General Information

SPECIFICATIONS

DESCRIPTION	SPECIFICATION	LIMIT
General		
Type	In-line, DOHC	
Number of cylinders	4	
Bore	91 mm (3.58 in)	
Stroke	96 mm (3.78 in)	
Total displacement	2497 cc (121.5 cu.in)	
Compression ratio	17.7 : 1	
Firing order	1-3-4-2	
Valve timing		
Intake valve		
Opens (BTDC)	8°	
Closes (ABDC)	38°	
Exhaust valve		
Opens (BBDC)	52°	
Closes (ATDC)	8°	
Cylinder head		
Flatness of gasket surface	0.15 mm (0.0059 in)	
Camshaft		
Cam height (LH)		
Intake	40.163 mm (1.5812 in)	
Exhaust	40.043 mm (1.5765 in)	
Cam height (RH)		
Intake	39.782 mm (1.5662 in)	
Exhaust	40.456 mm (1.5928 in)	
Journal outer Diameter	29.964 ~ 29.980 mm (1.1797 ~ 1.1803 in)	
End play	0.10 ~ 0.20 mm (0.0039 ~ 0.0079 in)	
Valve		
Valve length		
Intake	110.55 mm (4.352 in)	
Exhaust	110.55 mm (4.352 in)	
Stem outer diameter		
Intake	6.965 ~ 6.980 mm (0.2742 ~ 0.2748 in)	
Exhaust	6.935 ~ 6.950 mm (0.2730 ~ 0.2736 in)	

DESCRIPTION	SPECIFICATION	LIMIT
Face angle	45°	
Thickness of valve head (margin)		
Intake	1.8 ~ 2.0 mm (0.071 ~ 0.079 in)	
Exhaust	1.8 ~ 2.0 mm (0.071 ~ 0.079 in)	
Valve stem to valve guide clearance		
Intake	0.020 ~ 0.050 mm (0.0008 ~ 0.0020 in)	0.1mm (0.0039in)
Exhaust	0.050 ~ 0.080 mm (0.0020 ~ 0.0031 in)	0.15mm (0.0059in)
Valve guide		
Length		
Intake	43.3 mm (1.705 in)	
Exhaust	39.4 mm (1.551 in)	
Valve seat		
Width of seat contact		
Intake	1.5 mm (0.059 in)	
Exhaust	1.7 mm (0.067 in)	
Seat angle		
Intake	45°	
Exhaust	45°	
Valve spring		
Free length	48.2 mm (1.898 in)	
Load	258 ± 12 N/38 mm (26.3 ± 1.2 kg/38 mm, 569 ± 26 lb/1.496 in) 505.5 ± 24 N/28.8 mm (51.5 ± 2.4 kg /28.8 mm, 1114.4 ± 53 lb/1.134 in)	
Cylinder block		
Cylinder bore	91.000 ~ 91.030 mm (3.5827 ~ 3.5839 in)	
Flatness of gasket surface	0.05 mm (0.0020 in)	
Piston		
Piston outer diameter	90.910 ~ 90.940 mm (3.5791 ~ 3.5803 in)	
Piston to cylinder clearance	0.080 ~ 0.100 mm (0.0031 ~ 0.0039 in)	
Ring groove width		
No. 1 ring groove	2.378 ~ 2.398 mm (0.0936 ~ 0.0944 in)	
No. 2 ring groove	2.04 ~ 2.06 mm (0.0803 ~ 0.0811 in)	
Oil ring groove	3.03 ~ 3.05 mm (0.1193 ~ 0.1201 in)	

DESCRIPTION	SPECIFICATION	LIMIT
Piston ring		
Side clearance		
No. 2 ring	0.05 ~ 0.09 mm (0.0020 ~ 0.0035 in)	
Oil ring	0.04 ~ 0.08 mm (0.0016 ~ 0.0031 in)	
End gap		
No. 1 ring	0.25 ~ 0.40 mm (0.0098 ~ 0.0157 in)	
No. 2 ring	0.50 ~ 0.70 mm (0.0197 ~ 0.0276 in)	
Oil ring	0.20 ~ 0.40 mm (0.0079 ~ 0.0157 in)	
Piston pin		
Piston pin outer diameter	32.993 ~ 32.998 mm (1.2989 ~ 1.2991 in)	
Piston pin hole inner diameter	33.014 ~ 33.019 mm (12.998 ~ 1.3000 in)	
Piston pin hole clearance	0.016 ~ 0.026 mm (0.0006 ~ 0.0010 in)	
Connecting rod small end hole inner diameter	33.020 ~ 33.033 mm (1.3000 ~ 1.3005 in)	
Connecting rod small end hole clearance	0.022 ~ 0.040 mm (0.0009 ~ 0.0016 in)	
Connecting rod		
Connecting rod big end inner diameter	60.000 ~ 60.018 mm (2.3622 ~ 2.3629 in)	
Connecting rod bearing oil clearance	0.024 ~ 0.042 mm (0.0009 ~ 0.0016 in)	0.1mm(0.0039in)
Crankshaft		
Main journal outer diameter	66.982 ~ 67.000 mm (2.6371 ~ 2.6378 in)	
Pin journal outer diameter	56.982 ~ 57.000 mm (2.2434 ~ 2.2441 in)	
Main bearing oil clearance	0.030 ~ 0.054 mm (0.0012 ~ 0.0021 in)	0.1mm(0.0039in)
End play	0.05 ~ 0.25 mm (0.0020 ~ 0.0098 in)	
Flywheel		
Runout		0.13mm(0.0051in)
Oil pump		
Side clearance		
Inner rotor	0.040 ~ 0.085 mm (0.0016 ~ 0.0033 in)	
Outer rotor	0.050 ~ 0.100 mm (0.0020 ~ 0.0039 in)	
Body clearance	0.100 ~ 0.176 mm (0.0039 ~ 0.0069 in)	
Relief valve opening pressure	784.5 ± 78.4 Kpa	
Balance shaft		
Front journal outer diameter	48.975 ~ 49.000 mm (1.9281 ~ 1.9291 in)	
Rear journal outer diameter	47.965 ~ 47.990 mm (1.8884 ~ 1.8894 in)	
Front bush inner diameter	49.050 ~ 49.080 mm (1.9311 ~ 1.9323 in)	
Rear bush inner diameter	48.050 ~ 48.080 mm (1.8917 ~ 1.8929 in)	

DESCRIPTION	SPECIFICATION	LIMIT
Fornt bush oil clearance	0.050 ~ 0.105 mm (0.0020 ~ 0.0041 in)	
Rear bush oil clearance	0.060 ~ 0.115 mm (0.0024 ~ 0.0045 in)	
Engine oil		
Oil quantity (Total)	9.0L (9.51 US qt, 7.91 Imp qt)	
Oil quantity (Oil pan)	7.4L (7.82 US qt, 6.50 Imp qt)	
Oil quantity (Drain and refill including oil filter)	8.2L(8.66 US qt, 7.21 Imp qt)	
Oil quality	ABOVE API CF-4 (VGT:CH-4) or ACEA B4	
Cooling method		
Cooling system	Forced circulation with cooling fan	
Coolant quantity	10L	
Thermostat		
Type	Wax pellet type	
Opening temperature	82°C (180°F)	
Closing temperature	77°C (171°F)	
Pull opening temperature	95°C (203°F)	
Radiator cap		
Main valve opening pressure	107.9±14.7 Kpa	
Main valve closing pressure		
Vaccum valve opening pressure		
Water temperature sensor		
Type	Thermister type	
Resistance		
20°C (68°F)	2.45 ± 0.14 kΩ	
80°C (176°F)	0.3222 kΩ	

TIGHTENING TORQUE

* Bolt size = Diameter x Length

ITEM	Quantity	Tightening torque		
		N.m	kgf.m	lb-ft
Main bearing cap bolt	10	127.5 ~ 137.3	13 ~ 14	94.0 ~ 101.3
Connecting rod cap nut	8	58.8 → Loosen → (32.4~36.3) + (60 ~64°)	6.0 → Loosen → (3.3~3.7) + (60~64 °)	43.4 → Loosen → (23.9~26.8) + (60 ~64°)
Oil jet bolt	4	29.4 ~ 34.3	3.0 ~ 3.5	21.7 ~ 25.3
Crank shaft pulley bolt	1	274.6 ~ 294.2	28 ~ 30	202.5 ~ 217.0
Rear oil seal case bolt	5	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Rear plate bolt	2	7.8 ~ 9.8	0.8 ~ 1.0	5.8 ~ 7.2
Flywheel bolt	8	127.5 ~ 137.3	13 ~ 14	94.0 ~ 101.3
Water pump bolt (8 x 30)	5	19.6 ~ 26.5	2.0 ~ 2.7	14.5 ~ 19.5
Water pump bolt (8 x 45)	2	19.6 ~ 26.5	2.0 ~ 2.7	14.5 ~ 19.5
Oil cooler fixing nut	4	17.7 ~ 24.5	1.8 ~ 2.5	13.0 ~ 18.1
Oil cooler cover bolt (8 x 35)	8	19.6 ~ 25.5	2.0 ~ 2.6	14.5 ~ 18.8
Oil cooler cover bolt (8 x 60)	3	19.6 ~ 25.5	2.0 ~ 2.6	14.5 ~ 18.8
Oil pump bolt (8 x 22)	2	19.6 ~ 26.5	2.0 ~ 2.7	14.5 ~ 19.5
Oil pump bolt (10 x 35)	1	42.2 ~ 53.9	4.3 ~ 5.5	31.1 ~ 39.8
Oil pump bolt (10 x 60)	1	42.2 ~ 53.9	4.3 ~ 5.5	31.1 ~ 39.8
Oil screen bolt	2	19.6 ~ 26.5	2.0 ~ 2.7	14.5 ~ 19.5
Oil feed pipe bolt	3	19.6 ~ 26.5	2.0 ~ 2.7	14.5 ~ 19.5
Oil filter assembly	1	21.6 ~ 24.5	2.2 ~ 2.5	15.9 ~ 18.1
Oil pan bolt	2	2 9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Oil level gauge bolt	1	11.8 ~ 14.7	1.2 ~ 1.5	8.7 ~ 10.8
Bed plate bolt (6 x 18)	3	7.8 ~ 11.8	0.8 ~ 1.2	5.8 ~ 8.7
Bed plate bolt (6 x 30)	1	3 7.8 ~ 11.8	0.8 ~ 1.2	5.8 ~ 8.7
Bed plate bolt (8 x 45)	8	19.6 ~ 26.5	2.0 ~ 2.7	14.5 ~ 19.5
Bell housing cover bolt	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Oil pressure switch	1	14.7 ~ 21.6	1.5 ~ 2.2	10.8 ~ 15.9
Cylinder head cover bolt	1	6 9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Camshaft cap bolt	20	13.7 ~ 14.7	1.4 ~ 1.6	10.1 ~ 10.8
Cylinder head bolt	18	49.0+120°+90°	5.0 + 120°+90°	36.2+120°+90°
TDC sensor bolt	1	6.9-10.8	0.7-1.1	5.1-8.0
Water temperature sensor	1	29.4 ~ 39.2	3.0 ~ 4.0	21.7 ~ 28.9
Glow plug	4	14.7 ~ 19.6	1.5 ~ 2.0	10.8 ~ 14.5

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ITEM	Quantity	Tightening torque		
		N.m	kgf.m	lb-ft
Glow plug plate nut	4	0.8 ~ 1.5	0.08 ~ 0.15	0.6 ~ 1.1
Engine hanger bolt	4	18.6 ~ 28.4	1.9 ~ 2.9	13.7 ~ 21.0
Thermostat housing bolt	2	19.6 ~ 26.5	2.0 ~ 2.7	14.5 ~ 19.5
Exhaust manifold lock nut	8	16.7 ~ 25.5	1.7 ~ 2.6	12.3 ~ 18.8
Exhaust manifold heat protector bolt	3	14.7 ~ 21.6	1.5 ~ 2.2	10.8 ~ 15.9
Turbo charger nut	3	49.0 ~ 68.6	5.0 ~ 7.0	36.2 ~ 50.6
Turbo charger fitting nut	4	26.5 ~ 31.4	2.7 ~ 3.2	19.5 ~ 23.1
Turbo charger oil return pipe bolt	2	7.8 ~ 9.8	0.8 ~ 1.0	5.8 ~ 7.2
Turbo charger oil inlet pipe bolt	2	13.7 ~ 18.6	1.4 ~ 1.9	10.1 ~ 13.7
Turbo charger water inlet pipe bolt	2	34.3 ~ 49.0	3.5 ~ 5.0	25.3 ~ 36.2
Turbo charger heat protector bolt	3	14.7 ~ 21.6	1.5 ~ 2.2	10.8 ~ 15.9
Intake manifold bolt (8 x 112)	4	14.7 ~ 19.6	1.5 ~ 2.0	10.8 ~ 14.5
Intake manifold bolt (8 x 32)	2	14.7 ~ 19.6	1.5 ~ 2.0	10.8 ~ 14.5
Intake manifold nut	4	14.7 ~ 19.6	1.5 ~ 2.0	10.8 ~ 14.5
EGR valve bolt	2	16.7 ~ 25.5	1.7 ~ 2.6	12.3 ~ 18.8
EGR pipe nut	4	16.7 ~ 25.5	1.7 ~ 2.6	12.3 ~ 18.8
Timing chain lower under cover bolt (6 x 14)	4	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Timing chain lower under cover bolt (8 x 22)	1	19.6 ~ 26.5	2.0 ~ 2.7	14.5 ~ 19.5
Timing chain lower under cover bolt (8 x 30)	3	19.6 ~ 26.5	2.0 ~ 2.7	14.5 ~ 19.5
Timing chain lower under cover bolt (8 x 40)	1	19.6 ~ 26.5	2.0 ~ 2.7	14.5 ~ 19.5
LH balance shaft driven gear bolt	1	33.3 ~ 39.2	3.4 ~ 4.0	24.6 ~ 28.9
LH balance shaft sprocket nut	1	49.0 ~ 58.8	5.0 ~ 6.0	36.2 ~ 43.4
RH balance shaft sprocket bolt	1	33.3 ~ 39.2	3.4 ~ 4.0	24.6 ~ 28.9
Timing chain guide "A" bolt (upper)	1	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Timing chain guide "A" bolt (lower)	1	19.6 ~ 26.5	2.0 ~ 2.7	14.5 ~ 19.5
Timing chain lever "A" bolt	1	19.6 ~ 26.5	2.0 ~ 2.7	14.5 ~ 19.5
Timing chain auto tensioner "A" bolt	2	19.6 ~ 26.5	2.0 ~ 2.7	14.5 ~ 19.5
Timing chain guide "B" (1) bolt	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Timing chain guide "B" (2) bolt	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Timing chain auto tensioner "B" bolt	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Timing chain lower front cover bolt (8 x 22)	1	19.6 ~ 26.5	2.0 ~ 2.7	14.5 ~ 19.5
Timing chain lower front cover bolt (8 x 40)	1	19.6 ~ 26.5	2.0 ~ 2.7	14.5 ~ 19.5
Timing chain lower front cover bolt (8 x 50)	6	19.6 ~ 26.5	2.0 ~ 2.7	14.5 ~ 19.5
Timing chain lower front cover bolt (8 x 70)	6	19.6 ~ 26.5	2.0 ~ 2.7	14.5 ~ 19.5

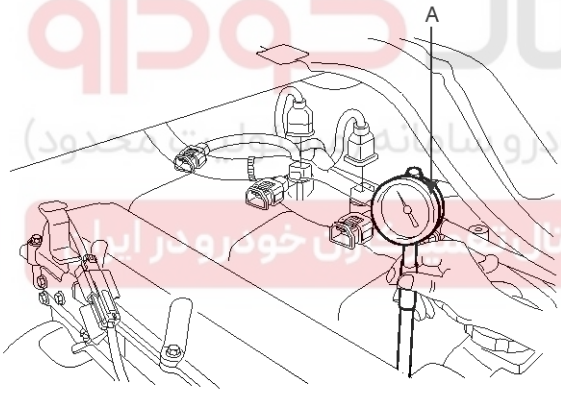
ITEM	Quantity	Tightening torque		
		N.m	kgf.m	lb-ft
Timing chain lower front cover bolt (8 x 80)	4	19.6 ~ 26.5	2.0 ~ 2.7	14.5 ~ 19.5
Timing chain upper front cover bolt (6 x 14)	4	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Timing chain upper front cover bolt (6 x 22)	9	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Timing chain upper front cover bolt (8 x 22)	1	19.6 ~ 26.5	2.0 ~ 2.7	14.5 ~ 19.5
Timing chain upper front cover bolt (8 x 40)	1	19.6 ~ 26.5	2.0 ~ 2.7	14.5 ~ 19.5
Timing chain upper under cover nut	1	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Timing chain guide "C" (1) bolt	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Timing chain guide "C" (2) bolt	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Timing chain lever "C" bolt	1	19.6 ~ 26.5	2.0 ~ 2.7	14.5 ~ 19.5
Timing chain auto tensioner "C" bolt	2	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
High pressure pump sprocket nut	1	64.7 ~ 74.5	6.6 ~ 7.6	47.7 ~ 55.0
Camshaft sprocket bolt	2	93.2 ~ 117.7	9.5 ~ 12	68.7 ~ 86.8
Timing chain upper front cover bolt	9	19.6 ~ 26.5	2.0 ~ 2.7	14.5 ~ 19.5
High pressure pump bracket bolt (8 x 35)	2	19.6 ~ 26.5	2.0 ~ 2.7	14.5 ~ 19.5
High pressure pump bracket bolt (8 x 38)	2	19.6 ~ 26.5	2.0 ~ 2.7	14.5 ~ 19.5
High pressure pump fixing nut	3	14.7 ~ 19.6	1.5 ~ 2.0	10.8 ~ 14.5
Common rail fixing bolt	3	14.7 ~ 21.6	1.5 ~ 2.2	10.8 ~ 15.9
Injector clamp bolt	4	27.5 ~ 33.3	2.8 ~ 3.4	20.3 ~ 24.6
High pressure pipe (pump to rail)	1	24.5 ~ 28.4	2.5 ~ 2.9	18.1 ~ 21.0
High pressure pipe (injector to rail)	4	24.5 ~ 28.4	2.5 ~ 2.9	18.1 ~ 21.0
Water pump pulley nut	4	9.8 ~ 11.8	1.0 ~ 1.2	7.2 ~ 8.7
Alternator bracket bolt (8 x 60)	2	18.6 ~ 27.5	1.9 ~ 2.8	13.7 ~ 20.3
Alternator bracket bolt (8 x 35)	2	18.6 ~ 27.5	1.9 ~ 2.8	13.7 ~ 20.3
Alternator fixing bolt nut (upper)	1	18.6 ~ 27.5	1.9 ~ 2.8	13.7 ~ 20.3
Alternator fixing bolt nut (lower)	1	18.6 ~ 27.5	1.9 ~ 2.8	13.7 ~ 20.3
Power steering pump bracket bolt (8 x 30)	1	19.6 ~ 26.5	2.0 ~ 2.7	14.5 ~ 19.5
Power steering pump bracket bolt (8 x 40)	3	19.6 ~ 26.5	2.0 ~ 2.7	14.5 ~ 19.5
Power steering pump bracket bolt (8 x 75)	2	19.6 ~ 26.5	2.0 ~ 2.7	14.5 ~ 19.5
Power steering pump fixing bolt (upper)	1	19.6 ~ 26.5	2.0 ~ 2.7	14.5 ~ 19.5
Power steering pump fixing bolt (lower)	1	19.6 ~ 26.5	2.0 ~ 2.7	14.5 ~ 19.5
Air conditioner compressor fixing bolt	4	19.6 ~ 26.5	2.0 ~ 2.7	14.5 ~ 19.5
Drive belt pulley fixing bolt	3	47.1 ~ 53.0	4.8 ~ 5.4	34.7 ~ 39.1
Drive belt auto tensioner fixing bolt	1	47.1 ~ 53.0	4.8 ~ 5.4	34.7 ~ 39.1
Starter fixing bolt	2	26.5 ~ 33.3	2.7 ~ 3.4	14.5 ~ 24.6

ITEM	Quantity	Tightening torque		
		N.m	kgf.m	lb-ft
Engine support bracket bolt	2	47.1 ~ 51.0	4.8 ~ 5.2	34.7 ~ 37.6

CHECKING COMPRESSION PRESSURE

1. Before checking engine compression, check the engine oil level. Also check that the starter motor and battery are all in normal operating condition.
2. Start the engine and wait until the engine coolant temperature reaches 80-95˚C (176-205˚F).
3. Turn "OFF" the engine and remove the aircleaner element.
4. Remove the Electric Control Unit(ECU) fuse.
5. Remove the injectors.
6. Crank the engine to remove any foreign material in the cylinders.
7. Insert the compression gauge (A) into the injector hole.
8. Crank the engine and read the gauge.

Standard value :
2942 kpa (30 kg/cm², 426 psi)



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9. Repeat steps 7 to 8 for all cylinders, ensuring that the pressure difference for each of the cylinders is within the specified limit.

Limit :
Max. 98.07 kpa (1.0 kg/cm², 14.22 psi) between cylinders

10. If a cylinder's compression or pressure differential is outside the specification, add a small amount of oil through the injector hole, and repeat steps 6 to 8.
    1) If the addition of oil causes the compression to rise, it is likely that there may be wear between the piston ring and cylinder wall.
    2) If compression remains the same, valve seizure, poor valve seating or a compression leak from the cylinder head gasket are all possible causes.

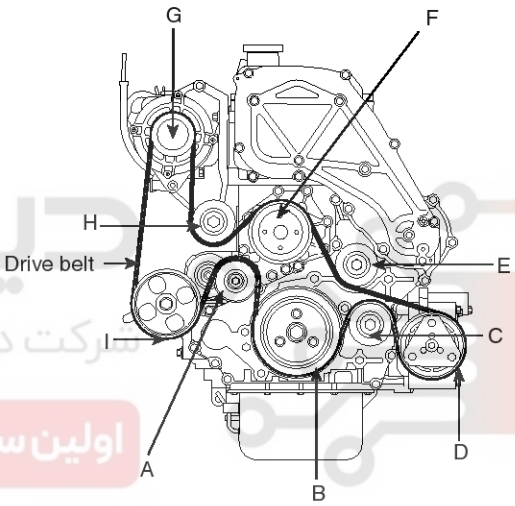
ADJUSTING DRIVE BELT AND TENSIONER

1. Check that the belts are not damaged and are properly placed for the pulley grooves.

⚠CAUTION

- **When installing the V-ribbed belt, check that the V-ribs are properly aligned.**
- **If noise or slippage is detected, check the belt for wear, damage, or breakage on the pulley contact surface, and check the pulley for scoring. Also check the amount that the belt is deflected.**

2. Install the belt in the following order.



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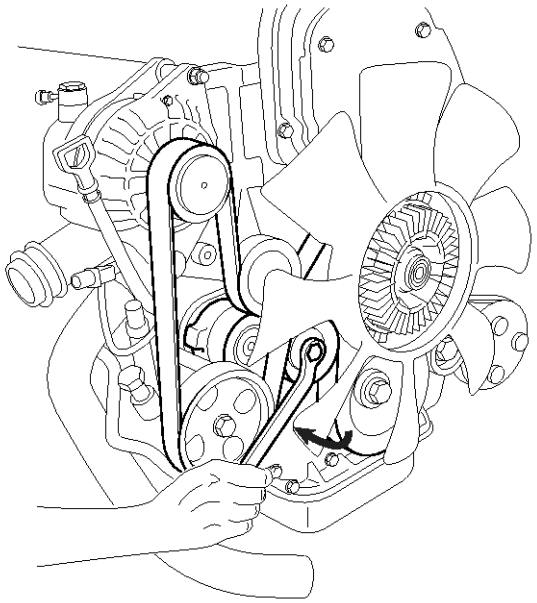
1. Install the belt in RH side of the auto-tensioner pulley.

   Auto-tensioner pulley(A) ⇒ Crankshaft pulley(B) ⇒ Idler(C) ⇒ Air conditioner compressor pulley (D) ⇒ Idler(E) ⇒ Water pump pulley(F)

2. Install the belt in LH side of the auto-tensioner pulley.

   Auto-tensioner pulley(A) ⇒ Power steering pump pulley(I) ⇒ Alternator pulley(G)

3. Loosen the belt tension by turning the auto-tensioner clockwise (about 39˚), and then install the belt on the idler between the alternator pulley and the water pump pulley.



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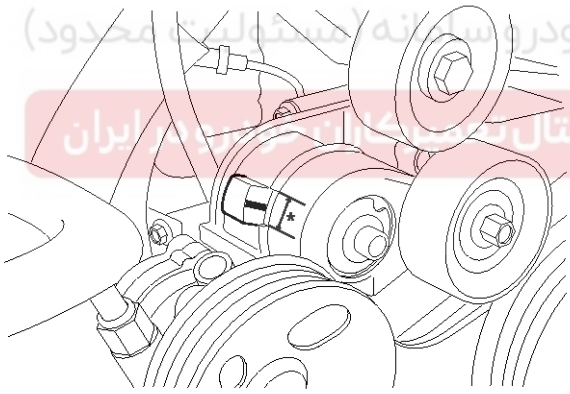
3. The tensioner mark should be between the " * " position.
   If not, replace the belt.



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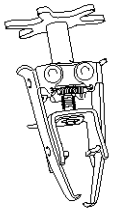
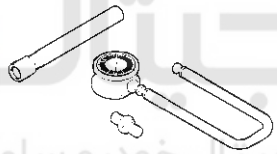
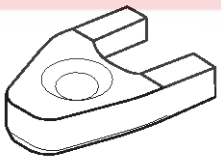
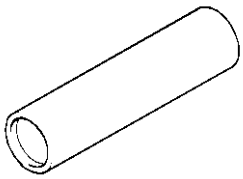
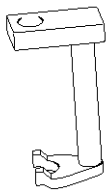
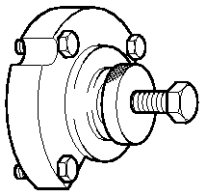
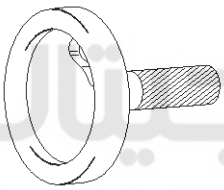
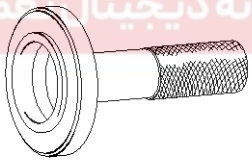
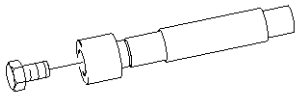
TROUBLESHOOTING

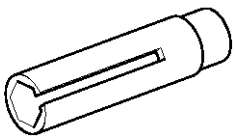
Symptom	Probable cause	Remedy
Low compression	Damaged cylinder head gasket	Replace gasket
	Worn or damaged piston rings	Replace rings
	Worn piston or cylinder	Repair or replace piston and/or cylinder block
	Worn or damaged valve seat	Repair or replace valve and/or seat ring
Oil pressure drop	Low engine oil level	Check engine oil level
	Faulty oil pressure switch	Replace
	Clogged oil filter	Replace
	Worn oil pump gears or cover	Replace
	Thin or diluted engine oil	Change and find out cause
	Oil relief valve stuck (open)	Repair
	Excessive bearing clearance	Replace
High oil pressure	Oil relief valve stuck (closed)	Repair
Excessive engine vibration	Loose engine mounting bolt	Retighten
	Loose transmission mounting bolt	Retighten
	Loose cross member bolt	Retighten
	Broken transmission mounting rubber	Replace
	Broken engine mounting rubber	Replace
Noisy valves	Thin or diluted engine oil (low oil pressure)	Change
	Worn or damaged valve stem or valve guide	Replace
Connecting rod and/main beaing noise	Insufficient oil supply	Check engine oil level
	Thin or diluted engine oil	Change and find out cause
	Excessive bearing clearance	Replace
Low coolant level	Leakage of coolant	
	Damaged radiator core joint	Replace
	Corroded or cracked hoses (radiator hose, heater hose, etc)	Replace
	Faulty radiator cap valve or setting of spring	Replace
	Faulty thermostat	Replace
	Faulty engine coolant pump	Replace
Clogged radiator	Foreign material in coolant	Replace

Symptom	Probable cause	Remedy
Abnormally high coolant temperature	Faulty thermostat	Replace
	Faulty radiator cap	Replace
	Restricted of flow in cooling system	Replace
	Loose or missing drive belt	Adjust or replace
	Faulty engine coolant pump	Replace
	Faulty temperature sensor wiring	Repair or replace
	Faulty electric fan	Repair or replace
	Faulty thermo-sensor on radiator	Replace
	Insufficient coolant	Refill coolant
Abnormally low coolant temperature	Faulty thermostat	Replace
	Faulty temperature sensor wiring	Repair or replace
Leakage from oil cooling system	Loose hose and pipe connection	Retighten
	Blocked or collapsed hose and pipe	Replace
Inoperative electrical cooling fan	Damaged, fuse	Replace or repair
Exhaust gas leakage	Loose connections	Retighten
	Broken pipe or muffler	Repair or replace
Abnormal noise	Detached baffle plate in muffler	Replace
	Broken rubber hanger	Replace
	Pipe or muffler contacting vehicle body	Correct
	Broken pipe or muffler	Repair or replace

SPECIAL TOOLS

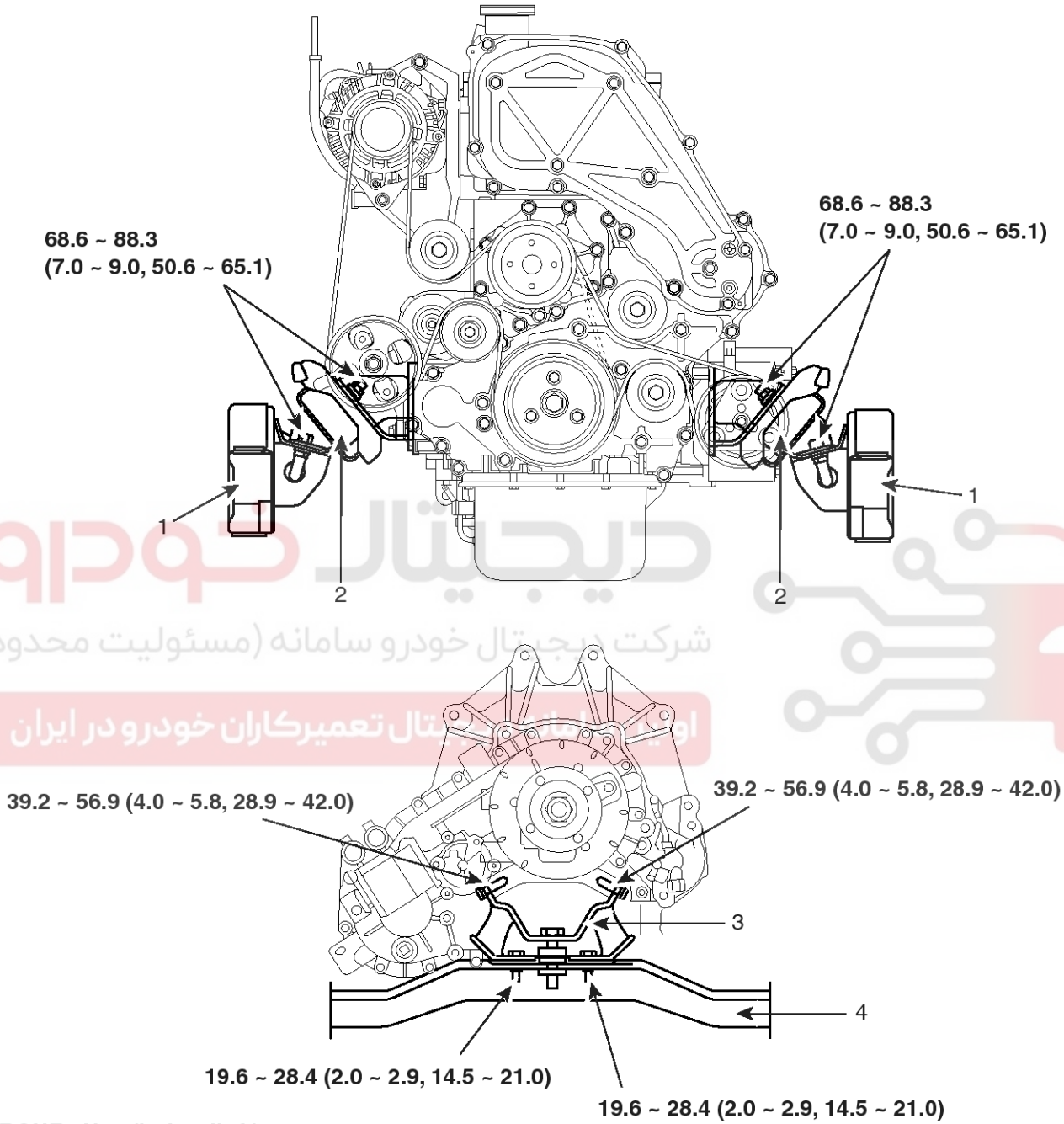
Tool (Number and Name)	Illustration	**Use**
Torque angle adapter (09221-4A000)		Installation of bolts & nuts needing an angular method
Valve spring compressor (09222-22100)		Removal and installation of intake and exhaust valves
Compression gauge & adapter (09351-27000) (09351-4A100)		Checking engine compression pressure
Compression gauge adapter clamp (09351-4A110)		Checking engine compression pressure
Valve stem seal installer (09222-4A000)		Installation of valve stem oil seals

Tool (Number and Name)	Illustration	**Use**
Injector remover (09351-4A000)		Removal of injectors
High pressure pump sprocket remover (09331-4A000)		Removal of high pressure pump sprockert
Crank shaft rear oil seal installer (09231-4A100)		Installation of crank shaft rear oil seals
Timing chain lower front cover oil seal installer (09214-4A000)		Installation of timing chain lower front cover oil seal
Balance shaft drive gear bearing (bush) installer/remover (09231-4A000)		Removal and installation of LH balance shaft drive gear bearing (bush)

Tool (Number and Name)	Illustration	**Use**
Water temperature sensor socket wrench (09221-25100)		Removal and installation of water temperature sensor

Engine And Transaxle Assembly

COMPONENTS



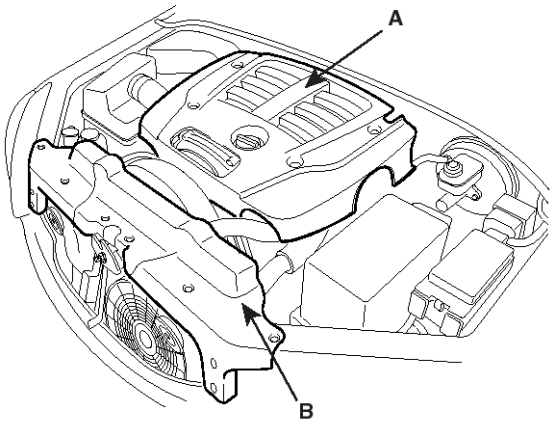
TORQUE : N.m (kgf.m, lb-ft)

1. Frame
2. Engine mounting
3. Transmission mounting
4. Cross member

SBLEM6010L

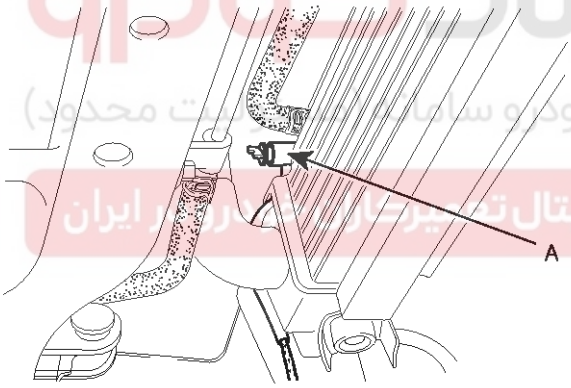
REMOVAL (A/T EQUIPPED VEHICLE)

1. Remove the engine hood.
2. Remove the engine cover(A) and seal board(B).



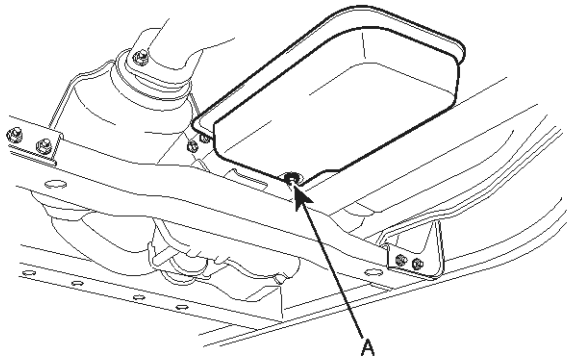
ACAF032A

3. Drain the engine coolant after removing drain plug(A).
   Remove the radiator cap to speed draing.



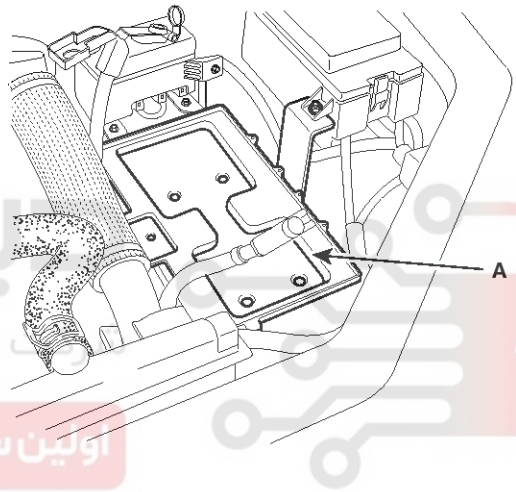
ACAF033A

4. Remove the transmission oil drain plug(A).



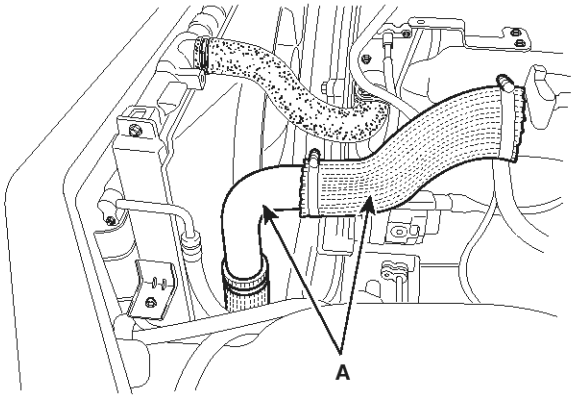
ACAF034A

5. Remove the battery and battery tray(A).



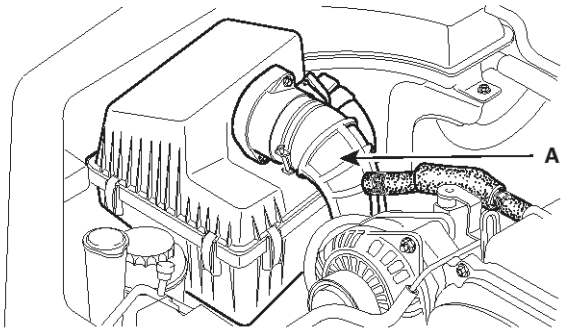
ACAF035A

6. Remove the inter cooler hose and pipe on the intake manifold side(A).



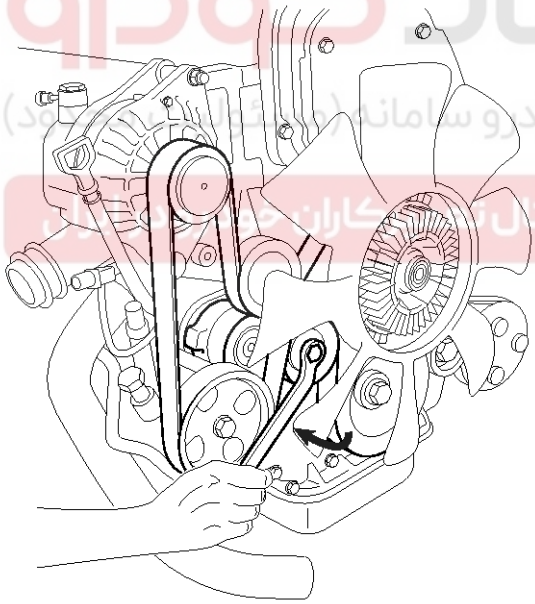
ACAF036A

7. Disconnect the air cleaner hose(A).



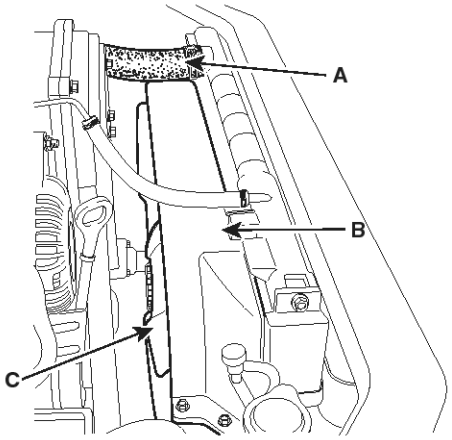
ACAF037A

8. Disconnect the engine coolant reservoir tank hose and the heater hose.
9. Remove the inter cooler hose on the turbo charger side.
10. Loosen the drive belt tension by turning auto-tensioner with spanner, and then remove the drive belt.



