VOLVO

Construction Equipment

Service Information

Document Title:	Function Group:	Information Type:	Date:
Engine, description	**200**	**Service Information**	**2015/3/29**
Profile:			

Engine, description

(YANMAR 4TNE94–SM)

- The engine is a 4–cycle, 4–cylinder, direct injected, water cooled diesel engine.
- The engine produces powerful performance using direct injection type combustion chamber.

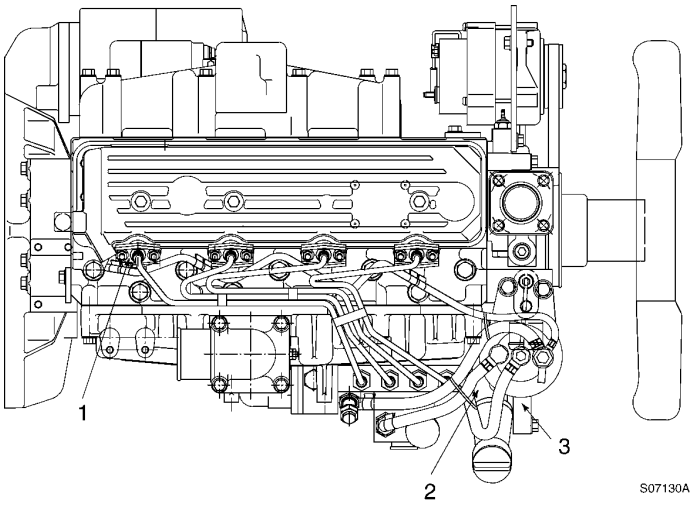


Figure 1
Top view, engine

1 Fuel injection nozzle
2 Gear case
3 Gear case cover
4 Starter motor
5 Exhaust manifold
6 Valve rocker cover
7 Cylinder head
8 Inlet manifold
9 Flywheel housing

