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Specification

Description	Specification	Limit		
General				
Туре	In-line, DOHC	-		
Number of cylinders	4	-		
Cylinder inner diameter	95 mm (3.74 in)	-		
Cylinder stroke	102 mm (4.02 in)	-		
Displacement	2891 cc (176.4 cu.in) -			
Compression ratio	16.1:1 -			
Firing order	1-3-4-2	-		
Intake valve timing		·		
Open (ATDC)	14°	-		
Closes (ABDC)	15°	-		
Exhaust valve timing				
Open (BBDC)	28°	-		
Closes (BTDC)	14°	-		
Cylinder head				
Flatness of gasket surface	0.05 mm (0.0020 in)	-		
Flatness of manifold mounting 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) -			
Camshaft cam height (RH)		·		
Intake	39,782 mm (1,5662 in)	-		
Exhaust	40.456 mm (1.5928 in) -			
Journal outer diameter	29.944 - 29.960 mm (1.1789 - 1.1759 in) -			
End play	0.10 - 0.20 mm (0.0039 - 0.0079 in) -			
Valve length				
Intake	110.55 mm (4.3524 in)	-		
Exhaust	110.55 mm (4.3524 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)			
Face angle	45°			

Des	cription	Specification		Limit
Thickness of valve he	ead (margin)			
Intake		1.8 - 2.0 mm (0.071 - 0.079 in)		-
Exhaust		1.8 - 2.0 m	m (0.071 - 0.079 in)	-
Valve stem to valve g	guide clearance			
Intake		0.020 - 0.050 n	nm (0.0008 - 0.0020 in)	0.10 mm (0.0039 in)
Exhaust		0.050 - 0.080 n	nm (0.0020 - 0.0031 in)	0.15 mm (0.0059 in)
Valve guide length				
Intake		43.3 mm (1.705 in)		-
Exhaust		39.4 1	mm (1.551 in)	-
Valve guide Inner dia	ameter			
Intake		7.000 - 7.015 n	nm (0.2756 - 0.2762 in)	-
Exhaust		7.000 - 7.015 n	nm (0.2756 - 0.2762 in)	-
Valve seat contact width				
Intake		1.3 - 1.7 mm (0.0512 - 0.669 in)		-
Exhaust		1.5 - 1.9 mm (0.0591 - 0.0748 in)		-
Seat angle				
Intake		45°		-
Exhaust		45°		-
Valve spring				
Free length		53.0 mm (2.067 in)		-
	Height	38 mm (1.496 in)	28.8 mm (1.134 in)	-
Spring load		245 - 271 N	433 - 468 N	
	Load	(25.0 - 27.6 kg, 55.1 - 60.9 lb)	(44.1 - 47.7 kg, 97.2 - 105.2 lb)	-
Cylinder block			· · · · · · · · · · · · · · · · · · ·	
Cylinder bore		95.000 - 95.030	mm (3.7402 - 3.7413 in)	-
Flatness of gasket su	rface	0.05 mm (0.020 in)		
Piston				
Piston outer diameter 94.910 - 94.940 mm (3.7366 - 3.7378 in) -		-		
Piston to cylinder clea	arance	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		2.06 - 2.08 mm (0.0811 - 0.0819 in)		-
Oil ring groove		3.03 - 3.05 mm (0.1193 - 0.1201 in)		-

Description	Specification	Limit		
Piston ring side clearance				
No.1 ring groove	0.08 - 0.12 mm (0.0031 - 0.0047 in)	-		
No.2 ring groove	0.07 - 0.11 mm (0.0028 - 0.0043 in)	-		
Oil ring	0.04 - 0.08 mm (0.0016 - 0.0031 in)	-		
End gap				
No.1 ring groove	0.23 - 0.38 mm (0.0091 - 0.0150 in)	-		
No.2 ring groove	0.70 - 0.90 mm (0.0276 - 0.0354 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	33.004 - 33.011 mm (1.2994 - 1.2996 in)	-		
Piston pin hole clearance	0.006 - 0.018 mm (0.0002 - 0.0007 in)	-		
Connecting rod small end 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 - 0.0017 in)	0.1 mm (0.0039 in)		
Side clearance	0.1 - 0.25 mm (0.0039 - 0.0098 in)	-		
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)	0.1 mm (0.0039 in)		
End play	0.12 - 0.30 mm (0.0047 - 0.0118 in)	-		
Flywheel				
Runout	0.45 mm (0.0177 in)	-		
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)	-		
Relief valve opening pressure	[330 kPa (3.4 kg/cm², 47.9 psi) ± 48 kPa (0.49 kg/cm², 7.0 psi)] [- 75°C(167°F)] / [380 kPa (3. 9 kg/cm², 55.1 psi) ± 45 kPa (0.46 kg/cm², 6.5 psi)] [90°C (194°F)-]	-		

Description		Specification	Limit
Engine oil			
	Oil pan	7.9 l(2.09 U.S.gal., 8.35 U.S.qt.,6.95 lmp.qt.)	-
Oliquantity	Replacement capacity	8.7 l(2.30 U.S.gal., 9.20 U.S.qt., 7.65 lmp.qt.)	Including oil filter
	Classification	ACEA C2/C3	-
Oil grade	SAE viscosity grade	Corresponding viscosity oil by temperature	Refer to the "Lubrication System"
Oil pressure (at idle)		78.45 kPa (0.8 kg/cm², 11.38 psi) above	Oil temperature in oil pan : 80°C (176°F)
Cooling system			
Cooling method		Forced circulation with cooling fan	-
Coolant	Concentration	45 - 50% (for frigid area : 55 - 60%)	-
Thermostat	'		
Туре		Wax pellet type	-
Opening temperature		88°C (190.4°F)	-
Closing temperature		83°C (181.4°F)	-
Radiator cap		97°C (206.6°F)	-
Thermostat			
Main valve opening pressure		93.2 - 122.6 kPa (0.95 - 1.25 kg/cm², 13.5 - 17.8 psi)	-

Tightening Torques

• Bolt size = Diameter x Length

li o uo	Tightening torque			
item	N.m	kgf.m	lb-ft	
Main bearing cap bolt	32.4 - 36.3 + (90° - 94°)	3.3 - 3.7 + (90° - 94°)	23.8 - 26.7 + (90° - 94°)	
Connecting rod cap bolt	58.8 → Loosen → (32.4 - 36.3) + (58 - 62°)	6.0 → Loosen → (3.3 - 3.7) + (58 - 62°)	43.4 → Loosen → (23.9 - 26.8) + (58 - 62°)	
Piston cooling oil jet	29.4 - 34.3	3.0 - 3.5	21.7 - 25.3	
Crankshaft damper pulley bolt	68.6 - 88.2 + (88 - 92°)	7.0 - 9.0 + (88 - 92°)	50.6 - 65.1 + (88 - 92°)	
Rear oil seal case bolt	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7	
Flywheel housing	42.2 - 53.9	4.3 - 5.5	31.1 - 39.8	
Flywheel	117.7 - 127.5	12.0 - 13.0	86.8 - 94.0	
Flywheel adapter	42.2 - 53.9	4.3 - 5.5	31.1 - 39.8	
Water pump bolt	19.6 - 26.5	2.0 - 2.7	14.5 - 19.5	
Oil cooler retaining bolt	7.8 - 11.8	0.8 - 1.2	5.8 - 8.7	
Oil cooler cover bolt	19.6 - 25.5	2.0 - 2.6	14.5 - 18.8	
Oil pump complete bolt (6 x18)	7.8 - 11.8	0.8 - 1.2	5.8 - 8.7	
Oil pump complete bolt (6 x30)	7.8 - 11.8	0.8 - 1.2	5.8 - 8.7	
Oil pump complete bolt (8 x45)	19.6 - 26.5	2.0 - 2.7	14.5 - 19.5	
Oil screen bolt	7.8 - 11.8	0.8 - 1.2	5.8 - 8.7	
Oil filter assembly	21.6 - 24.5	2.2 - 2.5	15.9 - 18.1	
Oil pan bolt	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7	
Oil pan nut	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7	
Oil level gauge bolt	19.6 - 26.5	2.0 - 2.7	14.5 - 19.5	
Oil pump cover bolt	7.8 - 11.8	0.8 - 1.2	5.8 - 8.7	
Oil pump cover screw	5.9 - 8.8	0.6 - 0.9	4.3 - 6.5	
Bell housing cover bolt	42.2 - 53.9	4.3 - 5.5	31.1 - 39.8	
Oil pressure switch	14.7 - 21.6	1.5 - 2.2	10.8 - 15.9	
Cylinder head cover bolt	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7	
Camshaft cap bolt	13.7 - 15.7	1.4 - 1.6	10.1 - 11.6	
Cylinder head bolt	49.0 + (120°) + (90°)	5.0 + (120°) + (90°)	36.2 + (120°) + (90°)	
Glow plug	15.0 - 20.0	1.5 - 2.0	11.1 - 14.7	
Glow plug plate nut	1.3 - 2.0	0.14 - 0.20	1.0 - 1.4	
Engine hanger bolt	19.6 - 28.4	2.0 - 2.9	14.4 - 21.0	
Thermostat housing bolt	19.6 - 26.5	2.0 - 2.7	14.5 - 19.5	
Water inlet fitting bolt	19.6 - 26.5	2.0 - 2.7	14.5 - 19.5	
Exhaust manifold lock nut	29.4 - 34.3	3.0 - 3.5	21.7 - 25.3	

14	Tightening torque			
nem	N.m	kgf.m	lb-ft	
Exhaust manifold lock bolt	29.4 - 34.3	3.0 - 3.5	21.7 - 25.3	
Exhaust manifold heat protector bolt	14.7 - 21.6	1.5 - 2.2	10.8 - 15.9	
Turbo charger fitting nut	49.0 - 68.6	5.0 - 7.0	36.2 - 50.6	
Oil drain pipe bolt	7.8 - 11.8	0.8 - 1.2	5.8 - 8.7	
Oil feed pipe bolt	14.7 - 21.6	1.5 - 2.2	10.8 - 15.9	
Turbo charger heat protector bolt	14.7 - 21.6	1.5 - 2.2	10.8 - 15.9	
Intake manifold bolt and nut	19.6 - 23.5	2.0 - 2.4	14.5 - 17.4	
EGR cooler bolt (M8)	19.6 - 23.5	2.0 - 2.4	14.5 - 17.4	
EGR cooler bolt (M6)	7.8 - 11.8	0.8 - 1.2	5.8 - 8.7	
EGR pipe nut	29.4 - 34.3	3.0 - 3.5	21.7 - 25.3	
EGR pipe bolt (6 x 14)	7.8 - 11.8	0.8 - 1.2	5.8 - 8.7	
EGR pipe bolt (8 x 18)	19.6 - 23.5	2.0 - 2.4	14.5 - 17.4	
Timing chain lower under cover bolt (6 x 14)	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7	
Timing chain lower under cover bolt (8 x 22))	19.6 - 26.5	2.0 - 2.7	14.5 - 19.5	
Timing chain lower under cover bolt (8 x 30)	19.6 - 26.5	2.0 - 2.7	14.5 - 19.5	
Timing chain lower under cover bolt (8 x 40)	19.6 - 26.5	2.0 - 2.7	14.5 - 19.5	
Timing chain guide "A" bolt (upper)	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7	
Timing chain guide "A" bolt (lower)	19.6 - 26.5	2.0 - 2.7	14.5 - 19.5	
Timing chain lever "A" bolt	19.6 - 26.5	2.0 - 2.7	14.5 - 19.5	
Timing chain auto tensioner "A" bolt	19.6 - 26.5	2.0 - 2.7	14.5 - 19.5	
Timing chain guide "B" (1) bolt	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7	
Timing chain guide "B" (2) bolt	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7	
Timing chain auto tensioner "B" bolt	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7	
Timing chain lower front cover bolt (8 x 22)	19.6 - 26.5	2.0 - 2.7	14.5 - 19.5	
Timing chain lower front cover bolt (8 x 40)	19.6 - 26.5	2.0 - 2.7	14.5 - 19.5	
Timing chain lower front cover bolt (8 x 50)	19.6 - 26.5	2.0 - 2.7	14.5 - 19.5	
Timing chain lower front cover bolt (8 x 70)	19.6 - 26.5	2.0 - 2.7	14.5 - 19.5	

