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Supplement

Engine Inspection Sheets

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SAFETY CAUTIONS

Warning Risk of fire and explosion ···0-2
- ●Never use open fire ·····0-2
- ●Keep things tidy around the engine ·····0-2
- ●Do not open the crankcase until it has cooled down·····0-2
- ●Pay attention to fuel and oil leakage ·····0-2
- ●Use explosion-proof light·····0-2
- ●Prevent short circuit ·····0-2
- ●Keep fire extinguisher and first-aid kit at hand ·····0-2

Warning Risk of entanglement into the machine·····0-3
- ●Keep guards on the rotating parts ·····0-3
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- ●Keep away from rotating parts while the engine is running·····0-3
- ●Lockout/tagout·····0-3
- ●Always stop the engine before any inspection/service·····0-3
- ●Remove the turning gear after use ·····0-3

Warning Risk of burn ·····0-4
- ●Do not touch the engine while it is running or for a while after it is stopped ·····0-4
- ●Be careful when opening/closing the radiator cap·····0-4
- ●Replenish coolant only when the coolant in the system is cold ·····0-4
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Warning Exhaust gas is poisonous·····0-4
- ●Ensure good ventilation while the engine is running·····0-4

Warning Hearing difficulty·····0-4
- ●Wear ear protector·····0-4

Warning Beware of falling engine ·····0-5
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- ●Do not climb on the engine ·····0-5
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- ●Only use the specified fuel, engine oil and coolant (LLC)·····0-5
- ●Handle LLC with care ·····0-5
- ●Lawful disposal of waste oil and coolant·····0-5

Caution Handling of battery·····0-6
- ●Handle the battery with care·····0-6

Caution How to handle emergencies·····0-6
- ●Engine overheat - Idle to cool down, then stop the engine ·····0-6
- ●Never restart the engine after a sudden stop unless the cause is eliminated ·····0-6
- ●Stop the engine immediately upon oil pressure drop ·····0-6
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Caution How to handle emergencies·····0-6
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2. Specifications

Engine Type				S3L	S3L2	S4L	S4L2
General	Type			Water-cooled; 4-stroke cycle; Diesel powered			
	No. of cylinders			3		4	
	Combustion			Swirl chamber type			
	Valve mechanism			Overhead valve type			
	Cylinder bore × stroke mm (in.)			78×78.5 (3.07×3.09)	78×92 (3.07×3.62)	78×78.5 (3.07×3.09)	78×92 (3.07×3.62)
	Total displacement ℓ (U.S. gal)			1.125 (0.297)	1.318 (0.348)	1.500 (0.396)	1.758 (0.464)
	Compression ratio			22.0 : 1			
	Fuel			Diesel fuel (JIS K2204 Special 1 - 3)			
	Firing order			1-3-2		1-3-4-2	
	Direction of rotation			Counterclockwise when viewed from the flywheel end			
	Dimensions	Overall length mm (in.)		536 (21.10)		620 (24.40)	
		Overall width mm (in.)		433 (17.04)		433 (17.04)	
		Overall height mm (in.)		572 (22.52)		572 (22.52)	
	Dry mass kg (lb)			135 (297.6)		155 (341.7)	
Engine main parts	Piston ring	No. of rings		Compression ring :2 Oil ring (w/expander) : 1			
	Valve timing (hot engine)	Inlet valve	Open	BTDC 15°			
			Close	ABDC 41°			
		Exhaust valve	Open	BBDC 54°			
			Close	ATDC 10°			
	Engine mounting			4 mounts			
	Starting method			Starter			
Fuel system	Injection pump	Type		Bosch M			
		Manufacturer		DENSO			
		Plunger diameter mm (in.)		ϕ5.5 (0.21)			
		MS retard (crank angle)		8°			
		Cam lift mm(in.)		15 (0.59)			
	Governor	Governing method		Centrifugal fly-weight type			
	Injection nozzle	Type		Throttle nozzle			
		Manufacturer		Bosch Automotive Systems Corporation			
		Spray angle mm (in.)		15°			
		Opening pressure MPa (kgf/cm²) [psi]		14.22 to 15.00 (145 to 153) [2062 to 2176]			
	Fuel filter	Type		Paper-element cartridge; Separate type w/ cock			
Oil system	Lubrication method			Forced circulation (pressure feed by trochoid pump)			
	Engine oil	Grade		CD Class (API Classification)			
		Capacity (entire engine) ℓ (U.S. gal)		3.7 (1.0)	4.2 (1.1)	5.4 (1.4)	6.0 (1.6)
	Oil pump	Type		Gear pump			
		Displacement ℓ (U.S. gal) /min		18 (4.8)			
	Relief valve	Type		Piston valve			
		Opening pressure MPa (kgf/cm²) [psi]		0.35±0.05 (3.6±0.5) [51±7]			
	Oil filter	Type		Paper element (spin-on type)			

