General Information

Specifications

Description	Specifications	Limit
General		
Type	In-line, Double Overhead Camshaft	
Number of cylinder	4	
Bore	86mm (3.385in) / 88mm (3.464in)	
Stroke	86mm (3.385in) / 97mm (3.819in.)	
Total displacement	1998cc (121.92in) / 2359cc (143.90cu.in.)	
Compression ratio	10.5	
Firing order	1-3-4-2	
Valve timing		
Intake valve		
Opens	ATDC 7° ~ 38°	
Closes	ABDC 67° ~ 22°	
Exhaust		
Opens	BBDC 44° ~ 4°	
Closes	ATDC 0° ~ 40°	
Valve		
Valve length		
Intake	113.18mm (4.4559in.)	112.93mm (4.4460in)
Exhaust	105.84mm (4.1669in.)	105.59mm (4.1570in)
Stem O.D.		
Intake	5.465 ~ 5.480mm (0.2151 ~ 0.2157in.)	
Exhaust	5.458 ~ 5.470mm (0.2149 ~ 0.2153in.)	
Face angle	45.25° ~ 45.75°	
Margin		
Intake	1.02mm (0.0401in.)	
Exhaust	1.09mm (0.0429in.)	
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		
Length		
Intake	43.8 ~ 44.2mm (1.7244 ~ 1.7401in.)	
Exhaust	43.8 ~ 44.2mm (1.7244 ~ 1.7401in.)	

Description	Specifications	Limit
Valve seat		
Width of seat contact		
Intake	1.16 ~ 1.46mm (0.0457 ~ 0.0575in.)	
Exhaust	1.35 ~ 1.65mm (0.0531 ~ 0.0649in.)	
Seat angle	44.75° ~ 45.10°	
Valve spring		
Free length	47.44mm (1.8677in.)	
Load	19.0 ± 0.6kg/35.0mm (41.88 ± 1.32lb/1.3779in.)	
Squarences	39.8 ± 1.2kg/26.0mm (87.74 ± 2.64lb/1.0236in.)	
	1.5° MAX.	
Valve clearance		
Cold (20°C[68°F])		
Intake	0.17 ~ 0.23mm (0.0067 ~ 0.0090in.)	0.10 ~ 0.30mm (0.0039 ~ 0.0118in.)
Exhaust	0.27 ~ 0.33mm (0.0106 ~ 0.0129in,)	0.20 ~ 0.40mm (0.0078 ~ 0.0157in.)
Cylinder head		
Flatness of gasket surface	Max. 0.05mm (0.0019in.)	
Flatness of manifold mounting surface	Max. 0.10mm (0.0039in.)	
Cylinder block		
Cylinder bore [2.0 / 2.4]	86.00 ~ 86.03mm (3.3858 ~ 3.3870in.) / 88.00 ~ 88.03mm (3.4645 ~ 3.4657in.)	
Out-of-round and taper of cylinder bore	Less than 0.05mm (0.0019in.)	
Clearance with piston (To set limits to new parts)	0.015 ~ 0.035mm (0.0005 ~ 0.0013in.)	
Piston		
O.D (To set limits to new parts) [2.0 / 2.4]	85.975 ~ 86.0050mm (3.3848 ~ 3.3860in.) / 87.975 ~ 88.005mm (3.4635 ~ 3.4647in.)	
Ring groove width		
No.1	1.235 ~ 1.250mm (0.0486 ~ 0.0492in.)	1.26mm (0.0496in.)
No.2	1.230 ~ 1.250mm (0.0484 ~ 0.0492in.)	1.26mm (0.0496in.)
Oil ring	2.01 ~ 2.03mm (0.0791 ~ 0.0799in.)	2.05mm (0.0807in.)
Piston ring		
Side clearance		
No.1	0.05 ~ 0.08mm (0.0019 ~ 0.0031in.)	0.1mm (0.004in.)
No.2	0.04 ~ 0.08mm (0.0015 ~ 0.0031in.)	0.1mm (0.004in.)
Oil ring	0.06 ~ 0.13mm (0.0023 ~ 0.0051in.)	0.2mm (0.008in.)

Description			Specifications	Limit
End gap				
No.1			0.15 ~ 0.30mm (0.0059 ~ 0.0118in.)	0.6mm (0.0236in.)
No.2			0.30 ~ 0.52mm (0.0118 ~ 0.0204in.)	0.7mm (0.0275in.)
Oil ring side rail			0.20 ~ 0.70mm (0.0078 ~ 0.0275in.)	0.8mm (0.0315in.)
Connecting rod				
Bend			0.05mm (0.0020in.) or less	
Twist			0.1mm (0.004in.) or less	
Connecting rod big end to crankshaft side clearance			0.100 ~ 0.250mm (0.0039 ~ 0.010in.)	0.35mm (0.0138in.)
Connecting rod bearing				
Oil clearance (To seat limits to new parts)			0.025 ~ 0.043mm (0.0009 ~ 0.0016in.)	0.05mm (0.0078in.)
Camshaft				
Cam height	Intake		44.20mm (1.7401in.)	
	Exhaust		45.00mm (1.7716in.)	
Journal O.D	Intake	No.1	ϕ 30mm (1.1811in.)	
		No.2, 3, 4, 5	ϕ 24mm (0.9449in.)	
	Exhaust	No.1	ϕ 36mm (1.4173in.)	
		No.2, 3, 4, 5	ϕ 24mm (0.9449in.)	
Bearing oil clearance	Intake	No.1	0.022 ~ 0.057mm (0.0008 ~ 0.0022in.)	0.09mm (0.0035in.)
		No.2, 3, 4, 5	0.045 ~ 0.082mm (0.0017 ~ 0.0032in.)	0.12mm (0.0047in.)
	Exhaust	No.1	0 ~ 0.032mm (0 ~ 0.0012in.)	
		No.2, 3, 4, 5	0.045 ~ 0.082mm (0.0017 ~ 0.0032in.)	0.12mm (0.0047in.)
End play			0.04 ~ 0.16mm (0.0015 ~ 0.0062in.)	0.20mm (0.0047in.)
Crankshaft				
Pin O.D.			47.954 ~ 47.972mm (1.8879 ~ 1.8886in.)	
Journal O.D.			51.942 ~ 51.960mm (2.0449 ~ 2.0456in.)	
End play			0.07 ~ 0.25mm (0.0027 ~ 0.0098in.)	
Crankshaft bearing				
Oil clearance			0.020 ~ 0.038mm (0.0007 ~ 0.0014in.)	
Cooling method			Water-cooled, pressurized. Forced circulation with water pump	
Engine oil				

Description		Specifications	Limit
Oil quantity	Total(2.0/2.4)	4.7 L(4.97 US qt, 4.13 Imp qt)/ 5.4 L (5.70 US qt, 4.75 Imp qt)	When replacing a short engine or a block assembly
	Oil pan(2.0/2.4)	3.8 L (4.02 US qt, 3.34 Imp qt)/ 4.2 L (4.43 US qt, 3.69 Imp qt)	
	Drain and refill(2.0/2.4)	4.1 L (4.33 US qt, 3.61 Imp qt)/ 4.5 L (4.75 US qt, 3.95 Imp qt)	Including oil filter
Oil grade	Recommendation (except Middle East)	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)[2.0/2.4]		108kPa (1.1kg/cm², 15.65psi) or above/ 147kPa (1.5kg/cm², 21.34psi) or above	Oil temperature in oil pan : 110±2°C (230±36°F)
Radiator			
Type		Pressurized corrugated fin type	
Radiator cap			
Main valve opening pressure		83 ~ 110kpa (12 ~ 16psi, 0.83 ~ 1.1kg/cm²)	
Vacuum valve opening pressure		-7kpa (-100psi, -0.07kg/cm²) or less	
Thermostat			
Type		Wax pellet type with jiggle valve	
Valve opening temperature		82°C (177°F)	
Full-opening temperature		95°C (201°F)	
Coolant pump		Centrifugal type impeller	
Drive belt			
Type		V-ribbed belt	
Engine coolant temperature sensor			
Type		Heat-sensitive thermistor type	
Resistance		2.31 ~ 2.59KΩ at 20°C (68°F)	
Air cleaner			
Type		Dry type	
Element		Unwoven cloth type	
Exhaust pipe			

Description	Specifications	Limit
Muffler	Expansion resonance type	
Suspension system	Rubber hangers	

Service Standrds

Standard value	
Antifreeze	Maxture ratio of anti-freeze in coolant
ETHYLENE GLYCOL BASE FOR ALUMINUM	50%

Tightening Torques

Item	N.m	kgf.m	lb-ft
Ladder frame bolt (M8 x 55)	23.5 ~ 27.4	2.4 ~ 2.8	17.4 ~ 20.2
Ladder frame bolt (M8 x 103)	23.5 ~ 27.4	2.4 ~ 2.8	17.4 ~ 20.2
Oil pump & Balance shaft module bolt (BSM)	16.7+ 60° + 60°	1.7 + 60° + 60°	12.3 + 60° + 60°
Oil pump bolt (NON BSM)	8.8 + 16.7 + 25.5	0.9 + 1.7 + 2.6	6.5 + 12.3 + 18.8
Timing chain cover bolt (M8)	18.6 ~ 22.5	1.9 ~ 2.3	13.7 ~ 16.6
Timing chain cover bolt (M6)	7.8 ~ 9.8	0.8 ~ 1.0	5.8 ~ 7.2
Oil pan bolt (M6 x 10)	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Oil pan bolt (M8 x 103)	26.5 ~ 30.4	2.7 ~ 3.1	19.5 ~ 22.4
Engine support bracket bolt (M8 x 30)	19.6 ~ 24.5	2.0 ~ 2.5	14.5 ~ 18.1
Engine support bracket bolt (M10 x 40)	39.2 ~ 44.1	4.0 ~ 4.5	28.9 ~ 32.5
Engine support bracket bolt (M12 x 45)	39.2 ~ 44.1	4.0 ~ 4.5	28.9 ~ 32.5
Camshaft bearing cap bolt (M6)	10.8 ~ 12.7	1.1 ~ 1.3	7.9 ~ 9.4
Camshaft bearing cap bolt (M8)	27.4 ~ 31.4	2.8 ~ 3.2	20.3 ~ 23.1
Cylinder head bolt	(32.4~36.3) + (90~95°) + (90~95°)	(3.3~3.7) + (90~95°) + (90~95°)	(23.9~26.8) + (90~95°) + (90~95°)
Engine hanger bolt	27.5 ~ 31.4	2.8 ~ 3.2	20.3 ~ 23.1
Cylinder head cover bolt	7.8 ~ 9.8	0.8 ~ 1.0	5.8 ~ 7.2
Crankshaft pulley bolt	166.6 ~ 176.4	17.0 ~ 18.0	122.9 ~ 130.1
Connecting rod bearing cap bolt	(17.7~21.6) + (88~92°)	(1.8~2.2) + (88~92°)	(13.0~15.9) + (88~92°)
Main bearing cap bolt	14.7 + (27.5~31.4) + (120~125°)	1.5 + (2.8~3.2) + (120~125°)	10.8 + (20.3~23.1) + (120~125°)
Flywheel bolt	117.6 ~ 127.4	12.0 ~ 13.0	86.8 ~ 93.9
Drive plate bolt	117.6 ~ 127.4	12.0 ~ 13.0	86.8 ~ 93.9
Timing chain tensioner bolt	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Timing chain tensioner arm bolt	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Timing chain guide bolt	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
OCV bolt	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
CVVT bolt	53.9 ~ 63.7	5.5 ~ 6.5	39.7 ~ 47.0
BSM chain tensioner arm bolt	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
BSM chain guide bolt	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
BSM chain tensioner bolt	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Oil pump chain guide bolt (NON BSM)	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Oil pump chain tensioner bolt (NON BSM)	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Water pump bolt	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4

Item	N.m	kgf.m	lb-ft
A/C compressor bracket bolt	19.6 ~ 23.5	2.0 ~ 2.4	14.5 ~ 17.4
P/S pump bracket bolt	44.1 ~ 53.9	4.5 ~ 5.5	32.5 ~ 39.8
Tensioner assy intergrated bracket bolt	39.2 ~ 44.1	4.0 ~ 4.5	28.9 ~ 32.5
Water temp. control bolt & nut	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Water inlet pipe nut	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Oil level gauge assembly bolt	7.8 ~ 11.8	0.8 ~ 1.2	5.8 ~ 8.7
Ignition coil bolt	3.9 ~ 5.9	0.4 ~ 0.6	2.9 ~ 4.3
Intake manifold bolt	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Intake manifold nut	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Intake manifold stay bolt	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Exhaust manifold heat protector bolt	7.8 ~ 11.8	0.8 ~ 1.2	5.8 ~ 8.7
Exhaust manifold nut	39.2 ~ 44.1	4.0 ~ 4.5	28.9 ~ 32.5
Exhaust manifold stay bolt (M8)	18.6 ~ 27.5	1.9 ~ 2.8	13.7 ~ 20.3
Exhaust manifold stay bolt (M10)	42.2 ~ 53.9	4.3. ~ 5.5	31.1 ~ 39.8
Muffler bolt	39.2 ~ 58.8	4.0 ~ 6.0	28.9 ~ 43.4
Engine cover mounting bracket bolt	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Crankshaft position sensor bolt	3.9 ~ 5.9	0.4 ~ 0.6	2.9 ~ 4.3
Oxygen sensor	34.3 ~ 44.1	3.5 ~ 4.5	25.3 ~ 32.5
Knock sensor	16.7 ~ 25.5	1.7 ~ 2.6	12.3 ~ 18.8
Camshaft position sensor	3.9 ~ 5.9	0.4 ~ 0.6	2.9 ~ 4.3
Oil pressure switch	7.8 ~ 11.8	0.8 ~ 1.2	5.8 ~ 8.7
Oil filter	11.8 ~ 15.7	1.2 ~ 1.6	8.7 ~ 11.6

Compression Pressure Inspection

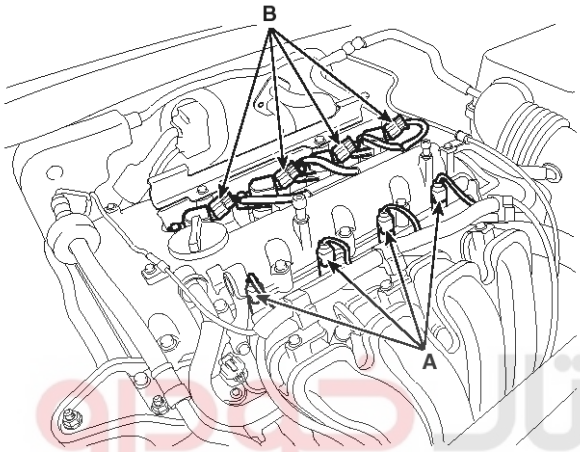
NOTICE

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

1. Warm up and stop engine.

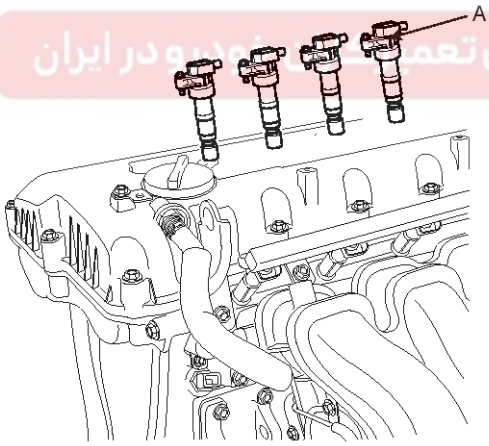
   Allow the engine to warm up to normal operating temperature.

2. Disconnect the injector connectors (A) and ignition coil connectors (B).



SMGEM9001D

3. Remove ignition coils(A).



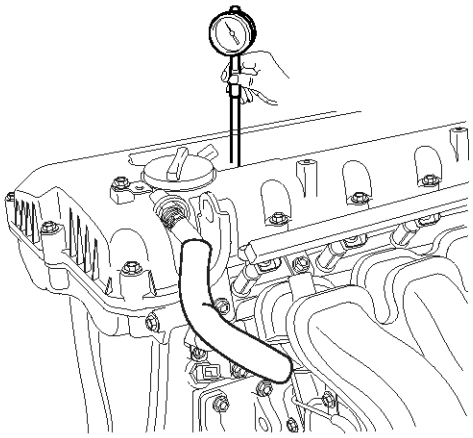
SNFEM8084L

4. Remove spark plugs.

   Using a 16mm plug wrench, remove the 4 spark plugs.

5. Check cylinder compression pressure.

   a. Insert a compression gauge into the spark plug hole.



SNFEM8076D

   b. Fully open the throttle.

   c. While cranking the engine, measure the compression pressure.

   NOTICE

   Always use a fully charged battery to obtain engine speed of 200 rpm or more.

   d. Repeat steps (a) through (c) for each cylinder.

   NOTICE

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

Compression pressure :
1,283kPa (13.0kgf/cm², 185psi)
Minimum pressure :
1,135kPa (11.5kgf/cm², 164psi)
Difference between each cylinder :
100kPa (1.0kgf/cm², 15psi) or less

   e. 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 (a) through (c) 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.

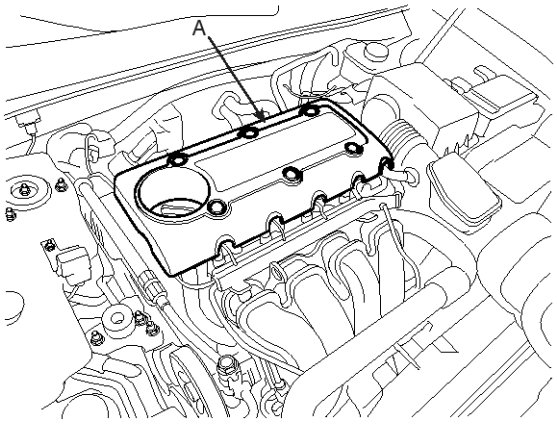
6. Reinstall spark plugs.
7. Install ignition coils.
8. Connect the injector connectors and ignition coil connectors.

Valve Clearance Inspection And Adjustment

NOTICE

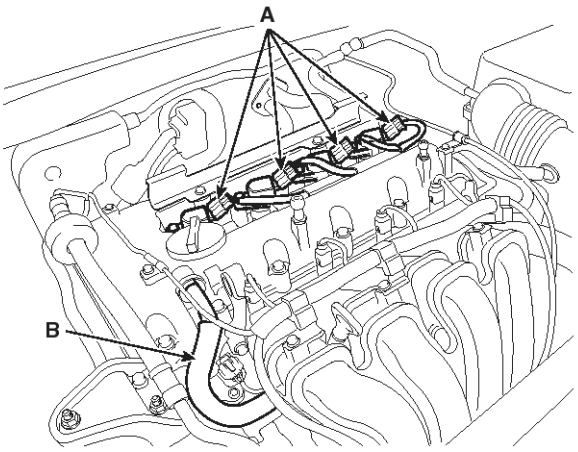
Inspect and adjust the valve clearance when the engine is cold (Engine coolant temperature : 20˚C(68˚F)) and cylinder head is installed on the cylinder block.

1. Remove the engine cover(A).



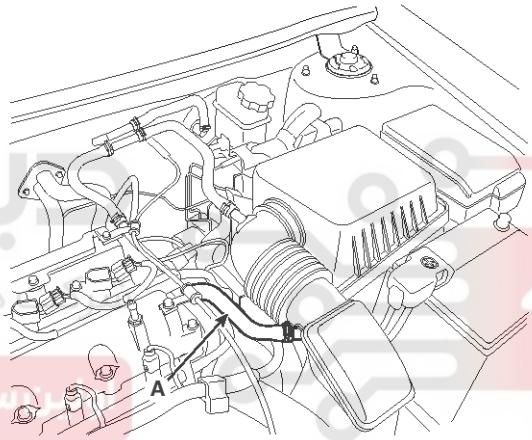
SNFEM8001D

2. Remove the cylinder head cover.
   a. Disconnect the ignition coil connectors(A) and remove the ignition coils.
   b. Disconnect the P.C.V hose(B).



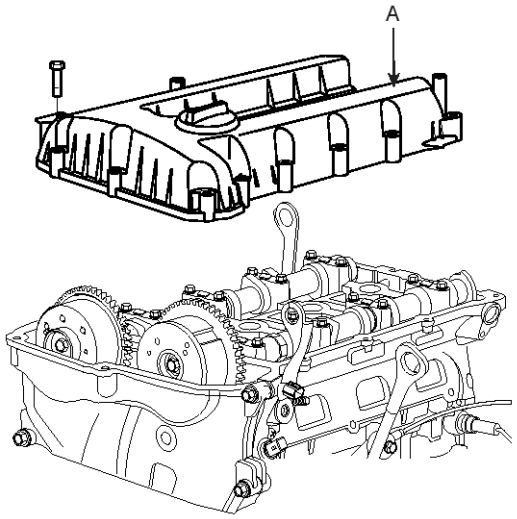
SMGEM9003D

   c. Disconnect the breather hose (A).



SMGEM9005D

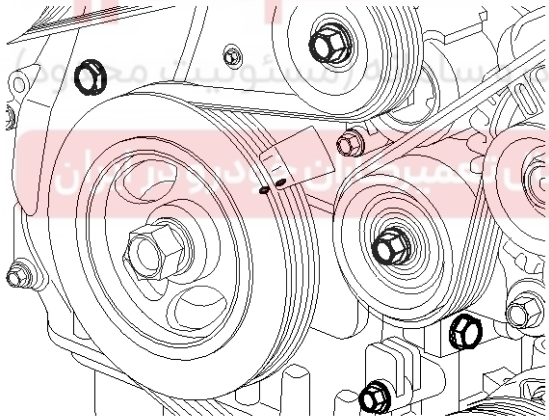
d. Loosen the cylinder head cover bolts and then remove the cover(A) and gasket.



SNFEM8019D

3. Set No.1 cylinder to TDC/compression.

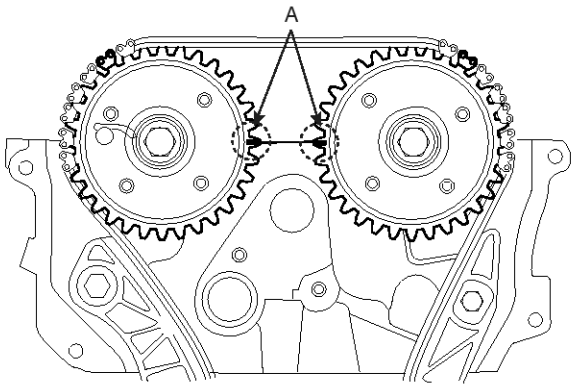
a. Turn the crankshaft pulley and align its groove with the timing mark "T" of the lower timing chain cover.



SNFEM8077D

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

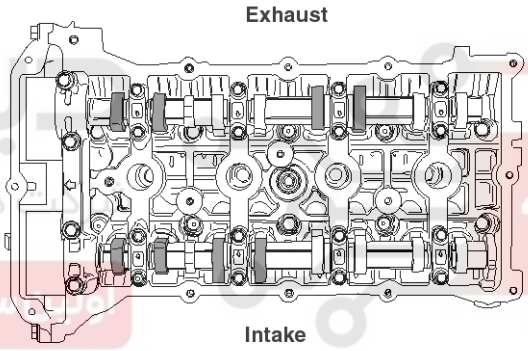
If not, turn the crankshaft one revolution (360˚)



SNFEM8017D

4. Inspect the valve clearance.

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



No1. Cylinder TDC/compression

SNFEM8079L

・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]

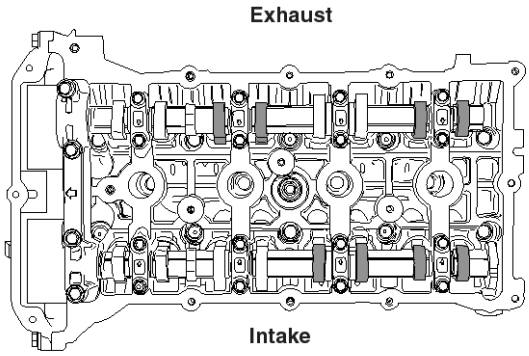
Limit

Intake : 0.10 ~ 0.30mm (0.0039 ~ 0.0118in.)

Exhaust : 0.20 ~ 0.40mm (0.0079 ~ 0.0157in.)

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

c. Check only valves indicated as shown. [NO. 4 cylinder : TDC/compression]. Measure the valve clearance.



No4. Cylinder TDC/compression

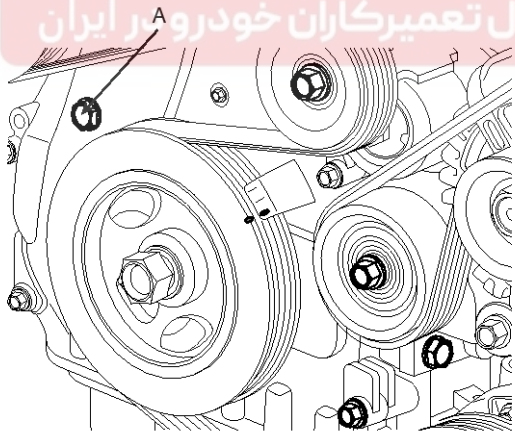
SNFEM8080L

5. Adjust the intake and exhaust valve clearance.

a. Set the No.1 cylinder to the TDC/compression.

b. Marks on the timing chain and camshaft timing sprockets.

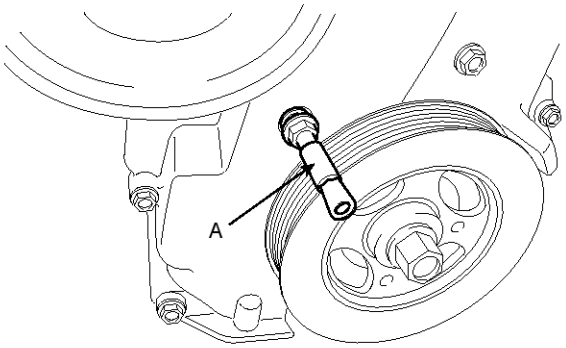
c. Remove the service hole bolt(A) of the timing chain cover.



SNFEM8078D

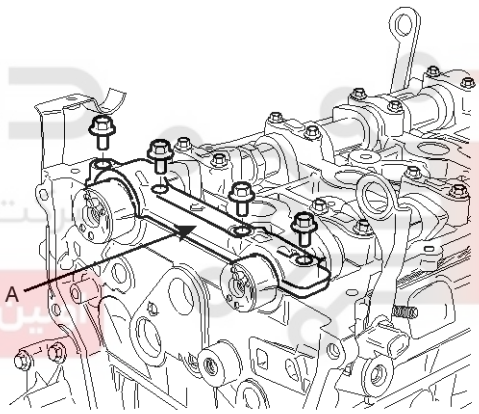
⚠CAUTION
The bolt must not be reused once it has been assembled.

d. Insert the SST(A) (09240-2G000) in the service hole of the timing chain cover and release the ratchet.



SMGEM8006D

e. Remove the front camshaft bearing cap(A).



SNFEM8054D

f. Remove the exhaust camshaft bearing cap and exhaust camshaft.

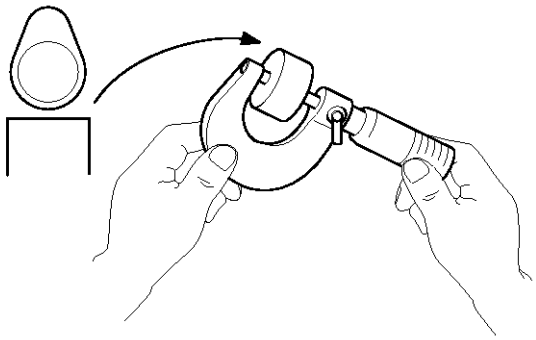
g. Remove the intake camshaft bearing cap and intake camshaft.

⚠CAUTION
When disconnect the timing chain from the camshaft timing sprocket, hold the timing chain.

h. Tie down timing chain so that it dosen't move.

⚠CAUTION
Be careful not to drop anything inside timing chain cover.

i. Measure the thickness of the removed tappet using a micrometer.



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

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

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

NOTICE
Shims are available in 47size increments of 0.015mm (0.0006in.) from 3.00mm (0.118in.) to 3.690mm (0.1452in.)

l. Place a new tappet on the cylinder head.

m. Hold the timing chain, and install the intake camshaft and timing sprocket assembly.

n. Align the matchmarks on the timing chain and camshaft timing sprocket.

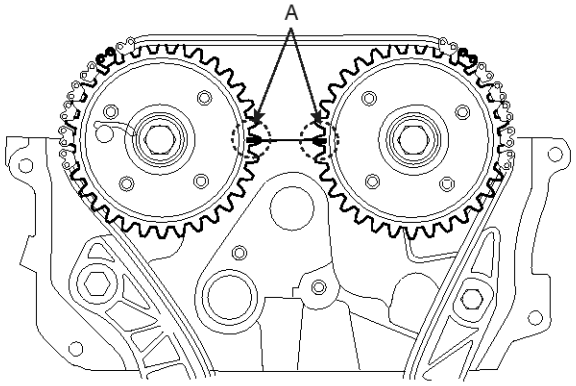
o. Install the intake and exhaust camshaft.

p. Install the front bearing cap.

q. Install the sevice hole bolt.

Tightening torque :
11.8 ~ 14.7N.m (1.2 ~ 1.5kgf.m, 8.7 ~ 10.8lb-ft)

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



SNFEM8017D

s. Recheck the valve clearance.

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

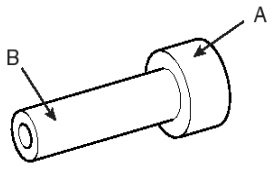
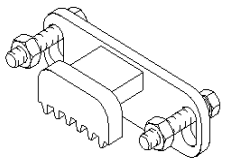
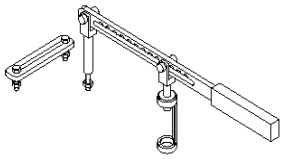
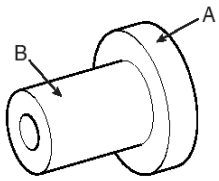
Troubleshooting

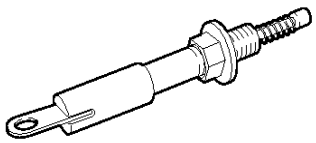
Symption	Suspect area	Remedy
Engine misfire with abnormal internal lower engine noises.	Worn crankshaft bearings Loose or improperly engine filwheel	Replace the crankshaft and bearings as required. Repair or replace the flywheel as required.
	Worn piston rings (Oil consumption may or may not cause the 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 buidup 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 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.

Symption	Suspect area	Remedy
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.
	Stetched 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 or replace 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 or replace as required.
	Worn drive belt, idler, tensioner and bearing.	Replace as required
Lower engine noise, regardless of engine speed	Low oil pressure	Repair or required.
	Loose or damaged flywheel.	Repair or replace the flywheel.
	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 or replace 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 or replace as required. • The connecting rod bearings. • The connecting rods. • The crankshaft pin journals.
	Excessive crankshaft bearing clearance	Inspect the following components, and repair or replace 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.

Symption	Suspect area	Remedy
Engine noise under load	Low oil pressure	Repair or replace as required.
	Excessive connecting rod bearing clearance	Inspect the following components and repair or replace as required : • The connecting rod bearings. • The connecting rods. • The crankshaft
	Excessive crankshaft bearing clearance	Inspect the following components, and repair or replace as required. • The crankshaft bearings. • The crankshaft main journals. • The cylinder block.
Engine will not crank-crankshaft will not rotate	Hydraulically locked cylinder • Coolant/antifreeze in cylinder. • Oil in cylinder. • Fuel in cylinder	1. Remove spark plugs and check for fluid. 2. Inspect for broken head gasket. 3. Inspect for cracked engine block or cylinder head. 4. Inspect for a sticking fuel injector and/or leaking fuel regulator.
	Broken timing chain and/or timing chain and/or timing chain gears.	1. Inspect timing chain and gears. 2. Repair as required.
	Material in cylinder • Broken valve • Piston material • Foreign material	1. Inspect cylinder for damaged components and/or foreign materials. 2. Repair or replace as required.
	Seized crankshaft or connecting rod bearings.	1. Inspect crankshaft and connecting rod bearing. 2. Repair as required.
	Bent or broken connecting rod.	1. Inspect connecing rods. 2. Repair as required.
	Broken crankshaft	1. Inspect crankshaft. 2. Repair as required.

Special Service Tools

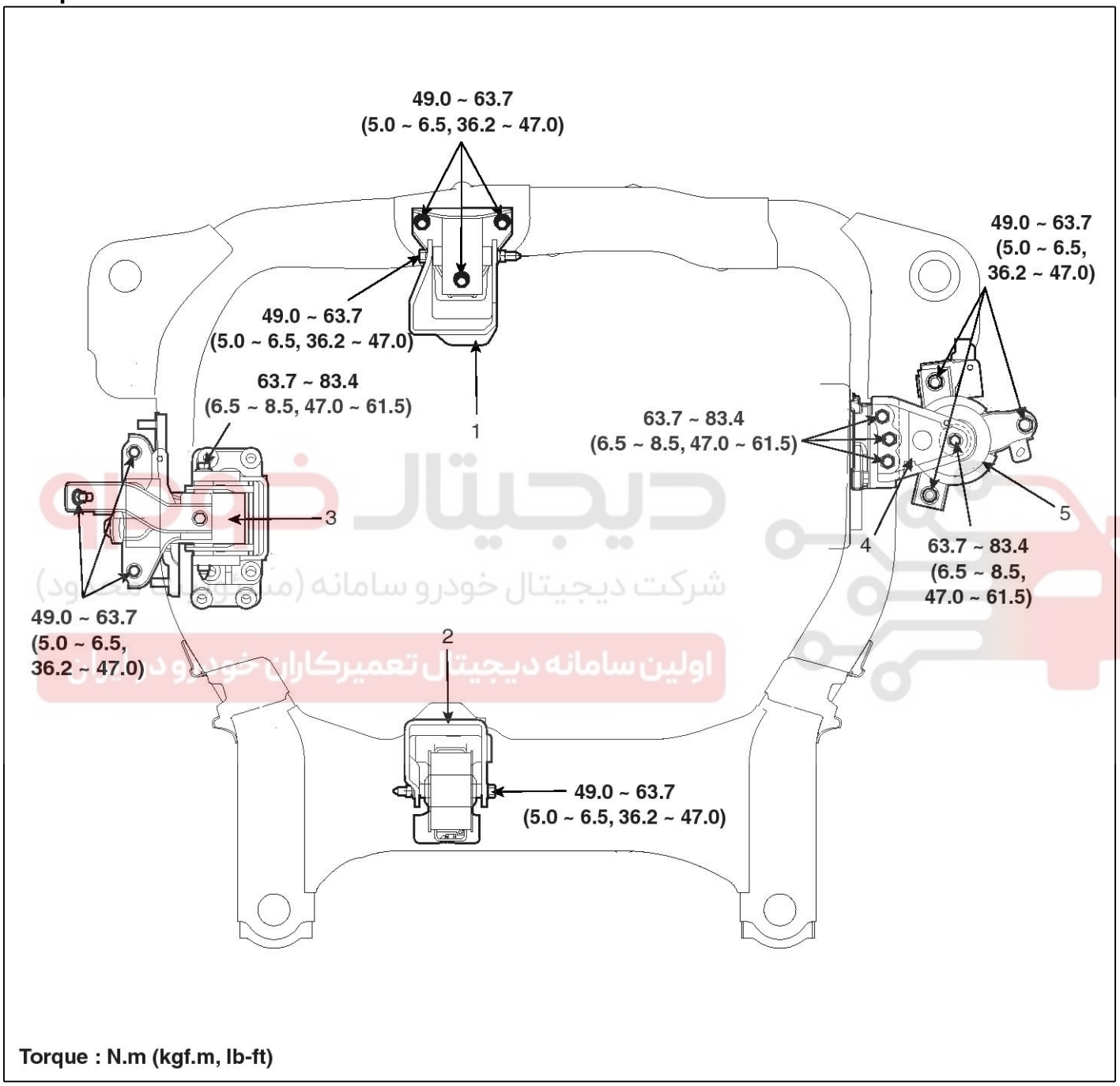
Tool (Number and name)	Illustration	Use
Crankshaft front oil seal installer (09214-3K000) (09231-H1100)	 ACRF002A	Installation of the front oil seal A : 09214-3K000 B : 09231-H1100
Flywheel stopper (09231-3K000)	 KCRF030D	Holds flywheel so that engine dosen't turn/move.
Torque angle adapter (09221-4A000)	 LCAC030A	Installtion of bolts & nuts needing an angular method of adjustment.
Valve stem oil seal installer (09222-4A000)	 LCAC030D	Installation of the valve stem oil seal
Valve spring compressor & holder (09222-3K000) (09222-3K100)	 KCRF030B	Removal and installation of the intake or exhaust valve 09222-3K100 (holder)
Crankshaft rear oil seal installer (09214-3K100) (09231-H1100)	 ACRF003A	Installation of the crankshaft rear oil seal A : 09214-3K100 B : 09231-H1100

Tool (Number and name)	Illustration	Use
Timing chain tensioner ratchet holder (09240-2G000)	 SMGEM8007D	Timing chain tension release In vehicle inspection and adjustment of valve clearance.

Engine And Transaxle Assembly

Engine Mounting

Components



SMGEM8015L

1. Front roll mount bracket assembly
2. Rear roll mount bracket assembly
3. Transmission mounting bracket assembly
4. Engine support bracket
5. Engine mount bracket assembly

Engine And Transaxle Assembly

Removal

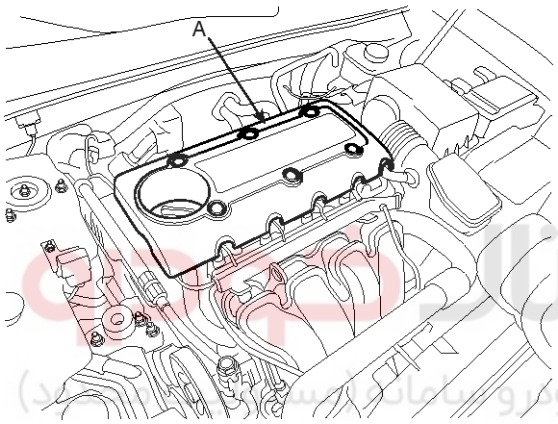
CAUTION

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

NOTICE

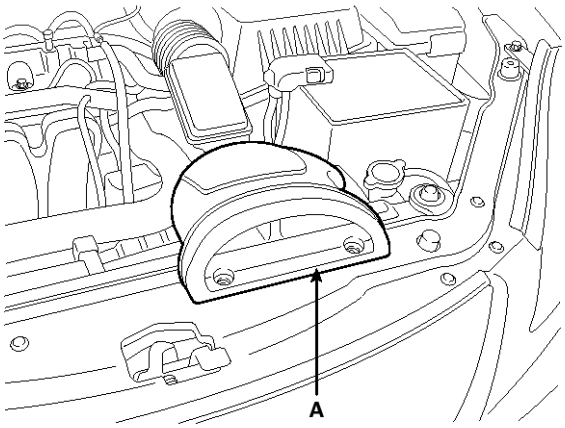
Mark all wiring and hoses to avoid misconnection.

1. Disconnect the battery terminals and remove the battery.
2. Remove the engine cover (A).



SNFEM8001D

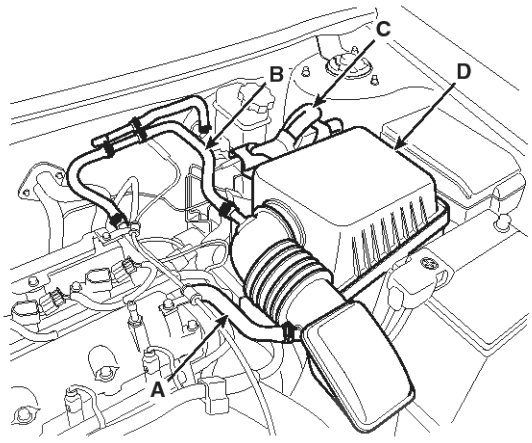
3. Remove the air duct (A).



