General Information

Specifications

Description		Specifications	Limit
General			
Type		In-line, DOHC	
Number of cylinders		4	
Bore		88mm (3.464in)	
Stroke		97mm (3.819in)	
Total displacement		2359cc (143.90cu.in)	
Compression ratio		11.3 ± 0.3 : 1	
Firing order		1-3-4-2	
Valve timing			
Intake valve	Opens (ATDC/BTDC)	ATDC 7° ~ BTDC 38°	
	Closes (ABDC)	ABDC 67° ~ 22°	
Exhaust valve	Opens (BBDC)	BBDC 44° ~ 4°	
	Closes (BTDC)	ATDC 0° ~ 40°	
Valve clearance [Engine coolant temperature : 20°C (68°F)]			
Intake valve		0.17 ~ 0.23mm (0.0067 ~ 0.0090in.)	0.10 ~ 0.30mm (0.0039 ~ 0.0118in.)
Exhaust valve		0.27 ~ 0.33mm (0.0106 ~ 0.0129in.)	0.20 ~ 0.40mm (0.0079 ~ 0.0157in.)
Camshaft			
Cam height	Intake	44.2mm (1.7401in.)	
	Exhaust	45.0mm (1.7716in.)	
Journal outer diameter	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 (0.00087 ~ 0.00224in.) No.2,3,4,5 : 0.045 ~ 0.082mm (0.00177 ~ 0.00323in.)	No.1 : 0.090mm (0.00354in.) No.2,3,4,5 : 0.120mm (0.00472in.)
	Exhaust	No.1 : 0 ~ 0.032mm (0 ~ 0.00126in.) No.2,3,4,5 : 0.045 ~ 0.082mm (0.00177 ~ 0.00323in.)	
End play		0.04 ~ 0.16mm (0.0016 ~ 0.0063in.)	0.20mm (0.0078in.)
Valve			
Valve length	Intake	113.18mm (4.4559in.)	112.93mm (4.4461in)
	Exhaust	105.84mm (4.1669in.)	105.59mm (4.1571in)

Description		Specifications	Limit
Stem outer diameter	Intake	5.465 ~ 5.480mm (0.21516 ~ 0.21575in.)	
	Exhaust	5.458 ~ 5.470mm (0.21488 ~ 0.21535in.)	
Face angle		45.25° ~ 45.75°	
Thickness of valve head (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.)	0.070mm (0.00275in.)
	Exhaust	0.030 ~ 0.054mm (0.00118 ~ 0.00212in.)	0.090mm (0.00354in.)
MLA outer diameter		31.964 ~ 31.980mm (1.2584 ~ 1.2590in.)	
Tappet bore inner diameter		32.000 ~ 32.025mm (1.2598 ~ 1.2608in.)	
MLA to tappet bore clearance		0.020 ~ 0.061mm (0.00078 ~ 0.00240in.)	0.070mm (0.00275in.)
Valve guide			
Length	Intake	43.8 ~ 44.2mm (1.7244 ~ 1.7401in.)	
	Exhaust	43.8 ~ 44.2mm (1.7244 ~ 1.7401in.)	
Inner diameter	Intake	5.500 ~ 5.512mm (0.21654 ~ 0.21701in.)	
	Exhaust	5.500 ~ 5.512mm (0.21654 ~ 0.21701in.)	
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	Intake	44.75° ~ 45.10°	
	Exhaust	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 39.8 ± 1.2kg/26.0mm (87.74 ± 2.64lb/1.0236in.)	
Out of squareness		Less than 1.5°	
Cylinder head			
Flatness of gasket surface		Less than 0.05mm (0.0019in.) for total area Less than 0.02mm (0.0007in.) for a section of 100mm (3.9370in.)×100mm (3.9370in.)	
Flatness of manifold mounting surface	Intake	Less than 0.10mm (0.0039in.)	
	Exhaust	Less than 0.10mm (0.0039in.)	
Piston			
Piston outer diameter		87.970 ~ 88.000mm (3.46338 ~ 3.46456in.)	
Piston to cylinder clearance		0.020 ~ 0.040mm (0.00079 ~ 0.00157in.)	

Description		Specifications	Limit
Ring groove width	No. 1 ring	1.235 ~ 1.250mm (0.04862 ~ 0.04921in.)	1.260mm (0.04961in.)
	No. 2 ring	1.230 ~ 1.250mm (0.04843 ~ 0.04921in.)	1.260mm (0.04961in.)
	Oil ring	2.010 ~ 2.025mm (0.07913 ~ 0.07972in.)	2.050mm (0.08071in.)
Piston ring			
Side clearance	No. 1 ring	0.050 ~ 0.080mm (0.00197 ~ 0.00315in.)	0.100mm (0.00394in.)
	No. 2 ring	0.040 ~ 0.080mm (0.00157 ~ 0.00315in.)	0.100mm (0.00394in.)
	Oil ring	0.020 ~ 0.055mm (0.00079 ~ 0.00217in.)	0.60mm (0.0236in.)
End gap	No. 1 ring	0.15 ~ 0.30mm (0.0059 ~ 0.0118in.)	0.60mm (0.0236in.)
	No. 2 ring	0.37 ~ 0.52mm (0.0145 ~ 0.0204in.)	0.70mm (0.0275in.)
	Oil ring	0.20 ~ 0.50mm (0.0079 ~ 0.0197in.)	0.80mm (0.0315in.)
Piston pin			
Piston pin outer diameter		21.997 ~ 22.000mm (0.86602 ~ 0.86614in.)	
Piston pin hole inner diameter		22.003 ~ 22.007mm (0.86626 ~ 0.86642in.)	
Piston pin hole clearance		0.003 ~ 0.010mm (0.00012 ~ 0.00039in.)	
Connecting rod small end hole inner diameter		22.005 ~ 22.011mm (0.86634 ~ 0.86657in.)	
Piston pin-to-connecting rod bushing oil clearance		0.005 ~ 0.014mm (0.00020 ~ 0.00055in.)	
Connecting rod			
Connecting rod big end inner diameter		51.000 ~ 51.018mm (2.00787 ~ 2.00858in.)	
Connecting rod bearing oil clearance		0.031 ~ 0.045mm (0.00122 ~ 0.00177in.)	0.050mm (0.00197in.)
Side clearance		0.10 ~ 0.25mm (0.0039 ~ 0.0098in.)	0.35mm (0.0138in.)
Crankshaft			
Main journal outer diameter		51.942 ~ 51.960mm (2.04496 ~ 2.04567in.)	
Pin journal outer diameter		47.954 ~ 47.972mm (1.88795 ~ 1.88866in.)	
Main bearing oil clearance		0.020 ~ 0.038mm (0.00079 ~ 0.00150in.)	0.100mm (0.00394in.)
End play		0.07 ~ 0.25mm (0.0028 ~ 0.0098in.)	0.30mm (0.0118in.)
Cylinder block			
Cylinder bore		88.00 ~ 88.03mm (3.4645 ~ 3.4657in.)	
Flatness of gasket surface		Less than 0.05mm (0.0019in.) for total area Less than 0.02mm (0.0007in.) for a section of 100mm (3.9370in.)×100mm (3.9370in.)	
Engine oil			

Description		Specifications	Limit
Oil quantity	Total	5.5 L (1.45 U.S.gal., 5.81 U.S.qt., 4.84 Imp.qt.)	When replacing a short engine or block assembly
	Oil pan	4.2 L (1.11 U.S.gal., 4.44 U.S.qt., 3.70 Imp.qt.)	
	Drain and refill	4.6 L (1.22 U.S.gal., 4.86 U.S.qt., 4.05 Imp.qt.)	Including oil filter
Oil grade	Recommendation	5W-20/GF4&SM	If not available, refer to the recommended API or ILSAC classification and SAE viscosity number.
	Classification	API SL, SM or above ILSAC GF3, GF4 or above	Satisfy the requirement of the API or ILSAC classification.
	SAE viscosity grade	Recommended SAE viscosity number	Refer to the "Lubrication System".
Oil pressure (at 1,000rpm)		147.09kPa (1.5kgf/cm², 22.33psi) or above	Oil temperature (oil pan): 110±2°C (230±35.6°F)
Cooling system			
Cooling method		Forced circulation with cooling fan	
Coolant quantity		6.8L (1.79 U.S.gal., 7.18 U.S.qt., 5.98 Imp.qt.)	
Thermostat	Type	Wax pellet type	
	Opening temperature	82±1.5°C (179.6±2.7°F)	
	Full opening valve lift/temperature	More than 8mm (0.3in.) / 95°C (203°F)	
Radiator cap	Main valve opening pressure	93.16 ~ 122.58kPa (0.95 ~ 1.25kgf/cm², 13.51 ~ 17.78psi)	
	Vacuum valve opening pressure	0 ~ 6.86 kPa (0 ~ 0.07kgf/cm², 0 ~ 0.99psi)	

Tightening Torques

Item	Quantity	N.m	kgf.m	lb-ft
Engine mounting				
Engine mounting bracket to body fixing bolt	4	58.8 ~ 73.5	6.0 ~ 7.5	43.4 ~ 54.2
Engine mounting insulator to engine mounting support bracket fixing nut	1	68.6 ~ 83.4	7.0 ~ 8.5	50.6 ~ 61.5
Engine mounting support bracket to engine support bracket fixing bolt	1	68.6 ~ 83.4	7.0 ~ 8.5	50.6 ~ 61.5
Engine mounting support bracket to engine support bracket fixing nut	2	68.6 ~ 83.4	7.0 ~ 8.5	50.6 ~ 61.5
Transaxle mounting bracket to body fixing bolt	3	49.0 ~ 63.7	5.0 ~ 6.5	36.2 ~ 47.0
Transaxle mounting bracket to body fixing nut	1	49.0 ~ 63.7	5.0 ~ 6.5	36.2 ~ 47.0
Transaxle mounting support bracket fixing bolt	2	58.8 ~ 78.5	6.0 ~ 8.0	43.4 ~ 57.9
Transaxle mounting support bracket fixing nut	2	78.5 ~ 98.0	8.0 ~ 10.0	57.9 ~ 72.3
Transaxle mounting bracket to transaxle mounting support bracket fixing bolt	2	88.3 ~ 107.9	9.0 ~ 11.0	65.1 ~ 79.6
Roll rod bracket to sub frame fixing bolt	2	49.0 ~ 63.7	5.0 ~ 6.5	36.2 ~ 47.0
Roll rod bracket to roll rod support bracket fixing bolt & nut	1	88.3 ~ 107.9	9.0 ~ 11.0	65.1 ~ 79.6
Timing system				
Idler bolt	2	53.9 ~ 63.7	5.5 ~ 6.5	39.7 ~ 47.0
Drive belt tensioner pulley bolt	1	53.9 ~ 63.7	5.5 ~ 6.5	39.7 ~ 47.0
Drive belt tensioner bolt	1	53.9 ~ 63.7	5.5 ~ 6.5	39.7 ~ 47.0
Crankshaft pulley bolt	1	166.6 ~ 176.4	17.0 ~ 18.0	122.9 ~ 130.1
Timing chain cover service hole bolt	1	11.8 ~ 14.7	1.2 ~ 1.5	8.7 ~ 10.8
Timing chain cover bolt (M6×25)	7	7.8 ~ 9.8	0.8 ~ 1.0	5.8 ~ 7.2
Timing chain cover bolt (M8×28)	7	18.6 ~ 22.5	1.9 ~ 2.3	13.7 ~ 16.6
Engine support bracket bolt (M8×30)	1	19.6 ~ 24.5	2.0 ~ 2.5	14.5 ~ 18.1
Engine support bracket bolt (M10×40)	1	39.2 ~ 44.1	4.0 ~ 4.5	28.9 ~ 32.5
Engine support bracket bolt (M10×45)	2	39.2 ~ 44.1	4.0 ~ 4.5	28.9 ~ 32.5
Timing chain tensioner bolt	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7

Item	Quantity	N.m	kgf.m	lb-ft
Timing chain tensioner arm bolt	1	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Timing chain guide bolt	3	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Timing chain oil jet bolt	1	7.8 ~ 9.8	0.8 ~ 1.0	5.8 ~ 7.2
Cylinder head				
Engine cover mounting bolt	4	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Ignition coil bolt	4	3.9 ~ 5.9	0.4 ~ 0.6	2.9 ~ 4.3
Cylinder head cover bolt	20	[3.9~5.9] + [7.8~9.8]	[0.4~0.6] + [0.8~1.0]	[2.9~4.3] + [5.8~7.2]
High pressure fuel pipe nut	2	26.5 ~ 32.4	2.7 ~ 3.3	19.5 ~ 23.9
High pressure fuel pump bolt	2	12.7 ~ 14.7	1.3 ~ 1.5	9.4 ~ 10.8
High pressure fuel pump bracket bolt	3	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Injector & rail assembly bolt	3	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
CVVT bolt (LH/RH)	2	53.9 ~ 63.7	5.5 ~ 6.5	39.7 ~ 47.0
Camshaft bearing cap bolt (M6) (LH/RH)	16	[5.9] + [10.8~12.7]	[0.6] + [1.1~1.3]	[4.3] + [8.0~9.4]
Camshaft bearing cap bolt (M8)	4	[14.7] + [27.5 ~ 31.4]	[1.5] + [2.8~3.2]	[10.8] + [20.3~23.1]
Cylinder head bolt	10	[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 (Front/Rear)	2	27.5 ~ 31.4	2.8 ~ 3.2	20.3 ~ 23.1
Camshaft position sensor (LH/RH)	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Oil control valve (OCV) bolt (LH/RH)	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Cylinder block				
Tensioner assembly intergrated bracket bolt	5	39.2 ~ 44.1	4.0 ~ 4.5	28.9 ~ 32.5
Flywheel bolt	7	117.7 ~ 127.5	12.0 ~ 13.0	86.8 ~ 93.9
Drive plate bolt	7	117.7 ~ 127.5	12.0 ~ 13.0	86.8 ~ 93.9
Oil filter bracket bolt	4	21.6 ~ 26.5	2.2 ~ 2.7	15.9 ~ 19.5
Ladder frame bolt	10	[8.8~9.8] + [17.7~20.6] + [27.5~31.4]	[0.9~0.1] + [1.8~2.1] + [2.8~3.2]	[6.5~7.2] + [13.0~15.2] + [20.3~23.1]
Connecting rod bearing cap bolt	8	[17.7~21.6] + [88~92°]	[1.8~2.2] + [88~92°]	[13.0~15.9] + [88~92°]
Main bearing cap bolt	10	[14.7] + [27.5~31.4] + [120~125°]	[1.5] + [2.8~3.2] + [120~125°]	[10.8] + [20.3~23.1] + [120~125°]
Piston cooling oil jet bolt	4	24.5 ~ 29.4	2.5 ~ 3.0	18.1 ~ 21.7
Crankshaft position sensor bolt	1	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Crankshaft position sensor cover bolt (M6)	1	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7

Item	Quantity	N.m	kgf.m	lb-ft
Crankshaft position sensor cover bolt (M8)	1	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Knock sensor	1	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Lubrication system				
Oil drain plug	1	34.3 ~ 44.1	3.5 ~ 4.5	25.3 ~ 32.5
Oil filter	1	11.8 ~ 15.7	1.2 ~ 1.6	8.7 ~ 11.6
Oil level gauge assembly bolt	1	7.8 ~ 11.8	0.8 ~ 1.2	5.8 ~ 8.7
A/C compressor bracket bolt	4	19.6 ~ 23.5	2.0 ~ 2.4	14.5 ~ 17.4
Oil pan bolt (M6)	16	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Oil pan bolt (M9)	2	30.4 ~ 34.3	3.1 ~ 3.5	22.4 ~ 25.3
BSM chain tensioner arm bolt	1	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
BSM chain guide bolt	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
BSM chain tensioner bolt	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Balance shaft module (BSM) bolt (M9X181.5)	4	[22.6~26.5] + [88~92°]	[2.3~2.7] + [88~92°]	[16.6~19.5] + [88~92°]
Balance shaft module (BSM) bolt (M9X95)	2	[22.6~26.5] + [43~47°]	[2.3~2.7] + [43~47°]	[16.6~19.5] + [43~47°]
Oil pressure switch	1	7.8 ~ 11.8	0.8 ~ 1.2	5.8 ~ 8.7
Cooling system				
Water pump pulley bolt	3	7.8 ~ 9.8	0.8 ~ 1.0	5.8 ~ 7.2
Water pump bolt	5	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Water pump housing bolt	5	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Water inlet fitting bolt	3	7.8 ~ 11.8	0.8 ~ 1.2	5.8 ~ 8.7
Water temperature control assembly nut	1	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Water temperature control assembly bolt	2	14.7 ~ 19.6	1.5 ~ 2.0	10.8 ~ 14.5
Water inlet pipe bolt	1	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Intake and exhaust system				
Air intake hose clamp bolt	2	2.9 ~ 4.9	0.3 ~ 0.5	2.2 ~ 3.6
Air cleaner asembly bolt	2	7.8 ~ 9.8	0.8 ~ 1.0	5.8 ~ 7.2
Electronic throttle control (ETC) module bolt	4	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Intake manifold stay bolt	4	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Intake manifold bolt	3	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Intake manifold nut	2	18.6 ~ 23.5	1.9 ~ 2.4	13.7 ~ 17.4
Oxygen sensor (Front/Rear)	2	39.2 ~49.0	4.0 ~ 5.0	28.9 ~ 36.2

Item	Quantity	N.m	kgf.m	lb-ft
Exhaust manifold heat protector bolt	3	7.8 ~ 11.8	0.8 ~ 1.2	5.8 ~ 8.7
Exhaust manifold stay bolt (M8)	2	18.6 ~ 27.5	1.9 ~ 2.8	13.7 ~ 20.3
Exhaust manifold stay bolt (M10)	1	51.9 ~ 57.8	5.3 ~ 5.9	38.3 ~ 42.6
Exhaust manifold nut	8	49.0 ~ 53.9	5.0 ~ 5.5	36.2 ~ 39.7
Catalytic converter / muffler nut	8	39.2 ~ 58.8	4.0 ~ 6.0	28.9 ~ 43.4

Compression Pressure Inspection

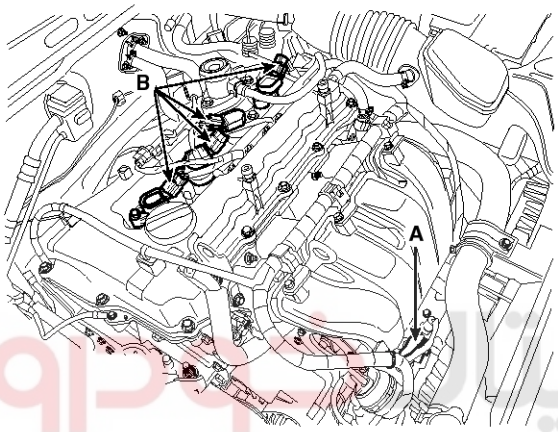
NOTICE

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 extension connector (A) and ignition coil connectors (B).



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3. Remove ignition coils (A).

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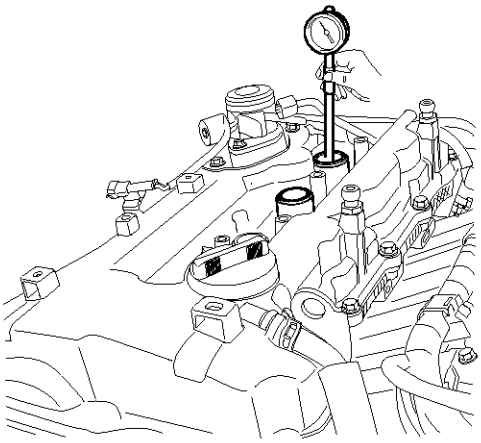
4. Remove spark plugs.

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

5. Check cylinder compression pressure.

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



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   2) Fully open the throttle.
   3) While cranking the engine, measure the compression pressure.

      NOTICE

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

   4) Repeat steps (1) through (3) for each cylinder.

      NOTICE

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

Compression pressure :
1,324kPa (13.5kgf/cm², 192psi) / 200 ~ 250rpm
Minimum pressure :
1,177kPa (12.0kgf/cm², 171psi)
Difference between each cylinder :
100kPa (1.0kgf/cm², 15psi) or less

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

6. Reinstall spark plugs.
7. Install ignition coils.
8. Connect the injector extension connector and ignition coil connectors.
9. Some DTC's may exist after the inspection test and may need to be manually cleared with GDS.

Valve Clearance Inspection And Adjustment

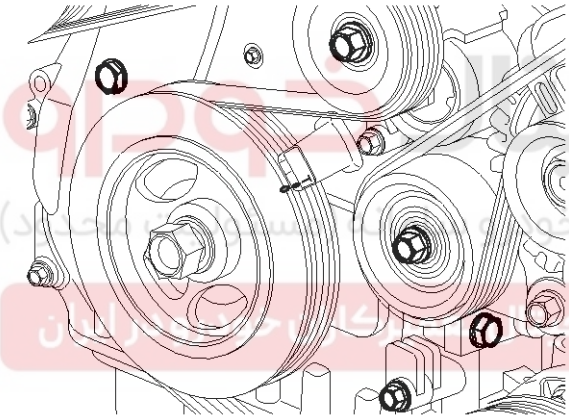
NOTICE

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.

WARNING

In case of removing the high pressure fuel pump, high pressure fuel pipe, delivery pipe, and injector, there may be injury caused by leakage of the high pressure fuel. So don't do any repair work right after engine stops.

1. Remove the cylinder head cover. (Refer to Timing system in this group)
2. Set No.1 cylinder to TDC/compression.
   1) Turn the crankshaft pulley and align its groove with the timing mark "T" of the lower timing chain cover.



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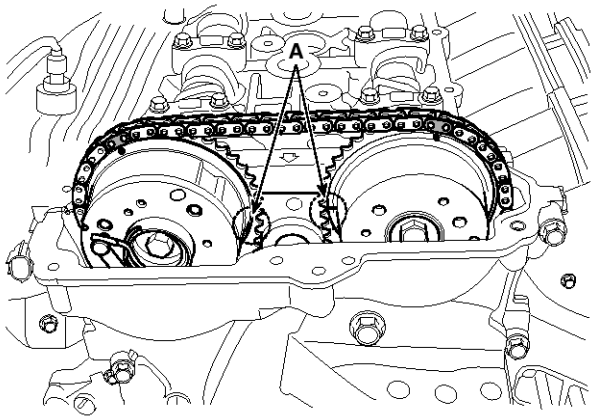
   2) Check that the TDC marks (A) of the CVVT sprockets are in straight line on the cylinder head surface as shown in the illustration.

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



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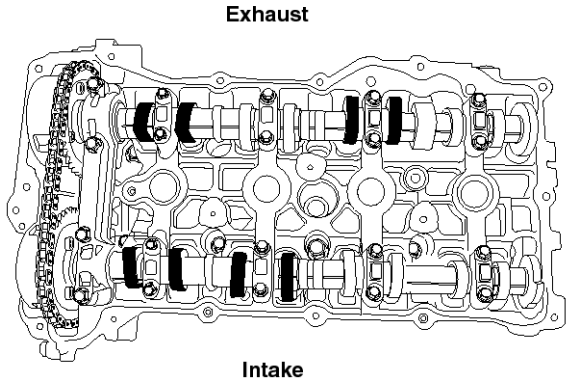
3. Inspect the valve clearance.
   1) Check only the valve indicated as shown. Measure the valve clearance.



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   - 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]

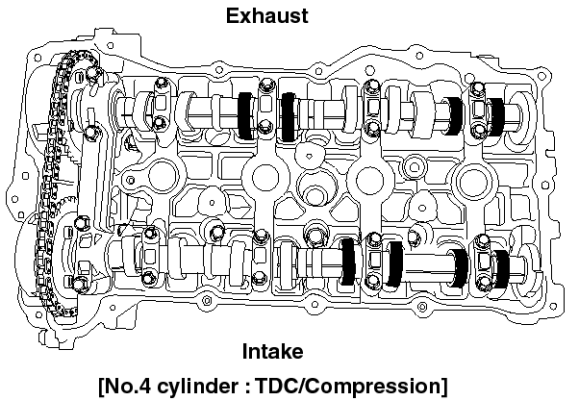
Limit

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

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

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

3) Check only valves indicated as shown. Measure the valve clearance.



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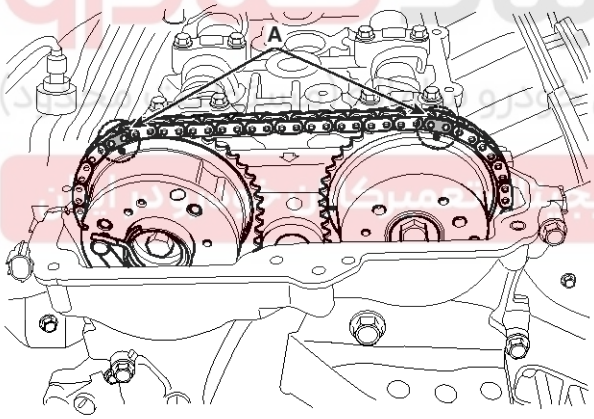
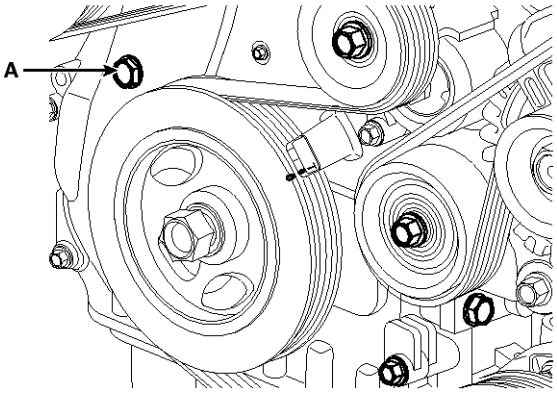
4. Adjust the intake and exhaust valve clearance.
   1) Set the No.1 cylinder to the TDC/compression.
   2) Mark the timing chains (A) on the timing marks of the CVVT sprockets.



SVGEM0156D

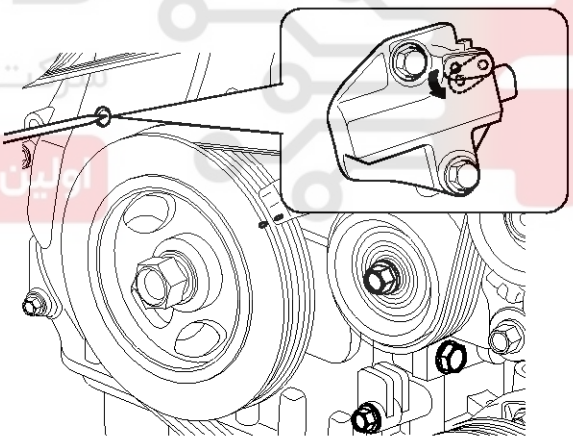
   3) Remove the front camshaft bearing cap.
   4) Turn the crankshaft pulley 15° clockwise.
   5) Remove the service hole bolt(A) of the timing chain cover.



STGEM9102D

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

   6) Release the ratchet of the timing chain tensioner by pulling the link down using a thin rod.



SYFEM0141N

   7) Remove the exhaust camshaft bearing cap and exhaust camshaft.
   8) Remove the intake camshaft bearing cap and intake camshaft.

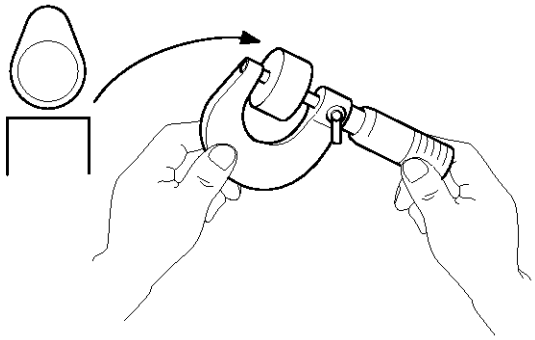
⚠CAUTION
When disconnect the timing chain from the CVVT sprocket, hold the timing chain.

9) Tie down timing chain so that it doesn't move.

CAUTION

Be careful not to drop anything inside timing chain cover.

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



EDKE889D

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

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

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

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

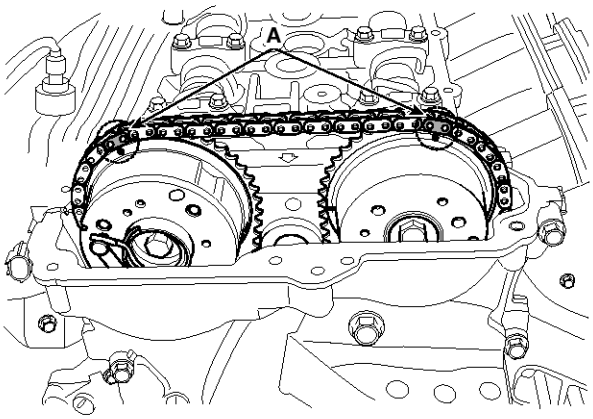
NOTICE

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

13) Place a new tappet on the cylinder head.

14) Hold the timing chain, and install the intake camshaft and CVVT assembly.

15) Align the timing marks (A) on the timing chains and CVVT sprockets.



SVGEM0156D

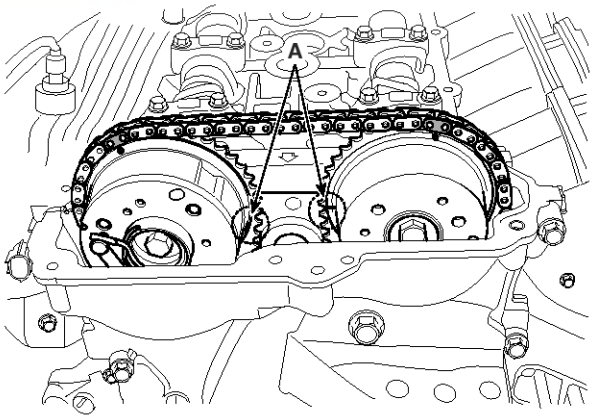
16) Install the exhaust camshaft and CVVT assembly after releasing the ratchet of the timing chain tensioner.

17) Install the front bearing cap.

18) Install the service hole bolt.

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

19) Turn the crankshaft two turns in the operating direction(clockwise), and then check that the TDC marks (A) of the CVVT sprockets are in straight line on the cylinder head surface.



SYFEM0001N

20) Recheck the valve clearance.

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

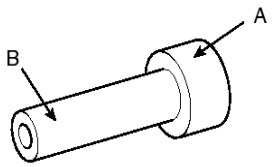
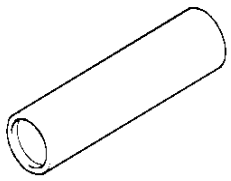
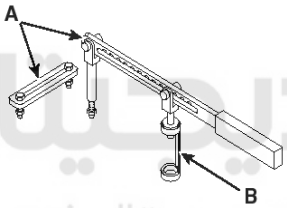
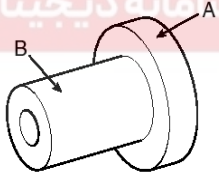
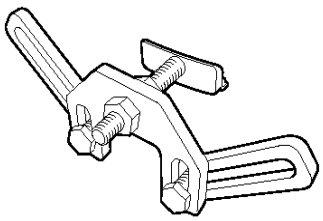
Troubleshooting

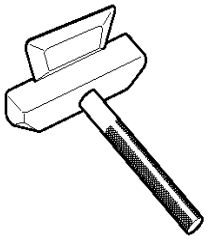
Symption	Suspect area	Remedy
Engine misfire with abnormal internal lower engine noises.	Worn crankshaft bearings Loose or out of specification engine flywheel	Replace the crankshaft and bearings as required. Repair or replace the flywheel as required.
	Worn piston rings (Oil consumption may or may not cause t he 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 Out of specification valve clearances	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 t he 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. (Check and compare with known good vehicle to determine normal condition.)	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.
	Stretched or broken timing chain and/or damaged sprocket teeth.	Replace the timing chain and sprockets.
	Worn timing chain tensioner, if applicable .	Replace the timing chain tensioner as required.
	Worn camshaft lobes.	• Inspect the camshaft lobes. • Replace the timing camshaft and valve lifters as required.
	Out of specification valve clearances 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 replace as 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 connecting rods. 2. Repair as required.
	Broken crankshaft	1. Inspect crankshaft. 2. Repair as required.

Special Service Tools

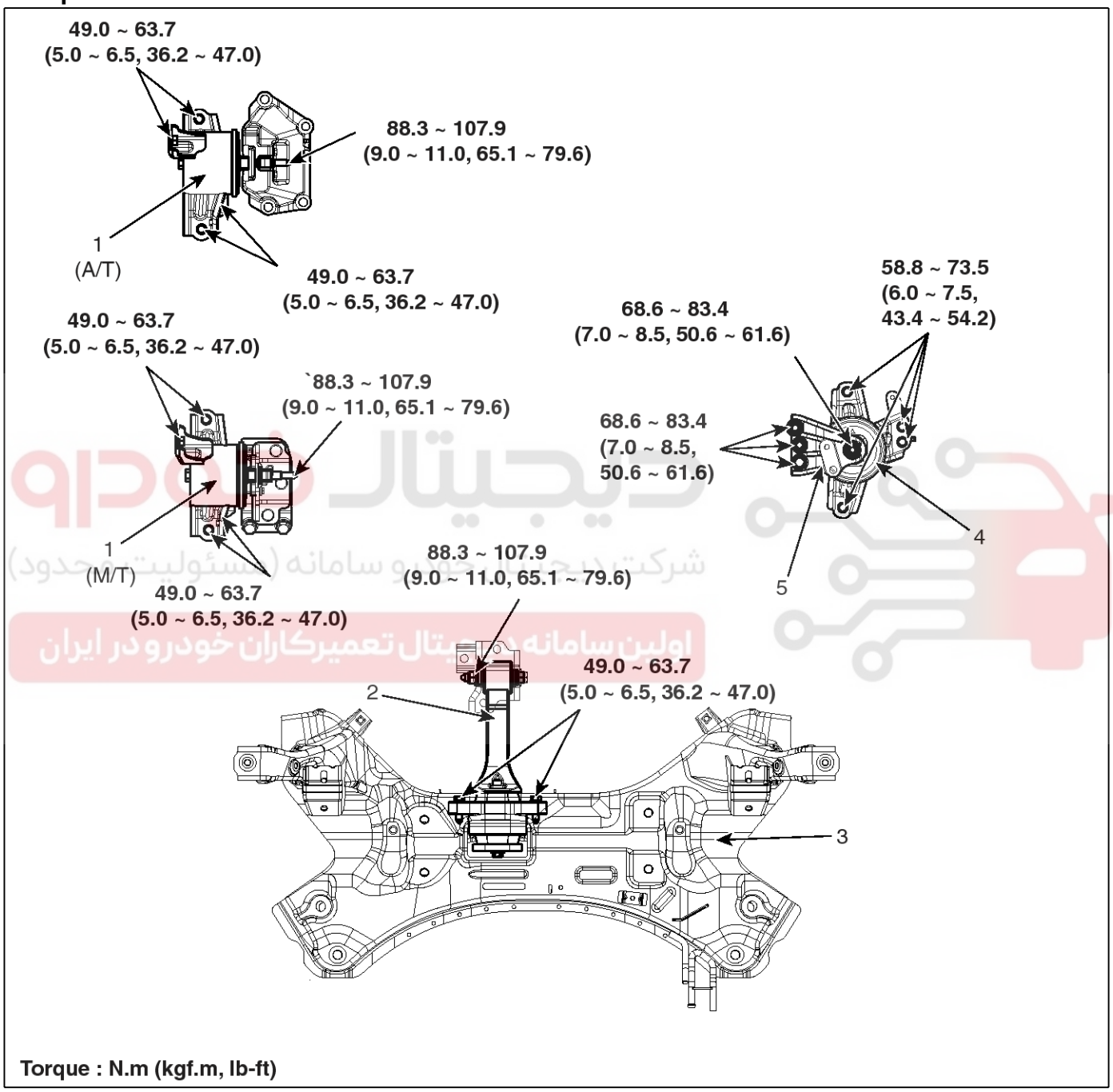
Tool (Number and name)	Illustration	Use
Crankshaft front oil seal installer (09214-3K000) (09231-H1100)	 ACRF002A	Installation of the front oil seal A : 09214-3K000 (installer) B : 09231-H1100 (handle)
Valve stem seal installer (09222-4A000)	 LCAC030D	Installation of the valve stem oil seal
Valve spring compressor (09222-3K000) (09222-3K100)	 SYFEM0182N	Removal and installation of the intake or exhaust valve A : 09222-3K000 (compressor) B : 09222-3K100 (holder)
Crankshaft rear oil seal installer (09214-3K100) (09231-H1100)	 ACRF003A	Installation of the crankshaft rear oil seal A : 09214-3K100 (installer) B : 09231-H1100 (handle)
Ring gear stopper (09231-2B100)	SHDEM6201D	Removal and installation of crankshaft pulley bolt.
Ring gear stopper (09231-3D100)	 SVGEM1001D	Removal and installation of crankshaft pulley bolt.

Tool (Number and name)	Illustration	Use
Torque angle adapter (09221-4A000)	 LCAC030A	Installation of bolts & nuts needing an angular method of adjustment.
Oil pan remover (09215-3C000)	 ACJF125A	Removal of oil pan
Oxygen sensor socket wrench (09392-2H100)	 SFDEM8050L	Removal and installation of oxygen sensor

Engine And Transaxle Assembly

Engine Mounting

Components



STFM1003N

1. Transaxle mounting bracket
2. Roll rod bracket
3. Sub frame
4. Engine mounting bracket
5. Engine mounting support bracket

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.**

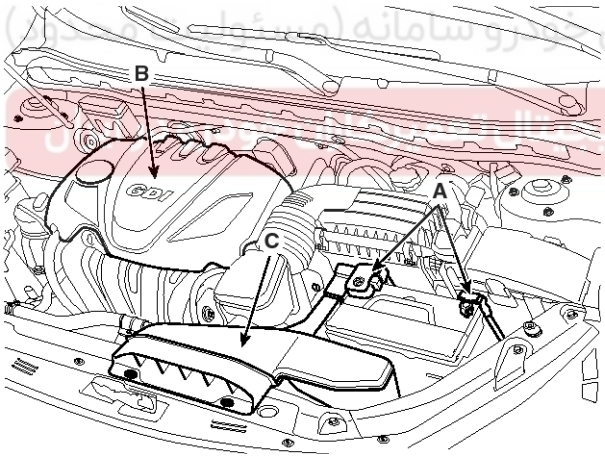
NOTICE

- *Mark all wiring and hoses to avoid misconnection.*
- *To release the fuel system pressure before removing the engine assembly, start the engine with the fuel pump relay removed. And then turn off the ignition switch after engine stops.*

1. Disconnect the battery terminals (A). The negative terminal first.

Tightening torque :
(+) terminal : 7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)
(-) terminal : 4.0 ~ 6.0N.m (0.4 ~ 0.6kgf.m, 3.0 ~ 4.4lb-ft)

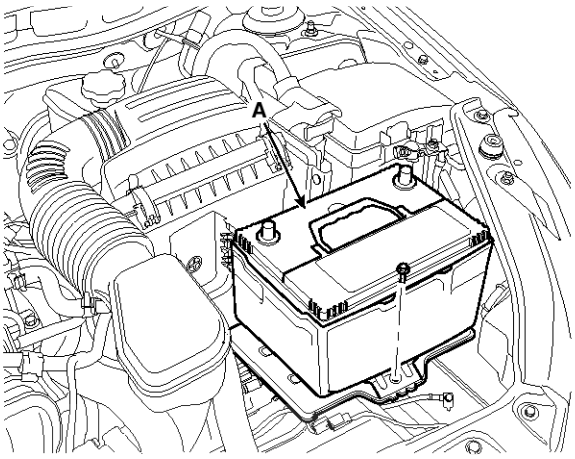
2. Remove the engine cover (B) and the air duct (C).



STFM11020D

3. Remove the battery (A) after removing the mounting bracket.

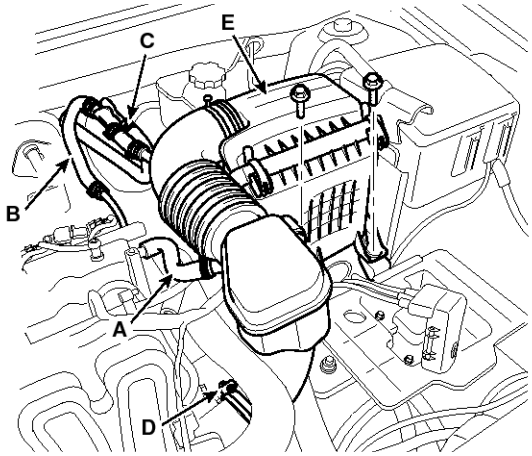
Tightening torque:
9.8 ~ 11.8 N.m (1.0 ~ 1.2 kgf.m, 7.2 ~ 8.7 lb-ft)



STFEM1002D

4. Remove the air cleaner assembly.
   1) Disconnect the breather hose (A), the brake booster vacuum hose (B) and the intensifier hose (C).
   2) Disconnect the air intake hose (D) and then remove the air cleaner assembly (E).

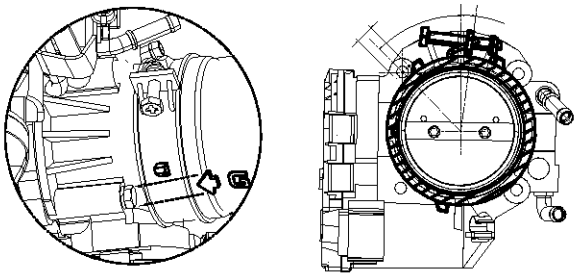
Tightening torque
Hose clamp bolt:
2.9 ~ 4.9N.m (0.3 ~ 0.5kgf.m, 2.2 ~ 3.6lb-ft)
Air cleaner assembly bolts:
7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)



STFM11008D

NOTICE

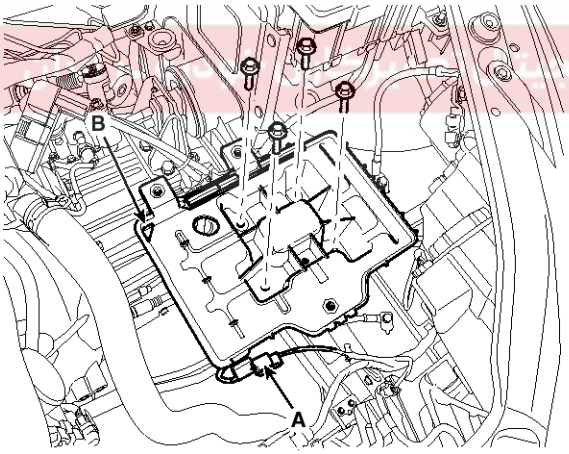
- *Install the air intake hose while the plate of the hose clamp must be in line with the stopper of the hose.*
- *Install the air intake hose match groove to throttle body groove.*



STFM11009D

5. Disconnect the front connector (A) and then remove the battery tray (B).

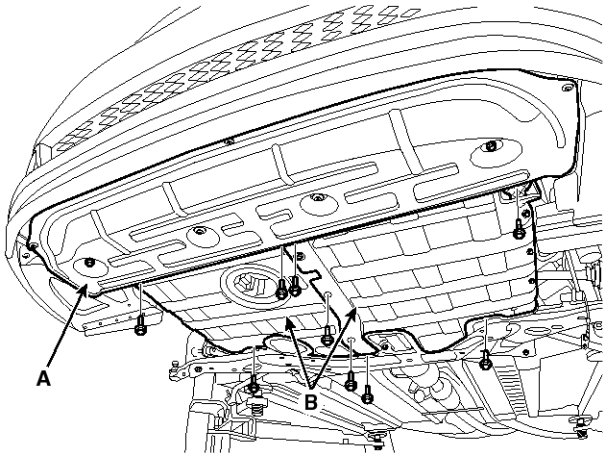
Tightening torque:
8.8 ~ 13.7N.m (0.9 ~ 1.4kgf.m, 6.5 ~ 10.1lb-ft)



STFEM1003D

6. Remove the under covers (A,B).

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

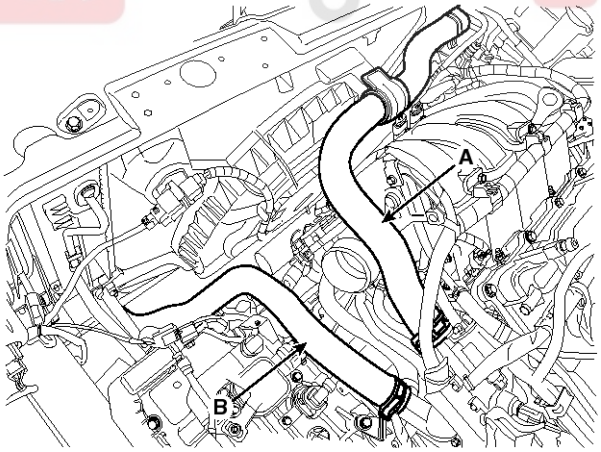


STFM11032D

NOTICE

When removing the under cover (B), unfasten the mounting bracket bolts and then remove the under cover and mounting bracket assembly.

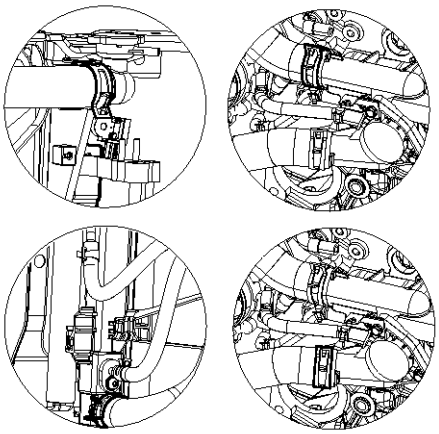
7. Loosen the drain plug, and drain the engine coolant. Remove the radiator cap to help drain the coolant faster. (Refer to Cooling system in this group)
8. Disconnect the radiator upper hose (A) and lower hose (B).



SYFEM0029N

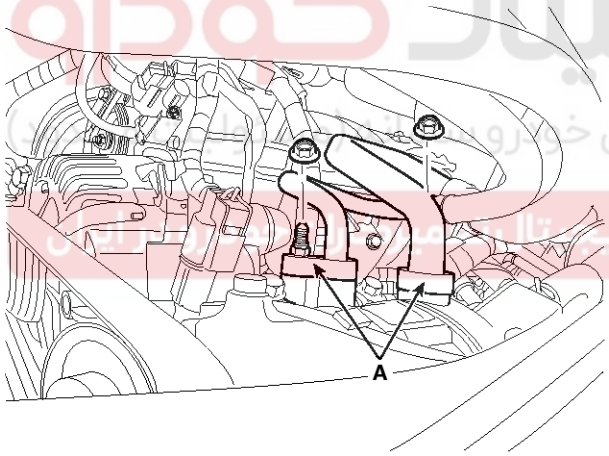
NOTICE

When installing radiator hoses, install as shown in illustrations.



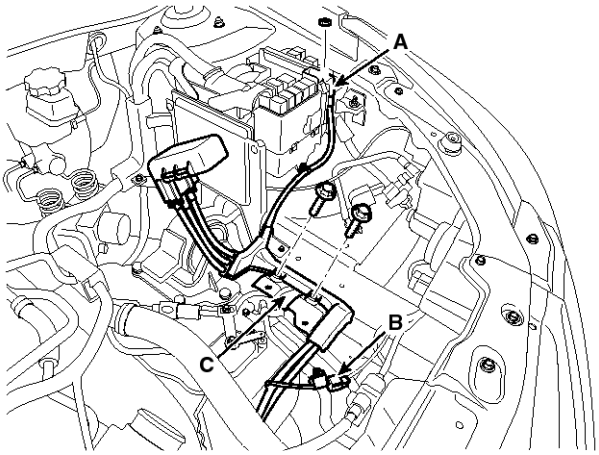
SVGEM0104D

9. Recover the refrigerant and then remove the high pressure pipe and low pressure pipe (A). (Refer to Air conditioning system in HA Group.)



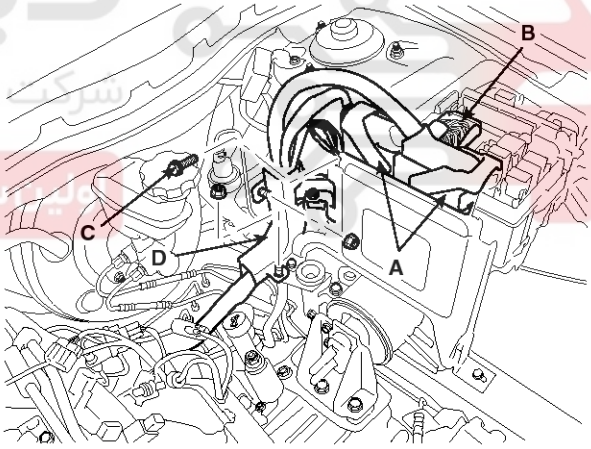
SYFEM0032N

10. Disconnect the (+) cable (A) from the fuse/relay box and the front connector (B). Then remove the wiring protector (C).



