SERVICING

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SAFETY FIRST

This symbol, the industry's "Safety Alert Symbol", is used throughout this manual and on labels on the machine itself to warn of the possibility of personal injury. Read these instructions carefully.

It is essential that you read the instructions and safety regulations before you attempt to repair or use this unit.

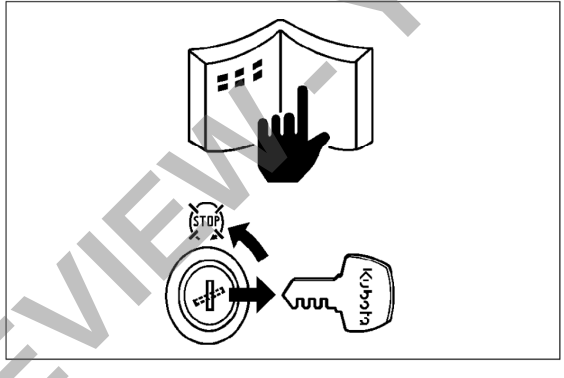
DANGER : Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING : Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION : Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

■ IMPORTANT : Indicates that equipment or property damage could result if instructions are not followed.

■ NOTE : Gives helpful information.



BEFORE SERVICING AND REPAIRING

- Read all instructions and safety instructions in this manual and on your machine safety decals.
- Clean the work area and machine.
- Park the machine on a firm and level ground, and set the parking brake.
- Lower the implement to the ground.
- Stop the engine, and remove the key.
- Disconnect the battery negative cable.
- Hang a "**DO NOT OPERATE**" tag in operator station.

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SPECIFICATIONS

Model	Z602-E	D902-E
Number of Cylinders	2	3
Type	Vertical, Water-cooled, 4 cycle diesel engine	
Bore × Stroke mm (in.)	72 × 73.6 (2.83 × 2.90)	
Total Displacement cm^3 (cu.in.)	599 (36.55)	898 (54.80)
SAE Net Continuous kW/min^{-1} (rpm) (HP/min^{-1} (rpm))	8.8 / 3200 (11.8 / 3200)	13.4 / 3200 (18.0 / 3200)
SAE Net Intermittent kW/min^{-1} (rpm) (HP/min^{-1} (rpm))	10.1 / 3200 (13.5 / 3200)	15.4 / 3200 (20.6 / 3200)
Maximum Bare Speed (min^{-1} (rpm))	3450	
Minimum Bare Idling Speed (min^{-1} (rpm))	900 to 1000	
Combustion Chamber	Spherical type (E-TVCS)	
Fuel Injection Pump	Bosch MD type mini pump	
Governor	Centrifugal ball mechanical governor	
Direction of Rotation	Counter-clockwise (viewed from flywheel side)	
Injection Nozzle	Bosch throttle type	
Injection Timing	0.30 to 0.33 rad (17 to 19 °) before T.D.C.	
Firing Order	1-2	1-2-3
Injection Pressure	13.73 MPa (140 kgf/cm^2, 1991 psi)	
Compression Ratio	24 : 1	
Lubricating System	Forced lubrication by pump	
Cooling System	Pressurized radiator, forced circulation with water pump	
Starting System	Cell starter (with glow plug)	
Starting Motor	12 V, 1.0 kW	12 V, 1.2 kW
Recommended Battery Capacity (5 Hr capacity)	12 V, 36 AH, equivalent	12 V, 52 AH, equivalent
Charging Alternator	12 V, 480 W	
Fuel	Diesel Fuel No.2-D	
Lubricating Oil	Class CF lubricating oil as per API classification is recommended. If this class of lubricating oil is not available, preferably use Class CD or CE lubricating oil. For details on recommended lubricating oils, see page S-16, 20.	
Lubricating Oil Capacity	2.5 L (2.64 U.S.gals)	3.7 L (3.91 U.S.gals)
Weight (Dry) kg (lbs)	57.0 (125.7)	72.0 (158.7)

* Specification are subjext to change without notice.
* The battery capacity is indicated in 5-hour ratio.