SMGEM8004D

4. Disconnect the breather hose (A), vacuum hose (B), ECM connector (C) and remove the air cleaner assembly (D).

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



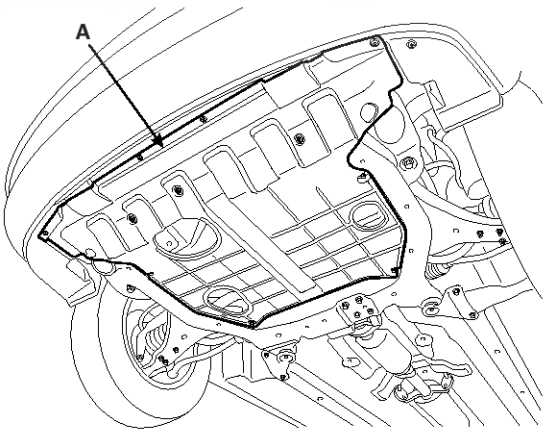
SMGEM9004D

5. Remove the front wheels.

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

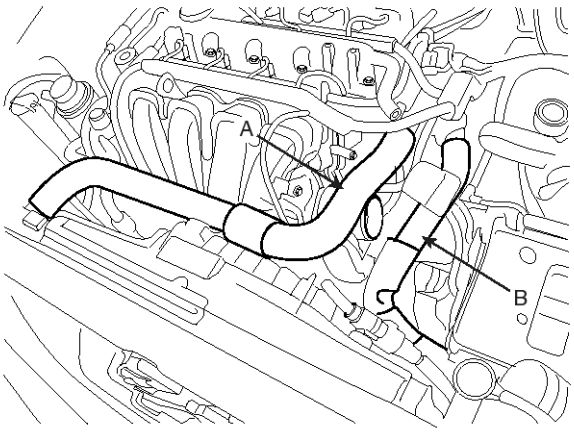
6. Remove the under cover (A).

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



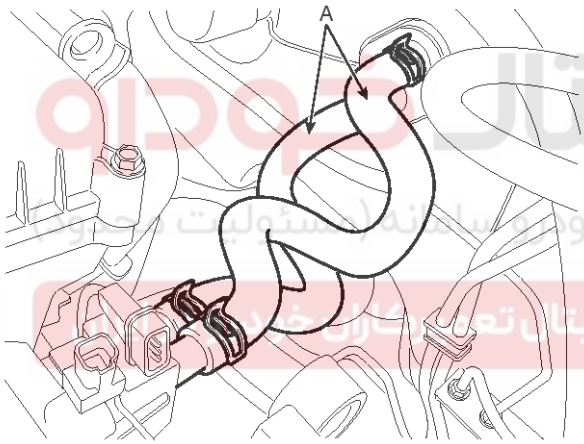
SMGEM8002D

7. Remove the drain plug and drain the engine coolant.
8. Remove the radiator upper hose (A) and lower hose (B).



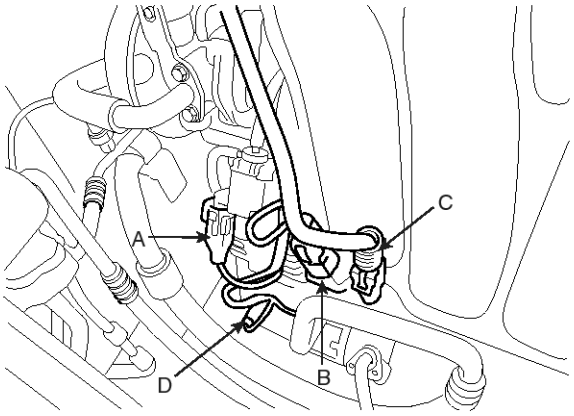
SNFEM8004D

9. Remove the heater hoses (A).



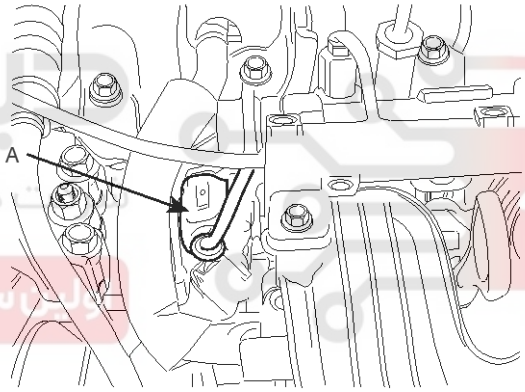
ACLG003A

10. Disconnect the VIS connector (A), OPS connector (B), knock sensor connector (C) and A/C switch connecter (D).



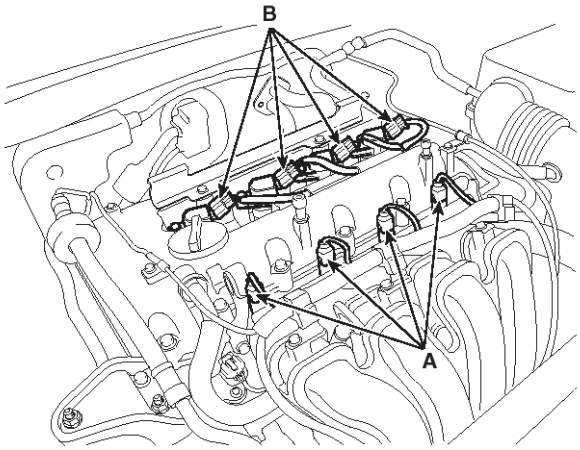
SNFEM8006D

11. Disconnect the intake OCV connector (A).



SNFEM8032D

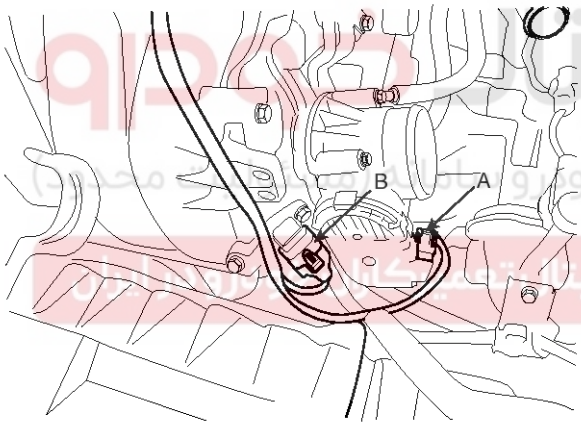
12. Disconnect the injector connectors (A) and ignition coil connectors (B).



SMGEM9001D

13. Disconnect the ETC connector (A) and MAP sensor connector (B).

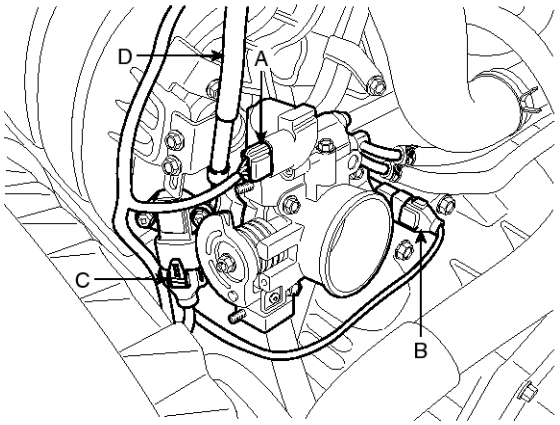
[2.4]



SNFEM8007D

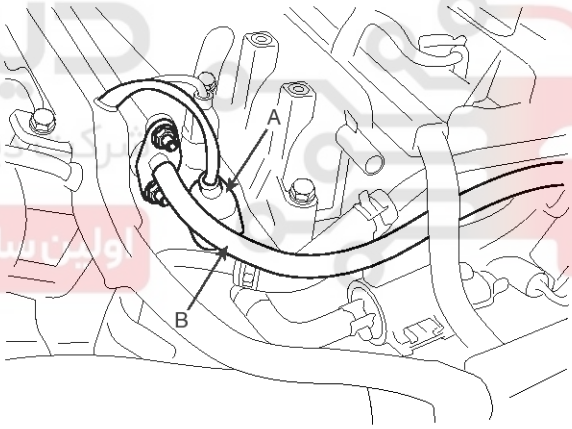
14. Disconnect the ISA connector (A), TPS connector (B) and MAP sensor connector (C) then remove the throttle cable (D).

[2.0]



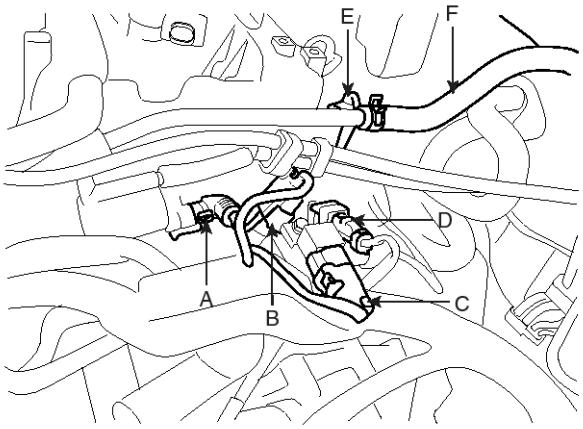
SNFEM8074D

15. Disconnect the CMP sensor connector (A) and fuel hose (B).



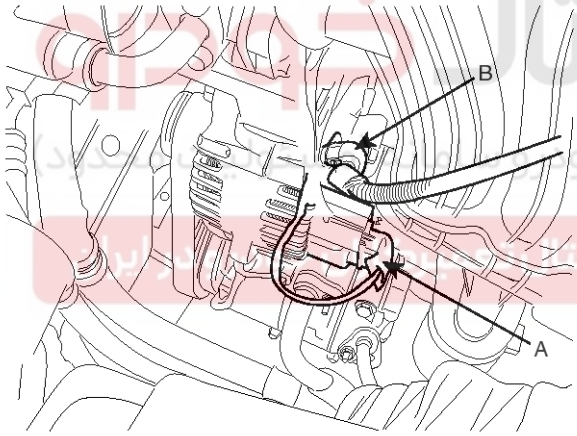
SNFEM8009D

16. Disconnect the PCSV connector (A), ECT connector (B), condenser connector (C), CKP sensor connector (D), CMP sensor connector (E) and brake booster vacuum hose (F).



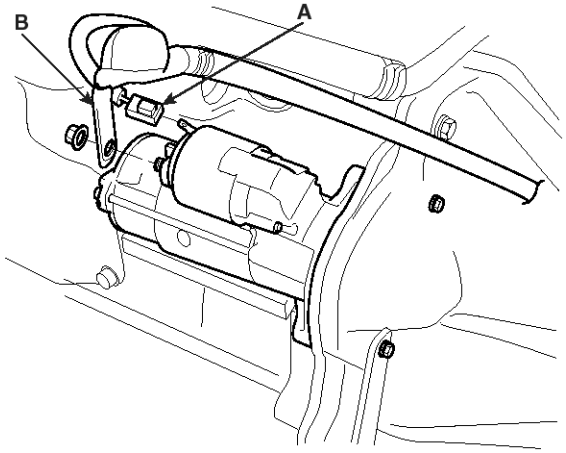
SNFEM8008D

17. Disconnect the alternator connector (A), and 'B' terminal cable (B).



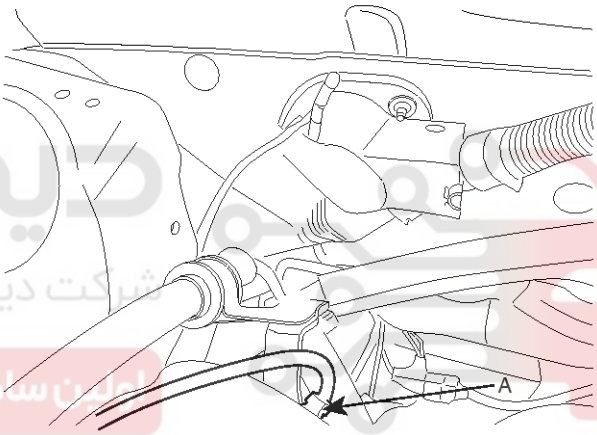
SNFEM8033D

18. Disconnect the starter connector (A), and cable (B).



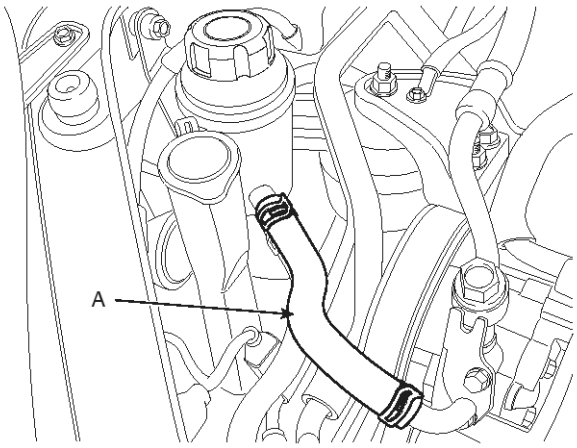
SNFEM8034D

19. Disconnect the exhaust OCV connector (A).



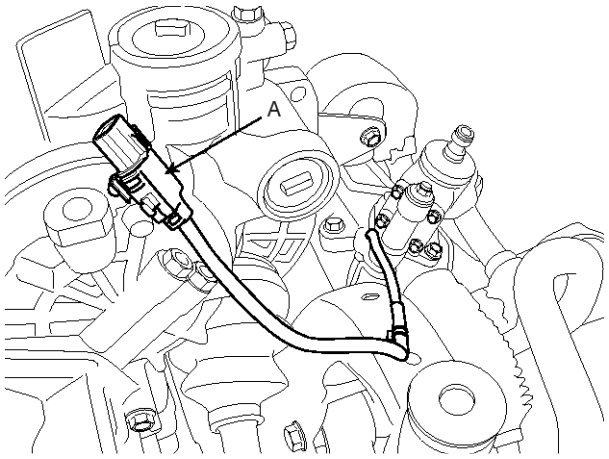
SMGEM8016D

20. Remove the power steering oil hose (A).



ACLG006A

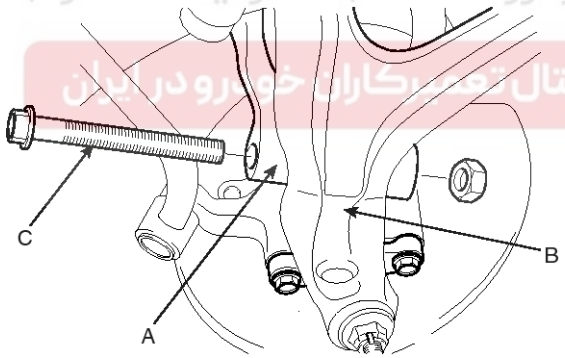
21. Disconnect the transaxle control cable and wiring connectors. (Refer to MT or AT group)
22. Recover refrigerant and remove the high & low pressure pipe. (Refer to HA Group).
23. Disconnect the EPS connector (A).



STGEM7007D

24. Remove the lower arm (B) & fork (A) mounting bolt (C). (Refer to SS group)

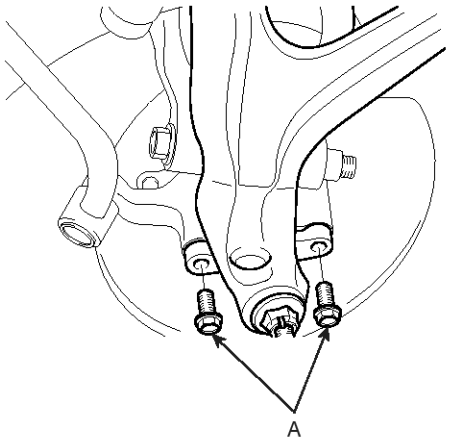
Tightening torque :
137.3 ~ 156.9N.m (14.0 ~ 16.0kgf.m, 101.3 ~ 115.7lb-ft)



KHBF110C

25. Remove the lower arm ball joint mounting bolts (A). (Refer to SS group)

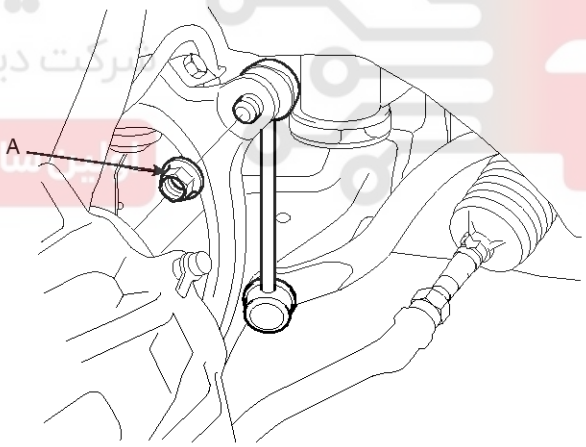
Tightening torque :
98.1 ~ 117.7N.m (10.0 ~ 12.0kgf.m, 72.3 ~ 86.8lb-ft)



KHBF120A

26. Remove the stabilizer bar link mounting nut (A). (Refer to SS group)

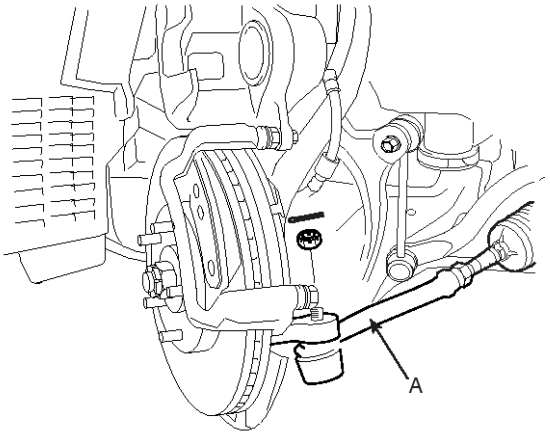
Tightening torque :
98.1 ~ 117.7N.m (10.0 ~ 12.0kgf.m, 72.3 ~ 86.8lb-ft)



STGEM7030D

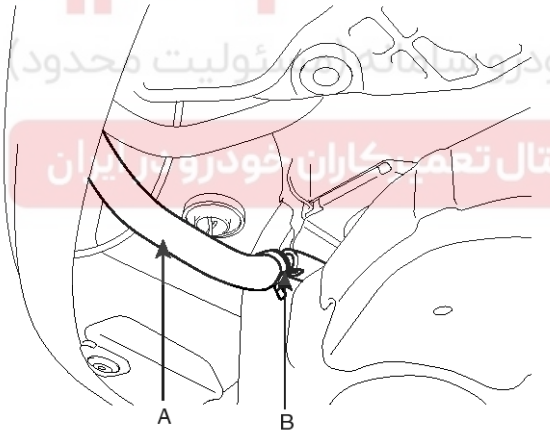
27. Remove the split pin and castle nut and then disconnect the tie rod end (A) with the knuckle. (Refer to ST group)

Tightening torque :
23.5 ~ 33.3N.m (2.4 ~ 3.4kgf.m, 17.4 ~ 24.6lb-ft)



STGEM7031D

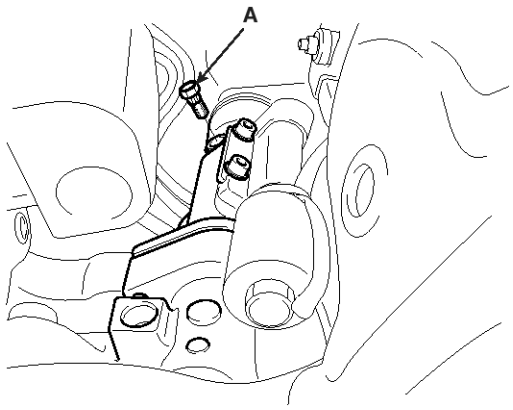
28. Disconnect the driveshaft from the axle hub.
29. Remove power steering return hose (A) and drain power steering fluid.



KMRE009J

30. Remove steering u-joint mounting bolt (A). (Refer to ST group)

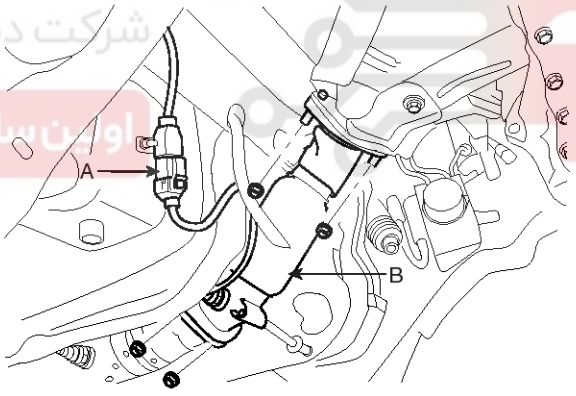
Tightening torque :
17.7 ~ 24.5N.m (1.8 ~ 2.5kgf.m, 13.0 ~ 18.1lb-ft)



STGEM7039D

31. Disconnect the O2 sensor connector (A) and remove the front muffler (B).

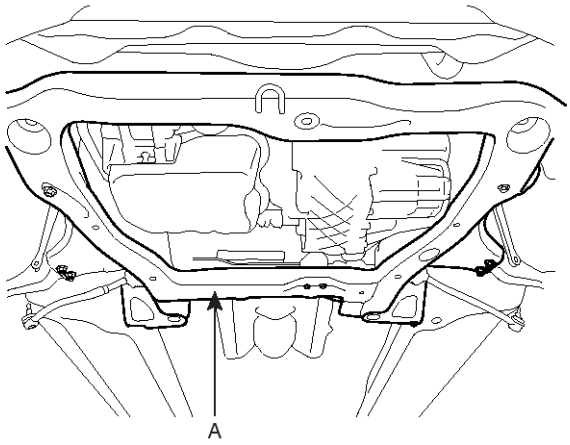
Tightening torque :
39.2 ~ 58.8N.m (4.0 ~ 6.0kgf.m, 28.9 ~ 43.4lb-ft)



SNFEM8018D

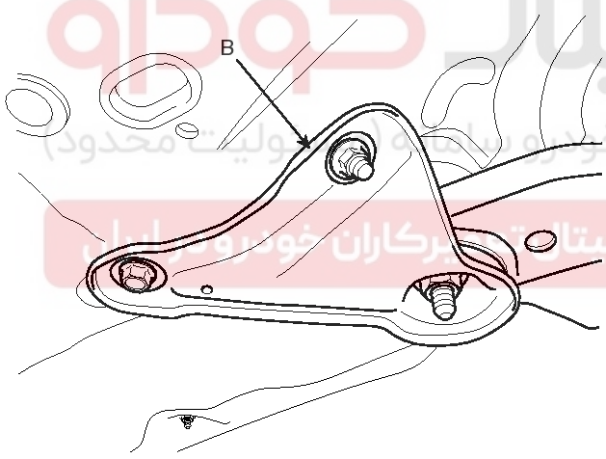
32. Support the sub frame (A) with a floor jack then remove the stay (B) and sub frame mounting bolts.

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



KMRE009R

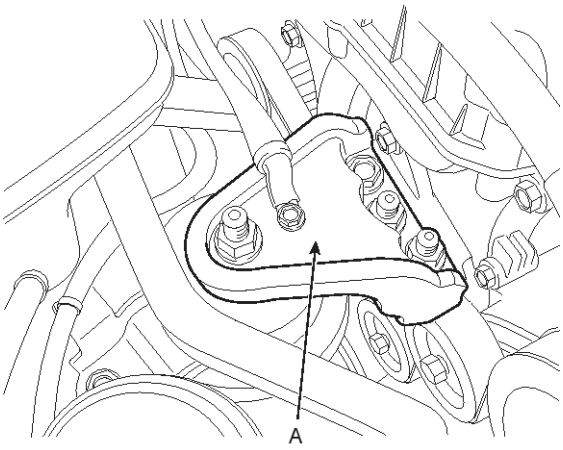
Tightening torque :
44.1 ~ 58.8N.m (4.5 ~ 6.0kgf.m, 32.5 ~ 43.4lb-ft)



SNFEM8036D

33. Disconnect the ground line and remove the engine mounting bracket (A).

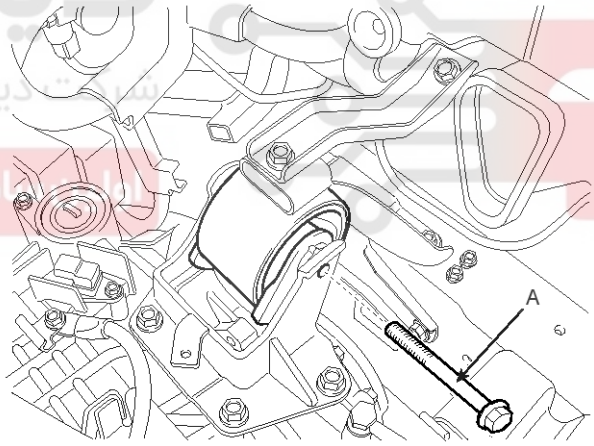
Tightening torque :
63.7 ~ 83.4N.m (6.5 ~ 8.5kgf.m, 47.0 ~ 61.5lb-ft)



ACLG009A

34. Remove the transaxle mounting bracket bolt (A).

Tightening torque :
63.7 ~ 83.4N.m (6.5 ~ 8.5kgf.m, 47.0 ~ 61.5lb-ft)



ACLG010A

35. Lift up the vehicle and ramove the engine and transaxle assembly from the bottom of vehicle.

⚠CAUTION
When removing the engine and transaxle assembly, be careful not to damage any surrounding parts or body componants.

Installation

Installation is in the reverse order of removal.

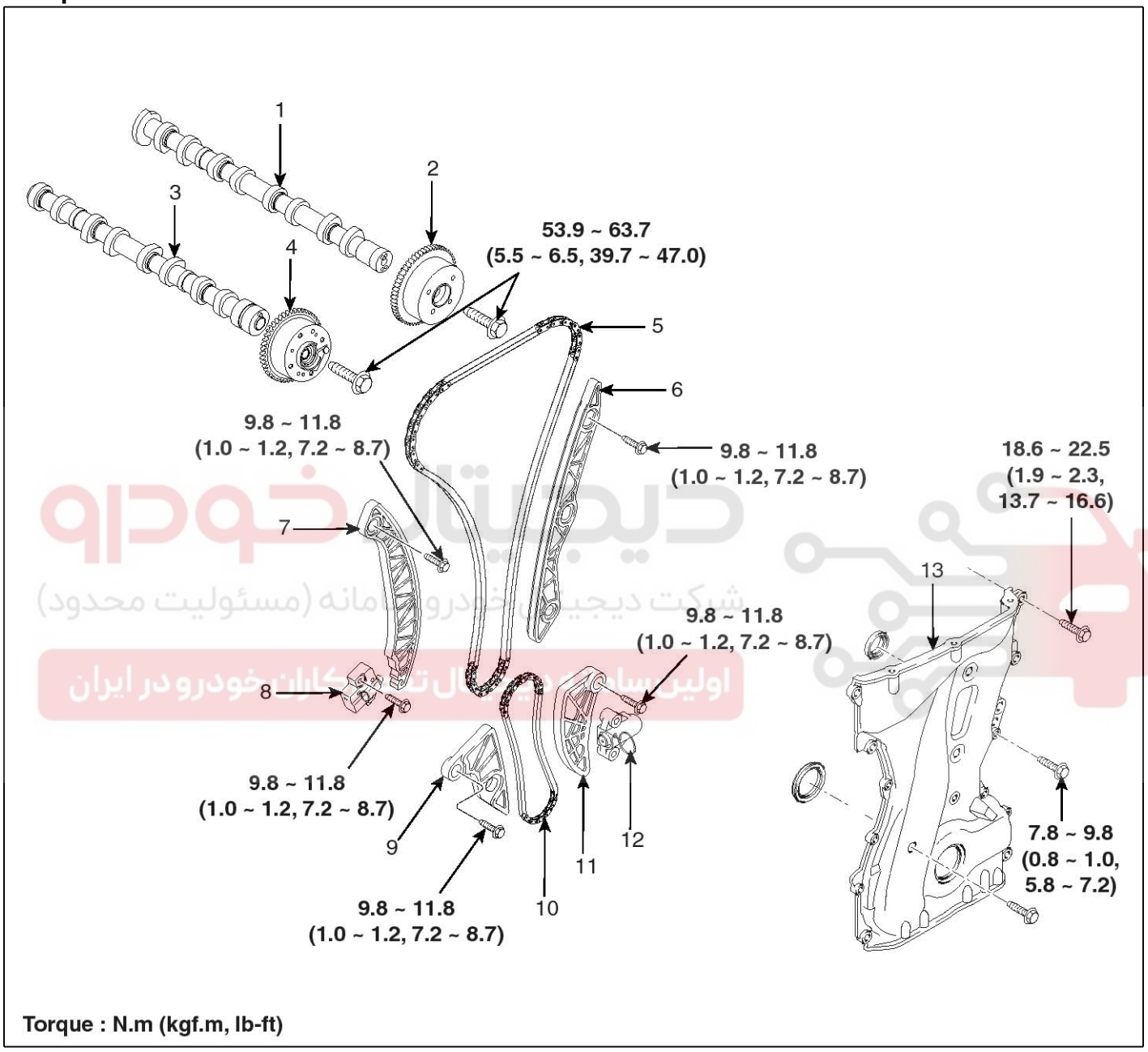
Perform the following :

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

Timing System

Timing Chain

Components

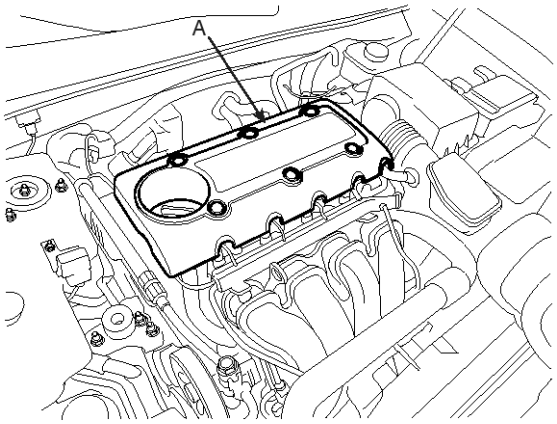


SNFEM8020L

1. Intake camshaft
2. Intake CVVT assembly
3. Exhaust camshaft
4. Exhaust CVVT assembly
5. Timing chain
6. Timing chain guide
7. Timing chain tensioner arm
8. Timing chain tensioner
9. Balance shaft chain guide
10. Balance shaft chain
11. Balance shaft chain tensioner arm
12. Balance shaft chain tensioner
13. Timing chain cover

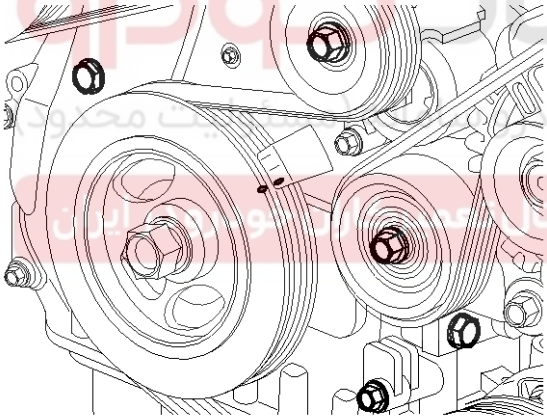
Removal

1. Disconnect the battery nagative cable.
2. Remove the engine cover (A).



SNFEM8001D

3. Remove the RH front wheel.
4. Remove the RH side cover.
5. Set No.1 cylinder to TDC/compression.

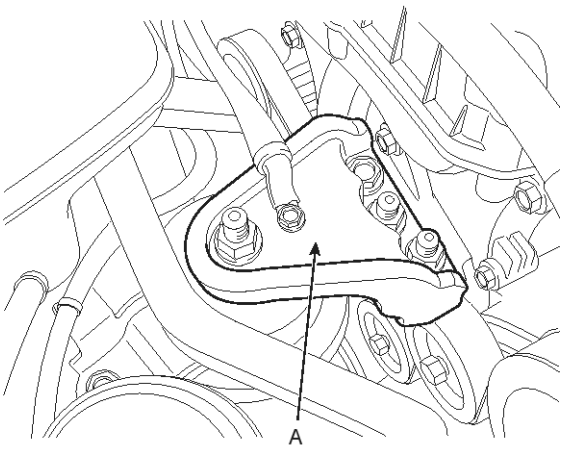


SNFEM8077D

6. Drain the engine oil, and then set a jack to the oil pan.

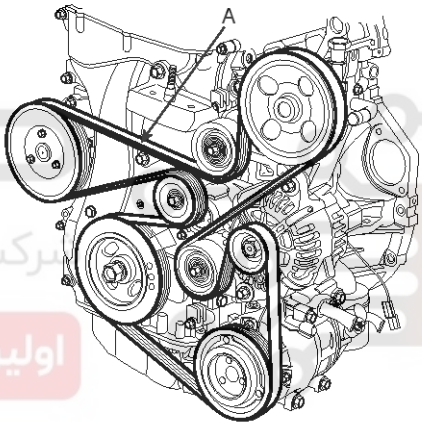
NOTICE
Place wooden block between the jack and engine oil pan.

7. Disconnect the ground line and remove the engine mounting bracket (A).



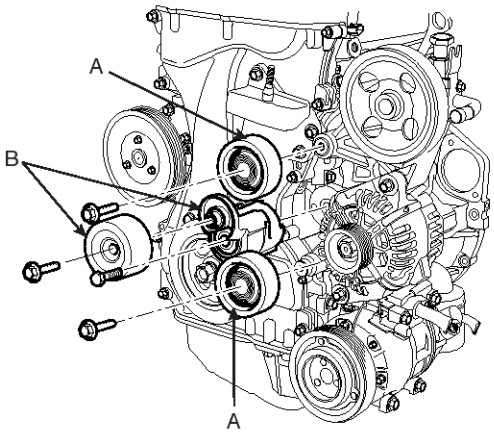
ACLG009A

8. Remove the drive belt (A).



KCRF108A

9. Remove the idler (A) and drive belt tensioner (B).

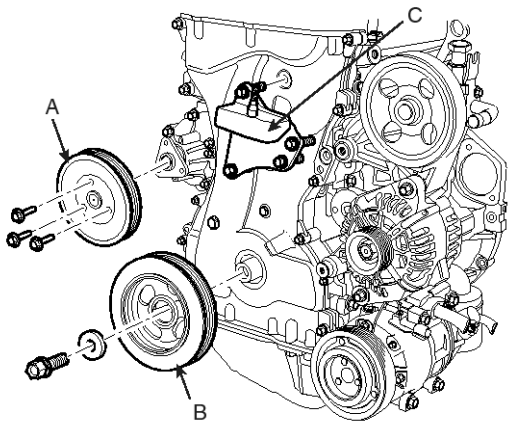


SNFEM8037D

CAUTION

Tensioner pulley bolt is left - handed screw.

10. Remove the water pump pulley (A), crankshaft pulley (B) and engine support bracket (C).

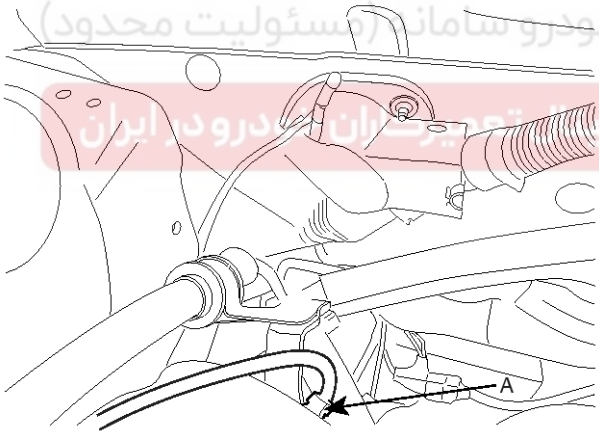


SNFEM8038D

NOTICE

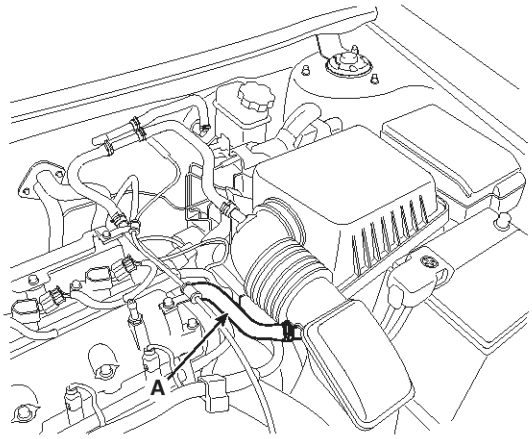
Use the SST(flywheel stopper, 09231-3K000) to remove the crankshaft pulley bolt, after remove the starter

11. Disconnect the exhaust OCV connector (A).



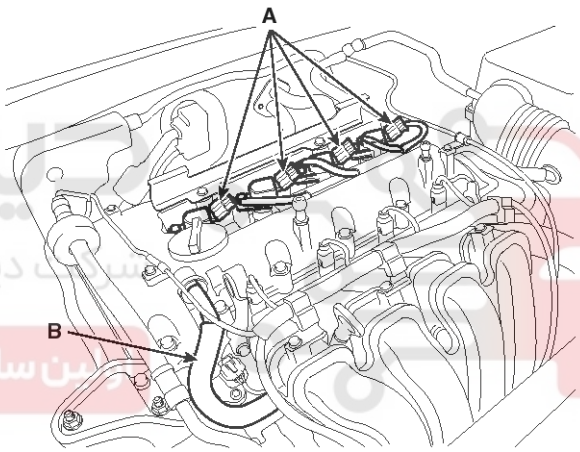
SMGEM8016D

12. Remove the breather hose (A).



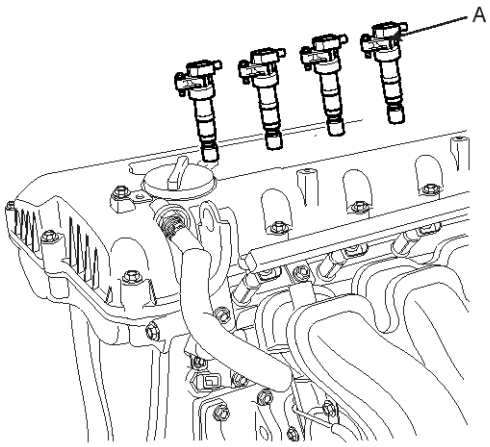
SMGEM9005D

13. Disconnect the ignition coil connectors (A) and PCV hose (B).



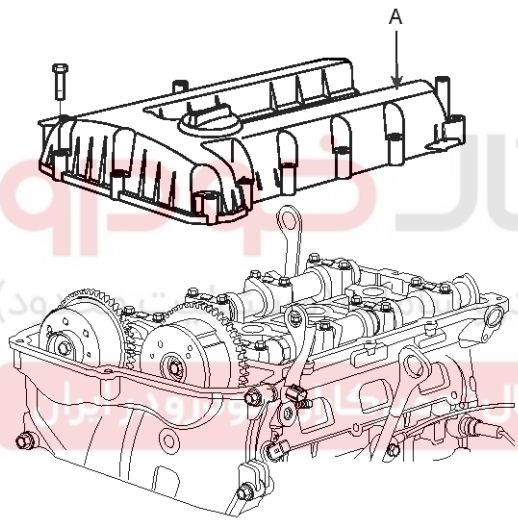
SMGEM9003D

14. Remove the ignition coils (A).



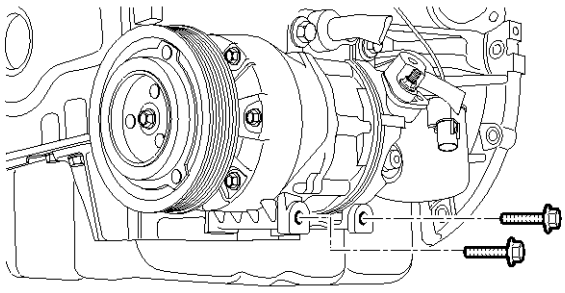
SNFEM8084L

15. Remove the cylinder head cover (A).



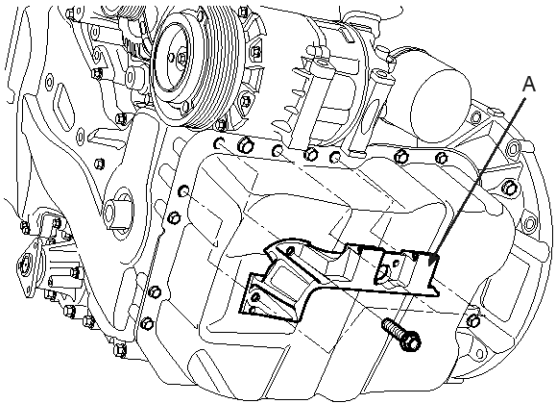
SNFEM8019D

16. Remove the compressor lower bolts.



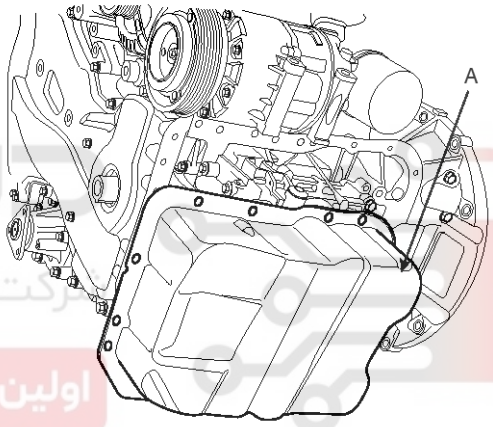
KCRF112A

17. Remove the compressor bracket (A).



KCRF113A

18. Remove the oil pan (A).

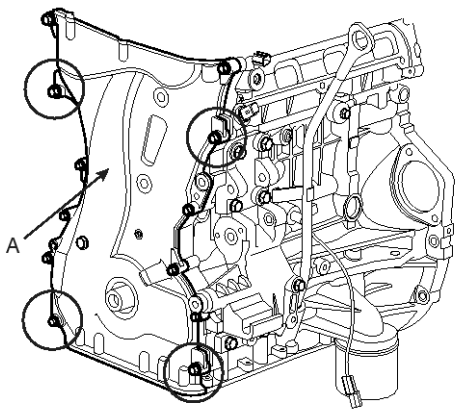


SNFEM8039D

⚠CAUTION

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

19. Remove the timing chain cover (A) by gently prying the portions between the cylinder head and cylinder block.

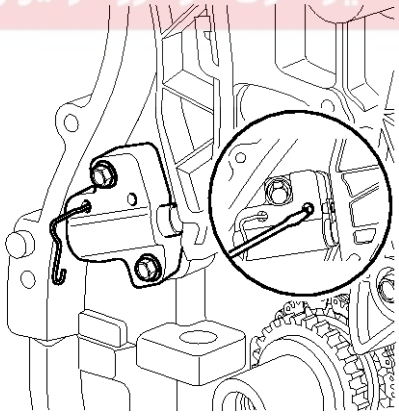


SNFEM8040D

⚠CAUTION

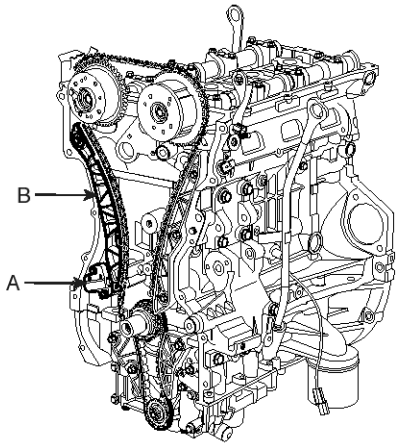
Be careful not to damage the contact surfaces of cylinder block, cylinder head and timing chain cover.