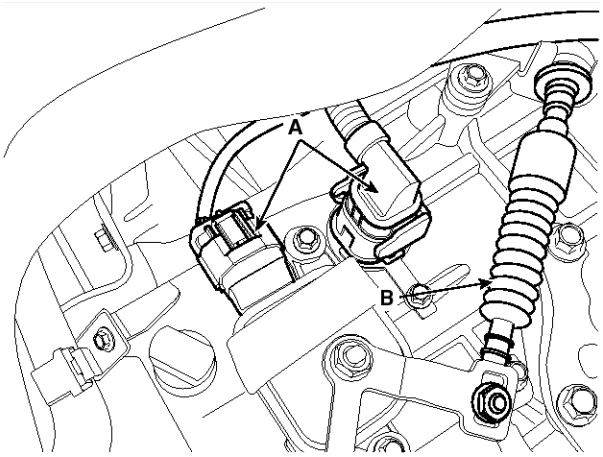
SYFEM0104N

11. Disconnect the ECM connectors (A) from the ECM, the fuse box connector (B) from the fuse/relay box and the engine ground line (C). Then remove the wiring protector (D).



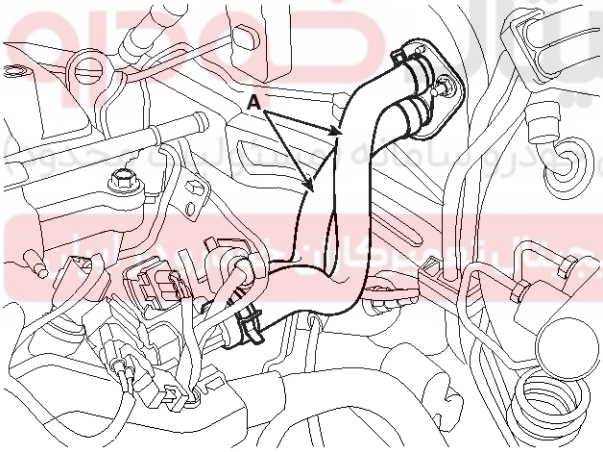
STFEM1007D

12. Remove the transaxle wire harness connectors (A) and control cable (B) from the transaxle. (Refer to AT or MT group).



SVGEM0116D

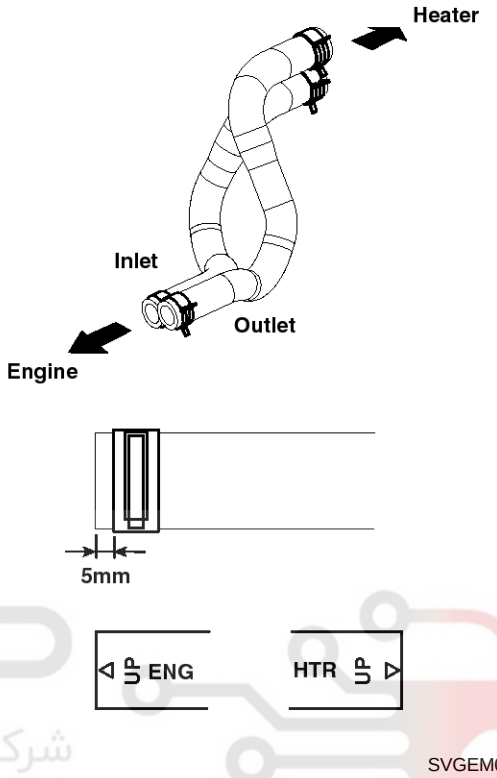
13. Disconnect the ATF cooler hoses.
14. Disconnect the heater hoses (A).



SYFEM0022D

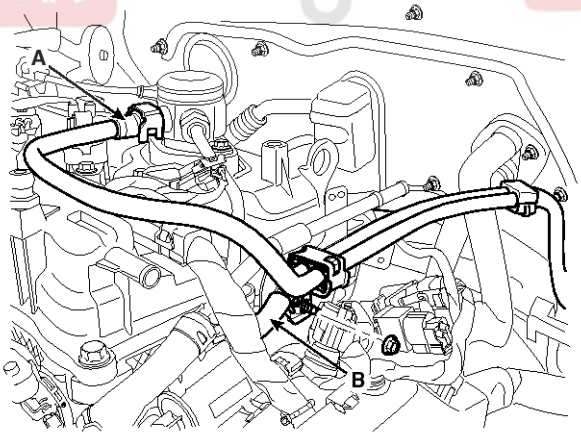
NOTICE

When installing the heater hoses, install as shown in illustrations.



SVGEM0105D

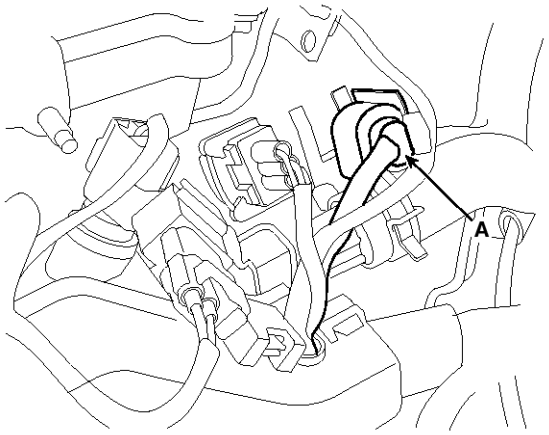
15. Disconnect the fuel hose (A) and PCSV (Purge control solenoid valve) hose (B).



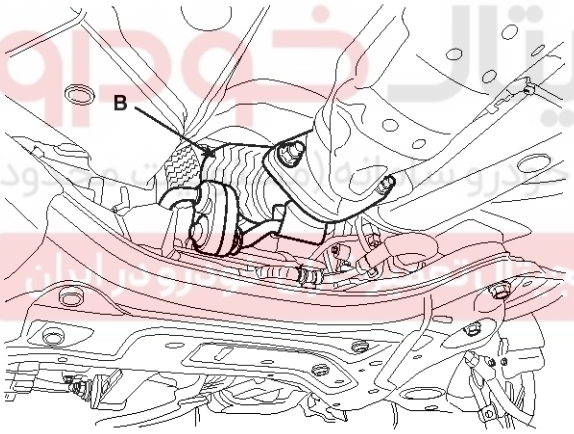
SYFEM0033N

16. Remove the front muffler (B) after disconnecting the front oxygen sensor connector (A.

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

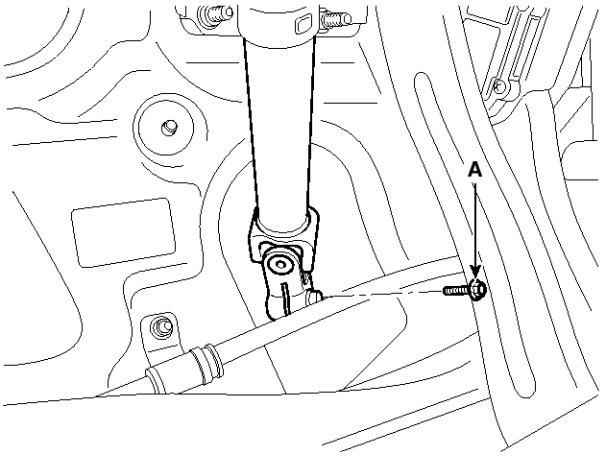


SYFEM0142N



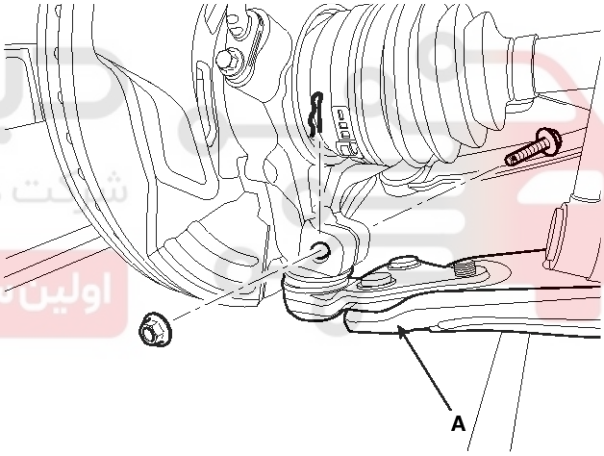
STFEM1009D

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



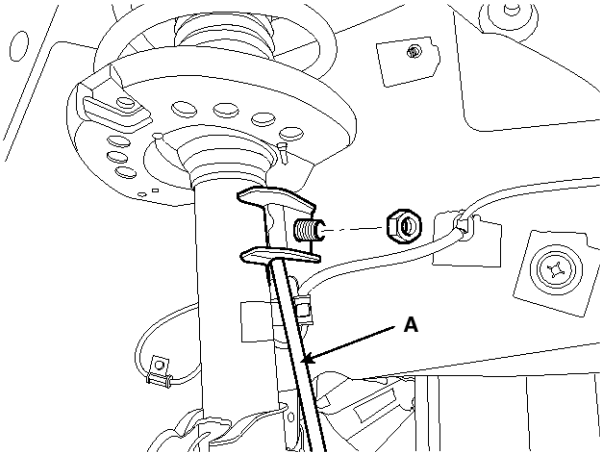
STFEM1101D

18. Remove the front wheels.
19. Remove the lower arms (A). (Refer to SS group)



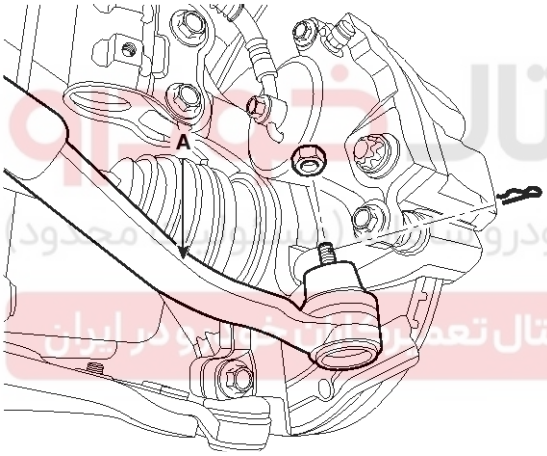
STFEM1049D

20. Remove the stabilizer bar links (A). (Refer to SS group)



STFEM1050D

21. Remove the tie rod ends (A). (Refer to ST group)

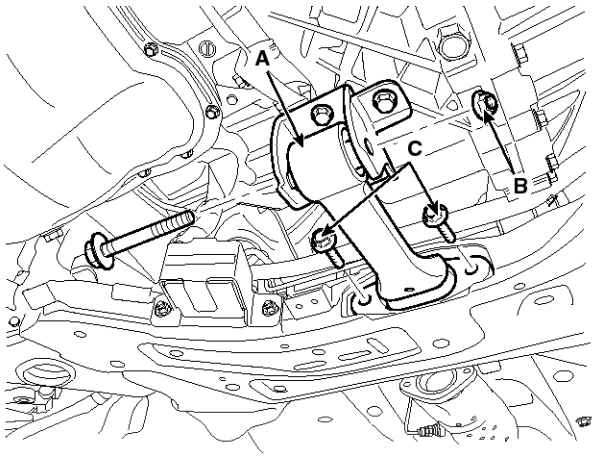


STFEM1051D

22. Disconnect the drive shafts from the axle hubs. (Refer to DS group)

23. Remove the roll rod bracket (A).

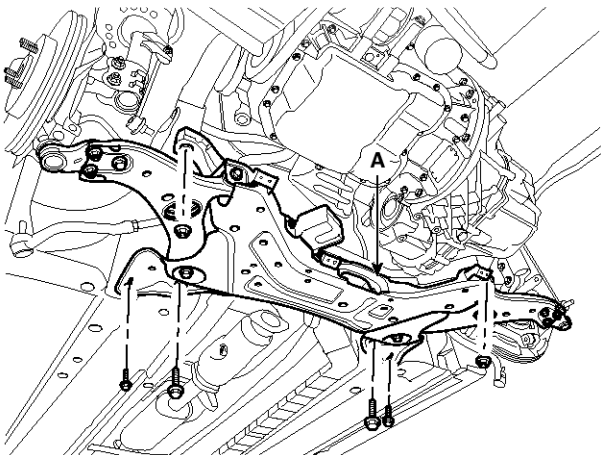
Tightening torque:
Nut (B) : 88.3 ~ 107.9 N.m (9.0 ~ 11.0 kgf.m, 65.1 ~ 79.6 lb-ft)
Bolt (C) : 49.0 ~ 63.7 N.m (5.0 ~ 6.5 kgf.m, 36.2 ~ 47.0 lb-ft)



STFEM1015D

24. Support the sub frame (A) with a floor jack, and then remove the sub frame mounting bolts and nuts.

Tightening torque:
Sub frame mounting bolts & nuts :
156.9 ~ 176.5 N.m (16.0 ~ 18.0 kgf.m, 115.7 ~ 130.2 lb-ft)
Stay mounting bolts :
44.1 ~ 58.8 N.m (4.5 ~ 6.0 kgf.m, 32.5 ~ 43.4 lb-ft)



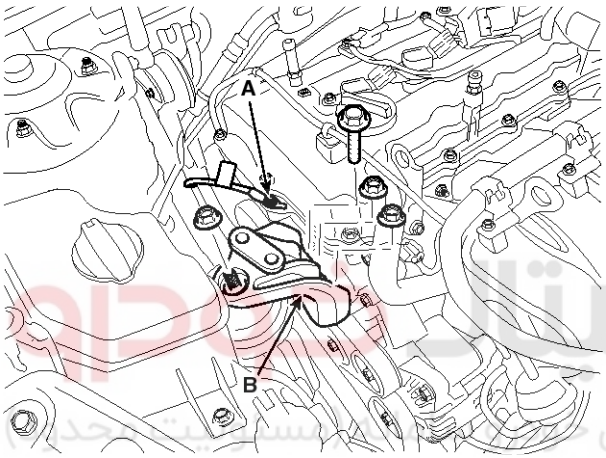
STFEM1019D

NOTICE

- *After removing the sub frame mounting bolt, the engine and transaxle assembly may fall downward, and so support them securely with floor jack.*
- *Verify that the hoses and connectors are disconnected before removing the engine and transaxle assembly.*

25. Disconnect the ground line (A), and then remove the engine mounting bracket (B).

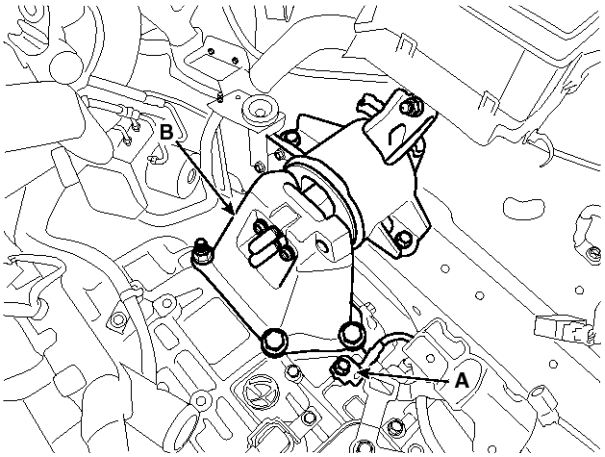
Tightening torque:
68.6 ~ 83.4 N.m (7.0 ~ 8.5 kgf.m, 50.6 ~ 61.5 lb-ft)



STFM11002D

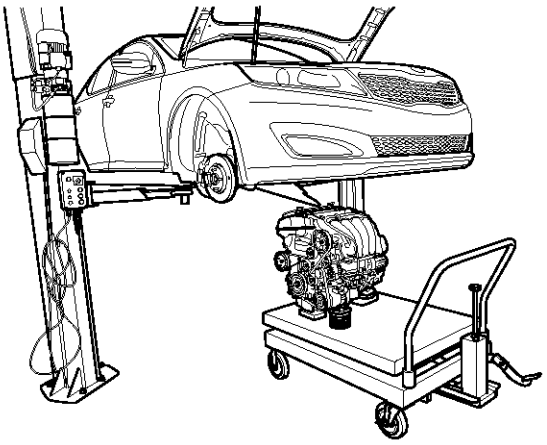
26. Disconnect the ground line (A), and then slowly loosen bolts to engine mounting bracket (B), and lower engine and transaxle assembly onto floor jack.

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



STFM11003D

27. Remove the engine and transaxle assembly by lifting vehicle.



STFEM1010D

CAUTION

When removing the engine and transaxleassembly, be careful not to damage anysurrounding parts or body components.

Installation

Installation is in the reverse order of removal.

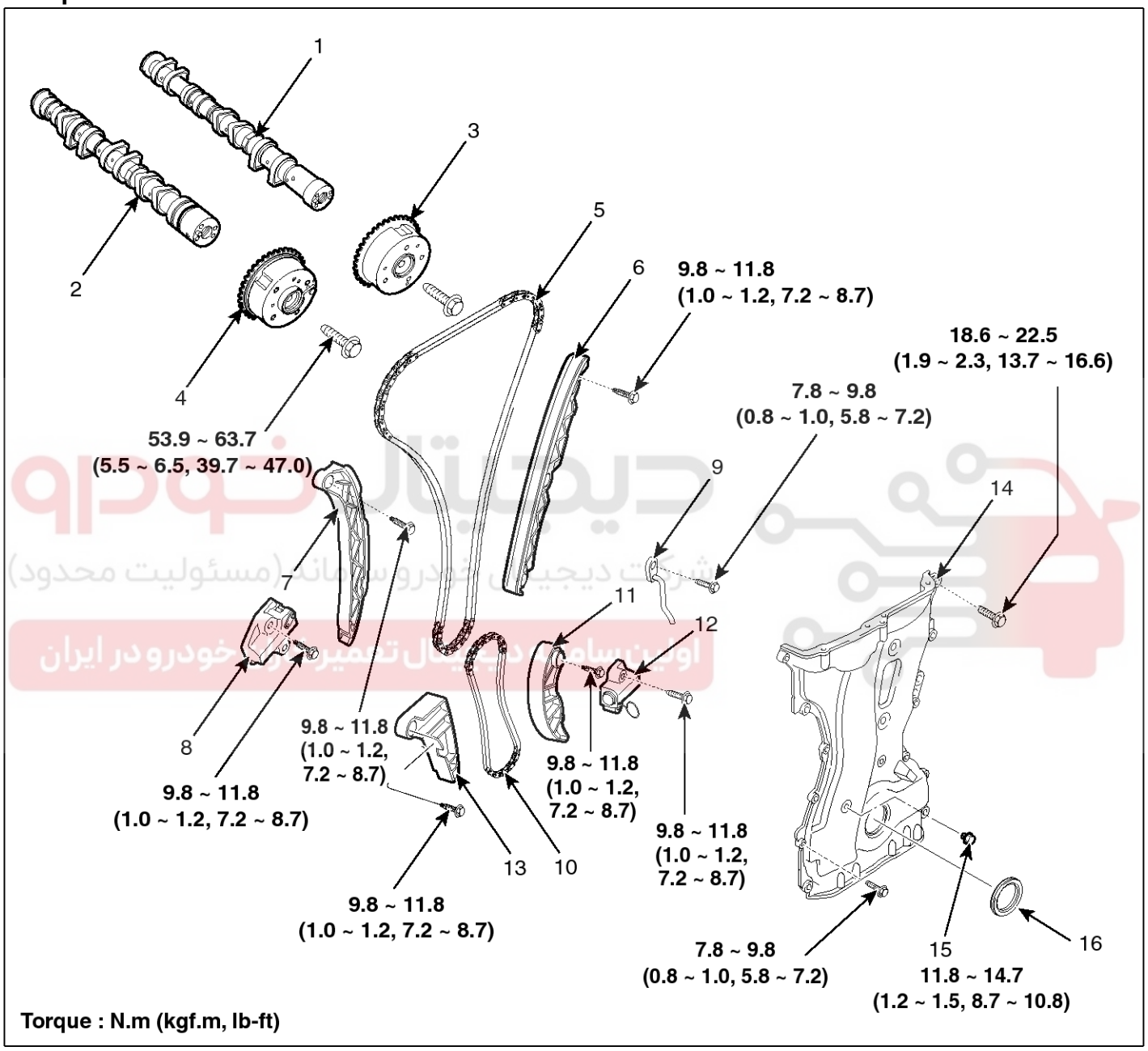
Perform the following :

- Adjust a shift cable.
- Refill engine with engine oil.
- Refill a transaxle with fluid.
- Refill a radiator and a reservoir tank with engine coolant.
- 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.
- 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.

Timing System

Timing Chain

Components



SYFEM0187N

1. Intake camshaft
2. Exhaust camshaft
3. Intake CVVT assembly
4. Exhaust CVVT assembly
5. Timing chain
6. Timing chain guide
7. Timing chain tensioner arm
8. Timing chain tensioner
9. Timing chain oil jet
10. Balance shaft chain
11. Balance shaft chain tensioner arm
12. Balance shaft chain tensioner
13. Balance shaft chain guide
14. Timing chain cover
15. Service hole bolt
16. Crankshaft front oil seal

Removal

CAUTION

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

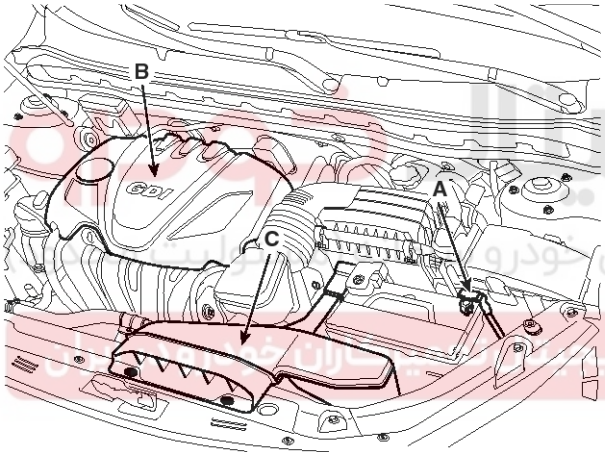
NOTICE

Mark all wiring and hoses to avoid misconnection.

WARNING

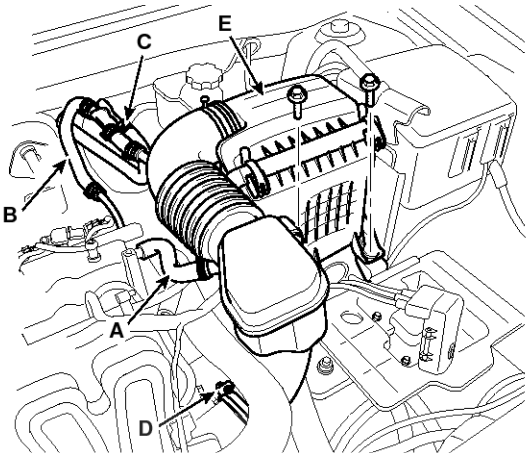
In case of removing the high pressure fuel pump, high pressure fuel pipe, delivery pipe, and injector, there may be injury caused by leakage of the high pressure fuel. So don't do any repair work right after engine stops.

1. Disconnect the battery negative terminal (A).
2. Remove the engine cover (B) and the air duct (C).



STFM11001D

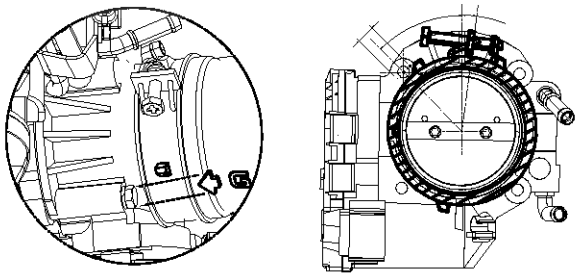
3. Remove the air cleaner assembly.
   1) Disconnect the breather hose (A), the brake booster vacuum hose (B) and the intensifier hose (C).
   2) Disconnect the air intake hose (D) and then remove the air cleaner assembly (E).



STFM11008D

NOTICE

- *Install the air intake hose while the plate of the hose clamp must be in line with the stopper of the hose.*
- *Install the air intake hose match groove to throttle body groove.*

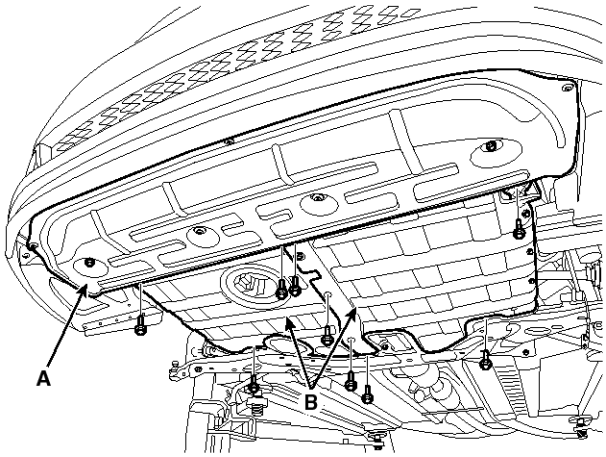


STFM11009D

4. Remove the RH front wheel.

5. Remove the under covers (A,B).

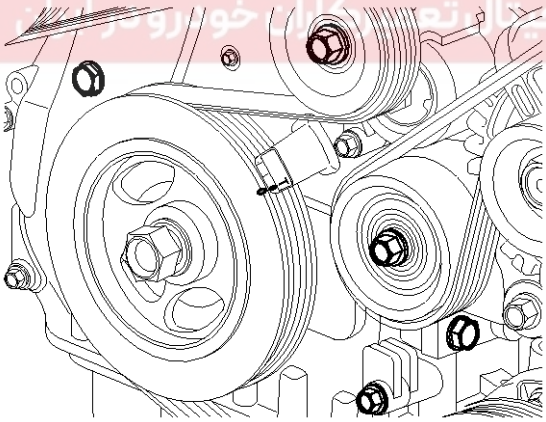
Tightening torque:
7.8 ~ 11.8N.m (0.8 ~ 1.2kgf.m, 5.8 ~ 8.7lb-ft)



STFM11032D

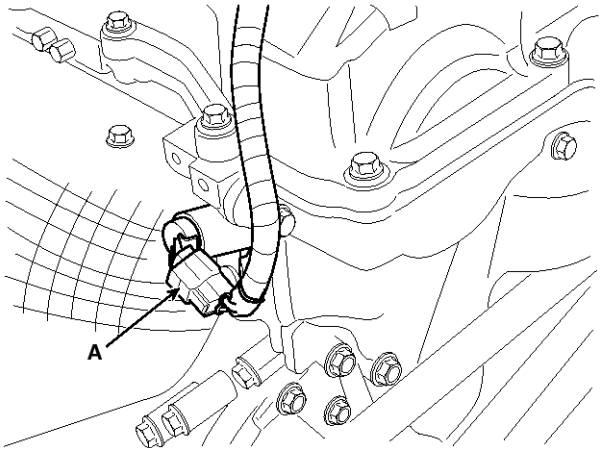
NOTICE
When removing the under cover (B), unfasten the mounting bracket bolts and then remove the under cover and mounting bracket assembly.

6. Turn the crankshaft pulley and align its groove with the timing mark of the timing chain cover to set the piston of No.1 cylinder to the top dead center on compression stroke.



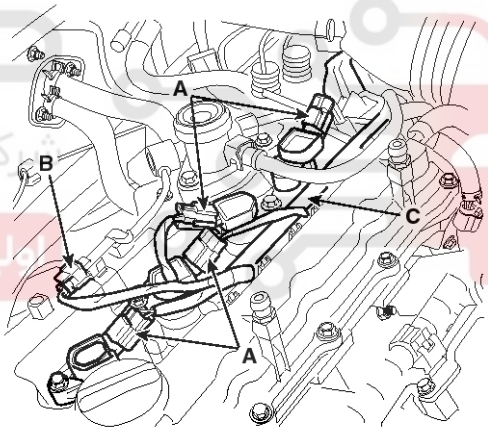
STGEM9101D

7. Disconnect the exhaust OCV (Oil control valve) connector (A).



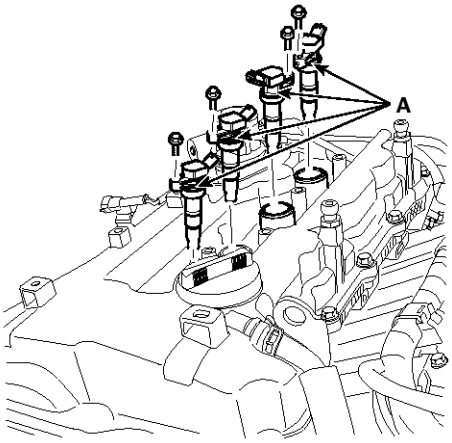
SYFEM0040N

8. Disconnect the ignition coil connectors (A) and the fuel pump connector (B), then remove the wiring protector (C).



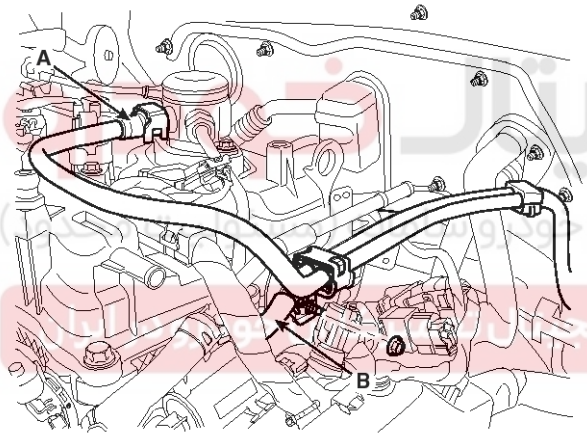
SYFEM0025N

9. Remove the ignition coils (A).



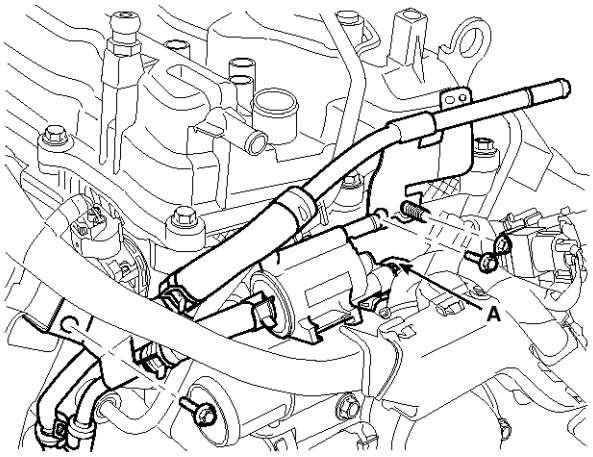
SYFEM0026N

10. Disconnect the fuel hose (A) and PCSV (Purge control solenoid valve) hose (B).



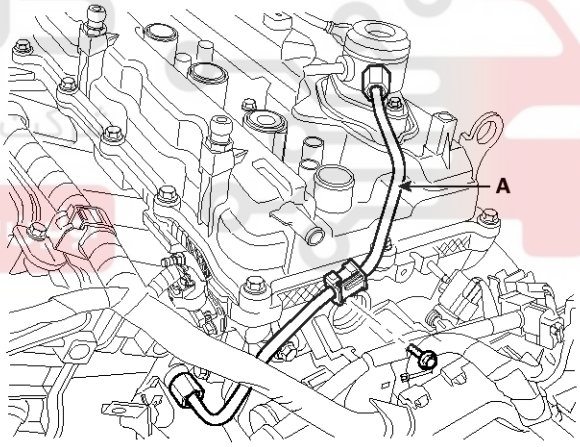
SYFEM0033N

11. Disconnect PCSV (Purge control solenoid valve) connector (A) and loosen the vacuum & PCSV (Purge control solenoid valve) pipe assembly mounting bolts and nut.



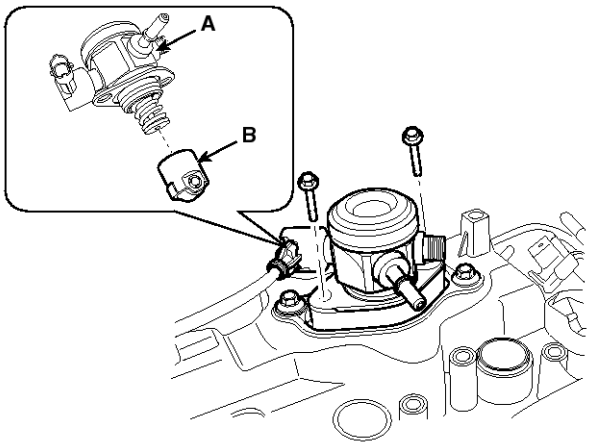
STFM11025D

12. Remove the high pressure pipe (A). (Refer to FL group)



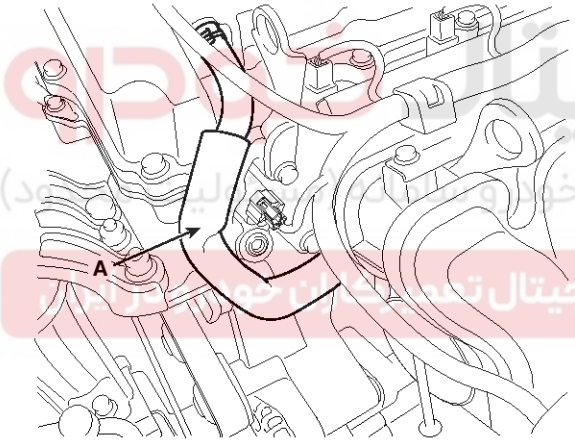
SYFEM0042N

13. Remove the high pressure fuel pump (A) and the roller tappet (B). (Refer to FL group)



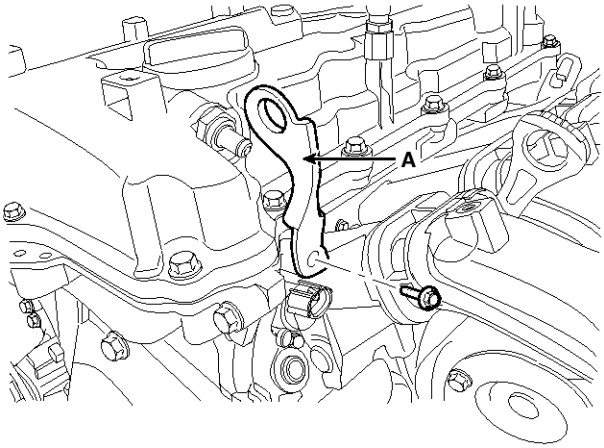
SYFEM0043N

14. Disconnect the PCV (Positive crankcase ventilation) hose (A).



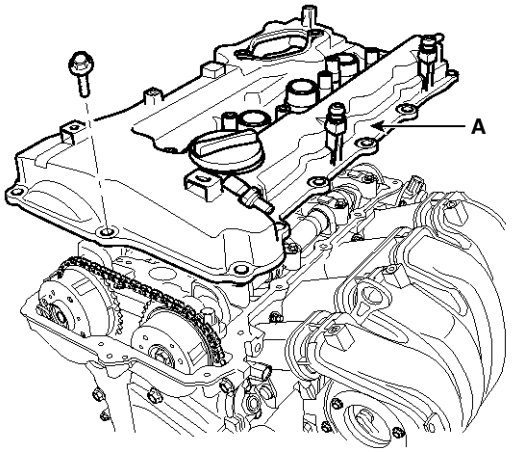
STFEM1028D

15. Remove the front engine hanger (A).



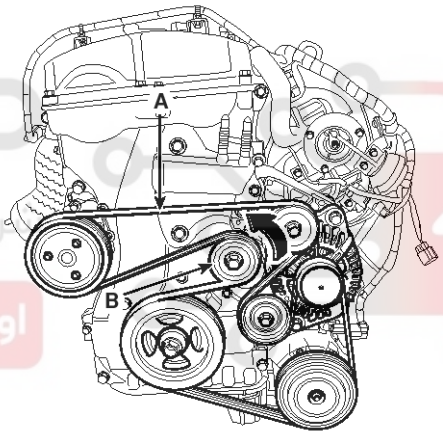
SYFEM0044N

16. Remove the cylinder head cover (A).



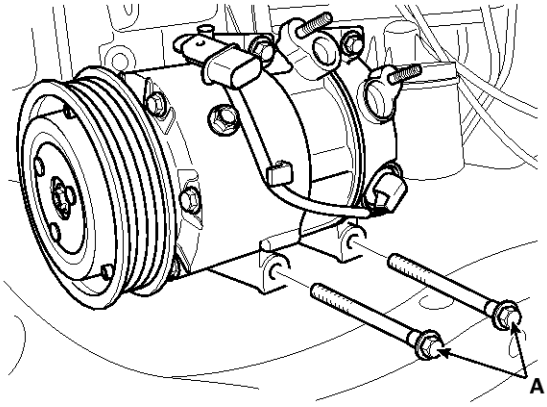
SYFEM0004N

17. Remove the drive belt (A) after turning the drive belt tensioner (B) counterclockwise.



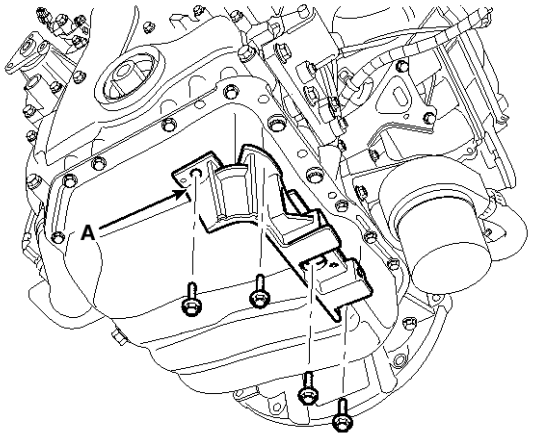
STFM11024D

18. Remove the A/C compressor lower bolts (A).



SYFEM0145N

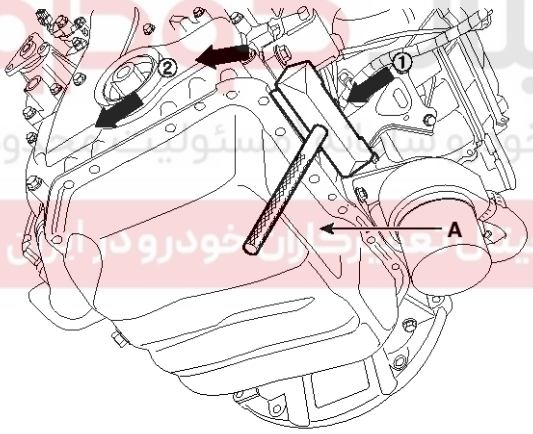
19. Remove the A/C compressor bracket (A).



SYFEM0039N

20. Drain the engine oil.

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



STFM11012D

NOTICE

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

22. Set the jack to the edge of ladder frame.

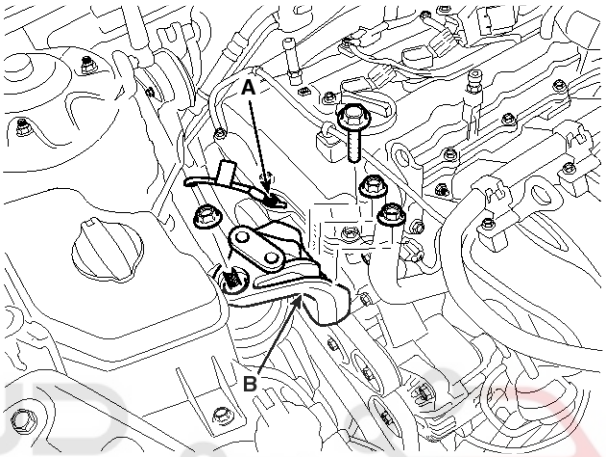
NOTICE

Put the wooden block between ladder frame and jack.

CAUTION

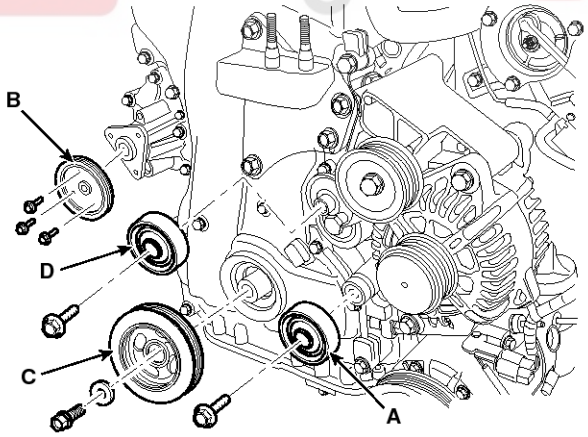
Be careful not to damage the balance shaft & oil pump module.

23. Disconnect the ground line (A), and then remove the engine mounting support bracket (B).



STFM11002D

24. Remove the idler (A), the water pump pulley (B), the crankshaft pulley (C) and the drive belt tensioner pulley (D).



STFM11021D

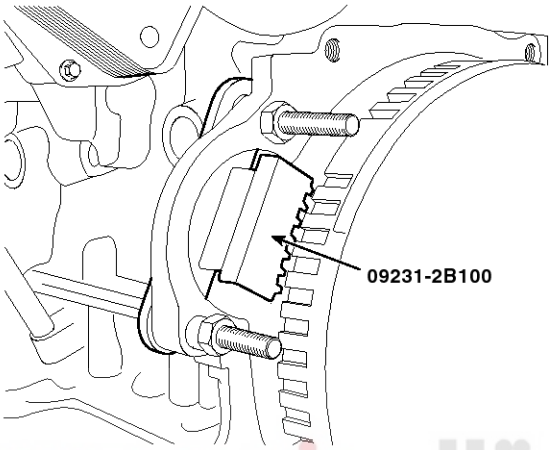
CAUTION

Tensioner pulley bolt is left-handed screw.

NOTICE

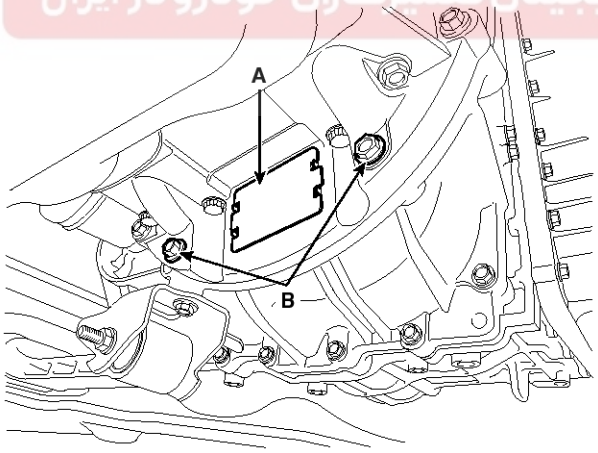
There are two methods to hold the ring gear when installing or removing the crankshaft damper pulley.

- *Install the SST (09231-2B100) to hold the ring gear after removing the starter.*



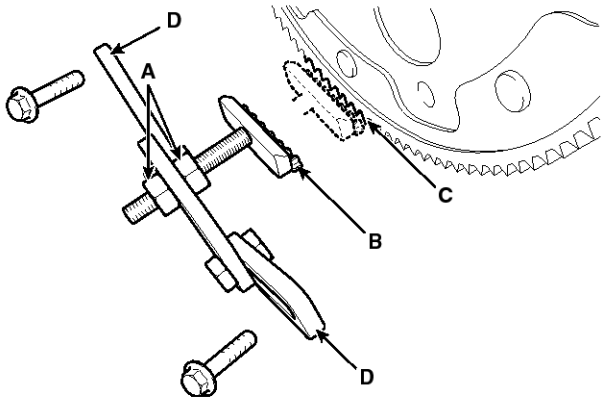
SVGM20026D

- *Install the SST (09231-3D100) to hold the ring gear after removing the dust cover.*
  1. *Remove the dust cover (A) on the bottom of the ladder frame and unfasten the two transaxle mounting bolts (B).*



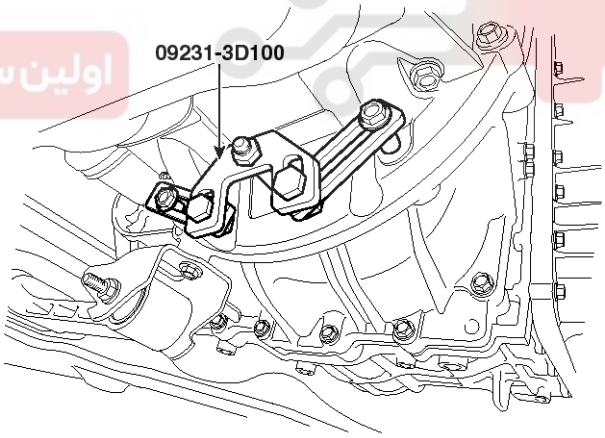
SVGEM1003D

2. *Adjust the length of the holder nuts (A) so that the front plate of the holder (B) puts in the ring gear (C) teeth.*
3. *Adjust the angle of the links (D) so that the two transaxle mounting bolts can be fastened to the original mounted holes.*



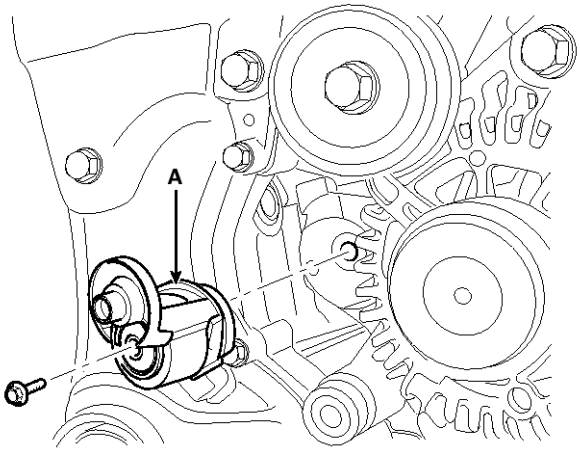
SVGEM1002D

4. *Install the SST (09231-3D100) using the two transaxle mounting bolts and spacers. Tighten the bolts and nuts of the holder and links securely.*



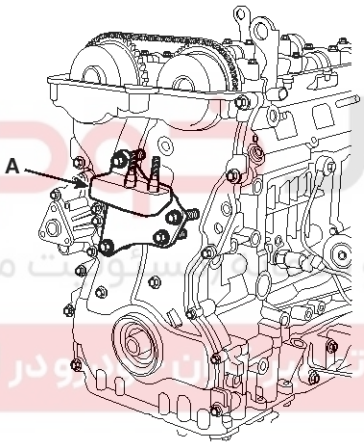
SVGEM1004D

25. Remove the drive belt tensioner (A).



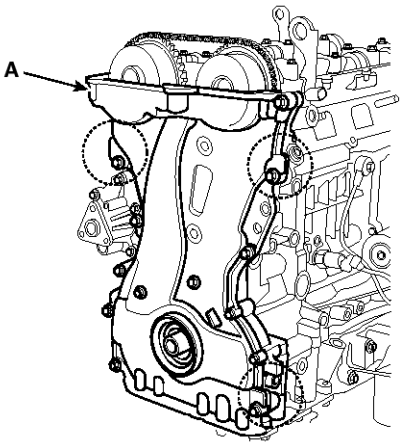
SYFEM0038N

26. Remove the engine support bracket (A).



STFM11023D

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

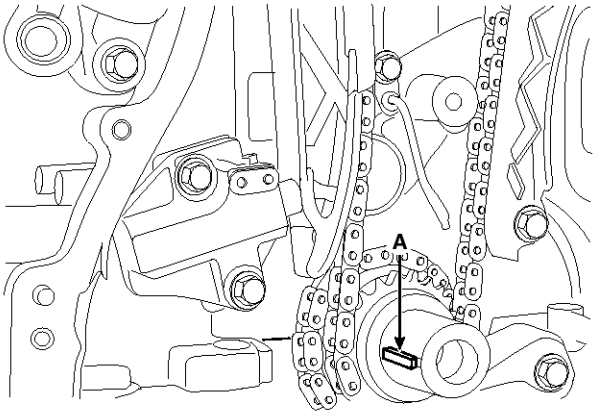


STFEM1057D

⚠CAUTION

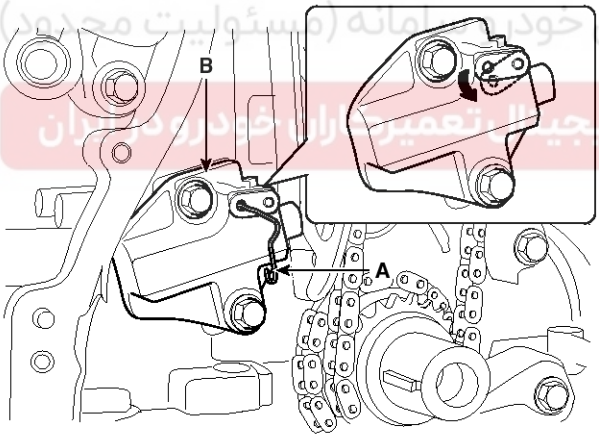
Be careful not to damage the contact surfaces of cylinder block, cylinder head and timing chain cover.

