Engine Mechanical System

GENERAL

SPECIFICATIONS E401C3BE

Description			Specifications	Limit
			3.8L	
General				
Type			V-type, DOHC	
Number of cylinders			6	
Bore			96mm(3.7795in)	
Stroke			87.0mm(3.4252in)	
Total displacement			3,778cc(230.55cu.in.)	
Compression ratio			10.4	
Firing order			1-2-3-4-5-6	
Idle RPM			700 RPM	
Valve timing				
Intake	Opens(ATDC)		10˚	
	Closes(ABDC)		62˚	
Exhaust	Opens(BBDC)		42˚	
	Closes(ATDC)		6˚	
Cylinder head				
Flatness of gasket surface			Less than 0.05mm (0.0019in.) [Less than 0.02mm (0.0008in.) / 150x150]	
Flatness of manifold mounting	Intake		Less than 0.1mm(0.0039in.) [Less than 0.03mm(0.001in)/110x110]	
	Exhaust		Less than 0.1mm(0.0039in.) [Less than 0.03mm(0.001in)/110x110]	
Camshaft				
Cam height	LH Camshaft	Intake	46.8mm(1.8425in.)	
		Exhaust	45.8mm (1.8031in.)	
	RH Camshaft	Intake	46.8mm(1.8425in.)	
		Exhaust	45.8mm (1.8031in.)	
Journal outer diameter	LH, RH Camshaft	Intake	No.1: 27.964 ~ 27.978mm (1.1009 ~ 1.1015in.) No.2,3,4: 23.954 ~ 23.970mm (0.9430 ~ 0.9437in.)	
		Exhaust	No.1: 27.964 ~ 27.978mm (1.1009 ~ 1.1015in.) No.2,3,4: 23.954 ~ 23.970mm (0.9430 ~ 0.9437in.)	
Bearing oil clearance	LH, RHcamshaft	Intake	No.1: 0.027 ~ 0.057mm (0.0011 ~ 0.0022in.) No.2,3,4: 0.030 ~ 0.067mm (0.0012 ~ 0.0026in.)	
		Exhaust	No.1: 0.027 ~ 0.057mm (0.0011 ~ 0.0022in.) No.2,3,4: 0.030 ~ 0.067mm (0.0012 ~ 0.0026in.)	
End play			0.02 ~ 0.18mm (0.0008 ~ 0.0071in.)	
Valve				

Description		Specifications	Limit
		3.8L	
Valve length	Intake	105.27mm(4.1445in.)	
	Exhaust	105.50mm (4.1535in.)	
Stem outer diameter	Intake	5.465 ~ 5.480mm (0.2151 ~ 0.2157in.)	
	Exhaust	5.458 ~ 5.470mm (0.2149 ~ 0.2153in.)	
Face angle		45.25° ~ 45.75°	
Thickness of valvehead(margin)	Intake	1.56 ~ 1.86mm(0.06142 ~ 0.07323in.)	
	Exhaust	1.73 ~ 2.03mm(0.06811 ~ 0.07992in.)	
Valve stem to valve guide clearance	Intake	0.020 ~ 0.047mm (0.00078 ~ 0.00185in.)	0.07mm (0.00275in.)
	Exhaust	0.030 ~ 0.054mm (0.00118 ~ 0.00212in.)	0.09mm (0.00354in.)
Valve guide			
Inner diameter	Intake	5.500 ~ 5.512mm (0.2165 ~ 0.2170in.)	
	Exhaust	5.500 ~ 5.512mm (0.2165 ~ 0.2170in.)	
Length	Intake	41.8 ~ 42.2mm (1.6457 ~ 1.6614in.)	
	Exhaust	41.8 ~ 42.2mm (1.6457 ~ 1.6614in.)	
Valve seat			
Width of seat contact	Intake	1.15 ~ 1.45mm(0.05118 ~ 0.05709in.)	
	Exhaust	1.35 ~ 1.65mm(0.05315 ~ 0.06496in.)	
Seat angle	Intake	44.75° ~ 45.20°	
	Exhaust	44.75° ~ 45.20°	
Valve spring			
Free length		43.86mm (1.7267in.)	
Load		19.3±0.8kg/34.0mm (42.7±1.8 lb/1.3386in.)	
		42.3±1.3kg/24.2mm (93.3±2.9 lb/0.9527in.)	
Out of squareness		Less than 1.5°	
MLA			
MLA outer diameter	Intake	34.964 ~ 34.980mm (1.3765 ~ 1.3772in.)	
	Exhaust	34.964 ~ 34.980mm (1.3765 ~ 1.3772in.)	
Cylinder head tappet bore inner diameter	Intake	35.000 ~ 35.025mm (1.3779 ~ 1.3789in.)	
	Exhaust	35.000 ~ 35.025mm (1.3779 ~ 1.3789in.)	
MLA to tappet bore clearance	Intake	0.020 ~ 0.061mm (0.0008 ~ 0.0024in.)	0.07mm (0.0027in.)
	Exhaust	0.020 ~ 0.061mm (0.0008 ~ 0.0024in.)	0.07mm (0.0027in.)
Valve clearance			
Intake		0.17 ~ 0.23mm (0.0067 ~ 0.0090in.)	0.10 ~ 0.30mm (0.0039~0.0118in.)

Description		Specifications	Limit
		3.8L	
Exhaust		0.27 ~ 0.33mm (0.0106 ~ 0.0129in.)	0.20 ~ 0.40mm (0.0078 ~ 0.0157in.)
Cylinder block			
Cylinder bore		96.00 ~ 96.03mm(3.7795 ~ 3.7807in.)	
Flatness of gasket surface		Less than 0.05mm (0.0019in.) [Less than 0.02mm (0.0008in.) / 150x150]	
Piston			
Piston outer diameter		95.96 ~ 95.99mm(3.7779 ~ 3.7791in.)	
Piston to cylinder clearance		0.03 ~ 0.05mm(0.0012 ~ 0.0020in.)	
Ring groove width	No. 1 ring groove	1.22 ~ 1.24mm(0.0480 ~ 0.0488in.)	1.26mm (0.0496in.)
	No. 2 ring groove	1.22 ~ 1.24mm (0.0480 ~ 0.0488in.)	1.26mm (0.0496in.)
	Oil ring groove	2.01 ~ 2.03mm (0.0791 ~ 0.0799in.)	2.05mm (0.0807in.)
Piston ring			
Side clearance	No. 1 ring	0.03 ~ 0.07mm(0.0012 ~ 0.0027in.)	0.1mm (0.004in.)
	No. 2 ring	0.03 ~ 0.07mm (0.0012 ~ 0.0027in.)	0.1mm (0.004in.)
	Oil ring	0.06 ~ 0.15mm (0.0024 ~ 0.0059in.)	0.2mm (0.008in.)
End gap	No. 1 ring	0.17 ~ 0.32mm (0.0067 ~ 0.0126in.)	0.6mm (0.0236in.)
	No. 2 ring	0.32 ~ 0.47mm (0.0126 ~ 0.0185in.)	0.7mm (0.0275in.)
	Oil ring	0.20 ~ 0.70mm (0.0078 ~ 0.0275in.)	0.8mm (0.0315in.)
Piston pin			
Piston pin outer diameter		23.001 ~ 23.006mm(0.9055 ~ 0.9057in.)	
Piston pin hole inner diameter		23.016 ~ 23.021mm(0.9061 ~ 0.9063in.)	
Piston pin hole clearance		0.01 ~ 0.02mm(0.0004 ~ 0.0008in.)	
Connecting rod small end inner diameter		22.974 ~ 22.985mm (0.9045 ~ 0.9049in.)	
Connecting rod small end hole clearance		-0.032 ~ -0.016mm (-0.0012 ~ 0.0006in.)	
Connecting rod			
Connecting rod big end inner diameter		58.000 ~ 58.018mm(2.2834 ~2.2842in.)	
Connecting rod bearing oil clearance		0.038 ~ 0.056mm (0.0015 ~ 0.0022in.)	
Side clearance		0.1 ~ 0.25mm (0.0039 ~ 0.0098in.)	
Crankshaft			
Main journal outer diameter		68.942 ~ 68.960mm (2.7142 ~ 2.7149in.)	
Pin journal outer diameter		54.954 ~ 54.972mm (2.1635 ~ 2.1642in.)	
Main bearing oil clearance		0.022 ~ 0.040mm (0.0008 ~ 0.0016in.)	
End play		0.10 ~ 0.28mm (0.0039 ~ 0.0110in.)	
Oil pump			

Description		Specifications	Limit
		3.8L	
Relief valve opening pressure		450 ~ 550kPa (4.59 ~ 5.61kgf/cm²,65.28 ~ 79.79psi)	
Engine oil			
Oil quantity (Total)		6.0L(6.34U.S.qts,5.28lmp.qts)	When replacing a short engine or a block assembly.
Oil quantity (Oil pan)		5.5L(5.81U.S.qts,4.84lmp.qts)	When replacing an oil pan only.
Oil quantity (Drain and refill)		5.2L(5.49U.S.qts,4.58lmp.qts)	
Oil quality		Above SJ or SL	
Oil pressure		130kPa(1.32kgf/cm²,18.77psi) [at 1000rpm,110°C(230°F)]	
Cooling system			
Cooling method		Forced circulation with electrical fan	
Coolant quantity		8.7L(9.19U.S.qts,7.66lmp.qts)	
Thermostat	Type	Wax pellet type	
	Opening temperature	82±2°C (179.6±35.6°F)	
	Fully opened temperature	95°C (203°F)	
	Full lift	10mm (0.3937in.) MIN	
Radiator cap	Main valve opening pressure	93.16 ~ 122.58kpa (0.95 ~ 1.25kg/cm², 13.51 ~ 17.78psi)	
	Vacuum valve opening pressure	0.98 ~ 4.90 kpa (0.01 ~ 0.05kg/cm², 0.14 ~ 0.71 psi)	
Water temperature sensor			
Type		Thermister type	
Resistance	20°C (68°F)	2.31 ~ 2.59KΩ	
	80°C(176°F)	0.3222 KΩ	

TIGHTENING TORQUE

Item	Quantity	Nm	kgf.m	lb-ft
Crankshaft pulley bolt	1	284.2 ~ 303.8	29.0 ~ 31.0	209.76 ~ 224.22
Timing chain cover bolt B	17	18.62 ~ 21.56	1.9 ~ 2.2	13.74 ~ 15.91
Timing chain cover bolt C	4	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Timing chain cover bolt D	1	58.80 ~ 68.80	6.0 ~ 7.0	43.40 ~ 50.63
Timing chain cover bolt E	1	58.80 ~ 68.80	6.0 ~ 7.0	43.40 ~ 50.63
Timing chain cover bolt F	2	24.50 ~ 26.46	2.5 ~ 2.7	18.08 ~ 19.53
Timing chain cover bolt G	4	21.56 ~ 23.52	2.2 ~ 2.4	15.91 ~ 17.36
Timing chain cover bolt H	1	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Timing chain cover bolt I	1	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Timing chain cover bolt J	1	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Cam to cam guide bolt	4	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Timing chain auto tensioner bolt	2	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Timing chain auto tensioner nut	2	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Timing chain guide bolt	4	19.60 ~ 24.50	2.0 ~ 2.5	14.17 ~ 18.08
Oil pump chain cover bolt	3	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Oil pump chain tensioner bolt	1	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Oil pump chain guide bolt	2	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Oil pump chain sprocket bolt	1	18.62 ~ 21.56	1.9 ~ 2.2	13.74 ~ 15.91
Lower oil pan bolt	13	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Drive belt auto tensioner bolt(M12)	1	81.4 ~ 85.3	8.3 ~ 8.7	60.0 ~ 62.9
Drive belt auto tensioner bolt(M8)	1	17.64 ~ 21.56	1.8 ~ 2.2	13.02 ~ 15.91
Drive belt idler bolt	1	53.90 ~ 57.82	5.5 ~ 5.9	39.78 ~ 42.67
OCV(oil control valve) bolt	2	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Cylinder head bolt	16	39.2 + 120° + 90°	4.0 + 120° + 90°	28.93+ 120° + 90°
Cylinder head bolt	1	18.62 ~ 23.52	1.9 ~ 2.4	13.74 ~ 17.36
CVVT & exhaust cam sprocket bolt	4	64.68 ~ 76.44	6.6 ~ 7.8	47.74 ~ 56.42
Camshaft bearing cap bolt	32	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Cylinder head cover bolt	38	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Connecting rod bearing bolt	12	19.60 + 90°	2.0 + 90°	14.46 + 90°
Main bearing cap inner bolt(M11)	8	49.00 + 90°	5.0 + 90°	36.16 + 90°
Main bearing cap outer bolt(M8)	8	19.60 + 120°	2.0 + 120°	14.46 + 120°
Main bearing cap side bolt(M8)	6	29.40 ~ 31.36	3.0 ~ 3.2	21.70 ~ 23.14
Oil drain cover bolt	6	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Rear oil seal case bolt	6	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Baffle plate bolt	12	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68
Upper oil pan bolt	16	9.80 ~ 11.76	1.0 ~ 1.2	7.23 ~ 8.68

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

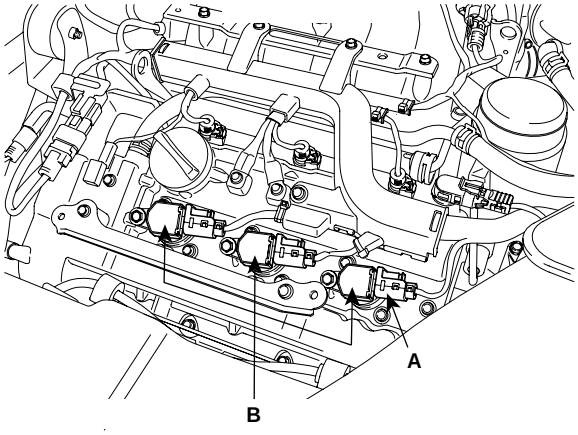
INSPECTION E404D6D0

COMPRESSION PRESSURE

NOTE

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

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



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

NOTE

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

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

NOTE

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

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

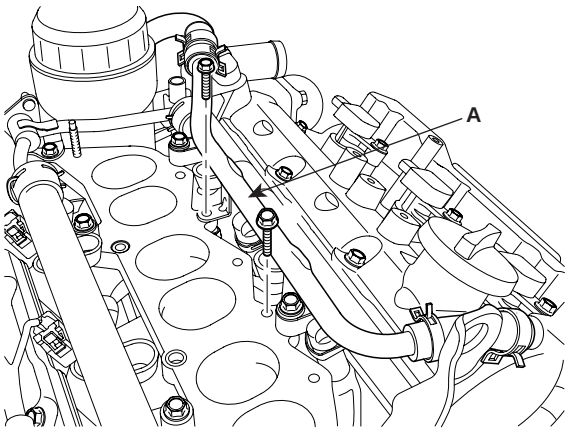
   5) If the cylinder compression in 1 or more cylinders is low, pour a small amount of engine oil into the cylinder through the spark plug hole and repeat steps (1) through (3) for cylinders with low compression.
      - If adding oil helps the compression, it is likely that the piston rings and/or cylinder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

VALVE CLEARANCE INSPECTION AND ADJUSTMENT

NOTE

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

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



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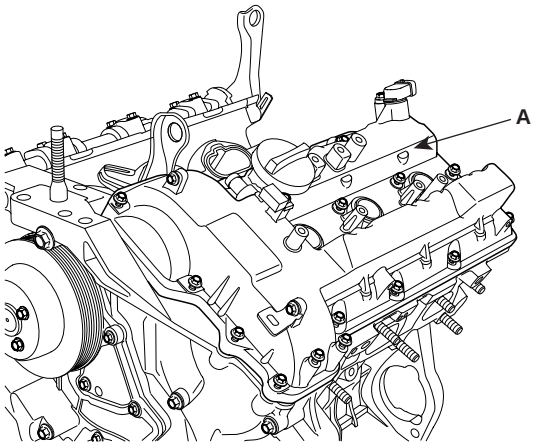
   3) Loosen the cylinder head cover bolts and then remove the cover(A) and gasket.



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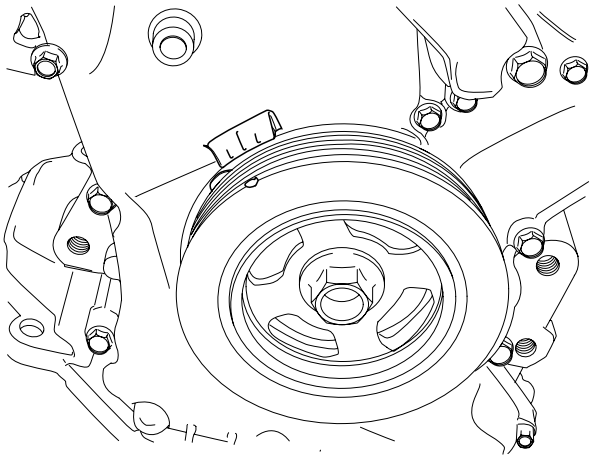
5. Set No.1 cylinder to TDC/compression.
   1) Turn the crankshaft pulley and align its groove with the timing mark "T" of the lower timing chain cover.



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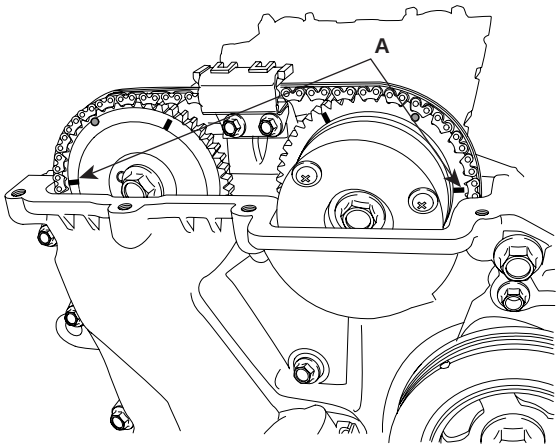
   2) Check that the mark(A) of the camshaft timing sprockets are in straight line on the cylinder head surface as shown in the illustration.
   If not, turn the crankshaft one revolution (360°)

NOTE

Do not rotate engine counterclockwise



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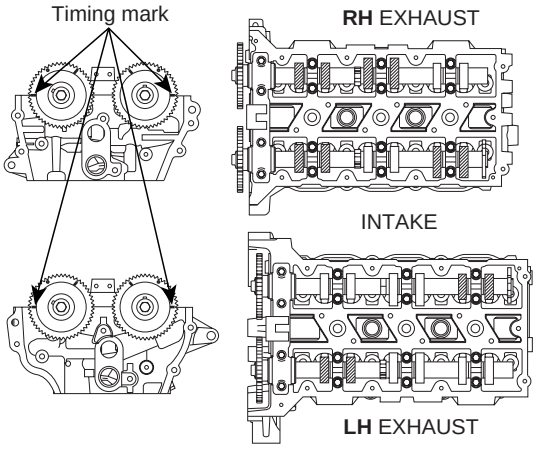
6. Inspect the valve clearance.

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



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Measurement method.

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

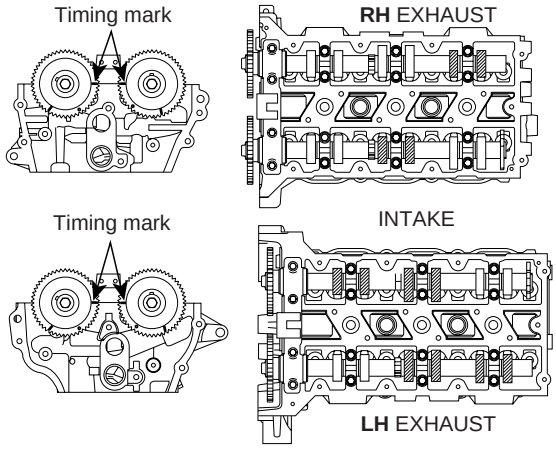
Valve clearance
Specification
Engine coolant temperature : 20°C [68°F]
Limit
Intake : 0.17~ 0.23mm (0.0067 ~ 0.0090in.)
Exhaust : 0.27 ~ 0.33mm (0.0106 ~ 0.0129in.)

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

NOTE

Do not rotate engine counterclockwise

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



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7. Adjust the intake and exhaust valve clearance.

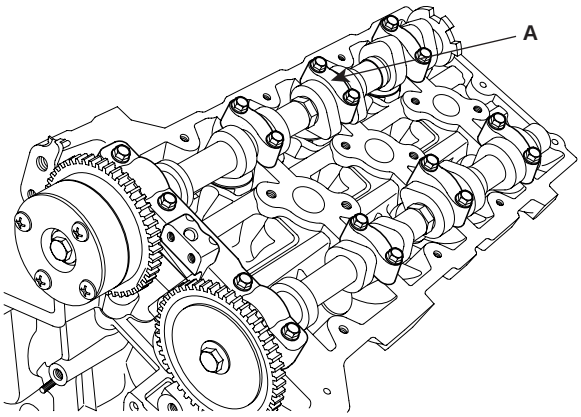
   1) Set the No.1 cylinder to the TDC/compression.

   2) Remove the timing chain.

NOTE

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

   3) Remove the camshaft bearing caps(A).



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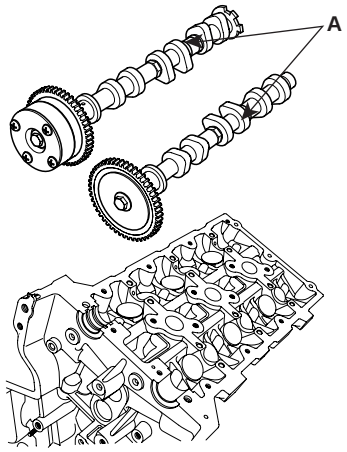
4) Remove the camshaft assembly(A).



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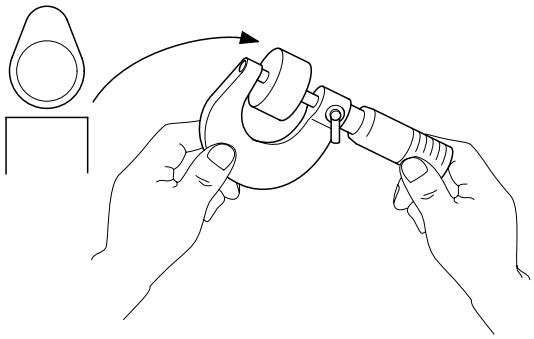
5) Remove MLAs.

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



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

Valve clearance(Engine coolant temperature: 20°C[68°F]) T : Thickness of removed tappet A : Measured valve clearance N : Thickness of new tappet Intake : N = T + [A - 0.20mm(0.0079in.)] Exhaust : N = T + [A - 0.30mm (0.0118in.)]

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

NOTE

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

9) Place a new tappet on the cylinder head.

NOTE

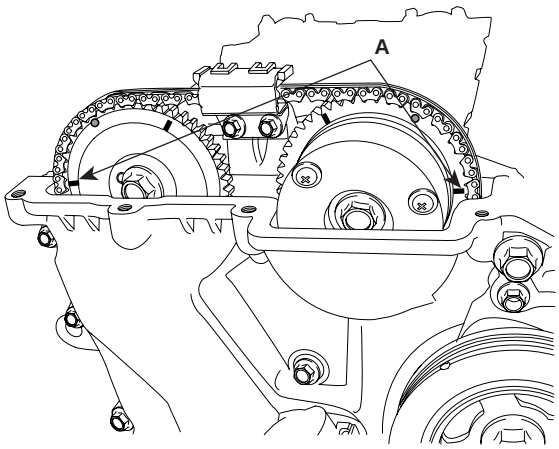
Apply engine oil at the selected tappet on the periphery and top surface.

10) Install the intake and exhaust camshaft.

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

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

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



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14) Recheck the valve clearance.

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

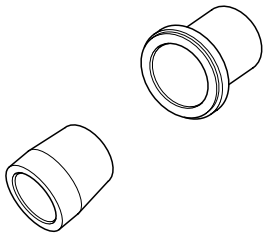
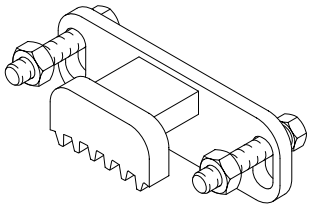
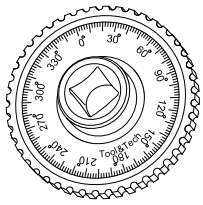
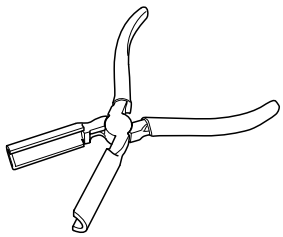
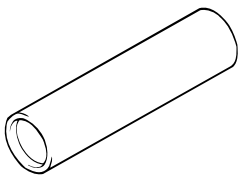
TROUBLESHOOTING EB9DDED8

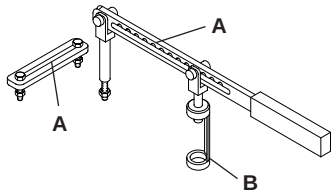
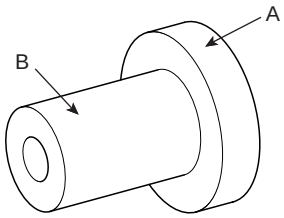
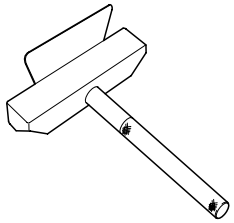
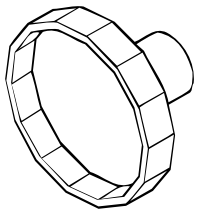
Symptom	Suspect area	Remedy
Engine misfire with abnormal internal lower engine noises.	Worn crankshaft bearings. Loose or damaged engine drive plate.	Replace the crankshaft and bearings as required. Repair or replace the drive plate as required.
	Worn piston rings. (Oil consumption may or may not cause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

Symptom	Suspect area	Remedy
Upper engine noise,regard-less of engine speed.	Low oil pressure.	Repair or replace as required.
	Broken valve spring.	Replace the valve spring.
	Worn or dirty valve lifters.	Replace the valve lifters.
	Stretched or broken timing chain and/or damaged sprocket teeth.	Replace the timing chain and sprockets.
	Worn timing chain tensioner, if applicable.	Replace the timing chain tensioner as required.
	Worn camshaft lobes.	• Inspect the camshaft lobes. • Replace the timing camshaft and valve lifters as required.
	Worn valve guides or valve stems.	Inspect the valves and valve guides,then repair as required.
	Stuck valves. Carbon on the valve stem or valve seat may cause the valve to stay open.	Inspect the valves and valve guides, then repair as required.
	Worn drive belt, idler, tensioner and bearing.	Replace as required.
Lower engine noise,regard-less of engine speed.	Low oil pressure.	Repair as required.
	Loose or damaged drive plate.	Repair or replace the drive plate.
	Damaged oil pan, contacting the oil pump screen.	• Inspect the oil pan. • Inspect the oil pump screen. • Repair or replace as required.
	Oil pump screen loose, damaged or restricted.	• Inspect the oil pump screen. • Repair or replace as required.
	Excessive piston-to-cylinder bore clearance.	• Inspect the piston, piston pin and cylinder bore. • Repair as required.
	Excessive piston pin-to-piston clearance.	• Inspect the piston, piston pin and the connecting rod. • Repair or replace as required.
	Excessive connecting rod bearing clearance	Inspect the following components and repair as required. • The connecting rod bearings. • The connecting rods. • The crankshaft pin journals.
	Excessive crankshaft bearing clearance.	Inspect the following components, and repair as required. • The crankshaft bearings. • The crankshaft main journals. • The cylinder block.
	Incorrect piston, piston pin and connecting rod installation	• Verify the piston pins and connecting rods are installed correctly. • Repair as required.

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

SPECIAL SERVICE TOOLS E787872C

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

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

ENGINE AND TRANSAXLE ASSEMBLY

REMOVAL E31DBAFC

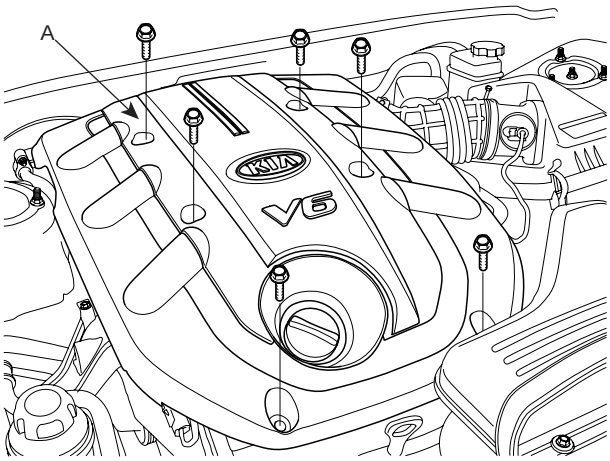
CAUTION

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

NOTE

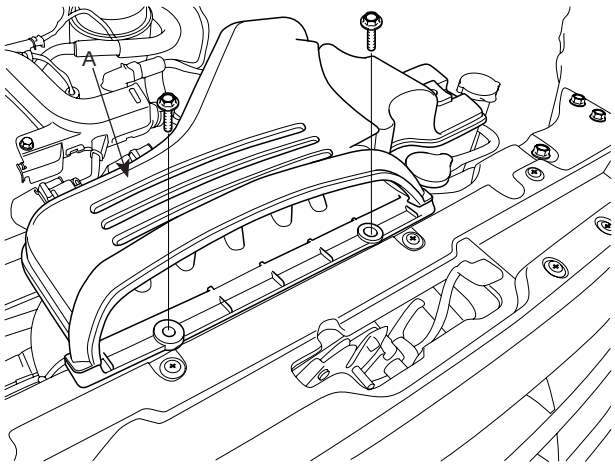
- *Mark all wiring and hoses to avoid misconnection.*

1. Remove the engine cover(A).



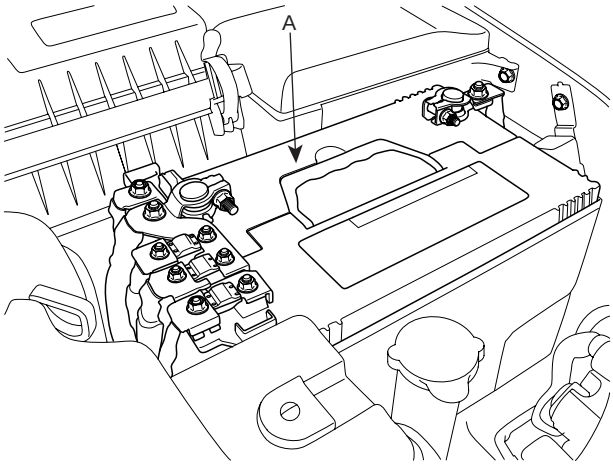
SGHAT7001N

2. Remove the air duct(A).



SGHAT7003N

3. Disconnect the neagative terminal from the battery(A).



SGHAT7002N

4. Recover refrigerant and remove the high & low pressure pipe. (Refer to Air conditioner compressor in HA Group)

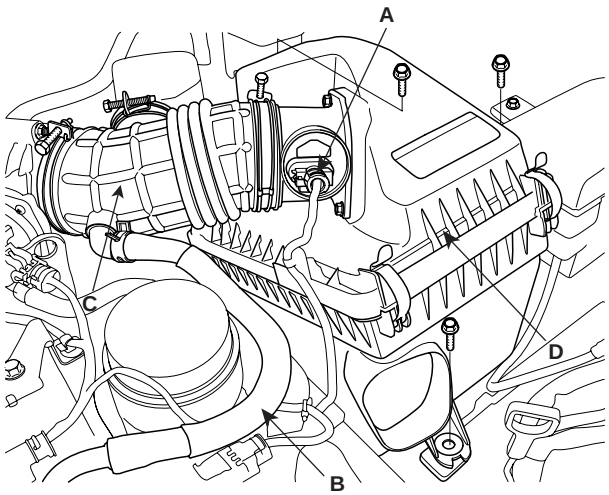
5. Remove the intake air hose and air cleaner assembly.

   1) Disconnect the AFS connector(A).

   2) Disconnect the breather hose(B) from air cleaner hose.

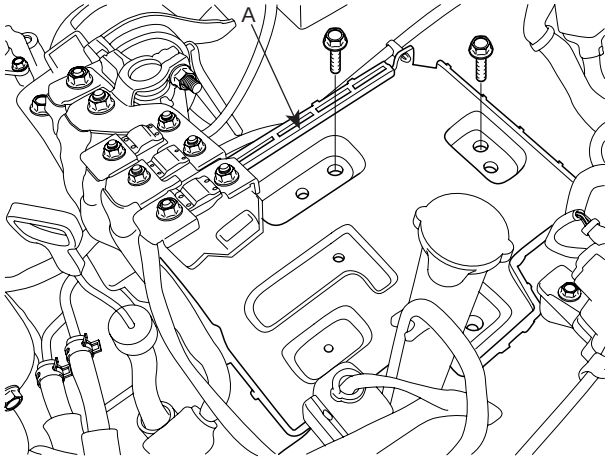
   3) Disconnect the ECM connector.

   4) Remove the intake air hose(C) and air cleaner body(D).



SGHEM7005N

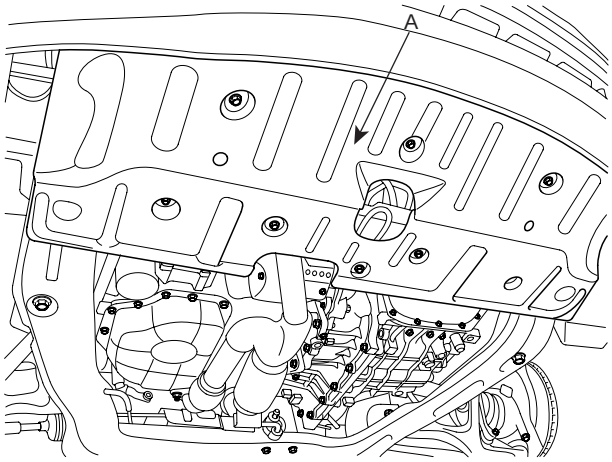
6. Remove the battery tray(A).



SGHAT7005N

7. Remove front wheels.

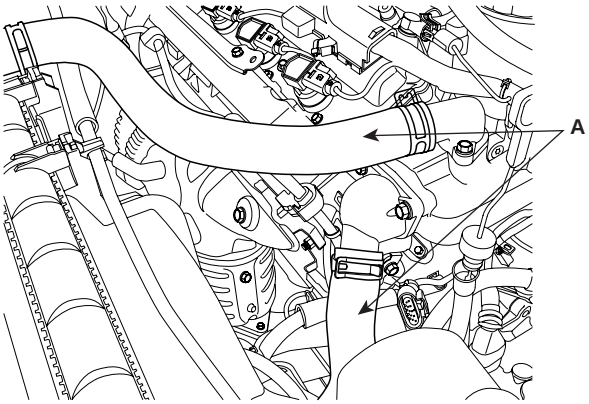
8. Remove under cover(A).



SGHAT6021D

9. Drain the engine coolant.
   Remove the radiator cap to speed draining.

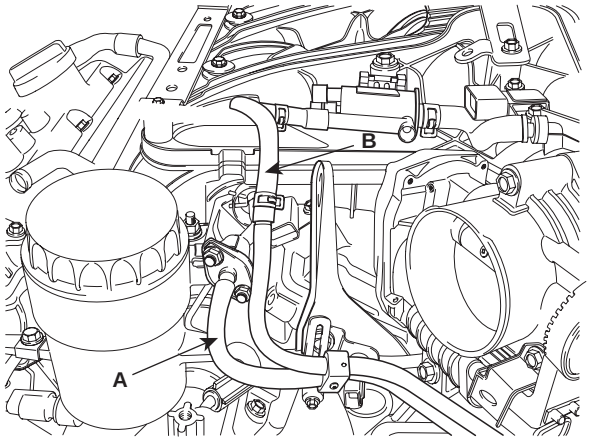
10. Remove the upper radiator hose and lower radiator hose(A).



KDRF148A

11. Remove transaxle oil cooler hose.

12. Remove fuel hose(A) and PCSV(B) hose.

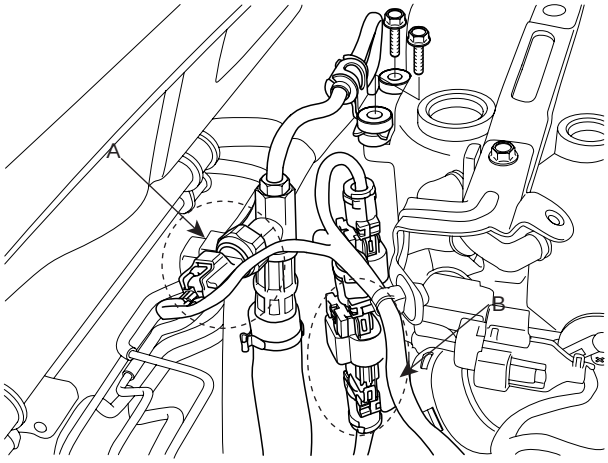


ACCF008A

13. Remove engine wiring.

    1) Disconnect RH oxygen sensor connector(B).