lk e ve	Tightening torque			
item	N.m	kgf.m	lb-ft	
Timing chain lower front cover bolt (8 x 80)	19.6 - 26.5	2.0 - 2.7	14.5 - 19.5	
Timing chain upper rear cover bolt (6 x 14)	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7	
Timing chain upper rear cover bolt (6 x 22)	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7	
Timing chain upper rear cover bolt (8 x 22)	19.6 - 26.5	2.0 - 2.7	14.5 - 19.5	
Timing chain upper rear cover bolt (8 x 40)	19.6 - 26.5	2.0 - 2.7	14.5 - 19.5	
Timing chain upper rear covernut	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7	
Timing chain guide "C" (1) bolt	19.6 - 26.5	2.0 - 2.7	14.5 - 19.5	
Timing chain guide "C" (2) bolt	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7	
Timing chain lever "C" bolt	19.6 - 26.5	2.0 - 2.7	14.5 - 19.5	
Timing chain auto tensioner "C" bolt	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7	
High pressure pump sprocketnut	64.7 - 74.5	6.6 - 7.6	47.7 - 55.0	
Camshaft sprocket bolt	93.2 - 117.7	9.5 - 12.0	68.7 - 86.8	
Timing chain upper front cover bolt	19.6 - 26.5	2.0 - 2.7	14.5 - 19.5	
High pressure pump bracket bolt	19.6 - 25.5	2.0 - 2.6	14.5 - 18.8	
Water pump pulley bolt	9.8 - 11.8	1.0 - 1.2	7.2 - 8.7	
Drive belt idler fixing bolt	47.1 - 53.0	4.8 - 5.4	34.7 - 39.1	
Drive belt auto tensioner fixing bolt	47.1 - 53.0	4.8 - 5.4	34.7 - 39.1	

General Information

Compression Pressure Inspection

Compression Pressure Inspection

- 1. Before checking engine compression, check the engine oil, starter and battery.
- 2. Start the engine and wait until the engine coolant temperature reaches 80 95°C (176 205°F).
- 3. Remove the injectors. (Refer to Engine Control / Fuel System - "Injector")
- 4. Crank the engine to remove any foreign material in the cylinders.
- 5. Install the compression pressure gauge (09351 270 00), adapter (09351-1M100).



6. Measure the compression pressure by cranking the engine.

Standard value:

2,452 - 2,745 kPa (25 - 28 kg/cm², 327 - 398 psi) at 160rpm

7. Repeat steps 5 to 6 for all cylinders, ensuring that the pressure difference for each of the cylinders is within the specified limit.

Limit :

Max. 294.2 kPa (3.0 kg/cm², 14.22 psi) between cylinders

- 8. 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 4 to 6.
 - 1) If compression pressure increases at this time, the piston and piston rings or cylinder walls may be worn or damaged.
 - 2) If the compression pressure does not increase, it may be stuck on the valve, poor valve contact or pressure leakage through the gasket.
 - 3) Failure of the right head gasket may be suspected if the compression pressure is measured low in the two adjacent cylinders.

Troubleshooting

Symptom	Probable cause	Remedy
	Damaged cylinder head gasket	Replace gasket
Low compression	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
	Low engine oil level	Check engine oil level
	Faulty oil pressure switch	Replace
	Clogged oil filter	Replace
Oil pressure drop	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
	Loose engine mounting bolt	Retighten
	Loose transmission mounting bolt	Retighten
Excessive engine vibration	Loose cross member bolt	Retighten
	Broken transmission mounting rubber	Replace
	Broken engine mounting rubber	Replace
Naisyushas	Thin or diluted engine oil (low oil pressure)	Change
	Worn or damaged valve stem or valve guide	Replace
	Insufficient oil supply	Check engine oil level
Connecting rod and/main beaing noise	Thin or diluted engine oil	Change and find out cause
	Excessive bearing clearance	Replace
	Leakage of coolant	Repair and refill the coolant
	Damaged radiator core joint	Replace
Low coolant level	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
	Faulty thermostat	Replace
	Faulty radiator cap	Replace
	Restricted of flow in cooling system	Replace
	Loose or missing drive belt	Adjust or replace
Abnormally high coolant temperature	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
	Faulty thermostat	Replace
Abnormally low coolant temperature	Faulty temperature sensor wiring	Repair or replace
	Loose hose and pipe connection	Retighten
Leakage from oil cooling system	Blocked or collapsed hose and pipe	Replace
Inoperative electrical cooling fan	Damaged, fuse	Replace or repair
E ha at a hala a	Loose connections	Retighten
Exhaust gas leakage	Broken pipe or muffler	Repair or replace
	Detached baffle plate in muffler	Replace
	Broken rubber hanger	Replace
Abnormal noise	Pipe or muffler contacting vehicle body	Correct
	Broken pipe or muffler	Repair or replace

Special Service Tools

Tool (Number and Name)	Illustration	Use
09222 - 3K000 Valve spring compressor 09222 - 3C300 Valve spring compressor adapter	09222-3K000 09222-3C300 STQEM1632L	Removal and installation of intake and exhaust valves.
09351-27000 Compression gauge	SCMEM7001L	Checking engine compression pressure.
09351-1M100 Compression pressure adapter	SXMEM9397D	Checking engine compression pressure.
09222 - 4A000 Valve stem seal installer	B224A000	Installation of valve stem oil seals.
09331- 4A000 High pressure pump sprocket remover	C314A000	Removal of high pressure pump sprocket.

Tool (Number and Name)	Illustration	Use
09214 - 4A000 Timing chain lower front cover oil seal installer	B144A000	Installation of timing chain lower front cover oil seal.
09231-2B100 Ring gear stopper	SHDEM6201D	 Removal and installation of crankshaft pulley bolt. Removal and installation of flywheel bolt.
09215 - 3C000 Oil pan remover	ACJFI25A	Removal of oil pan.

Basic Service Symbols

There are three primary symbols used to complement illustrations.

These symbols indicated the materials to be applied to parts during service.

Symbol	Meaning
SEMEMOO120D	Do not reuse the part. Replace a new one.
SEBOOO2L	Apply engine oil to the part.
SEALANT	Apply sealant to the part.

Drive Belt System

Components

[Low Fan]



- 1. Drive belt
- 2. Idler pulley
- 3. Drive belt tensioner
- 4. Crank pulley

- 5. Crankshaft damper pulley
- 6. Fan belt tensioner
- 7. Fan belt tensioner tension adjust bolt
- 8. Fan pulley

- 9. Cooling fan pulley bracket
 10. Drive belt pulley bracket
- 11. Fan belt

Drive Belt System

[High Fan]



- 1. Drive belt
- 2. Idler pulley
- 3. Drive belt tensioner
- 4. Crank pulley

- 5. Crankshaft damper pulley
- 6. Fan belt tensioner
- 7. Fan belt tensioner tension adjust bolt
- 8. Fan pulley

9. Cooling fan pulley bracket
 10. Drive belt pulley bracket
 11. Fan belt

Drive Belt System

Drive Belt

Removal and Installation

[Fan Belt]

 After provisionally tightening the fan belt tensioner mounting nuts (A), loosen the tension adjustment bolt (B) to release the tension of fan belt.



SEMEM01001D

- 2. Remove the fan belt (A).
- ▶ [Low Fan]



SEMEM01002D

▶ [High Fan]



SEMEM00503D

3. Install in the reverse order of removal.

Drive Belt System

[Drive Belt]

1. Turn the auto tensioner pulley (A) clockwise then install the fixed pin.



SEMEM00001D

2. Remove the drive belt (A).



3. Install in the reverse order of removal.

Inspection

Check the belt maintenance schedule and visually check the belt for excessive wear (abnormal wear or one-sided wear of V-rib) and frayed cords etc. If any defect has been found, replace the drive belt.

NOTICE

• Cracks on the rib side of a belt are considered acceptable. If the belt has chunks missing from the ribs, it should be replaced.

Drive Belt System

Idler

Removal and Installation

[Fan Pulley]

- 1. Remove the fan belt. (Refer to Drive Belt System - "Drive Belt")
- 2. Remove the fan pulley (A).

Tightening torque:

19.6 - 26.4 N.m (2.0 - 2.7 kgf.m, 14.4 - 19.5 lb-ft)

▶ [Low Fan]



SEMEM01003D

▶ [High Fan]



SEMEM00504D

3. Remove the cooling fan braket assembly (A).

Tightening torque :

42.1 - 53.9 N.m (4.3 - 5.5 kgf.m, 31.1 - 39.7 lb-ft)

▶ [Low Fan]



SEMEM01004D

▶ [High Fan]



4. Install in the reverse order of removal.

Drive Belt System

[Idler]

- 1. Remove the drive belt. (Refer to Drive Belt System - "Drive Belt")
- 2. Remove the idler (A).

Tightening torque:

47.0 - 52.9 N.m (4.8 - 5.4 kgf.m, 34.7 - 39.0 lb-ft)



SEMEM00003D

3. Install in the reverse order of removal.

Inspection

Check the idler for grease leak, abnormal rotation and vibration. Replace if necessary.

Drive Belt System

Drive Belt Tensioner

Removal and Installation

[Fan Belt Tensioner]

- 1. Remove the fan belt. (Refer to Drive Belt System - "Drive Belt")
- 2. Remove the fan belt tensioner (A).

Tightening torque:

19.6 - 26.4 N.m (2.0 - 2.7 kgf.m, 14.4 - 19.5 lb-ft)



SEMEM00011D

3. Remove the drive belt pulley braket (A).

Tightening torque:

19.6 - 26.4 N.m (2.0 - 2.7 kgf.m, 14.4 - 19.5 lb-ft)



SEMEM00012D

4. Install in the reverse order of removal.

[Drive Belt Tensioner]

- 1. Remove the drive belt. (Refer to Drive Belt System - "Drive Belt")
- 2. Remove the drive belt tensioner (A).

Tightening torque :

47.0 - 52.9 N.m (4.8 - 5.4 kgf.m, 34.7 - 39.0 lb-ft)



👔 information

- Tensioner pulley is hex bolt.
- 3. Install in the reverse order of removal.

Inspection

Check the belt tensioner for excessive dust, crack, and damage. Replace if necessary.

Drive Belt System

Crankshaft Damper Pulley

Removal and Installation

[Crank Pulley]

- 1. Remove the fan belt. (Refer to Drive Belt System - "Drive Belt")
- 2. Remove the crank pulley (A).

Tightening torque:

24.5 - 34.3 N.m (2.5 - 3.5 kgf.m, 18.0 - 25.3 lb-ft)



SEMEM00100D

NOTICE

• When removing the crank pulley, remove the bolt as shown in the below illustration.



3. Install in the reverse order of removal.

[Crankshaft Damper Pulley]

- 1. Remove the drive belt. (Refer to Drive Belt System - "Drive Belt")
- 2. Remove the crankshaft damper pulley (A).

Tightening t orque :

68.6 - 88.2 N.m (7.0 - 9.0 kgf.m, 50.6 - 65.0 lb-ft) + (88° -92°)



SEMEM00101D

3. Install in the reverse order of removal.

Inspection

Check the crankshaft damper pulley for vibration in rotation, oil or dust deposit of V - ribbed part. Replace if necessary.

Timing System



- 1. Timing chain upper front cover
- 4. Timing chain "C" lever
- 2. Timing chain "C"
- 3. Timing chain "C" auto tensioner
- 5. Timing chain "C" guide
- 6. Exhaust camshaft sprocket
- 7. Intake camshaft sprocket
- 8. Timing chain cam to cam guide
- 9. Timing chain upper rear cover

Timing System



- 1. Front oil seal
- 2. Timing chain lower front cover
- 3. Timing chain "B" auto tensioner
- 4. Timing chain "B"

- 5. Timing chain "A" auto tensioner
- 6. Timing chain "A"
- 7. Timing chain "A" lever
- 8. Timing chain "A" guide
- 9. Crankshaft sprocket
- 10. High pressure fuel pump sprocket
- 11. Timing chain lower rear cover

Timing System

Front Oil Seal

Replacement

- 1.Remove the crankshaft damper pulley. (Refer to Drive Belt System - "Crankshaft Damper Pulley")
- 2. Remove the front oil seal (A).