28. Make sure that the key (A) of crankshaft is aligned with the mating surface 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.



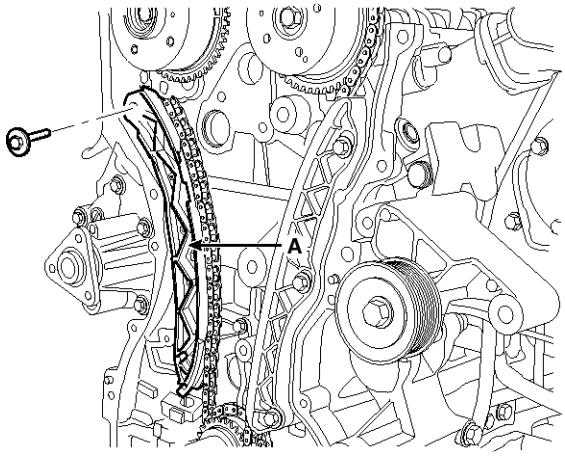
SYFEM0183N

29. Release the ratchet by pulling the link down using a thin rod. Compress the piston and then insert a stopper pin (A) into the hole on the ratchet to hold the compressed piston. Remove the timing chain tensioner (B).



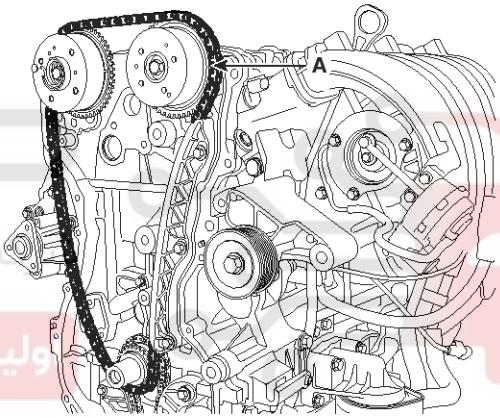
SYFEM0003N

30. Remove the timing chain tensioner arm (A).



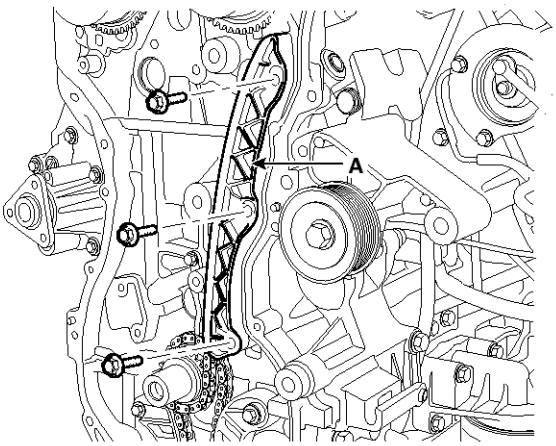
SYFEM0007N

31. Remove the timing chain (A).



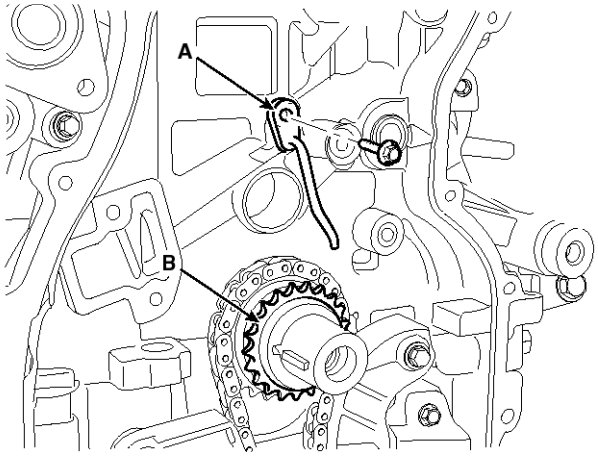
SYFEM0008N

32. Remove the timing chain guide (A).



SYFEM0009N

33. Remove the timing chain oil jet (A) and the crankshaft chain sprocket (B).



SYFEM0010N

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

Inspection

Sprockets, Chain Tensioner, Chain Guide, Chain Tensioner Arm

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

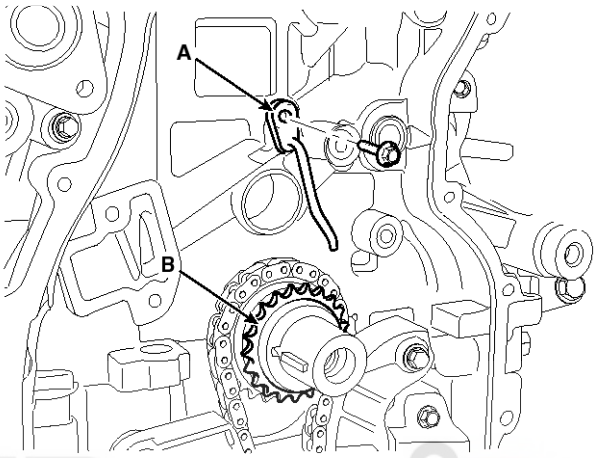
Drive belt, Idler, Pulley

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

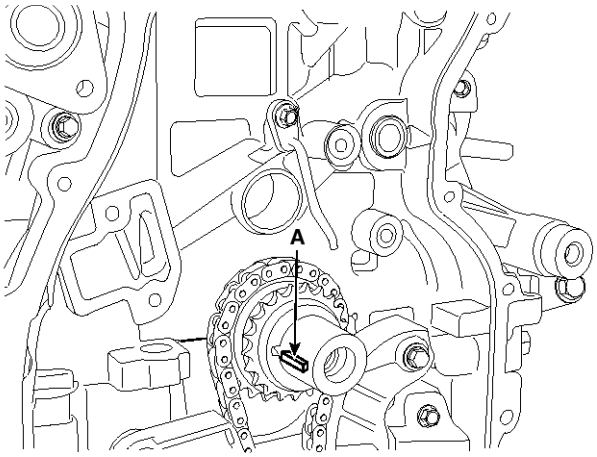
1. Install the balance shaft chain. (Refer to Lubrication system in this group)
2. Install the crankshaft chain sprocket (B) and the timing chain oil jet (A).

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

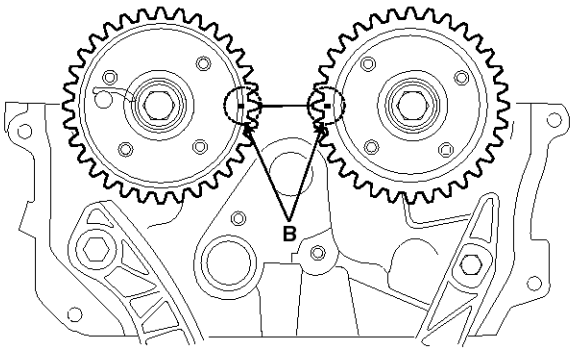


SYFEM0010N

3. Set the crankshaft so that the key (A) of crankshaft will be aligned with the mating surface of main bearing cap. Put the intake and exhaust camshaft assembly so that the TDC marks (B) of the intake and exhaust CVVT sprockets will be aligned with the top surface of cylinder head. As a result of this, the piston of No.1 cylinder is placed at the top dead center on compression stroke.



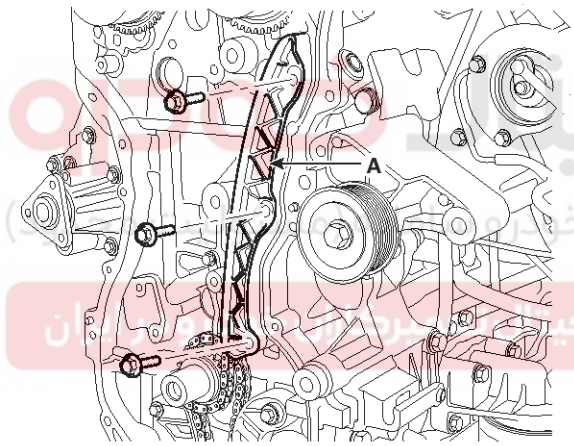
SYFEM0146N



SYFEM0109N

4. Install the timing chain guide (A).

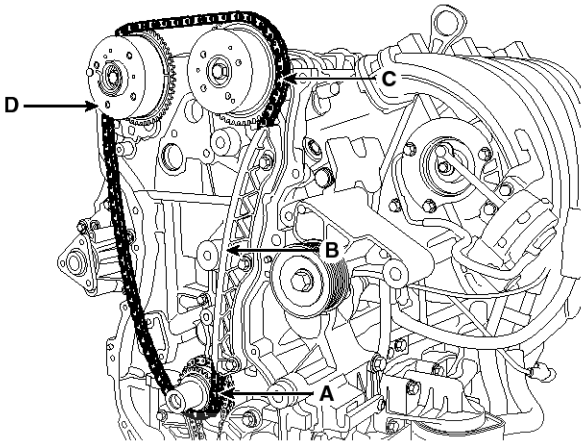
Tightening torque:
9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)



SYFEM0009N

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

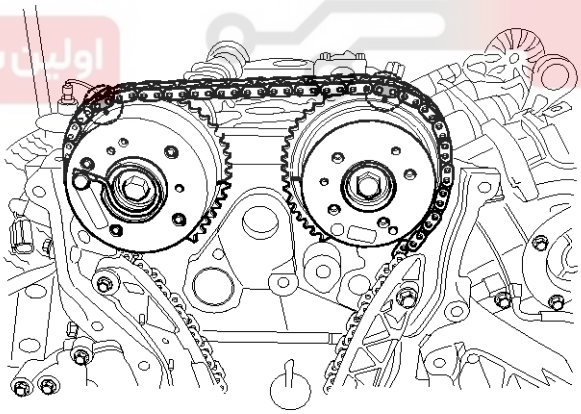
   Crankshaft sprocket (A) → Timing chain guide (B) → Intake CVVT sprocket (C) → Exhaust CVVT sprocket (D).



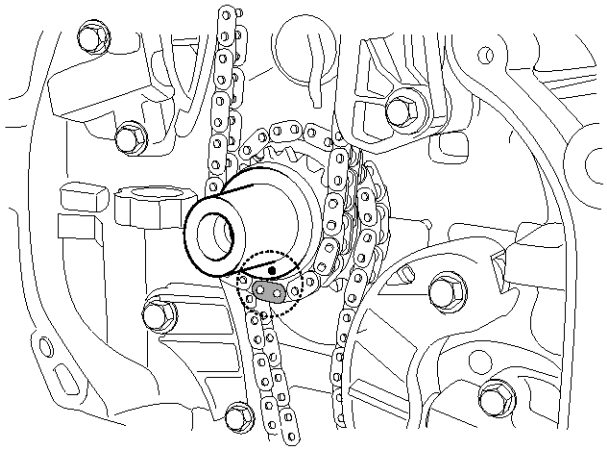
SYFEM0173N

NOTICE

The timing marks of each sprocket should be matched with timing marks (color link) of timing chain when installing the timing chain.



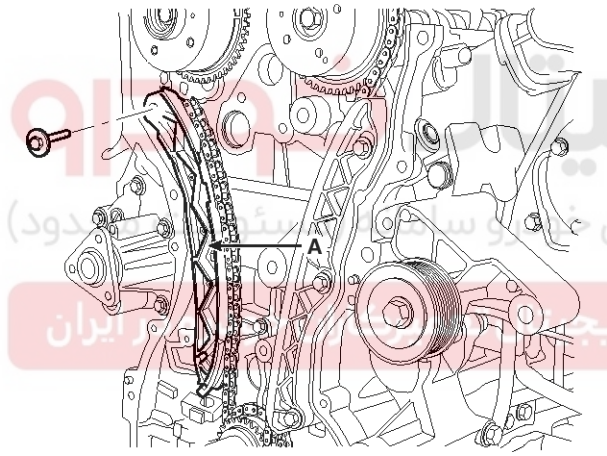
SYFEM0005N



SYFEM0006N

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

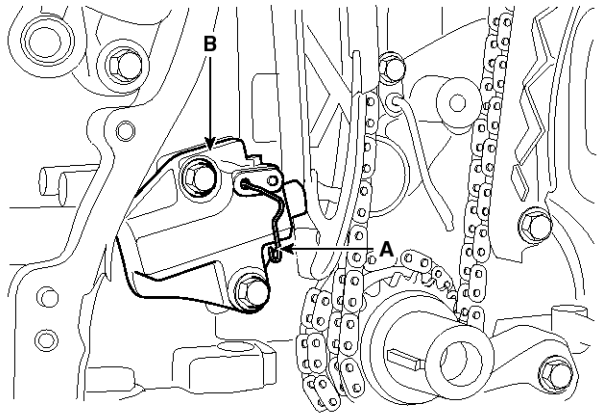
Tightening torque:
9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)



SYFEM0007N

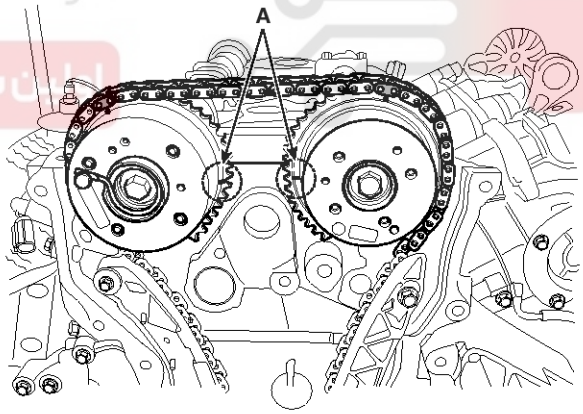
7. Install the timing chain auto tensioner (B) and remove the stopper pin (A).

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



SYFEM0147N

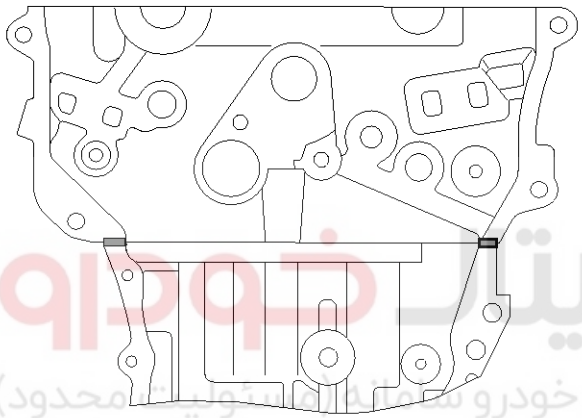
8. After rotating crankshaft 2 revolutions in regular direction (clockwise viewed from front), confirm that the TDC marks (A) on the intake and exhaust CVVT sprockets aligned with the top surface of cylinder head.



SYFEM0174N

9. Install the timing chain cover.
   1) Using a gasket scraper, remove all the old packing material from the gasket surfaces.
   2) 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.
   3) Before assembling the timing chain cover, liquid sealant Loctite 5900H or equivalent 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.)

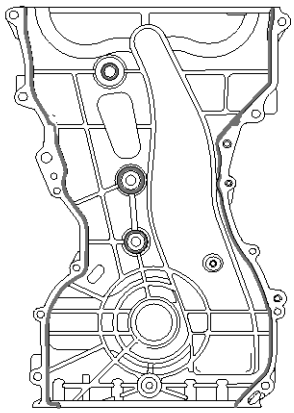


SVGEM0141D

   4) After applying liquid sealant Loctite 5900H or equivalent on the timing chain cover.

      The part must be assembled within 5 minutes after sealant was applied. Continuous bead of sealant should be applied to prevent any path of oil leakage.

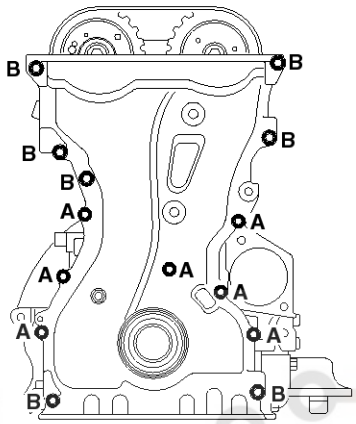
Bead width: 3.0mm (0.12in.)



STFEM1058D

   5) The dowel pins on the cylinder block and holes on the timing chain cover should be used as a reference in order to assemble the timing chain cover to be in exact position.

Tightening torque:
Bolts A (M6×25) :
7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)
Bolts B (M8×28) :
18.6 ~ 22.5N.m (1.9 ~ 2.3kgf.m, 13.7 ~ 16.6lb-ft)

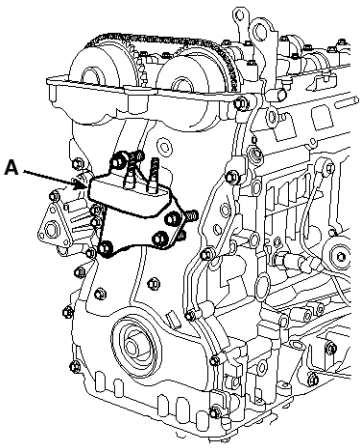


SYFM10151D

CAUTION
The engine starting or pressure tests should not be performed within 30 minutes after the timing chain cover was assembled.

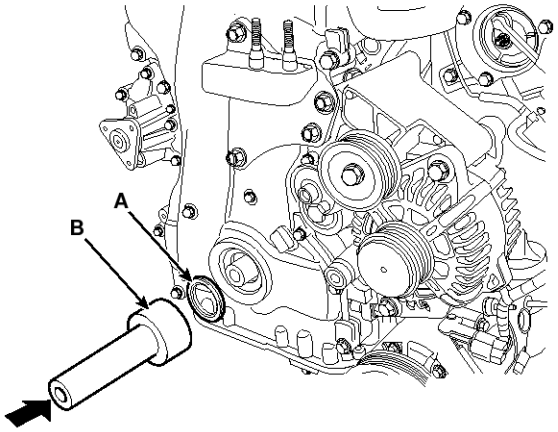
10. Install the engine support bracket (A).

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



STFM11023D

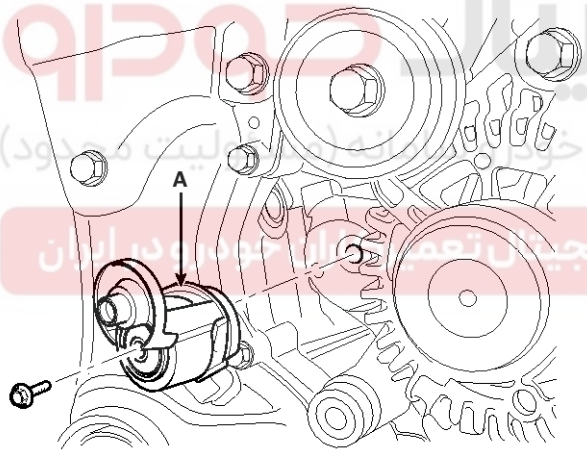
11. Install the crankshaft front oil seal (A) using SST (09214-3K000, 09231-H1100) (B).



STFM11022D

12. Install the drive belt tensioner (A).

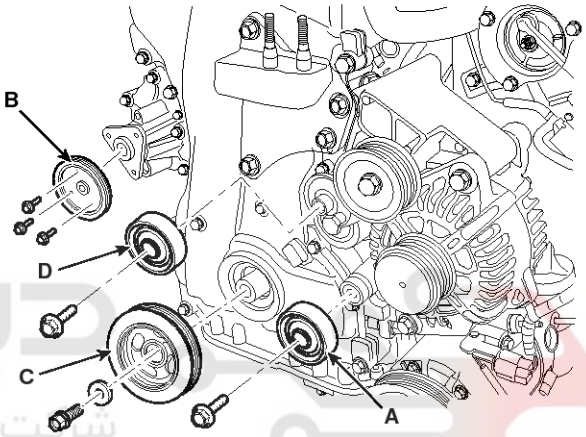
Tightening torque :
53.9 ~ 63.7N.m (5.5 ~ 6.5kgf.m, 39.7 ~ 47.0lb-ft)



SYFEM0038N

13. Install the idler (A), the water pump pulley (B), the crankshaft pulley (C) and the drive belt tensioner pulley (D).

Tightening torque :
Idler (A) :
53.9 ~ 63.7N.m (5.5 ~ 6.5kgf.m, 39.7 ~ 47.0lb-ft)
Water pump pulley (B) :
7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)
Crankshaft pulley (C) :
166.6 ~ 176.4N.m (17.0 ~ 18.0kgf.m, 122.9 ~ 130.1lb-ft)
Drive belt tensioner pulley (D) :
53.9 ~ 63.7N.m (5.5 ~ 6.5kgf.m, 39.7 ~ 47.0lb-ft)



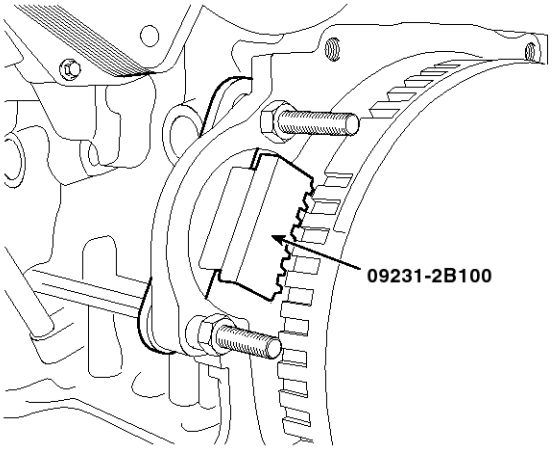
STFM11021D

⚠CAUTION
Tensioner pulley bolt is left-handed screw.

NOTICE

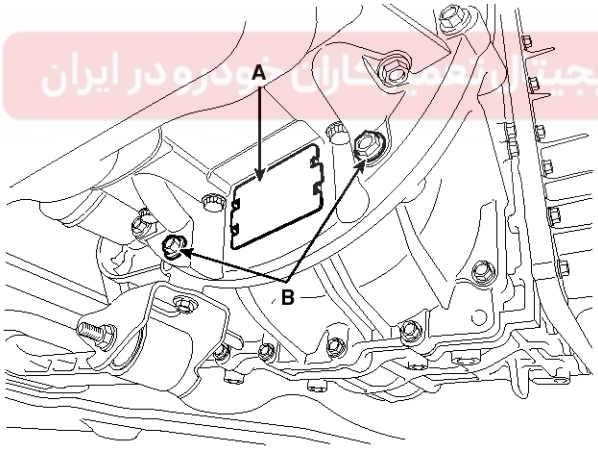
There are two methods to hold the ring gear when installing or removing the crankshaft damper pulley.

- *Install the SST (09231-2B100) to hold the ring gear after removing the starter.*



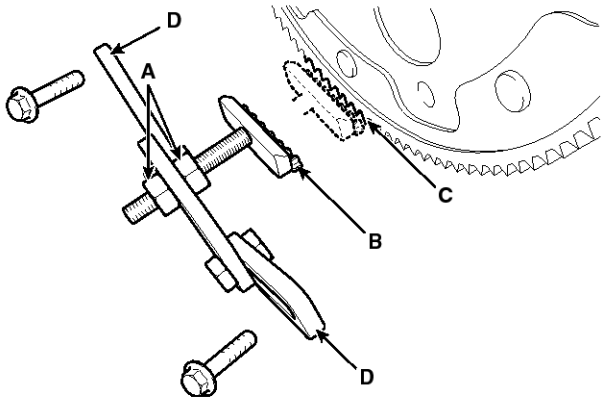
SVGM20026D

- *Install the SST (09231-3D100) to hold the ring gear after removing the dust cover.*
  1. *Remove the dust cover (A) on the bottom of the ladder frame and unfasten the two transaxle mounting bolts (B).*



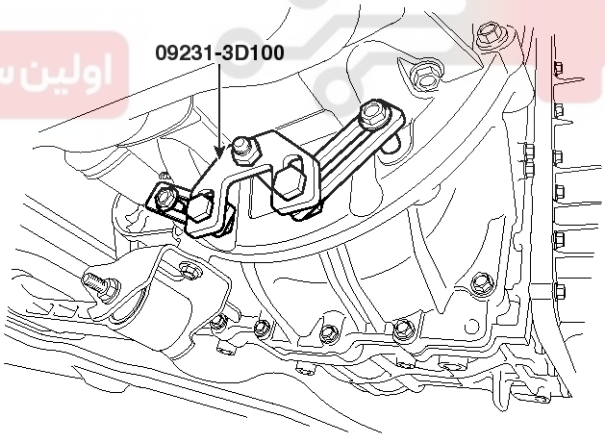
SVGEM1003D

2. *Adjust the length of the holder nuts (A) so that the front plate of the holder (B) puts in the ring gear (C) teeth.*
3. *Adjust the angle of the links (D) so that the two transaxle mounting bolts can be fastened to the original mounted holes.*



SVGEM1002D

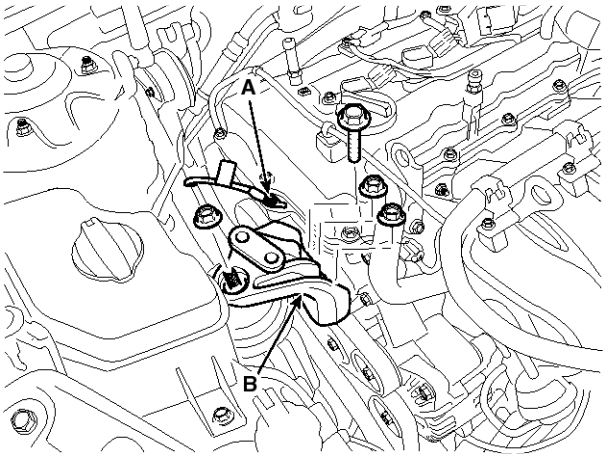
4. *Install the SST (09231-3D100) using the two transaxle mounting bolts and spacers. Tighten the bolts and nuts of the holder and links securely.*



SVGEM1004D

14. Install the engine mounting support bracket (B) and connect the ground line (A).

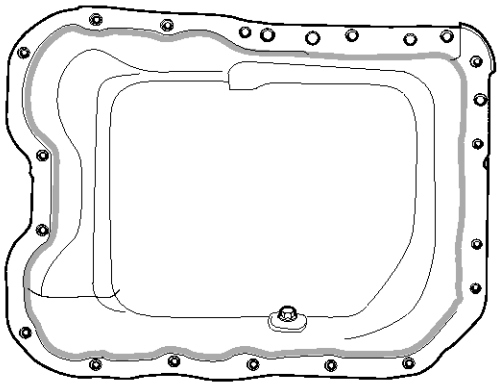
Tightening torque :
68.6 ~ 83.4 N.m (7.0 ~ 8.5 kgf.m, 50.6 ~ 61.5 lb-ft)



STFM11002D

15. Remove the jack from the ladder frame.
16. Install the oil pan.
    1) Using a gasket scraper, remove all the old sealant material from the gasket surfaces.
    2) Before assembling the oil pan, liquid sealant Loctite 5900H, Threebond 1217H or equivalent should be applied on oil pan. The part must be assembled within 5 minutes after sealant was applied.

Bead width : 3.0mm (0.12in.)



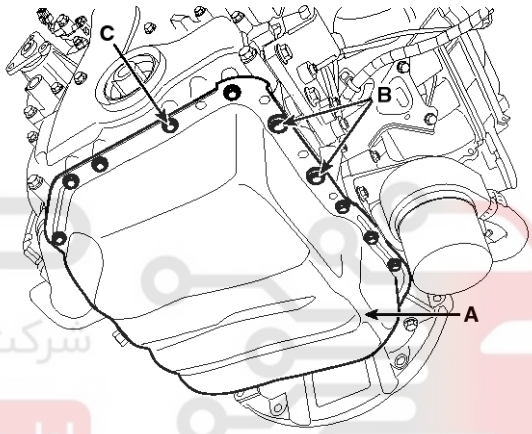
SYFEM0012N

CAUTION

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

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

Tightening torque
Bolts B (M9) :
30.4 ~ 34.3N.m (3.1 ~ 3.5kgf.m, 22.4 ~ 25.3lb-ft)
Bolts C (M6) :
9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)



SVGEM0149D

CAUTION

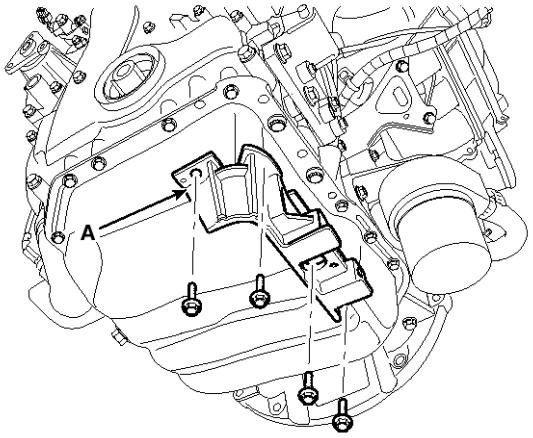
After assembly, wait at least 30 minutes before filling the engine with oil.

NOTICE

Always use a new drain plug gasket.

17. Install the A/C compressor bracket (A).

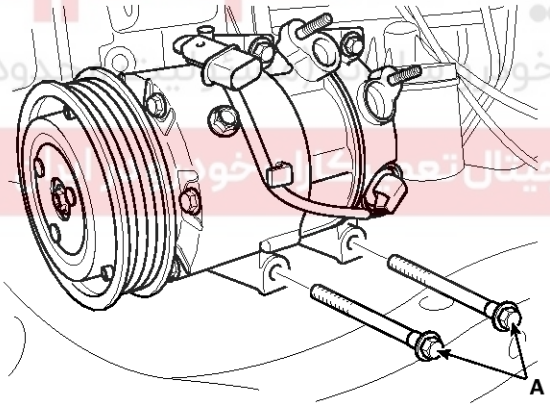
Tightening torque :
19.6 ~ 23.5N.m (2.0 ~ 2.4kgf.m, 14.5 ~ 17.4lb-ft)



SYFEM0039N

18. Install the A/C compressor lower bolts (A).

Tightening torque :
20.0 ~ 33.0N.m (2.04 ~ 3.36kgf.m, 14.8 ~ 24.3lb-ft)

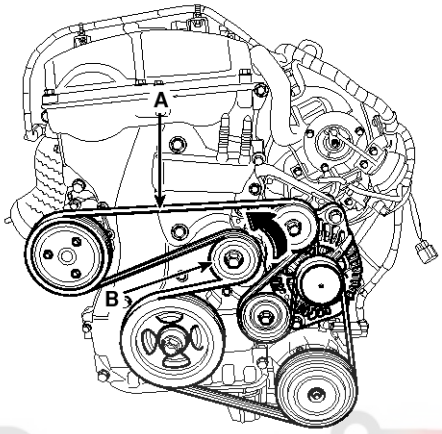


SYFEM0145N

19. Install the drive belt (A).

Crankshaft pulley → A/C pulley → Alternator pulley → Idler #1 pulley → Idler #2 pulley → Water pump pulley → Tensioner pulley.

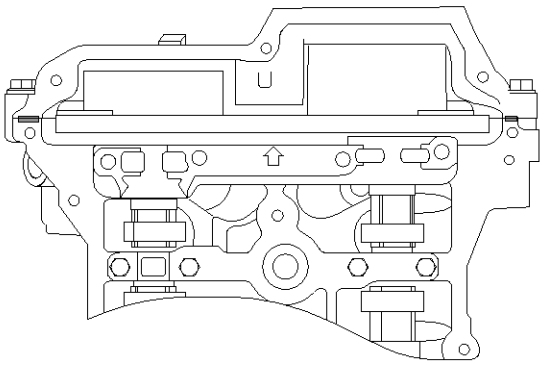
Rotate the drive belt tensioner arm (B) counterclockwise moving the tensioner pulley bolt with wrench. After putting the belt on the tensioner pulley, release the tensioner pulley slowly.



STFM11024D

20. Install cylinder head cover.
    1) The hardening sealant located on the upper area between timing chain cover and cylinder head should be removed before assembling cylinder head cover.
    2) After applying sealant, it should be assembled within 5 minutes.

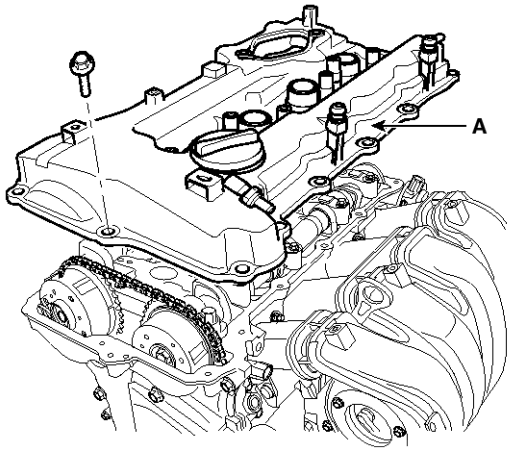
Bead width : 2.5mm (0.10in.)



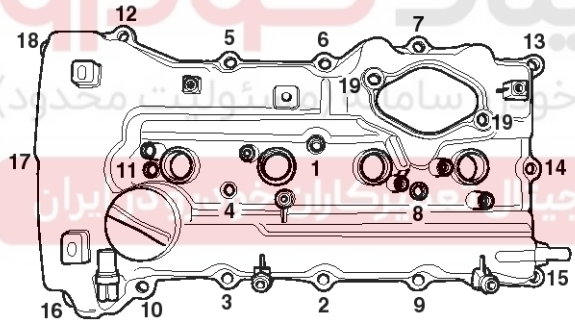
SNFEM8045D

3) Install the cylinder head cover (A) by tightening the bolts as following method.

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



SYFEM0004N



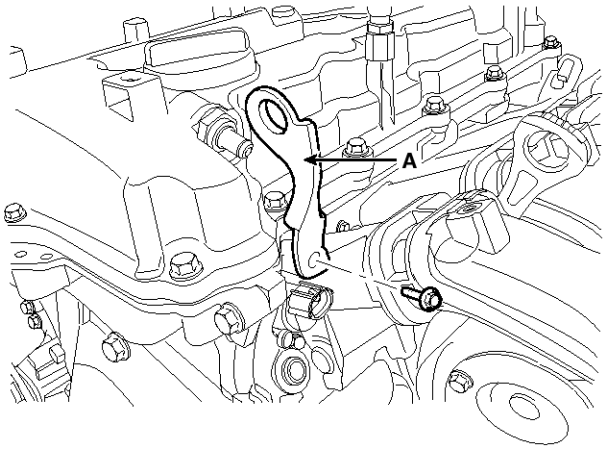
SYFEM0013N

⚠CAUTION

- **Do not reuse cylinder head cover gasket.**
- **The firing and/or blow out test should not be performed within 30 minutes after the cylinder head cover was assembled.**

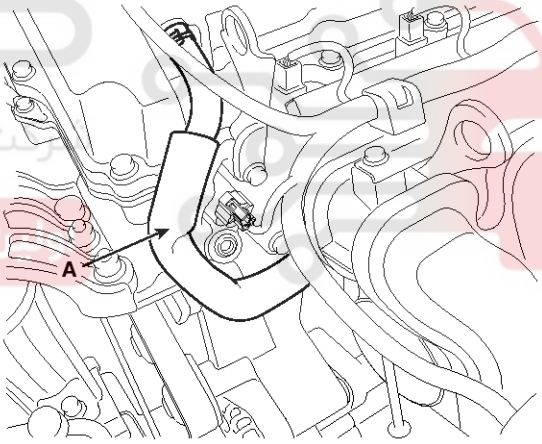
21. Install the front engine hanger (A).

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



SYFEM0044N

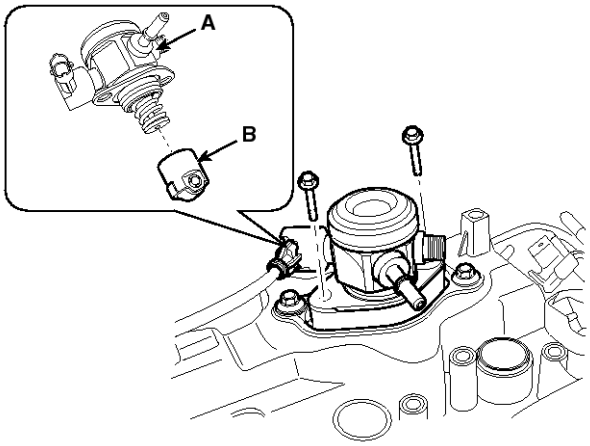
22. Connect the PCV (Positive crankcase ventilation) hose (A).



STFEM1028D

23. Install the high pressure fuel pump (A) and the roller tappet (B). (Refer to FL group)

Tightening torque :
12.7 ~ 14.7N.m (1.3 ~ 1.5kgf.m, 9.4 ~ 10.8lb-ft)



SYFEM0043N

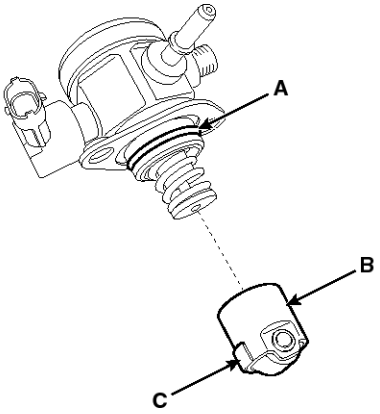
CAUTION
Before installing the high pressure fuel pump, position the roller tappet in the lowest position (BDC) by rotating the crankshaft. Otherwise the installation bolts may be broken because of tension of the pump spring.

NOTICE
Do not use already used bolt again.

NOTICE
When tightening the installation bolts of the high pressure fuel pump, tighten in turn the bolts in small step (0.5 turns) after tightening them with hand-screwed torque.

CAUTION
Note that internal damage may occur when the component is dropped. In this case, use it after inspecting.

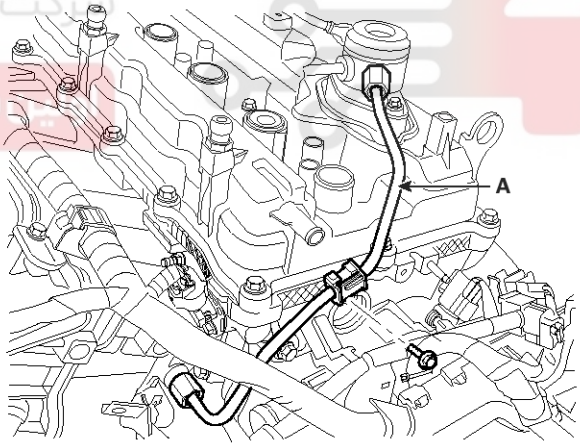
NOTICE
Apply engine oil to the O-ring (A) of the high pressure fuel pump, the roller tappet (B), and the protrusion (C). Also apply engine oil to the groove where the protrusion is installed.



SYFEM0175N

24. Install the high pressure pipe (A). (Refer to FL group)

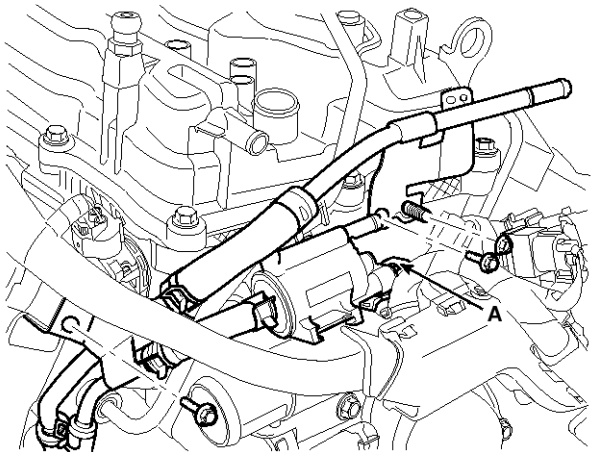
Tightening torque :
Bolt : 7.8 ~ 11.8N.m (0.8 ~ 1.2kgf.m, 5.8 ~ 8.7lb-ft)
Nuts : 26.5 ~ 32.4N.m (2.7 ~ 3.3kgf.m, 19.5 ~ 23.9lb-ft)



SYFEM0042N

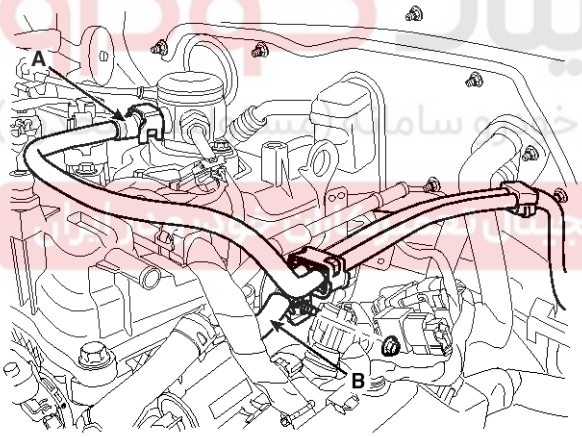
NOTICE
Do not reuse the high pressure pipe.

25. Connect PCSV (Purge control solenoid valve) connector (A) and tighten the vacuum & PCSV (Purge control solenoid valve) pipe assembly mounting bolts and nut.



STFM11025D

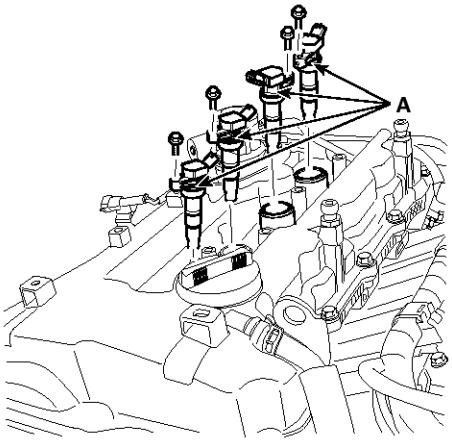
26. Connect the fuel hose (A) and PCSV (Purge control solenoid valve) hose (B).



SYFEM0033N

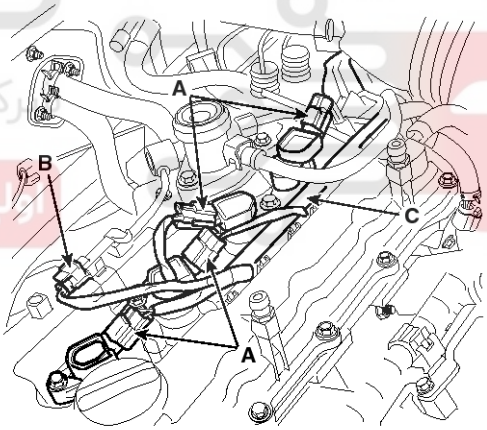
27. Install the ignition coils (A).

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



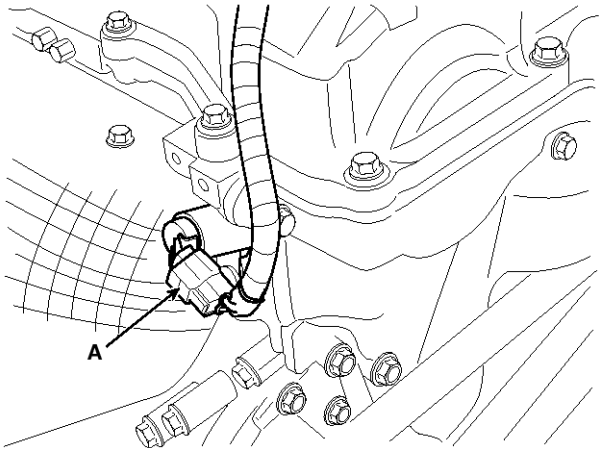
SYFEM0026N

28. Connect the ignition coil connectors (A) and fuel pump connector (B) after installing the wiring protector (C).



SYFEM0025N

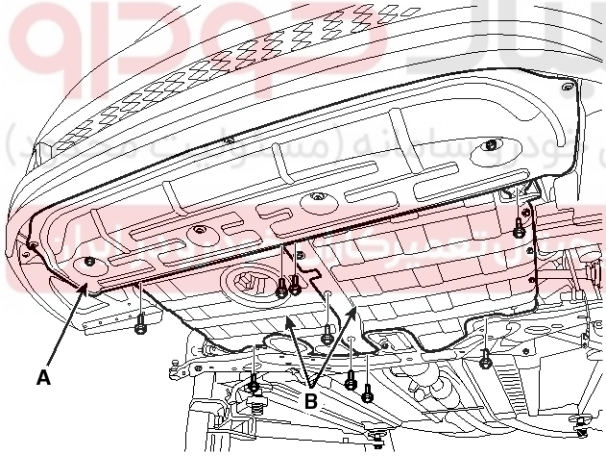
29. Connect the exhaust OCV (Oil control valve) connector (A).



SYFEM0040N

30. Install the under covers (A,B).

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



STFM11032D

NOTICE

When installing the cover (B), install the cover with the mounting bracket.

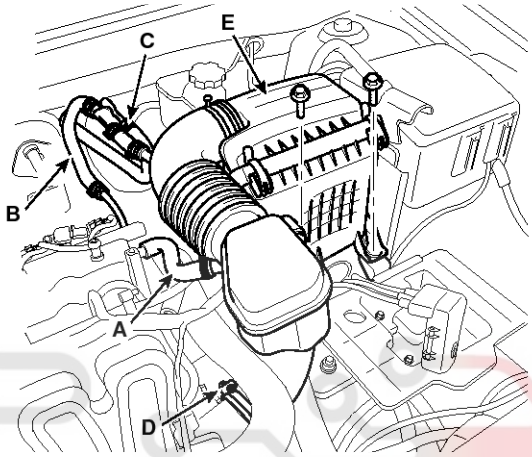
31. Install the RH front wheel.

32. Install the air cleaner assembly.

1) Install the air cleaner assembly (E) and then connect the air intake hose (D).

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

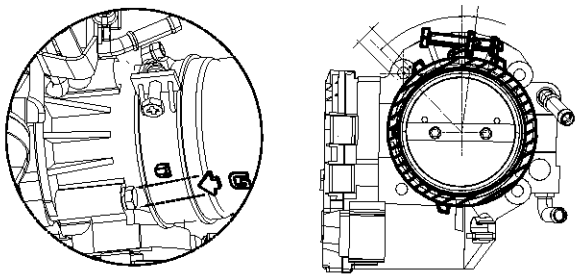
2) Connect the breather hose (A), the brake booster vacuum hose (B) and the intensifier hose (C).



