SHOP MANUAL

KOMATSU

70E, 76E-5 SERIES

DIESEL ENGINE

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PREFACE

This manual describes the service procedures for the 70E, 76E-5 series engines.

Please use this manual for accurate, quick and safe servicing of the said engine. Since the explanation in this manual assumes the standard type engine, the specifications and components may partially be different from the engine installed on individual machine. Please also refer to the shop manual for each machine for details.

The affected pages are indicated by the use of the following marks. It is requested that necessary actions be taken to these pages according to the table below.

Mark	Indication	Action required
○	Page to be newly added	Add
●	Page to be replaced	Replace
( )	Page to be deleted	Discard

Pages having no marks are those previously revised or made additions.

LIST OF REVISED PAGES

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SAFETY LABELS

- Most accidents are caused by negligence of basic safety rules and precautions. For accident prevention, it is important to avoid such causes before development to accidents.
  Please read this manual carefully before starting repair or maintenance to fully understand safety precautions and appropriate inspection and maintenance procedures.
  Attempting at a repair or maintenance job without sufficient knowledge may cause an unexpected accident.

- It is impossible to cover every possible danger in repair or maintenance in the manual. Sufficient consideration for safety is required in addition to the matters marked ⚠ CAUTION. Especially for safety precautions in a repair or maintenance job not described in this manual, receive instructions from a knowledgeable leader.

- Safety marks used in this manual and their meanings are as follows:

⚠ DANGER

DANGER – indicates an imminently hazardous situation which, if not avoided, WILL result in death or serious injury.

⚠ WARNING

WARNING – indicates a potentially hazardous situation which, if not avoided, COULD result in death or serious injury.

⚠ CAUTION

CAUTION – indicates a potentially hazardous situation which, if not avoided, MAY result in minor or moderate injury.

- **NOTICE** – indicates that if not observed, the product performance or quality may not be guaranteed.

SAFETY PRECAUTIONS

(1) SERVICE AREA

⚠ WARNING

- **Sufficient Ventilation**
  Inhalation of exhaust fumes and dust particles may be hazardous to ones health. Running engines welding, sanding, painting, and polishing tasks should be only done in well ventilated areas.

⚠ CAUTION

- **Safe / Adequate Work Area**
  The service area should be clean, spacious, level and free from holes in the floor, to prevent "slip" or "trip and fall" type accidents.

⚠ CAUTION

- **Bright, Safely Illuminated Area**
  The work area should be well lit or illuminated in a safe manner. For work in enclosed or dark areas, a "drop cord" should be utilized. The drop cord must have a wire cage to prevent bulb breakage and possible ignition of flammable substances.

⚠ CAUTION

- **Safety Equipment**
  Fire extinguisher(s), first aid kit and eye wash / shower station should be close at hand (or easily accessible) in case of an emergency.

(2) WORK - WEAR (GARMENTS)

⚠ CAUTION

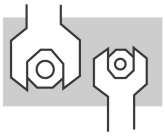
- **Safe Work Clothing**
  Appropriate safety wear (gloves, special shoes/boots, eye/ear protection, head gear, harness', clothing, etc.) should be used/worn to match the task at hand. Avoid wearing jewelry, unbuttoned cuffs, ties or loose fitting clothes around moving machinery. A serious accident may occur if caught in moving/rotating machinery.

(3) TOOLS

⚠ WARNING

- **Appropriate Lifting / Holding**
  When lifting an engine, use only a lifting device (crane, jack, etc.) with sufficient lifting capacity. Do not overload the device. Use only a chain, cable, or lifting strap as an attaching device. Do not use rope, serious injury may result.
  To hold or support an engine, secure the engine to a support stand, test bed or test cart designed to carry the weight of the engine. Do not overload this device, serious injury may result.
  Never run an engine without being properly secured to an engine support stand, test bed or test cart, serious injury may result.

⚠ CAUTION



- **Appropriate Tools**
  Always use tools that are designed for the task at hand. Incorrect usage of tools may result in damage to the engine and or serious personal injury.

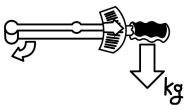
(4) GENUINE PARTS and MATERIALS

⚠ CAUTION

- **Genuine Parts**
  Always use genuine KOMATSU parts or KOMATSU recommended parts and goods. Damage to the engine, shortened engine life and or personal injury may result.

(5) FASTENER TORQUE

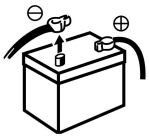
⚠ WARNING



- **Torqueing Fasteners**
  Always follow the torque values and procedures as designated in the shop manual. Incorrect values, procedures and or tools may cause damage to the engine and or personal injury.

(6) ELECTRICAL SYSTEM

⚠ WARNING



- **Short Circuits**
  Always disconnect the (–) Negative battery cable before working on the electrical system. An accidental "short circuit" may cause damage, fire and or personal injury. Remember to connect the (–) Negative battery cable (back onto the battery) last.
  Fasten the terminals tightly.

⚠ WARNING

- **Charging Batteries**
  Charging wet celled batteries produces hydrogen gas. Hydrogen gas is extremely explosive. Keep sparks, open flame and any other form of ignition away. Explosion may occur causing severe personal injury.

⚠ WARNING

- **Battery Electrolyte**
  Batteries contain sulfuric acid. Do NOT allow it to come in contact with clothing, skin and or eyes, severe burns will result.

(7) WASTE MANAGEMENT

⚠ CAUTION

Observe the following instructions with regard to hazardous waste disposal. Negligence of these will have a serious impact on environmental pollution concerns.

1) Waste fluids such as lube oil, fuel and coolant shall be carefully put into separate sealed containers and disposed of properly.
2) Do NOT dispose of waste materials irresponsibly by dumping them into the sewer, overland or into natural waterways.
3) Waste materials such as oil, fuel, coolant, solvents, filter elements and batteries, must be disposed of properly according to local ordinances. Consult the local authorities or reclamation facility.

(8) FURTHER PRECAUTIONS

⚠ WARNING

- **Fueling / Refueling**

  Keep sparks, open flames or any other form of ignition (match, cigarette, etc.) away when fueling/refueling the unit. *Fire and or an explosion may result.*

⚠ WARNING

- **Hot Surfaces.**

  Do NOT touch the engine (or any of its components) during running or shortly after shutting it down. *Scalding / serious burns may result*. Allow the engine to cool down before attempting to approach the unit.

⚠ WARNING

- **Rotating Parts**

  Be careful around moving/rotating parts. Loose clothing, jewelry, ties or tools may become entangled causing damage to the engine and or severe personal injury.

⚠ WARNING

- **Preventing burns from scalding**

  1) Never open the radiator filler cap shortly after shutting the engine down.
     Steam and hot water will spurt out and seriously burn you. Allow the engine to cool down before attempt to open the filler cap.
  2) Securely tighten the filler cap after checking the radiator.
     Steam can spurt out during engine running, if tightening loose.

PRECAUTIONS FOR SERVICE WORK

1. **Precautions for Safety**
   Read the safety precautions given at the beginning of this manual carefully and always mind safety in work.