SEMEM01005D

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



NOTICE

- Apply engine fluid to the circumference of oil seallip.
- Do not reuse the front oil seal.

Timing System

Timing Chain

Removal

Timing Chain "C"

 Align the timing mark (A) of timing chain lower front cover with the timing mark (B) of the damper pulley by turning the crankshaft damper pulley clockwise.



SEMEM00007D



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



SEMEM01006D

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



SEMEM01007D

 Remove the cylinder head cover. (Refer to Cylinder Head Assembly - "Cylinder Head Cover")

EM-28

Timing System

5. After pressing the timing chain "C" auto tensioner, insert the fixing pin into the mounting position (A) to fix the auto tensioner piston.



SLTEM70029L_N

NOTICE

- Install a set pin (Ø2.5mm (0.09 in) steel wire) after compressing the tensioner so that inner parts are not missing during disassembly.
- 6. Remove the timing chain "C" auto tensioner (A).



SLTEM70030L_N

7. Remove the timing chain "C" tensioner arm (A).



SLTEM70031L_N

8. Remove the timing chain "C" guide (A).



SEMEM00121D

9. Remove the timing chain "C" cam to cam guide (A).



SLTEM70033L_N

Timing System

10. Remove the intake and exhaust camshaft sprocket bolts (A).



SLTEM70034L

11. Remove the timing chain "C" (A) with the camshaft sprocket.



SEMEM01008D

12. Remove the timing chain upper rear cover (A).



SEMEM00126D

Timing Chain "B"

- 1. Remove the timing chain "C".
- 2. Drain the engine oil. (Refer to Lubrication System - "Engine Oil")
- 3. Remove the oil pan. (Refer to Lubrication System - "Oil Pan")
- 4. Remove the drive belt tensioner. (Refer to Drive Belt System - "Drive Belt Tensioner")
- Remove the crankshaft damper pulley. (Refer to Drive Belt System - "Crankshaft Damper Pulley")
- 6. Remove the timing chain lower front cover (A).



SEMEM00123D

7. After pressing the timing chain "B" auto tensioner, insert the fixing pin into the mounting position to fix the auto tensioner piston.

Timing System

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



SEMEM01009D

9. Remove the timing chain "B" (A).



SEMEM01010D

Timing Chain "A"

1. After pressing the timing chain "A" auto tensioner, insert the fixing pin into the mounting position to fix the auto tensioner piston.

NOTICE

- Install a set pin (Ø2.5mm (0.09 in) steel wire) after compressing the tensioner so that inner parts are not missing during disassembly.
- 2. Remove the timing chain "A" auto tensioner (A).



SEMEM01011D

3. Remove the timing chain "A" tensioner arm (A).



SEMEM01012D

EM-31

Timing System

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



SEMEM01013D

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



SEMEM01014D

7. Remove the crankshaft sprocket (A).



SEMEM01015D

NOTICE

• 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.)

Timing System

Installation

Timing Chain "A"

- 1. Check the worn of timing chain, chain guide, high pressure fuel pump sprocket, camshaft sprocket, balance shaft sprocket and replace them if necessary.
- 2. Install the crankshaft sprocket (A).



SEMEM01015D

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



SEMEM01016D

NOTICE

- When installing crankshaft sprocket, apply oil to the O - ring (A) inside the sprocket.
- When applying O ring, Install so that the O-ring does not come off.



SEMEM00118D

4. Align the timing marks of sprocket and chain when high pressure fuel pump sprocket is not installed to pump.



SEMEM01017D

EM-33

Timing System

5. Install the timing chain "A" (B) with the high pressure fuel pump sprocket (A).



SEMEM01014D

6. Align the timing mark (A) of timing chain with the timing mark of timing chain lower rear cover and crankshaft sprocket.



SEMEM00124D

7. Install the timing chain "A" guide (A).

Tightening torque :

19.6 - 26.4 N.m (2.0 - 2.7 kgf.m, 14.4 - 19.5 lb-ft)



SEMEM01013D

8. Install the timing chain "A" tensioner arm (A).

Tightening torque :

19.6 - 26.4 N.m (2.0 - 2.7 kgf.m, 14.4 - 19.5 lb-ft)



SEMEM01012D

Timing System

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

Tightening torque:

9.8 - 11.7 N.m (1.0 - 1.2 kgf.m, 7.2 - 8.6 lb-ft)



SEMEM01011D

NOTICE

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

Timing Chain "B"

- 1. Check the worn of timing chain, chain guide, high pressure fuel pump sprocket, camshaft sprocket, shaft sprocket, and replace them if necessary.
- 2. Install the timing chain "A".
- 3. Install the timing chain "B" (A).



SEMEM01010D

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

Tightening torque :

9.8 - 11.7 N.m (1.0 - 1.2 kgf.m, 7.2 - 8.6 lb-ft)



SEMEM01009D

EM-35

Timing System

5. Apply the sealant at the timing chain lower front cover.

Sealant type : Loctite #5902 Bead width :: 2.5 - 3.5 mm (0.09 - 0.13 in)



SEMEM01018D

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



- 7. Install the crankshaft damper pulley. (Refer to Drive Belt System - "Crankshaft Damper Pulley")
- 8. Install the drive belt tensioner. (Refer to Drive Belt System - "Drive Belt Tensioner")
- 9. Install the oil pan. (Refer to Lubrication System - "Oil Pan")

Bolt size = Diameter x Length



Bolt	Size	Quantity	Tightening torque N.m (kgf.m, lb-ft)
А	8 x 80	3 EA	19.6 - 26.5 (2.0 - 2.7, 14.5 - 19.5)
В	8 x 70	6 EA	19.6 - 26.5 (2.0 - 2.7, 14.5 - 19.5)
С	8 x 50	6 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)

Timing System

Timing Chain "C"

- 1. Check the worn of timing chain, chain guide, high pressure fuel pump sprocket, camshaft sprocket, balance shaft sprocket and replace them if necessary.
- 2. Install the timing chain lower front cover.
- 3. Apply the sealant at the timing chain upper rear cover.

Sealant type : Loctite #5902 Bead width : 2.5 - 3.5 mm (0.09 - 0.13 in)



SEMEM00019D

• 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 rear cover overlap.

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



SEMEM00126D





SEMEM00020D

Bolt	Size	Quantity	Tightening torque N.m (kgf.m, lb-ft)
А	6 x 14	4 EA	9.8 - 11.7 (1.0 - 1.2, 7.2 - 8.6)
В	6 x 22	9 EA	9.8 - 11.7 (1.0 - 1.2, 7.2 - 8.6)
С	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	Nuts	1 EA	9.8 - 11.7 (1.0 - 1.2, 7.2 - 8.6)
EM-37

Timing System

5. Install the intake and exhaust camshaft sprocket tentatively, and align the timing mark (A, B) with that of timing chain upper rear cover.



SLTEM70056L_N

6. Install the timing chain "C" (A), and align the timing mark with that of intake and exhaust camshaft.



SEMEM01008D

7. Check the timing mark of high pressure fuel pump sprocket and the timing mark of timing chain.



SEMEM01019D

8. Install the timing chain "C" cam to cam guide (A).

Tightening torque : 9.8 - 11.7 N.m (1.0 - 1.2 kgf.m, 7.2 - 8.6 lb-ft)



SLTEM70033L_N

Timing System

9. Install the timing chain "C" guide (A).

Tightening torque:

19.6 - 26.4 N.m (2.0 - 2.7 kgf.m, 14.4 - 19.5 lb-ft)



SEMEM00121D

10. Install the timing chain "C" tensioner arm (A).

Tightening torque : 19.6 - 26.4 N.m (2.0 - 2.7 kgf.m, 14.4 - 19.5 lb-ft)



SLTEM70031L_N

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

Tightening torque :

9.8 - 11.7 N.m (1.0 - 1.2 kgf.m, 7.2 - 8.6 lb-ft)



SLTEM70057L_N

12. Install the intake and exhaust camshaft sprocket bolts (A).

Tightening torque :

93.1 - 117.6 N.m (9.5 - 12.0 kgf.m, 68.7 - 86.7 lb-ft)



SLTEM70034L_N

NOTICE

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

Timing System

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

Sealant type : MS 721-40 A (Loctite #5902) Bead width : 2.5 - 3.5 mm(0.09 - 0.13 in)



ACAE337D_N

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

Tightening torque : 19.6 - 26.4 N.m (2.0 - 2.7 kgf.m, 14.4 - 19.5 lb-ft)



SEMEM01007D

15. Install the timing chain upper front cover acoustic shield (A).

Tightening torque :

9.8 - 11.7 N.m (1.0 - 1.2 kgf.m, 7.2 - 8.6 lb-ft)



SEMEM01006D

16. Install the other parts reverse order of removal.

Cylinder Head Assembly

Components



- 2. Cylinder head cover gasket 3. Front camshaft bearing cap
- 5. Exhaust camshaft 6. Intake camshaft
- 8. Cam carrier
- 9. Cam carrier gasket

EM-41

Cylinder Head Assembly



- 2. Hydraulic lash adjuster
 - (HLA)
- 3. Retainer lock
- 5. Valve spring

7. Valve

- 6. Valve stem seal
- 9. Glow plug plate 10. Glow plug 11. Cylinder head gasket
- 13. Cam carrier gasket

Cylinder Head Assembly

Cylinder Head Cover

Removal and Installation

- 1. Disconnect the battery (-) terminal.
- 2. Disconnect the breather hose (A).



SEMEM01020D

- 3. Remove the injector. (Refer to Engine Control / Fuel System - "Injector")
- 4. Disconnect the fuel hose (A) and fuel return hose (B).



SEMEM00024D

5. Remove the cylinder head cover (A) with the gasket.

Tightening torque : 9.8 - 11.7 N.m (1.0 - 1.2 kgf.m, 7.2 - 8.6 lb-ft)



SEMEM00025D

NOTICE

• Install the cylinder head cover by tightening the bolts, in several passes, in the sequence as shown.



6. Install in the reverse order of removal.

Cylinder Head Assembly

Vacuum Pump

Removal and Installation

- 1. Disconnect the battery (-) terminal.
- 2. Disconnect the brake vacuum hose (A).
- 3. Remove the vacuum pump (B).

Tightening torque :

18.6 - 23.5 N.m (1.9 - 2.4 kgf.m, 13.7- 17.3 lb-ft)



SEMEM00027D

4. Install in the reverse order of removal.

Cylinder Head Assembly

Camshaft

Removal and Installation

- 1. Disconnect the battery (-) terminal.
- Remove the cylinder head cover. (Refer to Cylinder Head Assembly - "Cylinder Head Cover")
- 3. Remove the timing chain "C" (Refer to Timing System - "Timing Chain")
- Remove the intake manifold. (Refer to Intake and Exhaust system - "Intake Manifold")
- 5. Remove the intake and exhaust camshaft sprocket (A).

Tightening torque :

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



SLTEM70064L_N

6. Remove the camshaft bearing caps (A).

Tightening torque :

13.7 - 15.6 N.m (1.4 - 1.6 kgf.m, 10.1 - 11.5 lb-ft)



SLTEM70066L_N

Cylinder Head Assembly

NOTICE

• Remove the camshaft bearing caps according to the number.



SEMEM00034D

• Install the camshaft bearing caps by tightening the bolts, in several passes, in the sequence as shown.



SEMEM00035D

7. Remove the camshafts (A).



SEMEM01021D

8. Install in the reverse order of removal.

Cylinder Head Assembly

Inspection

Camshaft

NOTICE

- Do not rotate the camshaft during inspection.
- 1. Install the camshafts (A).



