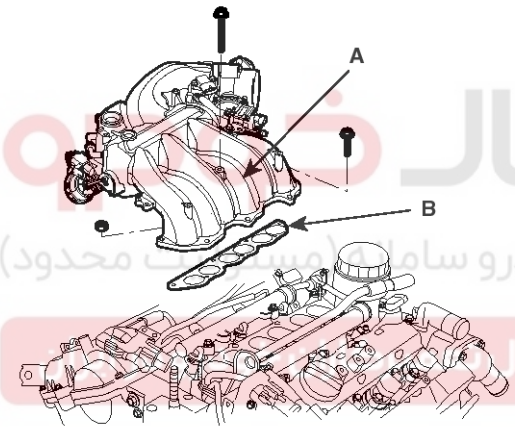
SENM17018L

16) Remove the connector bracket (A) from the surge tank.



SCMM16114N

17) Remove the surge tank (A).



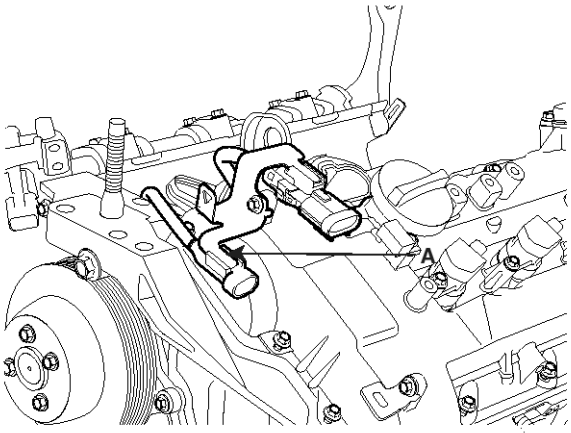
SCMM16115N

NOTICE

Cover the inlet of intake manifold with a clean woven stuff or vinyl cover to prevent foreign materials from entering.

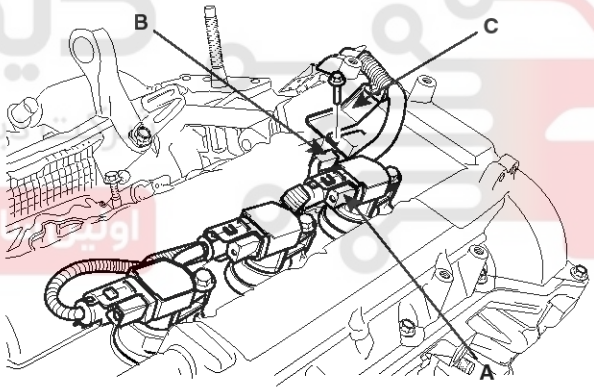
12. Remove the cylinder head cover.

1) Remove the connector bracket (A) from LH cylinder head cover.



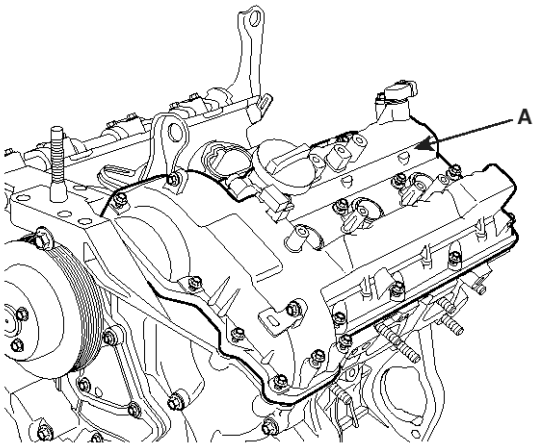
KDRF110A

2) Disconnect the RH ignition coil connector (A), condenser connector (B) and remove the wiring bracket (C).



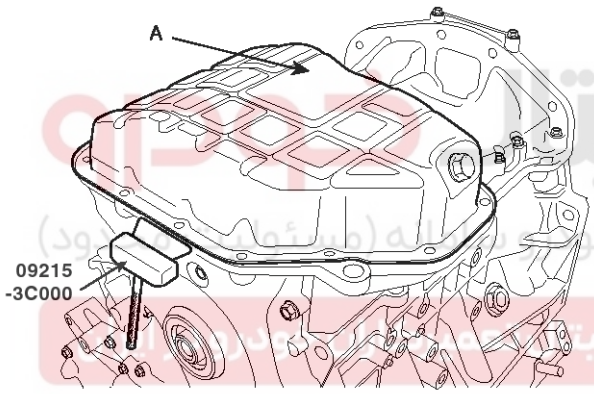
KDRF111A

3) Remove the LH, RH ignition coil.
4) Remove the LH, RH cylinder head cover (A).



KDRF112A

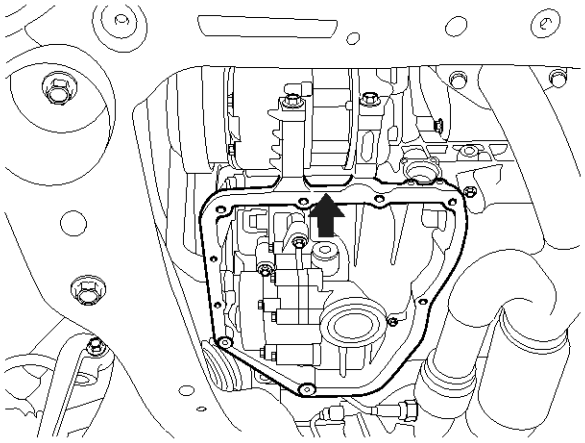
13. Using SST (09215-3C000) remove lower oil pan (A).



ECRF060A

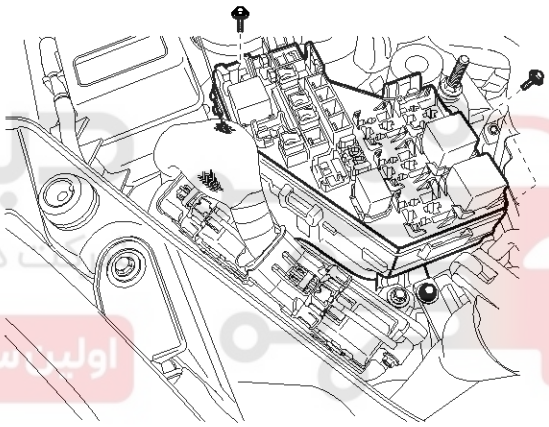
NOTICE
Be careful not to damage the contact surfaces of upper oil pan and lower oil pan.

14. Set a jack to the upper oil pan.



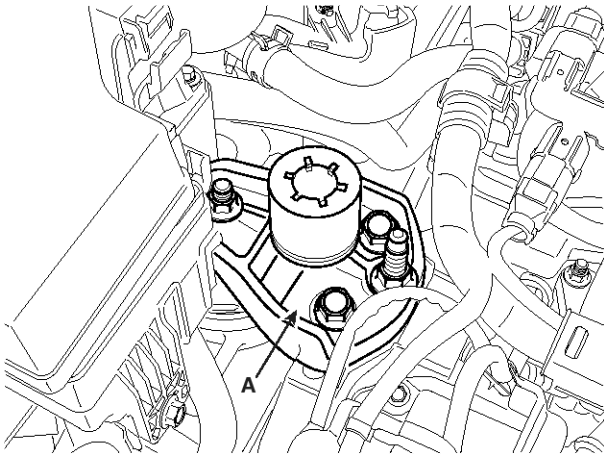
SNFM18025N

15. Remove the PCM & relay box cover and loosen the relay box mounting bolts.



SENEM7103N

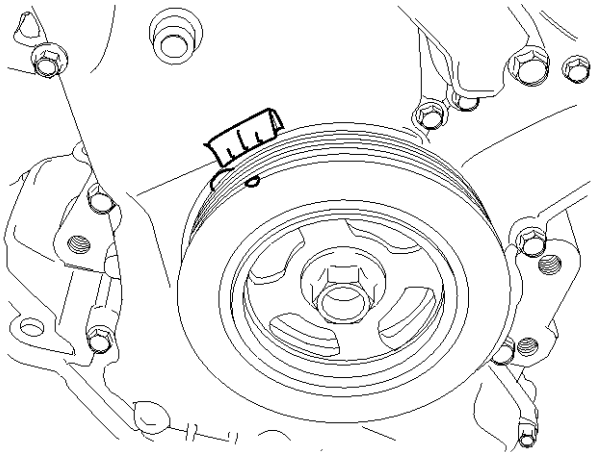
16. Remove the engine mounting bracket (A).



SENM17301L

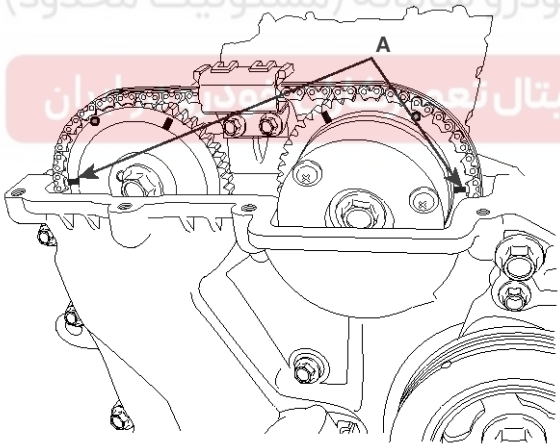
17. Set No.1 cylinder to TDC/compression.
    1) Turn the crankshaft pulley and align its groove with the timing mark "T" of the lower timing chain cover.

NOTICE
Do not rotate engine counterclockwise.



KDRF108A

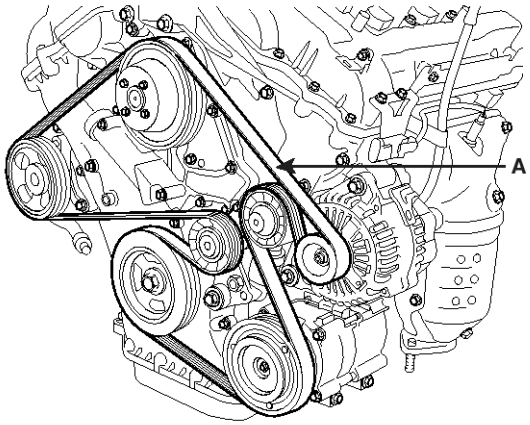
    2) Check that the mark (A) of the camshaft timing sprockets are in straight line on the cylinder head surface as shown in the illustration.
    If not, turn the crankshaft one revolution (360˚).



KDRF113A

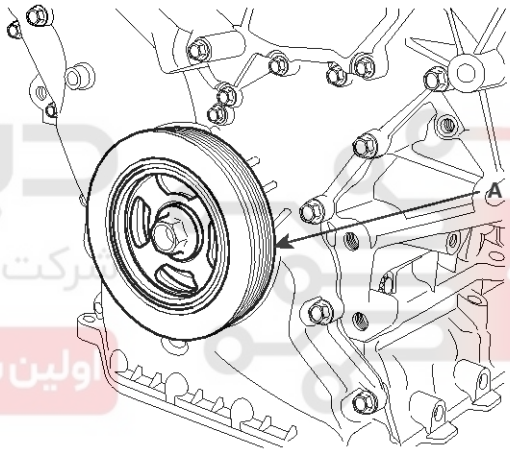
NOTICE
Do not rotate engine counterclockwise.

18. Remove the drive belt (A).

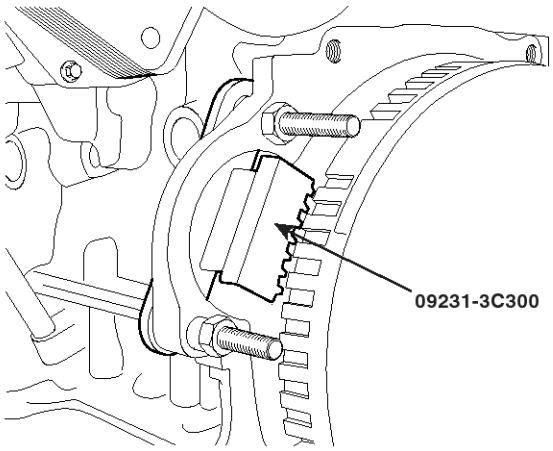


KDRF101A

19. Using SST (09231-3C300) remove the crankshaft damper pulley (A).

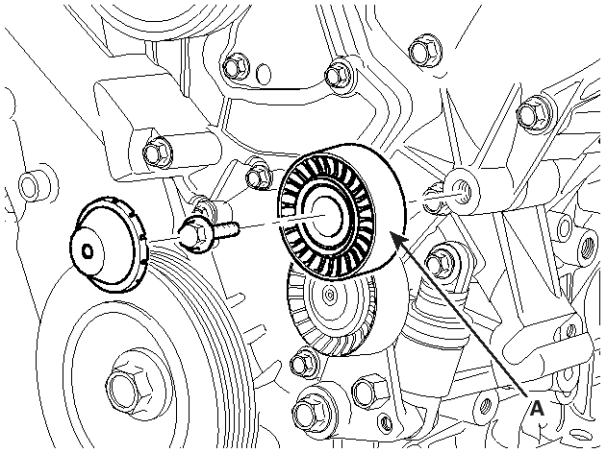


KDRF109A



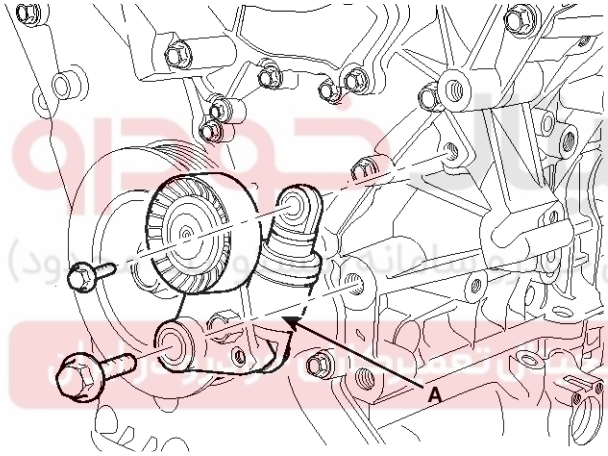
ECRF061A

20. Lift up the engine assembly to using the jack.
21. Remove the drive belt idler (A).



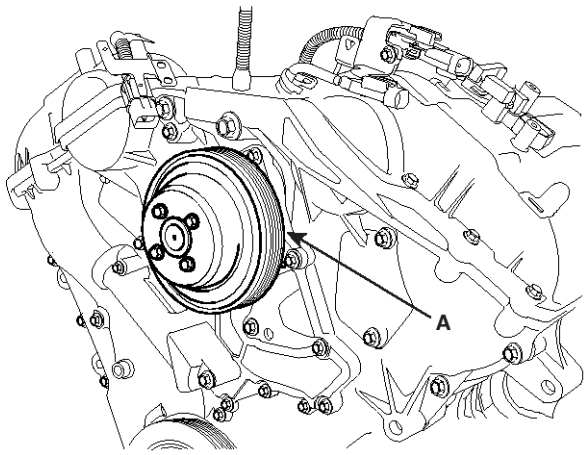
KDRF105A

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



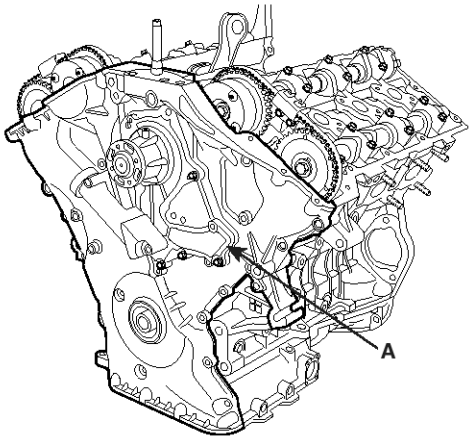
KDRF106A

23. Remove the water pump pulley (A).

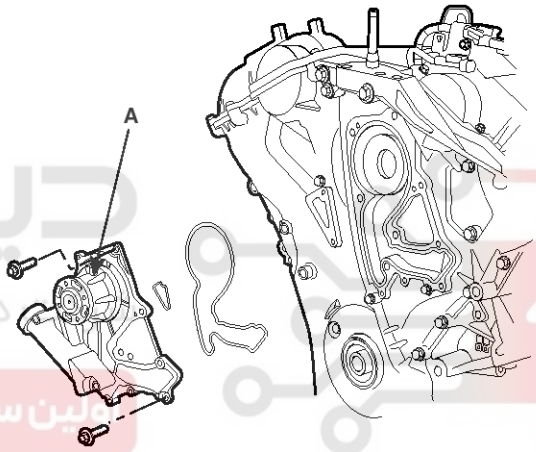


KDRF107A

24. Remove the timing chain cover (A). If necessary remove the water pump (B) first.



KDRF115A



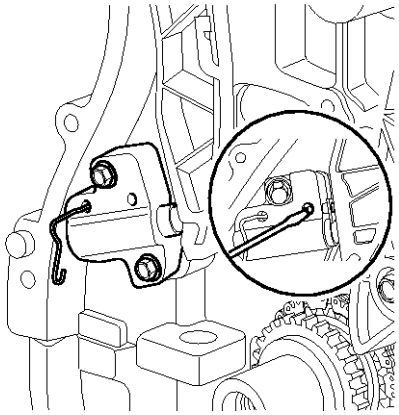
KDRF221A

NOTICE

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

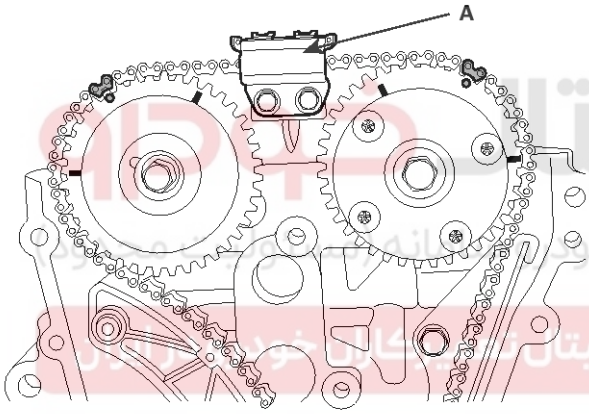
Before removing the timing chain, mark the RH/LH timing chain with an identification based on the location of the sprocket because the identification mark on the chain for TDC (Top Dead Center) can be erased.

25. Install a set pin after compressing the timing chain tensioner.



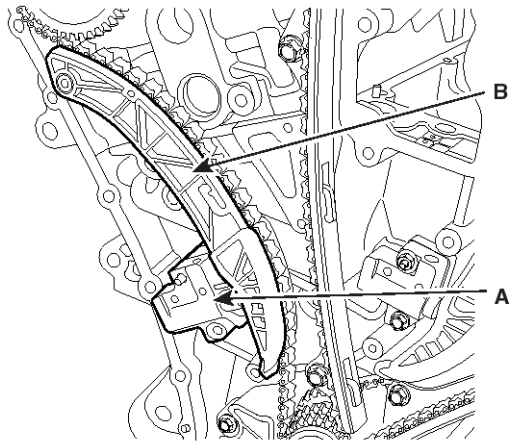
KCRF105A

26. Remove the RH cam-to-cam guide (A).



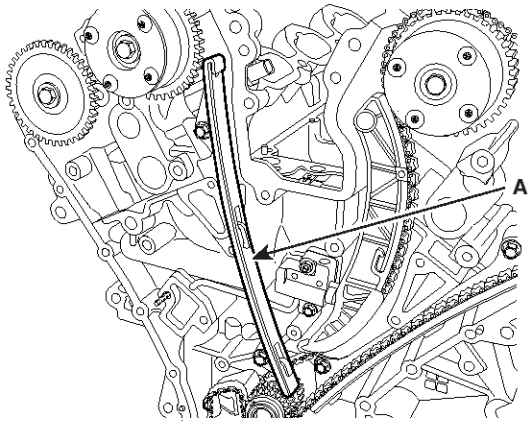
KDRF116A

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



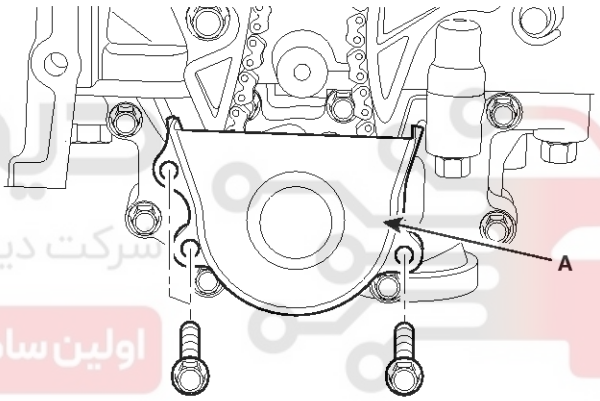
KDRF117A

28. Remove the RH timing chain.
29. Remove the RH timing chain guide (A).



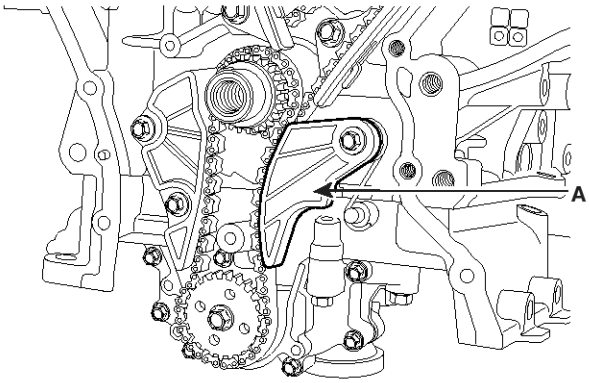
KDRF118A

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



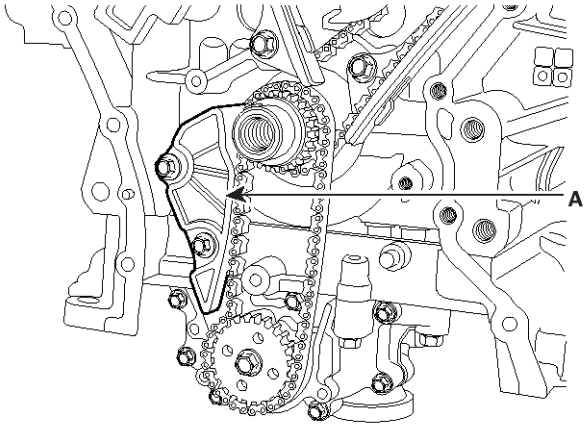
KDRF185A

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



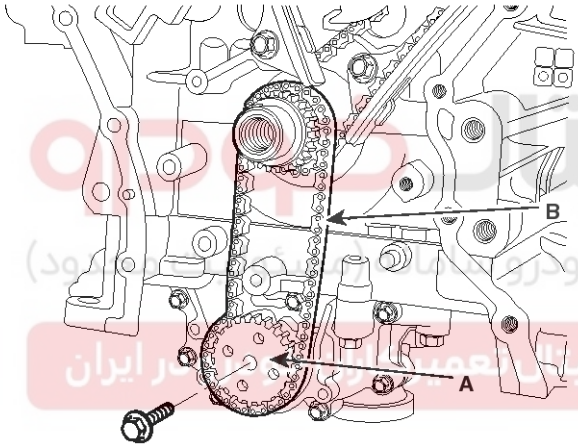
KDRF119A

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



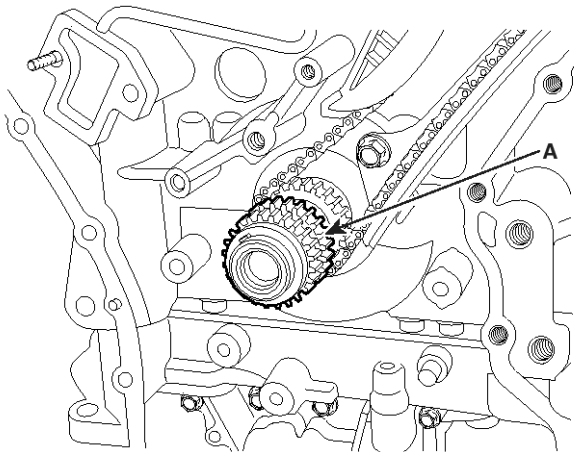
KDRF120A

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



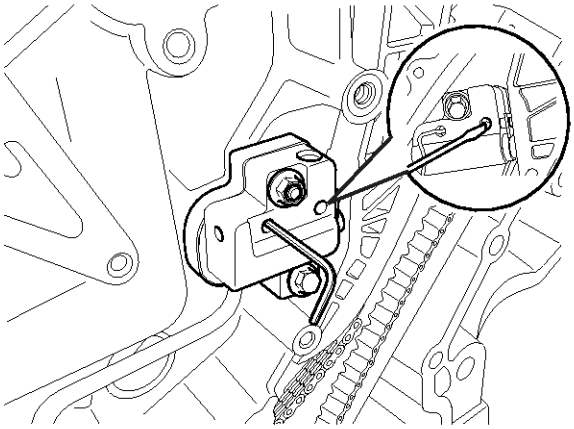
KDRF121A

34. Remove the crankshaft sprocket (A) (Oil pump & RH camshaft drive).



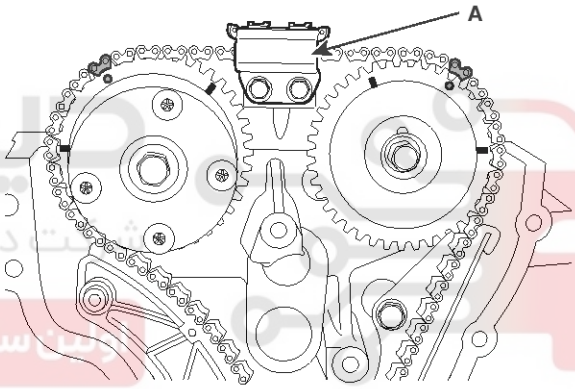
KDRF122A

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



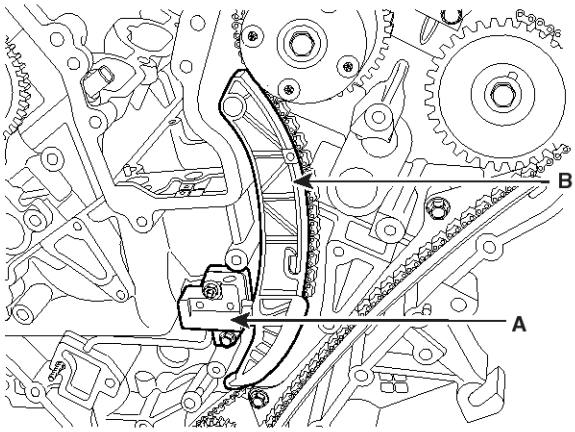
SBHEM8066D

36. Remove the LH cam-to-cam guide (A).



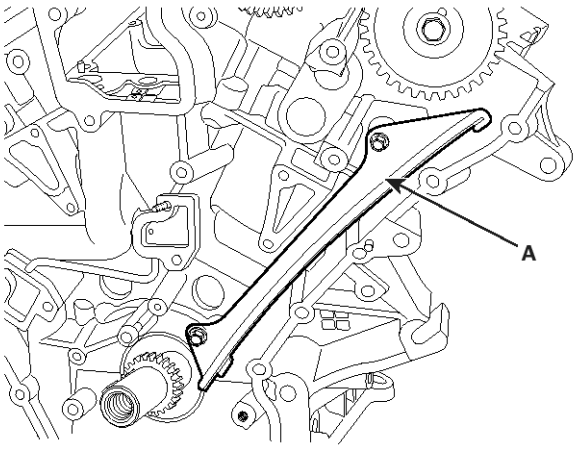
KDRF123A

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



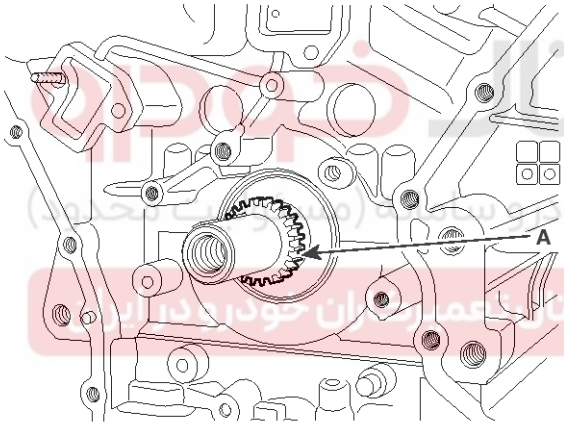
KDRF124A

38. Remove the LH timing chain.
39. Remove the LH timing chain guide (A).



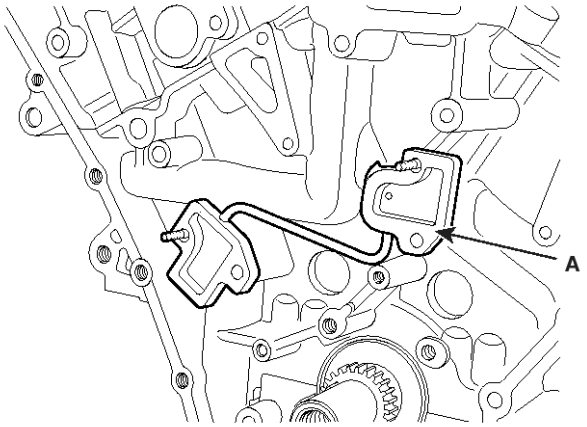
KDRF125A

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



KDRF126A

41. Remove the tensioner adapter assembly (A).



KDRF127A

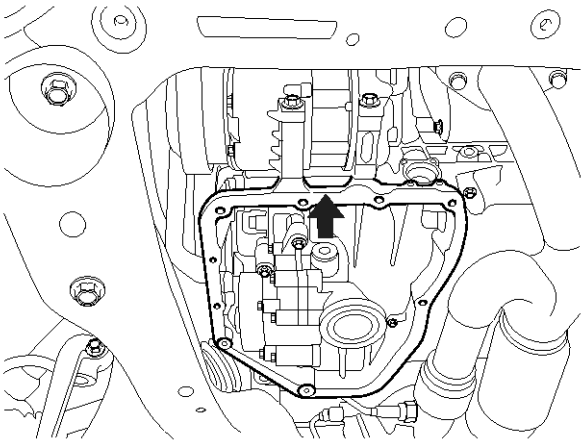
Inspection

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.

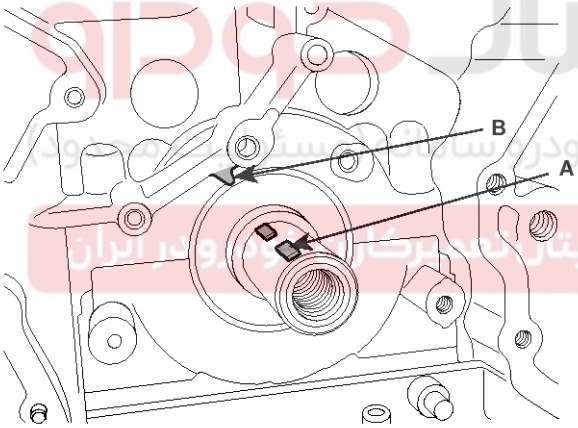
Installation

1. Install the jack to the upper oil pan.



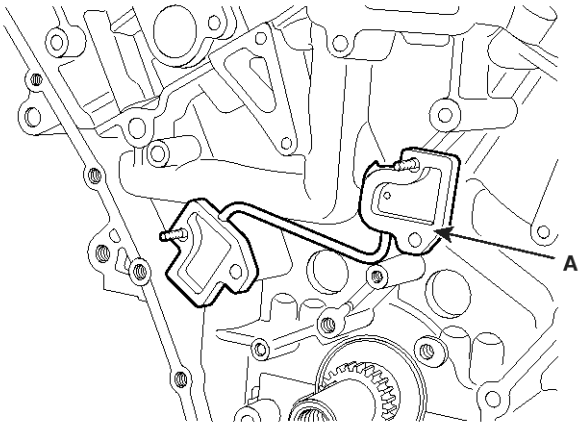
SNFM18025N

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



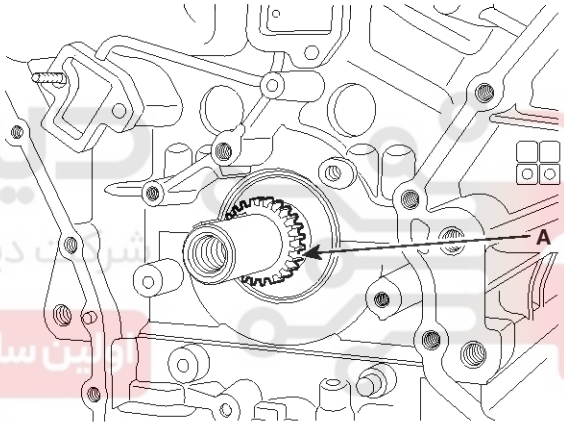
KDRF128A

3. Install the tensioner adapter assembly (A).



KDRF127A

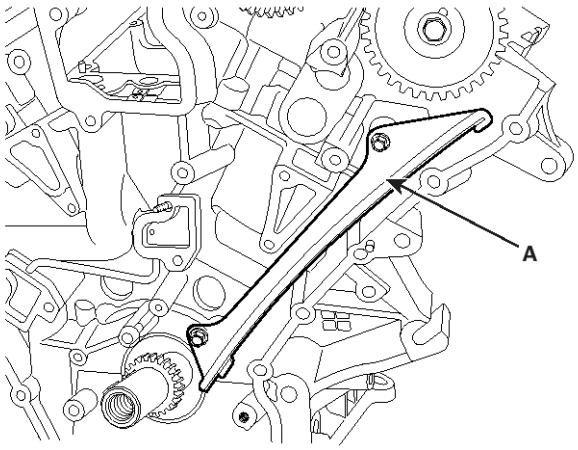
4. Install the crankshaft sprocket (A) (LH camshaft drive).



KDRF126A

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

Tightening torque
19.60 ~ 24.50Nm(2.0 ~ 2.5kgf.m, 14.17 ~ 18.08lb-ft)



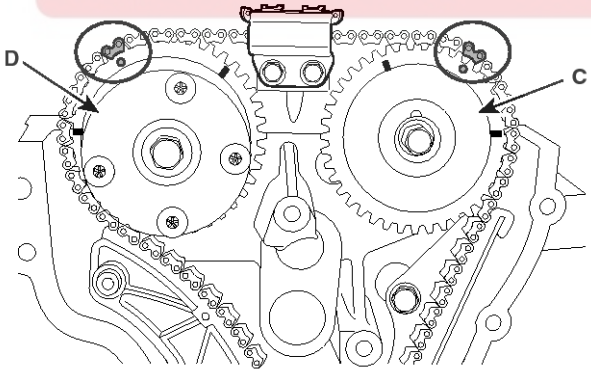
KDRF125A

6. Install LH timing chain.

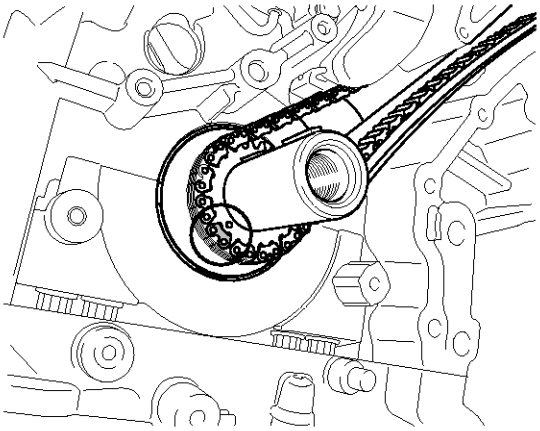
To install the timing chain with no slack between each shaft (cam, crank), follow the procedure below.