2. **Preparation for Service Work**
   Preparation is necessary for accurate, efficient service work. Check the customer ledger file for the history of the engine.
   - Preceding service date
   - Period/operation hours after preceding service
   - Problems and actions in preceding service
   - Replacement parts expected to be required for service
   - Recording form/check sheet required for service

3. **Preparation before Disassembly**
   - Prepare general tools, special service tools, measuring instruments, oil, grease, non reusable parts, and parts expected to be required for replacement.
   - When disassembling complicated portions, put match marks and other marks at places not adversely affecting the function for easy reassembly.

4. **Precautions in Disassembly**
   - Each time a parts is removed, check the part installed state, deformation, damage, roughening, surface defect, etc.
   - Arrange the removed parts orderly with clear distinction between those to be replaced and those to be used again.
   - Parts to be used again shall be washed and cleaned sufficiently.
   - Select especially clean locations and use clean tools for disassembly of hydraulic units such as the fuel injection pump.

5. **Precautions for Inspection and Measurement**
   Inspect and measure parts to be used again as required to determine whether they are reusable or not.

6. **Precautions for Reassembly**
   - Reassemble correct parts in correct order according to the specified standards (tightening torques, and adjustment standards). Apply oil important bolts and nuts before tightening when specified.
   - Always use genuine parts for replacement.
   - Always use new oil seals, O-rings, packings and cotter pins.
   - Apply sealant to packings depending on the place where they are used. Apply of grease to sliding contact portions, and apply grease to oil seal lips.

7. **Precautions for Adjustment and Check**
   Use measuring instruments for adjustment to the specified service standards.

HOW TO READ THIS MANUAL

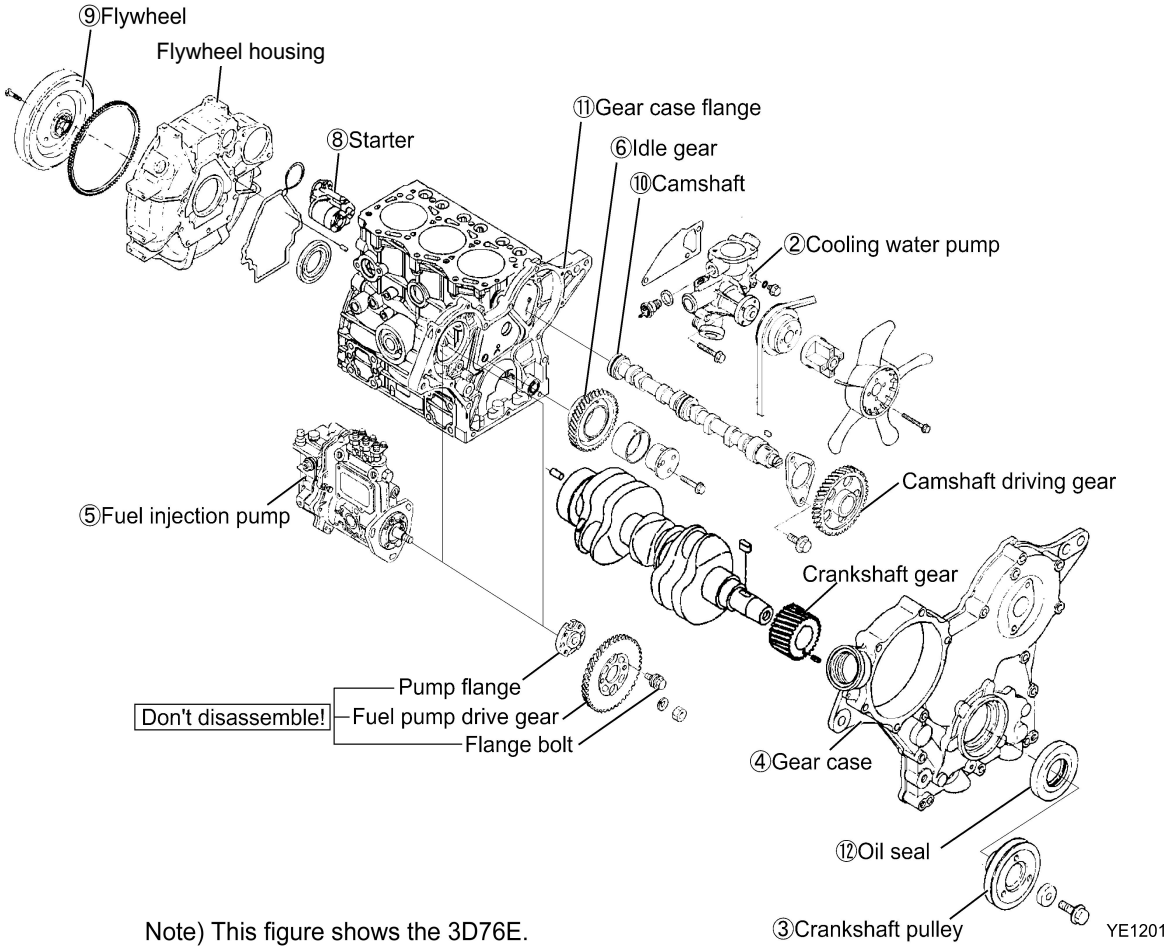
1. Range of Operation Explanation

This manual explains the troubleshooting, installation/removal, replacement, disassemble/reassembly, inspection, adjustment and adjusting operation procedures for the 76E-5 series engines.
Refer to the shop manual for each of the fuel injection pump, governor, starting motor and alternator except for their installation.

2. How to Read the Explanations

- An exploded view, sectional views, a system diagram, etc. are shown at the beginning of each section as required for easy understanding of the mounted states of the components.
- For the removal/installation of each part, the procedure is shown with the procedural step No. in the illustration.
- Precautions and key points for disassembly and reassembly of parts are described as **points**. In the explanation for each point, detailed operation method, information, standard and precautions are described.

Description Example



Note) This figure shows the 3D76E.

The job contents are described in the disassembly procedure for Nos. not shown in the illustration.

- Disassembly procedure
  1) Follow steps (1) to (15) of the cylinder head disassembly procedure.
  2) Remove the cooling water pump.
  3) Remove the crankshaft pulley. (**Point 1**) ← Operation point to be explained on a later page.

- Operation points
  Disassemble: Service point for removal
  Reassemble: Service point for installation
  Disassemble-Reassemble: Service point required in both removal and installation.

- Contents omitted in this manual
  Though the following jobs are omitted in the explanation in this manual, they should be conducted in actual work:
  1) Jacking up and lifting
  2) Cleaning and washing of removed parts as required
  3) Visual inspection

3. Definition of Terms

[NOTICE]: Instruction whose negligence is very likely to cause an accident. Always observe it.
Standard: Allowable range for inspection and adjustment.
Limit: The maximum or minimum value that must be satisfied during inspection or adjustment.