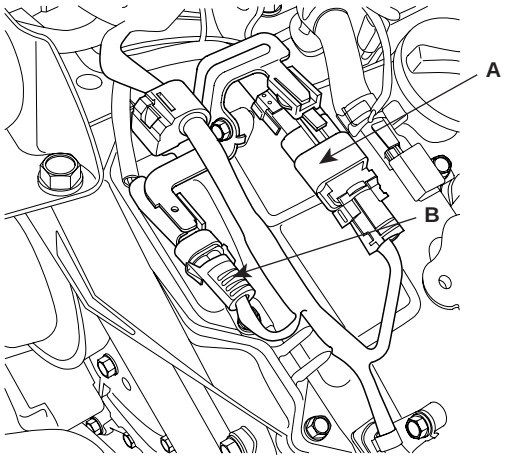
    2) Disconnect power steering oil pressure sensor connector(A).



SGHEM7008N

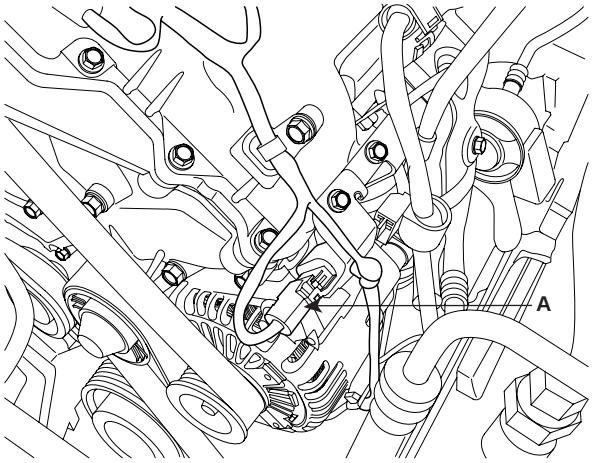
    3) Disconnect RH injector connector and ignition coil connector.

4) Disconnect OCV connector(A) and knock sensor connector(B).



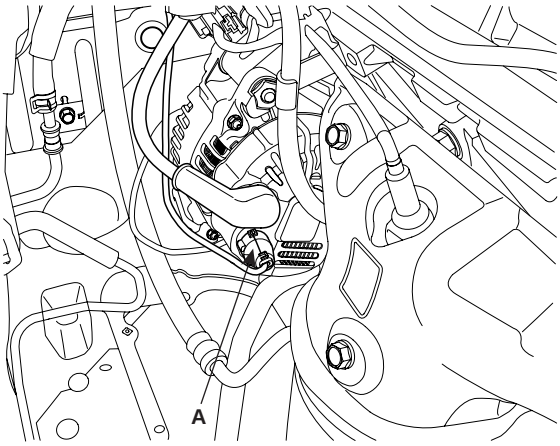
KDRF155A

5) Disconnect LH front oxygen sensor connector(A).



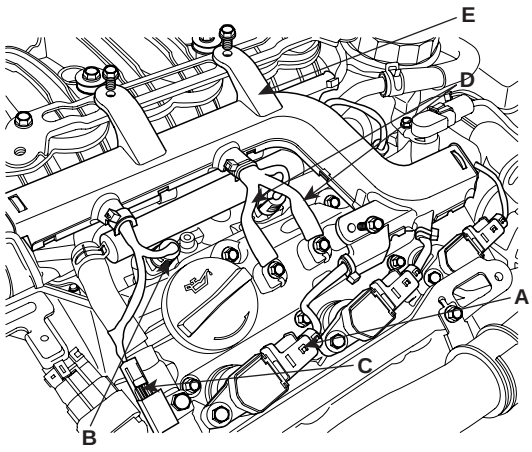
KDRF156A

6) Disconnect alternator connector(A).



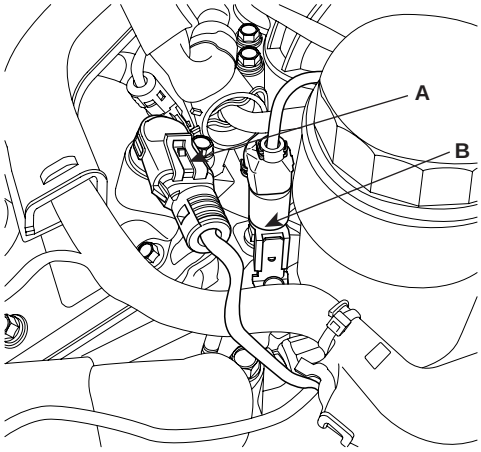
KDRF157A

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



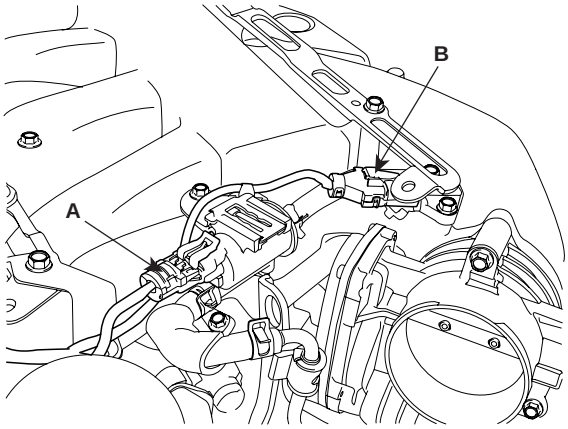
KDRF158A

8) Disconnect LH CMPS(A) and oil pressure switch connector(B).



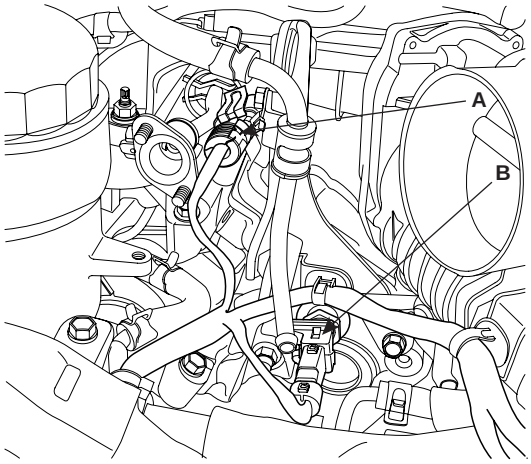
KDRF159A

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



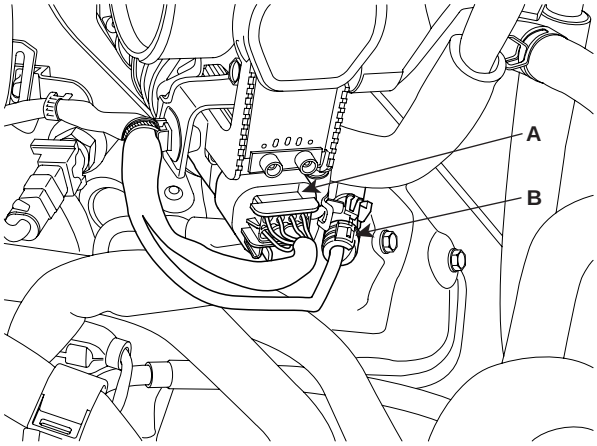
UCBF003A

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



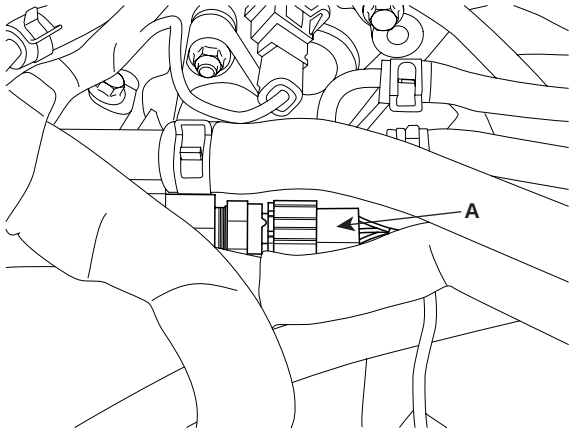
KDRF161A

11) Disconnect ETC connector(A) and knock sensor connector(B).



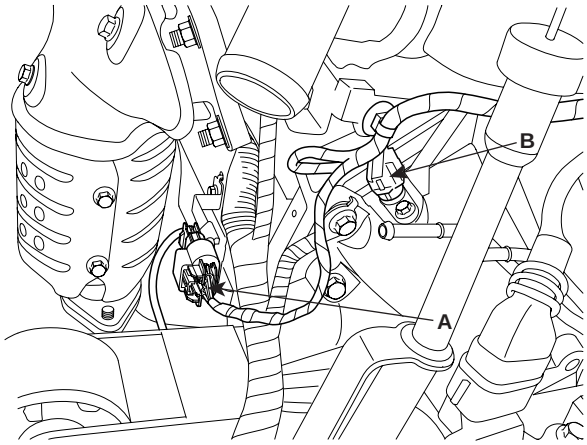
KDRF162A

12) Disconnect ECT sensor connector(A).



KDRF163A

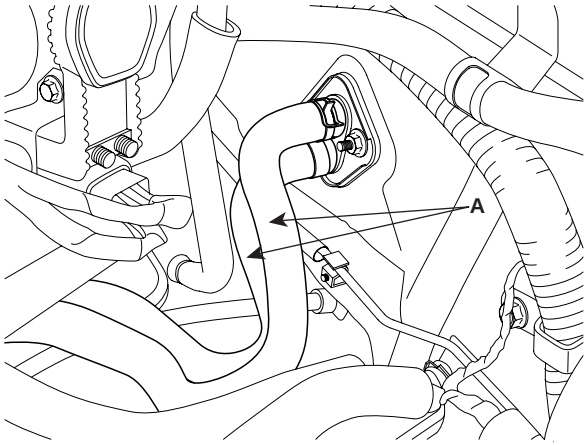
13) Disconnect LH rear oxygen sensor connector(A) and CPS connector(B).



KDRF164A

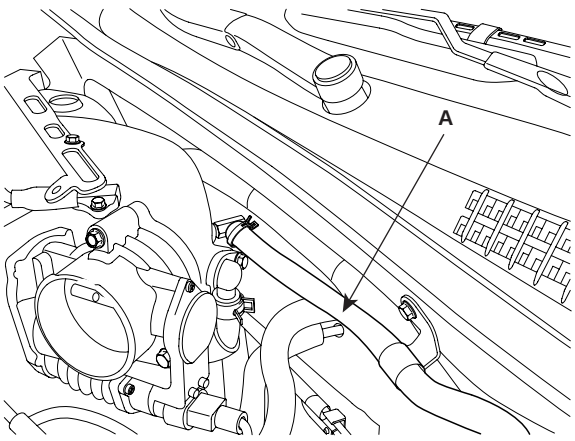
14. Disconnect the transaxle wire harness connector and remove the transaxle control cable.

15. Remove heater hose(A).



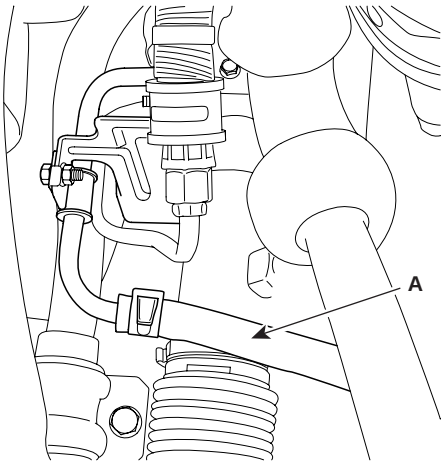
KDRF165A

16. Remove brake vacuum hose(A).



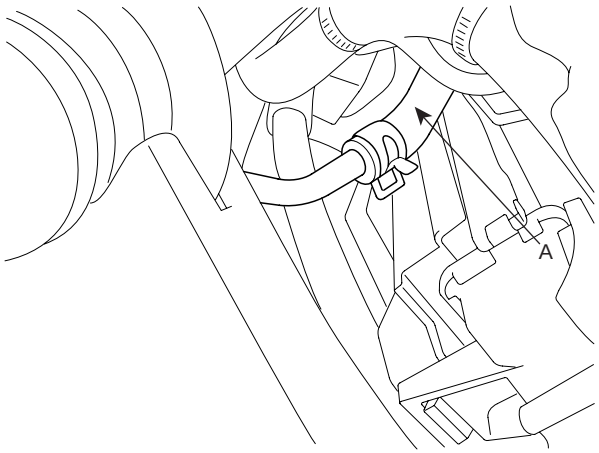
KDBF101A

17. Remove power steering pump hose(A).



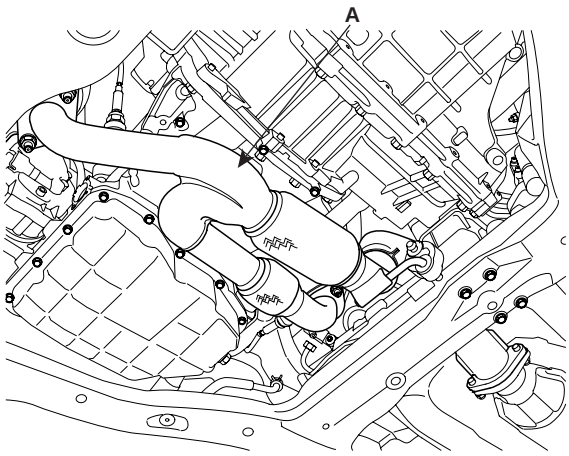
KDRF175A

18. Remove A/C compressor hose.
19. Drain transaxle oil.
20. Remove lower arm ball joint.
21. Remove tie rod end ball joint.
22. Remove stabilizer link.
23. After removing a split pin and nut from the steering bar tie rod, disconnect it.
24. Remove power steering return hose(A) and drain power steering oil.



SGHAT6022D

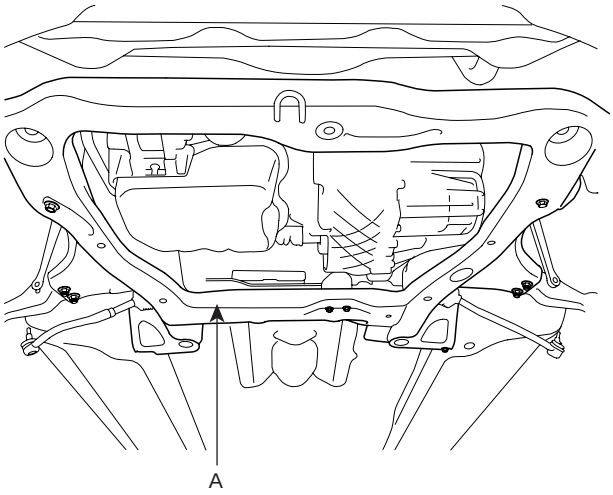
25. Remove front roll stopper mounting bolt.
26. Remove rear roll stopper mounting bolt.
27. Remove steering u-joint mounting bolt.
28. Remove front exhaust pipe(A).



KCBF102A

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

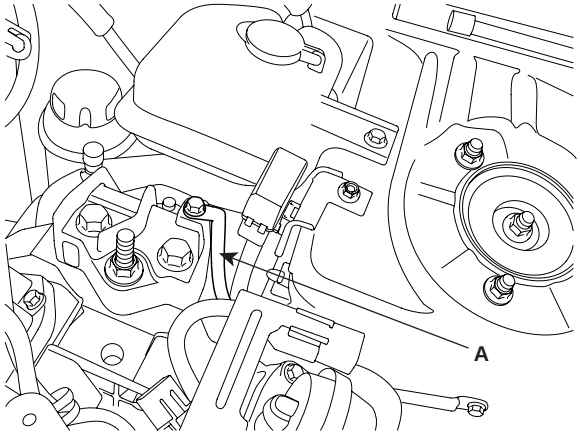
Tightening torque : 137.3~156.9Nm (14.0~16.0kgf.m, 101.3~115.7lb-ft)



KMRE009R

30. Remove drive shaft from transaxle.
31. Install jack for supporting engine and transaxle assembly.

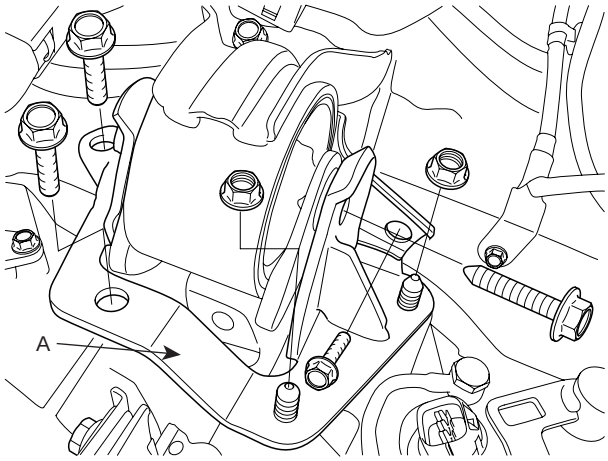
32. Disconnet the ground cable(A) from the engine mounting bracket.



KDBF102A

33. Remove the engine mounting bracket.

34. Remove the transaxle mounting bracket(A).



SGHEM7009N

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

NOTE

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

INSTALLATION EAD5D6B1

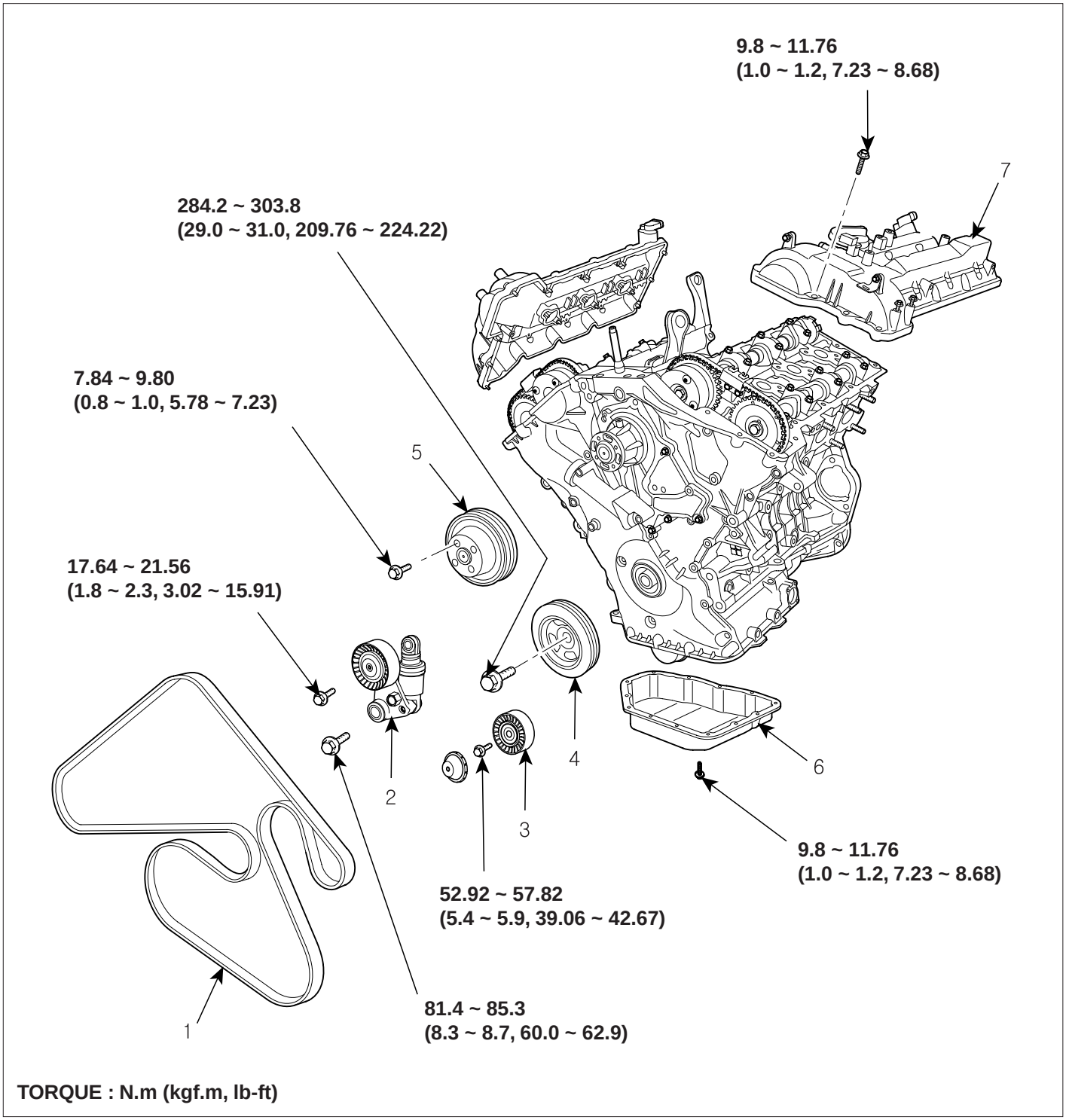
Installation is in the reverse order of removal.
Perform the following :

- Adjust the shift cable.
- Refill an engine with engine oil.
- Refill a transaxle with fluid.
- Refill a radiator with engine coolant.
- Bleed air from the cooling system with the heater valve open.
- Clean the battery posts and cable terminals with sandpaper assemble them, then apply grease to prevent corrosion.
- Inspect for fuel leakage.
  After assembling the fuel line, turn on the ignition switch (do not operate the starter) so that the fuel pump runs for approximately two seconds and fuel line pressurizes.
  Repeat this operation two or three times, then check for fuel leakage at any point in the fuel lines.

TIMING SYSTEM

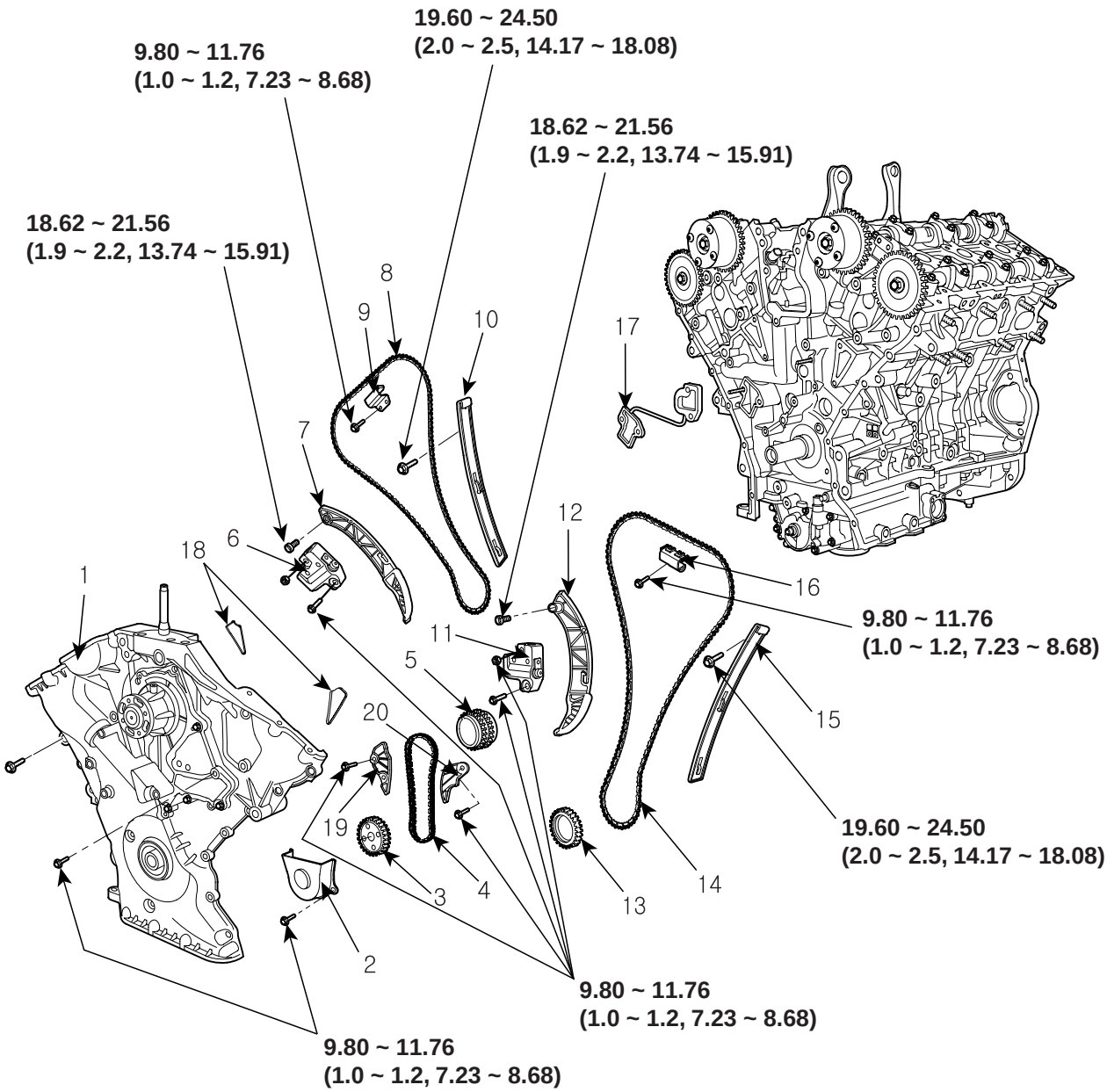
TIMING CHAIN

COMPONENTS EFFAFA9E



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

SGHEM7020N



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

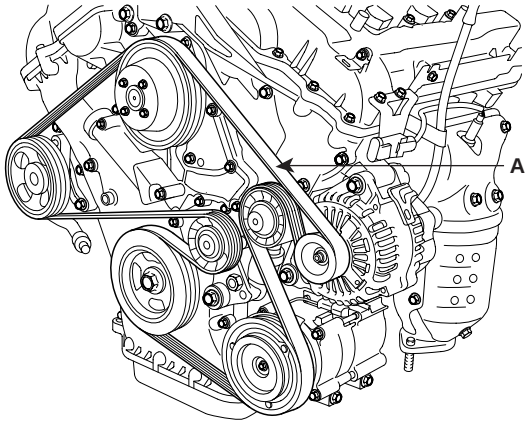
1. Timing chain cover
2. Oil pump chain cover
3. Oil pump sprocket
4. Oil pump chain
5. Crankshaft sprocket
6. Timing chain auto tensioner
7. Timing chain tensioner arm
8. Timing chain
9. Cam to cam guide
10. Timing chain guide
11. Timing chain auto tensioner
12. Timing chain tensioner arm
13. Crankshaft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

ECBF009A

REMOVAL EE688815

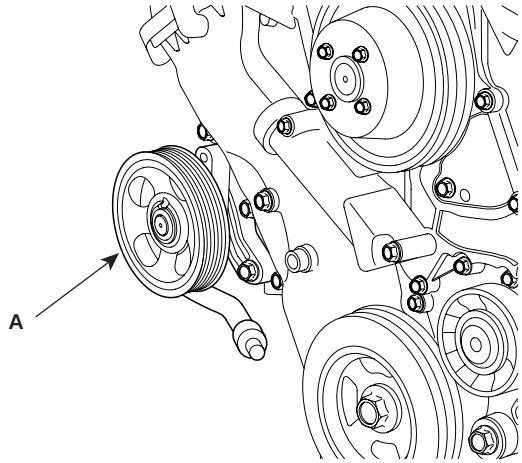
Engine removal is required for this procedure.

1. Remove the drive belt(A).



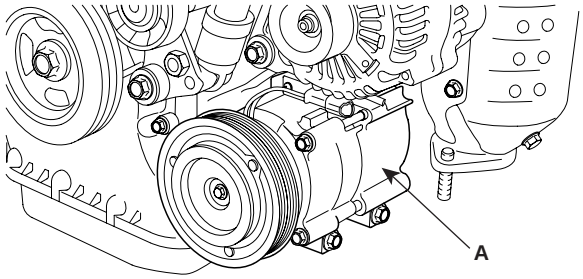
UCBF009A

2. Remove the power steering pump(A).



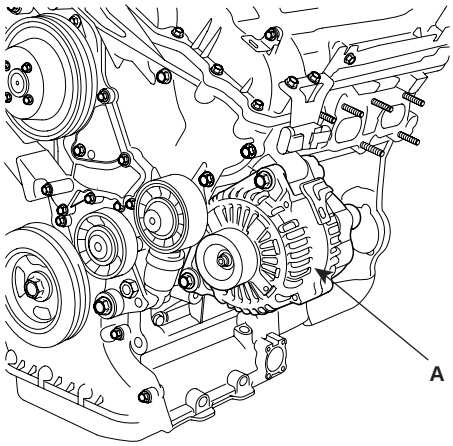
KDRF102A

3. Remove the A/C compressor(A).



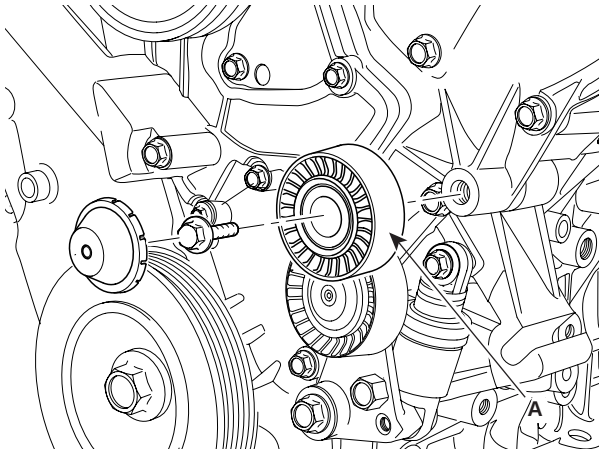
KDRF103A

4. Remove the generator(A).



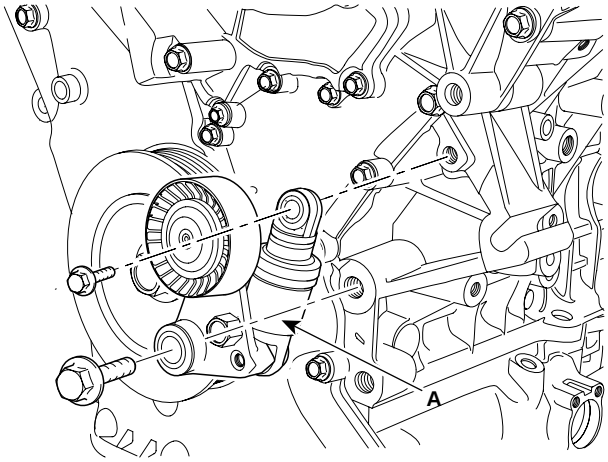
KDRF104A

5. Remove drive belt idler(A).



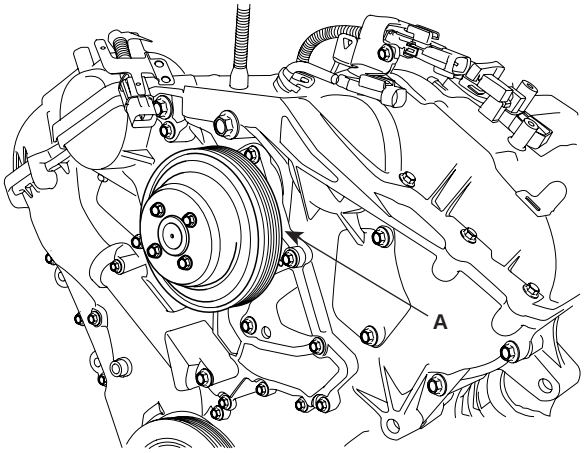
KDRF105A

6. Remove drive belt auto tensioner(A).



KDRF106A

7. Remove water pump pulley(A).

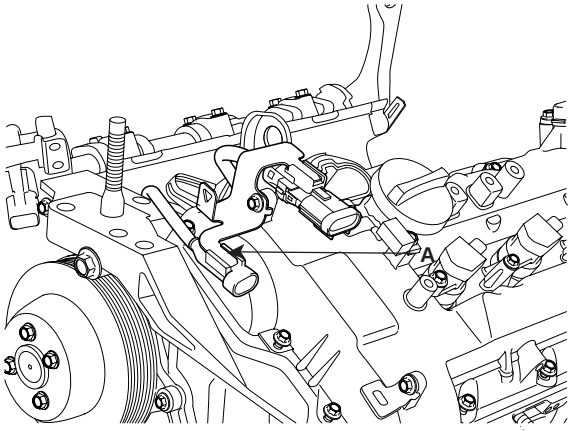


KDRF107A

8. Remove intake manifold.

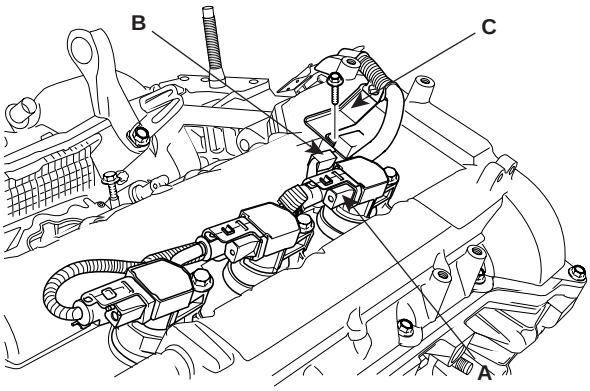
DISASSEMBLY ECE9DBD5

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



KDRF110A

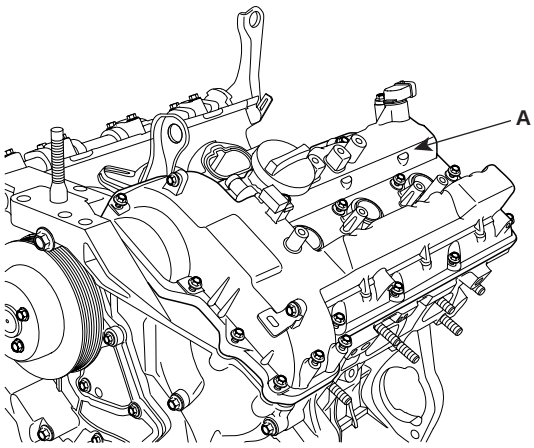
   b. Disconnect RH ignition coil connector(A), condenser connector(B) and remove wiring bracket(C)



KDRF111A

   c. Remove LH,RH ignition coil.

d. Remove LH,RH cylinder head cover(A).



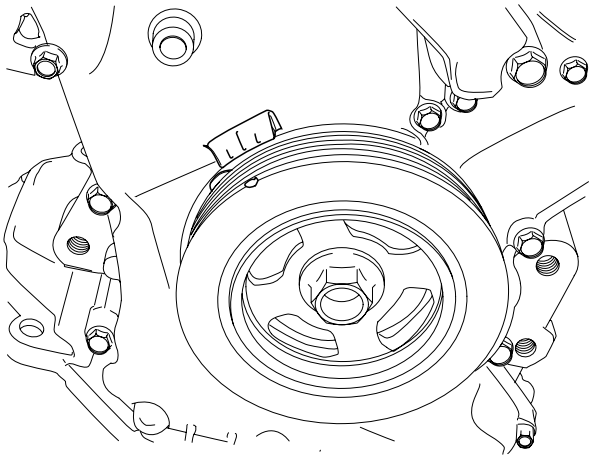
KDRF112A

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.

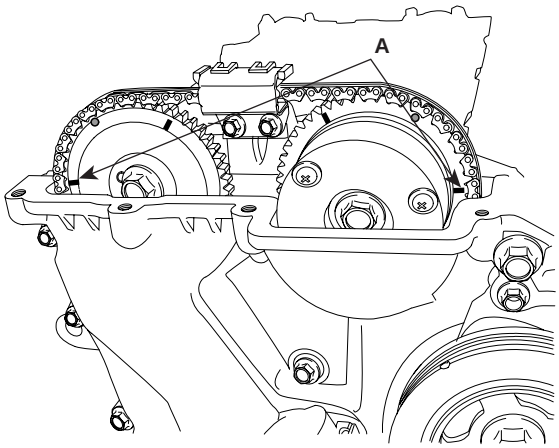
NOTE

Do not rotate engine counterclockwise.