Crankshaft sprocket → Timing chain guide → Exhaust camshaft sprocket(C) → Intake camshaft sprocket(D).

The timing mark of each sprocket should be matched with timing mark (color link) of timing chain at installing timing chain.



BCKG023A



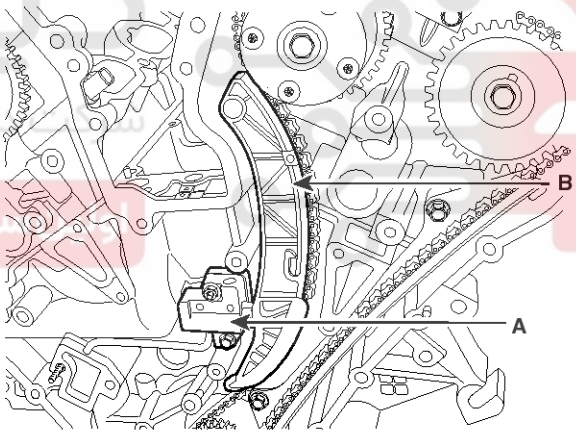
SBHEM8074D

7. Install the LH timing chain tensioner arm(B).

Tightening torque
18.62 ~ 21.56Nm(1.9 ~ 2.2kgf.m, 13.74 ~ 15.91lb-ft)

8. Install the LH chain tensioner (A).

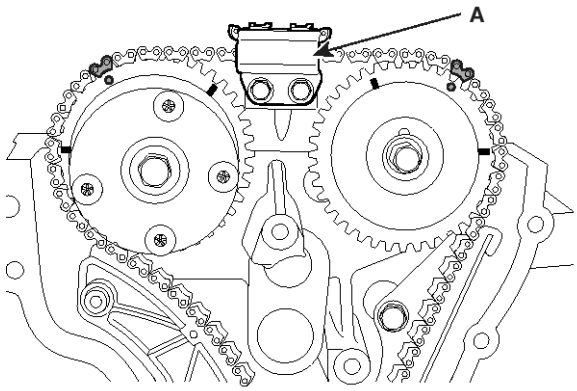
Tightening torque
9.80 ~ 11.76Nm(1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)



KDRF124A

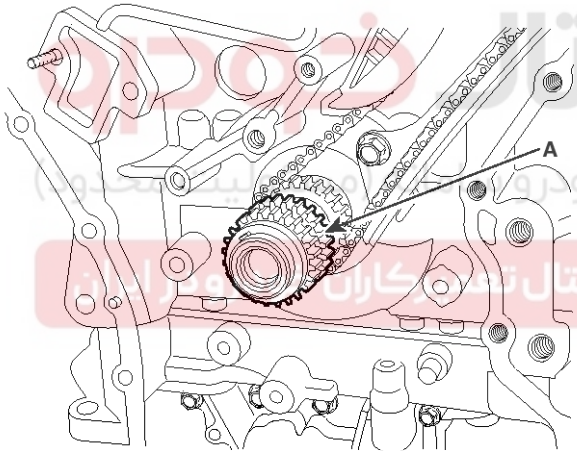
9. Install the LH cam-to-cam guide (A).

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



KDRF123A

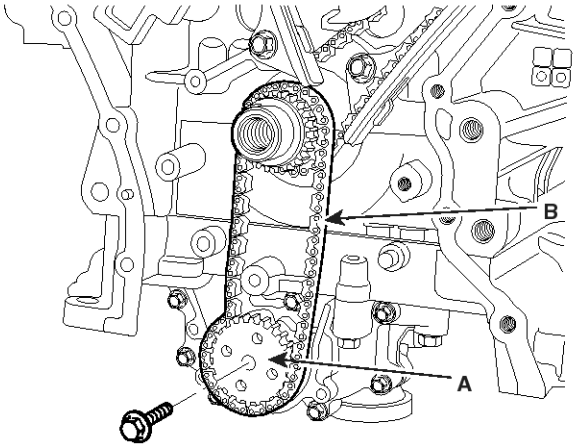
10. Install the crankshaft sprocket (A) (Oil pump & RH camshaft drive).



KDRF122A

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

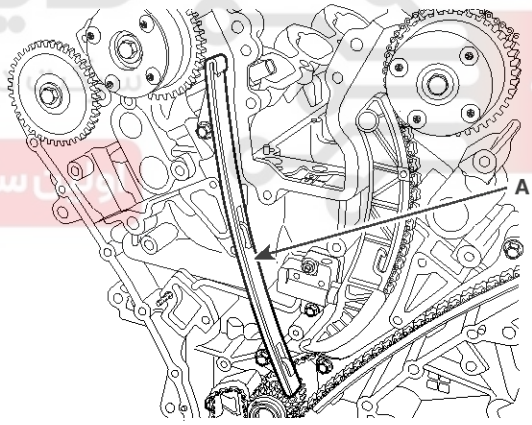
Tightening torque
18.62 ~ 21.56Nm(1.9 ~ 2.2kgf.m, 13.74 ~ 15.91lb-ft)



KDRF121A

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

Tightening torque
19.60 ~ 24.50Nm(2.0 ~ 2.5kgf.m, 14.17 ~ 18.08lb-ft)



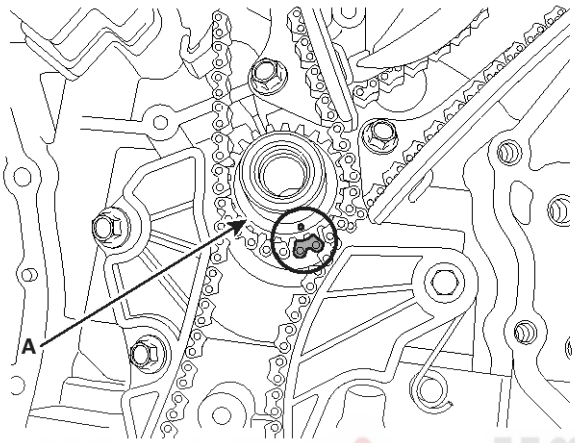
KDRF118A

13. Install the RH timing chain.

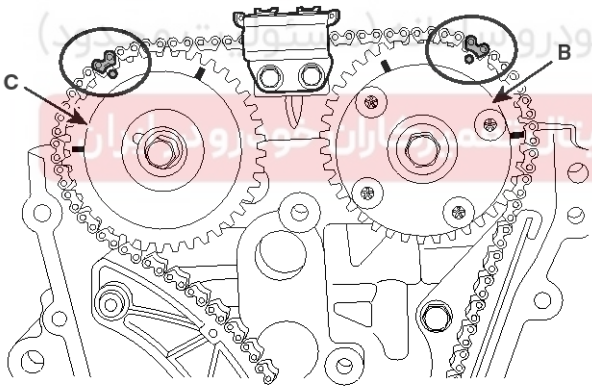
To install the timing chain with no slack between each shaft (cam, crank), follow the procedure below.

Crankshaft sprocket (A) → Intake camshaft sprocket (B) → Exhaust camshaft sprocket (C).

The timing mark of each sprocket should be matched with timing mark (color link) of timing chain at installing timing chain.



BCKG024A



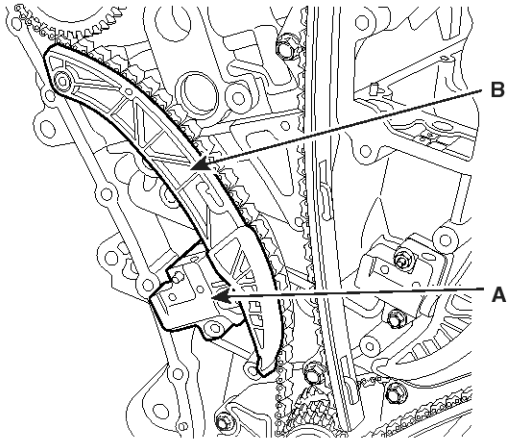
BCKG025A

14. Install the RH timing chain tensioner arm (B).

Tightening torque
18.62 ~ 21.56Nm(1.9 ~ 2.2kgf.m, 13.74 ~ 15.91lb-ft)

15. Install the RH timing chain auto tensioner (A).

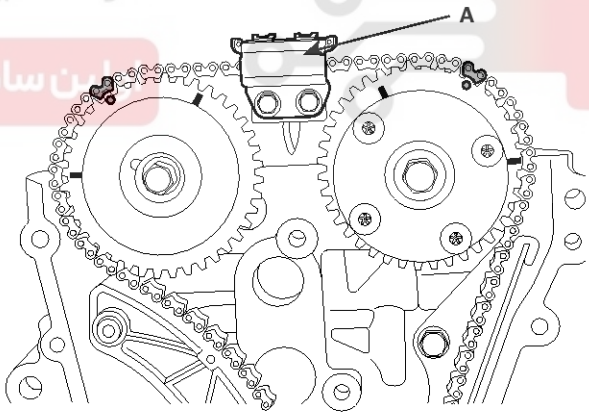
Tightening torque
9.80 ~ 11.76Nm(1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)



KDRF117A

16. Install the RH cam-to-cam guide (A).

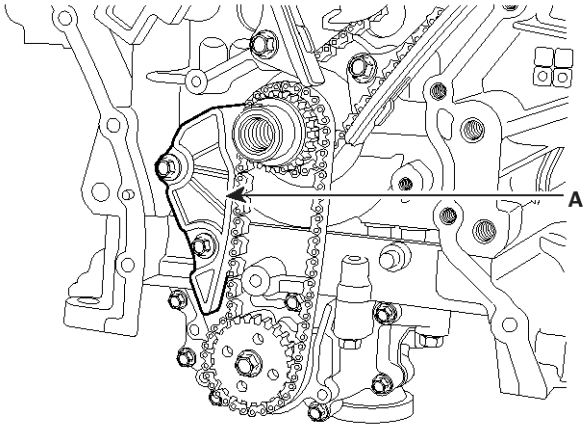
Tightening torque
9.80 ~ 11.76Nm(1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)



KDRF116A

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

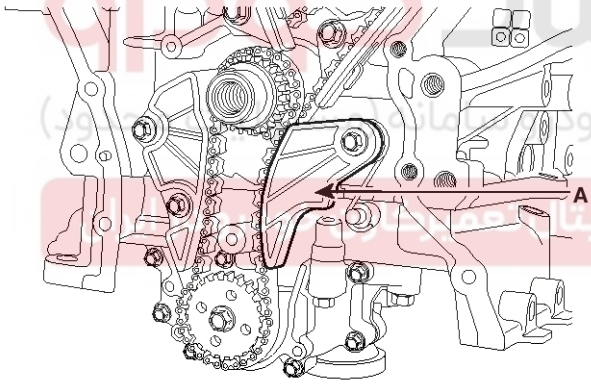
Tightening torque
9.80 ~ 11.76Nm(1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)



KDRF120A

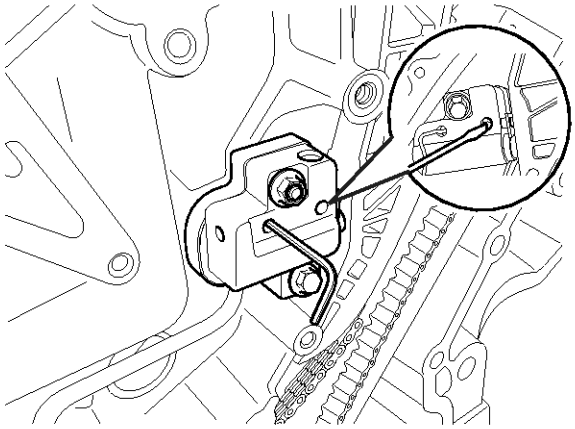
18. Install the oil pump chain tensioner assembly (A).

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

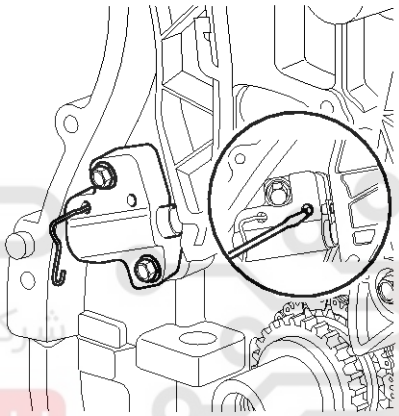


KDRF119A

19. Pull out the pins of hydraulic tensioners (LH & RH).



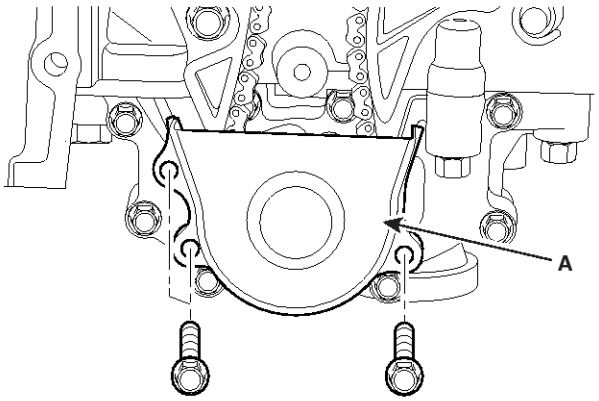
SBHEM8066D



KCRF105A

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

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



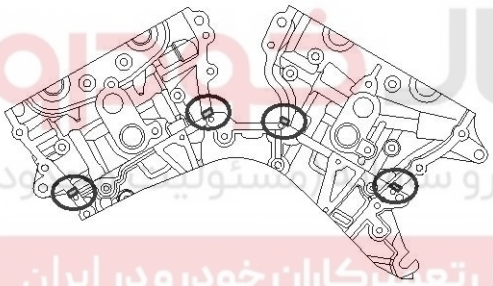
KDRF185A

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

NOTICE
Always turn the crankshaft clockwise.

22. 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 TB1217H should be applied on the gap between cylinder head and cylinder block.
       The part must be assembled within 5 minutes after sealant was applied.

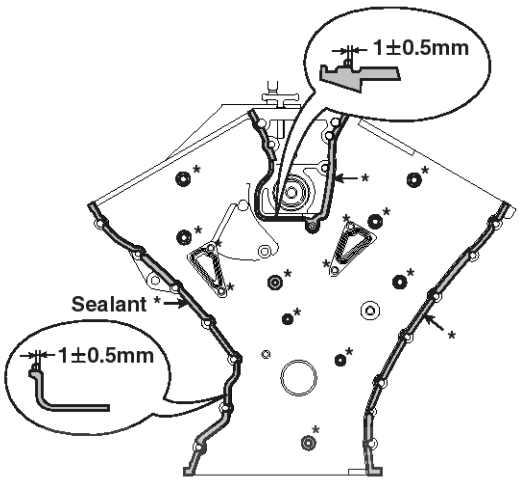
Bead width : 2.5mm(0.1in.)



KDRF134A

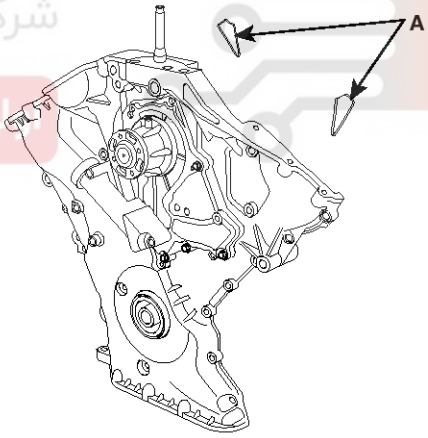
3) After applying liquid sealant TB1217H on the timing chain cover.
   The part must be assembled within 5 minutes after sealant was applied.
   Sealant should be applied without discontinuity.

Bead width : 2.5mm(0.1in.)



ECBF032A

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



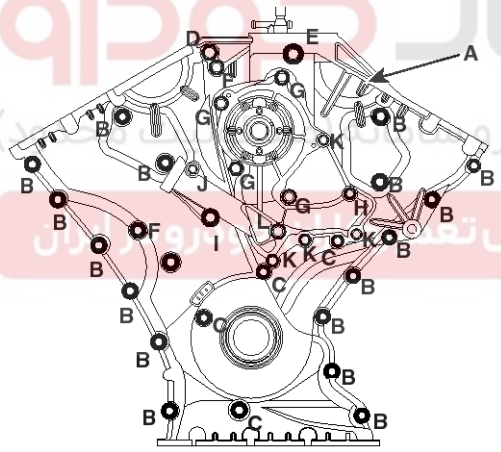
KDRF220A

NOTICE
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

B(17) :18.62 ~ 21.56N.m (1.9 ~ 2.2kgf.m, 13.74 ~ 15.91lb-ft)
C(4) :9.80 ~ 11.76N.m (1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)
D(1) :58.80 ~ 68.80N.m (6.0 ~ 7.0kgf.m, 43.40 ~ 50.63lb-ft)
E(1) :58.80 ~ 68.80N.m (6.0 ~ 7.0kgf.m, 43.40 ~ 50.63lb-ft)
F(2) :24.50 ~ 26.46N.m (2.5 ~ 2.7kgf.m, 18.08 ~ 19.53lb-ft)
G(4) :21.56 ~ 23.52N.m (2.2 ~ 2.4kgf.m, 15.91 ~ 17.36lb-ft)
H(1) :9.80 ~ 11.76N.m (1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)
I(1) :9.80 ~ 11.76N.m (1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)
J(1) :9.80 ~ 11.76N.m (1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)
K(4) :9.80 ~ 11.76N.m (1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)
L(1):21.56 ~ 26.46N.m (2.2 ~ 2.7kgf.m, 15.91 ~ 19.53lb-ft) - New bolt



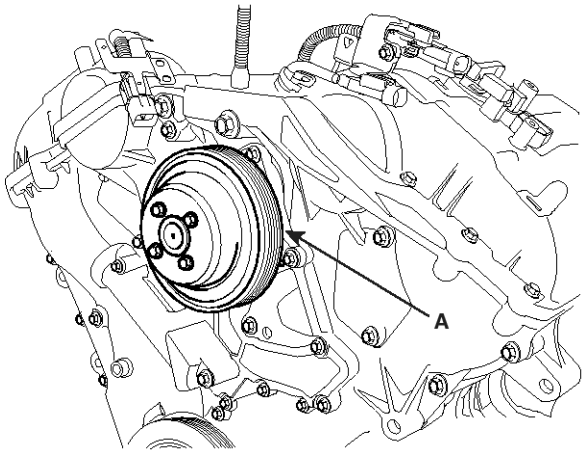
ECBF033A

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

23. Install the water pump pulley (A).

Tightening torque

7.84 ~ 9.80Nm(0.8 ~ 1.0kgf.m, 5.78 ~ 7.23lb-ft)

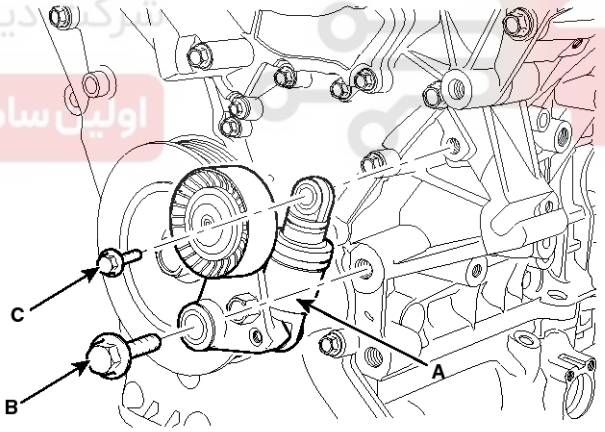


KDRF107A

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

Tightening torque

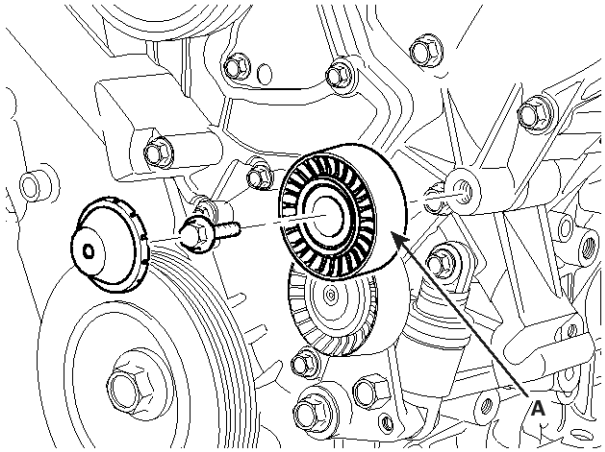
Bolt(B):81.39 ~ 85.32N.m (8.3 ~ 8.7kgf.m, 60.03 ~ 62.93lb-ft)
Bolt(C):17.64 ~ 21.56N.m (1.8 ~ 2.2kgf.m, 13.02 ~ 15.91lb-ft)



SGHEM7103N

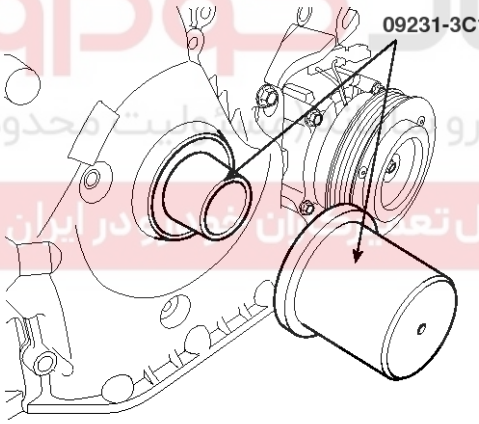
25. Install the drive belt idler (A).

Tightening torque
52.92 ~ 57.82Nm(5.4 ~ 5.9kgf.m, 39.06 ~ 42.67lb-ft)



KDRF105A

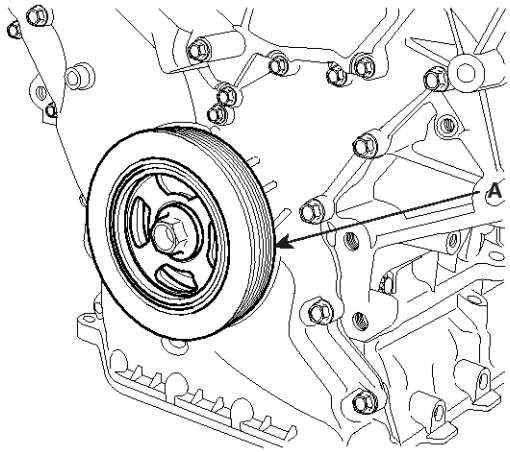
26. Lower the engine assembly by using the jack.
27. Using SST (09231-3C100), install timing chain cover oil seal.



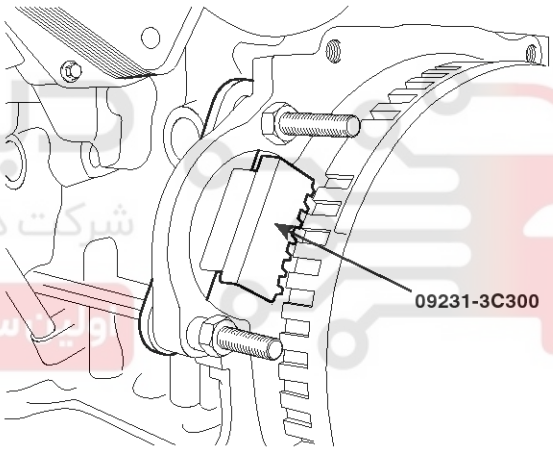
ECRF050A

28. Using SST (09231-3C300) install the crankshaft damper pulley (A).

Tightening torque
284.2~303.8N.m (29.0~31.0kgf.m, 209.76~224.22lb-ft)



KDRF109A



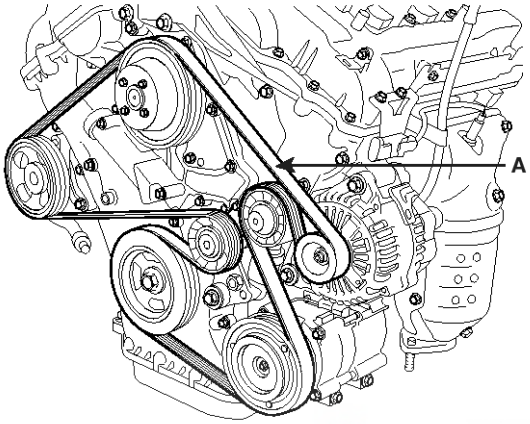
ECRF061A

29. Install the drive belt (A).

    Crankshaft pulley → A/C pulley → idler pulley → alternator pulley → water pump pulley → P/S pump pulley→ tensioner pulley.

    Rotate auto tensioner arm in the counterclockwise moving auto tensioner pulley bolt with wrench.

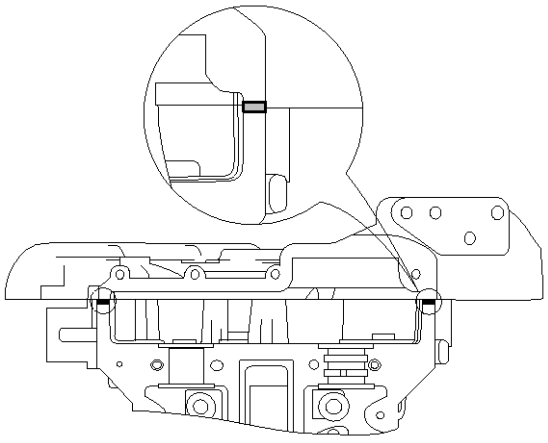
    After putting belt on auto tensioner pulley, release the auto tensioner pulley slowly.



KDRF101A

30. Install 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 (TB1217H), it should be assembled within 5 minutes.

Bead width : 2.5mm(0.1in.)

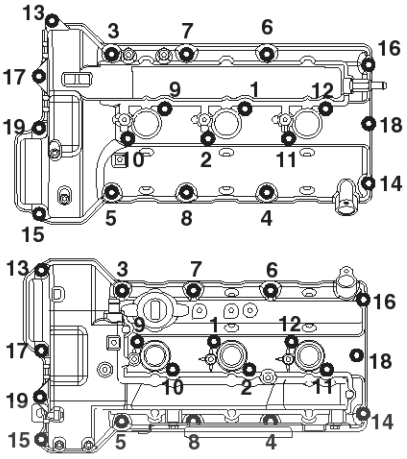


KDRF231A

    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

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

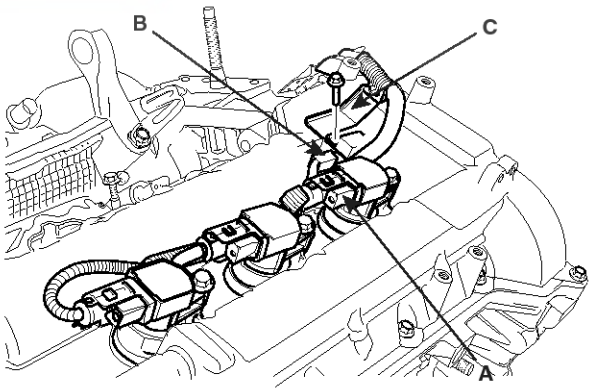


KDRF139A

⚠CAUTION

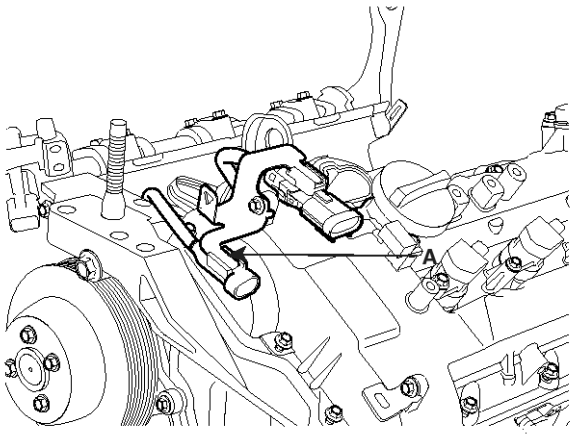
Do not reuse cylinder head cover gasket.

    5) Install the ignition coil.
    6) Connect the RH ignition coil connector (A), the condenser connector (B) and install the wiring bracket (C).



KDRF111A

7) Install the connector bracket (A) from LH cylinder head cover.

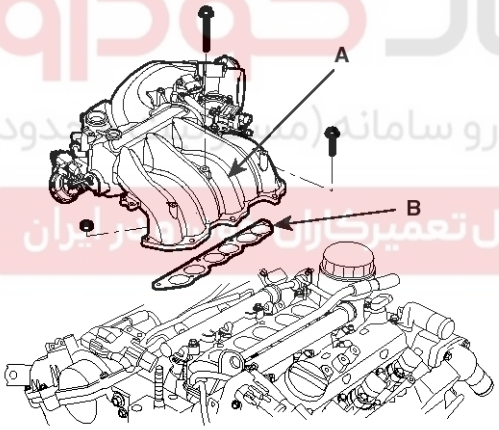


KDRF110A

31. Install the surge tank and wiring connectors.

1) Install the surge tank (A).

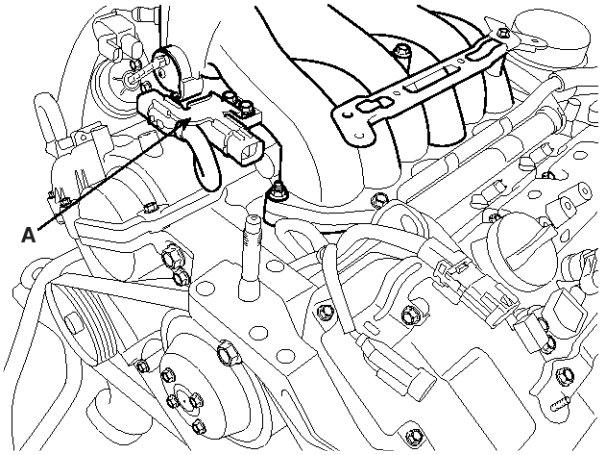
Tightening torque
9.80 ~ 11.76N.m (1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)



SCMM16115N

2) Install the connector bracket (A) to the surge tank.

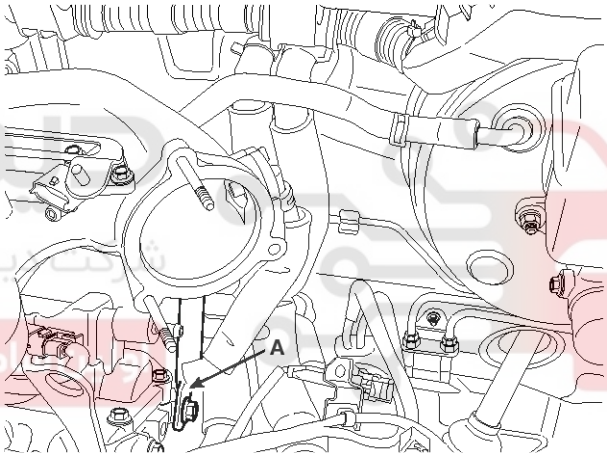
Tightening torque
6.86 ~ 10.78N.m (0.7 ~ 1.1kgf.m, 5.06 ~ 7.96lb-ft)



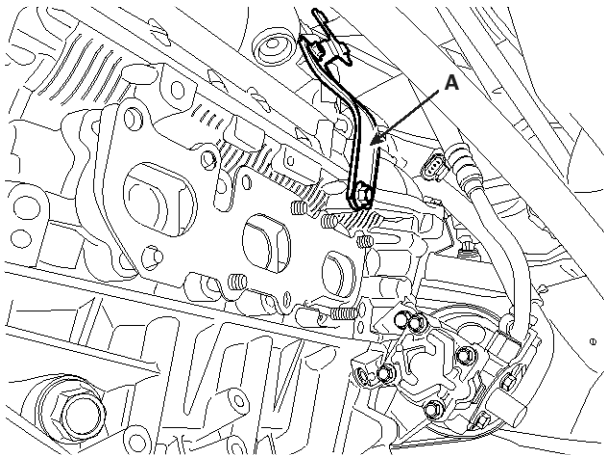
SCMM16114N

3) Install the surge tank stays (A).

Tightening torque
27.44 ~ 31.36N.m (2.8 ~ 3.2kgf.m, 20.25 ~ 23.14lb-ft)



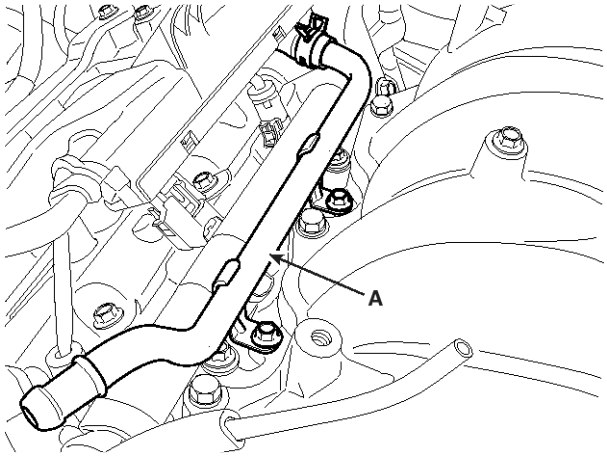
SENM17209L



SENM17018L

4) Install the breather pipe assembly (A).

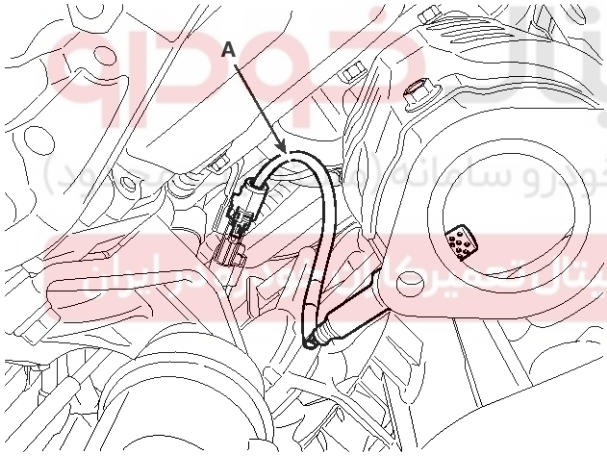
Tightening torque
9.80 ~ 11.76N.m (1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)



SENM17001L

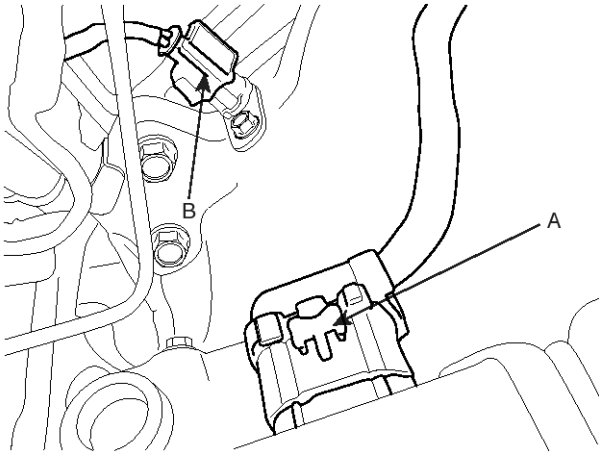
5) Connect the brake vacuum hose.

6) Connect the LH rear oxygen sensor connector(A).