4. Abbreviations

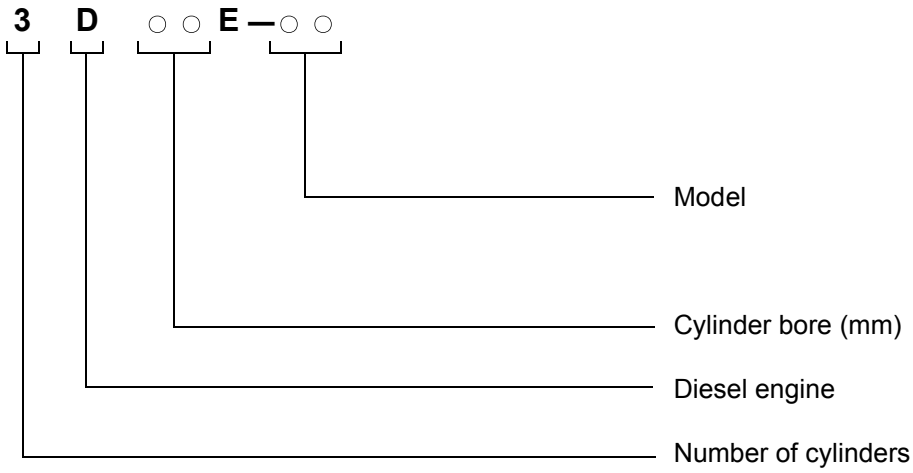
Abbreviation	Meaning	Abbreviation	Meaning
Ass'y	assembly	T.D.C.	top dead center
Sub-Ass'y	sub-assembly	B.D.C.	bottom dead center
A.T.D.C.	after top dead center	OS	oversize
B.T.D.C.	before top dead center	US	undersize
STD	Standard	rpm	revolutions per minute
IN	Intake	HP	Output (horsepower)
EX	Exhaust	T	Bolt/nut tightening torque
kW	Output (SI unit)		

APPLICATION CATEGORY

Application code	Usage	Eng. Rev. type.	Revolution speed (rpm)
VM	General use	Variable	2,000 – 3,000

★ For engine application category described in Chapter 1, Specifications.

Engine Nomenclature



APPLICABLE MACHINE, SERIAL NUMBER

Engine	Machine model	Machine Serial No.	Remarks
2D70E-5	PC09-1	12001 and up	
3D76E-5	PC20MR-2	15001 and up	

CONTENTS

1. GENERAL

1.1 Specifications

(1) 2D70E

Engine name		Unit	2D70E									
Engine specification class		–	VM									
Type		–	Vertical, in-line, 4-cycle, water-cooled diesel engine									
Combustion chamber		–	Swirl chamber type									
Number of cylinders		–	2									
Cylinder bore x stroke		mm x mm	70 x 74									
Displacement		ℓ (cc)	0.570 (570)									
Continuous rating	Revolving speed	rpm	–									
	Output	kW {HP}	–									
Rated output	Revolving speed	rpm	2,000	2,100	2,200	2,300	2,400	2,500	2,600	2,700	2,800	2,900	3,000
	Output	kW {HP}	6.0 {8.0}	6.3 {8.5}	6.6 {8.9}	7.0 {9.4}	7.3 {9.8}	7.6 {10.2}	7.9 {10.6}	8.2 {11.0}	8.5 {11.5}	8.8 {11.9}	9.1 {12.2}
Max. no-load speed (± 25)		rpm	2,160	2,250	2,355	2,460	2,570	2,675	2,780	2,890	2,995	3,100	3,210
Ignition order		–	1-2-1(No.1 cylinder on flywheel side)									
Power take off		–	Flywheel									
Direction of rotation		–	Counterclockwise (viewed from flywheel)									
Cooling system		–	Radiator									
Lubrication system		–	Forced lubrication with trochoid pump									
Starting system		–	Electric									
Applicable fuel		–	Diesel oil-ISO 8217 DMA, BS 2869 A1 or A2 (Cetane No.45 min.)									
Applicable lubricant		–	API grade class CD or CF									
Lubricant capacity (oil pan) (*1)	Total	ℓ	1.7									
	Effective	ℓ	0.7									
Cooling water capacity (engine only)		ℓ	0.6									
Engine Dimensions (with flywheel housing) (*1),(*2)	Overall length	mm	415									
	Overall width	mm	427									
	Overall height	mm	484									
Engine dry weight (*1),(*2) (with flywheel housing)		kg	84									
Cooling fan (std.) (*1)		mm	260 mm O/D, 5 blades pusher type F									
Crankshaft V pulley diameter & Fan V pulley diameter (std.) (*1)		mm	110 x 110									

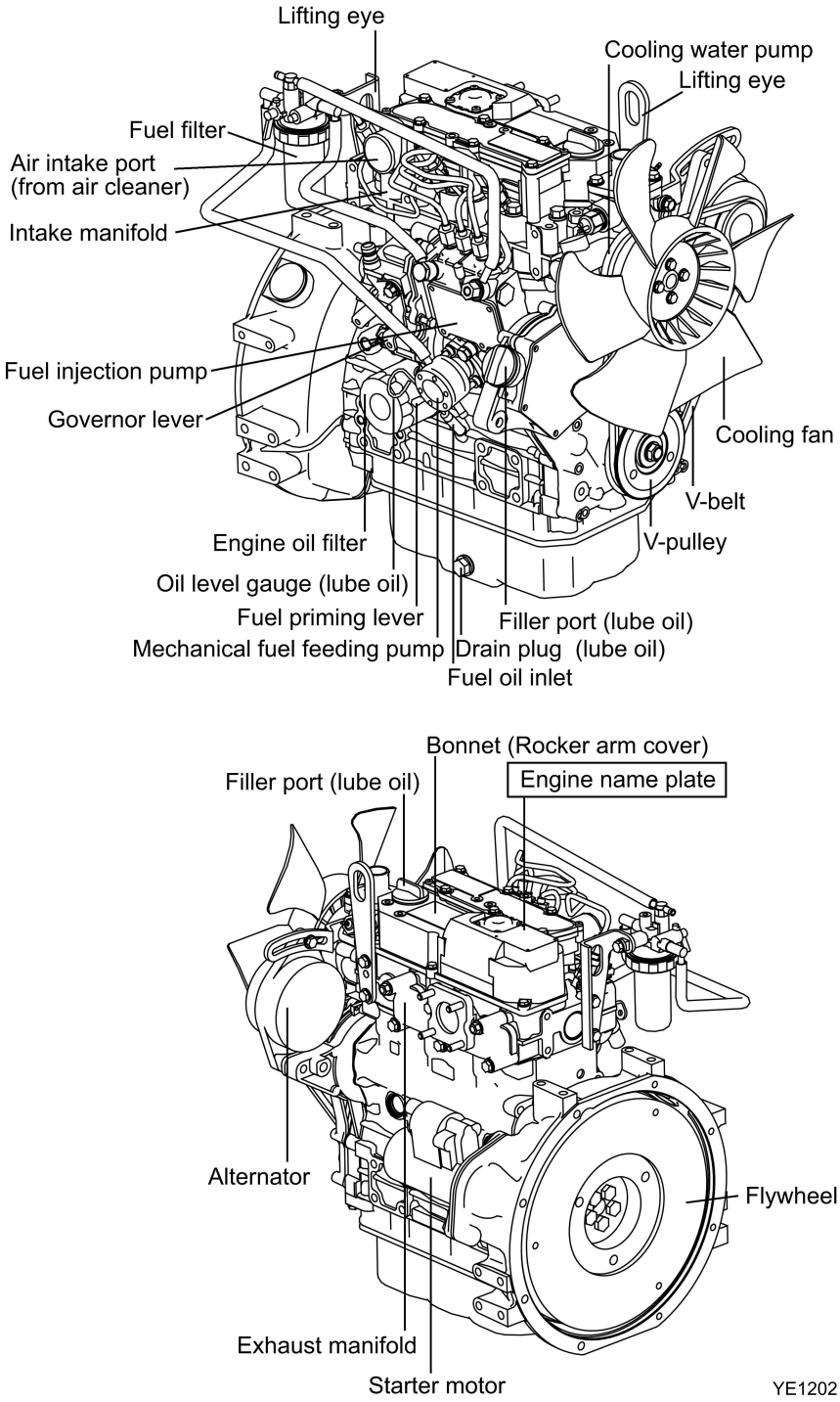
*1. Items may differ from the above depending on an engine installed on a machine unit.
*2. Engine weight and dimensions without radiator