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2. Tightening Torques Table

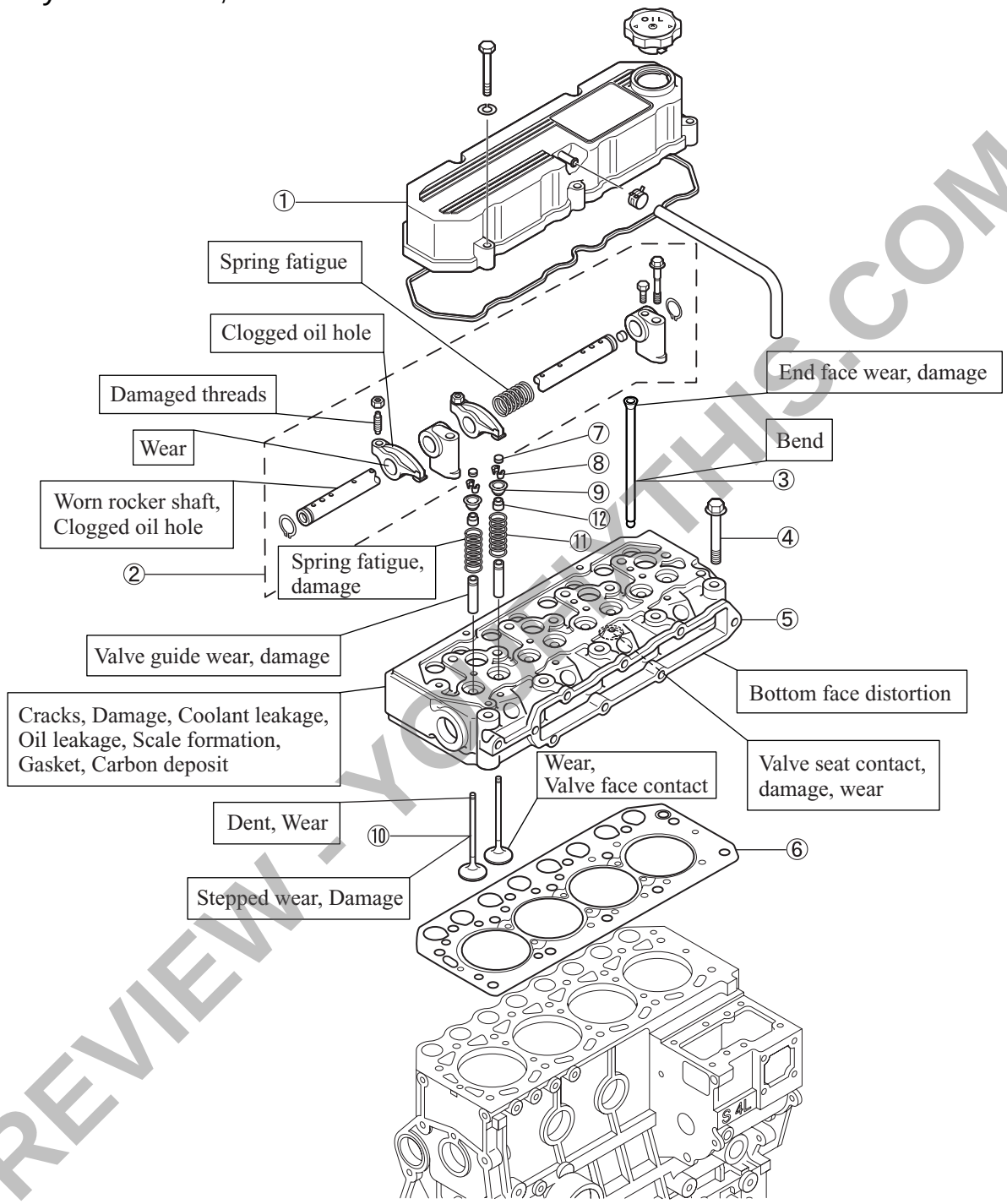
2.1 Major Bolts and Nuts

Fittings		Thread diameter ×pitch (mm)	Tightening torque			Remarks
			N·m	kgf·m	lbf·ft	
Engine proper						
Cylinder head bolt		M10×1.75	83.4 to 93.2	8.5 to 9.5	61.5 to 68.7	
Rocker cover bolt		M8×1.25	9.81 to 12.7	1.0 to 1.3	7.2 to 9.4	
Rocker shaft bracket bolt		M8×1.25	9.81 to 19.6	1.0 to 2.0	7.2 to 14.5	
Thrust plate bolt		M8×1.25	9.8 to 11.8	1.0 to 1.2	7.2 to 8.7	
Main bearing cap bolt		M10×1.25	49.0 to 53.9	5.0 to 5.5	36.2 to 39.8	
Connecting rod cap nut		M9×1.0	32.4 to 37.3	3.3 to 3.8	23.9 to 27.5	
Flywheel bolt		M12×1.25	127 to 137	13.0 to 14.0	94.0 to 101.3	
Crankshaft pulley nut		M18×1.5	147 to 196	15.0 to 20.0	108.5 to 144.6	
Rear plate mounting bolt		M12×1.25	53.9 to 73.5	5.5 to 7.5	39.8 to 54.2	Equivalent to 7T
Fuel system						
Hollow screw (fuel injection pump)		M14×1.5	19.6 to 24.5	2.0 to 2.5	14.5 to 18.1	
Delivery valve holder (fuel injection pump)		—	39.2 to 49.0	4.0 to 5.0	28.9 to 36.1	
Air bleeder plug (fuel injection pump)		M8×1.25	9.81 to 13.7	1.0 to 1.4	7.2 to 10.1	
Nozzle retaining nut	IDI	M16×0.75	34.3 to 39.2	3.5 to 4.0	25.3 to 28.9	
Nozzle holder	IDI	M20×1.5	49.0 to 58.8	5.0 to 6.0	36.2 to 43.4	
Fuel injection pipe nut		M12×1.5	24.5 to 34.3	2.5 to 3.5	18.1 to 25.3	