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[4] TROUBLE SHOOTING

Symptom	Probable Cause	Solution	Reference Page
Engine Does Not Start	No fuel	Replenish fuel	–
	Air in the fuel system	Bleed	S-21
	Water in the fuel system	Change fuel and repair or replace fuel system	–
	Fuel hose clogged	Clean	–
	Fuel filter clogged	Change	S-24
	Excessively high viscosity of fuel or engine oil at low temperature	Use specified fuel or engine oil	S-22
	Fuel with low cetane number	Use specified fuel	–
	Fuel leak due to loose injection pipe retaining nut	Tighten retaining nut	S-38
	Incorrect injection timing	Adjust	S-75
	Fuel camshaft worn	Replace	S-46
	Injection nozzle clogged	Repair or replace	S-78, 79
	Injection pump malfunctioning	Replace	S-44
	Seizure of crankshaft, camshaft, piston, cylinder or bearing	Repair or replace	–
	Compression leak from cylinder	Replace head gasket, tighten cylinder head screw, glow plug and nozzle holder	S-35
	Improper valve timing	Correct or replace timing gear	S-45
	Piston ring and cylinder worn	Replace	S-48, 62, 68, 69
	Excessive valve clearance	Adjust	S-27
Starter Does Not Run	Battery discharged	Charge	–
	Starter malfunctioning	Repair or replace	S-81
	Wiring disconnected	Connect	–
Engine Revolution Is Not Smooth	Fuel filter clogged or dirty	Replace	S-24
	Air cleaner clogged	Clean or replace	S-22
	Fuel leak due to loose injection pipe retaining nut	Tighten retaining nut	S-38
	Injection pump malfunctioning	Replace	S-44
	Incorrect nozzle injection pressure	Adjust	S-78, 79
	Injection nozzle stuck or clogged	Repair or replace	S-39, 78, 79
	Governor malfunctioning	Repair	S-46

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[6] MAINTENANCE CHECK LIST

To maintain long-lasting and safe engine performance, make it a rule to carry out regular inspections by following the table below.

The lubricating oil change intervals listed in the table below are for Classes CF, CE and CD lubricating oils of API classification with a low-sulfur fuel in use. If the CF-4 or CG-4 lubricating oil is used with a high-sulfur fuel, change the lubricating oil at shorter intervals than recommended in the table below depending on the operating condition.

Item	Service Interval											Refe rence page
	Initial 50 hrs	Every 50 hrs	Every 100 hrs	Every 200 hrs	Every 400 hrs	Every 500 hrs	Every 1 year	Every 800 hrs	Every 1500 hrs	Every 3000 hrs	Every 2 years	
Checking fuel hose and clamp bands	☆	☆										S-21
Changing engine oil	☆		☆									S-22
Replacing oil filter cartridge	☆			☆								S-24
Checking fan belt tension and damage			☆									S-22
Cleaning air cleaner element			☆									S-22
Cleaning fuel filter			☆									S-23
Checking radiator hoses and hose clamp bands				☆								S-23
Checking intake air line				☆								S-23
Replacing fuel filter					☆							S-24
Cleaning fuel tank inside						☆						S-25
Cleaning water jacket and radiator interior						☆						S-25
Replacing fan belt						☆						S-26
* Replacing air cleaner element							☆					S-26
Checking valve clearance								☆				S-27
**Checking fuel injection nozzle condition									☆			S-28
Checking injection pump										☆		S-28
Replacing intake air line											☆	S-28
Replacing radiator hoses and clamp bands											☆	S-28
Replacing fuel hoses and clamp bands											☆	S-28
Changing radiator coolant (L.L.C.)											☆	S-28

* Or, every sixth cleanings of air cleaner element.

** Maintenance interval as per EPA instructions.

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[3] TIGHTENING TORQUES

Screws, bolts and nuts must be tightened to the specified torque using a torque wrench, several screws, bolts and nuts such as those used on the cylinder head must be tightened in proper sequence and the proper torque.

(1) Tightening torques for special use screws, bolts and nuts

■ **NOTE**

- **For "*" marked screws, bolts and nuts on the table, apply engine oil to their threads and seats before tightening.**
- **The letter "M" in Size x Pitch means that the screw, bolt or nut dimension stands for metric. The size is the nominal outside diameter in mm of the threads. The pitch is the nominal distance in mm between two threads.**