(2) 3D76E

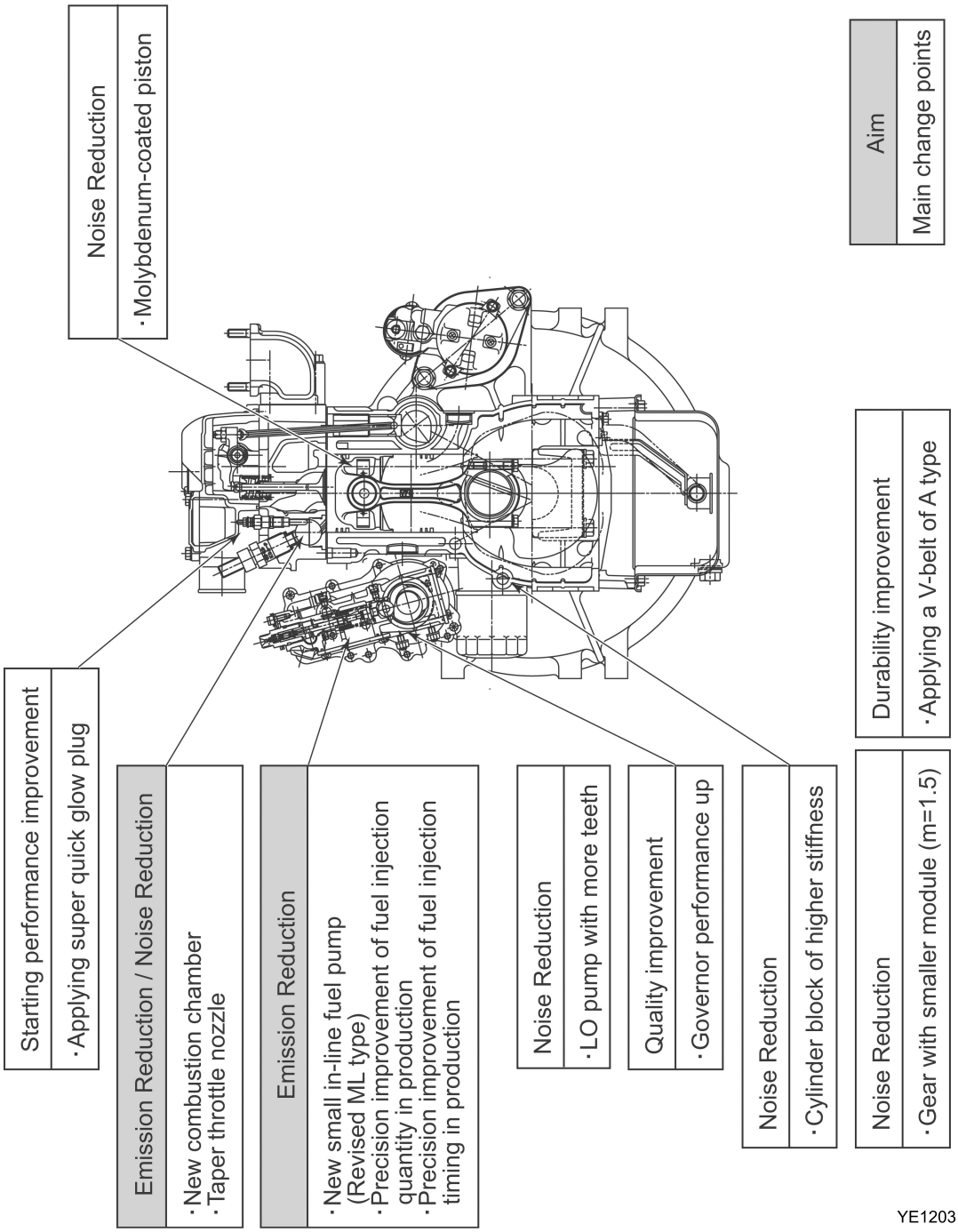
Engine name		Unit	3D76E									
Engine specification class		–	VM									
Type		–	Vertical, in-line, 4-cycle, water-cooled diesel engine									
Combustion chamber		–	Swirl chamber type									
Number of cylinders		–	3									
Cylinder bore x stroke		mm x mm	76 x 82									
Displacement		ℓ (cc)	1.115 (1,115)									
Continuous rating	Revolving speed	rpm	–									
	Output	kW {HP}	–									
Rated output	Revolving speed	rpm	2,000	2,100	2,200	2,300	2,400	2,500	2,600	2,700	2,800	2,900	3,000
	Output	kW {HP}	11.8 {15.8}	12.5 {16.8}	13.2 {17.7}	13.8 {18.5}	14.3 {19.2}	14.9 {20.0}	15.5 {20.8}	16.1 {21.6}	16.7 {22.4}	17.3 {23.2}	17.9 {24.0}
Max. no-load speed (± 25)		rpm	2,160	2,250	2,355	2,460	2,570	2,675	2,780	2,890	2,995	3,100	3,210
Ignition order		–	1-3-2-1(No.1 cylinder on flywheel side)									
Power take off		–	Flywheel									
Direction of rotation		–	Counterclockwise (viewed from flywheel)									
Cooling system		–	Radiator									
Lubrication system		–	Forced lubrication with trochoid pump									
Starting system		–	Electric									
Applicable fuel		–	Diesel oil-ISO 8217 DMA, BS 2869 A1 or A2 (Cetane No.45 min.)									
Applicable lubricant		–	API grade class CD or CF									
Lubricant capacity (oil pan) (*1)	Total	ℓ	3.5									
	Effective	ℓ	1.6									
Cooling water capacity (engine only)		ℓ	0.9									
Engine Dimensions (with flywheel housing) (*1),(*2)	Overall length	mm	485									
	Overall width	mm	436									
	Overall height	mm	535									
Engine dry weight (*1),(*2) (with flywheel housing)		kg	112									
Cooling fan (std.) (*1)		mm	335 mm O/D, 6 blades pusher type F									
Crankshaft V pulley diameter & Fan V pulley diameter (std.) (*1)		mm	110 x 100									

*1. Items may differ from the above depending on an engine installed on a machine unit.
*2. Engine weight and dimensions without radiator

1.2 Engine External Views



1.3 Structural Description



2. INSPECTION AND ADJUSTMENT

2.1 Periodic Maintenance Schedule

The engine periodic inspection timing is hard to determine as it varies with the application, load status, qualities of the fuel and lubricating oils used and handling status. General rules are described here.