SEMEM01021D

2. Install the camshaft bearing caps (A).

Tightening torque:

13.7 - 15.6 N.m (1.4 - 1.6 kgf.m, 10.1 - 11.5 lb-ft)



SLTEM70066L_N

3. Measure the end play by moving the camshaft back and forth of the cylinder head.

End play: 0.1 - 0.2 mm (0.0039 - 0.0079 in)



KDSE126A_N

- 4. Clean the contact faces of the camshafts and bearing caps and place the plastic gauge on the journal surface.
- 5. Install the camshaft bearing caps (A) with specified torque.

Tightening torque :

13.7 - 15.6 N.m (1.4 - 1.6 kgf.m, 10.1 - 11.5 lb-ft)



SLTEM70066L_N

Cylinder Head Assembly

6. Remove the camshaft bearing caps, and then measure the widest portion of the plastic gage on each journal.

Oil clearance :

0.04 - 0.08 mm (0.0016 - 0.0031 in)



KDSE143A_N

7. If the oil clearance is greater than the maximum value, reassemble the camshaft. If necessary, replace bearing caps and cylinder heads.

8. Check the cam lobes for damage. If the lobe is damaged, 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_N

EM-48

Cylinder Head Assembly

Cylinder Head

Removal

- 1. Remove the camshaft. (Refer to Cylinder Head Assembly - "Camshaft")
- Remove the vacuum pump. (Refer to Cylinder Head Assembly - "Vacuum pump")
- 3. Remove the cam carrier (A).



SLTEM70068L_N

4. Remove the cam followers (A).



SLTEM70069L_N

5. Remove the cylinder head bolts (A).



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



SEMEM00036D

Cylinder Head Assembly

6. Remove the cylinder head (A).



SEMEM01022D

NOTICE

- Be careful not to damage the contact sarfaces of the cylinder head and cylinder block.
- 7. Remove the cylinder head gasket (A).



SEMEM01023D

Disassembly

1. Remove the hydraulic lash adjusters (A).



- 2. Remove the cylinder head from the cylinder block.
- 3. Using SST (09222-3K000, 09222-3C300), remove the valve.



- STQEM1518L_N
- 4. Remove the valve stem seals (A).



STQEM1519L_N

Cylinder Head Assembly

Inspection

Cam follower

- 1. Check rotation of the roller. If they do not rotate smoothly or are loose, replace them.
- 2. Check the roller surface. Replace any damage found.
- 3. Check the roller surface Replace if necessary there is any damage or worn excessively.



LCAC317A_N

Hydraulic lash adjuster (HLA)

Hold A and press B by hand, If B moves, replace the HLA.



LCAC318A_N

Problem	Cause	Action	
Temporary noise when starting a engine.	Normal.	This noise will disappear after the oil in the engine reaches the normal pressure.	
Continuous noise when the engine is started after parking more than 48 hours.	Oil leak in high pressure room in HLA.	Noise will disappear within 15 minutes when engine runs at 2000-3000 rpm. If it doesn't disappear, refer to items below.	
Continuous noise when the engine is first started after rebuilding cylinder head.	Insufficient oil in cylinder head oil gallery.		
Continuous noise when starting after excessive engine cranking.	Air intake due to oil leak in high pressure room in HI A		
		 Do not run engine at a speed higher than 3000 rpm, as this may damage the HLA. 	
Continuous noise from engine start after HLA change	low oil in HLA.		
Continuous noise during idle after high speed driveing.	Engine oil level too high or too low.	Check oil level,drain or add oil as necessary.	
	Overflow of air into oil	Check oil supply system.	
	Oil deterioration	Replace the oil.	
Noise cotinues for more than 15 minutes.	Low oil pressure.	Check oil pressure and oil supply system of each part of engine.	

Cylinder Head Assembly

Valve and Valve Guide

- 1. Replace or reprocess the valve surface if necessary.
 - 1) Damage or bent stem.
 - 2) Roughness or damage to face.
 - 3) Damage or uneven wear to stem tip.
- 2. Check the valve head margin thickness (A) of each valve, replace it if necessary.

Margin thickness

Intake, Exhaust: 1.8 - 2.0 mm (0.0709 - 0.0787 in)



ACAE314A_N

3. Measure valve length.

Valve length Intake, Exhaust: 110.55 mm (4.3524 in)



ACAC314B_N

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_N

5. Measure valve guide inner diameter.

Valve inner diameter

Intake, Exhaust: 7.000 - 7.015 mm (0.2755 - 0.2761 in)





ECKD219A_N

Cylinder Head Assembly

6. Measure valve stem to clearance (C) by subtracting 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) Limit

Intake: 0.10 mm (0.0039 in)

Exhaust: 0.15 mm (0.0059 in)



ACAE314E_N

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

Valve Seat

- 1. For each valve seat contact surface and valve face, check the following.
 - 1) Roughness
 - 2) Damage
- If necessary, resurface valve seat with a 45°(Intke), 45°(Exhaust) valve seat cutter and/or resurface valve face.



LCAC315A_N

- 3. Apply a thin coat of prussian blue to valve face.
- 4. Press the valve on the valve seat to check the contact status of the valve.
 - 1) Press the valve on the valve seat to check the contact status of the valve.
 - 2) If blue does not appear 360° around valve seat, resurface valve seat.





LCAC315B_N

Cylinder Head Assembly

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_N

- 6. Check that valve seating position is at center of valve face.
 - 1) If seating position is too high (low), correct valve seat at an angle of 45 degrees of the cutter (intake, exhaust).





Exhaust

SBLEM6041L_N

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 the valve spring if necessary.

Free length : 53.0 mm (2.086 in) Out-of-square : Below 1.5°



ECKD222A_N

3. Measure the spring pressure. If out of reference, replace the spring.

Spring Height	Pressure	
38 mm (1.4961 in)	245.2 - 270.7 N (25 - 27.6 kg)	
28.8 mm (1.1339 in)	432.5 - 467.8 N (44.1 - 47.7 kg)	

Cylinder Head Assembly

Cylinder Head

- Inspect the cylinder head for damage, cracks and leakage of water and oil. Replace the cylinder head if necessary.
- 2. Measure cylinder head flatness in seven directions shown in the following picture.

Distortion: 0.05 mm (0.0020 in)



STQEM1520L_N



STQEM1025L_N

3. Measure the flatness of the intake and exhaust manifold in four directions.

Flatness: 0.15 mm (0.0059 in)





STQEM1521L_N

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

EM-55

Cylinder Head Assembly

Reassembly

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



NOTICE

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

2. Using SST (09222-3K000, 09222-3C300), install the valve.



STQEM1518L_N

EM-56

Cylinder Head Assembly

- 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.



SEMEM00506L



ACAC319B_N

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 g	gasket	mm (inch)		
Gasket grade	А	В	С	
Piston protrusion amount	0.006 - 0.101 (0.0002 - 0.0039)	0.101 - 0.196 (0.0039 - 0.0077)	0.196 - 0.290 (0.0077 - 0.0114)	
Piston protrusion allowable value	0.151 (0.0059)	0.246 (0.0096)	_	
Gasket thickness	0.92 - 0.98 (0.0362 - 0.0385)	0.97 - 1.03 (0.0381 - 0.0405)	1.02 - 1.08 (0.0401 - 0.0425)	
Identification mark				

SEMEM00507L



SEMEM00524L

Cylinder Head Assembly

4. Install the hydraulic lash adjuster (A).



KDSE124A_N

- 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.

NOTICE

• Stroke HLA in engine oil 4 - 5 times by pushing its cap while pushing the ball down slightly by hard steel wire.

(Take care not to severely push hard steel wire down since ball is several grames.)



SEMEM00508L

Cylinder Head Assembly

Installation

1. Install the cylinder head gasket (A).



SEMEM01023D

2. Install the cylinder head (A).

Tightening torque : 49.0 N.m (5.0 kgf.m, 36.1 lb-ft) + 120° + 90°



SEMEM01022D

• Recheck tightening torque 49.0 N.m (5.0 kgf.m, 36.1 lb.ft) of each cylinder head bolt, after installing a new cylinder head bolt according to the tightening torque 49.0 N.m (5.0 kgf.m, 36.1 lb.ft) in procedure down below.

Continuesly tighten with angle tightening torque(120°) following the procedure in picture below after tightening with angle tightening torque(90°) with no stop following the procedure down below



SLTEM70507L_N

Cylinder Head Assembly

3. Install the cam follower (A).



SLTEM70069L_N

4. Install the cam carrier (A).



SLTEM70068L_N

5. Install the other parts reverse order of removal.

Components



Cylinder Block Assembly



- 2. O-ring
- 3. Piston cooling oil jet
- 4. Crankshaft upper bearing
- 7. Thrust bearing
- 8. Main bearing cap

Cylinder Block Assembly



3. Rear oil seal

Fly wheel
 Fly wheel adapter

Cylinder Block Assembly

Rear Oil Seal

Removal and Installation

1. Remove the rear oil seal (A).



SEMEM01025D

2. Apply engine oil to a new rear oil seal lip

3. Install the new rear oil seal (A).



SEMEM01025D

NOTICE

- Always use a new rear oil seal.
- 4. Install the other parts reverse order of removal.

Cylinder Block Assembly

Fly Wheel

Removal and Installation

1. Remove the fly wheel adapter (A).

Tightening torque:

42.1 - 53.9 N.m (4.3 - 5.5 kgf.m, 31.1 - 39.7 lb-ft)



SEMEM00038D

2. Remove the fly wheel (A).

Tightening torque:

117.6 - 127.4 N.m (12.0 - 13.0 kgf.m, 86.7 - 94.0 lb-ft)



SEMEM00039D

3. Remove the bell housing cover mounting bolts (A).

Tightening torque :

42.1 - 53.9 N.m (4.3 - 5.5 kgf.m, 31.1 - 39.7 lb-ft)



SEMEM00089D

4. Remove the fly wheel housing (A).

Tightening torque :

42.1 - 53.9 N.m (4.3 - 5.5 kgf.m, 31.1 - 39.7 lb-ft)



SEMEM00040D

5. Install in the reverse order of removal.

Cylinder Block Assembly

Cylinder Block

Removal

- 1. Remove the fly wheel housing. (Refet to Cylinder Block - "Fly Wheel")
- 2. Remove the timing chain. (Refer to Timing System - "Timing Chain")
- Remove the intake manifold. (Refer to Intake And Exhaust System - "Intake Manifold")
- Remove the exhaust manifold. (Refer to Intake And Exhaust System - "Exhaust Manifold")
- 5. Remove the cylinder head assembly. (Refer to Cylinder Head Assembly - "Cylinder Head")
- Remove the oil level gauge and guide. (Refer to Lubrication System - "Oil Level Gauge and Guide")
- 7. Remove the power steering pump bracket. (Refer to Steering System - "Power Steering Pump")
- 8. Remove the alternator braket. (Refer to Engine Electrical System - "Alternator")
- 9. Remove the thermostat housing. (Refer to Cooling System - "Thermostat")
- 10. Remove the heater pipe. (Refer to Cooling System - "Thermostat")
- 11. Remove the oil cooler. (Refer to Lubrication System - "Oil Cooler")
- 12. Remove the water pump. (Refer to Cooling System - "Water Pump")

13. Remove the timing chain lower rear cover (A).



- 14. Remove the high pressure fuel pump bracket. (Refer to Engine Control / Fuel System - "High Pressure Fuel Pump")
- 15. Remove the oil pump complete (A).



SEMEM01027D

16. Remove the oil pump. (Refer to Lubrication System - "Oil Pump")

Cylinder Block Assembly

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



SEMEM00041D

Disassembly

1. Remove the connecting rod bearing caps (A) with bearings.



NOTICE

- Put marks on the connecting rod and cap so that they will be installed in the correct position when reassembling.
- 2. Remove the piston and connecting rod assembly (A) from the cylinder block.



SEMEM01029D

EM-67

Cylinder Block Assembly

3. Remove the main bearing caps (A) with main bearings.



SEMEM01030D

4. Remove the crankshaft (A) from the cylinder block.



SEMEM00044D

NOTICE

- Be careful not to damage the crankshaft journal.
- 5. Remove the piston cooling oil jet (A).