Fuel leak-off pipe nut		M12×1.5	20.6 to 24.5	2.1 to 2.5	15.2 to 18.1	
Sliding sleeve shaft		M10×1.25	29.4 to 41.2	3.0 to 4.2	21.7 to 30.4	
Torque spring set special nut		M12×1.0	14.7 to 24.5	1.5 to 2.5	10.8 to 18.1	
Oil system						
Oil relief valve		M22×1.5	44.1 to 53.9	4.5 to 5.5	32.5 to 39.8	
Oil pan drain plug		M14×1.5	34.3 to 44.1	3.5 to 4.5	25.3 to 32.5	
Oil filter		M20×1.5	10.8 to 12.7	1.1 to 1.3	8.0 to 9.4	
Oil pressure switch		PT1/8	7.85 to 11.8	0.8 to 1.2	5.8 to 8.7	
Oil pan mounting bolt		M8×1.25	9.80 to 12.7	1.0 to 1.3	7.2 to 9.4	Equivalent to 4T
Oil strainer nut		M16×1.5	24.5 to 29.4	2.5 to 3.0	18.1 to 21.7	
Cooling system						
Thermoswitch		M16×1.5	18.6 to 26.5	1.9 to 2.7	13.7 to 19.6	
Thermostat cover bolt		M8×1.25	16 to 20	1.6 to 2.0	11.8 to 14.8	
Thermo case bolt		M16×1.5	39.2 to 49.0	4.0 to 5.0	28.9 to 36.1	
Inlet and exhaust systems						
Inlet cover bolt		M8×1.25	14.7 to 21.6	1.5 to 2.2	10.8 to 15.9	
Exhaust manifold bolt		M8×1.25	14.7 to 21.6	1.5 to 2.2	10.8 to 15.9	
Electrical system						
Starter terminal B		M8×1.25	9.81 to 11.8	1.0 to 1.2	7.2 to 8.7	
Stop solenoid fixing nut		M30×1.5	39.2 to 49.0	4.0 to 5.0	28.9 to 36.1	
Stop solenoid blind plug		M30×1.5	39.2 to 49.0	4.0 to 5.0	28.9 to 36.1	
Glow plug		M10×1.25	14.7 to 19.6	1.5 to 2.0	10.8 to 14.5	