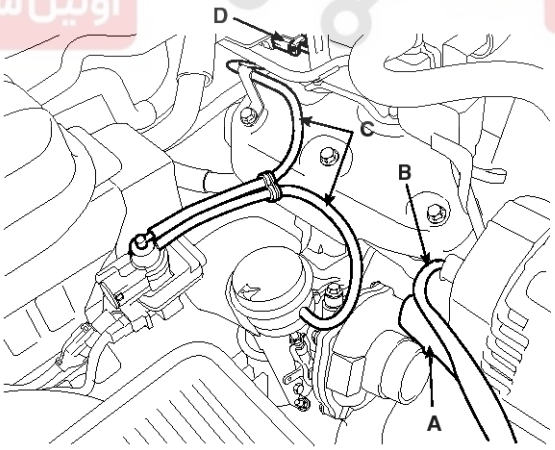
KDSE222A

11. Disconnect the radiator upper hose(A) and lower hose.
12. Remove the radiator cowl upper cover(B).



ACAF039A

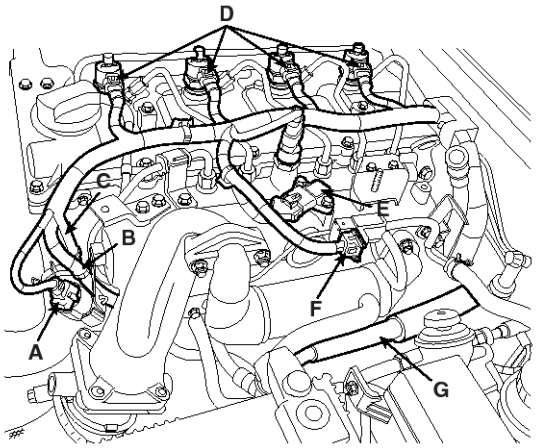
13. Remove the cooling fan(C).
14. Remove the radiator cowl lower cover.
15. Remove the fixing bolt of air-con condenser and ATF oil cooler bracket from the radiator assembly.
16. Disconnect the ATF oil hoses.
17. Remove the radiator assembly from engine room, after remove the radiator assembly bracket fixing nut.
18. Drain the power steering oil.
19. Disconnect the power steering pump hose and pipe.
20. Disconnect the alternator "B" terminal(A) and connector(B).
21. Remove the vacuum hose(C).



ACAF025A

22. Disconnect the earth terminal and the glow plug connector(D).
23. Disconnect the water temperature sensor connector.
24. Disconnect the high pressure connector(B).
25. Disconnect the TDC sendor connector(C).
26. Disconnect the inject connector(D).

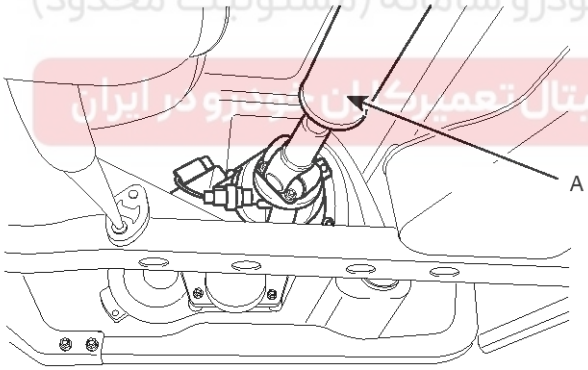
27. Disconnect the map sensor connector(E).
28. Disconnect the thorought flat funtion valve connector(F).
29. Remove the EGR cooler water hose(G).



ACAF026A

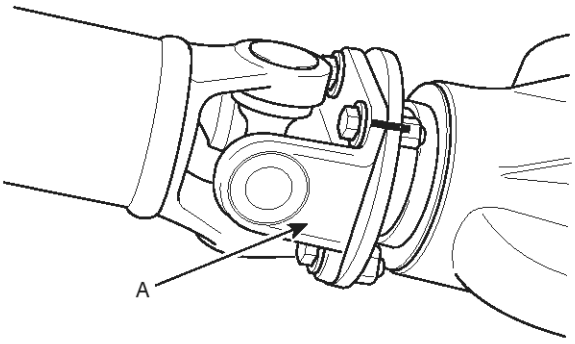
30. Remove the fuel hose from the high pressure pump.
31. Disconnect the earth terminal from the cylinder block.
32. Remove the transmission oil level gauge pipe.
33. Remove the rear propeller shaft(A).

■ Front side



SBLEM6031L

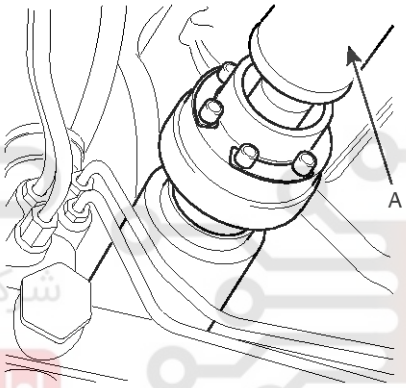
■ Rear side



SBLEM6032L

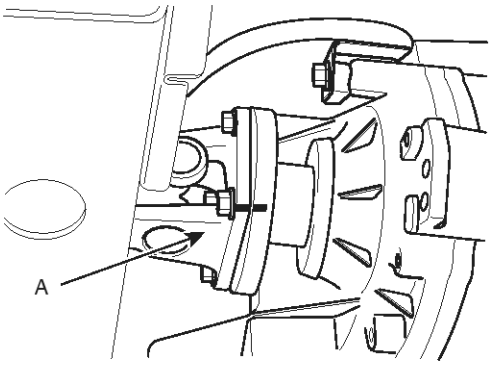
34. Remove the front propeller shaft(A).

■ Front side



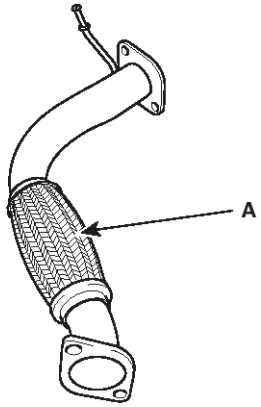
SBLEM6033L

■ Rear side

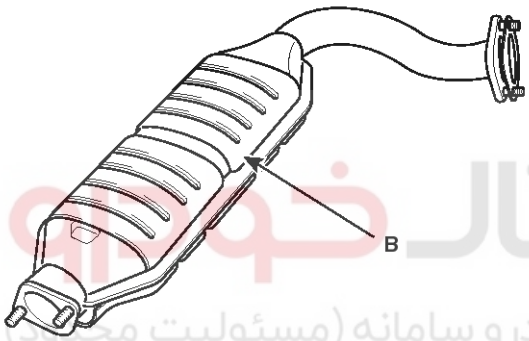


SBLEM6034L

35. Remove the front exhaust pipe(A) and muffler(B).

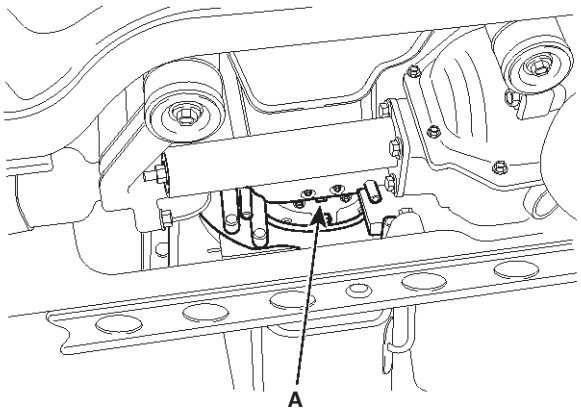


ACAF045A



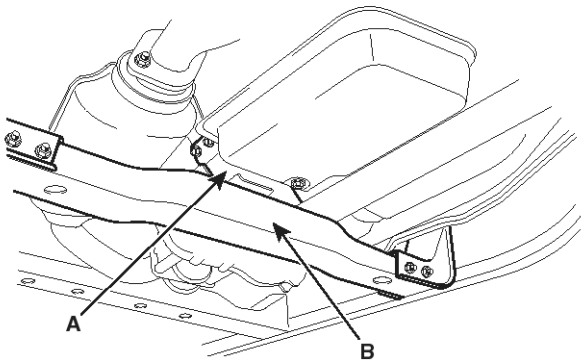
ACAF046A

36. Remove the shift cable from the transmission.
37. Disconnect the connectors from the transmission.(See TR group)
38. Remove the transmission oil pipes.
39. Remove the drive plate-to-torque converter fixing bolts (6EA), after remove the bell housing cover. Rotate crank shaft pulley to gain access to all bolts.



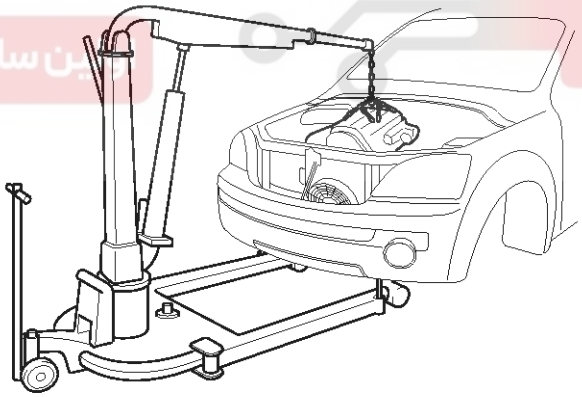
ACAF047A

40. Remove the starter.
41. Remove the transmission housing fixing bolts.
42. Remove the transmission mounting(A) and the cross member(B) after support the transmission by using a jack.



ACAF048A

43. Remove the transmission from the vehicle.
44. Remove the engine mounting.
45. Remove the engine assembly from engine room, by using a engine crane.

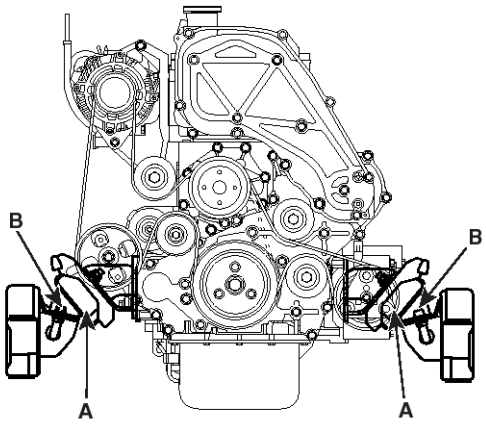


ACAF049A

INSTALLATION (A/T EQUIPPED VEHICLE)

1. Install the engine assembly to engine room, by using a engine crane.
2. Install the engine mounting(A).

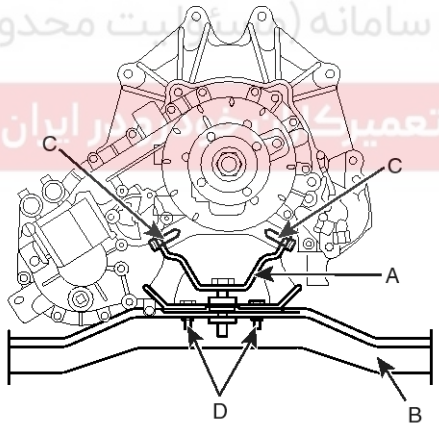
Tightening torque
68.6-88.3 N.m (7.0- 9.0 kgf.m, 50.6-65.1 lb-ft)



ACAF050A

3. Install the transmission to the vehicle by using a jack.
4. Install the transmission mounting(A) and the cross member(B).

Tightening torque
Transmission to Mounting:
39.2-56.9 N.m(4.0- 5.8 kgf.m, 28.9-42.0 lb-ft)
Mounting to Cross member :
19.6-28.4 N.m(2.0-2.9 kgf.m, 14.5-21.0 lb-ft)
Cross member to Frame :



ACAF051A

5. Install the transmission housing fixing bolts.
6. Install the starter.

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

7. Install the drive plate-to-torque converter fixing bolts (6EA). Rotate crank shaft pulley to gain access to all bolts.
8. Install the bell housing cover.

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

9. Install the transmission oil pipe.
10. Reconnect the connectors (8EA) to the transmission.
11. Install the shift cable to the transmission.
12. Install the front exhaust pipe and muffler.

Tightening torque
42.2-60.8 N.m(4.3-6.2 kgf.m, 31.1-44.8 lb-ft)

13. Install the front propeller shaft.

Tightening torque
Part time 4WD :
26.5·29.4 N.m (2.6-3.0 kgf.m, 18.8-21.7 lb-ft)
Full time 4WD :
49.0-58.8 N.m (5.0-6.0 kgf.m, 36.2-43.4 lb-ft)

14. Install the rear propeller shaft.

Tightening torque
49.0-58.8 N.m (5.0-6.0 kgf.m, 36.2-43.4 lb-ft)

15. Install the transmission oil level gauge pipe.
16. Install the earth terminal to the cylinder block.
17. Reconnect the vacuum hoses to the EGR valve and intake manifold.
18. Reconnect the fuel hose to the high pressure pump.
19. Reconnect the injector, TDC sensor, water temperature sensor and starter connector.
20. Install the air conditioner compressor to the cylinder block.

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

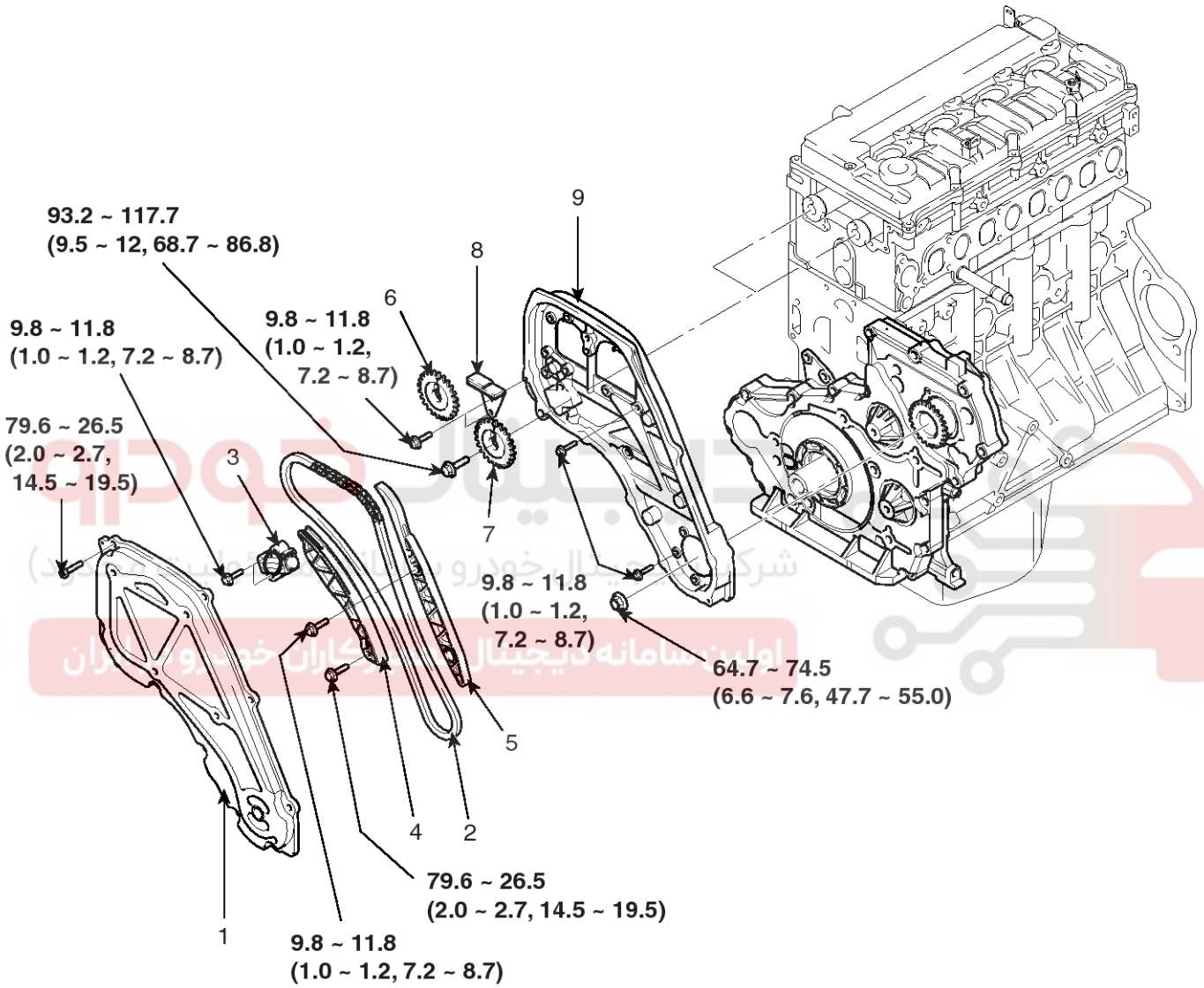
21. To install all of parts, follow the removal procedures in the reverse order.
22. Refill the transmission oil and the power steering oil and then check for leaks.
23. Refill the engine coolant and then check for leaks.

Timing System

Timing System

Timing Chain

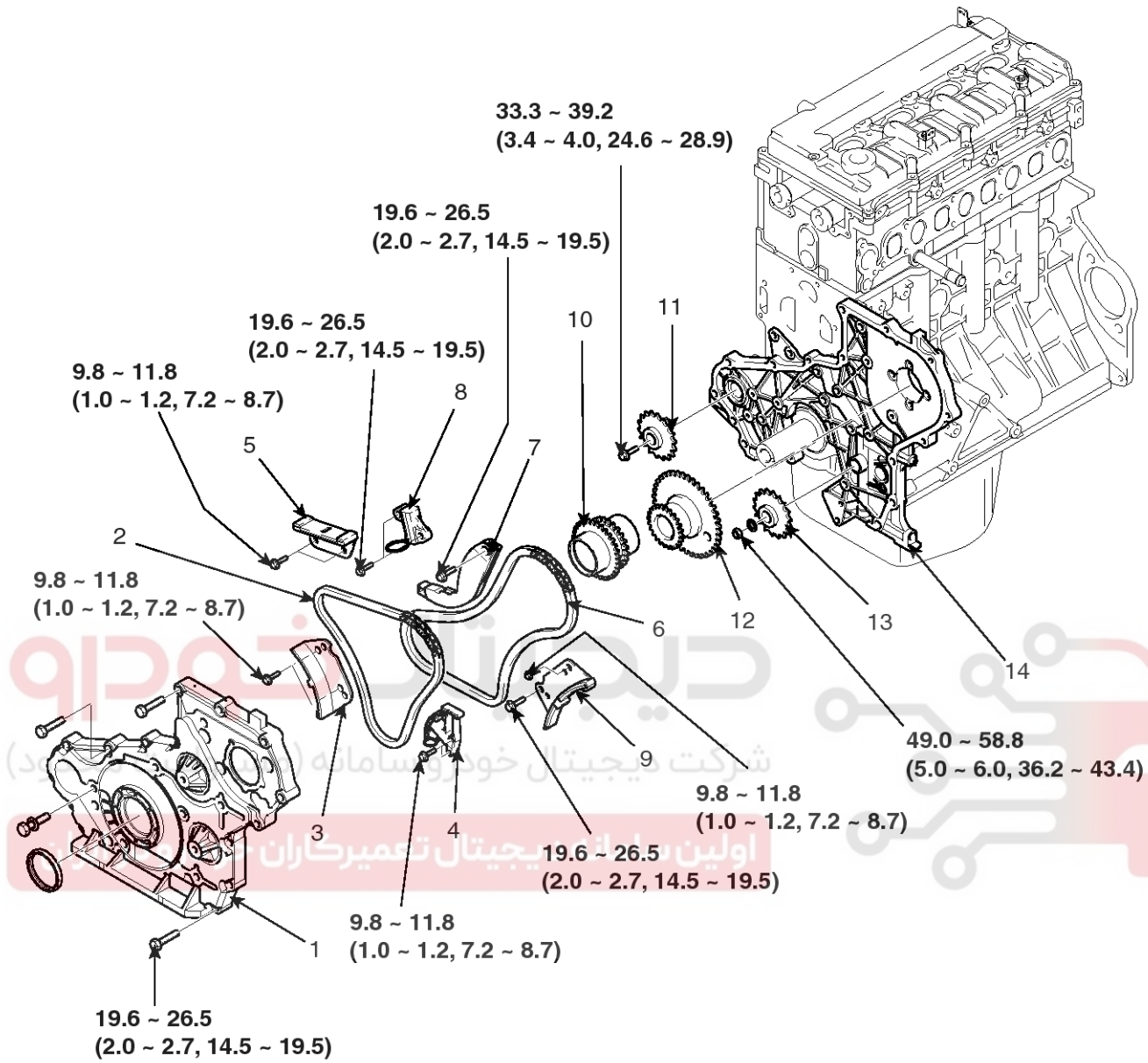
COMPONENTS



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

1. Timing chain upper front cover
2. Timing chain "C"
3. Auto-tensioner "C"
4. Lever "C"
5. Guide "C"
6. RH Camshaft sprocket
7. LH Camshaft sprocket
8. Guide "C2"
9. Timing chain upper under cover

SBLEM6012L



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

1. Timing chain lower front cover
2. Timing chain "B"
3. Guide "B2"
4. Auto tensioner "B"
5. Guide "B1"
6. Timing chain "A"
7. Lever "A"
8. Auto tensioner "A"
9. Guide "A"
10. Crankshaft sprocket
11. RH Balance shaft sprocket
12. High pressure pump sprocket
13. LH Balance shaft sprocket
14. Timing chain lower under cover

SBLEM6011L

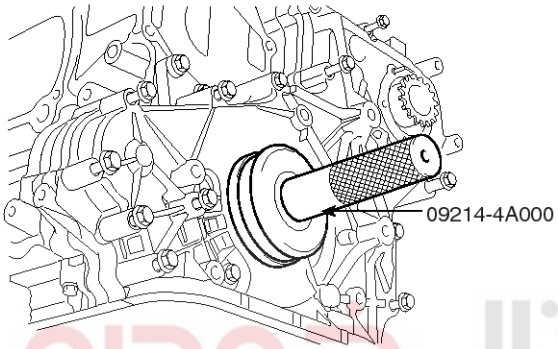
REPLACEMENT

TIMING CHAIN LOWER FRONT COVER OIL SEAL

1. With the timing chain lower front cover oil seal installed, install the oil seal using the special tool (09214-4A000).

NOTICE

Apply engine fluid to the circumference of oil seal lip.

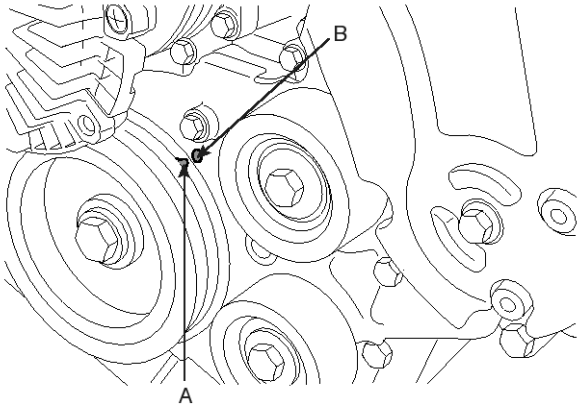


LCAC338A

DISASSEMBLY

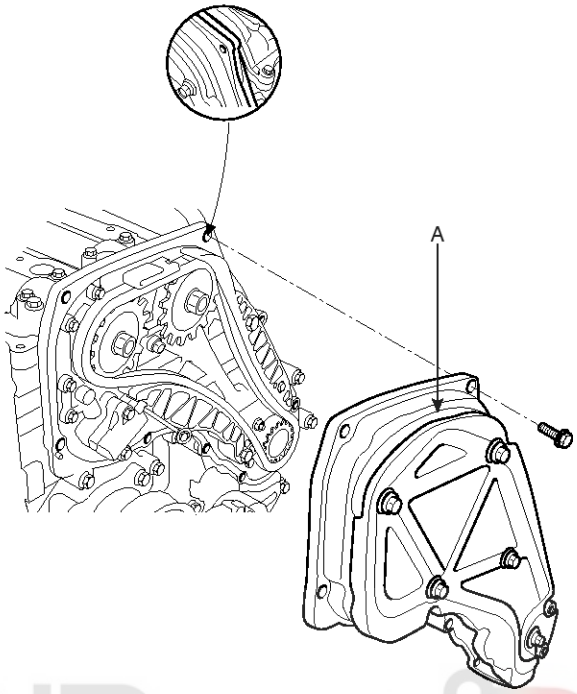
TIMING CHAIN "C"

1. Rotate the crankshaft pulley to align the timing mark(A) with TDC(B), in which No.1 piston locates at the top dead center of compression stroke.



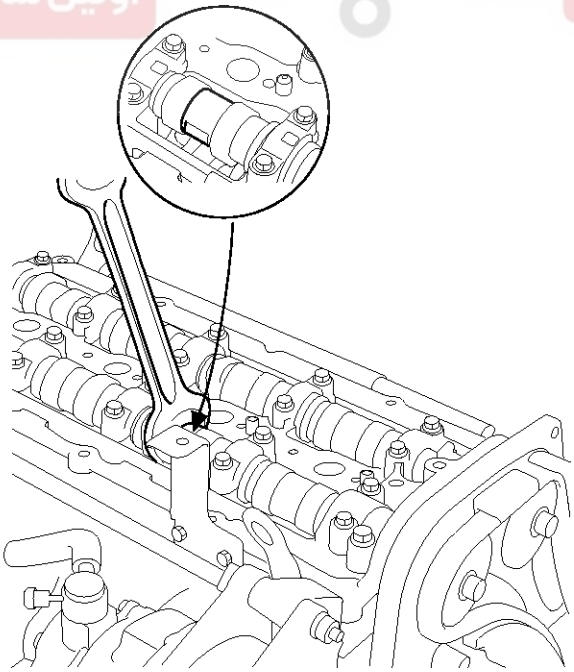
KDSE220A

2. Remove the timing chain upper front cover(A).



KDSE106A

3. Remove the cylinder head cover.
4. Holding the slot of the camshaft with the spanner, loosen the bolts for the high-pressure pump sprocket and camshaft sprocket.



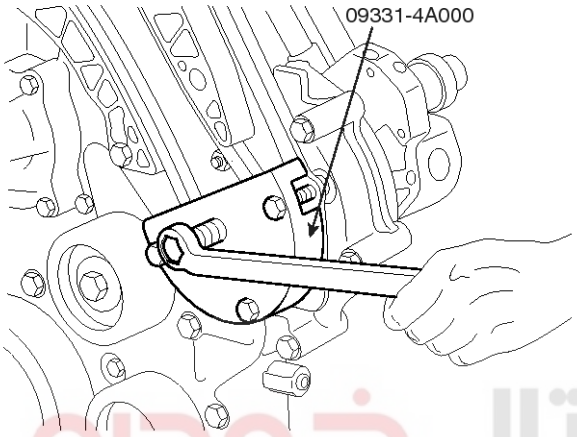
KDSE103A

5. Insert the SST(09311-4A00) into timing chain upper cover.

   And then remove the high pressure pump and sprocket.

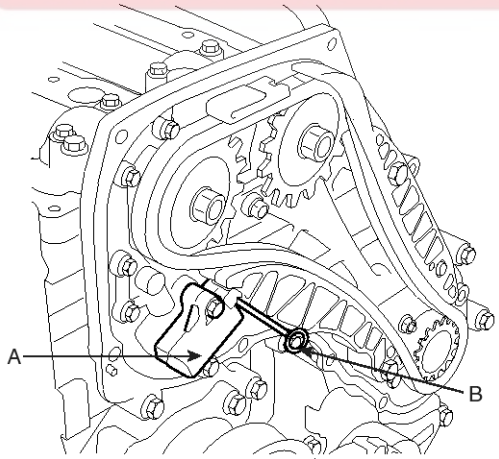
   NOTICE

   Loosen the high pressure pump fixing bolts first working.



KDSE228A

6. Remove the timing chain auto-tensioner "C"(A).

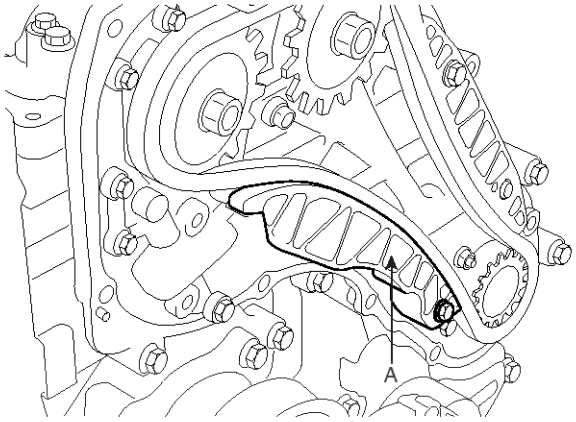


KDSE107A

NOTICE

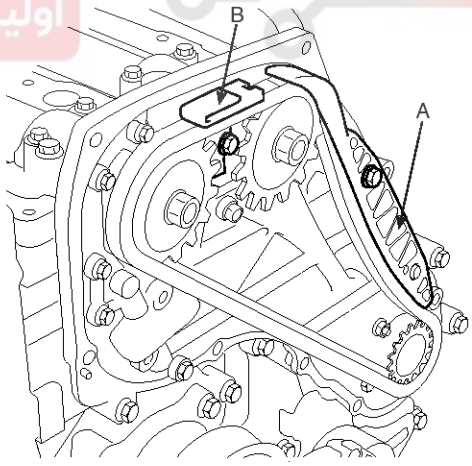
Before removing auto-tensioner "C", install a set pin(B) (Ø2.5mm steel wire) after compressing the tensioner so that inner parts are not missing during disassembly.

7. Remove the timing chain lever "C"(A).



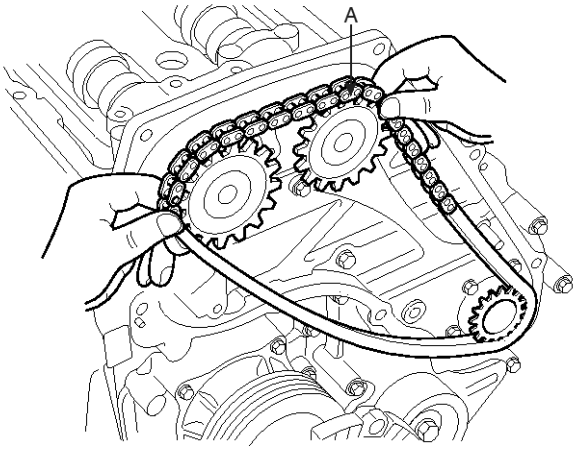
KDSE202A

8. Remove the timing chain guide "C(1)(A), C(2)(B)".



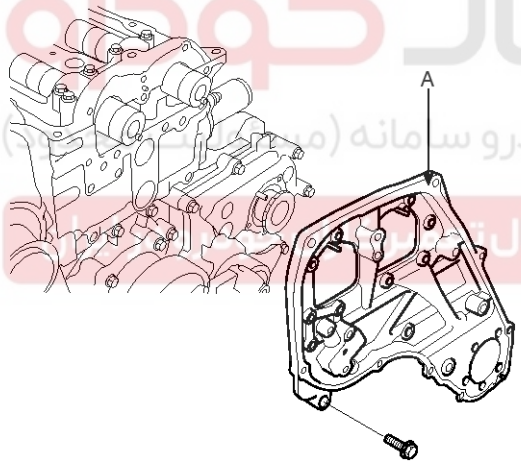
KDSE201A

9. Remove the LH and RH camshaft sprocket bolts.
10. Remove the timing chain "C"(A) with the camshaft sprocket.



KDSE121A

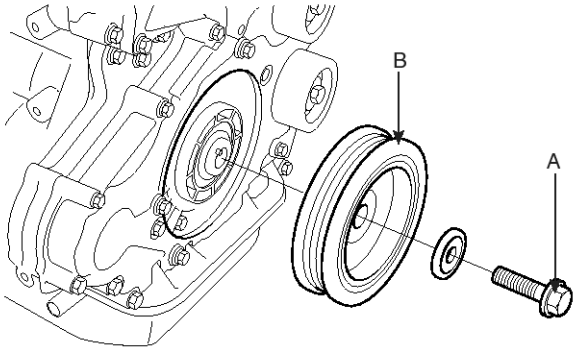
11. Remove the timing chain upper under cover(A).



KDSE104A

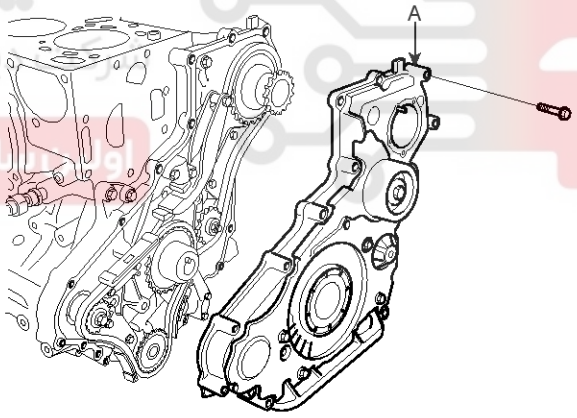
TIMING CHAIN "B"

1. Remove the timing chain "C".
2. Remove the crankshaft pulley(B).



KDSE141A

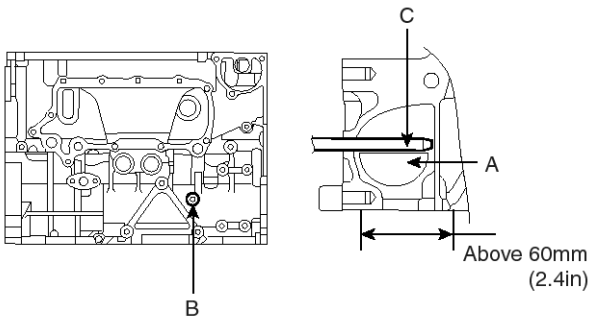
3. Remove the oil pan.
4. Remove the timing chain lower front cover(A).



KDSE152A

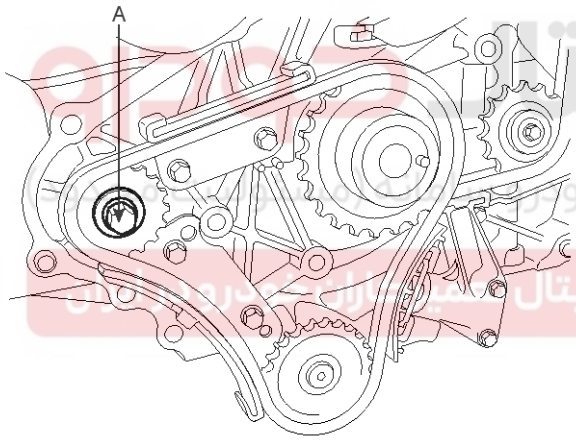
5. To prevent the rotation of RH balance shaft(A), remove the plug(B) at the side of cylinder block and insert the screwdriver(C) (or bolt) with an 8 mm(0.32in) diameter into the plughole more than 60 mm (2.4in).

■ RH side



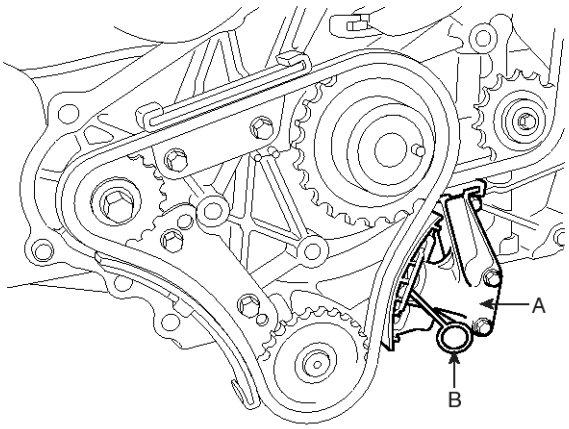
SBLEM6035L

6. Loosen the RH balance shaft sprocket bolt(A).



KDSE191A

7. Remove the timing chain auto-tensioner "B"(A).

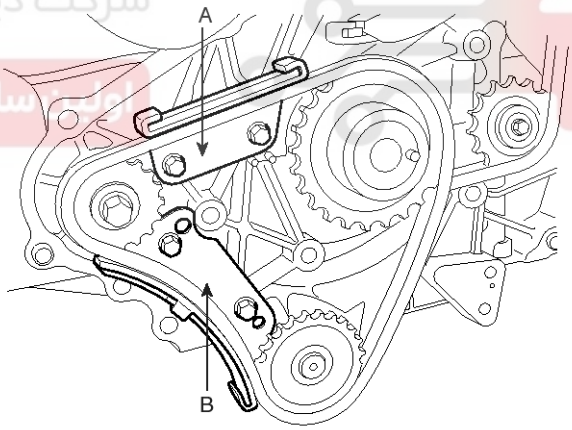


KDSE193A

NOTICE

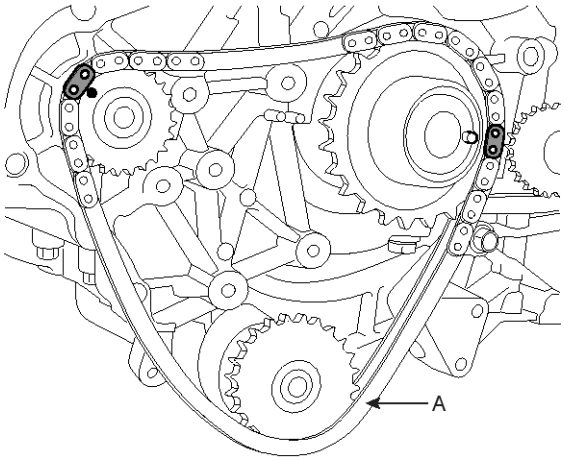
Before removing auto-tensioner "B", install a set pin (Ø2.5mm wire) after compressing the tensioner.

8. Remove the timing chain guide "B(1)(A), B(2)(B)".



KDSE192A

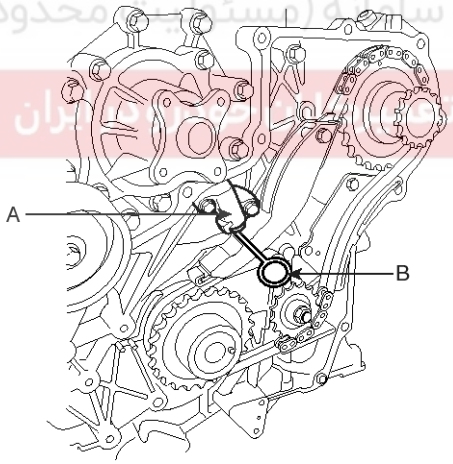
9. Remove the RH balance shaft sprocket bolt.
10. Remove the timing chain "B"(A) with the RH balance shaft sprocket.



KDSE190A

TIMING CHAIN "A"

1. Remove the timing chain "C" and "B".
2. Loosen the high-pressure pump sprocket.
3. Remove the timing chain auto-tensioner "A"(A).

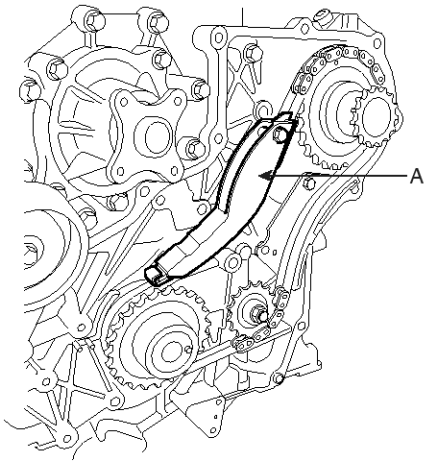


KDSE188A

NOTICE

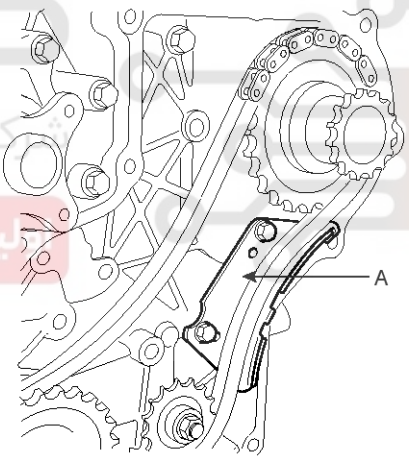
Before removing auto-tensioner "A", install a set pin (Ø2.5mm wire) after compressing the tensioner.

4. Remove the timing chain lever "A"(A).



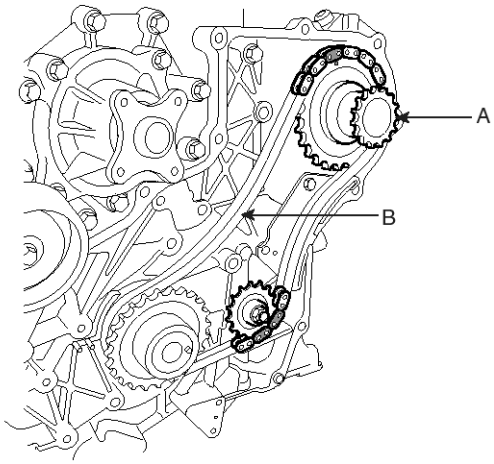
KDSE187A

5. Remove the timing chain guide "A"(A).



KDSE186A

6. Remove the timing chain "A"(B) with the high-pressure pump sprocket(A).



KDSE184A

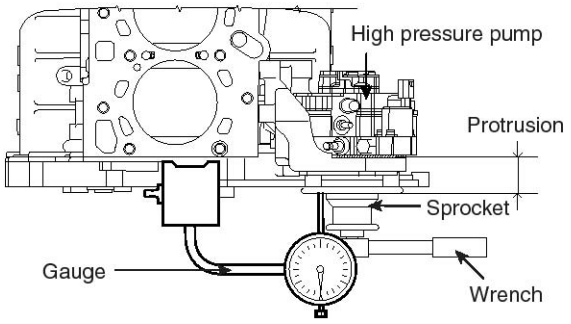
⚠CAUTION

Remove thoroughly sealant and oil etc left at the sealing surface after remove the chain cover and oil pan. (If any impurities are left at the sealing face, oil may leak after reassembly even with the sealant application.)

REASSEMBLY

TIMING CHAIN "A"

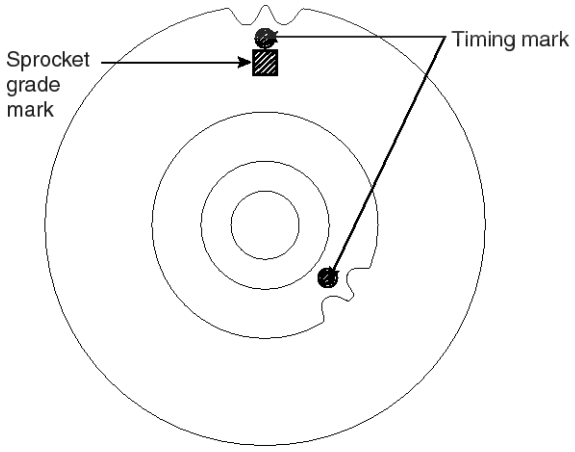
1. Check the worn of timing chain, lever, guide and sprocket and replace them if necessary.
2. Choose proper high pressure pump sprocket after measuring protrusion of sprocket
   a. Assemble a high-pressure pump sprocket (Grade A) tentatively to high-pressure pump.
   b. Install a gauge to the cylinder block as shown illustration. And then turn the high pressure pump sprocket once by using a wrench.