KDRF108A

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

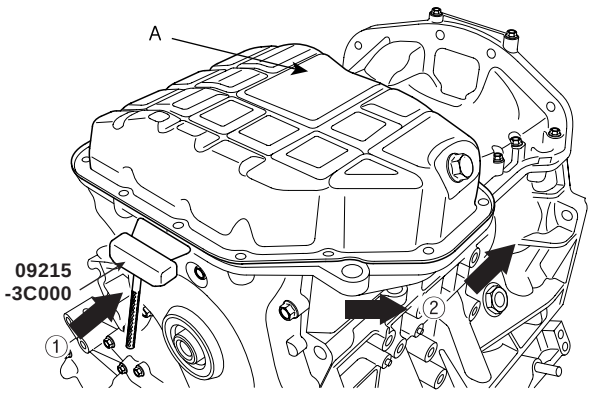


KDRF113A

NOTE

Do not rotate engine counterclockwise.

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

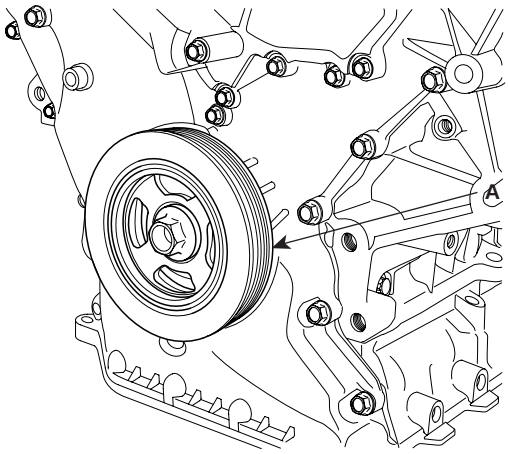


STGEM7100N

CAUTION

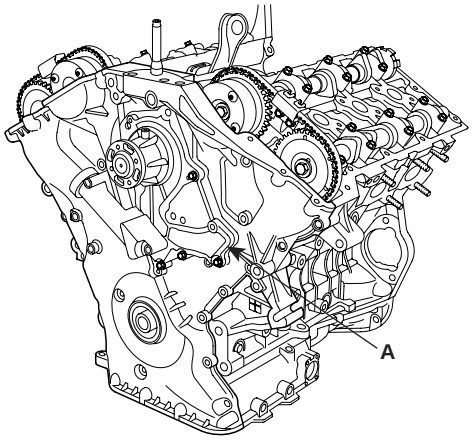
- ***Insert the SST between the oil pan and the ladder frame by tapping it with a plastic hammer in the direction of ① arrow.***
- ***After tapping the SST with a plastic hammer along the direction of ② arrow around more than 2/3 edge of the oil pan, remove it from the ladder frame.***
- ***Do not turn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

4. Remove the crankshaft damper pulley(A).



KDRF109A

5. Remove the timing chain cover(A).

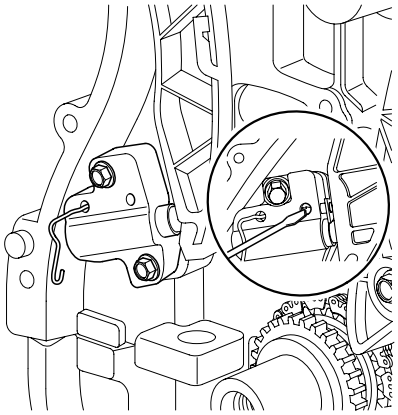


KDRF115A

NOTE

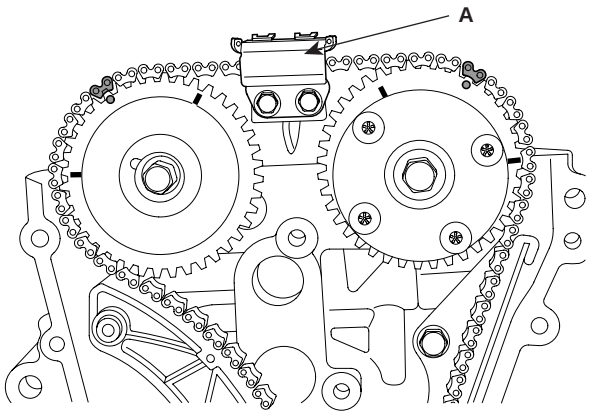
Be careful not to damage the contact surfaces of cylinder block, cylinder head and timing chain cover.
Before removing the timing chain, mark the RH/LH timing chain with an identification based on the location of the sproket because the identification mark on the chain for TDC(Top Dead Center) can be erased.

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



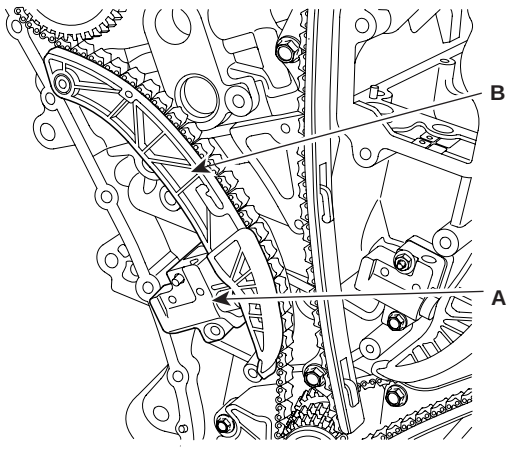
KCRF105A

7. Remove RH cam-to-cam guide(A).



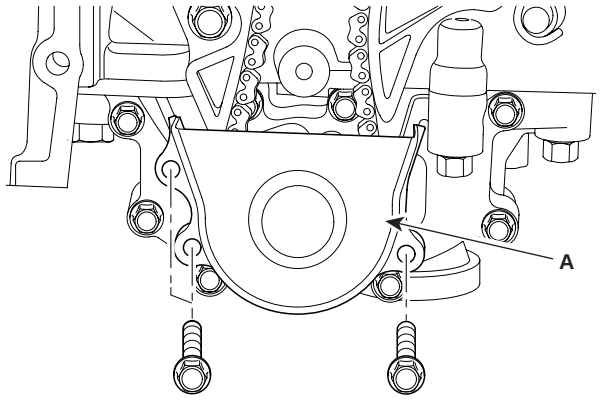
KDRF116A

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



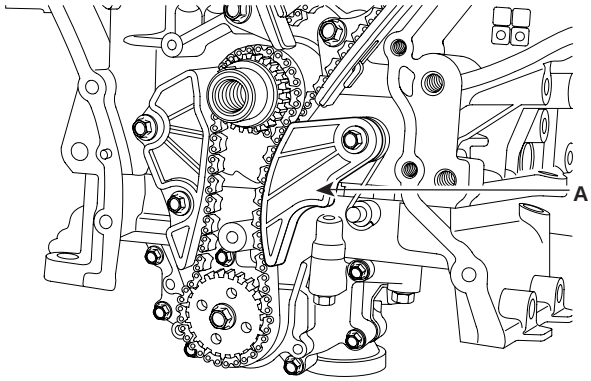
KDRF117A

9. Remove oil pump chain cover(A).



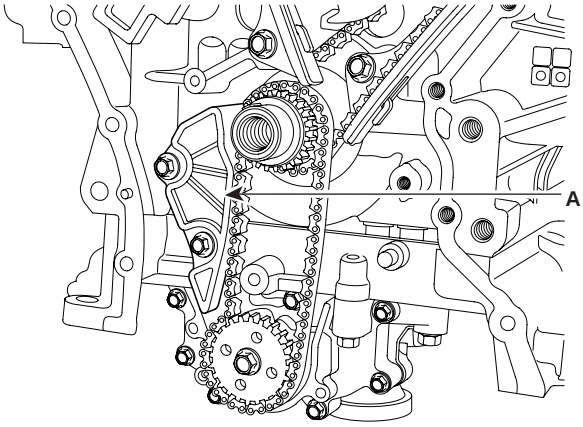
KDRF185A

10. Remove oil pump chain tensioner assembly(A).



KDRF119A

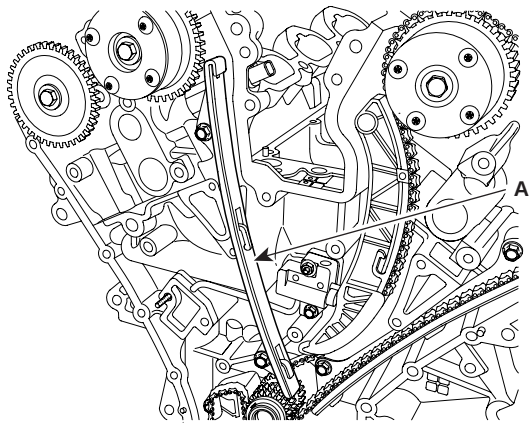
11. Remove oil pump chain guide(A).



KDRF120A

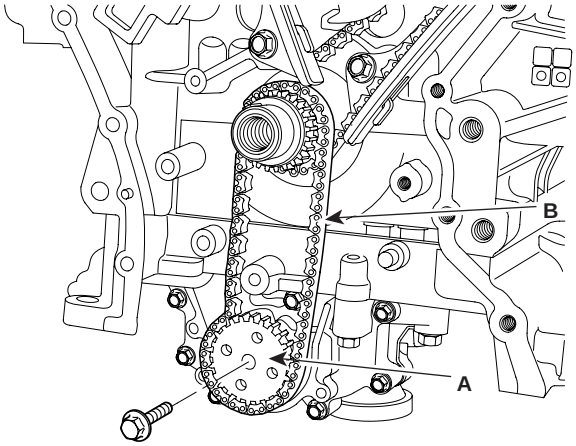
12. Remove RH timing chain.

13. Remove RH timing chain guide(A).



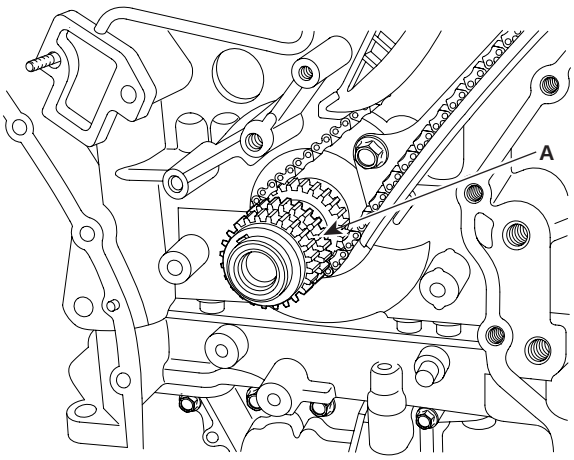
KDRF118A

14. Remove oil pump chain sprocket(A) and oil pump chain(B).



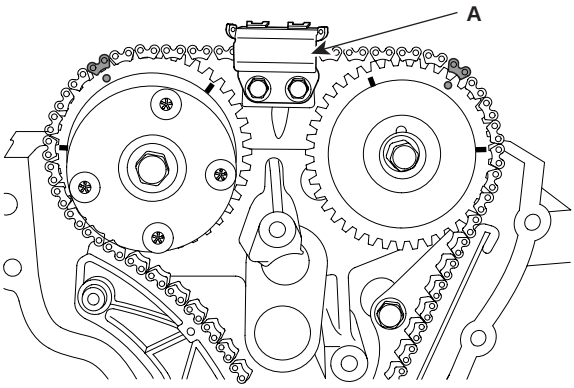
KDRF121A

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



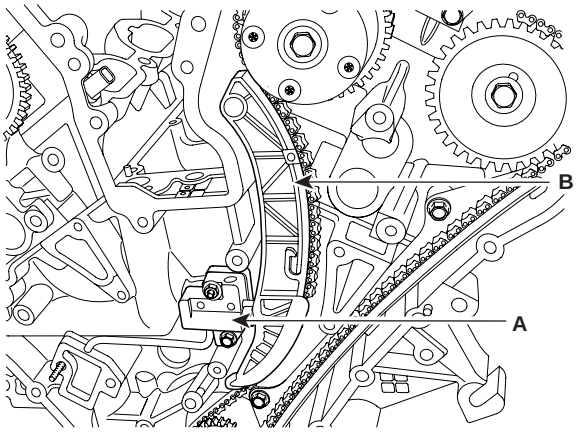
KDRF122A

16. Remove LH cam-to-cam guide(A).



KDRF123A

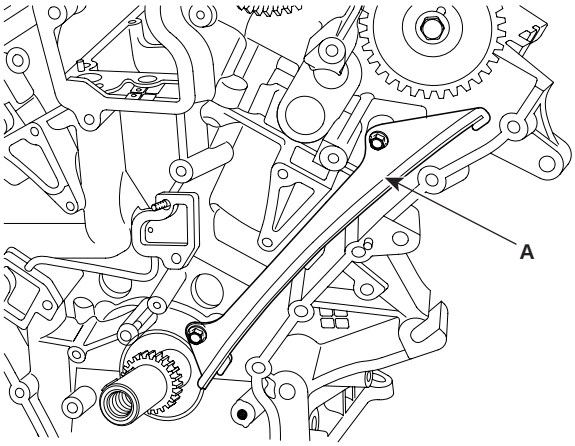
17. Remove LH timing chain auto tensioner(A) and LH timing chain tensioner arm(B).



KDRF124A

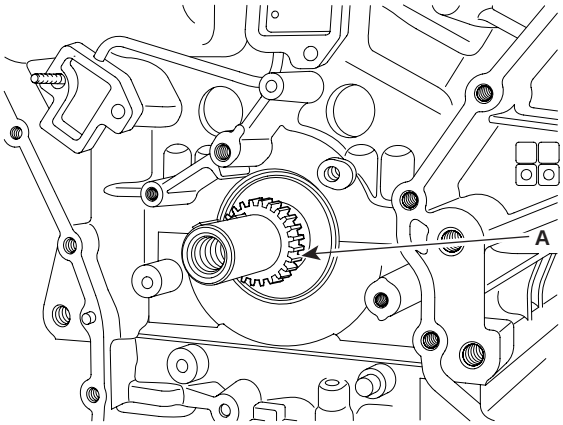
18. Remove LH timing chain.

19. Remove LH timing chain guide(A).



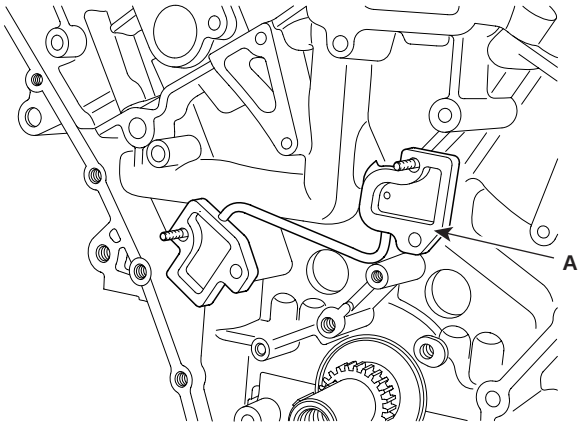
KDRF125A

20. Remove crankshaft sprocket(A)(LH camshaft drive).



KDRF126A

21. Remove tensioner adapter assembly(A).



KDRF127A

INSPECTION E33C7CDB

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.

BELT, IDLER, BELT TENSIONER, PULLEY

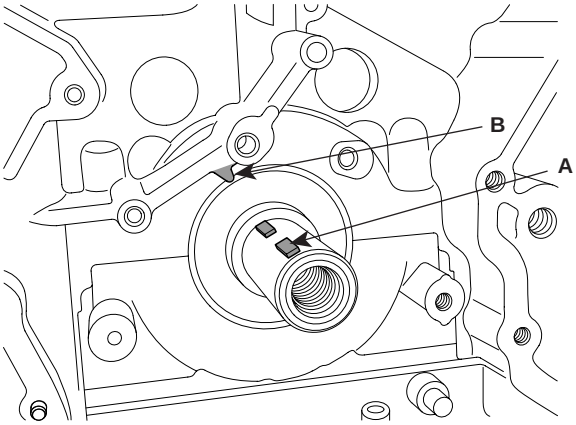
1. Check the belt for oil or dust deposits.
   Replace, if necessary.
   Small deposits should be wiped away with a dry cloth or paper. Do not clean with solvent.
2. When the engine is overhauled or belt tension adjusted, check the belt carefully. If any of the following flaws are evident, replace the belt.

   NOTE

   - *Do not bend, twist or turn the timing belt inside out.*
   - *Do not allow the timing belt to come into contact with oil, water and steam.*
3. Inspect the idler for easy and smooth rotation and check for play or noise.

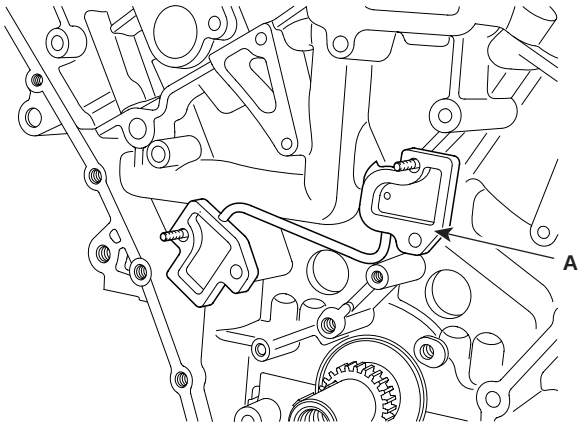
REASSEMBLY E0BF1C9F

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



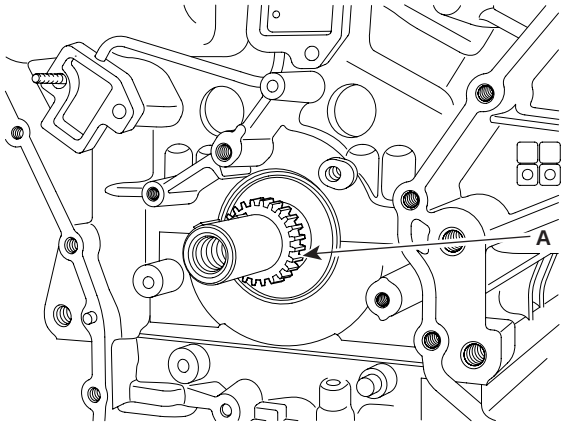
KDRF128A

2. Install tensioner adapter assembly(A).



KDRF127A

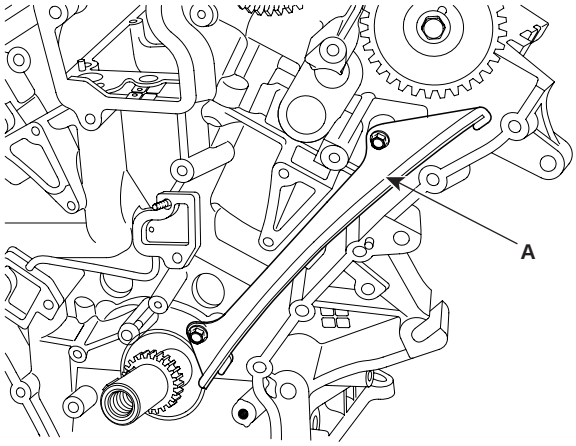
3. Install crankshaft sprocket(A)(LH camshaft drive).



KDRF126A

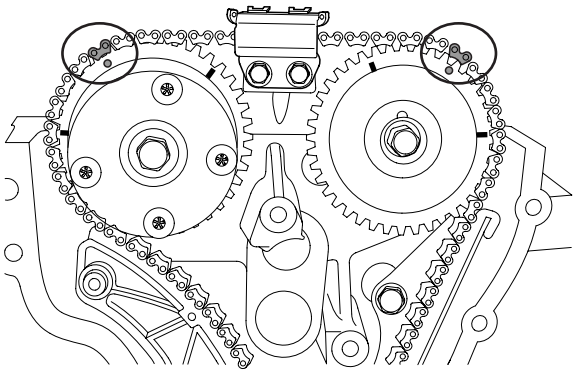
4. Install LH timing chain guide(A).

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



KDRF125A

5. Install LH 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) → Exhaust camshaft sprocket(C) → Intake camshaft sprocket(D).
The timing mark of each sprocket should be matched with timing mark (color link) of timing chain when installing timing chain.



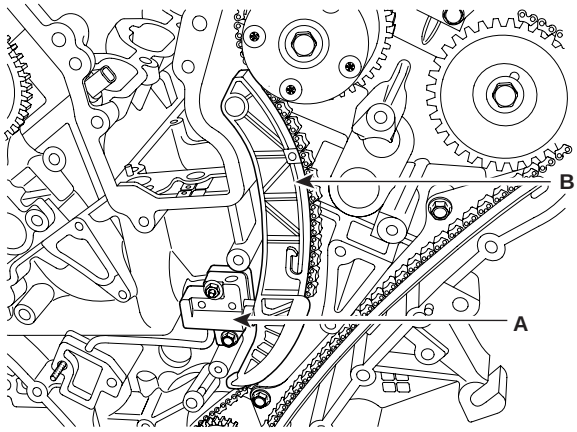
KDRF123B

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

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

7. Install LH chain tensioner(A).

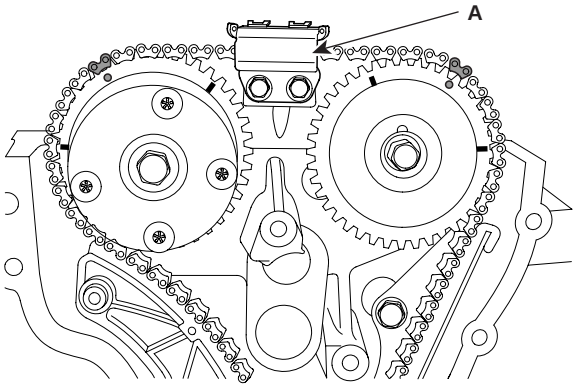
Tightening torque
9.80 ~ 11.76Nm(1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)



KDRF124A

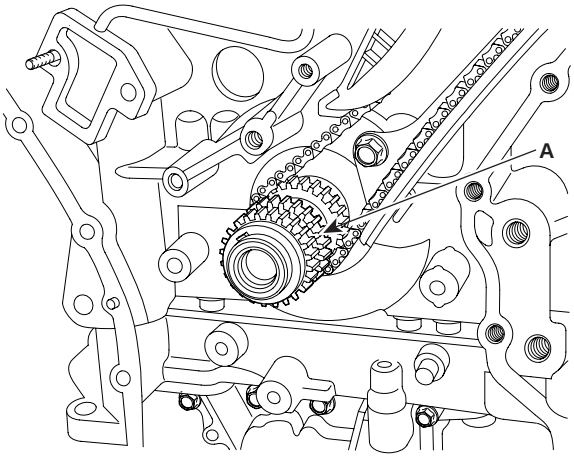
8. Install LH cam-to-cam guide(A).

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



KDRF123A

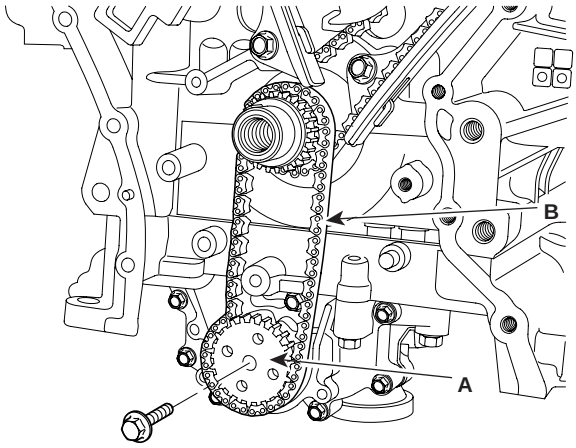
9. Install crankshaft sprocket(A)(Oil pump & RH camshaft drive).



KDRF122A

10. Install oil pump chain(B) and oil pump sprocket(A).

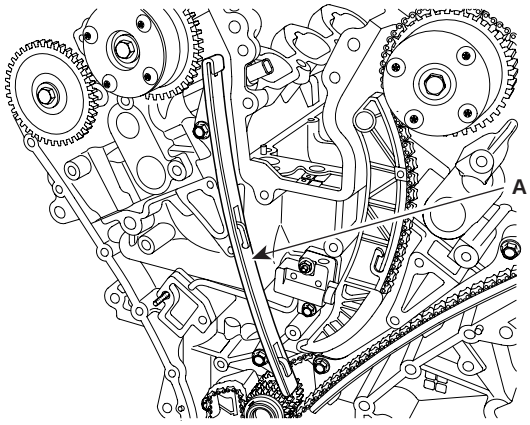
Tightening torque
18.62 ~ 21.56Nm(1.9 ~ 2.2kgf.m, 13.74 ~ 15.91lb-ft)



KDRF121A

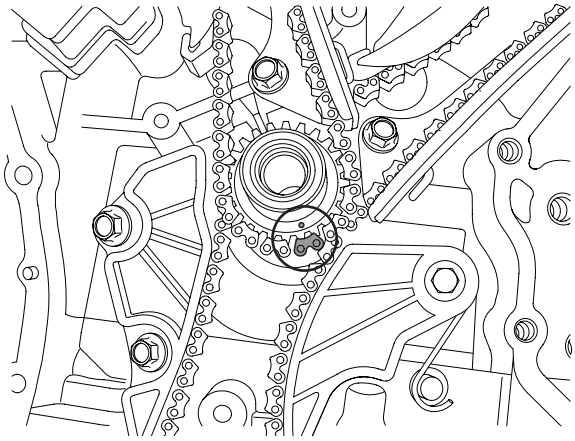
11. Install RH timing chain guide(A).

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

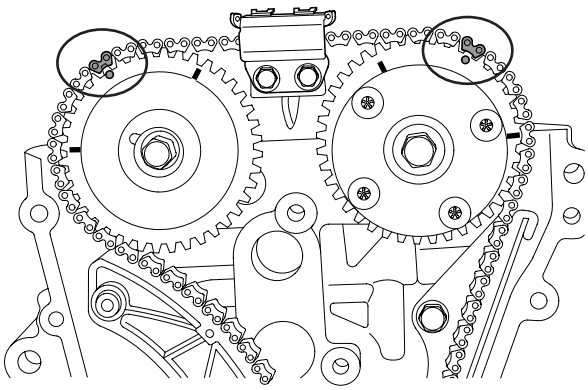


KDRF118A

12. Install RH timing chain.
To install the timing chain with no slack between each shaft (cam, crank), follow the below procedure.
Crankshaft sprocket(A) → Intake camshaft sprocket(B) → Exhaust camshaft sprocket(C).
The timing mark of each sprocket should be matched with timing mark (color link) of timing chain when installing timing chain.



KDRF129A



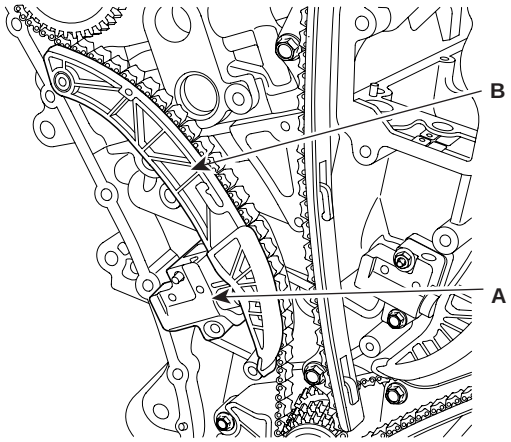
KDRF116B

13. Install RH timing chain tensioner arm(B).

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

14. Install RH timing chain auto tensioner(A).

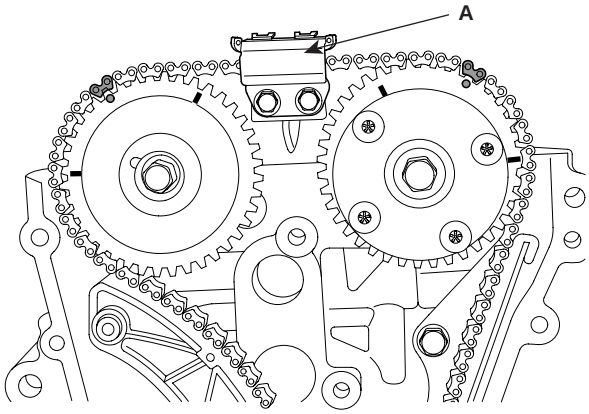
Tightening torque
9.80 ~ 11.76Nm(1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)



KDRF117A

15. Install RH cam-to-cam guide(A).

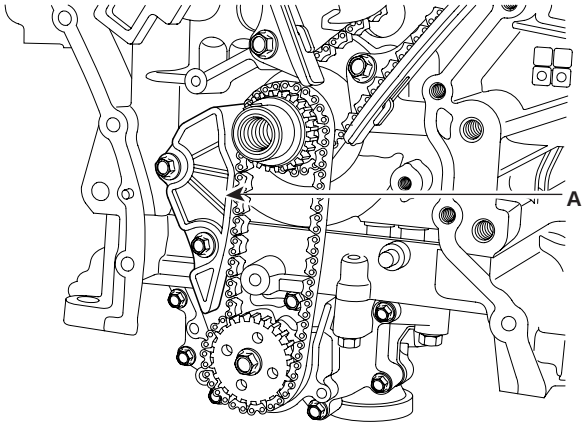
Tightening torque
9.80 ~ 11.76Nm(1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)



KDRF116A

16. Install oil pump chain guide(A).

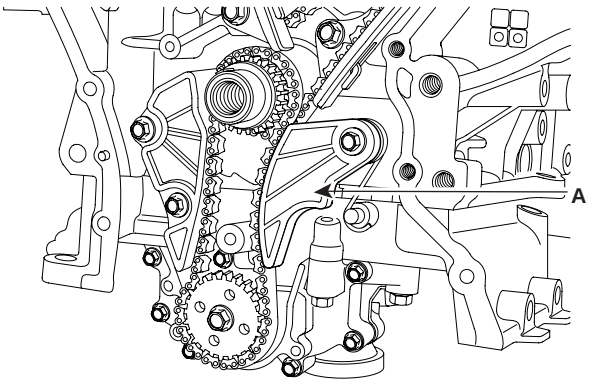
Tightening torque
9.80 ~ 11.76Nm(1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)



KDRF120A

17. Install oil pump chain tensioner assembly(A).

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

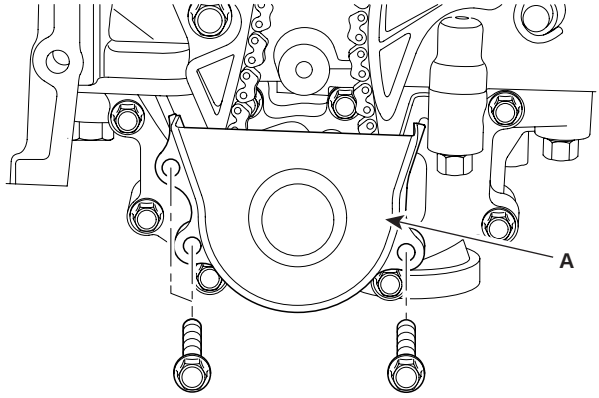


KDRF119A

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

19. Install oil pump chain cover(A).

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



KDRF185A

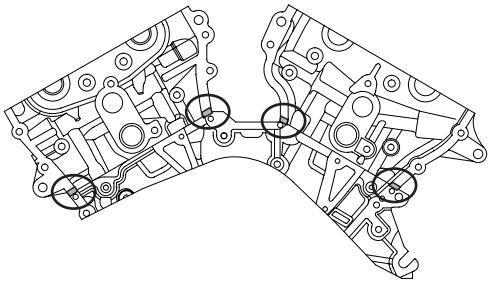
20. After rotating crankshaft 2 revolutions in regular direction(clockwise viewed from front), confirm the timing mark.

NOTE

Always turn the crankshaft clockwise.

21. Install timing chain cover.
    a. The sealant locations on chain cover and on counter parts (cylinder head, cylinder block, and lower oil pan) must be free of engine oil and ETC.
    b. Before assembling the timing chain cover, the liquid sealant TB1217H should be applied on the gap between cylinder head and cylinder block.
    The part must be assembled within 5 minutes after sealant was applied.

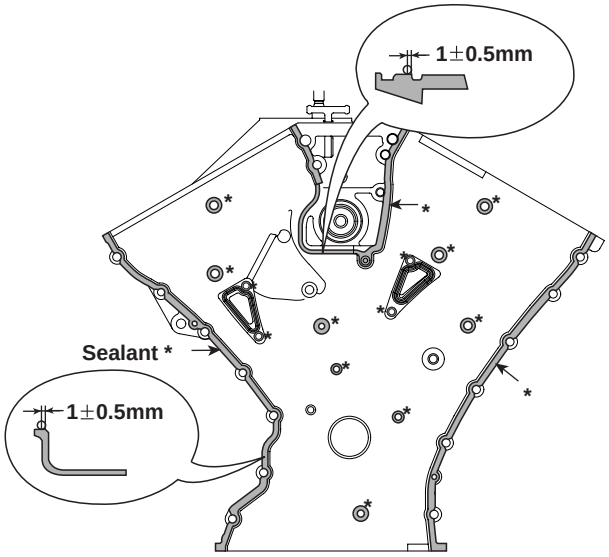
Bead width : 2.5mm(0.1in.)



KDRF134A

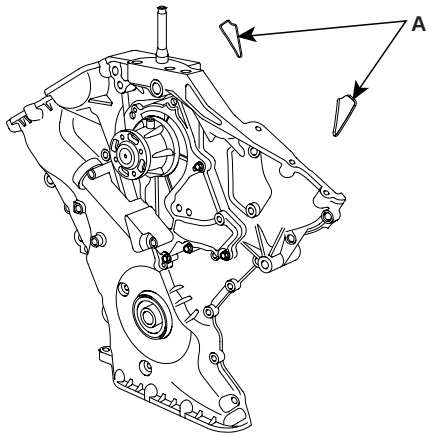
    c. Apply liquid sealant TB1217H on timing chain cover.
    The part must be assembled within 5 minutes after sealant was applied.
    Sealant should be applied without discontinuity.

Bead width : 2.5mm(0.1in.)



SBLM16200L

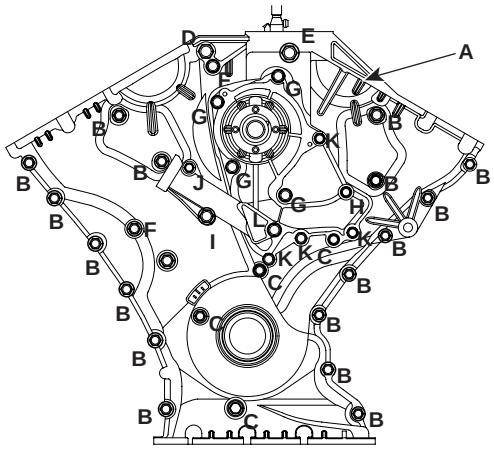
    d. Install the new gasket(A) to the timing chain cover.



KDRF220A

e. The dowel pins on the cylinder block and holes on the timing chain cover should be used as a reference in order to assemble the timing chain cover correctly.

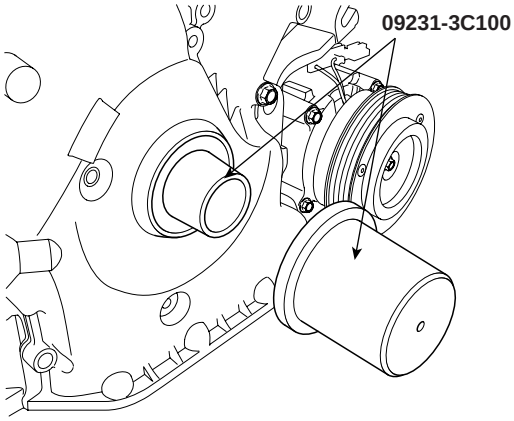
Tightening torque
B(17): 18.62 ~ 21.56Nm(1.9 ~ 2.2kgf.m, 13.74 ~ 15.91lb-ft)
C(4): 9.80 ~ 11.76Nm(1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)
D(1): 58.80 ~ 68.80Nm(6.0 ~ 7.0kgf.m, 43.40 ~ 50.63lb-ft)
E(1): 58.80 ~ 68.80Nm(6.0 ~ 7.0kgf.m, 43.40 ~ 50.63lb-ft)
F(2): 24.50 ~ 26.46Nm(2.5 ~ 2.7kgf.m, 18.08 ~ 19.53lb-ft)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



UCBF013A

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

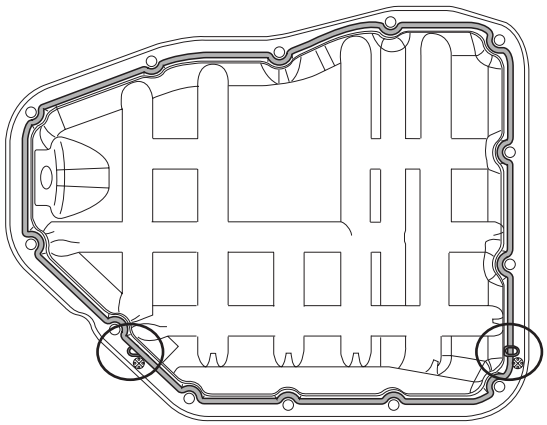
22. Using SST(09231-3C100), install timing chain cover oil seal.