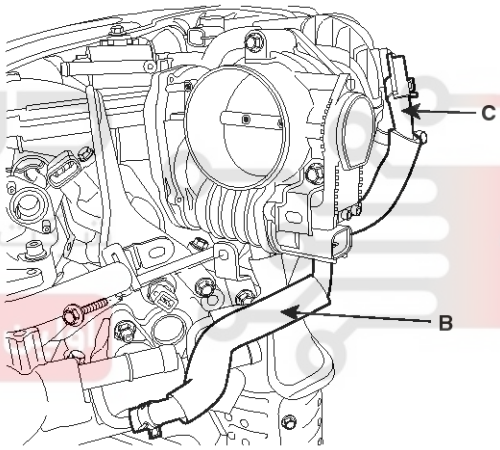
SENM17020L

7) Connect the TCU connector(A) and CKP sensor connector(B).



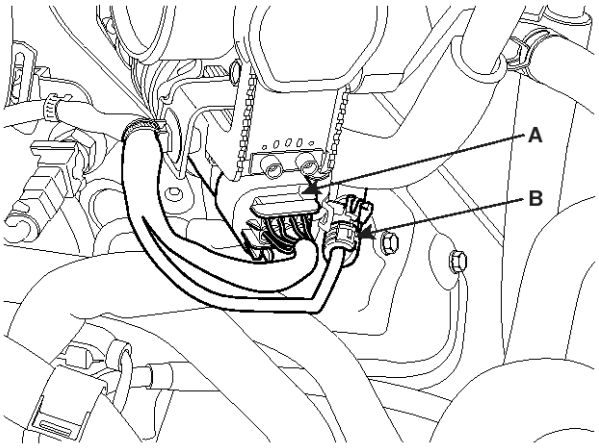
SENEM7105N

8) Connect the water hoses (B) to the ETC and PCV(C) hose.



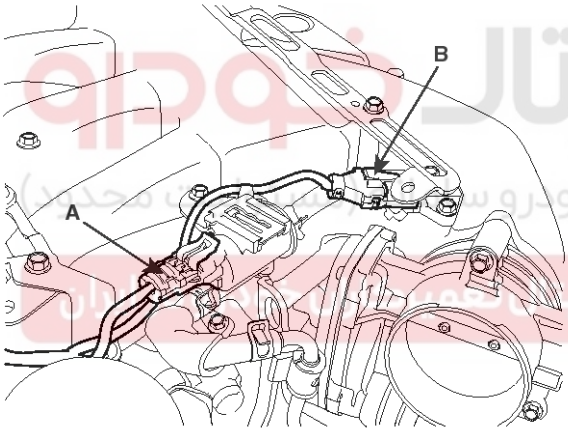
SENM17208L

9) Connect the ETC connector (A) and knock sensor connector (B).



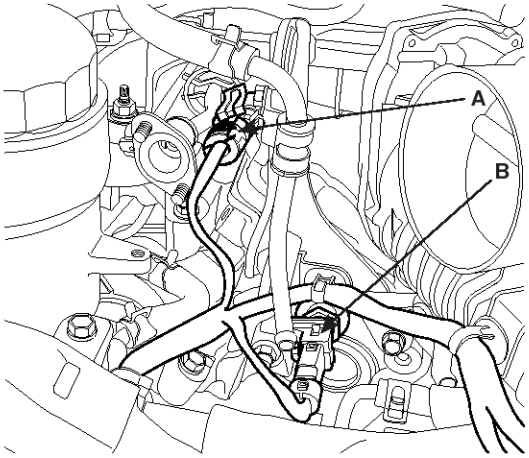
KDRF162A

10) Connect the PCSV connector (A), the MAP sensor connector (B) and the PCSV hose.



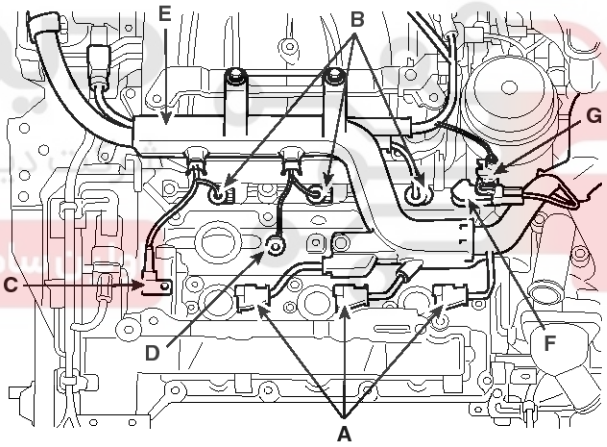
UCBF003A

11) Disconnect the RH CMPS (A) and the OTS connector (B).



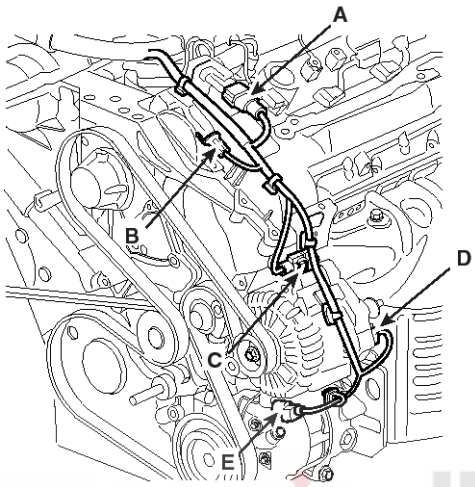
KDRF161A

12) Install the wiring harness protector (E) and connect the LH ignition coil connector (A), the injector connector (B), the condenser connector (C) and the ground (D).



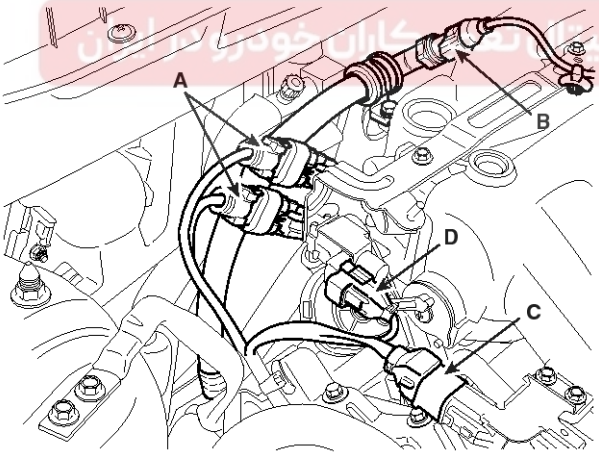
SENM17008L

13) Connect the alternator connector (D) and the air compressor connector (E).
14) Connect the LH front oxygen sensor connector (C).
15) Connect the OCV connector (A) and the knock sensor connector (B).
16) Connect the RH ignition coil connector.



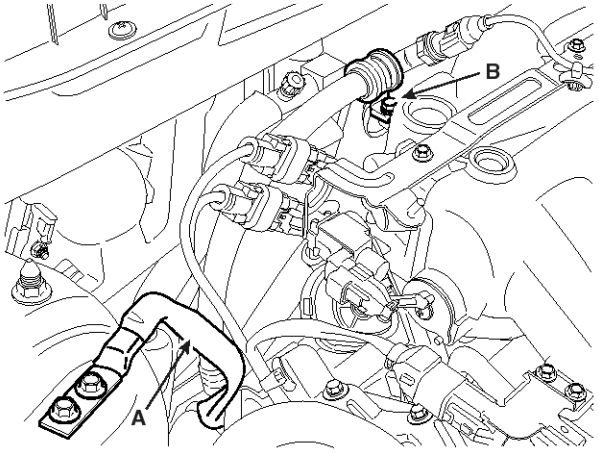
SENM17007L

17) Disconnect the RH front and rear oxygen sensor connectors (A), the power steering sensor connector (B), the RH injector harness connector (C) and the VIS solenoid valve connector (D).



SENM17207L

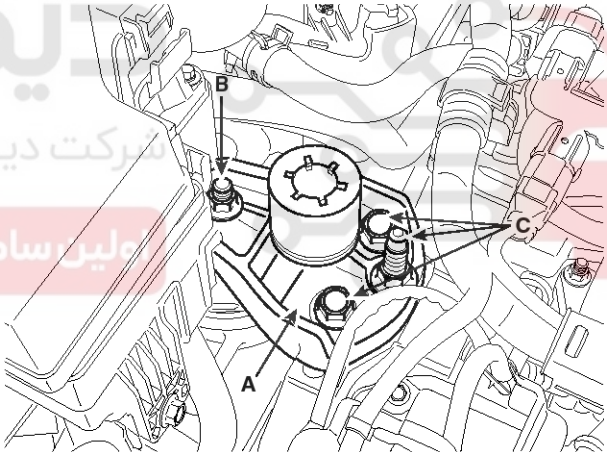
32. Connect the ground cable (A) and tighten the power steering hose mounting bolt (B).



SENEM7102N

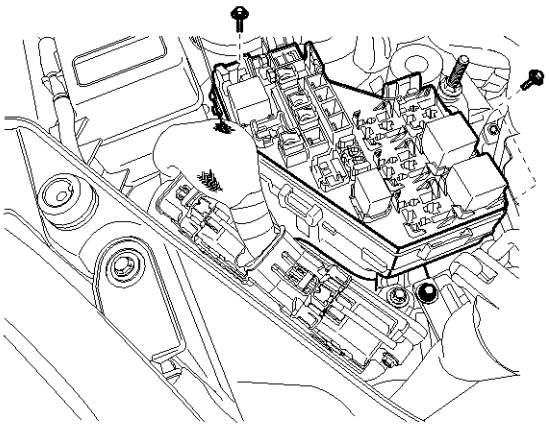
33. Install the engine mounting bracket (A).

Tightening torque
B: 78.5 ~ 98.0N.m (8.0 ~ 10.0kgf.m, 57.9 ~ 72.3lb-ft)
C: 63.7 ~ 83.4N.m (6.5 ~ 8.5kgf.m, 47.0 ~ 61.5lb-ft)



SENEM7104N

34. Tighten the relay box mounting bolts and install the PCM & relay box cover.

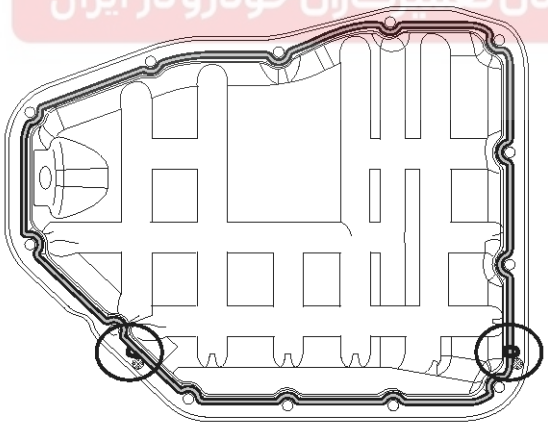


SENEM7103N

35. Remove the jack from the upper oil pan.
36. Install the lower oil pan.
    1) Using a gasket scraper, remove all the old packing material from the gasket surfaces.
    2) Before assembling the oil pan, the liquid sealant TB1217H 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.).
But marked area(*) to be 5.0mm(0.2in.)



KDRF136A

CAUTION

a. Make clean the sealing face before assembling two parts.

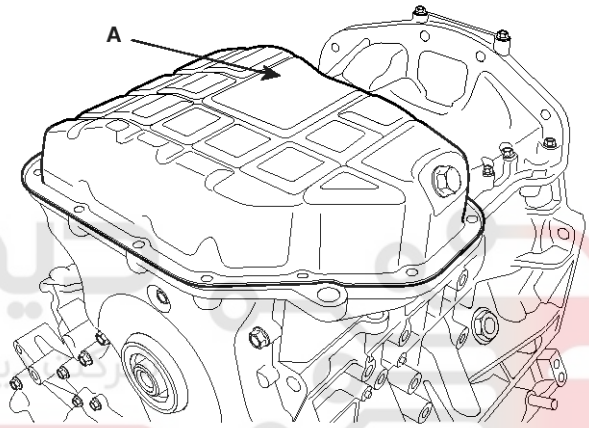
b. Remove harmful foreign matters on the sealing face before applying sealant.

c. When applying sealant gasket, sealant must not be protruded into the inside of oil pan.

d. To prevent leakage of oil, apply sealant gasket to the inner threads of the bolt holes.

    3) Install the lower oil pan (A).

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



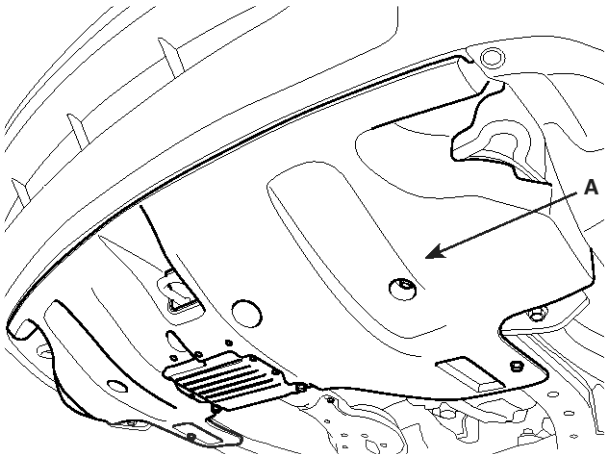
KDRF114A

37. Install the side cover.

Tightening torque
8.8 ~ 10.8N.m (0.9 ~ 1.1kgf.m, 6.5 ~ 7.9lb-ft)

38. Install the under cover (A).

Tightening torque
8.8 ~ 10.8N.m (0.9 ~ 1.1kgf.m, 6.5 ~ 7.9lb-ft)

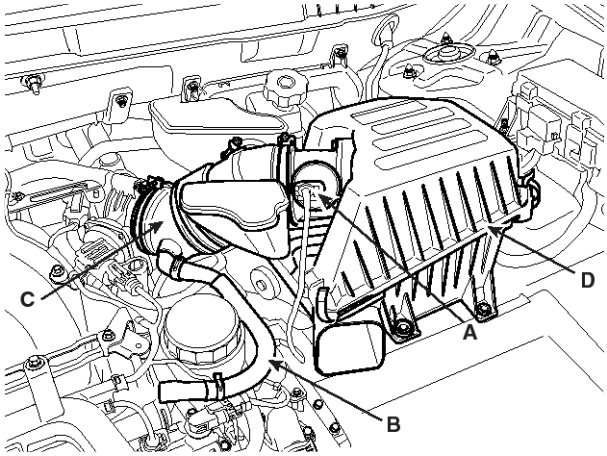


SENEM7101N

39. Install the RH front wheel.

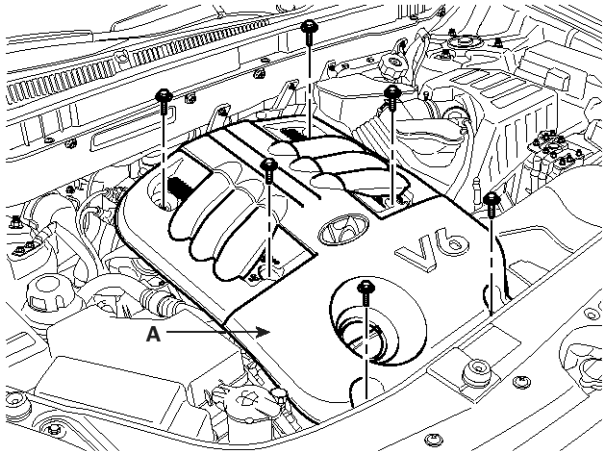
Tightening torque
88.3 ~ 107.9N.m (9.0 ~ 11.0kgf.m, 65.1 ~ 79.6lb-ft)

40. Install the intake air hose and air cleaner assembly.
    1) Install the intake air hose(C) and air cleaner body (D).
    2) Connect the breather hose (B) to the air cleaner hose.
    3) Connect the AFS connector (A).



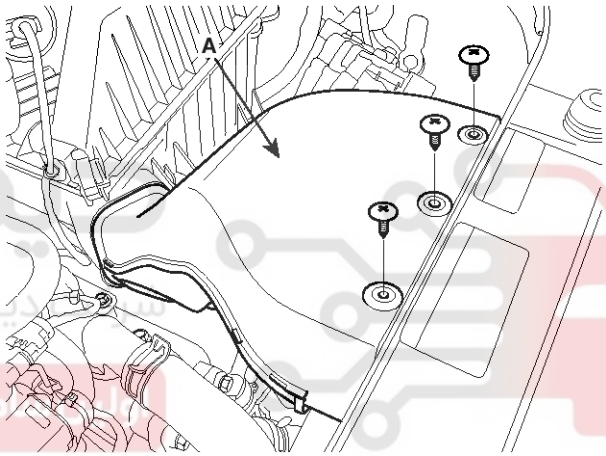
SENM17004L

41. Install the engine cover (A).



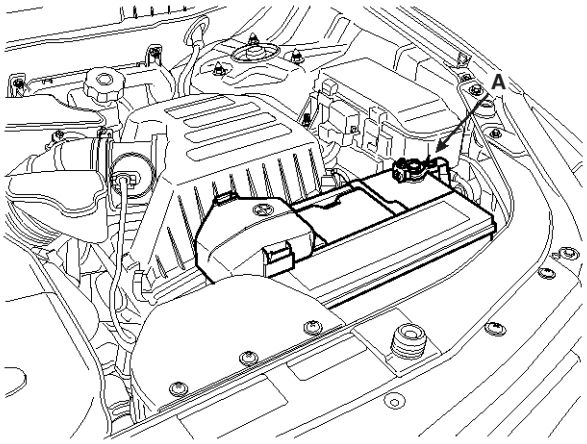
SENM17002L

42. Install the air duct (A).



SENM17213L

43. Connect the battery negative cable (A).



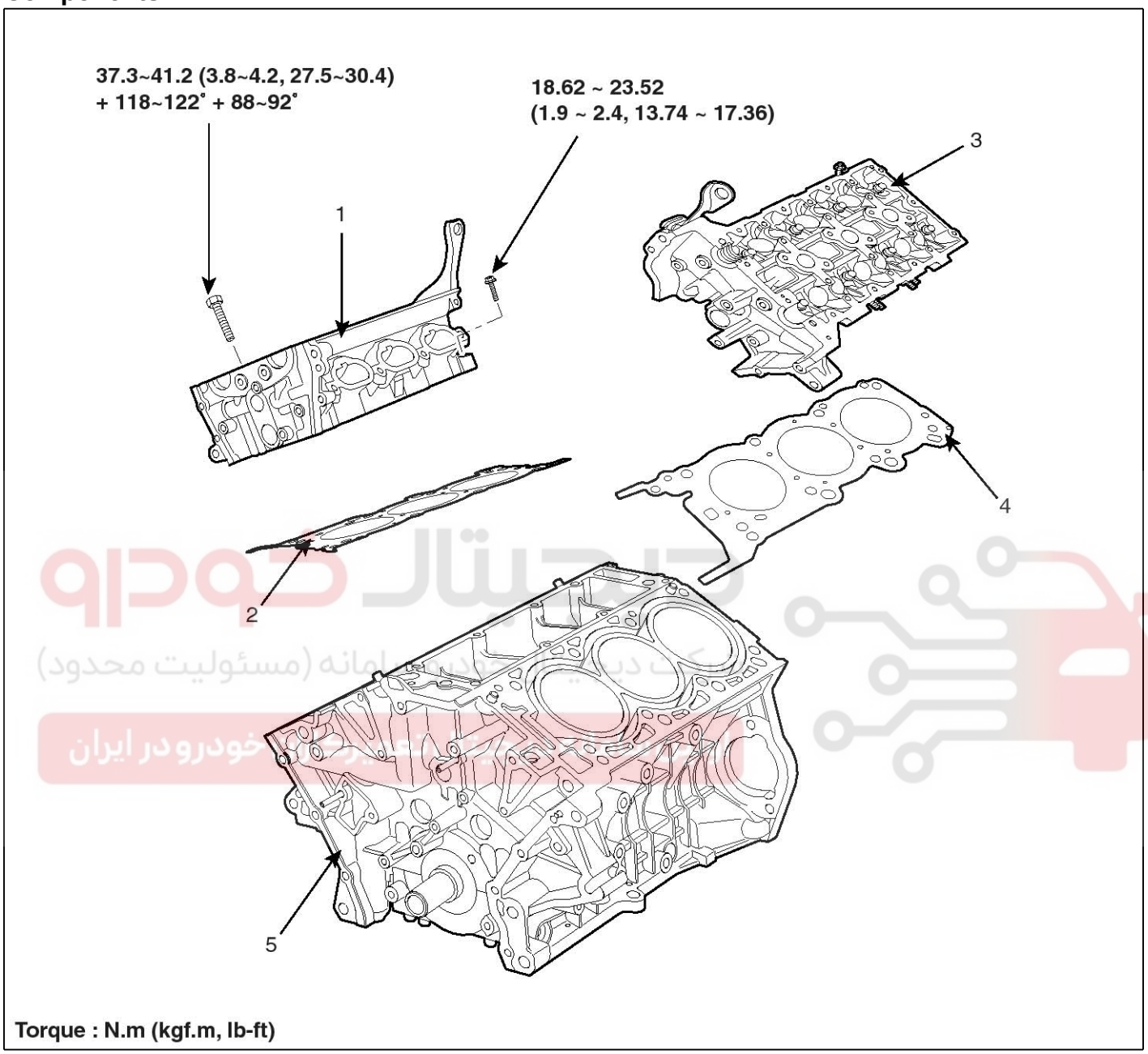
SENEM7100N

NOTICE

- *Refill engine with engine oil.*
- *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.*

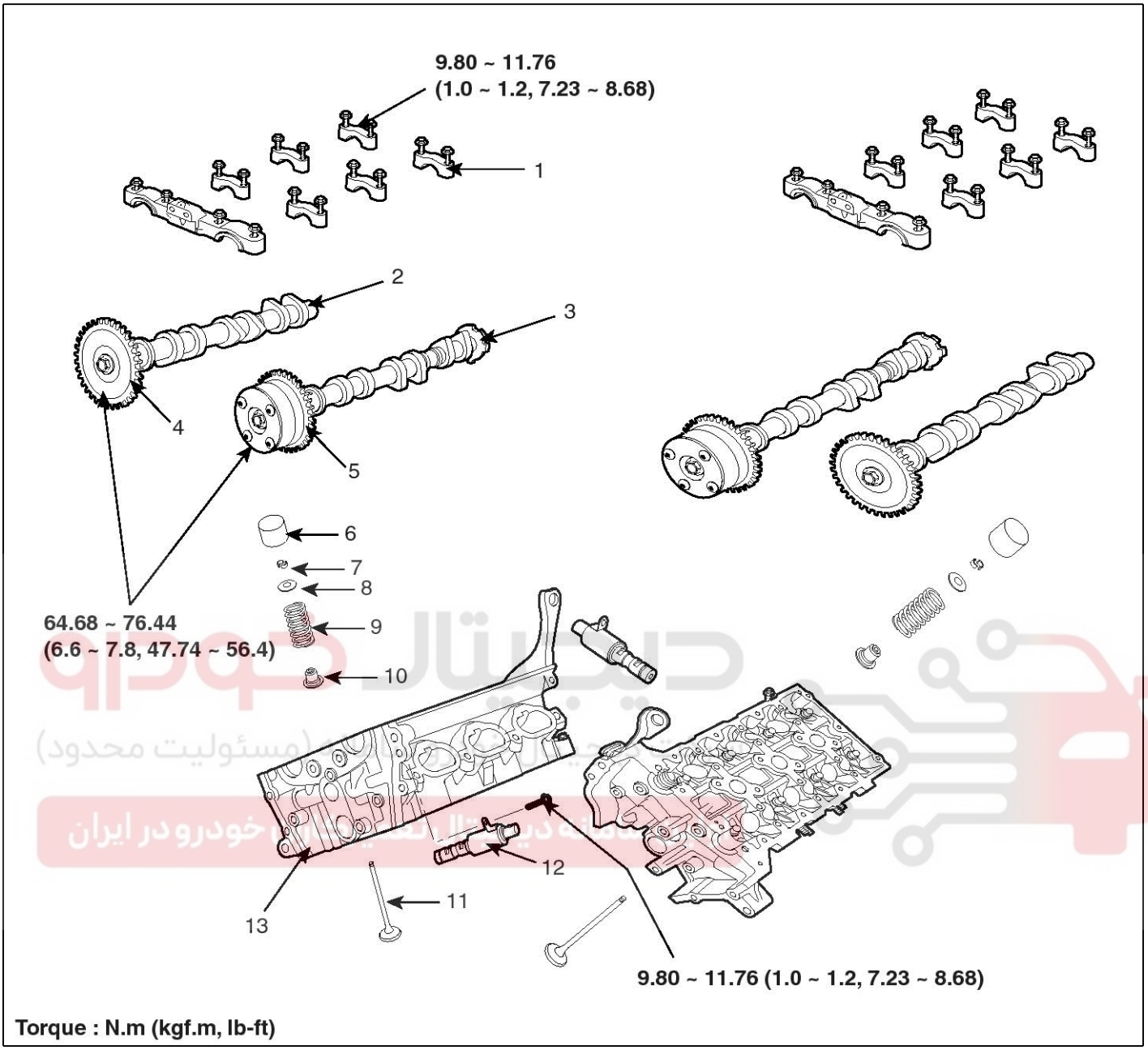
Cylinder Head Assembly

Components



SENEM9003N

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



SENEM9004N

1. Camshaft bearing cap
2. Exhaust camshaft
3. Intake camshaft
4. Exhaust camshaft sprocket
5. CVVT assembly
6. MLA
7. Retainer lock
8. Retainer
9. Valve spring
10. Valve stem seal
11. Valve
12. OCV
13. Cylinder head

Removal

CAUTION

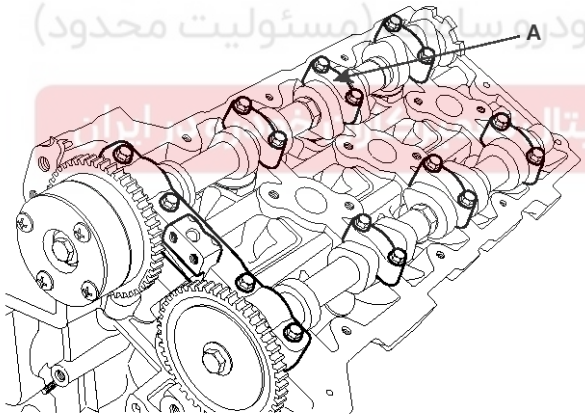
- **Use fender covers to avoid damaging painted surfaces.**
- **To avoid damaging the cylinder head, wait until the engine coolant temperature drops below normal operating temperature before removing it.**
- **When handling a metal gasket, take care not to fold the gasket or damage the contact surface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

NOTICE

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

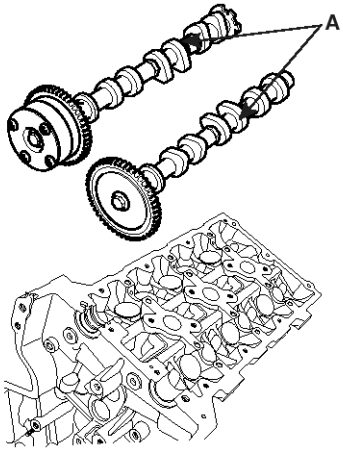
Engine removal is required for this procedure.

1. Remove the exhaust manifold.
2. Remove the intake manifold.
3. Remove the timing chain.
4. Remove the water temperature control assembly.
5. Remove the camshaft bearing cap(A).



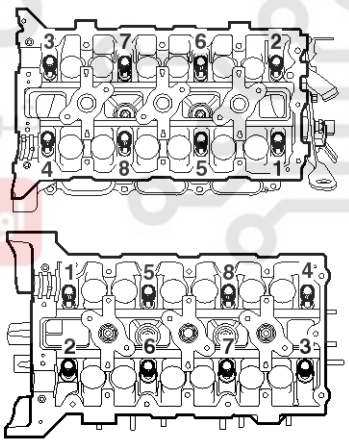
KDRF196A

6. Remove the camshaft assembly(A).



KDRF197A

7. Remove the cylinder head bolts, then remove cylinder head.
   1) Uniformly loosen and remove the 16 cylinder head bolts, in several passes, in the sequence shown. Remove the 16 cylinder head bolts and plate washers.



KDRF199A

CAUTION

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

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

CAUTION

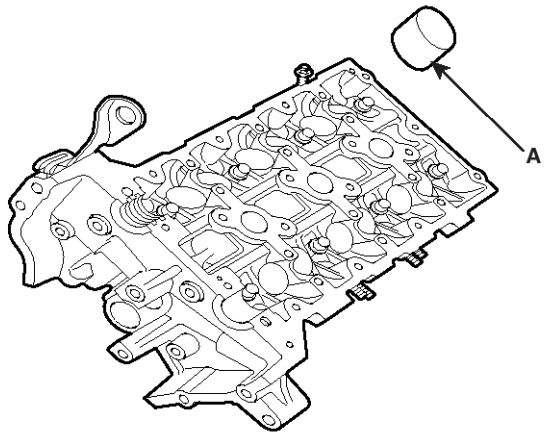
Be careful not to damage the contact surfaces of the cylinder head and cylinder block.

Disassembly

NOTICE

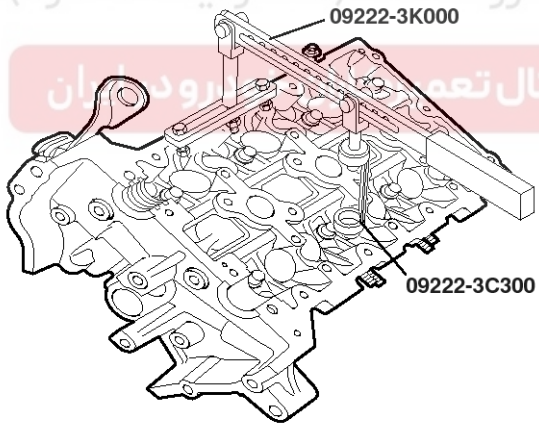
Identify MLA, valves and valve springs as they are removed so that each item can be reinstalled in its original position.

1. Remove the MLAs(A).



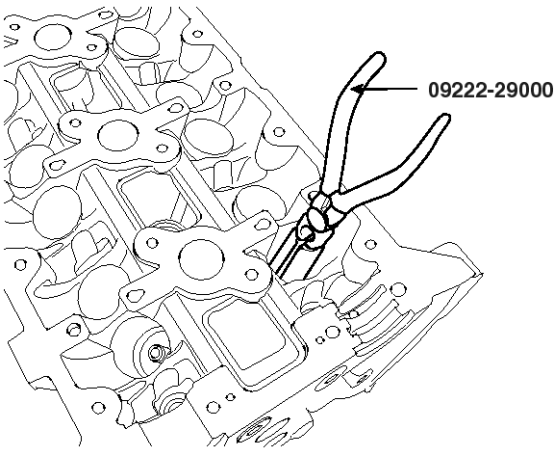
KDRF200A

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



KDRF201A

   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.

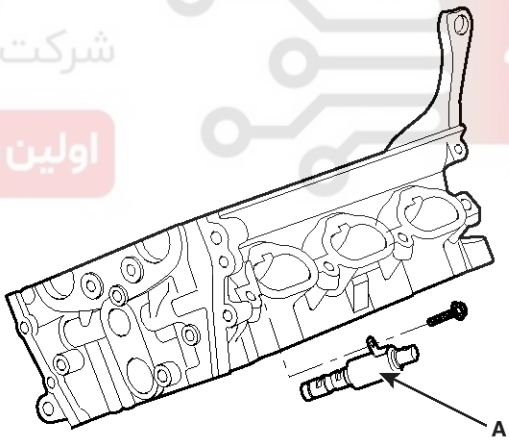


KDRF234A

NOTICE

Do not reuse old valve stem seals.

3. Remove the OCV(A).



KDRF202A

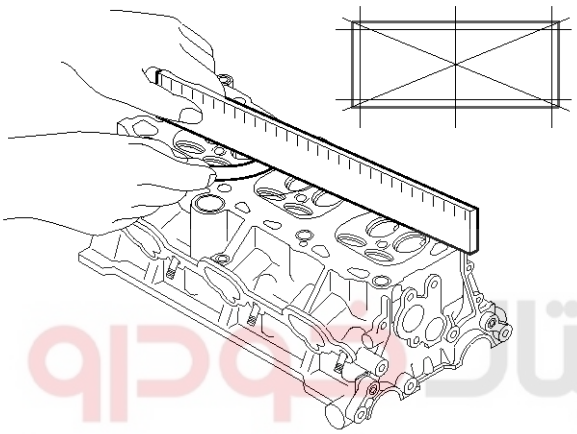
Inspection

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



EDQF160A

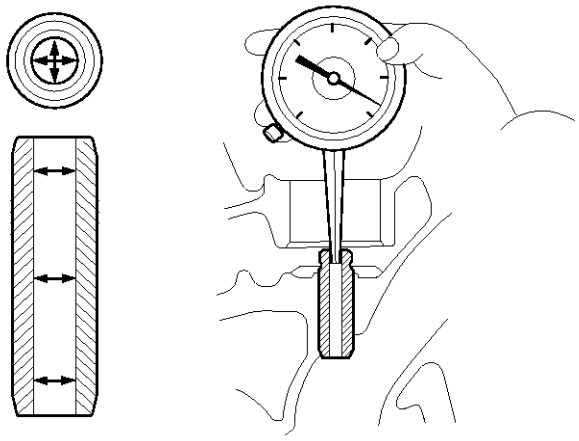
2. Inspect for cracks.

   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.

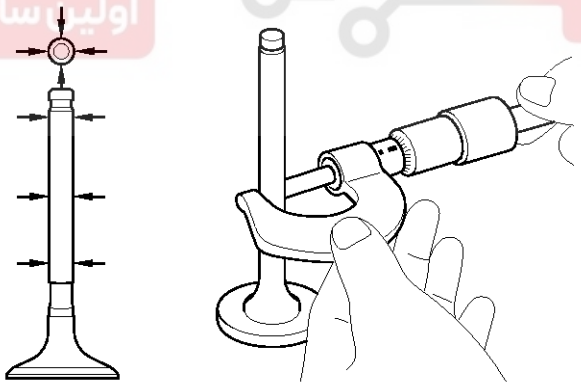
Valve guide I.D.
Intake / Exhaust : 5.500 ~ 5.512mm (0.216 ~ 0.217in.)



ECBF034A

   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.)



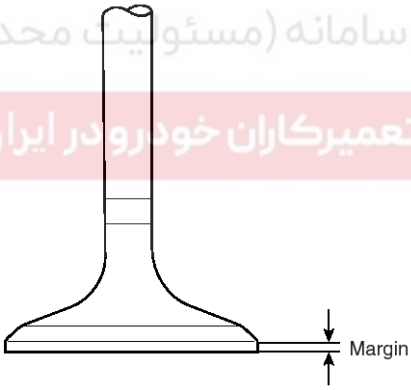
KCRF227A

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.)



ECKD221A

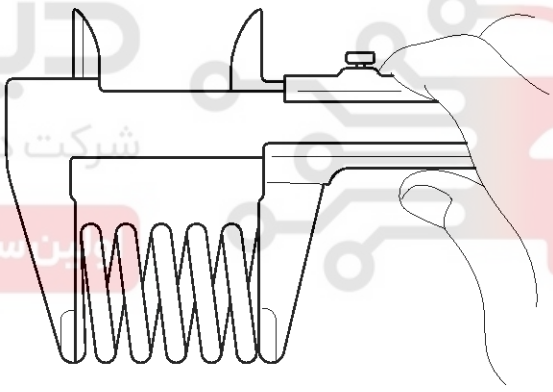
   4) Check the valve length.