STFM11008D

NOTICE

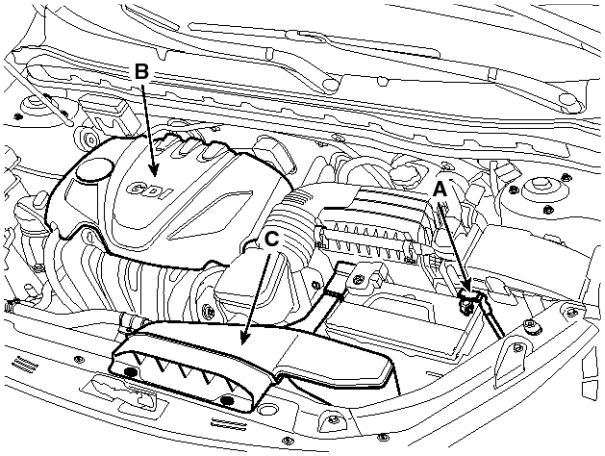
- *Install the air intake hose while the plate of the hose clamp must be in line with the stopper of the hose.*
- *Install the air intake hose match groove to throttle body groove.*



STFM11009D

33. Install the air duct (C) and the engine cover (B)
34. Connect the battery negative terminal (A).

Tightening torque:
4.0 ~ 6.0N.m (0.4 ~ 0.6kgf.m, 3.0 ~ 4.4lb-ft)



STFM11001D

35. Add all the necessary fluids and check for leaks. Connect GDS. Check for codes, note, and clear. Recheck.

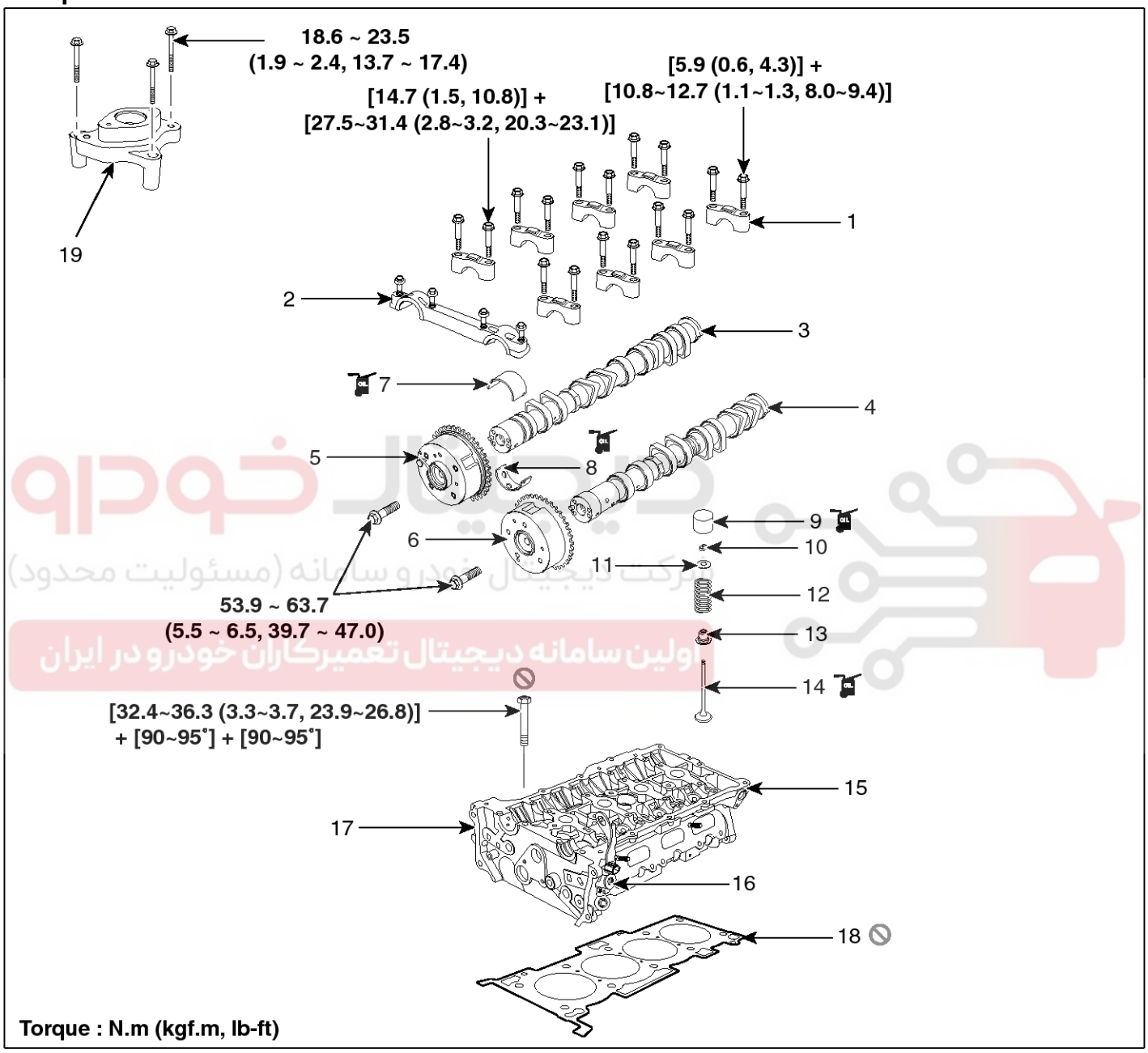
NOTICE

- *Refill engine with engine oil.*
- *Refill a transaxle with fluid.*
- *Refill a radiator and a reservoir tank with engine coolant.*
- *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 fuelline pressurizes.*
  - *Repeat this operation two or three times, then check for fuel leakage at any point in the fuel line.*
- *Refill radiator and reservoir tank with engine coolant.*
- *Bleed air from the cooling system.*
  - *Start engine and let it run until it warms up. (until the radiator fan operates 3 or 4 times.)*
  - *Turn Off the engine. Check the level in the radiator, add coolant if needed. This will allow trapped air to be removed from the cooling system.*
  - *Put radiator cap on tightly, then run the engine again and check for leaks*

Cylinder Head Assembly

Cylinder Head

Components



STFM1005N

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 (Oil control valve)
17. Exhaust OCV (Oil control valve)
18. Cylinder head gasket
19. Fuel pump bracket

Removal

CAUTION

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

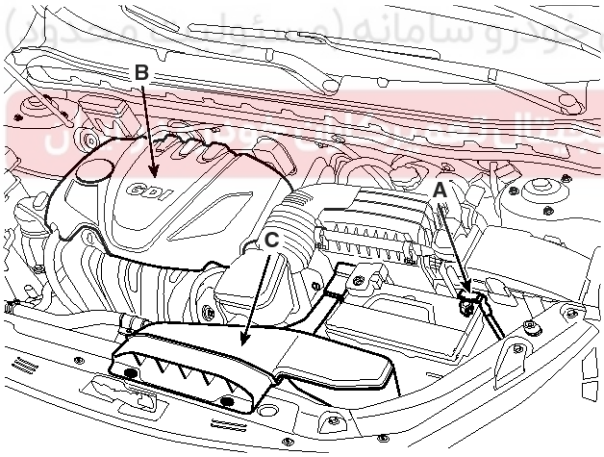
NOTICE

Mark all wiring and hoses to avoid misconnection.

WARNING

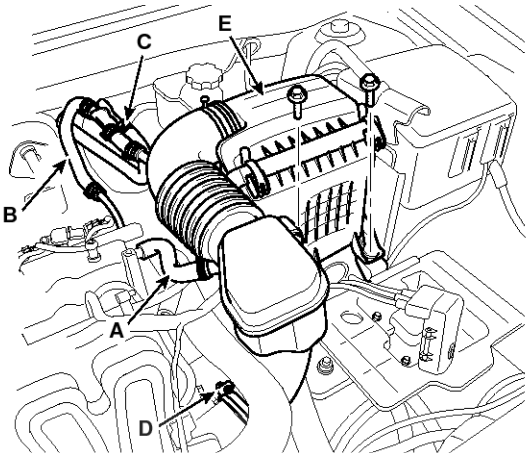
In case of removing the high pressure fuel pump, high pressure fuel pipe, delivery pipe, and injector, there may be injury caused by leakage of the high pressure fuel. So don't do any repair work right after engine stops.

1. Disconnect the battery negative terminal (A).
2. Remove the engine cover (B) and the air duct (C).



STFM11001D

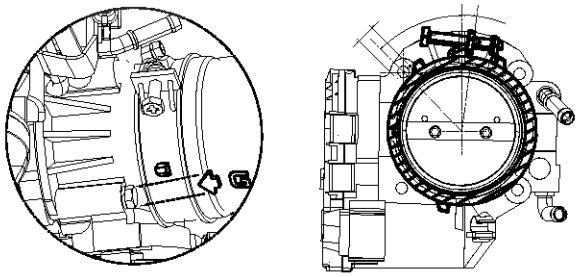
3. Remove the air cleaner assembly.
   1) Disconnect the breather hose (A), the brake booster vacuum hose (B) and the intensifier hose (C).
   2) Disconnect the air intake hose (D) and then remove the air cleaner assembly (E).



STFM11008D

NOTICE

- *Install the air intake hose while the plate of the hose clamp must be in line with the stopper of the hose.*
- *Install the air intake hose match groove to throttle body groove.*

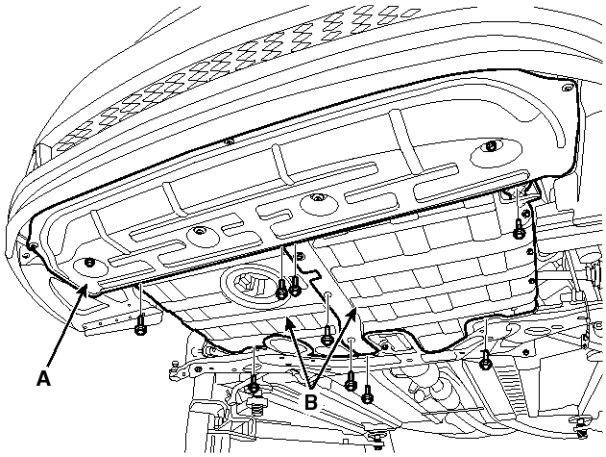


STFM11009D

4. Remove the RH front wheel.

5. Remove the under covers (A,B).

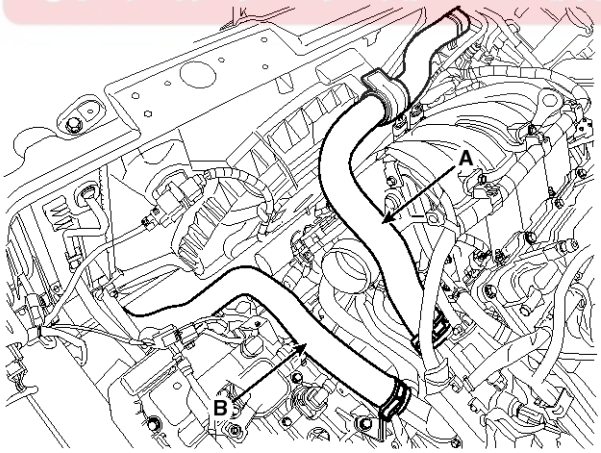
Tightening torque:
7.8 ~ 11.8N.m (0.8 ~ 1.2kgf.m, 5.8 ~ 8.7lb-ft)



STFM11032D

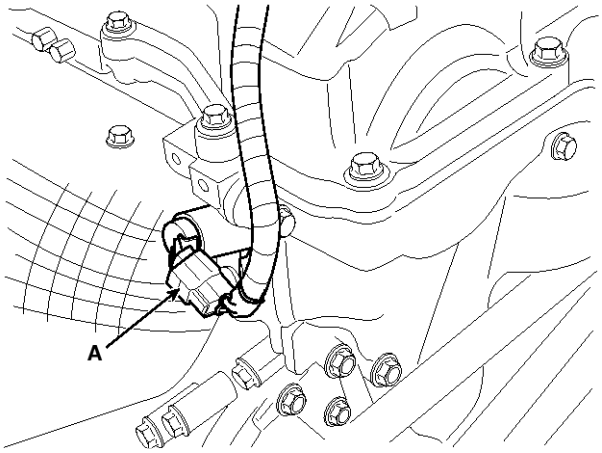
NOTICE
When removing the under cover (B), unfasten the mounting bracket bolts and then remove the under cover and mounting bracket assembly.

6. Loosen the drain plug, and drain the engine coolant. Remove the radiator cap to help drain the coolant faster. (Refer to Cooling system in this group)
7. Disconnect the radiator upper hose (A) and lower hose (B).



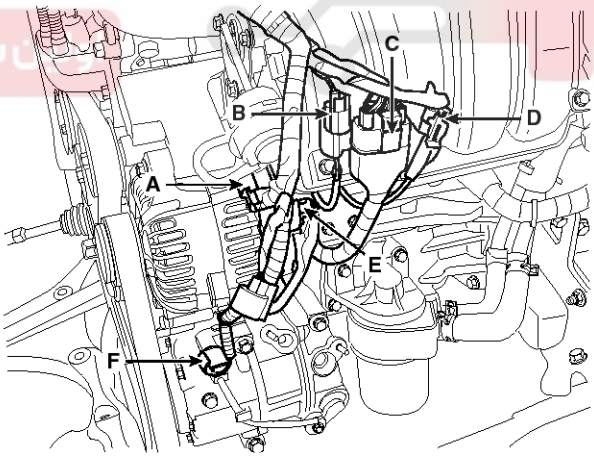
SYFEM0029N

8. Disconnect the wiring connectors and harness clamps, and remove the wiring protectors from the cylinder head, intake manifold and exhaust manifold.
   1) Disconnect the exhaust OCV (Oil control valve) connector (A).



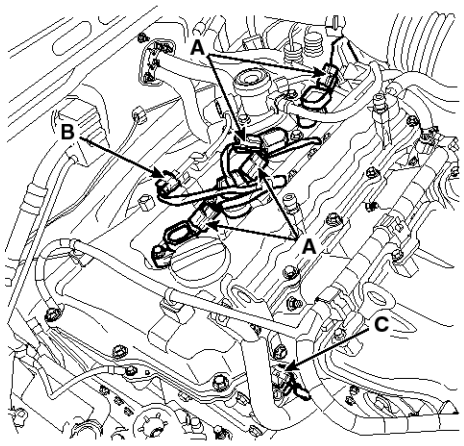
SYFEM0040N

   2) Disconnect the VIS (Variable intake system) connector (A), the OPS (Oil pressure switch) connector (B), the injector extension connector (C), the knock sensor connector (D), the alternator connector (E) and the A/C compressor switch connector (F).



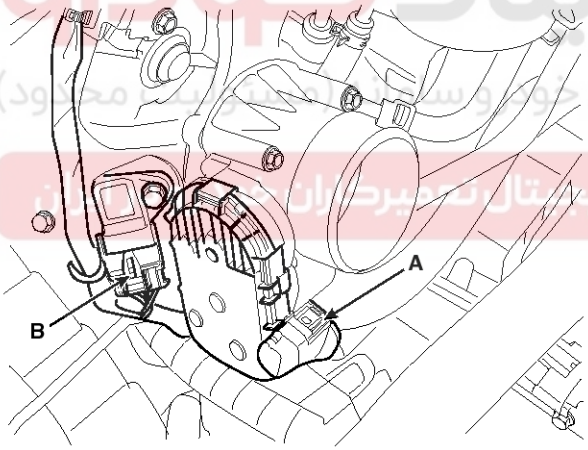
SYFEM0045N

3) Disconnect the ignition coil connectors (A), the fuel pump connector (B) and the intake OCV (Oil control valve) connector (C).



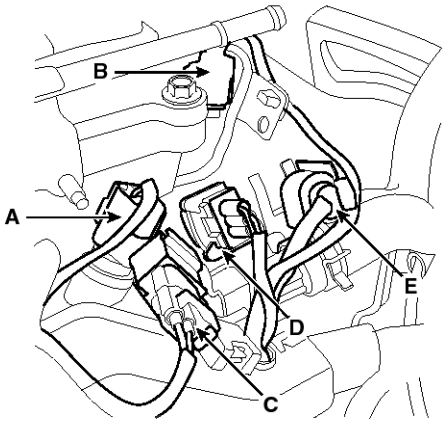
SYFEM0151N

4) Disconnect the ETC (Electronic throttle control) connector (A) and MAPS (Manifold absolute pressure sensor) & IATS (Intake air temperature sensor) connector (B).



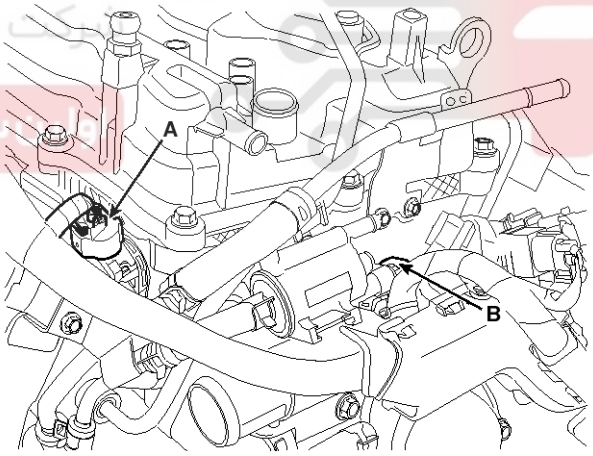
SYFEM0046N

5) Disconnect the ECTS (Engine coolant temperature sensor) connector (A) the exhaust CMPS (Camshaft position sensor) connector (B), the condenser connector (C), the CKPS (Crankshaft position sensor) connector (D) and the oxygen sensor connector (E).



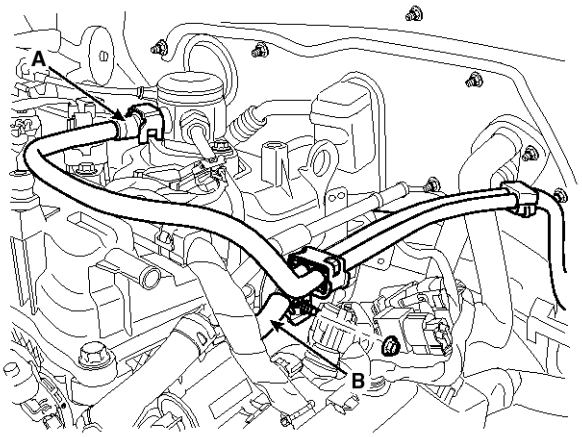
SVGEM0157D

6) Disconnect the intake CMPS (Camshaft position sensor) connector (A) and the PCSV (Purge control solenoid valve) connector (B).



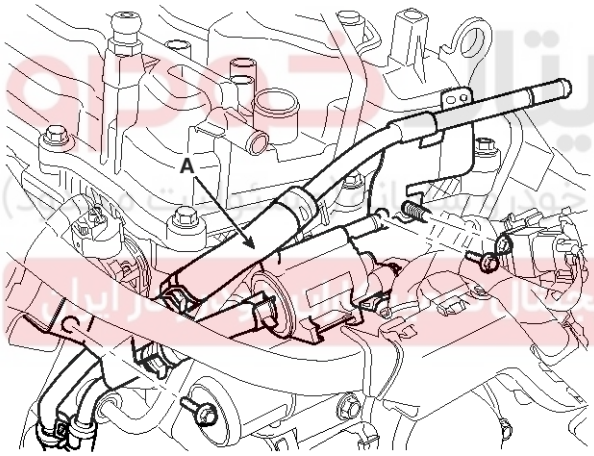
STFM11026D

9. Disconnect the fuel hose (A) and PCSV (Purge control solenoid valve) hose (B).



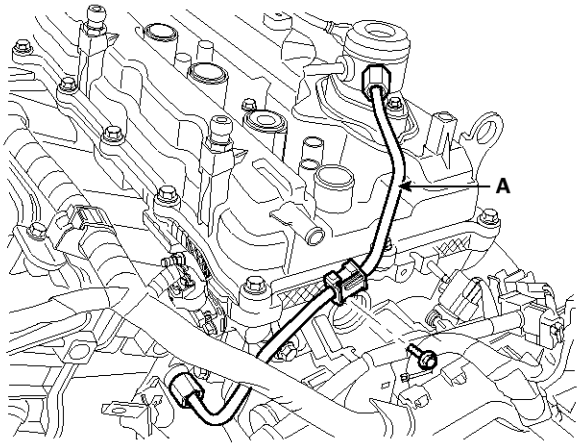
SYFEM0033N

10. Remove the vacuum & PCSV (Purge control solenoid valve) pipe assembly (A).



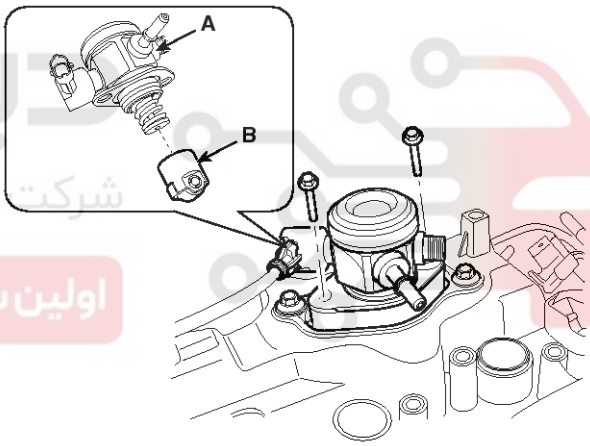
STFM11027D

11. Remove the high pressure pipe (A). (Refer to FL group)



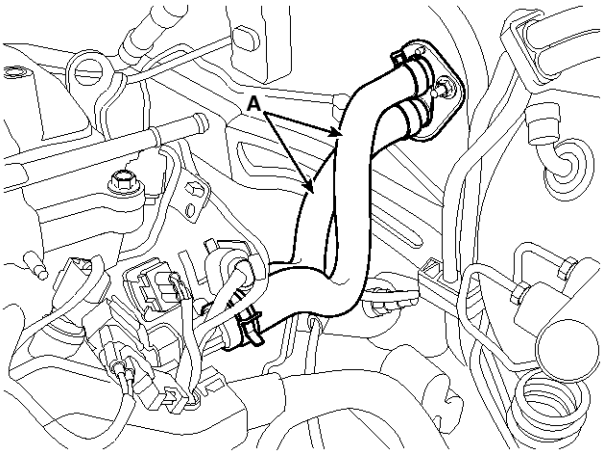
SYFEM0042N

12. Remove the high pressure fuel pump (A) and the roller tappet (B). (Refer to FL group)



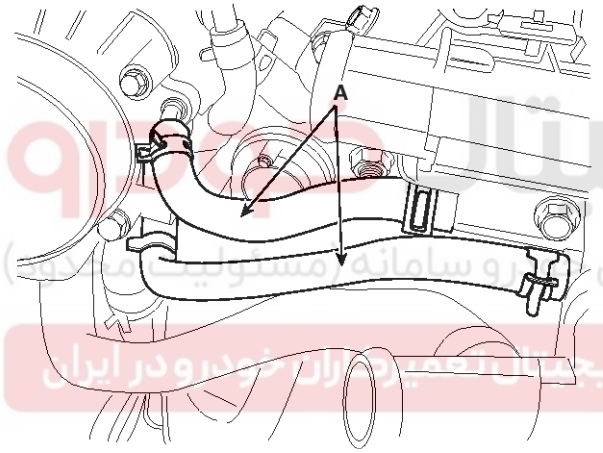
SYFEM0043N

13. Disconnect the heater hoses (A).



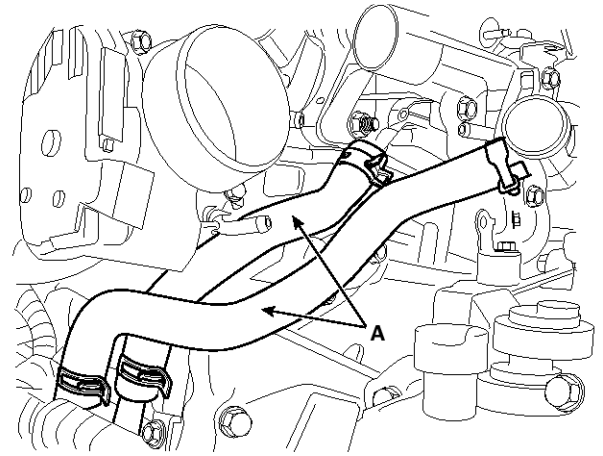
SYFEM0022D

14. Disconnect the throttle body coolant hoses (A).



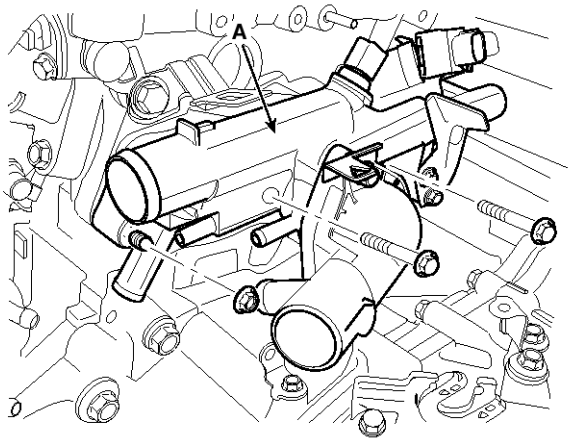
SYFEM0047N

15. Disconnect the oil cooler coolant hoses (A).

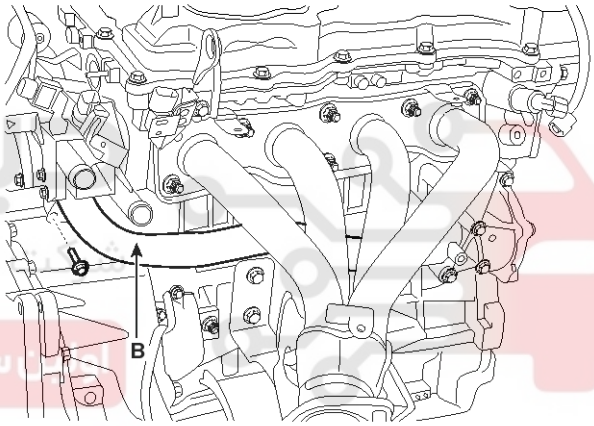


SYFEM0048N

16. Remove the water temperature control assembly (A) with the water inlet pipe (B).



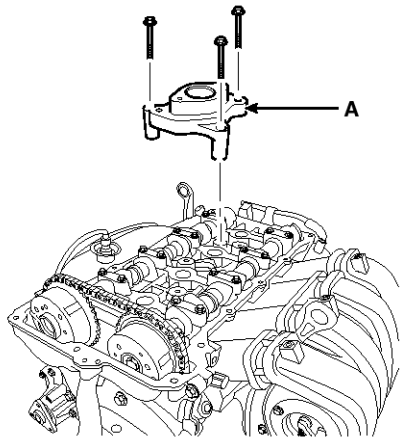
SYFEM0049N



STFM11029D

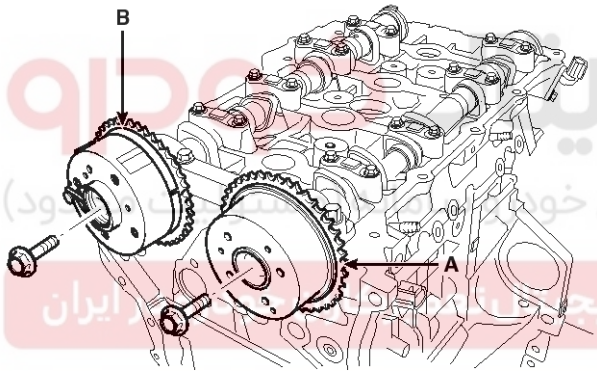
17. Remove the timing chain. (Refer to Timing system in this group)
18. Remove the intake and exhaust manifold. (Refer to Intake and exhaust system in this group)

19. Remove the high pressure fuel pump bracket (A).



SYFEM0074N

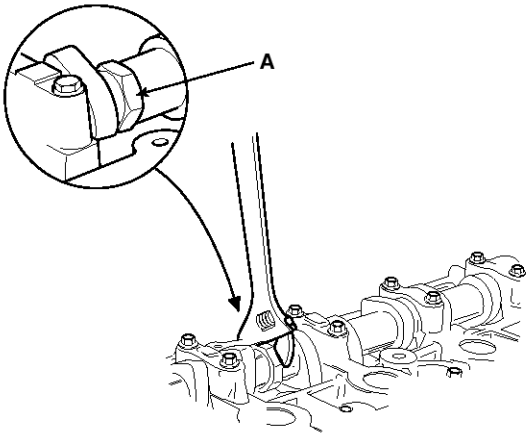
20. Remove the intake CVVT assembly (A) and exhaust CVVT assembly (B).



SYFEM0014N

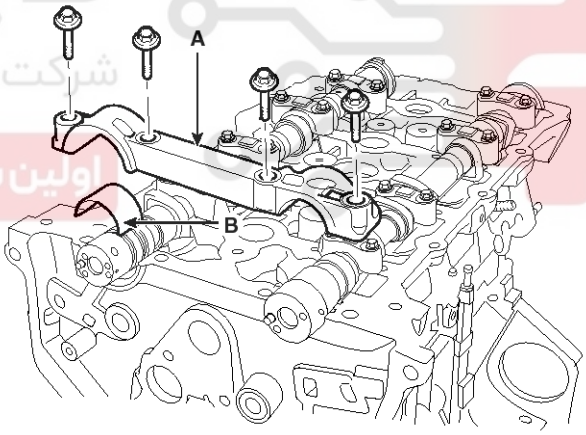
NOTICE

When removing the CVVT assembly bolt, prevent the camshaft from rotating by using a wrench at position A.



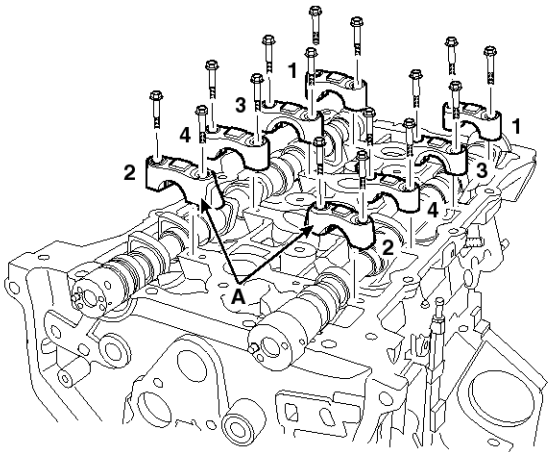
STDM19324L

21. Remove the camshaft.
    1) Remove the front camshaft bearing cap (A) with the upper bearing (B).



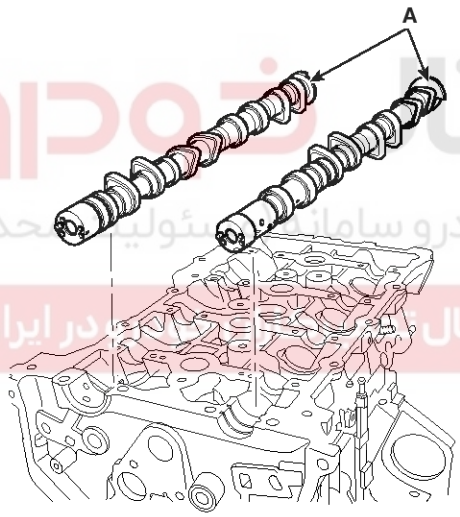
SYFEM0015N

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



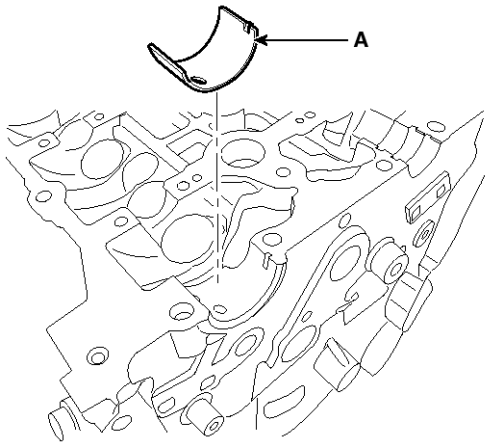
SYFEM0016N

3) Remove the camshafts (A).



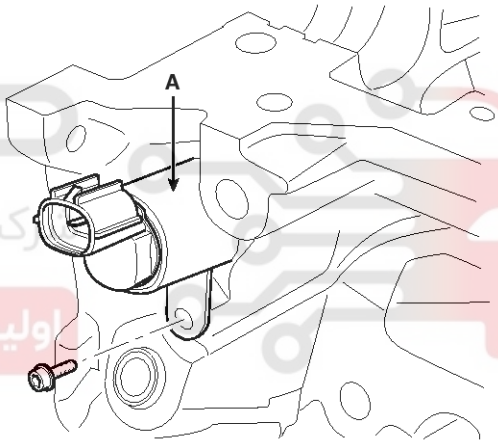
SYFEM0017N

4) Remove the exhaust camshaft lower bearing (A).



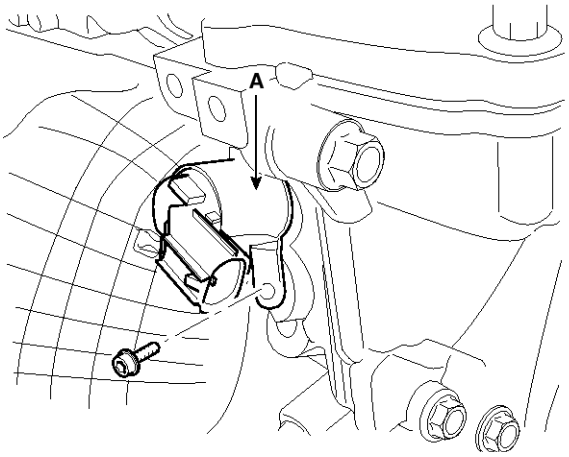
SYFEM0018N

22. Remove the intake OCV (Oil control valve) (A) using a torx wrench.



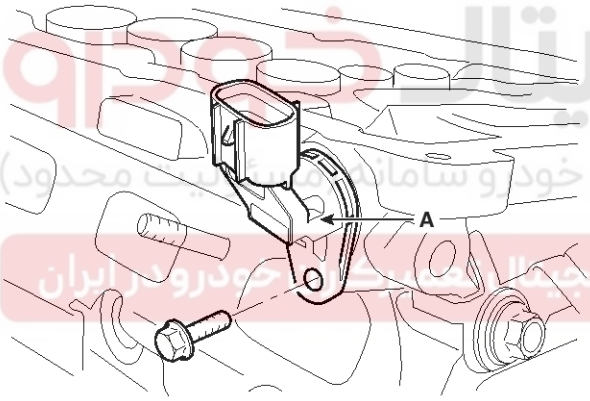
SYFEM0019N

23. Remove the exhaust OCV (Oil control valve) (A) using a torx wrench.



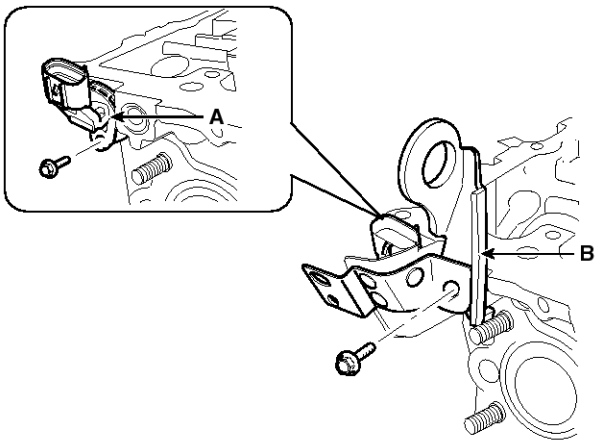
SYFEM0050N

24. Remove the intake CMPS (Camshaft position sensor) (A).



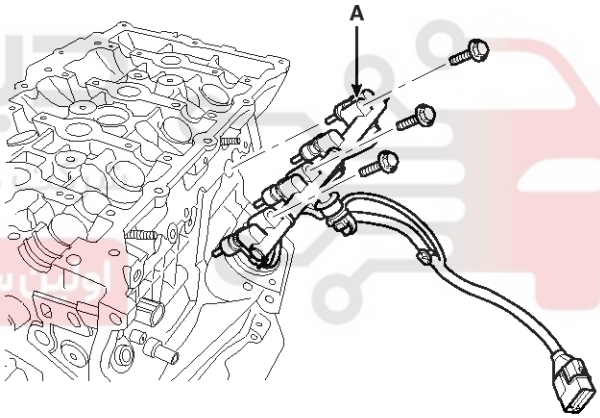
SYFEM0023N

25. Remove the exhaust CMPS (Camshaft position sensor) (A) after removing the engine hanger (B).



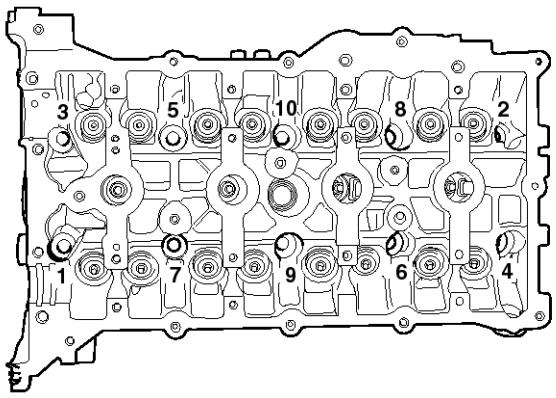
SYFEM0024N

26. Remove the injector & rail module (A). (Refer to FL group)



SYFEM0184N

27. Remove the cylinder head.
    1) Using triple square wrench, uniformly loosen and remove the 10 cylinder head bolts, in several passes, in the sequence shown. Remove the 10 cylinder head bolts and plate washers.



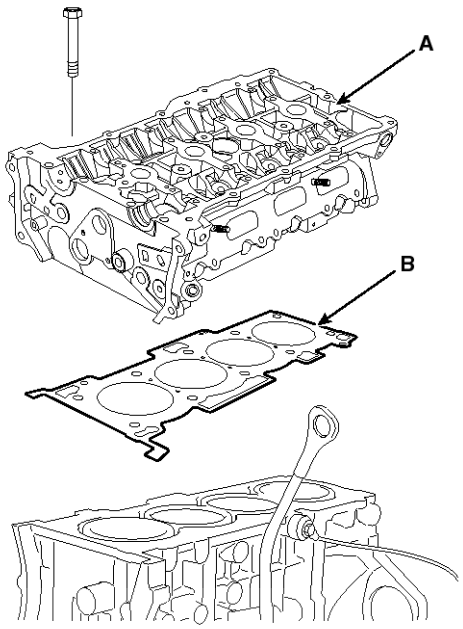
SYFEM0020N

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

    2) Lift the cylinder head (A) 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.

    3) Remove the cylinder head gasket (B).



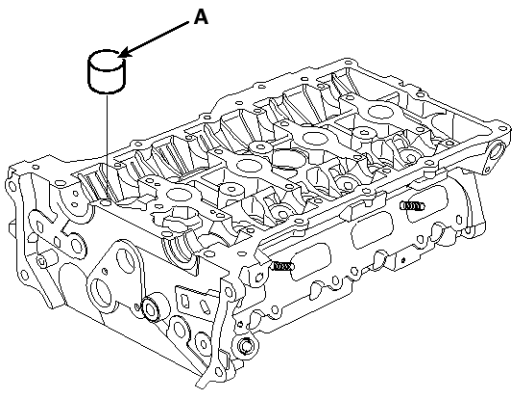
SYFEM0155N

Disassembly

NOTICE

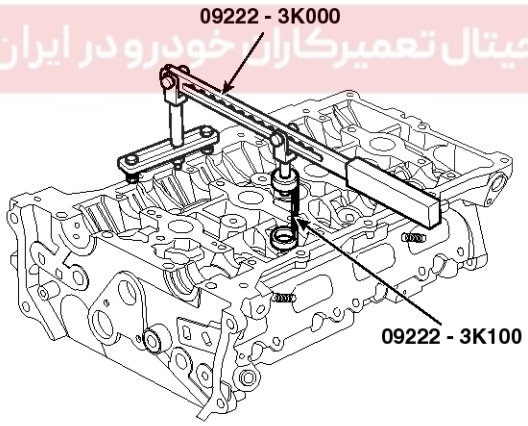
Identify MLA(Mechanical Lash Adjuster), valves, valve springs as they are removed so that each item can be reinstalled in its original position.

1. Remove the MLAs (A).



SYFEM0111N

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



SYFEM0112N

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

NOTICE

Do not reuse old valve stem seals.

Inspection

Cylinder Head

1. Inspect for flatness.

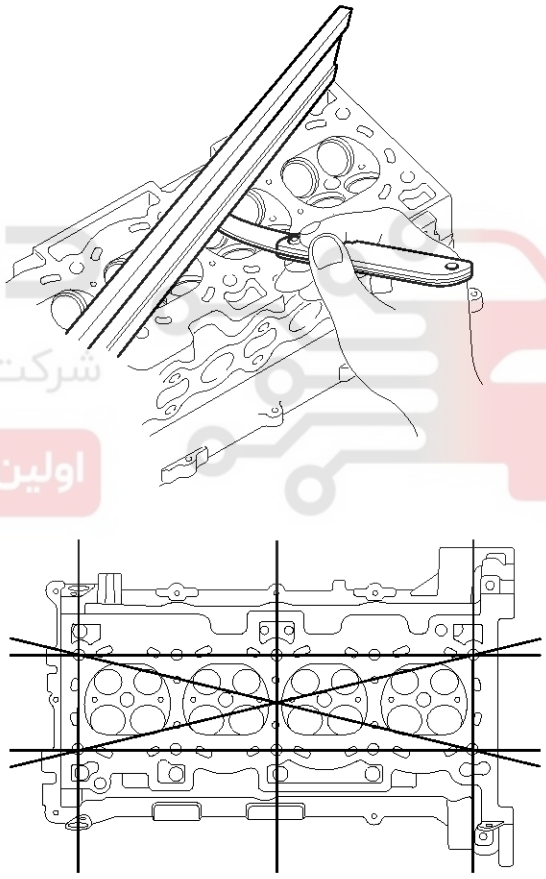
   Using a precision straight edge and feeler gauge, measure the contacting surface of the cylinder block and the manifolds for warpage.

Flatness of cylinder head gasket surface

Standard : Less than 0.05mm (0.0019in.) for total area
Less than 0.02mm (0.0007in.) for a section of 100mm (3.9370in.) X 100mm (3.9370in.)

Flatness of manifold mounting surface (Intake/Exhaust)

Standard : Less than 0.10mm (0.0039in.)



STQM39031D

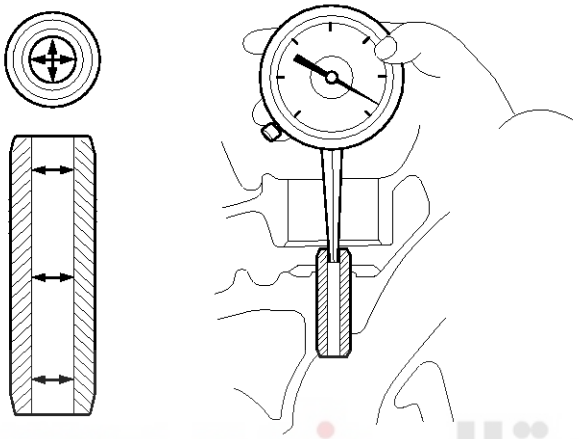
2. Inspect for cracks.

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

Valve And Valve Spring

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

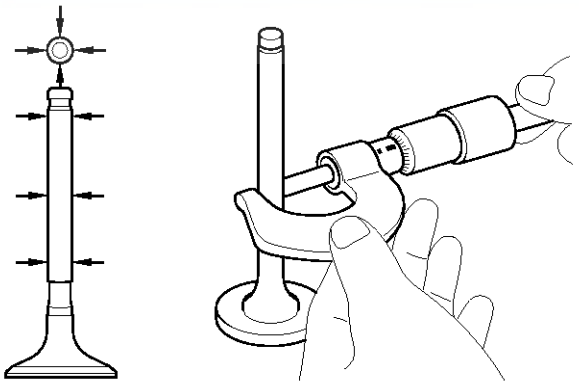
Valve guide inner diameter
Intake / Exhaust : 5.500 ~ 5.512mm (0.21654 ~ 0.21701in.)



SVIM19147D

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

Valve stem outer diameter
Intake : 5.465 ~ 5.480mm (0.21516 ~ 0.21575in.)
Exhaust : 5.458 ~ 5.470mm (0.214988 ~ 0.21535in.)



ECKD220A

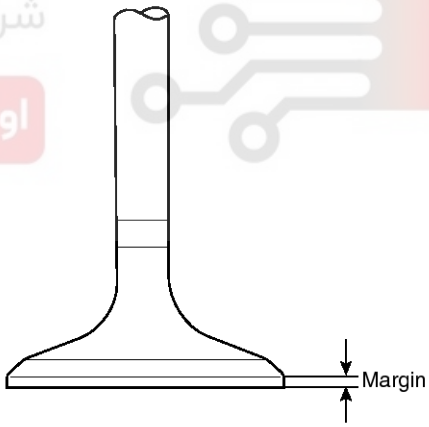
   3) Subtract the valve stem diameter measurement from the valve guide inside diameter measurement.

Valve stem-to-guide clearance
[Standard]
Intake : 0.020 ~ 0.047mm (0.00078 ~ 0.00185in.)
Exhaust : 0.030 ~ 0.054mm (0.00118 ~ 0.00212in.)
[Limit]
Intake : 0.070mm (0.00275in.)
Exhaust : 0.090mm (0.00354in.)

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

2. Inspect the 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.

Valve head thickness (Margin)
[Standard]
Intake : 1.02mm(0.0401in.)
Exhaust : 1.09mm(0.0429in.)



ECKD221A

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

   4) Check the valve length.

Valve length
[Standard]
Intake : 113.18mm(4.4559in.)
Exhaust : 105.84mm(4.1669in.)
[Limit]
Intake : 112.93mm(4.4461in.)
Exhaust : 105.59m(4.1571in.)

5) Check the surface of the valve stem tip for wear.

If the valve stem tip is worn, replace the valve.

3. Inspect the valve seats

1) Check the valve seat for evidence of overheating and improper contact with the valve face. Replace the cylinder head if necessary.

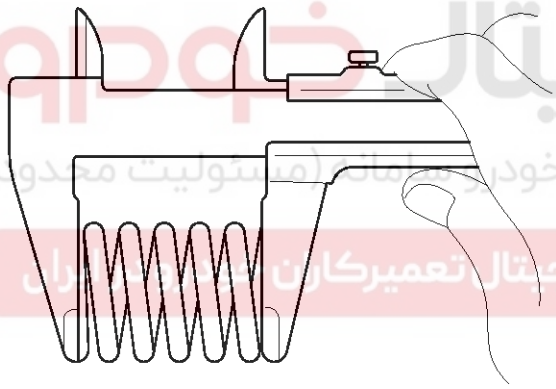
2) Check the valve guide for wear. If the valve guide is worn, replace the cylinder head.

4. Inspect the valve springs.

1) Using a steel square, measure the out-of-square of 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 : Less than 1.5°



ECKD222A

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

MLA (Mechanical Lash Adjuster)

1. Inspect the MLA.

Using a micrometer, measure the MLA outside diameter.

MLA outer diameter :
31.964 ~ 31.980mm (1.2584 ~ 1.2590in.)

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

Tappet bore inner diameter :
32.000 ~ 32.025mm (1.2598 ~ 1.2608in.)

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

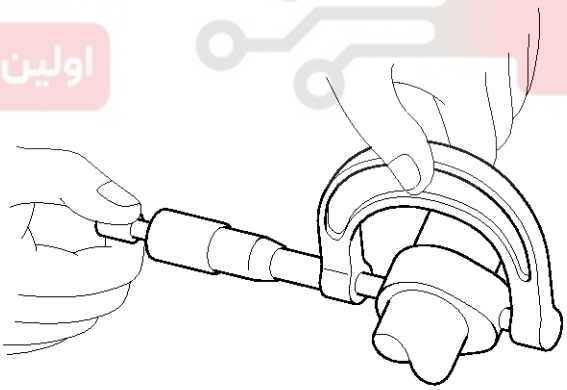
MLA to tappet bore clearance
[Standard] : 0.020 ~ 0.061mm (0.00078 ~ 0.00240in.)
[Limit] : 0.070mm (0.00275in.)

Camshaft

1. Inspect the cam lobes.

Using a micrometer, measure the cam lobe height.

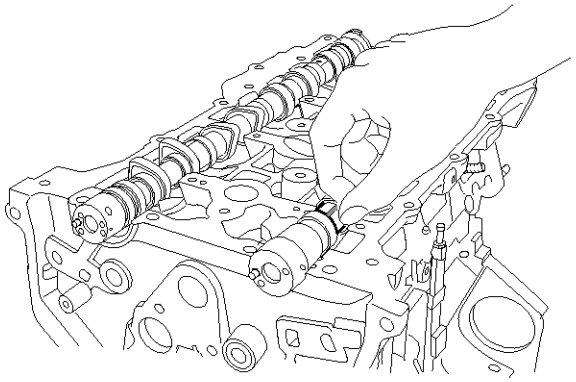
Cam height
[Standard value]
Intake : 44.10 ~ 44.30mm (1.7362 ~ 1.7440in.)
Exhaust : 44.90 ~ 45.10mm (1.7677 ~ 1.7756in.)



ECKD223A

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

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



SYFEM0113N

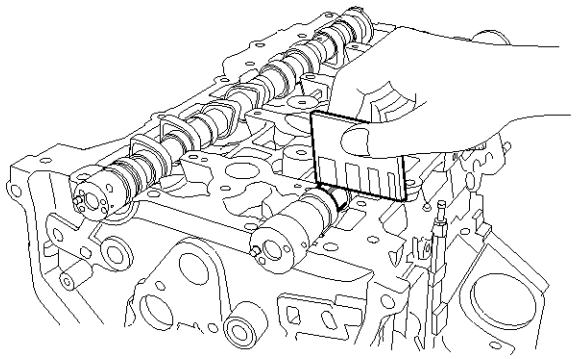
   4) Install the bearing caps.

⚠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 : 0.022 ~ 0.057mm (0.00087 ~ 0.00224in.)
No.2, 3, 4, 5 : 0.045 ~ 0.082mm (0.00177 ~ 0.00323in.)
Exhaust:
No.1 : 0 ~ 0.032mm (0 ~ 0.00126in.)
No.2, 3, 4, 5 : 0.045 ~ 0.082mm (0.00177 ~ 0.00323in.)

[Limit]
Intake:
No.1 : 0.090mm (0.00354in.)
No.2, 3, 4, 5 : 0.120mm (0.00472in.)
Exhaust :
No.1 : 0.090mm (0.00354in.)
No.2, 3, 4, 5 : 0.120mm (0.00472in.)