SEMEM01031D

Cylinder Block Assembly

Inspection

Connecting Rod Bearing

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

Side clearance: 0.1 - 0.25 mm (0.0039 - 0.0098 in)



STQEM1534L_N

2. Remove the connecting rod cap.

- 3. Measure connecting rod bearing oil clearance.
 - 1) Remove all foreign material and oil from the pin journals and connecting rod bearing surface.
 - 2) Position a plastic gauge on the pin journals in axial direction.
 - 3) Install the connecting rod cap and tighten nuts.

Tightening torque :

Step 1: Loosen completely after tightening to 58.8 N.m

(6.0 kgf.m, 43.3 lb-ft).

Step 2: Tighten at 32.4 - 36.3 N.m

(3.3 - 3.7 kgf.m, 23.9 - 26.8 lb-ft) + 58 - 62°

NOTICE

- Always use new connecting rod cap bolts.
 - 4) Remove the connecting rod cap, and measure the oil clearance on each journal.

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



STQEM1037L_N

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

Cylinder Block Assembly

Crankshaft Main Bearing

- Before removing the main bearing cap, measure crankshaft end play.
 If end play exceeds specification, replace the thrust bearing.
 - End play: 0.12 0.30 mm (0.0047 0.0118 in)



STQEM1038L_N

2. Remove the main bearing cap.

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

Tightening torque :

32.4 - 36.3 N.m

- (3.3 3.7 kgf.m, 23.9 26.8 lb-ft) + 90 94°
 - 4) Remove the main bearing cap, and measure the oil clearance on each journal.

Oil clearance: 0.030 - 0.054 mm (0.0012 - 0.0021 in)



STQEM1535L_N

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

Cylinder Block Assembly

Piston Pin

- 1. Check each piston damage.
- 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.





ECKD001Z_N

Piston pin outer diameter : 32.993 - 32.998 mm (1.2989 - 1.2991 in) Piston pin hole inner diameter : 33.004 - 33.011 mm (1.2994 - 1.2996 in) Connecting rod small-end inner diameter : 33.020 - 33.033 mm (1.3000 - 1.3005 in)

Piston Ring

- 1. Check piston ring for breakage, damage and abnormal wear. Replace the defective rings.
- 2. When the piston requires replacement, its ring should also be replaced.

Cylinder Block Assembly

3. Measure the clearance between piston ring and ring groove.

Piston ring side clearance

No.1 ring : 0.08 - 0.12 mm (0.0031 - 0.0047 in) **No.2 ring :** 0.07 - 0.11 mm (0.0028 - 0.0043 in) **Oil ring :** 0.04 - 0.08 mm (0.0016 - 0.0031 in)



ECKD001G_N

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

End gap

No.1 ring : 0.23 - 0.38 mm (0.0091 - 0.0150 in) **No.2 ring :** 0.70 - 0.90 mm (0.0276 - 0.0354 in) **Oil ring :** 0.20 - 0.40 mm (0.0079 - 0.0157 in)



ECKD001K_N

Cylinder Block Assembly

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.
- Remove contaminants from oil holes with compressed air and, at the same time, make sure that they are not blocked.
- Check for scratches, rust, and corrosion.
 Use also a flaw-detecting agent for the check.
 If defects are evident, fix the defects or replace the cylinder block.
- Using a straightedge and thickness gauge, check the cylinder block top surface for flatness. To measure, place the square ruler on the position shown in the illustration. When measuring, there should be no attached gasket pieces on the top surface of the cylinder block.

If flatness is not within the limit, replace the cylinder block.

Standard value : below 0.05 mm (0.002 in)



KDSE145B_N

3. Check cylinder wall for scratches and seizure. If defects are evident, fix the defects or replace the cylinder block

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

Standard value :

95.000 - 95.030 mm (3.7402 - 3.7413 in)



STQEM1540L_N

5. Measure the outside diameter of the piston.

Standard value :

94.910 - 94.940 mm (3.7366 - 3.7378 in)



ECKD001D_N

6. Calculate the difference between the cylinder bore inner diameter and the piston outer diameter.

Standard value :

0.080 - 0.100 mm (0.0031 - 0.0039 in)
Cylinder Block Assembly

Replacement

Crankshaft Main Bearing

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



KDSE164A_N

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.

Main Bearing Bore Diameter

Grade	Main bearing bore diameter
А	71.000 - 71.008 mm (2.7953 - 2.7956 in)
В	71.008 - 71.016 mm (2.7956 - 2.7959 in)
С	71.016 - 71.024 mm (2.7959 - 2.7962 in)

2. Check the cranksaft main journal diameter grade.



SEMEM00512L

NOTICE

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

Crankshaft Main Journal Diameter

Grade	Crankshaft main journal diameter
А	66.994 - 67.000 mm (2.6376 - 2.6378 in)
В	66.988 - 66.994 mm (2.6373 - 2.6376 in)
С	66.982 - 66.988 mm (2.6371 - 2.6373 in)

Cylinder Block Assembly

3. Choose proper main journal bearing in the table below.

► Main Journal Bearing Selection Table

Main journal bearing		Cylinder block main bearing bore size grade		
		А	В	С
Crankshaft pin	А	Green	Yellow	None
journal outer diameter	В	Yellow	None	Blue
grade	С	None	Blue	Red

Main journal bearing oil clearance :

0.030 - 0.054 mm (0.0012 - 0.0021 in)

► Main Journal Bearing Thickness

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

Connecting Rod Bearing

1. Check the size grade (A) of the connecting rod big end.



ACAE143A_N

NOTICE

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

► Connecting Rod Big End Diameter

Grade	Connecting rod big end diameter
А	60.000 - 60.006 mm (2.3622 - 2.3624 in)
В	60.006 - 60.012 mm (2.3624 - 2.3627 in)
С	60.012 - 60.018 mm (2.3627 - 2.3629 in)

Cylinder Block Assembly

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



ACAE143B_N

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.
- ► Crankshaft Pin Journal Outer Diameter

Grade	Crankshaft pin journal outer diameter
1	56.994 - 57.000 mm (2.2439 - 2.2441 in)
2	56,988 - 56,994 mm (2,2436 - 2,2439 in)
3	56,982 - 56,988 mm (2,2434 - 2,2436 in)

3. Choose the connecting rod bearing in the selection table.

► Connecting Rod Bearing Selection Table

Connecting rod bearing		Connecting rod big end inner grade		
		А	В	С
Crankshaft pin journal outer diameter grade	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

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



Cylinder Block Assembly

Piston

1. Check the cylinder bore inner diameter code on the cylinder block top face.

Grade	Cylinder bore inner diameter
А	95.000 - 95.010 mm (3.7402 - 3.7406 in)
В	95.010 - 95.020 mm (3.7406 - 3.7409 in)
С	95.020 - 95.030 mm (3.7409 - 3.7413 in)



KDSE144A_N

2. Check the piston outer diameter code on the piston top face.

Grade	Piston outer diameter
А	94.910 - 94.920 mm (3.7366 - 3.7370 in)
В	94.920 - 94.930 mm (3.7370 - 3.7374 in)
С	94.930 - 94.940 mm (3.7374 - 3.7378 in)



SEMEM00513L

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

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

Cylinder Block Assembly

Reassembly

1. Install the piston cooling oil jet (A).

Tightening torque:

29.4 - 34.3 N.m (3.0 - 3.5 kgf.m, 21.6 - 25.3 lb-ft)



SEMEM01031D

2. Install the main bearings (A) at the cylinder block and main bearing caps.

NOTICE

• Top main bearing is inside the oil groove.

3. Install the thrust bearings (B).



NOTICE

• The groove and surface should be placed outward.



SEUEM15-0030E_N

4. Install the crankshaft (A).



Cylinder Block Assembly

5. Install the main bearing caps (A) with bearings. Check and install the front mark and cap number.

NOTICE

· Check the front mark and cap number and install.

Tightening torque:

32.3 - 36.2 N.m (3.3 - 3.7 kgf.m, 23.8 - 26.7 lb-ft) + 90° - 94°



SEMEM01030D

6. Check the front marks on the piston and connecting rod.



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



KDSE170A_N

NOTICE

- Before inserting the piston pin, apply a sufficient amount of engine oil to the piston pin circumferential surface, piston pin hole and the connecting rod small end hole.
- 8. Install the snap ring.

Cylinder Block Assembly

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



SEMEM00515L



10. Insert the piston and connecting rod assembly from above the top of cylinder.

Ensure that the front mark on the piston crown and that (front mark) on the connecting rod face toward the front of engine (to the crankshaft pulley side).



SEMEM00513L

NOTICE

• Before installing the piston, apply a sufficient amount of engine oil to the oil ring groove.

EM-80

Cylinder Block Assembly

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



SEMEM01029D



STQEM1545L_N

12. Install the connecting rod bearing.

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

Tightening torque:

Step 1: Loosen completely after tightening to 58.8 N.m (6.0 kgf.m, 43.3 lb-ft).

Step 2: Tighten at 32.4 - 36.3 N.m

(3.3 - 3.7 kgf.m, 23.9 - 26.8 lb-ft) + 58 - 62°)



SEMEM01028D

NOTICE

• Do not reuse the connecting rod bolt.

Cylinder Block Assembly

Installation

1. Apply the sealant to the rear oil seal case.

Sealant type : Loctite #5900 **Bead width :** 3 ± 0. 5 mm (0.117 ± 0.02 in)



STQEM1546L_N

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

Tightening torque :

9.8 - 11.7 N.m (1.0 - 1.2 kgf.m, 7.2 - 8.6 lb-ft)



3. Install the oil pump. (Refer to Lubrication System - "Oil Pump")

4. After removing the foreign materials, apply the sealant on the timing chain lower under cover and then install the oil pump complete (A).



SEMEM01027D

Bolt size = Diameter x Length



STQEM1070L_N

Bolt	Size	Quantity	Tightening torque N.m (kgf.m, lb-ft)
A	6x18	3 EA	7.8 - 11.7 (0.8 - 1.2, 5.7 - 8.6)
В	6x30	13 EA	7.8 - 11.7 (0.8 - 1.2, 5.7 - 8.6)
С	8x45	8 EA	19.6 - 26.4 (2.0 - 2.7, 14.4 - 19.5)

Cylinder Block Assembly

5. After removing the foreign materials on the timing chain lower rear cover, apply the sealant (A).

Sealant type : Loctite #5902 Bead width : 2.5 - 3.5 mm (0.09 - 0.13 in)



SEUEM15-0047E_N

6. Install the timing chain lower rear cover (A).



SEMEM01026D

Bolt size = Diameter x Length



ACAC153C_N

Bolt	Size	Quantity	TTightening torque N.m (kgf.m, lb-ft)
А	6x14	4 EA	9.8 - 11.8 (1.0 - 1.2, 7.2 - 8.6)
В	8x22	1 EA	19.6 - 26.5 (2.0 - 2.7, 14.5 - 19.5)
С	8x30	3 EA	19.6 - 26.5 (2.0 - 2.7, 14.5 - 19.5)
D	8x40	1 EA	19.6 - 26.5 (2.0 - 2.7, 14.5 - 19.5)

7. Install the other parts reverse order of removal.

i information

 When replacing the cylinder block with a new one, select and install the appropriate crankshaft main bearings and pistons in accordance with the crankshaft journal bore mark and the cylinder bore size mark stamped on the cylinder block.

Cooling System

Coolant

Engine Coolant Replacement and Air Bleeding

WARNING

• Never remove the radiator cap when the engine is hot.

Serious scalding could be caused by hot fluid under high pressure escaping from the radiator.

- When pouring engine coolant, be careful not to spill coolant on the belts, electrical devices.
- 1. Make sure the engine and radiator are cool to the touch.
- 2. Remove the radiator cap.
- 3. Loosen the drain plug, and drain the coolant.
- 4. Tighten the radiator drain plug securely.
- 5. After draining engine coolant in the reservoir tank, clean the tank.
- 6. Fill the radiator with water through the radiator cap and tighten the cap.