20. The key of crankshaft should be aligned with the mating face of main bearing cap. As a result of this, the piston of No.1 cylinder is placed at the top dead center on compression stroke.
21. Install a set pin after compressing the timing chain tensioner.



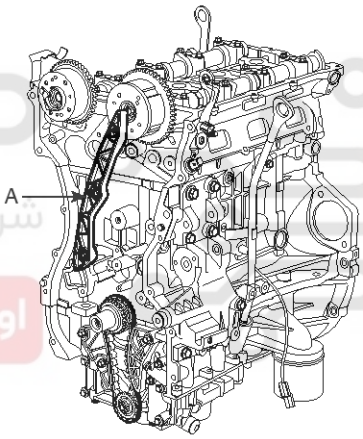
KCRF105A

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



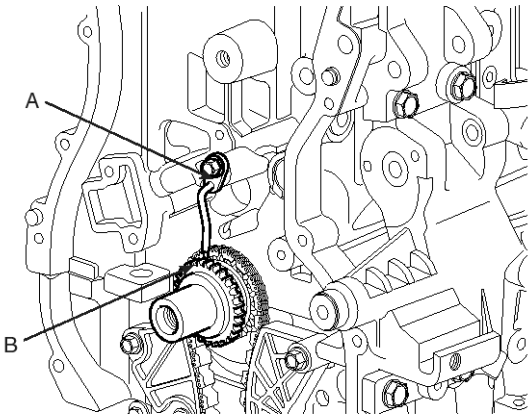
SNFEM8041D

23. Remove the timing chain.
24. Remove the timing chain guide (A).



SNFEM8022D

25. Remove the timing chain oil jet (A).
26. Remove the crankshaft chain sprocket (B).



KCRF101A

27. Remove the balance shaft chain.
    (Refer to Lubrication system in this group)

Inspection

Sprockets, Hydraulic Tensioner, Chain Guide, Tensioner Arm

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

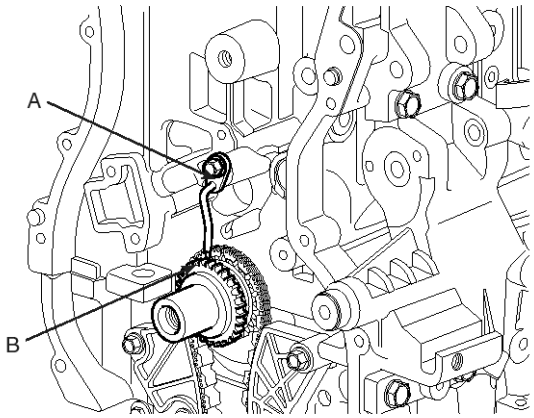
Belt, Idler, Pulley

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

Installation

1. Install the crankshaft chain sprocket (B).
2. Install the timing chain oil jet (A).

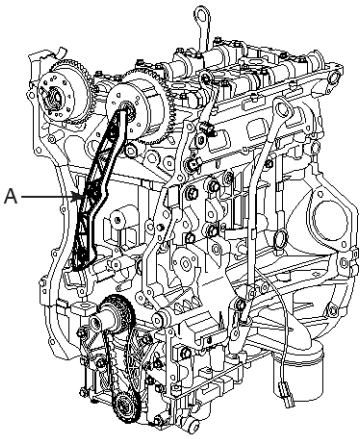
Tightening torque :
7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)



KCRF101A

3. Set crankshaft that the key of crankshaft should be aligned with the mating surface of main bearing cap. Put the intake, exhaust camshaft assembly that the TDC mark of intake sprocket and exhaust sprocket should be aligned with the top surface of cylinder head. As a result of this, place the piston on No.1 cylinder at the top dead center on compression stroke.
4. Install the timing chain guide (A).

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

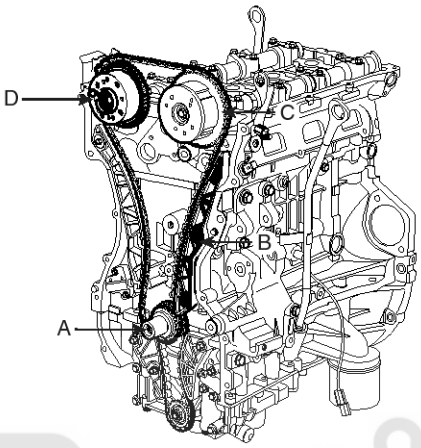


SNFEM8022D

5. Install the timing chain.

   To install the timing chain with no slack between each shaft (cam, crank), follow the below procedure.Crankshaft sprocket (A) -> Timing chain guide (B) -> Intake CVVT assembly (C) -> Exhaust CVVT assembly (D).

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



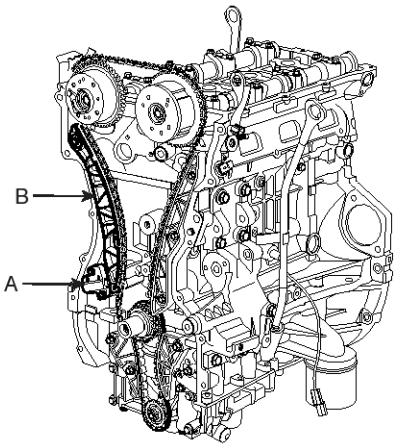
SNFEM8043D

6. Install the timing chain tensioner arm (B).

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

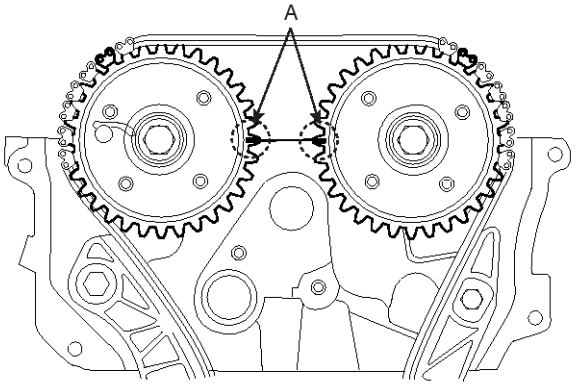
7. Install the timing chain auto tensioner (A) and remove the set pin.

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



SNFEM8041D

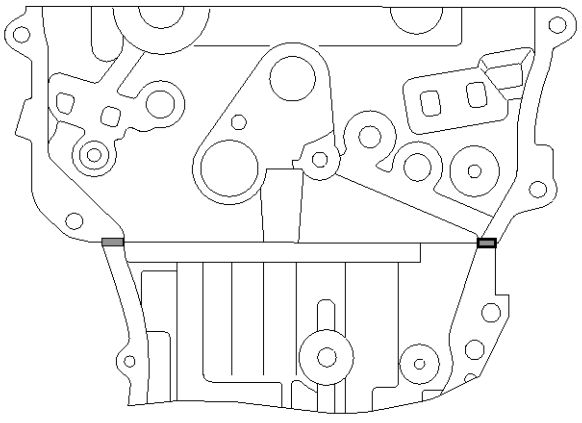
8. After rotating crankshaft 2 revolutions in regular direction (clockwise viewed from front), confirm the timing mark.



SNFEM8017D

9. Install timing chain cover.
   a. Using a gasket scraper, remove all the old packing meterial from the gasket surfaces.
   b. The sealant locations on chain cover and on counter parts (cylinder head, cylinder block, and ladder frame) must be free of engine oil and ETC.
   c. Before assembling the timing chain cover, the liquid sealant Loctite 5900H or THREEBOND 1217H should be applied on the gap between cylinder head and cylinder block.
      The part must be assembled within 5 minutes after sealant was applied.

Bead width : 3.0mm(0.12in.)



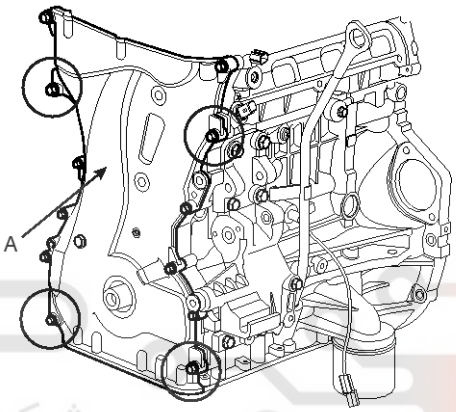
KCRF177A

   d. After applying liquid sealant Loctite 5900H on timing chain cover. The part must be assembled within 5 minutes after sealant was applied. Sealant should be applied without discontinuity.

Bead width : 3.0mm(0.12in.)

   e. 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.

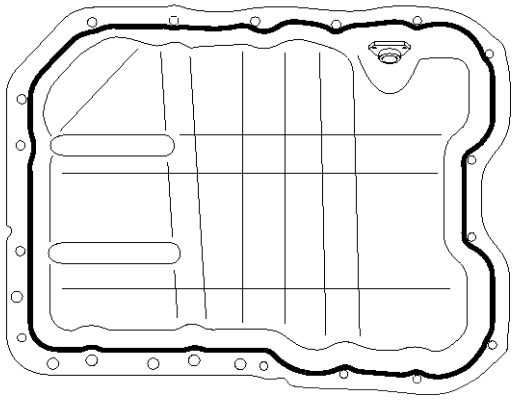
Tightening torque :
M6 : 7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)
M8 : 18.6 ~ 22.5N.m (1.9 ~ 2.3kgf.m, 13.7 ~ 16.6lb-ft)



SNFEM8040D

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

10. Install the 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 Loctite 5900H or THREEBOND 1217H should be applied on oil pan. The part must be assembled within 5 minutes after the sealant was applied.



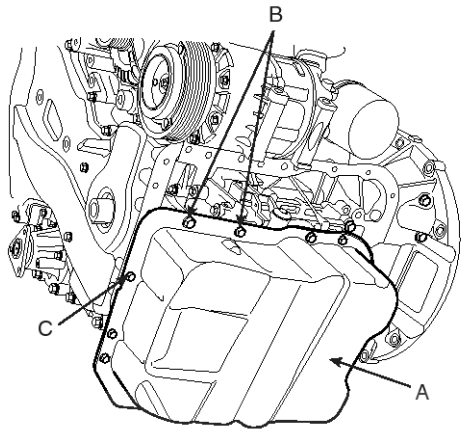
KCRF179A

⚠CAUTION

- **When applying sealant gasket, sealant must not be protruded into the inside of oil pan.**
- **To prevent leakage of oil, apply sealant gasket to the inner threads of the bolt holes.**

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

Tightening torque :
M8 (B) :
26.5 ~ 30.4N.m (2.7 ~ 3.1kgf.m, 19.5 ~ 22.4lb-ft)
M6 (C) :
9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)

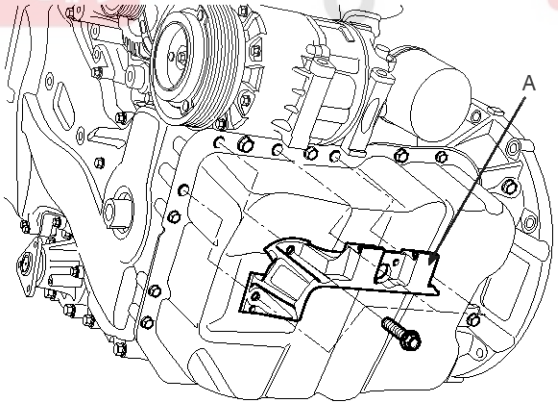


KCRF114B

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

11. Install the air compressor bracket (A).

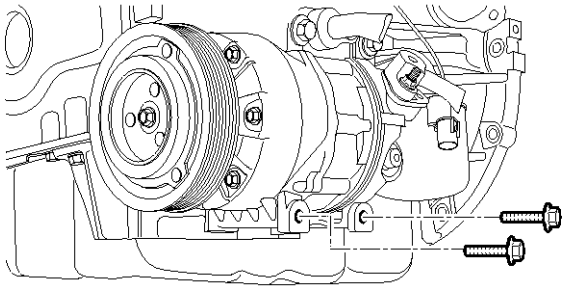
Tightening torque :
19.6 ~ 23.5N.m (2.0 ~ 2.4kgf.m,13.7 ~ 14.5lb-ft)



KCRF113A

12. Install the air compressor lower bolts.

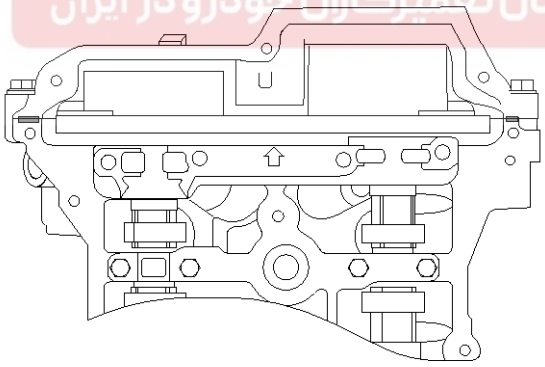
Tightening torque :
19.6 ~ 24.5N.m (2.0 ~ 2.5kgf.m,13.7 ~ 18.1lb-ft)



KCRF112A

13. Install the cylinder head cover.
    a. The hardened sealant located on the upper area between timing chain cover and cylinder head should be removed before assembling cylinder head cover.
    b. After applying sealant (Loctite 5900H), it should be assembled within 5 minutes.

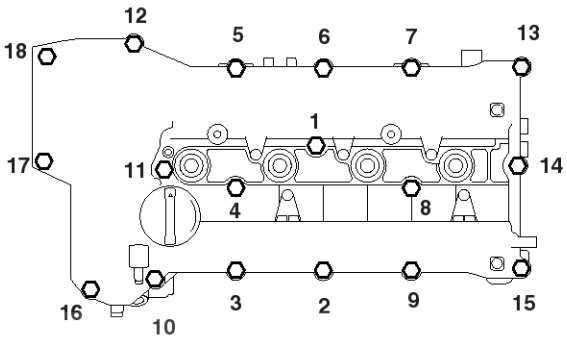
Bead width : 2.5mm(0.1in.)



SNFEM8045D

    c. The firing and/or blow out test should not be performed within 30 minutes after the cylinder head cover was assembled.
    d. Install the cylinder head cover bolts as following method.

Tightening torque :
Step 1 : 3.9 ~ 5.9N.m (0.4 ~ 0.6kgf.m, 2.9 ~ 4.3lb-ft)
Step 2 : 7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)

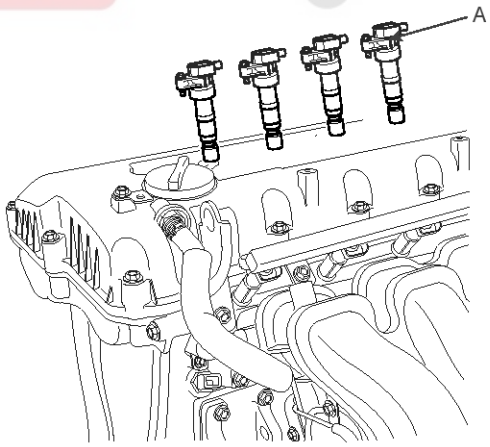


SNFEM8046D

⚠CAUTION
Do not reuse cylinder head cover gasket.

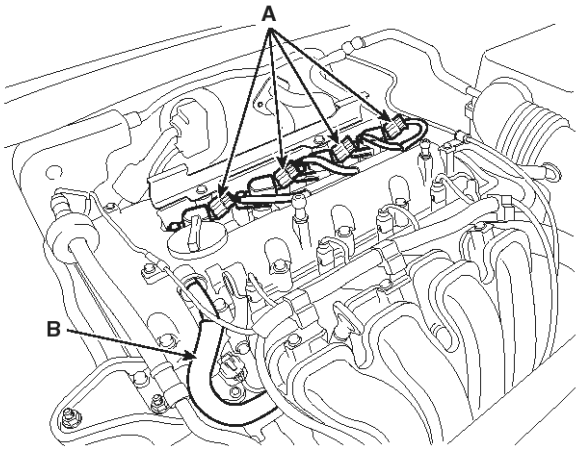
14. Install the ignition coils (A).

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



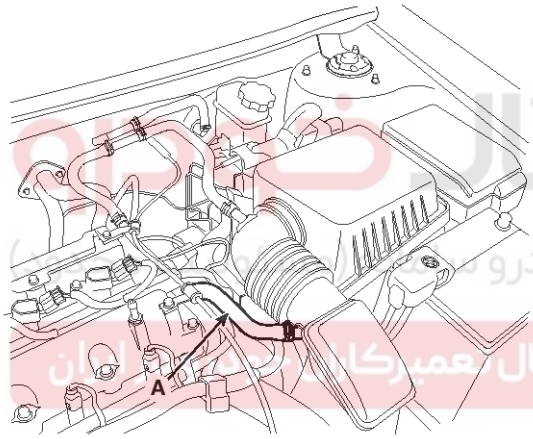
SNFEM8084L

15. Connect the ignition coil connectors (A) and PCV hose (B).



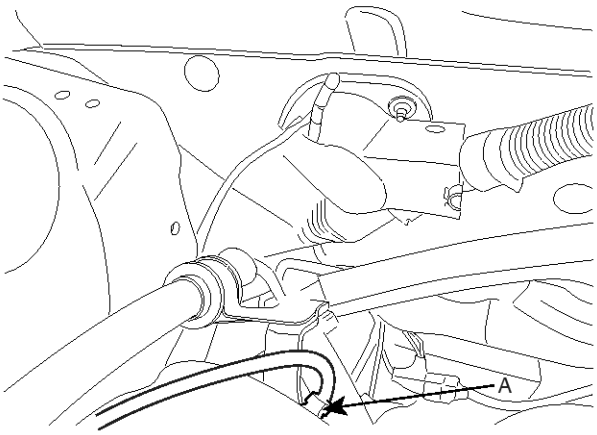
SMGEM9003D

16. Install the breather hose (A).



SMGEM9005D

17. Connect the exhaust OCV connector (A).



SMGEM8016D

18. Install the engine support bracket (C).

Tightening torque :
M10 : 39.2 ~ 44.1N.m (4.0 ~ 4.5kgf.m, 28.9 ~ 32.5lb-ft)
M8 : 19.6 ~ 24.5N.m (2.0 ~ 2.5kgf.m, 14.5 ~ 18.1lb-ft)

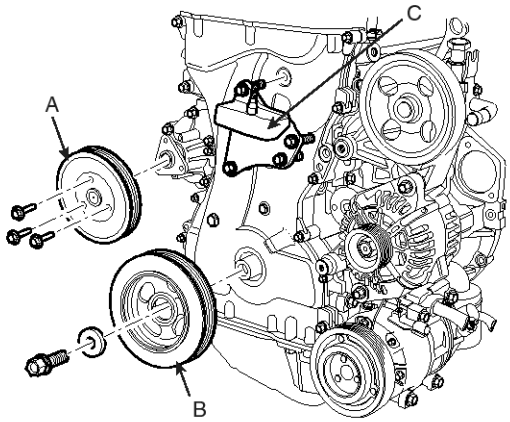
19. Install the crankshaft pulley (B).

Tightening torque :
166.6 ~ 176.4N.m (17.0 ~ 18.0kgf.m, 122.9 ~ 130.1lb-ft)

NOTICE
Use the SST(flywheel stopper, 09231-3K000) to install the crankshaft pulley bolt, after remove the starter.

20. Install the water pump pulley (A).

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



SNFEM8038D

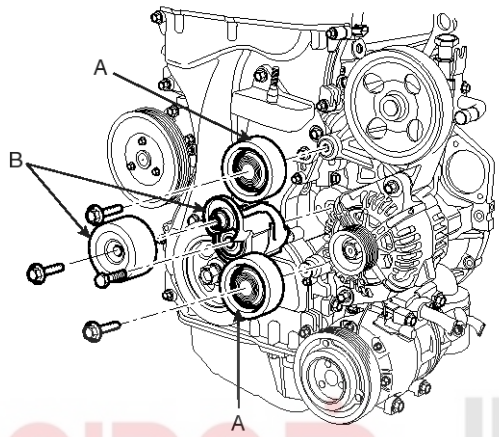
21. Install the drive belt tensioner (B).

Tightening torque :
53.9 ~ 63.7N.m (5.5 ~ 6.5kgf.m, 39.7 ~ 47.0lb-ft)

NOTICE
Tensioner pulley bolt is left - handed screw.

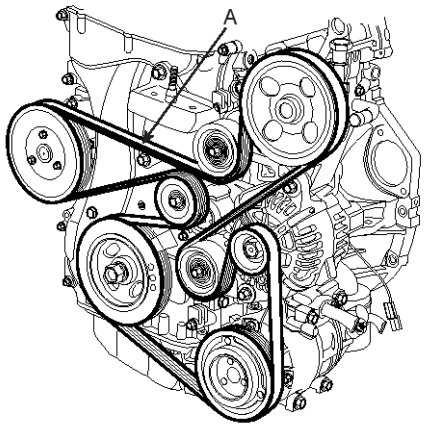
22. Install the idler (A).

Tightening torque :
53.9 ~ 63.7N.m (5.5 ~ 6.5kgf.m, 39.7 ~ 47.0lb-ft)



SNFEM8037D

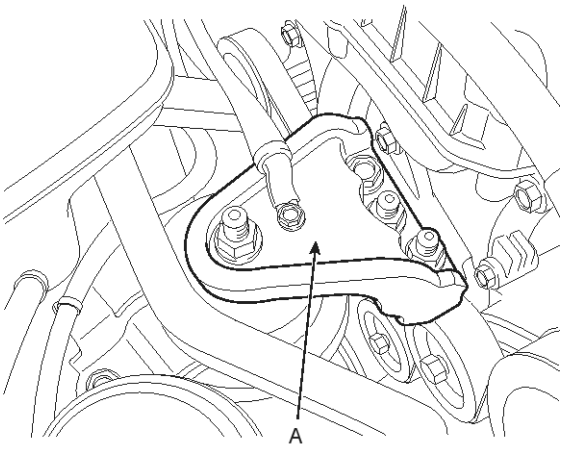
23. Install the drive belt (A).
Crankshaft pulley -> A/C pulley -> Alternator pulley -> Idler pulley -> P/S pump pulley -> Idler pulley -> Water pump pulley -> Tensioner pulley.
Rotate auto tensioner arm in the counter - clockwise moving auto tensioner pulley bolt with wrench. After putting belt on auto tensioner pulley, release the auto tensioner pulley slowly.



KCRF108A

24. Install the engine mounting bracket (A) and ground line.

Tightening torque :
63.7 ~ 83.4N.m (6.5 ~8.5kgf.m, 47.0 ~ 61.5lb-ft)



ACLG009A

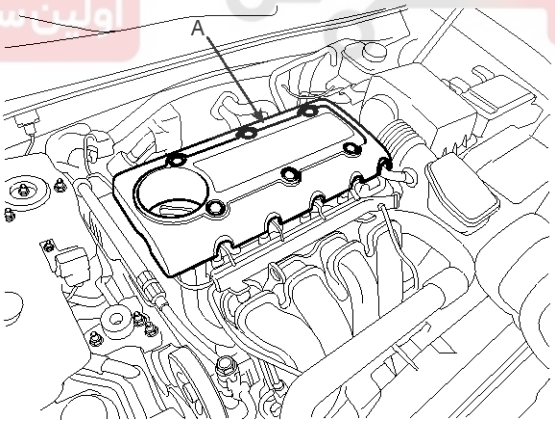
25. Install the RH side cover.

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

26. Install the RH front wheel.

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

27. Install the engine cover (A).



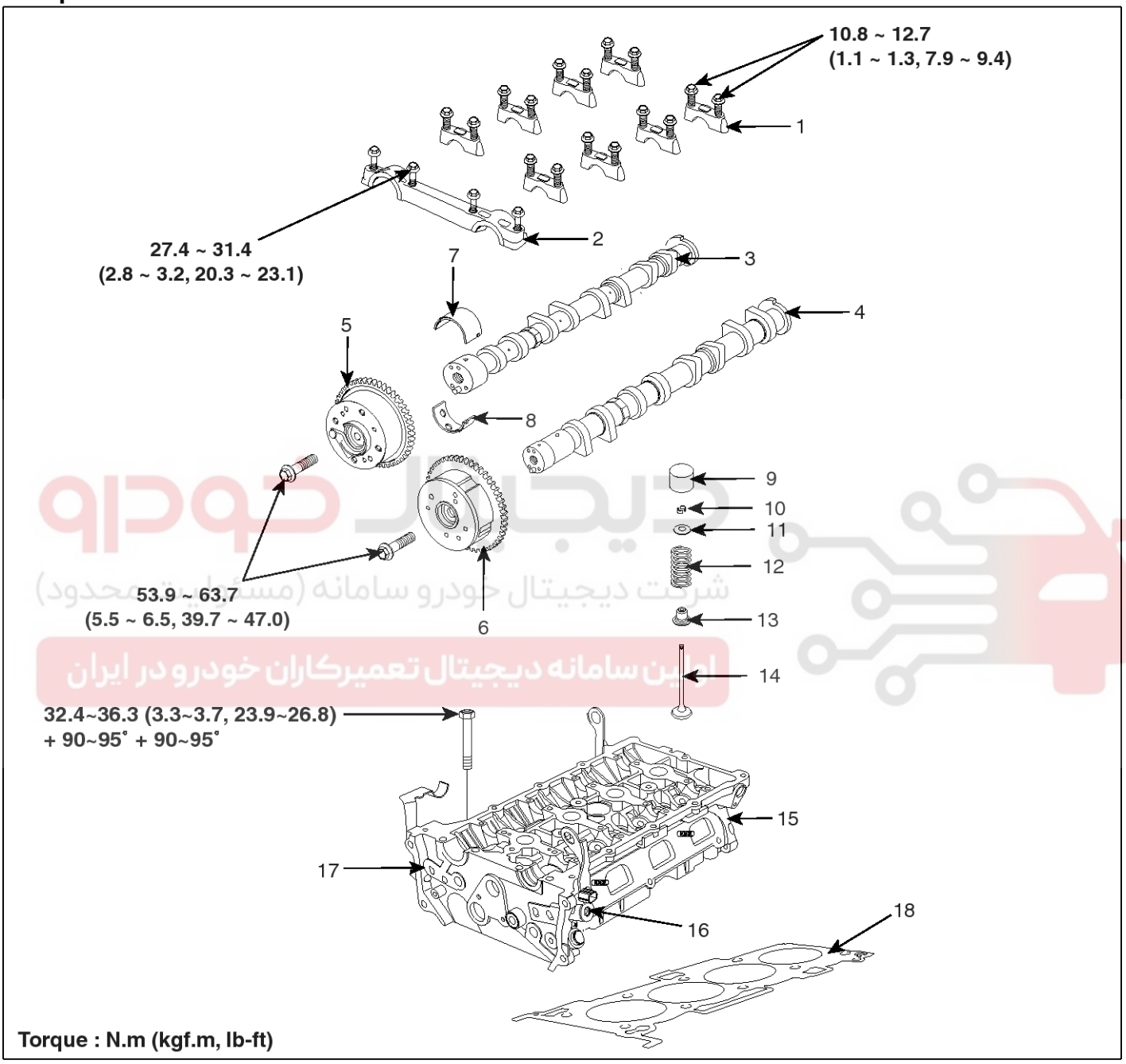
SNFEM8001D

28. Reconnect the battery nagative cable.

Cylinder Head Assembly

Cylinder Head

Components



SNFEM8023L

1. Camshaft bearing cap
2. Camshaft front bearing cap
3. Exhaust camshaft
4. Intake camshaft
5. Exhaust CVVT assembly
6. Intake CVVT assembly
7. Exhaust camshaft upper bearing
8. Exhaust camshaft lower bearing
9. MLA
10. Retainer lock
11. Retainer
12. Valve spring
13. Valve stem seal
14. Valve
15. Cylinder head
16. Intake OCV
17. Exhaust OCV
18. Cylinder head gasket

Removal

Engine removal is not required for this procedure.

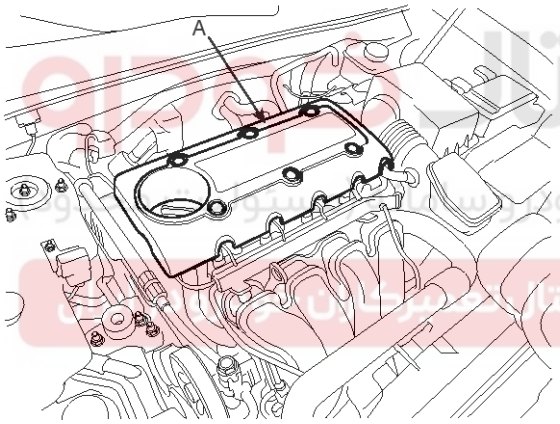
CAUTION

- **Use fender covers to avoid damaging painted surfaces.**
- **To avoid damaging the cylinder head, wait until the engine coolant temperature drops below normal temperature 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

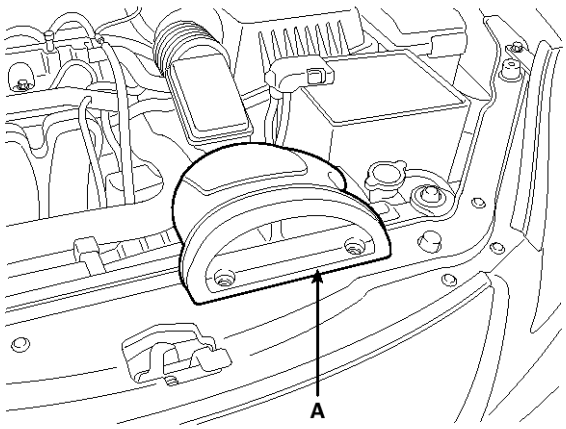
Mark all wiring and hoses to avoid misconnection.

1. Disconnect the battery terminals and remove the battery.
2. Remove the engine cover (A).



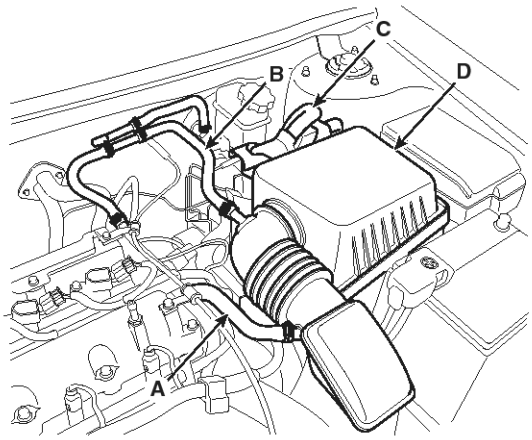
SNFEM8001D

3. Remove the air duct (A).



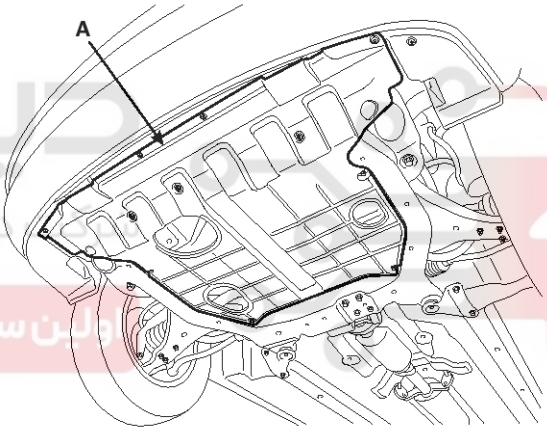
SMGEM8004D

4. Disconnect the breather hose (A), vacuum hose (B), ECM connector (C) and remove the air cleaner assembly (D).



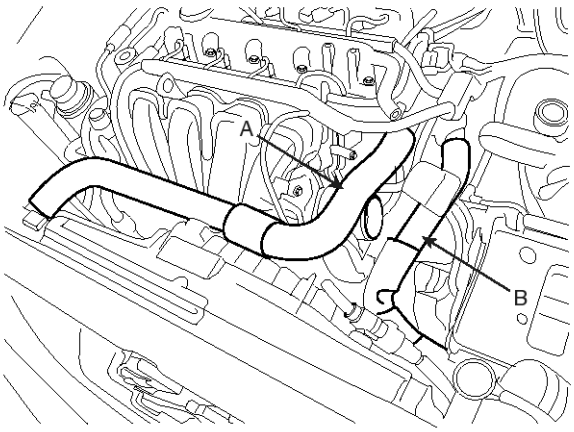
SMGEM9004D

5. Remove the under cover (A).



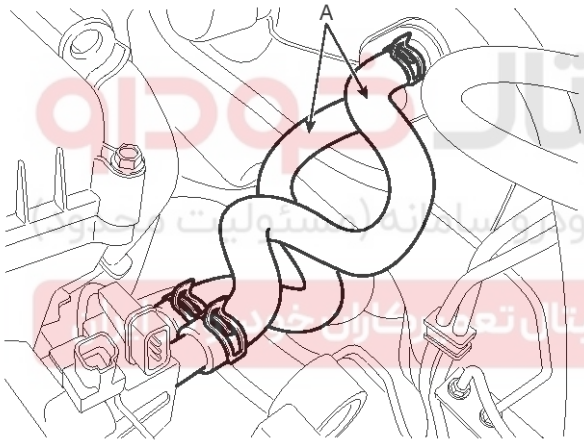
SMGEM8002D

6. Remove the drain plug and drain the engine coolant.
7. Remove the radiator upper hose (A) and lower hose (B).



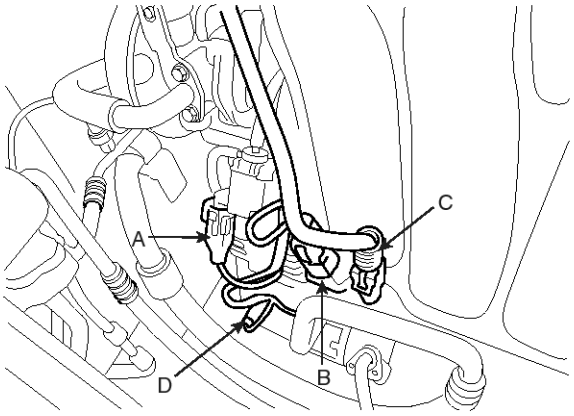
SNFEM8004D

8. Remove the heater hoses (A).



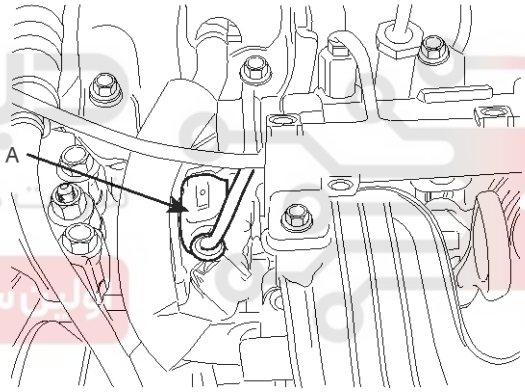
ACLG003A

9. Disconnect the VIS connector (A), OPS connector (B), knock sensor connector (C) and A/C switch connecter (D).



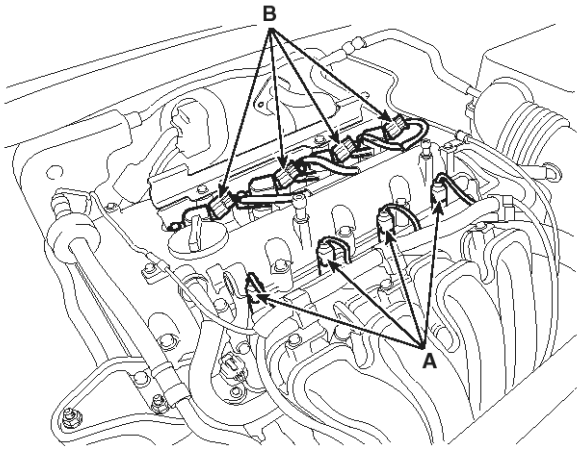
SNFEM8006D

10. Disconnect the intake OCV connector (A).



SNFEM8032D

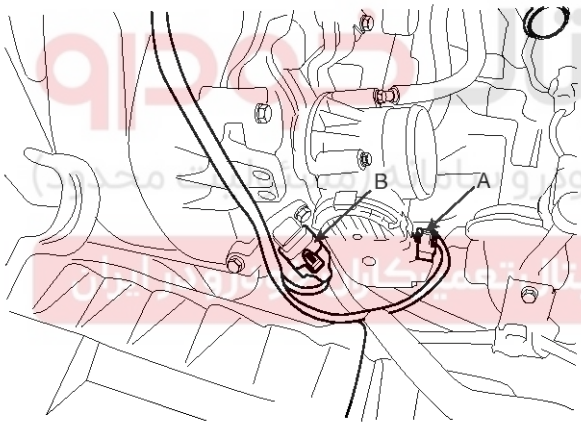
11. Disconnect the injector connectors (A) and ignition coil connectors (B).