ECRF050A

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

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



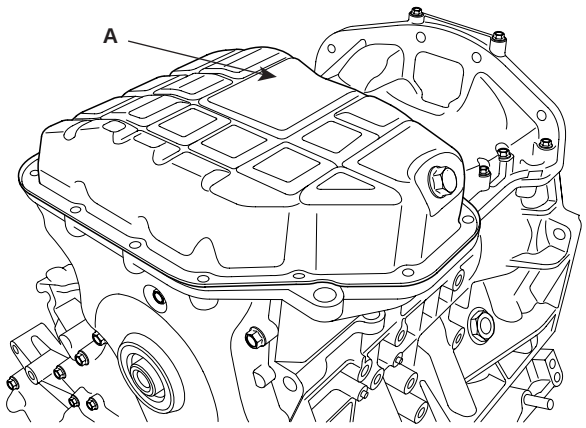
KDRF136A

CAUTION

- ***Clean the sealing face before assembling two parts.***
- ***Remove harmful foreign materials on the sealing face before applying sealant.***
- ***When applying sealant gasket, sealant must not protrude into the inside of oil pan.***
- ***To prevent leakage of oil, apply sealant gasket ot the inner threads to the bolt holes.***
- ***After assembly, wait at least 30 minutes before filling the engine with oil.***

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

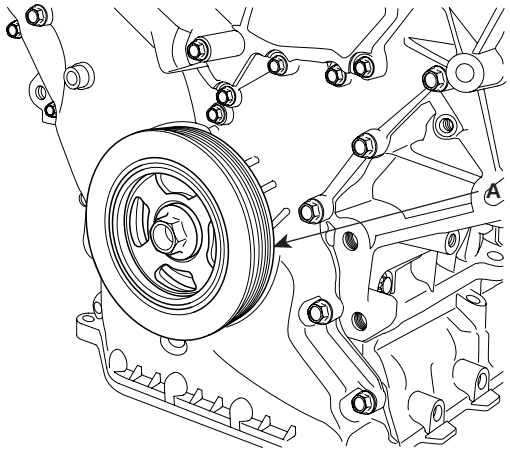
Tightening torque
9.80 ~ 11.76Nm(1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)



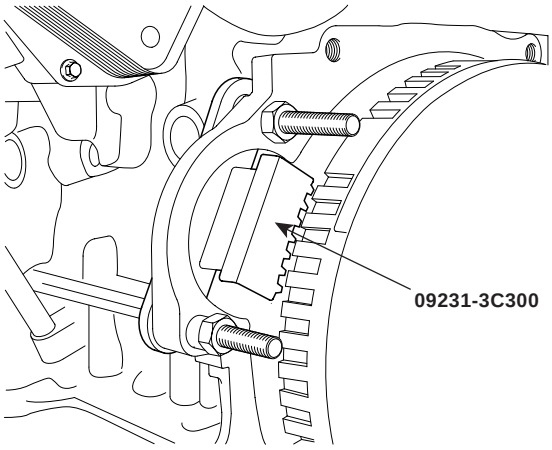
KDRF114A

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

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

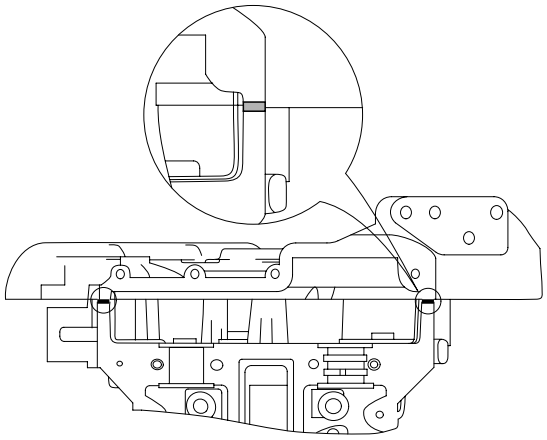


KDRF109A



ECRF061A

25. Install cylinder head cover.
   a. The hardening sealant located on the upper area between timing chain cover and cylinder head should be removed before assembling cylinder head cover.
   b. After applying sealant(TB1217H), it should be assembled within 5 minutes. Bead width : 2.5mm(0.1in.)

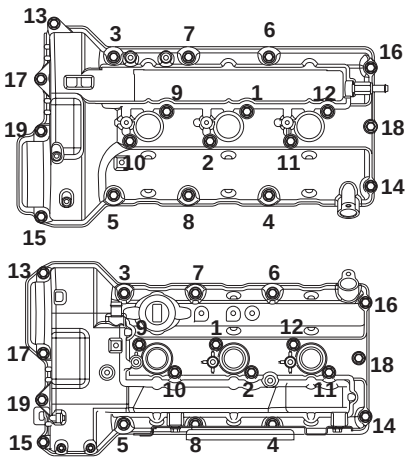


KDRF231A

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

d. Install the cylinder head cover bolts as following method.

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

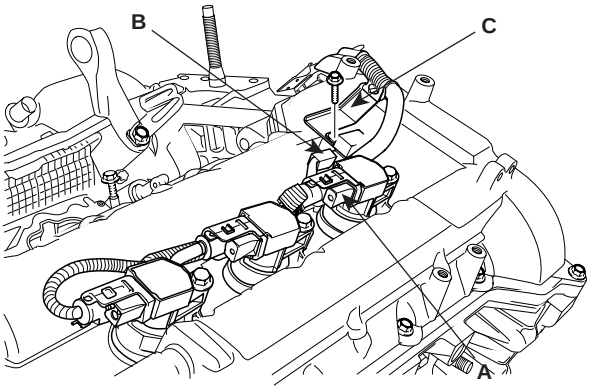


KDRF139A

CAUTION

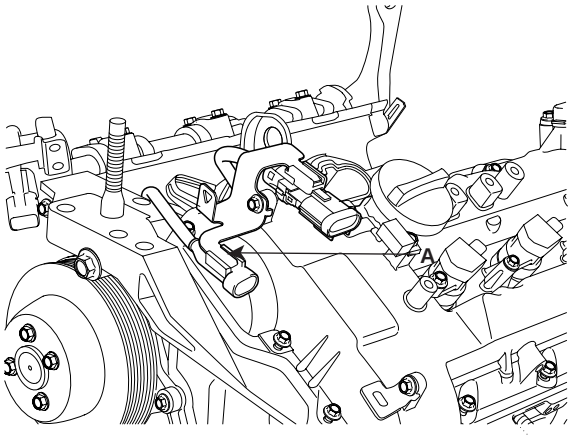
Do not reuse cylinder head cover gasket.

e. Install ignition coil
f. Connect RH ignition coil connector(A), condenser connector(B) and install wiring bracket(C).



KDRF111A

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

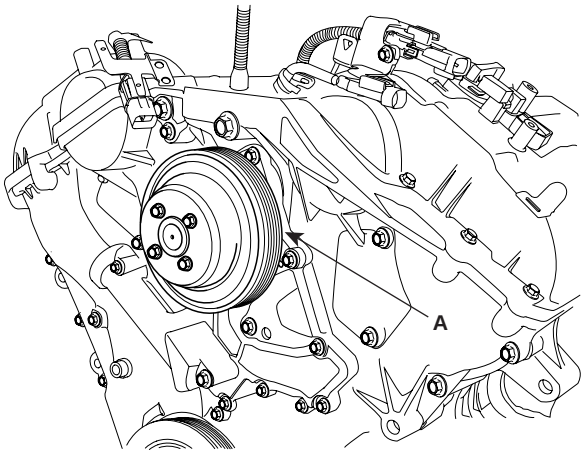


KDRF110A

INSTALLATION E0ED79CB

1. Install intake manifold.
2. Install water pump pulley(A).

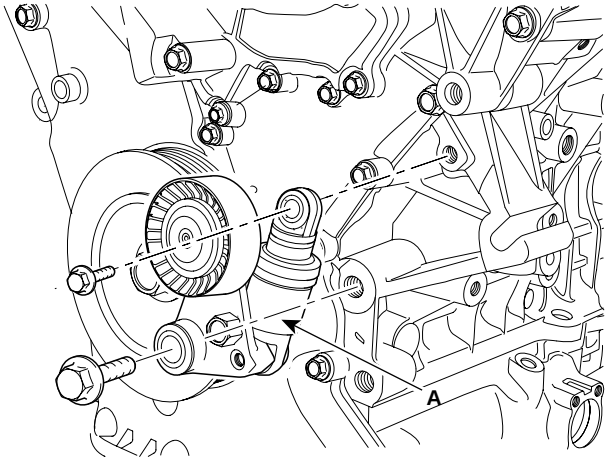
Tightening torque
7.84 ~ 9.80Nm(0.8 ~ 1.0kgf.m, 5.78 ~ 7.23lb-ft)



KDRF107A

3. Install drive belt auto tensioner(A).

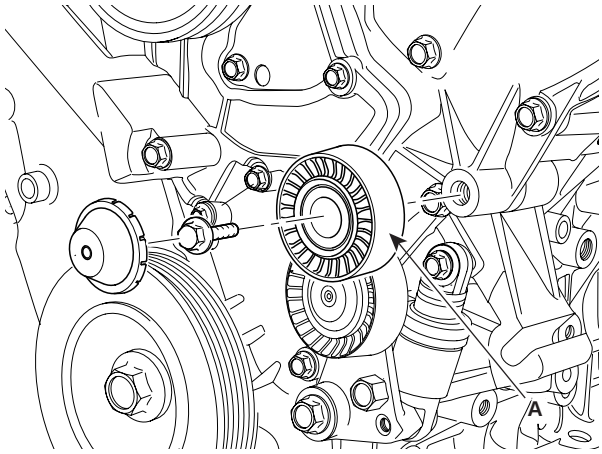
Tightening torque
81.4 ~ 85.3Nm(8.3 ~ 8.7kgf.m, 60.0 ~ 62.9lb-ft)
17.64 ~ 21.56Nm(1.8 ~ 2.2kgf.m, 13.02 ~ 15.91lb-ft)



KDRF106A

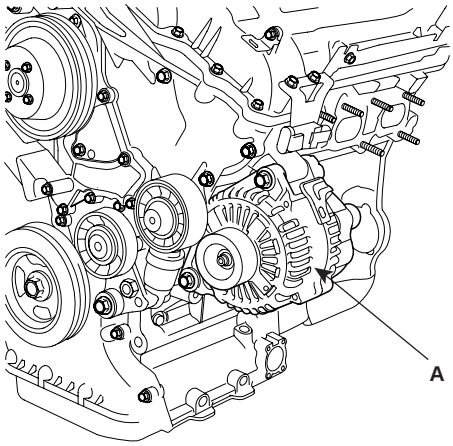
4. Install drive belt idler(A).

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



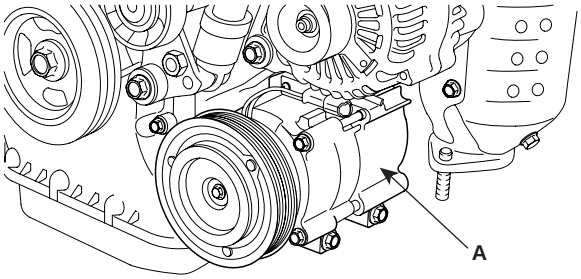
KDRF105A

5. Install the generator(A).



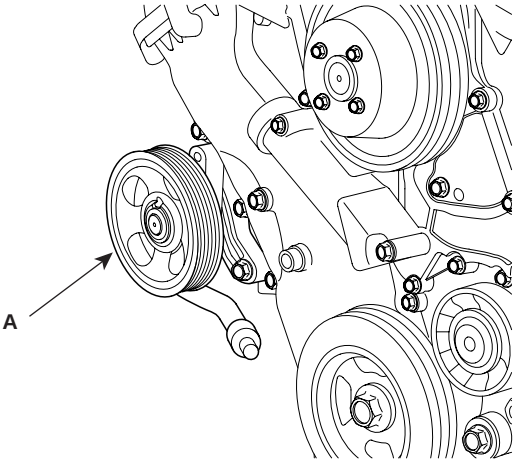
KDRF104A

6. Install air conditioner compressor(A).



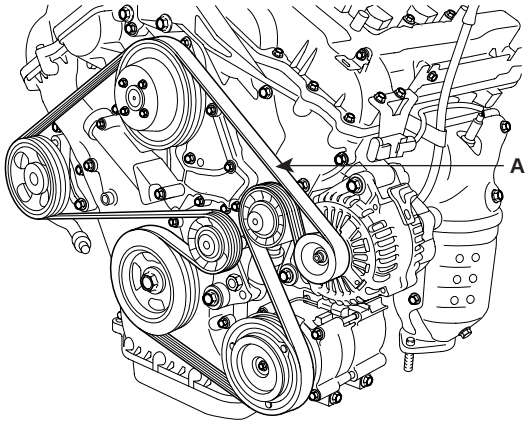
KDRF103A

7. Install power steering pump(A).



KDRF102A

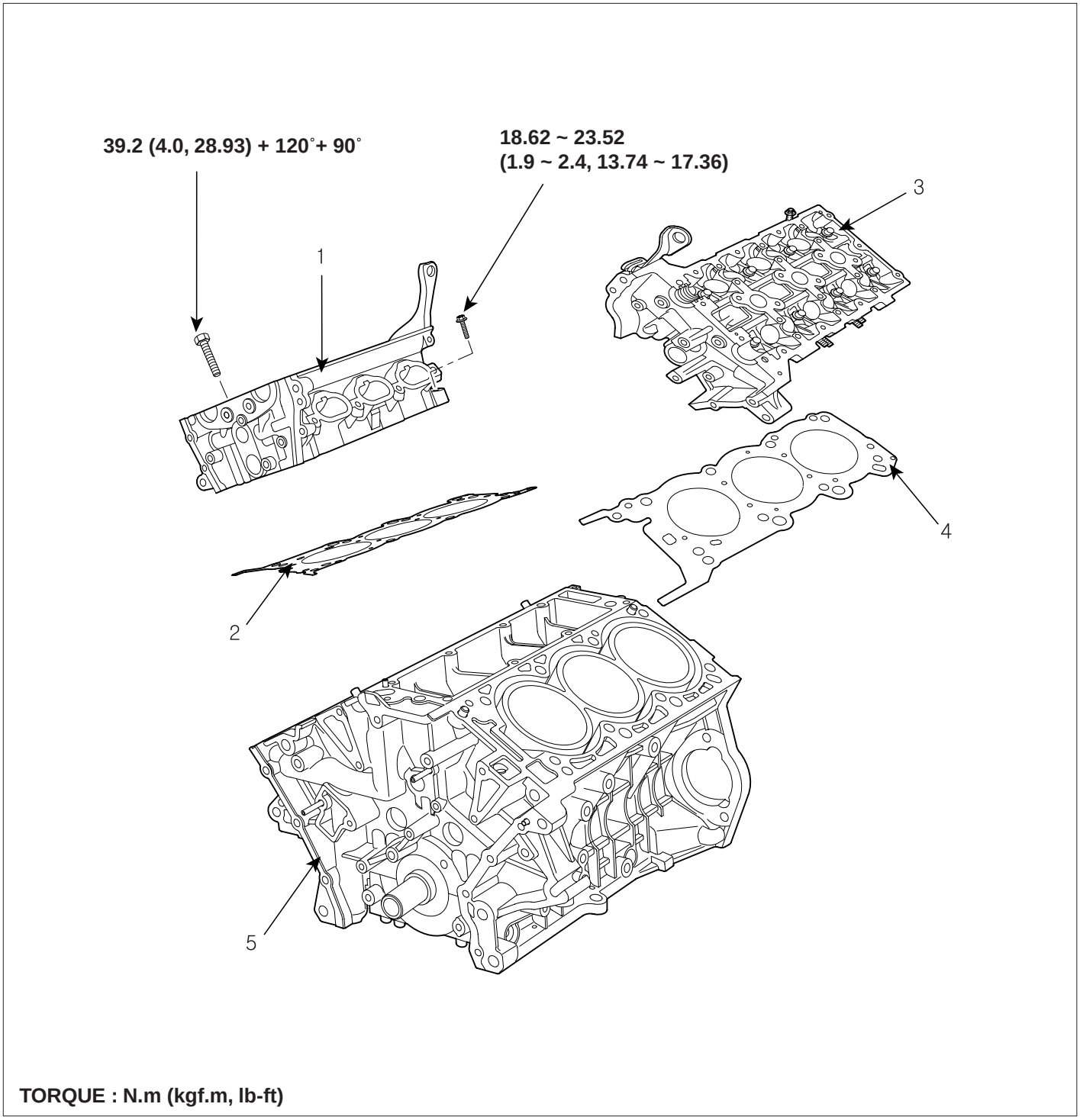
8. Install drive belt(A).
   Crankshaft pulley → A/C pulley → idler pulley → generator pulley → water pump pulley → P/S pump pulley → tensioner pulley.
   Rotate auto tensioner arm in the counter - clockwise direction while moving auto tensioner pulley bolt with wrench.
   After putting belt on auto tensioner pulley, release the auto tensioner pulley slowly.



KDRF101A

CYLINDER HEAD ASSEMBLY

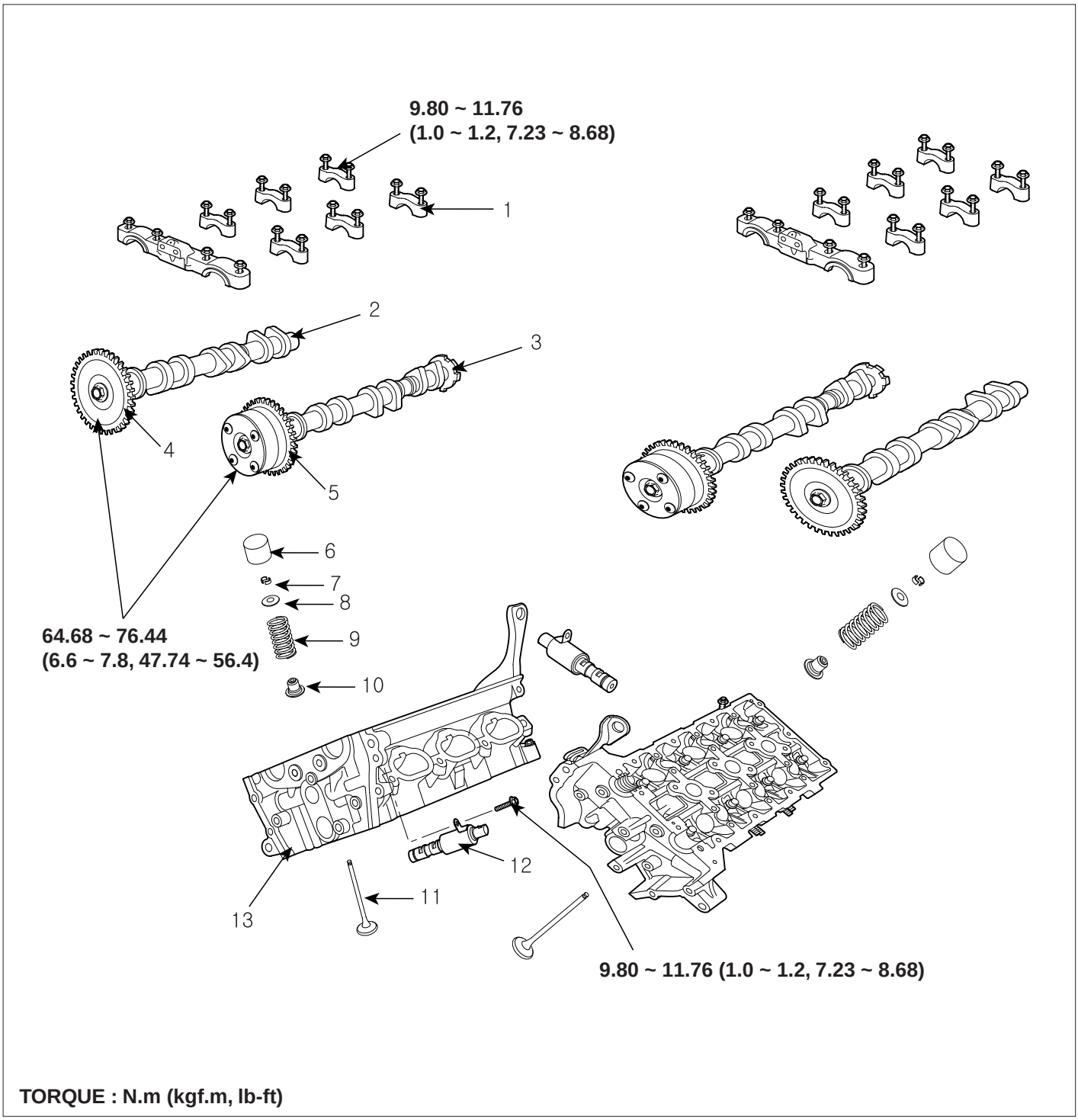
COMPONENTS EEECCDC0



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

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

ECBF010A



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

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

ECBF011A

REMOVAL EC0F8ABA

CAUTION

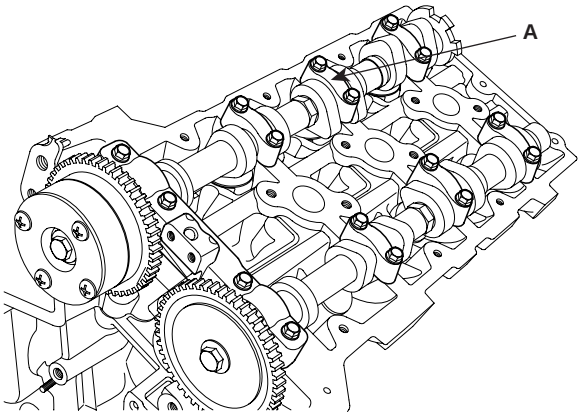
- ***Use fender covers to avoid damaging painted surfaces.***
- ***To avoid damaging the cylinder head, wait until the engine coolant temperature drops below normal operating temperature before removing it.***
- ***When handling a metal gasket, take care not to fold the gasket or damage the contact surface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

NOTE

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

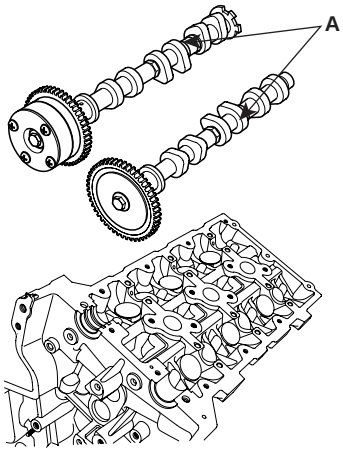
Engine removal is required for this procedure.

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



KDRF196A

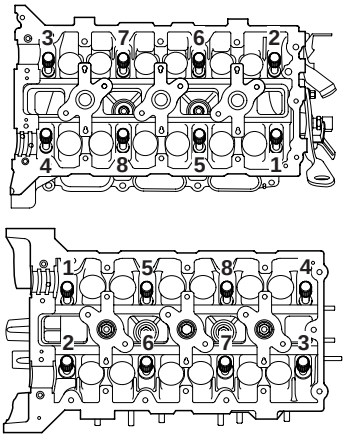
6. Remove camshaft assembly(A).



KDRF197A

7. Remove cylinder head bolts, then remove cylinder head.

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



KDRF199A

CAUTION

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

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

CAUTION

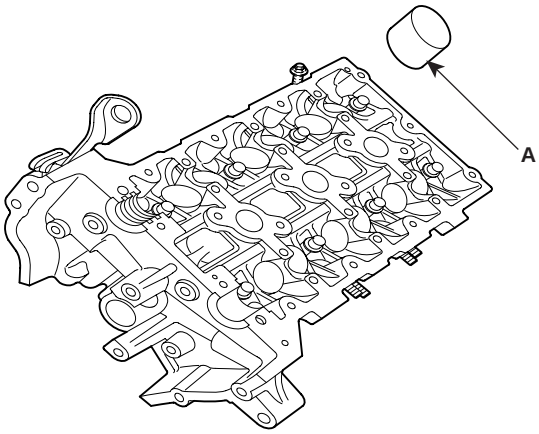
Be careful not to damage the contact surfaces of the cylinder head and cylinder block.

DISASSEMBLY EC0C0D1E

NOTE

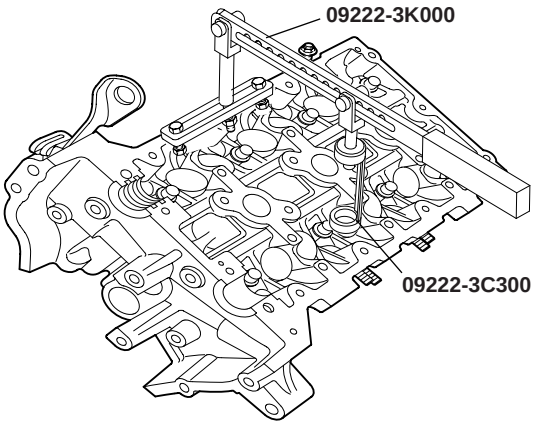
Identify MLA, valves and valve springs as they are removed so that each item can be reinstalled in its original position.

1. Remove MLAs(A).



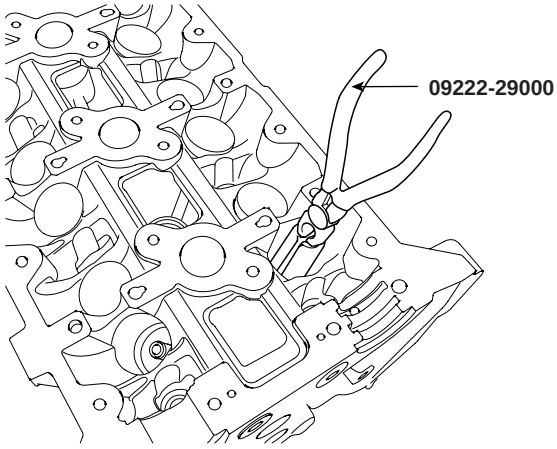
KDRF200A

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



KDRF201A

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

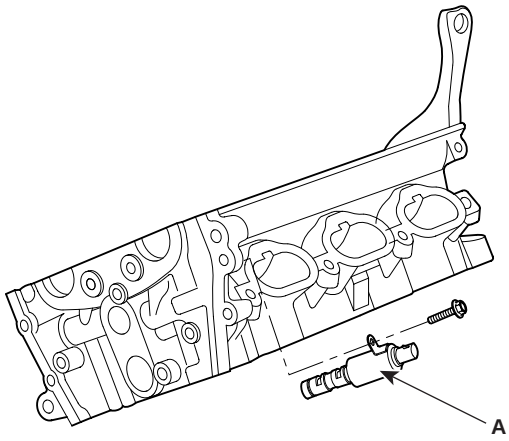


KDRF234A

NOTE

Do not reuse old valve stem seals.

3. Remove OCV(A).



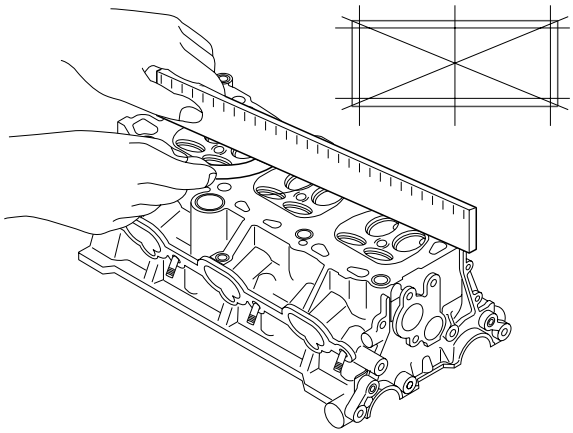
KDRF202A

INSPECTION EA4BD93A

CYLINDER HEAD

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

Flatness of cylinder head gasket surface
Standard : Less than 0.05mm(0.002in.)[Less than 0.02mm(0.0008in.)/150x150]
Flatness of manifold gasket surface
Standard : Less than 0.03mm(0.001in)/110x110



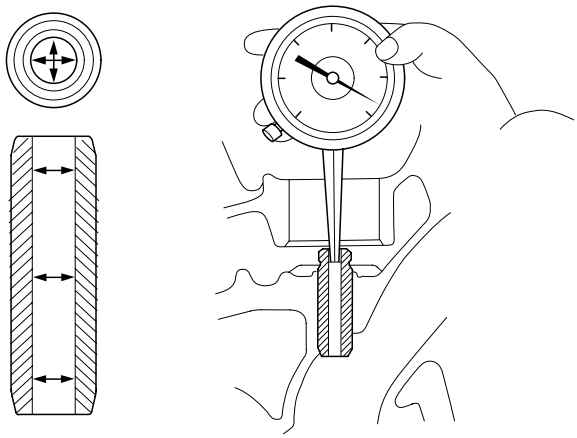
EDQF160A

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

VALVE AND VALVE SPRING

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

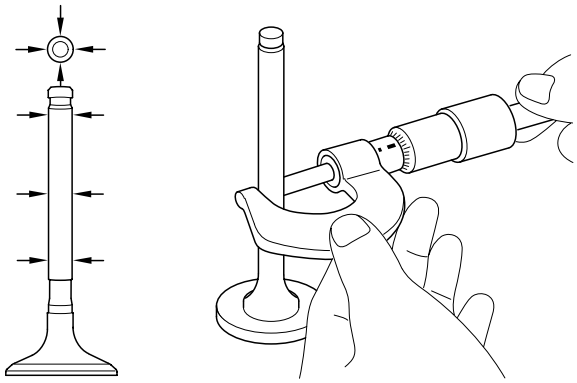
Valve guide I.D.
Intake / Exhaust : 5.500 ~ 5.512mm (0.216 ~ 0.217in.)



ECBF034A

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

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



KCRF227A

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

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

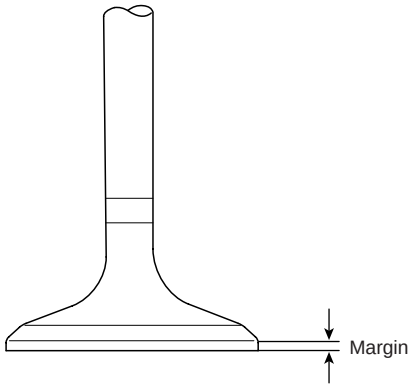
2. Inspect valves.

1) Check the valve is ground to the correct valve face angle.

2) Check that the surface of the valve for wear.
If the valve face is worn, replace the valve.

3) Check the valve head margin thickness.
If the margin thickness is less than minimum, replace the valve.

Margin
[Standard]
Intake : 1.56 ~ 1.86mm(0.06142 ~ 0.07323in.)
Exhaust : 1.73 ~ 2.03mm(0.06811 ~ 0.07992in.)



ECKD221A

4) Check the valve length.

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

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

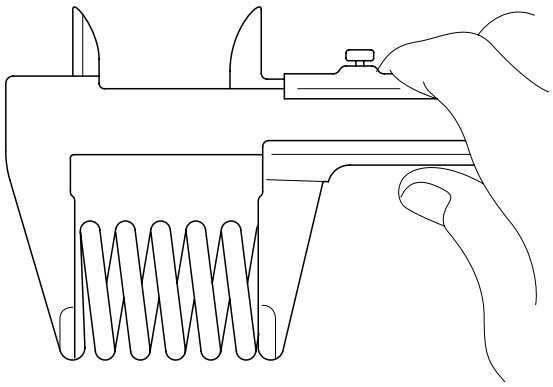
3. Inspect valve seats
Check the valve seat for evidence of overheating and improper contact with the valve face.
If the valve seat is worn, replace cylinder head.
Before reconditioning the seat, check the valve guide for wear. If the valve guide is worn, replace cylinder head. Recondition the valve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

4. Inspect valve springs.

1) Using a steel square, measure the out-of-square of the valve spring.

2) Using vernier calipers, measure the free length of the valve spring.

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



KCRF205A

MLA

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

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

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

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

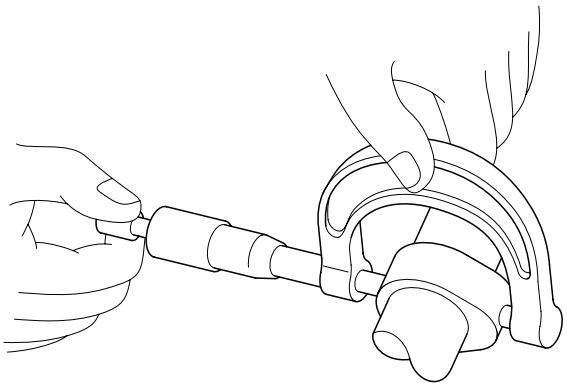
3. Subtract MLA outside diameter measurement from tappet bore inside diameter measurement.

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

CAMSHAFT

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

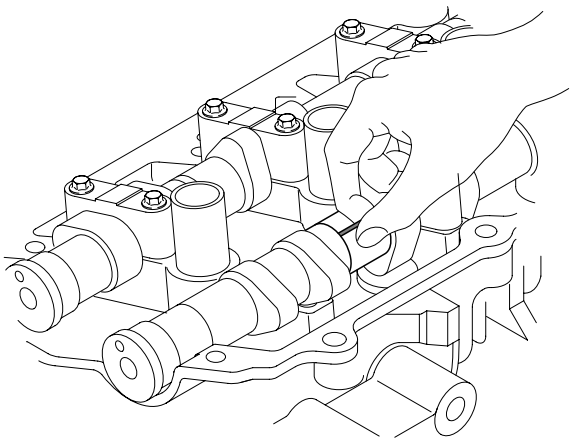
Cam height
[Standard value] Intake : 46.8mm (1.8425in.) Exhaust : 45.8mm (1.8031in.)



KCRF206A

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

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



KCRF207A

4) Install the bearing caps.

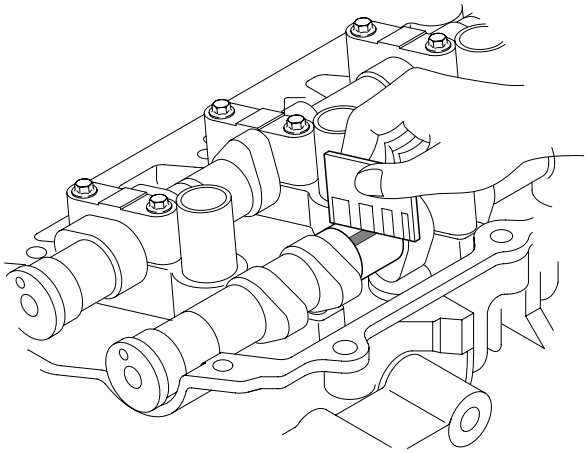
CAUTION

Do not turn the camshaft.

5) Remove the bearing caps.

6) Measure the plastigage at its widest point.

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



KCRF208A

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

7) Completely remove the plastigage.

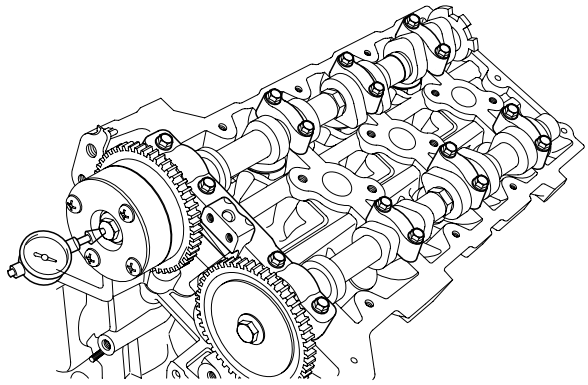
8) Remove the camshafts.

3. Inspect camshaft end play.

1) Install the camshafts.

2) Using a dial indicator, measure the end play while moving the camshaft back and forth.

Camshaft end play
[Standard value] : 0.02 ~ 0.18mm(0.0008 ~ 0.0071in.)



KDRF196B

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

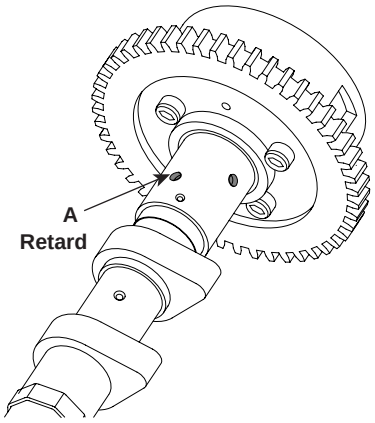
3) Remove the camshafts.

CVVT ASSEMBLY

1. Inspect CVVT assembly.

   1) Check that the CVVT assembly will not turn.