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

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

3. Inspect valve seats
   Check the valve seat for evidence of overheating and improper contact with the valve face.
   If the valve seat is worn, replace cylinder head.
   Before reconditioning the seat, check the valve guide for wear. If the valve guide is worn, replace cylinder head. Recondition the valve seat with a valve seat grinder or cutter. The valve seat contact width should be within specifications and centered on the valve face.
4. Inspect valve springs.
   1) Using a steel square, measure the out-of-square of the valve spring.
   2) Using vernier calipers, measure the free length of the valve spring.

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



KCRF205A

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.

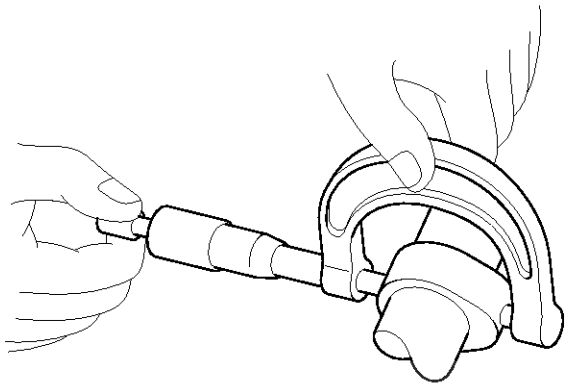
MLA to tappet bore clearance
[Standard]
Intake/Exhaust : 0.020 ~ 0.061mm(0.0008 ~ 0.0024in.)
[Limit]
Intake/Exhaust : 0.07mm(0.0027in.)

Camshaft

1. Inspect cam lobes.

   Using a micrometer, measure the cam lobe height.

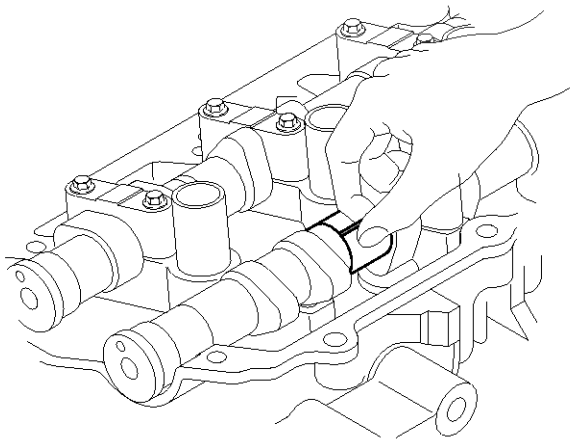
Cam height
[Standard value]
Intake : 46.8mm (1.8425in.)
Exhaust : 45.8mm (1.8031in.)



KCRF206A

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.



KCRF207A

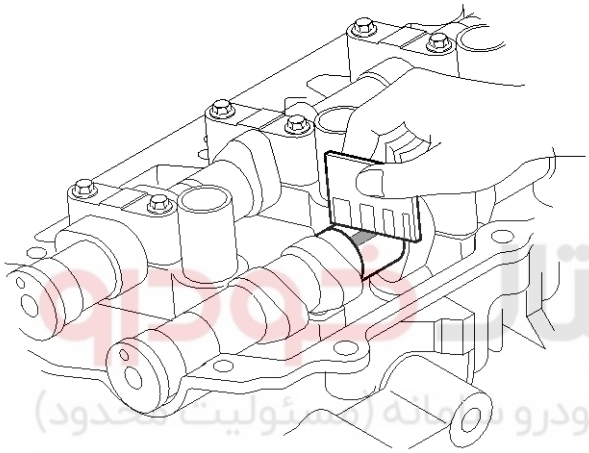
4) Install the bearing caps.

⚠CAUTION
Do not turn the camshaft.

5) Remove the bearing caps.

6) Measure the plastigage at its widest point.

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



KCRF208A

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

7) Completely remove the plastigage.

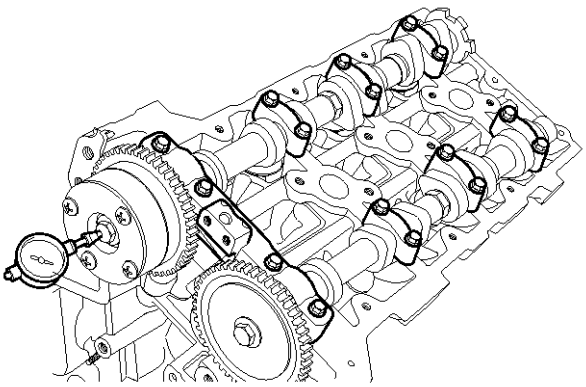
8) Remove the camshafts.

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.)



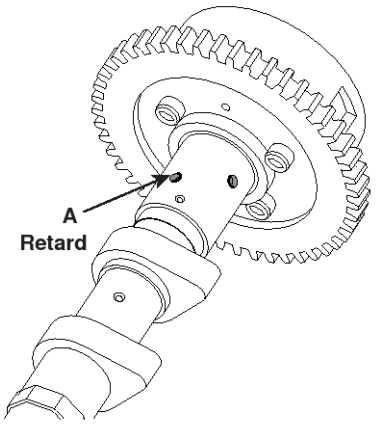
KDRF196B

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.



ECRF015A

   3) Wind tape around the tip of the air gun and apply air of approx. 150kpa(1.5kgf/cm², 21psi) to the port of the camshaft.

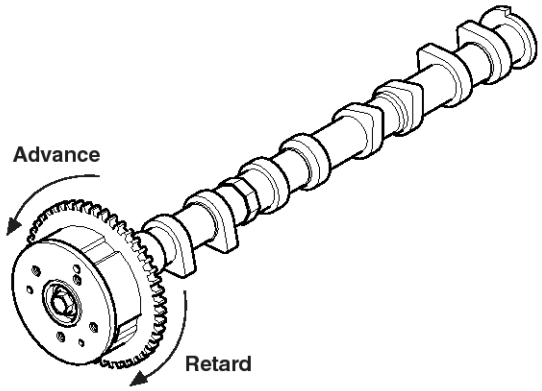
      (Perform this in order to release the lock pin for the maximum delay angle locking.)

      NOTICE

      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.



SGHEM7010N

   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 22.5°

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

Reassembly

NOTICE

Thoroughly clean all parts to be assembled.

Before installing the parts, apply fresh engine oil to all sliding and rotating surfaces.

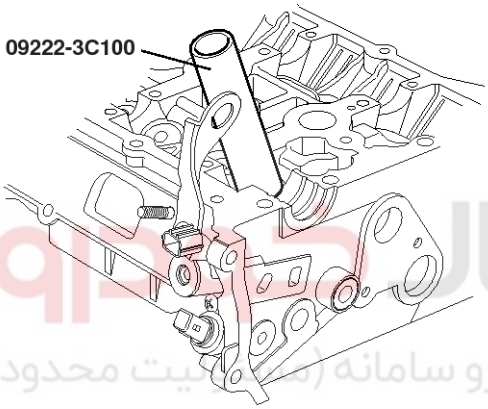
Replace oil seals with new ones.

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

      NOTICE

      Do not reuse old valve stem seals.

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



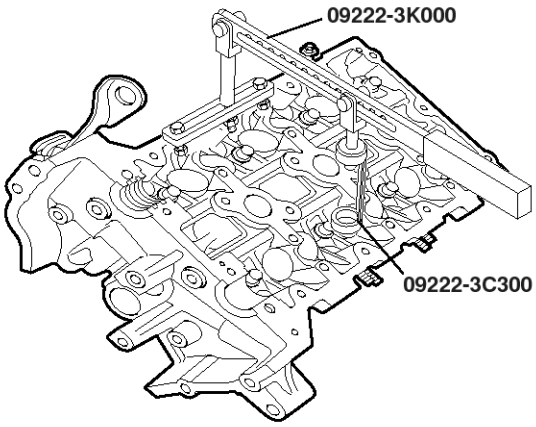
KCRF120B

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

      NOTICE

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

   3) Using the SST(09222 - 3K000, 09222-3C300), compress the spring and install the retainer locks. After installing the valves, ensure that the retainer locks are correctly in place before releasing the valve spring compressor.

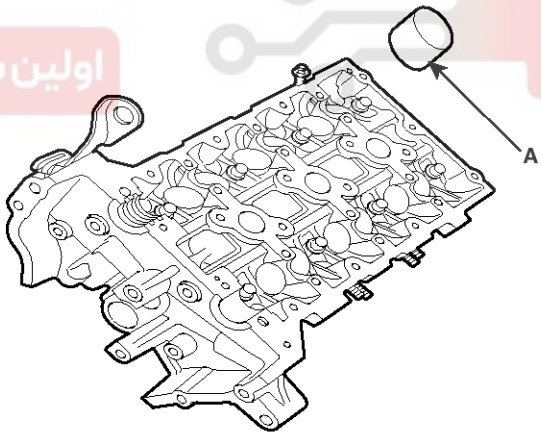


KDRF201A

   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.



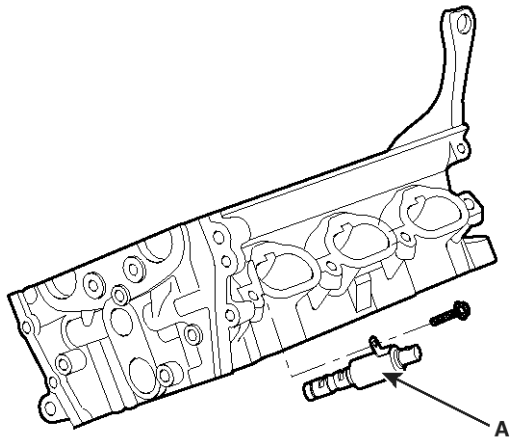
KDRF200A

NOTICE

MLA can be reinstalled in its original position.

3. Install the OCV(A).

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



KDRF202A

NOTICE

- *To install OCV with gray colored connector into RH bank.*
- *To 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.**

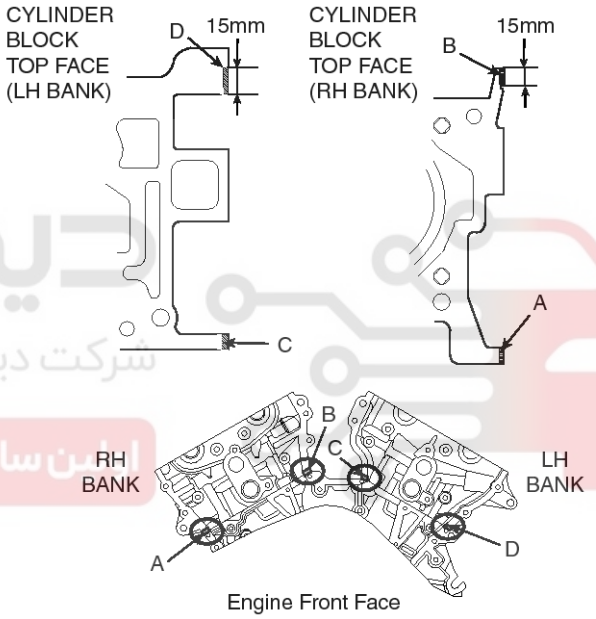
Installation

NOTICE

- *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.

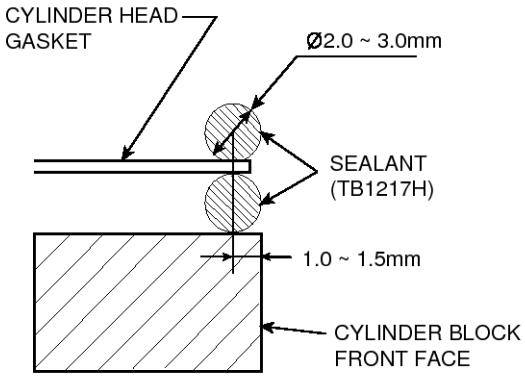


ECBF017A

NOTICE

Refer to the illustration below to apply the sealant.

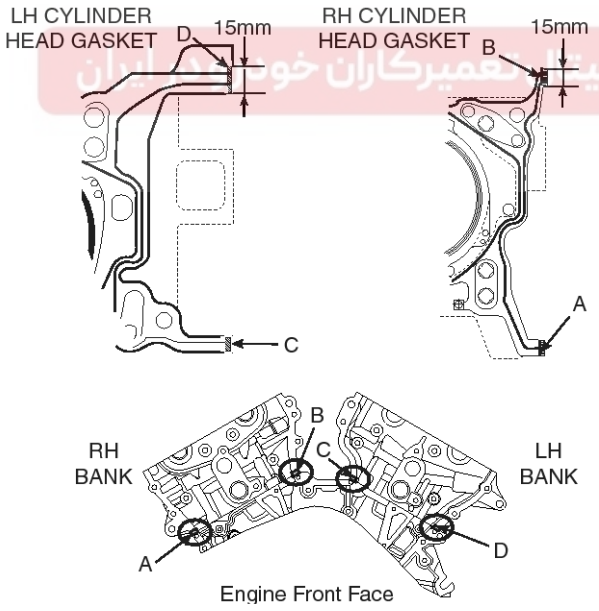
Bead width : 2.0~3.0 mm
Sealant locations : 1.0~1.5mm from block surface
Recommended sealant : Liquid sealant TB1217H



ECBF018A

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

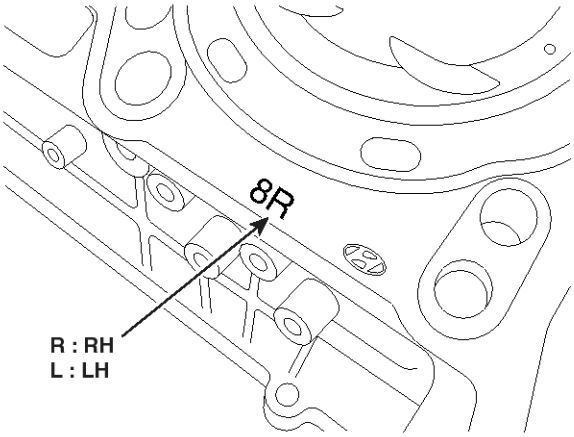
The part must be assembled within 5 minutes after sealant was applied.



ECBF019A

NOTICE

Be careful of the installation direction.

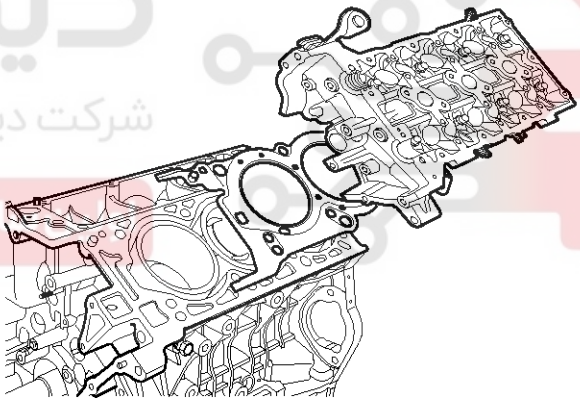


UCBF004A

d. Install the cylinder head.

NOTICE

Remove the extruded sealant after assembling cylinder heads.



KDRF198A

2. Place the cylinder head carefully to avoid damaging the gasket.
3. Install the cylinder head bolts.
   1) Do not apply engine oil on the threads and under the heads of the cylinder head bolts.
   2) Using the SST(09221-4A000), install and tighten the cylinder head bolts and plate washers, in several passes, in the sequence shown.

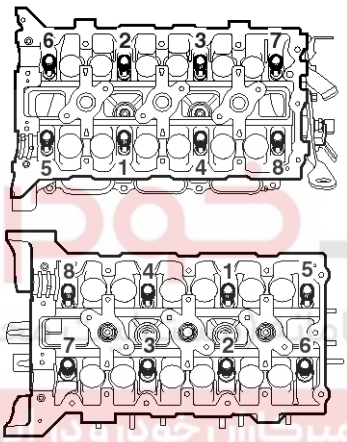
Tightening torque

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

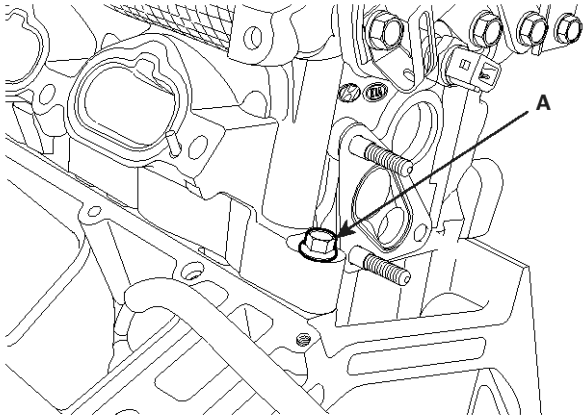
Bolt (A): 18.62 ~ 23.52Nm(1.9 ~ 2.4kgf.m, 13.74 ~ 17.36lb-ft)

NOTICE

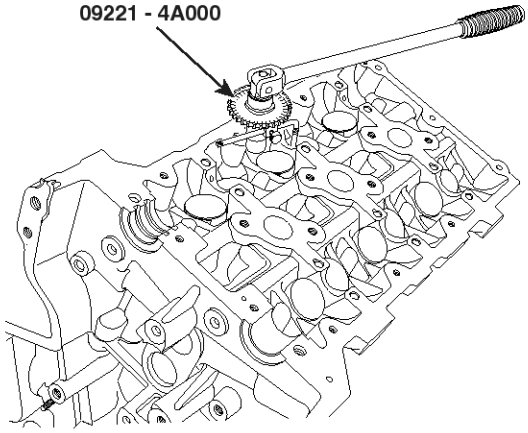
Always use new cylinder head bolts.



KDRF199B



ECBF035A

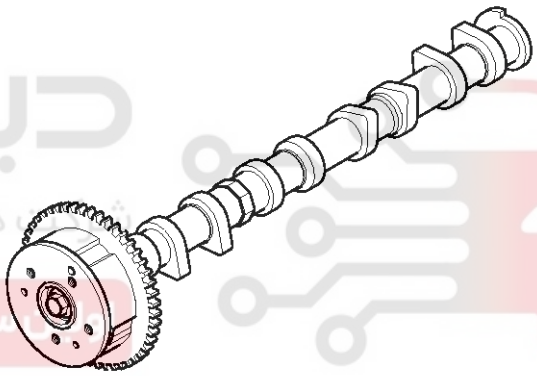


KDRF223A

4. Install the CVVT and camshaft sprocket.

Tightening torque

64.68 ~ 76.44Nm(6.6 ~ 7.8 kgf.m, 47.74 ~ 56.4lb-ft)



KCRF122A

NOTICE

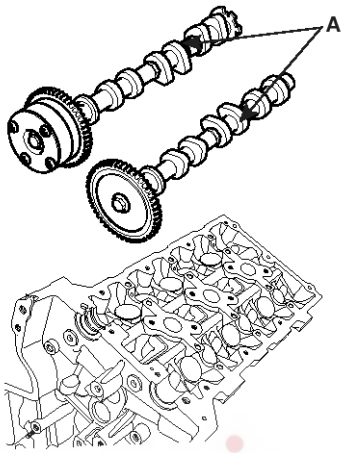
- *Install camshaft-inlet to dowel pin of CVVT assembly.*

  At this time, do not install 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.*

5. Install the camshafts(A).

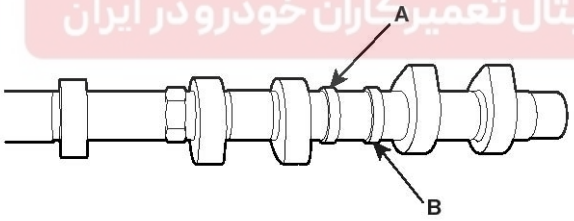
NOTICE

- *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.*



KDRF197A

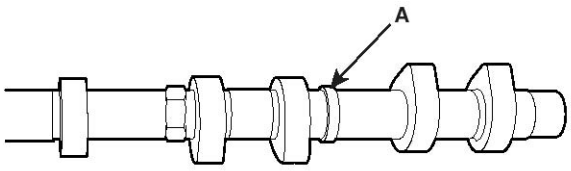
Intake Camshaft



KDRF226A

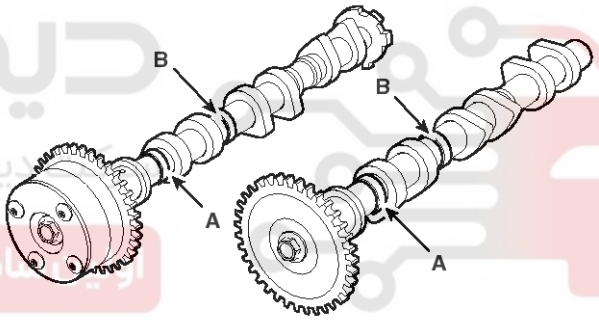
	LH	RH
3.8L	A : Ø30mm(1.1811in.) B : Ø27mm(1.0630in.)	A : Ø27mm(1.0630in.) B : Ø30mm(1.1811in.)

Exhaust Camshaft



KDRF227A

	LH	RH
3.8L	A : Ø27mm(1.0630in.)	A : Ø30mm(1.1811in.)

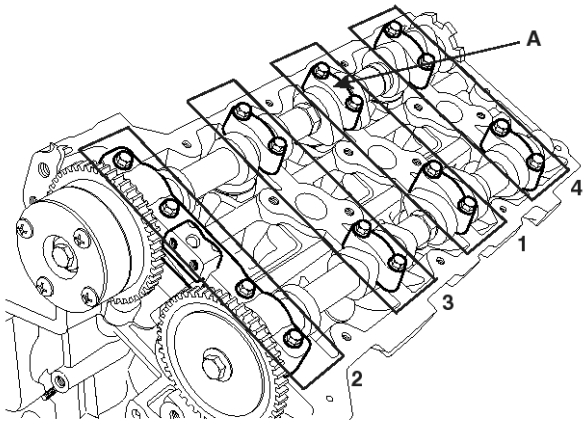


SBLM16209L

	LH	RH
3.8L	A : Ø30mm(1.1811in.) B : Ø30mm(1.1811in.)	A : Ø30mm(1.1811in.) B : Ø30mm(1.1811in.)

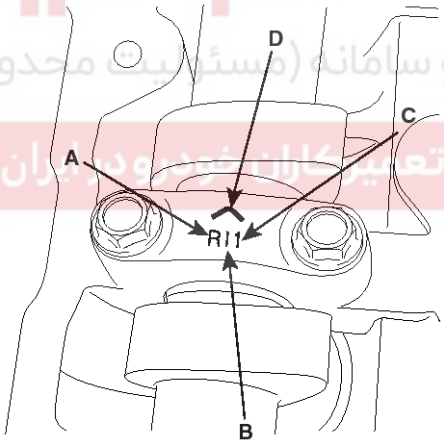
6. Install the camshaft bearing caps as following order.

Tightening torque
1st step: 5.9Nm(0.6 kgf.m, 4.3lb-ft)
2nd step: 9.80 ~ 11.76Nm(1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft) - 2nd step



UCBF014A

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



ECBF036A

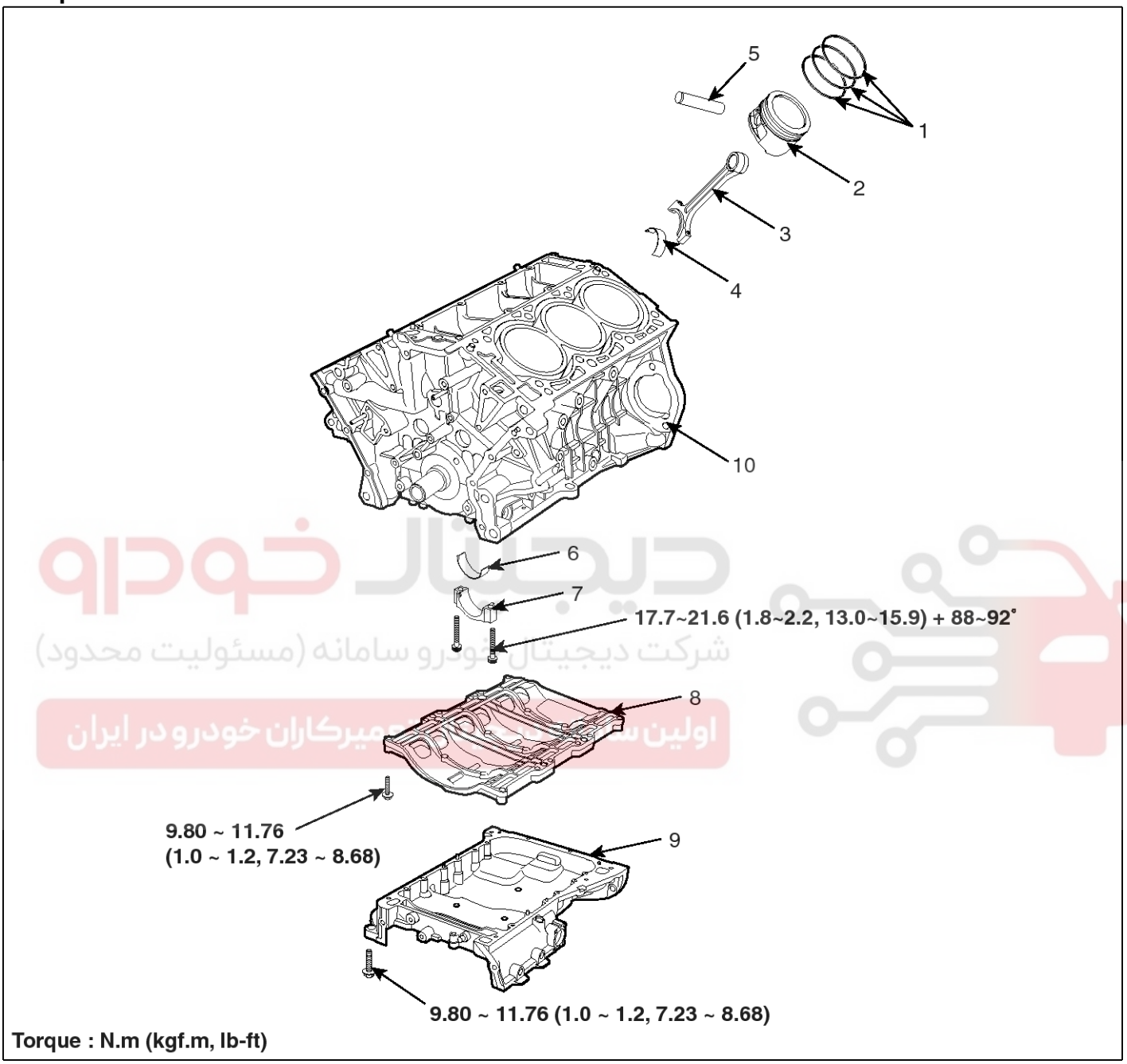
A : L(LH),R(RH)
B : I(Intake),None(Exhaust)
C : Journal number
D : Front mark

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

7. Install the water temperature control assembly.
8. Install the timing chain.
9. Check and adjust valve clearance.
10. Install the exhaust manifold.
11. Install the intake manifold.

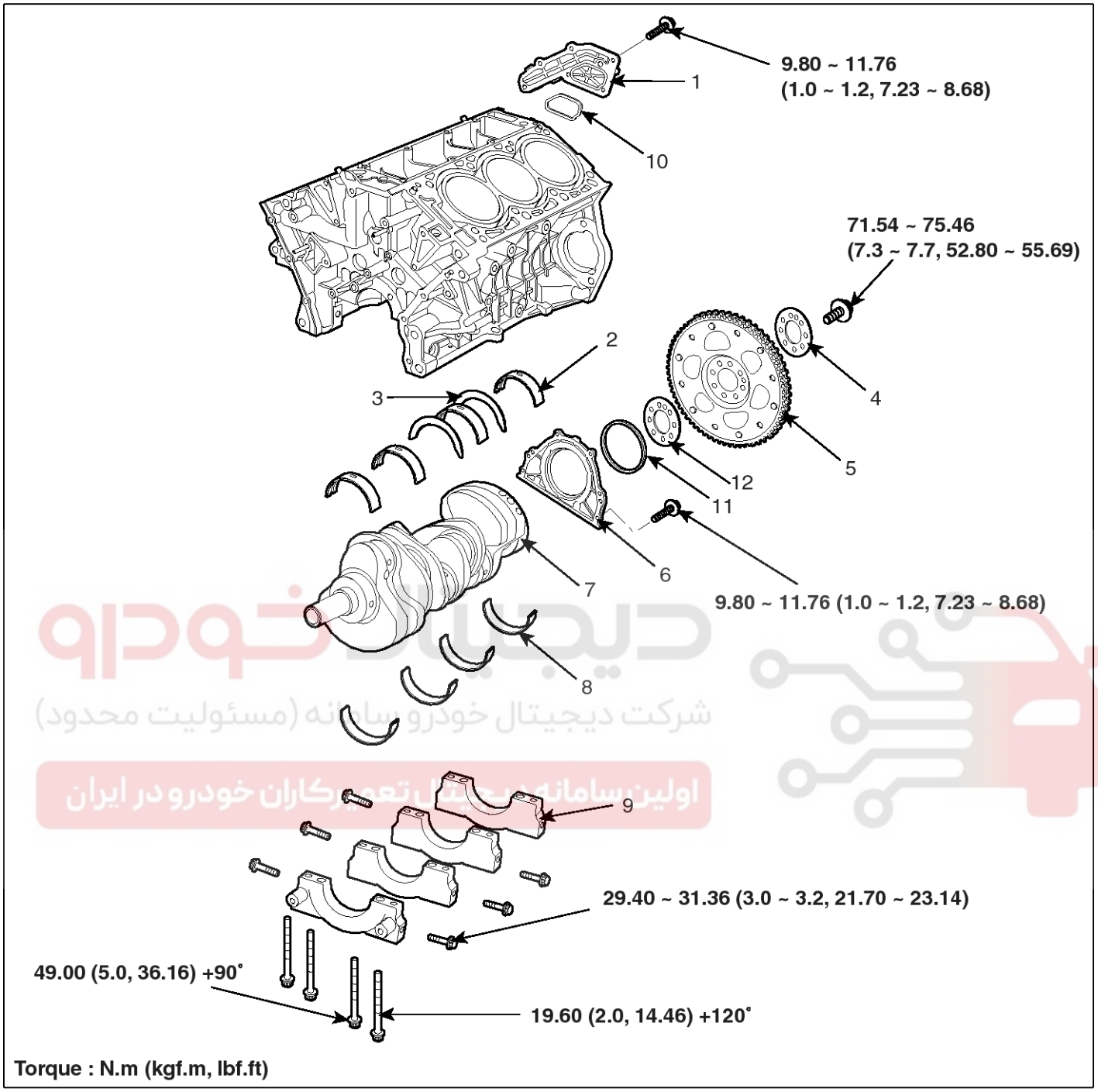
Cylinder Block

Components



SENEM9005N

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



SENEM9006N

1. Oil drain cover
2. Crankshaft upper bearing
3. Thrust bearing
4. Plate adapter
5. Drive plate
6. Rear oil seal case
7. Crankshaft
8. Crankshaft lower bearing
9. Main bearing cap
10. Oil drain cover gasket
11. Rear oil seal
12. Crank adapter

Removal

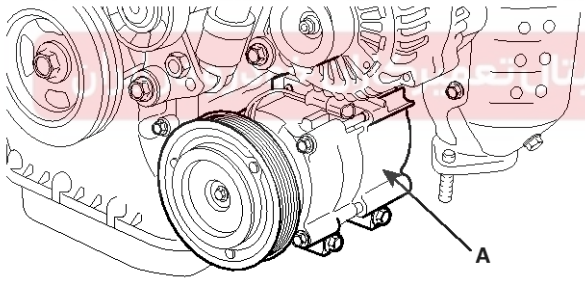
CAUTION

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

NOTICE

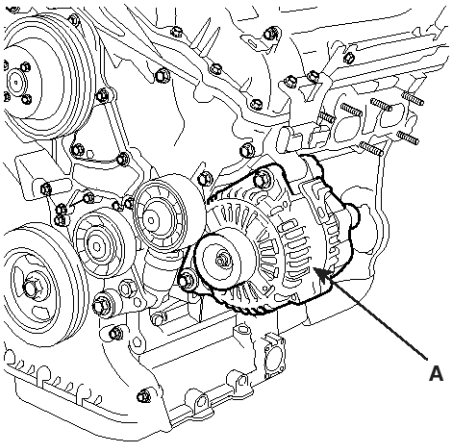
- *Mark all wiring and hoses to avoid misconnection.*
- *Inspect the timing belt before removing the cylinder head.*
- *Turn the crankshaft pulley so that the No.1 piston is at top dead center.*
- *Engine removal is required for this procedure.*

1. Remove the exhaust manifold.
2. Remove the intake manifold.
3. Remove the timing chain.
4. Remove the water temperature control assembly.
5. Remove the cylinder head.
6. Remove the oil pump.
7. Remove the oil filter assembly.
8. Remove the A/C compressor(A) from engine.



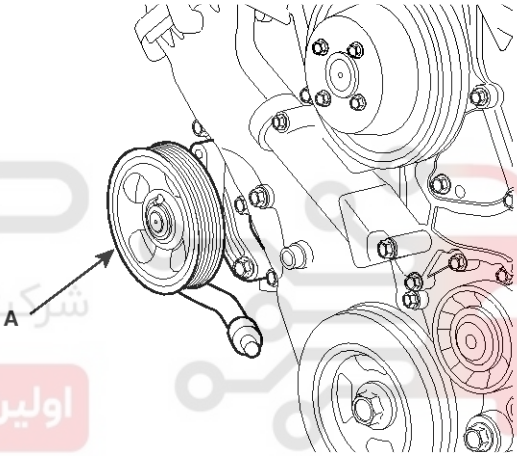
KDRF103A

9. Remove the alternator(A) from engine.



KDRF104A

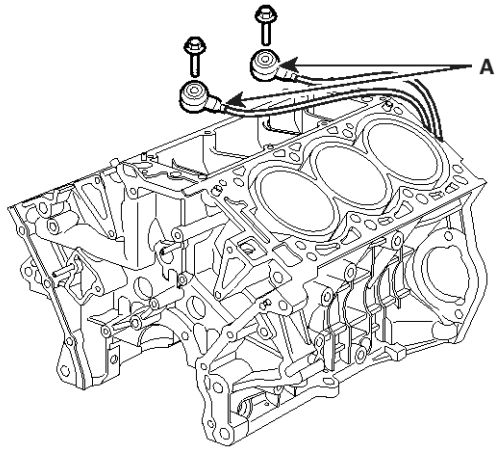
10. Remove the power steering pump(A) from engine.