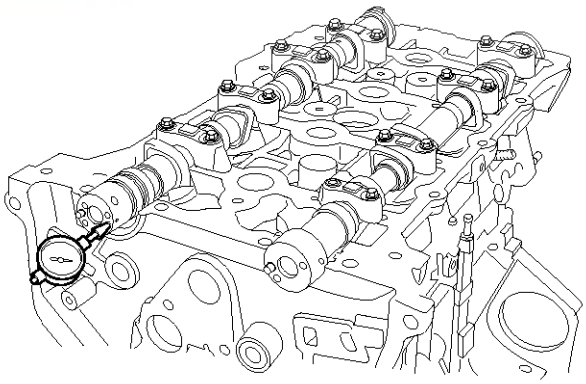


SYFEM0114N

   If the oil clearance is greater than maximum, replace the camshaft. If necessary, replace cylinder head.
   7) Completely remove the plastigage.
   8) Remove the camshafts.

3. Inspect the camshaft end play.
   1) Install the camshafts.
   2) Using a dial indicator, measure the end play while moving the camshaft back and forth.

Camshaft end play
[Standard value] : 0.04 ~ 0.16mm (0.0016 ~ 0.0063in.)
[Limit] : 0.20mm (0.0078in.)



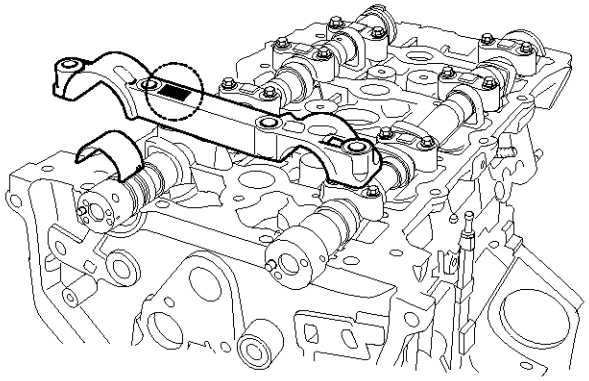
SYFEM0115N

   If the end play is greater than maximum, replace the camshaft. If necessary, replace cylinder head.
   3) Remove the camshafts.

Exhaust Camshaft Bearing

1. Check the cylinder head bore mark.

Cylinder Head Bore Identification Mark



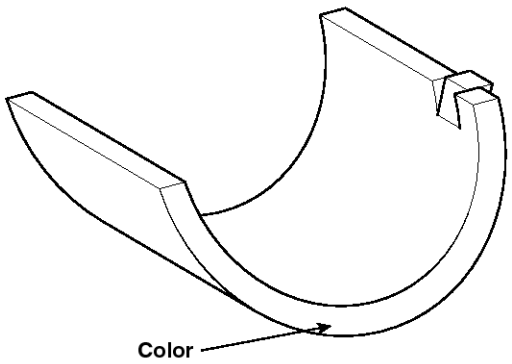
SYFEM0156N

Cylinder Head Specifications

Class	Mark	Exhaust No.1 Inside Diameter Of Cylinder Head Bore
a	A	40.000 ~ 40.008mm (1.57480 ~ 1.5751in.)
b	B	40.008 ~ 40.016mm (1.57511 ~ 1.57543in.)
c	C	40.016 ~ 40.021mm (1.57543 ~ 1.57563in.)

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

Exhaust Camshaft Bearing Identification Mark



ECRF021A

Exhaust Camshaft Bearing Specifications

Cylinder Head Bore Class	Bearing Class For Installing (Color)	Thickness Of Bearing
a (A)	C (Green)	1.996~2.000mm (0.07858~0.07874in.)
b (B)	B (None color)	2.000~2.004mm (0.07874~0.07890in.)
c (C)	A (Black)	2.004~2.008mm (0.07890~0.07905in.)

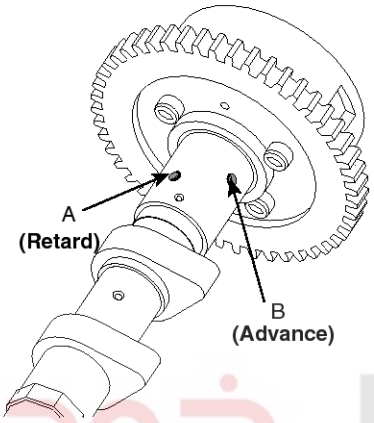
Oil clearance : 0 ~ 0.032mm (0 ~ 0.00126in.)

CVVT Assembly

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

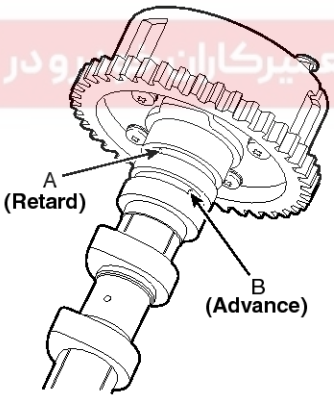
      Verify that the tape holds and put air through the port of the camshaft.

[Intake]



SXMM19073L

[Exhaust]



SXMM19074L

   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.

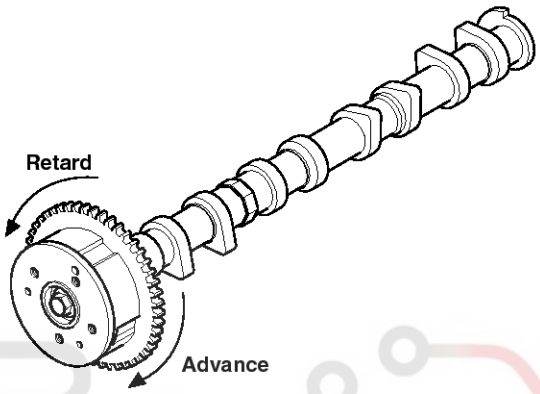
      (Perform this in order to release the lock pin.)

      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:

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

   6) Turn the intake CVVT assembly with your hand and lock it at the maximum retard angle position (counter clockwise).
   7) Turn the exhaust CVVT assembly with your hand and lock it at the maximum advance angle position (clockwise).

Reassembly

NOTICE

Thoroughly clean all parts to be assembled.

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

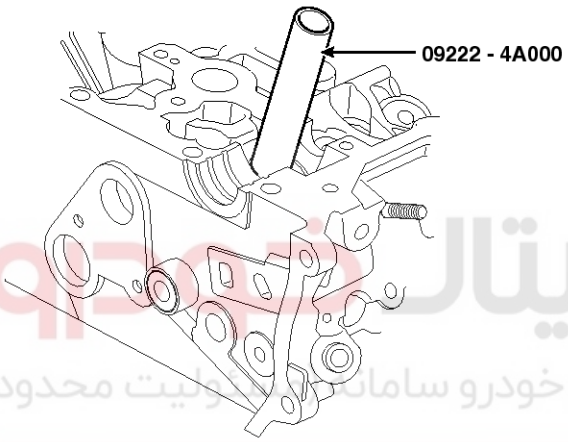
Replace oil seals with new ones.

1. Install 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.



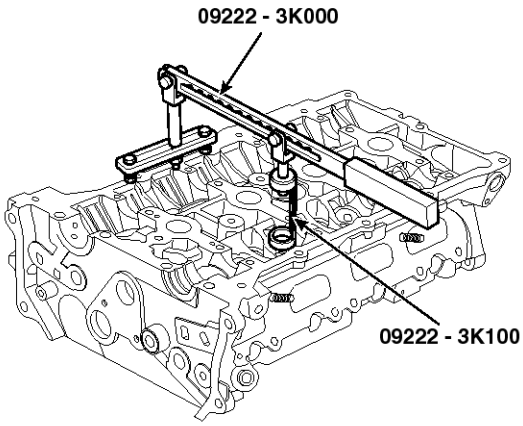
SYFEM0116N

   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.

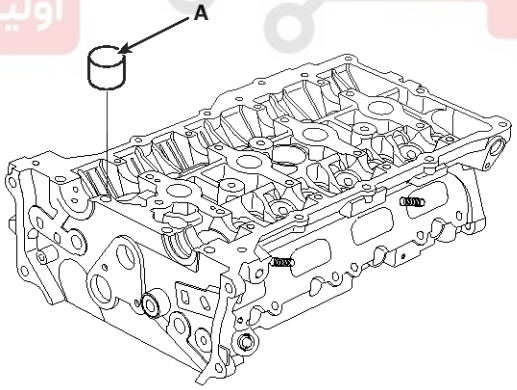


SYFEM0112N

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

2. Install the MLAs after appling engine oil.

   Check that the MLA rotates smoothly by hand.



SYFEM0111N

NOTICE

MLA can be reinstalled in its original position.

However, the valve lash clearances must be rechecked and adjusted accordingly before the cylinder head is installed onto the cylinder block.

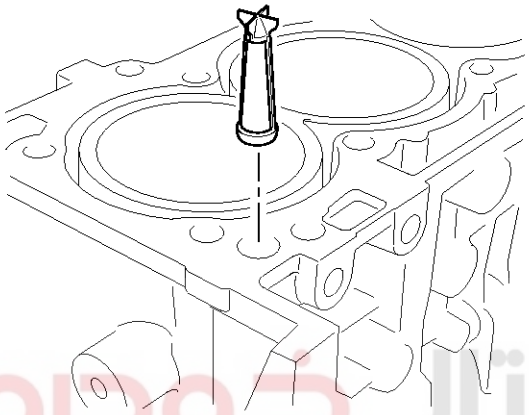
Refer to General information in EM section for Valve Clearance checking and adjustment procedure.

Installation

NOTICE

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

1. Install the OCV (Oil control valve) filter.



KCRF176A

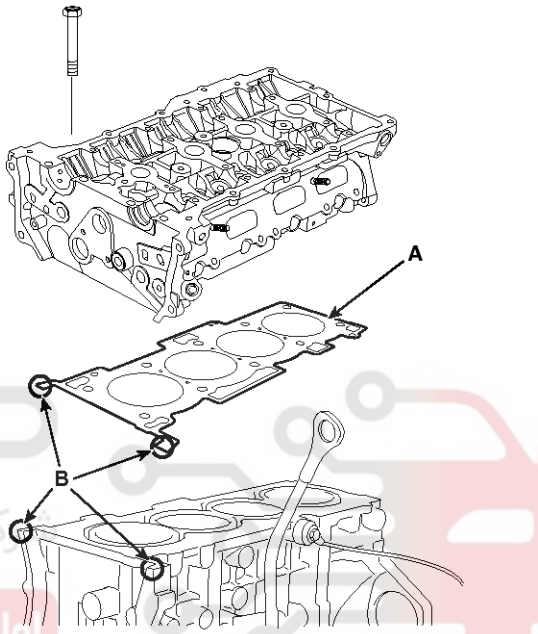
CAUTION

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 or equivalent) on the edge of cylinder head gasket upside and downside. (At the position 'B')*
- *After applying sealant, assemble the cylinder head in five minutes.*

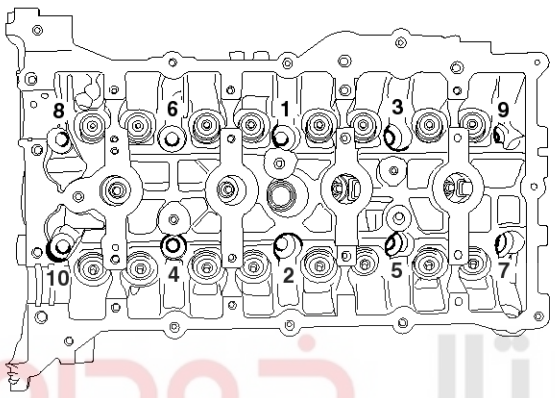


SYFEM0117N

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.
   1) Do not apply engine oil on the the cylinder head bolts.
   2) Using the SST(09221-4A000), tighten the 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°



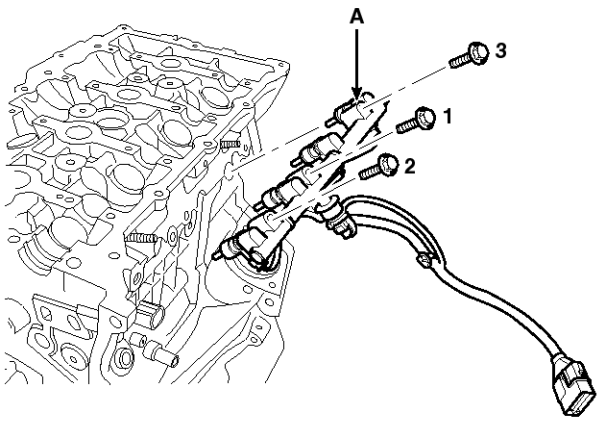
SYFEM0169N

⚠CAUTION
Always use new cylinder head bolt.

5. Install the injector & rail module (A). (Refer to FL group)

   Pre-tighten the bolts and then tighten the bolts with the specified torque in the sequence shown.

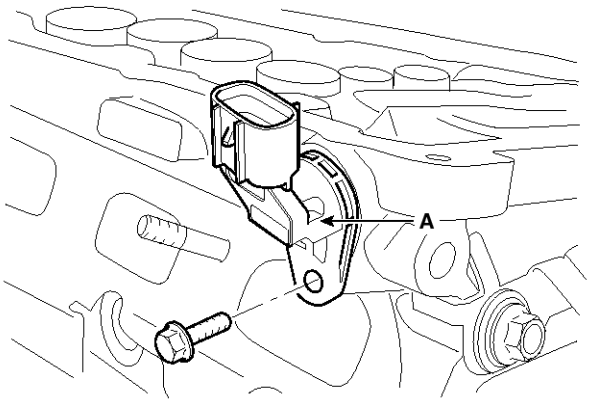
Tightening torque :
18.6~ 23.5N.m (1.9 ~ 2.4kgf.m, 13.7 ~ 17.4lb-ft)



SYFEM0073N

6. Install the intake CMPS (Camshaft position sensor) (A).

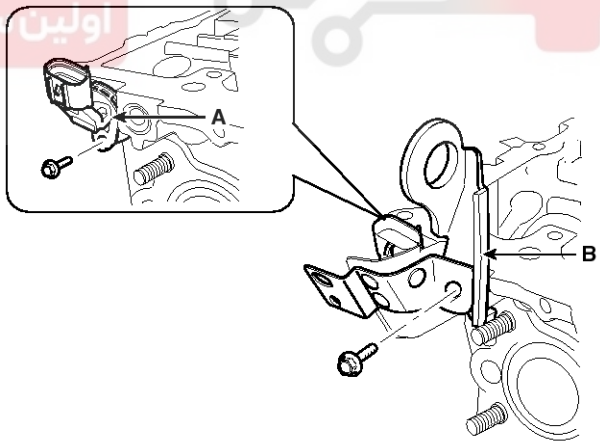
Tightening torque :
9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)



SYFEM0023N

7. Install the exhaust CMPS (Camshaft position sensor) (A) and the engine hanger (B).

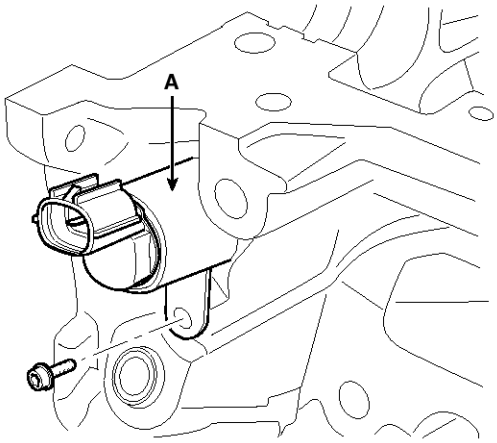
Tightening torque :
Sensor bolt: 9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)
Engine hanger bolt: 27.5 ~ 31.4N.m (2.8 ~ 3.2kgf.m, 20.3 ~ 23.1lb-ft)



SYFEM0024N

8. Install the intake OCV (Oil control valve) (A).

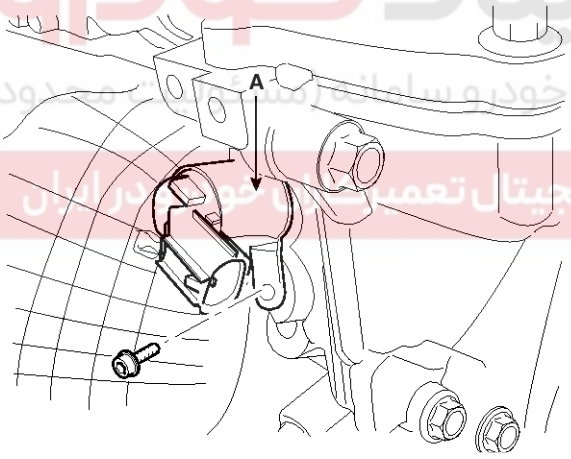
Tightening torque :
9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)



SYFEM0019N

9. Install the exhaust OCV (Oil control valve) (A).

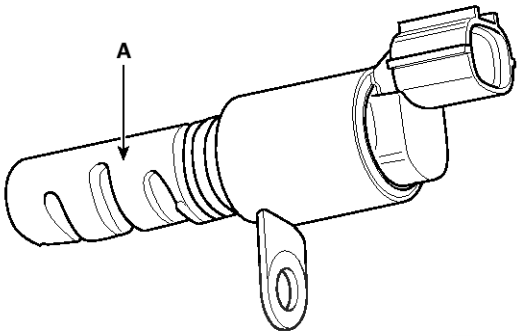
Tightening torque :
9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)



SYFEM0050N

CAUTION

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



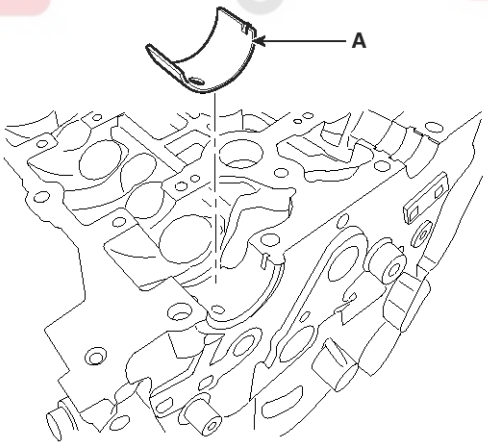
SYFEM0021N

10. Install the camshafts.

NOTICE

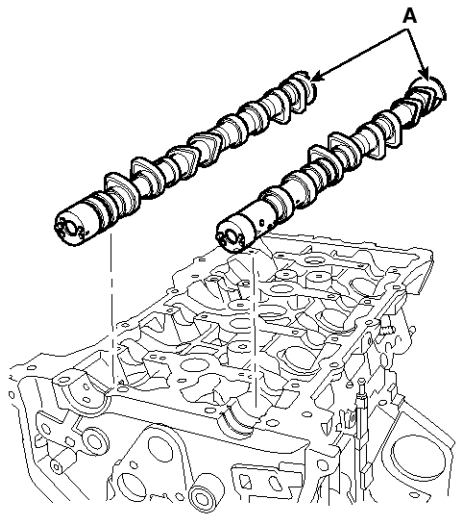
Apply a light coat of engine oil on camshaft journals.

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



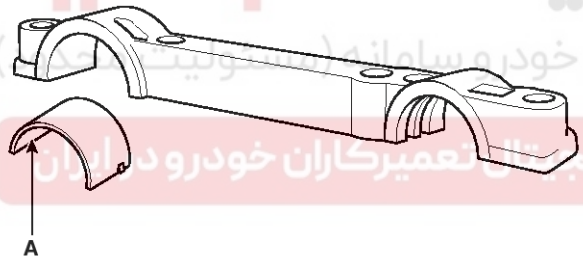
SYFEM0018N

2) Install the camshafts (A).



SYFEM0017N

3) Install the exhaust camshaft upper bearing (A) to the front bearing cap.



SNFEM8016D

4) Install camshaft bearing caps (A) in their proper locations.

Tightening order

Group A → Group B → Group C.

Tightening torque :

Step 1

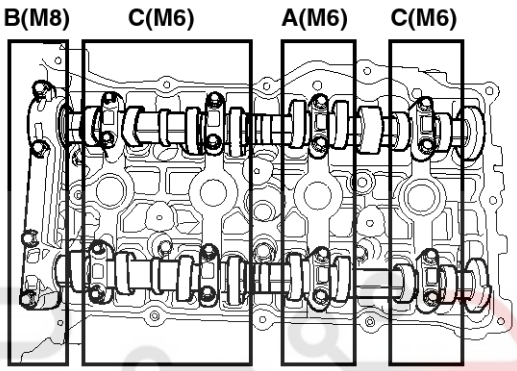
M6 : 5.9N.m (0.6kgf.m, 4.3lb-ft)

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

Step 2

M6 : 10.8 ~ 12.7N.m (1.1 ~ 1.3kgf.m, 8.0 ~ 9.4lb-ft)

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

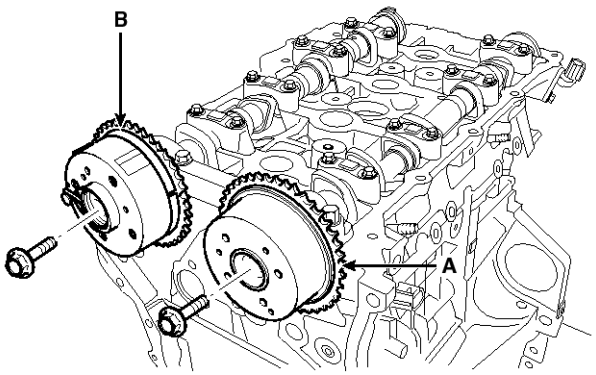


SYFEM0157N

11. Install the intake CVVT assembly (A) and exhaust CVVT assembly (B).

Tightening torque :

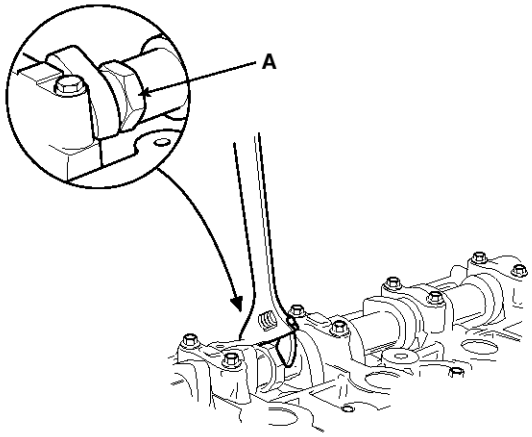
53.9 ~ 63.7N.m (5.5 ~ 6.5kgf.m, 39.7 ~ 47.0lb-ft)



SYFEM0014N

NOTICE

When installing the CVVT assembly bolt, prevent the camshaft from rotating by using a wrench at position A.

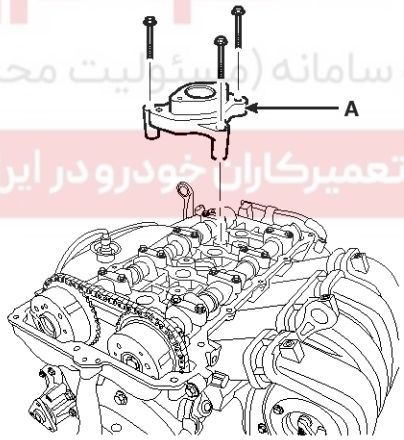


STDM19324L

12. Install the high pressure fuel pump bracket (A).

Tightening torque :

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



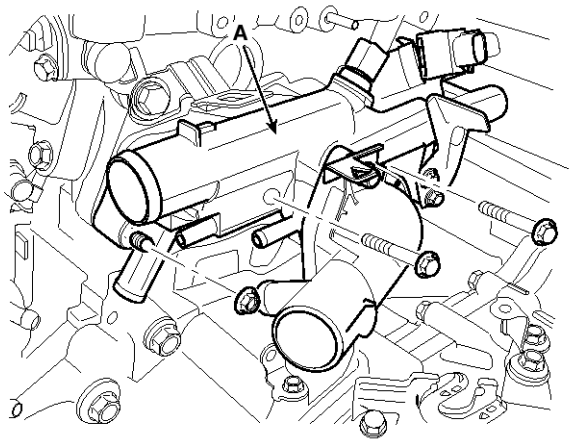
SYFEM0074N

13. Install the intake and exhaust manifold. (Refer to Intake and exhaust system in this group)
14. Install the timing chain. (Refer to Timing system in this group)
15. Check and adjust the valve clearance. (Refer to General information in this group)
16. Install the water temperature control assembly (A) with the water inlet pipe (B).

Tightening torque :

Bolts : 14.7 ~ 19.6N.m (1.5 ~ 2.0kgf.m, 10.8 ~ 14.5lb-ft)

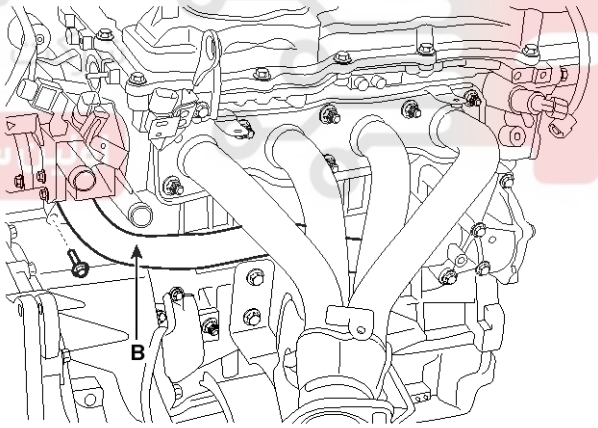
Nut : 18.6 ~ 23.5N.m (1.9 ~ 2.4kgf.m, 13.7 ~ 17.4lb-ft)



SYFEM0049N

Tightening torque :

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



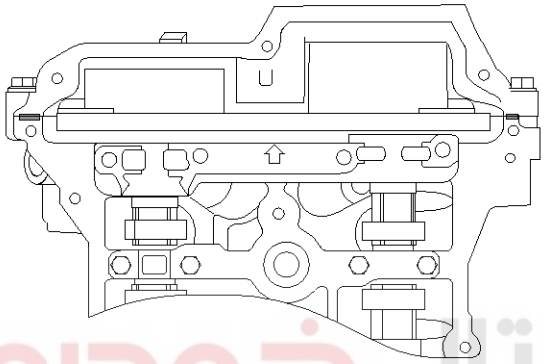
STFM11029D

NOTICE

- *Assemble water temp control assembly and water inlet pipe to water pump assembly before nuts for assembling of water inlet pipe to be tightened.*
- *Insert after wetting O-ring or inner surface of thermostat housing.*
- *Always use a new O-ring.*

17. Install cylinder head cover.
    1) The hardening sealant located on the upper area between timing chain cover and cylinder head should be removed before assembling cylinder head cover.
    2) After applying sealant (Loctite 5900H or equivalent), it should be assembled within 5 minutes.

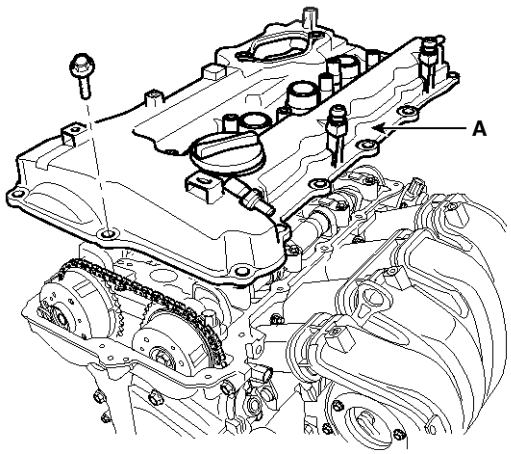
Bead width : 2.5mm (0.10in.)



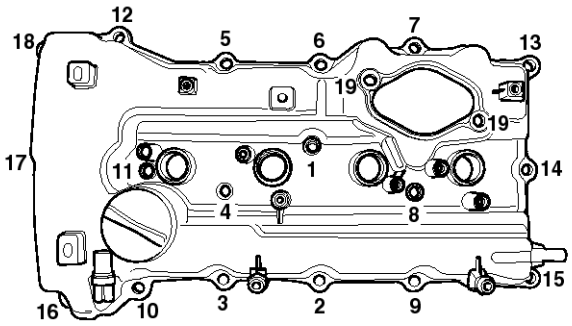
SNFEM8045D

    3) Install the cylinder head cover (A) by tightening the bolts as following method.

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



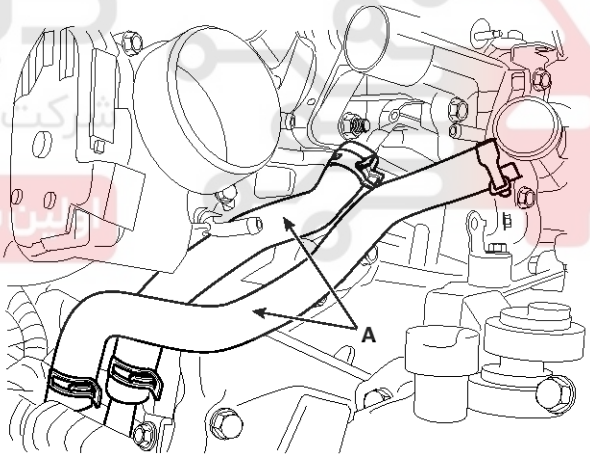
SYFEM0004N



SYFEM0013N

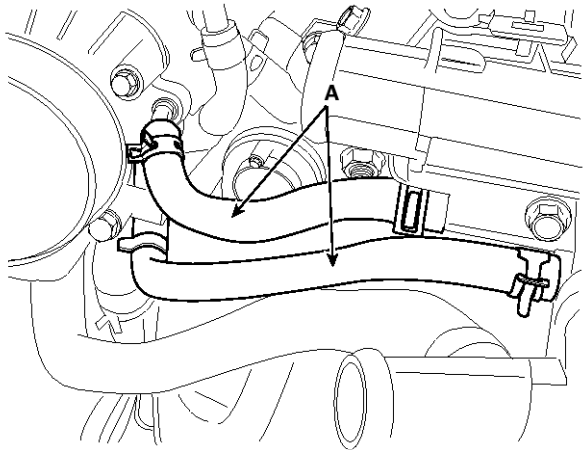
⚠CAUTION
- **Do not reuse cylinder head cover gasket.**
- **The firing and/or blow out test should not be performed within 30 minutes after the cylinder head cover was assembled.**

18. Connect the oil cooler coolant hoses (A).



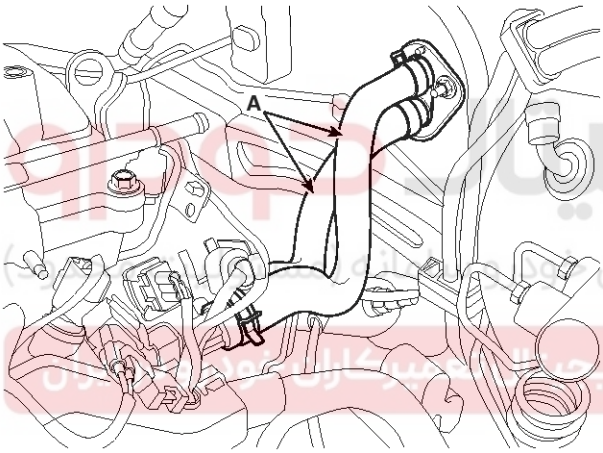
SYFEM0048N

19. Connect the throttle body coolant hoses (A).



SYFEM0047N

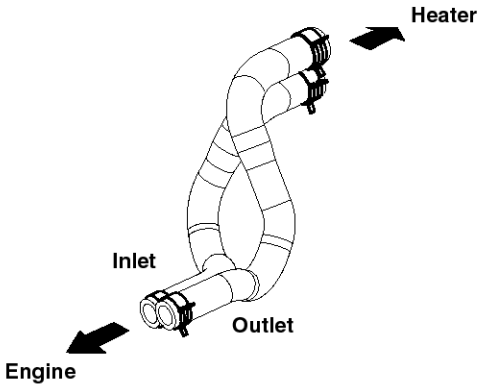
20. Connect the heater hoses (A).

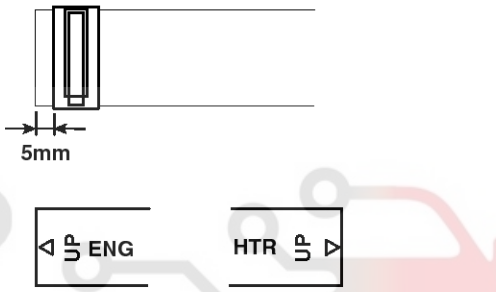


SYFEM0022D

NOTICE

When installing the heater hoses, install as shown in illustrations.

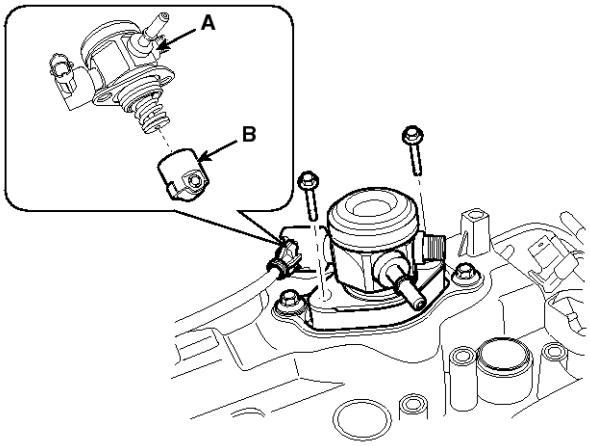




SVGEM0105D

21. Install the high pressure fuel pump (A) and the roller tappet (B). (Refer to FL group)

Tightening torque :
12.7 ~ 14.7N.m (1.3 ~ 1.5kgf.m, 9.4 ~ 10.8lb-ft)



SYFEM0043N

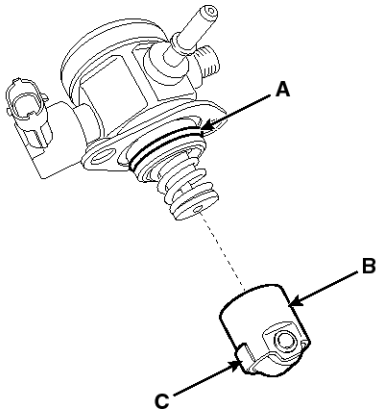
CAUTION
Before installing the high pressure fuel pump, position the roller tappet in the lowest position (BDC) by rotating the crankshaft. Otherwise the installation bolts may be broken because of tension of the pump spring.

NOTICE
Do not use already used bolt again.

NOTICE
When tightening the installation bolts of the high pressure fuel pump, tighten the bolts in small increments (0.5 turns) after tightening them by hand.

CAUTION
Note that internal damage may occur when the component is dropped. In this case, use it after inspecting.

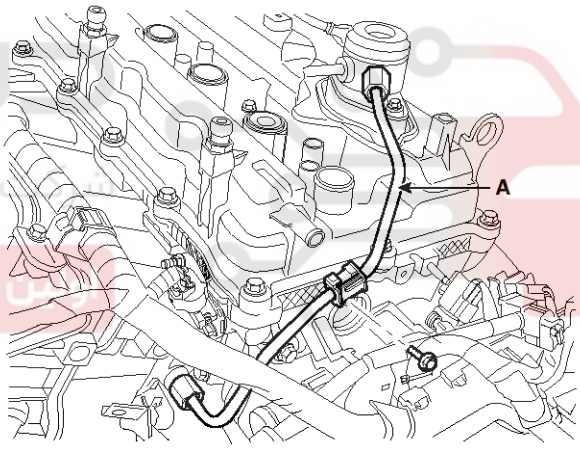
NOTICE
Apply engine oil to the O-ring (A) of the high pressure fuel pump, the roller tappet (B), and the protrusion (C). Also apply engine oil to the groove where the protrusion is installed.



SYFEM0175N

22. Install the high pressure pipe (A). (Refer to FL group)

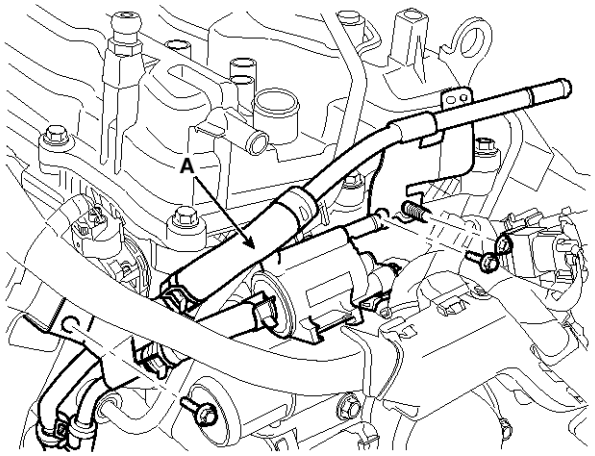
Tightening torque :
Bolt : 7.8 ~ 11.8N.m (0.8 ~ 1.2kgf.m, 5.8 ~ 8.7lb-ft)
Nuts : 26.5 ~ 32.4N.m (2.7 ~ 3.3kgf.m, 19.5 ~ 23.9lb-ft)



SYFEM0042N

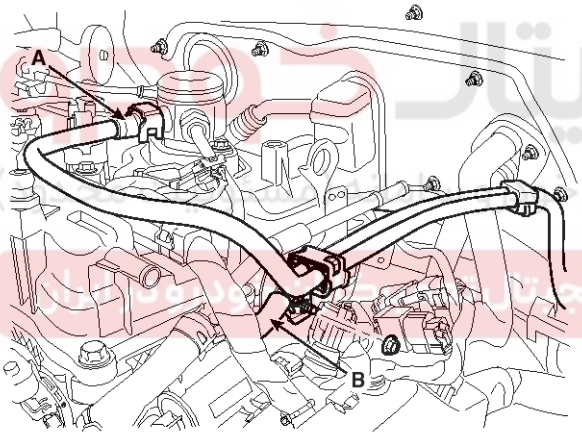
NOTICE
Do not reuse the high pressure pipe.

23. Install the vacuum & PCSV (Purge control solenoid valve) pipe assembly (A).



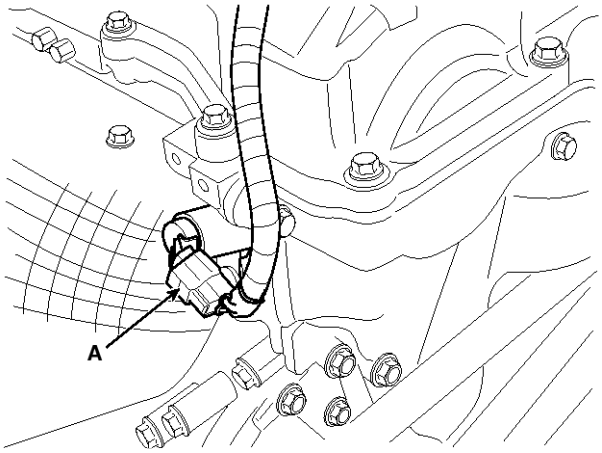
STFM11027D

24. Connect the fuel hose (A) and PCSV (Purge control solenoid valve) hose (B).



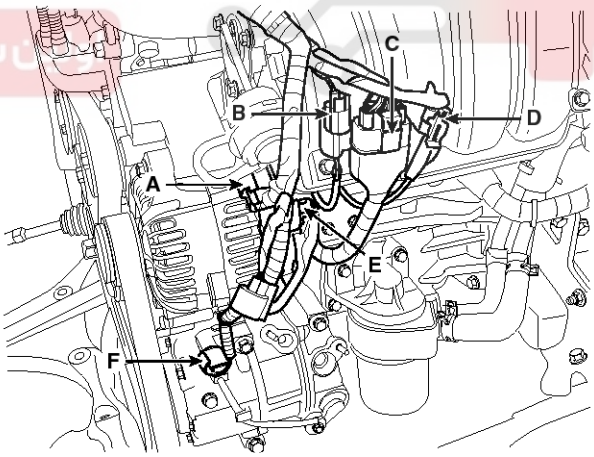
SYFEM0033N

25. Connect the wiring connectors and harness clamps, and install the wiring protectors to the cylinder head, intake manifold and exhaust manifold.
    1) Connect the exhaust OCV (Oil control valve) connector (A).



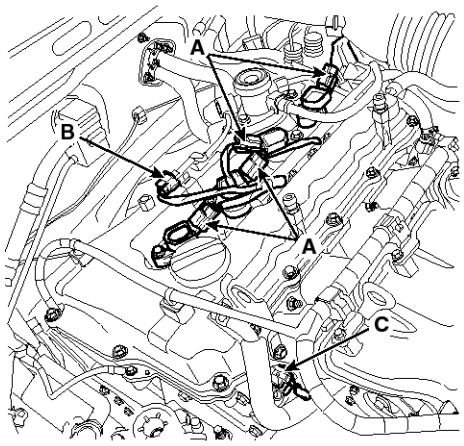
SYFEM0040N

    2) Connect the VIS (Variable intake system) connector (A), the OPS (Oil pressure switch) connector (B), the injector extension connector (C), the knock sensor connector (D), the alternator connector (E) and the A/C compressor switch connector (F).



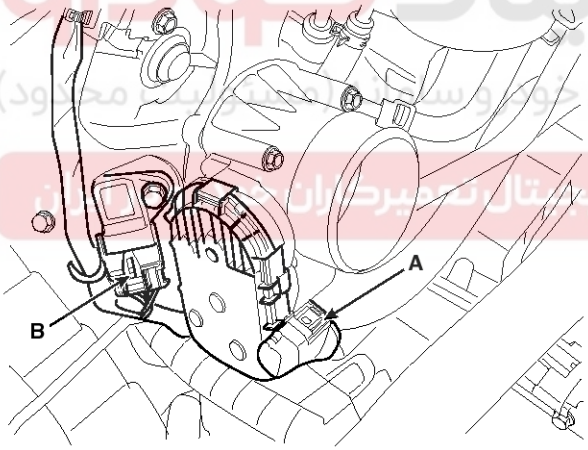
SYFEM0045N

3) Connect the ignition coil connectors (A), the fuel pump connector (B) and the intake OCV (Oil control valve) connector (C).



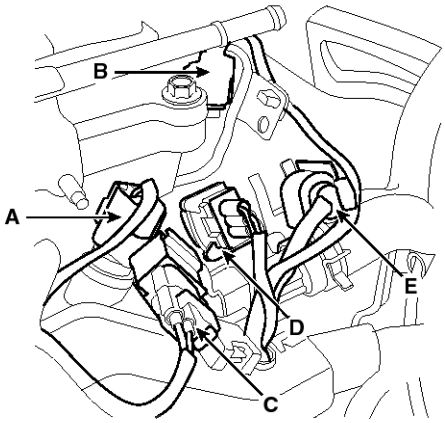
SYFEM0151N

4) Connect the ETC (Electronic throttle control) connector (A) and MAPS (Manifold absolute pressure sensor) & IATS (Intake air temperature sensor) connector (B).



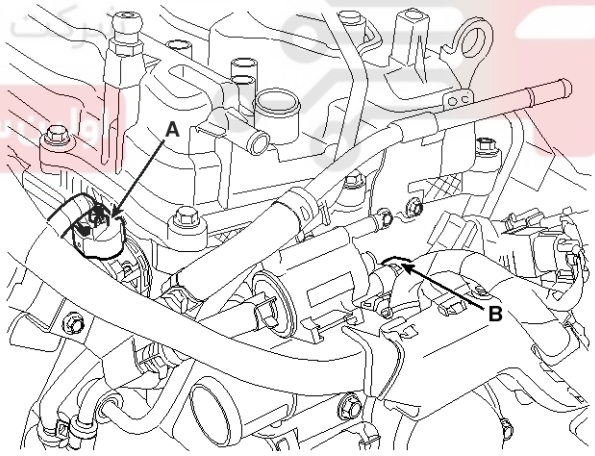
SYFEM0046N

5) Connect the ECTS (Engine coolant temperature sensor) connector (A), the exhaust CMPS (Camshaft position sensor) connector (B), the condenser connector (C), the CKPS (Crankshaft position sensor) connector (D) and the oxygen sensor connector (E).



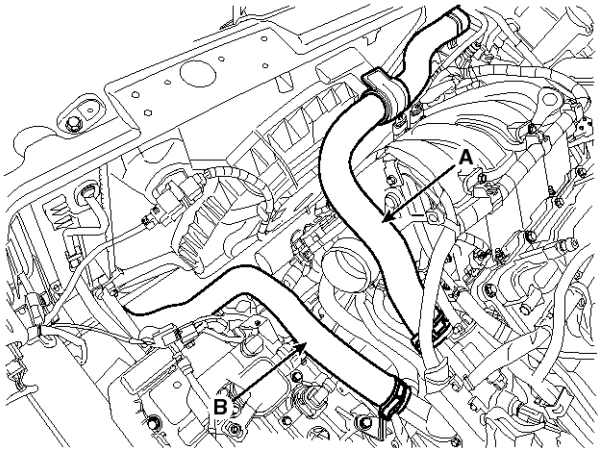
SVGEM0157D

6) Connect the intake CMPS (Camshaft position sensor) connector (A) and the PCSV (Purge control solenoid valve) connector (B).



STFM11026D

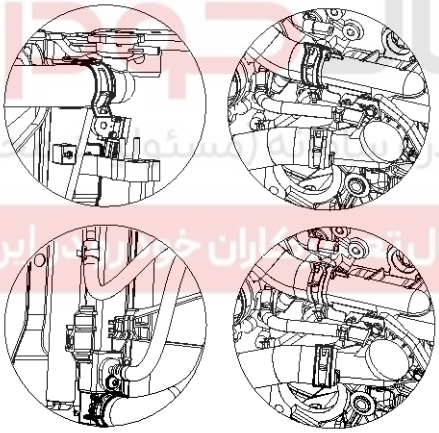
26. Connect the radiator upper hose (A) and lower hose (B).



SYFEM0029N

NOTICE

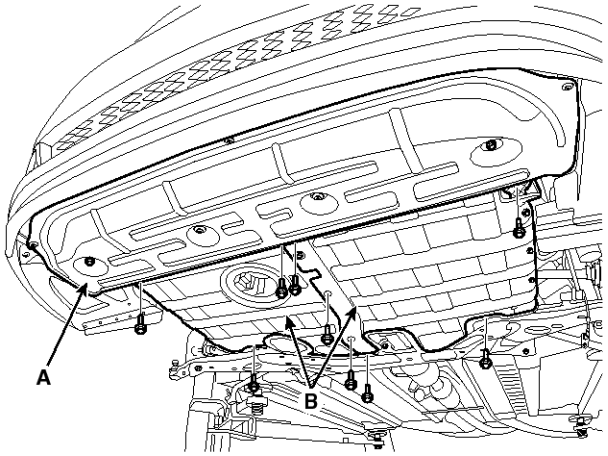
When installing radiator hoses, install as shown in illustrations.



SVGEM0104D

27. Install the under covers (A,B).

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



STFM11032D

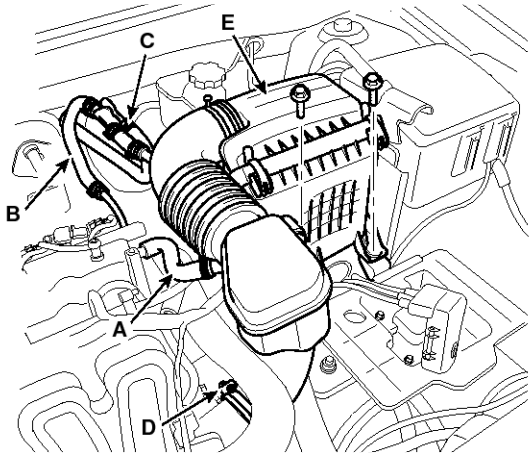
NOTICE

When installing the cover (B), install the cover with the mounting bracket.

28. Remove the RH front wheel.
29. Install the air cleaner assembly.
    1) Install the air cleaner assembly (E) and then connect the air intake hose (D).

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

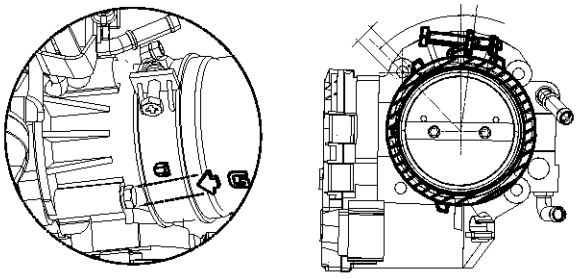
    2) Connect the breather hose (A), the brake booster vacuum hose (B) and the intensifier hose (C).