Item	Size x Pitch	N·m	kgf·m	ft-lbs
*Cylinder head cover screw	M6 x 1	6.86 to 11.3	0.7 to 1.15	5.1 to 8.3
Injection pipe retaining nuts	M12 x 1.5	24.5 to 34.3	2.5 to 3.5	18.1 to 25.3
Overflow pipe retaining nut	M12 x 1.5	19.6 to 24.5	2.0 to 2.5	14.5 to 18.1
Nozzle holder assembly	M20 x 1.5	49.0 to 68.6	5.0 to 7.0	36.2 to 50.6
Glow plugs	M8 x 1	7.85 to 14.7	0.8 to 1.5	5.8 to 10.8
*Rocker arm bracket nuts	M6 x 1	9.8 to 11.3	1.00 to 1.15	7.2 to 8.3
*Cylinder head screw	M8 x 1.25	37.3 to 42.2	3.8 to 4.3	27.5 to 31.1
*Fan drive pulley screw	M12 x 1.5	117.7 to 127.5	12.0 to 13.0	86.8 to 94.0
*Idle gear shaft mounting screw	M6 x 1	9.8 to 11.3	1.00 to 1.15	7.2 to 8.3
*Connecting rod screw	M7 x 0.75	26.5 to 30.4	2.7 to 3.1	19.5 to 22.4
*Flywheel screw	M10 x 1.25	53.9 to 58.8	5.5 to 6.0	39.8 to 43.4
Bearing case cover mounting screw	M6 x 1	9.8 to 11.3	1.00 to 1.15	7.2 to 8.3
*Main bearing case screw 2	M7 x 0.75	26.5 to 30.4	2.7 to 3.1	19.5 to 22.4
*Main bearing case screw 1	M6 x 1	9.8 to 11.3	1.00 to 1.15	7.2 to 8.3
Nozzle holder	-	34.3 to 39.2	3.5 to 4.0	25.3 to 28.9
Oil pressure switch	PT 1/8	14.7 to 19.6	1.5 to 2.0	10.8 to 14.5
Starter (C terminal nut)	-	5.9 to 11.8	0.6 to 1.2	4.3 to 8.7

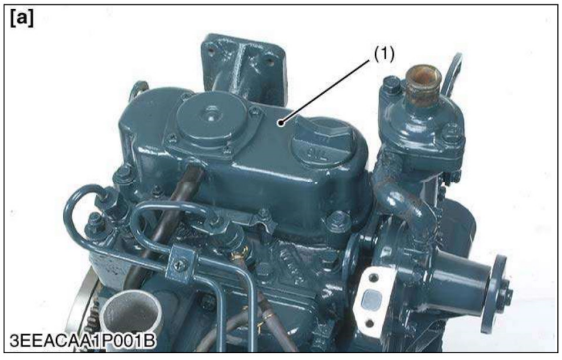
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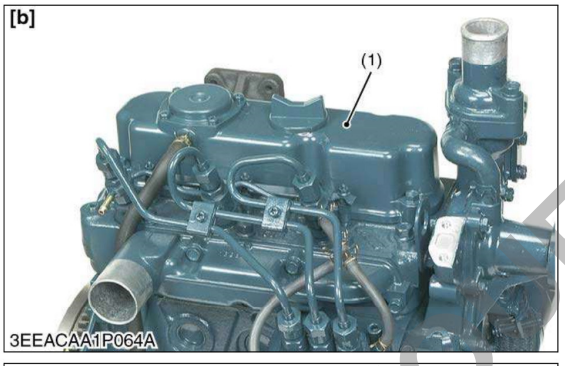
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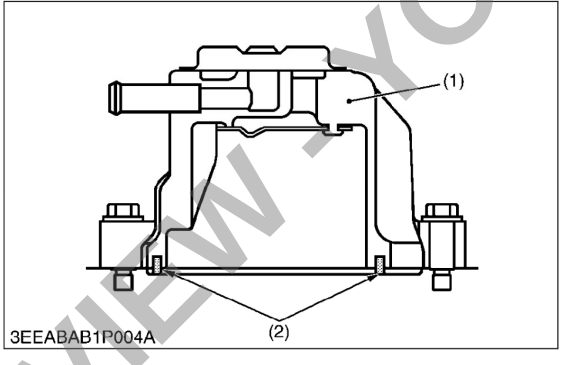
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1. ENGINE BODY

[1] HALF-FLOATING HEAD COVER







The rubber packing is fitting in to maintain the head cover 0.5 mm (0.02 in.) or so off the cylinder head. This arrangement helps reduce noise coming from the cylinder head.

(1) Cylinder Head Cover
(2) Rubber Packing

[a] **Z602-E**
[b] **D902-E**

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2. ENGINE BODY

[1] CHECKING AND ADJUSTING



Compression Pressure

1. Run the engine until it is warmed up.
2. Stop the engine.
3. Remove the air cleaner, the muffler, the head cover and all glow plugs.
4. Set a compression tester (Code No. 07909-30208) with the adaptor (Adaptor L, code No. 07909-31301) to the glow plug hole.
5. After making sure that the stop lever is set at the stop position (non-injection), run the engine with the starter and measure the compression pressure.
6. Repeat steps 4 and 5 for each cylinder.
7. If the measurement is below the allowable limit, apply a small amount of oil to the cylinder wall through the glow plug hole and measure the compression pressure again.
8. If the compression pressure is still less than the allowable limit, check the top clearance, valve clearance and cylinder head.
9. If the compression pressure increases after applying oil, check the cylinder wall and piston rings.