○: User-maintenance ◎: Parts replacement ●: Shop-inspection

Classification	Item	Daily	Maintenance period				
			Every 50 hours	Every 250 hours or 3 months	Every 500 hours or 6 months	Every 1000 hours or one year	Every 2000 hours or two years
Whole	Visual check around engine	○					
Fuel oil system	Fuel tank level check and fuel supply	○					
	Fuel tank draining		○				
	Water separator (Option) draining		○				
	Bleeding the fuel system		○				
	Water separator cleaning				○		
	Fuel filter element replacement				◎		
Lubricating oil system	Lube oil level check and replenishment	○					
	Lube oil replacement		◎ 1st time	◎ 2nd time and thereafter			
	Lube oil filter replacement						
Cooling water system	Cooling water level check and replenishment	○					
	Radiator fin cleaning			○			
	V-belt tension check		○ 1st time	○ 2nd time and thereafter			
	Cooling water replacement					◎	
	Cooling water path flushing and maintenance						●
Rubber house	Fuel pipe and cooling water pipe inspection and maintenance	○					●
Governor	Inspection and adjustment of governor lever and accelerator	○		○			
Air intake system	Air cleaner cleaning and element replacement			○	◎		
	Diaphragm ass'y inspection					● (2 years)	
	Turbocharger blower cleaning*					●	
Electrical system	Warning lamp & instruments function check	○					
	Battery electrolyte level check and battery recharging		○				
Cylinder head	Intake/exhaust valve head clearance adjustment					●	
	Intake/exhaust valve seat lapping						●
Fuel injection pump and nozzle	Fuel injection nozzle pressure inspection					●	
	Fuel injection timing adjustment Fuel injection pump inspection and adjustment						●

2.2 Periodic Inspection and Maintenance Procedure

2.2.1 Check before daily operation

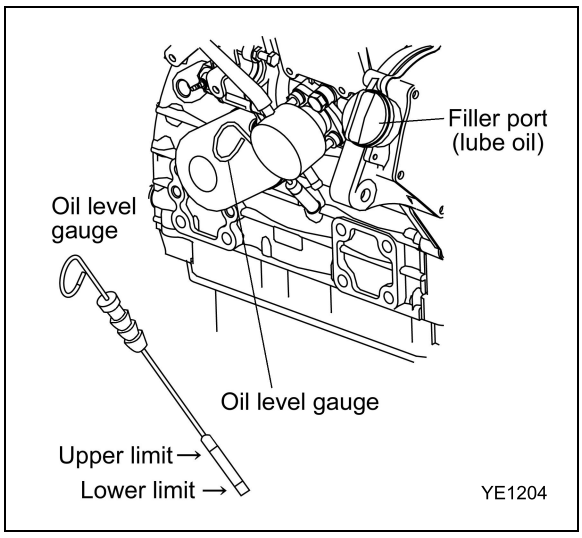
Be sure to check the following points before starting an engine every day.

No.	Inspection Item
(1)	Visual check around engine
(2)	Fuel tank level check and fuel supply
(3)	Lube oil level check and replenishment
(4)	Cooling water level check and replenishment
(5)	Fuel pipe and cooling water pipe inspection and maintenance
(6)	Inspection and adjustment of governor lever and accelerator
(7)	Warning lamp & instruments function check

(1) Visual check around engine
If any problem is found, do not use before the engine repairs have been completed.
- Oil leak from the lubrication system
- Fuel leak from the fuel system
- Cooling water leak from the cooling water system
- Damaged parts
- Loosened or lost bolts
- Fuel, radiator rubber hoses, V belt cracked, loosened clamp

(2) Fuel tank level check and fuel supply
Check the remaining fuel oil level in the fuel tank and refuel the recommended fuel if necessary. (Refer to 1.3.(1))

(3) Lube oil level check and replenishment
(a) Checking oil level
Check the lube oil level with the oil level gauge, after adjusting the posture of the machine unit so that an engine may become a horizontality. Insert the oil level gauge fully and check the oil level. The oil shall not be contaminated heavily and have appropriate viscosity. No cooling water or diesel fuel shall be mixed.
When lube oil is supplied after the engine running, check the lube oil level after about 10 minutes pass after the engine shutdown so that the lube oil inside may be retuned the oil pan.



Standard
The level shall be between the upper and lower limit lines on the oil level gauge.

(Unit: ℓ)

Model	Total volume	Effective volume
2D70E	1.7	0.7
3D76E	3.5	1.6

Lube oil capacity may differ from the above volume depending on an engine installed on a machine unit.

(b) Replenishing oil pan with lube oil
If the remaining engine oil level is low, fill the oil pan with the specified engine oil to the specified level through the filler port.

[NOTICE]
The oil should not be overfilled to exceed the upper limit line. Otherwise a naturally-aspirated engine may intake lube oil in the combustion chamber during the operation, then white smoke, oil hummer or urgent rotation may occur, because the blowby gas is reduced in the suction air flow.
In case of turbo-charged engine oil may jet out from the breather or the engine may become faulty.

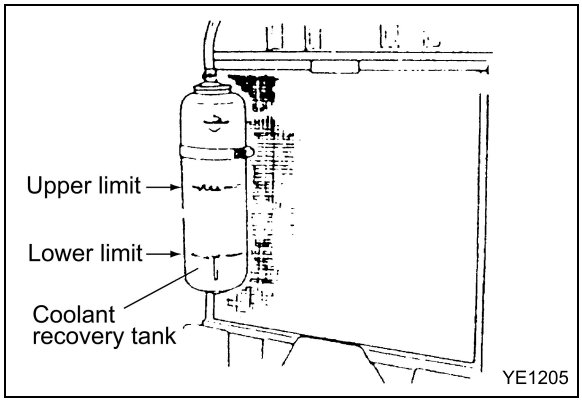
(4) Cooling water Inspection
Daily inspection of cooling water should be done only by coolant recovery tank.

⚠ WARNING

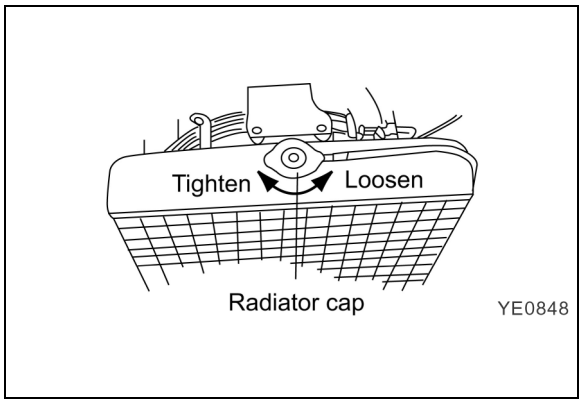
- Never open the radiator filler cap while the engine and radiator are still hot. Steam and hot water will spurt out and seriously burn you. Wait until the radiator is cooled down after the engine has stopped, wrap the filler cap with a rag piece and turn the cap slowly to gently release the pressure inside the radiator.
- Securely tighten the filler cap after checking the radiator. Steam can spurt out during operation, if the cap is tightened loosely.