SMGEM9001D

12. Disconnect the ETC connector (A) and MAP sensor connector (B).

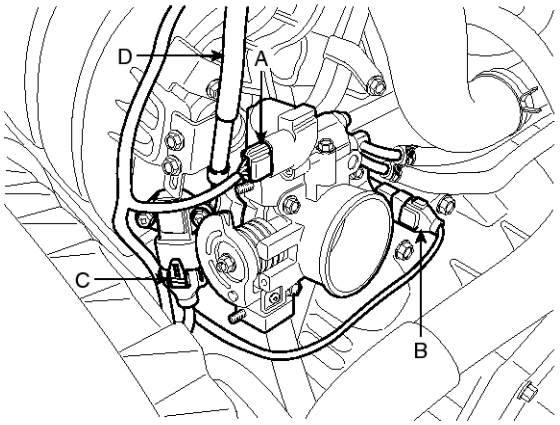
[2.4]



SNFEM8007D

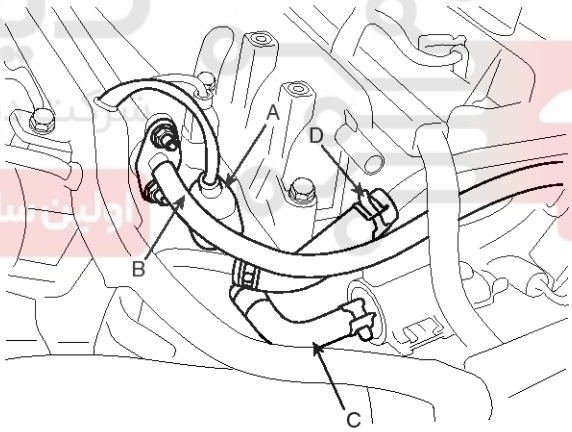
13. Disconnect the ISA connector (A), TPS connector (B) and MAP sensor connector (C) then remove the throttle cable (D).

[2.0]



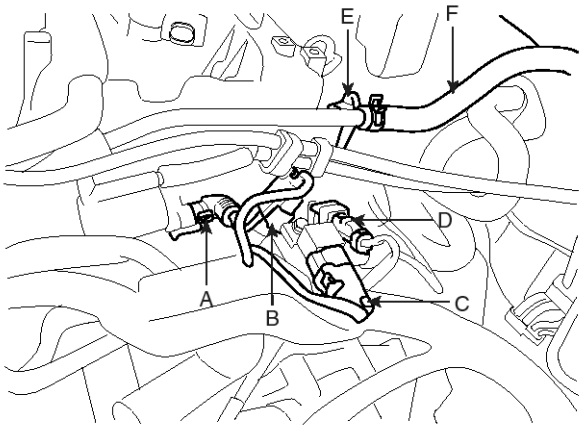
SNFEM8074D

14. Disconnect the CMP sensor connector (A), fuel hose (B), brake booster vacuum hose (C) and PCSV hose (D).



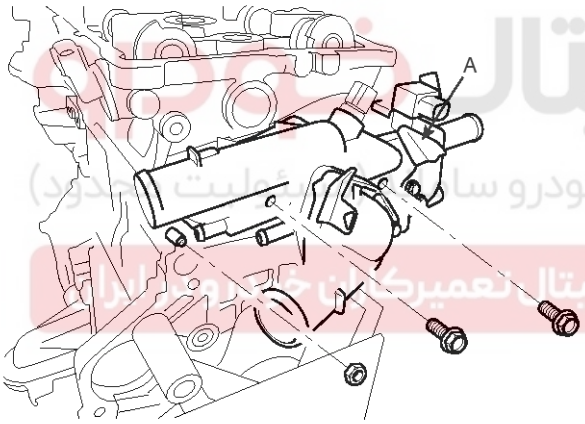
SNFEM8068D

15. Disconnect the PCSV connector (A), ECT connector (B), condenser connector (C), CKP sensor connector (D), CMP sensor connector (E) and brake booster vacuum hose (F).



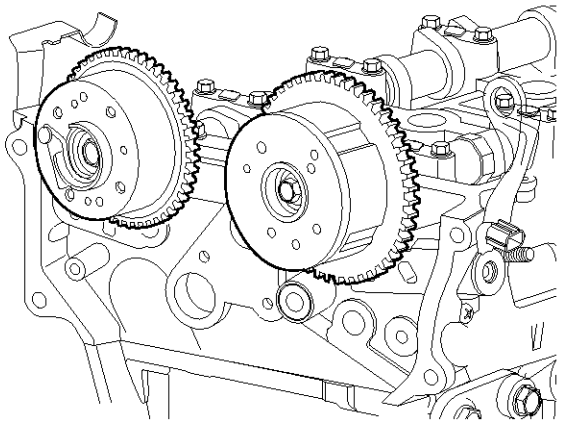
SNFEM8008D

16. Remove the water temp control assembly (A).



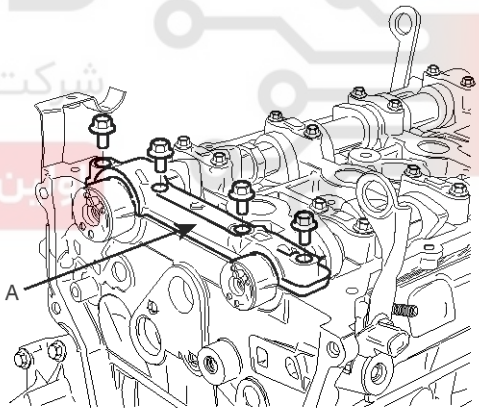
SNFEM8010D

17. Remove the timing chain. (Refer to Timing system in this group)
18. Remove the intake & exhaust manifold. (Refer to Intake and exhaust system in this group)
19. Remove the intake & exhaust CVVT assembly.



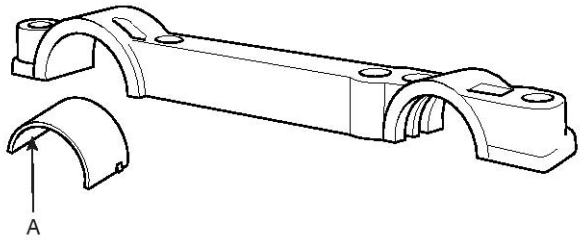
SNFEM8069D

20. Remove the cam shaft.
    a. Remove the front cam shaft bearing cap (A).



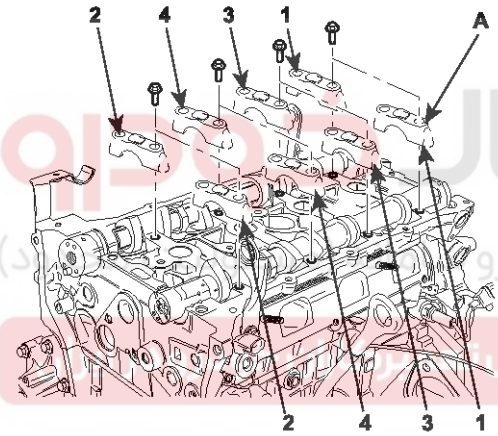
SNFEM8054D

b. Remove the exhaust cam shaft upper bearing (A).



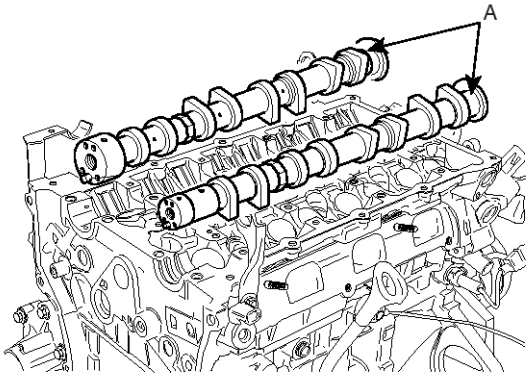
SNFEM8016D

c. Remove camshaft bearing cap (A), in the sequence shown.



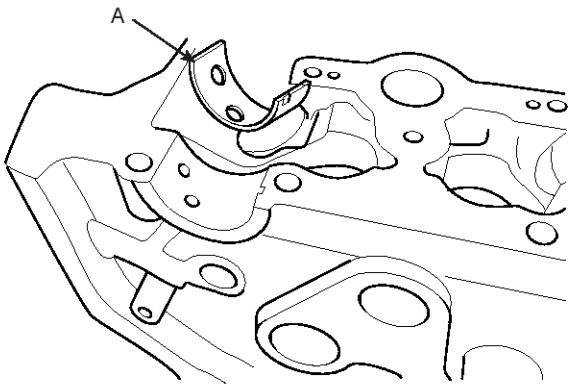
SNFEM8085L

d. Remove the cam shaft (A).



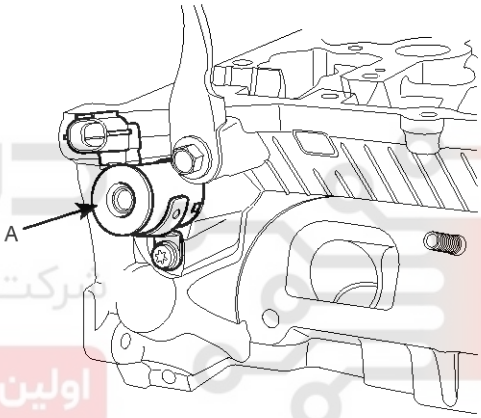
SNFEM8056D

e. Remove the exhaust cam shaft lower bearing (A).



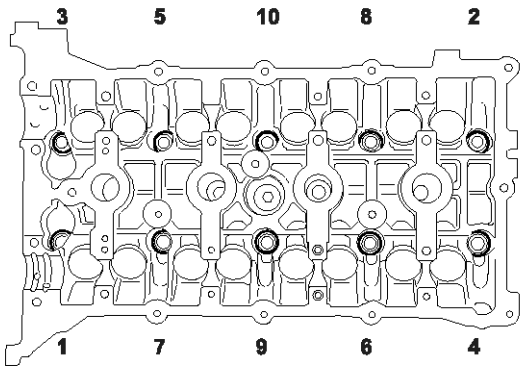
SNFEM8057D

21. Use a torx wrench, remove the intake OCV (A).



SNFEM8058D

22. Remove the exhaust OCV.
23. Remove the cylinder head bolts, then remove the cylinder head.
    a. Using triple square wrench, uniformly loosen and remove the 10 cylinder head bolts, in several passes, in the sequence shown.



SNFEM8086L

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

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

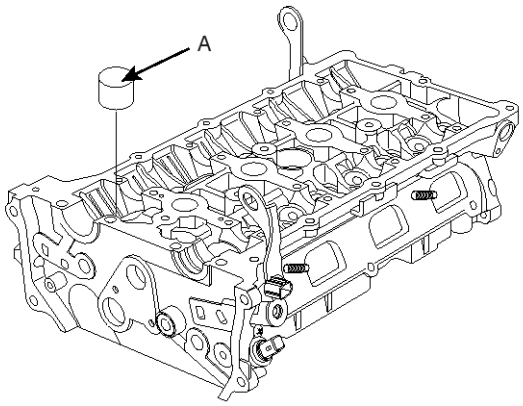
CAUTION
Be careful not to damage the contact surfaces of the cylinder head and cylinder block.

24. Remove the cylinder head gasket.

Disassembly

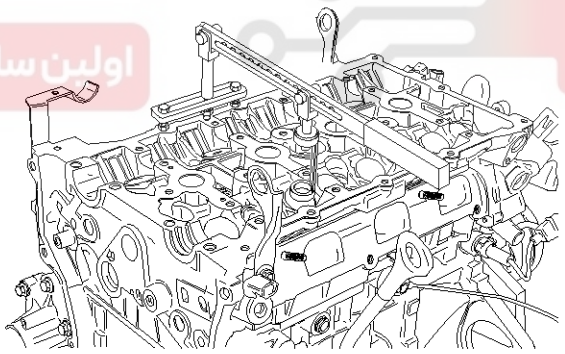
NOTICE
Identify MLA(Mechanical Lash Adjuster), valves, valve springs as they are removed so that each item can be reinstalled in its original position.

1. Remove MLAs(A).



KCRF125A

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



SNFEM8087L

    2) Remove the spring retainer.
    3) Remove the valve spring.
    4) Remove the valve.
    5) Using needle-nose pliers, remove the valve stem seal.

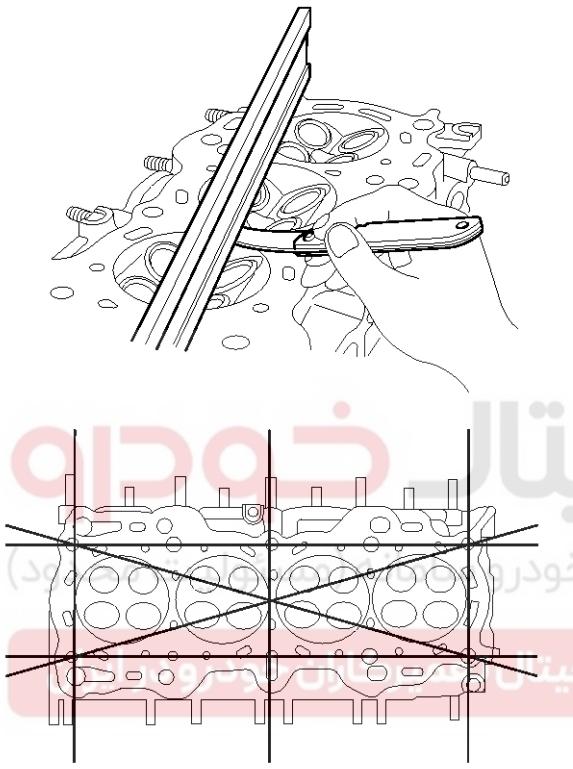
Inspection

Cylinder Head

1. Inspect for flatness.

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

Flatness of cylinder head gasket surface
Standard : Less than 0.05mm(0.002in.)



ECKD001H

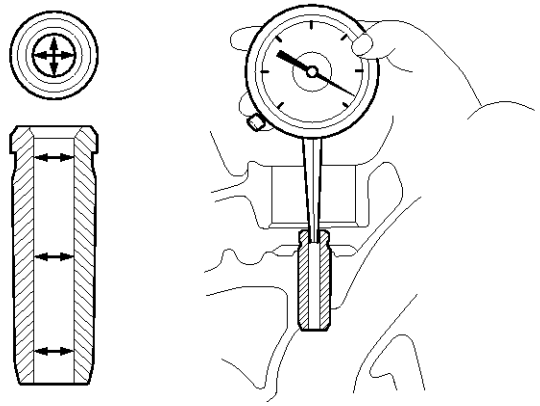
2. Inspect for cracks.

   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.

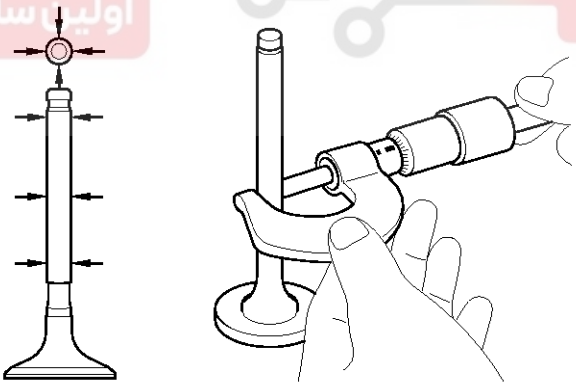
Valve guid I.D.
Intake / Exhaust : 5.500 ~ 5.512mm (0.216 ~ 0.217in.)



ECKD219A

   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.)



ECKD220A

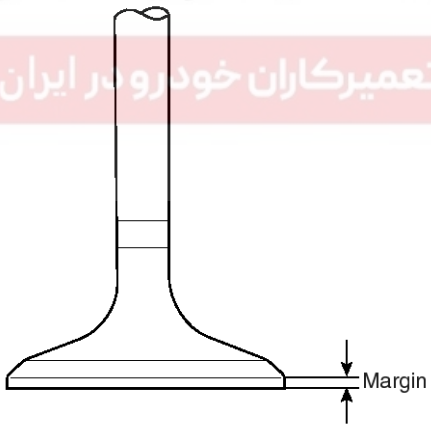
3) Subtract the valve stem diameter measurement from the valve guide inside diameter measurement.

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.)

If the clearance is greater than maximum, replace the valve and valve guide.

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 : 1.02mm(0.0401in.)
Exhaust : 1.09mm(0.0429in.)



ECKD221A

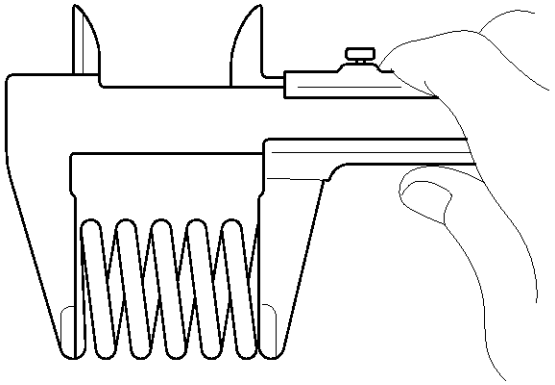
4) Check the valve length.

Valve length
[Standard]
Intake : 113.18mm (4.456in.)
Exhaust : 105.84mm (4.167in.)
[Limit]
Intake : 112.93mm (4.446in.)
Exhaust : 105.59mm (4.157in.)

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.
   Replace the seat if necessary.
   Before reconditioning the seat, check the valve guide for wear. If the valve guide is worn, replace it, then recondition the seat. 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 a vernier calipers, measure the free length of the valve spring.

Valve spring
[Standard]
Free height : 47.44mm (1.8677in.)
Out-of-square : 1.5°



ECKD222A

If the free length is not as specified, replace the valve spring.

MLA

1. Inspect MLA.

   Using a micrometer, measure the MLA outside diameter.

MLA O.D.
Intake/Exhaust :
31.964 ~ 31.980mm(1.2584 ~ 1.2590in.)

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

Tappet bore I.D.
Intake/Exhaust :
32.000 ~ 32.025mm(1.2598 ~ 1.2608in.)

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

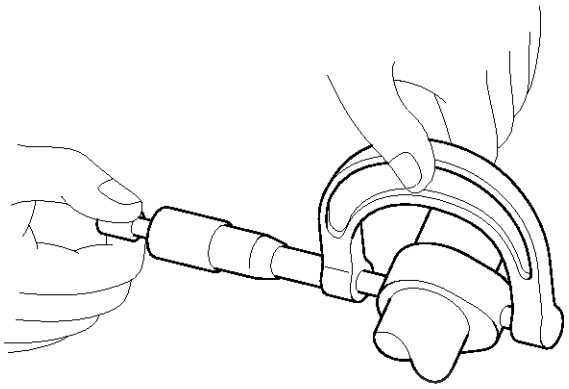
MLA to tappet bore clearance
[Standard]
Intake/Exhaust : 0.020 ~ 0.061mm(0.0008 ~ 0.0024in.)
[Limit]
Intake/Exhaust : 0.07mm(0.0027in.)

Camshaft

1. Inspect cam lobes.

   Using a micrometer, measure the cam lobe height.

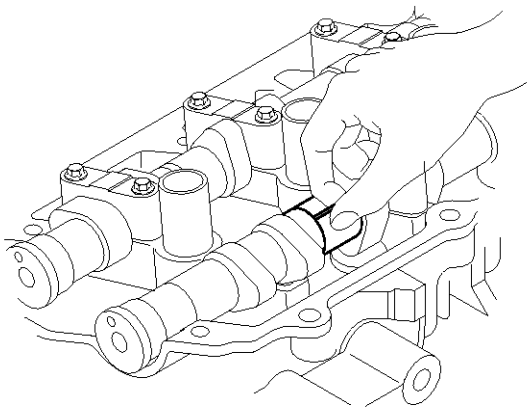
Cam height
[Standard value]
Intake : 44.10 ~ 44.30mm (1.7362 ~ 1.7440in.)
Exhaust : 44.90 ~ 45.10mm (1.7677 ~ 1.7756in.)



ECKD223A

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

2. Inspect 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 journal.



ECKD224A

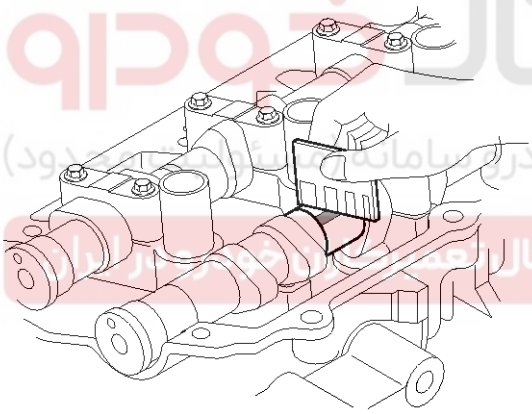
4) Install the bearing caps.

⚠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 : 0.022 ~ 0.057mm (0.0008 ~ 0.0022in.)
No.2,3,4,5, journal :
0.045 ~ 0.082mm (0.0018 ~ 0.0032in.)
Exhaust
No.1 journal : 0 ~ 0.032mm (0 ~ 0.0012in.)
No.2,3,4,5, journal :
0.045 ~ 0.082mm (0.0017 ~ 0.0032in.)
[Limit] :
Intake
No.1 journal : 0.09mm (0.0035in.)
No.2,3,4,5 journal : 0.12mm (0.0047in.)
Exhaust : 0.12mm (0.0047in.)



ECKD225A

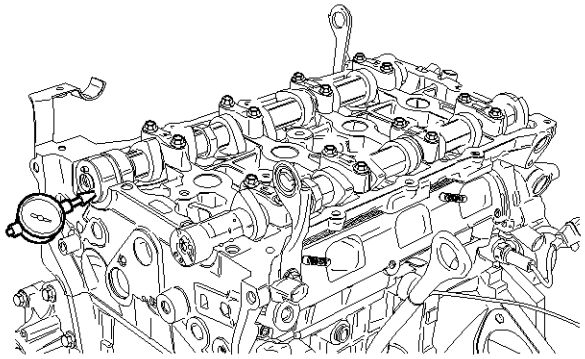
If the oil clearance is greater than maximum, replace the camshaft. If necessary, replace cylinder head.

7) Completely remove the plastigage.

8) Remove the camshafts.

3. Inspect 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] : 0.04 ~ 0.16mm(0.0015 ~ 0.0062in.)
[Limit] : 0.24mm (0.0094in.)



KCRF151B

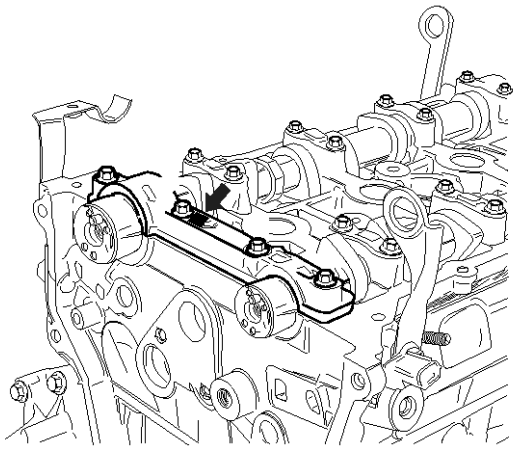
If the end play is greater than maximum, replace the camshaft. If necessary, replace cylinder head.

3) Remove the camshafts.

Exhaust Cam Shaft Bearing

1. Check the cylinder head bore mark.

Location Of Cylinder Head Bore Mark



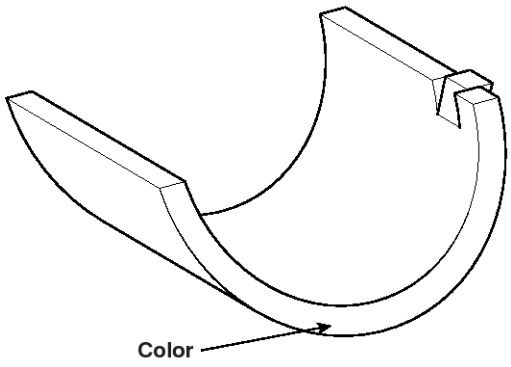
SNFEM8060D

Discrimination Of Cylinder Head

Class	Mark	Exhaust No.1 Inside Diameter Of Cylinder Head Bore
a	A	40.000 ~ 40.008 mm (1.5748 ~ 1.5751 in.)
b	B	40.008 ~ 4.016 mm (1.5751 ~ 1.5754 in.)
c	C	40.016 ~ 40.024 mm (1.5754 ~ 1.5757 in.)

2. Select class of camshaft bearing same as class of cylinder head as shown on the table below.

Place Of Exhaust Cam Shaft Bearing Identification Mark



ECRF021A

Discrimination Of Exhaust Camshaft Bearing

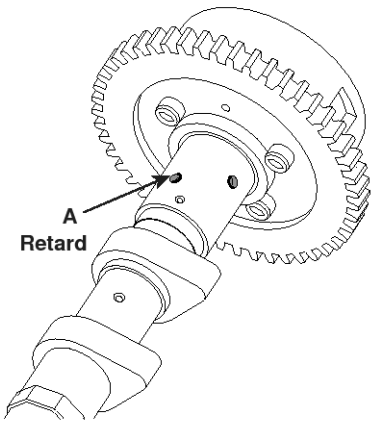
Cylinder Head Bore Class	Bearing Class For Installing (Color)	Thickness Of Bear-ing
a (A)	C (Green)	1.996~2.000mm (0.0785~0.0787in.)
b (B)	B (None color)	2.000~2.004mm (0.0787~0.0788in.)
c (C)	A (Black)	2.004~2.008mm (0.0788~0.0790in.)

Oil clearance : 0 ~ 0.032mm (0 ~ 0.0012in.)

CVVT Assembly

1. Inspect 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.

      Verify the hold to tape and the hold to put air in.



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.

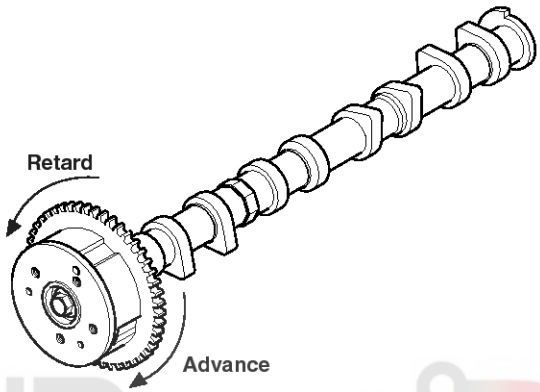
      (Perform this in order to release the lock pin.)

      NOTICE

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

   4) With air applied, as in step (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. Also, under the condition that the pressure can be hardly applied because of the air leakage from the port, there may be the case that the lock pin could be hardly released.



ECRF016A

   5) Turn the CVVT assembly back and forth and check the movable range and that there is no disturbance.

Standard:

Standard:Should move smoothly in a range from about 22.5° (Intake) / 20.0° (Exhaust)

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

Reassembly

NOTICE

Thoroughly clean all parts to be assembled.

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

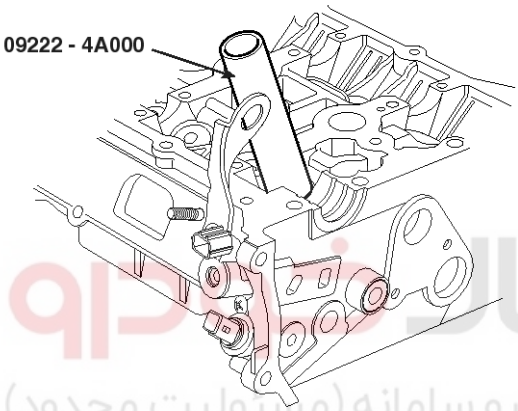
Replace oil seals with new ones.

1. Install valves.
   1) Using SST(09222-4A000), 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.



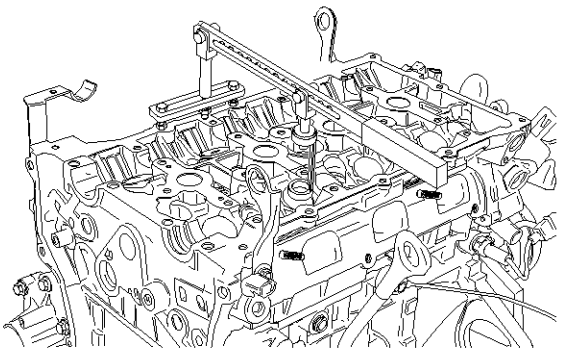
ACLG015A

   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 installs the retainer.

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

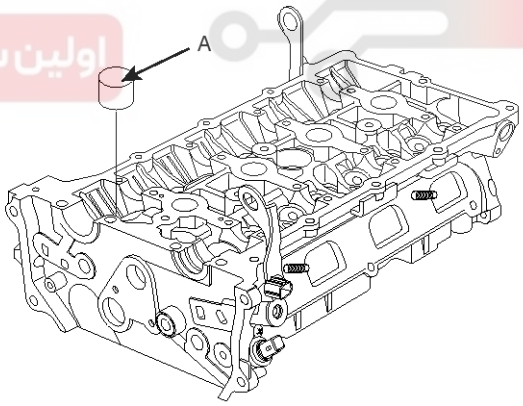


SNFEM8087L

   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 MLAs.

   Check that the MLA rotates smoothly by hand.



KCRF125A

NOTICE

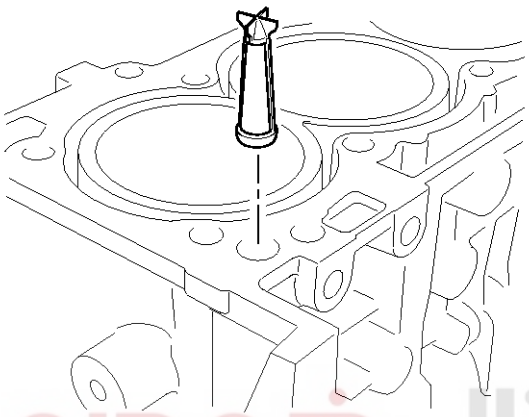
MLA can be reinstalled in its original position.

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 OCV filter.



KCRF176A

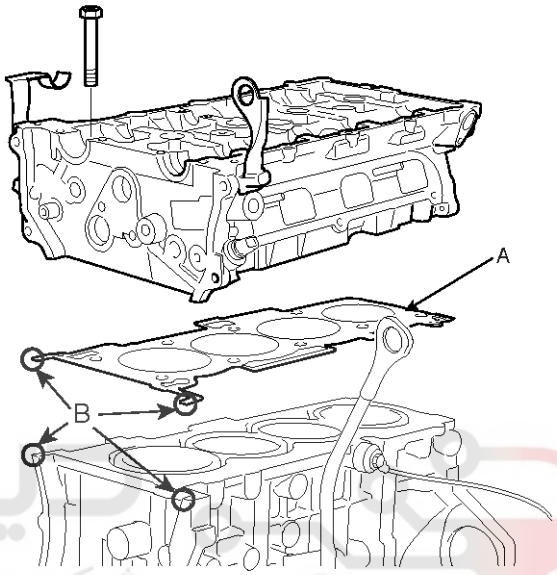
CAUTION

Keep the OCV filter clean.

2. Install the cylinder head gasket(A) on the cylinder block.

NOTICE

- *Be careful of the installation direction.*
- *Apply liquid gasket (Loctite 5900H) on the mark (B).*
- *After applying sealant, assemble the cylinder head in five minutes.*

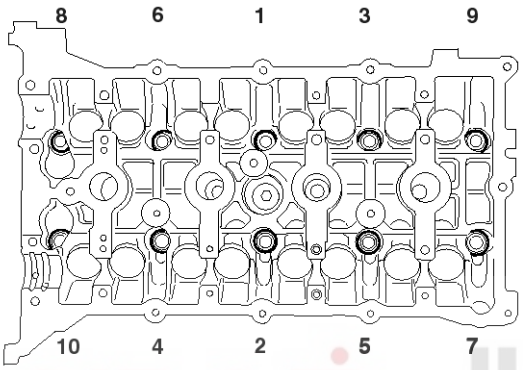


SUNM16114D

3. Place the cylinder head carefully in order not to damage the gasket with the bottom part of the end.

4. Install cylinder head bolts.
   a. Apply a light coat if engine oil on the threads and under the heads of the cylinder head bolts.
   b. Using hexagon wrench, install and tighten the 10 cylinder head bolts and plate washers, in several passes, in the sequence shown.

Tightening torque :
32.4~36.3Nm (3.3~3.7kgf.m, 23.9~26.8lb-ft) + 90~95° + 90~95°

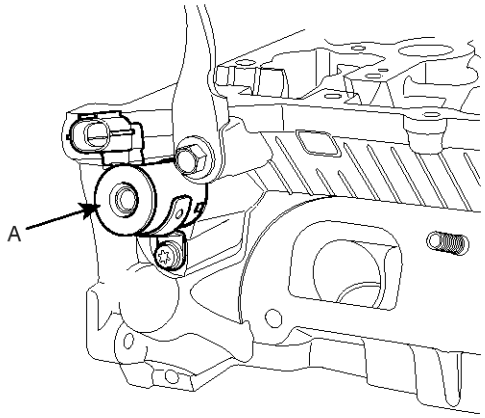


SNFEM8088L

NOTICE
Always use new cylinder head bolt.

5. Install the OCV(A).

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



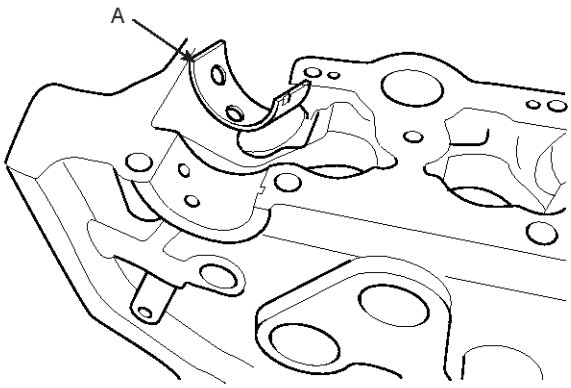
SNFEM8058D

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

6. Install the camshafts.

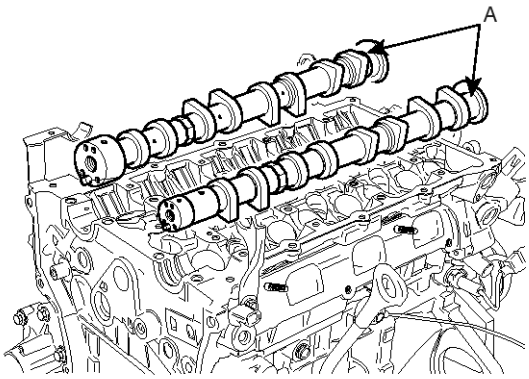
NOTICE
Apply a light coat of engine oil on camshaft journals.

a. Install the exhaust camshaft lower bearing (A).



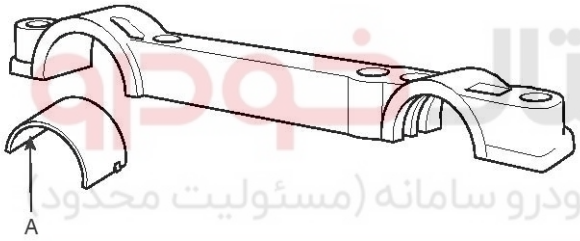
SNFEM8057D

b. Install the camshafts (A).



SNFEM8056D

c. Install the exhaust camshaft upper bearing (A).



SNFEM8016D

d. Install camshaft bearing caps in their proper locations.

Tightening order.

Group A → Group B → Group C.

Tightening torque

Step 1

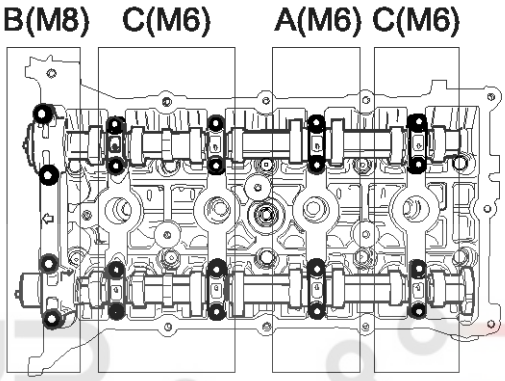
M6 : 5.9N.m(0.6kgf.m, 4.3lb-ft)

M8 : 14.7N.m(1.5kgf.m, 10.8lb-ft)

Step 2

M6 : 10.8 ~ 12.7N.m(1.1 ~ 1.3kgf.m, 7.9 ~ 9.4lb-ft)

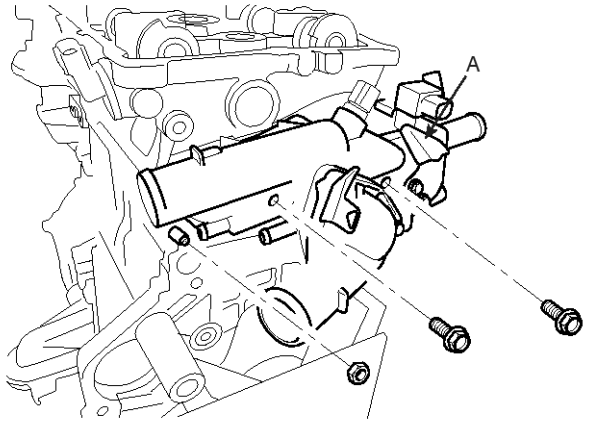
M8 : 27.5 ~ 31.4N.m(2.8 ~ 3.2kgf.m, 20.3 ~ 23.1lb-ft)



SUNM16115D

7. Install the water temp control assembly (A).

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



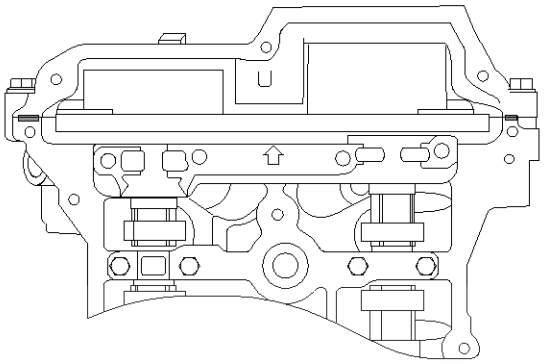
SNFEM8010D

⚠CAUTION

- **Assemble water temp control assembly and water inlet pipe to water pump assembly before nuts for assembling of water inlet pipe to be tightened.**
- **Always use a new O-ring.**

8. Install the timing chain.
9. Check and adjust valve clearance.
10. Install the cylinder head cover.
    a. The hardening sealant located on the upper area between timing chain cover and cylinder head should be removed before assembling cylinder head cover.
    b. After applying sealant, it should be assembled within 5 minutes.

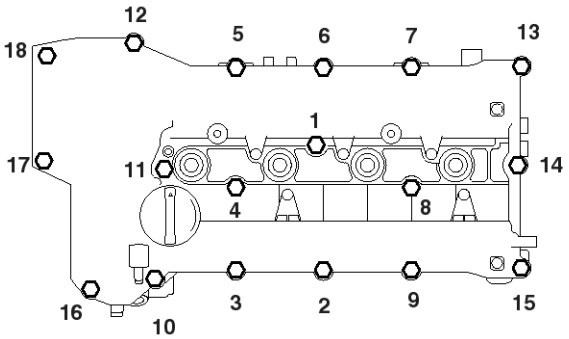
Bead width : 2.5mm(0.1in.)
Sealant : LOCTITE 5900H



SNFEM8045D

    c. The firing and/or blow out test should not be performed within 30 minutes after the cylinder head cover was assembled.
    d. Install the cylinder head cover bolts as following method.