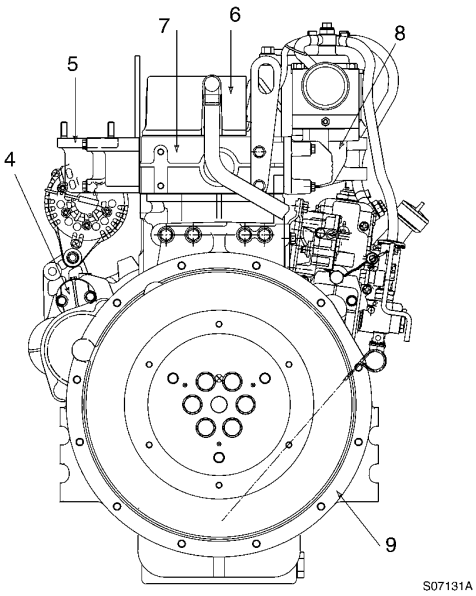


Figure 2
Flywheel side view, engine

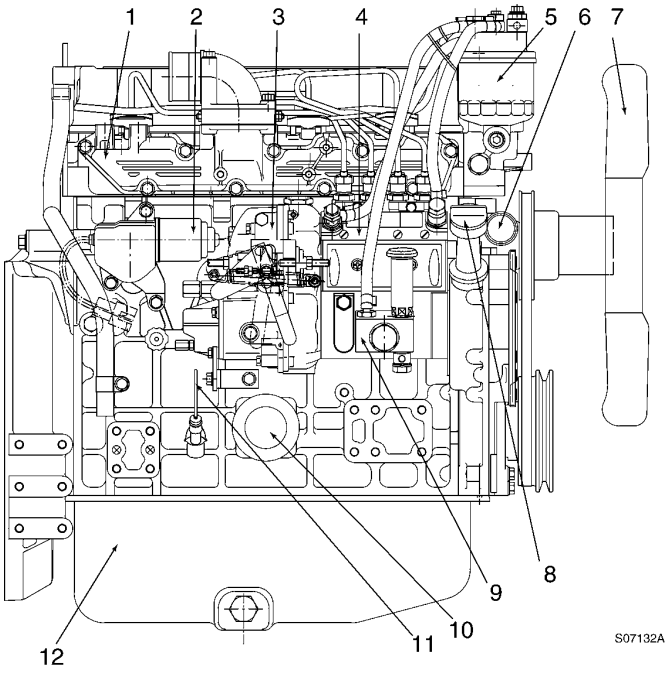


Figure 3
Fuel injection side view, engine

1 Inlet manifold
2 Stop motor
3 Governor
4 Fuel injection pump
5 Fuel filter
6 Cooling water inlet
7 Cooling fan
8 Oil filler port
9 Fuel feed pump
10 Lubrication oil filter
11 Dipstick
12 Oil pan
13 Cooling water pump
14 Alternator
15 Cooling water outlet

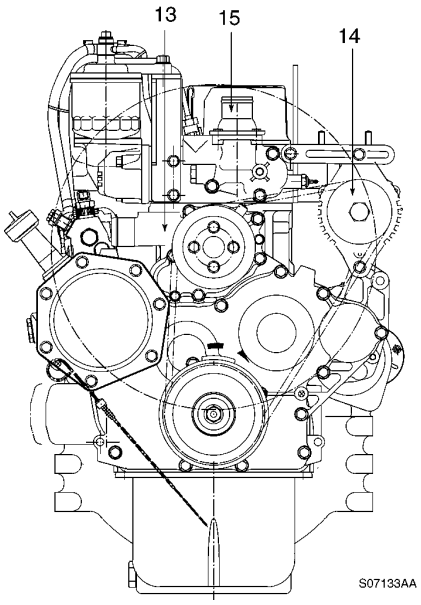


Figure 4
Fan side view , engine

Engine performance curve

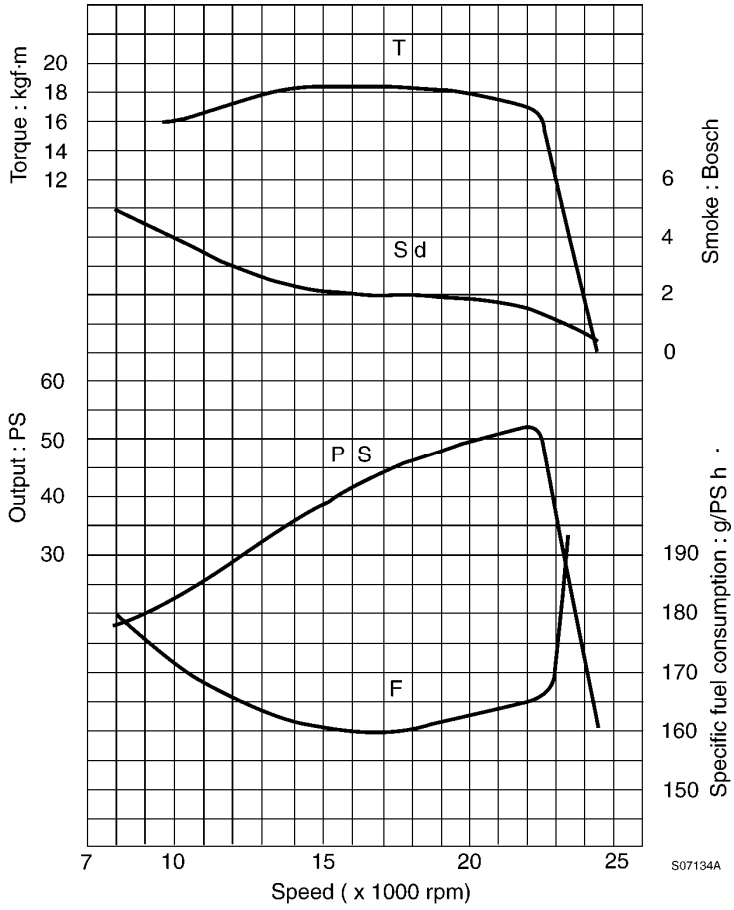


Figure 5
Engine performance curve

Engine performance condition

Item	Condition

Cooling fan	φ430 blower
Exhaust pressure	1000 mmAq
Air cleaner	6 inch
Radiator	Installed
Alternator	No charge