STFM11008D

NOTICE

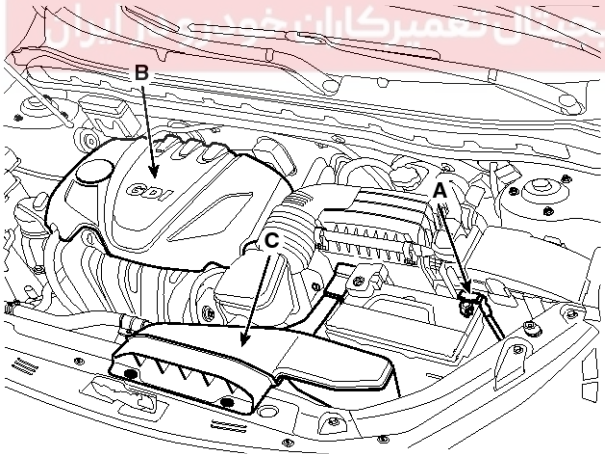
- *Install the air intake hose while the plate of the hose clamp must be in line with the stopper of the hose.*
- *Install the air intake hose while the center of the mark of hose must be in line with the throttle body bolt.*



STFM11009D

30. Install the air duct (C) and the engine cover (B).
31. Connect the battery negative terminal (A).

Tightening torque:
4.0 ~ 6.0N.m (0.4 ~ 0.6kgf.m, 3.0 ~ 4.4lb-ft)



STFM11001D

NOTICE

Perform the following :

- *Adjust a shift cable.*
- *Refill engine with engine oil.*
- *Refill a transaxle with fluid.*
- *Refill a radiator and a reservoir tank with engine coolant.*
- *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.
- *Bleed air from the cooling system.*

  - Start engine and let it run until it warms up. (until the radiator fan operates 3 or 4 times.)

  - Turn Off the engine. Check the level in the radiator, add coolant if needed. This will allow trapped air to be removed from the cooling system.

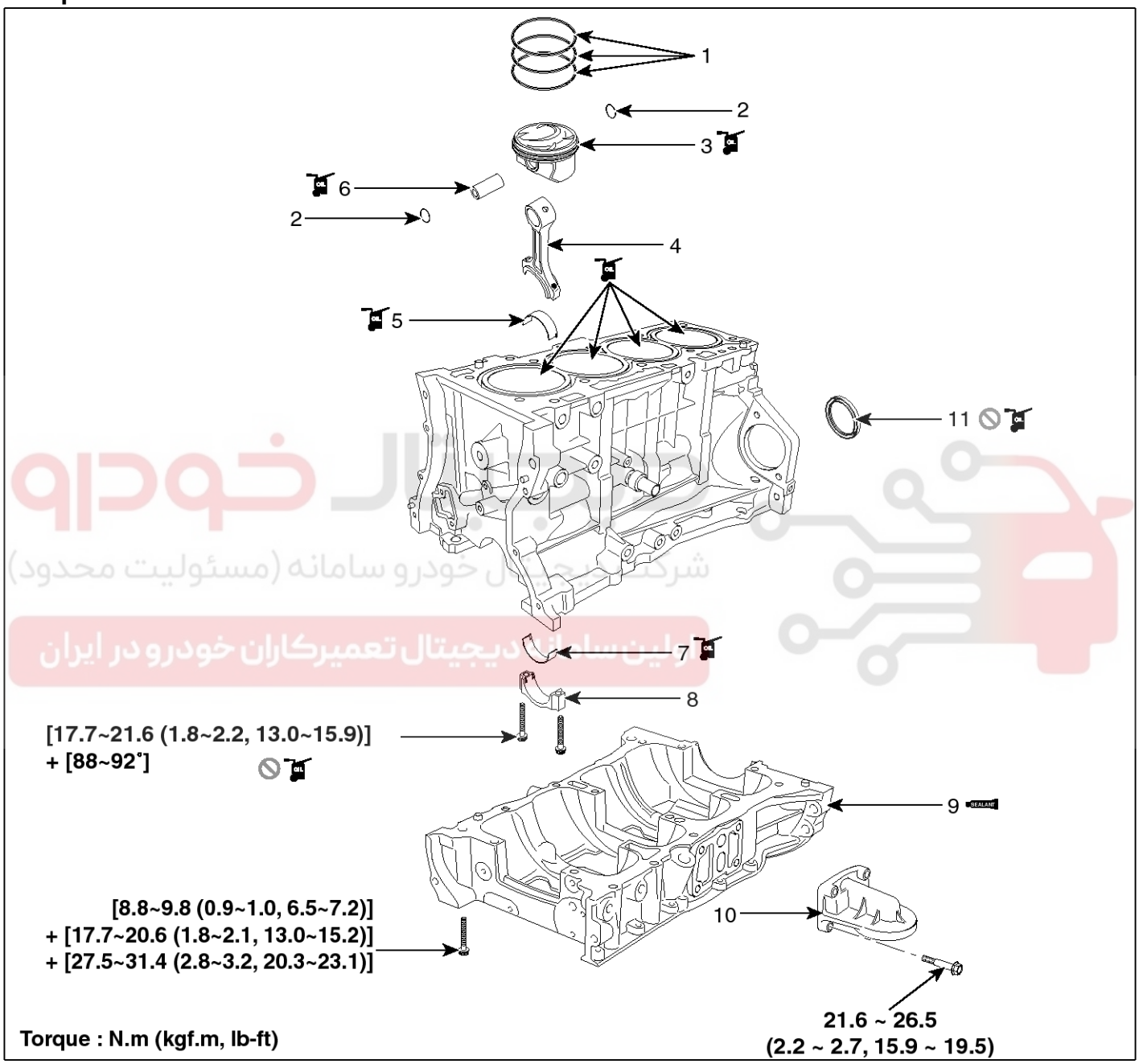
  - Put radiator cap on tightly, then run the engine again and check for leaks

Cylinder Block

Cylinder Block

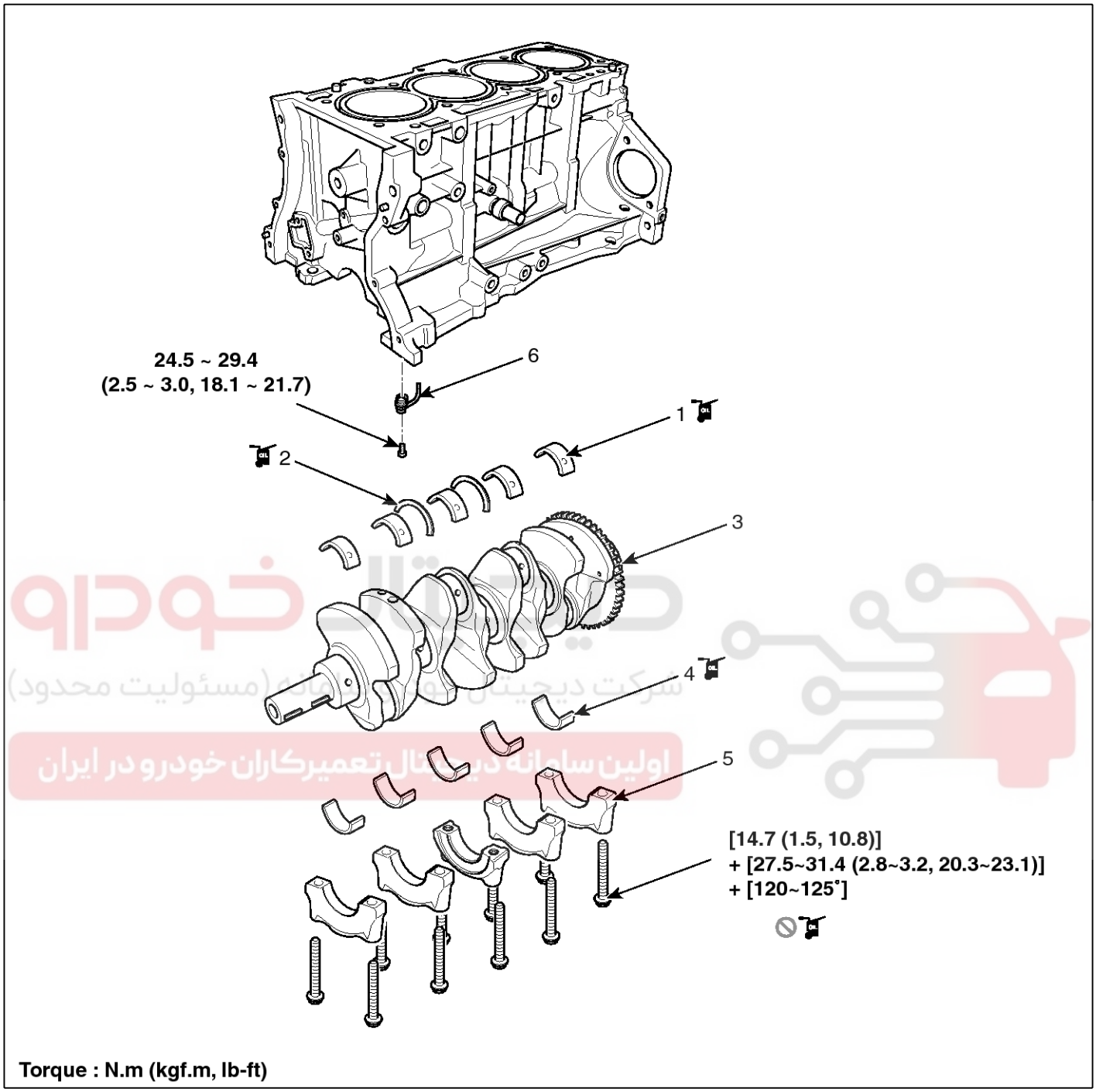
Cylinder Block

Components



STFM1006N

1. Piston ring
2. Snap ring
3. Piston
4. Connecting rod
5. Connecting rod upper bearing
6. Piston pin
7. Connecting rod lower bearing
8. Connecting rod bearing cap
9. Ladder frame
10. Oil filter bracket
11. Crankshaft rear oil seal



STFM1007N

1. Crankshaft upper bearing
2. Thrust bearing
3. Crankshaft
4. Crankshaft lower bearing
5. Main bearing cap
6. Piston cooling oil jet

Disassembly

CAUTION

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

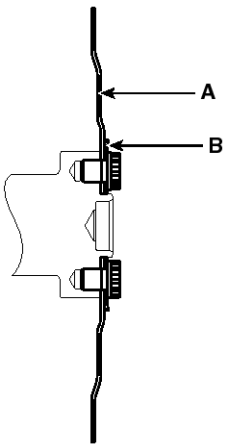
NOTICE

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

WARNING

In case of removing the high pressure fuel pump, high pressure fuel pipe, delivery pipe, and injector, there may be injury caused by leakage of the high pressure fuel. So don't do any repair work right after engine stops.

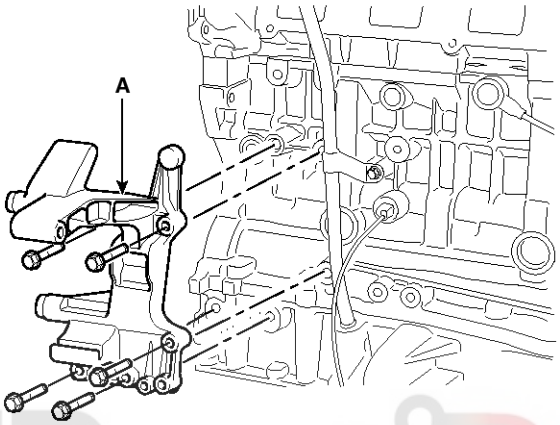
1. Remove the engine assembly from the vehicle. (Refer to Engine and transaxle assembly in this group)
2. Install the engine to an engine stand for disassembly.
3. Remove the intake manifold and exhaust manifold. (Refer to Intake and exhaust system in this group)
4. Remove the timing chain. (Refer to Timing system in this group)
5. Remove the cylinder head assembly. (Refer to Cylinder head in this group)
6. AT : Remove the drive plate (A) and the adapter plate (B).



KCRF224A

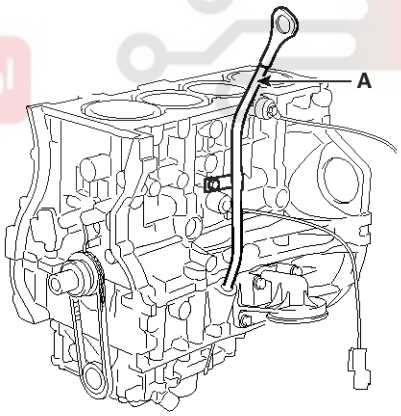
MT : Remove the flywheel.

7. Remove the balance shaft & oil pump assembly. (Refer to Lubrication system in this group)
8. Remove the A/C compressor. (Refer to HA group)
9. Remove the alternator. (Refer to EE group)
10. Remove the water pump assembly. (Refer to Cooling system in this group)
11. Remove the tensioner assembly integrated bracket (A).



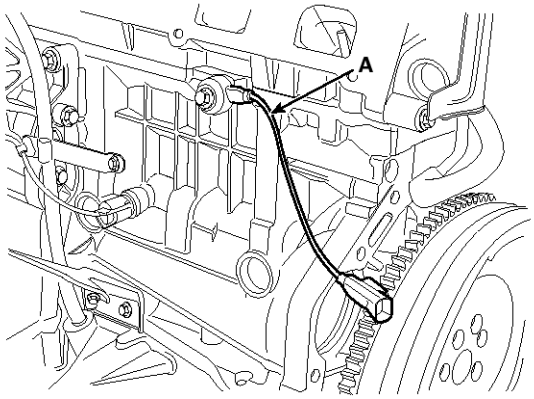
SYFEM0083N

12. Remove the oil level gauge tube (A).



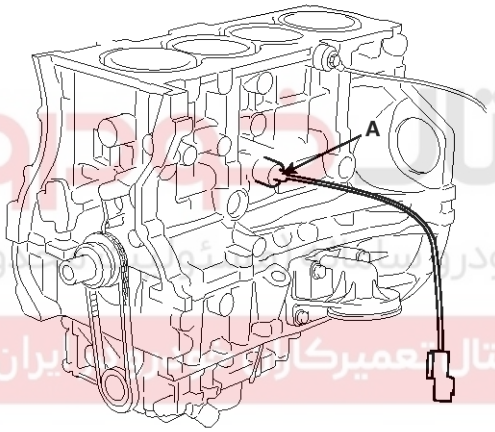
SXMM19108D

13. Remove the knock sensor (A).



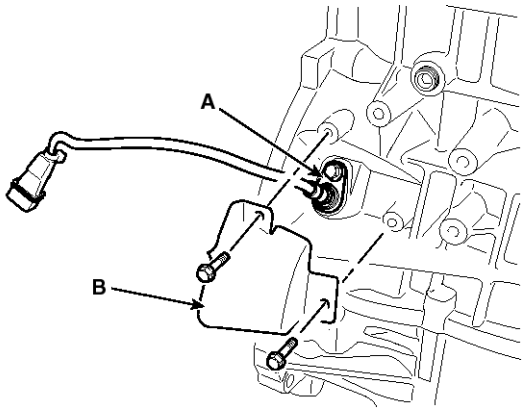
KCRF143A

14. Remove the oil pressure sensor (A).



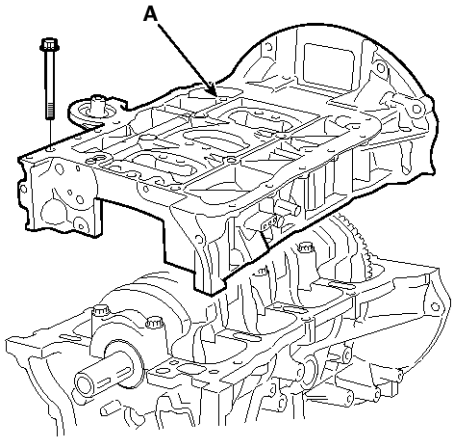
SXMM19109D

15. Remove the cover (B) and the CKPS (Crankshaft position sensor) (A).



SSLM10124D

16. Remove the ladder frame (A).



STGEM9037D

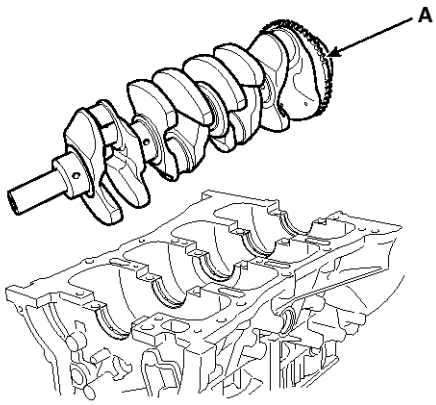
17. Check the connecting rod end play.
18. Remove the connecting rod caps and check oil clearance.
19. Remove piston and connecting rod assemblies.
    1) Using a ridge reamer, remove all the carbon from the top of the cylinder.
    2) Push the piston, connecting rod assembly and upper bearing through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

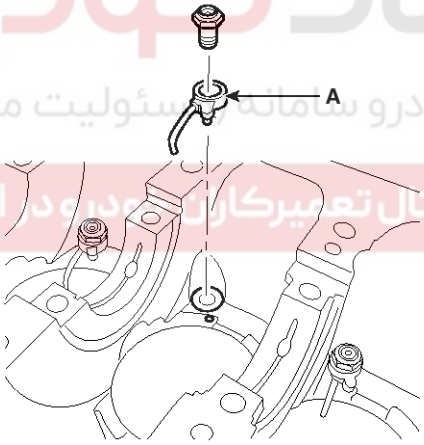
22. Lift the crankshaft (A) out of the engine, being careful not to damage journals.



SYFEM0118N

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

23. Remove the oil jet (A).



SYFEM0051N

24. 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.

25. Remove piston rings.
    1) Using a piston ring expander, remove the 2 compression rings.
    2) Remove oil ring.

    NOTICE
    Arrange the piston rings in the correct order only.

26. Remove the snap rings and then disconnect connecting rod from piston.

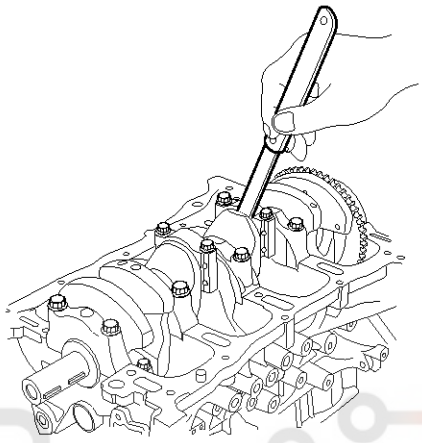
Inspection

Connecting Rod

1. Check the connecting rod end play.

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

End play :
Standard : 0.10~ 0.25mm (0.0039 ~ 0.0098in.)
Limit : 0.35mm (0.0138in.)



SYFEM0119N

- 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.

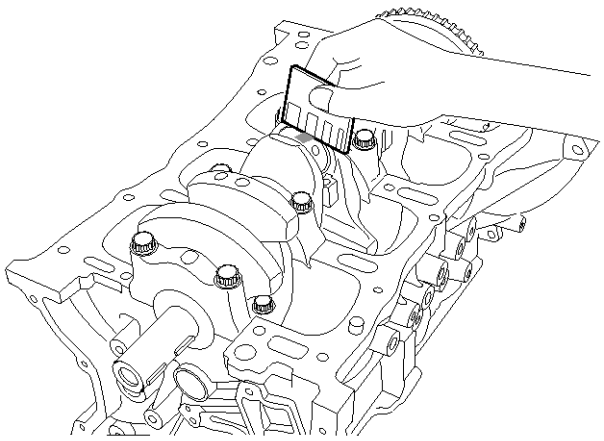
Tightening torque
17.7~21.6Nm (1.8~2.2kgf.m, 13.0~15.9lb-ft) + 88~92°

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
0.031 ~ 0.045mm (0.00122 ~ 0.00177in.)



SYFEM0120N

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.

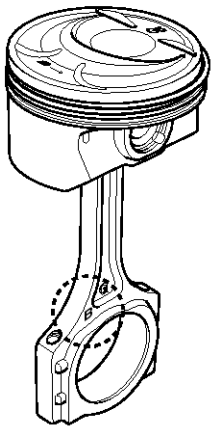
CAUTION
Do not file, shim, or scrape the bearings or the caps to adjust clearance.

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 Identification Mark

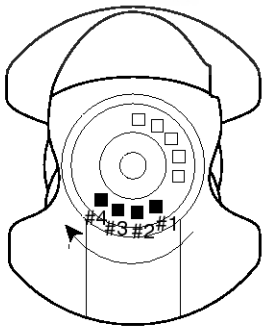


SYFEM0121N

Connecting Rod Specifications

Class	Mark	Inside Diameter
a	A	51.000 ~ 51.006mm (2.00787 ~ 2.00811in.)
b	B	51.006 ~ 51.012mm (2.00811 ~ 2.00834in.)
c	C	51.012 ~ 51.018mm (2.00834 ~ 2.00858in.)

Crankshaft Pin Identification Mark



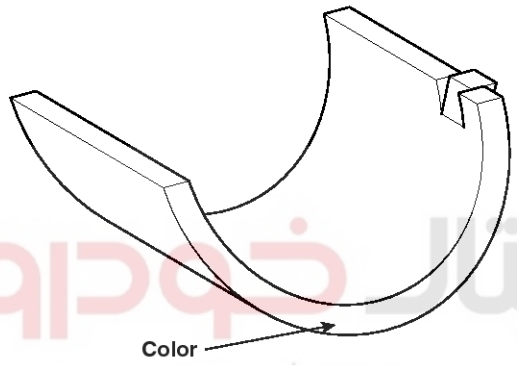
SNFEM8090L

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

Crankshaft Specifications

Class	Mark	Outside Diameter Of Pin
I	1	47.966 ~ 47.972mm (1.88842 ~ 1.88866in.)
II	2	47.960 ~ 47.966mm (1.88819 ~ 1.88842in.)
III	3	47.954 ~ 47.960mm (1.88795 ~ 1.88819in.)

Connecting Rod Bearing Identification Mark



ECRF021A

Connecting Rod Bearing Specifications

Class	Mark	Thickness Of Bearing
AA	Blue	1.515 ~ 1.518mm (0.05965 ~ 0.05976in.)
A	Black	1.512 ~ 1.515mm (0.05953 ~ 0.05965in.)
B	None	1.509 ~ 1.512mm (0.05941 ~ 0.05953in.)
C	Green	1.506 ~ 1.509mm (0.05929 ~ 0.05941in.)
D	Yellow	1.503 ~ 1.506mm (0.05917 ~ 0.05929in.)

Selection Chart For Connecting Rod Bearings

Crankshaft Identification 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. Inspect the connecting rods.
   1) When reinstalling, make sure that cylinder numbers put on the connecting rod and cap at disassembly match. When a new connecting rod is installed, make sure that the notches for holding the bearing in place are on the same side.
   2) Replace the connecting rod if it is damaged on the thrust faces at either end. 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 (0.0020 in.) or less for 100mm (3.94 in.)
Allowable twist of connecting rod :
0.10mm (0.0039 in.) or less for 100mm (3.94 in.)

Crankshaft

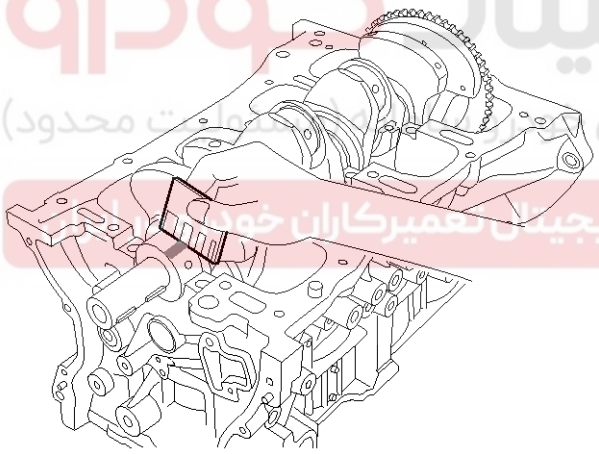
1. Check the crankshaft bearing oil clearance.
   1) To check main bearing-to-journal oil clearance, remove the main caps and bearing halves.
   2) Clean each main journal and bearing half with a clean shop tower.
   3) Place one strip of plastigage across each main journal.
   4) Reinstall the bearings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

Tightening torque
14.7N.m (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 (0.00079 ~ 0.00150in.)



SYFEM0122N

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

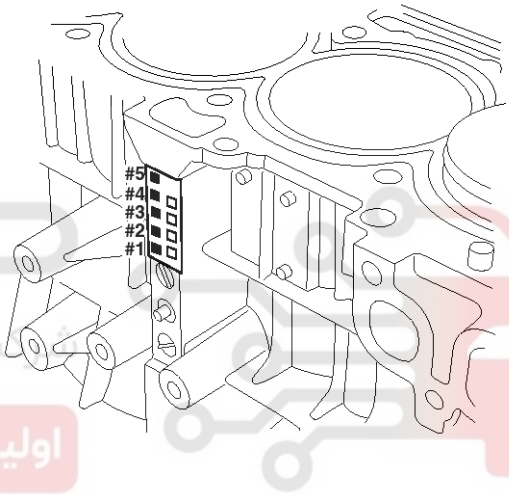
CAUTION
Do not file, shim, or scrape the bearings or the caps to adjust clearance.

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

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

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

Crankshaft Bore Identification Mark



SYFEM0054N

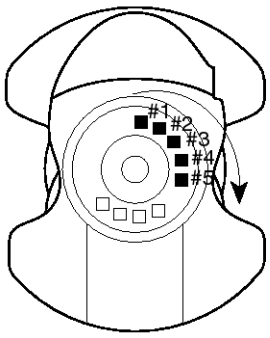
Letters have been stamped on the block as a mark for the size of each of the 5 main journal bores.

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

Cylinder Block Specifications

Calss	Mark	Inside Diameter
a	A	56.000 ~ 56.006mm (2.20472 ~ 2.20496in.)
b	B	56.006 ~ 56.012mm (2.20496 ~ 2.20519in.)
c	C	56.012 ~ 56.018mm (2.20519 ~ 2.20543in.)

Crankshaft Journal Identification Mark



SNFEM8092L

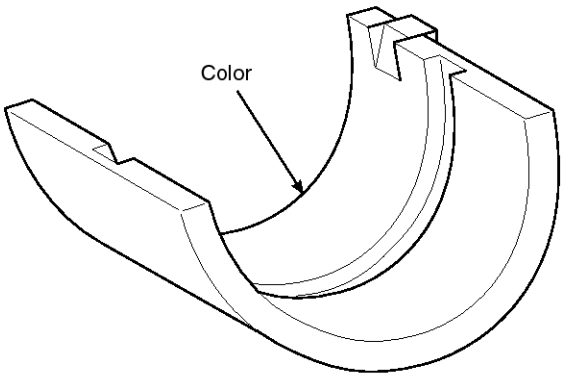
NOTICE

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

Crankshaft Specifications

Class	Mark	Outside Diameter Of Journal
I	1	51.954 ~ 51.960mm (2.04543 ~ 2.04567in.)
II	2	51.948 ~ 51.954mm (2.04519 ~ 2.04543in.)
III	3	51.942 ~ 51.948mm (2.04496 ~ 2.04519in.)

Crankshaft Bearing Identification Mark



ECRF022A

Crankshaft Bearing Specifications

Class	Mark	Thickness Of Bearing
AA	Blue	2.026 ~ 2.029mm (0.07976 ~ 0.07988in.)
A	Black	2.023 ~ 2.026mm (0.07965 ~ 0.07976in.)
B	None	2.020 ~ 2.023mm (0.07953 ~ 0.07965in.)
C	Green	2.017 ~ 2.020mm (0.07941 ~ 0.7953in.)
D	Yellow	2.014 ~ 2.017mm (0.07929 ~ 0.07941in.)

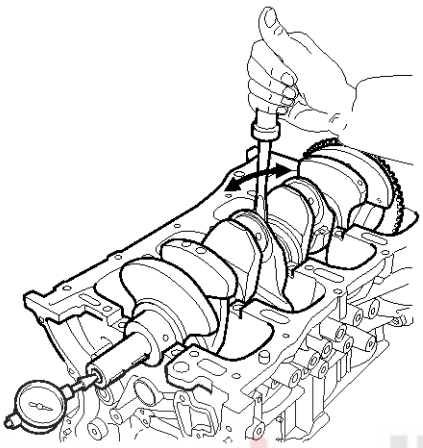
Selection Chart For Crankshaft Bearings

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)

2. Check crankshaft end play.

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

End play
Standard : 0.07 ~ 0.25mm (0.0028 ~ 0.0098in.)
Limit : 0.30mm (0.0118in.)



SYFEM0123N

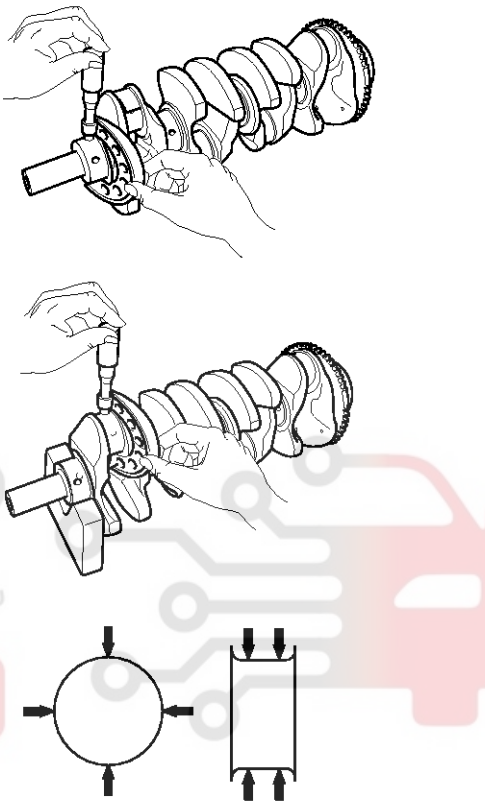
If the end play is greater than maximum, replace the thrust bearings as a set.

Thrust bearing thickness
1.925 ~ 1.965mm (0.07579 ~ 0.07736in.)

3. 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 (2.04496 ~ 2.04567in.)
Crank pin diameter :
47.954 ~ 47.972mm (1.88795 ~ 1.88866in.)



SYFEM0124N

Cylinder Block

1. Remove gasket material.

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

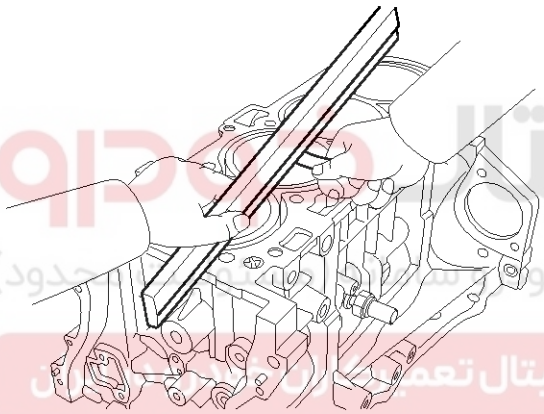
2. Clean cylinder block

   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 (0.0019in.) for all
Less than 0.02 (0.0007in.) for 100mm (3.9370in.) x 100mm (3.9370in.)



SYFEM0125N

4. Inspect cylinder bore diameter.

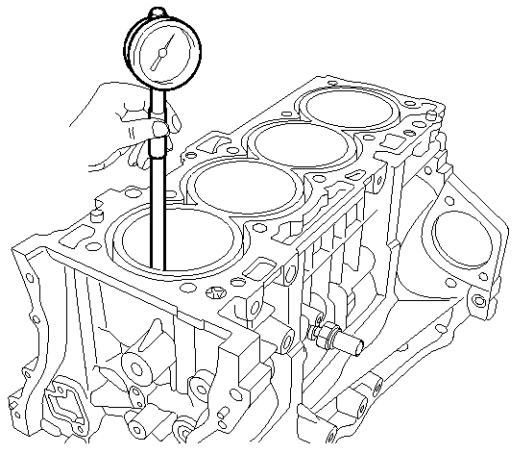
   Visually check the cylinder for vertical scratchs.

   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
88.00 ~ 88.03mm (3.4645 ~ 3.4657in.)

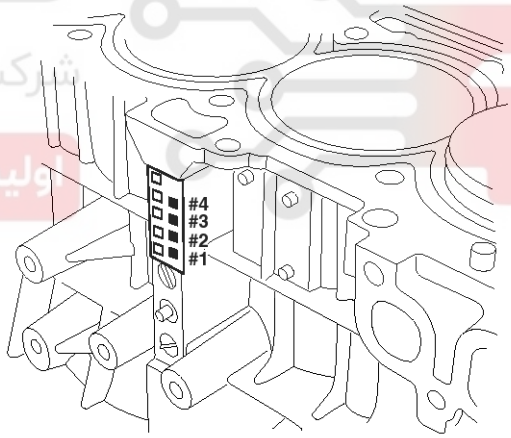


SYFEM0126N

NOTICE
Measure position points (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.

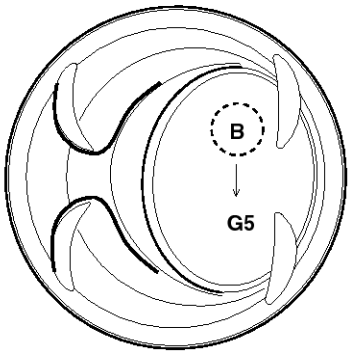


SYFEM0127N

Cylinder Bore Inner Diameter

Size Co-de	Cylinder Bore Inner Diameter
A	88.00 ~ 88.01mm (3.4645 ~ 3.4649in.)
B	88.01 ~ 88.02mm (3.4649 ~ 3.4653in.)
C	88.02 ~ 88.03mm (3.4653 ~ 3.4657in.)

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



STFM11030D

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

Piston Outer Diameter

Size Code	Piston Outer Diameter
A	87.970 ~ 87.980mm (3.46338 ~ 3.46377in.)
B	87.980 ~ 87.990mm (3.46377 ~ 3.46417in.)
C	87.990 ~ 88.000mm (3.46417 ~ 3.46456in.)

8. Select the piston related to cylinder bore class.

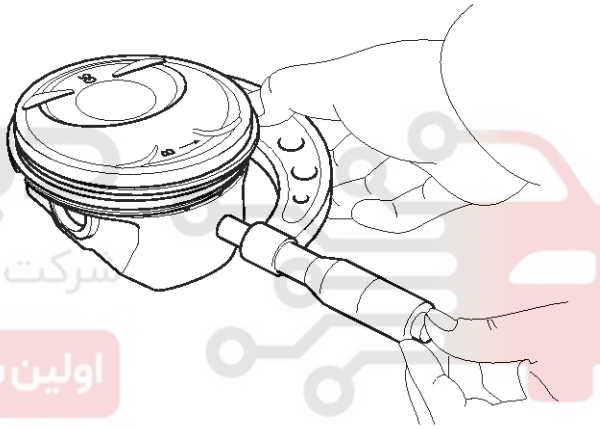
Clearance : 0.020 ~ 0.040mm (0.00079 ~ 0.00157in.)

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 17mm (0.67in.) from the top land of the piston.

Standard diameter
87.970 ~ 88.000mm (3.46338 ~ 3.46456in.)



SYFEM0128N

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

Piston-to-cylinder clearance
0.020 ~ 0.040mm (0.00079 ~ 0.00157in.)

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 : 0.050 ~ 0.080mm (0.00197 ~ 0.00315in.)

No.2 : 0.040 ~ 0.080mm (0.00157 ~ 0.00315in.)

Oil ring : 0.020 ~ 0.055mm (0.00079 ~ 0.00217in.)

Limit

No.1 : 0.100mm (0.00394in.)

No.2 : 0.100mm (0.00394in.)

Oil ring : 0.60mm (0.0236in.)

SYFEM0129N

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

5. Inspect piston ring end gap.

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

Piston ring end gap

Standard

No.1 : 0.15 ~ 0.30mm (0.0059 ~ 0.0118in.)

No.2 : 0.37 ~ 0.52m (0.0145 ~ 0.0204in.)

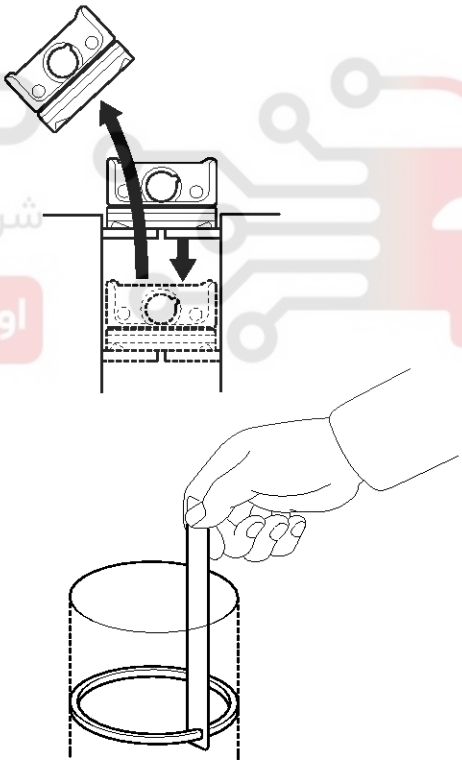
Oil ring : 0.20 ~ 0.50mm (0.0079 ~ 0.0197in.)

Limit

No.1 : 0.60mm (0.0236in.)

No.2 : 0.70mm (0.0275in.)

Oil ring : 0.80mm (0.0315in.)

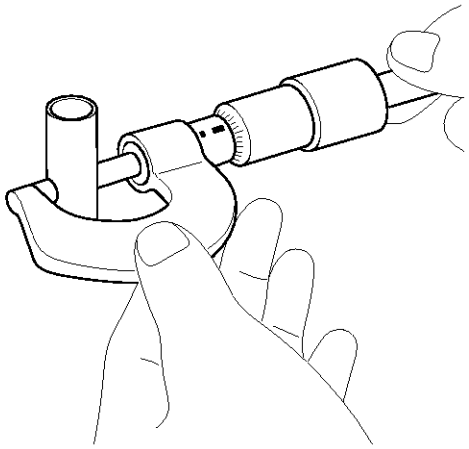


KCRF217A

Piston Pins

1. Measure the diameter of the piston pin.

Piston pin diameter
21.997 ~ 22.000mm (0.86602 ~ 0.86614in.)



KCRF218A

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

Piston pin-to-piston clearance
0.003 ~ 0.010m (0.00012 ~ 0.00039in.)

3. Check the difference between the piston pin diameter and the connecting rod bushing oil clearance.

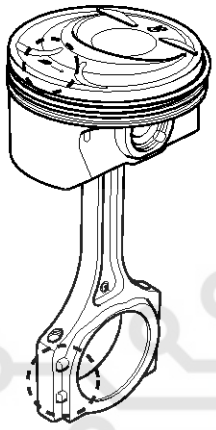
Piston pin-to-connecting rod interference
0.005 ~ 0.014mm (0.00020 ~ 0.00055in.)

Reassembly

NOTICE

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

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



SYFEM0059N

   2) Before pressing the piston pin, apply a coat of lubricant oil to the piston pin outer and connecting rod.

CAUTION

- **Take care that piston pin is not damaged during reassemble.**
- **When replace the piston pin, check the piston pin outer diameter and connecting rod small end inner diameter as below.**

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

  Piston pin hole inner diameter : 22.003mm ~ 22.007mm (0.8662 ~ 0.8664in)

  Connecting rod small end inner diameter : 22.005 ~ 22.011mm (0.8663 ~ 0.8665in)

  Interference : -0.014mm ~ -0.005mm (0.0006 ~ 0.0002in)

3) Set the snap ring in one side of piston pin hole and insert the piston pin into the piston pin hole & the small end bore of connecting rod while meeting the front mark of connecting rod & piston.

CAUTION

Be sure to keep the small end bore, pistonpin hole & piston pin from being damaged and scratched when inserting the piston pin.

NOTICE

Assembling condition

Temperature : piston side 70 to 80C , conrod & pin is to be normal room temperature.

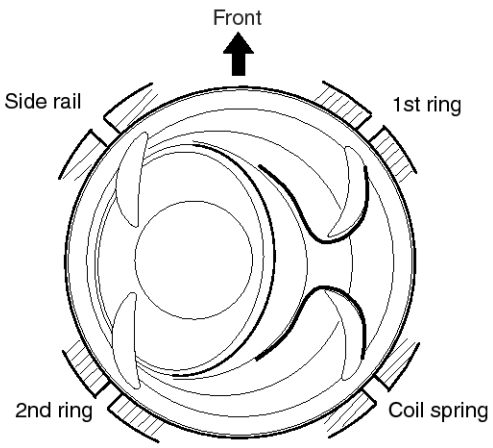
4) After inserting the piston pin, set the snap ring of the other side.

CAUTION

Set the snap ring so that it contacts completely with the groove of the piston pinhole.

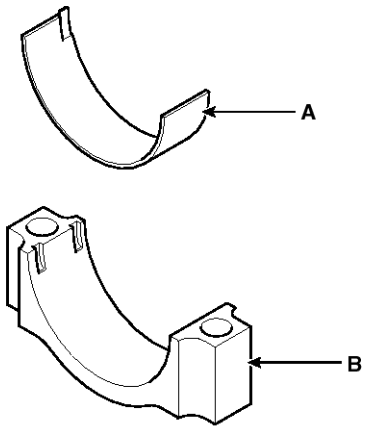
The snap ring must not be deformed from the installation tooling method.

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



SYFM21002L

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



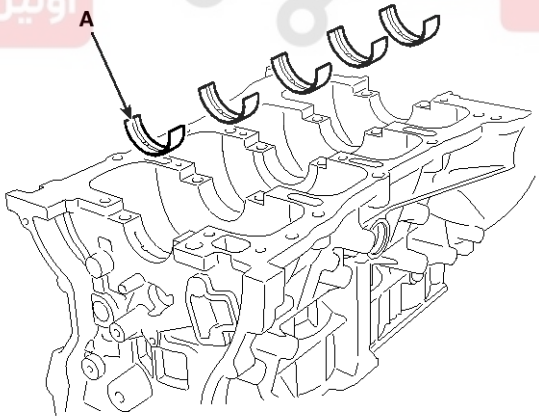
KCRF118B

4. Install the main bearings.

NOTICE

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

   1) Align the bearing claw with the claw groove of the cylinder block, push in the 5 upper bearings(A).

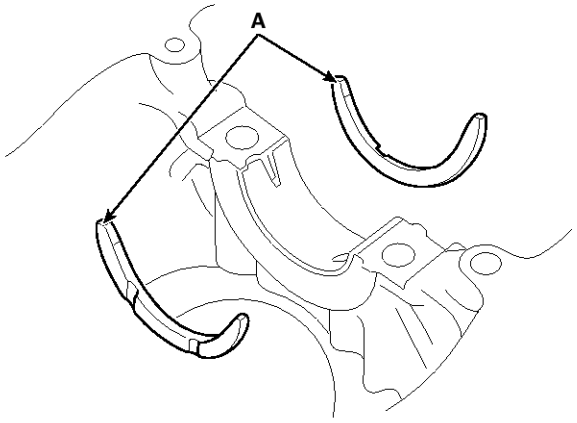


KCRF173A

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

5. Install the thrust bearings.

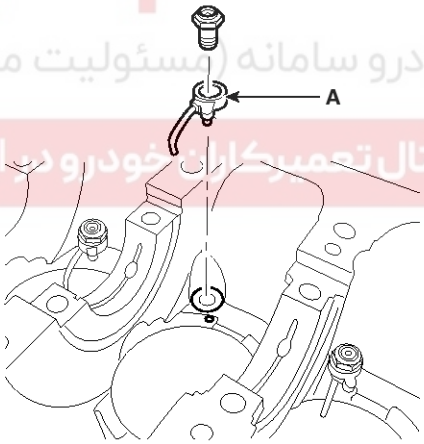
   Install the 2 thrust bearings(A) under the No.3 journal position of the cylinder block with the oil grooves facing outward.



KCRF222A

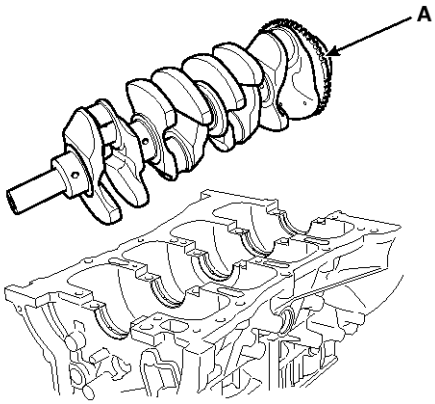
6. Install the oil jet (A).

Tightening torque
24.5 ~ 29.4Nm (2.5 ~ 3.0kgf.m, 18.1 ~ 21.7lb-ft)



SYFEM0051N

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



SYFEM0118N

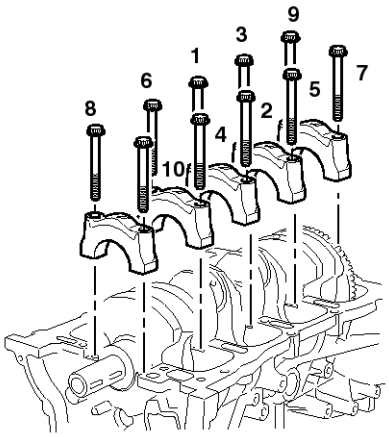
8. Place the main bearing caps on cylinder block.
9. Install the main bearing cap bolts.

CAUTION
Always use new main bearing cap bolts.

NOTICE
- *The main bearing cap bolts are tightened in 3 progressive steps.*
- *If any of the bearing cap bolts is broken ordeformed, replace it.*

1) Apply a light coat of engine oil on the threads and under the bearing cap bolts.
2) Using the SST (09221-4A000), install and uniformly tighten the 10 bearing cap bolts, in several passes, in the sequence shown.

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



KCRF171A

3) Check that the crankshaft turns smoothly.

10. Check crankshaft end play.
11. 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. Using the SST (09221-4A000), install the rod caps with bearings, and torque the bolts.

Tightening torque

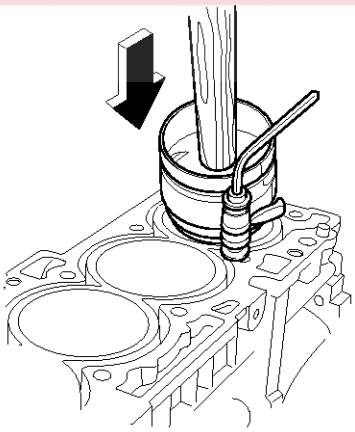
17.7~21.6Nm (1.8~2.2kgf.m, 13.0~15.9lb-ft) + 88~92°

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.

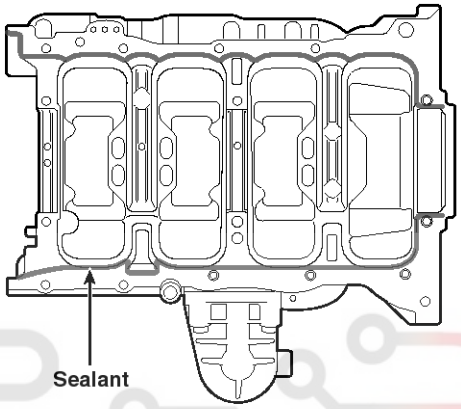


SYFEM0131N

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

NOTICE

- *When assembling ladder frame, the liquid sealant Loctite 5900H, Threebond 1217H or equivalent 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.*

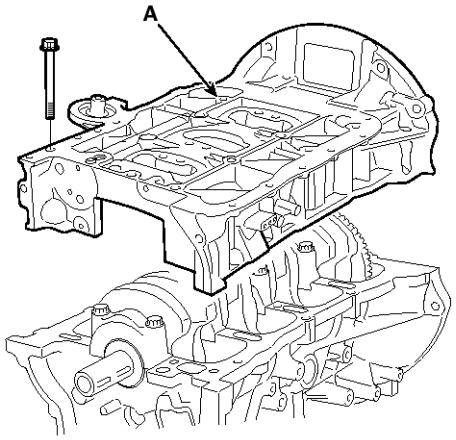


SYFEM0132N

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

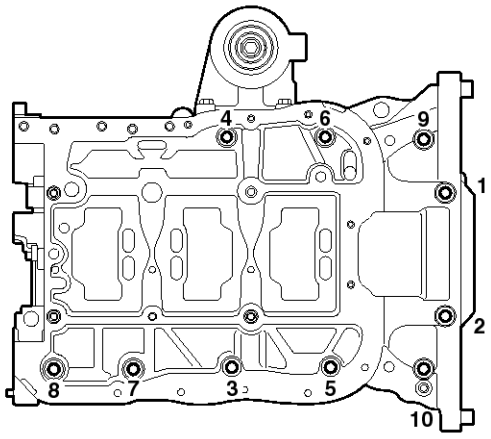
Tightening torque

Step 1 : 8.8 ~ 9.8N.m (0.9 ~ 1.0kgf.m, 6.5 ~ 7.2lb-ft)
Step 2 : 17.7 ~20.6N.m (1.8 ~ 2.1kgf.m, 13.0 ~ 15.2lb-ft)
Step 3 : 27.5 ~ 31.4N.m (2.8 ~ 3.2kgf.m, 20.3 ~ 23.1lb-ft)



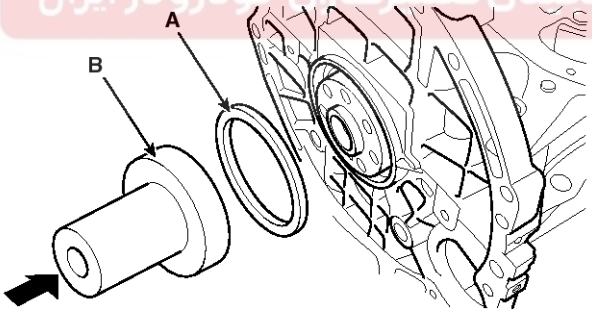
STGEM9037D

1) Tighten the bolts in order number as shown with the 3 steps.
2) Loosen the bolts as reverse tightening order.
3) Tighten the bolts in order number as shown with the 3 steps.