NOTICE

- To that the air in radiator is flown off easily, slowly pour water and press the upper/lower radiator hoses.
- 7. Start the engine and allow it to warm up to normal operating temperature.

Wait until the cooling fans turn on 2-3 times. Accelerate the engine to aid in purging trapped air. Shut the engine off.

- 8. Wait until the engine is cool.
- 9. Repeat steps 1 to 8 until the drained water runs clear.

10. Fill fluid mixture with coolant and water (55 - 60% (except for North America, Europe and China : 45 - 50%) slowly through the radiator cap.
Push the upper/lower hoses of the radiator so as bleed air easily.

NOTICE

- Use only genuine antifreeze/coolant.
- For best corrosion protection, the coolant concentration must be maintained year-round at 55% minimum.
 Coolant concentrations less than 55% may not

provide sufficient protection against corrosion or freezing.

• Coolant concentrations greater then 60% will impair cooling efficiency and are not recommended.

- Do not mix different brands of antifreeze/ coolants.
- Do not use additional rust inhibitors or antirust products.
- Start the engine and run until coolant circulates.
 When the cooling fan operates and coolant circulates, refill coolant through the radiator cap.
- 12. Repeat 11 until the cooling fan 3 5 times and bleed air sufficiently out of the cooling system.
- 13. Install the radiator cap and fill the reservoir tank to the "MAX" line with coolant.
- 14. Run the vehicle under idle until the cooling fan operates 2 3 times.
- 15. Stop the engine and wait coolant gets cool.
- 16. Repeat 10 15 until the coolant level doesn't fall any more, bleed air out of the cooling system.

NOTICE

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

Cooling System

Thermostat

Components



3. Water inlet fitting

- 5. Heater pipe "A" 6. Heater pipe "B"
- 8. Gasket 9. O-ring

Cooling System

Removal and Installation

Thermostat

- 1. Disconnect the battery (-) terminal.
- 2. Drain the coolant. (Refer to Cooling System - "Coolant")
- 3. Remove the water inlet fitting (A).

Tightening torque :

19.6 - 26.4 N.m (2.0 - 2.7 kgf.m, 14.4 - 19.5 lb-ft)



SEMEM00047D

4. Remove the thermostat (A).



SEMEM00048D

5. Remove the alternator. (Refer to Engine Electrical System - "Alternator") 6. Disconnect the water hose (A).



SEMEM00049D

7. Remove the thermostat housing (A).

Tightening torque :

19.6 - 26.4 N.m (2.0 - 2.7 kgf.m, 14.4 - 19.5 lb-ft)



- 8. Install in the reverse order of removal.
- 9. Fill the coolant. (Refer to Cooling System - "Coolant")

Cooling System

Water Outlet Fitting

- 1. Disconnect the battery (-) terminal.
- 2. Drain the coolant. (Refer to Cooling System - "Coolant")
- 3. Remove the water outlet fitting (A).

Tightening torque:

19.6 - 26.4 N.m (2.0 - 2.7 kgf.m, 14.4 - 19.5 lb-ft)



SEMEM01033D

4. Install in the reverse order of removal.

- ► Heater Pipe "A"
- 1. Disconnect the battery (-) terminal.
- Remove the exhaust manifold (Refer to Intake and Exhaust System - "Exhaust manifold")
- 3. Disconnect the water hose (A).



SEMEM00051D

4. Remove the heater pipe "A" (A).

Tightening torque :

19.6 - 26.4 N.m (2.0 - 2.7 kgf.m, 14.4 - 19.5 lb-ft)



SEMEM00052D

NOTICE

- Always use a new O ring.
- When installing the heater pipe, install it after spraying the antifreeze or soapy water on the Oring.
- 5. Install in the reverse order of removal.

Cooling System

- ► Heater Pipe "B"
- 1. Disconnect the battery (-) terminal.
- 2. Drain the coolant. (Refer to Cooling System - "Coolant")
- 3. Disconnect the water hose (A).



SEMEM00053D

4. Remove the heater pipe mounting bolt (A).

Tightening torque : 19.6 - 26.4 N.m (2.0 - 2.7 kgf.m, 14.4 - 19.5 lb-ft)



SEMEM00054D



SEMEM00055D

Cooling System

5. Remove the heater pipe "B" (A).



SEMEM00056D

NOTICE

- Always use a new O ring.
- When installing the heater pipe, install it after spraying the antifreeze or soapy water on the O ring.
- 6. Install in the reverse order of removal.
- 7. Fill the coolant. (Refer to Cooling System - "Coolant")

Cooling System

Water Pump

Components



2. Water pump

3. Water pump gasket

Cooling System

Troubleshooting

Symptoms		Possible Causes		Remedy
Coolant leakage	From the bleed hole of the water pump	Visually check	Check leaks after about ten-minute warming up.	If coolant still leaks, replace a water pump.
				If leakage stops, reuse the water pump (Do not replace the pump with a new one).
				NOTICE
				Fine vapor leakage can cause efflorescence. Therefore do not replace water pump only for efflorescence.
	From gaskets or bolts		Check the tightening of the water pump mounting bolts.	Retighten the mounting bolts.
			Check damage of gaskets or inflow of dust.	Replace the gasket and clean dust off.
	From outer surface of water pump		Check the material oil any cracks of the water pump.	Replace the gasket and clean dust off.
Noise	From bearings From mechanical seals Impeller interference	Inspection with a stethoscope	After starting the engine, check nois with a stethoscope.	If there is no noise, reuse the water pump. (Do not replace it).
				If there is any noise from the water pump, remove the drive belt and recheck.
		Inspection after removing a drive belt	After removing a water pump and drive belt, check noise again.	If there is noise, reuse the water pump. Check other drive line parts
				If there is no noise, replace the water pump with a new one.
		Inspection after removing a water pump	After removing a water pump and drive belt, check noise again.	If there is any interference between them, replace the water pump with a new one
Overheating	Damaged impeller Loosened impeller	Loosened impeller	Corrosion of the impeller wing	 Check engine coolant. Defective antifreeze (rust, etc.) / non- compliance with antifreeze replacement cycle Misuse of cooling water (groundwater, bottled water, etc.) Check for insufficient coolant, overheat, and air inflow Conduct additional inspection
			Impeller seperation from the shaft	Replace the water pump.

Cooling System

Removal and Installation

- 1. Disconnect the battery (-) terminal.
- 2. Remove the drive belt. (Refer to Drive Belt System - "Drive Belt")
- 3. Drain the coolant. (Refer to Cooling System - "Coolant")
- 4. Remove the water pump pulley (A).

Tightening torque:

```
9.8 - 11.7 N.m (1.0 - 1.2 kgf.m, 7.2 - 8.6 lb-ft)
```



5. Remove the water pump (A).

SEMEM00028D

Tightening torque:

19.6 - 26.4 N.m (2.0 - 2.7 kgf.m, 14.4 - 19.5 lb-ft)





👔 information

· Coolant may flow when water pump is removed.

6. Remove the water pump gasket (A).



SEMEM01037D

NOTICE

- When installing, replace with a new gasket.
- 7. Install in the reverse order of removal.

Lubrication System

Components



Lubrication System

Engine Oil

Engnie Oil and Filter Replacement

CAUTION

- Prolonged and repeated contact with mineral oil will result in the removal of natural fats from the skin, leading to dryness, irritation and dermatitis. In addition, used engine oil contains potentially harmful contaminants which may cause skin cancer.
- Exercise caution in order to minimize the length and frequency of contact of your skin to used oil. Wear protective clothing and gloves. Wash your skin thoroughly with soap and water, or

use water-less hand cleaner, to remove any used engine oil.

Do not use gasoline, thinners, or solvents.

- Be careful not to contaminate near parts when replacing engine oil.
- In order to preserve the environment, used oil and used oil filter must be disposed of only at designated disposal sites.
- 1. Drain the engine oil.
 - 1) Remove the oil filler cap.
 - 2) Remove the oil drain plug (A) and drain oil.



SEMEM01034D

2. Replace the oil filter (A).



SEMEM00071D

Lubrication System

3. Fill with engine oil.

1) Install the drain plug (A).

Tightening torque:

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



SEMEM01034D

NOTICE

- When installing an oil drain plug, use a new drain plug gasket.
 - Fill the oil filler with new engine oil.
 Before filling the oil, remove the oil level gauge.

Oil capacity

Total: 9.1 ℓ(2.40 U.S.gal., 9.61 U.S.qt., 8.00 lmp.qt.) Oil pan: 7.9 ℓ(2.09 U.S.gal., 8.35 U.S.qt., 6.95 lmp.qt.)

Drain and refill including oil filter :

8.7 (2.30 U.S.gal., 9.20 U.S.qt., 7.65 lmp.qt.)

NOTICE

• Do not over fill. This will cause oil aeration and loss of oil pressure.

information

- Fill half amount of total oil first and then do the rest after 1 minute or more.
- 3) Install the oil filler cap.
- 4) Install the oil level gauge.

- 4. Start engine and check for oil leaks.
- 5. Recheck the engine oil level.

NOTICE

- When re-checking the engine oil level, check the engine oil level after warming up the engine sufficiently.
- If warming up engine insufficiently, engine oil level may be checked below the specified value.

Inspection

1. Check the engine oil quality.

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

2. Check the engine oil level. After engine warm up stop the engine wait 15 minutes then check the oil level. Oil level should be between the "L" and "F" marks on the dipstick. If low check for leakage and add oil up to the "F"

NOTICE

mark.

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

Lubrication System

Engine Oil Grade

► ACEA oil grade : C2/C3

SAE viscosity : viscosity classification by temperature reference



NOTICE

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

1) Satisfy the requirement of the ACEA classification.

2) Have proper SAE grade number for expected ambient temperature range.

- Lubricants that do not have both an SAE grade number and ACEA service classification on the container should not be used.
- The ACEA certified engine oil is required as a service engine oil.

Only in case that ACEA certified engine oil is not available, the API certified engine oil (API CH-4 or above) is allowed restrictively.

• For the vehicle equipped with DPF, the service engine oil quality should meet the ACEA C2/C3 grade. However, oil refill with small amount of ACEA B4 grade between oil change intervals is possible.

Lubrication System

Oil Pump

Removal and Installation

- 1. Disconnect the battery (-) terminal.
- 2. Drain the engine oil. (Refer to Lubrication System - "Engine Oil")
- 3. Remove the oil pan. (Refer to Lubricaion System - "Oil Pan")
- 4. Remove the oil screen (A) from the oil pump.

Tightening torque :

7.8 - 11.7 N.m (0.8 - 1.2 kgf.m, 5.7- 8.6 lb-ft)



SEMEM01035D

- 5. Remove the timing chain "B". (Refer to Timing System - "Timing Chain")
- 6. Remove the oil pump cover (A).

Tightening torque

Bolt : 7.8 - 11.7 N.m (0.8 - 1.2 kgf.m, 5.7 - 8.6 lb-ft) **Screw :** 5.8 - 8.8 N.m (0.6 - 0.9 kgf.m, 4.3 - 6.5 lb-ft)



- 7. Install in the reverse order of removal.
- 8. Fill the engine oil. (Refer to Lubrication System - "Engine Oil")

Inspection

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

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

Lubrication System

Oil Cooler

Removal and Installation

- 1. Disconnect the battery (-) terminal.
- 2. Drain the coolant. (Refer to Cooling System - "Coolant")
- Drain the engine oil. (Refer to Lubrication System - "Engine Oil")
- 4.Remove the exhaust manifold (Refer to Intake and Exhaust System - "Exhaust Manifold")
- 5. Remove the heater pipe "A". (Refer the Cooling System - "Thermostat")
- 6. Remove the heater pipe mounting bolt (A).