Document Title: **Engine, specifications**	Function Group: **200**	Information Type: **Service Information**	Date: **2015/3/29**
Profile:			

Engine, specifications

Specifications

Item		**Unit**	**Specifications**
Make		–	Yanmar diesel
Model		–	4TNE94–SM
Type		–	Vertical, 4–cylinder, water cooling, upright series, direct injection, diesel engine
Rated output		PS (kW) / rpm	52 (38.2) / 2200
Maximum torque (Net)		kgf·m / rpm (lbf·ft / rpm)	18.5 ± 0.5 /1600 (134 ± 3 / 1600)
Number of cylinder – Bore × Stroke		mm (in)	4 – 94 × 100 (3.7 × 3.9)
Total displacement		cc (cu·in)	2776 (169)
Compression ratio		–	18 : 1
Low idle (No–load)		rpm	900 ± 30
High idle (No–load)			2450 ± 30
Fuel consumption (rated)		g/PS·h (g/kW·h)	165 (221)
Fuel tank	Capacity	Liter (gal)	90 (23.4)
	Filter	–	60#
Firing order		–	1 – 3 – 4 – 2
Nozzle pressure		kgf / cm2 (psi)	220 ~ 230 (3128 ~ 3270)
Valve clearance	Inlet	mm (in)	0.15 ~ 0.25 (0.006 ~ 0.010)
	Exhaust		0.15 ~ 0.25 (0.006 ~ 0.010)
Direction of rotation		–	Counterclockwise (viewed from flywheel)
Lubrication oil		–	SAE class CF
Oil pan capacity	Maximum/Minimum	Liter (gal)	9.7 (2.5) / 6.4 (1.7)
Weight of engine (dry)		kg/lb	230/506
Starter motor		–	12 V – 2.3 kW
Alternator		–	12 V – 40 A

Document Title: **Maintenance standards**	Function Group: **200**	Information Type: **Service Information**	Date: **2015/3/29**
Profile:			

Maintenance standards

Engine tuning

Maintenance standard, engine tuning

Inspection item		**Unit**	**Standard**	**Limit**
Gap at inlet/exhaust valve heads		mm (in)	0.15 ~ 0.25 (0.006 ~ 0.010)	–
V–belt tension 98N finger pressure (10 kgf/cm2)	Used part	mm (in)	10 ~ 15 (0.39 ~ 0.59)	–
	New part	mm (in)	7 ~ 9 (0.28 ~ 0.35)	–
Fuel injection pressure		kgf/cm2 (psi)	220 ~ 230 (3124 ~ 33266)	–
Fuel injection timing (FID, bTDC)		(degree)	bTDC 10 ~ 12	–
No load rpm	Maximum	rpm	2450 ± 30	–
	Minimum	rpm	900 ± 30	–
Compression at 250 rpm		kgf/cm2 (psi)	35 ± 1 (497 ± 14.2)	–
Top clearance		mm (in)	0.737 ~ 0.869 (0.029 ~ 0.034)	–
Coolant capacity (engine only)		Liter (gal)	4.2 (1.1)	–
Lubricating oil capacity (oil pan)	High	Liter (gal)	9.7 (2.5)	–
	Low	Liter (gal)	6.4 (1.7)	–
Lubricating oil pressure	Maximum (in cold state)	kgf/cm2 (psi)	6.0 (85)	–
	At rated output	kgf/cm2 (psi)	3.0 ~ 4.0 (43 ~ 57)	–
	At idling	kgf/cm2 (psi)	1.0 (14) or above	–
Oil pressure switch operating pressure		kgf/cm2 (psi)	0.5 ± 0.1 (7 ± 1)	–
Thermostat valve opening temperature		°C (°F)	82.0 ~ 95.0 (full open) (180 ~ 203)	–