SBLEM6036L

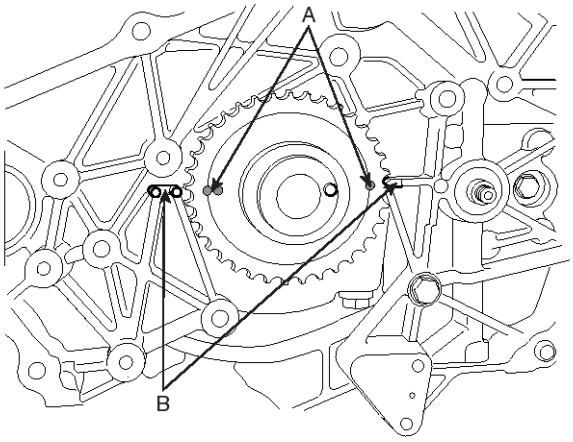
   c. Choose proper sprocket grade according to average of maximum and minimum value of gauge.

Grade	Color	Protrusion (mm(in))
A	Blue	34.2-35.0 (1.3465-1.3780)
B	White	33.4-34.2 (1.3150-1.3465)
C	Red	35.0-35.8 (1.3780-1.4094)



SBLEM6037L

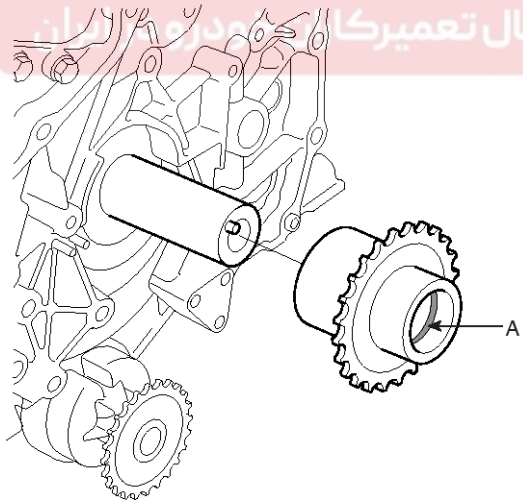
3. Install the crankshaft sprocket as the timing mark of crankshaft sprocket aligns with the timing mark(A) of lower under cover(B), at which No.1 piston locates at the top dead center of compression stroke.



KDSE180A

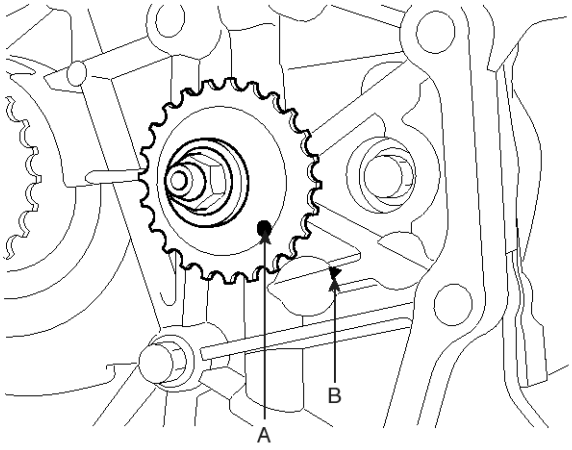
NOTICE

In installing crankshaft sprocket, apply oil to the O ring inside the sprocket.



KDSE181A

4. Align the timing mark of LH balance sprocket(A) with the timing mark of timing chain lower under cover(B).



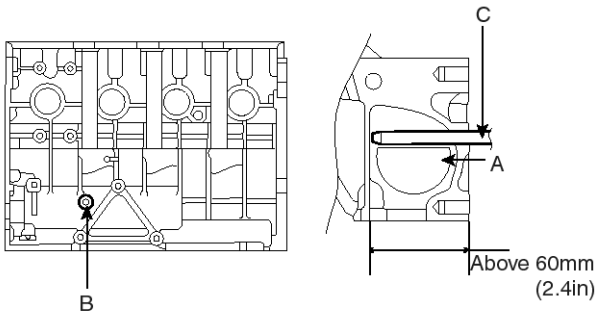
KDSE182A

5. Check the LH balance shaft(A) whether it is located at the right position. To prevent the rotation of balance shaft, remove plug(B) at the side of cylinderblock. Insert screwdriver(C) (or bolt) with an 8 mm (0.32in) diameter into the plughole and check whether it slides more than 60 mm(2.4in).

NOTICE

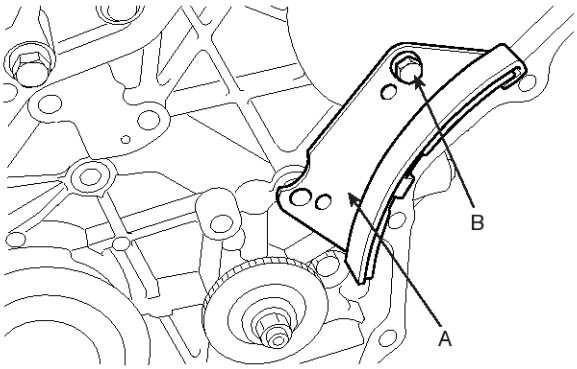
When the screwdriver (or bolt) depth is about 25-30mm(1-1.2in), rotate LH balance shaft sprocket 1 revolution. And insert the screwdriver (or bolt) again to check whether it slides more than 60mm(2.4in).

■ **LH side**



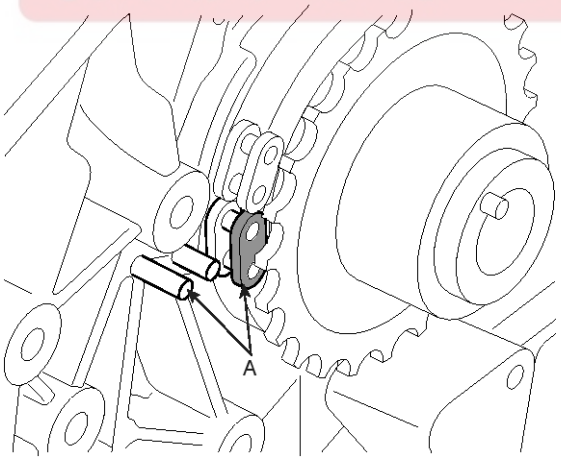
SBLEM6038L

6. Assemble the upper bolt of timing chain guide "A"(A) tentatively.

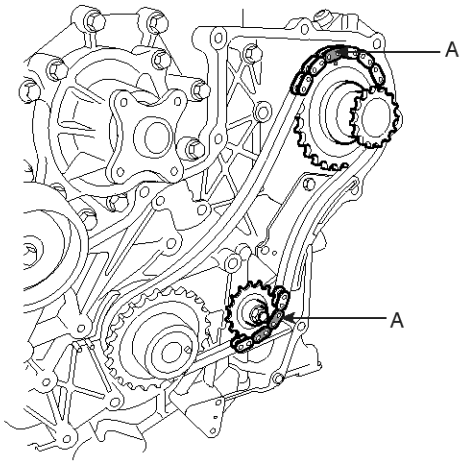


KDSE183A

7. Align the timing marks of sprocket and chain when high-pressure pump sprocket is not installed to pump.
8. Using the chain connected to the high-pressure pump sprocket, install as the timing marks of LH balance shaft sprocket(A) and crankshaft sprocket align with each other.



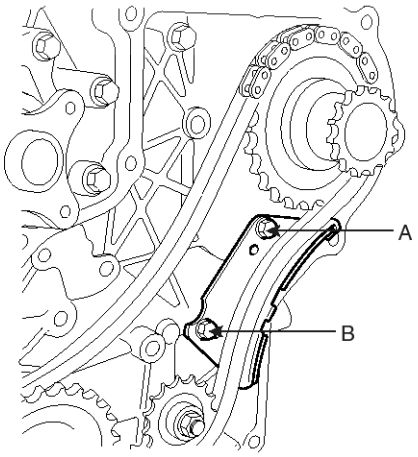
KDSE185A



KDSE184B

9. Assemble the high-pressure pump sprocket to the high-pressure pump tentatively.
10. Install the other bolt of the timing chain guide "A" at the lower side and tighten it.

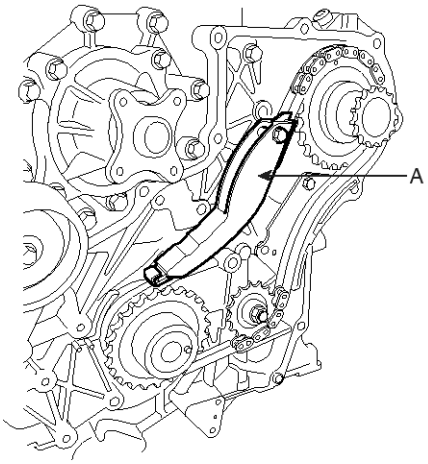
Tightening torque :
Upper bolt(A) :
9.8-11.8 N.m(1.0-1.2 kgf.m, 7.2-8.7 lb-ft)
Lower bolt(B) :
19.6-26.5N.m(2.0-2.7 kgf.m, 14.5-19.5 lb-ft)



KDSE186B

11. Install the timing chain lever "A"(A).

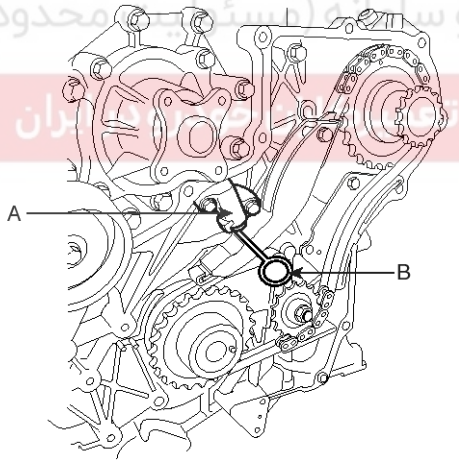
Tightening torque :
19.6-26.5 N.m(2.0-2.7 kgf.m, 14.5-19.5 lb-ft)



KDSE187A

12. Install the timing chain auto-tensioner "A"(A), and remove a set pin(B) from the auto-tensioner.

Tightening torque :
19.6-26.5 N.m(2.0-2.7 kgf.m, 14.5-19.5 lb-ft)

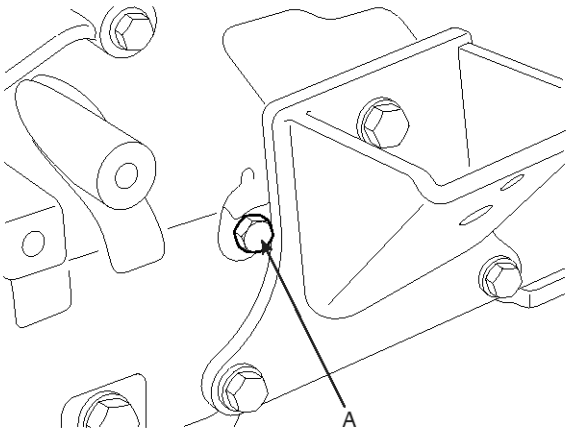


KDSE188A

NOTICE
After assembling timing chain, check whether chain is assembled within the rail at both sides.

13. Remove the screwdriver (or bolt) from the plughole and install the plug(A).

Tightening torque :
14.7-21.6 N.m(1.5-2.2 kgf.m, 10.8-15.9 lb-ft)

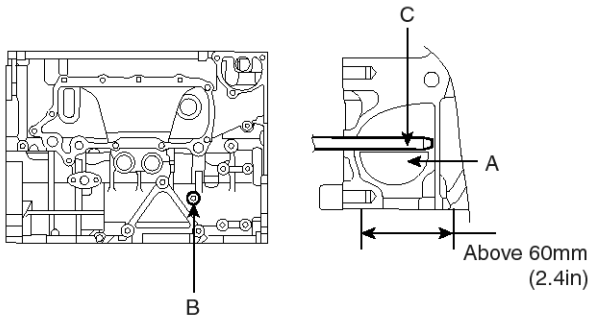


KDSE189A

TIMING CHAIN "B"

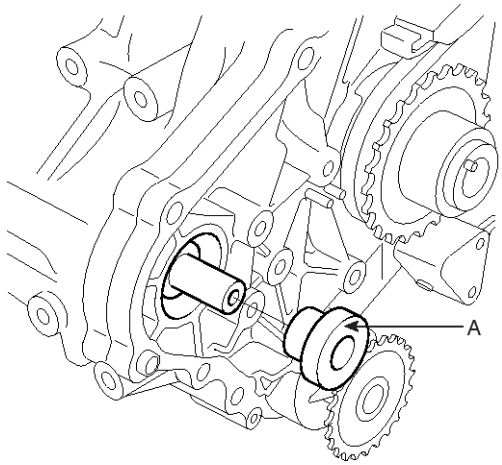
1. Check the worn of timing chain, lever, guide and sprocket and replace them if necessary.
2. Install the timing chain "A".
3. Check the RH balance shaft(A) whether it is located at the right position. To prevent the rotation of balance shaft, insertthe screwdriver(C) (or bolt) intothe plughole(B) at the side of cylinder block and check whether it slides more than 60 mm(2.4in).

■ **RH side**



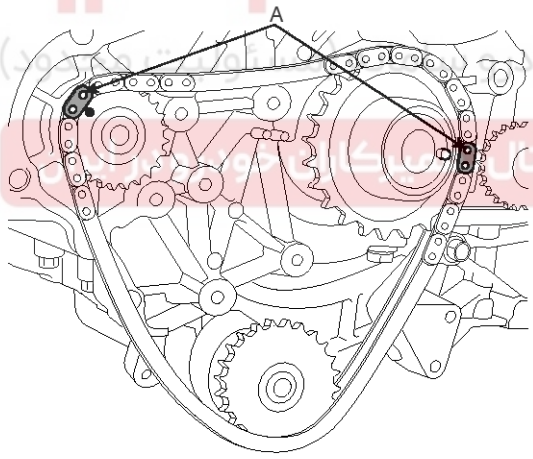
SBLEM6035L

4. Install the space washer(A) from RH balance shaft.



KDSE153A

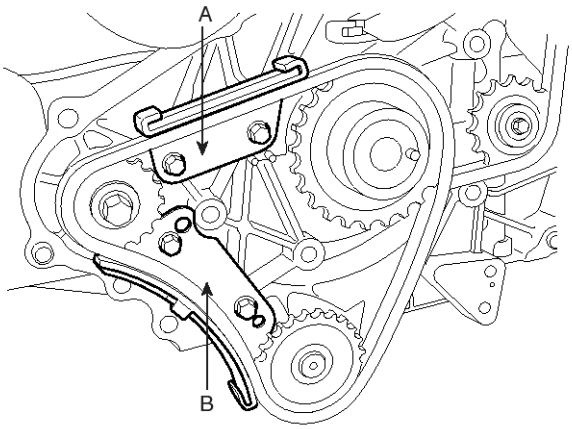
5. Using the chain connected to RH balance shaft sprocket, install as the timing marks(A) of crankshaft sprocket and oil pump sprocket align with each other.



KDSE190Z

6. Assemble the RH balance shaft sprocket to the balance shaft tentatively.
7. Install the timing chain guide "B(1)(A), B(2)(B)".

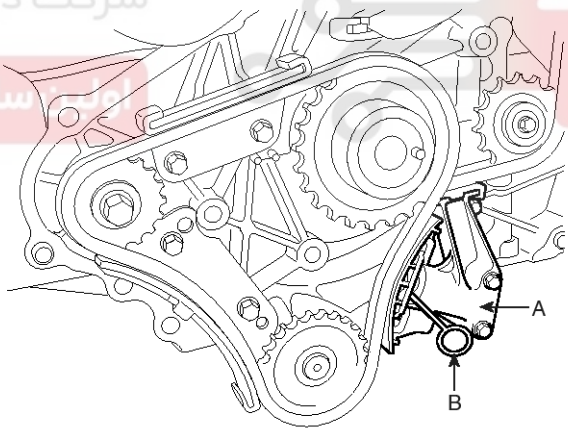
Tightening torque :
9.8-11.8 N.m(1.0-1.2 kgf.m, 7.2-8.7 lb-ft)



KDSE192A

8. Install the timing chain auto-tensioner "B"(A), and remove the set pin(B) from the auto-tensioner.

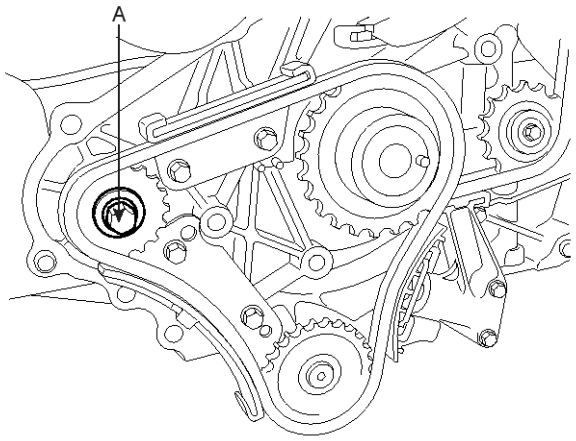
Tightening torque :
9.8-11.8 N.m(1.0-1.2 kgf.m, 7.2-8.7 lb-ft)



KDSE193A

9. Assemble the RH balance shaft sprocket bolt(A).

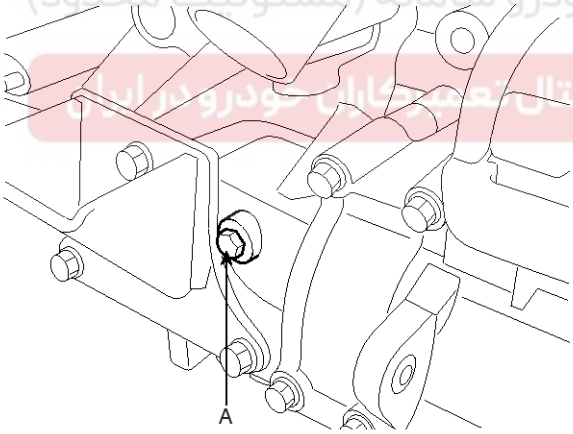
Tightening torque :
33.3-39.2 N.m(3.4-4.0 kgf.m, 24.6-28.9 lb-ft)



KDSE191A

10. Remove the screwdriver (or bolt) from the plughole(A) and install the plug.

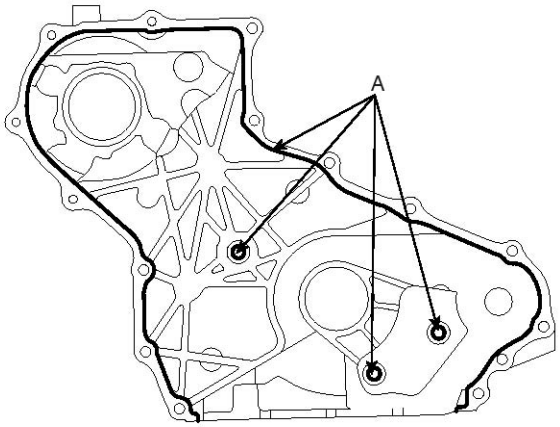
Tightening torque :
14.7-21.6 N.m(1.5-2.2 kgf.m, 10.8-15.9 lb-ft)



KDSE194A

11. Apply the sealant(A) at the timing chain lower front cover.

Sealant type : Lotite #5902
Bead width : 2-4 mm(0.08-0.16 in)

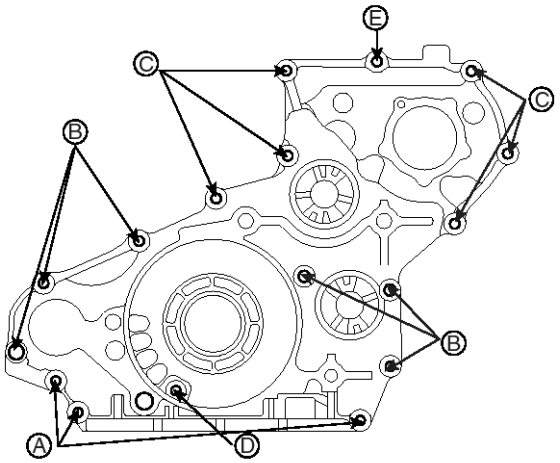


ACAE336C

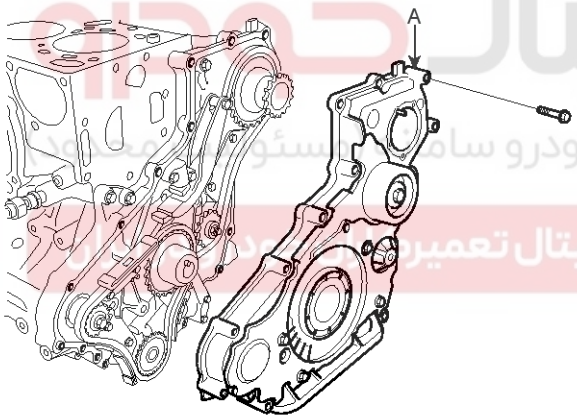
12. Install the timing chain lower front cover(A).

Bolt	Size	Quantity	Tightening torque N-m (kg-m, lb-ft)
A	8 x 80	4 EA	9.8-11.8 (1.0-1.2, 14.5-19.5)
B	8 x 70	1 EA	19.6-26.5 (2.0-2.7, 14.5-19.5)
C	8 x 50	3 EA	19.6-26.5 (2.0-2.7, 14.5-19.5)
D	8 x 40	1 EA	19.6-26.5 (2.0-2.7, 14.5-19.5)
E	8 x 22	1 EA	19.6-26.5 (2.0-2.7, 14.5-19.5)

* Bolt Size = Diameter x Length



ACAE336D



KDSE152A

13. Install the oil pan.

⚠CAUTION

Then apply the sealant additionally to prevent the oil leak to the overlapping part (T-joint: 4 points right and left ofthe engine), where bed plate, timing chain lower under cover, timing chain lower front cover and oil pan overlap.

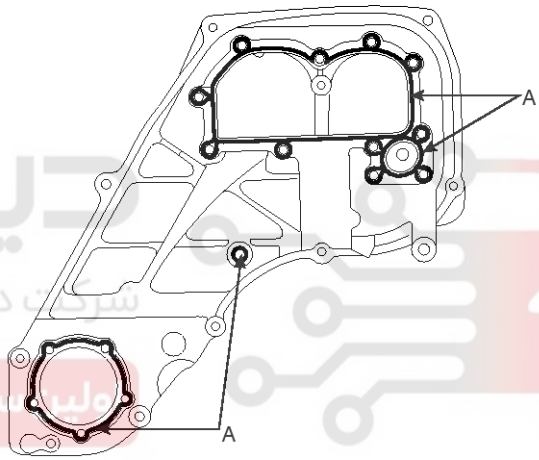
TIMING CHAIN "C"

1. Check the worn of the timing chain, lever, guide and sprocket and replace them if necessary.
2. Install the timing chain "A" and "B".
3. Apply the sealant(A) at the timing chain upper under cover.

Sealant type : Lotite #5902
Bead width : 2-4 mm (0.08-0.16 in)

⚠CAUTION

Then apply the sealant additionally to prevent the oil leak to the overlapping part (T-joint : 2 points right and left of the engine), where cylinder head, timing chain cover plate and timing chain upper under cover overlap.

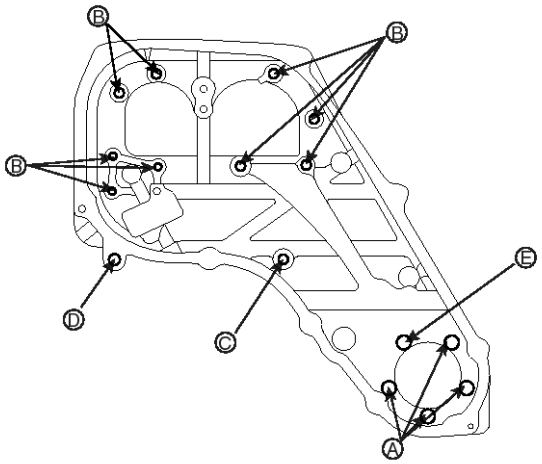


ACAE337A

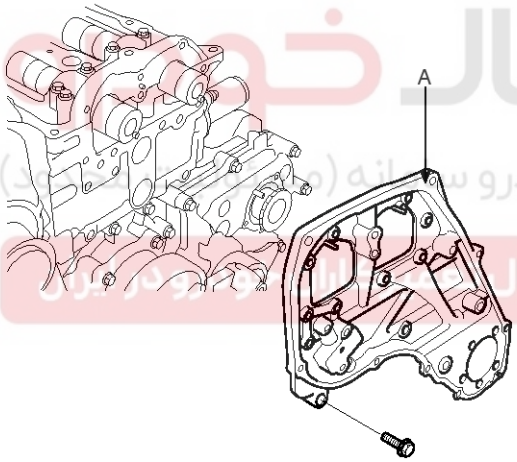
4. Install the timing chain upper under cover(A).

Bolt	Size	Quantity	Tightening torque N-m (kg-m, lb-ft)
A	6 x 14	4 EA	9.8-11.8 (1.0-1.2, 14.5-19.5)
B	6 x 22	9 EA	19.6-26.5 (2.0-2.7, 14.5-19.5)
C	8 x 22	1 EA	19.6-26.5 (2.0-2.7, 14.5-19.5)
D	8 x 40	1 EA	19.6-26.5 (2.0-2.7, 14.5-19.5)
E	Nut	1 EA	9.8-11.8 (1.0-1.2, 7.2-8.7)

* Bolt Size = Diameter x Length

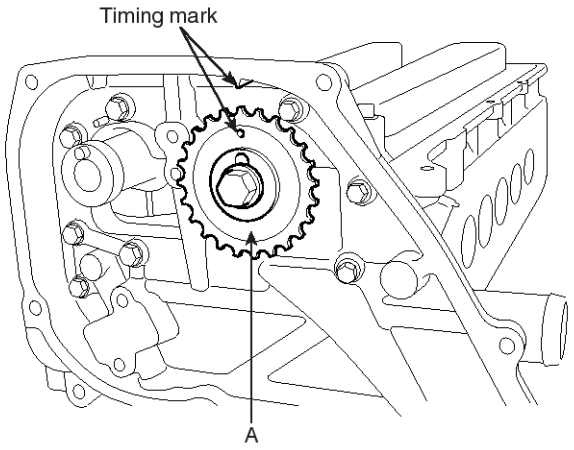


ACAC337B



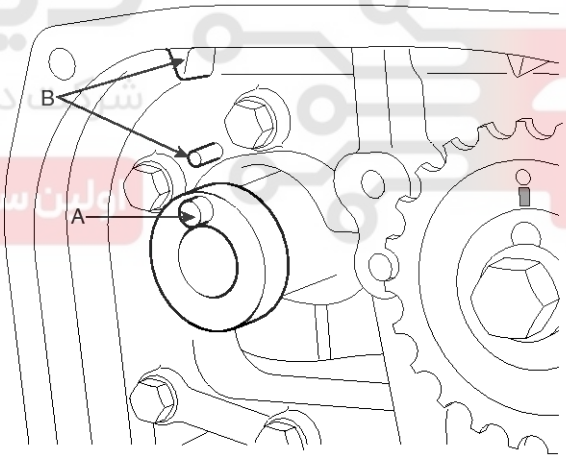
KDSE104A

5. Assemble the LH camshaft sprocket(A) tentatively, and align the timing mark with that of timing chain upper under cover.



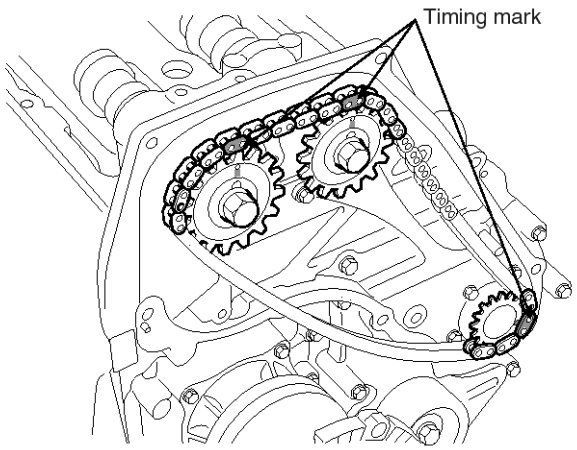
SBLEM6039L

6. Align the RH camshaft dowel pin(A) with the timing mark(B) of the timing chain upper under cover.



KDSE197A

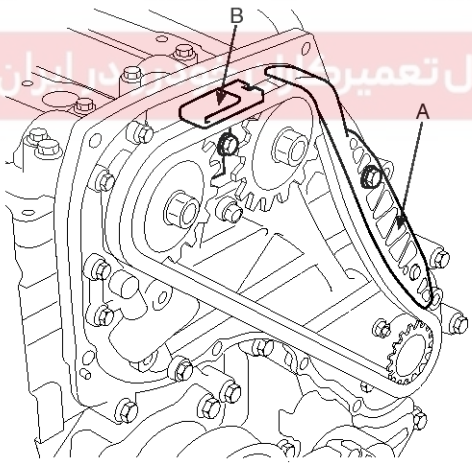
7. Align the timing marks of sprocket and chain when RH camshaft sprocket is not installed to the camshaft.
8. Using the chain connected to the RH camshaft sprocket, install as the timing marks of high-pressure pump sprocket and LH camshaft sprocket align with each other.



SBLEM6040L

9. Assemble the RH camshaft sprocket to the RH camshaft tentatively.
10. Install the timing chain guide "C(1)(A), C(2)(B)".

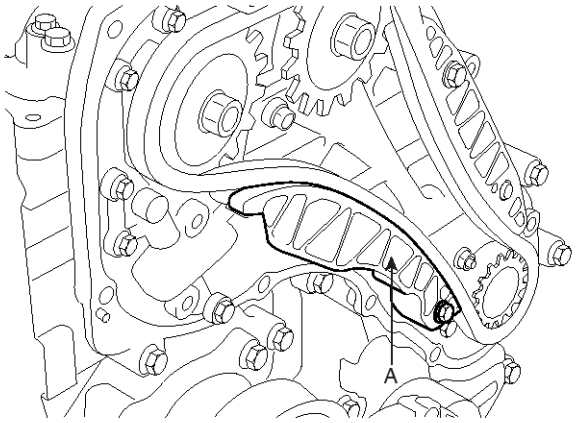
Tightening torque :
9.8-11.8 N.m(1.0-1.2 kgf.m, 7.2-8.7 lb-ft)



KDSE201A

11. Install the timing chain lever "C"(A).

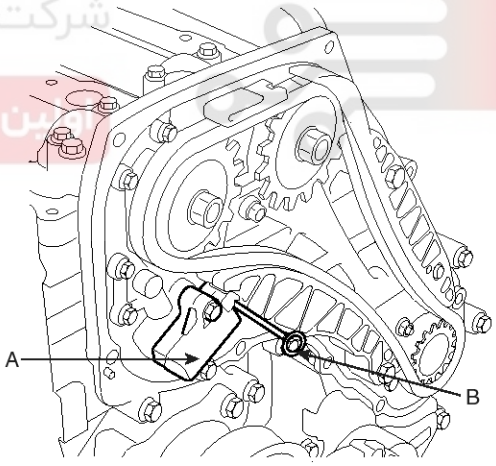
Tightening torque :
19.6-26.5 N.m(2.0-2.7 kgf.m, 14.5-19.5 lb-ft)



KDSE202A

12. Install the timing chain auto-tensioner "C"(A), and remove the set pin(B) from the auto-tensioner.

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



KDSE107A

13. Assemble the high-pressure pump sprocket bolt.

Tightening torque :
64.7-74.5 N.m (6.6-7.6 kgf.m, 47.7-55.0 lb-ft)

14. Assemble camshaft sprocket bolt.

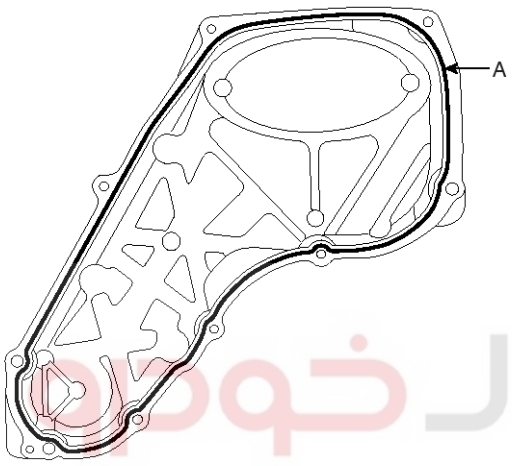
Tightening torque :
93.2-117.7 N.m (9.5-12 kgf.m, 68.7-86.8 lb-ft)

NOTICE

Then assemble the damper pulley to the crankshaft tentatively and align the timing mark of the damper pulley to that of chain cover. And check whether timing mark of the camshaft positions at the right place finally.

15. Apply the sealant(A) at the timing chain upper front cover.

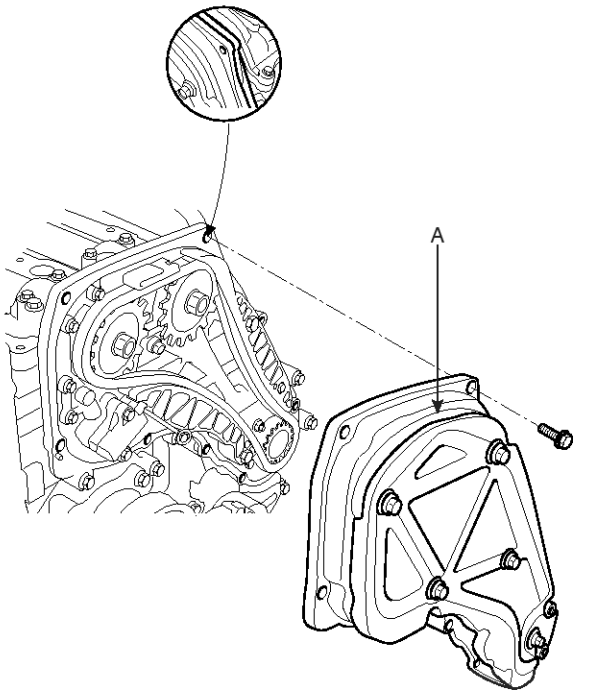
Sealant type : Lotite #5902
Bead width : 2-4 mm (0.08-0.16 in)



ACAE337D

16. Install the timing chain upper front cover(A).

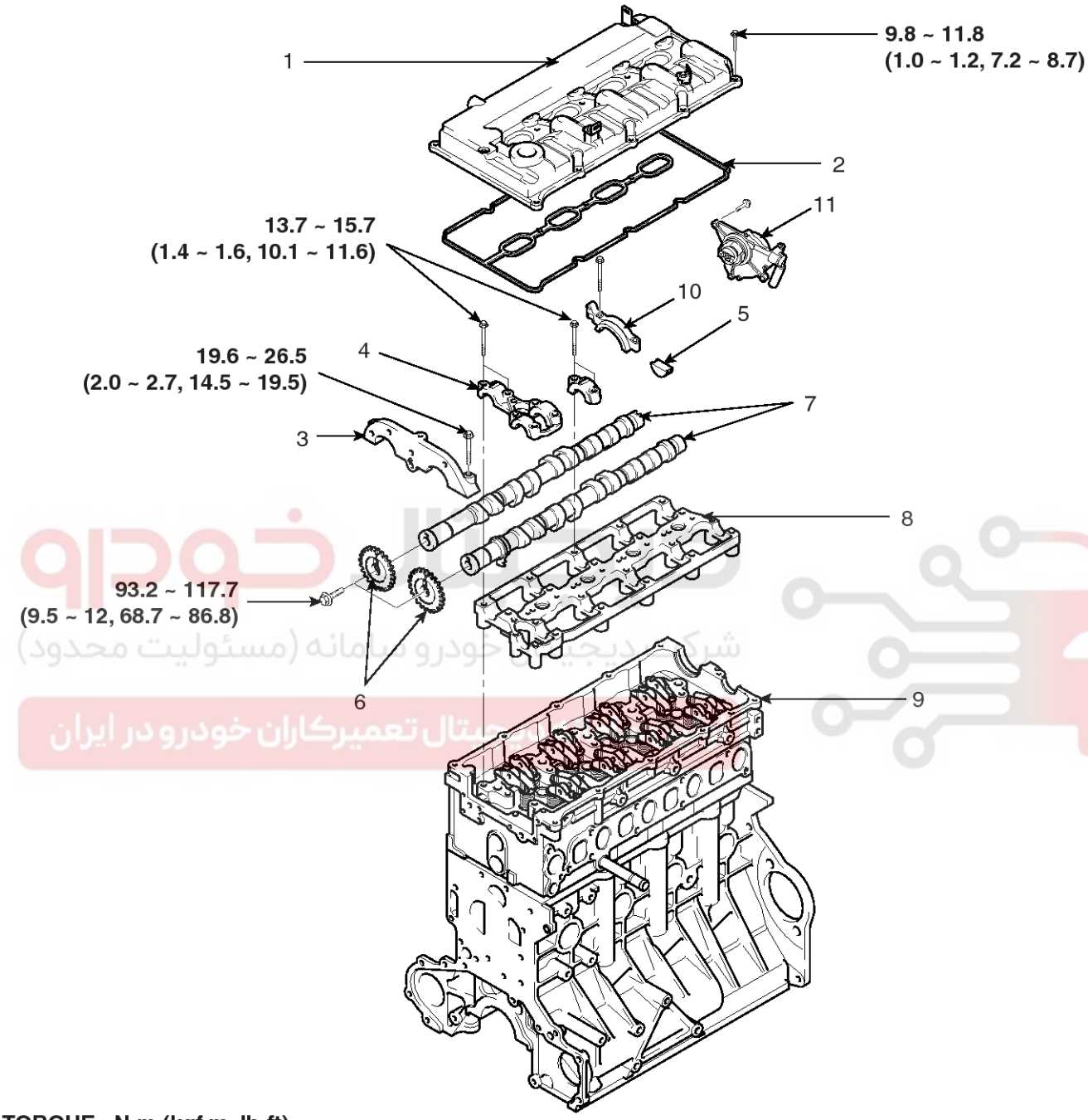
Tightening torque :
19.6-26.5 N.m(2.0-2.7 kgf.m, 14.5-19.5 lb-ft)



KDSE106A

Cylinder Head Assembly

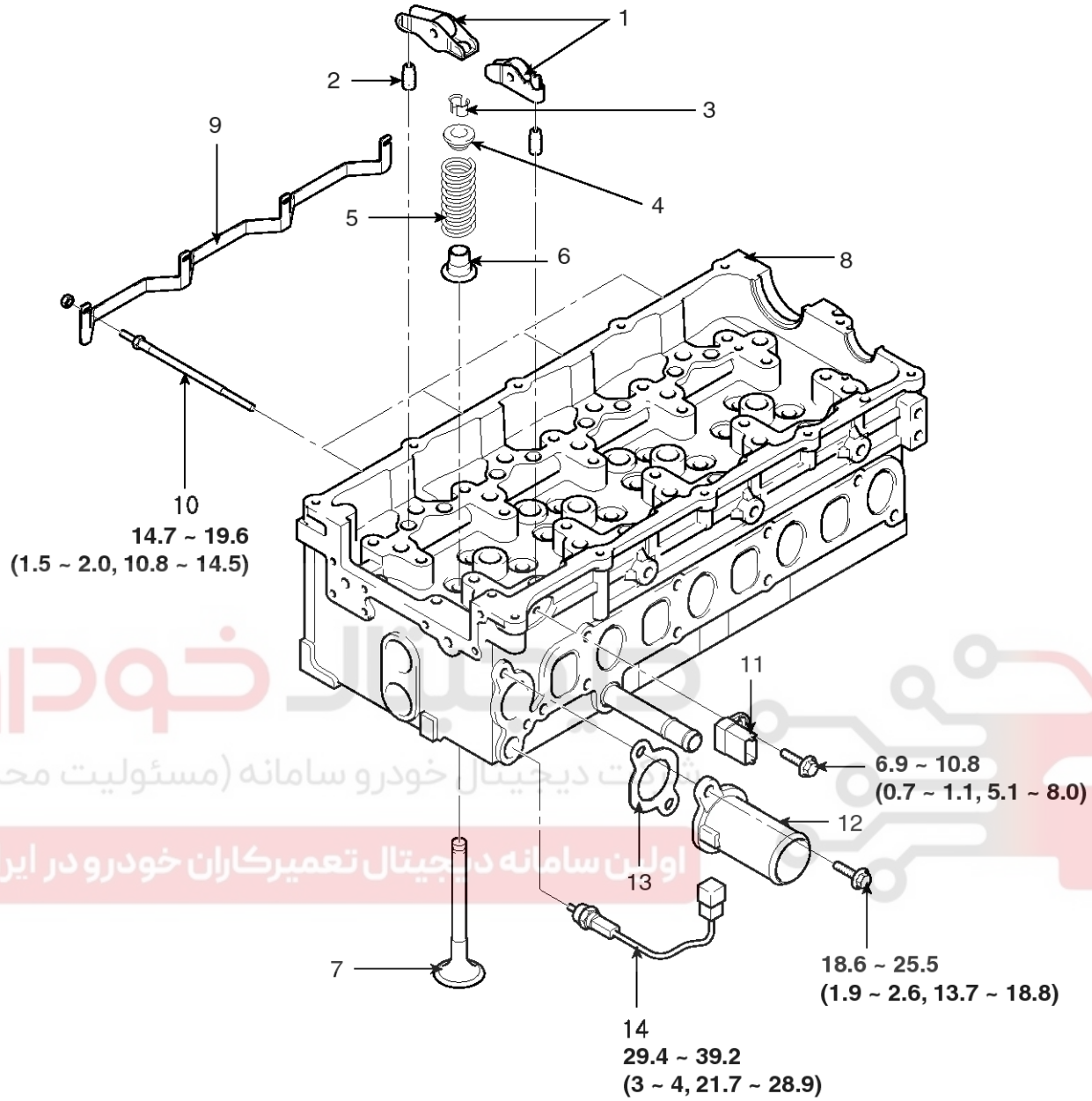
COMPONENTS



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

1. Cylinder head cover
2. Cylinder head cover gasket
3. Timing chain cover plate
4. Camshaft bearing cap
5. Semicircle packing
6. Camshaft sprocket
7. Camshaft
8. Camshaft carrier
9. Cylinder head
10. Vacuum pump bracket
11. Vacuum pump

SBLEM6013L



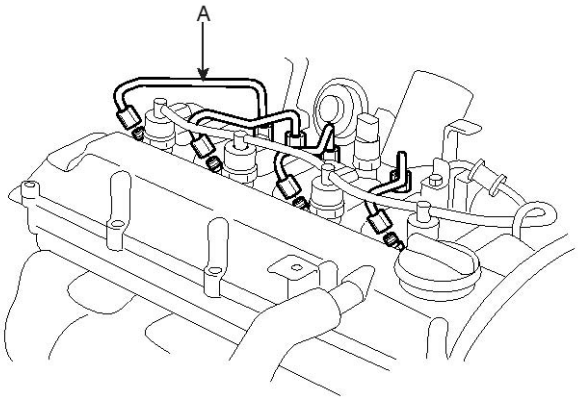
TORQUE : N.m (kgf.m, lb-ft)

1. Cylinder follow
2. HLA
3. Retainer lock
4. Valve retainer
5. Valve spring
6. Valve stem seal
7. Valve
8. Cylinder head
9. Glow plug plate
10. Glow plug
11. TDC sensor
12. Water outlet fitting
13. Gasket
14. Water temperature sensor

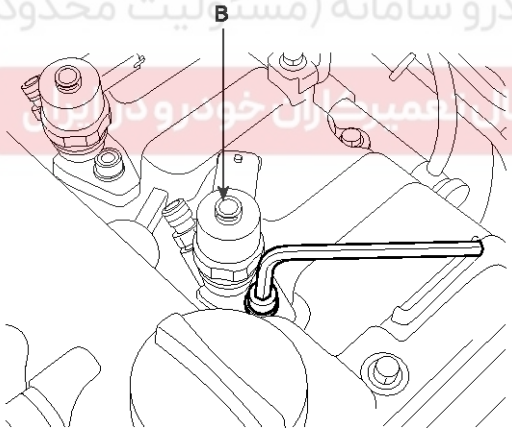
SBLEM6014L

REMOVAL

1. Remove the timing chain "C"
2. Remove the high pressure pipe(A) and the injector(B).(See "FL" group)



KDSE105A



SBLEM6015L

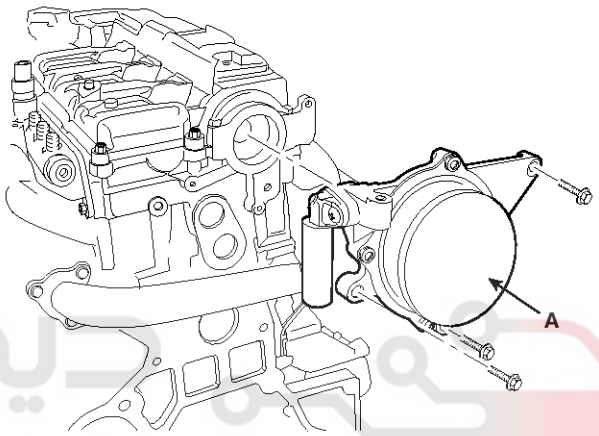
CAUTION

- **Never perform any work on injection system with engine running or within 30 seconds after stopping the engine.**
- **Always pay attention to safety precautions.**

NOTICE

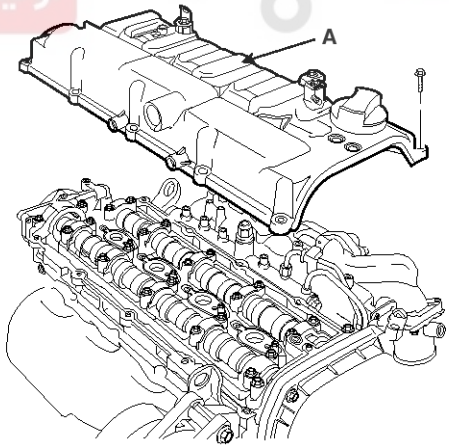
When remove the injectors, set the special tool (09351-4A000) to where the injector holder removed, install a slide hammer on the special tool, using the hammer, tap upward to remove the injector.