■ **NOTE**

- **Check the compression pressure with the specified valve clearance.**
- **Always use a fully charged battery for performing this test.**
- **Variances in cylinder compression values should be under 10 %.**

Compression pressure	Factory spec.	3.53 to 4.02 MPa 36 to 41 kgf/cm^2 512 to 583 psi
	Allowable limit	2.25 MPa 26 kgf/cm^2 370 psi

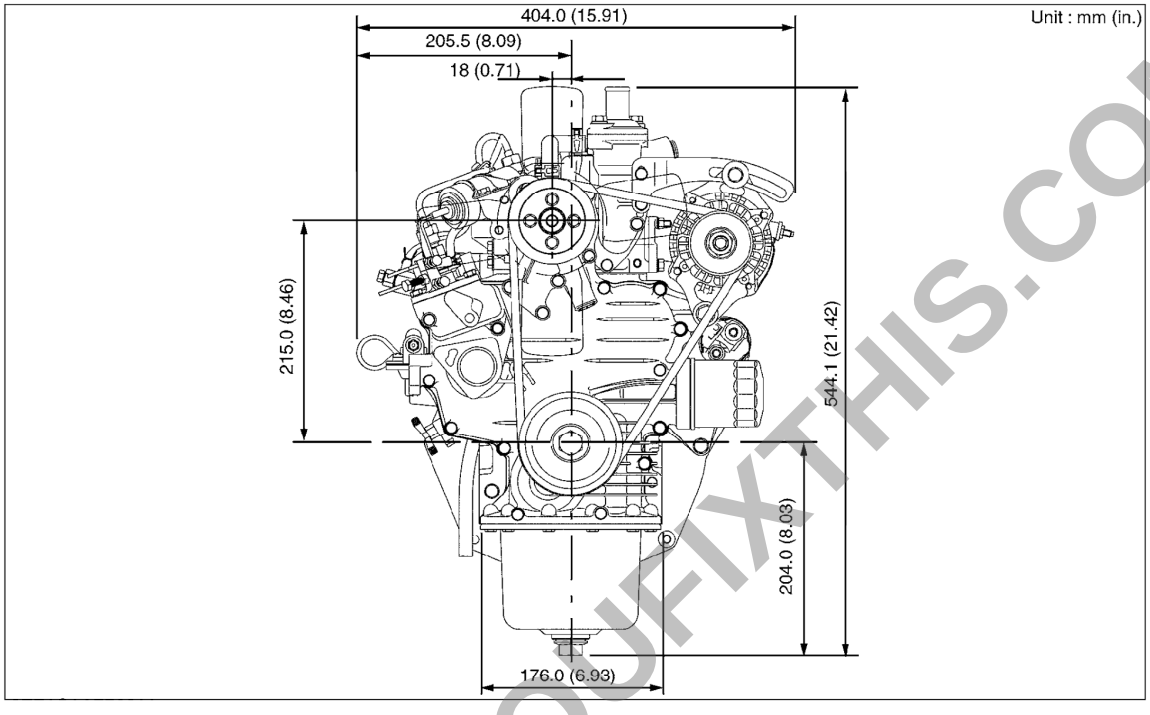
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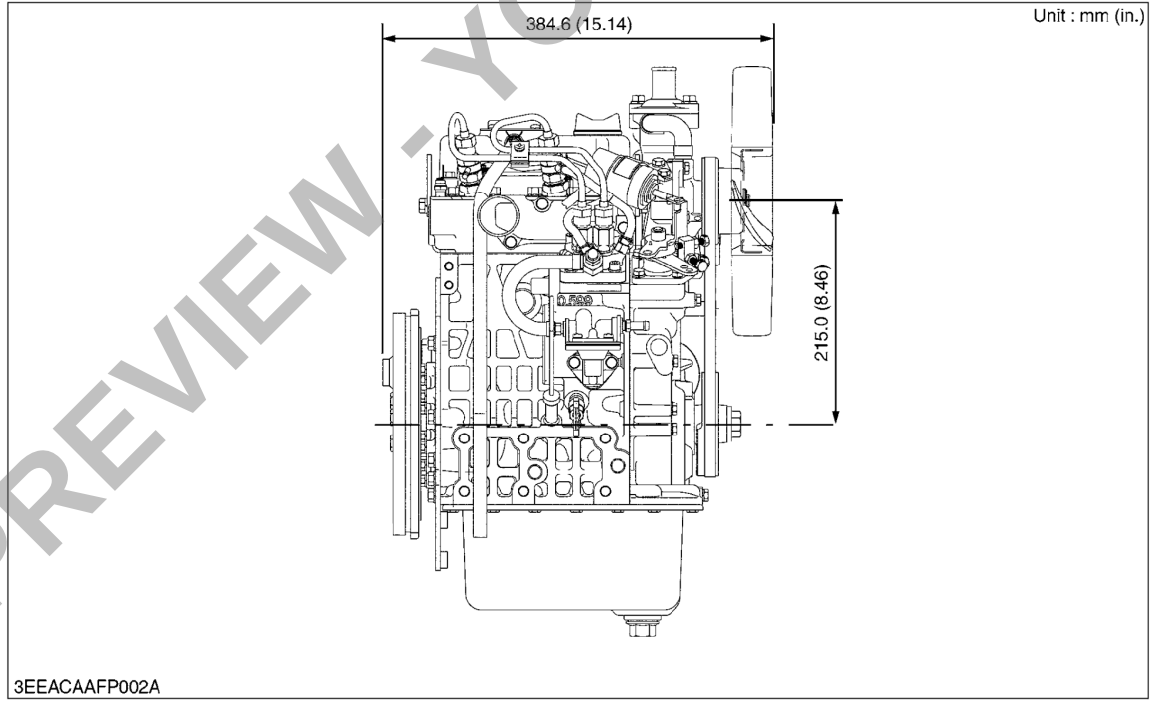
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DIMENSIONS