Tightening torque :

19.6 - 26.4 N.m (2.0 - 2.7 kgf.m, 14.4 - 19.5 lb-ft)



SEMEM00054D

7. Remove the oil filter adapter bracket (A).

Tightening torque :

24.5 - 34.3 N.m (2.5 - 3.5 kgf.m, 18.0 - 25.3 lb-ft)



SEMEM00069D

8. Remove the oil filter adapter (A).

Tightening torque : 24.5 - 34.3 N.m (2.5 - 3.5 kgf.m, 18.0 - 25.3 lb-ft)



SEMEM00090D

Lubrication System

9. Remove the oil cooler assembly (A) from the cylinder block.

Tightening torque:

19.6 - 25.4 N.m (2.0 - 2.6 kgf.m, 14.4 - 18.8 lb-ft)



SEMEM00070D

10. Remove the oil cooler (A) from oil cooler cover.

Tightening torque:

7.8 - 11.7 N.m (0.8 - 1.2 kgf.m, 5.7 - 8.6 lb-ft)



- 11. Install in the reverse order of removal.
- 12. Fill the coolant. (Refer to Cooling System - "Coolant")
- 13. Fill the engine oil. (Refer to Lubrication System - "Engine Oil")

Inspection

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



STQEM1553L_N

Lubrication System

Oil Pressure Switch

Removal and Installation

NOTICE

- When fitting a single unit, install the torque in accordance with the regulation.
- · Note that internal damage may occur when the component is dropped. If the component has been dropped, inspect before installing.
- 1. Disconnect the battery (-) terminal.
- 2. Drain the engine oil. (Refer to Lubrication System - "Engine Oil")
- 3. Disconnect the oil pressure switch connector (A).



SEMEM00073D

4. Remove the oil pressure switch (A).

Tightening torque :

14.7 - 21.5 N.m (1.5 - 2.2 kgf.m, 10.8 - 15.9 lb-ft)



SEMEM00074D

5. Install in the reverse order of removal.

NOTICE

· When installing the oil pressure switch, apply seal lock to the thread.

Seal lock: TB2403

Thickness: 0.2 - 0.4 mm (0.008 - 0.016 in)



SEMEM00534L

Lubrication System

Inspection

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

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



SHDEM6059D_N

2. Check the continuity between the terminal and the body when the fine wire is pushed.

If there is continuity even when the fine wire is pushed, replace the switch.



SHDEM6157D_N

 If there is no continuity when a 49 kPa (0.5 kgf/cm², 7.11 psi) is applied through the oil hole, the switch is operating properly.

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

Oil Level Sensor

Removal and Installation

- 1. Remove the oil pump complete. (Refer to Cylinder Block - "Cylinder Block")
- 2. Remove the oil level sensor (A) from the oil pump complete.

Tightening torque:

7.8 - 11.7 N.m (0.8 - 1.2 kgf.m, 5.7 - 8.6 lb-ft)



STQEM1047L_N

3. Install in the reverse order of removal.

Lubrication System

Oil Pan

Removal and Installation

- Drain the engine oil.
 (Refer to Lubrication System "Engine Oil")
- 2. Remove the oil pan (A).

Tightening torque : 9.8 - 11.7 N.m (1.0 - 1.2 kgf.m, 7.2 - 8.6 lb-ft)



SEMEM00037D

3. Install in the reverse order of removal.

• When installing the oil fan, apply the sealant additionally to prevent the oil leak to the overlapping part (T-joint : 4 points right and left of the engine), where bed plate, timing chain lower rear cover, timing chain lower front cover and oil pan overlap.



STQEM1082L_N

4. Fill the engine oil and check the oil leak.

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Lubrication System

Oil Level Gauge and Guide

Removal and Installation

- 1. Disconnect the battery (-) terminal.
- 2. Disconnect the oil pressure sensor wiring clip (A), and then remove the oil level gauge pipe mounting bolt (B).

Tightening torque:

19.6 - 26.4 N.m (2.0 - 2.7 kgf.m, 14.4 - 19.5 lb-ft)



SEMEM00030D

3. Disconnect the connector (A) from bracket, and remove the oil level gauge pipe mounting bolt (B).

Tightening torque:

19.6 - 26.4 N.m (2.0 - 2.7 kgf.m, 14.4 - 19.5 lb-ft)



SEMEM00031D

4. Remove the oil level gauge and guide (A).



SEMEM00032D

5. Install in the reverse order of removal.

Intake And Exhaust System

Intake Manifold

Components



- 1. Intake manifold
- 4. Air control valve (ACV)
- 2. Intake manifold gasket
- 3. EGR cooler adapter 6. Air co
- 5. EGR cooler adapter gasket
 6. Air control valve (ACV) gasket

EM-104

Intake And Exhaust System

Removal and Installation

- 1. Disconnect the battery (-) terminal.
- 2. Remove the air control valve (ACV) (A).

Tightening torque:

7.8 - 11.7 N.m (0.8 - 1.2 kgf.m, 5.7- 8.6 lb-ft)



SEMEM00072D

3. Disconnect the vacuum hose (A) and separate the vacuum pipe (B) from the intake manifold.

Tightening torque:

9.8 - 11.7 N.m (1.0 - 1.2 kgf.m, 7.2 - 8.6 lb-ft)



SEMEM00075D

4. Remove the sensor bracket (A).

Tightening torque : 9.8 - 11.7 N.m (1.0 - 1.2 kgf.m, 7.2 - 8.6 lb-ft)



SEMEM00076D

Intake And Exhaust System

5. Remove the exhaust gas temperature sensor (A).

Tightening torque :

27.4 - 31.3 N.m (2.8 - 3.2 kgf.m, 20.2 - 23.1 lb-ft)

▶ [Low Fan]



SEMEM00506D

▶ [High Fan]



SEMEM00077D

6. Remove the EGR cooler pipe (A).

Tightening torque : 19.6 - 23.5 N.m (2.0 - 2.4 kgf.m, 14.4- 17.3 lb-ft)



SEMEM00078D

7. Remove the EGR cooler adapter (A).

Tightening torque : 19.6 - 23.5 N.m (2.0 - 2.4 kgf.m, 14.4- 17.3 lb-ft)



SEMEM00079D

Intake And Exhaust System

8. Remove the high pressure fuel pipe mounting bolt (A).

Tightening torque :

9.8 - 11.7 N.m (1.0 - 1.2 kgf.m, 7.2 - 8.6 lb-ft)



9. Remove the intake manifold (A).

Tightening torque :

19.6 - 23.5 N.m (2.0 - 2.4 kgf.m, 14.4 - 17.3 lb-ft)



SEMEM00081D

10. Install in the reverse order of removal.

NOTICE

• When installing, replace with new gaskets.

Intake And Exhaust System

EGR Cooler

Components



- 1. EGR cooler assembly
- 4. EGR cooler hose
- 2. EGR cooler inlet pipe
- 3. EGR cooler outlet pipe
- 5. EGR cooler pipe gasket

Intake And Exhaust System

Removal and Installation

- 1. Disconnect the battery (-) terminal.
- 2. Disconnect the EGR cooler hoses (A).



SEMEM00082D

3. Remove the exhaust gas temperature sensor (A).

Tightening torque :

27.4 - 31.3 N.m (2.8 - 3.2 kgf.m, 20.2 - 23.1 lb-ft)

▶ [Low Fan]



SEMEM00506D

▶ [High Fan]



SEMEM00077D
Intake And Exhaust System

4. Remove the EGR cooler pipe (A).

Tightening torque :

19.6 - 23.5 N.m (2.0 - 2.4 kgf.m, 14.4 - 17.3 lb-ft)



SEMEM00084D

5. Disconnect the heater pipe hose (A).



SEMEM00085D

6. Remove the EGR cooler inlet pipe mounting bolts (A).

Tightening torque :

27.4 - 31.3 N.m (2.8 - 3.2 kgf.m, 20.2 - 23.1 lb-ft)



7. Remove the EGR cooler assembly (A).

Tightening torque :

19.6 - 23.5 N.m (2.0 - 2.4 kgf.m, 14.4 - 17.3 lb-ft)



SEMEM00087D

8. Install in the reverse order of removal.

Exhaust Manifold

Components



- 1. Exhaust manifold
- 2. Exhaust manifold gasket
- 3. Exhaust manifold heat protector
- 4. Turbo charger

- 5. Turbo charger gasket
- 6. Turbo charger heat protector
- 7. Turbo charger stay
- 8. Oil feed pipe

9. Oil drain pipe10. Oil drain pipe gasket11. O-ring

Intake And Exhaust System

Removal and Installation

CAUTION

- To prevent scalding by the hot exhaust parts, wait until the engine cools down to room temperature.
- 1. Disconnect the battery (-) terminal.
- 2. Remove the exhaust gas temperature sensor (A).

Tightening torque:

27.4 - 31.3 N.m (2.8 - 3.2 kgf.m, 20.2- 23.1 lb-ft)



SEMEM00061D

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

Tightening torque : 14.7 - 21.5 N.m (1.5 - 2.2 kgf.m, 10.8- 15.9 lb-ft)



SEMEM00062D

4. Remove the turbo charger heat protector (A).

Tightening torque :

14.7 - 21.5 N.m (1.5 - 2.2 kgf.m, 10.8- 15.9 lb-ft)



SEMEM00063D

5. Remove the oil feed pipe (A).

Tightening torque Eye bolt : 14.7 - 21.5 N.m (1.5 - 2.2 kgf.m, 10.8 - 15.9 lb-ft) **Pipe mounting bolt :** 19.6 - 25.4 N.m (2.0 - 2.6 kgf.m, 14.4 - 18.8 lb-ft)



SEMEM00064D

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Intake And Exhaust System

6. Remove the oil drain pipe (A).

Tightening torque :

7.8 - 11.7 N.m (0.8 - 1.2 kgf.m, 5.7 - 8.6 lb-ft)



SEMEM00065D

7. Remove the turbo charger stay (A).

Tightening torque : 29.4 - 34.3 N.m (3.0 - 3.5 kgf.m, 21.6 - 25.3 lb-ft)



SEMEM00066D

8. Disconnect the water hose (A).



SEMEM00053D

9. Remove the turbo charger (A).

Tightening torque : 49.0 - 68.6 N.m (5.0 - 7.0 kgf.m, 36.1 - 50.6 lb-ft)



SEMEM01040D

Intake And Exhaust System

10. Remove the exhaust manifold (A).

Tightening torque :

29.4 - 34.3 N.m (3.0 - 3.5 kgf.m, 21.6 - 25.3 lb-ft)



SEMEM01041D

11. Remove the exhaust manifold gasket (A).



SEMEM01042D

NOTICE

- When installing, always use new exhaust manifold gasket.
- 12. Install in the reverse order of removal.

NOTICE

• When installing, always use new gasket.

Turbocharger

Removal and Installation

- Remove the turbo charger. (Refer to Intake And Exhaust System - "Exhaust Manifold")
- 2. Install in the reverse order of removal.

Inspection

Turbocharger Diagnostic Flow



Intake And Exhaust System

- If any problem related with turbocharger, such as black of engine power, poor acceleration, abnormal engine noise or oil leaks, may occur, check the turbocharger according to the procedure as follows.
- 1. Check for assembling of the turbocharger and the exhaust fitting (or the after treatment).
 - Check if a gasket is installed.
 - Check if mounting bolts (or nuts) are tightened properly.
 - Check if there is a gas leak.
 - Check if there is any damage, such as crack, on the parts.

If a gas leak occur as a gasket was not installed or mounting bolts (or nuts) were tightened inadequately, it may cause abnormal engine noise.

If the cause of the problem is detected, retighten the mounting bolts (or nuts) as the specified torque or replace the gasket or damaged parts with new ones if necessary.

- 2. Check for assembling of the turbocharger and the exhaust manifold.
 - Check if a gasket is installed.
 - Check if the mounting bolts (or nuts) are tightened properly.
 - Check if there is a gas leak.
 - Check if there is any damage, such as crack, on the parts.

If a gas leak occur as a gasket was not installed or mounting bolts (or nuts) were tightened inadequately, it may cause abnormal engine noise.

f the cause of the problem is detected, retighten the mounting bolts (or nuts) as the specified torque or replace the gasket or damaged parts with new ones if necessary.

- 3. Check for assembling of the exhaust manifold and the cylinder head.
 - Check if a gasket is installed.
 - Check if the mounting bolts (or nuts) are tightened properly.
 - Check if there is a gas leak.