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1. Cylinder Head, Valve Mechanism



Disassembly of cylinder head and valve mechanism

<Disassembly sequence>

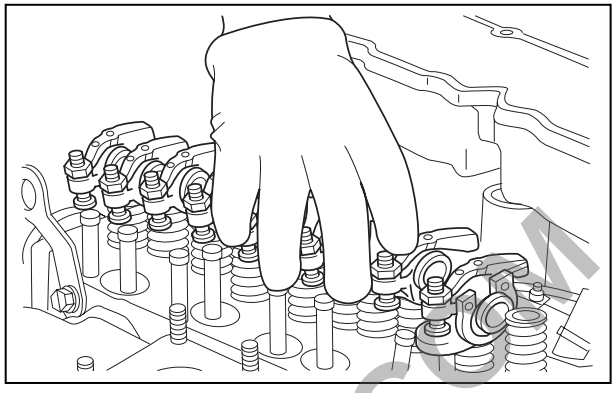
① Rocker cover	⑤ Cylinder head	⑨ Retainer
② Rocker shaft assembly	⑥ Cylinder head gasket	⑩ Valve
③ Push rod	⑦ Valve cap	⑪ Valve spring
④ Cylinder head bolt	⑧ Valve lock	⑫ Valve stem seal

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1.1 Removing the rocker shaft assembly

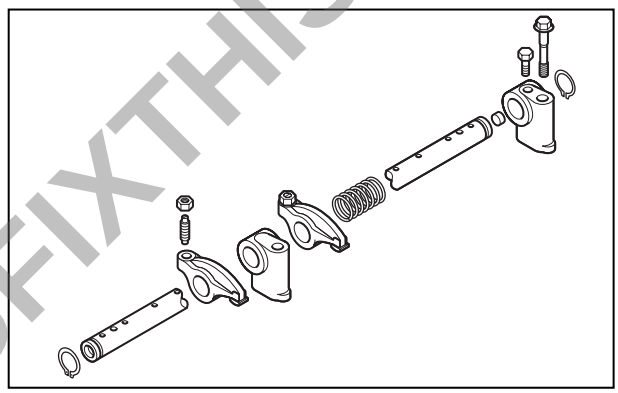
(1) Loosen the rocker stay bolts. Remove the rocker shaft assembly together with the rocker stay bolts.
(2) Remove the valve caps.
(3) Keep the rocker shaft assembly with the rocker stay bolts.