SVGEM0018D

14. Install rear oil seal.
    1) Apply engine oil to a new oil seal lip.
    2) Using SST(09231-H1100, 09214-3K100) (B) and a hammer, tap in the oil seal (A) until its surface is flush with the rear oil seal retainer edge.

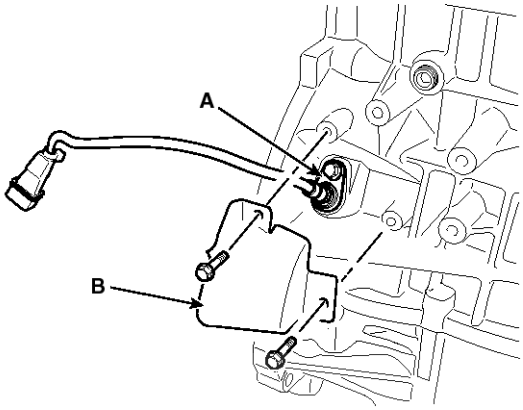


SYFEM0133N

15. Install CKPS (Crankshaft position sensor) (A) and sensor cover (B).

Tightening torque

Sensor bolt, Cover bolt (M6): 9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)
Cover bolt (M8): 18.6 ~ 13.5N.m (1.9 ~ 2.4kgf.m, 13.7 ~ 17.4lb-ft)

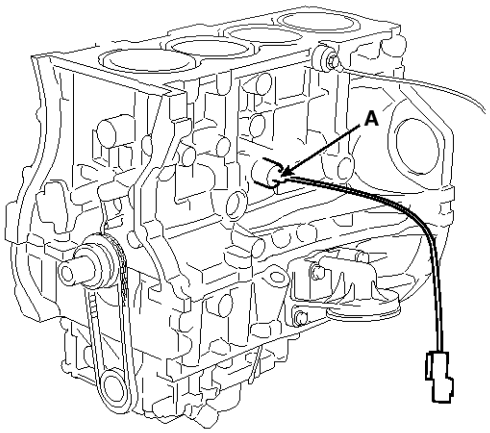


SSLM10124D

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

Tightening torque

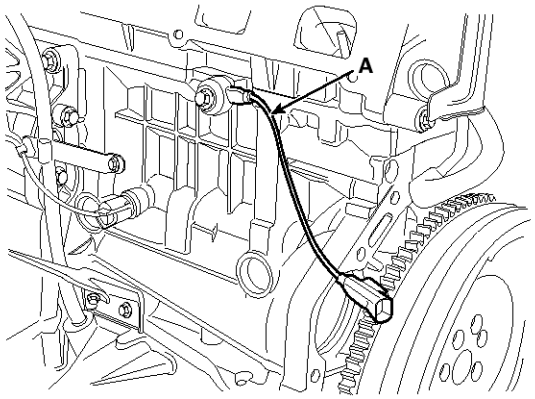
7.8 ~ 11.8N.m (0.8 ~ 1.2kgf.m, 5.8 ~ 8.7lb-ft)



SXMM19092L

17. Install knock sensor(A).

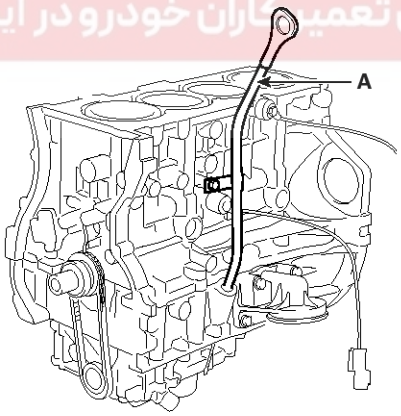
Tightening torque
18.6 ~ 23.5N.m (1.9 ~ 2.4kgf.m, 13.7 ~ 17.4lb-ft)



KCRF143A

18. 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.

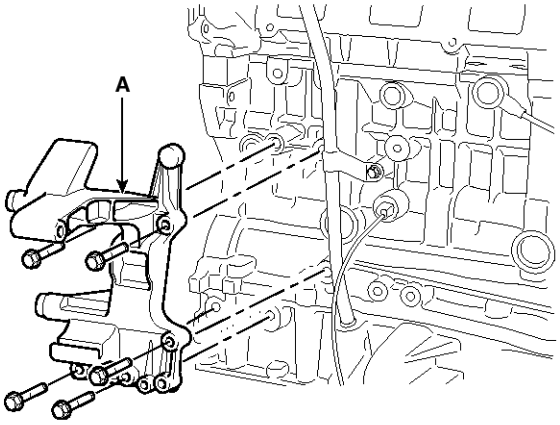
Tightening torque
7.8 ~ 11.8N.m (0.8 ~ 1.2kgf.m, 5.8 ~ 8.7lb-ft)



SXMM19108D

19. Install tensioner assembly integrated bracket(A).

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

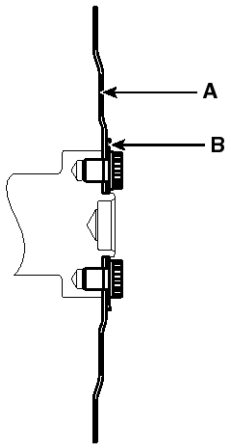


SYFEM0083N

20. Install the water pump. (Refer to Cooling system in this group)
21. Install the alternator. (Refer to EE group)
22. Install the balance shaft & oil pump assembly. (Refer to Lubrication system in this group)
23. Install the cylinder head assembly. (Refer to Cylinder head in this group)
24. Install the timing chain. (Refer to Timing system in this group)
25. Install the intake manifold and exhaust manifold. (Refer to Intake and exhaust system in this group)
26. Remove the engine from the engine stand.

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

Tightening torque :
117.7 ~ 127.5N.m (12.0 ~ 13.0kgf.m, 86.8 ~ 93.9lb-ft)



KCRF224A

MT : Install the flywheel.

Tightening torque :
117.7 ~ 127.5N.m (12.0 ~ 13.0kgf.m, 86.8 ~ 93.9lb-ft)

NOTICE

- *Always use new drive plate (or flywheel) bolts.*
- *Apply sealant to the screw part (10mm from the end of the bolt) when reusing the drive plate bolts.*

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

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

28. Install the engine assembly on the vehicle.

(Refer to Engine and transaxle assembly in this group)

Add all fluids to their normal operating levels.

Cooling System

Coolant

Refilling And Bleeding

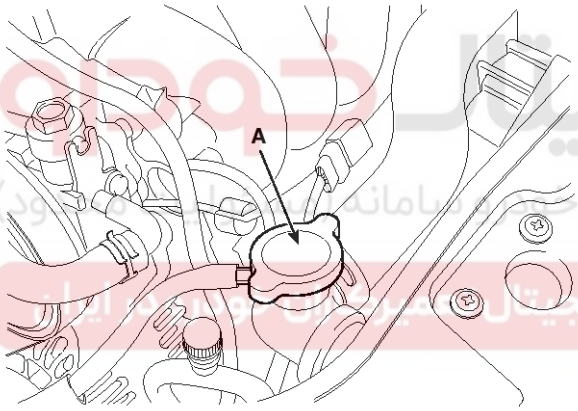
WARNING

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

CAUTION

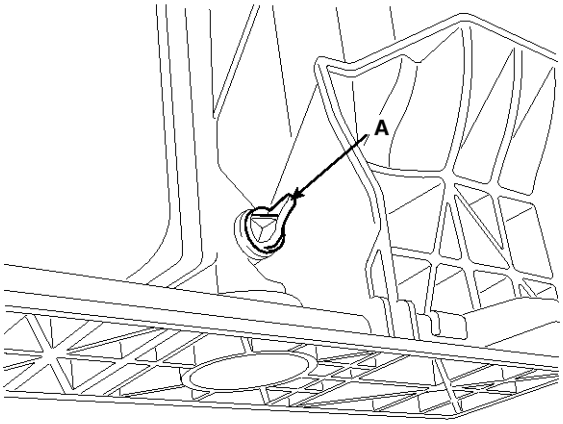
When pouring engine coolant, be sure to shut the relay box lid and not to let coolant spill on the electrical parts or the paint. If any coolant spills, rinse it off immediately.

1. Make sure the engine and radiator are cool to the touch.
2. Remove radiator cap (A).



STFM21002D

3. Loosen the drain plug (A), and drain the coolant.



STFM21003D

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

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

    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 until coolant circulates.

    When the cooling fan operates and coolant circulates, refill coolant through the radiator cap.

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

NOTICE

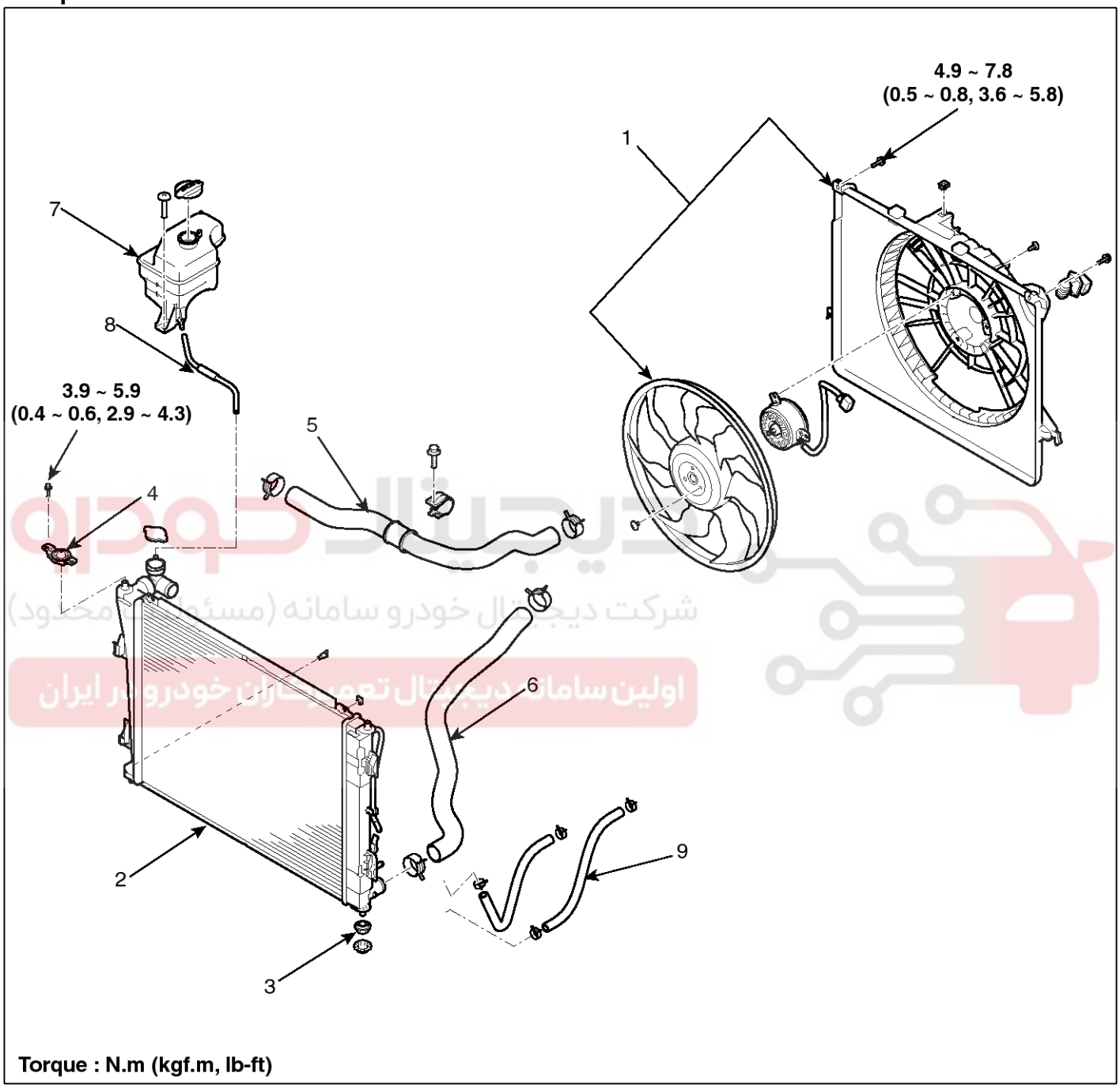
It takes time to bleed out all the air in the cooling system. Refill coolant when coolant gets cool completely, when recheck the coolant level in the reservoir tank for 2~3 days after replacing coolant.

Coolant capacity :

6.8L (1.79 U.S.gal., 7.18 U.S.qt., 5.98 lmp.qt.)

Radiator

Components

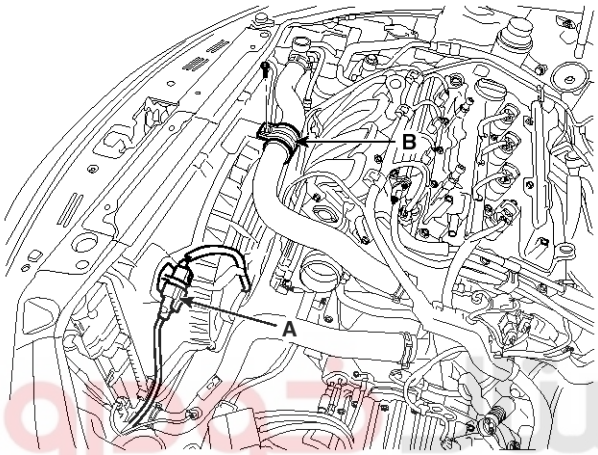


SYFEM0134N

1. Cooling fan assembly
2. Radiator
3. Mounting insulator
4. Radiator mounting bracket
5. Radiator upper hose
6. Radiator lower hose
7. Reservoir tank
8. Over flow hose
9. ATF cooler hose

Removal and Installation

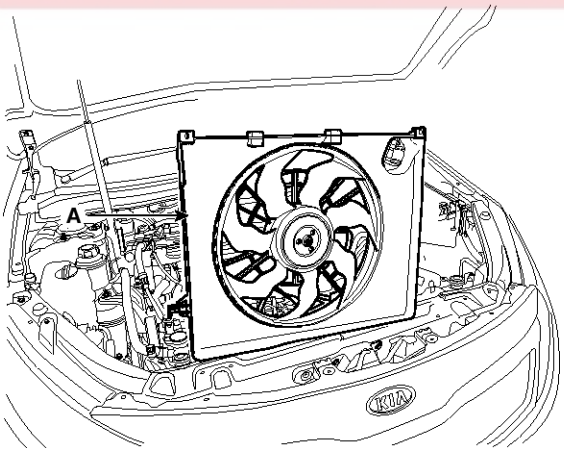
1. Disconnect the battery terminals. (Refer to Engine and transaxle assembly in this group)
2. Remove the air cleaner assembly. (Refer to Engine and transaxle assembly in this group)
3. Remove the battery and battery tray. (Refer to Engine and transaxle assembly in this group)
4. Disconnect the fan motor connector (A)
5. Remove the radiator upper hose clip bolt (B).



STFEM1047D

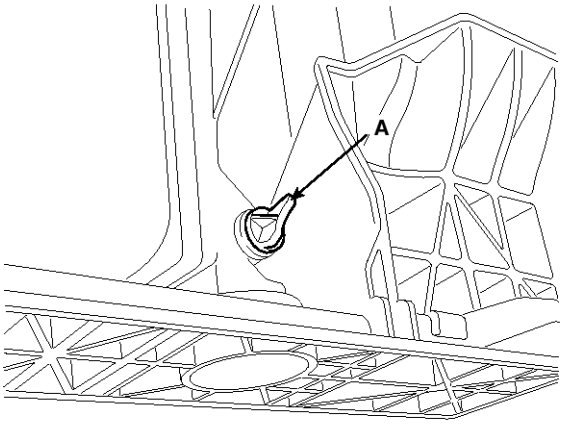
6. Remove the cooling fan assembly (A).

Tightening torque :
4.9 ~ 7.8 N.m (0.5 ~ 0.8 kgf.m, 3.6 ~ 5.8 lb-ft)



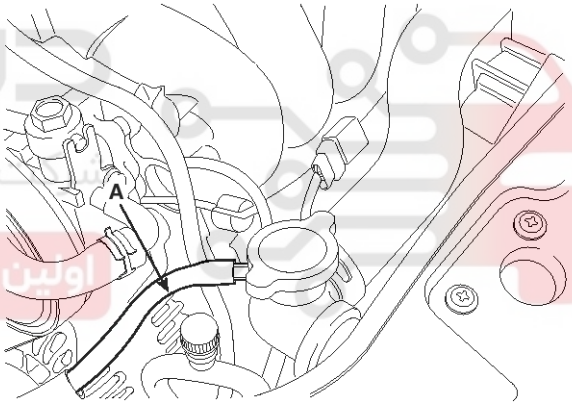
STFM21130D

7. Remove the under cover. (Refer to Engine and transaxle assembly in this group)
8. Loosen the drain plug (A), and drain the engine coolant. Remove the radiator cap to help drain the coolant faster.



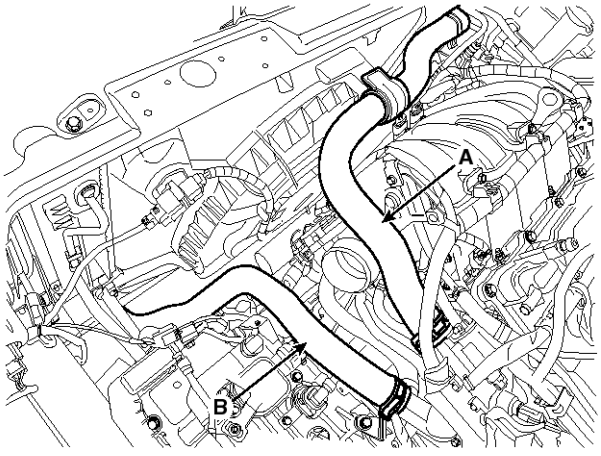
STFM21003D

9. Disconnect the over flow hose (A) from the radiator.



STFM21131D

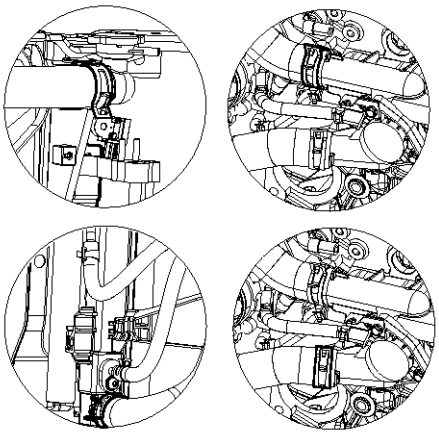
10. Disconnect the radiator upper hose (A) and lower hose (B).



SYFEM0029N

NOTICE

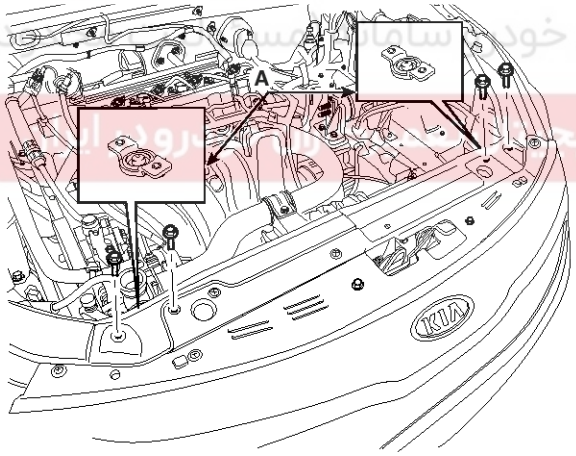
When installing radiator hoses, install as shown in illustrations.



SVGEM0104D

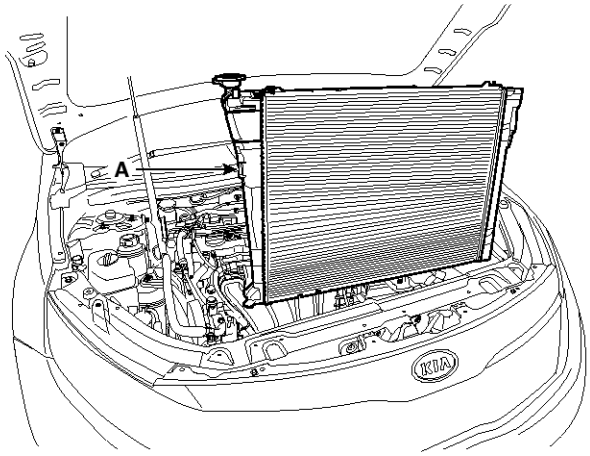
11. Disconnect the ATF cooler hoses (A/T only). (Refer to AT group)
12. Remove the radiator mounting brackets (A).

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



STFEM1017D

13. Separate the condenser from the radiator and then remove the radiator assembly (A).



STFEM1021D

14. Installation is the reverse order of removal.
15. Fill the radiator with coolant and check for leaks.

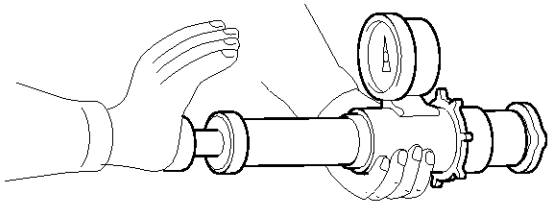
NOTICE

- *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 engine. Check the coolant level and add coolant if needed. This will allow trapped air to be removed from the cooling system.*
  - *Put the radiator cap on tightly, then run engine again and check for leaks.*

Inspection

Radiator Cap Testing

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

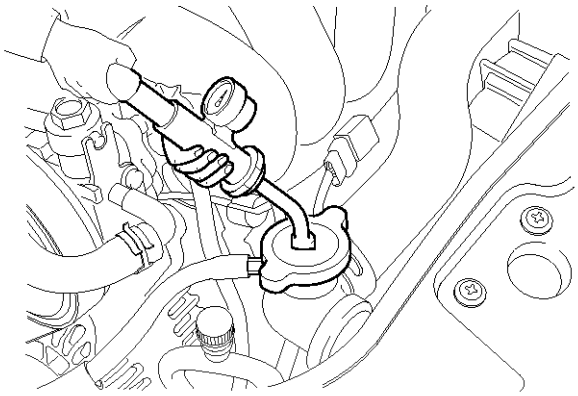


ECKD501X

2. Apply a pressure of 93.16 ~ 122.58kPa (0.95 ~ 1.25kgf/cm², 13.51 ~ 17.78psi).
3. Check for a drop in pressure.
4. If the pressure drops, replace the cap.

Radiator Leakage Test

1. Wait until engine is cool, then carefully remove the radiator cap and fill the radiator with engine coolant, then install it on the pressure tester.
2. Apply a pressure tester to the radiator and apply a pressure of 93.16 ~ 122.58kPa (0.95 ~ 1.25kgf/cm², 13.51 ~ 17.78psi).



STFM21129D

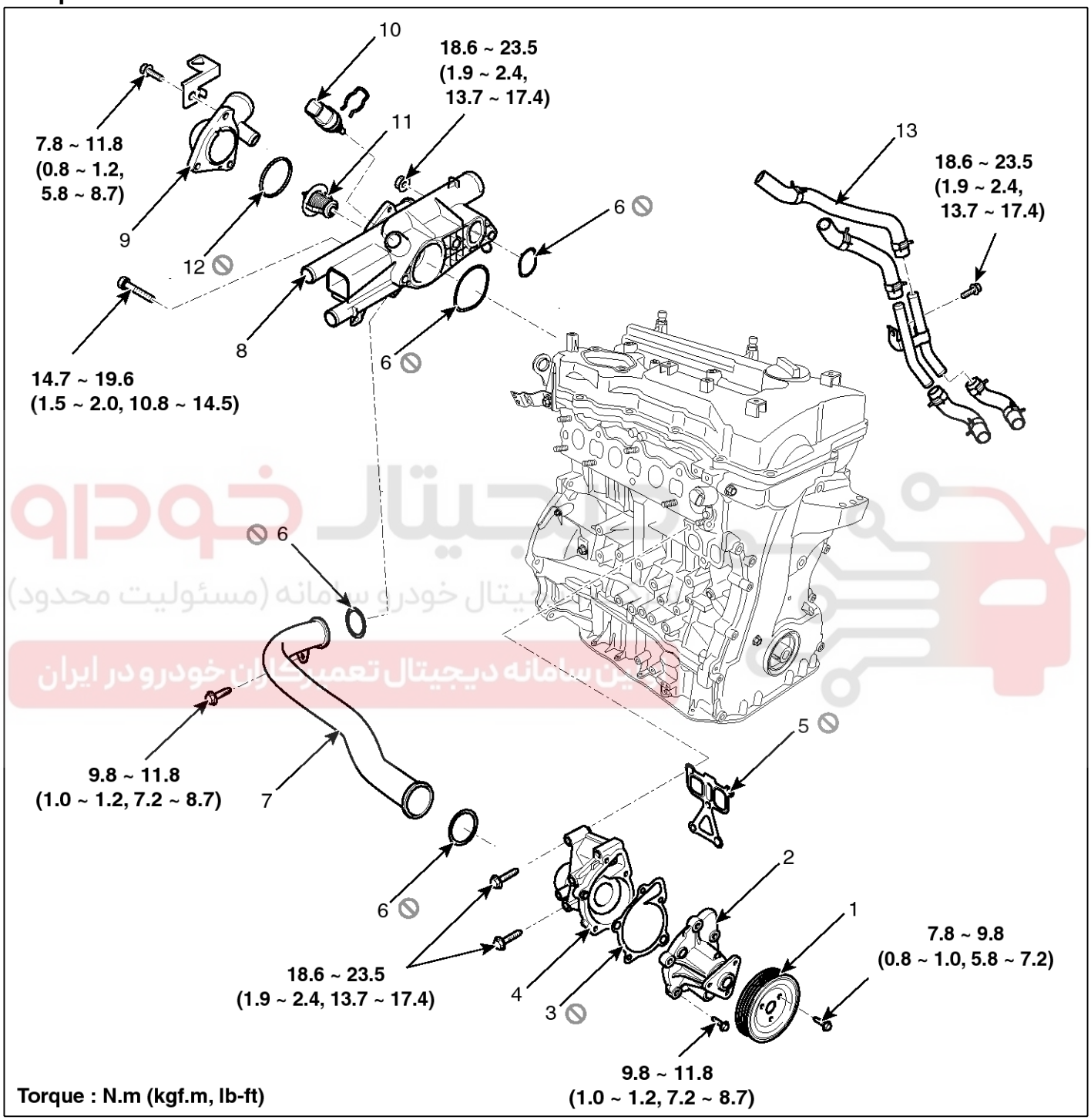
3. Inspect for engine coolant leaks and a drop in pressure.
4. Remove the tester and reinstall the radiator cap.

NOTICE

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

Water pump

Components

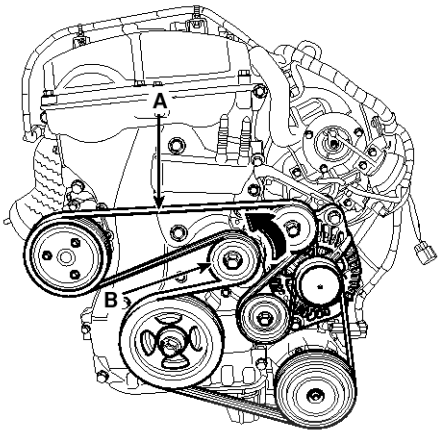


STFM1008N

1. Water pump pulley
2. Water pump
3. Water pump gasket
4. Water pump housing
5. Water pump housing gasket
6. O-ring
7. Water inlet pipe
8. Water temperature control assembly
9. Water inlet fitting
10. Engine coolant temperature sensor
11. Thermostat
12. Thermostat gasket
13. Throttle body coolant hose
14. Oil cooler coolant hose

Removal and Installation

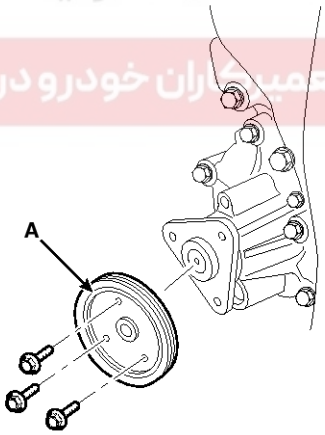
1. Loosen the drain plug, and then drain the engine coolant. Remove the radiator cap to help drain the coolant faster.
2. Remove the drive belt (A) after turning the drive belt tensioner (B) counterclockwise.



STFM11024D

3. Remove the water pump pulley (A).

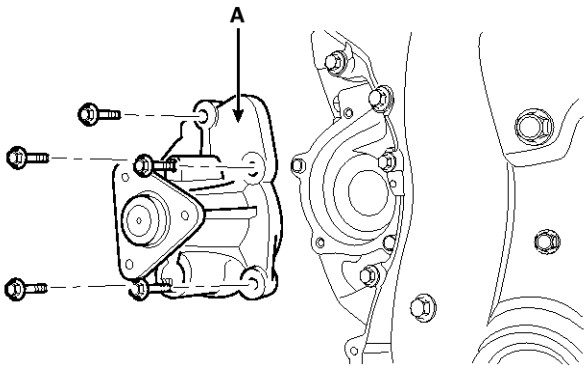
Tightening torque :
7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8~ 7.2lb-ft)



SYFEM0164N

4. Remove the water pump sub assembly (A) with the gasket.

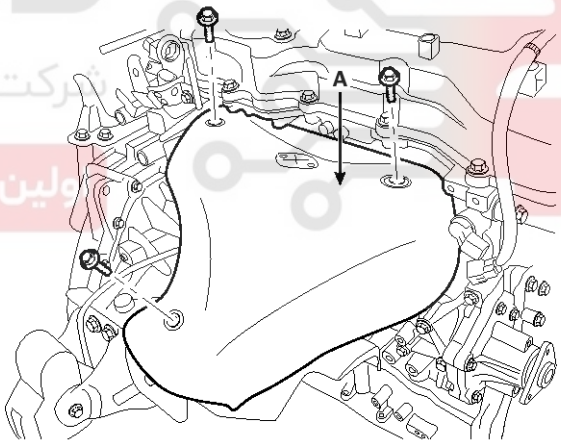
Tightening torque :
9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)



SYFEM0064N

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

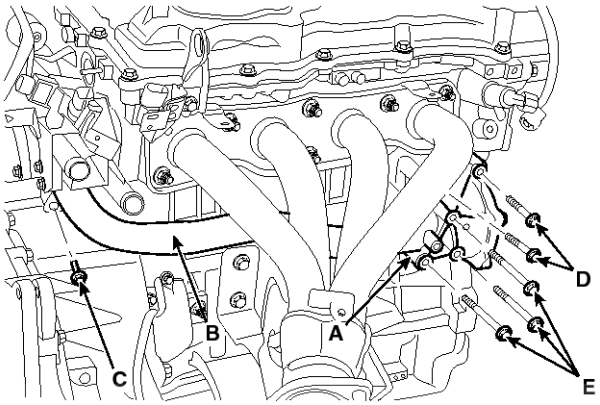
Tightening torque :
7.8 ~ 11.8N.m (0.8 ~ 1.2kgf.m, 5.8 ~ 8.7lb-ft)



SYFEM0065N

6. Remove the water pump housing (A) with the gasket and the water inlet pipe (B).

Tightening torque :
Bolt (C) : 9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)
Bolt (D, E) : 18.6 ~ 23.5N.m (1.9 ~ 2.4kgf.m, 13.7 ~ 17.4lb-ft)



SYFEM0066N

7. Installation is reverse order of removal with a new water pump gasket.
8. Fill the engine coolant.
9. Start the engine and check for leaks.
10. Recheck the coolant level.

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.

Troubleshooting

Water Pump

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

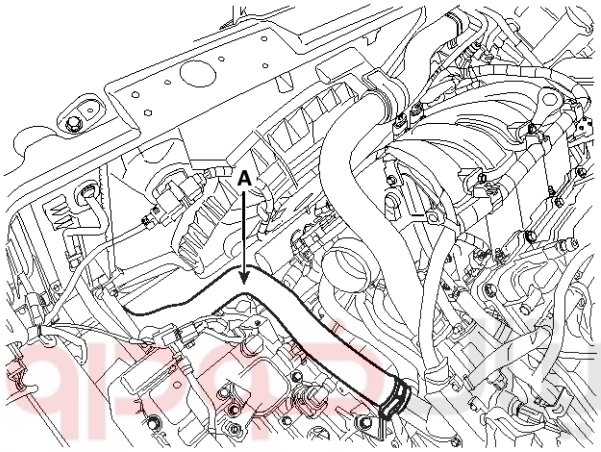
Thermostat

Removal and Installation

NOTICE

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

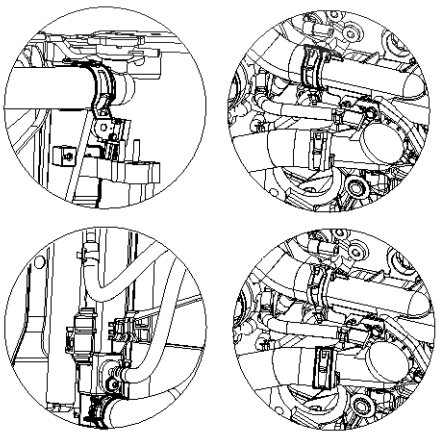
1. Drain engine coolant so its level is below thermostat.
2. Disconnect the radiator lower hose (A).



SYFEM0165N

NOTICE

When installing radiator hoses, install as shown in illustrations.

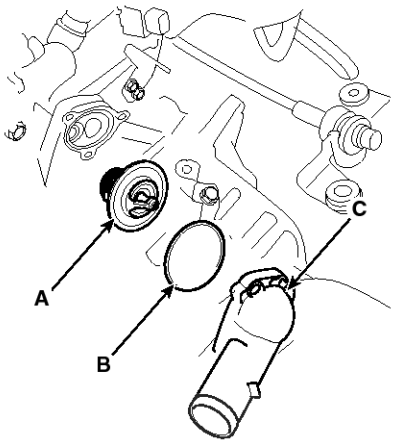


SVGEM0104D

3. Remove water inlet fitting (C), gasket (B) and thermostat (A).

Tightening torque :

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



SYFEM0136N

4. Installation is reverse order of removal.

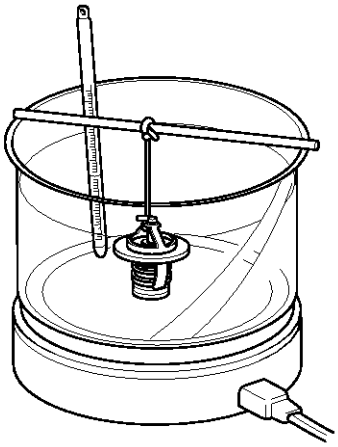
NOTICE

Install the thermostat with the jiggle valve upward.

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

Inspection

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



KCRF226A

2. Check the valve opening temperature.

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

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

3. Check the valve lift.

Valve lift : 8mm (0.3in.) or more at 95˚C (203˚F)

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

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 blows-out) • Thermogauge indicates 'LOW'	Visually check after removing the radiator cap.	• Insufficient coolant or leakage.	• After refilling coolant, recheck.
		GDS check & Starting engine	• Check DTCs • Check the fan motor performance as temperature varies. • 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. • Check the fan motor, the relay and the connector. • Replace the componants .
		Remove the thermostat and inspect	• Check if there are dusts or chips in the thermostat valve. • Check adherence of the thermostat.	• Clean the thermostat valve and reuse the thermostat. • Replace the thermostat, if it doesn't work properly .

Symptoms		Possible Causes		Remedy
Heated excessively	• Engine overheated • Thermogauge indicates 'HI'	Visually check after removing the radiator cap.	• Insufficient coolant or leakage. ※ Be careful when removing a radiator cap of the overheated vehicle. • Check air in cooling system.	• After refilling coolant, recheck. • Check the cylinder head gaskets for damage and the tightening torque of the mounting bolts.
		GDS check & Starting engine	• Check DTCs • Check the fan motor performance as temperature varies. • Check if the fan clutch slips. • Check the water pump adherence or impeller damaged.	• Check the engine coolant sensor, wiring and connectors. • Check the fan motor, the relay and the connector. • Replace the fan clutch, if it doesn't work properly. • Replace the water pump, if it doesn't work properly .
		Immerse the thermostat in boiling water and inspection.	• After removing the thermostat, check it works properly. ※ Check the thermostat opens at the valve opening temperature.	• Replace the thermostat, if it doesn't work properly .

Lubrication System

Engine Oil

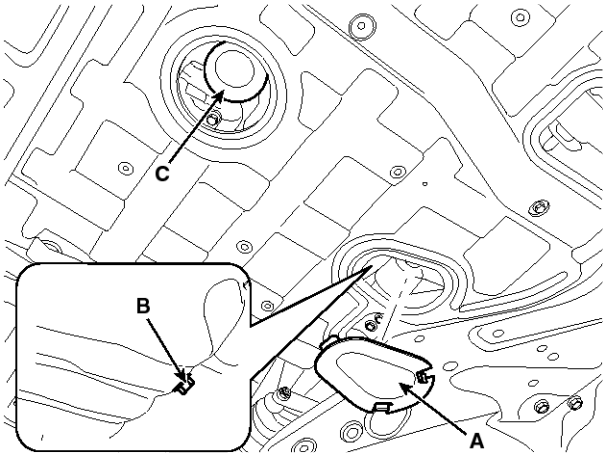
Oil And Filter Replacement

CAUTION

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

1. Park the car on level ground.
   Start the engine and let it warm up.
2. Drain engine oil.
   1) Remove the oil filler cap.
   2) After lifting the car, remove the oil drain plug hole cover (A).
   3) Remove the oil drain plug (B) and drain oil into a container.
3. Replace the oil filter (C).
   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)



STFM11005D

4. Install the oil drain plug with a new gasket.

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

5. Fill with new engine oil, after removing the engine oil level gauge.

Capacity :
Total : 5.5 L (1.45 U.S.gal., 5.81 U.S.qt., 4.84 lmp.qt.)
Oil pan : 4.2 L (1.11 U.S.gal., 4.44 U.S.qt., 3.70 lmp.qt.)
Drain and refill including oil filter :
4.6 L (1.22 U.S.gal., 4.86 U.S.qt., 4.05 lmp.qt.)

6. Install the oil filler cap.
7. Start engine and check for oil leaks and check the oil gauge or light for an indication of oil pressure.
8. Recheck the engine oil level.

Inspection

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

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

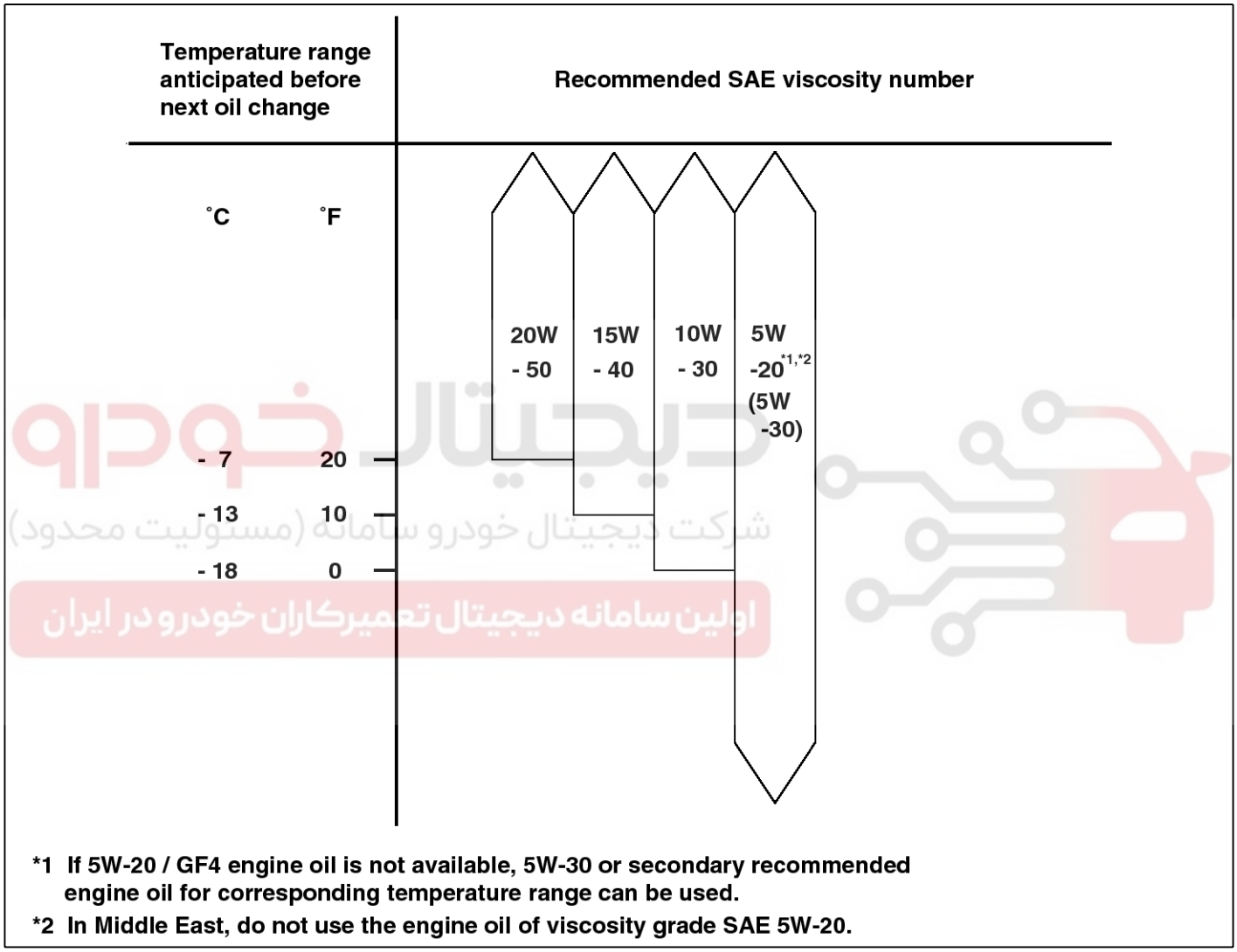
Selection Of Engine Oil

Recommendation : 5W-20/GF4&SM (If not available, refer to the recommended API or ILSAC classification

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

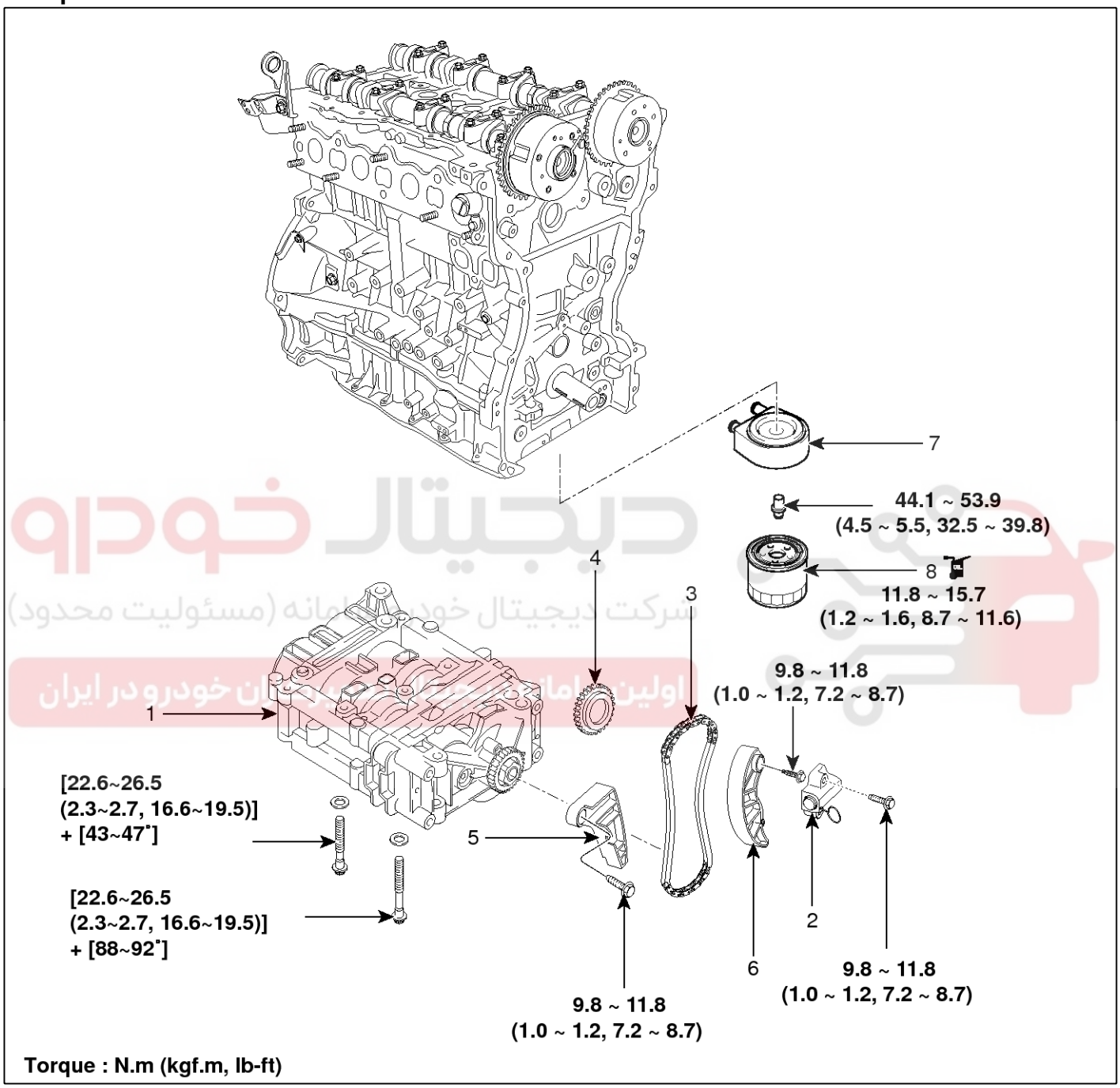
NOTICE

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.*

Balance Shaft & Oil Pump

Components

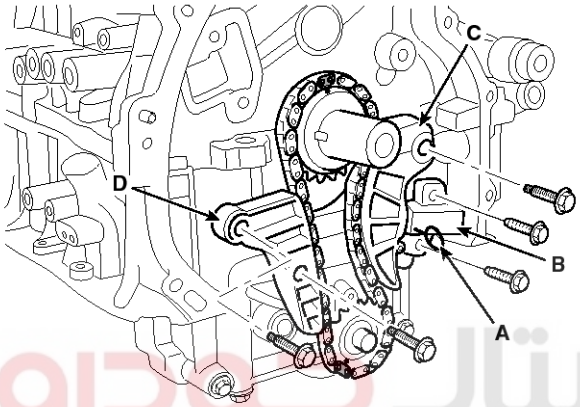


STFM1009N

1. Balance shaft & oil pump assembly
2. Balance shaft chain tensioner
3. Balance shaft chain
4. Balance shaft chain sprocket
5. Balance shaft chain guide
6. Balance shaft chain tensioner arm
7. Oil cooler
8. Oil filter

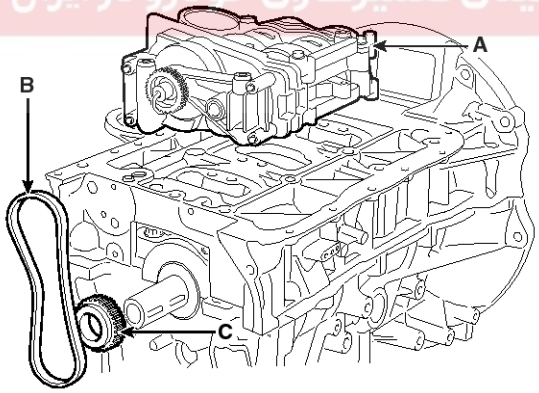
Removal

1. Remove the timing chain. (Refer to Timing system in this group)
2. Install a stopper pin (A) after compressing the balance shaft chain tensioner.
3. Remove the balance shaft chain hydraulic tensioner (B).
4. Remove the balance shaft chain tensioner arm (C).
5. Remove the balance shaft chain guide (D).