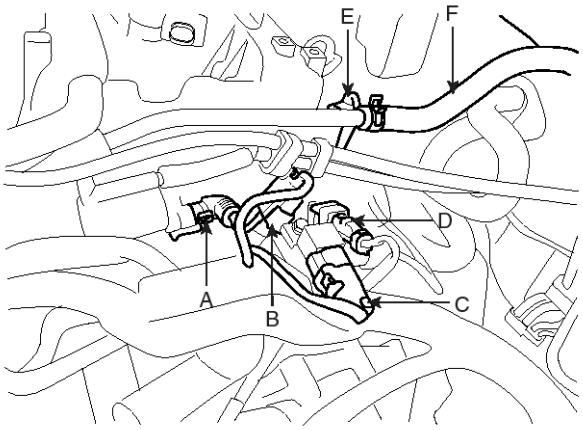
Tightening torque :
Step 1 : 3.9 ~ 5.9N.m(0.4 ~ 0.6kgf.m, 2.9 ~ 4.3lb-ft)
Step 2 : 7.8 ~ 9.8N.m(0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)



SNFEM8046D

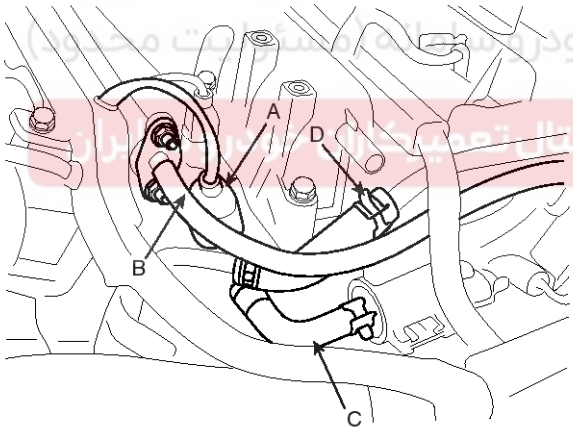
⚠CAUTION
Do not reuse cylinder head cover gasket.

11. Install the intake & exhaust manifold. (Refer to Intake and exhaust system in this group)
12. Connect the PCSV connector (A), ECT connector (B), condenser connector (C), CKP sensor connector (D), CMP sensor connector (E) and brake booster vacuum hose (F).



SNFEM8008D

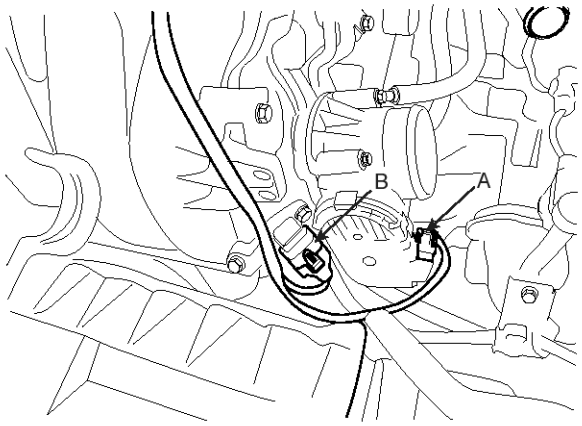
13. Connect the brake booster vacuum hose (D), PCSV hose (C) fuel hose (B) and CMP sensor connector (A).



SNFEM8068D

14. Connect the ETC connector (A) and MAP sensor connector (B).

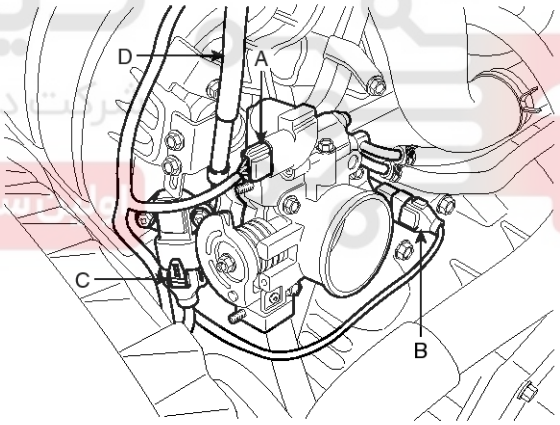
[2.4]



SNFEM8007D

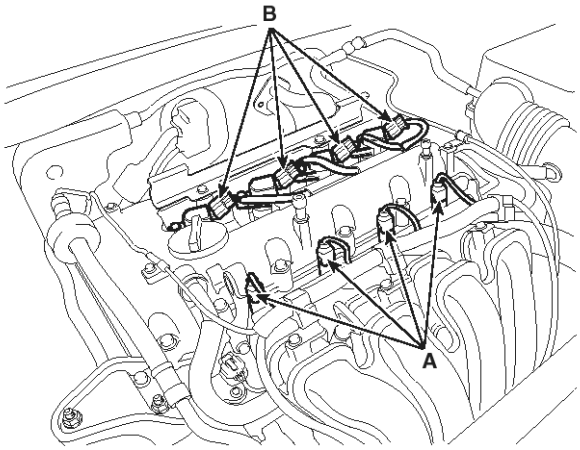
15. Connect the ISA connector (A), TPS connector (B) and MAP sensor connector (C) then Install the throttle cable (D).

[2.0]



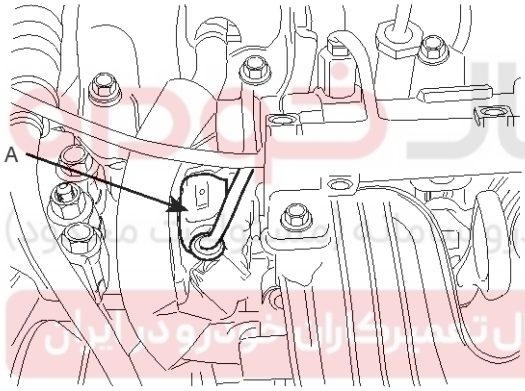
SNFEM8074D

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



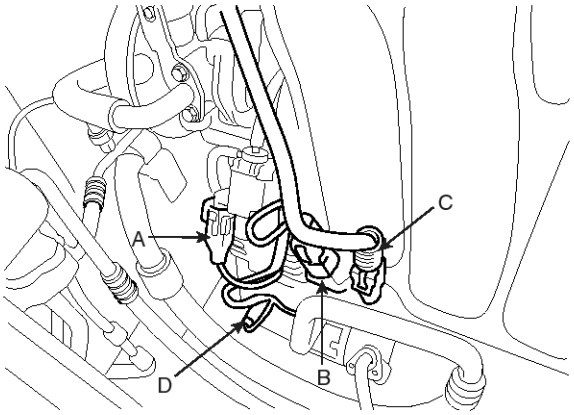
SMGEM9001D

17. Connect the OCV connector (A).



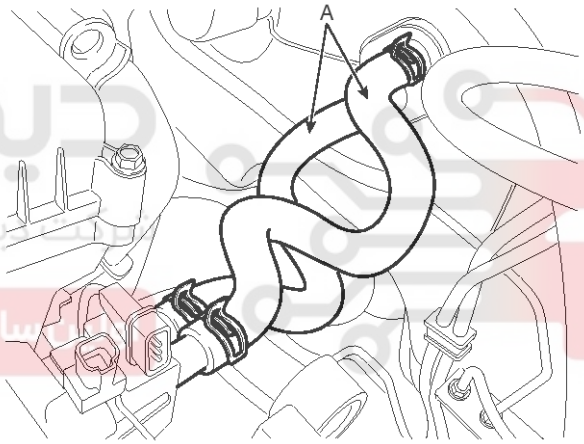
SNFEM8032D

18. Connect the VIS connector (A), OPS connector (B), knock sensor connector (C) and A/C switch connecter (D).



SNFEM8006D

19. Install the heater hoses (A).

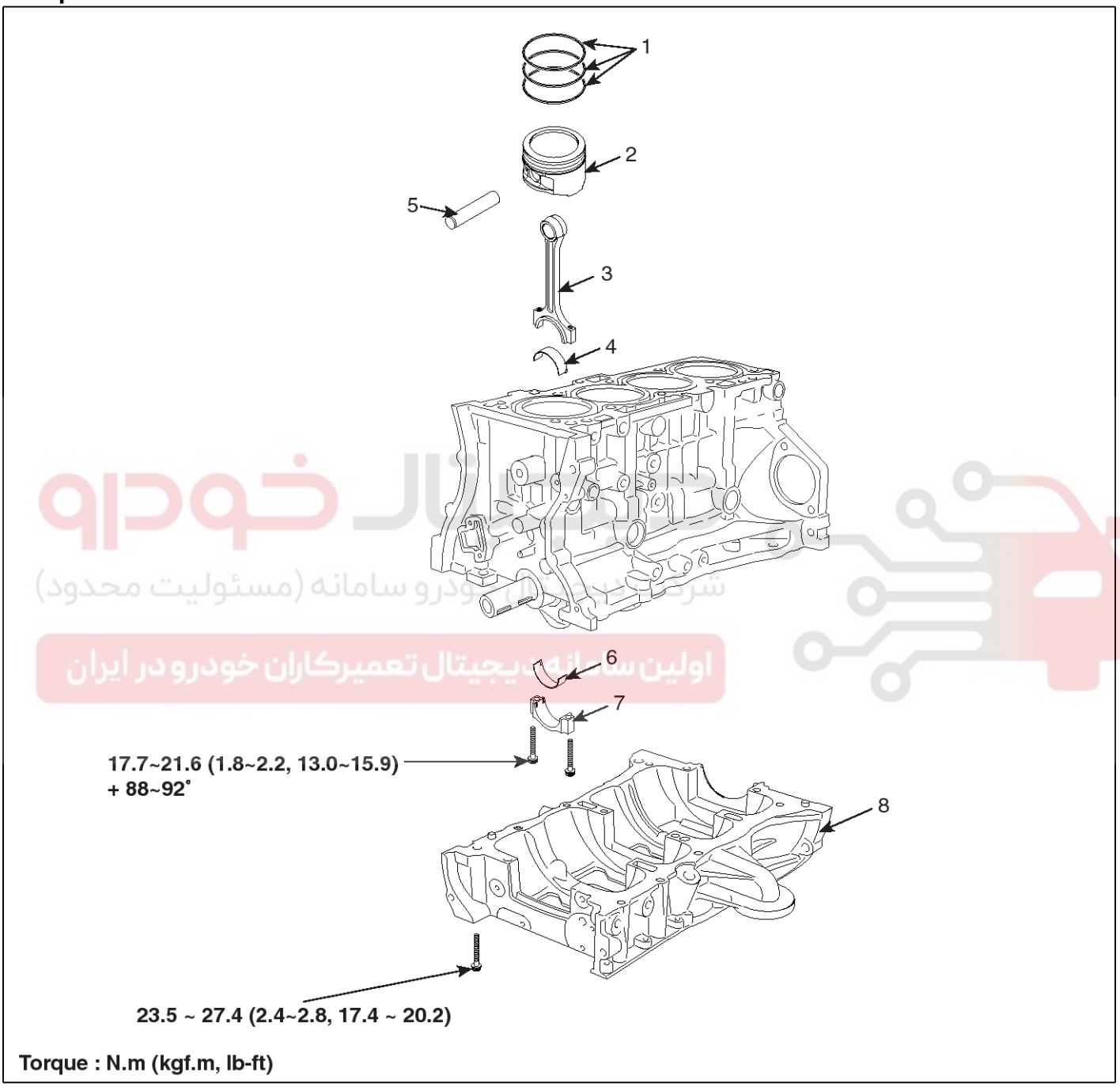


ACLG003A

Cylinder Block

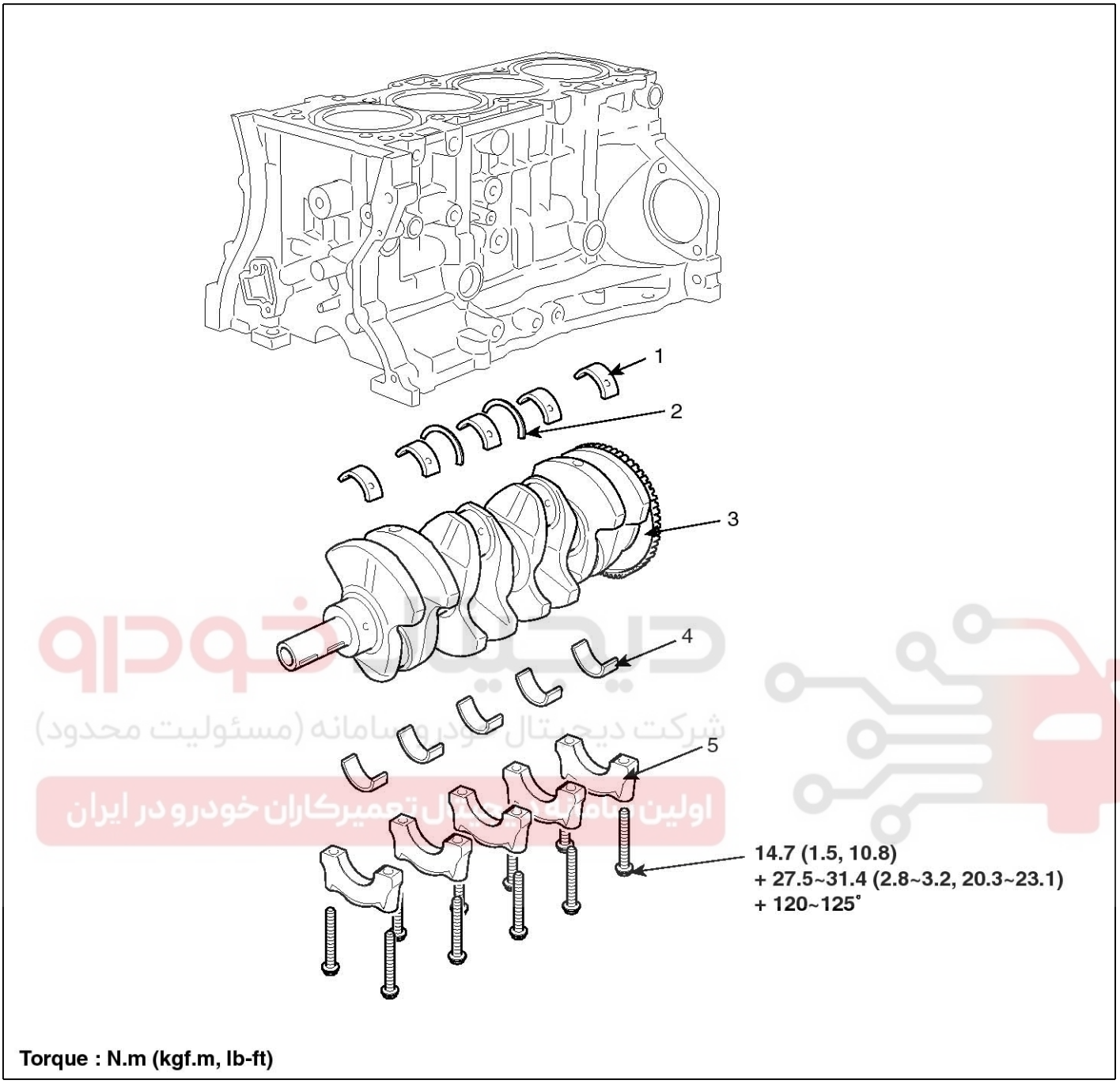
Cylinder Block

Components



SNFEM8063L

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. Ladder frame

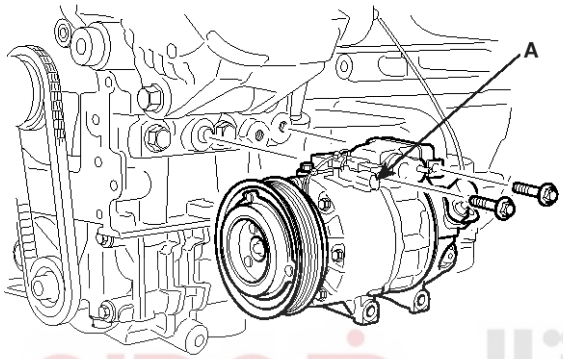


SNFEM8064L

1. Crankshaft upper bearing
2. Thrust bearing
3. Crankshaft
4. Crankshaft lower bearing
5. Main bearing cap

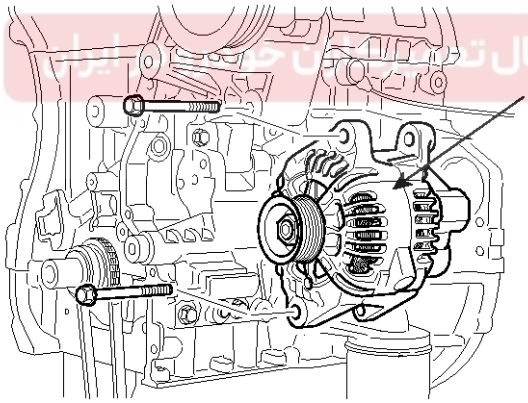
Disassembly

1. M/T : remove flywheel.
2. A/T : remove drive plate.
3. Install engine to engine stand for disassembly.
4. Remove timing chain. (Refer to Timing system in this group)
5. Remove cylinder head. (Refer to Cylinder block in this group)
6. Remove A/C compressor(A) from engine.



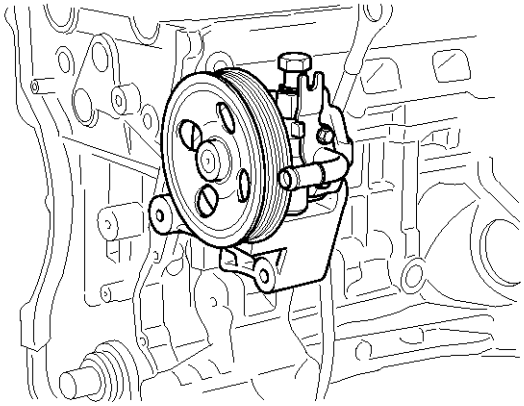
KCRF158A

7. Remove alternator(A) from engine.



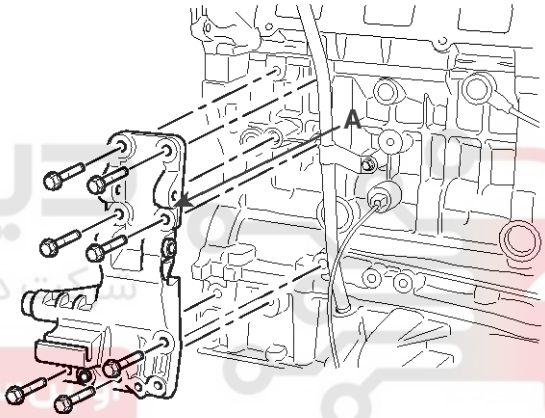
KCRF159A

8. Remove power steering pump and bracket.



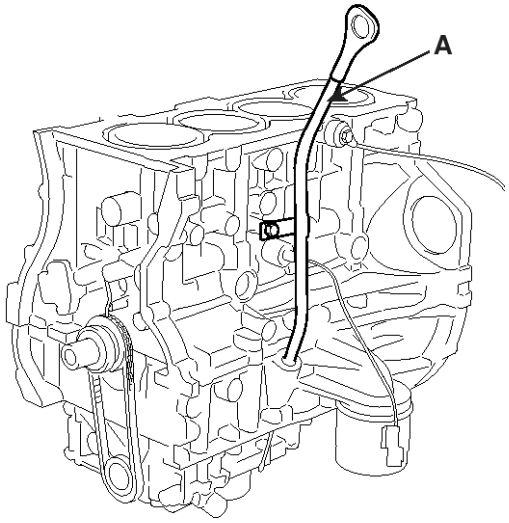
KCRF160A

9. Remove tensioner assembly integrated bracket(A).



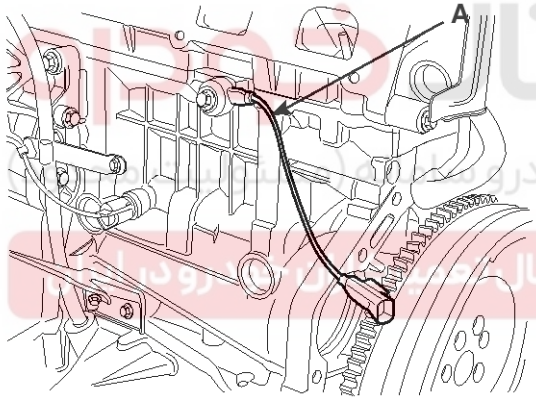
KCRF161A

10. Remove oil level gauge assembly(A).



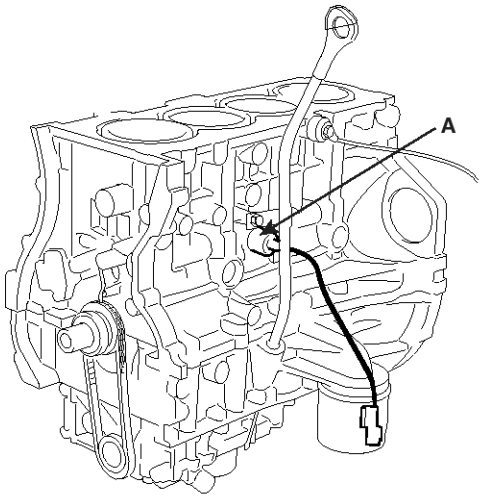
KCRF163B

11. Remove knock sensor(A).



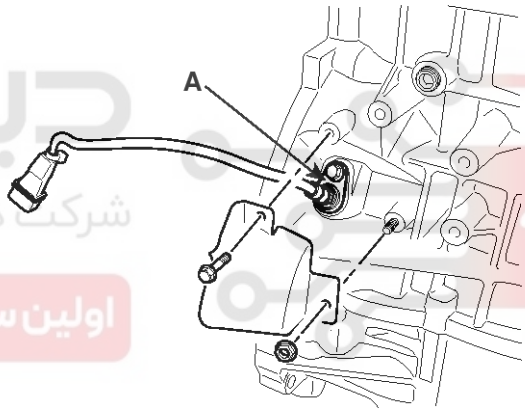
KCRF143A

12. Remove oil pressure sensor(A).



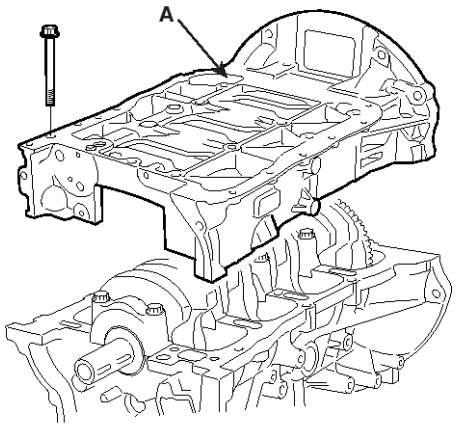
KCRF163C

13. Remove CKP sensor(A).



KCRF164A

14. Remove water pump.
15. Remove balance shaft module.
16. Remove ladder frame(A).

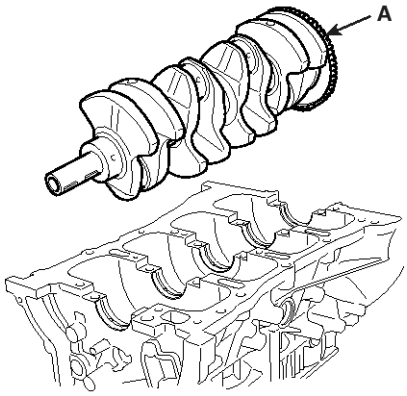


KCRF167A

17. Check the connecting rod end play.
18. Remove the connecting rod caps and check oil clearance.
19. Remove 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.*
20. Remove crankshaft bearing cap and check oil clearance.
21. Check the crankshaft end play.
22. Lift the crankshaft(A) out of the engine, being careful not to damage journals.

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



KCRF172A

23. Check fit between piston and piston pin.

    Try to move the piston back and forth on the piston pin. If any movement is felt, replace the piston and pin as a set.
24. Remove piston rings.
    1) Using a piston ring expender, 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.
25. Disconnect connecting rod from piston.

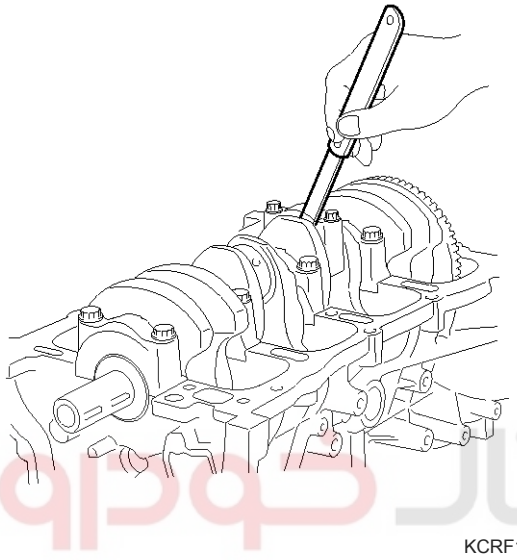
Inspection

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.)
Maximum end play : 0.35mm(0.0138in.)



KCRF169B

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

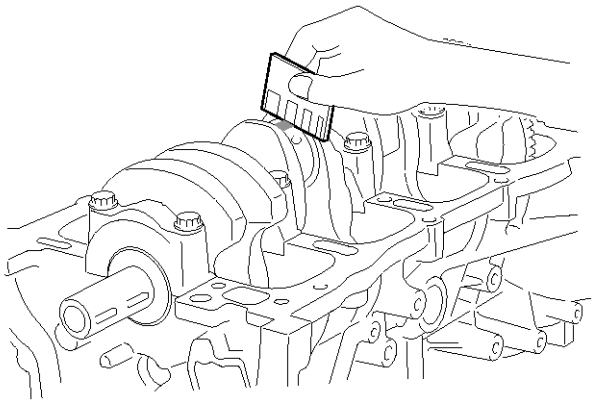
2. Check the connecting road bearing oil clearance.
   1) Check the matchmarks on the connecting rod and cap are aligned to ensure correct reassembly.
   2) Remove 2 connecting rod cap bolts.
   3) Remove the connecting rod cap and bearing half.
   4) Clean the crank pin and bearing.
   5) Place plastigage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

Tightening torque
17.7~21.6Nm (1.8~2.2kgf.m, 13.0~15.9lb-ft) + 88~92°

NOTICE
Do not turn the crankshaft.

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

Standard oil clearance
0.025 ~ 0.043mm(0.0009 ~ 0.0016in.)



KCRF169A

   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.

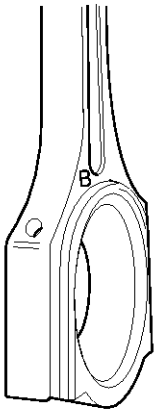
CAUTION
Do not file, shim, or scrape the bearings or the caps to adjust clearance.

   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



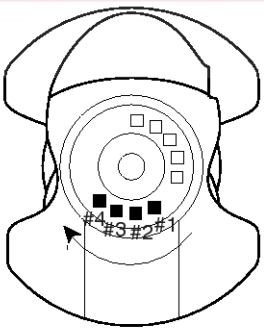
SNFEM8089L

Discrimination Of Connecting Rod

Class	Mark	Inside Diameter
a	A	51.000 ~ 51.006mm (2.0079 ~ 2.0081in.)
b	B	51.006 ~ 51.012mm (2.0081 ~ 2.0083in.)
c	C	51.012 ~ 51.018mm (2.0083 ~ 2.0085in.)

Crankshaft Pin Mark Location

Discrimination Of Crankshaft



SNFEM8090L

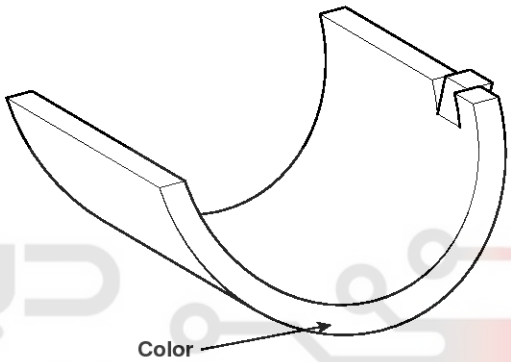
NOTICE

Conform to read stamping order as shown arrow direction from #1.

Discrimination Of Crankshaft

Class	Mark	Outside Diameter Of Pin
I	1	47.966 ~ 47.972mm (1.8884 ~ 1.8886in.)
II	2	47.960 ~ 47.966mm (1.8881 ~ 1.8884in.)
III	3	47.954 ~ 47.960mm (1.8879 ~ 1.8881in.)

Place Of Identification Mark (Connecting Rod Bearing) Discrimination Of Connecting Rod Bearing



ECRF021A

Discrimination Of Connecting Rod Bearing

Class	Mark	Thickness Of Bearing
AA	BLUE	1.517 ~ 1.520mm (0.0597 ~ 0.0598in.)
A	BLACK	1.514 ~ 1.517mm (0.0596 ~ 0.0597in.)
B	NONE	1.511 ~ 1.514mm (0.0595 ~ 0.0596in.)
C	GREEN	1.508 ~ 1.511mm (0.0594 ~ 0.0595in.)
D	YELLOW	1.505 ~ 1.508mm (0.0593 ~ 0.0594in.)

11) Selection

Crankshaft Indentification Mark	Connecting Rod Identification Mark	Assembing Classification Of Bearing
I (1)	a (A)	D (Yellow)
	b (B)	C (Green)
	c (C)	B (None)
II (2)	a (A)	C (Green)
	b (B)	B (None)
	c (C)	A (Black)
III (3)	a (A)	B (None)
	b (B)	A (Black)
	c (C)	AA (Blue)

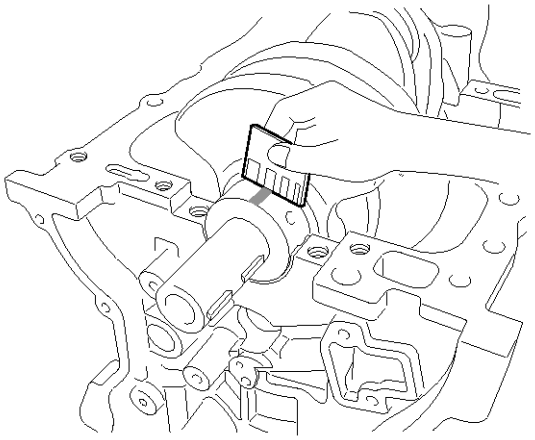
3. Check the crankshaft bearing oil clearance.
   1) To check main bearing-to-journal oil clearance, remove the main caps and bearing halves.
   2) Clean each main journal and bearing half with a clean shop tower.
   3) Place one strip of plastigage across each main journal.
   4) Reinstall the bearings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

Tightening torque
14.7Nm (1.5kgf.m, 10.8lb-ft) + 27.5~31.4Nm (2.8~3.2kgf.m, 20.3~23.1lb-ft) + 120~125°

NOTICE
Do not turn the crankshaft.

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

Standard oil clearance
0.020 ~ 0.038mm (0.0008 ~ 0.0015in.)



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.

Connecting Rods

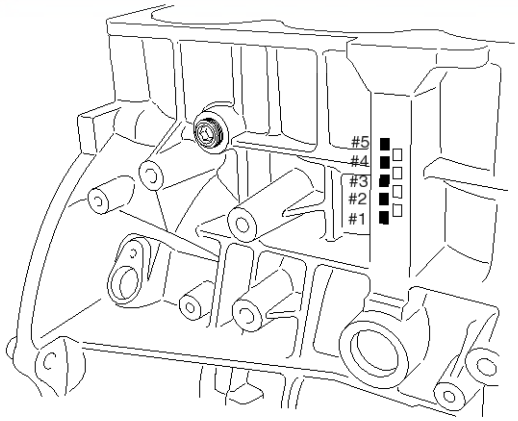
1. When reinstalling, make sure that cylinder numbers put on the connecting rod and cap at disassembly match. When a new connecting rod is installed, make sure that the notches for holding the bearing in place are on the same side.
2. Replace the connecting rod if it is damaged on the thrust faces at 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

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.

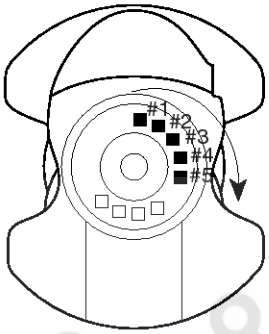


SNFEM8091L

Discrimination Of Cylinder Block

Calss	Mark	Inside Diameter
a	A	56.000 ~ 56.006mm (2.2047 ~ 2.2049in.)
b	B	56.006 ~ 56.012mm (2.2049 ~ 2.2052in.)
c	C	56.012 ~ 56.018mm (2.2052 ~ 2.2054in.)

Crankshaft Journal Mark Location Discrimination Of Crankshaft



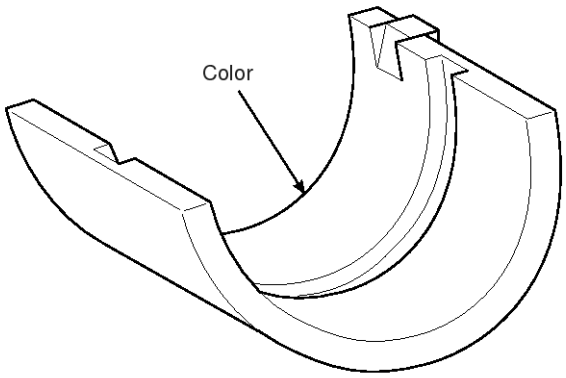
SNFEM8092L

NOTICE
Conform to read stamping order as shown arrow direction from #1.

Discrimination Of Crankshaft

Class	Mark	Outside Diameter Of Journal
I	1	51.954 ~ 51.960mm (2.0454 ~ 2.0456in.)
II	2	51.948 ~ 51.954mm (2.0452 ~ 2.0454.)
III	3	51.942 ~ 51.948mm (2.0449 ~ 2.0452in.)

Place Of Identification Mark (Crankshaft Bearing) Discrimination Of Crankshaft Bearing



ECRF022A

Discrimination Of Crankshaft Bearing

Class	Mark	Thickness Of Bearing
AA	Blue	2.026 ~ 2.029mm (0.0797 ~ 0.0798in.)
A	Black	2.023 ~ 2.026mm (0.0796 ~ 0.0797in.)
B	None	2.020 ~ 2.023mm (0.0795 ~ 0.0796in.)
C	Green	2.017 ~ 2.020mm (0.0794 ~ 0.795in.)
D	Yellow	2.014 ~ 2.017mm (0.0793 ~ 0.0794in.)

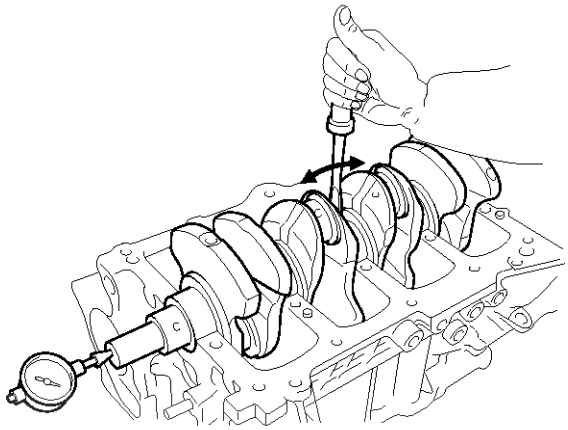
Selection

Crankshaft Identification Mark	Crankshaft Bore Identification Mark	Assembling Classification Of Bearing
I (1)	a (A)	D (Yellow)
	b (B)	C (Green)
	c (C)	B (None)
II (2)	a (A)	C (Green)
	b (B)	B (None)
	c (C)	A (Black)
III (3)	a (A)	B (None)
	b (B)	A (Black)
	c (C)	AA (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
0.07 ~ 0.25mm (0.0027 ~ 0.0098in.)
Limit : 0.30mm (0.0118in.)



KCRF211A

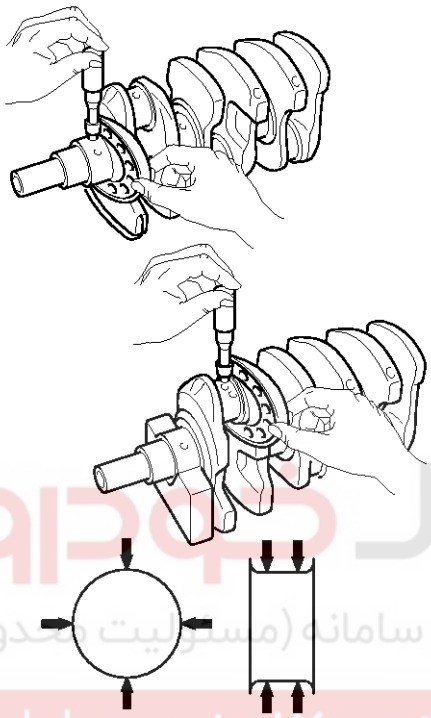
If the end play is greater than maximum, replace the thrust bearings as a set.

Thrust bearing thickness
1.925 ~ 1.965mm(0.0758 ~ 0.07736in.)

5. Inspect main journals and crank pins

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

Main journal diameter :
51.942 ~ 51.960mm (2.0449 ~ 2.0456in.)
Crank pin diameter :
47.954 ~ 47.972mm (1.8879 ~ 1.8886in.)



KCRF212A

Cylinder Block

1. Remove gasket material.

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

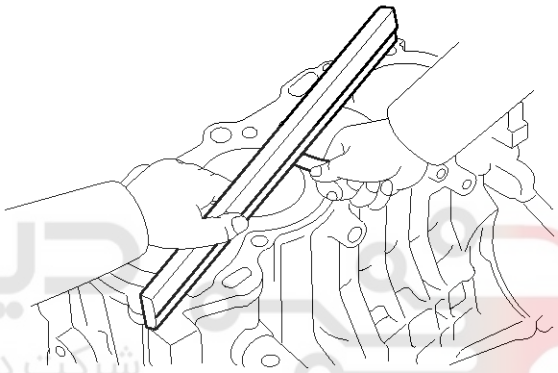
2. Clean cylinder block

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

3. Inspect top surface of cylinder block for flatness.

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

Flatness of cylinder block gasket surface
Standard : Less than 0.05mm(0.0020 in.)



KCRF213A

4. Inspect cylinder bore diameter

   Visually check the cylinder for vertical scratchs.

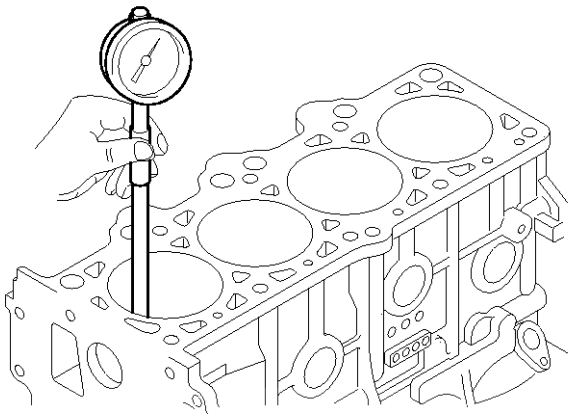
   If deep scratches are present, replace the cylinder block.

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

[2.4] : 88.00 ~ 88.03mm (3.4645 ~ 3.4657in.)
[2.0] : 86.00 ~ 86.03mm (3.3858 ~ 3.3870in.)