KDRF102A

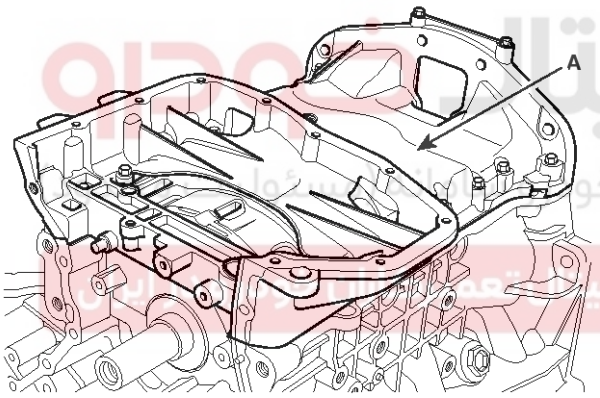
Disassembly

1. Remove the drive plate.
2. Remove the knock sensor(A).



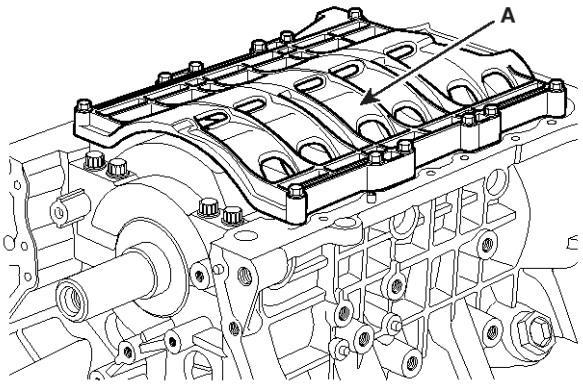
KDRF205A

3. Remove the upper oil pan(A).



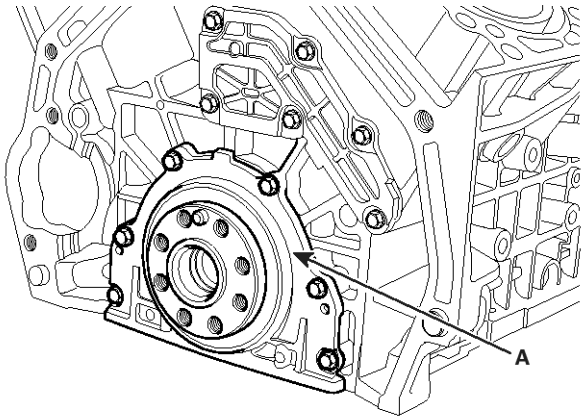
KDRF206A

4. Remove the baffle plate(A).



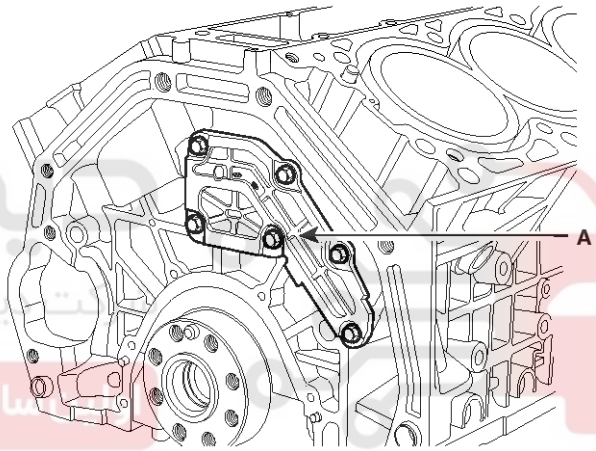
KDRF207A

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



KDRF208A

6. Remove the oil drain cover(A).



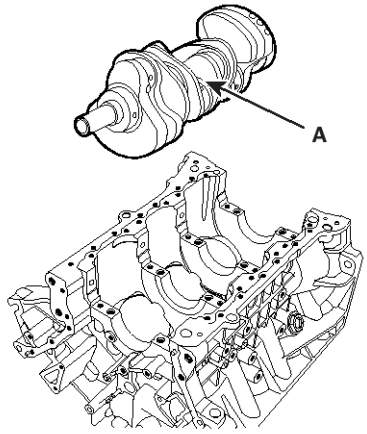
KDRF209A

7. Check the connecting rod end play.
8. Check the connecting rod cap oil clearance.
9. 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.

NOTICE

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

10. Remove the crankshaft main bearing cap and check oil clearance.
11. Check the crankshaft end play.
12. Lift the crankshaft(A) out of engine, being careful not to damage journals.



KDRF210A

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

13. Check fit between piston and piston pin.

    Try to move the piston back and forth on the piston pin. If any movement is felt, replace piston and piston pin as a set.
14. Remove the piston rings.
    1) Using a piston ring expander, remove the 2 compression rings.
    2) Remove 2 side rails and the spacer by hand.

NOTICE
Arrange the piston rings in the correct order only.

15. Disconnect connecting rod from piston.

    Using a press, remove the piston pin from the piston.

    (Press-in load : 800 ~ 1400kg (1764 ~ 3086lb)

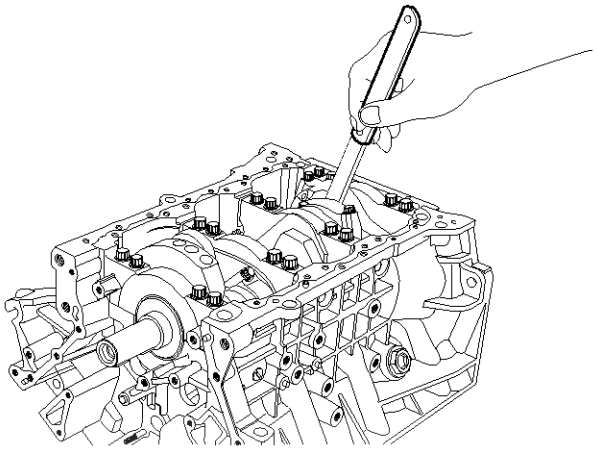
Inspection

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.)



KDRF211A

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

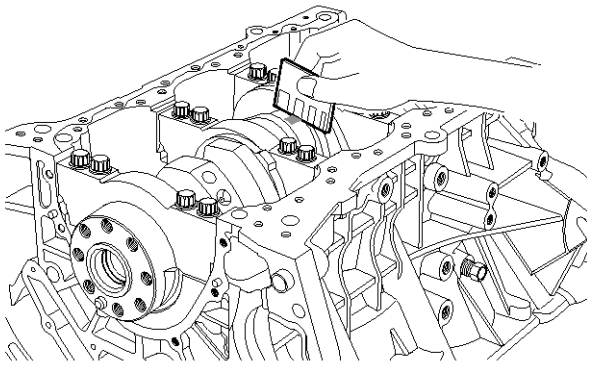
2. Check the connecting rod bearing oil clearance.
   1) Check the matchmarks on the connecting rod and cap are aligned to ensure correct reassembly.
   2) Remove 2 connecting rod cap bolts.
   3) Remove the connecting rod cap and bearing half.
   4) Clean the crank pin and bearing.
   5) Place plastigage across the crank pin.
   6) Reinstall the bearing half and cap, and torque the bolts.

Tightening torque
19.6Nm (2.0kgf.m, 14.46lb-ft) + 90°

NOTICE
Do not turn the crankshaft.

7) Remove 2 bolts, connecting rod cap and bearinghalf.
8) Measure the plastigage at its widest point.

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



KDRF212A

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.

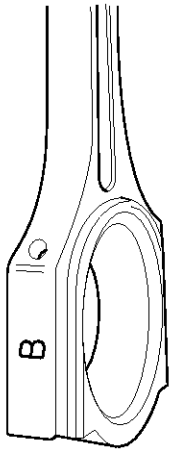
CAUTION
Do not file, shim, or scrape the bearings or the caps to adjust clearance.

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.

NOTICE
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



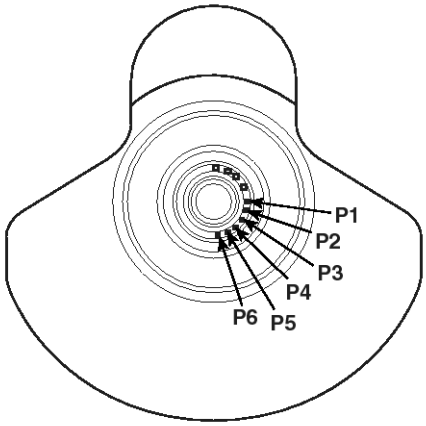
EDQF196A

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

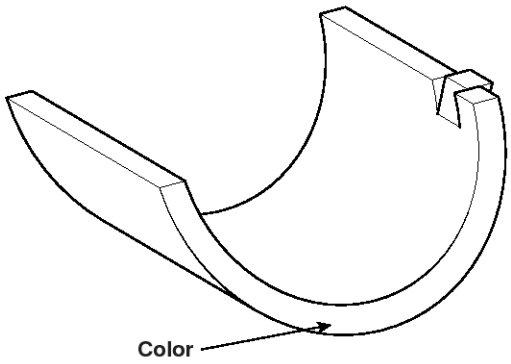


ECBF037A

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)



ECRF021A

Identification Of Connecting Rod Bearing

Class	Mark	Thickness Of Bearing
E	Blue	1.514 ~ 1.517mm (0.0596 ~ 0.0597in.)
D	Black	1.511 ~ 1.514mm (0.0595 ~ 0.0596in.)
C	Brown	1.508 ~ 1.511mm (0.0594 ~ 0.0595in.)
B	Green	1.505 ~ 1.508mm (0.0593 ~ 0.0594in.)
A	Yellow	1.502 ~ 1.505mm (0.0591 ~ 0.0593in)

11) Selection

		Connecting Rod Identification Mark		
		0(a)	1(b)	2(c)
Crankshaft Indentification Mark	1 or A	A (Yellow)	B (Green)	C (Brown)
	2 or B	B (Green)	C (Brown)	D (Black)
	3 or C	C (Brown)	D (Black)	E (Blue)

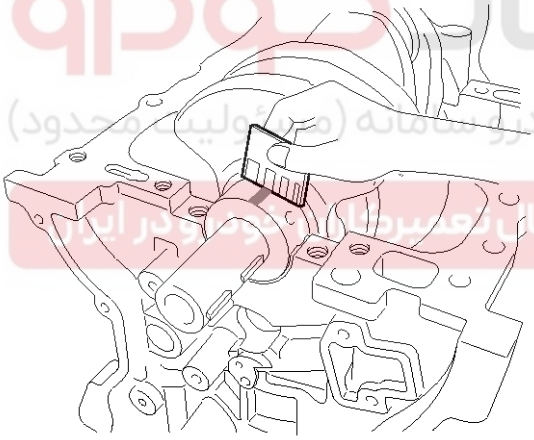
3. Check the crankshaft bearing oil clearance.
   1) To check main bearing-to-journal oil clearance, remove the main bearing caps and bearing halves.
   2) Clean each main journal and bearing half with a clean shop tower.
   3) Place one strip of plastigage across each main journal.
   4) Reinstall the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

Tightening torque
49.00Nm(5.0 kgf.m, 36.16lb-ft) + 90°
19.60 Nm(2.0 kgf.m, 14.46lb-ft)+ 120°
29.40 ~ 31.36Nm(3.0 ~ 3.2 kgf.m, 21.70 ~ 23.14lb-ft)

NOTICE
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.)



KCRF170A

   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.

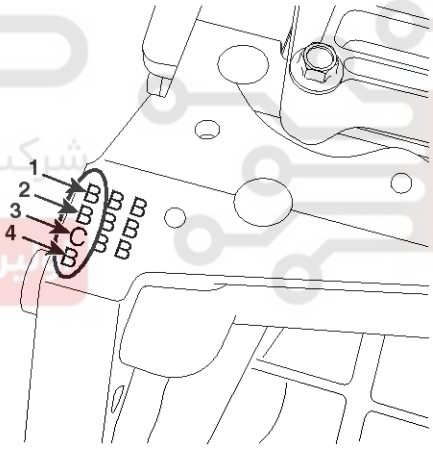
NOTICE
If the proper clearance cannot be obtained by using the appropriate larger or smaller bearings, replace the crankshaft and start over.

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 5 main journal bores.

Use them, and the numbers or bar stamped on the crank (marks for main journal size), to choose the correct bearings.



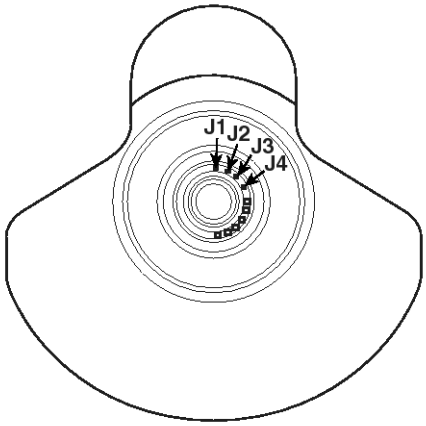
ECBF038A

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

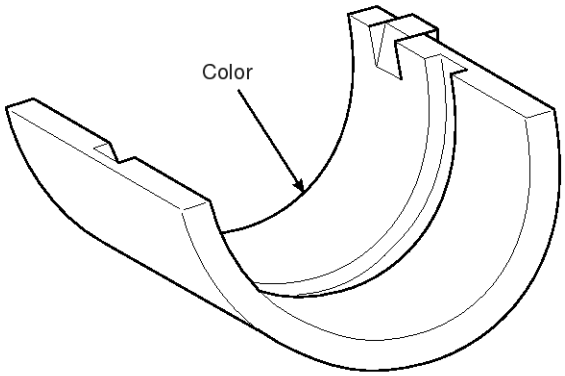


ECBF039A

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)



ECRF022A

Discrimination Of Crankshaft Bearing

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

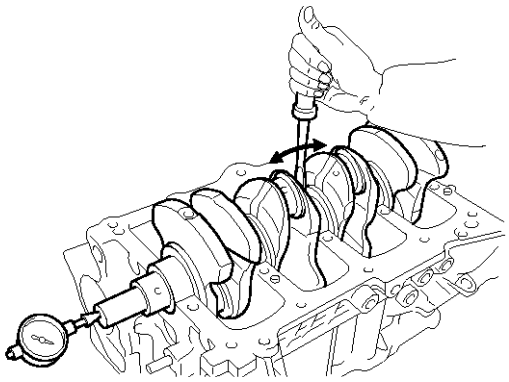
Selection

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

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.)



ECKD001B

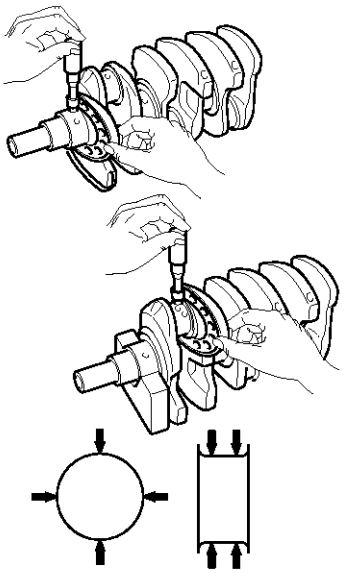
If the end play is greater than maximum, replace the thrust bearings as a set.

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.)



ECKD001E

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.

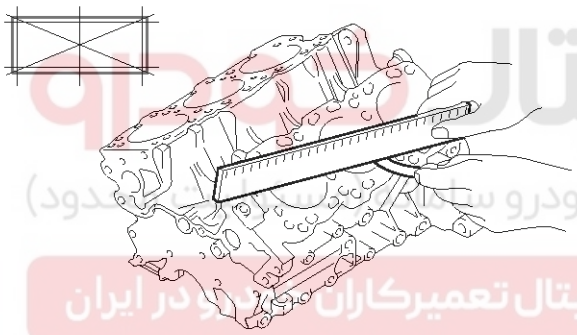
2. Clean the cylinder block

   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



EDQF154A

4. Inspect cylinder bore diameter

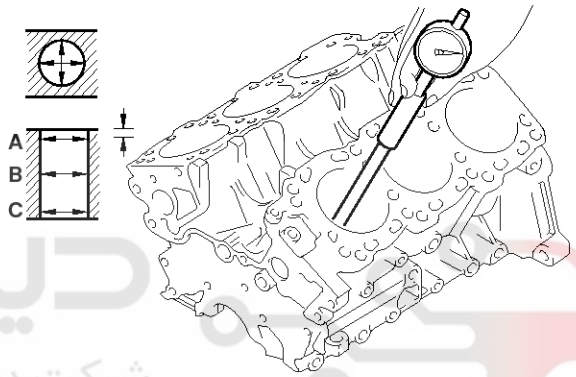
   Visually check the cylinder for vertical scratchs.

   If deep scratches are present, replace the cylinder block.

5. Inspect cylinder bore diameter

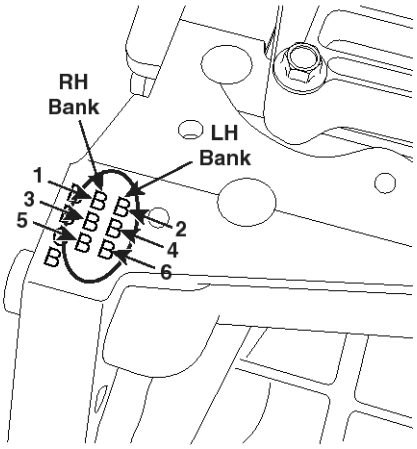
   Using a cylinder bore gauge, measure the cylinder bore diameter at position in the thrust and axial directions.

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



EDQF153A

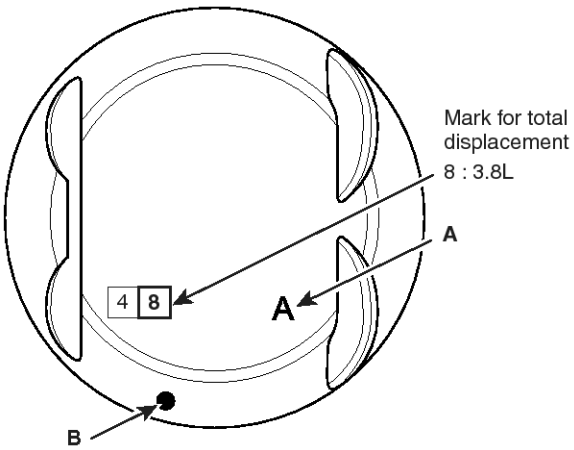
6. Check the cylinder bore size code on the cylinder block.



ECBF002A

Class	Size Code	Cylinder Bore Inner Diameter
		3.8L
A	A	96.00~96.01mm (3.7795 ~ 3.7799in.)
B	B	96.01~96.02mm (3.7799 ~ 3.7803in.)
C	C	96.02~96.03mm (3.7803 ~ 3.7807in.)

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



SGHEM7002N

Class	Size code	Piston outer diameter
		3.8L
A	A	95.96 ~ 95.97mm (3.7779 ~ 3.7783in.)
B	B	95.97 ~ 95.98mm (3.7783 ~ 3.7787in.)
C	C	95.98 ~95.99mm (3.7787 ~ 3.7791in.)

8. Select the piston related to cylinder bore class.

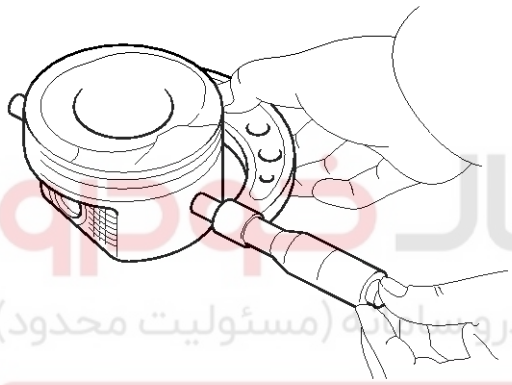
Clearance : 0.03 ~ 0.05mm(0.0012 ~ 0.0020in.)

Piston And Rings

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

   NOTICE
   Do not use a wire brush.
2. The standard measurement of the piston outside diameter is taken 14 mm (0.5512 in.) from the bottom of the piston.

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



ECKD001D

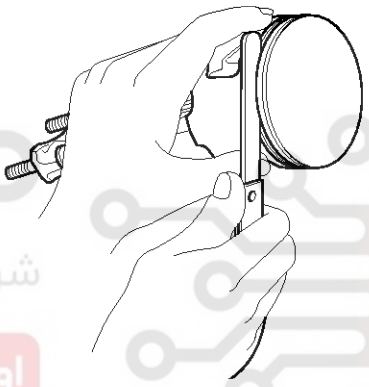
3. Calculate the difference between the cylinder bore diameter and the piston diameter.

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

4. Inspect the piston ring side clearance.

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

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



ECKD001G

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

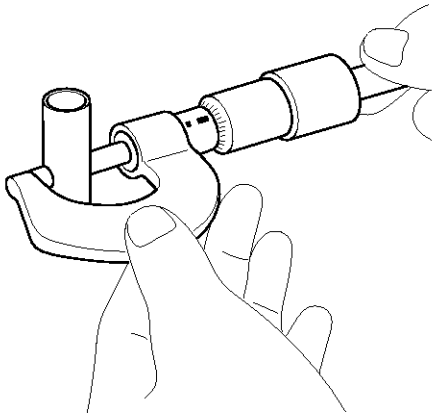
Standard
No.1 : 0.17 ~ 0.32mm (0.0067 ~ 0.0126in.)
No.2 : 0.32 ~ 0.47m (0.0126 ~ 0.0185in.)
Oil ring : 0.20 ~ 0.70mm (0.0079 ~ 0.0275in.)
Limit
No.1 : 0.6mm (0.0236in.)
No.2 : 0.7mm (0.0275in.)
Oil ring : 0.8mm (0.0315in.)

ECKD001K

Piston Pins

1. Measure the diameter of the piston pin.

Piston pin diameter
23.001 ~ 23.006mm (0.9056 ~ 0.9057in.)



ECKD001Z

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

Piston pin-to-piston clearance
0.009 ~ 0.017mm (0.0004 ~ 0.0007in.)

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

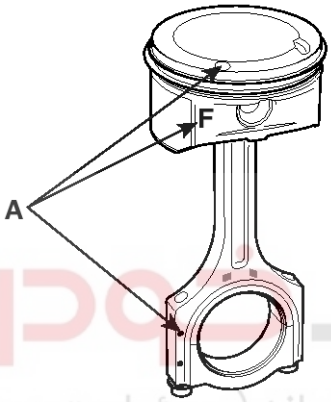
Piston pin-to-connecting rod interference
-0.032 ~ -0.017mm (-0.0012 ~ -0.0007in.)

Reassembly

NOTICE

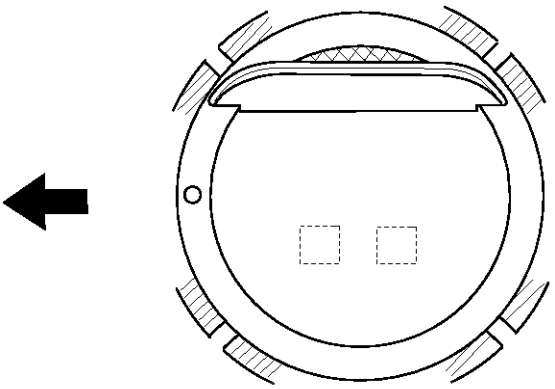
- *Thoroughly clean all parts to be assembled.*
- *Before installing the parts, apply fresh engine oil to all sliding and rotating surfaces.*
- *Replace all gaskets, O-rings and oil seals with new parts.*

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



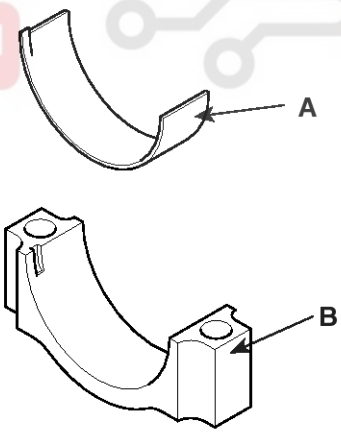
SGHEM7012N

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



ECKD321A

3. 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).



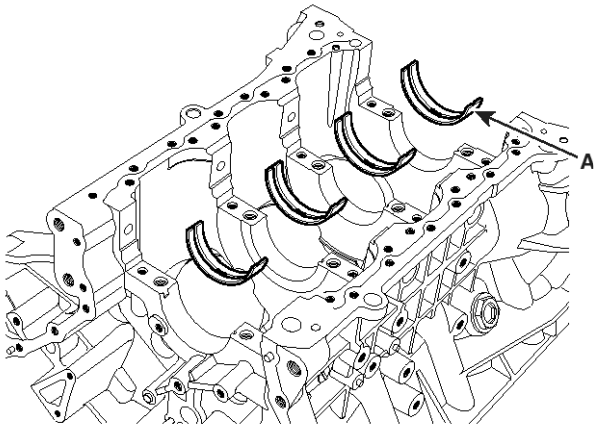
SGHEM7013N

4. Install the main bearings.

NOTICE

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).

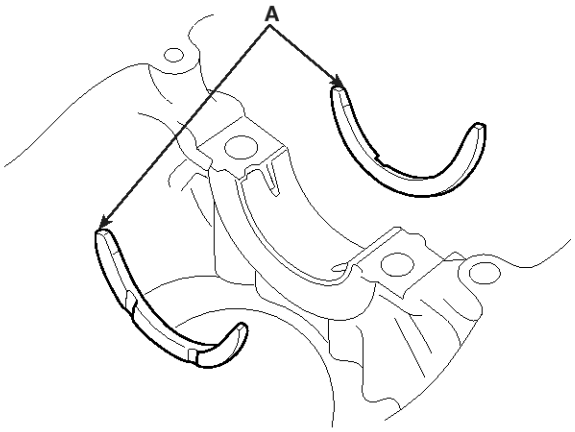


KDRF216A

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

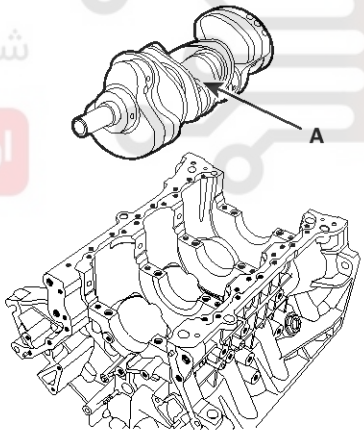
5. Install the thrust bearings.

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



ECKD324A

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

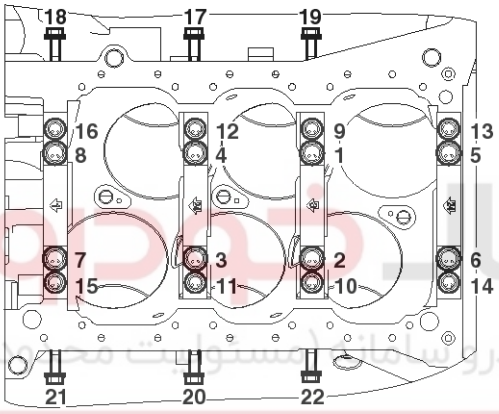


KDRF210A

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

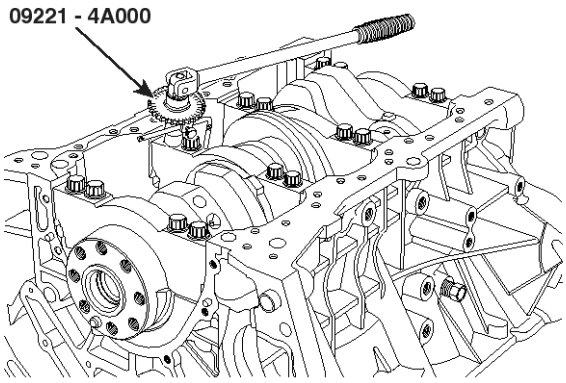
Tightening torque
Main bearing cap bolt
49.00Nm(5.0 kgf.m, 36.16lb-ft) + 90° (1 ~ 8)
19.60 Nm(2.0 kgf.m, 14.46lb-ft)+ 120° (9 ~ 16)
29.40 ~ 31.36Nm(3.0 ~ 3.2 kgf.m, 21.70 ~ 23.14lb-ft) (17 ~ 22)

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



KDRF140A

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



KDRF224A

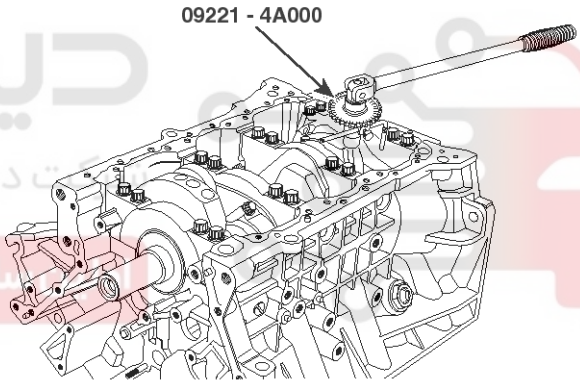
   2) Check that the crankshaft turns smoothly.
9. Check crankshaft end play.
10. Install the piston and connecting rod assemblies.

NOTICE
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
19.6Nm (2.0kgf.m, 14.46lb-ft) + 90°

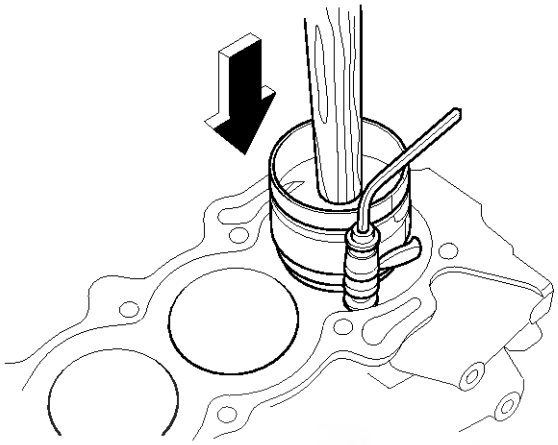
Use SST(09221-4A000), install connecting rod bearing cap bolts.



KDRF225A

NOTICE

- *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.*



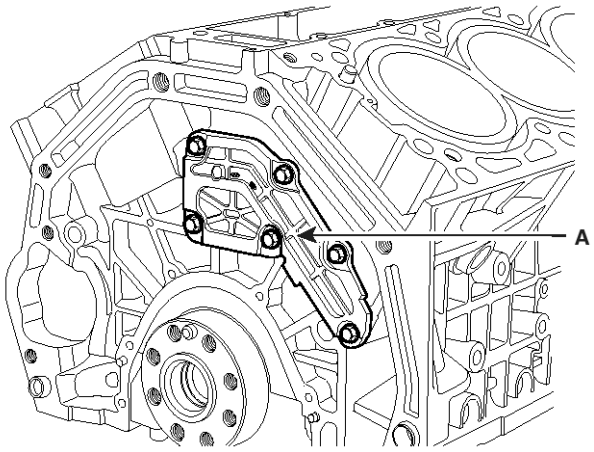
ECKD001F

11. Check the connecting rod end play.

12. Install the oil drain cover(A).

Tightening torque

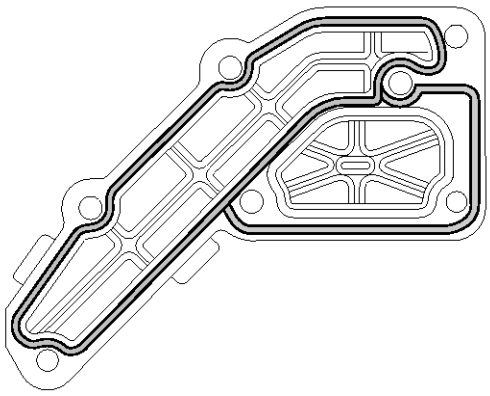
9.80 ~ 11.76Nm (1.0 ~ 1.2kgf.m, 7.23 ~ 8.67lb-ft)



KDRF209A

NOTICE

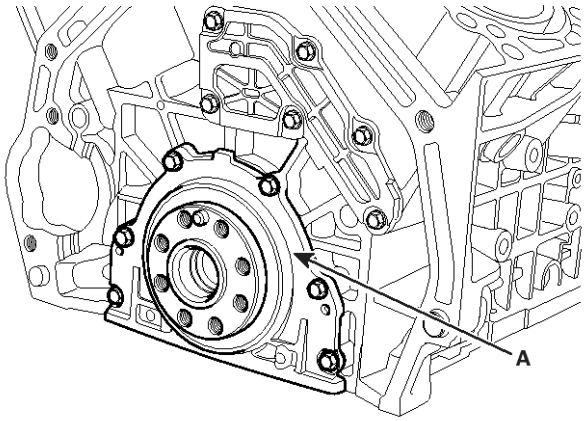
- *Clean the sealing face before assembling two parts.*
- *Remove harmful foreign materials on the sealing face before applying sealant*
- *Before assembling oil drain cover, the liquid sealant TB1217H should be applied to the oil drain cover.*
- *The part must be assembled within 5 minutes after sealant was applied.*
- *Apply sealant to the inner threads of the bolt holes.*



ECBF003A

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

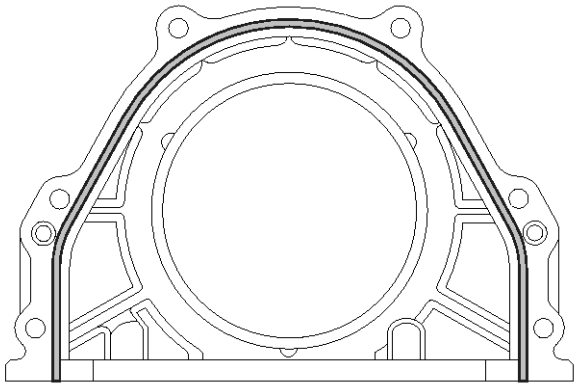
Tightening torque
9.80 ~ 11.76Nm (1.0 ~ 1.2kgf.m, 7.23 ~ 8.67lb-ft)



KDRF208A

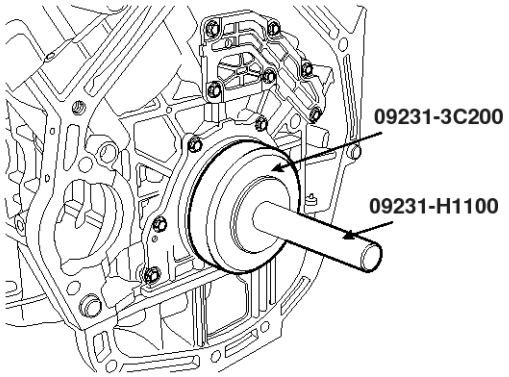
NOTICE

- *Clean the sealing face before assembling two parts.*
- *Remove harmful foreign materials on the sealing face before applying sealant*
- *Before assembling rear oil seal case, the liquid sealant TB1217H should be applied to the rear oil seal case.*
- *The part must be assembled within 5 minutes after sealant was applied.*
- *Apply sealant to the inner threads of the bolt holes.*



KDRF218A

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

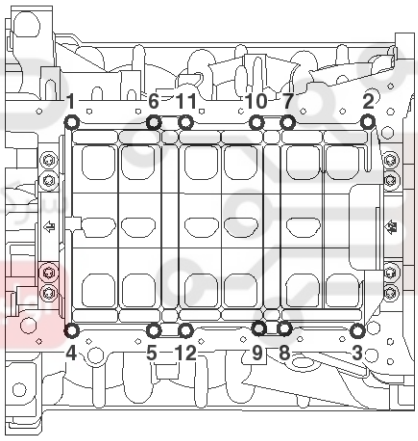


KDRF237A

15. Install the baffle plate.

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

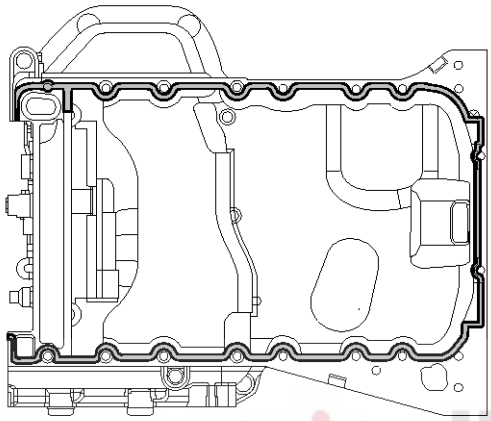
Tightening torque
9.80 ~ 11.76Nm (1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)



KDRF135A

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

Bead width : 2.5mm(0.1in.)