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



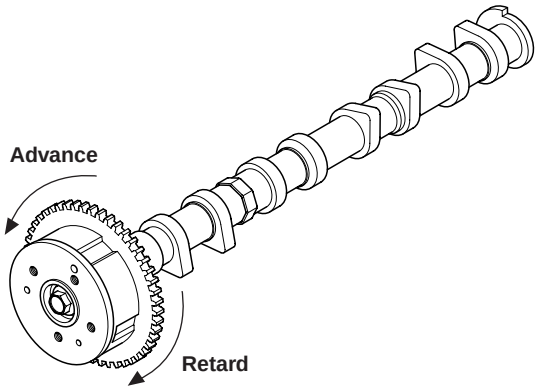
ECRF015A

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

NOTE

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

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



SGHEM7010N

   5) Except the position where the lock pin meets at the maximum delay angle, let the CVVT assembly turn back and forth and check the movable range and that there is no interference.

Standard: Movable smoothly in the range about 22.5°

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

REASSEMBLY ED39E8BC

NOTE

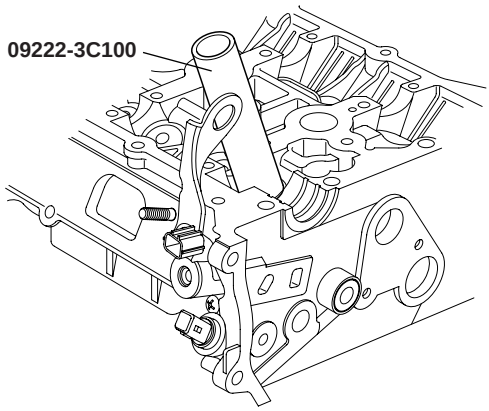
Thoroughly clean all parts to be assembled.
Before installing the parts, apply fresh engine oil to all sliding and rotating surfaces.
Replace oil seals with new ones.

1. Install valves.

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

NOTE

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



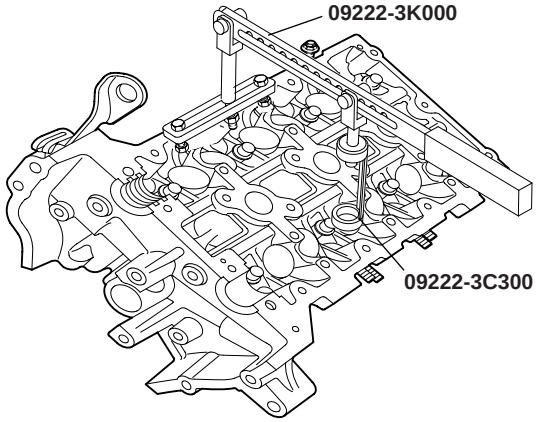
KCRF120B

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

NOTE

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

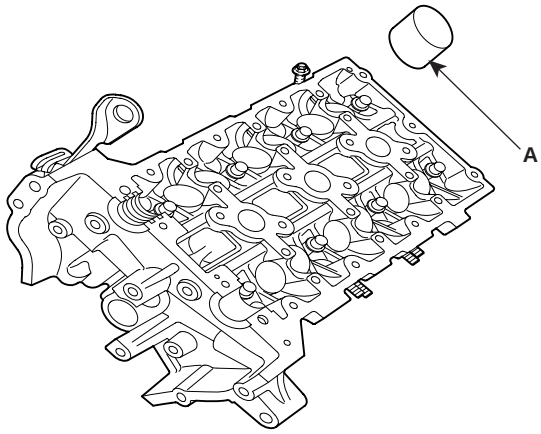
   3) Using the SST(09222 - 3K000, 09222-3C300), compress the spring and install the retainer locks. After installing the valves, ensure that the retainer locks are correctly in place before releasing the valve spring compressor.



KDRF201A

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

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



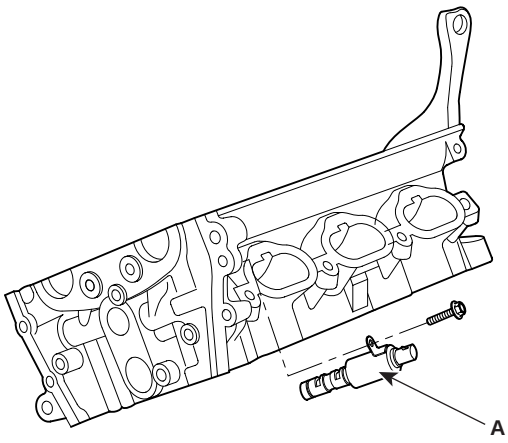
KDRF200A

NOTE

MLA can be reinstalled in its original position.

3. Install OCV(A).

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



KDRF202A

NOTE

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

CAUTION

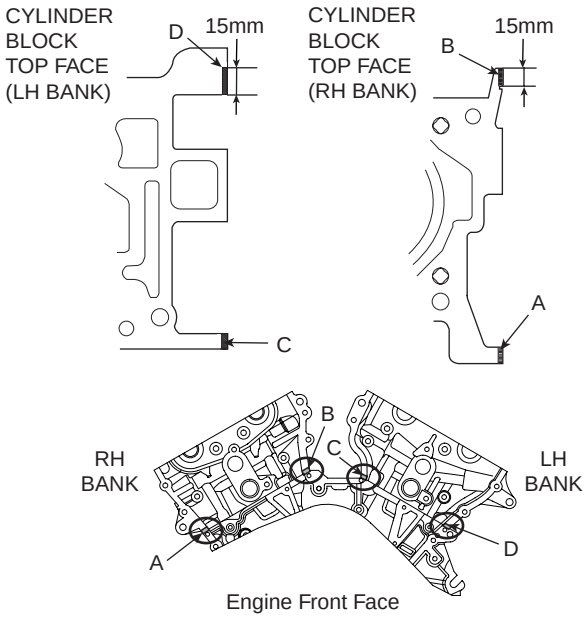
- ***Do not reuse the OCV when dropped.***
- ***Keep the OCV clean.***
- ***Do not hold the OCV sleeve during servicing.***
- ***When the OCV is installed on the engine, do not move the engine while holding the OCV yoke.***

INSTALLATION E63A6A04

NOTE

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

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

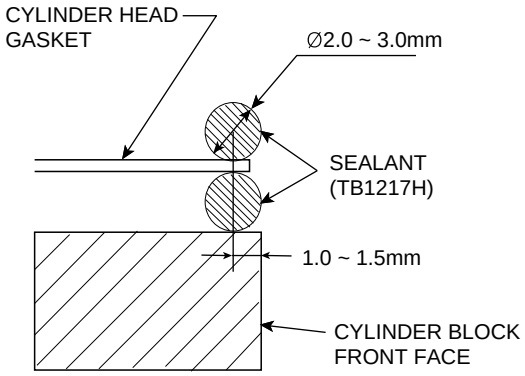


ECBF017A

NOTE

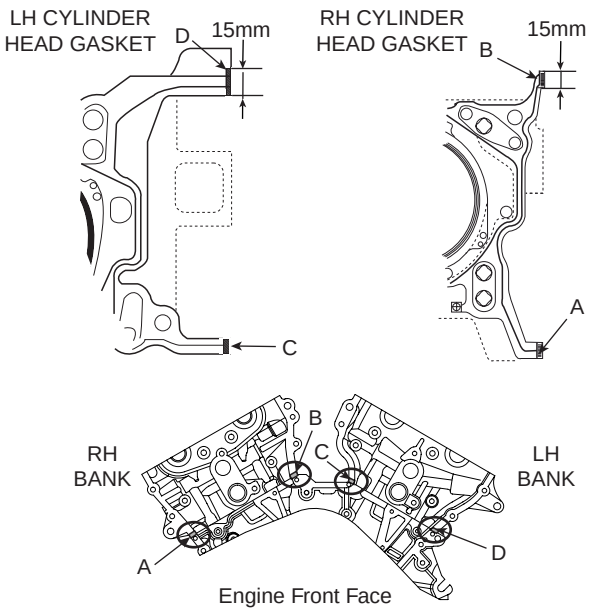
Refer to the illustration below to apply the sealant.

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



ECBF018A

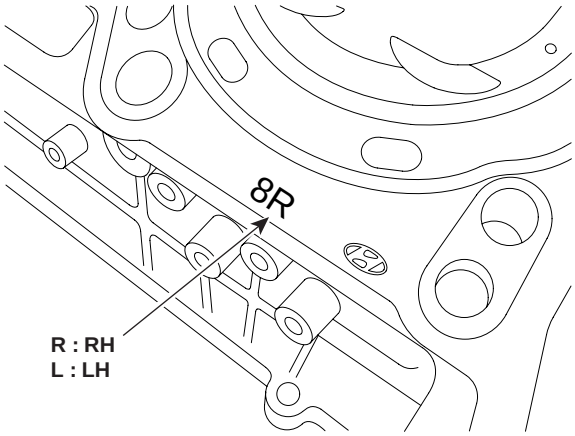
c. Apply sealant on cylinder head gaskets after assembling cylinder head gaskets on cylinder block. The part must be assembled within 5 minutes after sealant was applied.



ECBF019A

NOTE

Be careful of the installation direction.

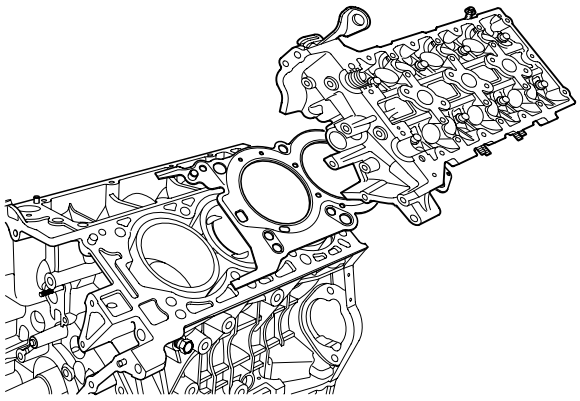


UCBF004A

d. Install the cylinder head.

NOTE

Remove the extruded sealant after assembling cylinder heads.



KDRF198A

2. Place the cylinder head carefully to avoid damaging the gasket.

3. Install cylinder head bolts.

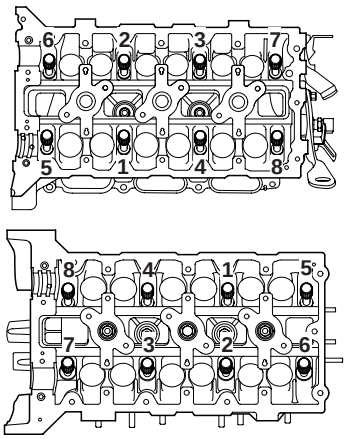
   1) Do not apply engine oil on the threads and under the heads of the cylinder head bolts.

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

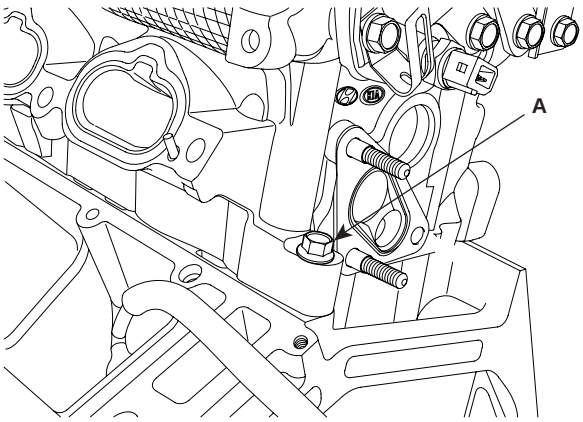
Tightening torque
1st step: 37.3~41.2Nm(3.8~4.2 kgf.m, 27.5~30.4 lb-ft)
2nd step:120˚ ±2˚
3rd step: 90˚ ±2˚
18.62 ~ 23.52Nm(1.9 ~ 2.4kgf.m, 13.74 ~ 17.36lb-ft)(A)

NOTE

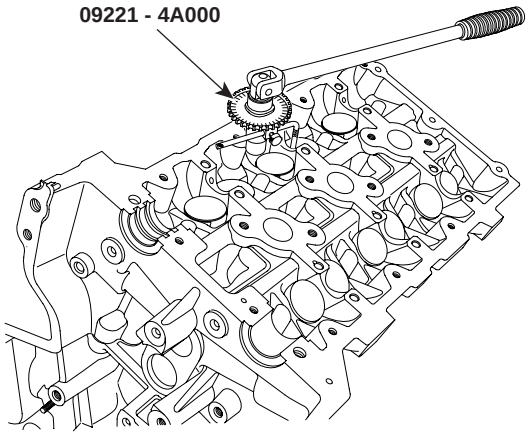
Always use new cylinder head bolts.



KDRF199B



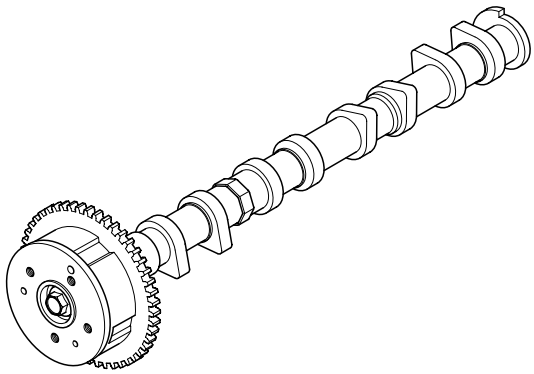
ECBF035A



KDRF223A

4. Install the CVVT and camshaft sprocket.

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



KCRF122A

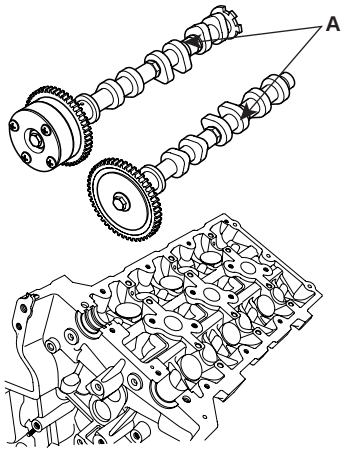
NOTE

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

5. Install camshafts(A).

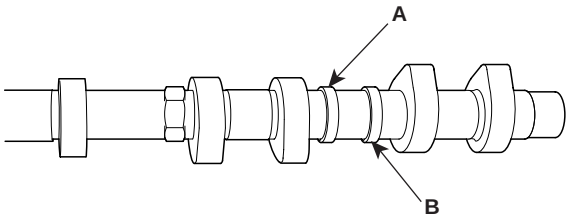
NOTE

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



KDRF197A

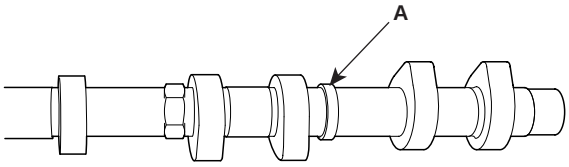
INTAKE CAMSHAFT



KDRF226A

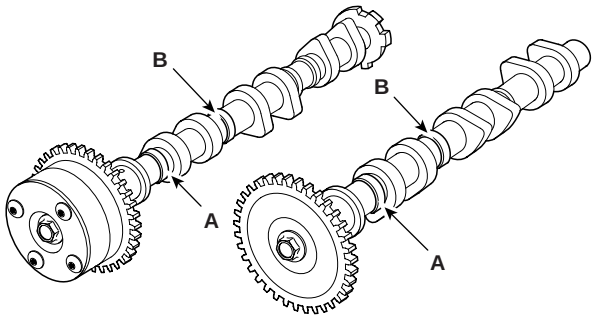
	LH	RH
3.8L	A : Ø30mm(1.1811in.) B : Ø27mm(1.0630in.)	A : Ø27mm(1.0630in.) B : Ø30mm(1.1811in.)

EXHAUST CAMSHAFT



KDRF227A

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

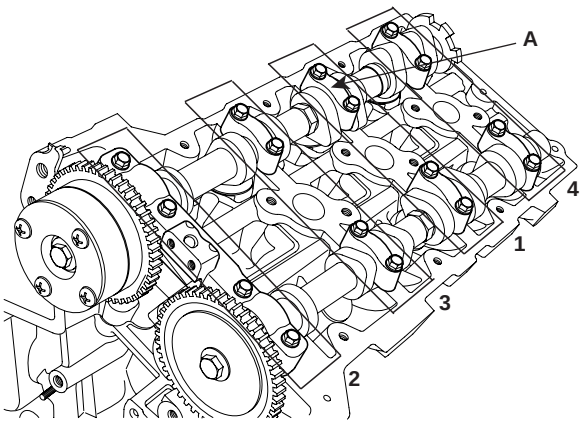


SBLM16209L

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

6. Install camshaft bearing caps as following order.

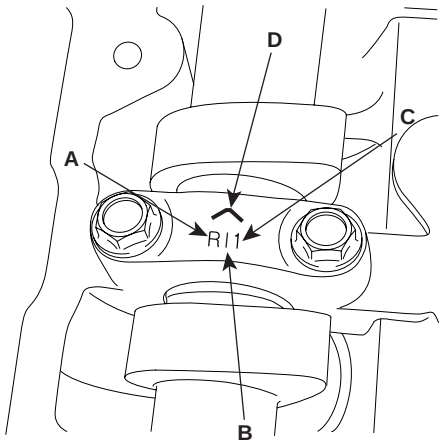
Tightening torque
1st step: 5.9Nm(0.6 kgf.m, 4.3 lb-ft)
2nd step: 9.80 ~ 11.76Nm(1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft) - 2nd step



UCBF014A

NOTE

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



ECBF036A

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

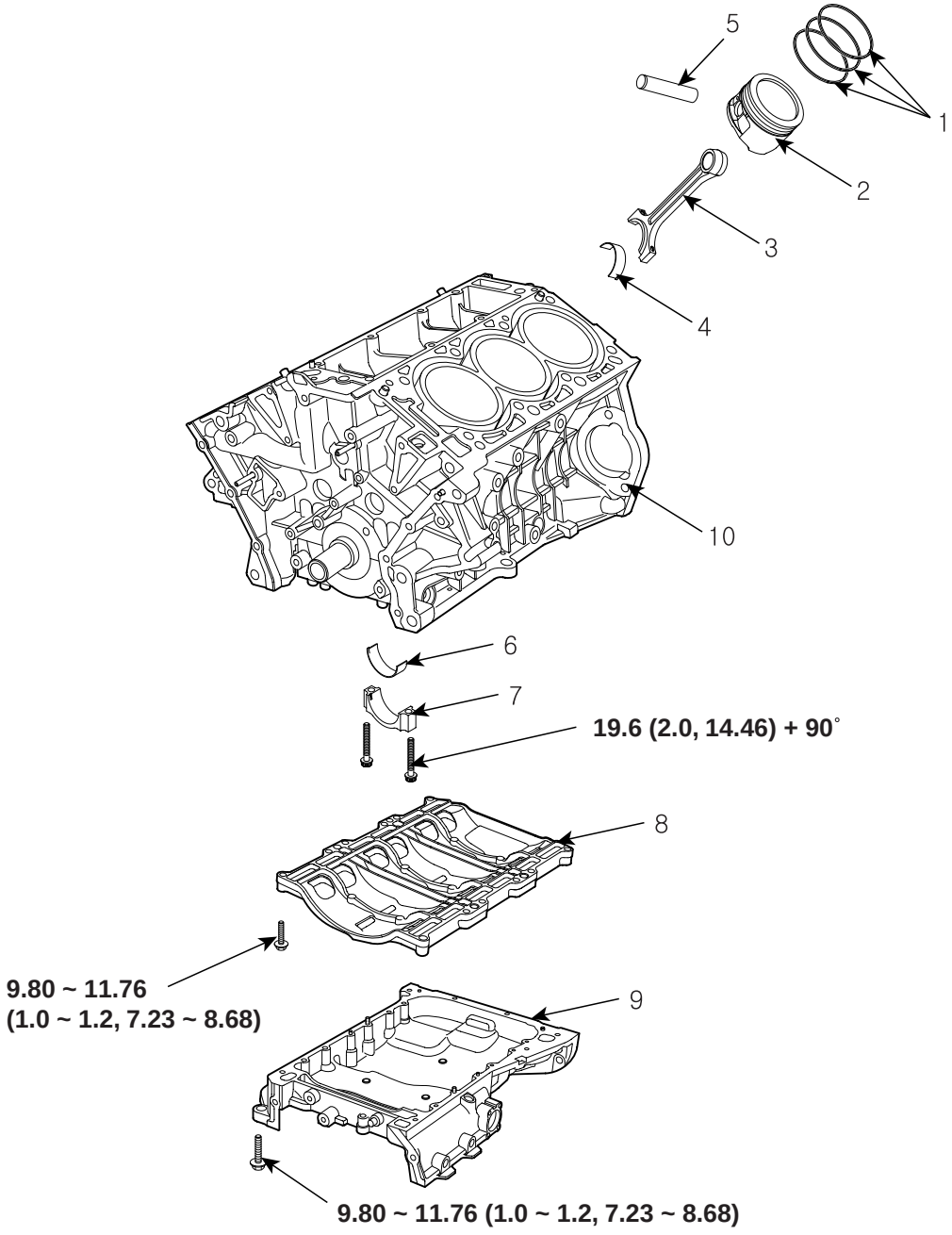
CAUTION

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

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

ENGINE BLOCK

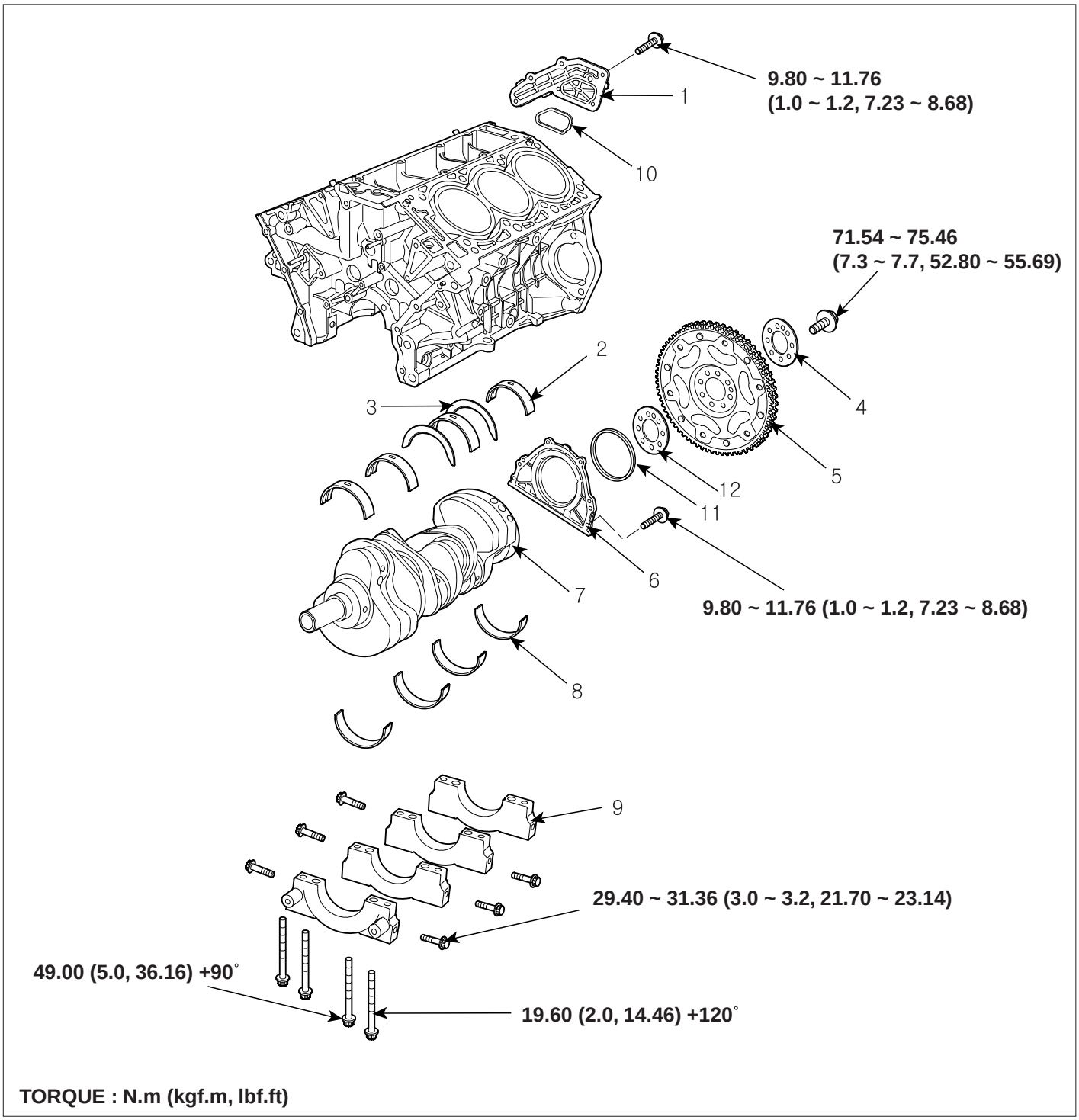
COMPONENTS EA1BE037



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

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

SGHEM7011N



TORQUE : N.m (kgf.m, lbf.ft)

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

SBLM16203L

REMOVAL E4DADBA3

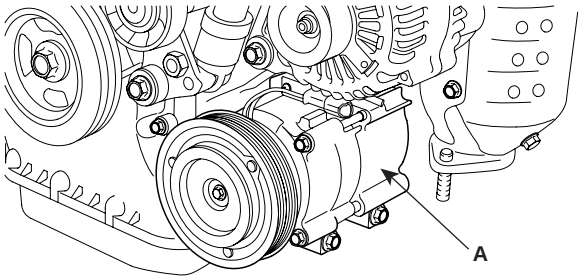
CAUTION

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

NOTE

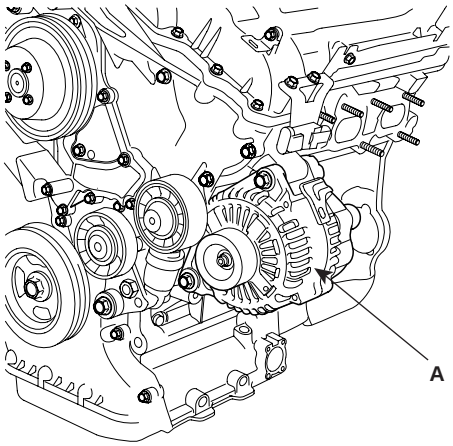
- *Mark all wiring and hoses to avoid misconnection.*
- *Inspect the timing belt before removing the cylinder head.*
- *Turn the crankshaft pulley so that the No.1 piston is at top dead center.*
- *Engine removal is required for this procedure.*

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



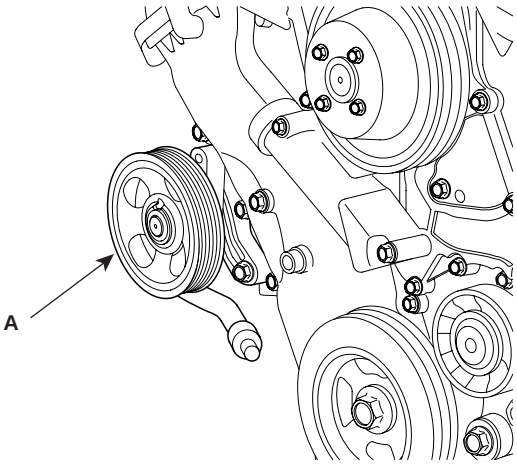
KDRF103A

9. Remove alternator(A) from engine.



KDRF104A

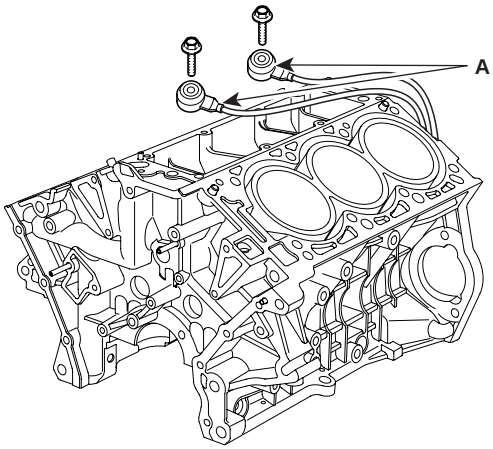
10. Remove power steering pump(A) from engine.



KDRF102A

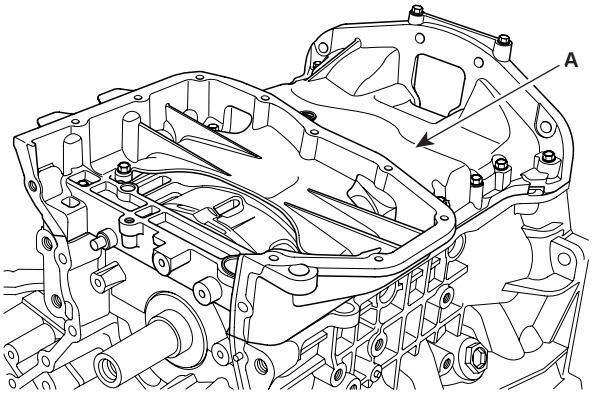
DISASSEMBLY EBCBF7FE

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



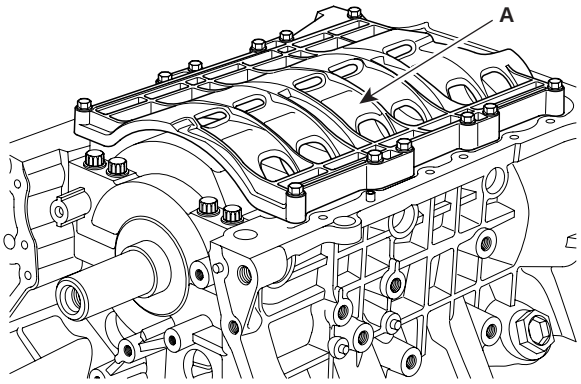
KDRF205A

3. Remove upper oil pan(A).



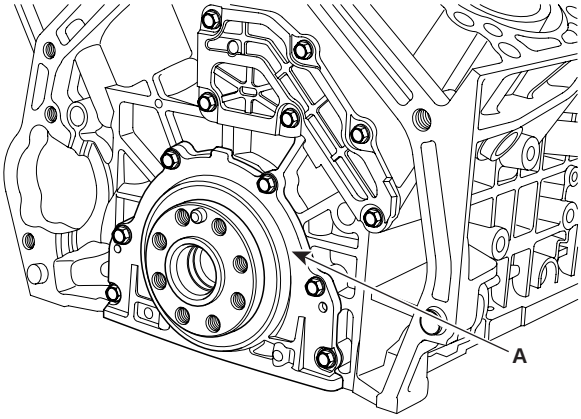
KDRF206A

4. Remove baffle plate(A).



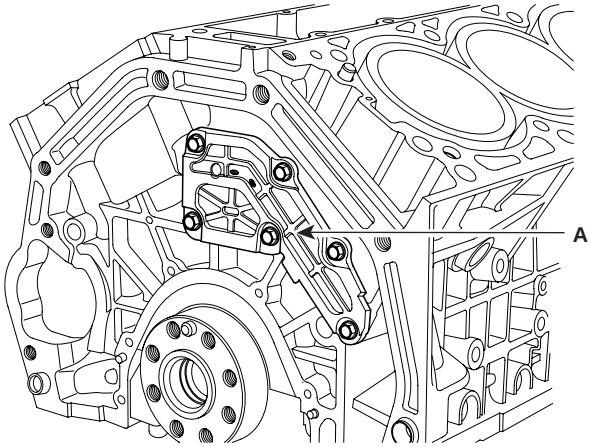
KDRF207A

5. Remove rear oil seal case(A).



KDRF208A

6. Remove oil drain cover(A).



KDRF209A

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

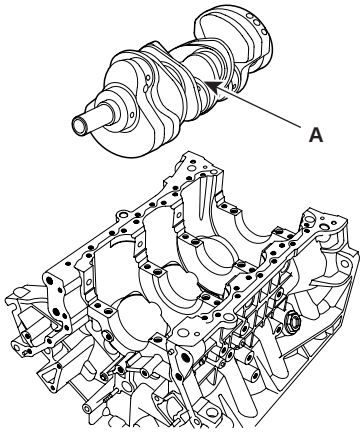
NOTE

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

10. Remove crankshaft main bearing cap and check oil clearance.

11. Check the crankshaft end play.

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



KDRF210A

NOTE

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

13. Check fit between piston and piston pin.
Try to move the piston back and forth on the piston pin. If any movement is felt, replace piston and piston pin as a set.

14. Remove piston rings.

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

    2) Remove 2 side rails and the spacer by hand.

NOTE

Arrange the piston rings in the correct order only.

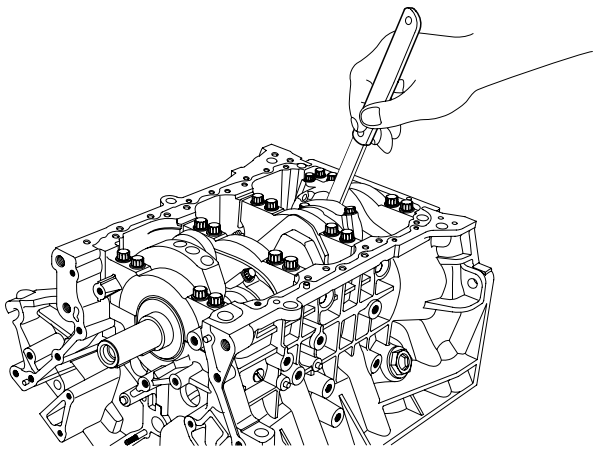
15. Disconnect connecting rod from piston.
Using a press, remove the piston pin from the piston. (Press-in load : 800 ~ 1400kg (1764 ~ 3086lb)

INSPECTION EAA56C18

CONNECTING ROD AND CRANKSHAFT

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

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



KDRF211A

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

2. Check the connecting rod bearing oil clearance.

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

    2) Remove 2 connecting rod cap bolts.

    3) Remove the connecting rod cap and bearing half.

    4) Clean the crank pin and bearing.

    5) Place plastigage across the crank pin.

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

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

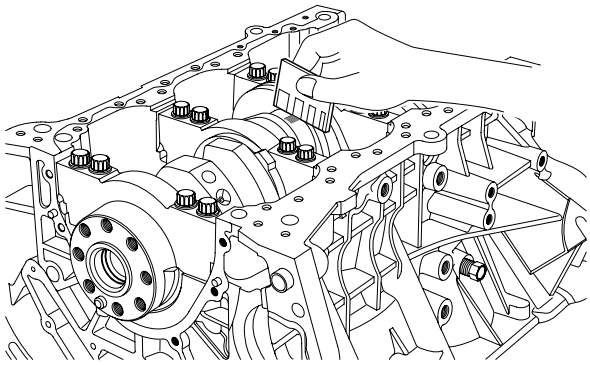
NOTE

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
0.038 ~ 0.056mm(0.0015 ~ 0.0022in.)



KDRF212A

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

CAUTION

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

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

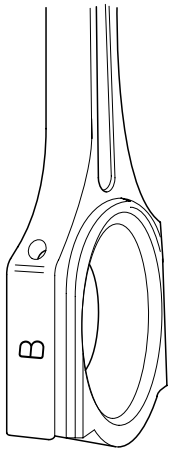
NOTE

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

CAUTION

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

CONNECTING ROD MARK LOCATION



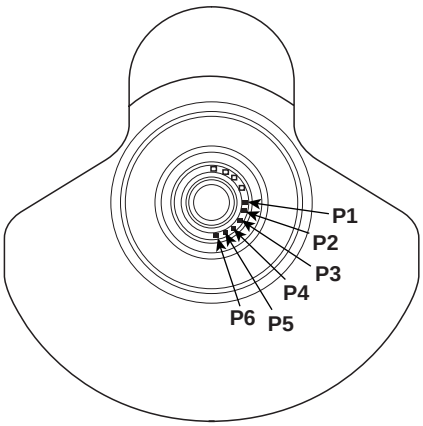
EDQF196A

IDENTIFICATION OF CONNECTING ROD

CLASS	MARK	INSIDE DIAMETER
0	a	58.000 ~ 58.006mm (2.2834 ~ 2.2837in.)
1	b	58.006 ~ 58.012mm (2.2837 ~ 2.2839in.)
2	c	58.012 ~ 58.018mm (2.2839 ~ 2.2842in.)

CRANKSHAFT PIN MARK LOCATION

IDENTIFICATION OF CRANKSHAFT

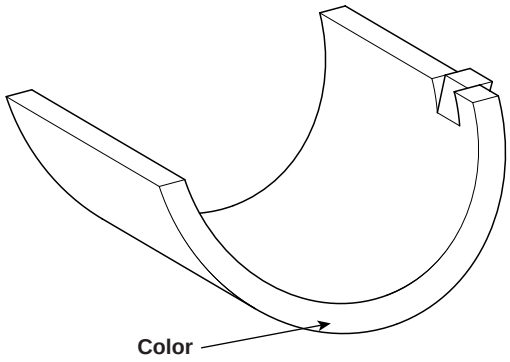


ECBF037A

DISCRIMINATION OF CRANKSHAFT

CLASS	MARK	OUTSIDE DIAMETER OF PIN
I	1 or A	54.966 ~ 54.972mm (2.1640 ~ 2.1642in.)
II	2 or B	54.960 ~ 54.966mm (2.1638 ~ 2.1640in.)
III	3 or C	54.954 ~ 54.960mm (2.1635 ~ 2.1638in.)