3. Remove the vacuum pump(A).



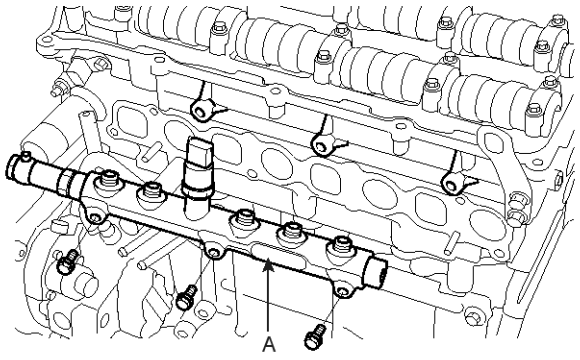
ACAF015A

4. Remove the cylinder head cover(A).



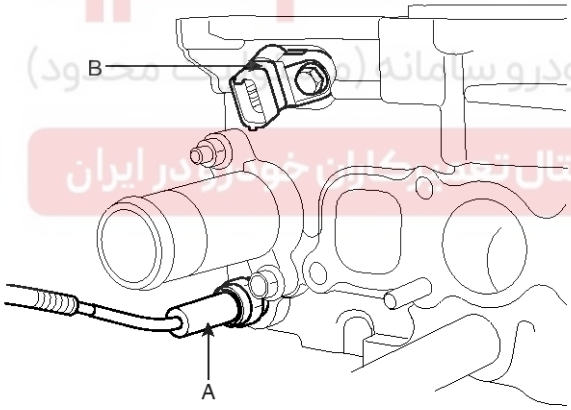
ACAF016A

5. Remove the exhaust manifold.
6. emove the intake manifold.
7. Remove the delivery pipe(A).



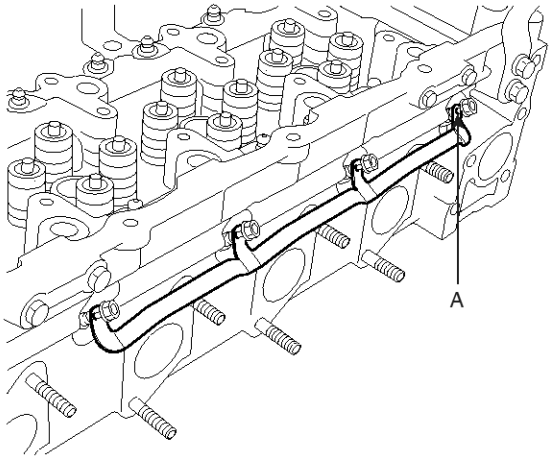
KDSE133A

8. Remove the water temperature sensor(A) and TDC sensor(B).



KDSE122A

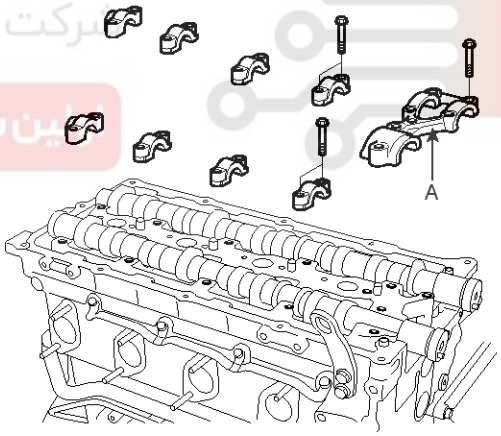
9. Remove the glow plug(A).



KDSE123A

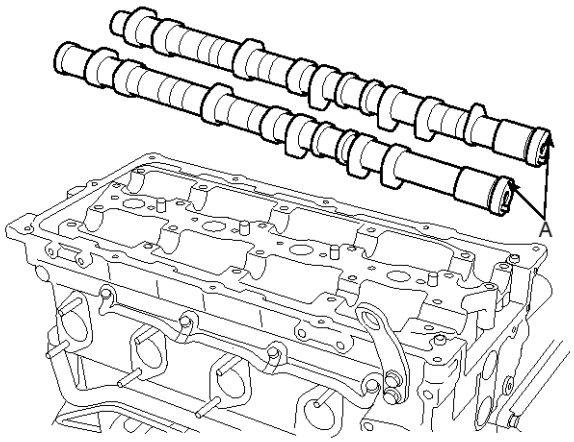
DISASSEMBLY

1. Remove the cam shaft sprocket.
2. Remove the cam shaft bearing cap(A).



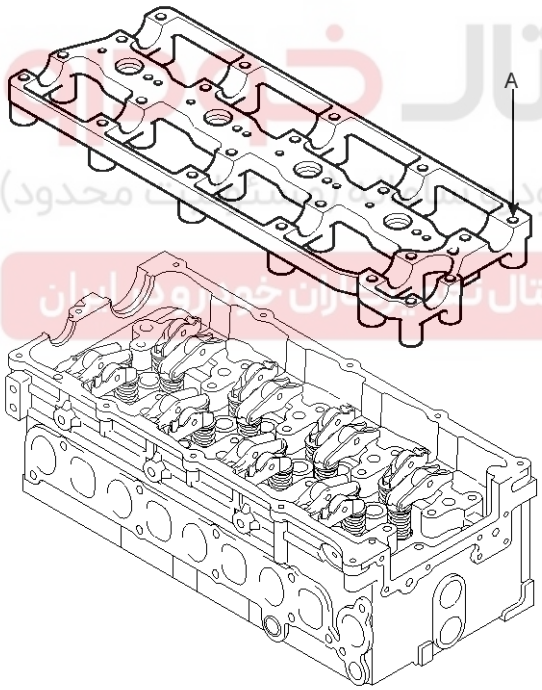
KDSE148A

3. Remove the cam shaft(A).



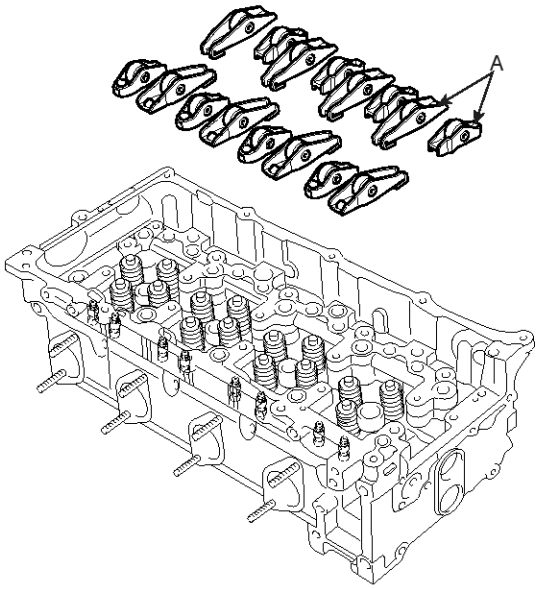
KDSE147A

4. Remove the cam shaft carrier(A).



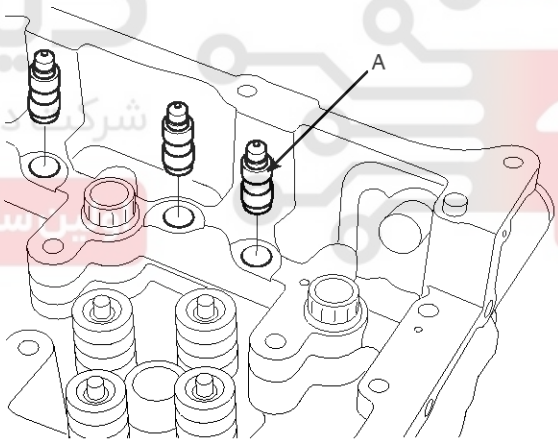
KDSE147B

5. Remove the cam follow(A).



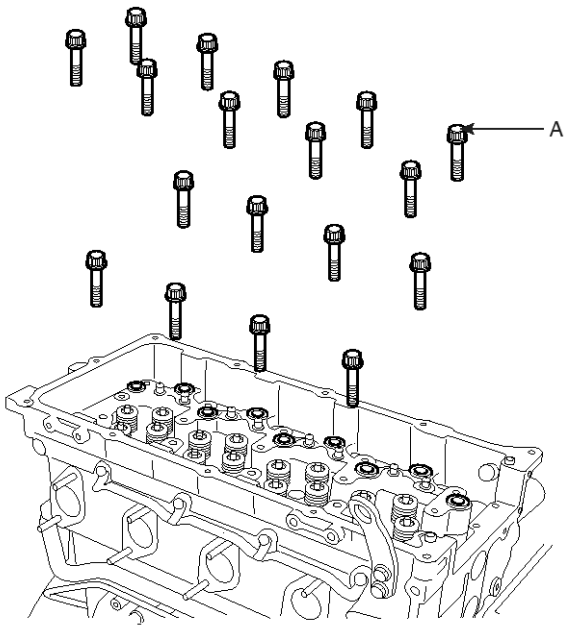
KDSE195A

6. Remove the HLA(A).



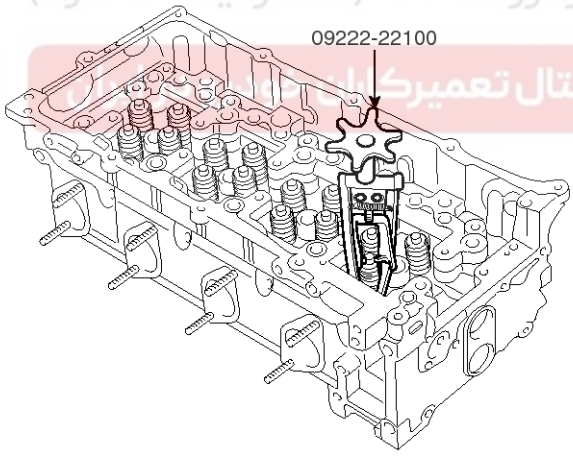
KDSE124A

7. Remove the cylinder head bolts(A).



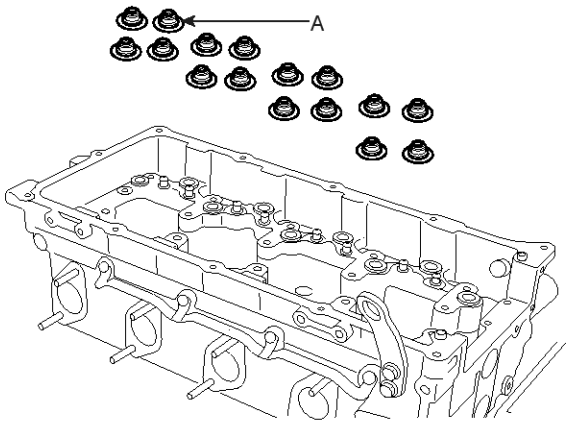
KDSE146A

8. Remove the cylinder block.
9. Using the special tool(09222-22100), remove the valve.



KDSE229A

10. Remove the valve stem seal(A).



KDSE230A

INSPECTION

CAMSHAFT

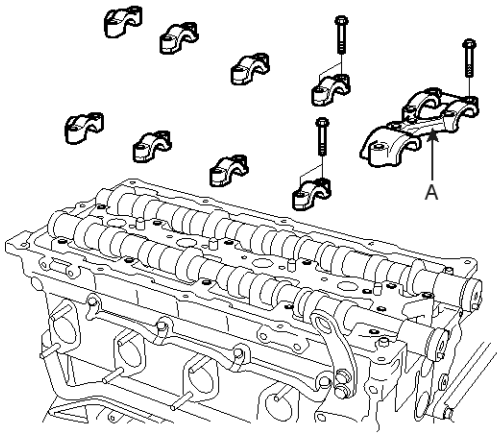
NOTICE

Do not rotate the camshaft during inspection.

1. Put the cam shaft and the camshaft bearing caps(A) on the cylinder head, and then tighten the bolts to the specified torque with the following sequence below.

Specified torque

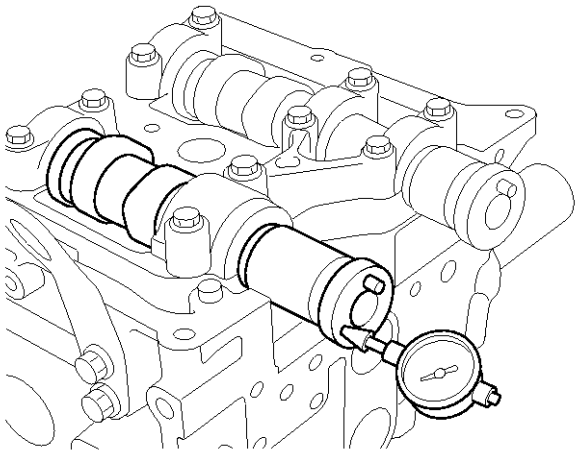
13.7 ~ 15.7 N.m(1.4 ~ 1.6 kgf.m,10.1~11.6 lb-ft)



KDSE148A

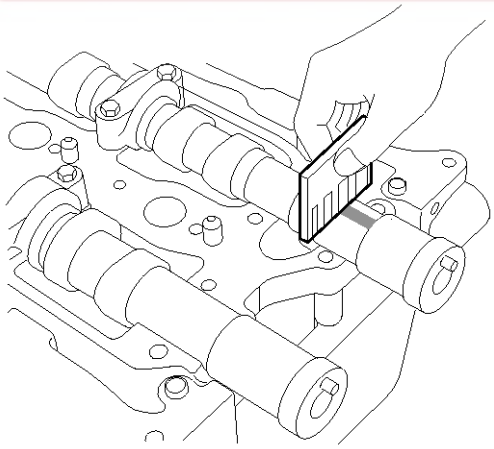
2. Check the camshaft journals for wear. If the journals are badly worn, replace the camshaft.

End play: 0.10 - 0.20 mm (0.0039 - 0.0079 in)



KDSE126A

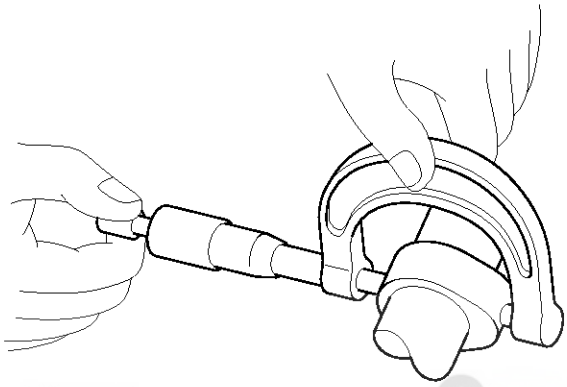
3. Clean the camshaft bearing surfaces in the cylinder head then set the camshaft back in place.
4. Install the camshaft bearing caps and tighten the bolts to the specified torque.
5. Remove the camshaft bearing caps, and then measure the widest portion of the plastic gage on each journal.



KDSE143A

6. Check the cam lobes for damage. If the lobe is damaged or worn excessively, replace the camshaft.

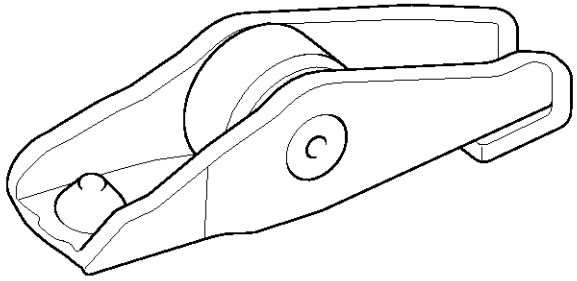
Cam height (LH) :
Intake : 40.163 mm (1.5812 in)
Exhaust : 40.043 mm (1.5765 in)
Cam height (RH) :
Intake : 39.782 mm (1.5662 in)
Exhaust : 40.456 mm (1.5928 in)



ECKD223A

CAM FOLLOW (ROCKER ARM)

1. Check rotation of the roller. If they do not rotate smoothly or are loose, replace them.
2. Check the roller surface. Replace if there is any dent, damage or evidence of seizure.
3. Check the valve contact surface for possible damage or evidence of seizure. Replace if necessary.

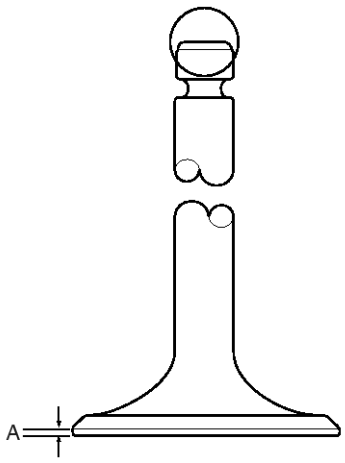


LCAC317A

VALVE AND VALVE GUIDE

1. Inspect each valve for following. Replace of resurface if necessary.
   a. Damage or bent stem.
   b. Roughness or damage to face.
   c. Roughness or damage to face.
2. Check valve head margin thickness(A). Replace if necessary.

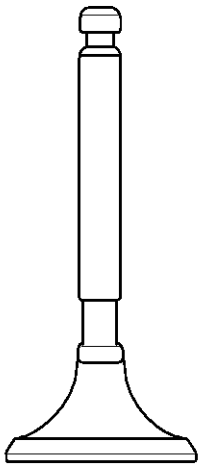
Margin thickness :
Intake, Exhaust: 1.8-2.0 mm (0.071-0.079 in)



ACAE314A

3. Measure valve length.

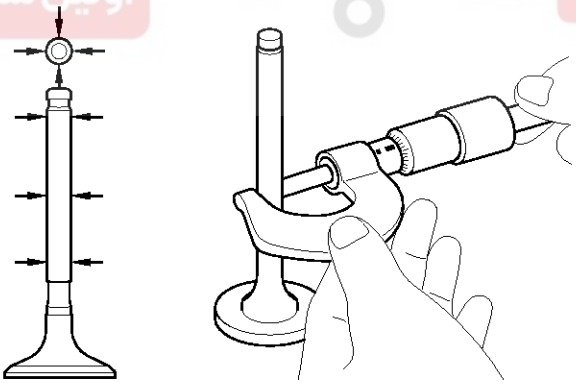
Valve length :
Intake, Exhaust : 110.55 mm (4.352 in)



ACAC314B

4. Measure valve stem diameter.

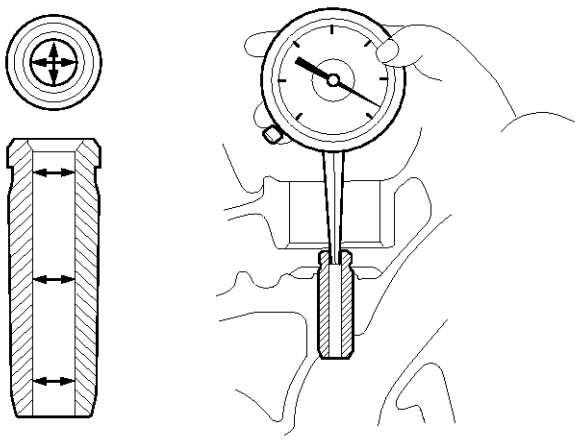
Valve stem diameter :
Intake : 6.965-6.980 mm (0.2742-0.2748 in)
Exhaust : 6.935-6.950 mm (0.2730-0.2736 in)



ECKD220A

5. Measure valve guide inner diameter.

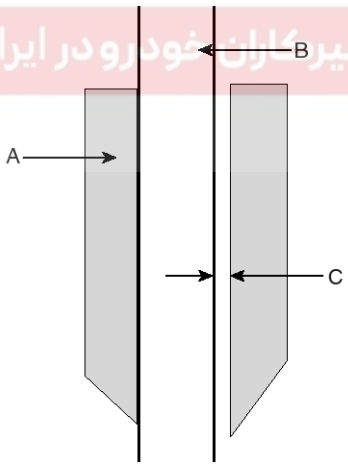
Inner diameter
Intake, Exhaust :
7.000-7.015 mm (0.2756-0.2762 in)



ECKD219A

6. Measure valve stem to guide clearance(C) by subtract outer diameter of valve stem(B) from inner diameter of corresponding valve guide(A).

Clearance :
Intake : 0.020-0.050 mm (0.0008-0.0020 in)
Exhaust : 0.050-0.080 mm (0.0020-0.0031 in)

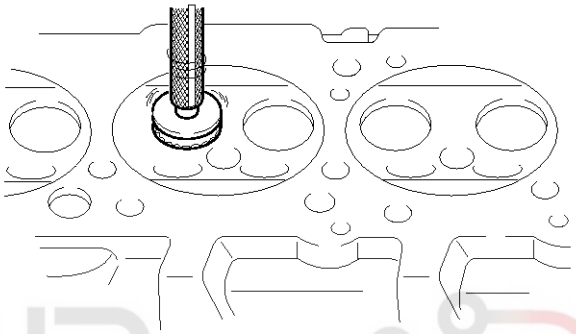


ACAE314E

7. If clearance exceeds maximum, replace valve and/or cylinder head

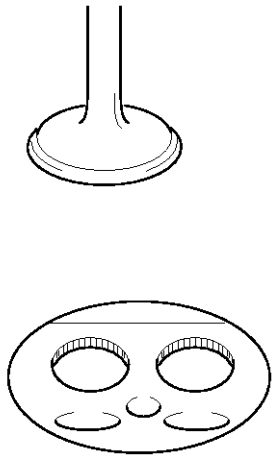
VALVE SEAT

1. Inspect contact surface of valve seat and valve face for following.
   a. Roughness
   b. Damage
2. If necessary, resurface valve seat with a 45°(Intake), 45°(Exhaust) valve seat cutter and/or resurface valve face.



LCAC315A

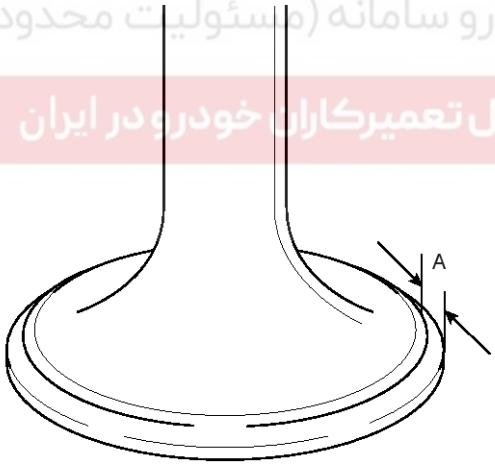
3. Apply a thin coat of Prussian blue to valve face.
4. Check valve seating by rotating valve against seat.
   a. If blue does not appear 360° around valve face, replace valve.
   b. If blue does not appear 360° around valve seat, resurface valve seat.



LCAC315B

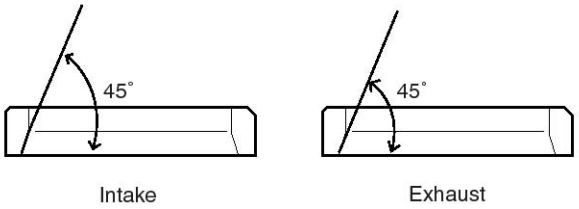
5. Check seat contact width (A).

Seat contact width :
Intake: 1.3-1.7 mm (0.0512-0.0669 in)
Exhaust: 1.5-1.9 mm (0.0591-0.0748 in)



ACAE315A

6. Check that valve seating position is at center of valve face.
   a. If seating position is too high (low), correct valve seat with a 45° (Intake), 45° (Exhaust) cutter.



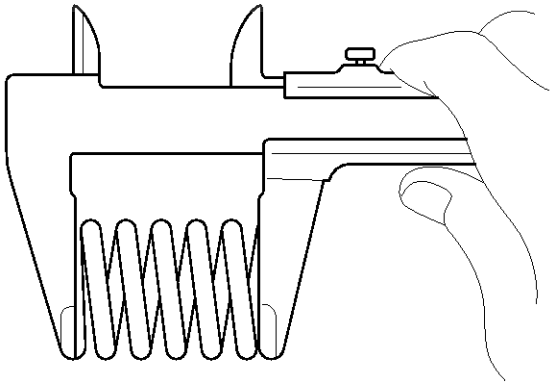
SBLEM6041L

7. Seat the valve to the valve seat with a lapping compound.

VALVE SPRING

1. Inspect each valve spring for cracks or damage.
2. Check free length and out-of-square. Replace if necessary.

Free length: 48.2 mm (1.898 in)
Out-of-square: Below 1.5°



ECKD222A

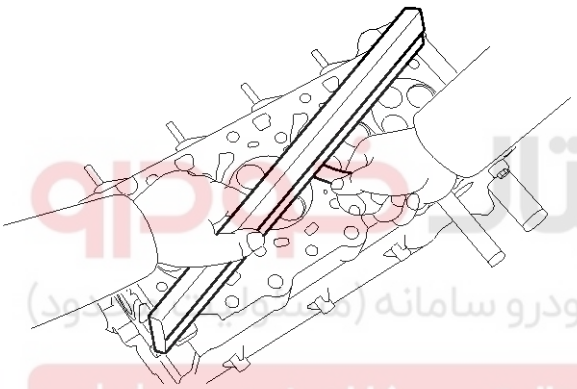
3. Check spring pressure, and replace it if necessary.

Spring pressure :
258 ± 12 N / 38 mm
(26.3±1.2 kg/38 mm, 569 ± 26 lb / 1.496 in)
505.5 ± 24 N/ 28.8 mm
(51.5±2.4 kg/28.8 mm, 1114.4 ± 53 lb / 1.134 in)

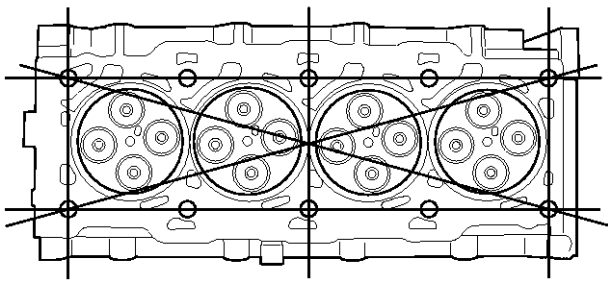
CYLINDER HEAD

1. Inspect the cylinder head for damage, cracks and leakage of water and oil. Replace the cylinder head if necessary.
2. Measure cylinder head distortion in seven directions shown in figure.

Distortion : 0.15 mm (0.0059 in)

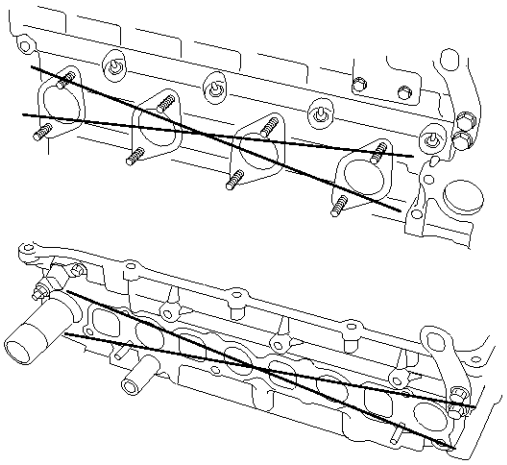


KDSE125A



EDKD610A

3. Measure manifold contact surface distortion in four directions shown in figure.



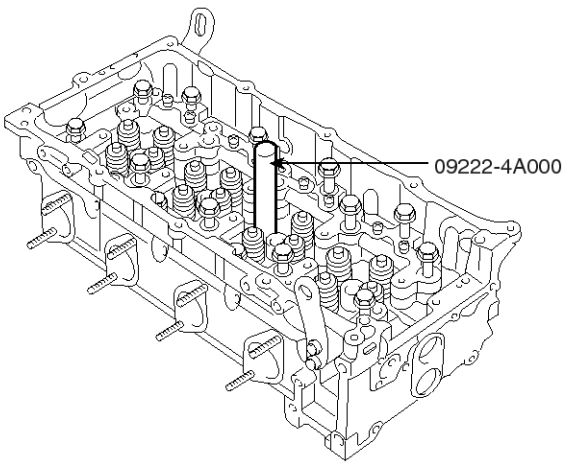
KDSE231A

4. If distortion exceeds specification, grind surface or replace cylinder head.

REASSEMBLY

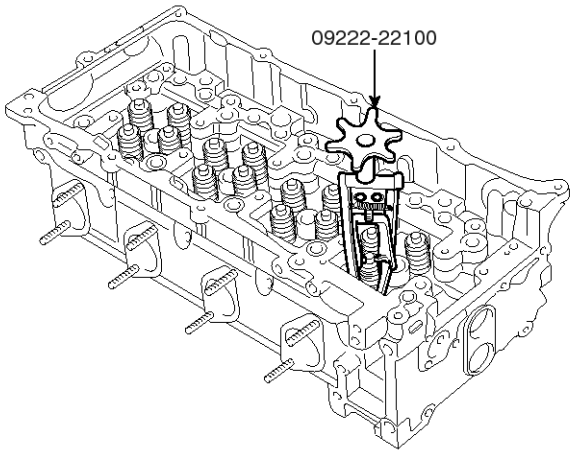
1. Install a new valve stem seal to the valve guide using the special tool (09222-4A000).

⚠CAUTION
- **Do not reuse the used valve stem seal.**
- **When installing the valve stem seal, using the special tool is needed, not to leak the fluid.**



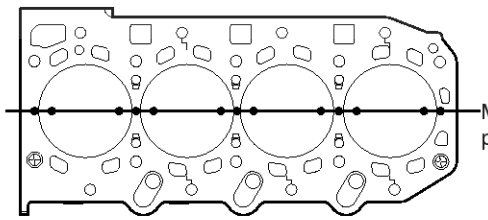
LCAC312A

2. Using the special tool (09222-4A000), remove the valve.

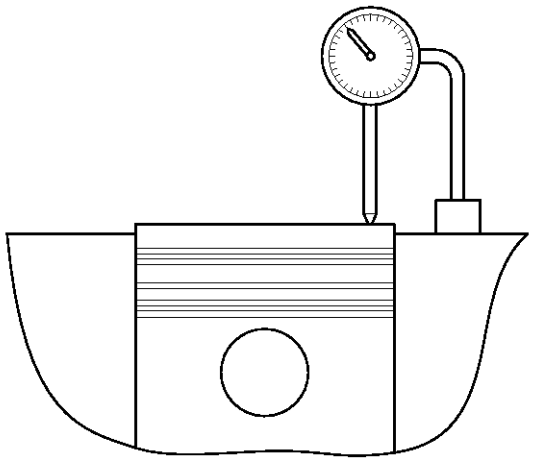


KDSE229A

3. Select the cylinder head gasket.
   1) Measure the piston protrusion (8 places) from the upper face of the cylinder block and calculate the average of the 8 piston protrusion.



SBLEM6016L



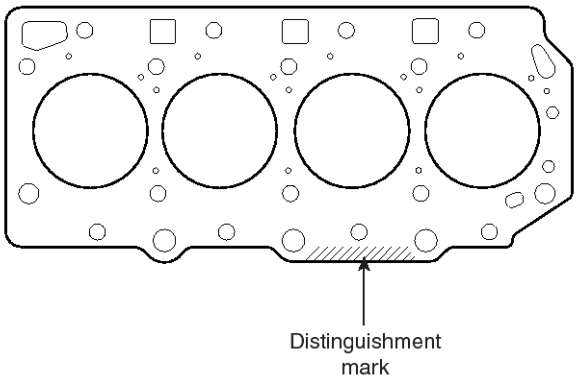
ACAC319B

   2) Select the gasket from the grade A to C in the table below using the average of the 8 piston protrusion.Even if only 1 point is over than the limit of piston protrusion at each grade, 1 grade upper gasket than specified below.

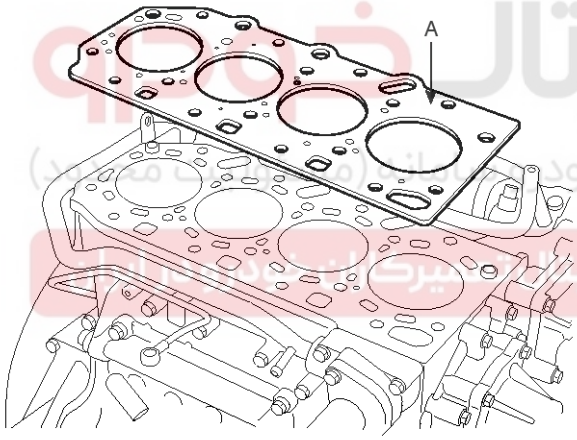
CYLINDER HEAD GASKET mm (in)

Gasket grade	A	B	C
Piston Protrusion	0.056-0.117 (0.0022-0.0046)	0.117-0.178 (0.0046-0.0070)	0.178-0.240 (0.0070-0.0094)
Limit of piston protrusion	0.167 (0.0066)	0.228 (0.0090)	–
Gasket Thickness	0.92-0.98 (0.0362-0.0386)	0.97-1.03 (0.0382-0.0406)	1.02-1.08 (0.0402-0.0425)
Mark for distinguishment	—	⌒—	⌒⌒

LCAC319H



SBLEM6017L

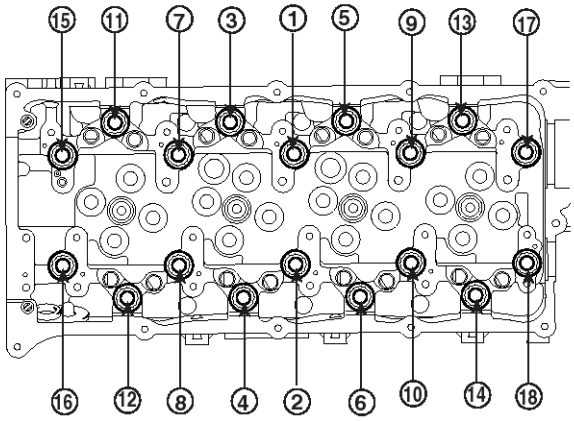


KDSE145A

4. Install the cylinder head assembly with the cylinder head gasket.

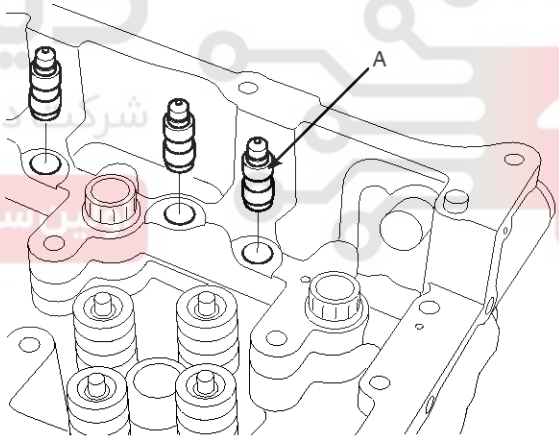
Tightening torque :
49.0 N.m (5.0 kgf.m, 36.2 lb-ft) + 120° + 90°

⚠CAUTION
Always use new cylinder head bolts.



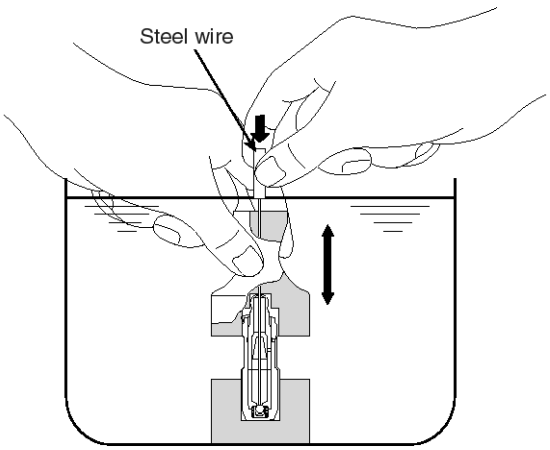
ACAC319D

5. Install the HLA(A) to the cylinder head.



KDSE124A

1) Until installing HLA shall be held upright so that diesel oil in HLA should not spill and assured that dust does not adhere to HLA.
2) HLA shall be inserted tenderly to the cylinder head not to spill diesel oil from HLA. In case of spilling, air bent shall be done in accordance with the air bent procedure.

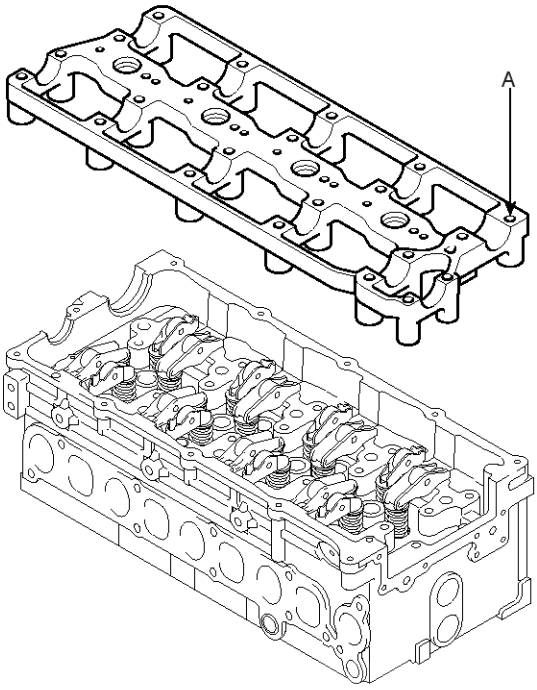


SBLEM6042L

6. Install the cam follow(A) (rocker arm) on the HLA and valve.

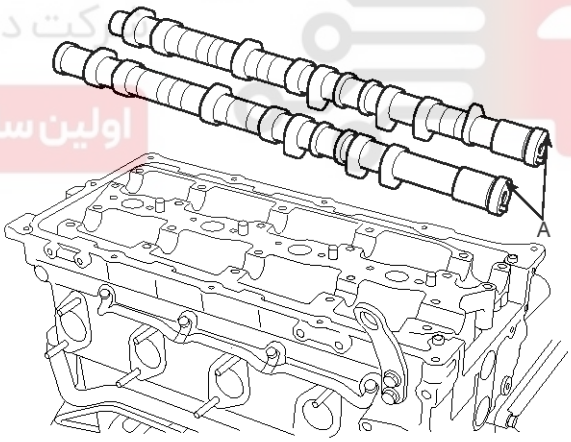
KDSE195A

7. Install the camshaft carrier (A) on the cylinder head.



KDSE147B

8. Install the camshaft (A) on the camshaft carrier.

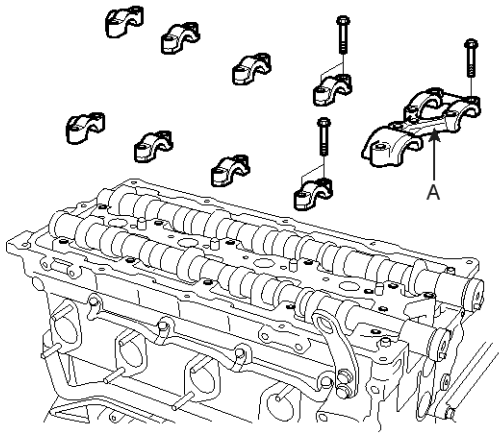


KDSE147A

⚠CAUTION
In assembling camshaft cap, all pistons to be in the middle position between TDC and BDC not to interfere with valves.