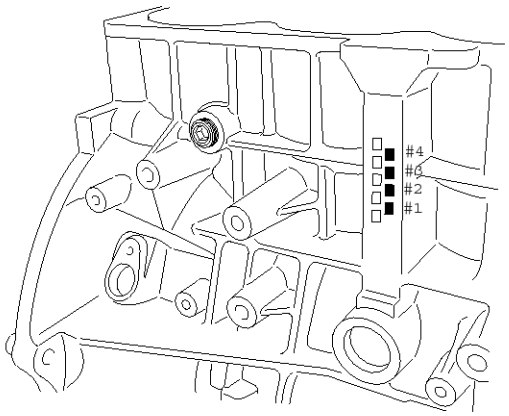
KCRF214A

NOTICE

Measure position(from the bottom of the cylinder block)

: 110.7mm(4.3582in.) / 160mm(6.2992in.) / 210mm(8.2677in.)

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

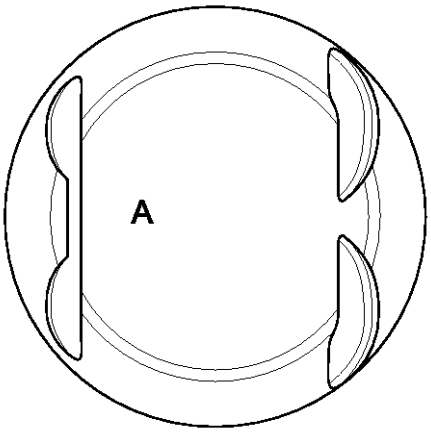


SNFEM8093L

Cylinder Bore Inner Diameter

Size Code	2.0	2.4
A	86.00 ~ 86.01mm (3.3858~ 3.3862in.)	88.00 ~ 88.01mm (3.4645~ 3.4649in.)
B	86.01 ~ 86.02mm (3.3862~ 3.3866in.)	88.01 ~ 88.02mm (3.4649~ 3.4653in.)
C	86.02 ~ 86.03mm (3.3866~ 3.3870in.)	88.02 ~ 88.03mm (3.4653~ 3.4657in.)

7. Check the piston size code on the piston top face.



ECKE320B

NOTICE
Stamp the grade mark of basic diameter with rubber stamp.

Piston Outer Diameter

Size Code	2.0	2.4
A	85.975 ~ 85.985mm (3.3848~ 3.3852in.)	87.975 ~ 87.985mm (3.4635~ 3.4639in.)
B	85.985 ~85.995mm (3.3852~ 3.3856in.)	87.985 ~ 87.995mm (3.4639~ 3.4643in.)
C	85.995 ~ 86.005mm (3.3856~ 3.3860in.)	87.995 ~88.005mm (3.4643~ 3.4647in.)

8. Select the piston related to cylinder bore class.

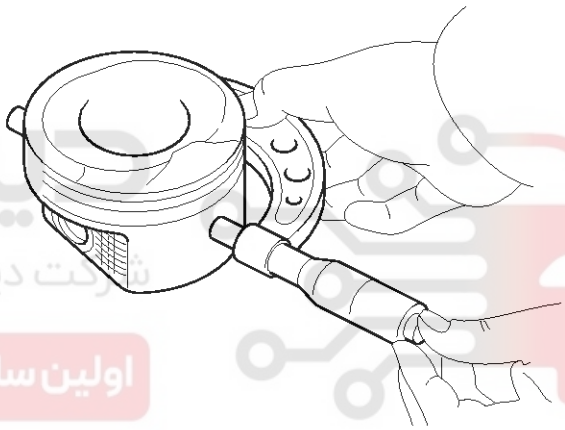
Clearance : 0.015 ~ 0.035mm (0.00059 ~ 0.00137in.)

Piston And Rings

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

   NOTICE
   Do not use a wire brush.
2. The standard measurement of the piston outside diameter is taken 14 mm (0.55 in.) from the top land of the piston.

Standard diameter
[2.4] : 87.975 ~ 88.005mm (3.4635 ~ 3.4647in.)
[2.0] : 85.975 ~ 86.005mm (3.3848 ~ 3.3860in.)



KCRF215A

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

Piston-to-cylinder clearance
0.015 ~ 0.035mm(0.00059 ~ 0.00137in.)

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 : 0.05 ~ 0.08mm (0.0019 ~ 0.0031in.)
No.2 : 0.04 ~ 0.08mm (0.0015 ~ 0.0031in.)
Oil ring : 0.06 ~ 0.15mm (0.0023 ~ 0.0059in.)
Limit
No.1 : 0.1mm (0.004in.)
No.2 : 0.1mm (0.004in.)
Oil ring : 0.2mm (0.008in.)

KCRF216A

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 rebored.

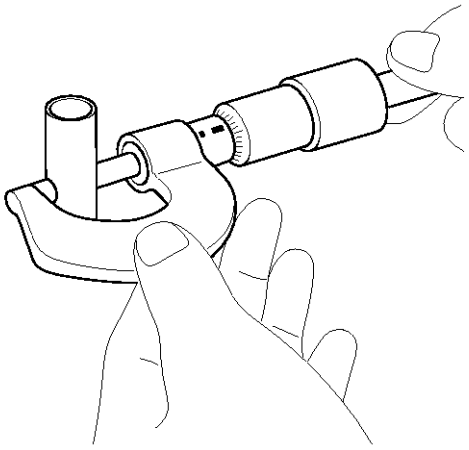
Piston ring end gap
Standard
No.1 : 0.15 ~ 0.30mm (0.0059 ~ 0.0118in.)
No.2 : 0.37 ~ 0.52m (0.0145 ~ 0.0204in.)
Oil ring : 0.20 ~ 0.70mm (0.0079 ~ 0.0275in.)
Limit
No.1 : 0.6mm (0.0236in.)
No.2 : 0.7mm (0.0275in.)
Oil ring : 0.8mm (0.0315in.)

KCRF217A

Piston Pins

1. Measure the diameter of the piston pin.

Piston pin diameter
21.001 ~ 21.006mm (0.8268 ~ 0.8270in.)



KCRF218A

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

Piston pin-to-piston clearance
0.01 ~ 0.02mm (0.0004 ~ 0.0008in.)

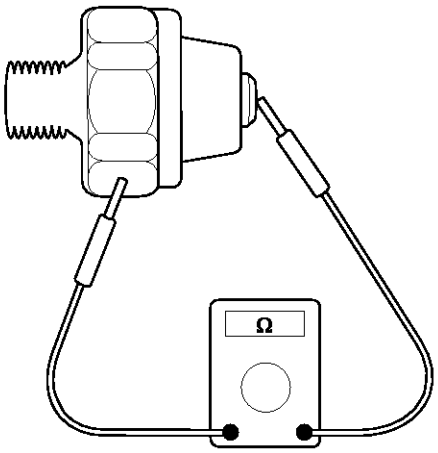
3. Check the difference between the piston pin diameter and the connecting rod small end diameter.

Piston pin-to-connecting rod interference
0.016 ~ 0.032mm (0.00063 ~ 0.00126in.)

Oil Pressure Switch

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

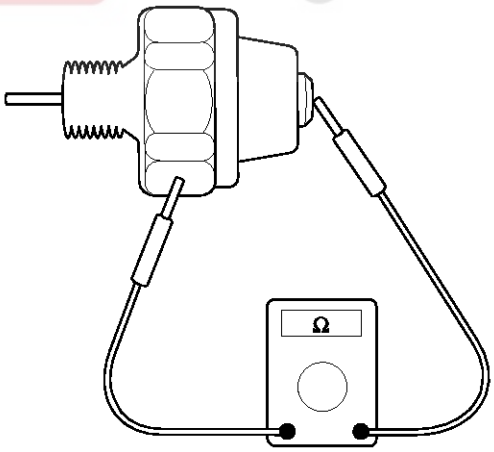
   If there is no continuity, replace the oil pressure switch.



KCRF219A

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 throgh the oil hole, the switch is operaing properly.

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



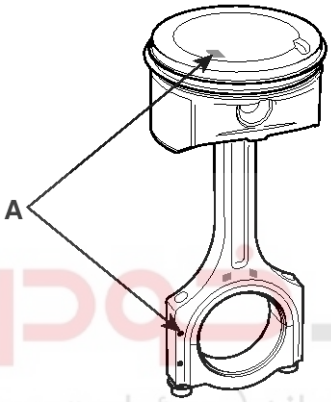
KCRF220A

Reassembly

NOTICE

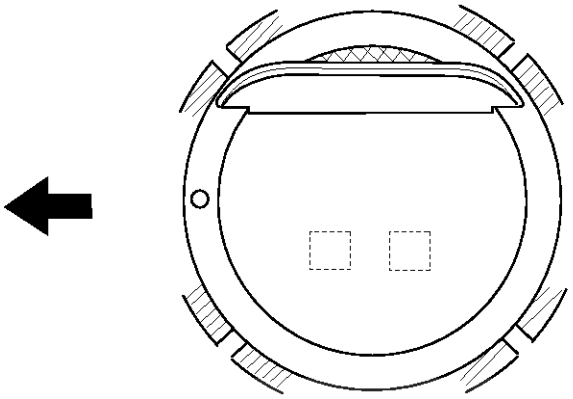
- *Thoroughly clean all parts to assembled.*
- *Before installing the parts, apply fresh engine oil to all sliding and rotating surfaces.*
- *Replace all gaskets, O-rings and oil seals with new parts.*

1. Assemble piston and 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.



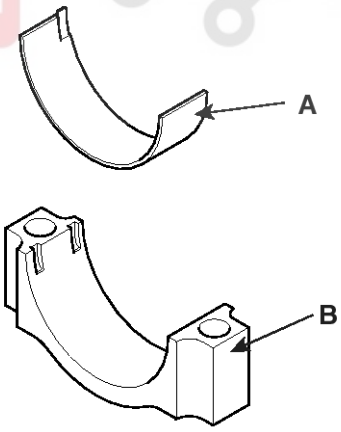
KCRF168A

2. Install 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.



KCRF221A

3. Install 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).



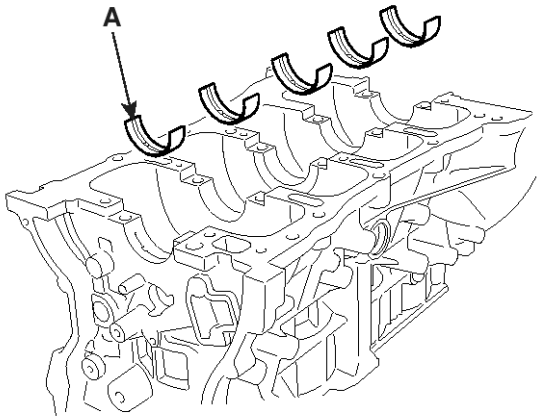
KCRF118B

4. Install 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 5 upper bearings(A).

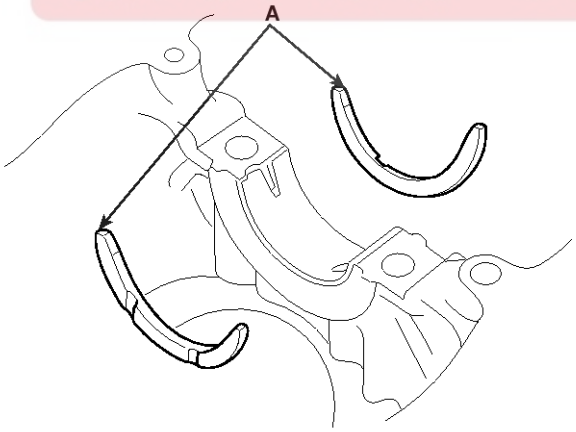


KCRF173A

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

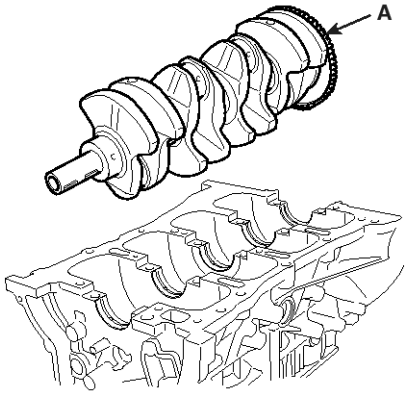
5. Install thrust bearings.

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



KCRF222A

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



KCRF172A

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

Tightening torque

14.7Nm (1.5kgf.m, 10.8lb-ft) + 27.5~31.4Nm (2.8~3.2kgf.m, 20.3~23.1lb-ft) + 120~125°

CAUTION

Always use new main bearing cap bolts.

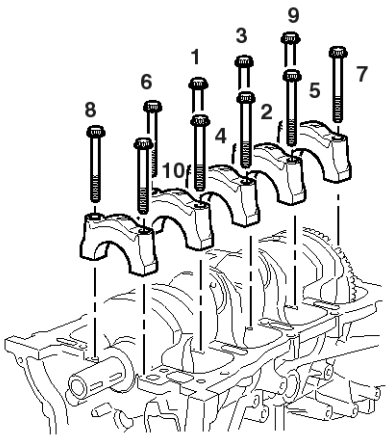
NOTICE

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

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

Tightening torque :

29.4N.m (3.0kgf.m, 21.7lb-ft)



KCRF171A

3) Retighten the bearing cap bolts by 120° in the numerical order shown.
4) Check that the crankshaft turns smoothly.

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

NOTICE

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

1) Remove the connecting rod caps, and slip short sections of rubber hose over the threaded ends of the connecting rod bolts.
2) 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.
3) Stop after the ring compressor pops free, and check the connecting rod-to-check journal alignment before pushing the piston into place.
4) Apply engine oil to the bolt threads. Install the rod caps with bearings, and torque the bolts.

Tightening torque

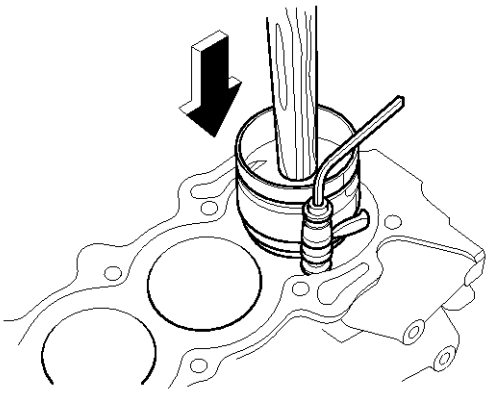
17.7~21.6Nm (1.8~2.2kgf.m, 13.0~15.9lb-ft) + 88~92°

CAUTION

Always use new connecting rod cap bolts.

NOTICE

Maintain downward force on the ring compressor to prevent the rings from expanding before entering the cylinder bore.

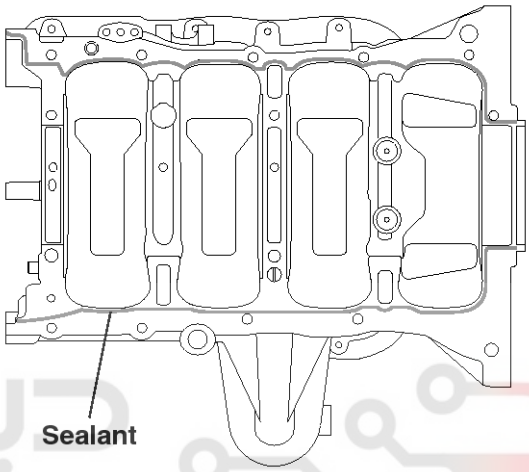


KCRF223A

11. Apply liquid gasket to the mating surface of cylinder block and ladder frame.

NOTICE

- *Be assembling ladder frame, the liquid sealant Loctite 5900 or THREEBOND 1217H should be applied ladder frame.*
- *The part must be assembled within 5 minutes after sealant was applied.*
- *Apply sealant to the inner threads of the bolt holes.*

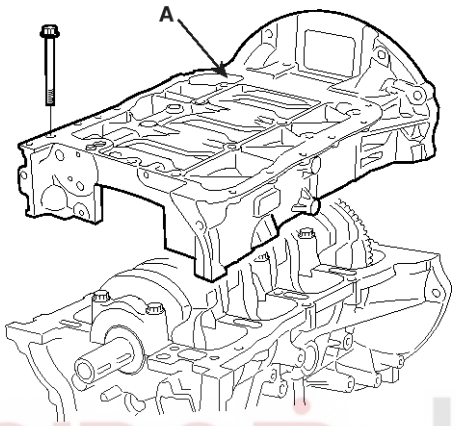


ECRF023A

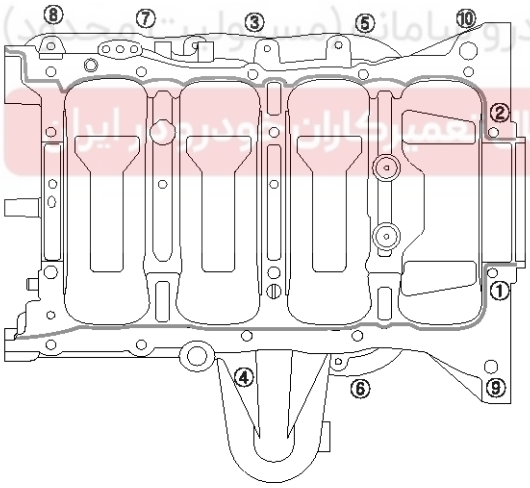
12. Install ladder frame(A) with 10 bolts in several passes in sequence shown.

Tightening torque

Step 1 :
7.8 ~ 8.8N.m (0.8 ~ 0.9kgf.m, 5.8 ~ 6.5lb-ft)
Step 2 :
15.7 ~18.6N.m (1.6 ~ 1.9kgf.m, 11.6 ~ 13.7lb-ft)
Step 3 :
23.5 ~ 27.5N.m (2.4 ~ 2.8kgf.m, 17.4 ~ 20.3lb-ft)



KCRF167A

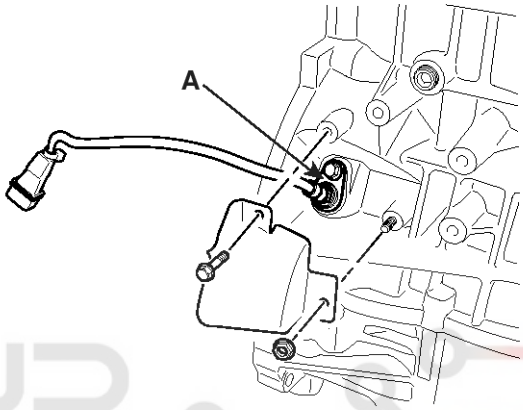


SNFEM8094L

13. Install rear oil seal.
    1) Apply engine oil to a new oil seal lip.
    2) Using SST(09231-H1100, 09214-3K100) and a hammer, tap in the oil seal until its surface is flush with the rear oil seal retainer edge.
14. Install balance shaft module.
15. Install water pump.
16. Install CKP sensor(A) and sensor cover.

Tightening torque

3.9 ~ 5.9N.m (0.4 ~ 0.6kgf.m, 2.9 ~ 4.3lb-ft)

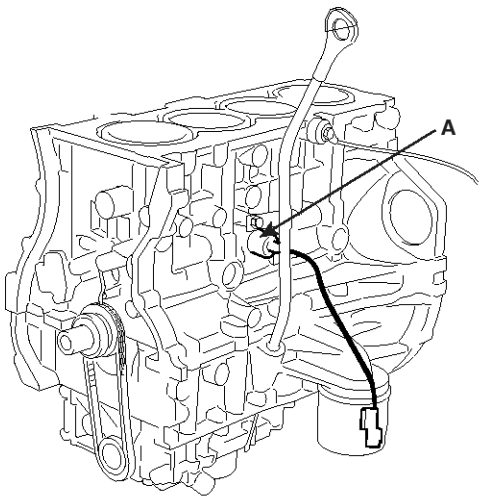


KCRF164A

17. Install oil pressure sensor.
    1) Apply adhesive to 2 or 3 threads.
    Adhesive : MS 721-39(B) or equivalent.
    2) Install the oil pressure sensor (A).

Tightening torque

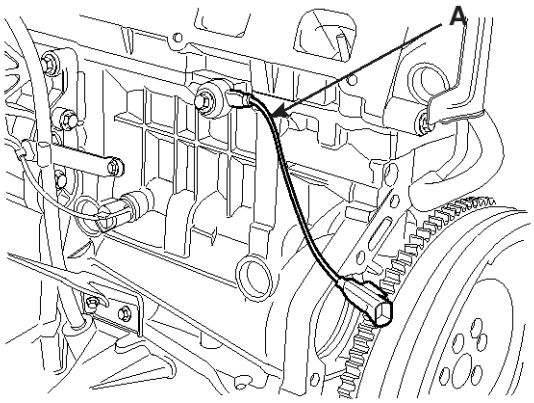
7.8 ~ 11.8N.m (0.8 ~ 1.2kgf.m, 5.8 ~ 8.7lb-ft)



KCRF163C

18. Install knock sensor(A).

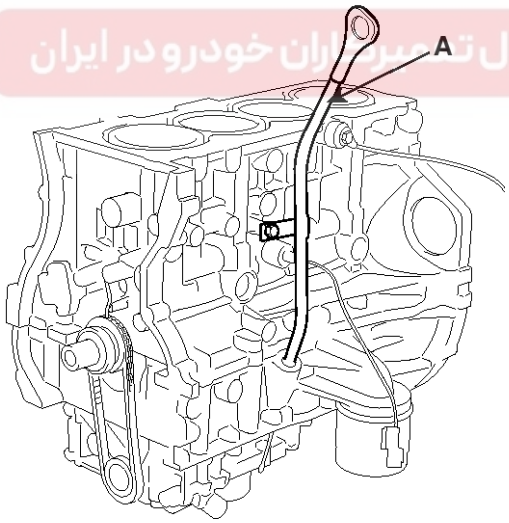
Tightening torque
16.7 ~ 25.5N.m (1.7 ~ 2.6kgf.m, 12.3 ~ 18.8lb-ft)



KCRF143A

19. Install oil level gauge assembly.
    1) Install a new O-ring on the oil level gauge.
    2) Apply engine oil on the O-ring.
    3) Install the oil level gauge assembly(A) with the bolt.

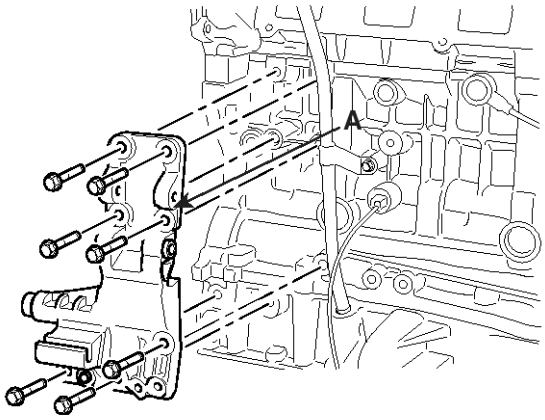
Tightening torque
7.8 ~ 11.8N.m (0.8 ~ 1.2kgf.m, 5.8 ~ 8.7lb-ft)



KCRF163B

20. Install tensioner assembly integrated bracket(A).

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



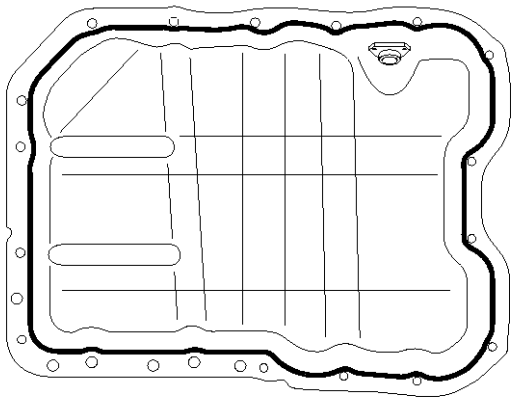
KCRF161A

21. Install the power steering pump bracket and power steering pump.
22. Install the alternator.
23. Install the A/C compressor.
24. Install the cylinder head.
25. Install the timing chain.
26. Install the oil pan.
    1) Using a razor blade and gasket scraper, remove all the old packing material from the gasket surfaces.

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

2) Apply liquid gasket as an even bead, centered between the edges of the mating surface.

Use liquid gasket LOCTITE 5900H or THREEBOND 1217H equivalent(MS721-40).



KCRF179A

NOTICE

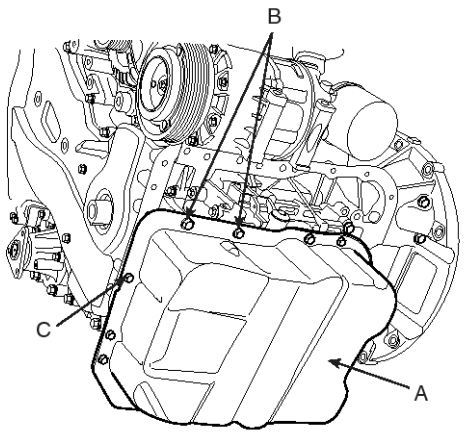
- *To prevent leakage of oil, apply liquid gasket to the inner threads of the bolt holes.*
- *Do not install the parts if five minutes or more have elapsed since applying the liquid gasket. Instead, reapply liquid gasket after removing the residue.*
- *After assembly, wait at least 30 minutes before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

3) Install the oil pan(A).

Uniformly tighten the bolts in several passes.

Tightening torque

M8(B):26.5 ~ 30.4N.m (2.7 ~ 3.1kgf.m, 19.5 ~ 22.4lb-ft)
M6(C):9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)



KCRF114B

27. Remove engine stand.

28. A/T : Install drive plate(A).

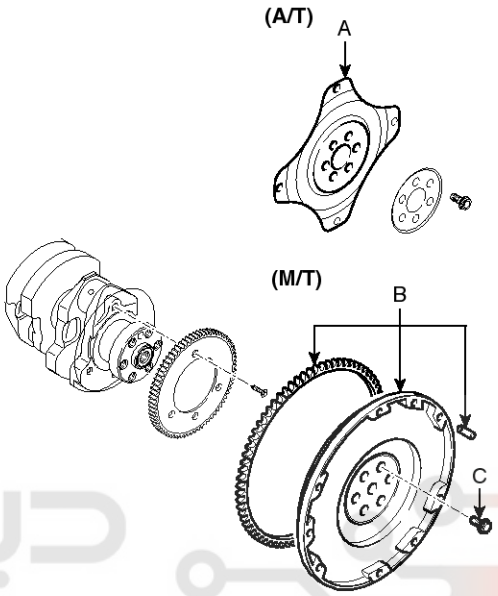
Tightening torque

117.7 ~ 127.5N.m (12 ~ 13kgf.m, 86.8 ~ 94.0lb-ft)

M/T : Install flywheel(B).

Tightening torque

117.7 ~ 127.5N.m (12 ~ 13kgf.m, 86.8 ~ 94.0lb-ft)

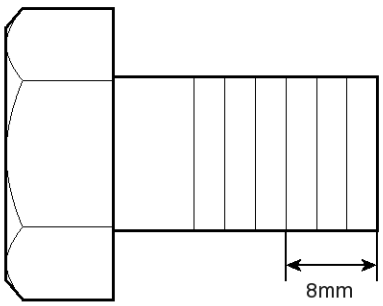


SNFEM7901L

NOTICE

- *Always use new flywheel(drive plate) bolts(C).*
- *Apply sealant to the screw part(8mm from the end of the bolt) when using new flywheel bolts.*

Sealant : *Three bond 2403, Loctite 200 or 204*



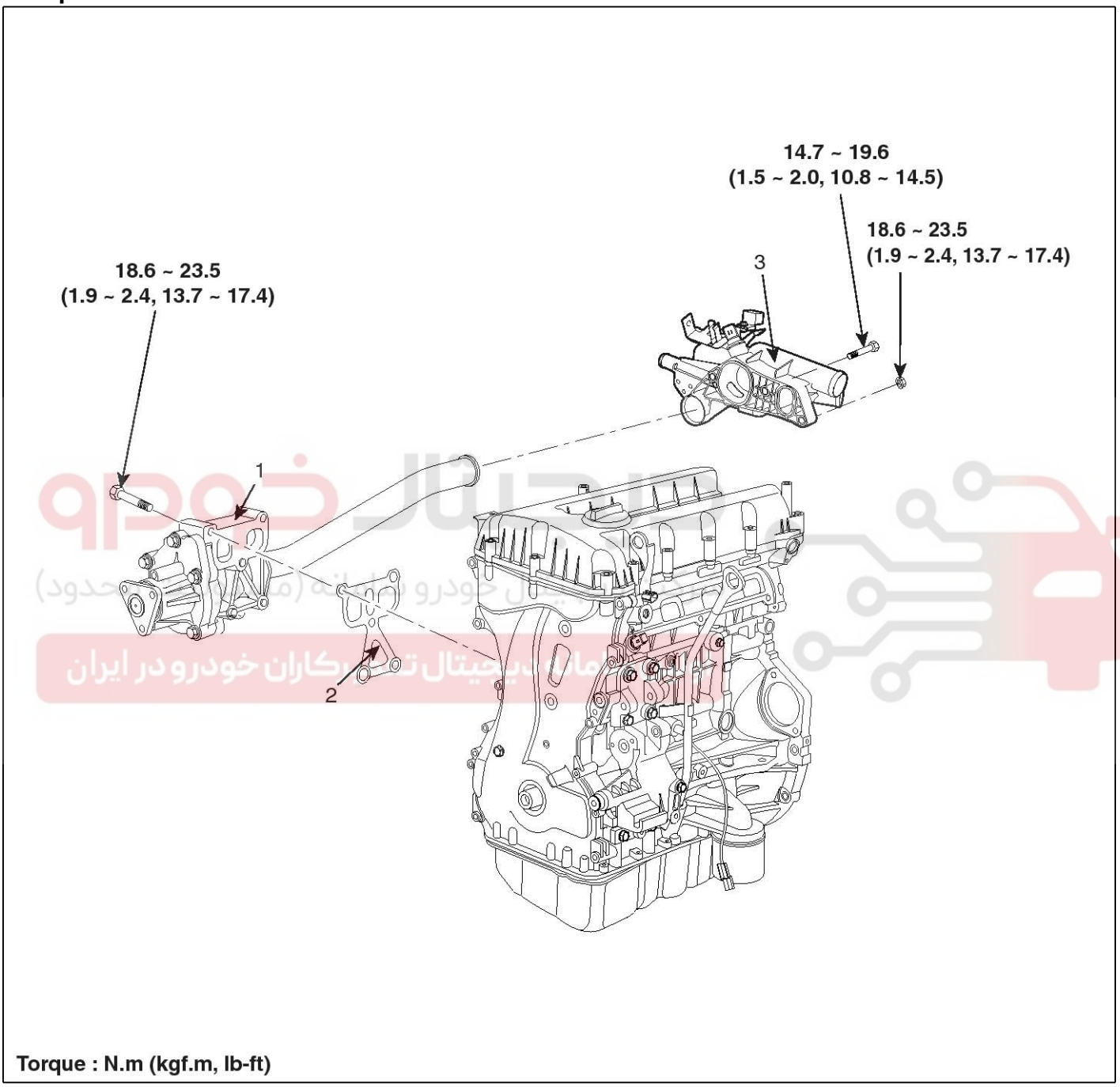
SNFEM7902L

- *Install and uniformly tighten the 7 bolts, in several passes.*

Cooling System

Water pump

Components

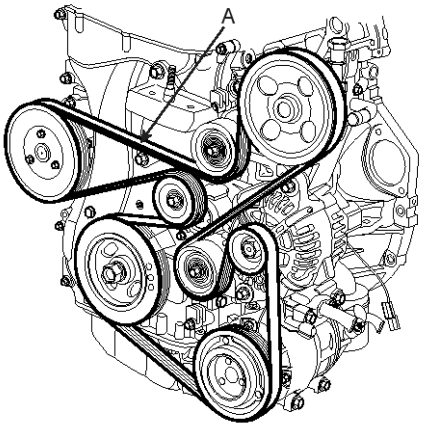


SNFEM8053L

1. Water pump
2. Gasket
3. Water temp. control assembly

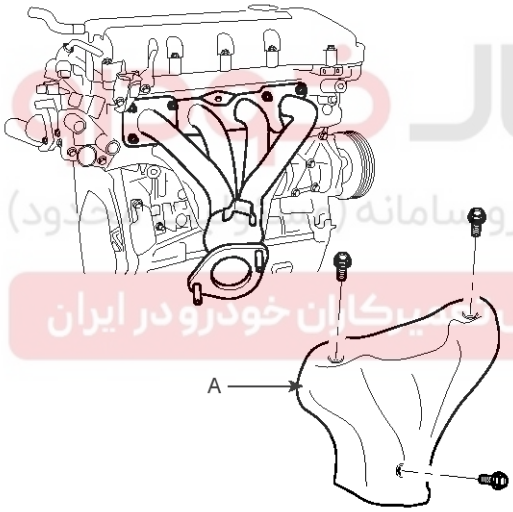
Removal

1. Drain the engine coolant.
2. Remove the drive belt (A).



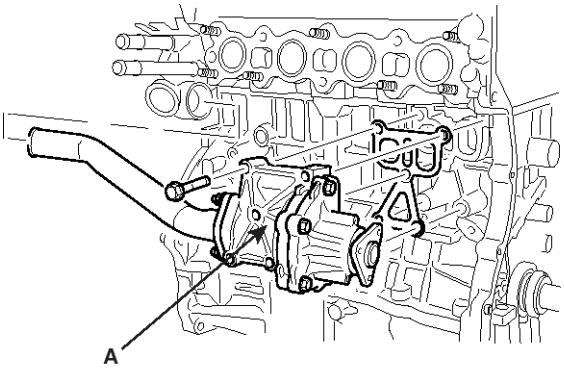
KCRF108A

3. Remove the exhaust manifold heat protector (A).



SNFEM8015D

4. Remove the water inlet pipe nut.
5. Remove the water pump (A) and water pump gasket.



KCRF157A

Inspection

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

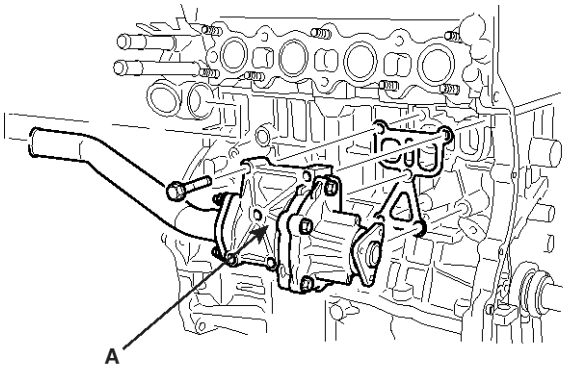
NOTICE

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

Installation

1. Install the water pump (A) with a new gasket.

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



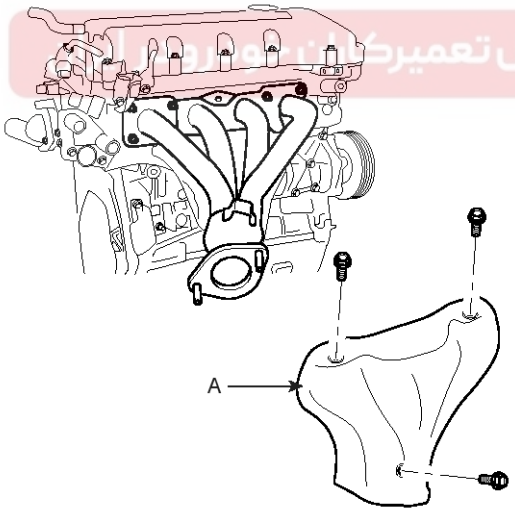
KCRF157A

2. Install the water inlet pipe nut.

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

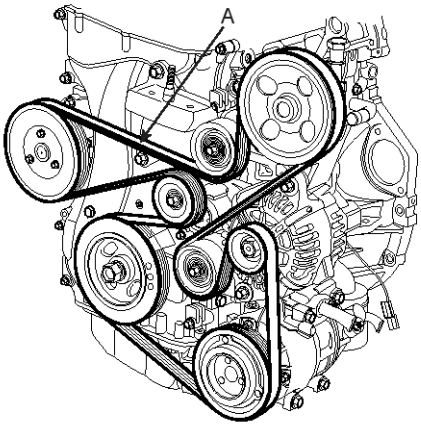
3. Install the exhaust manifold heat protector (A).

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



SNFEM8015D

4. Install the drive belt (A).



KCRF108A

5. Fill the engine coolant.
6. Start the engine and check for leaks.
7. Recheck the coolant level.

Troubleshooting

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

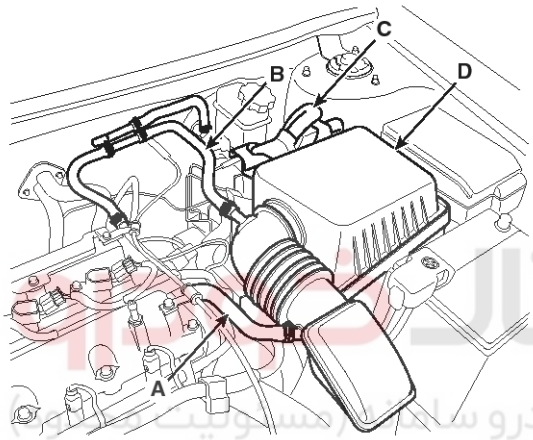
Thermostat

Removal

NOTICE

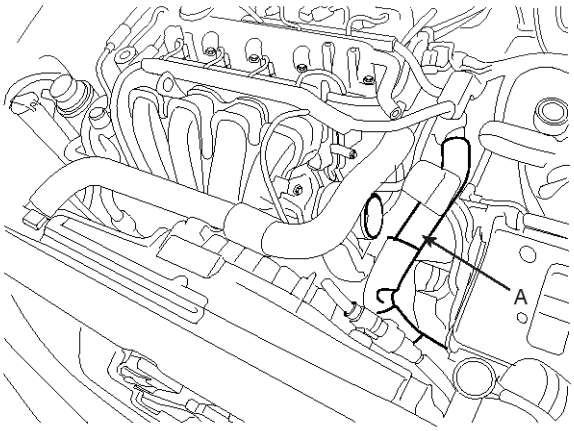
Removal of the thermostat would have an adverse effect, causing a lowering of cooling efficiency. Do not remove the thermostat, even if the engine tends to overheat.

1. Drain engine coolant so its level is below the thermostat.
2. Disconnect the breather hose (A), vacuum hose (B), ECM connector (C) and remove the air cleaner assembly (D).



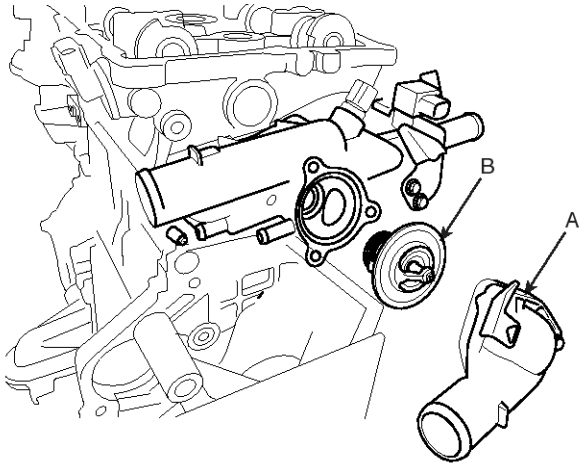
SMGEM9004D

3. Remove the radiator lower hose (A).



SNFEM8049D

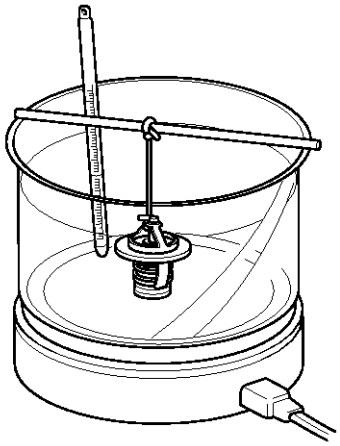
4. Remove water inlet fitting (A) and thermostat (B).