(a) Checking cooling water volume
Check the cooling water level in the coolant recovery tank. If the water level is close to the LOW mark, open the coolant recovery tank cap and replenish the coolant recovery tank with clean soft water to the FULL mark.

Standard
The water level of the coolant recovery tank shall be between the upper and lower limit lines.



(b) Replenishing engine with water
If the coolant recovery tank water level is lower than the LOW mark, open the radiator cap and check the cooling water level in the radiator. Replenish the radiator with the cooling water, if the level is low.
- Check the cooling water level while the engine is cool.
  Checking when the engine is hot is dangerous. And the water volume is expanded due to the heat.
- Daily cooling water level check and replenishing shall be done only at the coolant recovery tank. Usually do not open the radiator cap to check or replenish.



IMPORTANT:
If the cooling water runs short quickly or when the radiator runs short of water with the coolant recovery tank level unchanged, water may be leaking or the air tightness may be lost. Increase in the coolant recovery tank water level during operation is not abnormal.
The increased water in the coolant recovery tank returns to the radiator when the engine is cooled down.
If the water level is normal in the coolant recovery tank but low in the radiator, check loosened clamping of the rubber hose between the radiator and coolant recovery tank or tear in the hose.

Standard
Engine: The radiator shall be filled up.

(Unit: ℓ)

Model	Cooling water volume in an engine
2D70E	0.6
3D76E	0.9

Engine cooling water capacity may differ from the above volume depending on an engine installed on a machine unit.

(5) Fuel pipe and cooling water pipe inspection and maintenance
Check the rubber hoses for fuel and cooling water pipes cracked. If the cracked hose is found, replace it with new one. Check the loosened clamp. If found, tighten it.

(6) Inspection and adjustment of governor lever and accelerator
Make sure the accelerator of the machine unit can be operated smoothly before starting the engine. If it feels heavy to manipulate, lubricate the accelerator cable joints and pivots. Adjust the accelerator cable if there is a dislocation or excessive play between the accelerator and the governor lever. Refer to 3.2.3.

(7) Warning lamp & instruments function check
Before and after starting the engine, check to see that the alarm function normally. Failure of alarm cannot warn the lack of the engine oil or the cooling water. Make it a rule to check the alarm operation before and after starting engine every day. Refer to each manual for machine units in details.

2.2.2 Inspection after initial 50 hours operation

Be sure to check the following points after initial 50 hours operation, thereafter every 250 hours or 3 months operation.

No.	Inspection Item
(1)	Lube oil and filter replacement
(2)	V-belt tension check

(1) Lube oil and filter replacement (1st time)

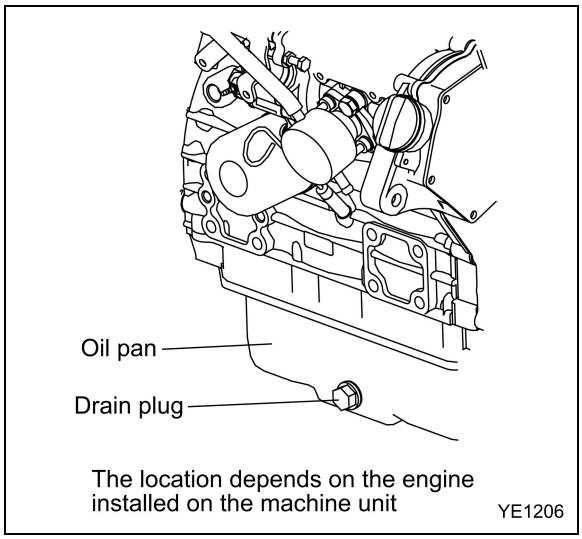
⚠ CAUTION

When an engine is still hot, be careful with a splash of engine oil which may cause burns. Replace engine oil after the engine oil becomes warm. It is most effective to drain the engine oil while the engine is still warm.

In early period of use, the engine oil gets dirty rapidly because of the initial wear of internal parts. Replace the engine oil earlier.
Lube oil filter should also be replaced when the engine oil is replaced.
The procedure of lube oil and lube oil filter replacement is as follows.

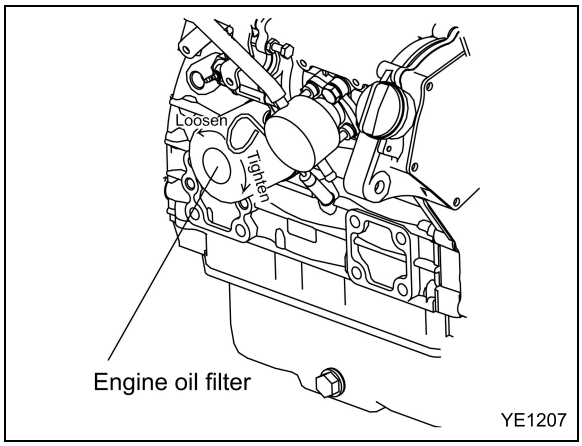
(a) Drain engine oil
- Prepare a waste oil container collecting waste oil.
- Remove the oil filler cap to drain easily while draining the lube oil.
- Loosen the drain plug using a wrench (customer procured) to drain the lube oil.
- Securely tighten the drain plug after draining the lube oil.

[NOTICE]
Use a socket wrench or a closed wrench when removing or tightening a drain plug.
Don't use a spanner because it has the possibility that the spanner will slip and it will get hurt.



(b) Replacing oil filter
- Turn the lube oil filter counter-clockwise using a filter wrench (customer procured) to remove it.
- Clean the mounting face of the oil filter.
- Moisten the new oil filter gasket with the engine oil and install the new engine oil filter manually turning it clockwise until it comes into contact with the mounting surface, and tighten it further to 3/4 of a turn with the filter wrench.
  Tightening torque:
  20 – 24 Nm {2.0 – 2.4 kgm}

Model	Applicable oil filter Part No.
2D70E 3D76E	YM119305-35150



(c) Filling oil and inspection
- Fill with new engine oil until it reaches the specified level.

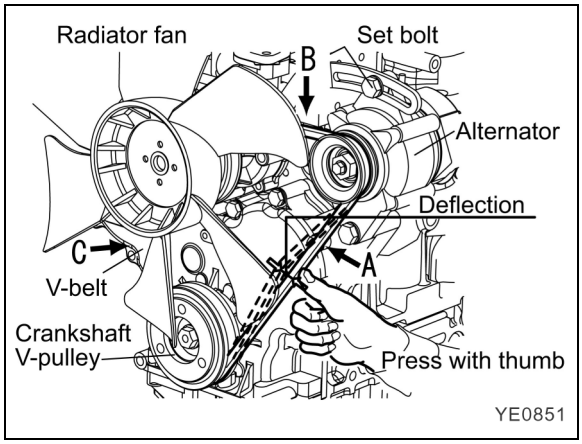
IMPORTANT:
Do not overfill the oil pan with engine oil.
Be sure to keep the specified level between upper and lower limit on the oil level gauge.