- FID : Fuel Injection Degree
- bTDC : before Top Dead Center

Engine body

Maintenance standard, cylinder head, unit : mm (in)

Inspection item			**Standard**	**Limit**
Combustion surface distortion			Maximum 0.05 (0.002)	0.15 (0.006)
Valve seat	Valve sink	Inlet	0.5 ~ 0.7(0.020 ~ 0.027)	1.0 (0.039)
		Exhaust	0.6 ~ 0.8 (0.024 ~ 0.031)	1.1 (0.043)
	Seat width	Intake	1.3 (0.051)	2.0 (0.079)
		Exhaust	2.2 (0.087)	3.0 (0.118)
	Seat angle (degree)	Intake	120	–
		Exhaust	90	–
	Seat correction angle (degree)		θ1 : 40, θ2 : 150	–

Maintenance standard, inlet/exhaust valve guide, unit : mm (in)

Inspection item		Standard	Limit
Inlet	Valve stem outside diameter	7.965 ~ 7.980 (0.3136 ~ 0.3142)	7.915 (0.3116)
	Guide inside diameter	8.015 ~ 8.030 (0.3156 ~ 0.3`61)	8.100 (0.3189)
	Clearance	0.035 ~ 0.065 (0.0014 ~ 0.0026)	1.185 (0.0073)
Outlet	Valve stem outside diameter	7.955 ~ 7.970 (0.3132 ~ 0.3138)	7.905 (0.3112)
	Guide inside diameter	8.015 ~ 8.030 (0.3156 ~ 0.3161)	8.100 (0.3189)
	Clearance	0.045 ~ 0.075 (0.0018 ~ 0.0029)	0.195 (0.0077)
Valve guide driving–in method		Cold–fitted	–
Valve guide protection from cylinder head		14.7 ~ 15.0 (0.5789 ~ 0.591)	–
Replacement valve guide inside diameter after insert		8.015 ~ 8.030 (0.3156 ~ 0.3161)	–

Maintenance standard, valve spring, unit : mm (in)

Inspection item	Standard	Limit
Free length	47.5 (1.87)	–
Inclination	–	1.0 (0.039)
Load for compressing uneven pitch portion by 1 mm	2.257 kgf (4.97 lb)	–

Maintenance standard, rocker arm and shaft, unit : mm (in)

Inspection item	Standard	Limit
Arm shaft hole diameter	18.50 ~ 18.52 (0.7283 ~ 0.7291)	18.57 (0.7311)
Shaft outside diameter	18.47 ~ 18.49 (0.7272 ~ 0.7279)	18.44 (0.7260)
Clearance	0.01 ~ 0.05 (0.0004 ~ 0.0020)	0.13 (0.005)

Maintenance standard, push rod, unit : mm (in)

Inspection item	Standard	Limit
Bend	–	0.03 (0.0012)

Maintenance standard, cam shaft, unit : mm (in)

Inspection item		Standard	Limit
Side gap		0.05 ~ 0.20 (0.002 ~ 0.008)	0.30 (0.012)
Bending (1/2 the dial gauge reading)		0.0 ~ 0.02 (0.00 ~ 0.0008)	0.05 (0.002)
Cam height		42.435 ~ 42.565 (1.6707 ~ 1.6758)	42.185 (1.6608)
Gear side	Camshaft outside diameter	49.925 ~ 49.950 (1.9656 ~ 1.9665)	49.890 (1.9642)
	Bushing inside diameter	49.990 ~ 50.055 (1.9681 ~ 1.9707)	50.130 (1.9736)
	Clearance	0.040 ~ 0.130 (0.0016 ~ 0.0051)	0.240 (0.0094)
Intermediate	Camshaft outside diameter	49.910 ~ 49.935 (1.9650 ~ 1.9659)	49.875 (1.9636)
	Block inside diameter	50.000 ~ 50.025 (1.9685 ~ 1.9695)	50.100 (1.9724)
	Clearance	0.065 ~ 0.115 (0.0026 ~ 0.0045)	0.225 (0.0089)
Flywheel	Camshaft outside diameter	49.925 ~ 49.950 (1.9656 ~ 1.9665)	49.980 (1.9642)
	Block inside diameter	50.000 ~ 50.025 (1.9685 ~ 1.9695)	50.100 (1.9724)
	Clearance	0.050 ~ 0.100 (0.0020 ~ 0.0039)	0.210 (0.0083)