SNFEM8072D

Inspection

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



KCRF226A

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 : 8mm (0.3in.) or more at 95˚C (205˚F)

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

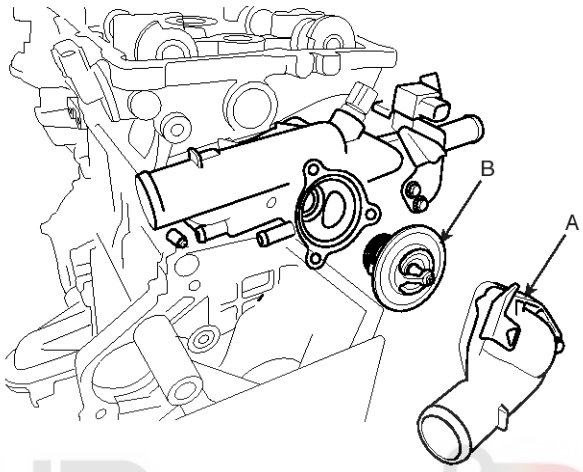
Installation

1. Place thermostat (B) in thermostat housing.

NOTICE
Install the thermostat with the jiggle valve upward.

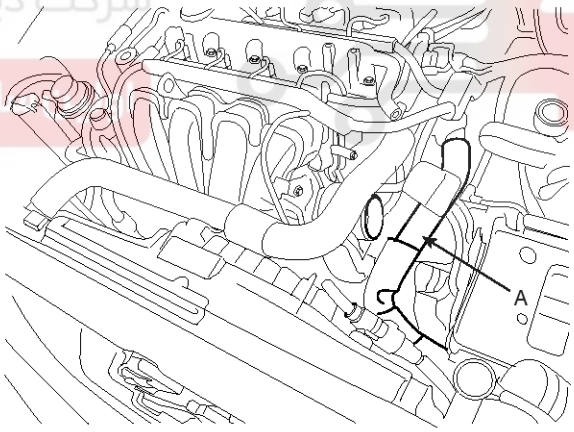
2. Install the water inlet fitting (A).

Tightening torque :
7.8 ~ 11.08 N.m (0.8 ~ 1.2 kgf.m, 5.8 ~ 8.7 lb-ft)



SNFEM8072D

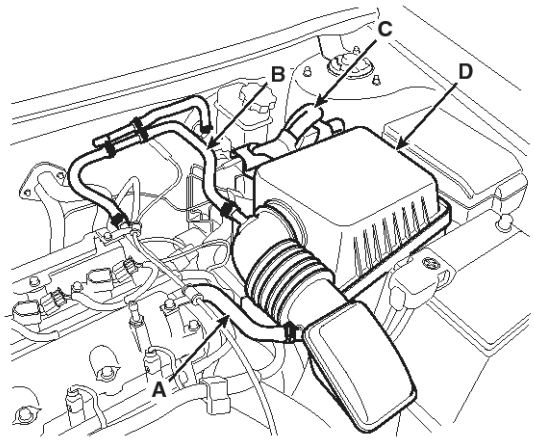
3. Install the radiator lower hose (A).



SNFEM8049D

4. Install the air cleaner assembly (D) then connect the breather hose (A), ECM connector (C), and vacuum hose (B).

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



SMGEM9004D

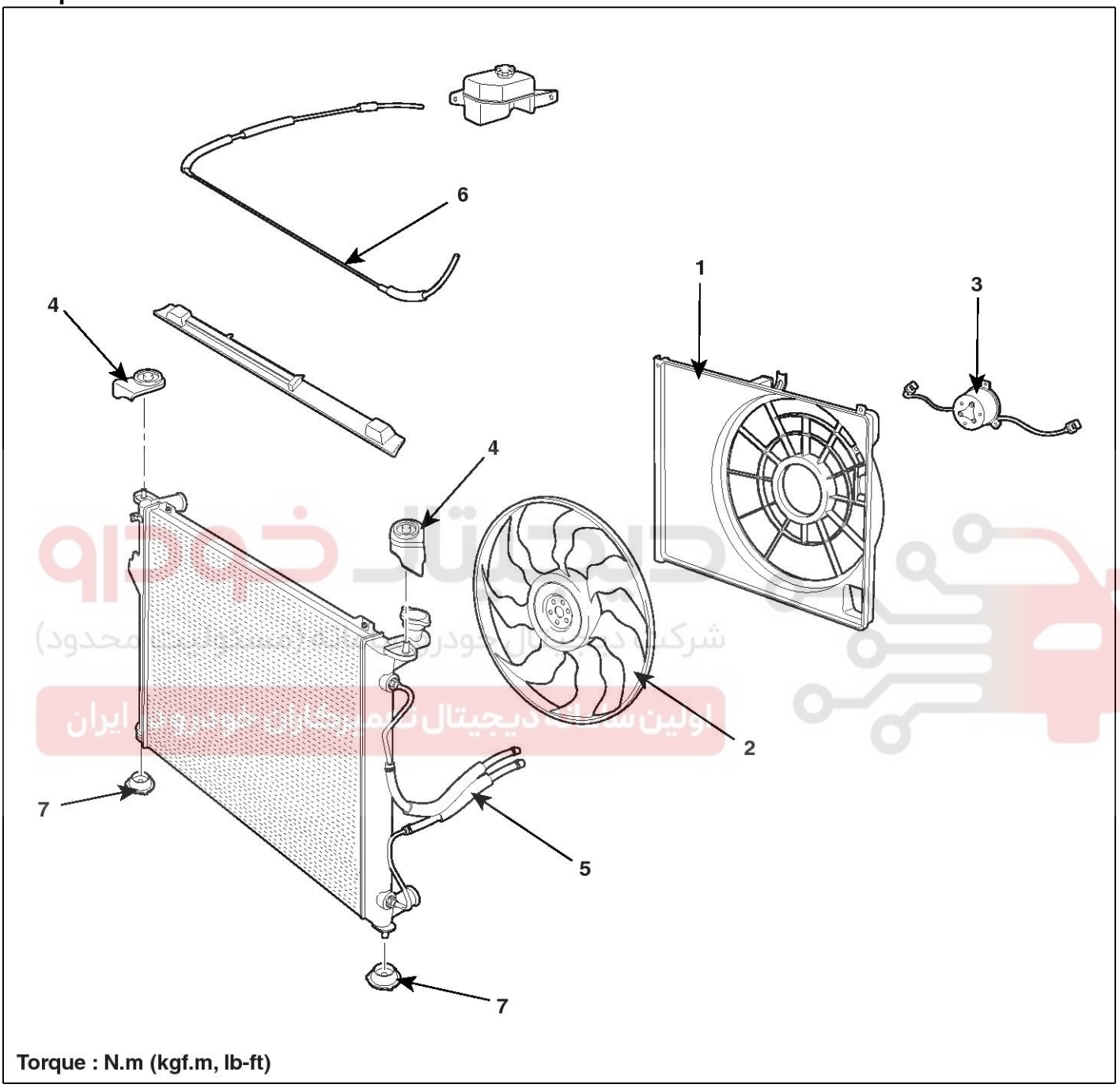
5. Fill the engine coolant.
6. Start the engine and check for leaks.
7. Recheck the coolant level.

Troubleshooting

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

Radiator

Components

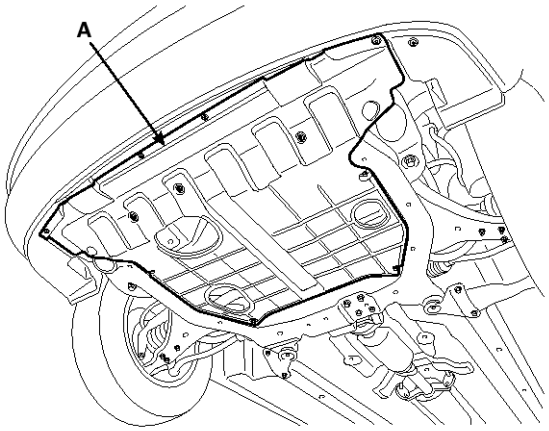


SMGEM8018L

1. Fan cover
2. Cooling fan
3. Motor assembly
4. Radiator upper mounting bracket
5. Oil cooler assembly
6. Water pipe assembly
7. Radiator mounting insulator

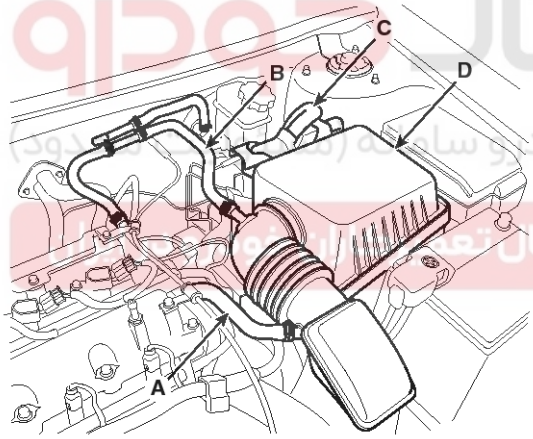
Removal

1. Remove the under cover (A).



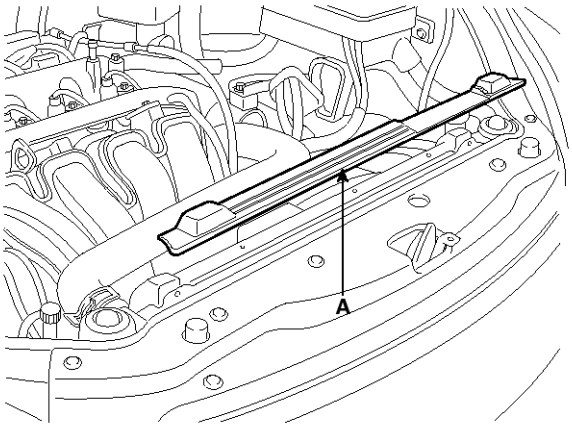
SMGEM8002D

2. Remove the drain plug and drain the engine coolant.
3. Disconnect the breather hose (A), vacuum hose (B), ECM connector (C) and remove the air cleaner assembly (D).



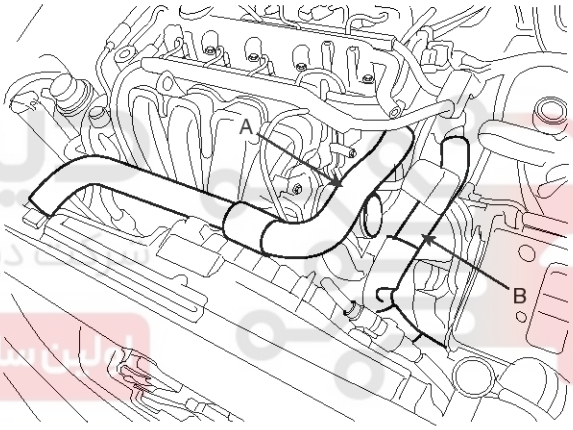
SMGEM9004D

4. Remove the radiator protector (A).



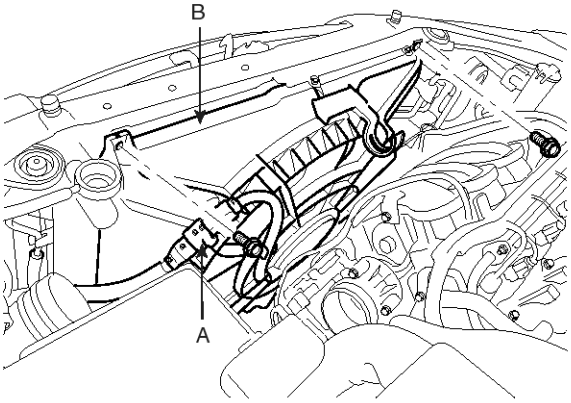
SMGEM8005D

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



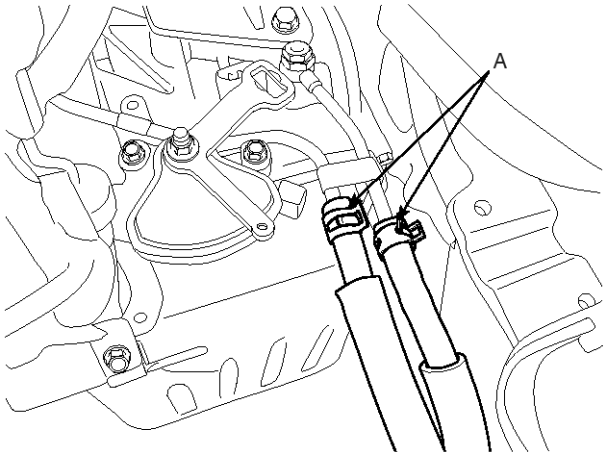
SNFEM8004D

6. Disconnect fan motor connector (A), and remove the cooling fan (B).



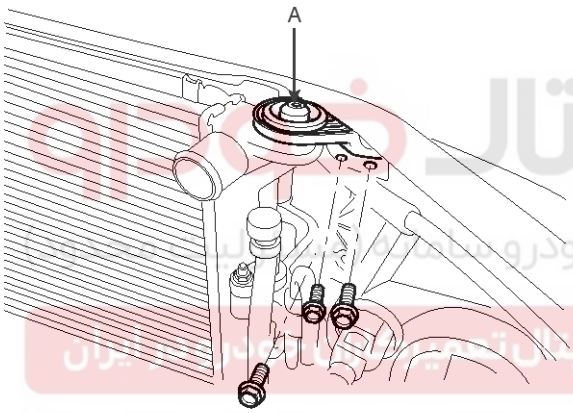
SNFEM8011D

7. Remove the ATF cooler hoses (A).



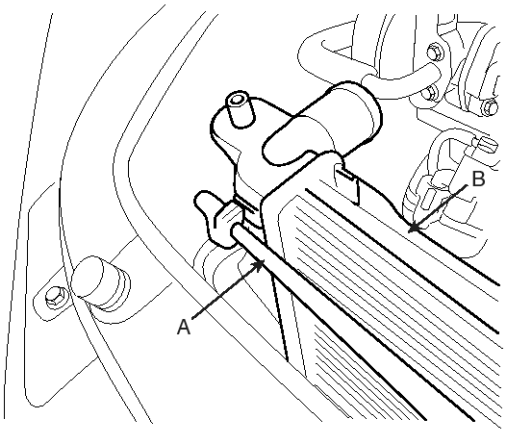
STGEM7004D

8. Remove the radiator mounting bracket (A) and condenser mounting bolt.



SNFEM8012D

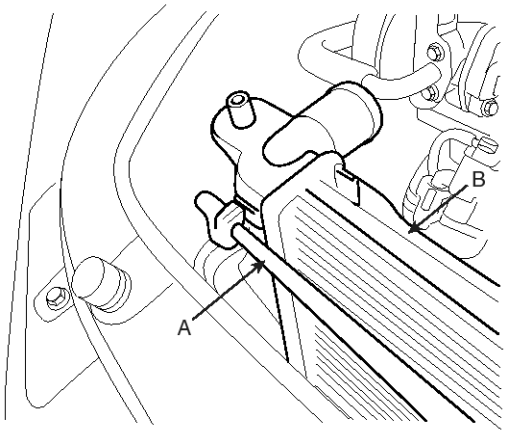
9. Remove the reservoir hose & pipe (A) and then remove the radiator assembly (B) from the vehicle.



SNFEM8013D

Installation

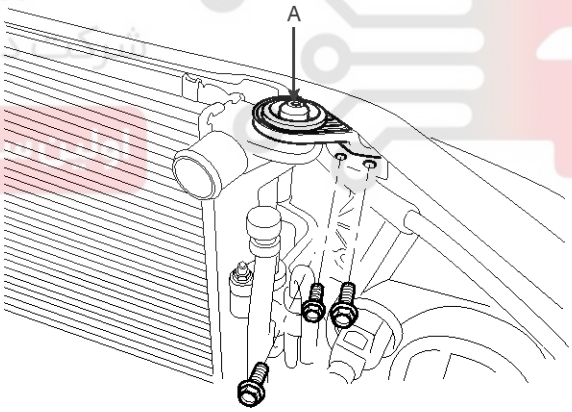
1. Install the radiator assembly (B) to the vehicle, and then install the reservoir hose & pipe (A) at the mounting clip.



SNFEM8013D

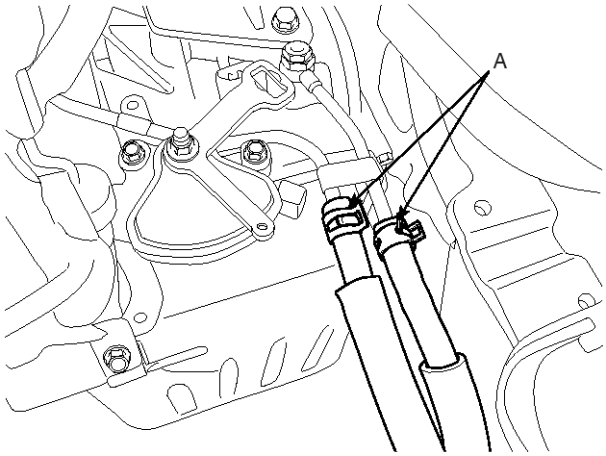
2. Install the condenser mounting bolt and radiator mounting bracket (A).

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



SNFEM8012D

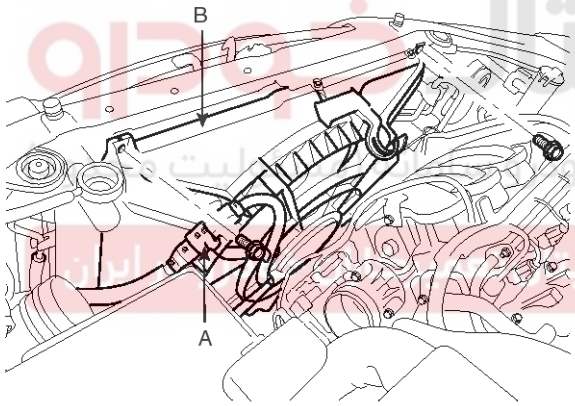
3. Install the ATF cooler hoses (A).



STGEM7004D

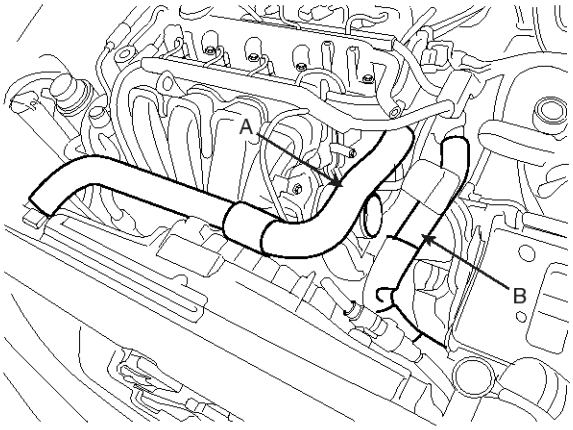
4. Install the cooling fan (B) and then connect the fan motor connector (A).

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



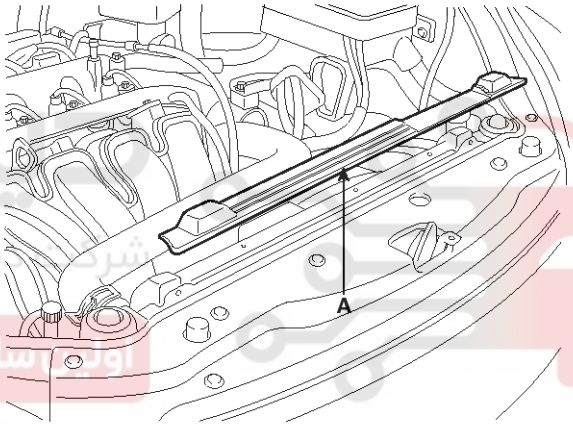
SNFEM8011D

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



SNFEM8004D

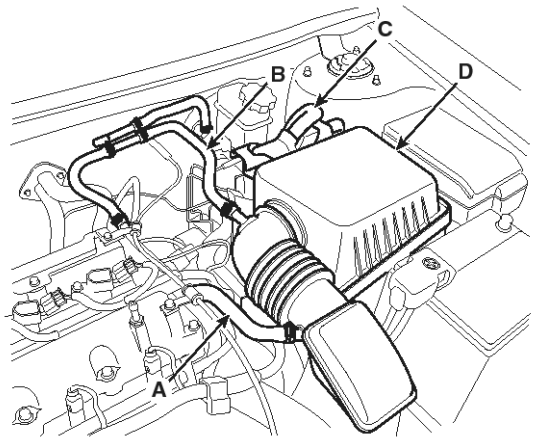
6. Install the radiator protector (A).



SMGEM8005D

7. Install the air cleaner assembly (D) then connect the breather hose (A), ECM connector (C), and vacuum hose (B).

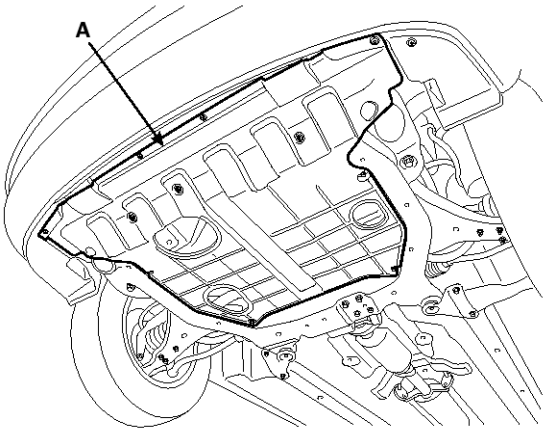
Tightening torque :
7.8 ~ 11.8 N.m (0.8 ~ 1.2 kgf.m, 5.8 ~ 8.7 lb-ft)



SMGEM9004D

8. Install the under cover (A).

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



SMGEM8002D

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

Coolant

Replacement And Air Bleeding

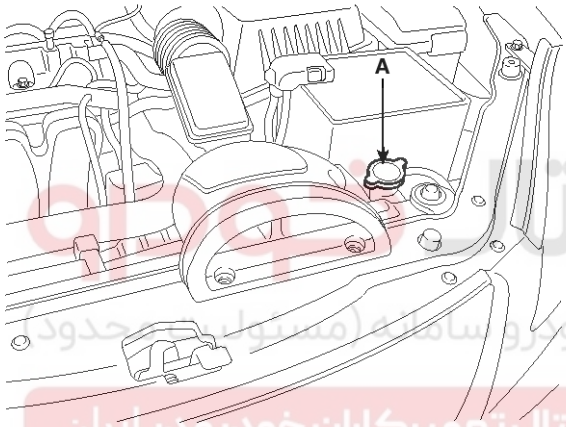
WARNING

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 radiator cap (A).



SMGEM8019D

3. Loosen the drain plug, and drain the coolant
4. Tighten the radiator drain plug securely.
5. After draining engine coolant in the reservoir tank, clean the tank.
6. Fill the radiator with water through the radiator cap and tighten the cap.

   NOTICE

   Pressure can blow water back out the radiator cap-pour water slowly while intermittently squeezing the radiator hoses.
7. After warming up the engine until the cooling fan operates several times, accelerate it at idle.
8. Wait until the engine is cool.
9. Repeat the step 1 to 8 until the drained water is clean.
10. Fill fluid mixture with coolant and water(5 : 5) (Tropical region – 4:6) slowly through the radiator cap. Push the upper/lower hoses of the radiator so as bleed air easily.

    NOTICE

    - *Use only genuine antifreeze/coolant.*
    - *For best corrosion protection, the coolant concentration must be maintained year-round at 35% minimum.*

      Coolant concentrations less than 35% may not provide sufficient protection against corrosion or freezing.
    - *Coolant concentrations greater then 60% will impair cooling efficiency and are not recommended.*

    CAUTION

    - **Do not mix different brands of antifreeze/coolants.**
    - **Do not use additional rust inhibitors or antirust products; they may not be compatible with the coolant.**
11. Start the engine and run coolant circulates.

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

    NOTICE

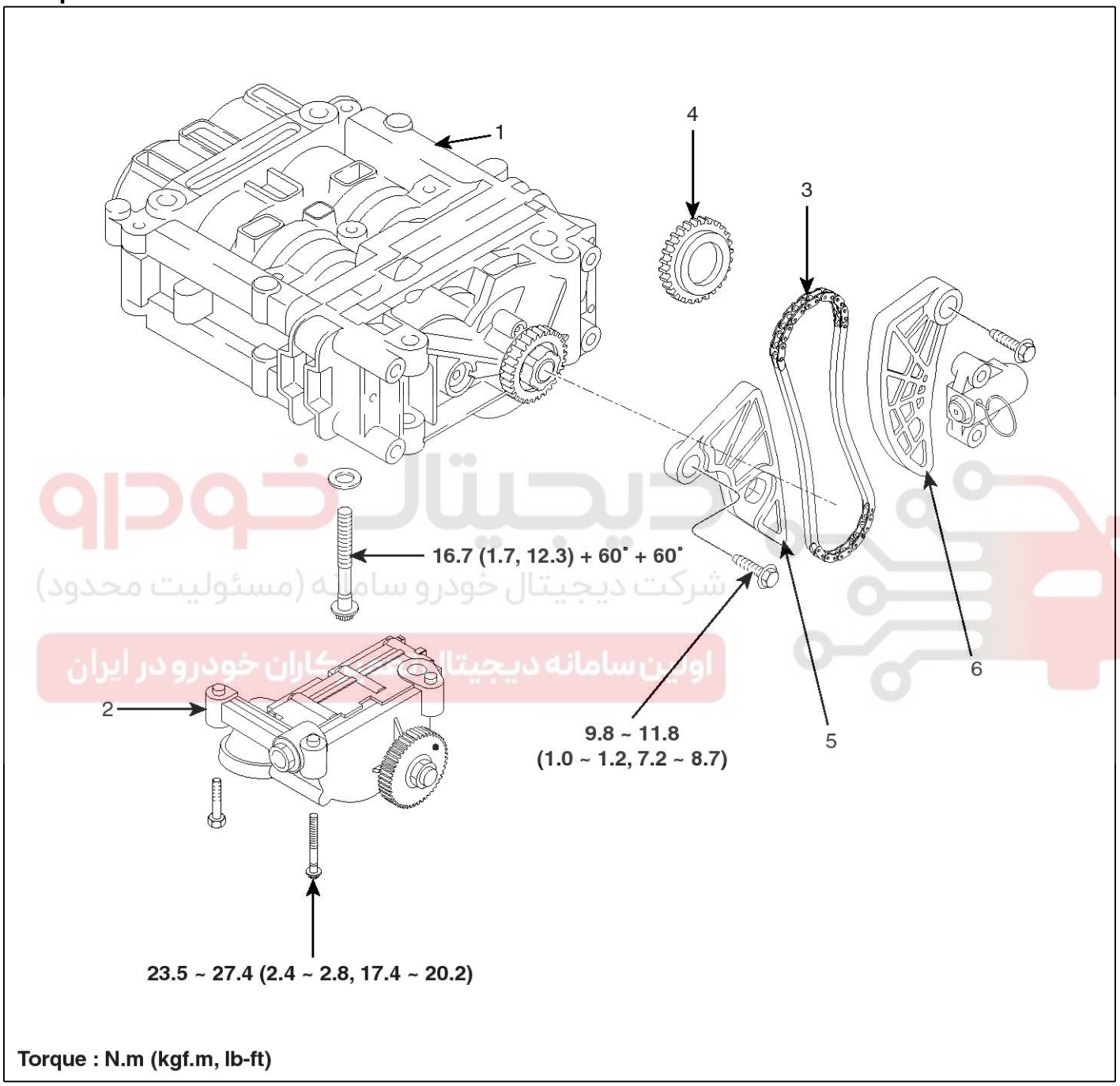
    As it is to bleed air out to the cooling system and refill coolant when coolant gets cool completely, recheck the coolant level in the reservoir tank for 2 ~ 3 days after replacing coolant.

Coolant capacity : 7.2 L

Lubrication System

Oil Pump

Components



SNFEM8048L

1. Balance shaft & oil pump assembly [2.4 BSM]
2. Oil pump [2.0 Non BSM]
3. Balance shaft chain
4. Balance shaft chain sprocket
5. Balance shaft chain guide
6. Balance shaft chain tensioner arm

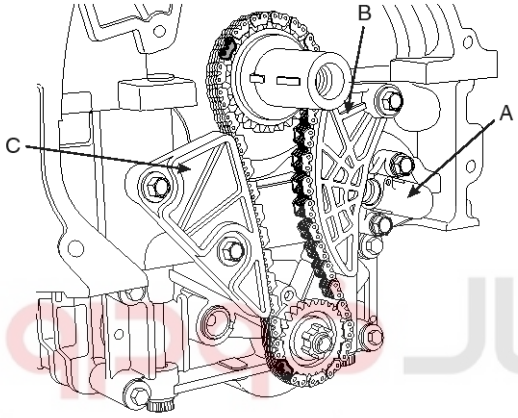
Removal

[2.4 BSM]

1. Remove the timing chain.
   (Refer to timing system in this group)

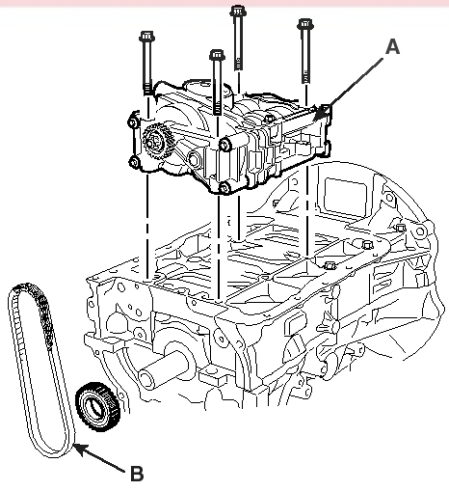
NOTICE

2. Install a set pin after compressing the balance shaft chain tensioner.
3. Remove the balance shaft chain hydraulic tensioner (A).
4. Remove the balance shaft chain tensioner arm (B).
5. Remove the balance shaft chain guide (C).



KCRF117A

6. Remove the oil pump & balance shaft module (A) and balance shaft chain (B).



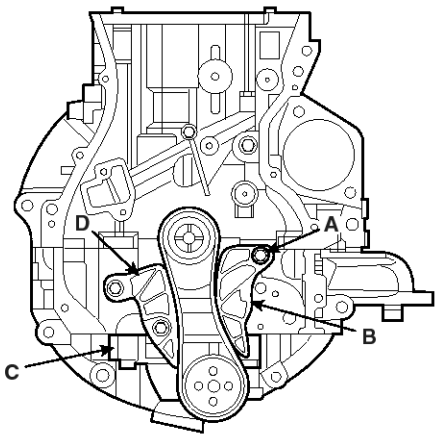
KCRF165A

CAUTION

Do not disassemble the oil pump & balance shaft module.

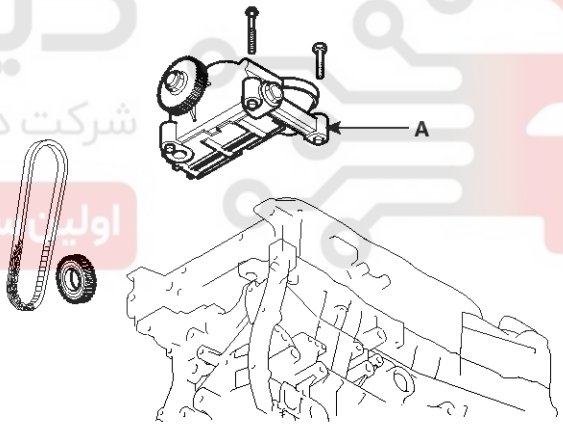
[2.0 NON BSM]

1. Remove the timing chain.
   (Refer to timing system in this group)
2. Remove the oil pump mechanical tensioner (B).
3. Remove the oil pump chain guide (D).



STQM28027L

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



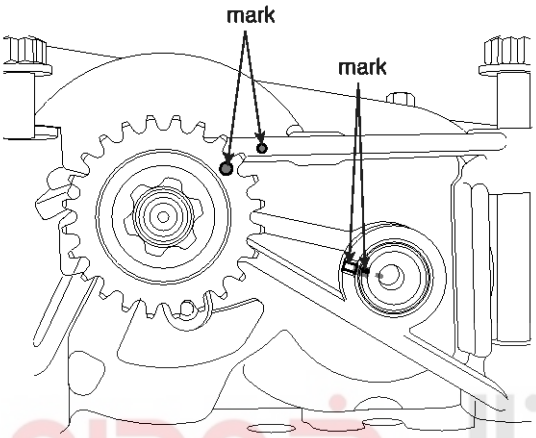
SNFEM8083D

Installation

[2.4 BSM]

1. The key of crankshaft should be aligned with the mating face of main bearing cap. As a result of this, the piston of No.1 cylinder is placed at the top dead center on compression stroke.
2. Confirm the balance shaft module timing mark.

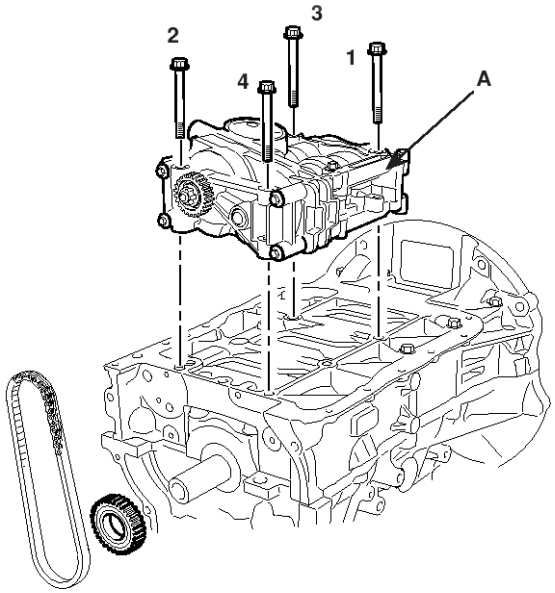
   Timing marks to be visually aligned with centers of adjacent cast timing notches.



SNFEM8095L

3. Install balance shaft module that the timing mark of balance shaft module sprocket should be matched with the timing mark (color link) of balance shaft chain.

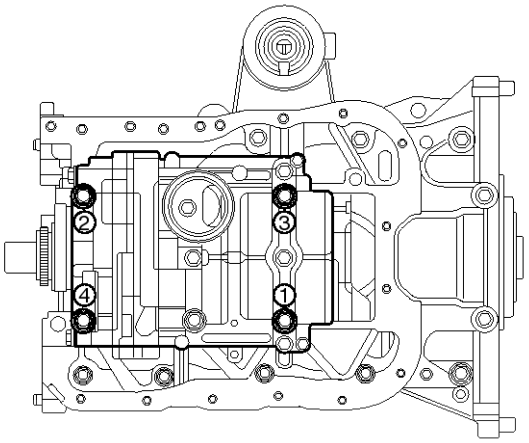
Tightening torque :
16.7N.m (1.7kgf.m, 12.3lb-ft) + 60° + 60°



KCRF165B

Bolting order

a. Assemble the bolts in order number as shown with seating torque 25.5 N.m (2.6kgf.m, 18.8 lb-ft)
b. Unfasten the bolts as reverse bolting order. (4-3-2-1)
c. Assemble the bolts as specified bolting order in same increments as follows.



SMGEM8010D

4. Remove the balance shaft chain guide (C).

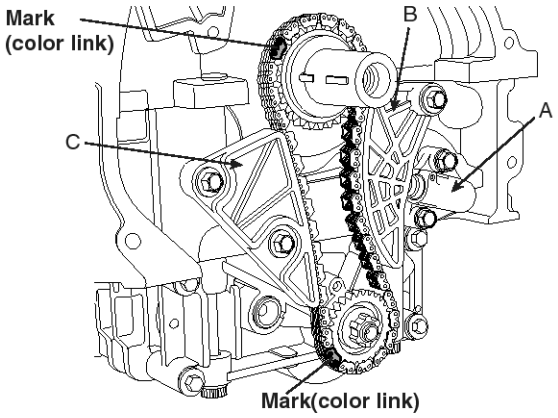
Tightening torque :
9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)

5. Install the balance shaft chain tensioner arm (B).

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

6. Install the balance shaft chain hydraulic tensioner (A) then remove the stopper pin.

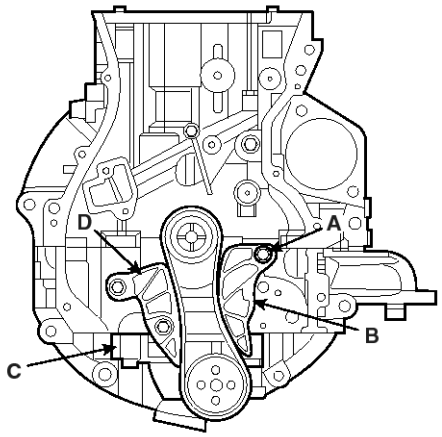
Tightening torque :
9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)



ECRF007A

7. Confirm the timing marks.
8. Install the timing chain.
   (Refer to Timing system in this group)

[2.0 NON BSM]



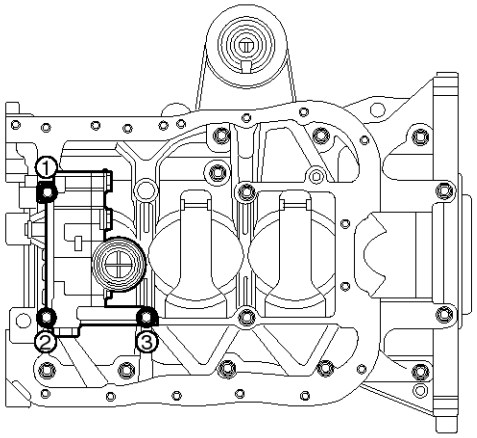
STQM28027L

1. The key of crankshaft should be aligned with the mating face of main bearing cap. As a result of this, the piston of No.1 cylinder is placed at the top dead center on compression stroke.
2. Assemble the crankshaft sprocket on the crankshaft as the front mark on the crankshaft sprocket to be outward.
3. Tighten the oil pump tensioner bolt(A) after placing the tensioner spring on the dowel pin located in ladder frame, and then insert stopper pin to fix the tensioner(B).

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

4. Assemble the oil pump chain on the crankshaft sprocket.
5. Assemble the oil pump assembly (C) on the ladder frame as placing oil pump sprocket in to oil pump.

Tightening torque :
8.8 + 16.7 + 25.5N.m
(0.9 + 1.7 + 2.6kgf.m, 6.5 + 12.3 + 18.8lb-ft)



SMGEM8011D

Bolting order

a. Assemble the bolts in order number as shown with seating torque 25.5 N.m (2.6kgf.m, 18.8 lb-ft)
b. Unfasten the bolts as reverse bolting order. (3-2-1)
c. Assemble the bolts as specified bolting order in same increments as follows.

6. Install the oil pump chain guide (D) then remove the stopper pin.

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

Engine Oil

Replacement

CAUTION

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

1. Drain the engine oil.
   1) Remove the oil filler cap.
   2) Remove the oil drain plug, and drain the oil into a container.
2. Replace the oil filter.
   1) Remove the oil filter.
   2) Check and clean the oil filter installation surface.
   3) Check the part number of the new oil filter is as same as old one.
   4) Apply clean engine oil to the gasket of a new oil filter.
   5) Lightly screw the oil filter into place, and tighten it until the gasket contacts the seat.
   6) Tighten it with the torque below.

Tightening torque :
11.8 ~ 15.7N.m (1.2 ~ 1.6kgf.m, 8.7 ~ 11.6lb-ft)

3. Refill with engine oil.
   1) Clean and install the oil drain plug with a new gasket.

Tightening torque :
39.2 ~ 49.0N.m (4.0 ~ 5.0kgf.m, 28.9 ~ 36.2lb-ft)

   2) Fill with fresh engine oil.