Removing the rocker shaft assembly

1.2 Disassembling the rocker shaft assembly

In the course of disassembly, place removed valve rockers as well as the other parts neatly in the order of disassembly so that they can be reassembled back onto their original locations. Doing so, original clearances between the valve rockers and the rocker shaft is restored upon reassembly.

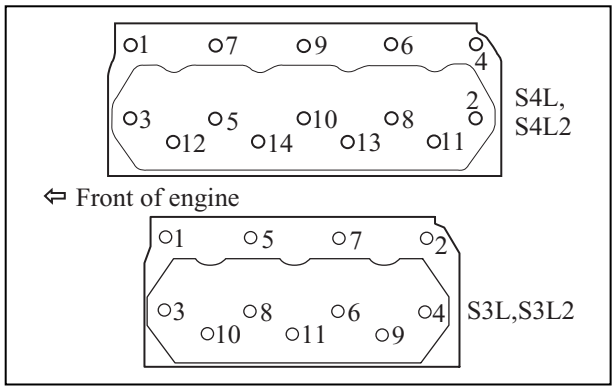


Disassembling the rocker shaft assembly

1.3 Removing the cylinder head bolts

Loosen the cylinder head bolts in the order of the numbers illustrated. Do not loosen one bolt completely before moving to the next bolt. Loosen the bolts in a couple of steps.

Note: Before removing the cylinder head bolts, check the cylinder head components for any fault. If faulty, check the bolts for tightness with a torque wrench.



Tightening order for cylinder head bolts

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2. Running-in Trial

Whenever the engine is reassembled after overhaul, run in the engine on a dynamometer. While the engine is being run-in, also perform the inspections listed below.

2.1 Starting the engine

(1) Before starting the engine, check the levels of coolant, engine oil and fuel. Also, bleed the fuel and cooling systems of air.
(2) With fuel shut off, operate the starter for approx. 10 seconds to crank the engine in order to distribute oil throughout the engine.
(3) Move the control lever slightly in the direction of increased fuel delivery (moving the lever to the full delivery position is not recommended). Turn the starter key switch to the START position to start the engine.
(4) With the engine started, move the control lever to the no-load, low idle position.

2.2 Inspecting the engine during running-in

While the engine is being run-in, check the followings. If faulty, stop the engine. Locate the cause and take appropriate actions to eliminate it.

(1) Oil pressure at the rated and low idle speeds
The oil pressure should be 0.29 to 0.39 MPa (3.0 to 4.0 kgf/cm^2) [42.07 to 56.57 psi] at the rated speed, and 0.098 MPa (1.0 kgf/cm^2) [14.22 psi] or above at the low idle speed.
(2) The coolant temperature, which should be 75 to 85°C (167 to 185 °F).
(3) The temperature of engine oil in the oil pan, which should be 60 to 95°C (140 to 194 °F).
(4) There should be no leakages of oil, coolant or fuel. Pay particular attention to the turbocharger lubrication oil pipe connections.
(5) Diesel knock should disappear as the coolant temperature rises. Other than that, there should be no noise.
(6) The exhaust gas for any abnormal color or smell.

2.3 Running-in timetable

The following table shows the running-in phases together with the relevant load and time duration for each phase.

Running-in timetable

	Engine speed	Load (PS)	Time (min)
1	Idle speed	No load	5
2	1200	No load	10
3	Rated speed	25 %	10
4	(varies depending on	50 %	10
5	engine specifications)	75 %	30
6		100 %	20

2.4 Inspection and adjustment after running-in

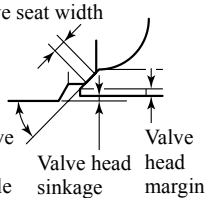
(a) Adjust the valve clearance
(b) Inspect the fuel injection timing
(c) Check the external bolts and nuts for tightness