Maintenance standard, idle gear shaft and bushing, unit : mm (in)

Inspection item	Standard	Limit
Shaft outside diameter	49.950 ~ 49.975 (1.8091 ~ 1.9675)	45.900 (1.8071)

Bushing inside diameter	46.000 ~ 46.025 (1.8110 ~ 1.8120)	46.075 (1.8140)
Clearance	0.025 ~ 0.075 (0.0010 ~ 0.0030)	0.175 (0.007)

Maintenance standard, backlash of each gear, unit : mm (in)

Inspection item	Standard	Limit
Crank gear, cam gear, idle gear, fuel injection pump, gear and PTO (power take-off) gear	0.08 ~ 0.14 (0.0031 ~ 0.0055)	0.16 (0.0063)
Lubricating oil pump gear	0.09 ~ 0.15 (0.0035 ~ 0.0059)	0.17 (0.0067)

Maintenance standard, cylinder block, unit : mm (in)

Inspection item			Standard	Limit
Cylinder bore	Inner diameter	4TNE94	94.000 ~ 94.030 (3.7008 ~ 3.7020)	94.130 (3.7059)
		4TNE98	98.000 ~ 98.030 (3.8583 ~ 3.8594)	98.130 (3.8634)
	Roundness		0.01 (0.0004) or less	0.03 (0.012)
	Cylindricity		0.01 (0.0004) or less	0.03 (0.012)

Maintenance standard, crank shaft, unit : mm (in)

Inspection item			Standard	Limit
Bending (1/2 the dial gauge reading)			–	0.02 (0.0008)
Crank pin	Pin outside diameter		57.952 ~ 57.962 (2.2816 ~ 2.2820)	57.902 (2.2796)
	Metal thickness	–	1.492 ~ 1.500 (0.0587 ~ 0.0591)	–
		US 0.25	1.617 ~ 1.625 (0.0637 ~ 0.0640)	–
	Clearance		0.038 ~ 0.074 (0.0015 ~ 0.0029)	0.150 (0.0059)
Crank journal	Journal outside diameter		64.952 ~ 64.962 (2.5572 ~ 2.576)	64.902 (2.5552)
	Metal thickness	–	1.995 ~ 1.980 (0.0760 ~ 0.0780)	–
		US 0.25	2.125 ~ 2.130 (0.0872 ~ 0.0839)	–
	Clearance		0.038 ~ 0.074 (0.0015 ~ 0.0027)	0.150 (0.0059)

Maintenance standard, thrust bearing, unit : mm (in)

Inspection item		Standard	Limit
Crankshaft side gap		0.11 ~ 0.21(0.0043 ~ 0.0083)	–
Thrust bearing thickness		1.930 ~ 1.980(0.0760 ~ 0.0780)	1.850 (0.0728)
	Oversize 0.25	2.055 ~ 2.105(0.0809 ~ 0.0829)	–

Maintenance standard, piston and ring, unit : mm (in)

Inspection item			Standard	Limit
Piston outside diameter	Standard	–	93.945 ~ 93.955 (3.6986 ~ 3.6990)	93.900 (3.6969)
		Oversize 0.25	94.195 ~ 94.205 (3.7085 ~ 3.7089)	–
		Oversize 0.50	94.445 ~ 94.455 (3.7183 ~ 3.7187)	–
Clearance with cylinder bore Note) Measure at 22 mm above the piston bottom face in vertical direction to the piston pin.			0.050 ~ 0.080 (0.0020 ~ 0.0031)	0.120 (0.0047)
Piston pin	Pin outside diameter		29.989 ~ 30.000 (1.1807 ~ 1.1811)	29.959 (1.1795)
	Hole inside diameter		30.000 ~ 30.009 (1.1811 ~ 1.1815)	30.039 (1.1826)
	Clearance		0.000 ~ 0.020 (0.000 ~ 0.0008)	0.080 (0.0031)
Top ring	Ring groove width		2.040 ~ 2.060 (0.0803 ~ 0.0811)	–
	Ring width		1.940 ~ 1.960 (0.0764 ~ 0.0772)	1.920 (0.0756)