SYFEM0067N

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



SSLM10156N

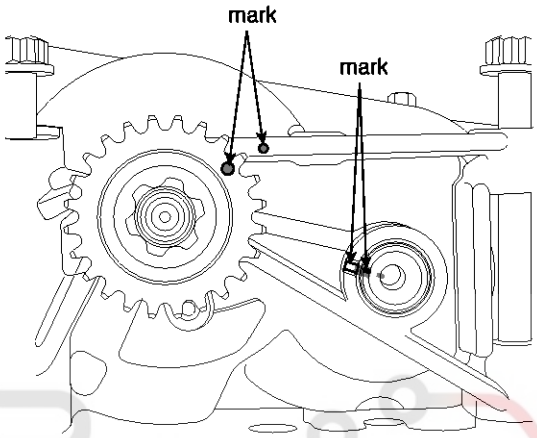
CAUTION

Do not disassemble the balance shaft & oil pump module.

Installation

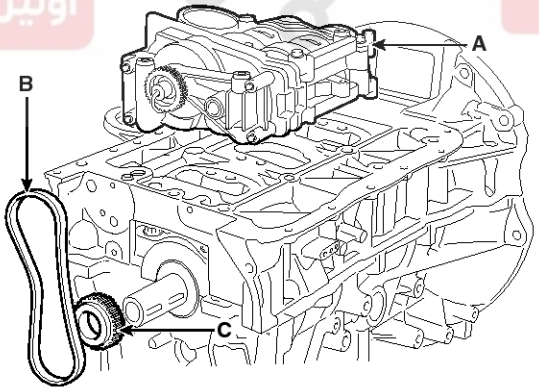
1. The key of crankshaft should be aligned with the mating face of main bearing cap. As a result of this, the piston of No.1 cylinder is placed at the top dead center on compression stroke.
2. Confirm the balance shaft & oil pump module timing mark.

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



SNFEM8095L

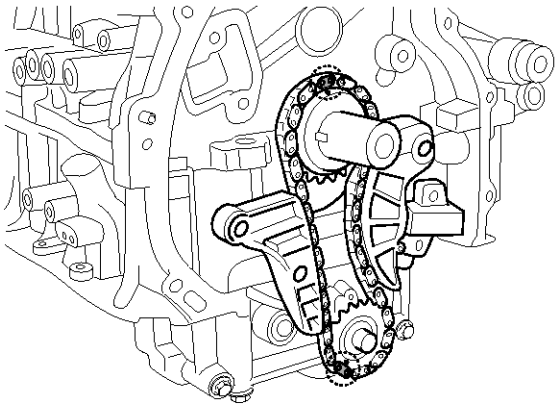
3. Install the balance shaft & oil pump module (A) with the chain (B) and the sprocket (C).



SSLM10156N

NOTICE

The timing marks of balance shaft & oil pump module sprocket and crankshaft sprocket should be matched with the timing marks (color link) of balance shaft chain.



SYFEM0162N

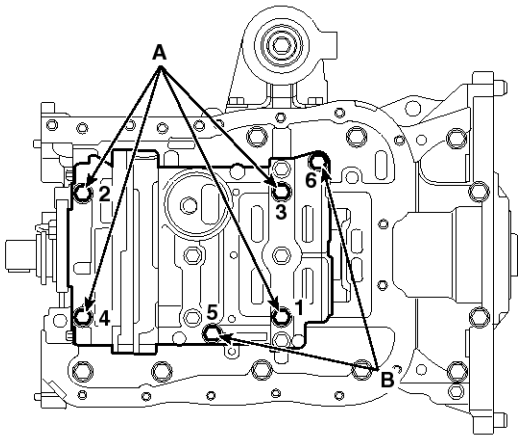
Tightening order

1) Tighten the bolts in order number as shown with seating torque 26.4 N.m (3.0kgf.m, 21.7 lb-ft) and then loosen the bolts as reverse tightening order. (6-5-4-3-2-1).
2) Using the SST (09221-4A000), tighten the bolts as specified tightening order in same increments as follows.

Tightening torque :

Bolts (A) (M9x181.5) : 22.6~26.5N.m (2.3~2.7kgf.m, 16.6~19.5lb-ft) + 88~92°

Bolts (B) (M9x95) : 22.6~26.5N.m (2.3~2.7kgf.m, 16.6~19.5lb-ft) + 43~47°



SSLEM0001N

4. Install the balance shaft chain guide (D).

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 (C).

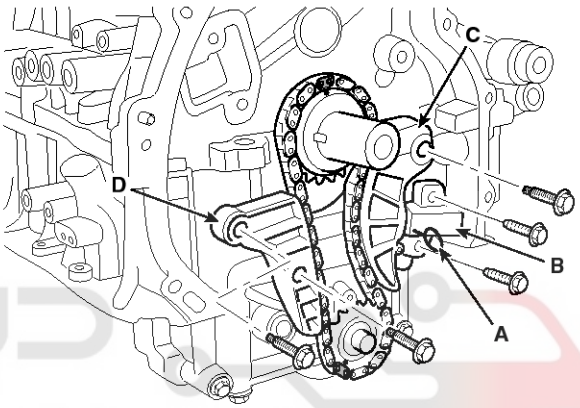
Tightening torque :

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

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

Tightening torque :

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



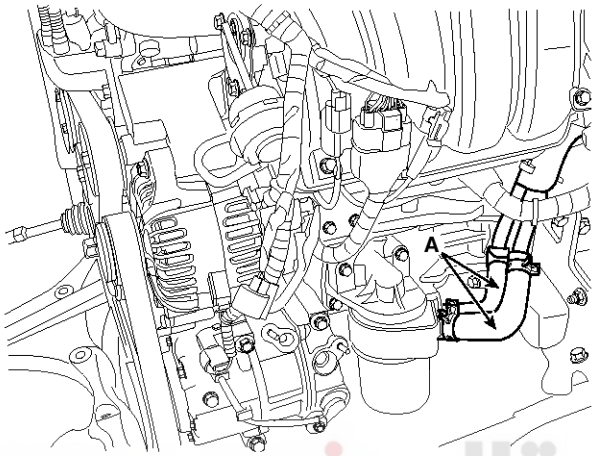
SYFEM0067N

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

Oil Cooler

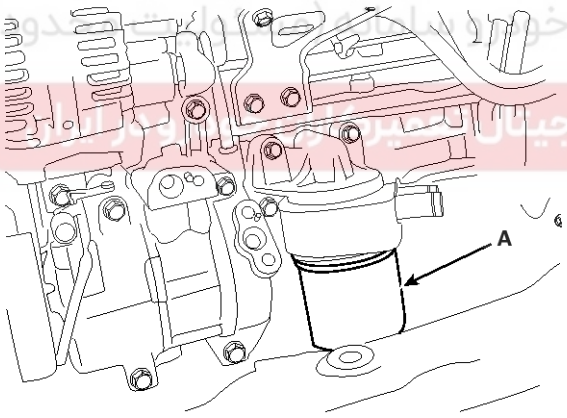
Removal

1. Loosen the drain plug, and drain the coolant. Remove the radiator cap to help drain the coolant faster.
2. Disconnect the oil cooler coolant hoses (A).



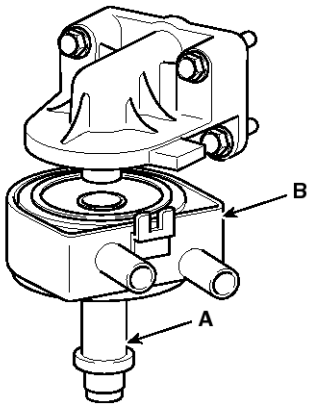
SYFEM0163N

3. Remove the oil filter (A).



SXMM19031D

4. Loosen the mounting bolt (A) and remove the oil cooler assembly (B).

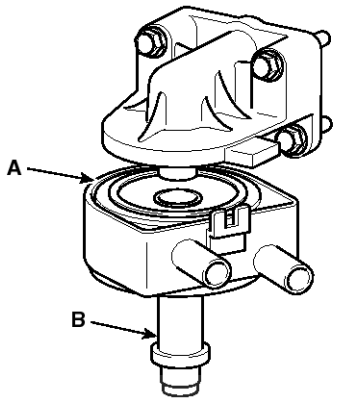


SXMM19017D

Installation

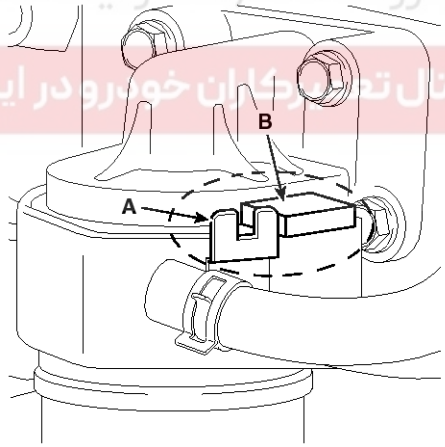
1. Apply a light coat of engine oil to the oil cooler packing surface (A), and then install the oil cooler with fix bolt (B).

Tightening torque:
44.1 ~ 53.9 N.m (4.5 ~ 5.5 kgf.m, 32.5 ~ 39.8 lb-ft)



SXMM19032D

⚠CAUTION
Fix position of oil cooler stopper(A) where oil cooler resists on ladder frame stopper (B).

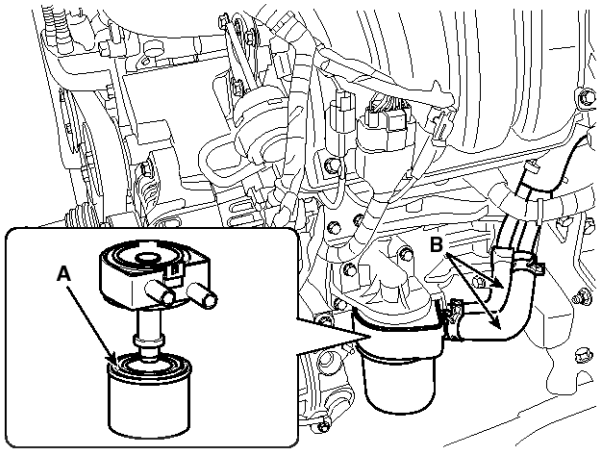


SXMM19033D

2. Apply a light coat of engine oil to the oil filter packing surface (A), and then install the oil filter.

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

3. Connect the oil cooler coolant hoses (B).



SYFEM0137N

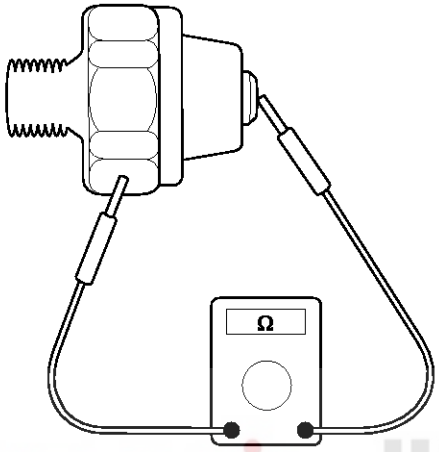
4. Fill the radiator with coolant and check for leaks.

Oil Pressure Switch

Inspection

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

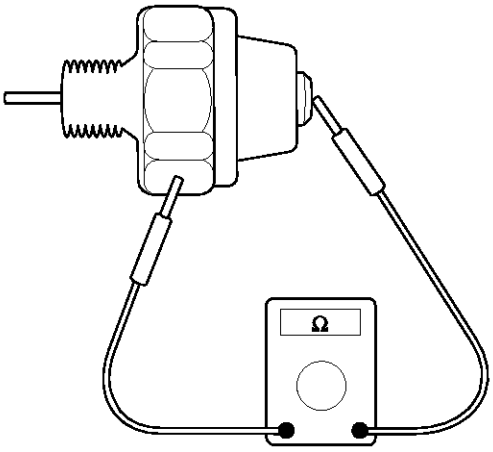
   If there is no continuity, replace the oil pressure switch.



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 (0.50kgf/cm², 7.25psi) is applied through the oil hole, the switch is operaing properly.

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

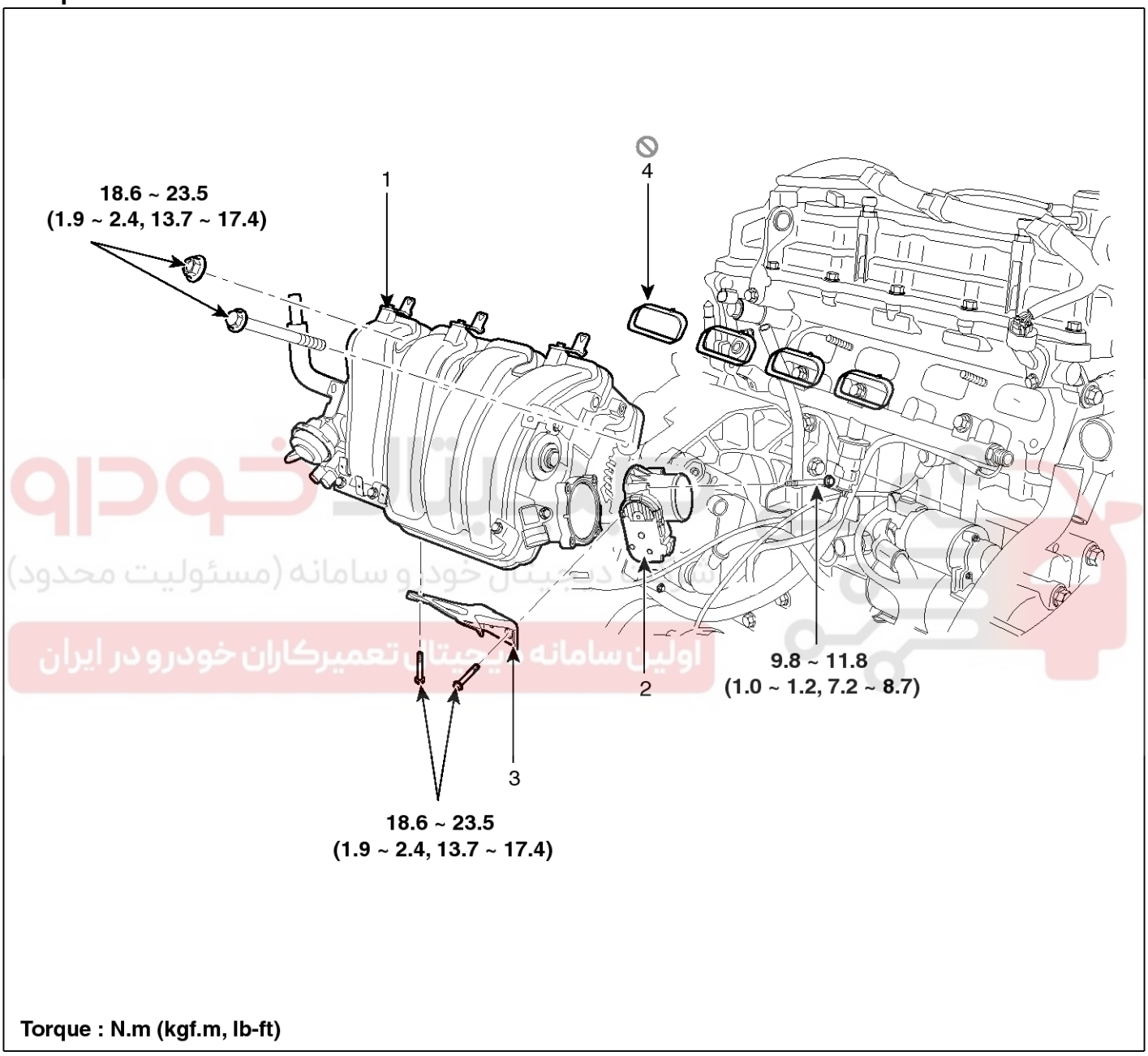


KCRF220A

Intake And Exhaust System

Intake Manifold

Components

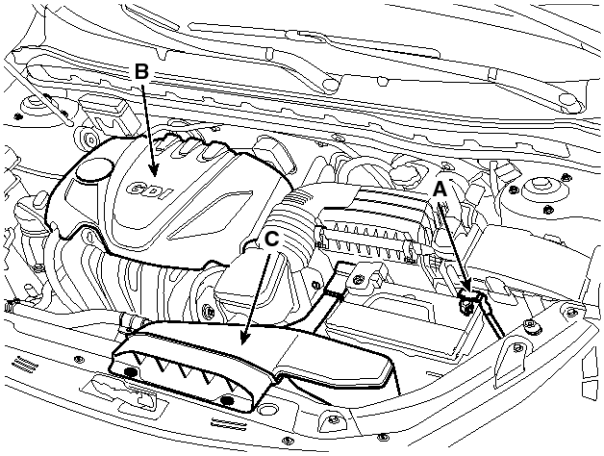


STFM1010N

1. Intake manifold assembly
2. Electronic throttle body
3. Intake manifold stay
4. Intake manifold gasket

Removal and Installation

1. Disconnect the battery negative terminal (A).
2. Remove the engine cover (B) and the air duct (C).

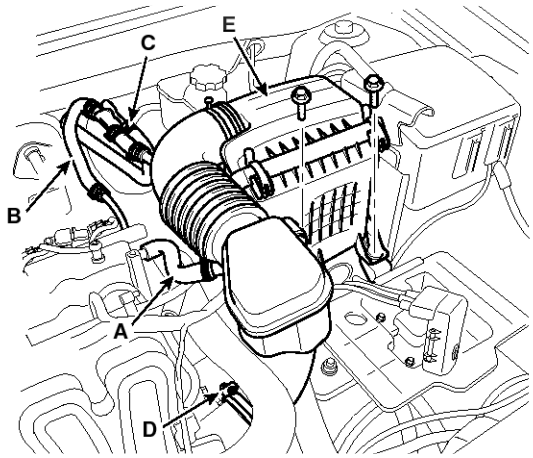


STFM11001D

3. Remove the air cleaner assembly.
   1) Disconnect the breather hose (A), the brake booster vacuum hose (B) and the intensifier hose (C).
   2) Disconnect the air intake hose (D) and then remove the air cleaner assembly (E).

Tightening torque

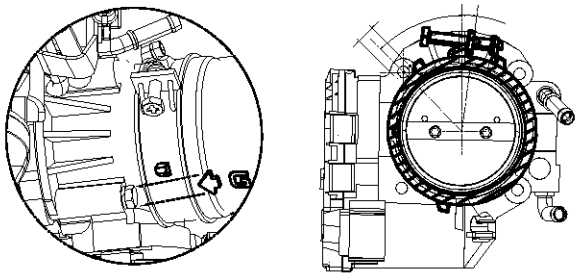
Hose clamp bolt:
2.9 ~ 4.9N.m (0.3 ~ 0.5kgf.m, 2.2 ~ 3.6lb-ft)
Air cleaner assembly bolts:
7.8 ~ 9.8N.m (0.8 ~ 1.0kgf.m, 5.8 ~ 7.2lb-ft)



STFM11008D

NOTICE

- *Install the air intake hose while the plate of the hose clamp must be in line with the stopper of the hose.*
- *Install the air intake hose match groove to throttle body groove.*



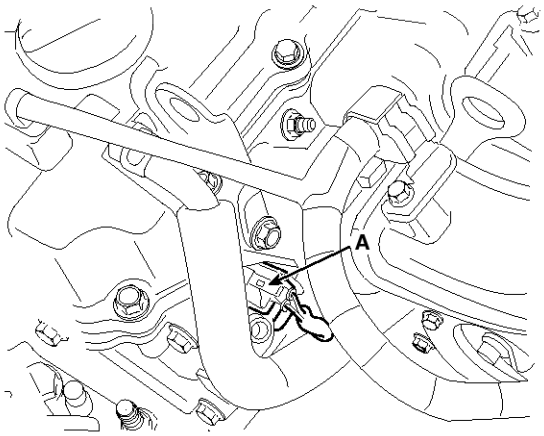
STFM11009D

4. Remove the under cover.

Tightening torque:

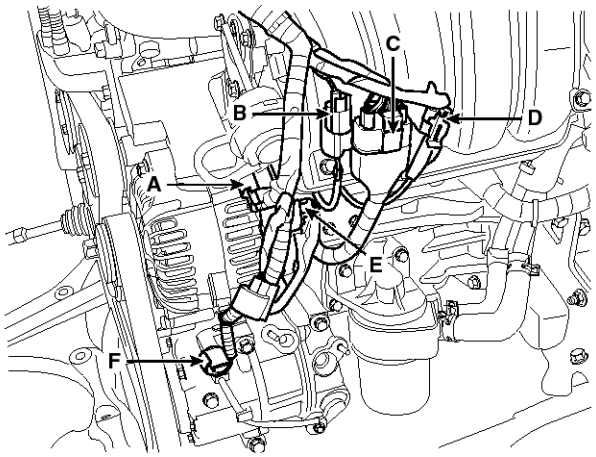
7.8 ~ 11.8N.m (0.8 ~ 1.2kgf.m, 5.8 ~ 8.7lb-ft)

5. Loosen the drain plug, and drain the engine coolant. Remove the radiator cap to help drain the coolant faster. (Refer to Cooling system in this group)
6. Disconnect the intake OCV (Oil control valve) connector (A).



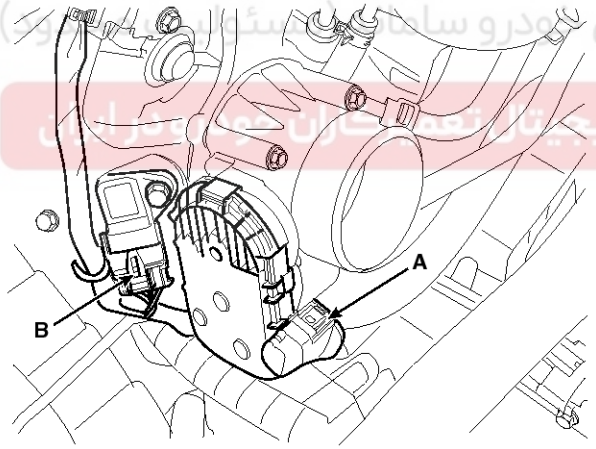
SYFEM0167N

7. Disconnect the VIS (Variable intake system) connector (A), the OPS (Oil pressure switch) connector (B), the injector extension connector (C), the knock sensor connector (D), the alternator connector (E) and the air compressor connector (F).



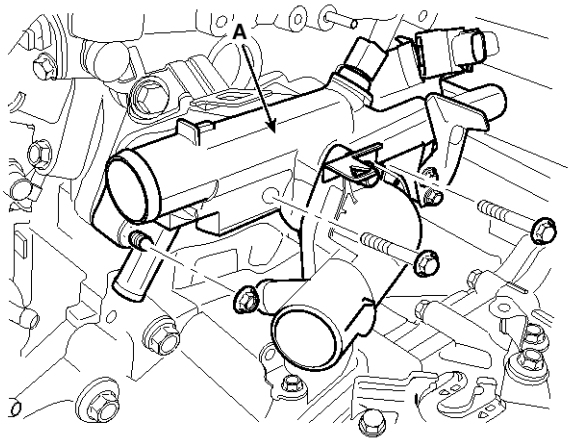
SYFEM0045N

8. Disconnect the ETC (Electronic throttle control) connector (A) and MAPS (Manifold absolute pressure sensor) & IATS (Intake air temperature sensor) connector (B).



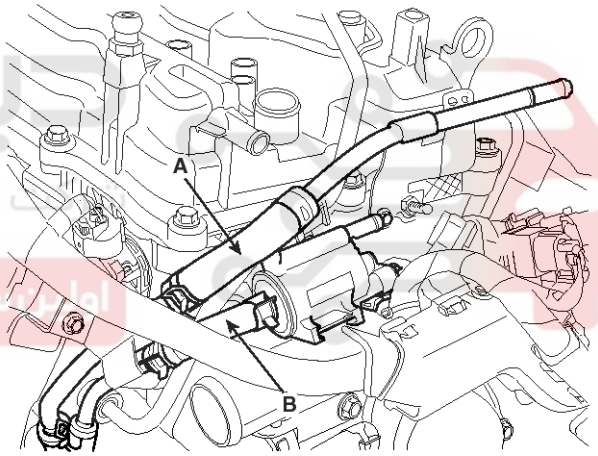
SYFEM0046N

9. Disconnect the PCV (Positive crankcase ventilation) hose (A).



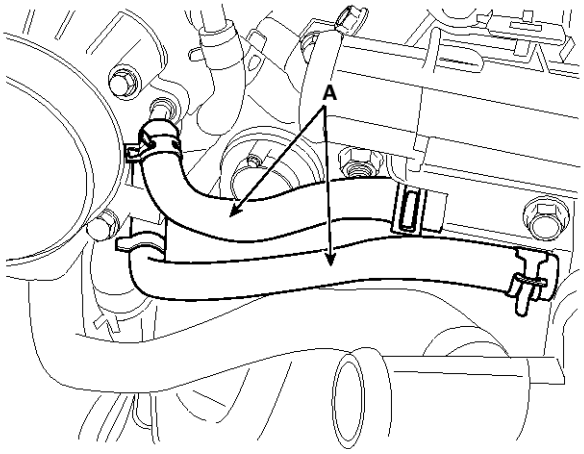
STFM11028D

10. Disconnect the vacuum hose (A) and PCSV (Purge control solenoid valve) hose (B).



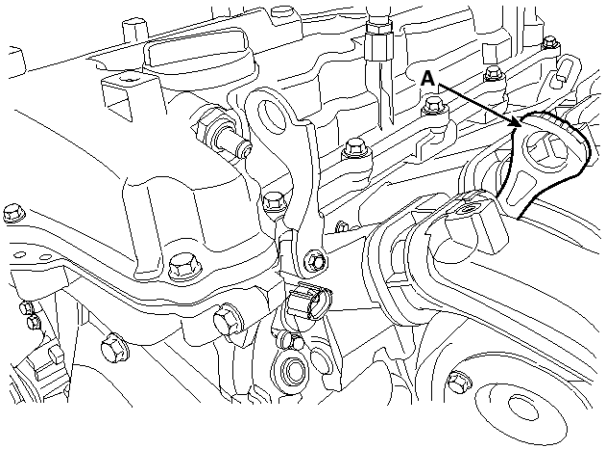
STFM11031D

11. Disconnect the throttle body coolant hoses (A).



SYFEM0047N

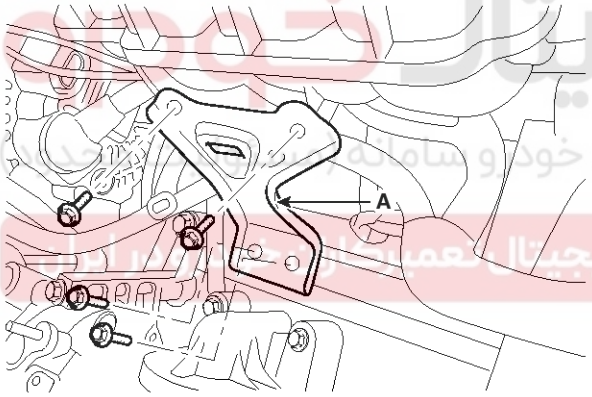
12. Remove the oil level gauge (A).



SYFEM0176N

13. Remove the intake manifold stay (A).

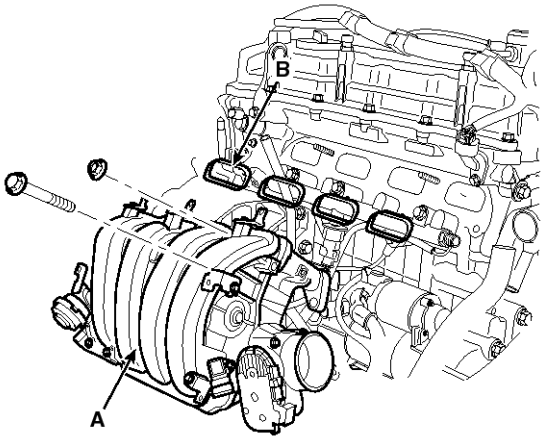
Tightening torque :
18.6 ~ 23.5N.m (1.9 ~ 2.4kgf.m, 13.7 ~ 17.4lb-ft)



SYFEM0068N

14. Remove the intake manifold (A) with the gasket (B).

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

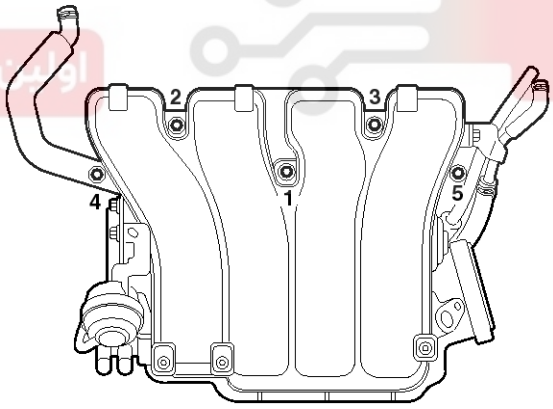


SYFEM0069N

NOTICE

When installing, replace with new gaskets.

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

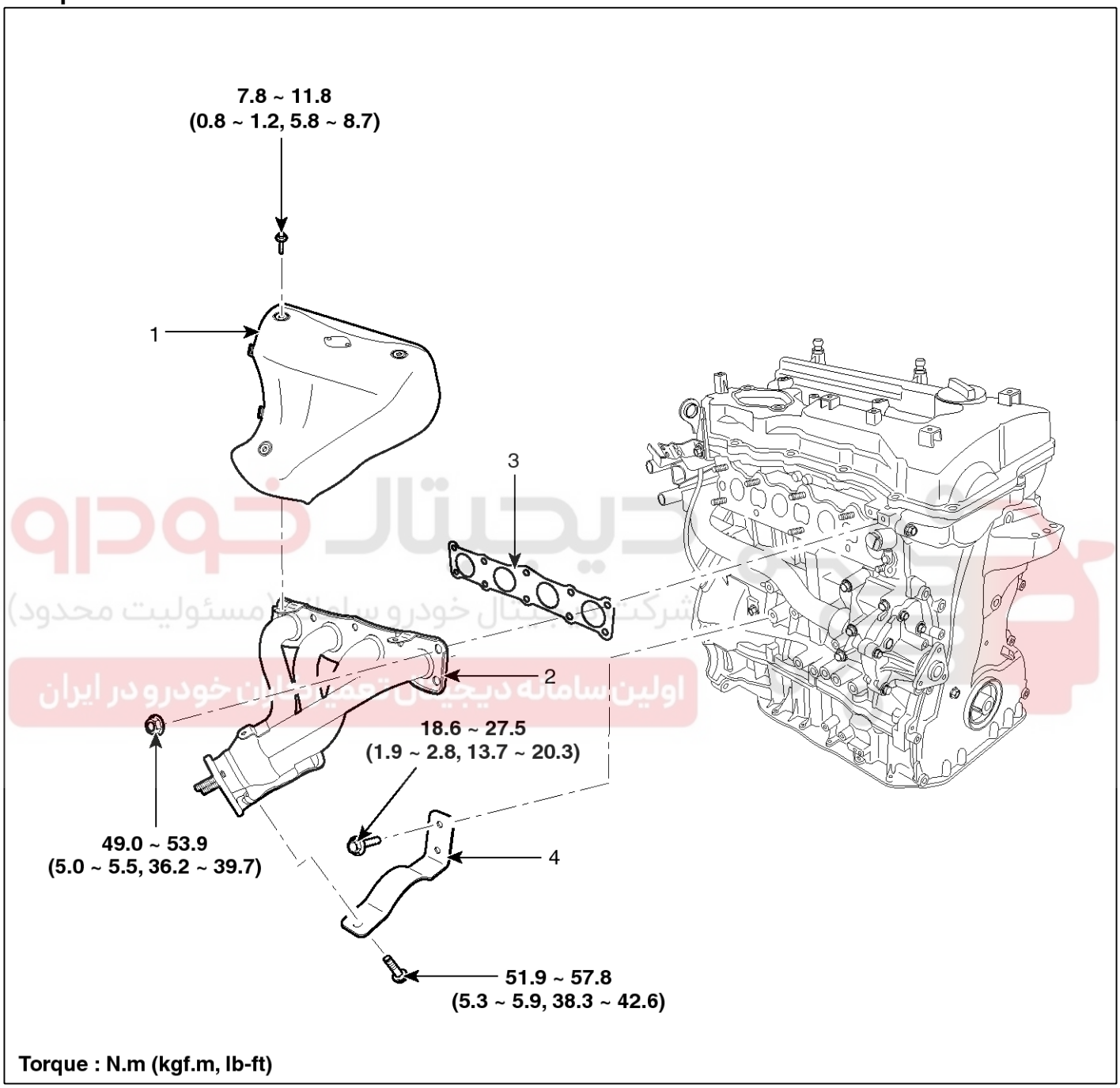


SYFEM0084N

15. Installation is reverse order of removal.

Exhaust Manifold

Components



SYFEM0082N

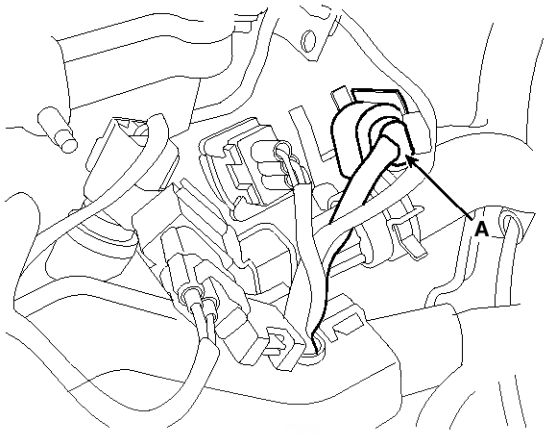
1. Heat protector
2. Exhaust manifold
3. Exhaust manifold gasket
4. Exhaust manifold stay

Removal and Installation

1. Remove the engine cover.
2. Disconnect the battery negative terminal.

Tightening torque
4.0 ~ 6.0N.m (0.4 ~ 0.6kgf.m, 3.0 ~ 4.4lb-ft)

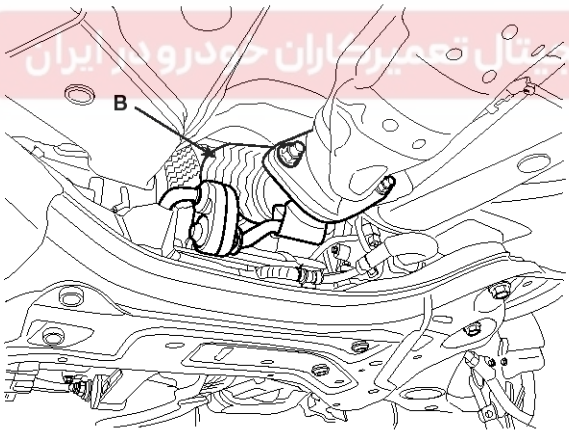
3. Disconnect the front oxygen sensor connector (A).



SYFEM0142N

4. Remove the front muffler (B).

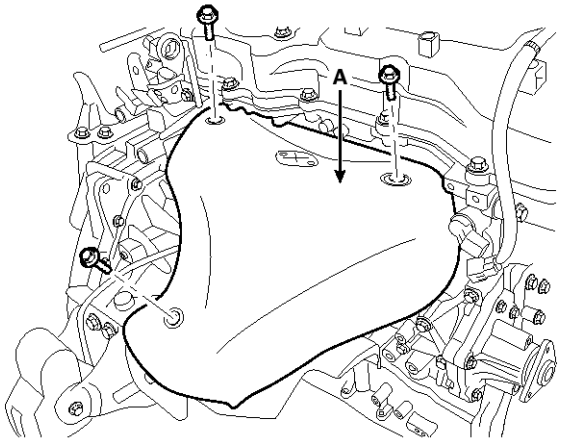
Tightening torque:
39.2 ~ 58.8 N.m (4.0 ~ 6.0 kgf.m, 28.9 ~ 43.4 lb-ft)



STFEM1009D

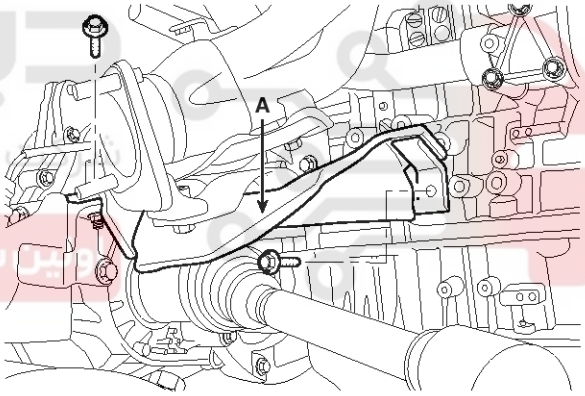
5. Remove the exhaust manifold heat protector (A).

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



SYFEM0065N

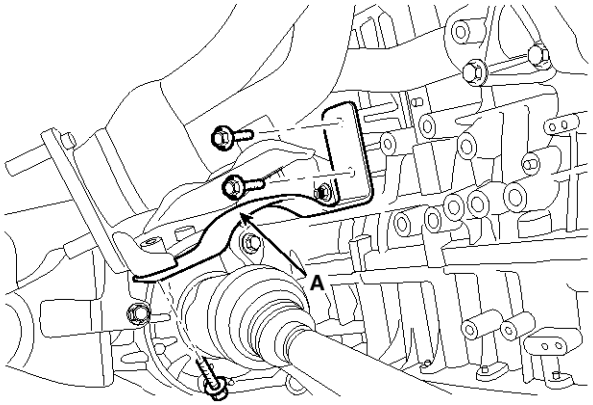
6. Remove the driveshaft heat protector (A).



SYFEM0071N

7. Remove the exhaust manifold stay (A).

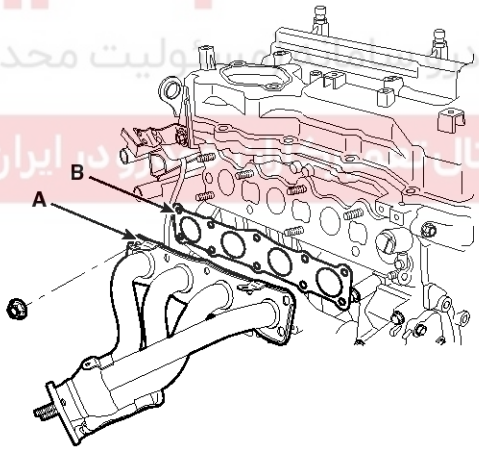
Tightening torque :
M8 :18.6 ~ 27.5N.m (1.9 ~ 2.8kgf.m, 13.7 ~ 20.3lb-ft)
M10 : 51.9 ~ 57.8.m (5.3 ~ 5.9kgf.m, 38.3 ~ 42.6lb-ft)



SYFEM0072N

8. Remove the exhaust manifold (A) with the gasket (B).

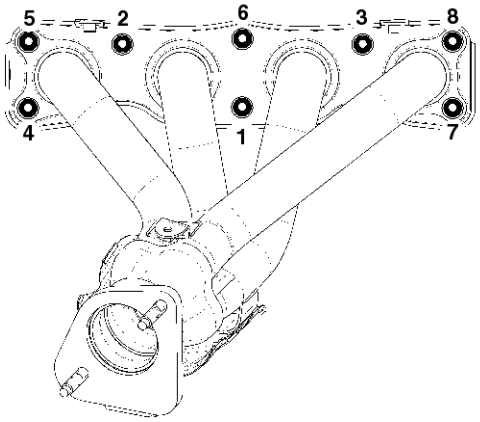
Tightening torque
49.0 ~ 53.9N.m (5.0 ~ 5.5kgf.m, 36.2 ~ 39.7lb-ft)



SYFEM0166N

NOTICE
When installing, replace with a new gasket.

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

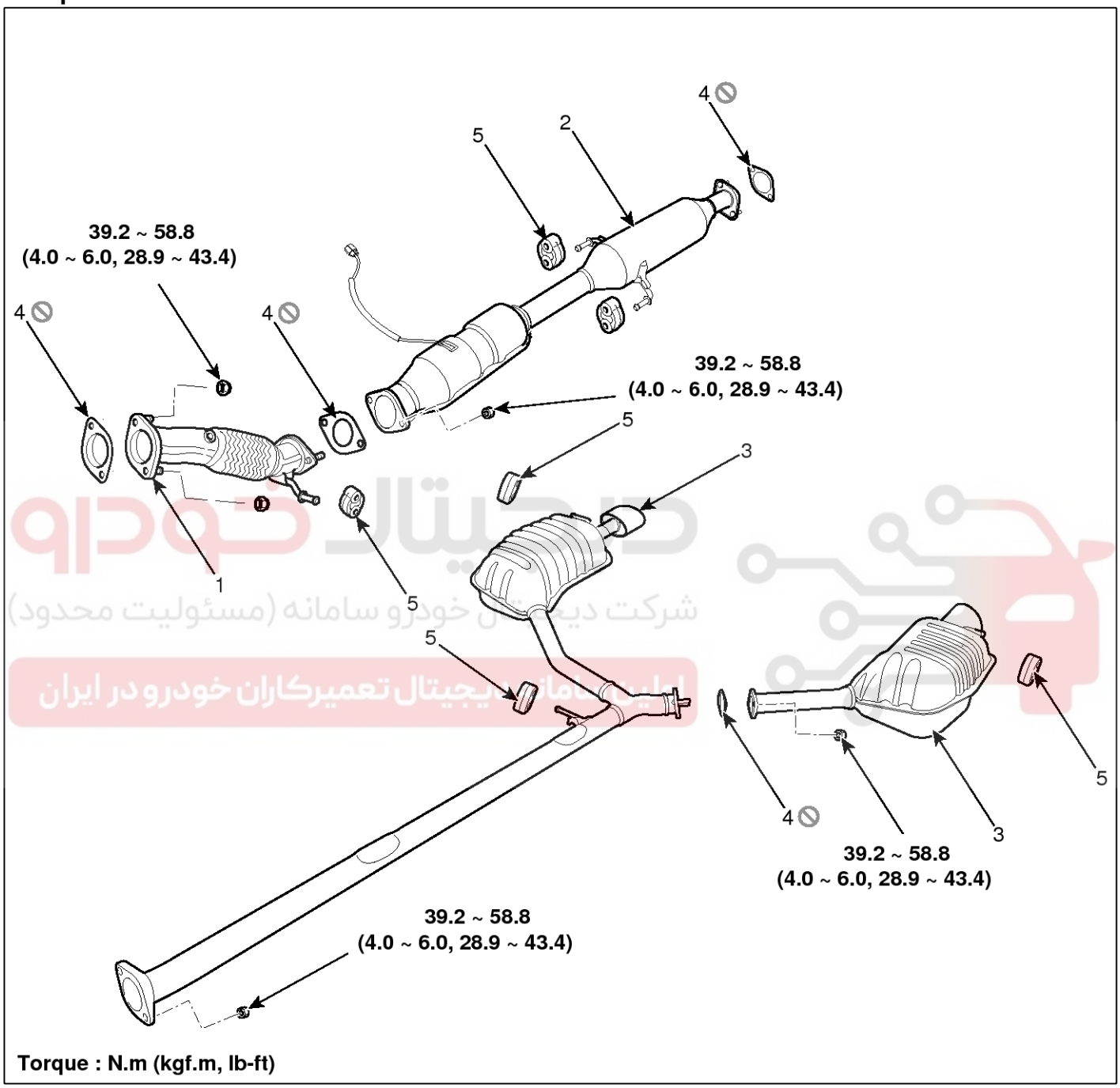


SVGEM0020D

9. Installation is reverse order of removal.

Muffler

Components



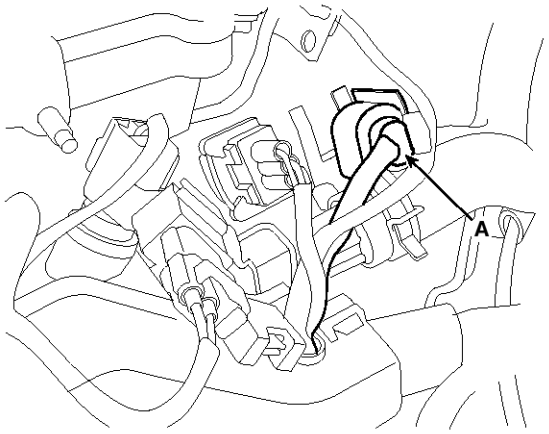
STFM1001N

1. Front muffler
2. Catalytic converter & center muffler assembly
3. Main muffler
4. Gasket
5. Hanger

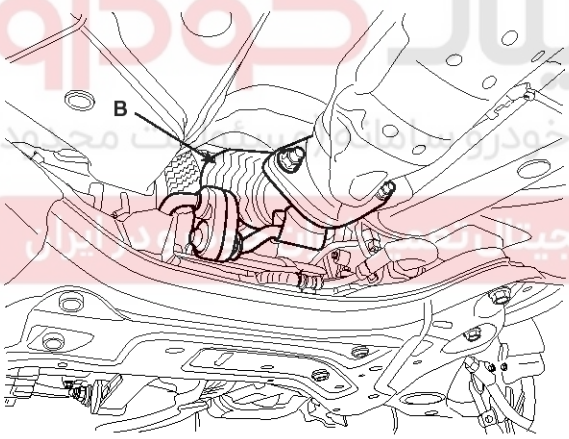
Removal and Installation

1. Remove the front muffler (B) after disconnecting the oxygen sensor connector (A).

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

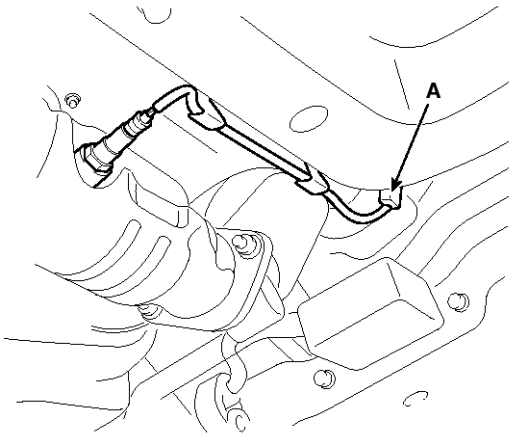


SYFEM0142N



STFEM1009D

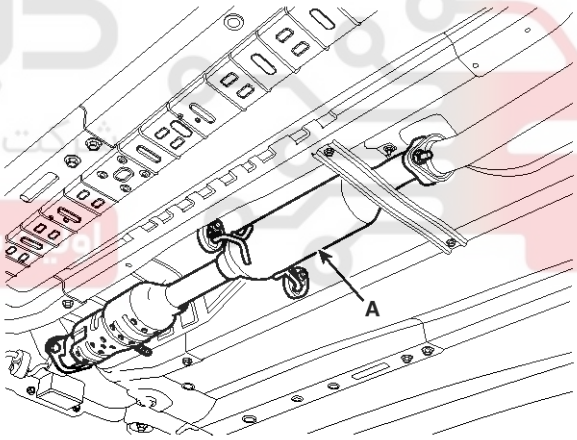
2. Disconnect the oxygen sensor connector (A).



SYFEM0180N

3. Remove the catalytic converter & center muffler assembly(A).

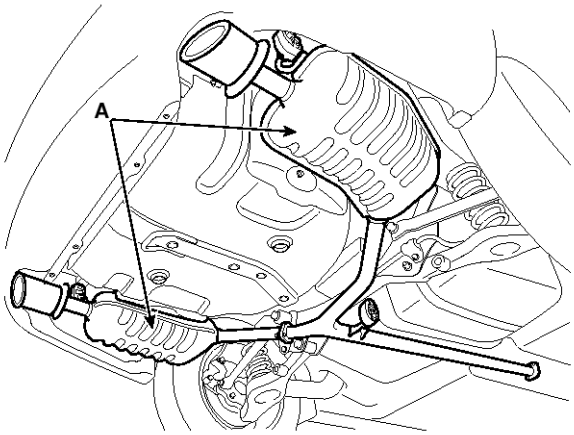
Tightening torque:
39.2 ~ 58.8 N.m (4.0 ~ 6.0 kgf.m, 28.9 ~ 43.4 lb-ft)



STFM11035D

4. Remove the main muffler (A).

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



STFM11033D

5. Installation is the reverse order of removal.

NOTICE
When installing, replace with new gaskets.