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1. Service Standards Table

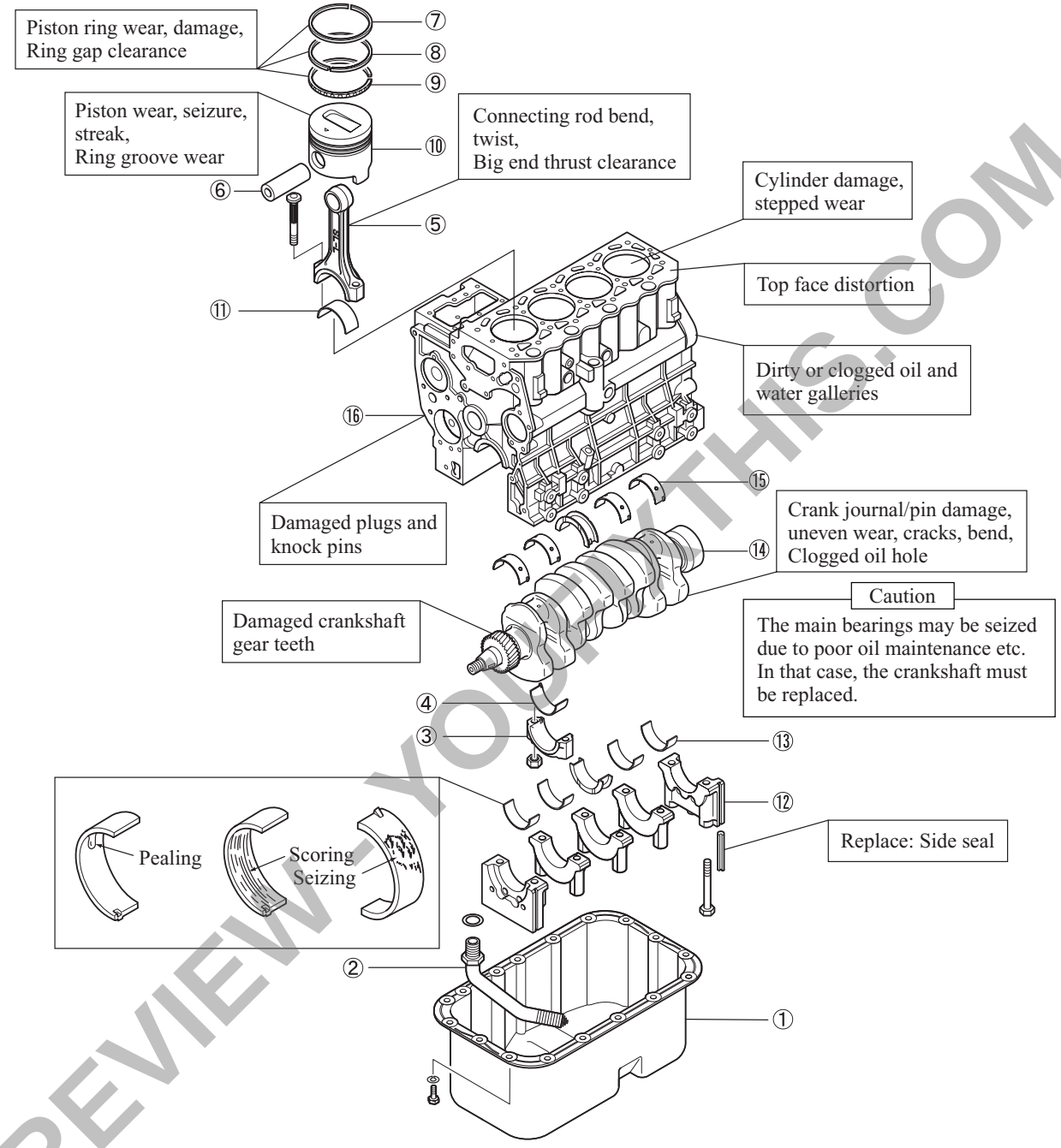
Unit: mm (in.)