PLACE OF IDENTIFICATION MARK (CONNECTING ROD BEARING)



ECRF021A

IDENTIFICATION OF CONNECTING ROD BEARING

CLASS	MARK	THICKNESS OF BEARING
E	BLUE	1.514 ~ 1.517mm (0.0596 ~ 0.0597in.)
D	BLACK	1.511 ~ 1.514mm (0.0595 ~ 0.0596in.)
C	BROWN	1.508 ~ 1.511mm (0.0594 ~ 0.0595in.)
B	GREEN	1.505 ~ 1.508mm (0.0593 ~ 0.0594in.)
A	YELLOW	1.502 ~ 1.505mm (0.0591 ~ 0.0593in)

11) Selection

		CONNECTING ROD IDENTIFICATION MARK		
		0(a)	1(b)	2(c)
CRANK-SHAFT INDEN-TIFICA-TION MARK	1 or A	A (YEL-LOW)	B (GREEN)	C (BROWN)
	2 or B	B (GREEN)	C (BROWN)	D (BLACK)
	3 or C	C (BROWN)	D (BLACK)	E (BLUE)

3. Check the crankshaft bearing oil clearance.

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

   2) Clean each main journal and bearing half with a clean shop tower.

   3) Place one strip of plastigage across each main journal.

   4) Reinstall the bearings and caps, then torque the bolts.

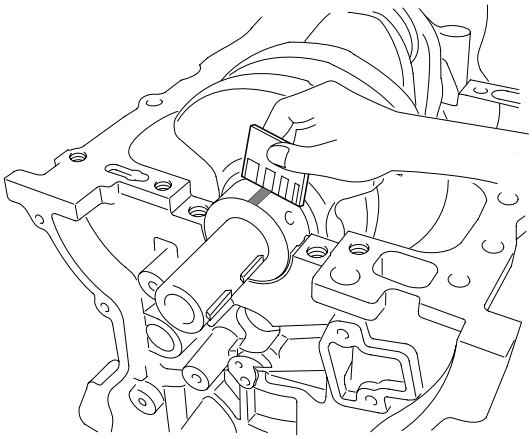
Tightening torque
49.00Nm(5.0 kgf.m, 36.16lb-ft) + 90°
19.60 Nm(2.0 kgf.m, 14.46lb-ft)+ 120°
29.40 ~ 31.36Nm(3.0 ~ 3.2 kgf.m, 21.70 ~ 23.14lb-ft)

NOTE

Do not turn the crankshaft.

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

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



KCRF170A

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

CAUTION

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

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

NOTE

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

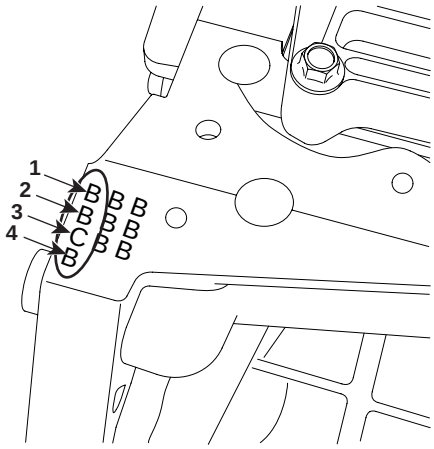
CAUTION

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

Crankshaft bore mark location

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

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



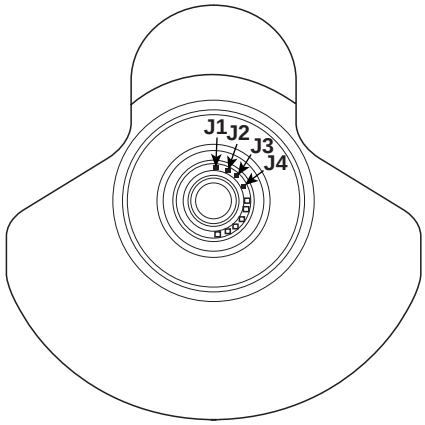
ECBF038A

DISCRIMINATION OF CYLINDER BLOCK

CLASS	MARK	INSIDE DIAMETER
a	A	73.500 ~ 73.506mm (2.8937 ~ 2.8939in.)
b	B	73.506 ~ 73.512mm (2.8939 ~ 2.8942in.)
c	C	73.512 ~ 73.518mm (2.8942 ~ 2.8944in.)

CRANKSHAFT JOURNAL MARK LOCATION

DISCRIMINATION OF CRANKSHAFT

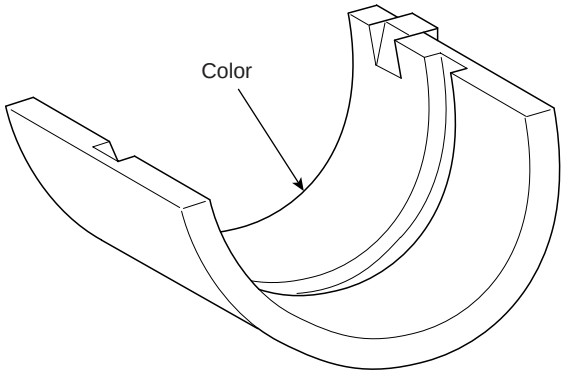


ECBF039A

DISCRIMINATION OF CRANKSHAFT

CLASS	MARK	OUTSIDE DIAMETER OF JOURNAL
I	1 ro A	68.954 ~ 68.960mm (2.7147 ~ 2.7150in.)
II	2 or B	68.948 ~ 68.954mm (2.7145 ~ 2.7147in.)
III	3 or C	68.942 ~ 68.948mm (2.7142 ~ 2.7145in.)

PLACE OF IDENTIFICATION MARK (CRANKSHAFT BEARING)



ECRF022A

DISCRIMINATION OF CRANKSHAFT BEARING

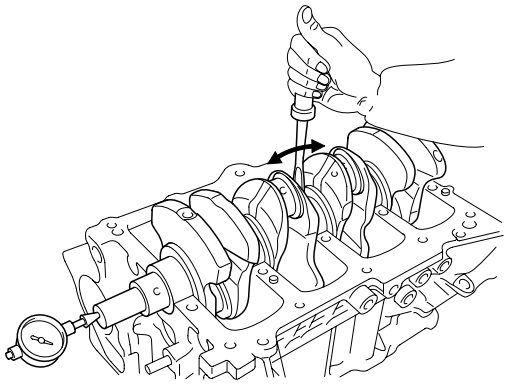
CLASS	MARK	THICKNESS OF BEARING
E	BLUE	2.277 ~ 2.280mm (0.0896 ~ 0.0897in.)
D	BLACK	2.274 ~ 2.277mm (0.0895 ~ 0.0896in.)
C	BROWN	2.271 ~ 2.274mm (0.0894 ~ 0.0895in.)
B	GREEN	2.268 ~ 2.271mm (0.0893 ~ 0.0894in.)
A	YELLOW	2.265 ~ 2.268mm (0.0892 ~ 0.0893in.)

SELECTION

		CRANKSHAFT BORE IDENTIFICATION MARK		
		a(A)	b(B)	c(C)
CRANK-SHAFT IDEN-TIFICA-TION MARK	1 or A	A (YEL-LOW)	B (GREEN)	C (BROWN)
	2 or B	B (GREEN)	C (BROWN)	D (BLACK)
	3 or C	C (BROWN)	D (BLACK)	E (BLUE)

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

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



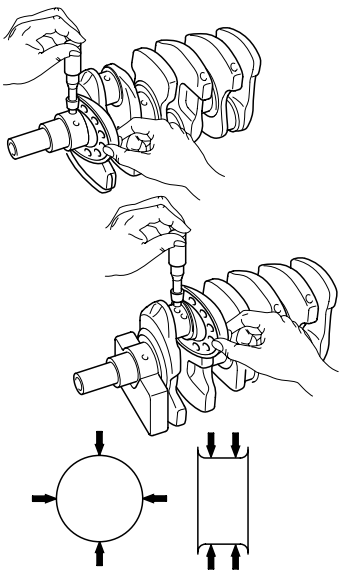
ECKD001B

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

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

5. Inspect main journals and crank pins
   Using a micrometer, measure the diameter of each main journal and crank pin.

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



ECKD001E

CONNECTING RODS

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

2. Replace the connecting rod if it is damaged on the thrust faces at either end. Also if step wear or a severely rough surface of the inside diameter of the small end is apparent, the rod must be replaced as well.

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

Allowable bend of connecting rod :
0.05mm / 100mm (0.0020 in./3.94 in.) or less
Allowable twist of connecting rod :
0.1mm / 100mm (0.0039 in./3.94 in.) or less

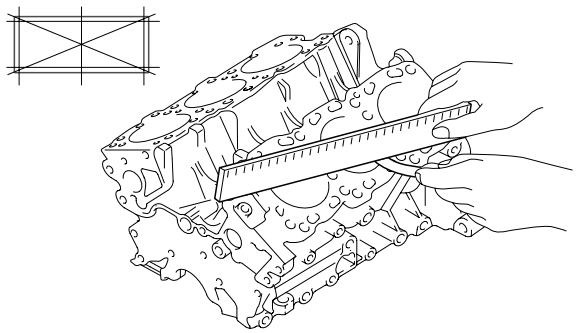
CYLINDER BLOCK

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

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

3. Inspect top surface of cylinder block for flatness.
Using a precision straight edge and feeler gauge, measure the surface contacting the cylinder head gasket for warpage.

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

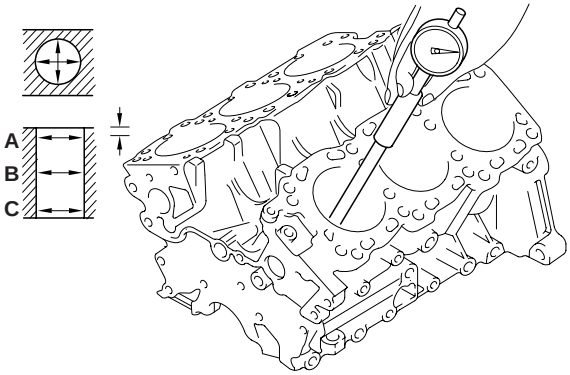


EDQF154A

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

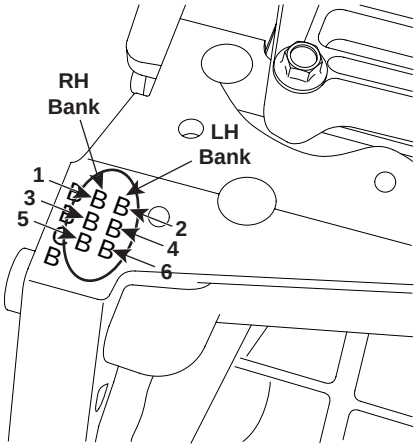
5. Inspect cylinder bore diameter
   Using a cylinder bore gauge, measure the cylinder bore diameter at position in the thrust and axial directions.

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



EDQF153A

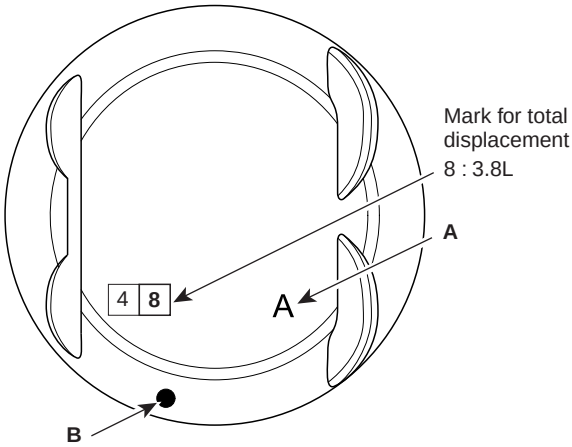
6. Check the cylinder bore size code on the cylinder block.



ECBF002A

Class	Size code	Cylinder bore inner diameter
		3.8L
A	A	96.00~96.01mm (3.7795 ~ 3.7799in.)
B	B	96.01~96.02mm (3.7799 ~ 3.7803in.)
C	C	96.02~96.03mm (3.7803 ~ 3.7807in.)

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



SGHEM7002N

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

8. Select the piston related to cylinder bore class.

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

PISTON AND RINGS

1. Clean piston

   1) Using a gasket scraper, remove the carbon from the piston top.

   2) Using a groove cleaning tool, clean the piston ring grooves.

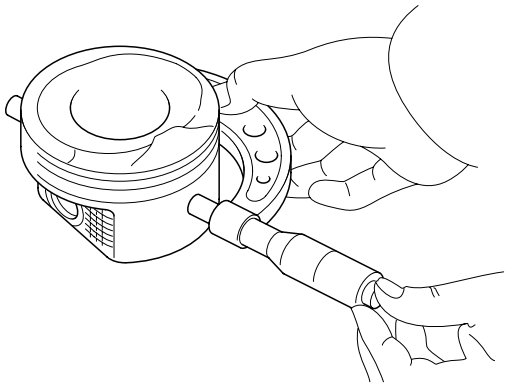
   3) Using solvent and a brush, thoroughly clean the piston.

   NOTE

   Do not use a wire brush.

2. The standard measurement of the piston outside diameter is taken 14 mm (0.5512 in.) from the bottom of the piston.

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



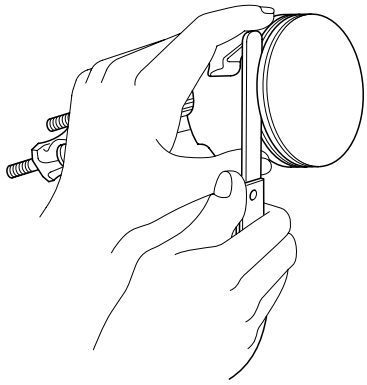
ECKD001D

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

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

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

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

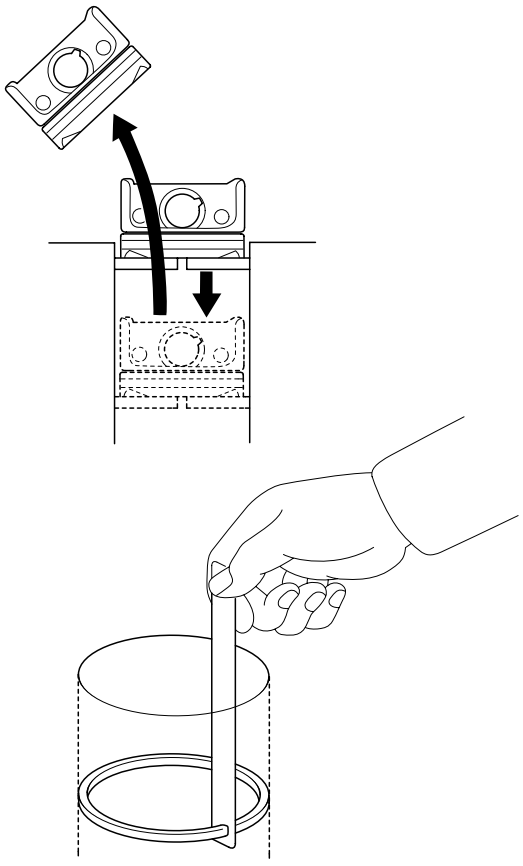


ECKD001G

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

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

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

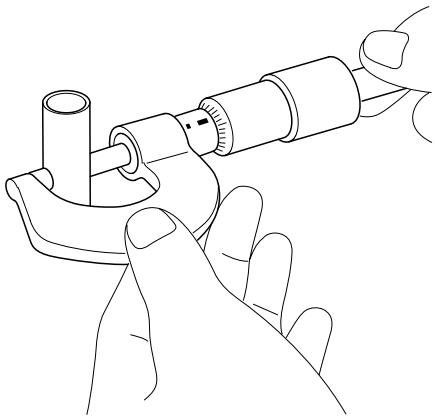


ECKD001K

PISTON PINS

1. Measure the diameter of the piston pin.

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



ECKD001Z

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

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

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

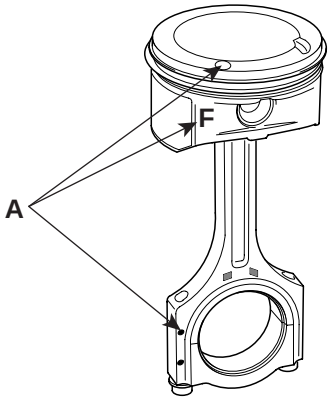
Piston pin-to-connecting rod interference
-0.032 ~ -0.016mm (-0.00126 ~ -0.00063in.)

REASSEMBLY E2B1FCB7

NOTE

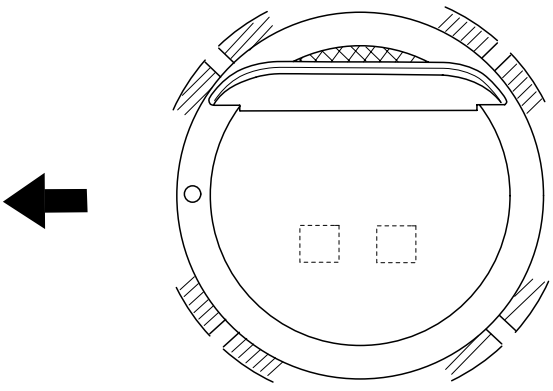
- *Thoroughly clean all parts to be assembled.*
- *Before installing the parts, apply fresh engine oil to all sliding and rotating surfaces.*
- *Replace all gaskets, O-rings and oil seals with new parts.*

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



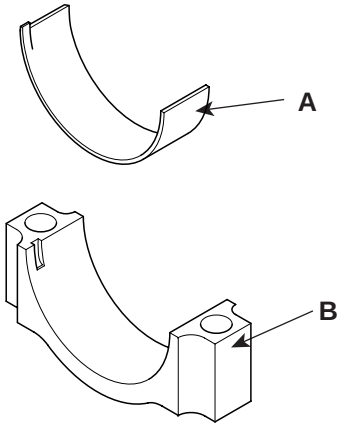
SGHEM7012N

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



ECKD321A

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



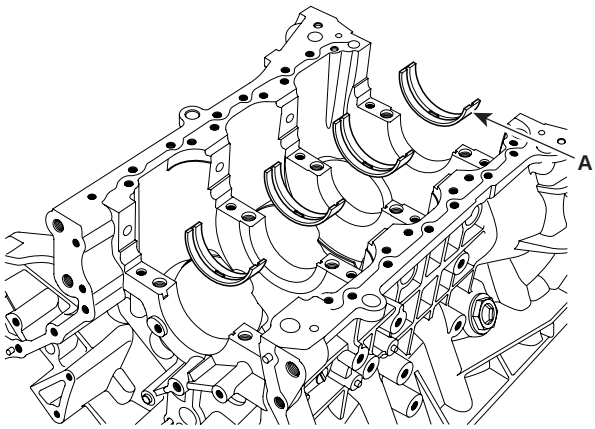
SGHEM7013N

4. Install main bearings.

NOTE

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

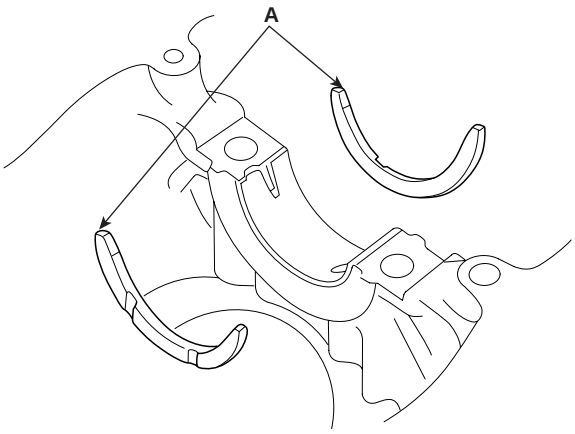
   1) Align the bearing claw with the claw groove of the cylinder block, push in the 4 upper bearings(A).



KDRF216A

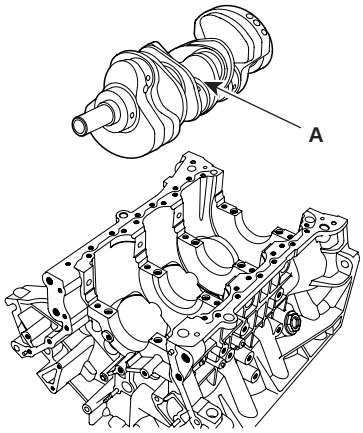
   2) Align the bearing claw with the claw groove of the main bearing cap, and push in the 4 lower bearings.

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



ECKD324A

6. Place crankshaft on the cylinder block.



KDRF210A

7. Place main bearing caps on cylinder block.

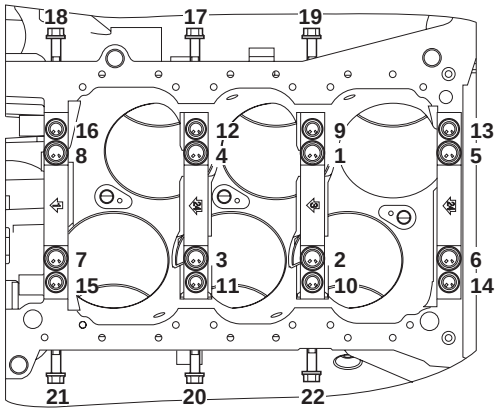
8. Install main bearing cap bolts.

1) Install and uniformly tighten the bearing cap bolts, in several passes, in the sequence shown.

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

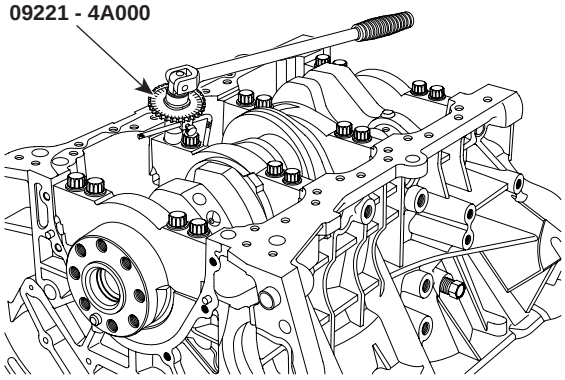
NOTE

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



KDRF140A

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



KDRF224A

2) Check that the crankshaft turns smoothly.

9. Check crankshaft end play.

10. Install piston and connecting rod assemblies.

NOTE

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

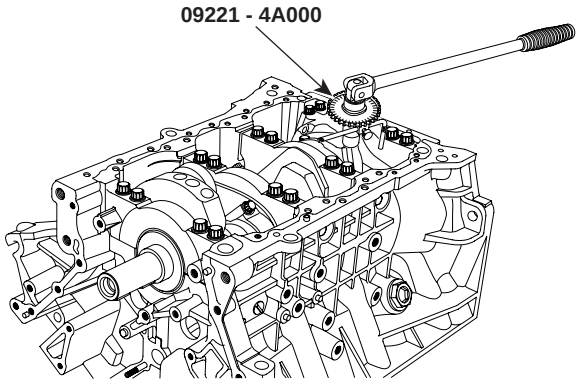
1) Install the ring compressor, check that the bearing is securely in place, then position the piston in the cylinder, and tap it in using the wooden handle of a hammer.

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

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

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

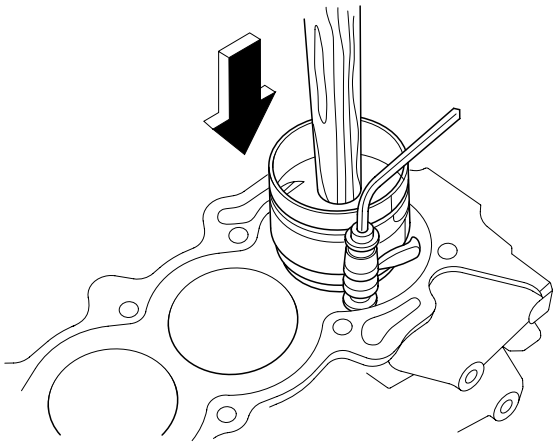
Use SST(09221-4A000), install connecting rod bearing cap bolts.



KDRF225A

NOTE

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

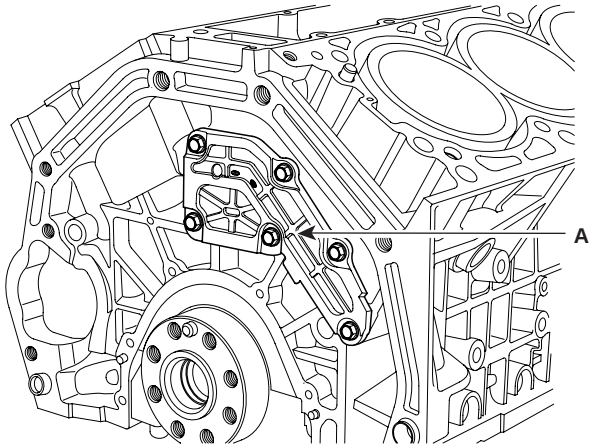


ECKD001F

11. Check the connecting rod end play.

12. Install oil drain cover.

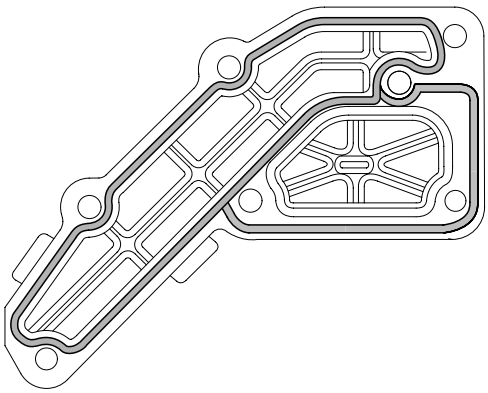
Tightening torque
9.80 ~ 11.76Nm (1.0 ~ 1.2kgf.m, 7.23 ~ 8.67lb-ft)



KDRF209A

NOTE

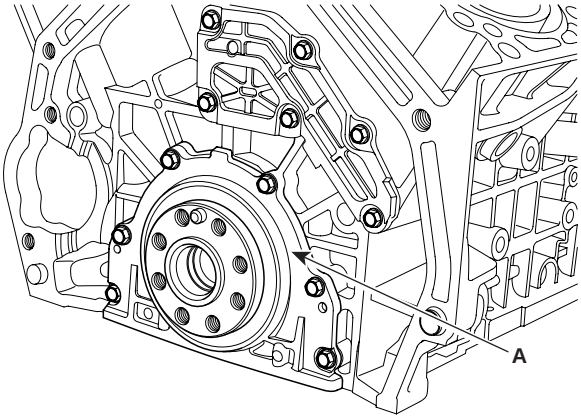
- *Clean the sealing face before assembling two parts.*
- *Remove harmful foreign materials on the sealing face before applying sealant*
- *Before assembling oil drain cover, the liquid sealant TB1217H should be applied to the oil drain cover.*
- *The part must be assembled within 5 minutes after sealant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



ECBF003A

13. Install rear oil seal case.

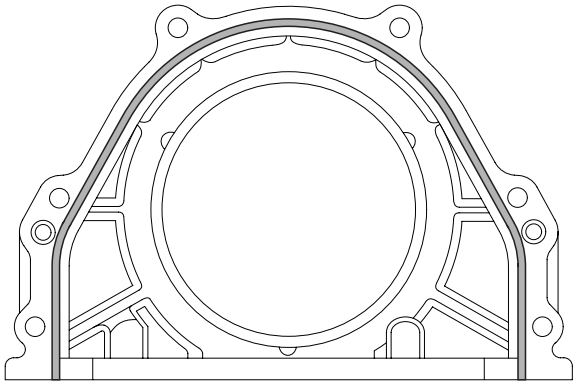
Tightening torque
9.80 ~ 11.76Nm (1.0 ~ 1.2kgf.m, 7.23 ~ 8.67lb-ft)



KDRF208A

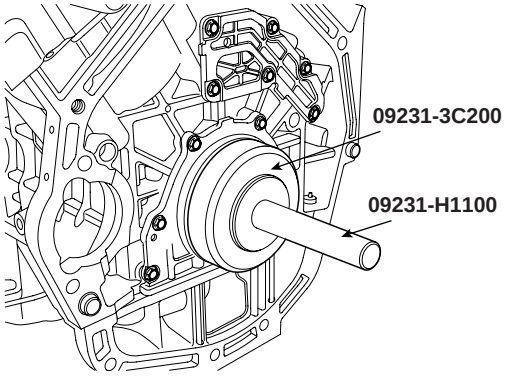
NOTE

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



KDRF218A

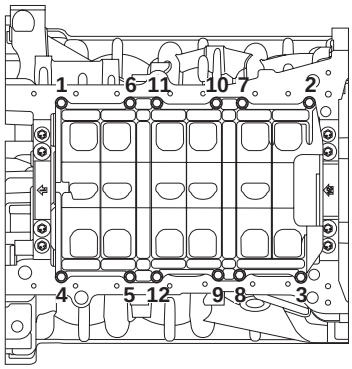
14. Using SST(09231-3C200, 09231-H1100), install rear oil seal.



KDRF237A

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

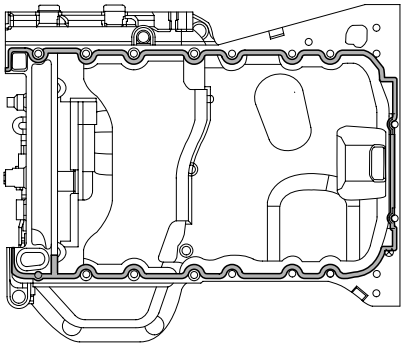
Tightening torque
9.80 ~ 11.76Nm (1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)



KDRF135A

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

Bead width : 2.5mm(0.1in.)



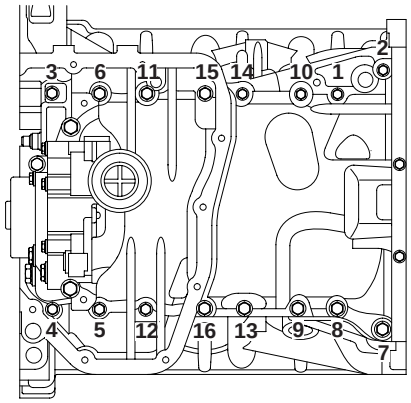
KDRF130A

NOTE

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

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

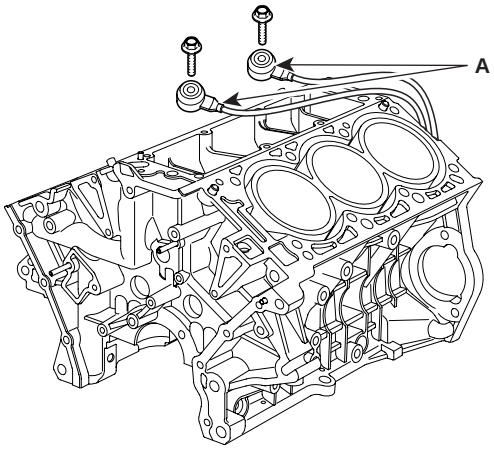
Tightening torque
9.80 ~ 11.76Nm (1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)



KDRF131A

17. Install knock sensor.

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



KDRF205A

18. Install drive plate.

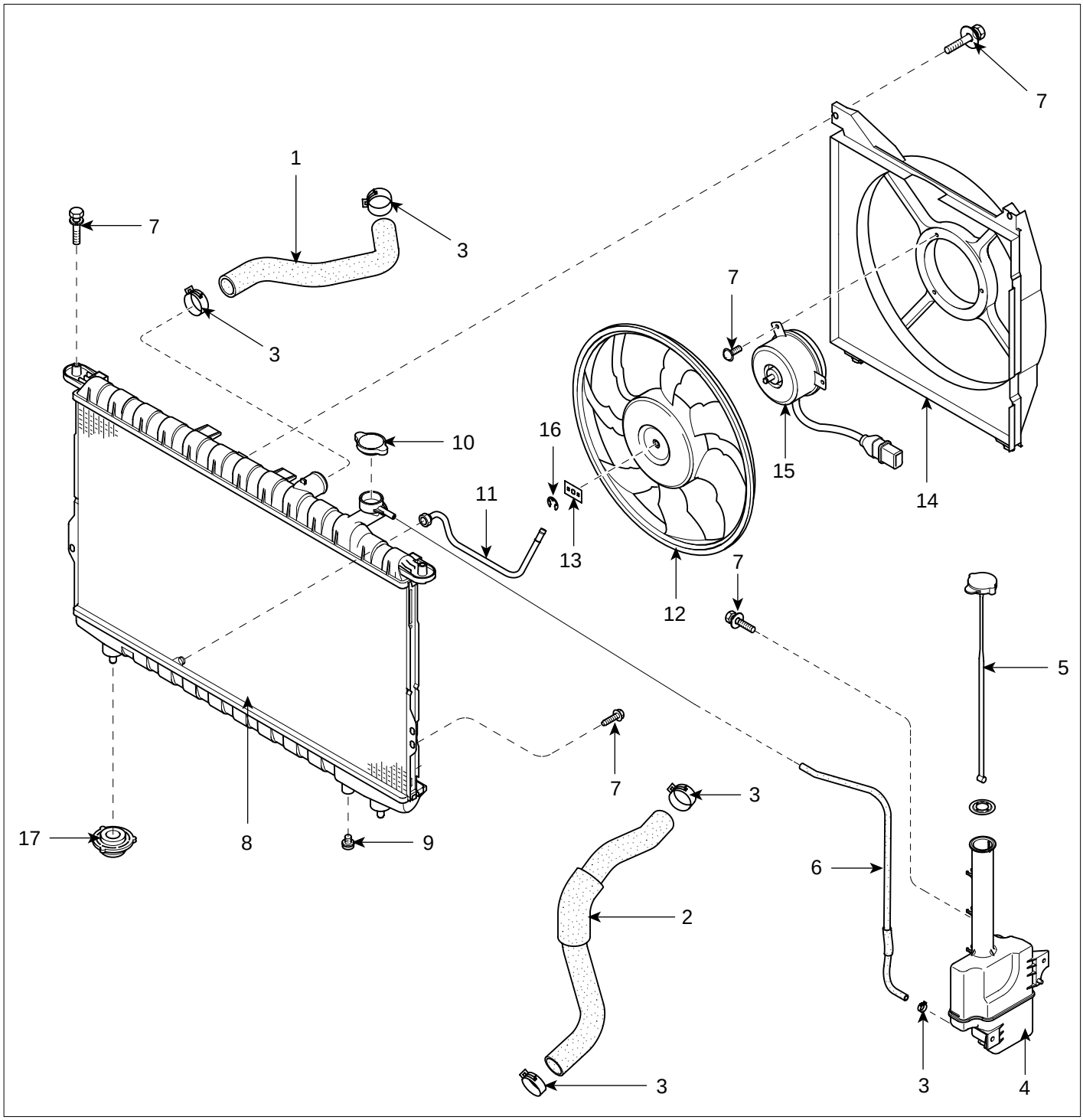
Tightening torque
71.54 ~ 75.46Nm (7.3 ~ 7.7kgf.m, 52.80 ~ 55.69lb-ft)