9. Install the camshaft caps (A).

Tightening torque :
13.7-15.7 N.m (1.4-1.6 kgf.m, 10.1-11.6 lb-ft)



KDSE148A

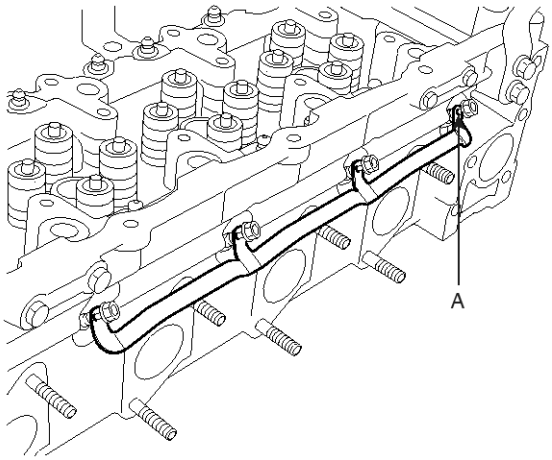
10. Install the camshaft sprocket.

Tightening torque :
93.2-117.7 N.m (9.5-12.0 kgf.m, 68.7-86.8 lb-ft)

INSTALLATION

1. Install the glow plug (A).

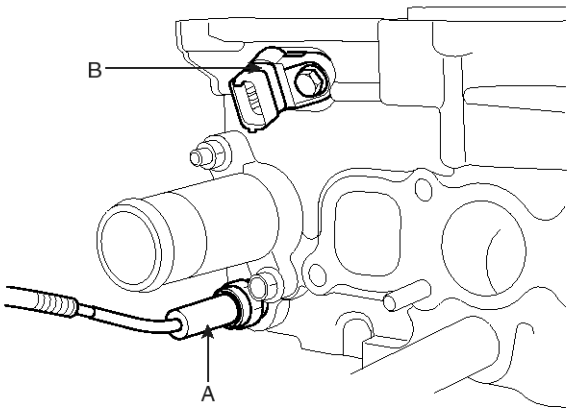
Tightening torque :
Glow plug :
15-20 N.m (1.5-2.0 kgf.m, 11-15 lb-ft)
Glow plug plate nut :
0.8-1.5 N.m (8-15 kgf.m, 0.6-1.1 lb-ft)



KDSE123A

2. Install the TDC sensor (B).

Tightening torque :
6.9-10.8 N.m (0.7-1.1 kgf.m, 5.1-8.0 lb-ft)



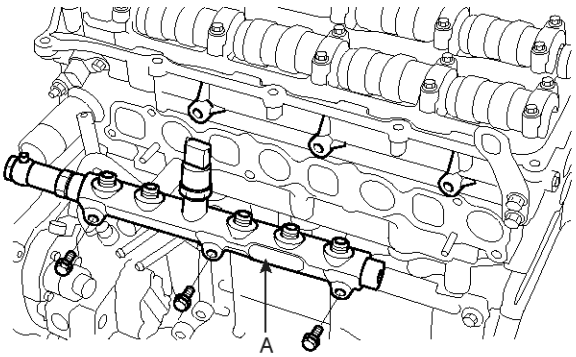
KDSE122A

3. Install the water temperature sensor (A).

Tightening torque :
29.4-39.2 N.m (3-4 kgf.m, 21.7-28.9 lb-ft)

4. Install the delivery pipe (A).

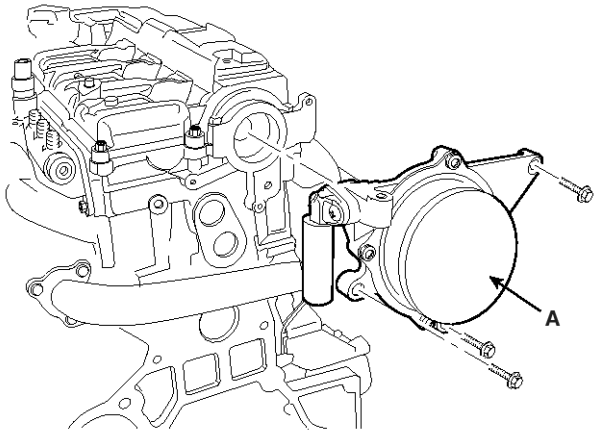
Tightening torque :
14.7-21.6 N.m (1.5-2.2 kgf.m, 6.8-15.9 lb-ft)



KDSE133A

5. Install the exhaust manifold and intake manifold.
6. Install the vacuum pump (A).

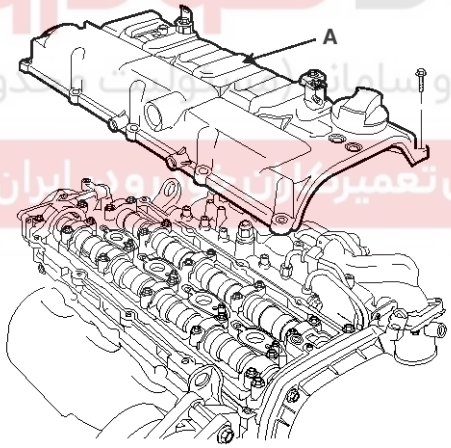
Tightening torque :
9.8-11.8 N.m (1.0-1.2 kgf.m, 7.2-8.7 lb-ft)



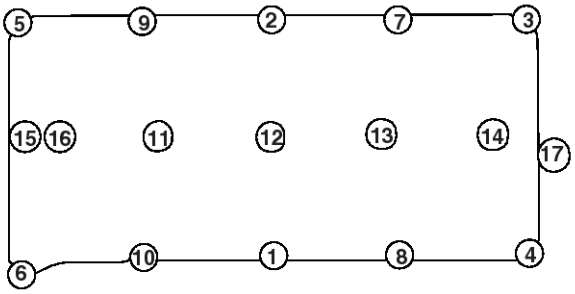
ACAF015A

7. Install the cylinder head cover (A).

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



ACAF016A

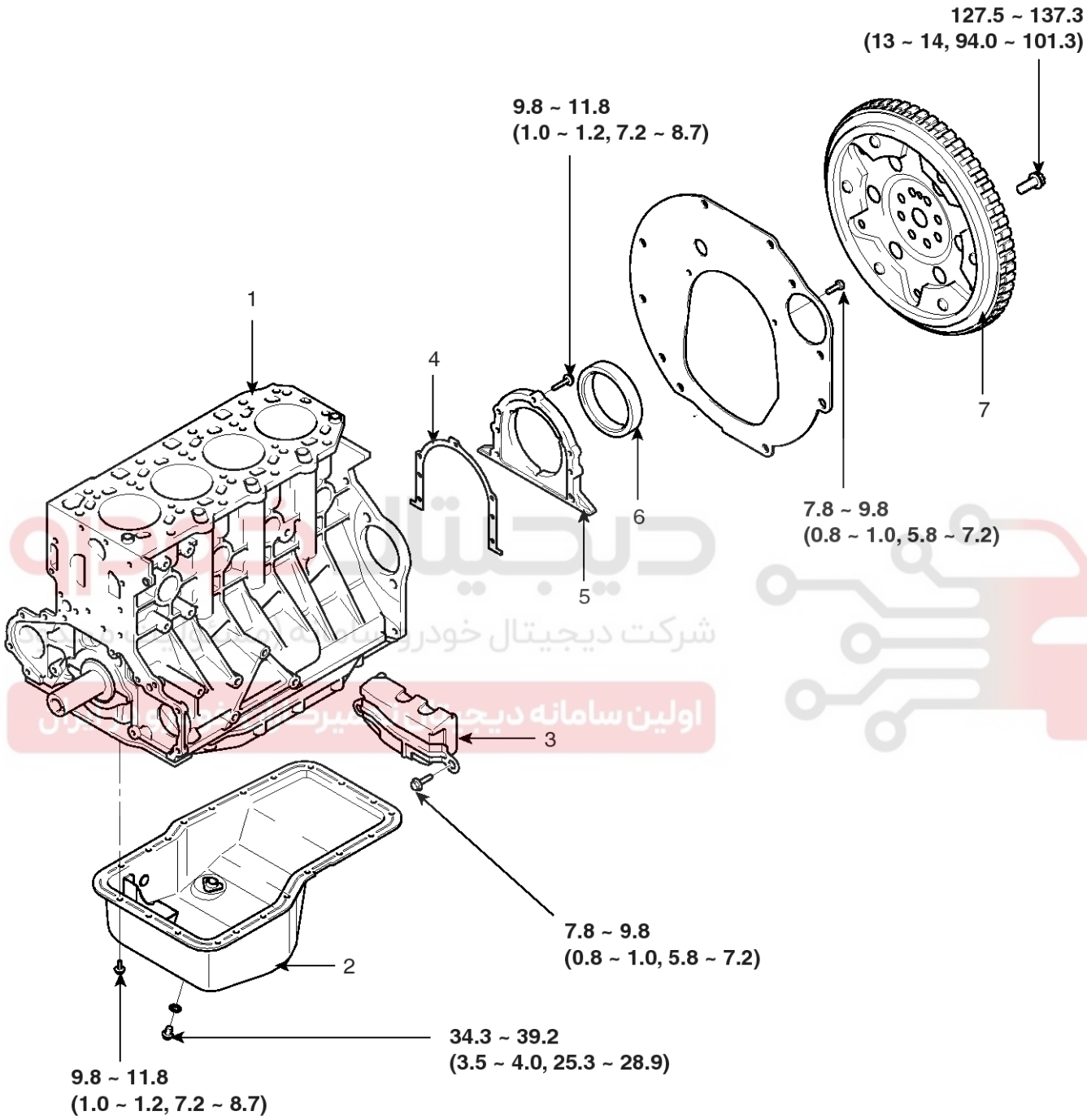


ACAF055A

8. Install the injector and high pressure pipe.
9. Install the timing chain "C".

Cylinder Block

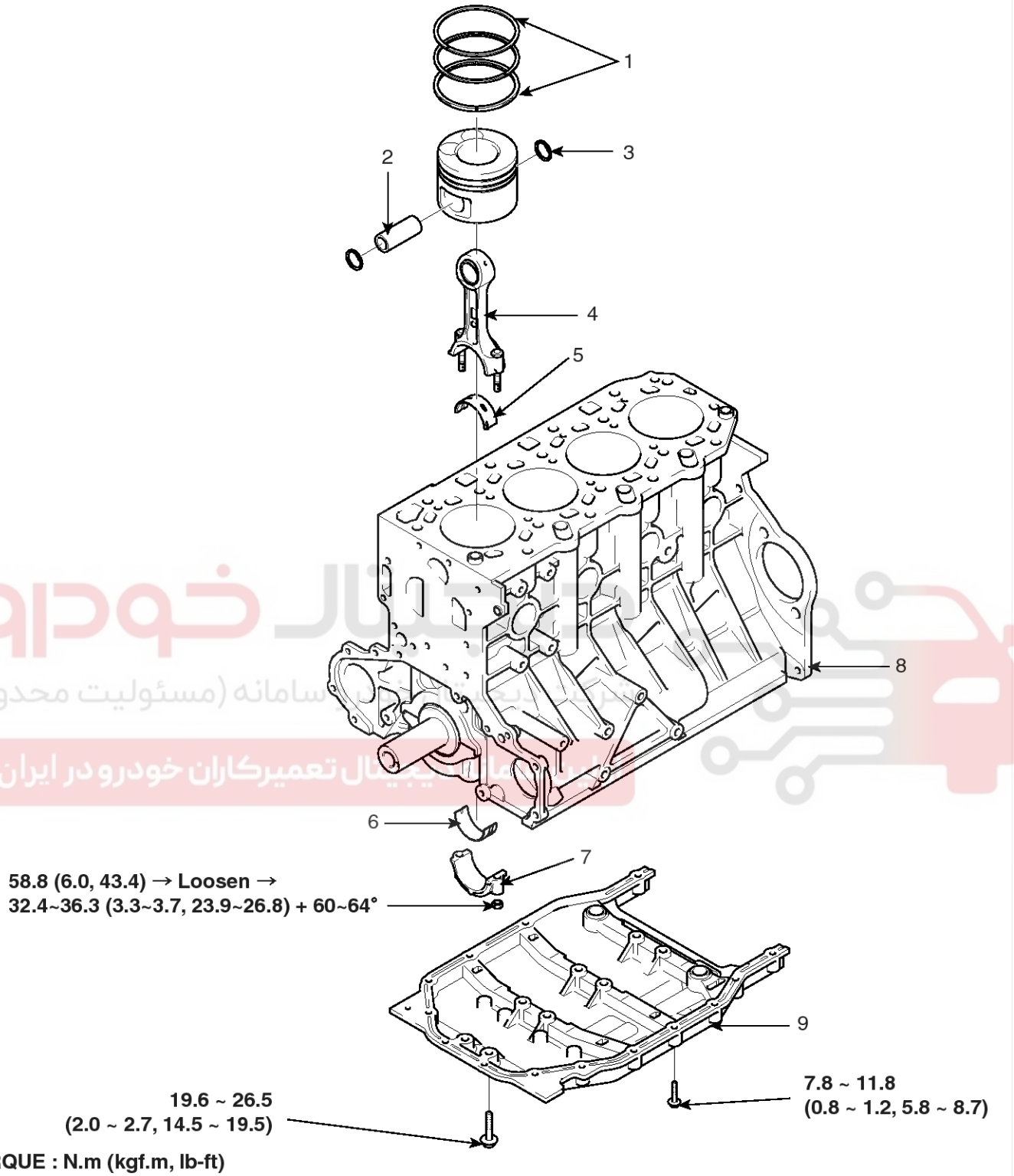
COMPONENTS



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

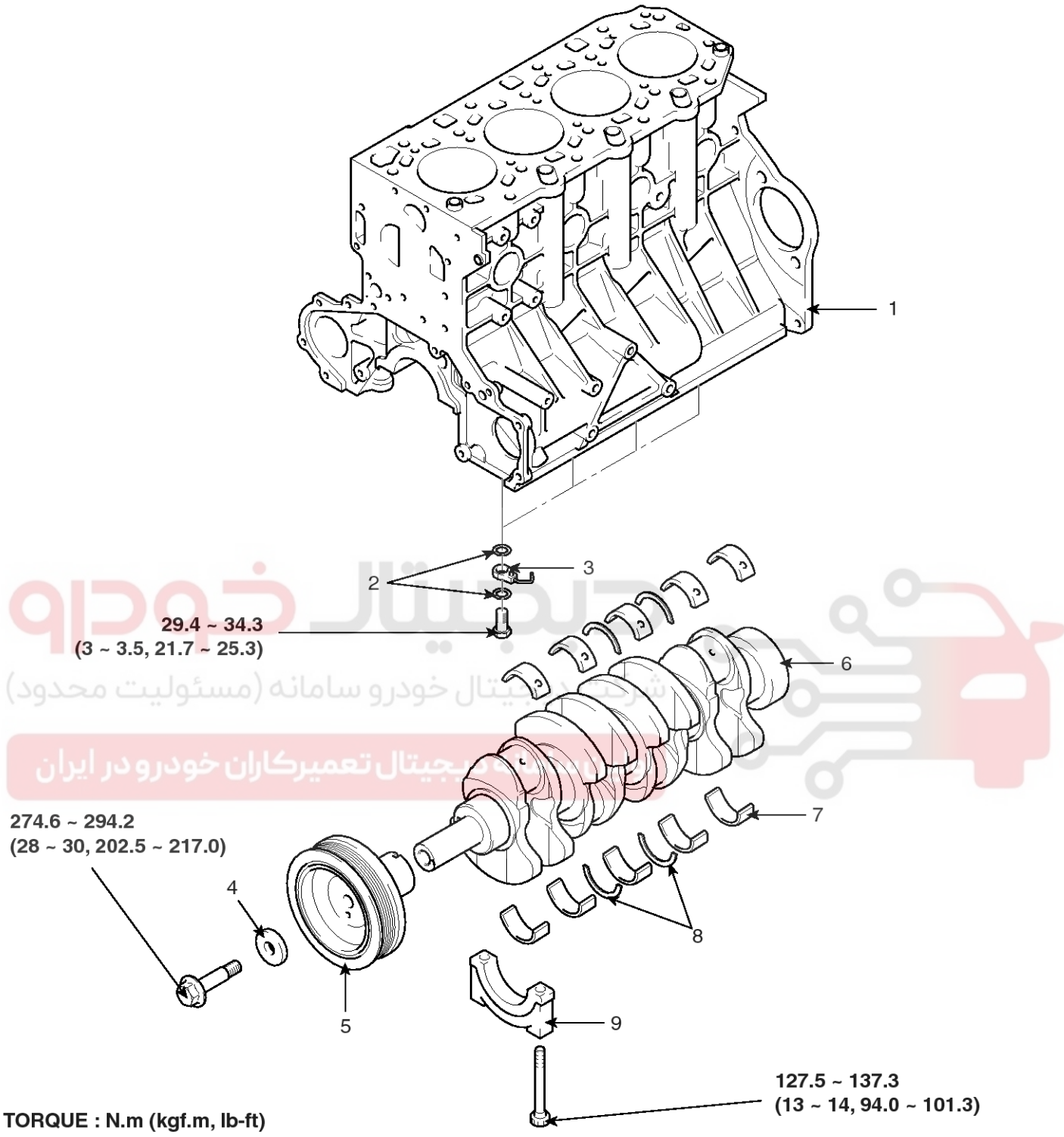
1. Cylinder block
2. Oil pan
3. Bell housing cover
4. Gasket
5. Oil seal case
6. Oil seal
7. Fly wheel

SBLEM6018L



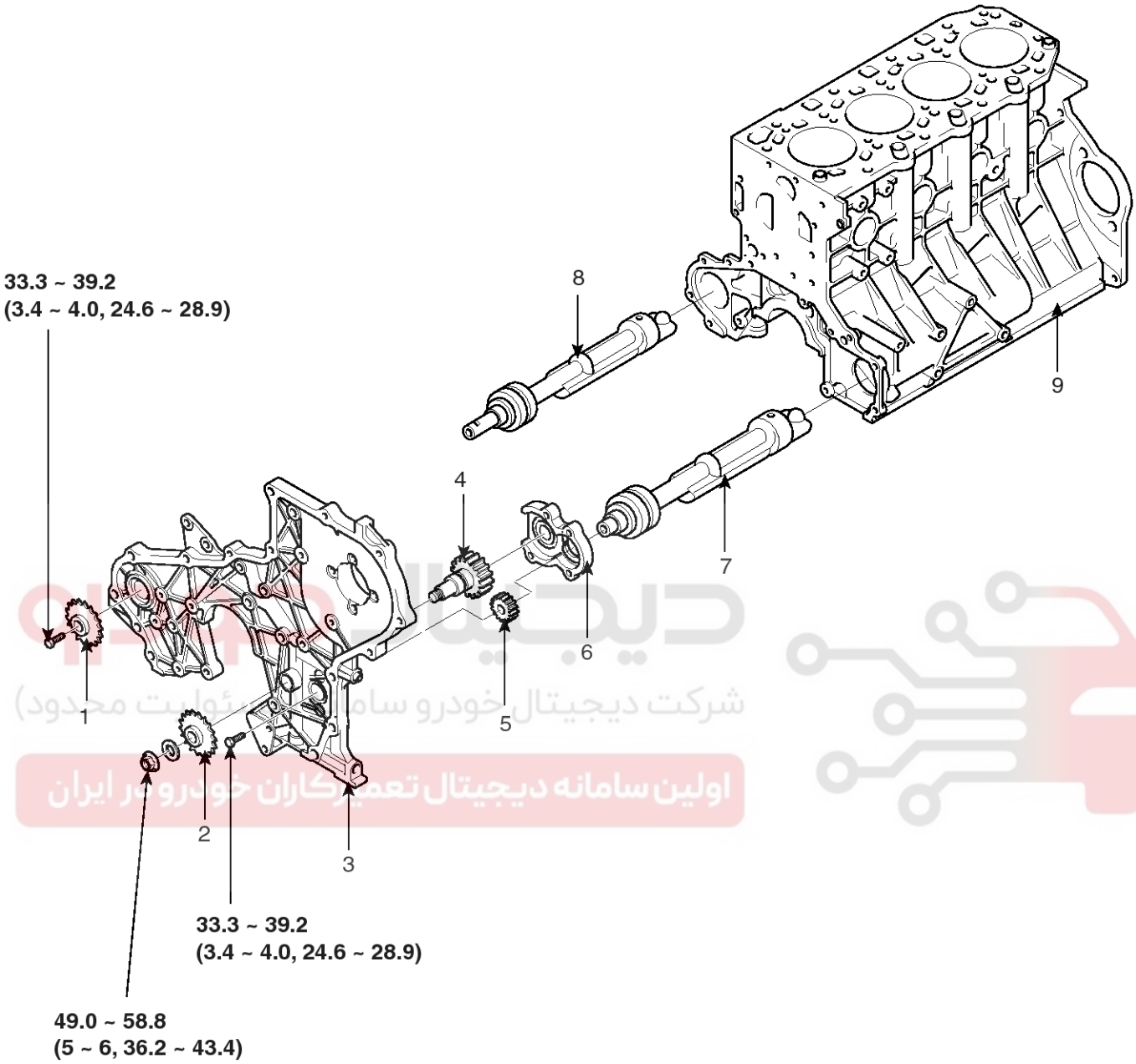
1. Piston ring
2. Piston pin
3. Snap ring
4. Connecting rod
5. Connecting rod bearing
6. Connecting rod bearing
7. Connecting rod bearing cap
8. Cylinder block
9. Bet plate

SBLEM6019L



1. Cylinder block
2. Gasket
3. Oil jet
4. Washer
5. Crankshaft pulley
6. Crankshaft
7. Main bearing
8. Thrust bearing
9. Main bearing cap

SBLEM6020L



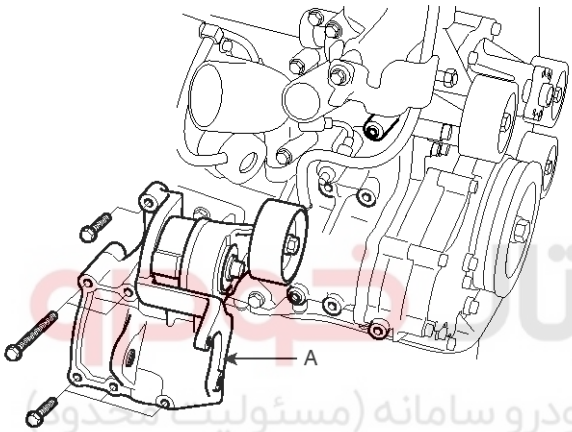
TORQUE : N.m (kgf.m, lb-ft)

1. RH Balance shaft sprocket
2. LH Balance shaft sprocket
3. Timing chain lower under cover
4. Drive gear
5. Driven gear
6. Cover
7. LH Balance shaft
8. RH Balance shaft
9. Cylinder block

SBLEM6021L

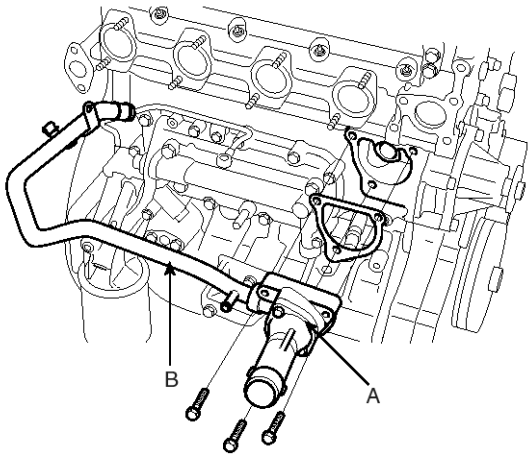
REMOVAL

1. Remove the engine and transaxle assembly from the vehicle.
2. Remove the fly wheel or drive plate.
3. Remove the timing chain
4. Remove the intake manifold and exhaust manifold.
5. Remove the cylinder head assembly.
6. Remove the oil lever gage assembly.
7. Remove the power steering pump.
8. Remove the power steering pump bracket (A).

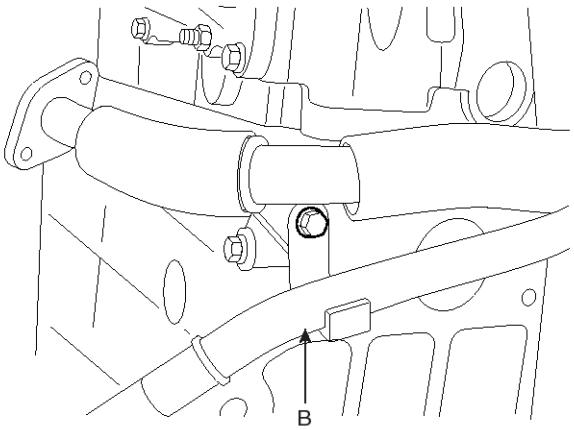


KDSE142A

9. Remove the thermostat housing (A) and heater pipe (B).

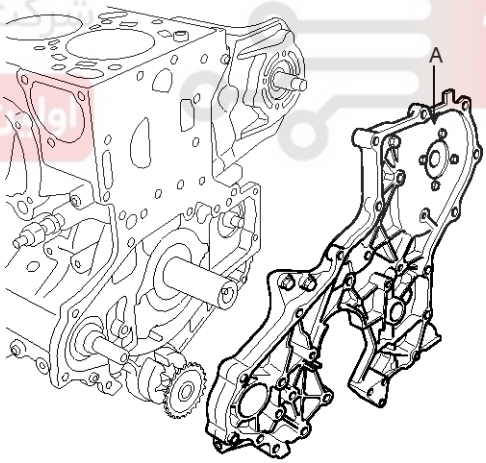


KDSE138A



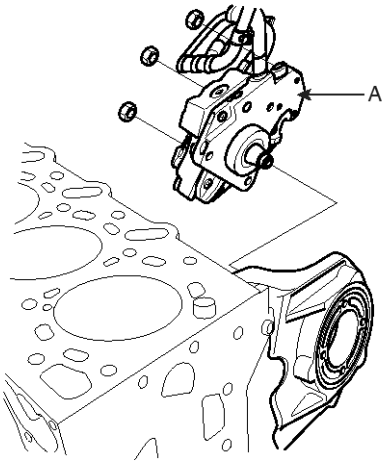
KDSE206A

10. Remove the oil cooler.
11. Remove the water pump.
12. Remover the timing lower under cover (A).



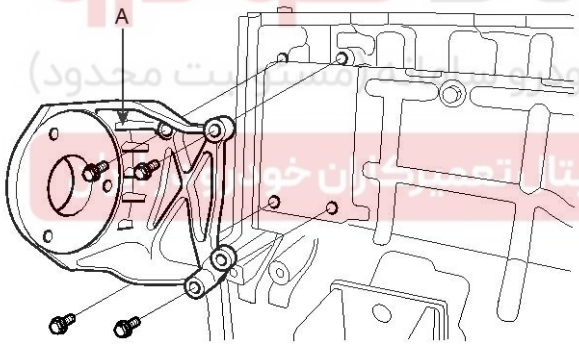
KDSE155A

13. Remove the fuel pump (A).



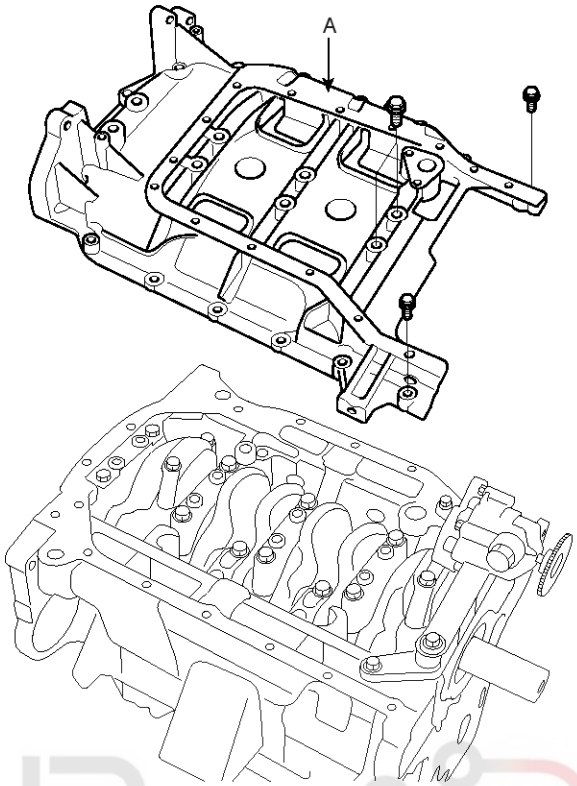
KDSE156A

14. Remove the fuel pump bracket (A).



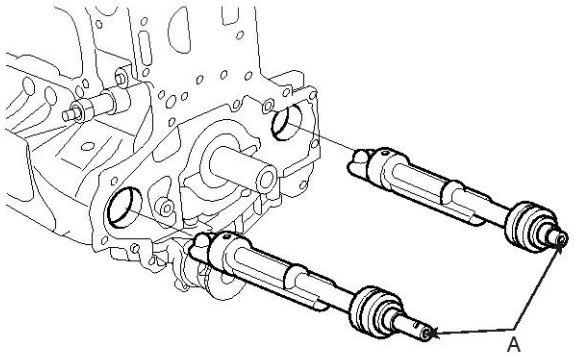
KDSE157A

15. Remove the air compressor. (See HA group - compressor)
16. Remove the oil screen and oil supply pipe.
17. Remove the bet plate (A).



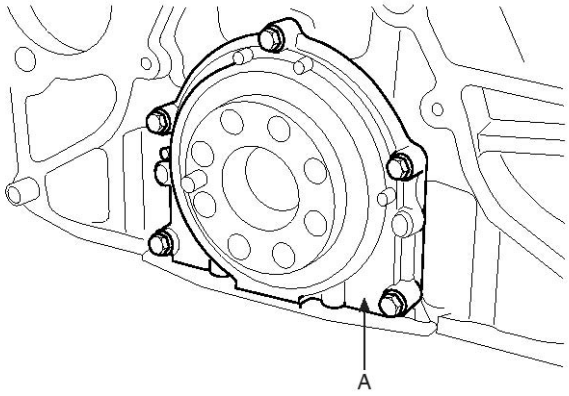
KDSE160A

18. Remove the oil pump.
19. Remove the balance shaft (A) from cylinder block.



KDSE158A

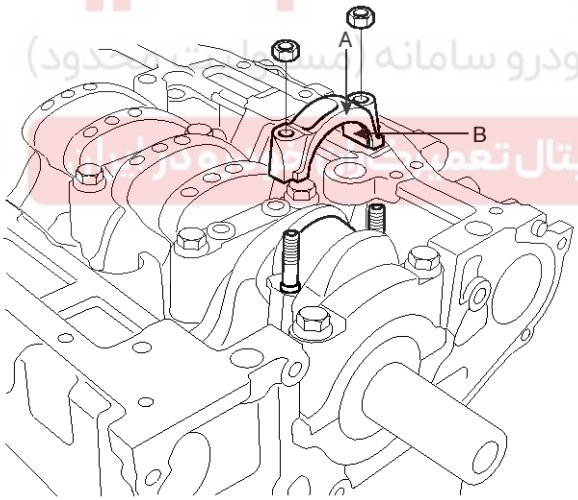
20. Remove the rear oil seal case (A).



KDSE165A

DISASSEMBLY

1. Remove the connecting rod bearing cap (A) and bearing (B).

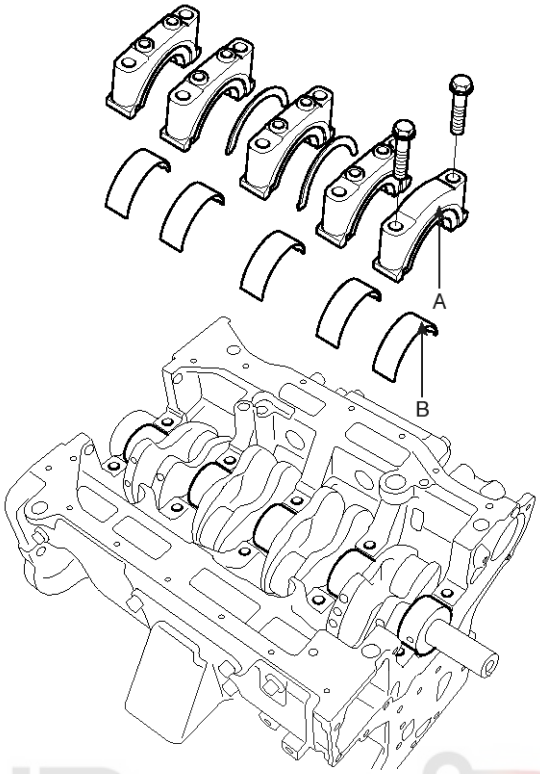


KDSE162B

NOTICE

Mark the connecting rod bearing caps to be able to reassemble in the original position and direction.

2. Remove the piston and connecting rod assembly from the cylinder block.
3. Remove the main bearing cap (A) and bearing (B).

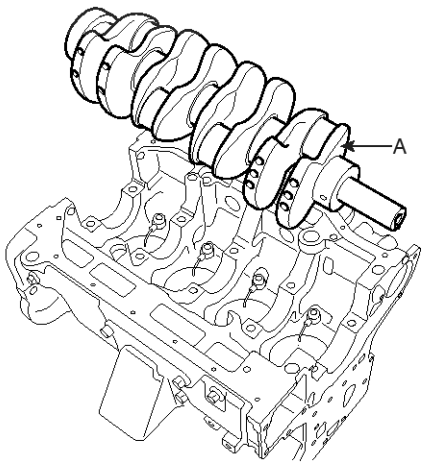


KDSE166A

4. Remove the clank shaft (A) from cylinder block.

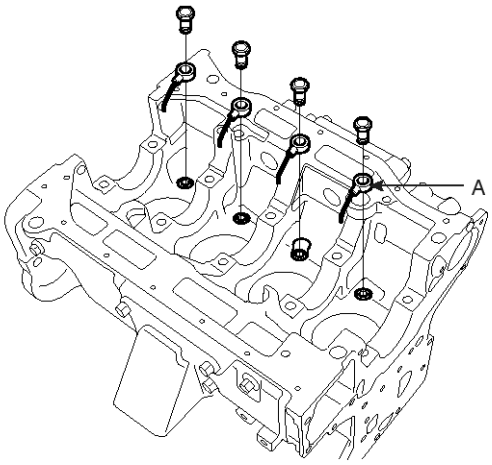
CAUTION

Clank shaft being careful not to damage the journals.



KDSE167A

5. Remove the oil jet (A).



KDSE168A

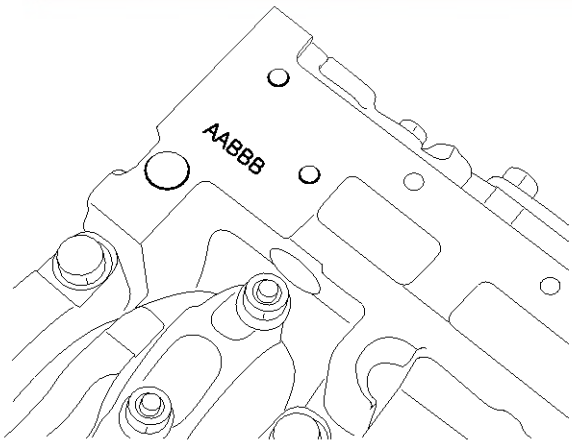
MAIN JOURNAL BEARING

1. Check the cylinder block main bearing bore size code.

NOTICE

Record the cylinder block main bearing bore size code letters on cylinder block as shown.

Reading order is from left to right with front main bearing bore size code shown first.



KDSE164A

CYLINDER BLOCK MAIN BEARING BORE DIAMETER

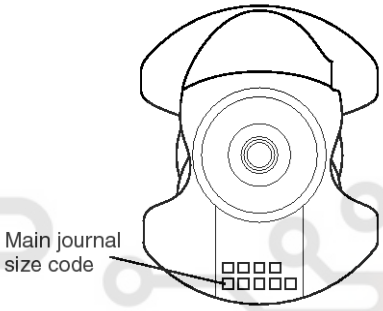
Code	Cylinder block main bearing bore diameter (mm (in))
A	71.000 - 71.008 (2.7953 - 2.7956)
B	71.006 - 71.016 (2.7956 - 2.7959)
C	71.016 - 71.024 (2.7957 - 2.7962)

2. Check the crankshaft main journal size code.

NOTICE

Record the main journal size code letters on the crankshaft balance weight.

Reading order is from left to right as shown, with No. 1 main journal size code shown first.



LCAC163B

CRANKSHAFT MAIN JOURNAL DIAMETER

Code	Crankshaft main journal diameter (mm (in))
A	66.994 - 67.000 (2.6376 - 2.6378)
B	66.988 - 66.994 (2.6373 - 2.6376)
C	66.982 - 66.988 (2.6371 - 2.6373)

3. Choose proper main journal bearing in below table.

MAIN JOURNAL BEARING SELECTION TABLE

Main journal bearing		Cylinder block main bearing bore size code		
		A	B	C
Crankshaft pin journal size code	A	Green	Yellow	None
	B	Yellow	None	Blue
	C	None	Blue	Red

Main journal bearing oil clearance :
0.030 - 0.054 mm (0.0012 - 0.0021 in)

MAIN JOURNAL BEARING THICKNESS

Color	Main journal bearing thickness (mm (in))
Red	1.994 - 1.997 (0.0785 - 0.0786)
Blue	1.991 - 1.994 (0.0784 - 0.0785)
None	1.988 - 1.991 (0.0783 - 0.0784)
Yellow	1.985 - 1.988 (0.0781 - 0.0783)
Green	1.982 - 1.985 (0.0780 - 0.0781)

CONNECTING ROD BEARING

1. Check the connecting rod big-end bore size code(A).

NOTICE

Record the connecting rod big-end bore size code letters on connecting rod cap as shown.

ACAE143A

CONNECTING ROD BIG-END DIAMETER

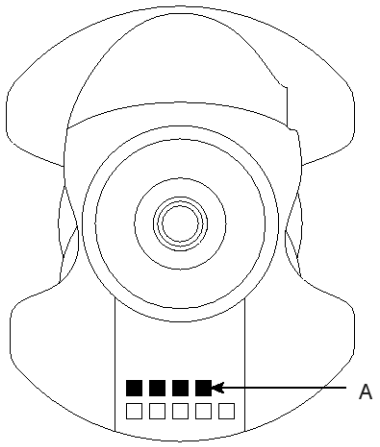
Code	Connecting rod big-end diameter mm (in)
A	60.000 - 60.006 (2.3622 - 2.3624)
B	60.006 - 60.012 (2.3624 - 2.3627)
C	60.012 - 60.018 (2.3627 - 2.3629)

2. Check the crankshaft pin journal size code(A).

NOTICE

Record the pin journal size code letters on the No. 1 crankshaft balance weight.

Reading order is from left to right as shown, with No. 1 pin journal size code shown first.