Group	Item			Nominal value	Standard value	Limit	Remarks
Engine general	Max. speed (based on the rated speed)				2700^{+30}_{-10} min^{-1}		
	Min. speed				1000±25 min^{-1}		
	Compression pressure (at 290 min^{-1})				2.9 MPa (30 kgf/cm^2) [421 psi] or above	2.6 MPa (27 kgf/cm^2) [377 psi] or less	Both oil and coolant temperatures at 20 to 30°C (68 to 86°F)
	Engine oil pressure	Rated speed			0.29 to 0.39 MPa (3.0 to 4.0 kgf/cm^2) [42.07 to 56.57 psi]		Oil temperature at 60 to 95°C (140 to 194°F)
		Low idle speed			0.098 MPa (1.0 kgf/cm^2) [14.22 psi]		
	Valve timing [with 2 mm (0.079 in.) clearance on the valve side; cold engine]		Inlet valve open		BTDC 15°		The theoretical valve timing figures for inspection vary from the actual valve timing.
			Inlet valve closed		ABDC 41°		
			Exhaust valve open		BBDC 54°		
			Exhaust valve closed		ATDC 10°		
	Valve clearance		Inlet valve		0.25 (0.01)		Cold engine
			Exhaust valve		0.25 (0.01)		
	Fuel injection timing (BTDC)				17 °		
Engine main parts	Rocker	Rocker arm inner diameter		φ19 (0.749)	18.910 to 18.930 (0.7450 to 0.7458)	—	
		Rocker shaft diameter		φ19 (0.749)	18.880 to 18.898 (0.7438 to 0.7445)	—	
		Arm-to-shaft clearance (oil clearance)			0.012 to 0.050 (0.0004 to 0.0019)	0.200 (0.0079)	Replace rocker arm.
	Valve	Valve stem diameter	Inlet	φ6.6 (0.260)	6.565 to 6.580 (0.2586 to 0.2592)	6.500 (0.256)	
			Exhaust	φ6.6 (0.260)	6.530 to 6.550 (0.2572 to 0.2580)	6.500 (0.256)	
		Valve guide inner diameter	Inlet	φ6.6 (0.260)	6.600 to 6.615 (0.2600 to 0.2606)		
			Exhaust	φ6.6 (0.260)	6.600 to 6.615 (0.2600 to 0.2606)		
		Valve stem-to-guide clearance	Inlet		0.020 to 0.050 (0.0008 to 0.0020)	0.100 (0.004)	Replace valve and valve guide.
			Exhaust		0.050 to 0.085 (0.0020 to 0.0033)	0.150 (0.006)	
	Valve seat and valve	Valve seat angle		45°			Valve seat width  Valve seat angle / Valve head sinkage / Valve head margin
		Valve head sinkage		0	0.25 to 0.75 (0.0098 to 0.0295)	1.5 (0.0591)	
		Valve seat width		1.6 (0.063)	1.30 to 1.80 (0.0512 to 0.0709)	2.5 (0.0985)	
		Valve head margin		1.5 (0.0591)	1.35 to 1.65 (0.0531 to 0.0650)	0.5 (0.0197)	
		Installed valve guide protrusion		10 (0.394)	9.5 to 10.5 (0.3743 to 0.4137)	—	

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3. Cylinder Block, Crankshaft, Pistons, Oil Pan



Disassembly of cylinder block, crankshaft, pistons and oil pan

<Disassembly sequence>

① Oil pan
② Oil strainer
③ Connecting rod cap
④ Connecting rod bearing (lower)
⑤ Connecting rod
⑥ Piston pin
⑦ No. 1 ring
⑧ No. 2 ring
⑨ Oil ring
⑩ Piston
(Remove ⑤ to ⑩ as an assembly.)
⑪ Connecting rod bearing (upper)
⑫ Main bearing cap
⑬ Main bearing (lower)
⑭ Crankshaft
⑮ Main bearing (upper)
⑯ Cylinder block

Note: If the crankcase is to be replaced, carefully remove the relief valve and other parts from the old crankcase for reassembly onto the new crankcase.