	Side clearance	0.080 ~ 0.120 (0.0031 ~ 0.0047)	–
	End clearance	0.250 ~ 0.450 (0.0098 ~ 0.0177)	0.540 (0.0213)
Second ring	Ring groove width	2.080 ~ 2.095 (0.0819 ~ 0.0825)	2.195 (0.0864)
	Ring width	1.970 ~ 1.990 (0.0776 ~ 0.0783)	1.950 (0.0768)
	Side clearance	0.090 ~ 0.125 (0.0035 ~ 0.0049)	0.245 (0.0096)
	End clearance	0.450 ~ 0.650 (0.0177 0.0256)	0.730 (0.0287)
Oil ring	Ring groove width	3.015 ~ 3.030 (0.1187 ~ 0.1193)	3.130 (0.1232)
	Ring width	2.970 ~ 2.990 (0.1169 ~ 0.1177)	2.950 (0.1161)
	Side clearance	0.025 ~ 0.060 (0.0010 ~ 0.0024)	0.180 (0.0071)
	End clearance	0.250 ~ 0.450 (0.0098 ~ 0.0177)	0.550 (0.0217)

Maintenance standard, connecting rod, unit : mm (in)

Inspection item		**Standard**	**Limit**
Thrust clearance		93.945 ~ 93.955 (3.6986 ~ 3.6990)	93.900 (3.6969)
Small end of rod	Bushing inside diameter	94.195 ~ 94.205 (3.7085 ~ 3.7089)	–
	Pin outside diameter	94.445 ~ 94.455 (3.7183 ~ 3.7187)	–
	Clearance	0.050 ~ 0.080 (0.0020 ~ 0.0031)	0.120 (0.0047)

Maintenance standard, tappet, unit : mm (in)

Inspection item	**Standard**	**Limit**
Tappet stem outside diameter	11.975 ~ 11.990 (0.4715 ~ 0.4720)	11.955 (0.4707)
Tappet hole (block) inside diameter	12.000 ~ 12.018 (0.4724 ~ 0.4731)	12.038 (0.4739)
Clearance	0.010 ~ 0.043 (0.0004 ~ 0.0017)	0.083 (0.0033)

Maintenance standard, trochoid pump (lubrication oil pump), unit : mm (in)

Inspection item		**Standard**	**Limit**
Clearance between outer rotor and gear case		0.100 ~ 0.155 (0.0039 ~ 0.0061)	0.25 (0.0098)
Side clearance between outer rotor and gear case		0.05 ~ 0.10 (0.0020 ~ 0.0039)	0.15 (0.0059)
Rotor shaft and gear case	Shaft outer diameter	12.955 ~ 12.970 (0.5100 ~ 0.5106)	12.945 (0.5096)
	Bearing inside diameter	12.980 ~ 13.020 (0.5110 ~ 0.5126)	13.050 (0.5138)
	Clearance	0.010 ~ 0.065 (0.0004 ~ 0.0026)	0.105 (0.0041)

VOLVO
Construction Equipment

Service Information

Document Title: **Periodic maintenance chart**	Function Group: **200**	Information Type: **Service Information**	Date: **2015/3/29**
Profile:			

Periodic maintenance chart

⚠ CAUTION

Make a periodic inspection plan according to the state of use. Perform periodic inspection accurately so that inspection will not be skipped. If periodic inspection is neglected, failures may occur or durability may be lost. Inspection and maintenance after 1000 hours require expertise and skill, so consult our dealer or distributor.