ACAE143B

CRANKSHAFT PIN JOURNAL DIAMETER

Code	Crankshaft pin journal diameter mm (in)
A	56.994 - 57.000 (2.2439 - 2.2441)
B	56.988 - 56.994 (2.2436 - 2.2439)
C	56.982 - 56.988 (2.2434 - 2.2436)

3. Choose proper connecting rod bearing in below table.

CONNECTING ROD BEARING SELECTION TABLE

Connecting rod bearing		Connecting rod big-end bore size code		
		A	B	C
Crankshaft pin journal size code	1	Green	Yellow	None
	2	Yellow	None	Blue
	3	None	Blue	Red

Connecting rod bearing oil clearance :
0.024 - 0.042 mm (0.0009 - 0.0017 in)

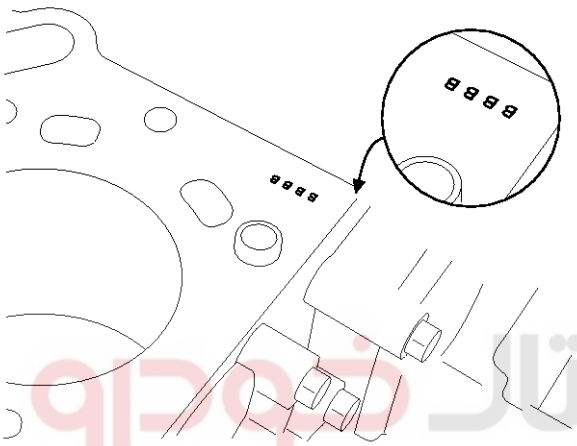
CONNECTING ROD BEARING THICKNESS

Color	Connecting rod bearing thickness - mm (in)
Red	1.497 - 1.500 (0.0589 - 0.0591)
Blue	1.494 - 1.497 (0.0588 - 0.0589)
None	1.491 - 1.494 (0.0587 - 0.0588)
Yellow	1.488 - 1.491 (0.0586- 0.0587)
Green	1.485 - 1.488 (0.0585 - 0.0586)

PISTON

1. Check the cylinder bore size code on the cylinder block bottom face.

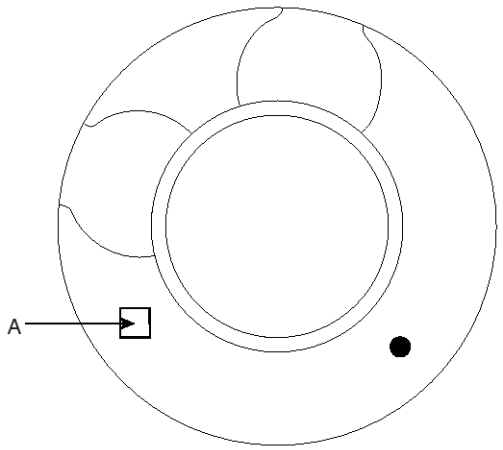
Code	Cylinder bore inner diameter (mm (in))
A	91.000-91.010 (3.5827-3.5831)
B	91.010-91.020 (3.5831-3.5835)
C	91.020-91.030 (3.5835-3.5839)



KDSE144A

2. Check the piston size code(A) on the piston top face.

Code	Piston outer diameter (mm (in))
A	90.910-90.920 (3.5791-3.5795)
B	90.920-90.930 (3.5795-3.5799)
C	90.930-90.940 (3.5799-3.5803)



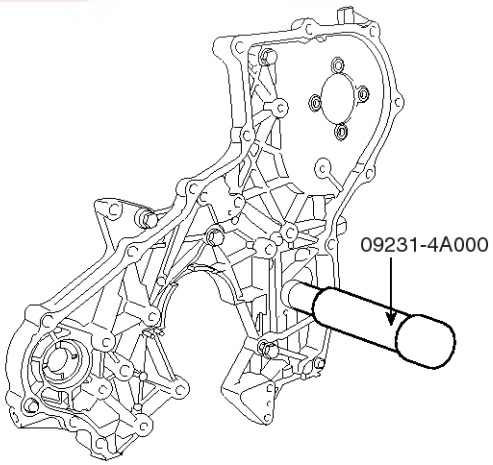
ACAE149B

3. Select the piston related to cylinder bore size code.

Oil clearance : 0.080-0.100 mm (0.0031-0.0039 in)

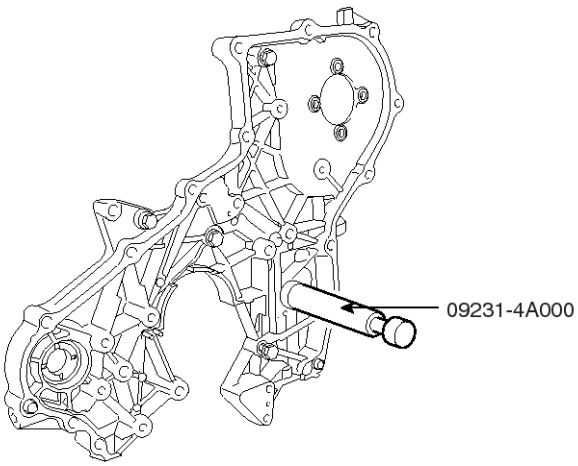
LH BALANCE SHAFT DRIVE GEAR BEARING (BUSH)

1. Use the special tool (09231-4A000) to install or remove the LH balance shaft drive gear bearing.
2. To remove the bearing, install the special tool (09231-4A000).



LCAC154A

3. When installing the bearing, apply enough fluid to the bearing surface and cover.
4. Press-fit the bearing after aligning the bearing oil hole with the timing chain lower under cover oil hole.



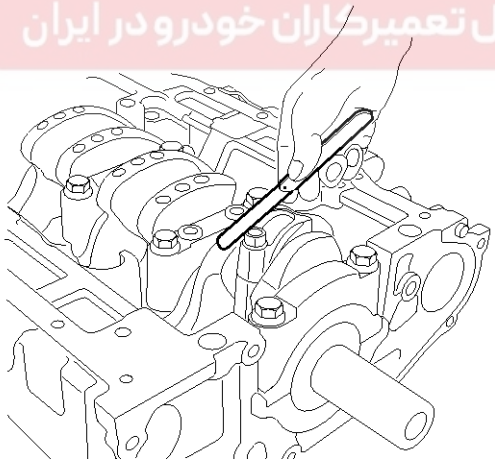
LCAC154B

INSPECTION

CONNECTING ROD BAERING

1. Before removing the connecting rod cap, measure connecting rod side clearance. If side clearance exceeds specification, replace the connecting rod.

Side clearance : 0.05 - 0.25 mm (0.0020 - 0.0098 in)



KDSE163A

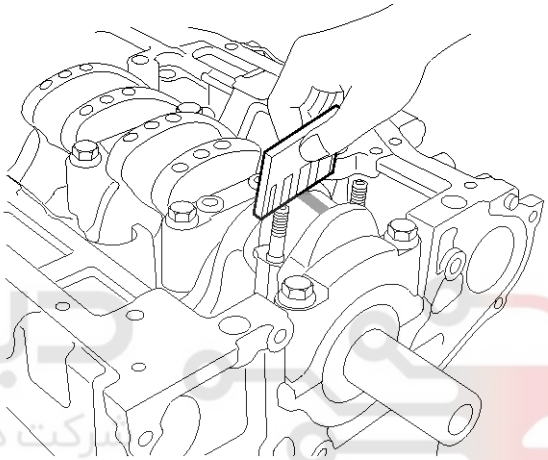
2. Remove the connecting rod cap.
3. Measure connecting rod bearing oil clearance.
   a. Remove all foreign material and oil from the pin journals and connecting rod bearing surface.
   b. Position a plastic gauge atop the pin journals in axial direction.
   c. Install the connecting rod cap and tighten bolts.

Tightening torque :
58.8 N.m (6.0 kgf.m, 43.4 lb-ft) → Loosen → 32.4~36.3 N.m (3.3~3.7 kgf.m, 23.9~26.8 lb-ft) + 60~64°

⚠CAUTION
Always use new connecting rod cap bolts.

   d. Remove the connecting rod cap, and measure oil clearance at each journal.

Oil clearance :
0.024 - 0.042 mm (0.0009 - 0.0017 in)



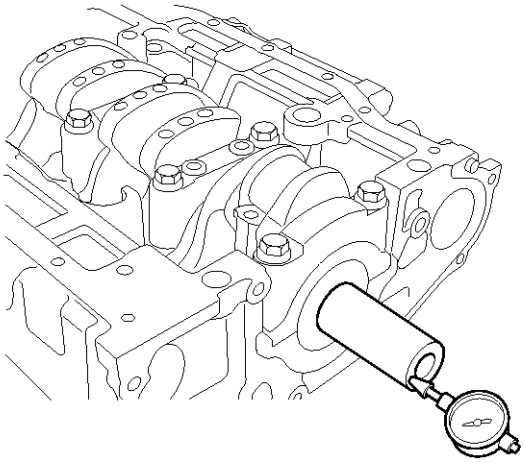
KDSE162A

4. If oil clearance exceeds specification, replace the connecting rod bearing.

CRANK SHAFT MAIN BEARING

1. Before removing the main bearing cap, measure crankshaft end play. If end play exceeds specification, replace the thrust bearing.

End play: 0.05 - 0.25 mm (0.0020 - 0.0098 in)



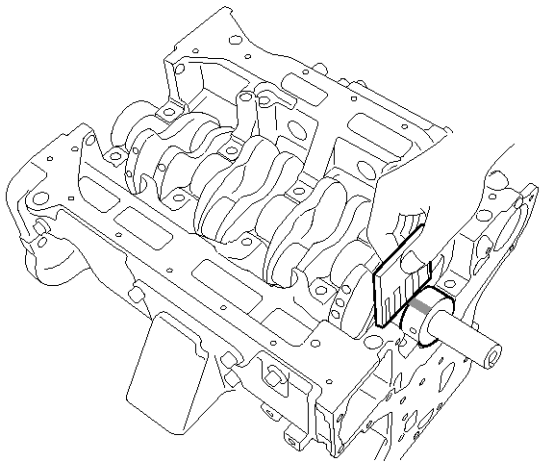
KDSE166B

2. Remove the main bearing cap.
3. Measure main bearing oil clearance.
   a. Remove all foreign material and oil from the main journals and main bearing surface.
   b. Position a plastic gauge atop the main journals in axial direction.
   c. Install the main bearing cap and tighten bolts.

Tightening torque :
127.5-137.3 N.m (13-14 kgf.m, 94.0-101.3 lb-ft)

   d. Remove the main bearing cap, and measure oil clearance at each journal.

Oil clearance :
0.024 - 0.042 mm (0.0009 - 0.0017 in)



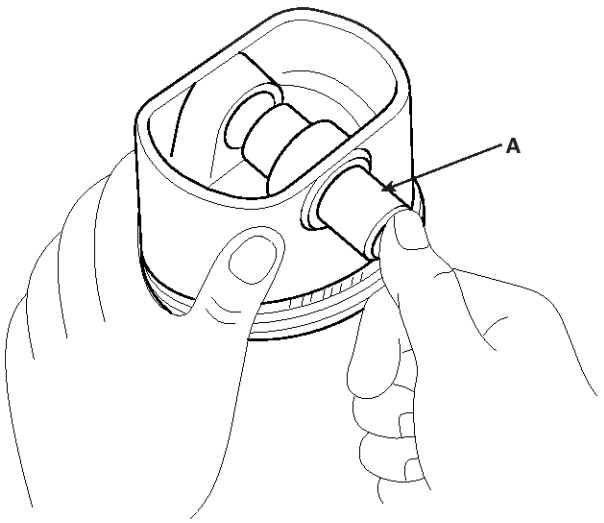
KDSE166C

4. If oil clearance exceeds specification, replace the main bearing.

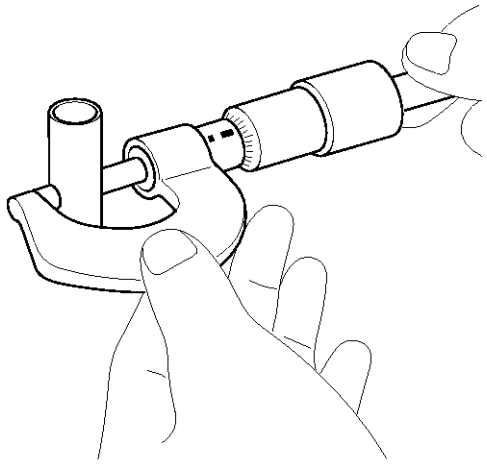
PISTON

1. Check each piston for scuffing, scoring, wear and other defects. Replace any piston that is defective.
2. Check that the piston pin fits in the piston pin hole. Replace any piston and pin assembly that is defective.

   The piston pin must be smoothly pressed by hand into the pin hole (at room temperature).



ECKD001M



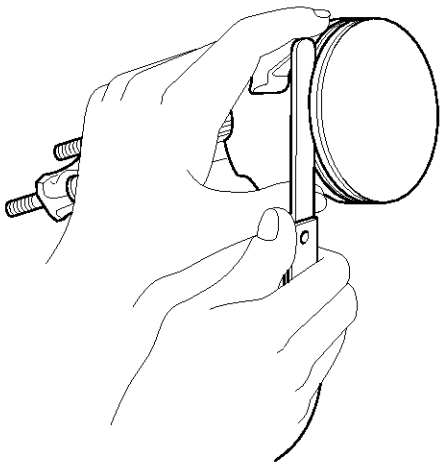
ECKD001Z

Piston pin outer diameter :
32.993-32.998 mm (1.2989-1.2991 in)
Piston pin hole inner diameter :
33.014-33.019mm (1.2998-1.3000 in)
Connecting rod small-end inner diameter :
33.020-33.033 mm (1.3000-1.3005 in)

PISTON RING

1. Check each piston ring for breakage, damage and abnormal wear. Replace the defective rings.
2. When the piston requires replacement, its ring should also be replaced.
3. Measure the clearance between piston ring and ring groove.

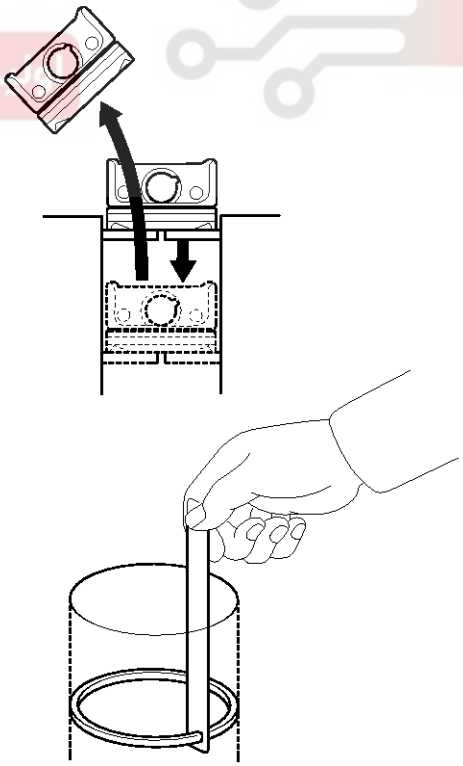
Piston ring side clearance :
No.2 ring : 0.05-0.09 mm (0.0020-0.0035 in)
Oil ring : 0.04-0.08 mm (0.0016-0.0031 in)



ECKD001G

4. Place a piston ring in the cylinder bore and set it square by pushing it down with piston.

Eng gap :
No.1 ring : 0.25-0.40 mm (0.0098-0.0157 in)
No.2 ring : 0.50-0.70 mm (0.0197-0.0276 in)
Oil ring : 0.20-0.40 mm (0.0079-0.0157 in)



ECKD001K

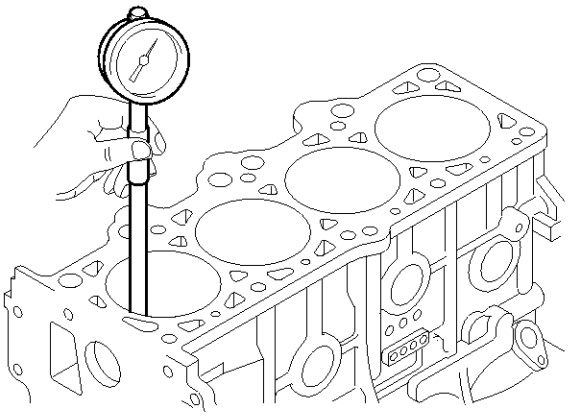
CYLINDER BLOCK

NOTICE

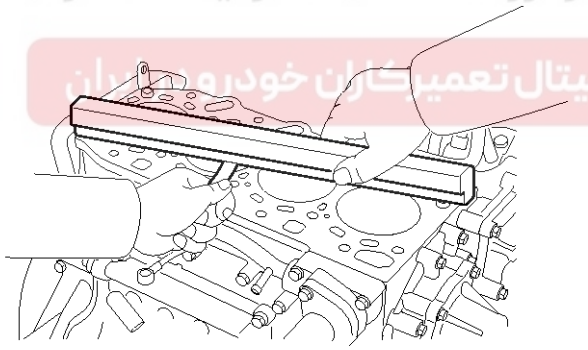
- *Before inspection and repair, clean parts to remove dirt, oil, carbon, deposits, and scale.*
- *Before cleaning the cylinder block, be sure to check for evidences of water leaks and damage.*
- *Remover contaminants from oil holes with compressed air and, at the same time, make sure that they are not blocked.*

1. Check for scratches, rust, and corrosion. Use also a flaw-detecting agent for the check. If defects are evident, correct or replace.
2. Using a straightedge and thickness gauge, check the cylinder block top surface for flatness. Lay the straightedge long ways and crossways as indicated by A, B,... in illustration. If flatness is flatness is not within the limit, replace the cylinder block top surface is free from any traces of gasket material.

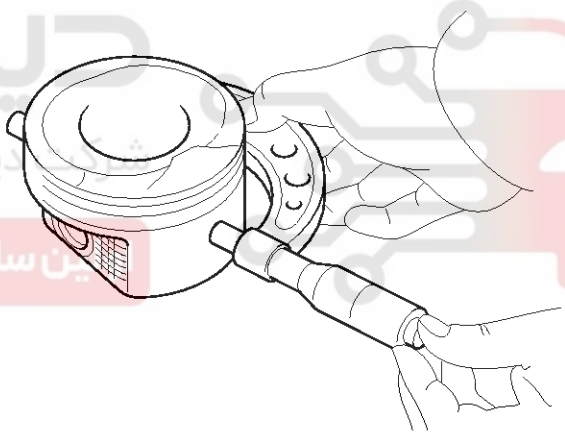
Standard value :
0.05 mm (0.002 in.)
Limit: 0.1 mm (0.004 in.)



ECKD318A



KDSE145B



ECKD001D

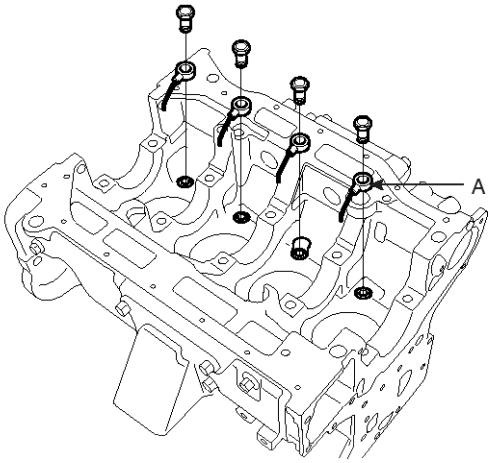
3. Check cylinder wall for scratches and seizure.
   If defects are evident, correct (to oversize) or replace.
4. Using cylinder gauge, measure the cylinder bore.
   If it wears out excessively, bore the cylinder to oversize and replace the piston and piston rings.
   Measurement points are as shown.

Standard value :
91.000 - 91.030 mm (3.5827-3.5839 in)

REASSEMBLY

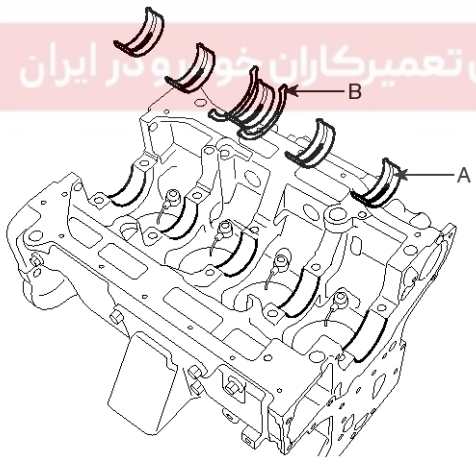
1. Install the oil jet (A).

Tightening torque :
29.4 ~ 34.3N.m (3 ~ 3.5kgf.m, 21.7 ~ 25.3lb-ft)



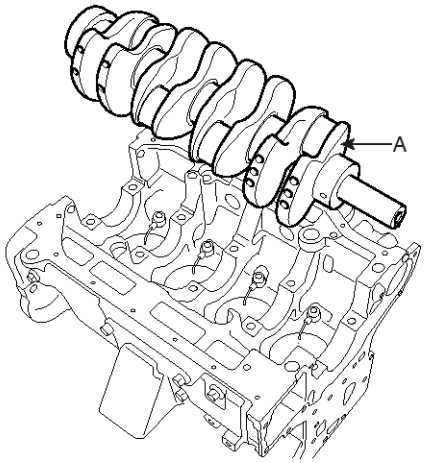
KDSE168A

2. Install the main bearing (A).



KDSE169A

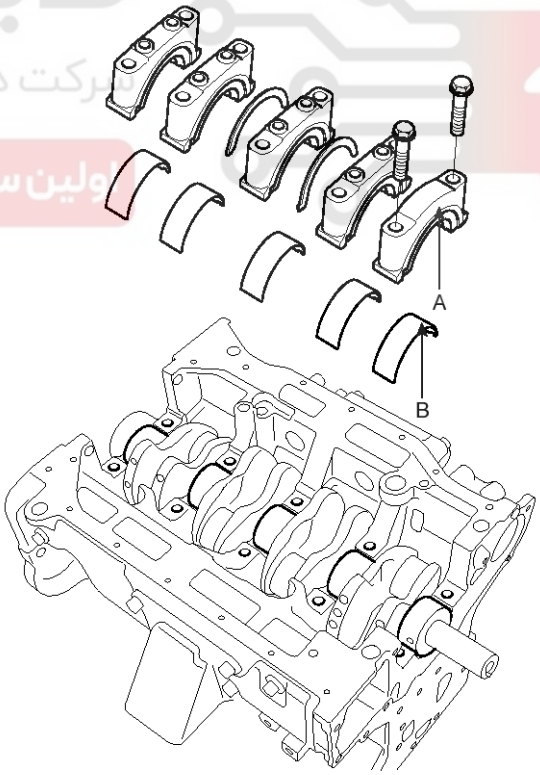
3. Install the thrust bearing (B).
4. Install the clank shaft (A).



KDSE167A

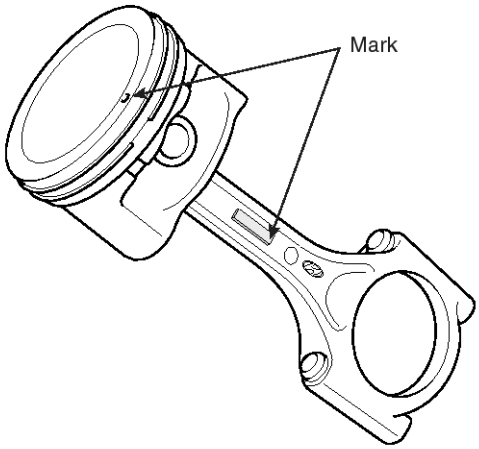
5. Check the main bearing, cap number. And then Install the main bearing (A) and bearing (B).

Tightening torque :
127.5 ~ 137.3N.m (13 ~ 14kgf.m, 94.0 ~101.3lb-ft)



KDSE166A

6. Check the front mark of the piston and connecting rod.

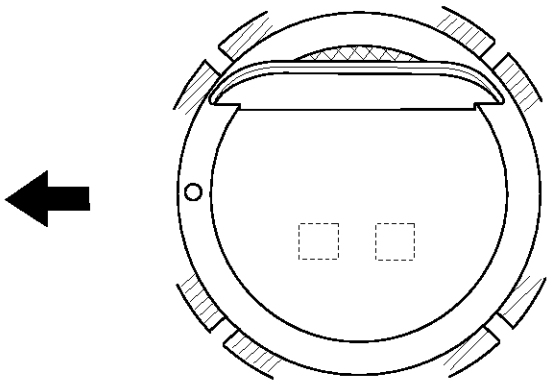


SBLEM6043L

7. Line up the front marks and insert the piston pin. The piston pin must be smoothly pressed by hand into position.

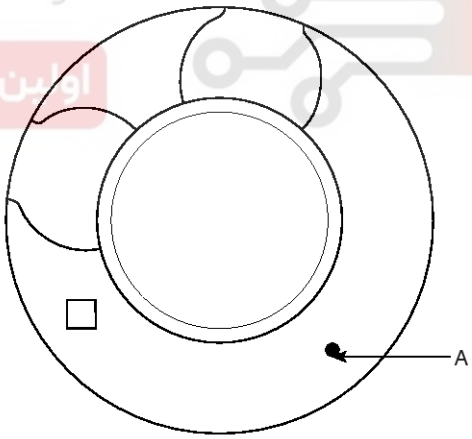
KDSE170A

8. Install the snap ring.
9. Install the piston rings.
   a. Install the oil ring expander and 2 side rails by hand.
   b. Using a piston ring expander, install the 2 compression rings with the code mark facing upward.
   c. Position the piston rings so that the ring ends are as shown.



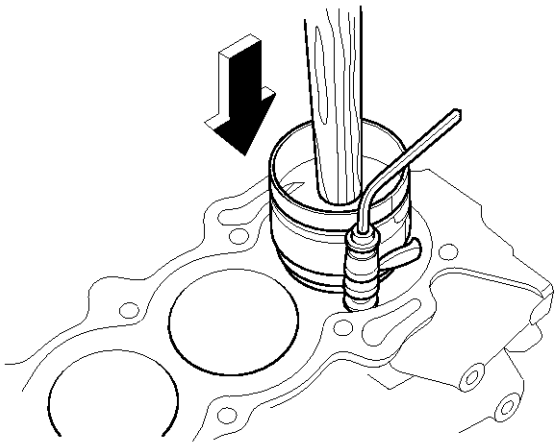
ECKD321A

10. Insert the piston and connecting rod assembly from above the top of cylinder. Ensure that the front mark (A) on the piston crown and that (front mark) on the connecting rod face toward the front of engine (to the crankshaft pulley side).



ACAE145A

11. Clamp firm the piston rings with the ring band and install the piston assembly into cylinder. Do not strike it hard into the piston, as broken piston ring or damaged crankshaft pin journal could result.

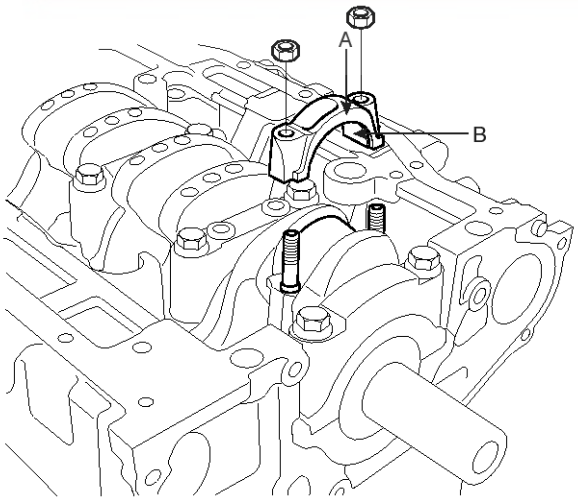


ECKD001F

12. Install the connecting rod bearing (B).
13. Install the connecting rod and cap (A) to crankshaft pin journal.

Tightening torque :
58.8 N.m (6.0 kgf.m, 43.4 lb-ft) → Loosen → 32.4~36.3 N.m (3.3~3.7 kgf.m, 23.9~26.8 lb-ft) + 60~64°

⚠CAUTION
Always use new connecting rod cap bolts.

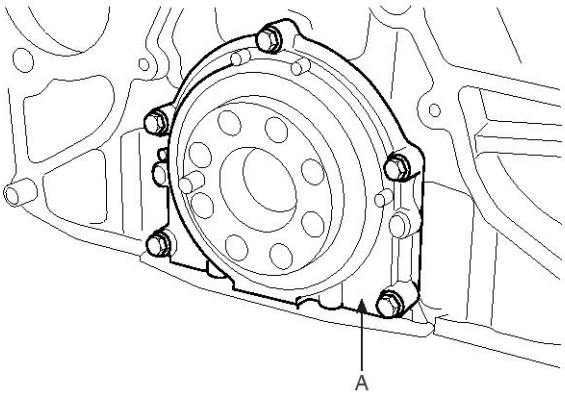


KDSE162B

INSTALLATION

1. Install the rear oil seal (A).

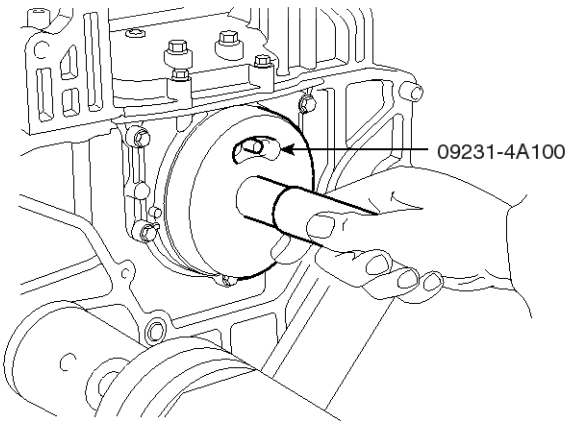
Tightening torque :
9.8 ~ 11.8N.m (1.0 ~ 1.2kgf.m, 7.2 ~ 8.7lb-ft)



KDSE165A

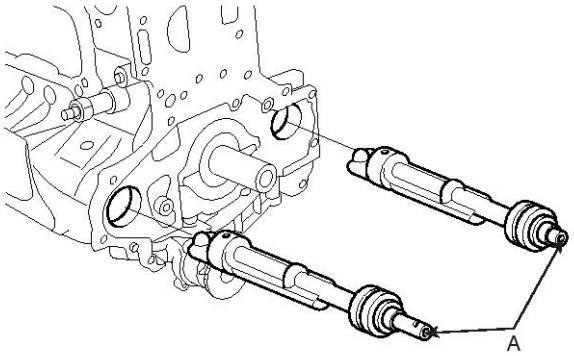
2. Temporarily install a new rear oil seal to the oil seal case and install the special tool (09231-4A100) through the rear oil seal case.

NOTICE
Apply engine fluid to the circumference of oil seal lip.



LCAC164A

3. Apply engine fluid to the balance shaft journal and balance shaft bearing (bush).
4. Install the balance shaft(A) into cylinder block.

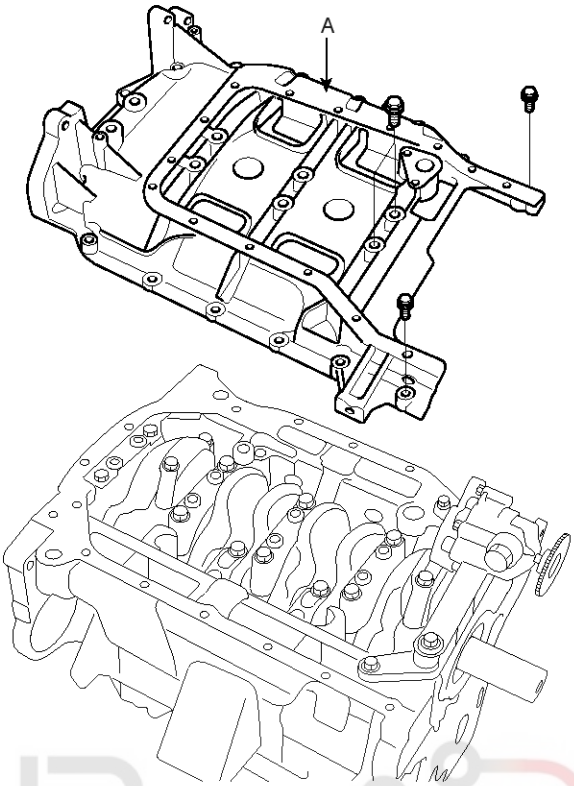


KDSE158A

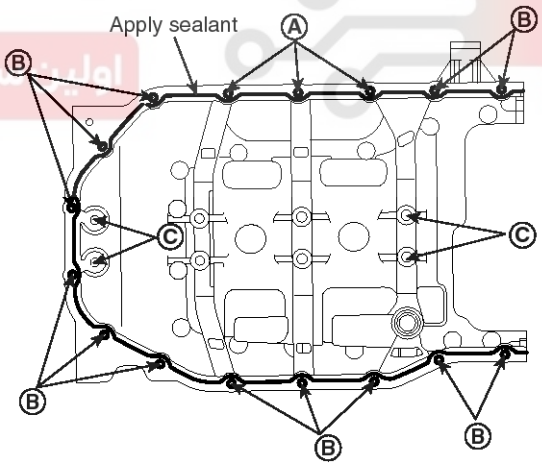
5. Install the oil pump.
6. Apply sealant on the timing chain lower under cover after clean foreign material. And Install the bet plate (A).

Bolt	Size	Quantity	Tightening torque N.m (kgf.m, lb-ft)
A	6 x 14	4 EA	9.8-11.8 (1.0-1.2, 7.2-8.7)
B	8 x 22	1 EA	19.6-26.5 (2.0-2.7, 14.5-19.5)
C	8 x 30	1 EA	19.6-26.5 (2.0-2.7, 14.5-19.5)
D	8 x 40	1 EA	19.6-26.5 (2.0-2.7, 14.5-19.5)

* Bolts size = Diameter x Length



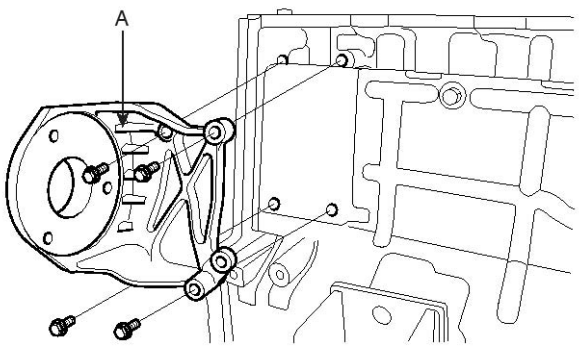
KDSE160A



SBLEM6045L

7. Install the oil screen and oil supply pipe.
8. Install the air compressor. (See HA group)
9. Install the fuel pump bracket (A).

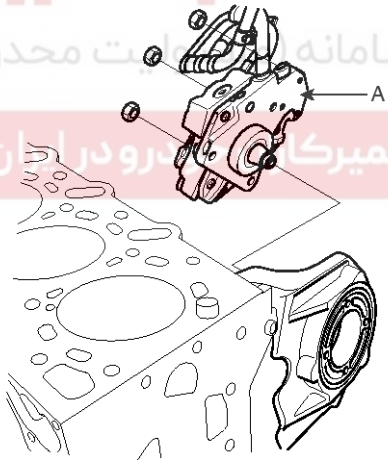
Tightening torque :
19.6 ~ 26.5N.m (2.0~ 2.7kgf.m, 14.5~19.5lb-ft)



KDSE157A

10. Install the fuel pump (A).

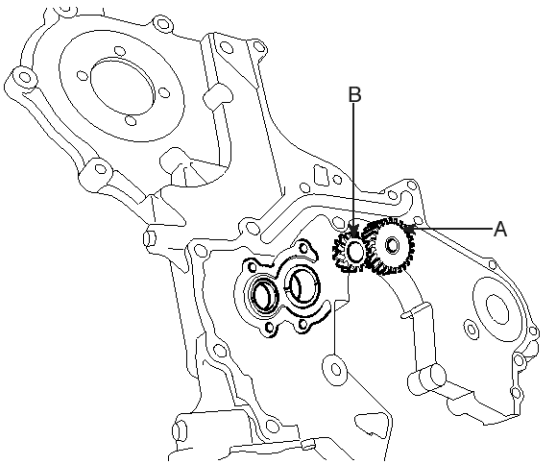
Tightening torque :
14.7 ~ 19.6N.m (1.5~ 2.0kgf.m, 10.8~14.5lb-ft)



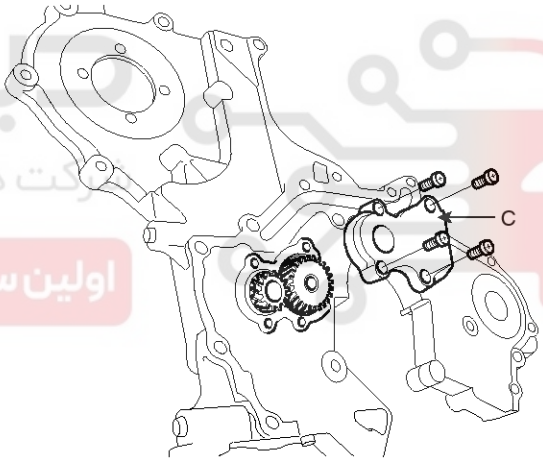
KDSE156A

11. Install the balance shaft drive gear (A) and driven gear (B) on the timing chain lower under cover.

Drive gear and driven gear cover (C) :
Tightening torque :
7.8-11.8 N.m (0.8-1.2 kgf.m, 5.8-8.7 lb-ft)

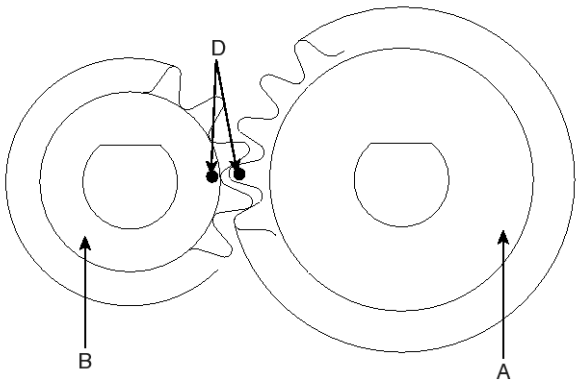


KDSE174A



KDSE175A

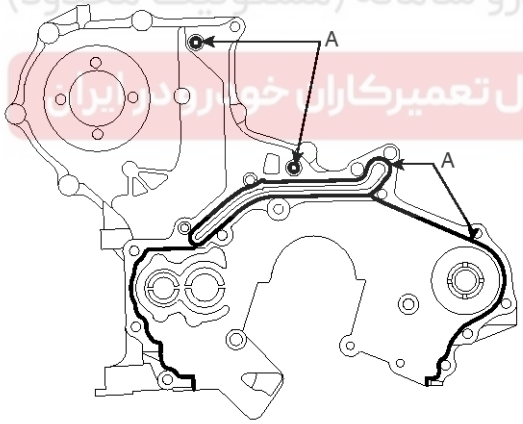
NOTICE
Align timing mark (D) on the drive gear (A) and driven gear (B).



ACAE153Z

12. Apply sealant (A) on the timing chain lower under cover after clean foreign material.

Sealant type: Lotite #5902
Bead width: 2 - 4mm (0.08 - 0.16 in)

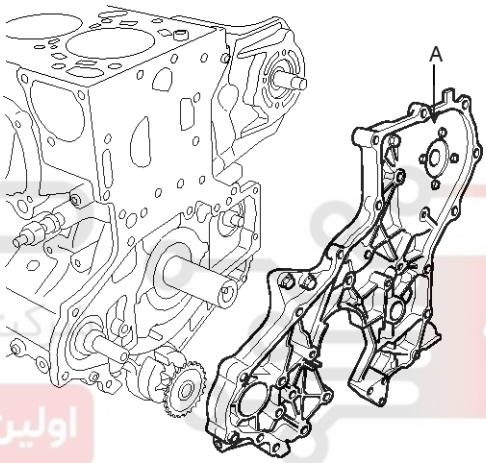


ACAE153B

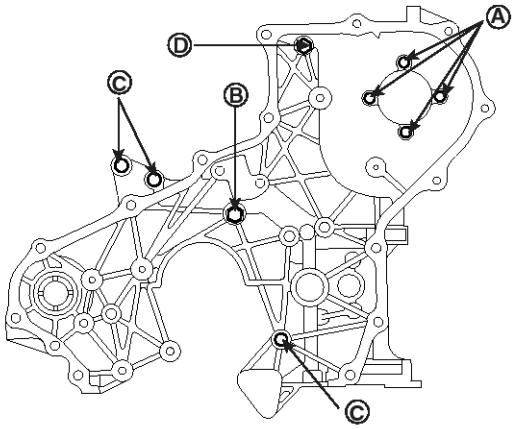
13. Install the timing chain lower under cover (A).