- Warm up the engine by running for 5 minutes while checking any oil leakage
- Stop the engine after warming up and leave it stopping for about 10 minute to recheck the engine oil level with oil level gauge and replenish the engine oil. If any oil is spilled, wipe it away with a clean cloth.

(2) V-belt tension check

When there is not enough tension in the V-belt, the V-belt will slip making it impossible for the alternator to generate power and cooling water pump and cooling fan will not work causing the engine to overheat.

Check and adjust the V-belt tension (deflection) in the following manner.



[NOTICE]

Be especially careful not to splash engine oil on the V-belt, because it will cause slipping, stretching and aging of the belt.

1) Press the V-belt with your thumb [approx. 98N {10kg}] at the middle of the V-belt span to check the tension (deflection).

Available positions to check and adjust the V-belt tension (deflection) are at the **A**, **B** or **C** direction as shown in the illustration right.

You may choose a position whichever you can easily carry out the check and adjustment on the machine unit.

- "New V-belt" refers to a V-belt which has been used less than 5 minutes on a running engine.
- "Used V-belt" refers to a V-belt, which has been used on a running engine for 5 minutes or more.

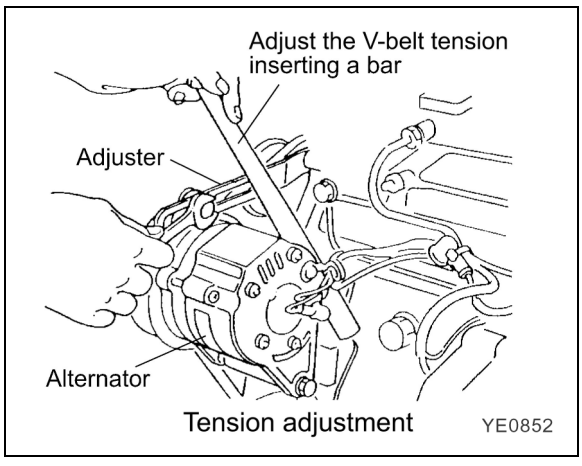
The specified deflection to be measured at each position should be as follows.

(Unit: mm)

Direction	A	B	C
For used V-belt	10 – 14	7 – 10	9 – 13
For new V-belt	8 – 12	5 – 8	7 – 11

2) If necessary, adjust the V-belt tension (deflection). To adjust the V-belt tension, loosen the set bolt and move the alternator to tighten the V-belt.

After replacing with a new V-belt and adjusting it, run the engine for 5 minutes and readjust the deflection to the value in the table above.



3) After replacing with a new V-belt and adjusting it, run the engine for 5 minutes and readjust the deflection to the value in the table above.

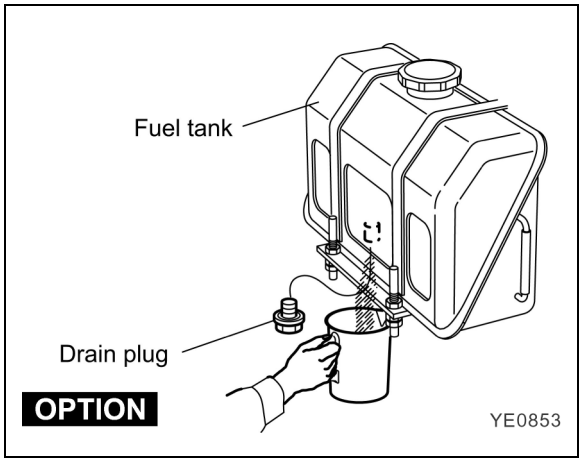
4) Visually check the V-belt for cracks, oiliness or wear. If any, replace the V-belt with new one.

2.2.3 Inspection every 50 hours

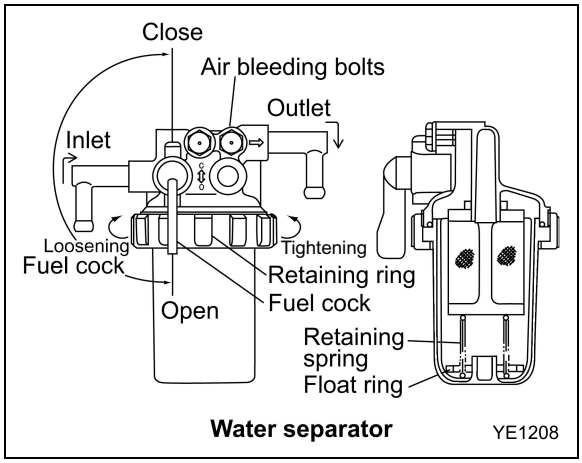
Be sure to check the following points every 50 hours operation.

No.	Inspection Item
(1)	Fuel tank draining
(2)	Water separator draining
(3)	Bleeding the fuel system
(4)	Battery electrolyte level check and battery recharging

(1) Fuel tank draining
1) Prepare a waste oil container.
2) Remove the drain plug of the fuel tank to drain (water, dust, etc.) from the fuel tank bottom.
3) Drain until fuel with no water and dust flow out. Then tighten the drain plug firmly.



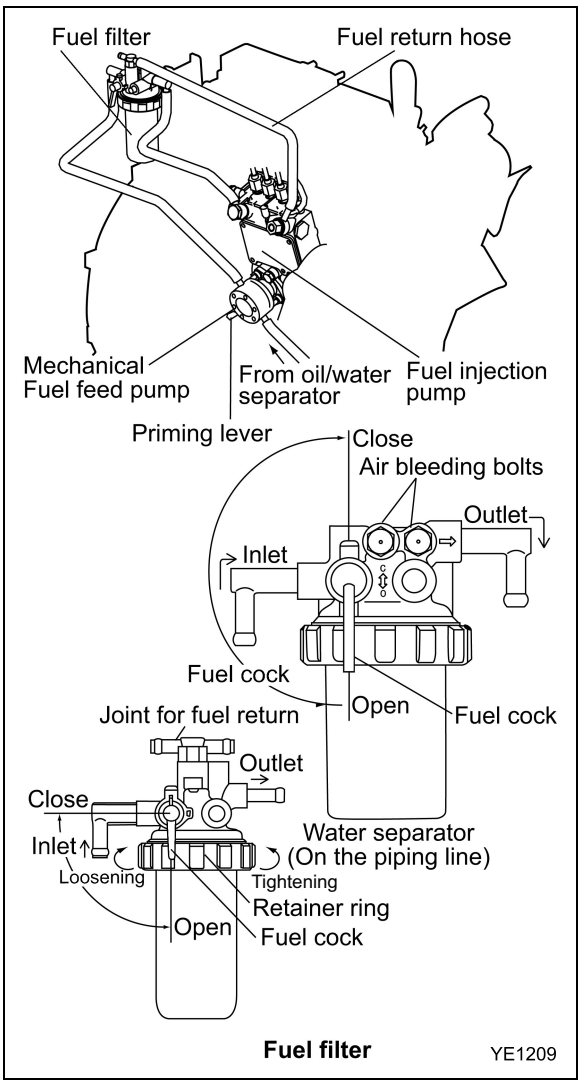
(2) Water separator draining
Drain off the water separator whenever there is a lot of drain collected in the water separator at the bottom of the cup even if not the time for periodic inspection hour. The cup of the water separator is made from semi-transparency material and in the cup, the red colored float ring which rises on the surface of the drain is installed to visualize the amount of drain. Also, the water separator with sensor to detect the drain for warning device on a control panel is provided as the optional.
Drain off the water separator in the following manner.
1) Close the fuel cock.
2) Loosen the retainer ring, and remove the cup, then throw collected water and trash away.
3) Put a float ring and a spring in the cup, and tighten the retainer ring.
Tightening torque:
13 – 16 Nm {1.3 – 1.6 kgm}
4) Be sure to bleed air in the fuel system.