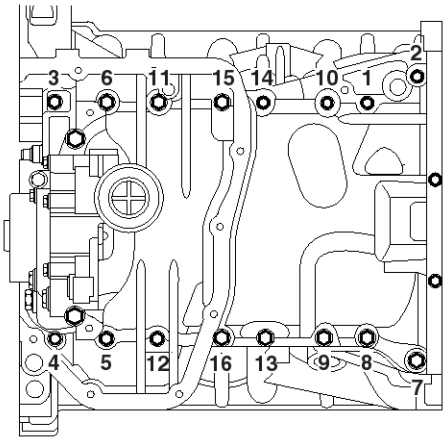
KDRF130A

NOTICE

- *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.

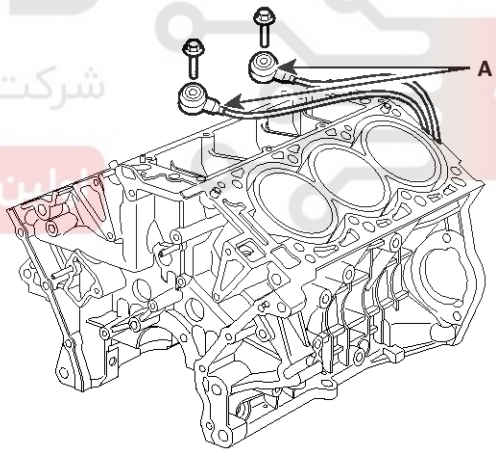
Tightening torque
9.80 ~ 11.76Nm (1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)



KDRF131A

17. Install the knock sensor(A).

Tightening torque
15.68 ~ 23.52Nm (1.6 ~ 2.4kgf.m, 11.57 ~ 17.36lb-ft)



KDRF205A

18. Install the drive plate.

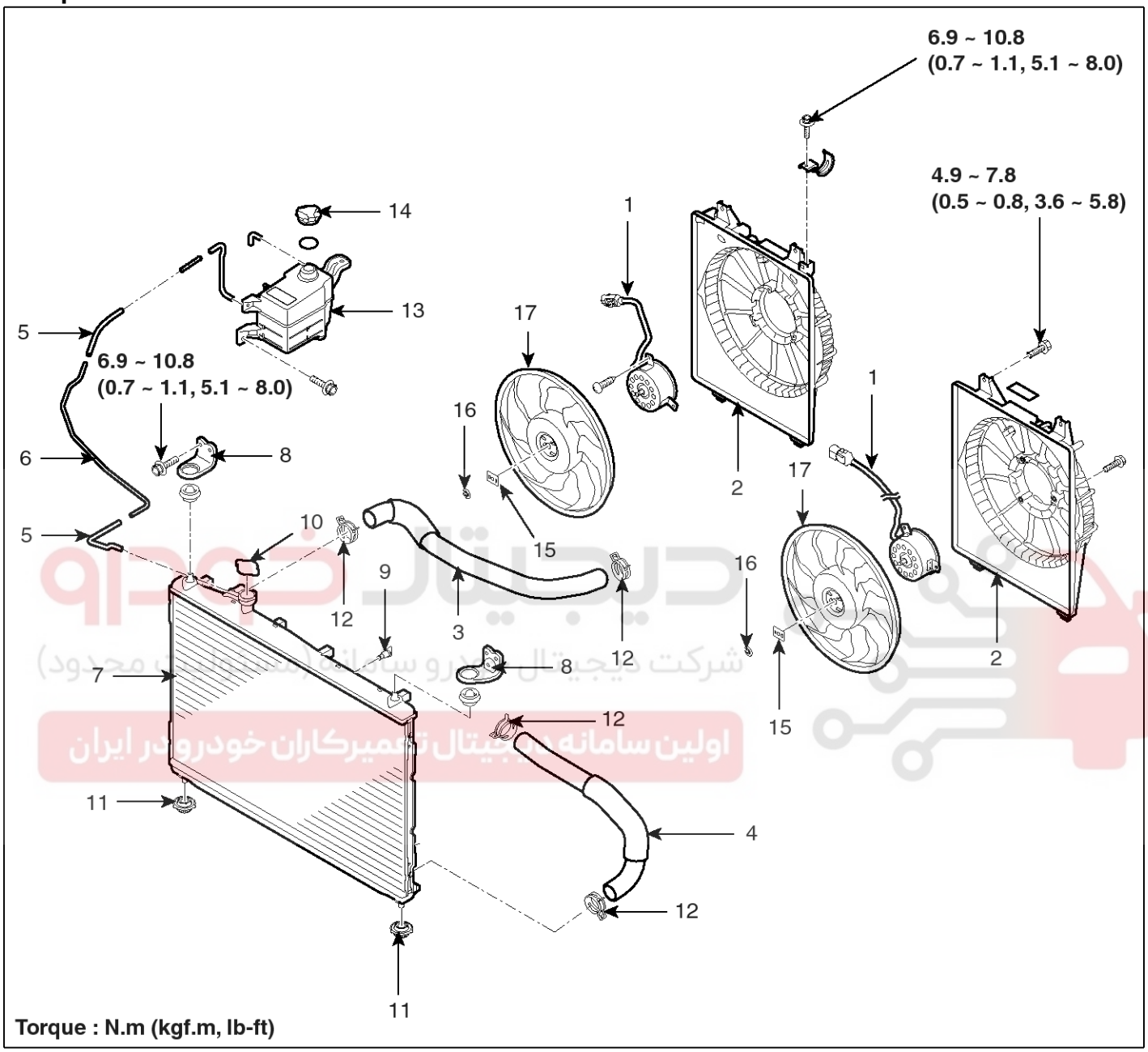
Tightening torque
71.54 ~ 75.46Nm (7.3 ~ 7.7kgf.m, 52.80 ~ 55.69lb-ft)

Installation

1. Install the power steering pump.
2. Install the alternator.
3. Install the air conditioner compressor
4. Install the oil filter assembly.
5. Install the oil pump.
6. Install the cylinder head.
7. Install the water temperature control assembly.
8. Install the timing chain.
9. Install the intake manifold.
10. Install the exhaust manifold.

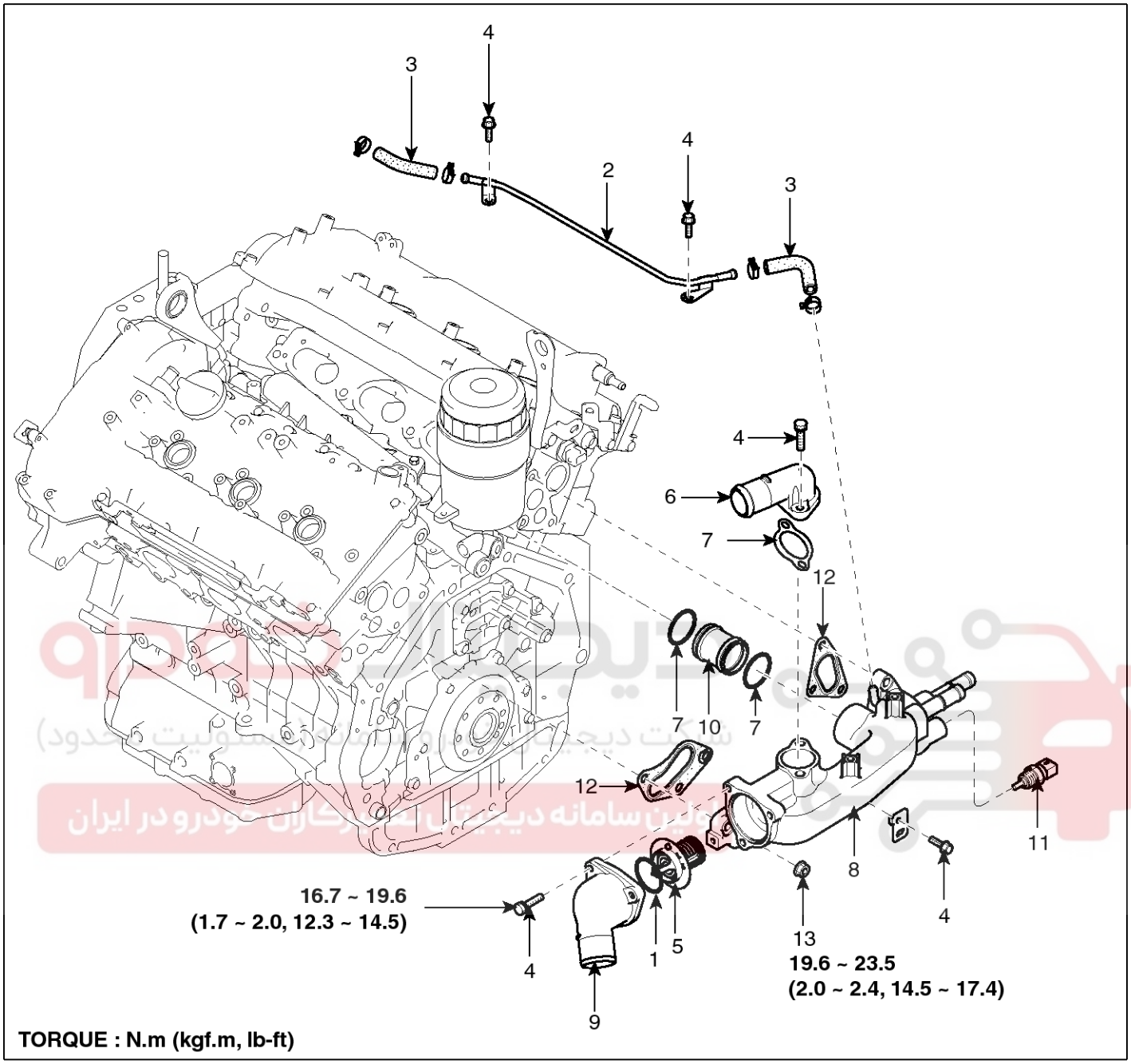
Cooling System

Components



SENEM9007N

1. Fan motor assembly
2. Shroud
3. Radiator upper hose
4. Radiator lower hose
5. Reservoir hose
6. Reservoir pipe
7. Radiator
8. Radiator upper mounting bracket
9. Drain plug
10. Radiator cap
11. Radiator lower mounting insulator
12. Clamp
13. Reservoir
14. Reservoir cap
15. Washer
16. Clip
17. Fan



SENEM9008N

1. Inlet fitting O-ring
2. Vent pipe
3. Vent hose
4. Bolt
5. Thermostat assembly
6. Outlet fitting
7. Gasket
8. Thermostat housing assembly
9. Inlet fitting
10. Tube
11. Engine coolant temperature sensor
12. Thermostat gasket
13. Nut

Engine Coolant Refilling And Bleeding

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.

CAUTION

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

1. Make sure the engine and radiator are cool to the touch.
2. Remove the radiator cap.
3. Loosen the drain plug, and drain the coolant.
4. Tighten the radiator drain plug securely.
5. Remove, drain and reinstall the reservoir. Fill the tank halfway to the MAX mark with water, then up to the MAX mark with antifreeze.
6. Fill fluid mixture with coolant and water(4 : 6) slowly through the radiator cap. Push the upper/lower hoses of the radiator so as to bleed air easily.

   NOTICE

   - *Use only genuine antifreeze/coolant.*
   - *For best corrosion protection, the coolant concentration must be maintained year-round at 50% minimum.*

     Coolant concentrations less than 50% may not provide sufficient protection against corrosion or freezing.
   - *Coolant concentrations greater than 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.**
7. Start the engine and run so coolant circulates.

   When the cooling fan operates and coolant circulates, refill coolant through the radiator cap.
8. Repeat 7 until the cooling fan cycles 3 ~ 5 times and bleed air sufficiently out of the cooling system.
9. Install the radiator cap and fill the reservoir tank to the "MAX" line with coolant.
10. Run the vehicle under idle until the cooling fan operates 2 ~ 3 times.
11. Stop the engine and wait until coolant gets cool.
12. Repeat 6 to 11 until the coolant level doesn't fall any more, bleed air out of the cooling system.

    NOTICE

    Bleed air out of the cooling system and refill coolant when coolant completely cools, recheck the coolant level in the reservoir tank for 2 ~ 3 days after replacing coolant.

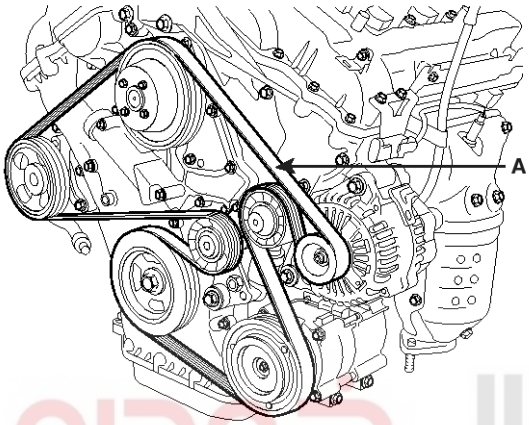
Removal

Water Pump

1. Drain the engine coolant.

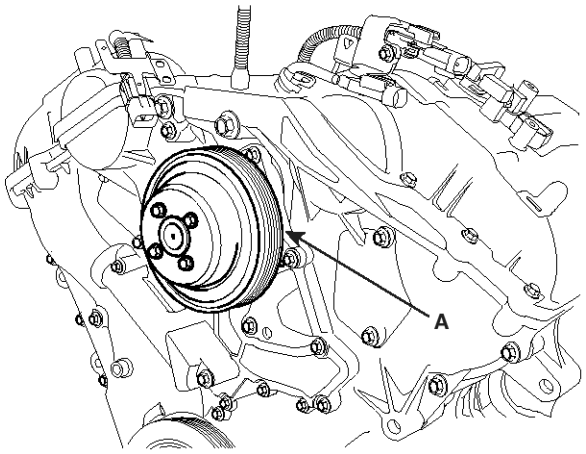
   WARNING
   System is under high pressure when the engine is hot. To avoid danger of releasing scalding engine coolant, remove the cap only when the engine is cool.

2. Remove the drive belt(A).



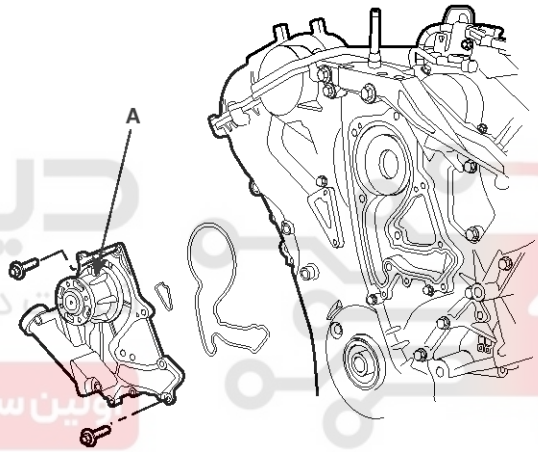
UCBF009A

3. Remove the 4 bolts and the pump pulley(A).



KDRF107A

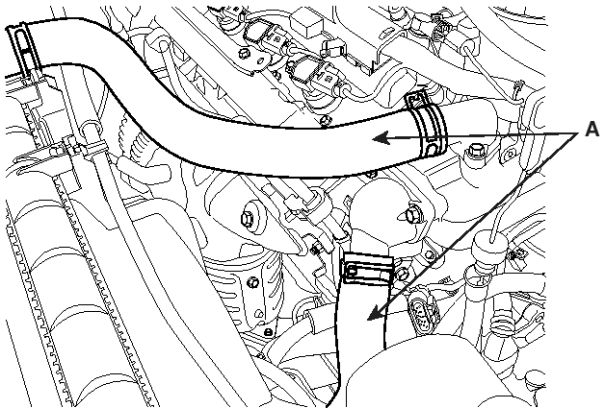
4. Remove the water pump(A) and gasket.



KDRF221A

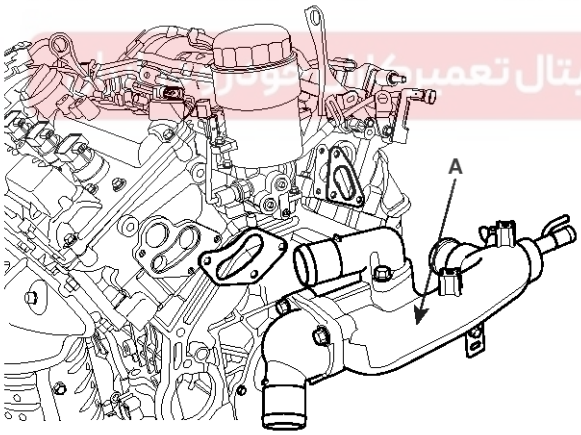
Water Temperature Control Assembly

1. Drain the engine coolant.
2. Remove the air cleaner assembly.
3. Disconnect the radiator upper and lower hose(A).



KDRF148A

4. Disconnect the ECT sensor connector.
5. Disconnect the heater hose, the water vent hose and the water hose from water temperature control assembly.
6. Remove the wiring protector.
7. Remove the water temperature control assembly(A).



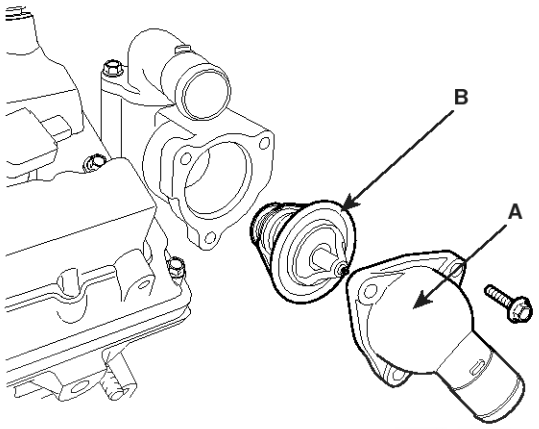
KDRF194A

Thermostat

NOTICE

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.

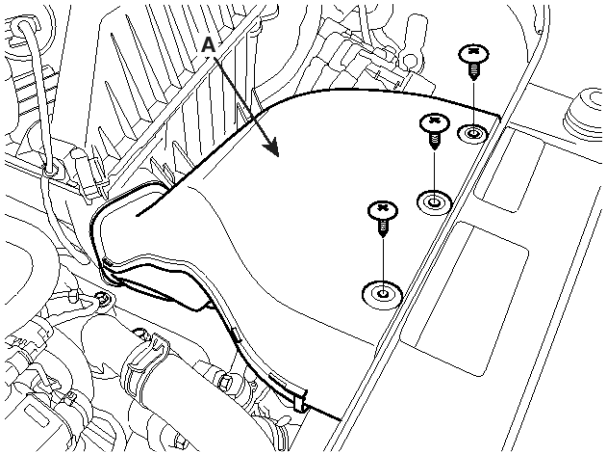
1. Drain engine coolant so its level is below thermostat.
2. Remove the water inlet(A) and the thermostat(B).



KDRF195A

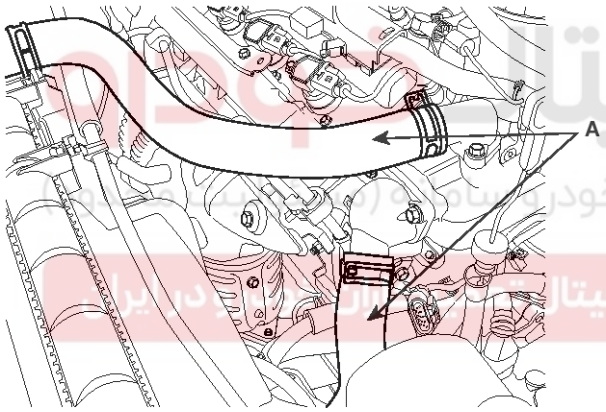
Radiator

1. Drain the engine coolant.
2. Remove the air duct(A).



SENM17213L

3. Disconnect the radiator upper and lower hoses(A).



KDRF148A

4. Disconnect transaxle oil cooler hoses.
5. Disconnect the radiator fan connector.
6. Remove the radiator bracket.
7. Remove the radiator.

Inspection

Water Pump

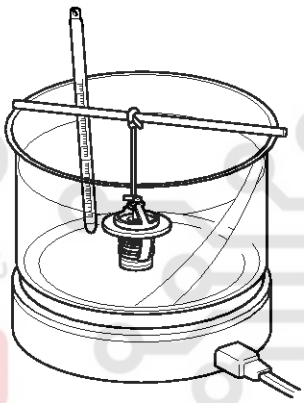
1. Check each part for cracks, damage or wear, and replace the coolant pump assembly if necessary.
2. Check the bearing for damage, abnormal noise and sluggish rotation, and replace the coolant pump assembly if necessary.
3. Check for coolant leakage. If coolant leaks from hole, the seal is defective. Replace the coolant pump assembly.

NOTICE

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

Thermostat

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



ECKD503B

2. Check the valve opening temperature.

   Valve opening temperature : 82˚C (177˚F)

   Full opening temperature : 95˚C (205˚F)

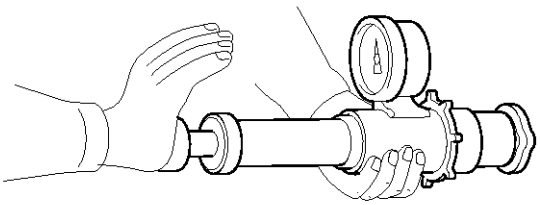
   If the valve opening temperature is not as specified, replace the thermostat.
3. Check the valve lift.

   Valve lift : Min. 10mm (0.4in.) at 95˚C (205˚F)

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

Cap Testing

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

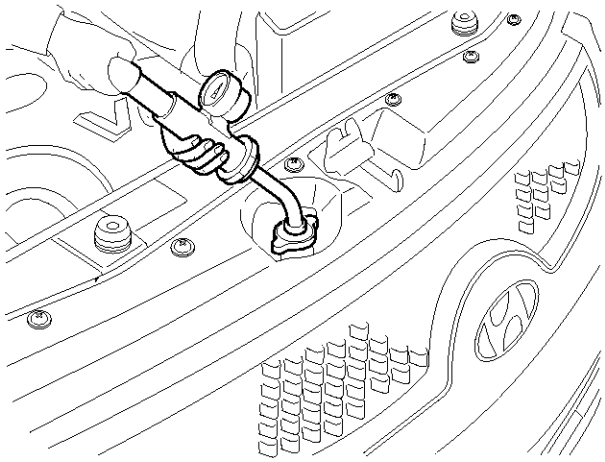


ECKD501X

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.

Testing

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



SENM17014L

2. Apply a pressure tester to the radiator and apply a pressure of 93 ~ 123kPa (0.95 ~ 1.25kgf/cm² 14 ~18psi).
3. Inspect for engine coolant leaks and a drop in pressure.
4. Remove the tester and reinstall the radiator cap.

NOTICE

Check for engine oil in the coolant and/or coolant in the engine oil.

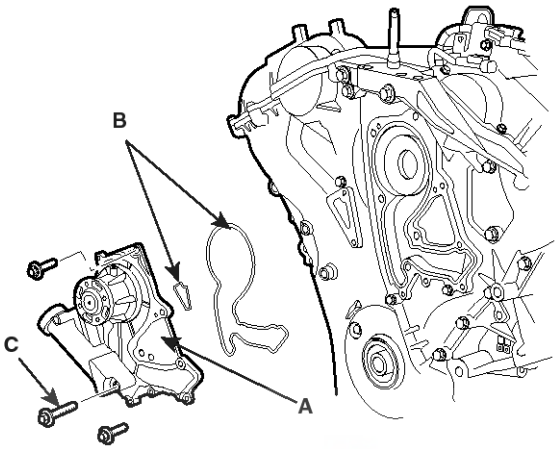
Installation

Water Pump

1. Install the water pump(A) and a new gasket(B) with 12 bolts.

Tightening torque

21.56 ~ 23.52Nm (2.2 ~ 2.4kgf.m, 15.91 ~ 17.36lb-ft)
9.80 ~ 11.76Nm (1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)



SGHEM7018N

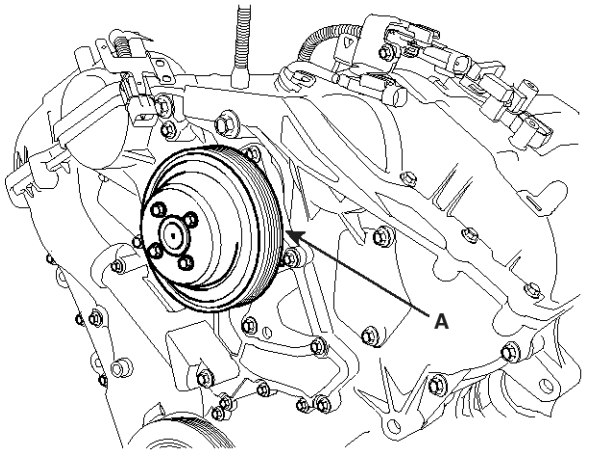
NOTICE

- *Clean the contact face before assembly.*
- *Always use a new bolt(C) and gaskets(B).*

2. Install the 4 bolts and the pump pulley(A).

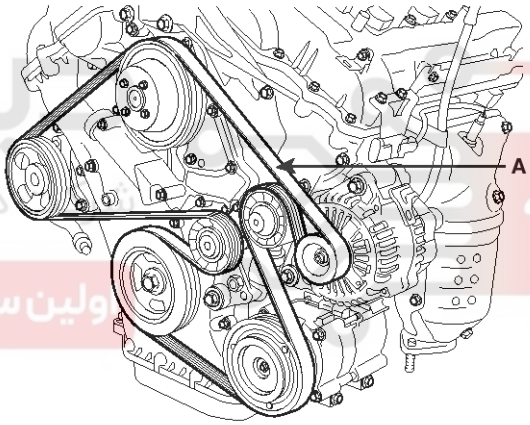
Tightening torque

7.84 ~ 9.80Nm (0.8 ~ 1.0kgf.m, 5.78 ~ 7.23lb-ft)



KDRF107A

3. Install the drive belt(A).



KDRF101A

4. Fill with engine coolant.
5. Start engine and check for leaks.
6. Recheck engine coolant level.

Water Temperature Control Assembly

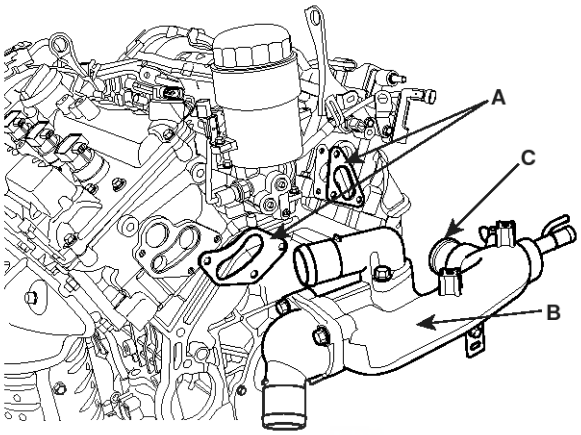
NOTICE

Clean the contact face before assembly.

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

Tightening torque

18.62 ~ 23.52Nm (1.9 ~ 2.4kgf.m, 13.74 ~ 17.36lb-ft)

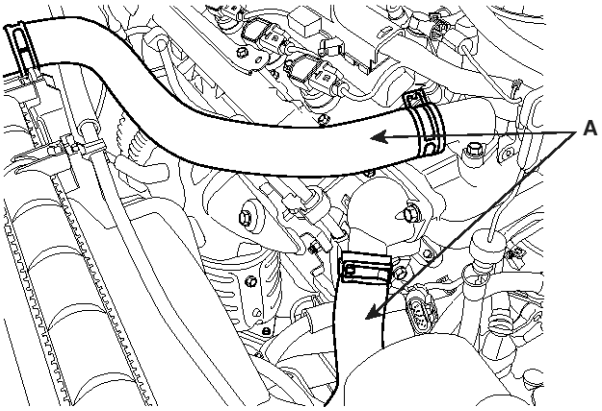


KDRF194B

NOTICE

Use new O-rings(C) when reassembling.

2. Connect water hoses to the water temperature control assembly.
3. Install the wiring protector.
4. Connect the ECT sensor connector.
5. Connect the radiator upper and lower hose(A).

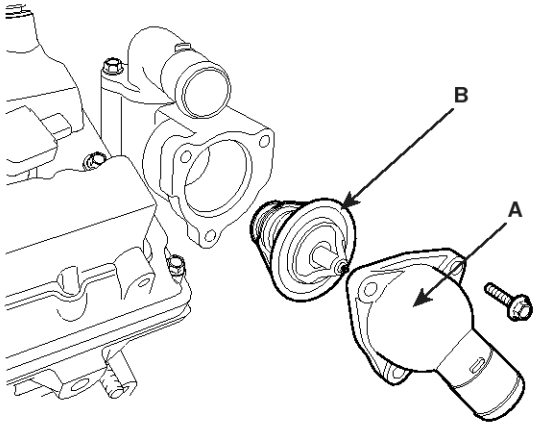


KDRF148A

6. Install the air cleaner assembly.
7. Fill with engine coolant.
8. Start engine and check for leaks.
9. Recheck engine coolant level.

Thermostat

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



KDRF195A

2. Install the water inlet(A).

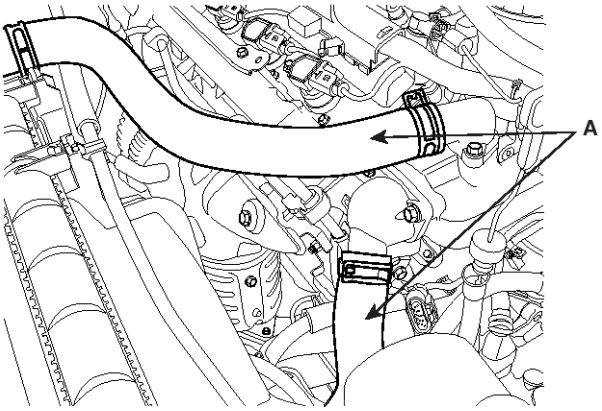
Tightening torque

16.66 ~ 19.60Nm (1.7 ~ 2.0kgf.m, 12.30 ~ 14.47lb-ft)

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

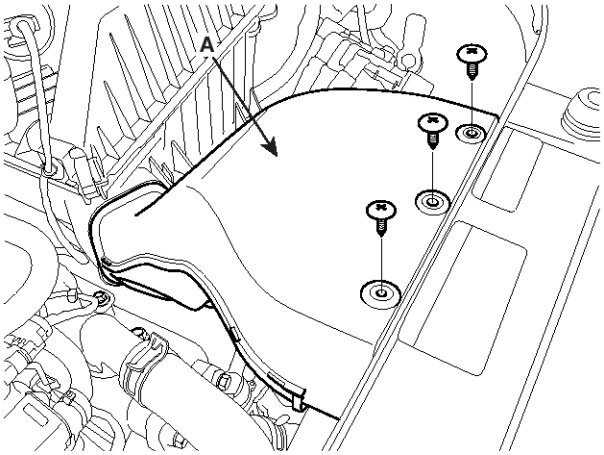
Radiator

1. Install the radiator.
2. Install the radiator bracket.
3. Reconnect the radiator fan connector.
4. Connect the transaxle oil cooler hoses.
5. Connect the radiator upper and lower hoses(A).



KDRF148A

6. Install the air duct(A).

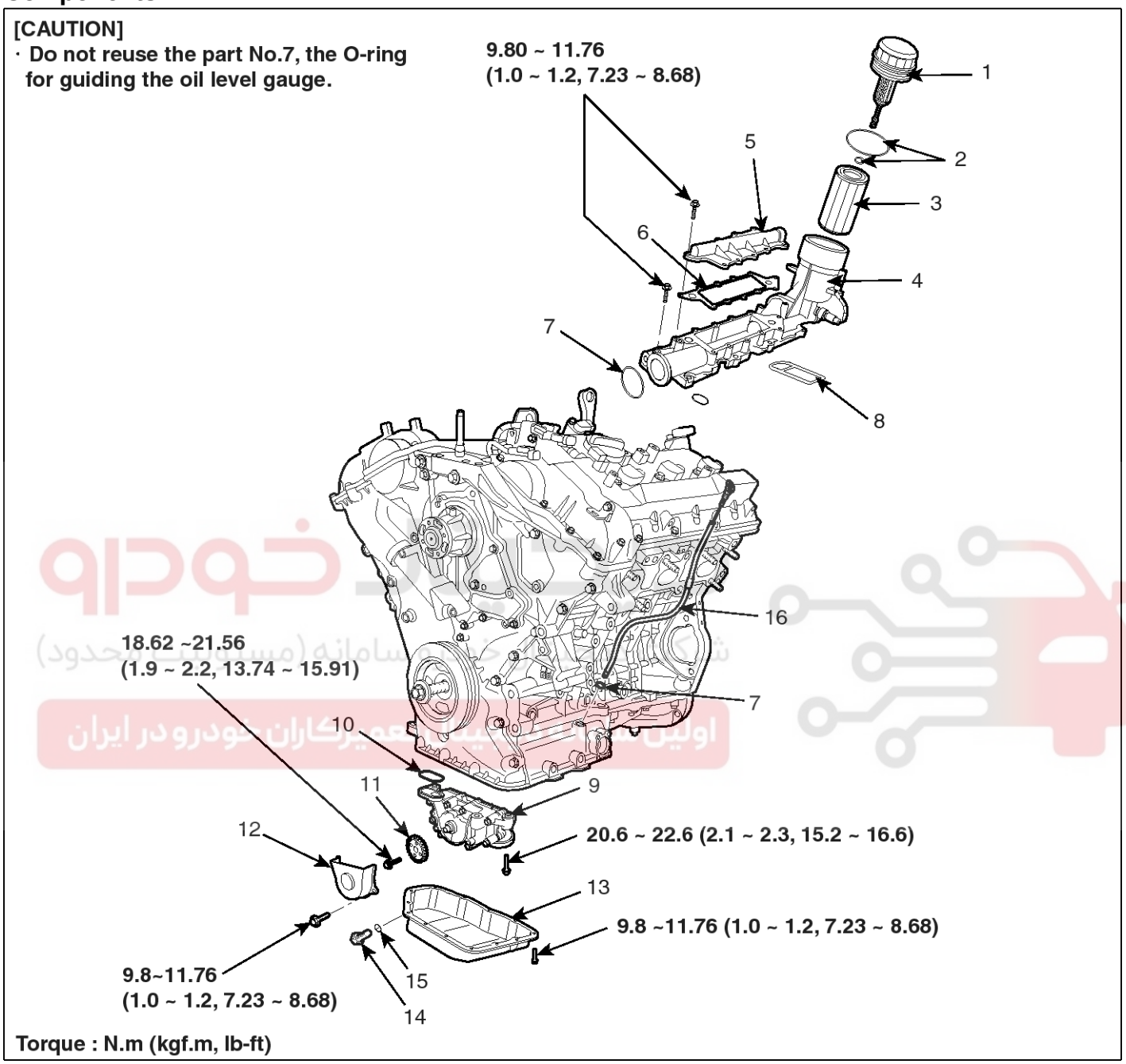


SENM17213L

7. Fill with engine coolant.
8. Start engine and check for leaks.
9. Recheck engine coolant level.

Lubrication System

Components



SENEM9009N

1. Oil filter cap
2. O - ring
3. Oil filter element
4. Oil filter body
5. Oil filter body cover
6. Gasket
7. O - ring
8. Gasket
9. Oil pump
10. Gasket
11. Oil pump sprocket
12. Oil pump chain cover
13. Lower oil pan
14. Drain oil plug
15. Drain oil plug gasket
16. Oil level gauge assembly

Oil And Filter

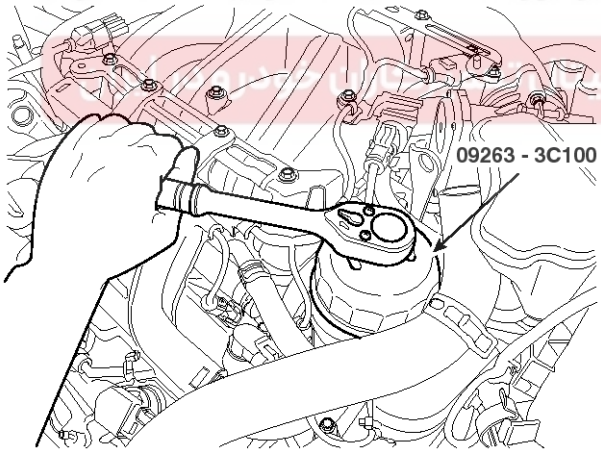
⚠CAUTION

- **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.