Periodic maintenance chart

Part	**Item**	**Daily**	**Every month or Every 50 hours**	**Every 3 month or Every 200 hours**	**Every 6 month or Every 400 hours**	**Every year or Every 1000 hours**
Fuel oil system	Check the fuel level and refill	O (before operation)				
	Drain the fuel tank sediment		O			
	Clean the fuel filter			O		
	Replace the fuel filter element				O	
	Drain the water separator if applicable			O		
	Check for fuel oil leakage	O (after operation)				
	Check the injection condition of fuel injection nozzle.					S
	Check the fuel injection timing					S
	Check the fuel injection pump					S
Lube oil system	Check the lube oil level in the oil pan and refill	O (before operation)				
	Replace the lube oil		O (1st time)		O (2nd time and thereafter)	
	Replace lube oil filter element		O (1st time)		O (2nd time and thereafter)	
	Check for lube oil leakage	O (after operation)				
Cooling system	Check the coolant level and refill	O (before operation)				
	Clean the cooling system					O
	Replace the coolant					O
	Check for coolant leakage	O (after operation)				
	Check radiator fin for clogging	O (before operation)				
	Clean the radiator fin			O		
	Adjust the fan belt tension		O (1st time)	O (2nd time and thereafter)		
	Check the fan belt	O (before operation)				
Air induction	Check the air cleaner element			O		
	Replace the air cleaner element				O	

system						
Electric system	Check the battery electrolyte level and refill	O (before operation)				
	Check warning lamps	O (when the engine is started)				
Engine body	Adjust the inlet and exhaust valve clearance					S

CAUTION

Item marked "S" should be serviced by an authorized Volvo Construction Equipment dealer, unless the owner has proficient mechanical ability and the proper tools.

VOLVO

Construction Equipment

Service Information

Document Title: **Precautions**	Function Group: **200**	Information Type: **Service Information**	Date: **2015/3/29**
Profile:			

Precautions

Make preparation as follows before starting engine inspection and service.

- Fix the engine on a horizontal base.

  WARNING

  Be sure to fix the engine securely to prevent injury or damage to parts due to falling during the work.

- Remove the cooling water hose, fuel oil pipe, wire harness, control wires etc. connecting the driven machine and engine, and drain cooling water, lubricating oil and fuel.
- Clean soil, oil, dust, etc. from the engine by washing with solvent, air, steam, etc. Carefully operate so as not to let any foreign matter enter the engine.

  WARNING

  Always wear glasses or other protectors when using compressed air or steam to prevent any foreign matter from getting in the eyes.

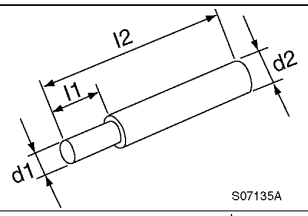
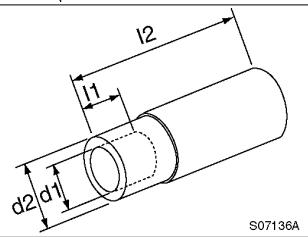
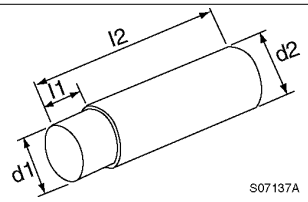
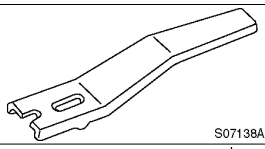
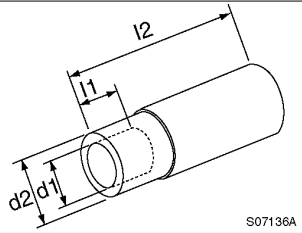
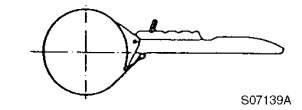
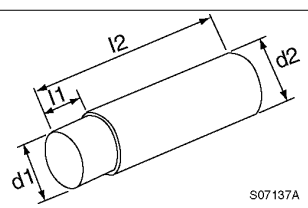
- Any part which is found defective as a result of inspection or any part whose measured value does not satisfy the standard or limit shall be replaced.
- Any part predicted to dissatisfy the standard or limit before the next service as estimated from the state of use should be replaced even when the measured value then satisfies the standard or limit.