If a gas leak occur as a gasket was not installed or mounting bolts (or nuts) were tightened inadequately, it may cause abnormal engine noise. If the cause of the problem is detected, retighten the mounting bolts (or nuts) as the specified torque or install a new gasket if necessary.

Intake And Exhaust System

- 4. Check the turbocharger oil feed pipe & hose and oil drain pipe & hose.
 - Check if a gasket is installed.
 - Check if the mounting bolts are tightened properly.
 - Check if the clamps are positioned in place.
 - Check if the oil pipes & hoses are damaged (bent, crushed, torn or cracked).

If a gas leak occur as a gasket was not installed or mounting bolts were tightened inadequately, it may cause oil leaks.

If the oil feed pipe & hose is damaged, engine oil is not supplied sufficiently to the turbocharger then it may damage the turbocharger. If the oil drain pipe & hose is damaged and clogged, engine oil is not drained smoothly then it may cause oil leaks from the turbocharger.

If the cause of the problem is detected, retighten the mounting bolts (or nuts) as the specified torque or replace the gasket or damaged parts with new ones if necessary.

- 5. Check for oil leaks between center housing and compressor housing.
 - Check if the mounting bolts are tightened properly.
 - Check if there is an oil leak.

If the O - ring (gasket) between the center housing and the compressor housing is damaged, it may cause oil leaks.

If an oil leak is detected, replace the turbocharger with a new one.

- 6. Check the turbocharger actuator.
 - Electronic actuator : Check for movement of the actuator rod when a forced actuator operating mode is performed by GDS. (Refer to DTC guide).



SEUEM15-0037E_N

If the turbocharger actuator is damaged, it may cause lack of engine power and poor acceleration. Disassemble the actuator rod(A), check the actuator lever(B) or linkage(C) movement.

- 1) When the actuator lever not moving : replace the actuator.
- 2) When the linkage not moving : replace the new turbocharger.

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Intake And Exhaust System

- 7. Check the turbocharger compressor wheel.
 - Check if the compressor wheel is damaged (bent or deformed).
 - Check if the compressor wheel rotates smoothly. EX)



SELEM0007L_N

If the compressor wheel are damaged, it may cause abnormal noise from the turbocharger and poor acceleration.

If the compressor wheel are damaged or deformed, replace the turbocharger with new ones.

- 8. Check the turbocharger turbine wheel.
 - Check if the turbine wheel is damaged.
 - Check if the turbine wheel rotates smoothly. EX)



SELEM0008L_N

If the turbine wheel are damaged, it may cause abnormal noise from the turbocharger and poor acceleration.

If the turbine wheel are damaged or deformed, replace the turbocharger with new ones.

Intake And Exhaust System

If any problem is not detected in the turbocharger, check the turbocharger-related parts according to the procedure as follows.

- 1. Check the blow-by hose. (Refer to Fuel System)
 - Check if the breather hose is damaged (bent, clogged).
 - Check if the positive crankcase ventilation (PCV) valve is clogged.

If the breather hose is bent or clogged, the internal pressure in the engine increases then engine oil is not supplied smoothly to the turbocharger. So it may cause damage of the turbocharger and oil leaks.

If the cause of the problem is detected, replace the breather hose or the related parts with new ones.

- 2. Check the air intake hose connected to the turbocharger.
 - Check if the air intake hose is damaged (bent, crushed, detached or torn).

If a cross-section of the hose diminishes as the air intake hose is bent or crushed, intake air to the turbocharger reduces and the pressure in front of turbocharger drops.

So it may cause damage of the turbocharger and oil leaks.

If the air intake hose is detached or torn, a foreign substance goes into the turbocharger and causes damage of it.

If the air intake hose is damaged, replace it with a new one.

- 3. Check the air cleaner.
 - Check the air cleaner filter for pollution state.
 - Check the air cleaner filter for water influx.
 - Check the air cleaner cover for dirtiness.
 - Check if the air cleaner filter is a genuine part.

If the air cleaner filter is moistened or polluted excessively or a non-genuine part is used, intake air to the turbocharger reduces and the pressure in front of turbocharger drops.

So it may cause damage of the turbocharger and oil leaks.

If the air cleaner filter is moistened or polluted excessively, replace it with a new one.

NOTICE

- Replace the air cleaner filter according to the maintenance schedule.
- 4. Check the intercooler hoses & pipes.
 - Check if the intercooler hoses & pipes are connected properly.
 - Check if the intercooler hoses & pipes are damaged (bent, detached or torn).)
 - Check if there is any damage, such as crack, on the intercooler pipes.
 - Check if the clamps are positioned in place.

If the intercooler hoses & pipes are damaged or disconnected, oil leaks may occur from the hoses & pipes and the turbocharger may exceed the permissible speed then it may cause damage of the turbocharger.

If the intercooler hoses & pipes are damaged, replace them with new ones.

NOTICE

• Use new clamps when replacing the hoses & pipes.

Intake And Exhaust System

- 5. Check the intercooler.
 - Check if the intercooler tubes and tanks are damaged (oil leak or crack).)

If the intercooler is damaged, the turbocharger may exceed the permissible speed then it may cause damage of the turbocharger.

If the intercooler is damaged, replace them with a new one.

NOTICE

• Use new clamps when replacing the intercooler.

6. Check the engine oil.

- Check the engine oil level.
- Check the engine oil for discoloration, water influx and viscosity degradation.
- Check the engine oil grade.

If the engine oil level is low, amount of engine oil fed to turbocharger reduces then the bearings in the turbocharger may adhere due to insufficient lubrication and cooling.

If the cause of the problem is detected, add or change engine oil.

NOTICE

• Change the engine oil according to the maintenance schedule.

- 7. Check the engine oil pressure.
 - Engine oil pressure: Check the oil pressure using an oil pressure gauge after removing the oil pressure switch on the cylinder block.
 - Check the engine oil screen in the oil pan if the engine oil level is low. Then check the injectors for gas leaks if foreign substances are accumulated on the oil screen.

If the engine oil level is low, amount of engine oil fed to turbocharger reduces then the bearings in the turbocharger may adhere due to insufficient lubrication and cooling.

If the cause of the problem is detected, add or change engine oil. If foreign substances are accumulated on the oil screen, wash the oil screen and replace the injector's washer with a new one after checking the injectors for gas leaks.

Check the engine oil-related parts, such as oil pump, if necessary.

NOTICE

- As the turbocharger rotates at high speed of 100,000 rpm or above, deterioration of engine oil can cause damage of the turbocharger bearings. Check engine oil for discoloration, water influx, viscosity degradation and oil pressure lowering.
- 8. Check the injectors, sensors, EGR valve, etc. (Refer to FL group)
 - Check if the injectors operate properly.
 - Check if the sensors, such as the mass air flow sensor (MAFS), intake air temperature sensor (IATS), boost pressure sensor (BPS), operate properly.
 - Check if the exhaust gas recirculation (EGR) valve operates properly.

If the injectors, sensors, EGR valve and etc. don't work properly, it may cause lack of engine power. If the cause of the problem is detected, replace the related parts with new ones.

DPF (Diesel Particulate Filter)

Description

The diesel particulate filter (DPF) system prevents particulate matter (PM) from being discharged to the atmosphere and consists of a filter assembly, two exhaust gas temperature sensor (EGTS) and a differential pressure sensor (DPS).

The filter is integrated in the catalytic converter assembly and has honeycomb cell structure which can filter the PM in the exhaust gas, while the exhaust gas passes the DPF, the PM is gathered in the DPF and the others (CO2, NO, etc.) are discharged to the atmosphere via muffler. This gathered PM in DPF is called "soot".

The soot emitted from the engine is physically accumulated in the soot filtration unit, and the soot is periodically eliminated as high heat is generated by the fuel injected into the exhaust pipe after the engine start.

Circuit Diagram



Components



2. DPF assembly

3. DPF assembly cover

4. Diesel oxidation catalyst (DOC) assembly

Intake And Exhaust System

Disassembly

SCR, AOC

1. Disconnect the NOx sensor (A).



SEMEM00508D

2. Disconnect the DOC temperature sensor (A).



SEMEM00509D

3. Remove the SCR and AOC (A).

Tightening torque

Clamp:

17.7 - 19.6 N.m (1.8 - 2.0 kgf.m, 13.0 - 14.5 lb-ft) SCR and AOC mounting bolt :

48.1 - 61.8 N.m (4.9 - 6.3 kgf.m, 35.4 - 45.6 lb-ft)



SEMEM00510D

Intake And Exhaust System

DOC, DPF

NOTICE

- DPF assembly ash cleaning is performed once every 3,000 hours.
- The ash cleaning cycle may different depending on the user's driving conditions.
- 1. Disconnect the differential pressure sensor hose (A).



SEMEM00511D

2. Remove DPF assembly cover & DOC assembly clamp (A).





SEMEM00512D

3. Remove the DOC assembly (A) and DPF assembly cover (B).



SEMEM00513D

4. Remove the DPF assembly (A).



SEMEM00103D

5. Assemble in reverse order of disassembly.

NOTICE

• When installing, always use new clamp and gasket.

Intake And Exhaust System

Dosing Module

Description

The dosing module injects urea water into the exhaust pipe. The change in current for each operation of the dosing valve consists of two steps. The flow of permanent current prevents the risk of overheating the coil. Without urea water, the dosing module is not allowed to operate. When operating in the dry state worsens wear and spray errors.

Removal and Installation

- 1. Turn off the vehicle, disconnect the battery (-) terminal.
- 2. Disconnect the dosing module connector.
- 3. Disconnect the urea water supply line quickconnector.
- 4. After loosening the dosing module clamp, remove the dosing module (A).



SEMEM00515D

5. Install in reverse order of removal.

NOTICE

• If the unit is dropped, it may cause invisible damage, so use it after checking its performance.

Intake And Exhaust System

NOx Sensor

Description

The exhaust system is equipped with two NOx sensors. It consists of a sensing device (zirconia multi-layer sensing unit), a control unit and a cable. The NOx sensor measures nitrogen oxides in the exhaust gas. The output signal is transmitted to the DCU through CAN communication.

Handling Precautions

NOx sensors are susceptible to careless handling. To avoid damage, pay attention to the following items.

- 1. It is best not to move it from the delivered box until it is ready for use.
- 2. NOx sensors are very susceptible to impact. If it falls to the floor or is shocked, it must be disposed of immediately.
- 3. NOx sensors must be kept clean and beware of contaminants.

Intake And Exhaust System

Removal

WARNING

• Immediately after turning off the engine, the exhaust system is very hot. Therefore, perform the work after cooling sufficiently.

▶ [SCR front-end NOx sensor]

- 1. Turn off the vehicle, disconnect the battery (-) terminal.
- 2. After loosening the mounting bolt, remove the sensor control unit.

Tightening torque

SCR front-end NOx sensor mounting bolt : 21.6 - 32.4 N.m (2.2 - 3.3 kgf.m, 15.9 - 23.9 lb-ft) SCR front-end NOx sensor wiring mounting bolt : 8.8 - 13.7 N.m (0.9 - 1.4 kgf.m, 6.5 - 10.1 lb-ft)

3. Disconnect the SCR front-end NOx sensor (A).

Tightening torque :

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



SEMEM00508D

4. Install in reverse order of removal.

NOTICE

• If the unit is dropped, it may cause invisible damage, so use it after checking its performance.

- ▶ [SCR rear-end NOx sensor]
- 1. Turn off the vehicle, disconnect the battery (-) terminal.
- 2. After loosening the mounting bolt, remove the sensor control unit.

Tightening torque

SCR rear-end NOx sensor mounting bolt : 21.6 - 32.4 N.m (2.2 - 3.3 kgf.m, 15.9 - 23.9 lb-ft) SCR rear-end NOx sensor wiring mounting bolt : 8.8 - 13.7 N.m (0.9 - 1.4 kgf.m, 6.5 - 10.1 lb-ft)

3. Disconnect the SCR rear-end NOx sensor (A).

Tightening torque :

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



SEMEM00516D

4. Install in reverse order of removal.

NOTICE

• If the unit is dropped, it may cause invisibledamage, so use it after checking its performance.