(3) Bleeding the fuel system
Bleed the fuel system according to the following procedures. When there is air in the fuel system, the fuel injection pump will not be able to function.
1) Check the fuel oil level in the fuel tank. Refuel if insufficient.
2) Open the fuel cocks of the water separator and the fuel filter.
3) Loosen the air bleeding bolt on the water separator by turning 2 – 3 turns to the counter-clockwise by using a screw driver.
4) When the fuel coming out is clear and not mixed with any bubble, tighten the air bleeding bolt.
5) Feed the fuel with the fuel priming pump or electro-magnetic fuel feed pump.

• In case of an engine installed with a fuel priming pump.
Move the priming lever by hand up and down, and feed fuel until the fuel surface inside the fuel filter cup goes up and the air disappears inside. (Move the lever until feeling your hand slightly heavy.)
• In case of an engine using the electro-magnetic fuel feed pump.
Turn the starter switch to the ON position, and hold it in the position and operate the electro-magnetic fuel feed pump for 10 – 15 seconds to bleed the fuel system automatically.

Note:
Don't do air bleeding by a starting motor.



Fuel filter

(4) Battery electrolyte level check and battery recharging

⚠ WARNING

Fire due to electric short-circuit

- Make sure to turn off the battery switch or disconnect the negative cable (–) before inspecting the electrical system. Failure to do so could cause short-circuiting and fires.
- Always disconnect the (–) Negative battery cable first before disconnecting the battery cables from battery. An accidental "Short circuit" may cause damage, fire and or personal injury.
  And remember to connect the (–) Negative battery cable (back onto the battery) LAST.

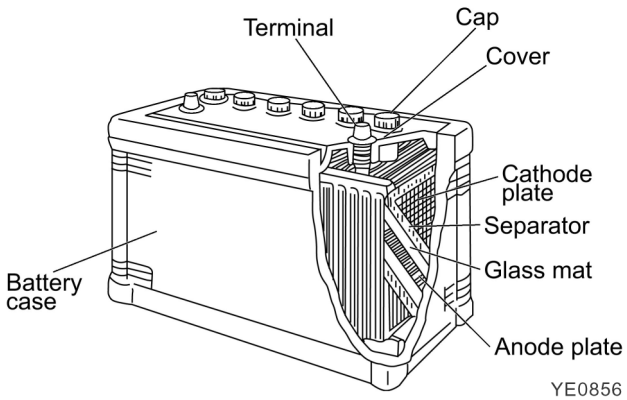
Proper ventilation of the battery area

Keep the area around the battery well ventilated, paying attention to keep away any fire source. During operation or charging, hydrogen gas is generated from the battery and can be easily ignited.

Do not come in contact with battery electrolyte

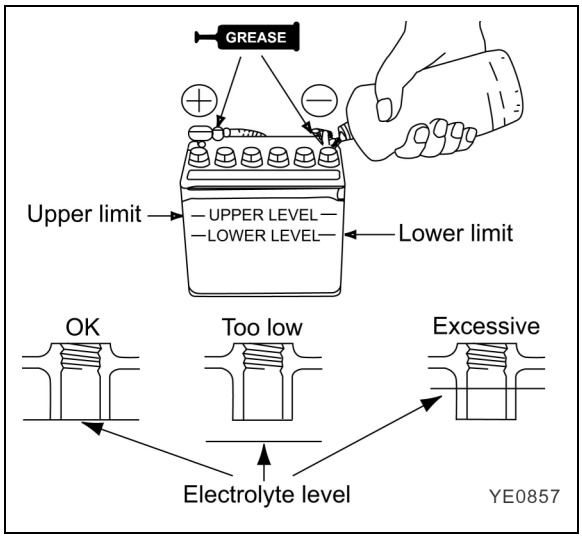
Pay sufficient attention to avoid your eyes or skin from being in contact with the fluid. The battery electrolyte is dilute sulfuric acid and causes burns. Wash it off immediately with a large amount of fresh water if you get any on you.

Battery structure



(1) Electrolyte level

- Check the level of fluid in the battery. When the amount of fluid nears the lower limit, fill with battery fluid (available in the market) to the upper limit. If operation continues with insufficient battery fluid, the battery life is shortened, and the battery may overheat and explode.
- Battery fluid tends to evaporate more quickly in the summer, and the fluid level should be checked earlier than the specified times.
- If the engine cranking speed is so slow that the engine does not start up, recharge the battery.
- If the engine still will not start after charging, replace the battery.
- Remove the battery from the battery mounting of the machine unit after daily use if letting the machine unit leave in the place that the ambient temperature could drop at –15°C or less. And store the battery in a warm place until the next use the unit to start the engine easily at low ambient temperature.



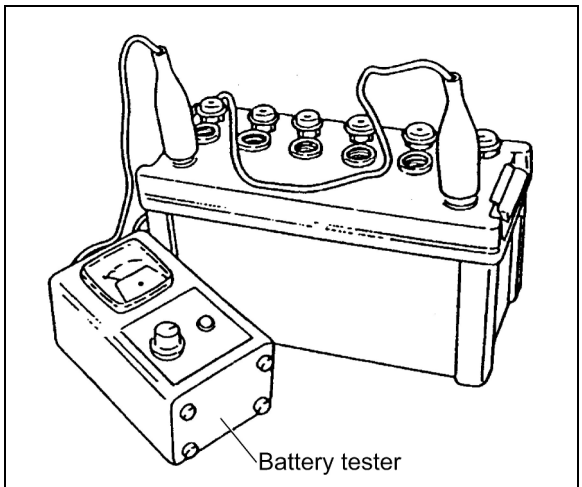
(2) Battery charge

Use a battery tester or hydrometer and check the battery condition. If the battery is discharged, recharge it.

(a) Measurement with a battery tester

When checking the battery with the battery tester, connect the red clip of the tester to the battery positive (+) terminal and black clip to the battery negative (–) terminal by pinching them securely, and judge the battery charge level from the indicator position.

Green zone: Normal
Yellow zone: Slightly discharged
Red zone: Defective or much discharged



Battery charge measurement with battery tester YE0858