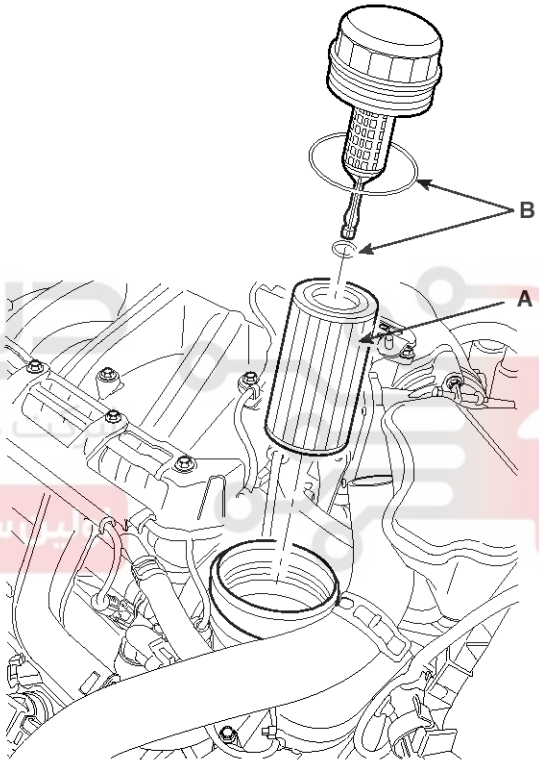
   Start the engine and let it warm up.
2. Turn the engine off and open the hood.

   Remove the engine cover.
3. Wait for 5 minutes after loosening the oil filter cap by turning it counterclockwise with the SST(09263-3C100) to drain well the oil in the oil filter.



SENM17017L

4. Drain engine oil.
   a. Remove the oil filler cap.
   b. After lifting the car, remove the oil drain plug and drain oil into a container.
5. Replace the oil filter.
   a. Disconnect the oil filter cap from the oil filter body.
   b. Remove the oil filter element.
   c. Check and clean the oil filter installation surface.
   d. Check the part number of a new oil filter is same as old one.
   e. Install a new oil filter element(A) and two new O-rings(B).



SENM17205L

   f. 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.
   g. Finally tighten it again by specified tightening torque.

Tightening torque
24.50Nm (2.5kgf.m, 18.08lb-ft)

6. Refill with engine oil.
   a. Install the oil drain plug with a new gasket.

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

   b. Fill with fresh engine oil, after removing the engine oil level gauge.

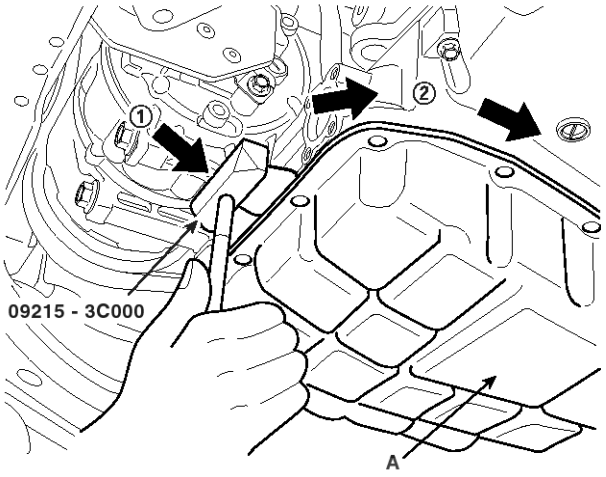
Capacity
Total : 6.0L (6.34US qt, 5.28Imp qt)
Oil pan : 5.5L (5.81US qt, 4.84Imp qt)
Drain and refill including oil filter : 5.2L (5.49US qt, 4.58Imp qt)

   c. 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 engine oil level.

Removal

Oil pump

1. Drain engine oil.
2. Using the SST(09215-3C000) remove the lower oil pan(A).



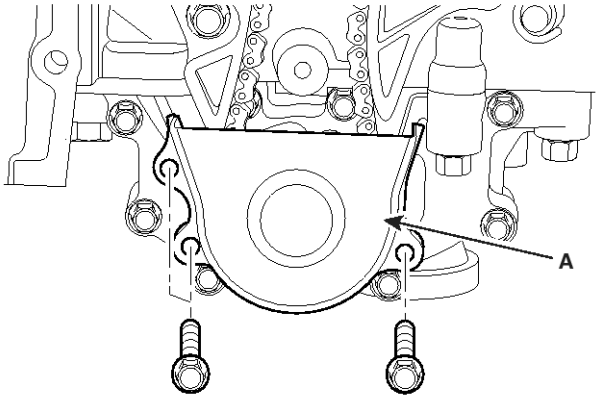
SENM17013L

NOTICE
Be careful not to damage the contact surfaces of upper oil pan and lower oil pan.

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

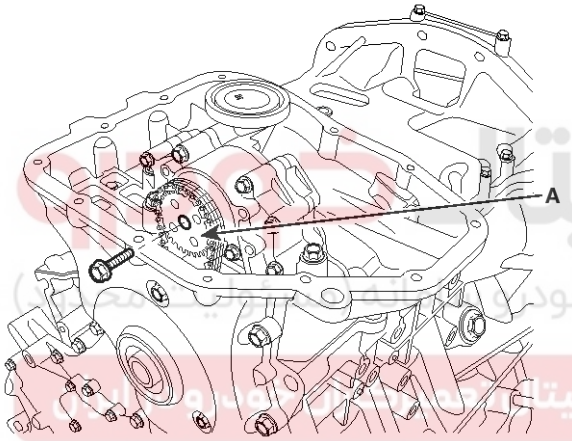
  It can result in damage of the SST.

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



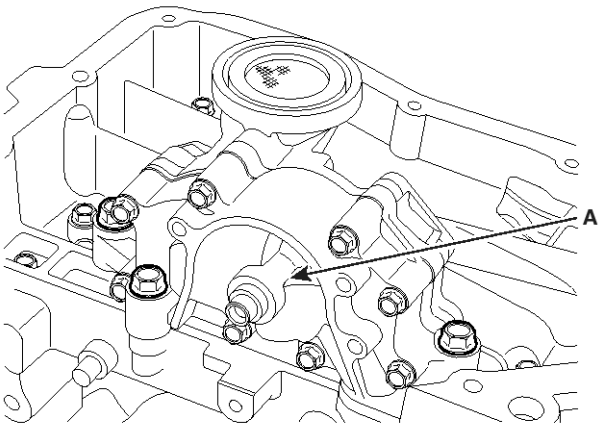
KDRF185A

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



KDRF189A

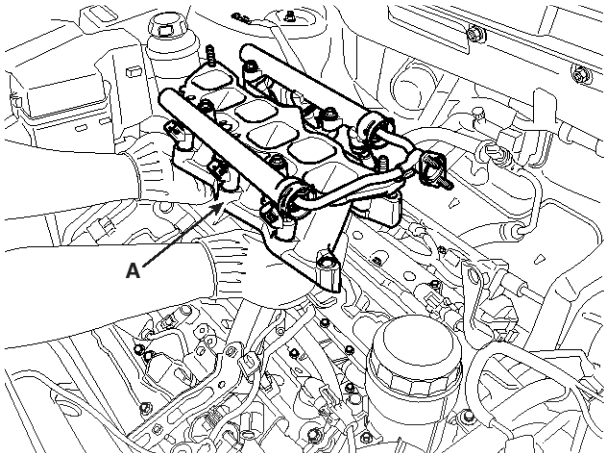
5. Remove the oil pump(A).



KDRF190A

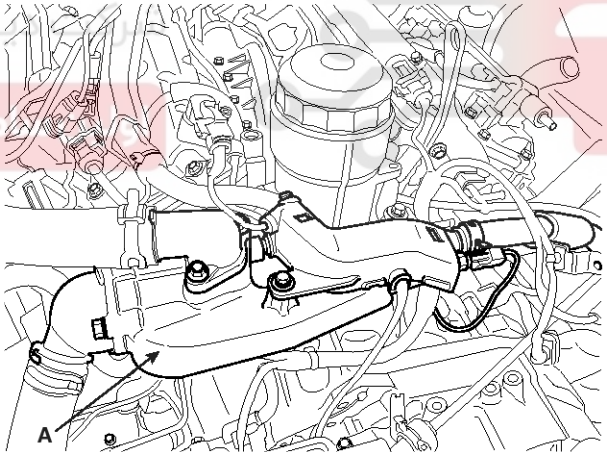
Oil Filter Assembly

1. Loosen the oil filter cap by turning it counterclockwise to drain oil in the oil filter.
2. Drain the engine coolant.
3. Disconnect the oil pressure switch connector.
4. Remove the surge tank and the intake manifold(A) with the delivery pipe assembly.



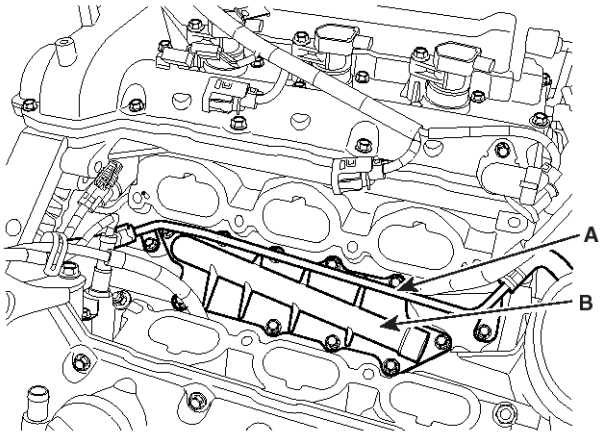
SENM17015L

5. Disconnect the water hoses from ETC.
6. Remove the water temperature control assembly(A).



SENM17016L

7. Disconnect the water vent hose(A).
8. Remove the oil filter body cover(B).



KDRF191A

9. Remove the oil filter body.

NOTICE

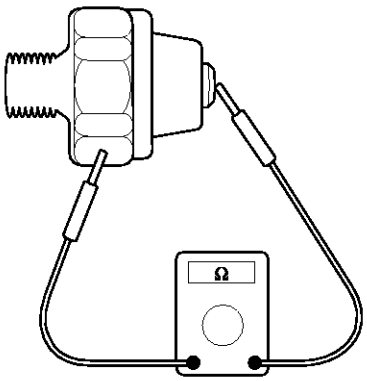
Be careful of the knock sensor connector.

Inspection

Oil Pressure Switch

1. Check the continuity between the terminal and the body with an ohmmeter.

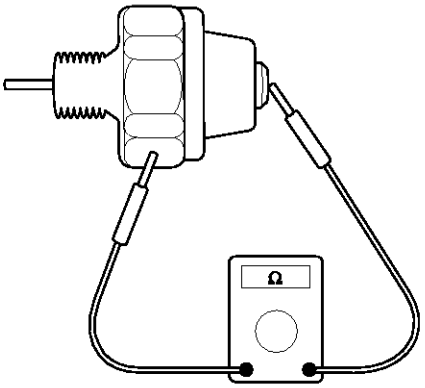
   If there is no continuity, replace the oil pressure switch.



ECKD001W

2. Check the continuity between the terminal and the body when the fine wire is pushed. If there is continuity even when the fine wire is pushed, replace the switch.
3. If there is no continuity when a 50kpa (7psi) is applied through the oil hole, the switch is operating properly.

   Check for air leakage. If air leaks, the diaphragm is broken. Replace it.



ECKD001Y

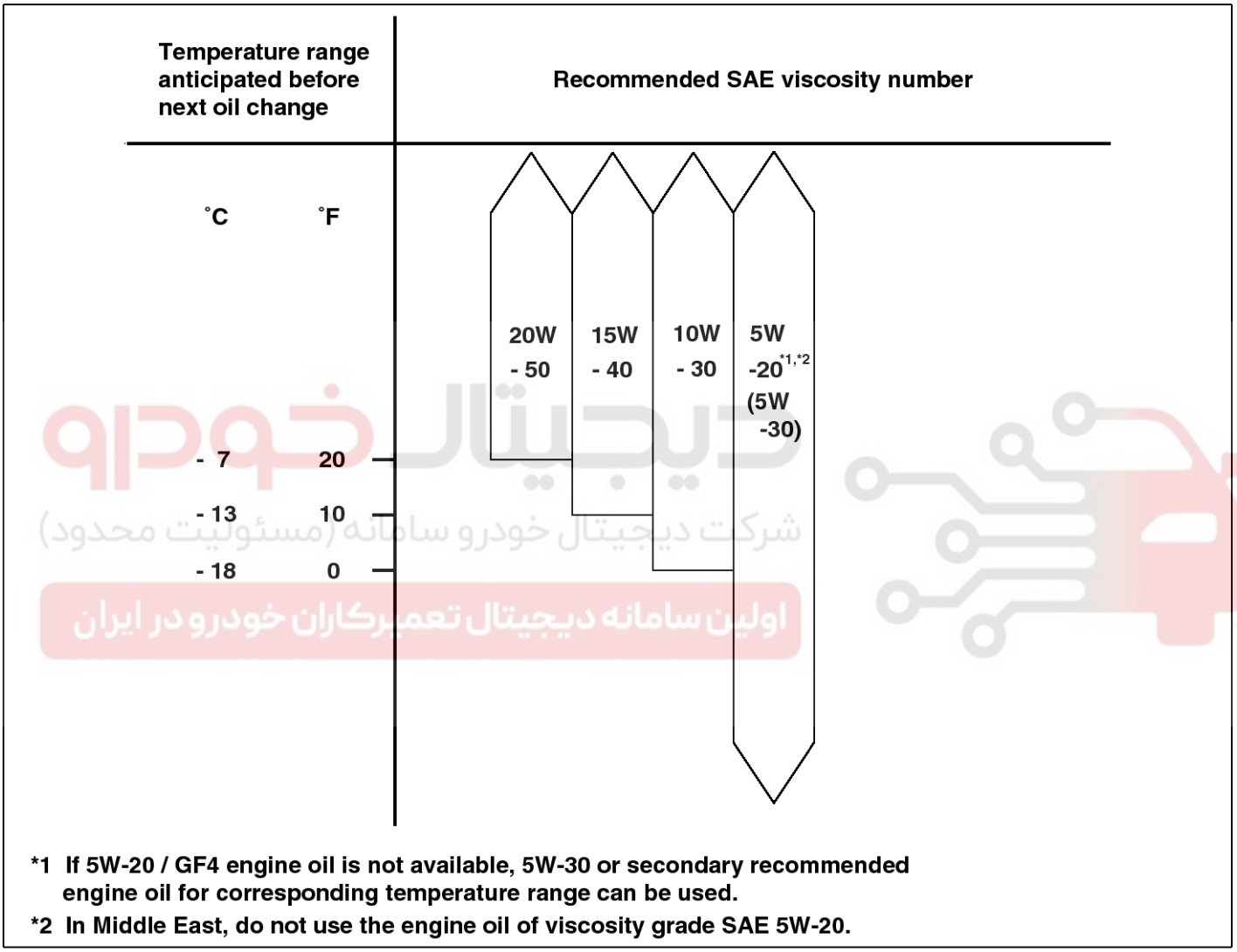
Selection Of Engine Oil

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

API classification : SL, SM or above

ILSAC classification : GF3, GF4 or above

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



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

***2 In Middle East, do not use the engine oil of viscosity grade SAE 5W-20.**

SAMM29103L

NOTICE

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

- *Satisfy the requirement of the API or ILSAC classification.*
- *Have proper SAE grade number for expected ambient temperature range.*

Lubricants that do not have both an SAE grade number and API or ILSAC service classification on the container should not be used.

Engine Oil

1. Check engine oil quality.

   Check the oil for deterioration, entry of water, discoloring or thinning.

   If the quality is visibly poor, replace the oil.

2. Check engine oil level.

   After warming up the engine and then 5 minutes after the engine stops, oil level should be between the "L" and "F" marks on the dipstick.

   If low, check for leakage and add oil up to the "F" mark.

   NOTICE

   Do not fill with engine oil above the "F" mark.

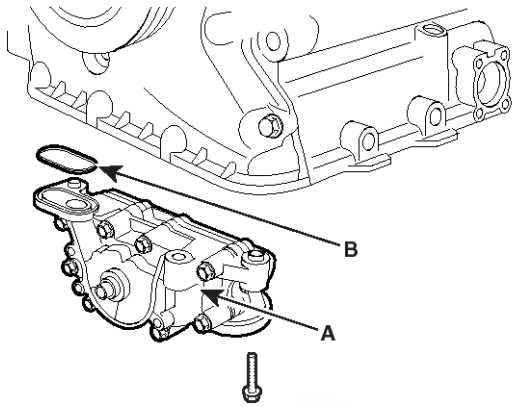
Installation

Oil pump

1. Install the oil pump(A).

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

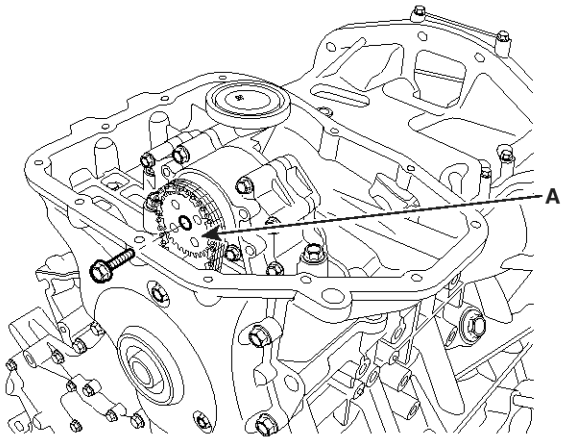
NOTICE
Always use a new O-ring(B).



KDRF222A

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

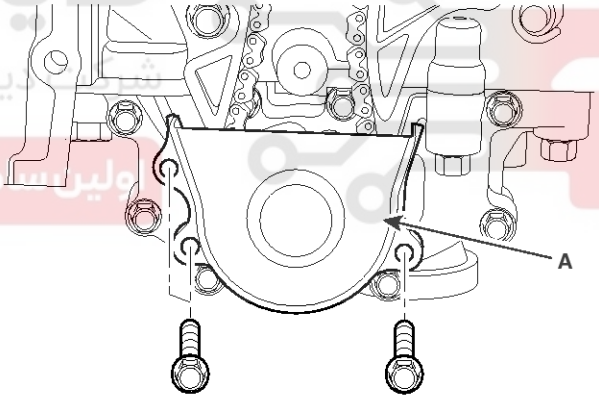
Tightening torque
18.62 ~ 21.56Nm (1.9 ~ 2.2kgf.m, 13.74 ~ 15.91lb-ft)



KDRF189A

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

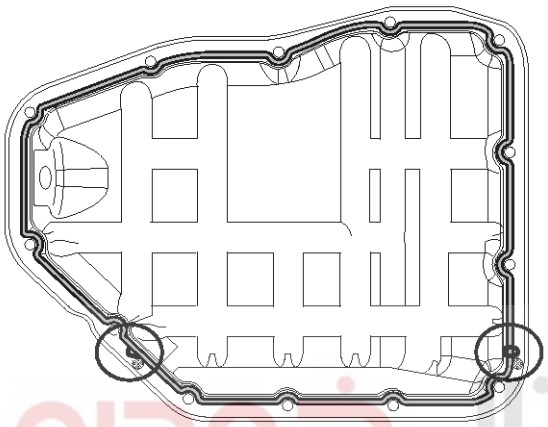
Tightening torque
9.80 ~ 11.76Nm (1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)



KDRF185A

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

Bead width : 2.5mm(0.1in.)
But marked area(*) to be 5.0mm(0.2in.)



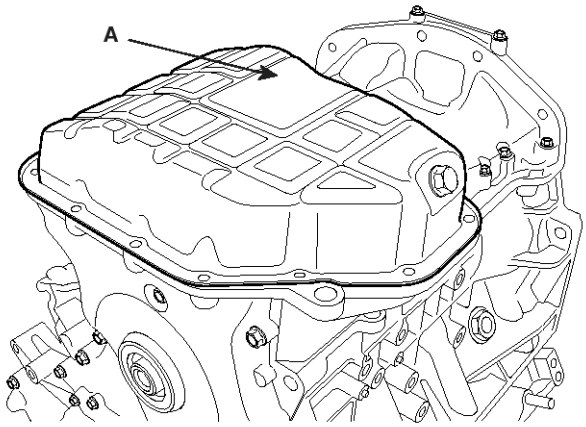
KDRF136A

⚠CAUTION

- **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 be 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 lower oil pan(A).
      Uniformly tighten the bolts in several passes.

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



KDRF114A

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

Oil Filter Assembly

1. Install the oil filter body and new O-rings.

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

NOTICE

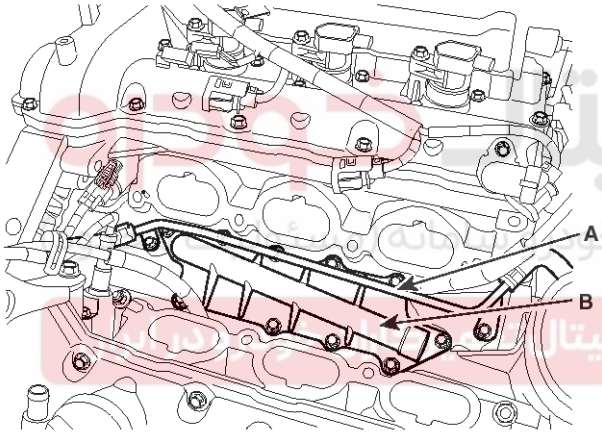
- *All rubber gaskets must not be damaged by assembling parts.*
- *Be careful of the knock sensor connector.*
- *Always use a new O-ring*

2. Install the oil filter body cover(B) and a new gasket on the oil filter body.

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

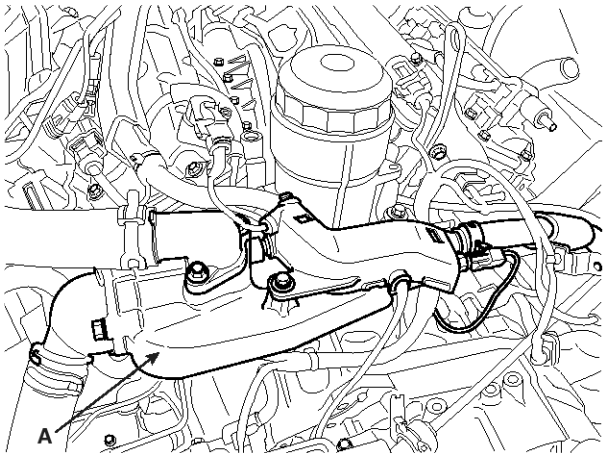
3. Connect the water vent hose(A)

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



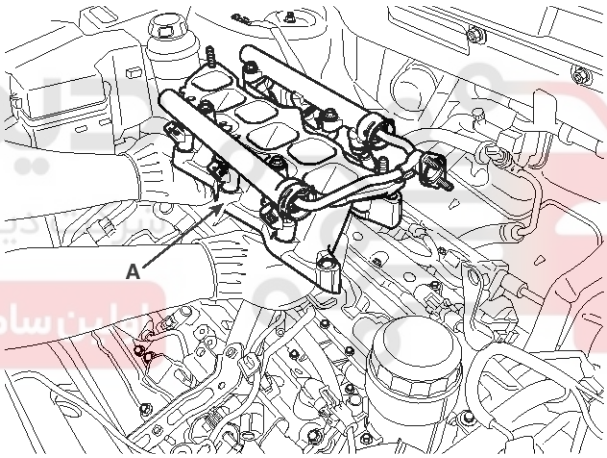
KDRF191A

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



SENM17016L

5. Connect the water hoses on the ETC.
6. Connect the oil pressure switch connector.
7. Install the intake manifold(A) and the surge tank.



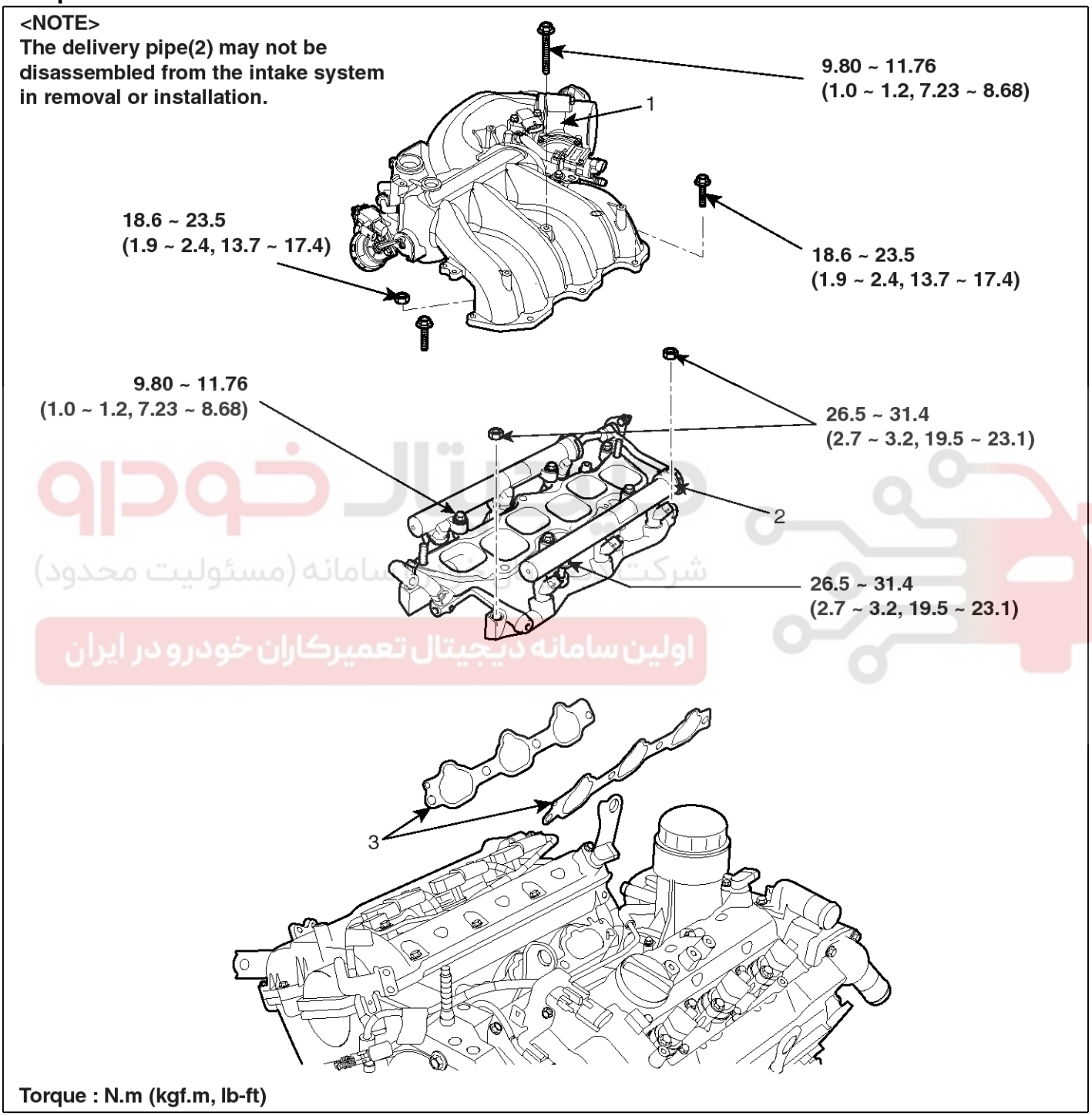
SENM17015L

8. Fill with engine coolant.
9. Start engine and check for leaks.
10. Recheck engine coolant level.

Intake And Exhaust System

Intake Manifold

Components

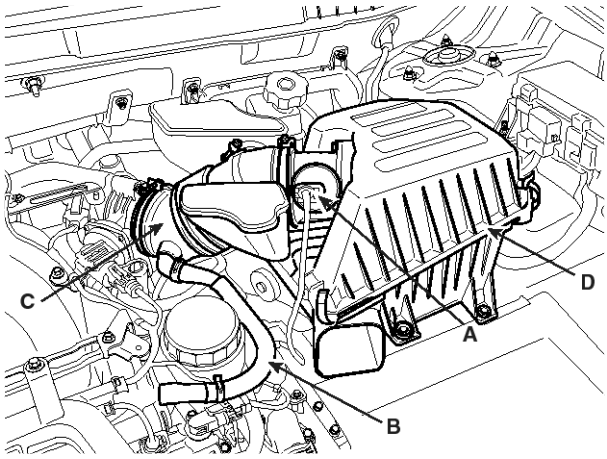


SENEM9010N

1. Surge tank
2. Delivery pipe and intake manifold
3. Intake manifold gasket

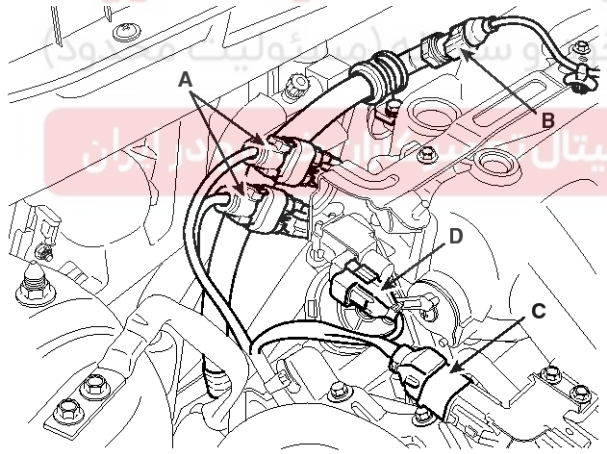
Removal

1. Disconnect the AFS connector(A) and the breather hose(B).
2. Remove the air cleaner body(D) and the intake hose(C).



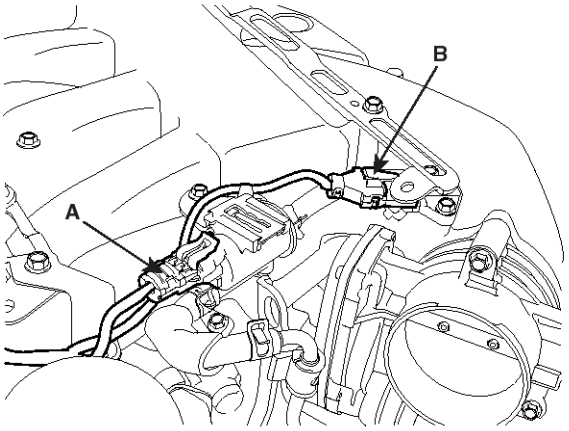
SENM17004L

3. Disconnect the RH front and rear oxygen sensor connectors(A), the power steering sensor connector(B), the RH injector harness connector(C) and the VIS solenoid valve connector(D).