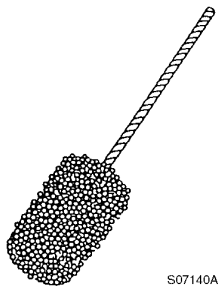
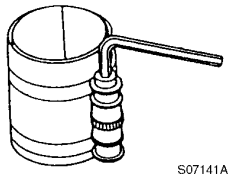
Document Title: **Special tools**	Function Group: **200**	Information Type: **Service Information**	Date: **2015/3/29**
Profile:			

Special tools

Special tools

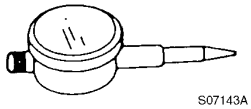
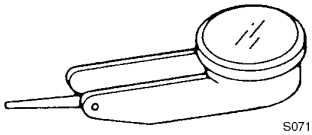
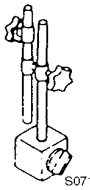
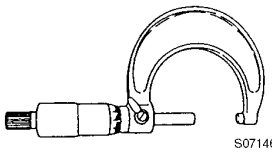
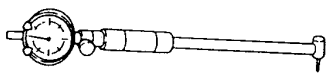
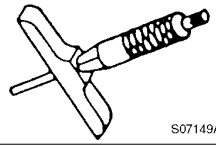
Special tools

Tool name	Applicable model and tool size	Illustration
Valve guide tool (for removing valve guide)	○ l1 : 20 mm ○ l2 : 75 mm ○ d1 : 7.5 mm ○ d2 : 11 mm	
Valve guide tool (for inserting valve guide)	○ l1 : 15 mm ○ l2 : 65 mm ○ d1 : 14 mm ○ d2 : 20 mm	
Connecting rod bushing replacer (for removal/ installation of connecting rod bushing)	○ l1 : 10 mm ○ l2 : 100 mm ○ d1 : 30 -0.3/-0.6 mm ○ d2 : 20 -0.3/-0.6 mm	
Valve spring compressor (for removal/installation of valve spring)	Part number : 129100–92630	
Stem seal inserter (for inserting stem seal)	○ l1 : 19 mm ○ l2 : 65 mm ○ d1 : 16.5 mm ○ d2 : 23 mm	
Filter wrench (for removal/installation of lubrication oil filter)	Available on the market	
Camshaft bushing tool (for removing camshaft bushing)	○ l1 : 18 mm ○ l2 : 70 mm ○ d1 : 50 -0.3/-0.6 mm ○ d2 : 53-0.3/-0.6 mm	

Flex–hone (for re–honing of cylinder liner)	○ Applicable engine model : 4TNE94 ○ Part number : 129400–92430 ○ Applicable bore : 83 ~ 95	 S07140A
Piston insertion tool (for inserting piston)	Part number : 95550–002476 The above piston insertion tool is applicable to 60 ~ 125 (mm) diameter piston	 S07141A
Piston ring replacer (for removal/ installation of piston ring)	Available on the market	 S07142A

Measuring tools

Measuring tools

Instrument name	Application	Illustration
Dial gauge	Measurements of shaft bending, strain and gap of surface	 S07143A
Test indicator	Measurements of narrow or deep portions that cannot be measured by dial gauge.	 S07144A
Magnetic stand	For holding the dial gauge when measuring using a dial gauge, standing angles adjustable	 S07145A
Micrometer	For measuring the outside diameter of crankshaft, pistons, piston pins, etc.	 S07146A
Cylinder gauge	For measuring the side diameters of cylinder liners, rod metal, etc.	 S07147A
Callipers	For measuring outside diameters, depth, thickness, etc.	 S07148A
Depth micrometer	For measuring of valve sink	 S07149A

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