Bolt	Size	Quantity	Tightening torque N.m (kgf.m, lb-ft)
A	6 x 14	4 EA	9.8-11.8 (1.0-1.2, 7.2-8.7)
B	8 x 22	1 EA	19.6-26.5 (2.0-2.7, 14.5-19.5)
C	8 x 30	3 EA	19.6-26.5 (2.0-2.7, 14.5-19.5)
D	8 x 40	1 EA	19.6-26.5 (2.0-2.7, 14.5-19.5)

*Bolts size = Diameter x Length



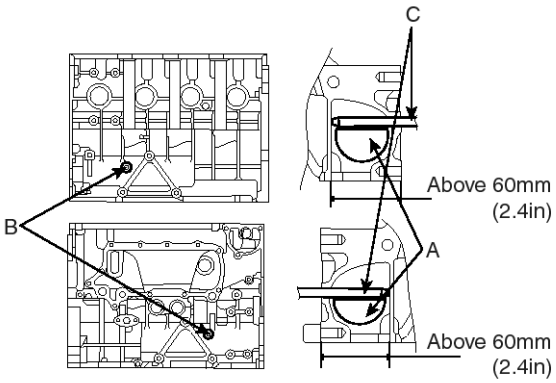
KDSE155A



ACAC153C

14. Insert a screw driver(C) in the cylinder block plug hole (B). Because, prevent rotation of balance shaft (A).

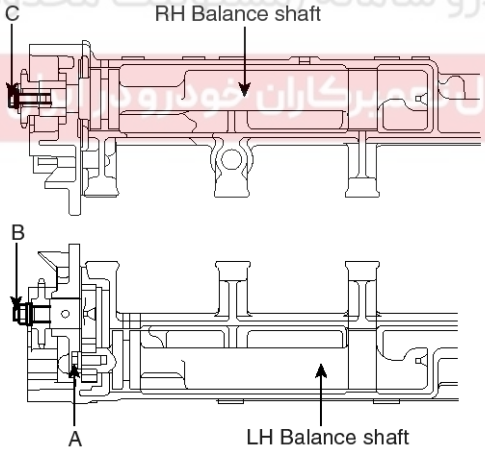
■ LH side



SBLEM6022L

15. Install the LH balance shaft driven gear bolt (A) (8 x 16).

Tightening torque :
33.3 ~ 44.1N.m (3.4~ 4.0kgf.m, 24.6~32.5lb-ft)



SBLEM6023L

16. Install the balance shaft sprocket.

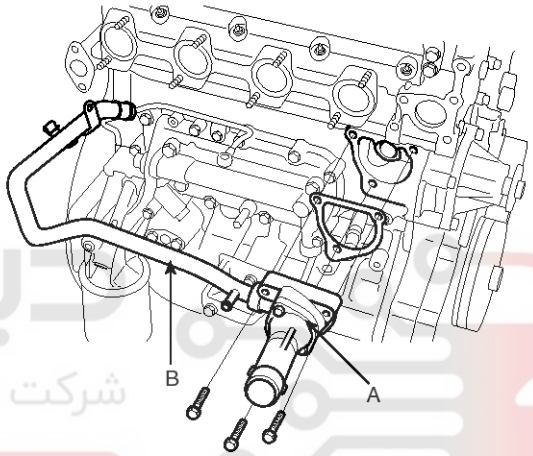
Tightening torque :
LH balance shaft sprocket nut :
49.0-58.8 N.m (5.0-6.0 kgf.m, 36.2-43.4 lb-ft)
RH balance shaft sprocket bolt (8 x 16) :
33.3-39.2 N.m (3.4-4.0 kgf.m, 24.6-28.9 lb-ft)

17. Install plug on the cylinder block after remove driver.

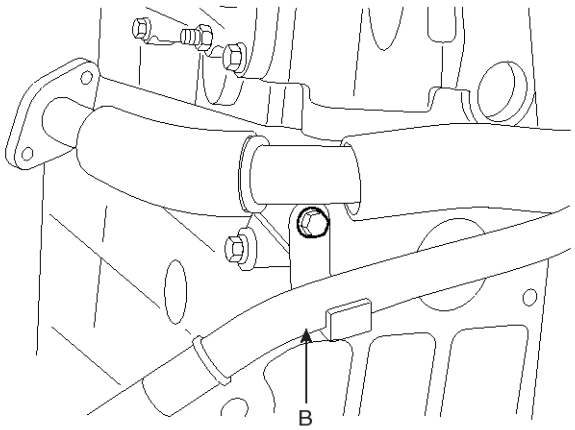
Tightening torque (plug) :
14.7-21.6 N.m (1.5-2.2 kgf.m, 10.8-15.9 lb-ft)

18. Install the water pump.
19. Install the oil cooler.
20. Install the thermostat housing (A) and heater pipe (B).

Tightening torque :
Thermostat housing: 19.6~26.5 N.m (2.0-2.7 kgf.m, 14.5 – 19.5 lb-ft)
Heater pipe: 7.8-11.8 N.m (0.8~1.2 kgf.m, 5.8-8.7 lb-ft)



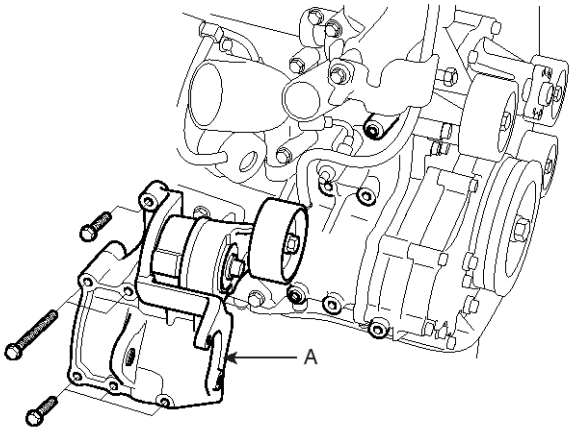
KDSE138A



KDSE206A

21. Install the power steering pump bracket (A).

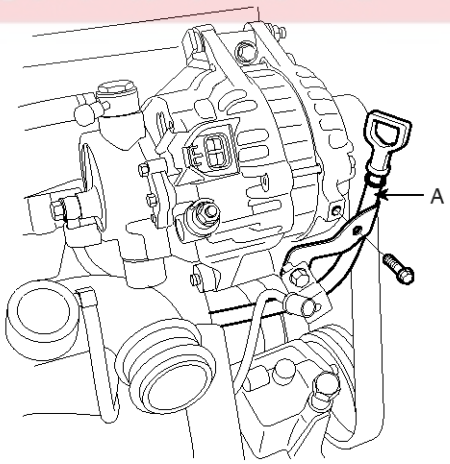
Tightening torque :
19.6~26.5 N.m (2.0-2.7 kgf.m, 14.5-19.5 lb-ft)



KDSE142A

22. Install the power steering pump.(See ST group)
23. Install the oil gage assembly (A).

Tightening torque :
19.6~26.5 N.m (2.0~2.7 kgf.m, 14.5~19.5 lb-ft)

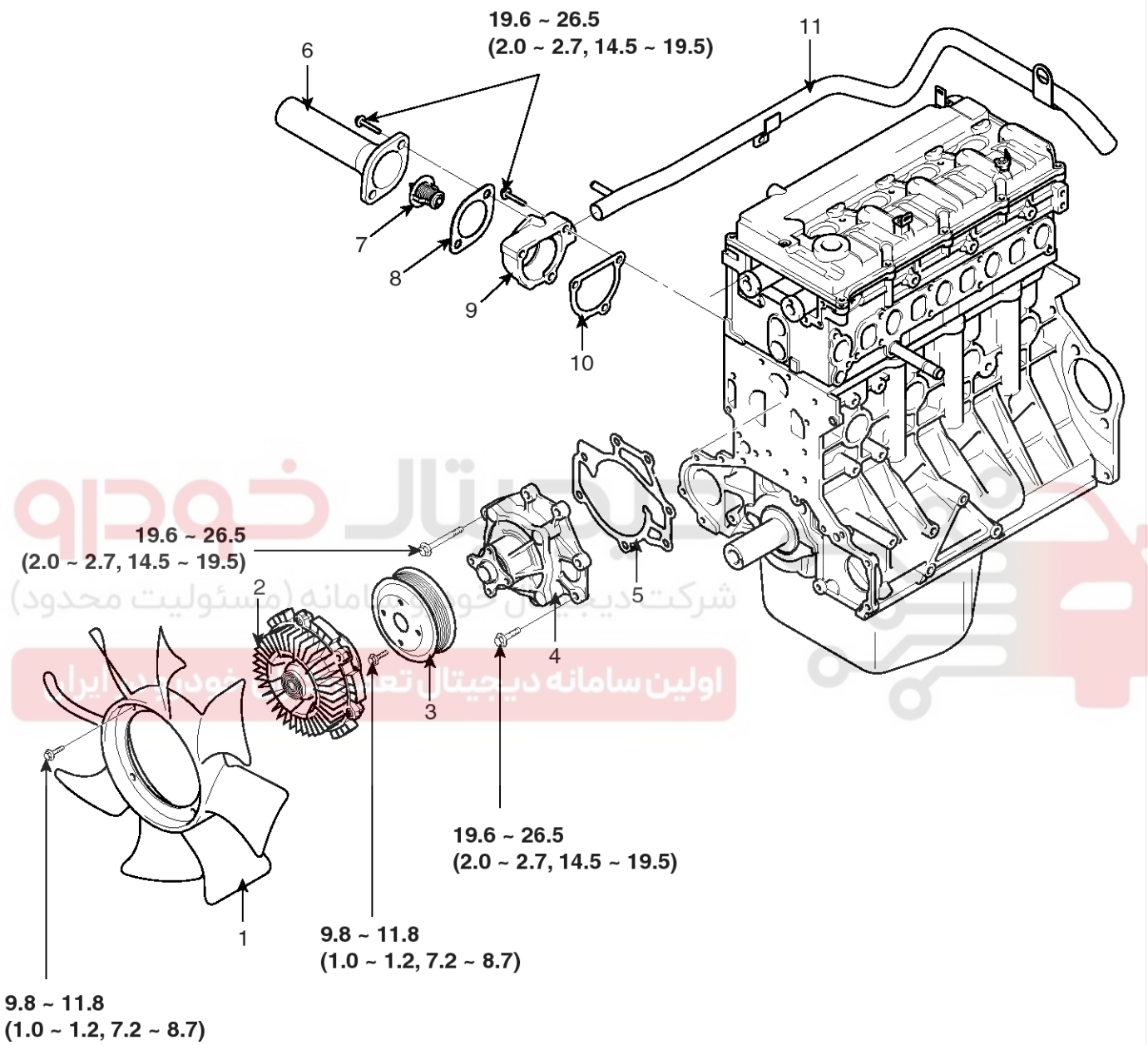


KDSE225A

24. Install the cylinder head.
25. Install the intake manifold and exhaust manifold.
26. Install the timing chain.
27. Install the fly wheel or drive plate.
28. Install the engine and trans axle.

Cooling System

COMPONENTS



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

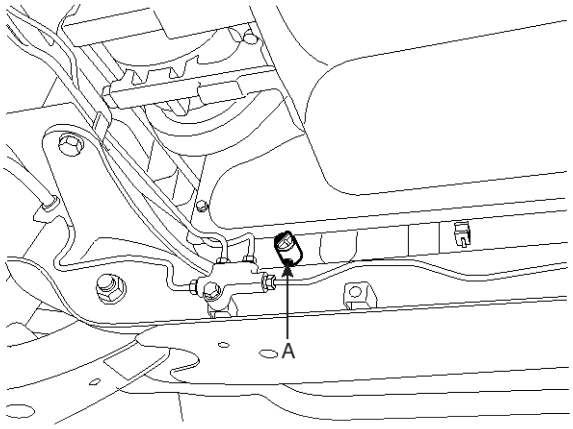
1. Fan
2. Fan cluch
3. Water pump pully
4. Water pump
5. Gasket
6. Water inlet
7. Thermostat fitting
8. Gasket
9. Thermostat housing
10. Gasket
11. Heater pipe

SBLEM6024L

REMOVAL

WATER PUMP

1. Remove the drain plug(A).

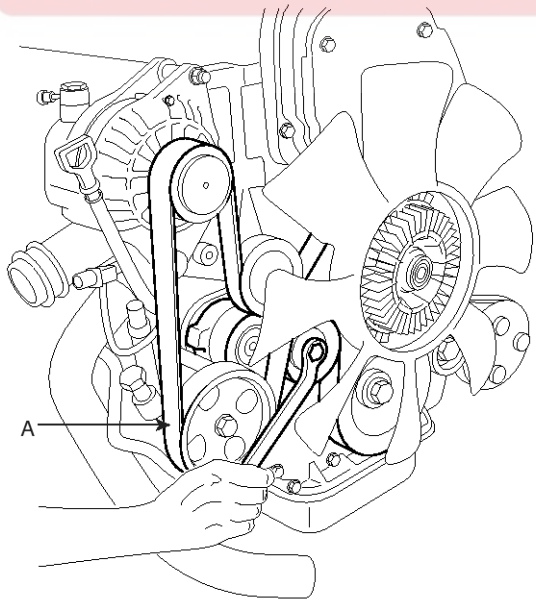


KDSE207A

2. Remove the radiator cowl cover.
3. Remove the drive belt(A).

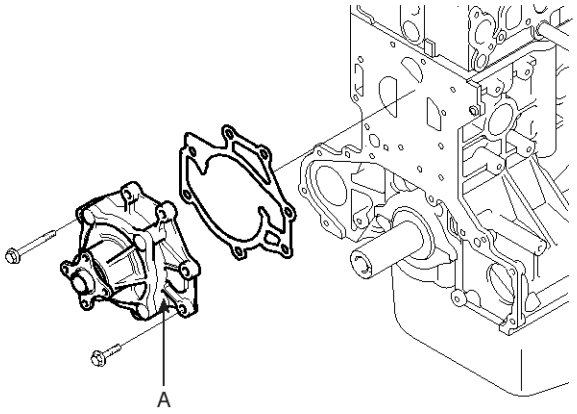
NOTICE

Loosen the water pulley bolt first, and remove the drive belt.



KDSE222B

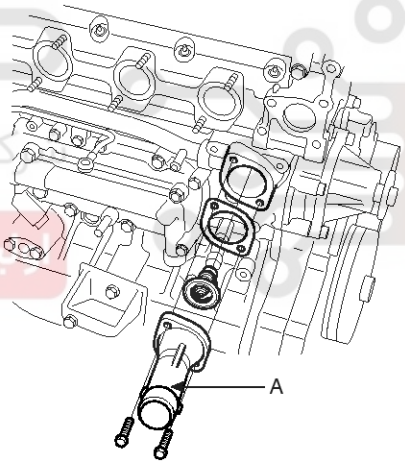
4. Remove the water pump pulley.
5. Remove the water pump(A) from cylinder block.



ACAF061A

Thermostat

1. Drain the coolant so its lever is below the thermostat.
2. Remove the water inlet fitting(A).



KDSE139A

3. Remove the thermostat.

INSPECTION

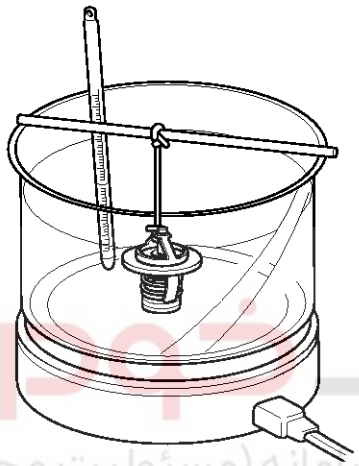
WATER PUMP

1. Check the pump for cracks, damage of wear. Replace the water pump assembly if necessary.
2. Check the bearing for damage, abnormal noise, and sluggish rotation. Replace the water pump assembly if necessary.
3. Check the bearing for damage, abnormal noise, and sluggish rotation. Replace the water pump assembly if necessary.

THERMOSTAT

1. Check that the valve operates properly.
2. Verify the temperature at which the valve begins to open.

ITEM	SPECIFICATION
Valve opening temperature	82˚C(180˚F)
Valve closing temperature	77˚C(171˚F)
Full opening temperature	95˚C(203˚F)



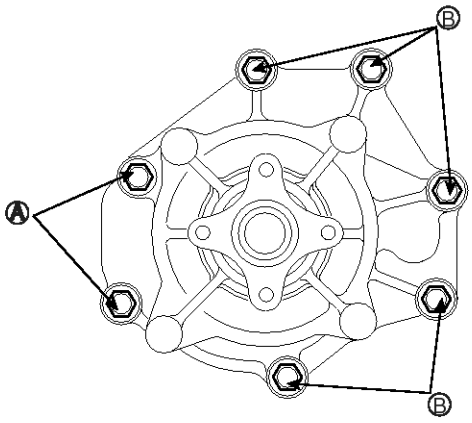
ECKD503B

INSTALLATION

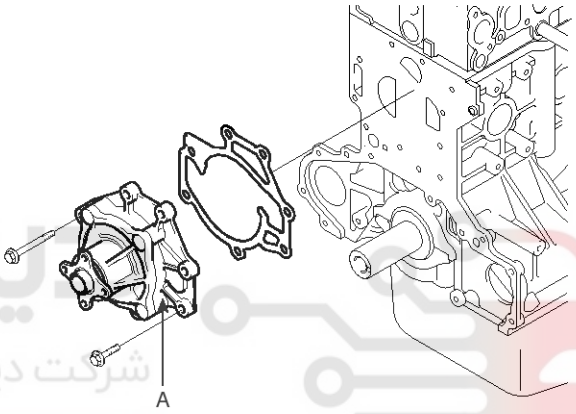
WATER PUMP

1. Install the water pump (A) with new gasket to the cylinder block.

Tightening torque :
A bolts (8 x 45) 2EA :
19.6-26.5 N.m (2.0-2.7 kgf.m, 14.5-19.5 lb-ft)
B bolts (8x45) 2EA:
19.6-26.5 N.m (2.0-2.7 kgf.m, 14.5-19.5 lb-ft)



ACAF062A



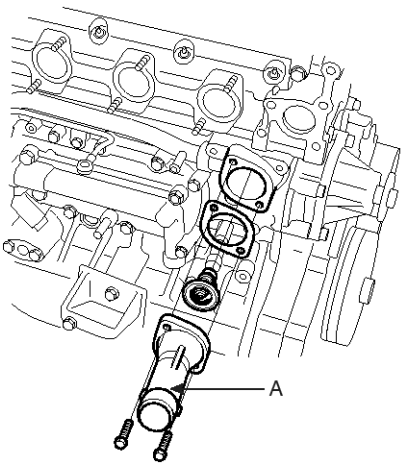
ACAF061A

2. Install the cooling fan.
3. Install the drive belt.
4. Install the radiator cowl upper cover.
5. Refill the engine coolant.

THERMOSTAT

1. Check that the flange of the thermostat is correctly seated in the socket of the thermostat housing.
2. Install the inlet fitting (A).

Tightening torque :
Engine coolant inlet fitting bolt :
19.6 - 26.5 N.m(2.0-2.7kgf.m, 14.5-19.5 lb-ft)

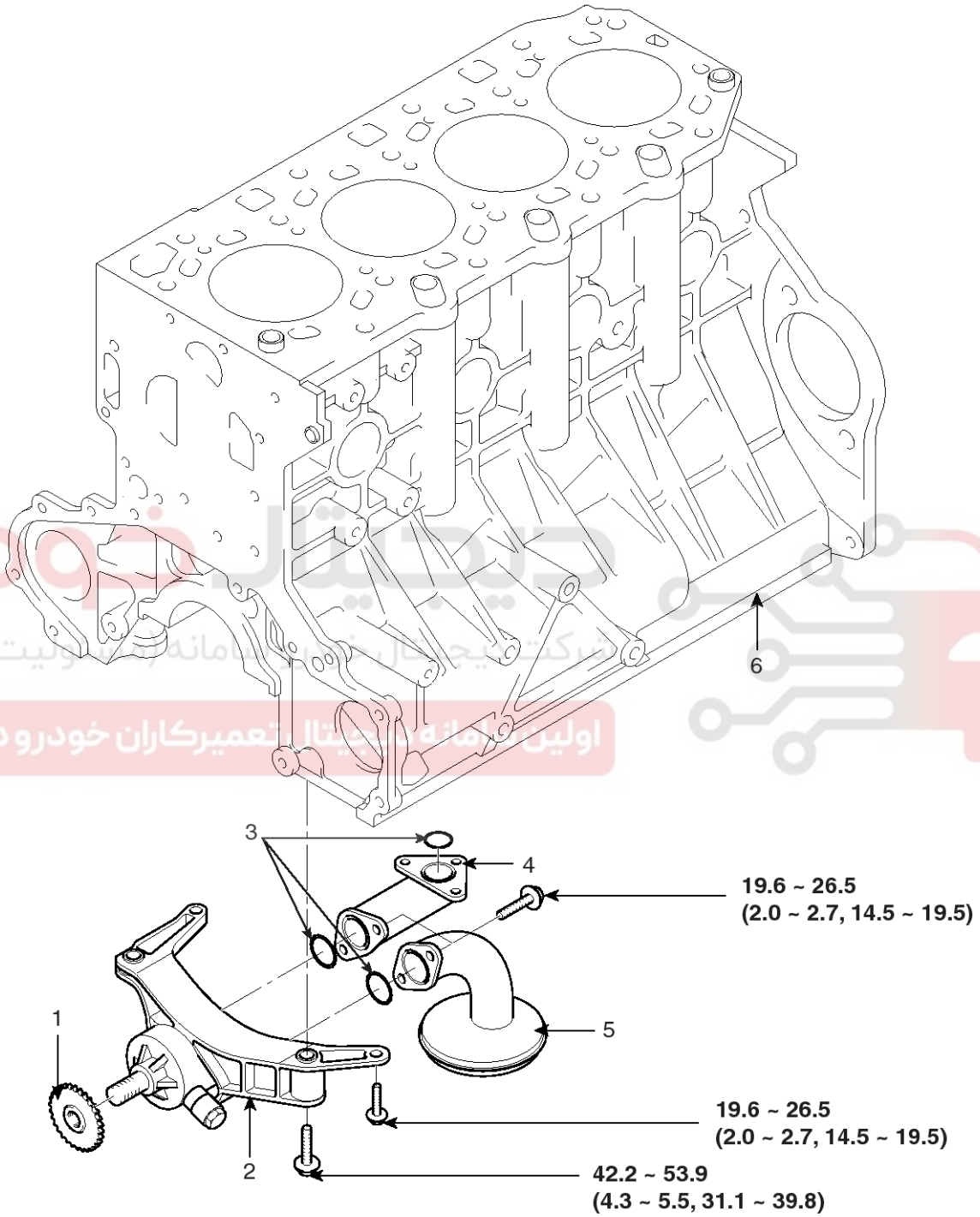


KDSE139A

3. Refill the coolant.

Lubrication System

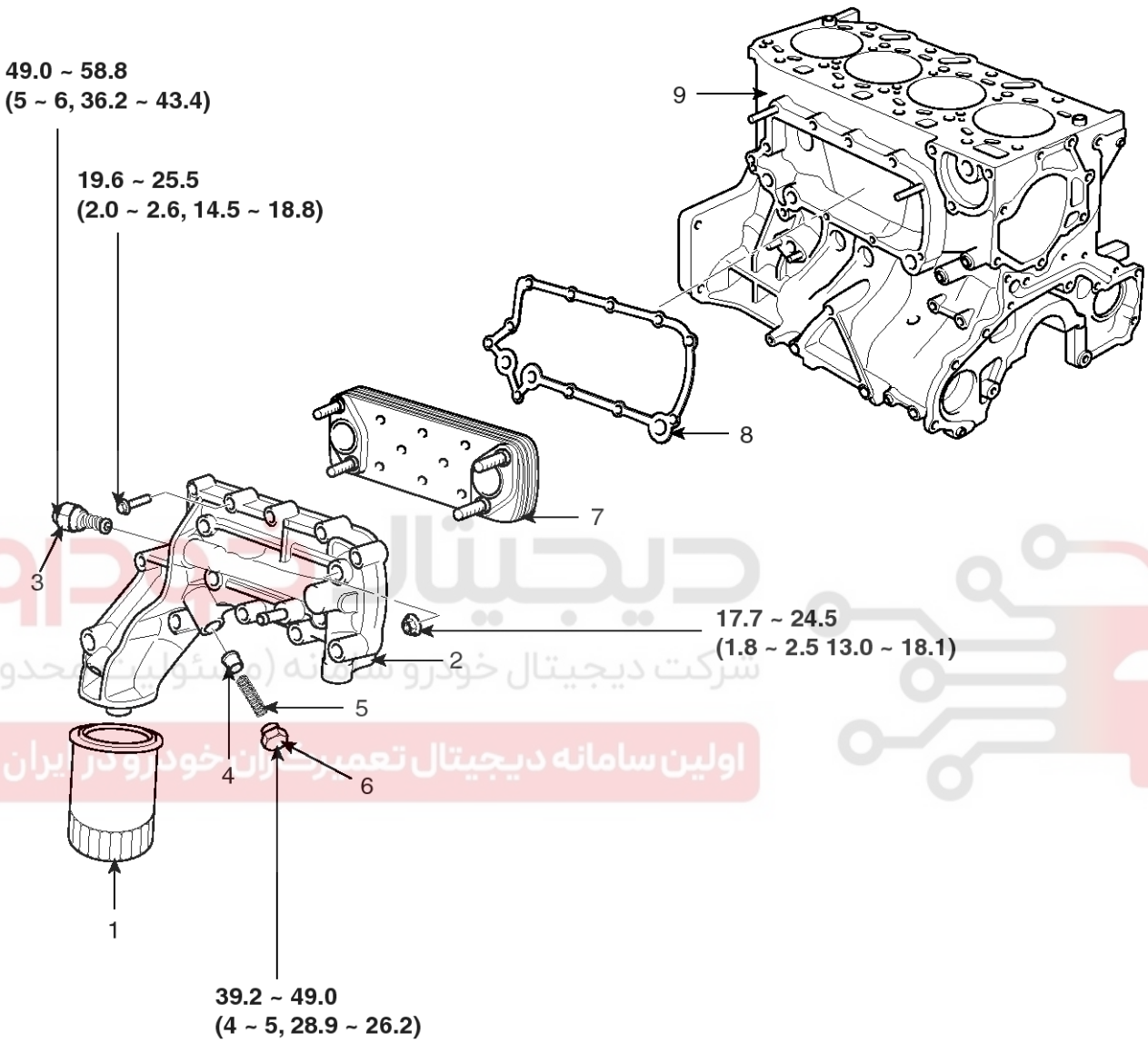
COMPONENTS



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

1. Oil pump sprocket
2. Oil pump
3. O-ring
4. Oil supply pipe
5. Oil screen
6. Cylinder block

SBLEM6025L



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

1. Oil filter
2. Oil cooler cover
3. Oil cooler by-fass valve
4. Relief plunger
5. Relief spring
6. Relief valve plug
7. Oil cooler
8. Gasket
9. Cylinder block

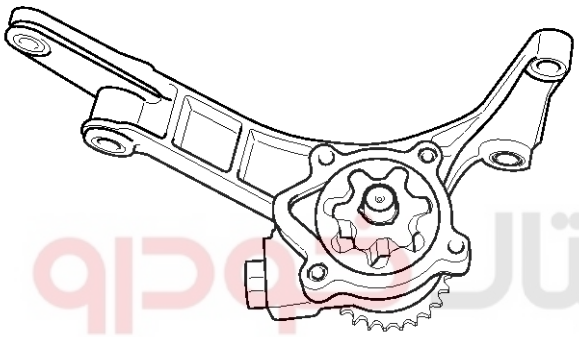
SBLEM6026L

INSPECTION

OIL PUMP

1. Make sure the outer rotor and inner rotor turn smoothly with no excessive play between them.
2. Check the side clearance and body clearance.

Side clearance :
Inner rotor: 0.040-0.085 mm (0.0016-0.0033 in)
Outer rotor: 0.050-0.100 mm (0.0020-0.0039 in)
Body clearance (Between outer rotor and body) :
0.100-0.176 mm (0.0039-0.0069 in)

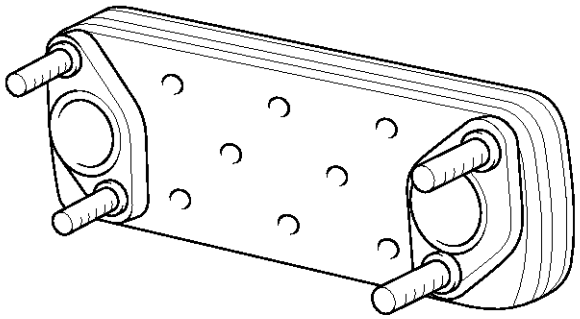


ACAC232A

3. If clearance is excessive, replace the oil pump.

OIL COOLER

1. Inspect visually the core for clogging or damage, and replace it if a problem is found.

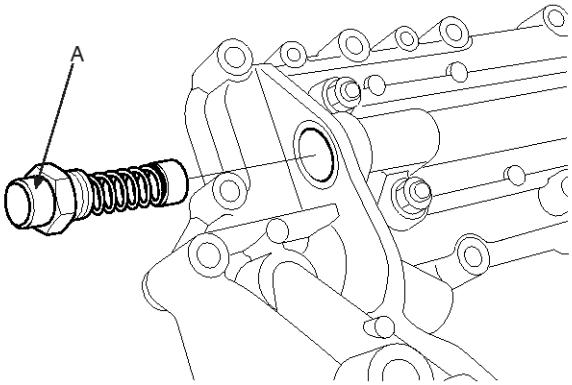


LCAC242A

OIL COOLER BY-PASS VALVE

1. Check that the valve operates properly.
2. Verify the temperature at which the valve (A) begins to open.

Item	Temperature °C (°F)	Lift mm (in)
Valve opening temperature	91.5-94.5 (196.7-202.1)	0.05 (0.002)
Full opening Full opening	97-103 (206.6-217.4)	5 (0.197)
Full lift	150 (302)	Below 11 (0.433)



KDSE179A

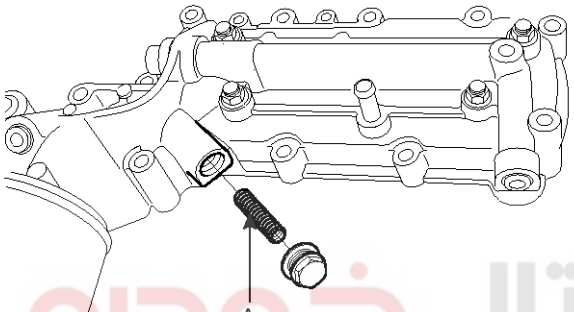
OIL RELIEF VALVE

1. Check the relief plunger for wear or damage.
2. Check the relief spring for weak.

Free length: 52.5mm (2.0669in)

3. Check the relief spring (A) of pressure.

Spring pressure :
6.7kg/40.1mm (14.8 lb/1.5787in)
8.7/36.3mm (19.2 lb/1.4291in)

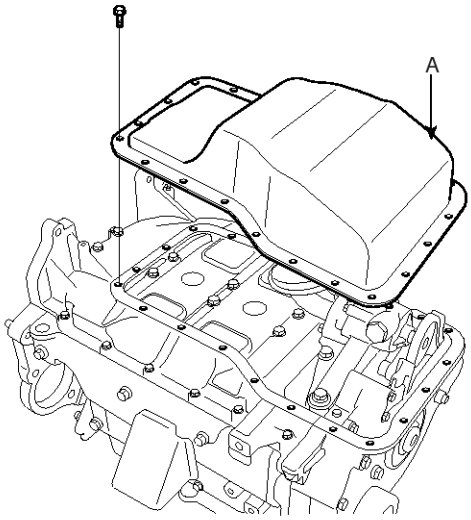


KDSE178Z

REMOVAL

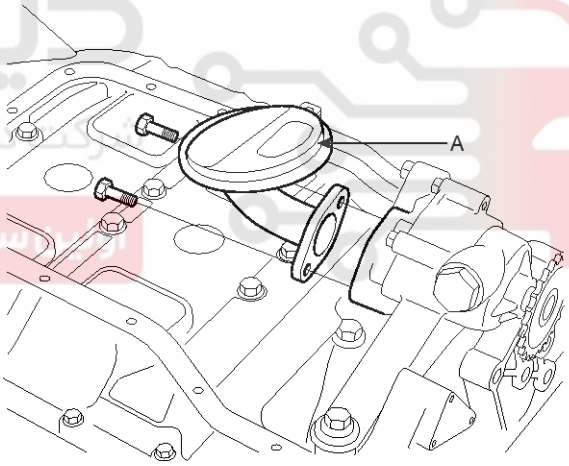
OIL PUMP

1. Drain engine oil.
2. Remove the timing chain "C" and "B".
3. Remove the oil pan. Refer to "Oil pan (A)".



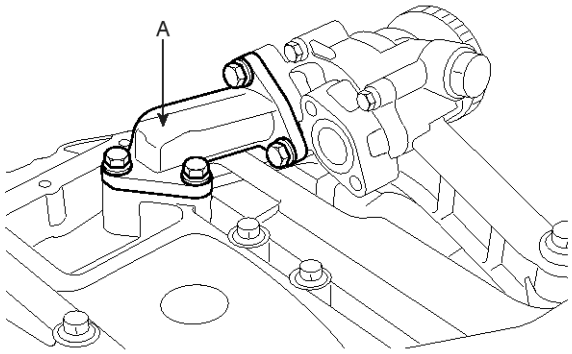
KDSE150A

4. Remove the oil screen (A) from the oil pump.



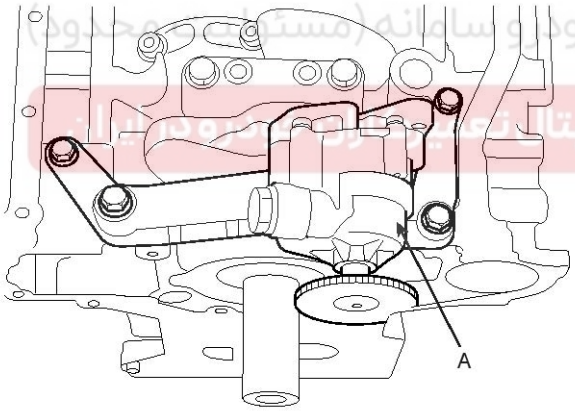
KDSE151A

5. Remove the oil feed pipe (A) from the oil pump and bed plate.



KDSE159A

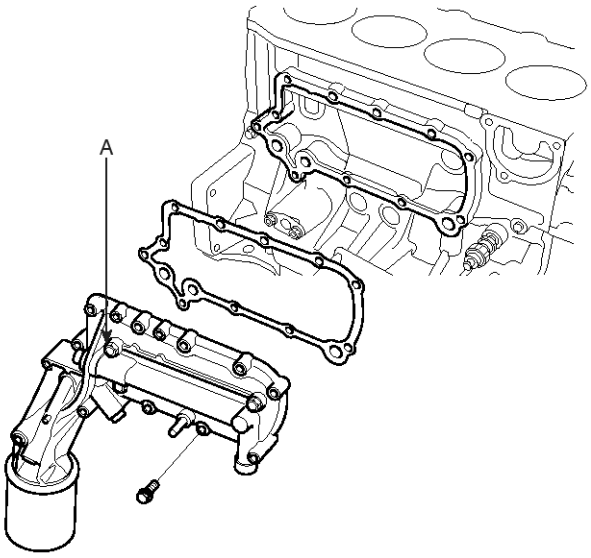
6. Remove the bet plate.
7. Remove the oil pump assembly (A) from the cylinder block.



KDSE161A

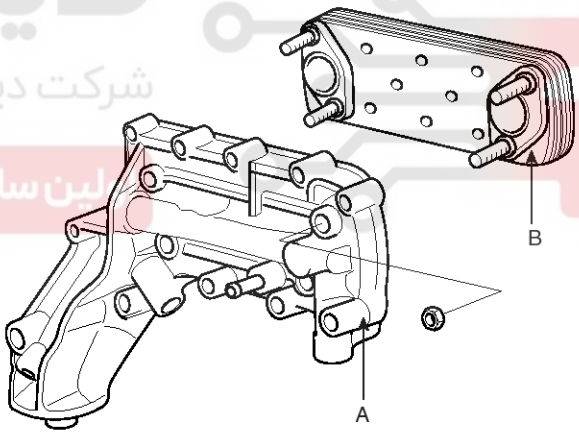
OIL COOLER

1. Drain engine coolant and engine oil.
2. Remove the engine oil filter.
3. Remove the oil cooler assembly (A) from the cylinder block.



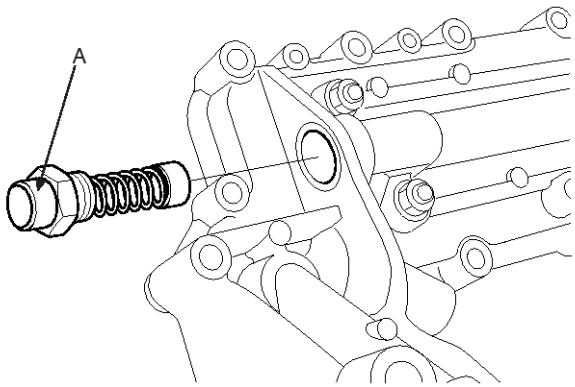
KDSE149A

4. Remove the oil cooler (B) from the oil cooler cover (A).

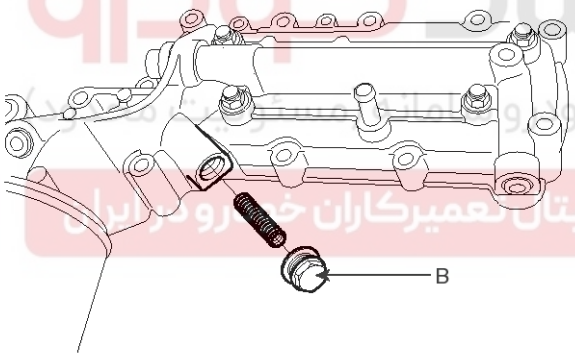


KDSE149B

5. Remove the oil cooler by-pass valve (A) and the relief valve (B) from the oil cooler cover.



KDSE179A

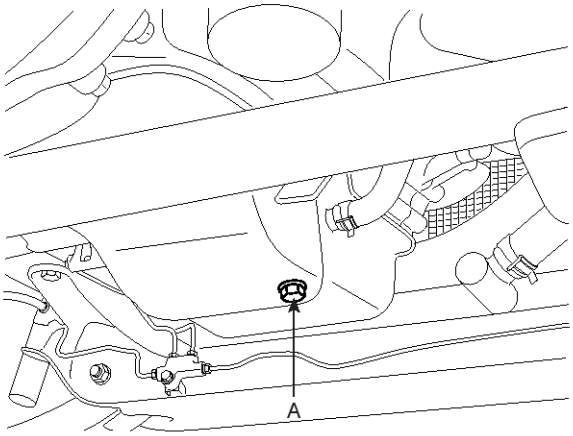


KDSE178A

OIL AND FILTER REPLACEMENT

1. Run the engine until it reaches normal operating temperature.
2. Turn off the engine.
3. Remove the oil filler cap and the drain plug. Drain the engine oil.
4. Tighten the drain plug (A) to the specified torque.

Tightening torque
Oil pan drain plug :
35 ~ 45 N.m (3.5 ~ 4.5 kgf.m, 25 ~ 33 lb-ft)



KDSE208A

NOTICE
Whenever tightening the oil drain plug, use a new drain plug gasket.

5. Fill new engine oil through the oil filler cap opening.

Capacity :
Total : 9.0L (9.51 US qt, 7.91 Imp qt)
Oil pan : 7.4L (7.82 US qt, 6.50 Imp qt)
Drain and refill including oil filter : 8.2L(8.66 US qt, 7.21 Imp qt)
Oil quality : ABOVE API CF-4 (VGT:CH-4) or ACEA B4

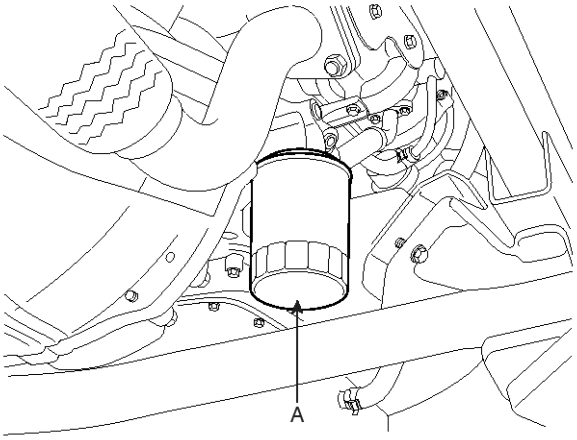
NOTICE
Do not overfill. This will cause oil aeration and loss of oil pressure.

6. Install the oil filler cap.
7. Start and run the engine.
8. Turn off the engine and then check the oil level. Add oil if necessary.

OIL FITER

1. Use a filter wrench to remove the oil filter.
2. Before installing the new oil filter on the engine, apply clean engine oil of the surface of the rubber gasket.
3. Tighten the oil filter (A) of the specified torque.

Oil filter :
22 ~ 25 N.m (2.2 ~ 2.5 kgf.m, 16 ~ 18 lb-ft)



KDSE209A

4. Start and run the engine and check for engine oil leaks.
5. After stopping the engine, check the oil level and add oil as necessary.

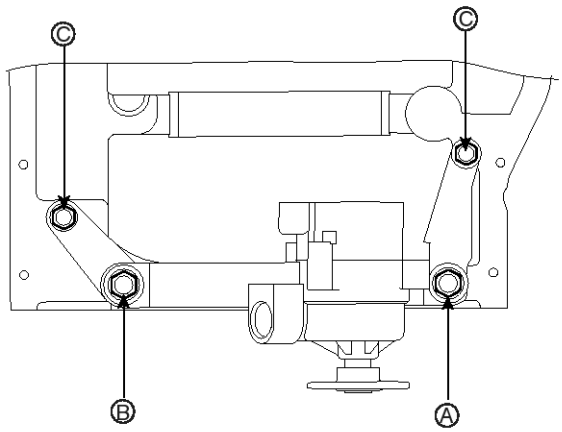
INSTALLATION

OIL PUMP

1. Install the oil pump assembly to the cylinder block.

Bolt	Size	Quantity	Quantity Tightening torque N.m (kgf.m, lb-ft)
A	10 x 35	1 EA	42.2-53.9 (4.3-5.5, 31.1-39.8)
B	10 x 60	1 EA	42.2-53.9 (4.3-5.5, 31.1-39.8)
C	8 x 22	2 EA	19.6-26.5 (2.0-2.7, 14.5-19.5)

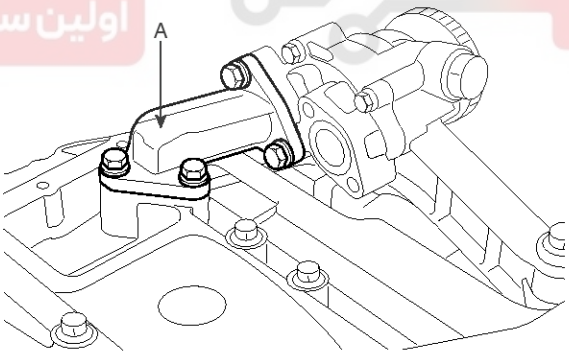
* Bolts size = Diameter x Length



ACAC233A

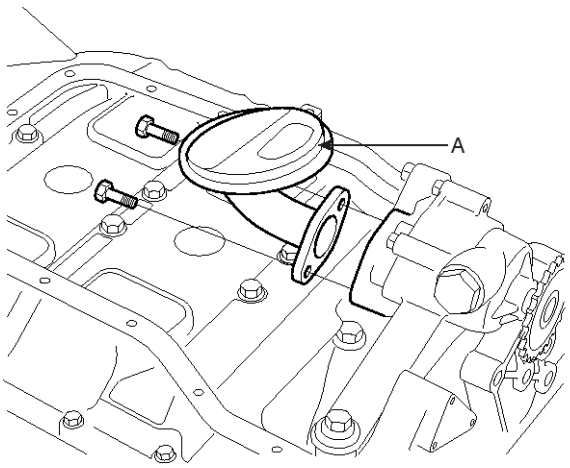
2. Install the bet plate.
3. Install the oil feed pipe (A) to the oil pump and bed plate.

Tightening torque :
19.6 ~ 26.5 N.m (2.0 ~ 2.7kgf.m, 14.5 ~ 19.5lb-ft)



KDSE159A

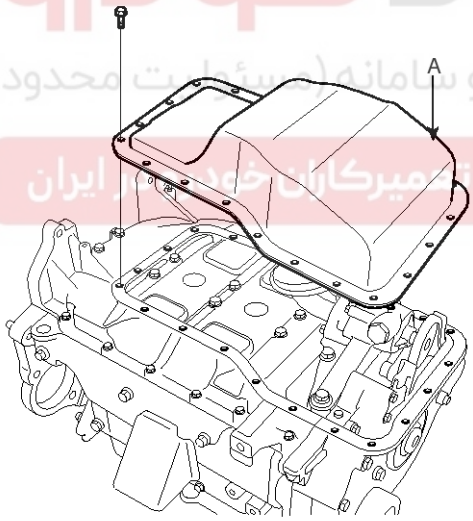
4. Install the oil screen (A) to the oil pump.