Capacity : [2.0(NON BSM) / 2.4(BSM)]
Total : 4.7 L (4.97 US qt, 4.13 Imp qt) / 5.4 L (5.70 US qt, 4.75 Imp qt)
Oil pan : 3.8 L (4.02 US qt, 3.69 Imp qt) / 4.2 L (4.43 US qt, 3.69 Imp qt)
Drain and refill including oil filter : 4.1 L (4.33 US qt, 3.61 Imp qt) / 4.5 L (4.75 US qt, 3.95 Imp qt)

   3) Install the oil filler cap.
4. Start engine and check for oil leaks and check the oil gauge or light for an indication of oil pressure.
5. Recheck the engine oil level.

Inspection

1. Check the engine oil quality.
   Check the oil deterioration, entry of water, discoloring of thinning. If the quality is visibly poor, replace the oil.
2. Check the engine oil level.
   After engine warm up stop the engine wait 5 minutes then check the oil level.Oil level should be befween 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.

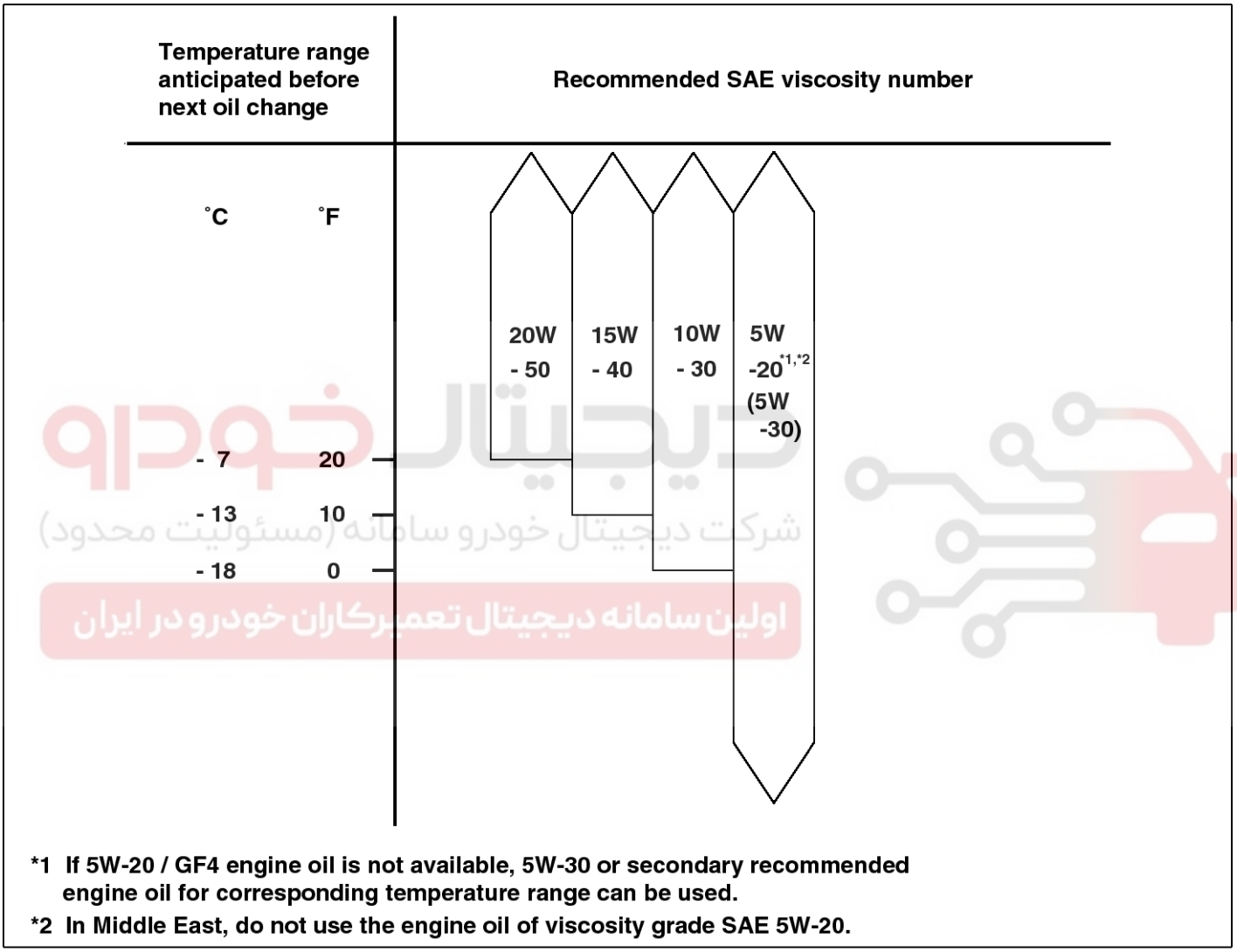
Selection Of Engine Oil

Recommendation (except Middle East) : 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

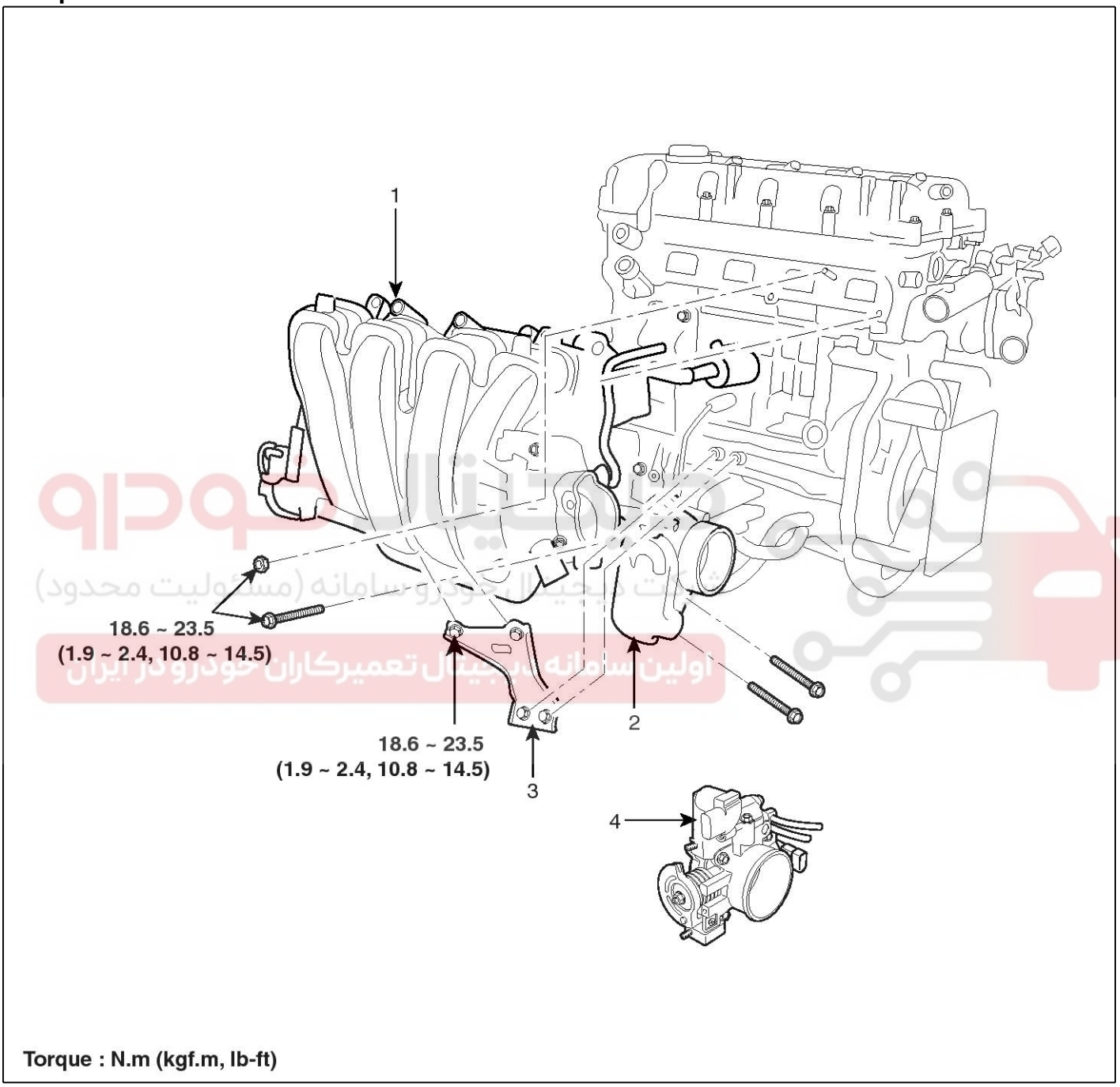
For best performance and maximum protection of all types of operation, select only those lubricants which :

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

Intake And Exhaust System

Intake Manifold

Components

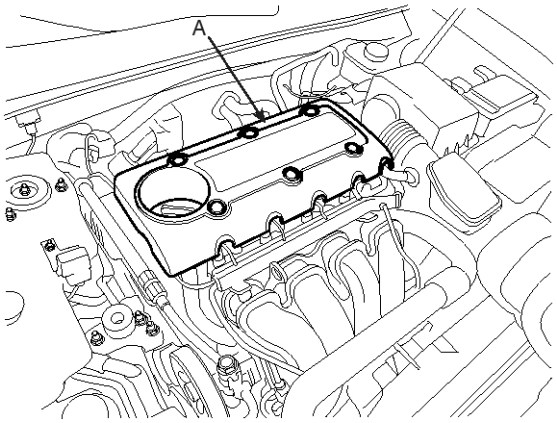


SNFEM8024L

1. Intake manifold assembly
2. Electronic throttle body [2.4]
3. Intake manifold stay
4. Throttle body [2.0]

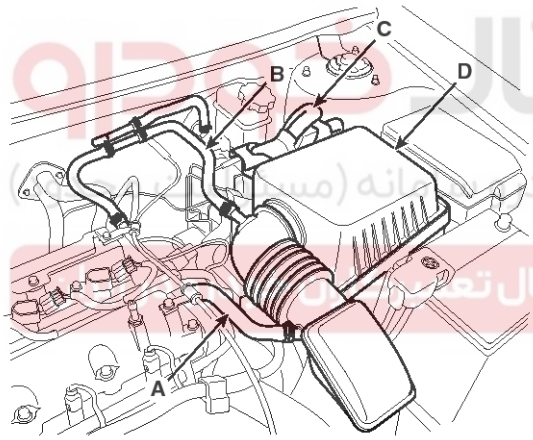
Removal

1. Remove the engine cover (A).



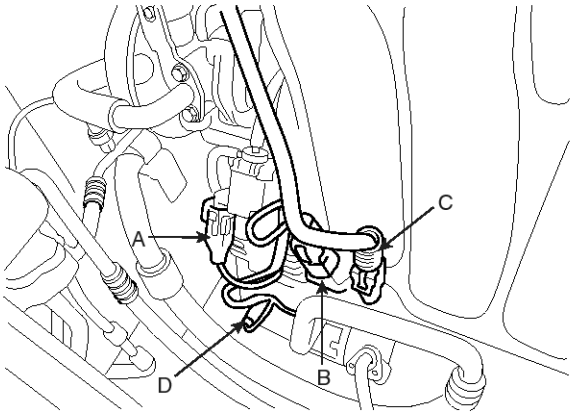
SNFEM8001D

2. Disconnect the breather hose (A), vacuum hose (B), ECM connector (C) and remove the air cleaner assembly (D).



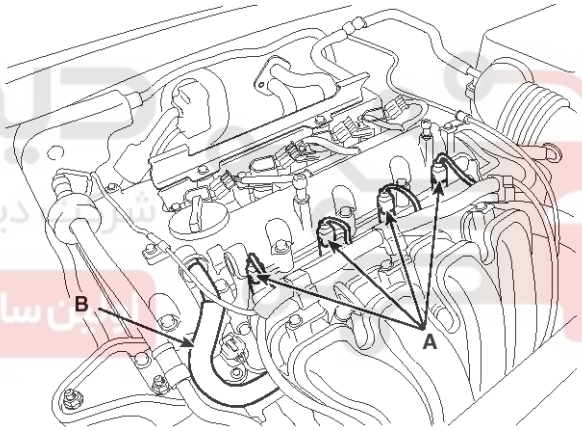
SMGEM9004D

3. Disconnect the VIS connector (A), OPS connector (B), knock sensor (C) and A/C switch connecter (D).



SNFEM8006D

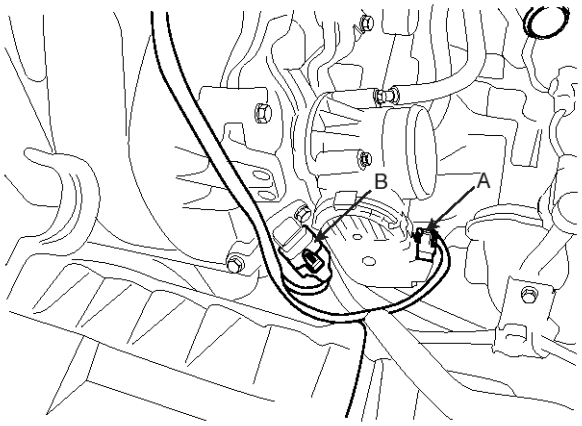
4. Disconnect the injector connectors (A) and PCV hose (B).



SMGEM9007D

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

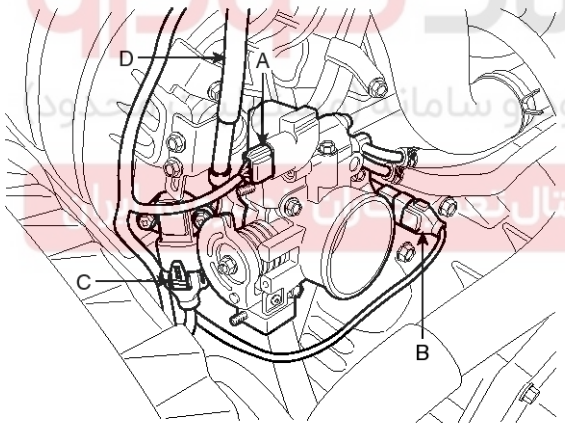
[2.4]



SNFEM8007D

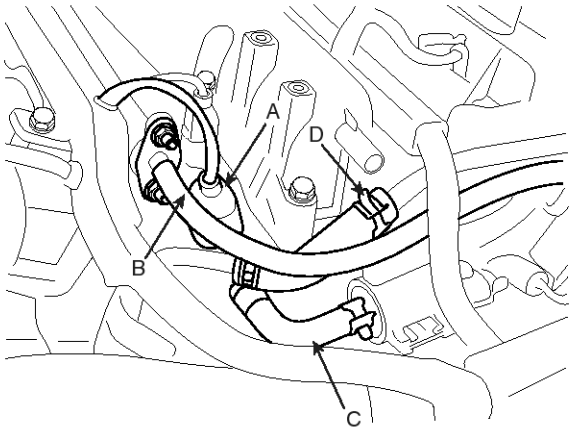
6. Disconnect the ISA connector (A), TPS connector (B) and MAP sensor connector (C) then remove the throttle cable (D).

[2.0]



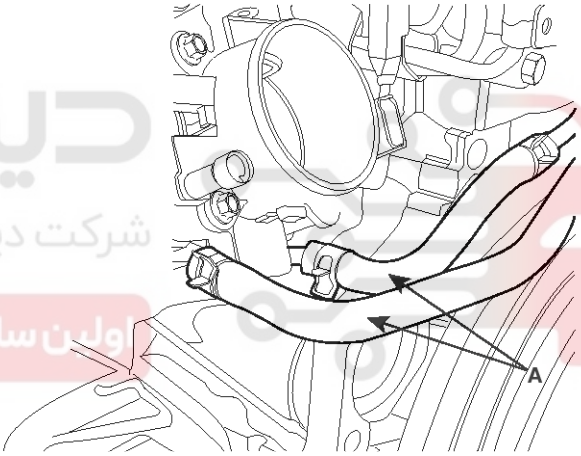
SNFEM8074D

7. Disconnect the CMP sensor connector (A), fuel hose (B), PCSV hose (C) and brake booster vacuum hose (D).



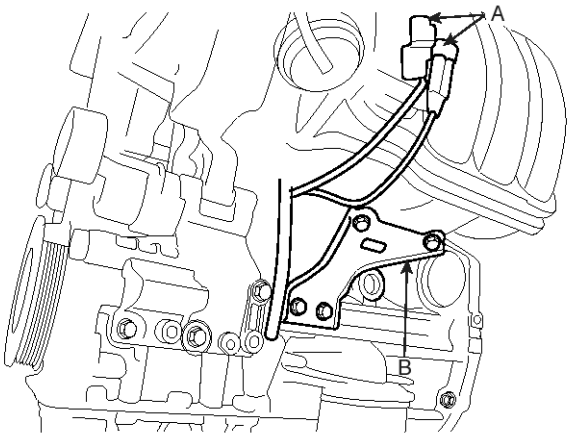
SNFEM8068D

8. Remove the coolant hose (A) from the throttle body.



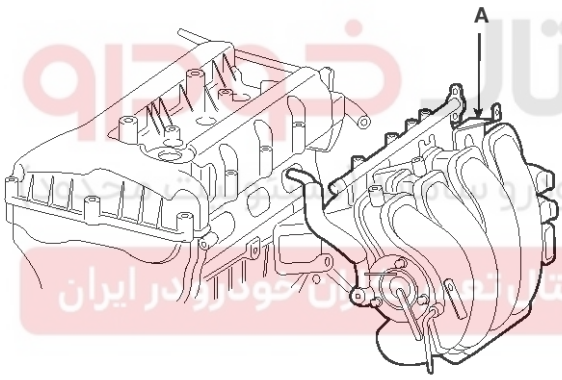
STGEM7037D

9. Remove the sensor connectors (A) from the bracket and then remove the intake manifold stay (B).



SNFEM8014D

10. Remove the oil level gauge.
11. Remove the intake manifold (A).

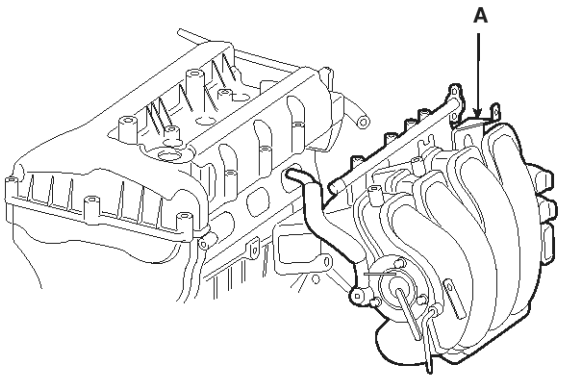


SNFEM8050D

Installation

1. Install the intake manifold (A).

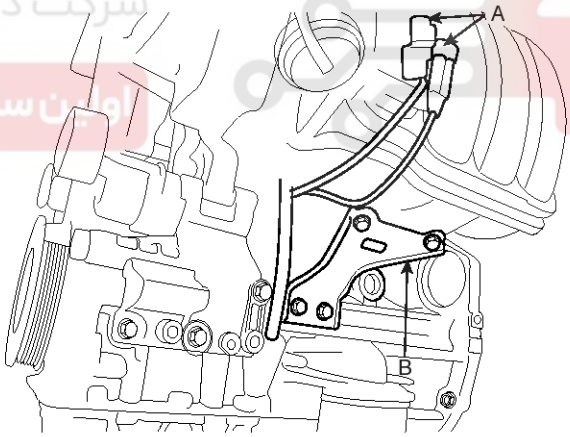
Tightening torque :
18.6 ~ 23.5N.m (1.9 ~ 2.4kgf.m,13.7 ~ 17.4lb-ft)



SNFEM8050D

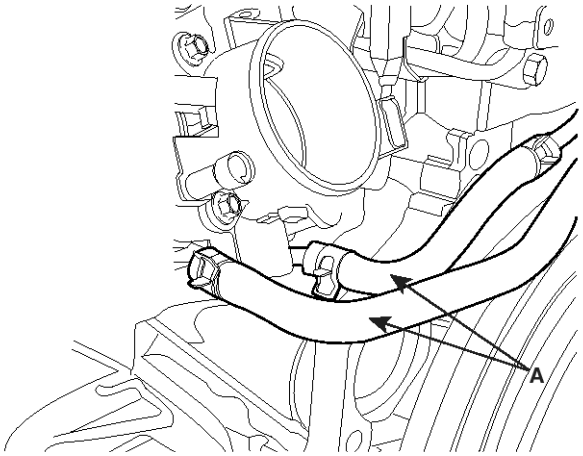
2. Install the oil level gauge.
3. Install the intake manifold stay (B) and then install the sensor connectors (A).

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



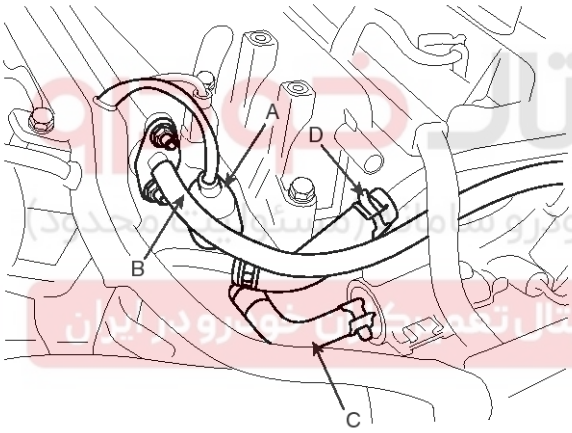
SNFEM8014D

4. Install the coolant hose (A) to the throttle body.



STGEM7037D

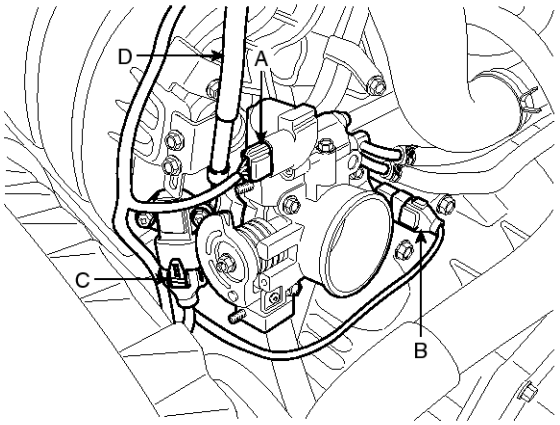
5. Connect the brake booster vacuum hose (D), PCSV hose (C), fuel hose (B) and CMP sensor connector (A).



SNFEM8068D

6. Connect the ISA connector (A), TPS connector (B) and MAP sensor connector (C) then Install the throttle cable (D).

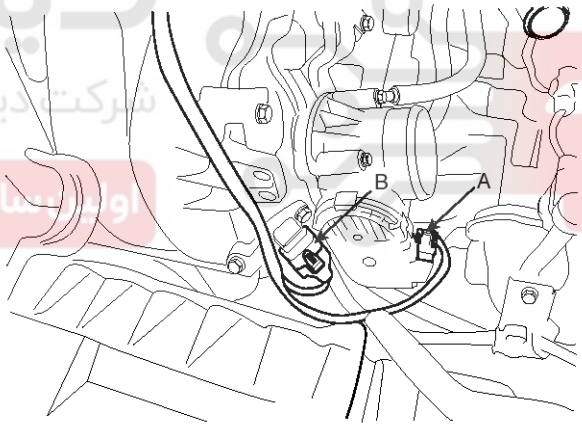
[2.0]



SNFEM8074D

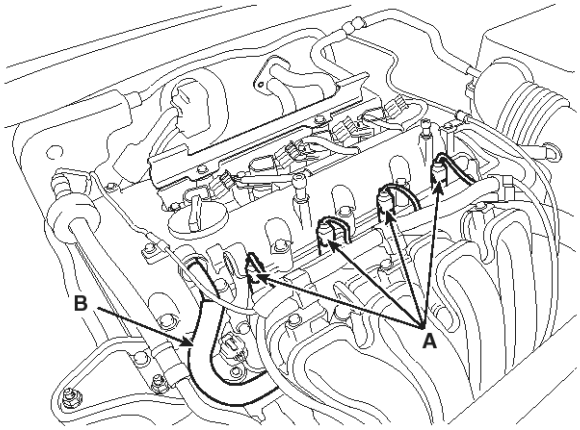
7. Connect the ETC connector (A) and MAP sensor connector (B).

[2.4]



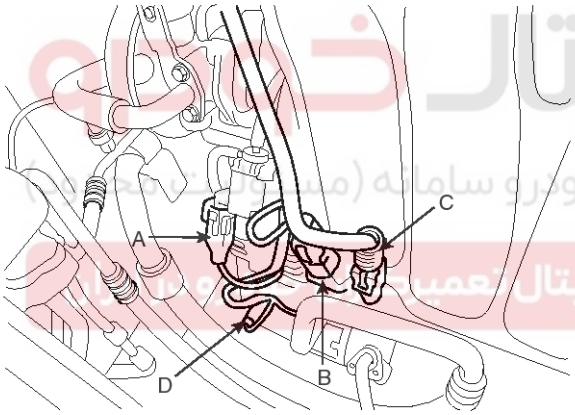
SNFEM8007D

8. Connect the injector connectors (A) and PCV hose (B).



SMGEM9007D

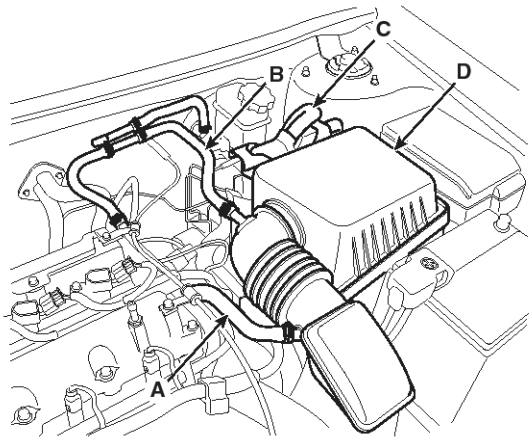
9. Connect the VIS connector (A), OPS connector (B), knock sensor connector (C) and A/C switch connecter (D).



SNFEM8006D

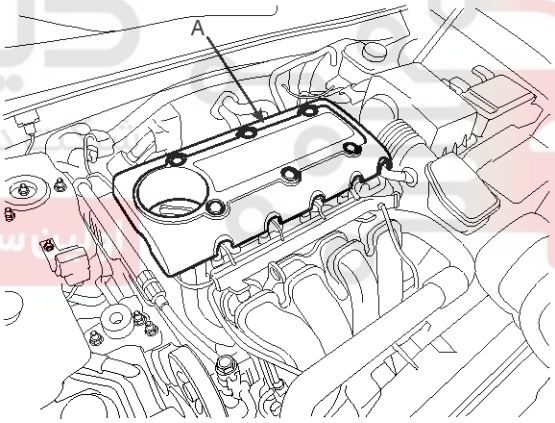
10. Install the air cleaner assembly (D) then connect the breather hose (A), ECM connector (C), and vacuum hose (B).

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



SMGEM9004D

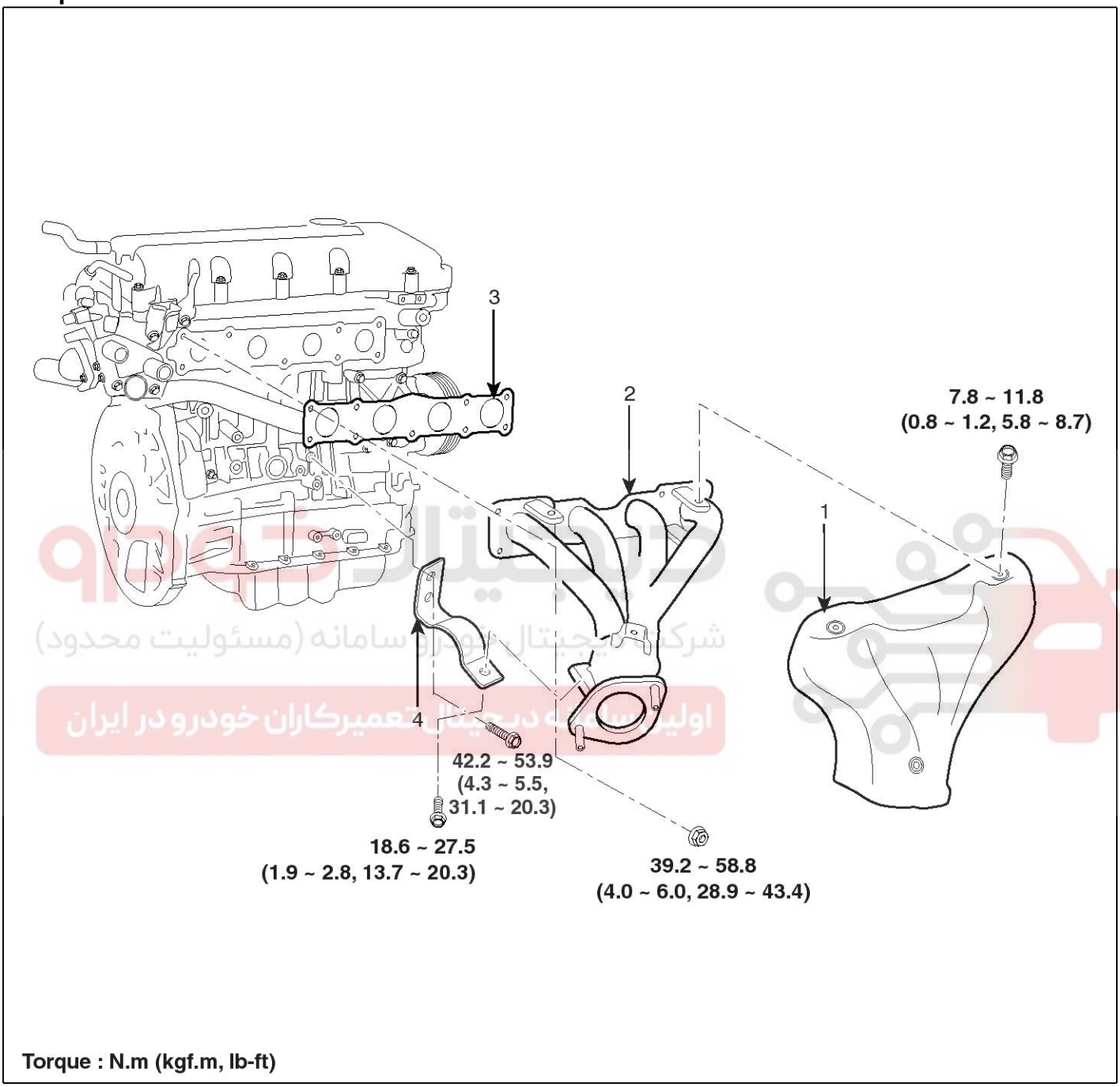
11. Install the engine cover (A).



SNFEM8001D

Exhaust Manifold

Components

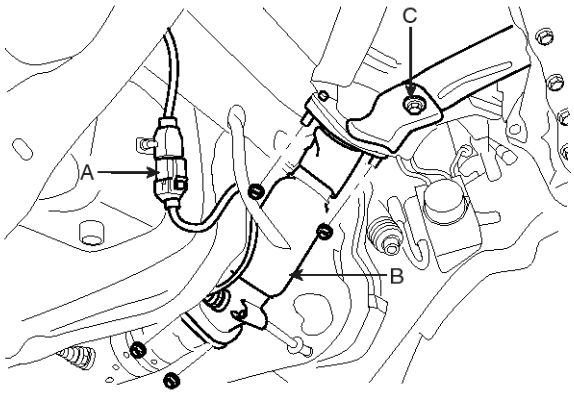


SNFEM8025L

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

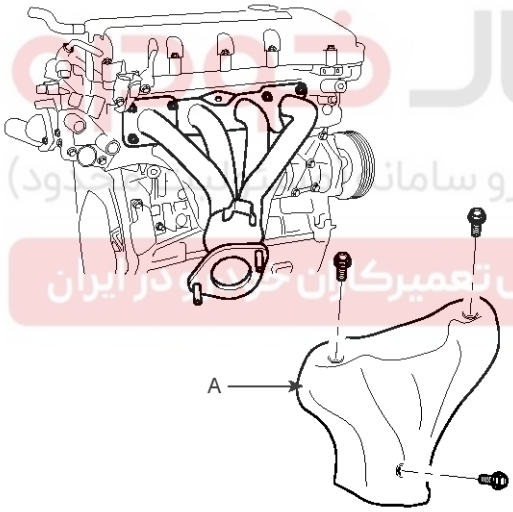
Removal

1. Disconnect the O2 sensor connector (A) and then remove the front muffler (B).
2. Remove the exhaust manifold stay bolt (C).



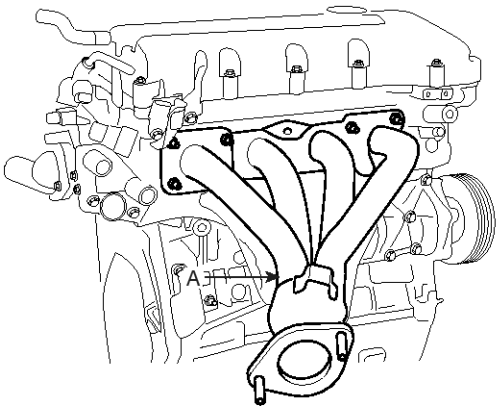
SNFEM8071D

3. Remove the heat protector (A).



SNFEM8015D

4. Remove the exhaust manifold (A) and gasket.

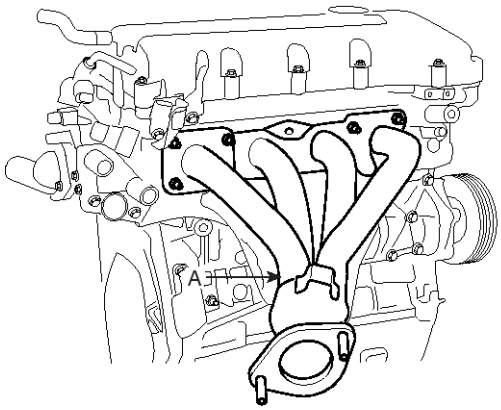


SNFEM8052D

Installation

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

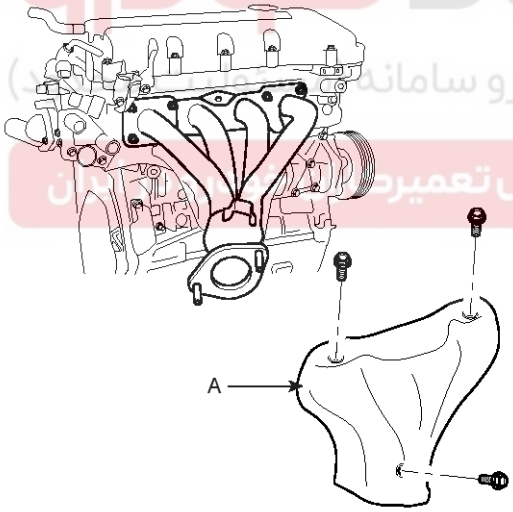
Tightening torque :
39.2 ~ 44.1N.m (4.0 ~ 4.5kgf.m, 28.9 ~ 32.5lb-ft)



SNFEM8052D

2. Install the heat protector (A).

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



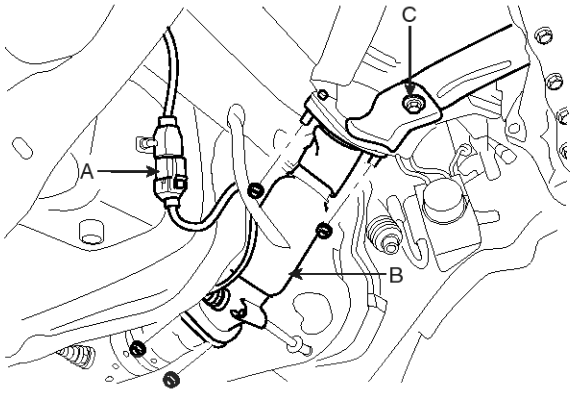
SNFEM8015D

3. Install the exhaust manifold stay bolt (C).

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

4. Install the front muffler (B) and then connect the O2 sensor connector (A).

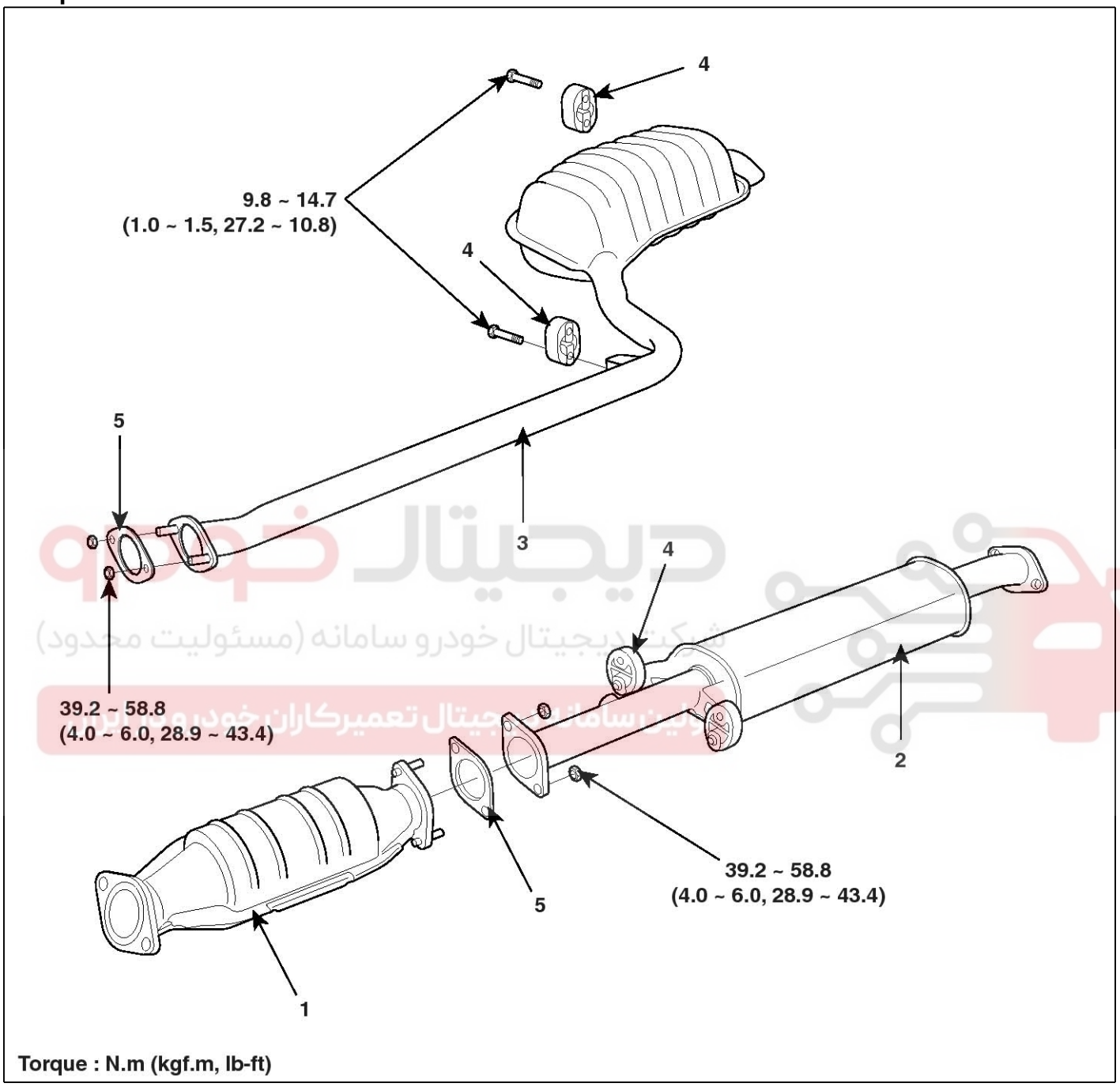
Tightening torque :
39.2 ~ 58.8N.m (4.0 ~ 6.0kgf.m, 28.9 ~ 43.4lb-ft)



SNFEM8071D

Muffler

Components



SNFEM8075L

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