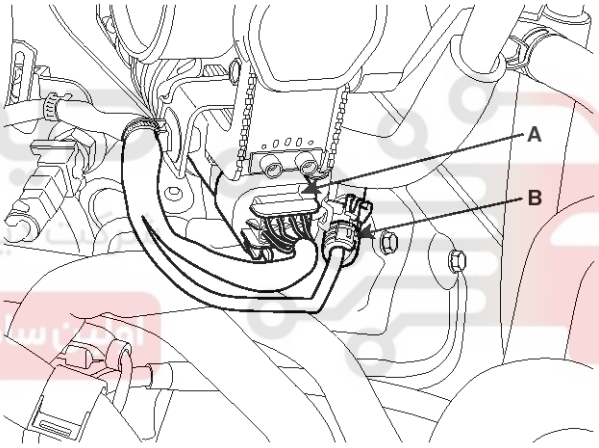
SENM17207L

4. Disconnect the PCSV connector(A), the MAP sensor connector(B) and the PCSV hose.



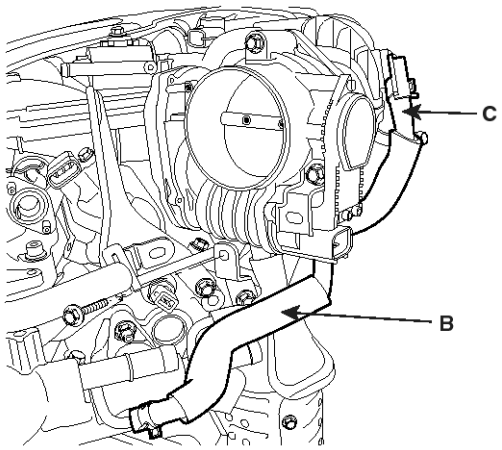
UCBF003A

5. Disconnect the ETC connector(A) and the knock sensor connector(B).



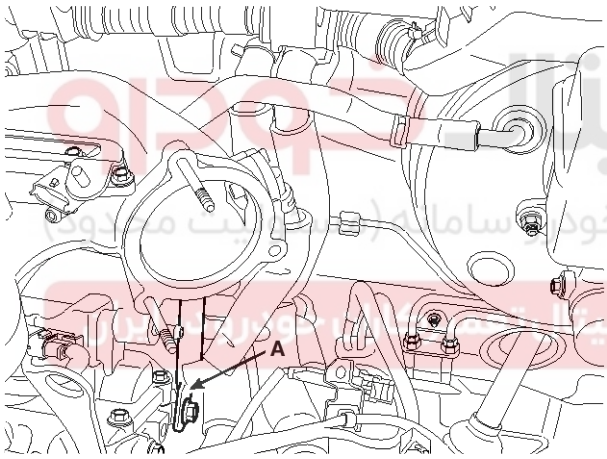
KDRF162A

6. Disconnect the water hoses(B) from ETC.
7. Disconnect the PCV(C) hose.

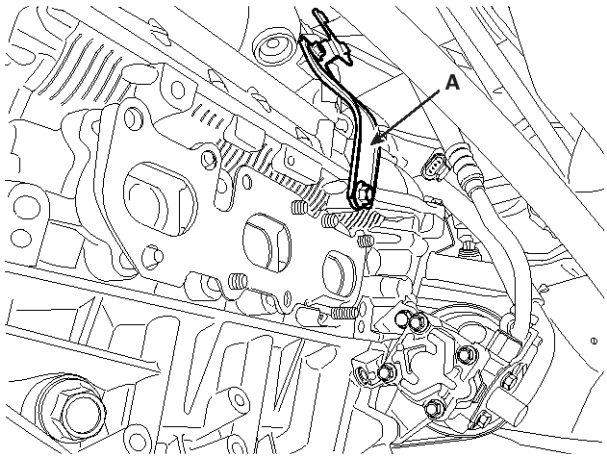


SENM17208L

8. Disconnect brake vacuum hose.
9. Remove the surge tank stays(A).

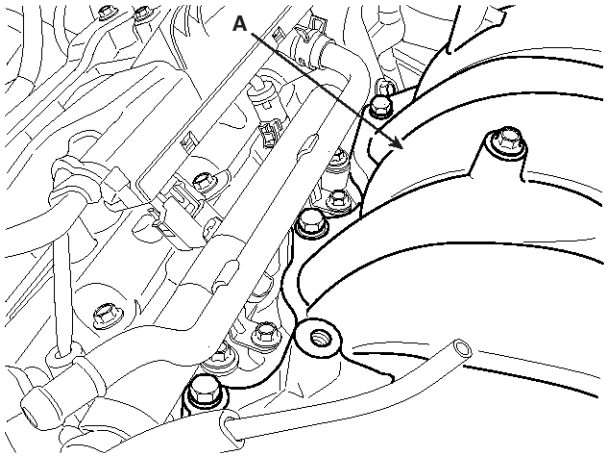


SENM17209L



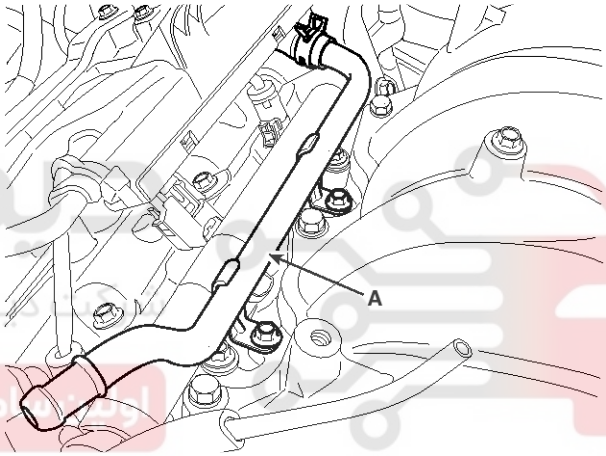
SENM17018L

10. Remove the surge tank(A).



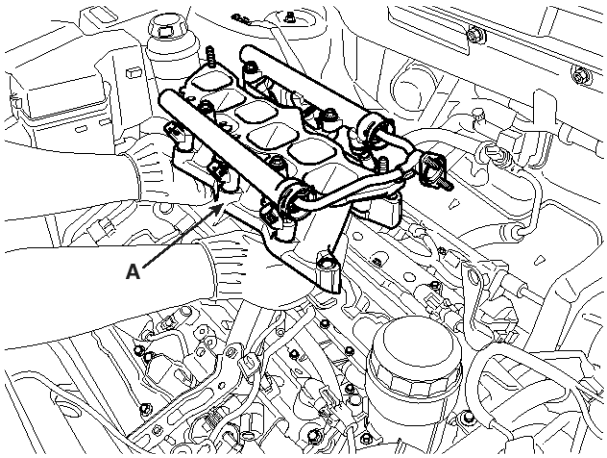
SENM17210L

11. Disconnect the breather Pipe assembly(A).



SENM17001L

12. Disconnect the LH injector harness connectors.
13. Remove the intake manifold(A) and gasket.



SENM17015L

Installation

1. Install the intake manifold and new gasket on the cylinder head.

Tightening torque

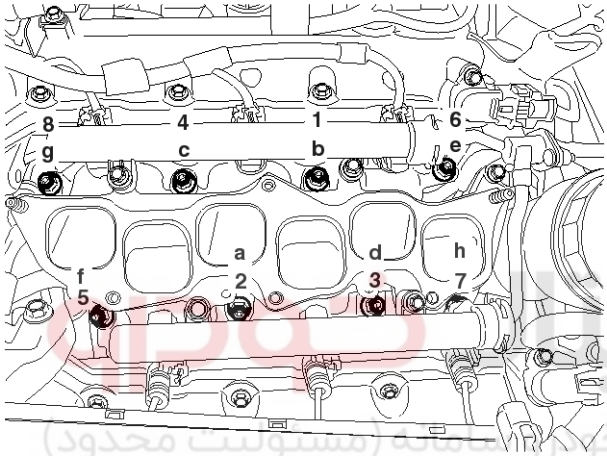
1st : 3.9 ~ 5.9Nm (0.4 ~ 0.6kgf.m, 2.9 ~ 4.3lb-ft)
2st : 18.62 ~ 23.52Nm
(1.9 ~ 2.4kgf.m, 13.74 ~ 17.36lb-ft)
3st : Repeat 2nd step twice or more.

NOTICE

Be careful of the installation direction.

a - h : 1st step order

1 ~ 8 : 2nd step order

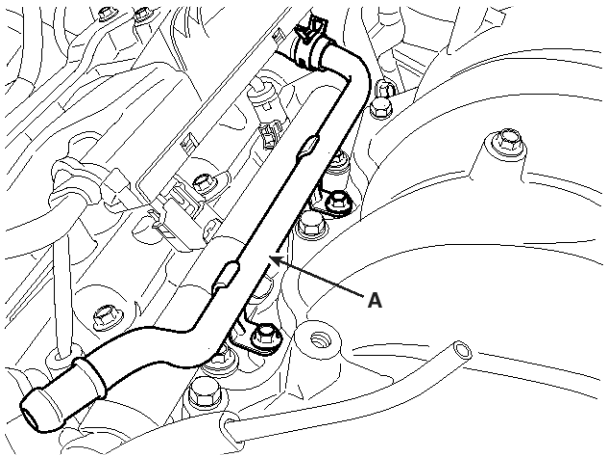


SENM17211L

2. Install the delivery pipe.(Refer to Delivery pipe in FL Group)
3. Connect the LH injector harness connectors.
4. Connect the breather pipe assembly(A).

Tightening torque

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



SENM17001L

5. Install the surge tank.

Tightening torque

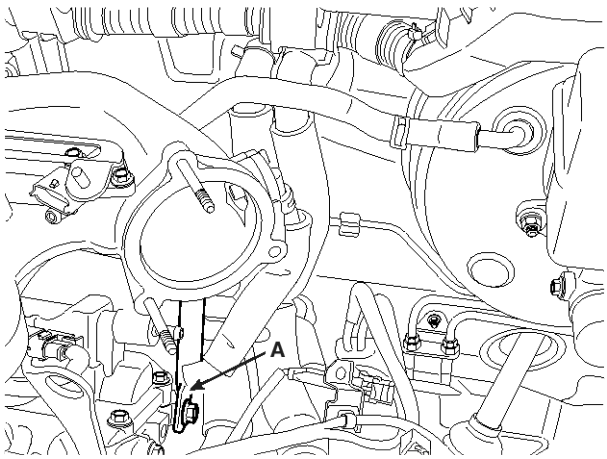
9.80 ~ 11.76Nm (1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft) - Long bolt 1EA
18.62 ~ 23.52Nm (1.9 ~ 2.4kgf.m, 13.74 ~ 17.36lb-ft) - Short bolts 3EA/Nuts 2EA

6. Install the surge tank stays(A).

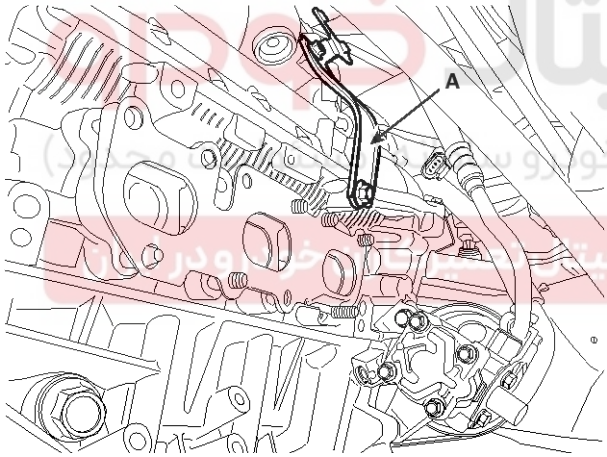
Tightening torque

27.44 ~ 31.36Nm (2.8 ~ 3.2kgf.m, 20.25 ~ 23.14lb-ft) - Engine front side

18.62 ~ 23.52Nm (1.9 ~ 2.4kgf.m, 13.74 ~ 17.36lb-ft) - Engine rear side

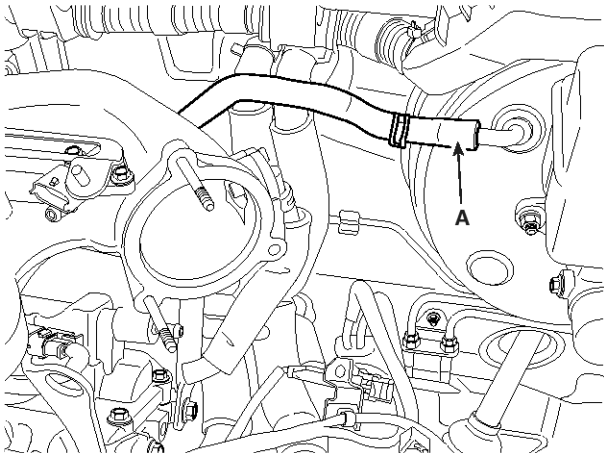


SENM17209L



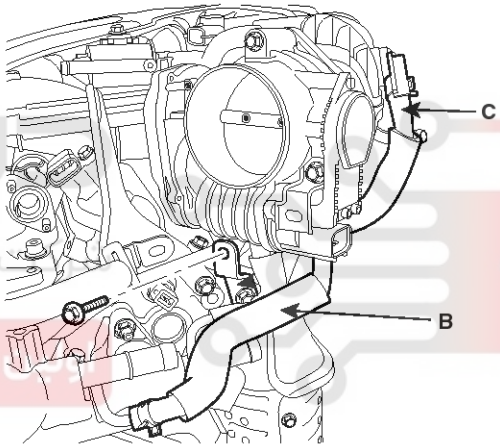
SENM17018L

7. Connect the brake vacuum hose(A).



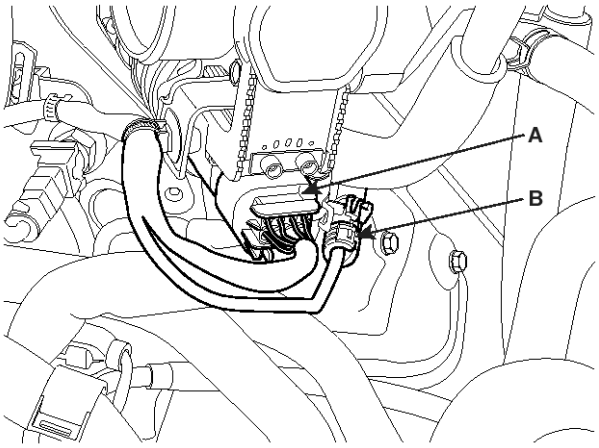
SENM17302L

8. Connect the PCV hose(C).
9. Connect the water hoses(B) to ETC.



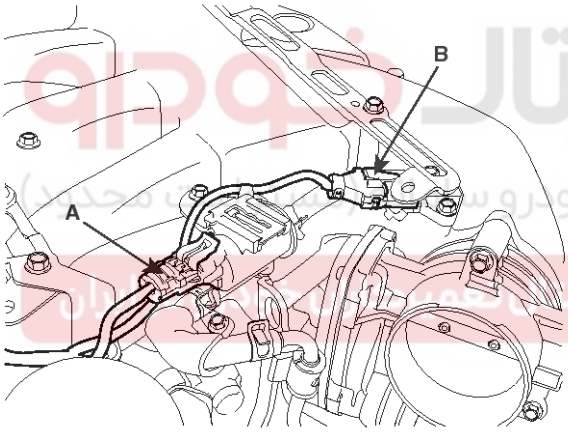
SENM17303L

10. Connect the ETC connector(A) and the knock sensor connector(B).



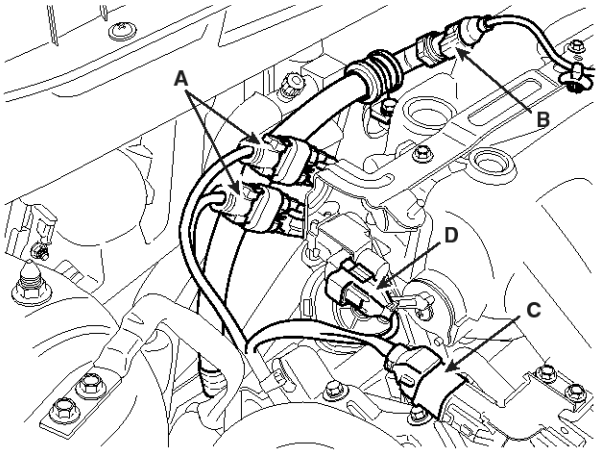
KDRF162A

11. Connect the PCSV connector(A), the MAP sensor connector and the PCSV hose(B).



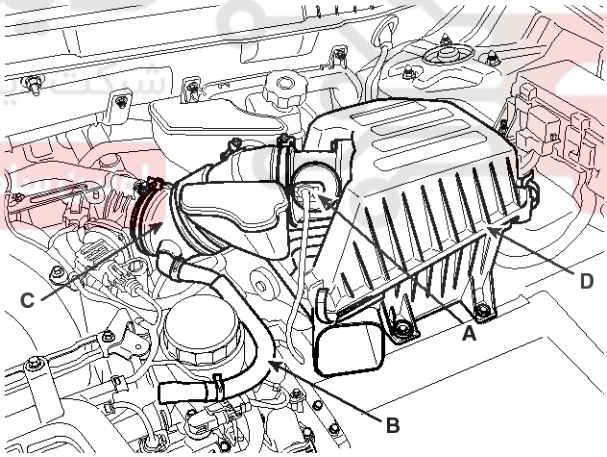
UCBF003A

12. Connect the RH injector harness connector(C) and the VIS solenoid valve connector(D).
13. Connect the RH front and rear oxygen sensor connectors(A) and the power steering sensor connector(B).



SENM17207L

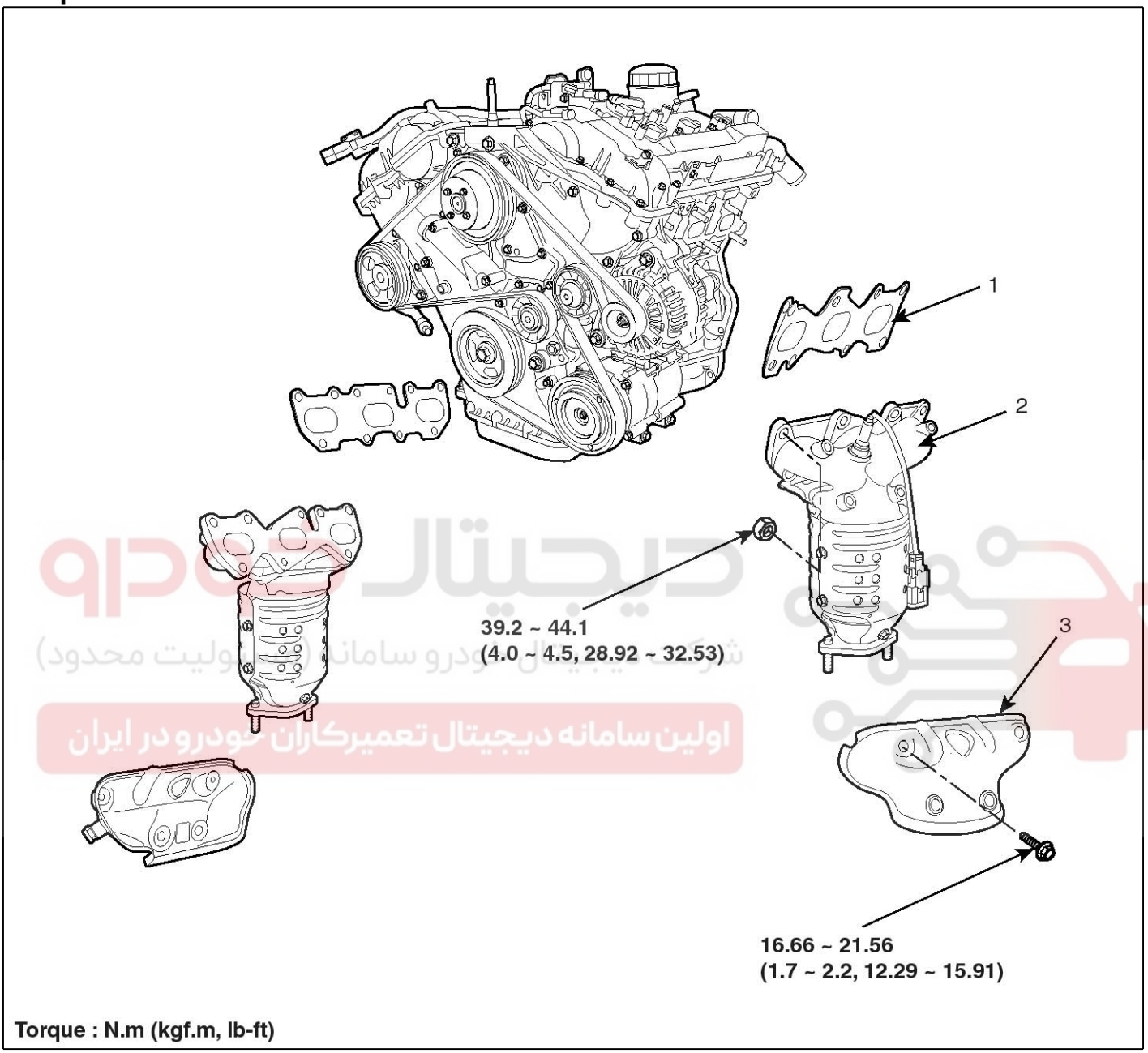
14. Install the air cleaner body(D) and the intake hose(C).
15. Connect the AFS(A) connector and the breather hose(B).



SENM17004L

Exhaust Manifold

Components

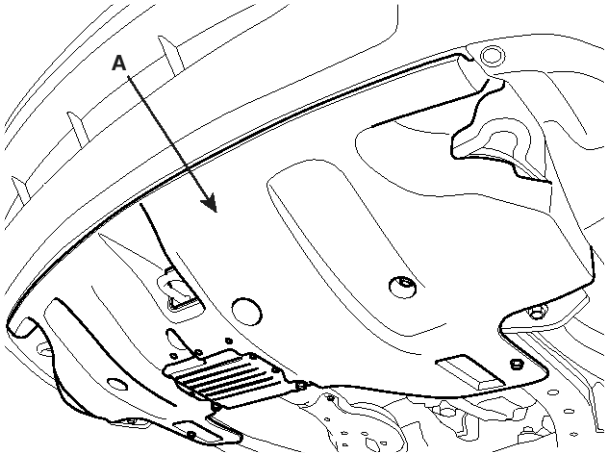


SENEM9011N

1. Gasket
2. Exhaust manifold
3. Heat protector

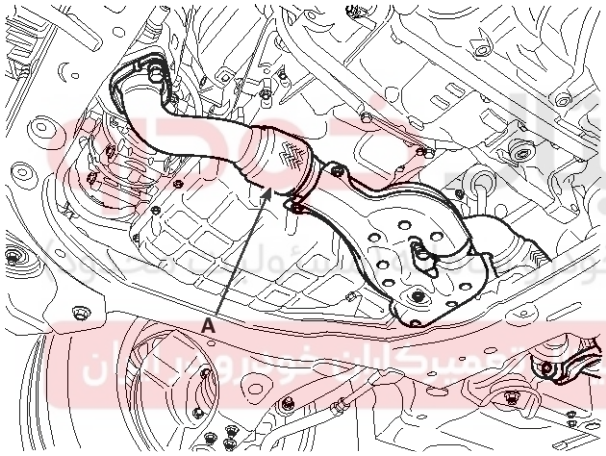
Removal

1. Remove the under cover(A).



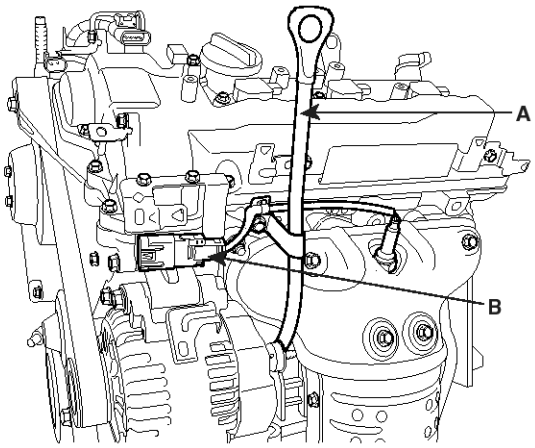
SENM17304L

2. Remove the front muffler(A).



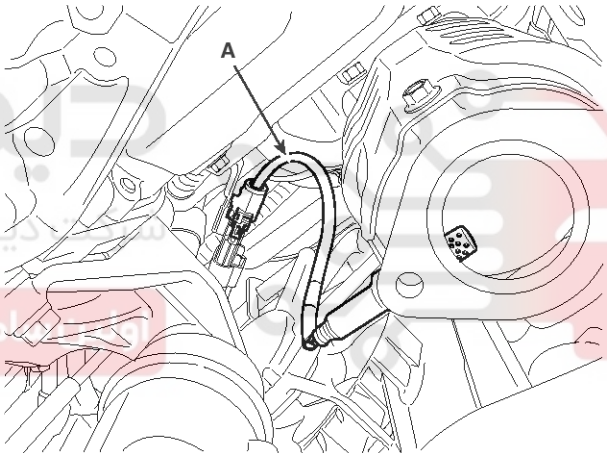
SENM17012L

3. Remove the oil level gauge(A).
4. Disconnect the LH front oxygen sensor connector(B) from the bracket.



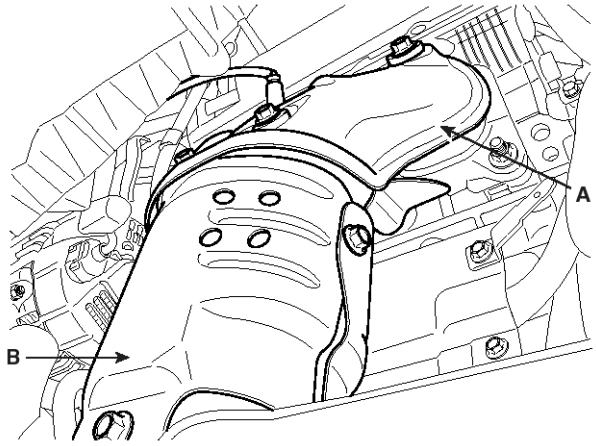
UCBF010A

5. Disconnect the LH rear oxygen sensor connector(A).



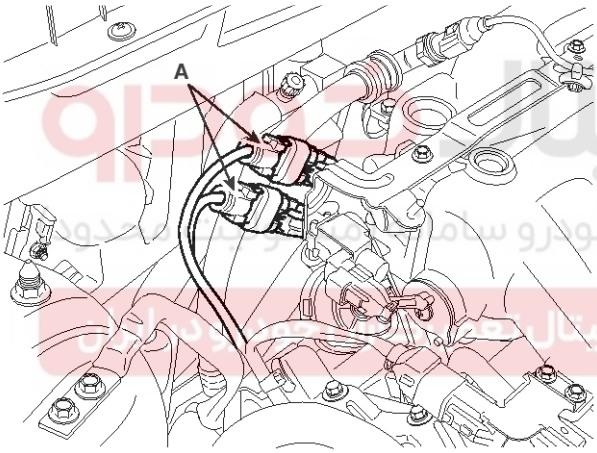
SENM17020L

6. Remove the LH heat protector(A).
7. Remove the LH exhaust manifold(B).



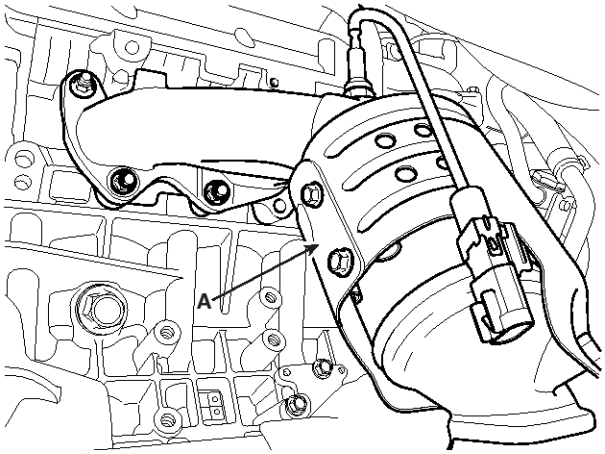
SENM17021L

8. Disconnect the RH front and rear oxygen sensor connectors(A) from bracket.



SENM17212L

9. Remove the RH heat protector.
10. Remove the RH exhaust manifold(A).



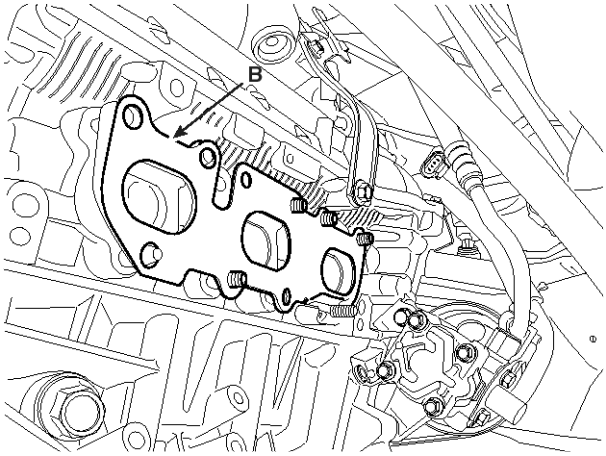
SENM17022L

Installation

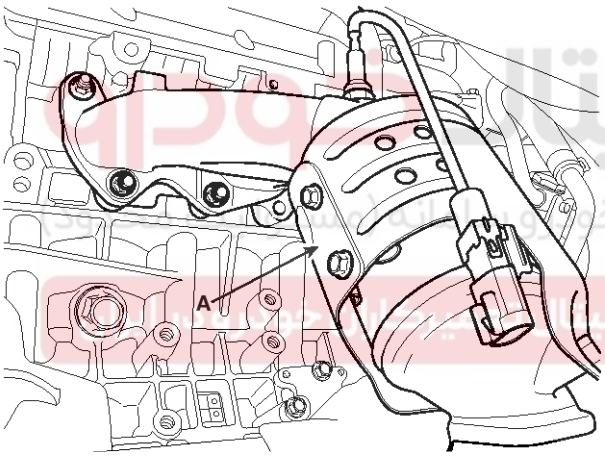
1. Install a new gasket(B) and the exhaust manifold(A).

Tightening torque

39.2 ~ 44.1Nm(4.0 ~ 4.5kgf.m, 28.92 ~ 32.53lb-ft)



SENM17214L



SENM17022L

2. Install the heat protector.

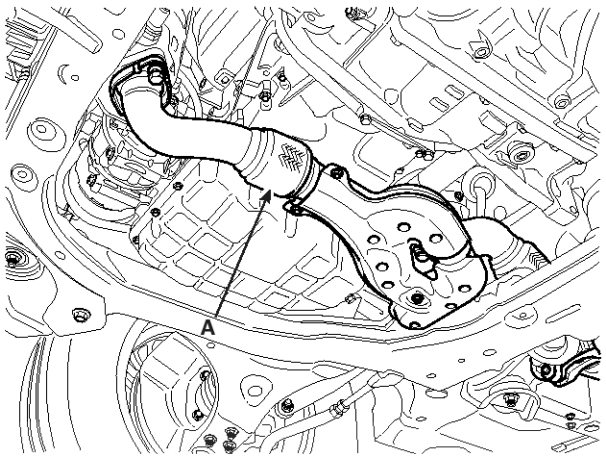
Tightening torque

16.66 ~ 21.56Nm(1.7 ~ 2.2kgf.m, 12.30 ~ 15.91lb-ft)

3. Install the front muffler(A).

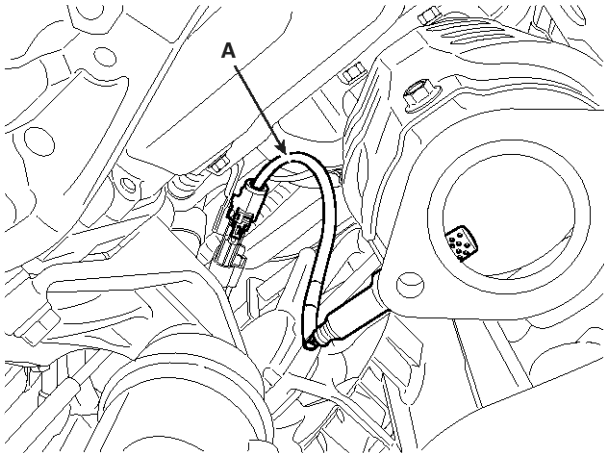
Tightening torque

39.2 ~ 58.8N.m(4.0 ~ 6.0kgf.m, 28.92 ~ 43.37lb-ft)

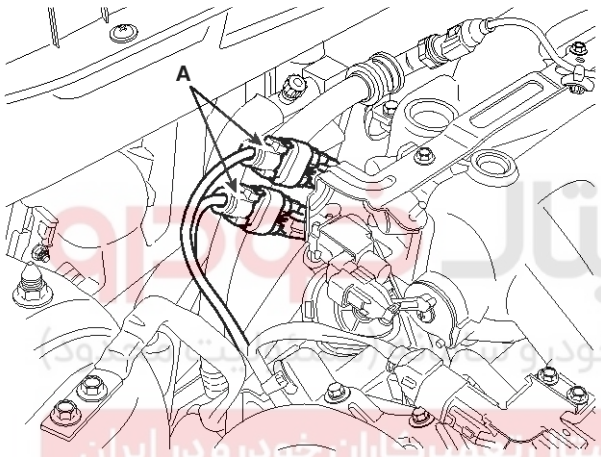


SENM17012L

4. Connect the oxygen sensor connectors(A).

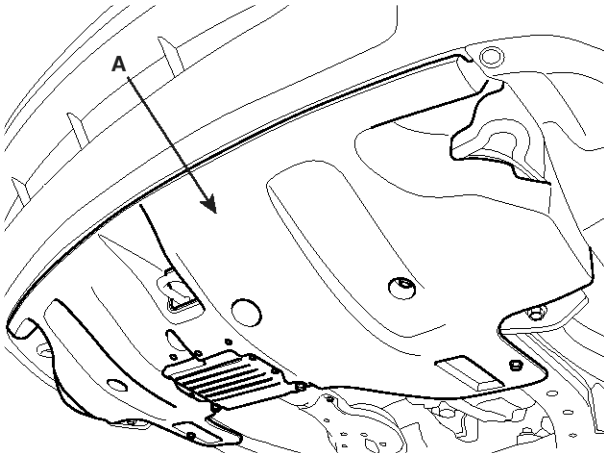


SENM17020L



SENM17212L

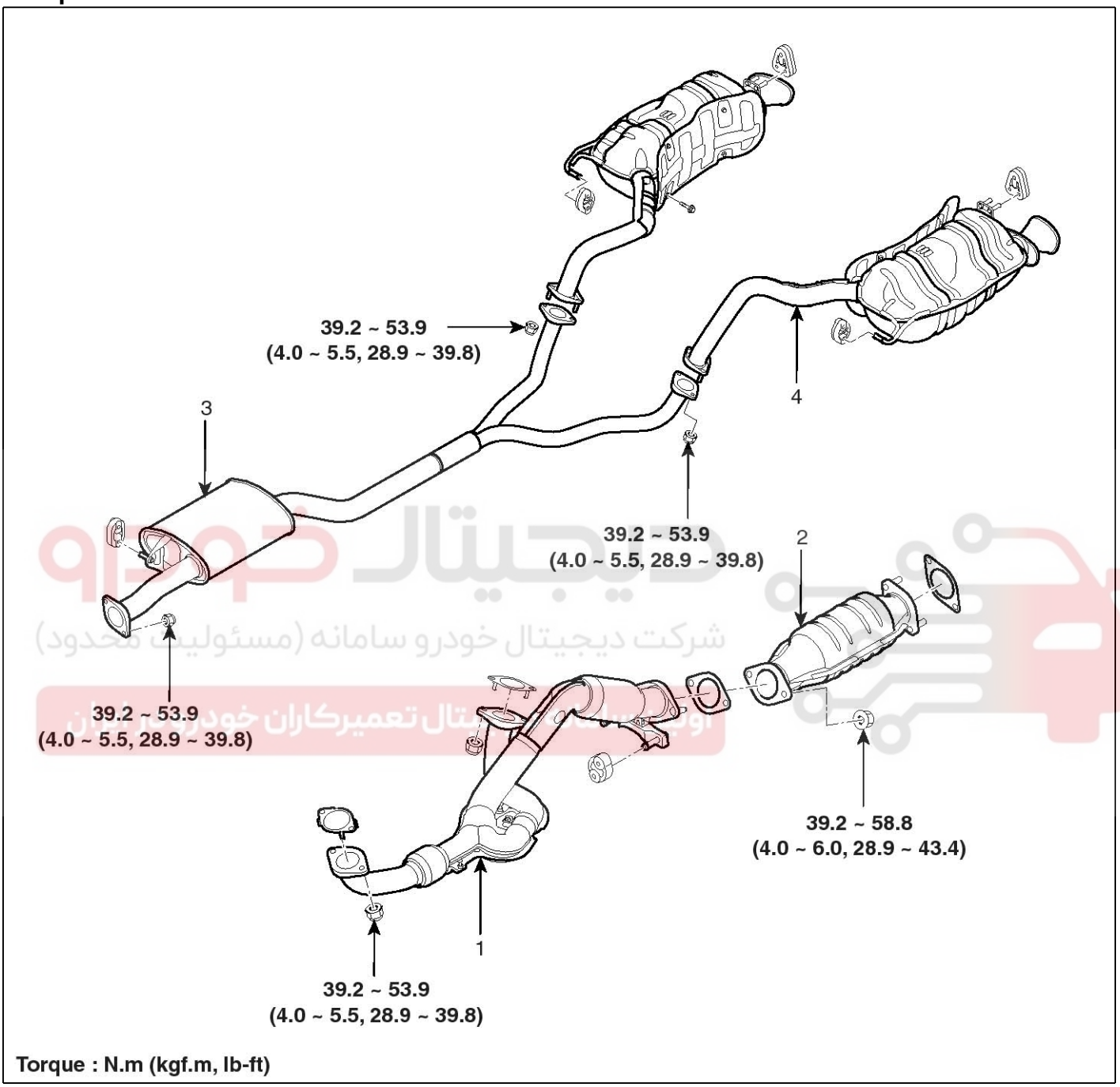
5. Install the under cover(A).



SENM17304L

Muffler

Components



SENM19001L

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