INSTALLATION EC9DBCE3

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

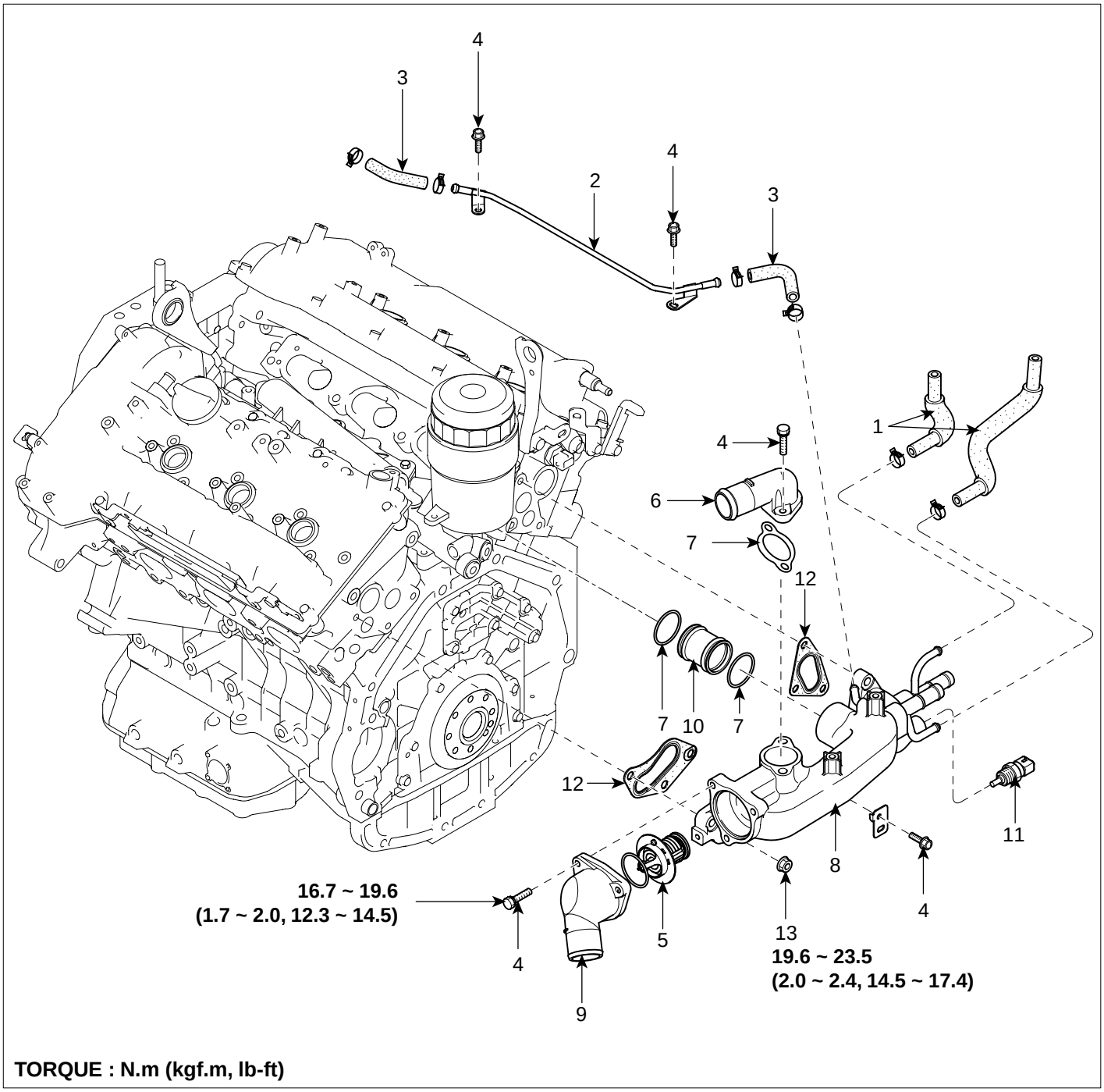
COOLING SYSTEM

COMPONENTS E6DF76AB



1. Radiator upper hose
2. Radiator lower hose
3. Hose clamp
4. Reservoir
5. Reservoir cap
6. Reservoir hose
7. Bolt
8. Radiator
9. Drain plug
10. Radiator cap
11. Oil cooler tube
12. Cooling fan
13. Washer
14. Radiator shroud
15. Motor assembly
16. Retainer
17. Radiator mounting lower insulator

SGHEM7003N



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

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

SGHEM7014N

ENGINE COOLANT REFILLING AND BLEEDING ED42148D

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

NOTE

- *Use only genuine antifreeze/coolant.*
- *For best corrosion protection, the coolant concentration must be maintained year-round at 50% minimum.*
  Coolant concentrations less than 50% may not provide sufficient protection against corrosion or freezing.
- *Coolant concentrations greater than 60% will impair cooling efficiency and are not recommended.*

CAUTION

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

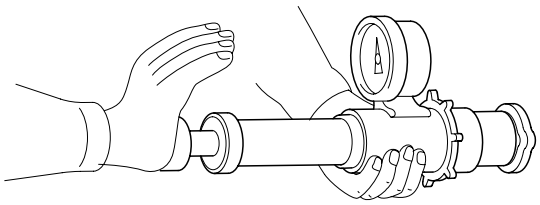
7. Start the engine and run so coolant circulates. When the cooling fan operates and coolant circulates, refill coolant through the radiator cap.
8. Repeat 7 until the cooling fan cycles 3 ~ 5 times and bleed air sufficiently out of the cooling system.
9. Install the radiator cap and fill the reservoir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

NOTE

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

CAP TESTING

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

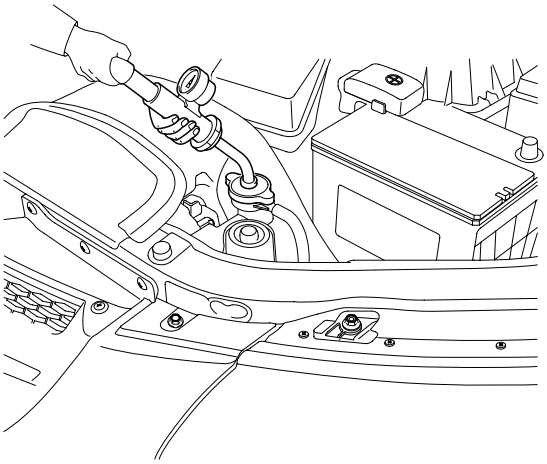


ECKD501X

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

TESTING

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



SGHEM7015N

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

NOTE

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

REMOVAL EECA3D1E

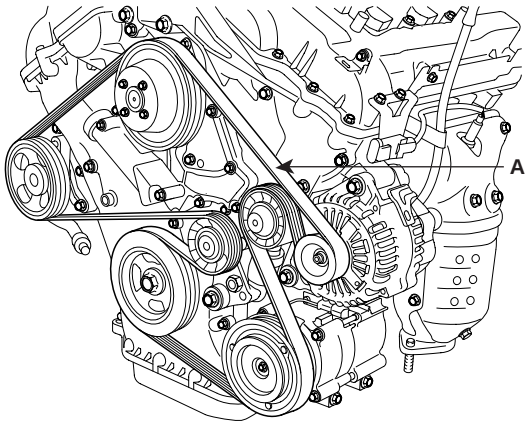
WATER PUMP

1. Drain the engine coolant.

WARNING

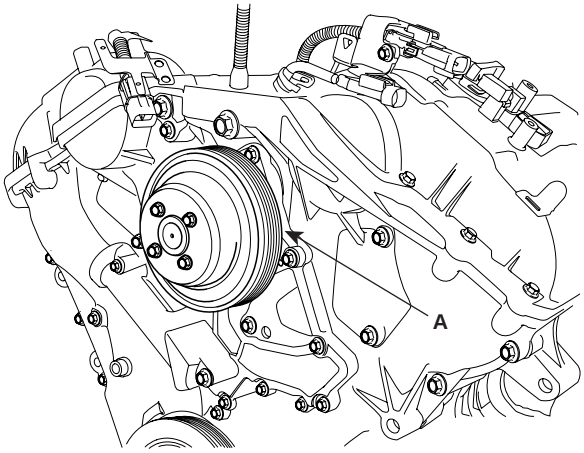
System is under high pressure when the engine is hot. To avoid danger of releasing scalding engine coolant, remove the cap only when the engine is cool.

2. Remove drive belt(A).



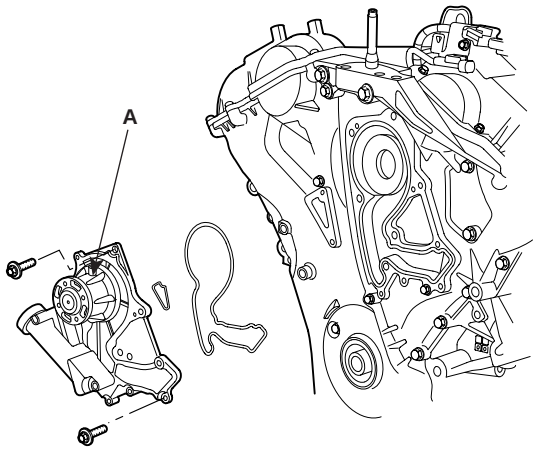
UCBF009A

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



KDRF107A

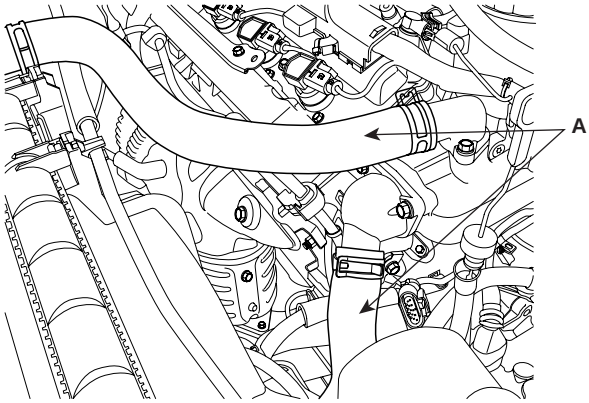
4. Remove the water pump(A) and gasket.



KDRF221A

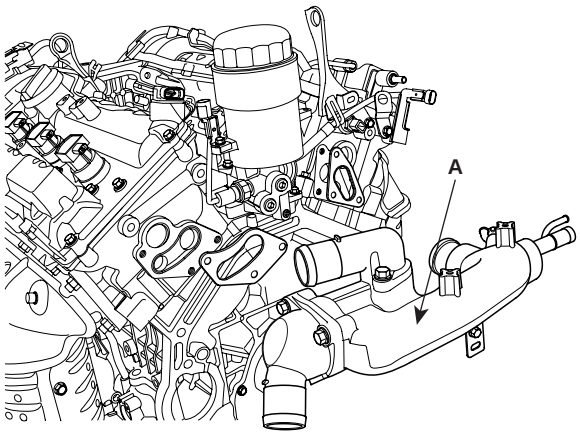
WATER TEMPERATURE CONTROL ASSEMBLY

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



KDRF148A

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



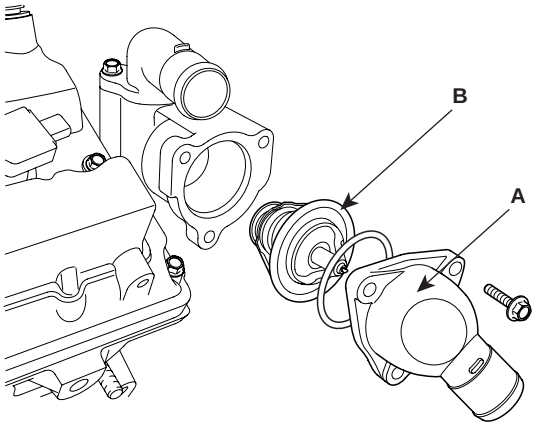
SGHEM7016N

THERMOSTAT

NOTE

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

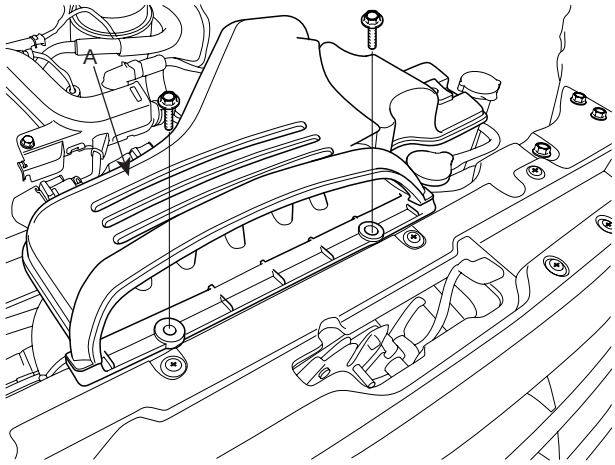
1. Drain engine coolant so its level is below thermostat.
2. Remove water inlet(A) and thermostat(B).



SGHEM7017N

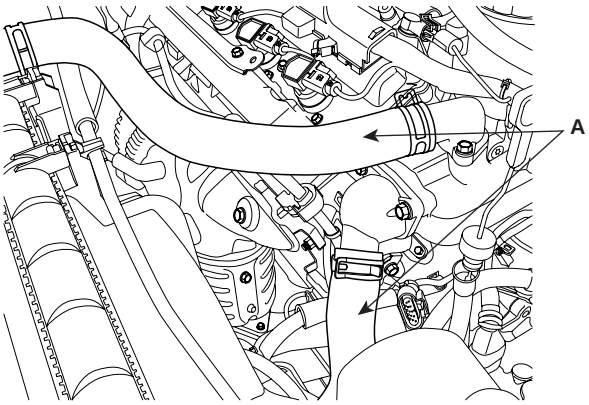
RADIATOR

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



SGHAT7003N

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



KDRF148A

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

INSPECTION EEE5DC80

WATER PUMP

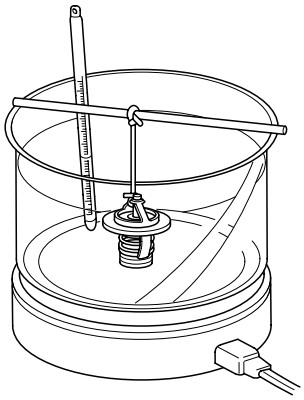
1. Check each part for cracks, damage or wear, and replace the coolant pump assembly if necessary.
2. Check the bearing for damage, abnormal noise and sluggish rotation, and replace the coolant pump assembly if necessary.
3. Check for coolant leakage. If coolant leaks from hole, the seal is defective.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

NOTE

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

THERMOSTAT

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



ECKD503B

2. Check the valve opening temperature.
   Valve opening temperature : 82°C (177°F)
   Full opening temperature : 95°C (205°F)
   If the valve opening temperature is not as specified, replace the thermostat.

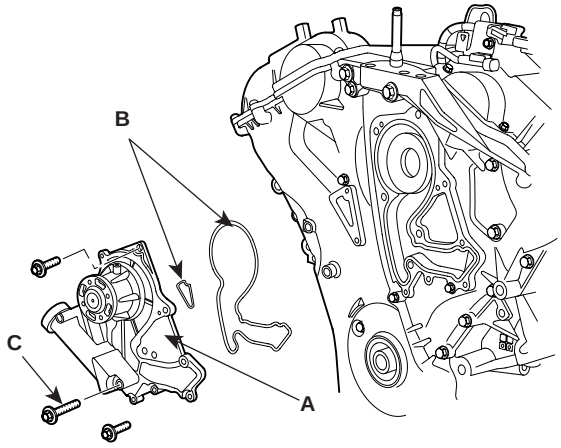
3. Check the valve lift.
   Valve lift : Min. 10mm (0.4in.) at 95°C (205°F)
   If the valve lift is not as specified, replace the thermostat.

INSTALLATION EFD4FFC4

WATER PUMP

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

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



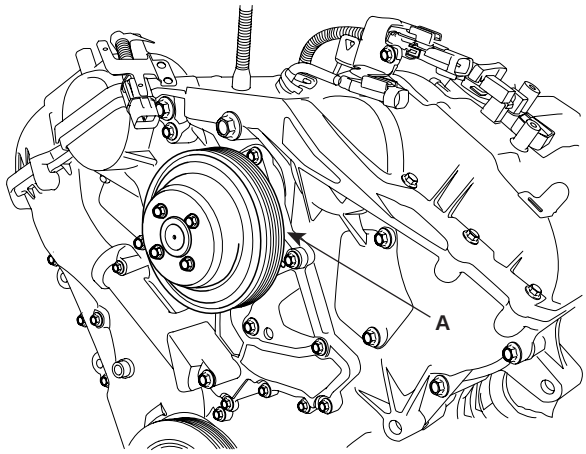
SGHEM7018N

NOTE

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

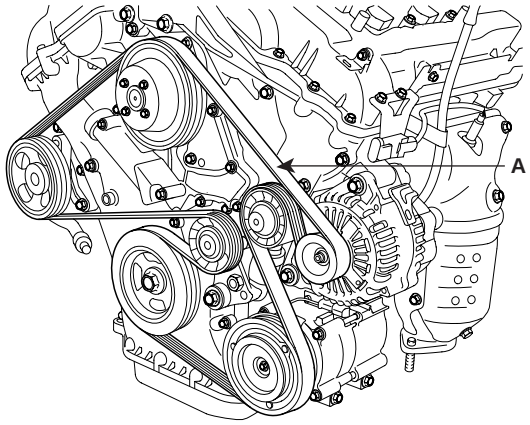
2. Install the 4 bolts and pump pulley(A).

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



KDRF107A

3. Install drive belt(A).



KDRF101A

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

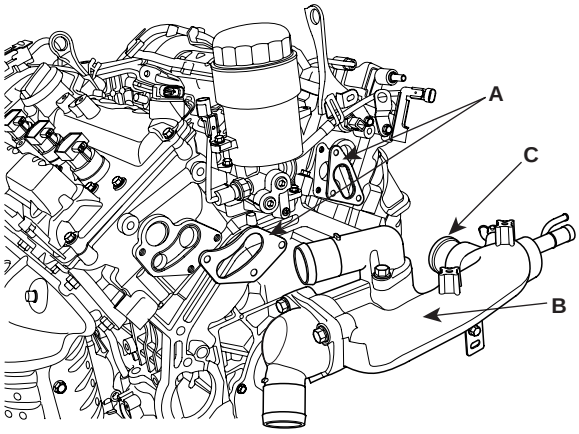
WATER TEMPERATURE CONTROL ASSEMBLY

NOTE

Clean the contact face before assembly.

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

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

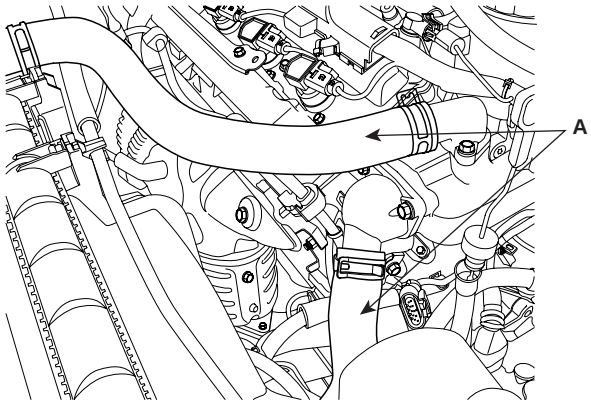


SGHEM7019N

NOTE

Use new O-rings(C) when reassembling.

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

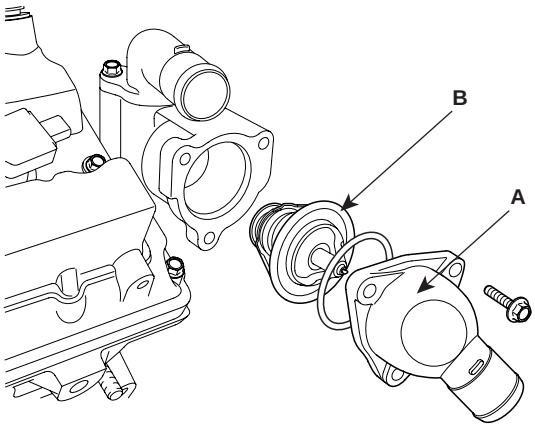


KDRF148A

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

THERMOSTAT

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



SGHEM7017N

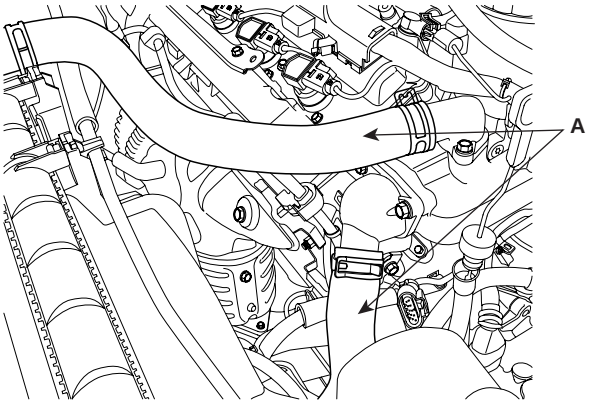
2. Install water inlet(A).

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

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

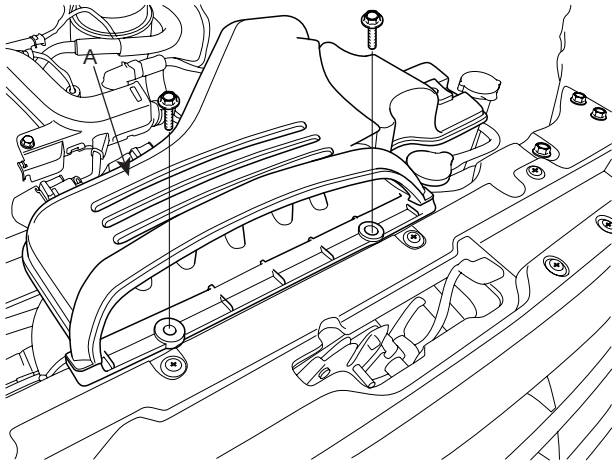
RADIATOR

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



KDRF148A

6. Install the air duct(A).

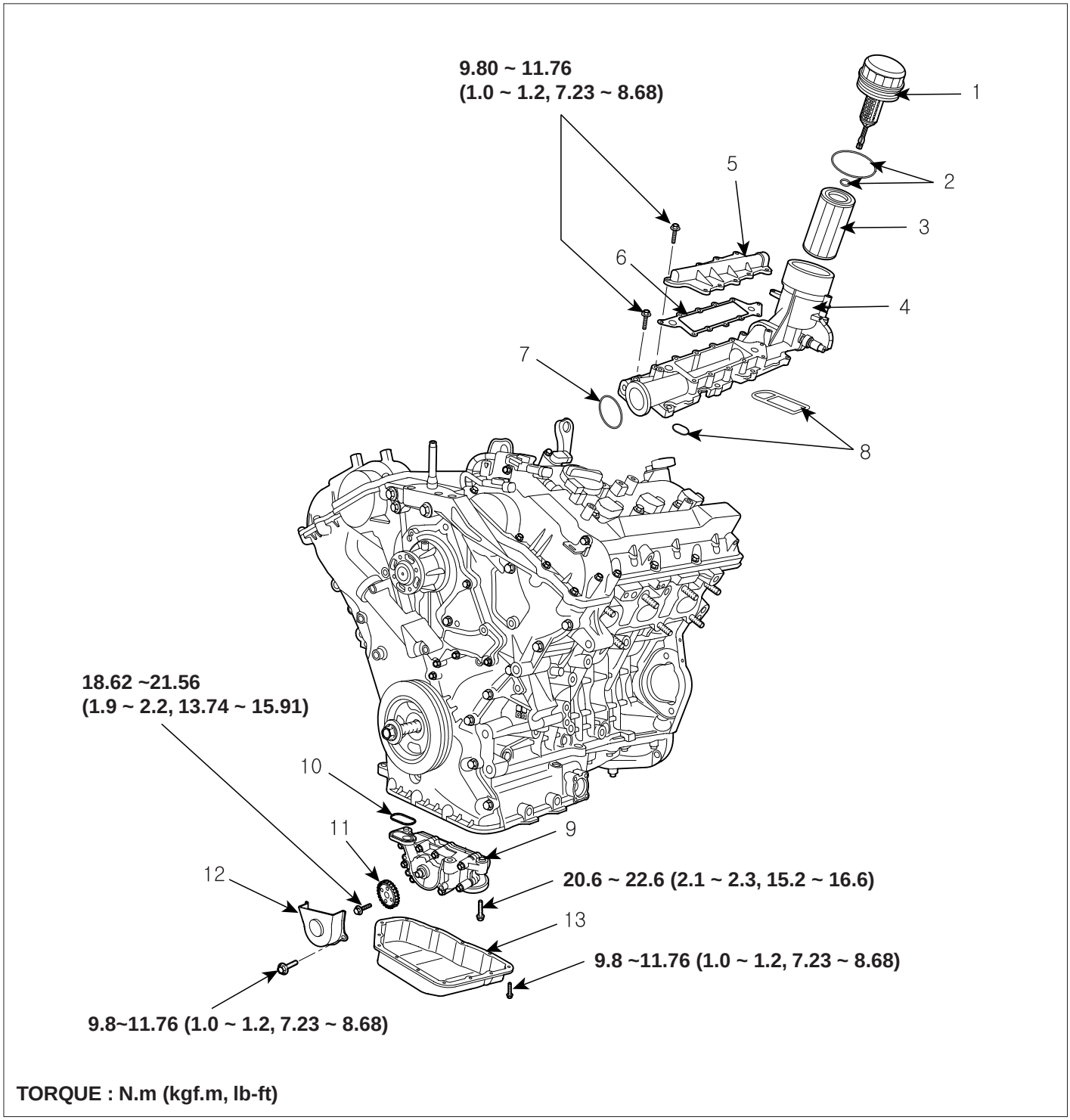


SGHAT7003N

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

LUBRICATION SYSTEM

COMPONENTS E35BD1AA



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

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

ECBF005A

INSPECTION EE8AE591

1. Check engine oil quality.
   Check the oil for deterioration, entry of water, discoloring or thinning.
   If the quality is visibly poor, replace the oil.

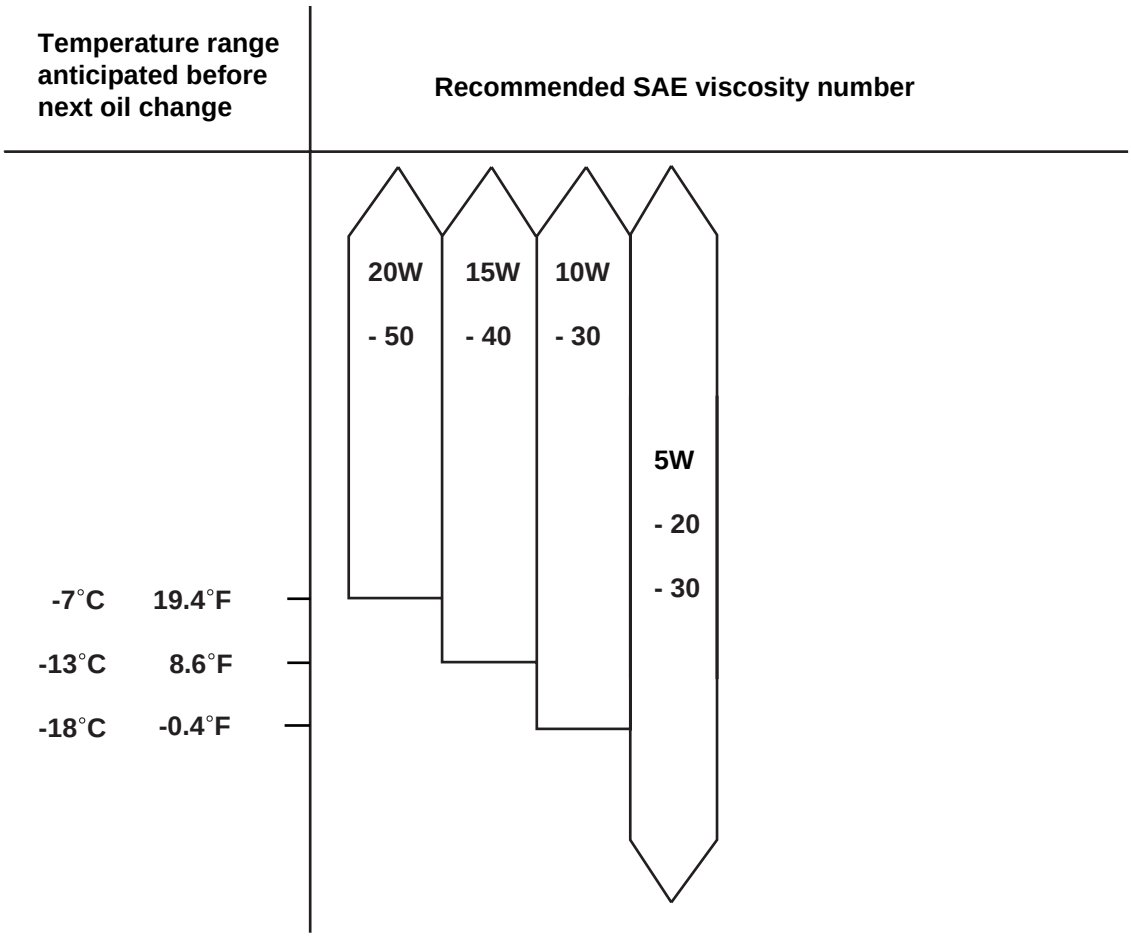
2. Check engine oil level.
   After warming up the engine and then 5 minutes after the engine stops, oil level should be between the "L" and "F" marks on the dipstick.
   If low, check for leakage and add oil up to the "F" mark.

NOTE

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

SELECTION OF ENGINE OIL

Recommended API classification : Above SJ or SL
Recommended SAE viscosity grades : 5W-20
If 5W-20 engine oil is not available, 5W-30 or secondary recommanded engine oil for corresponding temperature range can be used.



SGHEM7001L

NOTE

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

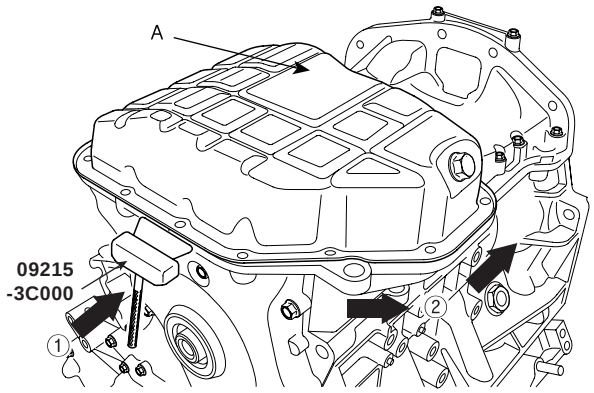
- *Satisfy the requirement of the API classification.*
- *Have proper SAE grade number for expected ambient temperature range.*

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

REMOVAL EEB453AF

OIL PUMP

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



STGEM7100N

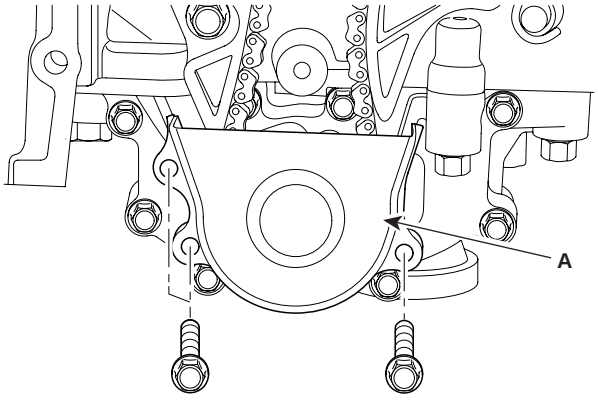
NOTE

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

CAUTION

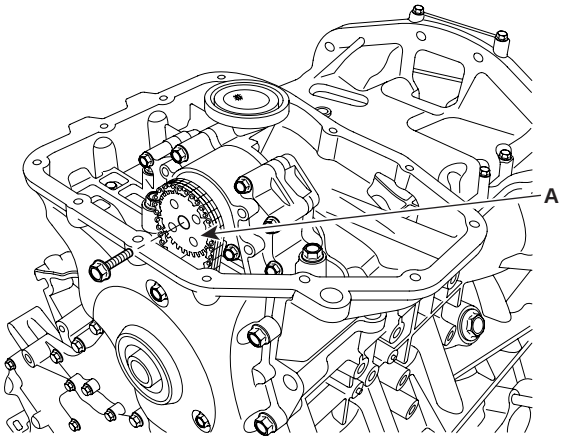
- ***Insert the SST between the oil pan and the ladder frame by tapping it with a plastic hammer in the direction of ① arrow.***
- ***After tapping the SST with a plastic hammer along the direction of ② arrow around more than 2/3 edge of the oil pan, remove it from the ladder frame.***
- ***Do not turn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

3. Remove oil pump chain cover(A).



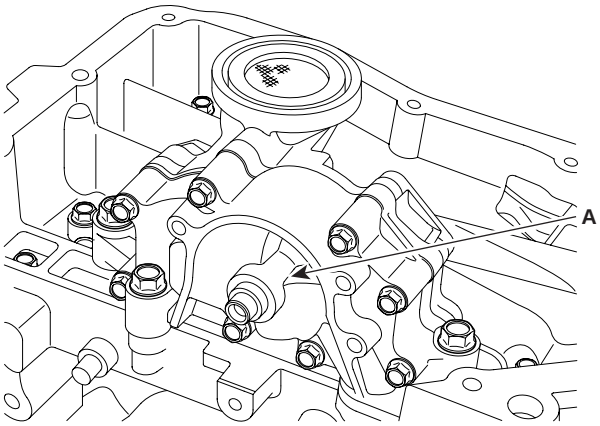
KDRF185A

4. Remove oil pump chain sprocket(A).



KDRF189A

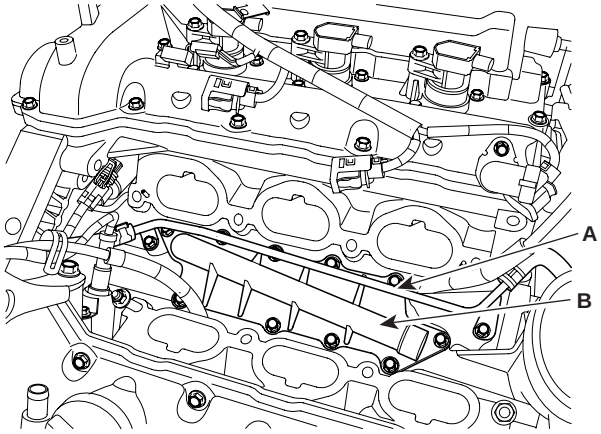
5. Remove oil pump(A).



KDRF190A

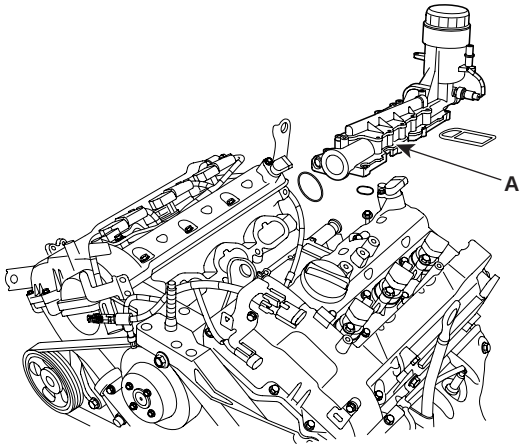
OIL FILTER ASSEMBLY

1. Loosen the oil filter cap by turning it counterclockwise to drain the oil in the oil filter.
2. Remove surge tank and intake manifold.
3. Disconnect oil pressure switch connector.
4. Drain the engine coolant.
5. Disconnect water hoses from ETC.
6. Remove water temperature control assembly.
7. Disconnect water vent hose(A).
8. Remove oil filter body cover(B).



KDRF191A

9. Remove oil filter body.(A).



KDRF192A

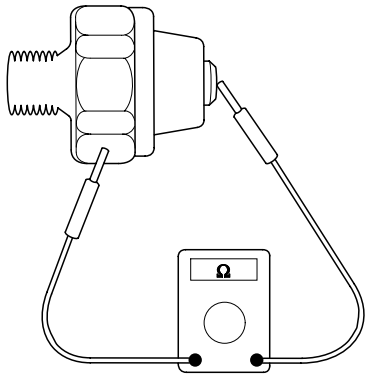
NOTE

Be careful of the knock sensor connector.

INSPECTION E9C606A4

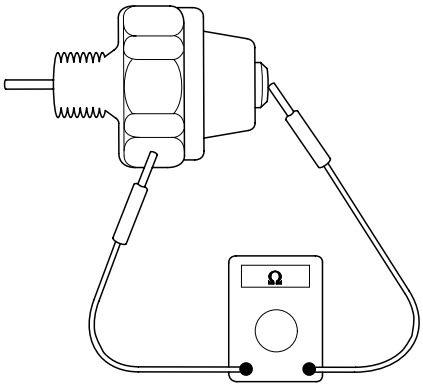
OIL PRESSURE SWITCH

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



ECKD001W

2. Check the continuity between the terminal and the body when the fine wire is pushed. If there is continuity even when the fine wire is pushed, replace the switch.
3. If there is no continuity when a 50kpa (7psi) vacuum is applied through the oil hole, the switch is operating properly.
   Check for air leakage. If air leaks, the diaphragm is broken. Replace it.