KDSE151A

5. Install the oil pan (A).

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



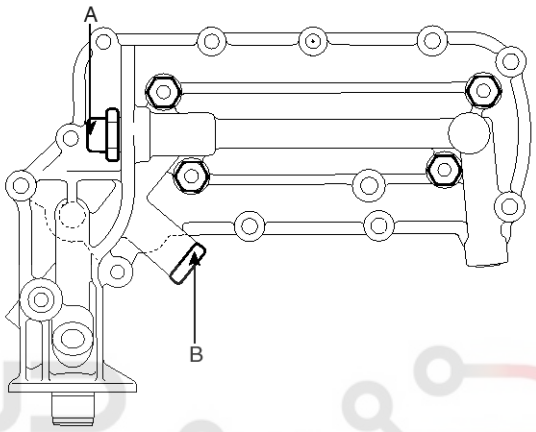
KDSE150A

6. Install the timing chain "B" and "C". Refer to "Timing chain".
7. Refill engine oil and check for oil leak.

OIL COOLER

1. Install the oil cooler by-pass valve (A) and the relief valve (B) to the oil cooler cover.

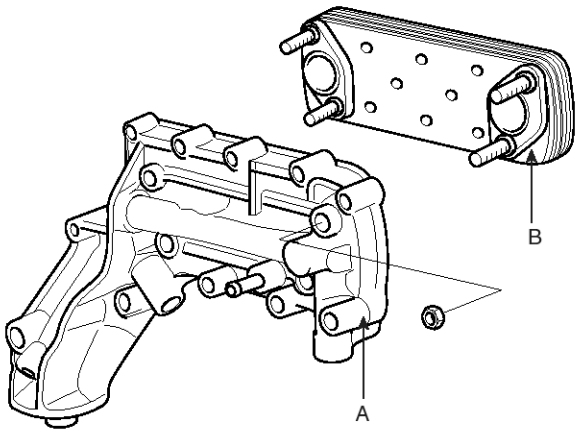
Tightening torque :
Oil cooler by-pass valve :
49.0 ~ 58.8 N.m (5 ~ 6kgf.m, 36.2 ~ 43.4lb-ft)
Relief valve plug :
39.2 ~ 49.0 N.m (4 ~ 5 kgf.m, 28.9 ~ 36.2 lb-ft)



ACAE245A

2. Install the oil cooler (B) to oil cooler cover (A).

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

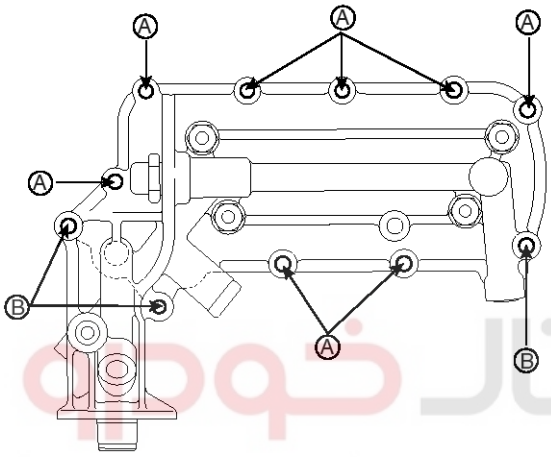


KDSE149B

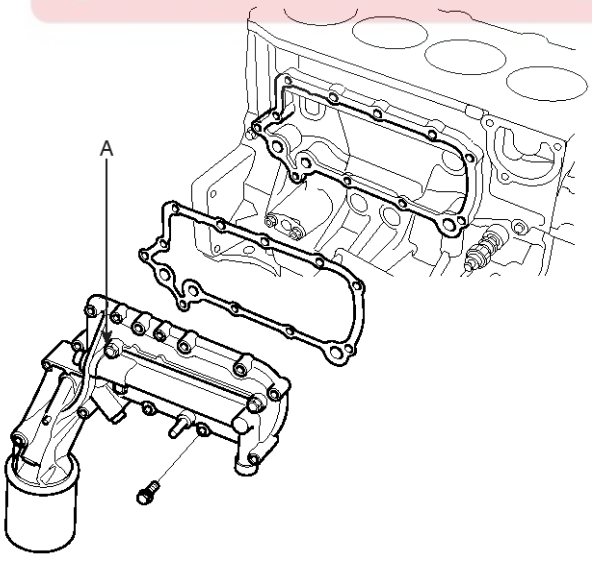
3. Install the oil cooler assembly (A) to the cylinder block with new gasket.

Bolt	Size	Quantity	Tightening torque N.m (kgf.m, lb-ft)
A	8 x 35	8 EA	19.6-25.5 (2.0-2.6, 14.5-18.8)
B	8 x 60	3 EA	(2.0-2.6, 14.5-18.8)

* Bolts size = Diameter x Length



ACAC245B



KDSE149A

4. Install the engine oil filter.

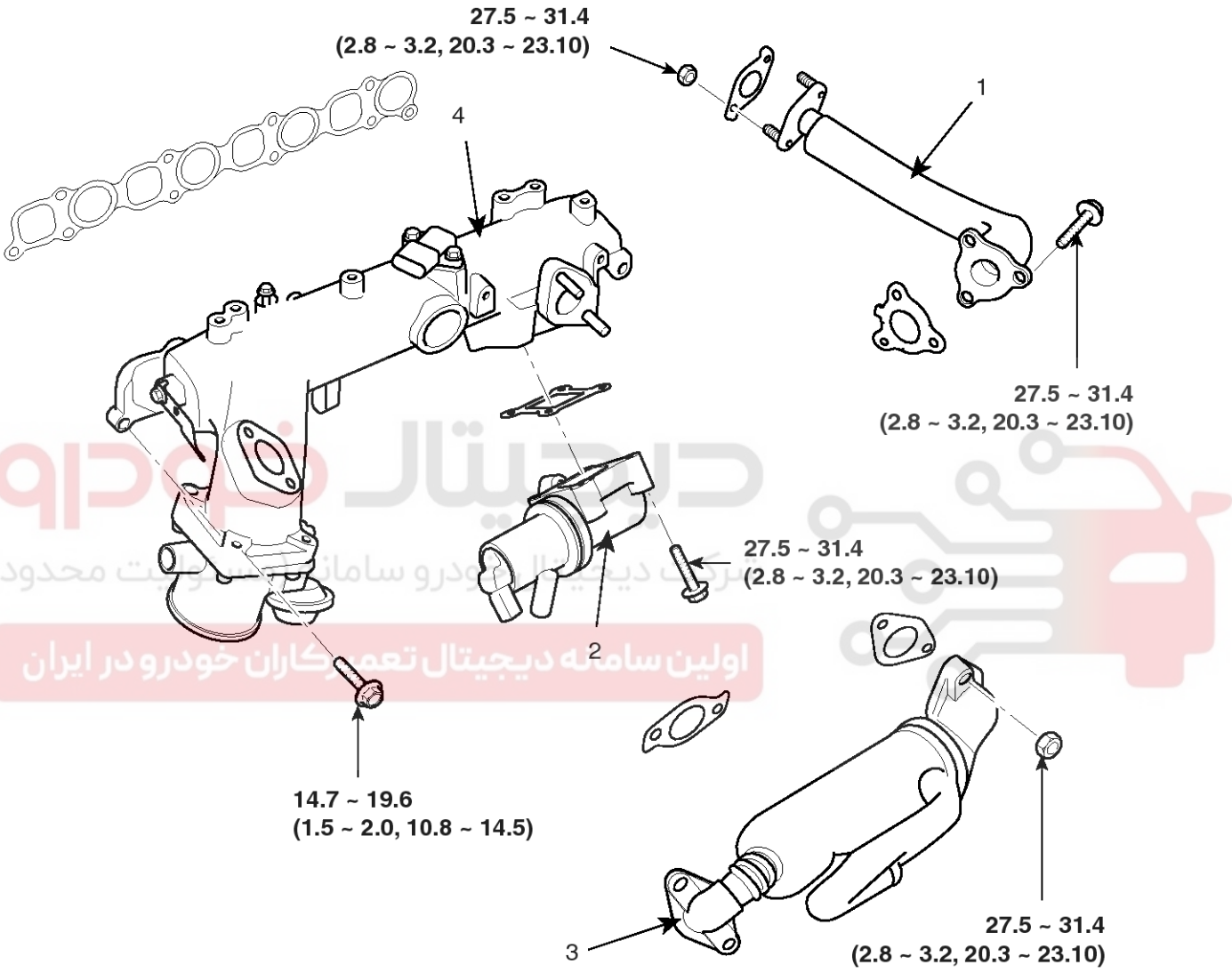
Tightening torque :
19.6 ~ 24.5 N.m (2.0 ~ 2.5kgf.m, 14.5 ~ 18.1lb-ft)

5. Refill the engine oil and engine coolant.
6. Check for oil and coolant leak.

Intake And Exhaust System

Intake Manifold

COMPONENTS



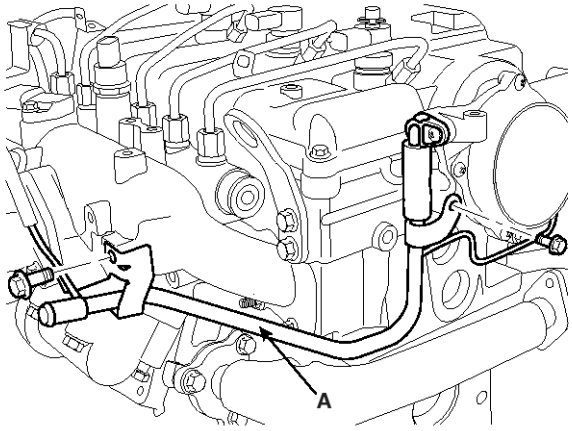
TORQUE : N.m (kgf.m, lb-ft)

1. EGR pipe
2. EGR solenoid valve
3. EGR cooler
4. Intake manifold

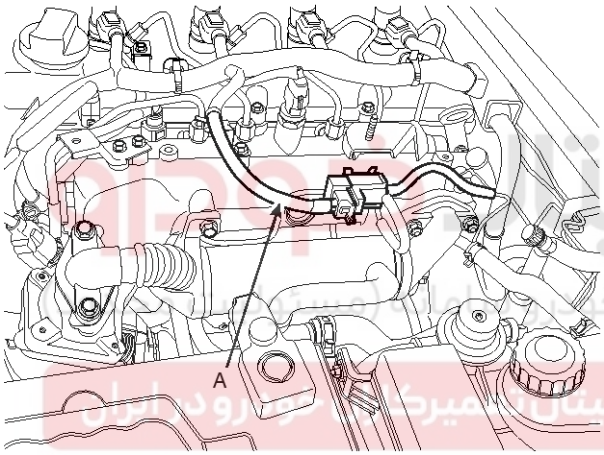
SBLEM6028L

REMOVAL

1. Remove the vacuum line(A, B).

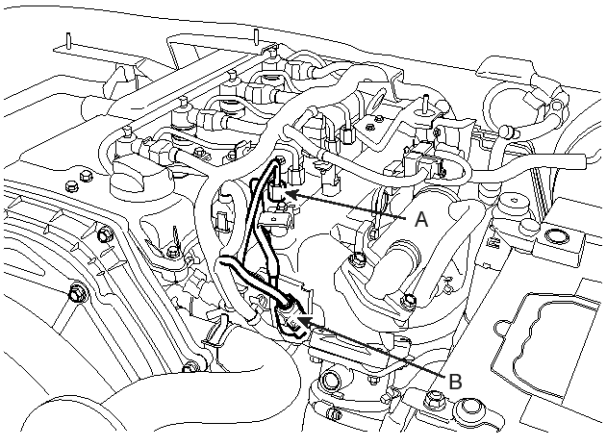


ACAF006A



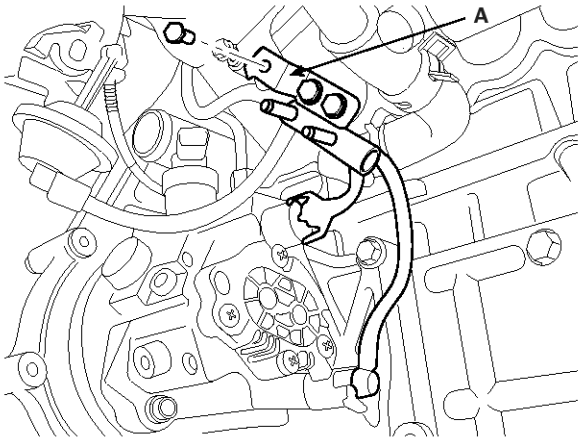
SBLEM6001L

2. Remove the high pipe bracket(A) and the coolant temperature sensor connector(B).



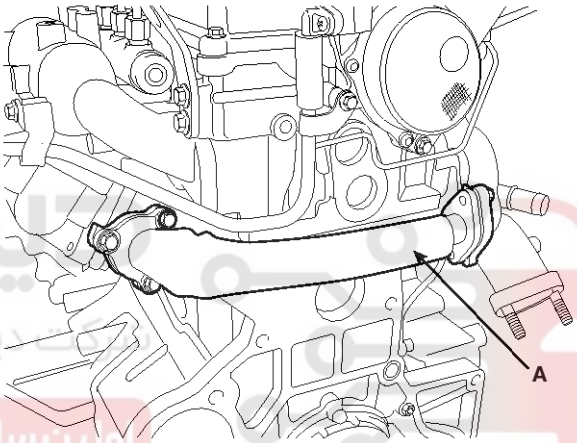
SBLEM6002L

3. Remove the high pump fuel hose bracket(A).



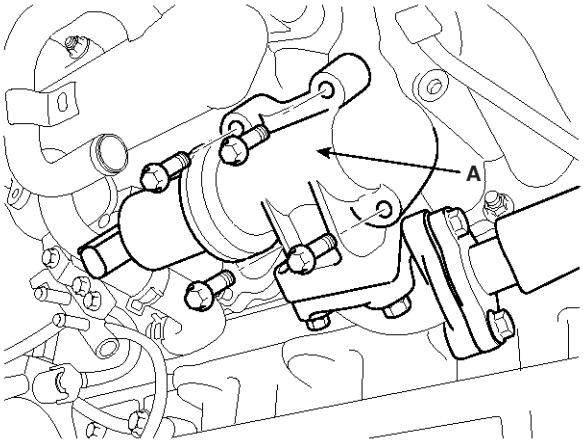
ACAF009A

4. Remove the EGR pipe(A).



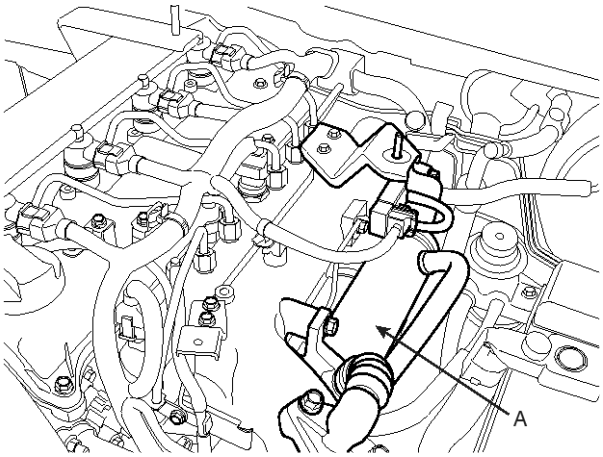
ACAF004A

5. Remove the EGR valve(A).



ACAF010A

6. Remove the EGR cooler(A).



SBLEM6003L

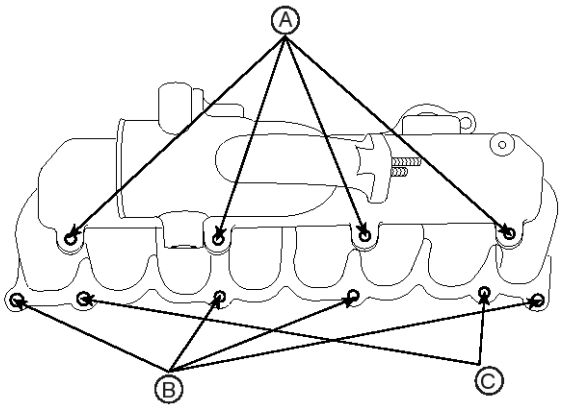
7. Remove the intake manifold.

INSTALLATION

1. Install the intake manifold with new gasket.

Bolt	Size	Quantity	Tightening torque N.m (kgf.m, lb-ft)
A	8 x 112	4 EA	14.7 ~ 19.6 (1.5 ~ 2.0, 10.8 ~ 14.5)
B	8 x 32	4 EA	14.7 ~ 19.6 (1.5 ~ 2.0, 10.8 ~ 14.5)
C	nuts	2 EA	14.7 ~ 19.6 (1.5 ~ 2.0, 10.8 ~ 14.5)

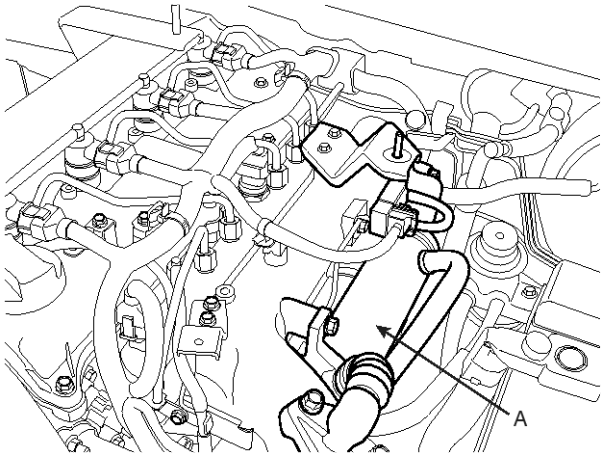
* Bolts size = Diameter x Length



ACAC261A

2. Install the EGR cooler(A).

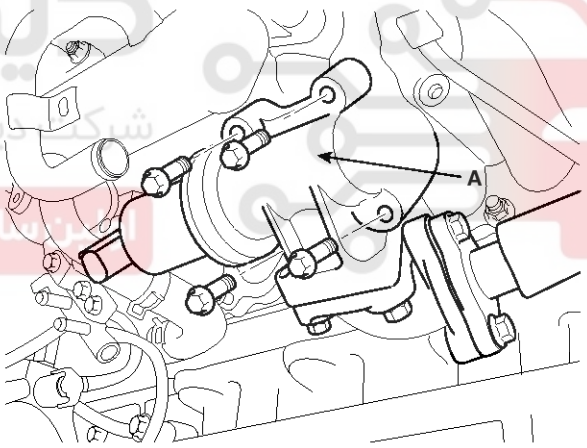
Tightening torque :
27.5 ~ 31.4N.m (2.8 ~ 3.2kgf.m, 20.3 ~ 23.1lb-ft)



SBLEM6003L

3. Install the EGR valve(A).

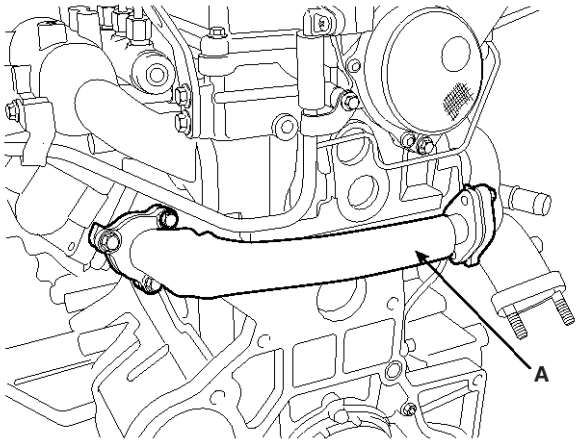
Tightening torque :
27.5 ~ 31.4N.m (2.8 ~ 3.2kgf.m, 20.3 ~ 23.1lb-ft)



ACAF010A

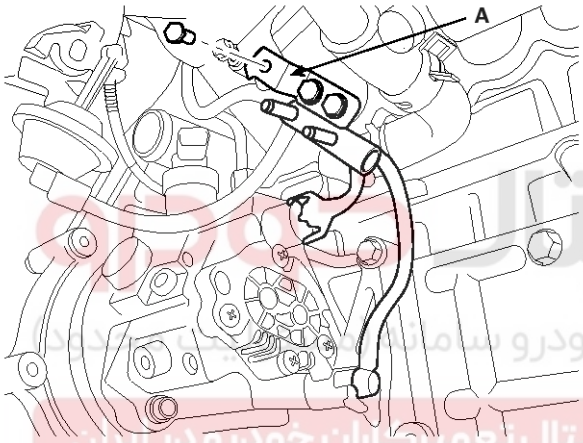
4. Install the EGR pipe(A).

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



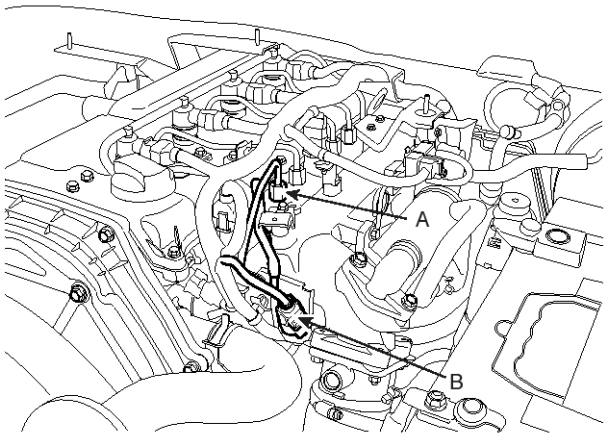
ACAF004A

5. Install the high pump fuel hose bracket(A).



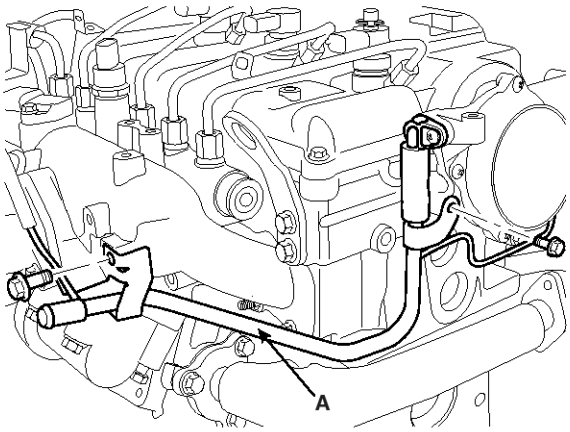
ACAF009A

6. Install teh high pipe bracket(A) and coolant temperature sensor connector(B).

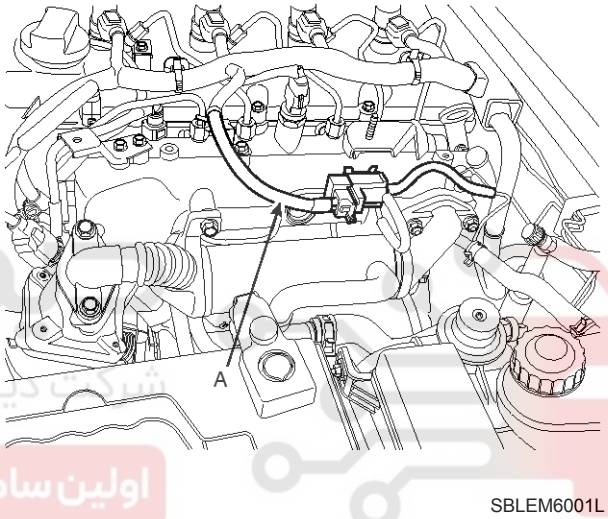


SBLEM6002L

7. Install the vacuum line(A, B).



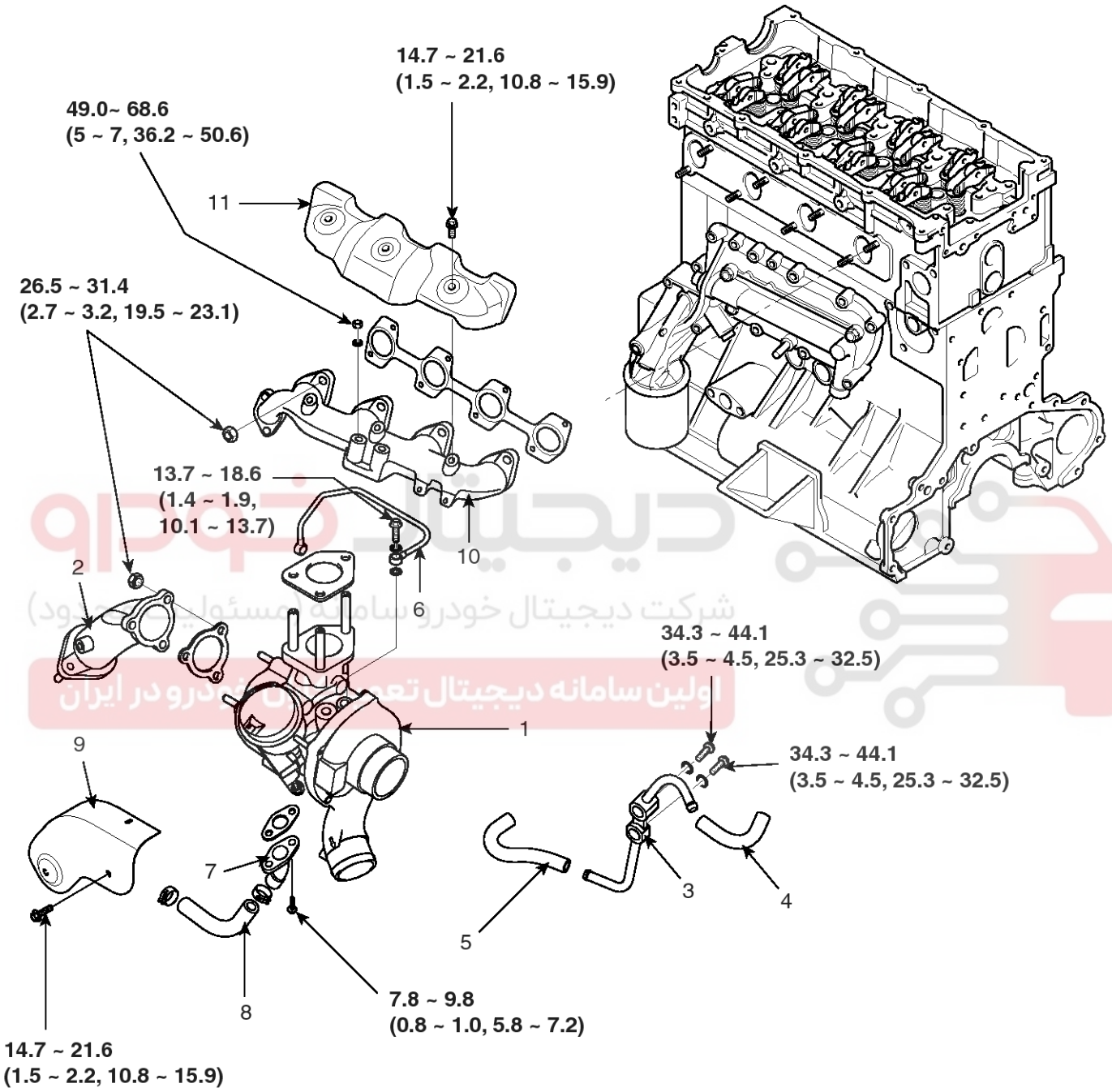
ACAF006A



SBLEM6001L

Exhaust Manifold

COMPONENTS



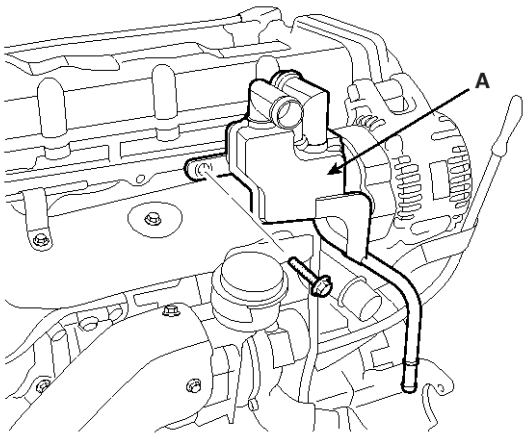
TORQUE : N.m (kgf.m, lb-ft)

1. Turbo charger assembly
2. Turbo charger outlet fitting
3. Turbo charger coolant pipe
4. Turbo charger coolant inlet hose
5. Turbo charger coolant outlet hose
6. Turbo charger oil inlet pipe
7. Turbo charger oil outlet pipe
8. Turbo charger oil outlet hose
9. Heater protector
10. Exhaust manifold
11. Heater protector

SBLEM6029L

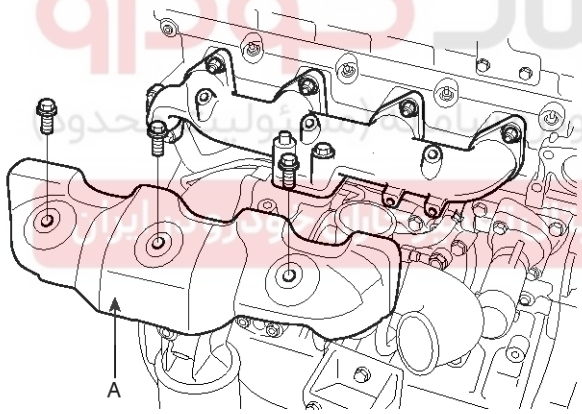
REMOVAL

1. Remove the oil separator(A).

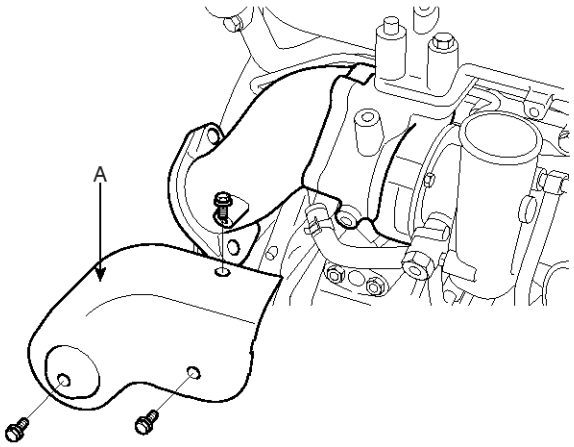


ACAF001A

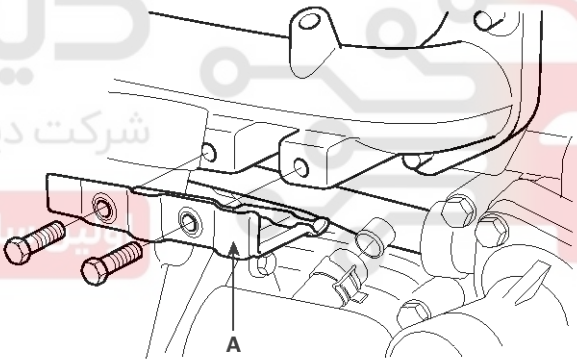
2. Remove the heater protectors(A).



KDSE132A

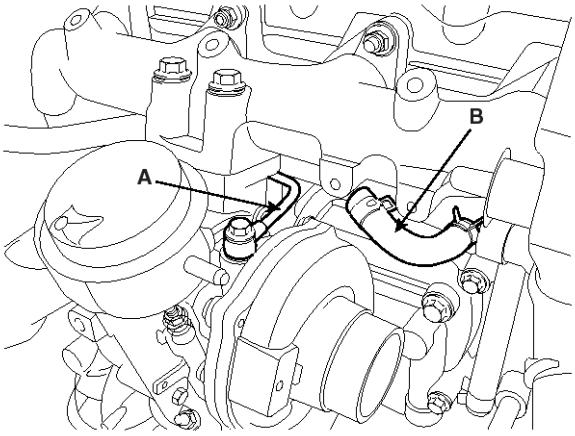


KDSE131A

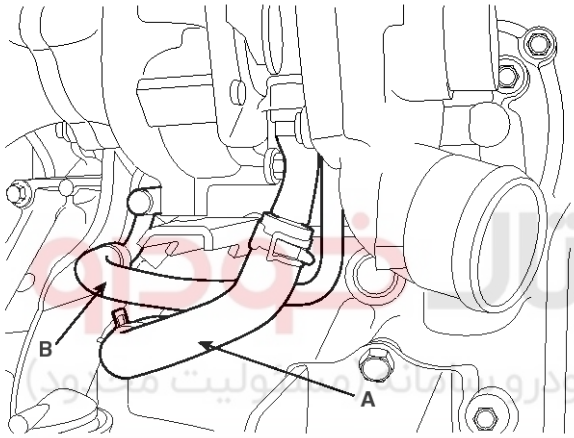


ACAF068A

3. Remove the oil hose(A) and coolant hose(B) from the turbo charger.

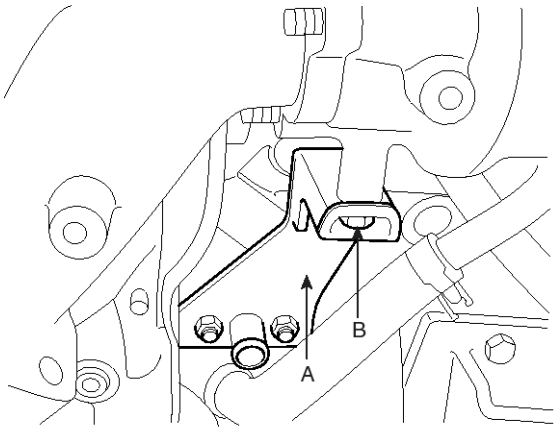


ACAF002A



ACAF003A

4. Remove the EGR pipe(A).
5. Remove the turbo charge bracket(A) and bolt(B).

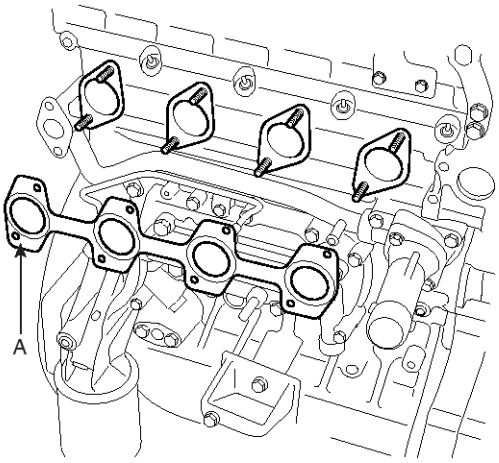


KDSE205A

6. Remove the exhaust manifold(A).

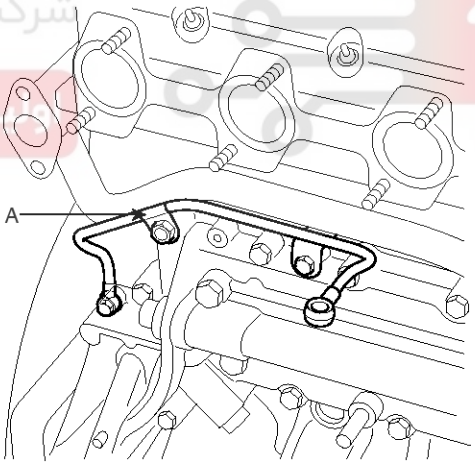
INSTALLATION

1. Install the exhaust manifold gasket(A).



KDSE140B

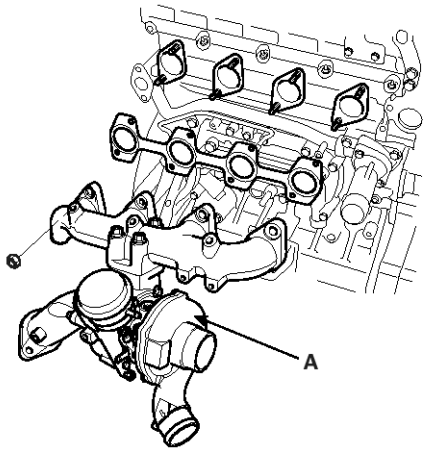
2. Install the turbo charge oil feed line(A).



KDSE204A

3. Install the exhaust manifold(A) from cylinder head.

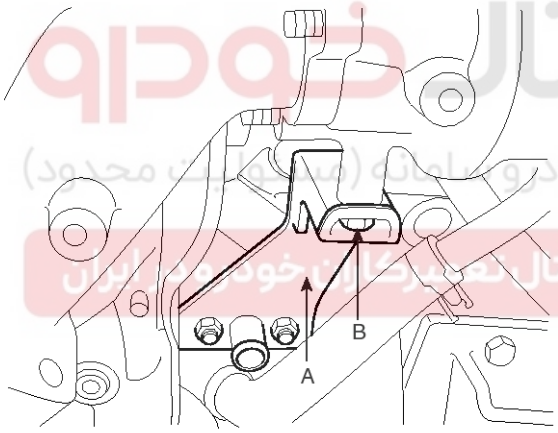
Tightening torque :
16.7 ~ 25.5N.m(1.7 ~ 2.6kgf.m, 12.3 ~ 18.8lb-ft)



ACAF005A

4. Install the bolt(B) from turbo charge bracket(A).

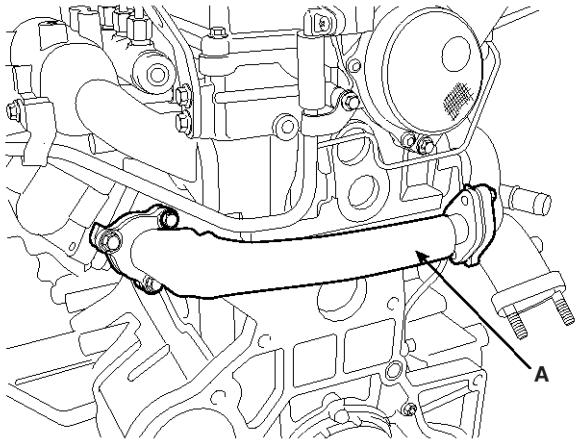
Tightening torque :
14.7 ~ 19.6N.m(1.5 ~ 2.0kgf.m, 10.8 ~ 14.5lb-ft)



KDSE205A

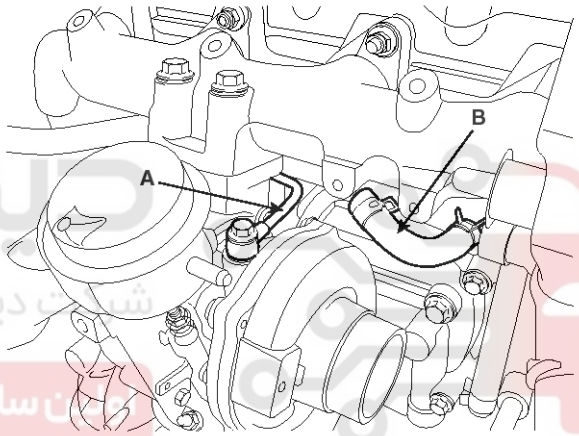
5. Install the EGR pipe(A).

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

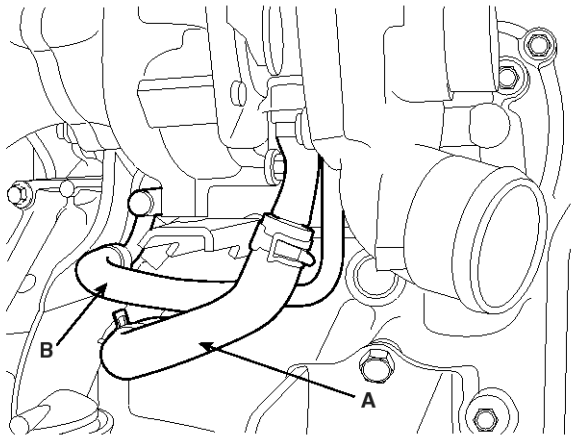


ACAF004A

6. Install the oil hose(A) and coolant hose(B) from turbo charge.



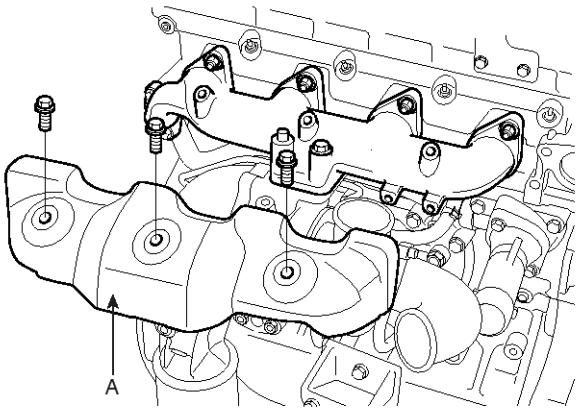
ACAF002A



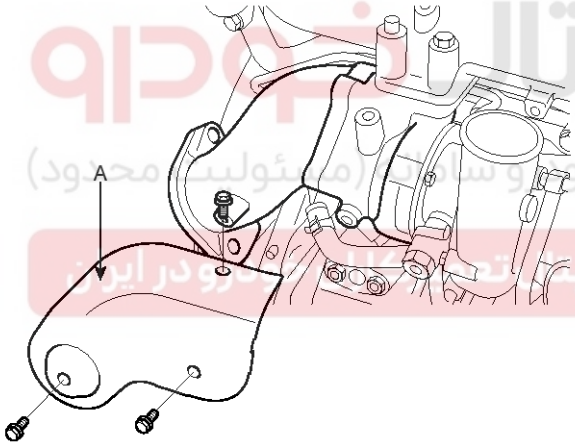
ACAF003A

7. Install the heater protector(A).

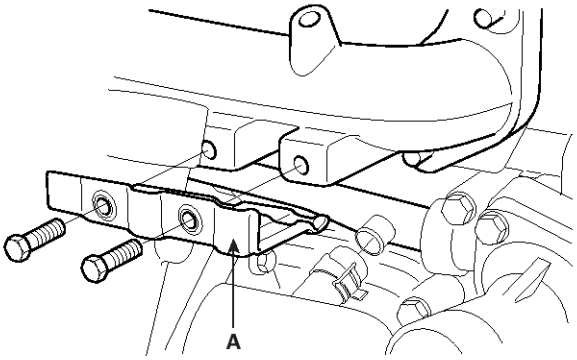
Tightening torque :
14.7 ~ 21.6N.m(1.5 ~ 2.2kgf.m, 10.8 ~ 15.9lb-ft)



KDSE132A



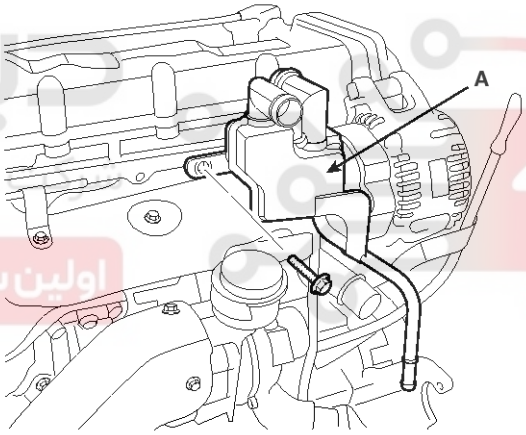
KDSE131A



ACAF068A

8. Install the oil sperator(A).

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



ACAF001A