■ Z602-E





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CAUTION

- **When changing or inspecting, be sure to level and stop the engine.**

■ NOTE

Lubricating Oil

With the emission control now in effect, the CF-4 and CG-4 lubricating oils have been developed for use of a low-sulfur fuel on-road vehicle engines. When an off-road vehicle engine runs on a high-sulfur fuel, it is advisable to employ the CF, CD or CE lubricating oil with a high total base number. If the CF-4 or CG-4 lubricating oil is used with a high-sulfur fuel, change the lubricating oil at shorter intervals.

- **Lubricating oil recommended when a low-sulfur or high-sulfur fuel is employed.**

Fuel / Lubricating oil class	Low sulfur (0.5 % ≥)	High sulfur	Remarks
CF	❍	❍	TBN ≥ 10
CF-4	❍	X	
CG-4	❍	X	

❍ : Recommendable X : Not recommendable

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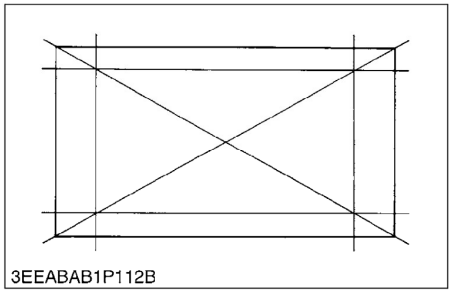
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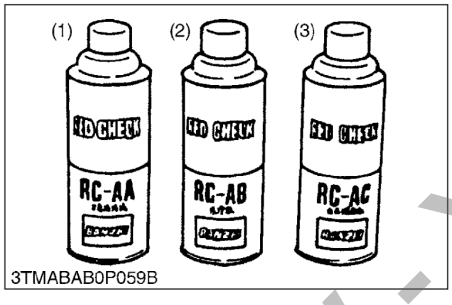
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[3] SERVICING

(1) Cylinder Head and Valves


3EEACAA1P042A


3EEABAB1P112B



3TMABAB0P059B

Cylinder Head Surface Flatness

1. Clean the cylinder head surface.
2. Place a straightedge on the cylinder head's four sides and two diagonal lines as shown in the figure.
3. Measure the clearance with a thickness gauge.
4. If the measurement exceeds the allowable limit, correct it with a surface grinder.

■ **IMPORTANT**

- **Do not place the straightedge on the combustion chamber.**
- **Be sure to check the valve recessing after correcting.**

Cylinder head surface flatness	Allowable limit	0.05 mm 0.0020 in.

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Cylinder Head Flaw

1. Prepare an air spray red check (Code No. 07909-31371).
2. Clean the surface of the cylinder head with the detergent (2).
3. Spray the cylinder head surface with the red permeative liquid (1). Leave it five to ten minutes after spraying.
4. Wash away the red permeative liquid on the cylinder head surface with the detergent (2).
5. Spray the cylinder head surface with the white developer (3).
6. If flawed, it can be identified as red marks.

(1) Red Permeative Liquid
(2) Detergent
(3) White Developer

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