ECKD001Y

OIL AND FILTER EB9D3DCB

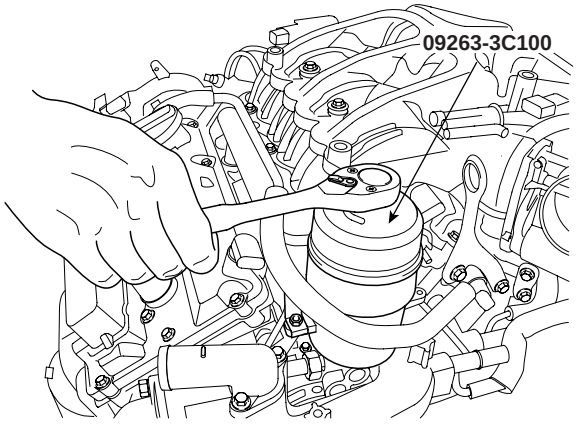
CAUTION

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

1. Park the car on level ground.
   Start the engine and let it warm up.

2. Turn the engine off and open the hood.
   Remove the engine cover.

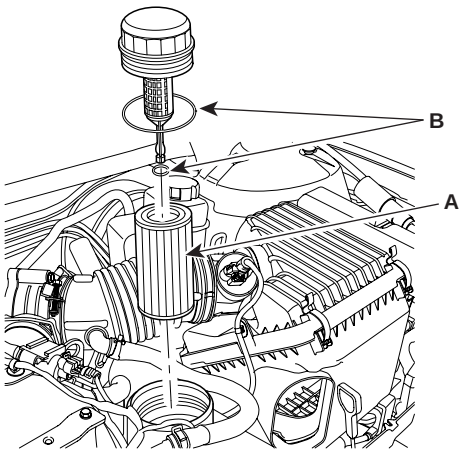
3. Wait for 5 minutes after loosening the oil filter cap by turning it counterclockwise with SST(09263-3C100) to drain well the oil in the oil filter.



ECRF051A

4. Drain the engine oil.
   a. Remove the oil filler cap.
   b. After lifting the car, remove the oil drain plug and drain the oil into a container.

5. Replace oil filter.
   a. Disconnect the oil filter cap from oil filter body.
   b. Remove the oil filter element.
   c. Check and clean the oil filter installation surface.
   d. Check the part number of the new oil filter is same as old one.
   e. Install new oil filter element(A) and two new O-rings(B).



KDRF188A

   f. Apply clean engine oil to the new O-rings. Lightly screw the oil filter cap into place, and tighten it until the O-ring contacts the seat.
   g. Finally tighten it again by specified tightening torque.

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

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

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

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

Capacity
When replacing a short engine or a block assembly :
6.0L(6.34U.S.qts,5.28lmp.qts)
When replacing an oil pan only :
5.5L(5.81U.S.qts,4.84lmp.qts)
Drain and refill : 5.2L(5.49U.S.qts,4.58lmp.qts)

   c. Install the oil filler cap and oil level gauge.

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

8. Recheck engine oil level.

INSTALLATION EF2EDF0E

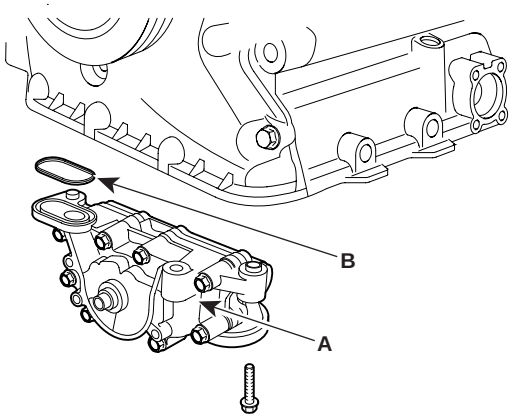
OIL PUMP

1. Install oil pump(A).

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

NOTE

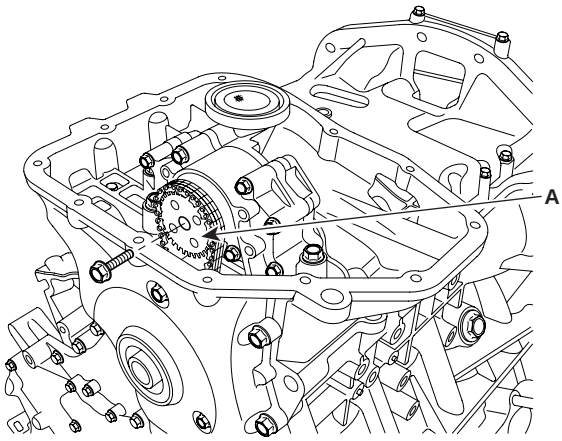
Always use a new O-ring(B).



KDRF222A

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

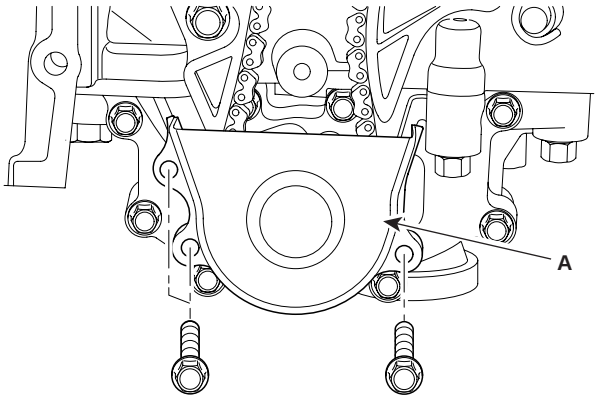
Tightening torque
18.62 ~ 21.56Nm (1.9 ~ 2.2kgf.m, 13.74 ~ 15.91lb-ft)



KDRF189A

3. Install oil pump chain cover(A).

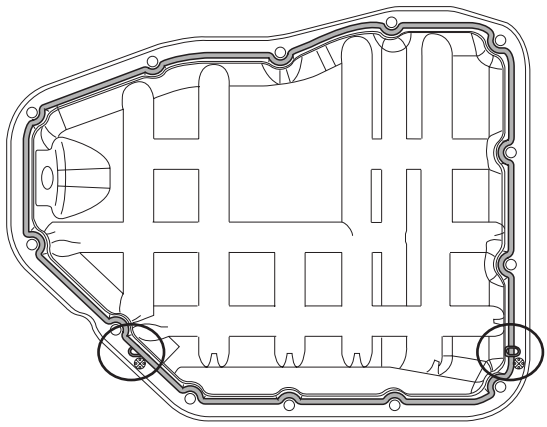
Tightening torque
9.80 ~ 11.76Nm (1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)



KDRF185A

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

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



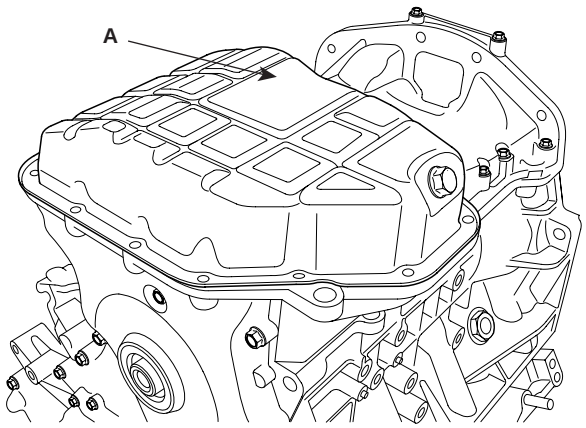
KDRF136A

CAUTION

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

e. Install lower oil pan.
Uniformly tighten the bolts in several passes.

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



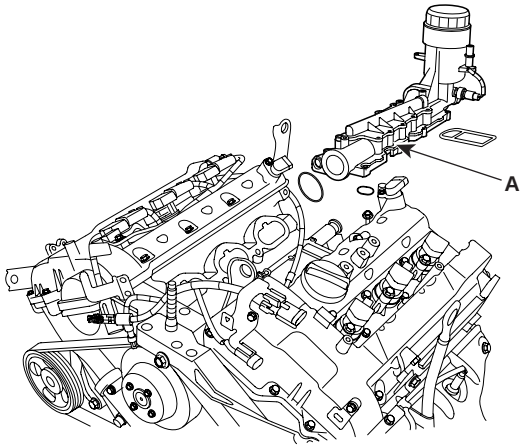
KDRF114A

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

OIL FILTER ASSEMBLY

1. Install oil filter body(A) and new O-rings.

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



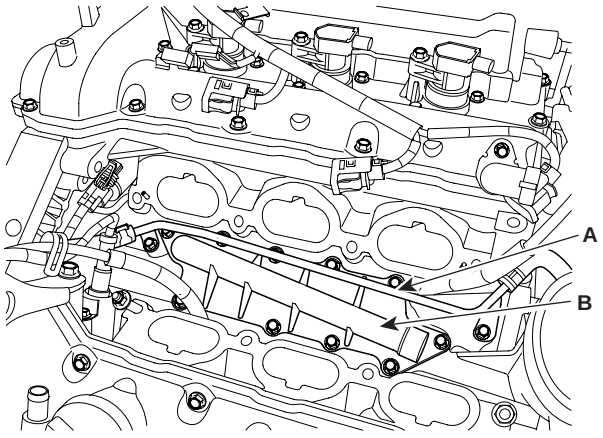
KDRF192A

NOTE

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

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

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



KDRF191A

3. Connect water vent hose(A)

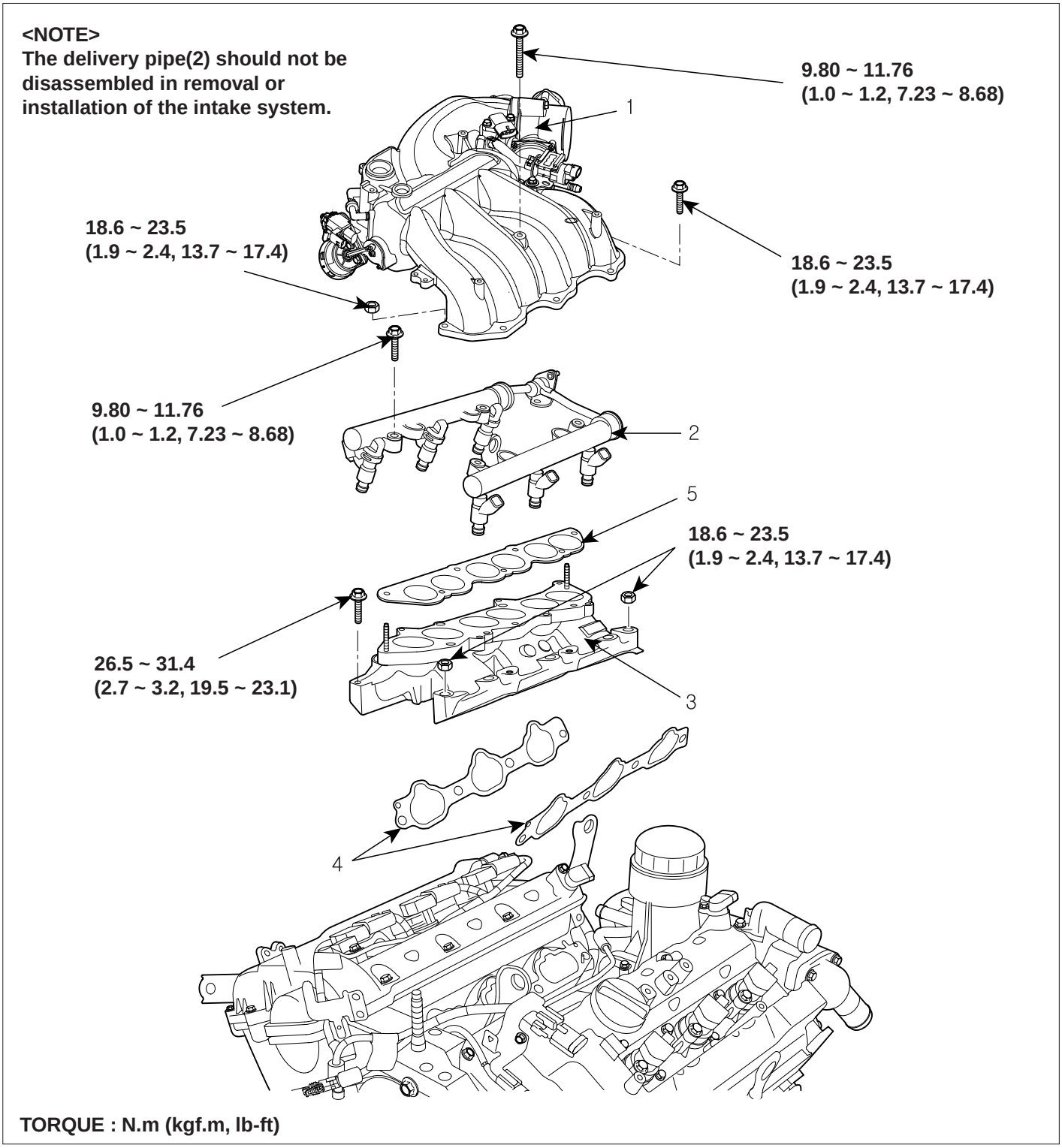
Tightening torque
9.80 ~ 11.76Nm (1.0 ~ 1.2kgf.m, 7.23 ~ 8.68lb-ft)

4. Install water temperature control assembly.
5. Connect water hoses on the ETC.
6. Connect oil pressure switch connector.
7. Install intake manifold and surge tank.
8. Fill with engine coolant.
9. Start engine and check for leaks.
10. Recheck engine coolant level.

INTAKE AND EXHAUST SYSTEM

INTAKE MANIFOLD

COMPONENTS EBCD8B14

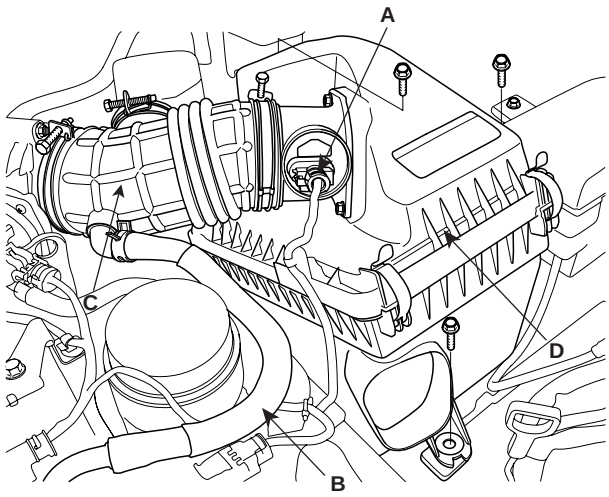


1. Surge tank
2. Delivery pipe
3. Surge tank gasket
4. Intake manifold
5. Intake manifold gasket

STGEM7101N

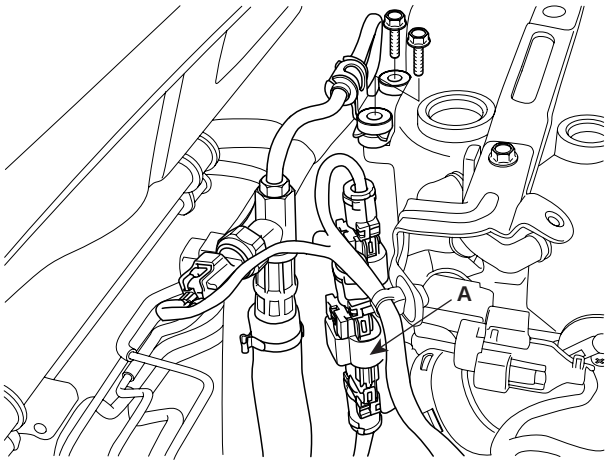
REMOVAL E3EAC1CF

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



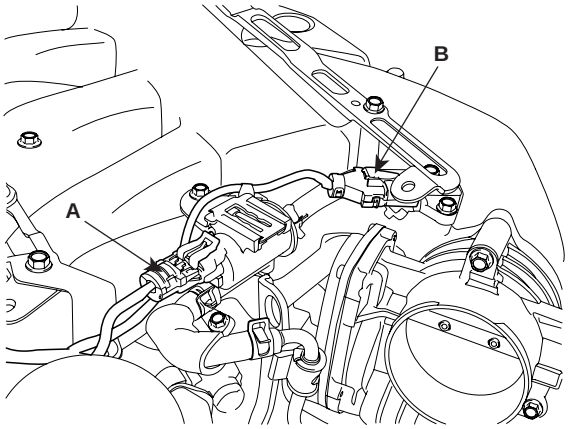
SGHEM7005N

3. Disconnect RH oxygen sensor connector(A).



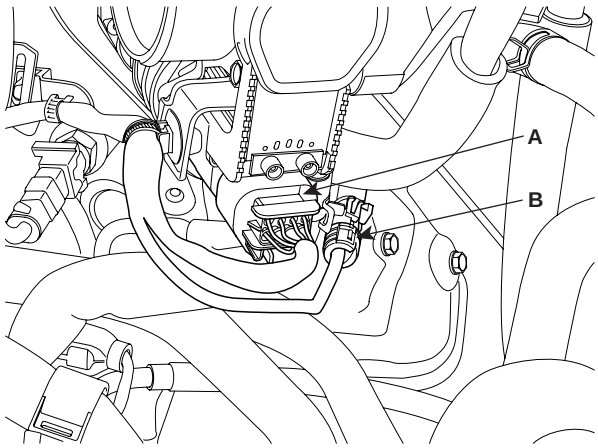
SGHEM7006N

4. Disconnect RH injector connector and ignition coil connector.
5. Disconnect PCSV connector(A), MAP sensor connector(B) and PCSV hose.



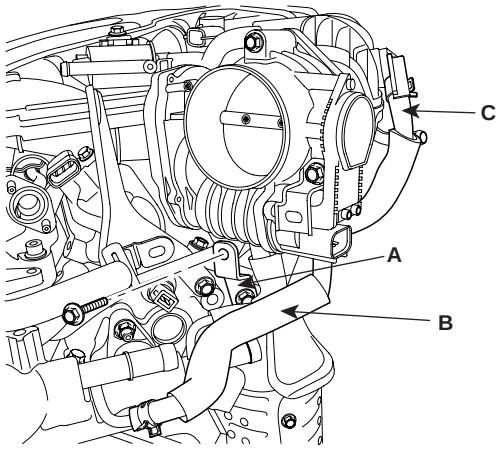
UCBF003A

6. Disconnect ETC connector(A) and knock sensor connector(B).



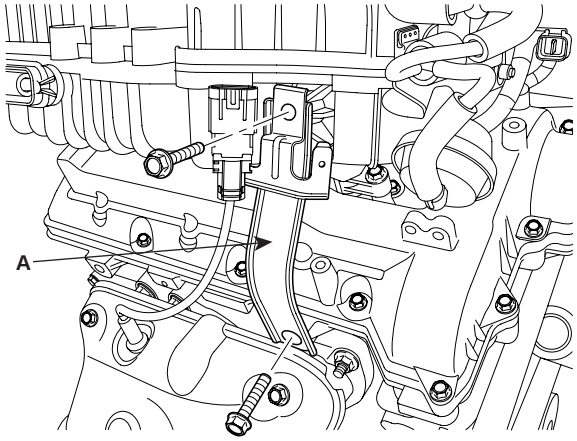
KDRF162A

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



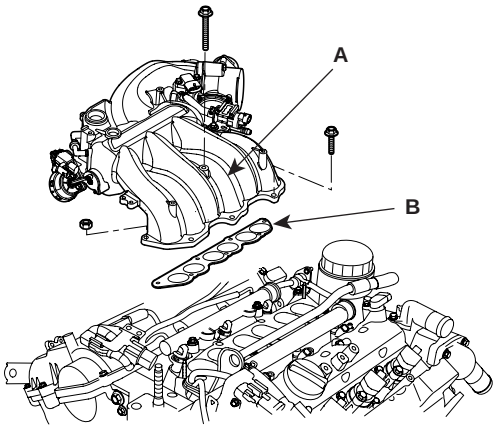
KDRF176A

9. Disconnect brake vacuum hose.
10. Remove surge tank stay(A).



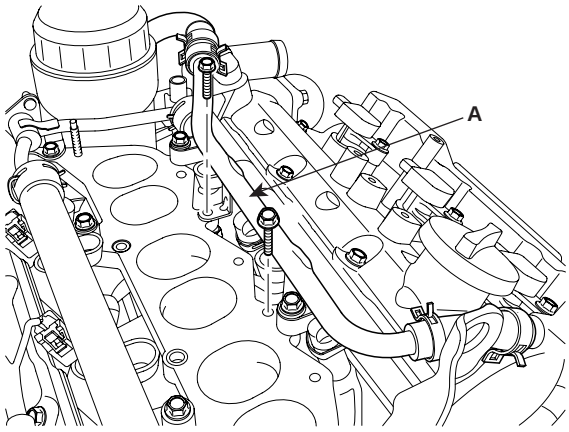
UCBF020A

11. Remove connector bracket from surge tank or connectors(2EA).
12. Remove surge tank(A).



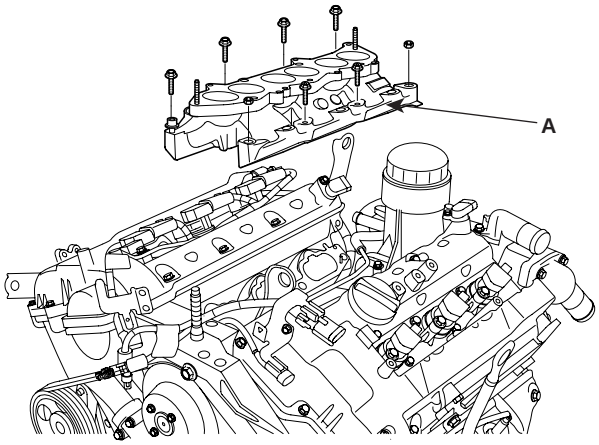
UCBF007A

13. Disconnect breather Pipe assembly(A).



ECBF031A

14. Disconnect LH injector connector.
15. Remove intake manifold(A) and gasket.



KDRF182A

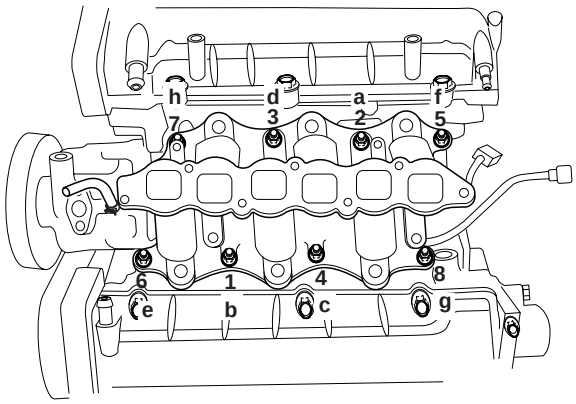
INSTALLATION EFC2A9A3

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

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

NOTE

Be careful of the installation direction.
a - h : 1st step order
1 ~ 8 : 2nd step order



SBLM16207L

2. Install delivery pipe.(Refer to FL group)
3. Connect LH injector connector.
4. Connect breather Pipe assembly.

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

5. Install surge tank.

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

6. Install connector bracket on the surge tank.

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

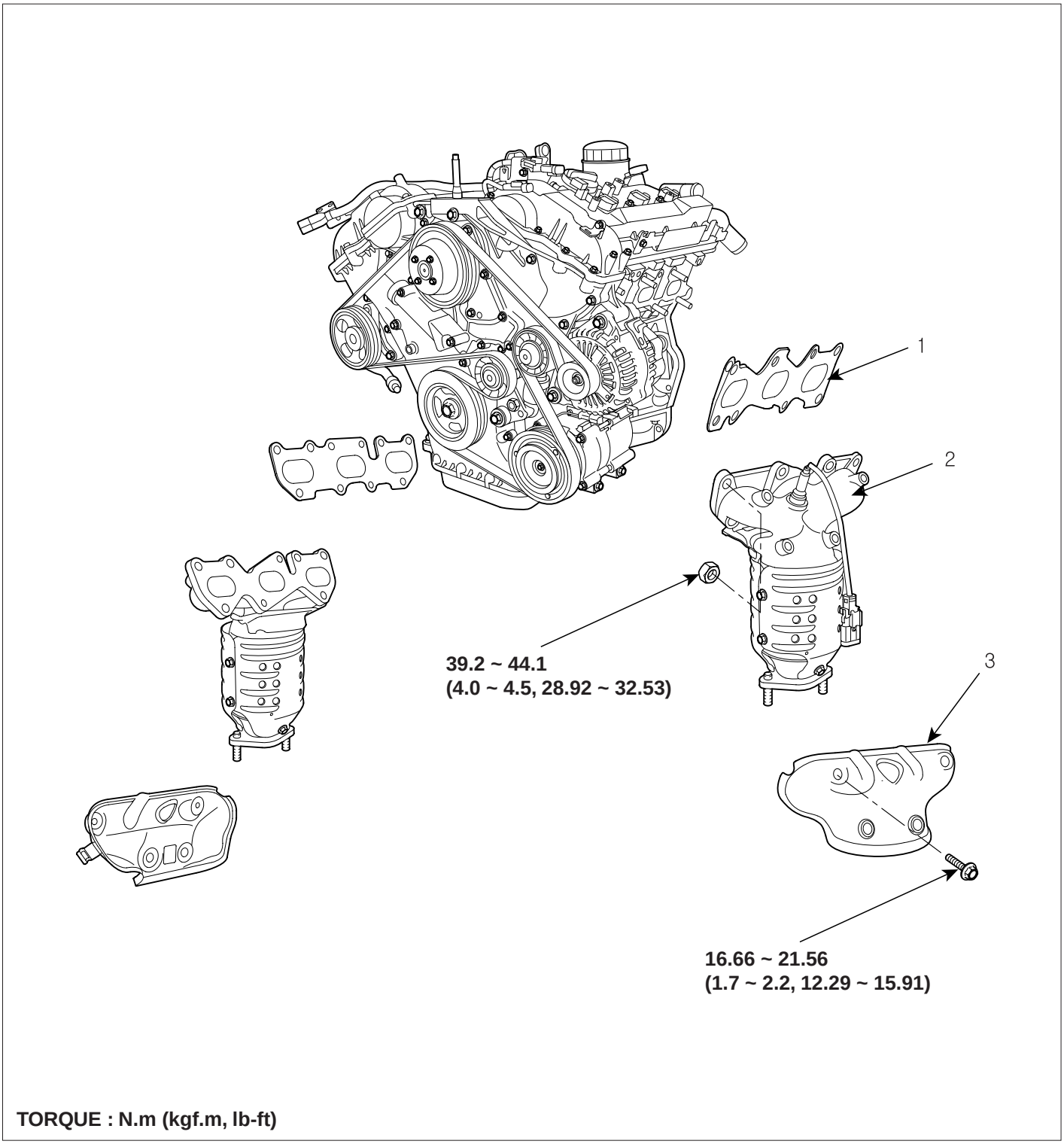
7. Install surge tank stay.

Tightening torque
27.44 ~ 31.36Nm (2.8 ~ 3.2kgf.m, 20.25 ~ 23.14lb-ft) - Engine front side
18.62 ~ 23.52Nm (1.9 ~ 2.4kgf.m, 13.74 ~ 17.36lb-ft) - Engine rear side

8. Connect brake vacuum hose.
9. Connect PCV hose.
10. Connect water hoses to ETC.
11. Connect ETC connector and knoch sensor connector.
12. Connect PCSV connector, MAP sensor connector and PCSV hoe.
13. Connect RH injector connector and ignition coil connector.
14. Connect RH oxygen sensor connector.
15. Install air cleaner upper cover and in take hose.
16. Connect AFS(A) and breather hose.

EXHAUST MANIFOLD

COMPONENTS E5AE5CA6

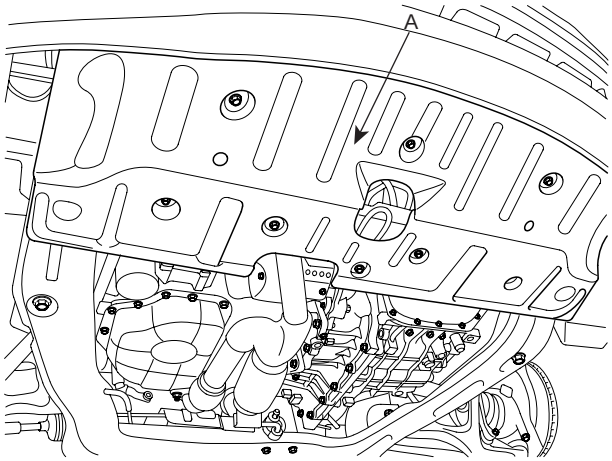


1. Gasket
2. Exhaust manifold
3. Heat protector

ECBF014A

REMOVAL E4376546

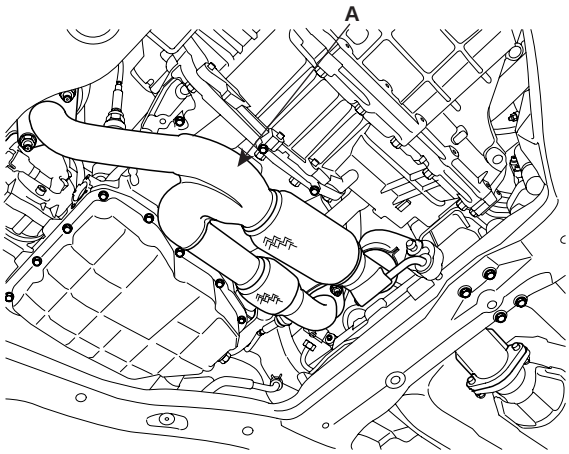
1. Remove under cover(A).



SGHAT6021D

2. Disconnect LH,RH rear oxygen sensor connector from bracket.

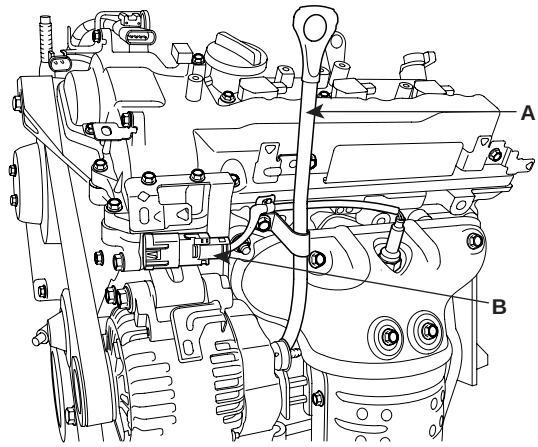
3. Remove front muffler(A).



KCBF102A

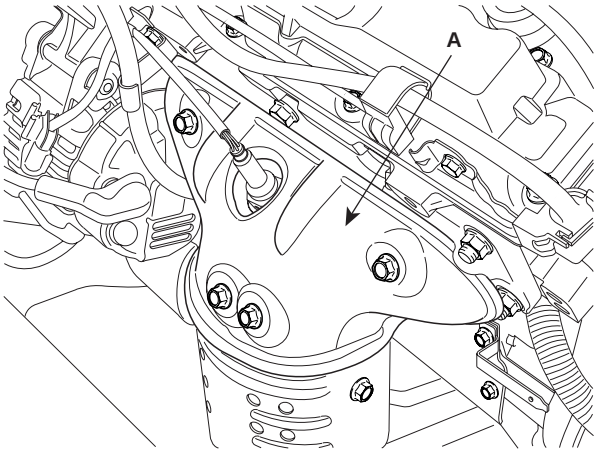
4. Remove oil level gauge(A).

5. Disconnect LH front oxygen sensor connector(B) from bracket.



UCBF010A

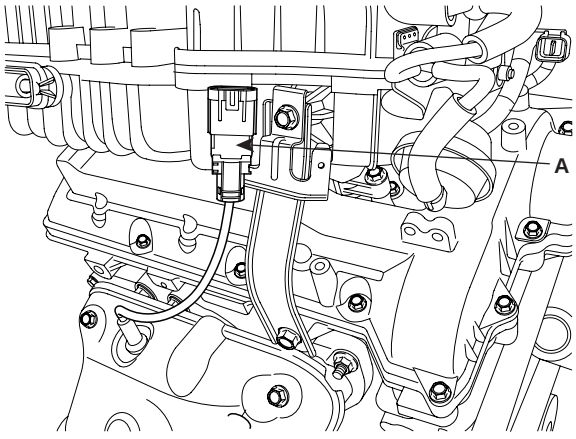
6. Remove LH heat protector(A).



UCBF011A

7. Remove LH exhaust manifold.

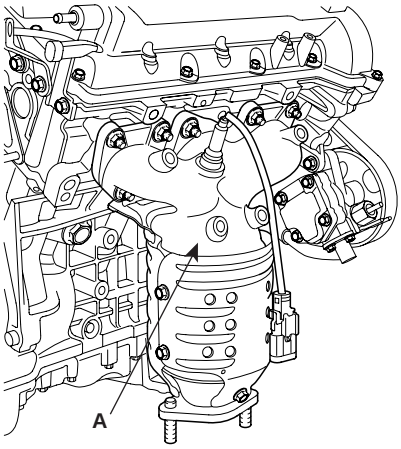
8. Disconnect RH front oxygen sensor connector from bracket.



KDRF177B

9. Remove RH heat protector.

10. Remove RH exhaust manifold.



UCBF012A

INSTALLATION E5DDACFB

1. Install new gasket and exhaust manifold.

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

2. Install heat protector.

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

3. Install front muffler.

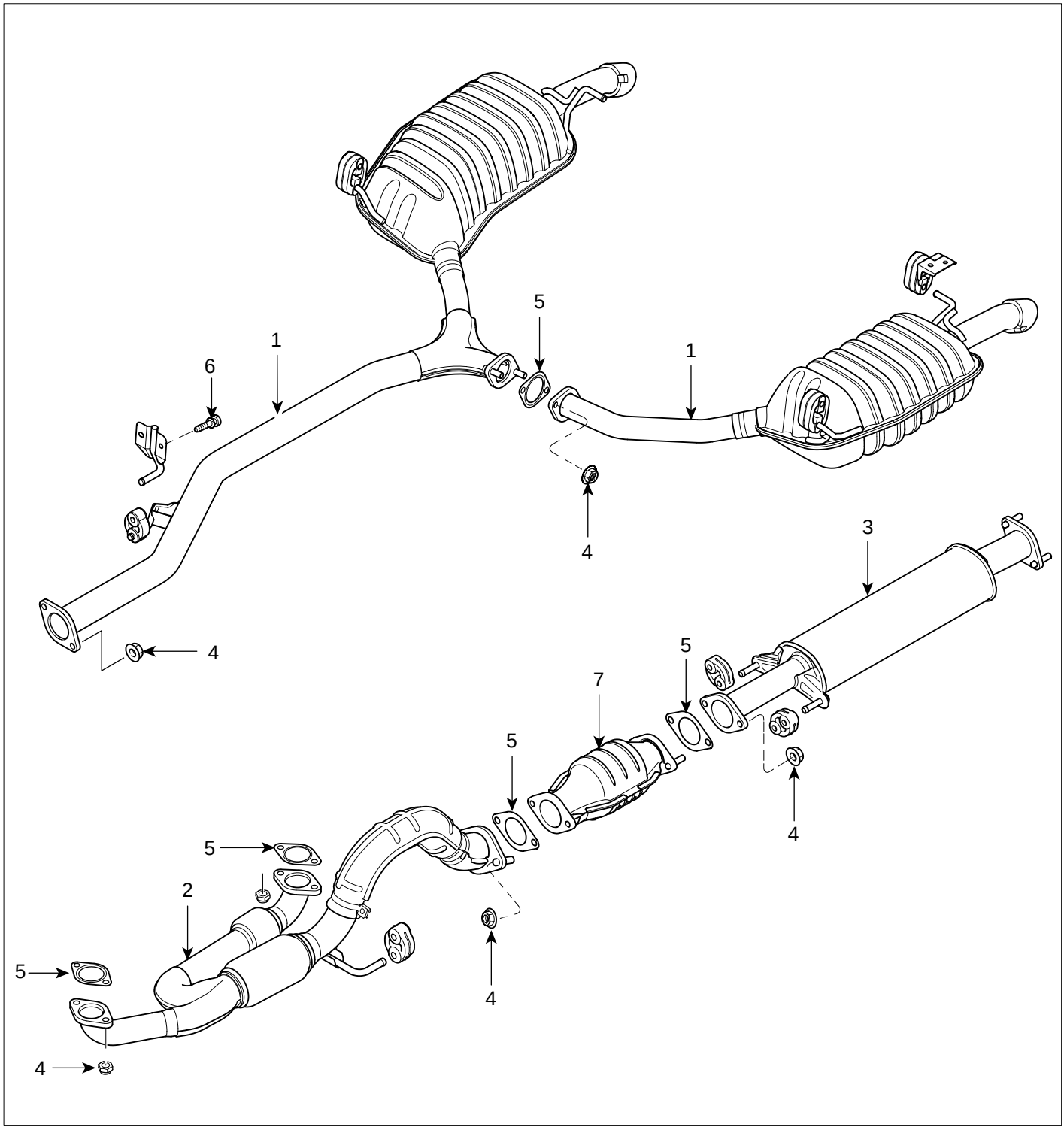
Tightening torque
39.2 ~ 58.8N.m(4.0 ~ 6.0kgf.m, 28.92 ~ 43.37lb-ft)

4. Connect oxygen sensor connector.

5. Install under cover.

EXHAUST PIPE

COMPONENTS E93A1D60



1. Main muffler assembly
2. Front muffler assembly
3. Center muffler assembly
4. Nut
5. Exhaust pipe gasket
6. Bolt
7. Catalytic converter

SGHEM7007N