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(6) Inspecting the control rack for smooth operation

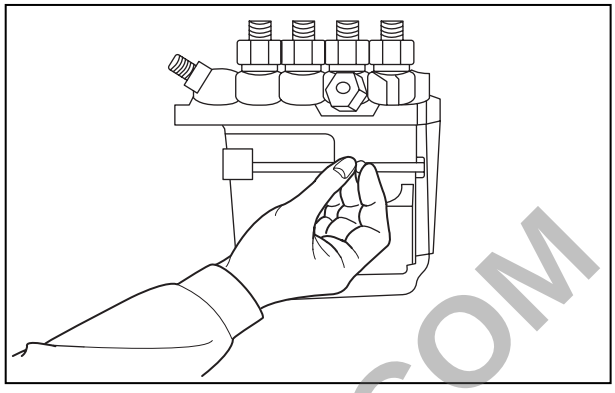
(a) With the fuel injection pumps assembled, ensure that the control rack slides smoothly.

(b) If not, possible causes include the following.

1) The elements do not slide smoothly.
2) Foreign matter is trapped between the teeth of rack and sleeve.
3) The delivery valve holders have been overtightened.

Disassemble and inspect.

(c) After reassembly, check the fuel injection timing.

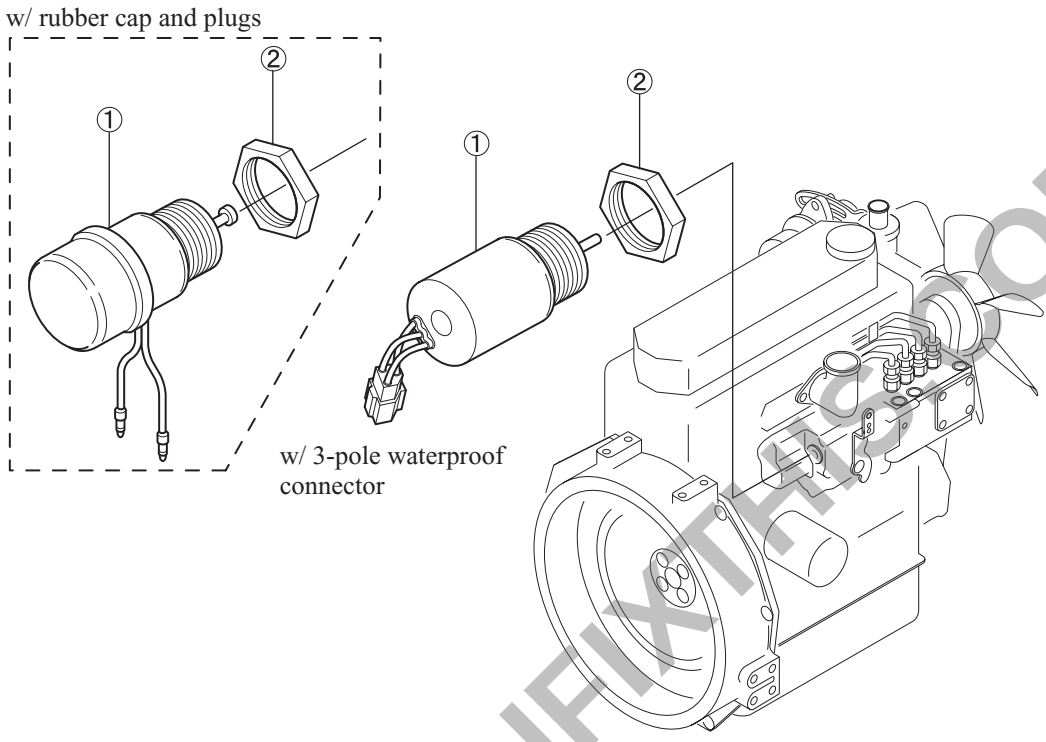


Inspecting the control rack for smooth operation

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3. Stop Solenoid



Removal of the stop solenoid

<Removal sequence>
① Stop solenoid
② Nut

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